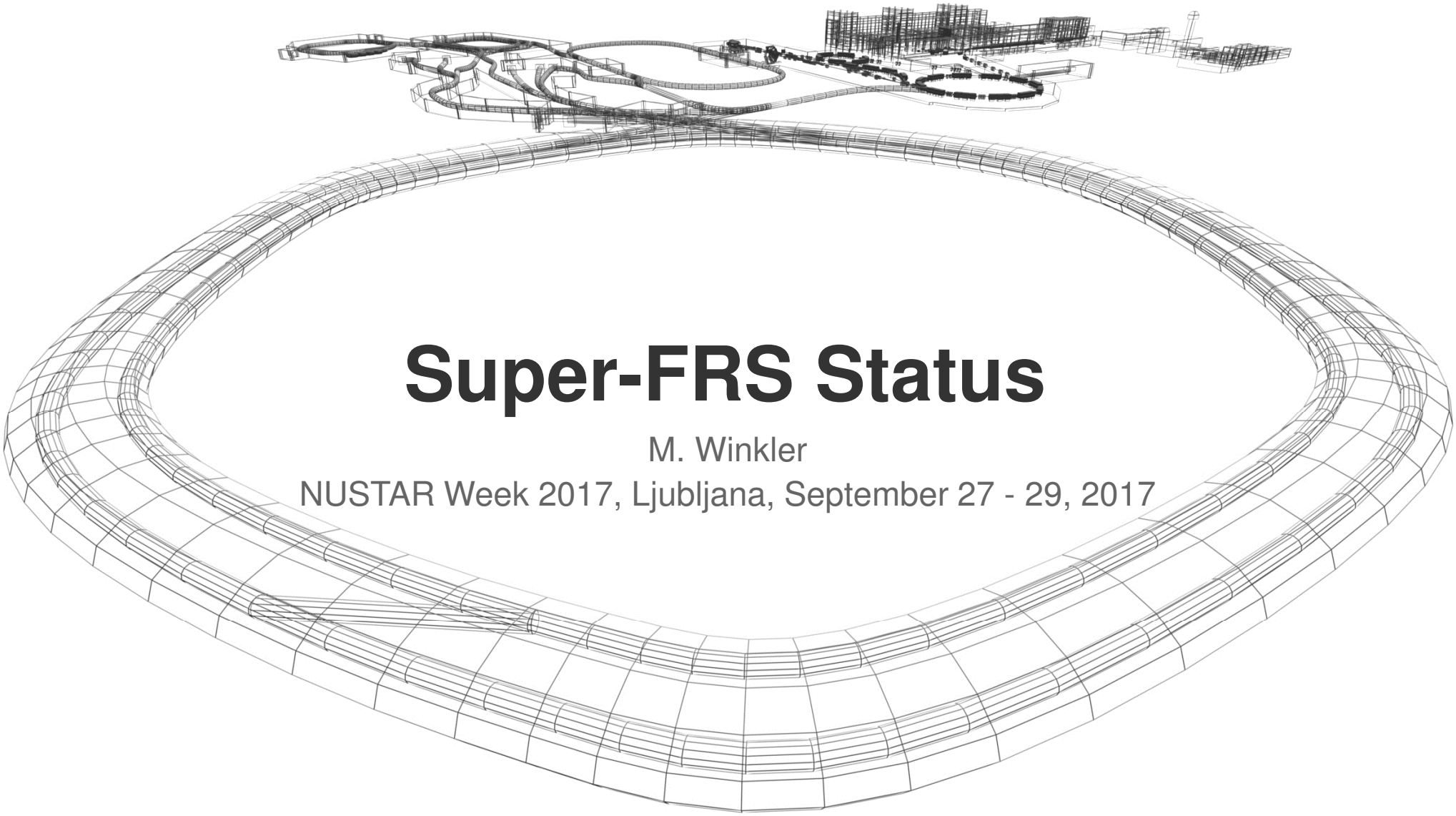


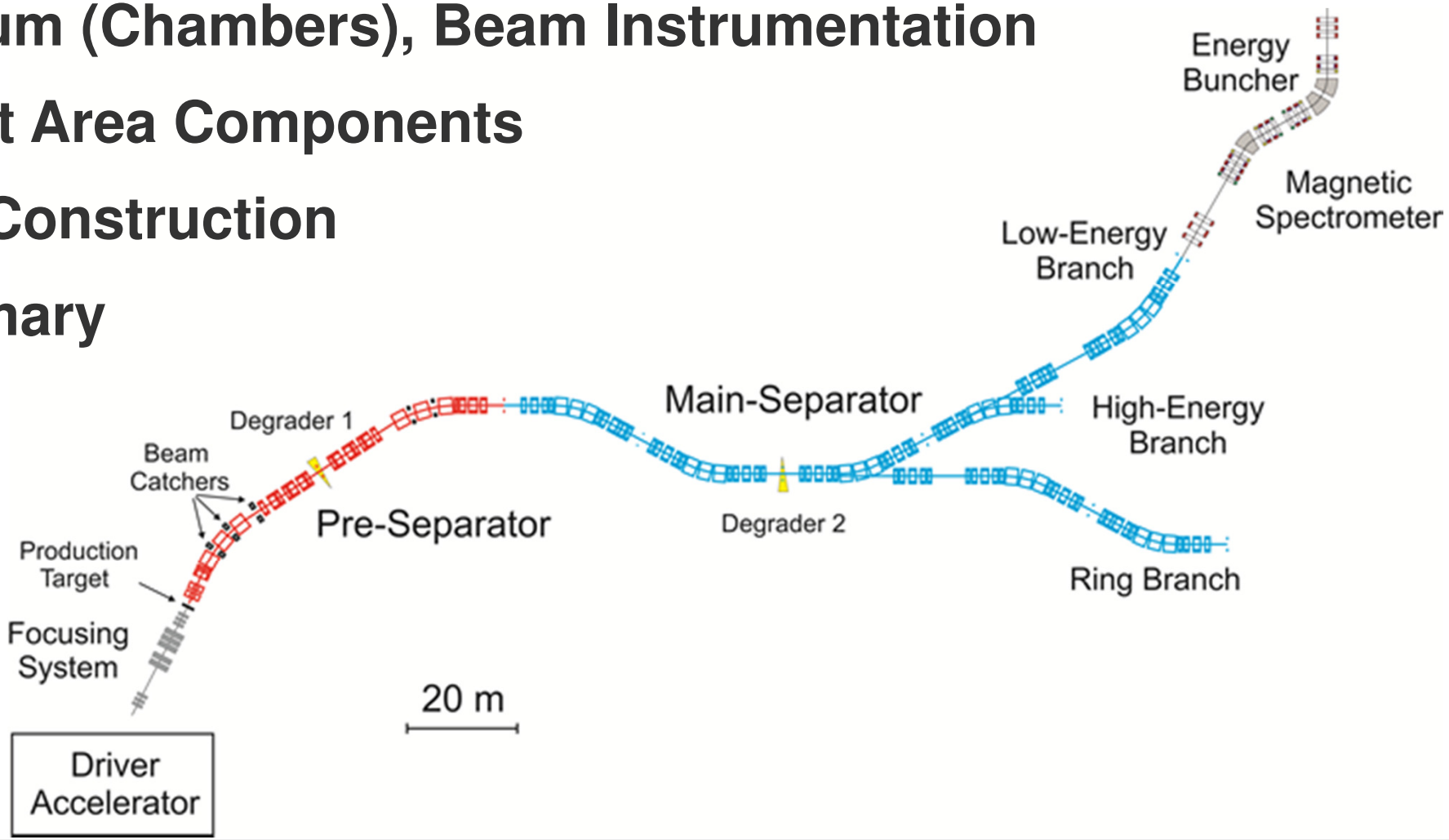
Super-FRS Status

M. Winkler

NUSTAR Week 2017, Ljubljana, September 27 - 29, 2017

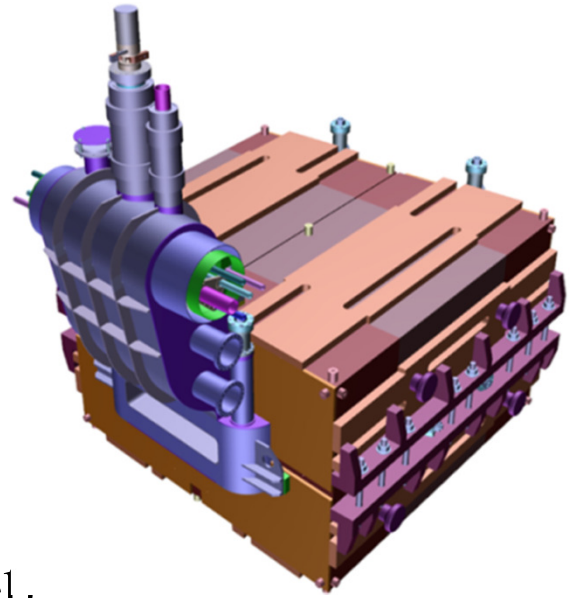
Outline

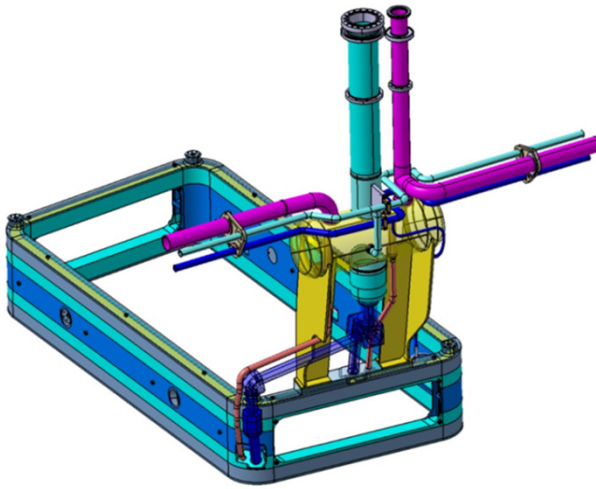
1) Magnets, Testing and Local Cryogenics
2) Vacuum (Chambers), Beam Instrumentation
3) Target Area Components
4) Civil Construction
5) Summary



Magnets I
(Status Standard SC Dipole Magnets)

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





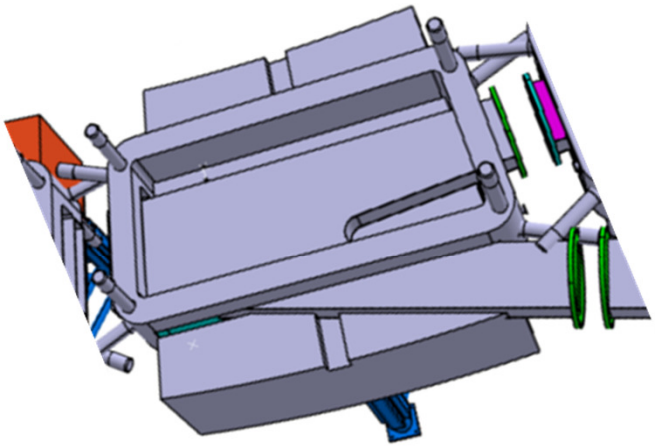
Collaboration with CEA, Saclay:
- ✓ TCC signed , includes:
  - Detailed design
  - Documentation (CDR, DS, 3D Model)
- ✓ Steering board kick-off , June 7, 2017
- ➢ Technical follow-up

Tender Status :
- ✓ Announcement published April 7, 2017
- ✓ Qualifying submission closed May 12, 2017
  - ➢ 6 out of 7 companies invited to tender
- ✓ Offers received by mid of July, 2017
- ✓ Offers analyzed (with CEA colleagues);
- Offer negotiation fixed for October 2017
- Contract award expected still in 2017

Magnets II
(R&D Branching Dipole Magnets)

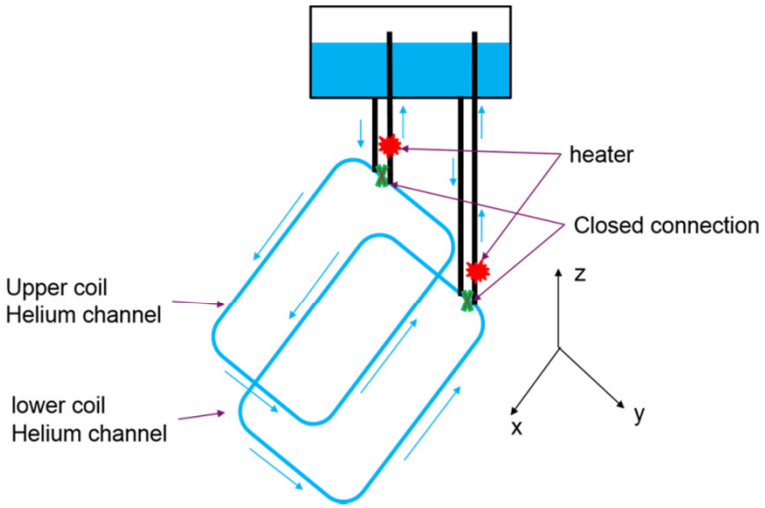
Differences to standard design

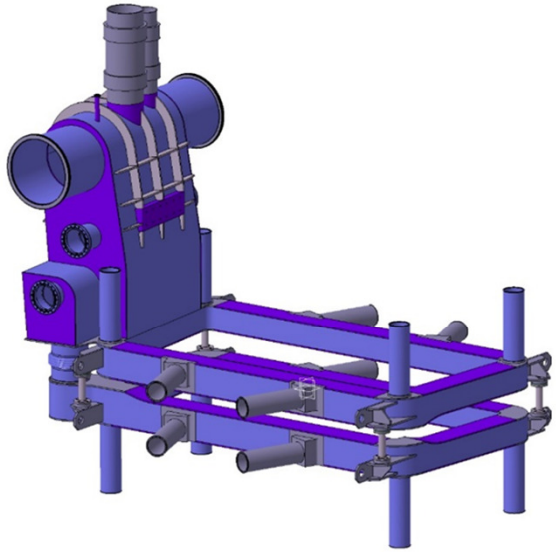
- Y-shaped vacuum chamber
  - ➢ complex magnet assembly
- Truncated magnetic circuit
  - ➢ magnetic
  - ➢ mechanic
- Split cryostat
  - ➢ mechanical: structure + magnetic forces
  - ➢ cryogenics



