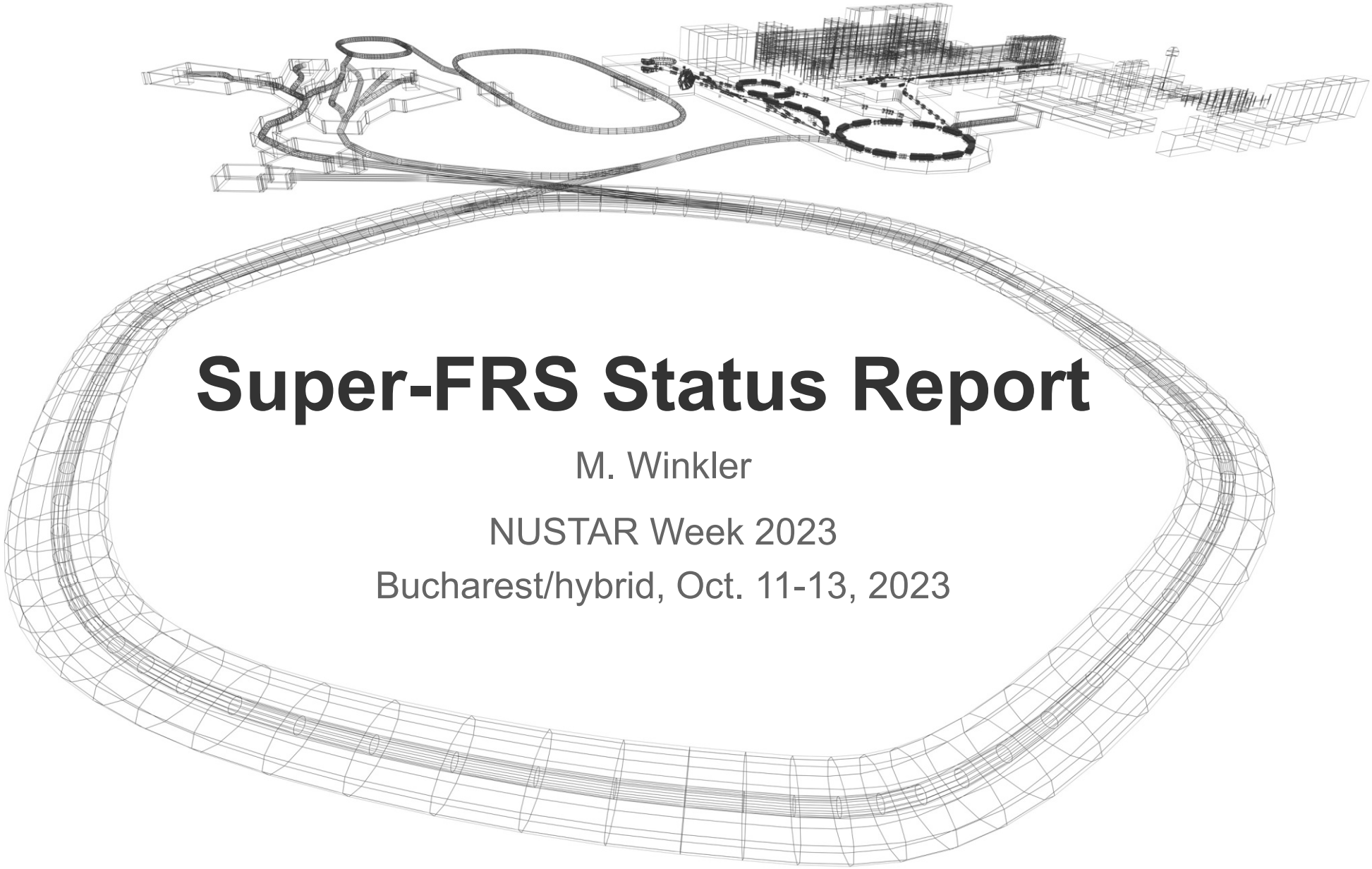


Super-FRS Status Report

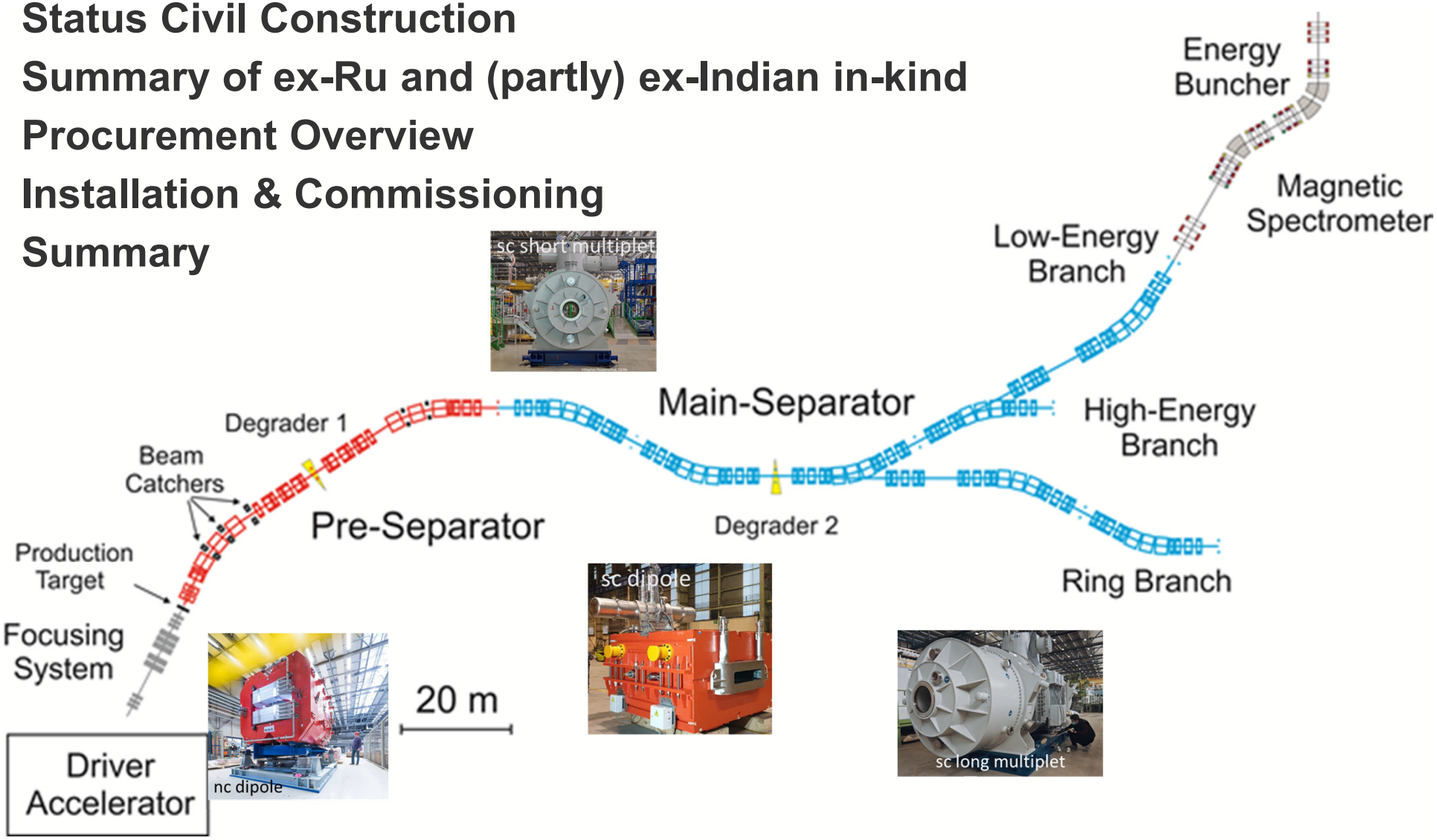
M. Winkler

NUSTAR Week 2023

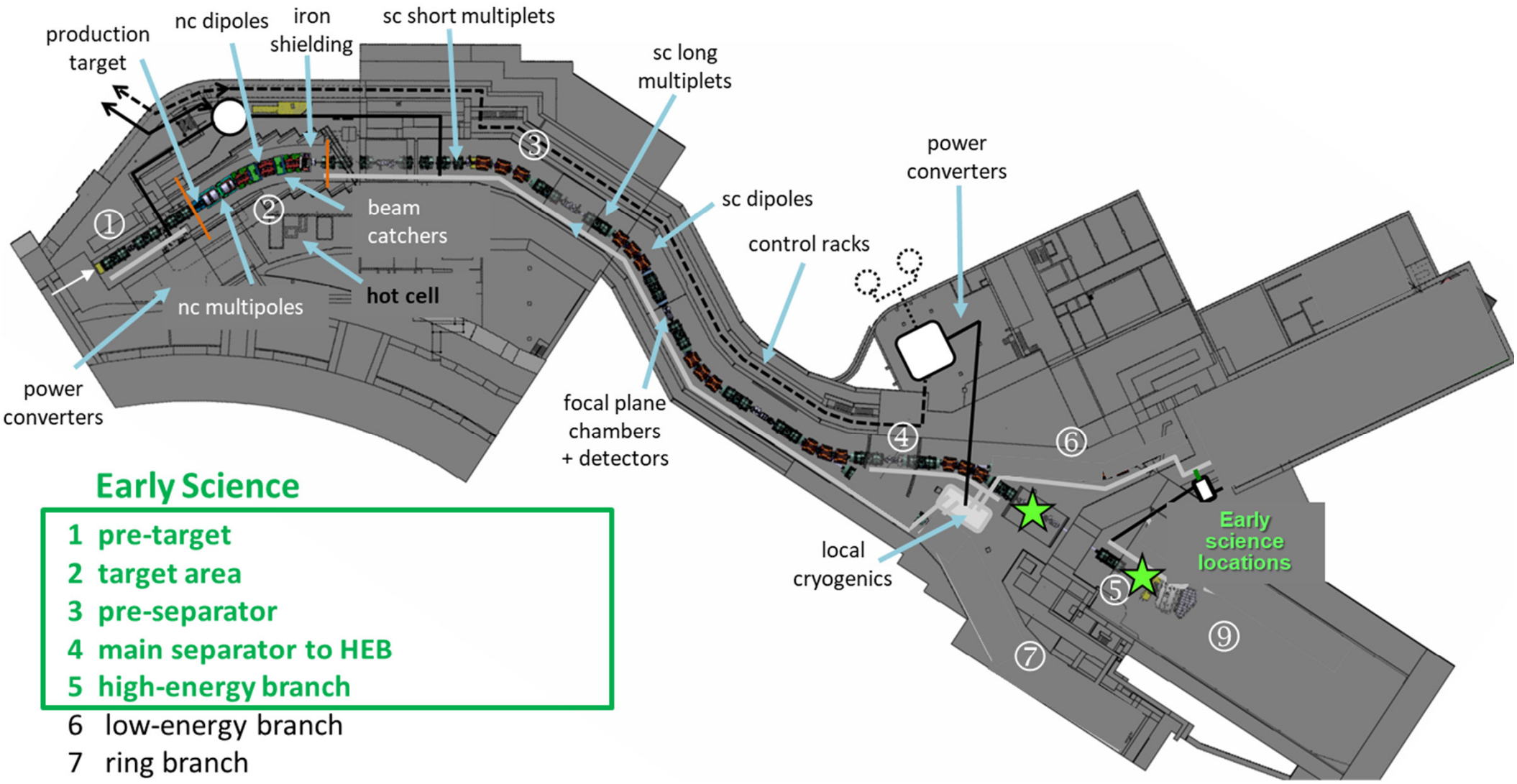
Bucharest/hybrid, Oct. 11-13, 2023

Outline

1) Early Science Scope
2) Status Civil Construction
3) Summary of ex-Ru and (partly) ex-Indian in-kind
4) Procurement Overview
5) Installation & Commissioning
6) Summary



