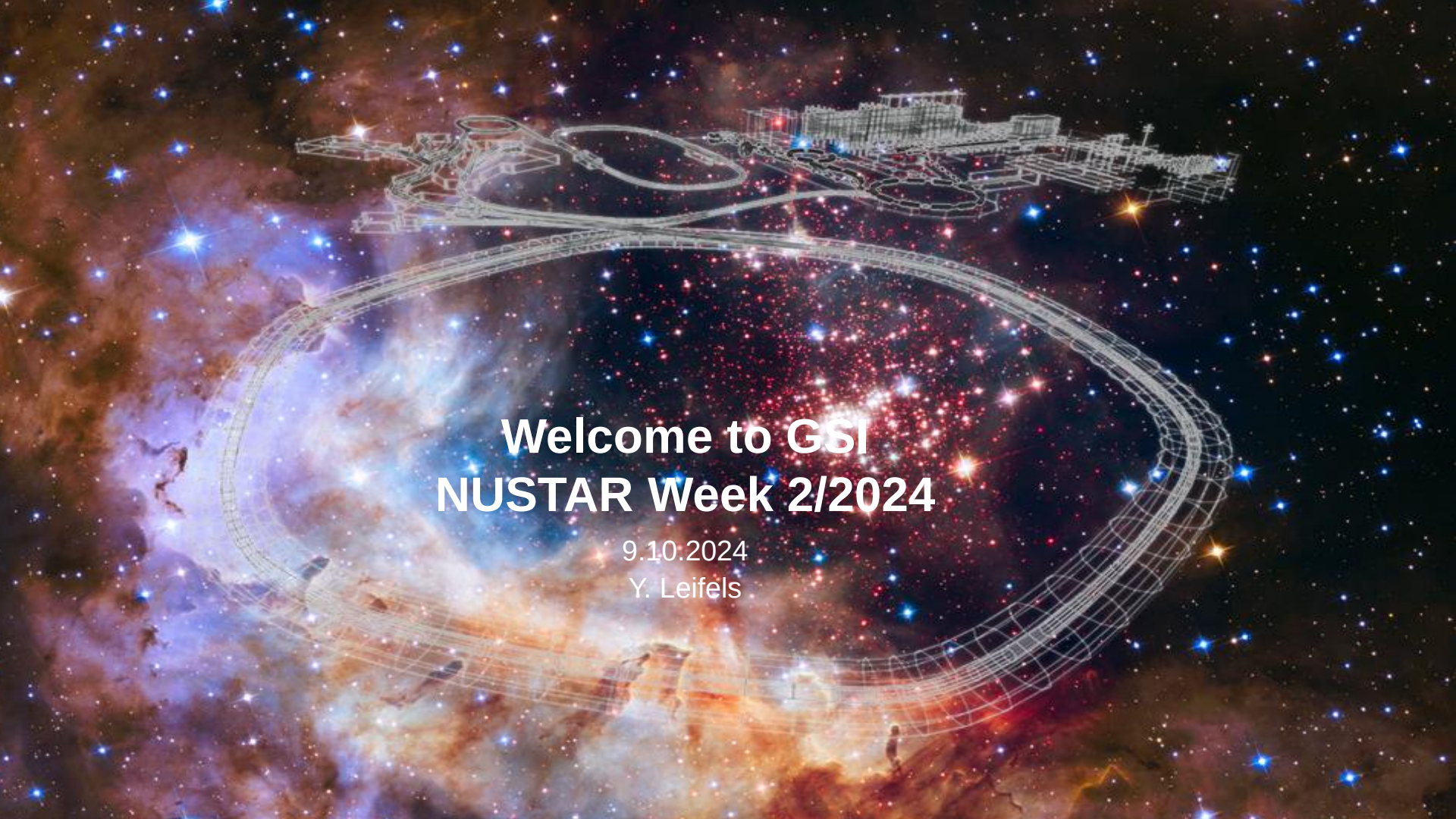


Welcome to GSI
NUSTAR Week 2/2024

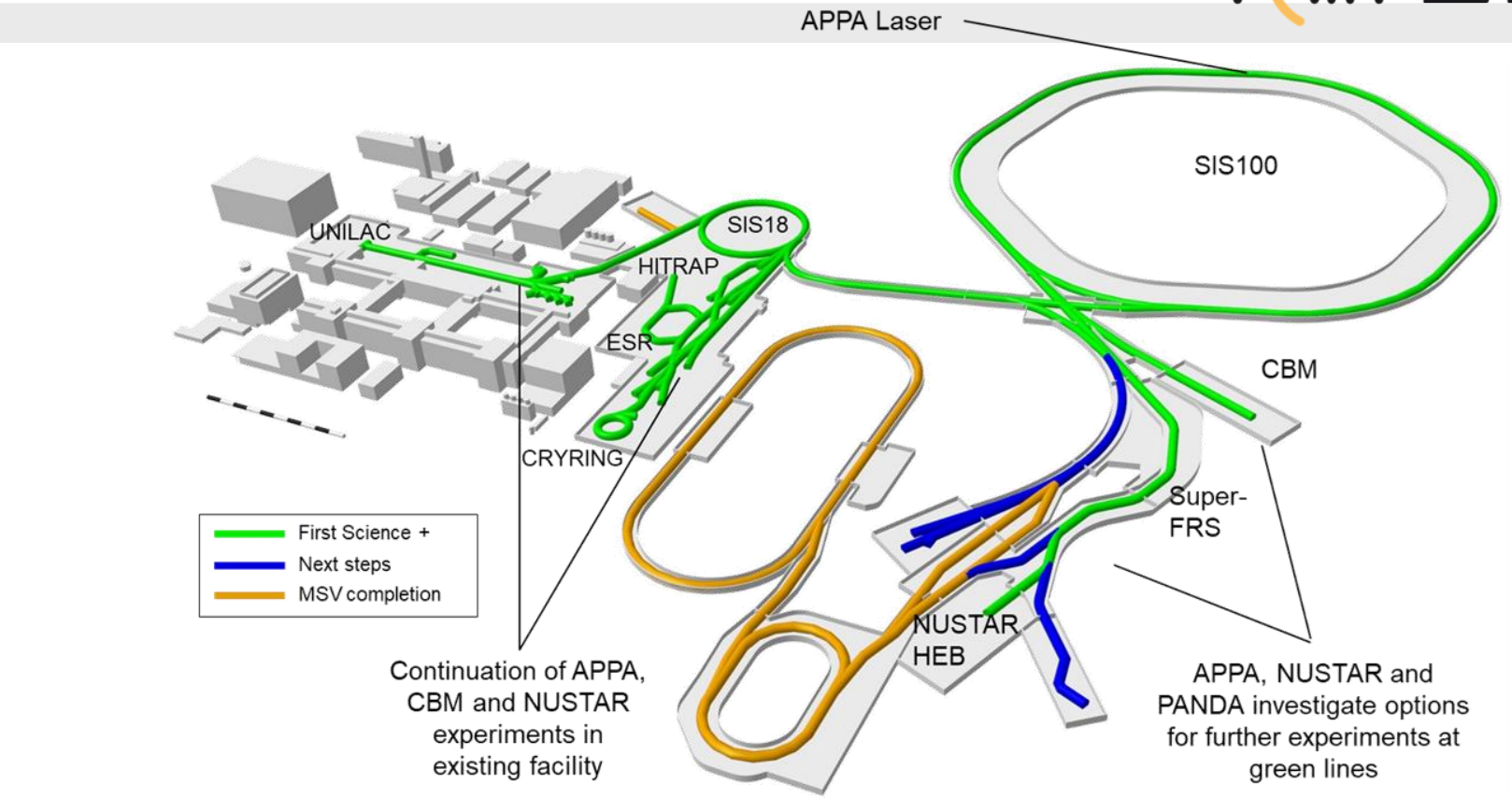
9.10.2024

Y. Leifels

FAIR – Civil construction

Q3/2024

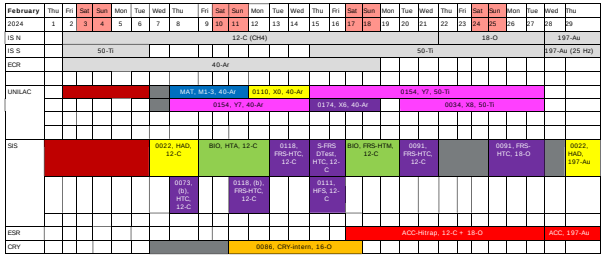
Continue with the „FAIR2028“ vision in mind

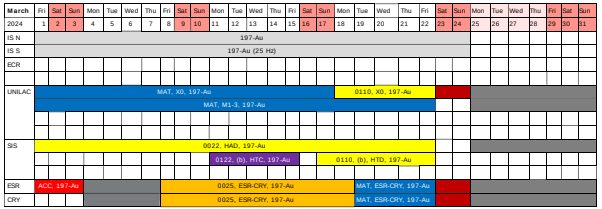


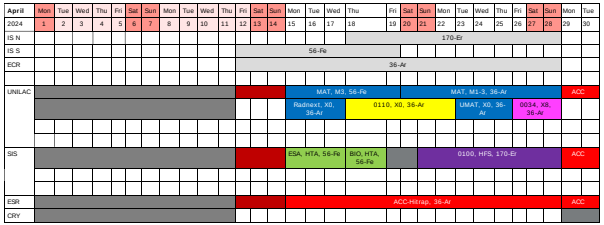
Beam time 2024

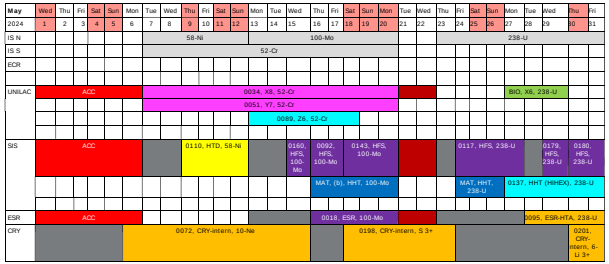
- Achieved in 2024
  - Accelerator installation started in January 2024
  - TBI installation works in builds are progressing
  - Contributions from France & Sweden secured realization of FS/FS+
  - Decision on commissioning budget for the years 2024 & 2025

