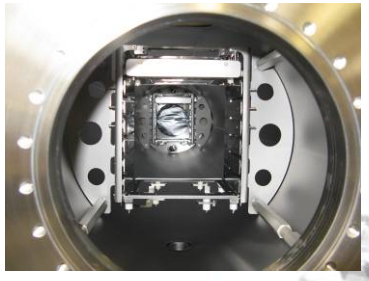
FAIR@GSI Project

Menu: NUSTAR related systems

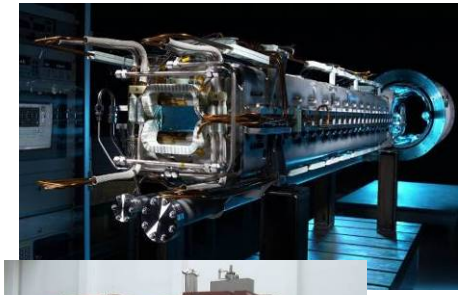
- The heavy ion injector upgrade
- Status FAIR accelerators
  - Primary beam chain: SIS100
    - SC magnets
    - magnet testing
  - HEBT
  - Super-FRS
    - target region and magnets
  - Storage Rings
    - Collector Ring

FAIR accelerator challenges

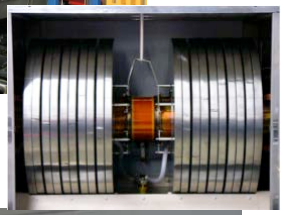
Diagnostic and XHV at highest intensities



Superconducting magnets



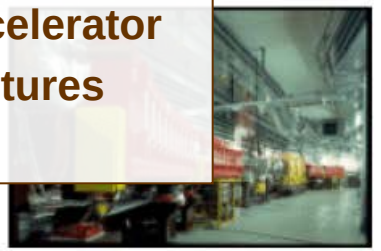
Rf-cavities

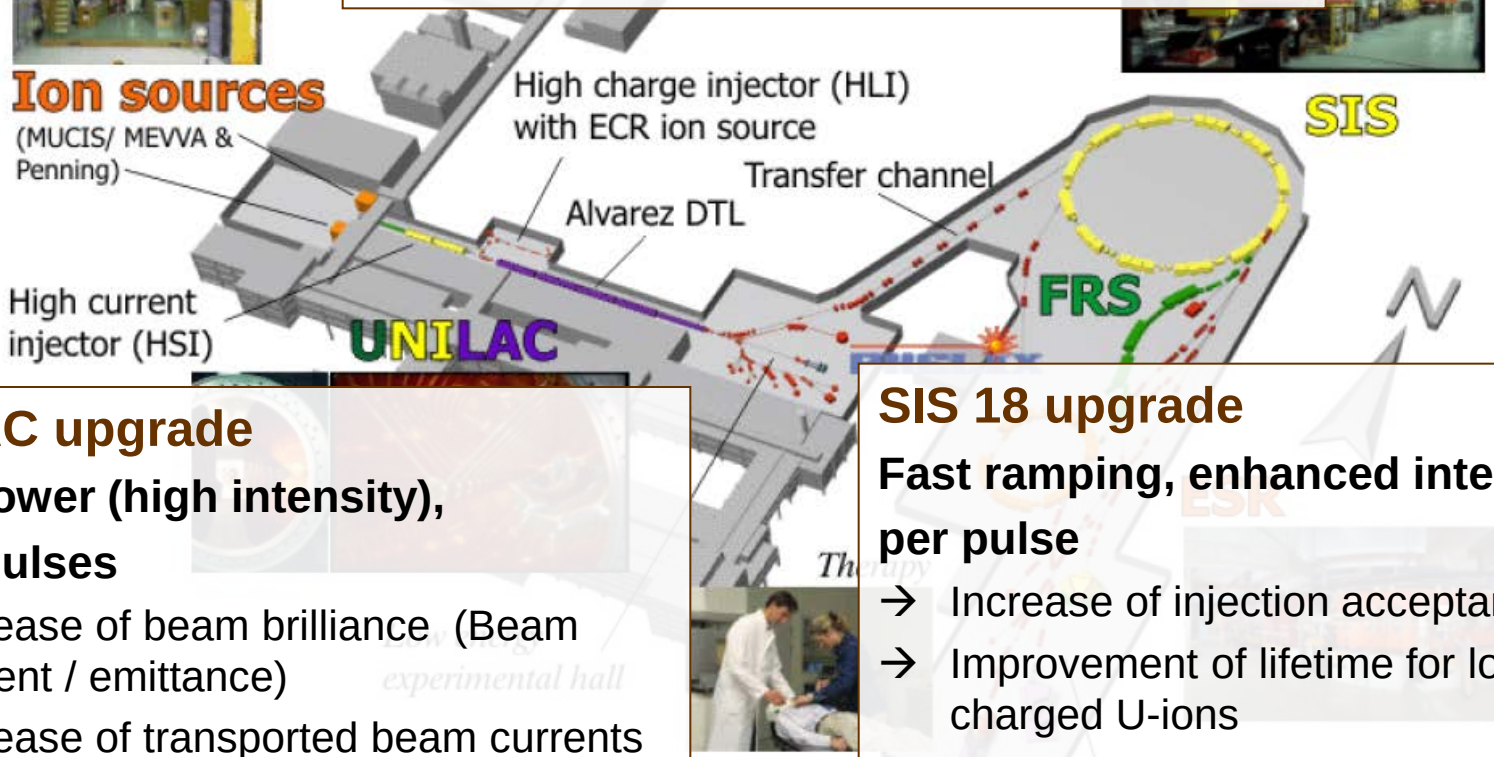


Beam cooling

Preparing the Injector Chain

Exchange of 35 years old Alvarez accelerator
With modern interdigital H-type structures
Higher intensities → 28 GHz ECRIS





UNILAC upgrade

High power (high intensity), short pulses

- → Increase of beam brilliance (Beam current / emittance)
- → Increase of transported beam currents
- → Improvements of high current beam diagnostics / operation