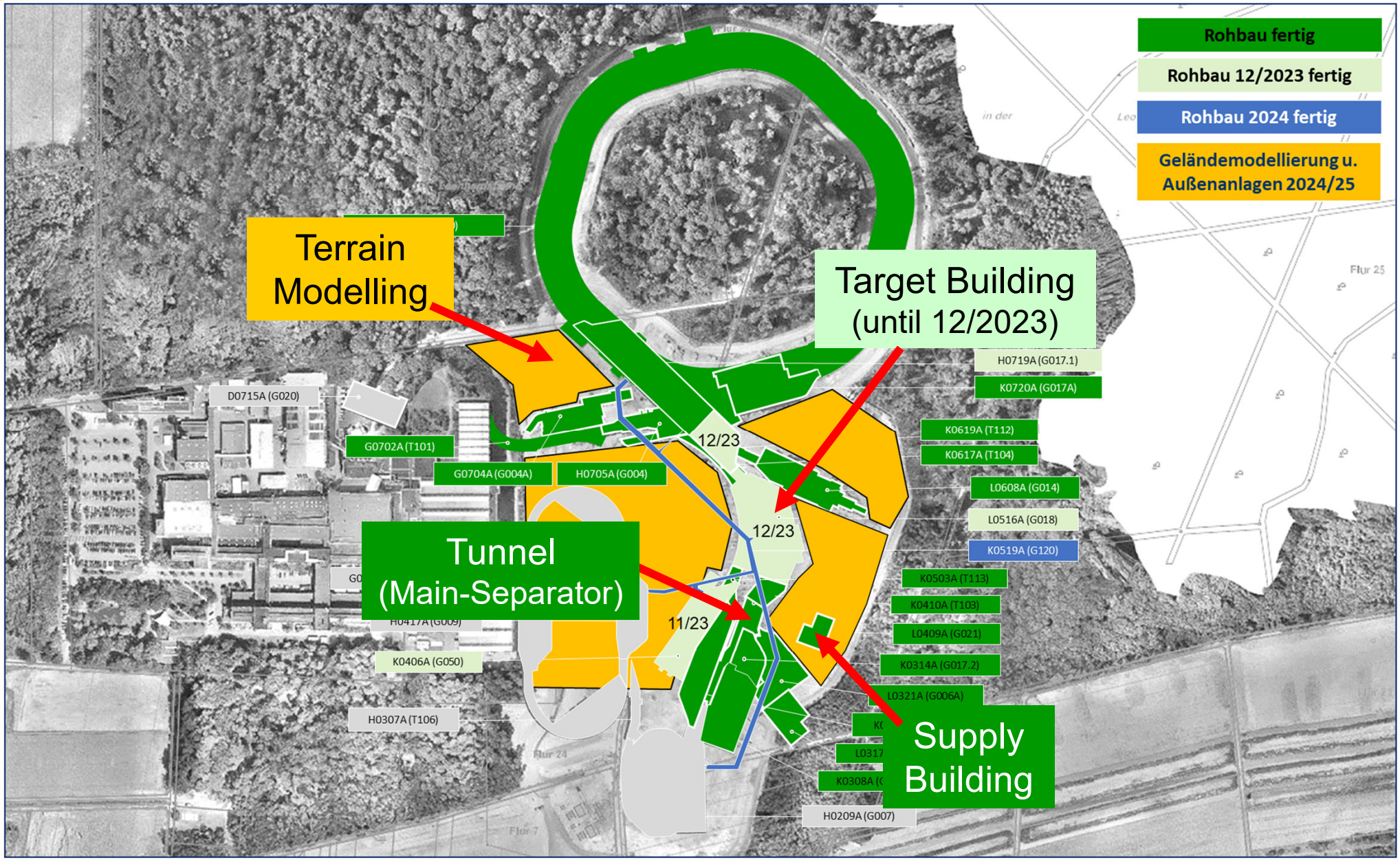
ES (Early Science)



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)

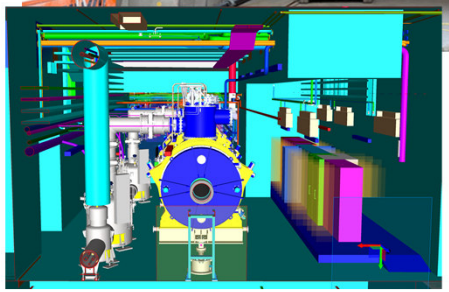
Status Shell Construction



Impression Target Building

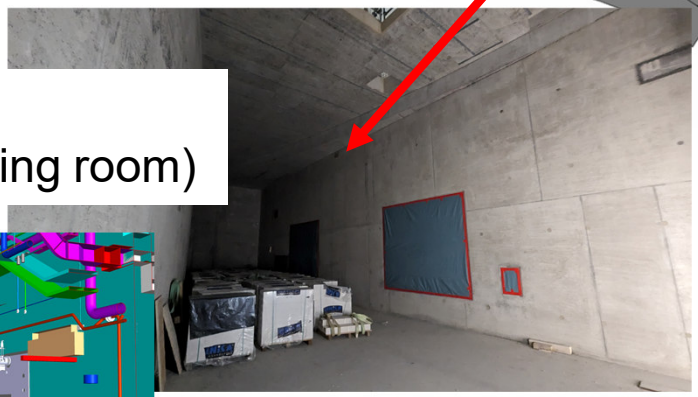
Pre-target area

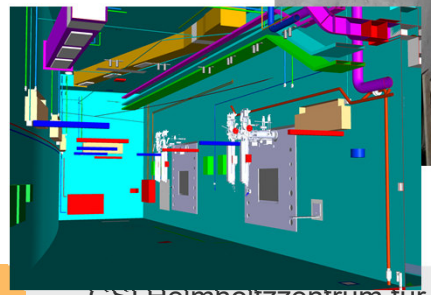
Target area

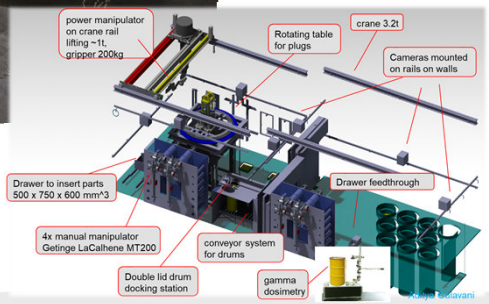


Hot Cell complex

Hot Cell
(manipulating room)





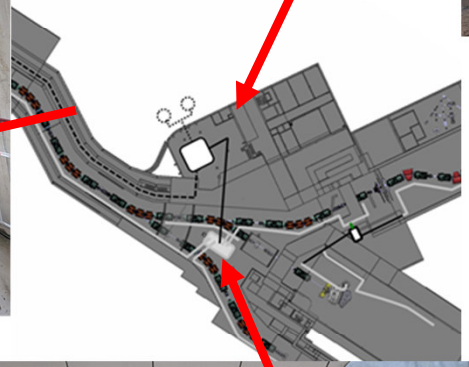


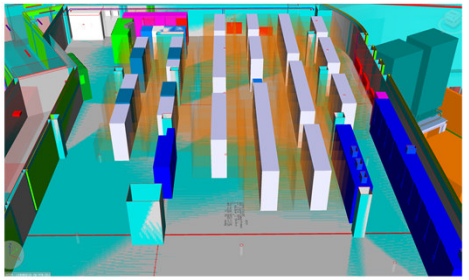
Impression Tunnel & Supply Building

supply tunnel

L0321A.E15
(main access)

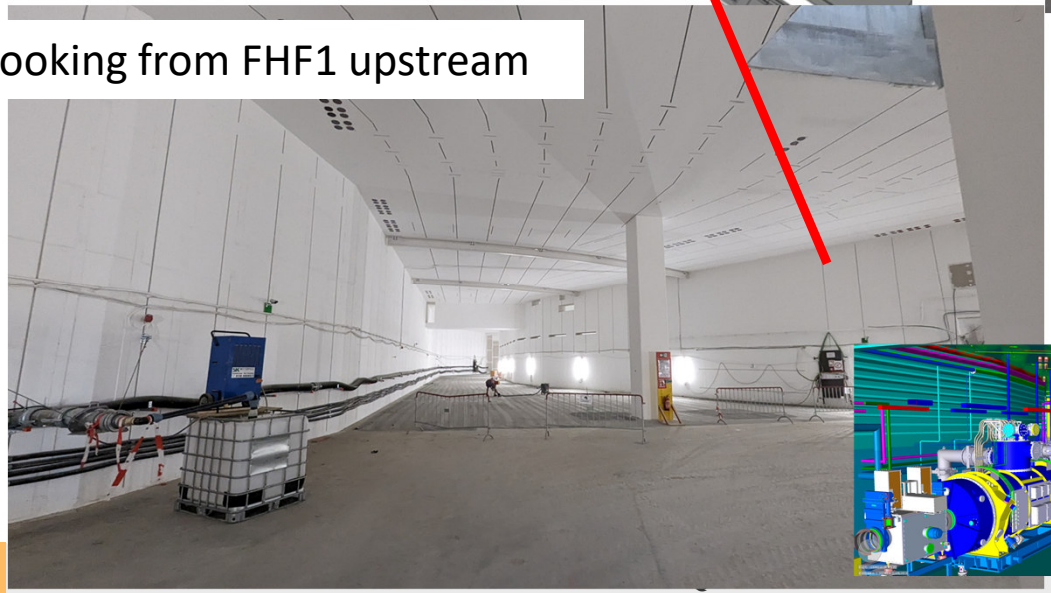
Main Entrance

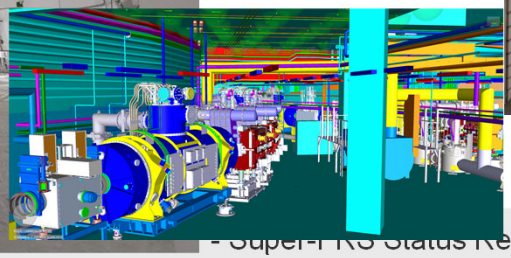




L0321A.E20
(power converter room)

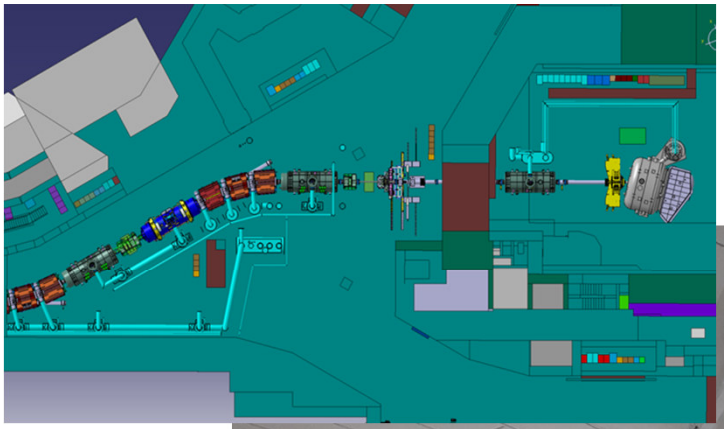
looking from FHF1 upstream

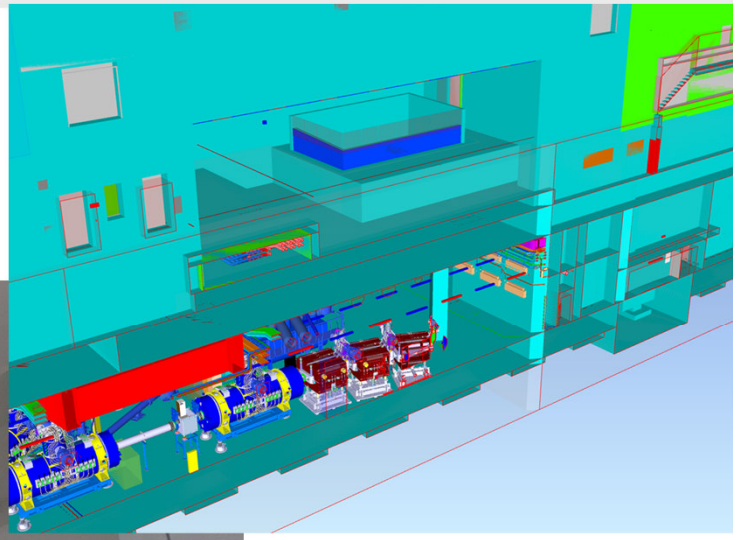




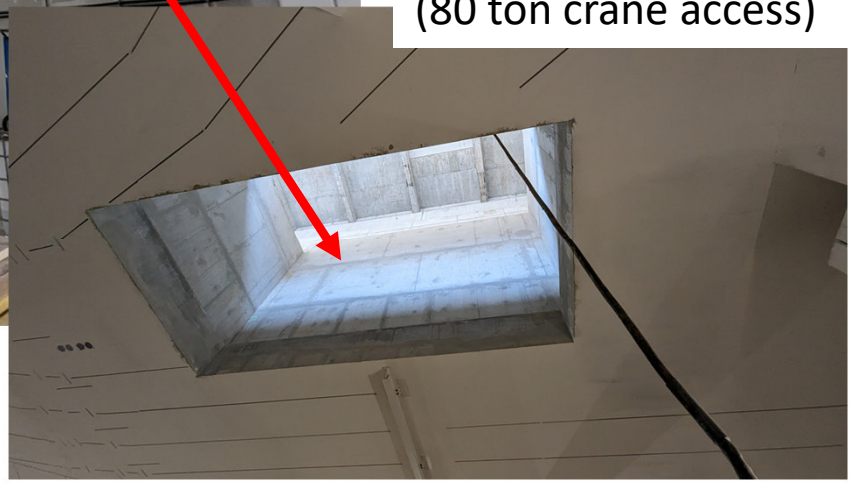
L0321A.E30
(Nustar preparation room)

