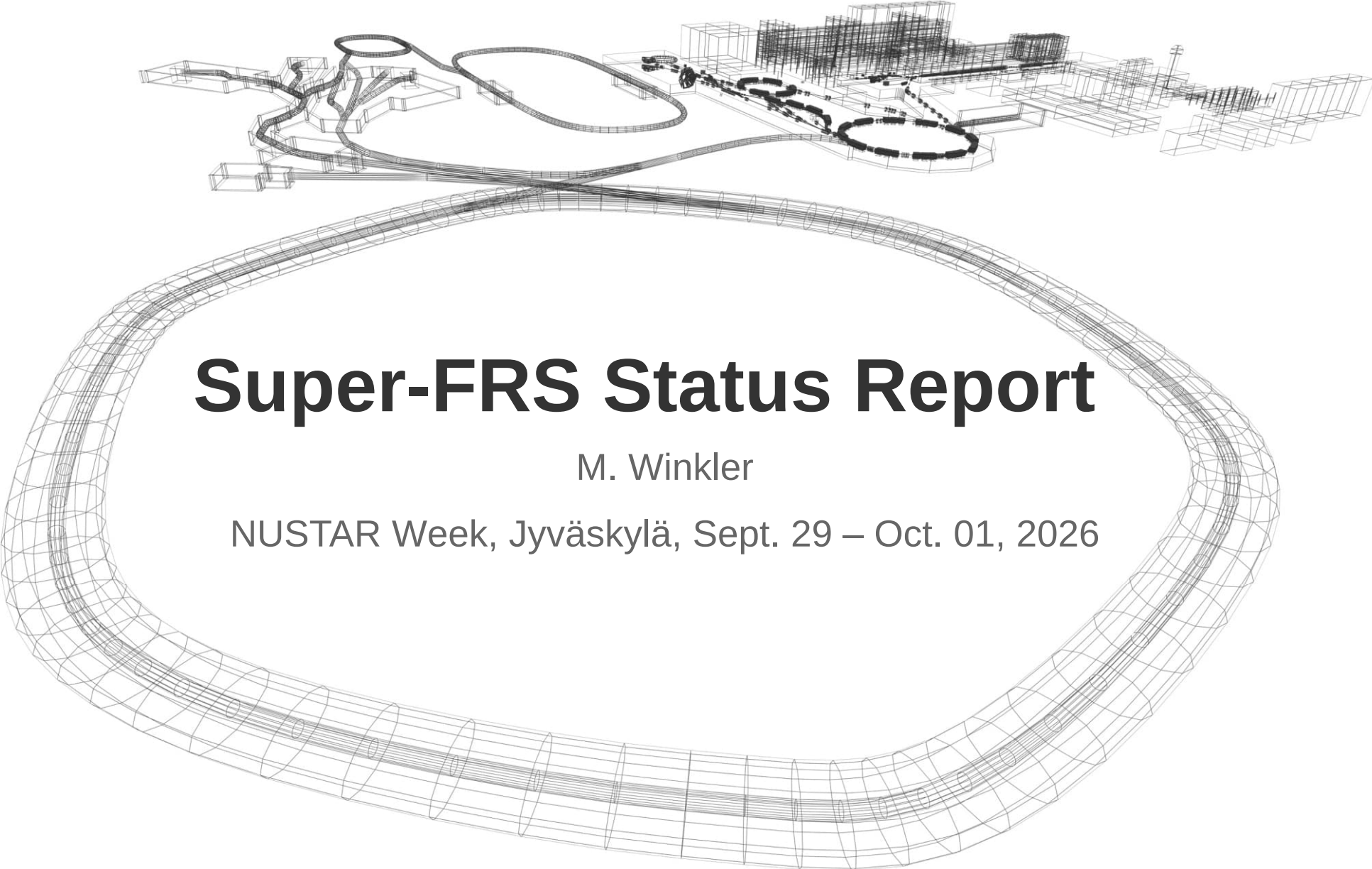




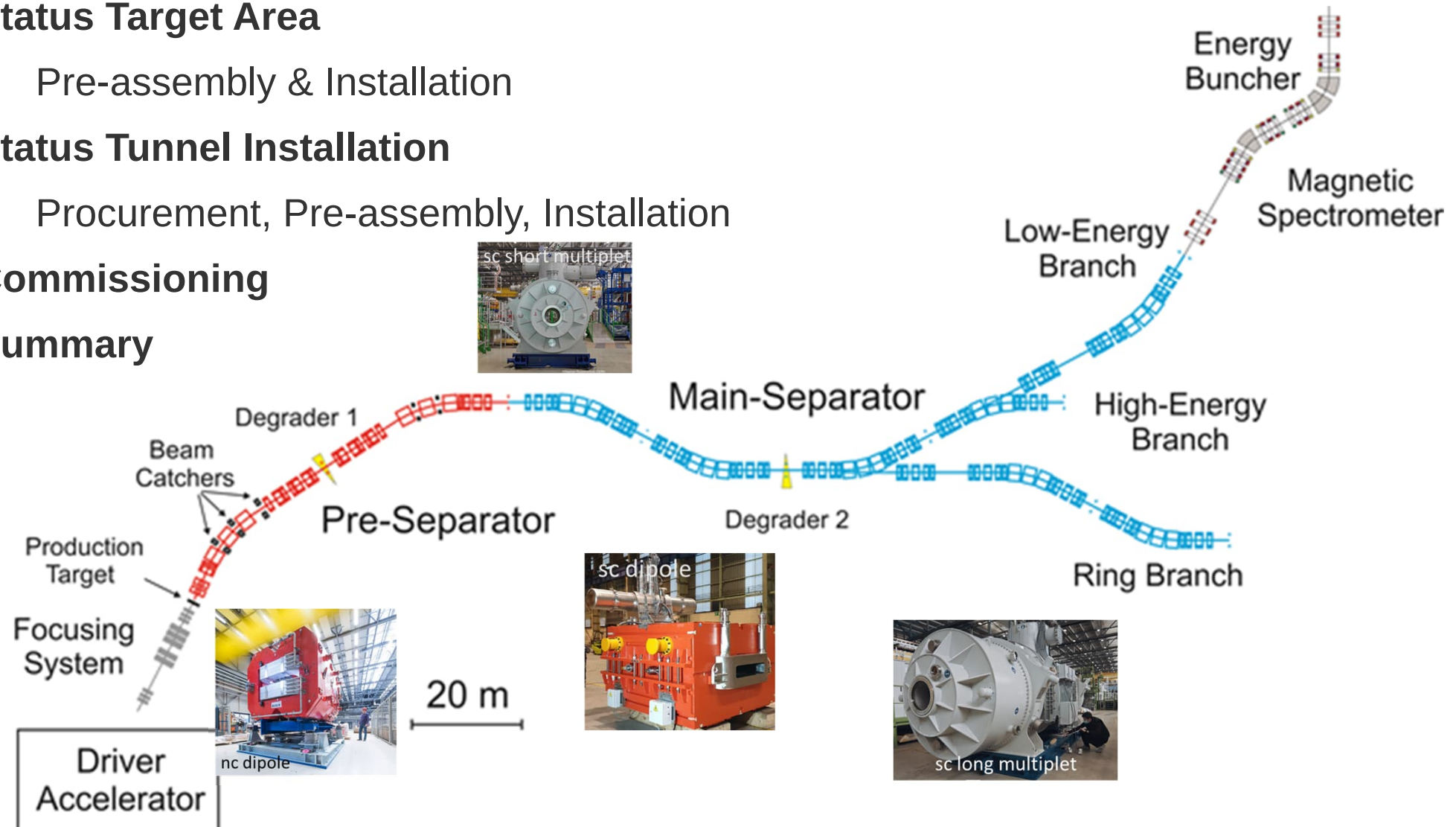
Super-FRS Status Report

M. Winkler

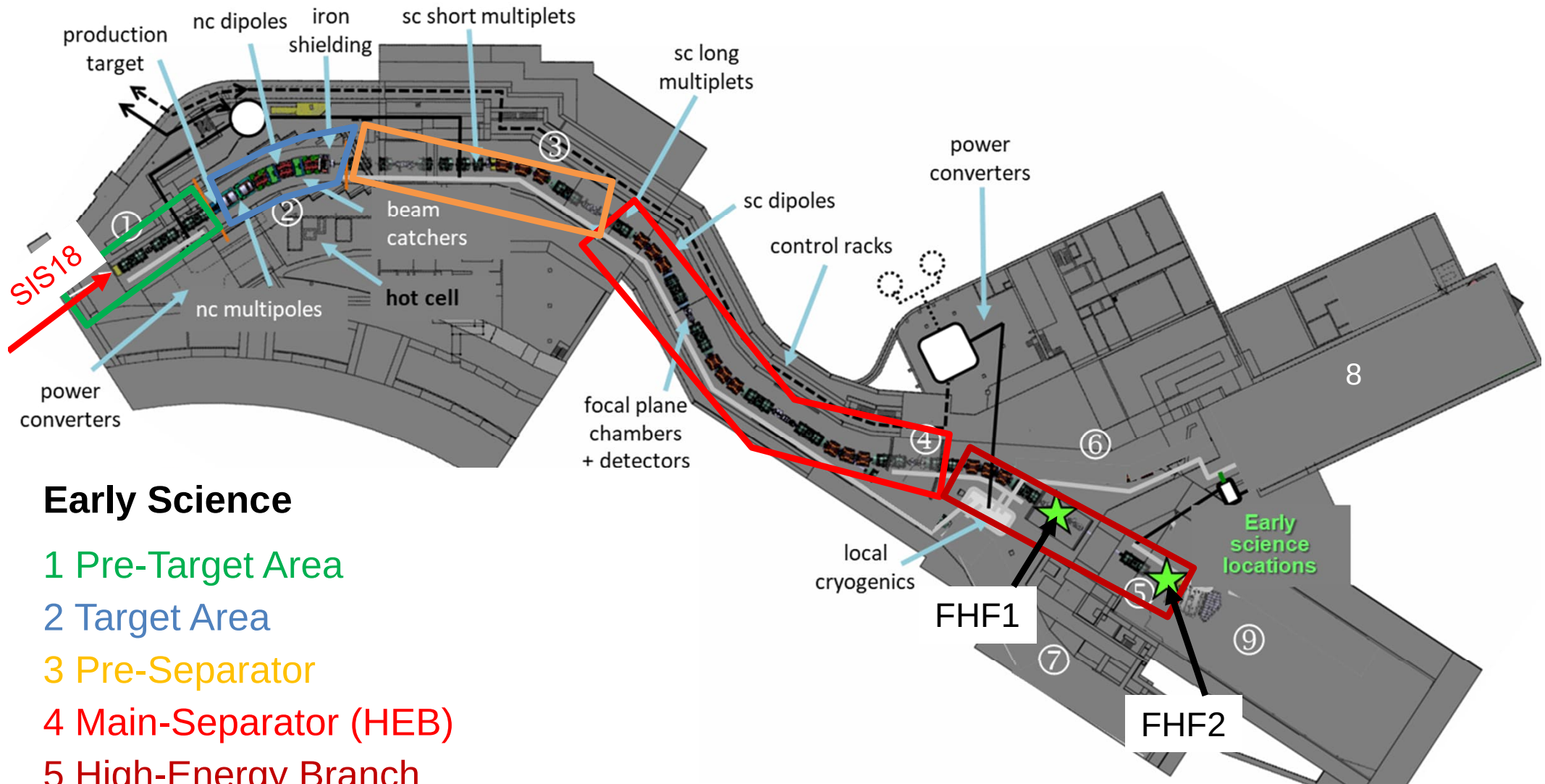
NUSTAR Week, Jyväskylä, Sept. 29 – Oct. 01, 2026

Outline

- Early Science Scope & Installation Schedule
- Status Target Area
 - Pre-assembly & Installation
- Status Tunnel Installation
