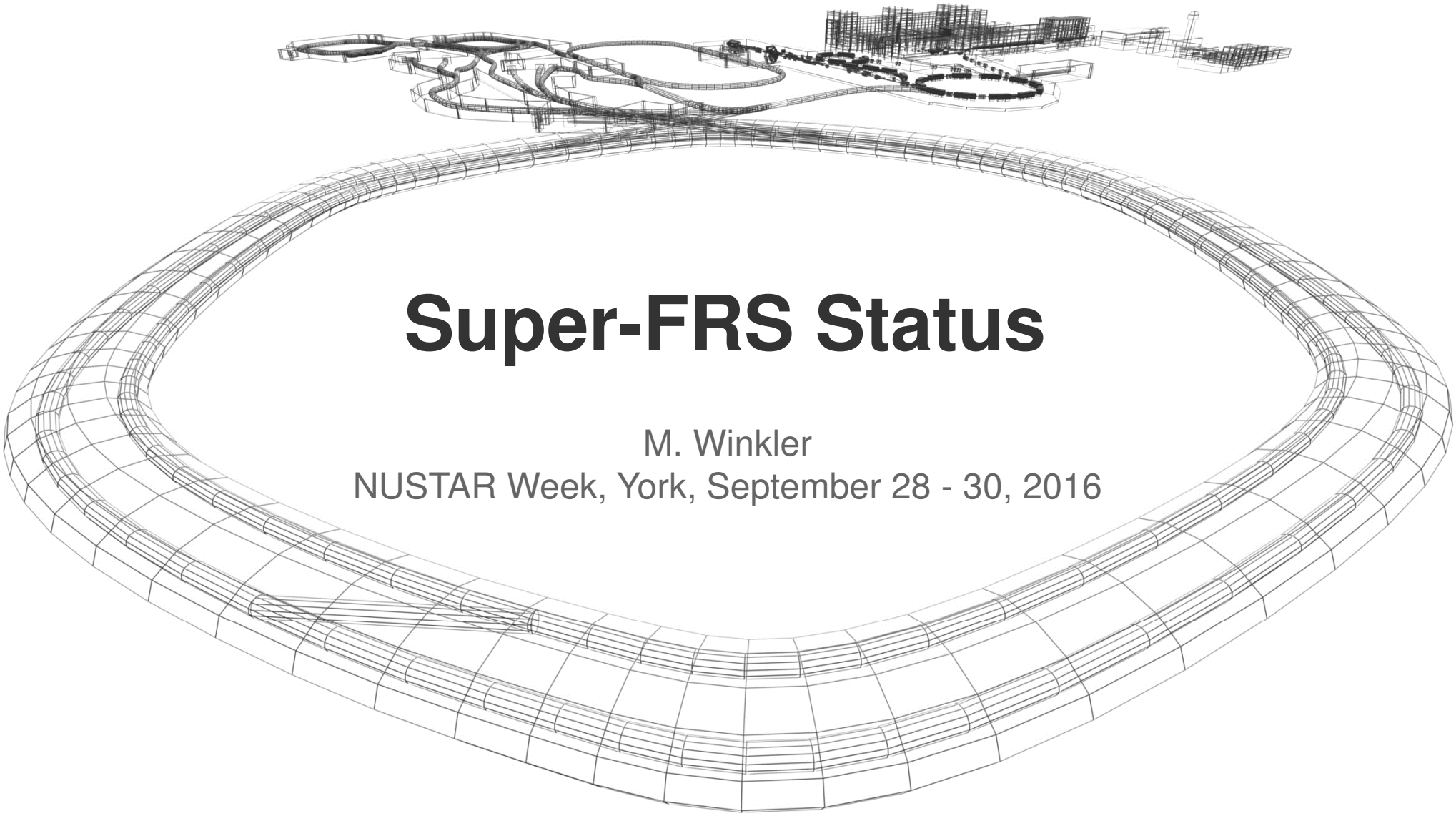


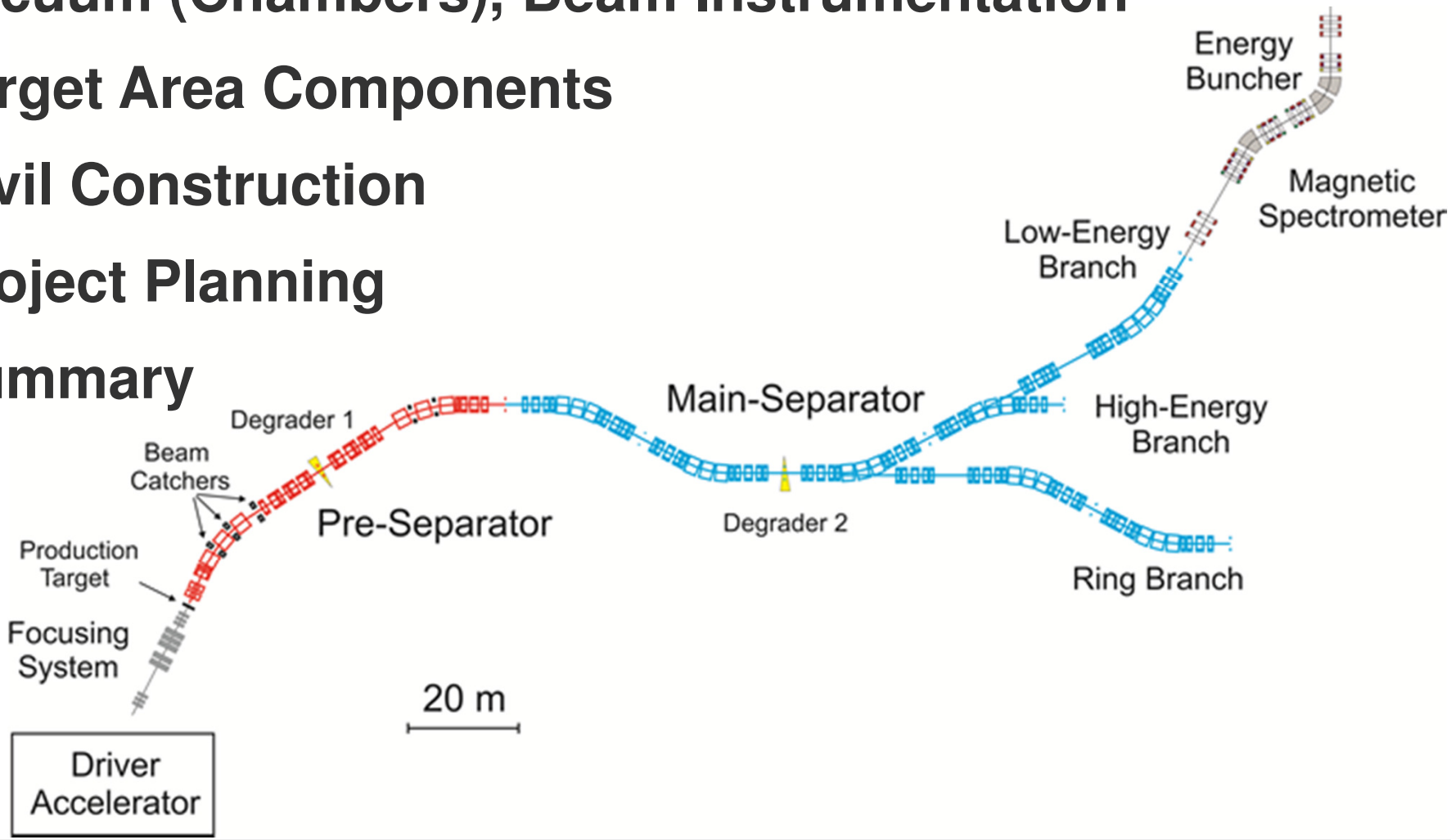
Super-FRS Status

M. Winkler

NUSTAR Week, York, September 28 - 30, 2016

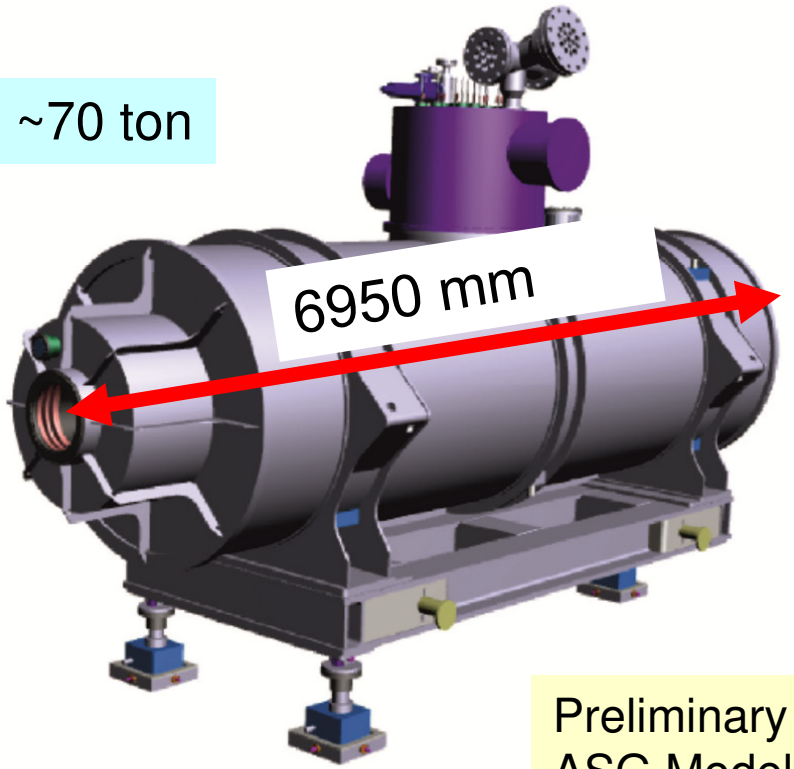
Outline

1) Magnets, Testing and Local Cryogenics
2) Vacuum (Chambers), Beam Instrumentation
3) Target Area Components
4) Civil Construction
5) Project Planning
6) Summary



Magnets I
(SC Multiplets, Overview)

