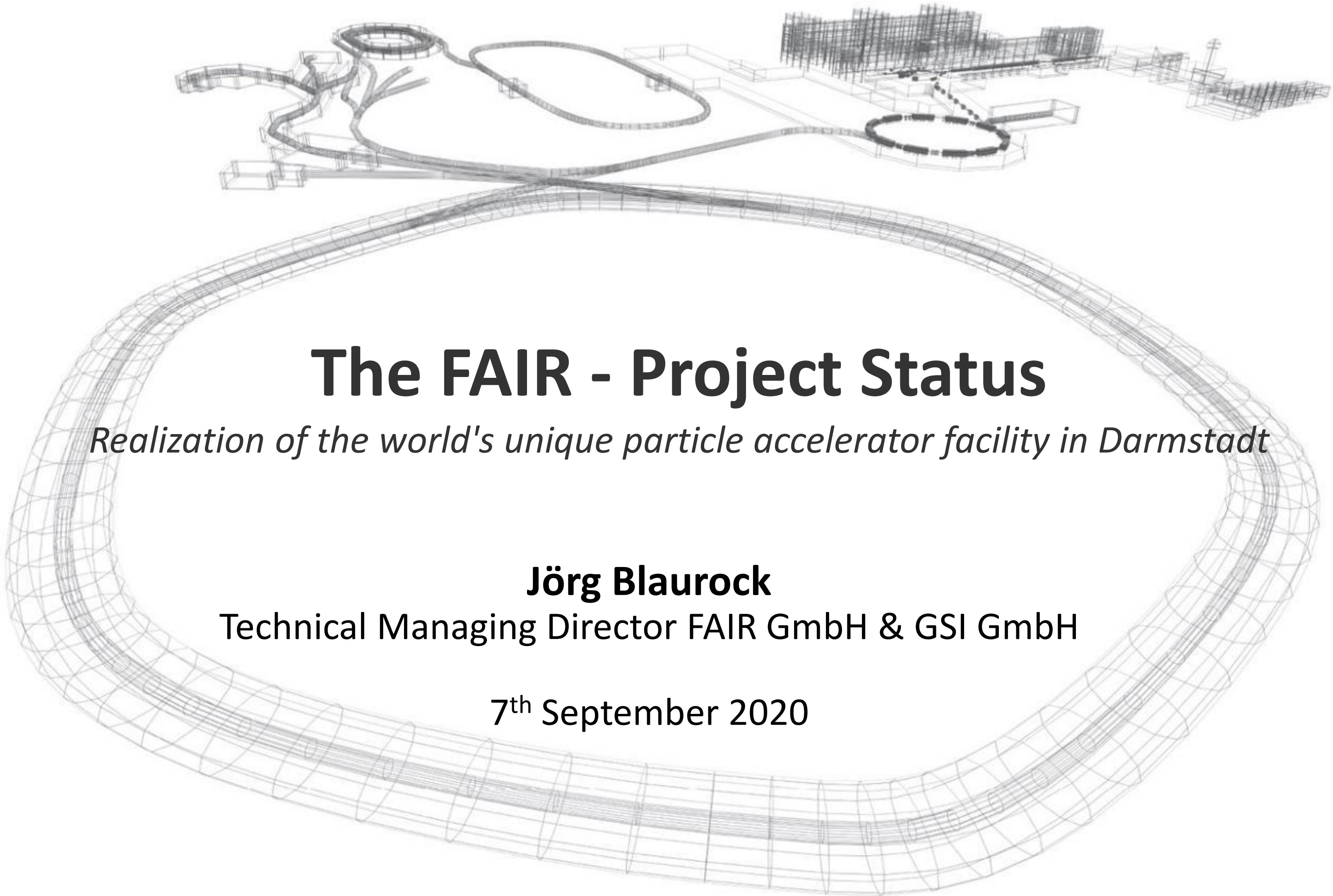


The FAIR - Project Status

Realization of the world's unique particle accelerator facility in Darmstadt

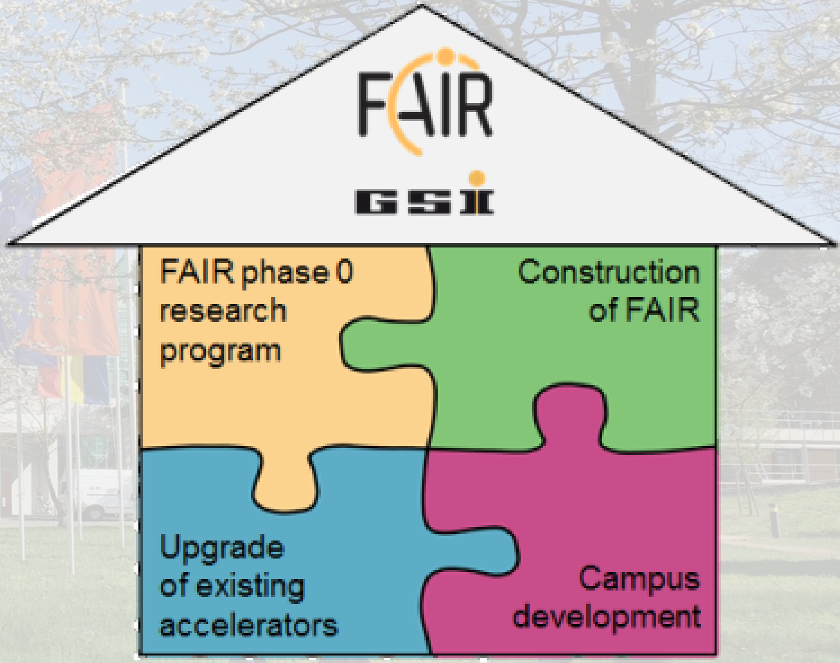
Jörg Blaurock

Technical Managing Director FAIR GmbH & GSI GmbH

7th September 2020

STRATEGIC OBJECTIVES OF GSI / FAIR

- **Construction of FAIR**
- **Upgrade of existing accelerators**
- **FAIR phase 0 research program**
- **Development on Campus**