Proposition :

Adapt the active thermosiphon loop concept to the Y-shaped vacuum chamber environment





Schedule (R&D work):

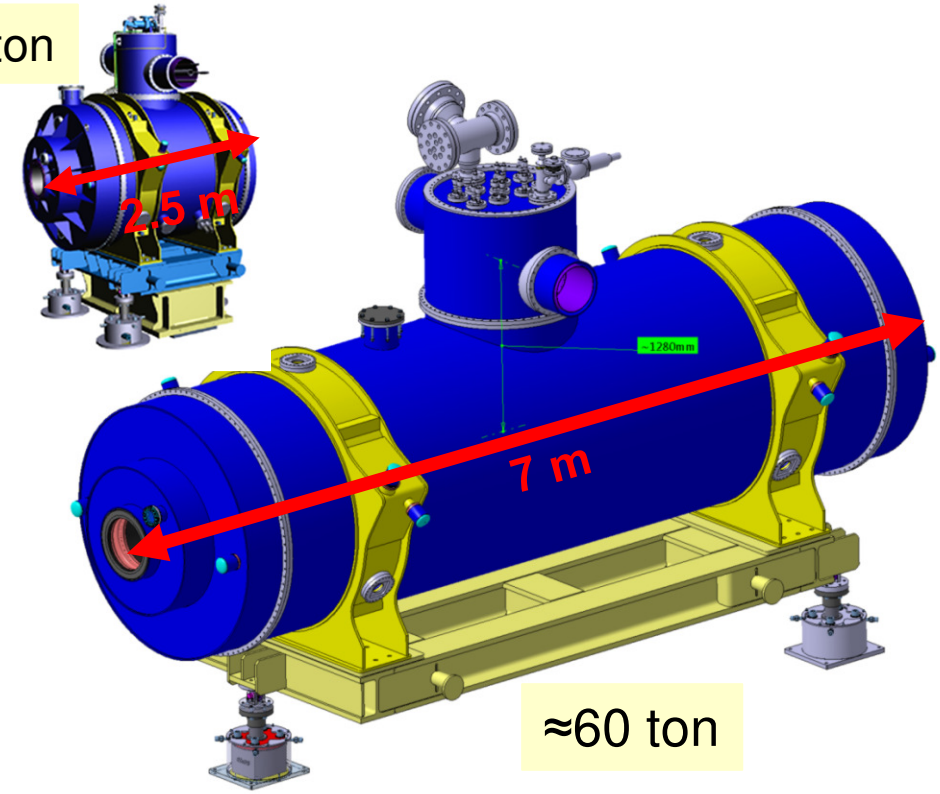
- ✓ Collaboration agreement with CEA/Saclay
- ✓ Kick-off meeting 06/2017
- CDR 11/2017
- FDR 05/2018
- Final Report, DS 06/2018

Magnets III
(SC Multiplets, Overview)

H. Müller,
E.J. Cho et al.

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

≈25 ton



Main characteristics:

- iron dominated, cold iron (up to 37 tons)
- common helium bath
- warm beam pipe (38 cm inner diameter)
- per magnet 1 pair of current leads
- max. current <300A for all magnets

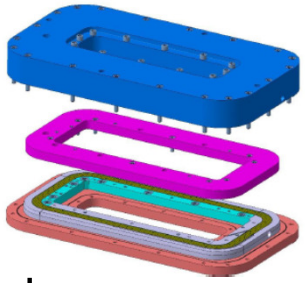
Schedule FoS SC multiplets

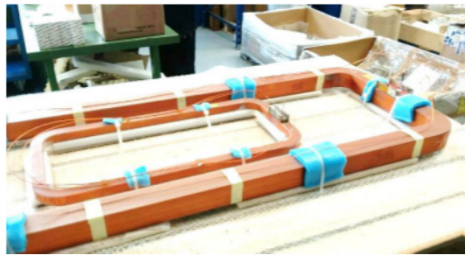
- ✓ Contract closed 07/2015
  - ➢ (ASG, Genova)
- ✓ Design phase for SM done, for LM running
  - ✓ PDR 07/2016
  - ✓ FDR 12/2016
  - ✓ PRR 07/2017 (short multiplet)
  - ➢ PRR LM Q4/2017
  - ➢ FAT of FOS short multiplet Q1/2018

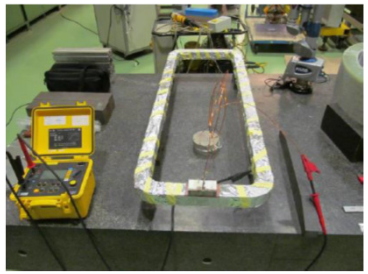
Magnets IV
(FoS SM Production)

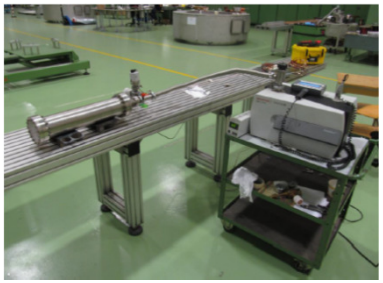
scope:
FAT Q1/2018

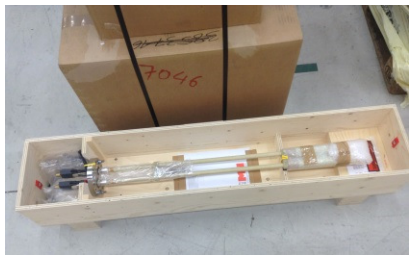
- Coil mock up produced (quadrupol, sextupol)
  - ➢ vacuum impregnation method
  - ➢ mechanical strength
  - ➢ electrical integrity tests
  - – 3kV test failed at GSI → updated coil produced
- Current lead prototype produced (20 bar, M&W)
  - ➢ test cryostat prepared at GSI
  - ➢ acceptance test running at GSI
- Steel procurement running
  - – some delay with provider
  - ✓ press refurbished, specimen produced
- ✓ beam tube specimen produced (already 3)
  - ➢ problem with cleaning process
- ✓ Execution drawings ready (SM)
  - ➢ procurement on sub-systems running
- ✓ Production sequence defined (SM)
  - ➢ design of assembly machines running
- ✓ Manufacturing and test procedures defined
  - ➢ QCP (Quality Control Plan)

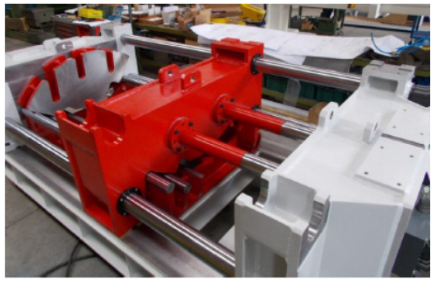


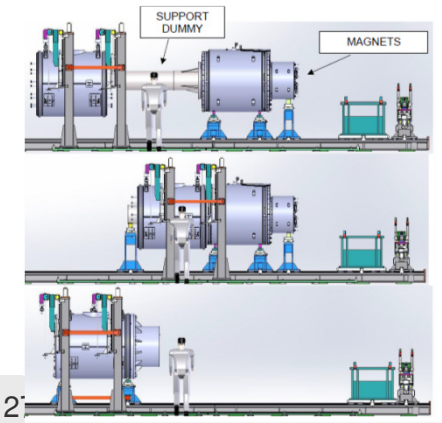








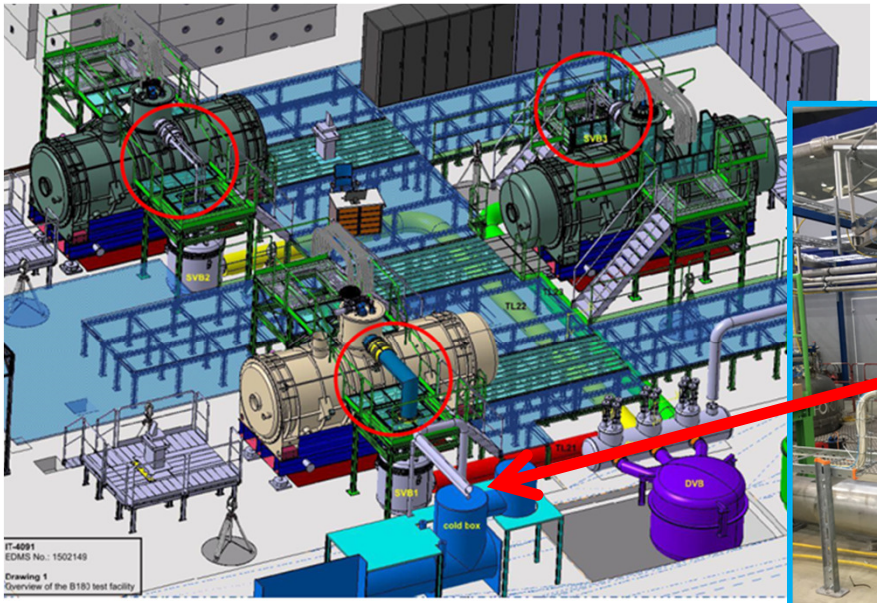




Magnets V
(Status Magnet Test Facility CERN)

K. Sugita,
G. Golluccio,

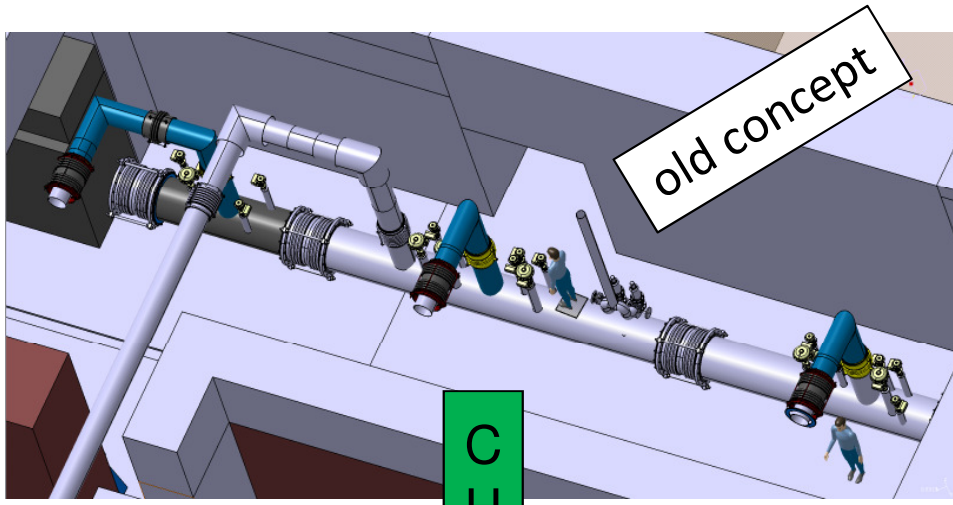
- ✓ Collaboration between CERN and GSI
  - CERN Building 180: Infrastructures, renovation done.
- ✓ Cold (4K) testing of the SC dipoles and multiplets
  - ➢3 test benches installed, 59 magnet cryo-modules
- ✓ Commissioning of the cryo-facility running
- ➢ Procurement of last missing components in progress (Jumper-line/elec. cabinets)
- ➢ FoS SM testing foreseen to start in Q2 2018



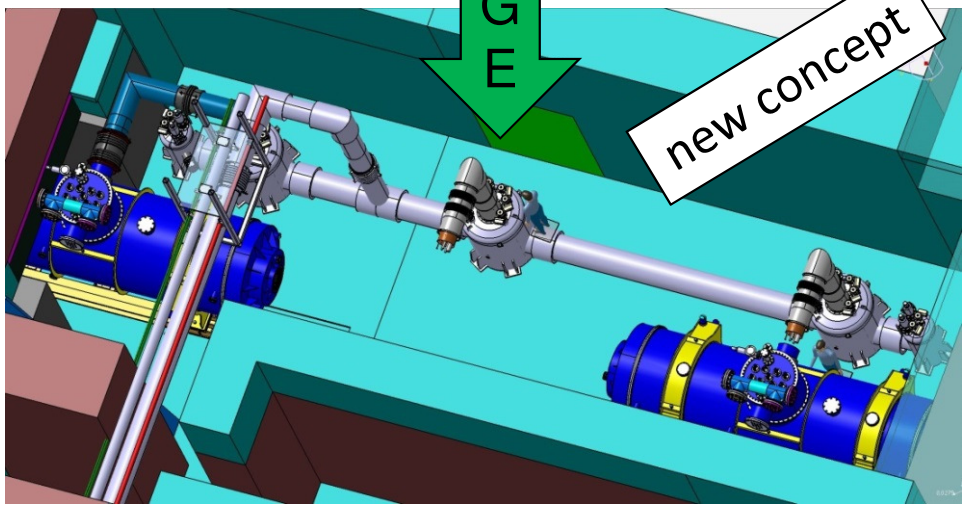
Local Cryogenics

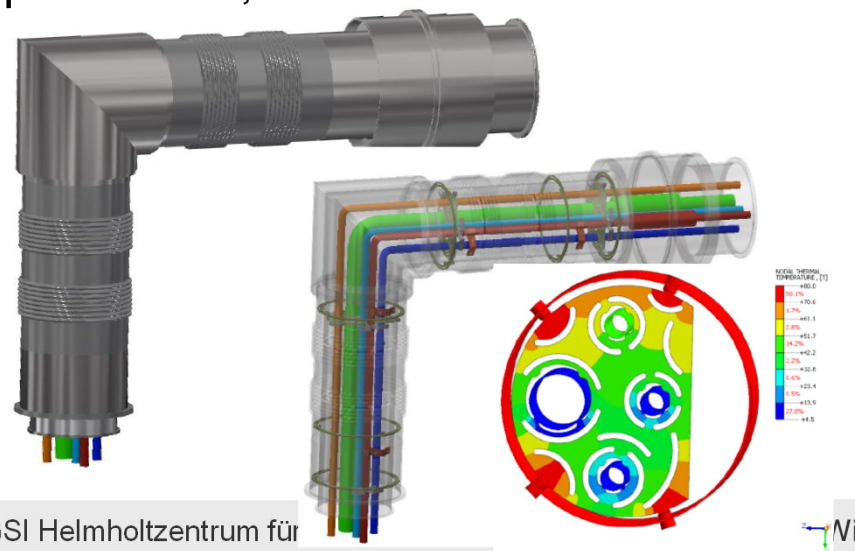
F. Wamers,
Y. Xiang et al.