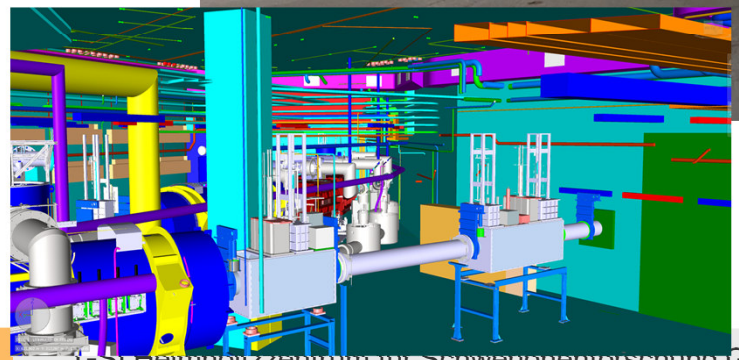
Impression Tunnel / FHF 1 Area



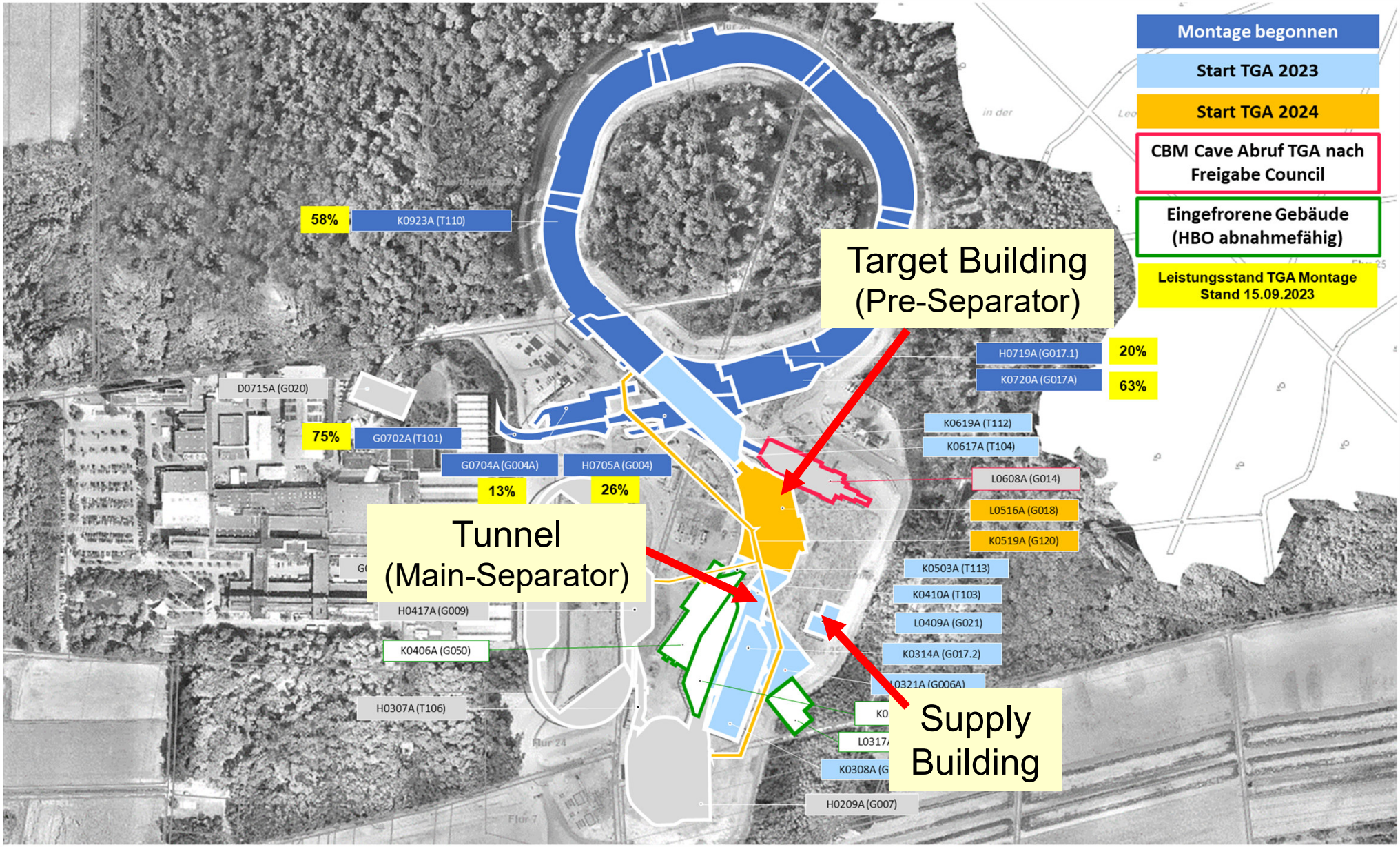


FHF1 roof opening
(80 ton crane access)





Status Technical Building Infrastructure



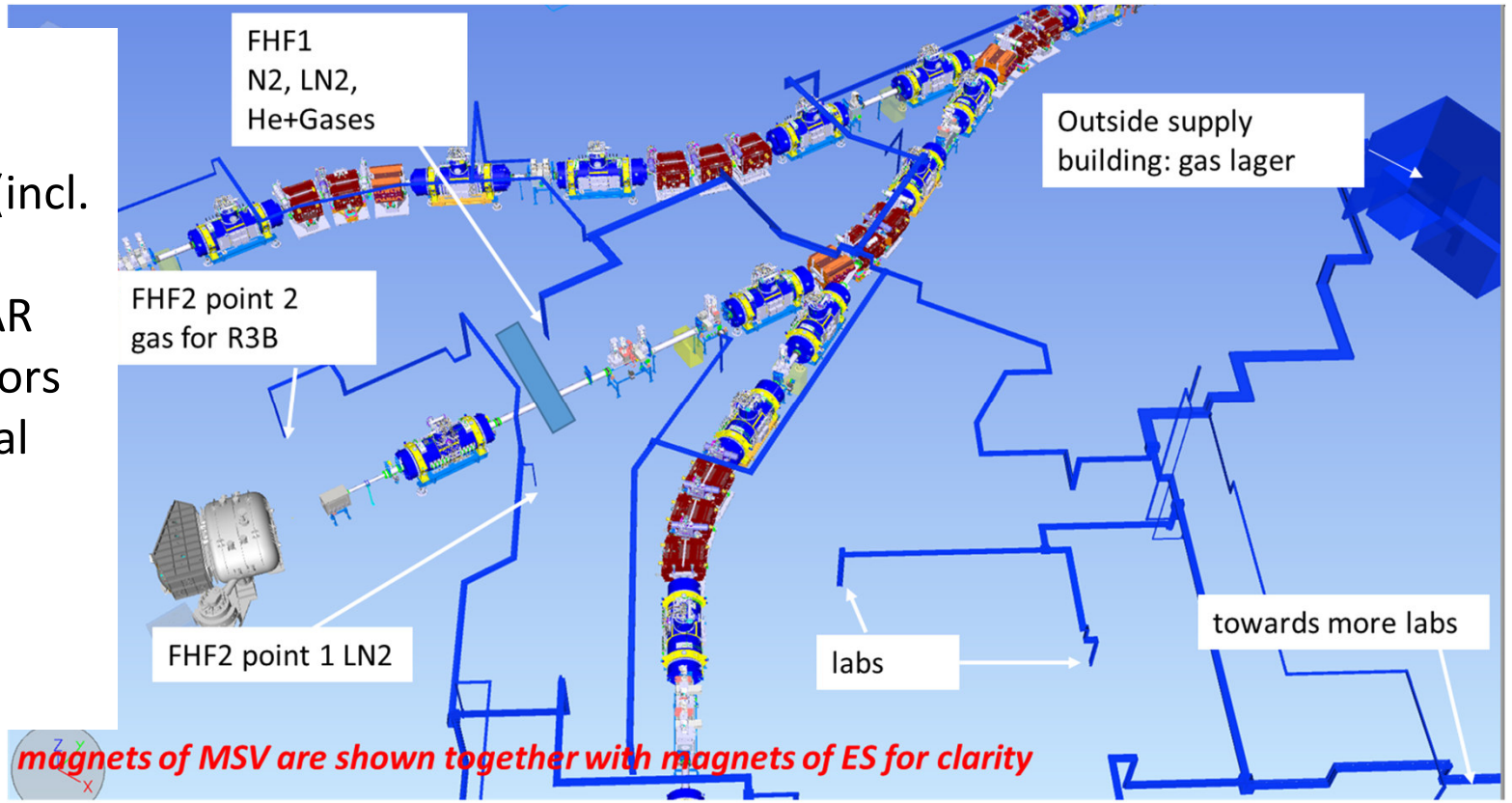
Technical Gas Supply

S. Pietri,
M.-M. Schmidt et al.

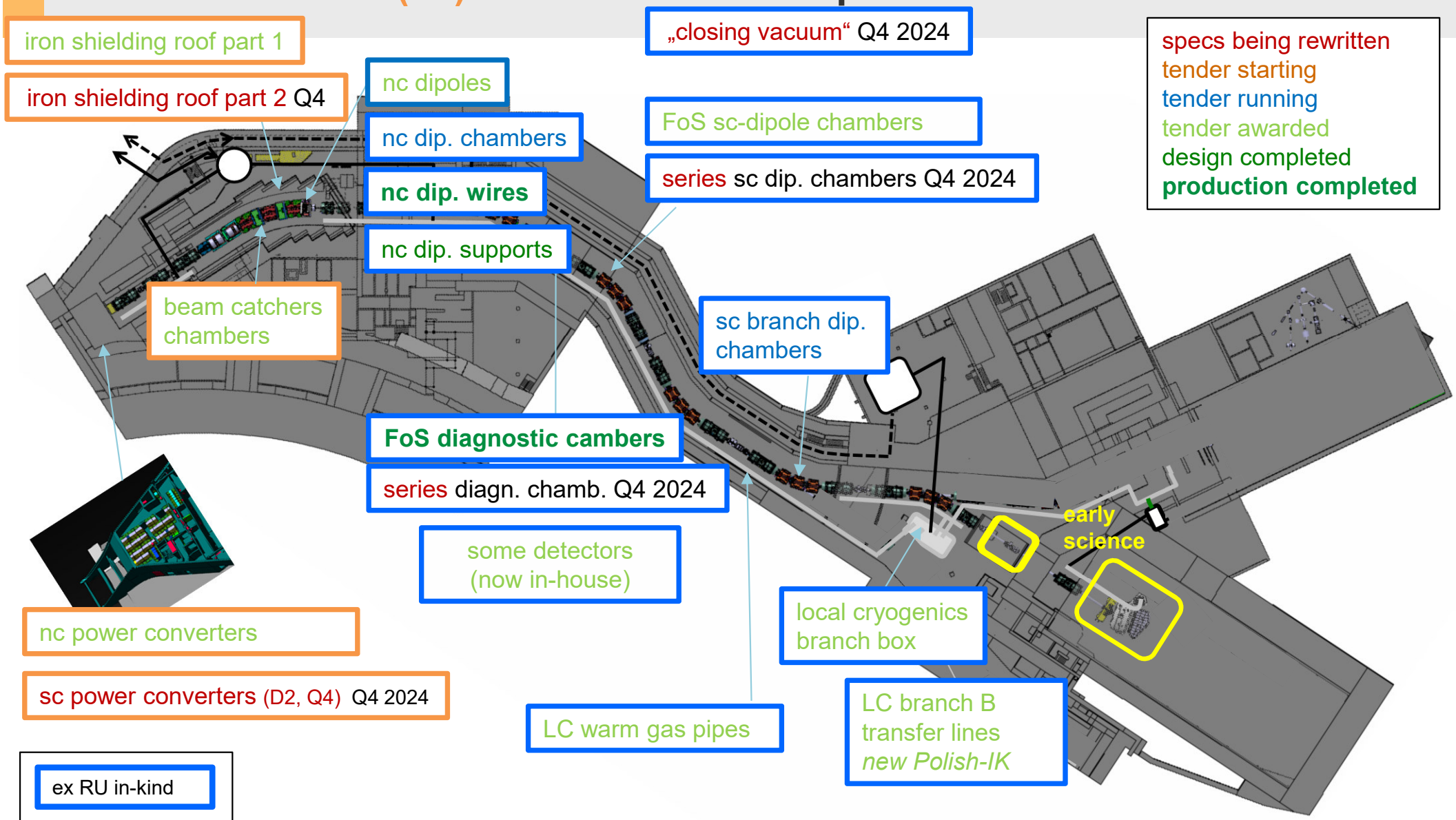
- Q4/2022 – Q1/2023:
  re-scoping of the Work Package to follow Early-Science/First-Science priorities
- Q2/2023:
  preparing call for tender; opening in 06/2023
- Presently:
  negotiations phase running

