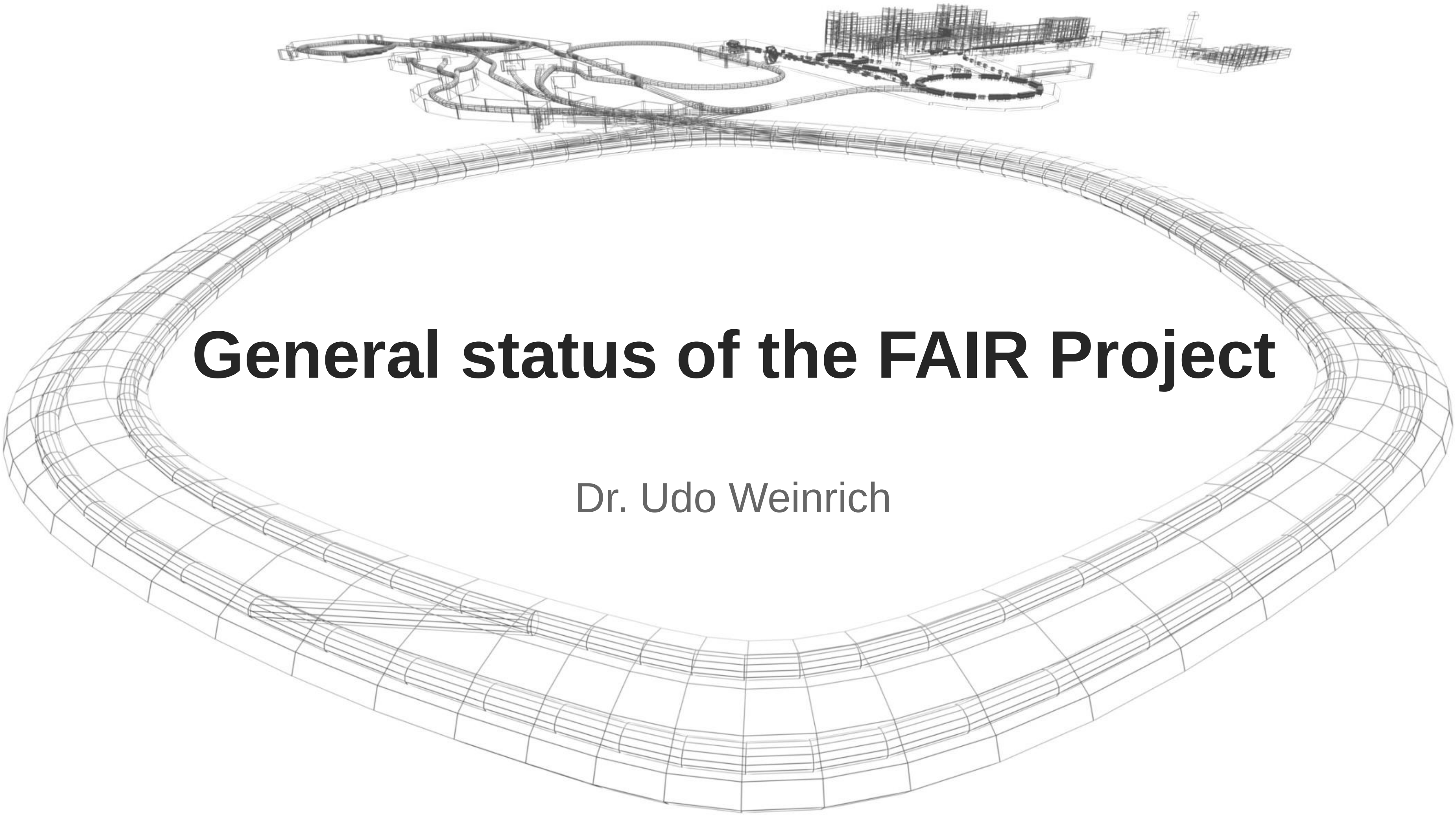


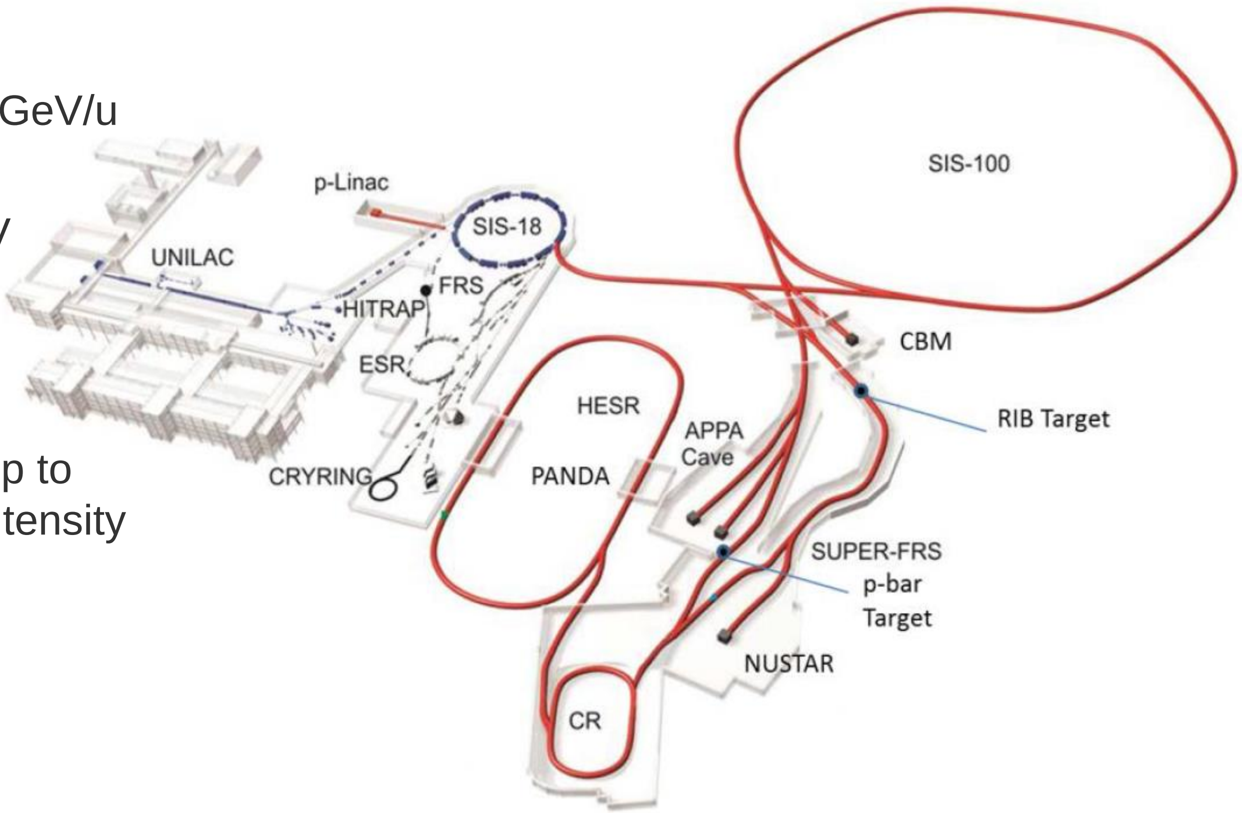
General status of the FAIR Project

Dr. Udo Weinrich

Outline

- Overview FAIR facility
- FAIR Organisation
- Progress FAIR heavy ion chain
- Introduction FAIR antiproton chain
- Summary and Outlook

Accelerator Performance for FAIR Experiments



Primary Beams SIS 100

- 4.5×10^{11} U^{28+} ions/spill; 1.5 GeV/u
- 10^{10}/s $^{238}U^{92+}$ up to 11 GeV/u
- 2×10^{13} protons/spill; 29 GeV

Secondary Beams

- range of radioactive ion beams up to 1.5 - 2 GeV/u; up to a factor of 10’000 higher in intensity than presently
- antiprotons 1.5 - 14.1 GeV

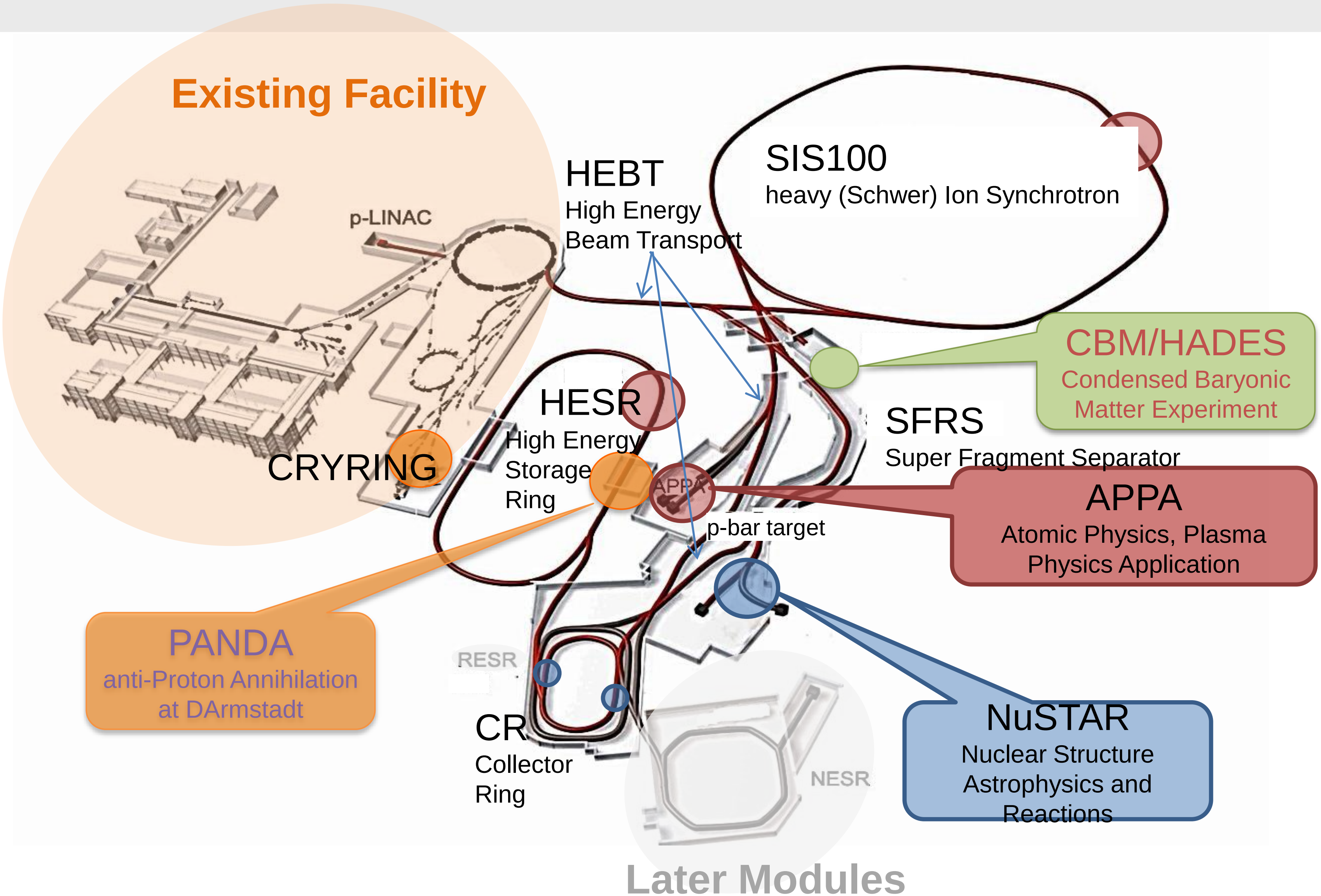
Storage and Cooler Rings

- radioactive ion beams
- antiproton beams:
  CR: 10^8 antiprotons; 3 GeV
  HESR: 10^{10} antiprotons; 1.5 - 14.1 GeV