- Updated FB concept (suggested by WUST)
  - One Feedbox per Magnet-Cryomodule
  - Separate Endboxes at Branch Ends
  - Interconnections via Transferline Pieces
- Updated procurement strategy
  - All component specs until Q2/2018
  - One entire InKind contract until Q4/2018
- Procurement of cryo-jumper for CERN Testing
  - Time critical !
  - Contract awarded (Cryosistems, PI), CDR presented, still in discussion with CERN



CHANGE

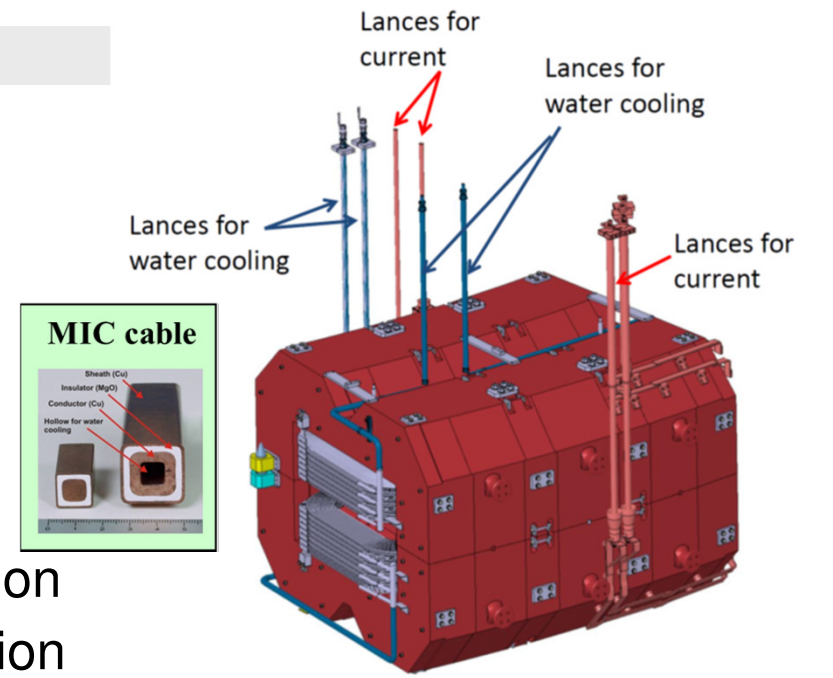


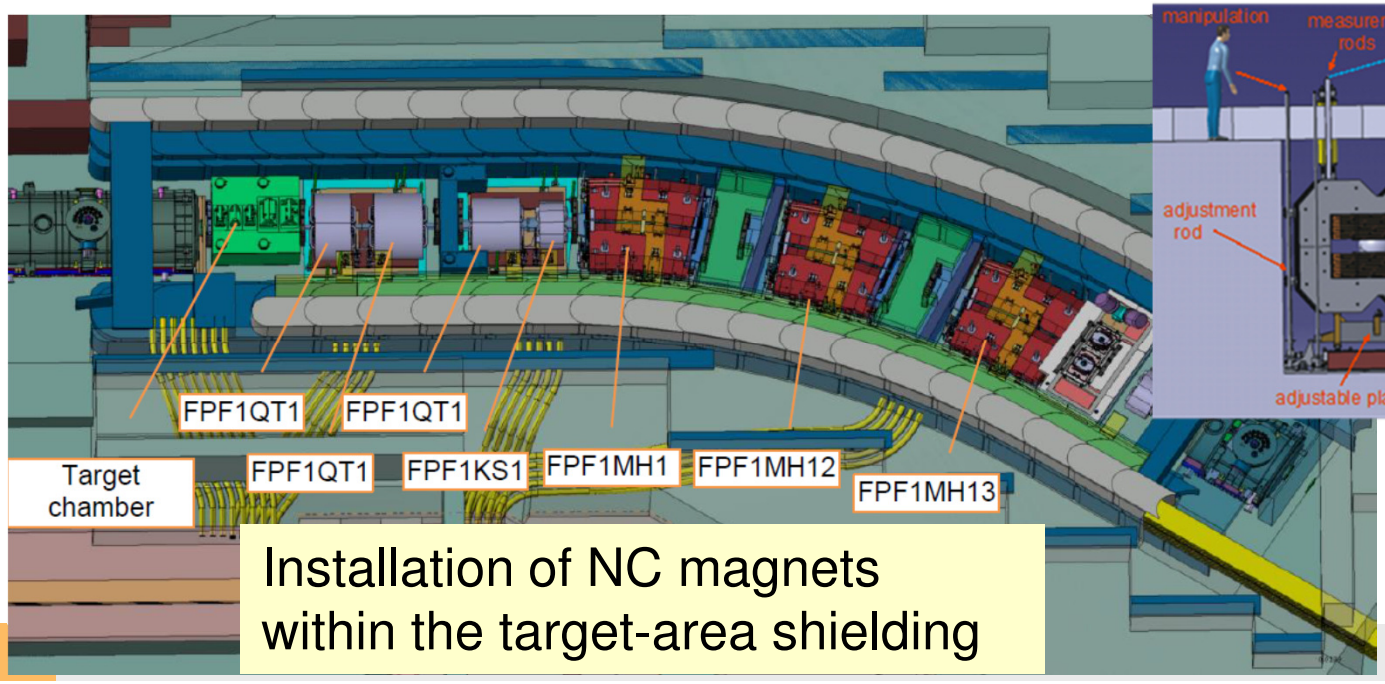


Magnets VI
(Radiation Resistant Magnets)

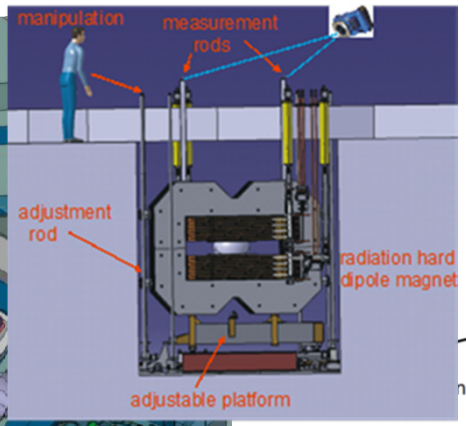
H. Leibrock,
T. Blatz, et al.

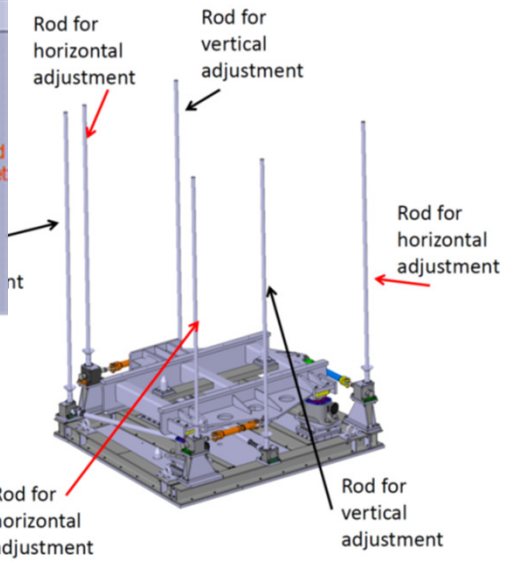
- 3 dipole, 3 quadrupole, and 2 sextupole
- Normal conducting magnets using MIC cable
- Remote connectors and alignment
- ✓ Prototype dipole built and tested by BINP
  - ➢ delivered and set-up to GSI
- ✓ Dedicated support structure constructed
- ✓ Dipole: specification released, tender in preparation
- Quadrupole & sextupole: specification in preparation





Installation of NC magnets within the target-area shielding

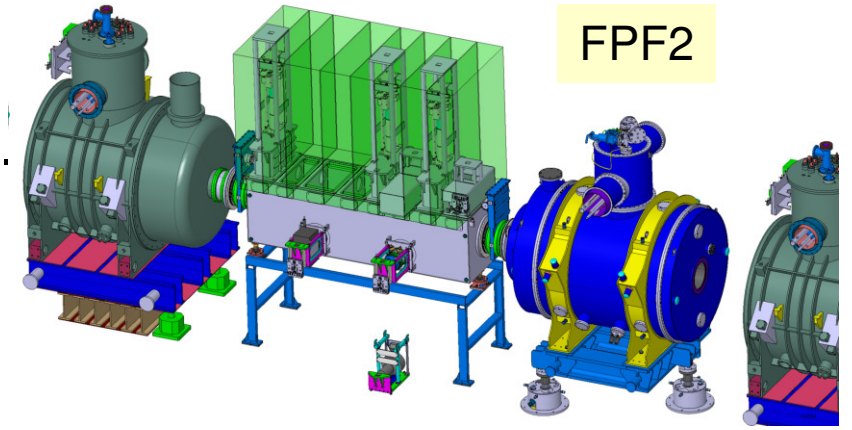


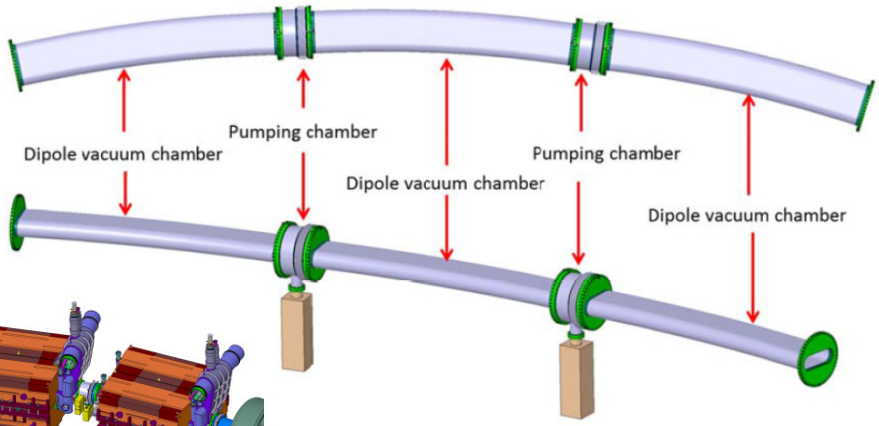


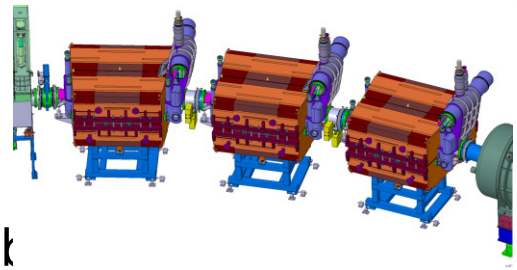
Vacuum System
(Vacuum Chambers)

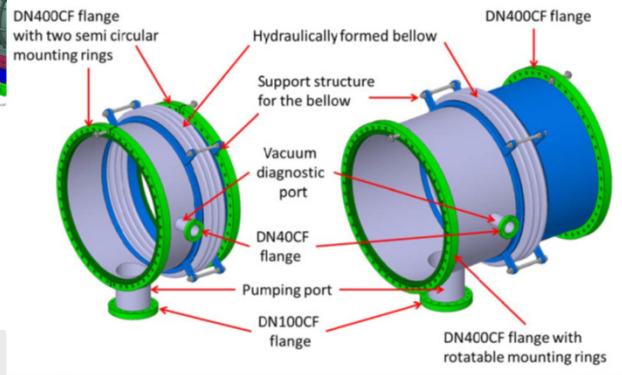
S. Purushotaman,
I. Mukha,
J. Kurdal et al.