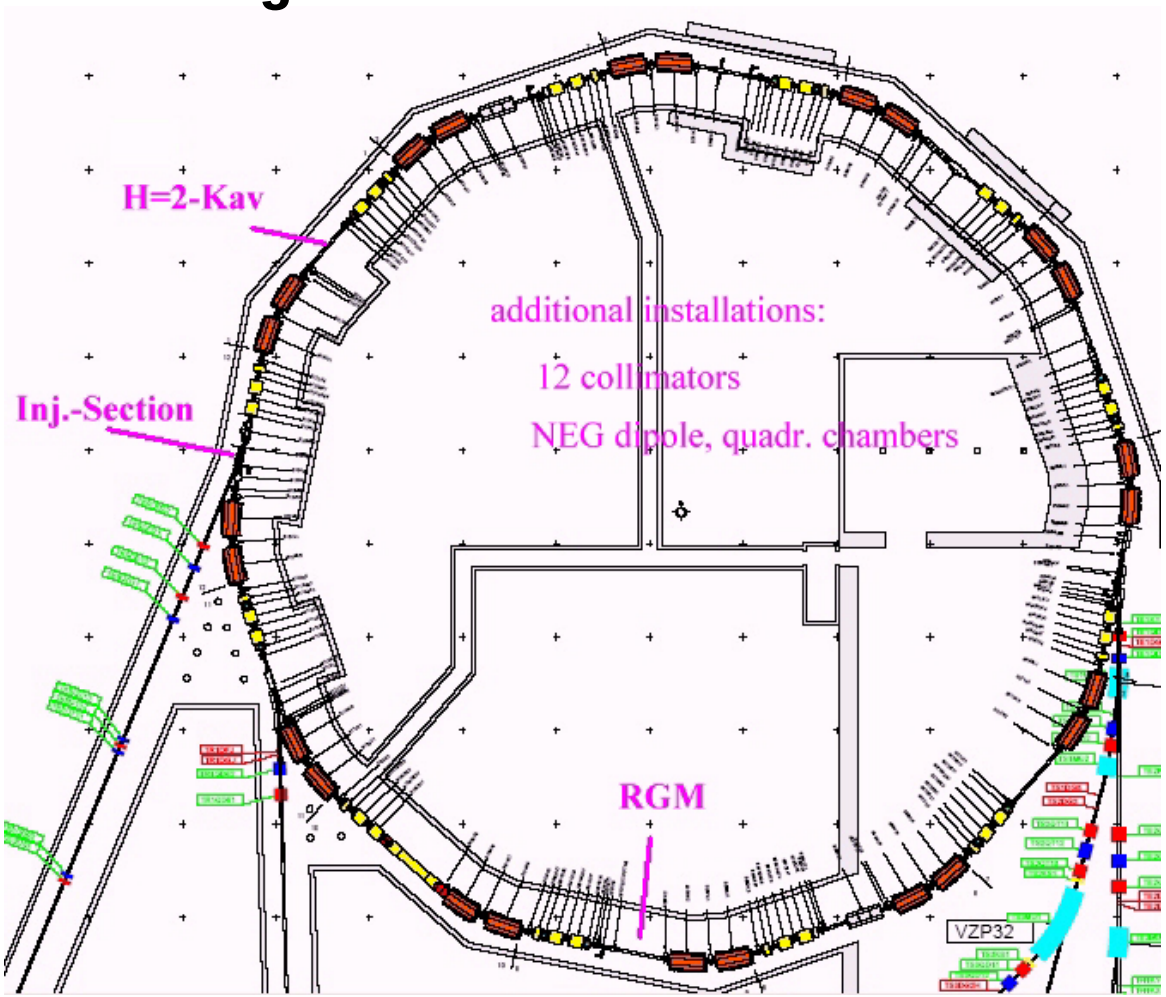
SIS 18 upgrade

Fast ramping, enhanced intensity per pulse

- → Increase of injection acceptance
- → Improvement of lifetime for low-charged U-ions
- → Increase of beam-intensity per time due to reduction of SIS18- cycle time

SIS18 high current upgrade

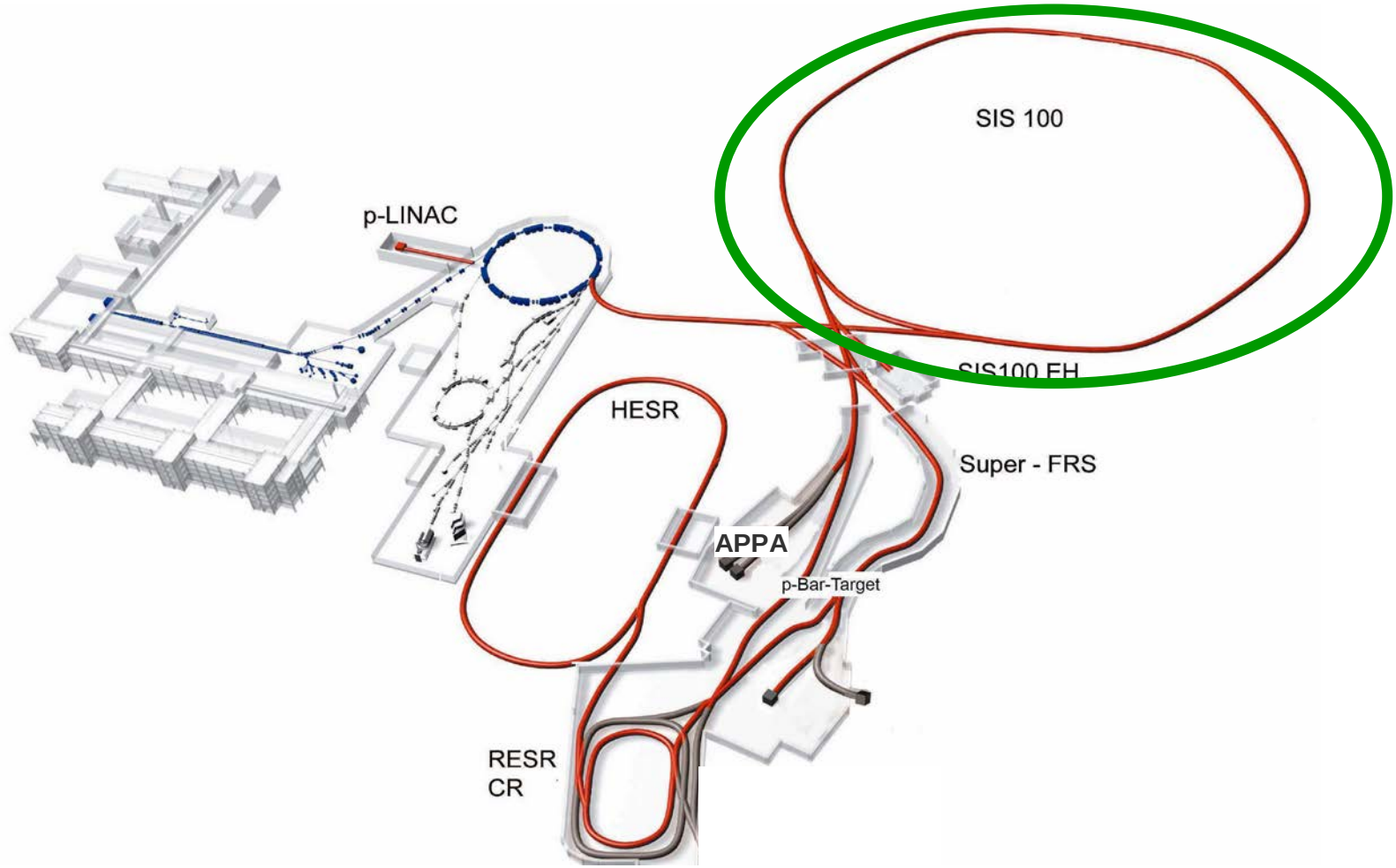
SIS-Ring with modifications



Main tasks:

- pulse power conn. finished (12 Tm fast ramping)
- new injection system finished
- Dynamic vacuum:
  - * UHV upgrade
  - * ion catcher system, collimators
  - * optimized beam diagnostics (RGM)
- Theoretical Investigations (**and machine Experiments**)
- Bunch compression

