Science Retreat
SuperFRS installation, testing and operation

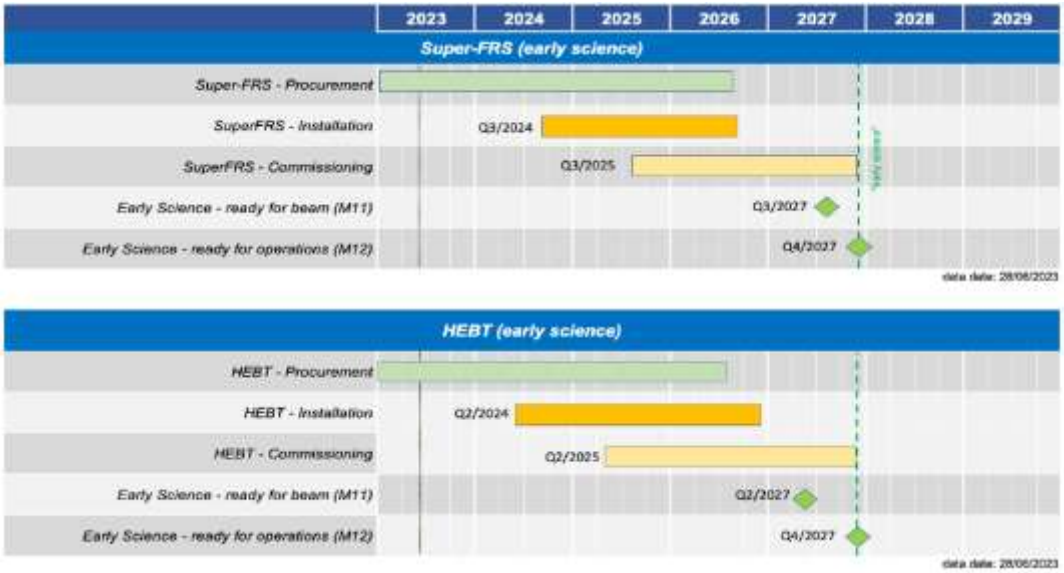
H. Simon

Results of Rebaselining

- Procurements
- Reprocurements (RU replacements, Delayed In-Kind contributions)
- Testing (SAT)
- Preassembly — Already ongoing for delivered components
- Installation — Mechanical Completion 08/2026
- Component commissioning → Dry runs
- Beam tests — in the course 2027

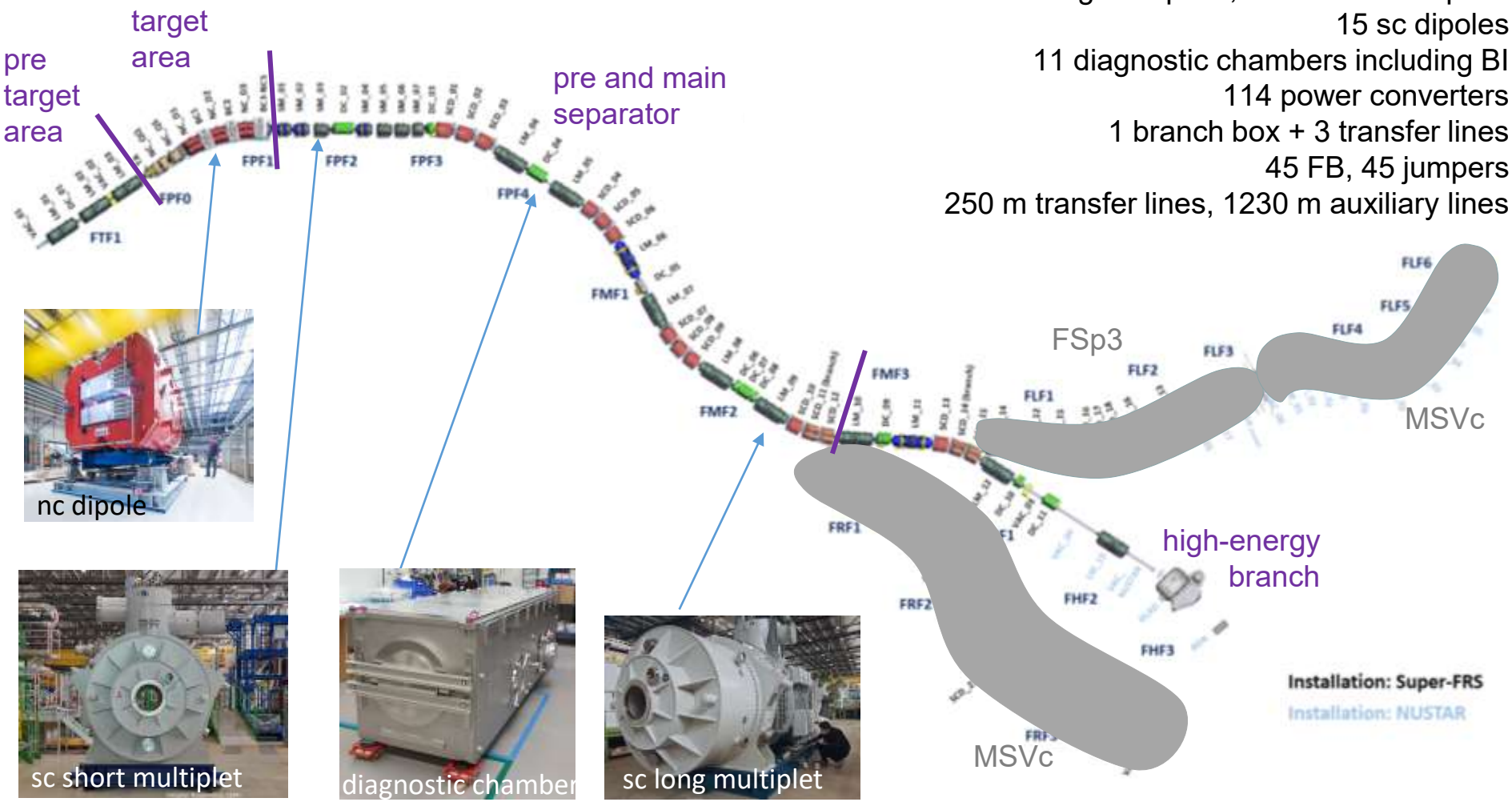
Activities are interleaved

Project interdependencies (especially with building construction are covered)