- ✓ Vacuum system closed
  - ➢ Numbers of bellows, valves, pump stations, etc. defined, exact dimensions to be determined
- Overall 21 focal plane chambers (Ru in-kind)
  - ➢ length between ≈800 mm to ≈ 4.400 mm
  - ➢ cross section ≈1x1 m^2
  - ✓ specification released
- Overall 24 dipole vacuum chambers (Ru in-kind)
  - ➢ 21 chambers for standard dipoles, including pumping ports between dipole units
  - ✓ specifications released
  - ➢ 3 chambers for branching dipoles
    - ✓ design specification released
    - ➢ chamber/cryostat integration tbd
- ➢ In-kind contract with Ru under preparation
- Multiplet vacuum chambers are system integrated





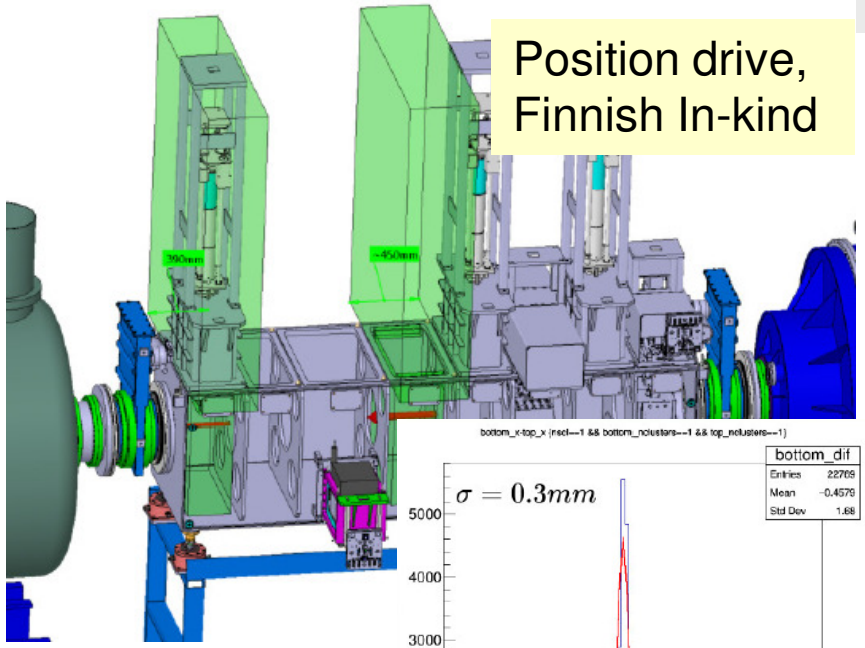


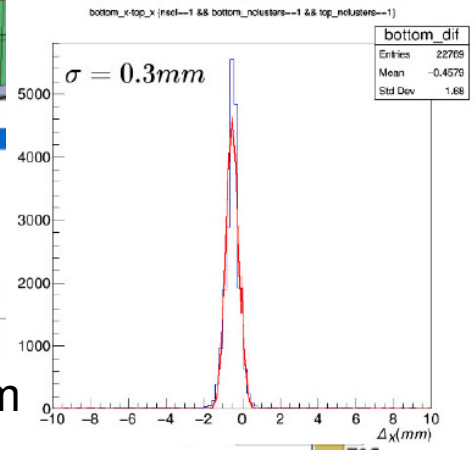


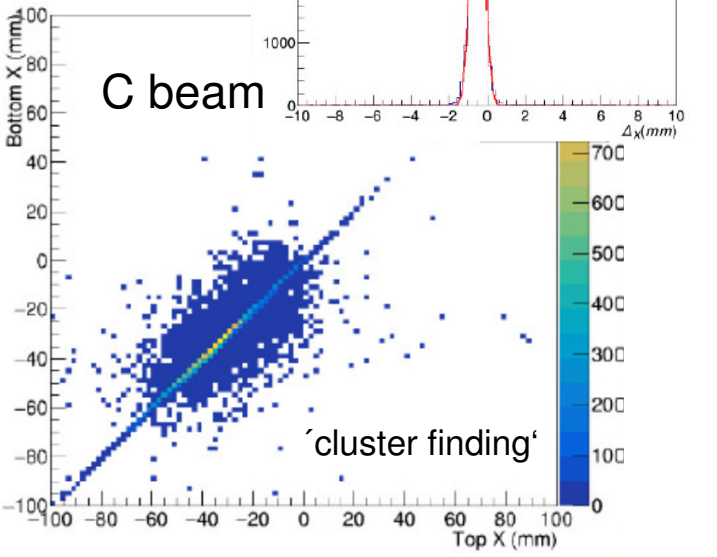
Beam Instrumentation I
(Position Detectors)

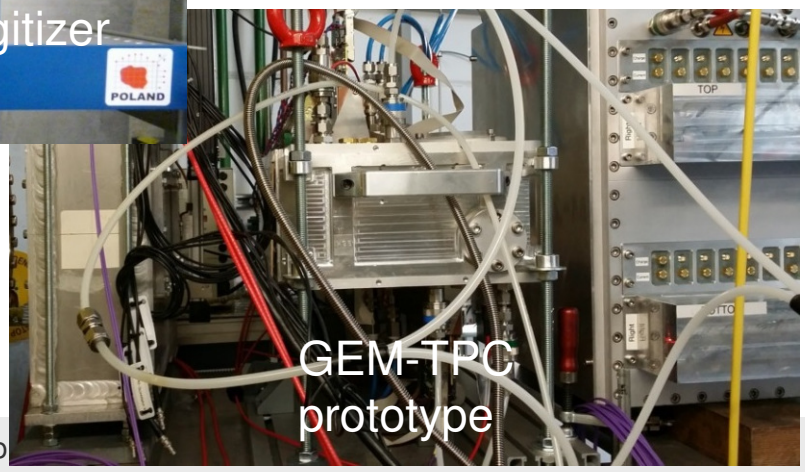
C. Nociforo,
A. Prochazka,
C. Caesar et al.

- SEM Grid (profile monitor), Finnish In-kind
  - ✓ Specifications released (Q1/2016)
  - ➢ IKC running
  - prototype SEM in-house (Ti & C wire)
  - beam test at JYFL Q4/2017
- GEM-TPC (tracking), Finnish in-kind
  - ➢ combined with SEM on a common drive
  - ✓ several prototype tested at JYFL and GSI
  - including new readout electronics
  - ✓ Specification released
  - ➢ IKC in preparation
  - ➢ Beam test at JYFL Q4/2017 ?



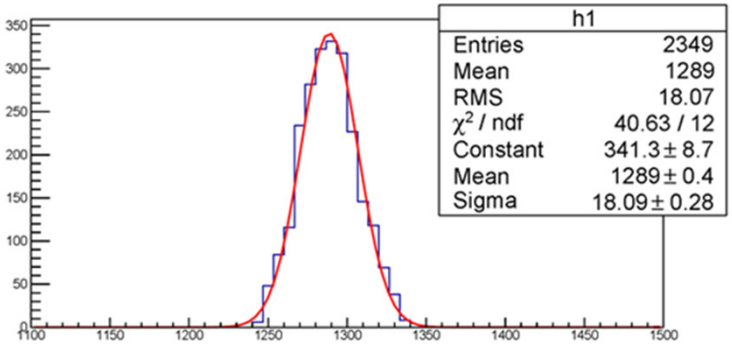




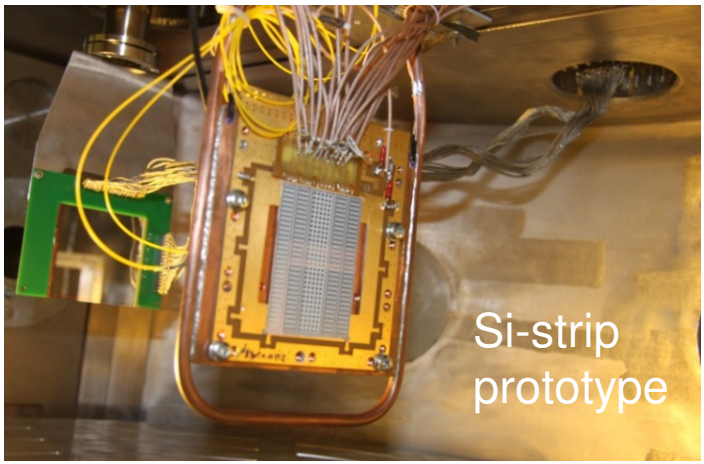


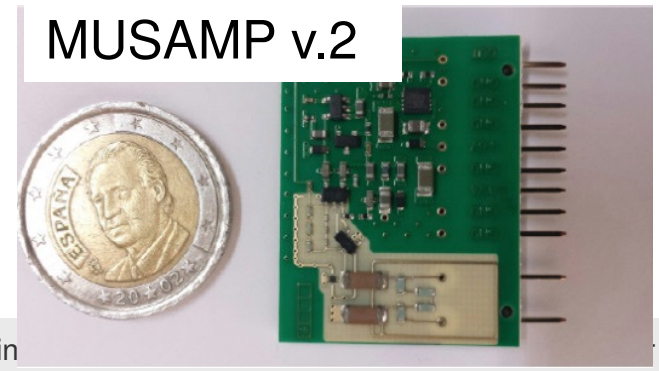
Beam Instrumentation II
(ToF and ΔE)

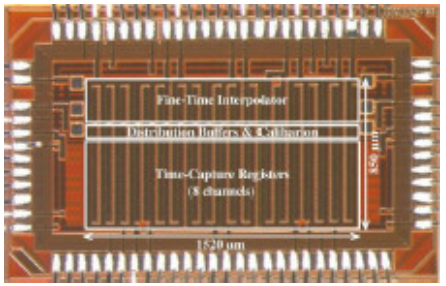
C. Nociforo,
O. Kiselev,
B. Voss et al.



- Time-of-Flight (Russian in-kind, IOFFE StP)
  - ✓ Specification released
  - ➢ **IKC close to be signed**
  - ➢ R&D on diamond and silicon ongoing
    (use of CERN/EP-ESE picoTDC under investigation)
- MUSIC (energy-loss, Finnish in-kind)
  - ✓ Specification released
  - ➢ **IKC close to be signed**
  - ○ PreAmps by CEA Bruyeres
    - ➢ successfully tested at beam time in 2016
    - ➢ contract ready for signature
- Plastics (Swedish in-kind)
  - ✓ Specification released
  - ➢ IKC running

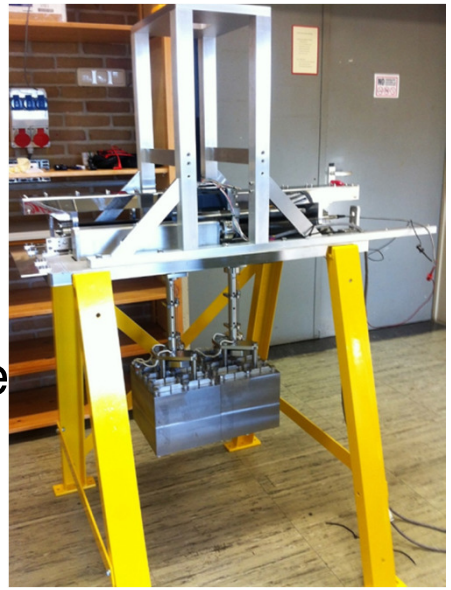






Beam Instrumentation III
(Slit Systems)

- Collaboration contract running with KVI-CART
- FoS X-slit manufactured
- FoS X-slit tested, FAT accepted
  - ✓ integral leakage rate (6x10^{-10} mbar) (vacuum chamber available)
  - ✓ minimum gap: 50 µm (uniformly over surface
  - ✓ movement precision: 0.1 mm
  - ✓ > 6.000 open-close cycles
  - ✓ heat absorption test >500 W
  - ✓ FAT documentation done (including CAD modell)



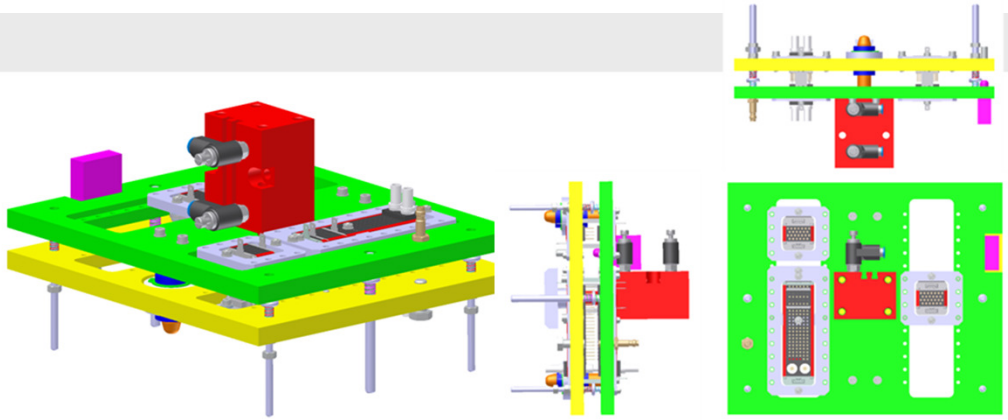
- X-series manufacturing & purchase ongoing
  - ✓ all parts ordered (including densimet)
  - ✓ all electronics components in-house
  - ✓ motors in-house and tested

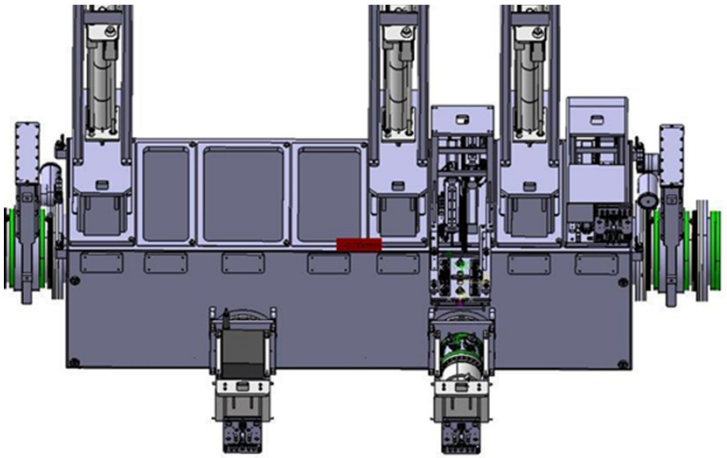
- FoS Y-slit manufactured
- FAT on pre-series Y-slit running
  - ✓ operating pressure test done
  - ✓ integral leakage rate test done
  - some problems with bellow during endurance test (bellow did not stay straight under vacuum)
  - ➢ problems solved by using different type of bellows

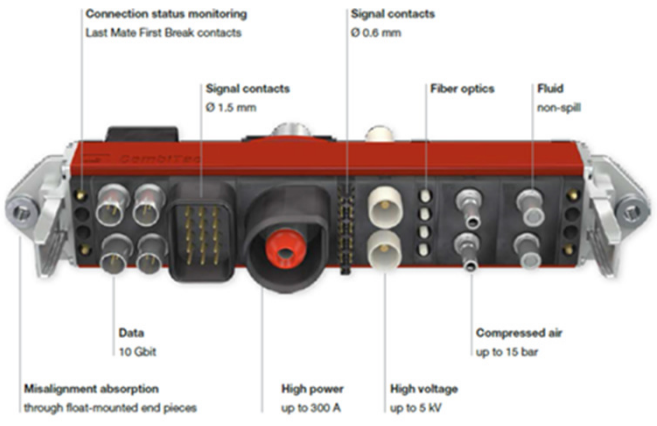
Beam Instrumentation IV
(Media Board development)