 - Procurement, Pre-assembly, Installation
- Commissioning
- Summary



ES Scope



Early Science

1 Pre-Target Area

2 Target Area

3 Pre-Separator

4 Main-Separator (HEB)

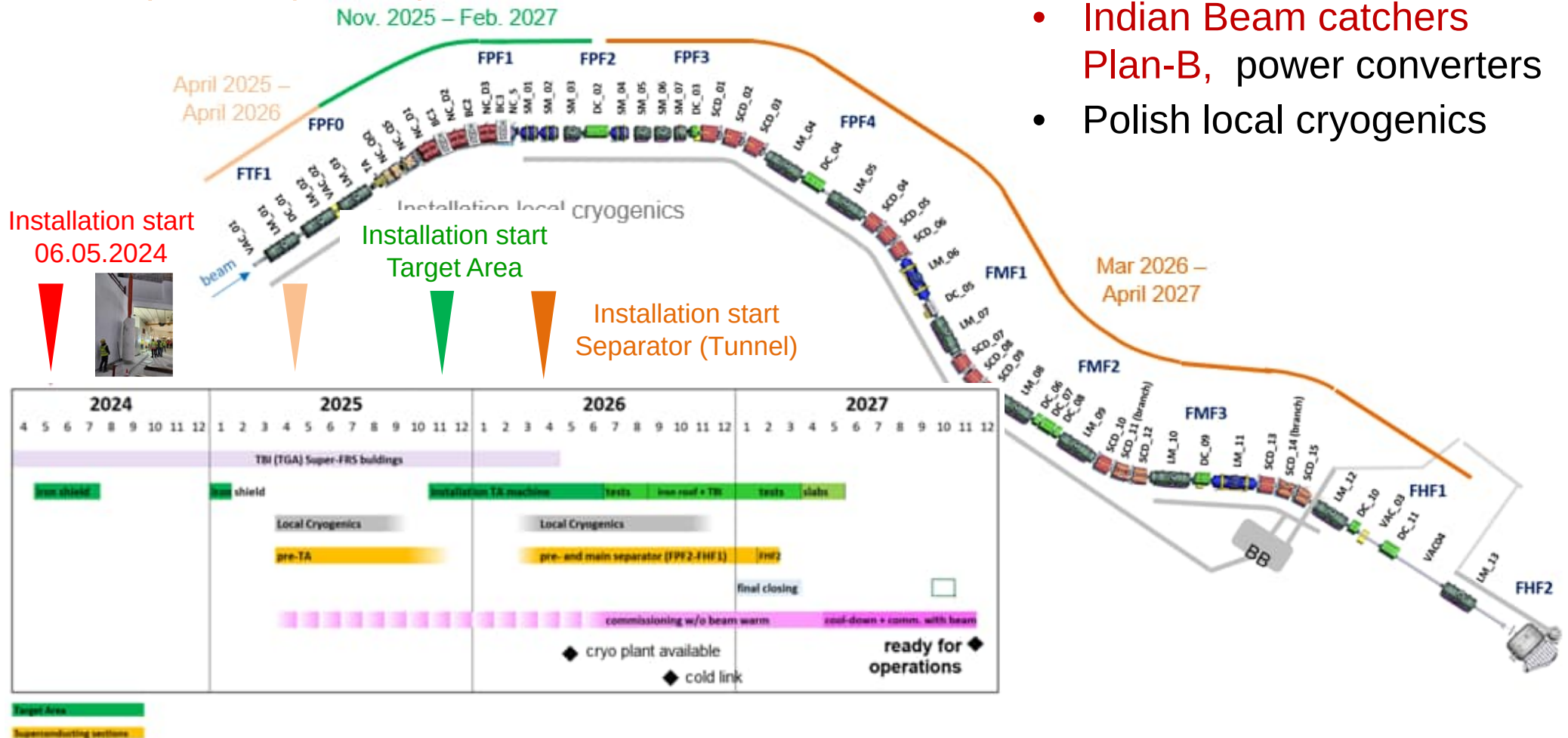
5 High-Energy Branch

9 High Energy Cave (NUSTAR)

1. Pre-Target Area
2. Target Area
3. Separator (Tunnel)

Challenging in-kind packages:

