Proceedings

of the

First Joint BINP - FAIR collaboration Coordination Workshop

5th – 9th November 2018
Budker Institute for Nuclear Physics, Akademgorodok, Novosibirsk

1st in the series of workshops covering all the aspects of the collaboration between FAIR and BINP within the projects.

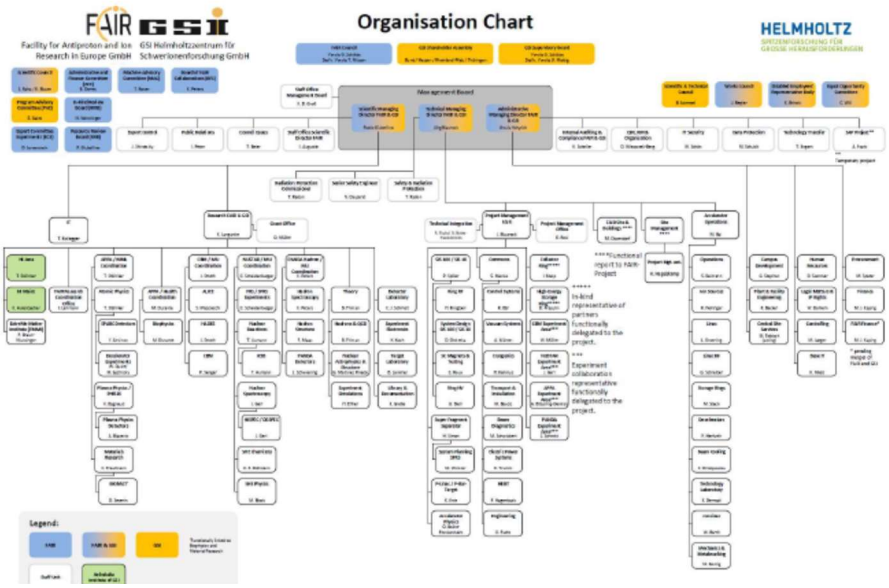
Organisers
P. Shatunov
M. Kuzin
S. Utermann

1 General reports

1.1 FAIR project status

Corresponding Author(s): j.blaurock@gsi.de

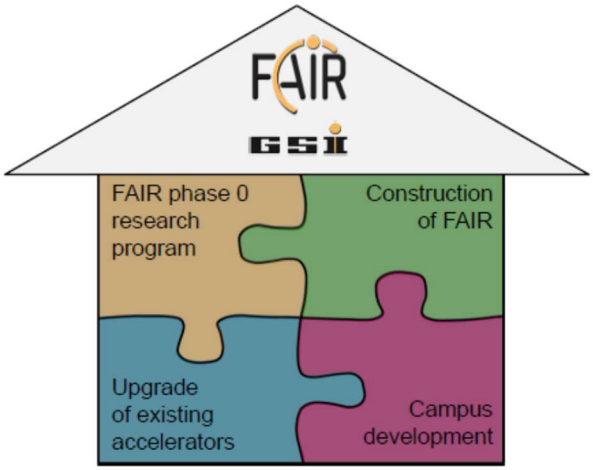
Since 2016: Integrated organization for GSI & FAIR



FAIR & GSI – Strategic objectives

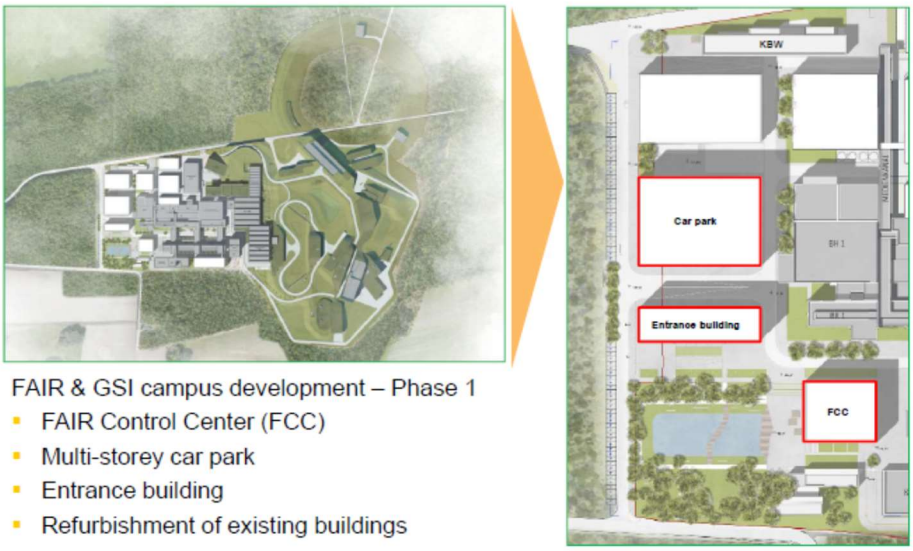
Four strategic objectives

- Construction of FAIR
- FAIR phase 0 research program
- Upgrade of existing accelerators
- Campus development



Campus Masterplan

Campus Masterplan



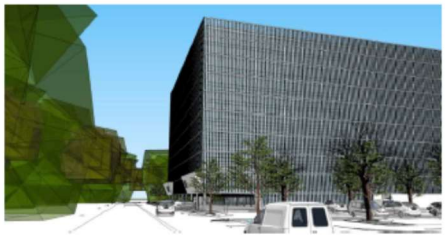
FAIR & GSI campus development – Phase 1

- FAIR Control Center (FCC)
- Multi-storey car park
- Entrance building
- Refurbishment of existing buildings

Campus Masterplan

New FAIR control center building at the campus

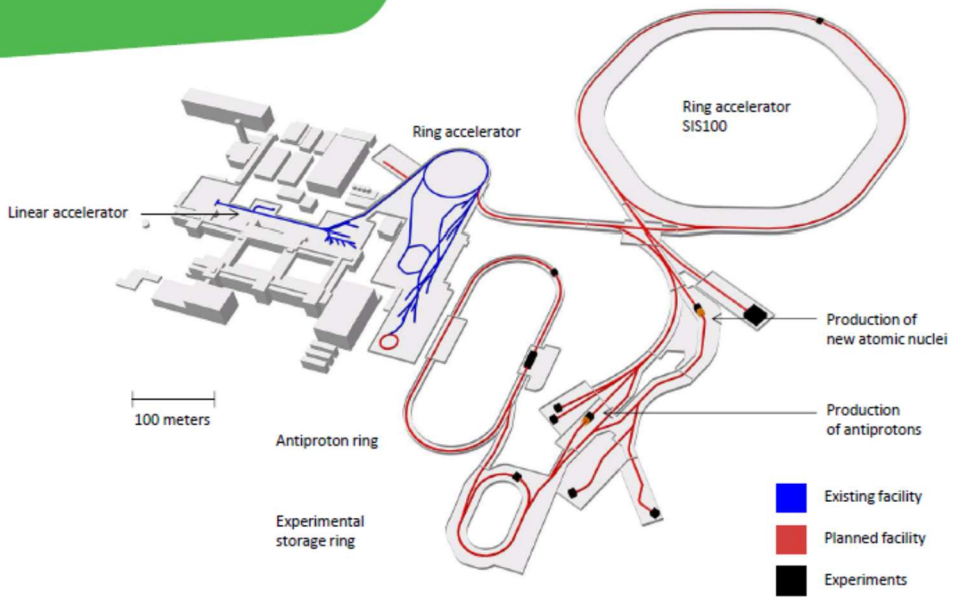
New FAIR Control Center
Planning is progressing as scheduled.



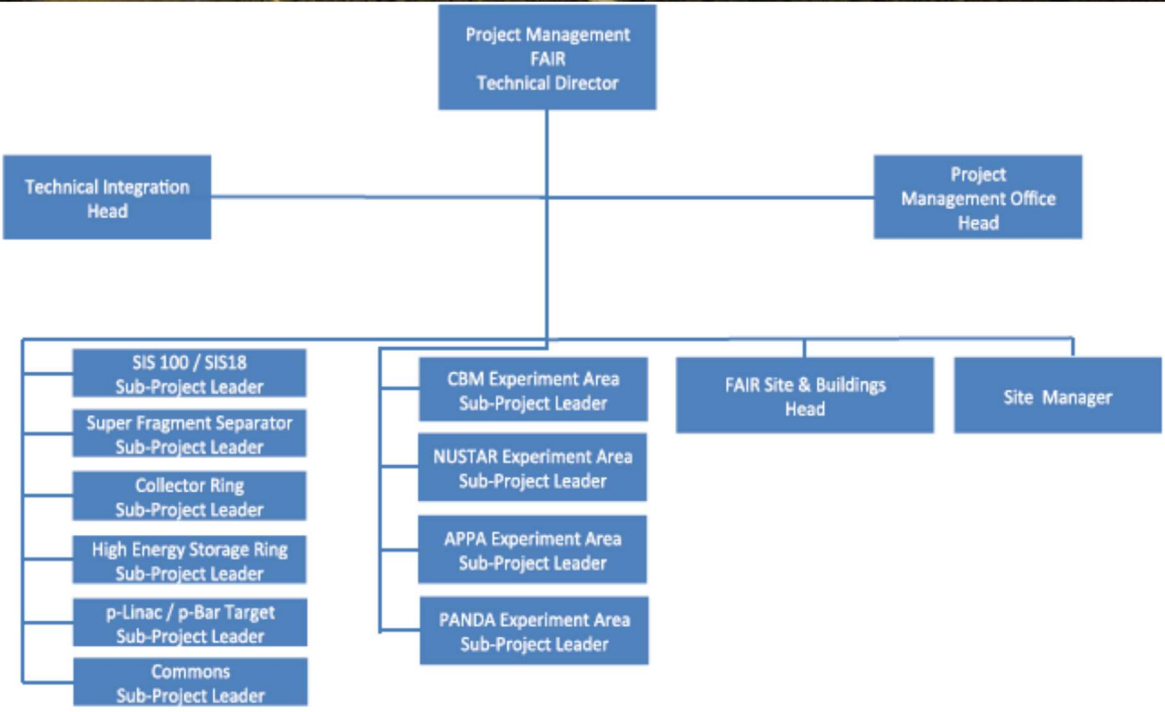
View to the parking garage at Planckstraße

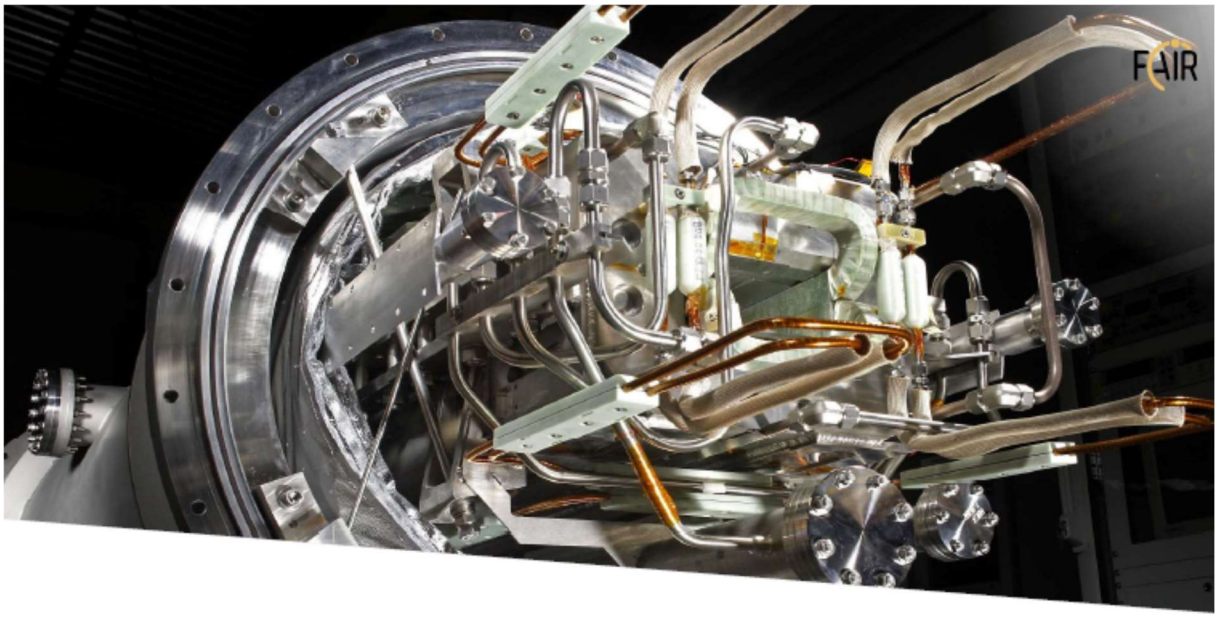
New Parking Garage
to be built in 2019 / 2020

FAIR - the facility




FAIR – the facility
FAIR
GSI


Project Management
FAIR
Technical Director
Technical Integration
Head
Project
Management Office
Head
SIS 100 / SIS18
Sub-Project Leader
Super Fragment Separator
Sub-Project Leader
Collector Ring
Sub-Project Leader
High Energy Storage Ring
Sub-Project Leader
p-Linac / p-Bar Target
Sub-Project Leader
Commons
Sub-Project Leader
CBM Experiment Area
Sub-Project Leader
NUSTAR Experiment Area
Sub-Project Leader
APPA Experiment Area
Sub-Project Leader
PANDA Experiment Area
Sub-Project Leader
FAIR Site & Buildings
Head
Site Manager



FAIR Accelerator Progress
- Highlights -

FAIR Accelerator Progress
- SIS18 Upgrade for FAIR -

FAIR GSI

- Re-commissioning of SIS18 with beam took place in May 2018
- FAIR control systems standards for SIS18 is now available with new hard- and software and the new LSA set-value generation

Bipolar dipole magnet, power converter and chamber for the connection of beam transport line to SIS100 ready for installation

New acceleration cavities

FAIR Accelerator Progress
- SIS100 -

- Quadrupole (QP) modules:
  - FOS QP units shipped from JINR to BNG for integration into FOS QP module
  - Contract for series testing of QP units @ JINR signed on 26th October 2018
  - Integration into QP modules by company BNG in Germany
  - QP module testing @ INFN, Salerno (Italy) – development of agreement
- Series production of many components e. g. dipole modules, cryo-catchers, cryo-adsorption pumps in progress

sc dipole modules in GSI storage area

QP Unit @ BNG

Resonance sextupole magnets

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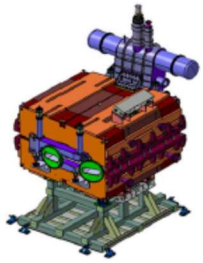
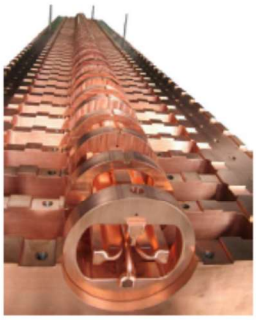
FAIR Accelerator Progress
- SFRS -

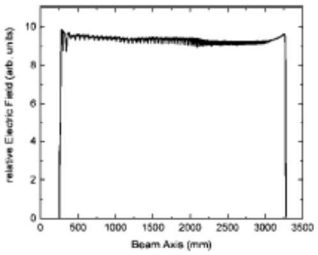
- Production of FoS sc short multiplets running, 1st delivery for testing to CERN in November 2018
- Production of FoS sc long multiplet started
- Testing Facility for sc magnets at CERN is ready for use



FAIR Accelerator Progress
- pLinac / pbar Target -

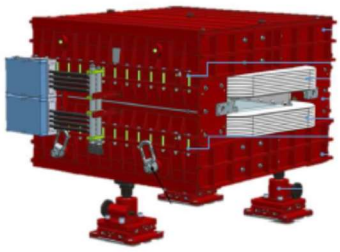
- Commissioning of ion source at CEA in progress
- First low level RF test for ladder-RFQ performed. Excellent agreement with theoretical predictions
- Seven klystrons on site. SAT progressing.





FAIR Accelerator Progress
- Collector Ring (CR) -

- Contract for remaining part of CR with BINP has been signed in June 2018
- 90 % of all CR specifications has been released
- Power amplifier prototype for Stochastic Cooling system has been produced and SAT successfully tested
- The series production of RF – debunchers is ongoing
- 1st BINP - FAIR Coordination Workshop from 5th to 9th November 2018 in Novosibirsk covering all aspects of the collaboration between FAIR and BINP for all subprojects



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FAIR Accelerator Progress
- HESR -

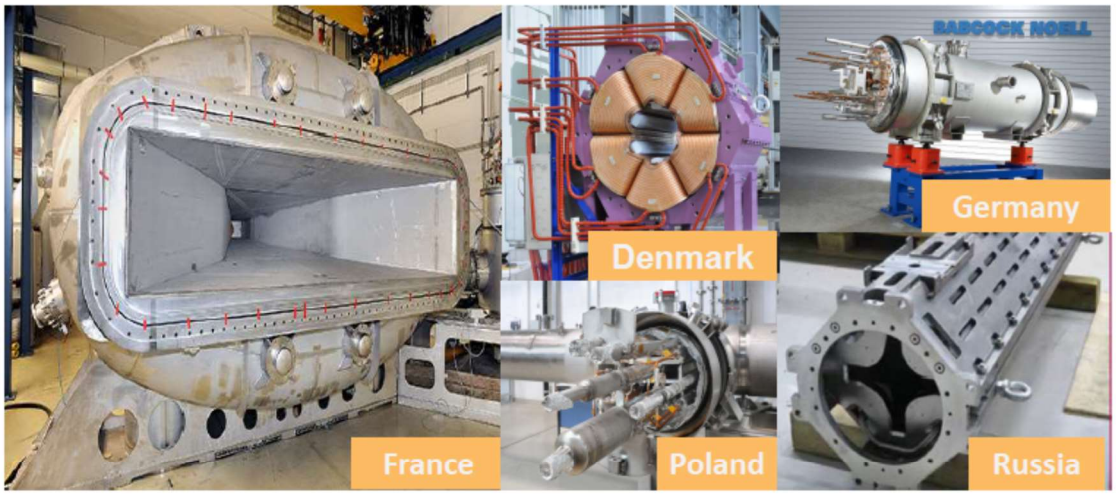
- All Dipoles are produced, in Jülich and 65% are delivered to FAIR
- Quadrupoles (QP) are all produced in Jülich


FAIR Accelerator Progress
- Commons -

- All 51 HEBT vacuum chambers of batch 1 delivered (BINP)
- 21 of 51 HEBT Dipoles from serial production delivered (Efremov)
- Delivery of 1st 6 series Power Converter from India, (ECIL, India)
- GSI control room refurbished with new prototype FAIR consoles and fixed displays, 1st basic and generic set of control room applications developed



FAIR Accelerator Progress
- Procurement in full swing -



- Accelerator and detector contributions from many different partner institutions
- Now in SERIES production

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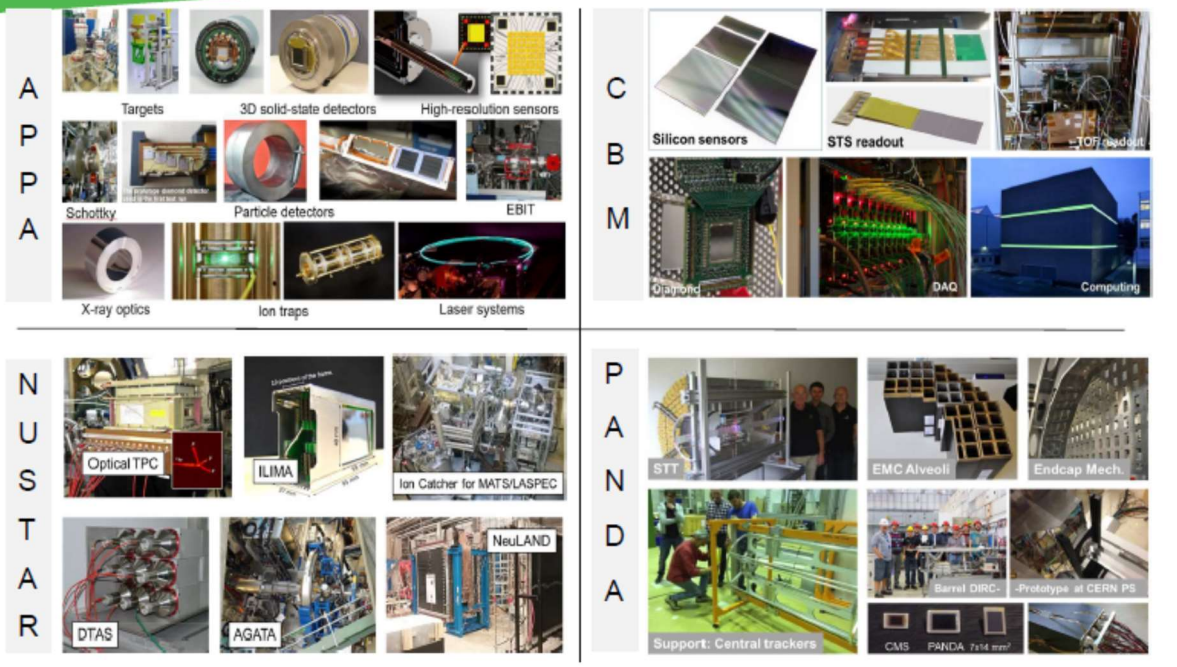
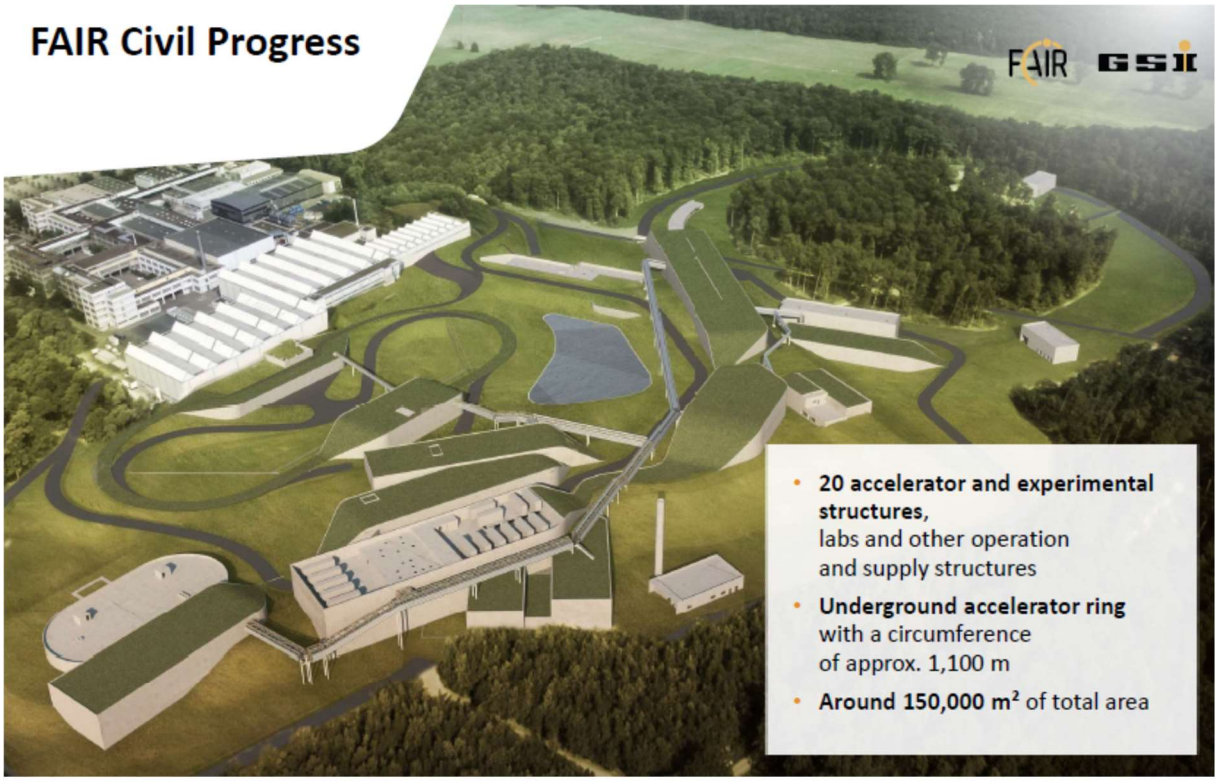
FAIR Experiment Progress
- well on track -



FAIR Civil Progress



Construction volumes

2 million m³
of earth

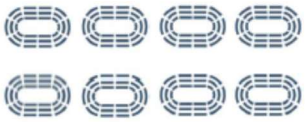
to be moved

As much as for 5,000 single-family homes

600,000 m³
of concrete

to be used

As much as eight Frankfurt soccer stadiums



65,000 tons
of steel

to be utilized

As much as nine Eiffel Towers

FAIR Project Execution Plan Civil

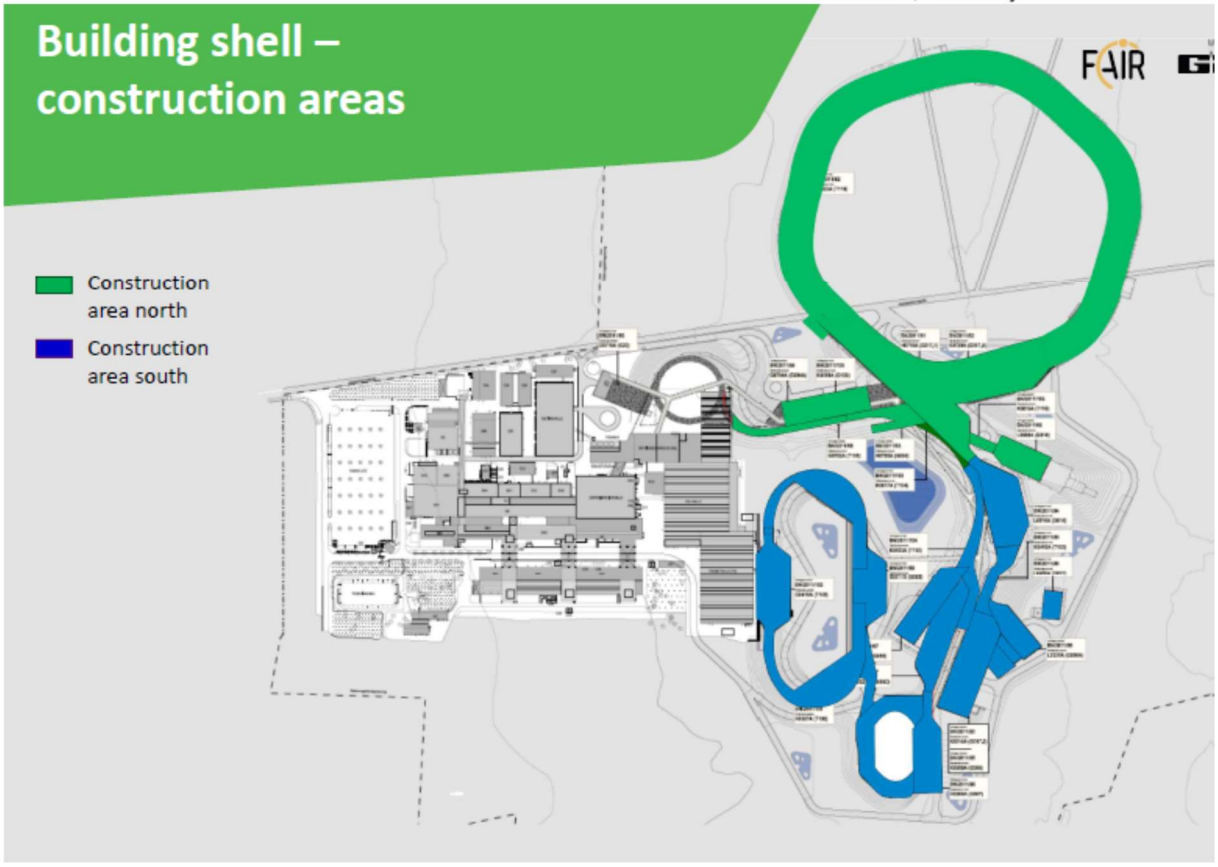
The universe in the laboratory

Civil construction of the world-wide unique particle accelerator facility

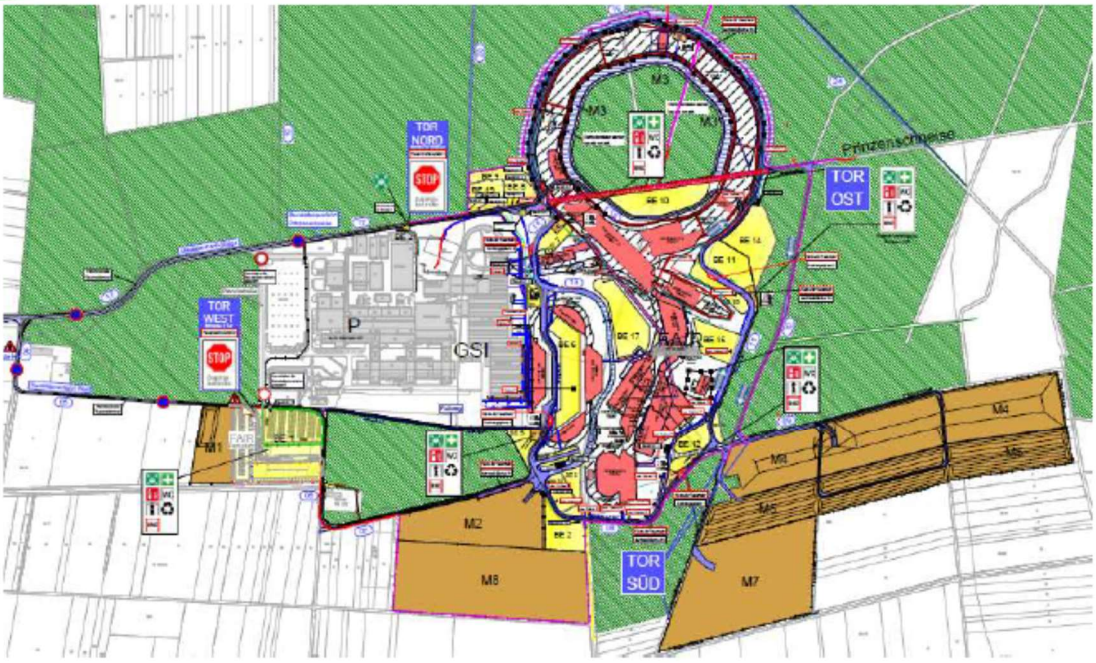
Facility for Antiproton and Ion Research

Darmstadt, Germany

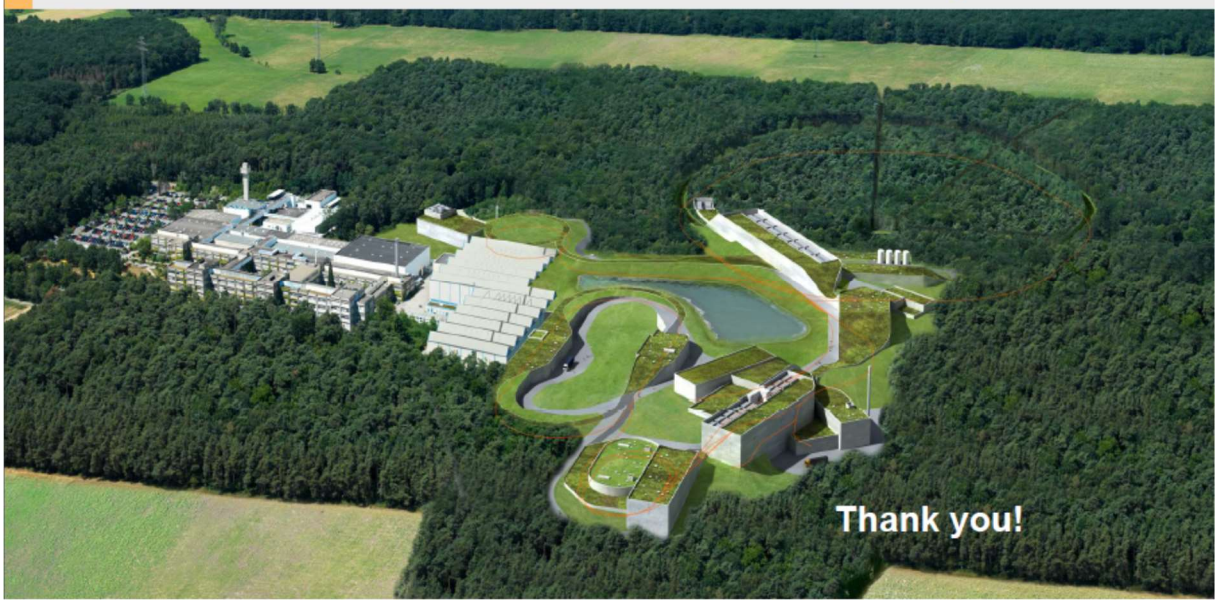
Building shell – construction areas



Map of site logistics and installation plan



FAIR – Facility for Antiproton and Ion Research
GSI Helmholtzzentrum für Schwerionenforschung



FAIR – the universe in the lab.

1.2 Status of HEBT

Corresponding Author(s): f.hagenbuck@gsi.de

1.3 Status of CR and TCR1

Corresponding Author(s): koop@inp.nsk.su

1.4 Status of pBar separator

Corresponding Author(s): k.knie@gsi.de

1.5 Status of Super-FRS

Corresponding Author(s): h.simon@gsi.de

NUclear Structure, Astrophysics and Reactions

What are the limits for existence of nuclei?

Where are the proton and neutron drip lines situated?

Where does the nuclear chart end?

How does the nuclear force depend on varying proton-to-neutron ratios?

What is the isospin dependence of the spin-orbit force?

How does shell structure change far away from stability?

How to explain collective phenomena from individual motion?

What are the phases, relevant degrees of freedom, and symmetries of the nuclear many-body system?

How are complex nuclei built from their basic constituents?

What is the effective nucleon-nucleon interaction?

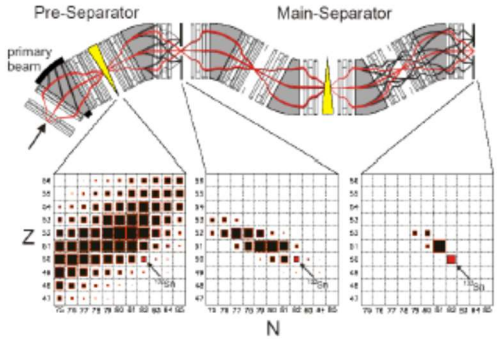
How does QCD constrain its parameters?

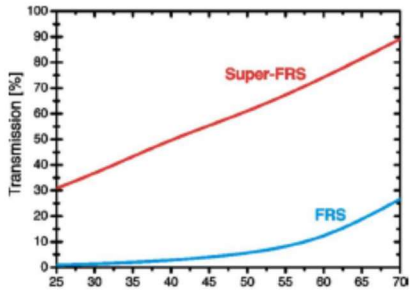
Which are the nuclei relevant for astrophysical processes and what are their properties?

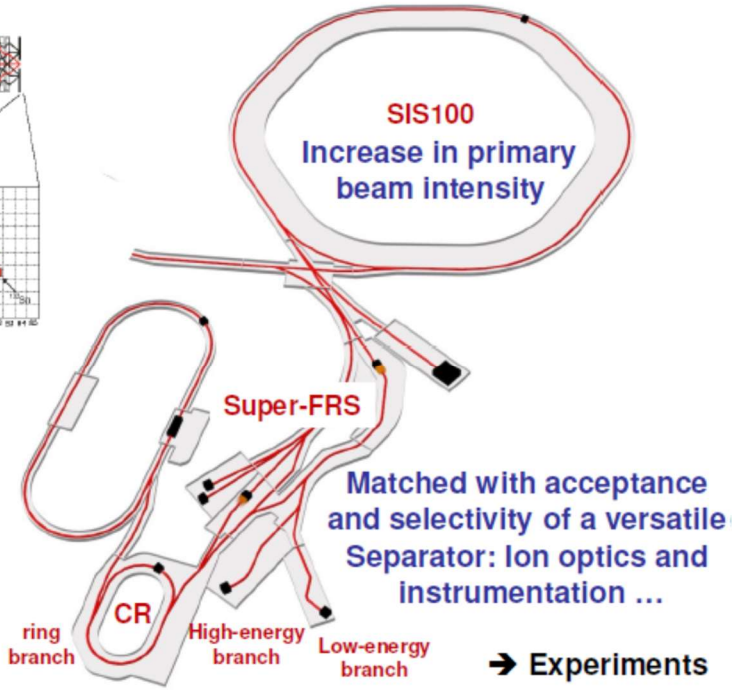
What is the origin of the heavy elements?

Need for intense secondary beams ➔ Super-FRS

Main Objectives



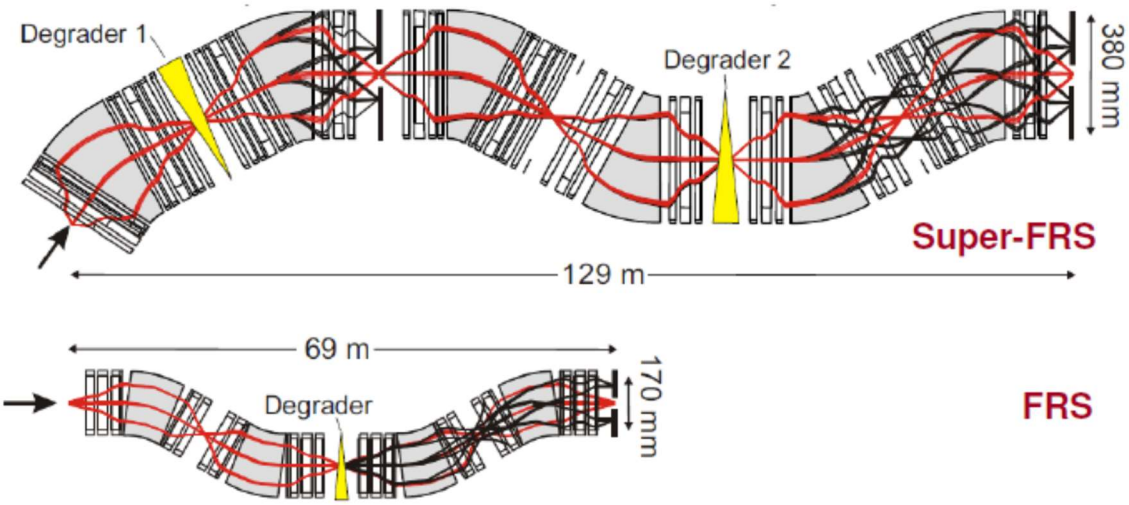




Matched with acceptance and selectivity of a versatile Separator: Ion optics and instrumentation …

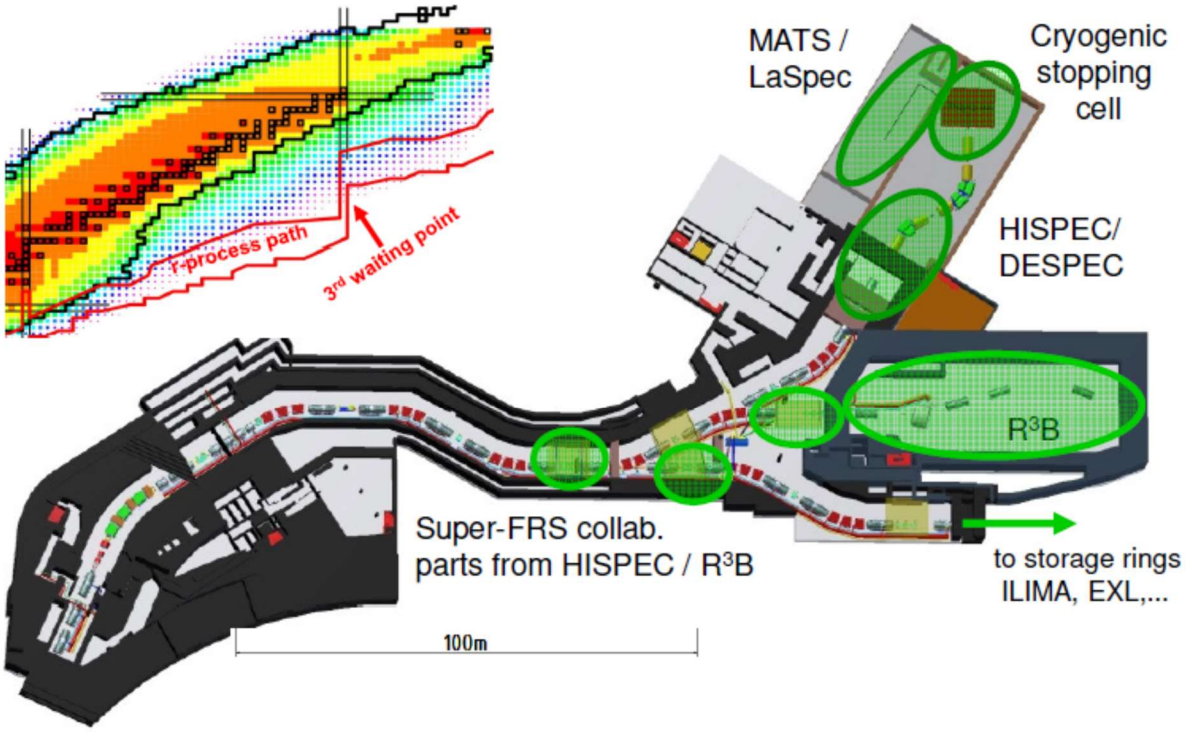
➔ Experiments

GSI FRS → FAIR Super-FRS



	$B\rho_{max}$	$\Delta p/p$	$\Delta\Phi_x$, $\Delta\Phi_y$	resolving power	gain factor ^{19}C	gain factor ^{132}Sn
FRS	18 Tm	1.0 %	± 13, ±13 mrad	1500	1	1
Super-FRS	20 Tm	2.5 %	±40, ±20 mrad	1500	5	10
				including primary rate	1000	7500

Location of experiments



NUSTAR – The project 1.2

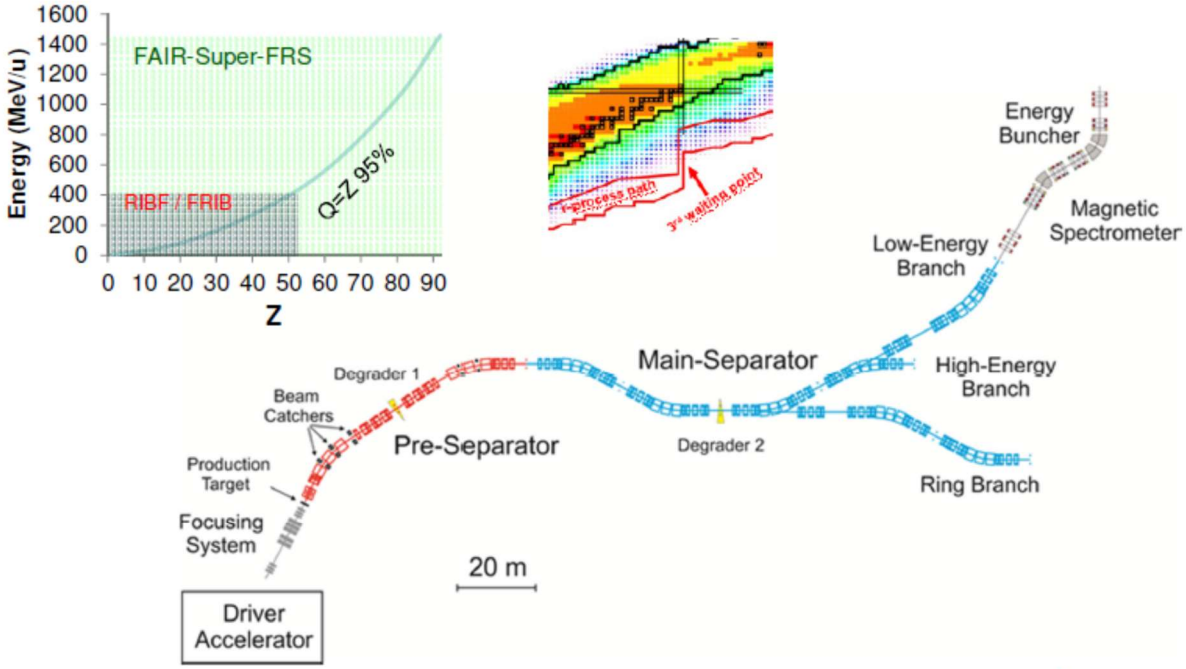
	Super-FRS	RIB production, separation, and identification
PSP	**Experiment**	**Description**
1.2.2	HISPEC/ DESPEC	In-beam γ-spectroscopy at low and intermediate energy, n-decay, high-resolution γ-, β-, α-, p-, spectroscopy
1.2.3	MATS	In-trap mass measurements and decay studies
1.2.4	LaSpec	Laser spectroscopy
1.2.5	R^3B	Kinematically complete reactions with relativistic radioactive beams
1.2.6	ILIMA	Large-scale scans of mass and lifetimes of nuclei in ground and isomeric states
1.2.10	Super-FRS Exp	High-resolution spectrometer experiments
1.2.11	SHE	Synthesis and study of super-heavy elements
1.2.8	ELISe(*)	Elastic, inelastic, and quasi-free e^--A scattering
1.2.9	EXL(*)	Light-ion scattering reactions in inverse kinematics

(*) NESR required – alternative/intermediate "operation" within MSV under discussion.
SHE physics case to be evaluated.

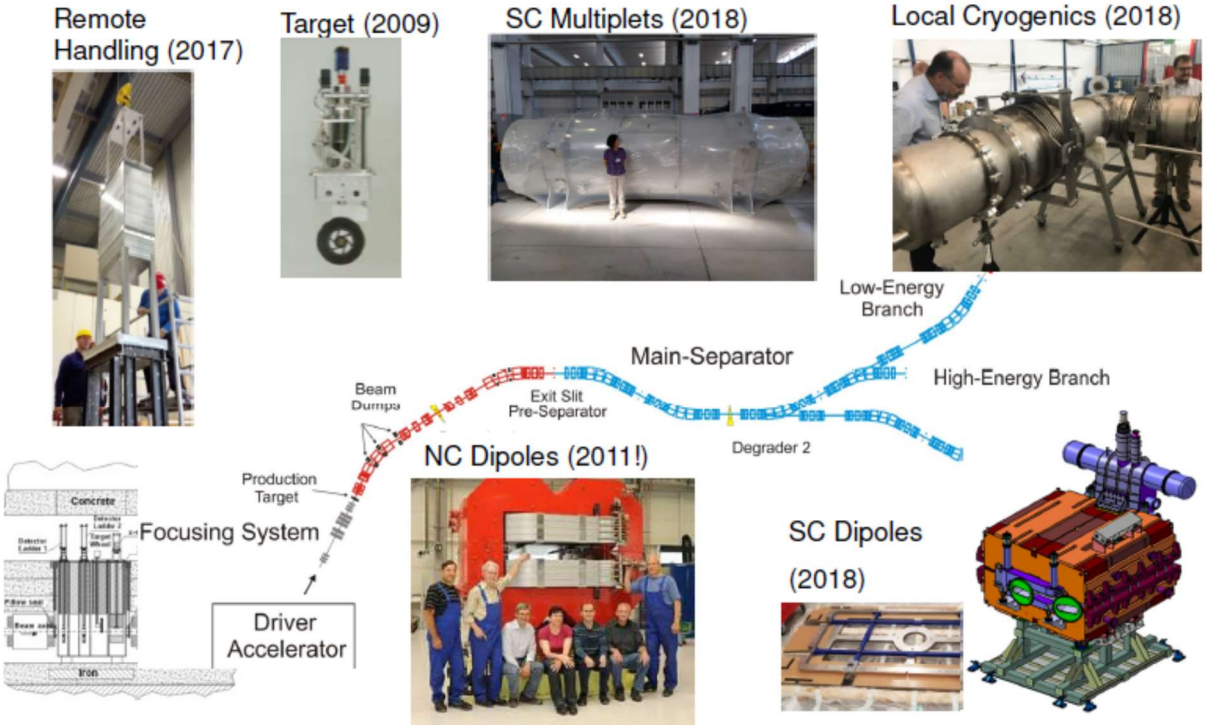
Definition of NUSTAR experiment phases

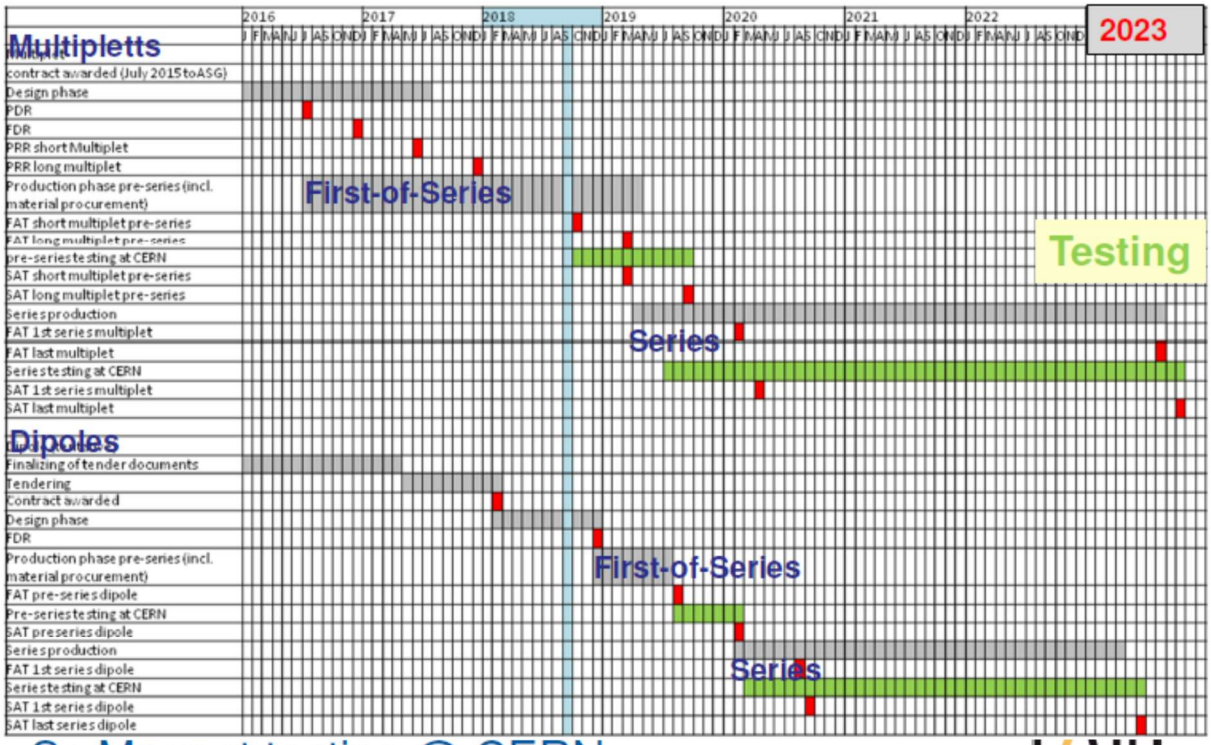
- **Phase 0 (2019 …)**
  - R&D and experiments to be carried out with present facilities and FAIR/NUSTAR equipment
- **Phase 1 (2025 …)**
  - Core detectors and subsystems completed
  - First measurements with FAIR/Super-FRS beams
    - **Carry out experiments with highest visibility as part of the core program and within the FAIR Modularized Start Version (MSV)**
- **Phase 2**
  - FAIR evolving towards full power
  - Completion of experiments within MSV
    - **Essentially the full program of MSV can be performed**
- **Phase 3**
  - Moderate projects, which have been initiated on the way (outside MSV) can be included (e.g. experiments related to return line for rings)
- **Phase 4**
  - Major new investments and upgrades for all experiments

Schematic Layout



Major Super-FRS components





Sc Magnet testing @ CERN

K. Sugita et al.

- Collaboration between CERN and GSI
  - ➢ CERN Build. 180: Infrastructures, renovation
- Cold (4K) testing of the SC dipoles and multiplets
  - ➢ 3 test benches,
  - ➢ incl. magnetic field measurements
- Addendum to collaboration agreement
  - Covering operation phase 5.5 years
  - ✓ **Signed January 2018**
- Facility commissioning ongoing
  - ➢ FoS multiplet expected for 11/18

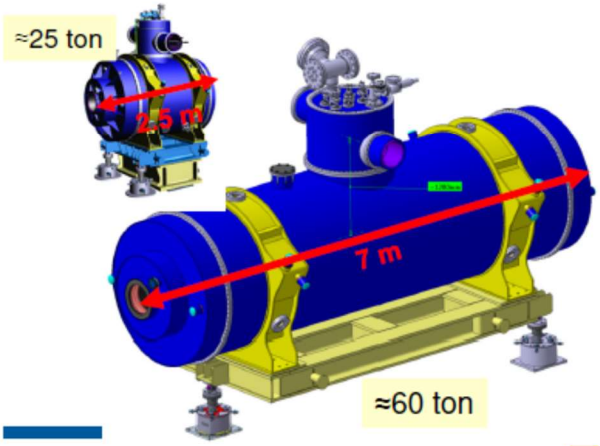
Sc Magnet testing facility (Bât. 180)

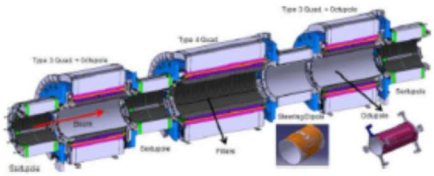
Sc Multiplets, Overview

H. Müller,
E.J. Cho et al.

Scope:

- 8 short multiplets (PS)
  - ➢ QS configuration
- 25 long multiplets (mainly MS)
  - ➢ Quadrupol triplet
- include corrector elements & steerer





Main characteristics:

- iron dominated, cold iron (up to 37 tons)
- common helium bath
- warm beam pipe (38 cm inner diameter)
- individual powering, max. current <300A

Schedule FoS SC multiplets

- ✓ Contract closed 07/2015 (ASG, Genova)
- ✓ Design phase for SM and LM done
  - ✓ FDR 12/16
  - ✓ PRR SM 07/17
  - ✓ PRR LM 12/17
- **Construction phase for FoS running**
  - ➢ **FAT FoS SM 09/18**
  - ➢ **shipment CERN 11/18, SAT FoS SM 03/19**

FOS short Multiplett production

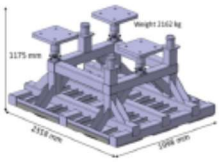
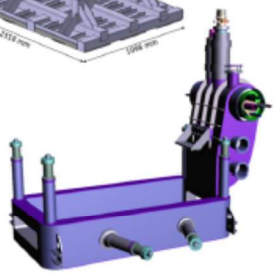
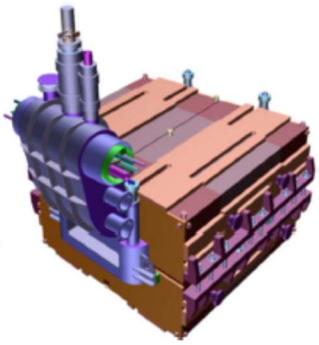
- All coils produced (quadrupol, sextupol)
  - ➢ vacuum impregnated
  - ➢ electrical integrity tests
- Laminations punched (sub-provider)
- Yoke assembly tool manufactured
- Yoke assembled (short quad, sextupole)
- CL prototype qualified (20 bar, M&W)
- ➢ CL for FoS SM manufactured
- ➢ Thermal shield manufactured
- ➢ LHe vessel manufactured
- ➢ Vacuum vessel manufactured
- ➢ Assembly bench manufactured (subprovider)
- ➢ **Final assembly & FAT in progress**




Sc Dipole Magnets

H. Müller,
E.J. Cho et al.

Scope
- 3 units 11°, 18 units 9.75° + support
- Warm iron, SC coil
- Aperture ±190mm x ±70mm
- Weight: 50 to 60 ton

Collaboration with CEA, Saclay:
- ✓ TCC signed , includes:
  - ➢ Detailed design, CDR, Spec, 3D Model
  - ➢ Technical follow-up

Tender Status :
- ✓ Announcement published April 2017
- ✓ Qualifying submission closed mid May 2017
- ✓ Offers received by mid July 2017
- ✓ 1st round negotiation closed mid November 2017
- ✓ 2nd round negotiation closed Jan. 22, 2018
- ✓ **Contract award Feb. 8, 2018**
- ✓ **Kick-off: March, 1, 2018**
- **FDR expected Q3/2018**
- **FAT of FoS expected Q2/2019**

manufacturing plant
ELYTT, Bilbao Spain

Power Converter

A. Wiest,
W. Freisleben et al.

Electronics Corporation of India Limited
A Govt. of India (Dept. of Atomic Energy) Enterprise

FAIR

Scope

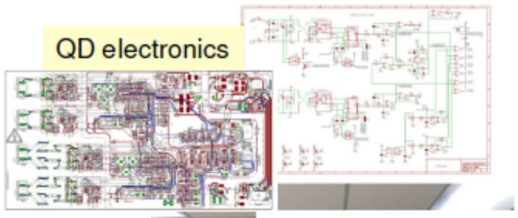
- in sum ~250 PC required
  - 9 PC with high-power (up to 500 kW)
  - other PC medium-power for SC magnets
- Voltage range: from 30V to 745V
- Current range: from 15A to 1.480A

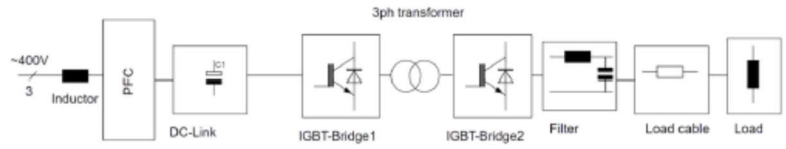
Features

- common topology proposed
- energy recovery system
- all PC are bipolar
- PC include Active Power Correction Factor
- Two different DC voltages for ramp and flat-top
- **QD electronics integrated within the PC rack**
- Output filter , switching frequency up to 90kHz
  - very small current ripple

Status

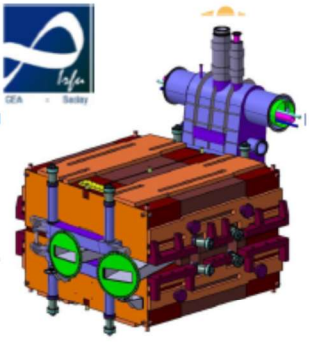
- ✓ in-kind (Council) of India
- ✓ Specifications released (2017)
- Prototype PC under construction
  - FAT expected Q3/2017
  - SAT Q4-18/Q1-19, with CERN FoS SM
- In-kind contract thereafter

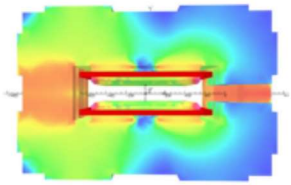




Branching Dipole Magnets

H. Müller,
E.J. Cho et al.



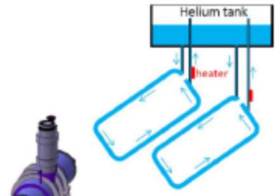


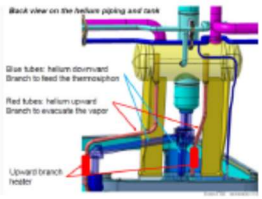
Schedule (R&D work):

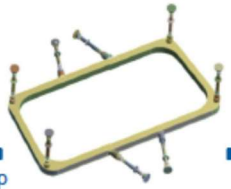
- ✓ Collaboration agreement with CEA/Saclay
  - Detailed design, CDR, Spec, 3D Model
- ✓ Kick-off meeting 06/2017
- ✓ PDR 12/2017
- ✓ FDR 09/2018
- Final Report, Detailed Specs 10/2018
  - FAIR tender directly after

PDR/FDR status

- Geometry (yoke, coil, cryostat)
  - ∫Bdl achieved, I adopted
  - magnetic field quality, chamfers included
- Assembly Scenario
- Thermal behavior after cool -down
  2 active thermosiphon loops foreseen
  - use heaters to force flow direction
  - design modification done
  - thermal budget simulated
  - thermosiphon experimental mock-up
- Magnetic interference
  - Fringe field evaluated
  - Interference study started



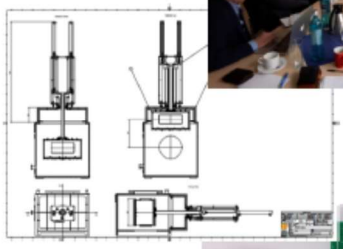


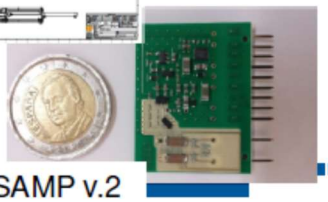


Beam Instrumentation
(e.g. ΔE and ToF)

C. Nociforo
B. Voss,
O. Kiselev, et al.

- MUSIC (energy-loss, Finnish in-kind)
  - ✓ Specification approved Q1/2017
  - ✓ 1st IKC for Super-FRS signed !
    - ➢ Field cage subcontracted to GSI
  - ✓ Kick-off meeting done
    - ➢ schematic design presented
    - ➢ schedule for design phase and FoS development agreed (ready Q3/19 → beam test if possible)
  - PreAmps by CEA Bruyeres
    - ➢ successfully tested at beam time in 2016
    - ➢ contract waiting for signature (CEA)
- Time-of-Flight (Russian in-kind, IOFFE StP)
  - ✓ Specification approved Q3/2016
  - ✓ IKC drafted Q3/2017
  - ➢ Final contract negotiated 10/2018
  - R&D on diamond and silicon ongoing



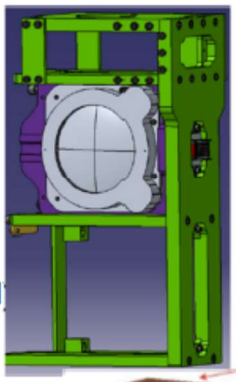


MUSAMP v.2

Beam Instrumentation III
(Beam Monitors)

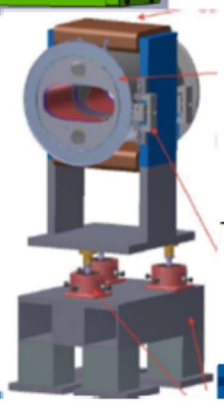
C. Nociforo,
F. Schirru,
S. Schlemme et al.