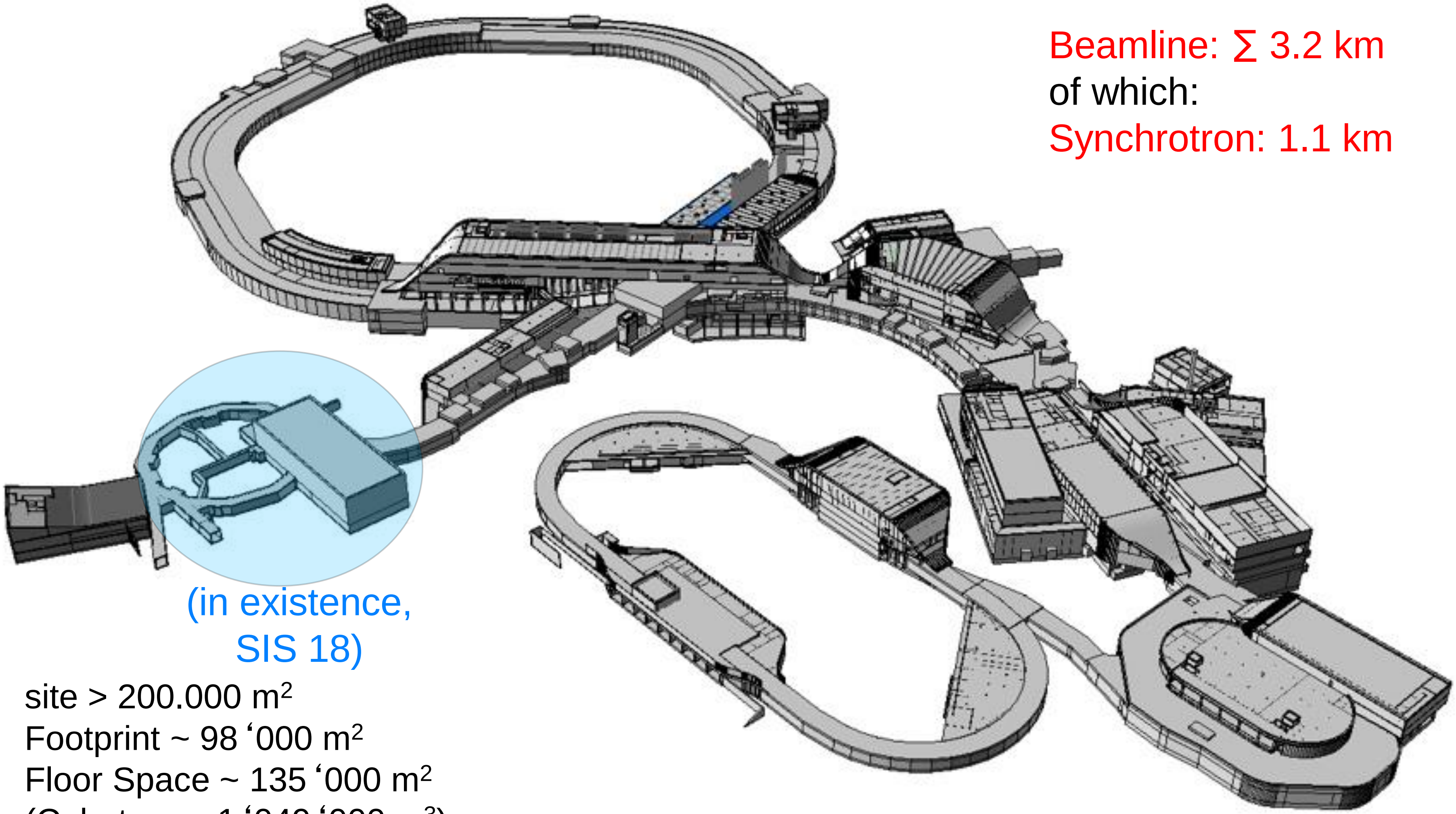
Technical Challenges

- Rapid cycling superconducting magnets
- rf-systems and control
- Beam lifetime (dynamic vacuum)
- Cooled beams

FAIR facility overview



FAIR buildings



Beamline: ∑ 3.2 km
of which:
Synchrotron: 1.1 km

site > 200.000 m^2
Footprint ~ 98 ‘000 m^2
Floor Space ~ 135 ‘000 m^2
(Cubature ~ 1 ‘049 ‘000 m^3)

FAIR Partner Countries

FAIR Management

- Scientific Managing Director FAIR
  - Prof. Dr. Boris Sharkov

- Administrative Managing Director FAIR/GSI
  - Ursula Weyrich

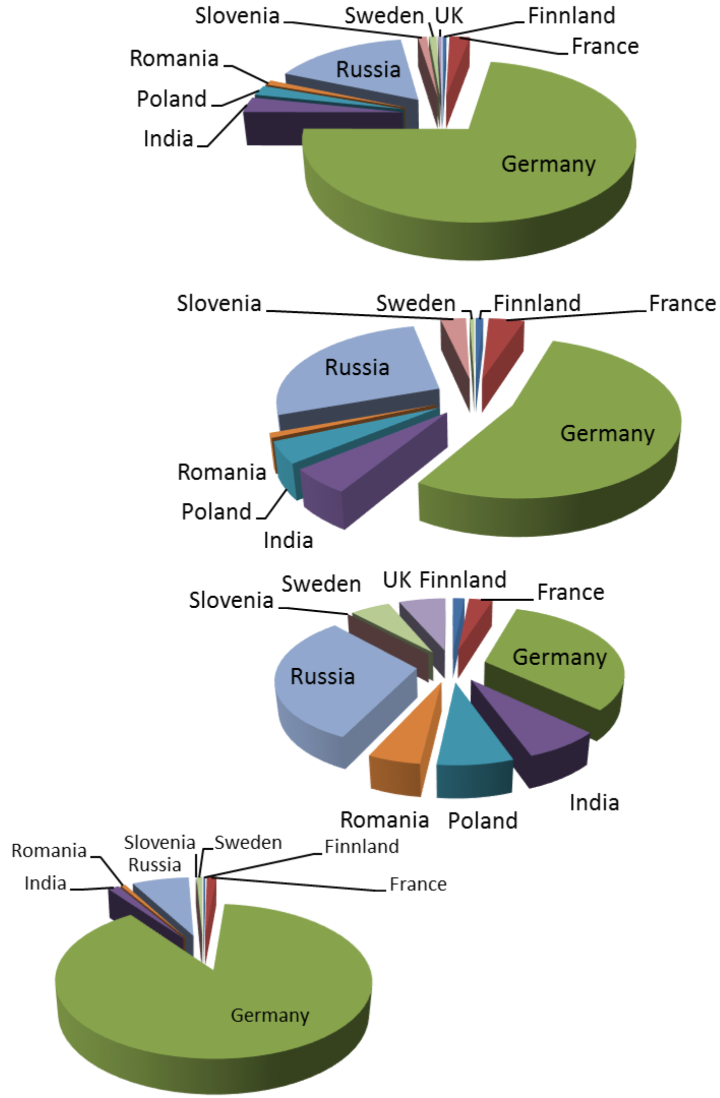
- Technical Director and FAIR Project Leader
  - Dr. Jürgen Henschel

- Selection processes for FAIR/GSI Technical Director and FAIR/GSI Scientific Director

FAIR Cost sharing FAIR partners

FAIR-Convention

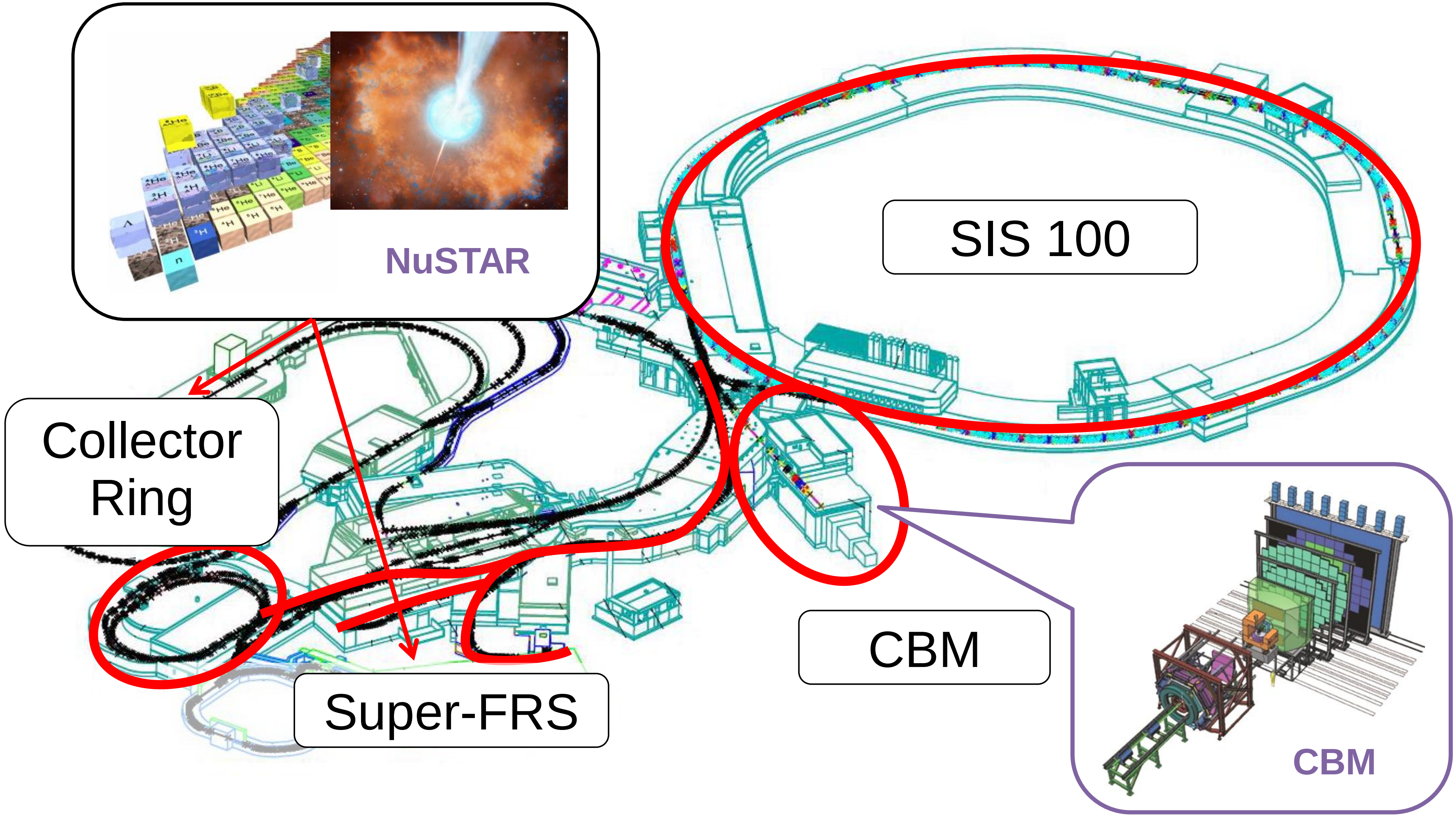
- Contributions to FAIR:
  - Total cost: 1027 M€ (2005)
- Contribution to accelerator:
  - total cost: 386M€ (FAIR Council)
  - Oversubscribed
  - Costbook: first com first served
- Contribution to experiments:
  - Total cost: ~200 M€
  - Limited to 78 M€ by FAIR Council Decision
  - Undersubscribed
  - Rest responsibility of Collaborations
- Civil Construction



Recent FAIR Council Decisions

- Realize FAIR MSV with scope of convention
- Cost frame of 1357 Mio. Euro in 2005 price level
- External Review of the project in 2019
- As fast as possible project execution in a reasonable stepwise approach to enable first FAIR experiments
- Economical project execution
- Commitment of shareholders for provision of financial means required for the project in steps