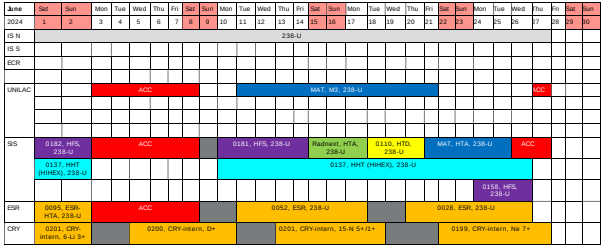
- Beam time 2024 completed successfully



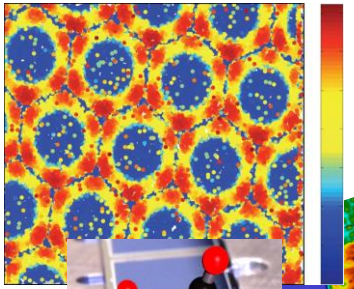


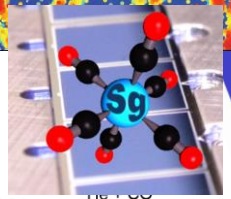


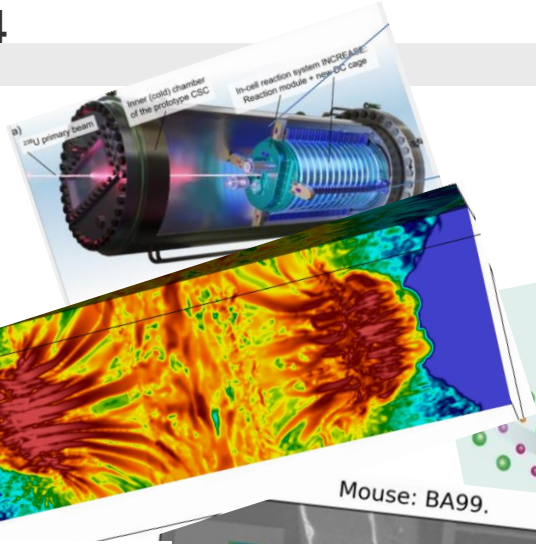


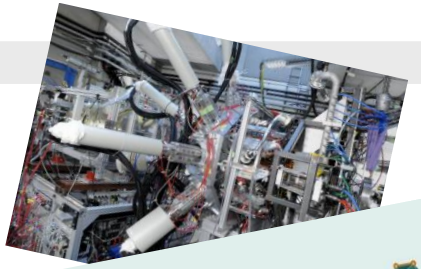


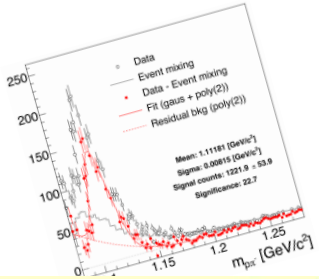
Beamtime 2024

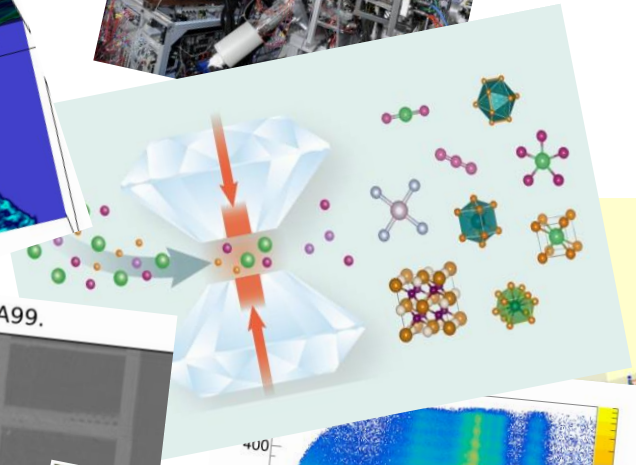


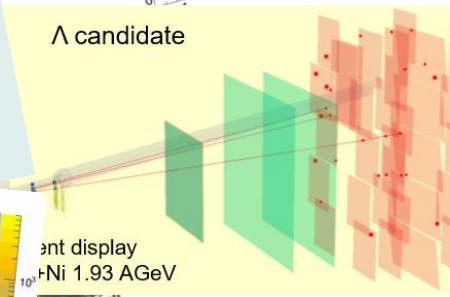


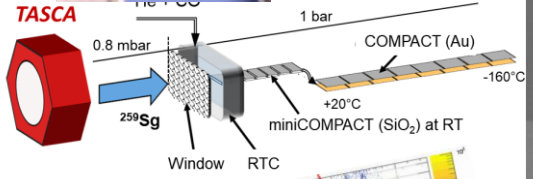


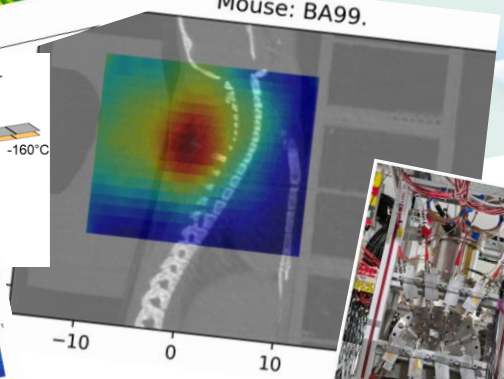


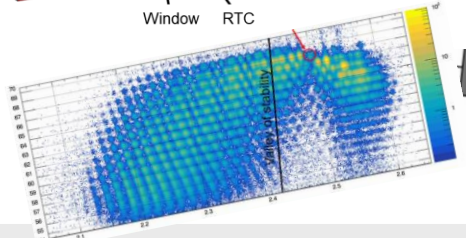


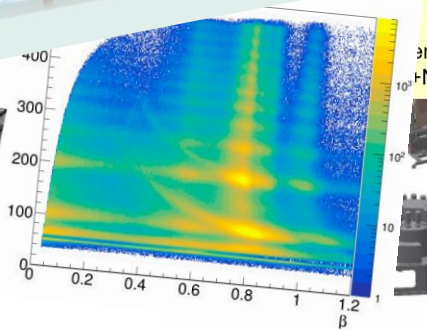


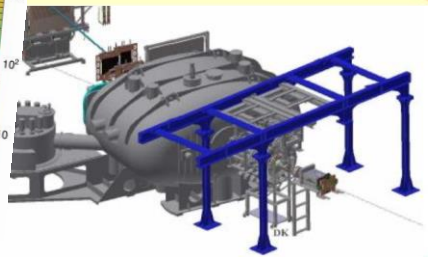




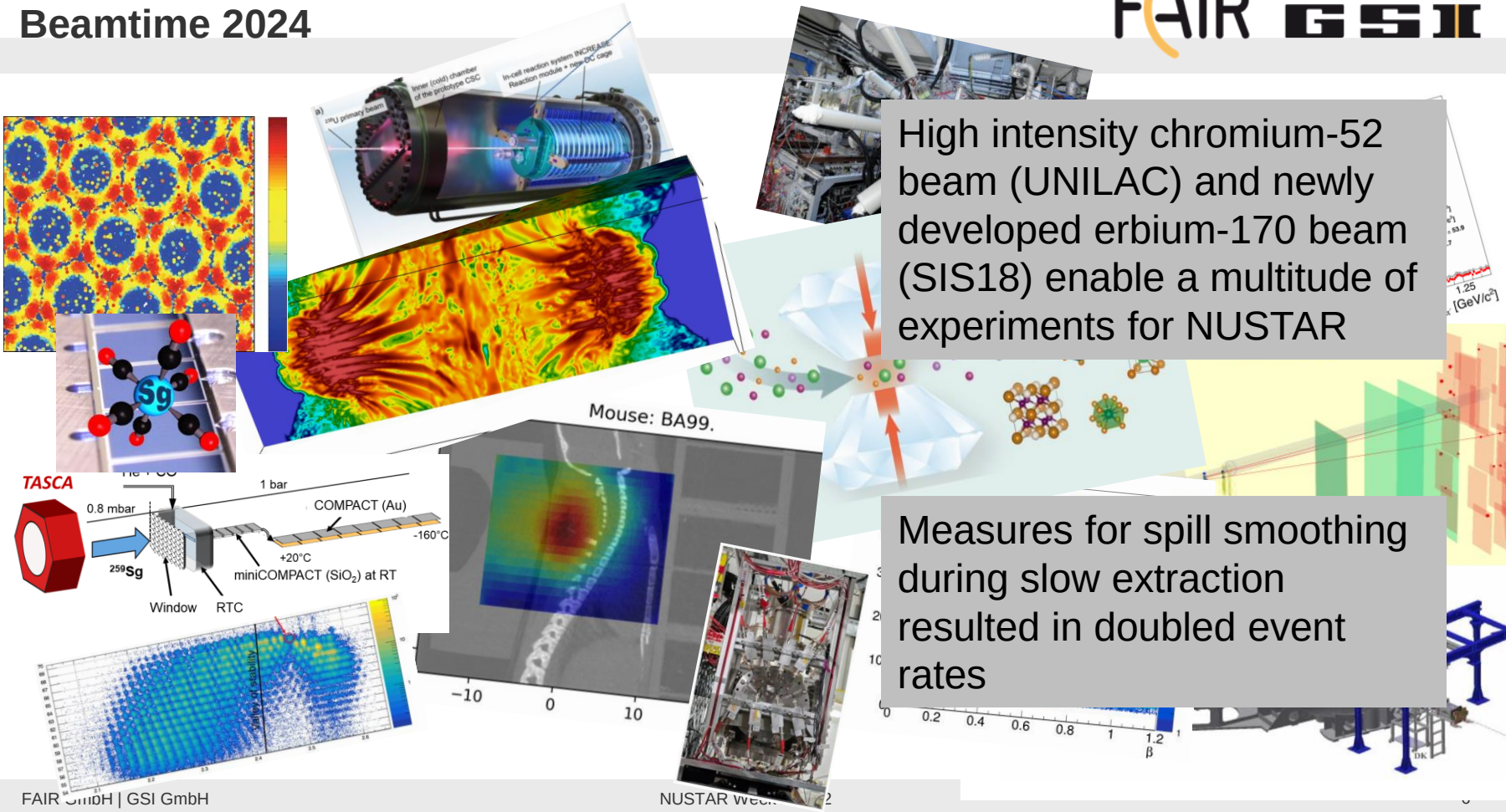








Beamtime 2024



High intensity chromium-52 beam (UNILAC) and newly developed erbium-170 beam (SIS18) enable a multitude of experiments for NUSTAR

