

From RedPANDA



to PANDA

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*PANDA Collaboration Meeting
Prague, June 13/14, 2023*

General Status

RedPANDA

Updated PANDA

FAIR Stages



FAIR Phase 0

- Existing GSI facility
- HITRAP, CRYRING, ESR
- HADES, R3B, FRS, BioMat

Early Science (from 2027)

- S-FRS, NUSTAR HEB, beam from SIS18

First Science (from 2028)

- In addition: SIS100

First Science + (from 2028)

- First Science + CBM

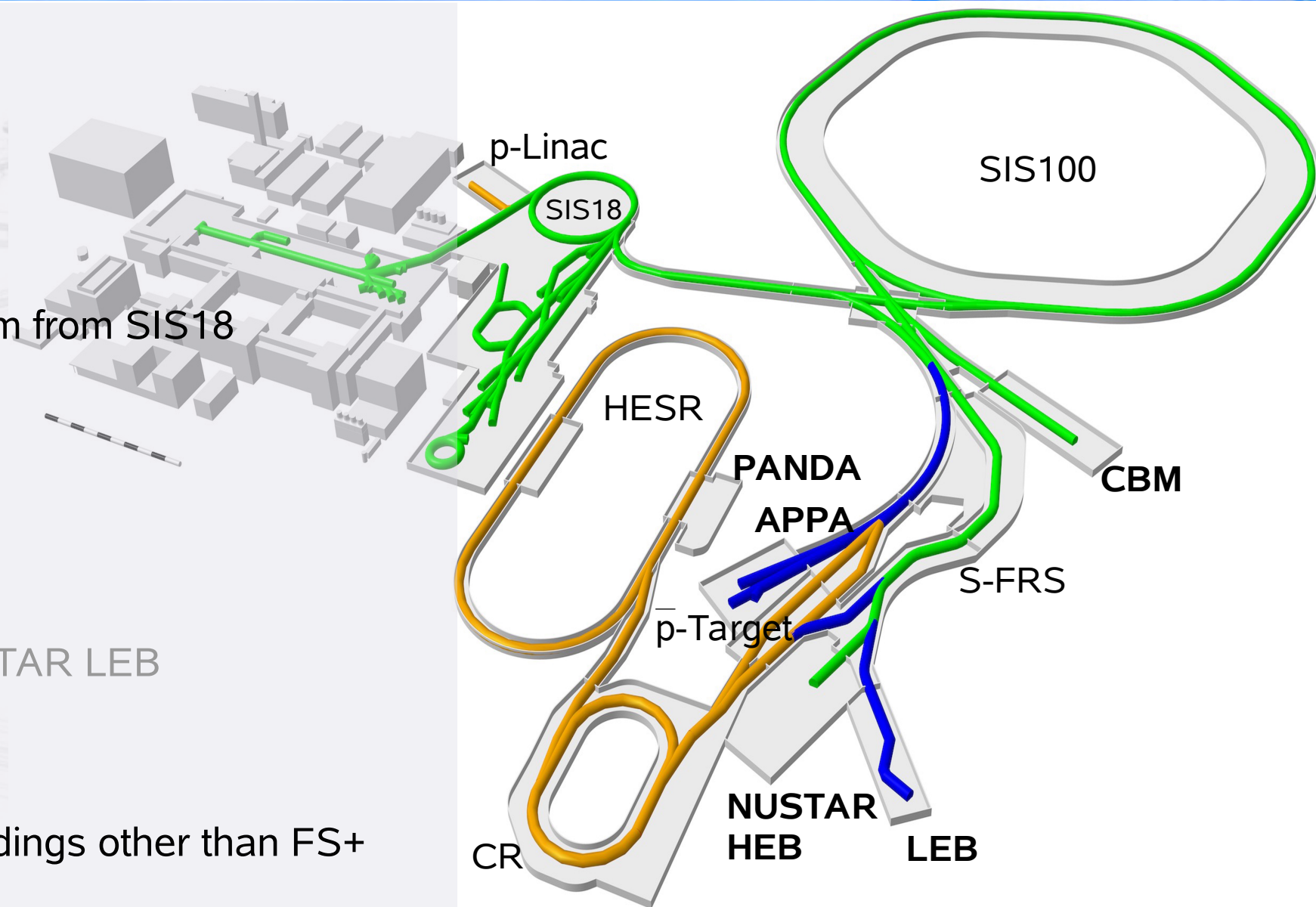
First Science ++

- In addition APPA cave, NUSTAR LEB

FAIR MSV

- pLinac, CR, HESR, PANDA

In current scope no TBI in buildings other than FS+



- **Ongoing and near future program**
 - Usage of individual PANDA components:
FT straws at HADES, BWE EMC at MAMI
 - Testbeam activities at GSI Cave C
- **Mid-term initiatives (2026+)**
 - Cooperation with CBM and HADES on hadron physics
 - PANDA Precursor experiment *RedPANDA* at GSI/FAIR
 - Detector integration and commissioning of as many systems as possible
 - Software commissioning: DAQT, controls, online/offline
 - Use of FWE EMC for physics measurements at ELSA or JLAB
 - Long lead items of PANDA till 2030:
 - Solenoid Magnet
 - Crystals for Barrel EMC
- **Long term goal (2030+)**
 - Installation of PANDA components as early as possible in PANDA hall
 - Antiprotons no later than 2032 (see Science Review)

Status of PANDA Systems



- **Cluster Jet Target:**
 - completion in 2024 apart from gas system
 - continue operation with or without beam to preserve know-how and optimise
- **MVD:** plans for completion of strip barrel (JLU, KIT, CTU), support for tracking applications
- **STT:** 1 sector in 2023/24, tests in HADES, application of detectors requires resources
- **Barrel DIRC:** Pre-series barbox till 2025, participation in intermediate program
- **Forward Tracker:** FT1/2 ready end 2025, FT3/4 end 2027, commission with sources/cosmics, open for usage in intermediate program
- **Outer Tracker:** transport to GSI in summer 2023, usage for various applications
- **Forward Endcap EMC:** assembly starting at FZJ, COSY beamtime approved, intermediate program proposed for ELSA or JLAB
- **Backward Endcap:** assembly complete end 2023, beam at MAMI A1 from 2024
- **Barrel EMC:** first slice ready, continuing towards 4 slices in 2028
- **Luminosity Detector:** Final detector till end 2025, detector planes can be used as forward pixels in intermediate program

Summary of Situation



Detectors

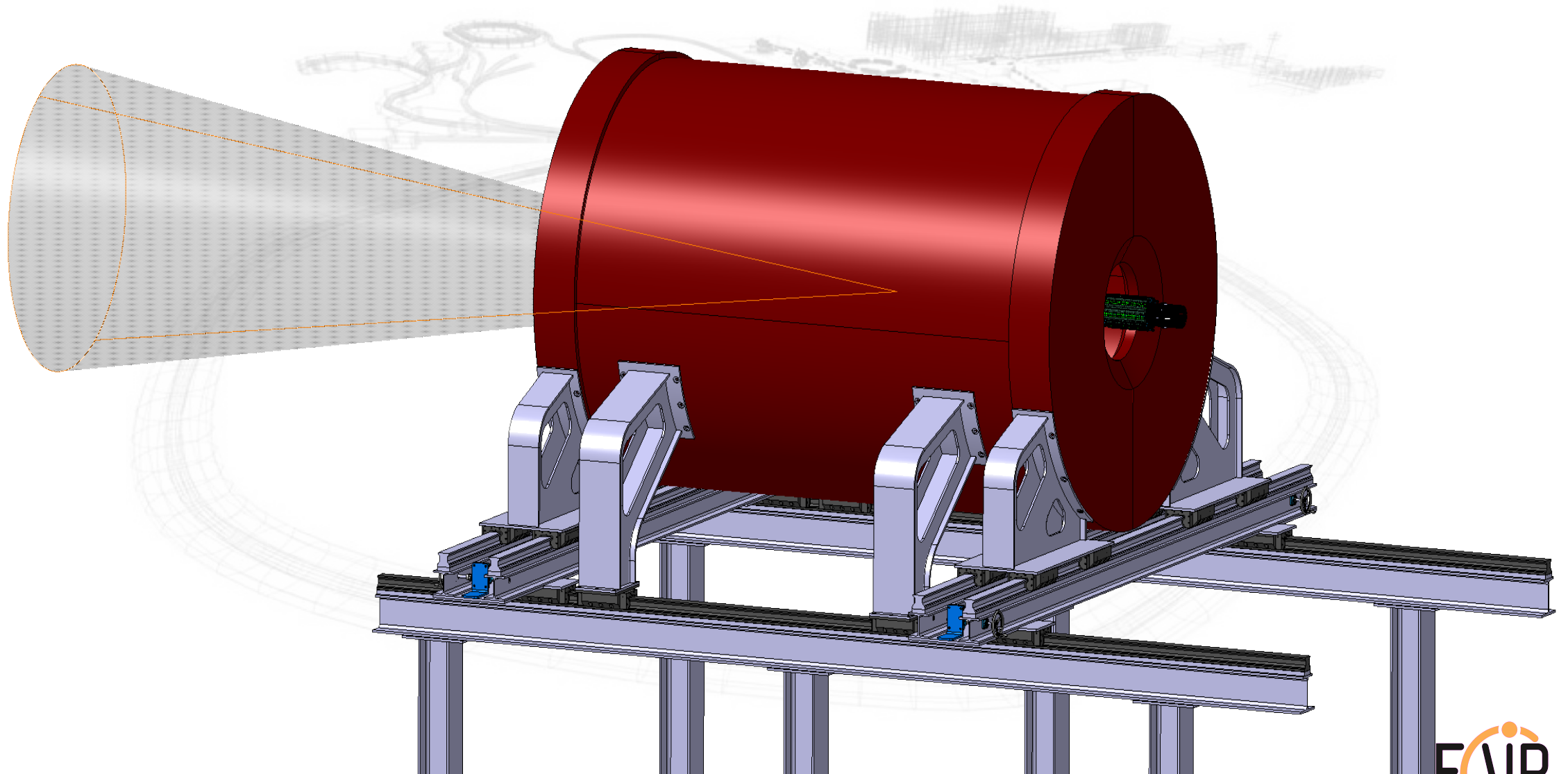
- Usage of ready detectors
- Continuation of detectors in construction
- Developments of missing systems with new technology

Magnet

- Long term: SC cable development with CERN
- Alternative: ZEUS magnet for intermediate program
- **ECE recommendation:** evaluate ZEUS for PANDA

Strategy

- Integration of all TS detectors in construction
- Testing with beam at GSI Cave C
- Alternative: physics program together with CBM