Covid-19 Pandemic

- Significant impact on FAIR GmbH and FAIR Project
- Safety measures in place for employees and people involved in FAIR Project
- Activities at the construction site and on Campus to continue as far as possible whilst keeping safety as top priority
- FAIR suppliers and institutions also strongly affected
- Preliminary assessment of first impact is on-going

Development on Campus

- Developing the buildings and facilities in view of the future operation of FAIR is one of the strategic goals of both FAIR and GSI.
- Two Measures taken to develop the Campus as a host lab and to provide a state of the art workplace and accompanying infrastructure are:

FAIR Control Centre

- Hosting the Main Control Room and some 200 work places
- Operation planned during year 2024

Sketch of the building: view of the visitors gallery and main control room in the front.

Parking Garage

- Providing parking space for approx. 800 cars
- Completion planned in Q1 2021

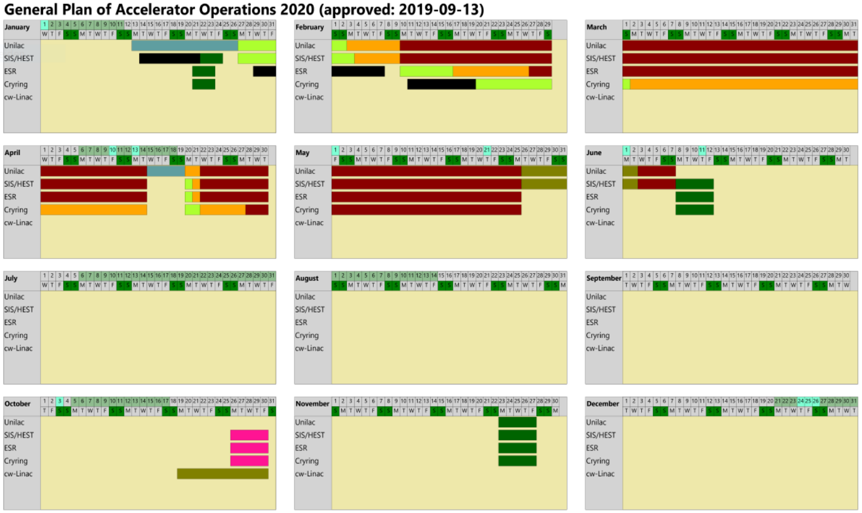
Picture showing the status of civil works of the parking garage mid-July 2020.

Accelerator and Experimental Facilities
Physics Run 2020 - FAIR Phase-0

Phase 0
Research Program

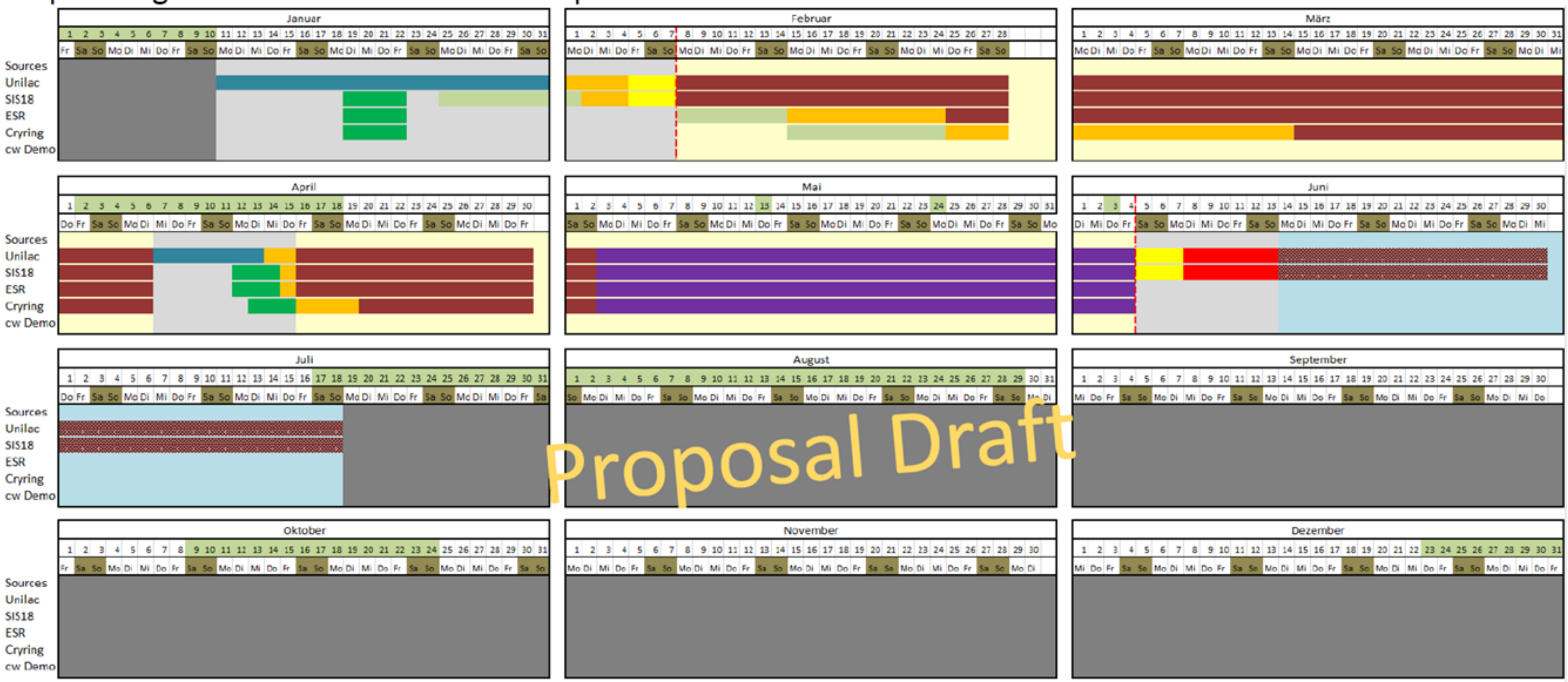
- Beamtime 2020 run
  - 2020 run started in Feb 2020 as planned
- Impact due to Covid-19 outbreak
  - Travel restrictions, changed working mode (distancing)
  - **SAFETY first** rule on campus, only experiments which could be performed satisfying safety rules have been performed.

