

of PANDA

L. Schmitt, GSI/FAIR

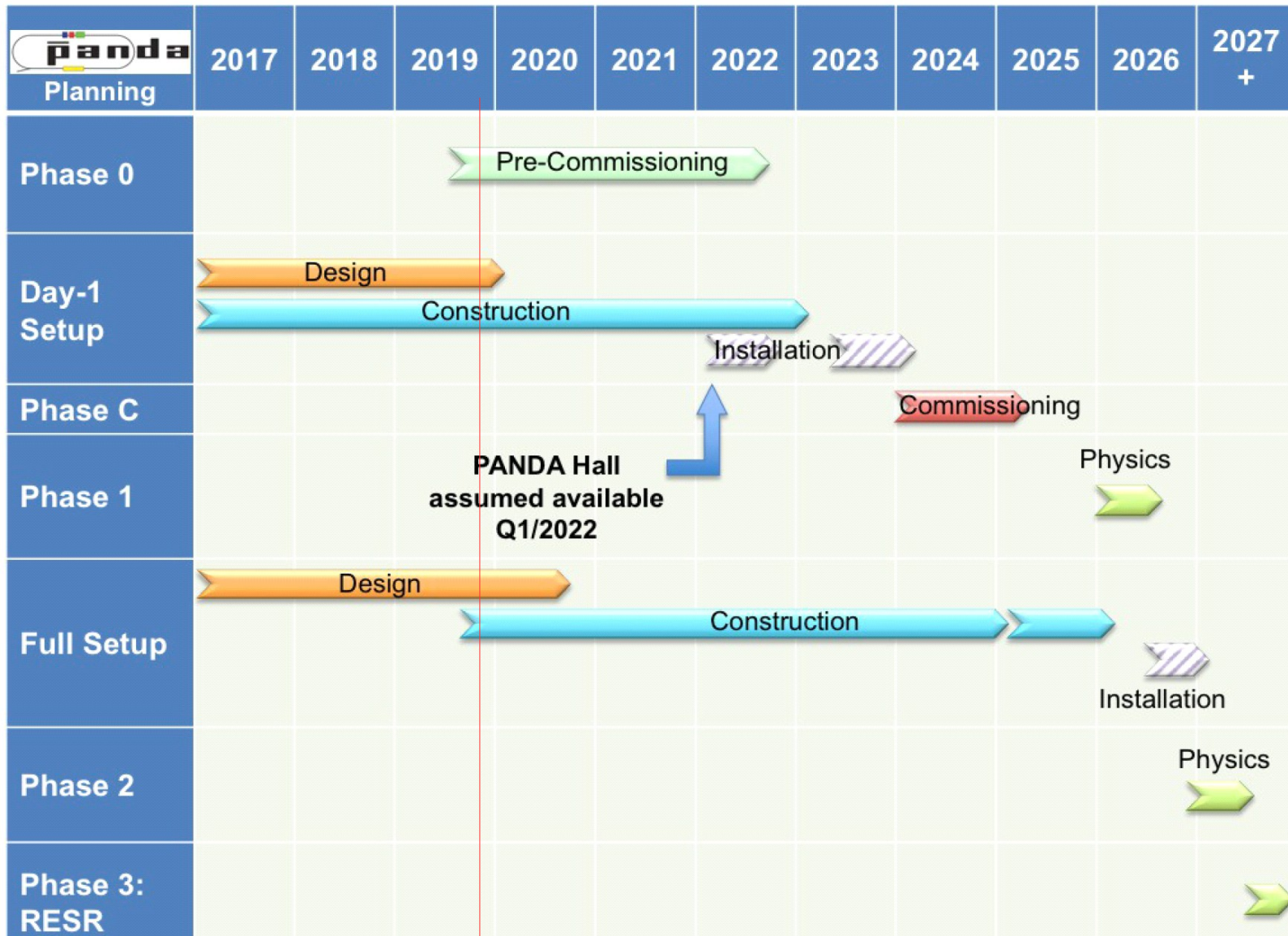
FAIR ECE 11,
GSI, November 4, 2019

Schedule and Day-1 Setup

Hall and Infrastructure

System Status

PANDA Schedule



• Construction of Phase 1 systems has started

Installation periods:

• 1/2022 - 8/2022: solenoid, dipole, supports etc.

• 5/2023 - 3/2024: all other systems

• Commissioning with protons 2025

• Start of physics with antiprotons 2026

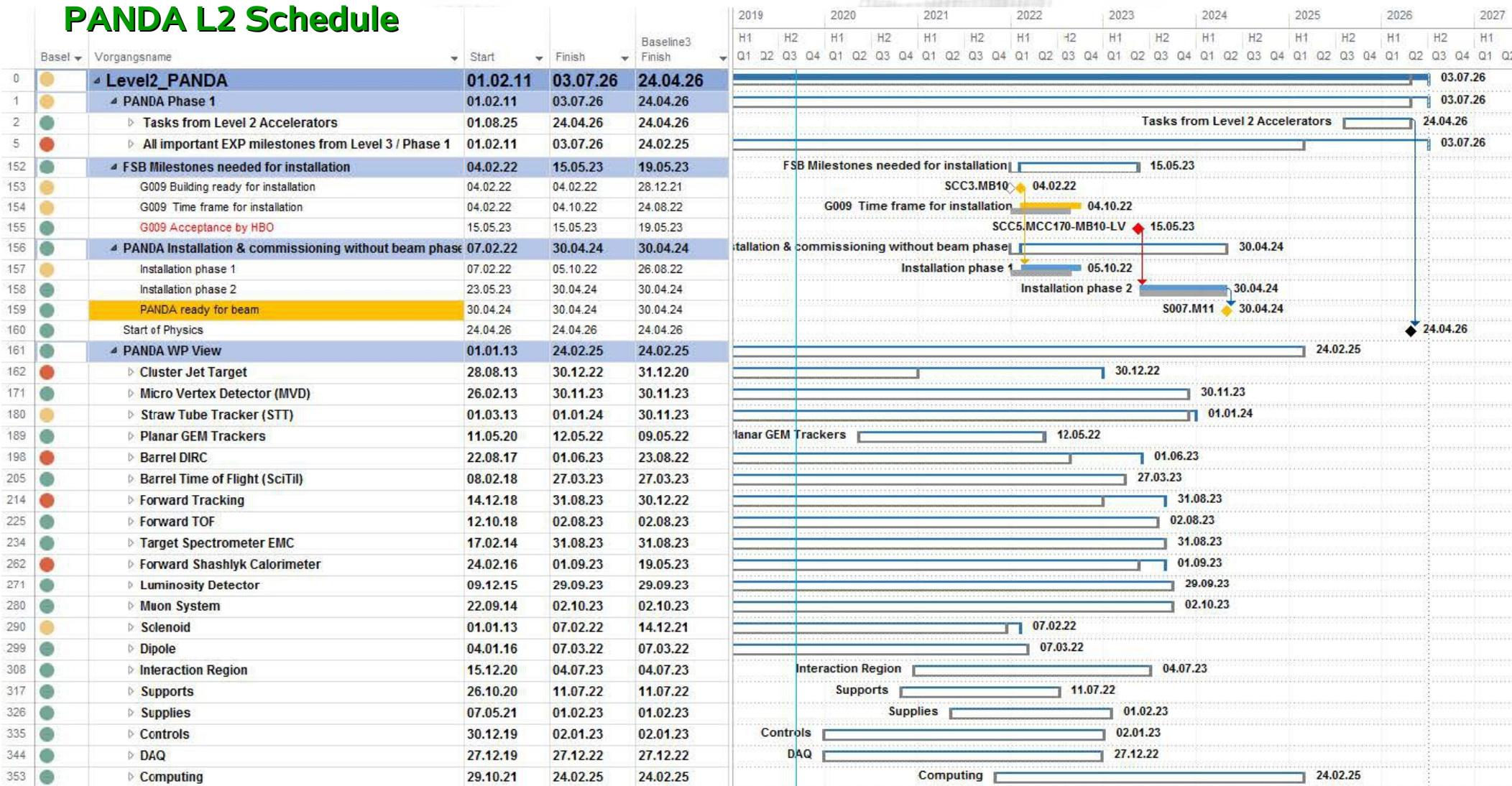
Today

Updates of Project Plans

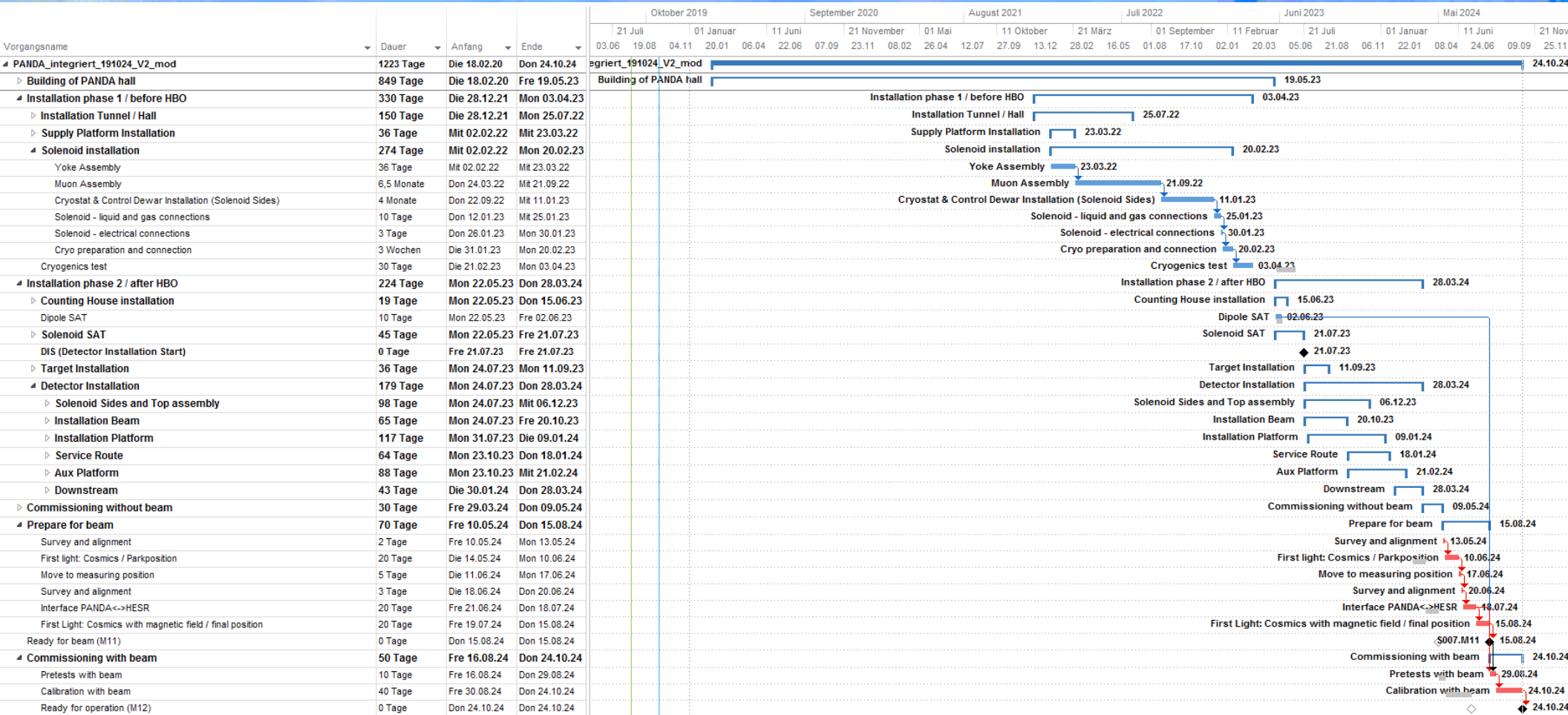


- Update of all FAIR project plans Dec 2018 - Re-baseline of all project plans
- PANDA update July 2019 – Milestones, Risks, Progress status, Scorecard

PANDA L2 Schedule



Installation Planning



- Start of installation phase 1: Q1 2022, start of magnet installation
- Building take over (HBO): May 2023
- Start of detector installation: July 2023, after Solenoid SAT
- End of installation, start of commissioning w/o beam: Q2 2024

TDR Status



System	Submission <i>Expected Submission</i>	<i>M3M3 (Approval)</i> <i>Expected M3</i>
PANDA PHASE 1		
Target Spectrometer EMC		08/08/2008
Solenoid		21/05/2009
Dipole		
Micro Vertex Detector (MVD)		26/02/2013
Straw Tube Tracker (STT)		29/01/2013
Cluster Jet Target		28/08/2013
Muon System		22/09/2014
Forward Shashlyk Calorimeter		03/03/2016
Barrel DIRC		20/08/2017
Barrel Time of Flight (TOF)		14/02/2018
Forward TOF		16/10/2018
Forward Tracking		16/10/2018
Luminosity Detector		04/04/2019
Controls	28/08/2019	<i>3/2020</i>
DAQ	<i>2/2020</i>	<i>8/2020</i>
Planar GEM Trackers	<i>3/2020</i>	<i>9/2020</i>
PANDA PHASE 2		
Endcap Disc DIRC	29/6/2018	<i>6/2019</i>
Forward RICH	<i>6/2020</i>	<i>12/2020</i>
Pellet Target	<i>3/2020</i>	<i>9/2020</i>
Hypernuclear Setup	<i>3/2020</i>	<i>9/2020</i>

Status 28/08/2019

Phase 1: 12 TDRs approved

- Luminosity Detector: approved Apr 2019
- **DCS TDR submitted end of Aug 2019**
- DAQT TDR draft in preparation
- GEM TDR much delayed

Phase 2:

- Endcap Disc DIRC: submitted to FAIR, review by ECE in final stage, early deployment of First-of-Series
- Pellet Target
- Forward RICH
- Hypernuclear Setup

For the items "Interaction Region", "Supports" and "Supplies" no TDRs are planned, only specification documents.