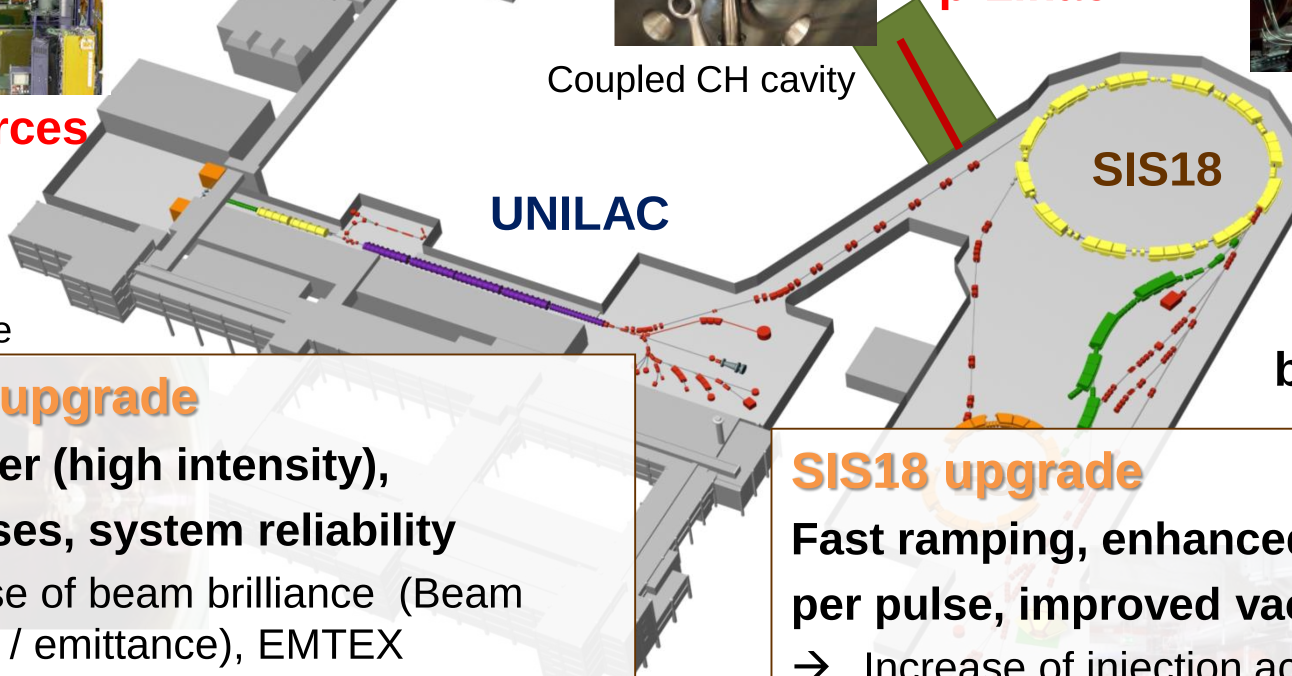
Heavy ion chain



UNILAC and SIS18 upgrade

Ion sources

Coupled CH cavity



UNILAC upgrade

High power (high intensity), short pulses, system reliability

→ Increase of beam brilliance (Beam current / emittance), EMTEX

→ Increase of transported beam currents

→ Improvements of high current beam diagnostics / operation

SIS18 upgrade

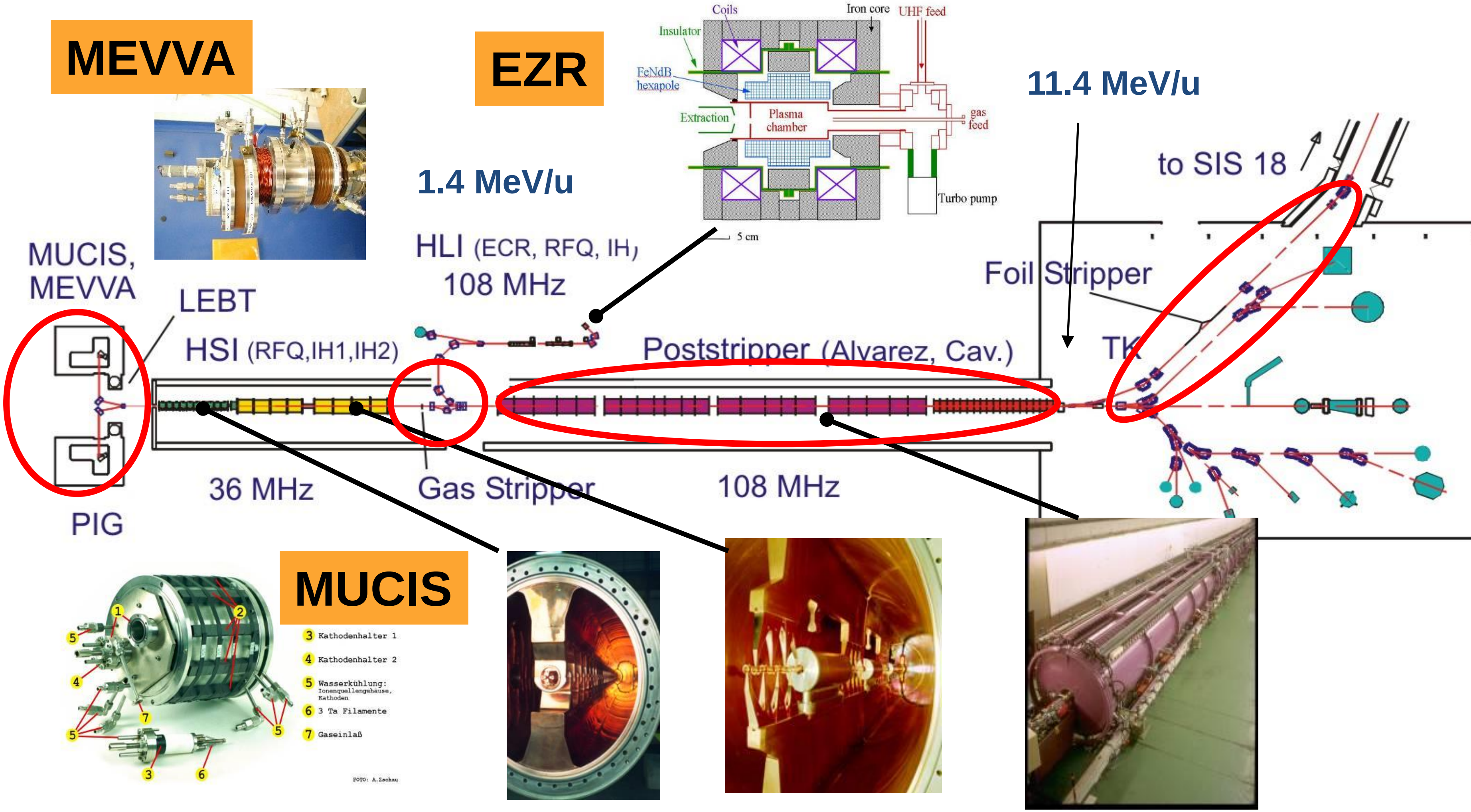
Fast ramping, enhanced intensity per pulse, improved vacuum system

→ Increase of injection acceptance

→ Improvement of lifetime for low-charged U-ions

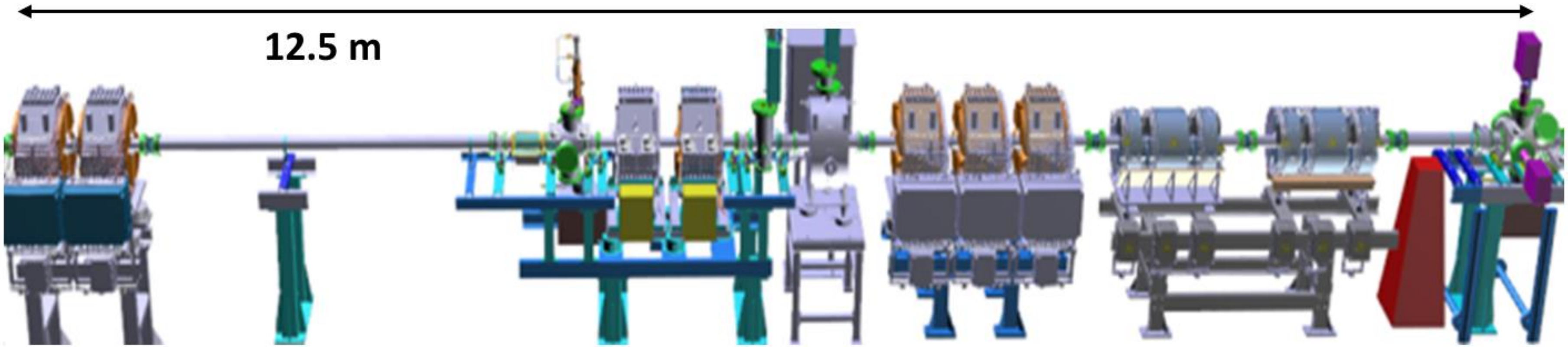
→ Increase of beam-intensity per time due to reduction of SIS18- cycle time

