SIS18/SIS100
Status and Perspectives

GSI Beschleunigerseminar

Peter Spiller

September 21, 2017

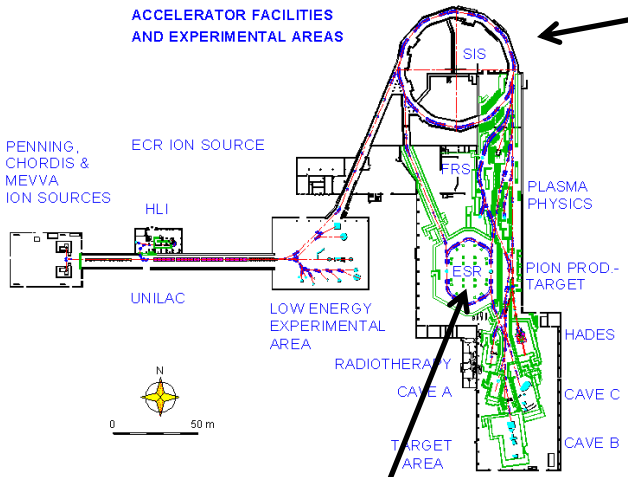
FAIR in Construction

Contract for building shell construction area North, shall be closed within 2017.

Official Ground Braking Event

Primary Beams > Secondary Beams

FAIR is the big brother of GSI – the overall facility topology is identical

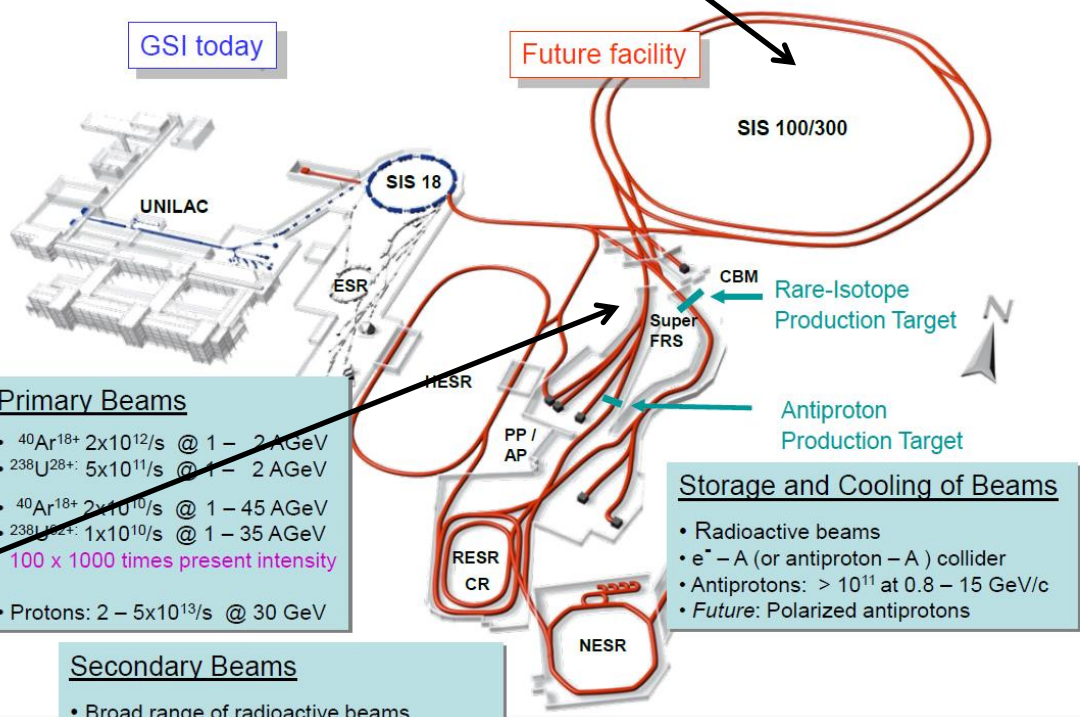


Primary Beams

Secondary Beams

GSI today

Future facility



Primary Beams

- $^{40}Ar^{18+}$ $2x10^{12}$/s @ 1 – 2 AGeV
- $^{238}U^{28+}$: $5x10^{11}$/s @ 1 – 2 AGeV
- $^{40}Ar^{18+}$ $2x10^{10}$/s @ 1 – 45 AGeV
- $^{238}U^{92+}$: $1x10^{10}$/s @ 1 – 35 AGeV

100 x 1000 times present intensity

- Protons: 2 – $5x10^{13}$/s @ 30 GeV

Storage and Cooling of Beams

- Radioactive beams
- e^- – A (or antiproton – A) collider
- Antiprotons: > 10^{11} at 0.8 – 15 GeV/c
- *Future*: Polarized antiprotons

Secondary Beams

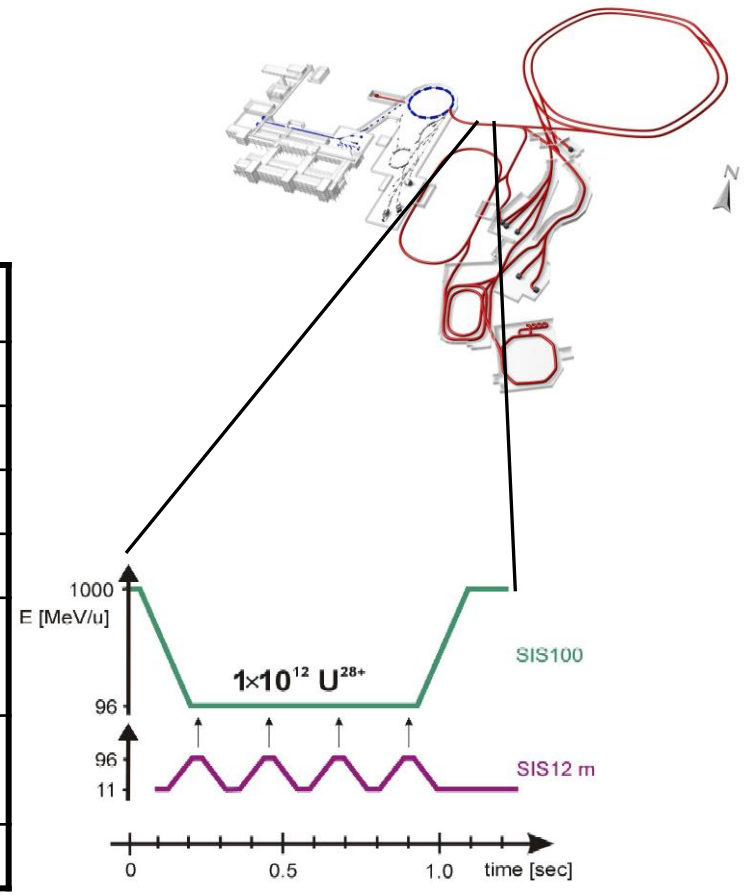
- Broad range of radioactive beams up to 1 – 2 AGeV
- RI- Intensities up to 10 000 over present
- Antiprotons

Beam Parameters SIS18/SIS100

SIS18	Protons	Uranium
Number of ions per cycle	5×10^{12}	1.5×10^{11}
Initial beam energy	70 MeV	11 MeV/u
Ramp rate	10 T/s	10 T/s
Final beam energy	4.5 GeV	200 MeV/u
Repetition frequency	2.7 Hz	2.7 Hz

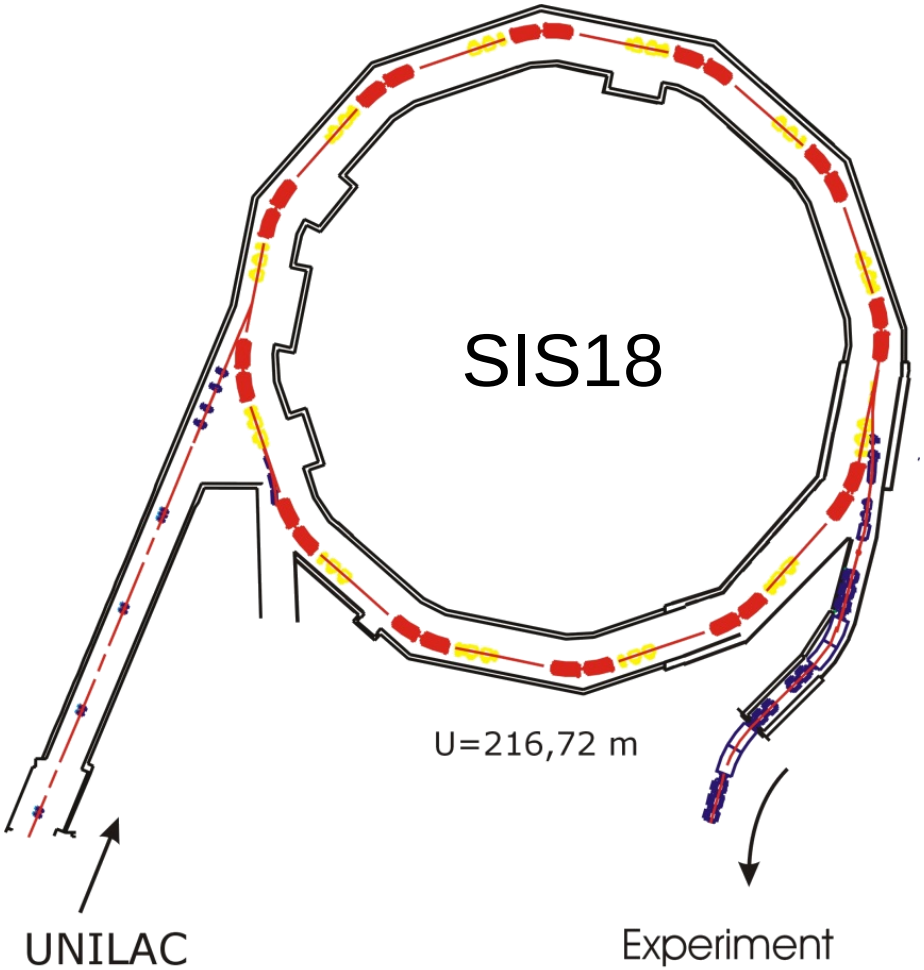
SIS100	Protons	Uranium
Number of injections	4	4
Number of ions per cycle	2.5×10^{13} ppp	5×10^{11}
Maximum Energy	29 GeV	2.7 GeV/u
Ramp rate	4 T/s	4 T/s
Beam pulse length after compression	50 ns	90 - 30 ns
Extraction mode	Fast and slow	Fast and slow
Repetition frequency	0.7 Hz	0.7 Hz

... and all other ion species



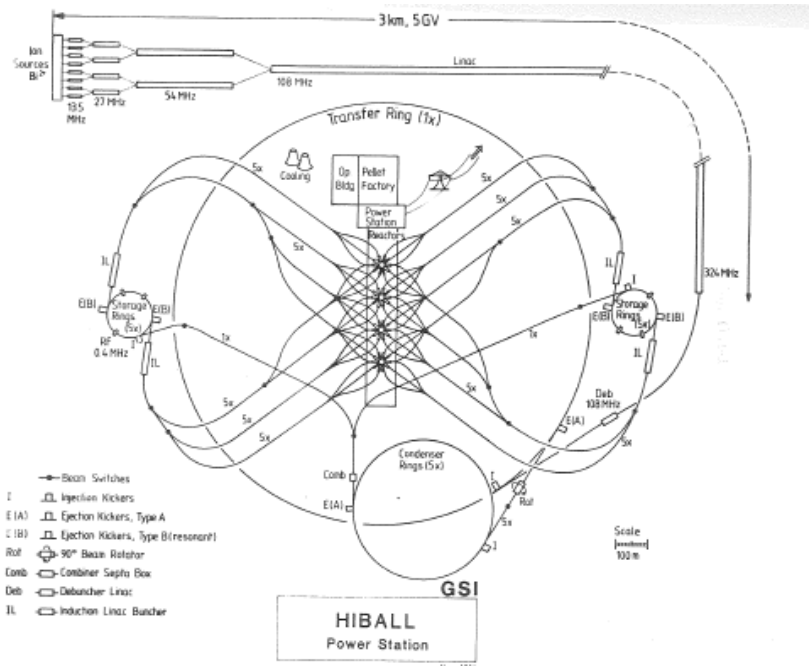
Transition from High to Low Charge State

	Today	FAIR Booster
Reference Ion	U^{73+} →	U^{28+} !
Maximum Energy	1 GeV/u	0.2 GeV/u
Maximum Intensity	$4x10^{9}$	$1.5x10^{11}$
Repetition Rate	0.3 - 1 Hz	2.7 Hz



GSI > FAIR > HIBALL

Today	FAIR	HIBALL
U73+	U28+	U1+
10^9	~10^{12}	10^{15}



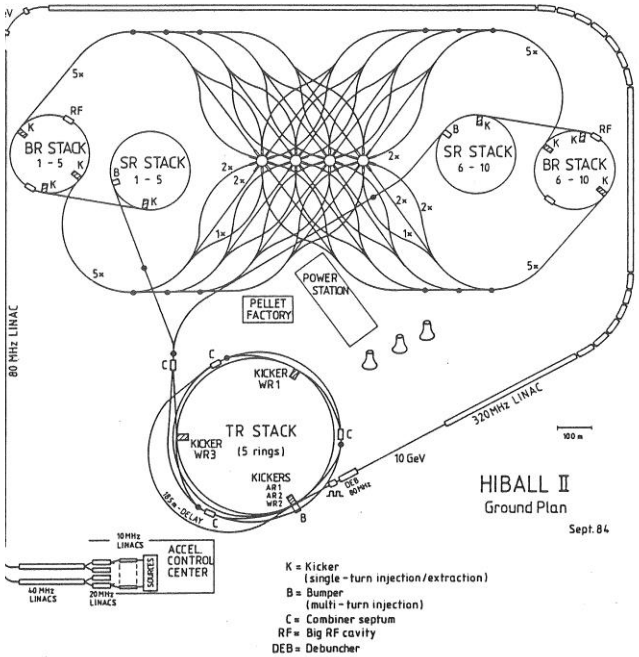


Fig. 1.2-1. HIBALL-II ground plan.

Heavy Ion Fusion Goal: Energy Production 8 GW - 4.8 MJ Bi^{1+} / Bi^{2+}-ions

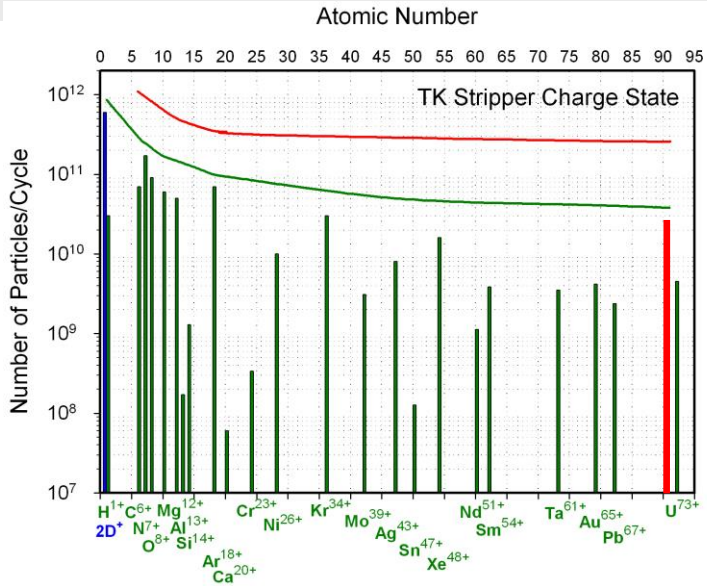
Intermediate Charge States for FAIR

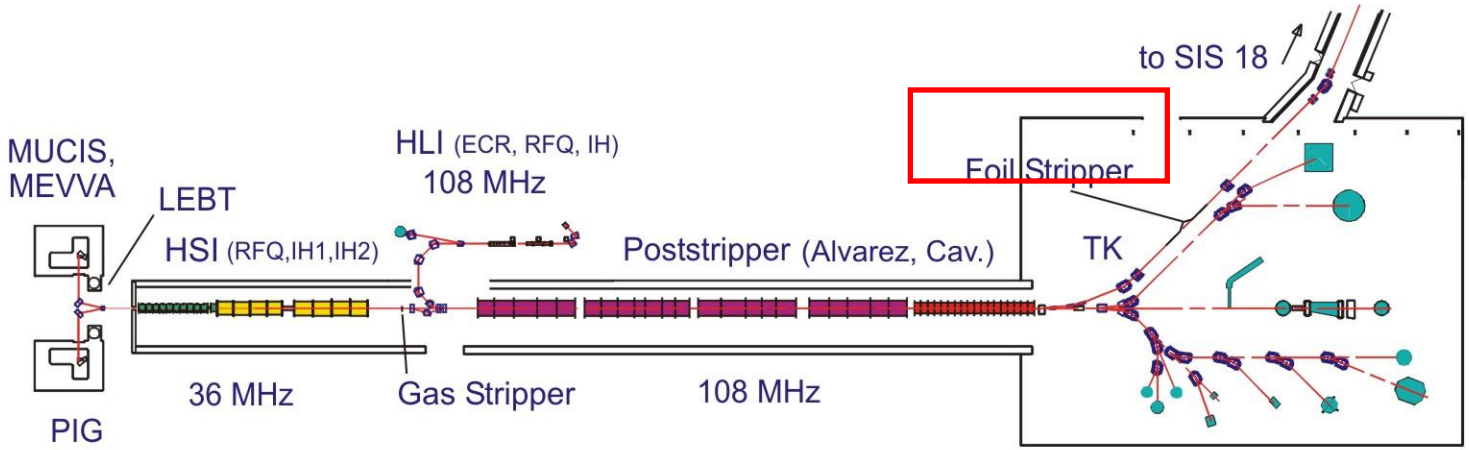
- FAIR intensity goals can only be reached by lowering the charge states
- Incoherent tune shift limits the maximum intensity in SIS18

$-dQ \propto Z^2/A$ > Poststripper charge states will be used

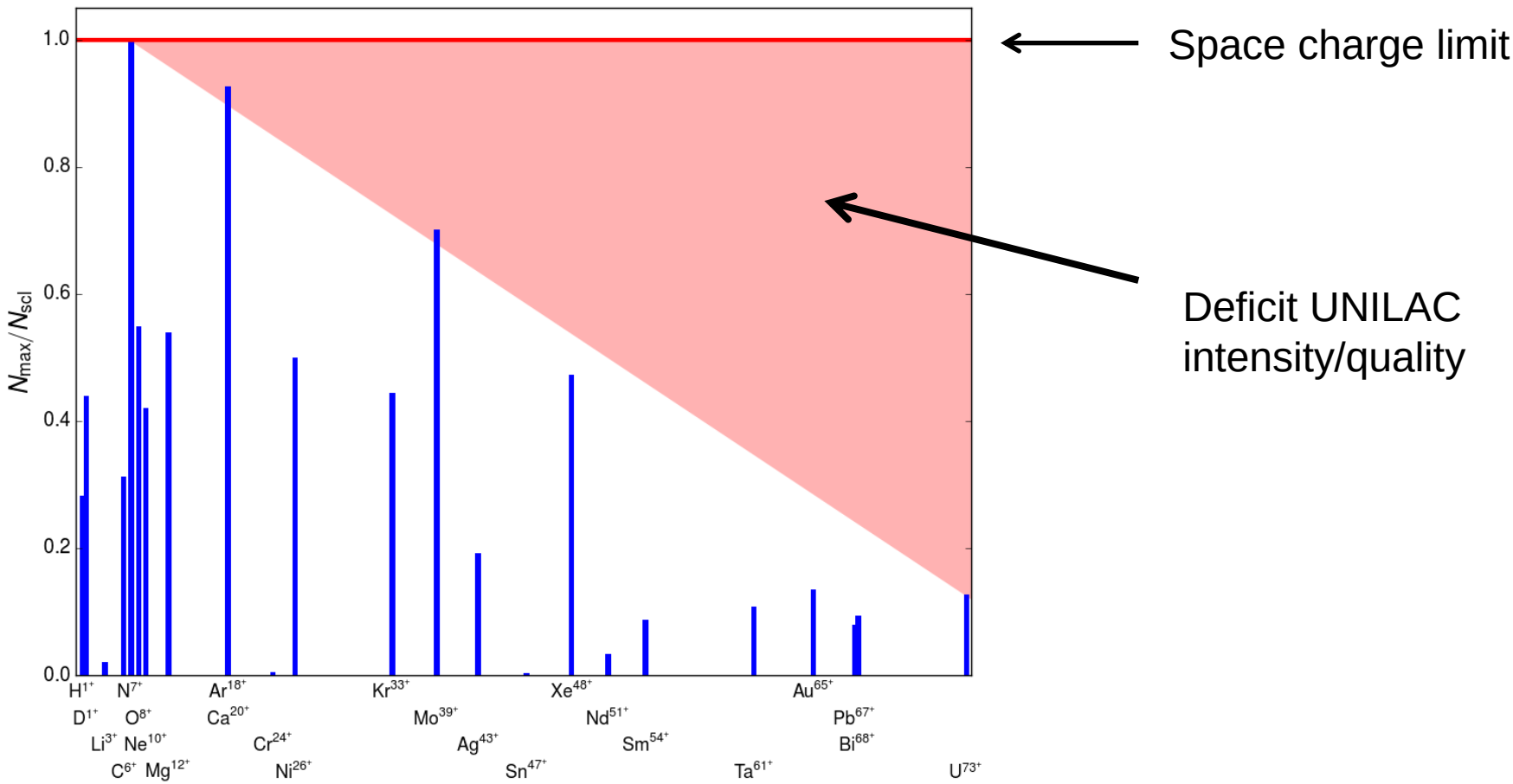
(e.g.: $Ar^{18+} > Ar^{10+}$.....$U^{73+} > U^{28+}$)

- Without stripping loss (charge spectrum) significantly enhance particle current ($N_{uranium}$ x7) !