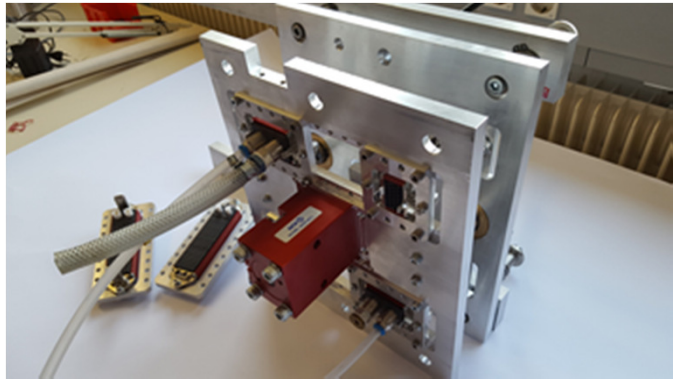
C. Schlör,
C. Karagiannis,
T. Blatz

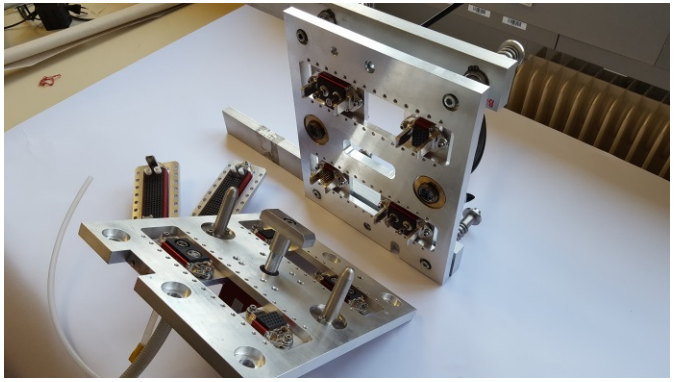
- ✓ Media board prototype designed and manufactured at GSI
- One board part of beam instrumentation equipment (prototype developed for slits)
- One board stiff connected to chamber
- Large connector variety (high power, high voltage, data (10 Bbit), signals, fiber optics, fluids, compressed air, ...)
- Connector allow for connection status monitoring (misalignment absorption)
- ➢ will be used in Pre-Separator
- ✓ very cost effective







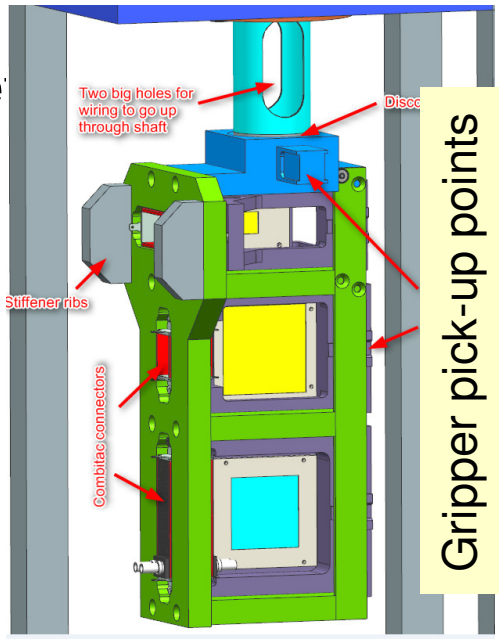


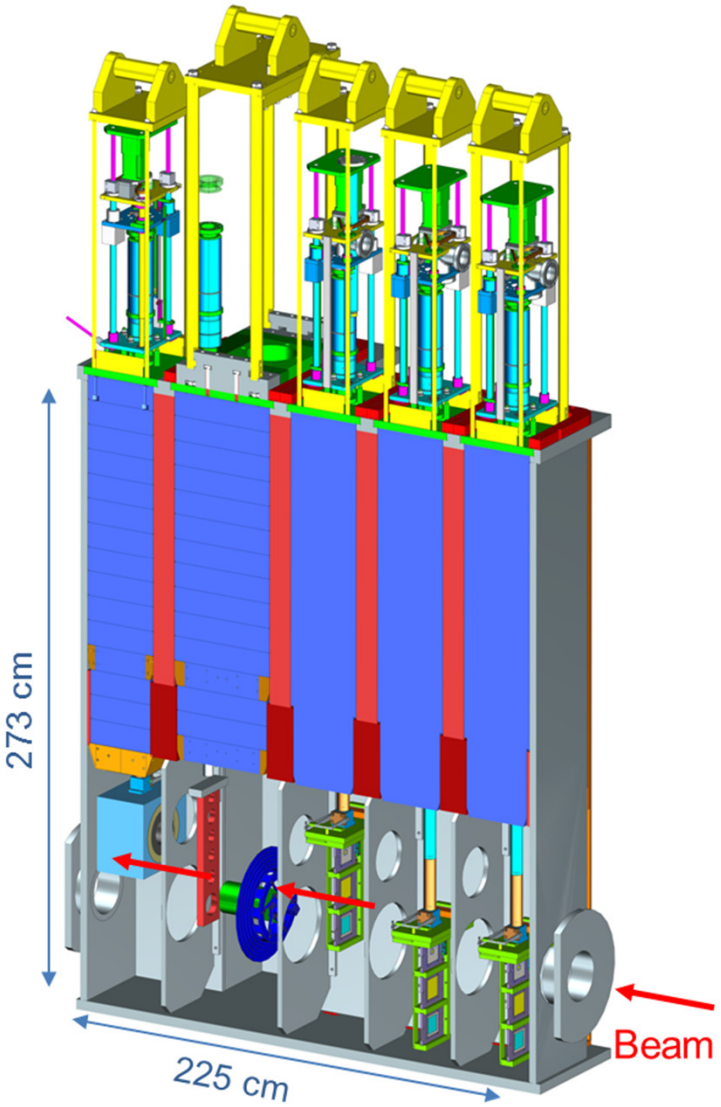


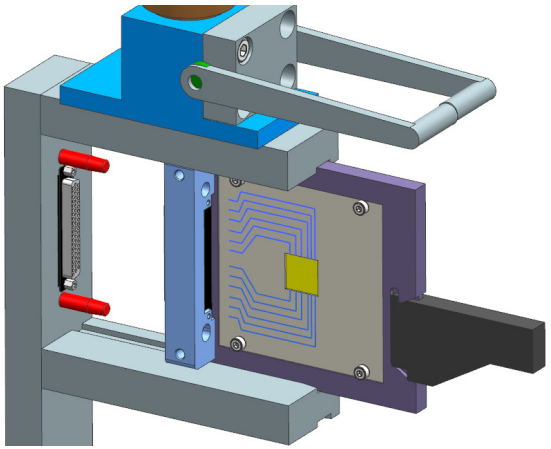
Target Area I
(Target Chamber & Plug Systems)

H. Weick,
C. Karagiannis et al.

- ✓ Collab. Contract with KVI-CART
- ✓ Specification released
- • Design phase running, includes:
  - ➢ chamber and plug design
    - ○ 5 plugs (2nd target ladder)
    - ○ remote handling
  - ➢ beam spot diagnostic on targe
  - ➢ plug adjustment/guidance (interface to transport flask)







Detector ladder with slots for single detectors

Target Area II
(Plug Guidance)

Michel Lindemulder,
Henk Smit, KVI-CART

university of groningen

automatic hooking,
by rotating square pin

top plate
= support

chamfered step

required: ± 20mm shift,
± 2 mrad tilt
tested up to 70 mm
or 7 mrad

corner rods

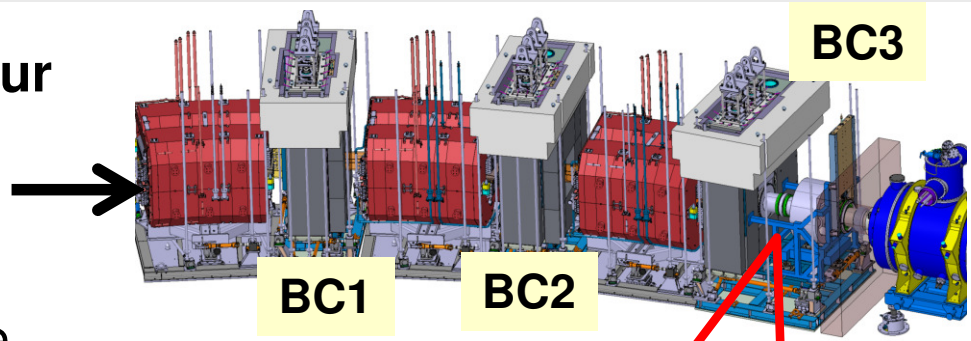
chamfered collar
(removable)

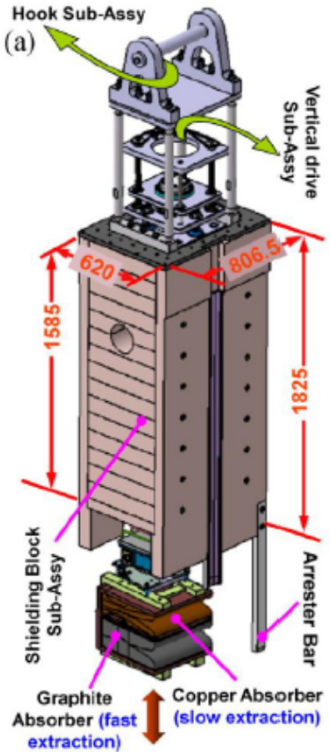
Target Area III
(Beam Catcher Plugs)

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

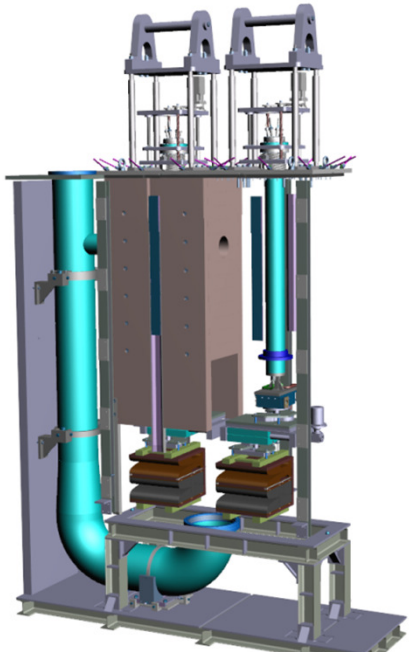
- Indian in-kind, Collaborator: **CMERI Durgapur**
- Design running, based on definition report
  - ➢ two absorber (fast/slow extraction)
  - ➢ RH capability
  - ➢ absorber geometry optimized → avoid Be

✓ updated CDR submitted

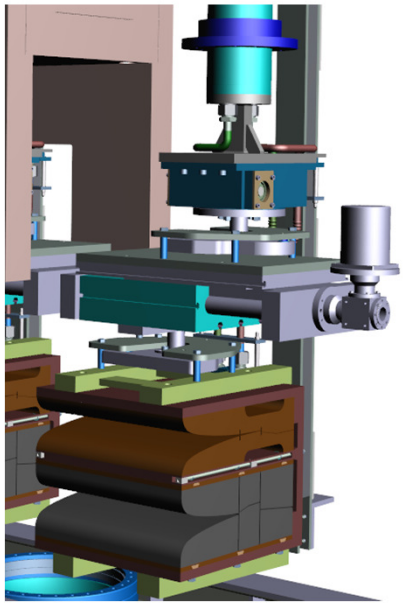




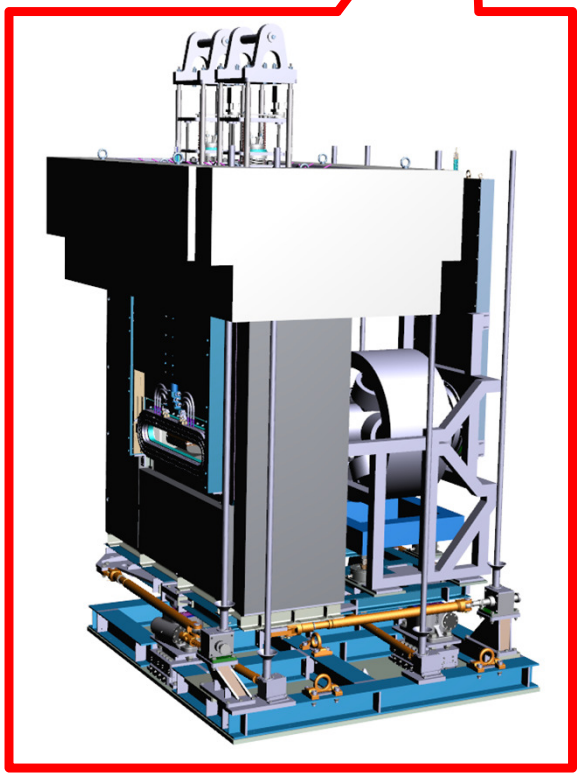
plug assembly (BC1)



