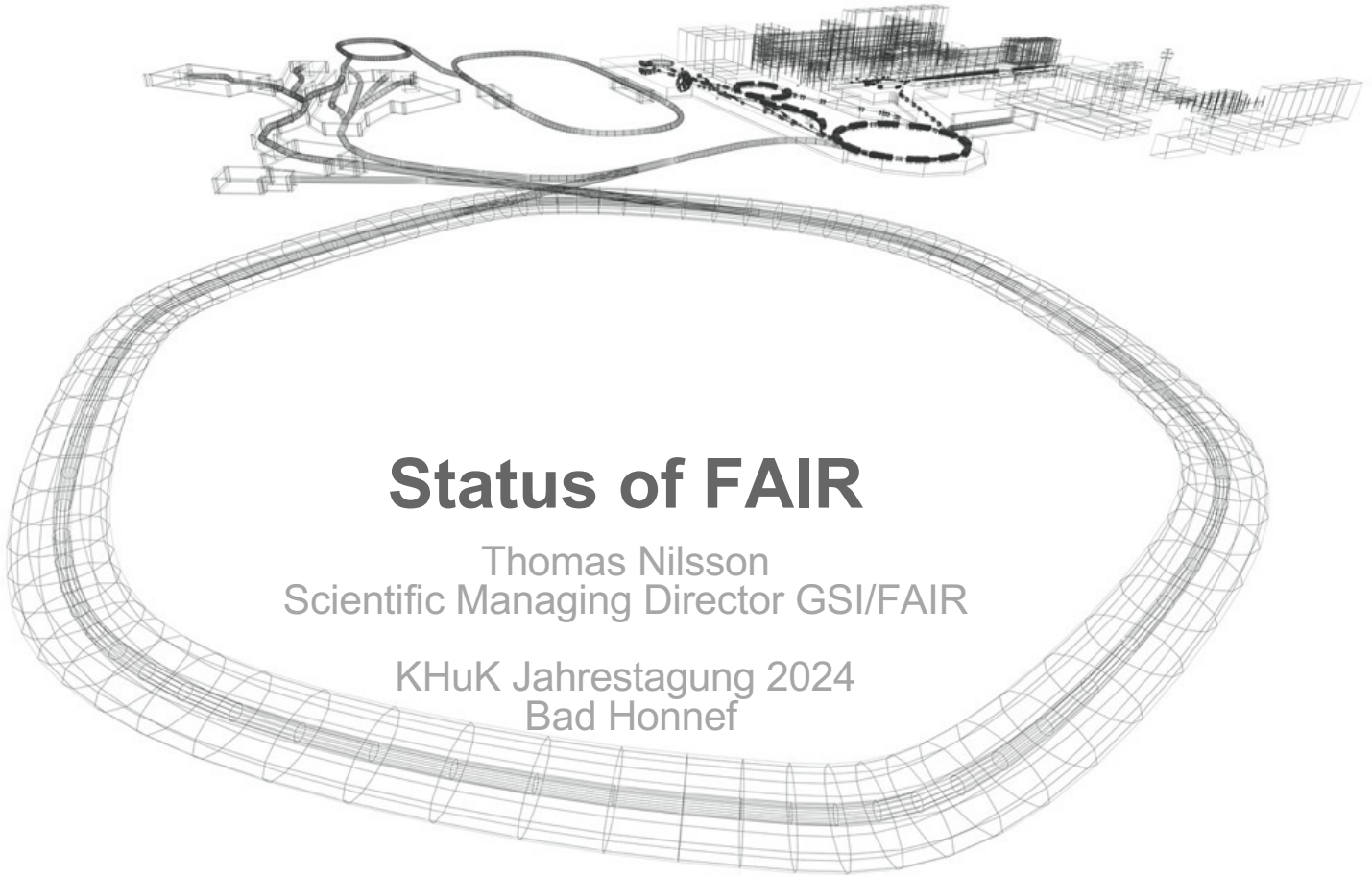


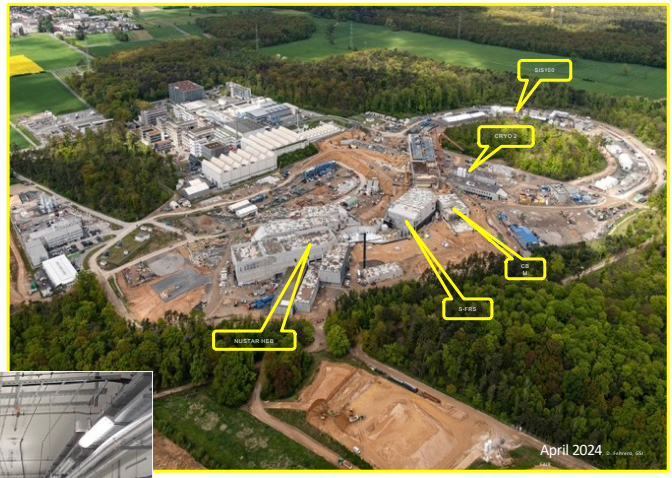
Status of FAIR

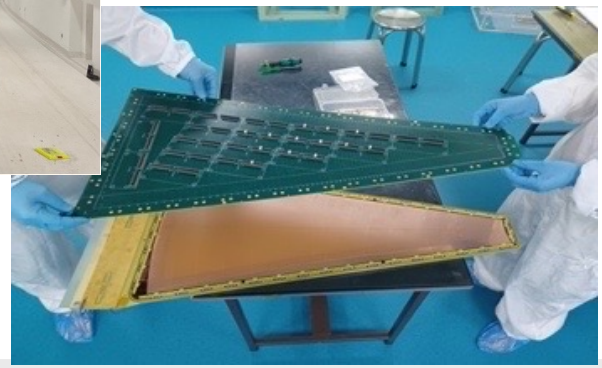
Thomas Nilsson
Scientific Managing Director GSI/FAIR