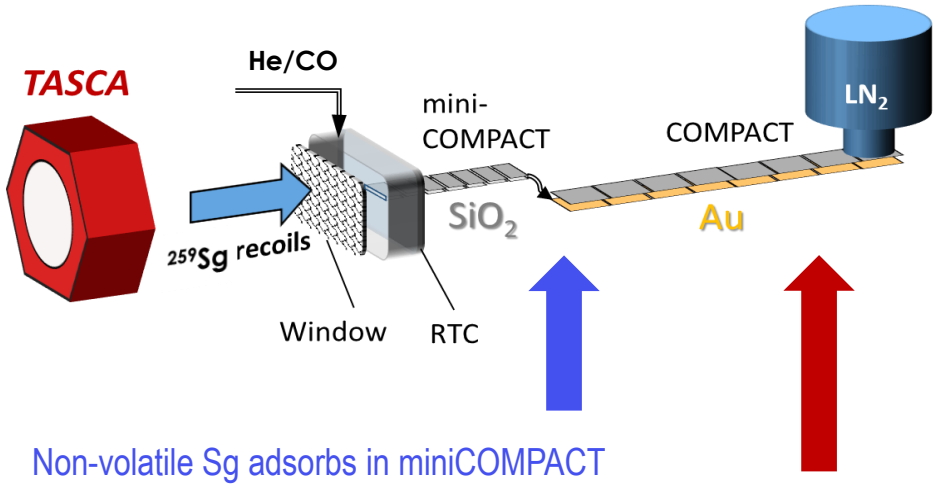
Measures for spill smoothing during slow extraction resulted in doubled event rates

$^{106}Sg(CO)_6$ – 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)

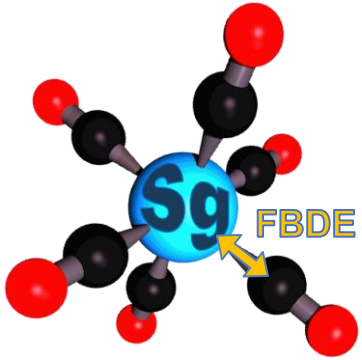
Determining chemical conversion yield Sg → $Sg(CO)_6$

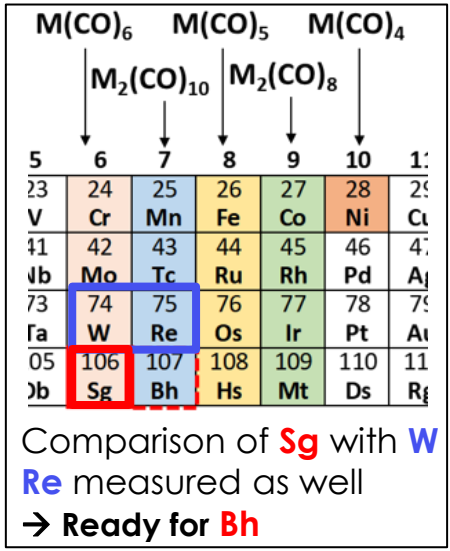


Non-volatile Sg adsorbs in miniCOMPACT

$Sg(CO)_6$ 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 $Sg(CO)_6$

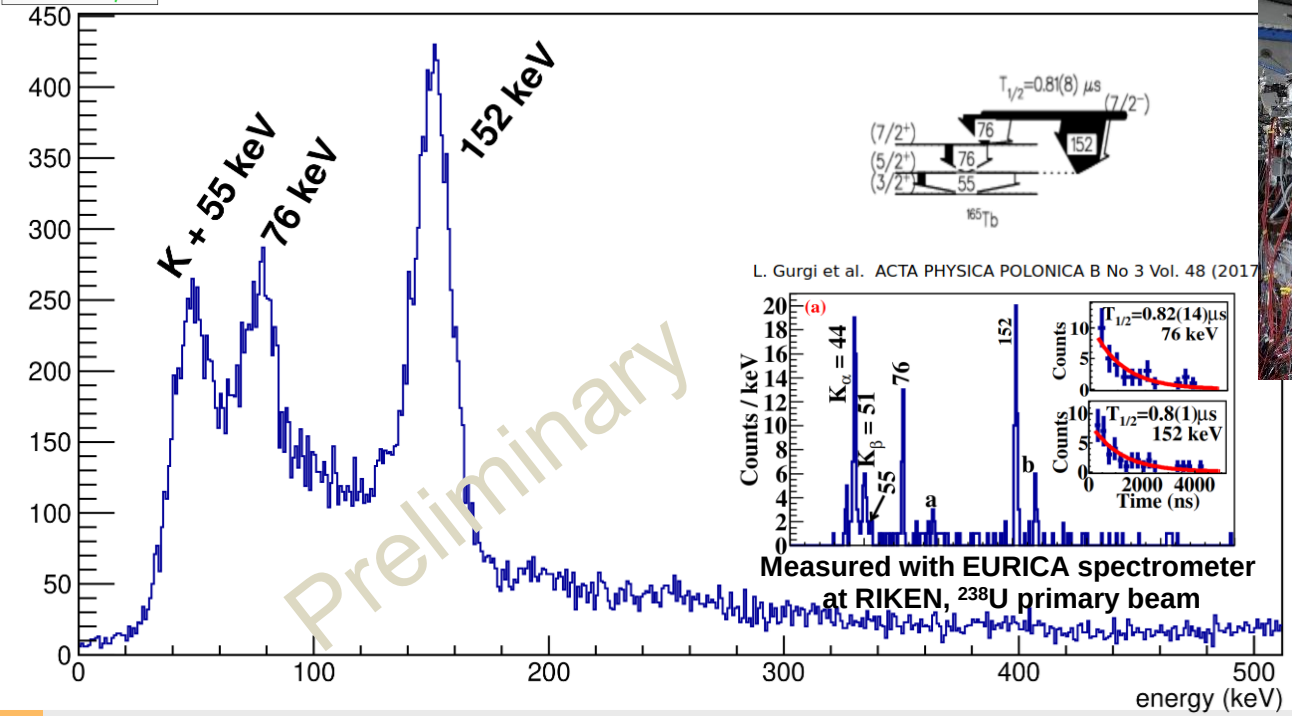
First-time measurement of bond strength in a SHE-molecule!

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

Preliminary data from S100 FAIR Phase-0

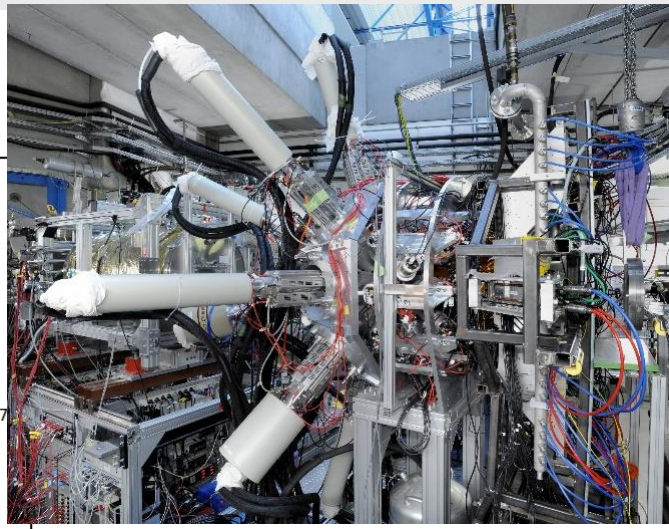
Fragmentation of ~1GeV/u ^{170}Er beam, H. Albers et al.

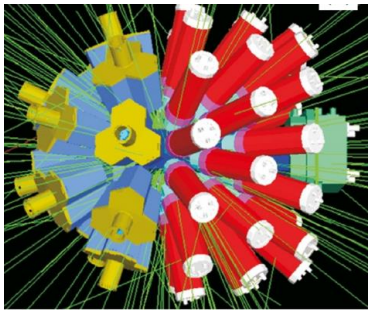
FATIMA energies, 165Tb, 300 ns after implantation, 3000 ns collection window



L. Gurgi et al. ACTA PHYSICA POLONICA B No 3 Vol. 48 (2017

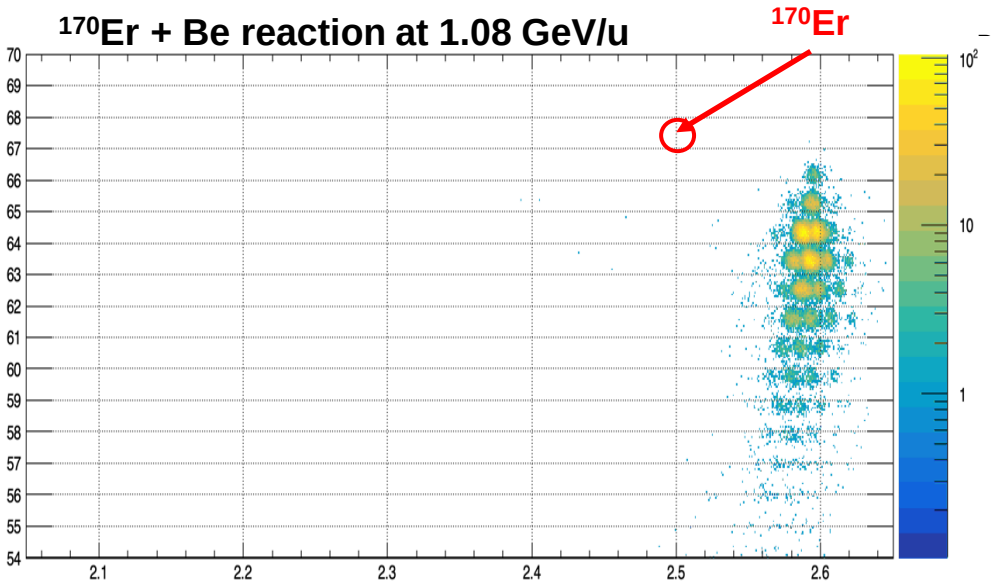
Measured with EURICA spectrometer at RIKEN, ^{238}U primary beam