RedPANDA with ZEUS Magnet



- Setup based on ZEUS solenoid from DESY
 - New yoke ~110 t
- Integrate central TS detectors
- Mechanics compatible with PANDA
- Forward tracking: LMD planes, FT, OT
- OT for muon range system
- Space for FWE EMC
- High luminosity targets, e.g.
 - LH2 cell of up to 0.5 cm length
 - Wire or foil targets
- Tests at Cave C: max 4.5 GeV/c protons
- Experiments at SIS100
 - 29 GeV protons at $10^{12}/\text{spill}$
 - Max. luminosity $\sim 4 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$ (1cm LH2)



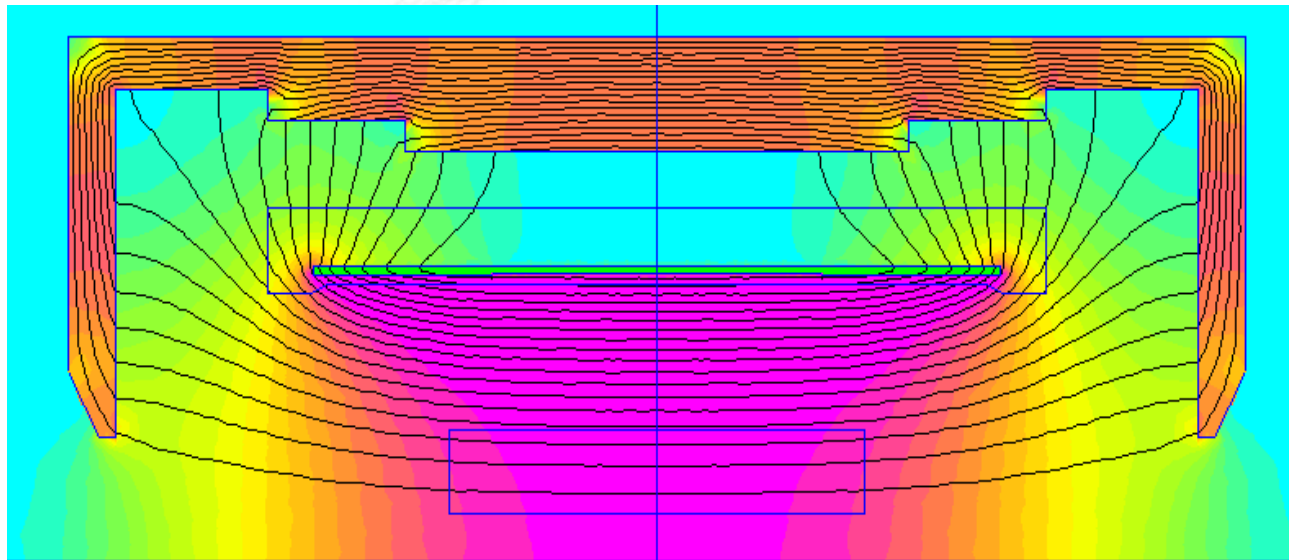
ZEUS magnet available at DESY

Magnet design based on ZEUS solenoid

- Cryo supply from HADES branch in CBM hall
- Separate support structure for yoke
- Support cylinder for inner PANDA detectors

New yoke

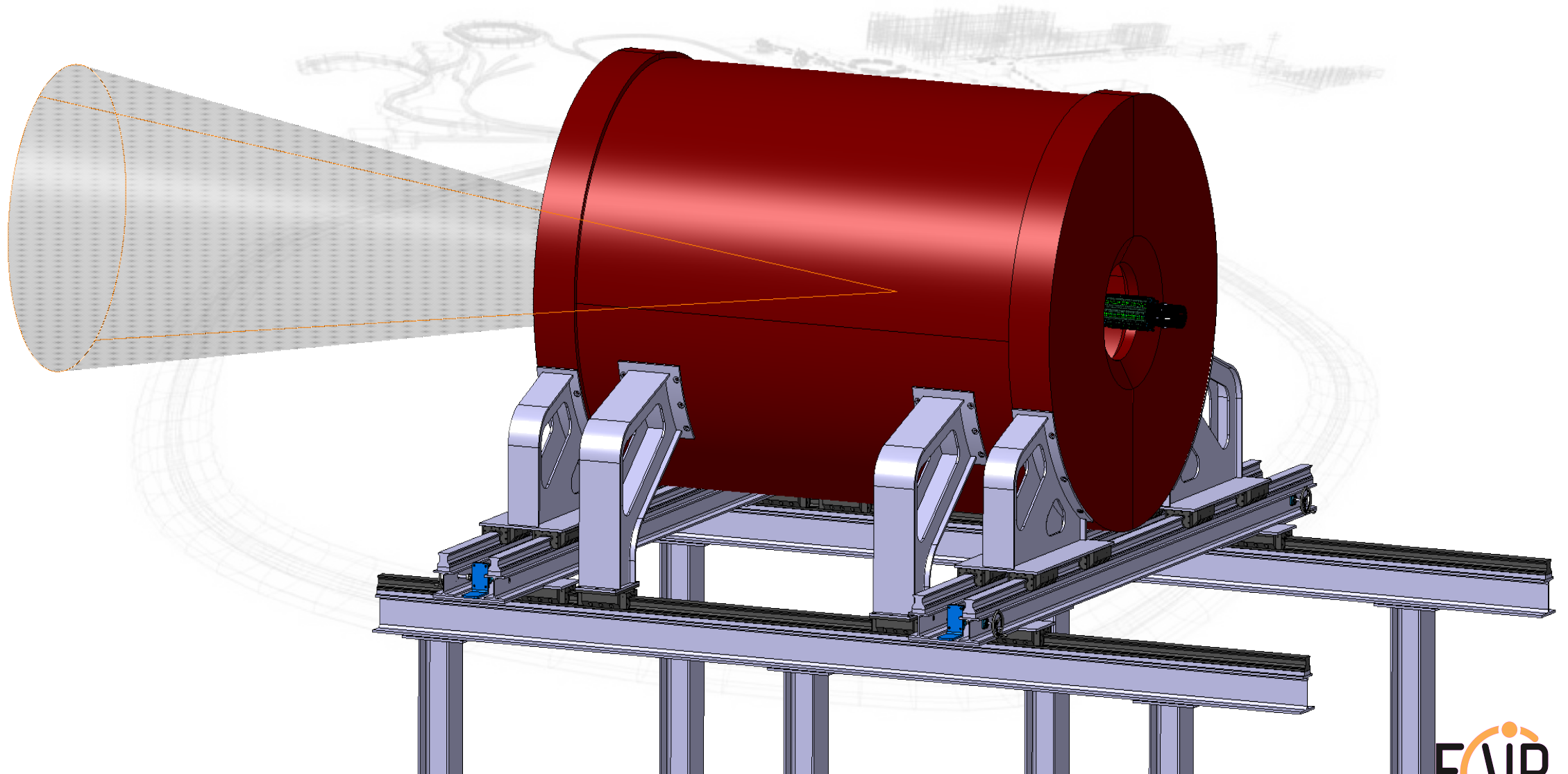
- Fitting yoke with 110t mass
- Length of cryostat: 2.8 m
- Yoke length 4.24 m, radius 1.69 m
- Approx. cost 250 k€



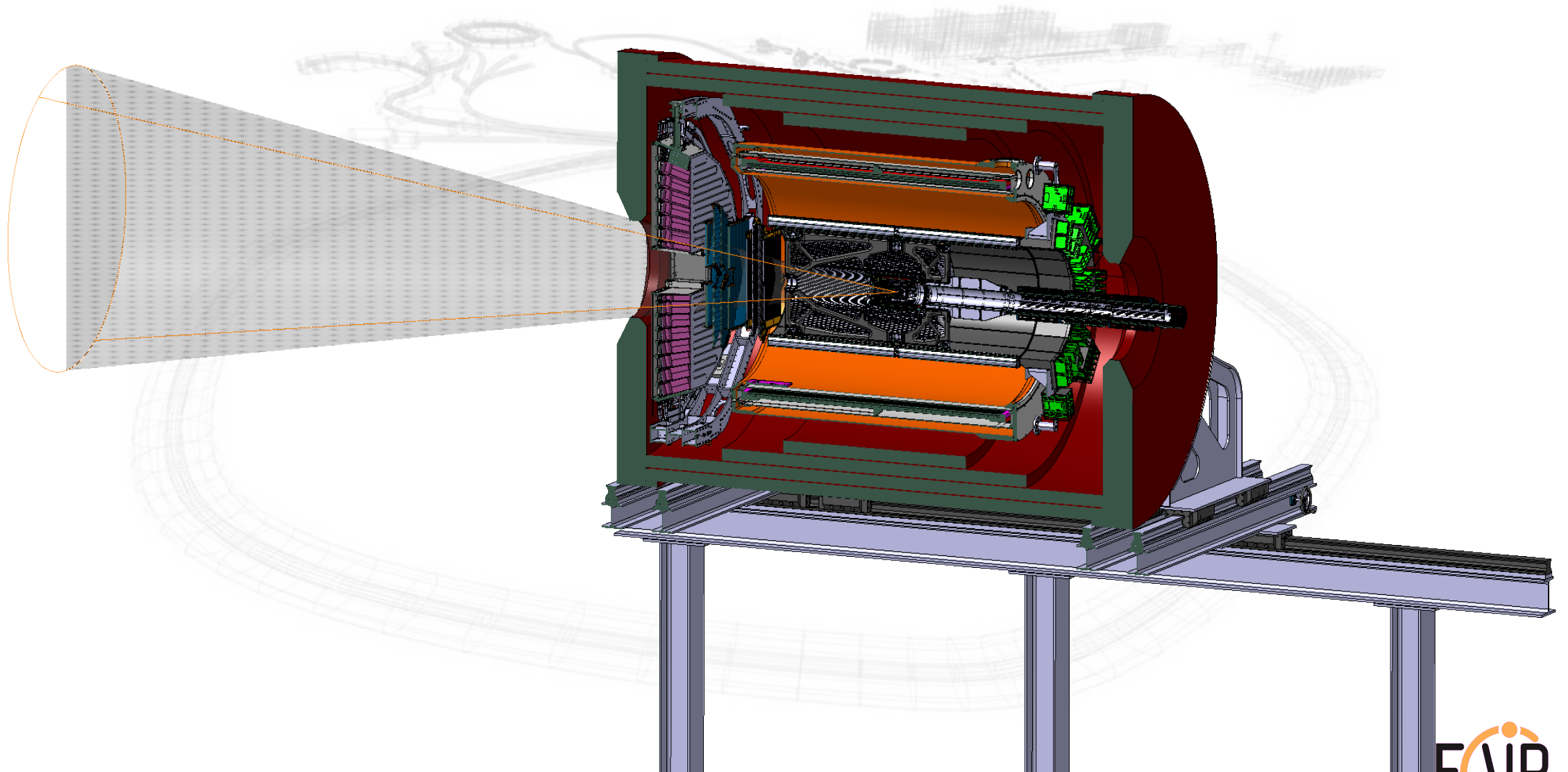
Magnetic field parameters

- Central magnetic field: 1.8 T
- Magnetic field energy: 9.7 MJ
- Central magnetic flux: 5.0 V·s
- Conductor current 4622 A
- Total current 4.243 MA (918 turns)