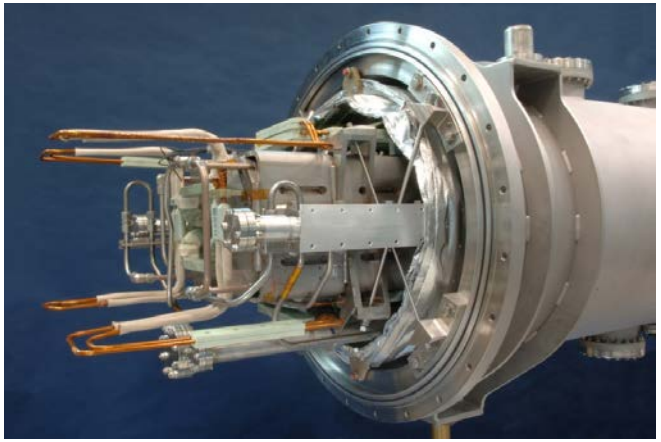
SIS100 synchrotron

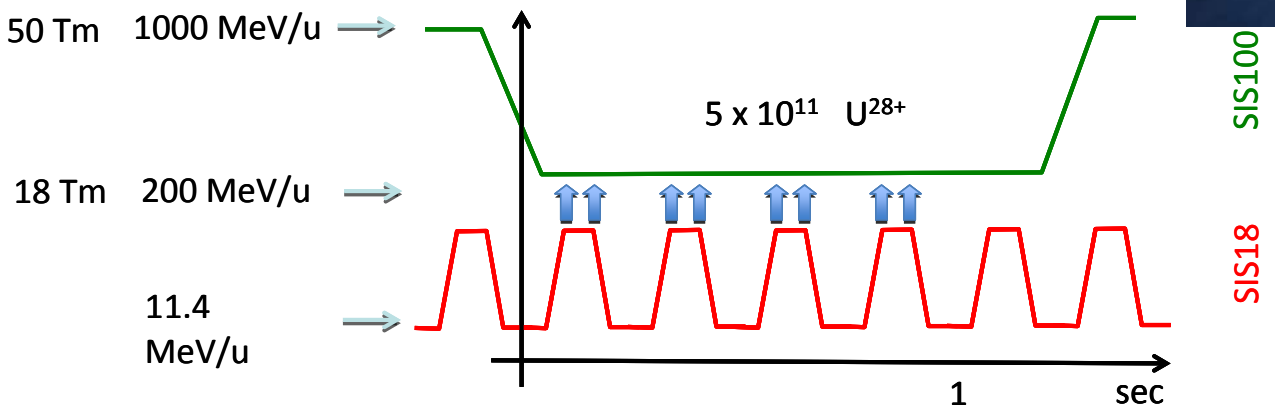


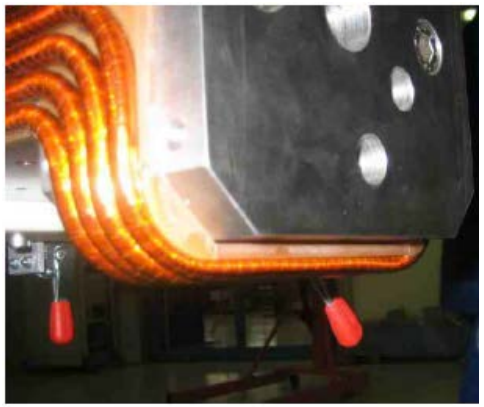
Challenges of the SC-magnets development for SIS100

Fast ramped magnets (synchrotrons)

- Dynamic load and AC heat losses
  Bρ= 100 Tm | Bmax= 1.9 T | dB/dt= 4 T/s
- High field quality, low multipole strength



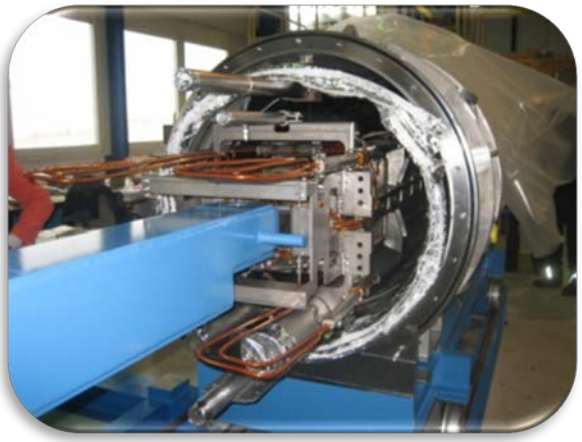




R&D Goals

- Reduction of eddy / persistent current effects
- Guarantee of long term mechanical stability (≥ 2*10^8 cycles)
  (mechanical stress →coil restraint)

SIS100 dipole modules: First magnet

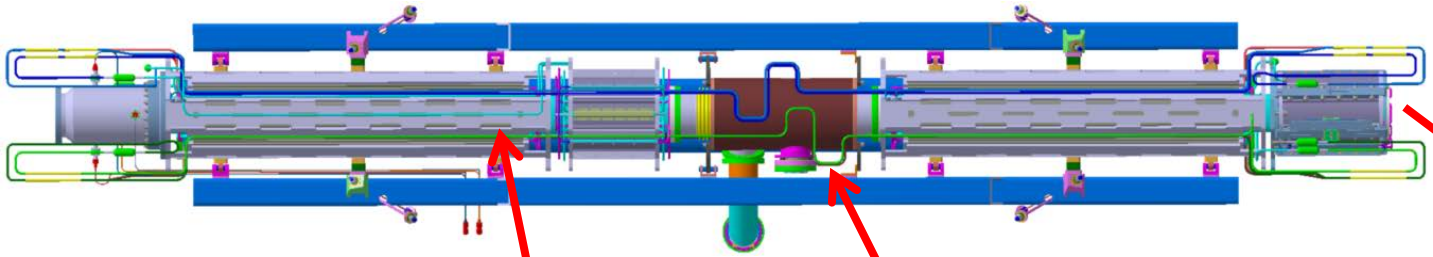


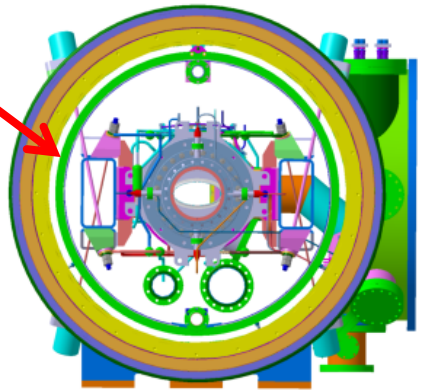
Assembly on dedicated rig:

1. **Place thermal shield in cryostat**
2. **Pull magnet into cryostat and suspend on rods**
3. **Align with laser-tracker**

Delivered to GSI:
June 3rd 2013 →

SIS100 QDMs – collaboration GSI / Dubna



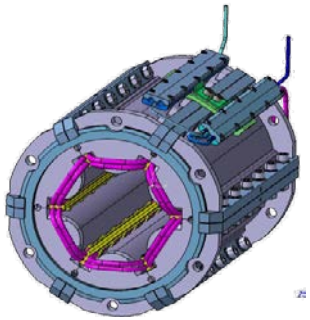


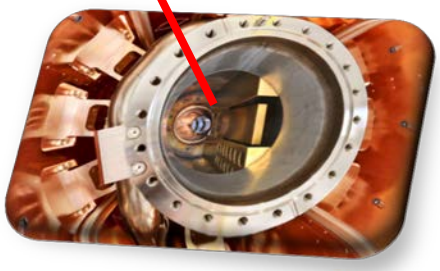
Integration into cryostat → GSI

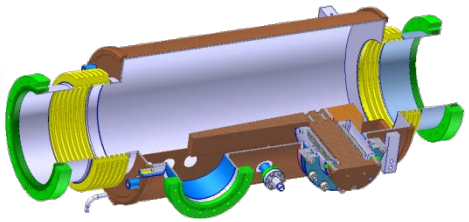
cryostat will be procured by GSI

SIS100 quadrupole unit (will be built by Dubna)