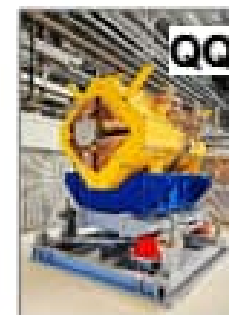
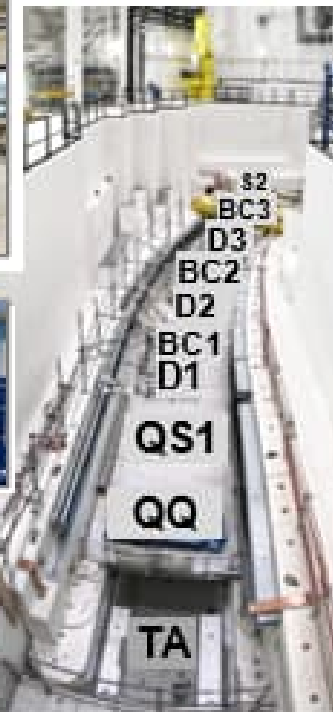
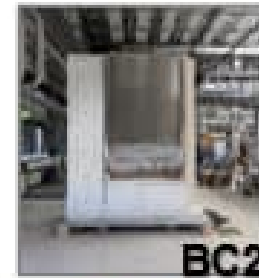
- Former Russian in-kind **needed replacement !**
- **Indian Beam catchers**
Plan-B, power converters
- Polish local cryogenics



Target Area

Overview

- Installation strictly 'along the beamline'
- Altogether 9 assembly units
- Closing of beam tunnel with 1 m thick iron roof after installing one assembly unit
- Two assembly units are connected via **pillow seal** plugs (3 different sizes)
- Section-wise vacuum commissioning
- ✓ **Installation of target chamber completed**
- ✓ Vacuum section LM_03 // TA commissioned
- Installation of QQ assembly unit running
 - ✓ **completed yesterday**
- In parallel: installation of utilities supplies



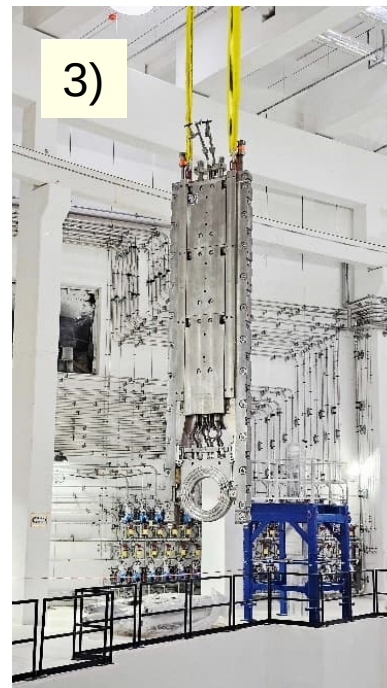
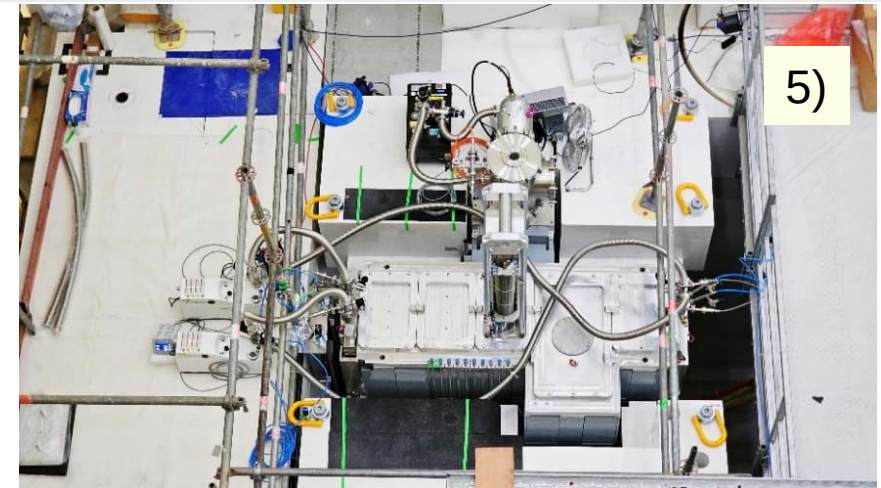
Target Area

Impression from TA Installation

P. Schwarz, K. Knie
, T. Blatz, V. Schöll
C. Karagiannis et al.



- 1) Delivery of target chamber
- 2) Bring target chamber in position
- 3) Delivery of pillow seals
- 4) Delivery of target plugs
- 5) Vacuum Commissioning
- 6) QQ unit in position



30.09.2026

Target Area

Impression from TA Pre-Assembly

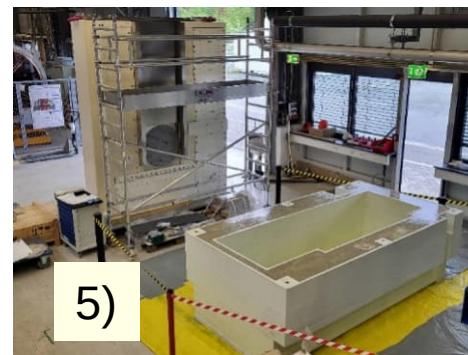
P. Rottländer et al.

M. Schütt

T. Blatz



- 1) QS assembly unit on HC roof
- 2) NC dipole in LEC
- 3) Ti chamber for NC dipole
- 4) Beam Catchers in Testinghalle
- 5) Collar (#1) for Beam Catchers



TA Maintenance

Shielding Flask & Hot Cell

F. Amjad
C. Karagiannis
A. Gulavani
H. Weick et al.



Plug-transport TA → HC via Shielding Flask

- combined Finland in-kind / FAIR
- Designed to have safety redundancy
- Remotely operated using control panel
- manufactured by BNET, FAT 09/2024
- functional test ongoing (on availability of plugs)

HC (equipment) for ES

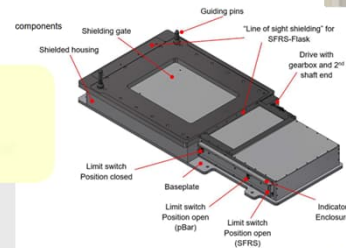
- Shell construction ready (by FSB)
- Roof slider (flask interface) in procurement
- Floor/Wall liner in procurement