Computing TDR together with FAIR Computing TDR:
FAIR Computing CDR late 2019



Day-1 Scorecard Aug 2019

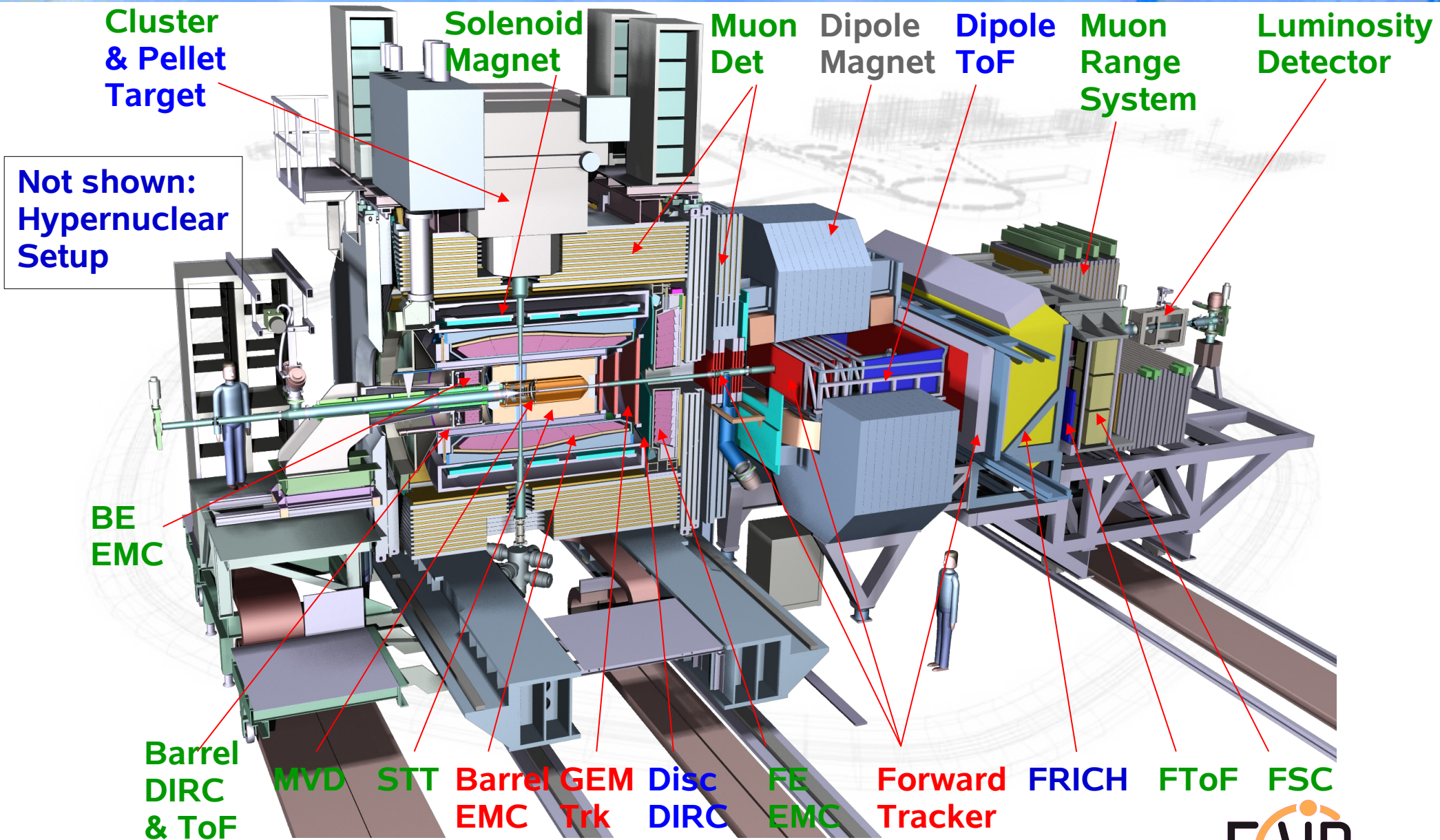


PANDA	TDR / Specs	Cost [k€ 2005]	% Funding (Sec / RUS / EoI / TBA)	Construction	Construction complete	Test/ Commissioning
Cluster Jet Target		771,00			08/2022	
Micro Vertex Detector (MVD) - Str		2.550,00			05/2023	
Micro Vertex Detector (MVD) - Pix		2.091,00			05/2023	
Straw Tube Tracker (STT) (1)		2.603,00			09/2023	
Planar GEM Tracker - 50%		555,00			03/2022	
Barrel DIRC		2.782,00			04/2023	
Barrel Time of Flight (TOF)		310,00			01/2023	
Forward Tracking (w/o FT 5/6) (1)		1.145,00			07/2023	
Forward TOF (2)		362,00			12/2021	
Barrel EMC System		8.001,00			03/2022	
Barrel EMC Crystals - 75% (2)		8.634,00			03/2022	
Backward Endcap EMC		1.309,00			06/2023	
Forward Endcap EMC		5.674,00			02/2020	
Forward Shashlyk Calorimeter (2)		1.447,00			06/2023	
Luminosity Detector		666,00			06/2023	
Muon Detectors (2)		2.318,00			06/2023	
Solenoid		5.800,00			10/2021	
Interaction Region		151,00			12/2022	
Infrastructure		4.006,00			01/2023	
DAQ Hardware (3)		1.350,00			12/2022	
	88% <i>value weighted</i>	52.525,00	67% 17% 15% 1%	31% <i>value weighted</i>		1% <i>value weighted</i>

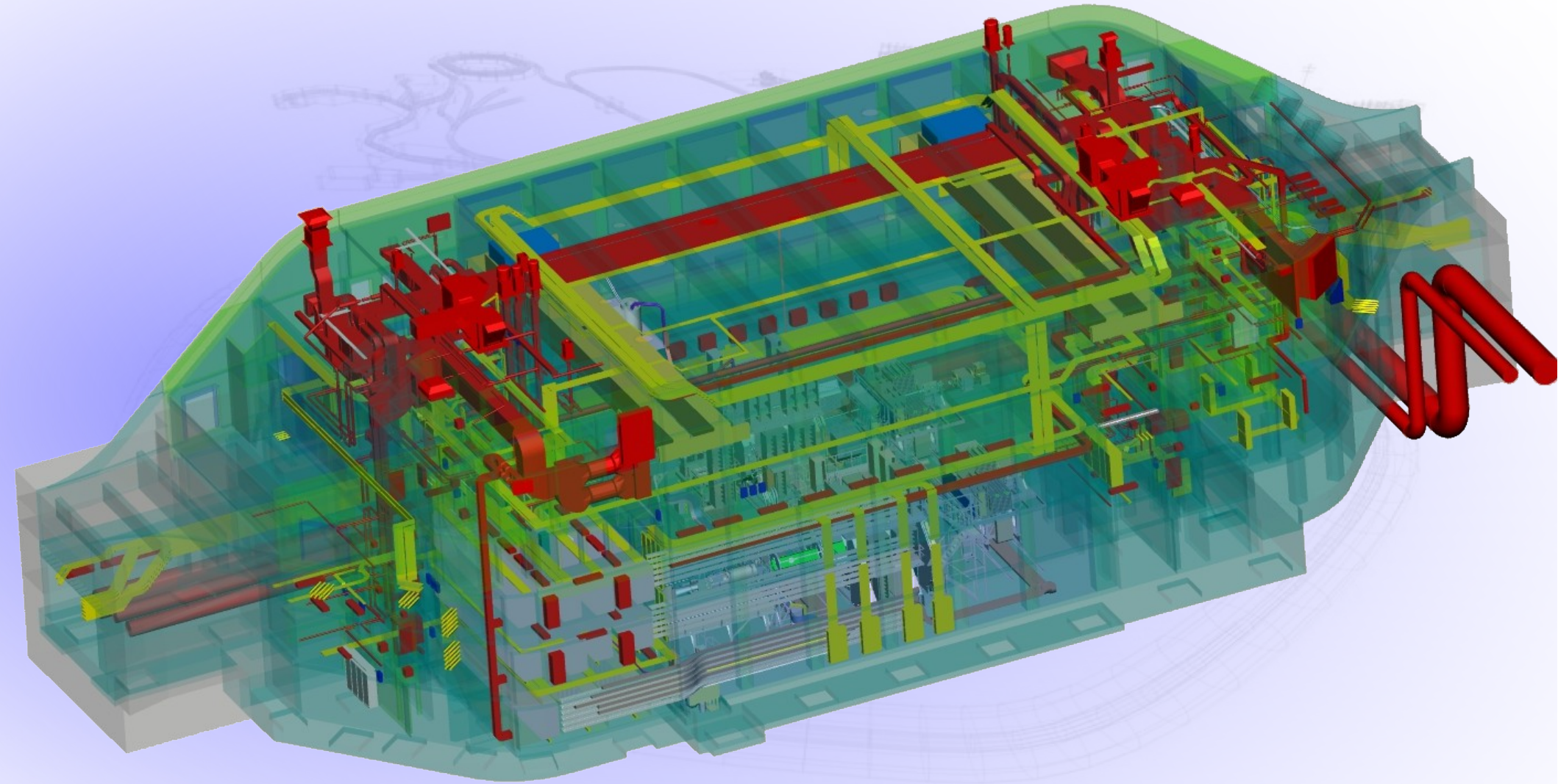
(1) if synergies between STT and Fw. Tracking realised
 (2) if German-Russian Roadmap realised

(3) DAQ computing via operation funds

PANDA Day-1 / Phase 1 / Phase 2



PANDA Hall and Infrastructure



Infrastructure Planning

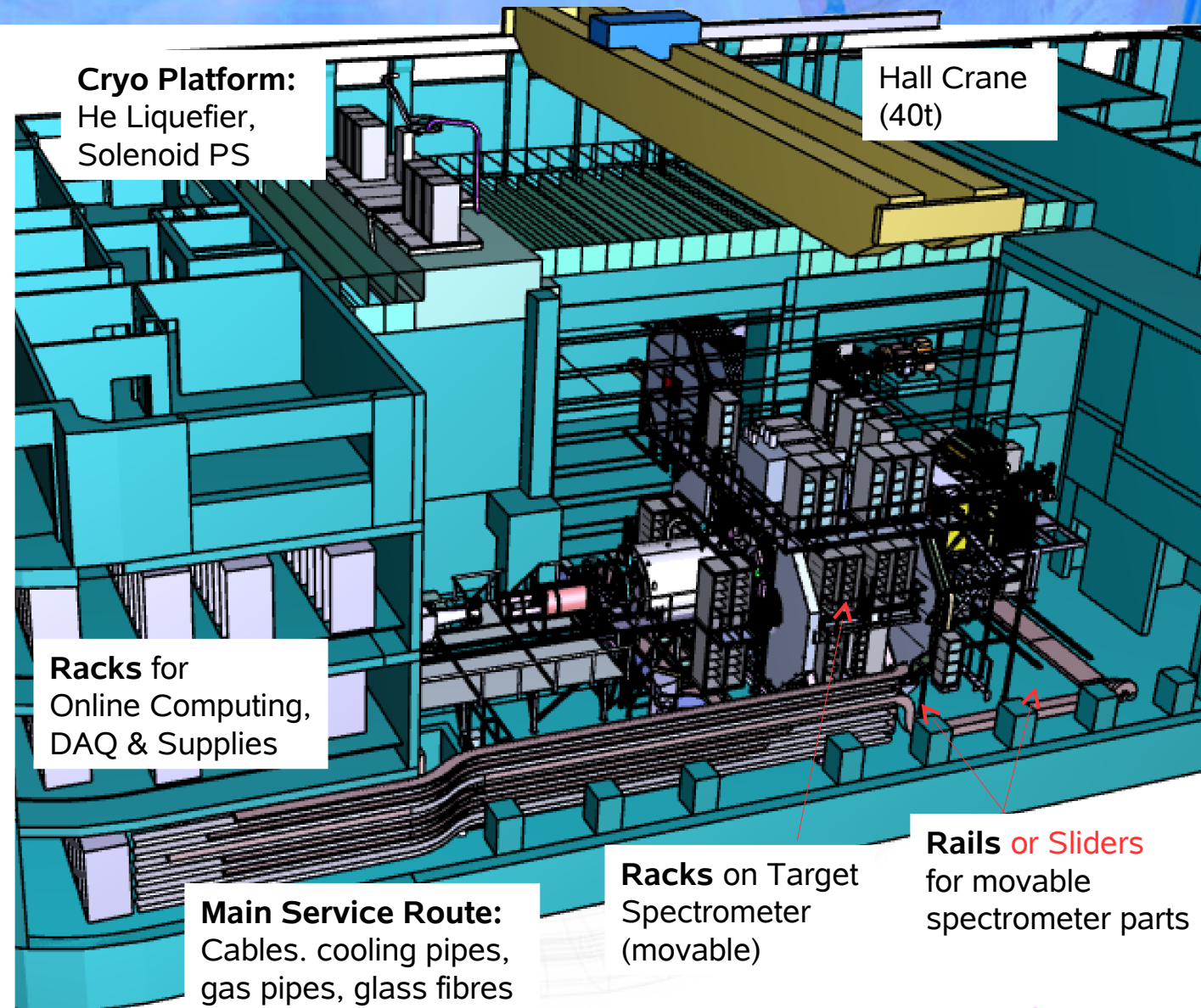


Infrastructure items

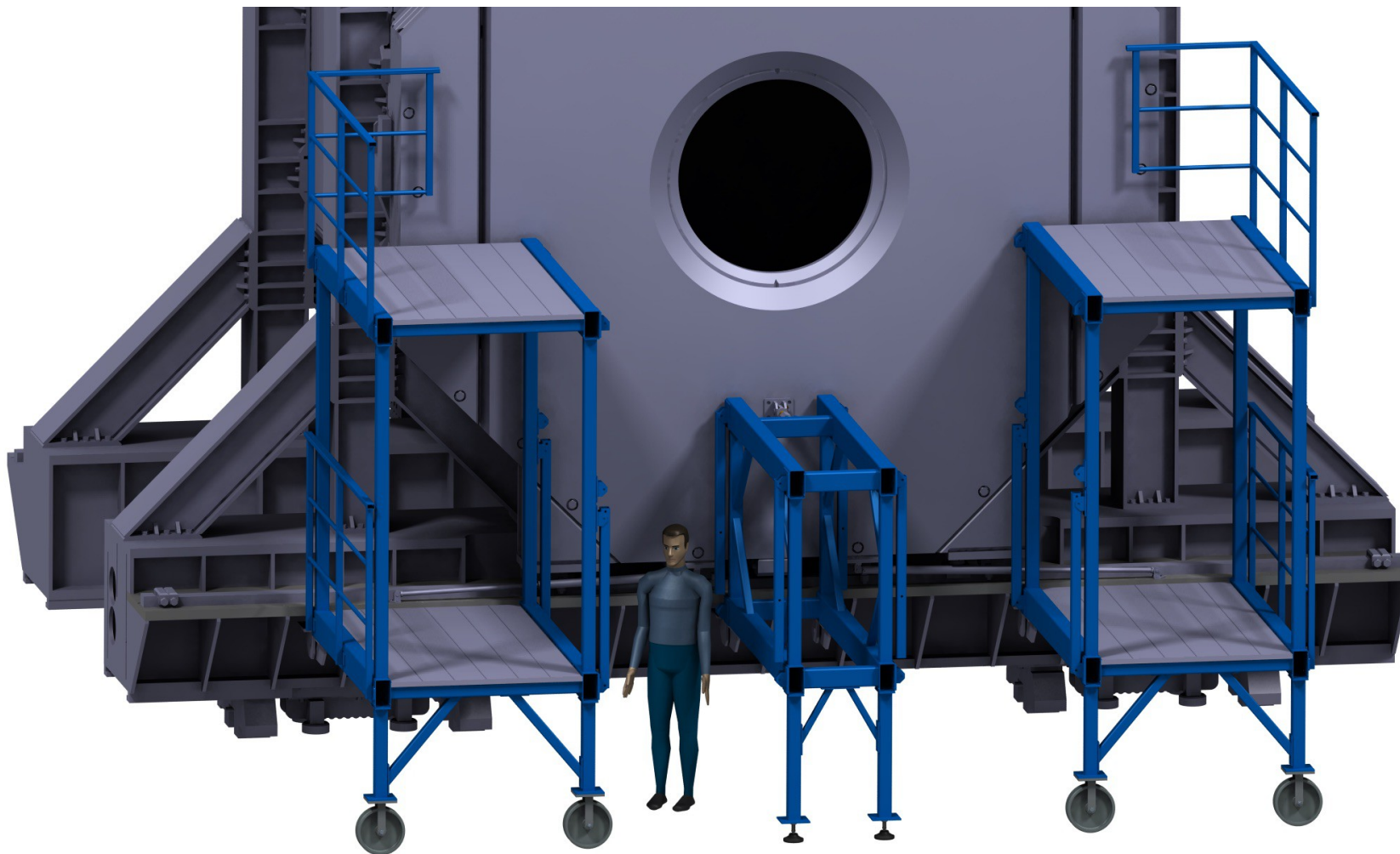
- Support structures
- Rails or Sliders
- Gas distribution
- Electrical power
- Cooling
- Service network
- Racks
- Infrastructure for control system