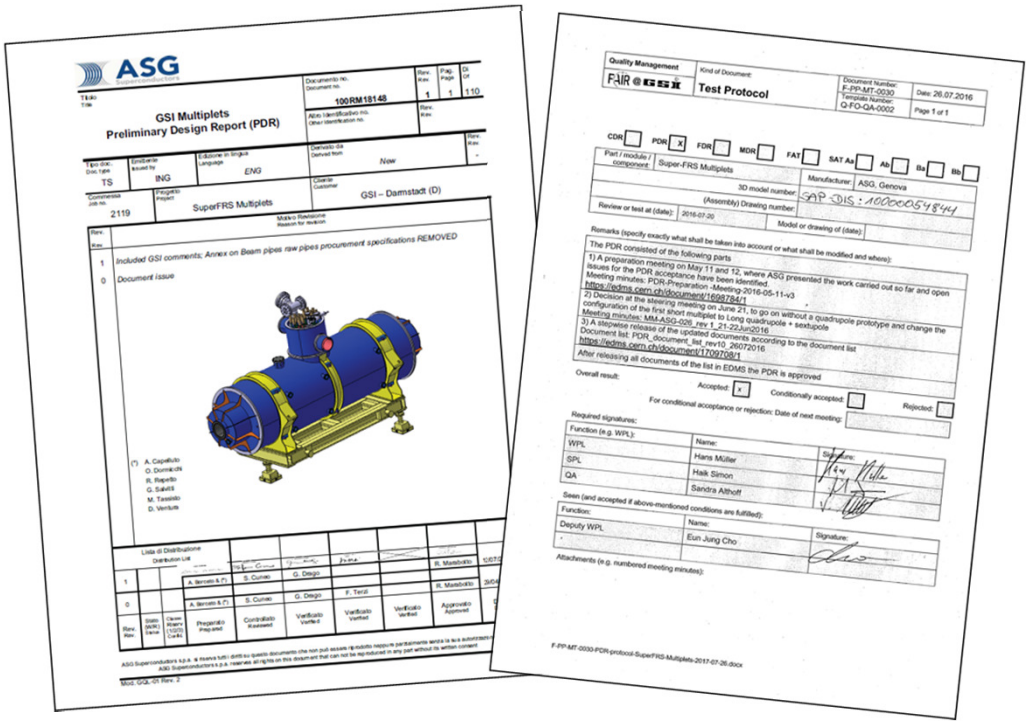
- 8 short multiplets (PS)
  - ➢ QS configuration
- 25 long multiplets (mainly MS)
  - ➢ Quadrupol triplet
- include corrector elements & steerer



Overall schedule SC multiplets

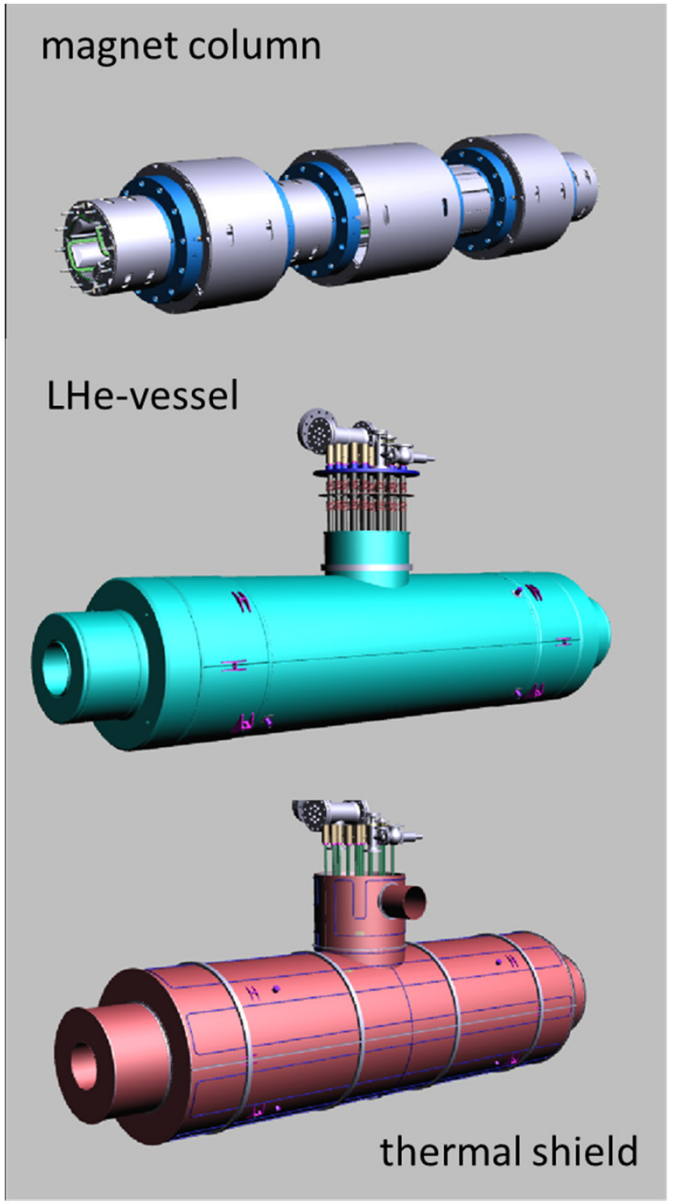
- ✓ Contract closed 07/2015
- ✓ Design phase running
  - ✓ PDR 07/2016
  - ➢ FDR 11/2016
  - ➢ PRR 02/2017
- FAT of FOS short multiplet 12/2017
  - ➢ SAT @ CERN, FOS SM 06/2018
  - ➢ SAT ok → start series production
- FAT of FOS long multiplet 07/2018
  - ➢ SAT @ CERN, FOS LM 01/2019
- Series testing @ CERN:
  - ➢ Q2/2019 – Q3/2022

Magnets II
(SC Multiplets, Status)



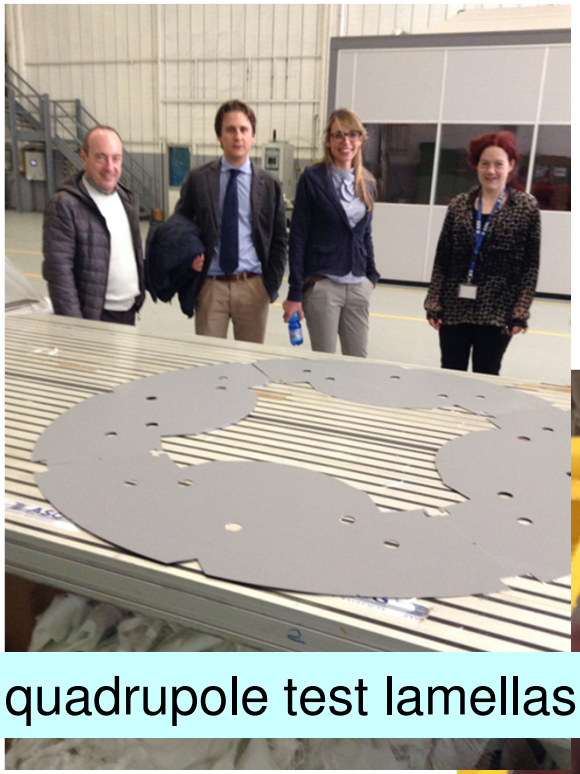
Preliminary Design Review (PDR)

- Magnetic and mechanical design
- Assembly concept for the pre-series multiplets
- Preparatory meeting on May 11-12
- Approval of 34 documents and model
- PDR released on July 26

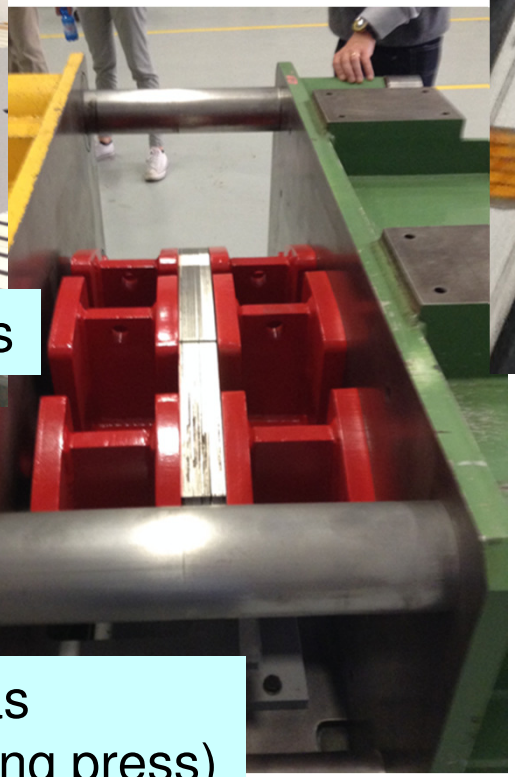


Magnets III
(SC Multiplets, Production Preparation)

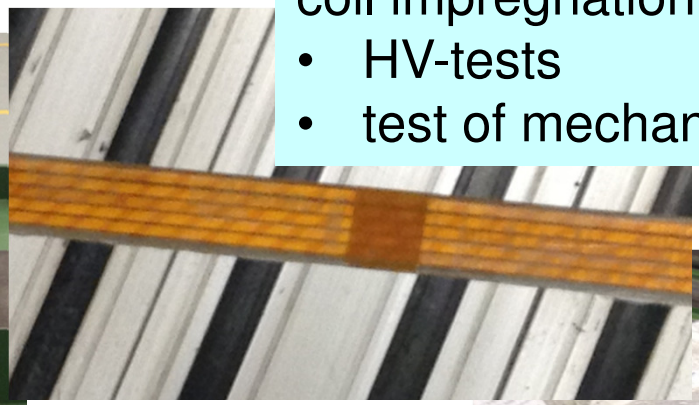
- Procurement of wire sub-provider running (ASG)
- Procurement of steel sub-provider running (ASG)
- Coil mock-up in preparation
- Building of specimens for various sub-components



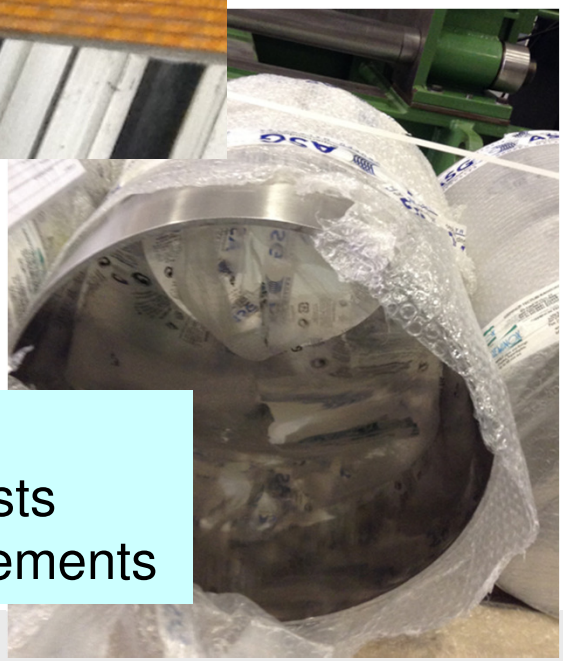
quadrupole test lamellas



test pressing of lamellas
(refurbishment of existing press)



coil impregnation
- HV-tests
- test of mechanical strength

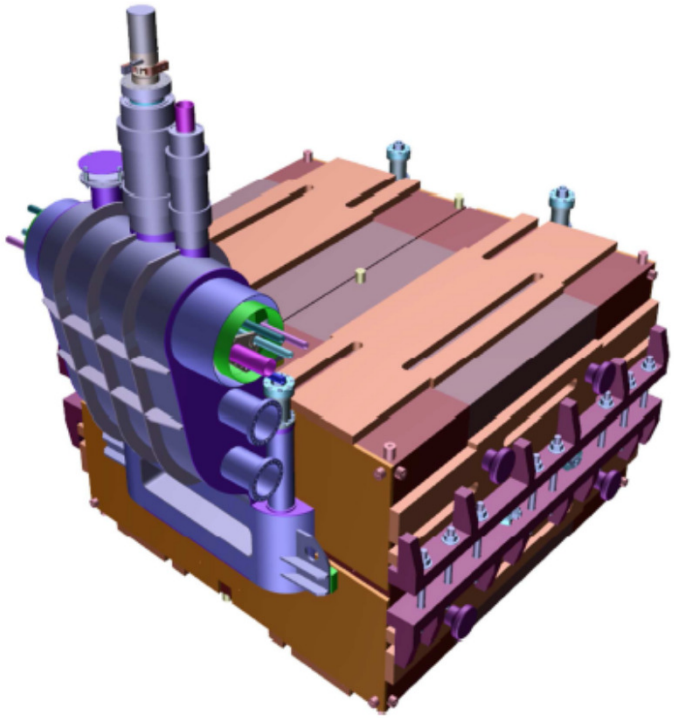


beam tube:
- vacuum tests
- μr measurements

Magnets IV
(SC Dipole Magnets, Status)