Target Area

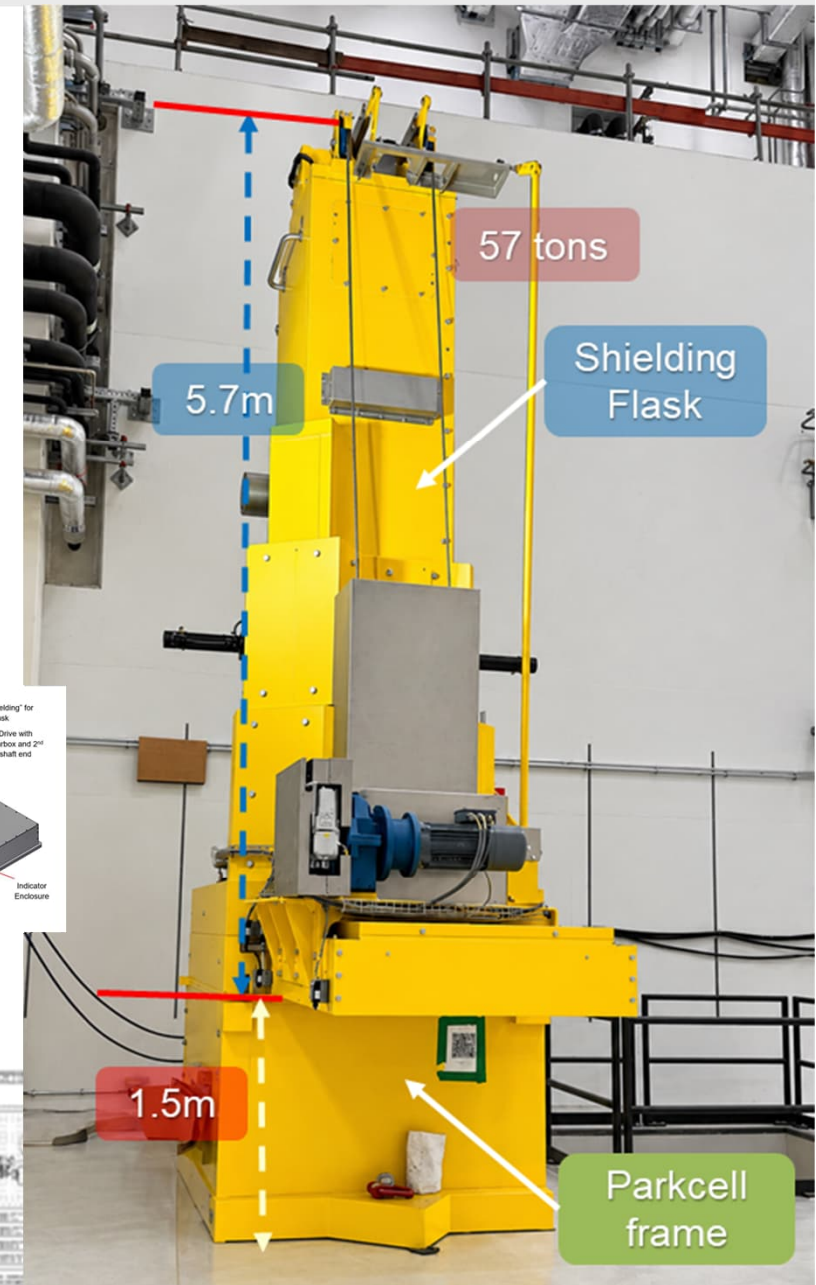
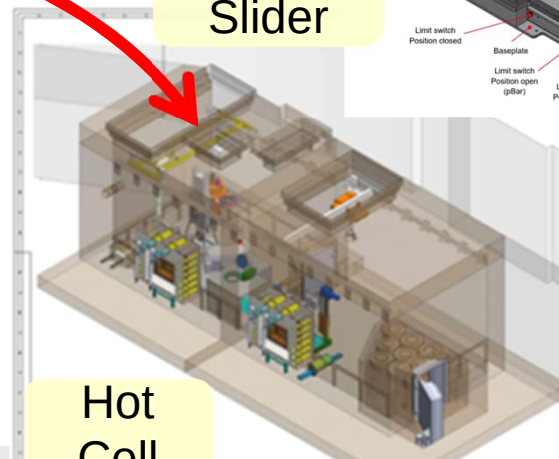


GSI Helmholtzzentrum für Schwerionenfors

Roof Slider



Hot Cell



Report

October 01, 2020

6

Tunnel Installation

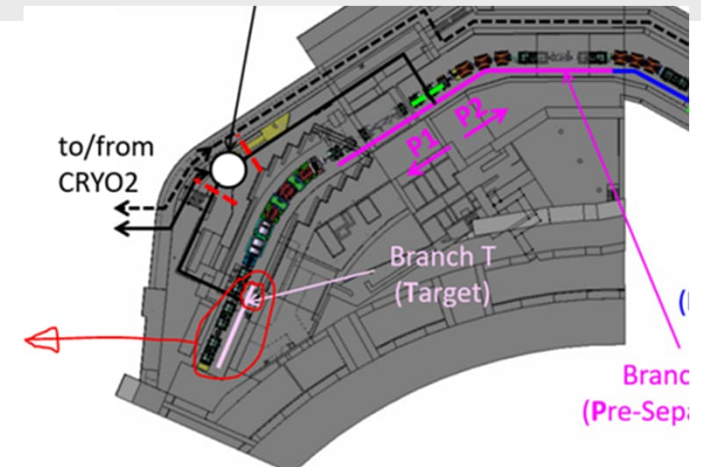
(General installation sequence)

Two tunnel installation areas

1. Pre-target area
2. Separator tunnel, subdivided into sections:
 - Pre-Separator section: P1, P2
 - Main-Separator section : M1, M2, M3
 - HEB section: H
 - NUSTAR section: G

Installation sequence follows

1. Technical Building Infrastructure
 - cable trays, power cables
2. Blue line
3. Local Cryogenics / cryo-branches
 - ✓ Branch Box and ACPS done
4. sc magnets
5. Diagnostic chambers
6. Remaining vacuum components
7. Beam instrumentation



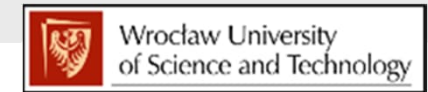
Pre-target area to large extend installed

(waiting for cryo-connection → DB2)



Local Cryogenics (Branches Overview)

F. Wamers, Y. Xiang,
D. Schad, F. Dziuba, J.
List, M. Miski-Oglu, et al.



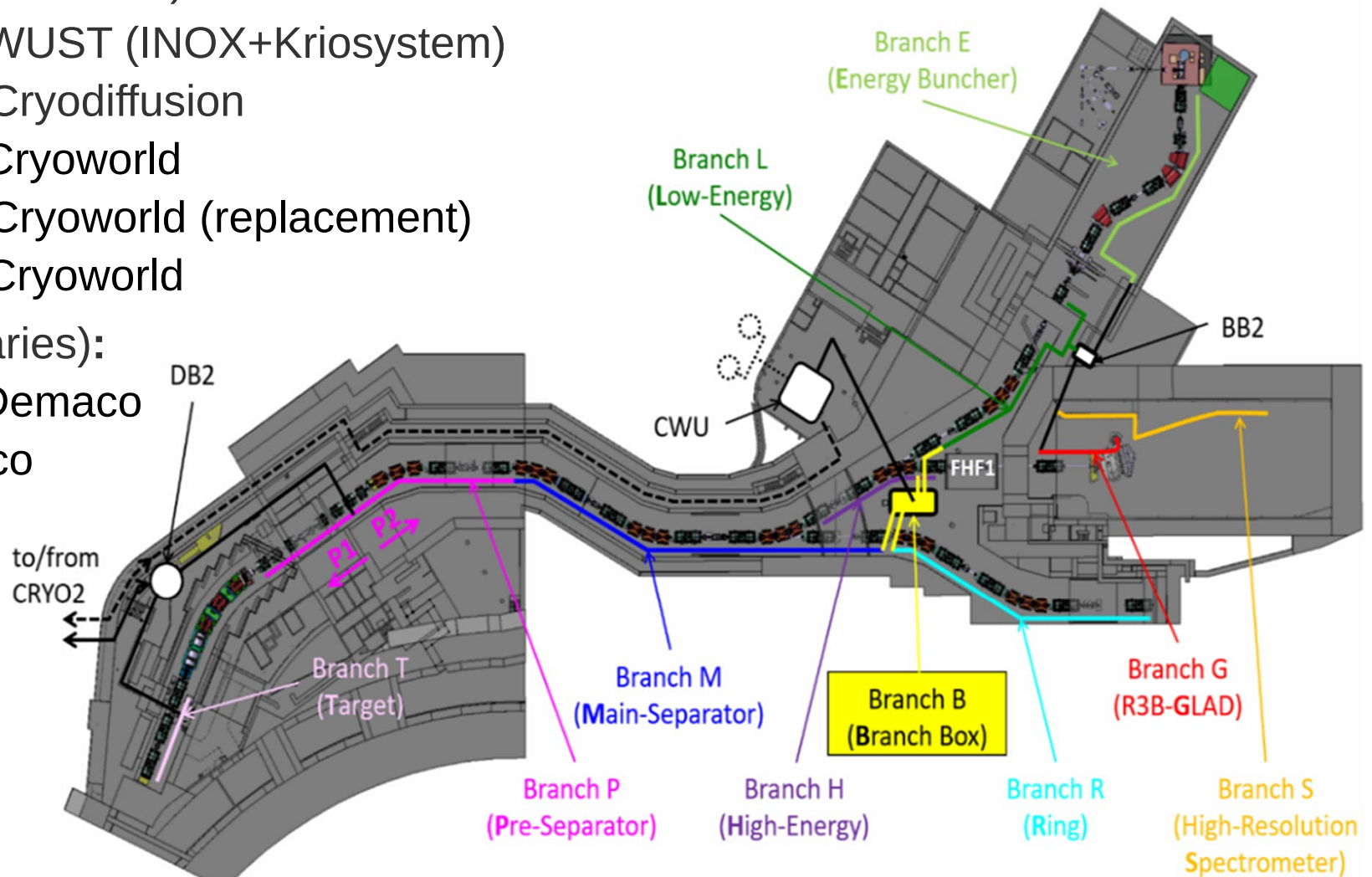
Conceptual System Design: WUST

Provider (Cryo-Branches):

