Technical Status of PANDA

L. Schmitt, GSI/FAIR

PANDA Session, FAIR ECE/ECSG Meeting
Online Meeting, October 27, 2020

Reporting and Schedule

System Highlights and Updates

Infrastructure and Installation

News from FAIR

- **Civil construction**
  - Excavation complete, North site progressing well
  - South site realization phase 1 started, phase 2 optional
  - South site preparation started, base plate concrete in Jan 2021
  - Technical building infrastructure awards on track for end 2020
- **Accelerators**
  - SIS100: all dipoles delivered, some delays with quadrupoles
  - pBar separator: contributions to be awarded to BINP
  - CR: progressing well, pre-assembly site in preparation
  - HESR dipole and quadrupole magnets complete, others almost
- **Funding Status**
  - Intermediate objective with German funds granted
  - Full MSV with funds from other shareholders for optional buildings
- **Conclusion:** Schedules need to be reanalyzed

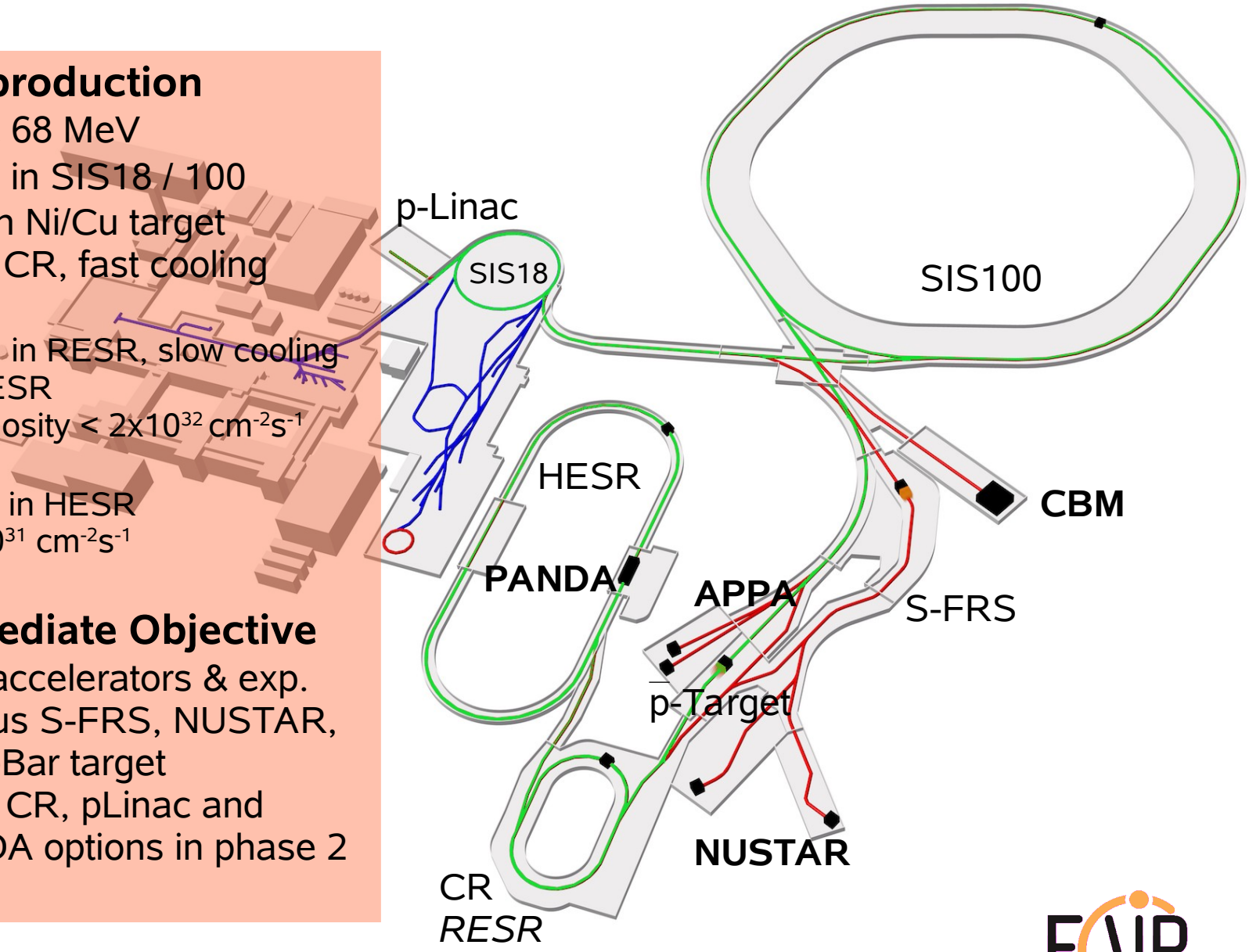
Antiproton Production at FAIR

Antiproton production

- Proton Linac 68 MeV
- Accelerate p in SIS18 / 100
- Produce $\bar{p}$ on Ni/Cu target
- Collection in CR, fast cooling
- *Full FAIR*:
  - Accumulation in RESR, slow cooling
  - Storage in HESR
  - $\bar{P}$ANDA luminosity < 2×10^{32} cm^{-2}s^{-1}
- *FAIR MSV*:
  - Accumulation in HESR
  - Luminosity 10^{31} cm^{-2}s^{-1}

FAIR Intermediate Objective

- Work on all accelerators & exp.
- North site plus S-FRS, NUSTAR, APPA hall, pBar target
- Buildings for CR, pLinac and HESR/PANDA options in phase 2



News from PANDA

- **Contracting**
  - STT-FT-FEE in-kind contract started work
  - FAIR Council approved funds for Barrel Muon Detectors
  - FT contract approaching signature
  - Contract with U Uppsala for more EMC PWO crystals in preparation
- **Reports**
  - DCS TDR approved
  - DAQT TDR submitted
  - Infrastructure and Installation report submitted
  - New report on updates to the EMC TDR (from 2008)
- **Progress highlights**
  - Solenoid magnet construction progressing visibly
  - Barrel DIRC production of radiator bars almost complete
- PANDA schedule needs to be updated w.r.t. new building schedule

PANDA Schedule

Current status

- Construction of many Phase 1 systems has started
- Integration and infrastructure planning progressing
- Delays in several parts due to delayed funding or contracting
- Covid-19 needs to be accounted still

Installation periods according to present plans:

- Installation period 1: solenoid, dipole, supports etc.
  in parallel with installation of technical building infrastructure
- Installation period 2: all other systems
  after building complete and accepted

Boundary conditions for plan revision:

- Completion of PANDA hall later than initially planned
- Mitigation: testing and pre-assembly of parts at other sites, storage

Consolidation of full FAIR schedule Q4/2020 – Q1/2021

- Current S-curves have to be taken with a grain of salt
- Replanning of PANDA installation and preparatory activities
  (pre-assembly, calibration, field mapping, ...)

PANDA Progress Scorecard

	PANDA	TDR / Specs	Cost [k€ 2005]	% Funding (Sec / RUS / EoI / TBA)	Construction	Construction complete	Test/ Commissioning
Day-1	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			12/2023	
	Straw Tube Tracker (STT) (1)		2.603,00			09/2023	
	Planar GEM Tracker - 50%		555,00			12/2023	
	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			08/2024	
	Forward TOF (2)		362,00			06/2023	
	Barrel EMC System		8.001,00			05/2023	
	Barrel EMC Crystals - 75% (2)		8.634,00			05/2023	
	Backward Endcap EMC		1.309,00			06/2023	
	Forward Endcap EMC		5.674,00			06/2022	
	Forward Shashlyk Calorimeter (2)		1.447,00			06/2023	
	Luminosity Detector		666,00			06/2023	
	Muon Detectors (2)		2.318,00			09/2022	
	Solenoid		5.800,00			04/2022	
	Interaction Region		151,00			12/2022	
	Infrastructure		4.006,00			06/2022	
	DAQ Hardware (3)		1.350,00			09/2023	
		89% *value weighted*	52.525,00	69% 16% 14% 1%	36% *value weighted*		
	Changes since report 20-I	1%		+1% secured	+3.7%		+0%

(1) if synergies between STT and Fw. Tracking realise
(2) if German-Russian Roadmap realised
(3) DAQ computing via operation funds

Note: Absolute dates subject to adjustment

PANDA TDR Schedule

System	Submission Expected Submissi	(Approval) Expected M3
PANDA PHASE 1		
Target Spectrometer EMC		18/08/2008
Solenoid	11/02/2009	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		12/10/2020
DAQ	25/8/2020	*2/2021*
Infrastructure	14/9/2019	*3/2021*
Planar GEM Trackers	*12/2020*	*6/2021*
PANDA PHASE 2		
Endcap Disc DIRC	29/6/2018	08/11/2011
Forward RICH	*3/2021*	*9/2021*
Pellet Target	*3/2021*	*9/2021*
Hypernuclear Setup	*12/2020*	*6/2021*

Status 15/10/2020

For the item “Interaction Region” no TDR is planned, only a specification document. Computing TDR together with FAIR Computing TDR.

Phase 1: 13 TDRs approved

- DCS TDR approved October 12
- DAQT TDR submitted,
- Infrastructure report submitted
- GEM TDR in preparation

Phase 2: 1 TDR approved

- Disc DIRC: approved Nov 2019
- Pellet Target: in preparation
- Forward RICH
- Hypernuclear Setup

PANDA Funding Risks (1)

Risk ID	Status	Work package	Risk title	Risk description	Probability	Performance impact	Risk Score	Strategy	Risk Response	Probability a.m.	Performance impact a.m.	Residual Risk	Approval status	Risk identification date
147	Mitigation ongoing	Barrel EMC	Funding of barrel EMC detector	**Cause:** **Production of 6100 crystals not assured by funding yet.** **Event:** **Delay of production or bailout of production company (Crytur).** **Impact:** **Partial or no barrel EMC detector available at Day-1. Potential price increase of >50% when money flow for crystal procurement is interrupted.**	90%	major	15	mitigate	**Preventive mitigation:** **Identify funding source (ongoing). Expression of willingness for mass production of crystals. Decision of mass production required. Russian pledge to be confirmed.** **mean mitigation cost (€):** **Contingency plan:** **Decide partial instrumentation of the barrel EMC (connected with item 1)**	90%	major	15	decided @ PANDA	2018-03-12
154	Mitigation planned	PANDA Micro Vertex Detector (MVD)	MVD Pixel part cannot be produced in time	**Cause:** **Critical situation of the MVD group of Torino in a stand-by position without funding by INFN 2016 & 2017. No invest was granted yet.** **Event:** **The pixel detector components cannot be produced.** **Impact:** **Component possibly not ready for Day-1 or reduced physics scope at Day-1.**	50%	major	13	mitigate	**Preventive mitigation:** **Project re-opened, research interest, Granting of funding in Italy. Lobbying in Italy with support from FAIR Sc. Man. Director (Paolo Giubellino) required. Strips for phase 1** **mean mitigation cost (€):** **Contingency plan:** **Development of a different design which will cause delay.**	50%	moderate	7	decided @ PANDA	2015-03-12
151	Mitigation ongoing	Barrel EMC	Barrel EMC APD funding	**Cause:** **10000 Avalanche Photo Diodes (APDs) are to be funded. BMBF funding on hold/not yet granted (4500 APDs), original Austrian funding contribution for 5400 APDs failed. Funding for 5200 APDs not assigned.** **Event:** **Delay or interruption of the production of multiple slices (APD production line at Hamamatsu needs start-up time (~3 month) after begin of funding).** **Impact:** **Delay of screening.**	50%	major	13	mitigate	**Preventive mitigation:** **Find funding source.** **mean mitigation cost (€):** **Contingency plan:** **Partial instrumentation of detector.**	0%	none	0	to be decided @PANDA	2018-03-12

PANDA Funding Risks (2)

Risk ID	Status	Work package	Risk title	Risk description	Probability	Performance impact	Risk Score	Strategy	Risk Response	Probability a.m.	Performance impact a.m.	Residual Risk	Approval status	Risk identification date
230	Mitigation ongoing	DAQ	DAQ system not available	**Cause: No funding for DAQ construction available, no EOI to request funding from any existing PANDA group.** **Event: No DAQ system.** **Impact: No data taking.**	20%	severe	12	mitigate	**Preventive mitigation:** **Provide funding.** **mean mitigation cost (€):** **Contingency plan:** **Try to open new funding possibilities/agencies/institutes, common fund.**	0%	none	0	decided @ PANDA	2018-08-15
144	Mitigation proposed	Supports	PANDA infrastructure supports & supplies	**Cause: The budget for infrastructure is not approved yet. It is supposed to come from common fund that requires a signed or at least agreed MoU.** **Event: No budget available to order infrastructure.** **Impact: Installation of experiment cannot start.**	20%	severe	12	mitigate	**Preventive mitigation:** **GSI or FAIR should advance cash to start infrastructure measures.** **mean mitigation cost (€):** **Contingency plan:** **Other money source have to be made available.**	0%	none	0	to be decided @ PANDA	2018-03-12
218	Accepted	Forward Shashlyk Calorimeter	Forward Shashlyk Calorimeter funding	Cause: Funding of the FSC is connected to Russia-Germany scientific 10-years roadmap agreement which is under discussion now. Event: Uncertain funding starting date. Impact: Delay of the contract signing.	20%	major	11	accept	Preventive mitigation: mean mitigation cost (€): Contingency plan: Find funding elsewhere.	20%	major	11		2018-08-14
222	Mitigation ongoing	Muon System	Muon system funding uncertain.	**Cause: Uncertain funding starting date.** **Event: A contract between FAIR and JINR is not signed in time.** **Impact: Delay of Muon system.**	20%	major	11	mitigate	**Preventive mitigation:** **FAIR-JINR contract should be signed until Q1 2021.** **mean mitigation cost (€):** **Contingency plan:**	0%	222	Mitigation ongoing	Muon System	Muon system funding uncertai n.

PANDA Personnel Risks

Risk ID	Status	Work package	Risk title	Risk description	Probability	Performance impact	Risk Score	Strategy	Risk Response	Probability a.m.	Performance impact a.m.	Residual Risk	Approval status	Risk identification date
335	Mitigation proposed	Planar GEM Trackers	GEM tracker detector system not available	**Cause:** Qualified personnel needed for key-technologies and basic functions not available (in amount and grade of qualification). **Event:** The detector system cannot be designed and built in time. **Impact:** The GEM-Tracker subsystem will not be available in due time.	40%	major	13	mitigate	**Preventive mitigation:** Attract students (depending on staff support available), train people, find & hire qualified personnel (at least one electronician). mean mitigation cost (€): **Contingency plan:**	30%	moderate	7	to be decided @ PANDA	2019-07-31
412	Mitigation planned	PANDA Micro Vertex Detector (MVD)	Shortage of manpower in PANDA MVD	**Cause:** Retirement of several experts and general shortage of manpower for certain components. **Event:** Realization will take more time. **Impact:** Components possibly not ready for Day-1.	50%	major	13	mitigate	**Preventive mitigation:** Find new experts in the mechanics development, cooling developmentand DCS development and manpower. Full involvement of the Prague group (Strip part) mean mitigation cost (€): **Contingency plan:**	20%	moderate	6	decided @ PANDA	2020-08-20
413	Mitigation ongoing	PANDA Controls	Loss of expertise in DCS core group.	**Cause:** Lack of man-power for most sub-systems. Additionally employment contracts not being extended. **Event:** Sub-systems control development is delayed. Loss of expertise in DCS core group. **Impact:** Work of Core Group cannot be completed in time. Sub-systems have no control system.	50%	major	13	mitigate	**Preventive mitigation:** Try to find common solutions prioritisation of DCS. Funding application for FTE is ongoing. mean mitigation cost (€): **Contingency plan:** Share manpower between different sub systems working on DCS.		not set	0	decided @ PANDA	2020-08-20
410	Mitigation proposed	Supports	Additional personnel for installation of PANDA	**Cause:** The complexity of installation work may be underestimated requiring additional work. **Event:** More personnel for installation has to be hired. **Impact:** Cost increase.	20%	major	11	mitigate	**Preventive mitigation:** a) Hire external labor from common construction fund. b) Second expert personnel from collaborating institutes as technical project associates. mean mitigation cost (€): 392600.00 **Contingency plan:**	20%	minor	2		2020-08-14