Measurement of fragmentation cross section of newly developed ^{170}Er beam

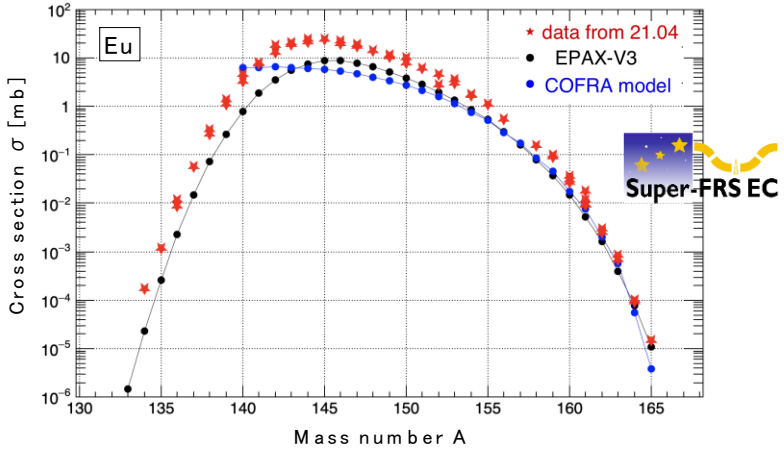
Very preliminary
Online analysis (data of first night)



- excellent particle separation and identification
- wide range of cross section data is important basis for future NUSTAR experiments

Measurement of fragmentation cross sections with newly developed Er beam

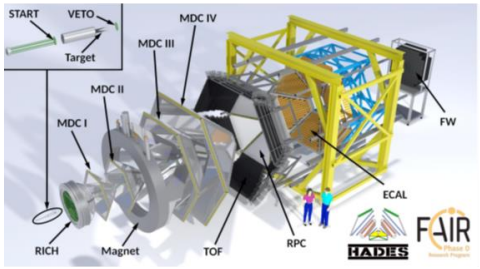
oduction cross section of Eu isotopes with ^{170}Er + Be reaction at 1.08 GeV/u



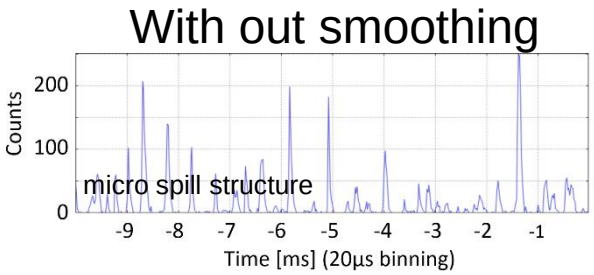
General trend follows EPAX model, but the measured cross sections tend to be larger by a factor ~ 2 − 10 in the neutron deficient side

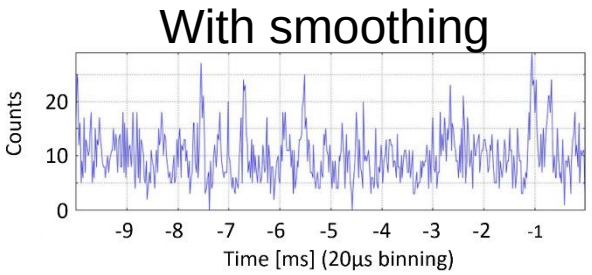
➔ Reliable rate and yield estimates for the first experiments at Super-FRS

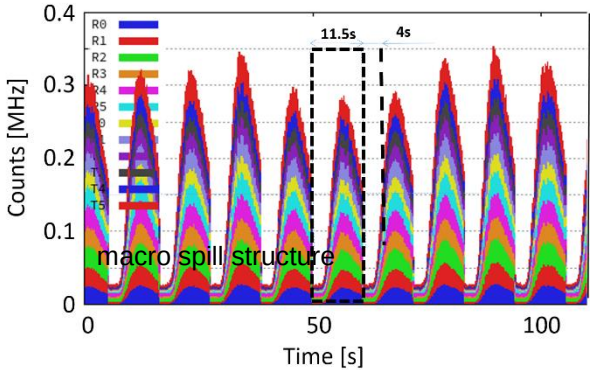
Spill smoothing at HADES

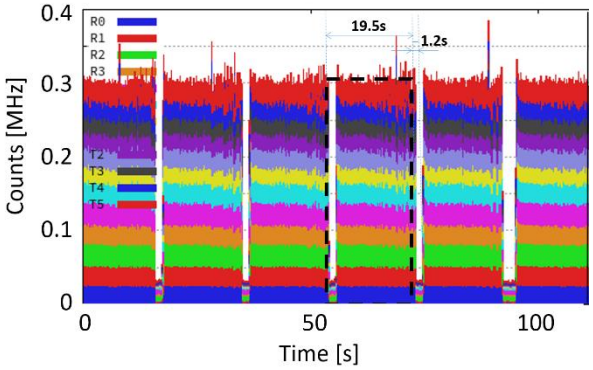


- For the first time, HADES was running Au beam extracted with Knock-out (KO) extraction, the new feedback system and smoothing cavity
- Super duty factor with effectively ~90 % beam on target time
- KO extraction with feedback improved substantially micro spill time structure
- Slow extraction with KO system enables data taking with ~twice larger speed









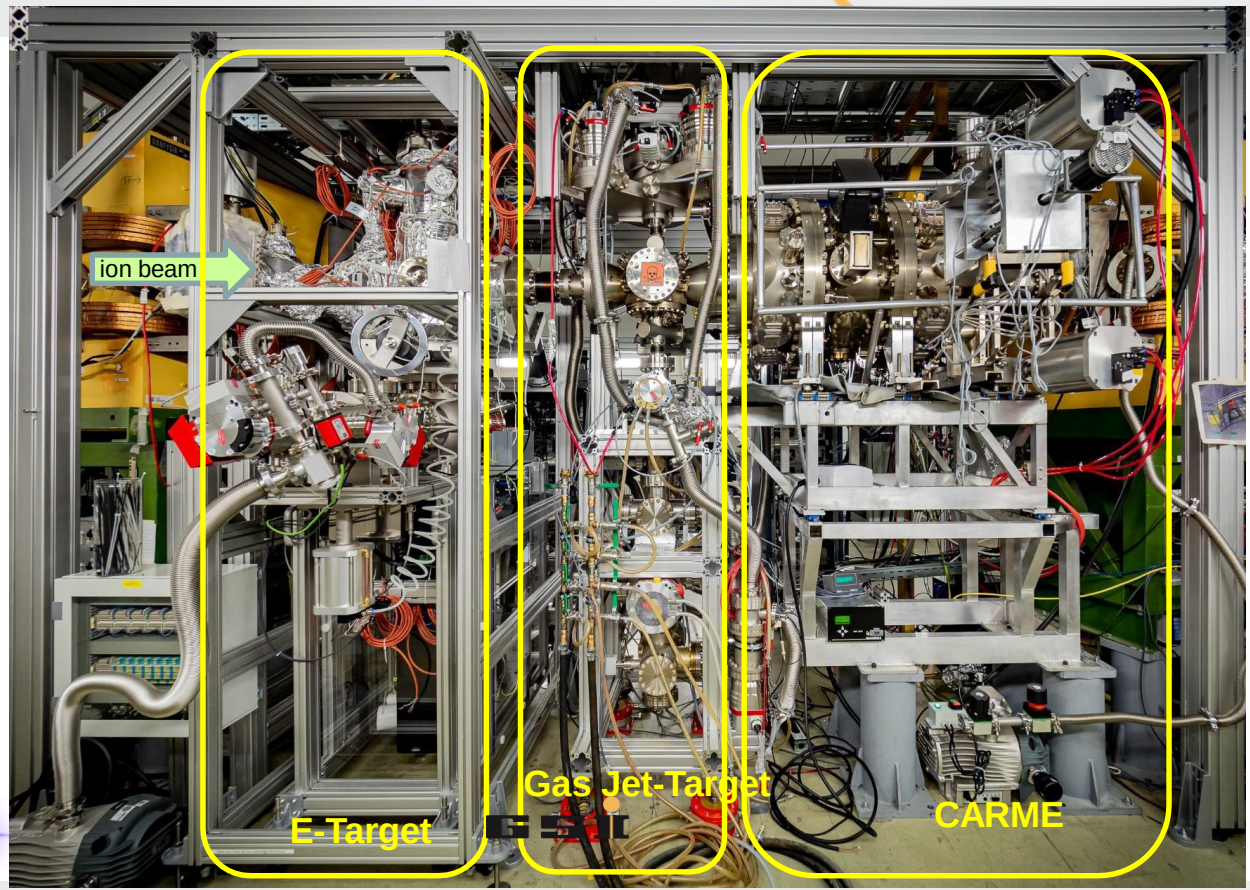
Factor 2 gain in event rate

Section YR09

Internal jet target: the hardware for the H2- gas system was installed. The technical acceptance from TÜV expected for May but it must still be scheduled.

E-Target:
final installation of additional hardware completed. Commissioning with beam scheduled for beginning of May.

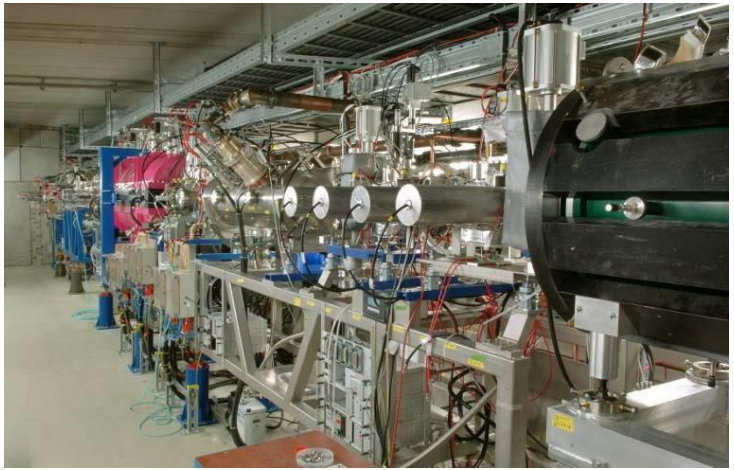
C. Brandau, A. Borovik, S. Schippers et al., GSI/JLU Gießen



HITRAP Commissioning; Ions captured (stopped), stored and extracted!