Assignments

- Experiment
- Civil construction (partial)

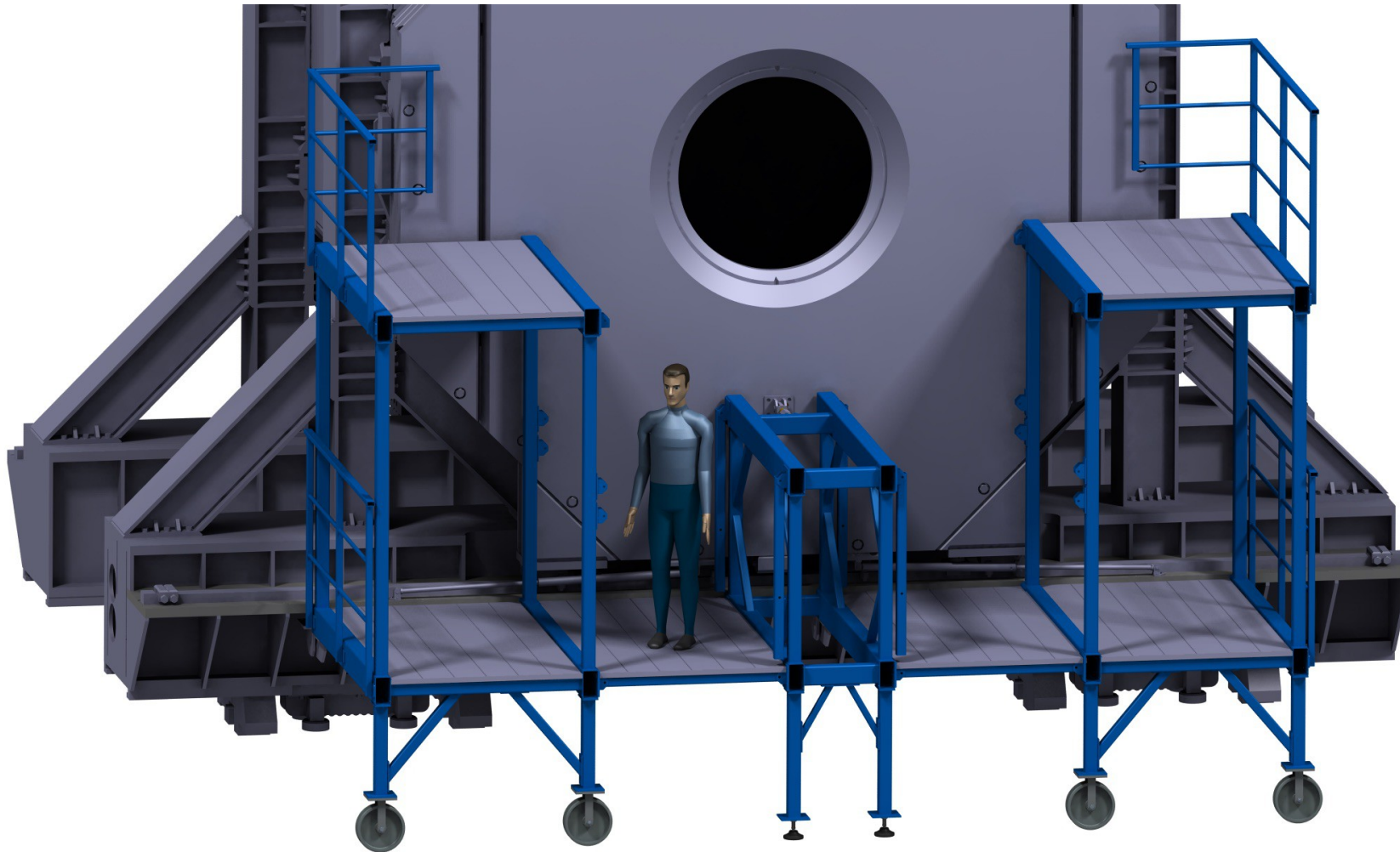


Support Structures and Platforms



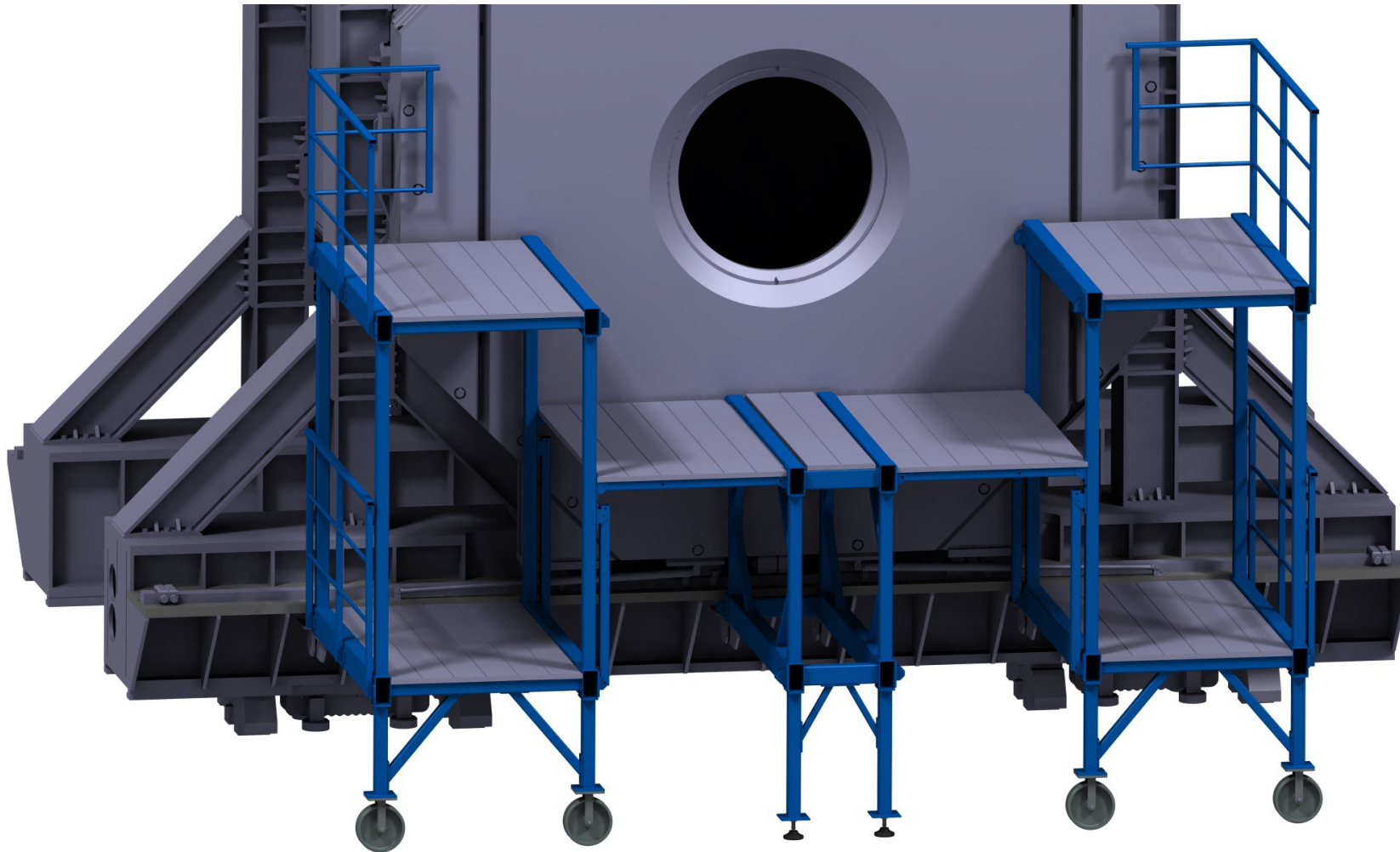
Auxiliary platform

Support Structures and Platforms



Auxiliary platform

Support Structures and Platforms



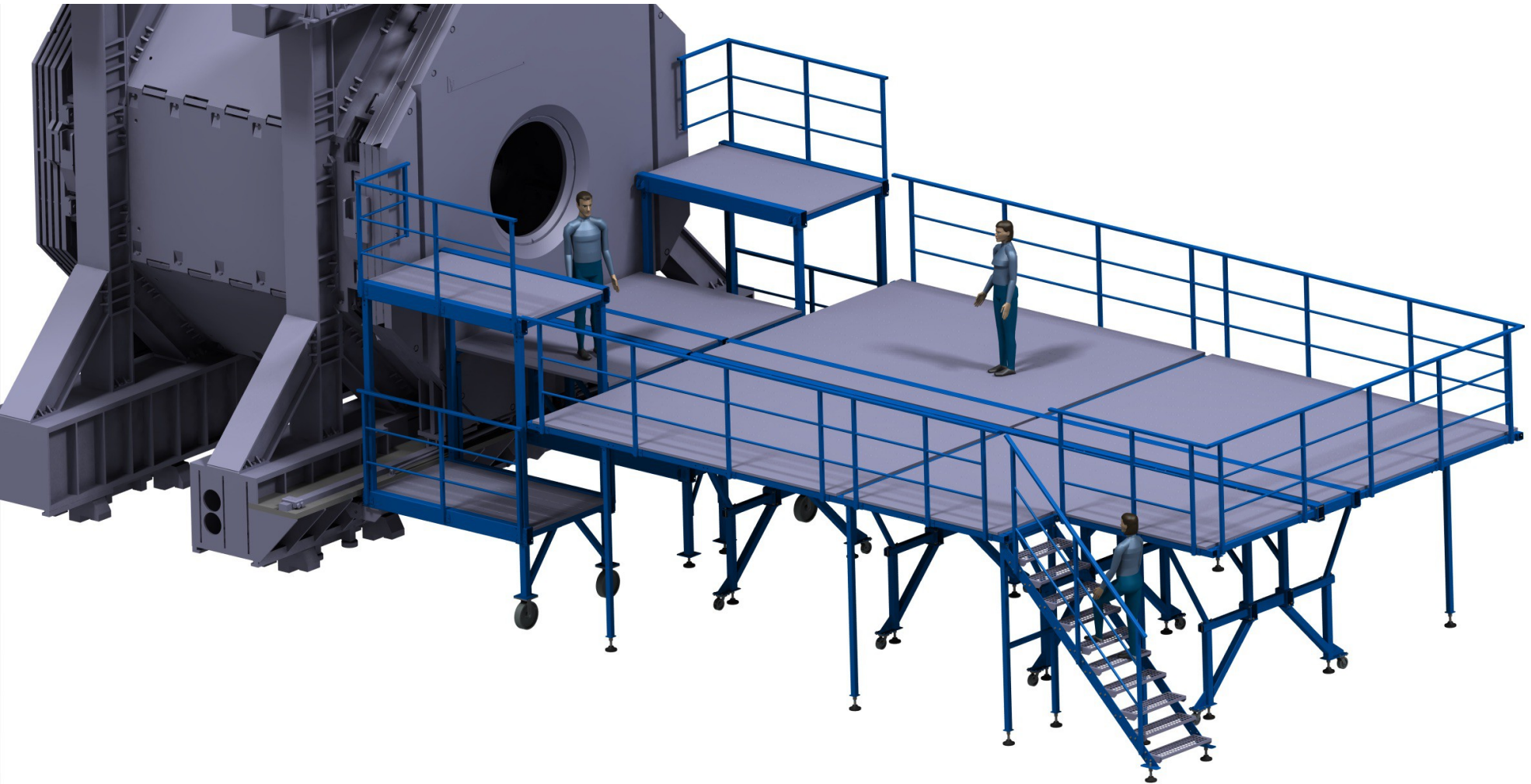
Auxiliary platform

Support Structures and Platforms



Auxiliary platform

Support Structures and Platforms



Auxiliary & installation platforms