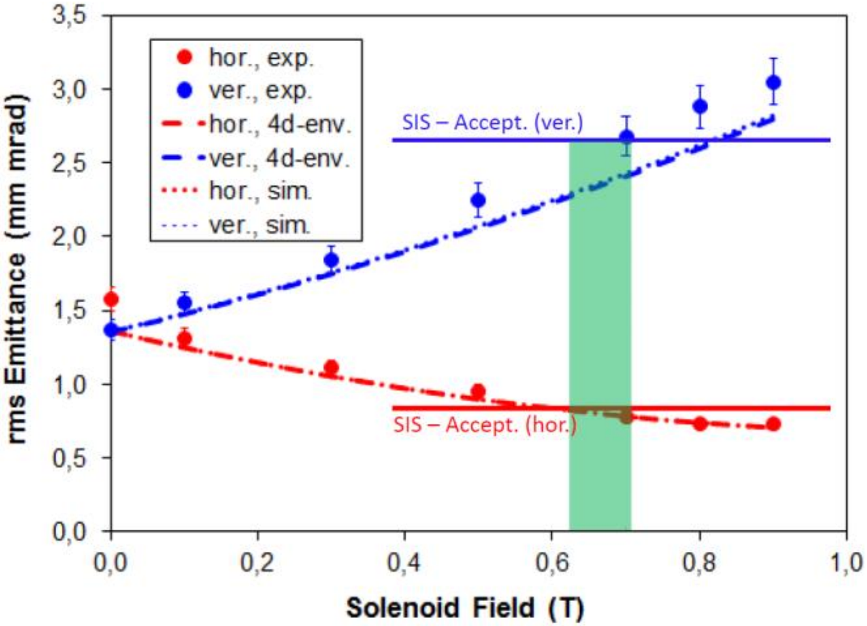
The UNILAC



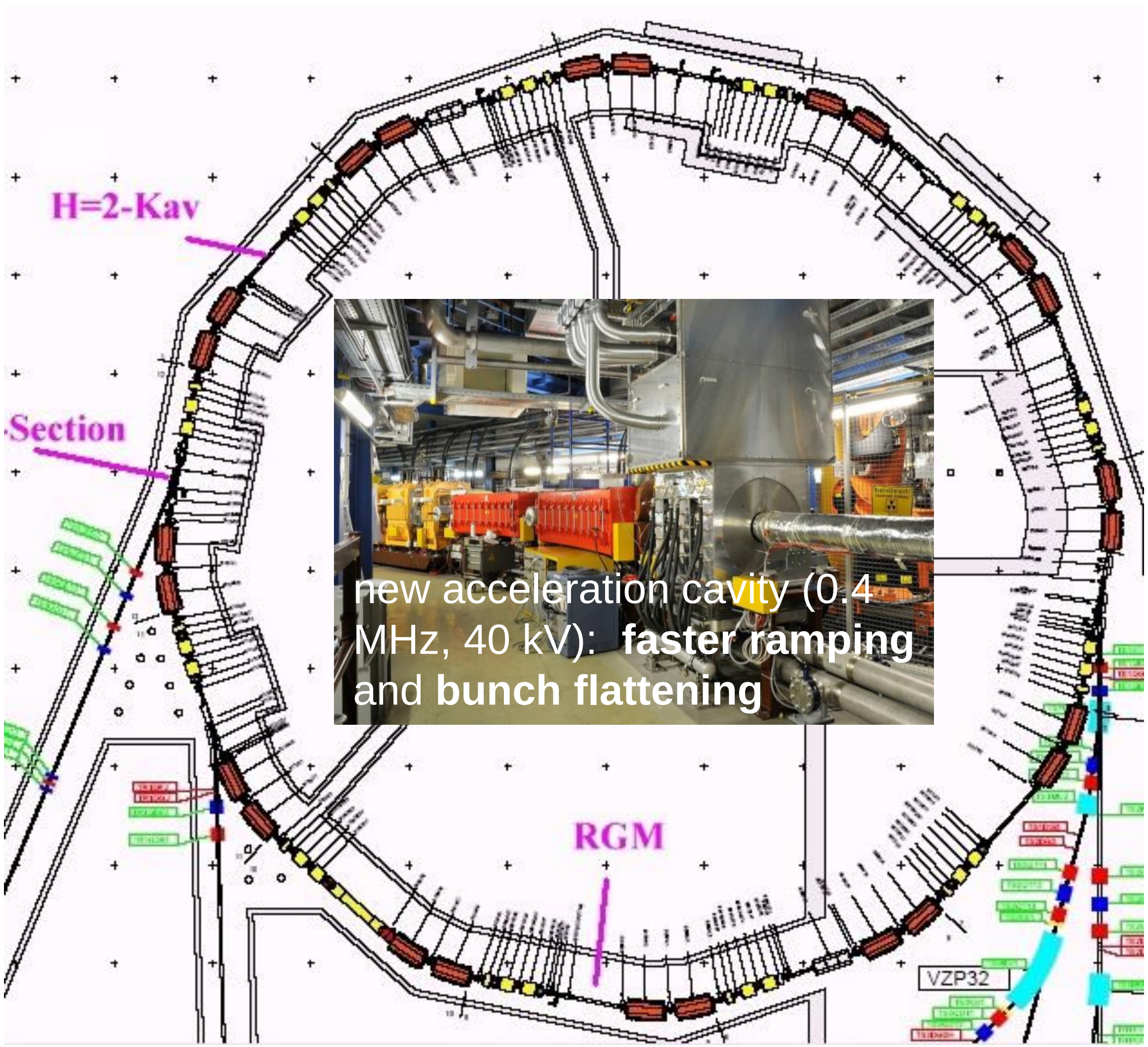
MEVVA
EZR
Coils
Iron core
UHF feed
Insulator
FeNdB hexapole
Extraction
Plasma chamber
gas feed
Turbo pump
5 cm
11.4 MeV/u
1.4 MeV/u
to SIS 18
MUCIS,
MEVVA
HLI (ECR, RFQ, IH)
108 MHz
Foil Stripper
LEBT
HSI (RFQ,IH1,IH2)
Poststripper (Alvarez, Cav.)
TK
36 MHz
Gas Stripper
108 MHz
PIG
MUCIS
3 Kathodenhalter 1
4 Kathodenhalter 2
5 Wasserkühlung: Ionenquellengehäuse, Kathoden
6 3 Ta Filamente
7 Gaseinlaß

EMTEX-beam line and first results





SIS18 high current upgrade



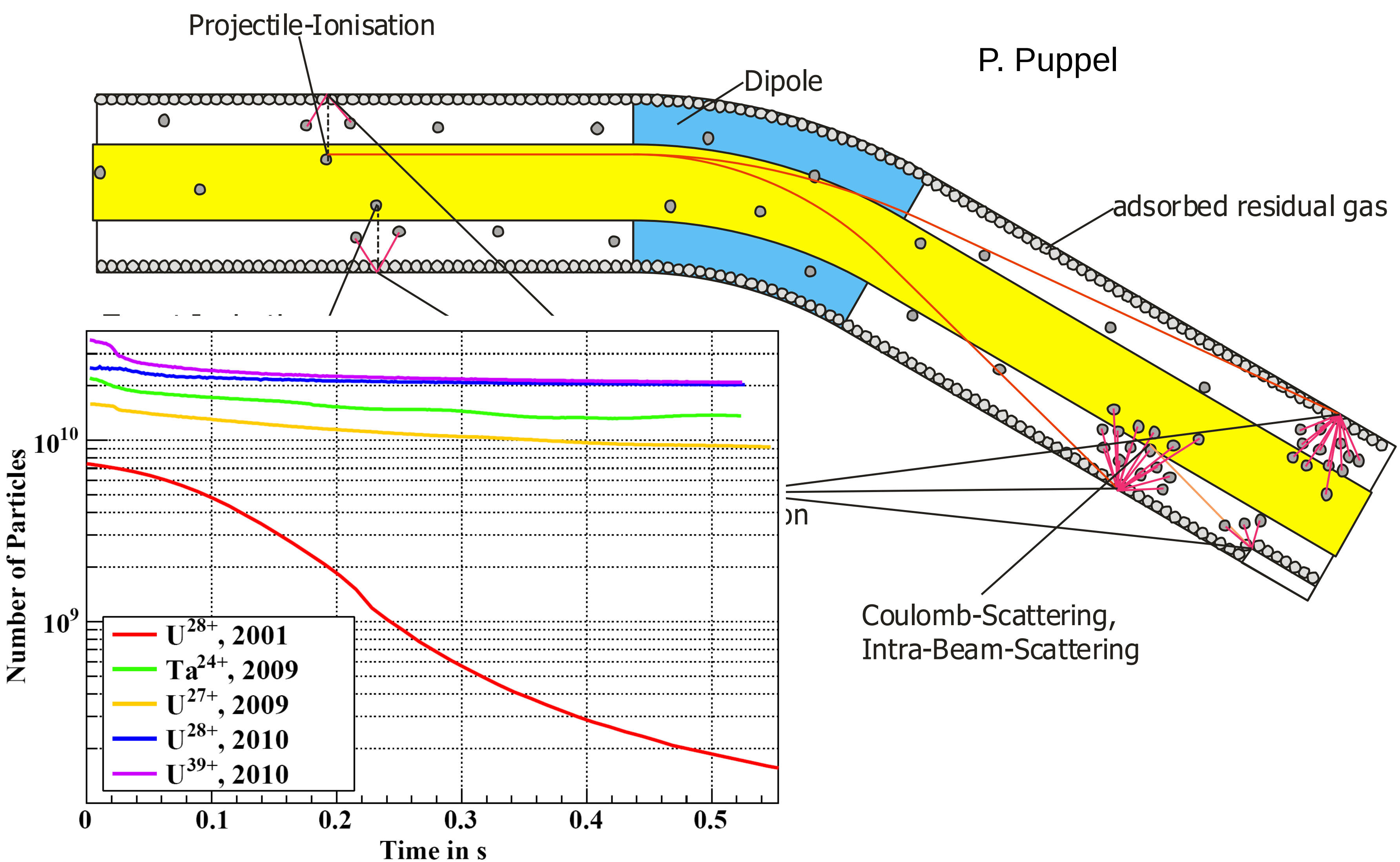
Main tasks done:

- new injection system finished
- Dynamic vacuum:
  - UHV upgrade
  - ion catcher and collimators
  - optimized beam diagnostics (Rest Gas Monitor)
- Bunch compression

To be completed:

- Main dipole power supply (fast ramping 10 T/s)
- h=2 cavities
- optimized slow extraction

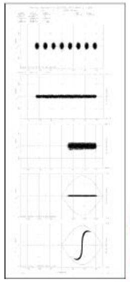
Dynamic Vacuum effect and collimation

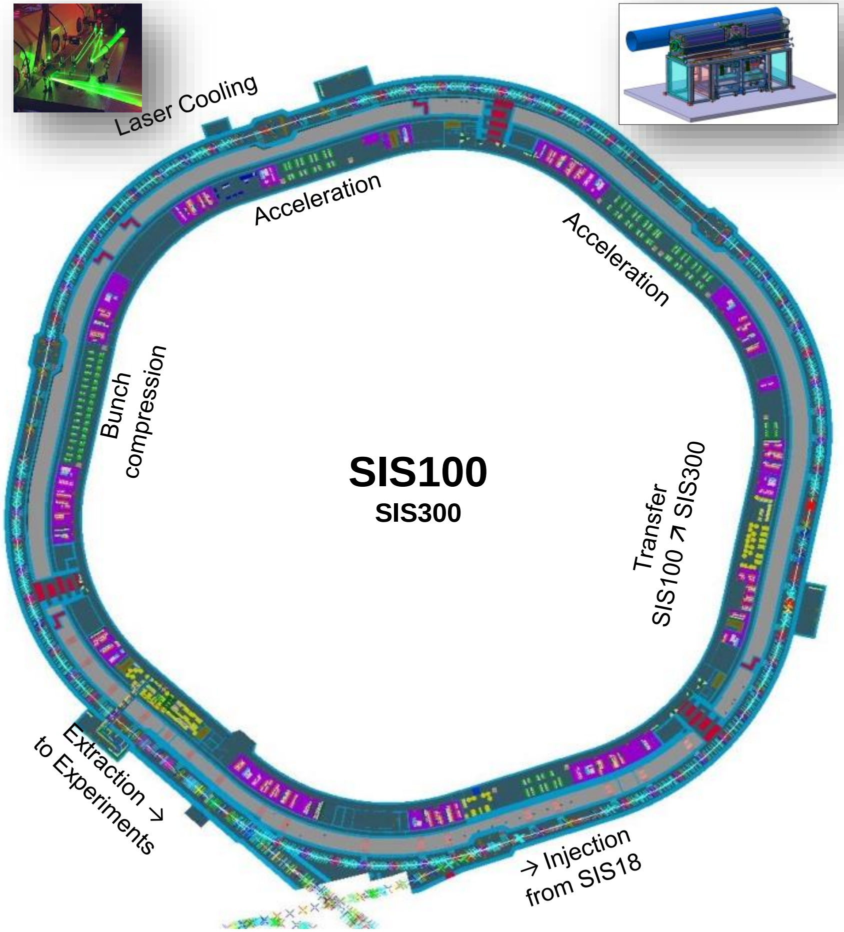


The SIS100 synchrotron

In order to fulfil the user requirements, SIS100 provides:

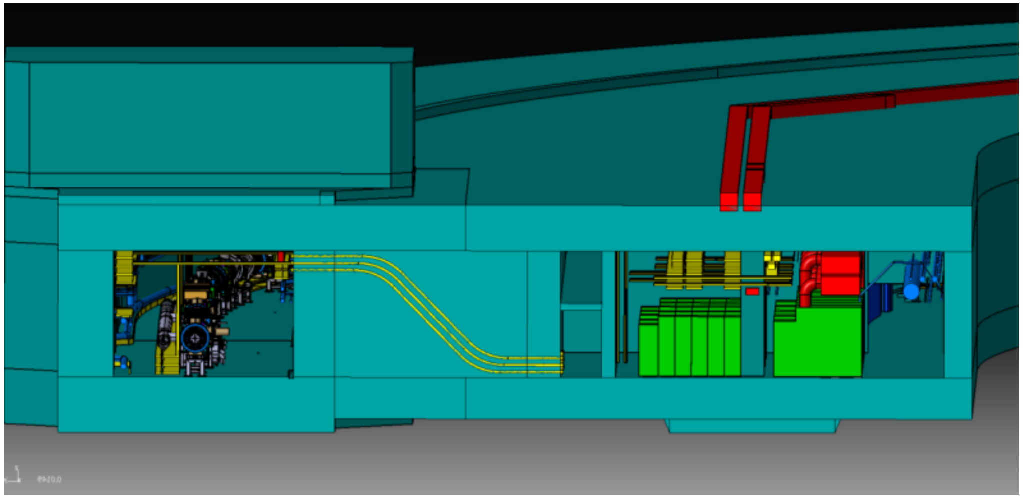
- high energetic beams of all ion species from Proton to Uranium
- beams of highest intensities per cycle and in average
- beams of various time structures (single bunches, compressed bunches, bunch trains, long spills)
- high flexibility in all settings from cycle to cycle which enables parallel operation of several experiments

