



# Super-FRS Status Report

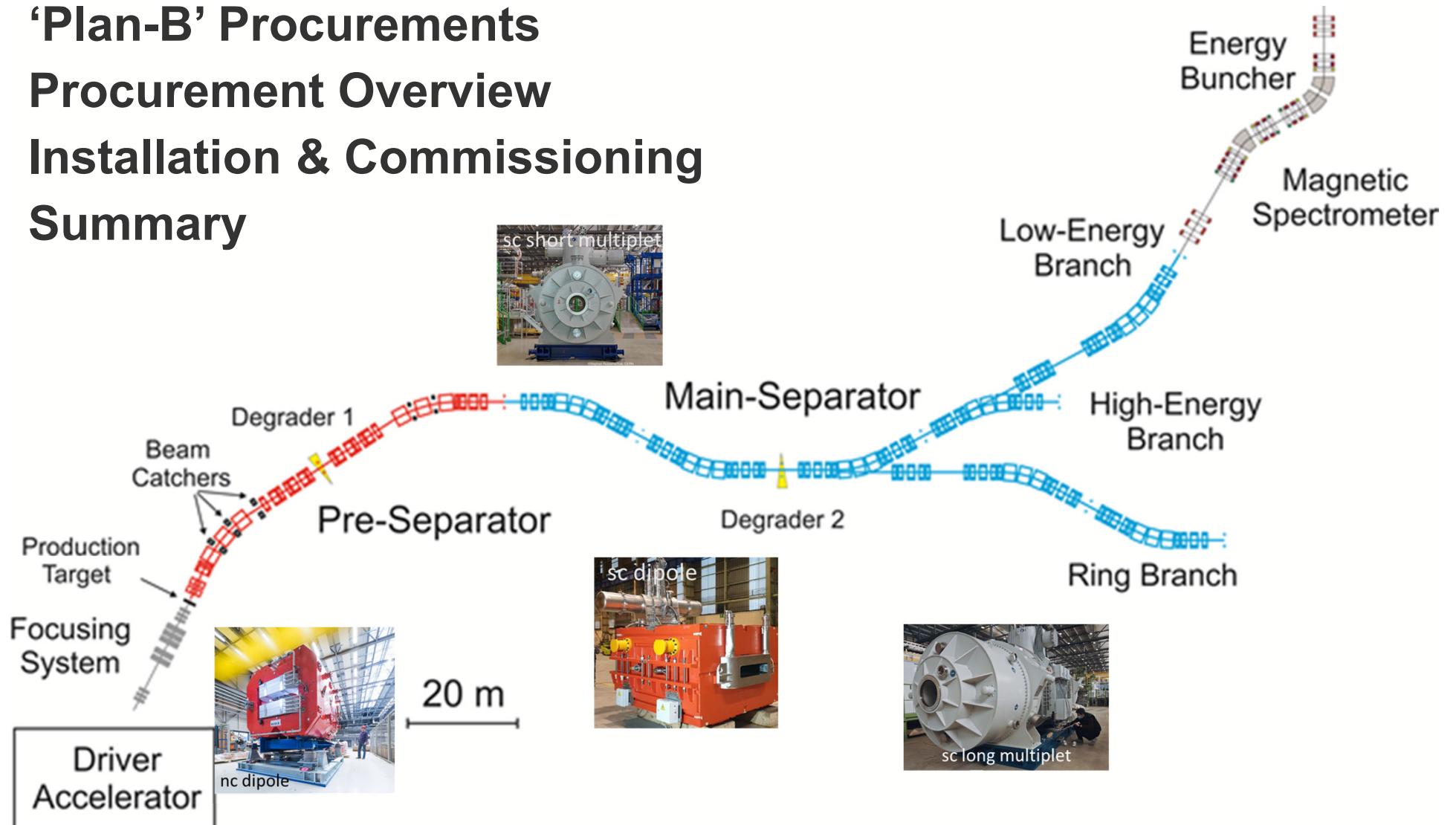
M. Winkler

NUSTAR Week 2024

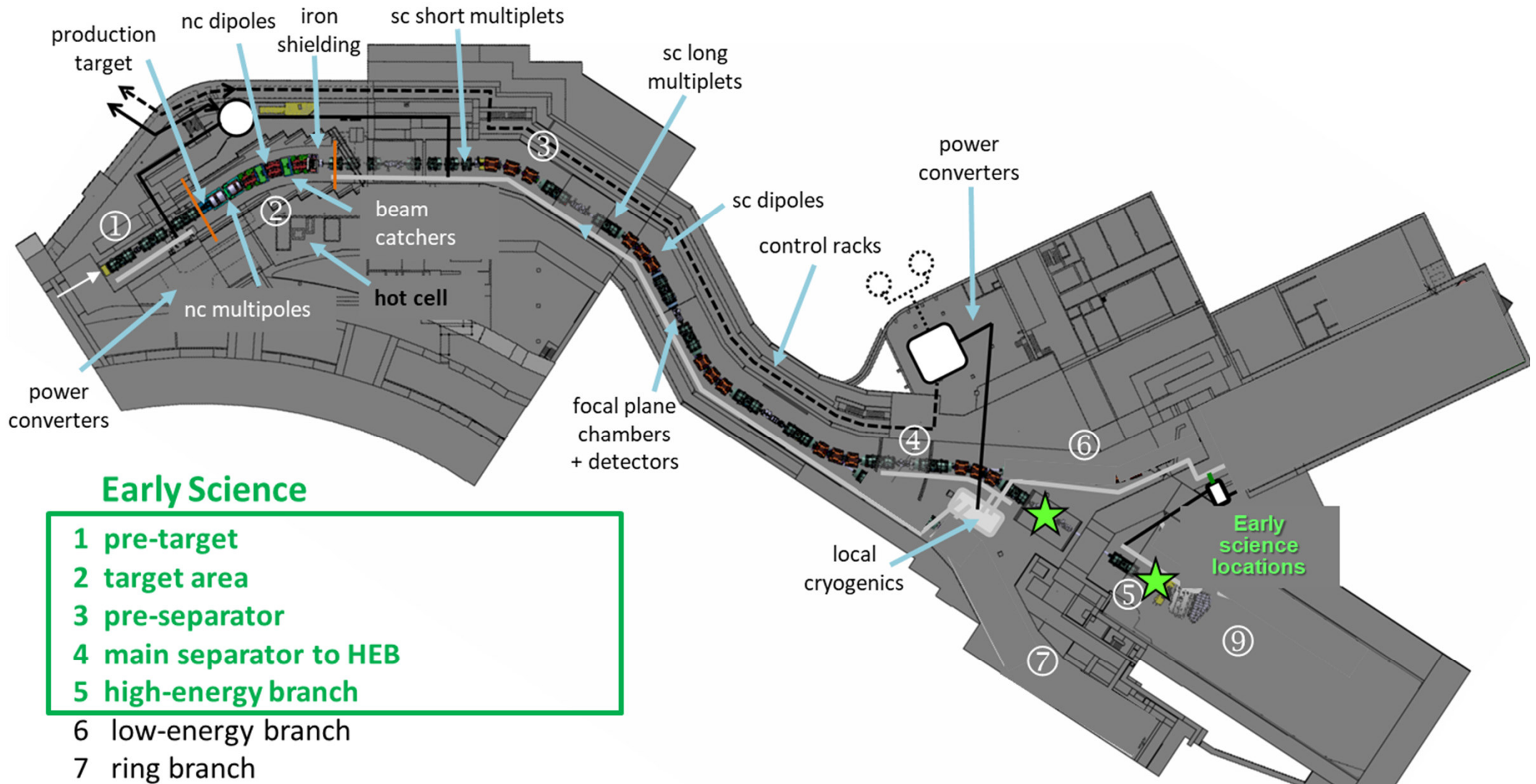
GSI/hybrid, Oct. 09, 2024

# Outline

- 1) Early Science Scope
- 2) 'Plan-B' Procurements
- 3) Procurement Overview
- 4) Installation & Commissioning
- 5) Summary