cryo-collimator → german in-kind

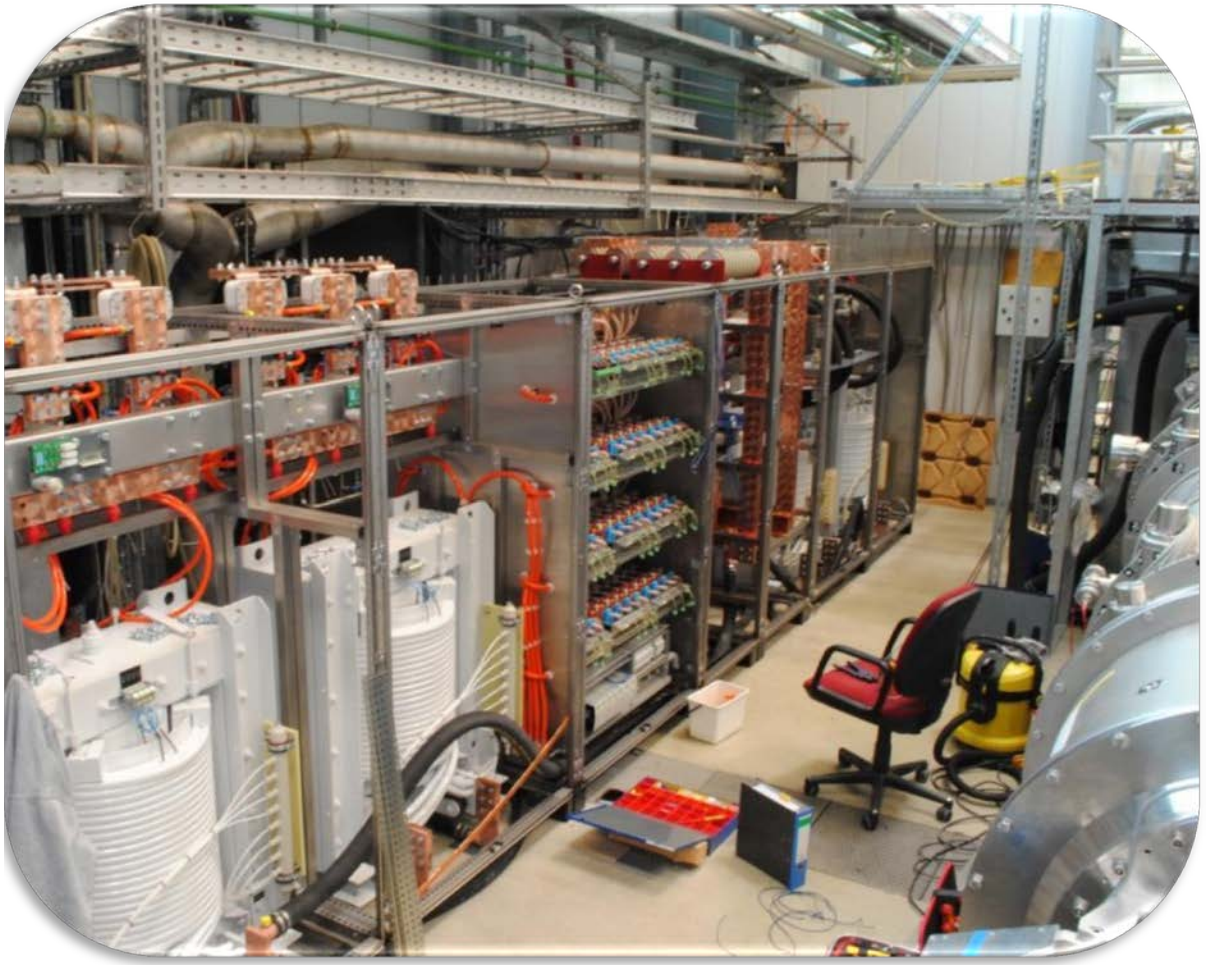






Preparation for FOS Testing: Power Converter

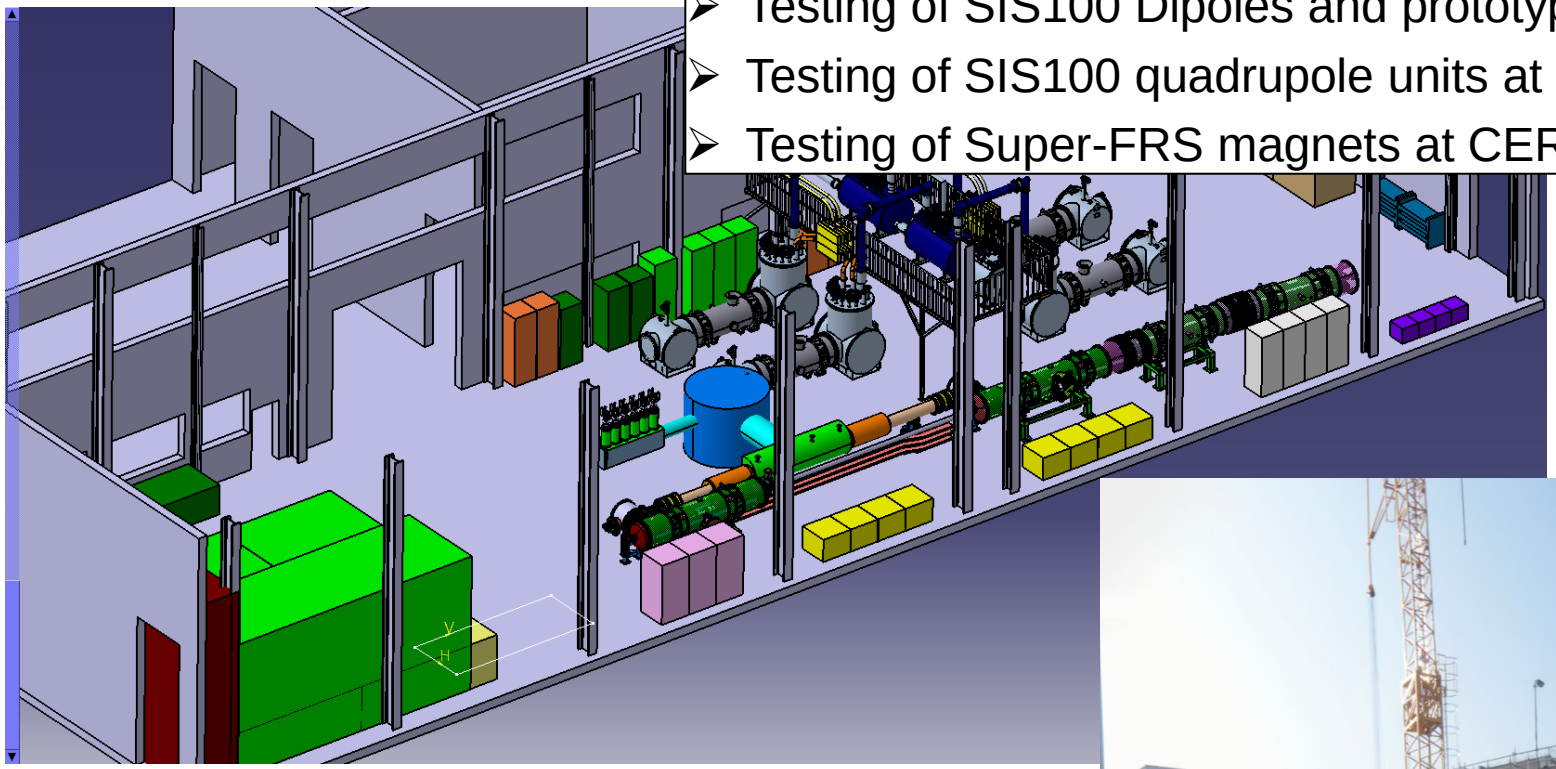
- upgrade of power converter → 20 kA
- first using ACU and thyristor + active filter
- „prototype“ for machines
- commissioned with sc. model magnet
- currently last fine tuning
- ramp controller tested