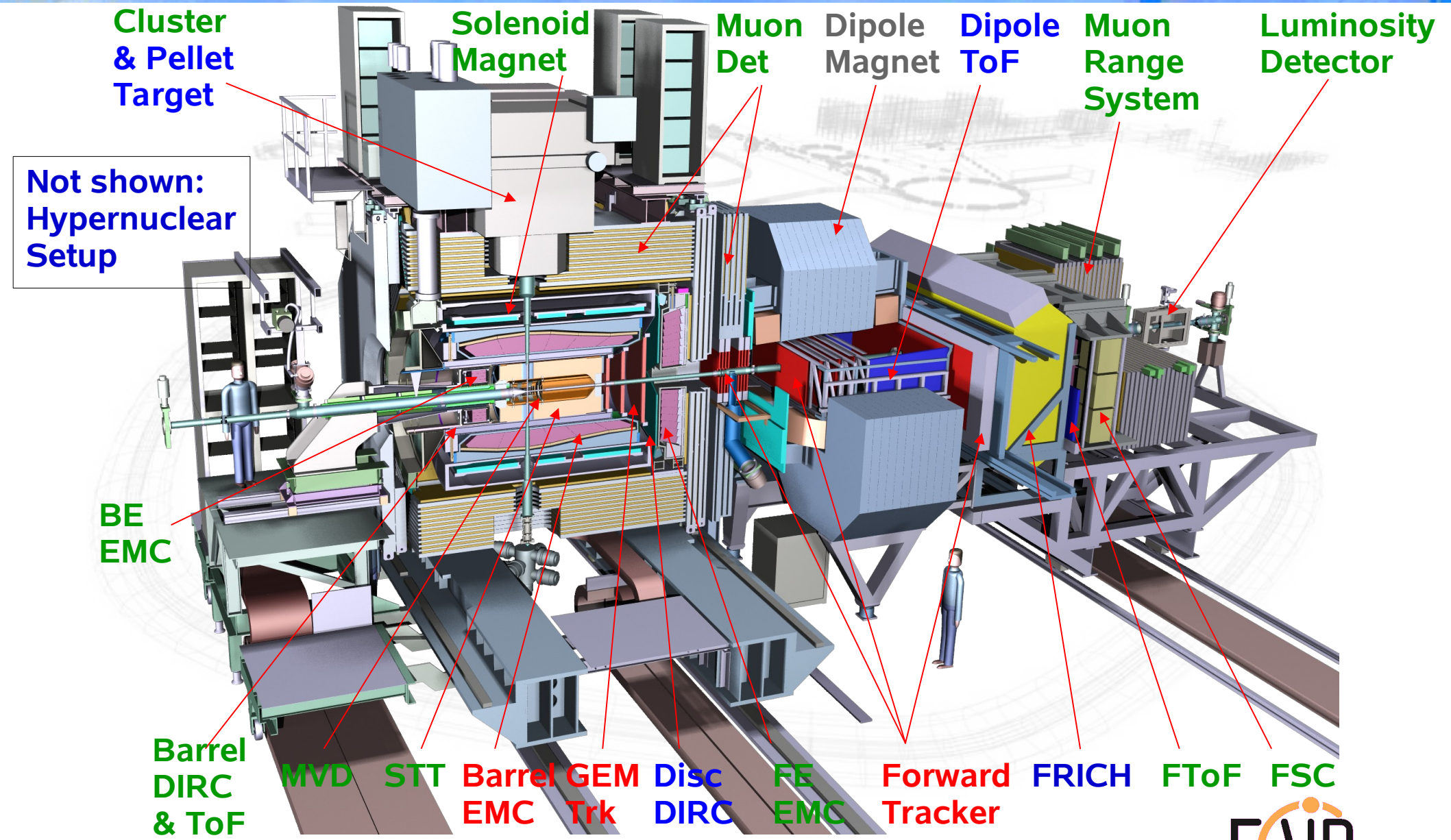
PANDA Technical Risks (1)

Risk ID	Status	Work package	Risk title	Risk description	Probability	Performance impact	Risk Score	Strategy	Risk Response	Probability a.m.	Performance impact a.m.	Residual Risk	Approval status	Risk identification date
202	Mitigation ongoing	Cluster Jet Target	PANDA cluster jet target: vacuum	**Cause:** Too narrow vacuum pipes in the PANDA solenoid. **Event:** High residual gas background at the PANDA IP. **Impact:** Reduced antiproton beam life time.	25%	major	13	mitigate	**Preventive mitigation:** Vacuum tests at COSY and Münster. Optimization of the vacuum system. Numerical simulations on vacuum and design studies on a new cryopump for PANDA. **mean mitigation cost (€):** **Contingency plan:**	15%	major	11	decided @ PANDA	2018-08-13
153	Mitigation ongoing	Barrel EMC	Barrel EMC readout concept	**Cause:** Hitdetection-ASIC chip is in an early development Phase and could fail. **Event:** Redesign of readout concept (electronics, cabling). **Impact:** Change in readout concept, requiring additional funding of SADCs as fall back readout and delays.	30%	major	13	mitigate	**Preventive mitigation:** Intensify design/prototyping/testing of Hitdetection ASIC.(tests and R&D ongoing) **mean mitigation cost (€):** **Contingency plan:** Recede to SADC readout.	5%	moderate	5	decided @ PANDA	2018-03-12
341	Mitigation proposed	Planar GEM Trackers	No rad-hard electronics readout system available	**Cause:** Designated electronics components, esp. the ASIC applied fails in operation or becomes unavailable. **Event:** No rad-hard electronics readout system available **Impact:** A delay to perform validation tests and achieve operability of the detector system.	40%	major	13	mitigate	**Preventive mitigation:** Choose interims solution to shift the problem to a later stage in the project. Perform p-o-p measurements with highly granular integrating electronics already available from industry. Strengthen in-house ASIC group in the central EE department. **mean mitigation cost (€):** **Contingency plan:** Look for other ASICs on the market. Potential candidates have been identified. Negotiations have not been started so far due to lack of qualified manpower. Foster own developments (HIT-detection chip a/o clock-TDC&PADI) to ensure long-term availability.	10%	moderate	5	to be decided @ PANDA	2019-07-31

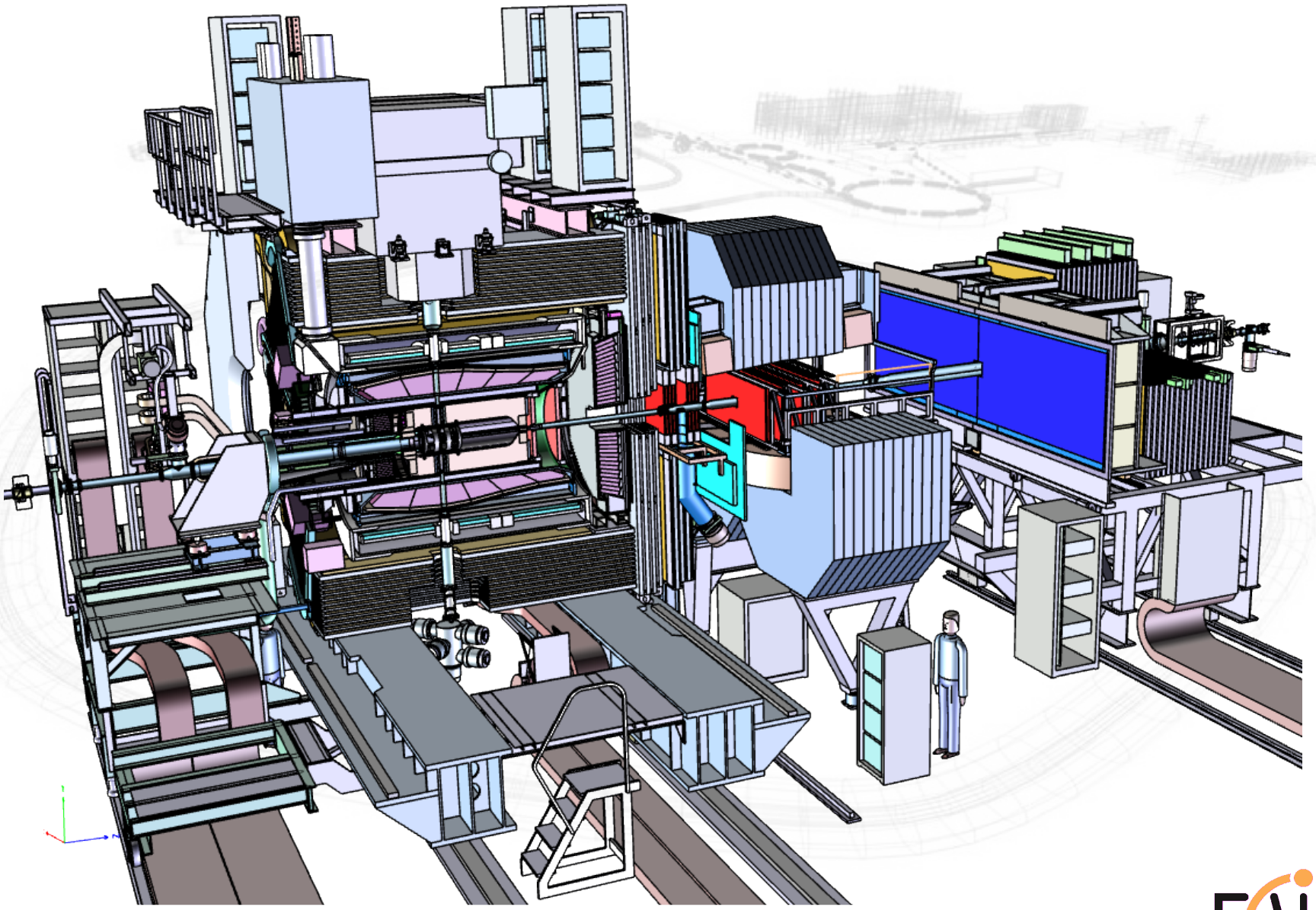
PANDA Technical Risks (2)

Risk ID	Status	Work package	Risk title	Risk description	Probability	Performance impact	Risk Score	Strategy	Risk Response	Probability a.m.	Performance impact a.m.	Residual Risk	Approval status	Risk identification date
415	Mitigation ongoing	DAQ	DAQ design	**Cause:** **1) Essential input for design decisions missing: event-based simulations instead of time-based simulations lead to insufficient or incorrect results.** **2) Lack of expert manpower for algorithms and firmware.** **Event:** **The DAQ may not fulfill the requirements.** **Impact:** **PANDA cannot run at the required luminosity to achieve its physics objectives and causes cost increase due to inefficient use of accelerator resources**	50%	major	13	mitigate	**Preventive mitigation:** **Strengthen the efforts simulation and algorithms. Better overall coordination of computing, DAQ and online-trigger groups. Provide more manpower** **mean mitigation cost (€):** **Contingency plan:** **Focus simulation on special channels**	0%	none	0	decided @ PANDA	2018-08-15
409	Mitigation proposed	Supports	Additional work floor of the PANDA hall	**Cause:** **The flatness of the floor of the PANDA hall is not adequate in the region of the target spectrometer rails.** **Event:** **Additional work has to be performed to improve the floor of the hall.** **Impact:** **Cost increase.**	20%	major	11	mitigate	**Preventive mitigation:** **Coordinate with FSB requirements for floor quality during execution.** **mean mitigation cost (€):** **100000.00** **Contingency plan:** **Perform additional floor levelling before start of rail installation.**	20%	minor	2		2020-08-14
212	Accepted	Barrel Time of Flight (SciTil)	Barrel TOF electronics	**Cause:** **Full length rail board is difficult to produce.** **Event:** **Production of rail boards is delayed.** **Impact:** **Delay of production and installation.**	20%	major	11	accept	**Preventive mitigation:** **Keep in close contact with manufacturer.** **mean mitigation cost (€):** **Contingency plan:** **Split the railboard into four parts.**	20%	major	11	decided @ PANDA	2018-08-13

PANDA Day-1 / Phase 1 / Phase 2



PANDA System News



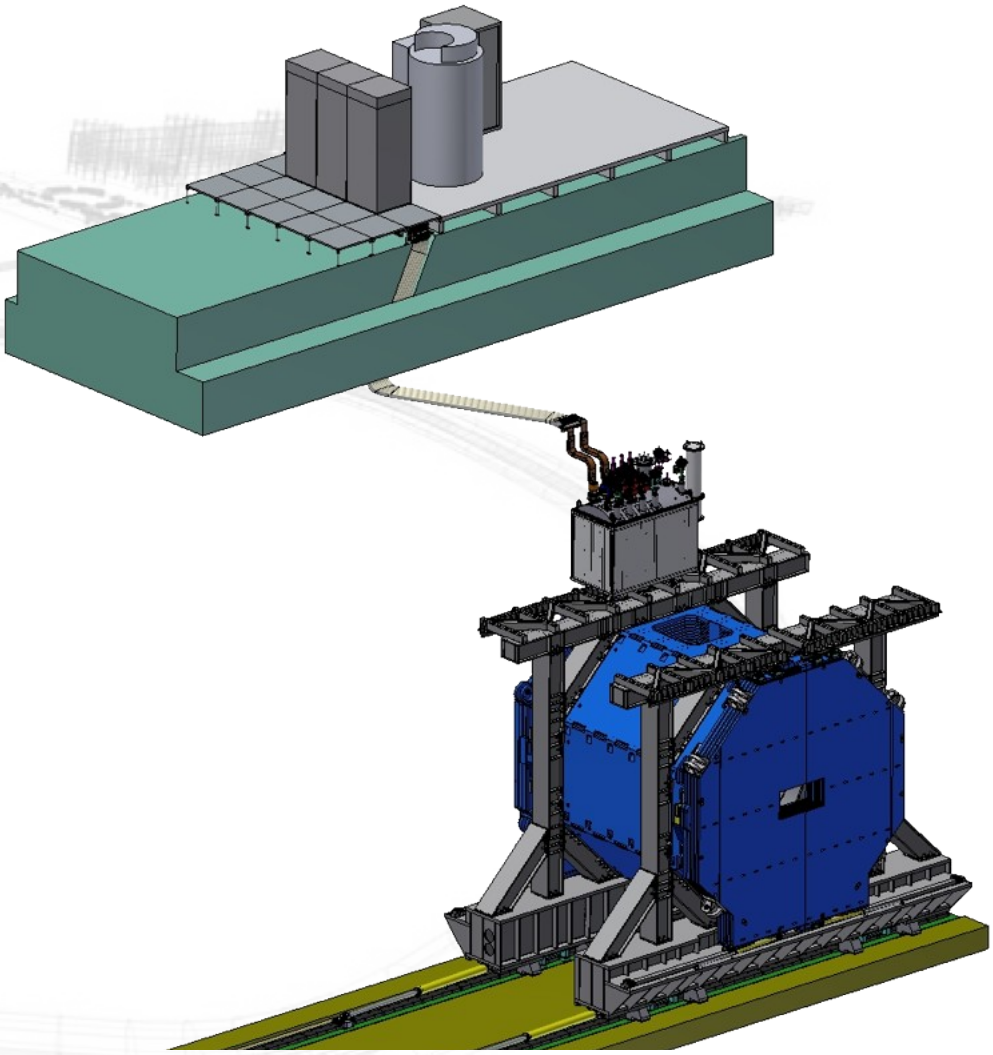
Solenoid Magnet

Project Status:

- Contract with BINP in March 2017
- Yoke components produced, first test assembly complete
- Cryostat component procurement
- Local cryogenics CDR close to final, FDR to follow soon after

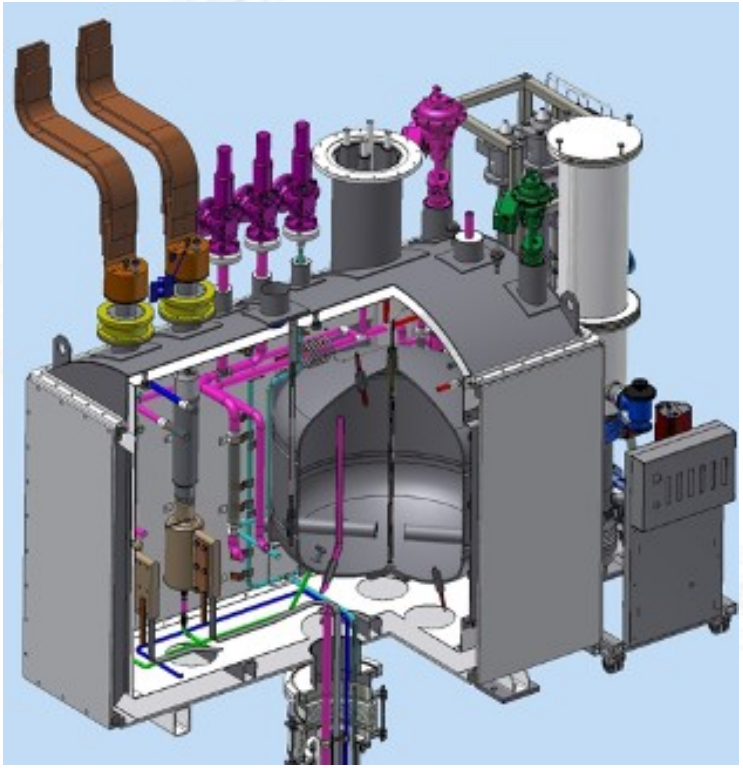
Critical Items:

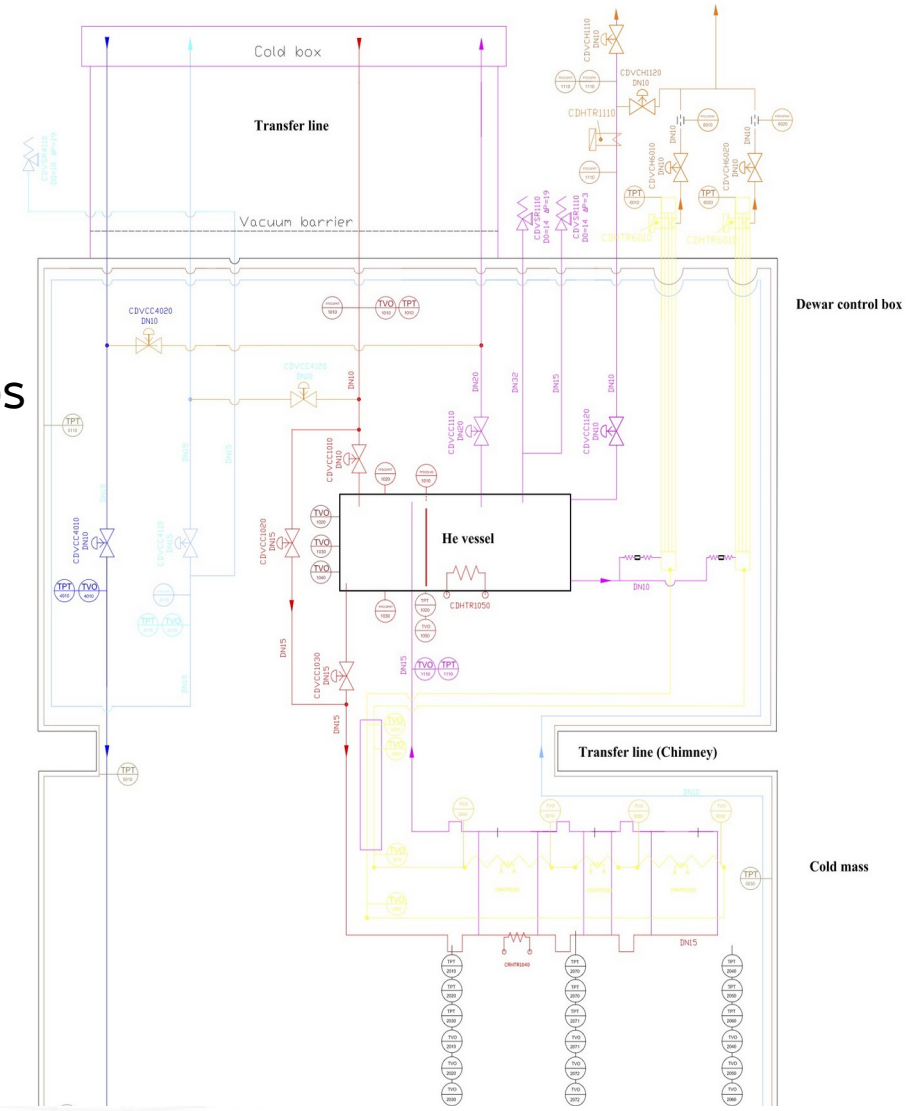
- Superconductor procurement
  - First contracts signed
- Schedule:
  - Coordination of installation at FAIR
  - Field-mapping to be done before at BINP
  - Insertion of muon detectors



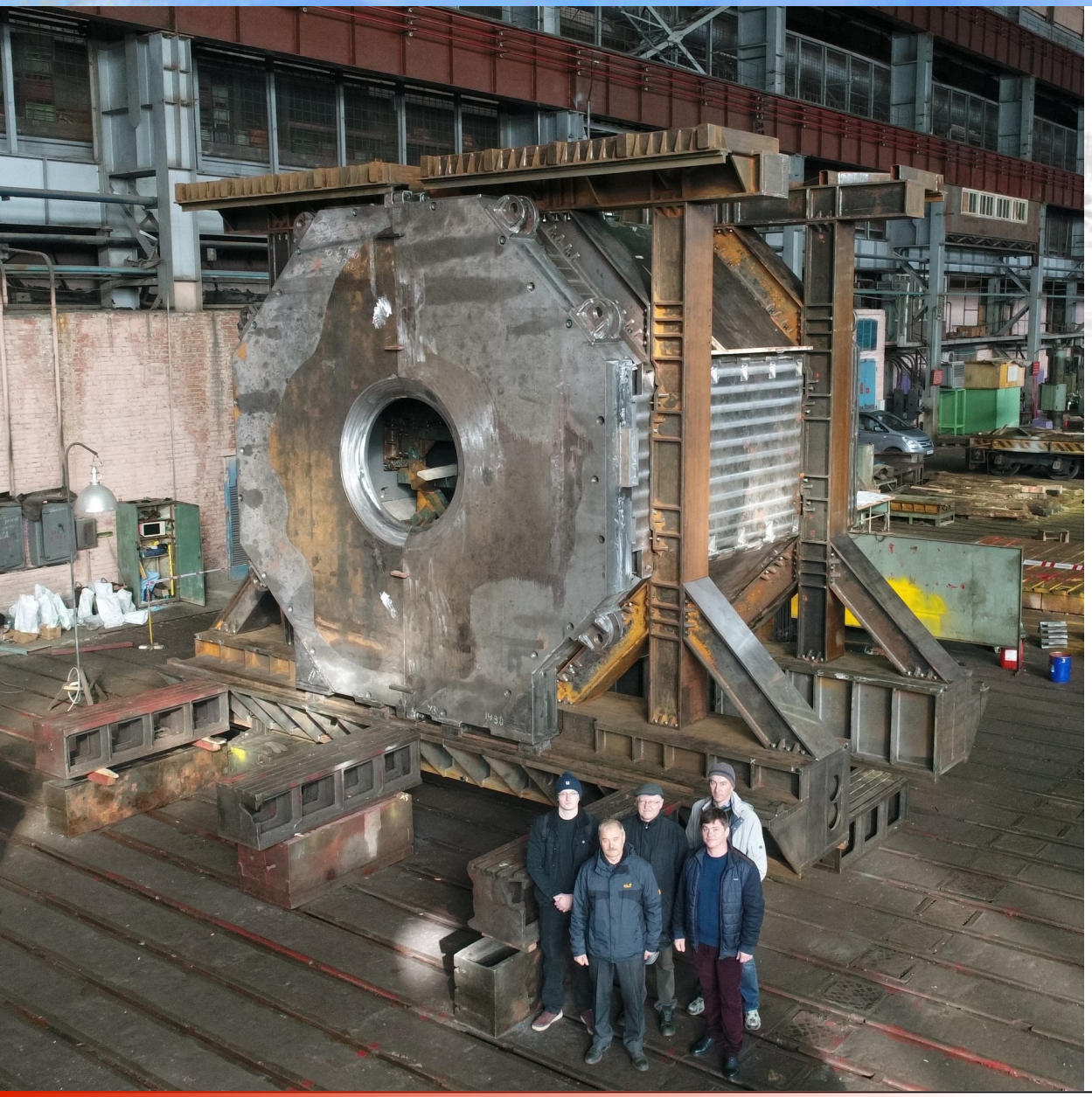
Solenoid: Control Dewar

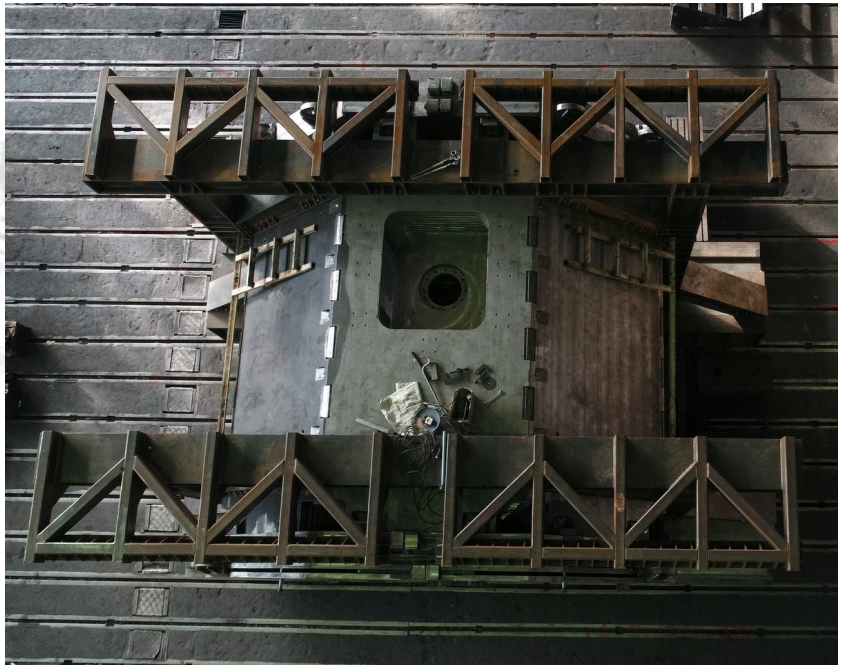
- Control Dewar: local cryogenics of solenoid (aka branch box, aka valve box)
- Last major component of design review
  - Cryogenic flow for all operation states
  - Feedthrough of current leads
  - Safety regime
- Review with FAIR Cryo and ATLAS Magnet groups





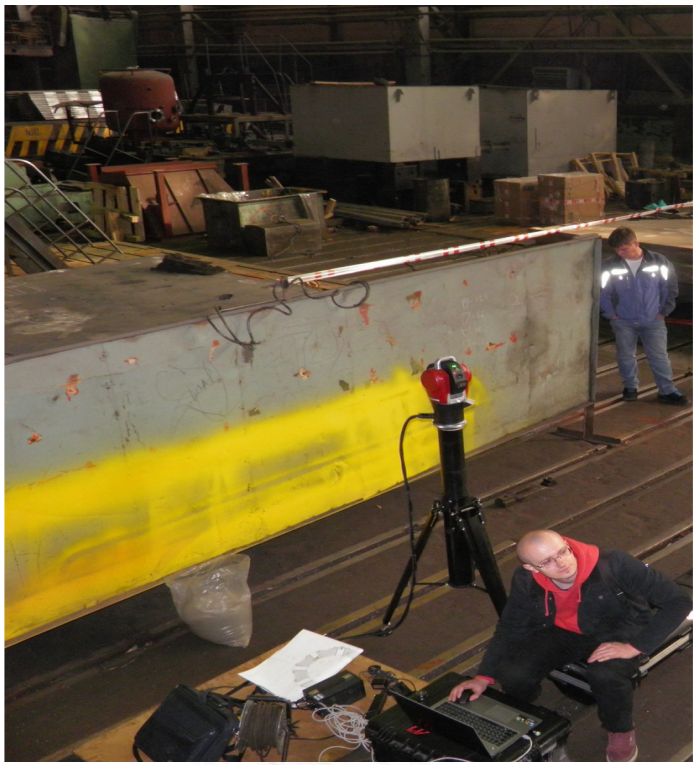
Solenoid: Yoke Status





- All parts manufactured
- Yoke first assembly done!
- Next steps:
  - Adjustments
  - Door mechanism
  - Painting
  - Transport to BINP

Solenoid: Further Activities



Laser tracker

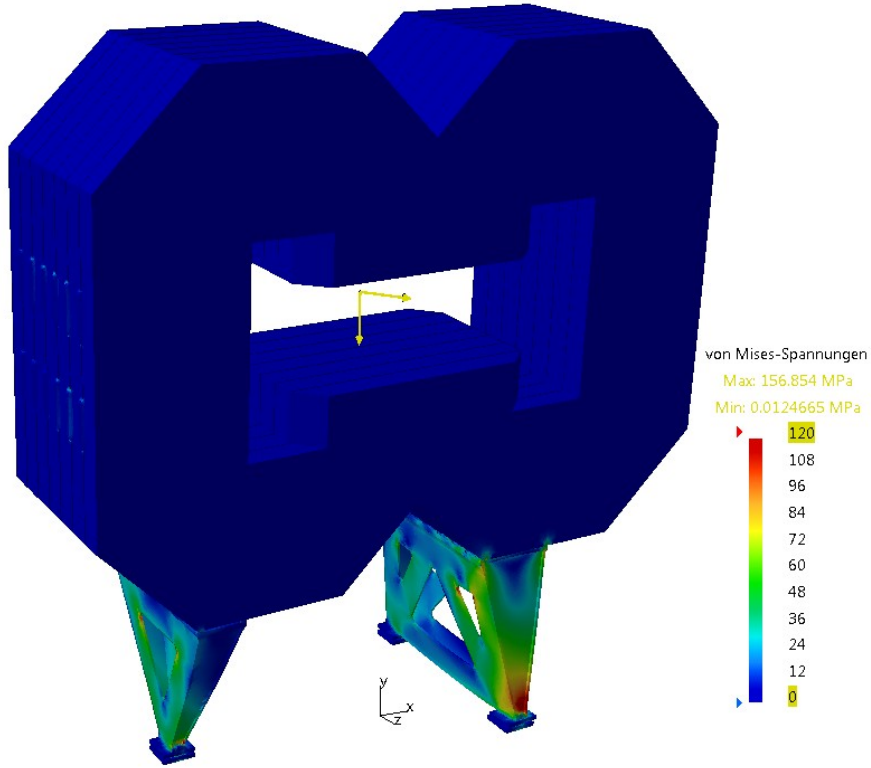
SMR placement

Prototype coil

Dipole Magnet

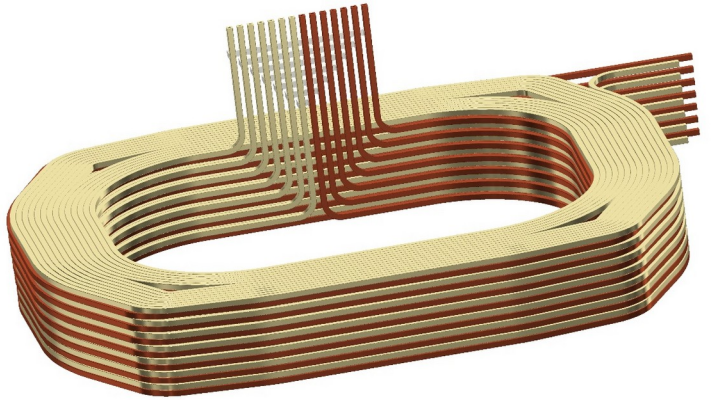
Project Status

- Magnet is part of HESR IOL,
  → considered as HESR component
- EoI by BINP
- Design contract FAIR-BINP:
  - 1st milestone reached,
  - full design almost complete
- Production contract:
  - Specs for magnet in final round
  - Specs for power converter complete



Technical Progress

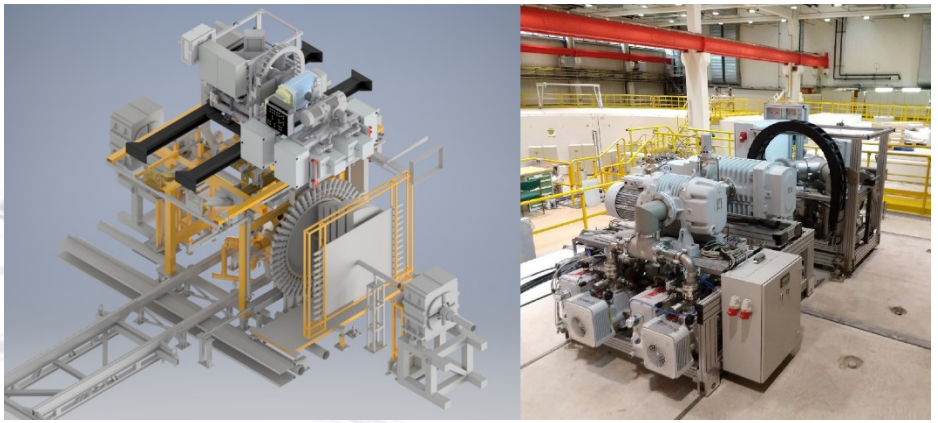
- Design work done at BINP:
  - Design of yoke, coils, support structure
  - Dynamic field calculations
  - Seismic stress calculations
- Develop field mapping procedure



Cluster Target

Cluster Target Hardware:

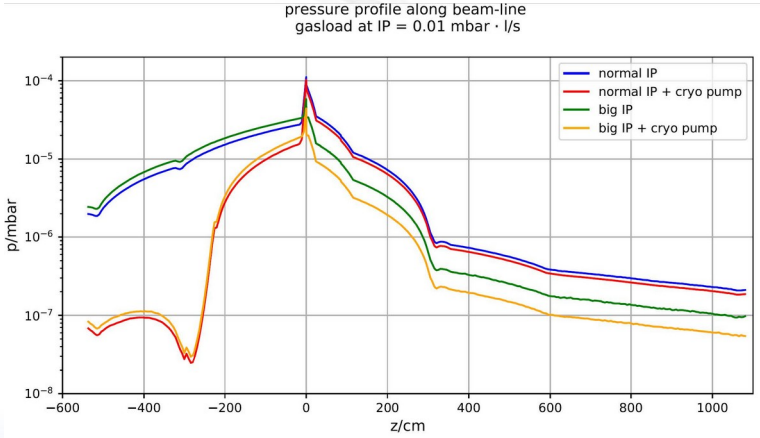
- PANDA cluster-jet target very advanced
- Design parameters already reached
- Development and test of new diagnostic tools
- Goal: improve performance



PANDA Cluster-Jet Target at COSY

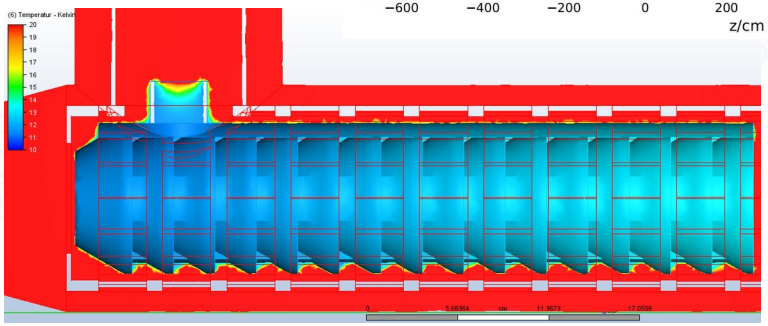
Experiments at COSY:

- Study of beam-target interaction
- Performance of stochastic/electron cooling in presence of the cluster target beam
- Vacuum situation at IP and improvements