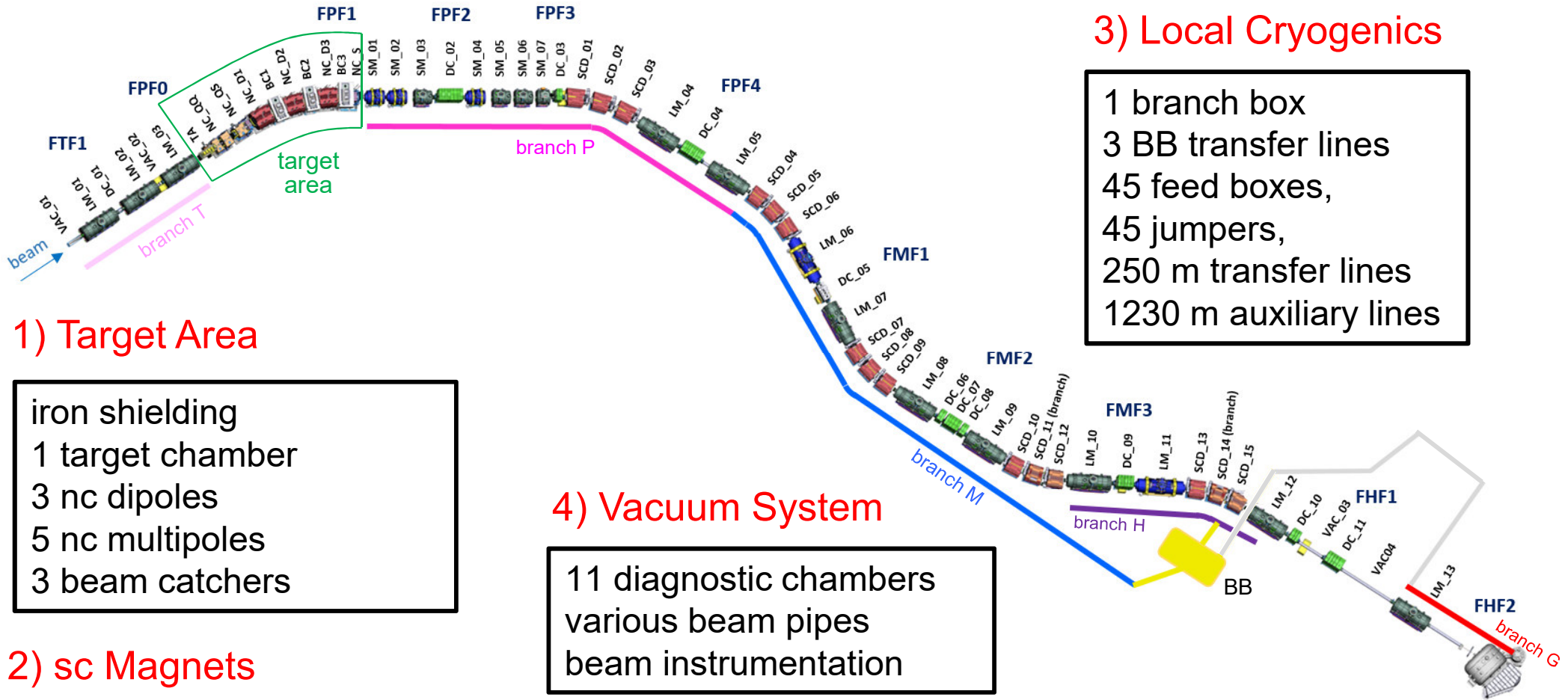
# ES Scope



## Early Science

- 1 pre-target
- 2 target area
- 3 pre-separator
- 4 main separator to HEB
- 5 high-energy branch
- 6 low-energy branch
- 7 ring branch
- 8 EB spectrometer, low-energy cave (NUSTAR)
- 9 high-energy cave (NUSTAR)

# Assembly Units for ES



## 1) Target Area

- iron shielding
- 1 target chamber
- 3 nc dipoles
- 5 nc multipoles
- 3 beam catchers

## 2) sc Magnets

- 7 sc short multipoles
- 13 sc long multipoles
- 13 standard sc dipoles
- 2 branched (Y) sc dipoles

## 3) Local Cryogenics

- 1 branch box
- 3 BB transfer lines
- 45 feed boxes,
- 45 jumpers,
- 250 m transfer lines
- 1230 m auxiliary lines