- PDC
  - combined particle rate detectors (diamond) and beam current monitors (IC, SEETRAM) designed at GSI
  - ✓ specs approved Q3/18
  - ➢ starting FAIR tendering process
  - ➢ ACC-DAQ ready (for PDC & BPM, German in-kind)
- Diamond (intensity monitor, Ru in-kind)
  - ✓ pcCVD/scCVD sensors by GSI-DL
  - ✓ Specification released
  - ➢ IKC ready for preparation
- Beam Position Monitor (BPM)
  - ✓ Design of TCR1 BPM by BINP existing
  - ➢ to be adapted to all FAIR BPM with large aperture (we require 400 mm inner diameter, round electrodes)
  - ➢ **BINP ?**



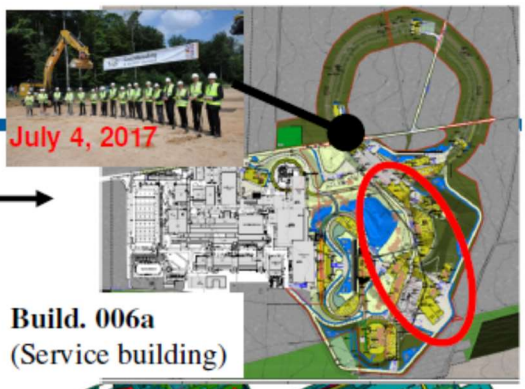
SEETRAM frame at FPF0

active area: Ø 100 mm



TCR1 BPM by BINP

Civil Construction
(Overview)



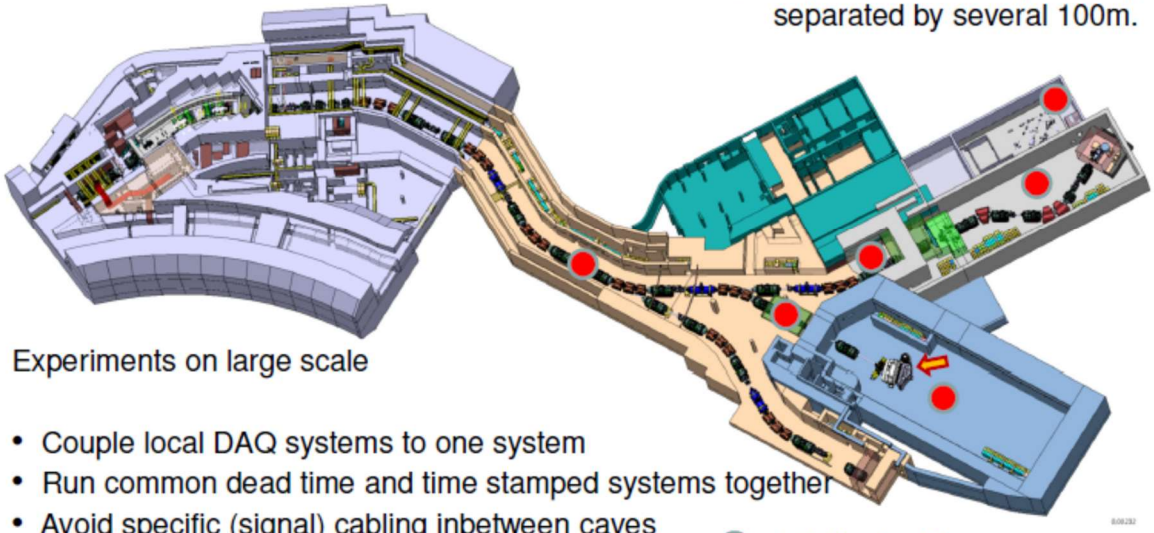
CC planning Phase 1-4 done
- ✓ equivalent to LP5 (execution planning)
- ✓ LEB cave integrated to full extend
- ✓ interfaces to 'machine' defined

Logistic planning & Installation planning running

Construction area south (NUSTAR and other):
- Tendering progressing
- **Installation time slots as part of LCM process**

Super-FRS DAQ

NUSTAR DAQ TDR accepted 2018 by ECE
https://edms.cern.ch/document/2024803/1



- Couple local DAQ systems to one system
- Run common dead time and time stamped systems together
- Avoid specific (signal) cabling inbetween caves

Remote Handling
(Media Board development)

C. Schlör,
C. Karagiannis,
T. Blatz

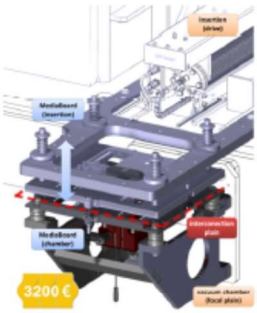
university of groningen

FAIR

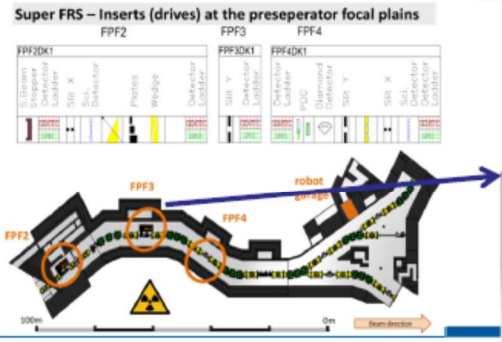
- Remote media connection (Pre-Separator)
  - ➢ board 1: part of beam instrumentation
  - ➢ board 2: stiff connected to vacuum chamber
- Prototype media board developed (for slit system)
- Large connector variety
- Connector status monitoring
- will be used in Pre-Separator

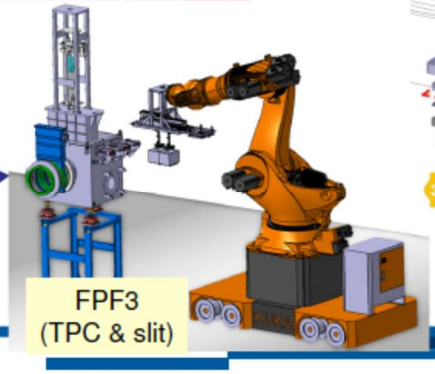
☺ very cost effective

CombiTac – modular connector system



Super FRS – Inserts (drives) at the preseperator focal plains





FPF3
(TPC & slit)

Target Area

H. Weick,
C. Karagiannis

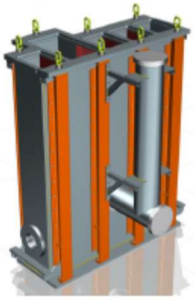
FAIR

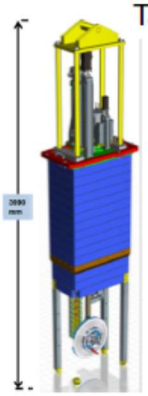
university of groningen

Target chamber

- ✓ Collab. Contract with KVI-CART
- ➢ Design phase running, includes:
  - chamber design including plug design
- ✓ CDR Q4/2018
- ✓ plug mock-up built , plug guidance verified

Target chamber





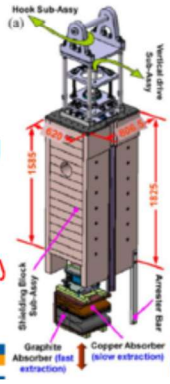
Target plug

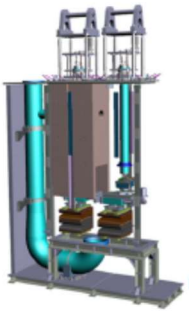
CSIR - CMERI
सी एस आई आर - केन्द्रीय यांत्रिक अभियांत्रिकी अनुसंधान संस्थान
CSIR – Central Mechanical Engineering Research Institute

Beam catcher

- Indian in-kind, CMERI
- CDR done → bases of DS
  - ➢ IKC in preparation
- FDR scheduled for Q1/2019;
  - ➢ review of technical drawing done
  - – absorber mock-up missing → test RH capability
  - ➢ tender preparation started by CMERI (qualification round)

Beam catcher plug

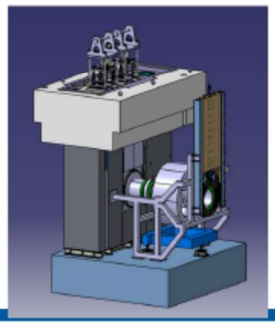


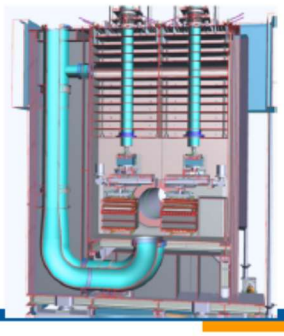


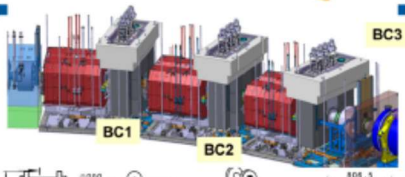
Target Area
(Beam Catcher Plugs)

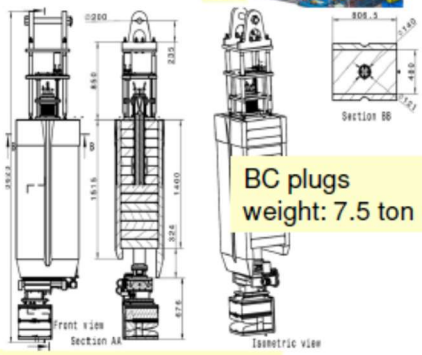
CSIR - CMERI
सी एस आई आर - केन्द्रीय यांत्रिक अभियांत्रिकी अनुसंधान संस्थान
CSIR - Central Mechanical Engineering Research Institute

- 3 BC station equipped with two absorber each
- Indian in-kind, Collaborator: **CMERI Durgapur**
- Design running, based on definition report
  - absorber geometry optimized
  - use C/Cu (fast/slow extraction) → avoid Be
- ✓ CDR released 12/17
  - build a absorber mock-up verify RH capability
  - DS in preparation (Q2/2018)
  - in-contract preparation (Q4/2018)
- India started company qualifying phase (Q4/2018)



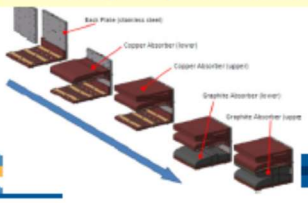


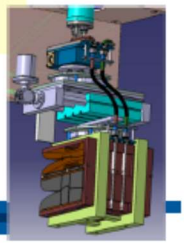




BC plugs weight: 7.5 ton

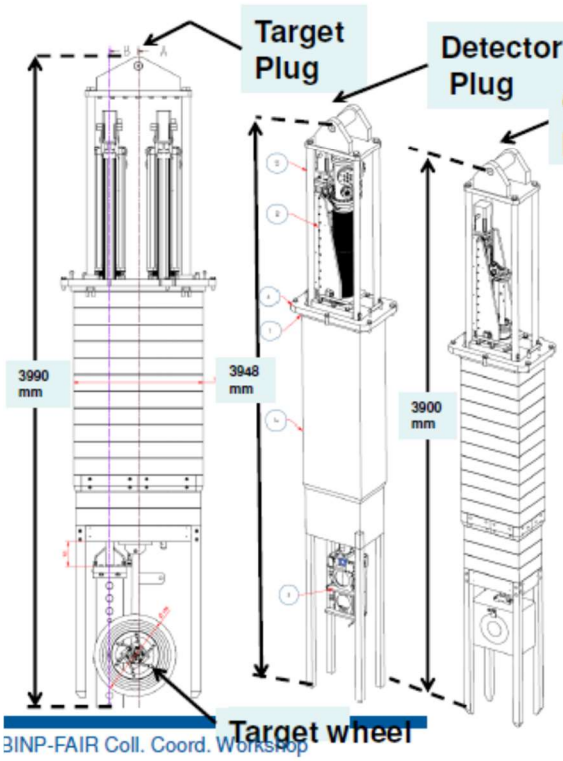
absorber and assembly sequence (RH)





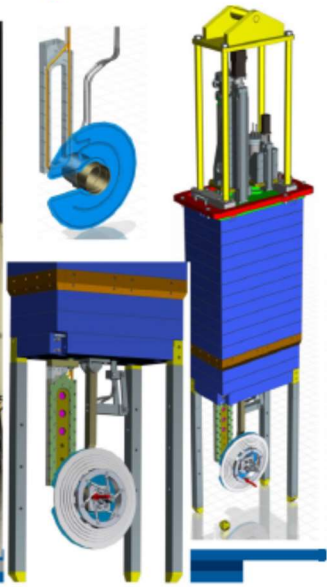
Target Area
(Plug System)

H. Weick,
C. Karagiannis
university of groningen



Target wheel plug (details)
- 4.2 ton (heaviest plug)
- includes target ladder (6 position)
- 2 linear drives + TW motor
- active cooling

Plug test setup

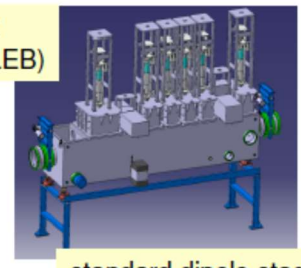


Vacuum System

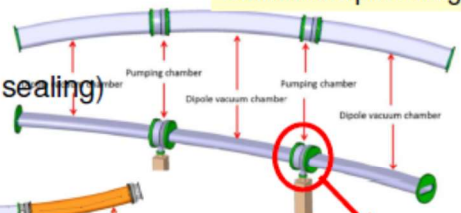
S. Purushotaman,
I. Mukha,
J. Kurdal et al.

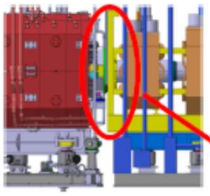
- Vacuum system concept clear
  - ➢ ATB updated after CBWG (04/2018, 06/2018)
- **21 focal plane chambers (Ru in-kind)**
  - ➢ length: 800 mm to ≈ 4.400 mm, cross section ≈1x1 m²
- **Overall 27 dipole vacuum chambers (Ru in-kind)**
  - ➢ **21 chambers for standard dipoles**
  - ➢ pumping ports between dipole units
  - ➢ **3 chambers for branching dipoles**
    part of dipole procurement, design by CEA
  - ➢ **3 chambers for NC dipoles (trumpet like)**
- Sealing in target area by 'pillow seals' (remote sealing)
  - ➢ **Session Thursday**

FLF2
(exit slit LEB)

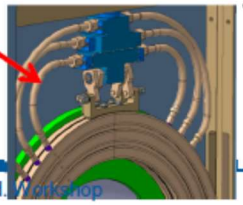


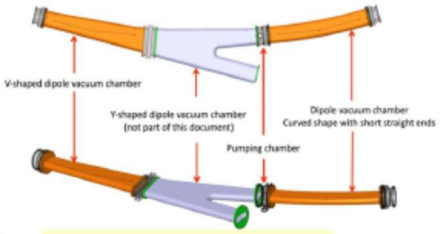
standard dipole stage



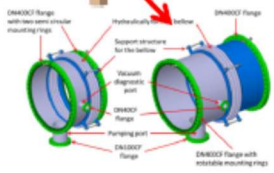


pillow seals
in target area





branching dipole stage



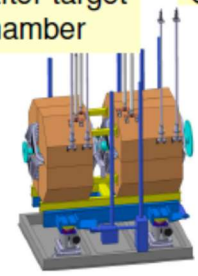
pumping ports

Magnets
(Radiation Resistant Magnets)

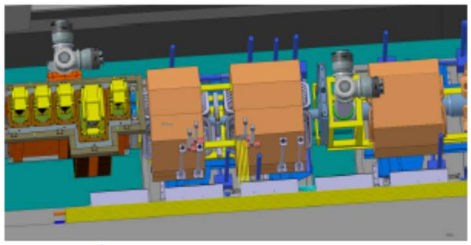
H. Leibrock,
T. Blatz, et al.

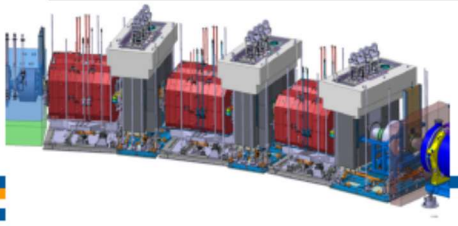
- 3 dipole, 3 quadrupole, and 2 sextupole
- Normal conducting magnets using MIC cable
- Remote connectors and alignment
- ✓ Prototype dipole built and tested by BINP
- ✓ Dedicated support structure constructed
- ✓ Dipole: specification released
  - ➢ FAIR procurement
  - ➢ Cable could be procured (offers exist)
- Two further specifications in preparation
  - ➢ DS for QQ
  - ➢ DS for QS, includes pump port
- ➢ **potential BINP contributions ! (Tuesday)**

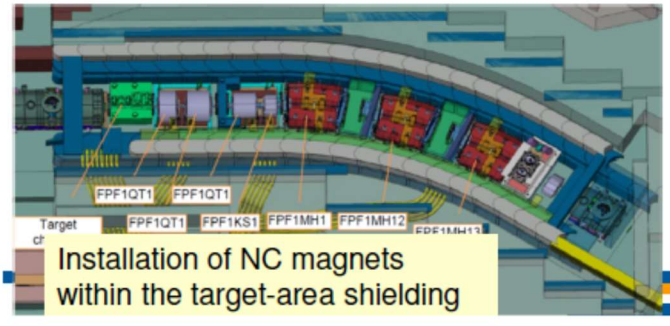
QQ after target chamber



QS plus pump port







Installation of NC magnets
within the target-area shielding

Summary

- Project in full swing, major components in procurement phase
- SC Magnets & Testing (most time critical items):
  - Standard dipoles: contract awarded Feb 2018, design almost finalized
  - Multiplets: design phase done; manufacturing of FoS SM: last steps
  - Testing@CERN: contract addendum signed, commissioning of cryo-facility running, FoS SM expected in 11/2018
- NC Magnets are open as BINP contribution
- BINP vacuum chamber package could still be enlarged
- Development and procurement of various other components under way
  - BPM still open as BINP contribution
- Civil Construction execution planning finalized; tender documentation in preparation, building services planning running
- Construction/Installation planning is being refined – schedule impact possible

Thank you for you attention !

1.6 Logistics, pre-assembly and examples

Corresponding Author(s): h.reich@gsi.de

Logistics, Pre-Assembly, Installation

Strategy FAIR Machine Installation

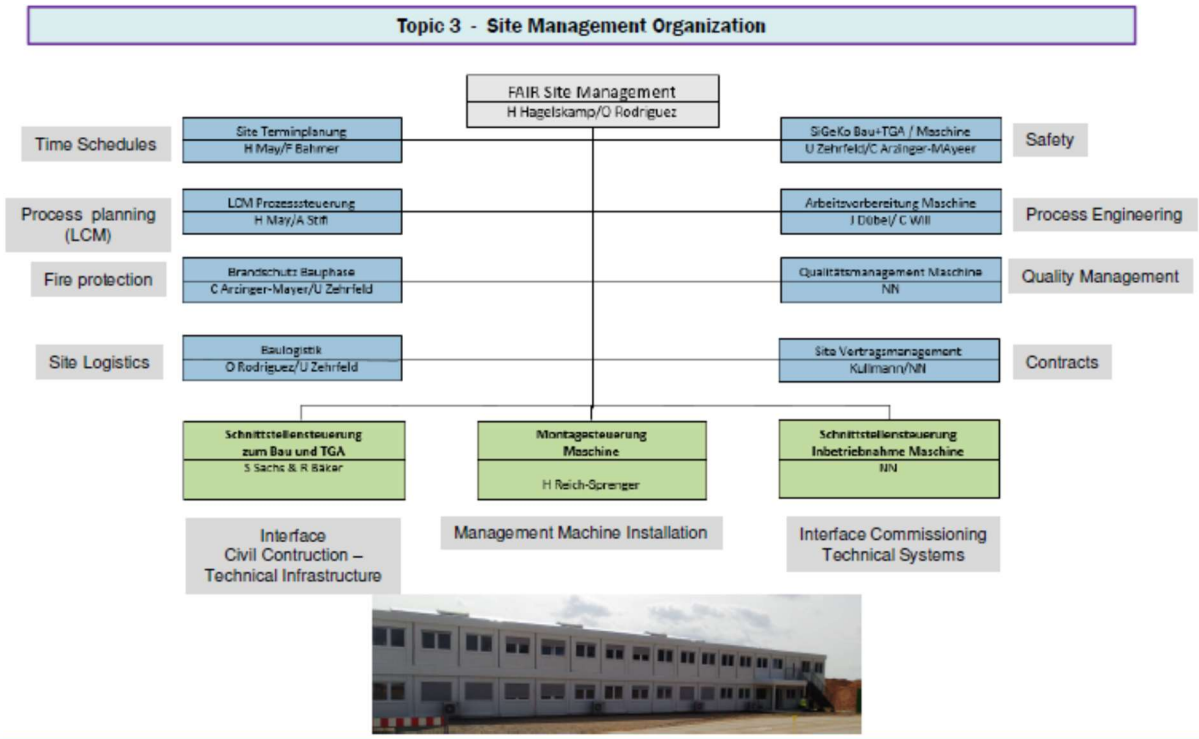
H Reich-Sprenger & H Hagelskamp

Logistics, Pre-Assembly, Installation
Strategy FAIR Machine Installation

Content

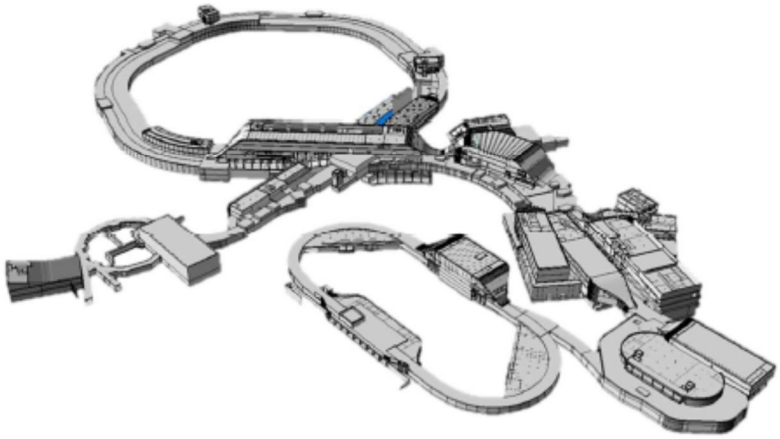
- Site Management Organisation
- Aims
- Installation Team and Strategy
- MS Project Installations Plans and Lean Construction Management (LCM)
- Pre-Assembly
- Logistics

- Summary



Machine Installation and Technical System Commisioning in time and budget

- starting from Q3/2020 (Cryo Distribution System SIS100 in T110): coordinated installation of all Subprojects andTechnical Infrastructure Systems
- based on an agreed strategy for Pre- Assembly, temporary storage, Installation on Site, technical commissioning

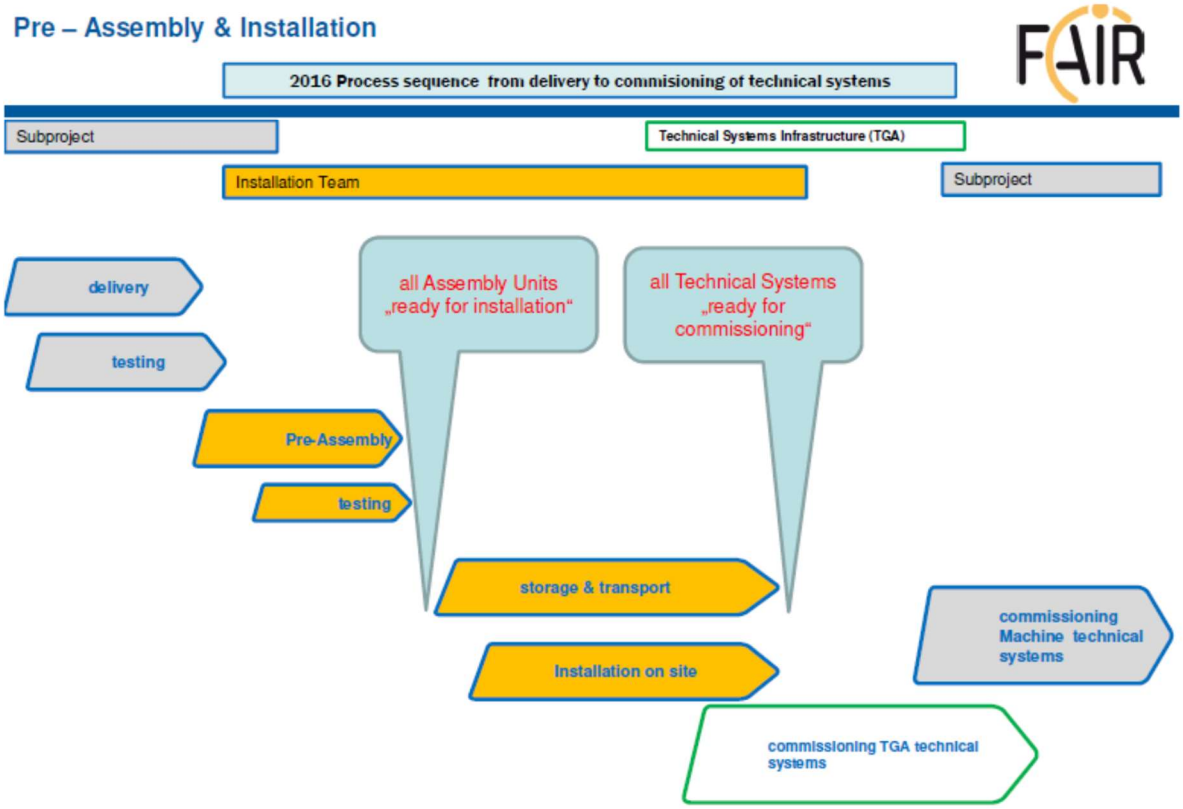


Installation strategy (3/2018)→ confirmed by PL and SPL (5/2018)

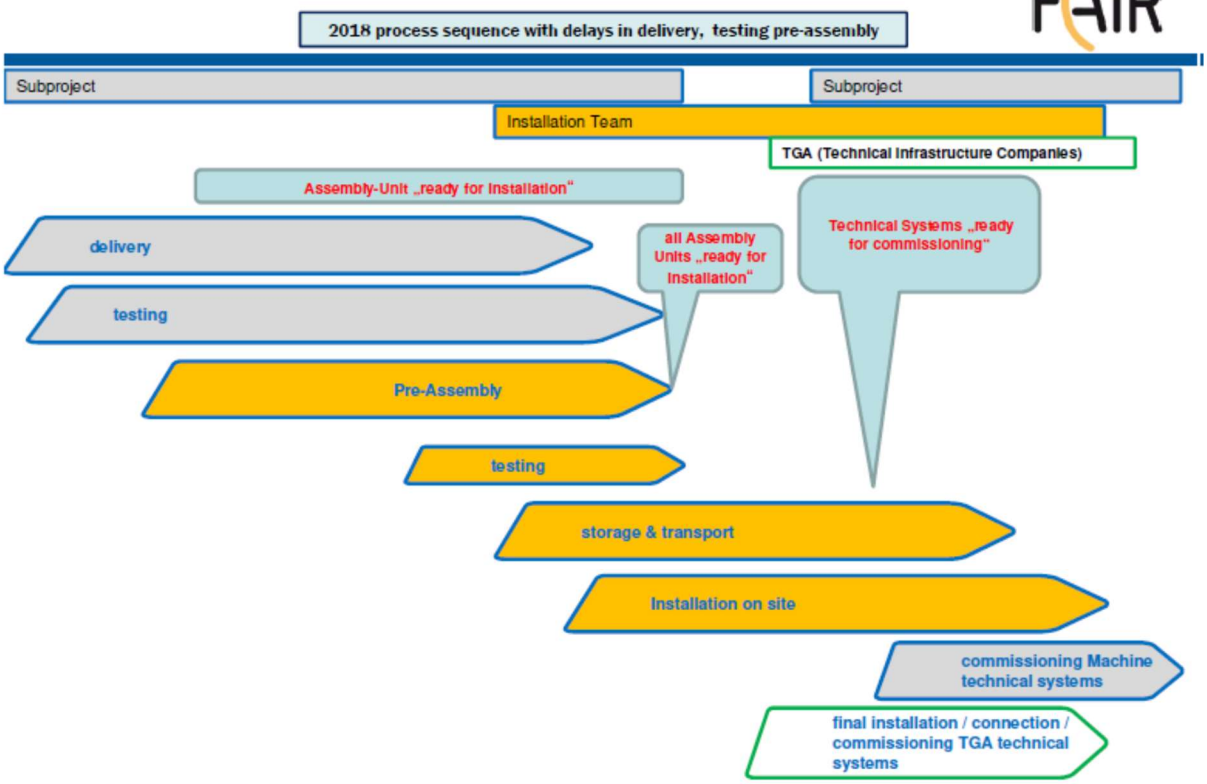
Installation Team with „Installation responsible person (MV)“ from each Subproject

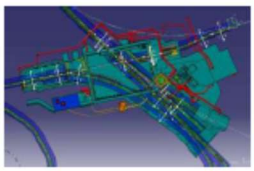
- bi-weekly meetings
- → definition of standards (e.g.: „Subproject Installation concept“, „Preparation of work (AV)“, Component-status „ready for Installation“ , delivery and transport, installation manpower qualification,.....)
- detailing scope of integration / pre-assembly / installation
- updating and detailing MSP installation plans (scope, timeline, resources)
- input to LCM workshops FSB (coordination TGA installation / Machine Installation
- input to Logistics (Delivery, storage, testing areas, transport, Site-Logistics,....)
- input to Documentation (PLM, EDMS,...)

Pre – Assembly & Installation

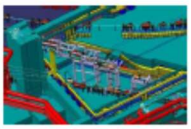


Pre – Assembly & Installation





Installation Team
- Centrally managed Acc & Exp Installation
- responsible representatives from all Subprojects
- standardized procedure for all machines and experiments



Installation Concept
Installation Concept
Installation Concept
Installation Concept Subproject

Process Engineering
- **work instructions**
- **safety instructions**
- **QA**

PLM (Product Lifecycle Management)
- **Complete** documentation of components and assembled units:
  - CID
  - technical data, drawings, location, status, ...
  - work instructions for pre-assembly and final installation

MS Project installation plans : timescale and ressources

Logistics

detailed planning for each assembly unit to be installed at FAIR

Minimum requirements for all installation plans

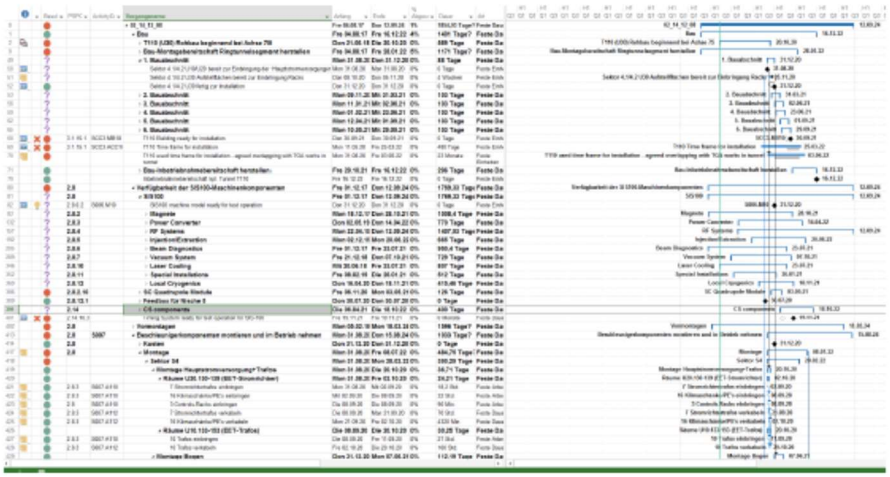
Link to Civil construction (PdR)

Link to procurement plans of subproject

Pre- Assembly
- from single component to pre-assembled unit (ready for installation)

Installation at FAIR
- detailled down to assembly units
- for beamline areas
- supply areas (racks, power converter,...)

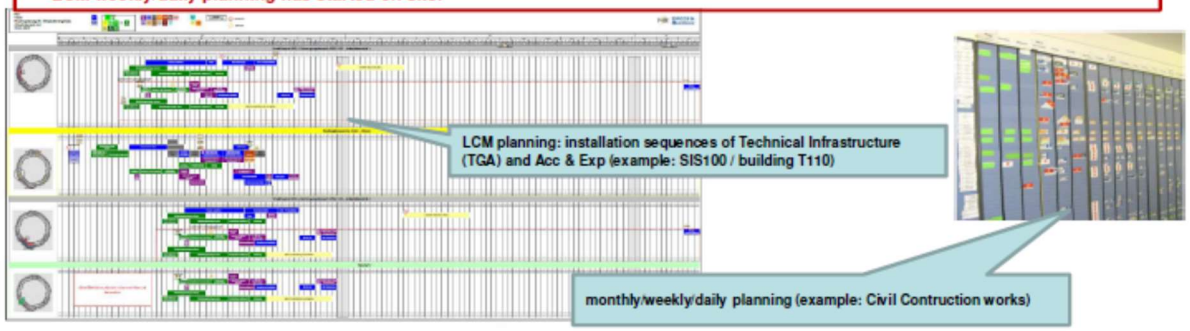
System commissioning (without beam)



Lean Construction Management (LCM)

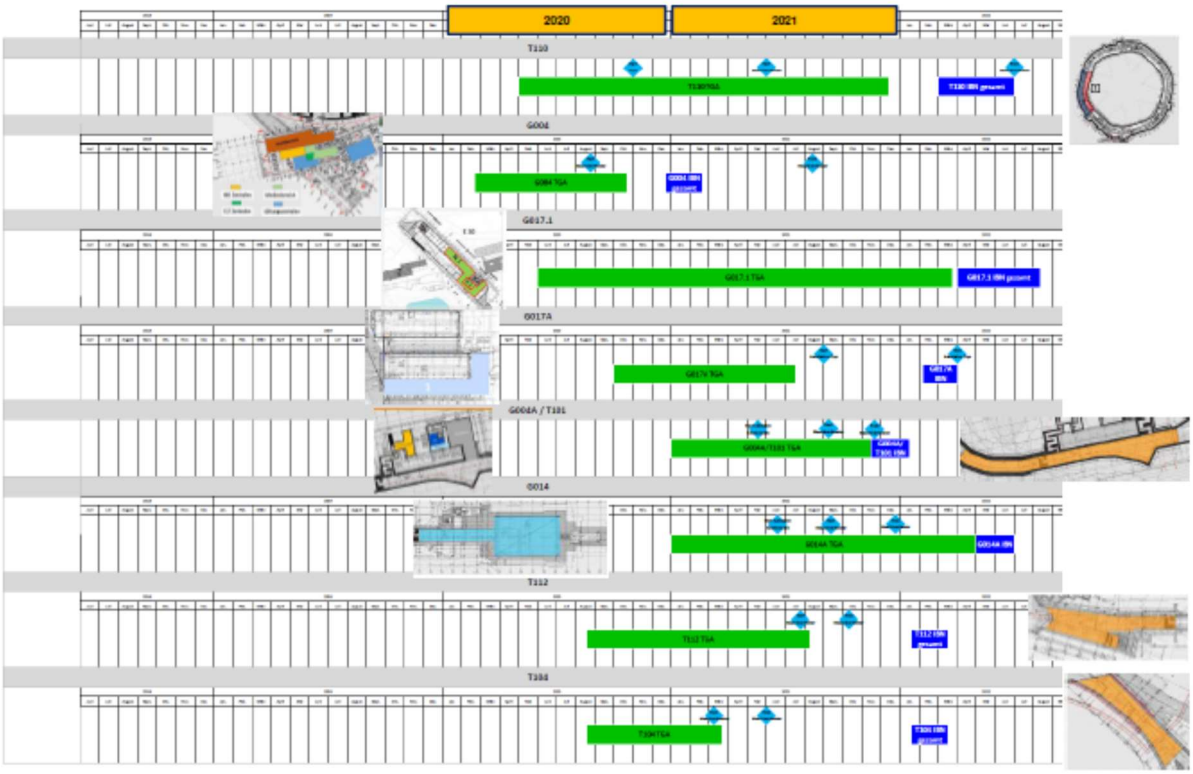
- Installation of the accelerator components will take place immediately after and interactively with the installation of the building technology (TGA).
- LCM (Lean Construction Management) was selected as the suitable process coordination tool to ensure a smooth coordination and management of all interfaces between building technologies and machine systems.
- Process plans for technical building equipment, including interfaces with accelerator and experiment activities have been defined in several LCM workshops.
- The Machine Installation Team will continue to plan, coordinate and manage these processes also during the installation phase in weekly/daily coordination meetings.

- **LCM Process Planning is completed for all buildings in package NORTH, buildings in package SOUTH started in 10/2018.**
- **LCM weekly/daily planning has started on site.**



Site Management Processes - LCM Results Buildings North

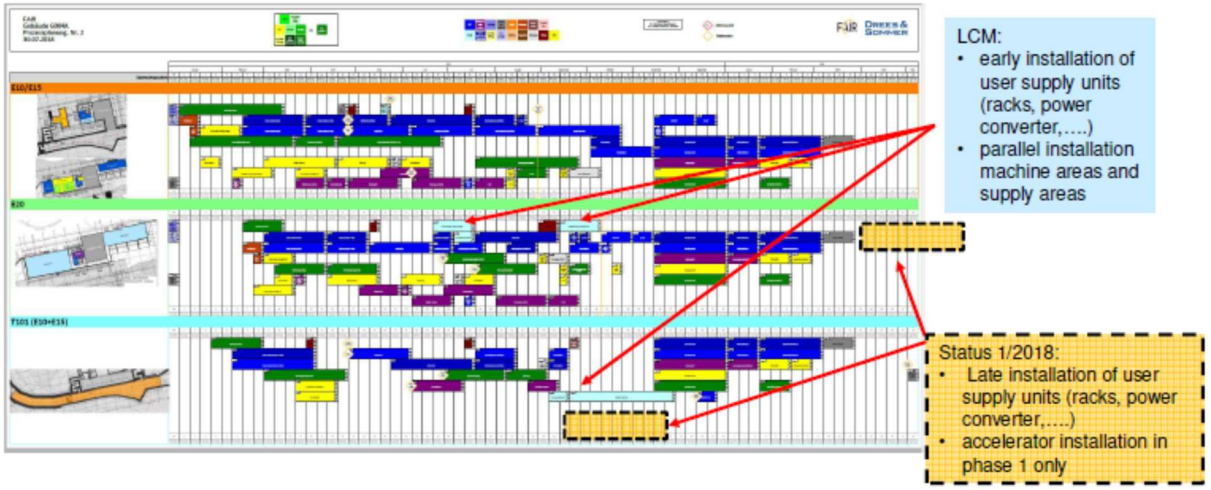
LCM Buildings South started in 10/2018 with building G018 (SFRS)



Example Building G004A

- ✓ optimized sequence of Techical Infrastructure Installation and Machine Installation (Acc areas and Supply areas)

  ⟹ advanced installation of Power Converter, Racks, Controls,.... in Supply areas



- All Assembly Units are in status „ready for installation“ at the date of plaaned final installation at FAIR
- All installation works are described in a standardized form and are released by the installation team
- Hazard analysis are performed, safety measures are prepared and released by the Construction Site Safety Responsibles
- Installation planning for the subproject (including approved ressources) is released by the Machine Installation Management
- Machine Installation Masterplan (including interface Links to Technical infrastructure and Civil Construction) is released by Site Management

The Tasks of the Pre-Assembly Team

To coordinate and logistically plan all pre-assembly activities.

- *The responsibility for the coordination and timing lies with the Installation Team.*
- *The responsibility for the technical correctness and quality of the installation lies with the Subproject.*

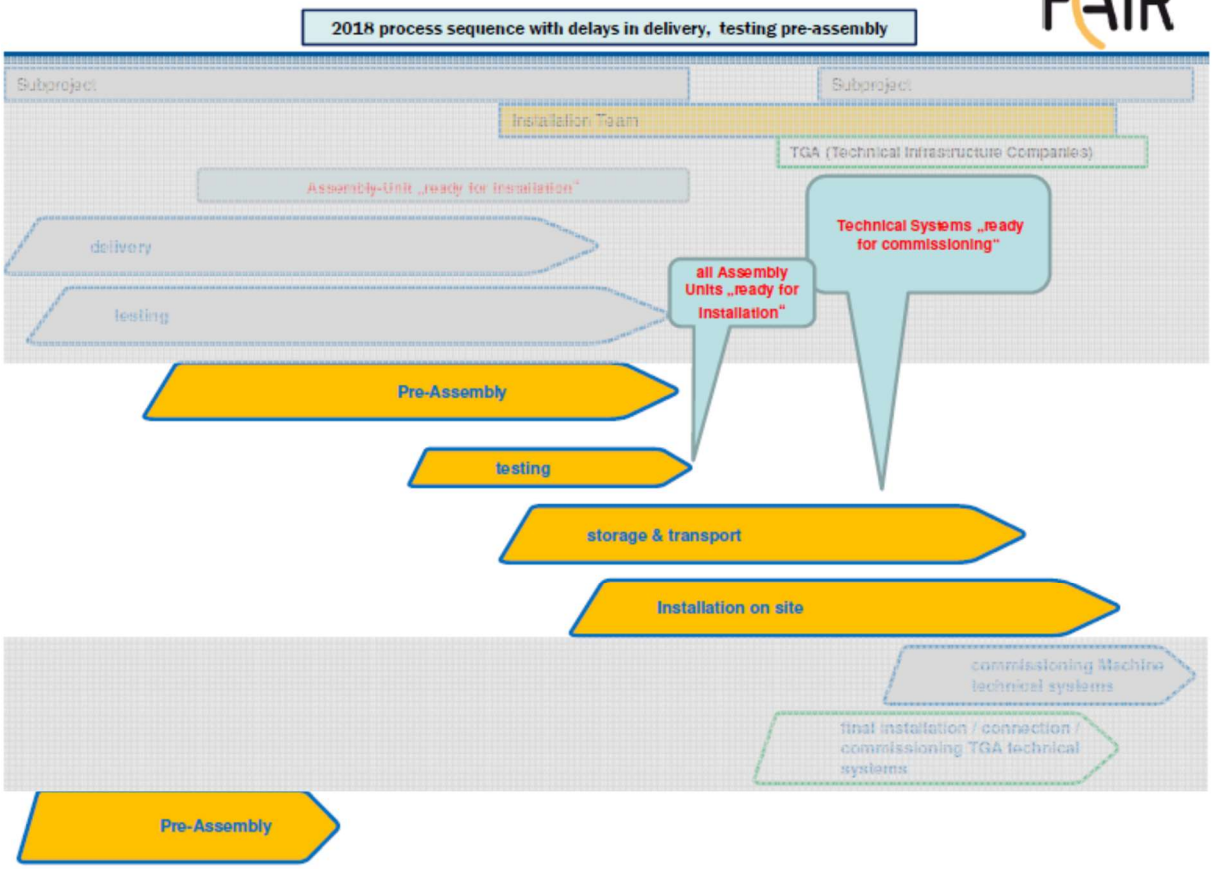
Definition of Pre-Assembly:

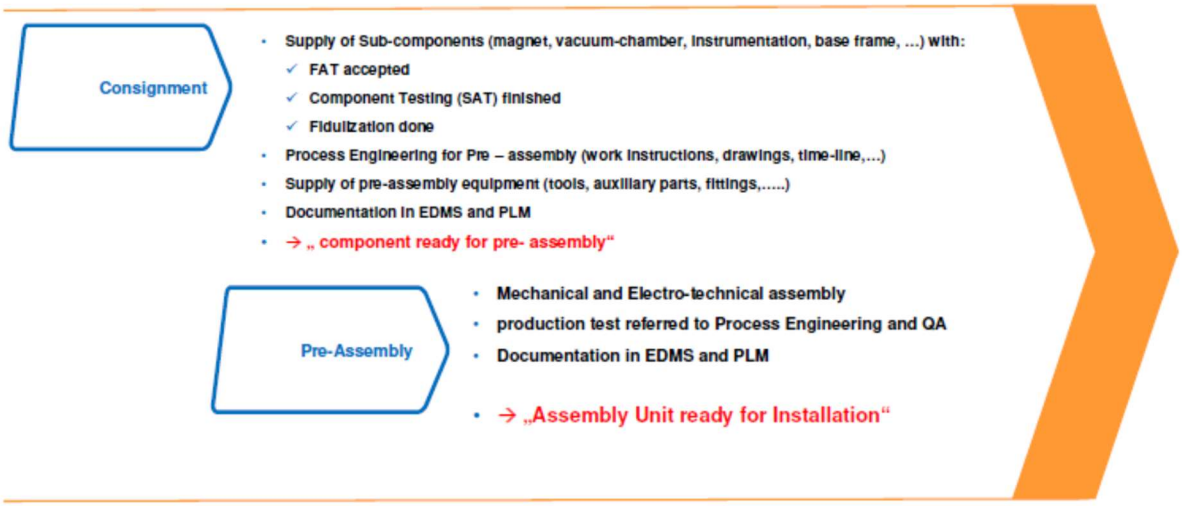
The Pre-Assembly Process is understood (defined) to include all activities required to complete an assembly group ready for installation in the FAIR Buildings.

- Intermediate storage of delivered and tested components.
- Planning and coordination of workshop facility capacity.
- Planning and coordination of tools and lifting devices.
- Planning and coordination of assembly resources.

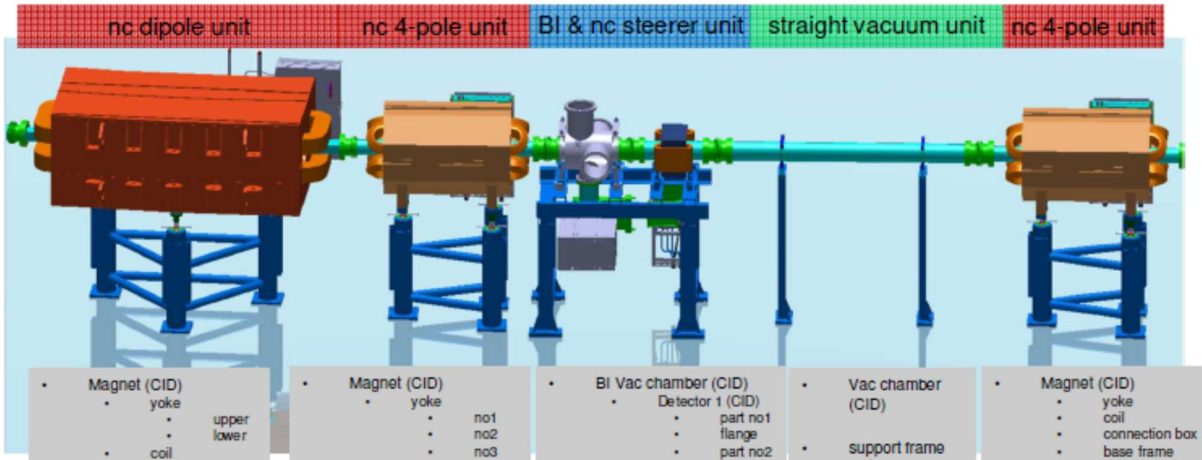
„Ready for installation Assembly Units“

Pre – Assembly & Installation





Definition of Assembly Units



- Magnet (CID)
  - yoke
    - upper
    - lower
  - coil
    - upper
    - lower
  - Hall-sensor
  - connection box
  - base frame
  - alignment supports
    - no 1
    - no 2
    - no 3
- Vacuum Chamber (CID)

- Magnet (CID)
  - yoke
    - no1
    - no2
    - no3
    - no4
  - coil
    - no1
    - no2
    - no3
    - no4
  - connection box
  - base frame
  - alignment supports
    - no 1
    - no 2
    - no 3
- Vacuum Chamber (CID)

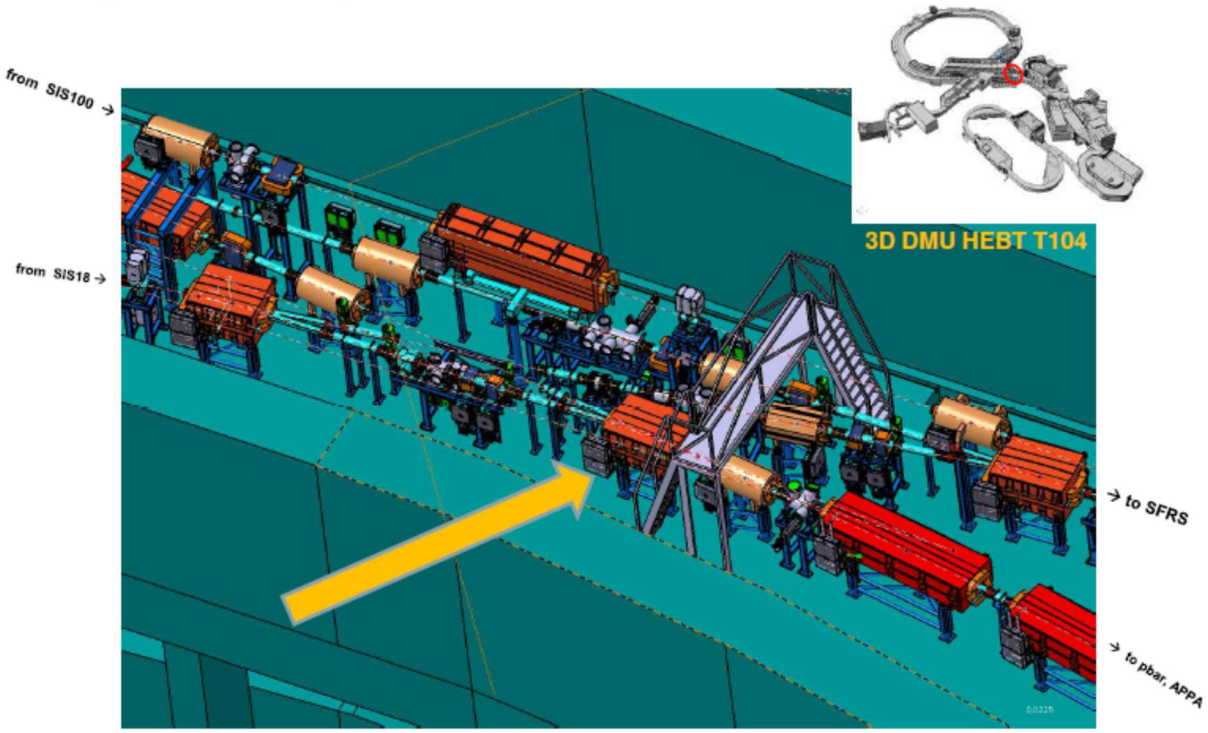
- BI Vac chamber (CID)
  - Detector 1 (CID)
    - part no1
    - flange
    - part no2
  - Detector 2 (CID)
    - part no1
    - flange
    - part no2
  - Vac pump (CID)
  - Vac diagnostics (CID)
  - connection box
  - base frame
  - alignment supports
    - no 1
    - no 2
    - no 3

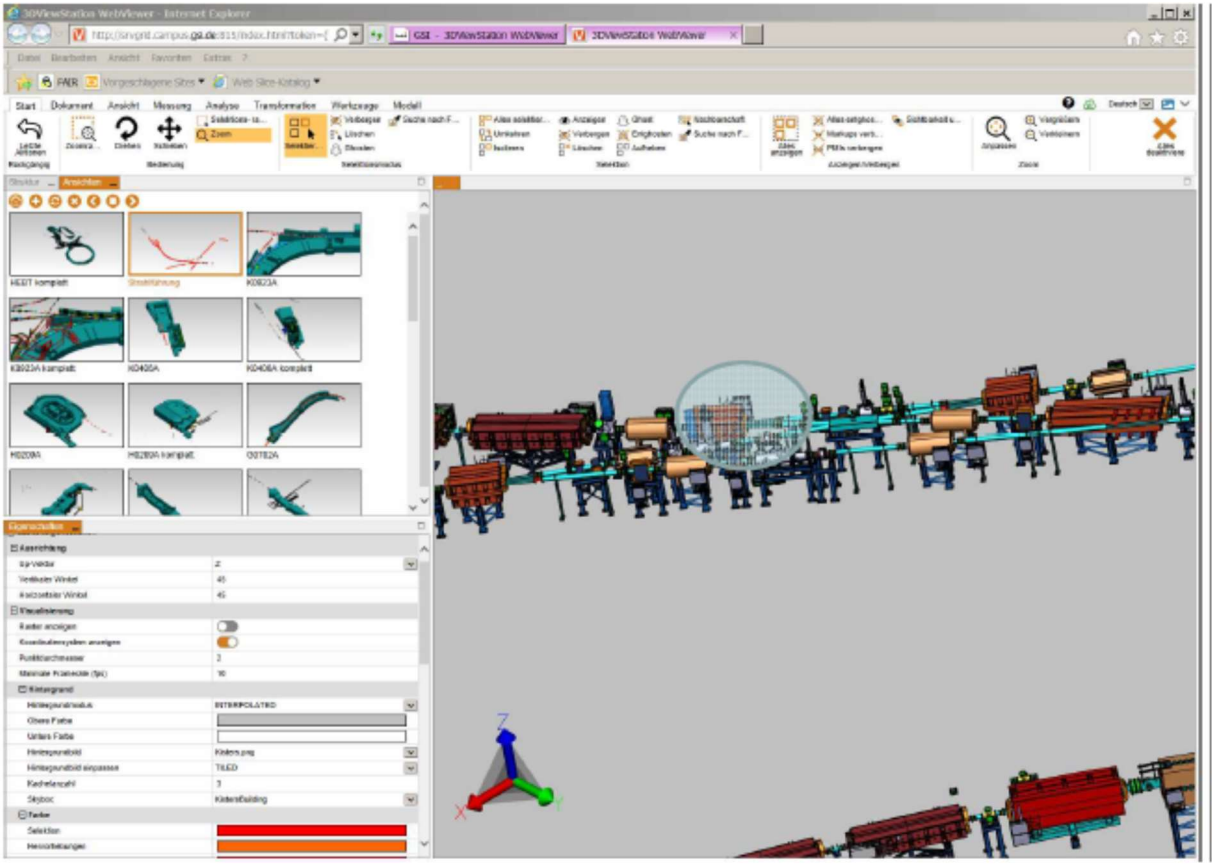
- Vac chamber (CID)
- support frame no1
- support frame no2

- Magnet (CID)
  - yoke
  - coil
  - connection box
  - base frame
  - alignment supports
- Vacuum Chamber (CID)

Each defined Assembly Unit:
- Documentation in PLM including:
  - Sub-components
  - Status
  - Location
  - executed works and tests

Example : HEBT Magnet Unit TSX2MH02





Consignment

Magnet Dip1f_0 (EFREMOV)

dip1f_0, Drawing No GSI: FT-BEMH-ZU-0000082, CID 18-000002-11-5

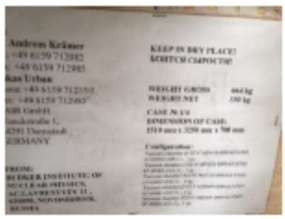
Base frame (EFREMOV)

CID: none → label (support belongs to…)

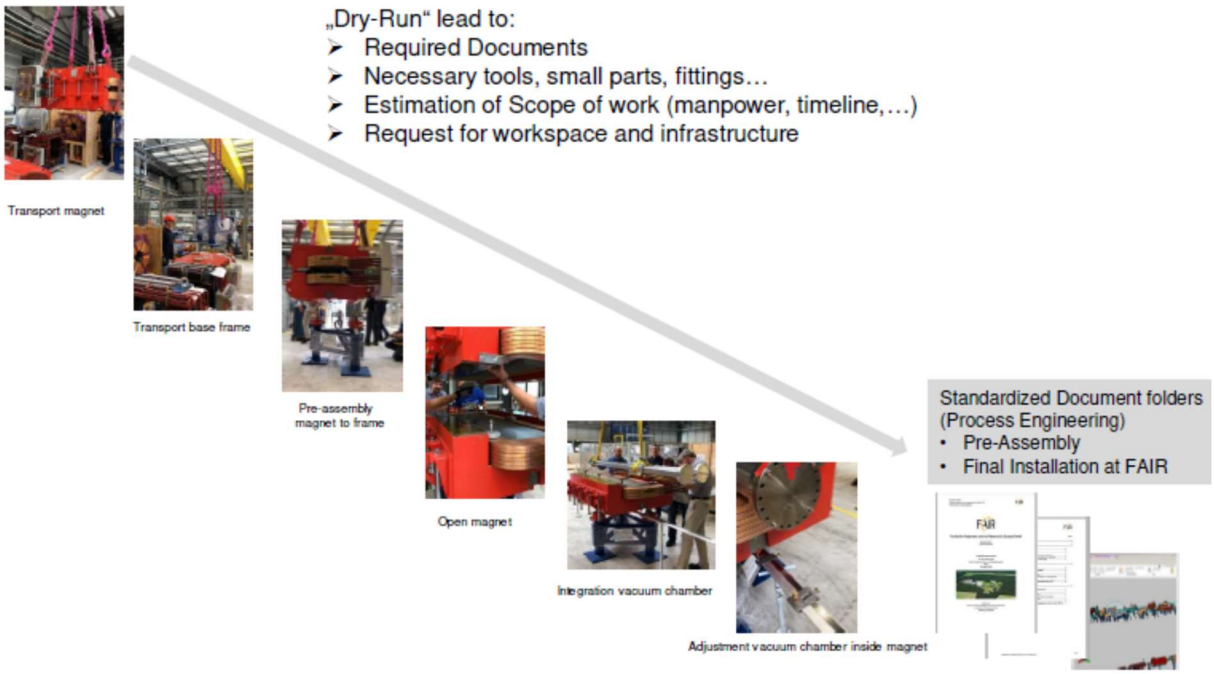
Vacuum Chamber (BINP)

CID: on flange→ labeled by supplier

Drawing No GSI: FT-BEMH-ZU-0000068, Drawing No BINP: FHTV MH069 0000 AS, CID 07-00001-031-2, AID: 0002050



Pre-Assembly of Magnet Unit



Essentials:

- Centralized management of all Machine installation activities:
  - managed by FAIR Site Management
  - additional external ressources managed by Machine Installation Management

- Safety
  - All Machine Installation Teams are regarded like industrial companies working in parallel on site
    - restricted access
    - permission to work needed
    - hazard analysis mandatory

- Planning:
  - all installation steps are planned according the guidelines of the PMO in MS project

- Process Engineering:
  - installation works to be described according the guidelines of the Process Engineering
  - all works supposed to be carried out by external partners are to be described in detail including timescale and required ressources (qualification)

- Installation on site:
  - only completely documented (in PLM) components or assembly units with status „ready for installation“
  - documentation of all installation works on site according work instructions
  - documentation of all QA measures
  - LCM follow up of all Machine installation activities
  - operation of cranes and building infrastructure managed by „Site Management Internal Logistics“

LOGISTICS (External storage, Transport, Construction Site)







Storage Logistics

The external storage Site will be managed by an external logistics company:

- storage of „ready for installation“ assembly units only (complete documentation, no residual works)
- presently storage areas are foreseen for HESR, HEBT, SIS100

Site Logistics

- Managed by FAIR Site Management
- Access to Construction Site according the general rules documented in „Baustellenhandbuch“ (Handbook for the FAIR construction Site)
- Transport ways
- BE areas: areas given temporary to companies active on site to be managed under their responsibilty
- Paved areas for crane / mobile crane placement

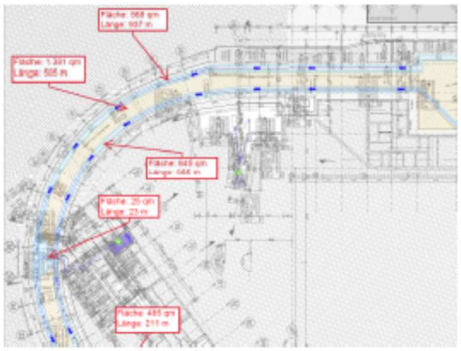
Internal Site Logistics

A working group was started in January 2018 to develop concepts for organizing and managing the logistics processes and interfaces inside the buildings for the installation of the technical building equipment (TGA):

- Planning of transportation and escape routes.
- Planning and estimate of temporary storage areas.
- Planning of access capacities (cranes and lifts).
- Estimation of material quantities and dimensions/weights.