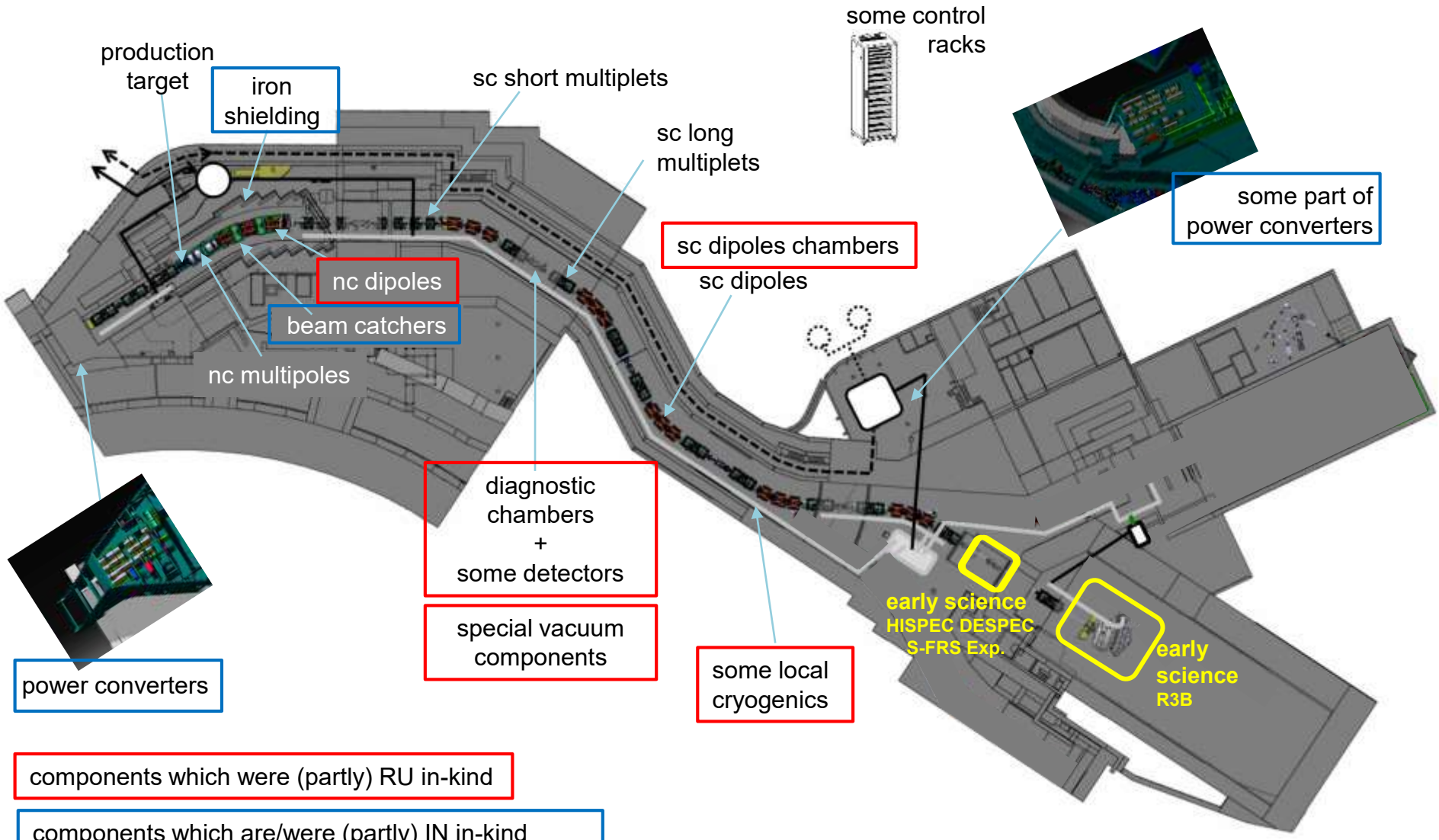


Scope for early science and installation blocks

3 nc dipoles, 1 target chamber, 3 beam catchers, 5 nc multipoles
13 sc long multiplets, 7 sc short multiplets
15 sc dipoles
11 diagnostic chambers including BI
114 power converters
1 branch box + 3 transfer lines
45 FB, 45 jumpers
250 m transfer lines, 1230 m auxiliary lines