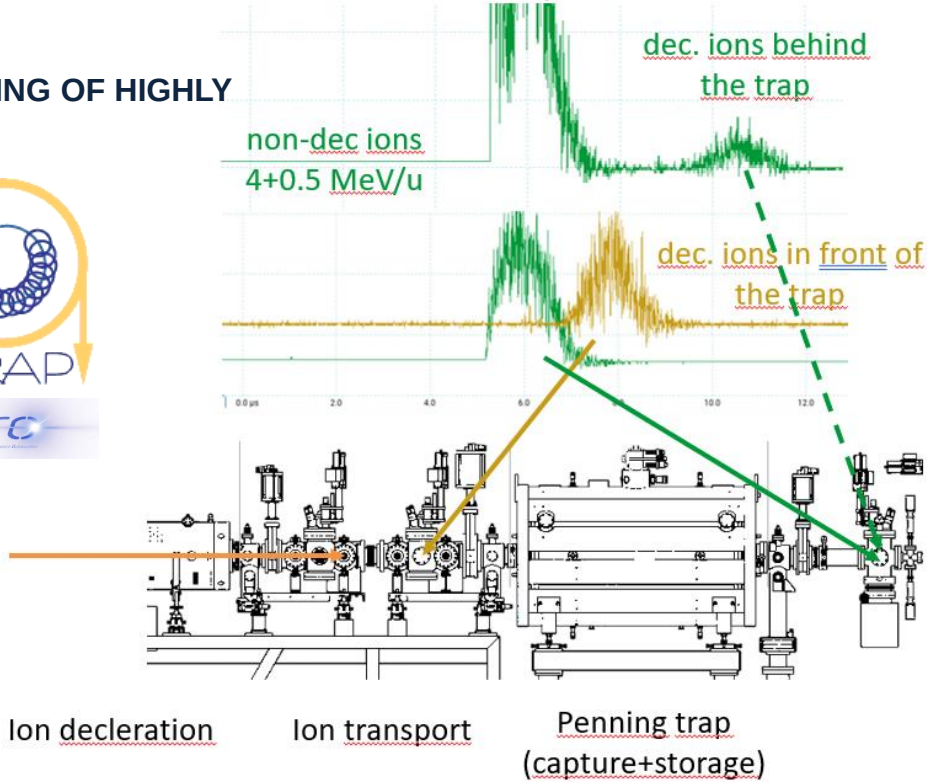
Beamtime 2024: $36\ Ar^{18+}$ ions from the ESR: successful deceleration and transport

THE HITRAP FACILITY FOR DECELERATION AND TRAPPING OF HIGHLY CHARGED IONS AND ANTI-PROTONS



HITRAP

sparc

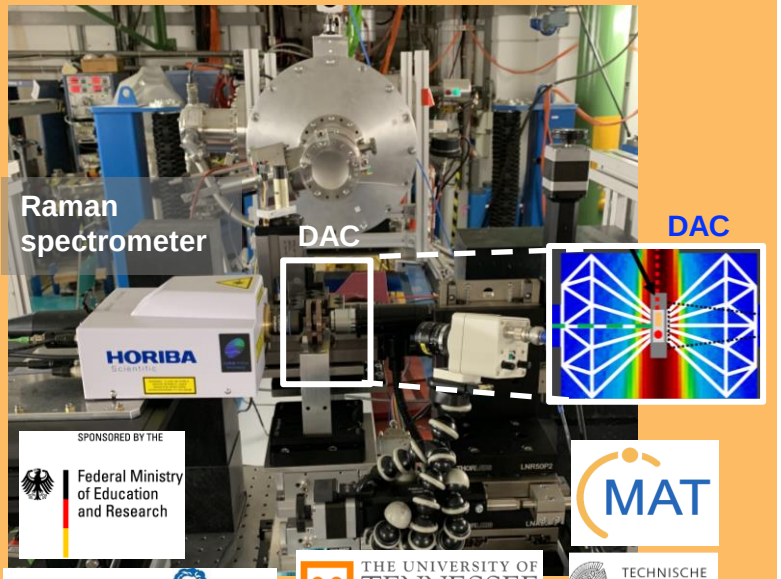


Frank Herfurth et al.

Upgraded high-pressure platform in operation in cave A

Beamtime June 2024: Successful experimental campaign at Cave A coordinated for 6 user groups

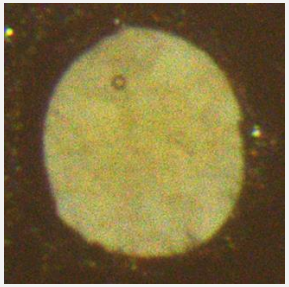
Diamond Anvil Cell (DAC)



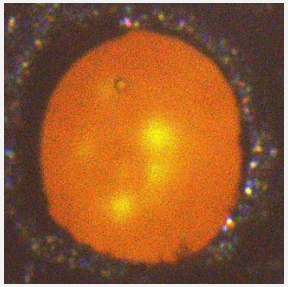
- New remote unified control system tested
- Successful irradiation of 18 DACs filled with benzene, CO, CO_2, Bi, Sb, nanomaterials, ….

***Example: B*enzene at 22.7 GPa**

Before irradiation

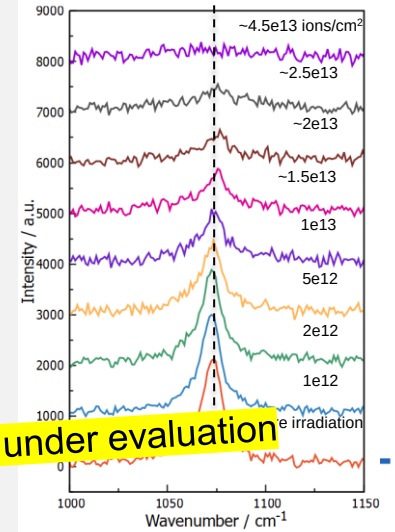


After irradiation



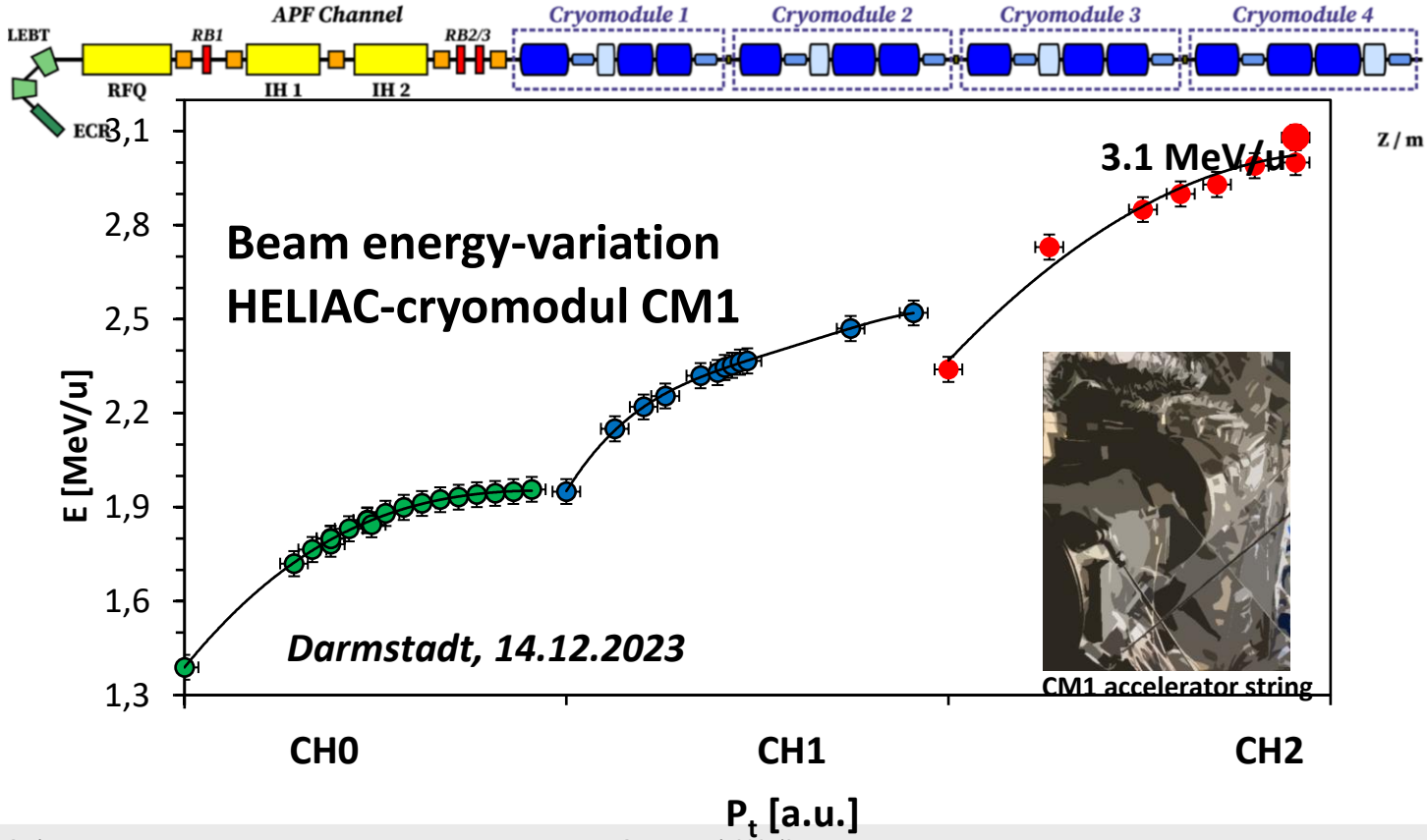
attributed to transformation
$sp^2 \rightarrow sp^3$ carbon bonds