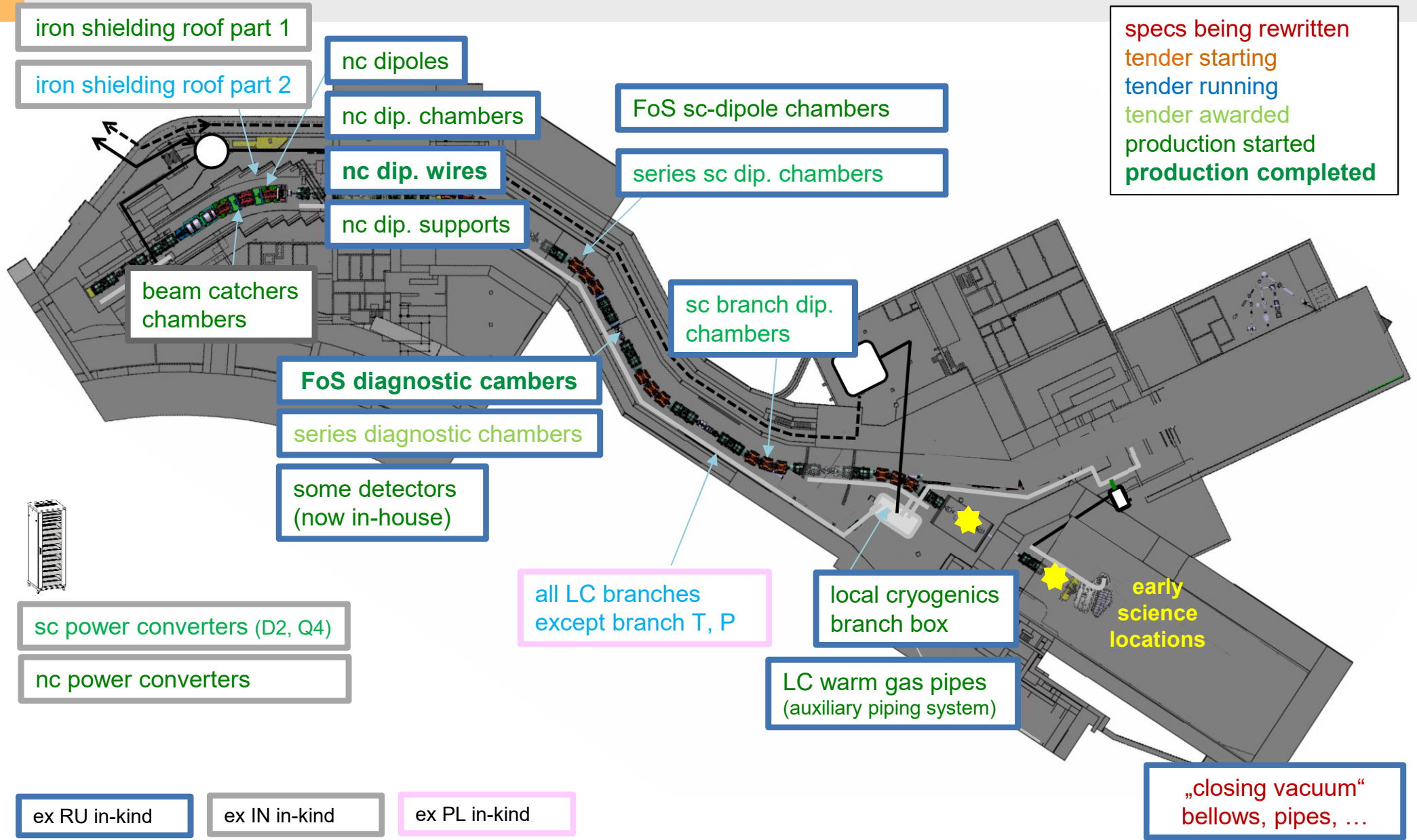
## 4) Vacuum System

- 11 diagnostic chambers
- various beam pipes
- beam instrumentation

## 5) Racks (not in beam-tunnel)

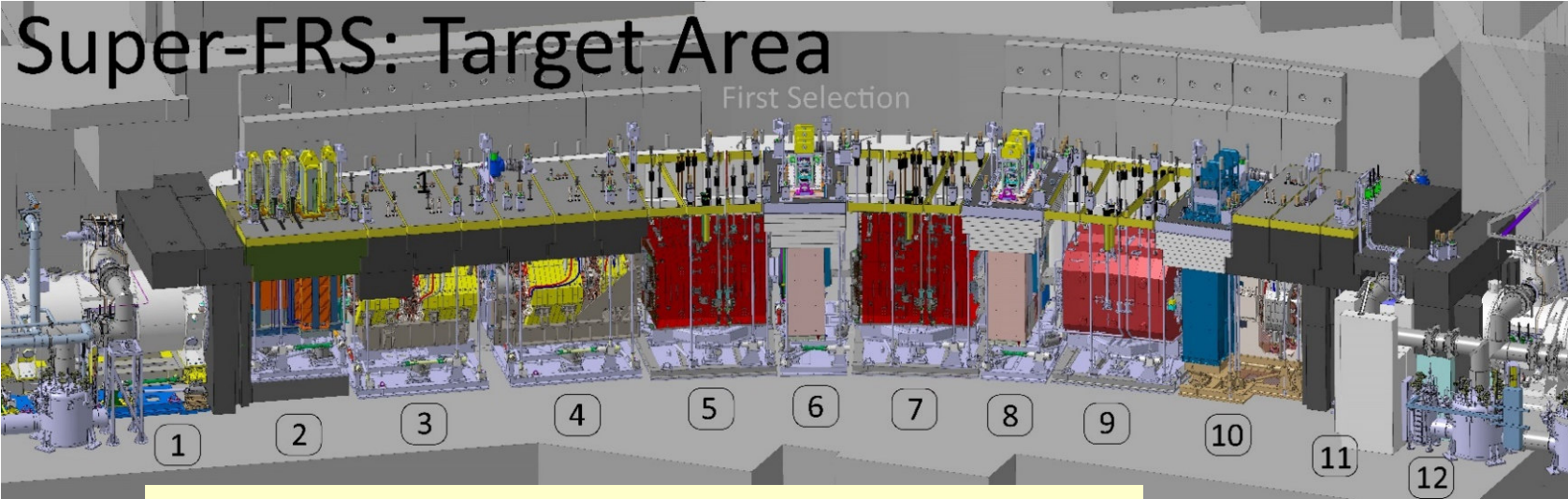
- Power Converters
- Control Racks

# Plan-B Procurements (ex-Russian, ex-Indian, ex-Polish)



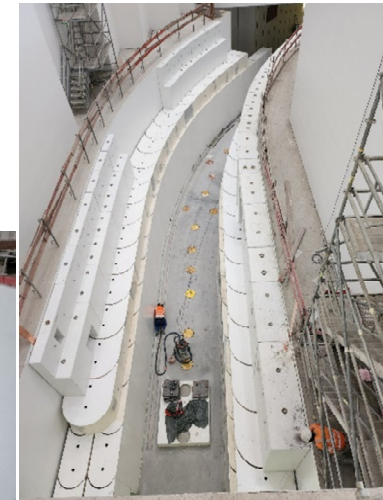
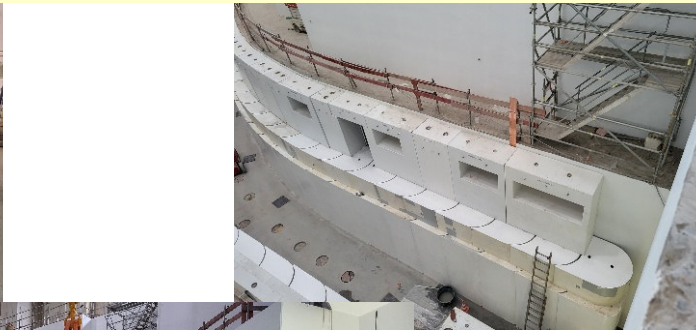
# Target Area Overview

## Super-FRS: Target Area



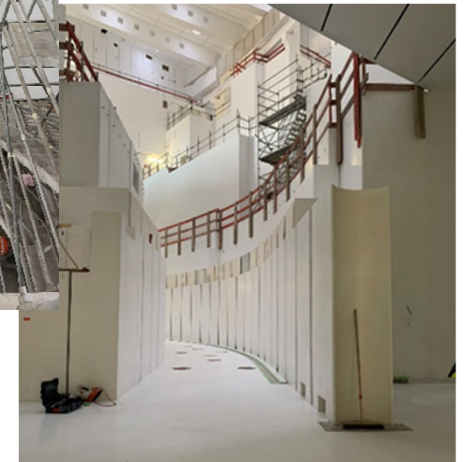
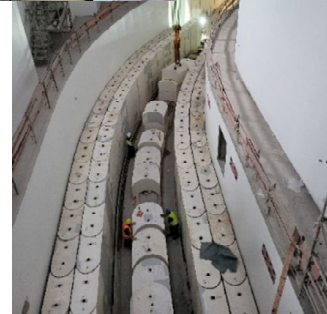
1. Magnetkryostat/-cryostate
2. Targetkammer/-chamber
3. Magnet (Linse/Lens)
4. Magnet (Linse/Lens)
5. Magnet (Ablenk~/Deflector)
6. Strahlfänger/Beamcatcher
7. Magnet (Ablenk~/Deflector)
8. Strahlfänger/Beamcatcher
9. Magnet (Ablenk~/Deflector)
10. Strahlfänger/Beamcatcher
11. Magnetkryostat/-cryostate
12. Magnetkryostat/-cryostate

Installation of lateral iron shielding Q2/2025



completed:  
July 24, 2024

1<sup>st</sup> iron block:  
May 7, 2024



# Target Area

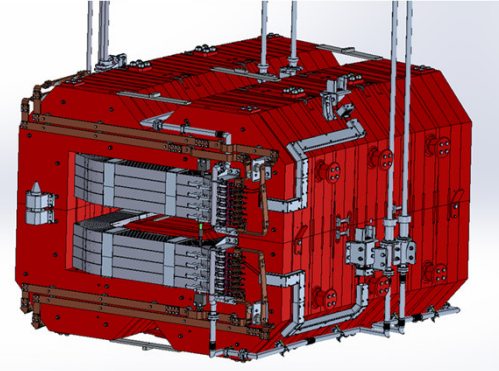
## NC magnets

H. Leibrock,  
C. Mühle et al.



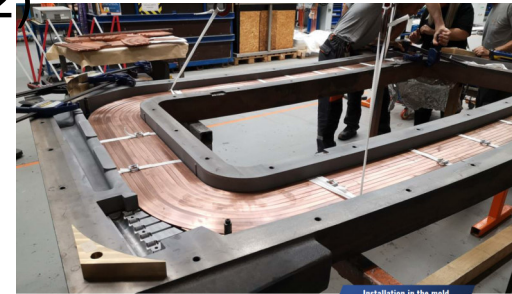
### NC Dipoles (Ru re-procurement, 2 units):

- ✓ Contract signed (Sigmaphi, Fr), **08/2023**
- ✓ MIC Cable (re-procured, nVent, Ca)
- ✓ Design phase / FDR completed
- Prototyping running
- FAT schedule: 05/2025 (D1), 10/2025 (D2)

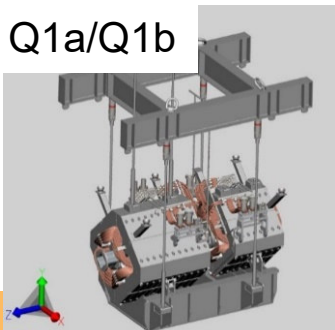


### NC multipoles (3 quads, 2 sext):

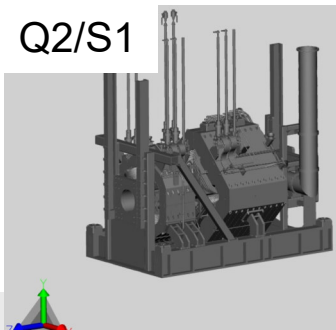
- ✓ Manufacturing (Buckley Systems, NZ)
- ✓ MIC Cable (procured, Hitachi, Jp)
- ✓ Design phase / FDR completed
- Batch 1: S2 assembly running, FAT 12/2025
- Batch 2: Q1a/Q1b & Q2/S1  
production running, FAT 05/2025



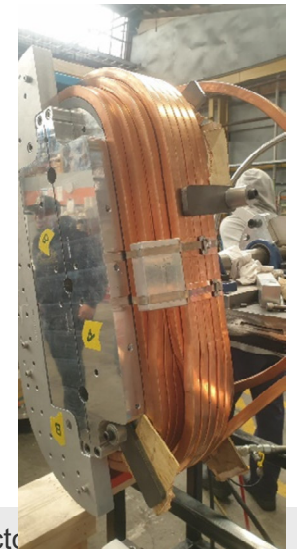
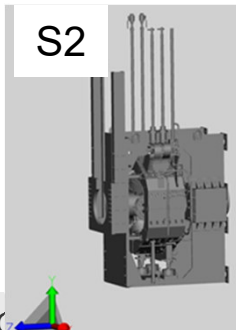
Q1a/Q1b



Q2/S1



S2



# Target Area

## Component procurement

H. Weick  
C. Karagiannis  
A. Kratz  
B. R. Knöbel et al.



- **Target chamber + Plugs:** (Fantini)  
manufacturing ongoing, FAT 11/2024

- **Beam catchers:**

In-kind India: (Trident Ltd.)

BC3 built, FAT scheduled 10/2024

BC1 / BC2 FDR running

**Plan B FAIR** (only empty chambers):

revised design by NTG, finalizing design phase

planned delivery Q3/2025 (BC1) Q4/2025 (BC2)

- **Alignment supports:** (Fantini), 8 pcs.

manufacturing of FoS, last FAT end of 2024.