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



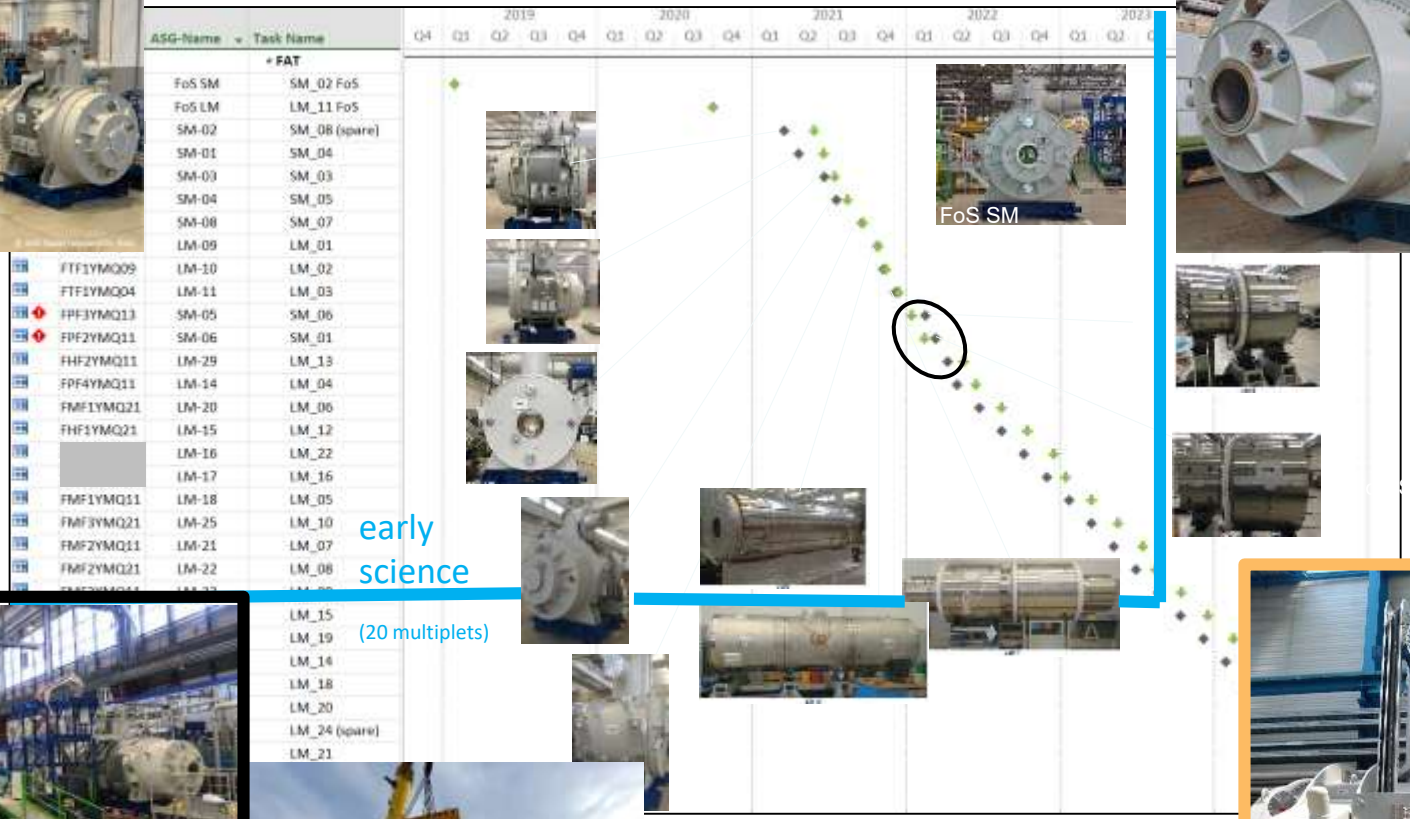
Status tenders of ex-RU components

component	tender status	re-writing specs for tender	contract award
NC-dipole wires	**delivered** (nVent Thermal)	done	done
NC dipoles	awarding phase	done	Q3-23
NC-dipoles alignment supports	awarded (Fantini)	done	done
NC-dipole chambers	awarding phase	done	Q3-23
FoS vacuum chambers SC standard-dipoles	**in production** (Omega Physics)	done	done
Series vacuum chambers SC standard-dipoles	budget foreseen in CB9	Q3-23	Q1-24
Vacuum chambers SC branched-dipoles	running	done	Q1-24
FoS (spares) Diagnostic chambers	**delivered** (Pfeiffer), **SAT done**	done	done
Series Diagnostic chambers	budget foreseen in CB9	Q3-23	Q1-24
pumping chambers	budget foreseen in CB9	Q4-23	Q2-24
supports for pumping chambers	budget foreseen in CB9	Q4-23	Q2-24
Branch Box	awarded (DEMACO)	done	done
Branch B transfer lines	in-kind PL (WUST, 06/2023)	-	in progress
Warm Piping System	running	done	Q4-23
MPL 1-channel lines	running	done	Q4-23
ToF detectors (replacement)	in-house production (budget in CB9)	-	-
IPM (ex BPM)	In-house assembly; main part ordered	done	-

Status of Indian in-kind components

component	tender status	re-writing specs for tender	contract award
Beam catcher chambers (plan B)	awarded (NTG)	done	done
Power Converters for nc magnets	withdrawn, awarded (signature phase)	done	Jul-23
Power Converters for sc magnets (D2 and Q4)	announced to be partially withdrawn, expected reduction of sharehold share, budget foreseen in CB9	Aug-23	Q1-24
Power Converters for sc magnets (C3)	confirmed by India, but budget foreseen in CB9 in case of delays with possible reduction of sharehold share	Sep-23	Q1-24
Iron roof	announced to be withdrawn 07/2023, expected reduction of sharehold share, budget foreseen in CB9. Critical pieces: tender already running Next critical pieces to be tendered	done done	Q2-23 unclear
Beam catchers (all)	IN provider awarded the tender to sub-contractor, but IK contract still missing (Vacuum chambers in procurement)	-	(IK) Jun-23

Status: Example for major component: sc multiplets - Procurement → Testing → Preassembly



early science

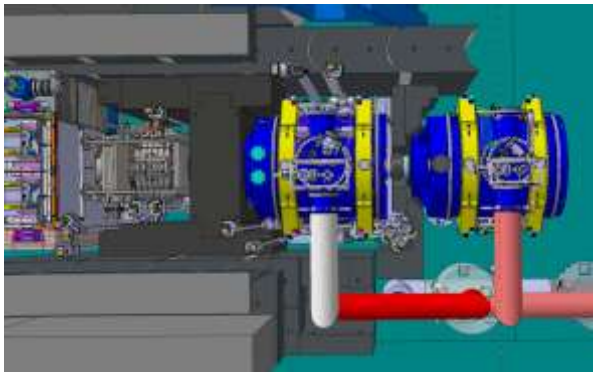
(20 multiplets)

First-of-Series Magnets readily prepared for tunnel installation

Critical Path analysis

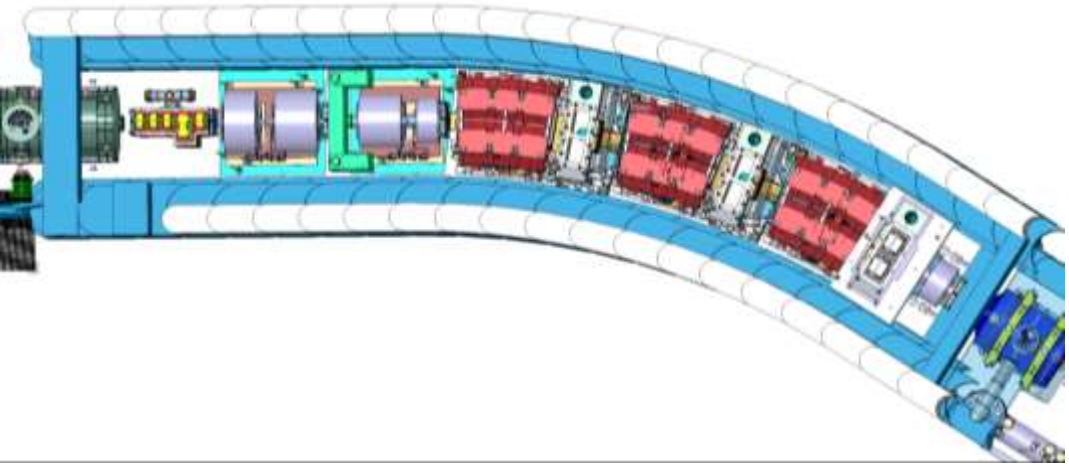
critical path:

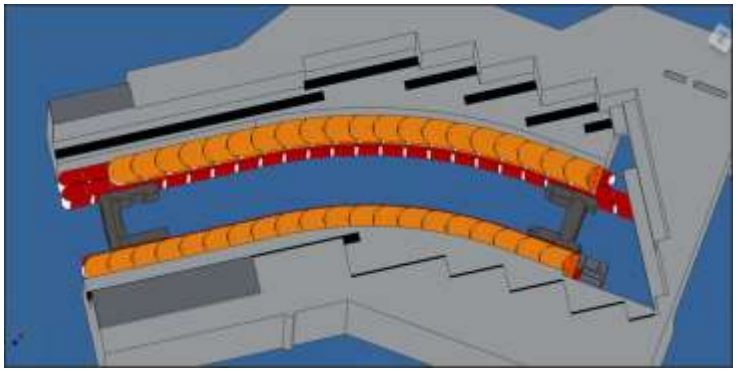
- nc dipoles (ex RU)
  mitigation: new FAIR tender published; proposed deliveries January and March 2025
- iron roof (Indian IK to be returned); installation: Sep 2025 (before TGA in target area)
  mitigation: FAIR tender prepared
- iron at entrance and exit (installation: June 2024)
  mitigation: FAIR tender



mitigated:

- beam catcher chamber (plan B, awarded)
- ncDipole cable (delivered) + stands (awarded)
- ncDipole Ti chamber (procurement dep.)
- nc magnet PCs (returned IK, tender running)





Critical components in tunnel

critical path:

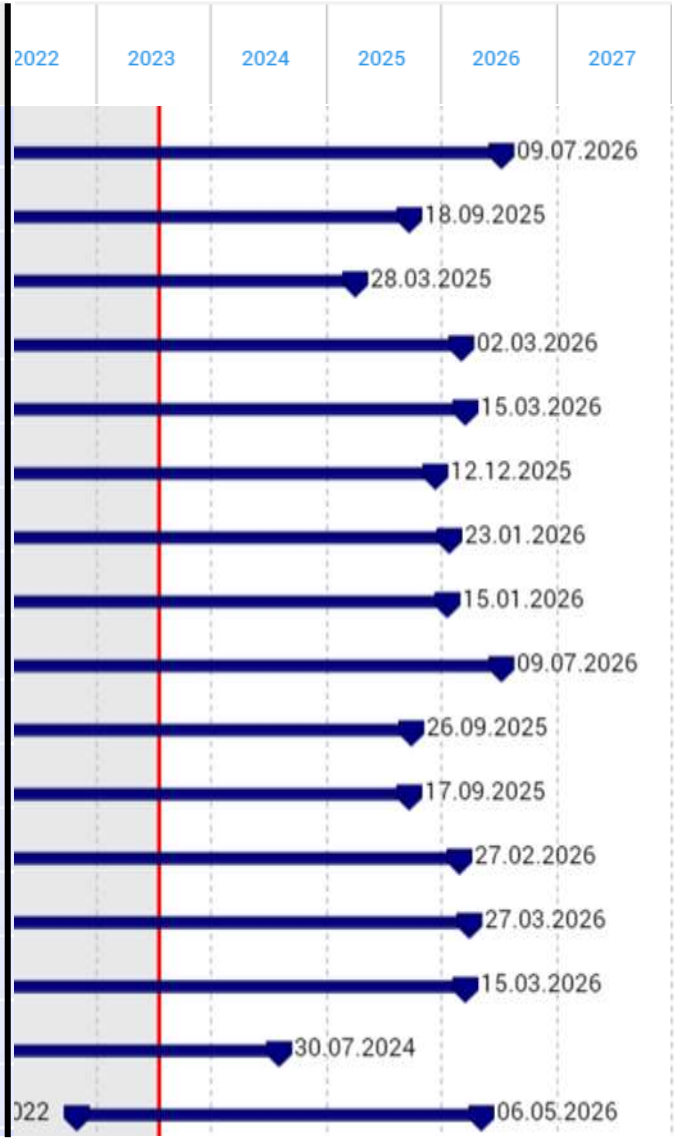
- sc magnet testing (SAT) at CERN extended testing phase
  mitigation: adaptation of installation sequence and test program
- sc dipoles manufacturing rate
  mitigation ongoing via double production shift (expediting at manufacturer)
- SE/FIN detectors (tracking detectors with drives / MUSIC): production schedule and technical difficulties
  mitigation: production of main series (MUSIC:2) via own resources, Sci-Fibre (Plan-B:14)
- local cryogenics components: (expediting at university)
  - Harmonized proposal to WUST with dedicated scope (COM, SIS100, Super-FRS)
  - Own tender of time critical components with many building interfaces
- sc magnet PCs (Q, D) (expediting at manufacturer)
  - Q,D supplies potentially outside Indian finances – return and own tender requested
  - India announced in July council to revisit package again – partial return expected and own tender prepared
  - Corrector (S,St,O) supplies arrive late 2025

mitigated:

- local cryogenics components:
  - Branch Box (ex RU): FAIR tender awarded to DEMACO
  - auxiliary lines (ex RU): FAIR tender
- diagnostic chamber prototypes (2/11) delivered
- standard dipole chambers close to CDR (2/13)
- BPM (ex RU) replaced by IPM (in house BEA)

Super-FRS availability of components for ES/FS

Name	Planned start	Planned finish
Procurement manufacturing shipment and SAT A (ES)	02.06.2014	09.07.2026
NC dipoles (1+2 pieces)	12.04.2021	18.09.2025
NC Multipoles	27.03.2019	28.03.2025
SC Dipoles (21+3 Pieces)	28.07.2016	02.03.2026
SC Multiplets	07.01.2015	15.03.2026
Power Converters	19.01.2017	12.12.2025
Beam Instrumentation	02.06.2014	23.01.2026
Vacuum Special Components	16.02.2022	15.01.2026
Vacuum Standard Components (catalogue items larg...	27.11.2020	09.07.2026
Special Installations	26.10.2018	26.09.2025
Local Cryogenics	06.02.2019	17.09.2025
Experimental Interface	25.03.2019	27.02.2026
Test sc magnets at CERN (30+2+24)	22.08.2014	27.03.2026
Quench D/P (243 + 112 + 243) (IK GSI)	30.04.2019	15.03.2026
Technical Gas Supply (FAIR) (ES)	21.01.2022	30.07.2024
Pre-assembly units	02.11.2022	06.05.2026