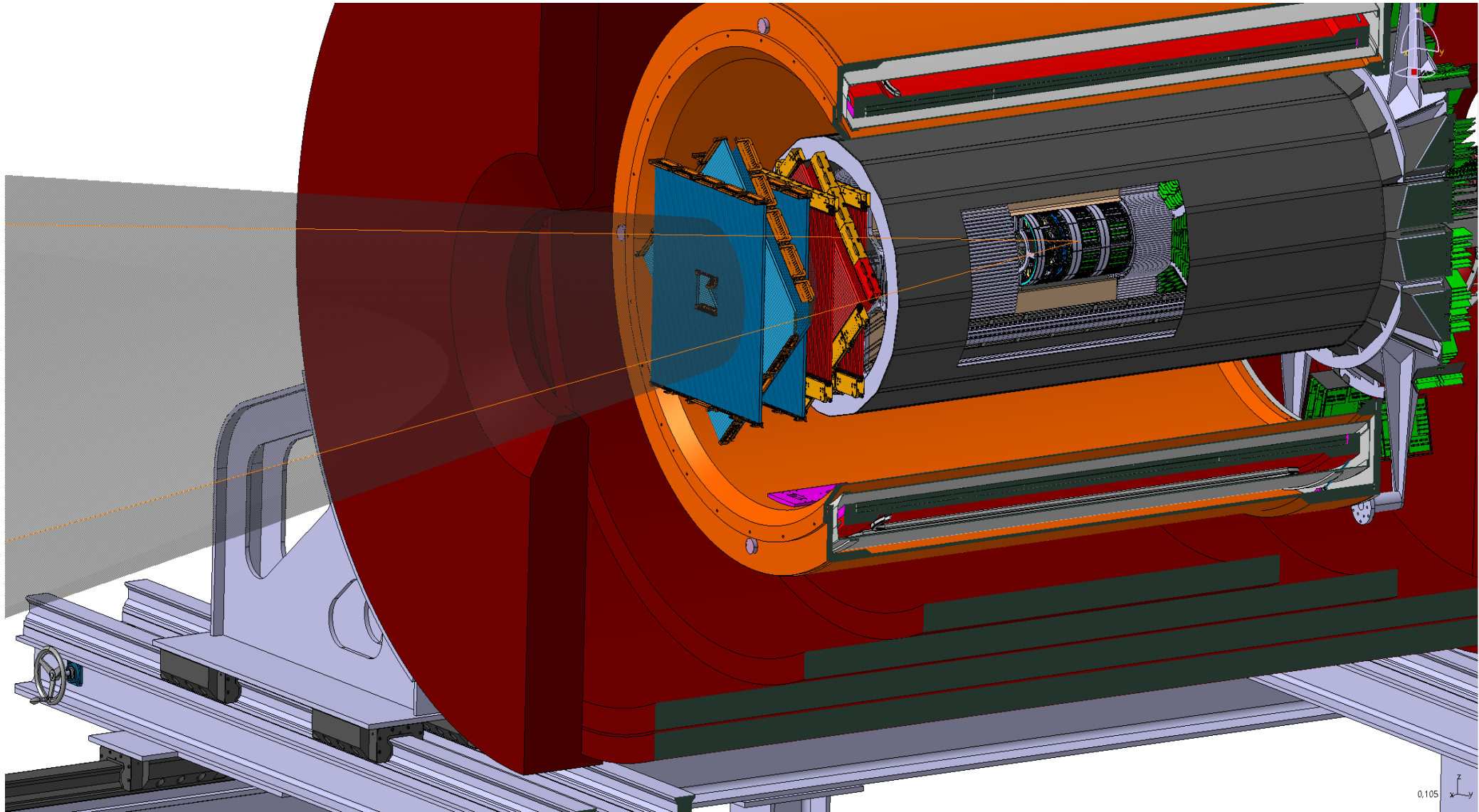
RedPANDA: Only Charged Particles



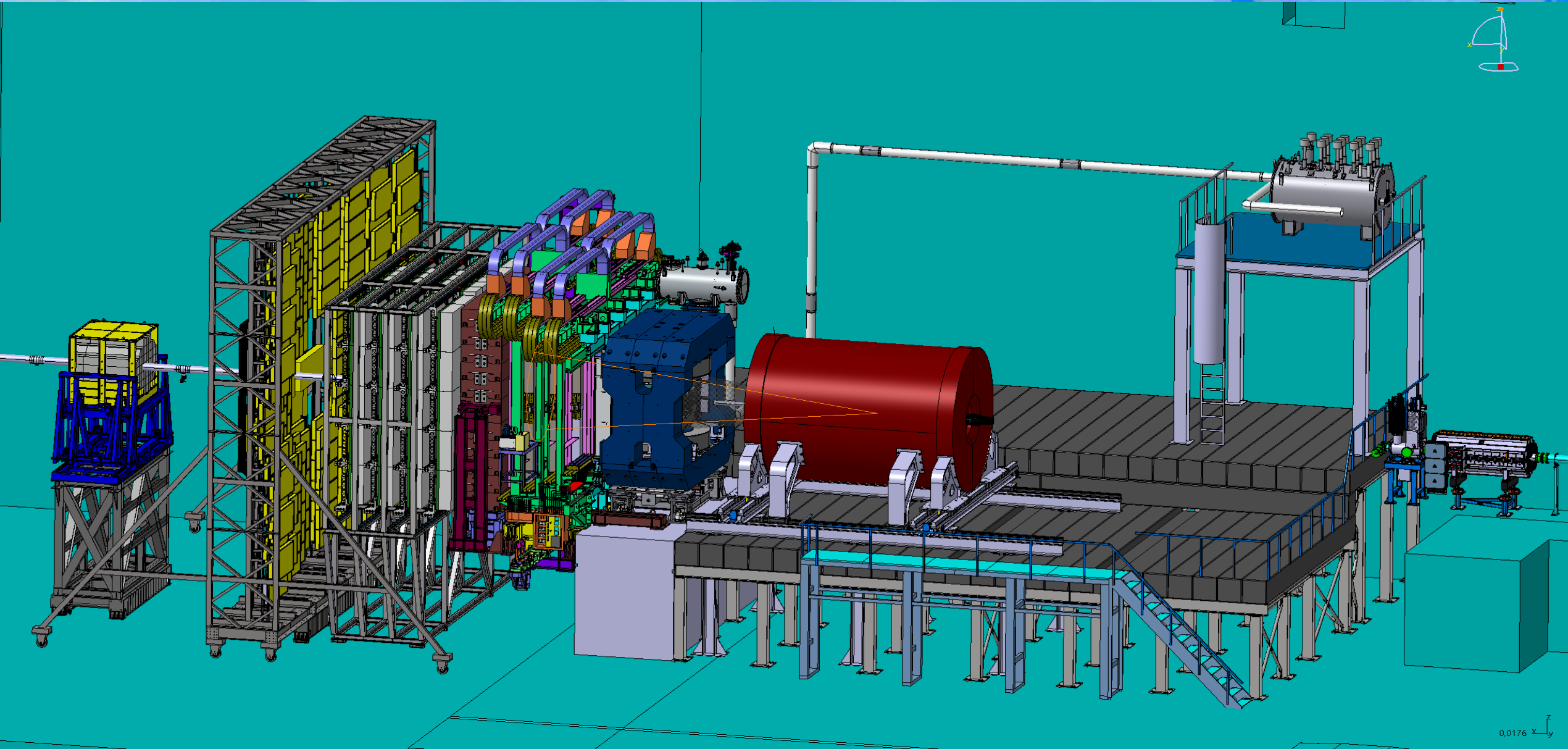
RedPANDA: Only Charged Particles



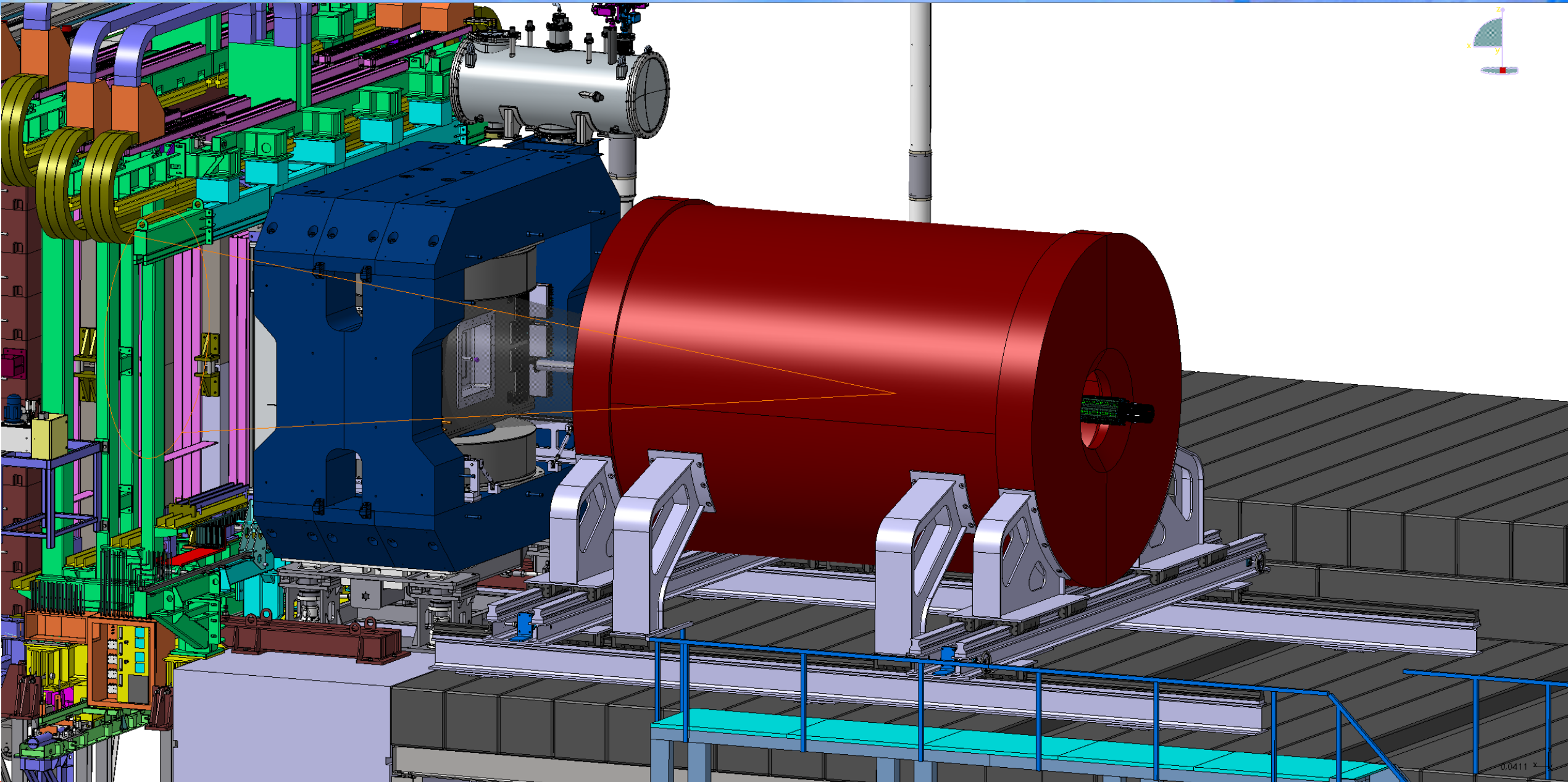
RedPANDA: Only Charged Particles



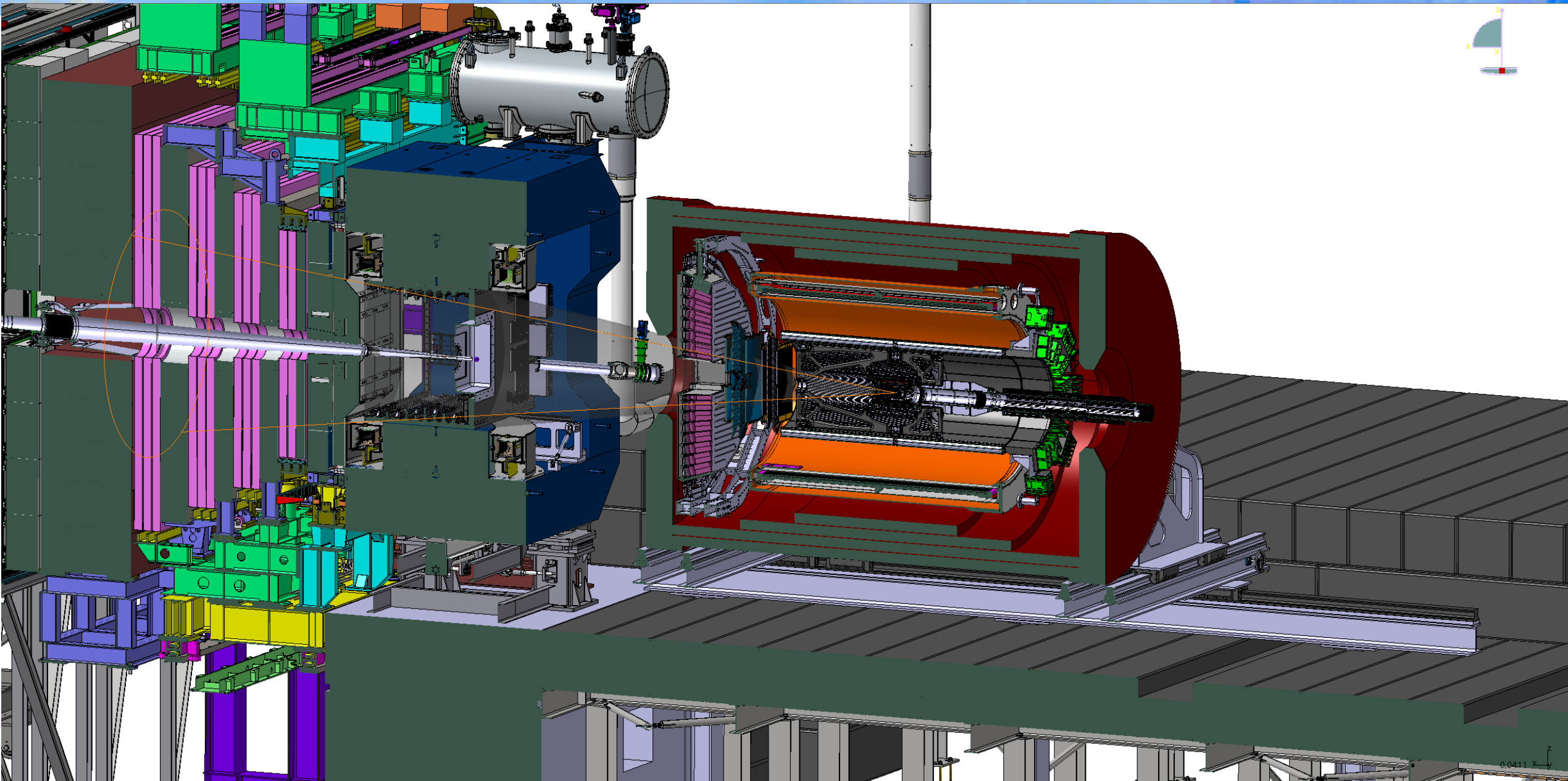
RedPANDA Setup



RedPANDA Setup



RedPANDA Setup



RedPANDA Setup Options