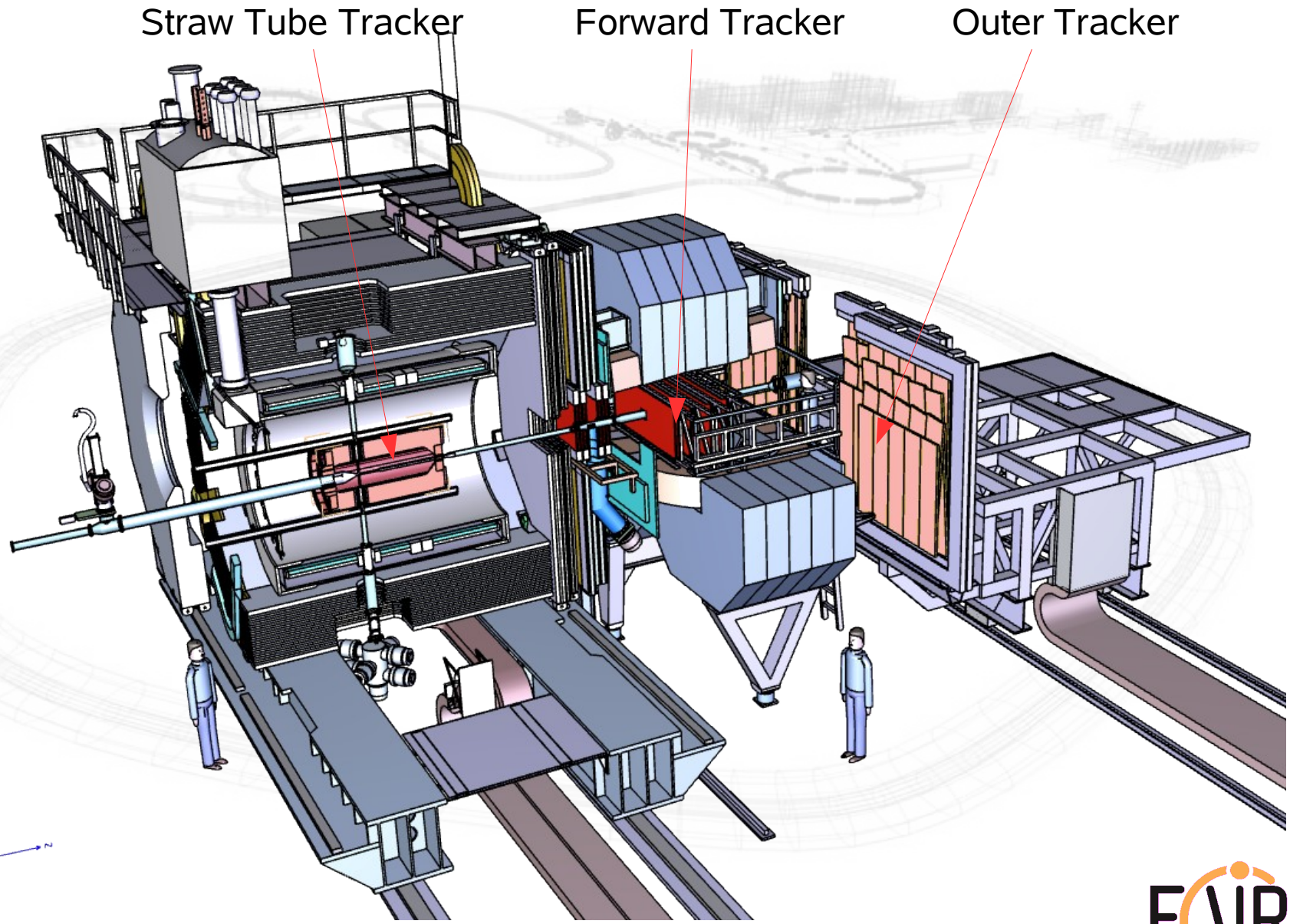


Simulation and design

- Variation of IP shape and pumping
- Start of design of cryo pump inside the beam pipe



Straw Trackers in PANDA

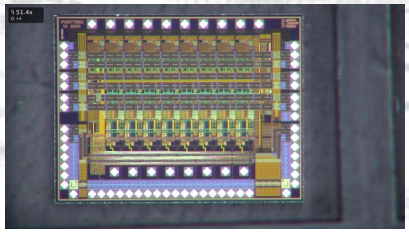


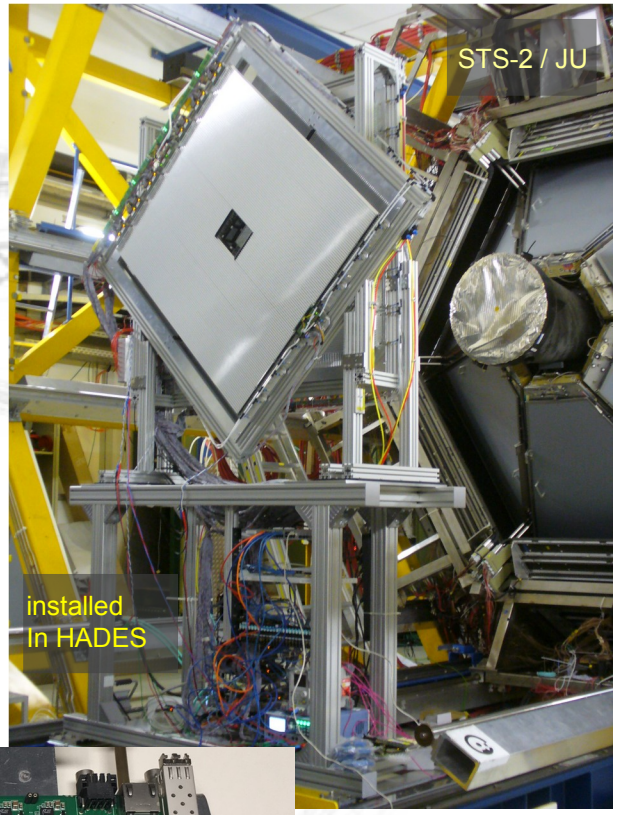
Straw Trackers in PANDA

Straw Tube Tracker STT (TS Central Tracker)

- Module production started
- Activities on Phase 0 at HADES
- FEE progress (Polish IKC):
  - PASTTREC ASIC submitted
  - Board design started

PASTTREC ASIC



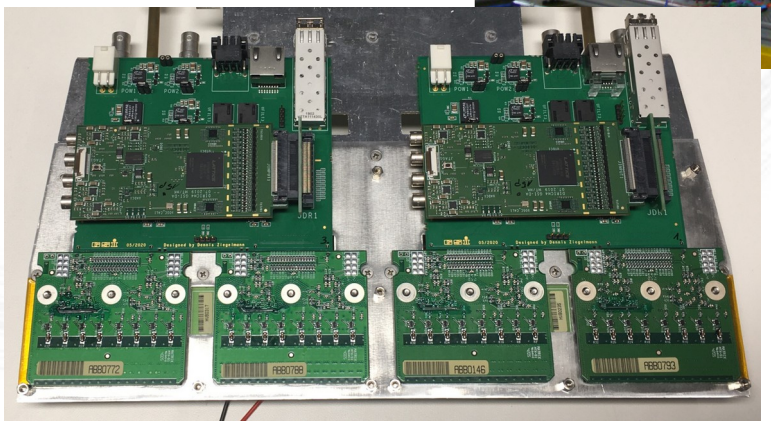


Forward Tracker

- In kind contract prepared
- Activities on Phase 0 at HADES

Outer Tracker (LHCb straw tracker)

- Readout interface prototype ready
- High voltage available
- Preparation of tests at GSI

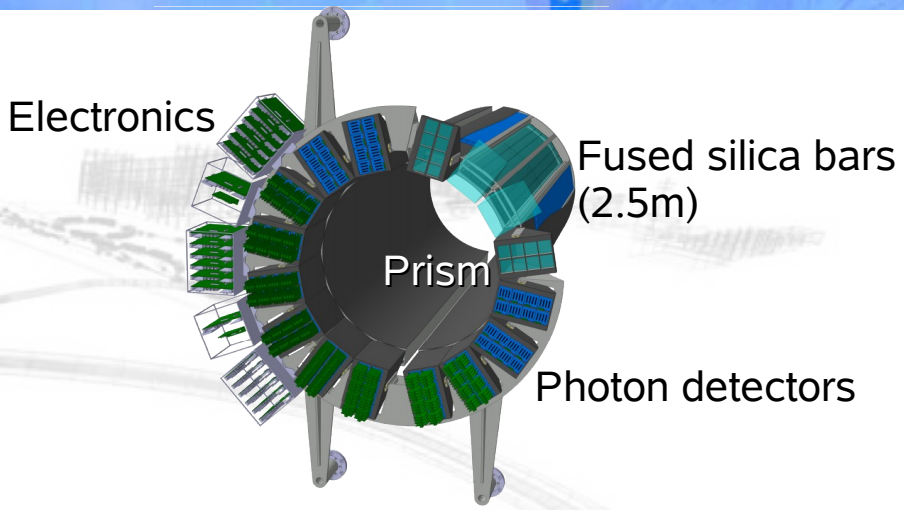


LHCb OT FEE with i/f to DIRICH

Barrel DIRC

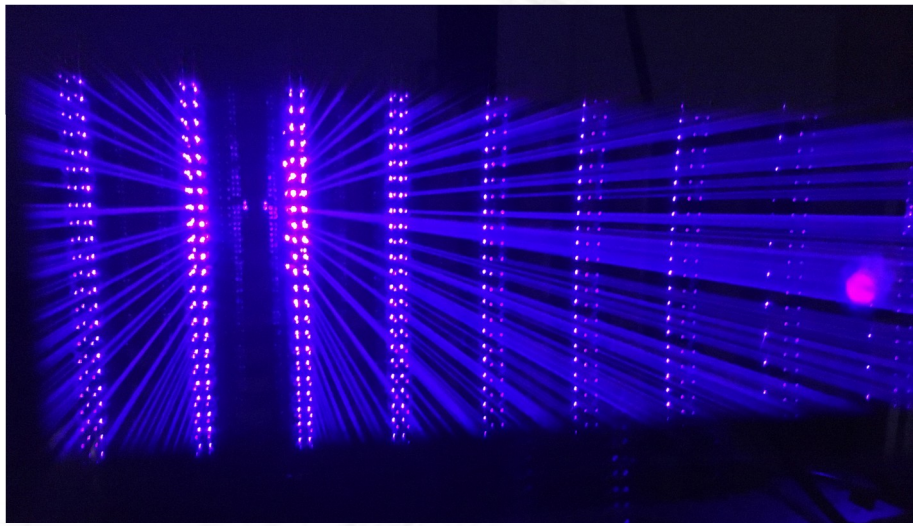
Baseline design

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



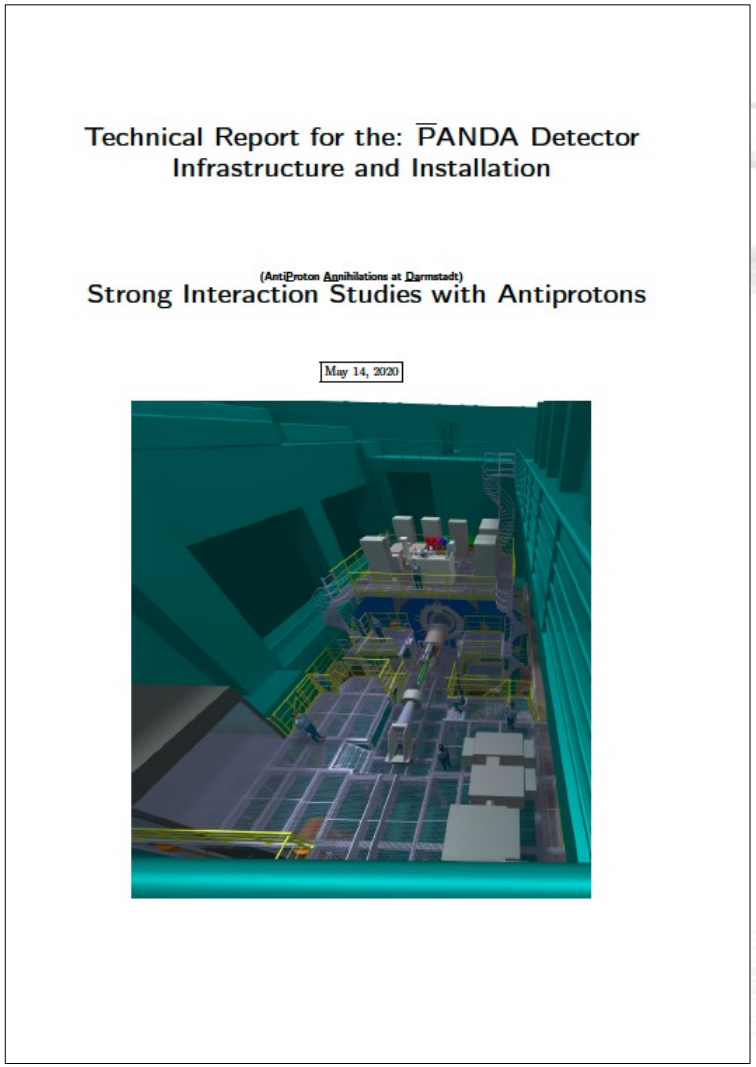
Project status

- Series production of DIRC bars at Nikon
- Already 90/98 bars delivered to GSI
  - detailed evaluation ongoing
  - preparation of order for spares
- MCP PMT tender:
  - evaluation of samples completed
  - magnet tests at FZJ performed
  - assessment of data, contract soon
- Phase 0: Participation at Glue X DIRC



Kaleidoscopic image of a HeCd laser beam in one DIRC bar on test bench

Infrastructure and Installation Report


Technical Report for the: $\overline{\text{P}}$ANDA Detector
Infrastructure and Installation

(AntiProton Annihilations at Darmstadt)
Strong Interaction Studies with Antiprotons

May 14, 2020

Technical layout & cost assessment

of infrastructure comprising:
- Common supports
- Supply infrastructure

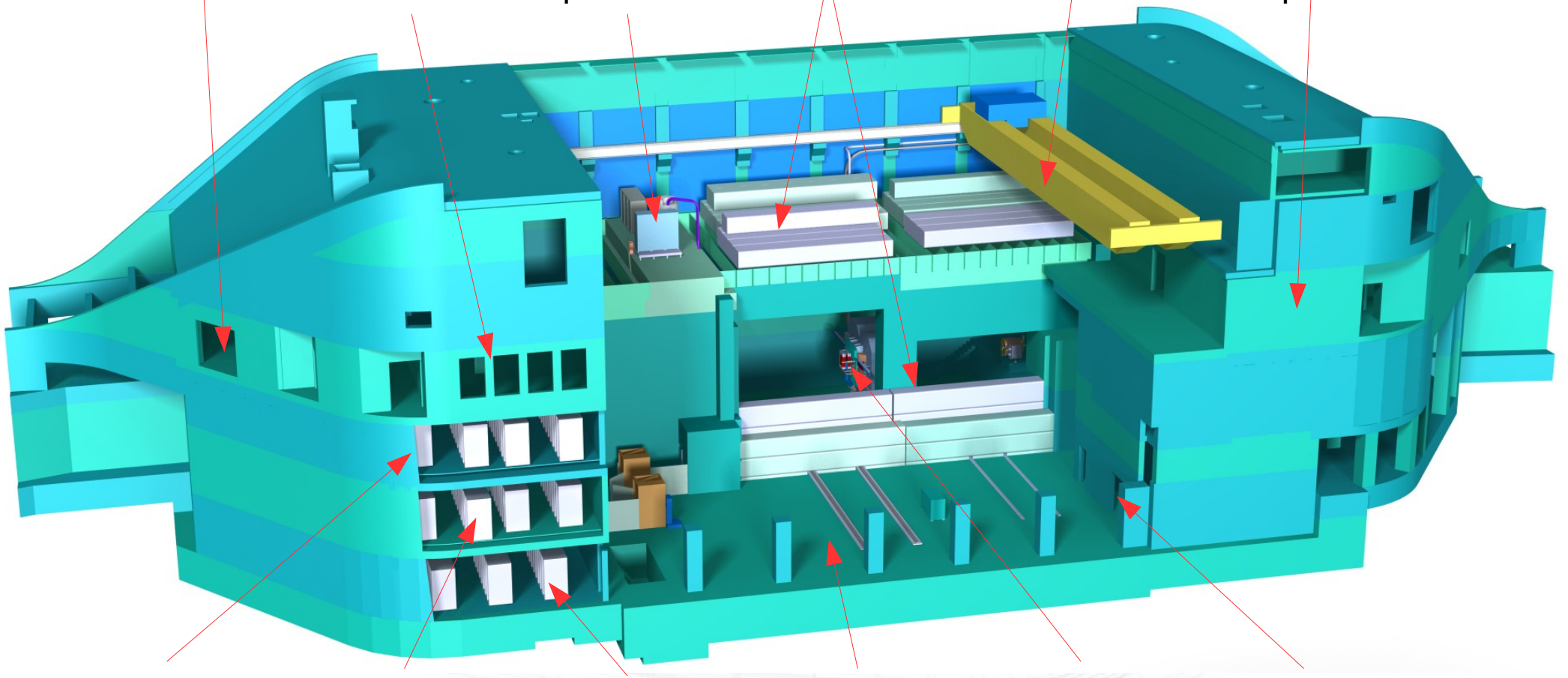
in the framework of
- Integration requirements
- Installation procedures

Current status:
- Report was released to the collaboration
- Review with external experts in summer
- Submission to ECE in September