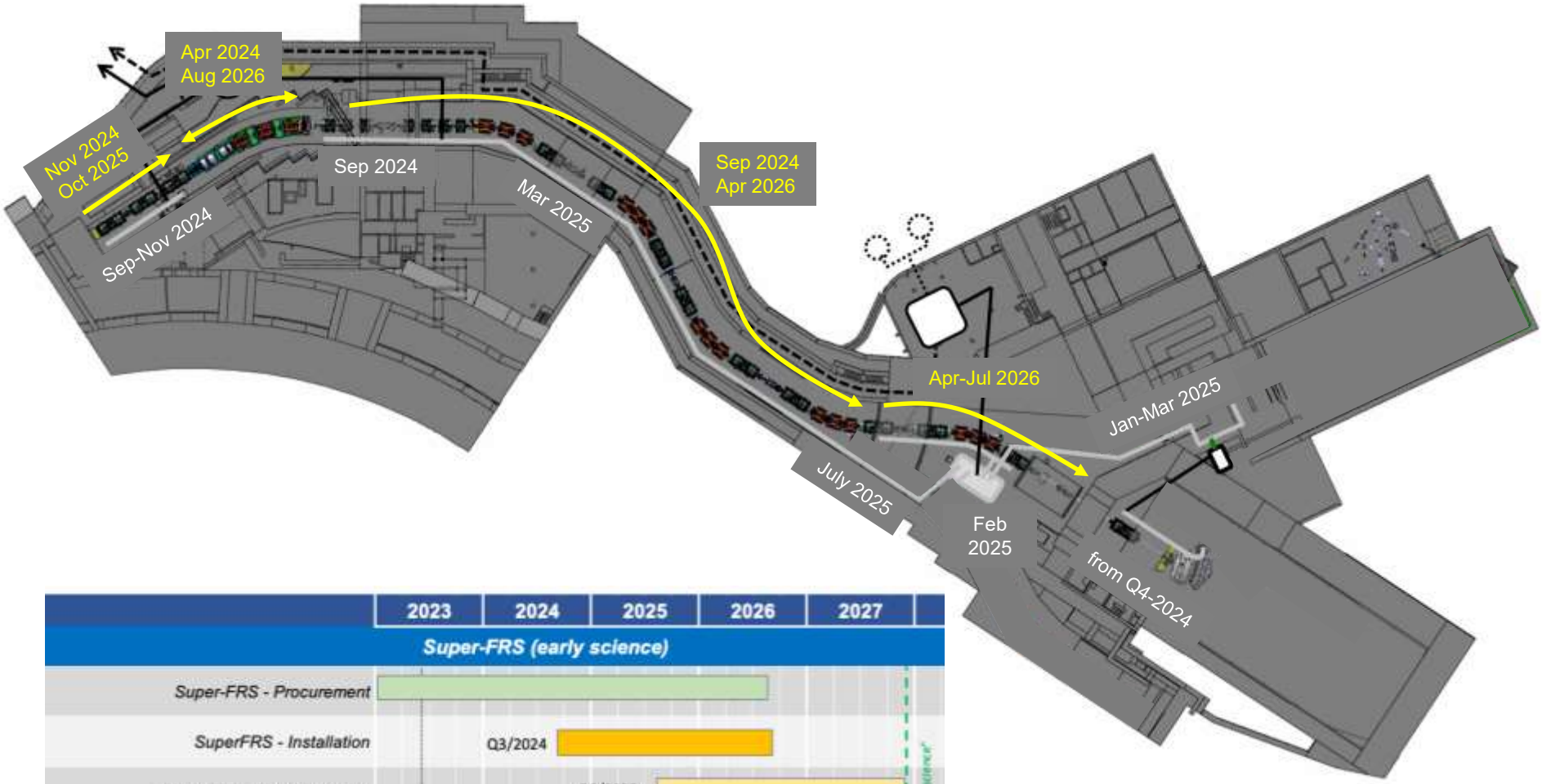
Schedule Beam Instrumentation

exRu, exSE, plan-B FI

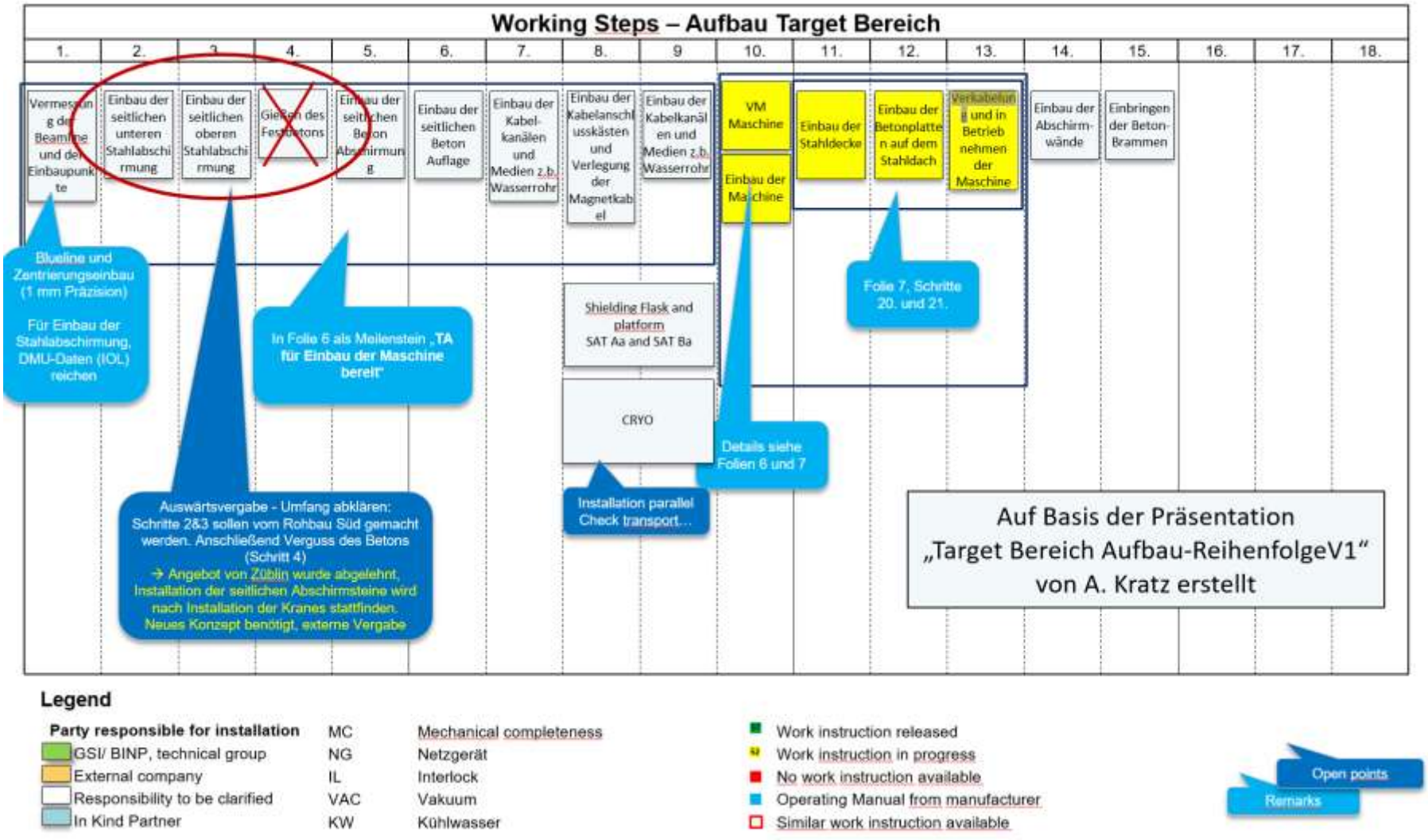
BI component (2.4.6)	Specs (M3)	Contract (M4)	FDR (M7)	FAT (M9)	SAT (M10)	Comment
GEM-TPCs (Fi) (Plan-B Sci Fib.,14pcs)	Done	Done (1st part, 5pcs)	Dec 2023	Jul 2025	Jan 2026	Technologically challenging
SEM grids (FI→ EEL)	Done	Done	Oct 2023	Jan 2025	May 2025	FoS successfully tested
Drives (SEM/GEM) (FI)	Done	Done	Dec 2023	Aug 2025	Sep 2025	Straight forward item
MUSICs (FI->DEL→ EEL)	Done	Done	Jan 2024	Feb 2025	Jun 2025	FoS under test
Plastics (replace ex-RU)	Done	Done (in house)	Dec 2023	Jan 2025	Nov 2025	ToF replacement
Media boards	Done	Done (in house)	Together with the FDR of BI items	Together with the FAT of BI items	Together with the SAT of the BI items	FoS successfully tested
IPM (ex-RU, via BEA)	Done	Closing for main component	Jun 2024	Sep 2024	Dec 2024	T Branch installation
PDCs	Done	Done (in house)	Done	Sep 2024	Feb 2025	FoS successfully tested concept
Beam stoppers	Done	Done	Done	Oct 2023	Ready by 2023	under production
Diamonds (ex-RU)	Done	Done (in house)	Feb 2024	Jan 2025	Mar 2025	FoS successfully tested
Slits	Done	Done	Done	Done	Ready by 2023	SAT running
Control drive (hardware, SE→BEA)	Done	Done	Not needed	Not needed	Together with the SAT of BI items	Straight forward items
ACC DAQ (BEA)	Done	Done	Not needed	Not needed	Together with the SAT of BI items	Straight forward items