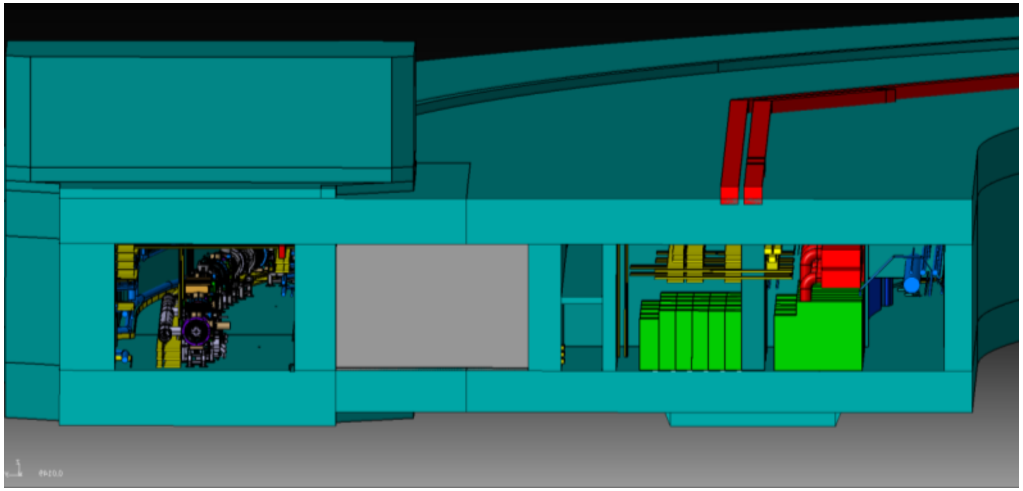




Images courtesy of M. Konradt / J. Falenski

Typical Tunnel Cross Section





HVAC and electric systems colour codes

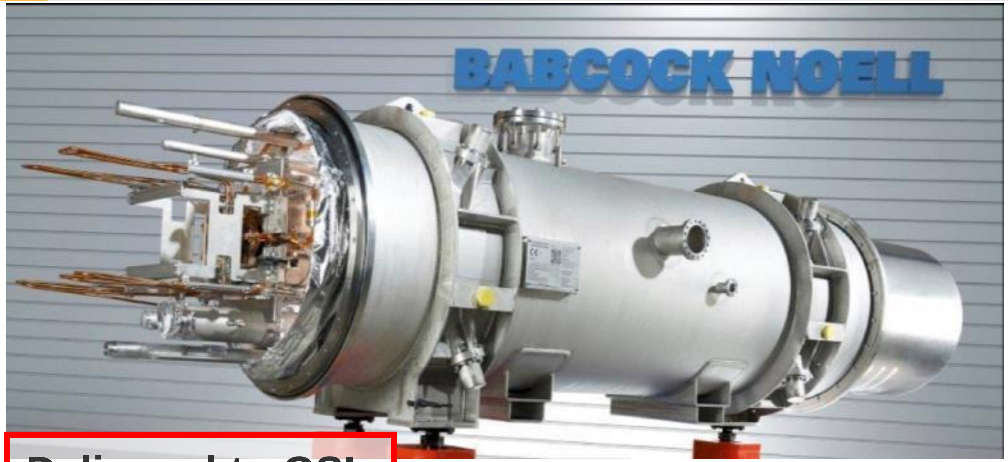
red: air ventilation, re-coolers
blue: cooling water, media supply
yellow: cable trays

Position with cable ducts running from beam tunnel to supply area.

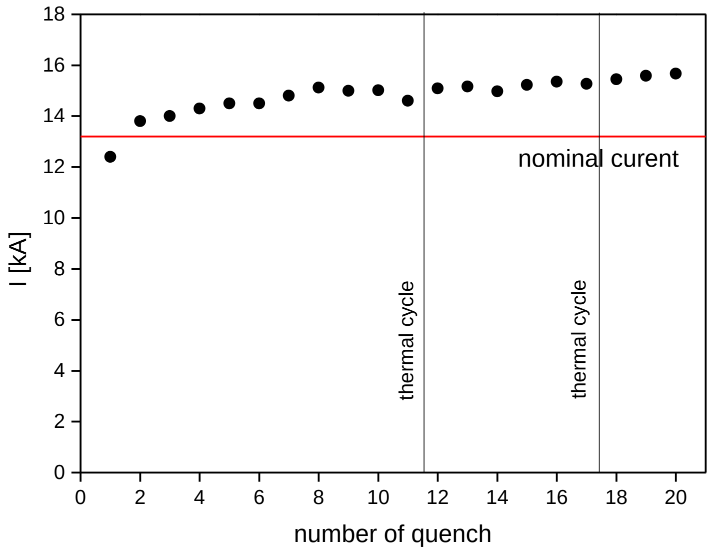
Position with earth shielding package between beam tunnel to supply area.

SIS100 tunnel review with positive result => go for finalized building permission and preparation of tendering

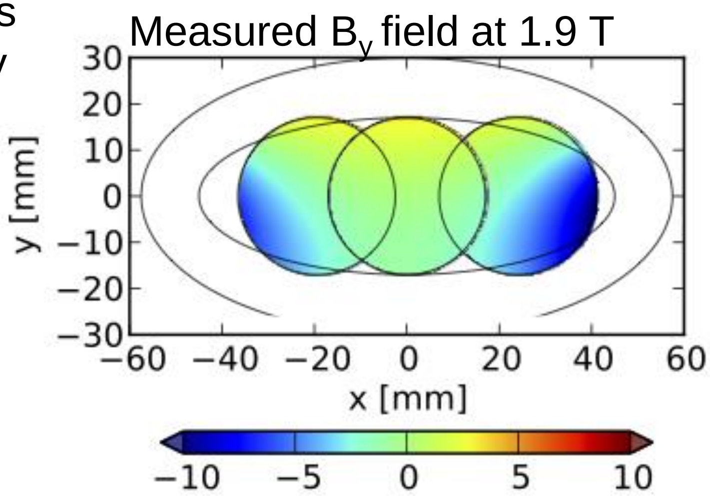
SIS100 dipole modules: First of series magnet



Delivered to GSI: June 3rd 2013



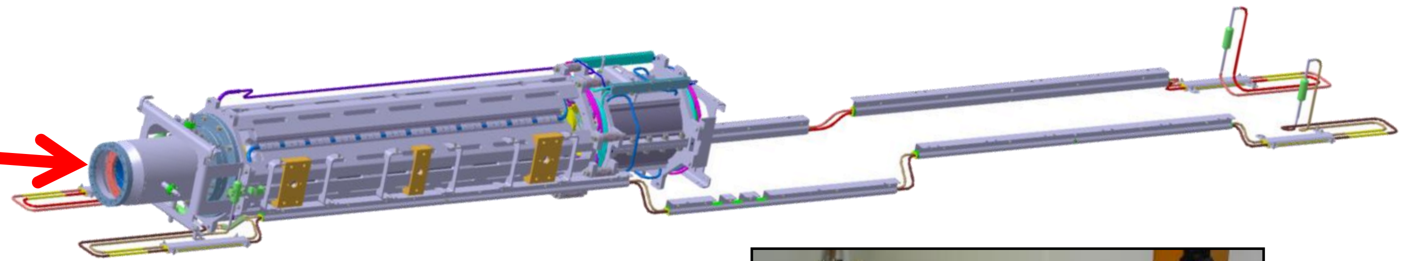
Sophisticated high accuracy field measurements
Indicated geometry errors outside specification.



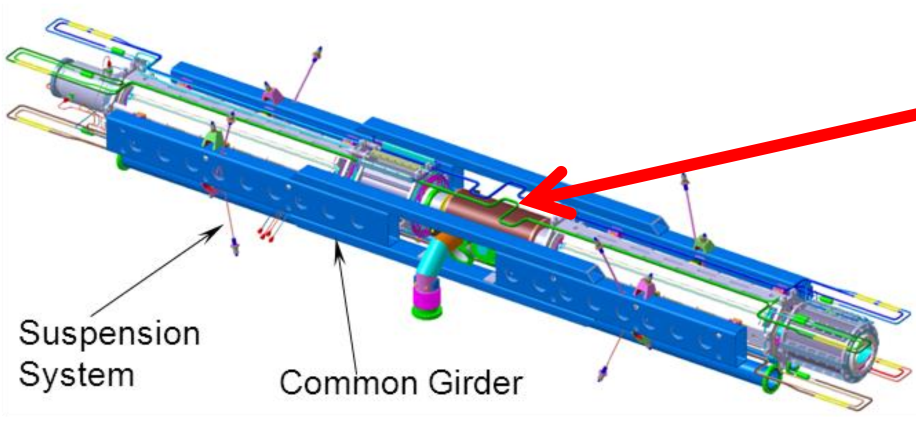
SIS100 Quadrupole Doublet Modules (QDM)