➤ **Two extra supports** needed for sc multiplets,

GSI-design, provider Fantini, deliverer: Q1/2025

long-lead items ordered in advance

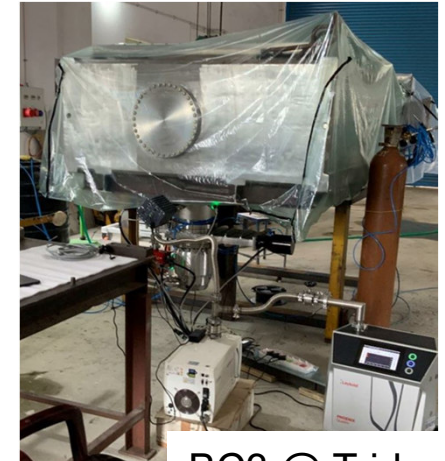
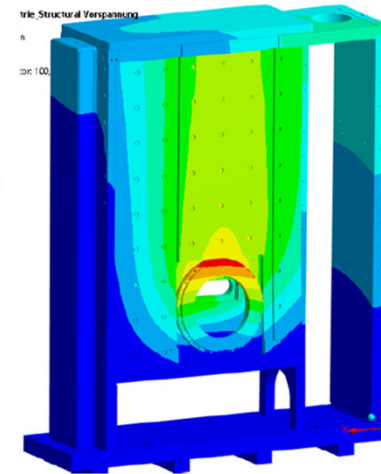
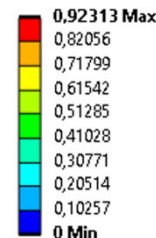
- **Pillow seals:** (Mewasa, 3 types),

FAT of FoS, many produced, last FAT Q4/2024

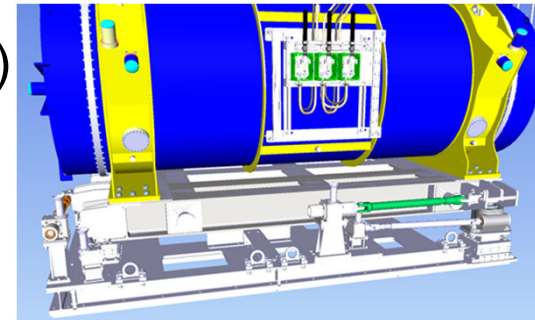
- **Pillow-seal plugs:** (Asturfeito),

production running, FAT Q1/2025

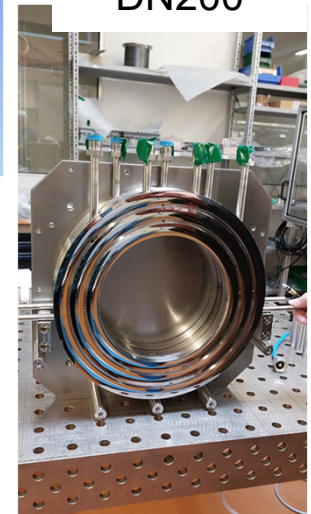
BC1 by NTG  
deformation /mm



BC3 @ Trident



Pillow seal  
DN200



Pillow seal  
rectangular

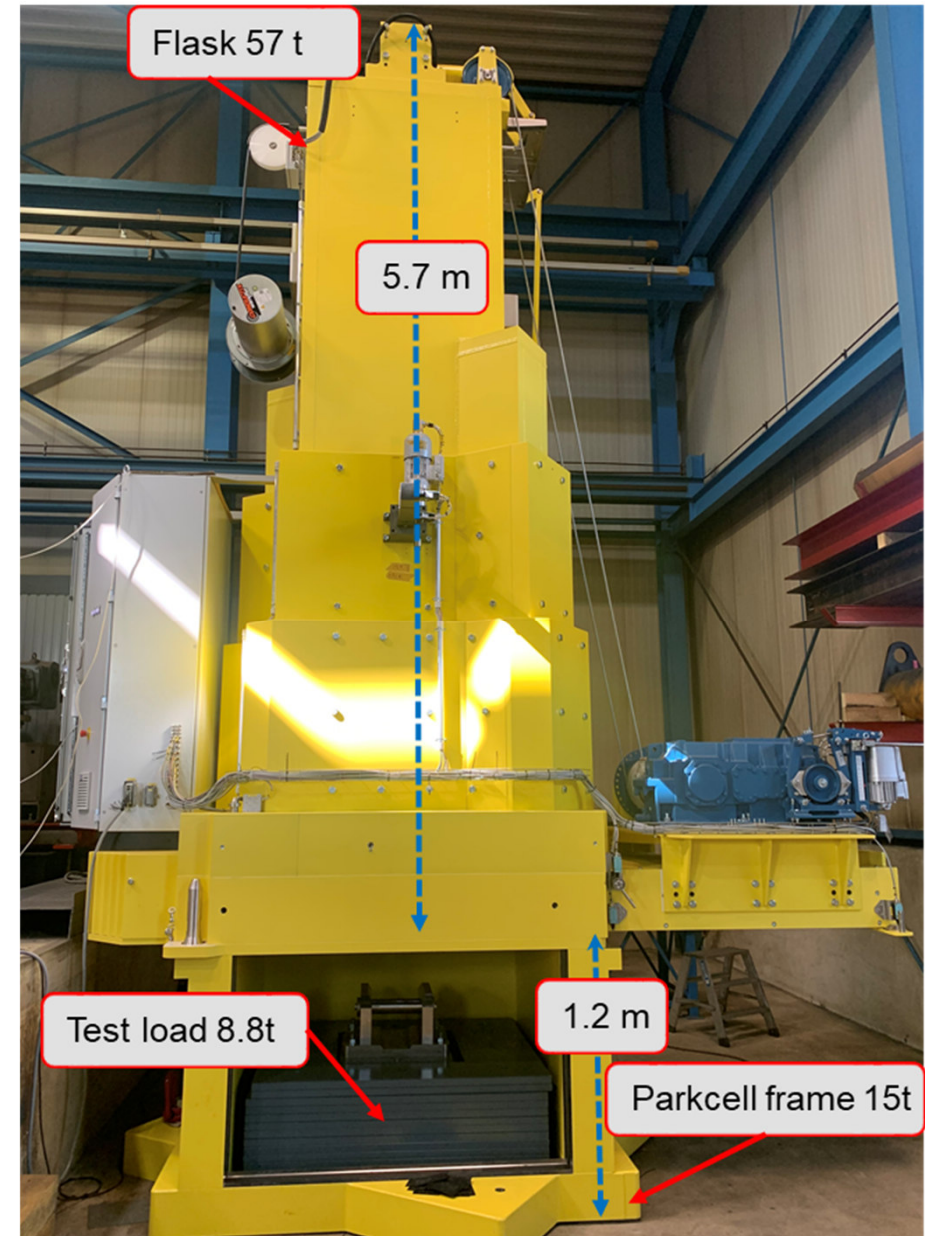


# Target Area Shielding Flask

F. Amjad  
H. Weick et al.



- combined Fin in-kind / FAIR
- Provider: Bilfinger Noell
- Project duration 2020 → 2024.
- ✓ FAT successfully completed Sep 2024
- Delivery planned for Nov 2024
- Equipped to handle 21 Super-FRS plugs
- Shielding up to 35 cm thick
- Designed to have safety redundancy
- Remotely operated using control desk



# Vacuum System

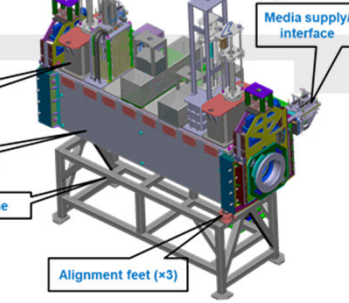
(Ru re-procurement)

S. Purushotaman  
N. Kurichiyani et al.



## 1) Diagnostic chambers (11 + 2 chambers, ES)

- 2 FoS chambers produced by Pfeiffer (DE), delivered; **reprocurement & production  $\approx$  1year!**
- **FAIR tender for series ready to be awarded**
- Planned delivery: Q3/2025 to Q2/2026



## 2) vacuum chambers for standard sc dipoles

- 2 FoS chambers (9,75°, 11°); Provider: VTP, Sp
- ✓ FAT D2 chamber done, delivery in preparation
- FAT D3 chamber scheduled for 11/2024
- Series chambers **awarded 09/2024**; Provider: Fantini (It)
- low- $\mu_r$  stainless steel will be provided (in-house)
- Integration of chambers into dipoles during pre-assembly