Actual Peak Intensity versus Space Charge Limit



With the completion of the SIS18upgrade program, the deficit from medium to high mass particles will not be closed without major improvements at the UNILAC:

Intermediate Charge State Heavy Ions

Existing and planned Heavy Ion Accelerators operated with Low Charge States worldwide

AGS Booster	BNL	$5x10^9$	Au^{31+}
LEIR	CERN	$1x10^9$	Pb^{54+}
NICA Booster	JINR	$4x10^9$	Au^{32+}
SIS18	**GSI/FAIR**	$1.5x10^{11}$	U^{28+}
SIS100	**FAIR**	$5x10^{11}$	U^{28+}
B Ring	**HIAF**	$1x10^{11}$	U^{34+}

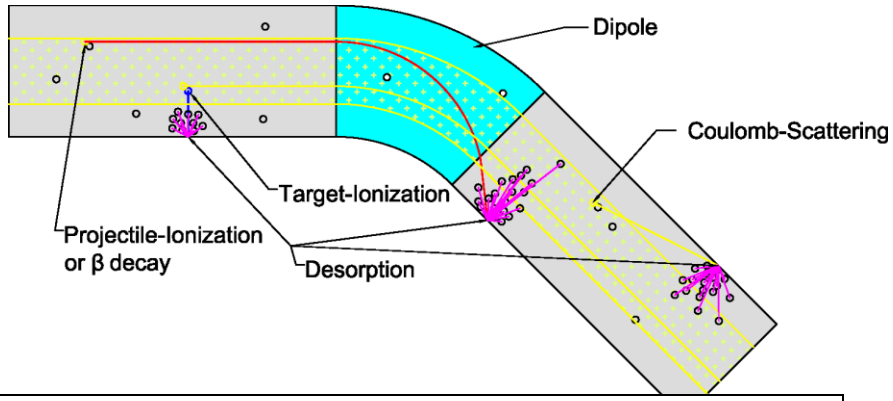
SIS18 served as a pilot facility for the development of

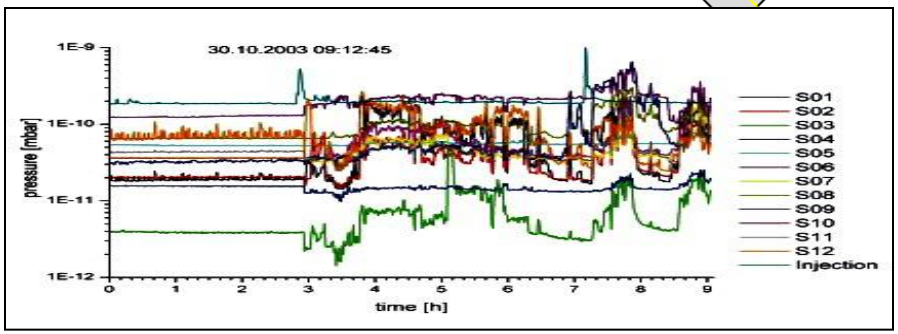
- new accelerator concepts
- new technologies and
- the understanding

... to overcome vacuum instabilities and ionization beam loss at high intensity heavy ion operation.

Ionization Beam Loss and Dynamic Vacuum determines the system design and the accelerator technologies of SIS18 and SIS100 and limit the maximum intensity much earlier than space charge and current effects.

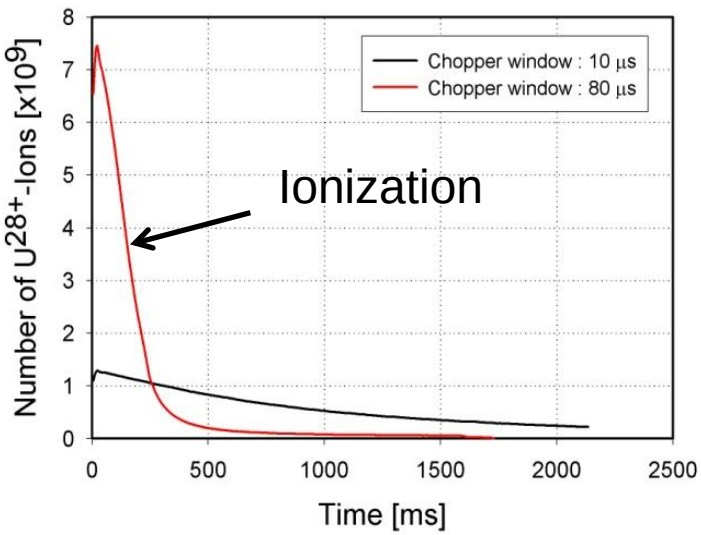
Ionization and Dynamic Vacuum





Static Dynamic

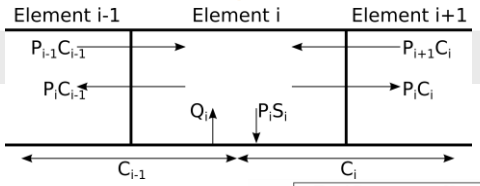
U^{28+}- operation in 2001



Main beam loss mechanism in SIS18 and SIS100 (far below the space charge limit)

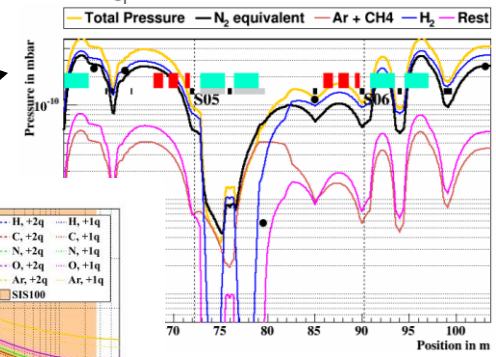
- Life time of U^{28+} is significantly lower than of U^{73+}
- Life time of U^{28+} depends strongly on the residual gas pressure
- Ion induced gas desorption ($\eta \approx$ 10 000) generates local pressure bumps
- Beam loss increases with intensity (dynamic vacuum)

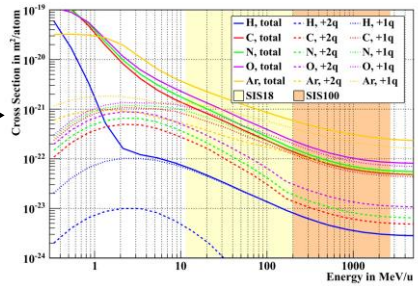
STRAHLSIM-Simulation of Dynamic Vacuum and Ionization Beam Loss

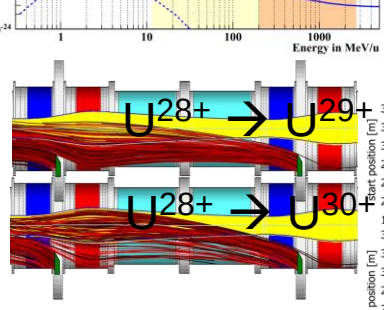


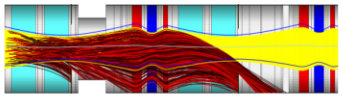
StrahlSim – a world wide unique code - has been developed in the past decade for FAIR at GSI:

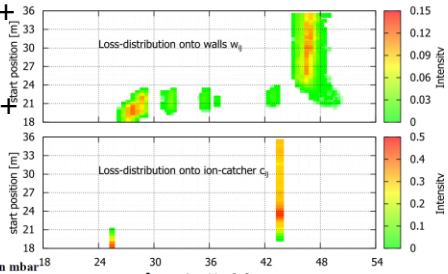
- Simulation of a self-consistent pressure profile along the ring (in space and time) for each residual gas component individually
- Number of charge exchanged ions is calculated for each time step individually, according to energy dependent cross sections for different ionization channels, including multiple ionization
- Loss distribution for each ionization channel is calculated via linear ion optics, ionized ions are distributed according to this tracking
- Simulation of ion induced desorption: Outgasing at the impact cells is increased, depending on the surface and the presence of ion catcher
- Number of lost ions and number of pumped gas particels is counted (saturation calculations)
- Pressure profile is re-calculated for the next time step → pressure profile evolution
- Realistic machine cycles is considered with shrinking of emittance and energy dependence of cross sections

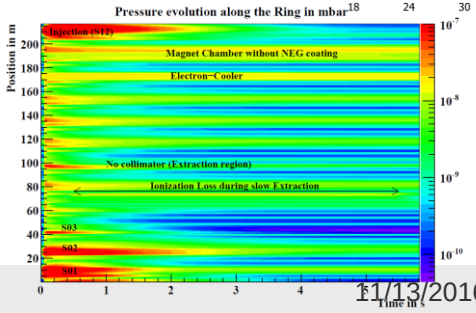












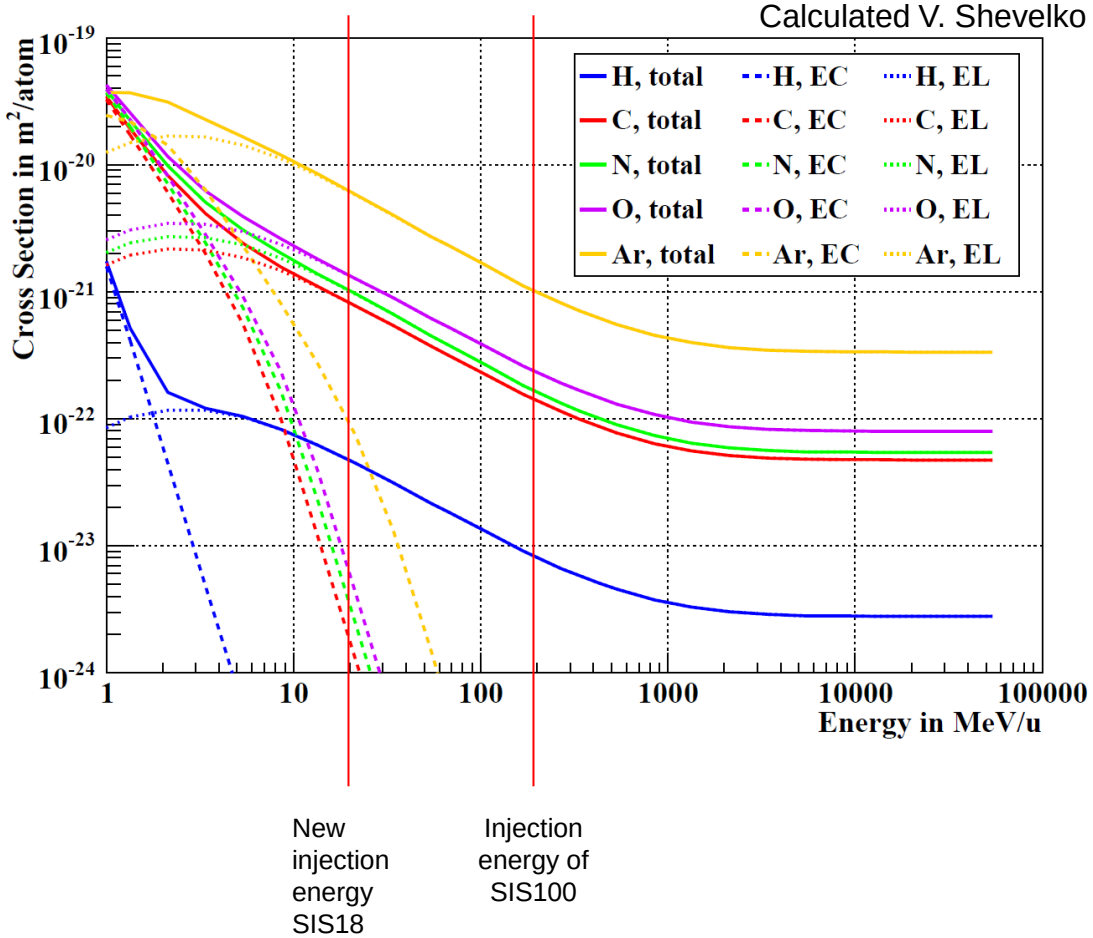
Ionization and Capture Cross Sections

Intense and unique collaboration with the GSI atomic physics department on cross sections for

- projectile ionization and multiple ionization
- electron capture
- target specific cross sections
- energy dependency
- target ionization

All data are summarized in a data base for the STRAHLSIM dynamic vacuum code.

Calculated V. Shevelko



Strength of Charge Exchange and Dynamic Vaccum

Charge exchange loss and dynamic vacuum scale with : $[N \times \sigma_{int}] \times f_{rep}$

Accelerator	**Institut**	**Ion species**	**Total integ. cross section**	**Number of ions**	**N x σ_{int}**	**Rep. rate [Hz]**	**N x σ x frep**
AGS Booster	BNL	Au^{31+}	4.5×10^{-21}	5×10^{9}	2.2×10^{-11}	5	1.1×10^{-10}
LEIR	CERN	Pb^{54+}	5.5×10^{-20}	1×10^{9}	5.5×10^{-11}	0.25	1.4×10^{-11}
NICA Booster	JINR	Au^{32+}	4.9×10^{-21}	4×10^{9}	1.9×10^{-11}	0.25	4.7×10^{-12}
SIS18	GSI	U^{28+}	8.7×10^{-22}	1.5×10^{11}	1.3×10^{-10}	3	3.9×10^{-10}
SIS100	FAIR	U^{28+}	1.8×10^{-21}	6×10^{11}	1.1×10^{-9}	0.5	5.5×10^{-10}
Bring	HIAF	U^{34+}	2.5×10^{-21}	5×10^{11}	1.25×10^{-9}	0.09	1.1×10^{-10}

Dynamic Pressure Stabilization Recipe

- Short cycle times, short sequences and short injection plateau

  Fast ramping (SIS18: 10 T/s, SIS100: 4 T/s)

  (power connection, power converters, Rf system,

  fast ramped (superconducting) magnets)

- XHV and huge pumping power

  (NEG-coating, cryo pumping - local and distributed)

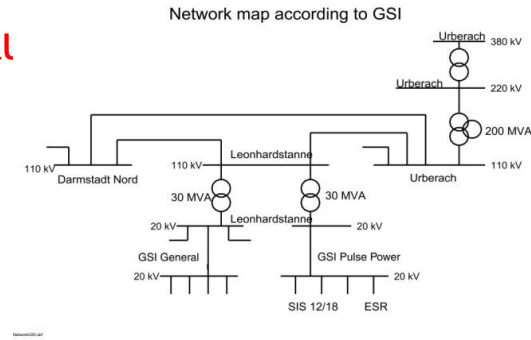
- Localizing beam loss and controle/suppression of desorption gases

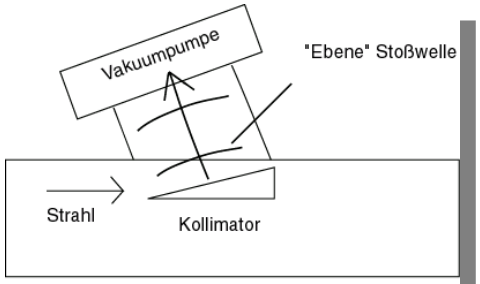
  (Ion catcher system with low desorption yield surfaces,

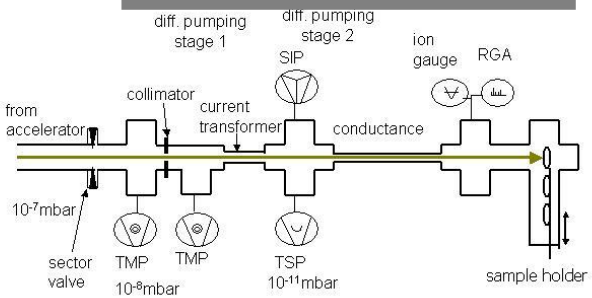
  Synchrotron optics and lattice design)

- Minimum „effective“ initial beam loss

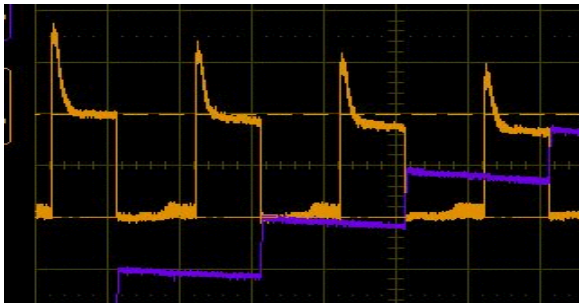
  (TK halo collimation, low desorption yield surfaces)



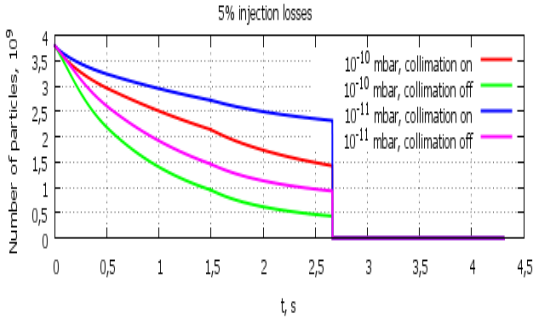




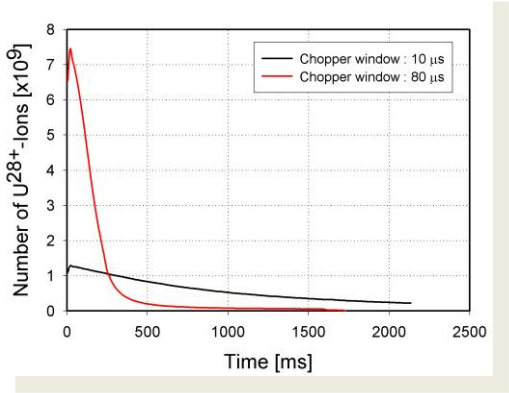
Intermediate Charge State Operation and Charge Exchange Beam Loss



AGS booster (measured)



NICA booster (predicted)



SIS18 (as measured in 2001)

Space charge limit: $2x10^{11}$

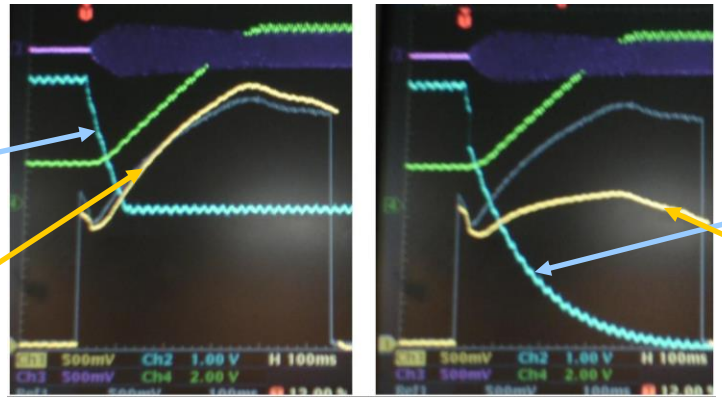
Pressure Bump
by High Voltage Break Through

Injection of a MW heavy ion beam.