- **Planning for all buildings is completed.**
- **A guideline for Internal Logistics is in preparation for tendering purposes.**

The coordination of the Internal Site Logistics will be managed in the LCM Tool by the Machine Installation Team.



Logistics → Component Delivery & Acceptance

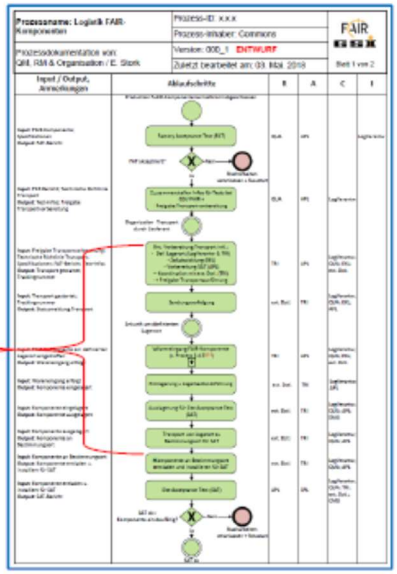
The Objective:

- To implement a central logistic control of **all component** deliveries to FAIR/GSI.
- To achieve reliable delivery date forecasts and a thorough preparation of goods receiving routines.
- To reduce WPL's work load and allow focus on technical issues.

The Status:

- The Procurement Department has developed a goods delivery and receiving process.
- The main organizational parameters are:
  - **WPLs** lead the overall supply chain process – M3 to M10.
  - **Logistics** take the lead for sub-process delivery, customs, receiving (between FAT and SATb).
    - leads communication with supplier, forwarding company and customs.
    - leads preparation of receiving, inspection, unloading process at GSI/FAIR.
    - adhere to time frame given by WPL.

→ To be finalized and established by end 2018.



Essentials:

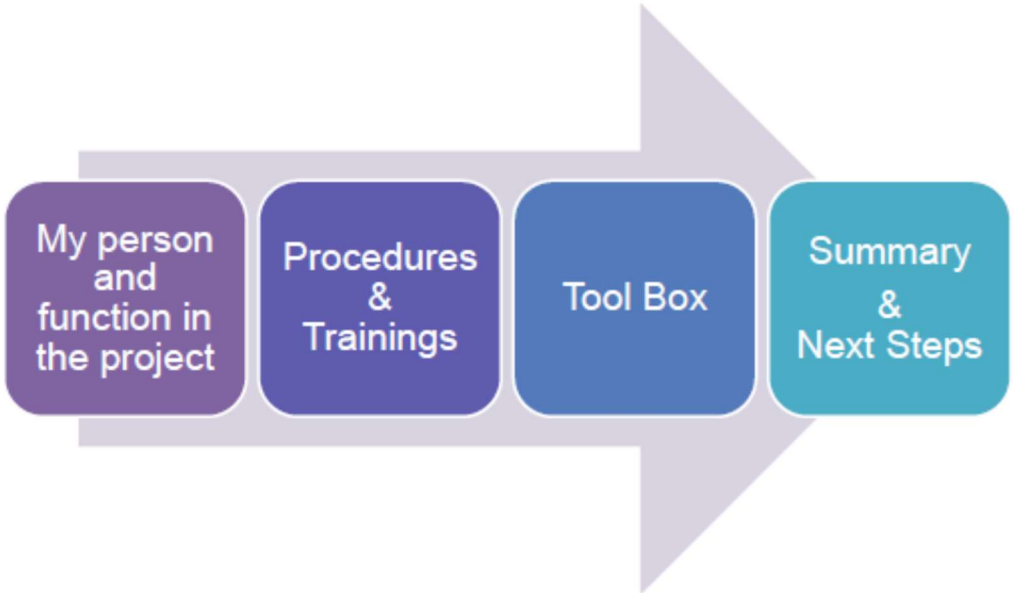
- Centralized comunication on all delivery activities :
  - no start of transports after confirmed FAT without release by FAIR logistics (TG_transport is part of general specs)
- External storage Sites and custom processes will be managed by an external partner:
  - reliable dates of delivery of FAIR components are mandatory
  - complete documentation and labelling according Technical guidelines and accoding FAIR procurement rules are required
- Site Logistics:
  - managed by FAIR Site Management
  - restricted access to Construction Site
  - surface areas management
  - transport ways
- Internal Site Logistics:
  - managed by FAIR Site Mangement
  - restricted access to buildings
  - inside areas management
  - transport ways inside buildings

Summary

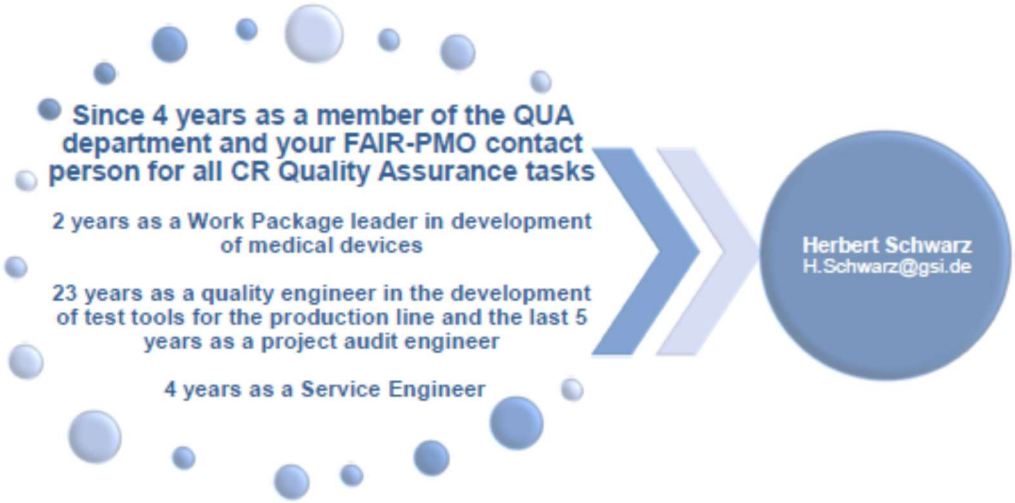
- Machine Installation and Site Logistics are managed by FAIR Site Management
- Machine Installation is organized under a common standard for all subprojects:
  - Time schedules → tool: MS Project,
  - Process planning → tool: LCM
  - complete documentation of technical systems and installation work → tool: PLM
- Installation Team work will be in close coordination with Technical Infrastructure work
- Logistics are prepared by GSI/FAIR procurement department (delivery) and by FAIR Site Management (access to Construction Site, Safety,..transport ways,....)
- All activities on site have to follow the general rules of the FAIR Construction Site

1.7 PMO, Quality assurance and BINP

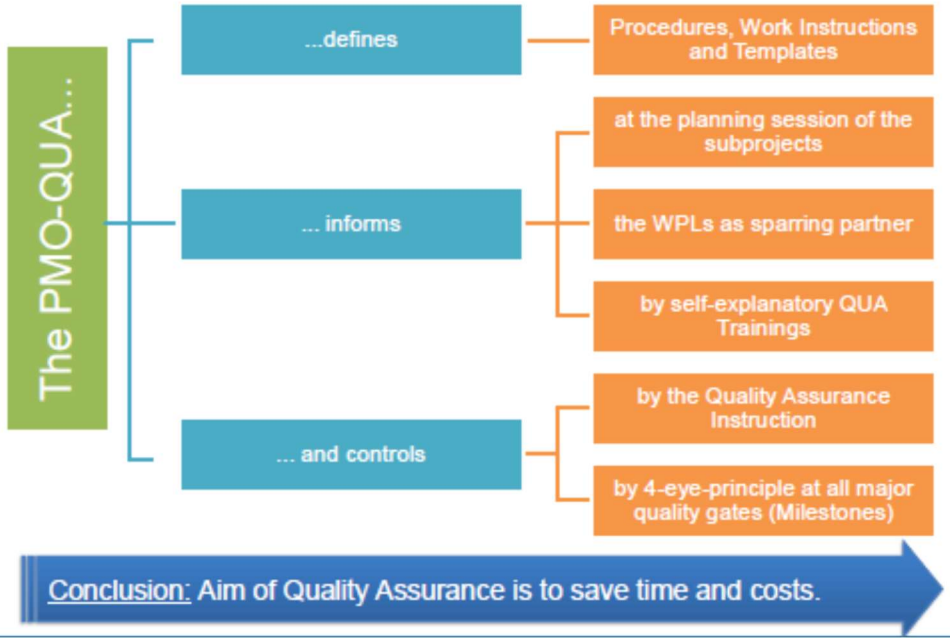
Corresponding Author(s): h.schwarz@gsi.de



My person and function in the project



Introduction



Lessons Learned

- Quality assurance is not an additional hurdle.
  → *Most quality related activities are straightforward project activities.*

- The specifications and contract terms are the base of nearly most quality assurance related measures.
  → *Clear and stringent formulations are needed.*
  → *Any shortcuts will lead to (massive) additional efforts at a later stage.*

Lessons Learned

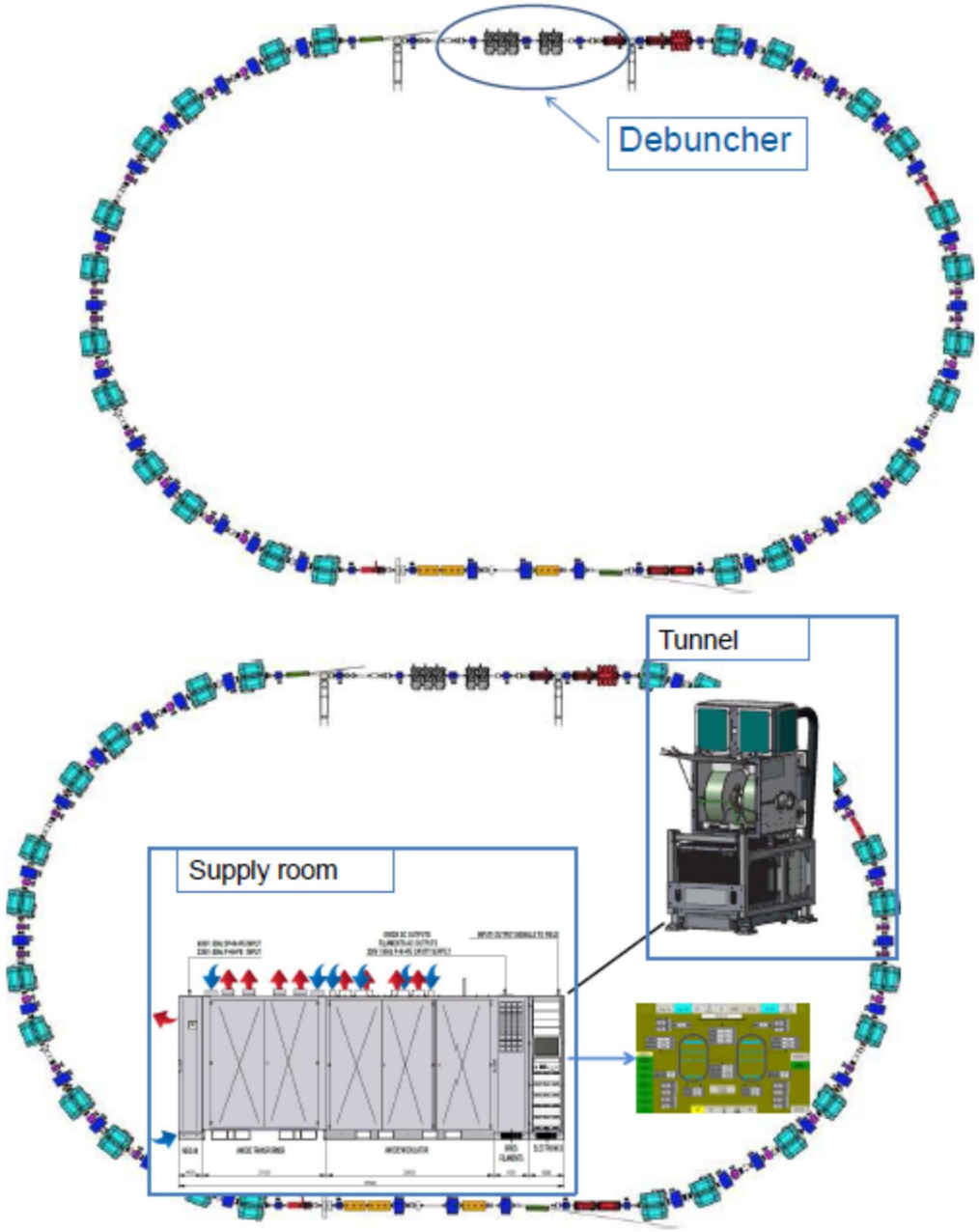
- Difficulties and deviations from the specification are usual.
  → *Dealing with Non-Conformities is an inherent topic of quality assurance.*

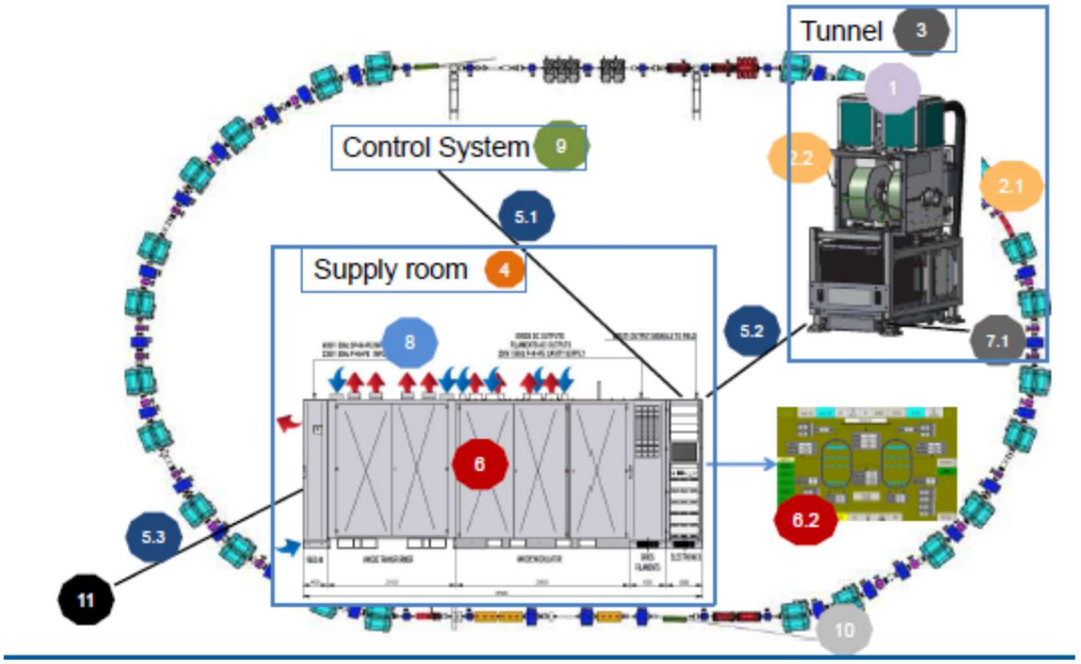
- Verbal agreements work until something goes wrong.
  → *Compliance with the specified processes, procedures and templates is essential for a successful project completion.*

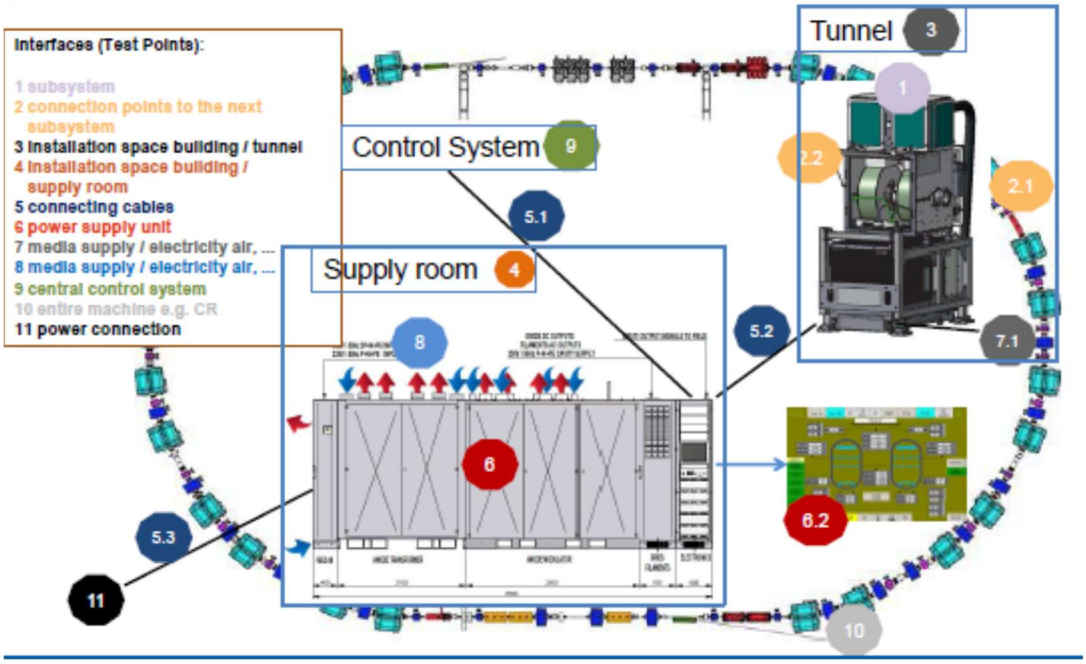
- Solution based flexibility is necessary.
  → *But large-scale project involving many stakeholders requires compliance with processes, therefore quality assurance sometimes needs to be some kind of formal.*

Lessons Learned by CR example

... the Debuncher requirements for the interfaces, tests and inspections




Tunnel
3
Control System
9
5.1
Supply room
4
8
5.2
6
6.2
5.3
11
10
1
2.2
2.1
7.1


Interfaces (Test Points):
1 subsystem
2 connection points to the next subsystem
3 installation space building / tunnel
4 installation space building / supply room
5 connecting cables
6 power supply unit
7 media supply / electricity air, ...
8 media supply / electricity air, ...
9 central control system
10 entire machine e.g. CR
11 power connection
Tunnel
3
Control System
9
5.1
Supply room
4
8
5.2
6
6.2
5.3
11
10
1
2.2
2.1
7.1

Lessons Learned by CR example

... the Debuncher requirements for the interfaces, tests and inspections

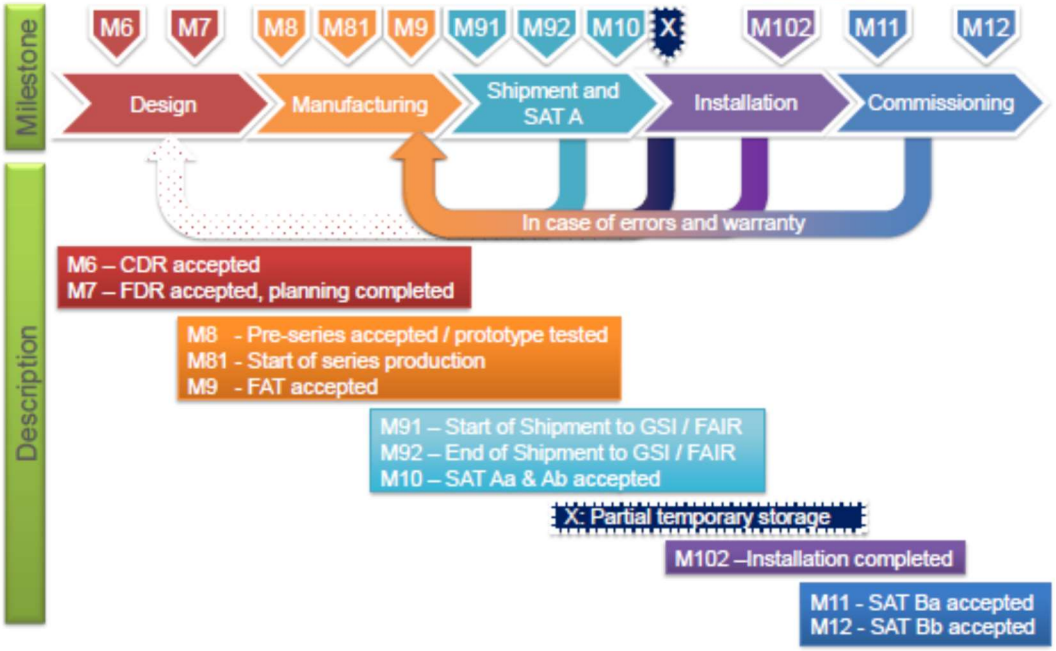
- The CR Debuncher is one example for teamwork during the design phases M6 and M7.
  → The WPL presents his or contract partners work in a design meeting and finalizes his/their design documents with this step.

  Overview of the participating departments in this case:
  - *- Control Systems (ACO) / - Commons (COM) / - Transport & Installation (TRI)*
    - Engineering (ENG) / - Mechanical Integration (MIN)
    - Vacuum Systems (VAC) / - Accelerator Radiation Protection (SRP) /
    - Safety Officer /
    - Quality Assurance (QuA)

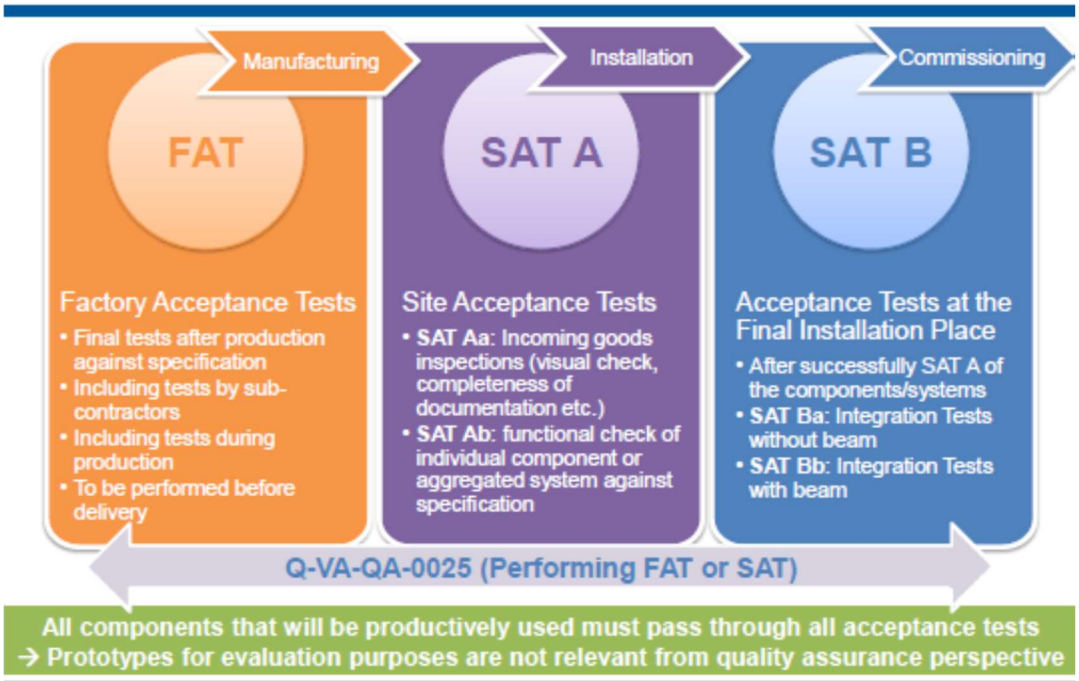
Conclusion:
Define your interface partner.
Teamwork saves time and costs.

Milestones & Descriptions

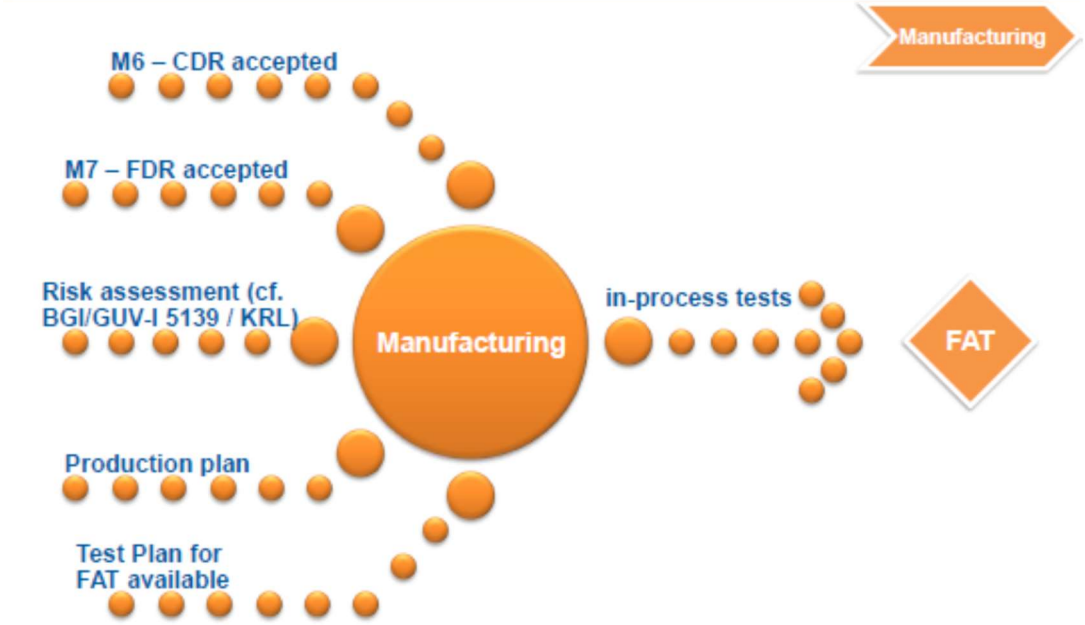
Underlying rules and processes are valid for all FAIR Suppliers.



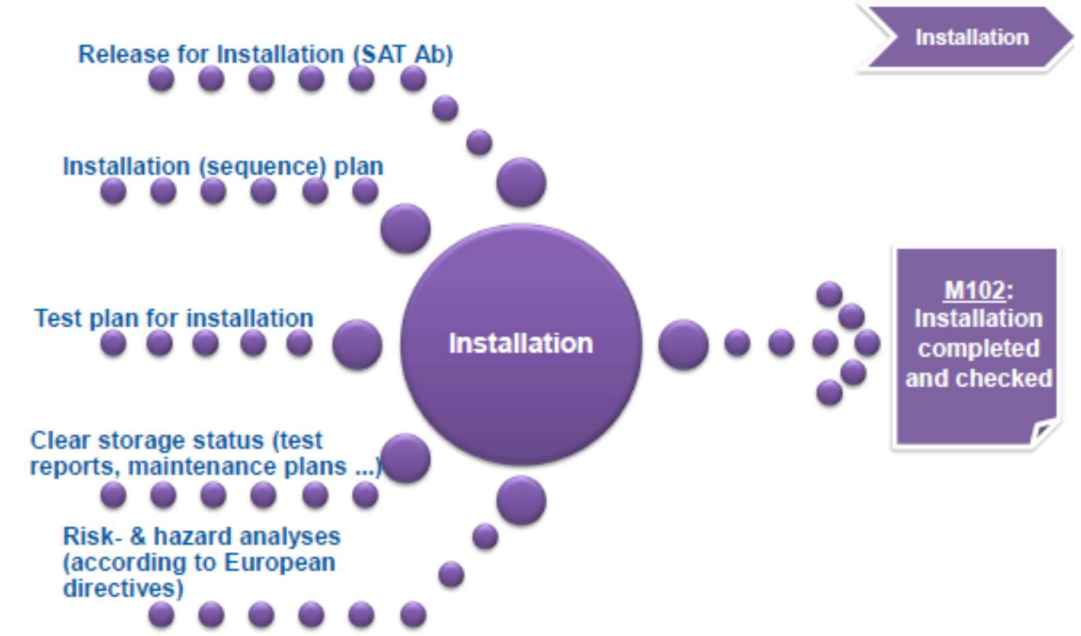
FAT / SAT Overview



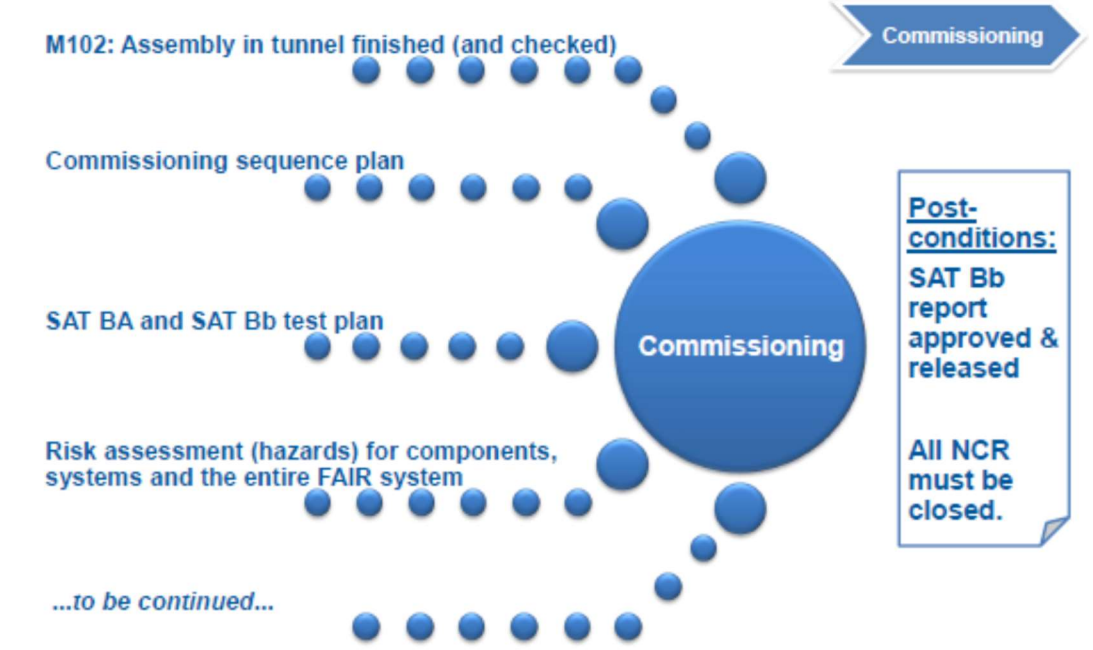
Preconditions for Manufacturing



Preconditions for Installation



Preconditions for Commissioning



Summary: Manufacturing, Installation & Commissioning

- From quality assurance perspective, the acceptance tests for the **milestones M9 (FAT) to M12 (SAT Bb) build the foundation** for the manufacturing, installation and commissioning.
- The **test plans** must be prepared in advance and agreed by QUA.
- Acceptance records are to be created and **stored in EDMS** together with the accompanying documents.
- **Quality deviations** (non-conformities) must be documented and followed up until clarification.

Particularly relevant for milestone	Procedure/ Template	Description	Link to EDMS
M6, M7	Q-VA-QA-0006	Design Reviews	edms.cern.ch/document/1514206
M10, M11, M12	Q-VA-QA-0022	Management of Test Equipment	edms.cern.ch/document/1730749
M9, M10, M11, M12	Q-VA-QA-0025	FAT or SAT	edms.cern.ch/document/1514174
M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12	F-VA-QUA-en-0030 (formerly Q-VA-QA-0030)	Dealing with Non-Conformities	edms.cern.ch/document/1503121
M8, M9, M10, M11, M12	F-VA-QUA-en-0031	Capability of Measuring Equipment	edms.cern.ch/document/1830692

Particularly relevant for milestone	Procedure/ Template	Description	Link to EDMS
M6, M7, M8, M9, M10, M11, M12	Q-FO-QA-0002	Template for an Acceptance Record	edms.cern.ch/document/1458121/
M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12	F-FO-QUA-bl-0003	Template for a Non-Conformity Report	edms.cern.ch/document/1503137
M10, M11, M12	F-FO-QUA-bl-0004	Template for Stoppage Card	edms.cern.ch/document/1503140
M9, M10, M11, M12	Q-FO-QA-0006	Template for a Test Record	edms.cern.ch/document/1517696
M6, M7, M8, M9, M10	F-FO-QUA-bl-0007	Template for an Inspection Plan	edms.cern.ch/document/1810648
M6, M7, M8, M9, M10	Q-FO-QM-0010	Template for a Test Instruction	edms.cern.ch/document/1512546
M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12	F-FO-QUA-en-0012	Template for Meeting Minutes	edms.cern.ch/document/1573659
M6, M7, M8, M9, M10	Q-FO-QA-0013	Template for Required Documents	edms.cern.ch/document/1732710

Tool Box QUA Training Modules

QUA Instruction Module
https://instruct-guest.gsi.de

QUA Training Modules	Link to EDMS
QUA-Training 2018-01-25 - QUA on a page - Document Approval - Design Reviews (CDR & FDR) - Acceptance Tests (FAT, SAT A) - Dealing with Non-Conformities - Standards, Guidelines and Laws - Required Documents	edms.cern.ch/document/1867402
QUA-Training 2017-01-17 - Capability of Measuring Systems - Schedule & Q-Plan - Shipment, Storage, Installation - Design Reviews (CDR & FDR) - Acceptance Tests (FAT, SAT A) - Management of Test Equipment	edms.cern.ch/document/1747874
QUA-Training 2016-06-24 - QA Overview - Design Reviews - Acceptance Tests (FAT, SAT Aa & SAT Ab) - Dealing with Non-Conformities - Management of Test Equipment - Document Approval	edms.cern.ch/document/1747876

Summary

Milestones (Spec, FDR, FAT, SATs) must be taken seriously.
→ **Full commitment of SPL and WPLs is mandatory!!!**

Documentation is essential.
→ **EDMS must be used for all required documents.**

Tracking of **individual components & systems** is necessary.
→ **PLM structures must be implemented**
Product Lifecycle Management

Responsibilities must be clear.
→ **Logistics, Aggregated Systems, Safety, Commissioning**

No time for planning (e.g. for testing and installation)?
→ **Every minute in planning saves 10 min. in execution.**

Next Steps / Open Issues

1. Start the subprojects with kick-off meetings for each work package 2.5.x.
   - Define the team with name, function and mail address.
   - Create EDMS Structures based on PLM requirements.
     For that contact Klaus Höhne (Klaus.Hoehne@fair-center.eu)
   - Define how the team will work together.

2. Early clarification on how the risk assessments should look like
   - If necessary, consult a notified body (e.g. TÜV).

3. Keep MS Project Plan and EDMS updated.
   - If not, start to clarify the users and their access rights.

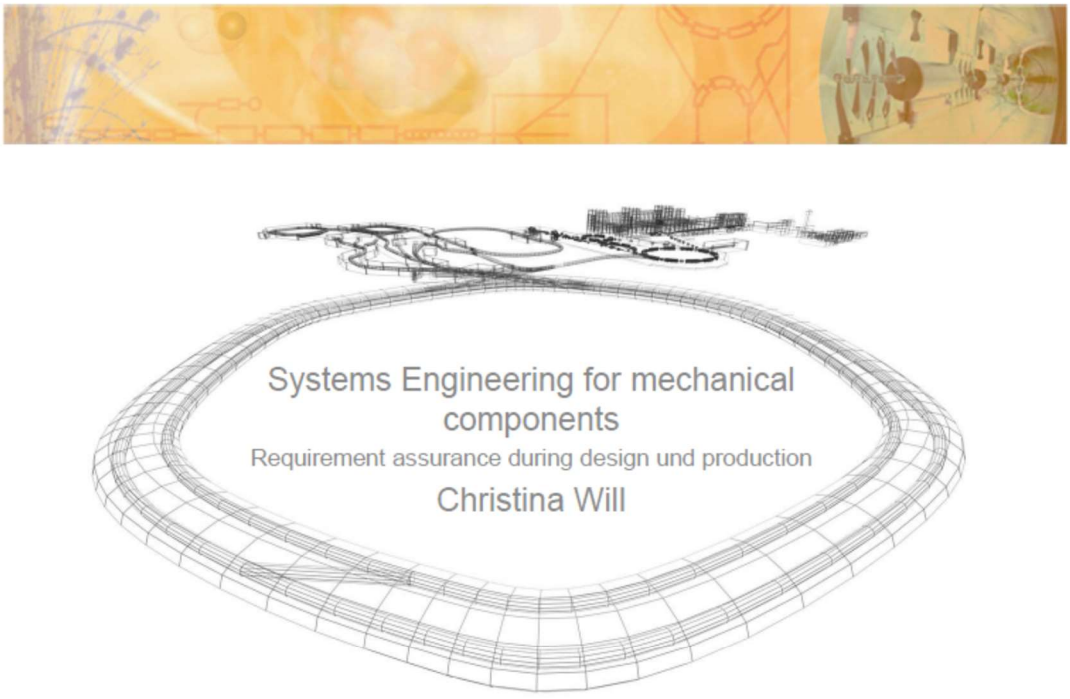
I am your FAIR-PMO contact person for all Quality Assurance tasks for CR

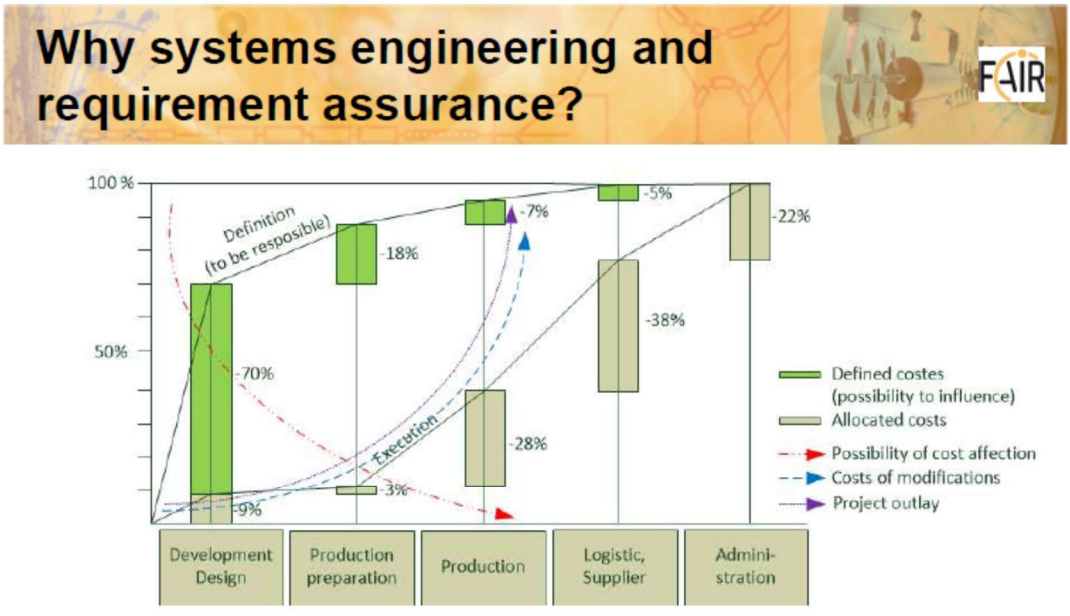
Responsible for quality

Every employee

1.8 Digital mock-up

Corresponding Author(s): c.will@gsi.de





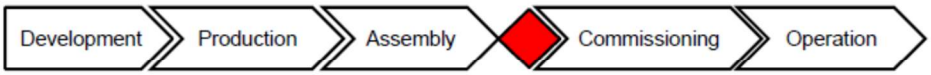
Legal aspects and target for FAIR

All partners which produce in the EU or will import into the EU have to follow the legal rules of the EU.

The following regulations have to be followed:

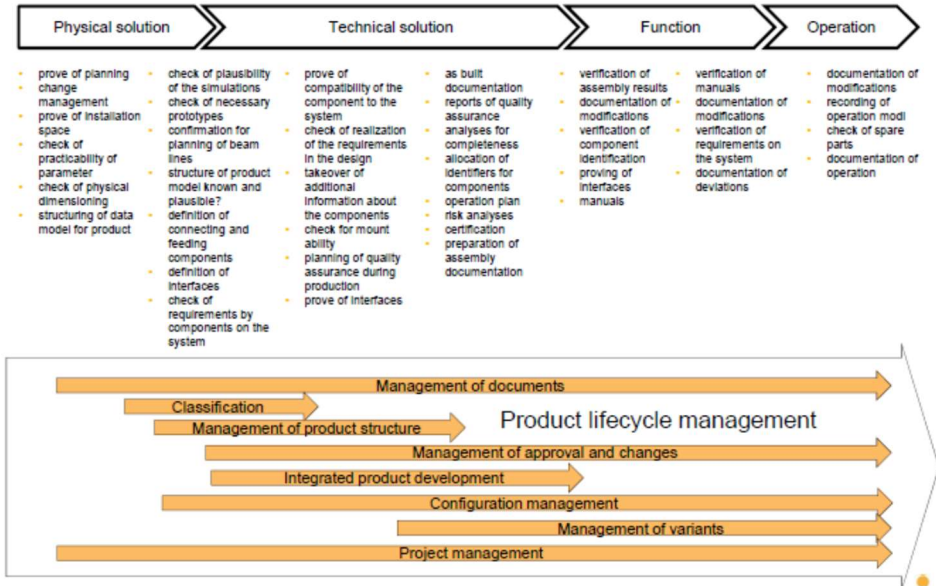
- 2006/42/EG Machinery directive
- 89/391/EWG, 2007/30/EG Regulation to avoid accidents
- ProdSG- Act on making products available for the market
- 2014/35/EU Low voltage regulation
- 2014/68/EU Pressure Vessel regulation (i.n.)

For certification: Information guide „Manufacturing and operation of equipment designed for research purposes", CE conformity and workplace safety, BGI/GUV-I 5139 E



Permission in reference to Radiation
Legal authorization

Development and Management Tasks



Lessons learned

- Definition of physical and technical requirements in context of system design as early as possible
- Describing requirements in specifications and draft models
- Conceptual design review (CDR) with model for checking of solution, checking of data integration, checking of interfaces, draft for documentation
- Final design review (FDR) checking of data integration, checking of content incl. tolerances
- First of Series (FoS): aim: no planned modification of design, only for checking if the design contains mistakes

Main tasks

Minimize development costs
- Development costs = Physical development + Technical development
- Physical development = Parameter table and specifications
- Technical development = DMU + specification drawings
- Costs calculations while development and design process
- Checking integrity of models in comparision to GSI/FAIR CAD-system

Minimize assurance costs
- Using checklists
- Checking solutions as early as possible in comparison to the defined requirements
- Establish checking procedures for all components for CDR, FDR, FAT

Minimize production costs
- Development of production documents in reference to minimize the costs for material and production
- Checking drawings to avoid mistakes during production
- Reuse of components to minimze production costs

Minimize assembly costs
- Participation of all involved departments in the development of the components
- Implementation of experiences of previous projects
- Reuse of components to develop a common knowledge

Technical Guidelines

Technical guidelines:

- Are part of the specifications as common approved information
- Are used for knowledge management
- Combine knowledge of different subject domains with technical solutions
- Are a collection of best practice experiences
- Are generally available

Technical guidelines have to be seen:

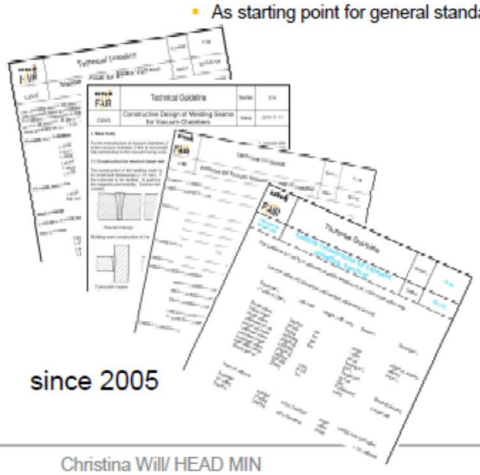
- As a collection of technical data that are used in GSI
- As an intentionally written guideline and not as specification
- In order to take into consideration the technical know-how
- As information about for instance basic equipment of GSI/FAIR
- As starting point for general standardization at GSI.

Content and Structure:

Classification of the guidelines

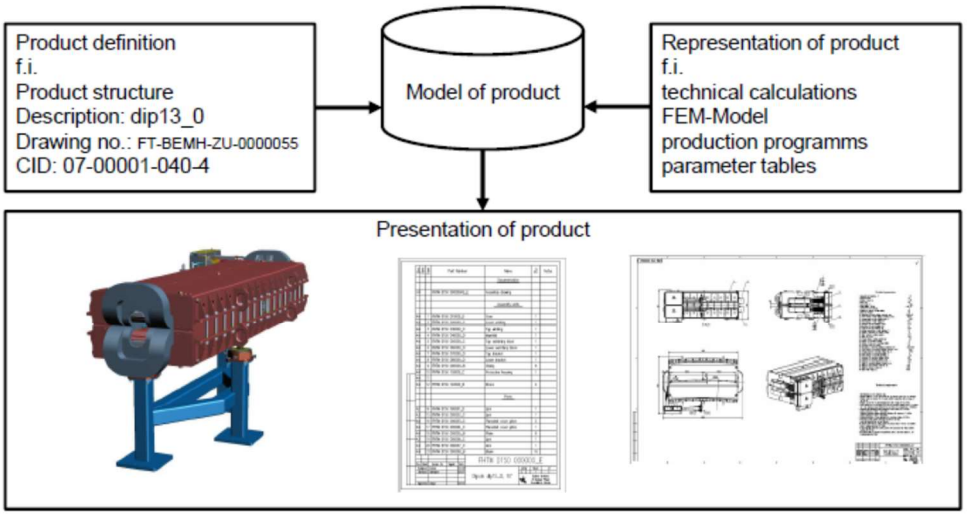
1. Several Information
2. Selection of materials
3. Engineering Design
4. Heating
5. Surfaces
6. Cleaning
7. Acceptance Tests
8. Material Procurement
9. Transport and Packaging
10. Documentation
11. Basic Equipment GSI/FAIR
12. Catalogue of GSI Main Storage
13. Installation Instructions
14. Miscellaneous

+ register with keywords



since 2005

Model of Product data



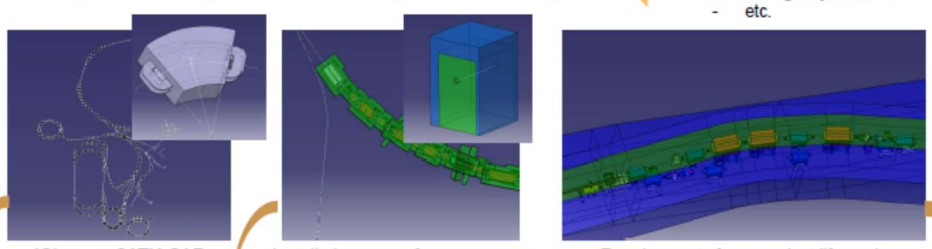
adapted figure after : Aderi, Trippner, Step, Teubner Verlag Stuttgart, 20000

From Physical to Technical Solution

Transfer of the physical solution into technical requirements:

- Choosing the active principle for realization of function
- Positioning of the function in the system (Ion optical Layout)
- Definition of necessary space of the function
- Definition of necessary media
- Adaption of requirements from product life-cycle

- Maintenance
- Alignment
- Emergency scenario
- etc.

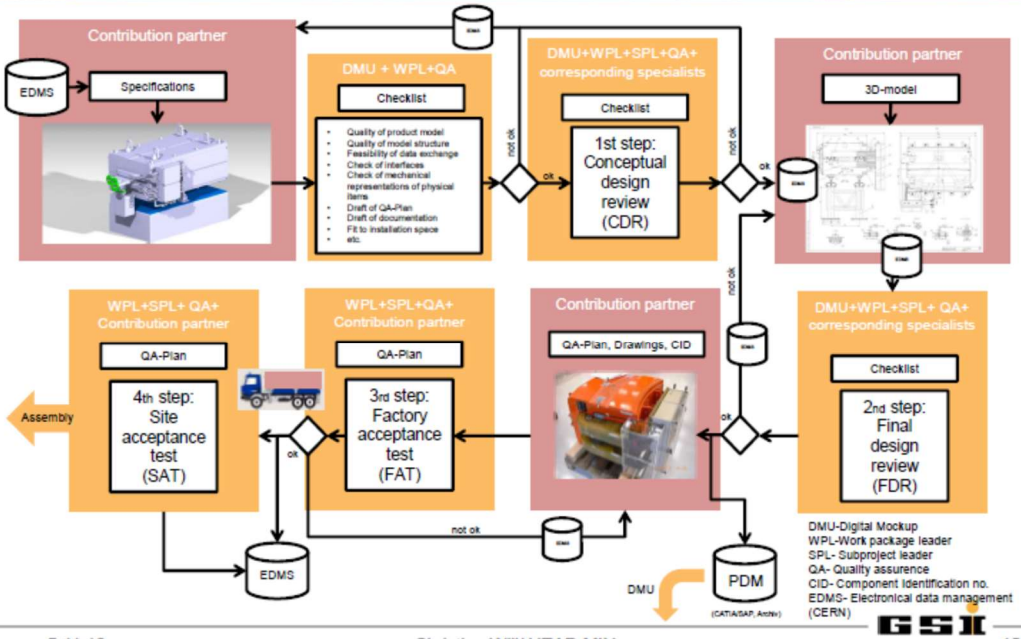


IOL(Step)->CATIA SAP | Installation space for components | Requirements from product life-cycle

Civil construction

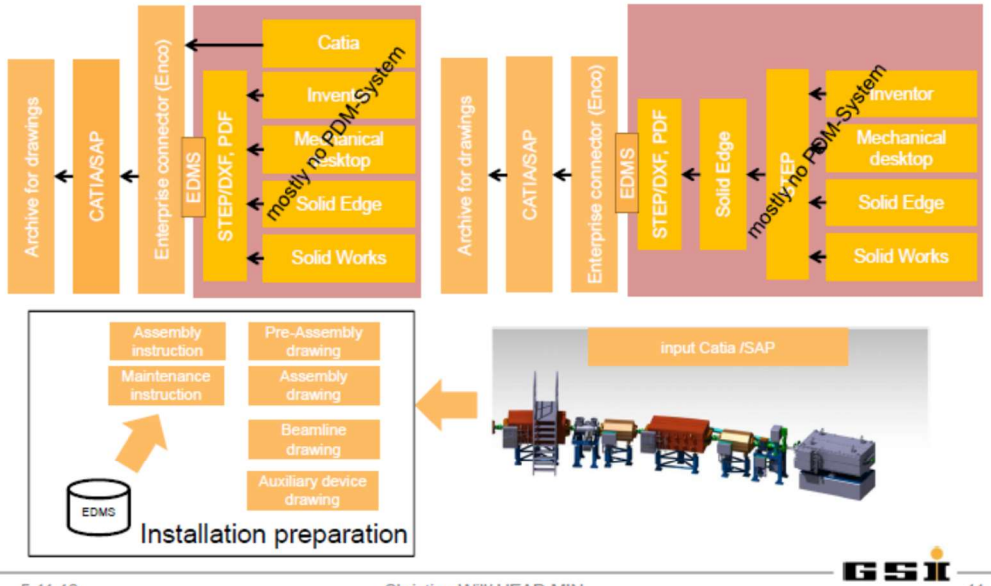
Specifications

Testing of Technical Solution



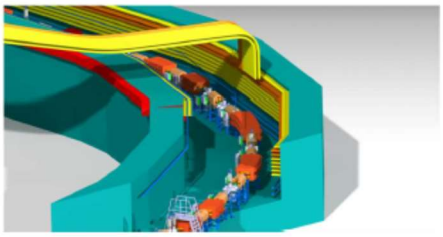
CAD Integration

Scenarios for CAD data creation, implementation and use



Testing of Technical Solution

DMU Combination of 3D-models from different sources to one common overview



Development of models for beamlines as basis for:

- Interface drawings
- Drawings for installation
- Digital representations as basis for installation and maintenace
- A basis for simulations for remote manipulation of radioactive components

Combination of:

- Models of different sources like civil construction, GSI and contribution partners
- 3D-Scans with CAD-Models as As-built-documentation

Proof of:

- Completeness of product structure
- Interfaces
- Installation scenarios
- Maintenance scenarios
- Emergency scenarios

Conclusions

- Defining requirements of components in reference the needs of Systems Engineeing as early as possible
- Definition of common product structures as basis for product management
- Definition the conditions for data transfer
- Common definition of design results
- Definiton of roles for mutual information (following also processes of ISO9001)
- Definition of approval procedures
- …

1.9 SPARC@HESR

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2 Collector Ring

2.1 CR project(s) kick-off

Corresponding Author(s): koop@inp.nsk.su

GSI – minutes	**Nr.:** 20181106
Minutes of the CR parallel session, 06th November 2018, 1st BINP-FAIR Collaboration Coordination workshop	Name: O. Gorda

Important:	***How to treat this document:*** ***I: Information (by xy)*** ***P: Presentation*** ***R: Remark*** ***D: Decision*** ***Q: Question*** ***A: Action Item***

Topic		**Due Date**	**Respsbl.**
1.	**CR project – general aspects.**		
1.1	P (O. Dolinskyy) General overview and status of the CR project.		
1.2	TCR1 diagnostics I (I. Koop): BINP is interested in production of the rest of TCR1 diagnostic components (fast current transformer and scintillation screens) which are presently assigned to GSI. A: BINP will prepare a letter of proposal to assign the rest TCR1 diagnostics to BINP. List of corresponding items with PSP-codes shall be provided to BINP by O. Chorniy. The letter of proposal will be prepared by Y. Rogovskiy/I. Koop and given to D. Urner who will		

	then take necessary formal actions. We are interested in assignment of the components to BINP as soon as possible taking into account that BINP is already planning CDR/FDR.	09.11.2018	O.Chorniy, Y.Rogovsky, I.Koop
1.3	<u>pbar channel diagnostics</u> I (I. Koop): We would like to overtake the pbar-channel diagnostics if it is identical to CR/TCR1 design as we have already started the procurement. R (M. Schwickert): For pbar part diagnostics, we have to first discuss technical details before discussing the assignment and contracting of the pbar diagnostics. A: Technical discussion on the possibility to use the CR-type design of the beam diagnostics devices in the pbar-separator shall be organized during this workshop.	09.11.2018	O. Chorniy, Y.Rogovsky, M.Schwickert
1.4	<u>Building planning</u> R (O. Dolinskyy) Two change requests (building planning and power requirements) have been prepared and submitted by BINP. FAIR S&B has accepted the change requests. Currently planning of the CR building is stopped. It will be discussed in the dedicated workshop between FAIR S&B and BINP when and how to proceed with the building planning. A: The date of the workshop FAIR S&B and BINP has to be fix soon. The agenda for the workshop has to be prepared in advance.	20.12.2018	H. Hageslkamp, O. Dolinskyy
	<u>Organizational issues</u>		

1.5	A: Monthly CR coordination meeting shall be re-established. Date and time has to be fixed during this workshop. A: Date for the next workshop between BINP and FAIR at GSI has to be fixed during this workshop. R (O. Dolinskyy): Monthly reporting in EDMS has to be regularly prepared for each WP prior to the regular PPM meetings.	09.11.2018 09.11.2018	I.Koop
1.6	Project Structure I (O. Dolinskyy) WP CR Installation – Oleg Gumenyuk is proposed to overtake this work-package starting from January 2019.		
1.7	Communication A: Visit of the BINP QA expert shall be organized to discuss QA aspects with H. Shwartz. Date for this visit shall be agreed and fixed during this workshop. A: In table of the contact persons, Mr. Karnaev shall be replaced by Mr. Senchenko. Mr. Kolmogorov shall be replaced by Mr. Senkov. Rahimov shall be corrected to Rakhimov.	09.11.2018 09.11.2018	I.Koop, H.Schwarz O.Dolinskyy
	Alignment A: BINP experts on magnet alignment will be invited to attend one of the sessions of this workshop and discuss communication issues. A visit of the BINP alignment team to GSI shall be planned during this workshop.	09.11.2018	I.Koop

1.8	Risk assessment and safety A: BINP shall designate a person who will be responsible for the risk assessment and implementation of safety regulations and directives. A: E. Petrova will contact H. Schwarz during this workshop to discuss requirements and necessary steps in the risk assessment issues.	09.11.2018 09.11.2018	I.Koop E.Petrova, H.Schwarz
1.9	Planning A: Time schedule for all required milestones for all BINP WPs has to be clarified and fixed during this workshop. R (O. Dolinskyy) Completion of required milestones is defined and fixed by the corresponding protocol with signatures of the involved BINP and GSI/FAIR persons as defined by the SPL. A: Optimization of the time frame for the CR pre-assembly and installation shall be discussed, and corresponding dates shall be fixed during this workshop.	09.11.2018 09.11.2018	WPLs WPLs, SPL
1.10	Manpower resources I (O. Dolinskyy) Preliminary estimations for the required manpower resources from GSI technical departments have been done for the CR project during the next years. A: We shall clarify with BINP WPLs during this workshop, what is the amount of GSI manpower resources that BINP needs as assistance		

	from GSI technical departments during the execution of the CR project in the next years.		
2. CR beam diagnostics.			
2.1	P (Y. Rogovsky): Overview and status of CR beam diagnostics.		
2.2	<u>CR Beam Position Monitor</u> A: CDR of the CR BPM will be presented during this workshop.	09.11.2018	Y.Rogovsky
2.3	<u>CR Scintillation Screen</u> A: CDR of the CR Scintillation Screen will be presented during this workshop.	09.11.2018	Y.Rogovsky
2.4	<u>CR Beam Loss Monitor</u> A: During this workshop, we have to clarify whether the BLM should be assigned to GSI.	09.11.2018	Y.Rogovsky
2.5	<u>Planning</u> A: A more detailed and accurate time schedule of the component delivery shall be discussed. A:	09.11.2018	Y.Rogovsky

	Separate delivery schedule milestones have to be specified for the TCR1 diagnostics components.	09.11.2018	Y.Rogovsky
2.6	<u>Procurement</u> R (O. Dolinskyy) BINP components which should be procured by GSI, have to be included into a list together with other components and delivered to D. Urner as a request for procurement. A: Possibility of delivery of the Libera to BINP has to be discussed with D. Urner. As a second option, delivery of the GSI test-box for pre-amplifier can be considered. A: Establish contact to Slovenia provider on the possibility to apply their pneumatic drives which have been planned for other devices at GSI also for BINP diagnostics. BINP drawings shall be provided to the provider.	16.11.2018 20.12.2018	Y.Rogovsky, O.Chorniy O.Chorniy, M.Schwickert
2.7	P (O. Chorniy) Overview of CR beam diagnostics – GSI in-kind.		
2.8	<u>DAQ CR Scintillation Screen</u> A: It shall be checked with D. Urner whether the DAQ for scintillation screens has already been contracted. If not, it has to be included into the next in-kind contract between FAIR and GSI.	09.11.2018	O.Chorniy
2.9	<u>CCC</u> I (O. Chorniy): The prototype of the CCC cryostat is presently under production. The prototype will be tested at CRYRING. Afterwards, the specification will be prepared for the CR device. Then GSI will produce the device for CR.		