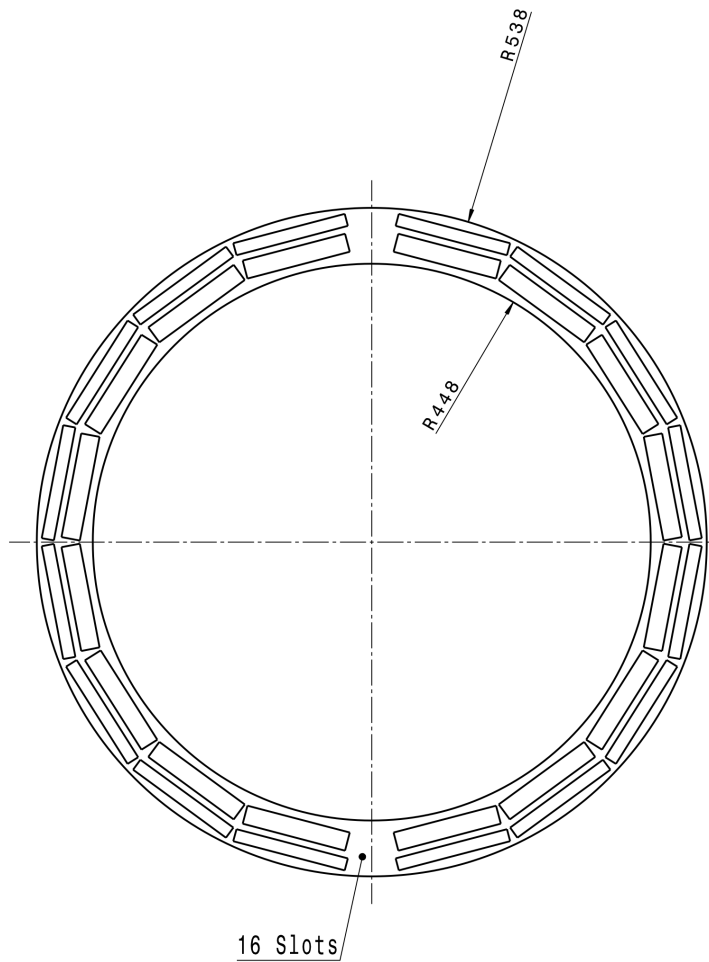
Charged particles only

- MVD Strip Barrel as is
- STT as is
- Barrel DIRC as is
- FT 2 stars from FT1/2 and FT3/4 modules

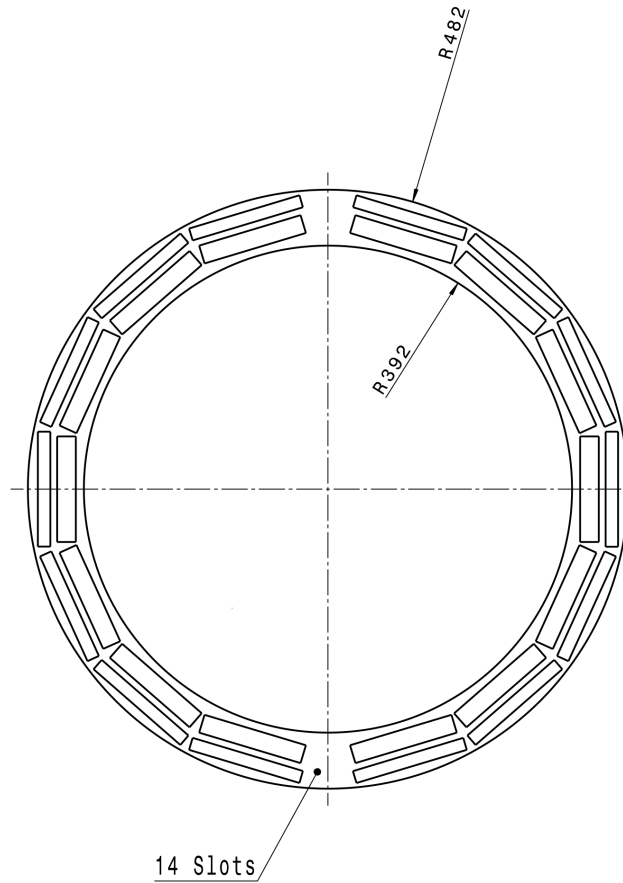
Calorimetry with reduced radius

- Reduced size STT
- Barrel DIRC 12 slices
- Barrel EMC 4 slices at 2028, 12 slices full
- Only one FT star