Beam loss in electrostatic injection septum drives HV break downs

Voltage of electrostatic injection septum

Beam current over acceleration



High voltage break down

Beam current under the influence of pressure bump

Gas desorption in the injection channel of the injection septum results in HV voltage break downs which again generates pressure bump and ionizes a large fraction of the beam after injection.

Strong pumping is needed in the injection septum. NEG panels installed.

Minimal „Effective“ Initial Beam Loss

SIS18

Halo Collimation in Transfer Channel

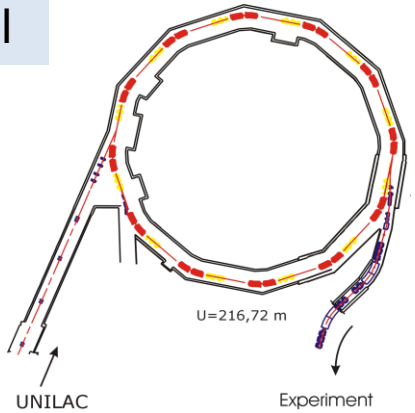
Collimation of transverse phase space and imaging optics upstream injection

1. Image plane

(Injection channel)

Imaging optical system

Object plane (three stage collimation)

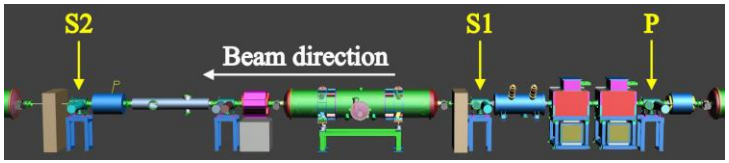


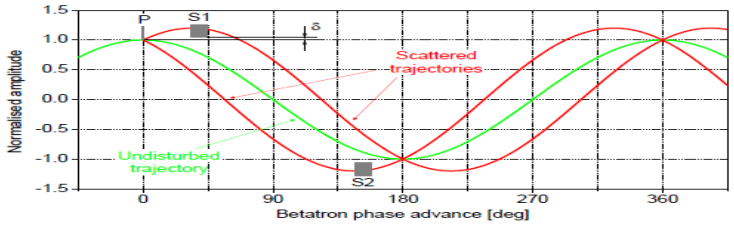
2. Image plane

(Backside injection septum)

SIS100

Halo Collimation System in SIS100 Straight





Major concern:
Beam loss of bunched beam with large tune spread over 1 s storage time at injection (resonance trapping).

Special requirements on field quality
Field quality
Reproducibility of manufacturing errors (random errors)
Resonance correction

Categories of SIS18 Development

The SIS18 development is subdivided into three categories:

1. SIS18 upgrade towards the FAIR booster operation (link existing facility) (1).
2. Developments and improvements for the running experimental program (2).
3. Advanced accelerator R&D towards a SIS18 upgrade 2 program (3).

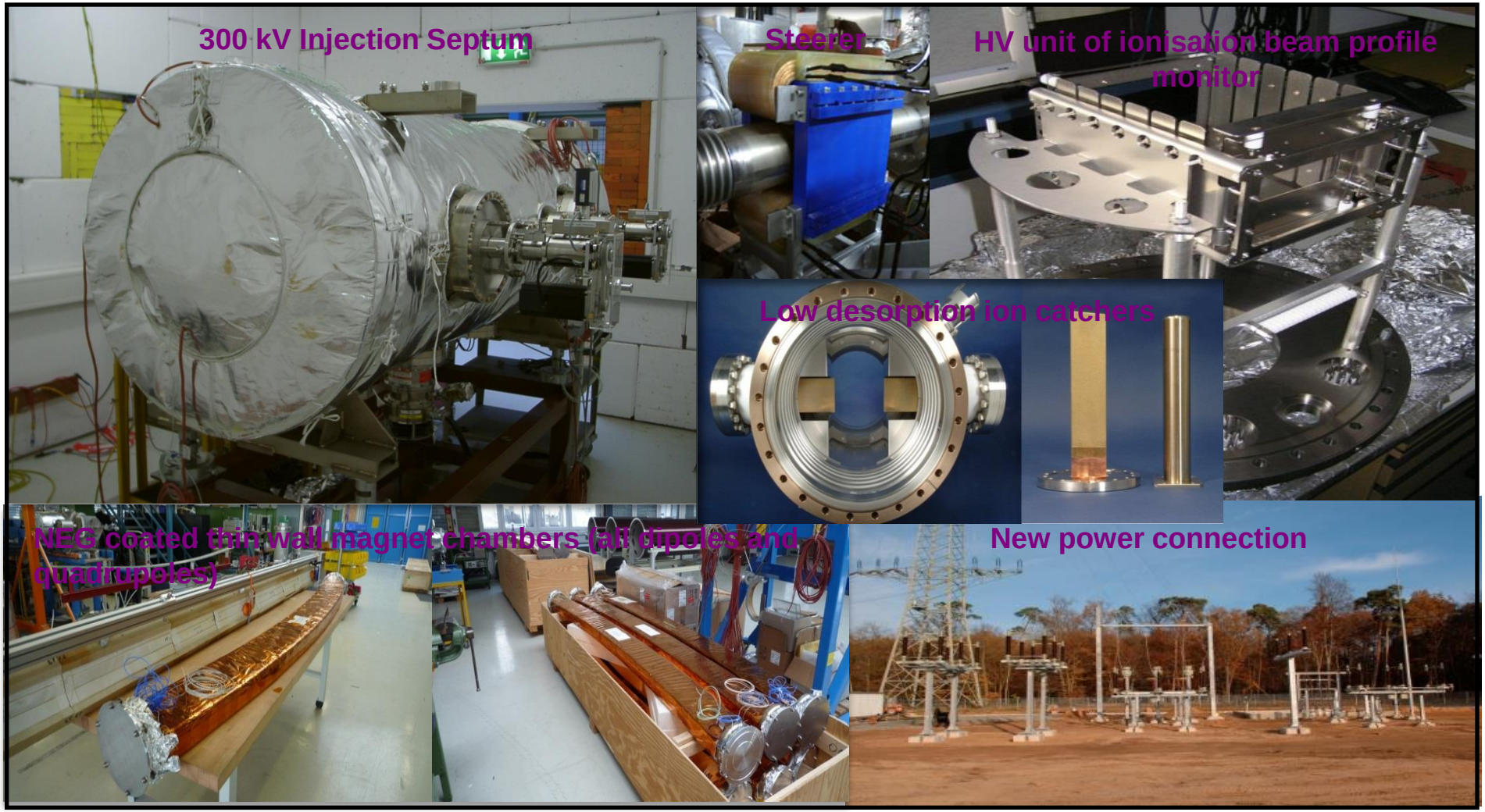
1. is (beside others) financed from FAIR projects funds and is focused onto the intermediate charge state heavy ion operation
2. is financed from annual institutional funds and is focused onto the requirements and needs of the presently performed experiments
3. is financed from ARD (accelerator research and development) funds, EUCARD/ARIES (accelerator reserach and innovation for european science and society)

SIS18 - Link Existing Facility

Activities executed and to be completed until mid of 2018:

- New Transformer Station North (FAIR cc activity)
- GAF Civil Construction Upgrade
- FAIR Part of Civil Construction Upgrade (FAIR cc activity)
- GAF driven Accelerator Issues
- TS1MU1 – New Bipolar Dipole Magnet (link to the FAIR beam lines)
- New IPM Ionisation Beam Profile Monitor
- New main Dipole Power Converter Upgrade
- New MA Acceleration Cavities
- Controls System retrofit
- New Device Interfaces to match new controls environment
- New LSA Set-Value Generation System
- Main Control Room referbishement
- Transfer Channel Shielding Enhancement and P-Linac Beam Dump
- Alignment and evtl. lifting of components
- Radio Protection Permits

SIS18 Upgrade - Completed



New Dipole Power Converter

Fast ramping with 10 T/s up to 18 Tm (19kA/s up to 3500A)

Status:

- Contract signed in December.2012 with GE (USA)
- Delivery of power grid filter unit mid of 2013 completed.
- Installation of new water cooled power cable completed.
- Scheduled final comissioning with 10 T/s in March 2018

New power grid filter delivered mid of 2013

High average beam intensity and low charge state operation requires fast short cycle times with fast ramping.

- Shortening of cycle time (intermediate charge states)
- Higher repetition rate (booster operation 2.7 Hz)
- Increased average intensity (x 3-5)

FAIR Transformer Station North

- Transformer Station North (FAIR Puls Power) enables the operation of SIS18 with 50 MW and SIS100 with 25 MW pulse power.
- No further compensation measures (capacitive storage, fly wheel etc.) required.
- Planned completion: December 2017

New MA Acceleration Cavities

- Sufficient voltage for fast ramping with low charge state heavy ions
  U^{73+} acceleration with 4 T/s ($2x10^{10}$ ions)
  U^{28+} acceleration with 10 T/s ($1.5x10^{11}$ ions)

- Sufficient bucket area for minimum loss (50 kV)
  (30 % safety)

- **Flat bunch profile (high Bf) for lower inc. tune shift**
  two harmonic acceleration
  h=4 (existing cavity) and h=2 (new cavity)
  > Shift space charge limit by x1.5

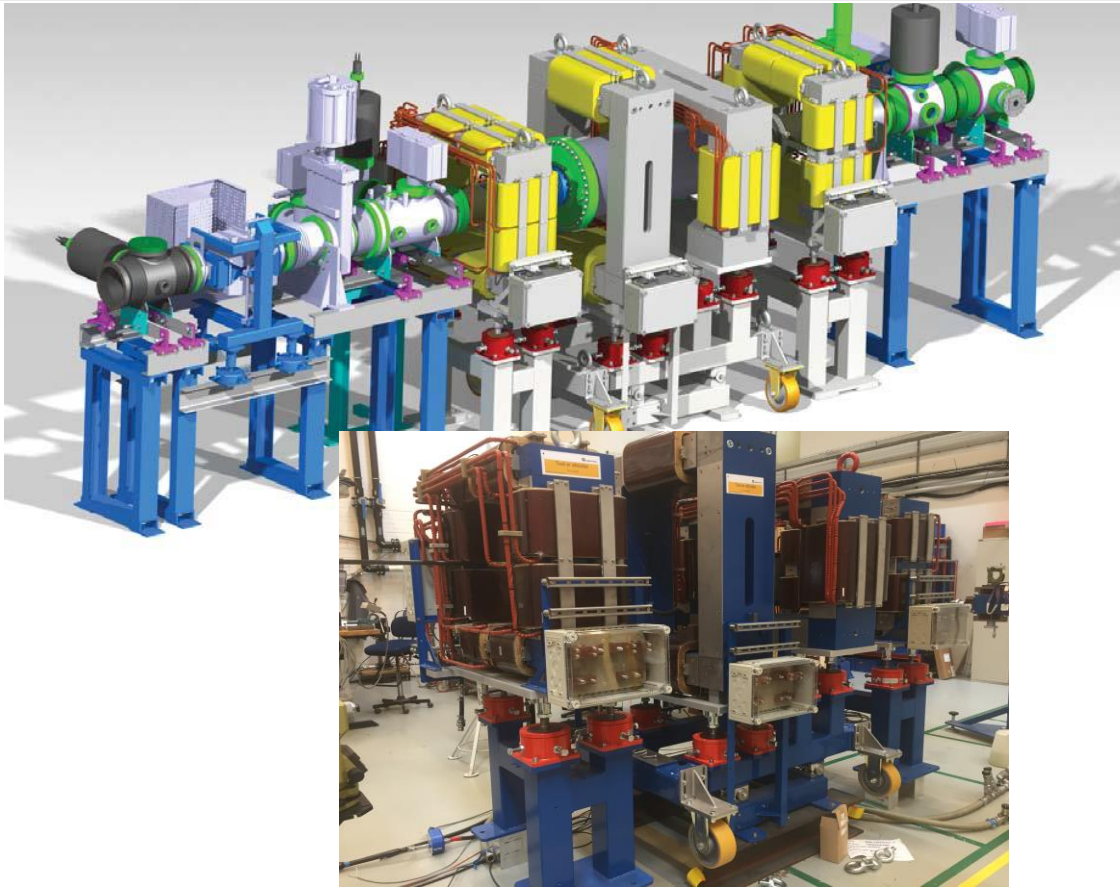
- **Compatibility with SIS100 Rf cycle**

MA cavities installed in SIS18

OCEM supply units for 1.8 MW cw operation

Ionization Beam Profile Monitor

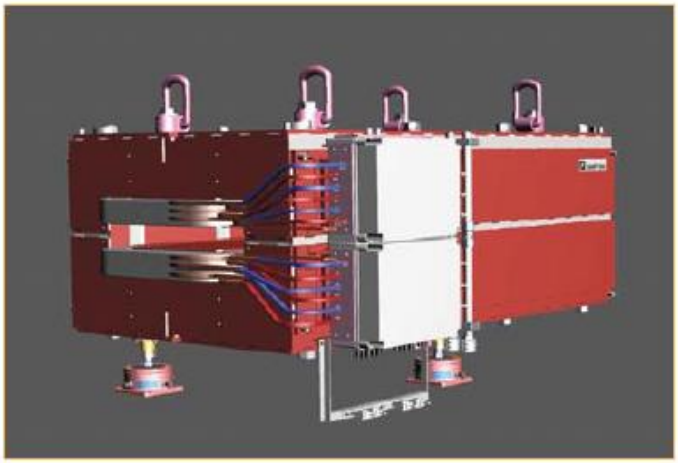
- Fast, turn-by-turn measurement, e.g. during injection process, resonace crossing etc. of the transverse beam size.
- Magnetic and electric field for imaging of the ionized residual gas ions and electrons under the influence of strong beam space charge onto a phosphor screen.



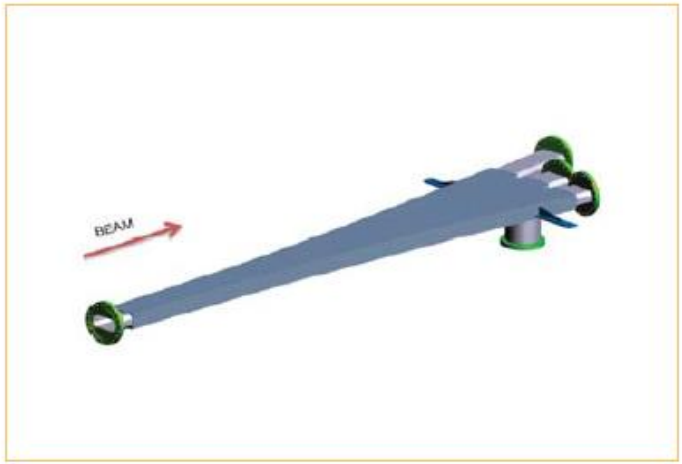
IPM magnet system at DANFYSIK

High voltage units manufactured. Magnet system for SIS18 and SIS100 manufactured and in FAT at DANFYSIK. UHV chamber tendering on short term.

New Bipolar Dipole Magnet



3D model for new bipolar TS1MU1



Contract closed for large magnet chamber

Milled yoke half

Completed coils for the dipole magnet

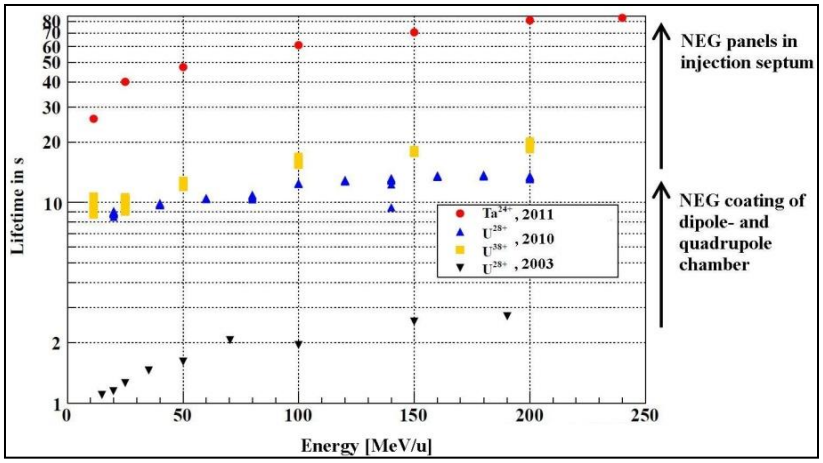
Bipolar dipole magnet shall be delivered July 2017.