2.10	<u>Super-FRS BPM</u> A: Information regarding the required changes (flange type etc.) of the BPM design for Super-FRS will be delivered to BINP during this workshop.	09.11.2018	M.Schwickert
	3. CR magnets.		
3.1	P (A. Starostenko) Status of CR magnets.		
3.2	A: A more detailed production and delivery time schedule including separate milestones for each of the series components shall be prepared for all magnets during this workshop.	16.11.2018	A.Starostenko, I.Koop
3.3	A: Meeting with QA experts shall be organized to discuss and clarify details on the documentation preparation.	09.11.2018	A.Starostenko
3.4	A: Concept of integration of the SC microwave damping modules into the wide quadrupole-sextupole chamber has to be discussed and clarified during this workshop.	09.11.2018	A.Starostenko

2.2 CR kick-off continuation

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Suggestion to include the following topics into the CR parallel I/II session

- BINP liaison officer
- CR installation plan / CR Schedule
  - Establishment of baseline schedule during workshop.
  - procedure how to modify schedule in future
  - discussion of possible conflicts with priorisation of FAIR items in workshop and design office
- Provision of items by FAIR:
  - establish procedure
- Update of WPL list including email addresses an phone number of BINP CR team and FAIR CR team
- Come up with a procedure for CDRs and FDRs also in view of a biannual workshop.

2.3 CR vacuum system

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2.4 CR beam diagnostics

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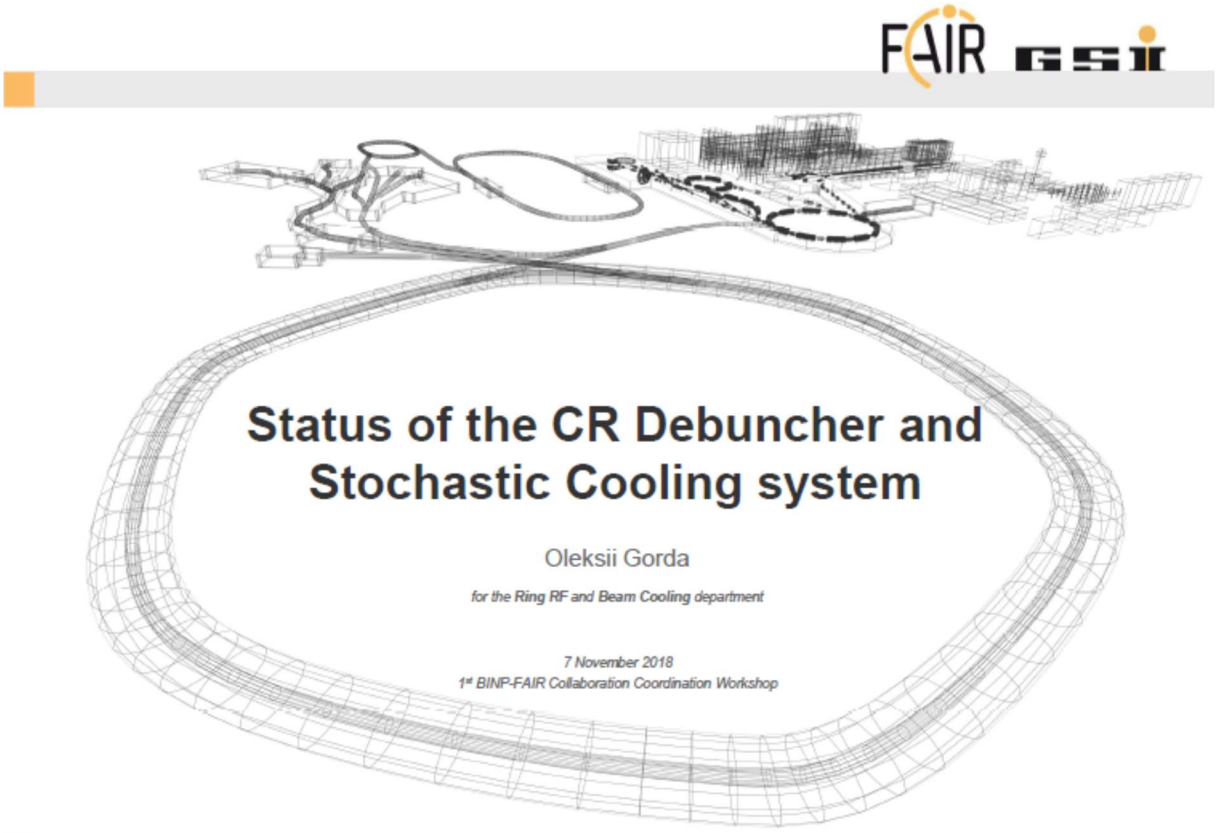
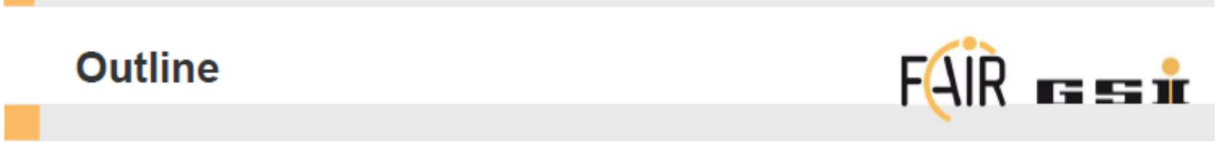
2.5 CR beam dynamics

Corresponding Author(s): dshwartz@inp.nsk.su

2.6 GSI contribution to CR (RF, debuncher, stochastic cooling etc.)

Corresponding Author(s): o.gorda@gsi.de



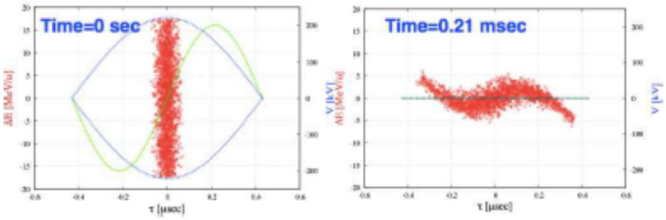


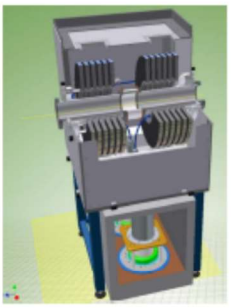
- WP 2.5.4 CR RF debuncher (GSI in-kind)
- WP 2.5.10 CR Stochastic Cooling (GSI in-kind)
- Expected performance of the CR

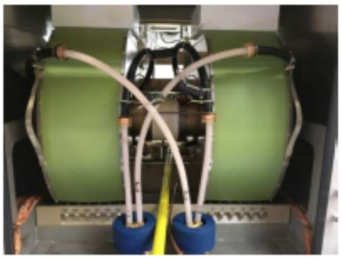
CR debuncher - Overview

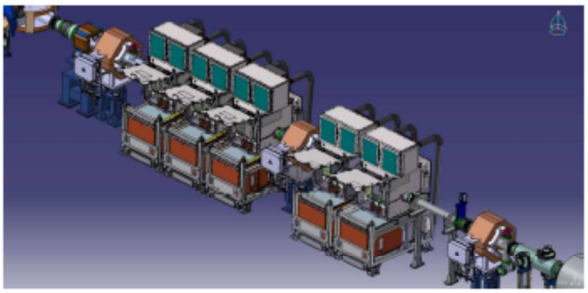
- Bunch rotation of antiprotons or heavy ions by a quarter of synchrotron oscillation period.
- Reduction of the momentum spread by factor of 3 to match the momentum acceptance of the stochastic cooling system.

Bunch rotation of heavy ion beam within 220 turns.









- Two inductively loaded coaxial quarter wavelength resonators working on a common ceramic gap.

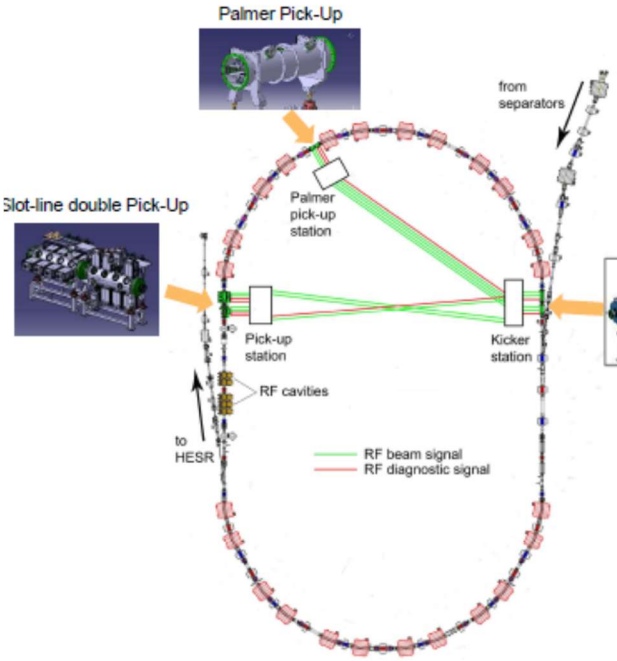
- Max. voltage 40 kV/unit
  Number of units 5
  Frequency range 1.1 – 1.5 MHz

CR Debuncher - Status

- FAT/SAT 1st series cavity – successfully tested and accepted in 2017.
- FAT 2nd series cavity – ready.
- FAT/SAT 1st and 2nd series power supply unit – ready.
- Manufacturing of all series cavities and power supply units completed. FAT is ongoing.
- Shipment of all series CR debunchers and power supply units to FAIR – until end of 2018.

First of Series CR debuncher during commissioning at GSI.

CR Stochastic Cooling (SC) - Overview



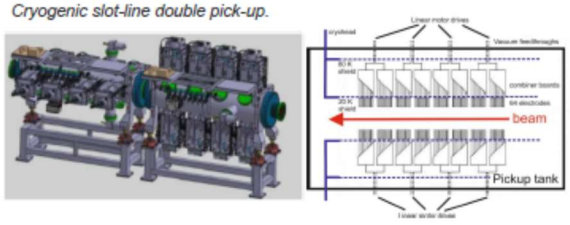
	Antiprotons 3 GeV, 10^7 ions		Rare isotopes/stable heavy ions 740 MeV/u, cooling of 10^8 ions	
	$\delta p/p$ (rms)	$\varepsilon_{x,y}$ (rms) [π mm mrad]	$\delta p/p$ (rms)	$\varepsilon_{x,y}$ (rms) [π mm mrad]
Before/after cooling	0.35 % / 0.05 %	40 / 1.25	0.2 % / 0.025 %	35 / 0.125
Phase space reduction	7×10^3		6×10^3	
Cooling time down/cycle	≤ 9 s / 10 s		≤ 1 s / 1.5 s	

CR Technical design Report (2014)

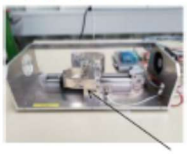
- 3D cooling by Filter, Palmer or TOF method.
- System bandwidth 1-2 GHz (MSV).
- Slot-line pick-ups with movable (plunging) electrode modules at cryogenic temperature (20-30 K).
- Palmer pick-up for pre-cooling of hot radioactive ion beams.

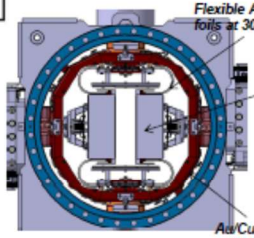
CR SC – Plunging Pick-Up

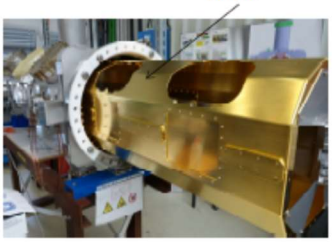
Cryogenic slot-line double pick-up.



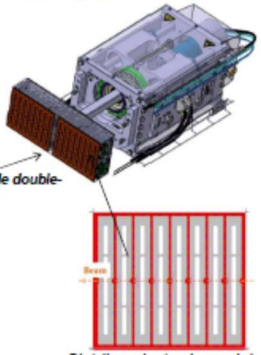
Test-bench for testing of the plunging Ag/BeCu foils.



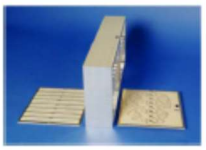




Assembly of the electrode double-module mounted to the linear motor drive unit.



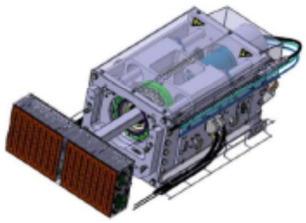
Slot-line electrode module on Al2O3 ceramic substrate.



Milled module body with pick-up board & combiner board

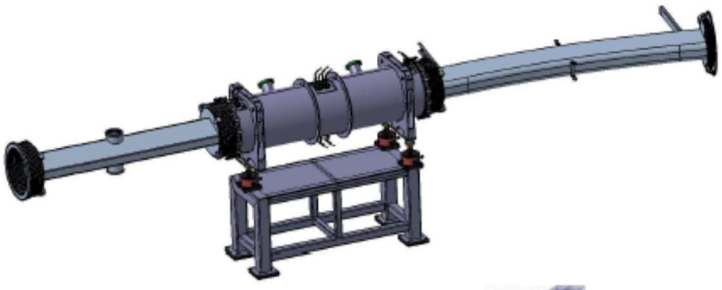
- Towards fixing remaining design issues.
- Testing of the full cryo-plunging concept in the GSI prototype tank ongoing.
- Engineering/mechanics/assembly activities ongoing.
- Long-time mechanical durability tests of the plunging foils ongoing.
- Vacuum-compatibility tests of materials.
- Electrode module re-design, contacts with providers.

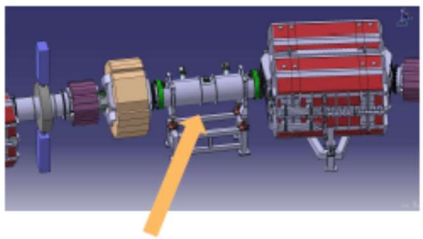
CR SC pick-up – Motor Drive Unit

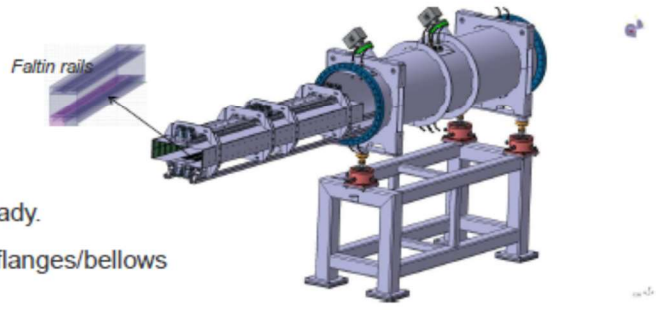


- Linear motor drives designed to synchronously move the electrode modules from ±80 mm to ±10 mm towards the beam axis.
- Concept successfully tested at GSI test bench for all required plunging directions.
- Procurement of the series motor drive units finished.

CR SC – Palmer Pick-Up







- RF concept + engineering ready.
- DMU integration with ISO-K flanges/bellows (BINP proposal) ready.
- Draft specification of the vacuum tank ready.
- Q4/2018: Final specification and manufacturing drawings for tendering the vacuum tank.

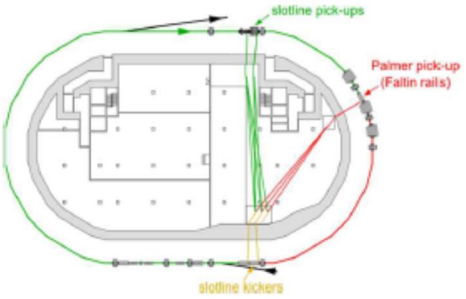
CR SC – Power Amplifiers

- 8 kW installed microwave CW power at the kickers for cooling.
- Series: 34 power amplifiers (250 W each).
- SAT of 1st series power amplifier successfully passed in Q3/2018.
- Preparation for the series production ongoing.
- Start of the series production expected in Q4/2018.

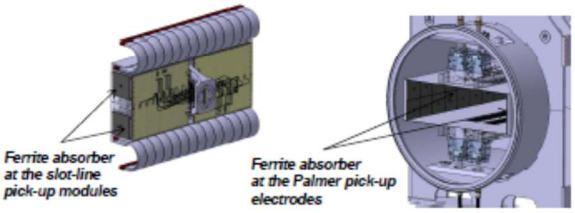
Test-bench at GSI for SAT of power amplifiers.

CR SC – Microwave Damping (1)

- Many RF-modes are excited by the electric fields applied at the kickers and propagate back through the large-aperture CR vacuum chambers.
- High gain (> 130 dB) in signal paths between pick-ups and kickers.
- Concept of passive, vacuum compatible, RF-absorbing materials (in 1-2 GHz mw range) for suppression the unwanted RF modes ready.



1. Ferrite absorbers inside S.C. pick-ups & kickers (≤ 2 m² per tank)

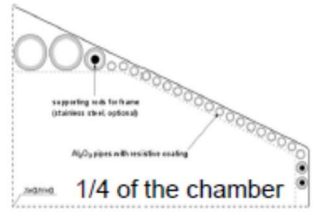


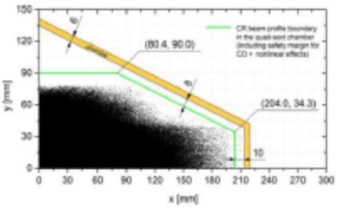
- Ferrite design ready.
- UHV test done (outgassing rate acceptable).
- Ferrites tiles purchased for all pick-ups.

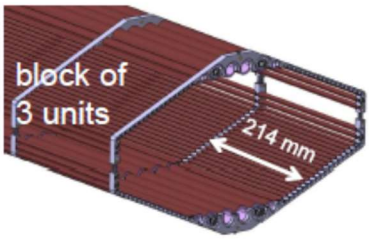
CR SC – Microwave Damping (2)

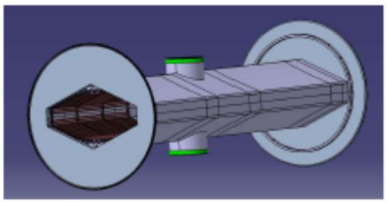
2. Resistively coated ceramic tube modules inside inside all hexagonal quadrupole/sextupole vacuum chambers in the CR arcs

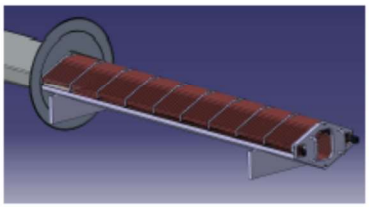
- Al_2O_3 tubes (4 standard diameters ⌀ 6...24 mm).
- Total module surface < 60 m² /arc.







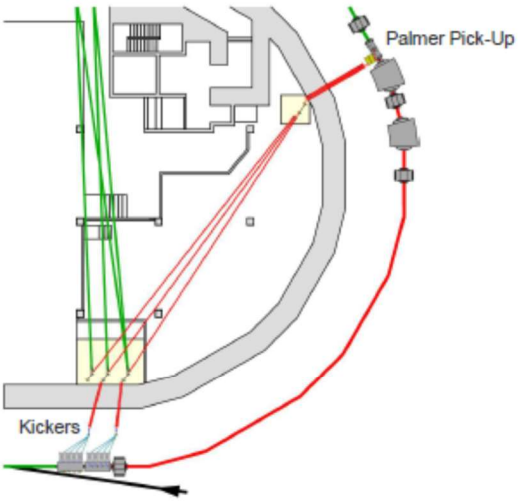


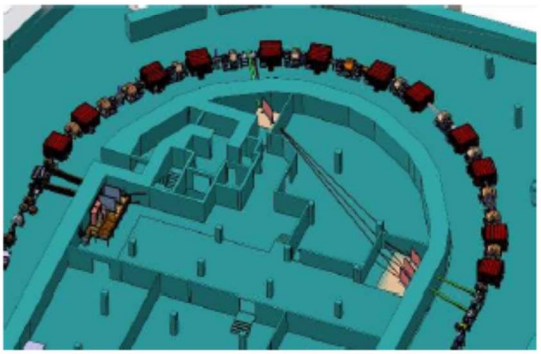


- Draft engineering concept ready.
- First batch of Al_2O_3 tubes for prototyping purchased. Resistive coating of prototype tubes ready.
- UHV+RF tests of tubes ongoing. Procurement of series if tested successfully.
- Q2/2019: assembly and full damping tube concept test after delivery of a prototype chamber by BINP.
- Procurement of the series of holders if tested successfully.

CR SC – Building Integration

- Almost no reserve for signal path time with respect to the ion beam flight time from Palmer pick-up to kickers.
- Optimization of the signal path is ongoing.
- Currently working on the proposal of changing the position/angle of the holes for the signal path in the inner building wall.
- Corresponding change request will be submitted to FAIR S&B until end of 2018.





Expected Performance of CR

- Collaboration with Dr. Takeshi Katayama (Nihon University, Japan) on theoretical study of beam dynamics for the full cooling cycle including RF manipulations and stochastic cooling.
- Measured RF properties from the commissioning of the 1st series CR debuncher are used in simulations.

CR cooling cycle

(1) Injection → (2) Bunch rotation and de-bunching → (3) Cooling → (4) Re-bunching → (5) Extraction

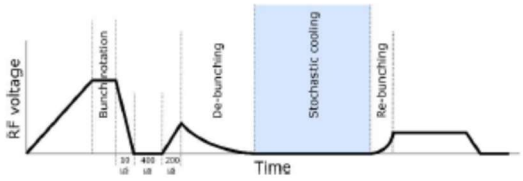
(1) Injection of a short bunch from pbar-separator or Super-FRS.

(2) Bunch rotation by RF system to match the beam parameters to the requirements of the stochastic cooling system.

(3) Cooling (Filter, Palmer or TOF method).

(4) The beam has to be bunched again by RF system before extraction.

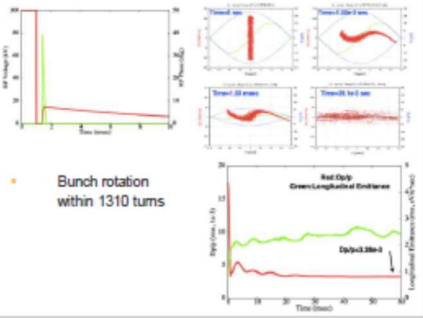
(5) Extraction to HESR.



Antiproton Beam Dynamics

Bunch rotation and de-bunching

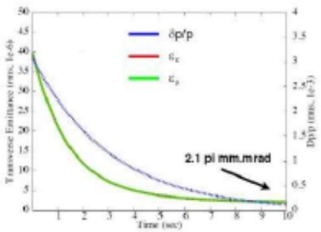
Initial momentum distribution	±3% (uniform)
Bunch width (rms) Gaussian truncated at ±3σ	12.5 ns
Revolution frequency	1.384 MHz
RF harmonic number	1
Momentum slipping factor	0.014

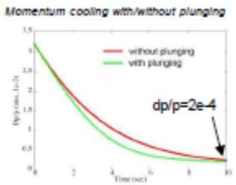


- Bunch rotation within 1310 turns

Stochastic cooling

Particle number	10^8
Objective cooling time	10 s





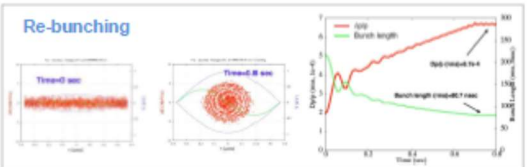
- Transverse emittance after 10 s cooling: ~2 mm mrad (rms).
- Momentum spread after 10 s cooling: ~2e-4 (rms).
- Plunging helps to reach equilibrium value at ~7 s.

Matching CR/HESR

Momentum spread after re-bunching	6.7e-4(rms)
HESR momentum acceptance	7e-4 (rms)
HESR stochastic cooling system momentum acceptance	6e-4 (rms)
HESR transverse acceptance	2.4 mm mrad (rms)

No margin! Possible option to mitigate the problem: dynamic ion-optics variation (eta-ramping) can reduce dp/p to ~4e-4(rms).

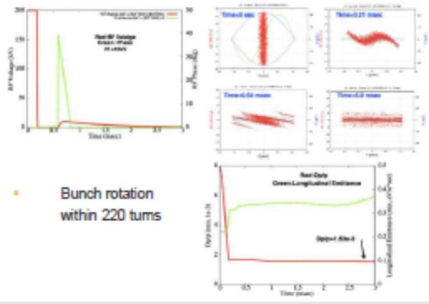
Re-bunching



Rare Isotope Beam Dynamics

Bunch rotation and de-bunching

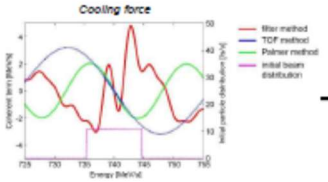
Initial momentum distribution	
Gaussian truncated at ±1.2σ	1.25e-2 (rms)
Bunch width (rms) Gaussian truncated at ±3σ	25.0 ns
Revolution frequency	1.148 MHz
RF harmonic number	1
Momentum slipping factor	0.178

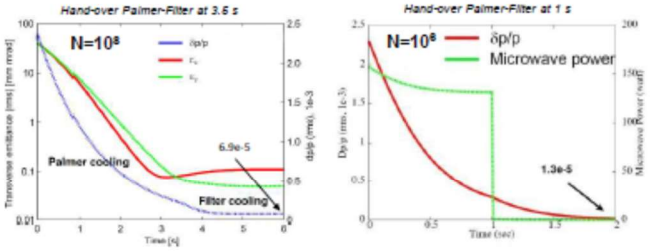


- Bunch rotation within 220 turns

Stochastic cooling

Reference ion type	$^{132}Sn^{50+}$
Particle number	10^6 and 10^8
Objective cooling time	< 5 s
Assumed momentum spread before cooling	2e-3 (rms)
Cooling method	Palmer, TOF or filter





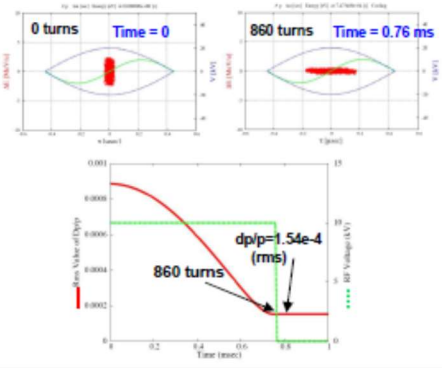
- HESR momentum acceptance 7e-4 (rms).
- HESR transverse acceptance 2.6 mm mrad (rms).

Stable Heavy-Ion Beam Dynamics

- Cooled stable heavy ions from SIS-18.

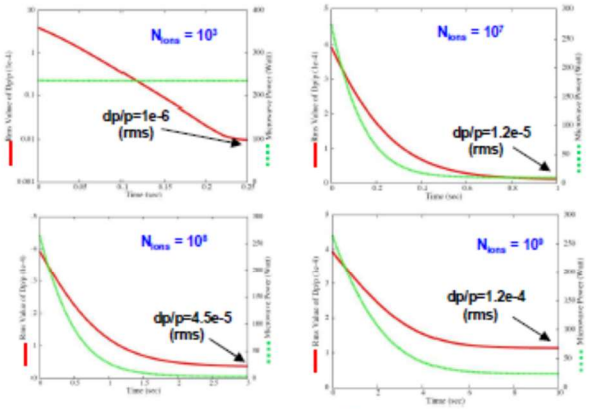
Bunch rotation and de-bunching

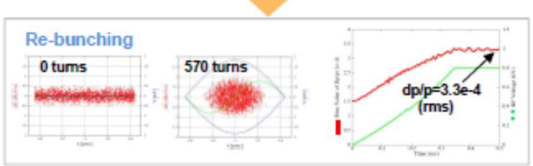
Initial momentum distribution	
Gaussian truncated at ±2σ	1e-3 (rms)
Bunch width (rms) Gaussian truncated at ±3σ	12.5 ns
Revolution frequency	1.148 MHz
RF harmonic number	1
Momentum slipping factor	0.178



Stochastic cooling

Reference ion type	$^{238}U^{92+}$
Particle number	10^3,10^7,10^8 and 10^9
Cooling method	Filter





- After re-bunching, the beam is within the HESR momentum acceptance of 7e-4 (rms).

- GSI/FAIR Workshop on Stochastic Cooling will take place on 21-23 January 2019 at GSI.
- Focus on theory, simulation and hardware developments.

Thank you for attention

2.7 CR vacuum

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2.8 CR installation

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2.9 CR injection/extraction

Corresponding Author(s): p.yu.shatunov@inp.nsk.su

2.10 ILIMA

Corresponding Author(s): h.weick@gsi.de

ILIMA Experiments in the CR

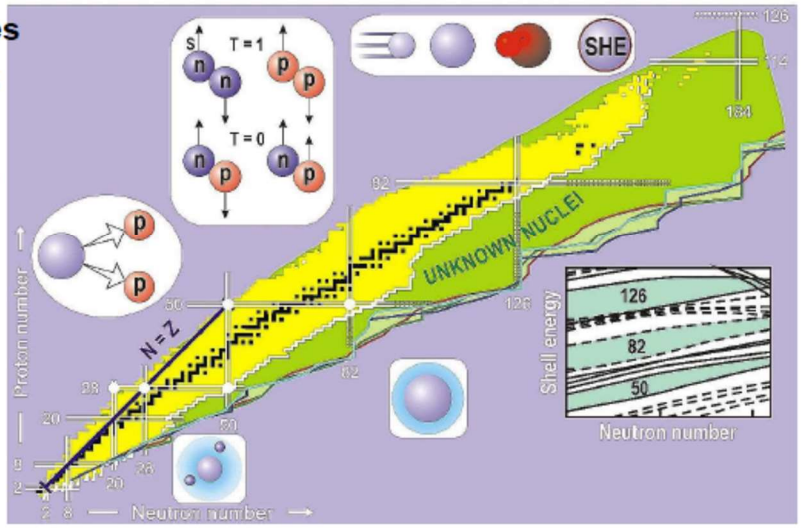
Helmut Weick, GSI
Budker-GSI collab. workshop Novosibirsk, 8th Nov 2018

- Goals of Experiments
- Detector Systems (Schottky, ToF, Heavy-Ion)
- Integration into the CR
- Requirements on CR

GSI FAIR

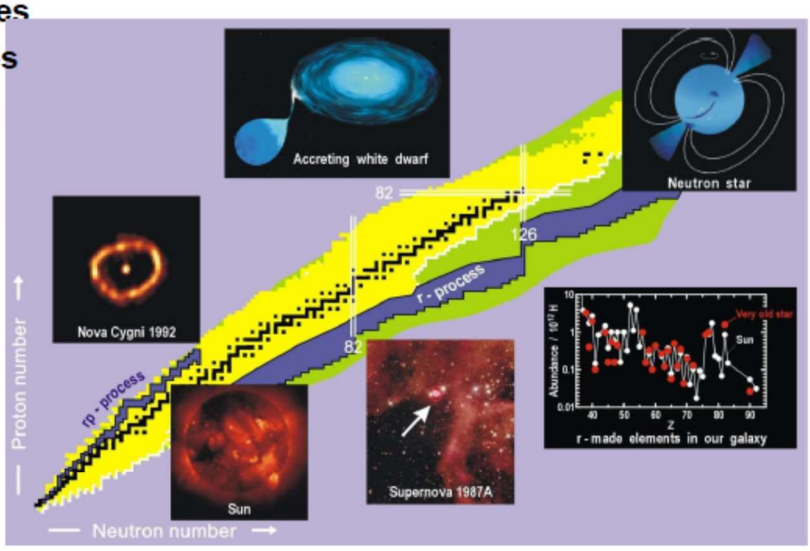
ILIMA = Isomeres, LIfetimes and MAsses

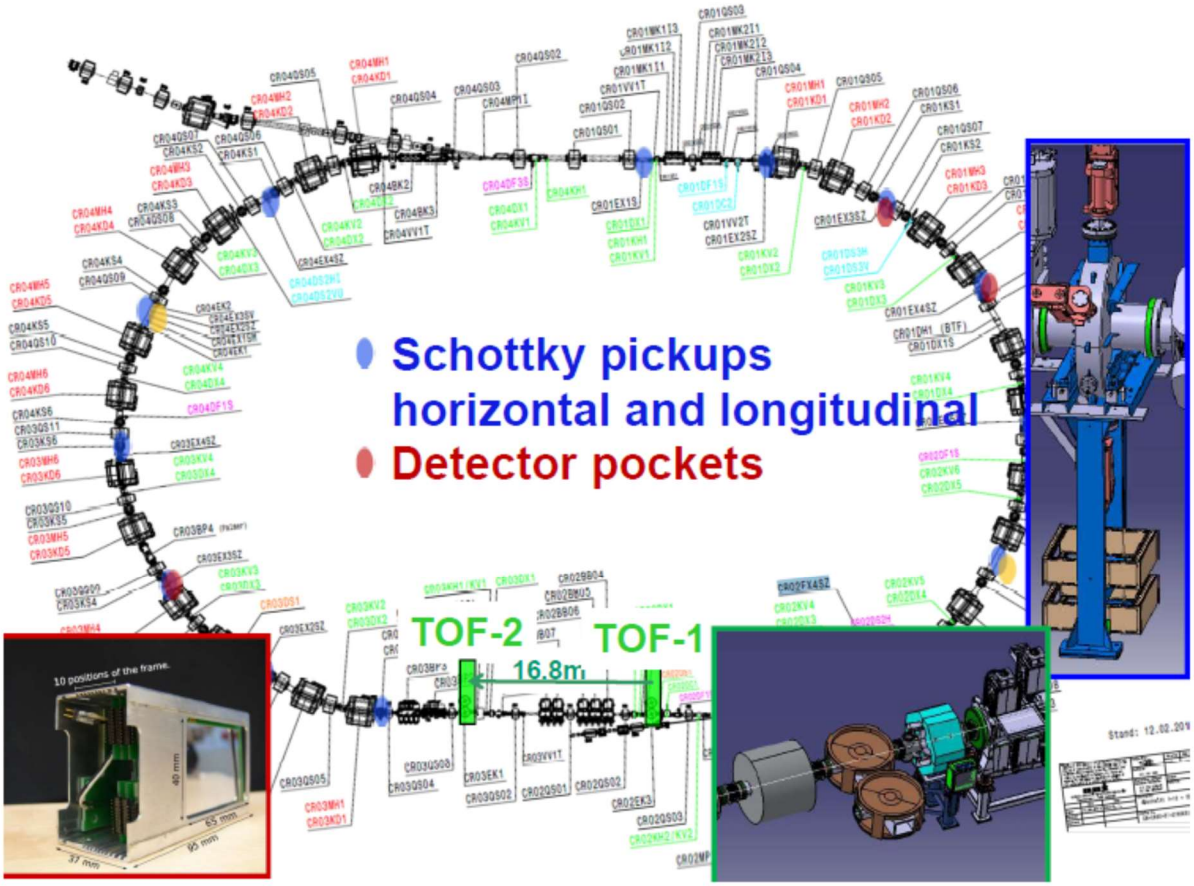
- Total binding energies
- Nuclear decay modes
- Separation energies
- Driplines
- Pairing correlations
- Deformations
- Shell closures
- Reaction Q-values
- Testing and improving nuclear theories



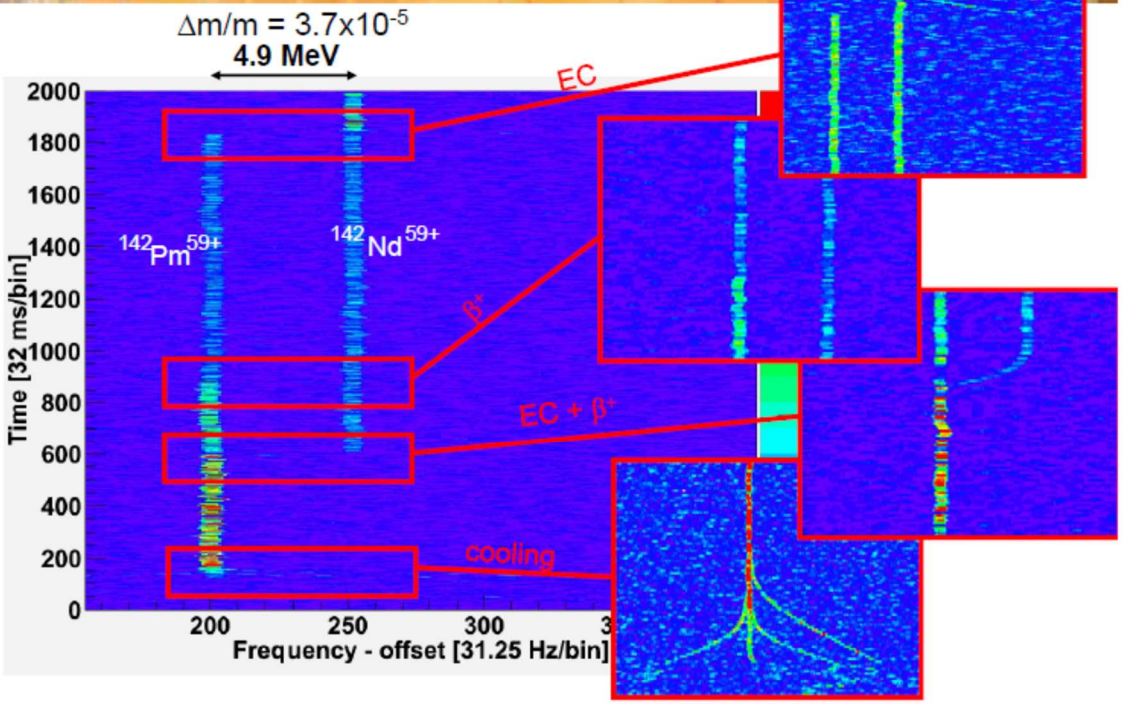
ILIMA = Isomeres, LIfetimes and MAsses

- Total binding energies
- Nuclear decay modes
- Separation energies
- Driplines
- Pairing correlations
- Deformations
- Shell closures
- Reaction Q-values
- Testing and improving nuclear theories
- Path ways of nucleosynthesis

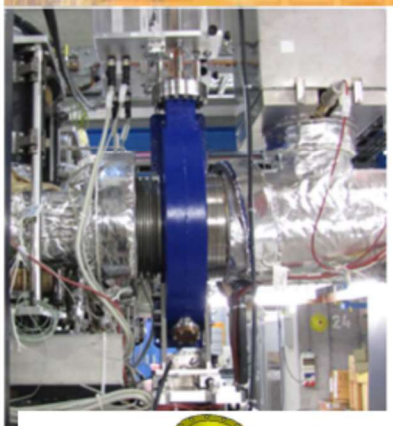




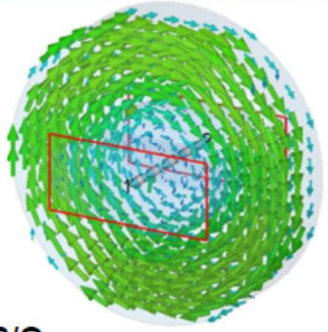
EC decay in ESR
cooling, 2 EC and 2 β^+ -decays



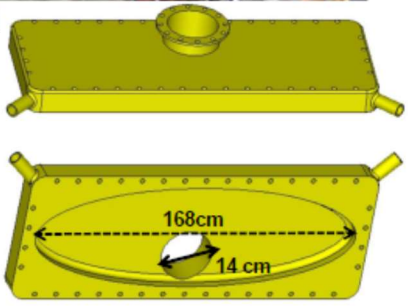
Resonant Schottky Pickup
(with transverse position measurement)

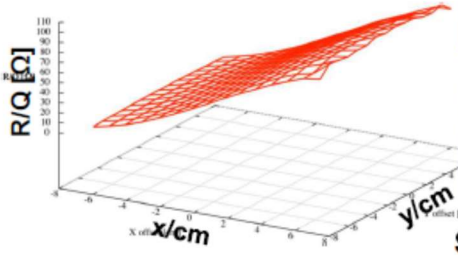


Use pill box cavity in
T010 monopole mode
f_R tunable,
quality factor Q
also adjustable.



Elliptical cavity possible
to introduce gradient in R/Q,
signal strength gives position



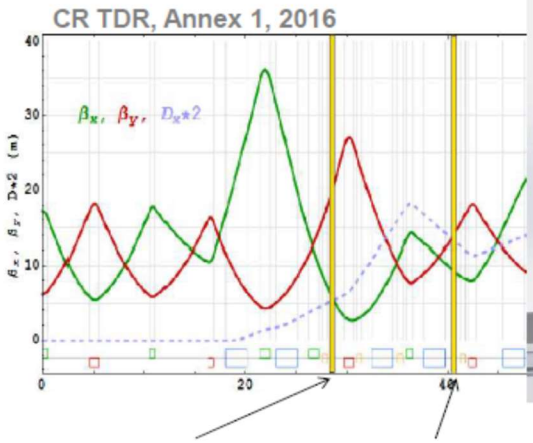


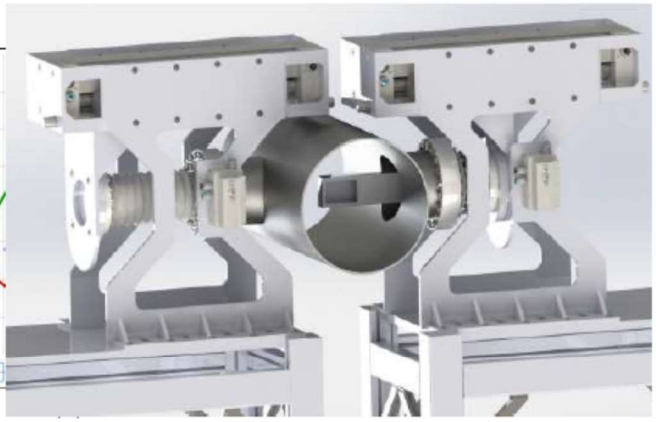
S. Sanjari, X. Chen

Detector Pockets

e.g. for β delayed neutron emission

CR in RIB mode, x-width = sqrt(β_x ε_x)





Δx = -72 mm
for Z=50, m=132

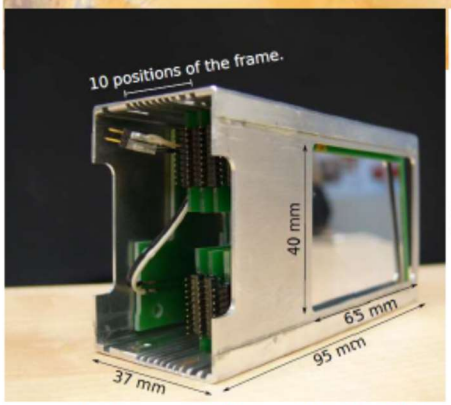
Δx = -130 mm
for Z=82, m=126

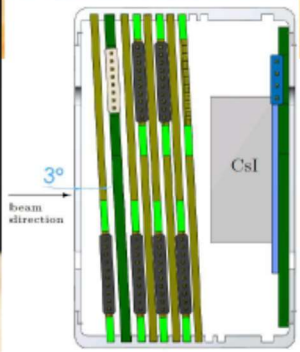
pocket out during injection
→ fast drive with servo motor

cooled beam (ε_x = 1 mm mrad)
➔ x-width = 2.2 – 3.2 mm

R. Gernhäuser

CsISiPHOS Heavy Ion Detector

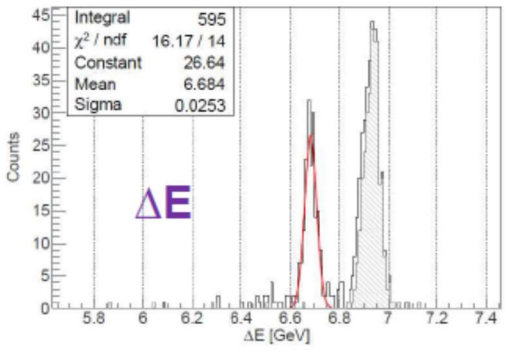


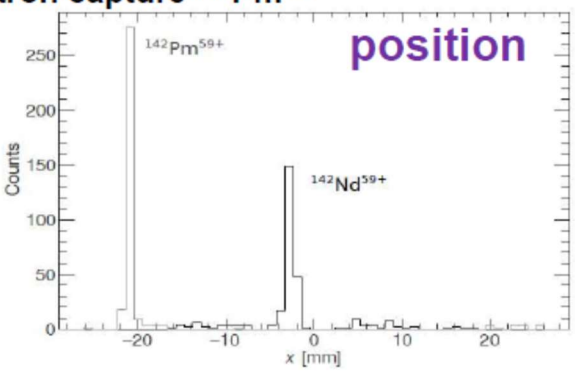


S/DSSD stack for ΔE, x
active area 40mm x 60mm
with CsI calorimeter +
Si photo diode to identity
Z and A by ΔE, E.

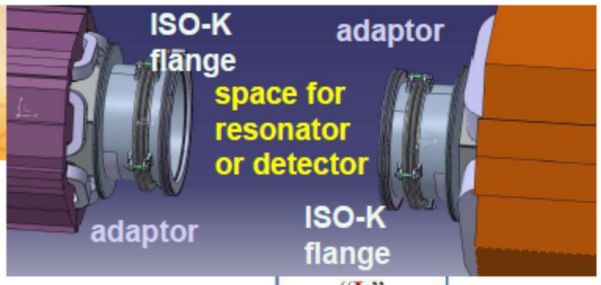
Ali Najafi et al.
NIM A836 (2016) 1.

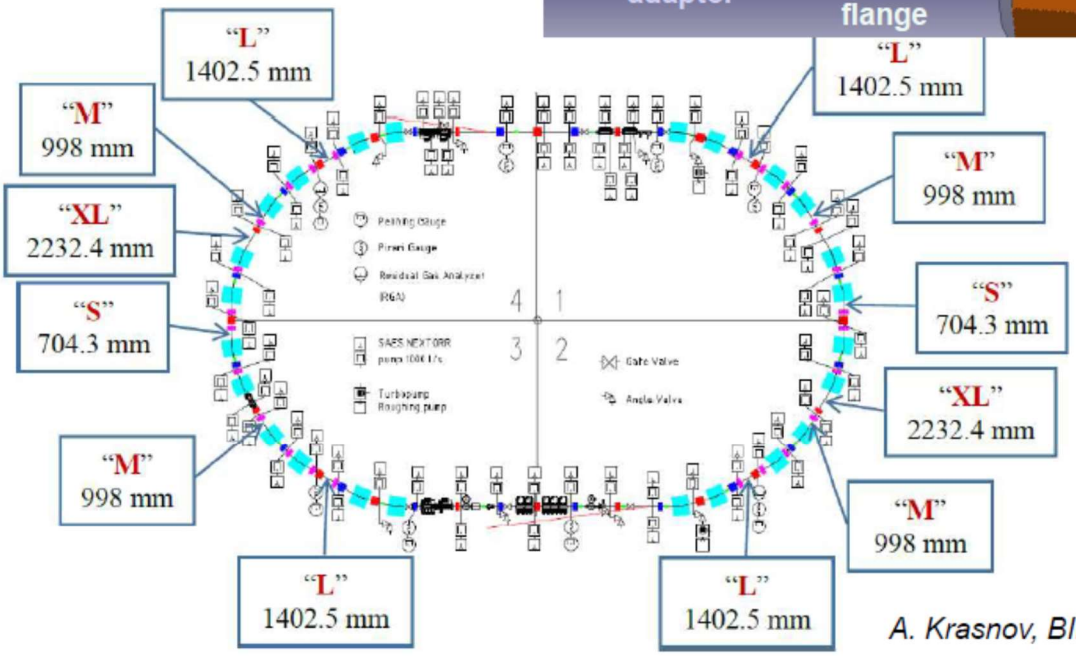
β⁺ decay: $^{142}Pm^{60+}$ → $^{142}Nd^{59+}$, electron capture $^{142}Pm^{59+}$





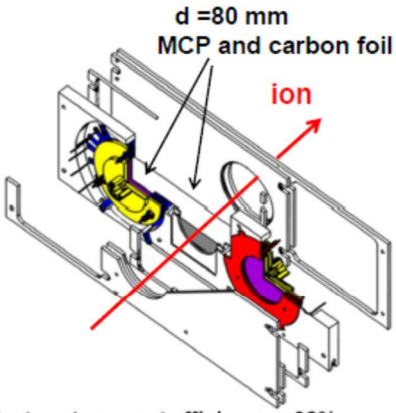
Detector Positions





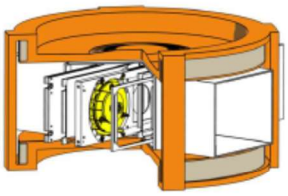
A. Krasnov, BINP

TOF Detector System for CR



Electron transport efficiency ≈ 98%
Timing accuracy ≈ 35 ps

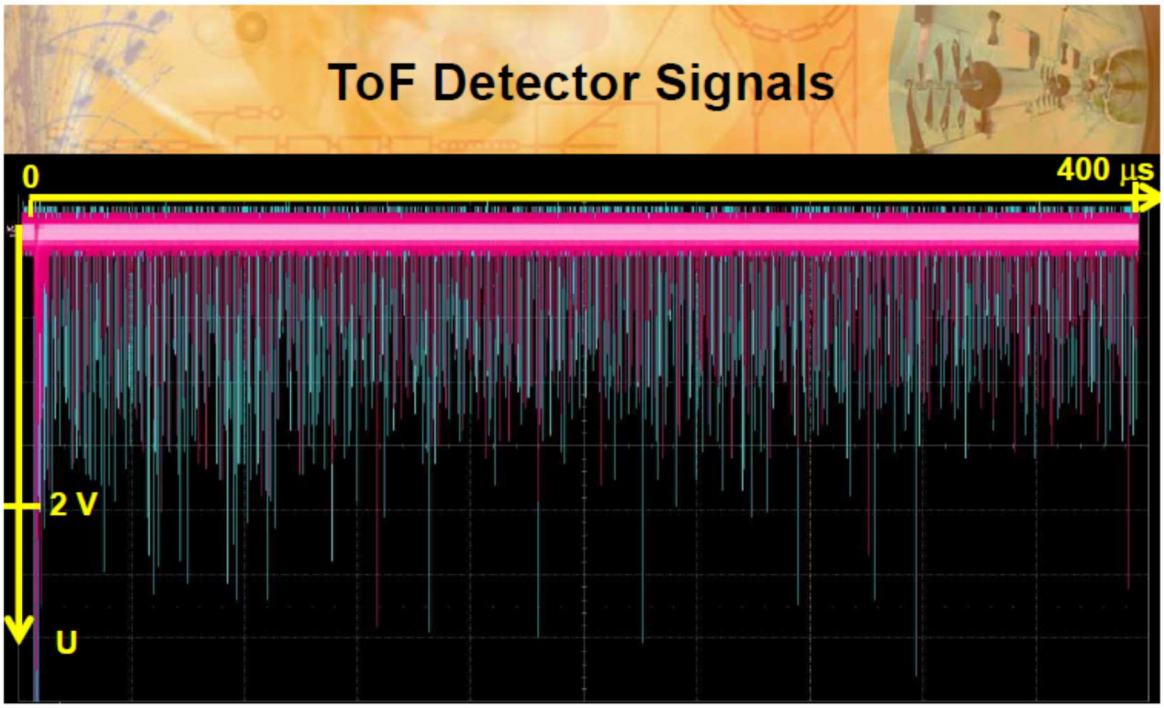
Isochronous electron transport by crossed E, B fields.



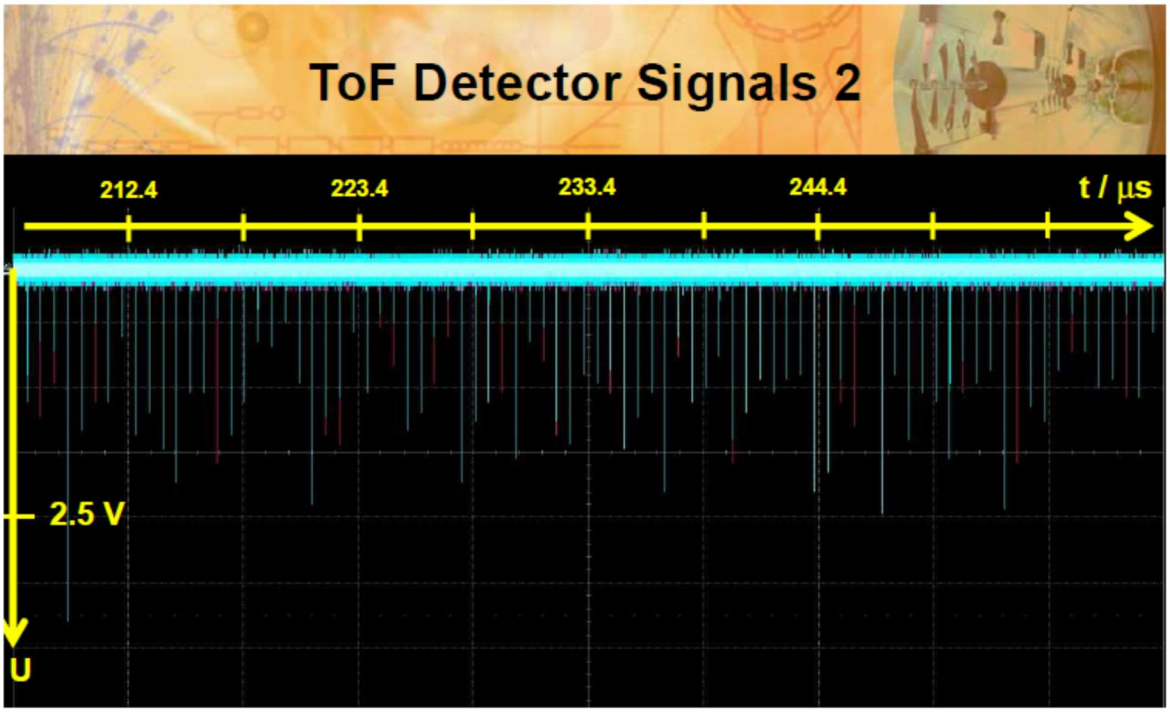
yoke diameter 900mm
magnet hom. $\Delta B/B = 10^{-3}$

- Active area d=80mm wanted, accepted emittance (x * y) scales with d^4 !
- Simulations + Tests for detector show even better timing than ESR detector

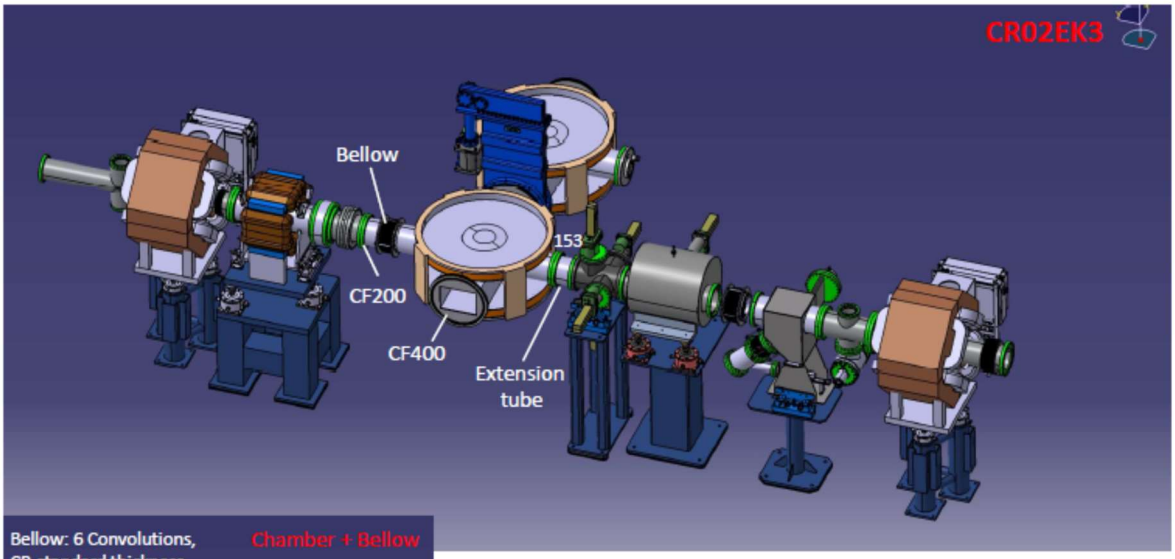
M. Diwisch thesis, University Giessen 2014, N. Kuzminchuk et al., NIM B 821, 160 (2016), accepted TDR 2018.

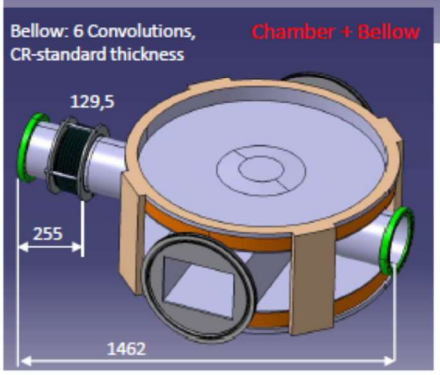


^{238}U beam on improved ToF detector in ESR, Oct 2014
old detector but new channel plates, new field settings,
Almost no decrease of pulse height even after 800 turns.



A good signal from every turn on both sides (blue and red),
in the past only shorter sequences with gaps.

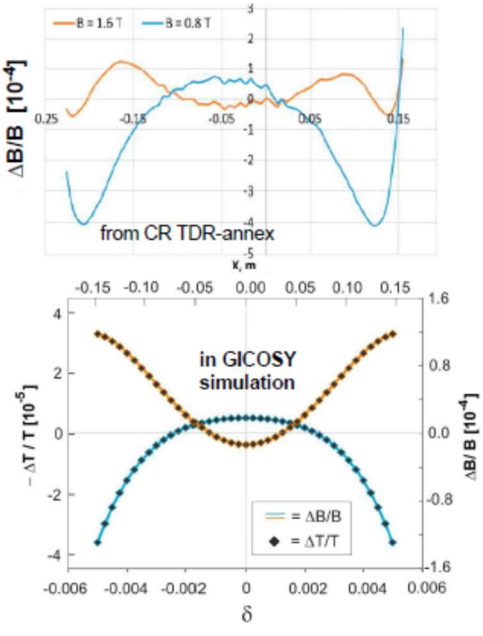




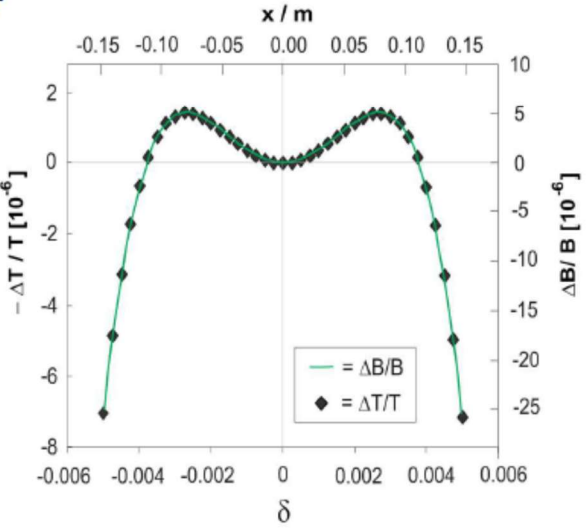
Installation in ring

Decapole Corrector

Sextupoles, octupoles are foreseen, but also a 4th order corrector is needed.