Work package includes:

- gas lager equipment
- piping up to the wall (incl. manifold)
- LN2 supply for NUSTAR
- gas pipes SFRS detectors
- gas pipes experimental collaboration
- exhaust pipes
- control
- safety



Summary of
ex-Russian and (ex) Indian in-kind components

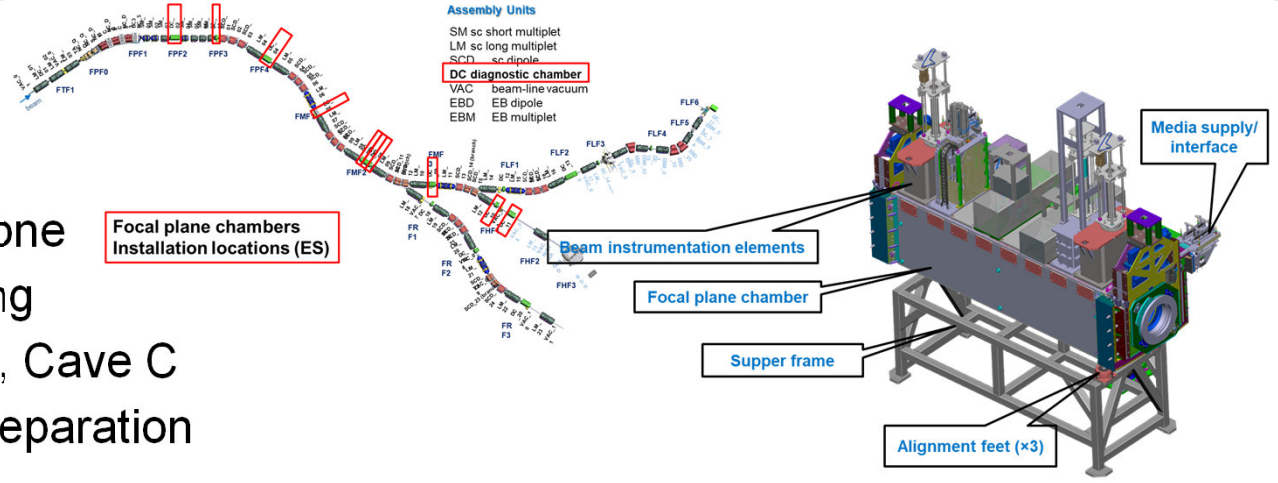


Special Vacuum
Focal Plane Chambers

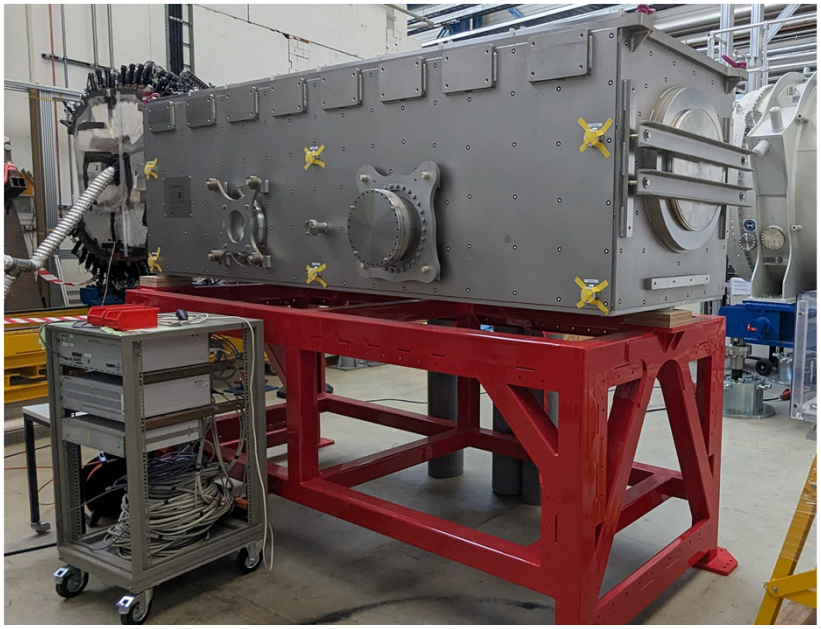
S. Purushotaman
M. Czogalik et al.

Status

- former Ru in-kind
- ✓ 2 FOS chambers delivered, SAT done
  - ➢ FPF2DK1: Pre-Assembly training
  - ➢ FMF1DK1: beamtime test 2023, Cave C
- ➢ Series chambers (ES): Specs in preparation



FMF1DK1 Installed at cave-C for beamtime Dec 2023 of beam diagnostic elements



FPF2DK1 Installed at target hall for SAT and Pre-Assembly training

Special Vacuum

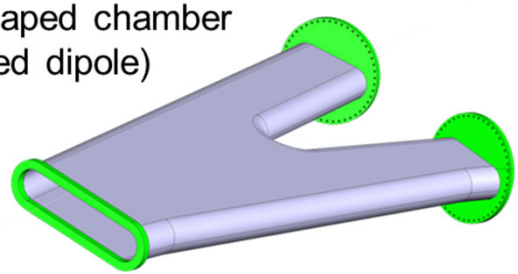
Magnet Chambers, pipes, etc.

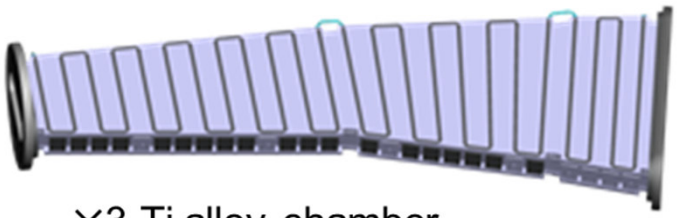
S. Purushotaman
N. Kurichiyanil
H. Weick et al.

Status

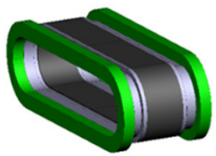
- former Ru in-kind
- 2 FOS SC dipole chamber: in production
- Series SC dipole chambers (ES): Specs in preparation
- Y-shaped dipole chambers: tender running
- NC dipole chambers: ready for award
- Beamline elements (ES): Specs in preparation

×3 Y-shaped chamber
(branched dipole)

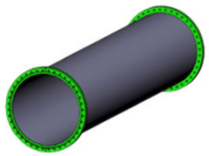




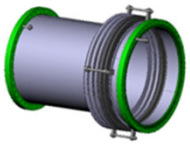
×3 Ti alloy chamber
(NC dipoles in target area)



× 3 ractrack/rectangular edge wlded bellows



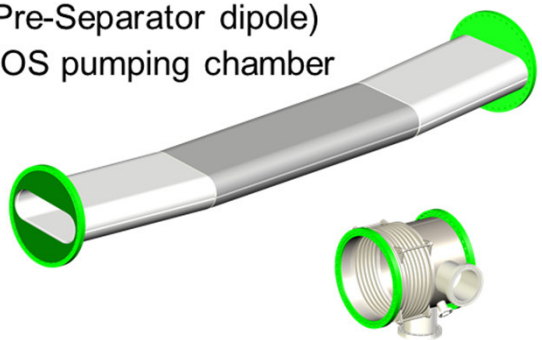
× 19 beam pipes



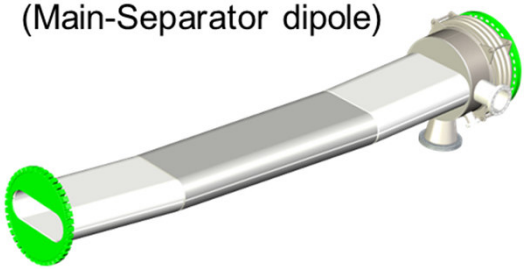
× 19 hydroformed bellows

× 19 Pumping chambers

FOS 11° chamber
(Pre-Separator dipole)
FOS pumping chamber



FOS 9.75° chamber +
integrated pumping port
(Main-Separator dipole)



Target Area

NC magnets and support frames

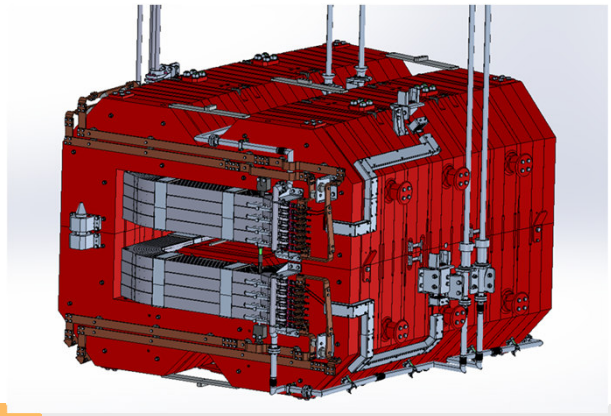
H. Leibrock,
H. Weick
T. Blatz et al.

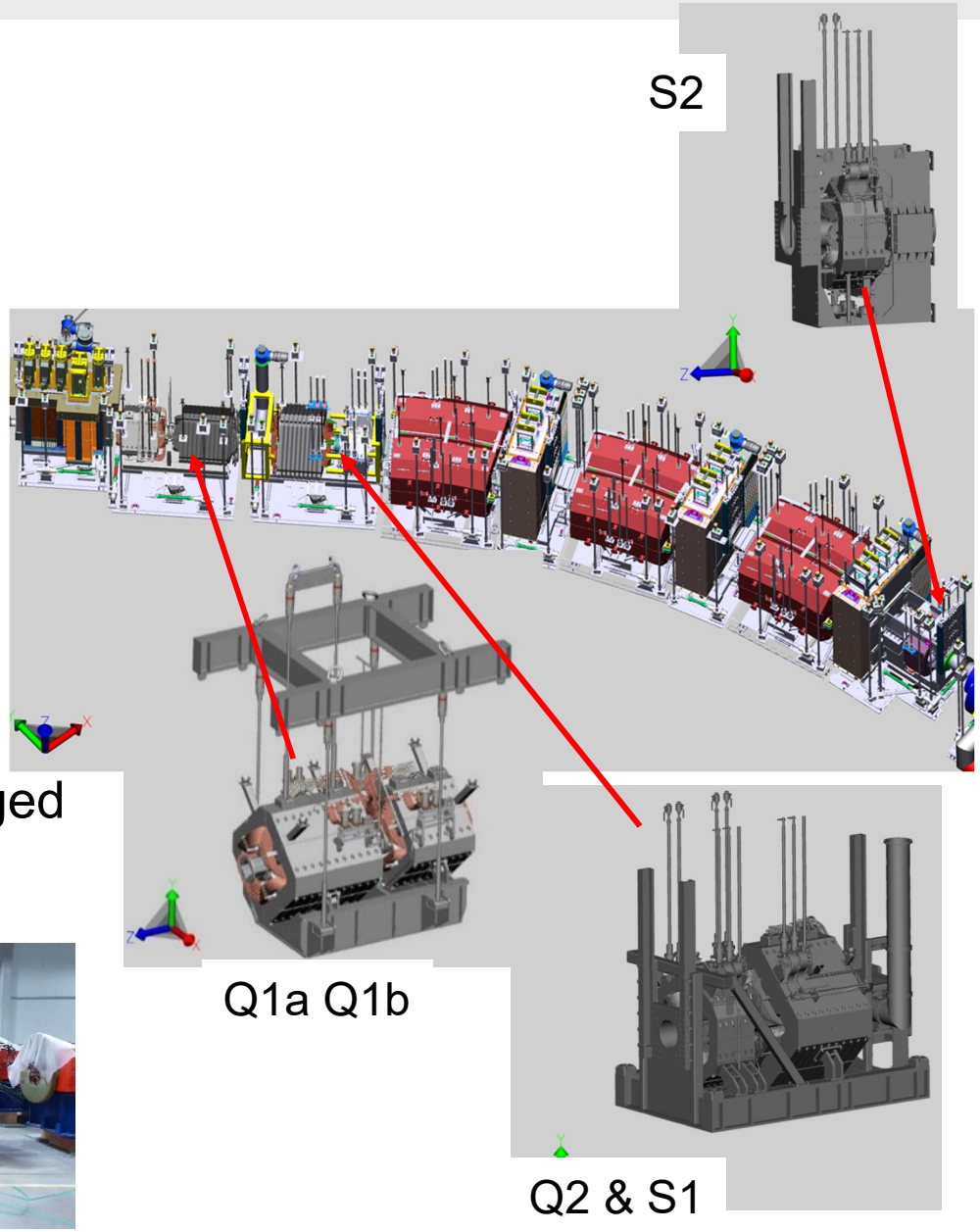
NC multipoles (3 quads, 2 sext):