Additional work load covered with redirected personnel

Installation schedule
mechanical completion (M102): Aug 2026



Installation: LCM workshops ongoing



Commissioning phases for ACC

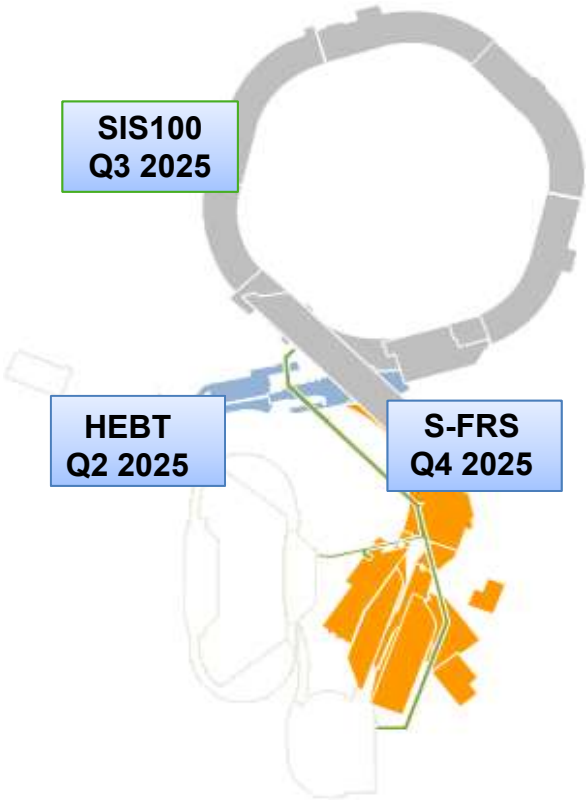
inst.

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



Example:
Commissioning RIBF and first experiments

History of RIBF commissioning

Dec. 28th , 2006
First Beam $^{27}Al^{10+}$ 345 MeV/u at RIBF-SRC

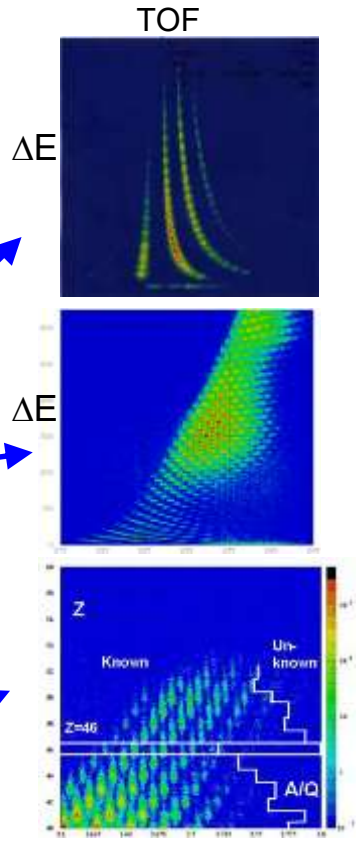
Break at the facility !

March, 2007
12th $^{86}Kr^{31+}$ beam at 345 MeV/u several pnA.
13th First production of RI beams with ^{86}Kr beam
23rd First successful acceleration of $^{238}U^{86+}$ beam at 345 MeV/u and 0.002 pnA
27th First production of RI beams with ^{238}U beam

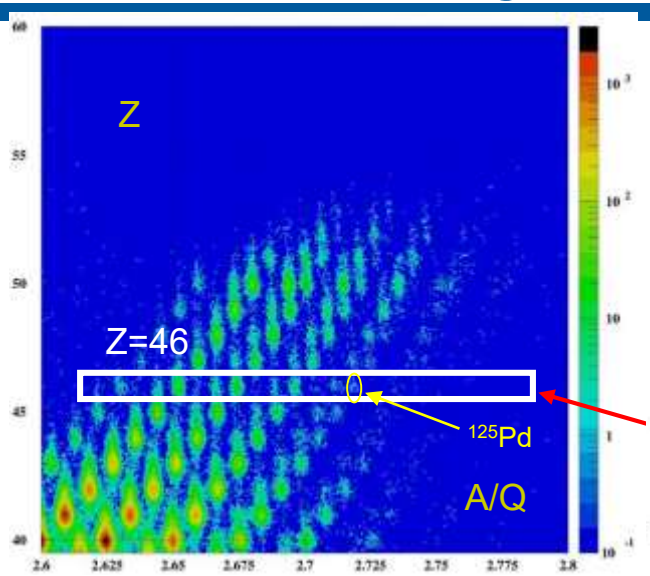
May-June, 2007 (without ZDS) (~1x10^8 pps)
with ^{238}U beam at 345 MeV/u and 0.02 pnA max

