NUSTAR Technical Status

RRB-13

17th May 2024

H.M. Albers

Technical Highlights (I)


Half CALIFA including forward sector

2023-2024

- Full coverage of CALIFA calorimeter at forward angles

Mitigation action for CEPA Phoswich

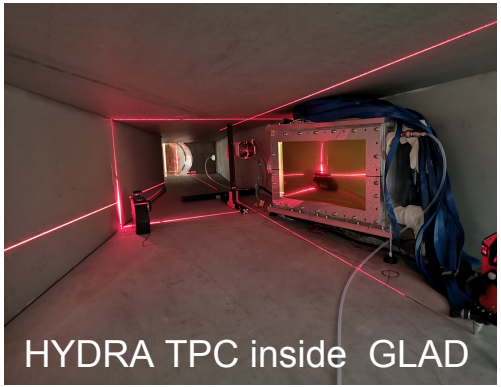
- Target recoil tracking Stage 1 commissioned

Mitigation action for L3T Si Tracker

- Commissioning of HYDRA TPC inside GLAD
- Commissioning of full R^3B setup for the 2024 campaign

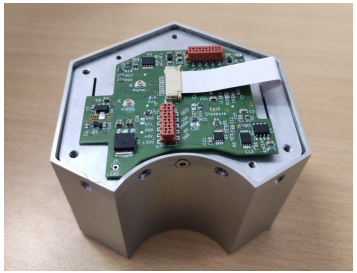

Detailed view of R3B Target área
Recoil tracking Stage 1

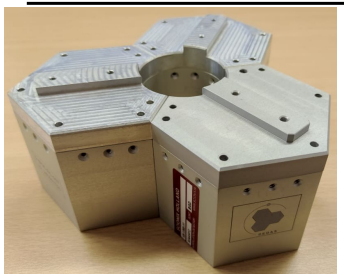

Tracking detectors behind GLAD


HYDRA TPC inside GLAD

Technical Highlights (II)

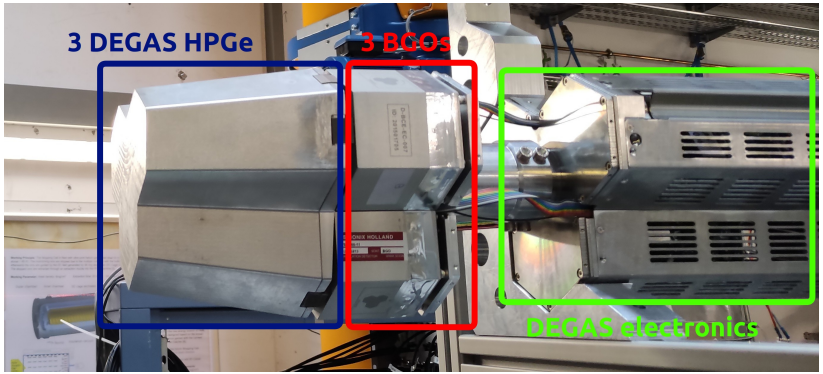
HISPEC/DESPEC BGO Backcatchers for DEGAS



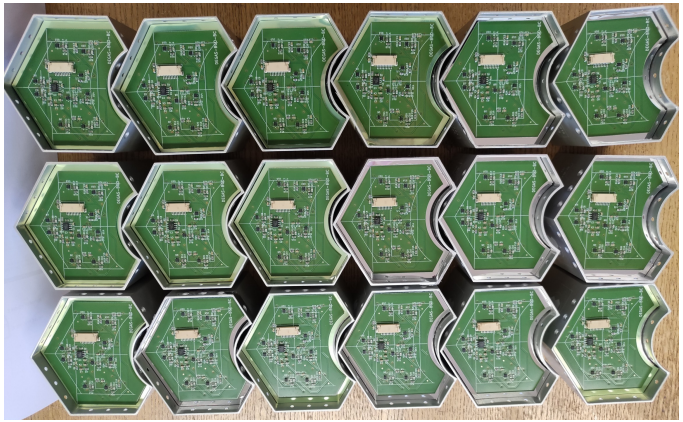


Single (left) and triple (right) BGO modules

- DEGAS detector comprises **3 x HPGe and 3 x BGO**
- BGOs operate in anti-coincidence with the HPGe, to reduce the Compton continuum measured by the HPGes
- 18 BGO backcatchers (JSI, Ljubljana) **assembled**, **tested** and **delivered** for use in upcoming FAIR Phase-0 experiments