KHuK Jahrestagung 2024
Bad Honnef

Outline

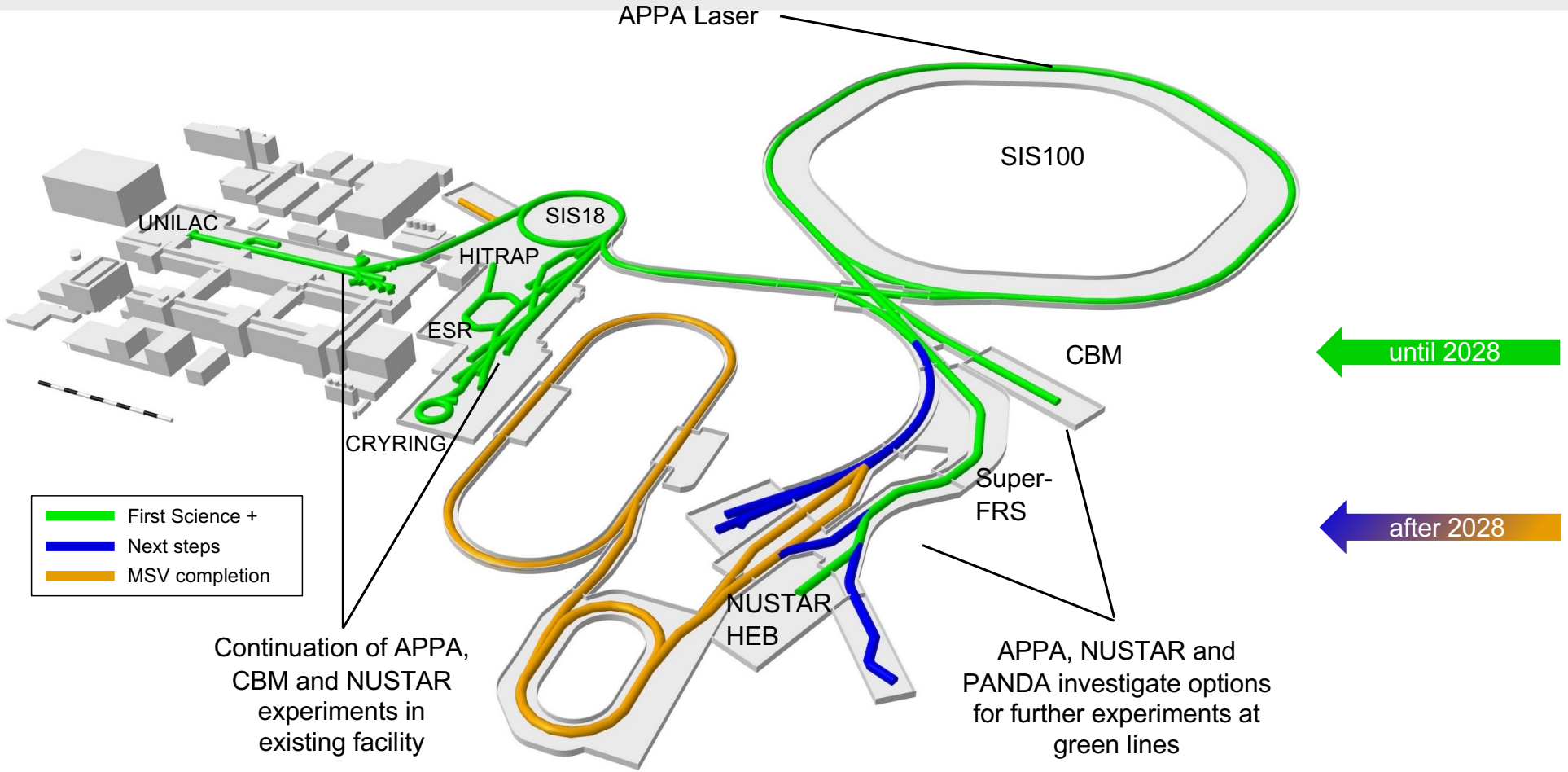
- General news
- Civil construction
  - Concrete works completed
  - Cables, ventilation, etc (TBI) ongoing
- Accelerators
  - Installations started beginning of 2024
  - First magnets being installed in tunnels
- Experiments
  - On track for FAIR 2028
- FAIR Phase-0
  - Highlights from beam time





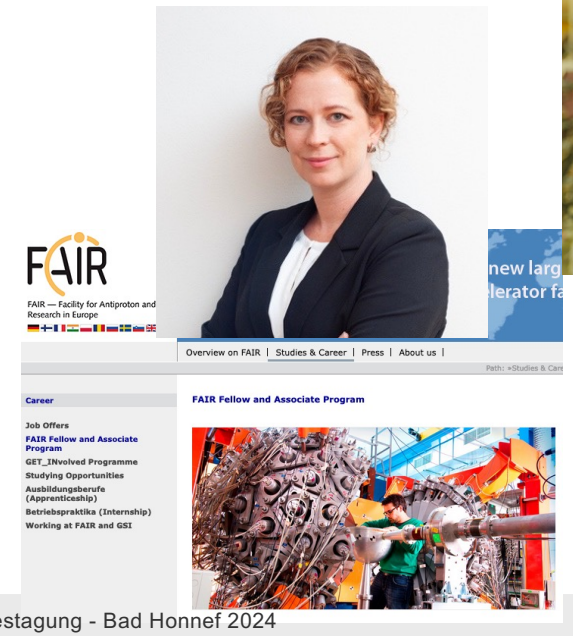
New drone video with latest picture from FAIR

“FAIR2028”


APPA Laser
SIS100
UNILAC
SIS18
HITRAP
ESR
CRYRING
CBM
Super-
FRS
NUSTAR
HEB
First Science +
Next steps
MSV completion
until 2028
after 2028
Continuation of APPA,
CBM and NUSTAR
experiments in
existing facility
APPA, NUSTAR and
PANDA investigate options
for further experiments at
green lines

News from FAIR, shareholders, etc

- Katharina Stummeyer is the new Administrative Managing Director
- Thomas Nilsson is the new Scientific Managing Director
- The FAIR Council chair is Catarina Sahlberg (UU/Big Science Sweden)
- The commissioning phase of FAIR has been agreed and started in 2024 with technical infrastructures, cryo-plants and the:



- Associate/Fellow programme
  - First candidates selected

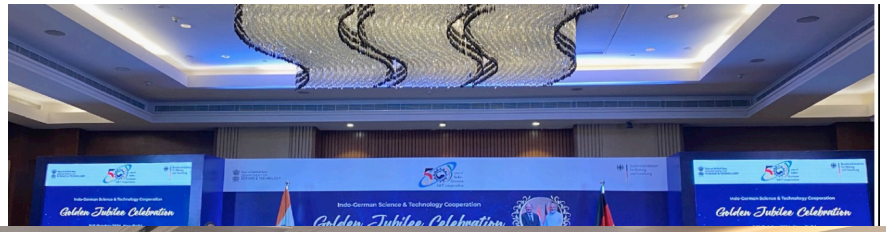
News from FAIR, shareholders, etc

- AFC meeting in Ljubljana, 7-9 Oct 2024
- FAIR Council meeting at the BOSE Institute, Kolkata, on 3-4 December 2024
- Progress to secure FS+ completion through commitments by shareholders
- Spanish interest to join FAIR
- Events on 50 years of Indo-German science & technology cooperation
  - German event hosted at GSI/FAIR in Darmstadt in May 2024
  - Indian event in New Dehli on 24 Oct 2024 with prominent FAIR representation

Golden Jubilee Celebration
Indo-German Science & Technology Cooperation

News from FAIR, shareholders, etc

- AFC meeting in Ljubljana, 7-9 Oct 2024
- FAIR Council meeting at the BOSE Institute, Kolkata, on 3-4 December 2024
- Progress to secure FS+ completi commitments by shareholders
- Spanish interest to join FAIR
- Events on 50 years of Indo-Germ & technology cooperation
  - German event hosted at GSI/FAIR i May 2024
  - Indian event in New Dehli on 24 Oct prominent FAIR representation



News from FAIR, shareholders, etc

- AFC meeting in Ljubljana, 7-9 Oct 2024
- FAIR Council meeting at the BOSE Institute, Kolkata, on 3-4 December 2024
- Progress to secure FS+ completion through commitments by shareholders
- Spanish interest to join FAIR
- Events on 50 years of Indo-German science & technology cooperation
  - German event hosted at GSI/FAIR in Darmstadt in May 2024
  - Indian event in New Dehli on 24 Oct 2024 with prominent FAIR representation