Scope

- 3 dipole units 11°
- 21 dipole units 9.75°
  - ➢ 3 times modified cryostat
- Warm iron, SC coil
- Aperture ±190mm x ±70mm
- Weight: 50 to 60 ton



Design Status (branching dipoles not included):

- ✓ Collaboration agreement with CEA/Saclay:
  - ➢ TCC is signed, includes
  - ➢ Detailed design, Technical follow-up
- ✓ 3D Model & 2D definition drawings are finalized
- Conceptual Design Report nearly finished
- Detailed Specification nearly finished
  - ➢ Meeting scheduled for Oct. 12/13 on open issues
- Tender documentation in preparation
  - ➢ **Goal: Start of tender still in 2016**

Branching Magnets:

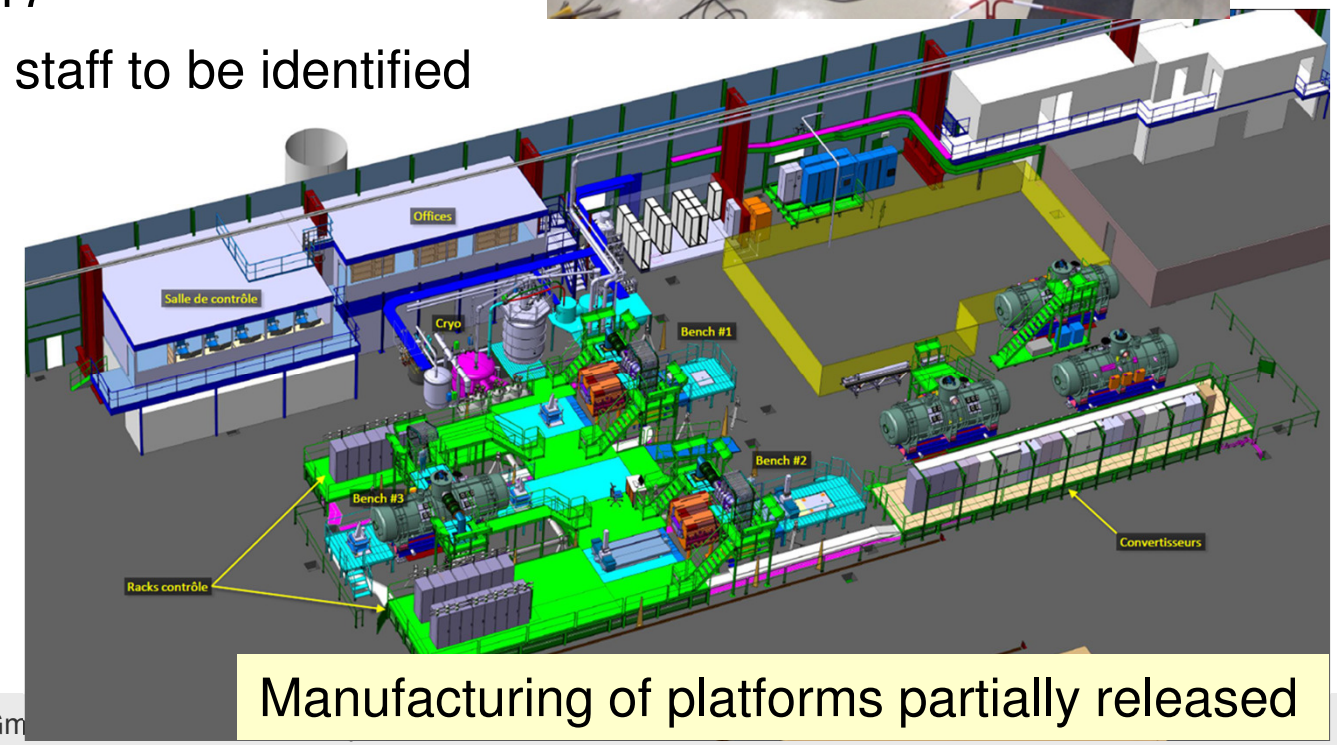
- needs special design for yoke & cryostat
  - ➢ integration of y-shape vacuum chamber to reinforce cryostat
- Collaboration agreement with CEA/Saclay:
  - ➢ R&D contract is signed

Magets V
(Magnet Testing @ CERN)

- Scope (separator magnets):
  - ✓ 24 Dipoles (PS & MS)
  - ✓ 31 Multiplets (+ 2 spare)
- 3 universal test benches + preparation area
- Installation for cryogenics nearly finished
  - ➢ Cryogenic interfaces (magnets) specified
- Facility commissioning in 2017
- Operation phase: test facility staff to be identified

feedboxes for test benches

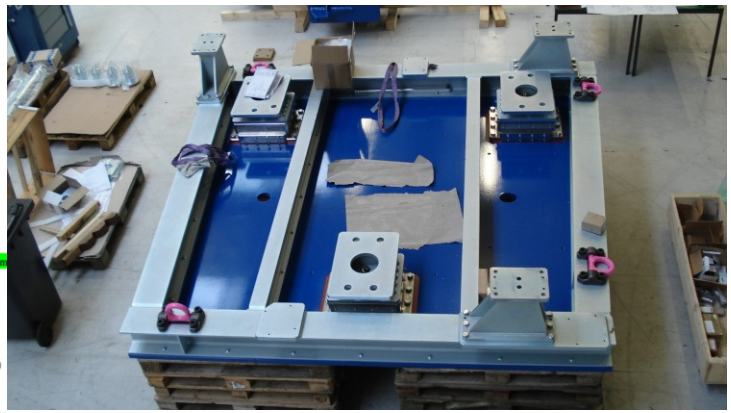
precooler and distribution box



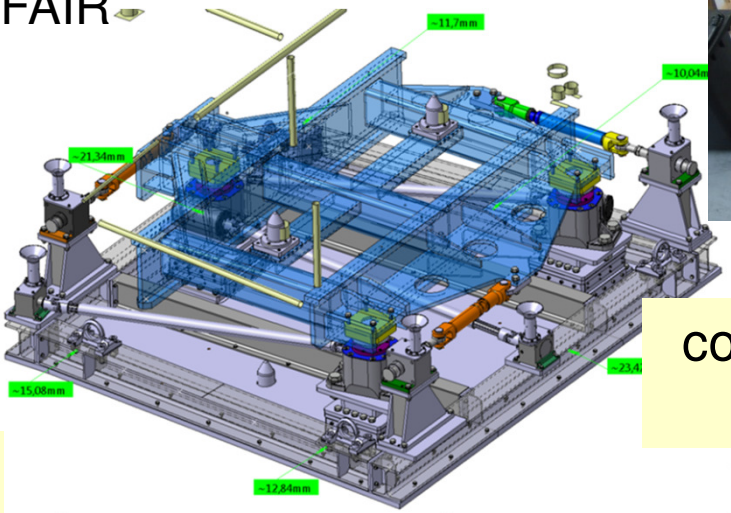
Manufacturing of platforms partially released

Magnets VI
(Radiation Resistant Magnets)

- Magnets located in the target area
- Normal conducting magnets using MIC cable
- 3 dipole units, 3 quadrupoles, 2 sextupoles
- Test on existing prototype dipole:
  - ✓ Heating test done (>95% of Q into water)
  - ✓ Current and water connectors successfully tested
  - ✓ Construction of modified remote alignment
  - ○ Repetition of alignment test last week
    however, not yet satisfactory
  - ○ Finalizing of specification running
- Tendering of magnets via FAIR