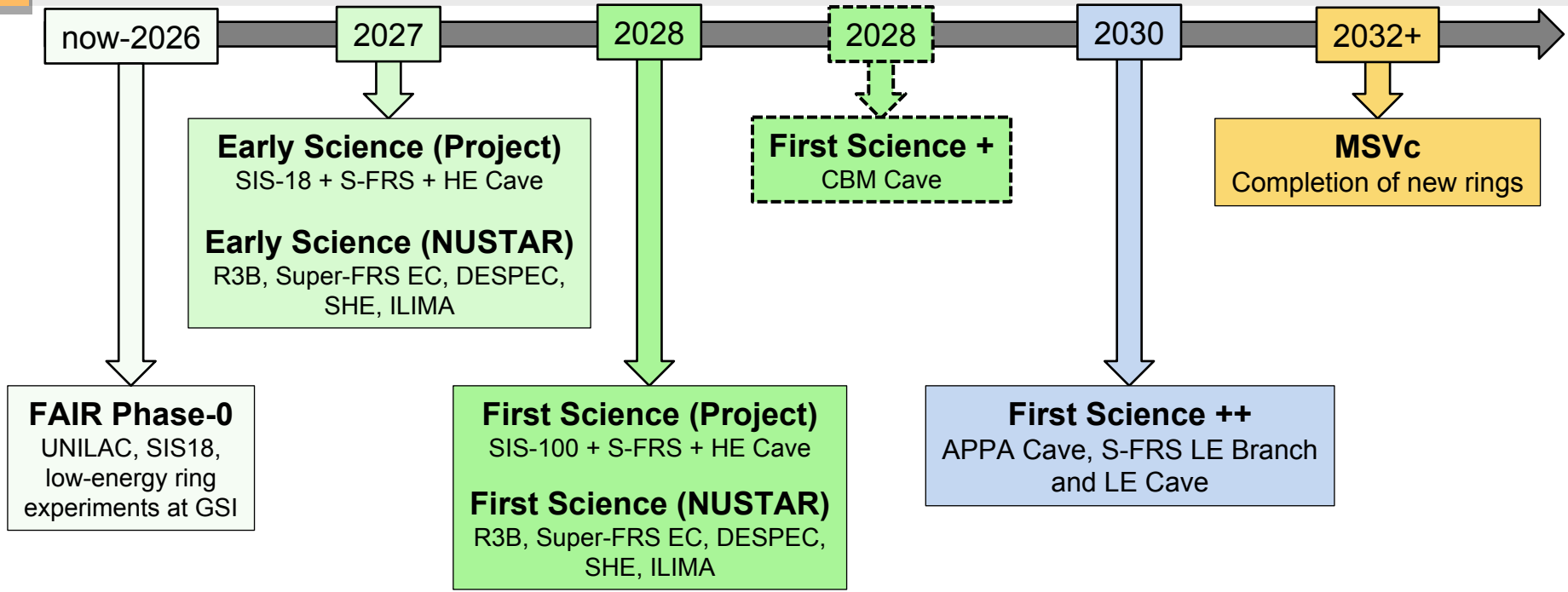


Main components of a DEGAS detector



G. Kosir *et al.*, BGO active shield for DEGAS, Nuclear Inst. and Methods in Physics Research, A (2024), doi: https://doi.org/10.1016/j.nima.2024.169157

NUSTAR timeline: the ‘simple’ picture



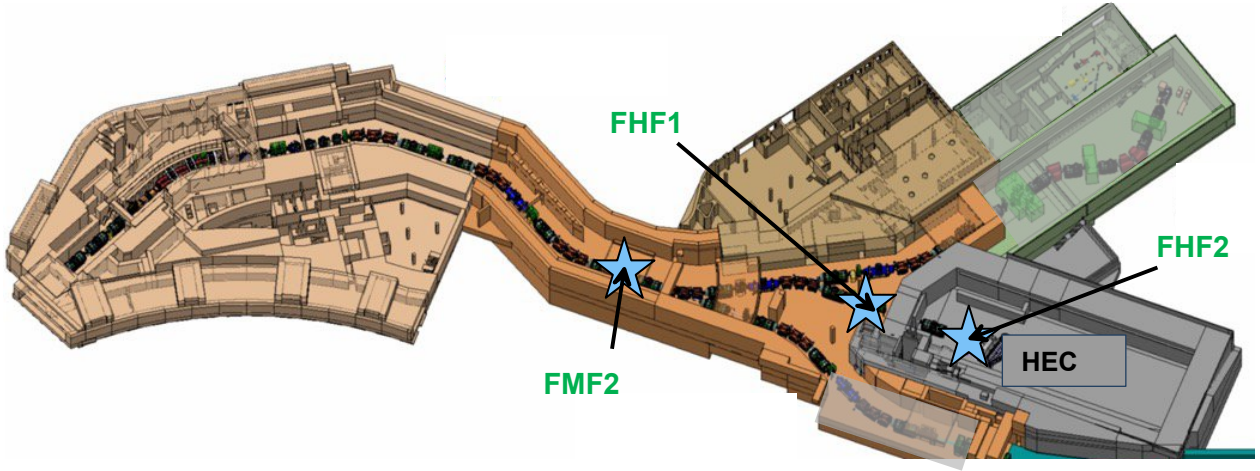
Green: Budget available
Green: Budget decision expected soon
Blue: Civil construction complete
Orange: Significant additional investment required

– Timeline dependent on Council decisions and timely delivery of SIS100 quadrupoles
– Additional funding needed in 2026 for continuation of skilled workforce

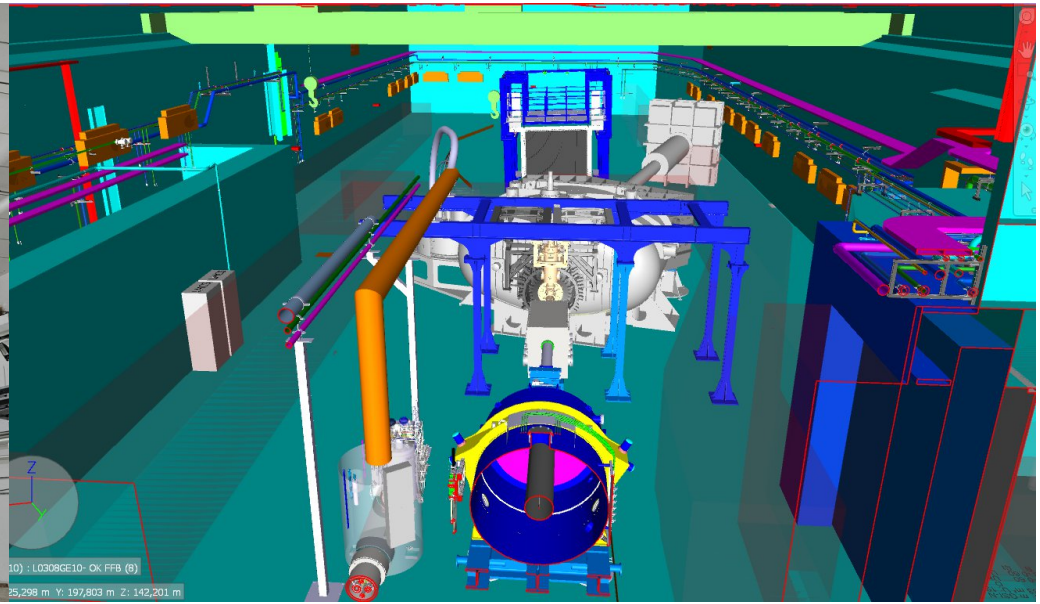
Overview of ES/FS at the S-FRS

Three key focal points of the S-FRS:

- **FMF2** mid-point of main separator
- **FHF1** (tunnel)
- and **FHF2** (HEC) along high-energy branch

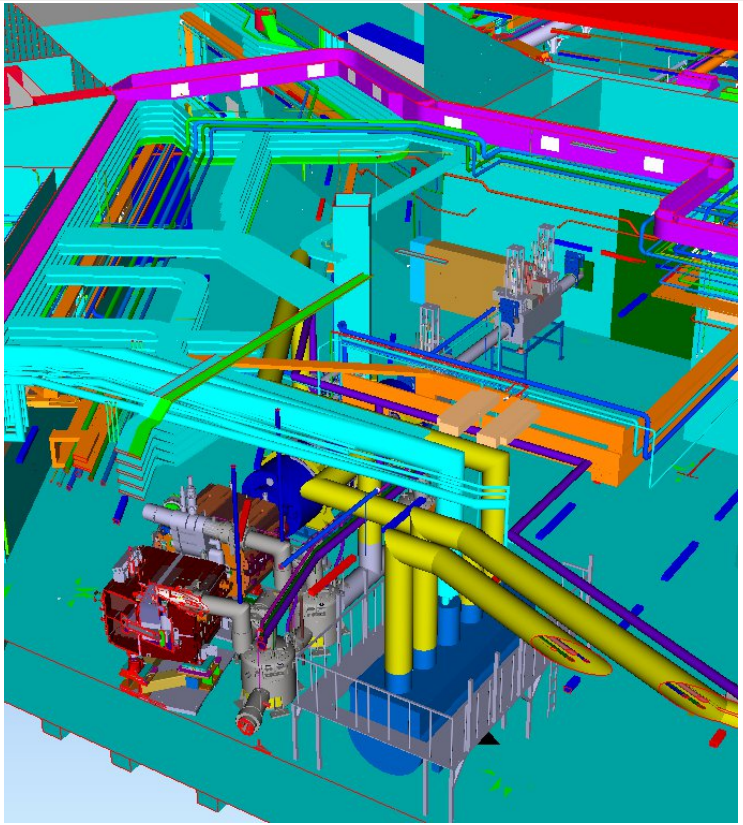


Construction update – Q1 2024

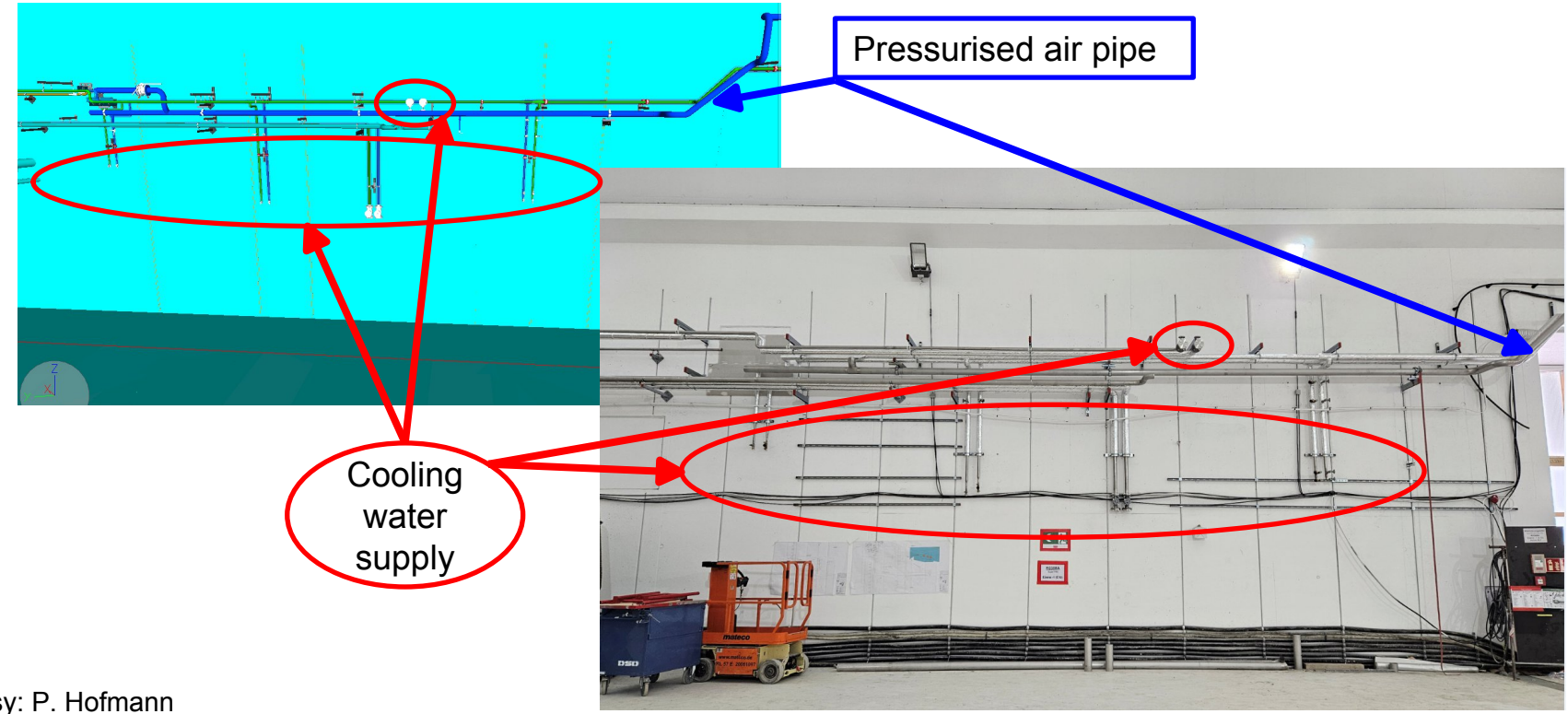


NUSTAR High-Energy Cave

Construction update – Q1 2024