Golden Jubilee Celebration
Indo-German Science & Technology Cooperation

Civil Construction
Main supply building

Technical installations on the roof completed

Civil Construction
Super-FRS

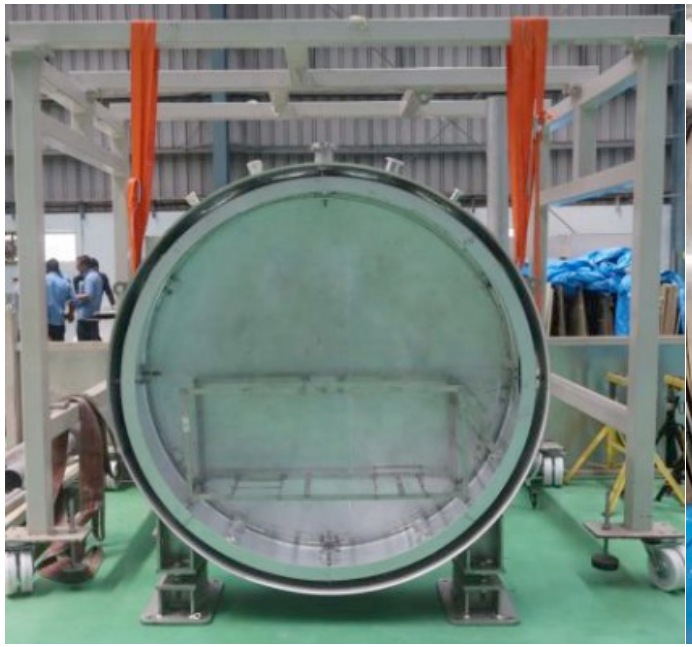
Completion of installation of lateral shielding blocks, target foundation and coating work inside the target area

Civil Construction
SIS100 Tunnel

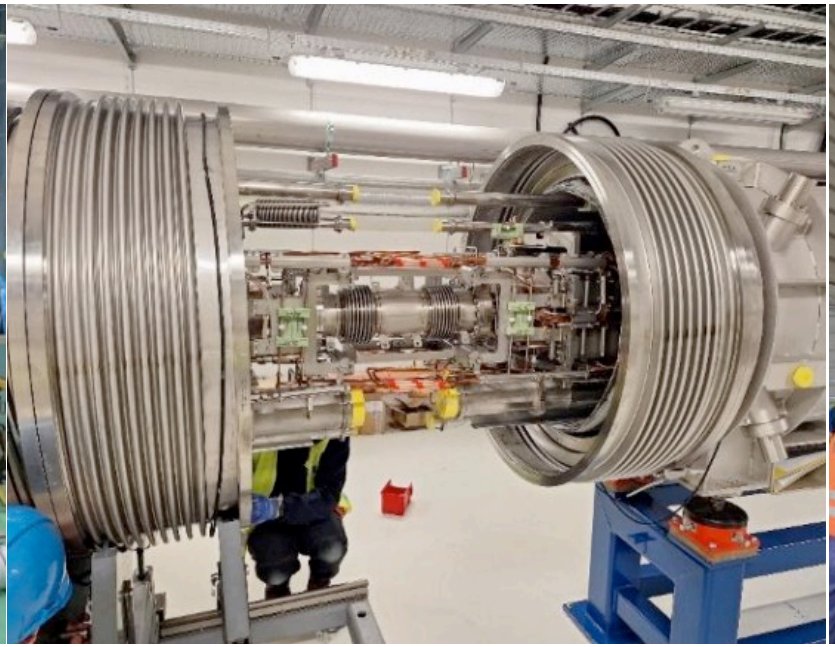
TBI installations

Civil Construction
FAIR Control Center

FAIR Accelerators
SIS100



Start of manufacturing of the current lead boxes



First interconnection of a pair of dipoles in the tunnel (IFN PAN Krakow)

Installation of transformers and switch gears of the main power supply of the Dipole Quadrupole Magnets

FAIR Accelerators
Super-FRS

Installation of lateral iron shielding completed in July

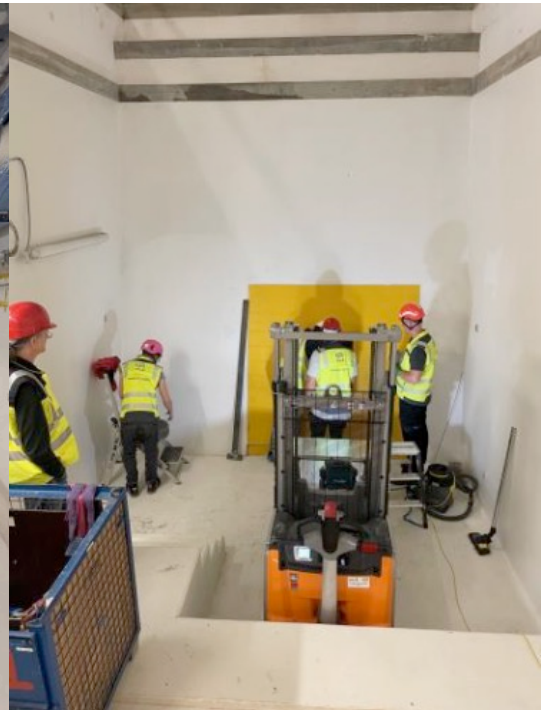
Repaird sc multiplet successfully tested at CERN

Local cryogenics branch T from INOX (India), FOS for cold test in November

FAIR Accelerators Installations

SIS100 Sector 3 Arc: Dipole Pairs Installation completed

SIS100 Straight 4 – partially completed



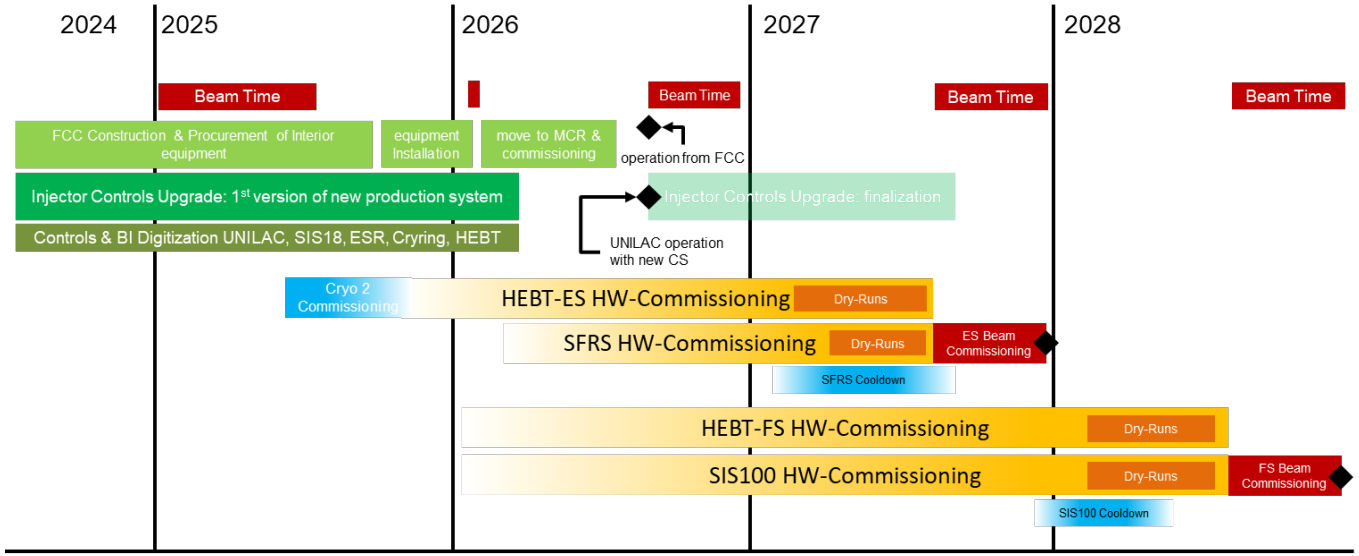
SIS18/HEBT Beam Dump: Installation completed