Support Structures and Platforms

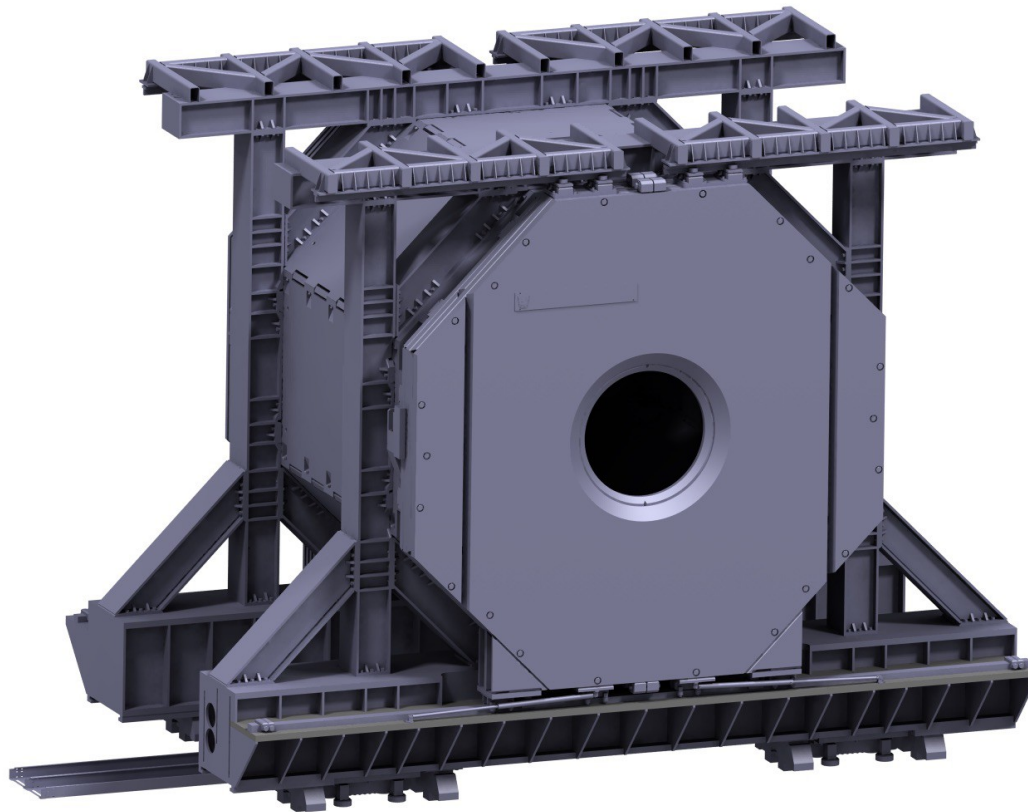


Installation platforms

Support Structures and Platforms

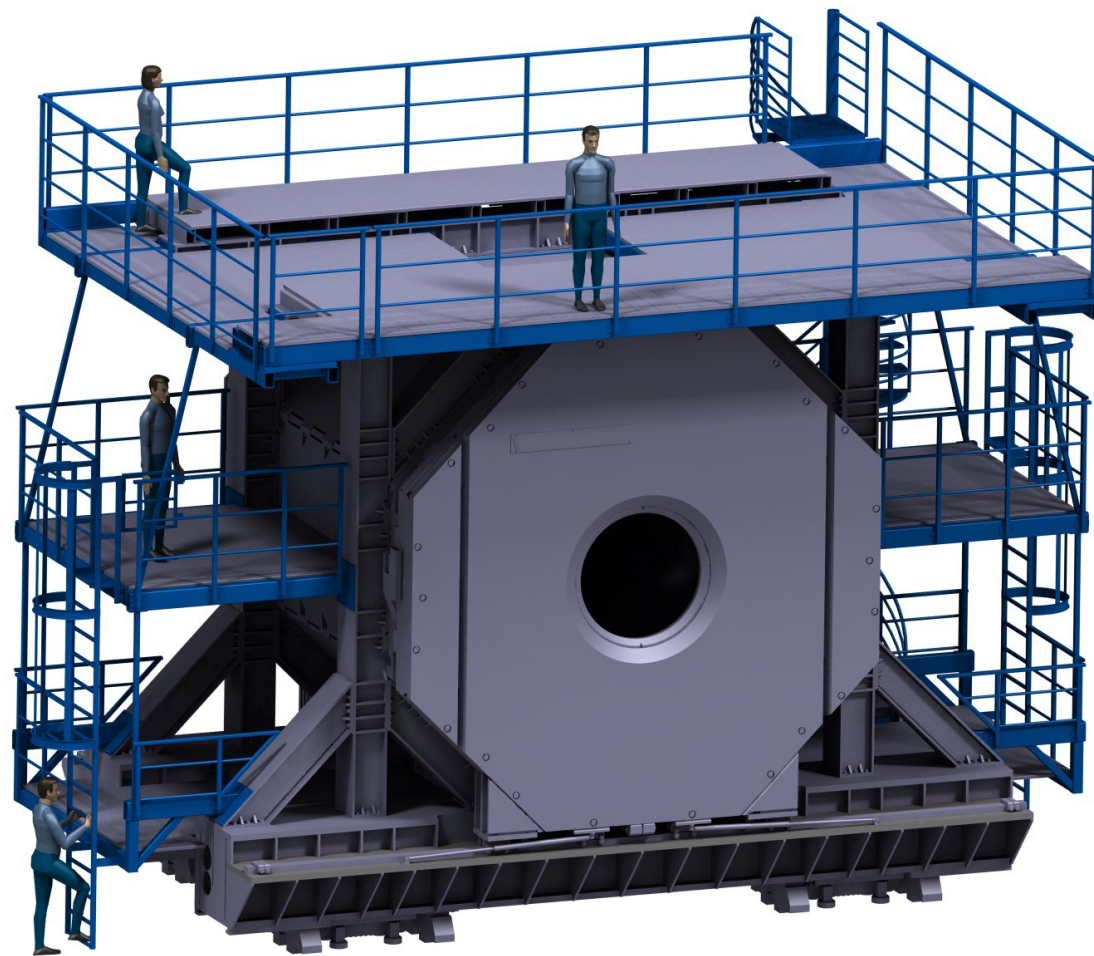


Installation platforms



Solenoid without supports

Support Structures and Platforms



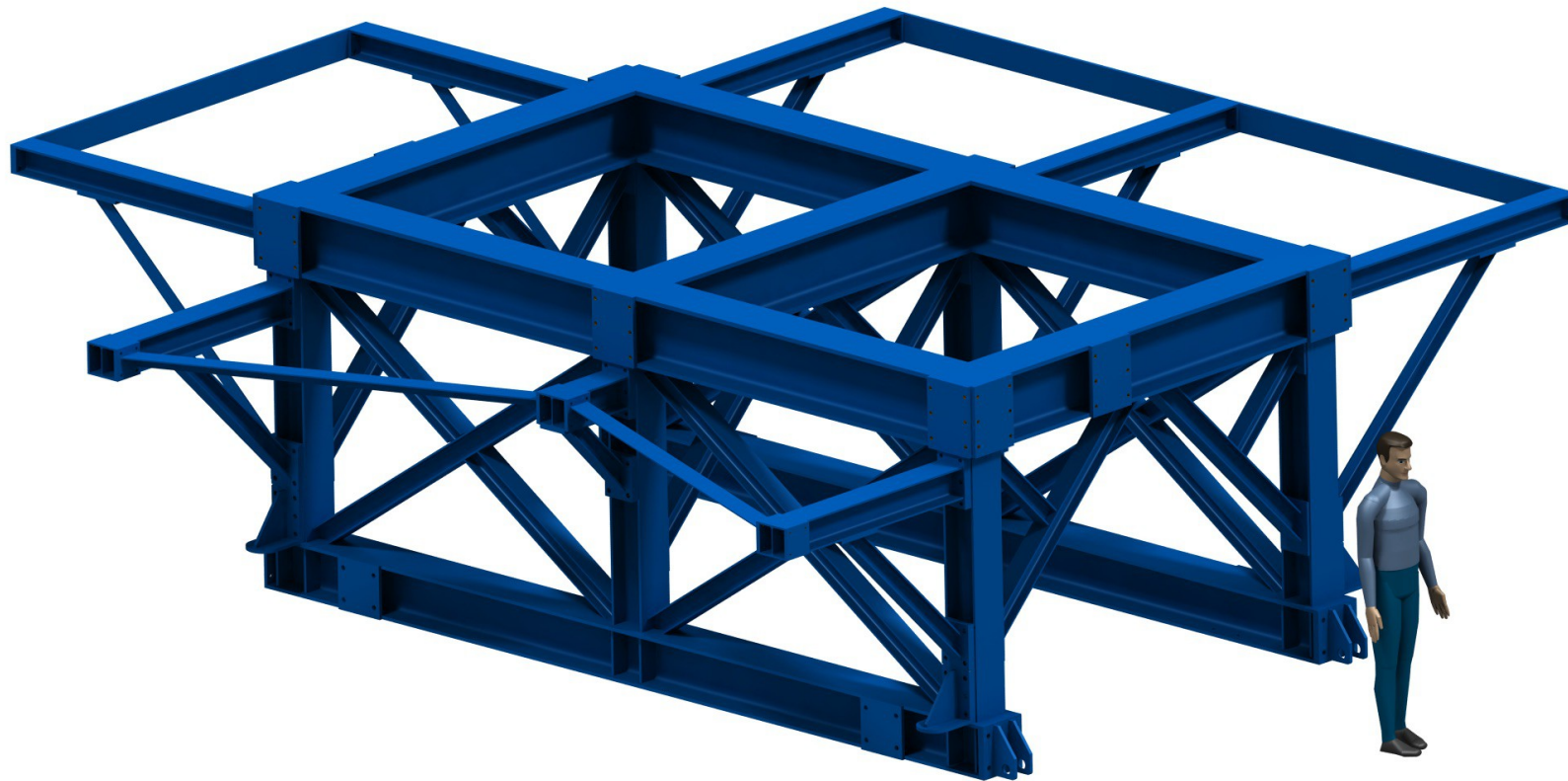
**Solenoid with rack supports
and top platform**

Support Structures and Platforms



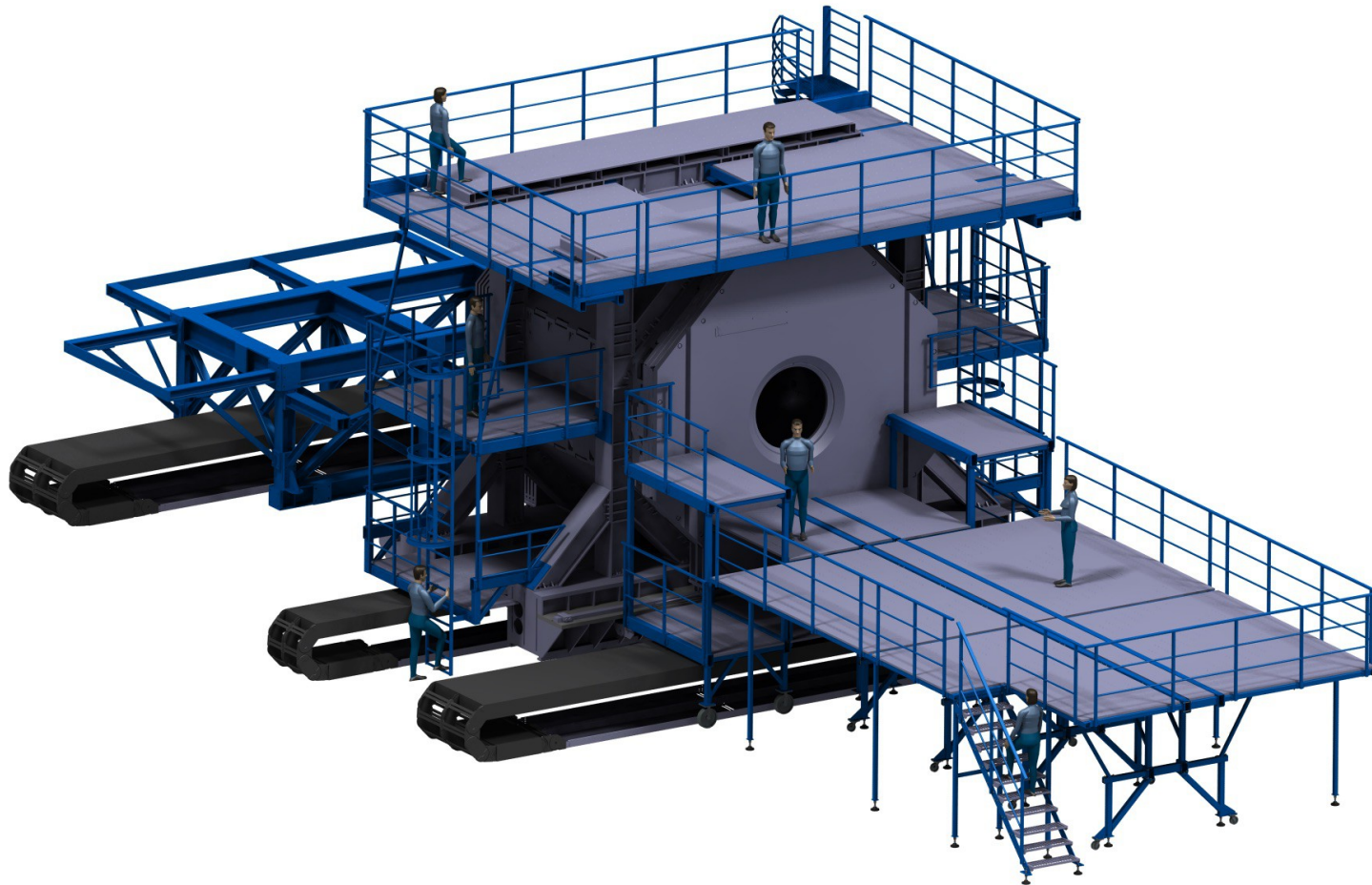
**Solenoid with rack supports
and top platform**