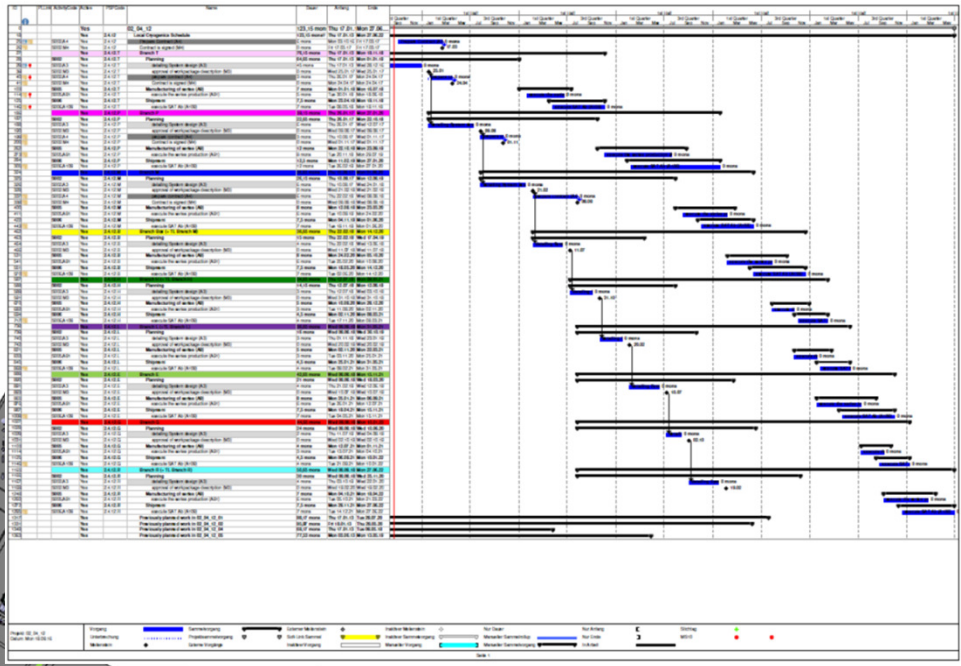
heat test: encased dipole

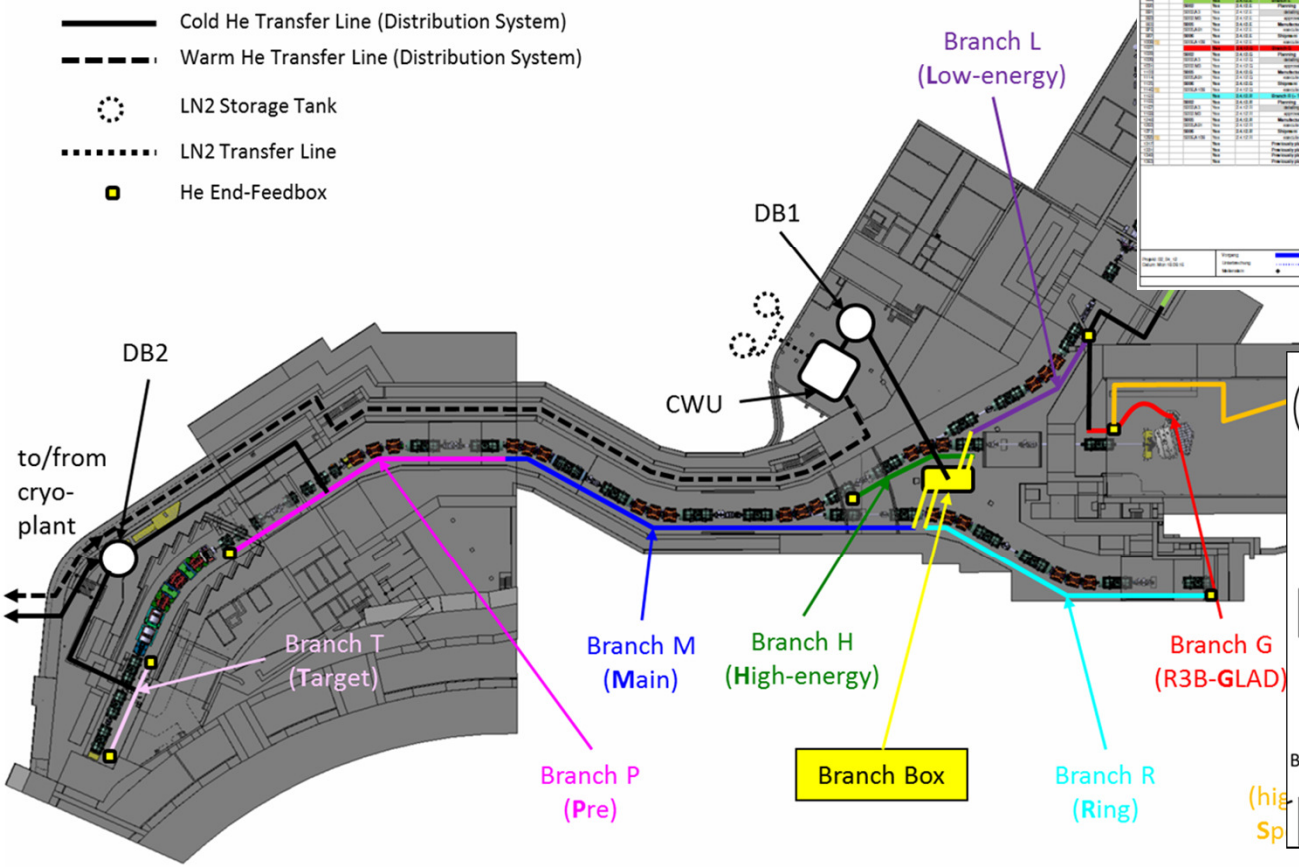


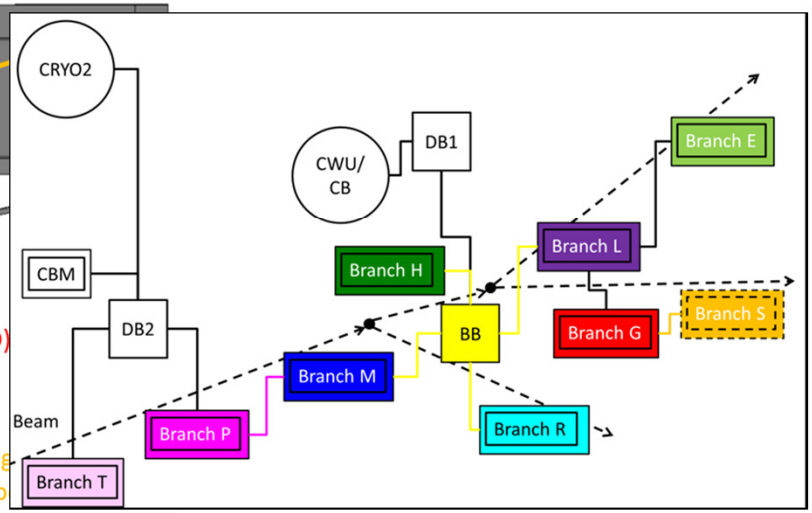
construction of new lubricants-free support structure

Local Cryogenics I
(Topology of the Local Cryogenic)

- In total 8 Cryogenic Branches plus 1 Branch Box → 9 major items
- Complete list of components established
- Specification, contracting, and production: item by item, along Super-FRS beam line

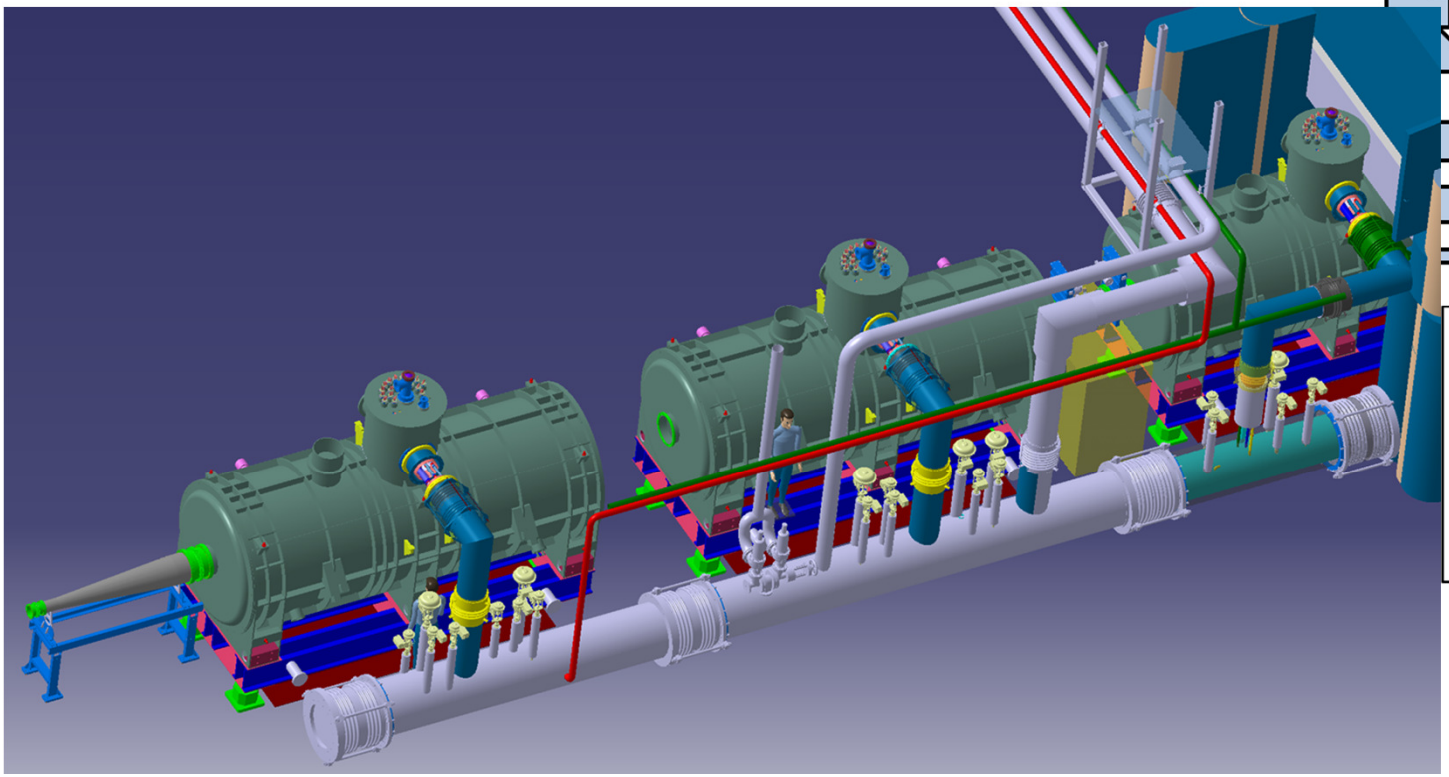


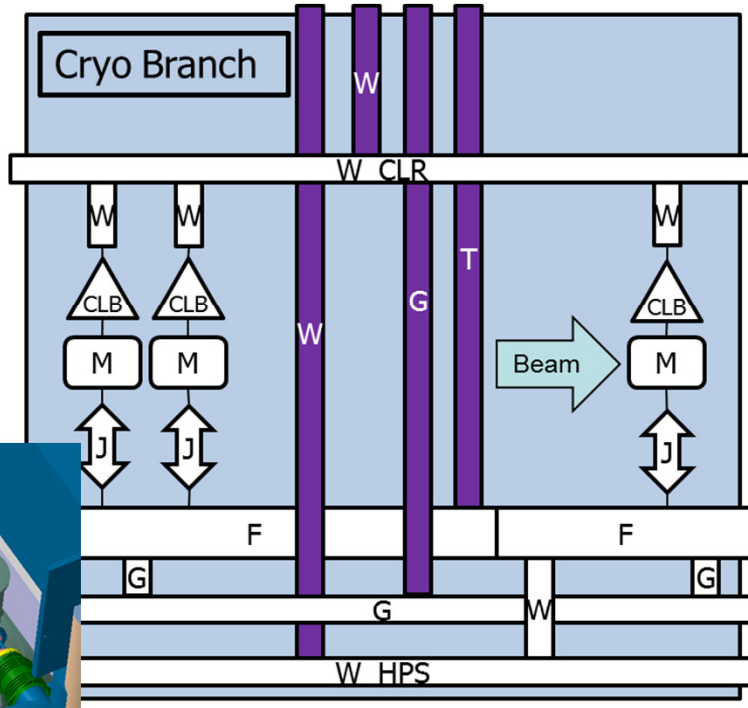




Local Cryogenics II
(Conceptual Layout of the Cryo-Branch T)