- Nonetheless, about 2/3 of the planned experiments could be completed
- Research projects are being developed to contribute to the management of the Covid-19 pandemic (BIOMAT collaboration)



Accelerator and Experimental Facilities
Physics Run Proposal 2021

planning of the General Accelerator Operations 2021



Legend	Days
Bake Out	0
Dry-Run	8
Commisioning without Beam	25
Beam Commisioning	38
Physics Run	75
Engineering Run	6
Operator Training	6
RF-Conditioning	28
Physics Run (without A4)	33
to discuss: Proton Beam without A4	35

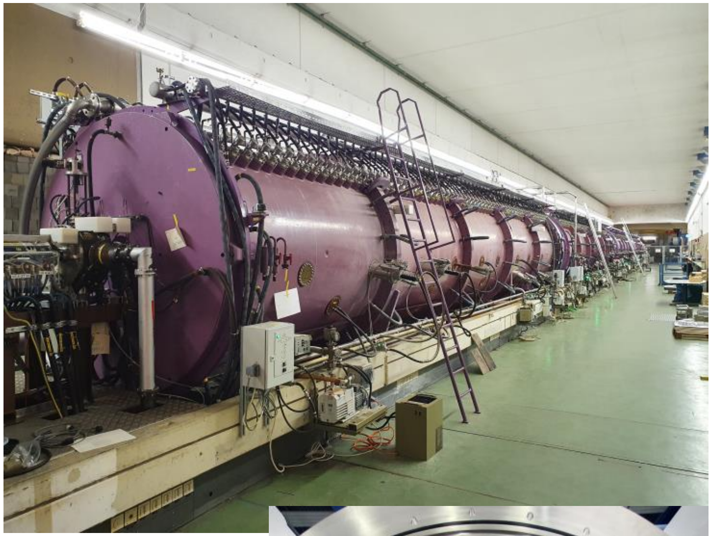
beginning of the beam-time for Physics Run:
February 8, 2021
end of the beam-time:
June 4, 2021
Option for 3-days operator training, 1 week engineering run for Machine development and a dedicated HADES proton run:
June 5, 2021 to July 18, 2021

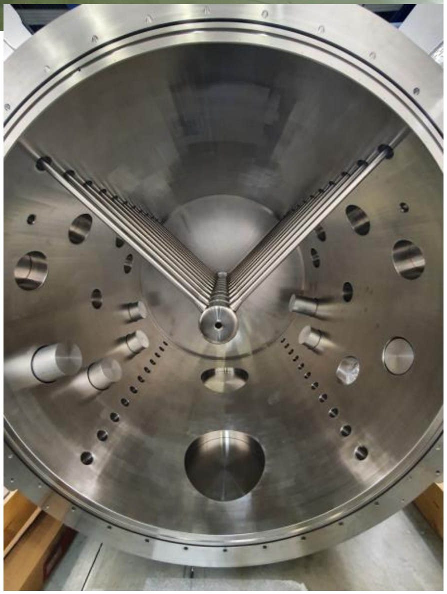
Accelerator and Experimental Facilities
Replacement UNILAC post-stripper DTL section

- It comprises five rf-cavities, each with
  - 11 m of length
  - 2 m of diameter
  - 10 t of weight

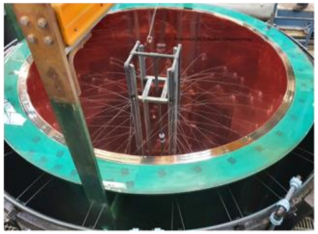
- First of series (FoS) started and progressing as anticipated