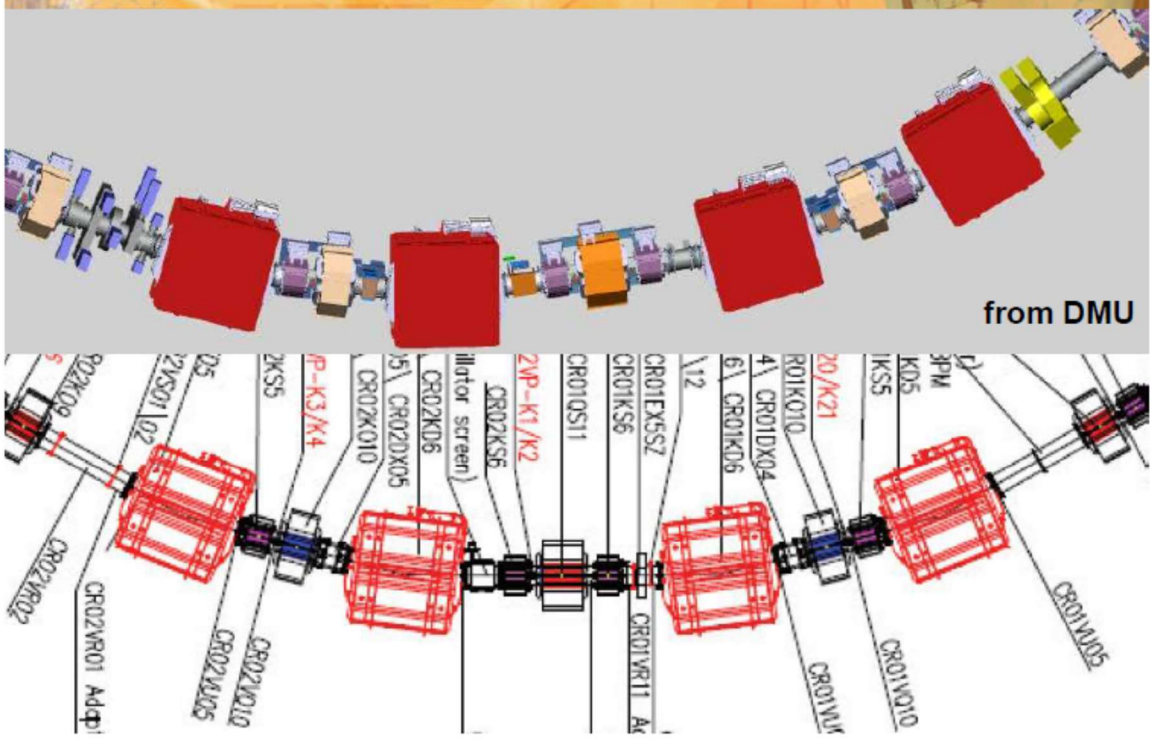


With full correction

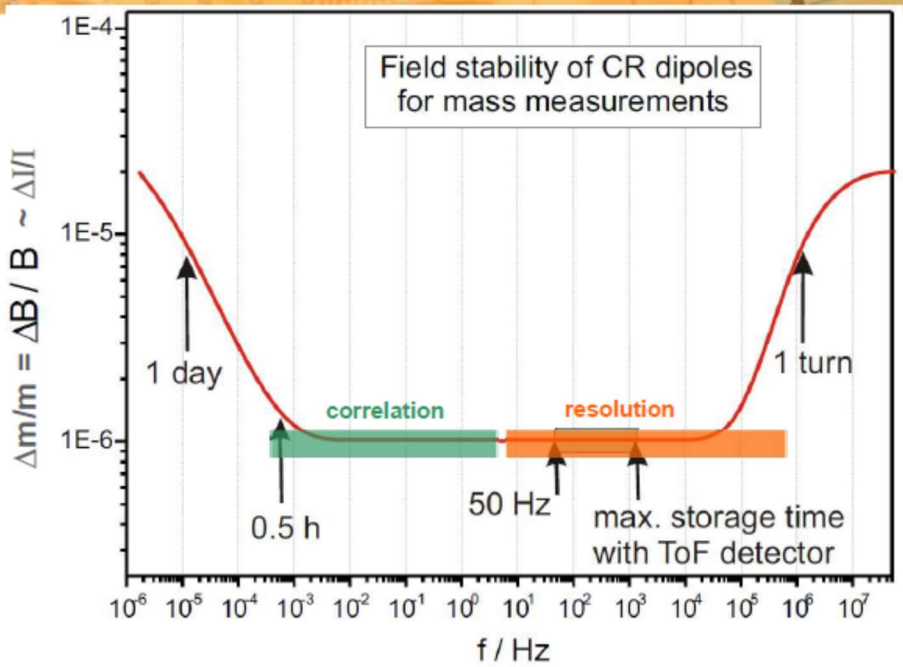


$B^{(4)}L$ = 80 Tm/m⁴ at best position over one turn for Bρ = 13Tm, e.g. B = 0.02 T on r_0 = 0.235 m, L = 0.5m (Y-steerers have larger B-field)

CR Arc



Power Supply Stability



Specs : $\Delta I / I = \pm 0.5 \times 10^{-5}$

Conclusion

Scheme for integration of Heavy-ion detectors and Schottky pickups found. Also just enough space for ToF detectors.

Heavy-ion and ToF TDR approved, Schottky still under approval, asked for German in-kind funding at FAIR Council (Nov 2018).

740 k€ German project money (2005 prices) + few other sources
ToF detectors and some pockets can be provided at first installation,
Schottky pickups probably not all -> dummy tubes needed.

Still looking for decapole corrector, weak but very useful
to increase acceptance. Find a position!

2.11 GSI contribution to CR beam diagnostics

Corresponding Author(s): o.chorniy@gsi.de

GSI Contribution to CR beam diagnostics and common questions

O. Chorniy

Outlook

Future contracts :

- ❑ 400 mm diagnostics devices (SFRS, pBar, HEBT):
- ❑ 3 BPM pickups 400x400 and 3 BPM pickups 400x200
- ❑ 2 BPM LNA (amplifiers for pBar BPMs)
- ❑ 4 Screens vacuum chamber
- ❑ Flanges modified to DN 400 CF

Working questions:

- ❑ Clarification drive type for beam stopper: pneumatic or stepper motor drive
- ❑ BINP feedback and commitment on PDC procurement (update of motor number! 5x 4 motors for scrapers + 2x 1 for stoppers?)
- ❑ Clarification In-Kind Slovenia: Pneumatic drives (number and type) to be built by Vacutech

...

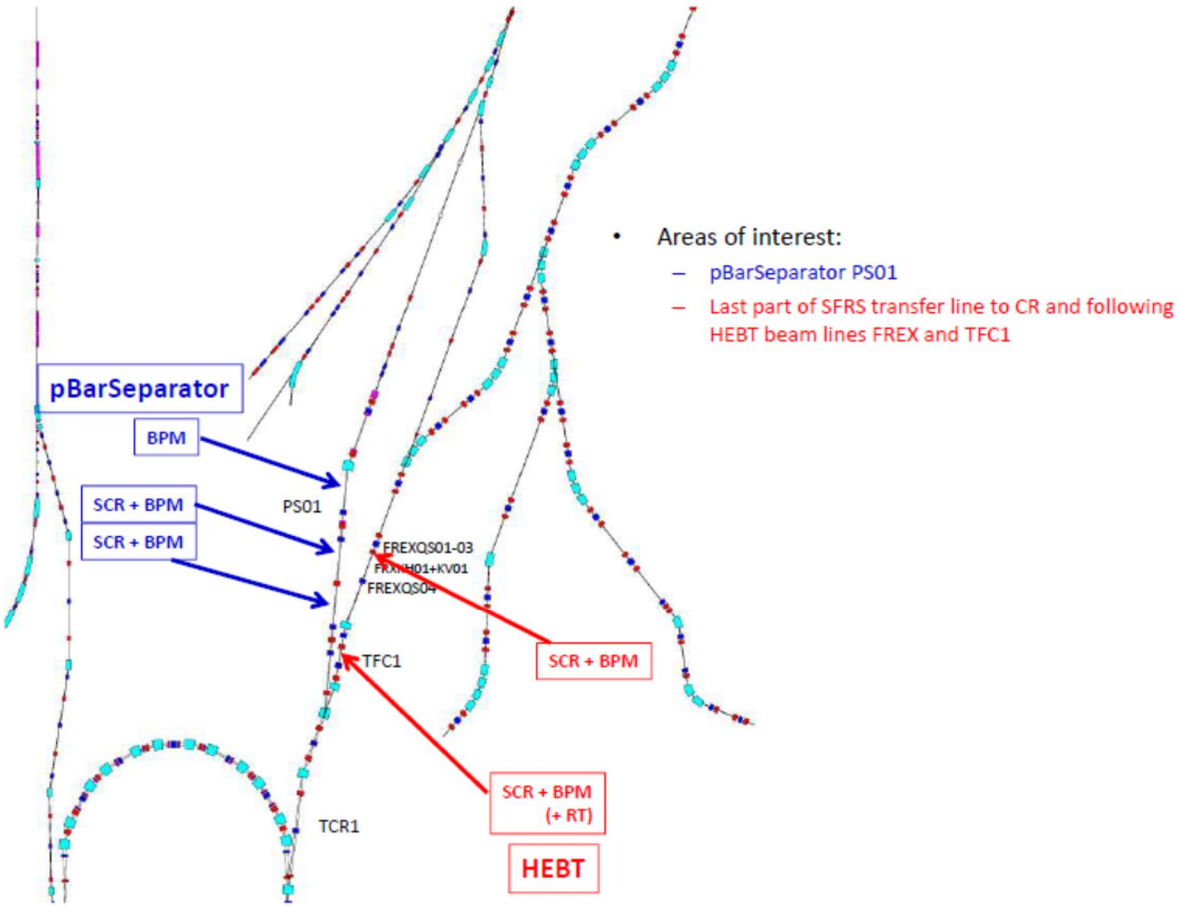
Status of "GSI" components:

- ❑ CCC
- ❑ Schottky
- ❑ BTF
- ❑ DAQ:
  - BPM
  - FCT
  - DCT
  - BLM
  - Screens
- ❑ PLC control

Future Contracts

Table of known demand
for 400 mm diagnostics (BPMs and Screens)

A. Reiter	12th September 2018					
Subproject	**Det. type**	**No. of devices**	**PSP Code**	**Component**	**Aperture (mm x mm)**	**Comments**
SFRS	BPM	1	2.4.6.1.5	Pick-up	400 x 400	FAIR
			2.4.7.1.12.1	vacuum chamber		separate PSP, assigned already to BINP
pBar Diagnostics	BPM	1	2.9.6.2.1.1	Pick-up	400 x 400	GSI in-kind
		1	2.9.6.2.2	vacuum chamber		GSI in-kind
	BPM	2	2.9.6.2.1.1	Pick-up	400 x 200	GSI in-kind
		2	2.9.6.2.1.2	Pre-Amplifier		GSI in-kind consistency to other TCR1 BPMs
		2	2.9.6.2.2	vacuum chamber		GSI in-kind
	SCR	2	2.9.6.3.2.2	vacuum chamber	450 x 450 as TCR1 Type 1	GSI in-kind
		2	2.9.6.3.2.3	Mechanics, alignment bridge		GSI in-kind , optional
			2.9.6.3.2.3.2	Pneumatic Drive		GSI in-kind, optional
HEBT	BPM	2	2.3.6.4.1.1.1.1	Pick-up	1x (400x400) 1x (400x200)	FAIR
		2	2.3.6.4.1.2.1	vacuum chamber		FAIR
	SCR	2	2.3.6.5.2.2	vacuum chamber		FAIR
		2	2.3.6.5.2.3.0	Mechanics, alignment bridge		FAIR
		2	2.3.6.5.2.3.1	Pressurized air drive		SLO (Tehnodrom)



Comments / Remarks on BPMs

– SFRS:
- 1x BPM with round electrodes (400 mm hor. and vert. aperture)
- No amplifier (see HEBT)
- Special case: vacuum chamber already assigned to Budker institute
- Vacuum flanges: DN 400 CF
- Check: available installation length, suitability of geometry for primary beam (large plate voltages)!

– pBar:
- 1x BPM with round electrodes (400 mm hor. and vert. aperture), special BPM in target hall -> no amplifier
- 2x BPM as TCR1 type 1 (400 mm x 200 mm apertures) in separator line PS01
- 2x BPM low-noise pre-amplifier LNA (to keep identical electronics chain for TCR1 beam line: 8 BPMs = 2x pBar + 6x TCR1 = 2x fully equipped Libera Platform B; possible cost reduction: GSI and BINP can combine HW -> 2 fully equipped Libera Hadrons!)
- Vacuum flanges: DN 400 CF

– HEBT:
- 1x BPM (400 mm x 200 mm aperture, corresponding to magnet aperture)
- 1x BPM (400 mm x 400 mm aperture)
- No amplifiers needed; Hadron HPA will be used as for HEBT BPM system
- Vacuum flanges: DN 400 CF

Working Questions

Component	BINP tasks	GSI tasks	Common tasks
FCT	Organize the procurement: to buy or provide money to FAIR	Procurement of DAQ hardware, Software development.	NO (everything clear)
DCT			
BLM	Formal decision: Withdraw the detector or decide on alternative option - to buy from GSI	tbd. for detectors	tbd., probably NO
BPM	Order Libera from Slovenia? Clarify preamp interface to DAQ.	Provide the software for preamp tests ?	Planning when this all will be needed
BTF	Check interfaces to Vacuum systems	Contract preparation	To re-approve the corrected (ITEP and GSI QA modifications) version
Schottky			
Screens, BStop	Contact the Slov. concerning pneumatic drives. Clarification drive type for beam stopper: pneumatic or stepper motor drive	Prepare table with PLC elements "pallet"	Engineering drawings approval interaction? Chose the proper PLC configuration for CR systems
Scrapers	Stepper motor controll status? (again, the custom solution PDC is hardly accepted, i.e. it must be ready product from Slovenia, the Programmable Multi-Axis Controller is already bought for CR)		PDC (Power Drive Case) procurement Update of motor number! 5x 4 motors for scrapers + 2x 1 for stoppers?)

Status of "GSI" components

DCCT, BLM and FCT DAQ

	FCT		DCCT		BLM	
	Hardware	**Software**	**Hardware**	**Software**	**Hardware**	**Software**
Design	platform is defined, components under developm.	based on existing SIS18 FCT	defined	ready, formal steps to be clarified	defined	ready, formal steps to be clarified
Prototype	1st version delivered, tests to be started	programming to be started	delivered and fully operational		delivered and tests are ongoing	
FDR	next step, low priority at the moment					

All systems will be used in SIS18/ESR beatimes during next year/s
All systems are "CR-ready"

Scintillating Screens

	DAQ		PLC for pneumatic drives	
	Hardware	**Software**	**Hardware**	**Software**
Design	Fully operational (for non-rad camera) and used in GSI beam times since a long time		In operation at GSI and PLC scheme is under permanent improvement and optimization	
Prototype				
FDR	DAQ will be checked if it can be applied as is to CR		Configuration and Components to be chosen	

Example of PLC Siemens components for possible CR prototype

CPU		
1	6ES7516-3AN00-4AB3	SIMATIC CPU 1516 PN/DP mit Software
2	6EP1334-3BA10	SITOP PSU200M 10A
3	6GK7543-1AX00-0XE0	Kommunikationsprozessor, CP 1543-1, Industrial Ethernet
IO-Station für 6 Antriebe pro Elektronikraum		
1	6ES7155-6AU00-0AB0	SIMATIC ET 200SP Digital PROFINET
2	6EP1334-3BA10	SITOP PSU200M 10A
3	6ES7132-6HD00-0BB1	RQ NO 4x120VDC/230VAC/5A ST
4	6ES7193-6BP20-0BB0	BU-Typ B0, 12 Push-In, 4 AUX
5	6ES7131-6BF00-0CA0	DI 8x24VDC/0,5A HF
6	6ES7193-6BP00-0BA0	BU-Typ A0, 16 Push-In, 2 Einspeisekl. Gebrückt (Digital-/Analog, 24VDC/10A)
Gesamt Netzwerkinfrastruktur für Profinet LOBI ohne Kabel		
1	6GK5206-2BS00-2AC2	SCALANCE XC206-2SFP managebarer Layer 2 IE Switch

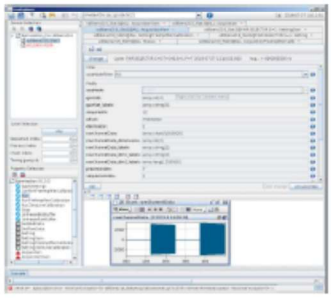
BPM DAQ status

Milestone	Libera Hadron	FTRN receiver	Frontend FESA class	Operational GUI app
Design	x	-	x	-
Prototype	x	-	x	x
FDR	x	-	to be done	-
Shipment	x	to be done		-
SatAa	x			-
SatAb	to be done			-

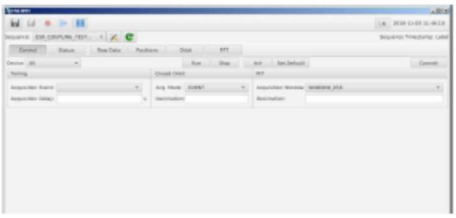
System is fully prepared to be used during ESR beam time 2018-2019

LIBERA Hadron

FESA class in FESA Explorer



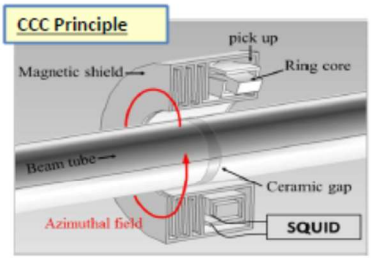
Control panel of GUI



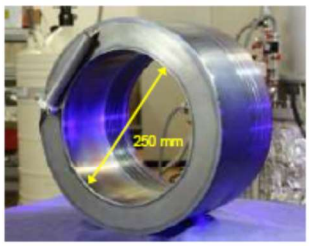
Cryogenic Current Comparator (CCC) Development for nA Beam Measurements

T. Sieber, D. Haider, N. Marsic, M. Schwickert, R. Stolz, T. Stoehlker, V. Tympel et al. / *GSI, HI Jena, TUD, FSU and IPHT Jena*

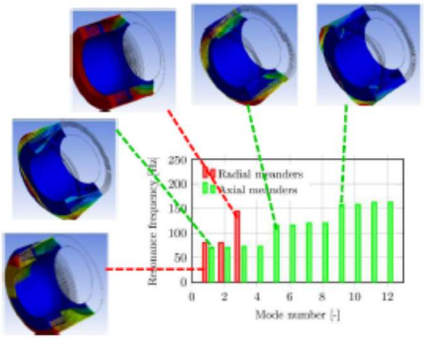
CCC Principle



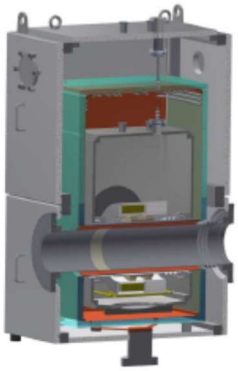
Superconducting shield/pickup -> detection of beam azimuthal field with SQUID sensor



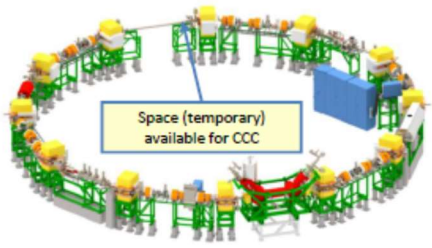
CCC-XD Nb detector and shield for 150 mm beam tubes. Tested and ready for operation



Mechanical Eigenmode calculations (ANSYS) for improved geometry of shielding and cryostat



Design of new UHV cryostat finished, production starts 06/2018



CCC in CRYRING (2018/2019):

→ tool for commissioning

→ support for exp. program

→ test bench for further development

CCC R&D in CRYRING (start 2019):

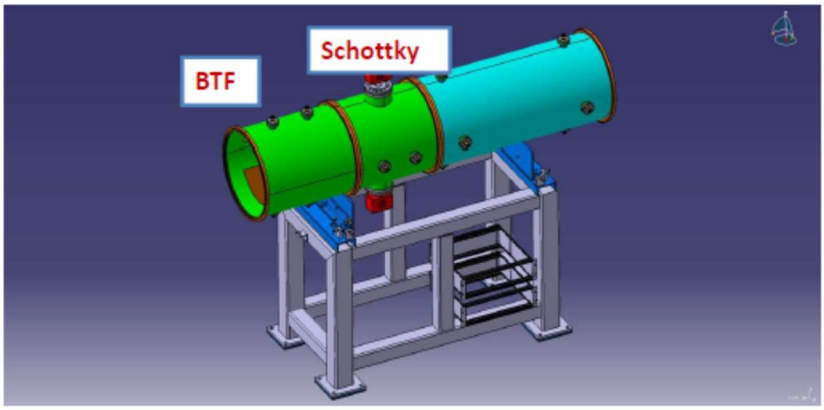
- Demonstration of cryostat + CCC-XD functionality under UHV conditions
- Improvement of system robustness
- Improvement of cost efficiency

→ Material tests Pb vs. Nb

- Shielding with axial meanders
- Pickup without toroid

BTF and Schottky

The preliminary model of the CR Kicker (left half with two short vacuum chambers) and CR Shottky (right half with one long vacuum chamber) detectors with a common support.



Status:

- Split in delivery of components
- DS are actualized (in EDMS)
- Official letter with contract under preparation

DS do not bind the Contractor to specific interface:

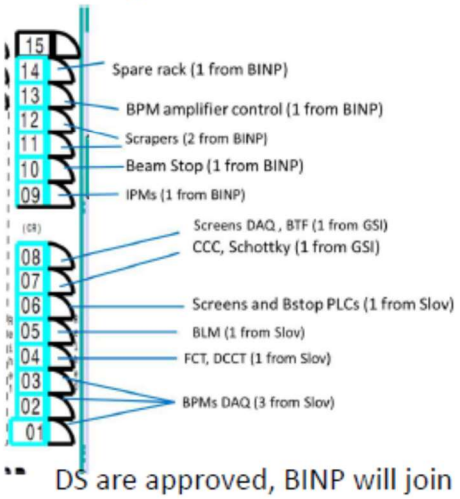
...Contractor will have to accept the potential impact of possible CR modifications on the Pickup/Kicker design:

- change of flange type
- reduction of the total length of the Pickup/Kicker
- adding of bellows at the ends of assembly

The exact parameters ... will be agreed by the Company and Contractor at CDR stage.

Recent clarifications: Electronic Racks and UPS/CPS

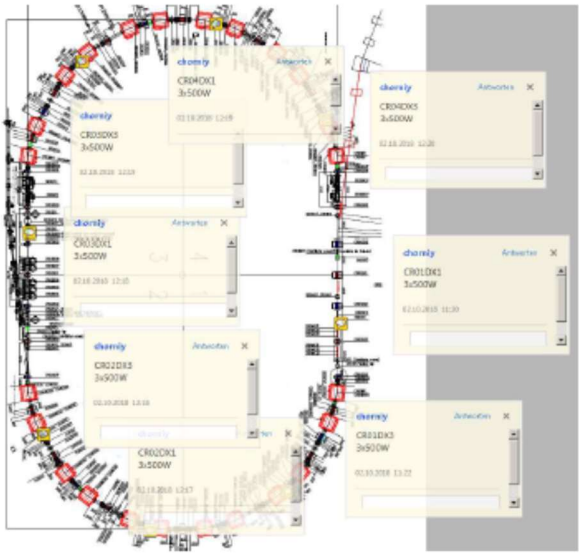
Preliminary share of the Racks



DS are approved, BINP will join the delivery

Document Title	**Detailed Specification of Beam Instrumentation 19-inch Racks**
Description	This document contains the Detailed Specification of the beam diagnostics 19-inch racks for pLinac, SIS100, pBar-Target, CR, HESR, HEBT and APPA.
Division/ Organization	BEA – Beam Instrumentation Department
Field of application	FAIR GmbH and GSI GmbH

Clean Power Supply sources uniformly distributed in CR



Summary

There no obvious technical problems on the CR from the point of DAQ foreseen:

- BPM will be tested in ESR with 12 BMPs
- FCT prototype on a new platform will be tested in ESR (may be not very soon but certainly in 2019)
- Schottky/BTF DAQ delivered by ITEP can be test with GSI rings

At least for the DAQ/software part of GSI deliverz , there no strict requirements for BINP to participate in ALL procedures till FDR,
On FDRs it will be OK to have their presence using videoconferense

2.12 CR magnets status

Corresponding Author(s): astar_qqq@yahoo.com

https://edms.cern.ch/document/2025535/1

2.13 CDR CR vacuum chambers

Corresponding Author(s): a.kraemer@gsi.de

https://edms.cern.ch/document/2037672/1

2.14 FDR CR dipole

Corresponding Author(s): koop@inp.nsk.su

2.15 CDR CR pickups

Corresponding Author(s): rogovsky@inp.nsk.su

3 Super Fragment Separator

3.1 Radiation hard magnets for Super-FRS

Corresponding Author(s): h.leibrock@gsi.de

Parallel Session Super-FRS on nc Magnets (20181106 12:00-~16:00)/DRAFT

Email distribution list:

a.v.utkin@inp.nsk.su ; d.s.gurov@inp.nsk.su ; h.weick@gsi.de; m.eibach@gsi.de; c.muehle@gsi.de; c.will@gsi.de; s.puroshothaman@gsi.de; h.simon@gsi.de ; s.utermann@gsi.de ;

Participants: Christina Will, Hanno Leibrock, Carsten Mühle, Sivaji Purushothaman, Martin Eibach, Denis Gudrow, Anatoly Utkin, Sonia Utermann (first part), Victor Varentsov (first part), Yuri Shatunov (first part), Haik Simon (minutes)

12-13: Dipole Presentation (H. Leibrock)

Dipoles

Q-BINP: Lubricant type? TFPE Oil (Flustar up to 1MGray) . Why not Graphite or similar ?
Recommendation by the supplier of gear boxes, no issue from radiation side, lubricant presence for case of rare use.
Responsibility for design on GSI side, i.e. no technical issue.

Conditions in shielded tunel: Site shall accessible only occasionally for urgent maintenance.

Installation procedure : Support, lower yoke with chamber, top part

No technical issues left (BINP ok)

14- 15 Qudrupole Presentation (H. Leibrock)

Q1a-Q1b combination

Q-BINP: Will different types for Q1a 1b require different tools? - yes

Coil production: Winding scheme? Pan cakes (see attached document)
(separation with standard length of Hitachi, loger would be Tyco cable)

AI: GSI (H. Leibrock) provide details of winding idea and choice of direct cooling
(focus on molding form)

Installation procedure: Support, (frame with chamber and quad) – ok
Q-GSI: Could system be prepared for being split up in two parts? - ok

General question:
Why a directly cooled magnet is used? Cable with water duct infers potential difficulties
AI: GSI (H. Leibrock) provide details on indirect vs. Direct cooling.

Q-BINP: Who produces cable? -
Hitachi: GSI has contact via RIKEN,
Q-BINP: What is the price per meter?

AI: GSI (WPL) shall find cable supplier and price (focus on Japanese suppliers and Tyco)

Q-BINP: Are the lifting bayonetts items that can be purchased (40t)?
Shall it be an own design with related responsibility or a purchasing piece?

AI: GSI (Ch. Will) checks whether this is available

Q-GSI: Can the same steel be used as for the dipoles – yes

<u>QS combination:</u>

Installation sequence: support –yellow frame with installed magnets

Q-GSI: Can BINP chamber be alreday be integrated?
(Full system delivery avoids interface and pre-assmbly issues)

AI: BINP Can chamber integration be foreseen at BINP premises ?
AI: GSI(S. Puroshotaman/H. Weick) Check chamber dimension and shape

Q-BINP: How should water interconnections between lower and upper part be done (swagelock)? - Metal seals required, wleding/cutting shall be avoided

Full assembly at BINP would be favourable

Magnet Q2-S scheme ok, no show stopper (full integration tob e checked),
prerequisite: cable procurement conditions clarified.

<u>Sextupole Beam Catcher combination</u>

Installation sequence: Support – Internal frame with Sextupole (potentially with beam pipe)

AI: GSI+BINP Scope definition: Sextupole+internal frame ((+ chamber) + Support)
Clarification of Interfaces: to Beam catcher (CMERI) & Shielding

No obvious issues, final scope & interfaces to be clarified

<u>Conclusion/Remaing issues</u>

Question to management:
Can a supporting R&D contract be closed (e.g. on coil production) in order to further clarify price tags and remove technical uncertainties? – AI (BINP): Clarify necessary R&D items

Overall schedule:

Dipole schedule / Multipole schedule

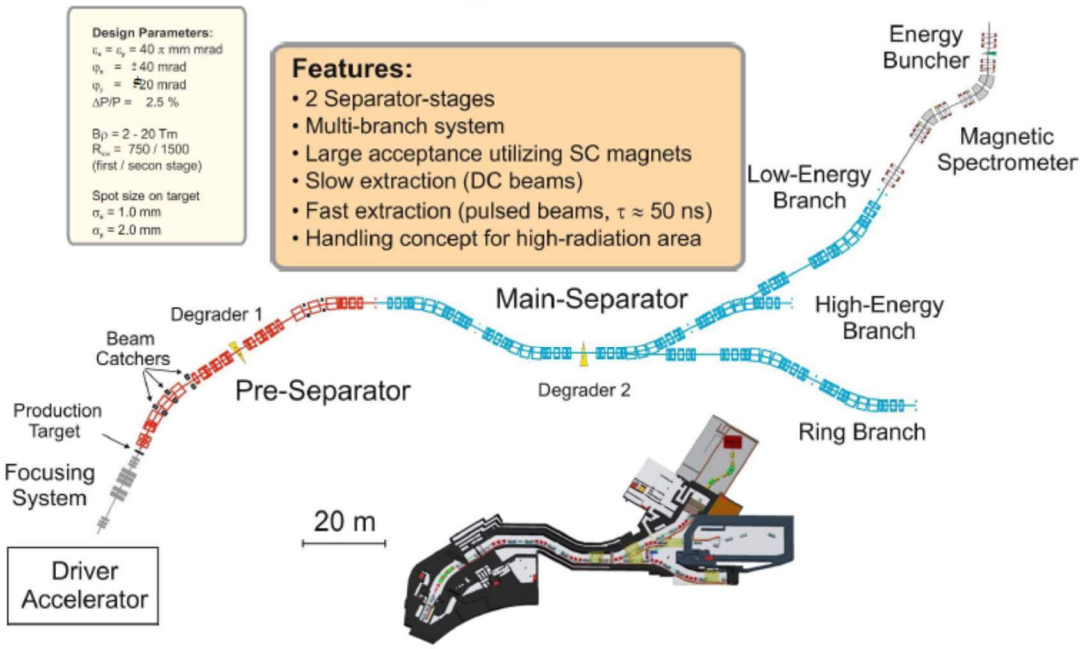
Attachments:

- Presentation
- Information Material on coil winding

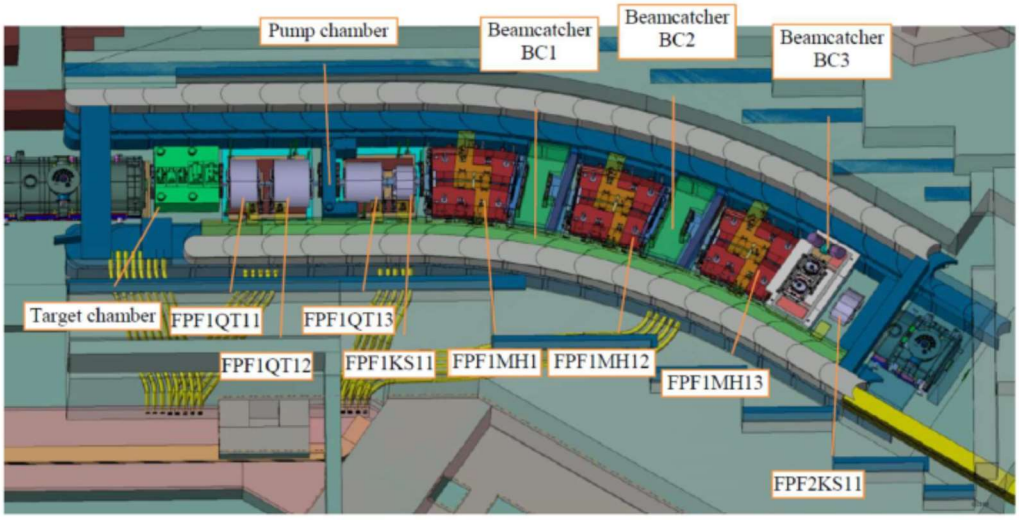
Radiation resistant Super-FRS magnets

November 6th, 2018

Super-FRS

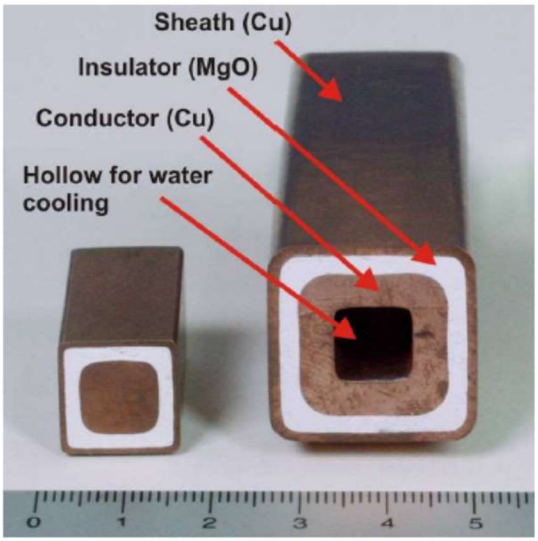


Heavily shielded target area



The positions of radiation resistant quadrupoles FPF1QT11 (Quadrupole 1a), FPF1QT12 (Quadrupole 1b), FPF1QT13 (Quadrupole 2), the two sextupoles FPF1KS11, FPF2KS11 and the three dipoles FPFMH1, FPFMH12 and FPFMH13 are indicated.

radiation resistant cables



Special mineral insulation (MgO) cables for those magnets.

These cables can withstand a radiological dose of more than 10^{11} Gray.

Minimum bending radius of cables: 6 × diameter!

Dipoles are indirect cooled. Quadrupoles and sextupoles are direct cooled conductors.

MgO is hygroscopic.

Magnets of high radiation area

PSP code	Magnet	Number of magnets	Min. field strength	Max. field strength	Effective length (m)	Useable aperture (mm)	Field Quality
2.4.2.1.1	Dipole 1	3	0.15 T	1.6 T	2.400	1200 × 140	$\pm 3 \cdot 10^{-4}$
2.4.2.2.1	Quadrupole 1a	1	1.6 T/m	15.4 T/m	0.933	Ø 130	$\pm 1 \cdot 10^{-3}$
2.4.2.2.1	Quadrupole 1b	1	1.2 T/m	11.8 T/m	1.244	Ø 180	$\pm 1 \cdot 10^{-3}$
2.4.2.2.2	Quadrupole 2	1	0.6 T/m	6.1 T/m	1.200	380 × 240	$\pm 1 \cdot 10^{-3}$
2.4.2.3.1	Sextupole 1	2	3.5 T/m²	34 T/m²	0.600	Ø 380	$\pm 5 \cdot 10^{-3}$

At first only one kind Quadrupole 1 was planned. But our magnet design experts and a russian expert didn't find a feasible design of a radiation resistant quadrupole with 15 T/m gradient, 180 mm aperture and 0.1% field quality.

Solution: separation to two different magnet designs.
=> every radiation resistant quadrupole is unique.

One dipole prototype exists

Magnetic tests of the 90 tons prototype were successful. Only two additional dipoles must be produced.

A prototype of the radiation resistant dipole has been made in Novosibirsk (Budker Institute).

H-type design was chosen for the dipoles.

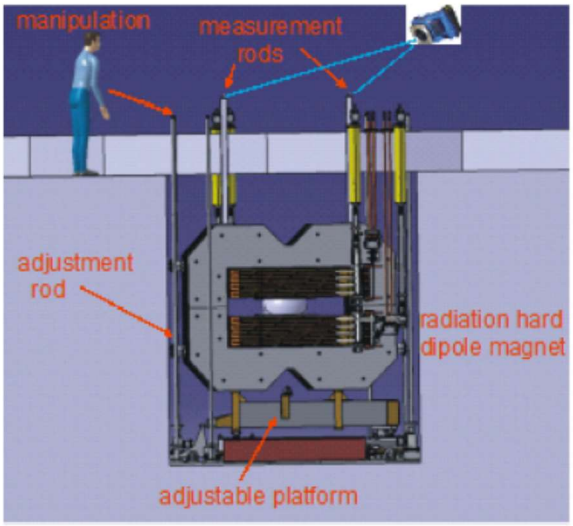
The standard operation of the magnets in the Super-FRS will be DC. Only for the conditioning cycle, which is used before changing the settings, a ramp up from zero to maximum current within 120 s is needed.

Therefore, instead of using thin laminations the design could be based on iron plates. They are between 120 mm and 140 mm thick.

dipole coil

- Double pancakes are potted with solder to stiff structures.
- Only one soldering point inside a double (at the interconnection of two single pancakes).
- The cooling of the coil is indirect. The radiator is made of a copper plate, the cooling tubes of stainless steel. The water connectors are separated to different ends of the coil.

Alignment



- After the operation of the Super-FRS is started, direct access to the magnets is impossible because of the high radiation.
- An one meter thick plate of steel will be installed above the magnets.
- Misalignment due to settlement must be corrected with remote alignment.
- The remote alignment will be done with bares and gears from above the steel screen.

Alignment

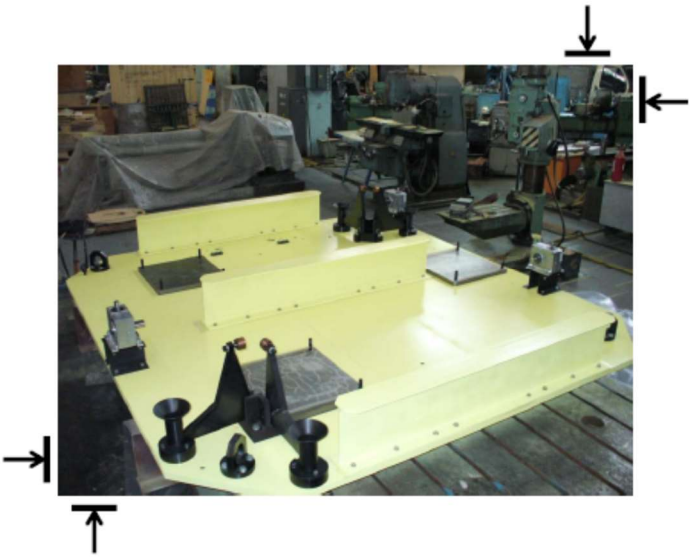
Each dipole lies on one adjustable support frame

Each adjustable support frame stands on three feet. Every foot is vertically adjustable.

Two layers of needle bearing allows horizontal movements of each foot.

Feet allows the adjustment of height, roll and pitch.

Alignment



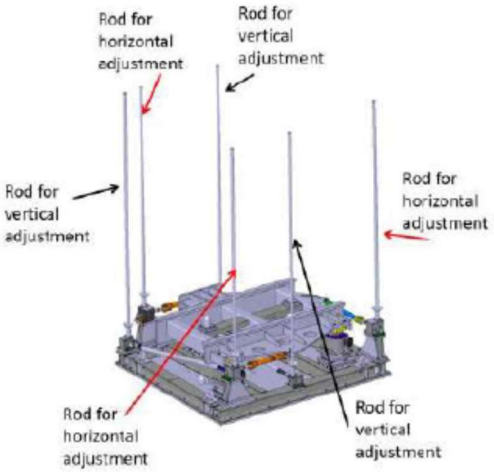
4 stamps adjusted and fixed the horizontal position.

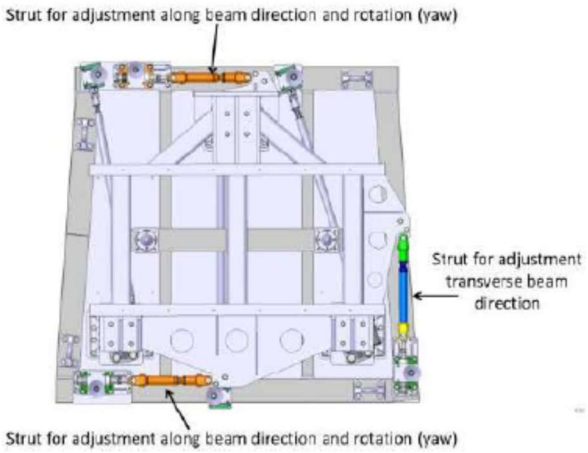
The support frame with the magnets moves uncontrollable after opening the stamps.

Our alignment team was not able to adjust support frame remotely (and without sight). It is not usable in our case.

GSI made a new design of an adjustable support frame.

Alignment system of a dipole.

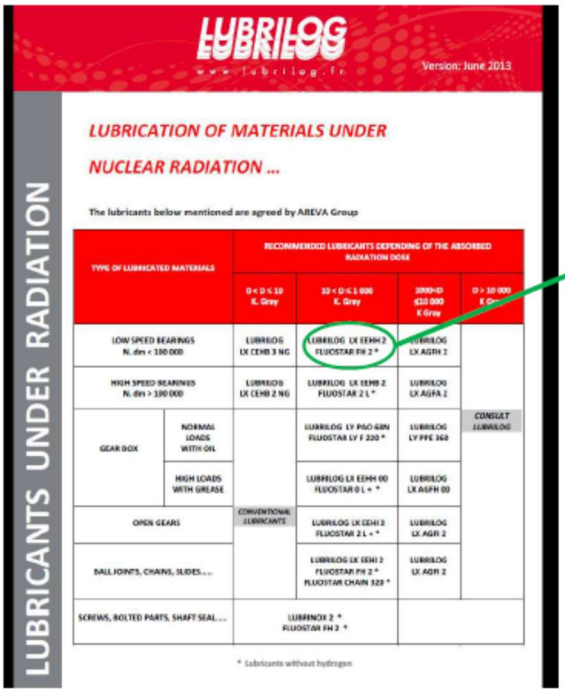




Left: overview with the six adjustment rods, right: top view on the support frame.
A 3-strut system is used for horizontal adjustments.

The same principle will be used for the quadrupol 1a/1b, quadrupol 2/sextupole and sextupole/beamcatcher .

radiation resistant lubricant



LUBRILOG

www.lubrilog.fr

Version: June 2013

LUBRICANTS UNDER RADIATION

LUBRICATION OF MATERIALS UNDER NUCLEAR RADIATION ...

The lubricants below mentioned are agreed by AREVA Group

TYPE OF LUBRICATED MATERIALS		RECOMMENDED LUBRICANTS DEPENDING OF THE ABSORBED RADIATION DOSE			
		0 < D ≤ 10 K. Gray	10 < D ≤ 1 000 K. Gray	1000<D ≤10 000 K Gray	D > 10 000 K Gray
LOW SPEED BEARINGS N. dm < 100 000		LUBRILOG LX CEHB 3 NG	LUBRILOG LX EEHH 2 FLUOSTAR FH 2 *	LUBRILOG LX AGFH 2	
HIGH SPEED BEARINGS N. dm > 100 000		LUBRILOG LX CEHB 2 NG	LUBRILOG LX EEHB 2 FLUOSTAR 2 L *	LUBRILOG LX AGFA 2	
GEAR BOX	NORMAL LOADS WITH OIL		LUBRILOG LY PAO 68N FLUOSTAR LY F 220 *	LUBRILOG LY PPE 360	CONSULT LUBRILOG
	HIGH LOADS WITH GREASE		LUBRILOG LX EEHM 00 FLUOSTAR 0 L + *	LUBRILOG LX AGFH 00	
OPEN GEARS		CONVENTIONAL LUBRICANTS	LUBRILOG LX EEHI 2 FLUOSTAR 2 L + *	LUBRILOG LX AGFI 2	
BALL JOINTS, CHAINS, SLIDES....			LUBRILOG LX EEHI 2 FLUOSTAR FH 2 * FLUOSTAR CHAIN 320 *	LUBRILOG LX AGFI 2	
SCREWS, BOLTED PARTS, SHAFT SEAL....		LUBRINOX 2 * FLUOSTAR FH 2 *			

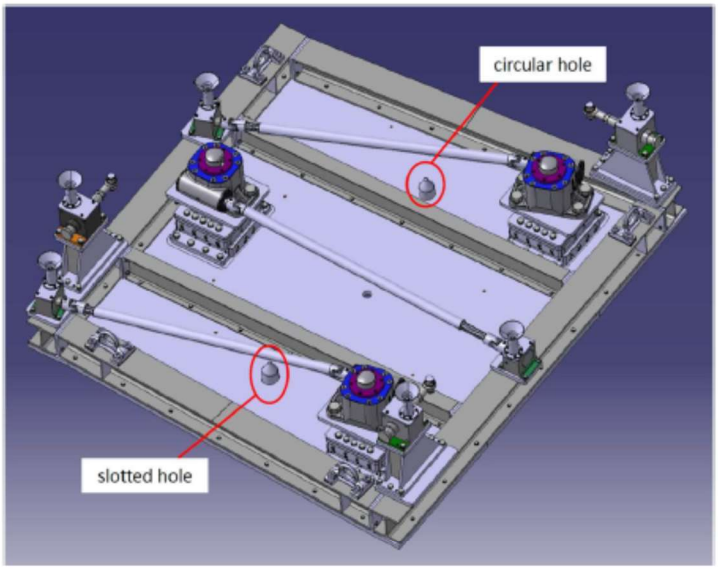
* Lubricants without hydrogen

10 < D ≤ 1 000 K. Gray

FLUOSTAR FH 2

All gears and bearings must be lubrified with the lubricant FLUOSTAR FH 2 of the company LUBRILOG (France). This lubricant is radiation resistant up to 1.0 MGy.

Positioning of the support frames



A round hole and a slotted hole on the bottom plate of the adjustable support frame together with the two cones on the floor will position the support frame with a high accuracy

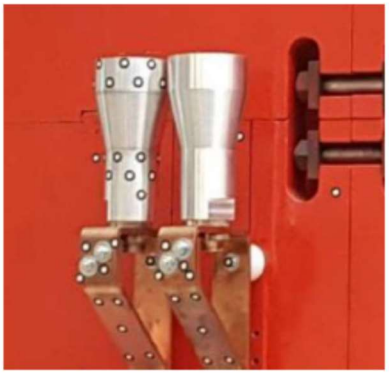
Modifications on the prototype

The connections of current and water must be displaced due to radiation reasons.

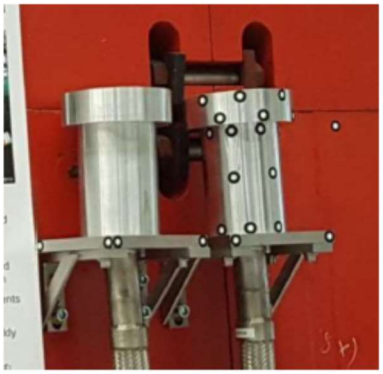
Copper bars connect the coils with the current interfaces

Modifications on the prototype

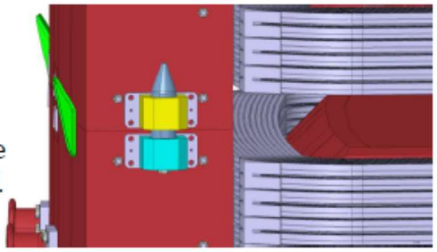
The connections of current.



The connections of water.



New cone-cylinder combinations for the positioning of the upper yoke half onto the lower yoke half.



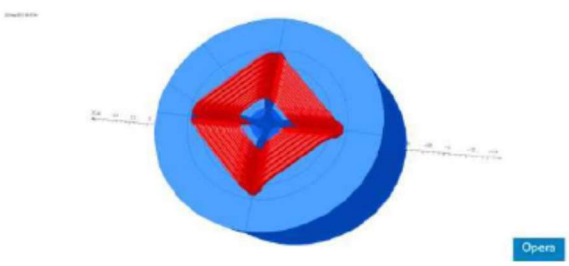
Radiation resistant dipole

Heating test done (>95% of heat into water)

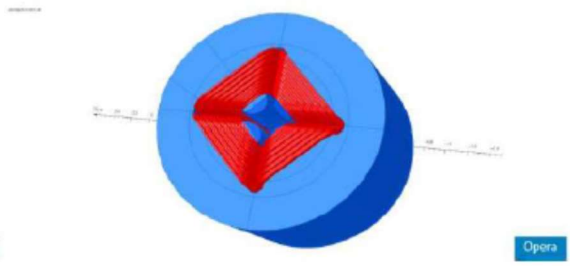
Remote connectors for current and water successfully tested

First two radiation resistant quadrupoles

quadrupole 1a



quadrupole 1b



PSP code	Magnet	gap (mm)	Dimension (m) (x,y,z)	Max. current	inductance (mH)	Resistance (mOhm)	Power (kw)	H2O (l/min)
2.4.2.2.1	Quadrupole 1a	70	1.19 / 1.8 / 1.8	981	72	49	47	27
2.4.2.2.1	Quadrupole 1b	95	1.15 / 1.8 / 1.8	1408	80	59	116	67

Magnetical design made by Peter Rottländer (GSI)

First two radiation resistant quadrupoles

Opera 2d models

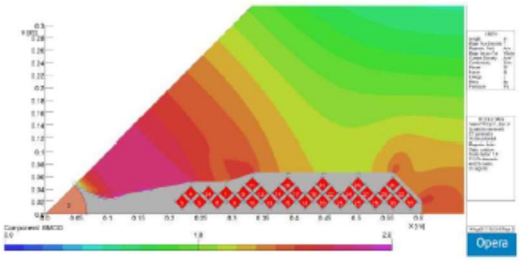


Figure 4: Pole field in the 2D model for quadrupole 1a

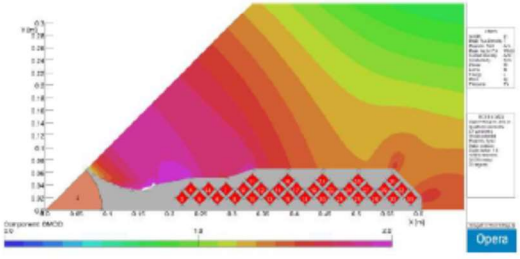
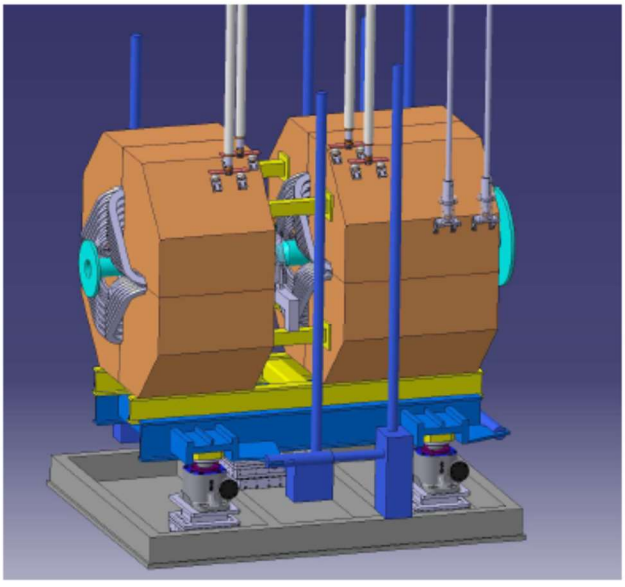
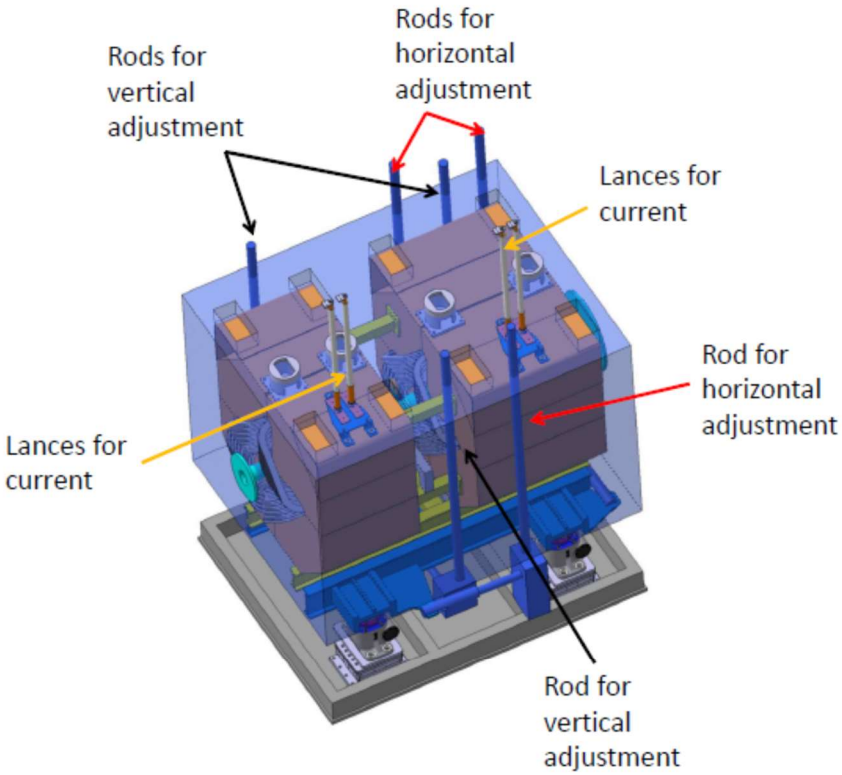
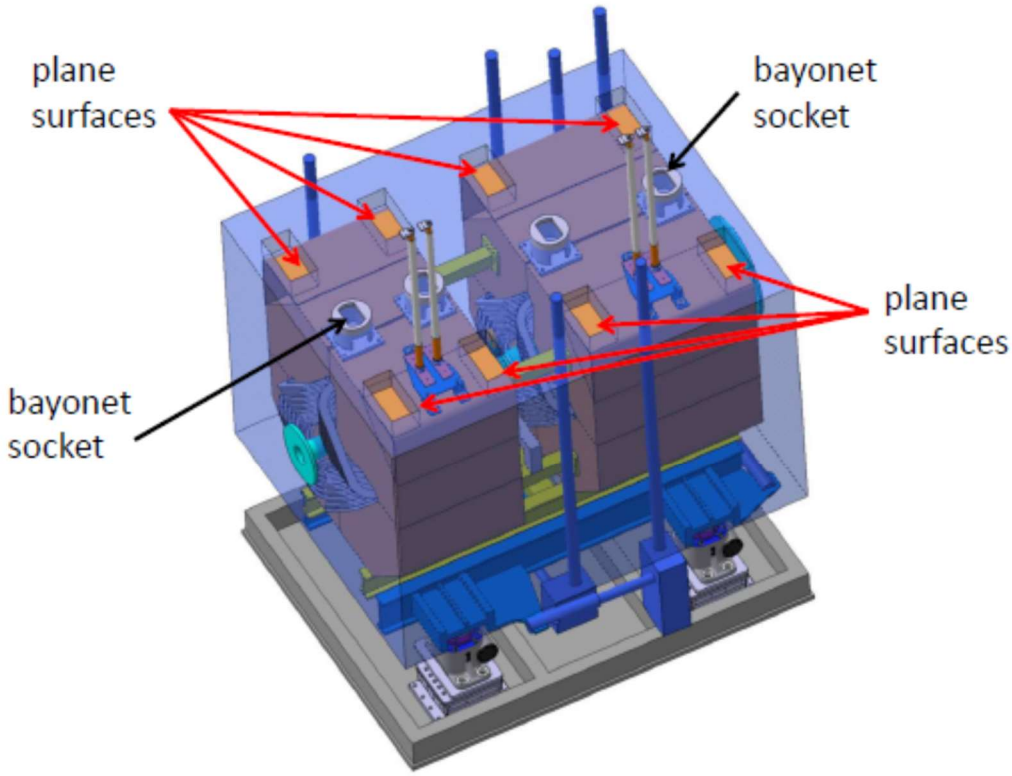


Figure 5: Pole field in the 2D model for quadrupole 1b

quadrupole 1a quadrupole 1b

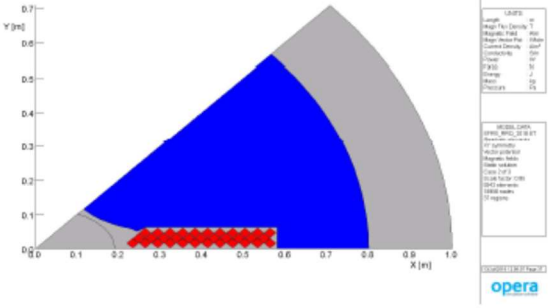



Rods for vertical adjustment
Rods for horizontal adjustment
Lances for current
Rod for horizontal adjustment
Lances for current
Rod for vertical adjustment