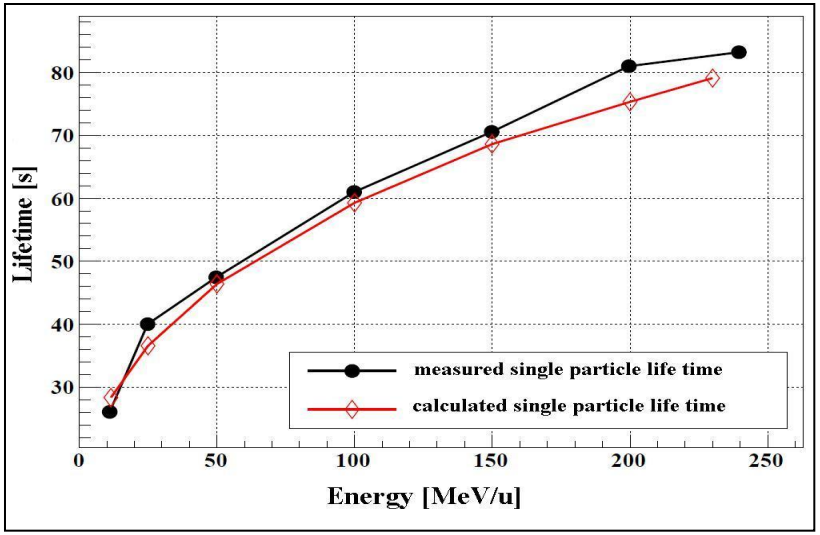
(Static) Single Particle Lifetime

As a result of the various upgrade stages, the beam lifetime could be continuously increased. These Figures show the measured lifetimes of intermediate charge state, heavy ions for different stages of the UHV system upgrade.

E.g. the measured lifetimes of intermediate charge state, heavy ions after NEG coating of the dipole- and quadrupole chambers and after inserting NEG panels in the injection septum.

After the installation of NEG panels in the injection septum, a perfect agreement has been achieved between the measured and expected beam lifetime and its energy dependence.

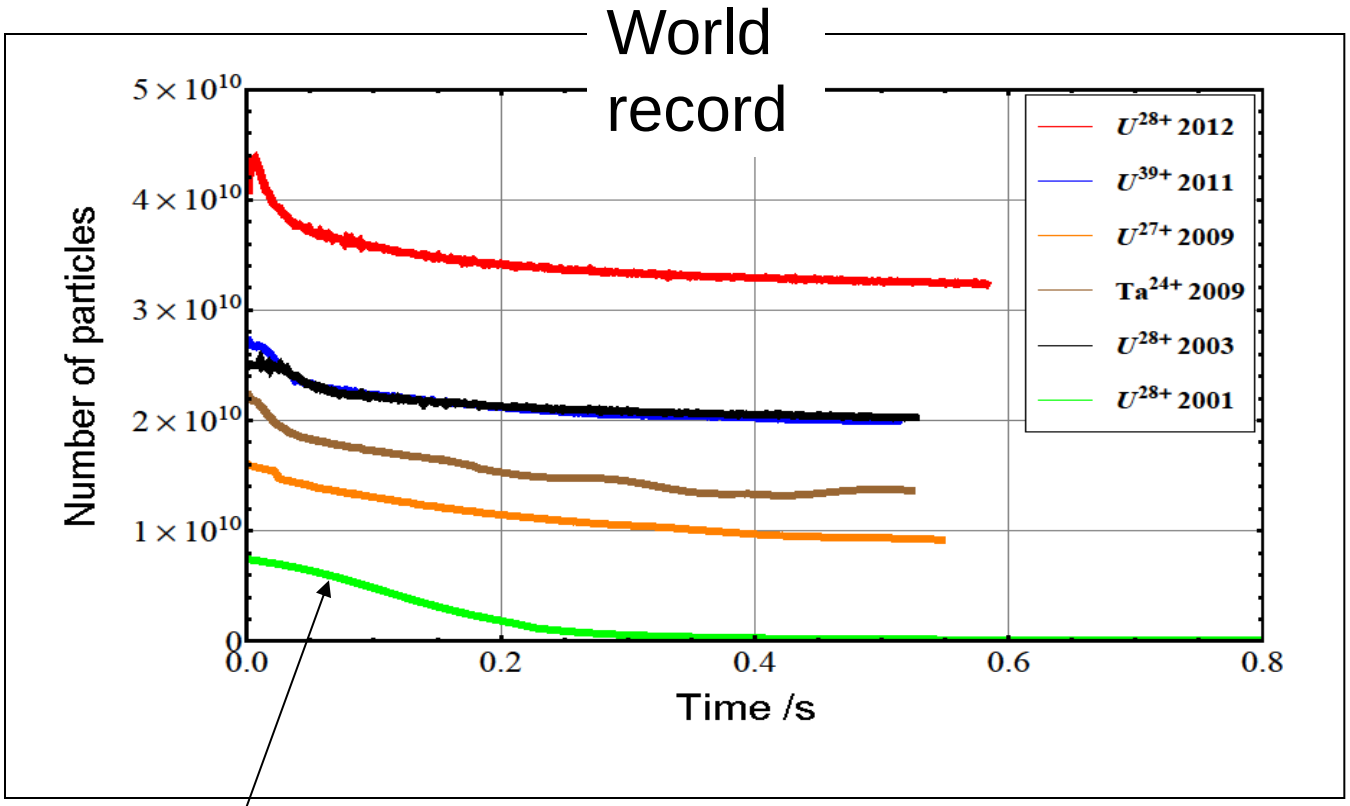




U^{28+} - Beam Intensity

World record intensity for intermediate charge state heavy ions.

The feasibility of high intensity beams of intermediate charge state heavy ions has been demonstrated.

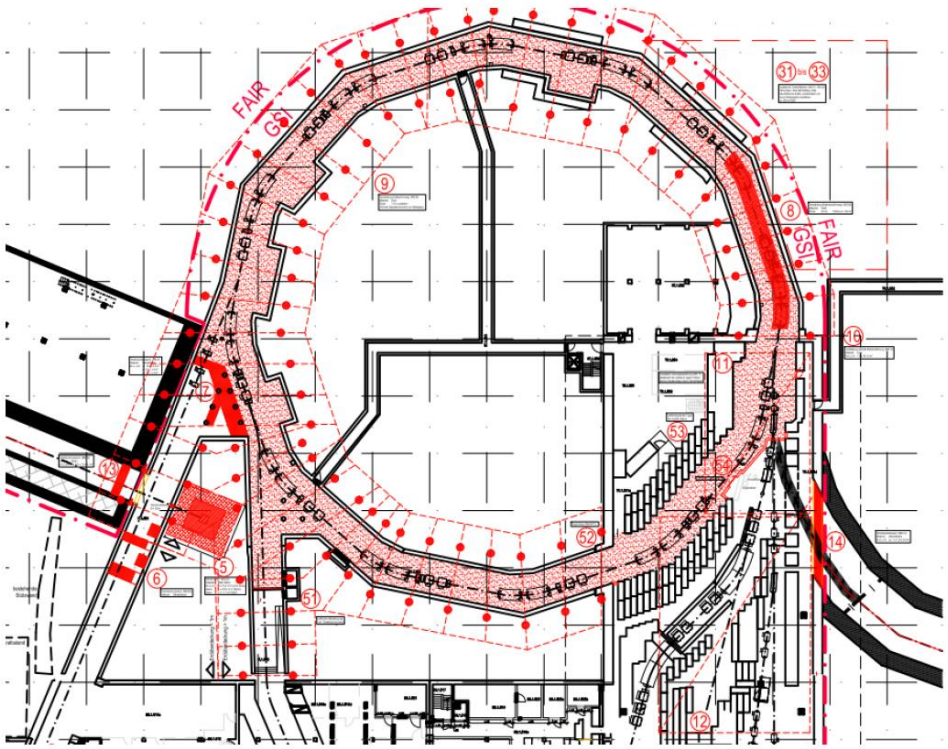


2001 FAIR conceptual design report (FAIR proposal)

SIS18 Civil Construction (Link Existing Facility)

Link existing facility –
Civil construction comprises:

- the shielding enhancement on top of the existing tunnel carried by a table like construction with independend foundation
- additional radiation protection measures
- underpressure radioactive air management system
- Nitrogen floading based fire prevention system
- link to the FAIR tunnel 101
- the inner and outer reinforment walls



- the beam dump for the proton linac on the western side of the transfer channel (TK)
- the shielding enhancement of the TK eastern wall to enable an early construction of the p-linac building

All works will be completed until May 2018.

GAF Civil Construction (Link Existing Facility)

SIS18 construction site

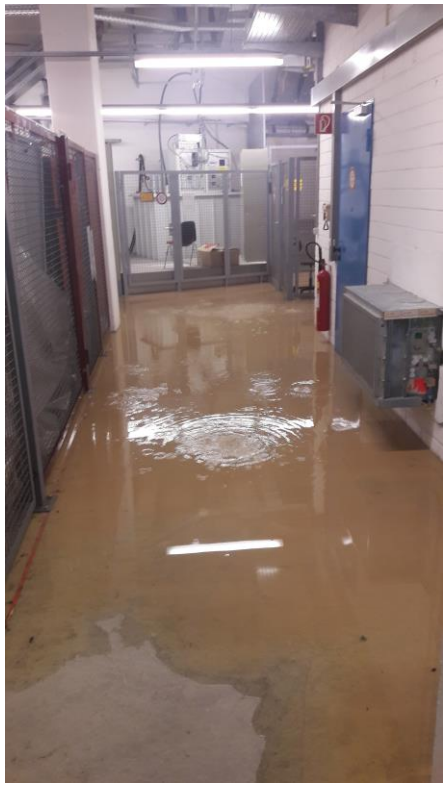
Interface to FAIR tunnel 110

Northern retaining wall

New transformer station North

GAF SIS18: Issues for Re-Commissioning

Risks for personnel injuries and facility damages
(in case of device/electronics damage, potential shut down for years)

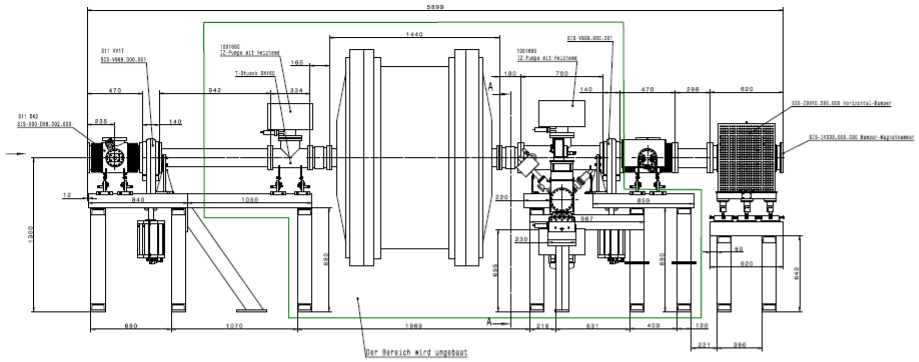


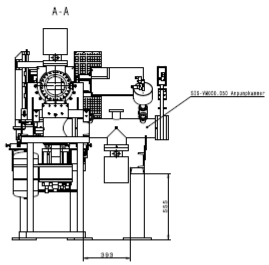
Repeated and distributed water and sludge in accelerator areas

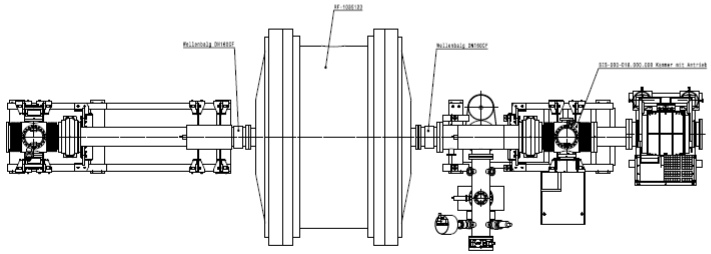
Large devices fallen from support – vibrations and insufficient protection

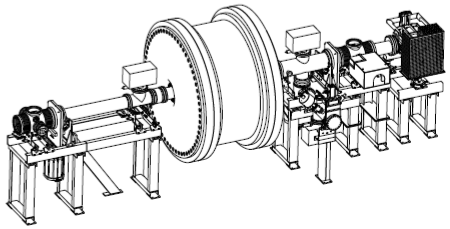
Destroyed kicker-cable

SIS18 Highlight: New Spill Cavity





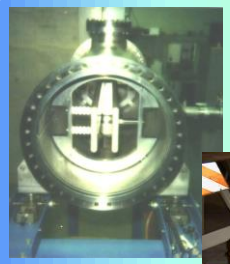




Cavity for smoothing the spill microstructure (which is a major problem for many experiments since decades). UNILAC single resonator cavity could be referbished with institutional funds. Installation is planned before beam time 2018.

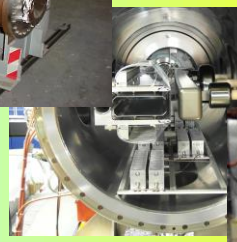
Proposal for SIS18upgrade 2

The SIS18 upgrade 2 program addresses issues at
a) operation of SIS18 for the running experiments in FAIR phase 0 and b) the FAIR booster operation.

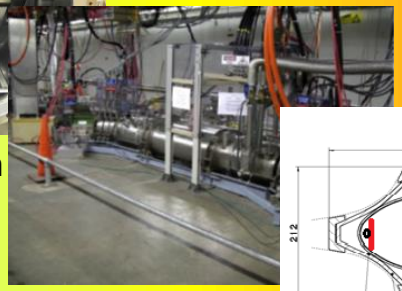


Injection Chopper

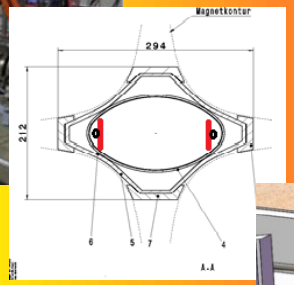
Microspill Cavity



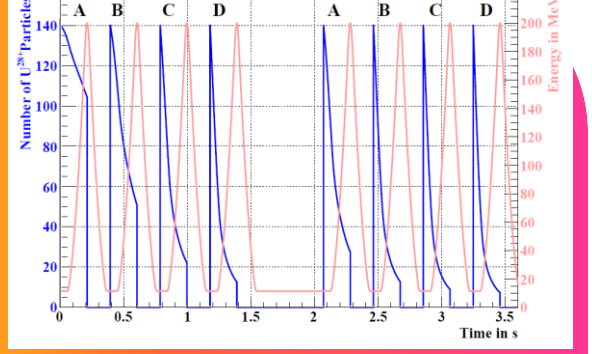
Extraction Septum



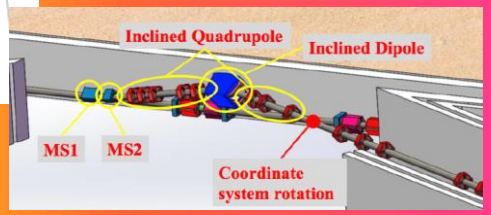
Space Charge Lens



Cryo Pumping



Ionization beam loss at high intensity and high repetition rate operation

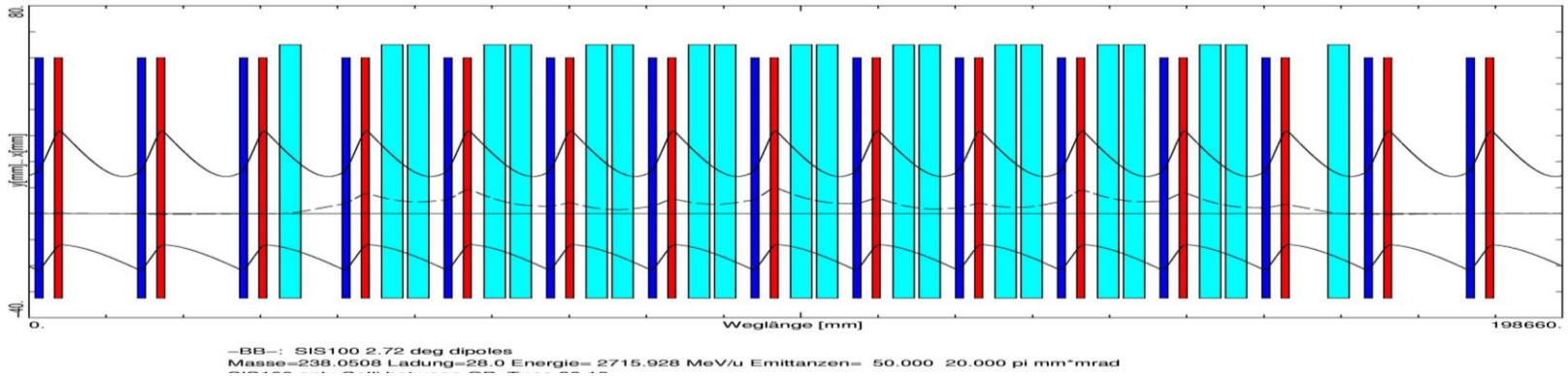


Two Plane Injection
or/and Pulsed Skew Quad

2017 2018 2019 2020 2021 2022

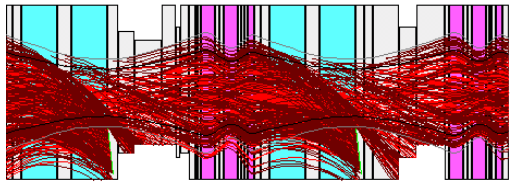
SIS100 Lattice Characteristics

- Maximum transverse acceptance (minimum 3x emittance at injection) at limited magnet apertures (problems: pulse power, AC loss etc.)
- Vanishing dispersion in the straight sections for high dp/p during compression
- Low dispersion in the arcs for high dp/p during compression
- Sufficient dispersion in the straight section for slow extraction with Hardt condition
- Three reference working points for different operation modes enabled by three quadrupole circuits
- Variable optical setting, including (shiftable) transition energy
- Sufficient efficient use of space for all components
- Featuring slow, fast and emergency extraction and potential transfer to SIS300
- Peaked distribution and highly efficient collimation system for ionization beam loss

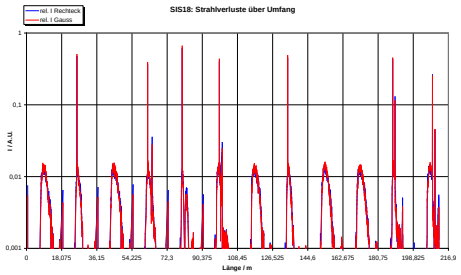


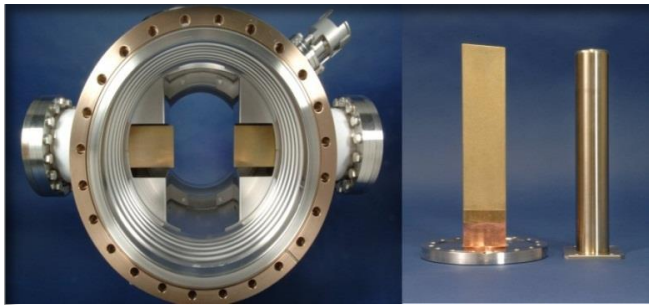
Localized Beam Loss and Controle of Gas Desorption and Pressure Bumps