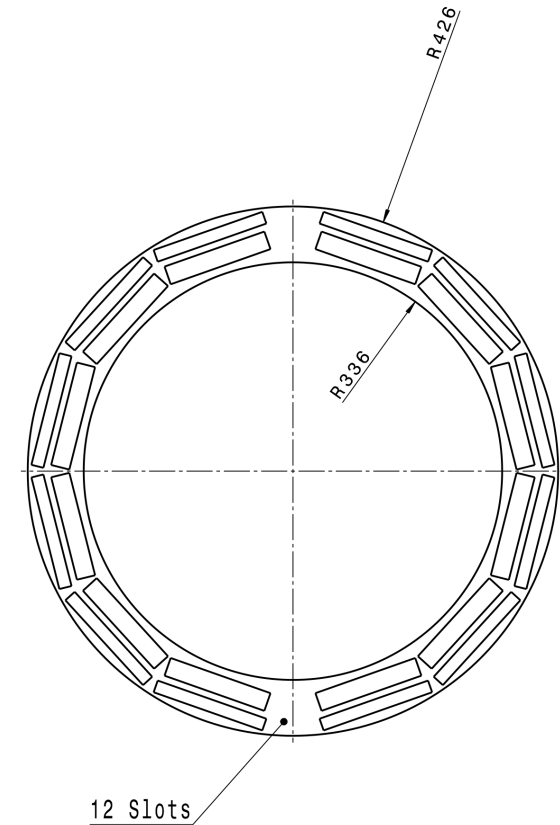
RedPANDA: Reduced Radius



Barrel DIRC with 16 bar-boxes
 $r=448$ mm

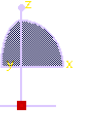
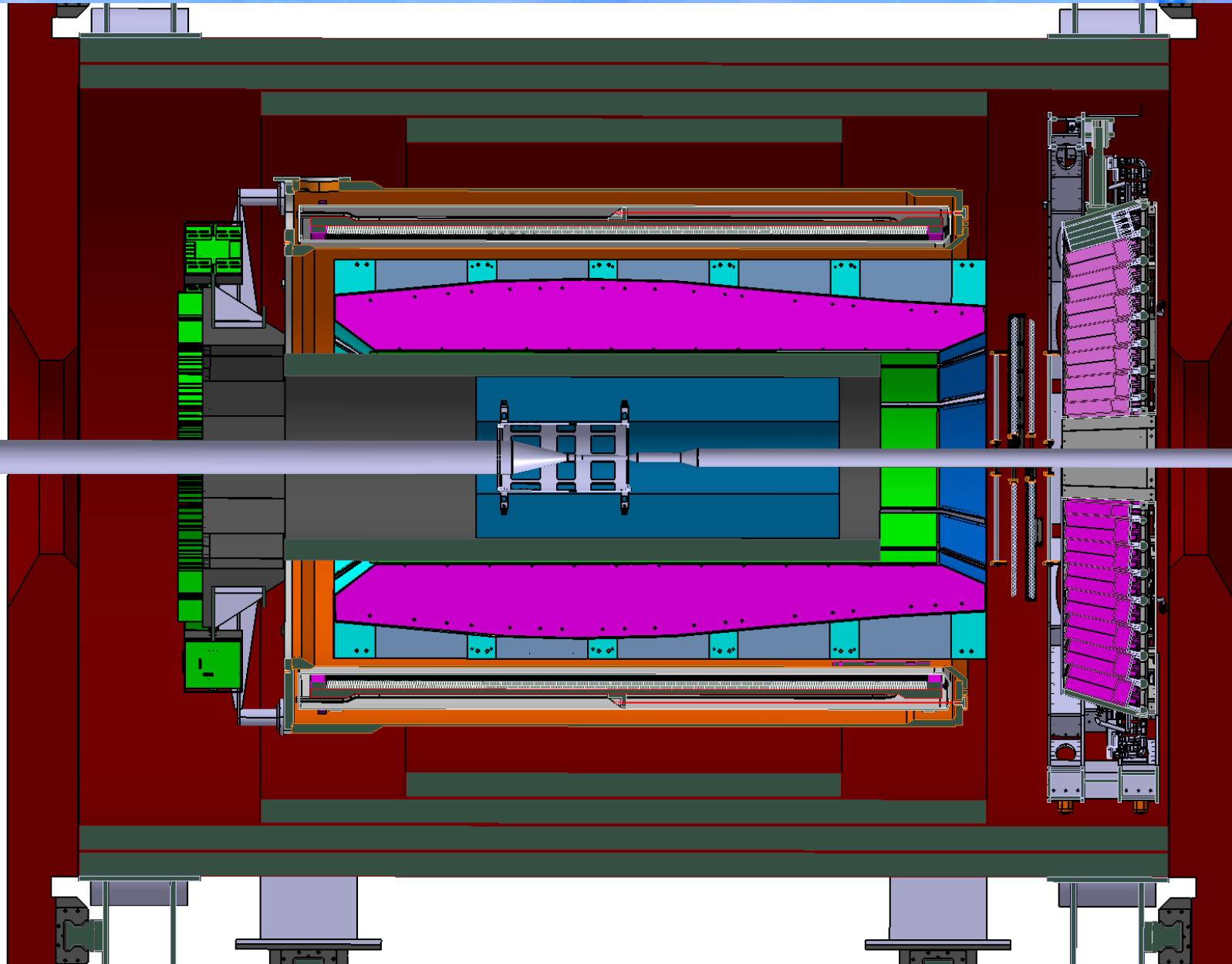