May 16th-23th BigRIPS commissioning experiment
May 24th – June 3rd Search for new isotopes
End of June(a few days) detector testing

Nov. 2007 acceleration test with ^{86}Kr beams, 30 pnA



Example:
Commissioning RIBF and first experiments



Searching for new isotopes May 2007

J. Phys. Soc. Jpn. 79, 073201 (2010) [5 Pages]

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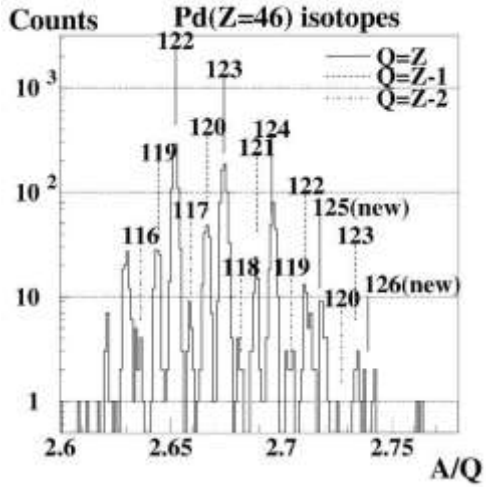
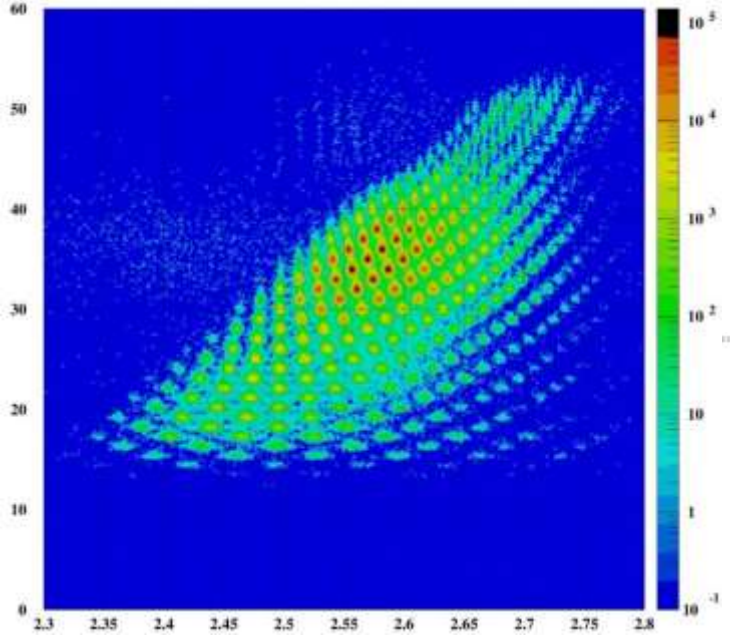
LETTERS

Identification of 45 New Neutron-Rich Isotopes Produced by In-Flight Fission of a ^{238}U Beam at 345 MeV/nucleon



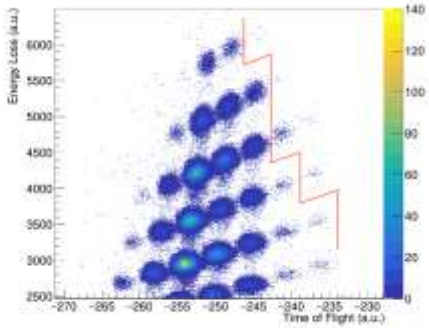


H. Crawford et al.
FRIB (2022)

FRIB'S FIRST EXPERIMENT CONCLUDES SUCCESSFULLY

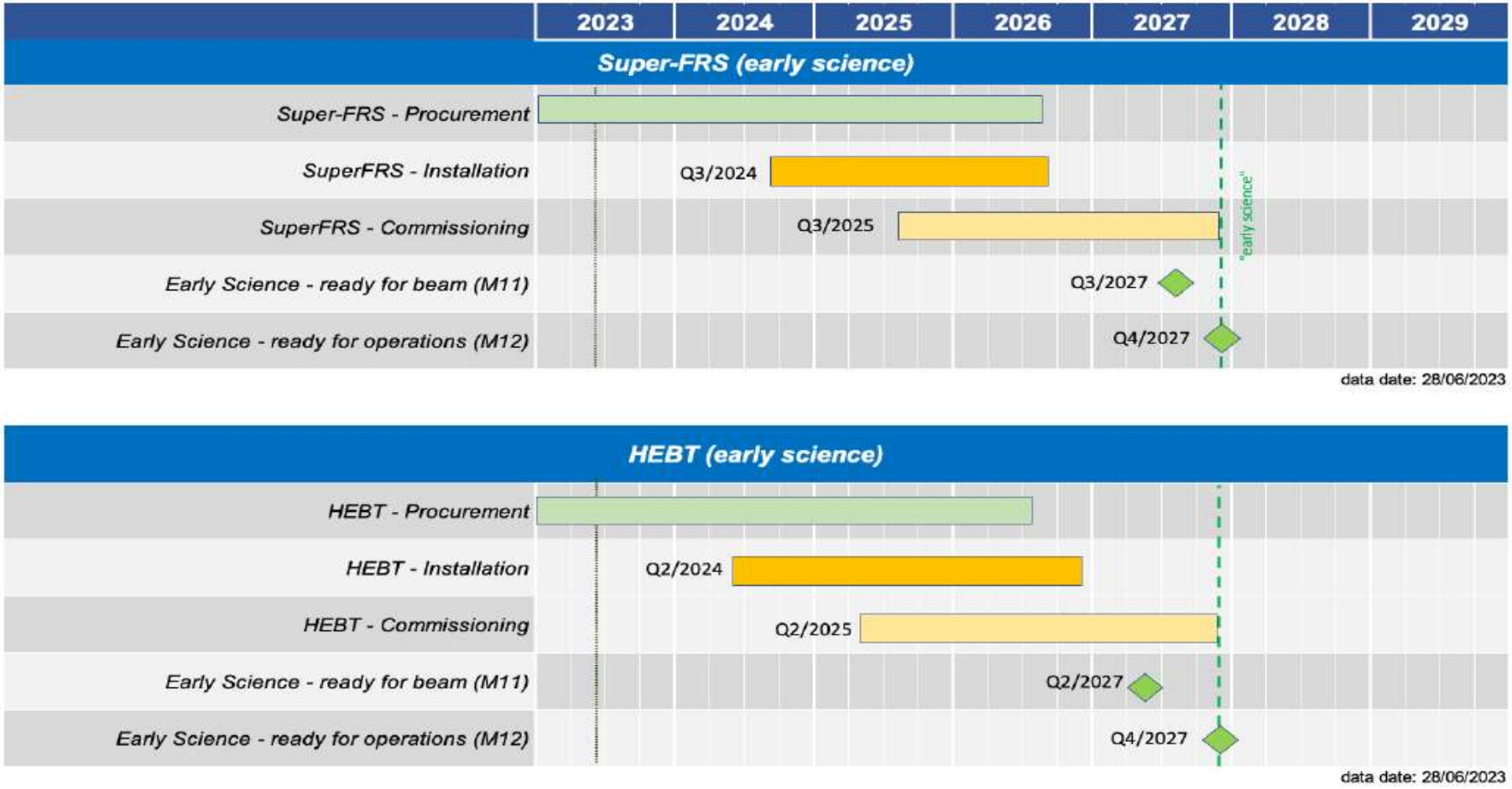
14 June 2022

The first experiment at FRIB—which studied the beta-decay of calcium-48 fragments that are so unstable that they only exist for mere