Raman spectra vs. ion fluence



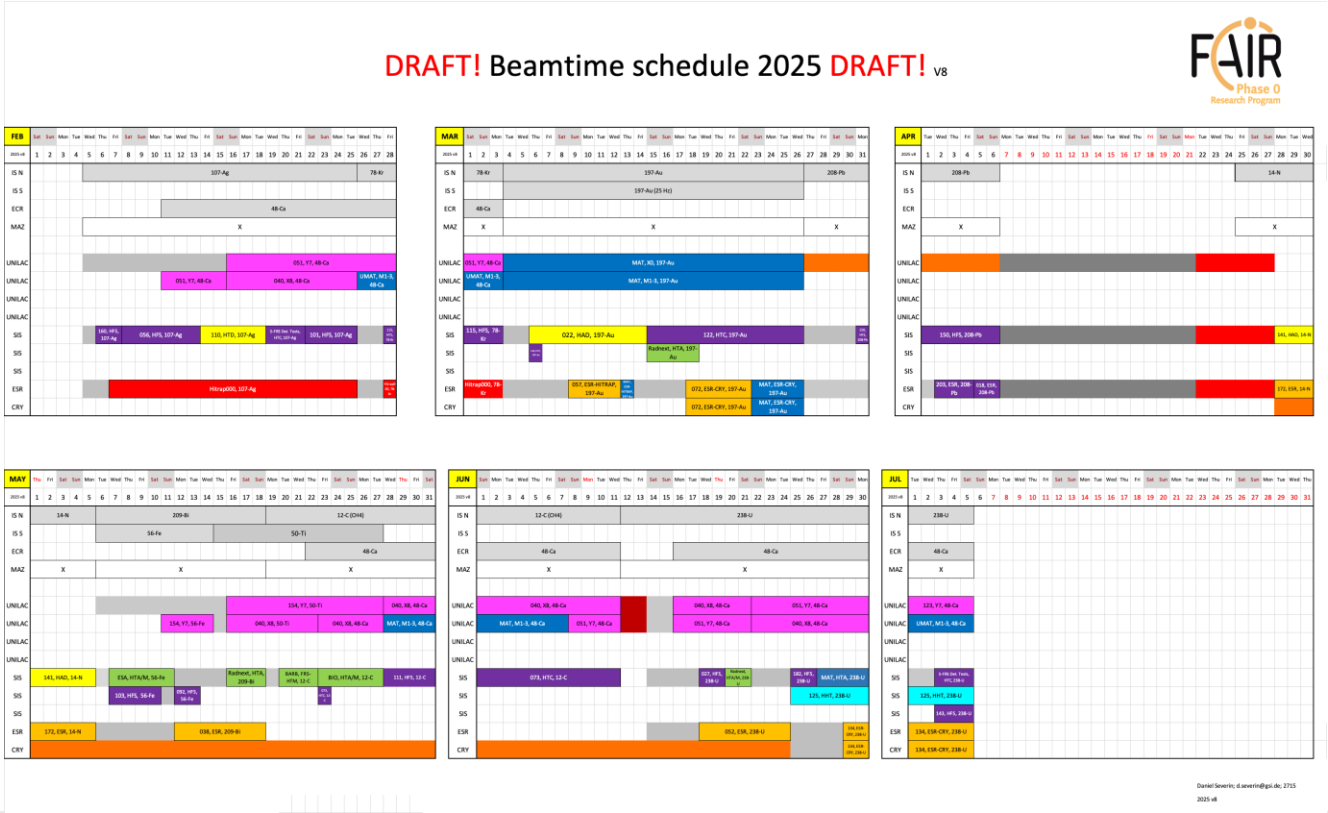
data under evaluation

Beam commissioning of HELIAC-cryomodule CM1



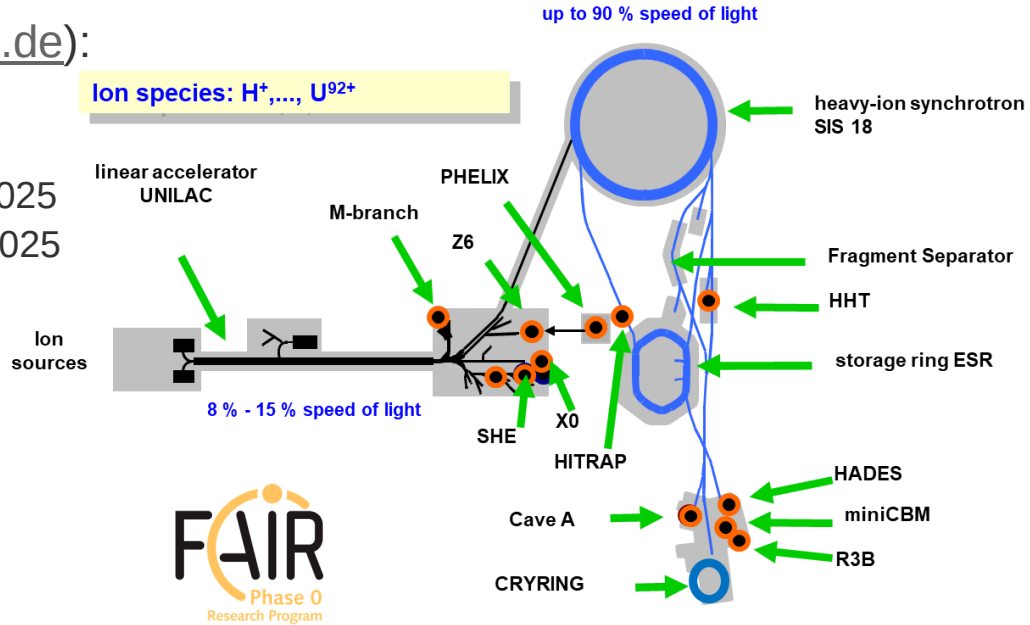
Beamtime 2025 (Daniel‘s presentation)

- 130 days physics beamtime
- Scheduling almost done - slide adaptions under discission
- Open presentation of the BT schedule on October 8th 4pm



Calls for proposals 2024

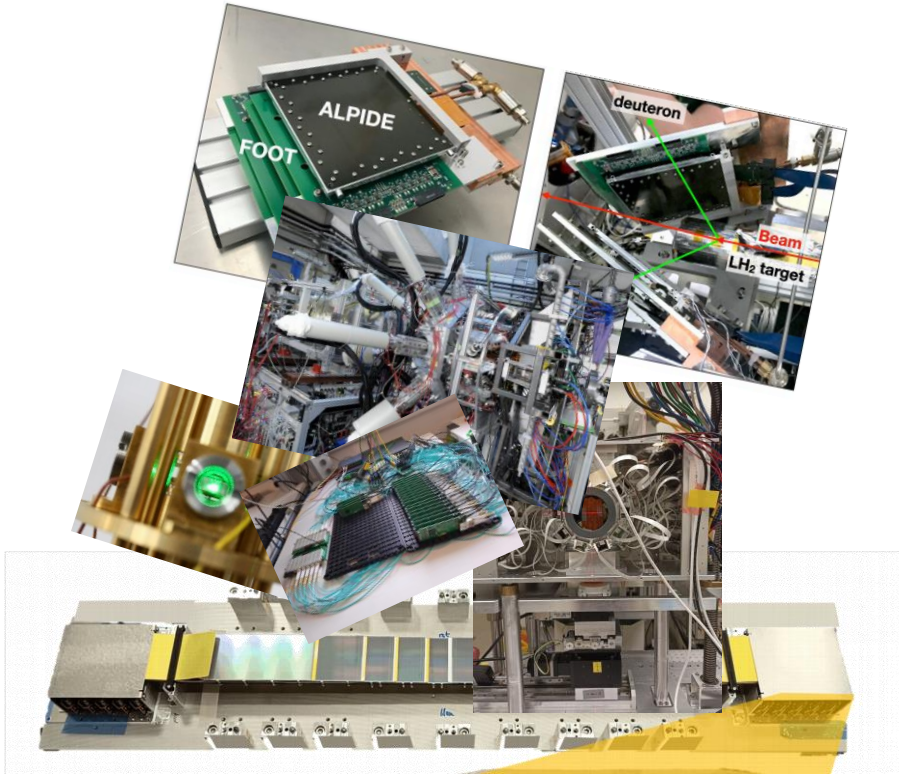
- For beamtime in 2026 and 2027
- Submission via GATE (https://gate.gsi.de):
  - PPAC now – 26.11.2024
  - **G-PAC now – 2.12.2024**
  - Mat-PAC November – mid-January 2025
  - Bio-PAC mid-January – mid-March 2025
- N° of shifts to be recommended
  for all PACs combined:
  - 350 shifts at UNILAC,
  - 300 shifts at SIS18,
  - 250 shifts in total for at
    ESR, ESR-HITRAP and ESR-CRYRING,
  - 100 shifts at PHELIX.