Next steps:
- Cost review with ECSG
- Common fund: MoU & RRB

Infrastructure and Installation Report

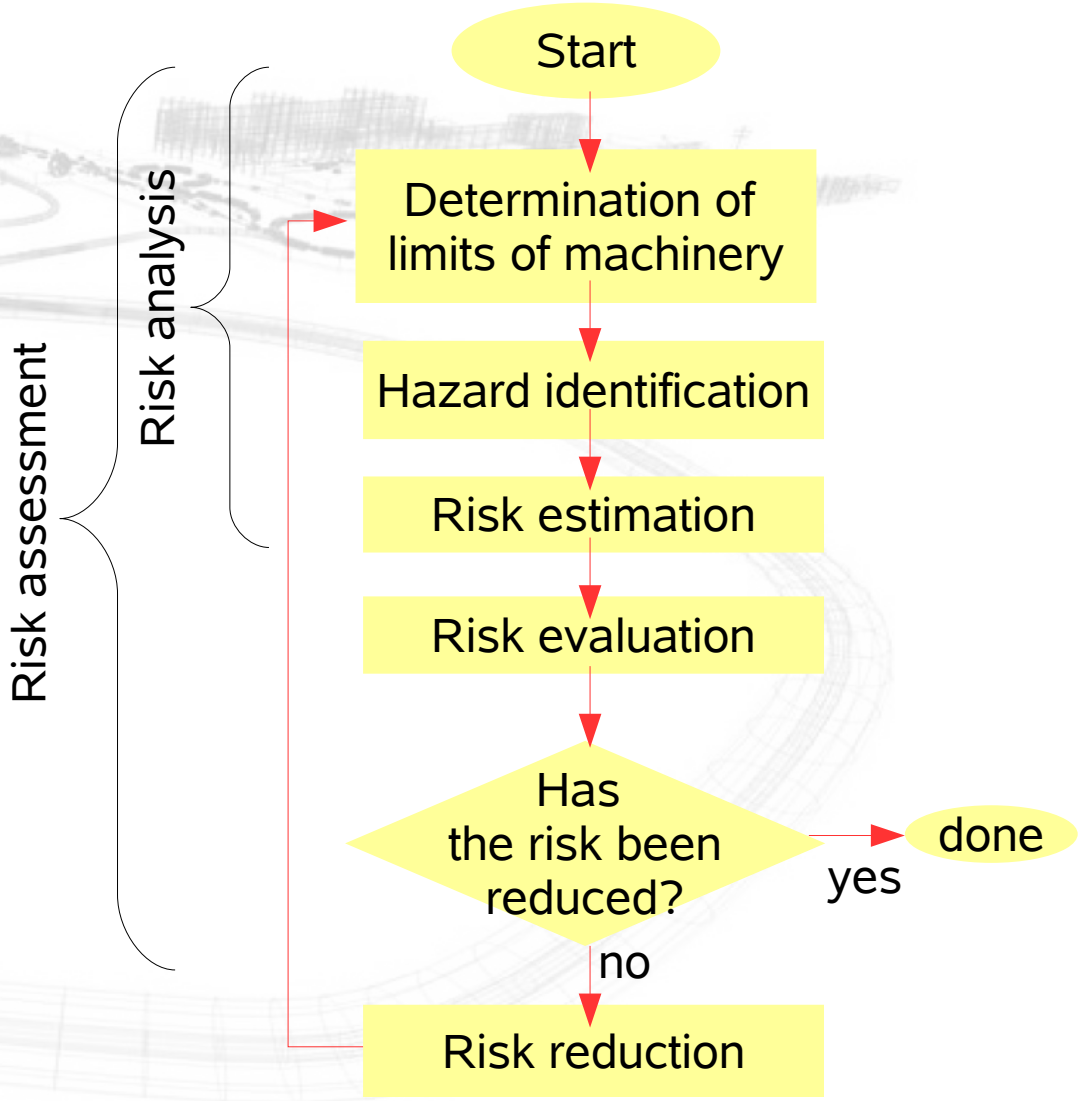
PANDA Hall Layout



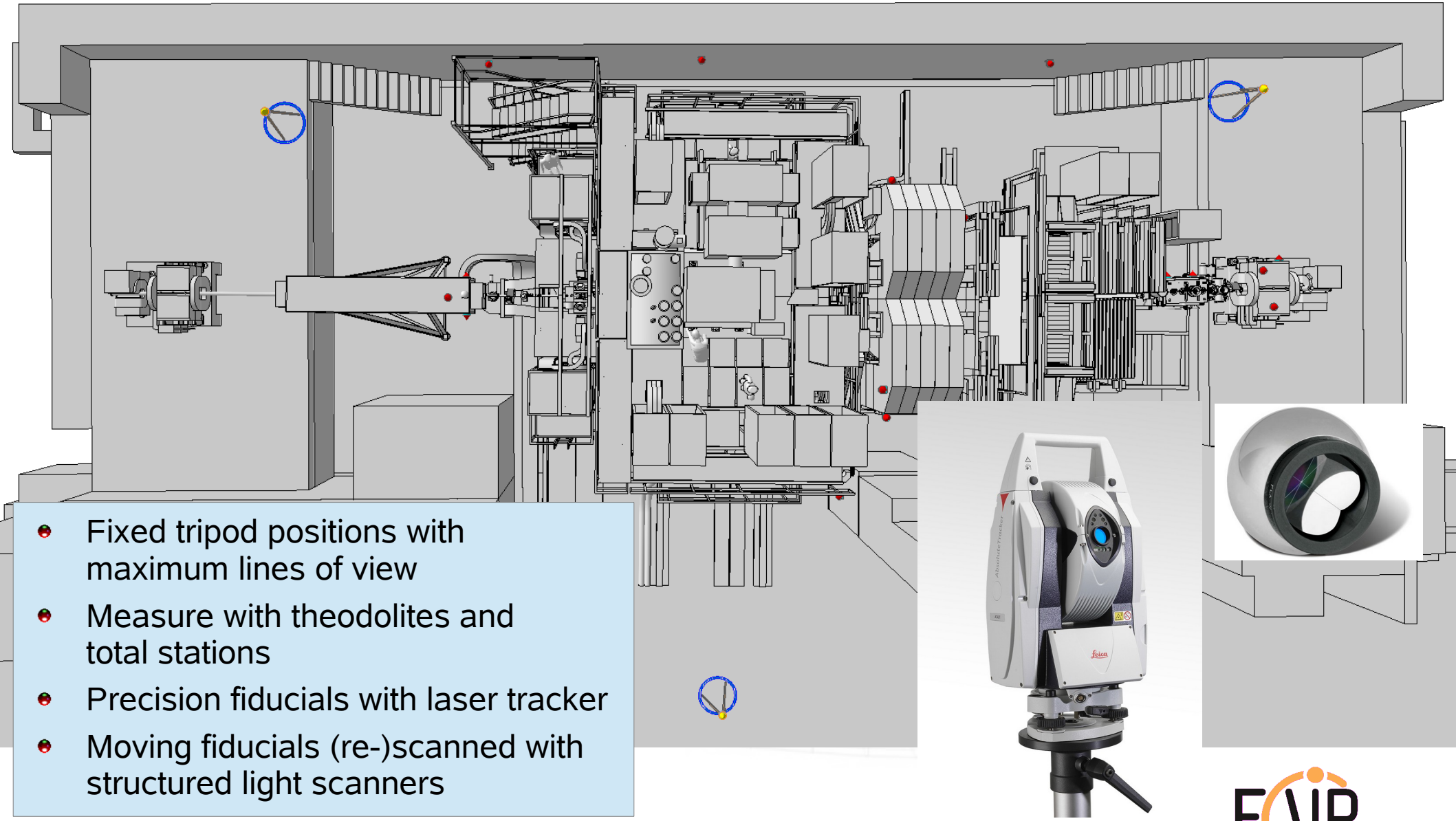
Conformity and Risk Assessment

- *Risk analysis*
  - Limits of machinery
  - Hazard identification
  - Risk estimation
- *Risk evaluation*

  Measures to reduce risks:
  - By design
  - Protective measure
  - Adequate information for use
- *Related information*
  - User specification
  - Machinery specification
  - Regulations and standards
  - Experience of use

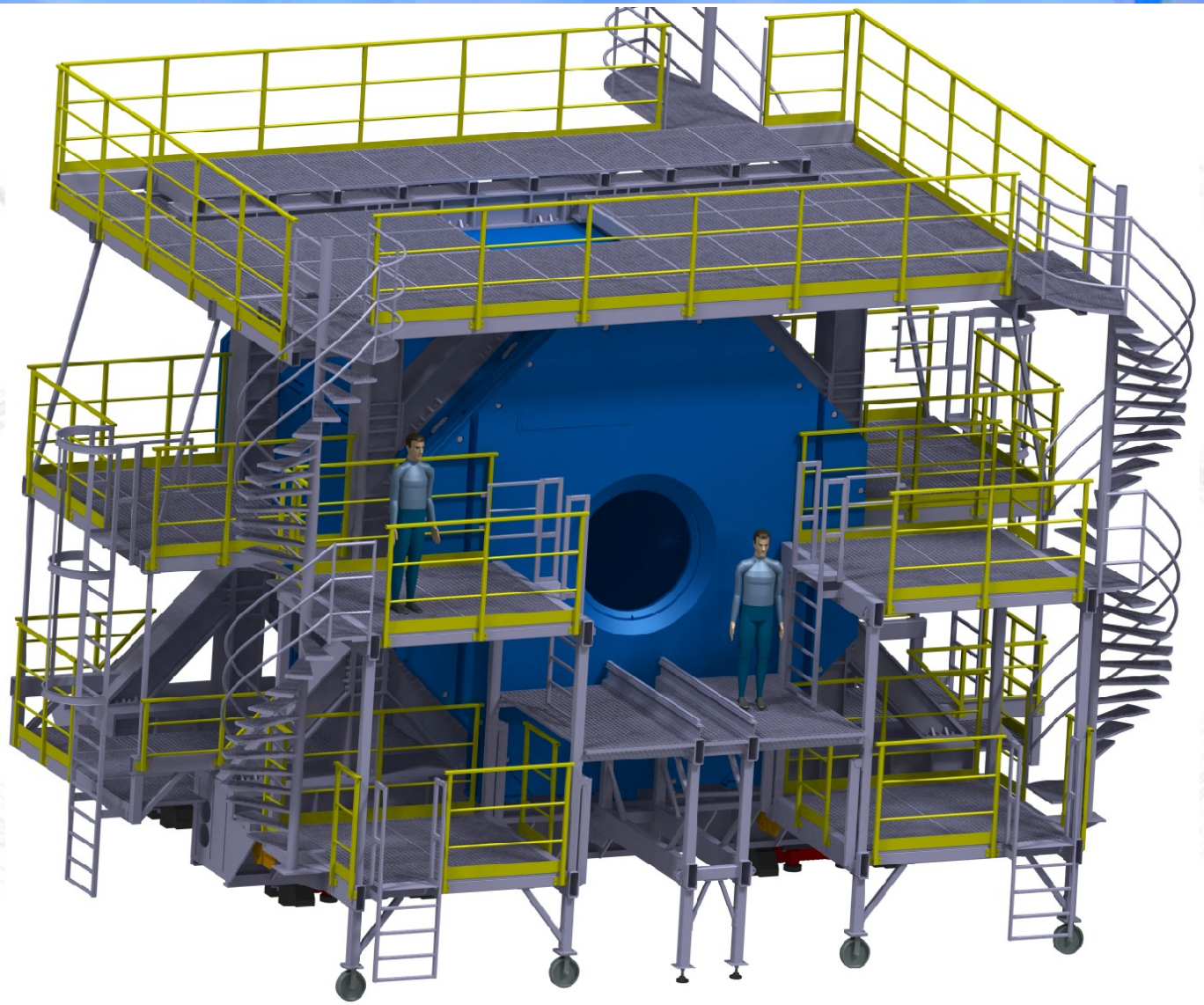


Survey and Alignment



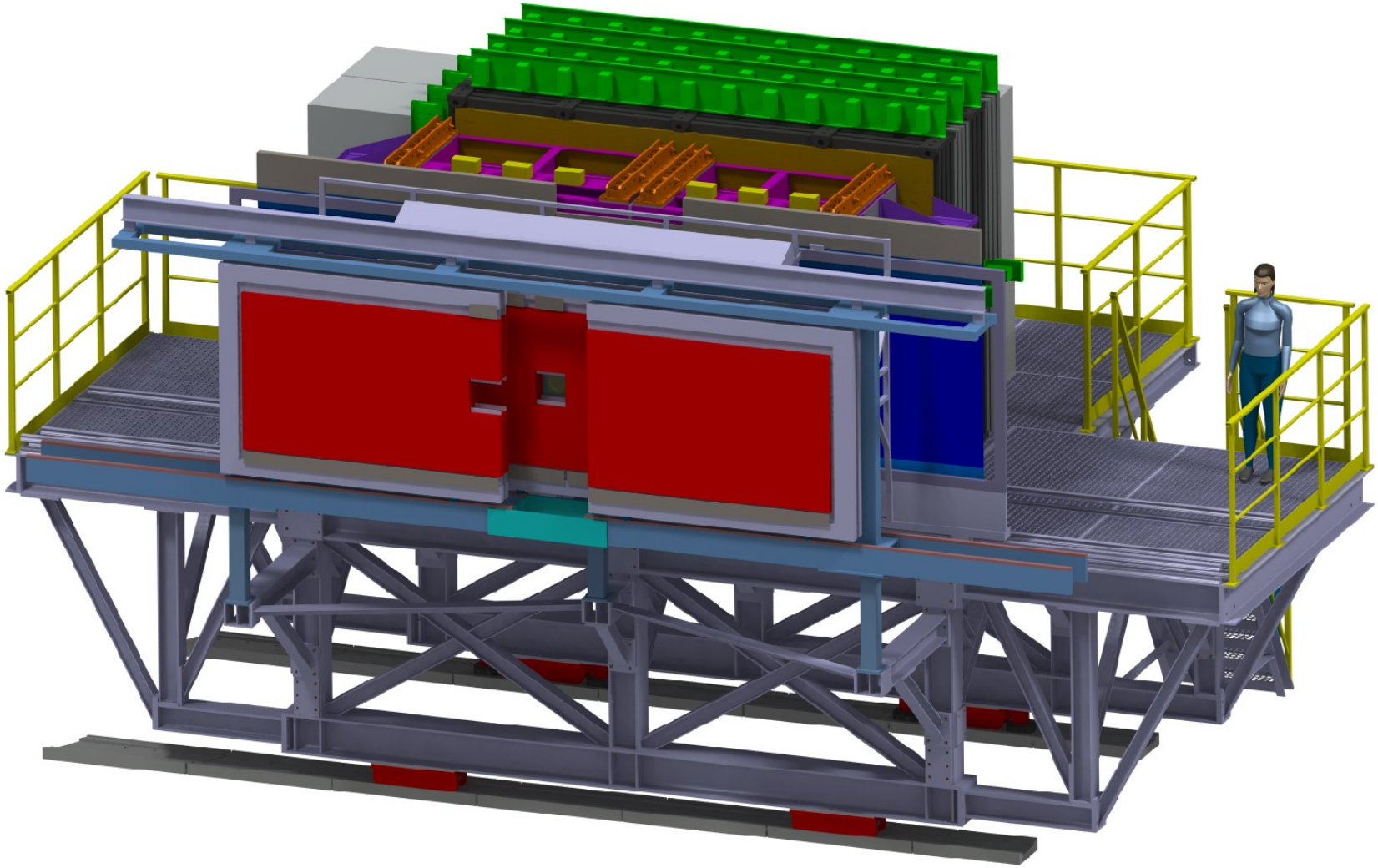
- Fixed tripod positions with maximum lines of view
- Measure with theodolites and total stations
- Precision fiducials with laser tracker
- Moving fiducials (re-)scanned with structured light scanners