cut through BC chamber including pumping duct



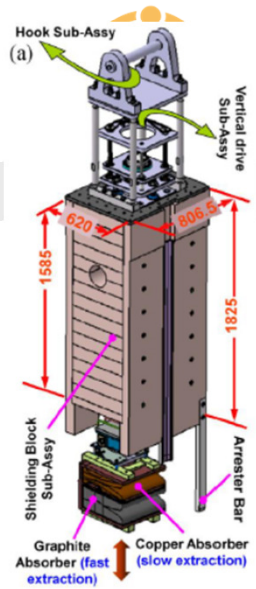
BC3 movable / linear drive



CAD model of BC3 and sextupole on common adjustment platform

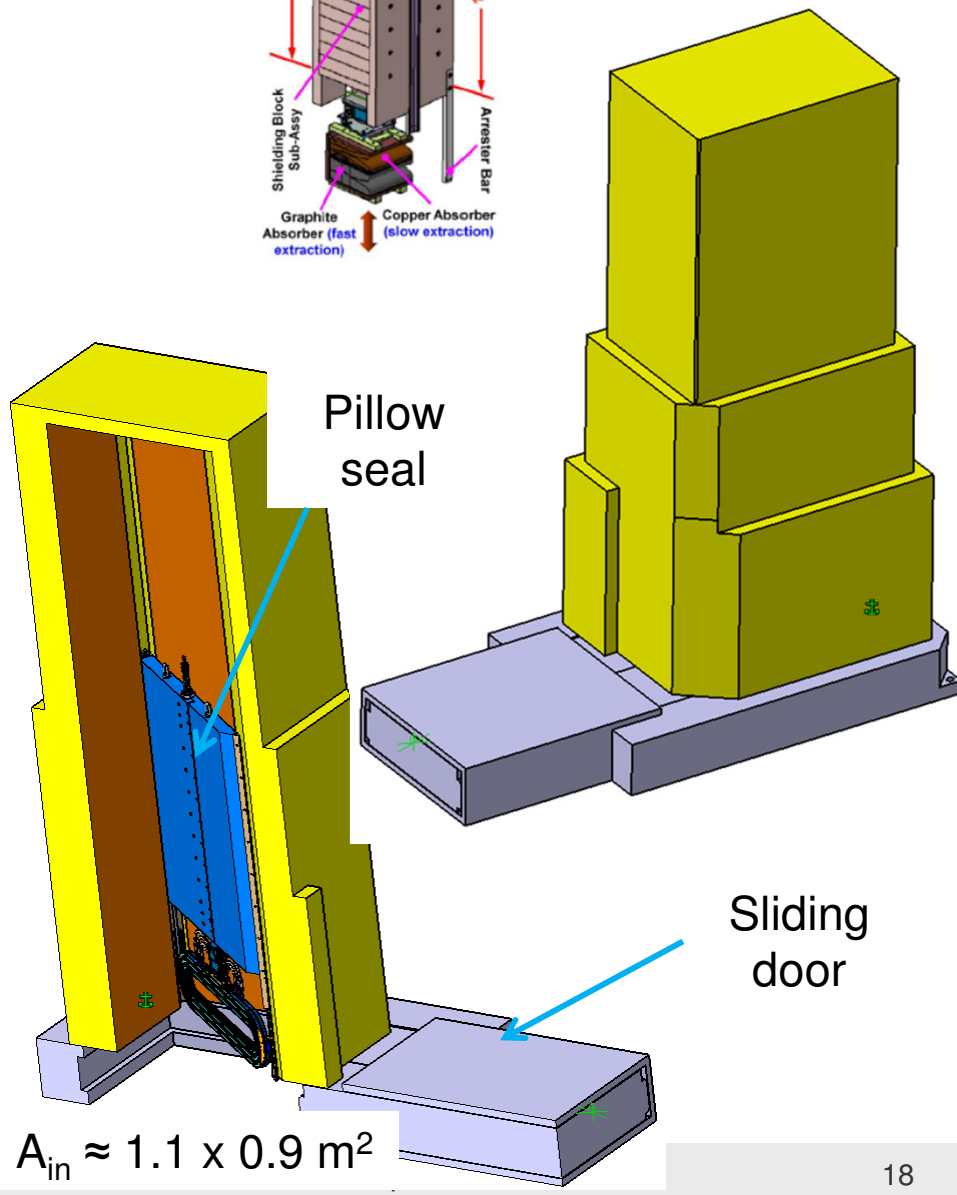
Target Area IV (Shielding Flask)

H. Weick,
F. Amjad et al.



- ✓ Finland in-kind contribution
  - ➢ contract discussions initiated
  - ➢ KVI identified as potential provider
- Design adopted to house all RH components (including rectangular pillow seal)
- Finalizing specification
- R&D activities of flask subsystems running:
  - ✓ 9 tons internal crane with automatic gripper
  - ✓ Support platform and interface plate
  - ✓ Additional shielding / airgap cover
  - ✓ Double door sliding mechanism
- Synergies with pbar flask under discussion
  - Joint control system units
  - Hot Cell interface units
  - Internal crane lifting mechanisms
  - Sensory arrangements

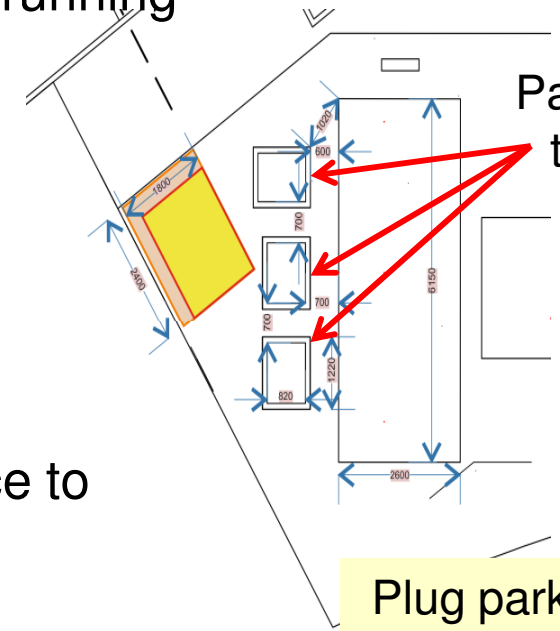
H ≈ 4.1 m

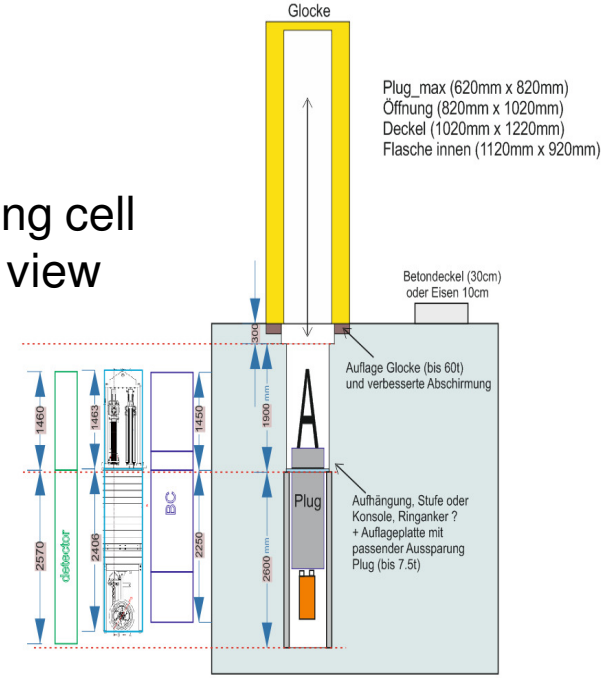


Target Area V (Hot Cell)

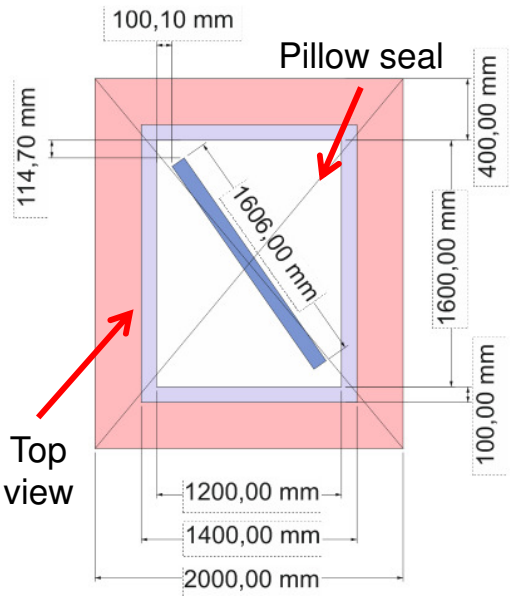
H. Weick,
C. Karagiannis et al.

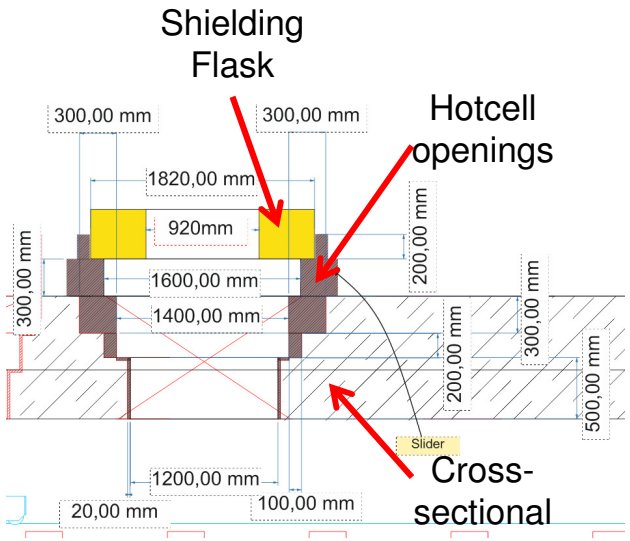
- Detail planning with NT company running
  - ➢ define CC shell interfaces
  - ➢ update of shielding protection documentation
  - ➢ specification of HC equipment
- Parking cell positioning update
- HC fixed support for plugs for RH
- HC top opening modified (interface to shielding flask)



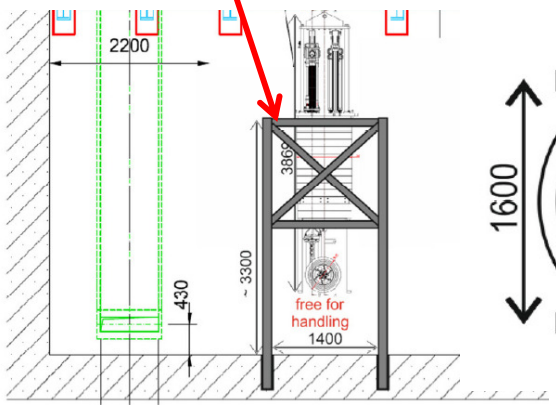


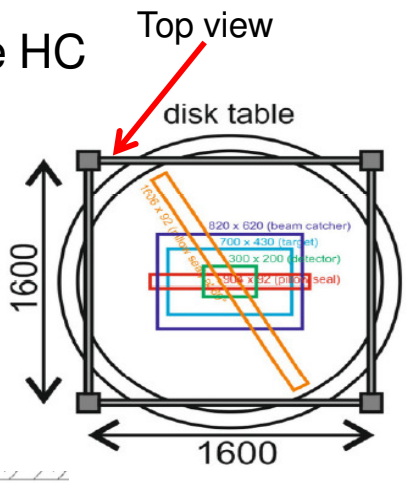
Plug parking cell design





Plug fixed support inside HC



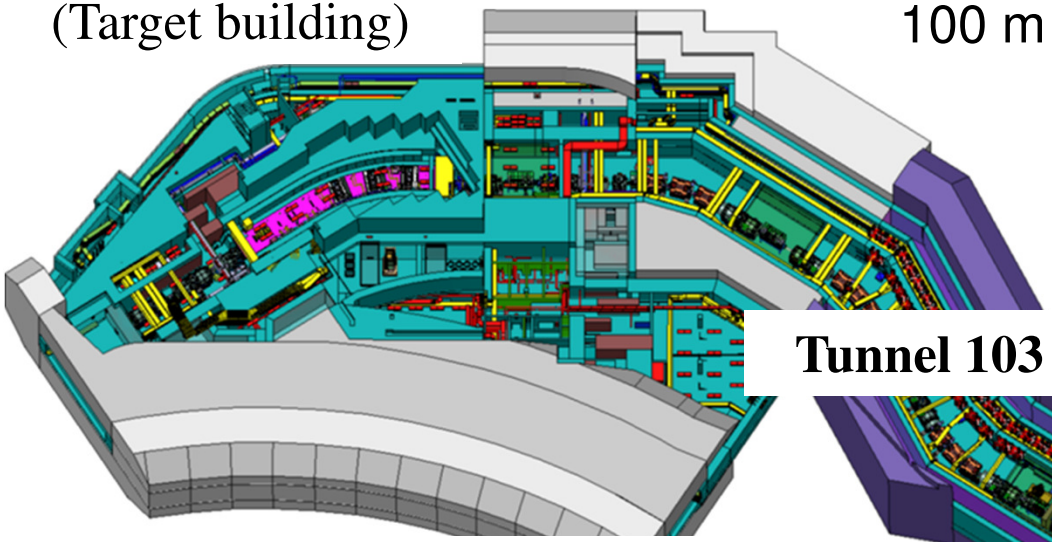


Civil Construction I
(Overview)