- ✓ Structure of ‘standard’ cryo-branches defined
- ✓ Conceptual Design Ready
- • Detailed Spec in preparation Q4/2016
- • In-Kind Contract until Q2/2017
  - ➢ Following cryo-Branches: same workflow

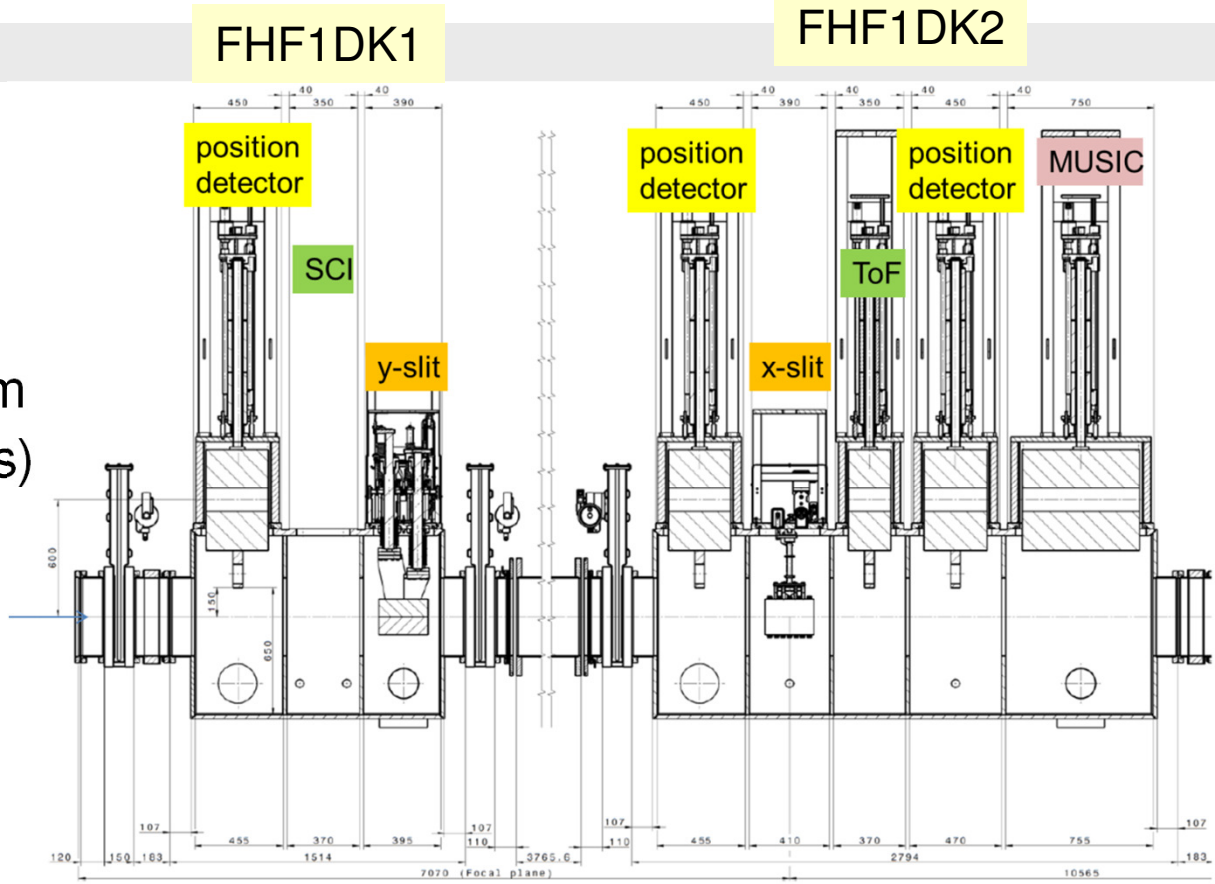


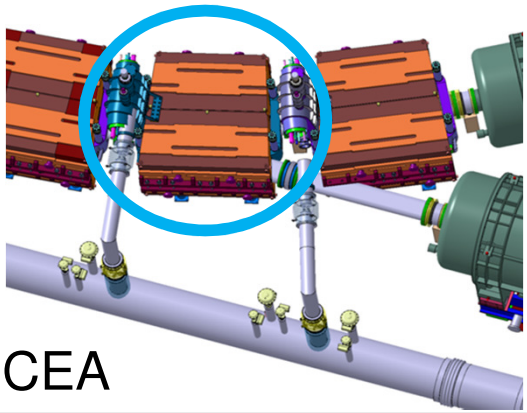


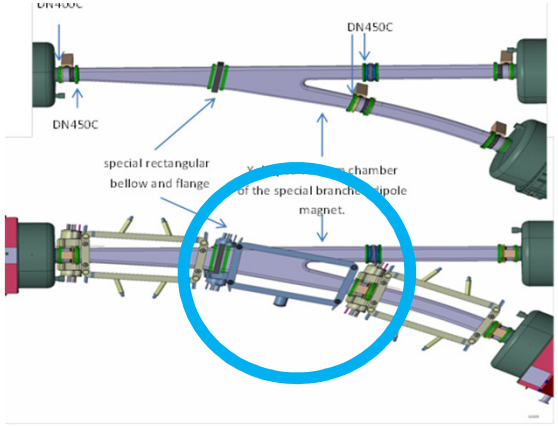
M	= Cryostats (Dipoles, or Multipoles)
J	= Jumper
FE	= Feed- & Endbox
T	= Transfer Line
G	= Multipurpose line
W_HPS	= High-Pressure Warm-Gas Supply
W_CLR	= Warm-Gas Current-Leads Return
CLB	= Current-Lead Valve Box

Vacuum System I
(Vacuum Chambers)

- Focal Plane Chambers
  - ➢ Russian in-kind (BINP)
  - ➢ Overall 21 chambers
  - ➢ Chambers length:
    between ≈800 mm to ≈ 4.400 mm
  - ➢ Chambers cross section (3 types)
    - 720 x 1130 mm²
    - 970 x 1130 mm² (slits)
    - 970 x 1280 mm² (degrader)
  - ➢ draft specification available,
    finalization running
- Dipole Vacuum Chambers:
  - ➢ Russian in-kind (BINP)
  - ➢ Overall 21 chambers
  - ➢ Specifications in preparation
- Branching Dipole Chambers:
  - ✓ design specification approved
  - ➢ chamber/cryostat integration tbd by CEA

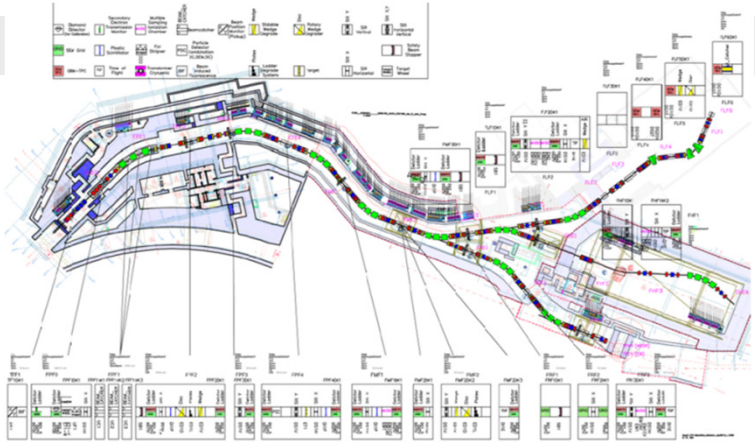


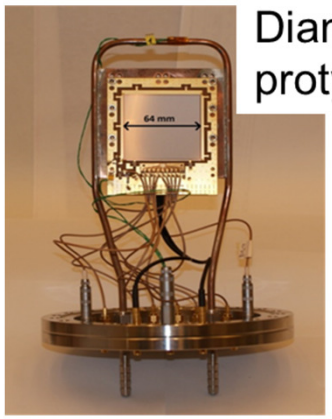




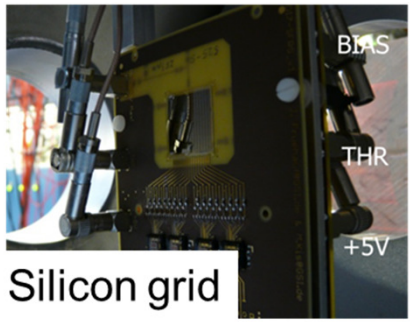
Beam Instrumentation I
(Beam diagnostics)

- Beam instrumentation defined for each FP
- Full isotope identification (x, y, x', y', ΔE,TOF)
- Modes: fast- and slow-extracted beams
- Position Detectors → next slides
- Time-of-Flight (Russian in-kind)
  - ✓ Specification approved Q3/2016
  - ✓ Contract documentation provided Q3/2016
  - ➢ IKC running (FAIR, kick-off done)
  - ○ R&D on diamond and silicon ongoing (data analysis of beam tests running)
- Plastics (Swedish in-kind)
  - ➢ Specification under approval
  - ✓ Contract documentation prepared
  - ➢ IKC to be started in Q4/2016
- MUSIC (energy-loss, Finnish in-kind)
  - ➢ Specification in preparation
  - ✓ PreAmps by CEA Bruyeres, tested at beamtime

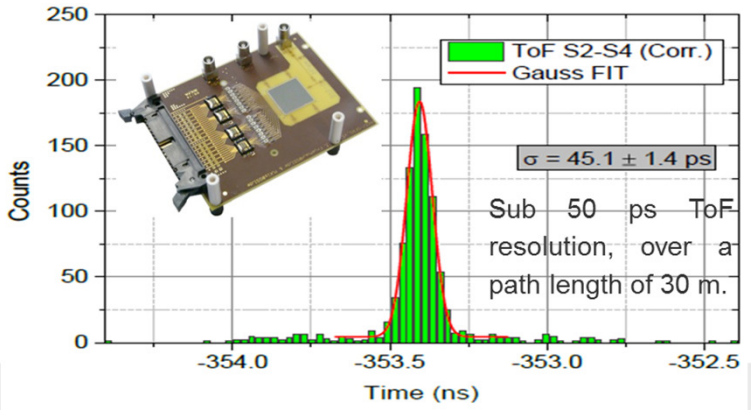




Diamond protype



Silicon grid



Beam Instrumentation II
(Beam Profile Detectors)

- 25 units required (+ spares)
- ✓ Specification approved Q1/2016
- ✓ Contract documents provided
- Finnish in-kind, IKC in preparation (FAIR)
  - ➢ Fermilab contacted as sub-Contractor
- ✓ Partly synergies with FAIR/HEBT
  - ➢ Order of POLAND components started by GSI.