- ✓ Manufacturing (Buckley Systems, NZ)
- ✓ MIC Cable (procured, Hitachi, Jp)
- • Module 1: S2 (FDR completed)
  → manufacturing started
- • Module 2: Q1a & Q1b (FDR running)
- • Module 3: Q2 & S1 (advanced model)

NC Dipoles:

- ✓ Contract signed (Sigmaphi, Fr), **08/2023**
- ✓ MIC Cable (re-procured, nVent, Ca)
  - o few delivery damages → cables exchanged



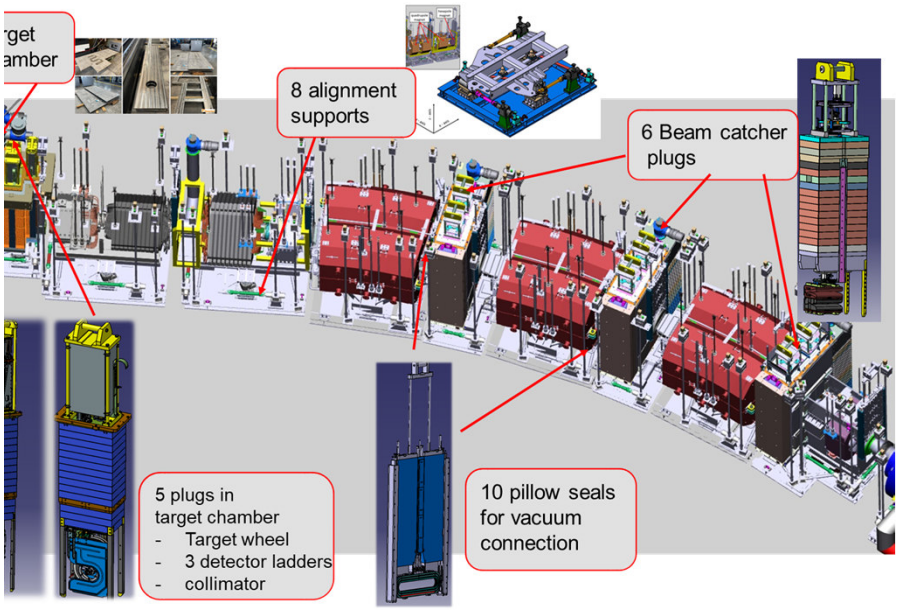


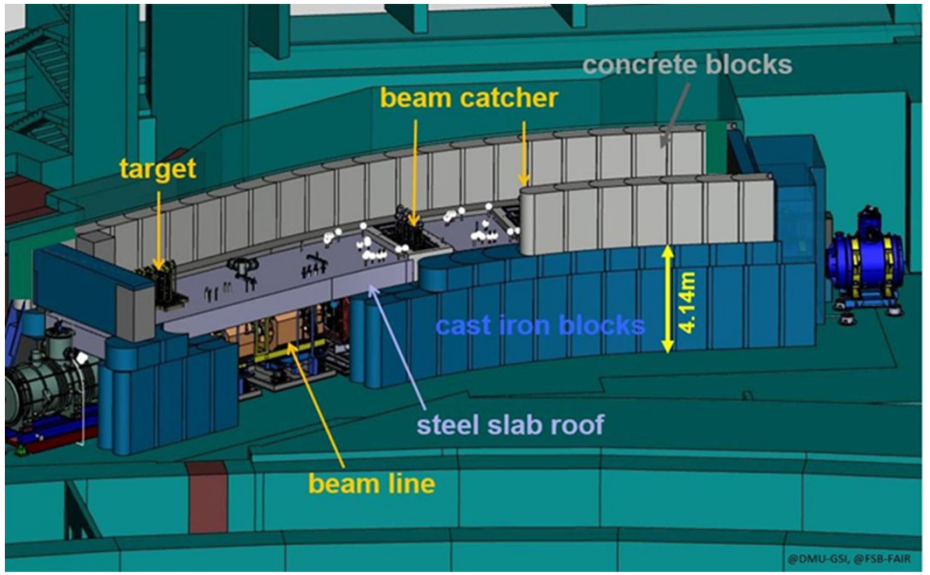
Target Area

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

Procurement Status:

- ✓ Target chamber + Plugs: **awarded** (Fantini)
  manufacturing started
- ✓ Pillow seals: **awarded** (Mewasa),
  FDR running
- • Pillow seal plugs: ready to be awarded
- ✓ Beam catcher + Plugs,
  in-kind India: **awarded** (Trident),
  FDR running
  Plan B FAIR: **awarded** (NTG),
  FDR running
- ✓ Alignment supports: **awarded** (Fantini),
  manufacturing started
- ✓ Iron roof shielding (ex India in-kind)
  Lot 1 (end sections): **awarded** (Coswig)
  Lot 2 (middle section): tender in preparation





Beam Instrumentation

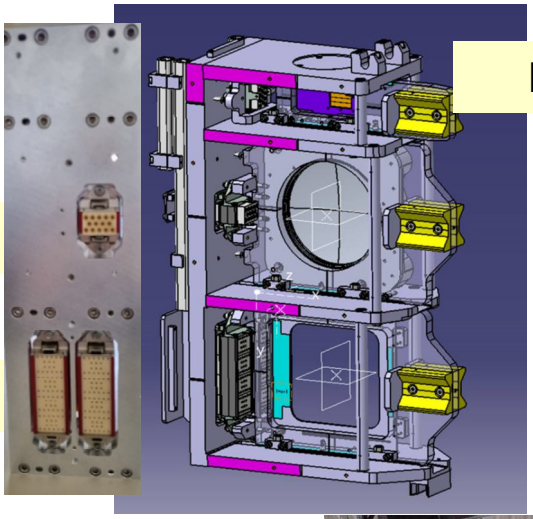
C. Nociforo, T. Blatz,
M. Czogalik, M. Alfonsi,
J. Galvis Tarquino et al.

- Particle Detector Combination (FAIR in-house)
  - ✓ FPF4 under production
  - ✓ FPF0 ladder under test
- Slit System (KVI)
  - ✓ FAT/SAT series ongoing
- Beam Stopper (Axilon)
  - ✓ FAT running
  - ✓ visit soon
- Drive control (Chalmers)
  - ✓ test with slits ongoing
- Diamonds (ex-Ru →FAIR in-house)
  - ✓ FDR in preparation (Q1/24)
  - ✓ FPF0 PCB ready
  - ✓ drive design (FPF4) ongoing
- Plastic scintillator (ex Swe → FAIR in-house)
  - ✓ vacuum test of the PMTs done
  - ✓ FoS manufactured
  - ✓ to be tested in Q4/23 with beam

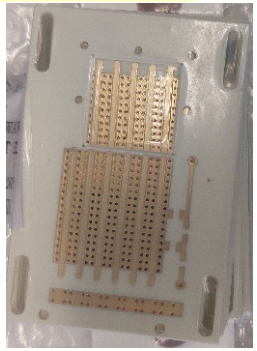
mock-up

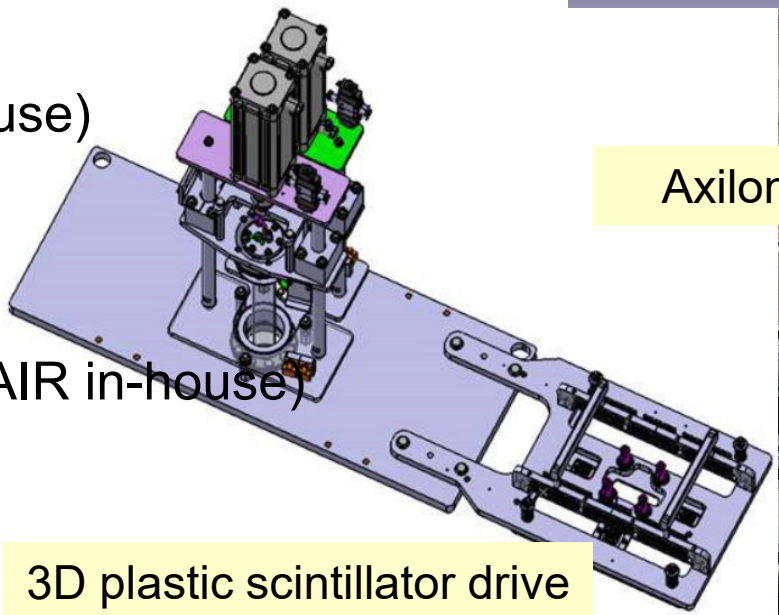
SEETRAM

SEM



Diamond





3D plastic scintillator drive

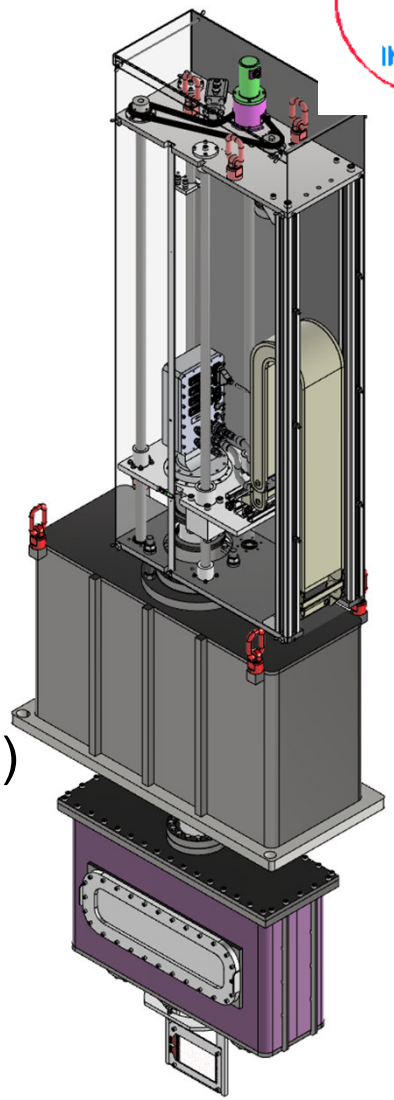
Axilon beam stoppers

Beam Instrumentation

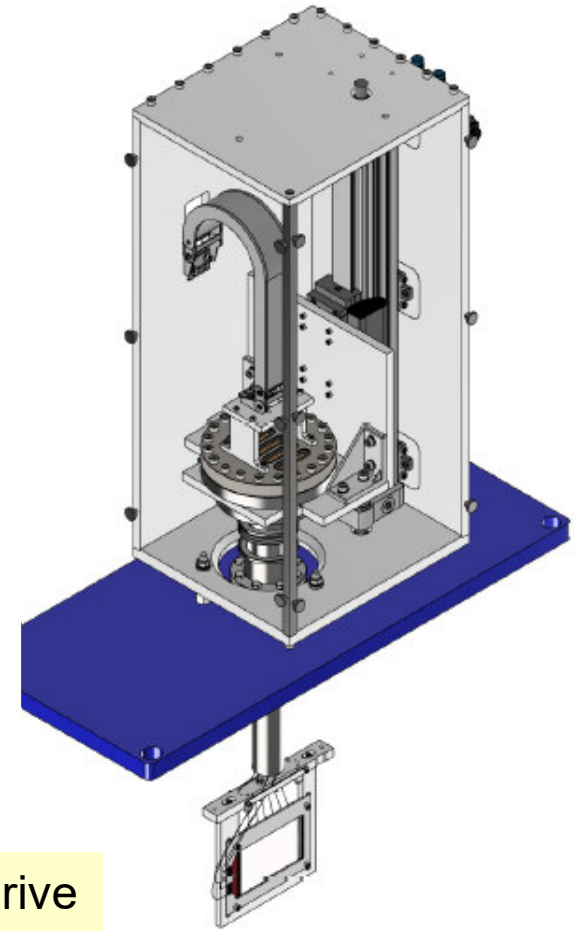
Finnish in-kind contributions

C. Nociforo, E. Rocco,
J. Galvis Tarquino,
B. Voss et al.

- MUSIC (energy-loss, Uni Jyvaskyla)
  - ✓ FoS detector under test in clean room
  - ✓ drive optimization ongoing
  - - in-beam test to be performed ?
- SEM Grid (profile monitor, HIP)
  - - FDR not ready yet
  - - FoS delivery expected by ?
- GEM-TPC (tracking)
  - - CDR in preparation
  - - Steering meeting at HIP (15-16 Sep 2023)
- Position drive (HIP)
  - - CDR 2nd review (Q4/23)
  - - 2 FoS units under production (Q4/23)
  - - vacuum window to be tested ?