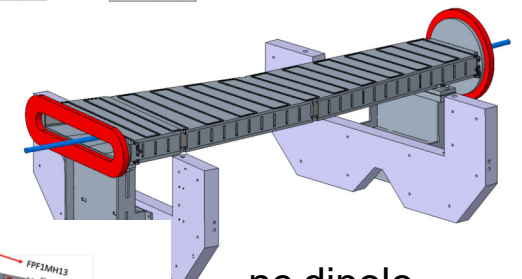
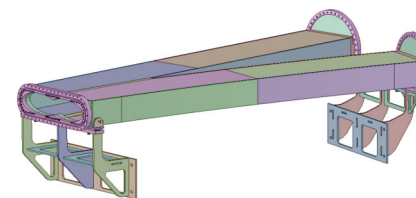
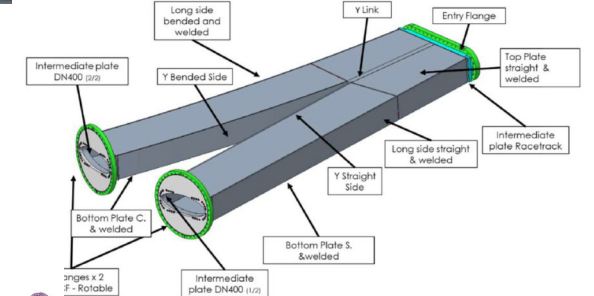


FOS D2 chamber

## 3) 2 vacuum chambers for branched sc dipoles

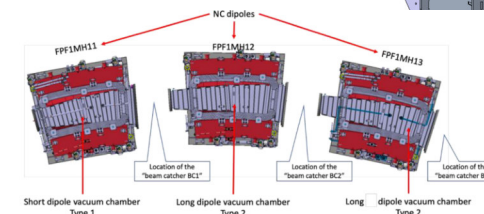
- Provider: CNIM (Fr), **awarded 06/2024**
- design phase running
- planned delivery: Q1/2026

branched chamber



## 4) 3 vacuum chambers for nc dipoles (Ti alloy)

- Provider: CNIM Systèmes Industriels, Fr
- design phase completed, **FDR 07/2024**
- Production running; planned delivery: July 2025



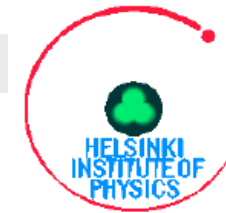
nc dipole chamber

# Beam Instrumentation

## Finnish in-kind contributions

C. Nociforo, E. Rocco,  
J. Galvis, B. Voss,  
D. Urner, S. Udrea,  
C. Caesar, et al.

FAIR



GSI



UNIVERSITY OF JYVÄSKYLÄ  
JYVÄSKYLÄN YLIOPISTO

- MUSIC (energy-loss, GSI & Uni Jyvaskyla)

- ✓ FoS detector under test at GSI
- to be tested in 2025 with beam

- SEM Grid (profile monitor, HIP)

- ✓ FDR in preparation
- FoS delivery expected by 2024

- GEM-TPC (tracking, HIP)

- ✓ FDR in preparation

- SciFiber (tracking, GSI plan B)

- ✓ CDR approved
- ✓ FoS under production
- to be tested in 2025 with beam

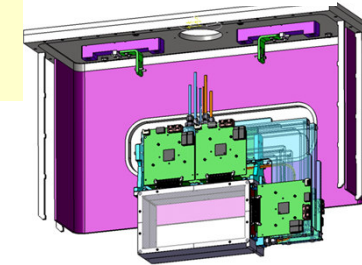
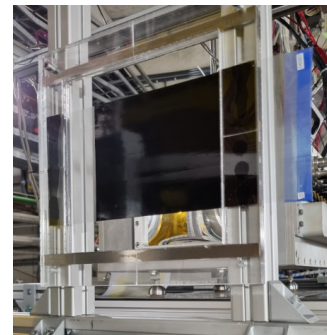
- Position drive (HIP)

- ✓ FDR in preparation
- FoS units shipped to GSI for testing

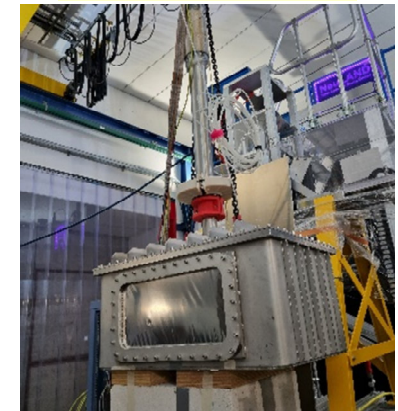
- IPM (FAIR in-house)

- dedicated chamber ordered
- prototype build, beam test in 2025 with beam

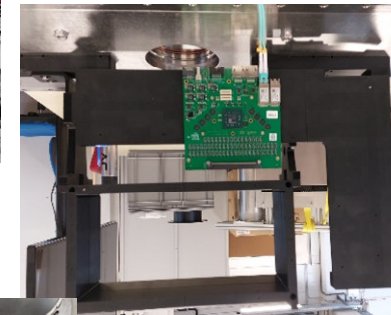
Scintillating  
Fibers



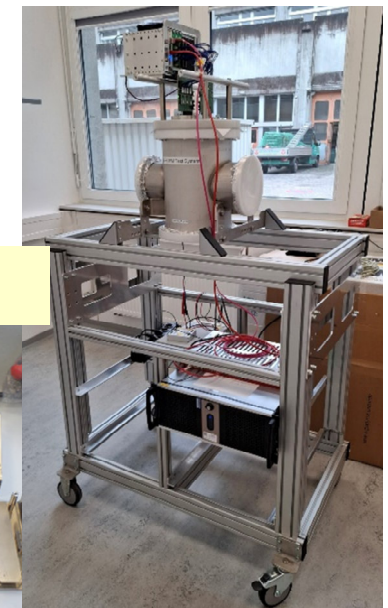
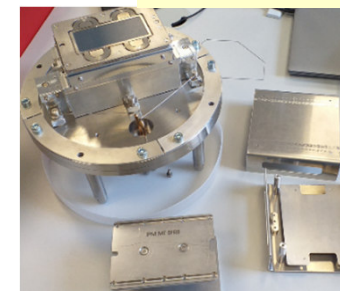
FoS MUSIC



FoS Drive



IPM

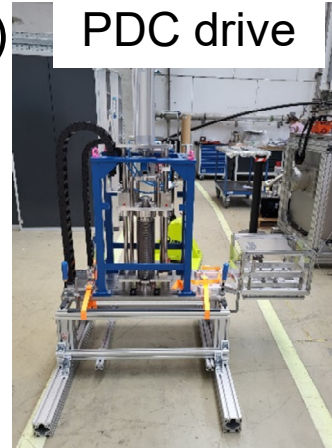


# Beam Instrumentation

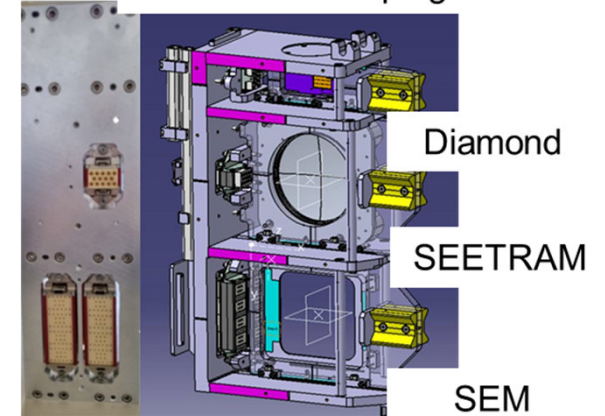
- Particle Detector Combination (FAIR in-house)
  - FPF4 drive under test
  - ✓ o-ring test passed
  - FPF0 ladder under test
- Slit System (KVI)
  - ✓ all slits in-house, SAT series ongoing
- Drive control (Uni Chalmers)
  - ✓ FDR done (Q2/23)
  - to be procured
- Diamonds (FAIR in-house)
  - FPF0 FDR under review
  - Electronics/DAQ under test
- Plastic scintillator (FAIR in-house, 7 units)
  - ✓ FDR released
  - 2 FoS detectors under production in house
  - to be tested in 2025 with beam
  - system will replace ToF during ES
- Beam stopper (Fa. Axilon)
  - ✓ SAT released



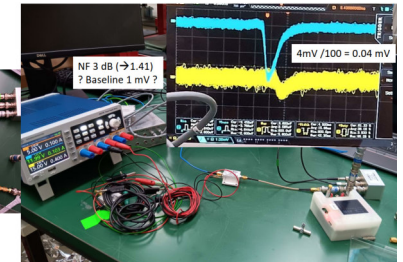
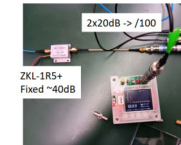
PDC drive