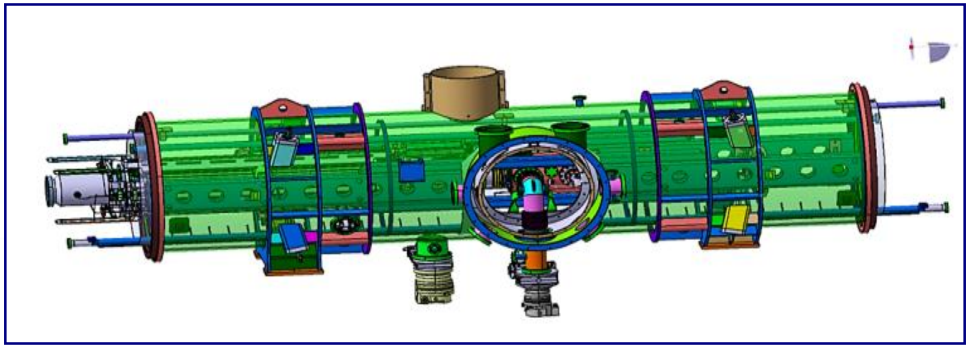
Module with QP, chrom. SP, BPM

→ **test of 169 units in JINR/Dubna**



Doublet with Cryo-Catcher module



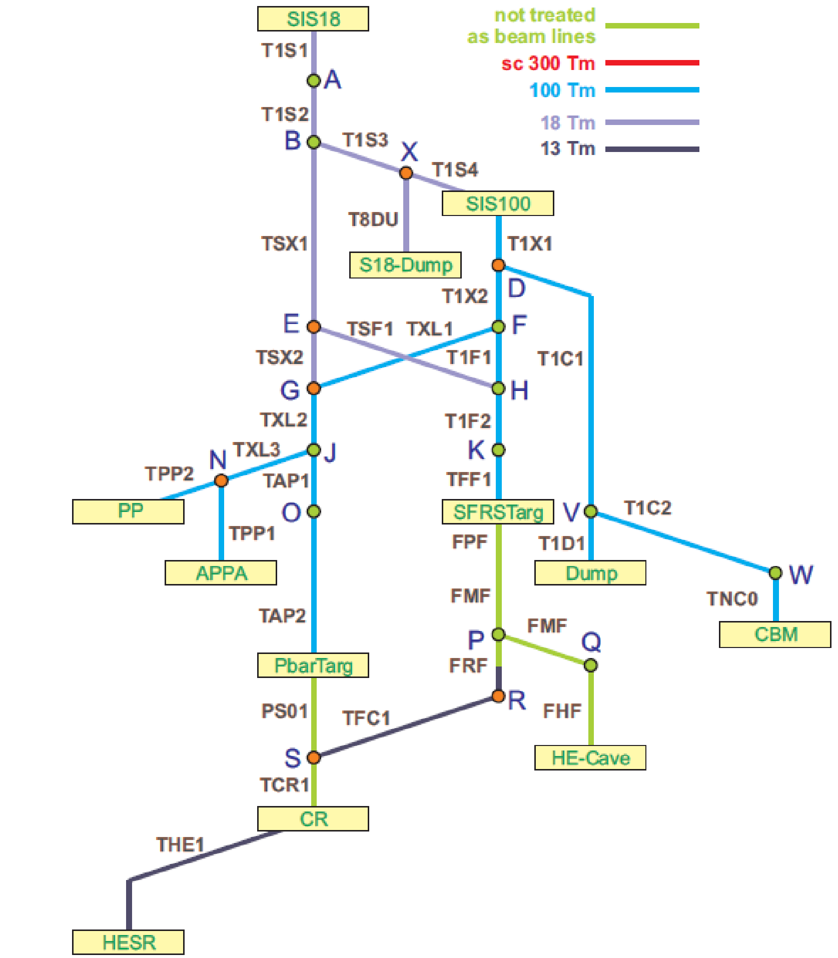


Functional elements installed in common girder

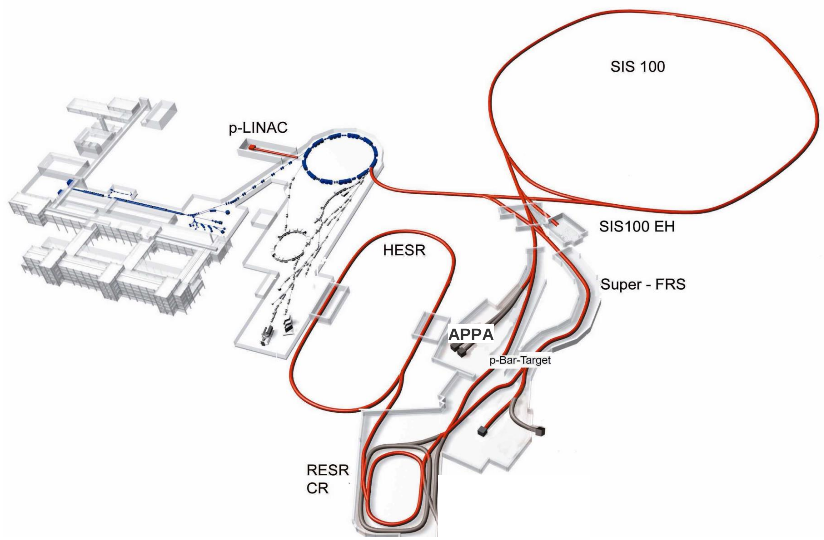
Test Benches of the STF

- 700 m² floor space for preparing and testing
- 4 independent test benches for a performance of 1 magnet per week
- Space for the SIS100 string test

HEBT – MSV (Module 0-3)

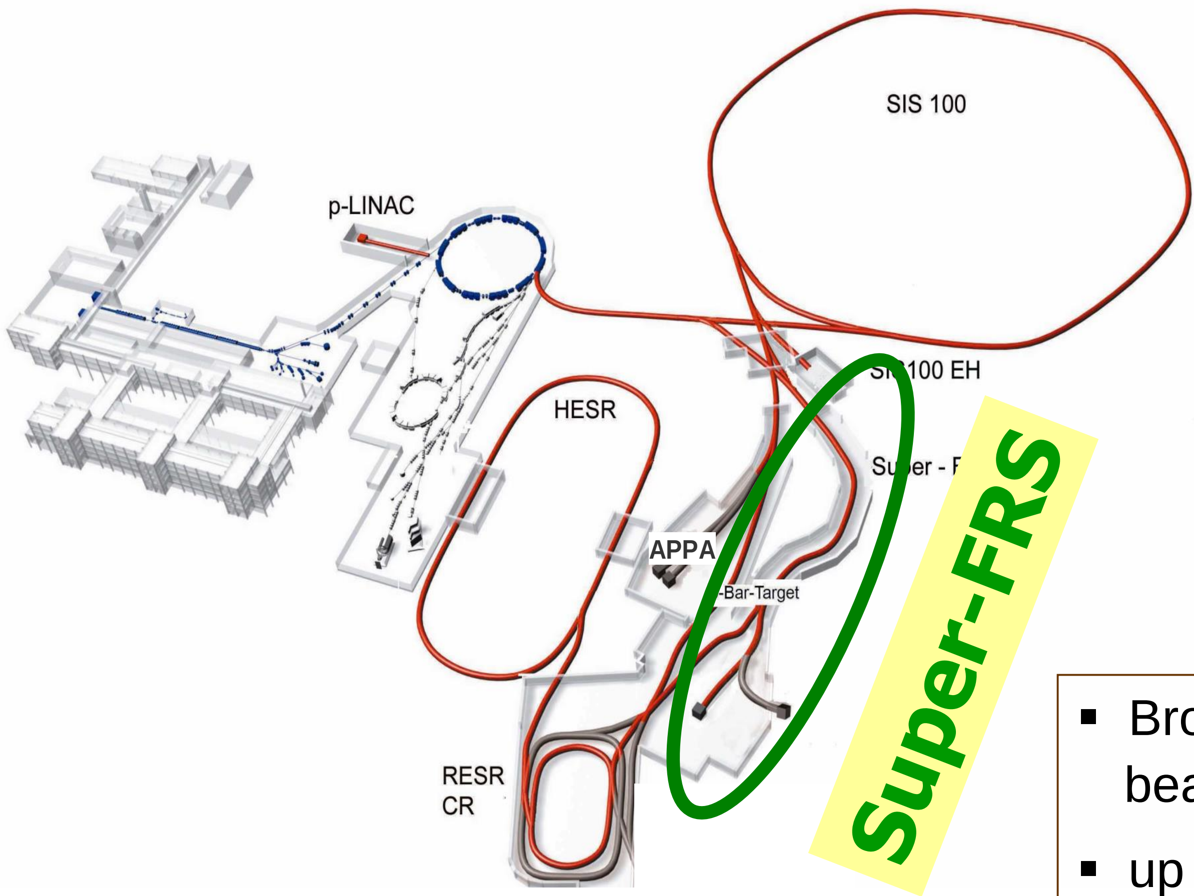


Green spots at junctions indicate that the connection going straight is open when the junction dipole is switched of



- 27 sections (11 connections/beam lines)
- Total length (HEBT) ca. 1.5 km
- All beam lines normal conducting
- Nominal magnetic rigidity: 100Tm, 18Tm, 13Tm
- Parallel operation

Super-FRS at FAIR



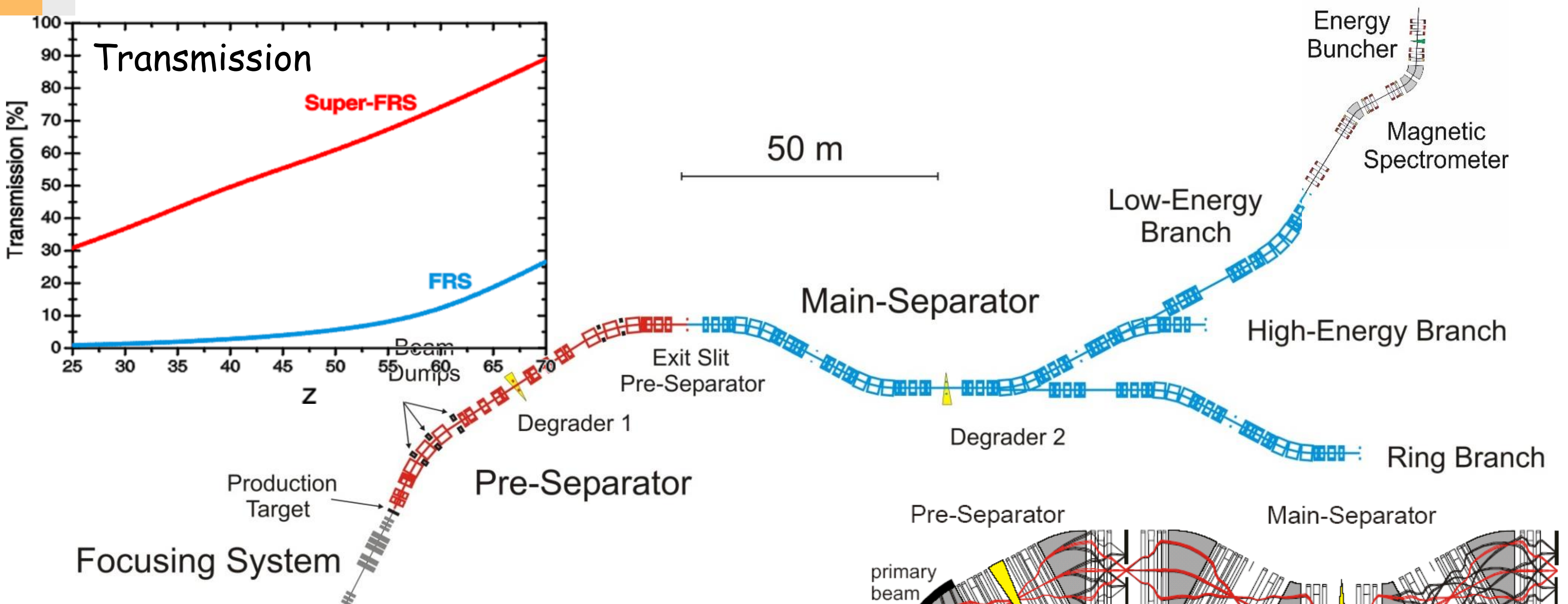
Primary Beams

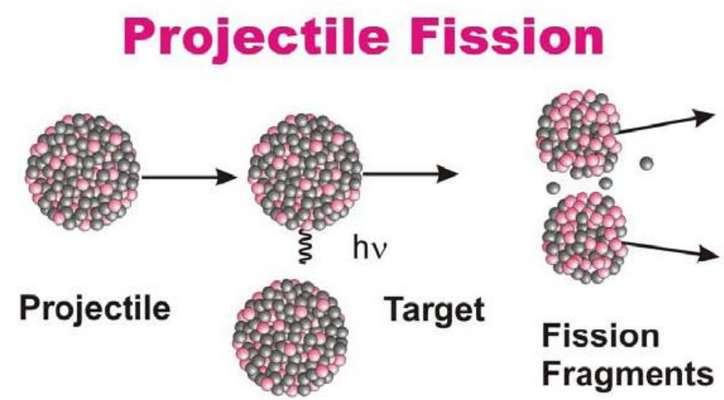
- $3 \cdot 10^{11}$ $^{238}U^{28+}$/s (Slow extr.) @ 1.5 GeV/u
- $4 \cdot 10^{11}$ $^{238}U^{28+}$ (pulsed) @ 1 GeV/u