Support Structures and Platforms



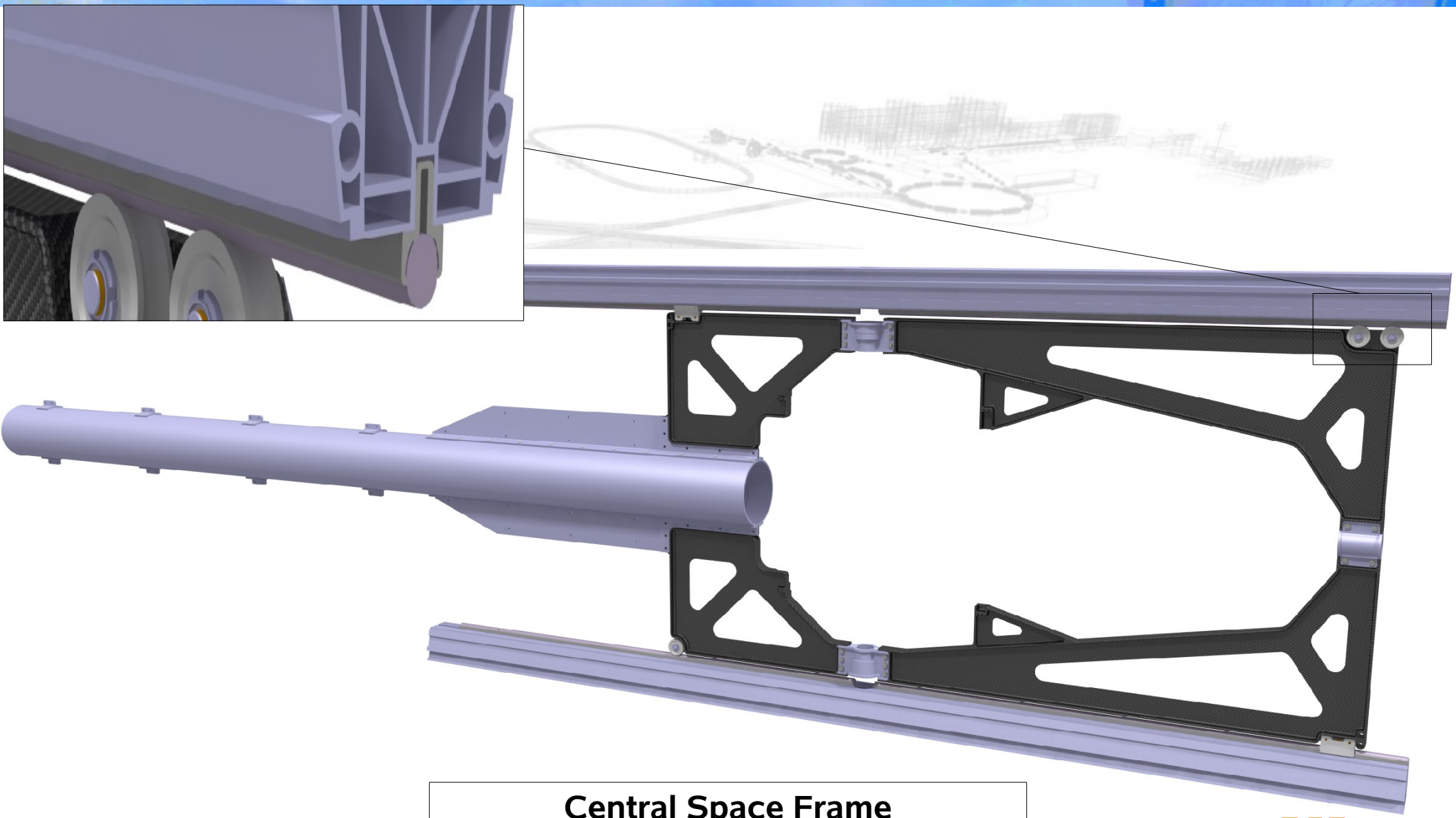
Solenoid Magnet with Supports

Support Structures and Platforms



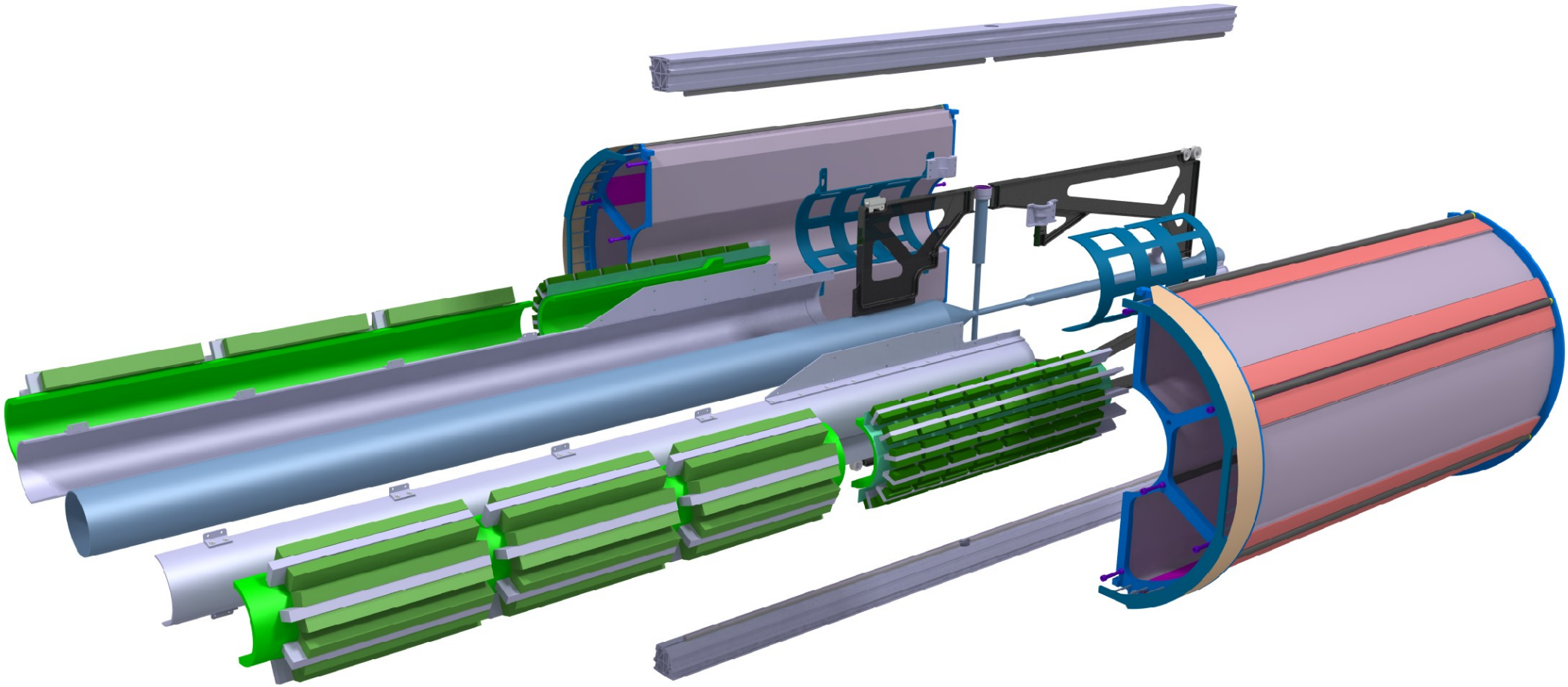
Forward Spectrometer Platform

Detector Supports



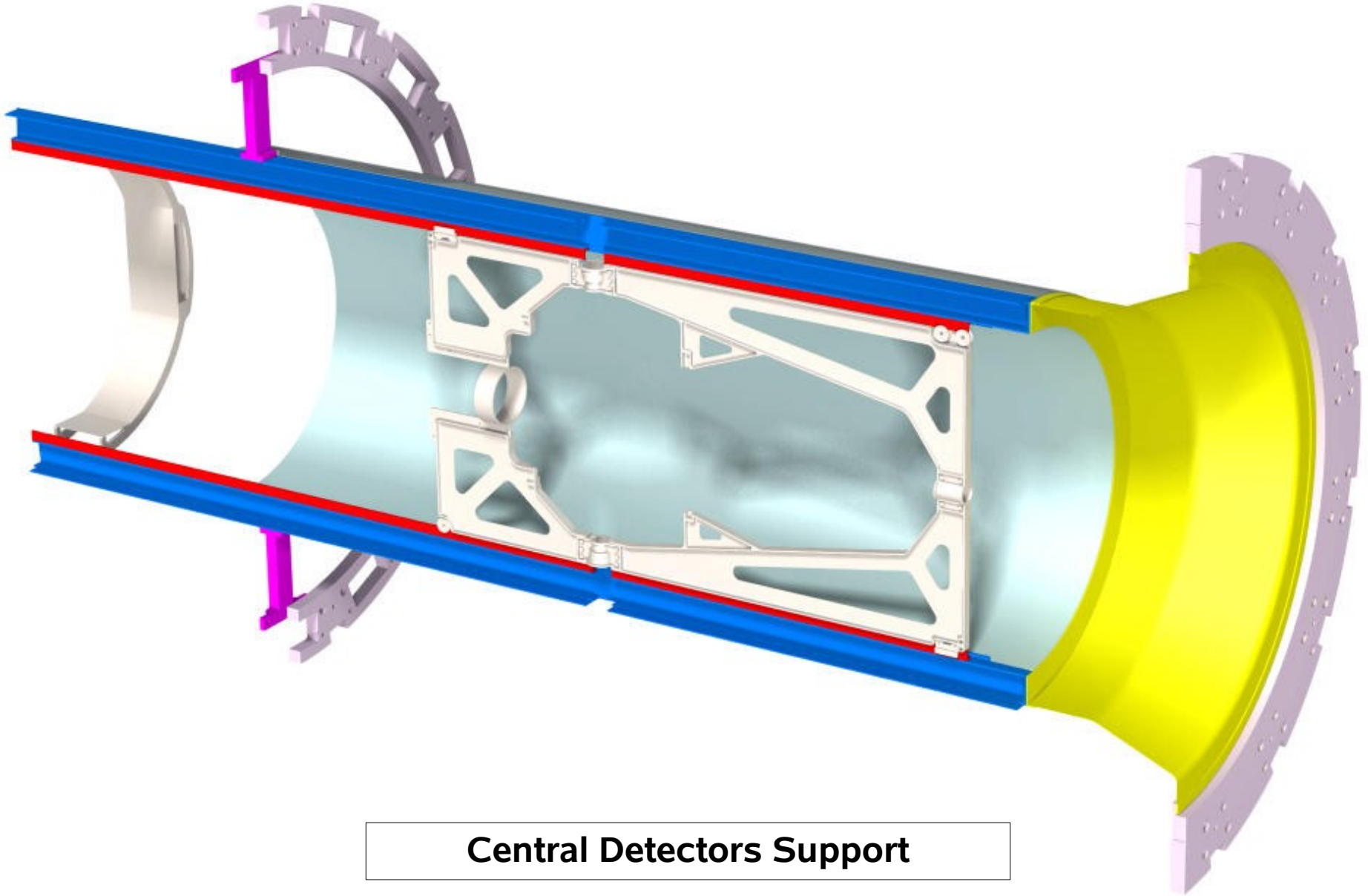
Central Space Frame

Detector Supports



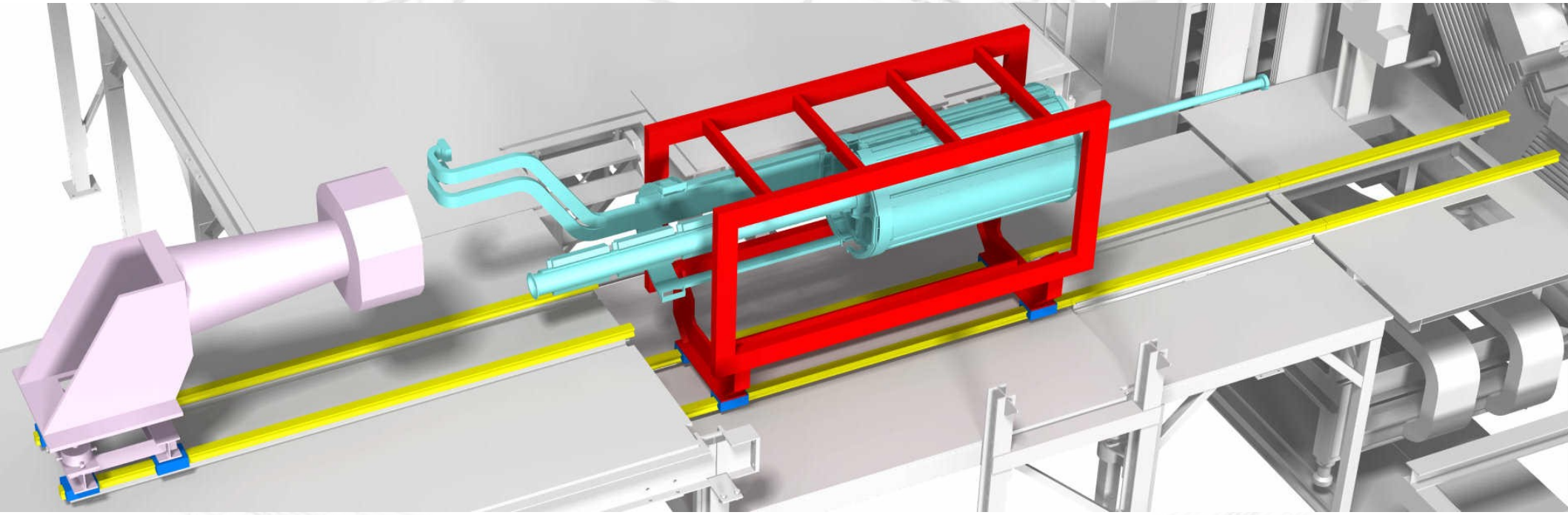
Central Space Frame

Detector Supports



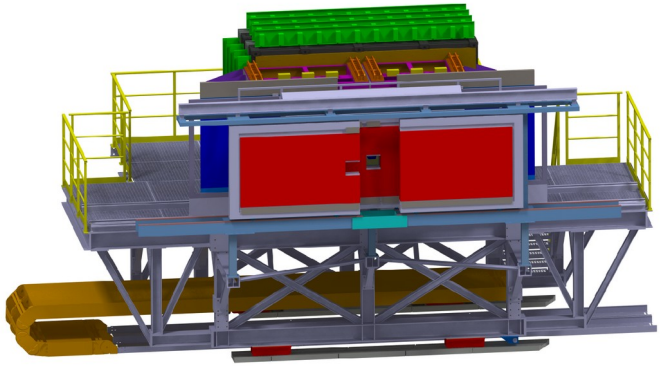
Central Detectors Support

Detector Supports

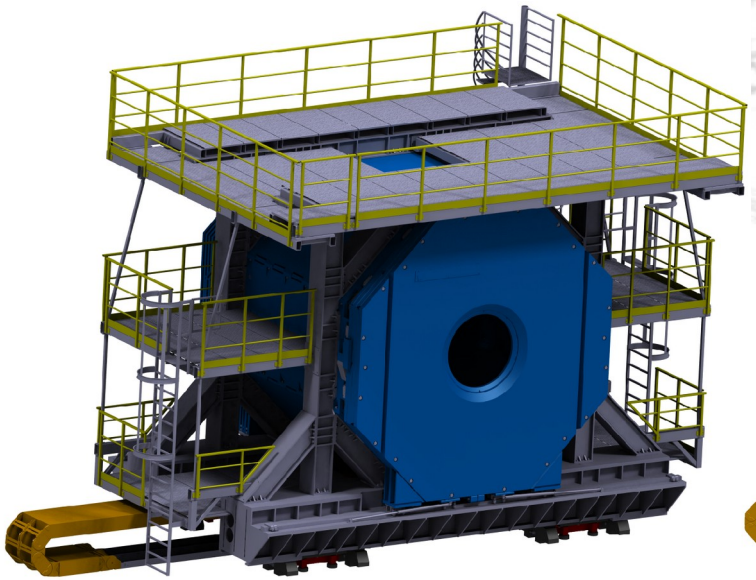


Rail System for Central Detectors

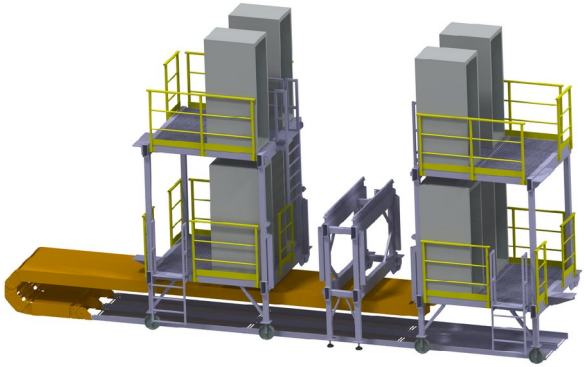
Supplies: Drag Chains



FS Platform



Solenoid



Aux Platform

Supplies: Power, Cooling, Air

Electrical Power

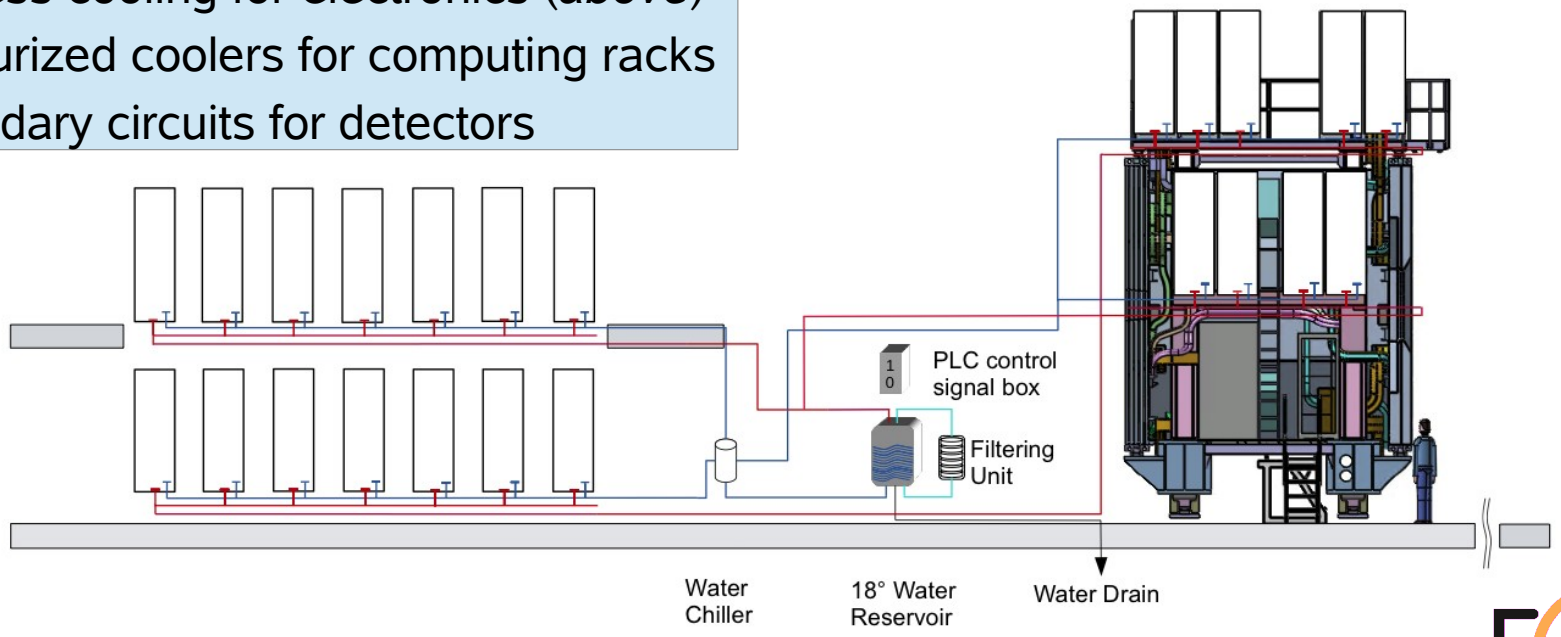
- Power distribution on platforms
- 48V supply for on-detector FEE
- Star shaped electronics grounding