FAIR Accelerators Commissioning

Preparing hardware commissioning

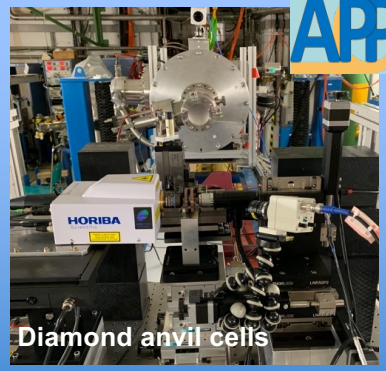
The following steps are taken for each system type

1. Development of the commissioning procedure
2. Collection of preconditions and boundary conditions for each step
3. Review of resource estimation
4. Review of integrated schedule
5. Preparation of written commissioning instructions
6. Implementation of sequencer task for test automation



FAIR Experiments

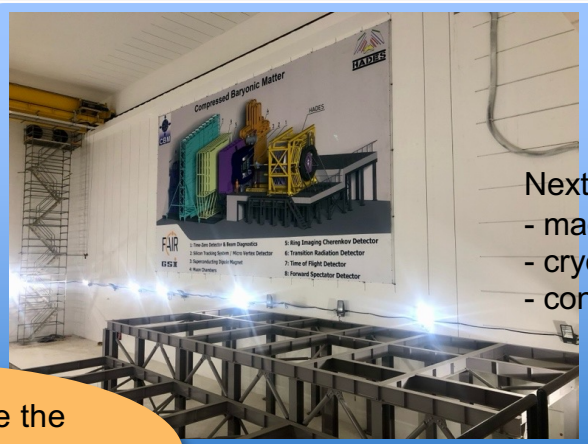
APPA



Diamond anvil cells


Paris-Edinburgh press

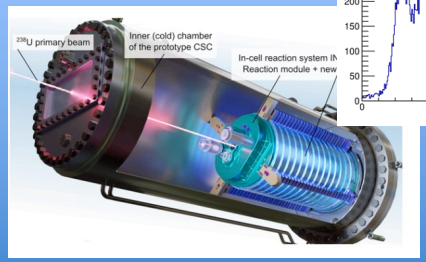
CBM

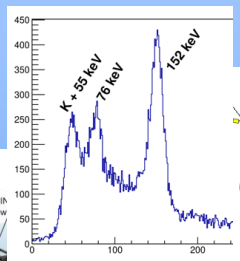


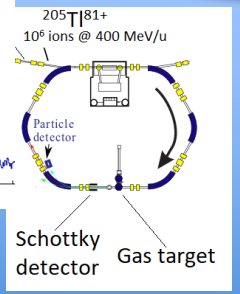
Next steps
- magnet foundation
- cryo platform
- concrete slabs