3D model SEM drive



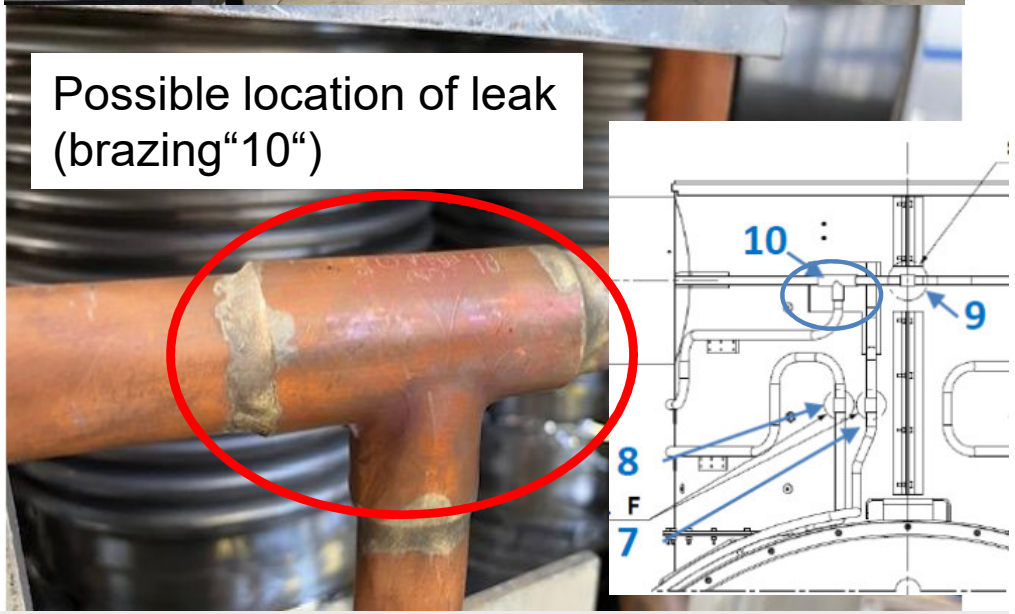
3D model position drive

SC Multiplets

E.J. Cho,
H. Müller et al.

- ✓ **FAT completion at ASG SpA:**
  - ➢ 7 short multiplets **(= all SM)**
  - ➢ 9 long multiplets.
  - • FAT for 14 multiplets was approved
  - • FAT for 2 multiplets are under review.
  - ➢ This corresponds to about **75 %** of required multiplets **for ES**

- ▪ **He leak in thermal shield circuit was detected during SAT in Q3 2023**
  - • LM11 will be shipped back to ASG for root cause analysis and repair.
  - • GSI-CERN-ASG Task Force established in order to review
    - • TS design, TS Cu brazing method
    - • Quality control of brazing, Resolutions



SC Dipoles

H. Müller,
E.J. Cho et al.
CEA Saclay

Scope:

- D2: 3 x 11° **(3 ES)**
- D3: 18 x 9.75° **(10 ES)**
- branched dipole, 3 x 9.75° **(2 ES)**

Provider:

- Elytt, Bilbao, Sp

Production Status:

✓ SAT of FOS D2 and FOS D3

➢ Repair FOS D2 ongoing

1. chamfer fixation; method & tooling developed
2. TS leakages; new brazing method develop

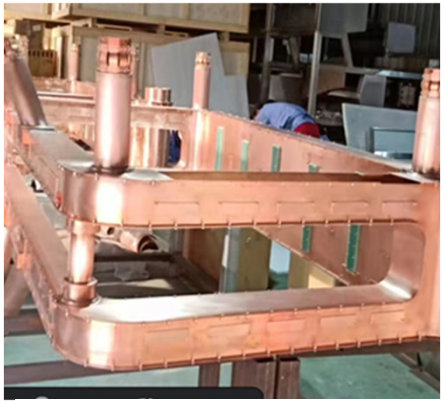
➢ measures will be applied to all other dipoles

- FOS D2: after applying (1) → shipping to GSI
- FOS D3 after applying (1) & (2) → re-SAT CERN
- Series production running
  - ➢ 3rd D3 assembly ongoing, FAT expected 10/2023
  - ➢ 2nd D3 HV insulation repair, assembly ongoing. FAT expected 11/2023
  - ➢ branched dipole production started.

TS joint repair

Closed window on vacuum vessel

HV-insulation repair (He-vessel opening)



TS of branched dipole

Finished dipole yokes

EB Dipole
design phase CEA

H. Müller et al.
CEA Saclay

Status / Schedule:

- ✓ final documentation delivered 06/2023
- ✓ review and release 07/23
- ➢ contract terminated since not ES relevant

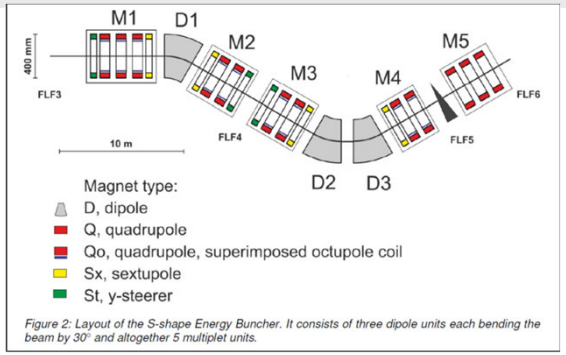
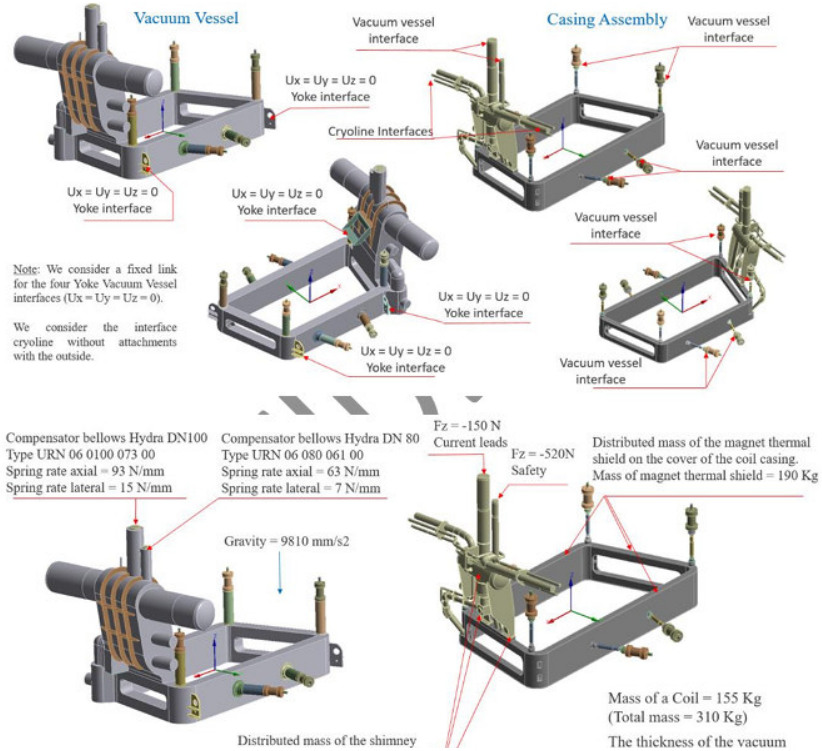
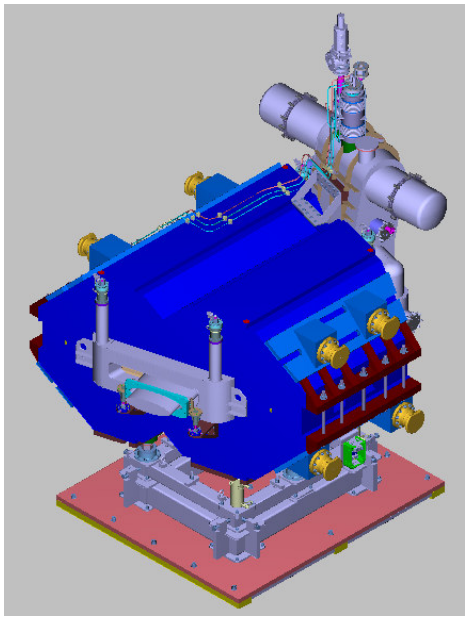


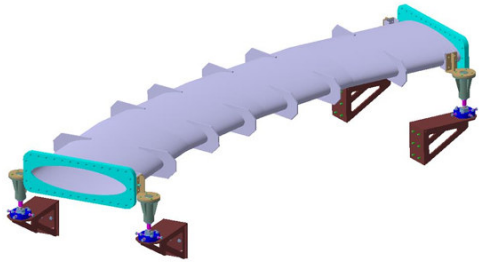
Figure 2: Layout of the S-shape Energy Buncher. It consists of three dipole units each bending the beam by 30° and altogether 5 multiplet units.

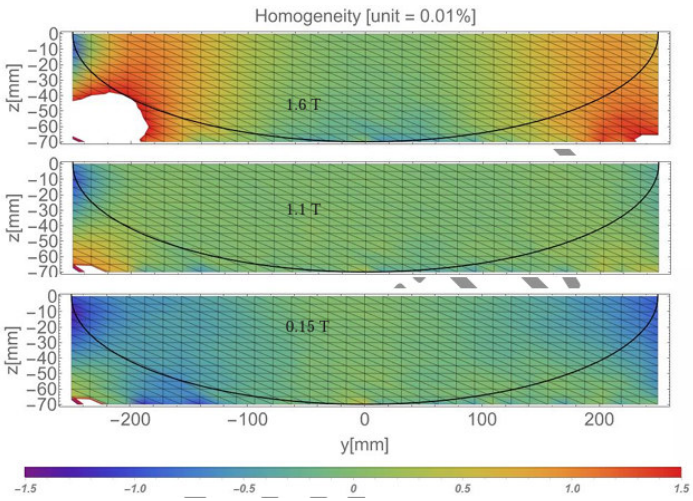
✓ field quality

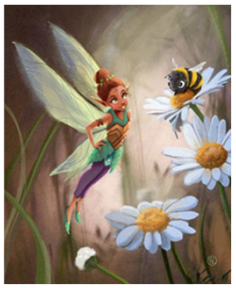


Full model of cryostat
vacuum vessel, casing assembly, CW supports









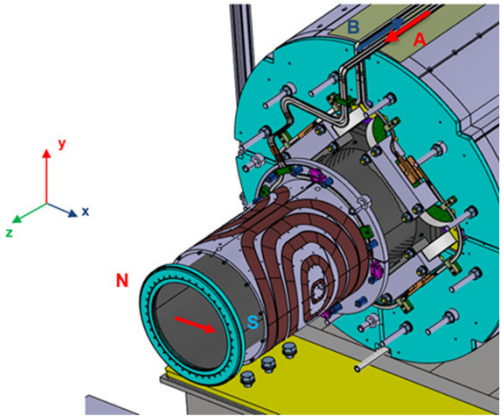
CEA proposal
FAIR EB →
Fairy-bee

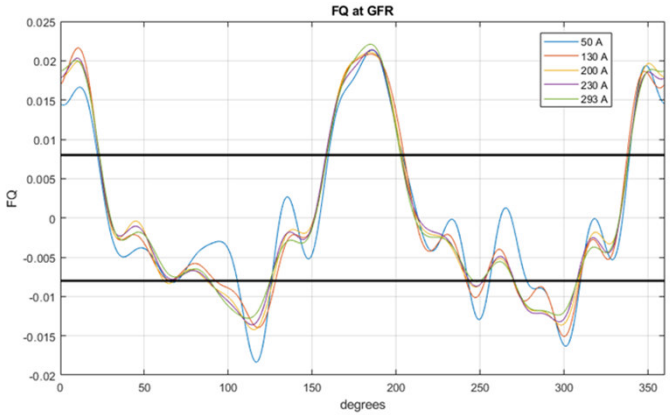
edits: Lidia Hajdu
https://www.artstation.com/artwork/PoDAX4