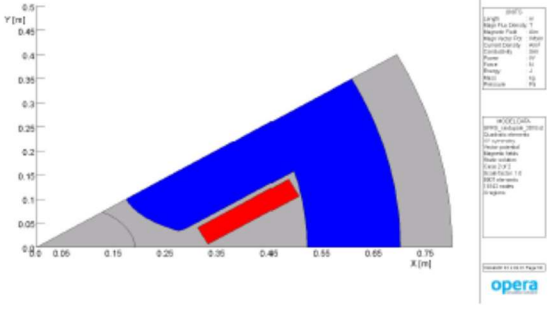

plane surfaces
bayonet socket
plane surfaces
bayonet socket

Third radiation resistant quadrupole and radiation resistant sextupole

quadrupole 2



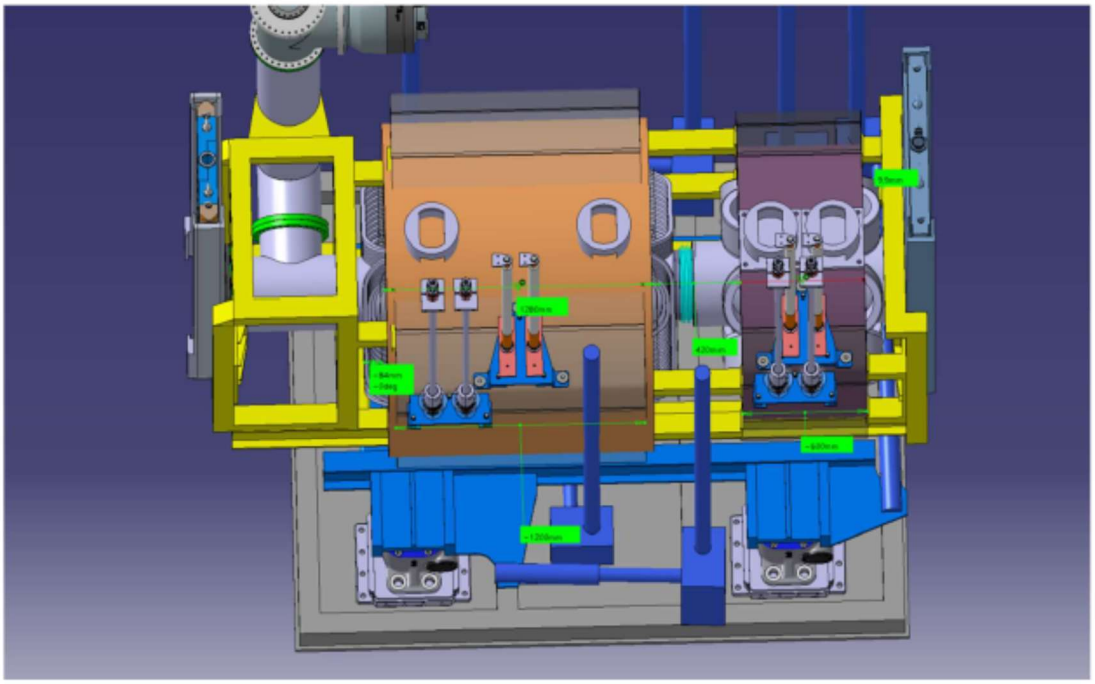
sextupole 1



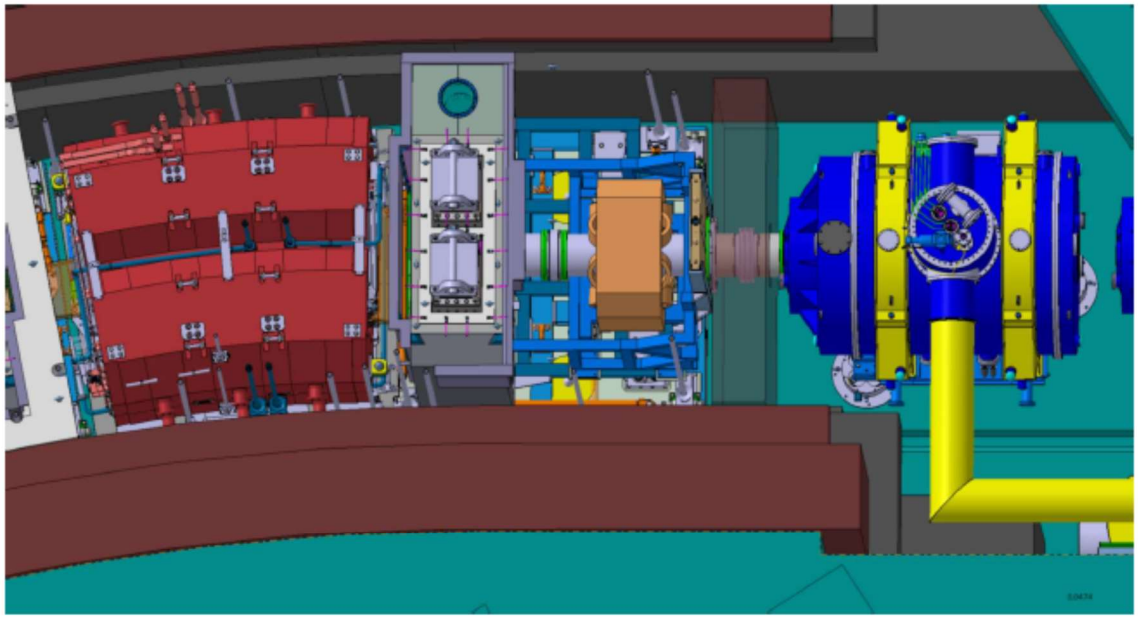
PSP code	Magnet	gap (mm)	Dimension (m) (x,y,z)	Max. current	inductance (mH)	Resistance (mOhm)	Power (kw)	H2O (l/min)
2.4.2.2.2	Quadrupole 2	163	1.5 / 1.6 / 1.6	1800	61	64	205	115
2.4.2.3.1	Sextupole 1	195	0.75 / 1.3 / 1.3	1800	18.3	28	90	52

Magnetical design made by Alexander Kalimov

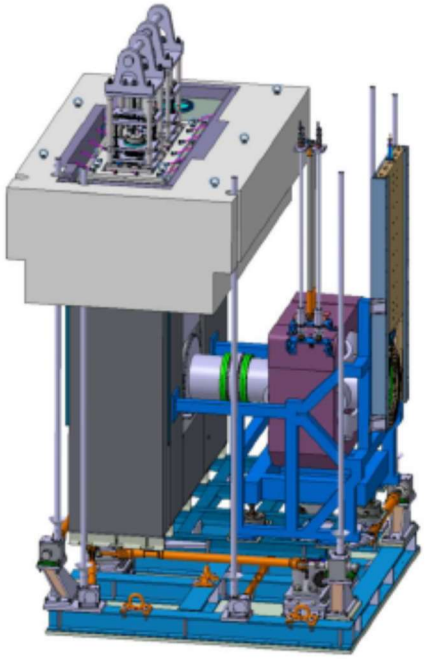
Quadrupole 2 – Sextupole combination



Sextupole-Beamcatcher combination

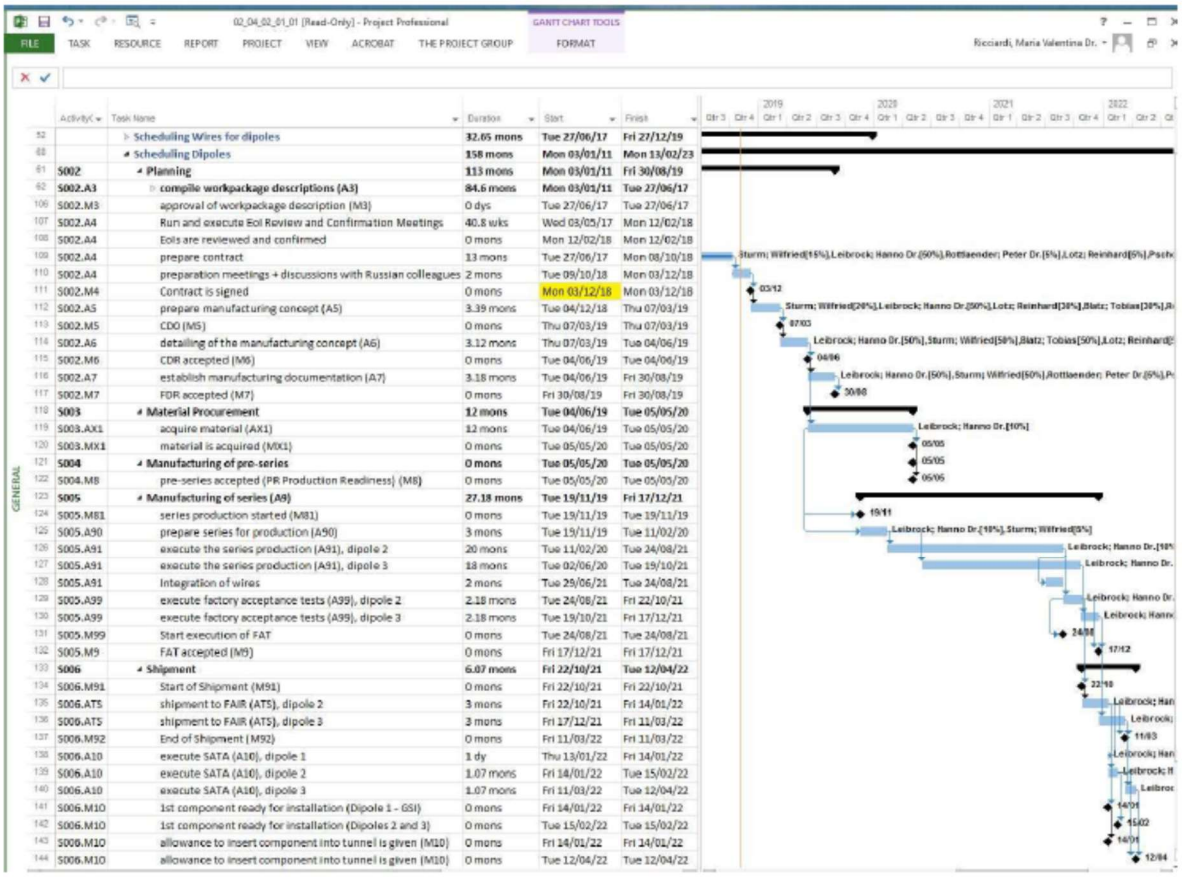


Sextupole-Beamcatcher combination

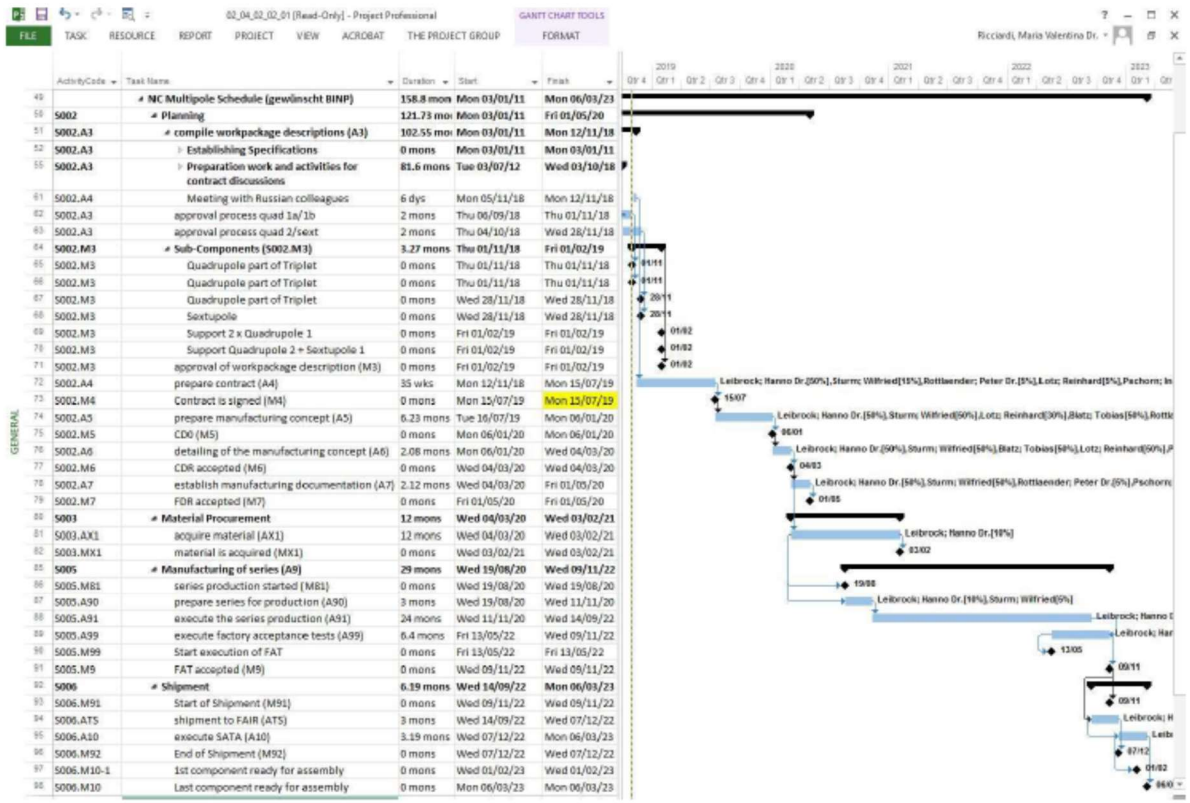


Status of specifications of radiation resistant Super-FRS magnets

- Dipoles: specification is approved, a prototype exists. Modified water and current interfaces are tested (operated 1 month with maximum current). Last test of modified adjustable support frame is planned for December 2018
- Quadrupole 1a/1b: specification is approved
- Quadrupole 2 and sextupoles: magnetic design finished. The specification is under progress
- Drawing of adjustable support frames of quads and sextupoles in preparation. Expected to be finished December 2018.



	Activity	Task Name	Duration	Start	Finish
52		Scheduling Wires for dipoles	32.65 mons	Tue 27/06/17	Fri 27/12/19
60		Scheduling Dipoles	158 mons	Mon 03/01/11	Mon 13/02/23
61	S002	Planning	113 mons	Mon 03/01/11	Fri 30/08/19
62	S002.A3	compile workpackage descriptions (A3)	84.6 mons	Mon 03/01/11	Tue 27/06/17
106	S002.M3	approval of workpackage description (M3)	0 dys	Tue 27/06/17	Tue 27/06/17
107	S002.A4	Run and execute EoI Review and Confirmation Meetings	40.8 wks	Wed 03/05/17	Mon 12/02/18
108	S002.A4	EoIs are reviewed and confirmed	0 mons	Mon 12/02/18	Mon 12/02/18
109	S002.A4	prepare contract	13 mons	Tue 27/06/17	Mon 08/10/18
110	S002.A4	preparation meetings + discussions with Russian colleagues	2 mons	Tue 09/10/18	Mon 03/12/18
111	S002.M4	Contract is signed	0 mons	Mon 03/12/18	Mon 03/12/18
112	S002.A5	prepare manufacturing concept (A5)	3.39 mons	Tue 04/12/18	Thu 07/03/19
113	S002.M5	CDD (M5)	0 mons	Thu 07/03/19	Thu 07/03/19
114	S002.A6	detailing of the manufacturing concept (A6)	3.12 mons	Thu 07/03/19	Tue 04/06/19
115	S002.M6	CDR accepted (M6)	0 mons	Tue 04/06/19	Tue 04/06/19
116	S002.A7	establish manufacturing documentation (A7)	3.18 mons	Tue 04/06/19	Fri 30/08/19
117	S002.M7	FDR accepted (M7)	0 mons	Fri 30/08/19	Fri 30/08/19
118	S003	Material Procurement	12 mons	Tue 04/06/19	Tue 05/05/20
119	S003.AX1	acquire material (AX1)	12 mons	Tue 04/06/19	Tue 05/05/20
120	S003.MX1	material is acquired (MX1)	0 mons	Tue 05/05/20	Tue 05/05/20
121	S004	Manufacturing of pre-series	0 mons	Tue 05/05/20	Tue 05/05/20
122	S004.M8	pre-series accepted (PR Production Readiness) (M8)	0 mons	Tue 05/05/20	Tue 05/05/20
123	S005	Manufacturing of series (A9)	27.18 mons	Tue 19/11/19	Fri 17/12/21
124	S005.M81	series production started (M81)	0 mons	Tue 19/11/19	Tue 19/11/19
125	S005.A90	prepare series for production (A90)	3 mons	Tue 19/11/19	Tue 11/02/20
126	S005.A91	execute the series production (A91), dipole 2	20 mons	Tue 11/02/20	Tue 24/08/21
127	S005.A91	execute the series production (A91), dipole 3	18 mons	Tue 02/06/20	Tue 19/10/21
128	S005.A91	Integration of wires	2 mons	Tue 29/06/21	Tue 24/08/21
129	S005.A99	execute factory acceptance tests (A99), dipole 2	2.18 mons	Tue 24/08/21	Fri 22/10/21
130	S005.A99	execute factory acceptance tests (A99), dipole 3	2.18 mons	Tue 19/10/21	Fri 17/12/21
131	S005.M99	Start execution of FAT	0 mons	Tue 24/08/21	Tue 24/08/21
132	S005.M9	FAT accepted (M9)	0 mons	Fri 17/12/21	Fri 17/12/21
133	S006	Shipment	6.07 mons	Fri 22/10/21	Tue 12/04/22
134	S006.M91	Start of Shipment (M91)	0 mons	Fri 22/10/21	Fri 22/10/21
135	S006.ATS	shipment to FAIR (ATS), dipole 2	3 mons	Fri 22/10/21	Fri 14/01/22
136	S006.ATS	shipment to FAIR (ATS), dipole 3	3 mons	Fri 17/12/21	Fri 11/03/22
137	S006.M92	End of Shipment (M92)	0 mons	Fri 11/03/22	Fri 11/03/22
138	S006.A10	execute SATA (A10), dipole 1	1 dy	Thu 13/01/22	Fri 14/01/22
139	S006.A10	execute SATA (A10), dipole 2	1.07 mons	Fri 14/01/22	Tue 15/02/22
140	S006.A10	execute SATA (A10), dipole 3	1.07 mons	Fri 11/03/22	Tue 12/04/22
141	S006.M10	1st component ready for installation (Dipole 1 - GSI)	0 mons	Fri 14/01/22	Fri 14/01/22
142	S006.M10	1st component ready for installation (Dipoles 2 and 3)	0 mons	Tue 15/02/22	Tue 15/02/22
143	S006.M10	allowance to insert component into tunnel is given (M10)	0 mons	Fri 14/01/22	Fri 14/01/22
144	S006.M10	allowance to insert component into tunnel is given (M10)	0 mons	Tue 12/04/22	Tue 12/04/22



	ActivityCode	Task Name	Duration	Start	Finish
49		**NC Multipole Schedule (gewünscht BINP)**	**158.8 mons**	**Mon 03/01/11**	**Mon 06/03/23**
50	**S002**	**Planning**	**121.73 mo**	**Mon 03/01/11**	**Fri 01/05/20**
51	**S002.A3**	**compile workpackage descriptions (A3)**	**102.55 mo**	**Mon 03/01/11**	**Mon 12/11/18**
52	**S002.A3**	**Establishing Specifications**	**0 mons**	**Mon 03/01/11**	**Mon 03/01/11**
55	**S002.A3**	**Preparation work and activities for contract discussions**	**81.6 mons**	**Tue 03/07/12**	**Wed 03/10/18**
61	S002.A4	Meeting with Russian colleagues	6 dys	Mon 05/11/18	Mon 12/11/18
62	S002.A3	approval process quad 1a/1b	2 mons	Thu 06/09/18	Thu 01/11/18
63	S002.A3	approval process quad 2/sext	2 mons	Thu 04/10/18	Wed 28/11/18
64	**S002.M3**	**Sub-Components (S002.M3)**	**3.27 mons**	**Thu 01/11/18**	**Fri 01/02/19**
65	S002.M3	Quadrupole part of Triplet	0 mons	Thu 01/11/18	Thu 01/11/18
66	S002.M3	Quadrupole part of Triplet	0 mons	Thu 01/11/18	Thu 01/11/18
67	S002.M3	Quadrupole part of Triplet	0 mons	Wed 28/11/18	Wed 28/11/18
68	S002.M3	Sextupole	0 mons	Wed 28/11/18	Wed 28/11/18
69	S002.M3	Support 2 x Quadrupole 1	0 mons	Fri 01/02/19	Fri 01/02/19
70	S002.M3	Support Quadrupole 2 + Sextupole 1	0 mons	Fri 01/02/19	Fri 01/02/19
71	S002.M3	approval of workpackage description (M3)	0 mons	Fri 01/02/19	Fri 01/02/19
72	S002.A4	prepare contract (A4)	35 wks	Mon 12/11/18	Mon 15/07/19
73	S002.M4	Contract is signed (M4)	0 mons	Mon 15/07/19	Mon 15/07/19
74	S002.A5	prepare manufacturing concept (A5)	6.23 mons	Tue 16/07/19	Mon 06/01/20
75	S002.M5	CD0 (M5)	0 mons	Mon 06/01/20	Mon 06/01/20
76	S002.A6	detailing of the manufacturing concept (A6)	2.08 mons	Mon 06/01/20	Wed 04/03/20
77	S002.M6	CDR accepted (M6)	0 mons	Wed 04/03/20	Wed 04/03/20
78	S002.A7	establish manufacturing documentation (A7)	2.12 mons	Wed 04/03/20	Fri 01/05/20
79	S002.M7	FDR accepted (M7)	0 mons	Fri 01/05/20	Fri 01/05/20
80	**S003**	**Material Procurement**	**12 mons**	**Wed 04/03/20**	**Wed 03/02/21**
81	S003.AX1	acquire material (AX1)	12 mons	Wed 04/03/20	Wed 03/02/21
82	S003.MX1	material is acquired (MX1)	0 mons	Wed 03/02/21	Wed 03/02/21
85	**S005**	**Manufacturing of series (A9)**	**29 mons**	**Wed 19/08/20**	**Wed 09/11/22**
86	S005.M81	series production started (M81)	0 mons	Wed 19/08/20	Wed 19/08/20
87	S005.A90	prepare series for production (A90)	3 mons	Wed 19/08/20	Wed 11/11/20
88	S005.A91	execute the series production (A91)	24 mons	Wed 11/11/20	Wed 14/09/22
89	S005.A99	execute factory acceptance tests (A99)	6.4 mons	Fri 13/05/22	Wed 09/11/22
90	S005.M99	Start execution of FAT	0 mons	Fri 13/05/22	Fri 13/05/22
91	S005.M9	FAT accepted (M9)	0 mons	Wed 09/11/22	Wed 09/11/22
92	**S006**	**Shipment**	**6.19 mons**	**Wed 14/09/22**	**Mon 06/03/23**
93	S006.M91	Start of Shipment (M91)	0 mons	Wed 09/11/22	Wed 09/11/22
94	S006.ATS	shipment to FAIR (ATS)	3 mons	Wed 14/09/22	Wed 07/12/22
95	S006.A10	execute SATA (A10)	3.19 mons	Wed 07/12/22	Mon 06/03/23
96	S006.M92	End of Shipment (M92)	0 mons	Wed 07/12/22	Wed 07/12/22
97	S006.M10-1	1st component ready for assembly	0 mons	Wed 01/02/23	Wed 01/02/23
98	S006.M10	Last component ready for assembly	0 mons	Mon 06/03/23	Mon 06/03/23

3.2 Super-FRS magnet testing

Corresponding Author(s): h.simon@gsi.de

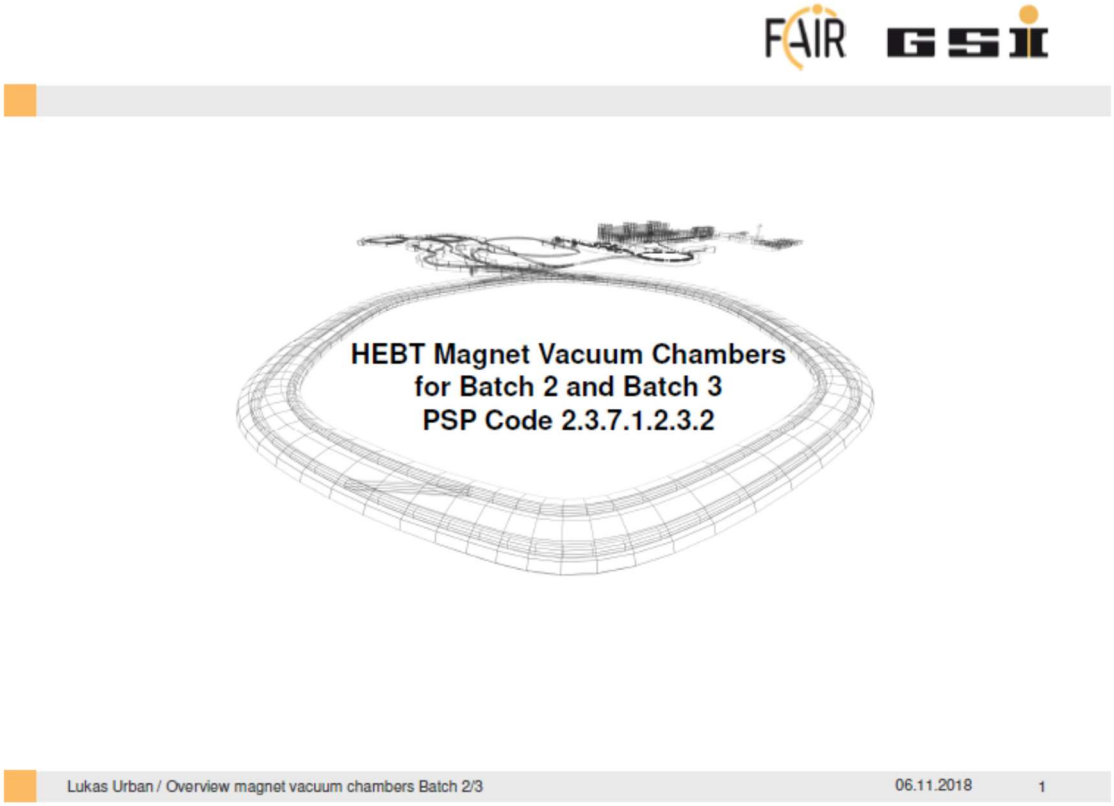
3.3 Super-FRS installation

Corresponding Author(s): h.simon@gsi.de

4 High Energy Beam Transport

4.1 HEBT vacuum chambers batches 2&3

Corresponding Author(s): l.urban@gsi.de



Overview about all magnet chambers

PSP-Code	Chamber type	Quantity	Subtypes	Status
2.3.7.1.2.2.10	dip10 (branching)	6	3	to be assigned
2.3.7.1.2.2.13.2	dip13_0 dip13_3	5	1	BINP (Council)
2.3.7.1.2.2.15	dip15_0 dip15_1	5	3	to be assigned
2.3.7.1.2.2.16	dip16	1	1	to be assigned
2.3.7.1.2.2.17	dip17	1	1	to be assigned
2.3.7.1.2.2.19	dip19	4	1	to be assigned
2.3.7.3.2.3.1	quad 1	1	1	to be assigned (FBL)
2.3.7.1.2.3.10	quad10	4	1	BINP (Council)
2.3.7.1.2.3.11	quad11	69	19	to be assigned
2.3.7.1.2.3.12	quad12	17	8	to be assigned
2.3.7.1.2.3.2	quad2	81	12	BINP (Council)
2.3.7.3.2.3.2	quad2	9		to be assigned (FBL)
2.3.7.1.2.4.1	s100	29	19	to be assigned
2.3.7.1.2.4.2	s18h/v	31	16	to be assigned
2.3.7.3.4.2	s18h/v	3		to be assigned (FBL)
2.3.7.1.2.4.3	s13 large aperture	4	3	to be assigned
2.3.7.3.2.2.4 2.3.7.3.2.2.5	dip4 (bending) dip4 (branching)	1 1	1 1	to be assigned
	Total	**272**	**91**	

Milestones

Milestone	Work Description	Date
M4	• Exchange of signed Contract	01/2019
M6	• Conceptual Design Review (CDR) accepted	03/2019
M7	• Final Design Review (FDR) accepted	05/2019
M8	• Factory Acceptance Test (FAT) of pre-series accepted	07/2019
M9	• Factory Acceptance Test (FAT) accepted	05/2021
M92	• Site Acceptance Test (SATaa) accepted	07/2021
M10	• Site Acceptance Test (SATab) accepted	07/2021
-	• Documentation	09/2021
-	• Final Acceptance	09/2021
-	• Warranty starts	

Vacuum properties

Vacuum properties	Non-bakeable	Bakeable
Integral leak rate	$\leq 1 \times 10^{-10} \frac{\text{mbar l}}{\text{s}}$	$\leq 1 \times 10^{-10} \frac{\text{mbar l}}{\text{s}}$
Outgassing rate (after **10h** of pumping)	$\leq 5 \times 10^{-10} \frac{\text{mbar l}}{\text{s cm}^2}$	$\leq 1 \times 10^{-12} \frac{\text{mbar l}}{\text{s cm}^2}$
Residual gas analysis (after **24h** of pumping)	1. All peaks between mass 18 and 45 must be **100** times lower than mass 18, except mass 28 and 44. 2. All peaks higher mass 45 must be **1000** lower than mass 18.	1. All peaks between mass 12 – 18 and mass 28 must be **≤ 10%** from mass 2. 2. All peaks between mass 22 – 32, except mass 28, must be **≤ 0.5%** from mass 2. 3. Peak 44 must be **≤ 20%** of mass 2. 4. All peaks between mass 49 – 100 must be **≤ 0.1%** from mass 2.

Inspection Reports (FAT):

- pumping time for measurements must be:
  10h for the outgassing rate
  24h for RGA measurement
  (deviations can´t be accepted)

Vacuum chamber 2.3.7.1.2.2.14 for magnet dip14_v1 S/N01

CVC6- Check off of spectrum of residual gases / Сверка спектра остаточных газов

Residual gas spectrum is shown below / Спектр остаточных газов показан ниже.	Pressure after 120 hours pumping: 9,1E-8 mbar
Type of residual gas analyzer / Тип анализатора остаточного газа	Stanford RGA100 (S/N 160713)
All mass peaks between 18 amu and 46 amu (except peak 28, 32 and 44) shall be 100 times less than the sum of all peaks. All mass peaks higher than 46 amu shall be 1000 times less than sum of peaks of masses 2, 18, 28 and 44 amu.	OK
Outgassing rate after 120 h of continuous pumping	3,2E-11 mbar*l*s^{-1}*cm^{-2}
Type of pressing gauge / Тип датчика давления	IKR 270 (serial number: 44275349)

Mechanical properties

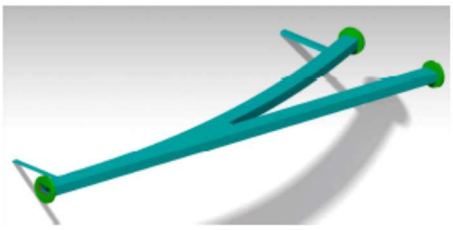
Mechanical properties:

- Check of welding seam according to DIN EN ISO 9712, quality class DIN EN ISO 5817 B
- Surface quality R_z=25
- Magnetic permeability:
  - Parts of the body of vacuum chamber that are located at a distance less than the magnetic gap from the yoke edge → $\mu_{rel} \leq 1.01$
  - Parts of the body of vacuum chamber that are located at a distance greater than the magnetic gap from the yoke edge → $\mu_{rel} \leq 1.05$
  - Components of the vacuum chamber such as flanges, bellows, and other fixed elements such as supports, bolts, nuts, washers, etc. → $\mu_{rel} \leq 1.05$
- Chamber material according DIN EN 10088: 1.4306, 1.4307, 1.4404, 1.4429 or 1.4435
- Flange Material according DIN EN10088: 1.4306, 14307 or higher quality
- Material for bakeable flanges: 1.4429 ESR

HEBT: Dipole Chambers

Chamber type	Quantity	Subtypes
dip10	6	3
dip13_0 dip13_3	5	1
dip15_0 dip15_1	5	3
dip16	1	1
dip17	1	1
dip19	4	1
dip4	2	2
Total	24	12

- Overall length: 2000-4500 mm
- Shape: rectangular, bending and branching
- Flanges: DN160CF – DN400CF



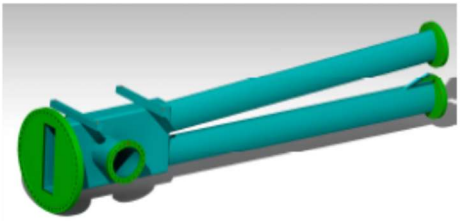
dip4 branching chamber

dip10 branching chamber

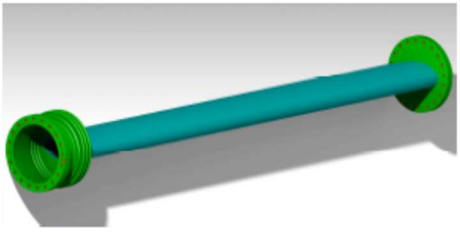
HEBT: Quadrupole Chambers

Chamber type	Quantity	Subtypes
quad 1	1	1
quad10	4	1
quad11	69	19
quad12	17	8
quad2	90	12
Total	181	41

- Overall length: 1000-2600 mm
- Shape: round and oval, branching
- Flanges: DN160CF – DN400CF
- Some chambers with bellows



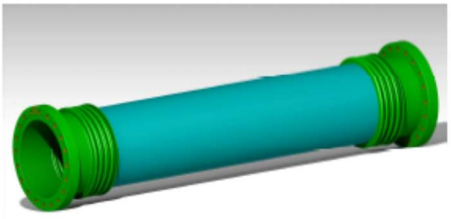
quad12 branching chamber (pre-series)



quad12 oval chamber

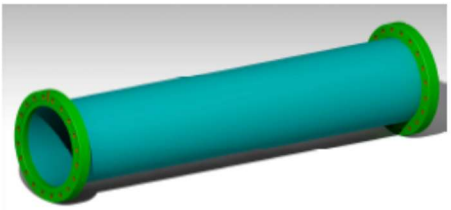
HEBT: Steerer Chambers

Chamber type	Quantity	Subtypes
s100	29	19
s18h/v	34	16
s13 large aperture	4	3
Total	67	38



s18 round chamber with bellows

- Overall length: 500-1800 mm
- Shape: round
- Flanges: DN160CF – DN400CF
- Some chambers with bellows



s100 round chamber

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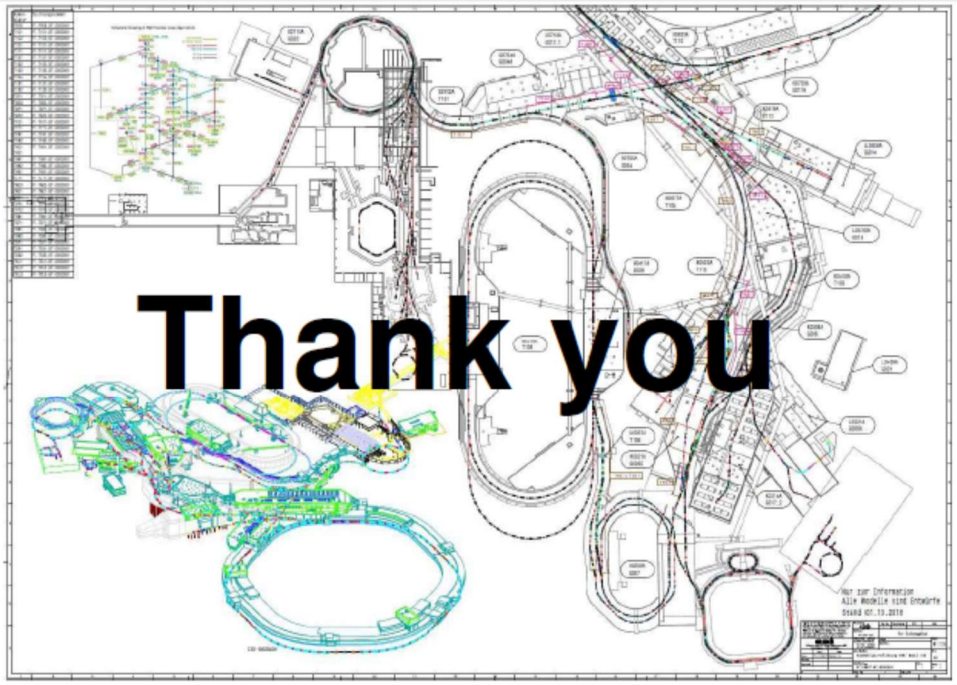
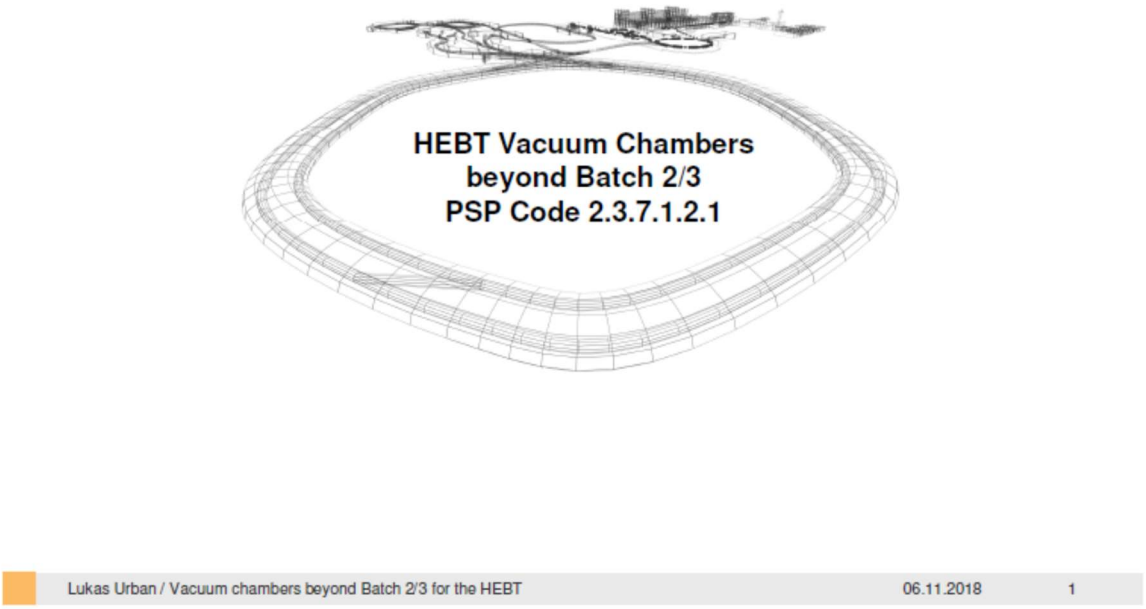


4.2 HEBT vacuum components beyond batches 2&3

Corresponding Author(s): l.urban@gsi.de



PSP-Code	Chamber type	Quantity	Subtypes	Status
2.3.7.1.2.1.1	pumping chambers	52	29	BINP (Council)
2.3.7.1.2.1.4	adaptor pumping chamber	45	5	to be assigned
2.3.7.1.2.1.2.1	roughing chambers	41	1	BINP (Council)
2.3.7.1.2.1.3	straight tubes	327	166	BINP (Council)
2.3.7.1.2.1.3	straight tubes with stand	131	107	BINP (Council)
2.3.7.1.2.1.5	bellows	528	10	BINP (Council)
2.3.7.1.2.1.3	x-cross chamber	1	1	BINP (Council)
2.3.7.3.2.1.1	pumping chambers	1		to be assigned (FBL)
2.3.7.3.2.1.2	roughing chambers FBL	3		to be assigned (FBL)
2.3.7.3.2.1.3	straight tubes FBL	14		to be assigned (FBL)
2.3.7.3.2.1.5	bellows FBL	27		to be assigned (FBL)
	Total	**1170**	**319**	

Milestone	Work Description	Date
M4	• Exchange of signed Contract	03/2019
M6	• Conceptual Design Review (CDR) accepted	05/2019
M7	• Final Design Review (FDR) accepted	07/2019
M8	• Factory Acceptance Test (FAT) of pre-series accepted	08/2019
M9	• Factory Acceptance Test (FAT) accepted	08/2021
M92	• Site Acceptance Test (SATaa) accepted	09/2021
M10	• Site Acceptance Test (SATab) accepted	09/2021
-	• Documentation	11/2021
-	• Final Acceptance	11/2021
-	• Warranty starts	

Vacuum properties

Vacuum properties	Non-bakeable	Bakeable
Integral leak rate	$\leq 1 \times 10^{-10} \frac{\text{mbar l}}{\text{s}}$	$\leq 1 \times 10^{-10} \frac{\text{mbar l}}{\text{s}}$
Outgassing rate (after **10h** of pumping)	$\leq 5 \times 10^{-10} \frac{\text{mbar l}}{\text{s cm}^2}$	$1 \times 10^{-12} \frac{\text{mbar l}}{\text{s cm}^2}$
Residual gas analyse (after **24h** of pumping)	1. All peaks between mass 18 and 45 must be **100** times lower than mass 18, except mass 28 and 44. 2. All peaks higher mass 45 must be **1000** lower than mass 18.	1. All peaks between mass 12 – 18 and mass 28 must be **≤ 10%** from mass 2. 2. All peaks between mass 22 – 32, except mass 28, must be **≤ 0.5%** from mass 2. 3. Peak 44 must be **≤ 20%** of mass 2. 4. All peaks between mass 49 – 100 must be **≤ 0.1%** from mass 2.

Inspection Reports (FAT):

- pumping time for measurements must be:
  10h for the outgassing rate
  24h for RGA measurement
  (deviations can´t be accepted)

Mechanical properties

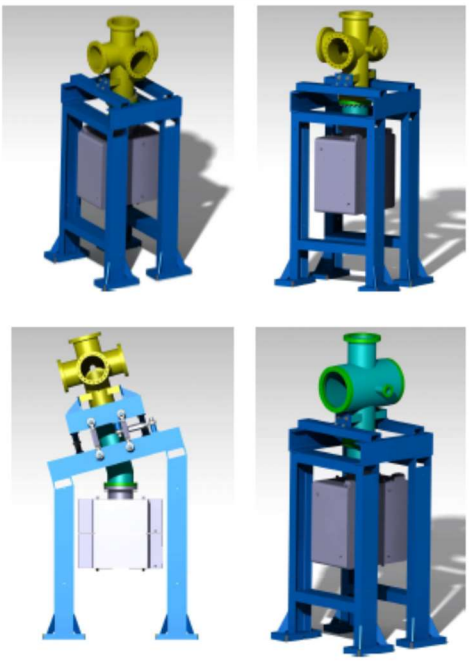
Mechanical properties:

- Check of welding seam according to DIN EN ISO 9712, quality class DIN EN ISO 5817 B
- Surface quality R_z=25
- Magnetic permeability:
  - Parts of the body of vacuum chamber → $\mu_{rel} \leq 1.05$
  - Components of the vacuum chamber such as flanges, bellows, and other fixed elements such as supports, bolts, nuts, washers, etc. → $\mu_{rel} \leq 1.05$
- Chamber material according DIN EN 10088: 1.4306, 1.4307, 1.4404, 1.4429 or 1.4435
- Flange Material according DIN EN10088: 1.4306, 14307 or higher quality
- Material for bakeable flanges: 1.4429 ESR

HEBT: pumping chambers

Chamber type	Quantity	Subtypes
pumping chambers	53	29

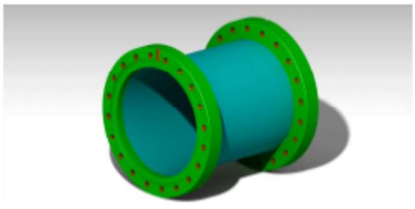
- Flanges: DN160CF – DN200CF
- Flange material 1.4429 ESR
- Stands are included in the delivery; pumps are not part of the delivery
- Some chambers with bellows
- Some beamlines are ascending and descending
- Draft version of the 3D model



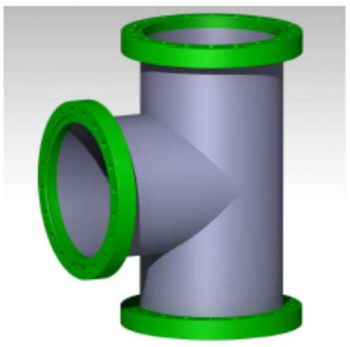
HEBT: roughing chambers

Chamber type	Quantity	Subtypes
adaptor pumping chamber	45	5
roughing chamber	44	1

- Flanges: DN160CF – DN200CF
- Draft version of the 3D models



adaptor pumping chamber

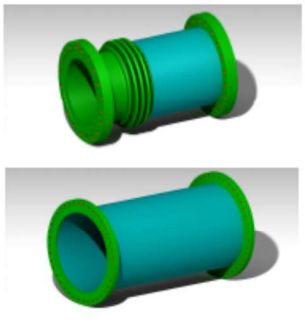


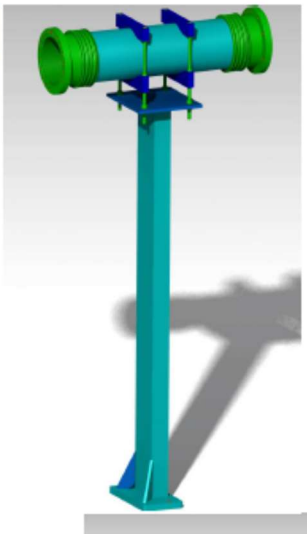
roughing chamber

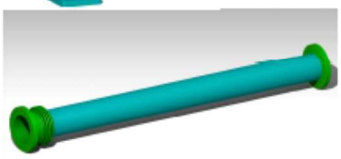
HEBT: Straight Chambers with stands

Chamber type	Quantity	Subtypes
straight tubes	341	166
straight tubes with stand	131	107

- Overall length: 250mm – 6700mm
- Flanges: DN160CF – DN400CF
- Stands are included in the delivery
- Some chambers with bellows
- Some beamlines are ascending and descending
- Draft version of the 3D models



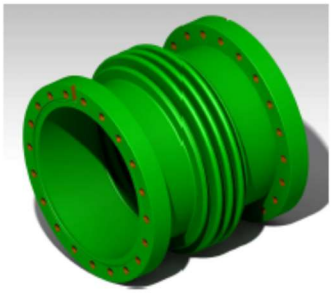




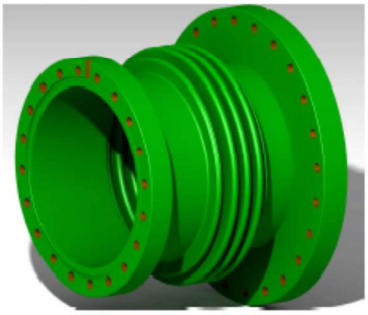
Bellows

Chamber type	Quantity	Subtypes
bellows	555	10

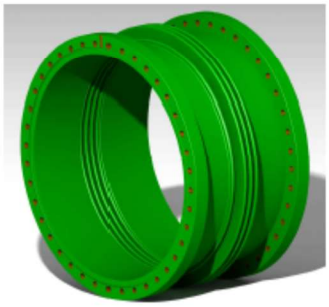
- Flanges: DN160CF – DN400CF
- Some bellows are bakeable
- Draft version of the 3D models



DN160CF



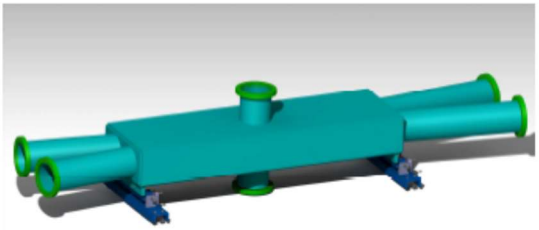
DN160CF - DN200CF

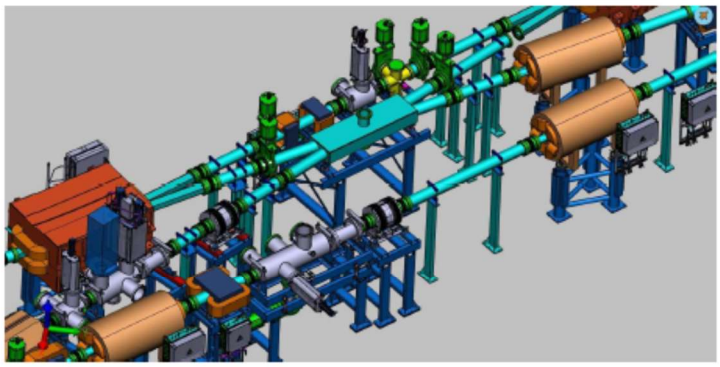


DN400CF

HEBT: X-cross chamber

- Flanges: 6 x DN160CF
- Maximal construction room reserved
- Draft version of the 3D models





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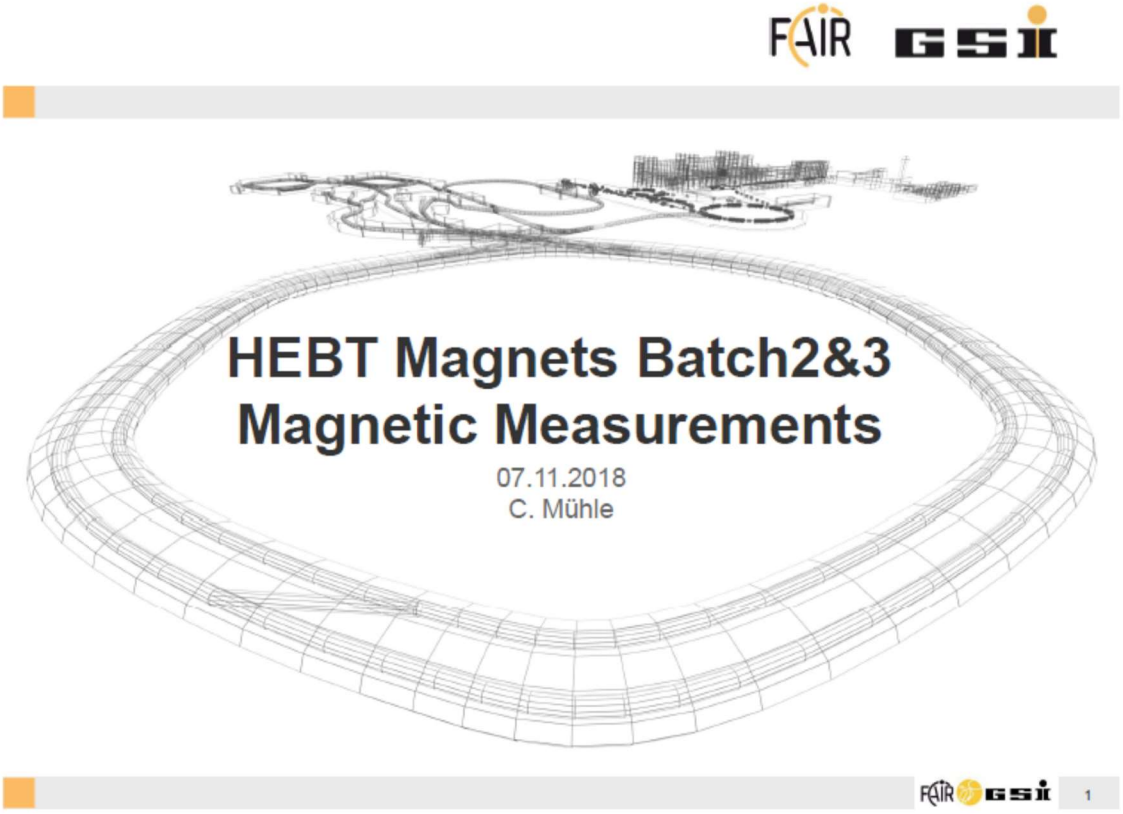
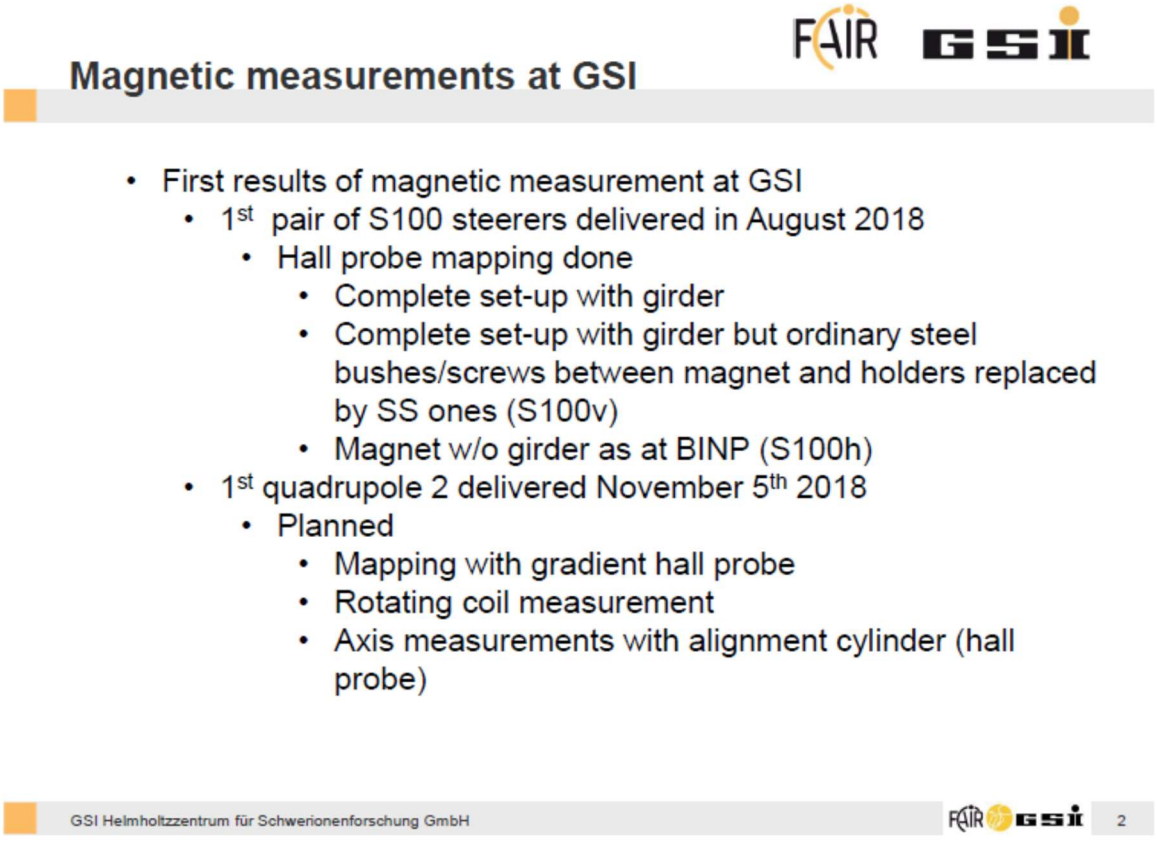
4.3 HEBT magnets batches 2 and 3

Corresponding Author(s): c.muehle@gsi.de





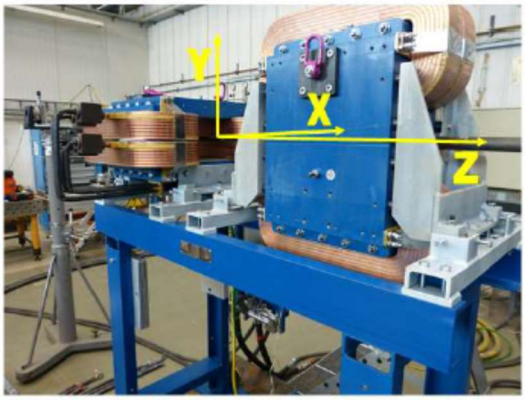
Prototype quadrupole 2

- Delivered on November 5th 2018
- No damages
- Documentation not complete yet

S100 steerer pair on girder

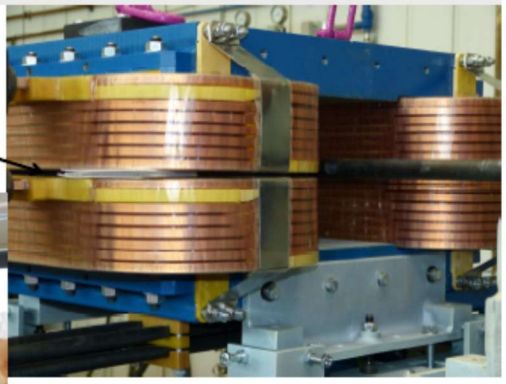
30.08.2018

MeasPicture_20180830A01



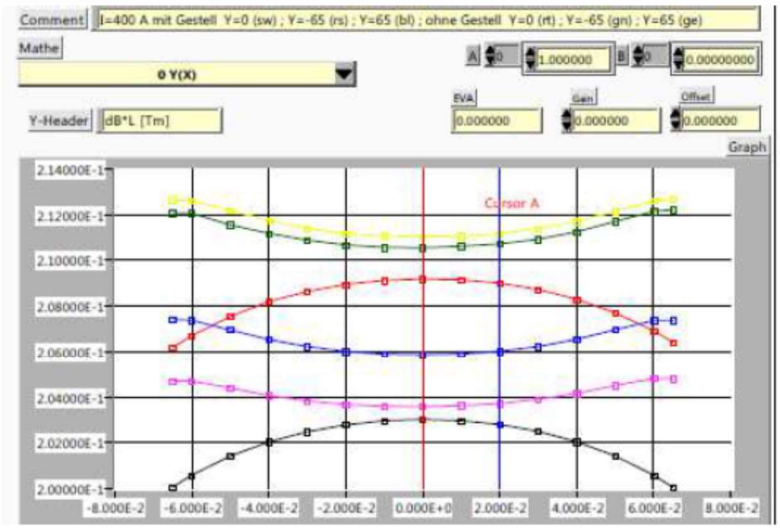
S100 steerer coil movement

- Video
- Temporary repair
- Improved design
  (still ~0.5mm movement



Comparison with and w/o girder 1

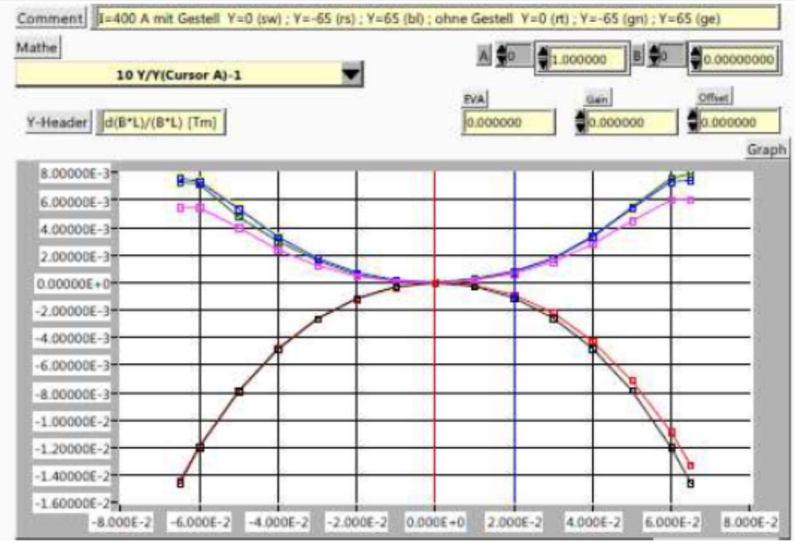
$\int Bdl=f(x)$
I=400A



With girder: black-y=0, pink-y=-65mm, blue-y=65mm
W/o girder: red-y=0, green-y=-65mm, yellow-y=65mm

Comparison with and w/o girder 2

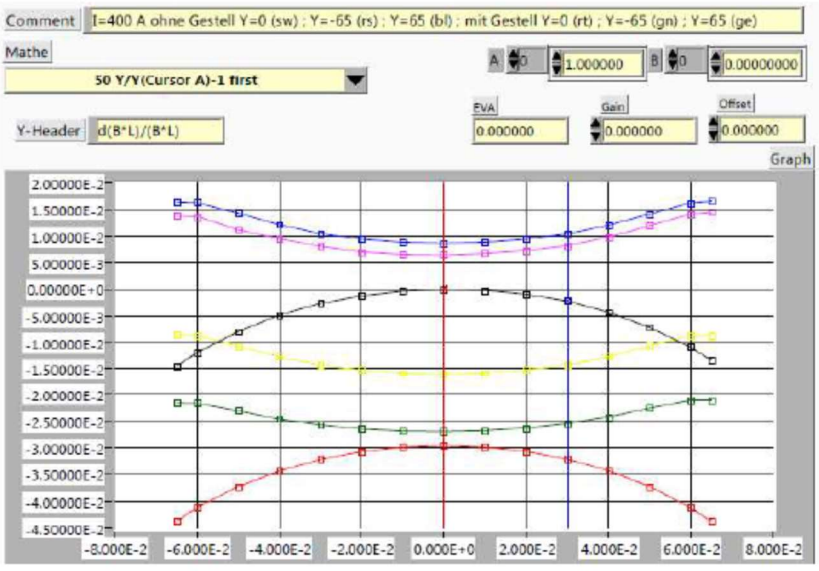
∫Bdl/∫Bdl(x=0)=f(x)
Not x=0, y=0.
I=400A



With girder: black-y=0, pink-y=-65mm, blue-y=65mm
W/o girder: red-y=0, green-y=-65mm, yellow-y=65mm

Comparison with and w/o girder 3

∫Bdl/∫Bdl(x=0)=f(x)
I=400A

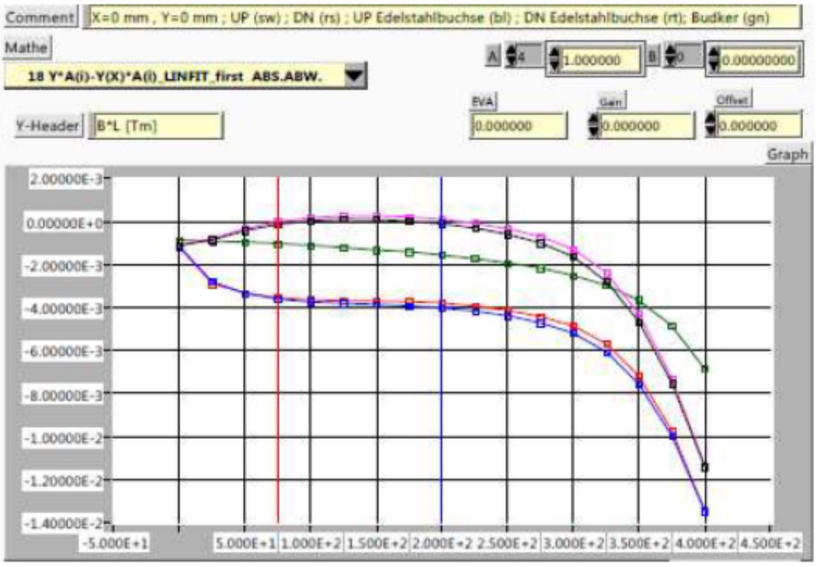


W/o girder: black-y=0, pink-y=-65mm, blue-y=65mm
With girder: red-y=0, green-y=-65mm, yellow-y=65mm