100 POLAND units
range: $10^{-12} < Q < 10^{-6}$ C/ wire

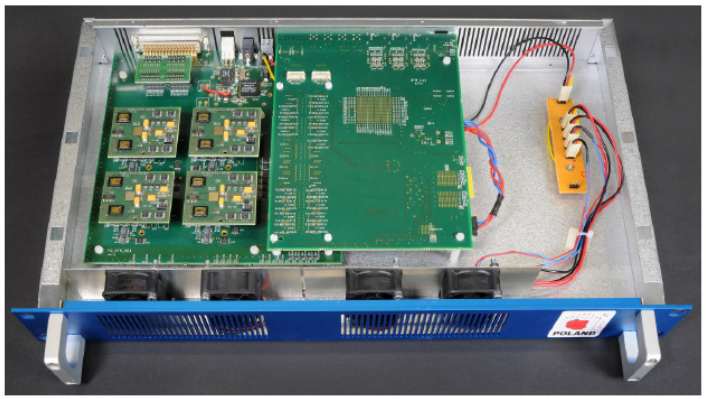
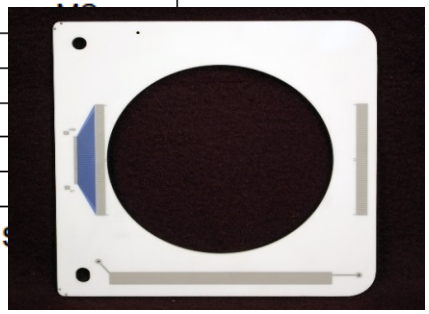


Figure 3.10: The POLAND unit.

Station	Unit	Separator region
FPF0	4	target
FPF2	2	PS
FPF3	1	PS
FPF4	2	PS
FMF1	2	MS
FMF2	2	MS
FMF3	2	MS
FHF1	2	
FLF1	1	
FLF2	2	
FRF1	1	
FRF2	2	
FRF3	2	

Table 2.1: Beam Profile detectors at the S



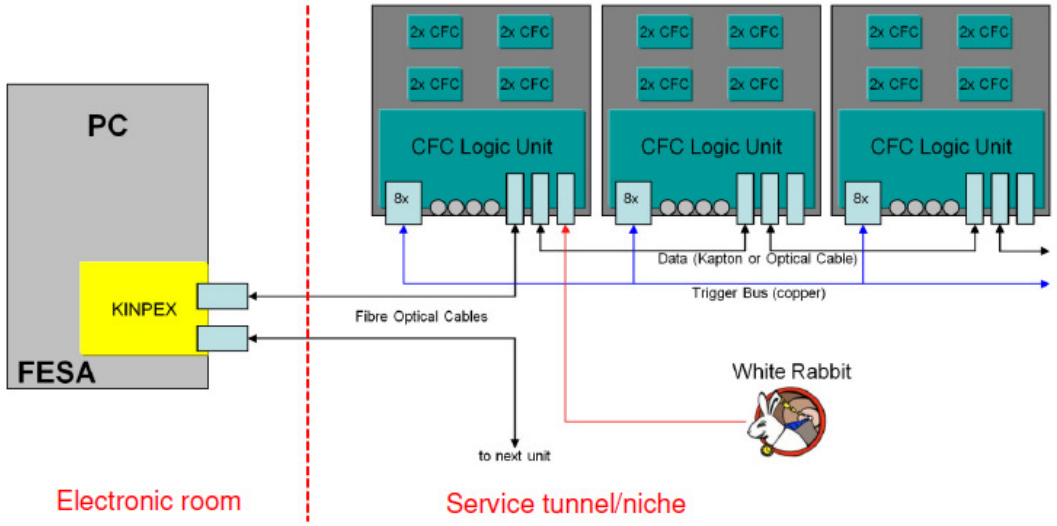
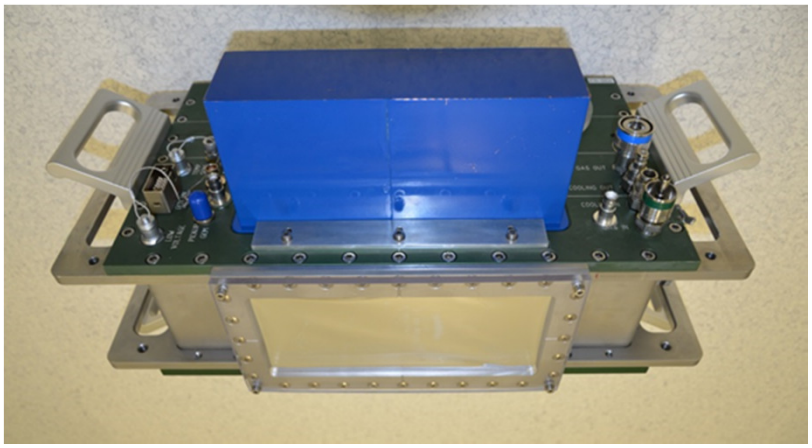
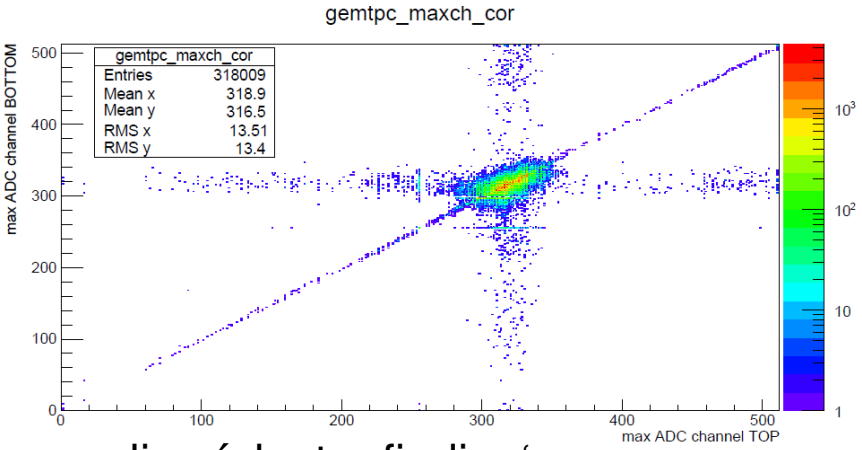


Figure 3.11: Scheme of the POLAND readout system.

Beam Instrumentation III
(Tracking Detectors)

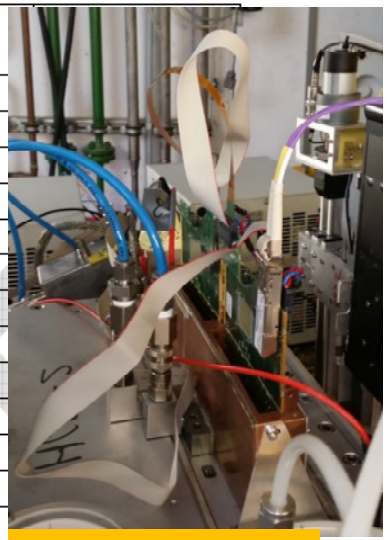
- 32 units required, Finnish in-kind
  - ➢ combined with SEM-Grid on a common drive
- ✓ Twin prototype tested in-beam at JYFL and GSI
- ✓ New GMX_2NX board based on XYTER v. 2 designed and tested at GSI,
  - ➢ Data analysis ongoing
- Specification in preparation





online ´cluster finding‘
(after baseline subtraction)

Focal plane	X(mm)	Y(mm)	Twin Type
FPF2	380	80	-
FPF3	380	150	-
FPF4	200	80	X
FMF1	380	80	X
FMF2	380	80	X
FMF2a	380	80	X
FMF3	380	80	X
FHF1	200	80	X
FHF1a	200	80	X
FLF1	380	80	-
FLF2	200	80	X
FRF3	200	80	-
FLF4	380	150	X
FLF5	380	150	-
FLF6	200	80	-

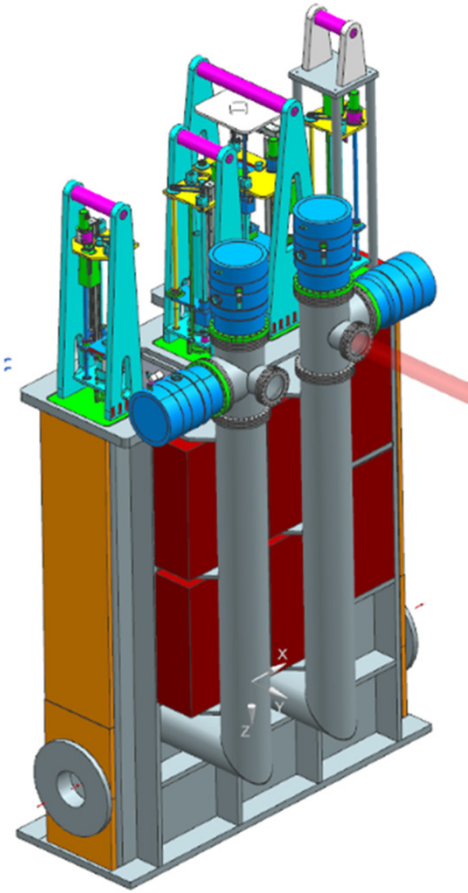


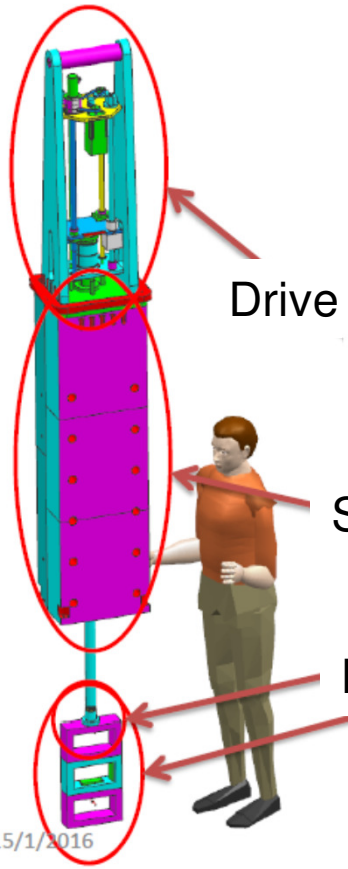
GMX_2NX

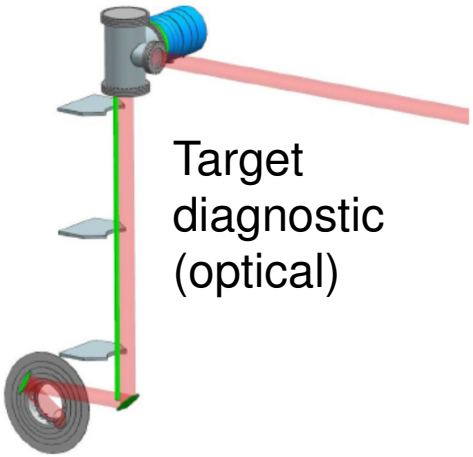
Table 3.1: Minimum active area of the Tracking Detectors. A cross is indicated where a twin type is required.