- series production in 2023 – 2026

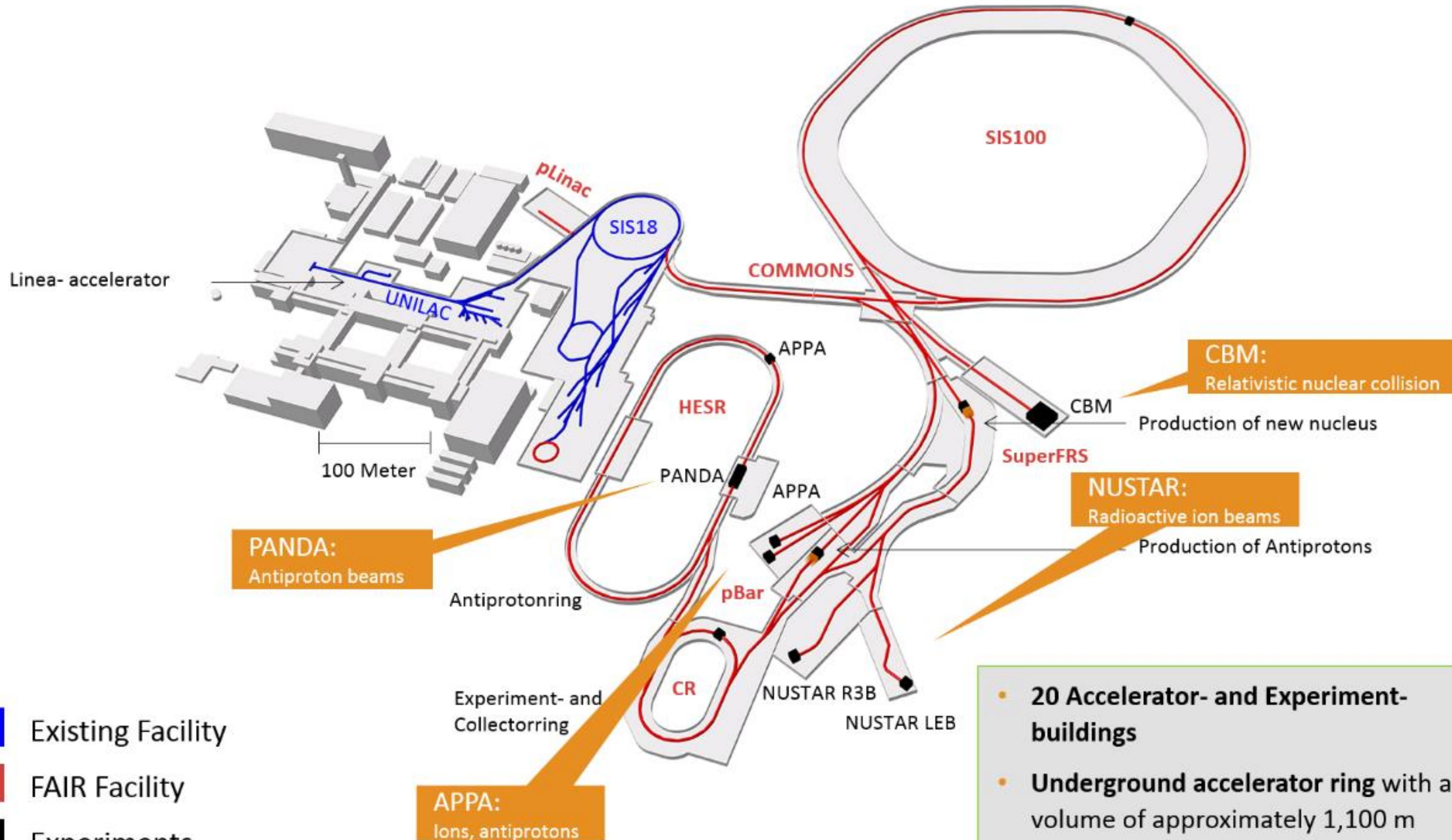







FAIR – The facility



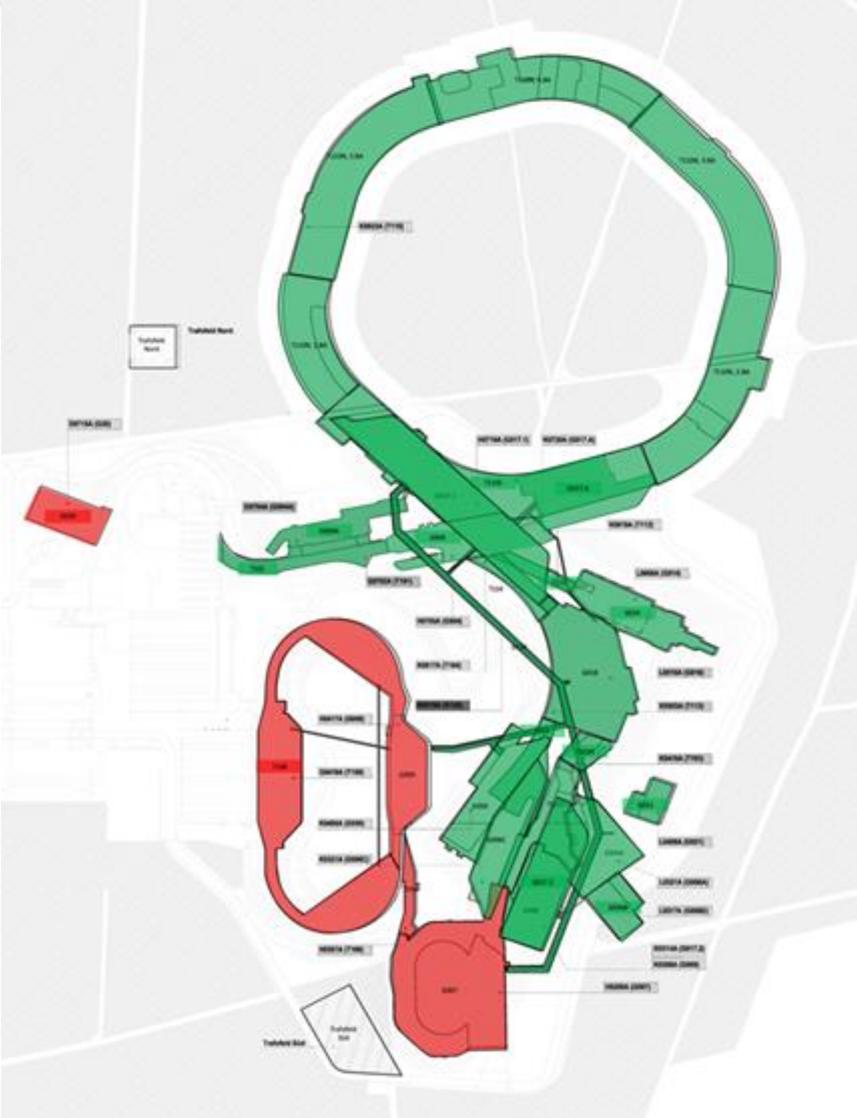
- Existing Facility
- FAIR Facility
- Experiments

- **20 Accelerator- and Experiment-buildings**
- **Underground accelerator ring** with a volume of approximately 1,100 m
- **Around 150,000 m ²** total space

Construction Dimension

FAIR Intermediate Objective

- The Council decision in February 2020 to build the FAIR Intermediate Objective is a major step in continuing project execution towards the realisation of the FAIR MSV