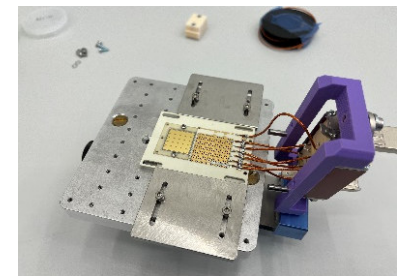
FPF0 ladder / plug



Slit @ GSI storehouse



Beam stopper





# SC Dipoles

H. Müller,  
E.J. Cho et al.  
CEA Saclay



## New induction brazing method and in-situ control

### Scope (ES):

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

### Main characteristics:

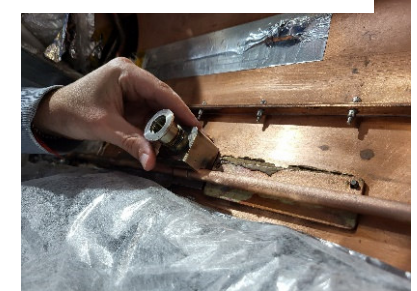
- iron dominated, warm iron. large aperture
- individual powering,  $I_{\max} < 300A$

### Provider:

- Elytt, Bilbao, Sp

### Production Status:

- ✓ New brazing method developed (by induction) + x-ray
- ✓ FAT of 3<sup>rd</sup> D3 05/2025
- SAT at CERN running (includes field qualification)
  - ✓ field quality within specification
  - chamfer movement observed; fixation method defined
- Series production running
  - new brazing method applied to all dipoles
  - new chamfer fixation method applied to all dipoles
  - this year still shipment of 2 dipoles to CERN scheduled



3D3 ready for CERN shipment



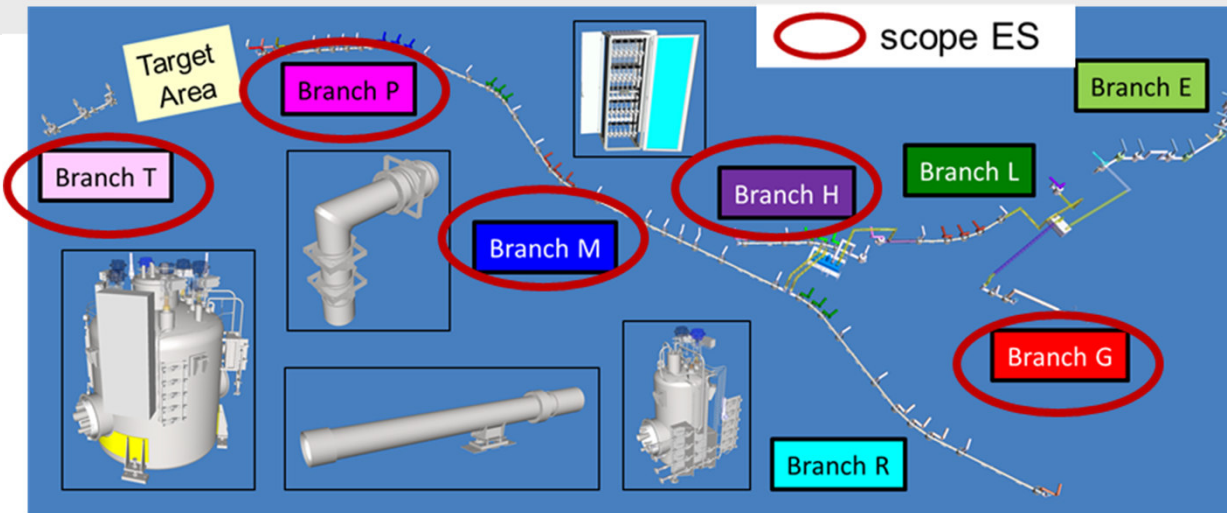
Chamfer movement



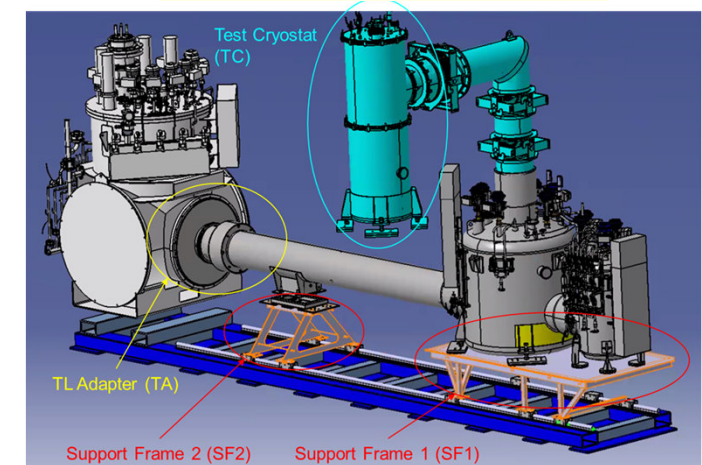
Preliminary fixation

# Local Cryogenics (Branches)

F. Wamers,  
Y. Xiang,  
D. Schad, et al.



## FoS Test Facility



- In-kind Partner: Poland
- Overall system design by WUST
- Component design by WUST

### T-Branch

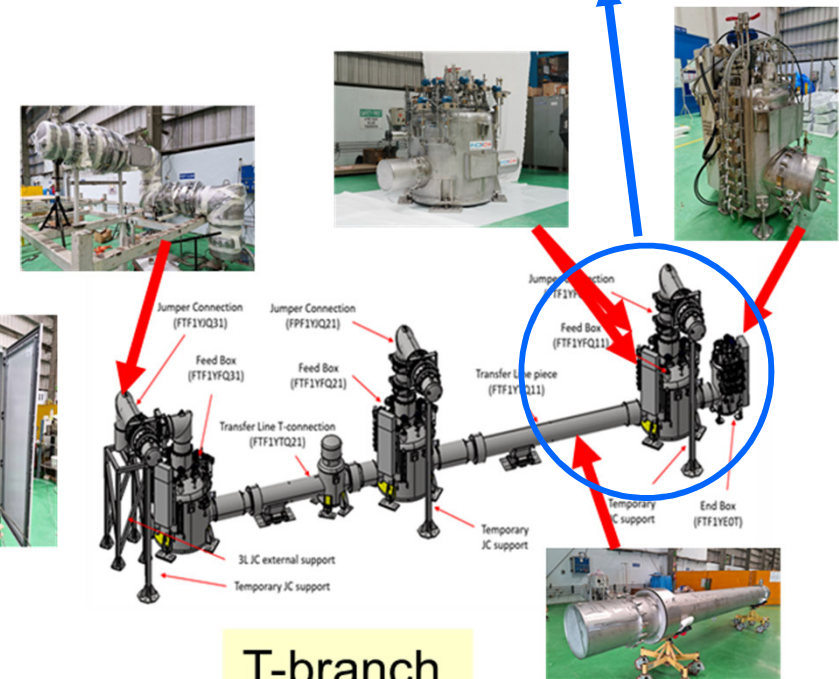
- Provider: INOX, Ind
- ✓ FAT done, delivery: on ship → arrival 11/2024
- FoS test @ STF in preparation → installation

### P- Branch (PL in-kind)

- WUST tender to be awarded

### M, H, G Branches (ex PI, now FAIR)

- FAIR tender running; award expected Q4/2024



T-branch

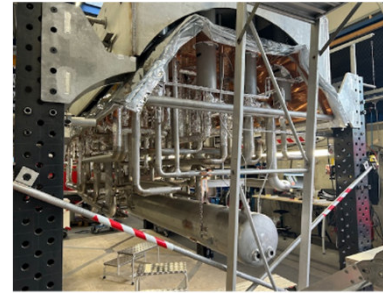
# Local Cryogenics (Utilities)

F. Wamers,  
Y. Xiang,  
D. Schad, et al.



## Branch Box (ex Ru, Plan-B)

- central local cryo control facility
- 45 cold valves, high operational flexibility
- ~15.5 tons, mostly stainless steel
- ~ 2.5 m diameter, ~ 6.7 m length
- Provider: Demaco NL
- Production running; delivery Feb. 2025
- start installation: March 2025

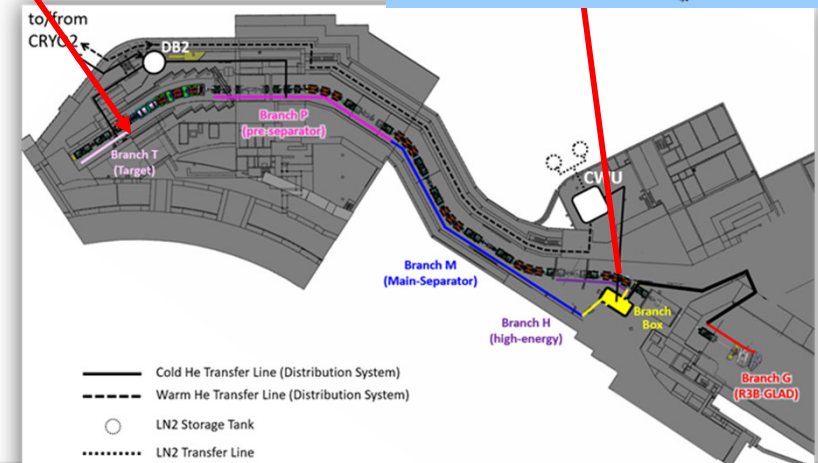
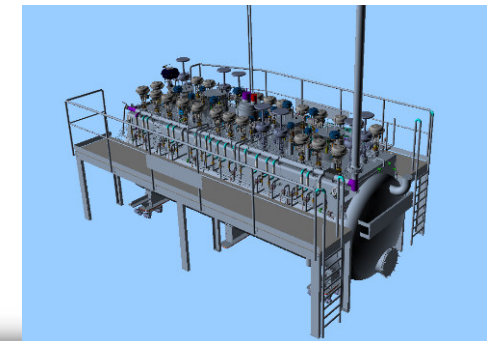