Target Area I
(Target Chamber & Plug Systems)

- ✓ German in-kind → collaboration with KVI-CART (umbrella MoU)
- ✓ Specification released
- ✓ R&D contract on design, includes:
  - chamber and plug design (4/5 plugs + pillow seals)
  - plug adjustment (interface to transport flask)
    - ✓ first dummy plug system already build
  - (infrared) diagnostic of beam spot on target
- ➢ PDR expected for Q4/2016
- ➢ FDR expected for Q1/2018
- • R&D contract on manufacturing after FDR



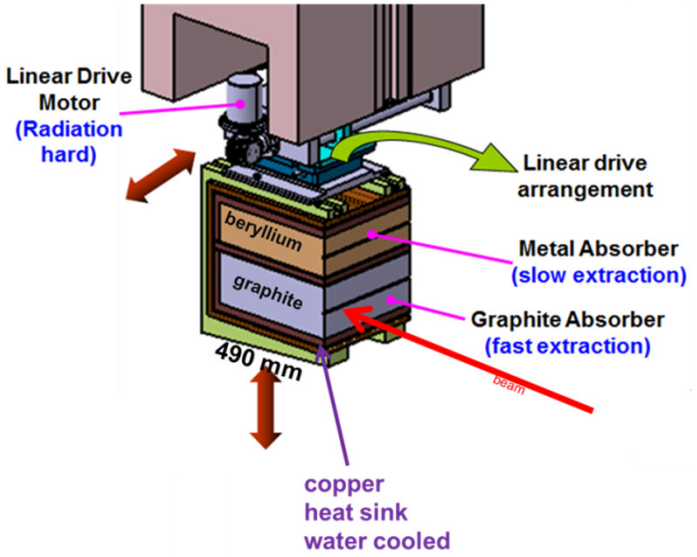


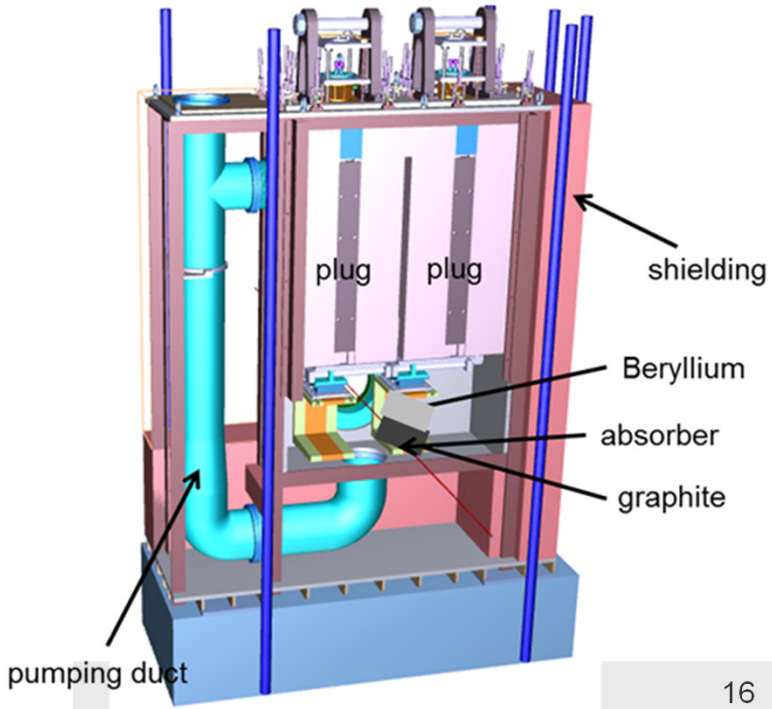


Dummy plug
(guidance)

Target Area II
(Beam Catcher II, Indian in-kind)

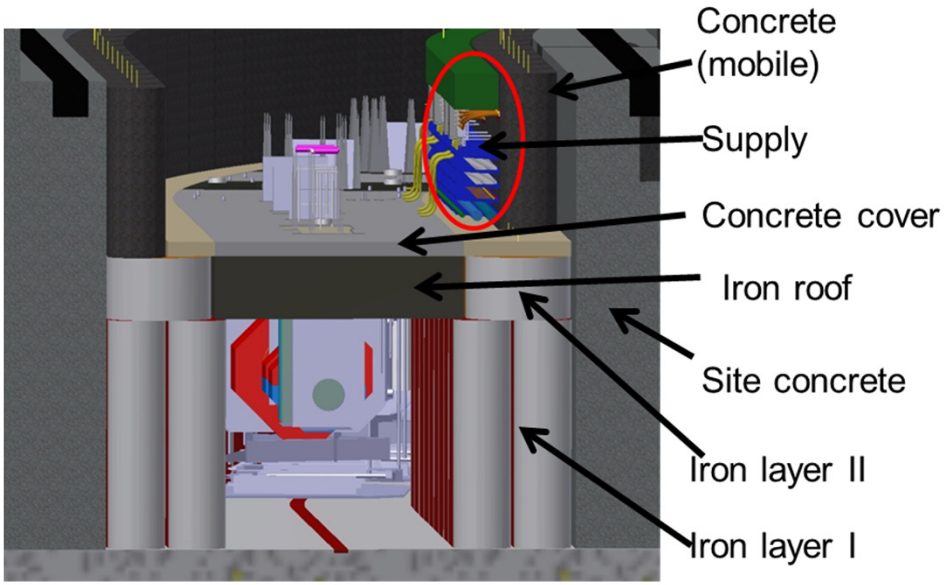
- ✓ Technical Design by **CMERI Durgapur**
- ✓ Definition report agreed
- ✓ Preliminary design running @ CMERI
- ✓ Design review March 2016, India, includes:
  - Enhanced beam stopping simulation (LS-Dyna)
  - Absorber design
    - metal absorber for slow-extracted beams
    - graphite absorber for fast-extracted beams
    - linear drive (BC 3)
  - BC chamber & sub-systems
    - vacuum chamber and internal shielding
    - shielding plugs with hook arrangement
    - pumping duct
    - plug guidance system
    - cooling system (piping, interlock, fittings)
  - Tunnel environment
    - interface issues: magnets & shielding
    - approach for quick maintenance from top
- Discussion with potential manufacturer started

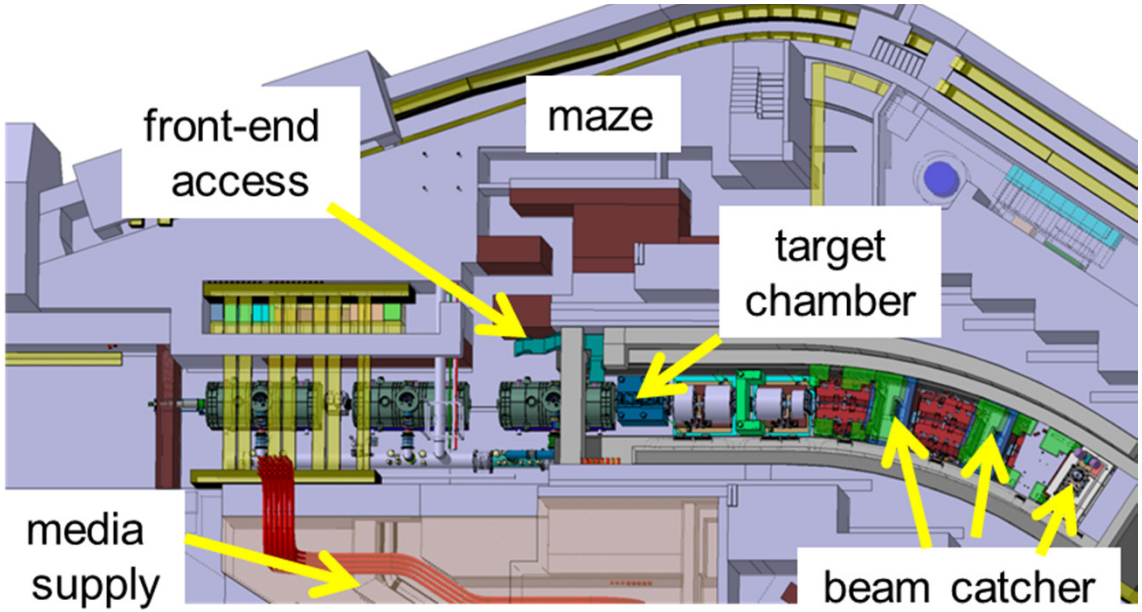


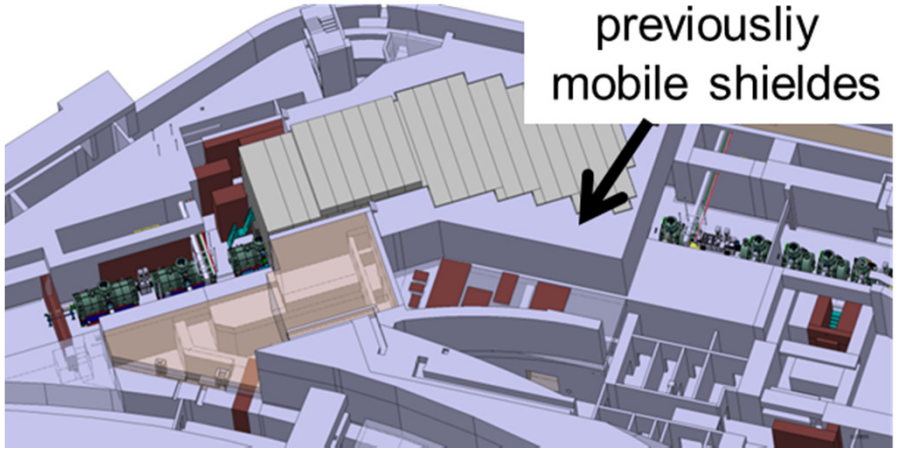


Target Area III
(Target Area / Shielding Planning)

- Detailing of target area planning
  - optimize tunnel shielding
  - ➢ saved ≈ 1.600 ton Fe !
  - ➢ ≈ 1.000 m3 mobile concrete → site concrete
  - ➢ slab shielding (roof): only 2 different forms
  - advanced planning of maintenance-tunnel
  - new supply routing → relax space issues