AGENDA

FAIR Project Progress Highlights

a. Accelerator

b. Experiments

c. Civil Construction

FAIR Next Steps

GSI/FAIR: R&D topics

FAIR Recent Accelerator Highlights (Part 1)

May 2020

5 HEBT- dipole magnets were delivered for SAT testing from NIIEFA (Russia) to GSI, in total we have 43 out of 51 magnets on campus

June 2020

Delivery of 2 SIS100 injection septum magnets to GSI from Danfysik for site acceptance test

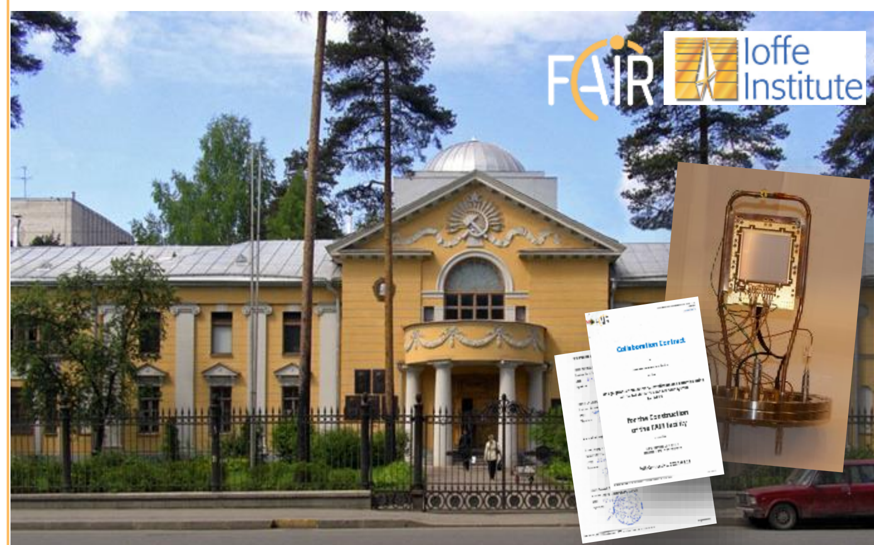
FAIR Recent Accelerator Highlights (Part 2)

April 2020

36 Power Converters for HEBT steerer magnets were delivered to Weiterstadt by ECIL, India.

July 2020

SuperFRS Time of Flight (TOF)-Detectors contract has been signed by IOFFE Institute (Russia) and FAIR.



FAIR Recent Accelerator Highlights (Part 3)

May 2020

4th BINP – FAIR Workshop took place on 25th – 29th of May 2020 via Video conference

November 2019

The first integrated SIS100 Quadrupole Doublet Module arrived at GSI for testing

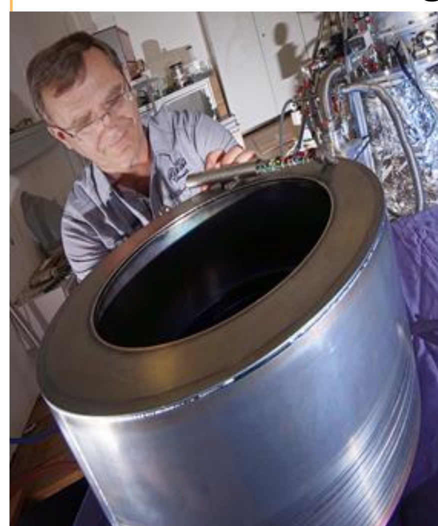
FAIR Recent Accelerator Highlights (Part 4)

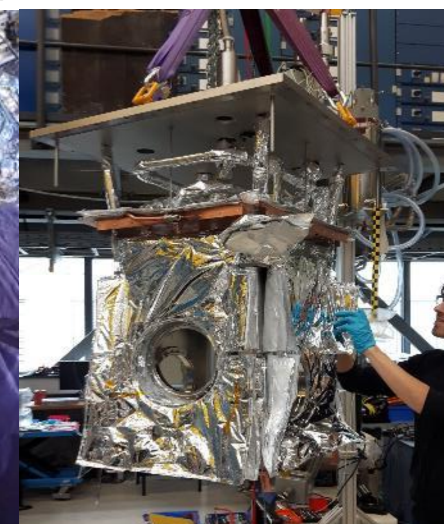
July 2020

CR- Stochastic cooling Palmer Pick-Up assembled and prepared for integration and testing with beam at COSY (FZJ)

February 2020

After 10 years of R&D, first Cryogenic Current Comparator detector in collaboration with HI Jena, Uni. of Jena and the SPARC Collaboration is ready for testing in CRYRING





FAIR Highlights (Part 5)

Storage Warehouse Weiterstadt … filling in progress!

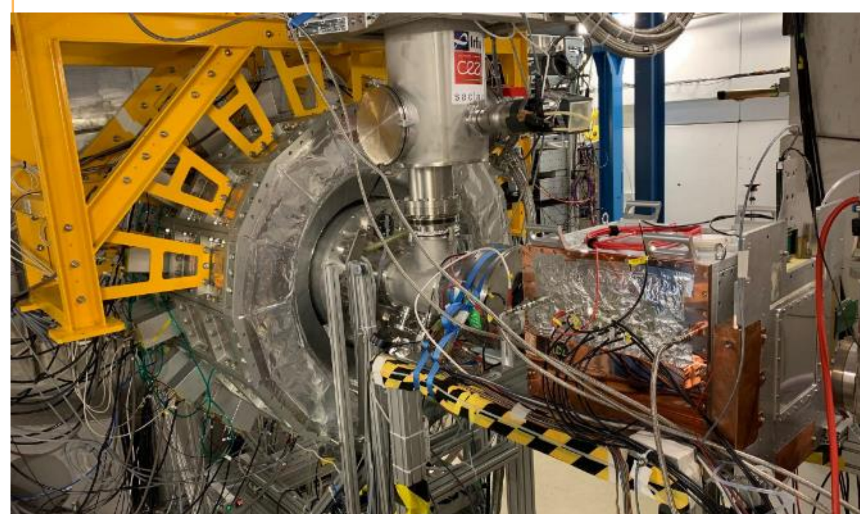
FAIR Recent Experiment Highlights (Part 1)