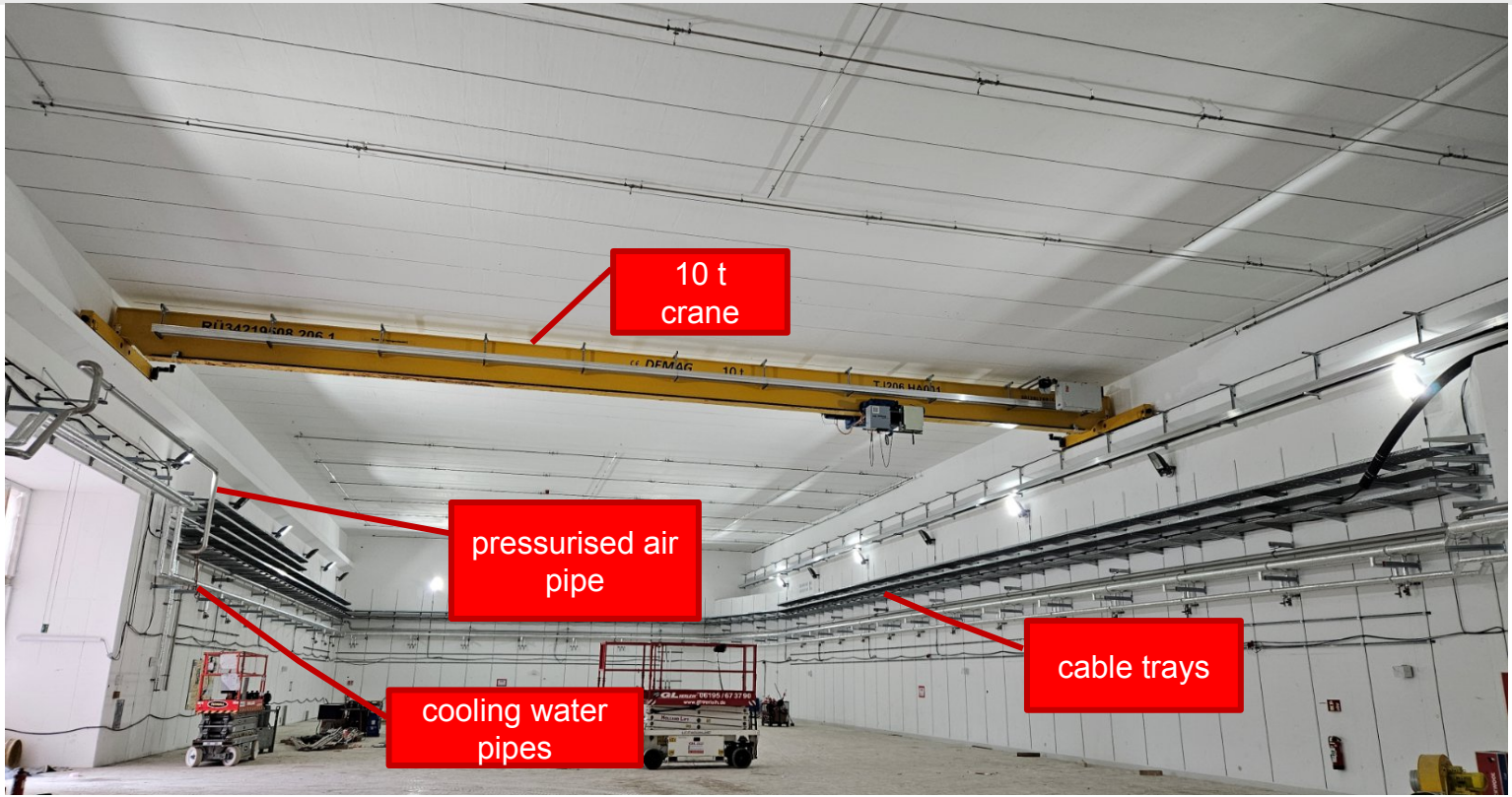


The model comes to life – example: rack niche HEC



Courtesy: P. Hofmann

Technical Building Infrastruction (TBI) progress update
Q1 2024, inside HEC



Courtesy: P. Hofmann

Technical Building Infrastruction (TBI) progress update