Comparison bushes/screws ordinary steel/stainless steel 1

∫Bdl=f(I)
x=0 y=0

Linear fit (black curve) subtracted

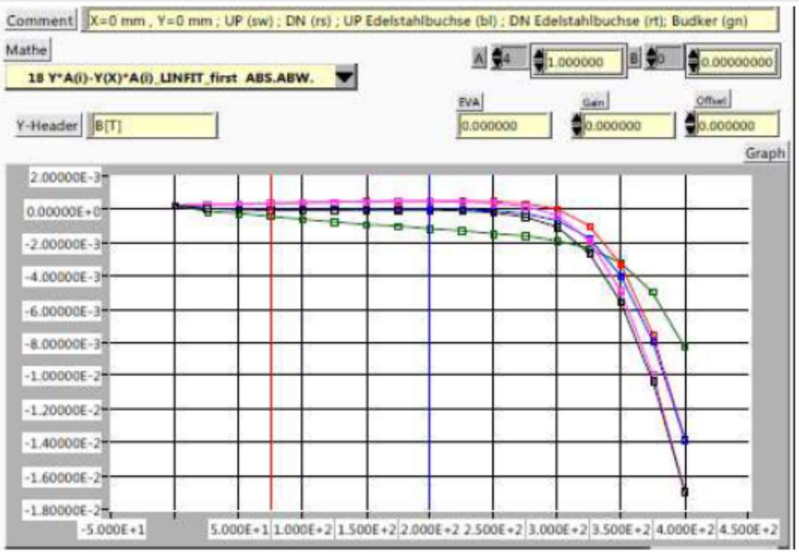


GSI: Ordinary steel: black-up, pink-down
Stainless steel: blue-up, red-down
BINP: Ordinary steel: green

Comparison bushes/screws ordinary steel/stainless steel 2

B=f(I)
x=0 y=0

Linear fit (black curve) subtracted

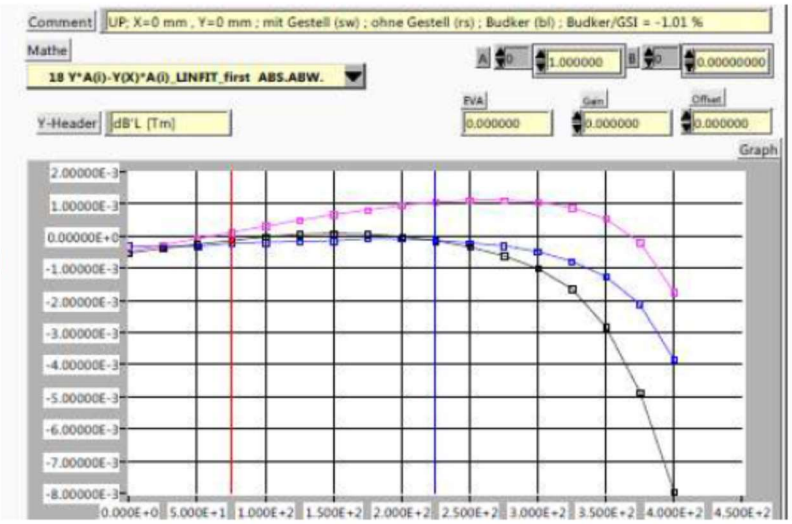


GSI: Ordinary steel: black-up, pink-down
Stainless steel: blue-up, red-down
BINP: Ordinary steel: green

Comparison BINP/GSI 1

∫Bdl=f(I)
x=0 y=0
Linear fit (black curve) subtracted

Gain between BINP and GSI ~1.01%

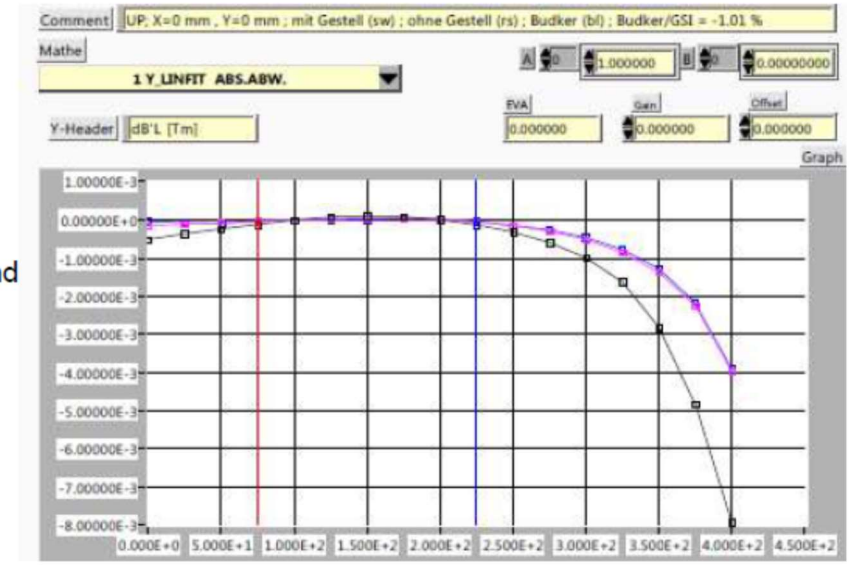


BINP: blue-w/o girder
GSI: black–with girder , pink-w/o girder

Comparison BINP/GSI 2

∫Bdl=f(I)
x=0, y=0
Linear fit (individual) subtracted

Gain between BINP and GSI subtracted

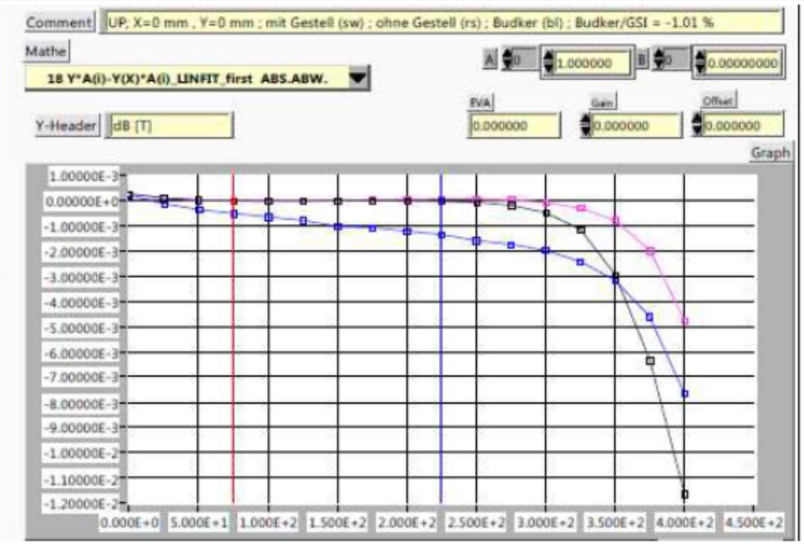


BINP: blue-w/o girder
GSI: black–with girder , pink-w/o girder

Comparison BINP/GSI 3

B(in center)=f(I)
x=0, y=0
Linear fit (black curve) subtracted

Gain between BINP and GSI ~1.01%

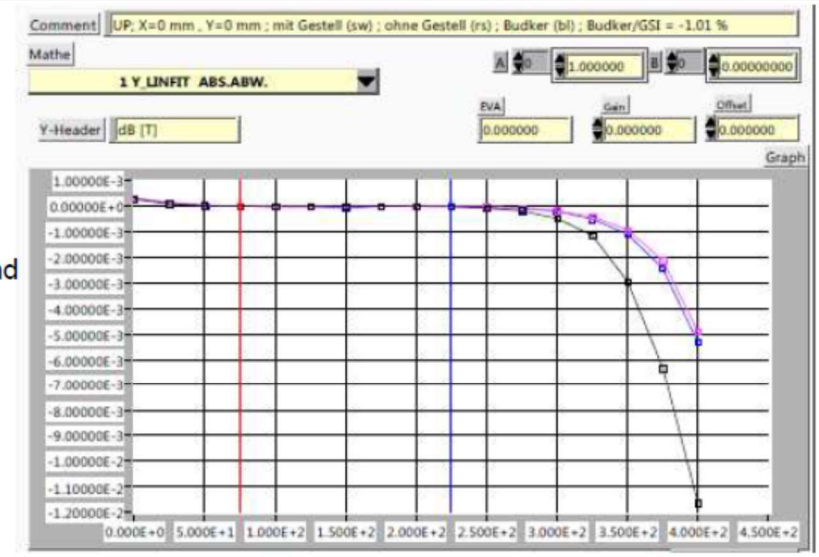


BINP: blue-w/o girder
GSI: black–with girder , pink-w/o girder

Comparison BINP/GSI 4

B(in center)=f(I)
x=0, y=0
Linear fit (individual) subtracted

Gain between BINP and GSI subtracted



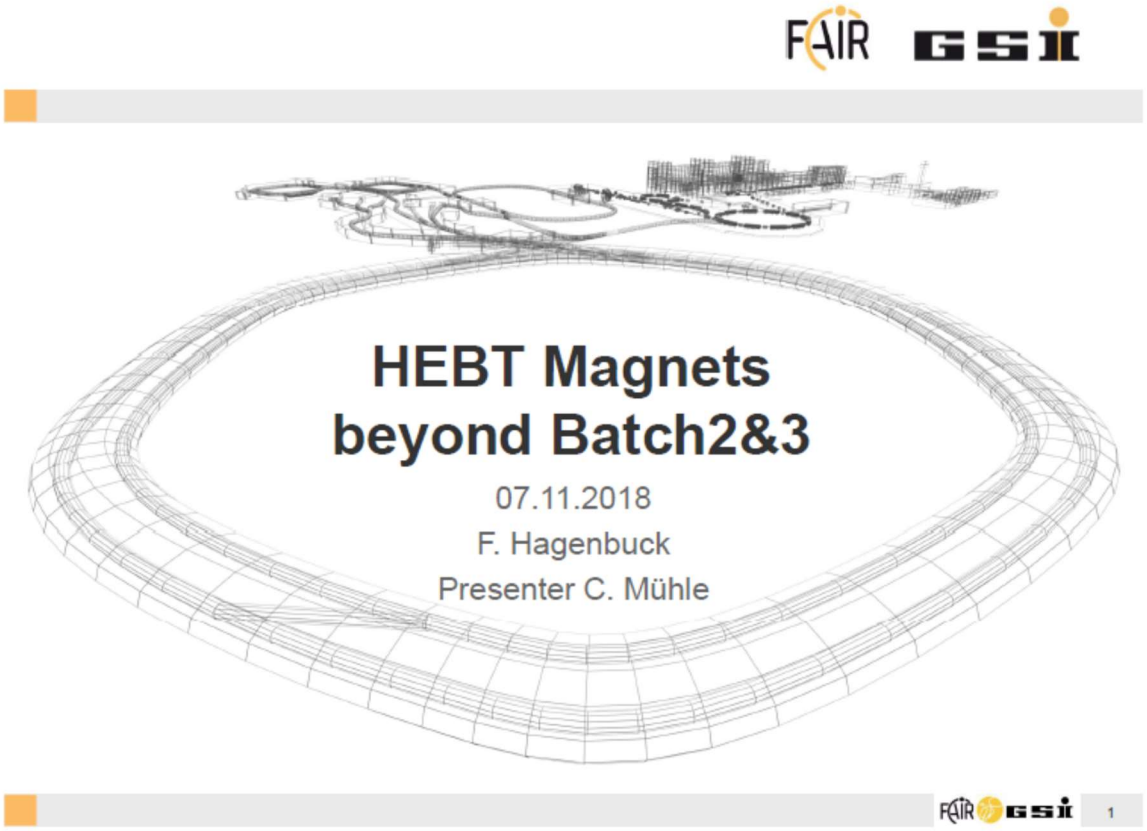
BINP: blue-w/o girder
GSI: black–with girder , pink-w/o girder

Conclusions

- Visual check during powering up and under power
  -> Will be part of FAT for prototypes in future
- Magnetic measurement in completely assembled position mandatory
- Improved coil fixation for S100
- Improvements for girder of S100
- Absolute magnetic field values to be checked

4.4 HEBT magnets beyond batches 2 and 3

Corresponding Author(s): c.muehle@gsi.de



HEBT Magnets beyond Batch2&3

Direct connection SIS18 – CR
(„Forgotten beamline“, HEBT beam line sections TSN1 and TSR1)

- 9 quadrupole magnets quad2
- 1 quadrupole magnet quad1
  (short version of quad2 with l_{yoke}=0.6m)
- 4 steering magnets s18
- 2 dipole magnets dip4
  (same cross section as dip15_0 with R=8.125m, φ=22.34°,
  one magnet of branching type with bore for beam passage
  in straight direction)
- All magnets are
  - specified in Detailed Specification Batch3
    (F-DS-MT-03e_HEBT-NC-Magnets_Batch3_v1.1
    https://edms.cern.ch/document/1541676/2)
  - not in ACB 7 (Accelerator Costbook)
  - proposed for ACB 8

HEBT Magnets beyond Batch2&3

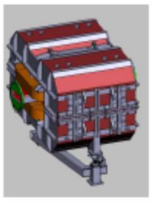
HighEnergyDensity@FAIR beam matching section (APPA cave)

- 1 quadrupole magnet quad11
- 4 quadrupole magnets quad2_customized
  (long version of quad2 with l_{yoke}=1.2m)
- 2 steering magnets s100
- Magnets are
  - not yet specified, however quadrupole magnet type quad11 and steering magnet type s100 are known from Batch2&3 and quad2_customized is a long version of known quad2
  - not in ACB 7
  - proposed for ACB 8

HEBT Magnets beyond Batch2&3

CR-like magnets (HEBT beam line sections FREX, TFC1)

- 5 quadrupole magnets quad3 (CR wide type) (PSP 2.3.2.2.3)
- 2 dipole magnets dip3_3 (PSP 2.3.2.1.3.4)



Adaption of CR-dipole design

Yoke cross section and coils cross section are identical to actual straight CR- dipole design (BINP-MT-Ptab 2016-07.1)

Lengthes are adapted to match a bending angle of 10.12°.

- Magnets are
  - specified in
    - dip3_3 F-DS-MT-102e_HEBT_dipole3_3_v3 (https://edms.cern.ch/document/1474310/4)
    - quad3 F-DS-NCM-en_MT_0124_HEBT_quad3_2018_01_19-V003 (https://edms.cern.ch/document/1174040/3)
  - in ACB 7and assigned to BINP by Council decision XI.18.15

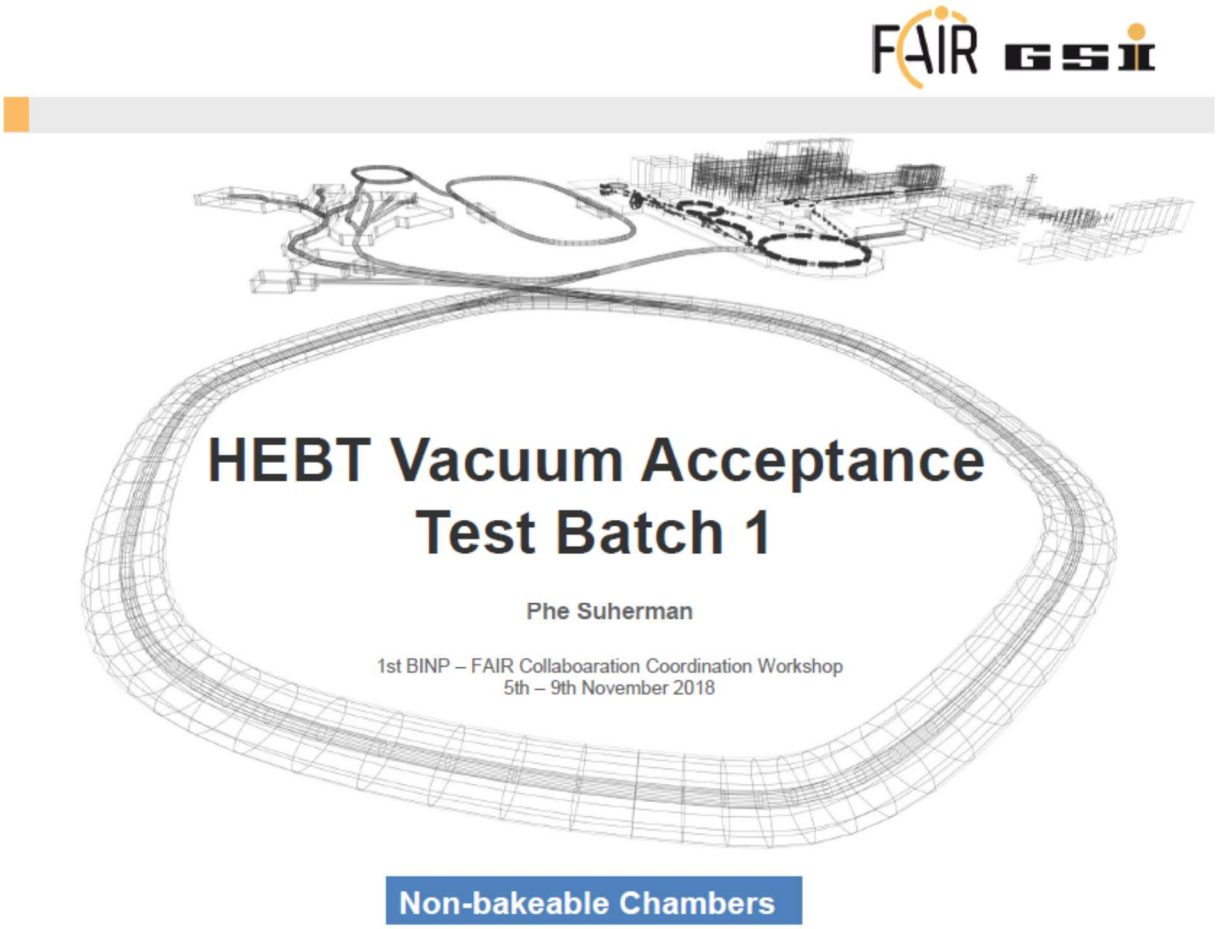
Summary

Magnet type	Quantity	Ptab	Det. Spec.	needed in	status
quad1	1	✓	✓	FBL	proposed for ACB 8
quad2	9	✓	✓	FBL	proposed for ACB 8
quad2_custom.	4	✓	-	HED@FAIR	proposed for ACB 8
quad3	5	✓	✓	FREX, TFC1	in ACB 7, Council Res. XI 18.15
quad11	1	✓	-	HED@FAIR	proposed for ACB 8
s18	4	✓	✓	FBL	proposed for ACB 8
s100	2	✓	-	HED@FAIR	proposed for ACB 8
dip3_3	2	✓	✓	TFC1	in ACB 7, Council Res. XI 18.15
dip4	2	✓	✓	FBL	proposed for ACB 8

All magnets needed until beginning of 2021, except CR-like magnets quad3 and dip3_3.
Schedule for CR-like magnets to be adapted to schedule of CR-magnets

4.5 HEBT vacuum acceptance: test batch 1

Corresponding Author(s): p.m.suherman@gsi.de



Non-bakeable Chambers

Integral Leak Test	Outgassing Rate	Residual Gas Composition
• He leak check • **Q ≤ 1x10^{-10} mbar.l/s**	• After 24 h pump down **→ q ≤ 1x10^{-10} mbar.l/(s.cm^2)** – Batch1 • After 10 h pump down **→ q ≤ 5x10^{-10} mbar.l/(s.cm^2)** – Batch 2/3	• Dominant gas: H_2O (after 24 h pump down) • All peaks for masses **between 18 – 45 amu** have to be **100 times** lower than the peaks of mass 18, except for mass 28 and 44. • All peaks for masses higher than 45 amu has to be **1000 times** lower than the peaks of mass 18 (*revealing any organic contamination, ineffective cleaning, post processing e.g. handling, packaging*).

Bakeable Chambers (Batch 2/3 and beyond Batch 2/3)

Integral Leak Test	Outgassing Rate	Residual Gas Composition
• He leak check • **$Q \leq 1x10^{-10}$ mbar.l/s**	• Before bake-out and after 24 h pump down **→ $q \leq 1x10^{-10}$ mbar.l/(s.cm²)** • After bake-out and cooling down to room temperature **→ $q \leq 5x10^{-12}$ mbar.l/(s.cm²)**	• Dominant gas: H_2 (after bake-out and cool down to room temperature) • All peaks from masses 12 – 18 amu and mass 28, have to be ≤ 10% of the H_2 peak • All peaks from masses 22 – 32 amu (except mass 28), have to be ≤ 0.5% of the H_2 peak. • All peaks from masses 34 – 48 amu (except mass 44), have to be ≤ 0.25% of the H_2 peak. • The peak from mass 44 has to be ≤ 5% of the H_2 peak. • All peaks from masses 49 to 100 have to be ≤ 0.1% of the H_2 peak

Vacuum Acceptance Procedure (@ GSI)

FAIR GSI

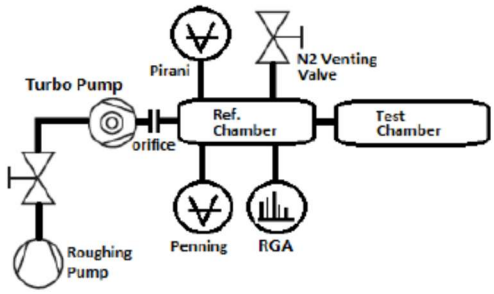
Pump down (min. 24 h)
- Recording time dependent pressure (from atmospheric condition)
- Determine the slope of pump down curve at molecular region.

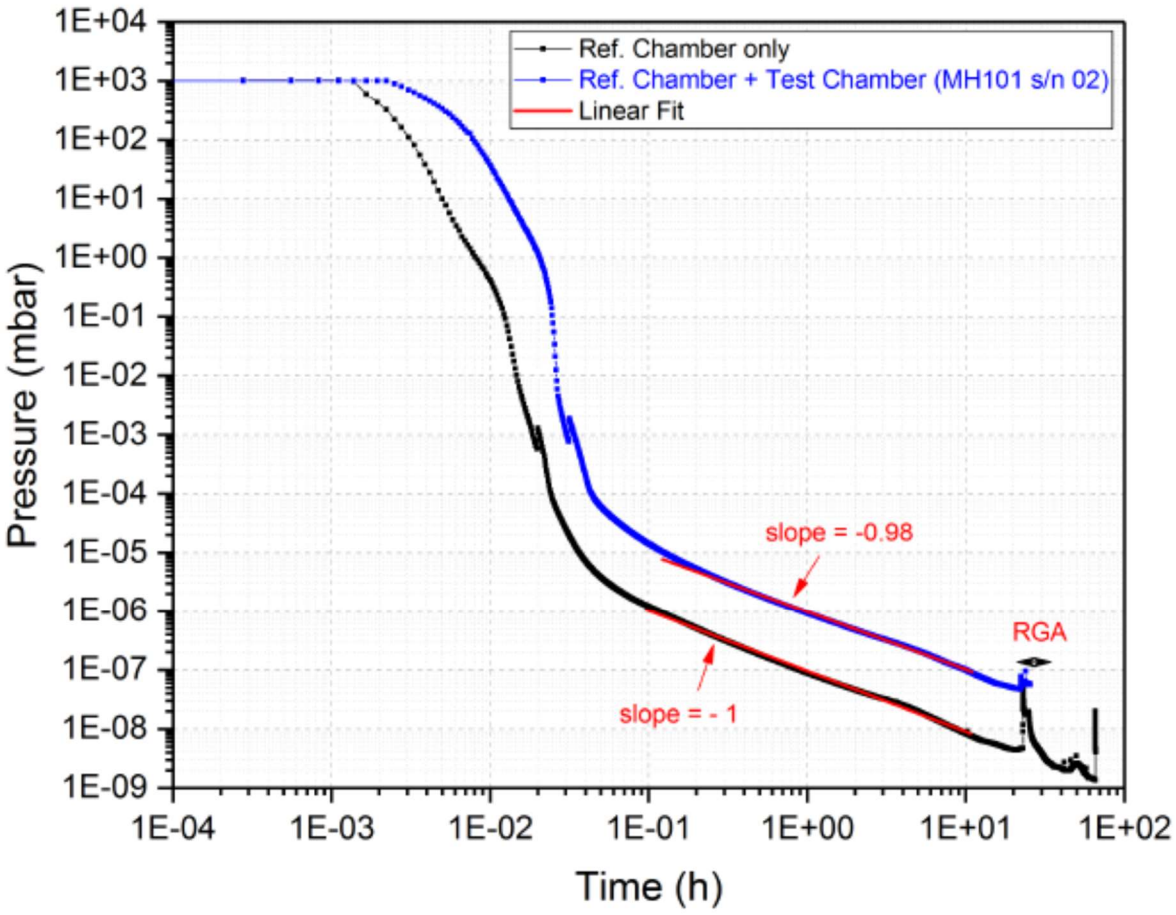
Integral Leak Test

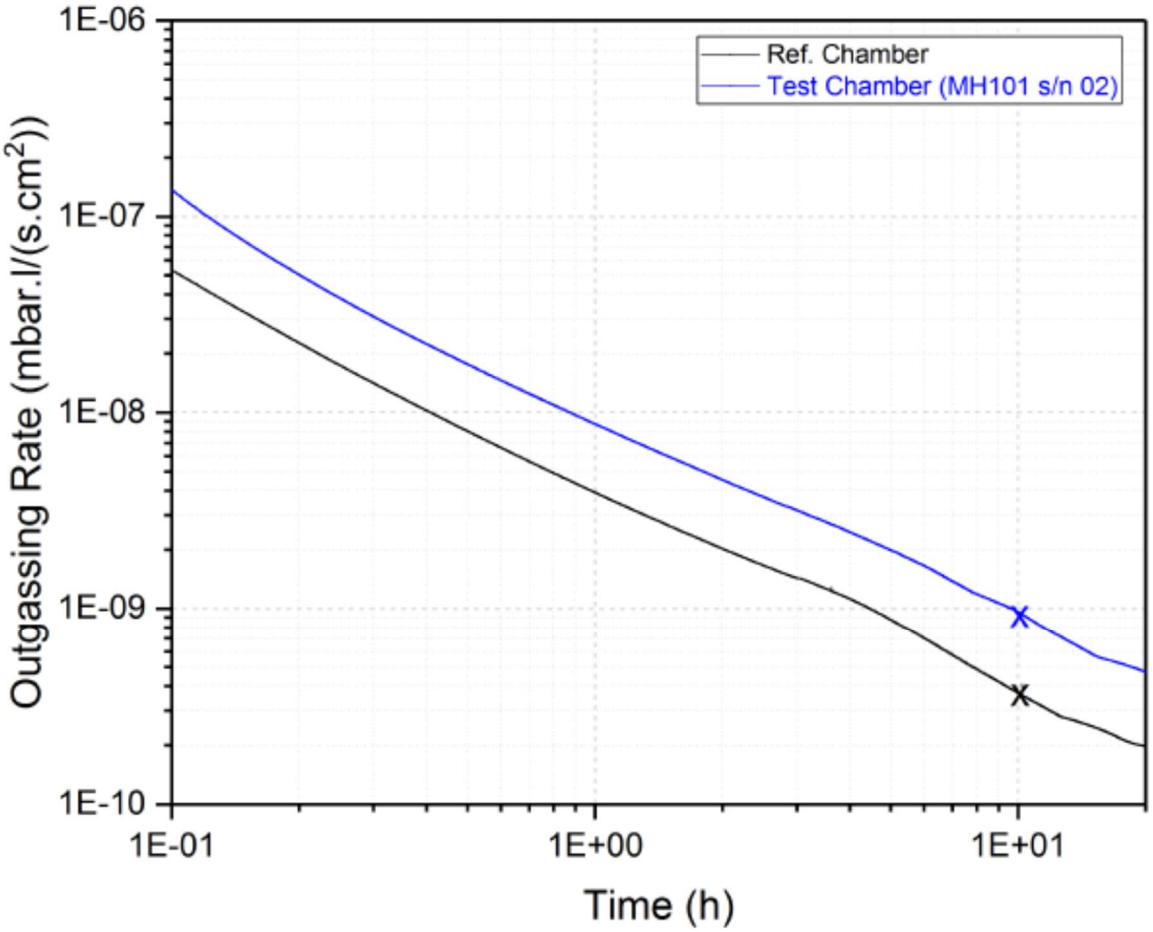
Outgassing Rate Measurement

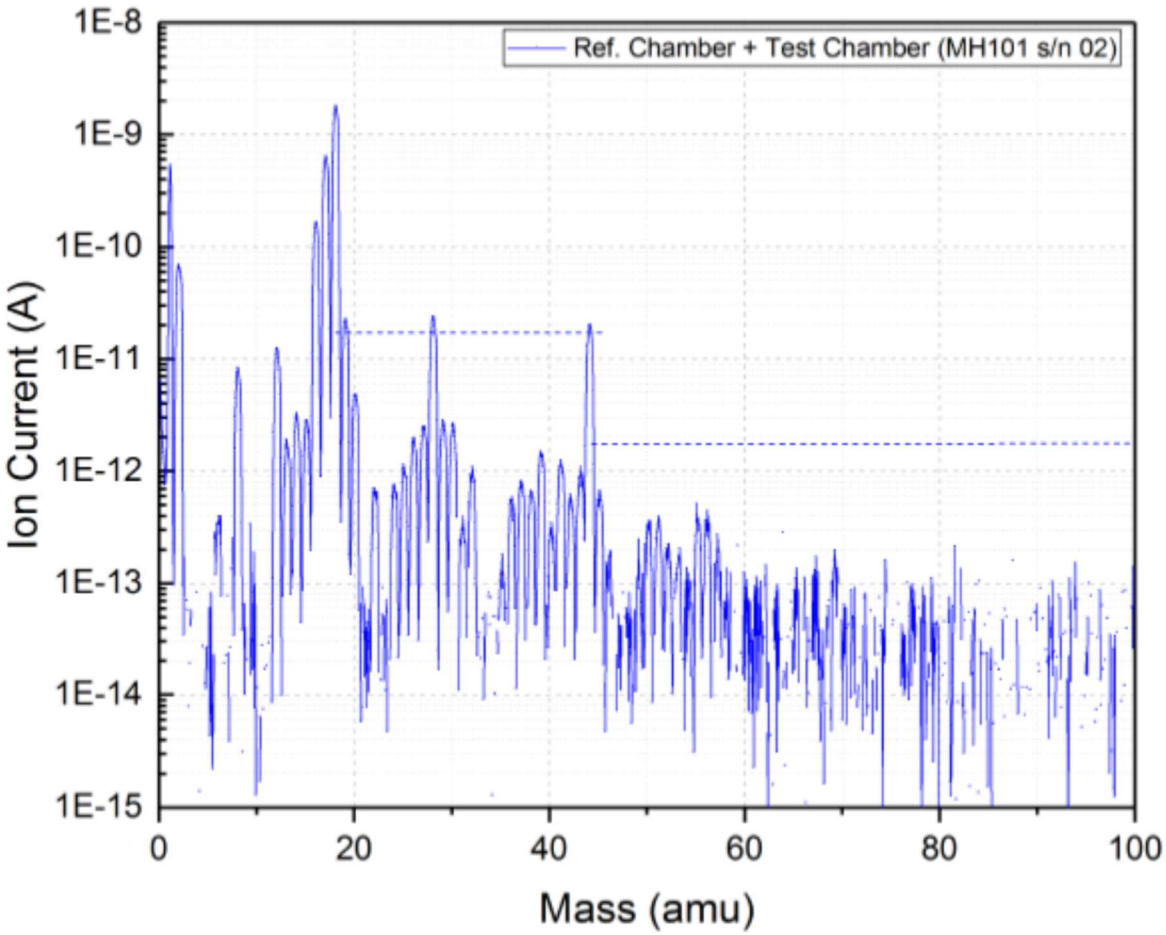
Residual Gas Analysis
- Spectra recorded after 2-3 h filament ignition

Bake-out Cycle (24 h, 250 °C)

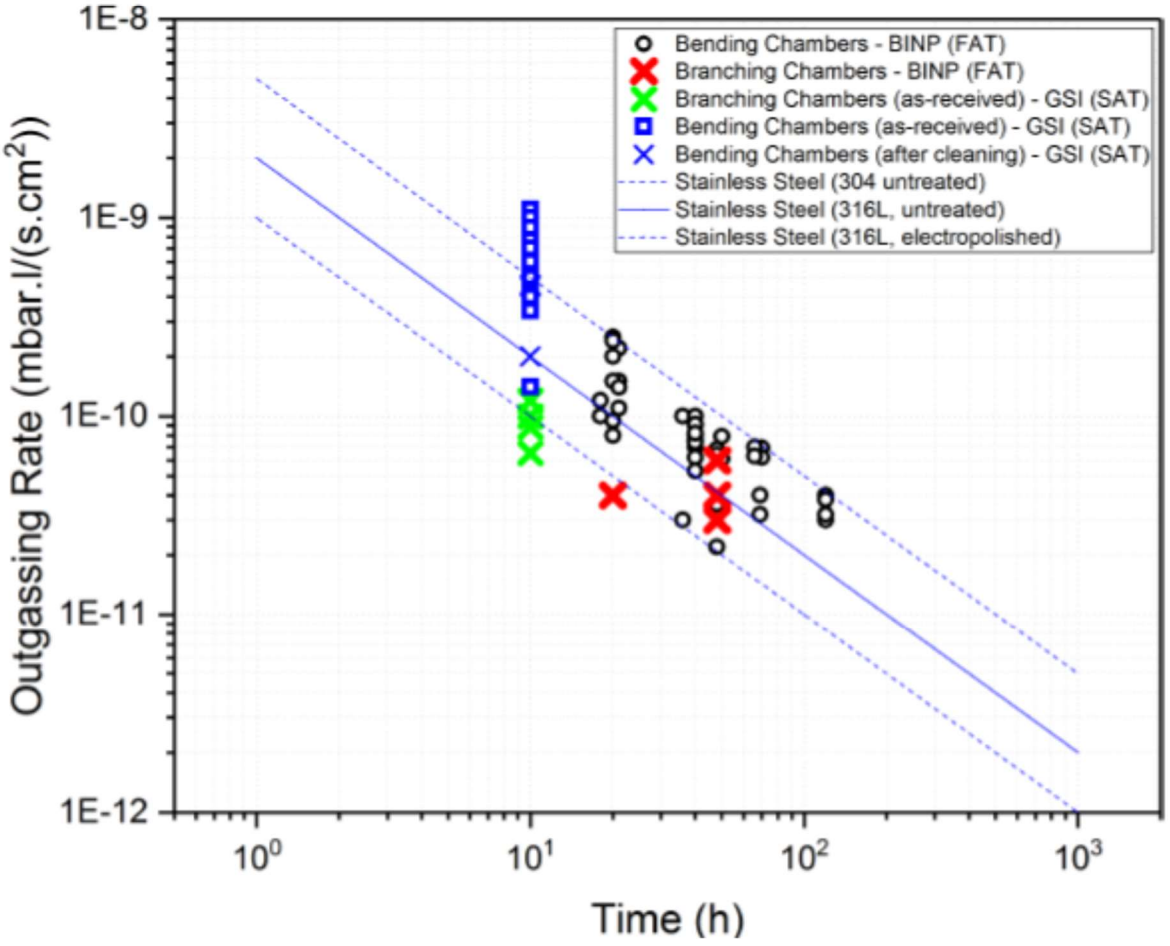


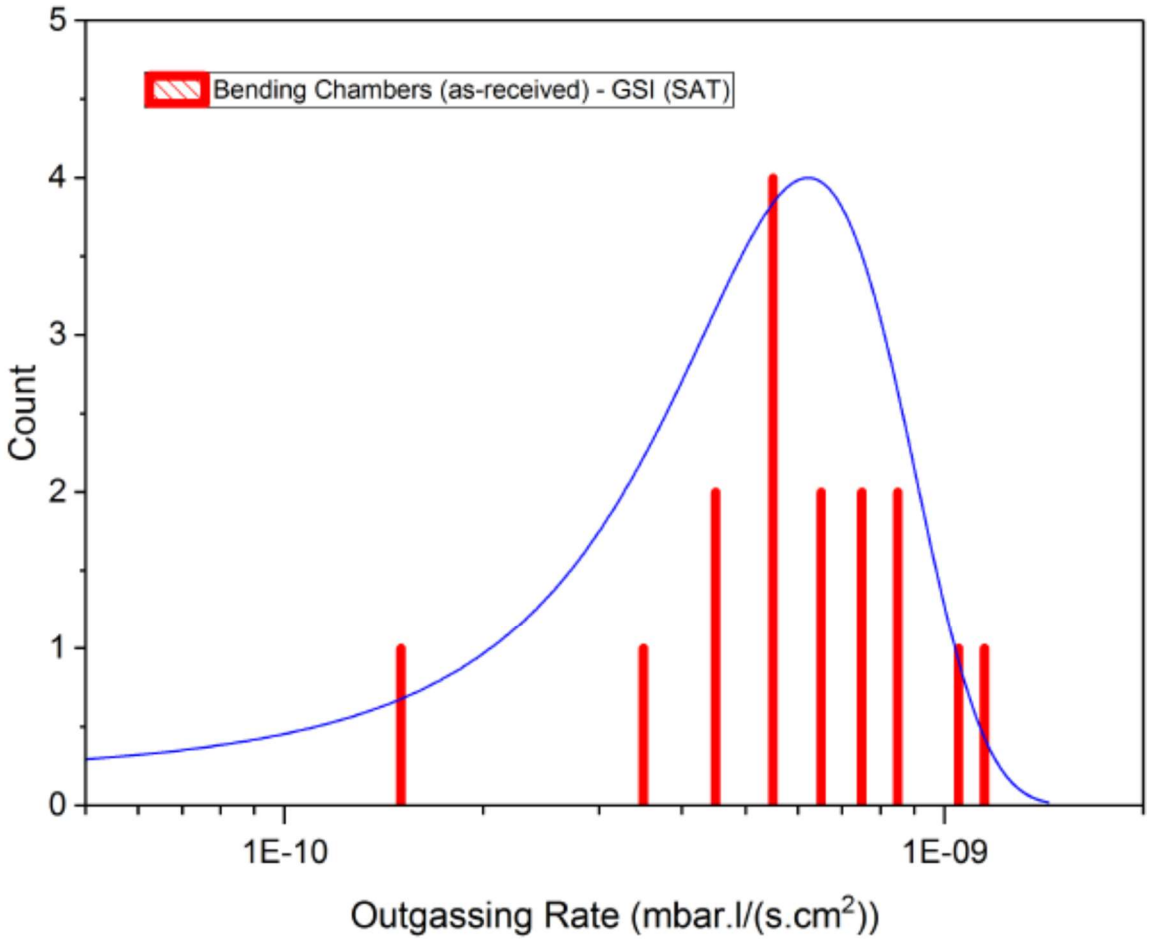

Ref. Chamber only
Ref. Chamber + Test Chamber (MH101 s/n 02)
Linear Fit
slope = -0.98
slope = - 1
RGA
Pressure (mbar)
Time (h)
1E+04
1E+03
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
1E-04
1E-05
1E-06
1E-07
1E-08
1E-09
1E-04
1E-03
1E-02
1E-01
1E+00
1E+01
1E+02


Ref. Chamber
Test Chamber (MH101 s/n 02)
Outgassing Rate (mbar.l/(s.cm²))
1E-06
1E-07
1E-08
1E-09
1E-10
1E-01
1E+00
1E+01
Time (h)


Ref. Chamber + Test Chamber (MH101 s/n 02)
Ion Current (A)
1E-8
1E-9
1E-10
1E-11
1E-12
1E-13
1E-14
1E-15
0
20
40
60
80
100
Mass (amu)

FAT & SAT Comparison (Outgassing Rate)





Average Outgassing Rate (mbar.l/s.cm²)

	FAT *	SAT **
Branching Chambers	4.6×10^{-11}	9.5×10^{-11}
Bending Chambers	9.1×10^{-11}	6.0×10^{-10}

*** based on various pump down time**
**** based on 10 h pump down time**

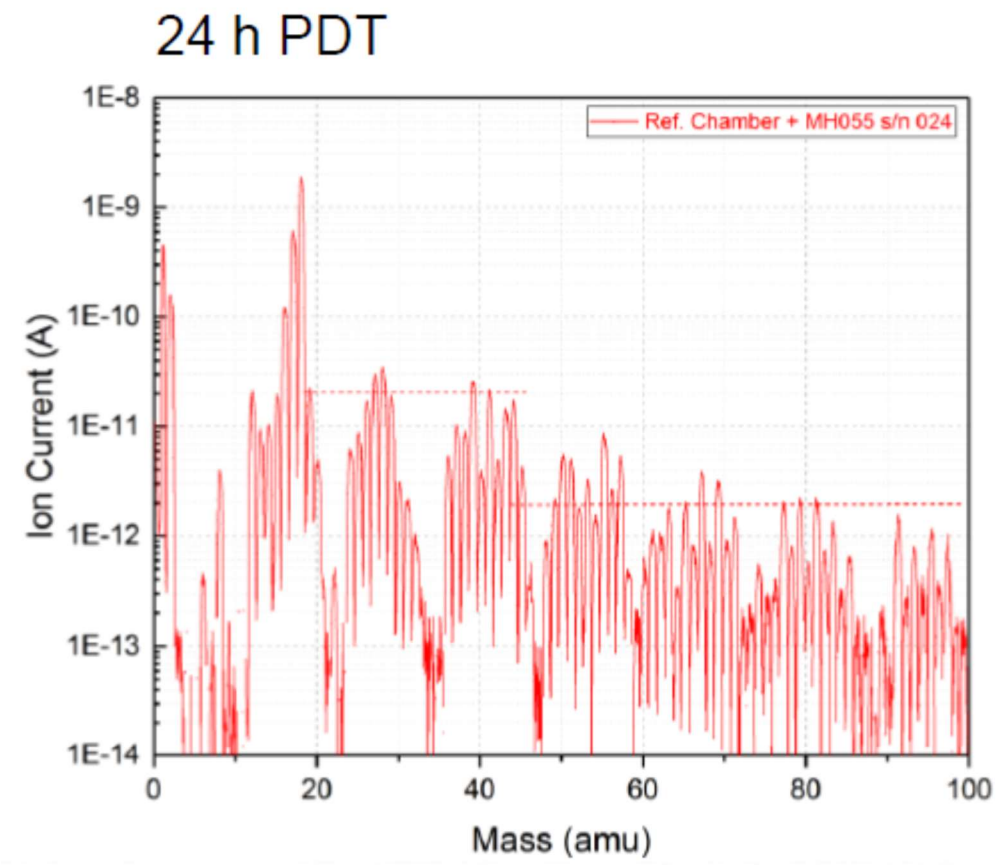
FAT & SAT Comparison (RGA)

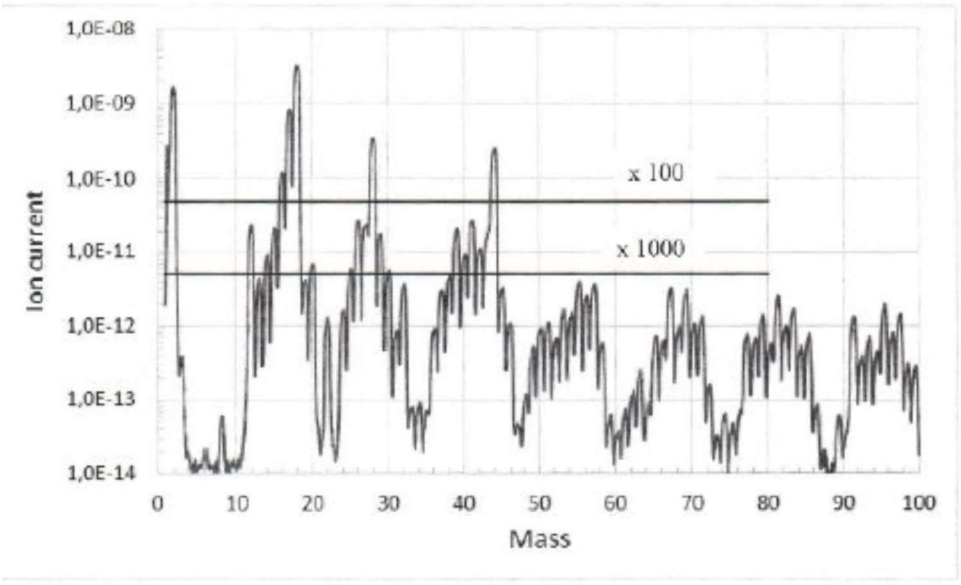
Bending Chamber MH055 s/n 024 (BINP and GSI)

Vacuum chamber 2.3.7.1.2.2.13 for magnet dip13-0_v1 S/N24

CVC6- Check off of spectrum of residual gases / Снятие спектра остаточных газов

Residual gas spectrum is shown below / Спектр остаточных газов показан ниже.	**Pressure after 120 hours pumping: 1,4E-7 mbar**
Type of residual gas analyzer / Тип анализатора остаточного газа	**Stanford RGA100 (S/N 160713)**
All mass peaks between 18 amu and 46 amu (except peak 28, 32 and 44) shall be 100 times less than the sum of all peaks. All mass peaks higher than 46 amu shall be 1000 times less than sum of peaks of masses 2, 18, 28 and 44 amu.	**OK**
Outgassing rate after 120h of continuous pumping	**3,1E-11 mbar*l*s^{-1}*cm^{-2}**
Type of penning gauge / Тип датчика давления	**IKR 270 (serial number: 44275349)**

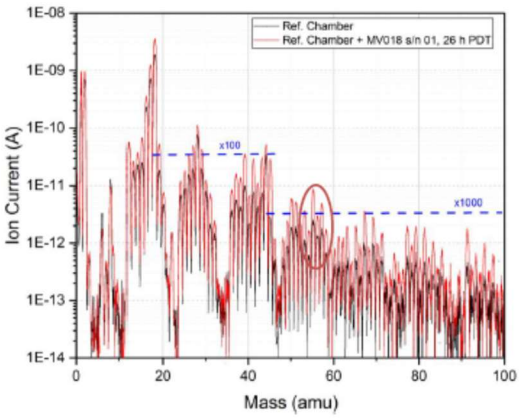




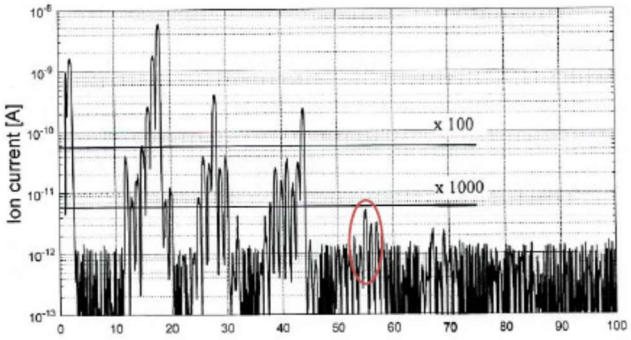
Spectrum of testing chamber (S/N 24)

Branching Chamber MV018 s/n 01 (BINP and GSI)

24 h



48 h



Spectrum of testing chamber (S/N 01)

4 out of 5 branching chambers have similar RGA spectra

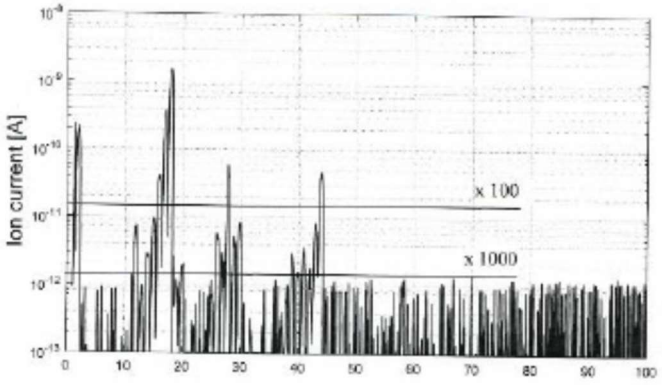
FAT – RGA

Branching Chambers (20h vs 48h)

V026 Vacuum chamber (026) 2.3.7.1.2.2.1.2 for magnet Dip 1f-0 S/N 01

CVC6- Check off of spectrum of residual gases after 20 hours pumping/ Снятие спектра остаточных газов после откачки

Residual gas spectrum is shown below / Спектр остаточных газов показан ниже.	Pressure 4E-8 mbar
Type of residual gas analyzer / Тип анализатора остаточного газа	**Stanford RGA200 (S/N 160853)**
All mass peaks between 18 amu and 46 amu (except peak 28, 32 and 44) shall be 100 times less than the sum of all peaks. All mass peaks higher than 46 amu shall be 1000 times less than sum of peaks of masses 2, 18, 28 and 44 amu.	OK
Outgassing rate after 20h of continuous pumping	4E-11 mbar*l*s^{-1}*cm^{-2}
Type of penning gauge / Тип датчика давления	IKR 270 (serial number: 44275349)



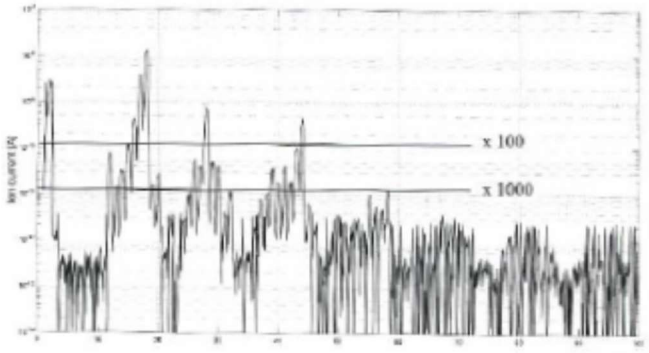
Spectrum of testing chamber (S/N 01)

069

Vacuum chamber 2.3.7.1.2.2.1 for magnet Dip 1s-0 S/N 02

CVC6- Check off of spectrum of residual gases after 48 hours pumping/ Снятие спектра остаточных газов после откачки

Residual gas spectrum is shown below / Спектр остаточных газов показан ниже.	Pressure 6E-8 mbar
Type of residual gas analyzer / Тип анализатора остаточного газа	**Stanford RGA200 (S/N 160853)**
All mass peaks between 18 amu and 46 amu (except peak 28, 32 and 44) shall be 100 times less than the sum of all peaks. All mass peaks higher than 46 amu shall be 1000 times less than sum of peaks of masses 2, 18, 28 and 44 amu.	OK
Outgassing rate after 18h of continuous pumping	4E-11 mbar*l*s^{-1}*cm^{-2}
Type of penning gauge / Тип датчика давления	IKR 270 (serial number: 44275349)



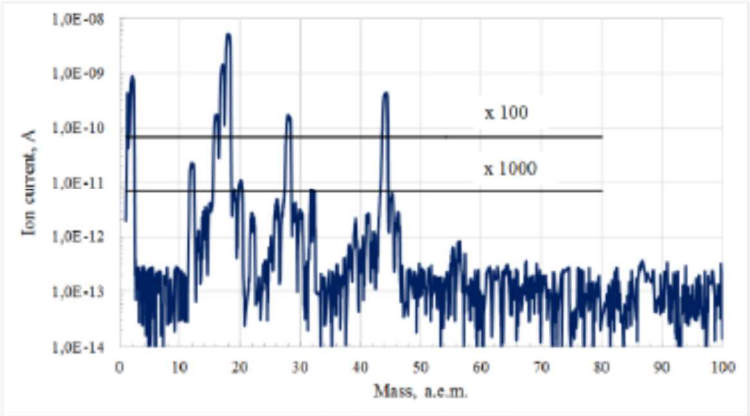
Spectrum of testing chamber (S/N 02)

Branching Chambers vs Bending Chambers (RGA – FAT results after 120 hours)

Vacuum chamber 2.3.7.1.2.2.1 for magnet dip1f-0_v1 S/N02

CVC6- Check off of spectrum of residual gases / Снятие спектра остаточных газов

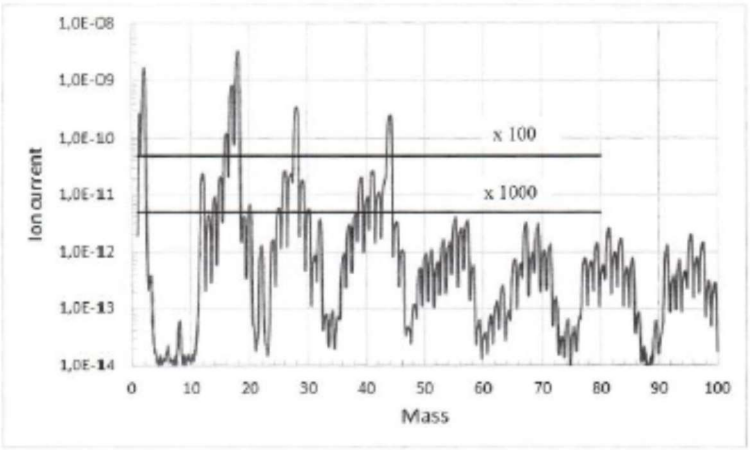
Residual gas spectrum is shown below / Спектр остаточных газов показан ниже.	**Pressure after 120 hours pumping: 9,1E-8 mbar**
Type of residual gas analyzer / Тип анализатора остаточного газа	**Stanford RGA100 (S/N 160713)**
All mass peaks between 18 amu and 46 amu (except peak 28, 32 and 44) shall be 100 times less than the sum of all peaks. All mass peaks higher than 46 amu shall be 1000 times less than sum of peaks of masses 2, 18, 28 and 44 amu.	**OK**
Outgassing rate after 120 h of continuous pumping	**3,8E-11 mbar*l*s^{-1}*cm^{-2}**
Type of penning gauge / Тип датчика давления	**IKR 270 (serial number: 44275349)**



Spectrum of testing chamber (S/N 02)

CVC6- Check off of spectrum of residual gases / Снятие спектра остаточных газов

Residual gas spectrum is shown below / Спектр остаточных газов показан ниже.	**Pressure after 120 hours pumping: 1,4E-7 mbar**
Type of residual gas analyzer / Тип анализатора остаточного газа.	**Stanford RGA100 (S/N 160713)**
All mass peaks between 18 amu and 46 amu (except peak 28, 32 and 44) shall be 100 times less than the sum of all peaks. All mass peaks higher than 46 amu shall be 1000 times less than sum of peaks of masses 2, 18, 28 and 44 amu.	**OK**
Outgassing rate after 120h of continuous pumping	**3,1E-11 mbar*l*s^{-1}*cm^{-2}**
Type of penning gauge / Тип датчика давления	**IKR 270 (serial number: 44275349)**



Spectrum of testing chamber (S/N 24)

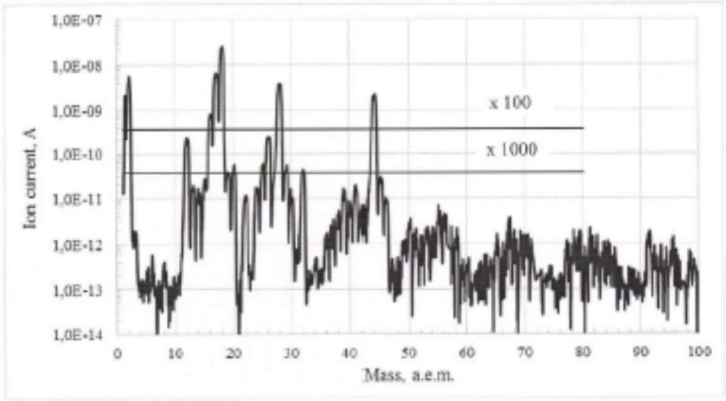
Bending Chamber
MH055 s/n 020 07-00001-001-5

Bending Chamber MH055 s/n 020 (BINP and GSI)

Vacuum chamber 2.3.7.1.2.2.13 for magnet dip13-0_v1 S/N20

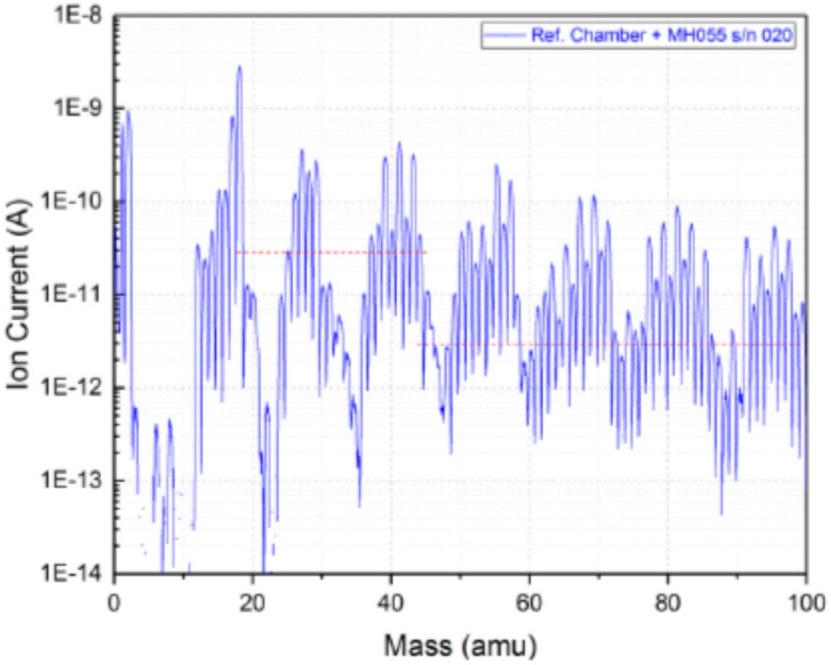
CVC6- Check off of spectrum of residual gases / Снятие спектра остаточных газов

Residual gas spectrum is shown below / Спектр остаточных газов показан ниже.	**Pressure after 20 hours pumping: 5,04E-7 mbar**
Type of residual gas analyzer / Тип анализатора остаточного газа	**Stanford RGA100 (S/N 160713)**
All mass peaks between 18 amu and 46 amu (except peak 28, 32 and 44) shall be 100 times less than the sum of all peaks. All mass peaks higher than 46 amu shall be 1000 times less than sum of peaks of masses 2, 18, 28 and 44 amu.	**OK**
Outgassing rate after 20h of continuous pumping	**8E-11 mbar*l*s^{-1}*cm^{-2}**
Type of penning gauge / Тип датчика давления	**IKR 270 (serial number: 44275349)**

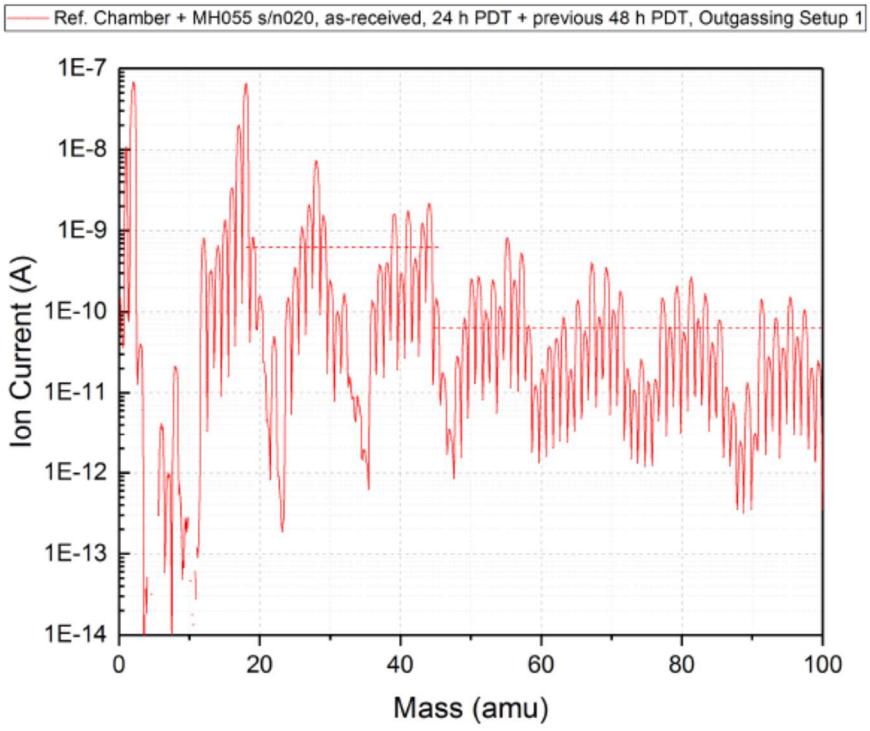


Spectrum of testing chamber (S/N 20)