Effort to best use the part of FAIR which will be available by 2028

NUSTAR





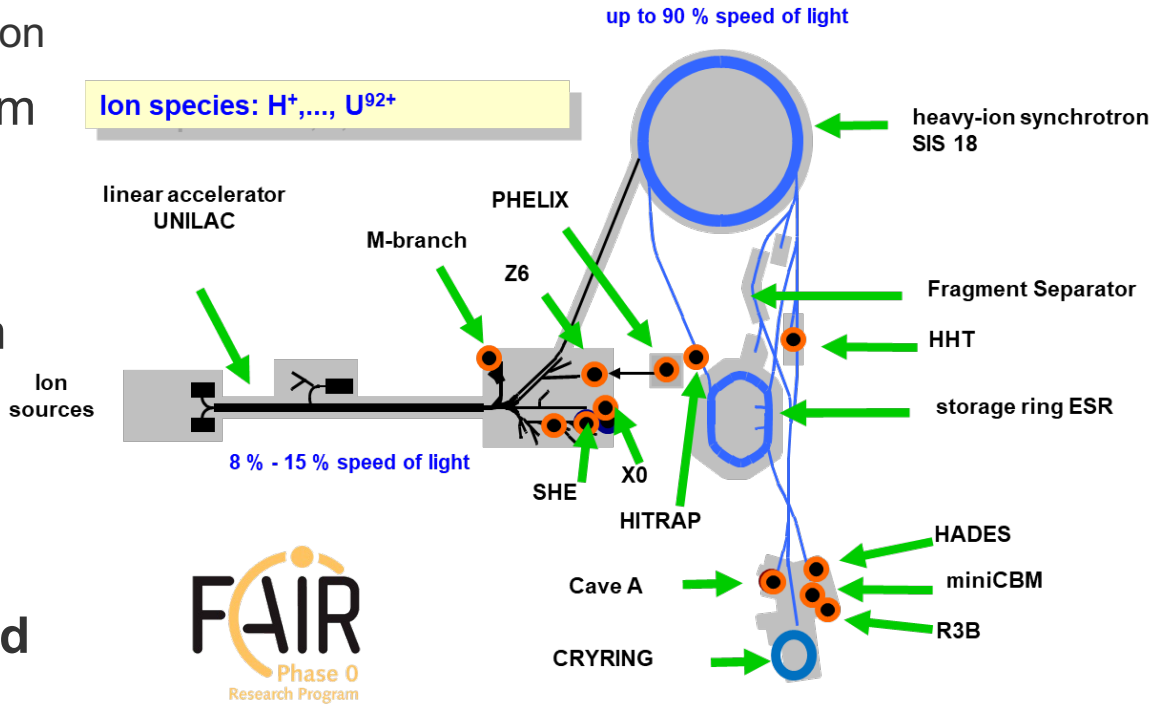


PANDA

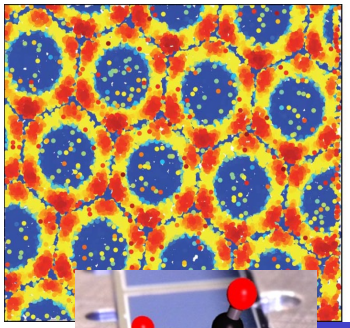
EMC Endcap at ELSA

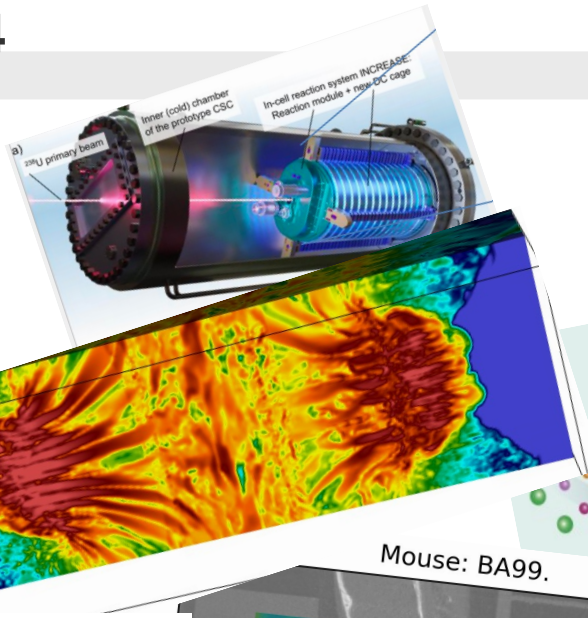
FAIR Phase-0

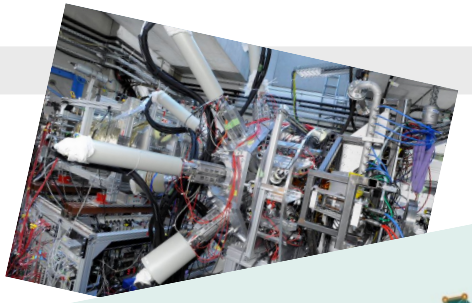
- Started in 2018
  - Annual runs of 100 days until FAIR operation
- Last call for proposals in 2022 for beam time in 2023/2024
  - beam time 2023 shifted to 2024
- New call of proposal for beam times in 2026/2027
  - PAC meetings beginning of 2025
- **Employing upgraded GSI accelerators and detectors designed for FAIR**
  - smooth start of FAIR science