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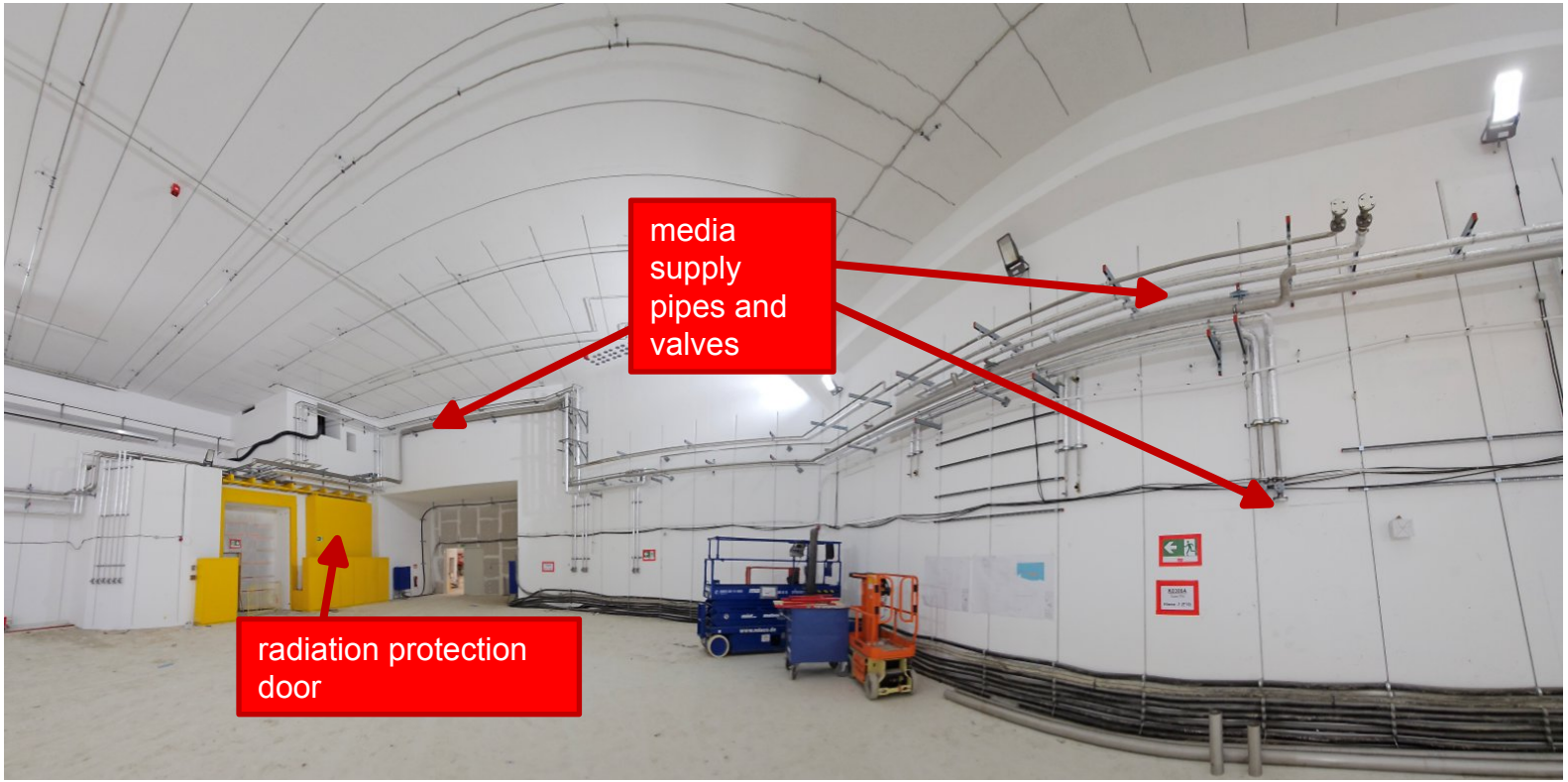
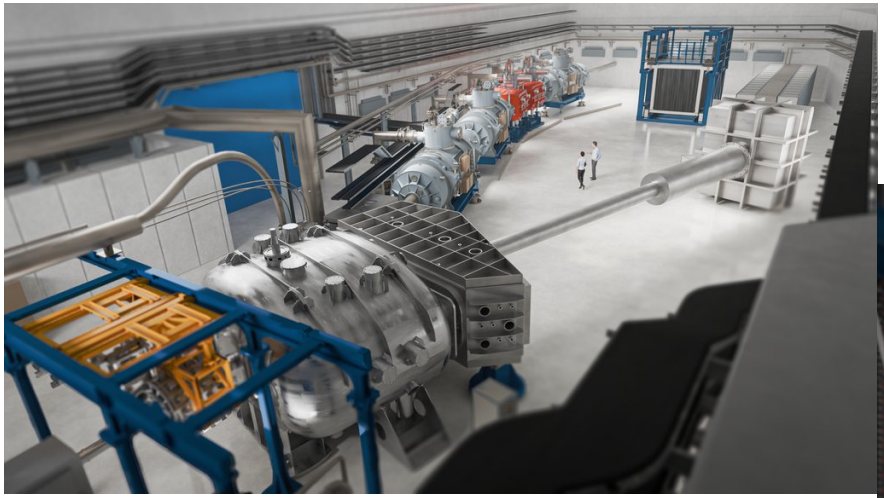


Courtesy: P. Hofmann

NUSTAR High-Energy Cave Visualisation



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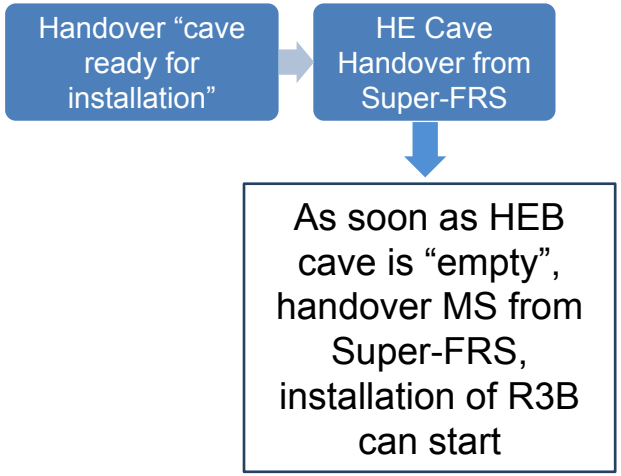
NUSTAR Strategy towards FS