Pressurized Air

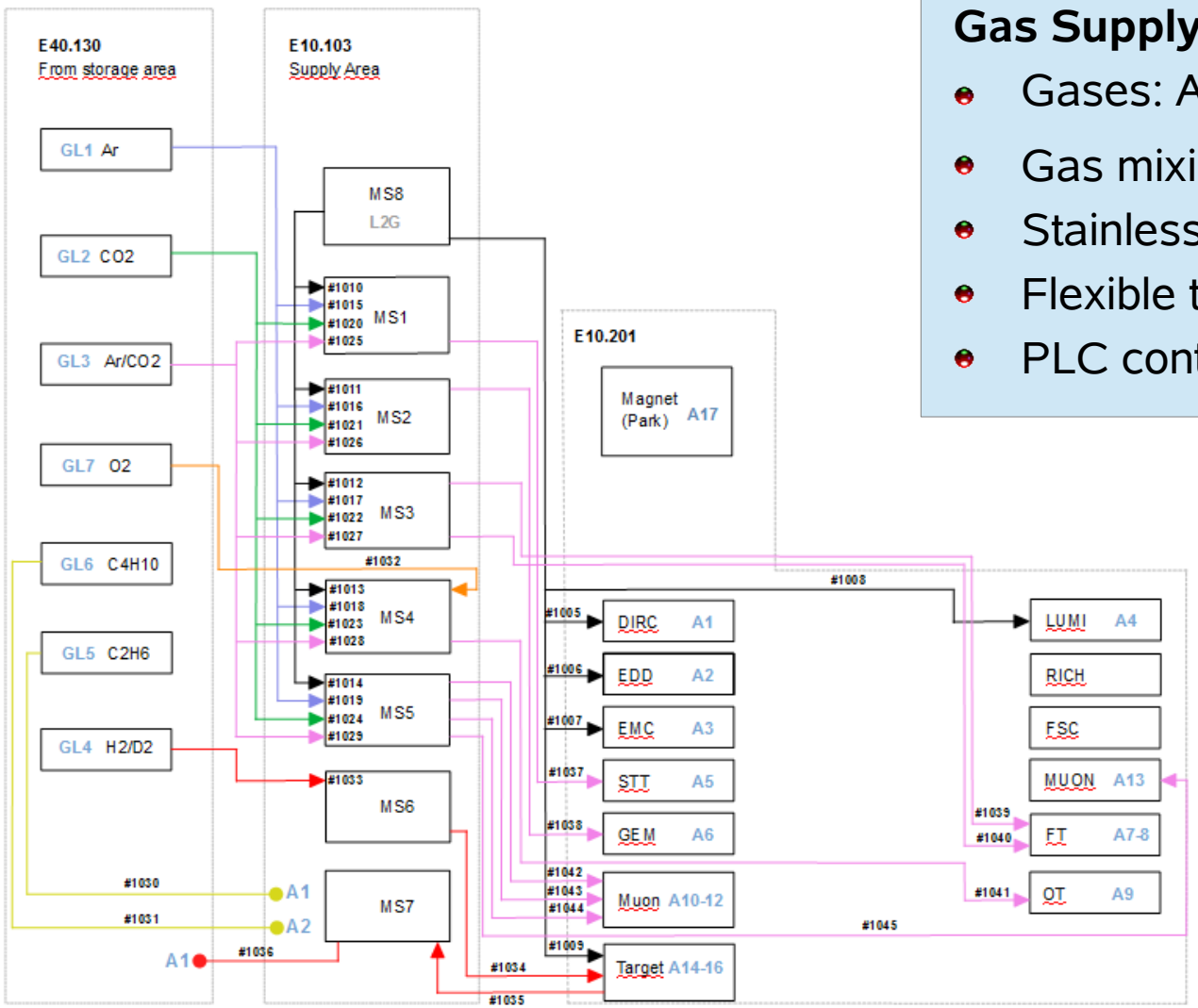
- 5-7 bar pressure
- Outlets every 20m
- ISO8573-1 Class 1.3.1
- Dew point < -25°C

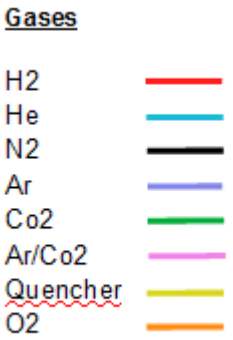
Water Cooling

- Leakless cooling for electronics (*above*)
- Pressurized coolers for computing racks
- Secondary circuits for detectors



Supplies: Technical Gases

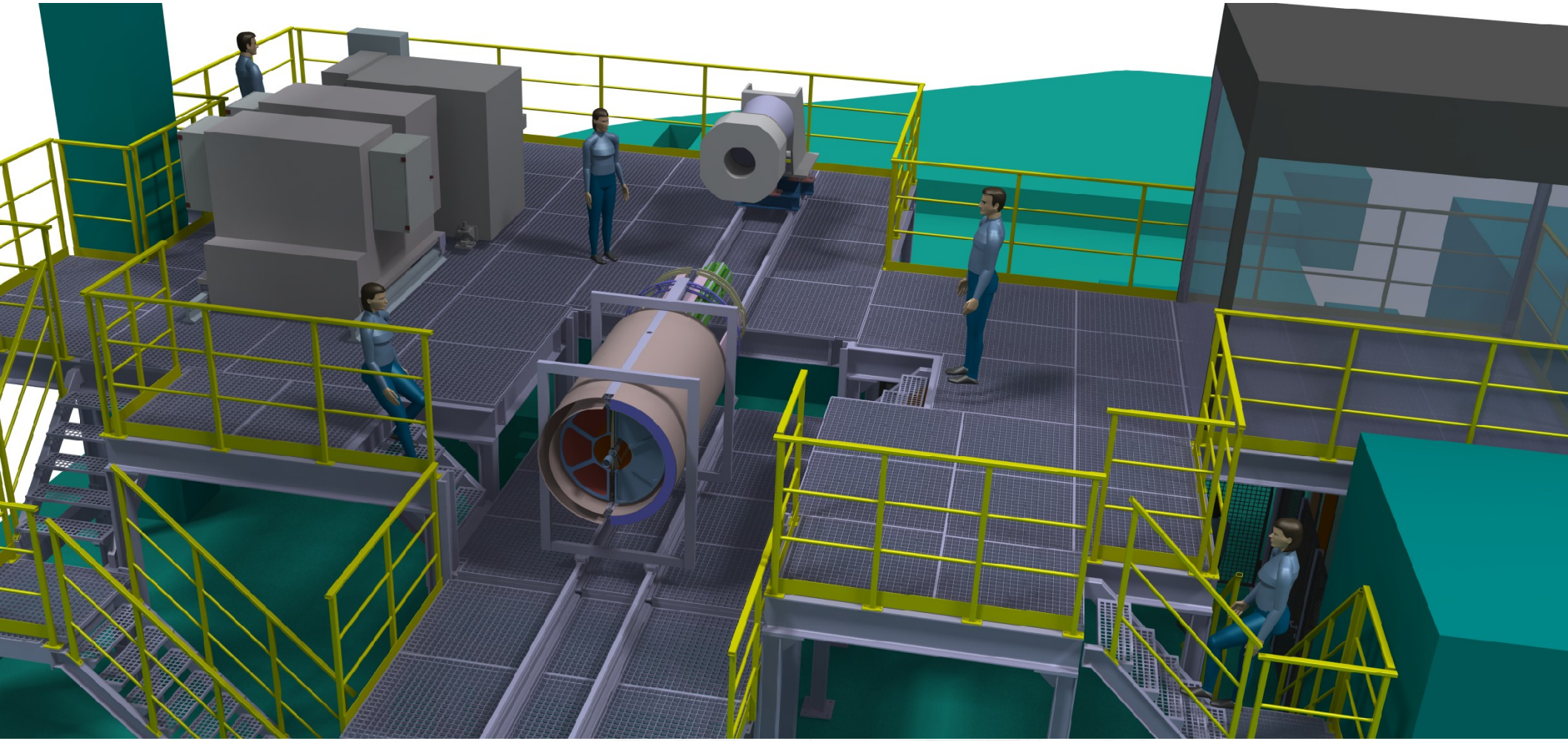




Gas Supply

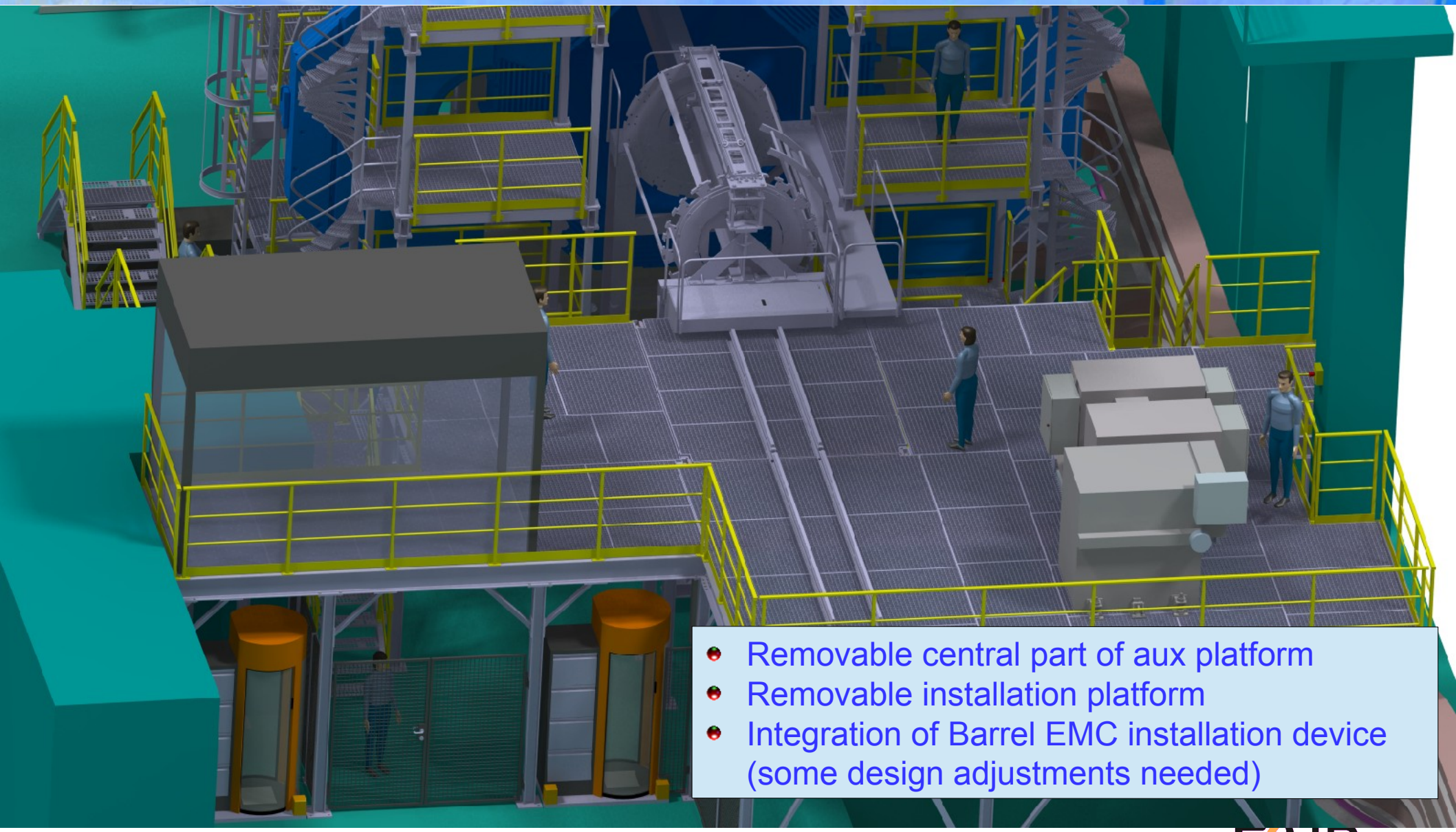
- Gases: Ar, CO_2, H_2, O_2, C_2H_6/C_4H_{10}
- Gas mixing in supply area
- Stainless steal pipes
- Flexible tubes in drag chains
- PLC control

Installation Platform



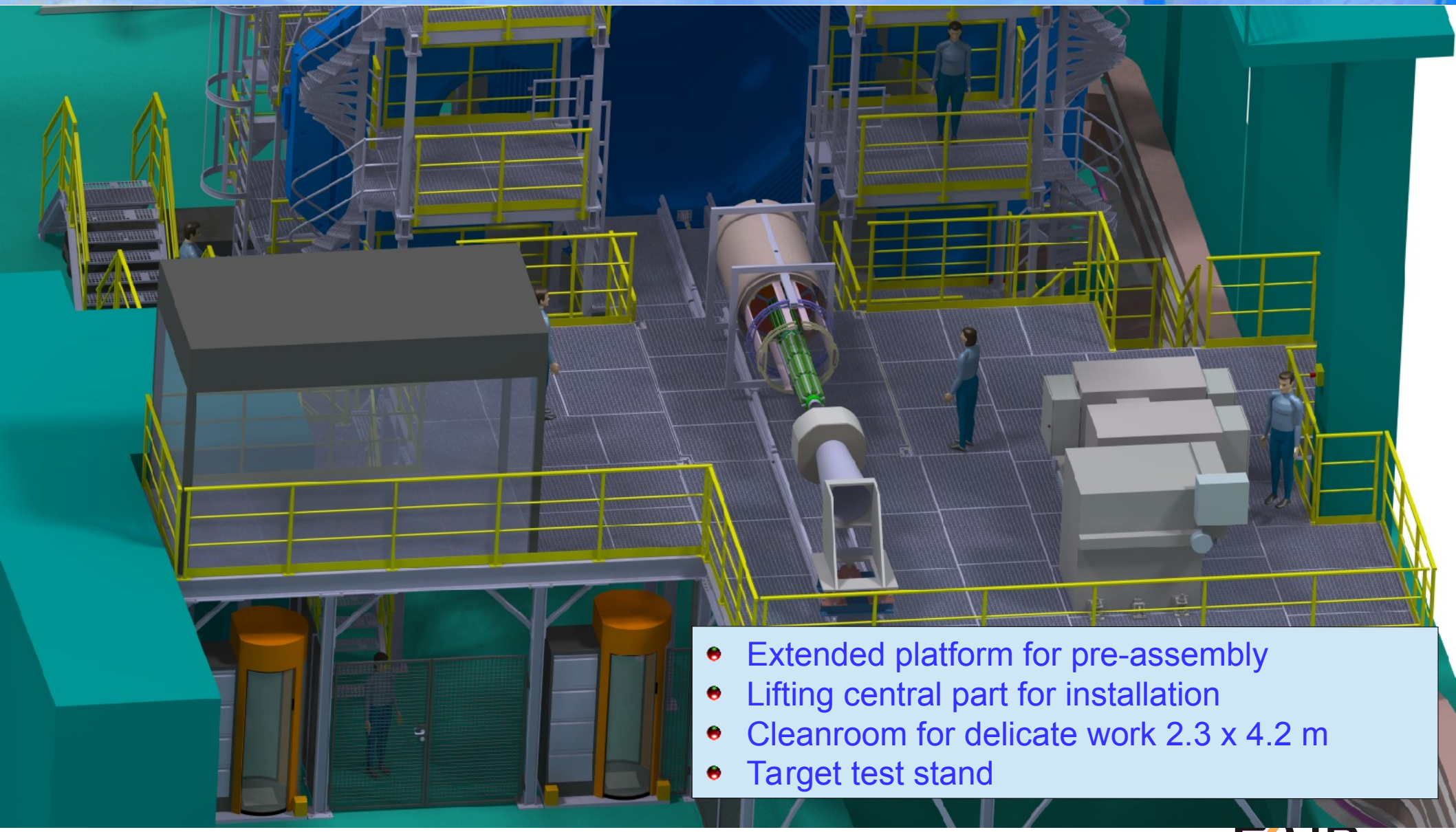
Extended Installation Platform

Maintenance Area



- Removable central part of aux platform
- Removable installation platform
- Integration of Barrel EMC installation device (some design adjustments needed)