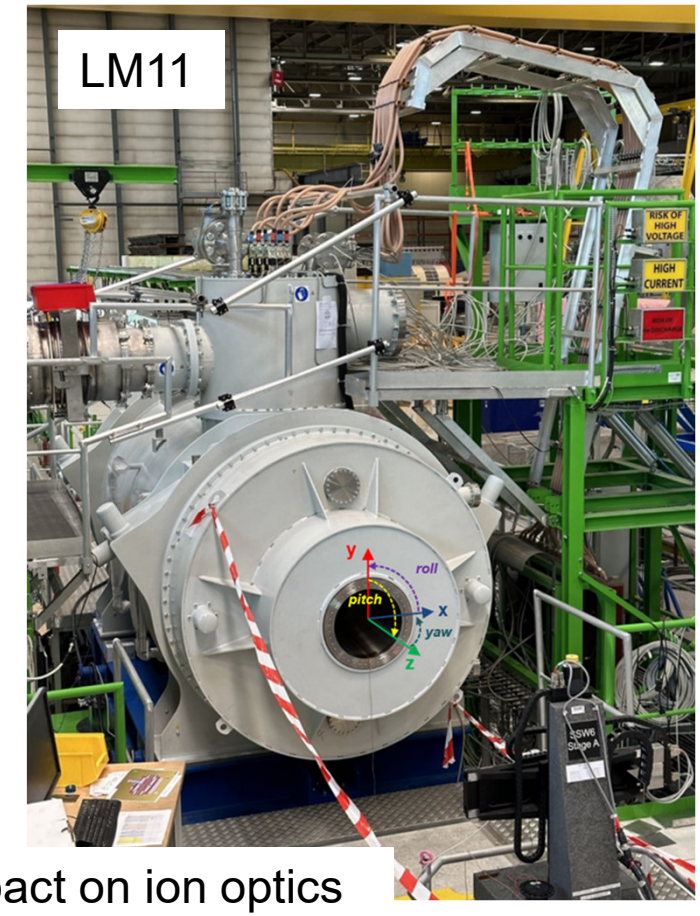
Magnet Testing @ CERN

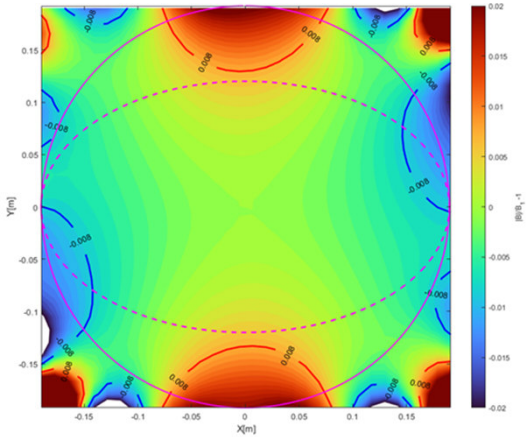
K. Sugita
P. Kosek et al.

- ✓ Series multiplet testing running ‘routinely’
  - in particular qualifying steerer FTF1KH01 and FTF1KV01
- ➢ D3 dipole (FOS) testing expected for 11/2023
- Test manager (GSI) left for INFN









Harmonics analysis → check impact on ion optics

I	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
[A]	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}
293.0	-3.62	134.08	-0.28	57.19	0.29	21.72	-1.71	15.23	-2.63	-11.73	-1.95	-13.14	-4.31	-2.17

I	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15
[A]	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}	10^{-4}
293.0	-1.57	-18.10	-2.14	10.11	2.42	-8.81	0.24	0.60	-0.30	-1.60	1.53	2.10	1.22	-3.97

Pre-Assembly
SC Magnets

V. Velonas
F. Kaether et al

- Pre-assembly location: GSI target hall
- Storage location: hall BE42

✓ Pre-assembly completed:
- FOS LM, FOS SM, SM08, SM01, SM06

➢ Pre-assembly running:
- SM03

Overall coordination by SCM (GSI)

➢ **TRI (GSI)**
Transportation, N2 filling

➢ **IFJ (Krakow), in-kind**
BP cleaning, vacuum tests, integration of: power box, PC strain relief, proportional valves, terminal boxes, assembly / disassembly of transportation rods

➢ **SCM (GSI)**
integration sensor cable strain relief, electrical tests

➢ **NCM (GSI)**
Geometrical tests, feet tests

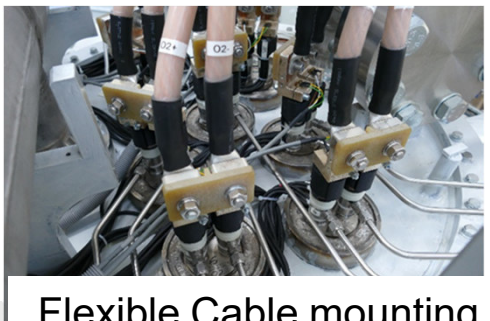
➢ **SMG/SCM**
Documentation → release for installation


GSI target hall


Storage BE42

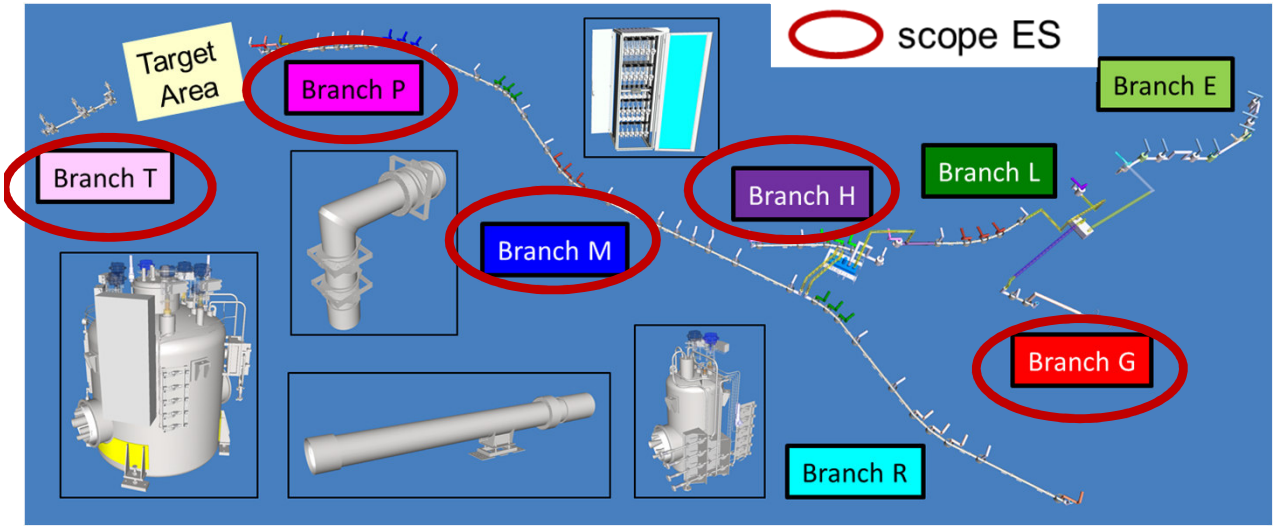

FOS LM


strain relief system


Flexible Cable mounting

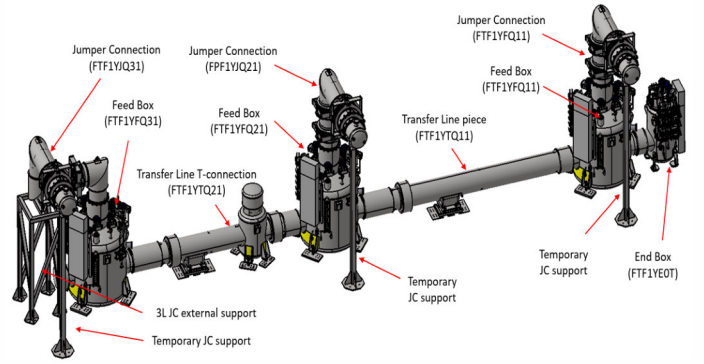
Local Cryogenics
WUST Activities

F. Wamers, Y. Xiang,
D. Schad, A. Weber,
H. Kollmus, et al.



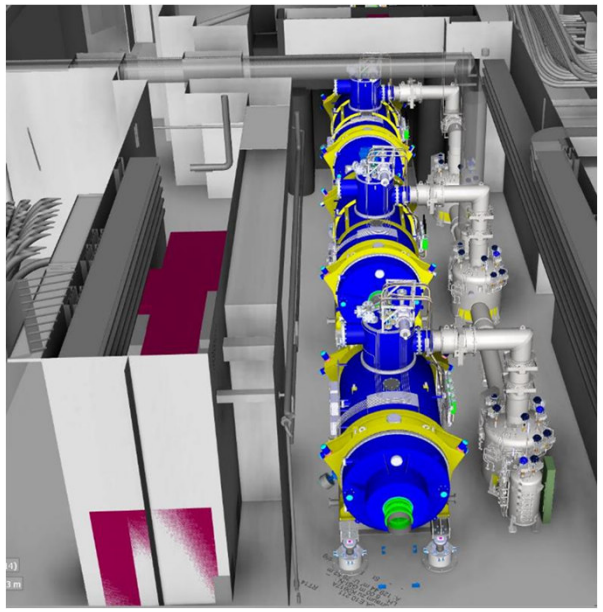
Local Cryo T Branch

- ✓ **awarded 08/2013: Inox India**
- ➢ FDR expected Q1 2024



Conceptual Designs (CDR)

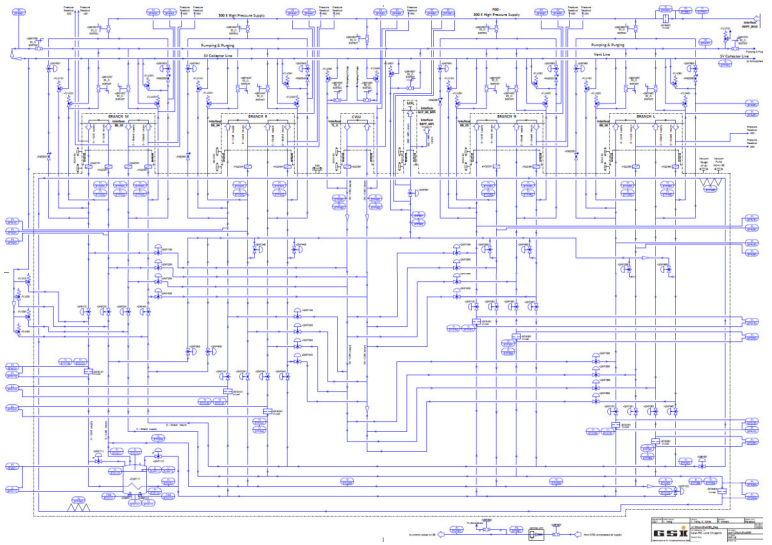
- Multiplet Feed Boxes (standard) (completed)
- Multiplet Feed Boxes (Branch-End) (completed)
- Dipole Feed Boxes (completed)
- End Boxes (completed)
- Transfer Line Pieces (in progress)
- Branch Hydraulics and SVs (completed)
- Jumper Connections (completed)
- Branch Mechanics and Electrics (in progress)
- NUSTAR – LEC (Energy Buncher) (not Early Science)

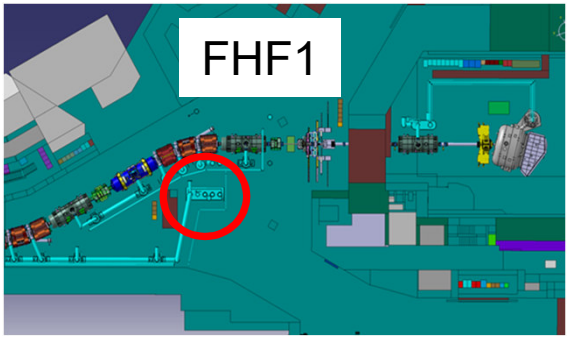


Local Cryogenics (Branch Box)