- Branch T+P: WUST (INOX+Kriosystem)
- Branch M: Cryodiffusion
- Branch H: Cryoworld
- Branch L: Cryoworld (replacement)
- Branch G: Cryoworld

Provider (Auxiliaries):

- Branch Box: Demaco
- ACPS: Demaco



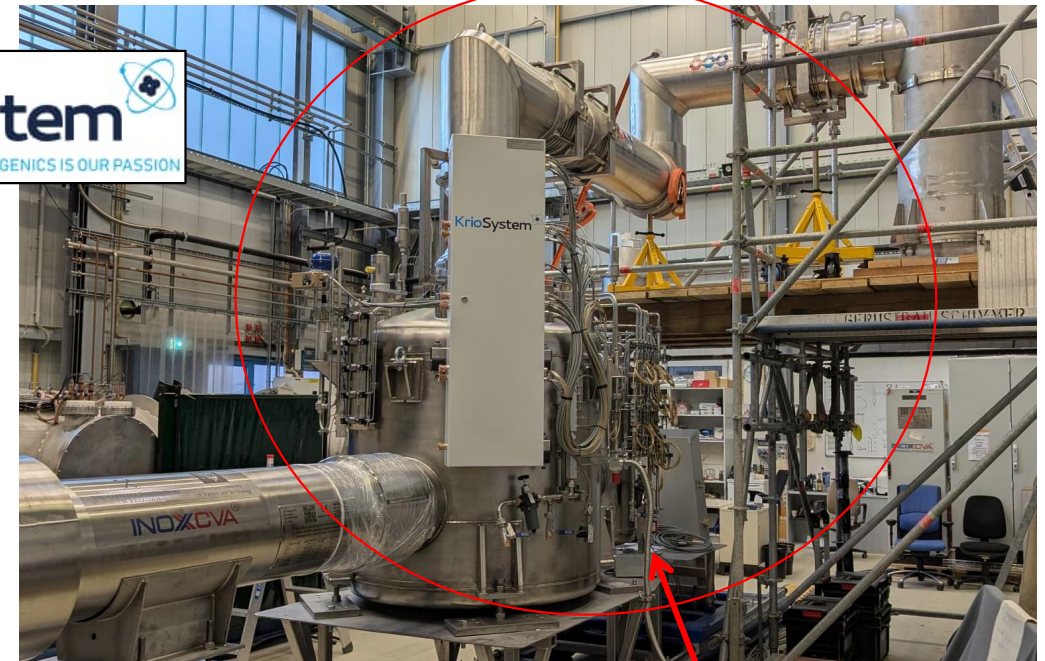
Branches R, E, S – not Early Science

Local Cryogenics (Branch P – FoS Testing)

F. Wamers, Y. Xiang,
D. Schad, F. Dziuba, J.
List, M. Miski-Oglu, et al.



Branch P FoS Cold Testing at STF (GSI) – Q1-Q2 2026

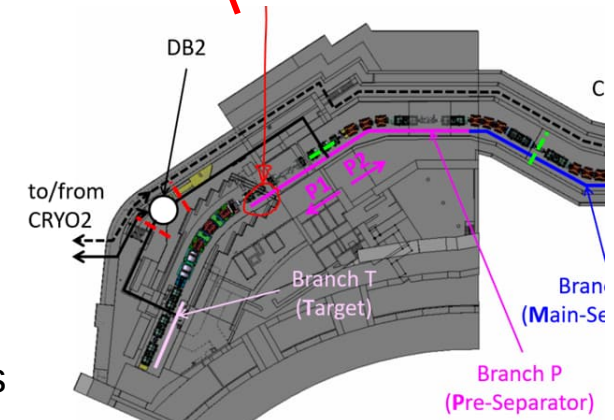


**Test Scope: Branch P,
part P1:**

- EB, FB_01, JC_01

Test Results:

- Qualitatively: **much better than T**
- Quantitative analysis (heat loads) **ongoing**

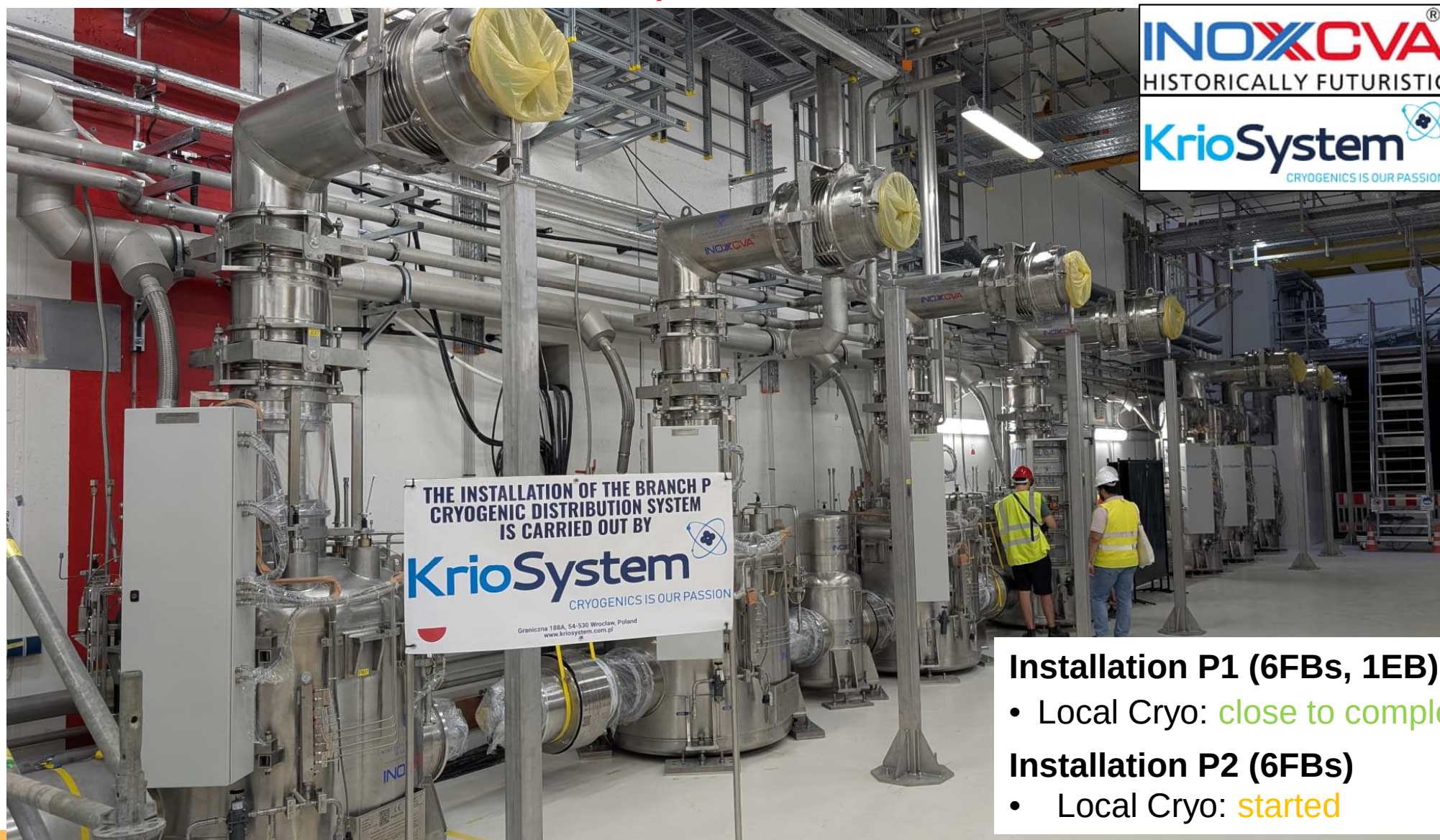


Local Cryogenics (Branch P1 – Installation)