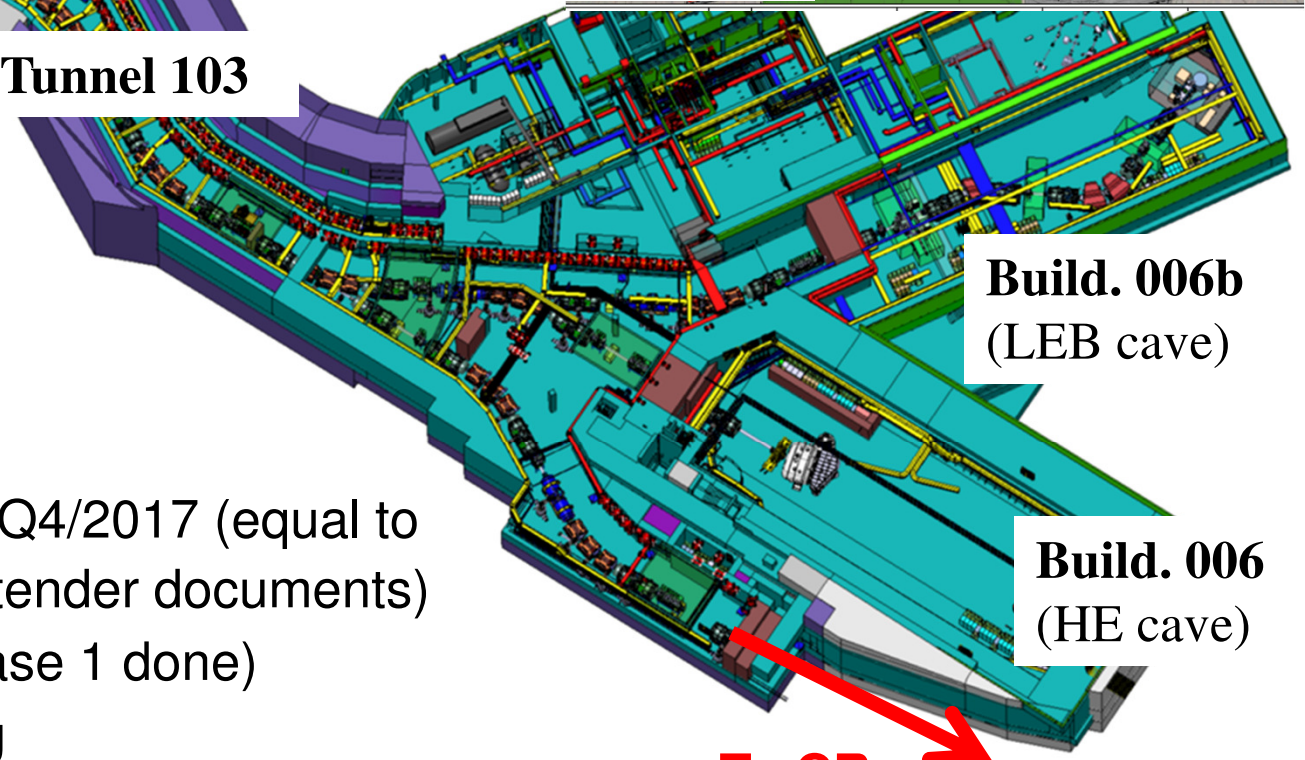
Build. 018
(Target building)

100 m

Build. 006a
(Service building)



Tunnel 103



Build. 006b
(LEB cave)

Build. 006
(HE cave)

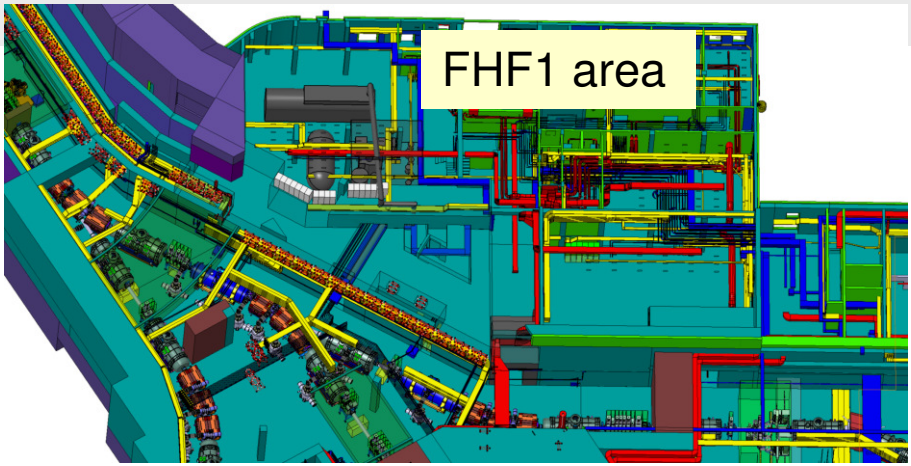
To CR

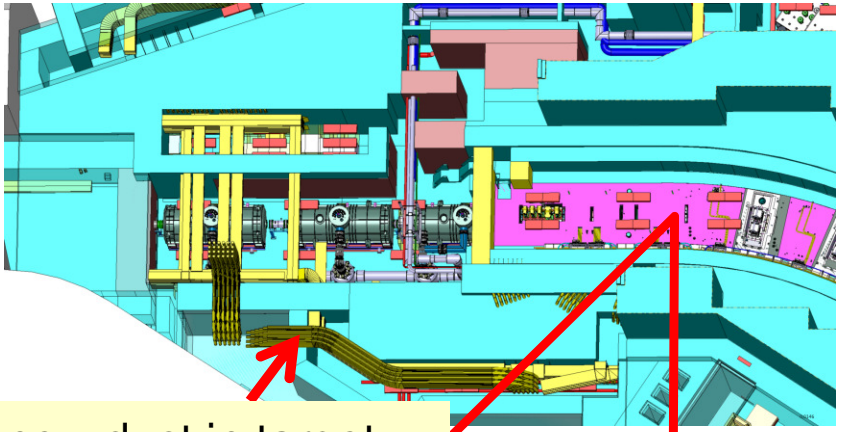
0.00235

- ✓ CC planning Phase 1&2 done
  - ➢ LEB cave integrated
- • CC planning Phase 3 running
- ➢ end of 4th phase scheduled for Q4/2017 (equal to execution planning → prepare tender documents)
- • Technical service planning (phase 1 done)
  - ➢ Building installation planning
  - ➢ Cable planning & rooting (CDB filled)
  - ➢ Detector gas supply planning

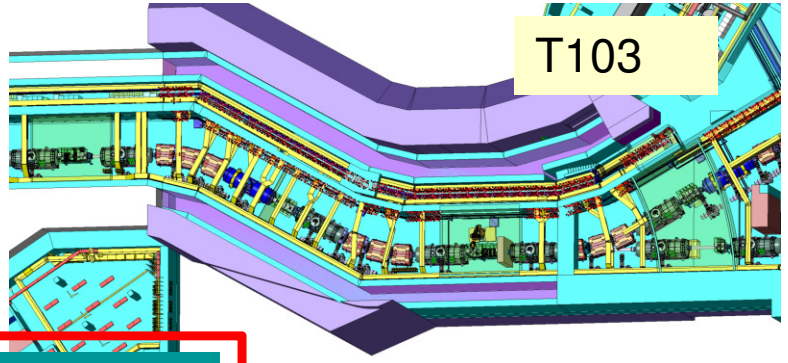
Civil Construction II
(Building services)

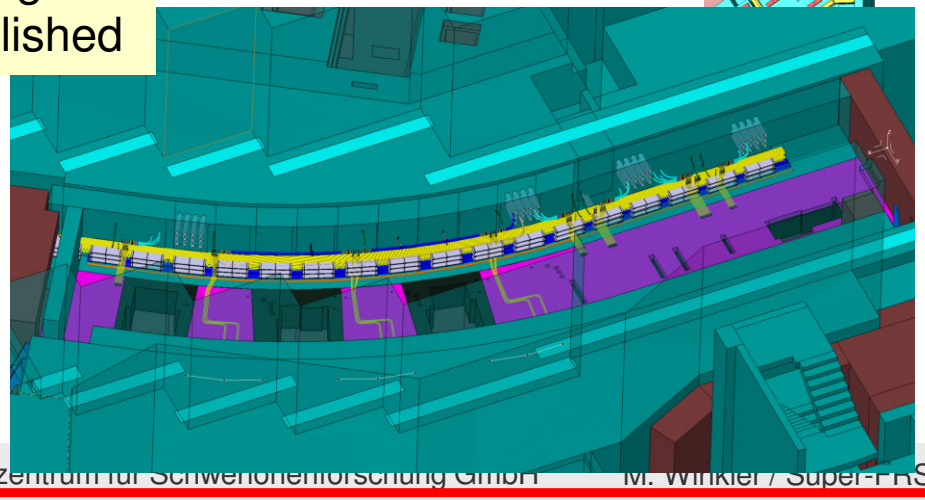
- ✓ 1st phase technical services (TGA)
  - ➢ collision check (all NUSTAR buildings)
  - ➢ includes power cable rooting & ventilation
  - • new data from CDB still to be included

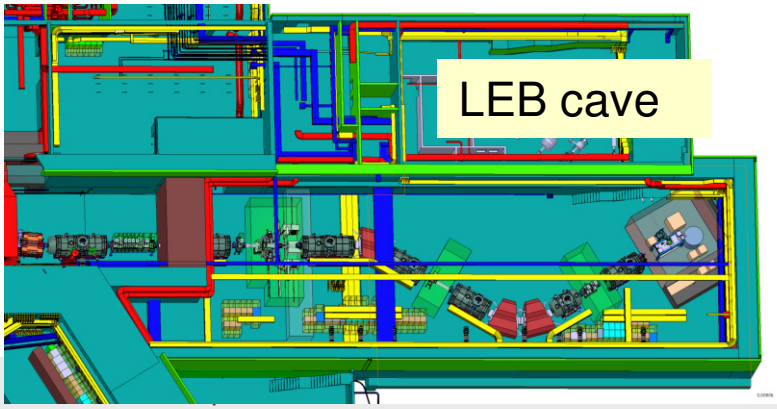




new duct in target building established

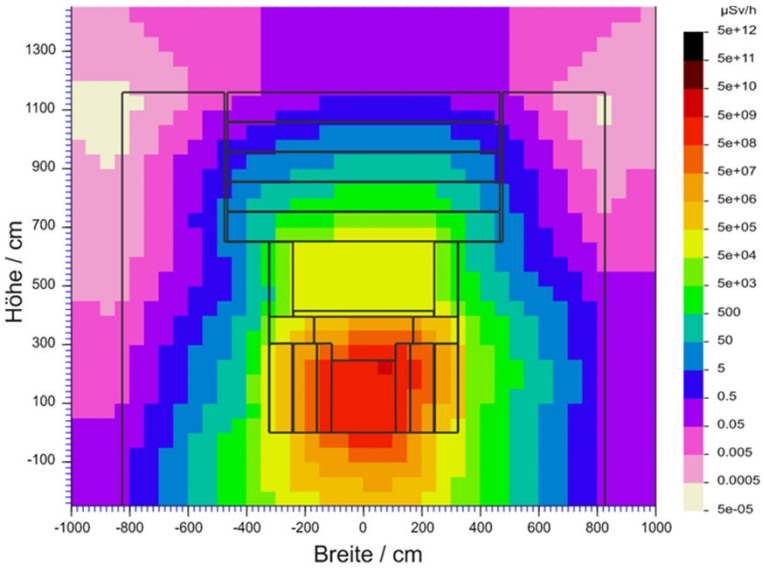


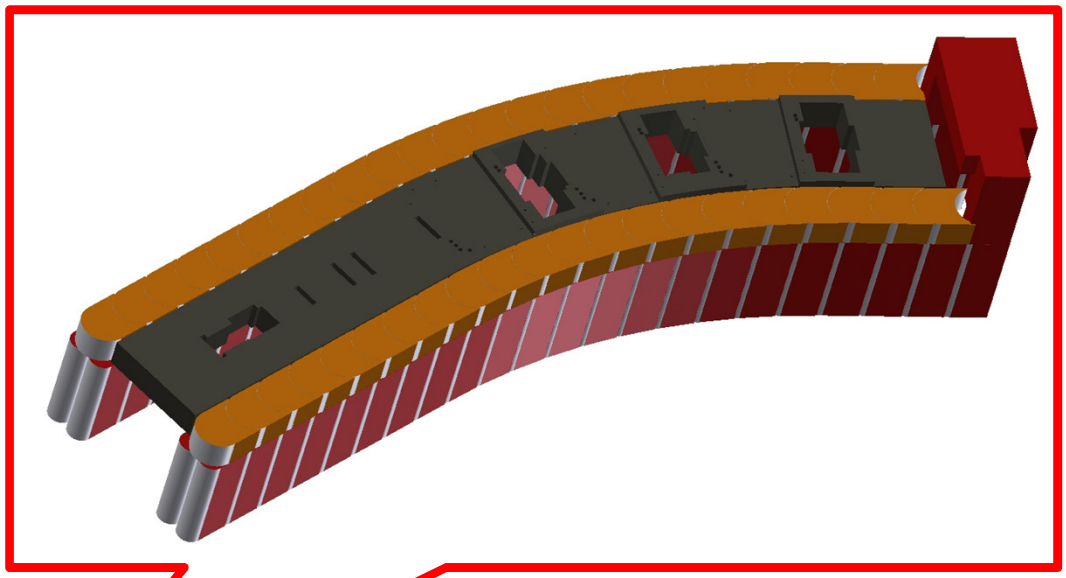


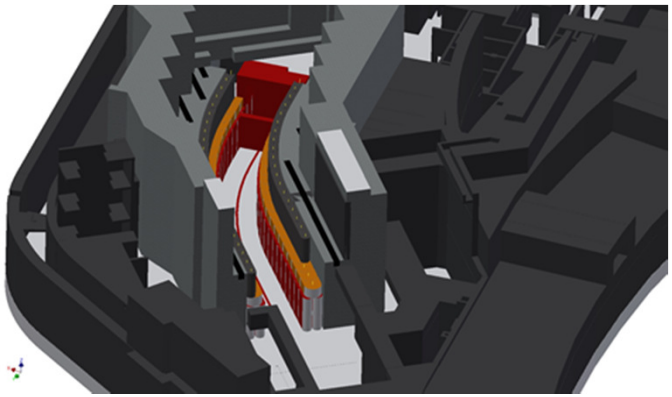


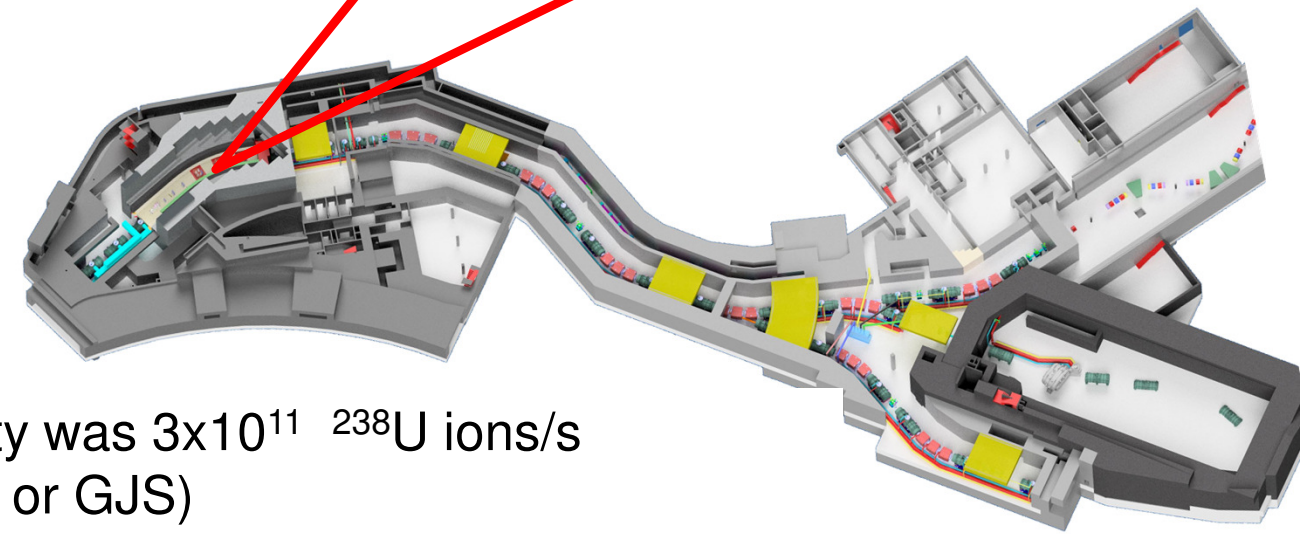
Civil Construction III
(Target area shielding)