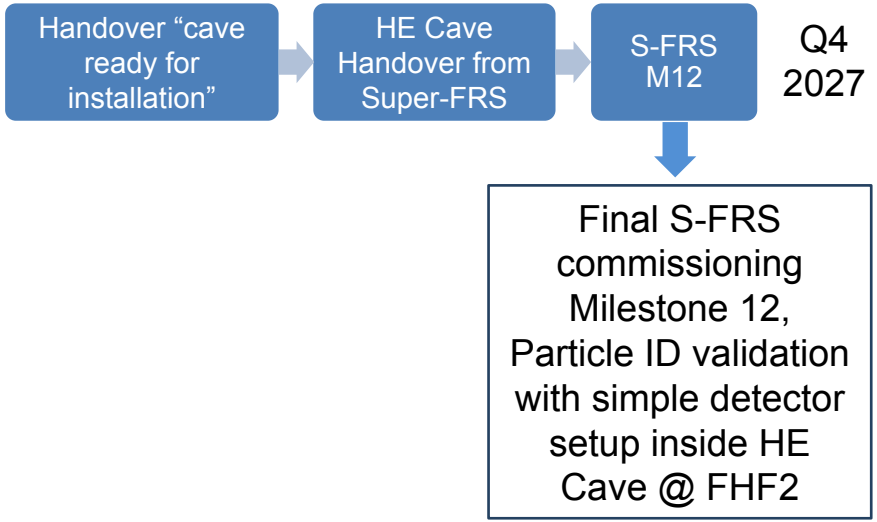
Handover “cave ready for installation”

As soon as building is ready for installation, some infrastructure items can be installed (limited due to work on Super-FRS)

NUSTAR Strategy towards FS



NUSTAR Strategy towards FS

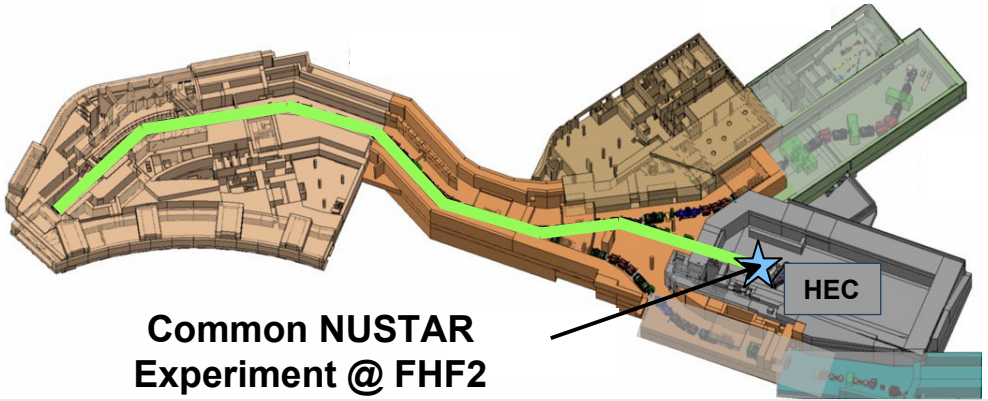


NUSTAR Strategy towards FS

Handover “cave ready for installation” → HE Cave Handover from Super-FRS → S-FRS M12 → Q4 2027 → Common NUSTAR experiment @ FHF2

Common NUSTAR experiment. S-FRS settings and setup likely to overlap with M12

Simple, compact setup, fast results needed!
Lessons learned from FRIB (and RIKEN)



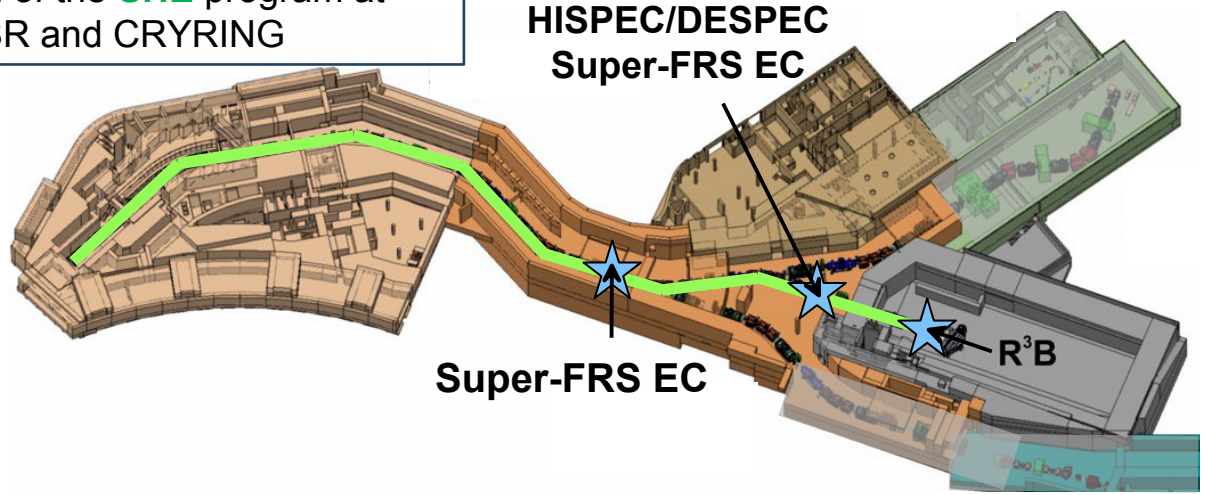
Common NUSTAR Experiment @ FHF2

NUSTAR Strategy towards FS

Handover "cave ready for installation" → HE Cave Handover from Super-FRS → S-FRS M12 → Q4 2027 → Common NUSTAR experiment @ FHF2 → NUSTAR Early Science → NUSTAR First Science

NUSTAR ES and FS:
individual sub-collaborations **(Super-FRS EC, partial HISPEC/DESPEC and R3B)** running PAC-approved experiments at S-FRS focal planes, continuation of the **SHE** program at UNILAC and **ILIMA** at the ESR and CRYRING