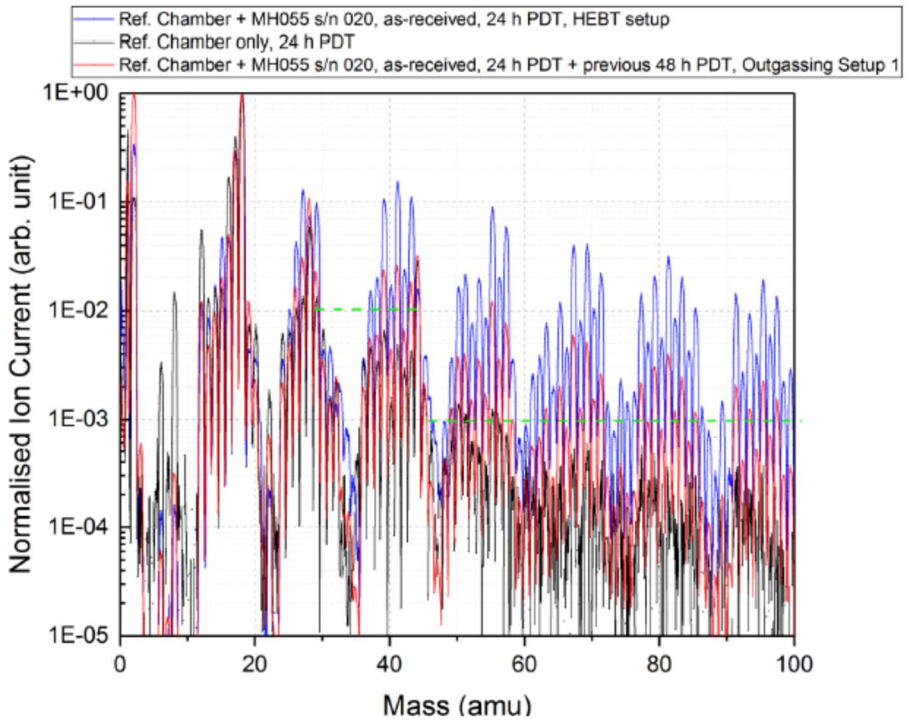
24 h PDT



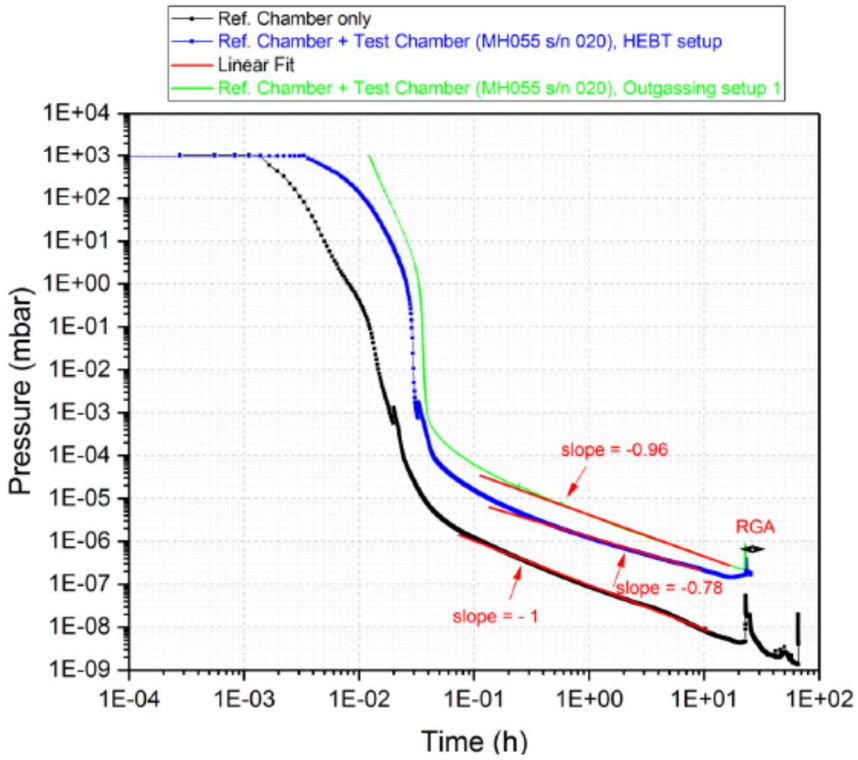
Bending Chamber MH055 s/n 020 (SAT - RGA)



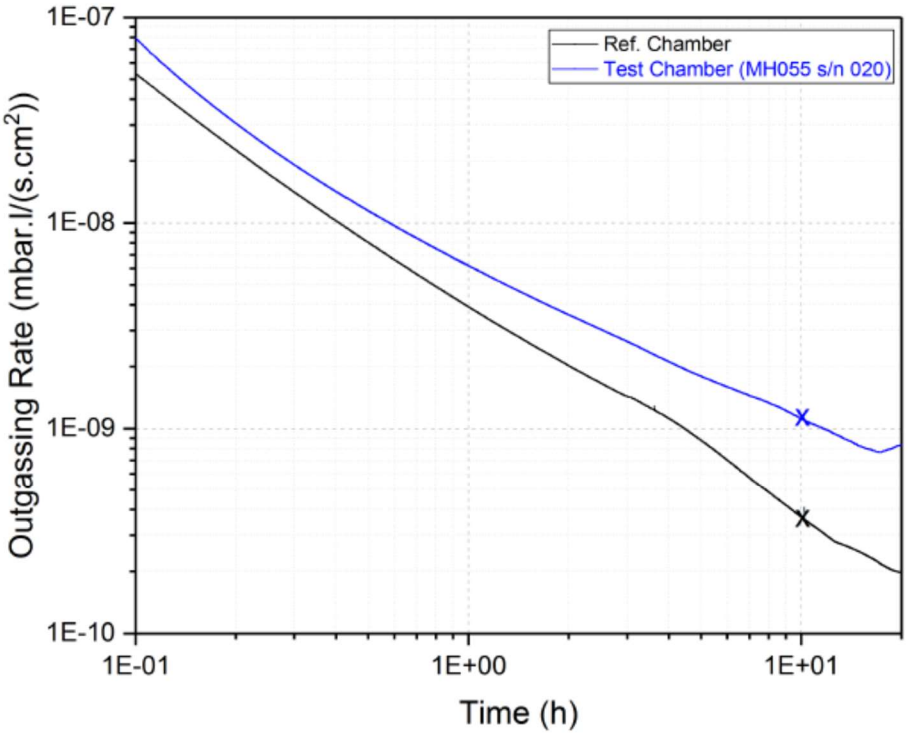
Bending Chamber MH055 s/n 020 (SAT - RGA)



Bending Chamber MH055 s/n 020 (SAT – Pump Down Curve)



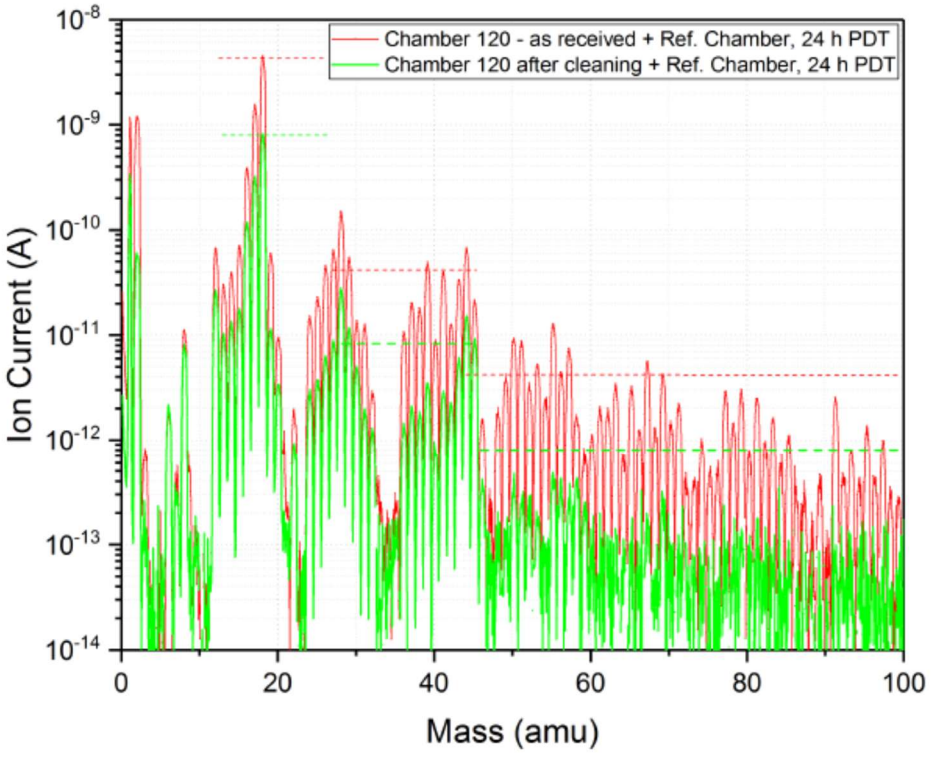
Bending Chamber MH055 s/n 020 (SAT – Outgassing Rate)



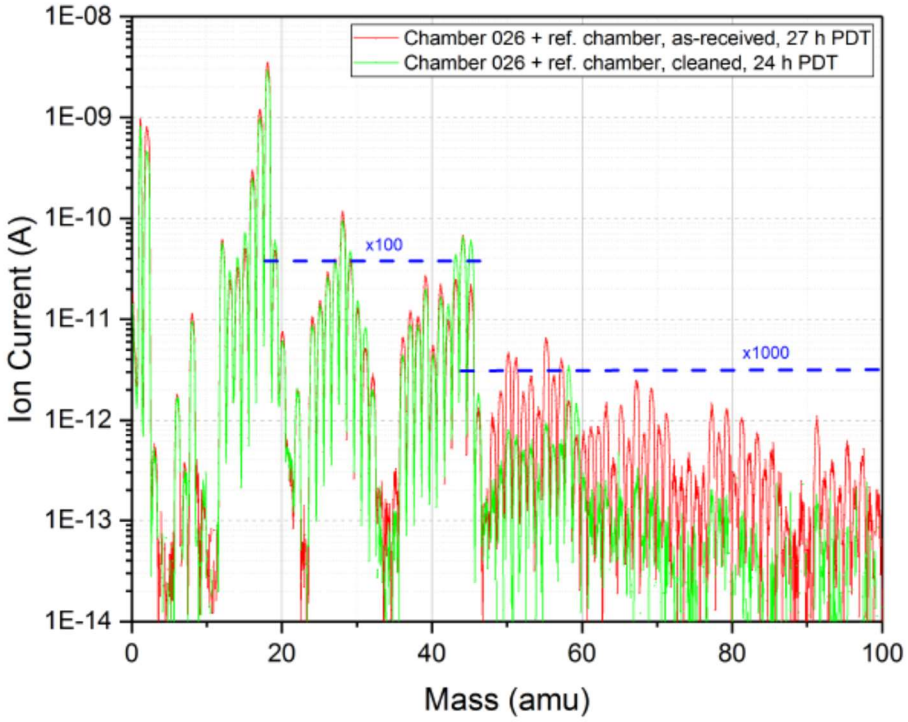
- Consistency in pump down time during the vacuum acceptance test is important.
  - The outgassing rate and residual gas composition vary with pumping time - especially for unbaked vacuum components
  - Many vacuum chambers (51 for Batch 1 HEBT and 272 for batch 2/3 HEBT) will undergo vacuum acceptance test
  - A better 'like for like' comparison – in case of any necessity to cross check the results between FAT and SAT.
- Re-cleaning all chambers due to uncertainty of the chamber cleanliness

RGA Comparison
(before and after cleaning @ GSI)

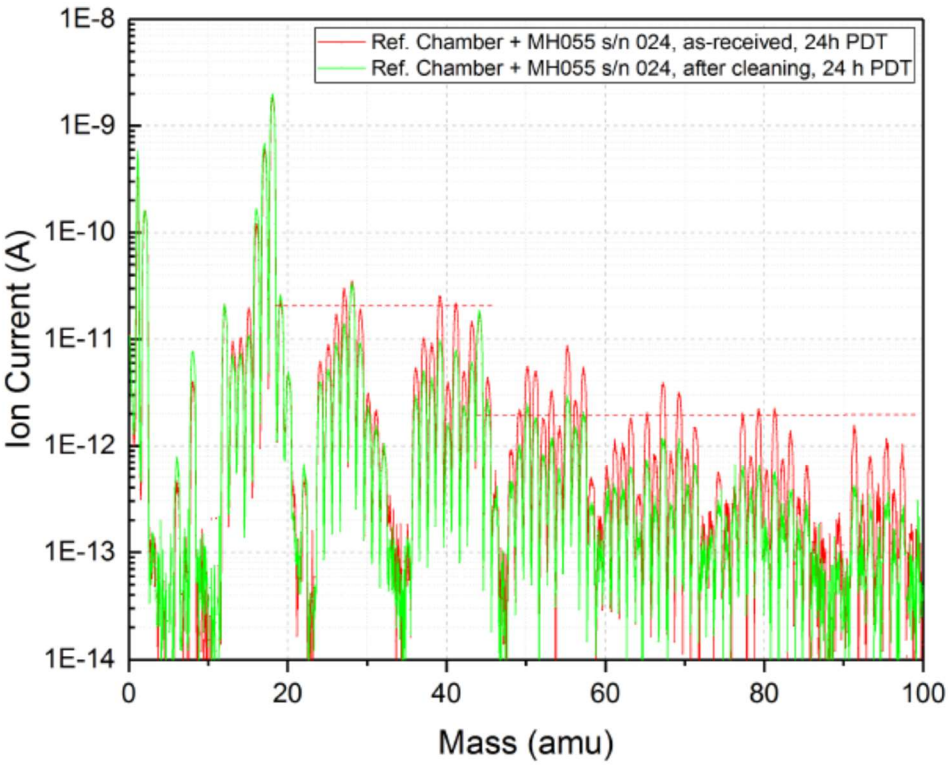
Branching Chamber MH120 s/n 01
(before and after cleaning)



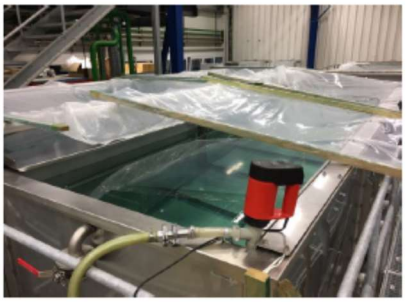
Branching Chamber V026 s/n01 (before and after cleaning)



Bending Chamber MH055 s/n 24 (before and after cleaning)



Ultrasonic Cleaning at GSI



Three ultrasonic cleaning baths
(5 m x 1.5 m x 1.5 m)

Drying Oven (5 m x 1.5 m x 1.5m /~5000€)

Heater on the oven

Technical data of the heater

Cleaning process:

1. Cleaning
   15-30 min. in the first bath with SurTec092 and SurTec138 (50/50)
2. Washing
   5-10min in the second bath and in the third bath with distilled water
3. Drying
   6h in the oven with maximal available heat (~180°C)

SAT Batch 1 – 1st delivery and Fitting to the magnet

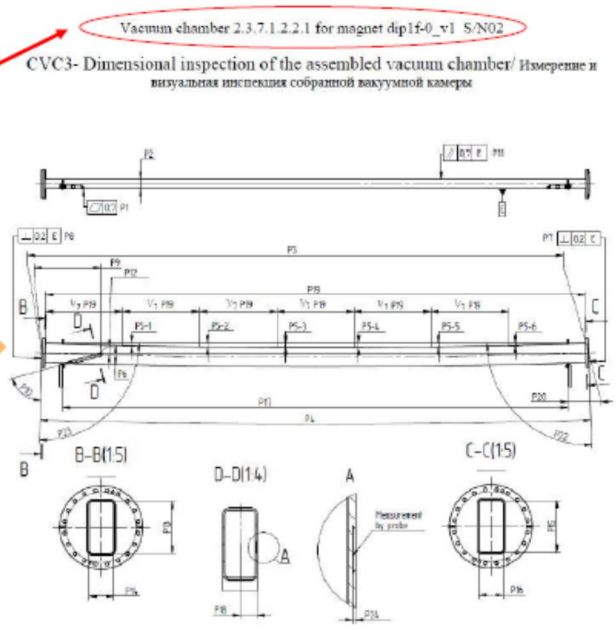
Future Work Improvement (Batch 2/3 and beyond Batch 2/3)

- **Consistency** during FAT (pump down time, measurement parameters)
- There should not be any re-work or re-cleaning at GSI during SAT
- Improvement for the cleaning facility at BINP
  - regular check for the ultrasonic cleaning bath
  - drying oven instead of pressurised air drying
- Better handling and storage
  - prevent dents and scratches which may cause rust
  - avoid contact of the stainless-steel chambers with other metal components
- Data handling and presentation:
  - data recording during pump down (e.g. Hyper-terminal, LabView, direct recording from the controller via USB stick, etc.)
  - RGA spectra for both reference chamber only and test chamber

FAT Inspection Report (Batch 2/3 and beyond Batch 2/3)

CID of the vacuum chamber must be included in the cover page and at the header of each page in the FAT Inspection Report.

The drawing for mechanical check in the Inspection Report must be made larger (minimum on **A3**-size paper) and correspond to the chamber type. Separate pdf file or *.dwg file should be provided.



Thank You for Your Attention !!

4.6 HEBT time schedule

Corresponding Author(s): f.hagenbuck@gsi.de

4.7 Pre-assembly and istallation

Corresponding Author(s): h.reich@gsi.de

4.8 HEBT round-up

FAIR GSI	Kind of Document **Meeting Minutes**	Template Number: F-FO-QUA-en-0012	Page 1 of 3

Meeting:	**HEBT parallel I and II at 1st BINP-FAIR workshop**	
Date:	06.11.2018 12:00-16:00	**Author: L. Urban**
Participants:	P. Suherman L. Urban A. Krämer M. Schwickert A. Krasnov A. Semenov T. Bedereva S. Glukov I. Morozov V. Vostrikov	
Distribution:	Participants + F. Hagenbuck, B. Merk, D. Urner, S. Uterman, M. Marenich	
Document Number:	F-PR-...to_follow (see work instruction for document identification)	

A: Action, D: Decision, I: Information		Who	Due Date
1. **HEBT parallel I (Batches 1 results)**			
I	The results of vacuum acceptance test of chambers from Batch 1 were presented. The chambers from the second delivery have a better 'outer appearance' (i.e. no sign of rust and cleaner). The RGA from some chambers (mainly the MH055 series), still showed a trace of hydrocarbon that are above the requirement threshold. All the chambers will be re-cleaned at GSI and will be mounted in the magnets soon after the cleaning. The SATab is still ongoing and the reports will be uploaded in EDMS. There should not be any re-work at GSI for Batch 2/3 and Batch 4.	P.Suherman	04. 11. 2018
A	Information about the ultrasonic cleaning facility at GSI will be send to BINP – as requested by A. Krasnov.	L. Urban	23. 11. 2018
A	Presentation about the results of vacuum acceptance test of chambers from Batch 1 will be send in BINP	P. Suherman	23. 11. 2018
A	In the future, the inspection report for the FAT should have the information of CID of the chamber and the mechanical drawing of the corresponding chamber in a 'readable' size/file.	BINP	n/a
A	BINP agrees to improve the acceptance test procedure in the future (for Batch 2/3 and 4), i.e. consistent pump down time, possibility of recording the test data during measurement, and improving the cleaning and handling processes.	BINP	n/a

2. **HEBT parallel II (Batch 2/3 magnet chambers)**			
I	The types and the quantity of chambers were presented to BINP.	L. Urban	04. 11. 2018
A	BINP needs a list with cost and delivery dates for each type of chamber including the chambers that have not been assigned to BINP.	L. Urban	16. 11. 2018
A	BINP should tell GSI what type of tubes they would like to use (with the size and tolerances according to the corresponding norm). With this information GSI can check if these can be accepted or not. Note from BINP that the CDR for all types needs approximately one year.	A. Krasnov	23. 11. 2018
A	Need more discussion on chamber for quad12	BINP/GSI	n/a
A	The milestones for the chambers in Batch 2/3 should be synchronized with the milestones for magnets.	BINP/GSI	n/a
A	BINP asks to send the presentation for Batch 2&3 chambers.	L. Urban	23. 11. 2018
3. **HEBT parallel II (Batch 4 chambers)**			
I	The types and the quantity of pumping chambers, roughing chambers, straight tubes and bellows were presented to BINP.	L. Urban	04. 11. 2018
A	BINP needs a list with cost and delivery dates for each type of chamber including the chambers that have not been assigned to BINP. The types and prices for the stands are needed as well.	L. Urban	16. 11. 2018
A	BINP would like to have a more detailed information of bellows (types, quantity), because BINP might order the batch of bellows together for CR.	L. Urban	23. 11. 2018
A	GSI will give a detailed information on X-cross chamber	L. Urban	23. 11. 2018
A	BINP has to inform GSI/FAIR as early as possible if BINP would like to produce chambers for the Forgotten Beam Line, to enable enough time for GSI/FAIR to prepare a tender - if required.	BINP	06. 12. 2018
A	BINP asks to send the presentation for Batch 4 chambers	L. Urban	23. 11. 2018

4. **Update on Beam instrumentation (HEBT, pBar Separator, SFRS)**			
I	GSI proposed to start a new collaboration for the production of 6 chambers for Beam Profile Monitors by BINP. These chambers have similar design as for CR. For 3 chambers pick-ups with elliptical cross-section are required (100% identical to the CR layout) and for the 3 remaining chambers a design of round pick-ups (400 mm diameter) is required. The chambers would need to have DN400CF flanges.	M. Schwickert	04. 11. 2018
A	In addition, GSI requested if the production and delivery of 4 scintillating screen setups (vacuum chamber, detector, pneumatic drive) identical to the CR design could be performed by BINP.	BINP	23. 11. 2018
A	BINP will inform GSI if BINP is willing to start collaboration on these subjects.	BINP	n/a
A	Depending on the decision from BINP, GSI could also make this collaboration as a special/dedicated Collaboration Contract, not as an In-Kind.	BINP/GSI	n/a

5 pBar

5.1 P-bar power converter

Corresponding Author(s): u.clausen@gsi.de

5.1.1 P-bar power converter components

Pieces	PSP	Typ		Nomenclature
1	2.9.3.1.1.1	pB.D1	Dipole	PS01MH01
8	2.9.3.2.1.1.1	pB.Q1	Wide Quadrupole	PS01QS04-11
1	2.9.3.2.2.1	pB.Q2	Wide Quadrupole radiation hard	PS01QS03
2	2.9.3.2.1.1.3	pB.Q4	Narrow Quadrupole radiation hard	PS01QS01-2
4	2.9.3.3.1.1	pB.C1	Sextupole	PS01KS01-4
7	2.9.3.4	pB.C2	Steerer	PS01KH01-3 PS01KV01-4

5.1.2 Action items

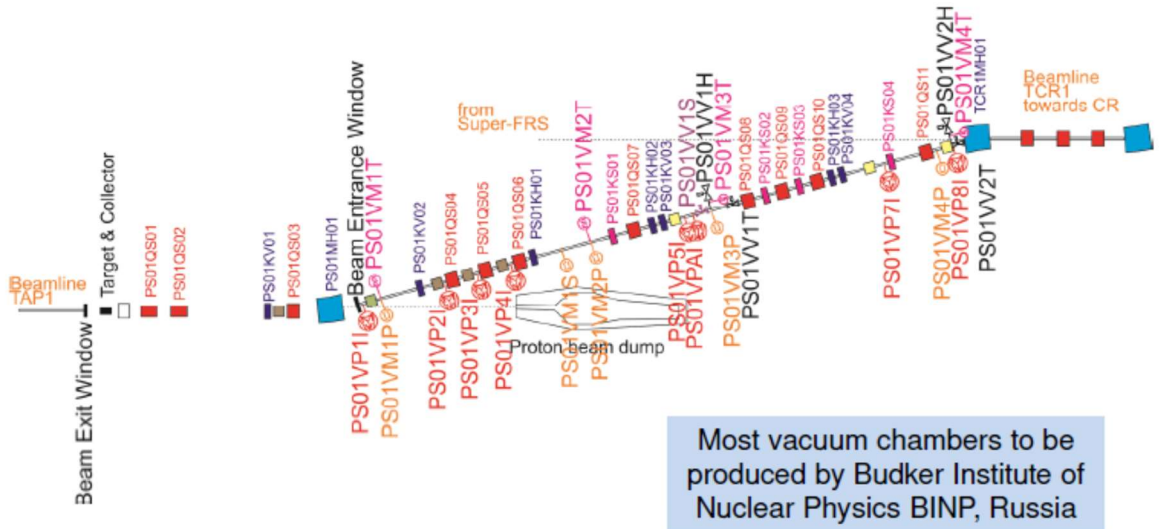
- Data for Quadrupole magnets, radiation hard, still needs to be defined
- Contract for power converter is needed

5.2 P-bar vacuum

Corresponding Author(s): a.kraemer@gsi.de

Vacuum System of the pbar-Separator

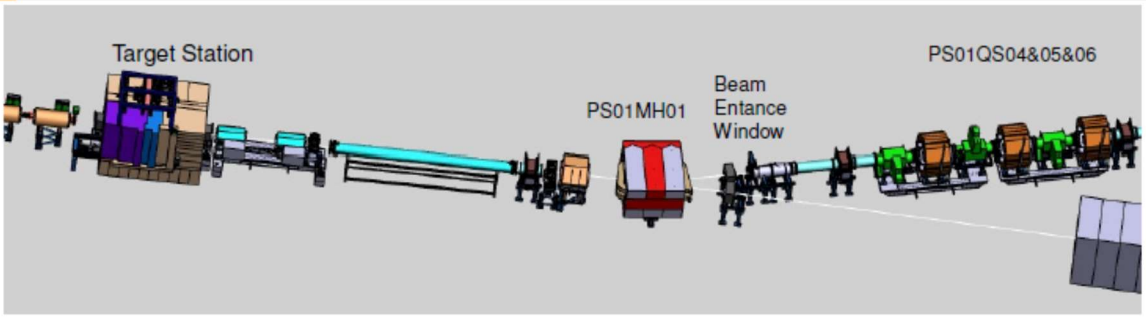
- Pbar-target is in air. Vacuum System ends with an exit window in HEBT and starts with entrance window after first dipole behind target.

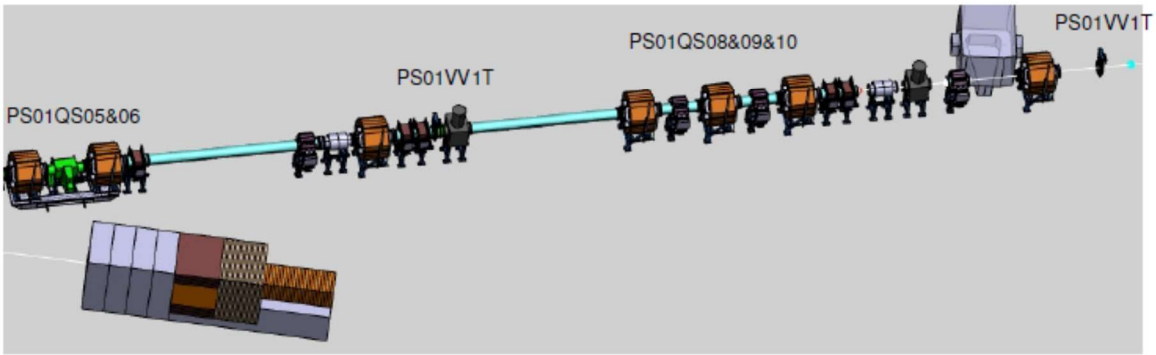


Most vacuum chambers to be produced by Budker Institute of Nuclear Physics BINP, Russia

FAIR GmbH | GSI GmbH A. Krämer, 1st BINP-FAIR Collaboration Coordination Workshop 1

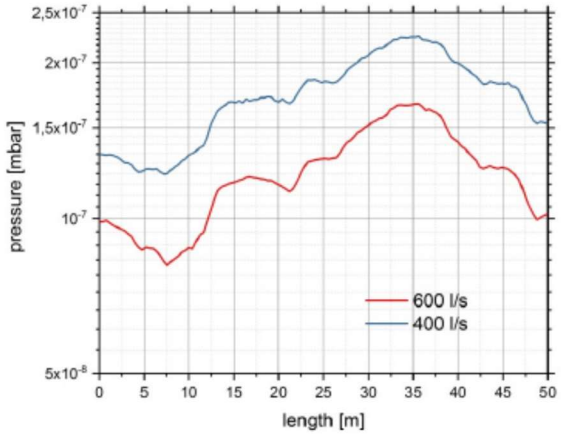
pbar-Separator: Draft 3D Model





FAIR GmbH | GSI GmbH A. Krämer, 1st BINP-FAIR Collaboration Coordination Workshop 2

pbar-Separator
Pressure Profile Calculations (MOLFLOW+)



Vacuum components pbar Separator

- Vacuum system design not yet finalized

Components	Quantity	Remarks
Roughing Stations	1	Mobile (TMP&forepump 700l/s&30m3/h)
Ion Getter Pumps	8	Pumping Speed 400l/s
Sector Gate Valve	2	all-metal, DN400
Angle Valves	2	DN160CF for roughing stations
Fast Valves	1	
Cold Cathode Gauges	4	
Pirani Gauges	4	
Fast Valve Sensor	1	

Technical properties of vacuum chambers

Vacuum properties	Non-bakeable
Integral leak rate	$\leq 1 \times 10^{-10} \frac{\text{mbar l}}{\text{s}}$
Outgassing rate (after **10h** of pumping)	$\leq 5 \times 10^{-10} \frac{\text{mbar l}}{\text{s cm}^2}$
Residual gas analyse (after **24h** of pumping)	1. All peaks between mass 18 and 45 must be **100** times lower than mass 18, except mass 28 and 44. 2. All peaks higher mass 45 must be **1000** lower than mass 18.

Mechanical requirements:

- Check of welding seam according to DIN EN ISO 9712, quality class DIN EN ISO 5817 B
- Surface quality R_z=25
- Magnetic permeability:
  - Parts of the body of vacuum chamber that are located at a distance less than the magnetic gap from the yoke edge → $\mu_{rel} \leq 1.01$
  - Parts of the body of vacuum chamber that are located at a distance greater than the magnetic gap from the yoke edge → $\mu_{rel} \leq 1.05$
  - Components of the vacuum chamber such as flanges, bellows, and other fixed elements such as supports, bolts, nuts, washers, etc. → $\mu_{rel} \leq 1.05$
- Chamber material according DIN EN 10088: 1.4306, 1.4307, 1.4404, 1.4429 or 1.4435
- Flange Material according DIN EN10088: 1.4306, 14307 or higher quality

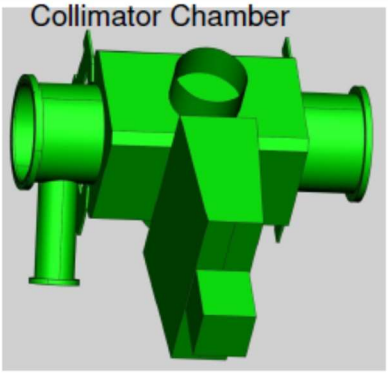
Vacuum Chambers pbar-Separator

- Large aperture beam pipe DN400/450,
- Mainly round and straight chambers
- Vacuum chambers not designed in detail

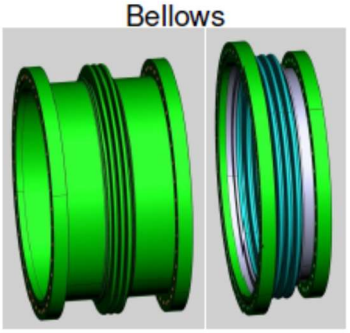
Chamber Type	Pieces	Shape	Dimensions
Bellows	~31	round	L= , d=400mm
Round Chambers	~18		~1000<L<6000mm, d=400mm
Pumping/roughing Chamber	~3		
Wide Quadrupole Chamber	~8	octagonal	L=1300mm, 400x180mm2, flange DN450
Vert./Horiz. Collimator Chamber	~3		

Draft 3D Model of Chambers

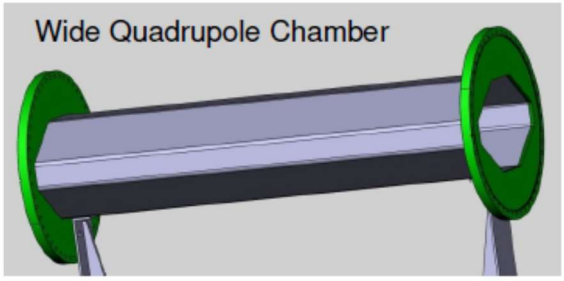
Collimator Chamber

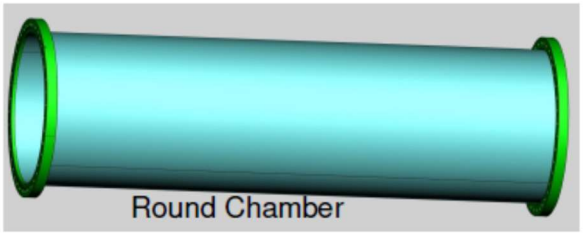


Bellows



Wide Quadrupole Chamber





Round Chamber

5.3 P-bar magnets

Corresponding Author(s): p.yu.shatunov@inp.nsk.su

5.4 TCR1 magnets

Corresponding Author(s): p.yu.shatunov@inp.nsk.su

5.5 P-bar diagnostics

Corresponding Author(s): rogovsky@inp.nsk.su

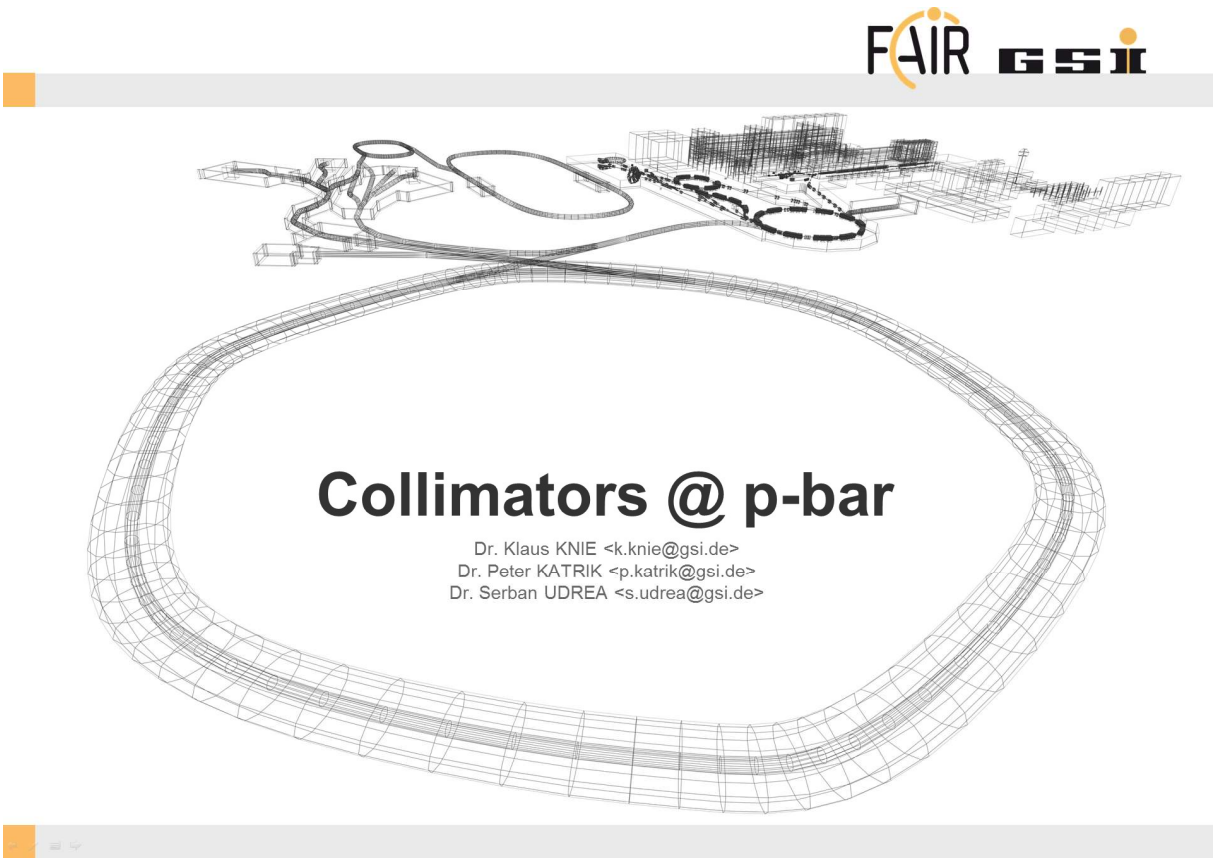
5.6 Update on p-Bar beam instrumentation

Corresponding Author(s): m.schwickert@gsi.de

4. Update on Beam instrumentation (HEBT, pBar Separator, SFRS)			
I	GSI proposed to start a new collaboration for the production of 6 chambers for Beam Profile Monitors by BINP. These chambers have similar design as for CR. For 3 chambers pick-ups with elliptical cross-section are required (100% identical to the CR layout) and for the 3 remaining chambers a design of round pick-ups (400 mm diameter) is required. The chambers would need to have DN400CF flanges.	M. Schwickert	04. 11. 2018
A	In addition, GSI requested if the production and delivery of 4 scintil-lating screen setups (vacuum chamber, detector, pneumatic drive) identical to the CR design could be performed by BINP.	BINP	23. 11. 2018
A	BINP will inform GSI if BINP is willing to start collaboration on these subjects.	BINP	n/a
A	Depending on the decision from BINP, GSI could also make this col-laboration as a special/dedicated Collaboration Contract, not as an In-Kind.	BINP/GSI	n/a

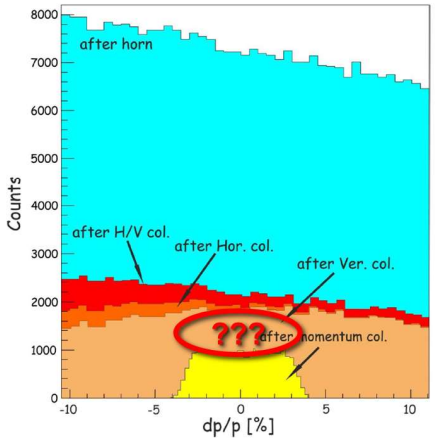
5.7 p-Bar collimators

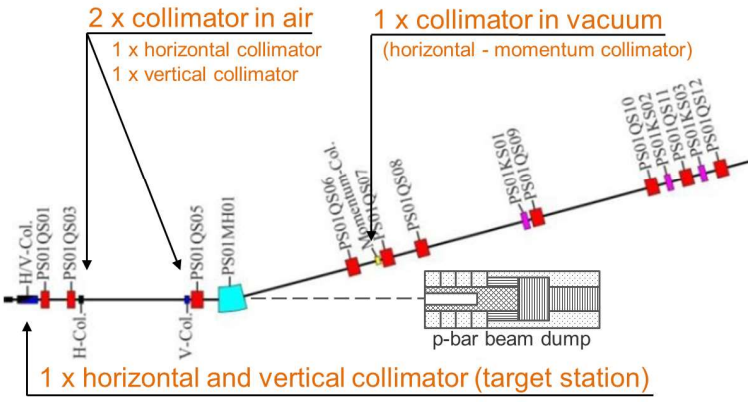
Corresponding Author(s): p.katrik@gsi.de



Collimators at the p-bar installation

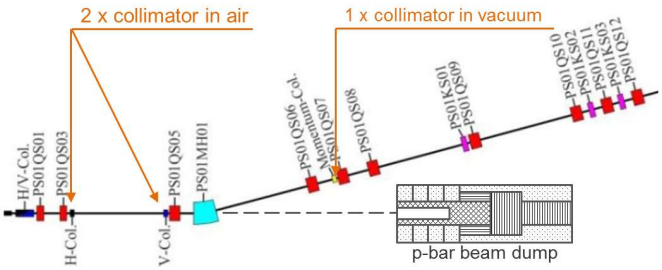
- investigation of collimator efficiency
  - How important are H-Col. & V-Col.?
  - Why are "±3% dp/p" p-bars affected by Momentum-Col.?
- specifications of collimators
  - Does FAIR and BINP use the same Ion optics layout?
  - P. Shatunov @ RUPAC2016 presented to us an unknown version.
- possibility of collimators fabrication at BINP



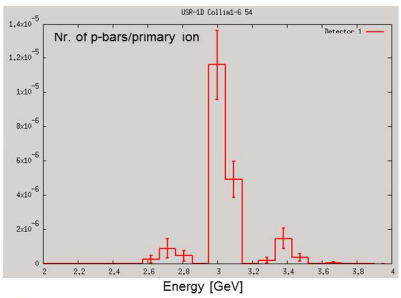


An impact of collimators

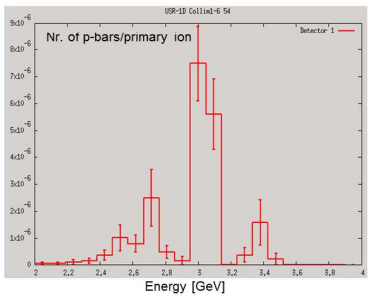
- Ideal collimators
  - all 3 collimators made of black body
- Iron collimators
  - all 3 collimators made of iron
- Momentum collimator only
  - 1st and 2nd collimators are removed
  - 3rd collimator made of black body



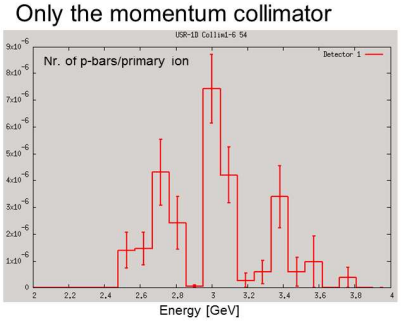
3 x Ideal collimators



3 x Iron collimators

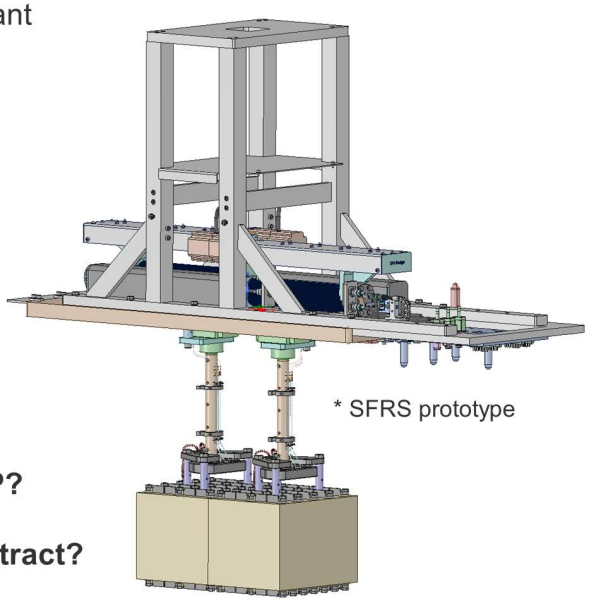


Only the momentum collimator



Collimators at the p-bar installation

- H-col. and V-col. do not have significant influence > may have a simpler/cheaper design
- Movable momentum collimator in the vacuum is the main collimator at this stage
- SFRS prototype of the movable collimator in the vacuum



* SFRS prototype

Summary:

- **Is it possible to fabricate it at BINP?**
- **May it be included in the main contract?**

6 Steering activities

6.1 Steering 1

Corresponding Author(s): david.urner@fair-center.eu

Meeting:	**Steering parallel II at 1st BINP-FAIR workshop**
Date:	06.11.2018 13:00-17:45 **Author: S. Utermann**
Participants:	Y. Levichev V. Varentsov D. Urner J. Blaurock A. Andreanov D. Shwarz S. Utermann M. Schwickert M. Marenich L. Urban A. Krämer A. Krasnov H. Simon
Distribution:	Participants + K. Knie, Y. Rogochev, Y. Tichonov, P. Shatunov, F Hagenbuck
Document Number:	F-PR-...to_follow (see work instruction for document identification)

A: Action, D: Decision, I: Information		Who	Due Date
HEBT vacuum chambers (batches 2&3) without FBL			
D	1.544 M€ at 2018 prices and scope are acceptable to BINP		
I	Want to close this ASAP without FBL FAIR needs a letter of assignment, IKRB will write recommendation to Council, Council makes assignment, then official negotiations. Request for assignment is drafted, FAIR will support this letter. FAIR is confident that request will be recommended by IKRB (we have submitted estimates based on information from BINP). Specs are ready, CB value is ready		
A		SU, YL	2 weeks

A: Action, D: Decision, I: Information		Who	Due Date
A	S. Utermann to send request for assignment draft to Y. Levichev. ROSATOM does not need to sign. YL returns to IOP (DU, SU or MM) within two weeks.	F. Hagenbuck	By council
A	HEBT SPL needs to specify size of initial tubes (standard tube size or not (this has financial consequences) --> This needs to be sorted before council (mid-December)		
	Action: Aim to close batch 2 and 3 contract 2018 SU to send to YL within two weeks. Partly unassigned, we can put a disclaimer to this end in the contract.	SU	2 weeks
Beam Diagnostics (mechanical and pre-amp, screens and drives)			
I	Items identical or similar to CR		
A	M. Schwickert will send Y. Leveichev, D. Shwarz & Y. Rogovsky--> a technical description and scope and PSP and CB value. (YR is BINP responsible)	MS, DS, YR	
A	YL will answer first informally in writing, then assignment will follow as above.	YL, FAIR IOP	
I	First technical, then administrative		
I	Capacity is available at BINP for greater productivity beyond batches 2 & 3		
HEBT Vacuum batch 4			
I	Technical aspects were discussed in parallel session. Because there is little scope for series production (many types), A. Krasnov has concerns about BINP workshop capacity.		
A	Action: L. Urban sends list to A.Krasnov	LU	
A	Action: FAIR looks at relaxing schedule wrt to pre-assembly and also looks at standardisation	LU & DMU	Q1 2019
A	Meeting L. Urban and A. Krasnov to look at the proposed delivery schedule for batch 4 this week	LU & AK	This week

A: Action, D: Decision, I: Information		Who	Due Date
A	BINP to check workshop capacity, taking into account batches 2&3 and all the others (S-FRS, CR etc.)	AK	Q1 2019
Radiation resistant dipoles for Super FRS (2 pcs)			
I	1.9 M € per dipole, and FAIR would supply the cable at 450 k per dipole (2018 prices) So BINP would make 2 dipoles for 1.45 M each, 2018 prices. Not yet assigned to BINP. BINP can possibly buy the steel for the dipoles and multipoles together: it is the same steel, should BINP agree to provide multipoles Dipole contract is on the critical path Specs and draft contract are ready.		
A	Decision from BINP this week, after magnet expert meetings	YL and BINP magnet experts	This week
	SU to send YL draft contract. Aiming for 2018 signature (as HEBT vacuum batches 2&3) including the assignment clause.	SU	
A	IOP to get the assignment done, responsible IOP.	IOP	2 weeks
A			By council
Radiation resistant multipoles for Super-FRS			
I	3 different quadupoles, 2 sextupoles and beam catcher, not assigned 1.2 M Euro H. Simon reports that technical discussions are still underway re. steel procurement, titanium for chamber with grazing primary beam.		
A	Action: BINP to make a cost estimate: H Simon will send technical information to the sessions during this week.	HS, YL	This week
A	BINP to assess the resources needed to develop cost estimate by the end of November.	BINP	By 30 Nov
A	Video conference for follow up (also supports, beams, pipes). Result may be R&D contract or price quote.	HS, YL, others	End Nov

A: Action, D: Decision, I: Information		Who	Due Date
D	No assignment until then.		
Super-FRS diagnostics chambers			
I	Status: Assigned to BINP, CB exists. Specs are ready. BINP can produce at CB 2005 escalated to 2018. Specs are ready for beam diagnostics chambers. A. Krasnov: BINP has capacity.		
D	Decision: no AFAAs (Annex for additional assignment)		
A	SU to send draft to YL within two weeks	SU	2 weeks
D	Aim for contract signature end of 2018		
Super-FRS dipole chambers			
I	Super FRS dipole chambers are very similar to CR vacuum chambers. Assigned to BINP, PSP in CB. There has been change of scope -->dedicated beam catcher in the chamber. Need adjustment of specs (titanium or not?)		
A	Action: joint preliminary technical decision process starting this week.	HS, others	This week
A	Preliminary assessment finished by the end of 2018 in writing as joint initiative. Then BINP needs to estimate price.	FAIR, BINP	End 2018
p-bar rest contract			
Q	Workshop capacity? It was close before CR was moved by a year.		

A: Action, D: Decision, I: Information		Who	Due Date
	Scope includes 2 quadrupoles and 1 dipole radiation hard.		
D	Elements before TCR line that are identical to CR: BINP agrees to produce all items that are already series items. CR type quadrupoles: BINP capacity is there.		
Q	What about beam optics? What happened to the change request to optical ion layout?		
A	Who is the responsible person at fair? Sergey Litvinov? FAIR to answer this week.	DU	This week
A	Complete beam optics: K. Knie end of February 2018 (to be confirmed by KK) --> send to D. Shwartz and P. Shatunov	KK	28.2.19?
A	Scope/list of components: K. Knie --> BINP	KK	Q1 2019?
Vacuum chambers forgotten beam line (FBL)			
I	CB 8 value = 4.8 M€ in 2018 money (power, magnets, vacuum etc. D. Urner notes that some of FBL was reassigned to ACC from EXP. Same type, FAIR will join the PSPs. Not in costbook 7		
A	Action: FAIR to prepare detailed steering activities this for 2nd FAIR-BINP meeting.	IOP, PMU	Q1 2019
Q	How soon does BINP need the contract? To this end:		
A	Action: FAIR itemised list AtB to Y. Levichev, A. Krasnov and I. Morozov in two weeks	DU	2 weeks
A	Q is optical layout ready? Action: D. Urner to check	DU	2 weeks
A	BINP to say when they need the contract in order to fit FBL production into existing series production.	A.Krasnov	Q1 2019

A: Action, D: Decision, I: Information		Who	Due Date
D	Aim for contract signature 2nd half of 2019		
PANDA dipole			
I	Proposal: common collaboration contract FAIR-BINP In draft at FAIR Then action an implementing agreement for the PANDA dipole. 300 k€ R&D engineering agreement exists, signed between FAIR and BINP		
A	Action: meeting D. Urner and Y. Tichonov to discuss the status of the R&D contract and future contracts this week	DU & YT	This week
Other business			
D	On Thursday afternoon there will be a parallel session to disccuss progress 17:00 and 18:00. action S Utermann: communicate this, D. Shwartz to invite on the BINP side	SU, DS	Wed.
D	BINP liaison officer programme: all parties wish an extension. 90 days is not enough.		
A	Letter to Y. Leveichev from J. Blaurock --> BINP directorate	JB	
A	Next liaison officer need a visa with a work permit for Germany. FAIR to check.	DU	

6.2 Possible future collaborations

Corresponding Author(s): david.urner@fair-center.eu

FAIR GSI	Kind of Document **Meeting Minutes**		Page 1 of 3

Meeting:	Steering meeting part 2 at 1st BINP-FAIR workshop	
Date:	08.11.2018 16:55-18:15	**Author: M. Marenich**
Participants:	Y. Levichev I. Koop P. Shatunov A. Krasnov D. Shwarz D. Urner S. Utermann M. Marenich H. Hagelskamp Anatoly Utkin (Rad.Res.Dipols) Denis Gurov (Rad.Res.Dipols) M. Schwickert A. Krämer H. Simon C. Will C. Mühle H. Schwartz	
Distribution:	Participants + K. Knie, Y. Rogochev, Y. Tichonov, F Hagenbuck, O. Dolinskyy, V. Varentsov	
Document Number:		

Contents:

	A: Action, D: Decision, I: Information	Who	Due Date
1. pbar rest ion optical layout			
A D	• Agreement between K.Knie and P. Shatunov to compare both of their calculation approaches of anti-potron losses (ion optical lay-out). If there are differences a couple of month of research may be necessary in addition. o Everything should be done, to not change the TCR1 de-sign.	K.Knie and P. Shatunov	22.Dez.2018
SFRS Rad.Res.Dipols			

A: Action, D: Decision, I: Information		Who	Due Date
D	• Agreement that BINP built SFRS Rad.Res.Dipols for 1.9 MEUR(2018) each minus 450 TEUR(2018) each for the wires.		
D	• Decision that BINP will receive a SFRS Rad.Res.Multipoles Research Contract in order to estimate price and design details.		
A	○ FAIR will make a suggestions of deliverables till 15.Nov.2018.	FAIR	15.Nov.2018
A	○ BINP will sent list of manpower and deliverables till 22.Nov.2018.	BINP	22.Nov.2018
HOAI contract between BINP and FAIR			
	• Components written both in the existing or future CR HOAI contract and CR-Rest Contract between FAIR and BINP.		
A	○ FAIR request a component list from BINP which components FAIR should purchase commonly for BINP. Example: pumps etc.	BINP	15. february 2019
A	○ Installation detail planning between FAIR and BINP according to the matrix written in the existing CR-Rest Contract. It is proposed that both FAIR and BINP proceed with detailed planning and detailed time schedule per work-package till 1.february 2019. Example: pre-assembly etc.	FAIR / BINP	1.february 2019
A	○ FAIR propose a detail analysis from BINP if the CR-Magnet Production plan may be shifted forward a couple of month according to BINPs production capacity.	FAIR / BINP	1.february 2019
Plan of action for future CDRs			
I	• Kick-off meetings ○ According to FAIR Quality every PSP Code needs a kick-off meeting to define responsibilities, interface partner and the whole CDR process. ○ According to BINP the CR had one kick-off meeting for all PSP with SPL Dolinskyy and it was sufficient.		
I	• BINP and FAIR agree on the basic CDR process, but there are still different opinions on the CDR content and level of detailization and level of finalization between FAIR and BINP. ○ FAIR emphasis that for example "final 3d models" during CDR helps to minimize efforts on both BINP and FAIR side. BINP sees CDR as concept presentation, where finished 3d Models are not necessary. ○ FAIR AND BINP agree that the CDR needs some changes: ▪ According to the definition of which people may be involved on BINP and FAIR side. For example that the same vacuum experts from both BINP and FAIR participate together if this topic is on the agenda. ▪ The CDR is focused on mechanical components, but missing details on software and electronics.		

A: Action, D: Decision, I: Information		Who	Due Date
A	• FAIR and BINP agree to re-evaluate and solve this issue during a meeting on 9.11.2018, with the current available CDR documents and the CDR Slides shown by QA during this workshop .	C.Will and D.Shwarz	9.11.2018 4:00 pm
HEBT VAC Batches 2+3			
I	• FAIR realised that project time delays occurs, if production items are not available from stock. In such situation BINP kindly shall provide as fast as possible an analyses of different solutions, especially time, costs and risk wise.		
A	• HEBT VAC Batches 2+3 solution and analysis provided by BINP.	BINP	16.Nov.2018
2. **other business**			
	none		

6.3 NEG pumps (and ion getter pumps?)

Corresponding Author(s): a.kraemer@gsi.de

FAIR GSI	Kind of Document **Meeting Minutes**	Template Number: F-FO-QUA-en-0012	Page 1 of 2

Meeting:	**Vacuum and Magnet parallel V at 1st BINP-FAIR workshop; Session NEG pumps**	
Date:	08.11.2018 14:00-15:30	**Author: L. Urban**
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Distribution:	Participants + S. Uterman, M. Marenich	
Document Number:	F-PR-...to_follow (see work instruction for document identification)	

A: Action, D: Decision, I: Information		Who	Due Date
1. **NEG pumps**			
I	The types and the quantity of NEG cartridge and NEG getter combination pumps which will be used at FAIR were presented. In addition the different available types for NEG ion getter combinations pumps from SAES Getters were presented too.	A. Krämer	
I	BINP would like to participate in the tender of NEG pumps for FAIR.	BINP	
I	Both types of ion getter pumps (either StarCell type or Noble Diode) in the combination pump could be used by BINP for the CR, if they are similar in price.	BINP	
A	A.Krämer will ask for list price of both types of pumps.	A. Krämer	week 46
I	The detailed specification of the NEG pumps for the tender will be seed by GSI/FAIR to BINP, including the NEG pumps required for CR , for aprroval by BINP. The specifications will take into account the already existing functional specification written by BINP.	BINP/GSI	June 2019
D	Installation of pumps It still needs clarification or discussion, if the NEG pumps for CR should be installed at BINP or at GSI/FAIR facility. • BINP would like the NEG pumps to be installed in the tunnel. For the leak check of the welded units inside the tunnel, BINP needs the flanges occupied by the pumps for the leak check.	GSI/FAIR	
	• On the other hand, it has been planned/proposed by FAIR that BINP should deliver the CR unit as an assembly unit, where the pumps are already installed.		

NEG Pumps for FAIR

- Specifications for NEG cartridge and NEG cartridge / ion-getter-combination pumps should be ready end Q2/2019. Specs don't include controllers.
- Start procurement via call for tender (or if SAES getters is the only supplier) by direct order. Gamma Vacuum delivers NEG cartridge pumps up to 400l/s. To be discussed with GSI/FAIR procurement department.
- Start delivery Q3/2020 until Q4/2021

Subproject	Type	Quantity (pcs)
HESR	CapaciTorr D1000 (NEG cartridge)	90
HEBT	NexTorr D1000-StarCell (NEG catridge/Ion-getter-combination pumps)	2
SIS100	CapaciTorr D3500 (NEG cartridge)	44 (+17)
SIS100	NexTorr D500-5 or NexTorr-StarCell (NEG catridge/Ion-getter-combination-pumps)	94 (+7)
CR	NexTorr D1000-10 (or NexTorr D1000-StarCell) (NEG catridge/Ion-getter-combination-pumps)	75

NexTorr® pumps by SAES Getters combining NEG and ion pumping technologies

Three Types:

NEXTorr® "D" series:
pumps are based on St172 NEG material, operating in the field of UHV/XHV applications since early '90s. Ion pump: noble diode,
pumping speed up to 2000l/s for H_2 and 10l/s for Ar (type D2000-10)

NEXTorr® "Z" series:
pumps integrate the new ZAO UHV NEG alloy further improving:
-pumping performance for H2
-mechanical robustness
-outgassing during the activation
Ion pump: noble diode
pumping speed up to 400l/s for H_2 and 6l/s for Ar (type NexTorr Z 300)

NEXTorr®-StarCell
combining the **sintered NEG technology** by SAES with the highly reputed **StarCell ION pump** by Agilent Technologies. Pumps are based on St172 NEG material
pumping speed up to 1000l/s for H_2 and 21l/s for Ar (type NexTorr D1000-StarCell)

- FAIR/GSI did not finally decide up to now, which of the three types will be used in the various subprojects. Will be discussed in the course of writing the specifications.
- If the pumps will be controlled by the available combined controller or the ion pump and the NEG cartridge individually is not decided. Will be discussed in the course of detailing of operation scenario and vacuum control system.
- Procurement strategy to be discussed:
  a. separate call for tender for NEG cartridge pumps and combination pumps
  b. common call for tender for both types

- **What does BINP needs for the CR?**