14 bar-boxes
 $r=392$ mm

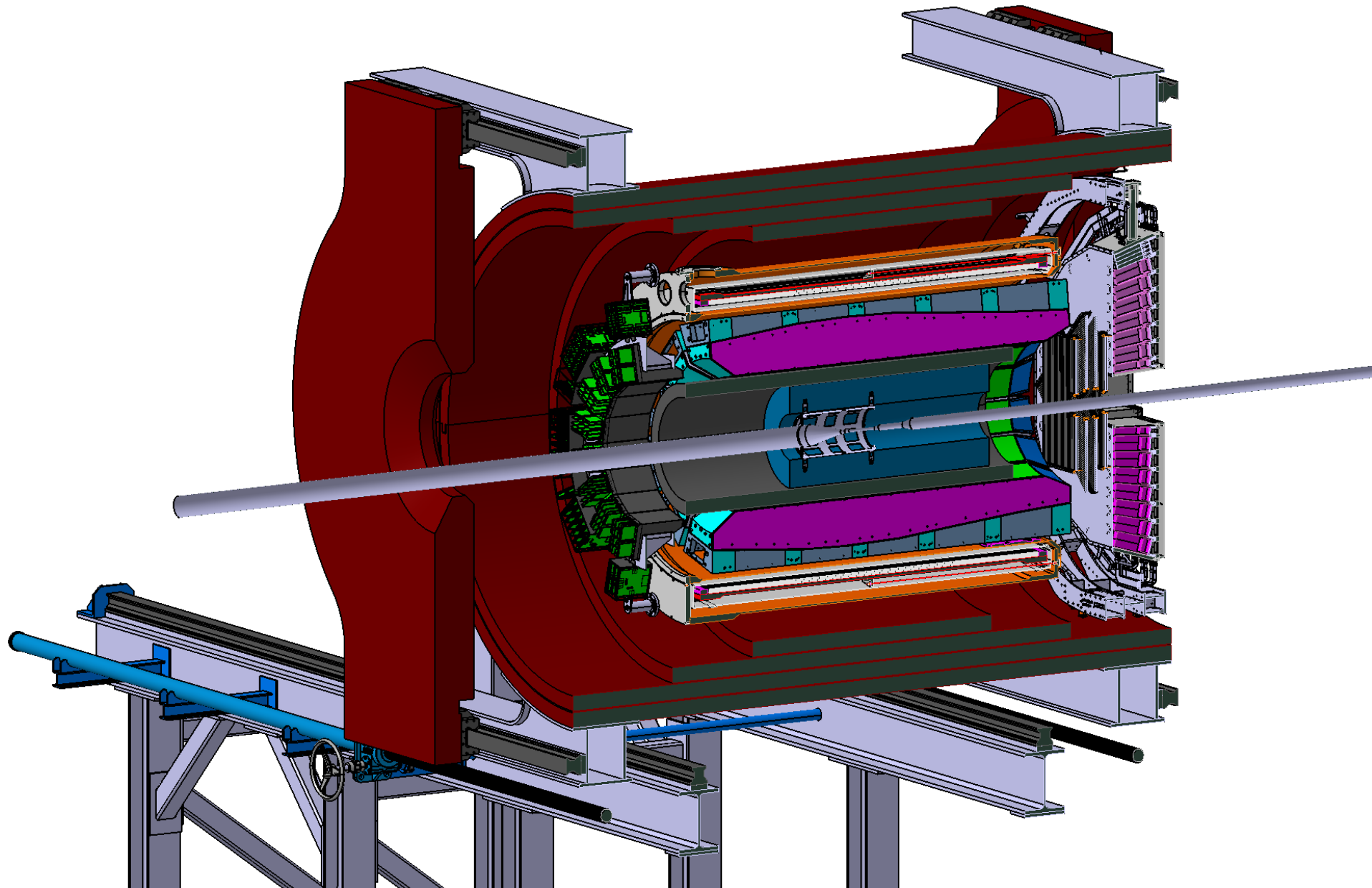


12 bar-boxes
 $r=336$ mm

RedPANDA with Barrel EMC

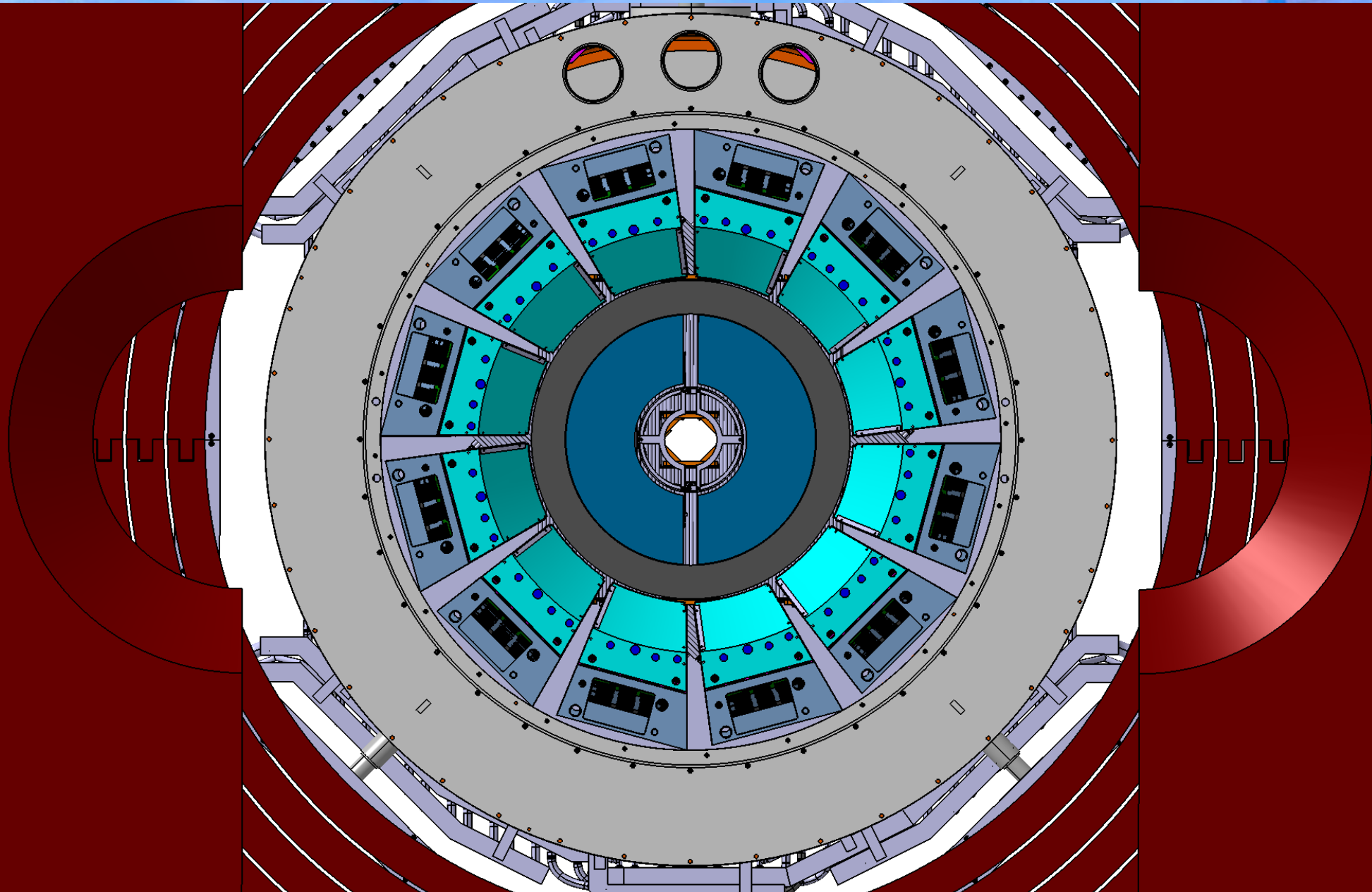


RedPANDA with Barrel EMC

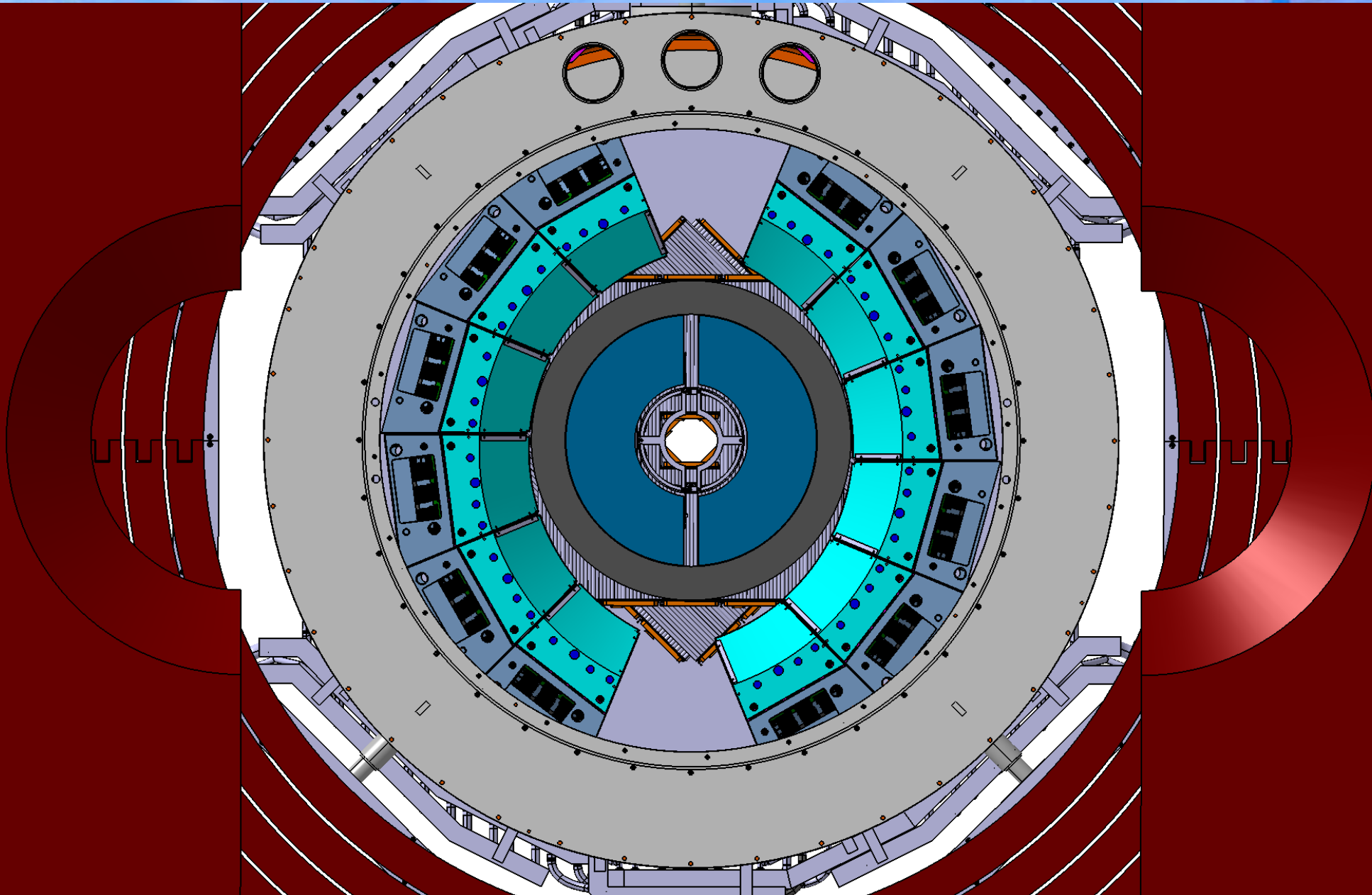


0,0562 \times \downarrow x

Barrel EMC with 12 Slices

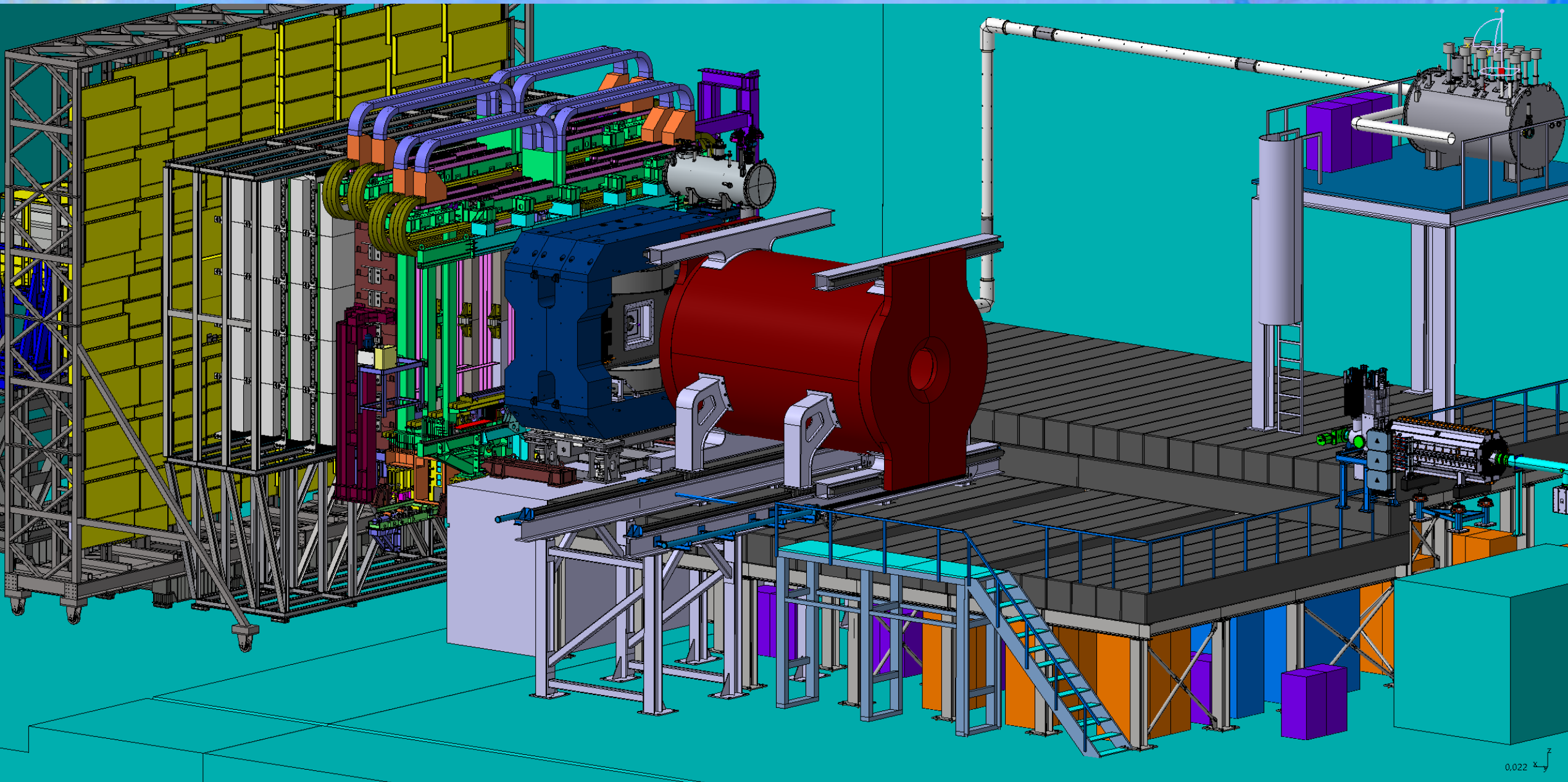


Barrel EMC with 12 Slices

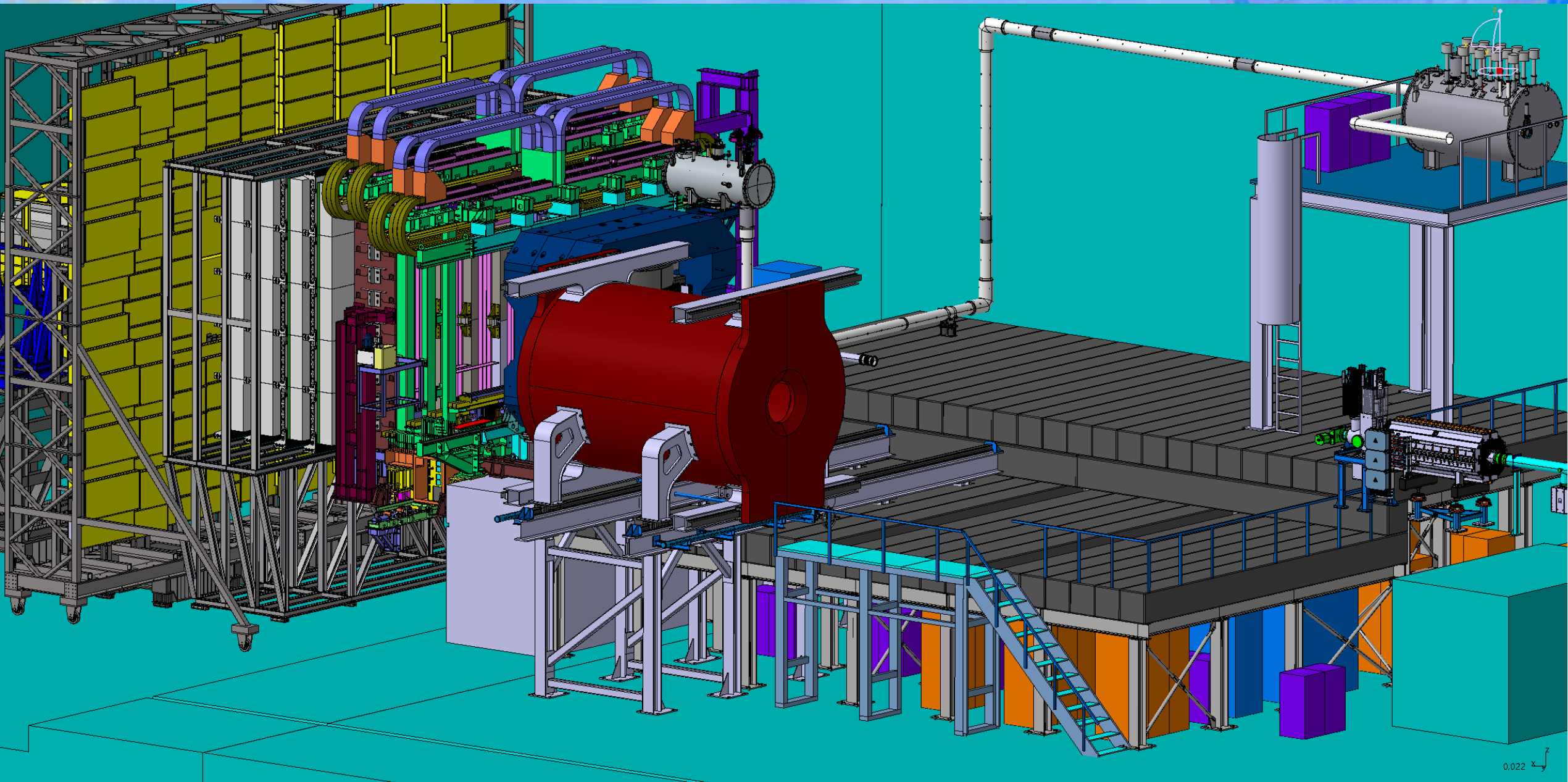


0.135

RedPANDA Setup at CBM

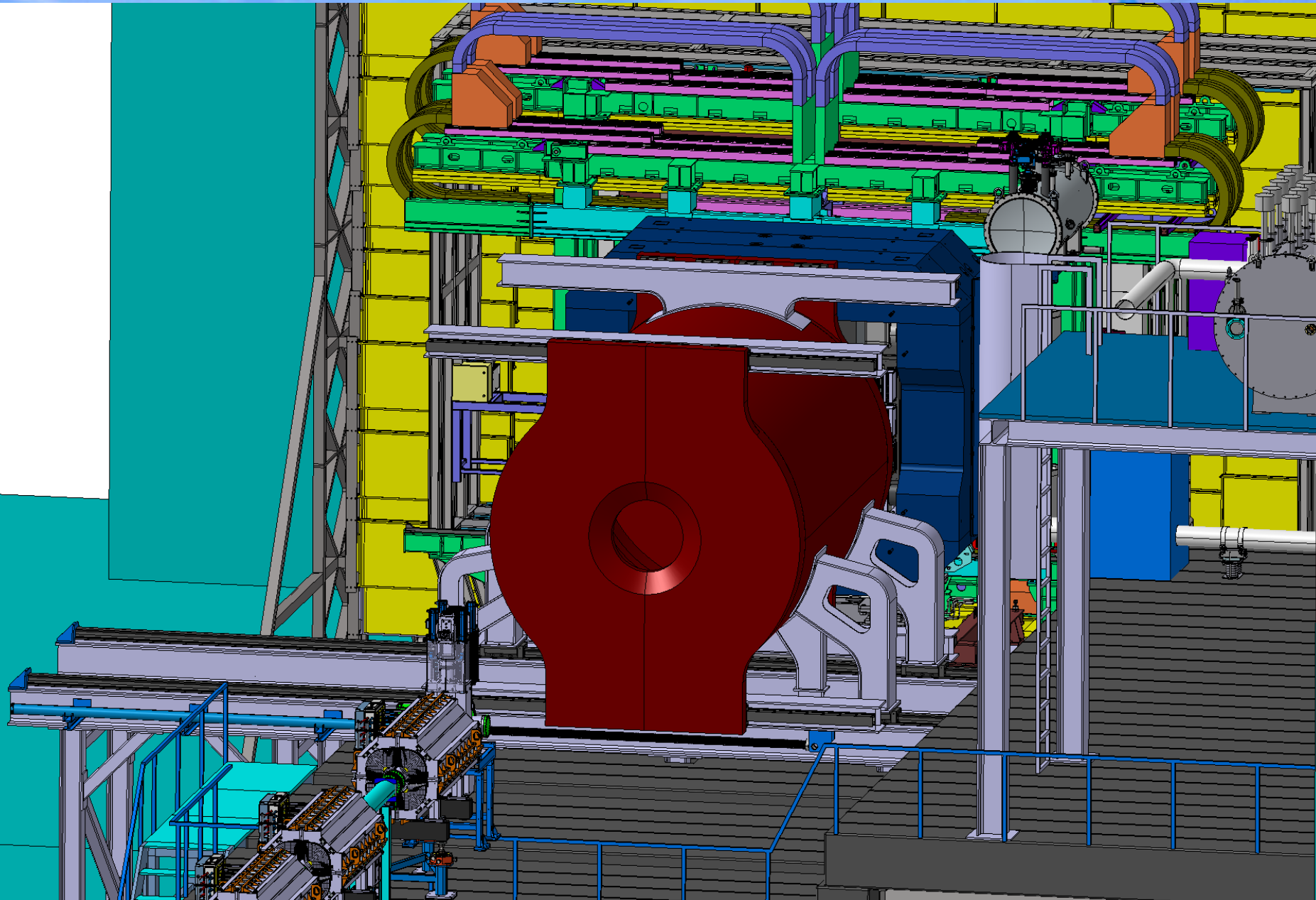


RedPANDA Setup at CBM



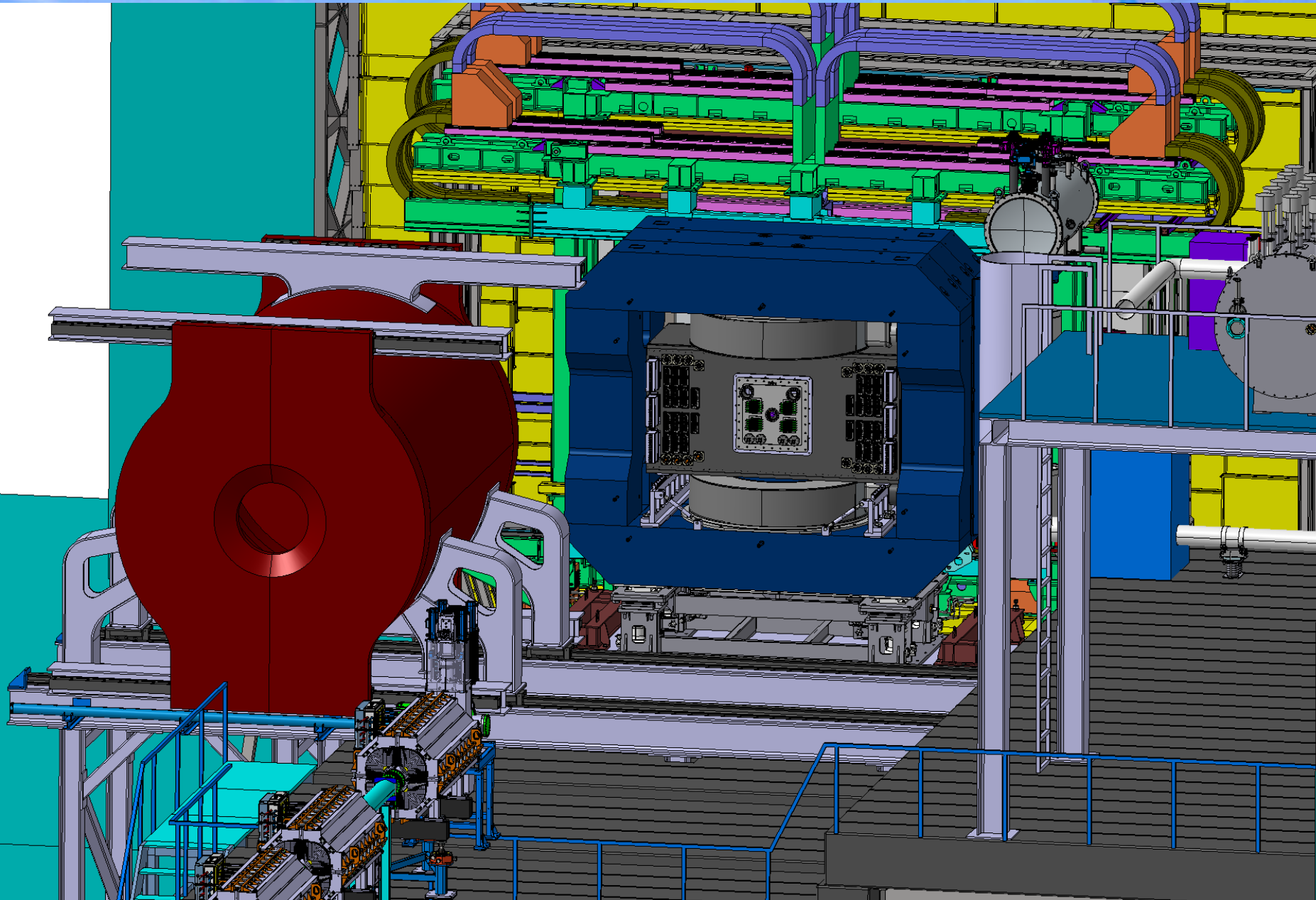
0,022 x