## ACPS (ex Ru, Plan-B)

- Auxiliary Cryogenics Piping System:
  - Multipurpose Return (MPL)
  - Warm GHe Supply (WGS)
  - Current-Leads Return (CGR)
- Provider: Demaco NL
- Production running; delivery beanch wise
- ✓ **installation T-Branch running now**



ACPS @ T-branch





# Installation Schedule

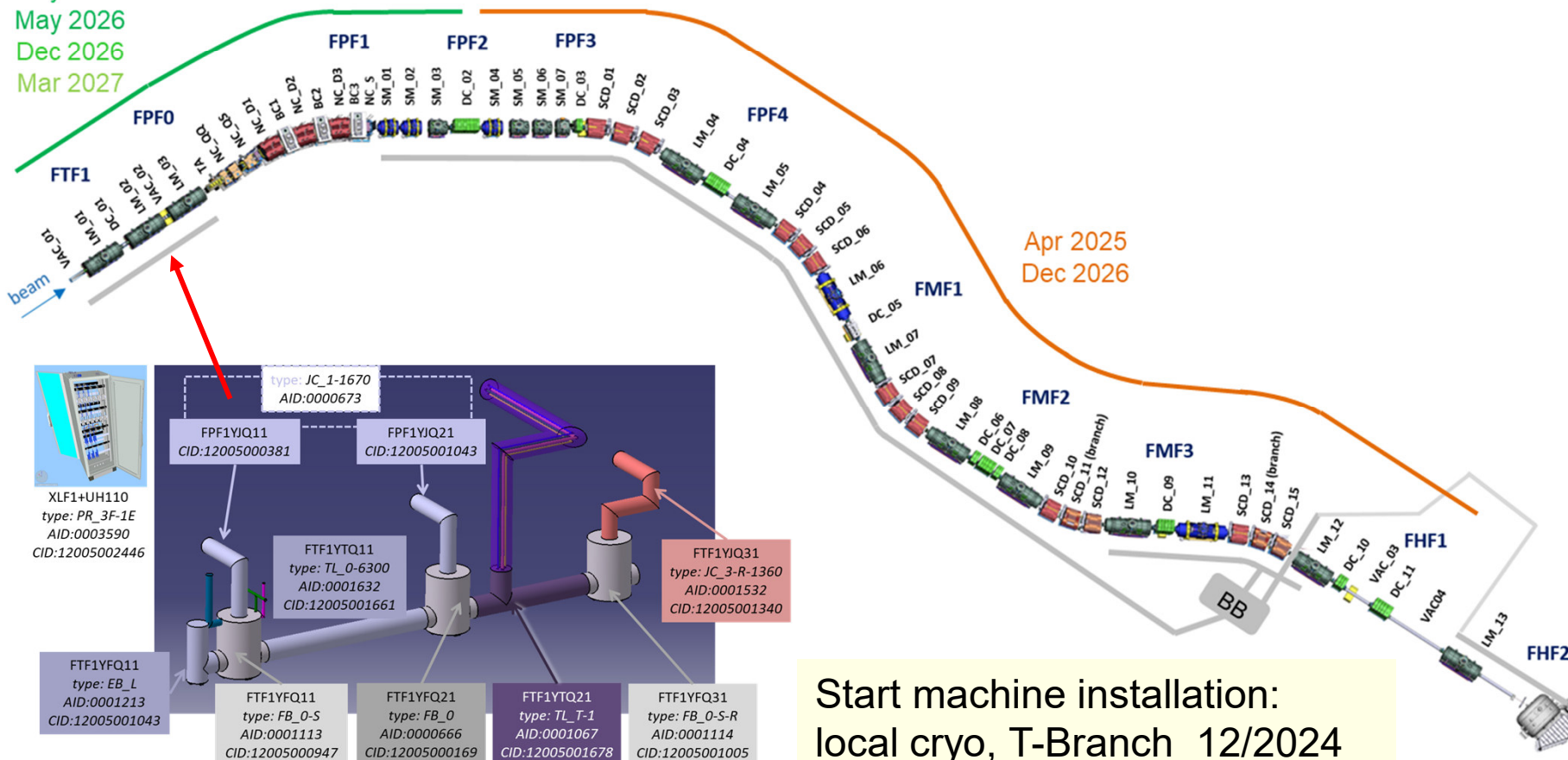
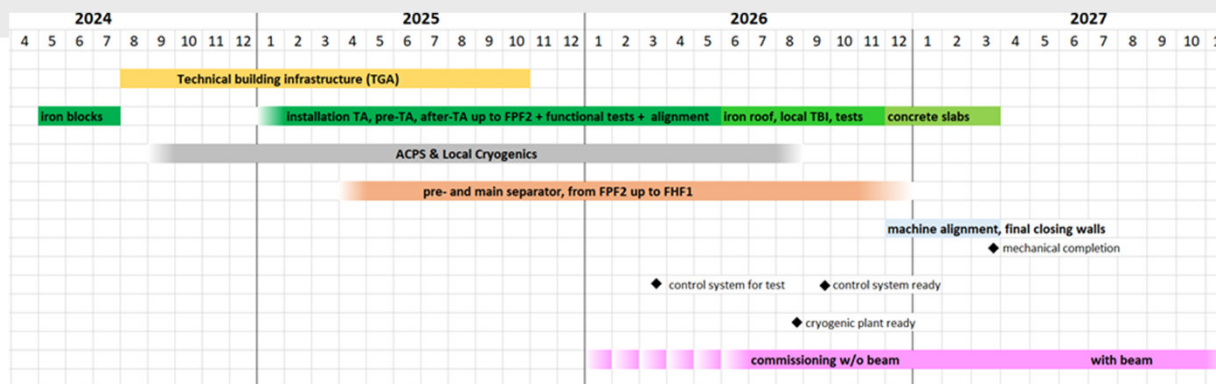
K. Knie,  
H. Marcocelli,  
V. Ricciardi et al.



Iron shielding:  
start 05/2024



May 2024  
May 2026  
Dec 2026  
Mar 2027



Start machine installation:  
local cryo, T-Branch 12/2024

# Impression Tunnel & Supply Building

M. M. Schmidt,  
M. Rodionova et al.



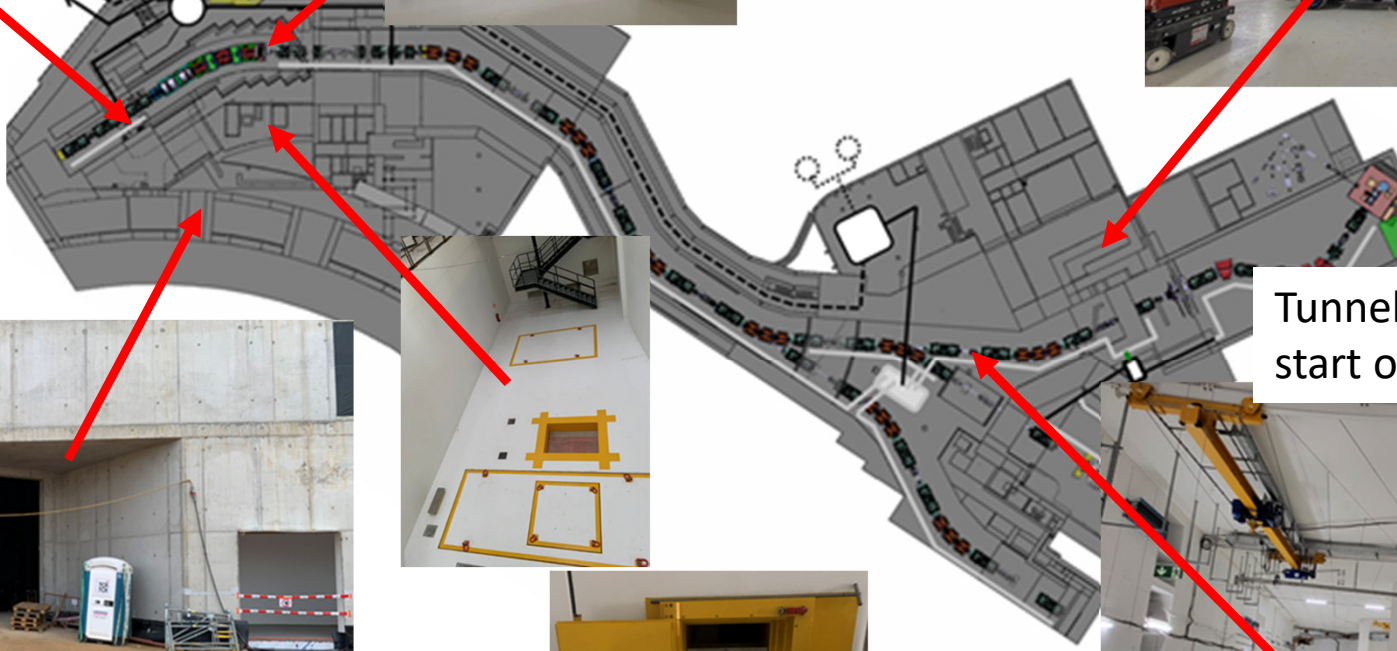
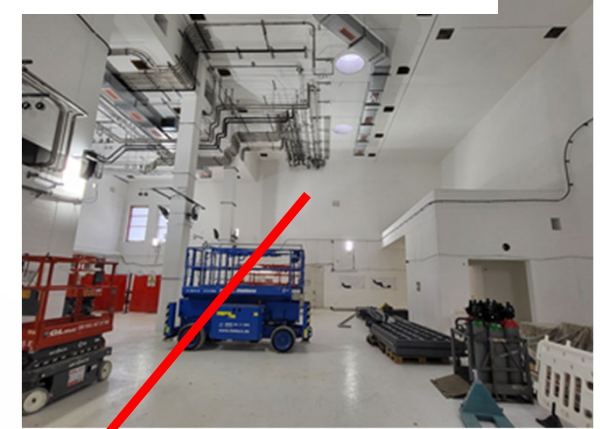
Pre-Target Area:  
installation of TBI advanced