July 2020

Quadrupoles (SigmaPhi, France) and power supplies for the APPA HED@FAIR Experiment PRIOR at GSI are in construction at company Ampulz (NL)

August 2020

First NUSTAR- CALIFA with fission set-up successfully installed and commissioned in Cave C at GSI



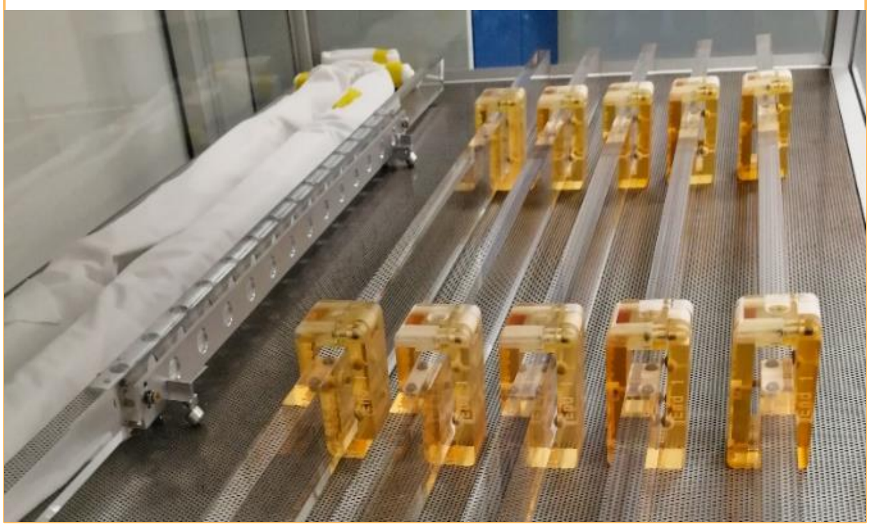
FAIR Recent Experiment Highlights (Part 2)

June 2020

13 modules have been constructed for CBM Projectile Spectator Detector (PSD) and are now used at NA61/SHINE experiment at CERN during FAIR-phase-0.

April 2020

For the PANDA Barrel DIRC 5 evaluation samples of radiator bars from Nikon were delivered to GSI

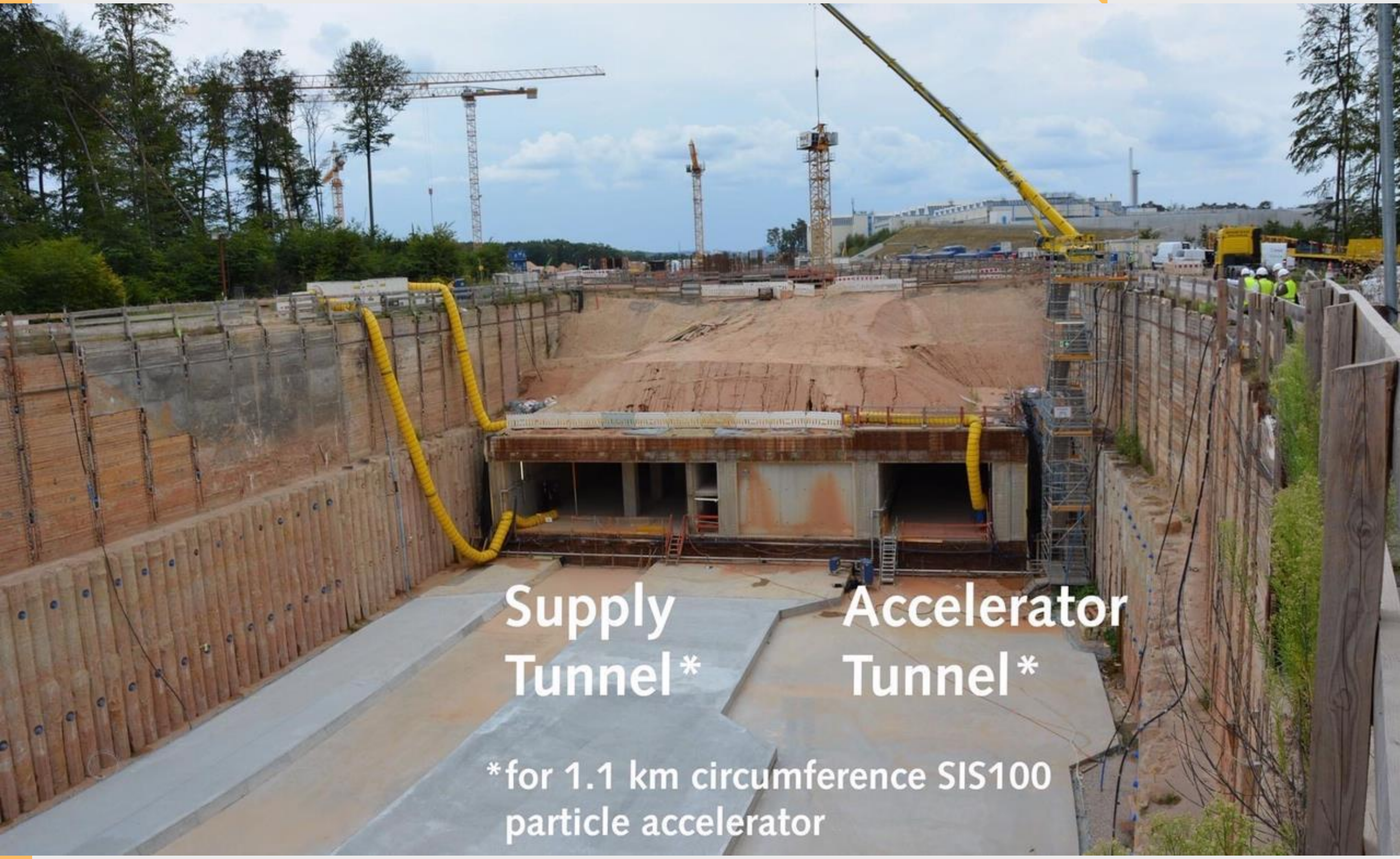


FAIR Recent Civil Construction Highlights (Part 1)