Detailed installation timelines to be developed and refined in LCM workshops

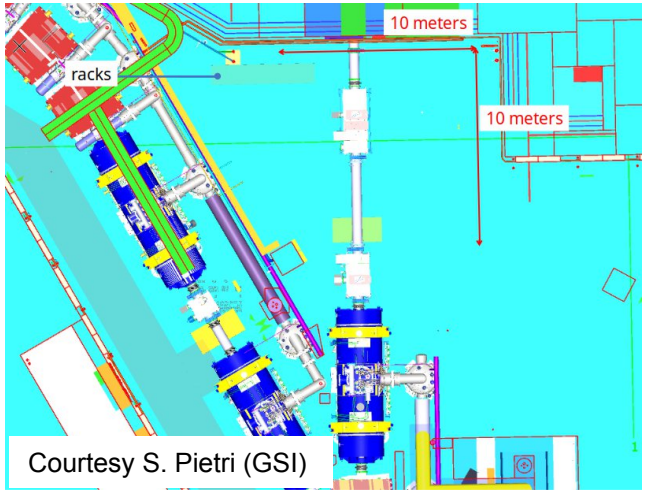


NUSTAR setups @ FHF1

- FHF1 to be shared between DESPEC and Super-FRS EC Ion Catcher
- Detailed discussion on a number of topics to ensure we will be ready in 2027
- **NUSTAR ES experiments will be the first at FAIR**
- Information on what, who and how equipment will be operated needed for safety considerations and planning
- Series of Workshops co-organised by NUSTAR and S-FRS

Participants from:
NUSTAR Infrastructure Team
Super-FRS project (SFS)
Radiation Safety
DESPEC
Super-FRS EC

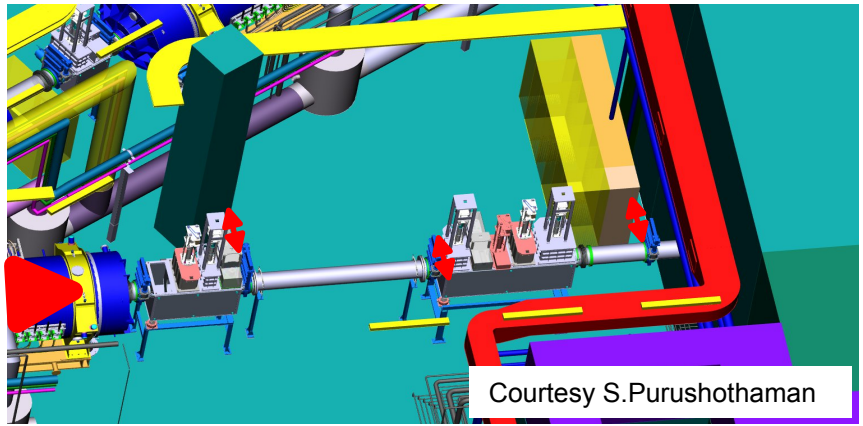
A) Clarification of all components to be in use at FHF1 and their requirements
B) How each setup (DESPEC or Ion Catcher) will be arranged at FHF1 in 'experimental mode'
C) Transport of components to FHF1
D) Exchange of setups
E) Storage of experimental equipment in the tunnel



Courtesy S. Pietri (GSI)

NUSTAR setups @ FHF1

- **Main outcomes:**
  - Detailed checks performed for the **DESPEC platform** and **Super-FRS EC Ion Catcher**
  - 3 S-FRS diagnostic chambers currently planned – downstream chamber will be moved upstream to make space for NUSTAR components (details under discussion)
  - **Both setups fit into the space**, with enough room for a common-use detector table, safety pathway and a beamdump downstream (if required)
  - **A promising solution** for how to maneuver and align components without the use of rails has been identified
  - Detailed checks of **component transportation** from the NUSTAR laboratories (and elsewhere) being carried out
  - Next: **safe storage** of experimental equipment in the tunnel (along with S-FRS components)



Courtesy S.Purushothaman

NUSTAR setups @ FHF1

NUSTAR ES/FS planning **fully endorsed by ECE/ECSG** at the November 2023 and April 2024 meetings

The committee compliments the collaboration for the excellent planning towards the Early Science (ES) and First Science (FS) phases and endorses performing ES&FS experiments at the Super-FRS high-energy branch (R3B, DESPEC, S-FRS EC collaboration) in view of the facts that it is

- Technically feasible and scientifically sound
- Does not create delays
- Creates no additional costs (other than a small additional contribution already foreseen in the NUSTAR Common Fund)