Support Structures and Platforms



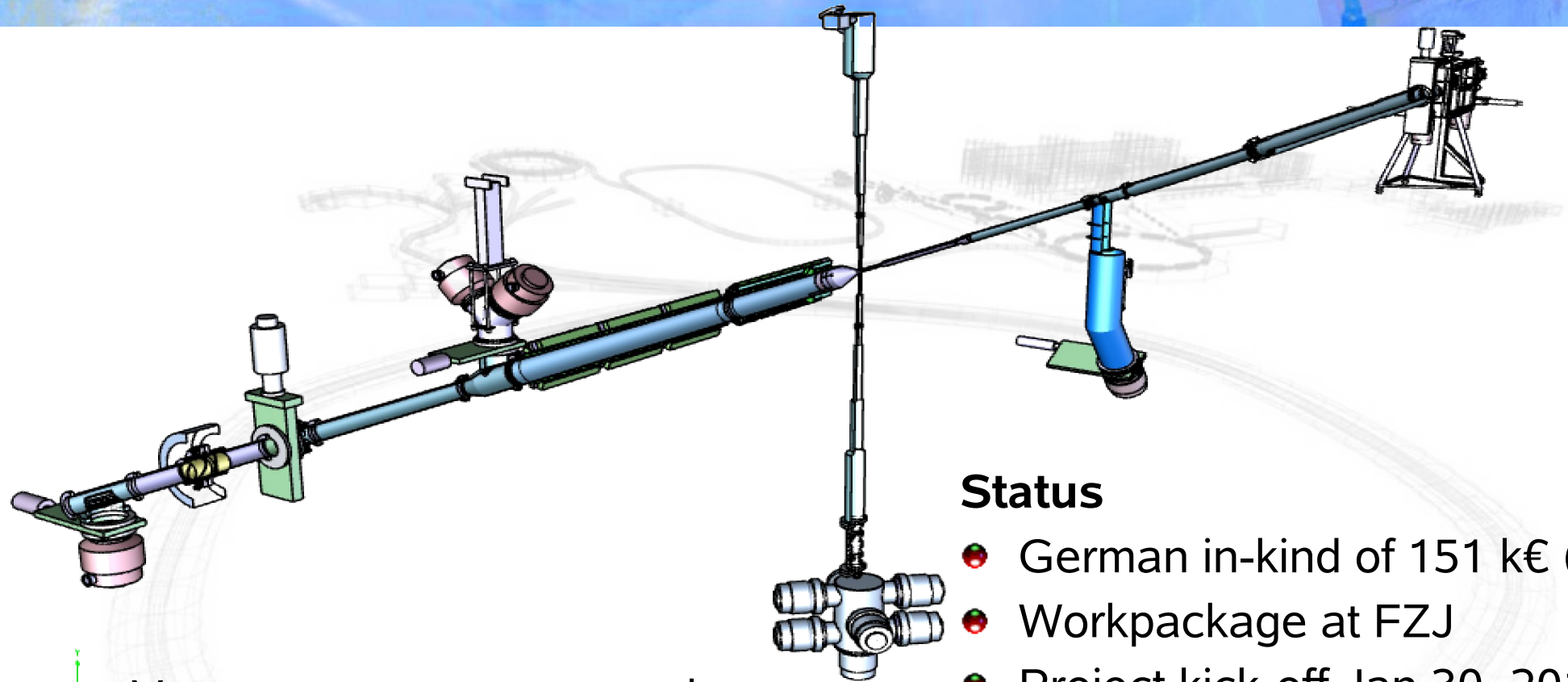
Forward platform

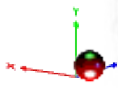




Support Structures and Platforms









**Solenoid with service drag chains
and all supports and platforms**

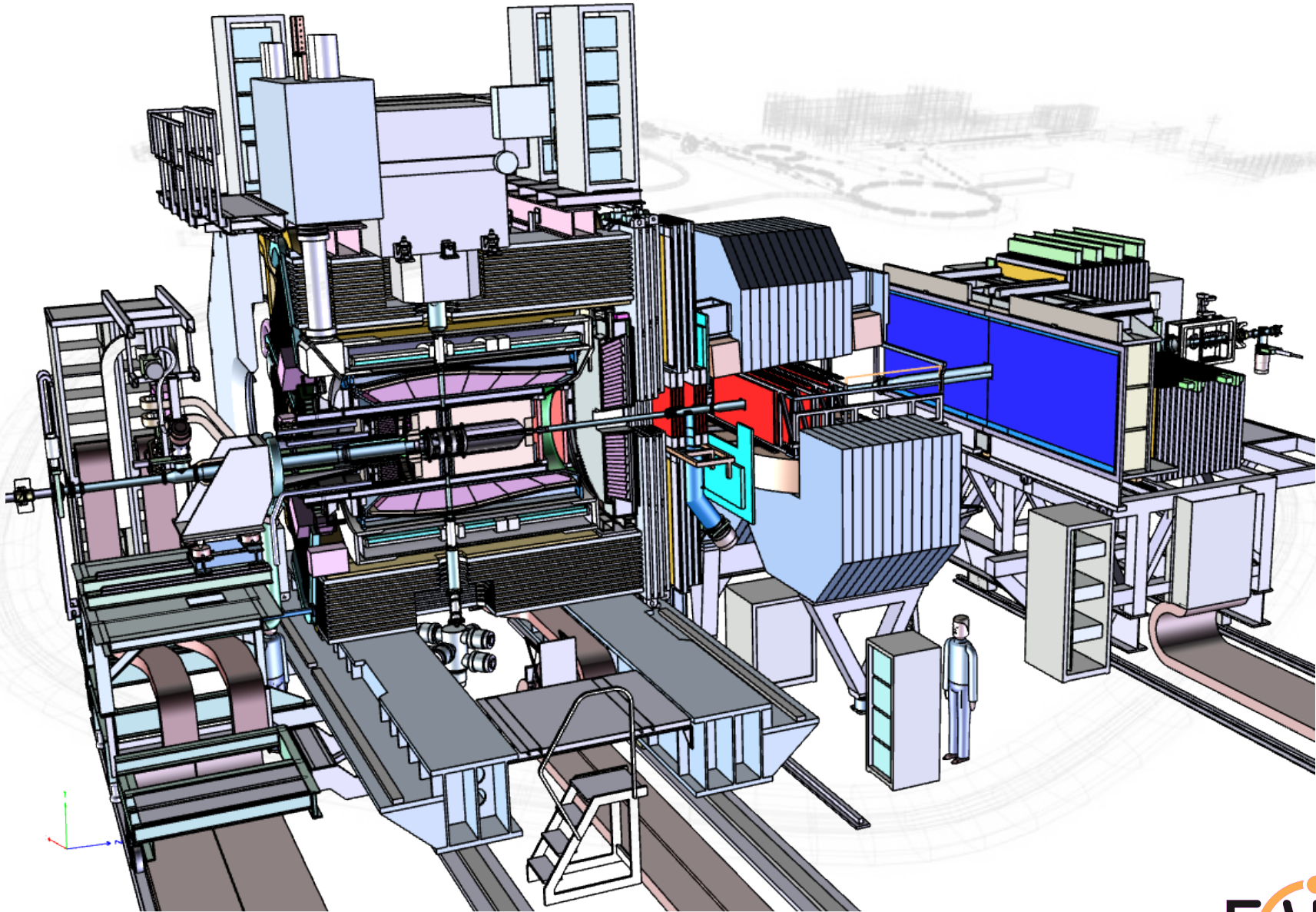
Interaction Region



-  Vacuum system, pumps, shutters
-  Beam pipe, target cross, flanges
-  Interfaces with detectors, target
-  Support for pipe, MVD services
-  Mounted on central space frame

Status

-  German in-kind of 151 k€ (2005)
-  Workpackage at FZJ
-  Project kick-off Jan 30, 2018:
ZEA-1 started development
-  **Prototype designs: Ti pipes**
-  **Follow-up meetings**
-  **Proposed Central Support to carry MVD services**





Solenoid Magnet

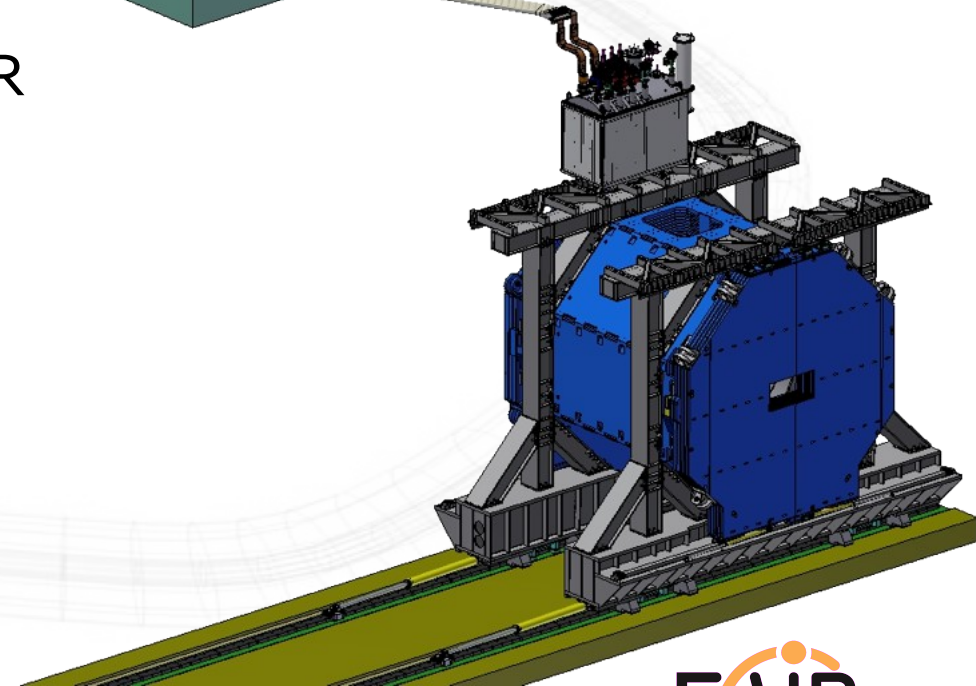
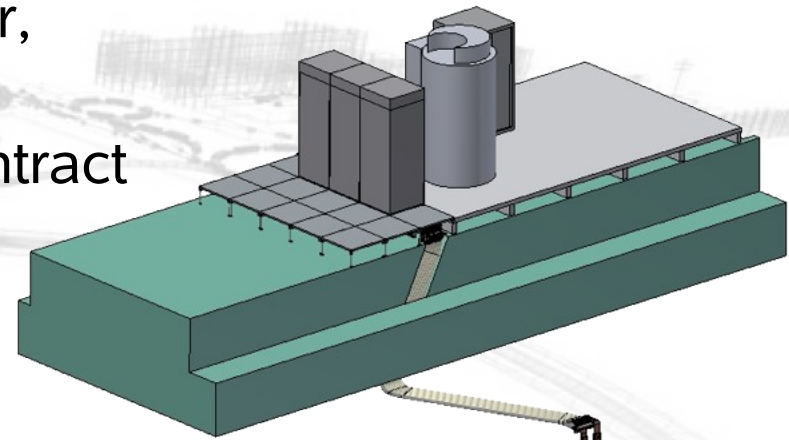


Project Status:

- New design with optimized conductor, sub-coils and outer winding (CERN)
- Scope: field mapping in separate contract
- Main contract signed in March 2017
- CERN team for technical follow-up
- All octants produced
- Cryostat, PS & Energy Extraction FDR

Critical Items:

- Superconductor procurement
- Schedule:
 - Installation at FAIR planned for Q1 2022
 - Field-mapping to be done before at BINP
 - Insertion of muon detectors



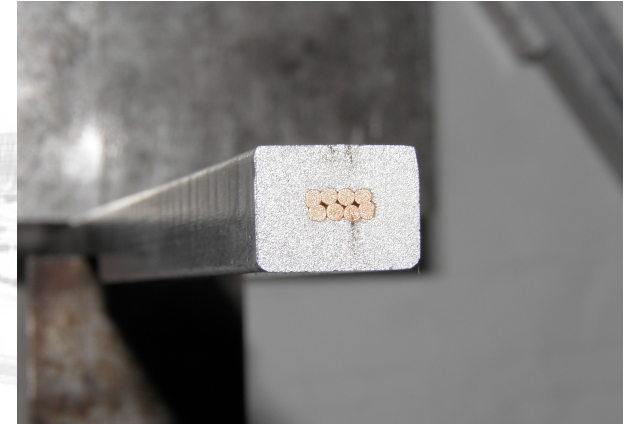
Solenoid Yoke Status



- All octants manufactured
- Door plates in preparation
- Components of platform ready
- Yoke test assembly in preparation:
 - adjustment shims for octants
 - flat area for assemble to be prepared
- Completion in Q1 2020

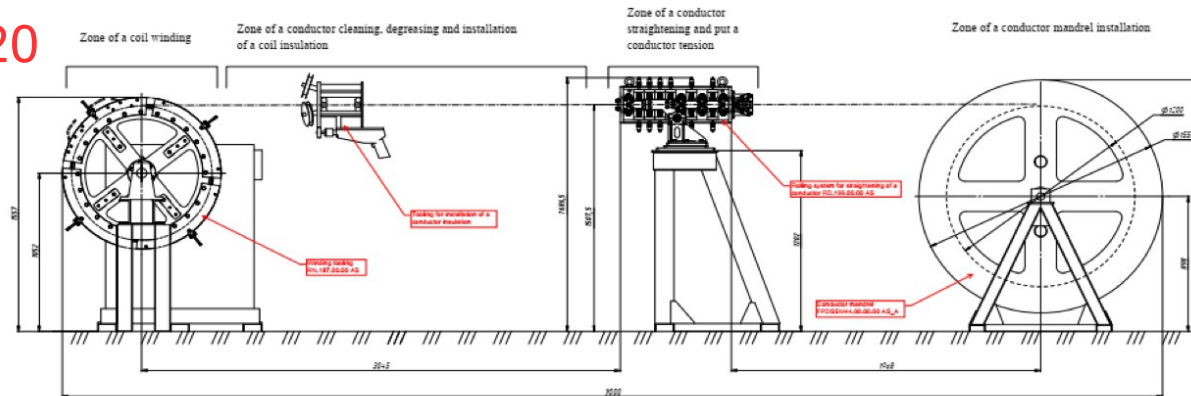
Superconductor:

- Furukawa currently cannot deliver, but is interested to provide parts
- Russian joint venture in R&D phase, BINP & Russian Institutes
- Several prototype runs of extrusion
- Final pure Al / SC cable end 2020



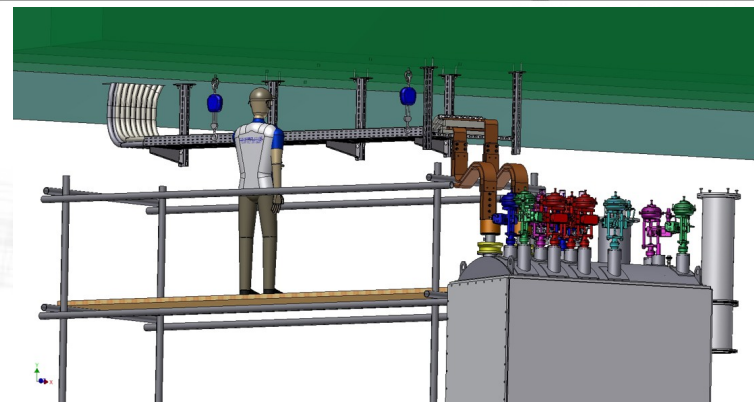
Cold mass and coil winding:

- Procedure defined
- Tooling in production
- Next step: dummy coil
- Local cryogenics: 1st design review



Electrical systems:

- Procurement of material
- Planning of power cable layout





Cluster Target



Status:

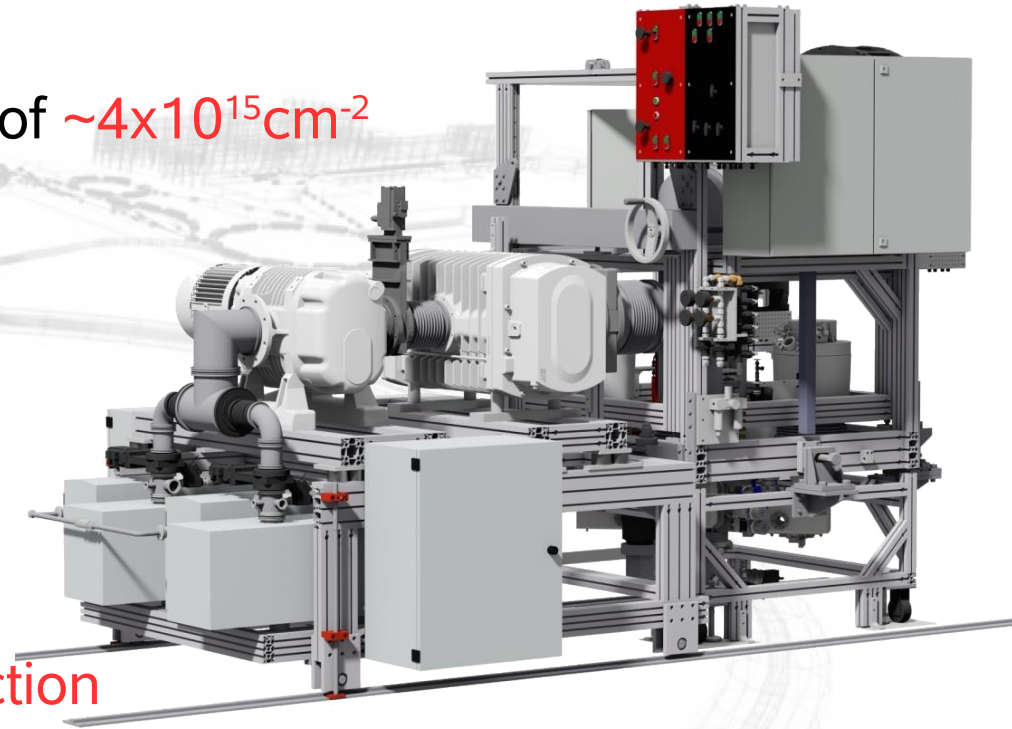
- Well advanced, world record density of $\sim 4 \times 10^{15} \text{cm}^{-2}$
- PANDA target from U Münster, now at COSY for extended tests
- Production of new nozzles
- Gas purifier replaced