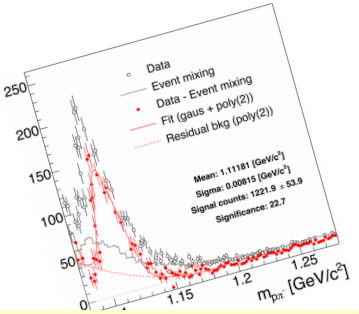


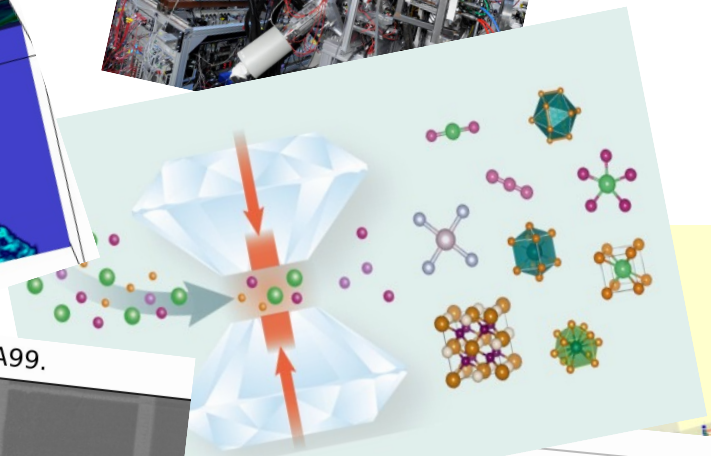
Beamtime 2024

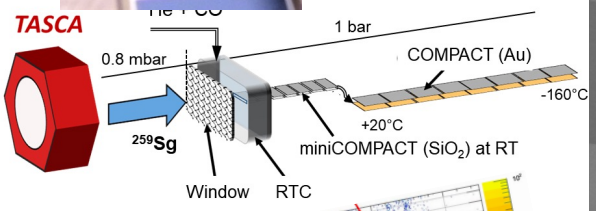


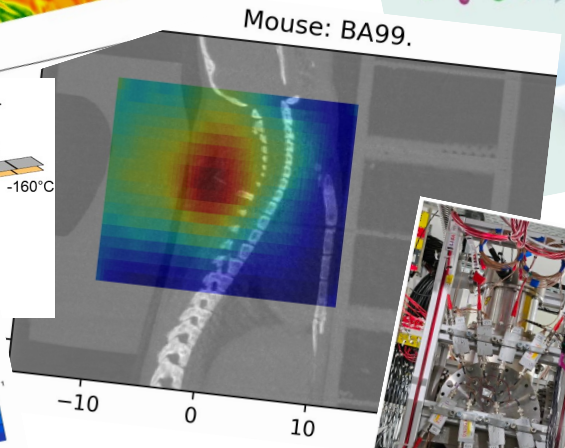


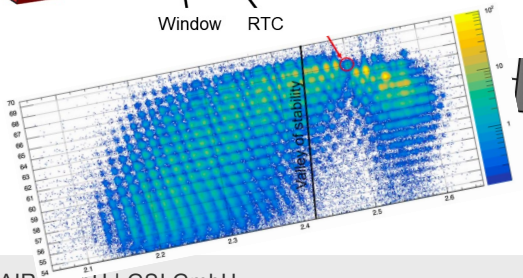


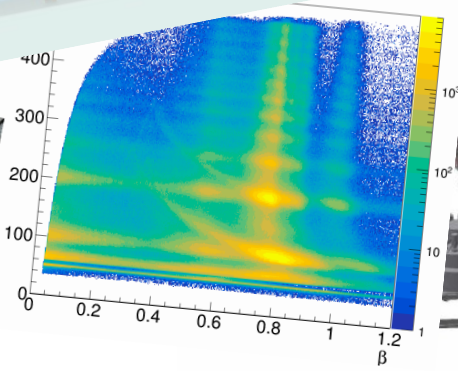


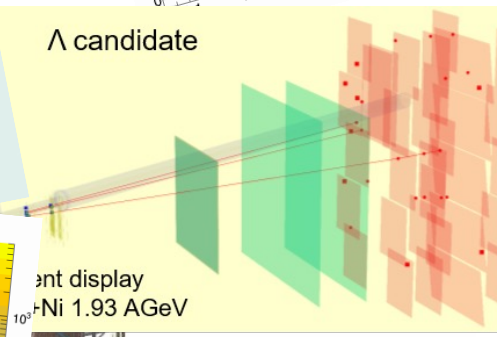










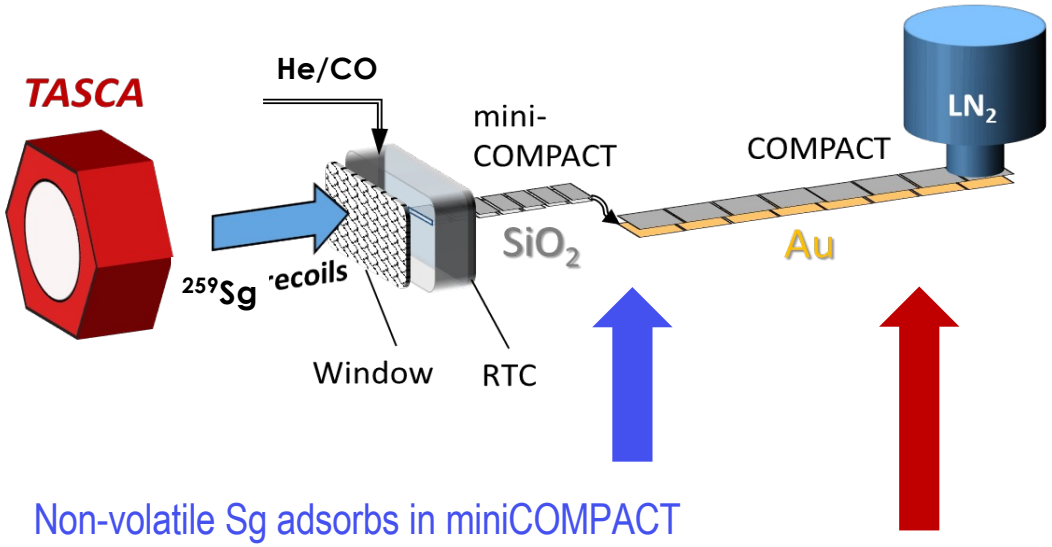


$^{106}Sg(CO)_6$ – Reaction kinetics and stability of a superheavy molecule

Nuclear production of Sg: $^{208}Pb(^{52}Cr,n)^{259}Sg$ with superb Cr beam → 60+ Sg events

Chemical conversion: Sg + 6 CO → $Sg(CO)_6$ (g)

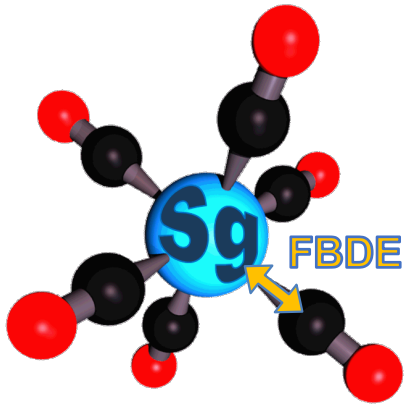
Determining chemical conversion yield Sg → $Sg(CO)_6$

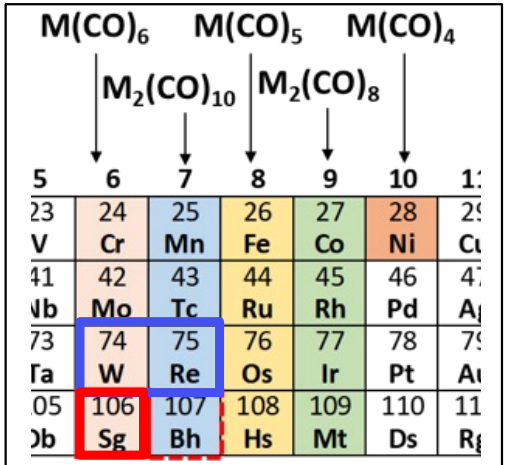


Non-volatile Sg adsorbs in miniCOMPACT

$Sg(CO)_6$ is volatile and reaches COMPACT

Ratio of Sg chains → reaction equilibrium constant





Comparison of **Sg** with **W**
Re measured as well
→ **Ready for Bh**

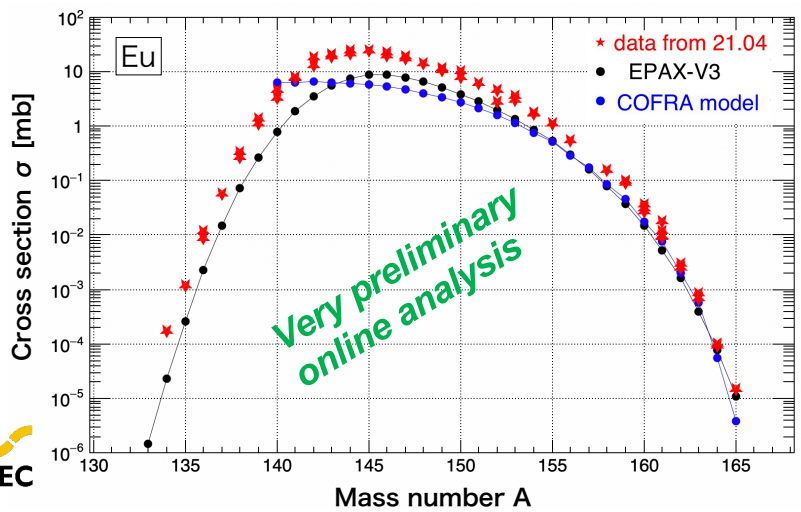
Equilibrium constant yields
first bond dissociation energy (FBDE), i.e., stability of $Sg(CO)_6$
First-time measurement of bond strength in a SHE-molecule!

UNILAC proposal G-22-00034 (Spokesperson A. Yakushev)

New experiment opportunities with new beams

Measurement of fragmentation cross sections with newly developed Er beam

Production cross section of Eu isotopes with ^{170}Er + Be reaction at 1.08 GeV/u



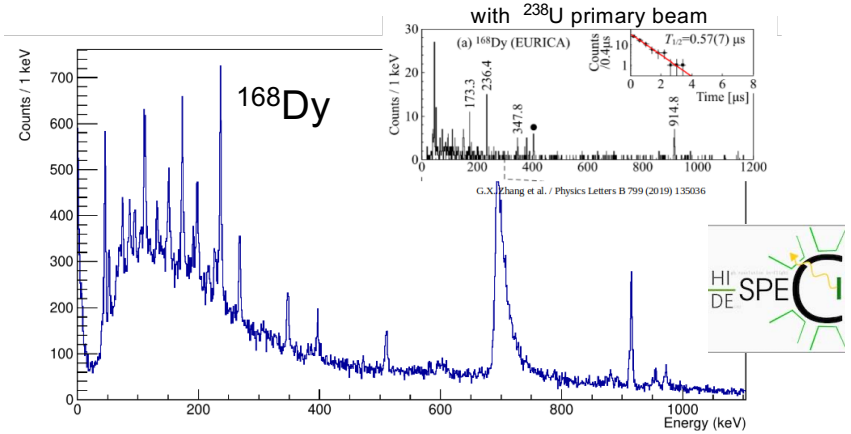
Super-FRS EC

FAIR Phase 0 Research Program FRS

General trend follows EPAX model, but the measured cross sections tend to be larger by a factor ~ 2 – 10 in the neutron deficient side

Structure of neutron-rich, rare-earth nuclei far from stability

Results from EURICA at RIKEN with ^{238}U primary beam



Subset of online data, DEGAS HPGe spectrum

^{170}Er: new beams → new opportunities!