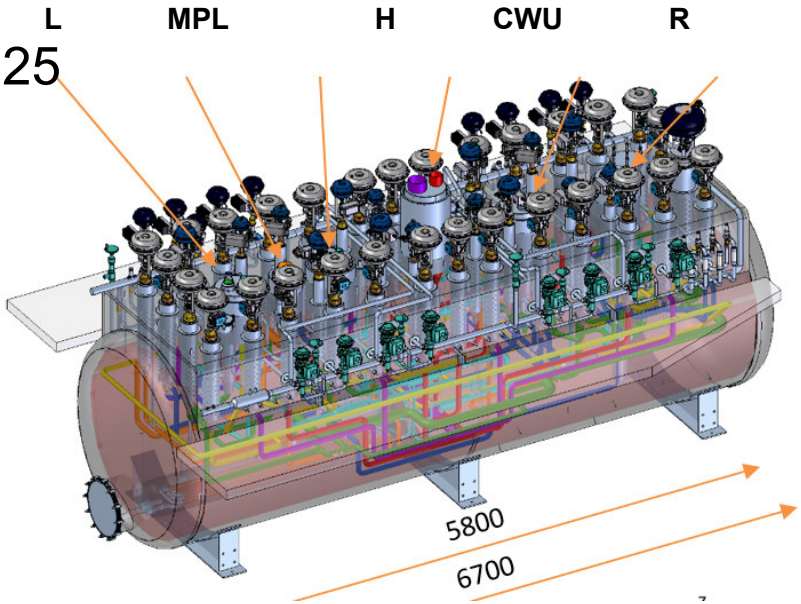
F. Wamers,
Y. Xiang,
D. Schad,
H. Kollmus, et al.

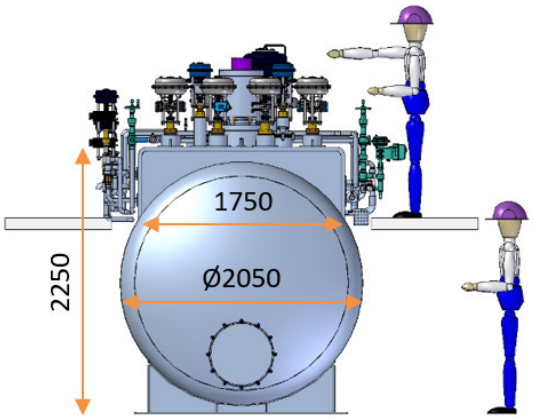
- former Ru in-kind
- ➢ independent operation of Branches with CRYO2 and/or CWU
- ➢ high operational flexibility of Cryo Branches
- 45 cold valves
- ~15.5 tons, mostly stainless steel
- ~ 2.5 m diameter, ~ 6.7 m length
- ✓ Industry contract: April 2023
- PDR: running;
- Installation planned: Q1 2025



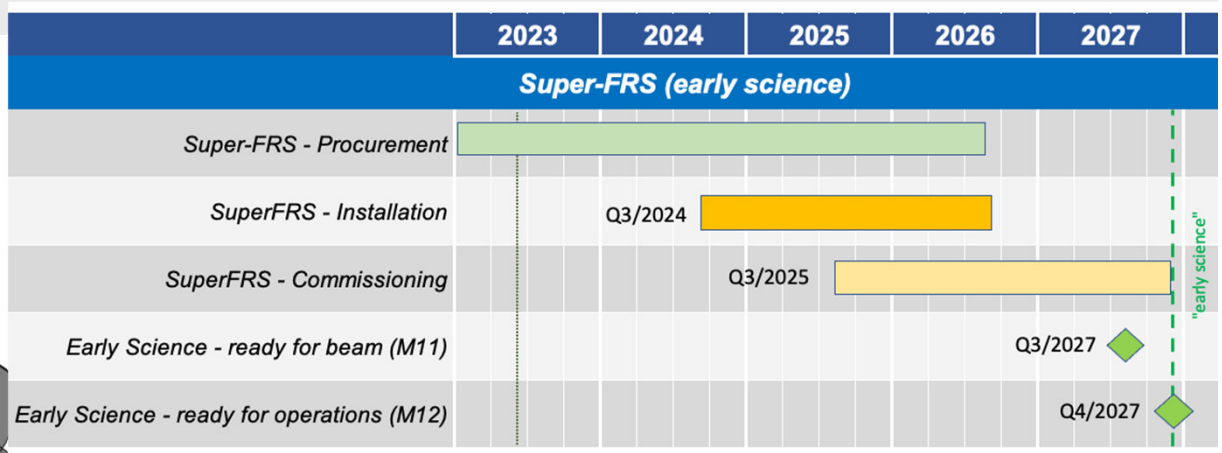


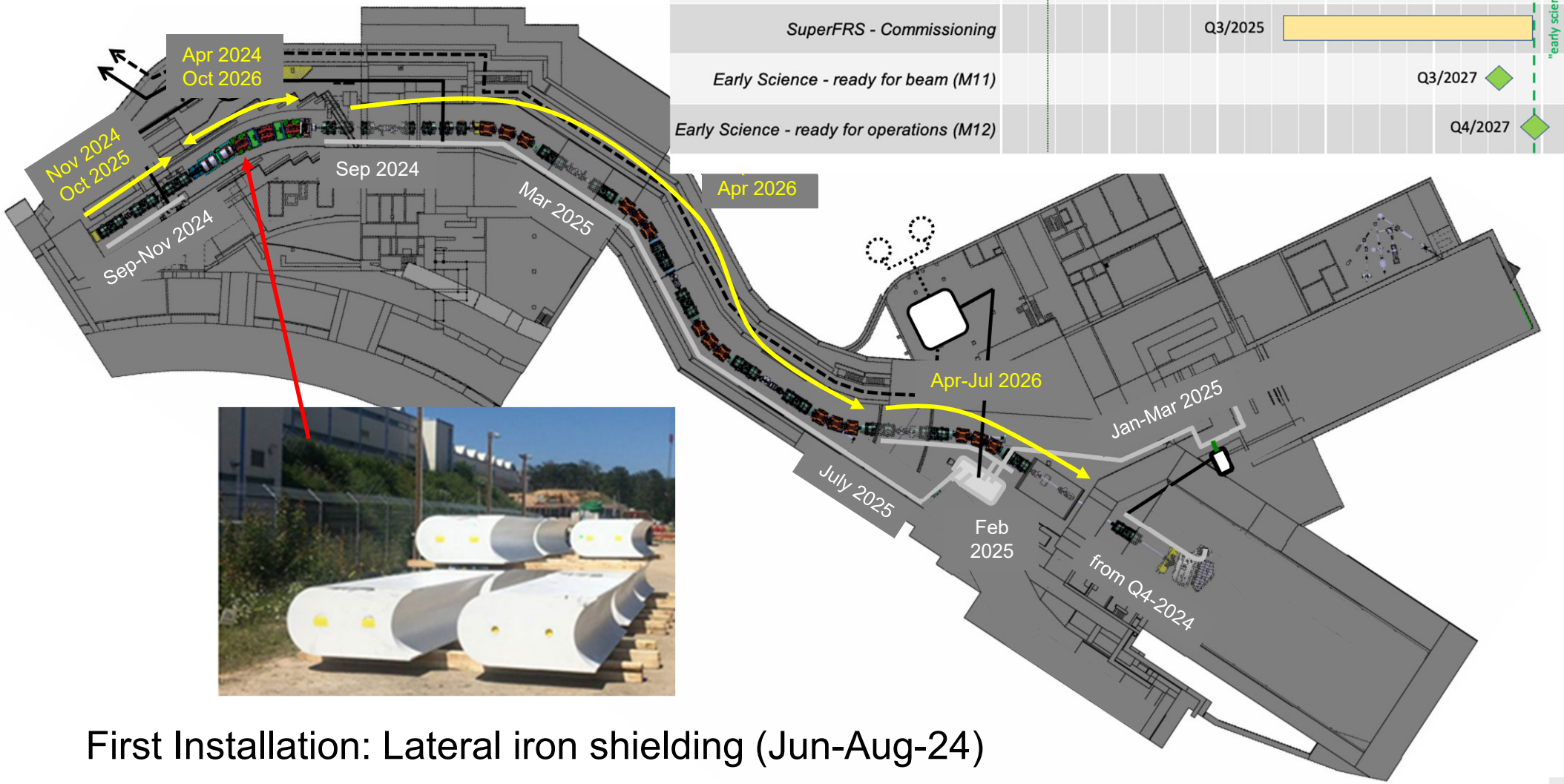
DEMACO





Installation Schedule





First Installation: Lateral iron shielding (Jun-Aug-24)

Commissioning phases for ACC

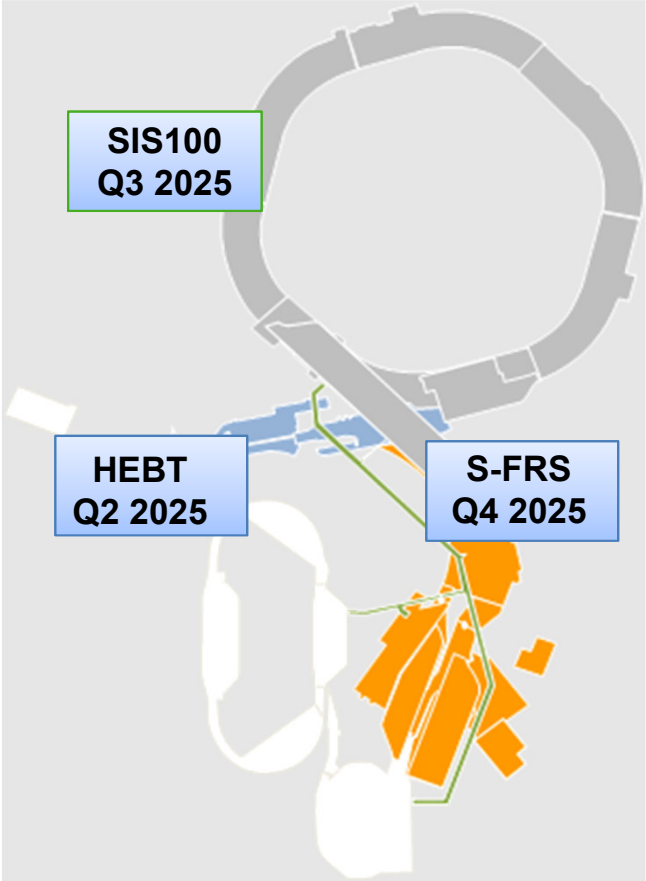
inst.

Commissioning without Beam

Beam Commissioning

#	commissioning stage	accelerators & transfer lines	detectors
1 (M??)	local HW-commissioning	• **local system tests** in tunnel and supply areas • Special cable connections by system experts • **Control system not needed** (only in limited aspects)	• single detector tests • tests of individual components • install. service & controls
2 (M??)	remote & system commissioning	• **single system test** (vertical system integration test) • **remote testing** from MCR (sequences, checklists) • **control system integration of the system and timing is needed**	• system tests (with HV, gas, ...) • pre-test of DAQ system • local control
3 (M11)	integration	• (3.1) multi system tests & (3.2) full Dry-Runs • control system and accelerator models for pilot beam scenarios fully available	• full detector test and DAQ using cosmics
4 (M12)	pilot beam commissioning	• commissioning with pilot beam	• commissioning with pilot beam
		handover to operations	
	beam commission & operation	• operation with PCP-beam respectively status quo beam • development towards nominal intensities • commissioning of advanced systems	

Start of ACC Commissioning



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

Summary

- Shell construction for Super-FRS buildings almost ready
- Start of technical infrastructure (TGA) installation foreseen for Q1 2024
- All major ex-Ru in-kind mitigated; in particular procurement of NC dipole magnet awarded in 08/2023
- Good progress in multiplet production (75% of ES), however, recently some Non Conformities related to thermal shield leakages (under mitigation)
- Non Conformities of sc dipole magnets cured; SAT testing expected to restart in Nov. 2023
- T-branch of local cryo system awarded ton Inox India
- Super-FRS installation start foreseen in Q3 2024 (lateral iron shielding)

Thank you for you attention !