Current work:

- Tests at COSY since Aug 2018
 - realistic tests of beam-target-interaction
 - commissioning successful: energy loss, beam lifetime, HF feedback
- Development of PANDA Slow Control

Critical:

- Vacuum at PANDA IP, interfaces with beam-target pipe, interaction region (FZJ)





Micro Vertex Detector



MVD (TDR M3 2014)

- Barrel: 2 pixel layers, 2 strip layers
- Forward: 6 disks, 2 mixed strips and pixels
- Advanced mechanical engineering
- ToPix ASIC prototype with full functionality

But slowed down in 2016/17

First priority: strip barrel

- New 64 ch ASIC ToASt in design
- Submission late fall 2019

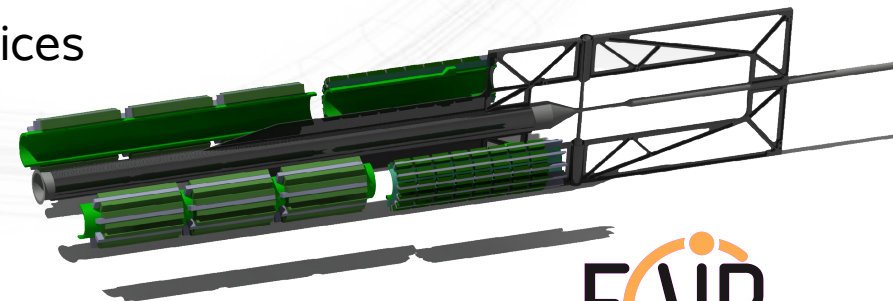
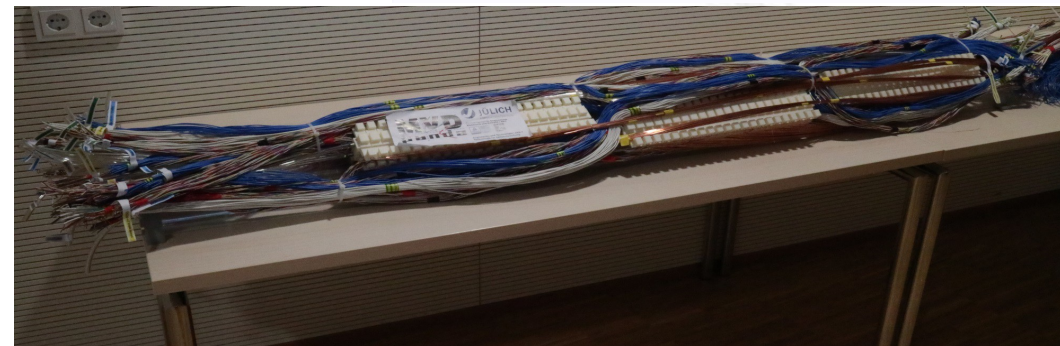
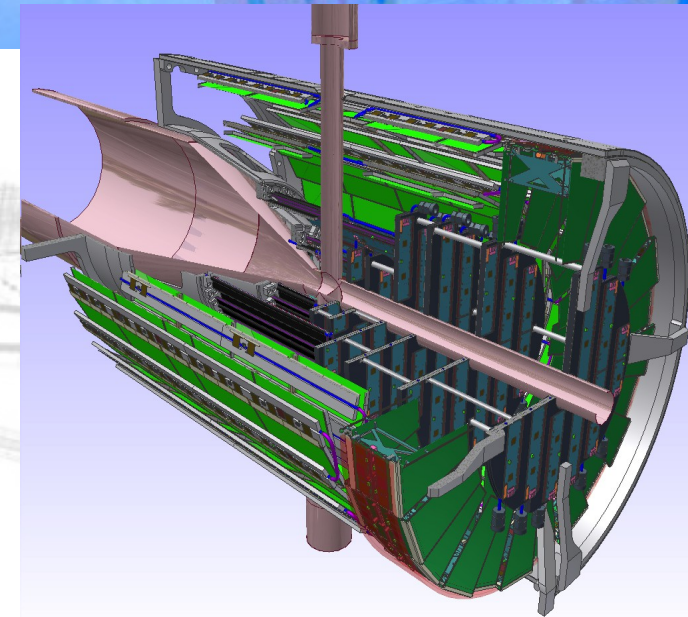
Open issues:

- Pixel part from Italy not yet funded,
- Mitigation strategy pixels for Day-1
- Services of MVD within BWE EMC



→ boundary conditions fixed by mock-up of services

- New Central Space Frame design reduces load on beam pipe (GSI)





Straw Tube Tracker



System status

- Straw production finished
- Module assembly starting 2020
- Prototype frame installed
- **Open WPs (formerly Italy):**
 - support frame, rails & gas system

Electronics Candidates:

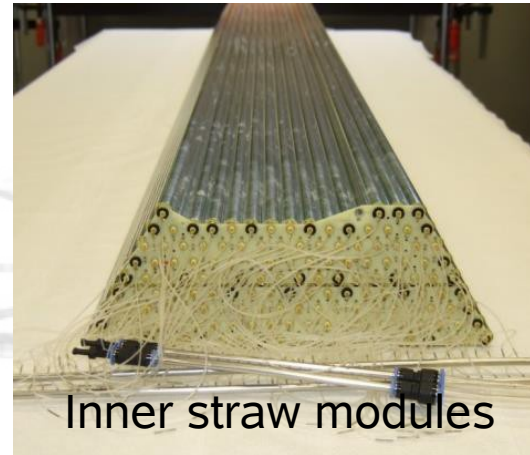
- PASTTREC ASIC + TRB TDC:
- Sampling ADC: time and pulse area
- Day-1 approach: ASIC/TRB for STT and Forward Tracker
- **Contract ready for signature**

Phase 0 Activities

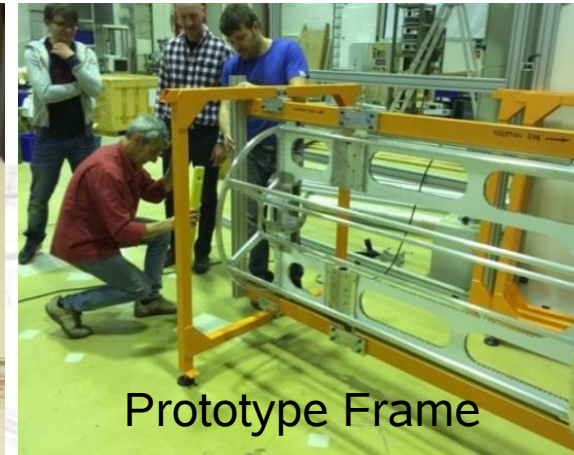
Straw Tracker Station for PANDA@HADES
Q3/2019, 20 modules, 640 ch., → FT3/4

Critical Items

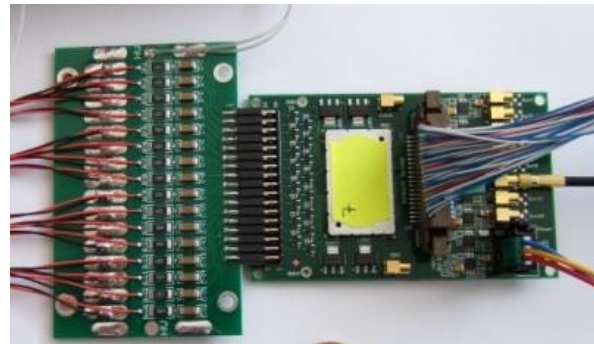
- Mechanical support production design
- PASTTREC FEE mechanics layout



Inner straw modules



Prototype Frame



PASTTREC card



HADES-PANDA
Straw Tracker Station 1



Forward Tracker



Technical Design:

- Straw tubes very similar to STT
- 6 stations with 4 projections each
- Modular design
- TDR approved by FAIR Oct 16 2018
- Assignment by FAIR Council
- Contract in preparation

Prototyping:

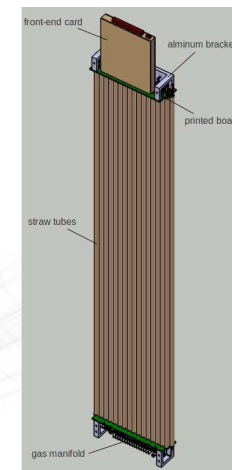
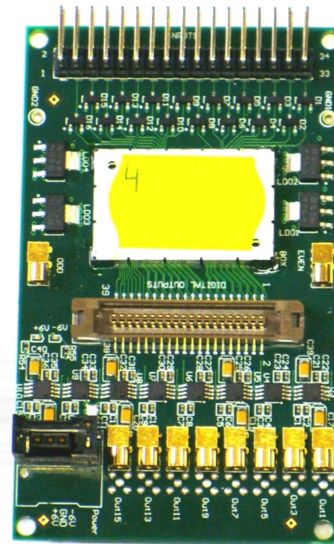
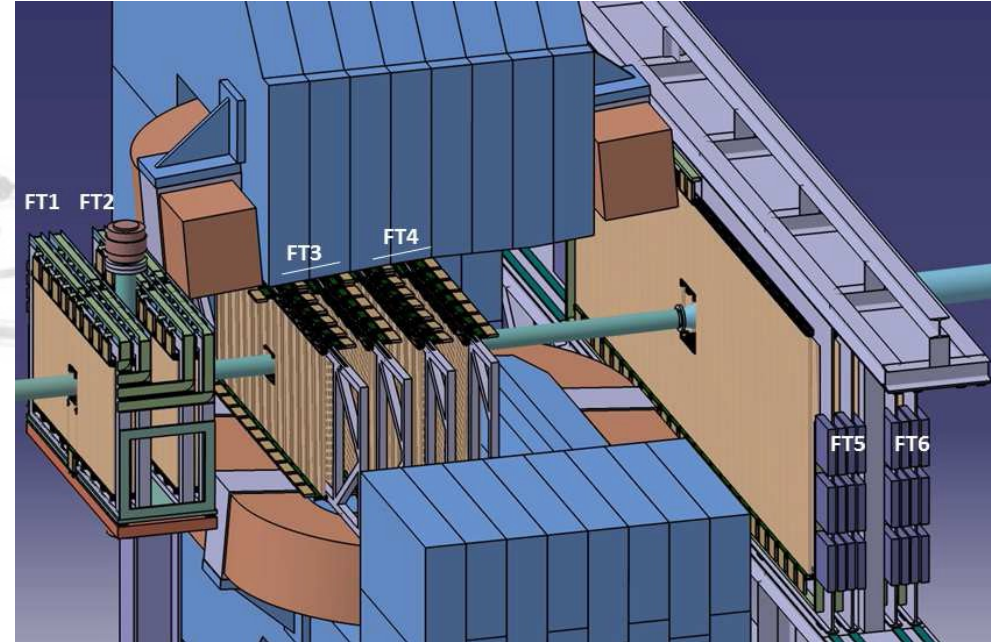
- Half plane of FT5 chamber (12 mod)

Phase 0 Activities:

- Straw Tracker for HADES based on FT5

Reduced Day-1 setup:

- Staging of setup: FT1-4 or FT1/2/5/6
- Not all stations funded yet
- Replacement by LHCb OT considered



Modular layout





Barrel DIRC



Baseline design

- Fused silica (SiO_2) radiator bars and prisms
- MCP PMT for readout
- Focusing by 3-layer spherical lenses
- Fast readout to suppress BG

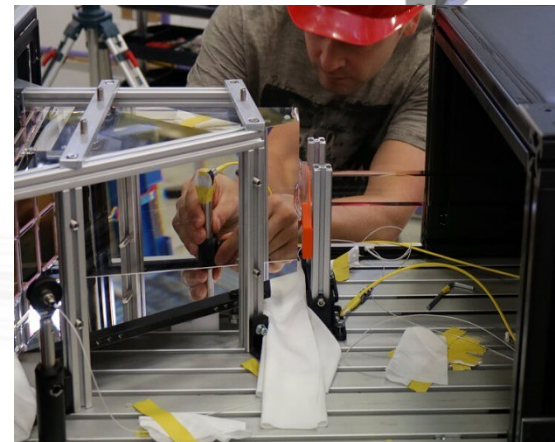
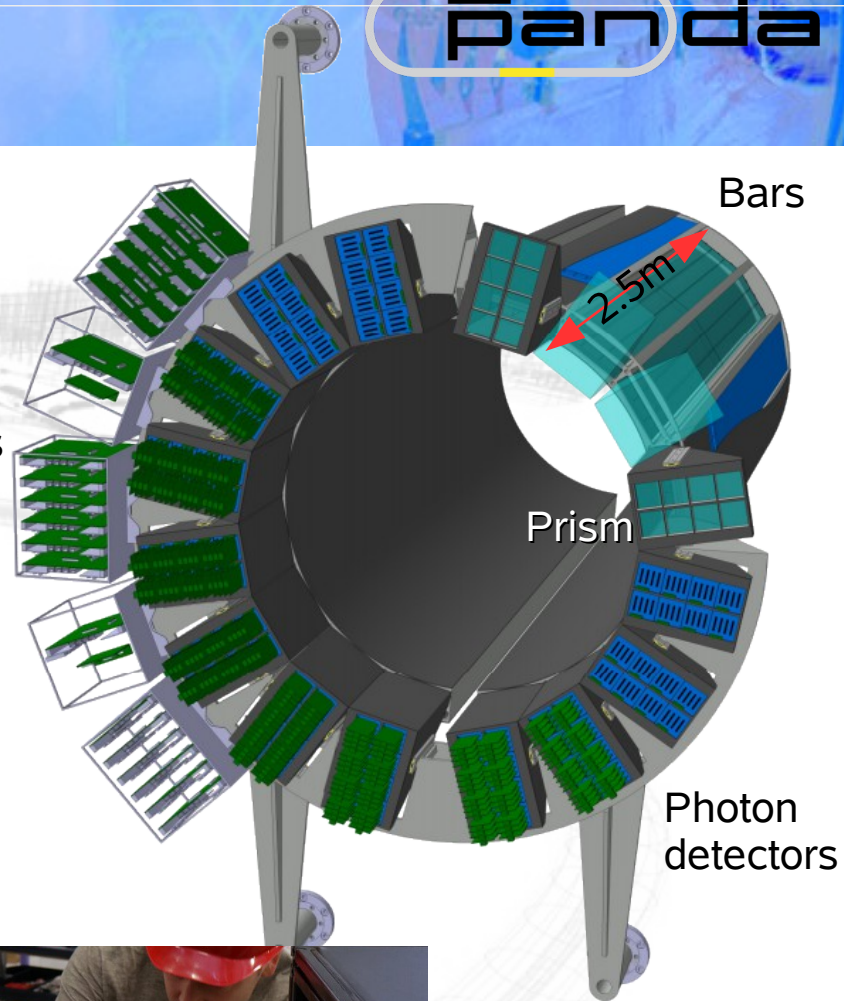
Testbeams at CERN:

- Several campaigns with improved prototypes
- Measured results agree well with simulation
- Optimisation of readout options
- π/K separation of 4.3σ reached

Project status

- Baseline design verified
- Plate radiator shows lower performance
- TDR approved in Aug 2017
- Procurement of bars awarded to Nikon
- Tender for PMTs ongoing
- Mechanics and optics production design
- Readout with DIRICH electronics - tests started

Electronics



Prism in testbeam
July/August 2018



PWO Crystal Production

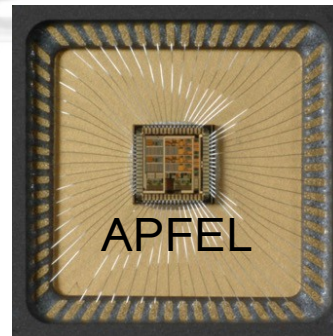
- Good prototypes from CRYTUR
- Funding issue for remaining crystals
- Start of first batch in 2018: complete one more slice

Barrel progress

- All alveoles produced
- APD readout ASIC produced
- **First slice construction complete, finalisation of cooling circuitry**

Critical issues:

- Timely crystal production
- APD production and screening
- Partial installation 12/16, placeholder mechanics
- **Impact on inner systems of TS**



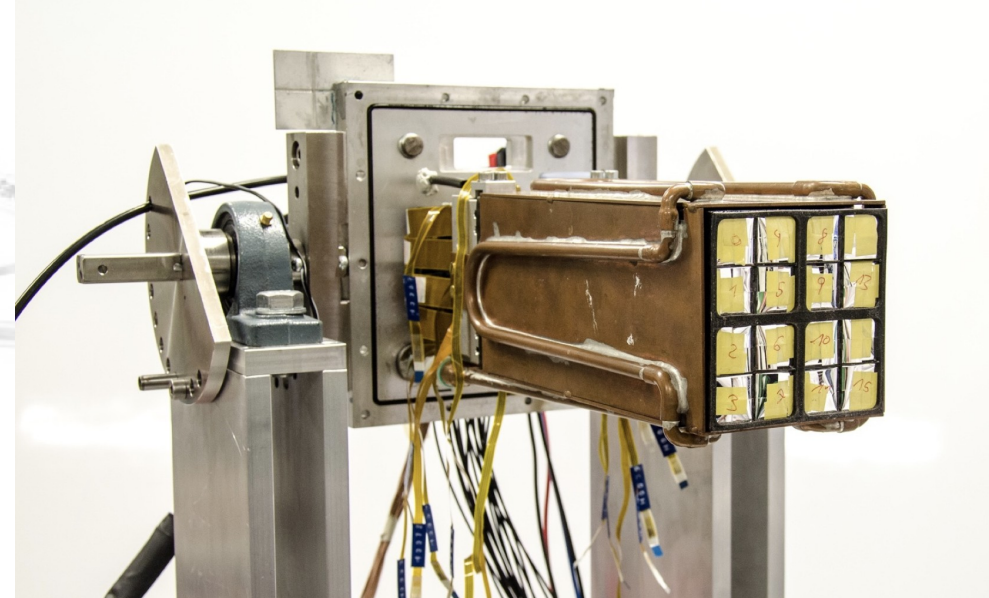


Backward Endcap EMC



Current status

- Layout of alveoles done
- Full implementation in simulation
- Feature extraction algorithms
- Cooling design and simulations
- Testbeam activities at MAMI
- Tests of new HitDetection ASIC
- PRR on series production of modules

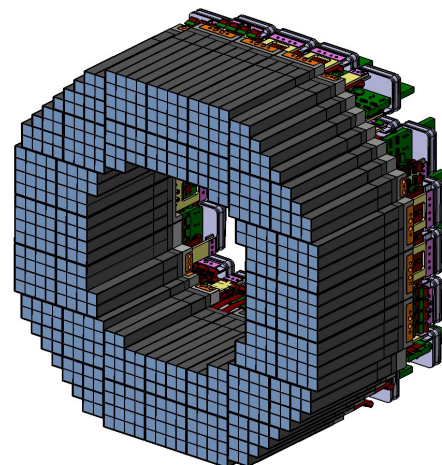


Critical issues:

- Final boundary with MVD
- Interaction with STT FEE

Further steps:

- Planning of Phase 0
- Finalization of layout



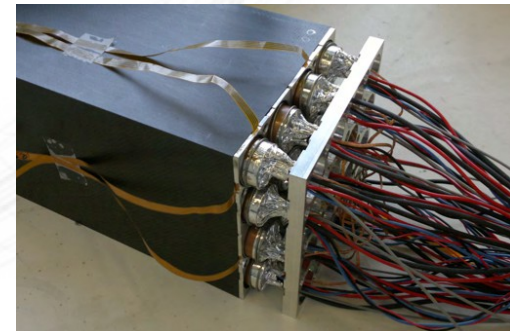
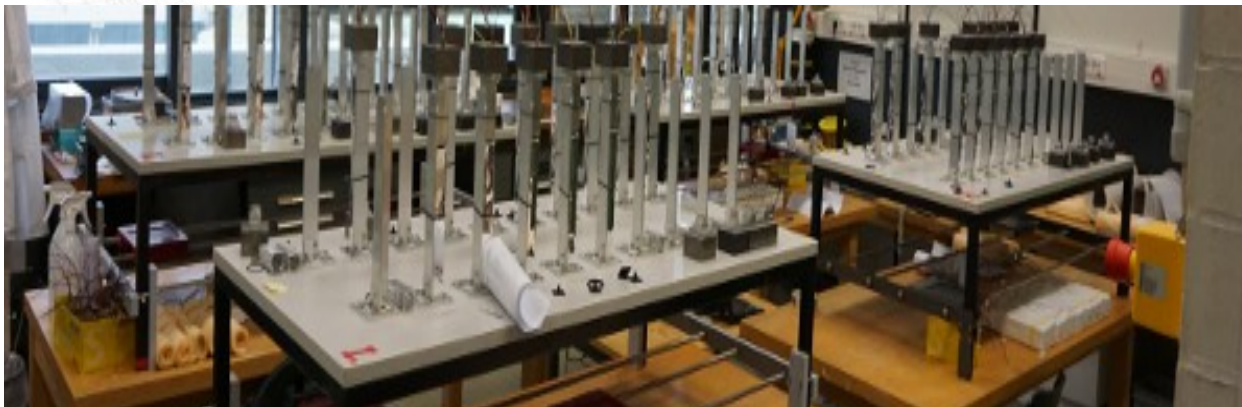
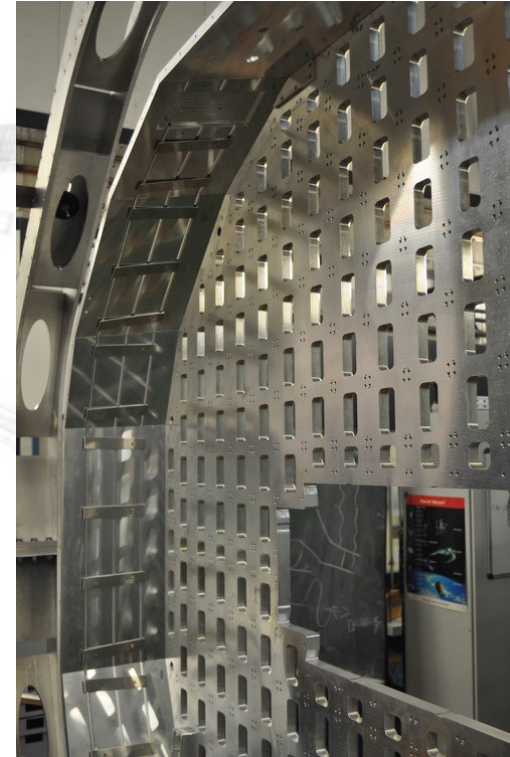
BWE EMC
alveoles



Forward Endcap EMC

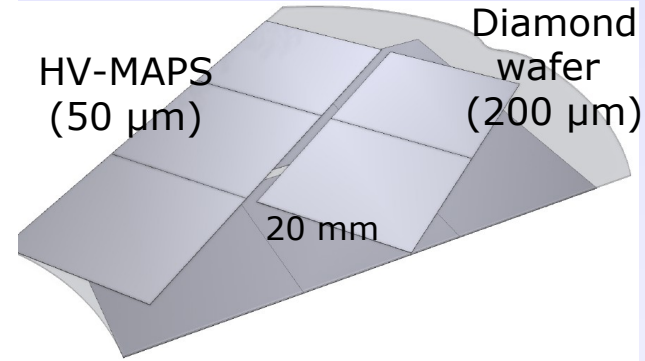
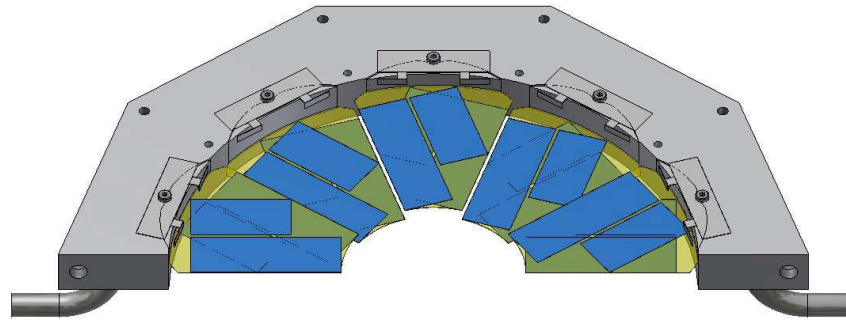
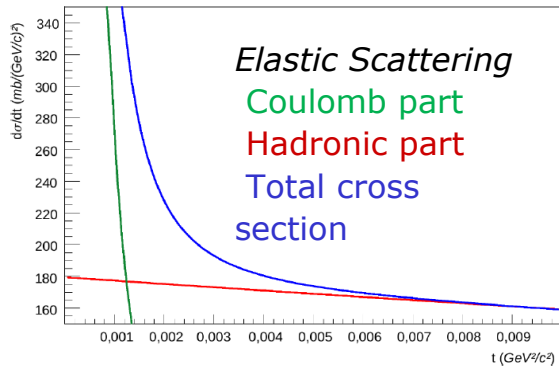


- First detector system to be fully assembled
- Cooling system available, ongoing work on controls
- Test stand for module calibration with cosmics
- All VPTT modules produced, ongoing calibration
- APD Module assembly started:
 - PRR on APD modules done
 - APD mass-screening: RUB; irradiation: JLU; QE samples: GSI
 - APD module design adapted for blue LED
- Pre-assembly prepared at FZJ
- Installation frame concept, **need design & construction**
- Next: Last PRR on system assembly





Luminosity Detector

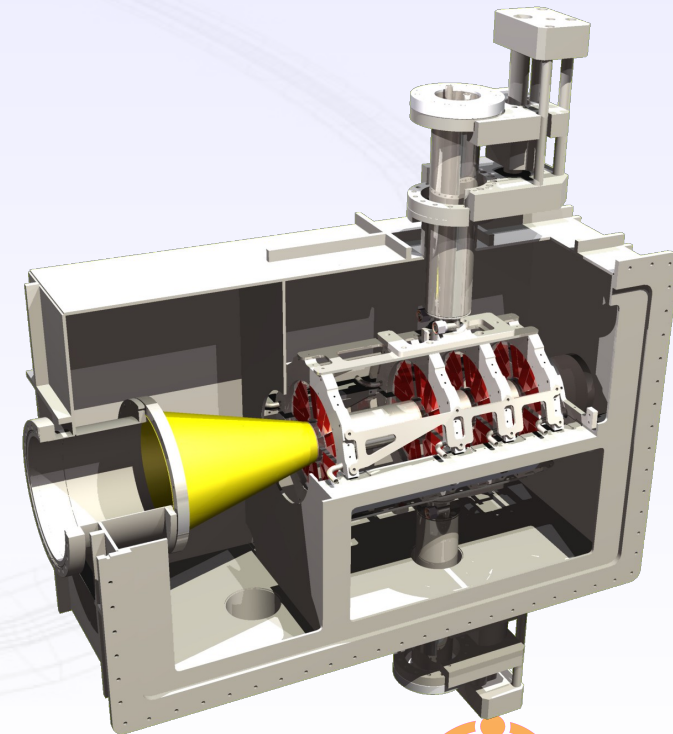


Detector layout:

- Roman pot system at $z=11$ m
- Silicon pixels ($80 \times 80 \mu\text{m}^2$):
4 **layers** of HV MAPS (50 μm thick) from Mu3e
- CVD diamond supports (200 μm)
- Retractable half planes in sec. Vacuum

Project status:

- Prototypes of vessel, cooling and vacuum, production design ongoing
- CVD diamond supports available
- New MuPix prototype $1 \times 2 \text{ cm}^2$ in test
- **TDR approved Apr 4, 2019**





Day-1: GEM Tracker



Forward Tracking in TS:

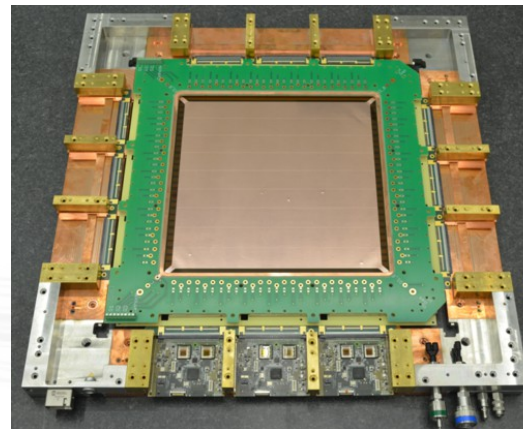
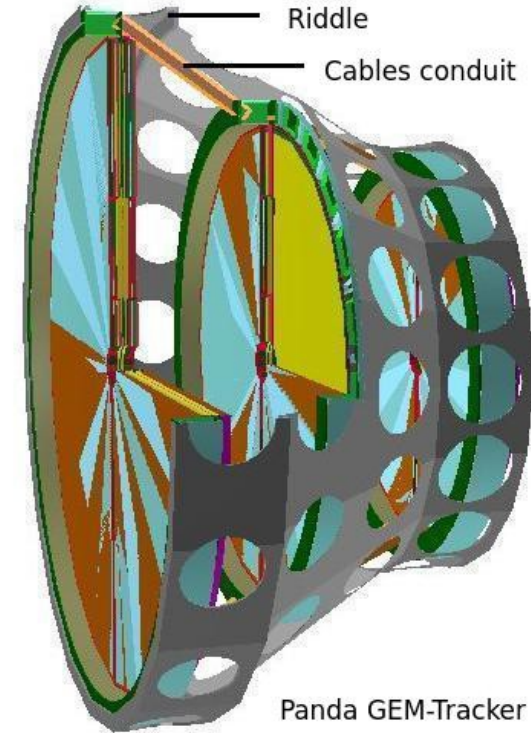
- Tracking in high occupancy region
- Important for large parts of physics

Current status:

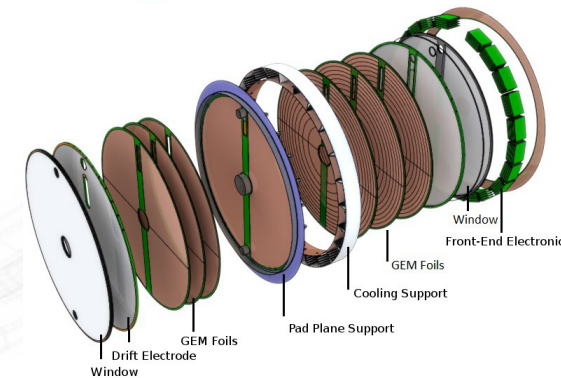
- Advanced mechanical concept
- Construction of demonstrator ongoing, first GEM foils from TECTRA received, expect delays due to fire at TECTRA
- Preparation of testbeam at GSI
- Study of different readout options
- Intensified integration planning
- Goal: TDR draft early 2020**

Ongoing issues:

- Characterisation of GEM foils
- Readout foil design
- Full size prototype design
- Lack of manpower



2D Demonstrator





Day-1: Detector Controls



Field Layer

- PANDA sub-systems specific
- **Interface: Detector Safety System**

Control Layer

- Native EPICS I/O controllers
- Target: hybrid LabView-Epics
- Archiving by each sub-system

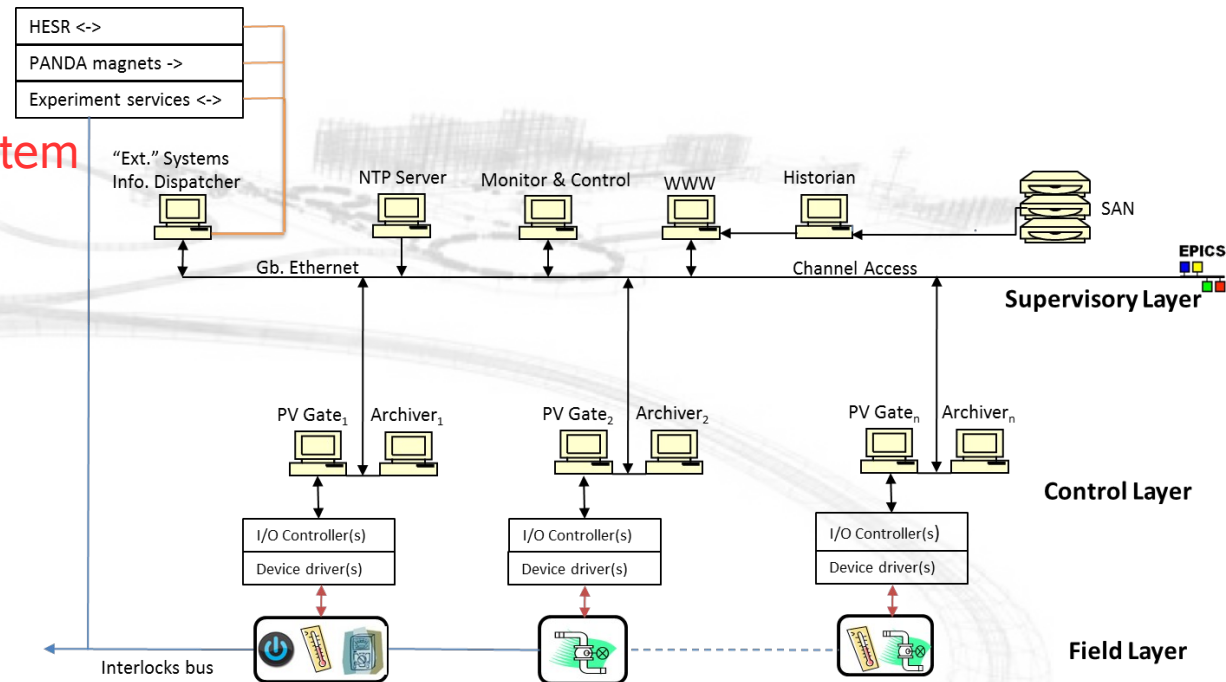
Supervisory Layer

- Controls GUI interface
- **Interfaces: HESR, DAQ, Experiment Control System**
- Databases PV & configuration addressed

- Synergies with other FAIR experiments (CBM) ongoing

- **DCS Test-bed in Mainz running, with 3 systems EMC, LMD, HYP**

- **TDR: reviewed, revised and submitted to FAIR ECE**





Day-1: Data Acquisition



Architecture:

- Time stamps: SODAnet
- Intelligent frontends
- Selection/Rejection in steps:
 - FPGA compute nodes: **H/W defined**
 - Computer farm: **Green Cube**
- High speed network

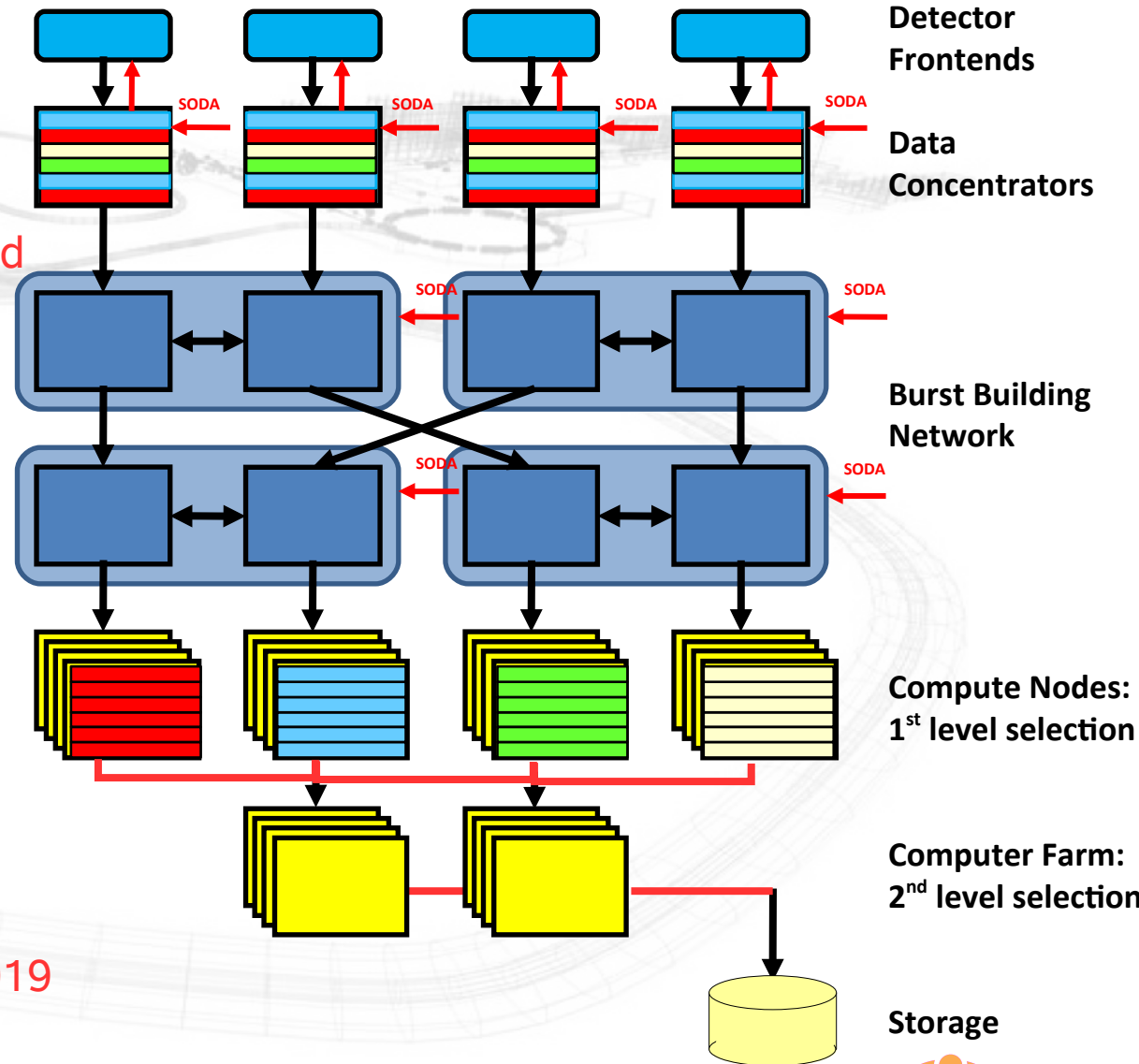
Design status:

- SODAnet basically ready
- First PT DAQ
- Boundary conditions: lumi & physics

TDR work:

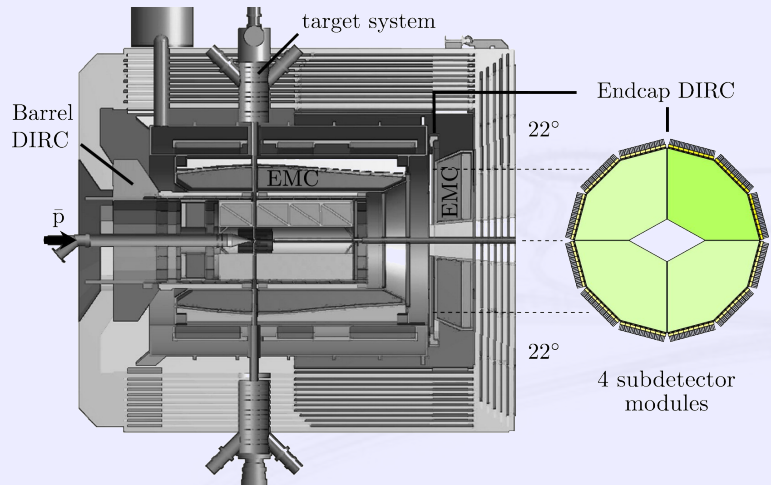


- Trigger simulations done
- DAQ tests done in spring 2019
- Draft advanced, finalisation end 2019
- Preparations for internal review





Phase 2: Endcap Disc DIRC

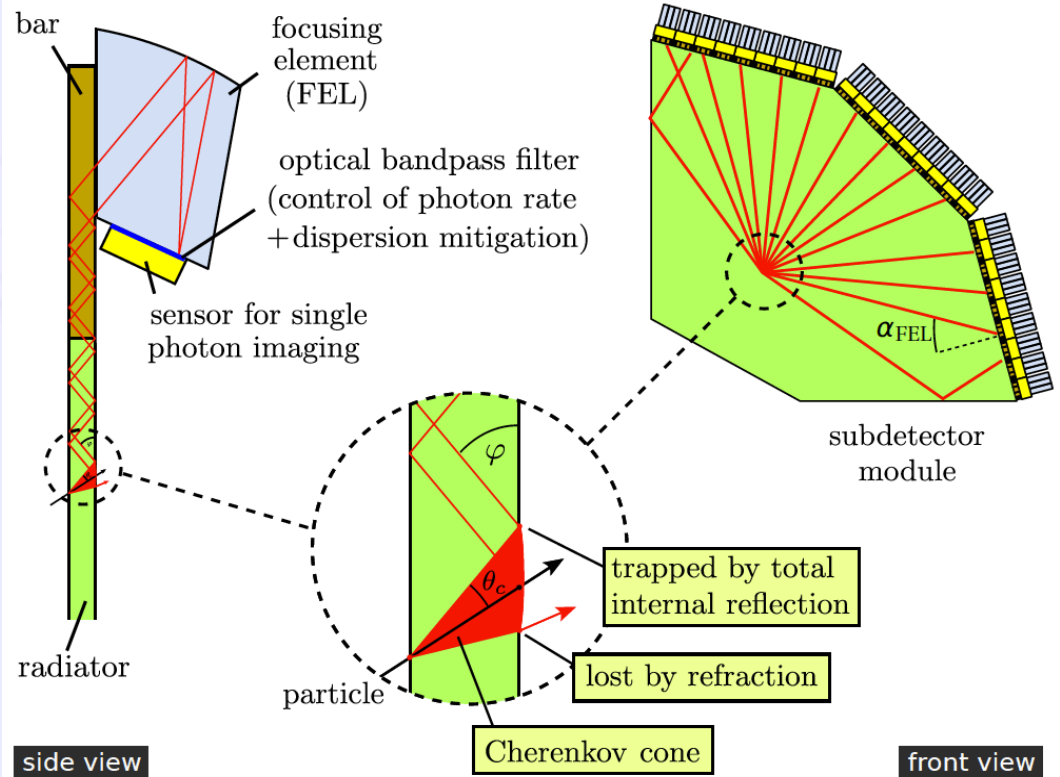


Novel concept for forward PID

- Based on DIRC principle
- Disc shaped radiator
- Photon detection on radiator rim

Basic components:

- SiO₂ radiator disc
- Focusing element
- Optical bandpass filter
- MCP PMT for photon readout in mag field
- ToFPET ASIC for electronic readout



side view

front view

Project status:

- Advanced design
- Several testbeams at CERN
- TDR submitted to FAIR ECE
- Review questions received
- Goal: quarter disc prototype



Conclusion



Main achievements:

- Solenoid construction in full swing – test assembly delayed till January '20
- Dipole design work ongoing, construction contract in preparation
- Barrel DIRC procurement started, contract for bars signed, PMTs in preparation
- Barrel EMC first slice assembled, cooling being finalized till end 2019
- Installation planning for TS completed

Upcoming milestones:

- Forward tracker and Straw FEE IKCs with Poland
- Solenoid:
 - Yoke construction complete spring 2020
 - Super-conductor production to finish by end 2020
- GEM demonstrator by end 2019
- DAQ TDR draft 12/2019
- DCS TDR submitted 8/2019
- Infrastructure cost assessment

In summary: PANDA is on track for Day-1