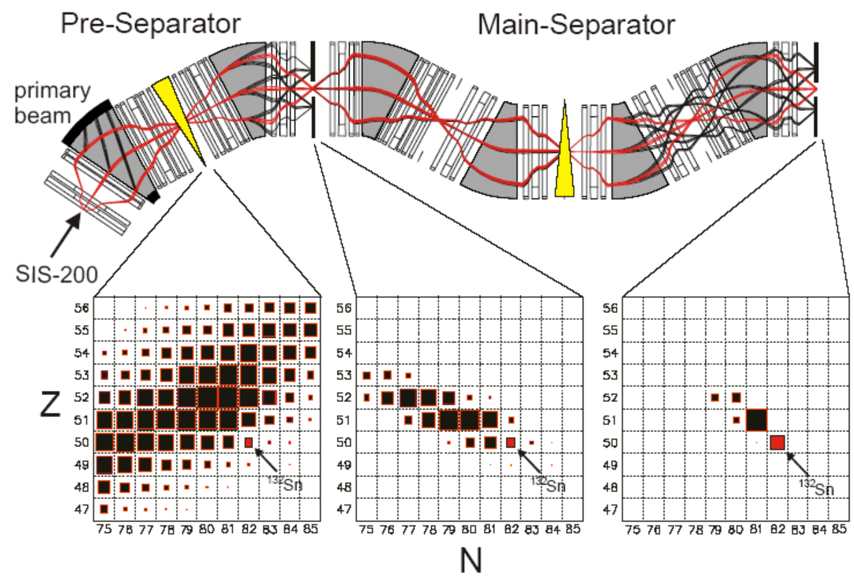
Secondary Beams

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

Superconducting FRagment Separator

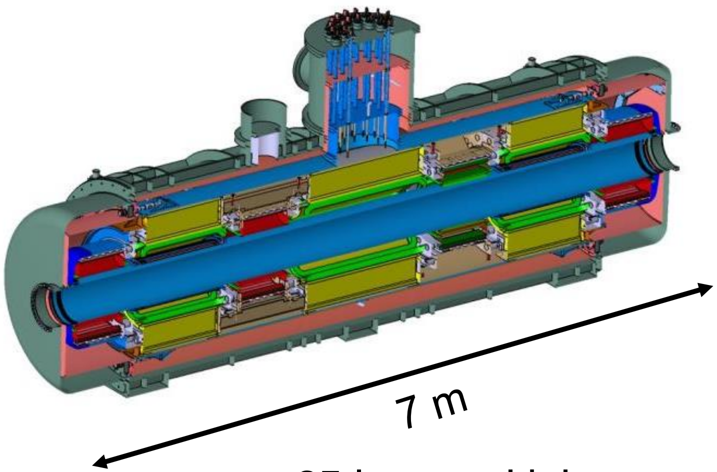






Super-FRS SC magnets

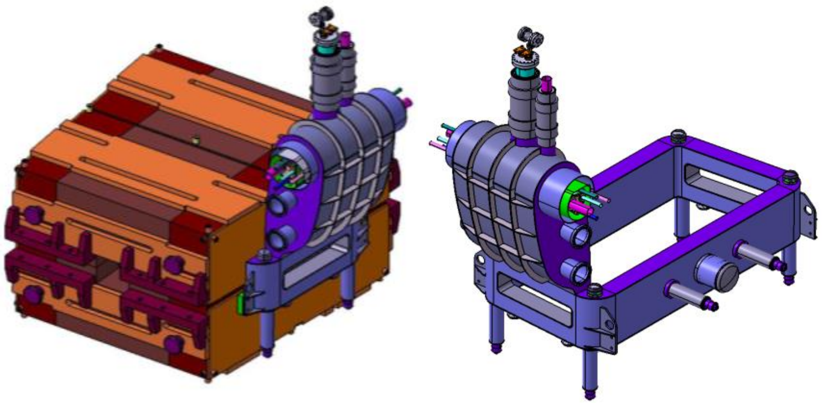
Multiplets:
- iron dominated, cold iron (≈40 tons)
- common helium bath, LHe ≈ 1.300 l
- warm beam pipe (38 cm inner diameter)
- per magnet 1 pair of current leads
- max. current <300A for all magnets



25 long multiplets
8 short multiplets

Dipole magnet design and procurement.
→ Collaboration agreement with CEA/Saclay on detailed design & Technical follow-up

Tender by FAIR starting Q4/2015
First of Series ready for testing: Q2/2017
Series production & testing (at CERN):
3-4 years

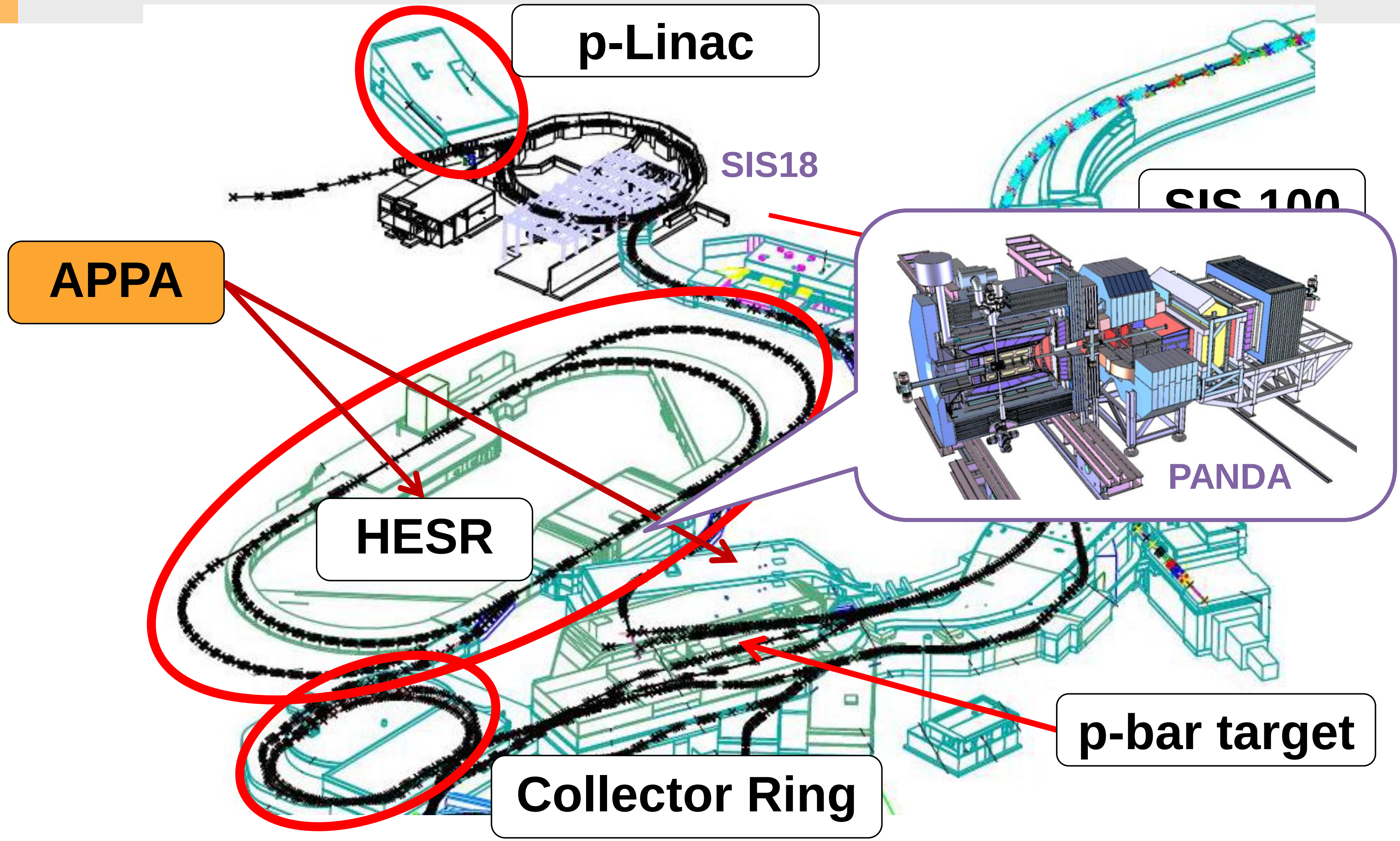


CEA revised SC dipole design

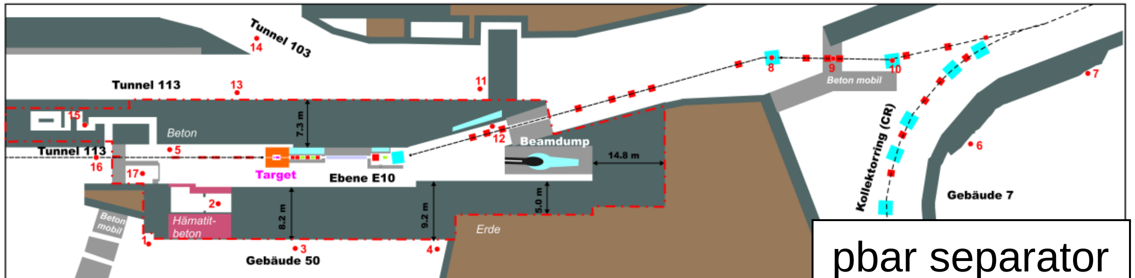
GLAD magnet delivered

- For R3B collaboration
- 60 ton superconducting dipole
- produced by CEA Saclay
- arrival on GSI site at 5.11.2015
- intermediate use in GSI facility