Awarding of building shell south in May 2020 to Züblin & Strabag (GER) and firefighting system to Multimon (GER)

FAIR Recent Civil Construction Highlights (Part 2)

FAIR Recent Civil Construction Highlights (Part 3)



FAIR Recent Civil Construction Highlights (Part 4)

FAIR Recent Civil Construction Highlights (Part 5)

FAIR Recent Civil Construction Highlights (Part 6)

A G E N D A

FAIR Project Progress Highlights

a. Accelerator

b. Civil Construction

c. Experiments

FAIR Next Steps

GSI/FAIR: R&D topics

Summary of next project steps

- Award of Technical Building Installation packages until Q1/ 2021
- Start construction works in the construction area south in Q3/ 2020
- Secure a timely delivery of ACC components

A G E N D A

FAIR Project Progress Highlights

a. Accelerator

b. Civil Construction

c. Experiments

FAIR Next Steps

GSI/FAIR: R&D topics

GSI/FAIR: R&D topics

Advanced technology (examples):

- fast ramping superconducting magnets (SIS100)
- control of dynamical XUHV pressures (SIS100)
- large aperture superconducting magnets (S-FRS)

Opportunities/Challenges:
Commissioning and subsequent intensity ramp up
-> Control, Diagnositics, Automatisation

Key components (R&D):

- Ion sources (ECR, for example)
- Compact rf structures
- Charge strippers
- Beam cooling
- Control of high intensity beams:
  Simulation models, feedback,..
- Vacuum und diagnostics
- Beam diagnostics

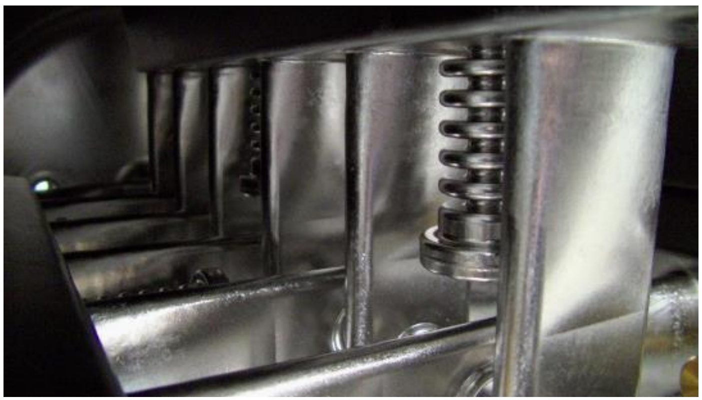
Possible contributions from university groups !

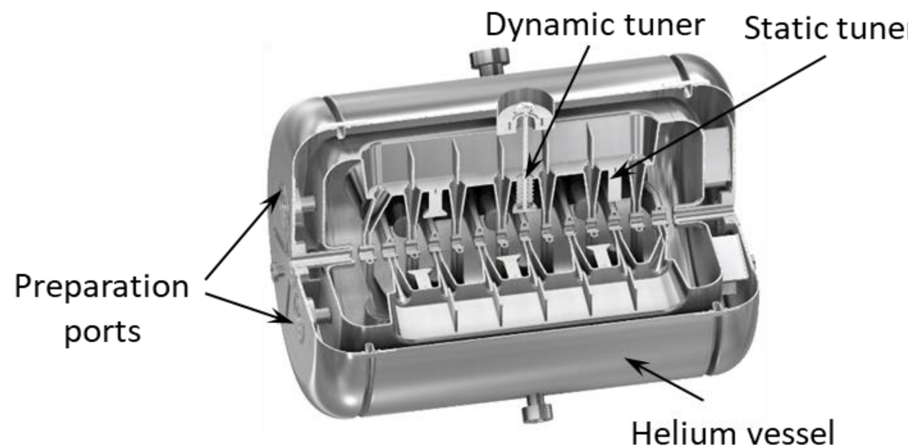
Some examples on the next slides

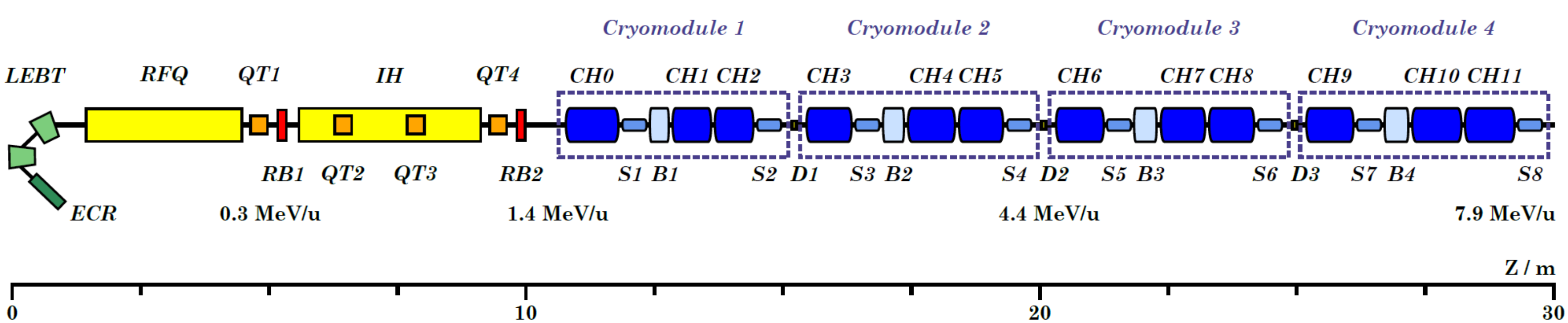
SRF for (compact) hadron linacs

cw-linac for heavy ions at GSI: SRF structures for low energy (β<1)