F. Wamers, Y. Xiang,
D. Schad, F. Dziuba, J.
List, M. Miski-Oglu, et al.



Branch P tunnel installation, part P1 – status 09 / 2026



Installation P1 (6FBs, 1EB)

- Local Cryo: **close to complete**

Installation P2 (6FBs)

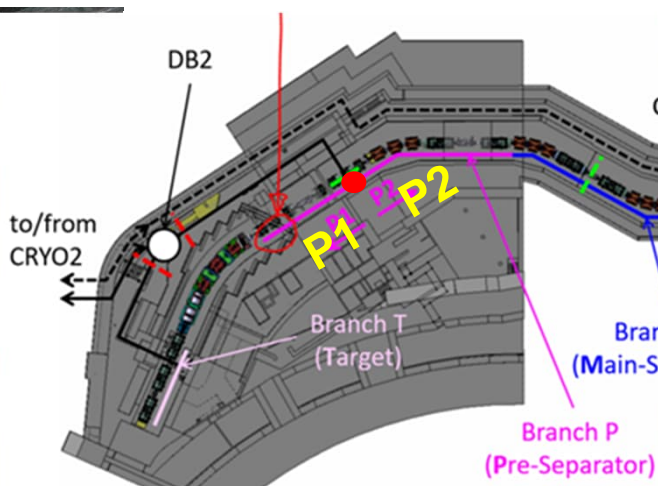
- Local Cryo: **started**

Local Cryogenics (Branch P2 - Installation)

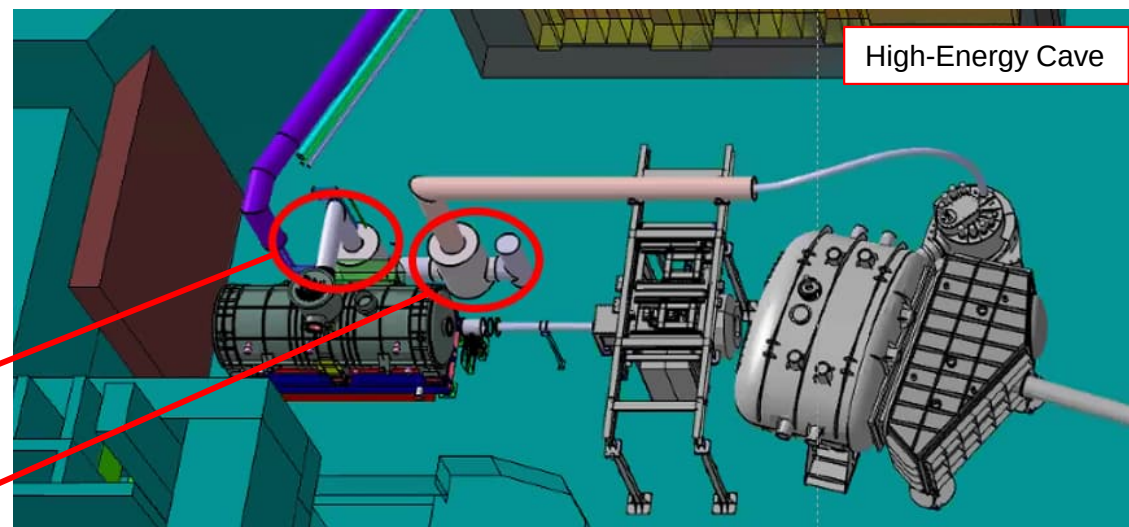
F. Wamers, Y. Xiang,
D. Schad, F. Dziuba, J.
List, M. Miski-Oglu, et al.



Branch P tunnel installation, part P2 – status 09 / 2026



Branch G FoS Test Setup at STF (GSI) – Q3-Q4 2026



Test Scope (String):

- EB, GLAD FB, LM FB + Jumper
- Warm Tests (warm GHe mixing, 'Quench' test, filters)
- Cold Tests (valves, instruments, warm GHe mixing, heat loads)

→ Installation in HEC starts in Q4/2026

SC Multiplets

E.J. Cho,
V. Velonas et al.



Scope (ES):

- 7 short multiplets, 13 long multiplets

Provider:

- ASG, Genova, Italy

Production and Testing Status:

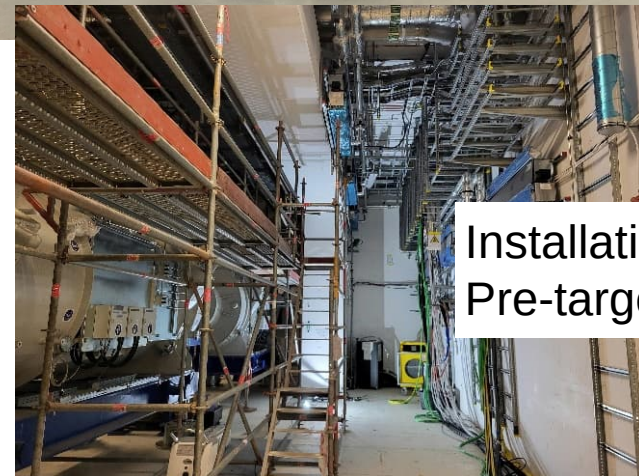
- **Production of all ES multiplet completed.**
- **Cryogenic testing, ES scope: only 3 LMs left**
- **LM in NUSTAR Cave:**
CERN testing running; delivery beginning 2027
- non-ES multiplet production continues.

Pre-assembly and Installation

- Pre-Target area:
 - ✓ 3 LMs installation completed
- Pre-Separator:
 - ✓ SMs pre-assembly completed, stored in tunnel
- Main-Separator
 - ✓ some LM pre-assembly completed and stored in tunnel
 - otherwise LM pre-assembly running in LEC



Pre-assembly in LEC



Installation in
Pre-target area



Storage in Ring Branch

SC Dipoles

H. Müller,
V. Velonas et al.



Scope (ES):

- D2: 3 x 11°
- D3: 10 x 9.75°
- branched dipole, 2 x 9.75°

→ replaced in ES by standard D3 x 2

Provider:

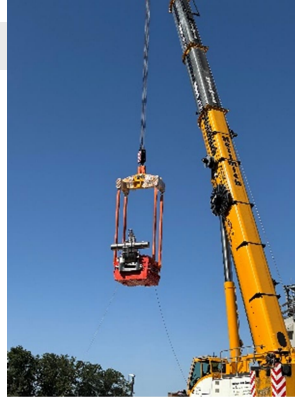
- Elytt, Bilbao, Spain

Production and Testing Status:

- 4 dipole magnets delivered to FAIR
 - D02, D04, D05, D06
- D01: mapping completed
- D03: quench issue at low current (under investigation)
- D07: FAT in preparation @ Elytt
- remaining production ongoing, 4 benches operational