A. Kratz,
H. Weick,
S. Purushotaman et al.





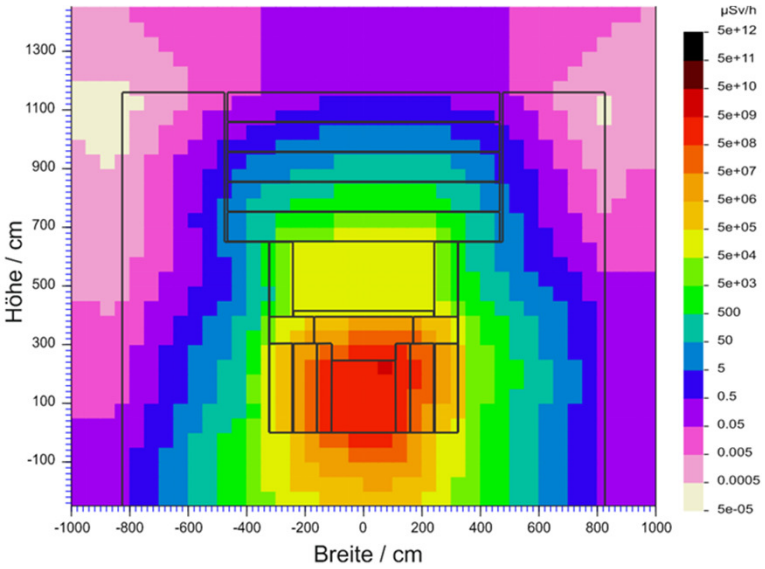


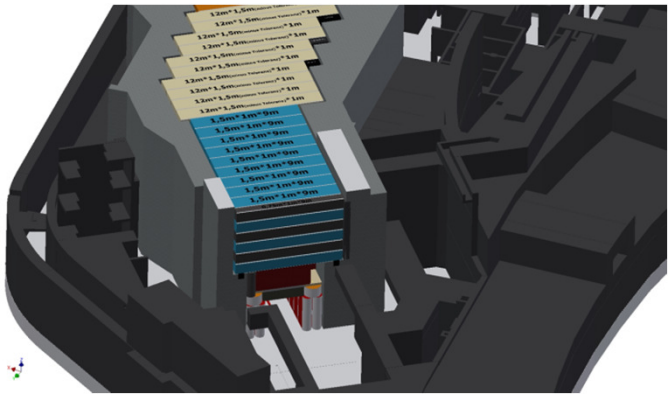


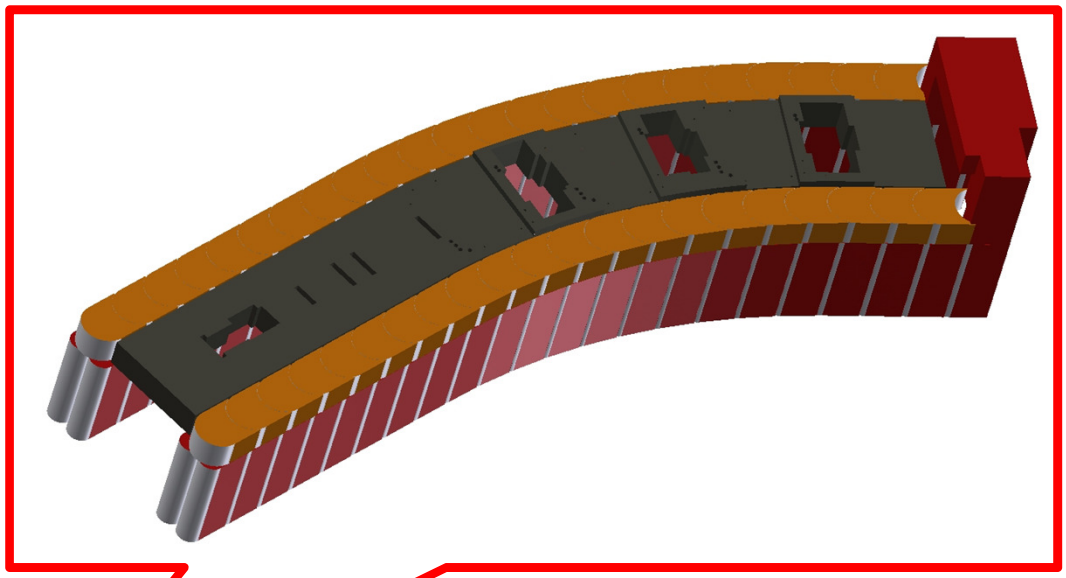
- baed on FLUKA, beam intensity was $3x10^{11}$ ^{238}U ions/s
  - ➢ cast iron (grade GJL 150 - 250 or GJS)
  - ➢ steel slabs (grade S235, between beam and maintenance tunnel
  - ➢ concrete slabs (upper roof shielding)

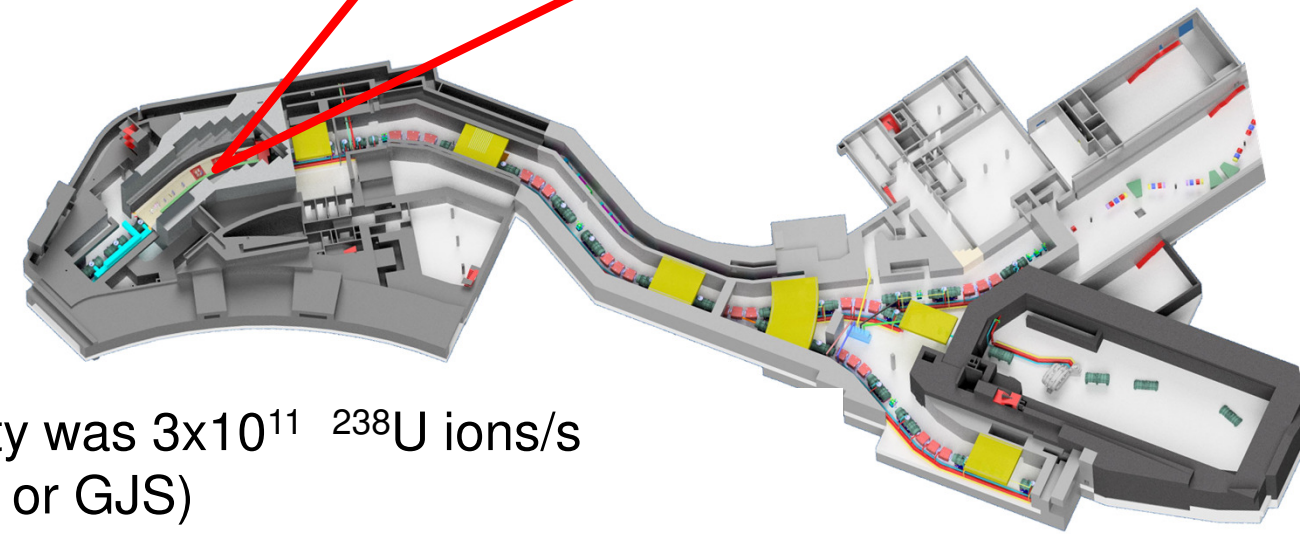
Civil Construction III
(Target area shielding)

A. Kratz,
H. Weick,
S. Purushotaman et al.









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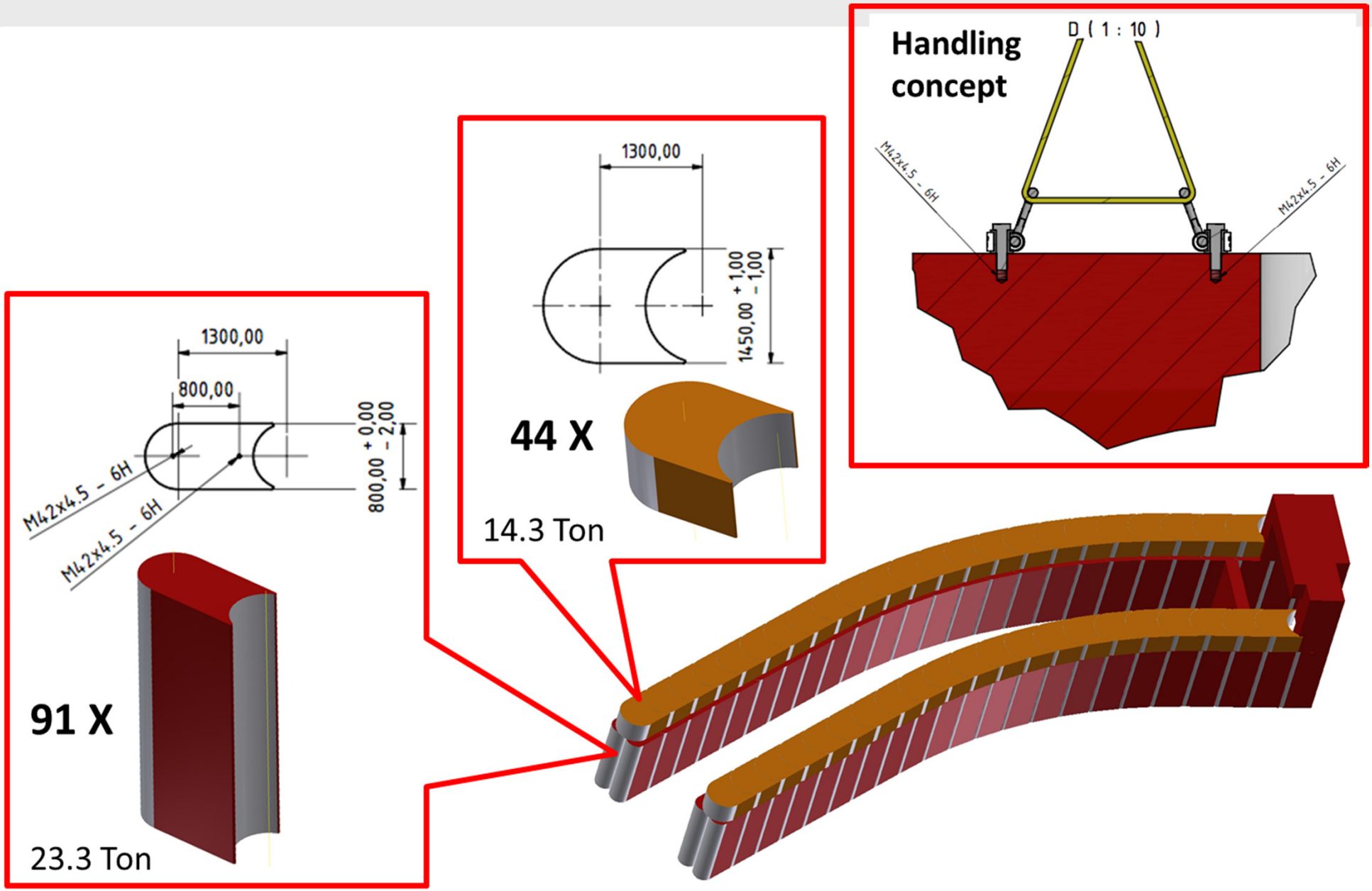
  - ➢ concrete slabs (upper roof shielding)

Civil Construction IV
(Iron shielding)



Summary

- SC Magnets & Testing (most time critical items):
  - Standard dipoles: tender started, contract award expected in 2017
  - Branching dipoles: R&D phase started (CEA), expected to last 1 year
  - Multiples: design SM done (PDR, FDR, PRR) ; FoS in preparation
  - Testing facility at CERN: commissioning of cryo-facility running, procurement of last components running; FoS SM expected in Q2/2018
- Development and procurement of various other components under way
  - Specification of focal plane chambers and dipole vacuum chambers released; IKC (Ru) in preparation
  - Specification of various beam instrumentation components released and corresponding IKC running (IKC on ΔE and ToF expected to be signed soon)
  - Full-size target plug mock-up tested successfully
  - CDR of beam-catcher system submitted by CSIR - CMERI
  - Shielding flask: finalizing of specification, detail design on sub-systems running
  - Hot Cell: detailing planning running (including CC shell interface)
- Civil Construction planning running; expected to be finalized in 2017
  - 'Exececution planning' to be finalized
  - Building service planning running (including finalization of CDB)
  - Specification of target area (iron) shielding under preparation