- Infos on webpages of the PACs: www.gsi.de/g-pac, /ppac, /mat-pac, /bio-pac
- Call for CRYRING in standalone-mode in 2025 (for beamtime 2026)

Detector tests included in call

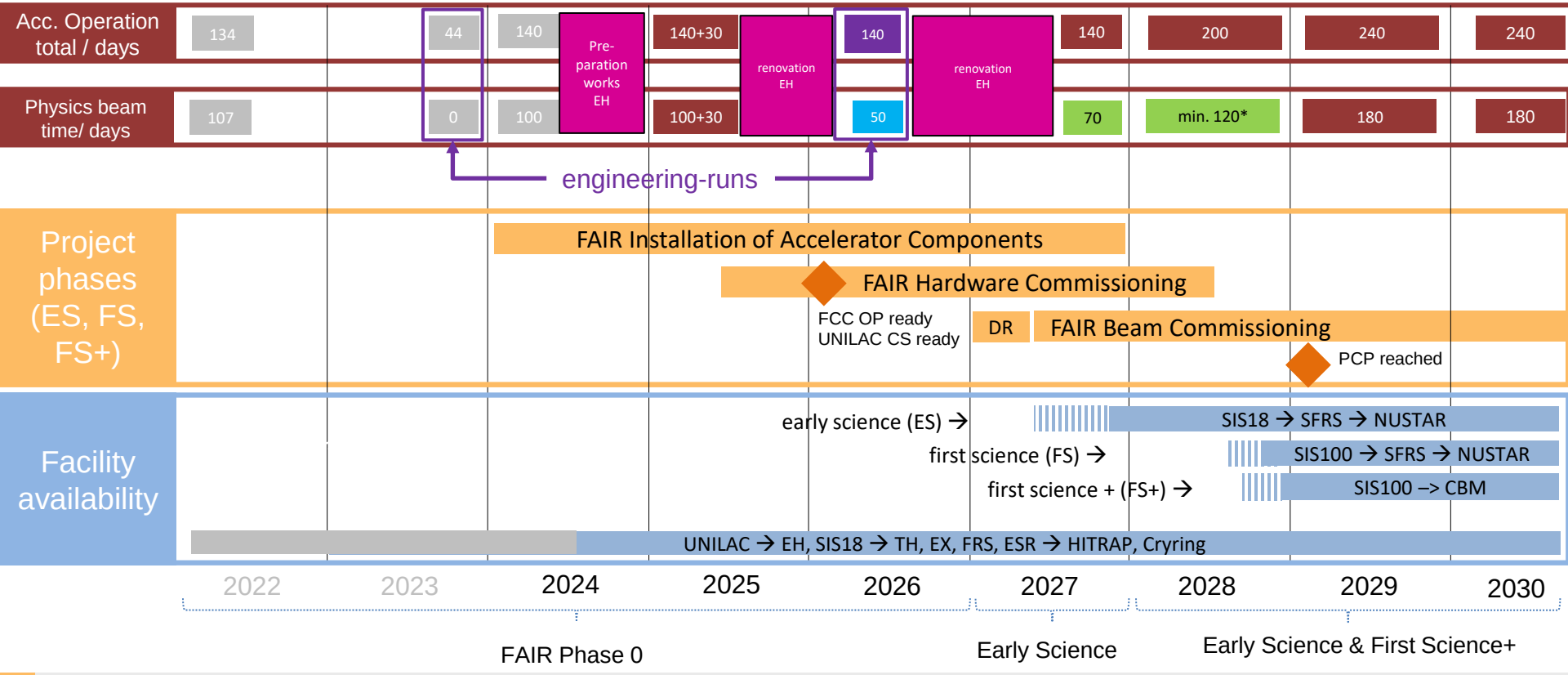
- Detector test: no direct scientific goal
- Not to be submitted as regular proposals
- Please contact respective Scientific Secretary of the PAC, e.g. Manuel Vogel for G-PAC (on special submission into GATE)
- Same deadline as G-PAC proposals



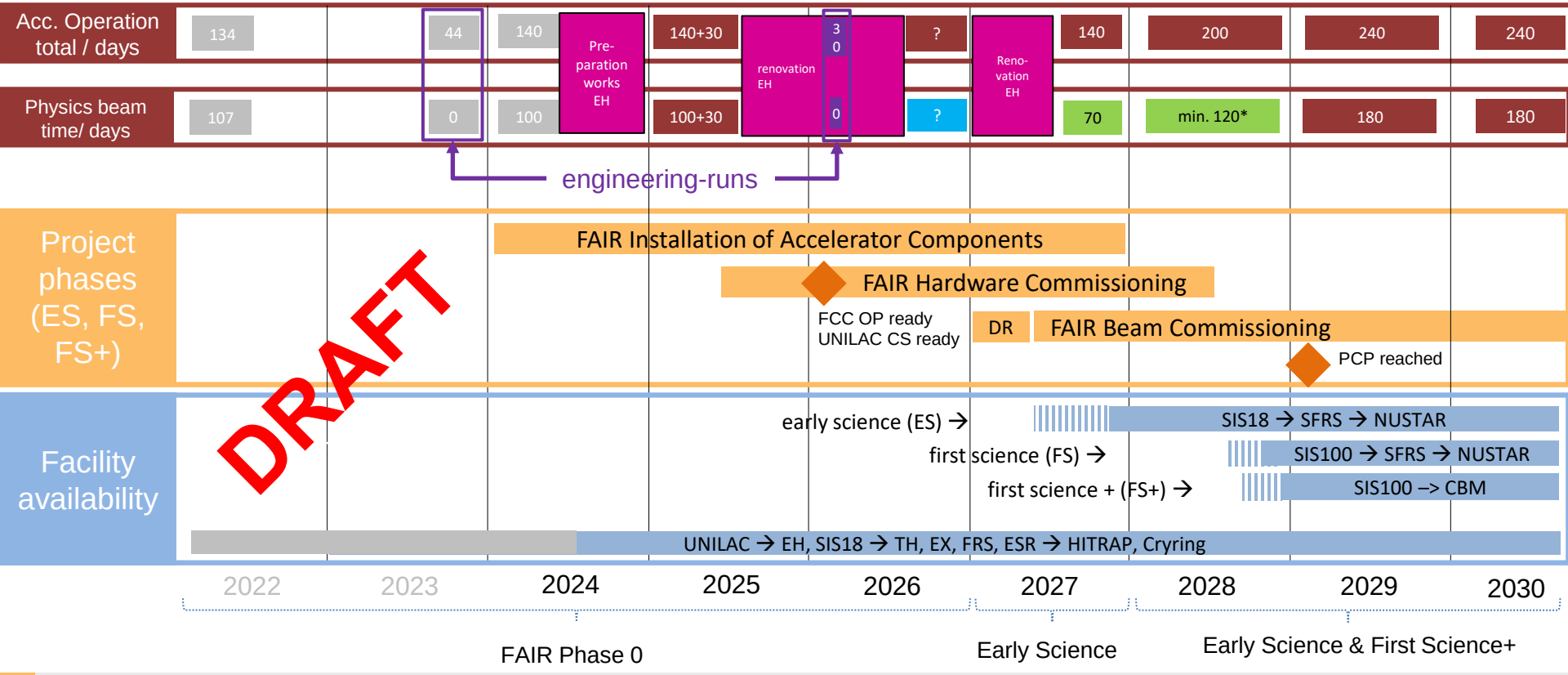
Physics beamtime modes

Mode A	Physics beamtime	- highest priority on physics - full parallel operation - full on-call service at any time
Mode B	Best effort operation (BEO)	- priority on physics - limited parallel operation - on-call service by arrangement
Mode C	Second priority	- priority on FAIR commissioning - limited parallel operation - on-call service by arrangement