SIS18



Triplett lattice provides
70% catching efficiency

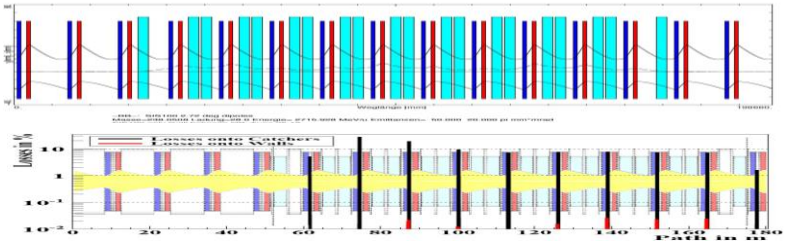




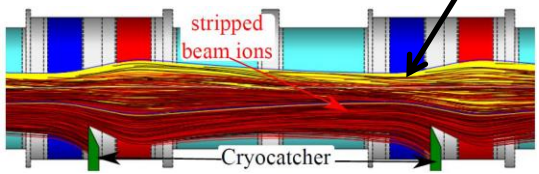
Room temperature ion-catchers with low desorption yield surfaces and NEG coated chamber

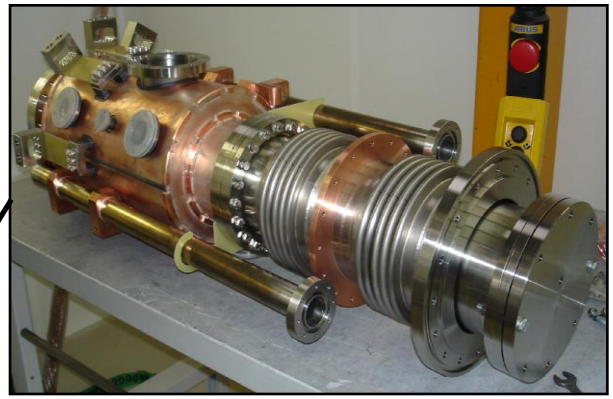
SIS100

Charge separator lattice



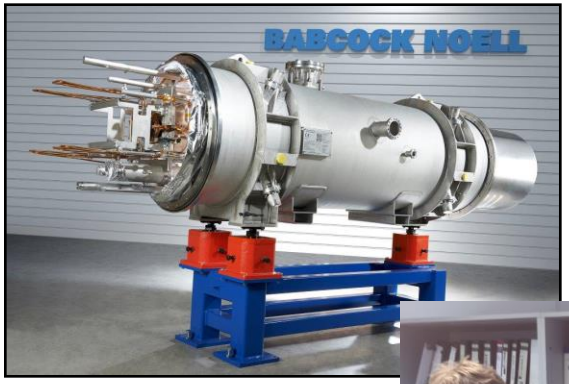
Charge separator lattice provides
100% catching efficiency





Cryogenic ion-catchers with low desorption yield surfaces and cryo-pumping chamber

FoS and Series of Superconducting Dipole Magnets



Copyright Babcock Noell GmbH

(109 pieces required)

Status:

- The FDR for the series design and the approval for series production readiness has been passed in July 2016.
- A contract ammendment has been set-up to cover additional cost due to technical changes from FOS to series and the improved manufacturing technology.
- BNG has moved to a new hall for series production.
- The full amount of steel has been produced.
- First half yokes are send to the subcontractor for welding.
- Series production has been started.

First series magnets will be delivered next Thursday !

The final rate of delivery is one magnet per week

Superconducting Magnet Test Facility SIS100 Dipole Magnets at GSI

Cryogenic Plant (compressor, liquefier incl. distribution to feed boxes)

Status: Contract awarded to Linde (*Germany*), and Cryoworld (*Netherlands*). All components delivered and assembled.

- Field measurement:

Design adapted by GSI. Manufacturing and calibration of cold rotating coil system for field measurements is completed. Electronics developed and manufactured by CERN and delivered. Overall system under commissioning at cold.

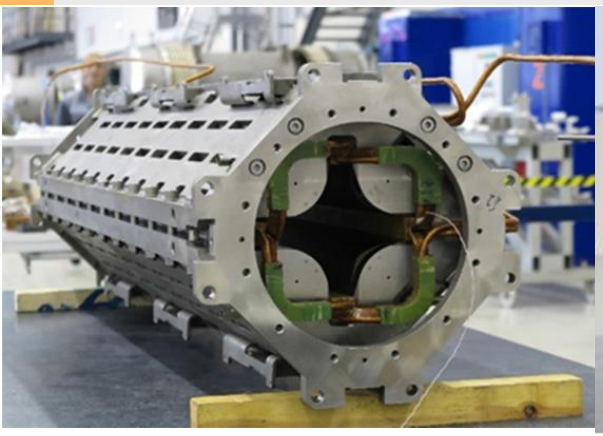
- Electrical integrity:

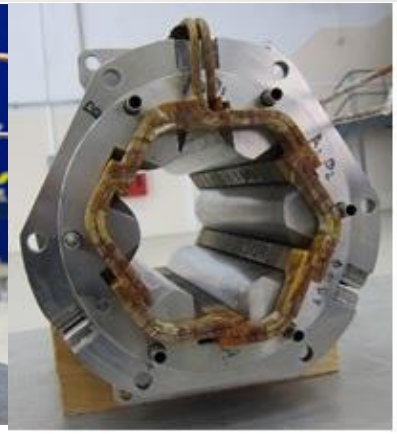
GUT develops and builds the electrical integrity measurement equipment. First unit will be deliverd in September.

Series testing starts from September 2017. Each magnet experiences a four week acceptance procedure (from delivery to storage). Three magnets will be mounted at different testing stages at the feed boxes.

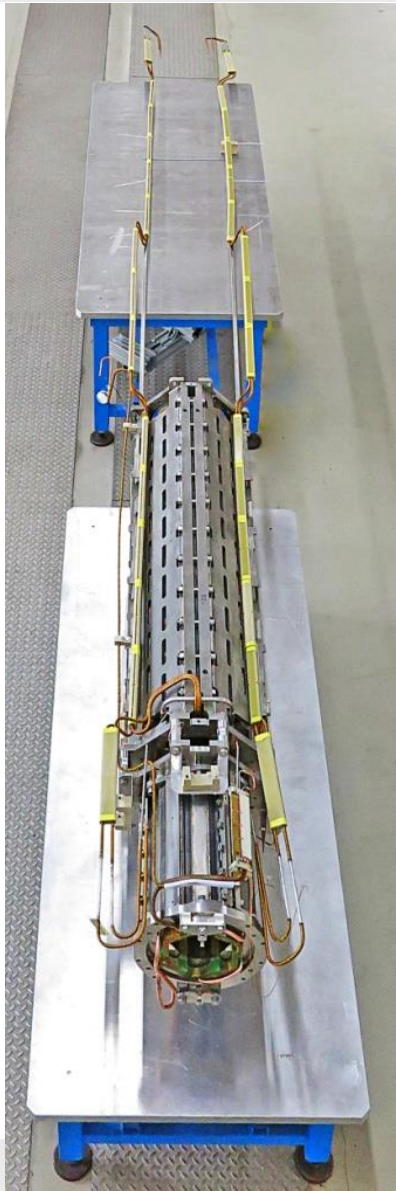
The set-up of the testing team has to be done in agreement with other tasks and activities of GSI.

Superconducting Quadrupole Units





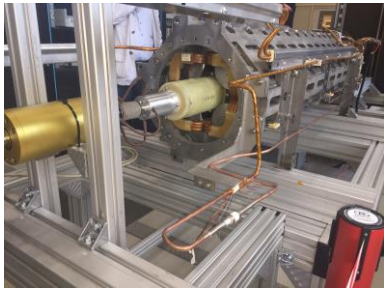
- The FOS FDR has been passed in December 2015.
- The steel for the FOS yokes has been procured by GSI and supplied end of 2015.
- JINR has subcontracted the manufacturing for the quadrupole units to two companies: NPO Atom and Savelovo.
- Two FOS quadrupole yokes have been produced based on different manufacturing technologies:
  a) machining the aperture after assembly of the half yoke and
  b) no machining and no glueing of
  lamella according to the dipole production.
- The yoke produced without milling does not meet the specified tolerances.
- Two units, one quadruple + steerer and one quadrupole + sextupole have been produced and assembled.
- Cold tests will start in September 2017



Commissioning of Magnet Test Facility

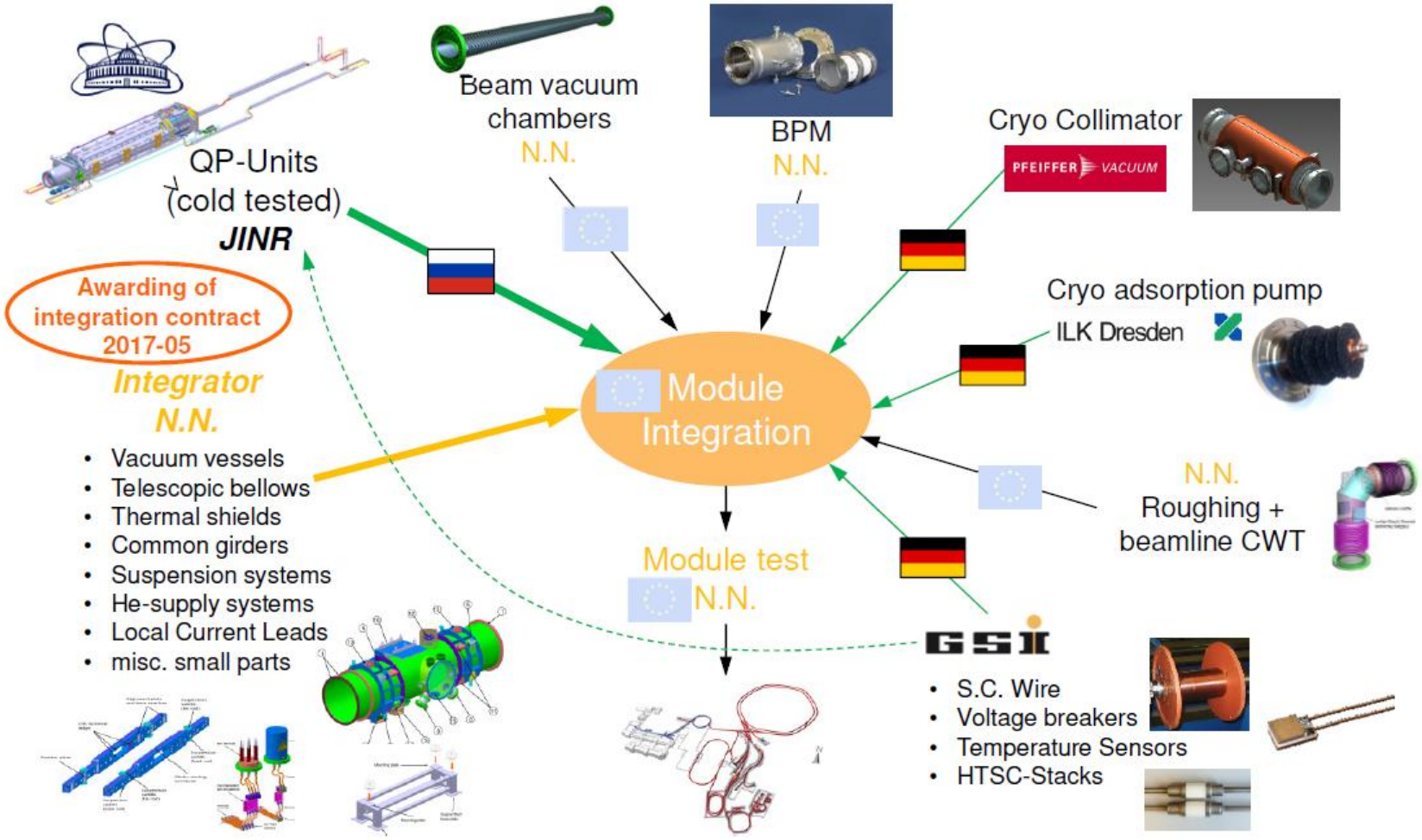
The test facility for superconducting magnets at JINR, for the NICA and FAIR project has been completed and commissioned.
The commissioning has been celebrated in the frame of a public event in November 2016.

Six feed boxes are foreseen for NICA and SIS100 s.c. magnets, each three for NICA and SIS100.

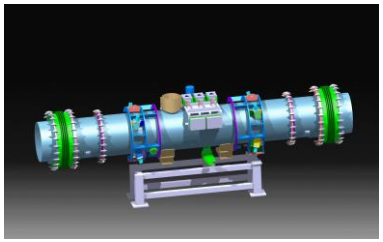


The equipment for magnetic field measurements and electrical tests is available.

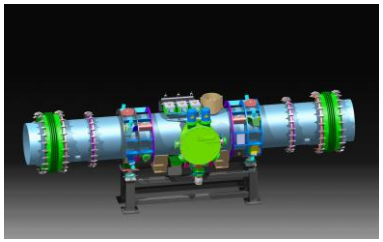
Quadrupole Module Procurement Status



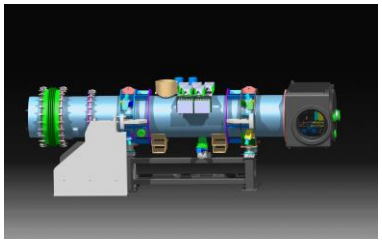
Manufacturing Design of Quadrupole Modules



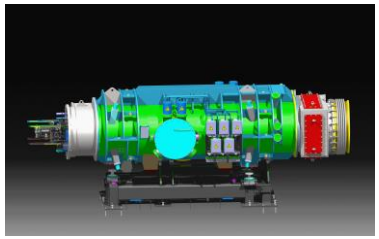
Module 1.6



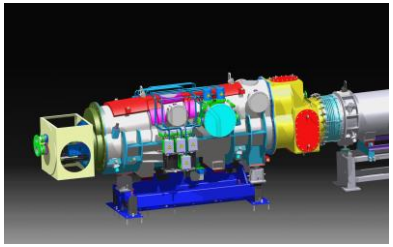
Module 1.7b



Module 1.e

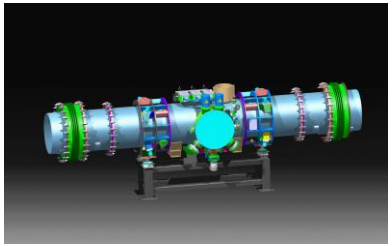


Module 1.i

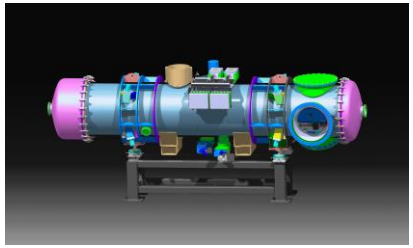


Module 2.4

Module 2.4x

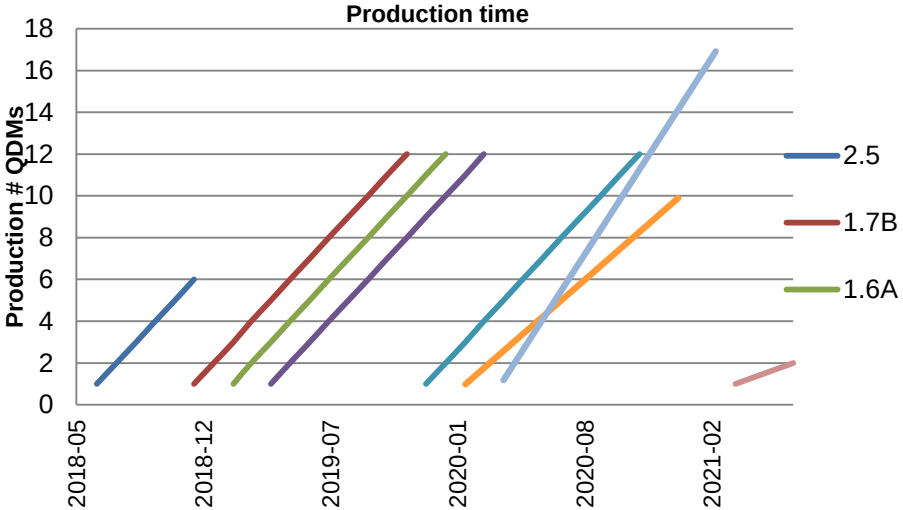


Module 2.5



Module 2.13

- Industrialized design of the overall cryomagnetic quadrupole modules has been completed.
- Due to the design freeze, the final completion will be done in the GSI design office. The estimated time for competion is ¾ year.
- The design of the FOS module 2.5 is completed and ready for manufacturing.



Quadrupole Modul Cold Testing

Three éxpression of interest have been received and are evaluated for testing of the integrated modules:

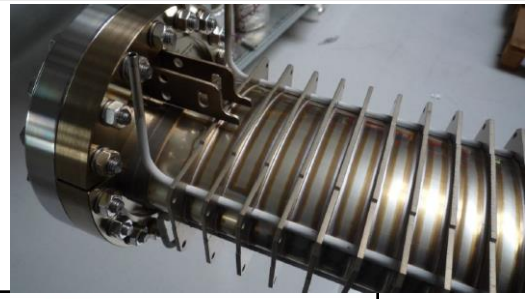
a) at NAFASSY Salerno as potential Italien contribution to FAIR
b) at CEA Saclay as potential inkind contribution to FAIR
c) at ILK as industrial offer

All options are presently studied in detail involving various points of view.

Overview of SIS100 UHV System

Cryogenic Sections

1. LHe cooled main **dipole and quadrupole chambers**
2. **Cryosorption pumps** between each dipole pair and in each straight section module in each lattice cell
3. **LHe cryocatcher chamber** in between the quadrupole pair in each lattice cell

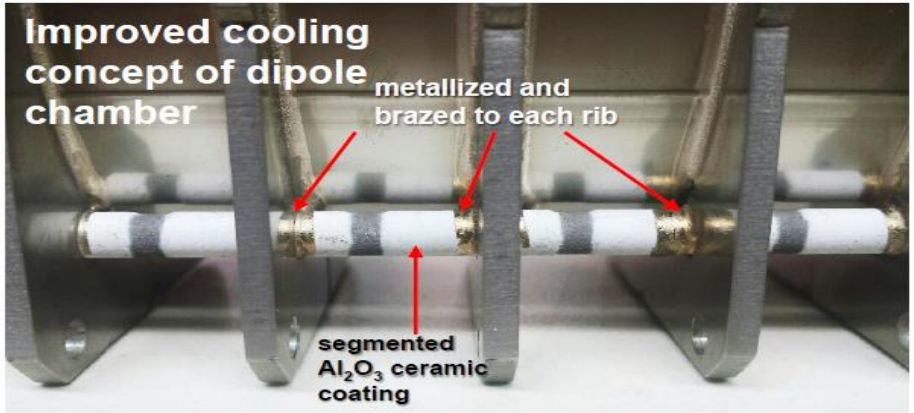


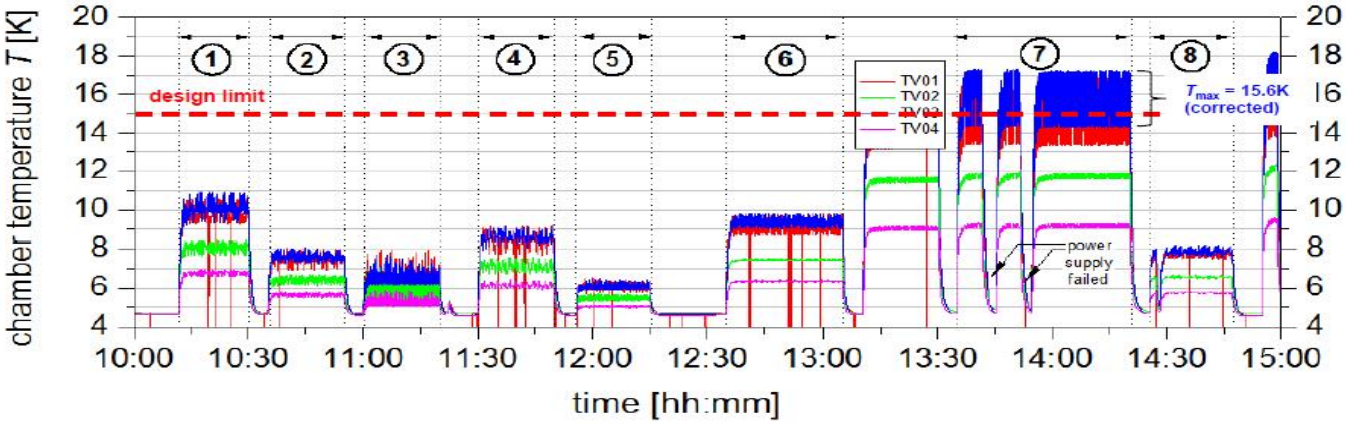
(only #1 suffer from inductive heating !
#2 and #3 are stationary)

Room Temperature Sections

- Powerful conventional pumping power at each room temperature device
- Every device bakeable
- Standard UHV pumping chambers equipped with ion getter pumps and NEG pumps
- Additionally many chambers NEG coated
- Additionally NEG panels especially at conductance limitations (e.g. injection/extraction channel)

Thin-wall LHe-cooled Dipole Chambers





Acceptable ✓

magnet cycles tested

①	Proton cycle	⑤	RIB cycle 400 MeV
②	RIB cycle	⑥	Triangle RIB cycle 400 MeV
③	CBM cycle	⑦	Triangle CBM cycle
④	RIB cycle 2.7 GeV	⑧	(old) 2c cycle

The insulation of the LHe cooling pipes is still an issue.