Pre-assembly started in LEC

- Beam chamber installation in preparation



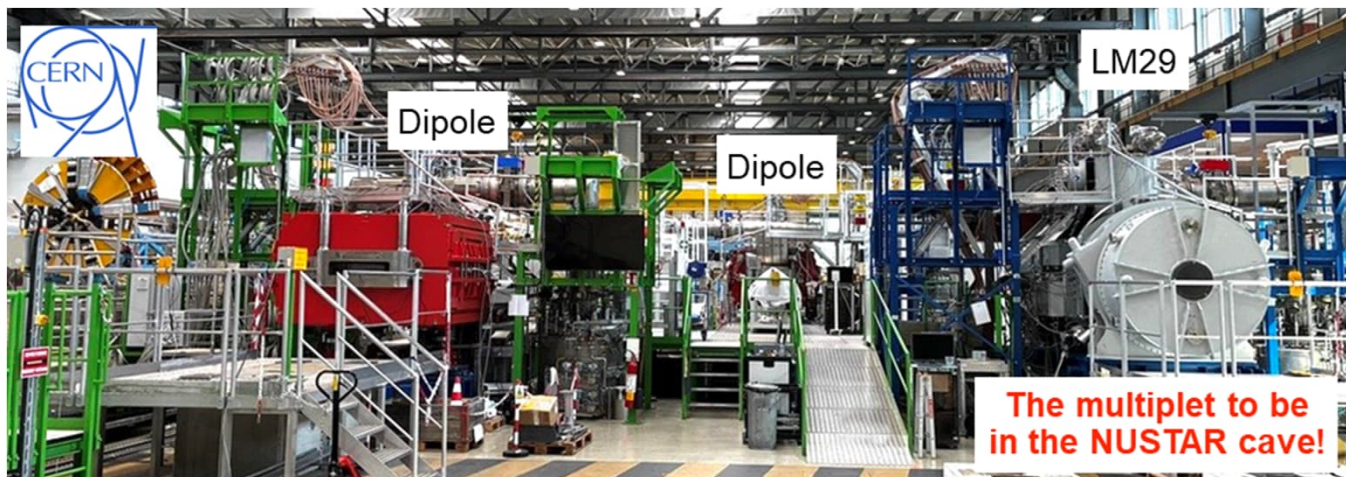
Testing at CERN

H. Bajas
K. Sugita et al.



Very successful collaboration with CERN !

- Series magnet-testing running routinely
 - Various improvements implemented during last years
 - Personal is being increased (in total 6 GSI colleagues at CERN)
 - Knowledge transfer from the testing to FAIR commissioning
 - GSI-CERN Workshop and Collaboration Board Meeting in April 2026
- AVATAR project started
- “digital twin” electromagnetic model of the real dipole magnet
 - dedicated magnetic measurements implemented



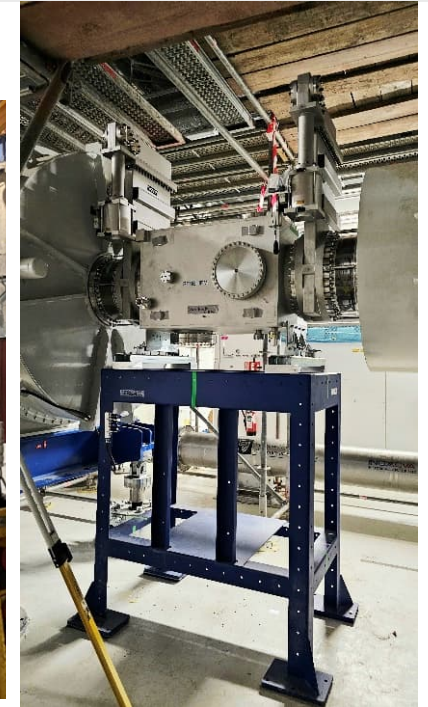
Vacuum Components (Diagnostic Chambers)

S. Purushothaman
N. Kurichiyani
C. Schlör et al.



Former Ru in-kind; re-procurement running

- Diagnostic chambers (9 + 2 FoS + 2 Ref)
 - includes support frames & gate valve holder
 - exchangeable at FMF2 and FHF1
 - 2 FoS chambers delivered (Pfeiffer)
 - 2 // 3 batches in-house (Streicher)
- ✓ Pre-assembly in preparation (MATS /LASPEC)
- ✓ 1 IPM chamber delivered and installed



Vacuum Components

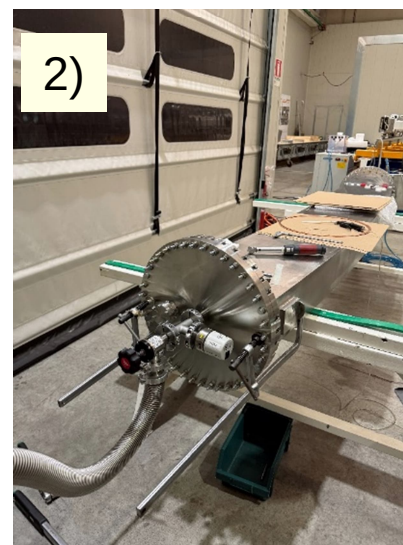
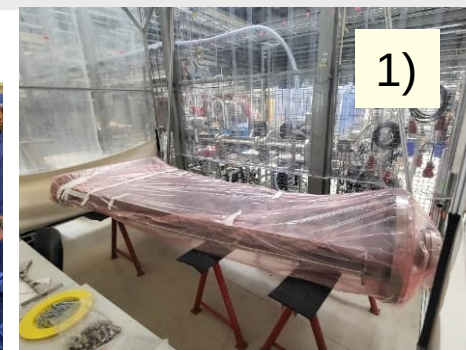
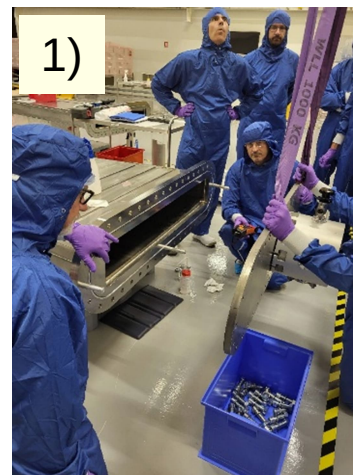
(Magnet Chambers & more)

S. Purushothaman
N. Kurichiyanil et al.



Former Ru in-kind; re-procurement running

- 1) 3 NC dipole chambers (CNIM)
 - 1 // 3 chamber FAT done
 - delivery and SAT running
 - 2 // 3 chambers FAT in 10/2026
- 2) SC dipole chambers (13 + 2 FoS)
 - 2 FoS Chambers delivered (TVP, Sp)
 - 2 // 13 FAT done (Fantini), rest until Q1/2027
 - implementation in sc dipole in preparation
- 3) 2 branching (CNIM), production started; chamber implementation only in 2028
- 4) Beam Pipes & Bellows, various (T.E.E.S)
 - production running; 1st components delivered
- 5) Pumping chambers, various (T.E.E.S)
 - production running; 1st batch FAT 12/2026



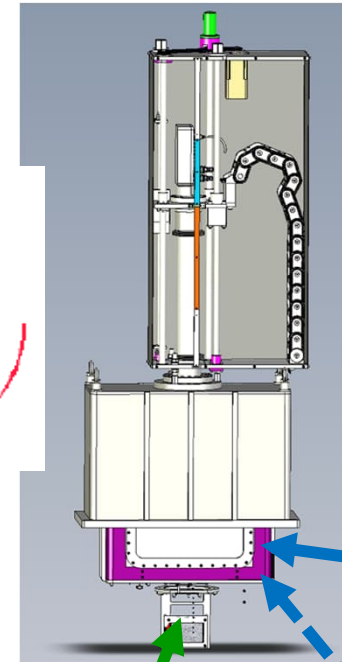
Beam Instrumentation

(mainly PID detectors for ES)

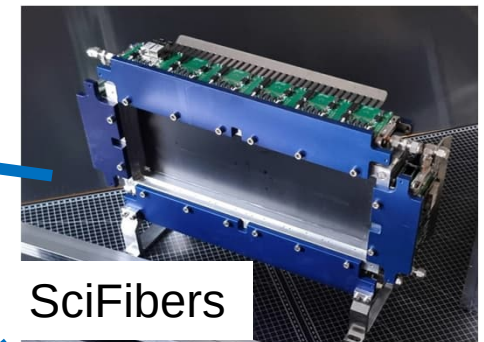
M. Schwickert, J. Galvis,
C. Caesar, C. Nociforo,
M. Czogalik, B. Voss,
D. Urner, S. Udrea, et al.



- Plastic Scint. (ToF, **ES**)
 - ✓ FoS produced (in-house); non-segmented EJ-230, qualified / in-beam test 2025
 - ✓ Series (5 drives) produced and delivered 05/2026; SAT & pre-assembly running
- Drive / position detectors
 - ✓ FoS units at GSI and tested
 - ✓ Design optimization finalized
 - Tender for series running
- SciFiber (tracking, **ES**)
 - ✓ FoS produced; in-beam test GSI 02/2025
 - production of series running (DetLab)
 - GEM-TPC development running (**FS**)
- MUSIC (ΔE)
 - ✓ FoS (FMF1) in-beam test GSI 2025
 - design adaption for FHF1 ongoing
- and much more activities ...
SEM Grids, Slits, beam stopper, PDC, IPM ...