Target Area: installation  
of lateral iron shielding



Super-FRS preparation  
area: installation of TBI



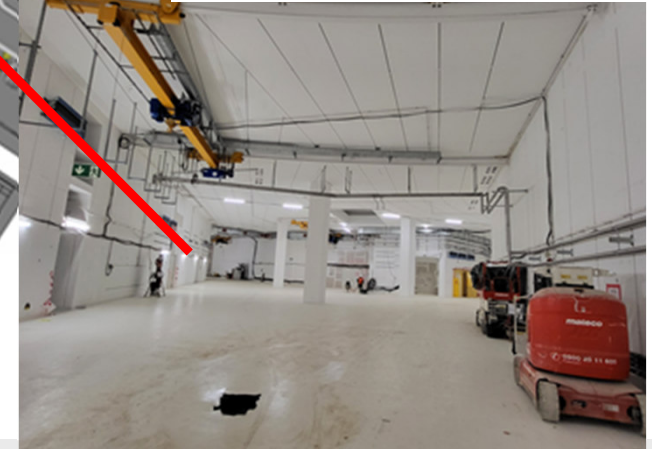
Tunnel / FHF1 area:  
start of TBI installation



Target Building:  
road to main access)



Hot Cell shell  
construction

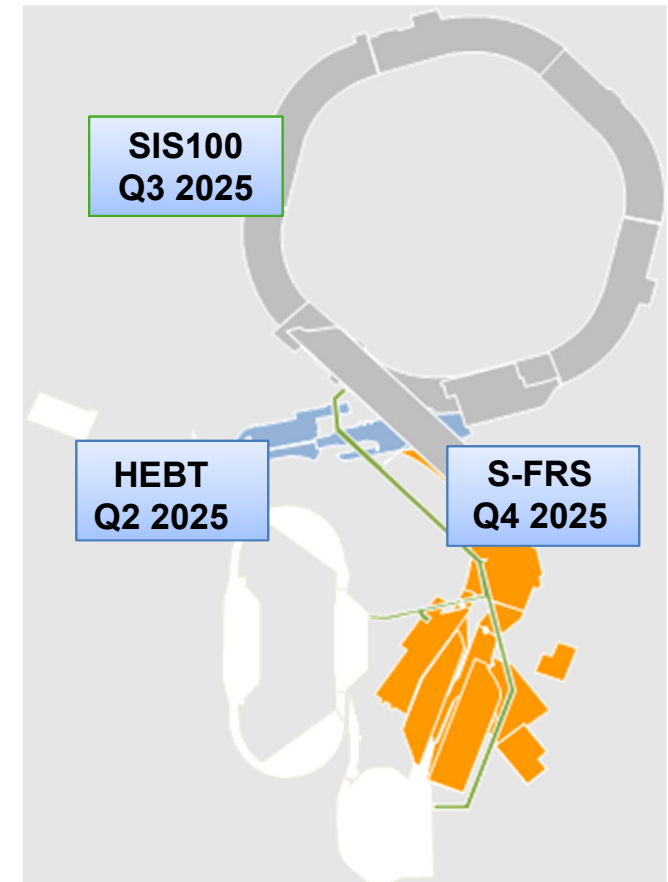


# Commissioning phases for ACC

inst.	#	commissioning stage	accelerators & transfer lines	detectors
Commissioning without Beam	1 <small>(M??)</small>	local HW-commissioning	<ul style="list-style-type: none"> <li>• <b>local system tests</b> in tunnel and supply areas</li> <li>• Special cable connections by system experts</li> <li>• <b>Control system not needed</b> (only in limited aspects)</li> </ul>	<ul style="list-style-type: none"> <li>• single detector tests</li> <li>• tests of individual components</li> <li>• install. service &amp; controls</li> </ul>
	2 <small>(M??)</small>	remote & system commissioning	<ul style="list-style-type: none"> <li>• <b>single system test</b> (vertical system integration test)</li> <li>• <b>remote testing</b> from MCR (sequences, checklists)</li> <li>• <b>control system integration of the system and timing is needed</b></li> </ul>	<ul style="list-style-type: none"> <li>• system tests (with HV, gas, ...)</li> <li>• pre-test of DAQ system</li> <li>• local control</li> </ul>
	3 <small>(M11)</small>	integration	<ul style="list-style-type: none"> <li>• (3.1) multi system tests &amp; (3.2) full Dry-Runs</li> <li>• control system and accelerator models for pilot beam scenarios fully available</li> </ul>	<ul style="list-style-type: none"> <li>• full detector test and DAQ using cosmics</li> </ul>
Beam Commissioning	4 <small>(M12)</small>	pilot beam commissioning	<ul style="list-style-type: none"> <li>• commissioning with pilot beam</li> </ul>	<ul style="list-style-type: none"> <li>• commissioning with pilot beam</li> </ul>
		beam commission & operation	<ul style="list-style-type: none"> <li>• operation with PCP-beam respectively status quo beam</li> <li>• development towards nominal intensities</li> <li>• commissioning of advanced systems</li> </ul>	

handover to operations

## Start of ACC Commissioning



Action 5 (commissioning/early operation pre-budget 2024)

# Status Commissioning

Department	System Type	1st. workshop done	procedure developed	prerequisites collected	review resources	review schedule	work instruction doc.	sequence procedure	sequence implementation	Status	next action	open points
CRY	cryogenics	100%	50%	50%	50%	0%	0%	0%	0%	31%	meeting scheduled 26.11	.xls
SFR	gas system	100%	50%	50%	0%	0%	0%	0%	0%	25%	wait cryocap. finished	contractor
VAC	vacuum system	100%	100%	100%	75%	0%	0%	0%	0%	47%	discuss ressource small circle	ressource evaluation
NCM	normal conducting magnets & PS	100%	50%	50%	0%	0%	25%	0%	0%	28%	LCM	
SCM	super conducting magnets	100%	100%	100%	0%	0%	0%	0%	0%	38%	ask ressource	
SFR, DTL	BD chambers & components	100%	100%	100%	50%	0%	0%	0%	0%	44%	LCM	none
SFR, DTL, VAC	Target Area	100%	50%	50%	0%	0%	0%	0%	0%	25%	LCM	
<b>SFRS overall preparation status</b>		<b>34%</b>										

## Summary

- All major ex-Ru in-kind mitigated !
- Non-conformities of sc multiplets cured; first repaired multiplets successfully re-tested; reparation and production of remaining multiplets running in parallel; back on track
- Main non-conformity on TS leakage of sc dipoles cured; however, additional non-conformity popped-up during SAT; mitigation is implemented right now
- Few new mitigation action started, like FAIR procurement of part of local cryogenic branches or parallel development of alternative tracking detectors for ES
- Installation of TBI started (advances in pre-target area)
- First component installation done (lateral iron shielding, ACPS in pre-target area); installation of local-cryo T-branch scheduled to start still in 2024
- Commissioning planning started; sub-systems defined and kick-off LCMs done

**Thank you for you attention !**