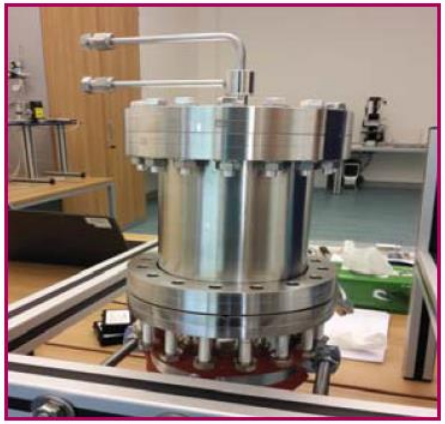
Cryo - Adsorption Pumps

SIS100 Adsorption Pumps

(78 pieces)

Status:

- The contract for production has been awarded to ILK.
- It could be proven that the offered alternative coal provides the specified pumping power.
- Delivery and acceptance of two FOS device completed.
- Series production running.

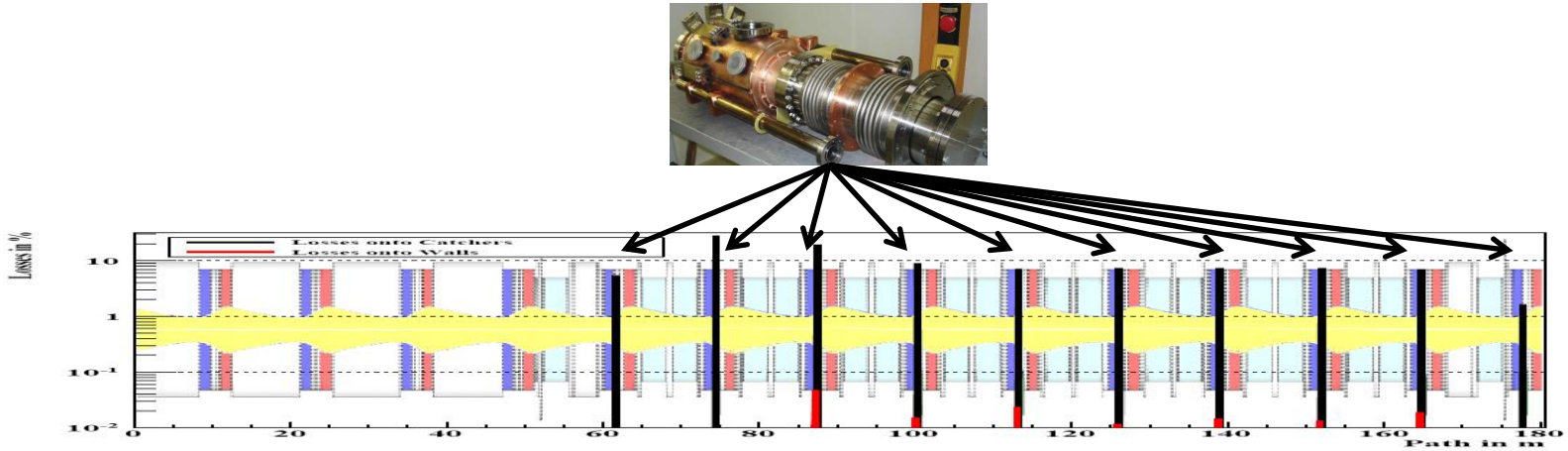


Adsorption pump prototype developed and tested at GSI with outstanding hydrogen pumping characteristics

Peaks of Gas Load

Gas Load Peaks

1. in the middle between the quadruple doublet by ion induced desorption



Cryocatcher: Low desorption surfaces coupled with huge local (cryo) pumping power.

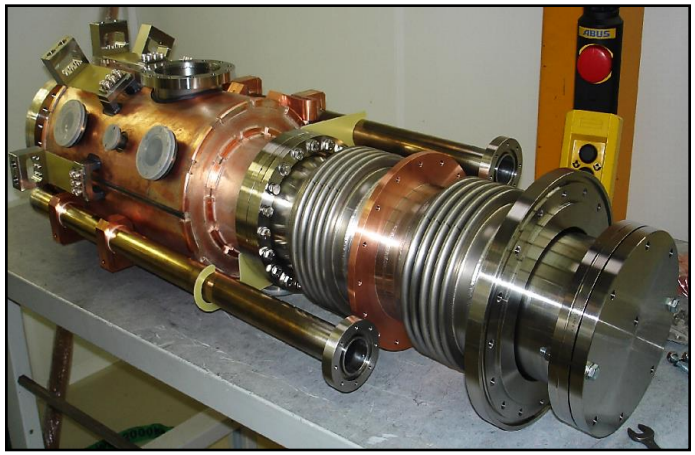
Multiple ionized projectiles may be lost upstream (in the qudrupole chambers) (20%) and lead to enhanced desorption.

2. at entrance and exit of cryogenic sections by diffusion from the warm sections

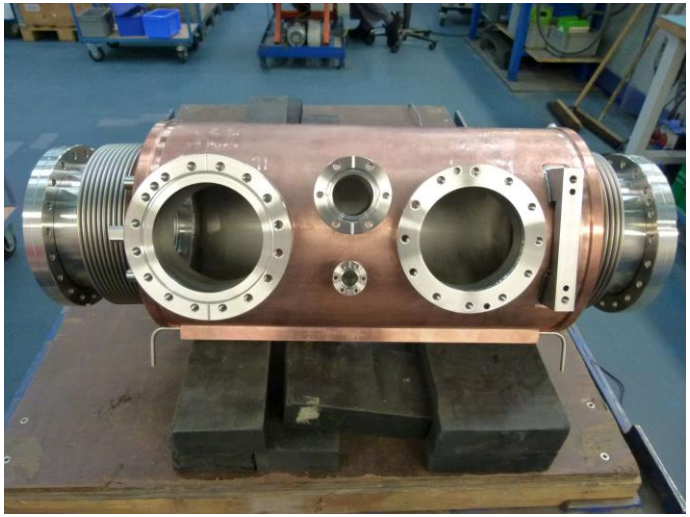
Cryo-Catcher System

Status:

- The contract for the FOS and series cryo catcher system has been awarded to Trinos.
- The manufacturing of the FOS device is completed. Acceptance test ongoing.



EUCARD prototype cryo catcner



FOS cryo catcher at TRINOS

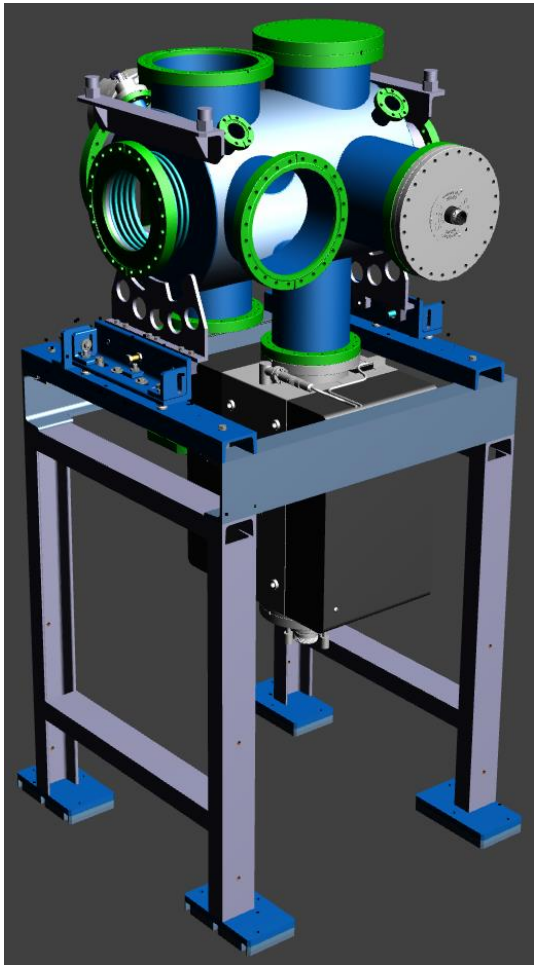
High Energy Laser Cooling

Laser Cooling Facility is funded from the HGF ARD program and will used for atomic physics experiment by the SPARC community and for the generation of short ion bunches as an accelerator component.

PBSC Polarizing Beam Splitter Cube

Power Detector (vacuum compatible)

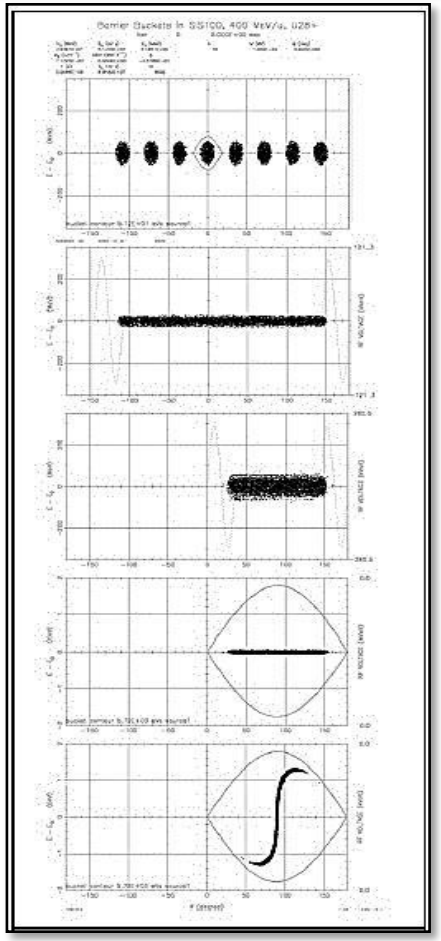
- Two laser tables
- Laser beam stabilization system
- High-quality optics for the laser beamline (mirrors, lenses, PBSC, etc.)
- High-quality optical components (mounts, posts, etc.)
- Vacuum compatible and normal, piezo-controlled mirror holders
- Basic lab kit containing components for cleaning, mounting, testing, etc.
- Osci, cupboard and trolley for safe and proper storage of components and ease of use



Laser cooling chamber

Procurement of laser chamber started.

Short pulses for optimum target matching and fast cooling in CR



Major bunch manipulations are required in the FAIR synchrotrons and storage rings:

- **Acceleration**

  (single and dual harmonic)
- **Merging**
- **Batch compression**
- **Fast compression**

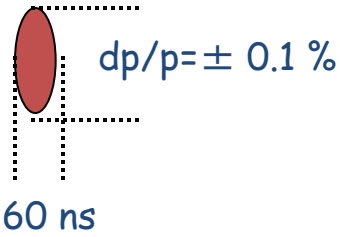
  (bunching)
- **Fast decompression**

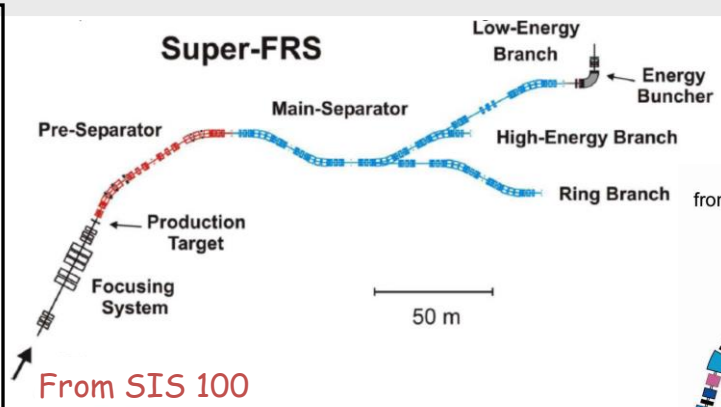
  (debunching)

RIB generation and pre-cooling

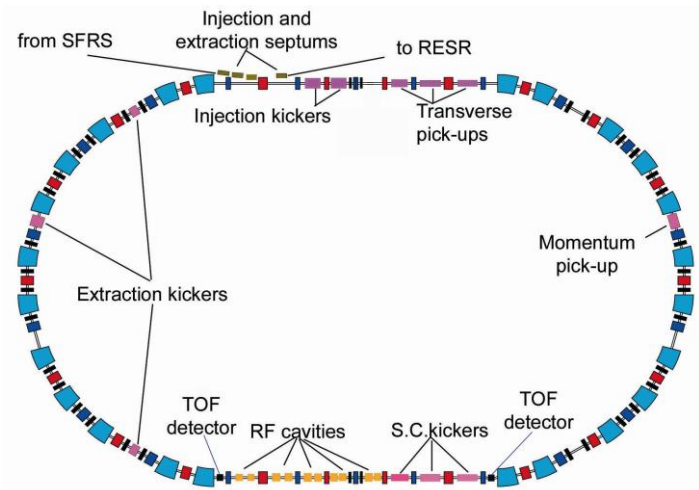
Target matching and fast bunch rotation in the CR

Short SIS 100 bunches:
- target matching
- RIB/pbar pre-cooling

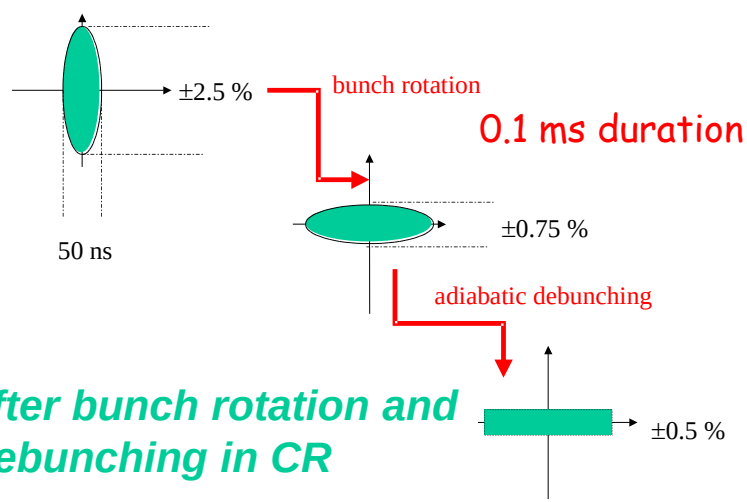




Collector Ring (CR)
circumference 212 m
rigidity 13 Tm



RF voltage in the CR: 200 kV (1.5 MHz)



after bunch rotation and debunching in CR

CR ring properties:

	RIB	pbar
energy	740 MeV/u	3.0 GeV
mom. accept.	± 1.5 %	± 3.0 %
transv. accept.	200×10^{-6} m	240×10^{-6} m
Cooling down time	1.5 s	10 s

RF Acceleration Systems

(14 pieces required)

Status:

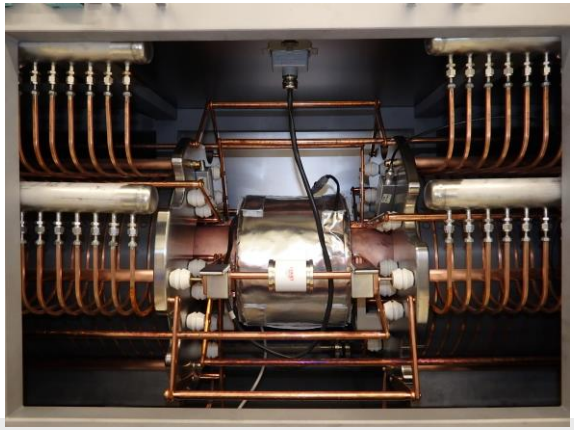
• The contract for the production of the series ferrite cores has been signed between RI and Ferroxcube.

• The development and manufacturing of the FOS cavity has been completed.

• The FOS cavity is in the FATs.

• The cavity has reached its nominal gap voltage !