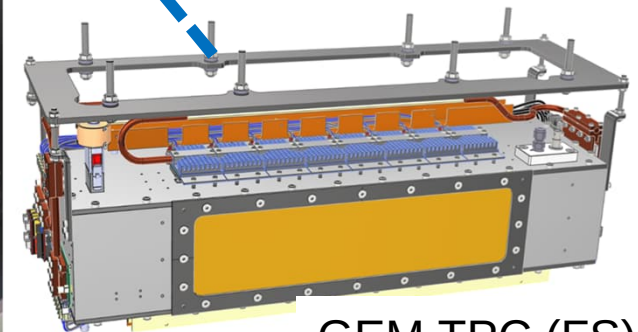
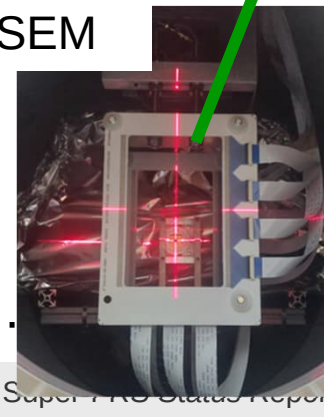


Plastics



SciFibers

SEM

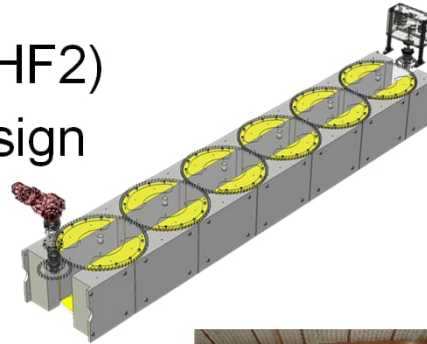


GEM TPC (FS)

Interfaces

PHYSICAL REVIEW ACCELERATORS AND BEAMS **29**, 094201 (2026)

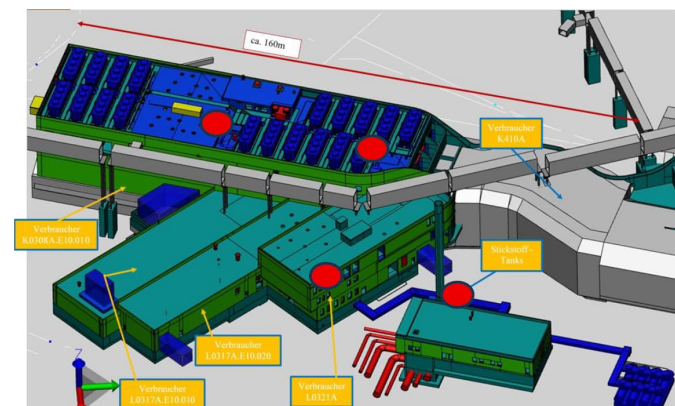
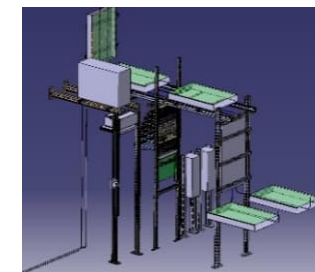
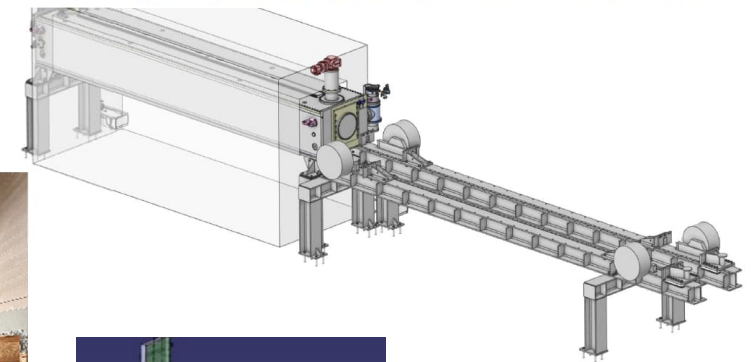
- Switchable beamdump (FHF1 → FHF2)
 - tender based on engineering design
 - Including control system
 - Offer received 20260929
- Procurement of User Racks
 - ≈90 racks (including NUSTAR racks)
 - 1 // 3 batch delivered, rest: Q4/2026
- Patch Panels development with IFJ-PAN
 - Conceptual design and prototype panel available
- Cable management (pulling running continuously)
- Auxiliary Systems
 - LN2 Distribution System (NUSTAR);
 - tender via GSI, published 20260929
 - Technical Gas System (Super-FRS & NUSTAR)
 - implementation via FSB



Compact in-vacuum switchable beam-dump system for radiation safety at accelerator beamlines

Sivaji Purushothaman^{*}, Neeraj Kurichiyanil[✉], and Ekaterina Kozlova[✉]
GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany

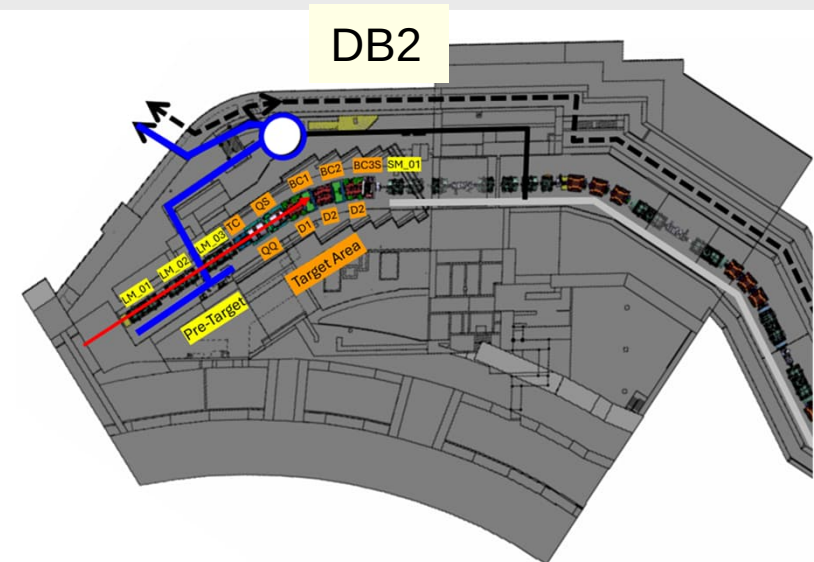
David J. Morrissey[✉]
Department of Chemistry, Michigan State University, East Lansing, Michigan 48824, USA



Super-FRS Commissioning

(Road map towards ES after fire 2026:)

- Main focus: cooling T-branch (**requires DB2**)
- Once Branch T cold: commissioning of pre-target
- Detailed Commissioning Planning for each technical system established
 - magnet tests
 - quench tests
 - commissioning power converters
- Beam possible on target / target area (BC1)
 - **‘First Beam Event’ → Q4/2027 (PARTiH)**
(MAC recommendation)
 - First Beam Event requires that radiation access areas NE50 (pre-target area and target area) as well as NE52 (Pre-Separator) are closed.
 - Parallel installation/commissioning in NE 53 possible
- Commissioning Pre-/Main-Separator (NE52/NE53)
 - **→ Q1/2028 (PARTiH)** , (C-beam)



Summary

- Target Area installation running
 - all major TA procurements in-house
 - target chamber installed and vacuum commissioning done
 - pre-assembly of following assembly units running (along the beamline)
- Pre-Target Area installation to large extend done (waiting for DB2 connection)
- Tunnel / Separator installation running
 - 4 provider for various local cryo branches
 - P1 branch installed, Installation of P2 branch started
 - All sc multiplet for ES produced; few remaining SAT of LM at CERN running
 - First sc dipoles delivered to FAIR, however, series production still running
 - Vacuum component to large extend produced
- Commissioning planning towards First Beam Event running

Thank you for you attention !