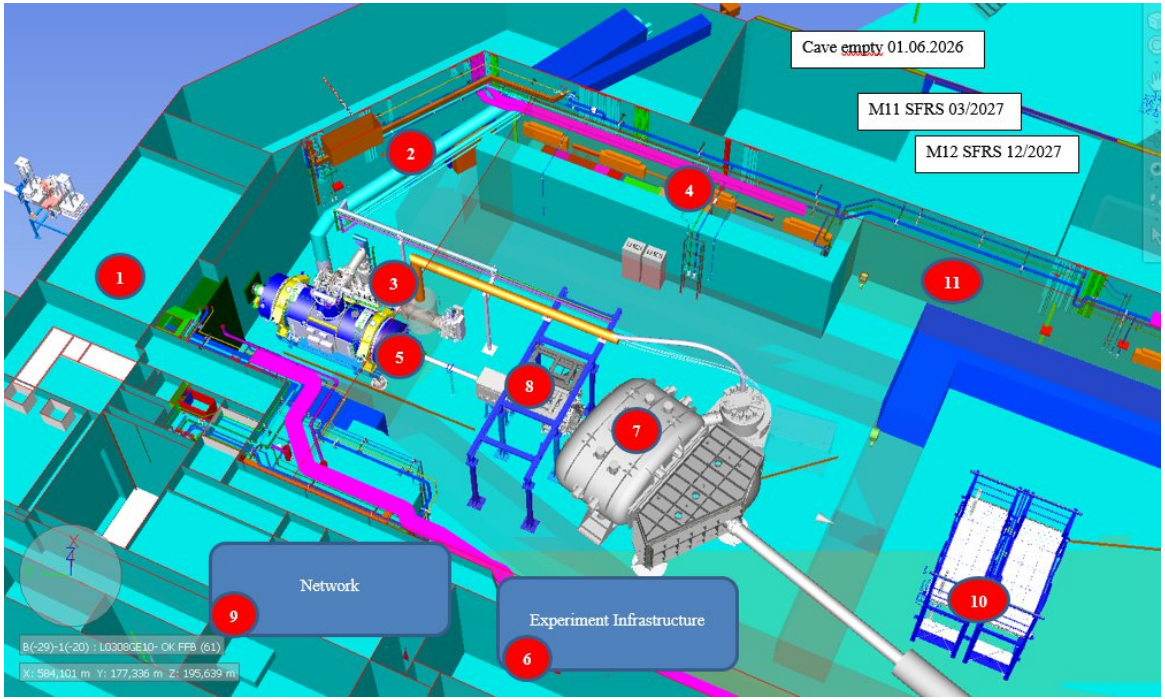
A document prepared by NUSTAR was submitted to the ECE/ECSG in October 2023, outlining details of the technical planning for Early and First Science. A comprehensive evaluation was carried out by NUSTAR of the infrastructure that will be available in the Early and First Science stages of FAIR when the S-FRS high-energy branch and the NUSTAR High Energy Cave will be fully commissioned and ready for experiments. The planning optimizes the use of the available resources to maximize the scientific output of FAIR. In conclusion, the ECE re-emphasizes that equipment, formerly planned for the low-energy branch, such as DESPEC, shall be installed and operated at the HEB, to maximize the scientific opportunities offered at FAIR.

Summary

- Installation of infrastructure in the NUSTAR areas **progressing well**
- NUSTAR ES/FS planning **fully endorsed** by the ECE/ECSG
- Detailed workshops for NUSTAR setups at FHF1 carried out; more planned for other S-FRS focal planes
- A strategy for **optimised operation** along the S-FRS for Early Science under development


Thank you

HEC Installation Planning



Cave empty 01.06.2026

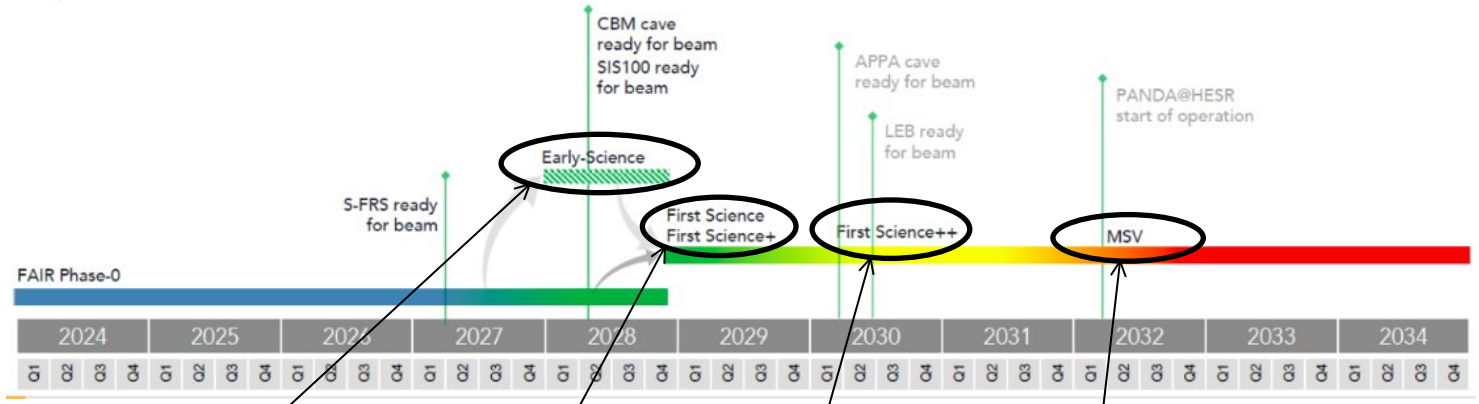
1) Mobile wall 06-07/26
2) Cryo Distribution Line 08/26
3) Local Cryo 08-09/26
4) Racks and cables (machine) 08/26
5) Multiplet (inc. connections to media) 09-11/26
6) Experiment Infrastructure
7) GLAD
8) CALIFA
9) Network
10) NEULAND
11) Closing of outside wall 03/27

} 10-12/26 (..03/27)

R3B Commissioning w/o beam 11/26 – 09/27

Courtesy P. Hofmann

Anticipated NUSTAR Timeline



Q4 2027 SIS18, S-FRS high-energy branch and high-energy Cave

Q4 2028 SIS-100 beams available

2030 Low-energy branch operation

2032 MSV completion inc. ring branch

- Timeline pending Council decisions
- Assumes timely installation of SIS-100 magnets and release of new budget for > FS in 2025/2026

NUSTAR Risk Register (Top items, status 03/24)

Risk ID	Scenario	Status	Description	Prob	Risk Score	Status/mitigating actions
402	ES	Mitigation ongoing	Energy resolution of CEPA scintillator detectors is insufficient due to position dependence.	90%	9	Mid-term mitigation in place for ES. No technical solution yet for long-term operation (probability increased since last report)
173	ES	Mitigation ongoing	No budget approved for NUSTAR infrastructure	10%	8	Mitigation: fund to be established via NUSTAR MoU. Signatures expected soon (probability reduced since last report)
358	ES	Mitigation ongoing	Detection threshold of Si tracker far too high	10%	8	Mitigation: TDR submitted, final stages of signing co-operation agreement (STFC-FAIR) (probability reduced since last report)