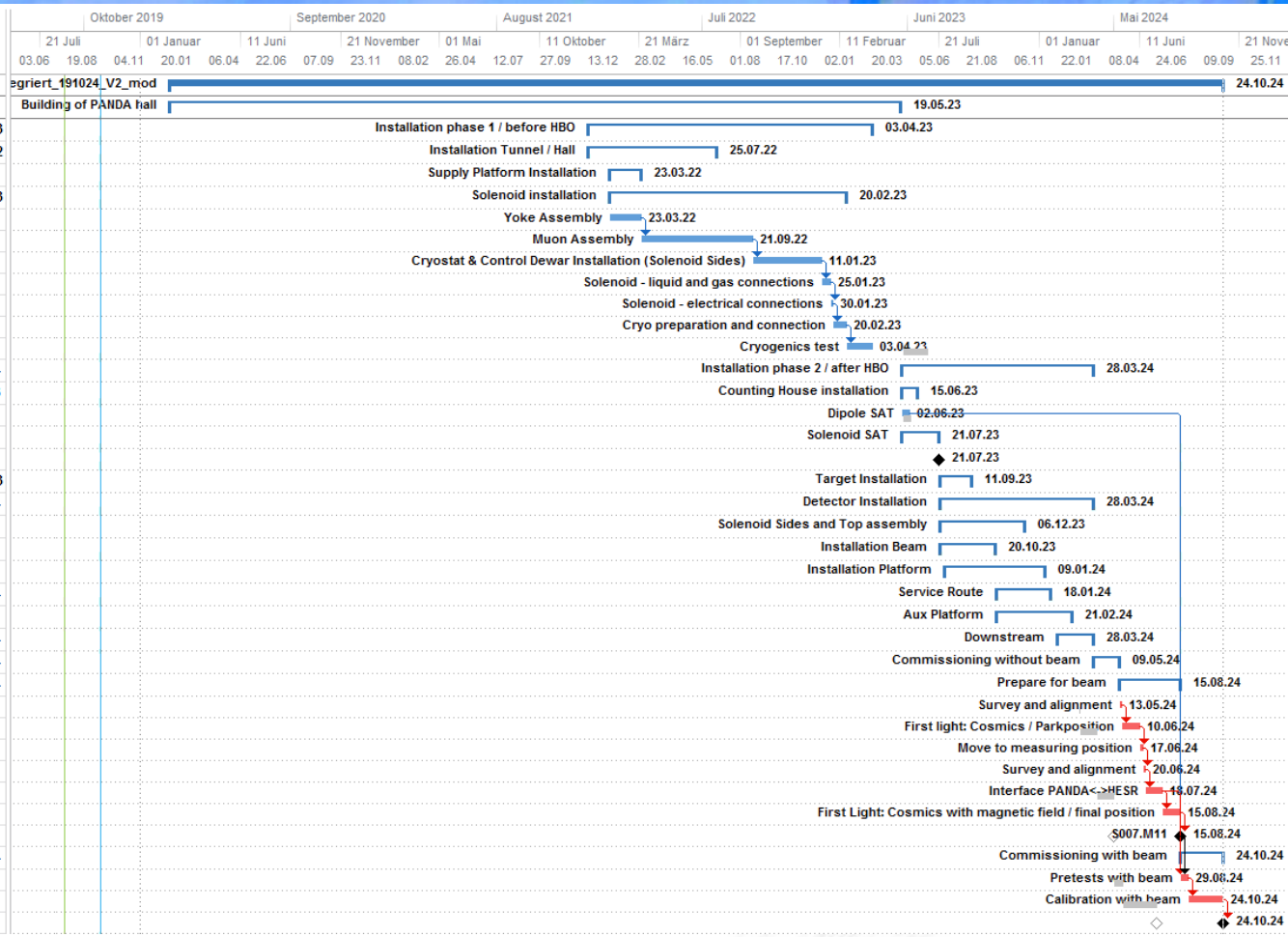
Maintenance Area



- Extended platform for pre-assembly
- Lifting central part for installation
- Cleanroom for delicate work 2.3 x 4.2 m
- Target test stand

Installation Planning

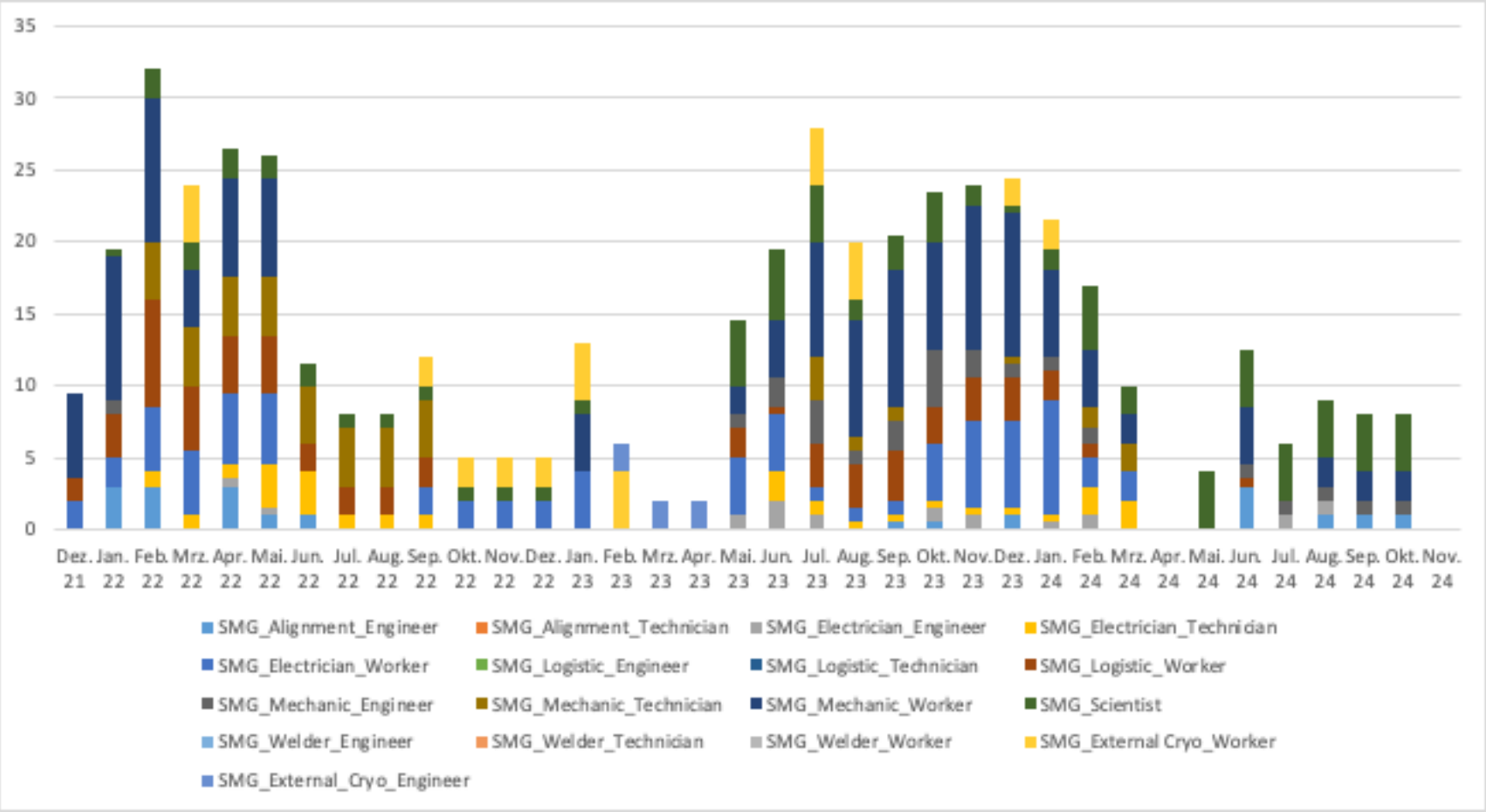
Vorgangsname	Dauer	Anfang	Ende
PANDA_integriert_191024_V2_mod	1223 Tage	Die 18.02.20	Don 24.10.24
Building of PANDA hall	849 Tage	Die 18.02.20	Fre 19.05.23
Installation phase 1 / before HBO	330 Tage	Die 28.12.21	Mon 03.04.23
Installation Tunnel / Hall	150 Tage	Die 28.12.21	Mon 25.07.22
Supply Platform Installation	36 Tage	Mit 02.02.22	Mit 23.03.22
Solenoid installation	274 Tage	Mit 02.02.22	Mon 20.02.23
Yoke Assembly	36 Tage	Mit 02.02.22	Mit 23.03.22
Muon Assembly	6,5 Monate	Don 24.03.22	Mit 21.09.22
Cryostat & Control Dewar Installation (Solenoid Sides)	4 Monate	Don 22.09.22	Mit 11.01.23
Solenoid - liquid and gas connections	10 Tage	Don 12.01.23	Mit 25.01.23
Solenoid - electrical connections	3 Tage	Don 26.01.23	Mon 30.01.23
Cryo preparation and connection	3 Wochen	Die 31.01.23	Mon 20.02.23
Cryogenics test	30 Tage	Die 21.02.23	Mon 03.04.23
Installation phase 2 / after HBO	224 Tage	Mon 22.05.23	Don 28.03.24
Counting House installation	19 Tage	Mon 22.05.23	Don 15.06.23
Dipole SAT	10 Tage	Mon 22.05.23	Fre 02.06.23
Solenoid SAT	45 Tage	Mon 22.05.23	Fre 21.07.23
DIS (Detector Installation Start)	0 Tage	Fre 21.07.23	Fre 21.07.23
Target Installation	36 Tage	Mon 24.07.23	Mon 11.09.23
Detector Installation	179 Tage	Mon 24.07.23	Don 28.03.24
Solenoid Sides and Top assembly	98 Tage	Mon 24.07.23	Mit 06.12.23
Installation Beam	65 Tage	Mon 24.07.23	Fre 20.10.23
Installation Platform	117 Tage	Mon 31.07.23	Die 09.01.24
Service Route	64 Tage	Mon 23.10.23	Don 18.01.24
Aux Platform	88 Tage	Mon 23.10.23	Mit 21.02.24
Downstream	43 Tage	Die 30.01.24	Don 28.03.24
Commissioning without beam	30 Tage	Fre 29.03.24	Don 09.05.24
Prepare for beam	70 Tage	Fre 10.05.24	Don 15.08.24
Survey and alignment	2 Tage	Fre 10.05.24	Mon 13.05.24
First light: Cosmics / Parkposition	20 Tage	Die 14.05.24	Mon 10.06.24
Move to measuring position	5 Tage	Die 11.06.24	Mon 17.06.24
Survey and alignment	3 Tage	Die 18.06.24	Don 20.06.24
Interface PANDA<->HESR	20 Tage	Fre 21.06.24	Don 18.07.24
First Light: Cosmics with magnetic field / final position	20 Tage	Fre 19.07.24	Don 15.08.24
Ready for beam (M11)	0 Tage	Don 15.08.24	Don 15.08.24
Commissioning with beam	50 Tage	Fre 16.08.24	Don 24.10.24
Pretests with beam	10 Tage	Fre 16.08.24	Don 29.08.24
Calibration with beam	40 Tage	Fre 30.08.24	Don 24.10.24
Ready for operation (M12)	0 Tage	Don 24.10.24	Don 24.10.24



- Planning of detailed steps of magnet, detector and infrastructure installation
- 1st phase: magnets and infrastructure
- 2nd phase: detector installation

Note: Absolute dates subject to adjustment

Installation Planning



- Planning of detailed steps of magnet, detector and infrastructure installation
- 1st phase: magnets and infrastructure
- 2nd phase: detector installation
- Resource planning of additional workforce

Note: Absolute dates subject to adjustment

Infrastructure Cost

Supports (PSP 1.4.1.18.1)	k€
Auxiliary platform, 7.8 m x 2.5 m x 3.7 m	30.7
Yoke support, 8.6 m x 5.8 m x 6.0 m	60.5
Forward platform, 11.0 m x 6.7 m x 2.1 m	79.7
Supports between solenoid and dipole	64.0
Inner detectors - Central space frame	96.0
Inner detectors - Central support rail system	104.0
Rail system and central tracker shuttle	21.3
Forward Endcap supports and trolley	50.0
Hydraulic equipment	50.2
Rollers and rails for target spectrometer	104.2
Rollers and rails for forward spectrometer	70.4
Installation platform, 2.0 m x 2.7 m x 2.5 m	8.2
Extended platform, 14.6 m x 8.8 m x 3.6 m	98.0
Extended platform - drive system	23.8
Clean room cabin	19.0
Spindle stairs	36.4
Installation - Tooling	48.0
Installation - Workshop equipment	96.4
Installation - Hired labor	392.6
Surveying	56.0
Certification of conformity	80.0
	1589.4

Supplies (PSP 1.4.1.18.2)	k€
Drag chains	28.4
Cable trays	23.0
Fixed forward system cable ducts	9.9
48\,V power supply system	136.8
Grounding	24.6
Pressurized cooling circuits	103.0
Leakless cooling / infrastructure racks	983.0
Gas installation	60.0
Gas storage	267.2
	1635.9
Controls (PSP 1.4.1.18.3)	
as of DCS-TDR	376.0
Control room equipment	82.6
	458.6
TOTAL SUM Infrastructure	**3683.9**
DAQ (PSP 1.4.1.19)	**920.0**

- Contracted equipment incl. certification and installation
- Installation labor: electricians, technicians, mechanics workers, survey engineers
- Personnel contribution of collaborators to installation work foreseen

Feedback from Internal Review

Internal Review July 20

- Participants:
  - Rolf Lindner, LHCb (CERN)
  - Werner Riegler, ALICE (CERN)
- Report was submitted beginning of July
- Meeting of 4 hours of presentation, Q&A
- Report with recommendations received Aug 28

Remarks and recommendations (regarding personnel and budget)

- *"Core team of engineers, designers and especially technicians is essential."*
- *"A safety person is essential for the consistent implementation and follow up of all safety related items."*
- *"The common fund contains only 400kEuro of hired labour. We consider this to be significantly underestimated."*
- *"As minimum a contingency of 30% should be foreseen."*
- *"Allow an operational budget for personnel and 'consumables' that are needed during the installation."*

Conclusion

Main achievements:

- Solenoid construction in full swing – first yoke test assembly done
- Dipole design work ongoing, construction contract in preparation
- Barrel DIRC procurement started, delivery 90/98 bars, PMT evaluation complete
- Barrel EMC first slice assembled, testing ongoing, finalisation of cooling
- Reports: DCS TDR approved;
  DAQT TDR, Infrastructure Report, EMC TDR Update Report submitted

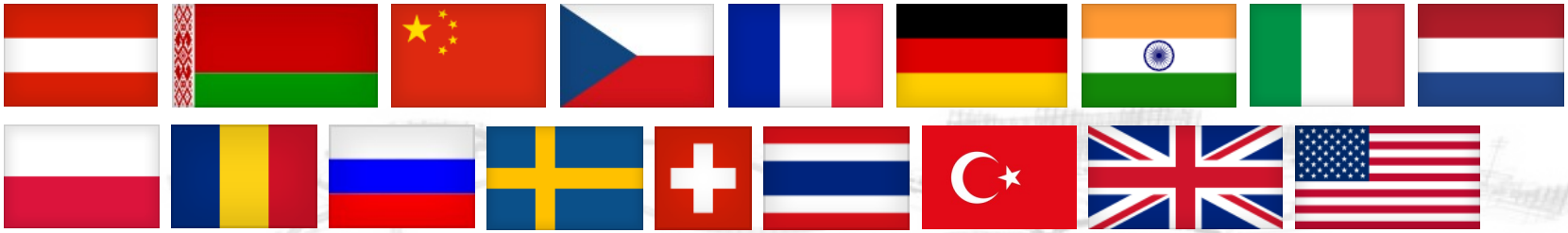
Upcoming milestones:

- Forward tracker IKC with Poland
- Solenoid:
  - Start of cryostat construction
  - Super-conductor production to finish by end 2021
- GEM TDR submission early 2021
- Dipole contract (with HESR)

In summary: PANDA remains on track for Day-1

Turn schedule risks into schedule opportunities

PANDA Collaboration



UP Marche Ancona
U Basel
IHEP Beijing
U Bochum
Abant Izzet Baysal
U Golkoy, Bolu
U Bonn
U Brescia
IFIN-HH Bucharest
AGH UST Cracow
IFJ PAN Cracow
JU Cracow
Cracow UT
FAIR Darmstadt
GSI Darmstadt
JINR Dubna
U Erlangen

NWU Evanston
U Frankfurt
LNF-INFN Frascati
U & INFN Genova
U Gießen
Giresun U
U Glasgow
KVI-CART Groningen
Gauhati U, Guwahati
USTC Hefei
URZ Heidelberg
Doğuş U, Istanbul
Okan U, Istanbul
FZ Jülich
Karlsruhe Institute of Technology
IMP Lanzhou
INFN Legnaro

Lund U
HI Mainz
U Mainz
RINP Minsk
NRC "Kurchatov Institute" - ITEP Moscow
MPEI Moscow
U Münster
BINP Novosibirsk
Novosibirsk State U
U Wisconsin, Oshkosh
U & INFN Pavia
PNPI St. Petersburg
West Boh. U, Pilzen
Charles U, Prague
Czech TU, Prague

IHEP Protvino
Irfu Saclay
KTH Stockholm
Stockholm U
SUT, Nakhon Ratchasima
SVNIT Surat-Gujarat
S Gujarat U, Surat-Gujarat
FSU Tallahassee
Nankai U, Tianjin
U & INFN Torino
Politecnico di Torino
U Uppsala
SMI Vienna
NCBJ Warsaw
U York

more than 420 physicists from 65 institutions in 18 countries