Power converter during assembly

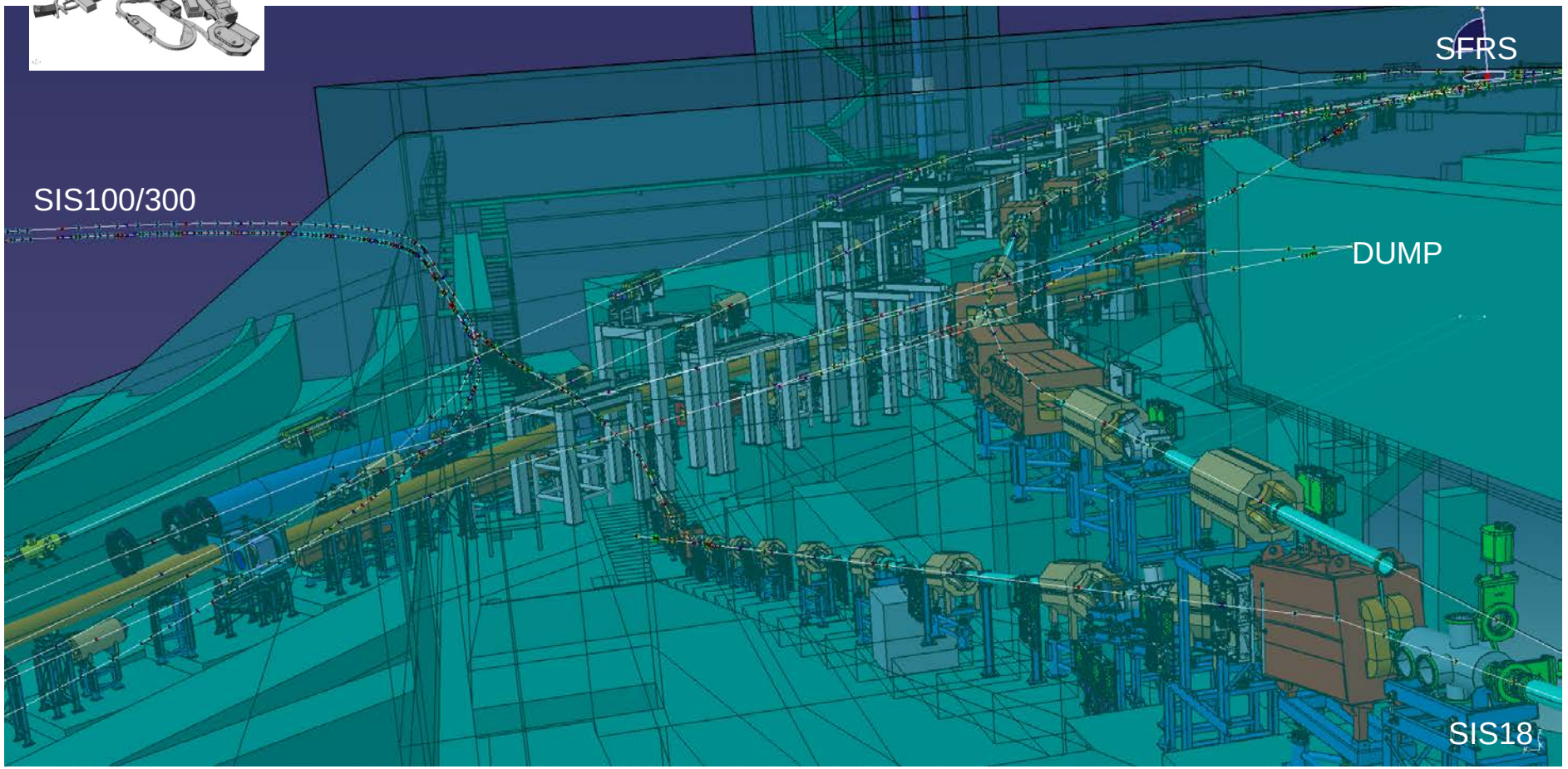
Test Facilities: GSI, Dubna, CERN

- Testing of SIS100 Dipoles and prototypes at GSI
- Testing of SIS100 quadrupole units at Dubna
- Testing of Super-FRS magnets at CERN

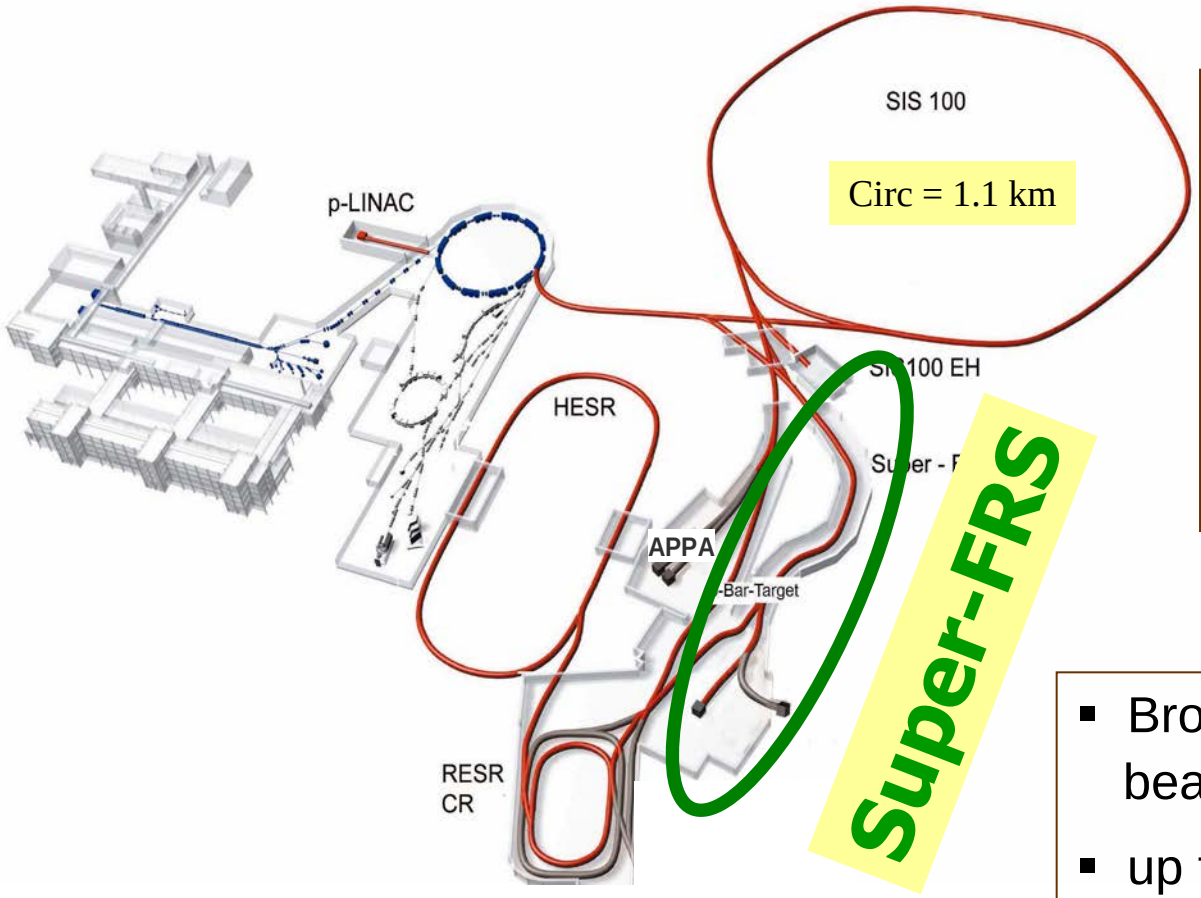


- ✓ 3 — 4 Test benches for SIS100 dipoles
- ✓ String test preparation in parallel
- ✓ Utilities in Annex building (cryo supply, power converters, ...)