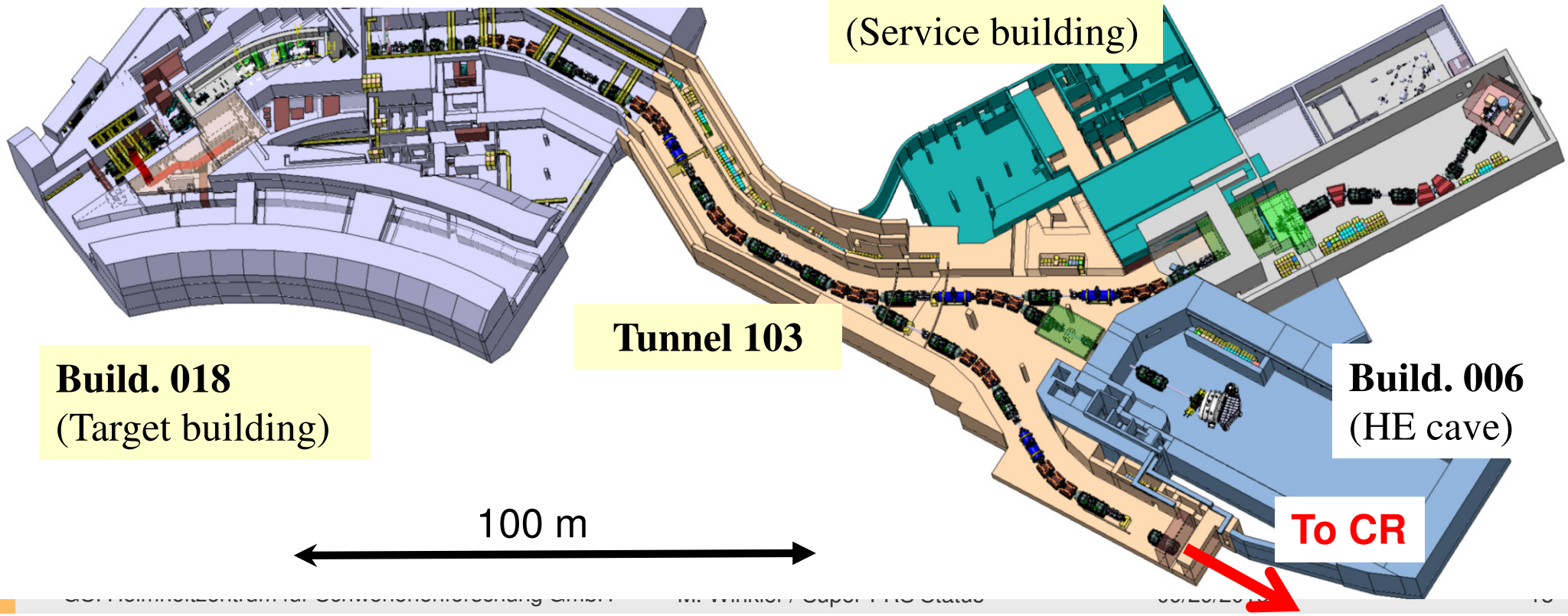




Civil Construction
(Overview)

- ✓ Optimization target area shielding
- ✓ Planning of LEB cave
  - ➢ consolidation of building service engineering
  - ➢ interface experimental interfaces
- ✓ Resuming 'approval planning' for all buildings
  - ➢ Assessment (1) 'building design'
  - ➢ Assessment (1) 'rooting'

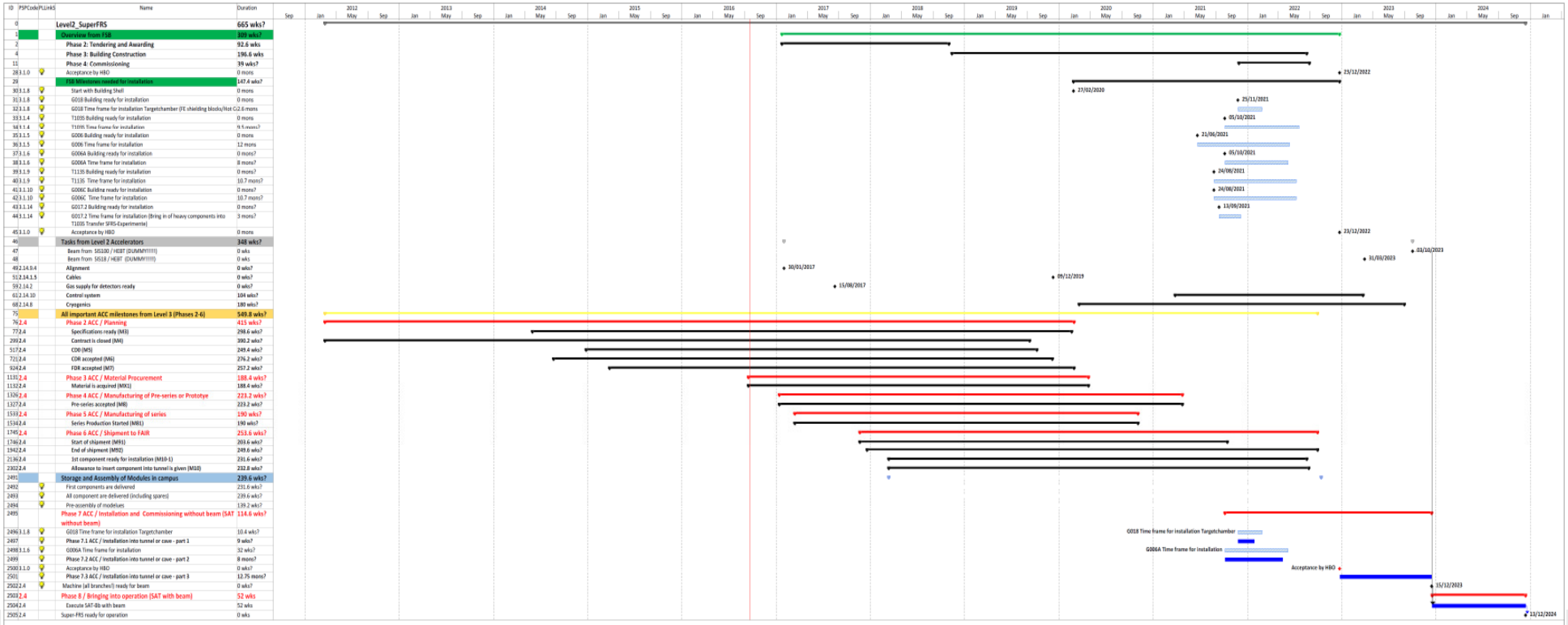
Build. 006b
(Low-Energy cave)
was basically missing
in CC planning



Project Planning I (Schedule)

- Reordered planning
  - ➢ mostly consistent picture (directly in plans)
- inconsistencies: some (M3) milestones drop off (date M3>M4) via extr. tool
  - ➢ reiteration necessary
    (here e.g. local cryo set-up 07/2016 latest plan release last week …)

➢ Installation plan (>500 steps)
(installation window usage to be further refined)



Project Planning II
(ATB list)

- 3668 items / 589 missing COTS vacuum items identified recently (analysis ongoing)
- Some cables/tubes still missing (NN/NA) ~50
- Few open interface items to experiments

Along the Beamline Elements

Responsibility		Element	
WP	WP Name	Number	%
NN	**Not assigned**	**50**	**1,4%**
2.4.0.4	Super-FRS Experiment Interface	7	0,2%
2.4.2.1.1	Normal Conducting Dipoles	7	0,2%
2.4.2.1.2	Superconducting Dipoles	200	5,5%
2.4.2.1.4	Energy Buncher Modules	9	0,2%
2.4.2.2.1	Normal Conducting Multipoles	2	0,1%
2.4.2.2.3	Superconducting Multiplets	349	9,5%
2.4.2.2.7	Energy Buncher Multipoles	10	0,3%
2.4.3	Super-FRS Power Converters	428	11,7%
2.4.6	Super-FRS Beam Instrumentation	123	3,4%
2.4.7	**Super FRS Vacuum (standard components)**	**1212**	**33,0%**
2.4.7	Super FRS Vacuum (special components)	165	4,5%
2.4.11	Super-FRS Special Installations	157	4,3%
2.4.12	Super-FRS Local Cryogenics	333	9,1%
2.4.23	Super-FRS Civil Construction Interface	11	0,3%
2.14.9.4	Commons / Alignment	2	0,1%
2.14.13.22	Magnet Testing Super-FRS (SC)	3	0,1%
2.14.14.2	Quench Detection/Protection Super-FRS	6	0,2%
1.2.5	R3B	63	1,7%
2.14.8.2.1	Commons / Cryogenic distribution system	12	0,3%
2.14.15.2	Commons / ACU	272	7,4%
2.14.15.3	Commons / DCCT	244	6,7%
1.2.2	HISPEC/DESPEC	3	0,1%
	Total	**3668**	**100%**

Sub-components are counted too (e.g. SC Dipoles)

Along the Beamline Elements

Responsibility		PSP			
WP	WP Name	Assigned	%	Missing	%
NN	**Not assigned**	**1**	**2%**	**49**	**98,0%**
2.4.0.4	Super-FRS Experiment Interface	7	100%	0	0,0%
2.4.2.1.1	Normal Conducting Dipoles	6	86%	1	14,3%
2.4.2.1.2	Superconducting Dipoles	173	87%	27	13,5%
2.4.2.1.4	Energy Buncher Modules	9	100%	0	0,0%
2.4.2.2.1	Normal Conducting Multipoles	2	100%	0	0,0%
2.4.2.2.3	Superconducting Multiplets	276	79%	73	20,9%
2.4.2.2.7	Energy Buncher Multipoles	10	100%	0	0,0%
2.4.3	Super-FRS Power Converters	427	100%	1	0,2%
2.4.6	Super-FRS Beam Instrumentation	123	100%	0	0,0%
2.4.7	**Super FRS Vacuum (standard components)**	**623**	**51%**	**589**	**48,6%**
2.4.7	Super FRS Vacuum (special components)	165	100%	0	0,0%
2.4.11	Super-FRS Special Installations	156	99%	1	0,6%
2.4.12	Super-FRS Local Cryogenics	331	99%	2	0,6%
2.4.23	Super-FRS Civil Construction Interface	11	100%	0	0,0%
2.14.9.4	Commons / Alignment	2	100%	0	0,0%
2.14.13.22	Magnet Testing Super-FRS (SC)	3	100%	0	0,0%
2.14.14.2	Quench Detection/Protection Super-FRS	6	100%	0	0,0%
1.2.5	R3B	57	90%	6	9,5%
2.14.8.2.1	Commons / Cryogenic distribution system	12	100%	0	0,0%
2.14.15.2	Commons / ACU	272	100%	0	0,0%
2.14.15.3	Commons / DCCT	233	95%	11	4,5%
1.2.2	HISPEC/DESPEC	2	67%	1	33,3%
	Total	**2907**	**79%**	**761**	**21%**

There are 260 different PSP-Codes along the beamline among which 248 are under the responsibility of Super-FRS

Summary

- SC Magnets & Testing (most time critical items):
  - multiplets: design running; PDR done, FDR still 2016 scheduled
  - dipoles: TCC, CDR and DS to be finalized, tendering in preparation; design of branching units still tbd
  - Testing facility at CERN under construction; commissioning in 2017
- Development and procurement of various other components under way
  - contract for target chamber and plug inserts is signed
  - various IKC in preparation (beam diagnostic)
- Civil Construction
  - approval planning for all NUSTAR buildings under way
- Project Planning
  - time planning revised/reordered; installation planning added
  - list ‘Along The Beamline’ established; contains all components for realization of Super-FRS