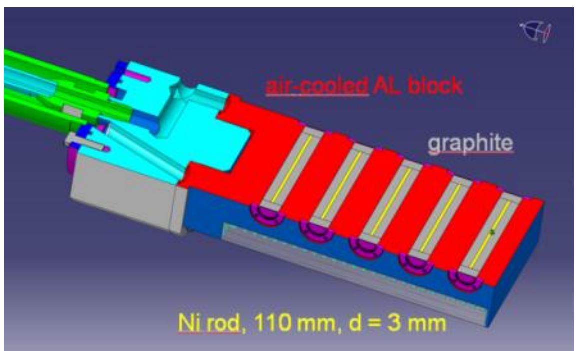
Anti proton accelerator chain



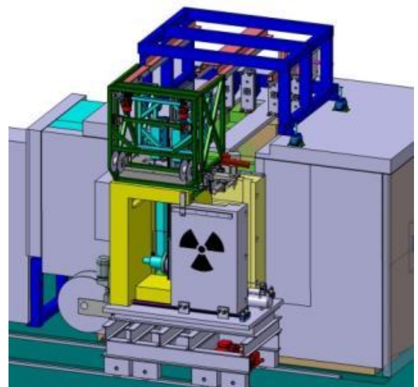
The pbar target and separator



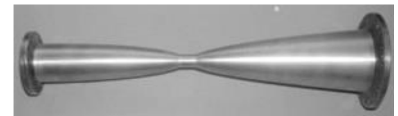
pbar separator

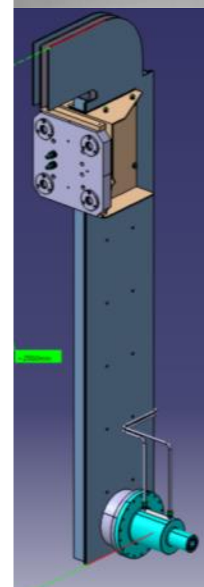


target

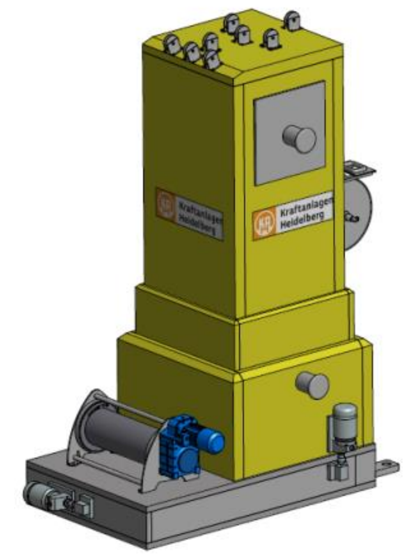


target station (250t) with remote handling



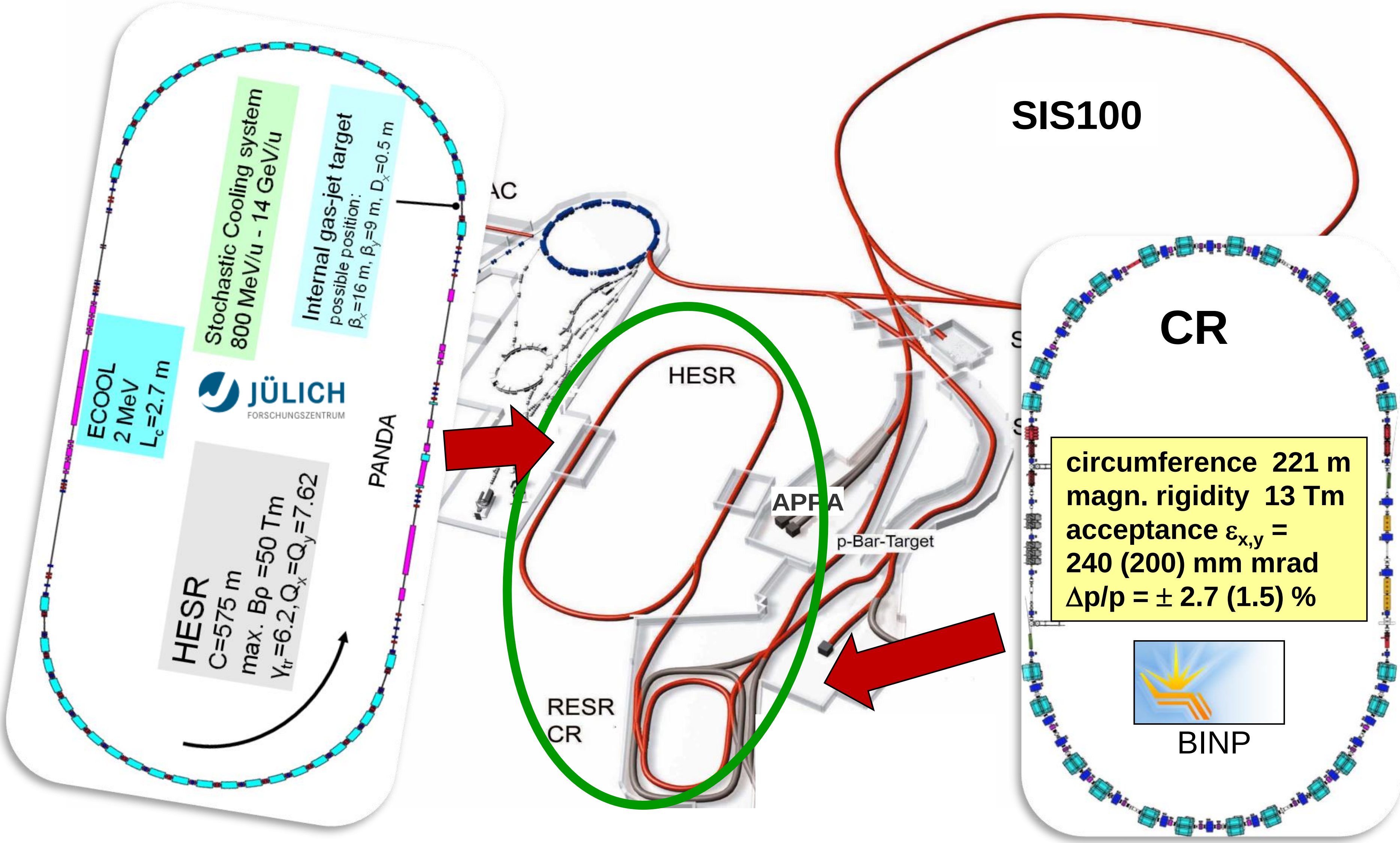


magnetic horn



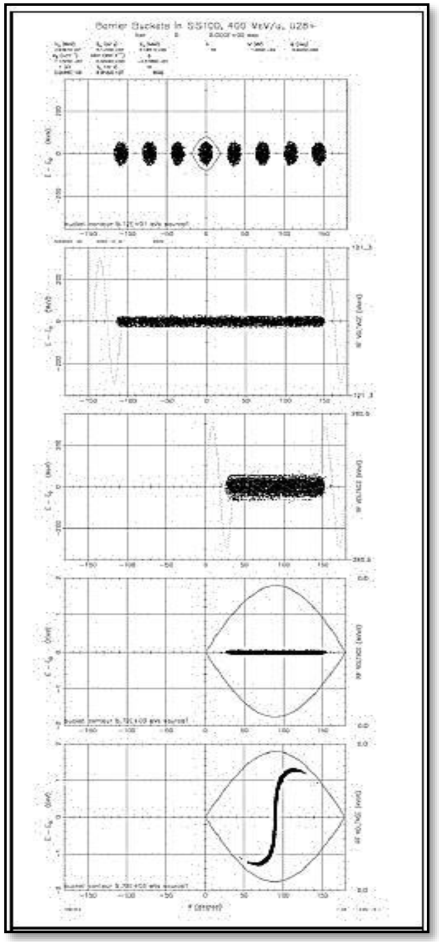
shielding flask (25 t)

The FAIR storage rings



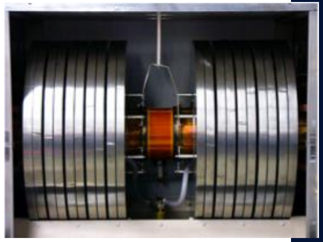
Beam manipulation for secondary beam production

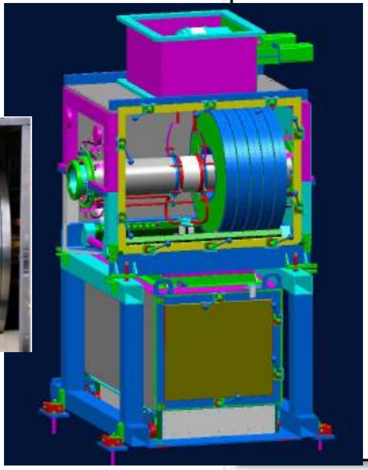
Short pulses for optimum target matching and fast cooling in CR

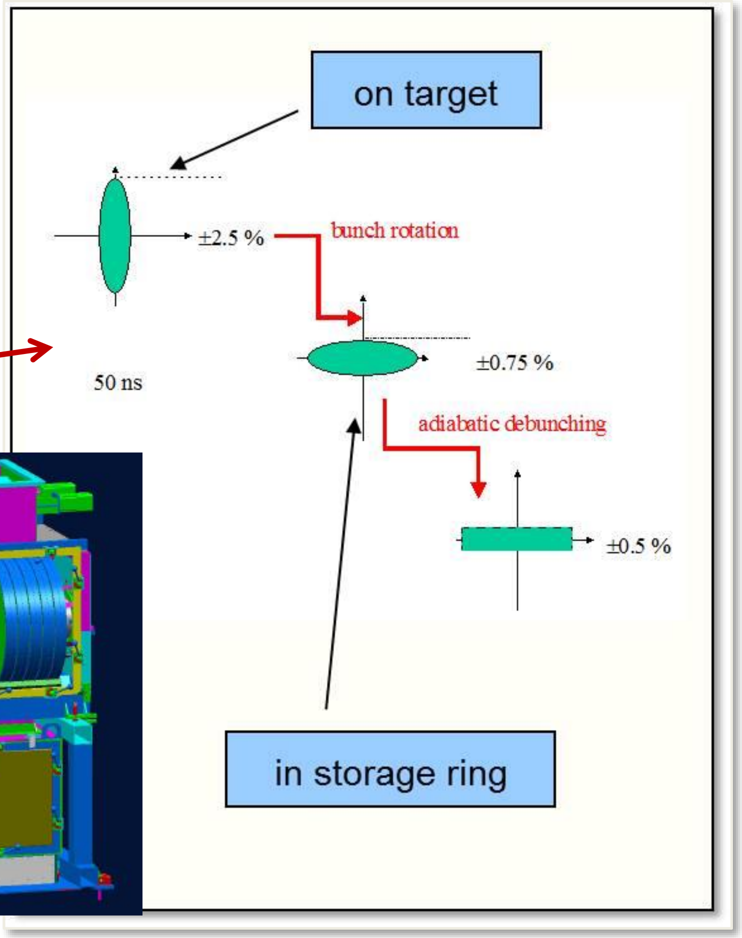


Major bunch manipulations are required in the FAIR synchrotrons and storage rings:

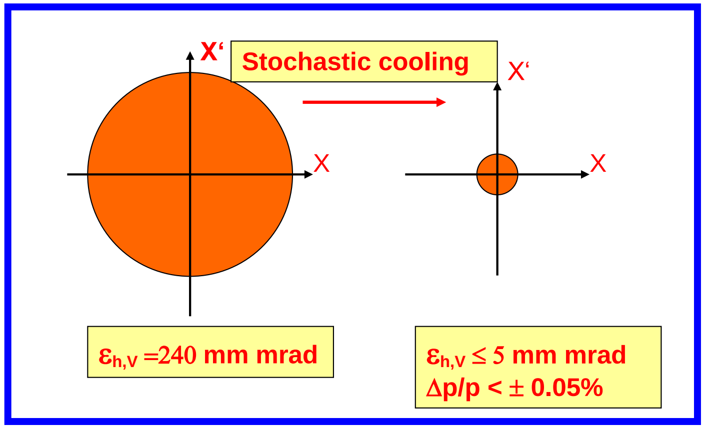
Fast decompression (debunching)

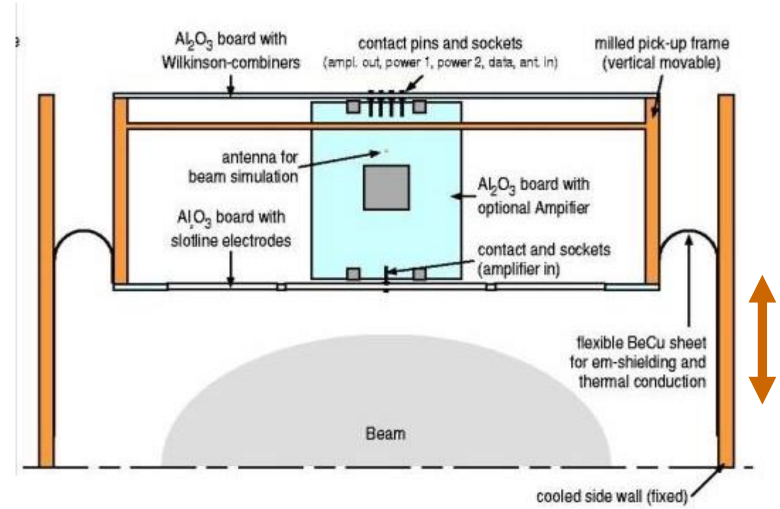


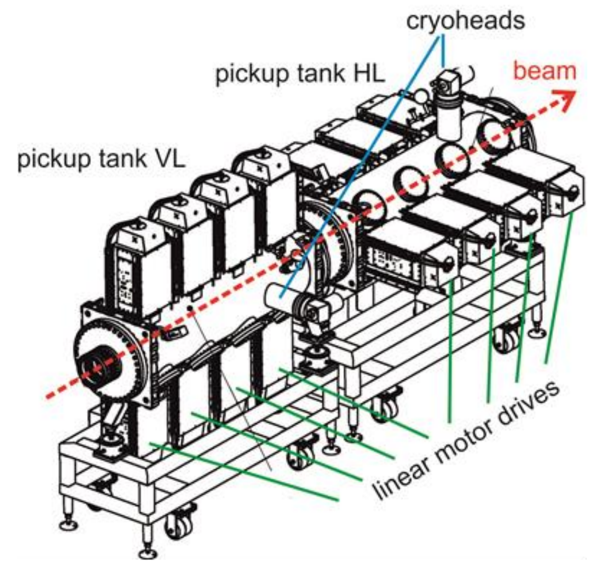




Stochastic Cooling development







Challenges:

- fast stochastic cooling (1-2 GHz) of antiprotons (10 s) and RIBs (1.5 s).
  pbar: Momentum spread - from 2% to 0.1%,
  Emittance - from 240 to 5 mm mrad
  RIBs: RIB momentum spread from 1% to 0.05%,
  Emittance from 200 to 0.5 mm mrad
- 2 GHz band (large bandwidth required)
- UHV conditions and on 20 K temperature level

Summary and Outlook

- FAIR shareholders confirmed full MSV (stepwise)
- FAIR management level rearranged
- Two new FAIR/GSI directors to start in 2016
- GSI accelerators upgrade progressing well
- Large fraction of accelerator components in production

=> After intense review processes in 2015 the FAIR project will stepwise progress towards the full MSV

- Courtesy to Oliver Kester und David Urner for the provision of material for this presentation