HEBT system lay-out of transfer lines



Super-FRS at FAIR



Primary Beams

- **$3 \cdot 10^{11}$ $^{238}U^{28+}$/s (Slow extr.)** @ 1.5 GeV/u
- **$4 \cdot 10^{11}$ $^{238}U^{28+}$ (pulsed)** @ 1 GeV/u
- factor **100** in intensity over present

Secondary Beams

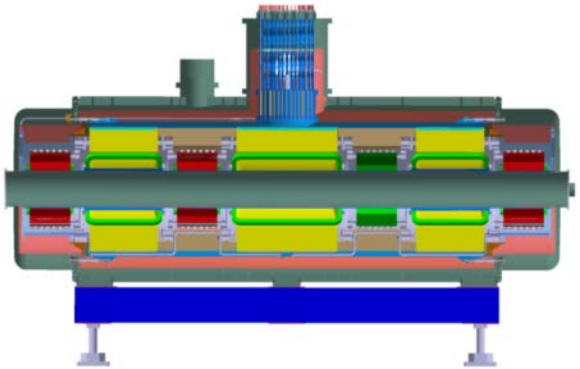
- Broad range of radioactive beams up to **1.5 GeV/u**
- up to **factor 10 000 in intensity** over present

Work on the Super-FRS

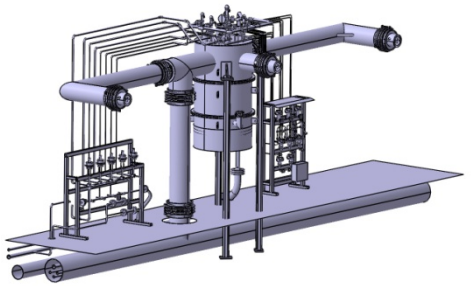
Remote Handling

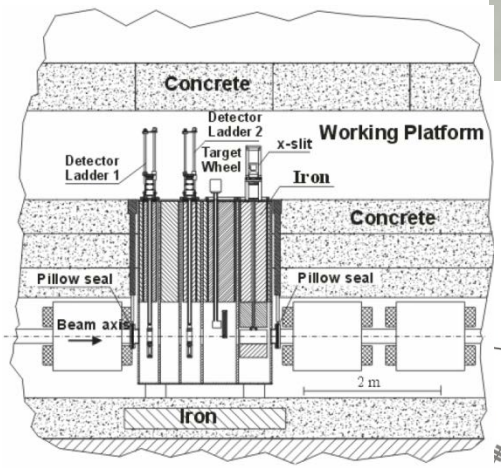
Target

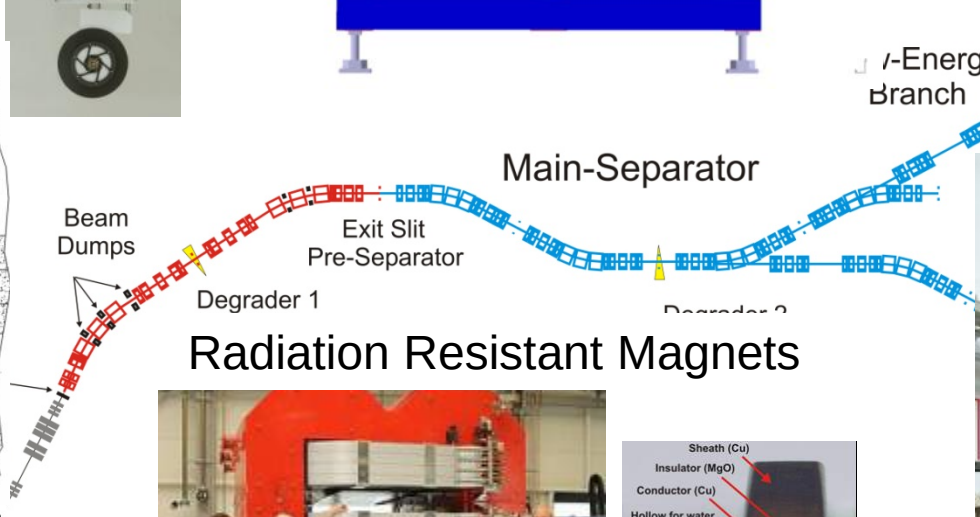
SC Multiplets



Local Cryogenics

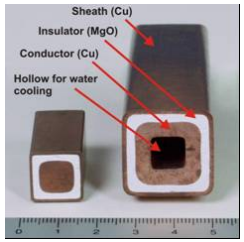






Driver Accelerator

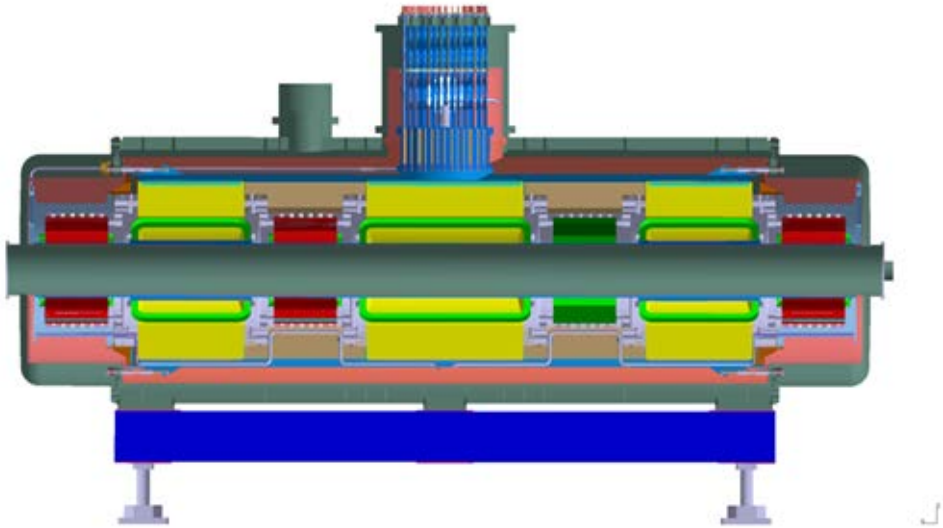
Radiation Resistant Magnets

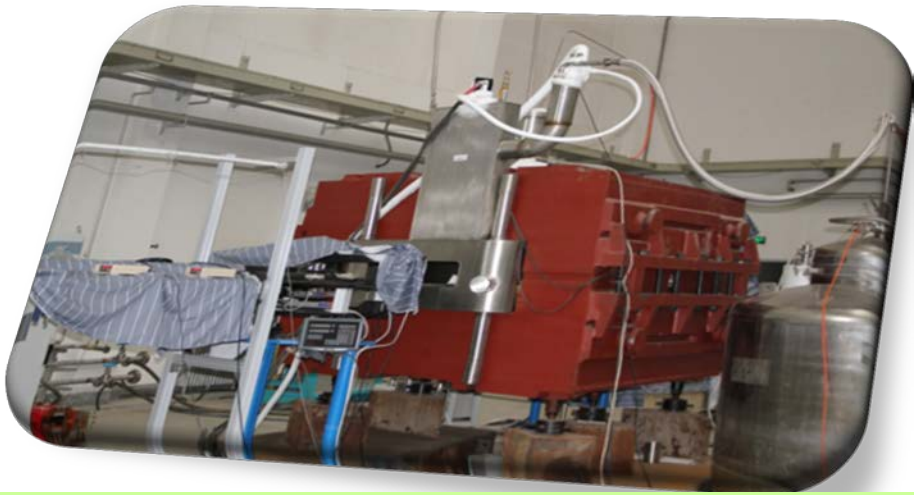


SC Dipoles

FAIR — HELMHOLTZ ASSOCIATION — GSI

SC Magnets



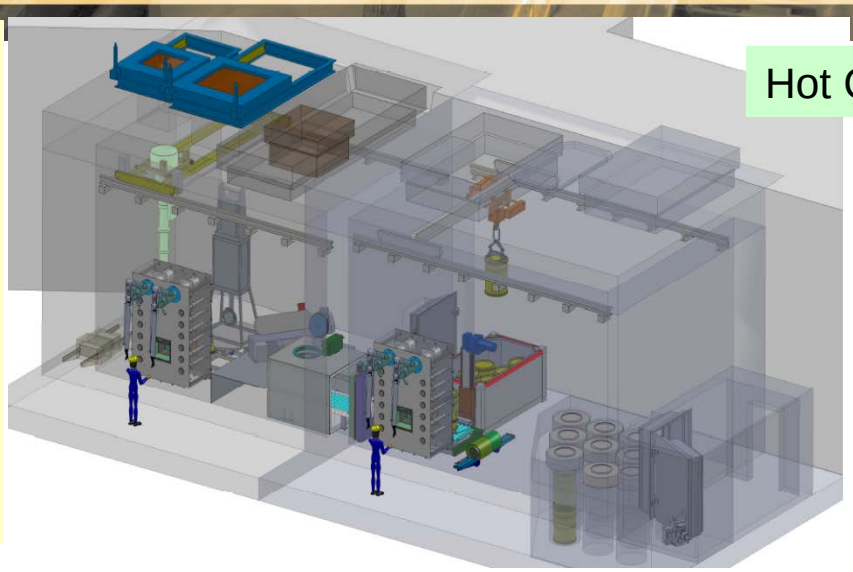


- Specifications finished
- Tender in process:
  Contract negotiations ongoing
- Signing of contract: 04/2014
- Testing of First short multiplet at CERN:
  09/15 – 03/16
- Testing of first long multiplet at CERN:
  12/15 – 09/16
- Series testing at CERN: 09/16 – 02/19

- Prototype succesfully tested in 2011
- Collaboration with CEA/SACLAY
  under preparation:
  - Finalising design
  - Technical follow-up
- Tender by FAIR
- First of Series ready for testing at
  CERN: 10/15
- Series production and testing:
  01/16 – 03/18

Super-FRS target region- collaboration with KVI-CART

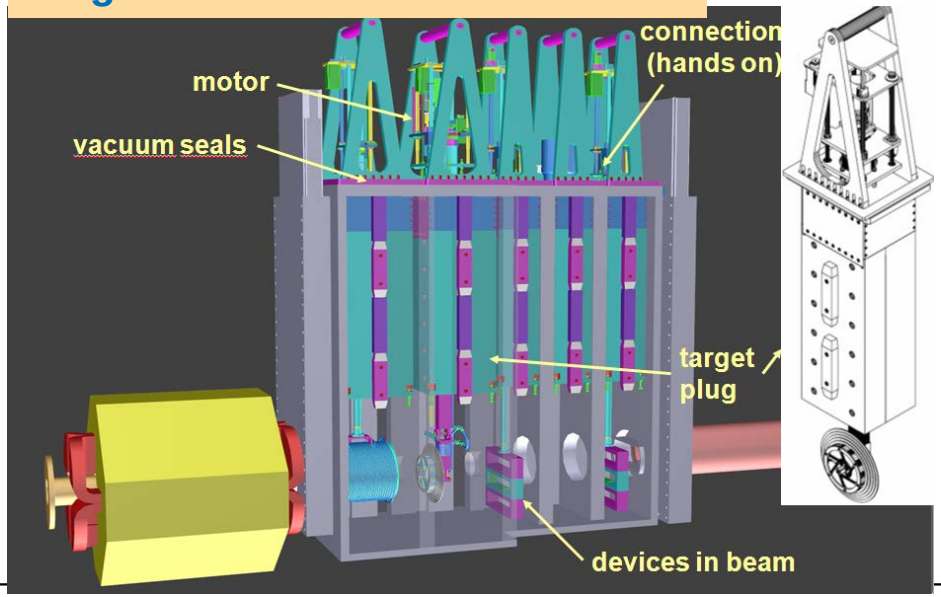
- Target Chamber with plug inserts
- Target Wheel
- Collimator
- Target Detectors
- Hot Cell Complex
- Transport Flask
- Remote Handling
- Beam Catcher
- Energy Degrader



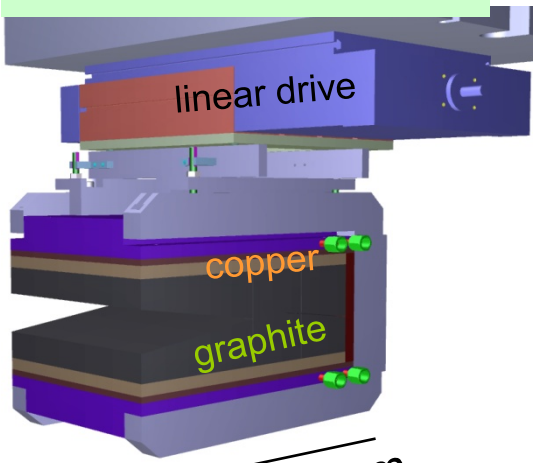
Hot Cell

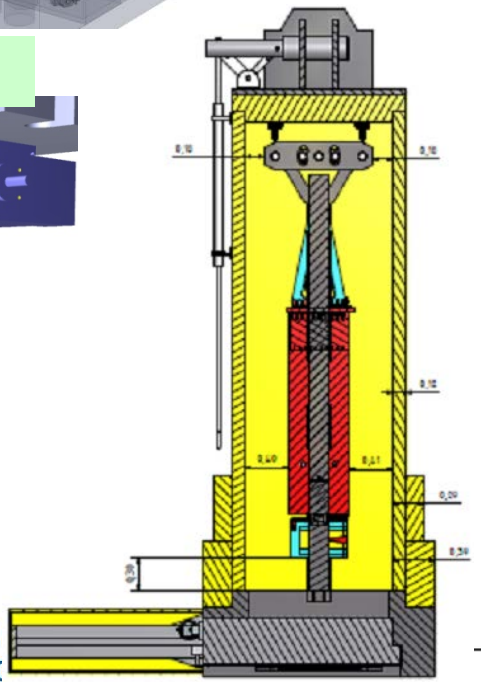
Transport Flask

Target Chamber with Inserts



movable beam catcher





FAIR ‘materials’

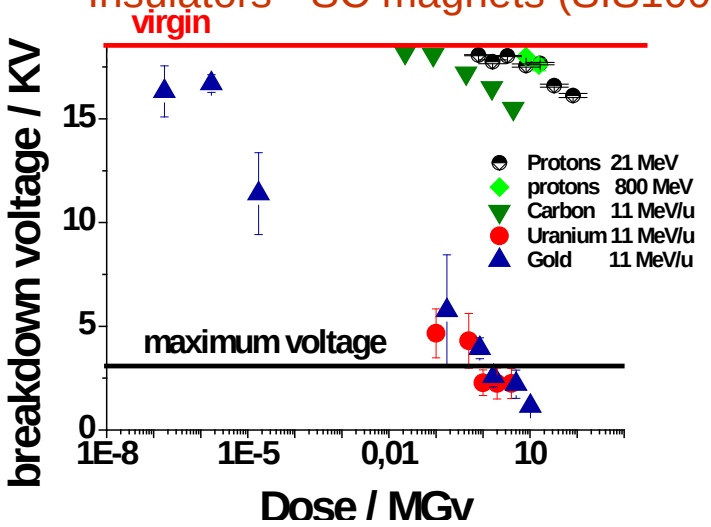
Carbon materials for Super-FRS:

- Mechanism of radiation damage, critical dose
- Structural and thermo-mechanical properties degradation

Insulators:

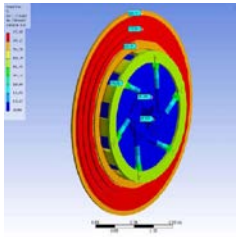
- critical dose determined
- break down voltage of insulating material after irradiation