FAIR/GSI strategic operation scenario towards FS+

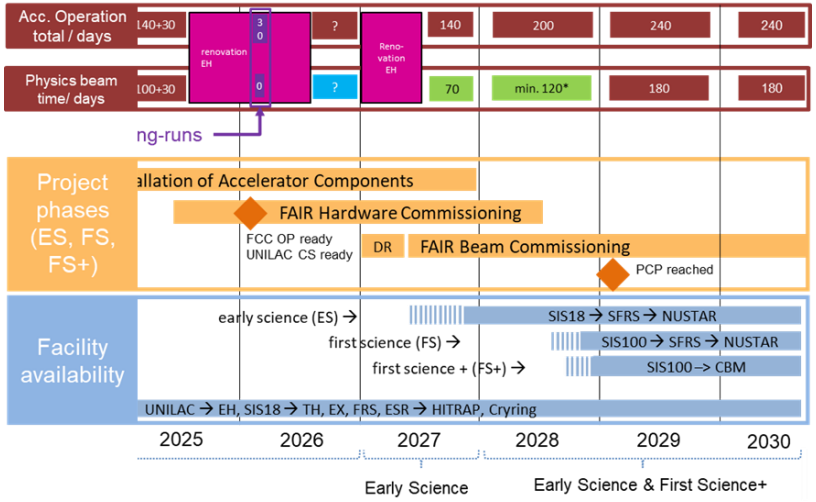


FAIR/GSI strategic operation scenario towards FS+

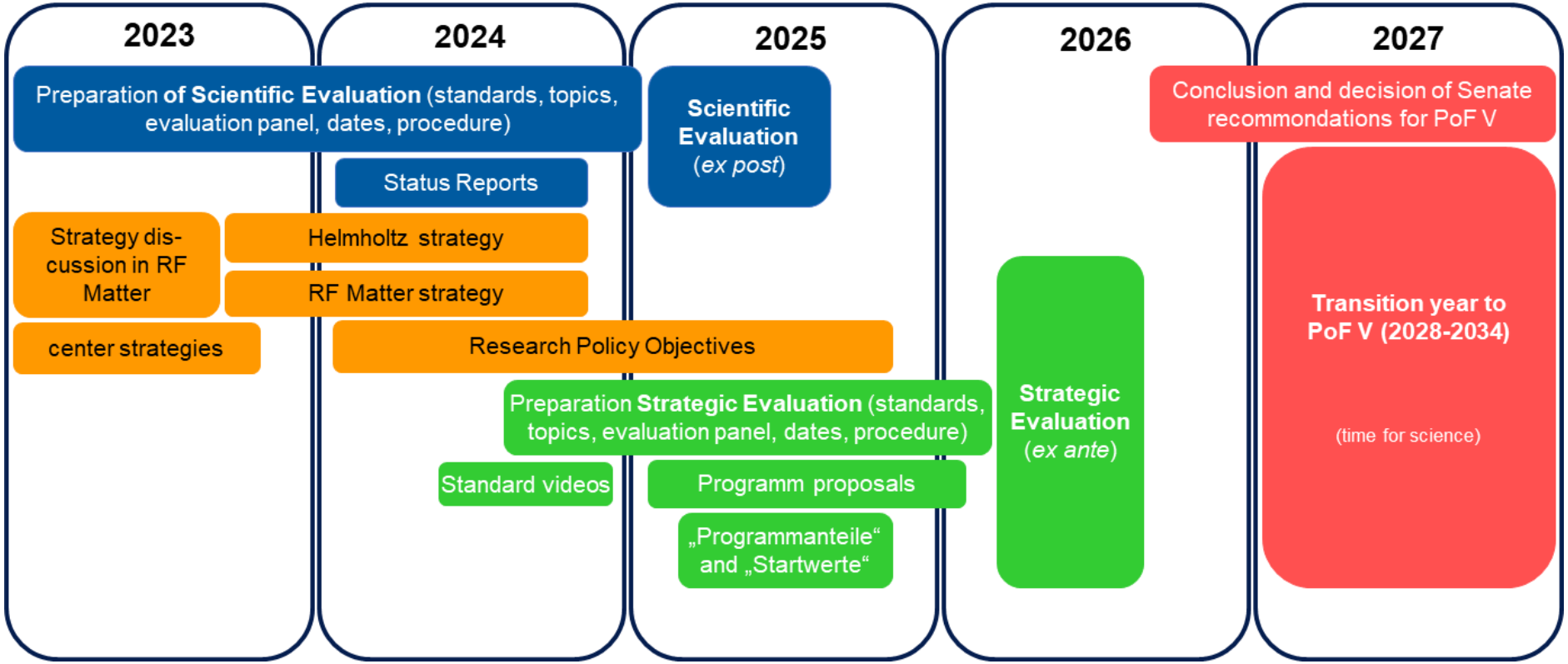


Further steps

- 2024
  - call for 2026/27: last beamtime with UNILAC/SIS18 only
- 2025
  - beamtime
  - restructuring of the committees
  - start of commissioning phase for the FAIR experiments
  - start of FAIR Hardware Commissioning
- 2026
  - beamtime
  - FCC ready: accelerator controls moving
- 2027
  - beamtime
  - start of FAIR accelerator commissioning
  - start of early science end of the year

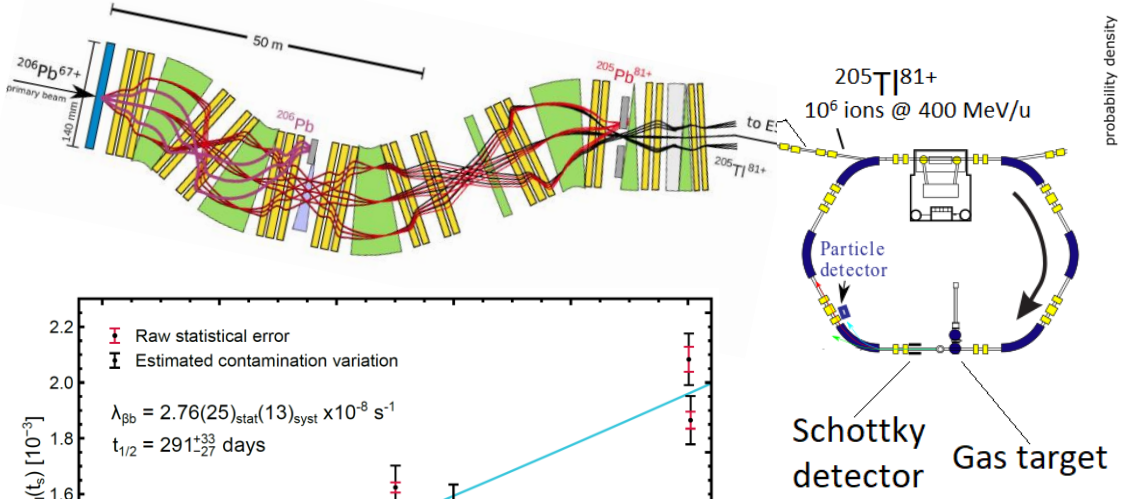


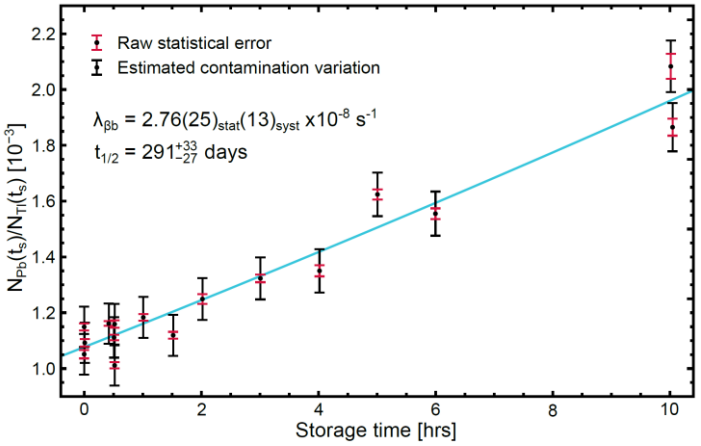
GSI in Helmholtz



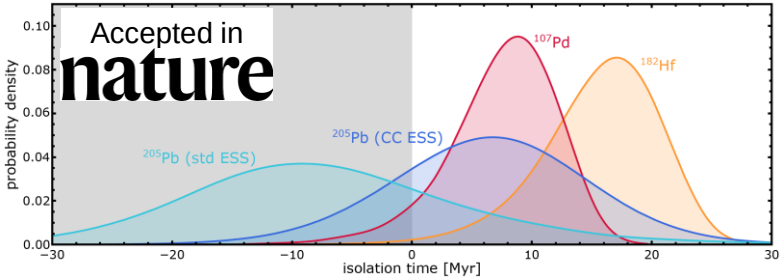
Finally some highlights
Bound state beta decay of $^{205}Tl^{81+}$

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



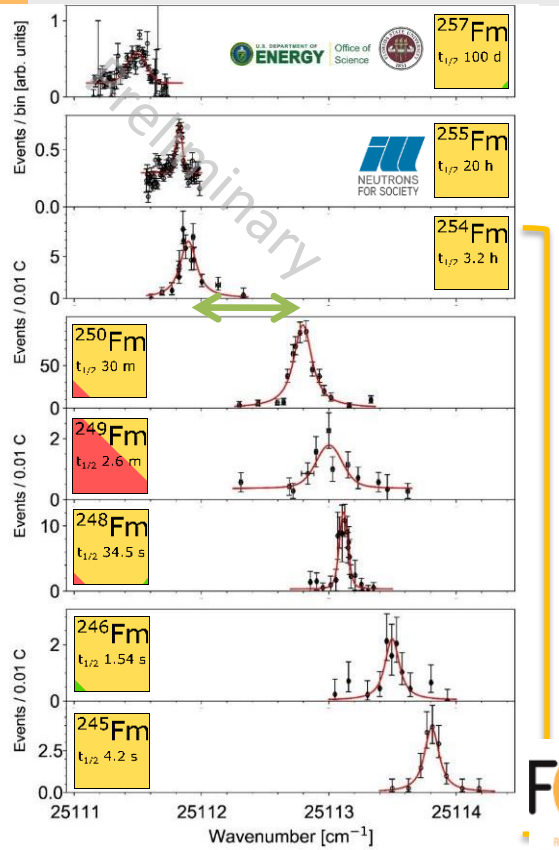
Combined with meteoritic data, new ^{205}Pb and ^{205}Tl decay rates in plasmas, and astrophysical simulations, the isolation time of the solar matter from the last synthesis of ^{205}Pb is for the first time positive!

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

Laser spectroscopy of fermium isotopes

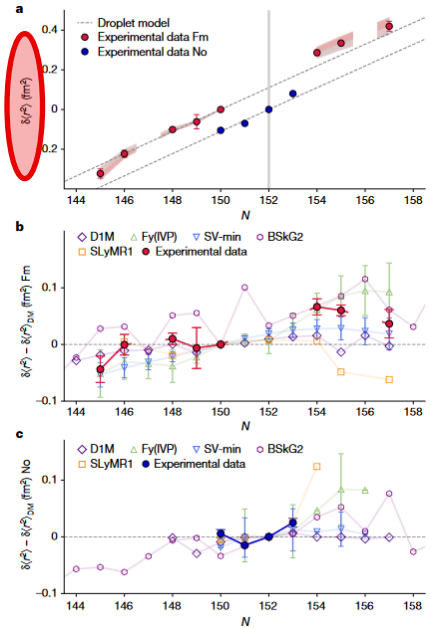


Smooth trends in fermium charge radii and the impact of shell effects

Determination of change in nuclear charge radii from isotope shifts for a long chain of Fm isotopes produced in different reactions

$$\delta\langle r^2\rangle^{AA'} = \left(\Delta\nu^{AA'} - \frac{A-A'}{AA'}M\right)\frac{1}{F}$$

comparison to nuclear EDF calculations



nature

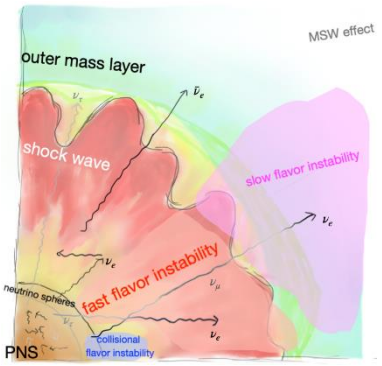
J. Warbinek et al., nature, Accepted for publication

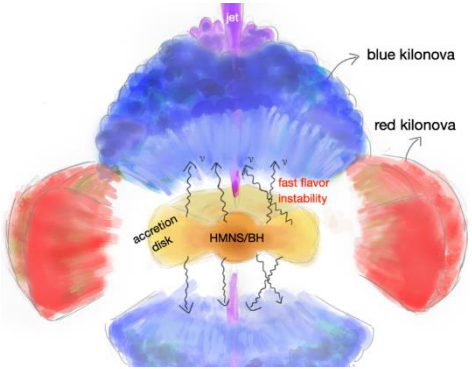
ERC Starting Grant (NeuTrAE)

NeuTrAE: Neutrino flavor Transformations in dense Astrophysical Environments.

PI: Zewei Xiong

Funding: 1.5 M€ for five years





Scientific goals:

- performing quantum kinetic simulations for neutrino flavor transformations
- developing numerically effective schemes that can be incorporated in state-of-the-art hydrodynamic simulations
- asses the impact of neutrino flavor transformations on heavy element nucleosynthesis and its electromagnetic signatures and identify key reactions to be measured at GSI/FAIR


Thank you for your attention