First beam in the facility Dec. 28th , 2006

Commissioning



For the first **NUSTAR** experiment right after commissioning
the first focal plane of the Super-FRS (FHF1) is blocked with the last PID chamber.
Verification (e.g. by Isomer tagging) could help to verify the ID in the high mass region.

Potential experimental places at the Super-FRS

Idea: install and operate magnets to FLF2/3 instead of storage

- Not covered: vacuum items, special installation, infrastructure extra cost, feed boxes (local cryogenics reduced scope), instrumentation (could be initially in air), power converters
- Modified shielding wall position for FLF2/3 science location
- Freezing scenario shall be presented to scrutiny group following up council decision in July

RB will end at the branched dipole magnet, further beam-line will not be installed, magnets to be stored.

Possible science location prior to FS++
HI/DESPEC/SEC (J. Gerl, H. Albers)

13,600k€
CB8@2005

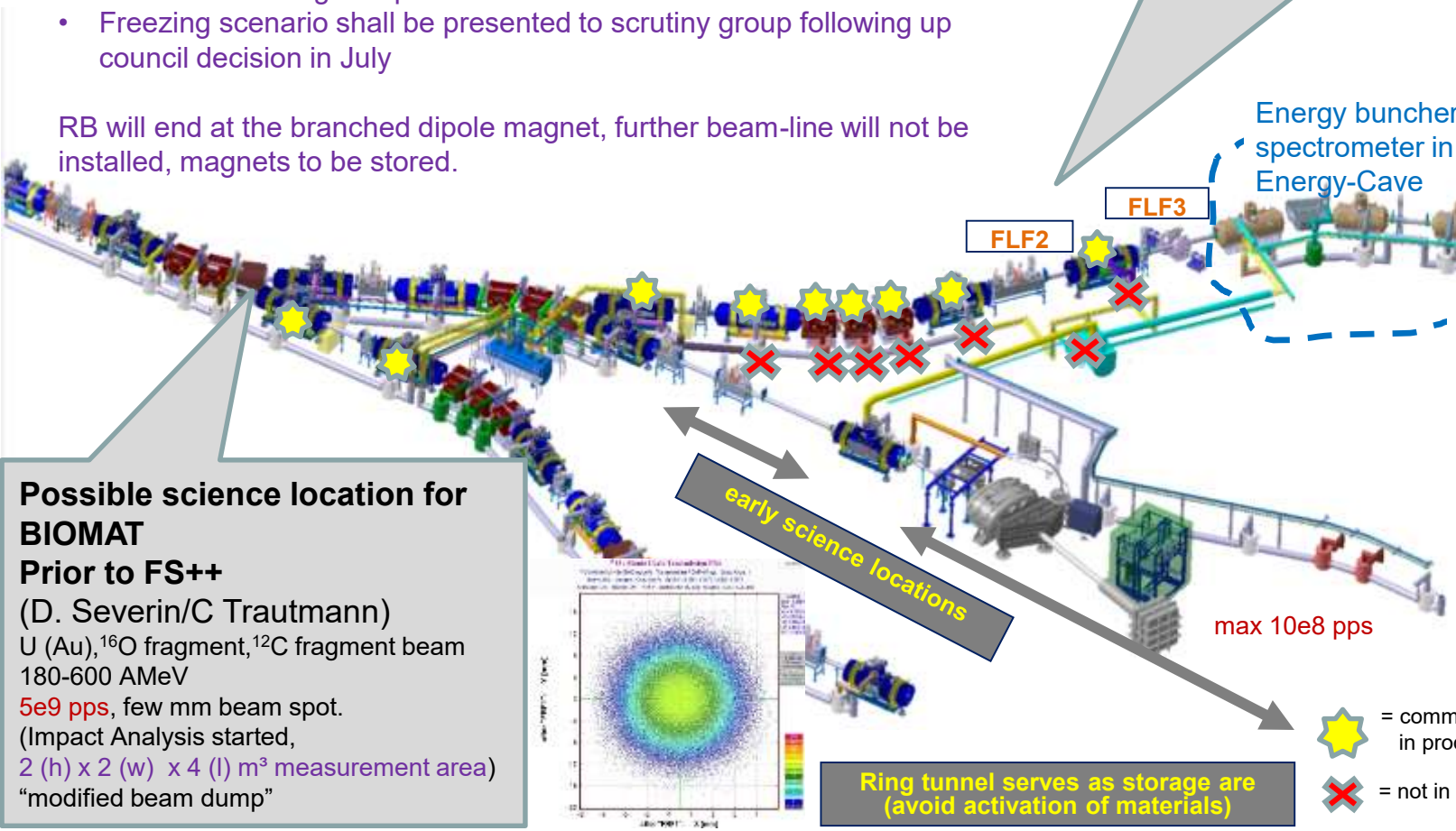
FLF 6

Energy buncher spectrometer in Low-Energy-Cave

FLF3

FLF2

TGA ~ 10,000k€
max 10e7 pps



Possible science location for BIOMAT
Prior to FS++
(D. Severin/C Trautmann)
U (Au),^{16}O fragment,^{12}C fragment beam
180-600 AMeV
5e9 pps, few mm beam spot.
(Impact Analysis started,
2 (h) x 2 (w) x 4 (l) m³ measurement area)
"modified beam dump"

Ring tunnel serves as storage are (avoid activation of materials)

= committed and partially in production

= not in scope and budget

Summary

- Very busy period in view of all actions related to returned in-kind and exRU contributions. → Ressource Limitations
  → Mitigation via redirected personnel.
- Pre-installation (preparation for tunnel installation) started.
- (Pre-)Installation process overlaps with procurement phase.
- Scenario for Commissioning with and without beam developped.

- Initial configuration allows for program at FHF1 and FHF2, possible opportunities are studied.


Thank you