SIS100 ferrit loaded acceleration cavity:
V_0= 20 kV f_0= 1.1 – 3.2 MHZ

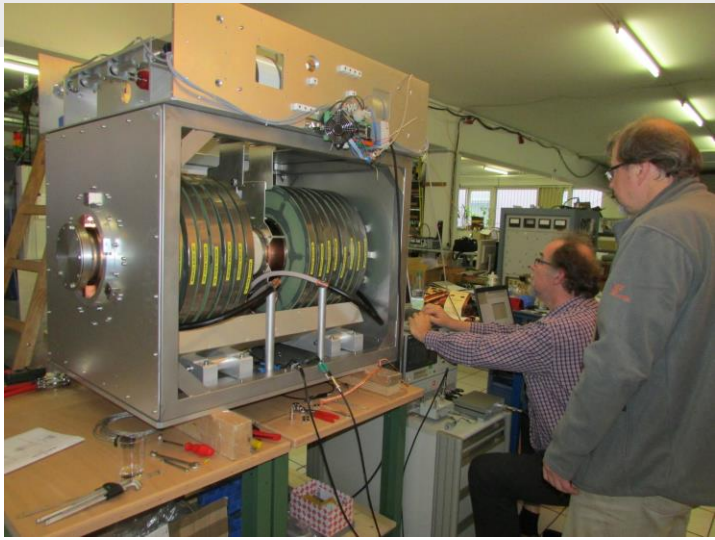


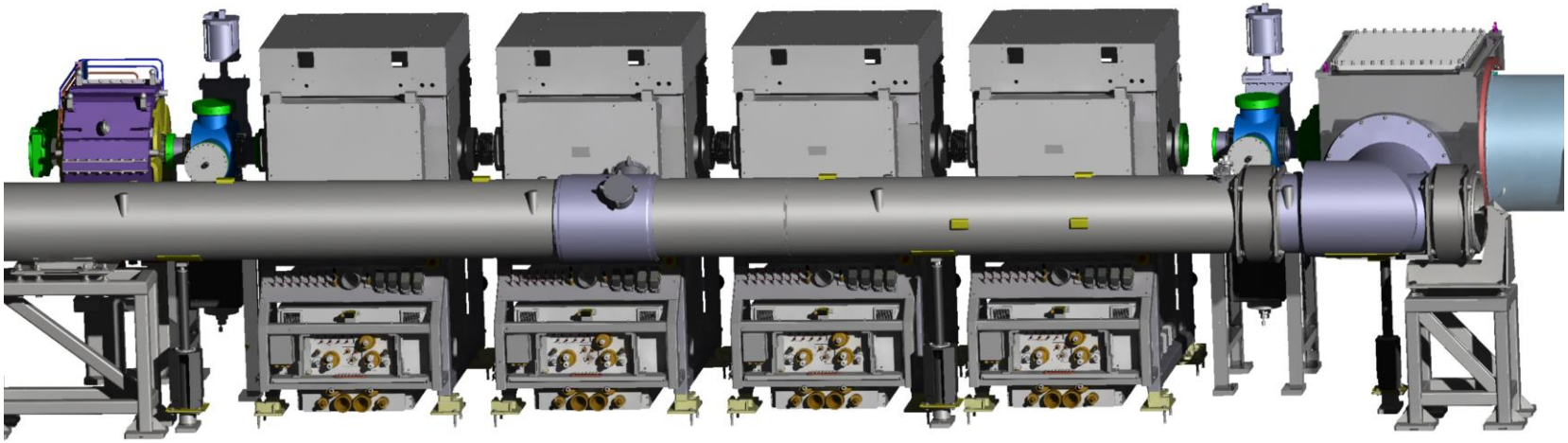
RF Bunch Compression Systems

(9 pieces)

Status:

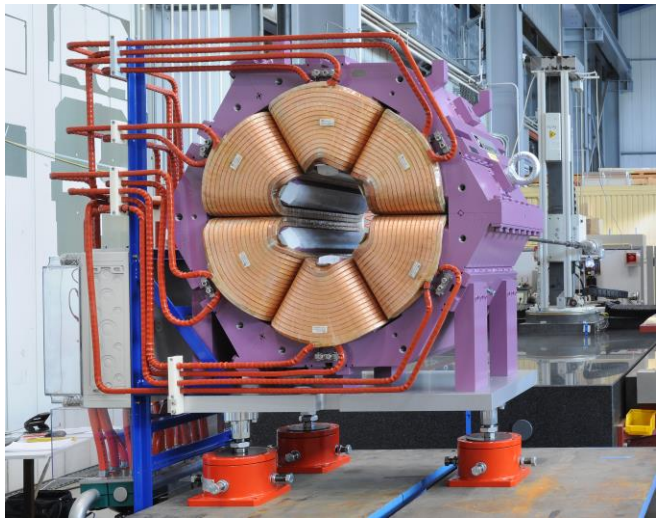
- Specified gap voltage of 40 kV reached in FOS cavity.
- FDR for series device approved. Series production released and running. MA cores and other components ordered.
- Planned completion of two more cavities in 2017.

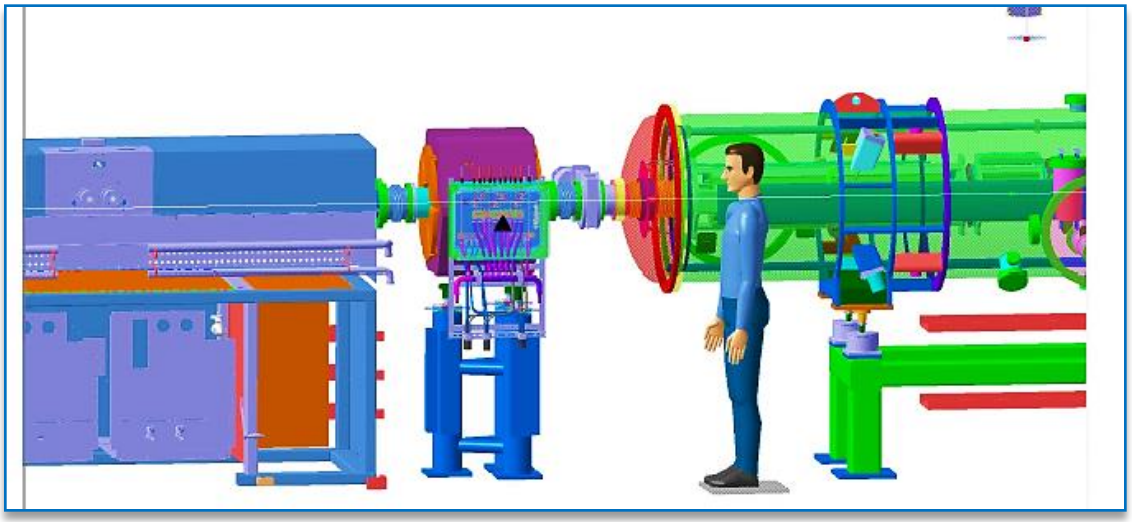




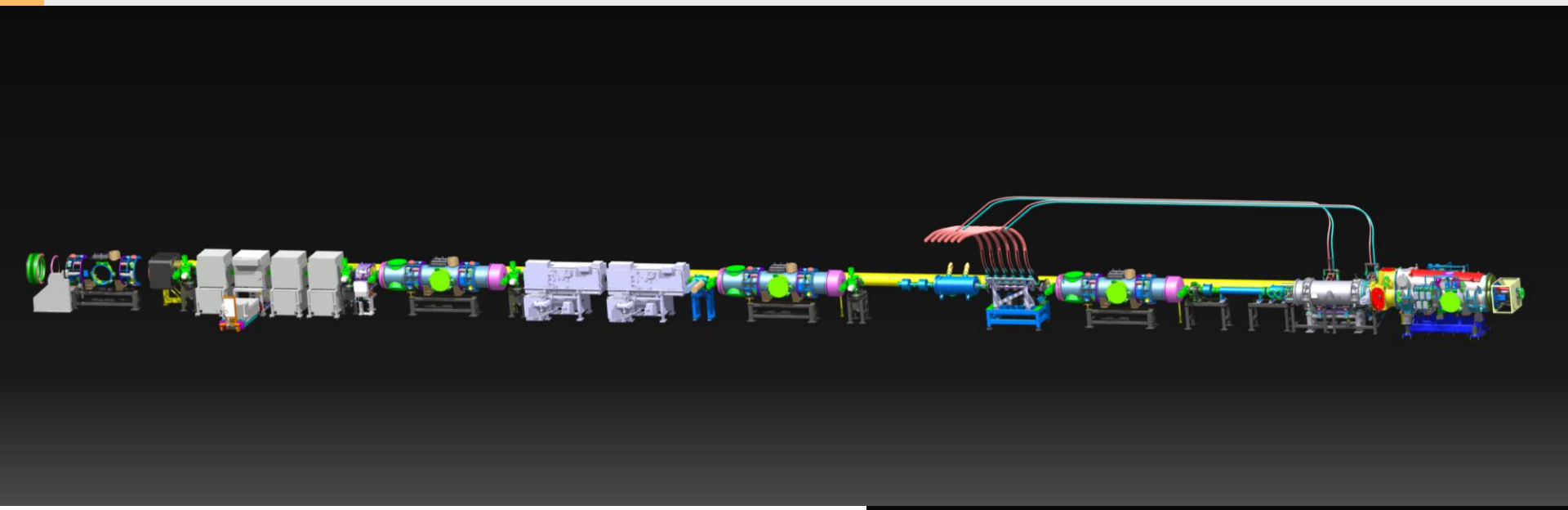
Resonance Sextupole Magnets

Status:
- Contract signed and awarded to Danfysik.
- FOS sextupole magnet delivered and tested.
- FDR series design approved.
- Series production ongoing.
- Delivery if full (six magnets) series August 2017

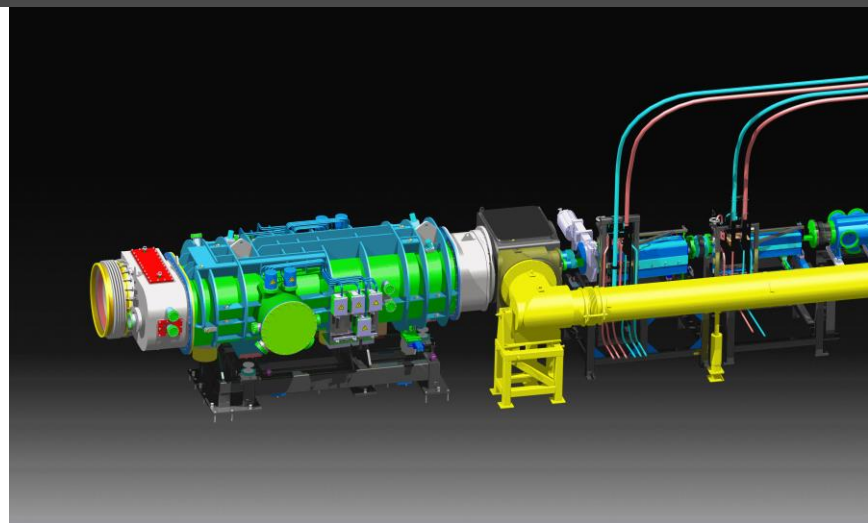




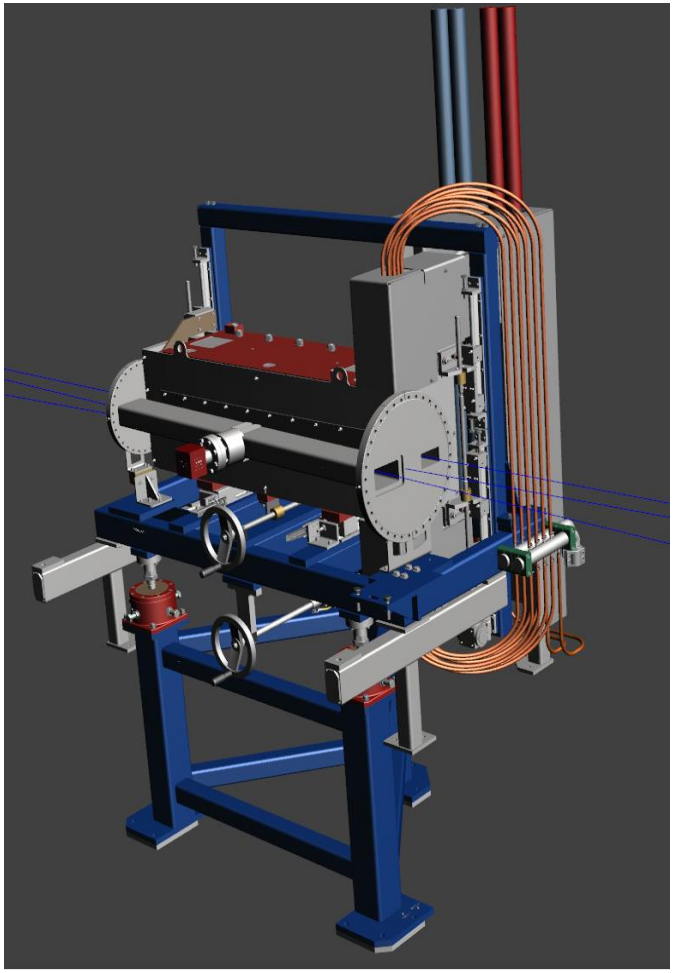
Injection Straight Section

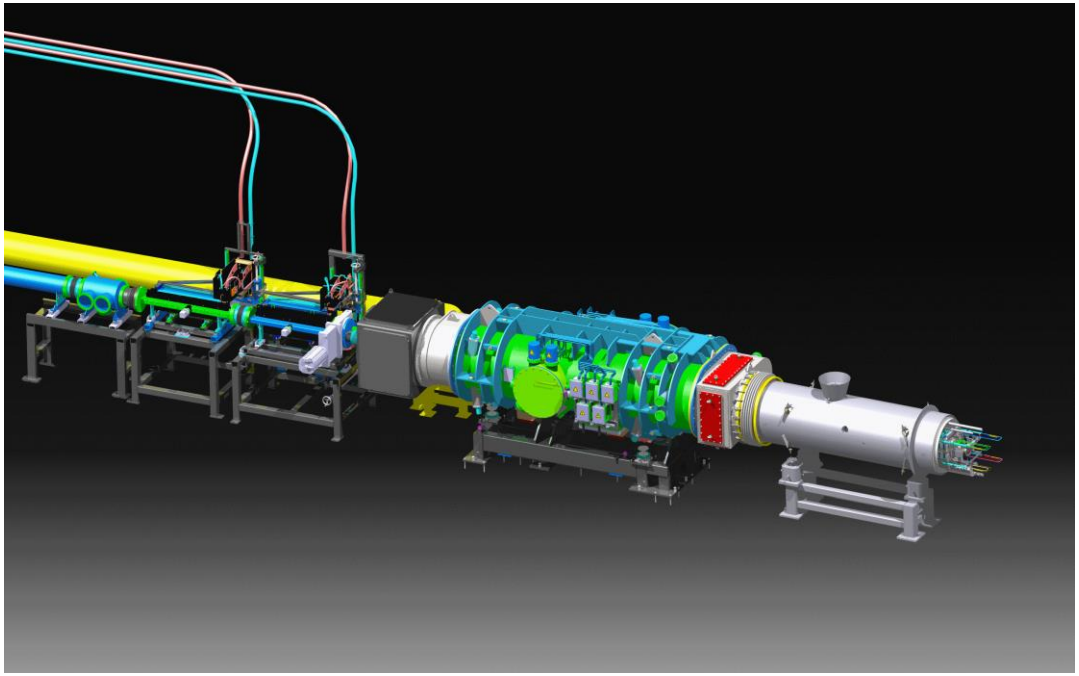


- DMU, integration and pre-design of injection straight including all injection devices and Rf systems completed.



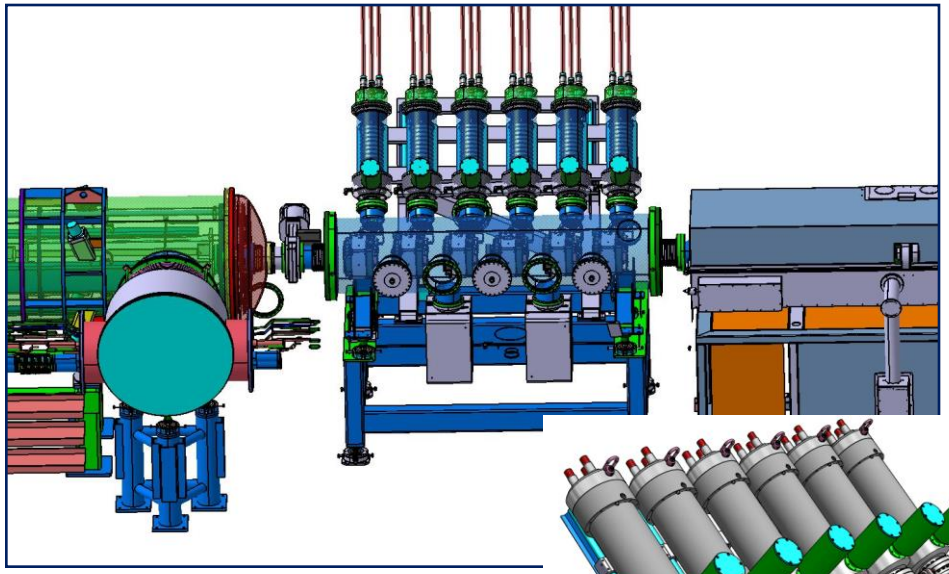
Injection Septum Magnets

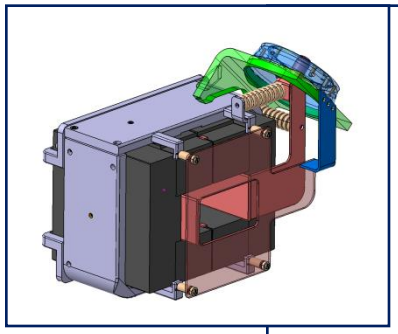


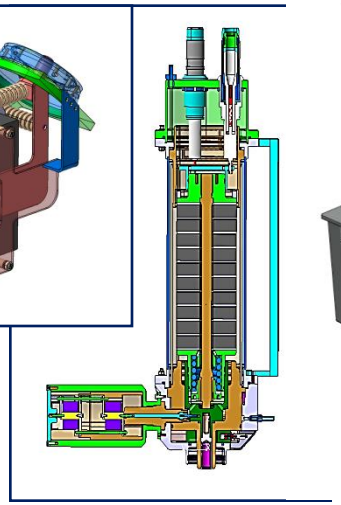


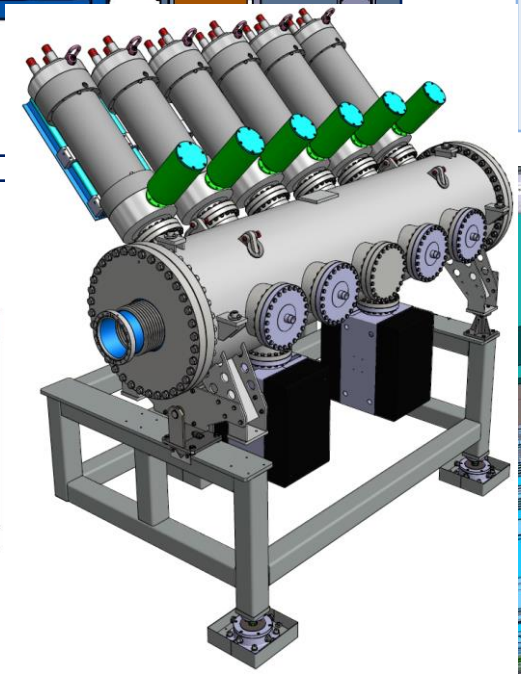
- Tendering for the injection septum magnets completed. Offers received and approved.
- Contract awarded to Danfysik.
- PDR for injection septum 2 passed.
- PDR for injection septum 1 under preparation.