Structure developments at the universities





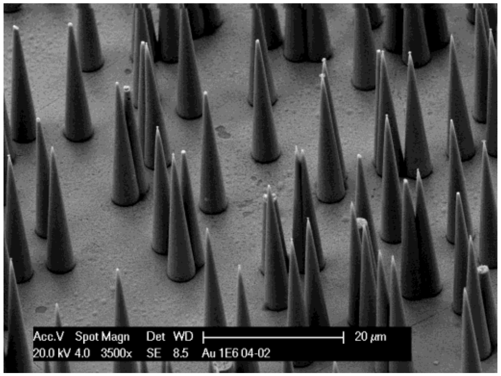


Advanced/fast diagnostics

Beam control requires fast and precise diagnostics of beam and vacuum properties.

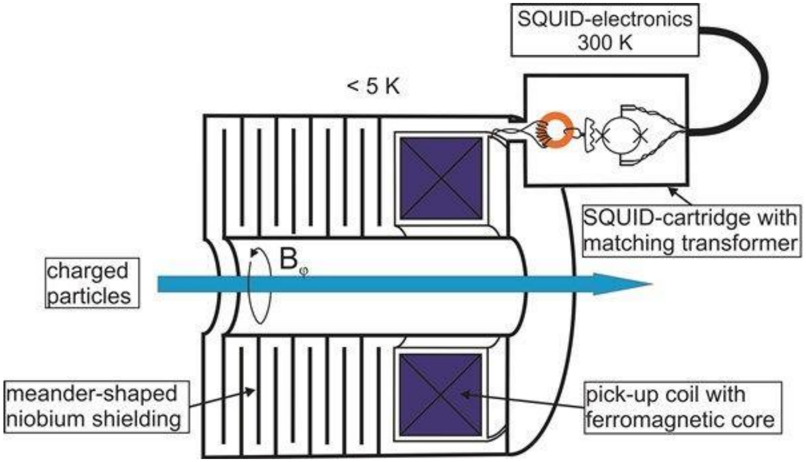
Important observables:

- Currents (Extremly low and very high !)
- Offsets and oscillations (for corrections and feedback)
- Beam profiles and emittances (beam quality)
- Local beam loss
- Residual gas pressure (local, for beam lifetime)



Nanocones as electron emitter for residual gas pressure measurements in the cryogenic SIS100 vacuum chamber.

Examples



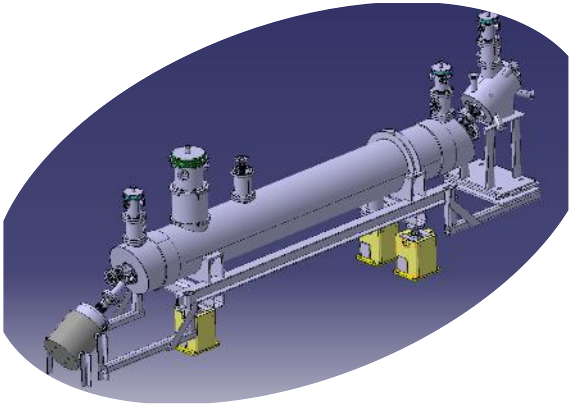
Improving the sensitivity of CCCs (**cryogenic current comparator**)

Increasing beam intensity thresholds in SIS18/SIS100

SIS100 beam pipe:
Impedances, heat load

Heat load, beam instabilities, resonance crossing and beam losses are major **intensity thesholds** in the FAIR synchrotrons SIS18 and SIS100.

Electron lenses: Space charge limit and Landau damping

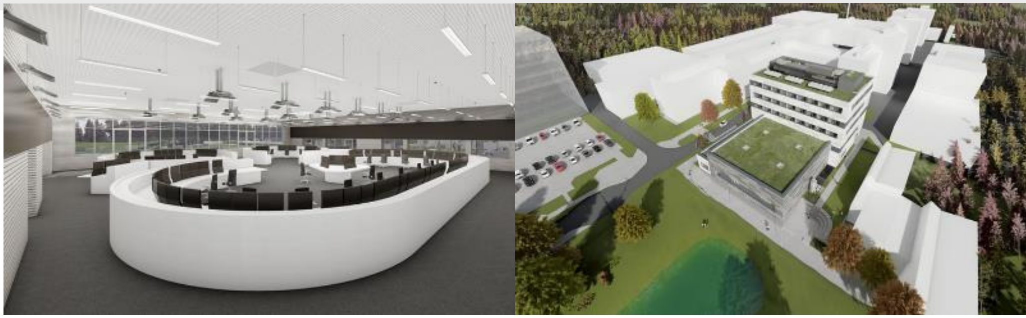


Counter measures (and example R&D topics):

- Vacuum chamber design and coatings
- Passive (Landau) damping schemes
- Active damping (broad band feedback systems)
- Impedance calculations and reductions
- Beam dynamics models and simulation

AI for the control room

GSI control room (today)



FAIR Control Center (FCC) 2025

FAIR operation will rely on automatised parameter settings with underlying complex machine and beam models. **Machine learning** and **advanced optimisation schemes** are expected to play an important role for the future FAIR accelerator operation, especially with high intensity beams. Performance of the methods is an important boundary condition.

Examples:

1) Avoid beam induced component damage due to wrong settings for high intensities
2) Fast and automatized correction of the orbit and optical functions
3) Optimised working points for high intensity operation

This field is rapidly evolving, with applications at all major accelerator facilities. At GSI and in collaboration with the universities tests at the existing GSI accelerators can be performed.

Thank you for your attention !