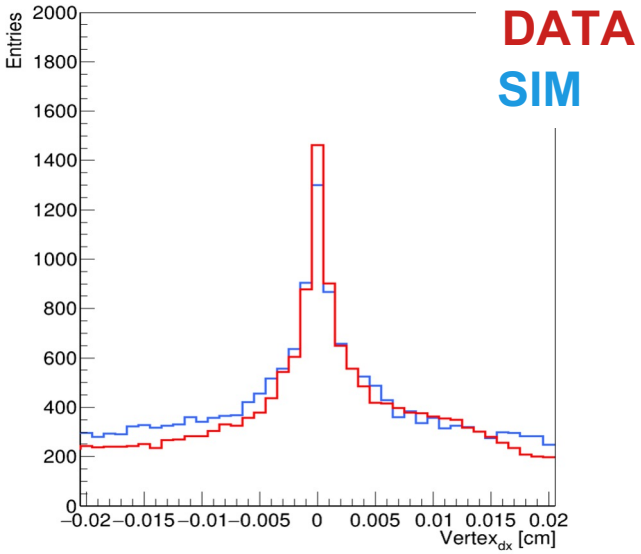
→ Reliable rate and yield estimates for the first experiments at Super-FRS

→ Superior secondary-beam rates despite the ~1,000 times lower primary-beam intensity

Beam time 2024
Performance Evaluation of STS Prototypes in mCBM

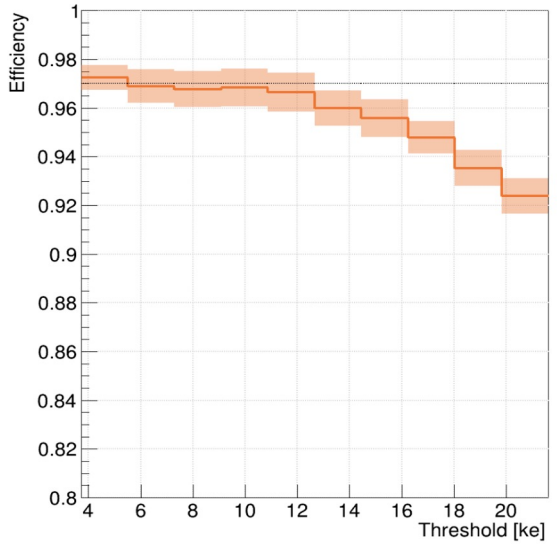
Quality Control:
The tests consist of
- verification of the IV characteristics of the sensors;
- calibration of the ADC of the ASICs mounted in the front-end electronics;
- evaluation of the overall noise performance of the module;
- thermal stress test.

Shown is a setup with three modules.



Primary Event Vertex Reconstruction:
The vertex of an event is reconstructed from CA*)-tracks with a precision of 30 µm and is in accordance with expectations from simulations.

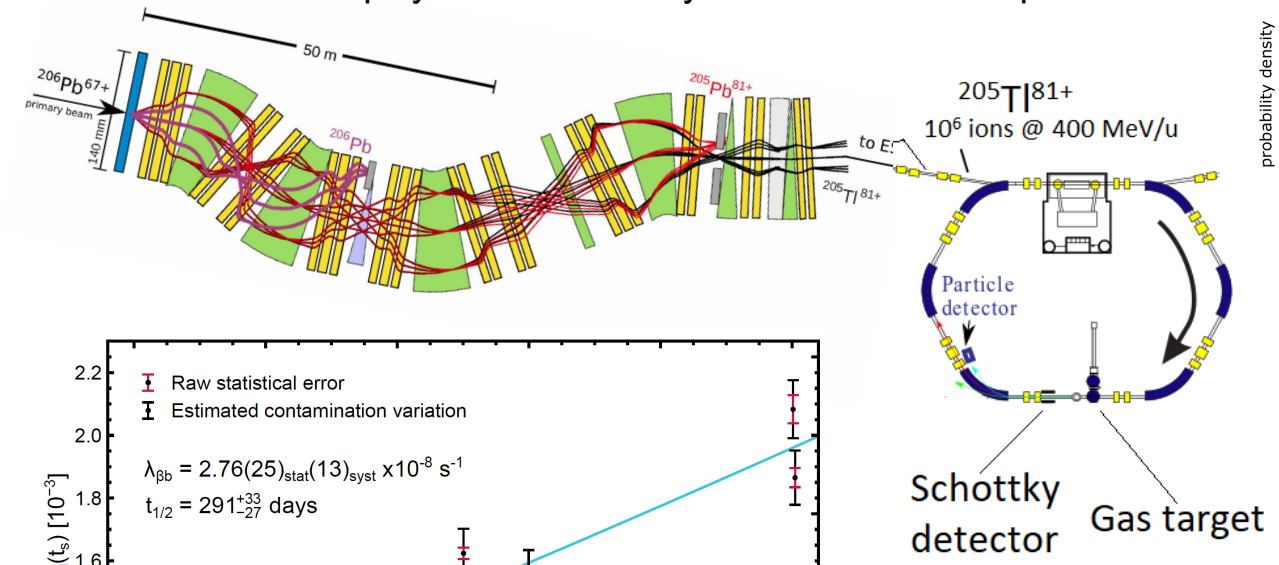
*) CA = Cellular Automaton

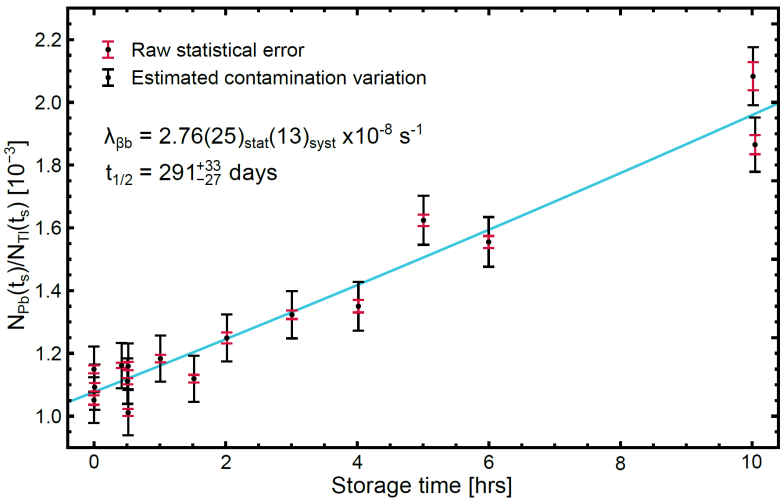


Reconstruction Efficiency:
Based on CA-tracking, the hit reconstruction efficiency is defined as the probability to reconstruct a hit where the tracking would expect one, and is measured to be > 97% in the detector active area.

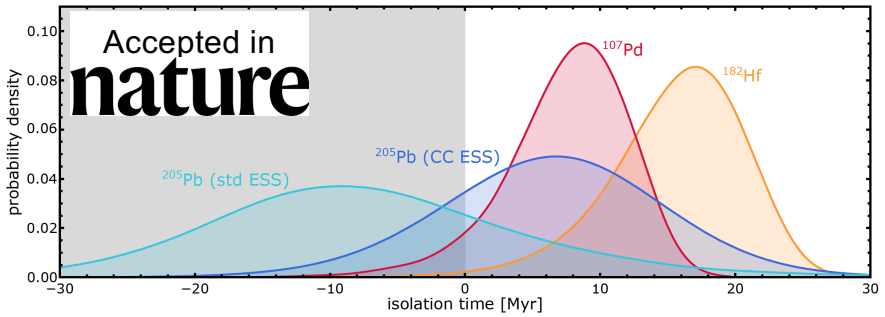
Recent highlight
Bound state beta decay of $^{205}Tl^{81+}$

Performance of employed machines beyond their standard operation





ESR: Accumulation
Stochastic cooling
Electron cooling
Internal gas target
Destructive and non-destructive detection
Storage times of up to 10 hours



Combined with meteoritic data, new ^{205}Pb and ^{205}Tl decay rates in plasmas, and astrophysical simulations, the isolation time of the solar matter from the last synthesis of ^{205}Pb is for the first time positive!