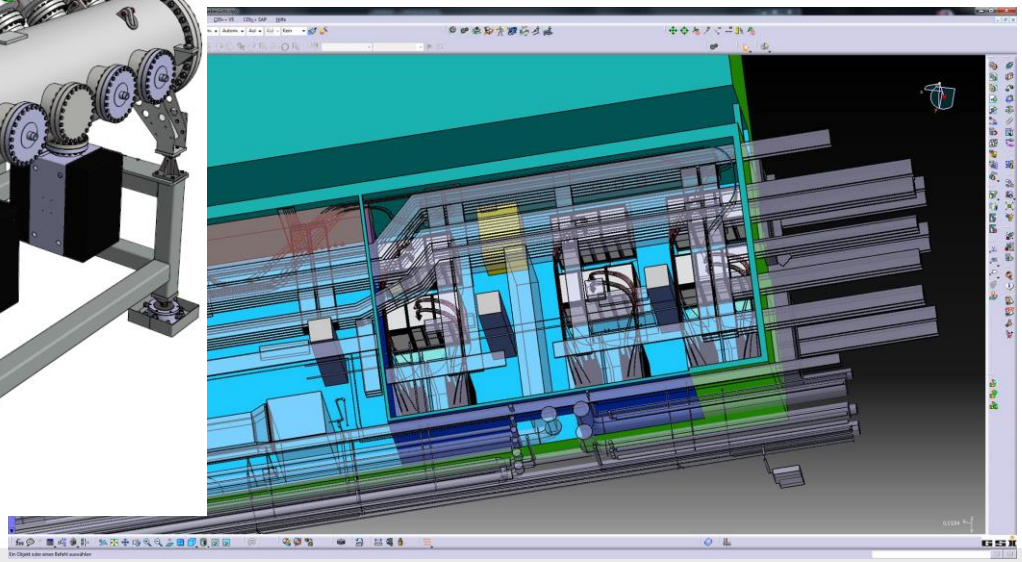
SIS100 Injection Kicker Module









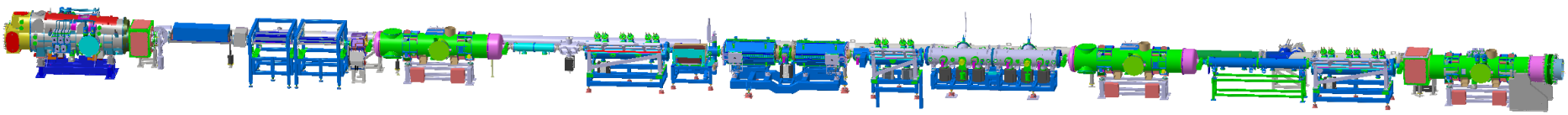


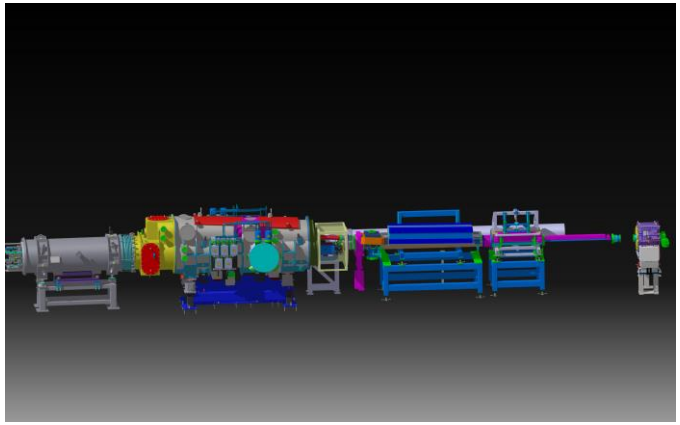
Injection Kicker System

Status

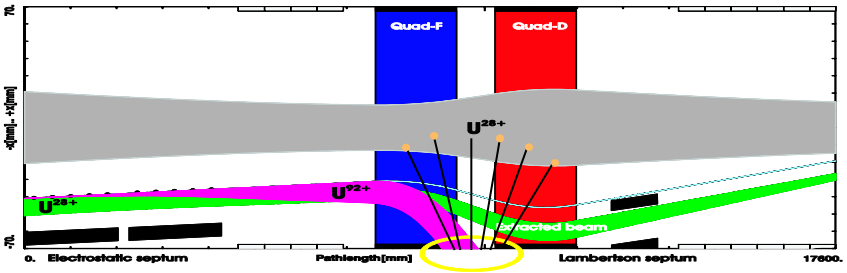
- Contract awarded to PPT/AMPEGON
- Kick-off meeting passed.
- Thyratron order for injection and extraction kickers in preparation.
- PDR and FDR passed.
- Manufacturing started.
- Cable routing not triavial.

Extraction Straight Section





- Extraction straight DMU, pre-design and integration well developed



Beam loss at U^{28+}-operation

- **Radiation hard nc magnets**:

Some difficulties have shown up in the design and integration of the nc radiation hard quadrupole magnets of the extraction straight. The heating jackets had to be integrated and the coil design revised.

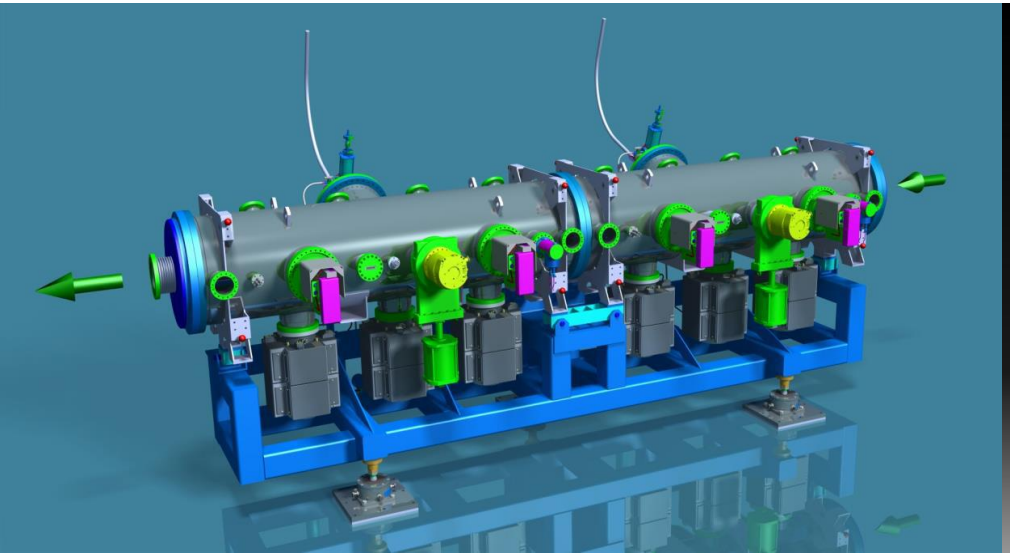
- **Electrostatic Septa**

Pre-design of electrostatic septa completed. Difficulty: High energy deposition of heavy ions in wires (melting). Conservative approach for commissioning. In parallel, R&D on radiation hard septum.

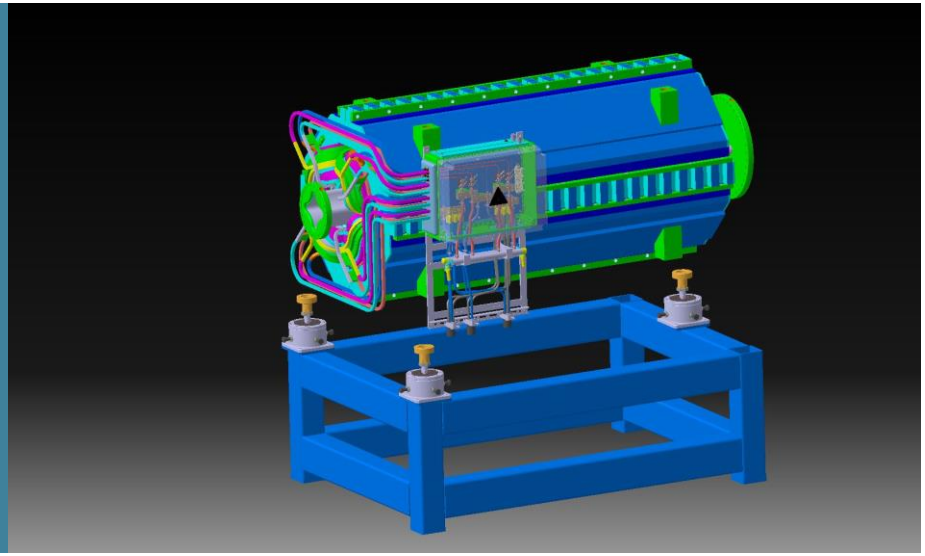
- **Procurement target:**

DMU and pre-design of components shall be completed in 2016. Procurement of all items shall start beginning of 2016.

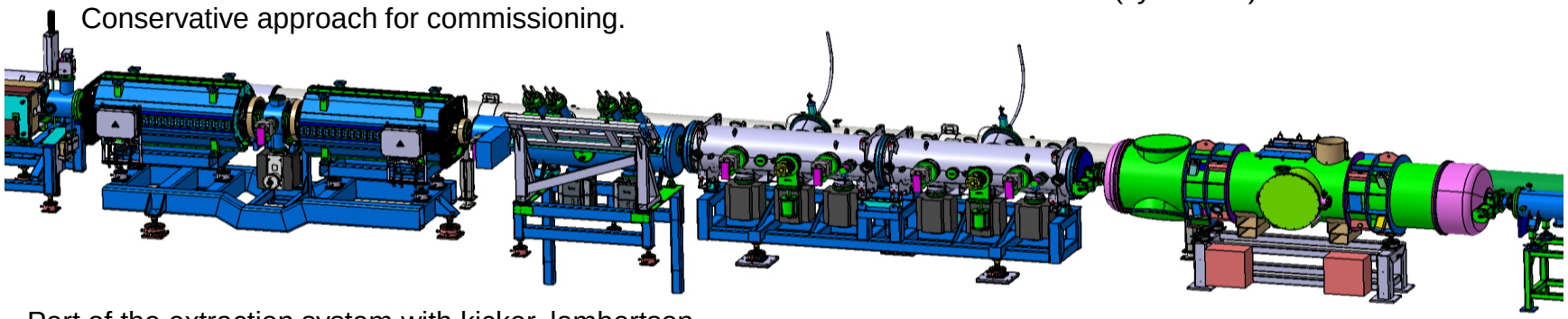
Radiation Hard n.c. Extraction Quadrupoles



3D model of electrostatic septum.
Septum wire may melt under heat load at high intensity heavy ion operation
Conservative approach for commissioning.



Pre-design of radiation hard n.c. extraction quadrupole magnet with polyimid (cyanester) insulation.



Part of the extraction system with kicker, lambertson septum and radiation hard quadrupoles

Dynamic Heat Load

- Due to the fast ramping, up to 85 % of the head load to the cryosystem is created by AC loss
- The requested flexible user operation, generated large differences in the heat load from cycle to cycle.

➢ SIS100 is a unique superconducting synchrotron, designe for operation with hig AC loss and large variations in the heat load.

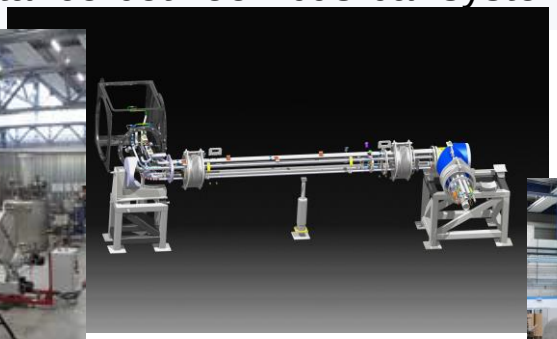
Active measures for the control of the heat load variation:

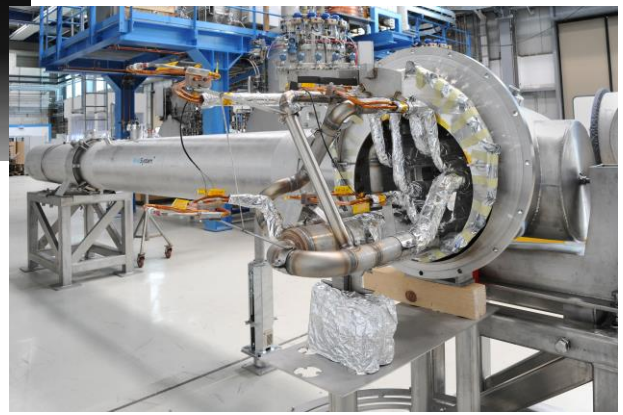
1. Heaters in LHe circuits for artificial generation of heat load in low loss cycles.
2. Variable He pressure in supply header
3. Hydraulicaly adjusted cooling circuits matching to the range of heat loads in different cycles
4. LHe pumps in feed boxes
5. Prediction of heat load model by set-value generation system.

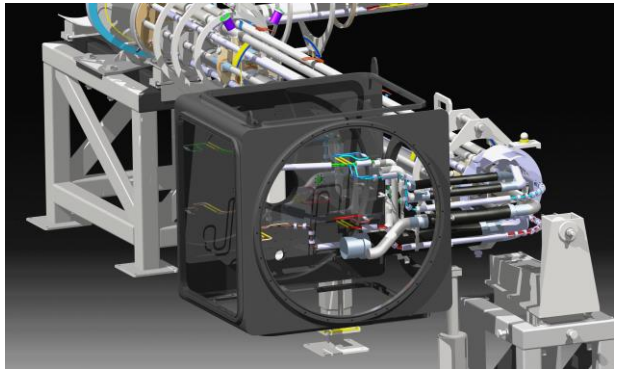
Local Cryogenics System

Status:

• Production and delivery of first segment of bypass line completed. Bypass line has been accepted after „conditioning“ of resistance between bus bar system and ground.



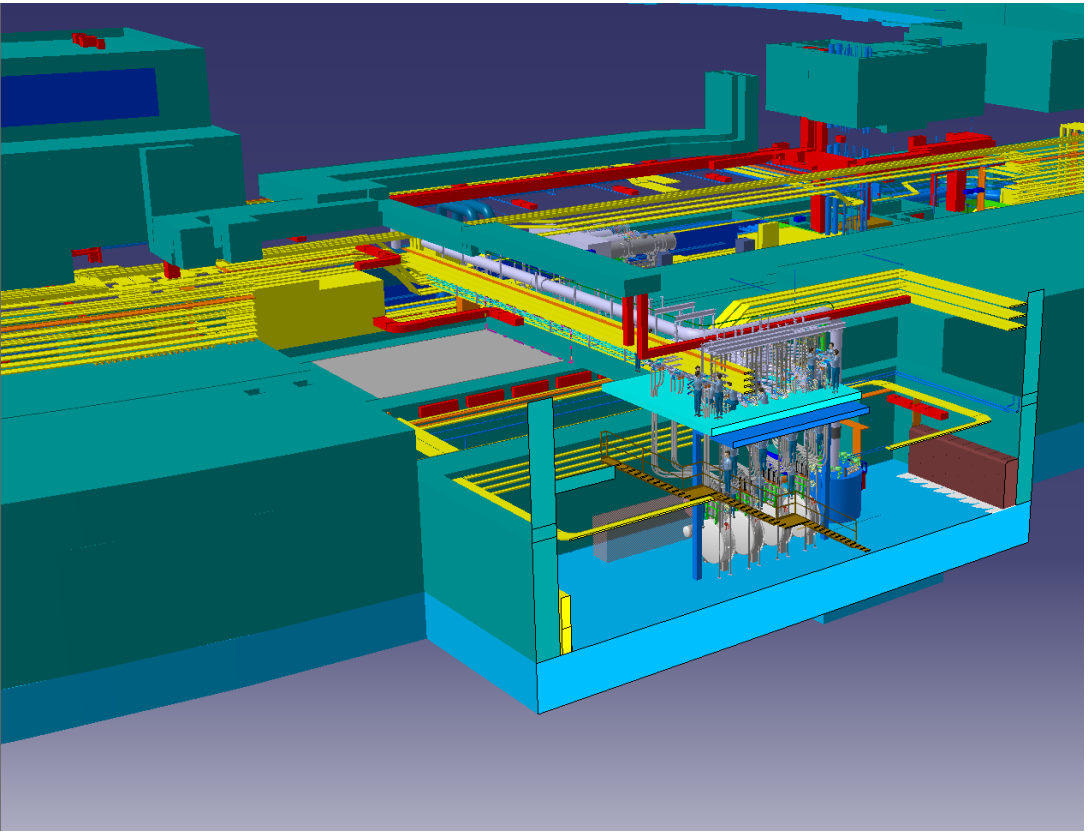


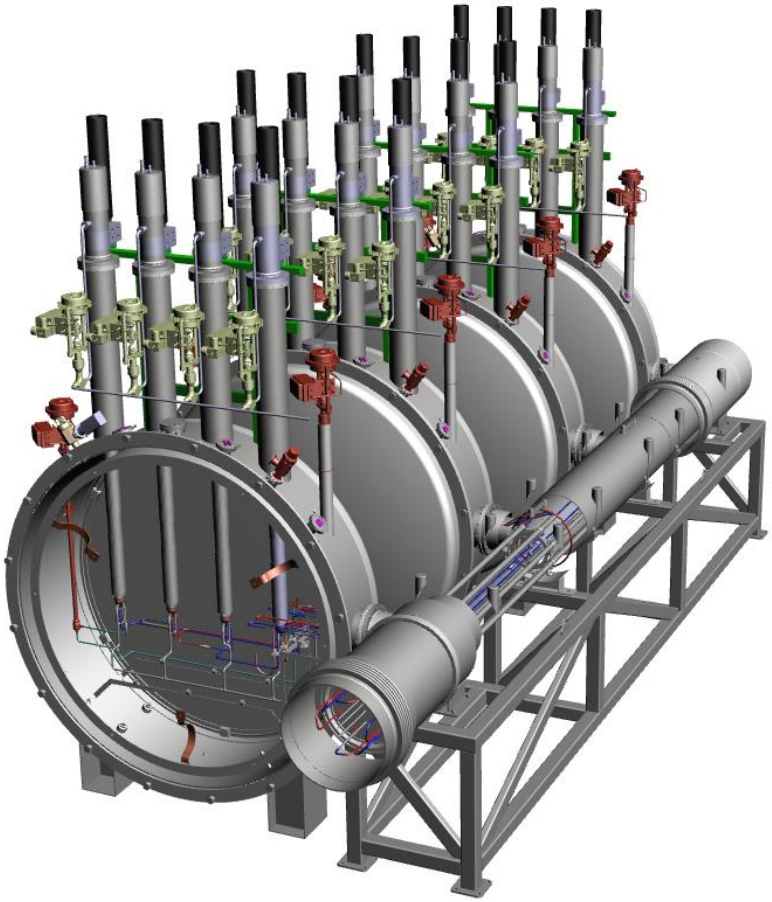


- Bus bar system in bypass line is challenging.
- Problems with bus bar clamps (insulation destroyed during cool down).
- Problems with a feed though in a vacuum barrier.
- Procurement of series has been launched and terminated by WUST.
- Financial issues shall addressedin AFC meeting
- Tendering shall be repeated after approval of new schedule.

Current Lead Box and Feed Box

- Inkind contract for current lead box signed.
- Design of the current lead box was changed but is now almost completed.
- Specification of feed box and feed-in line in approval process.
- Inkind contract prepared and under negotiations.





Summary

SIS18

- The SIS18upgrade program, as originally defined, will be completed beginning of 2018.
- Further upgrade measures to stabilize the dynamic vacuum in a 3 Hz operation mode have been proposed and need to be implemented.
- Additional effort has been taken to improve the operation for the user program in FAIR phase 0. E.g. a high harmonic micro spill smoothing cavity will be tested in 2018.
- Civil construction for „Link existing facility“ is running and progressing well.

SIS100

- A major amount and value of the SIS100 components has been contracted.
- Main technical equipment has been build as FOS devices and tested.
- Delivery and testing of accelerator components is running.

On behalf of the subproject group SIS100/SIS18 and all others supporting these activities.