Insulators - SC magnets (SIS100)

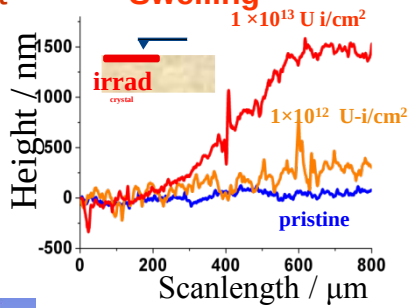


Targets and Beam Catchers - Super-FRS

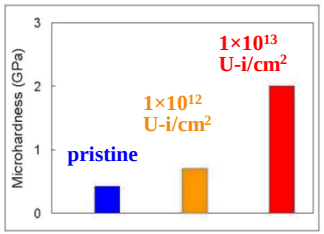
Production target



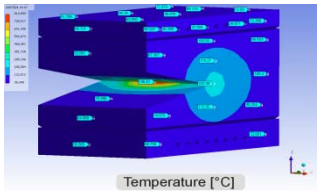
Swelling

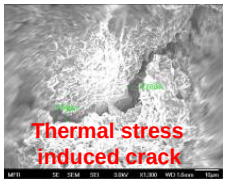


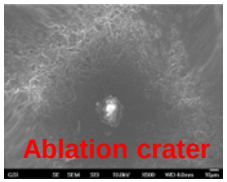
Hardening



Beam catcher

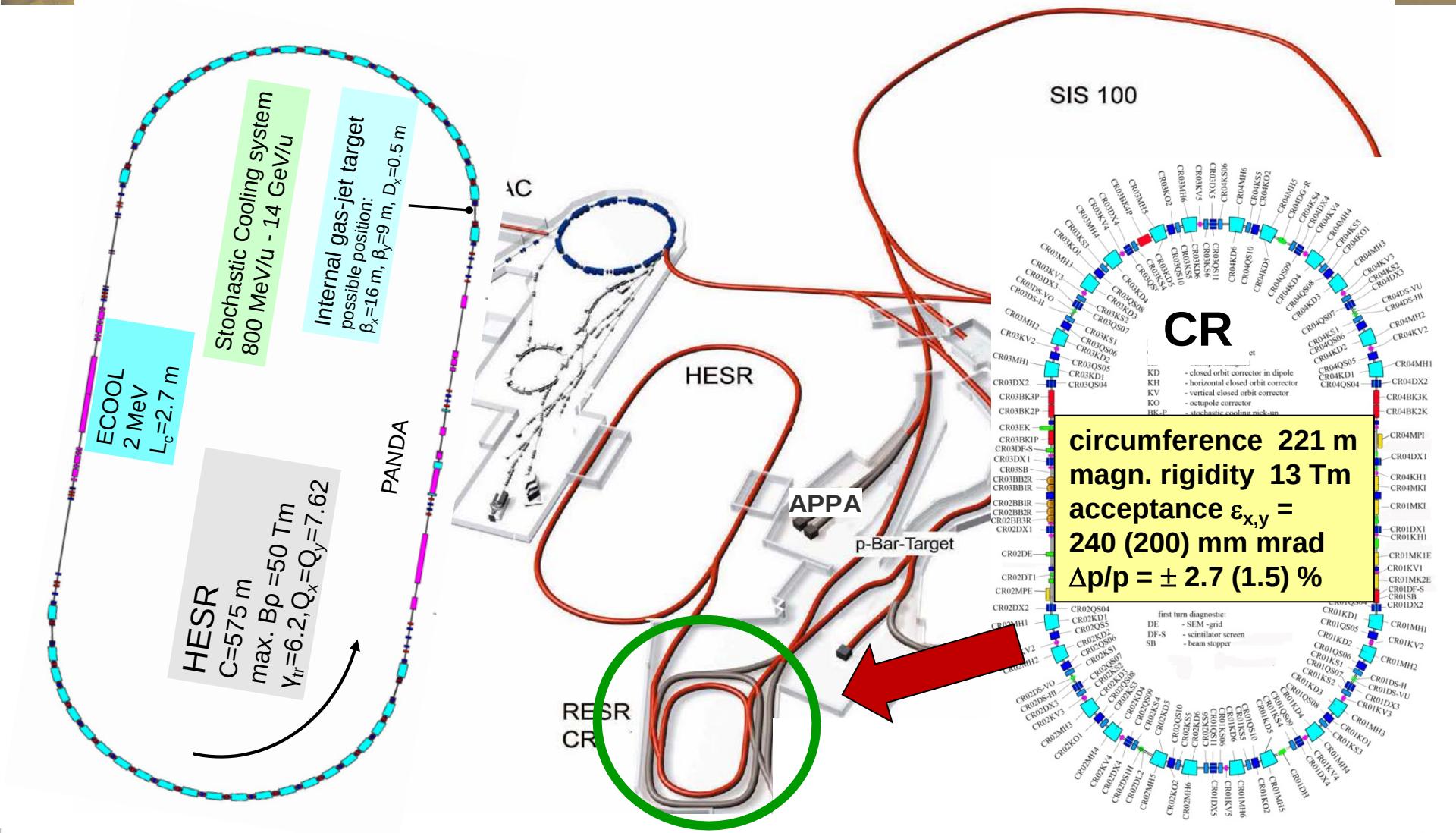






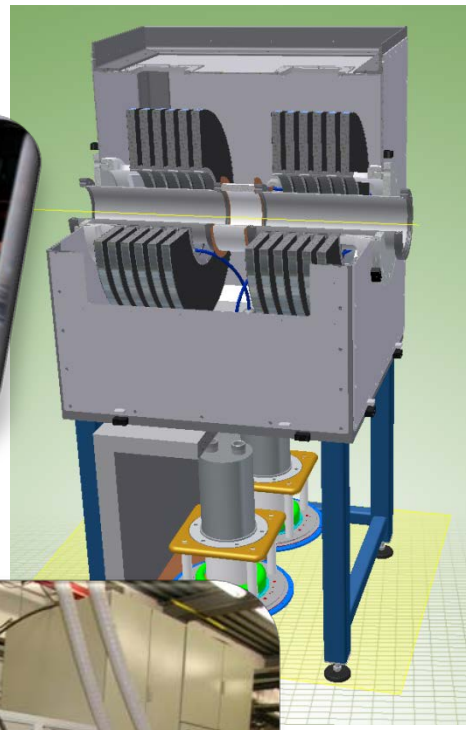
- Investigate radiation damage and failure mechanism of FAIR accelerators materials
- Lifetime estimations for FAIR components
- Innovative materials for extreme conditions

The FAIR storage rings
- NUSTAR: ILIMA



CR – responsibility to BINP

Prof. Dr. A. Skrinsky for BINP	Prof. Dr. Y. Shatunov for BINP
Prof. Dr. O. Kester for GSI	Dr. O. Dolinskyy for GSI
Prof. Dr. B. Sharkov for FAIR	Dr. E. Mahner for FAIR



Proposal to consider the entire CR machine (except stochastic cooling and CR-debuncher), as Russian in-kind contribution (similar to the HESR with Jülich)

- MoU signed (Oct. 2013)
- Contract Preparations ongoing.
- Workshop on Workpackages: 24-28.2.2014
- TDR just accepted (Feb. 2014)

Summary

Progress in several NUSTAR relevant packages:

- **FAIR starts with the injectors**
  UNILAC and SIS 18 high current upgrade

- **SIS100**
  SC magnets – dipole FOS, QDM design, test facility
  Beam dynamics
  HEBT
- **Super-FRS**
  Superferric magnets, test facility, target region
- **Storage Rings**
  Transfer of technical responsibility of CR to Budker institute