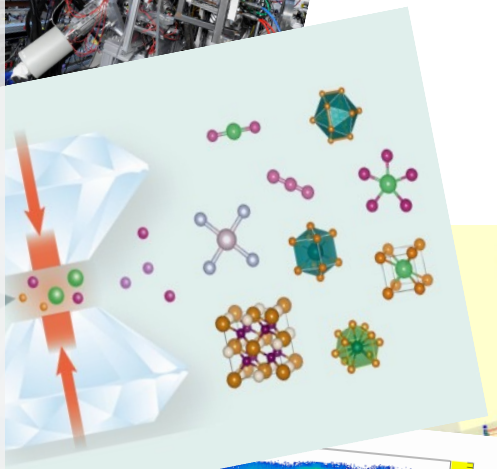
G. Leckenby et al., Nature (2024) in print

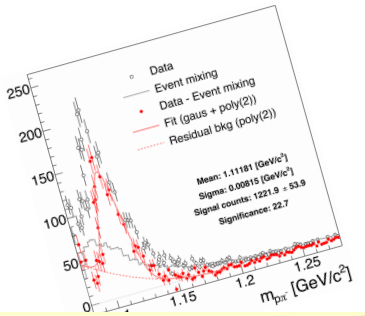
Combined with new neutrino capture rates, the new ^{205}Tl decay constant sets precise constraints on the production of ^{205}Pb by solar pp neutrinos, and thus for the LOREX project aiming at measuring ^{205}Pb in lorandite minerals

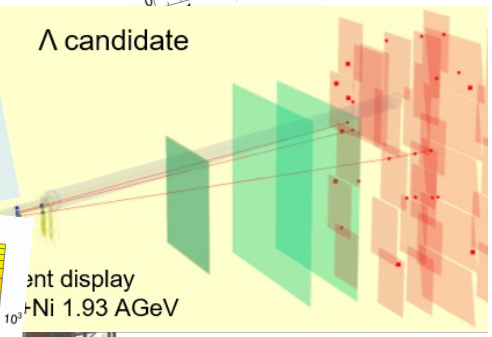
R. S. Sidhu et al., Phys. Rev. Lett. (2024) in print

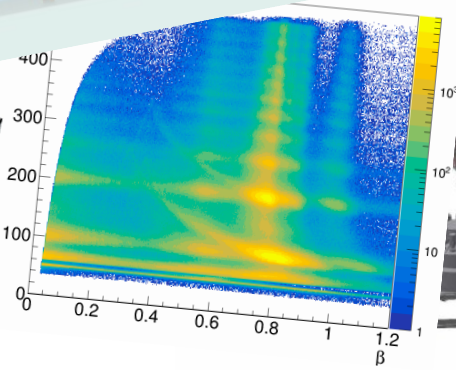
Summary and conclusions

- Concrete works are essentially completed
- Installation have started beginning of 2024
- SIS100 first arc and first straight section completed (except quadrupole units)
- Beamtime 2024 successfully concluded despite a number of problems
  - failure of SIS18 septum
  - failure of HADES magnet cooling
- New call for proposals for beam times in 2026 and 2027
- FAIR hardware commissioning will start in 2025
- FAIR beam commissioning in 2027

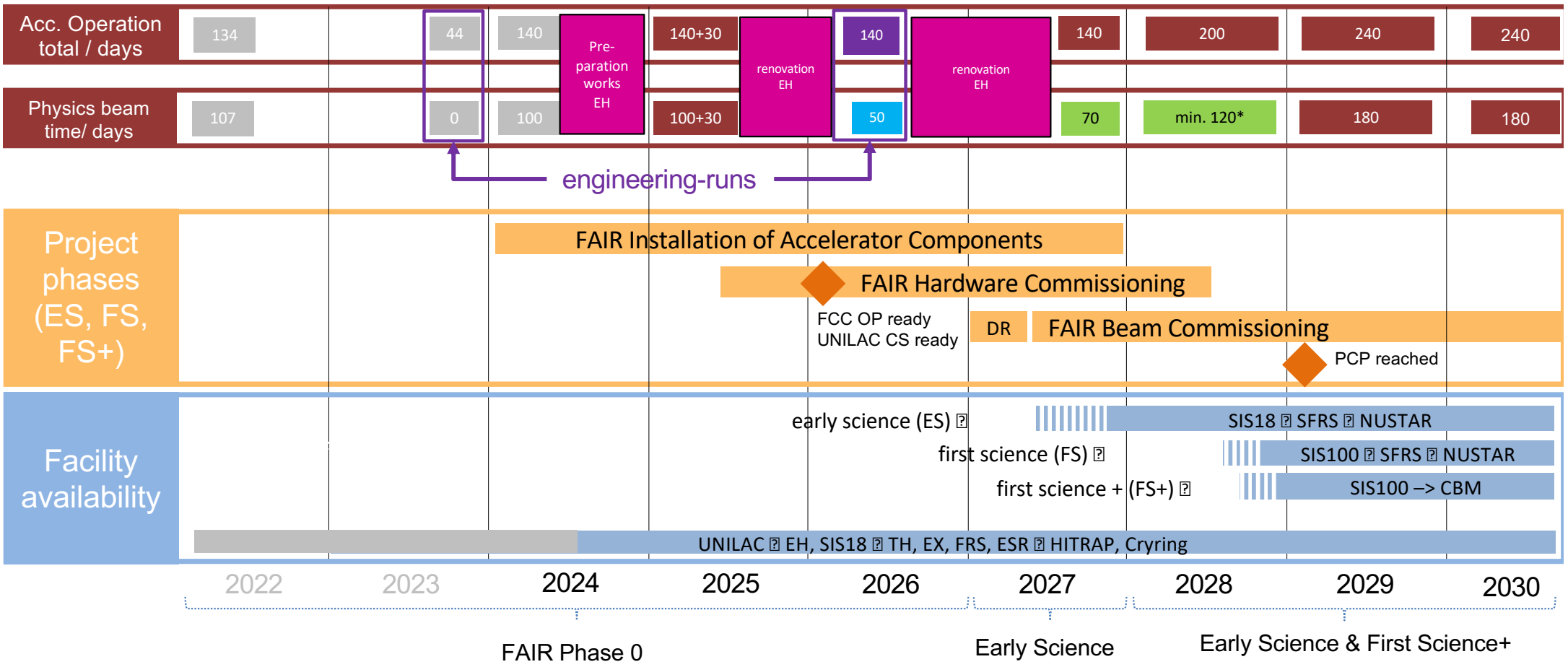








FAIR/GSI strategic operation scenario towards FS+




Thank you for your attention