RedPANDA Setup at CBM



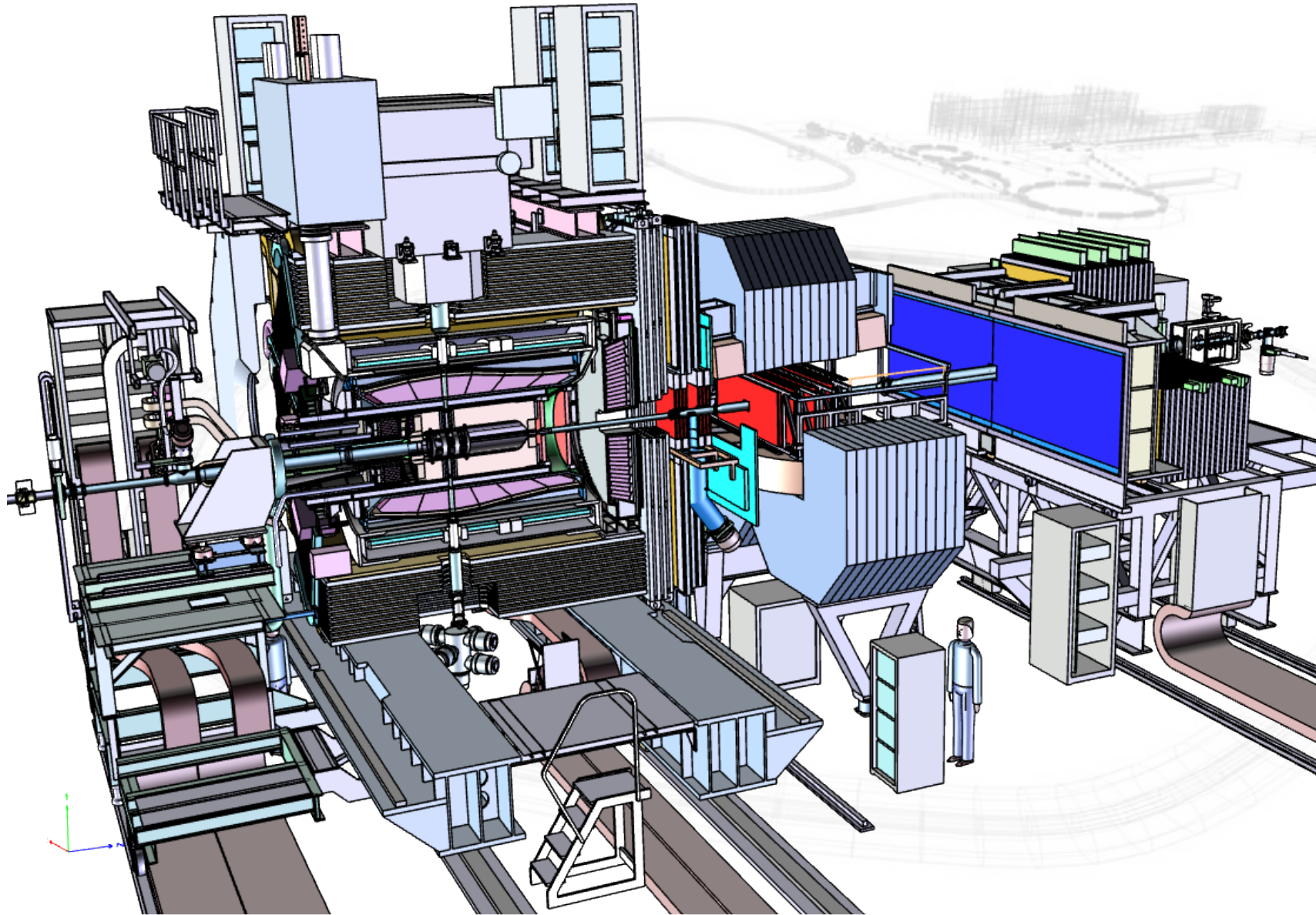
0.0327 μ β

RedPANDA Setup at CBM



0,0327 μ δ

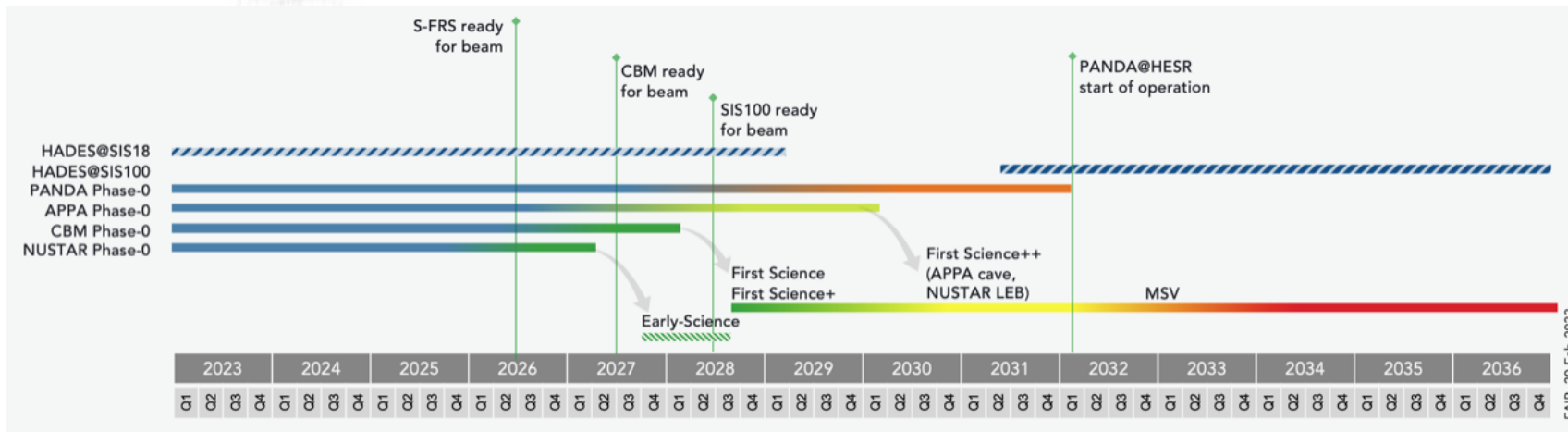
From RedPANDA to PANDA



Developing Schedule for PANDA

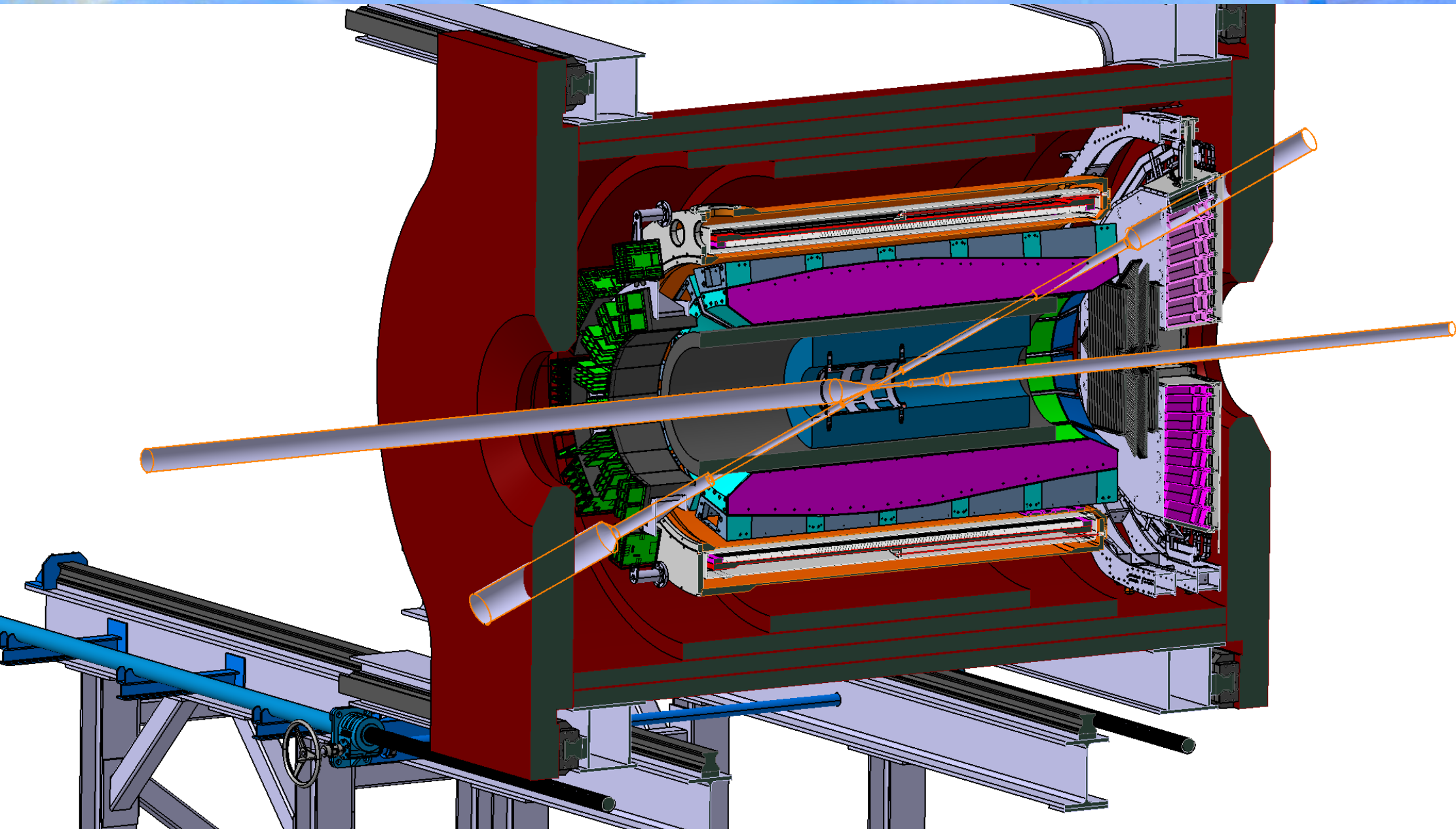


- FAIR Science Review
 - Physics of PANDA is excellent and unique
 - Max. delay of 5 years, PANDA before 2032
- Civil Construction start no later than 2028
 - **Funding decisions in 2025/26**
 - Keep planning team FAIR Site&Buildings
- Opportunities for antiprotons:
 - CR based on AA
 - RESR based on COSY
- A possible time-line:
 - PANDA long lead procurement start:
 - Barrel crystals 2024
 - Solenoid 2025
 - 2028: start of civil construction
 - 2030: start of PANDA installation
 - 2032: antiprotons at FAIR
- RedPANDA operation only 2028-2030



- PANDA Solenoid Magnet Perspectives
 - Magnet construction needs SC cable
 - Unlikely to complete before 2025
 - No group and no funding
- Construction of PANDA detectors continues
- ZEUS magnet for detector integration
- Antiprotons in 2032: PANDA needs to be ready
- How to implement a target in ZEUS?

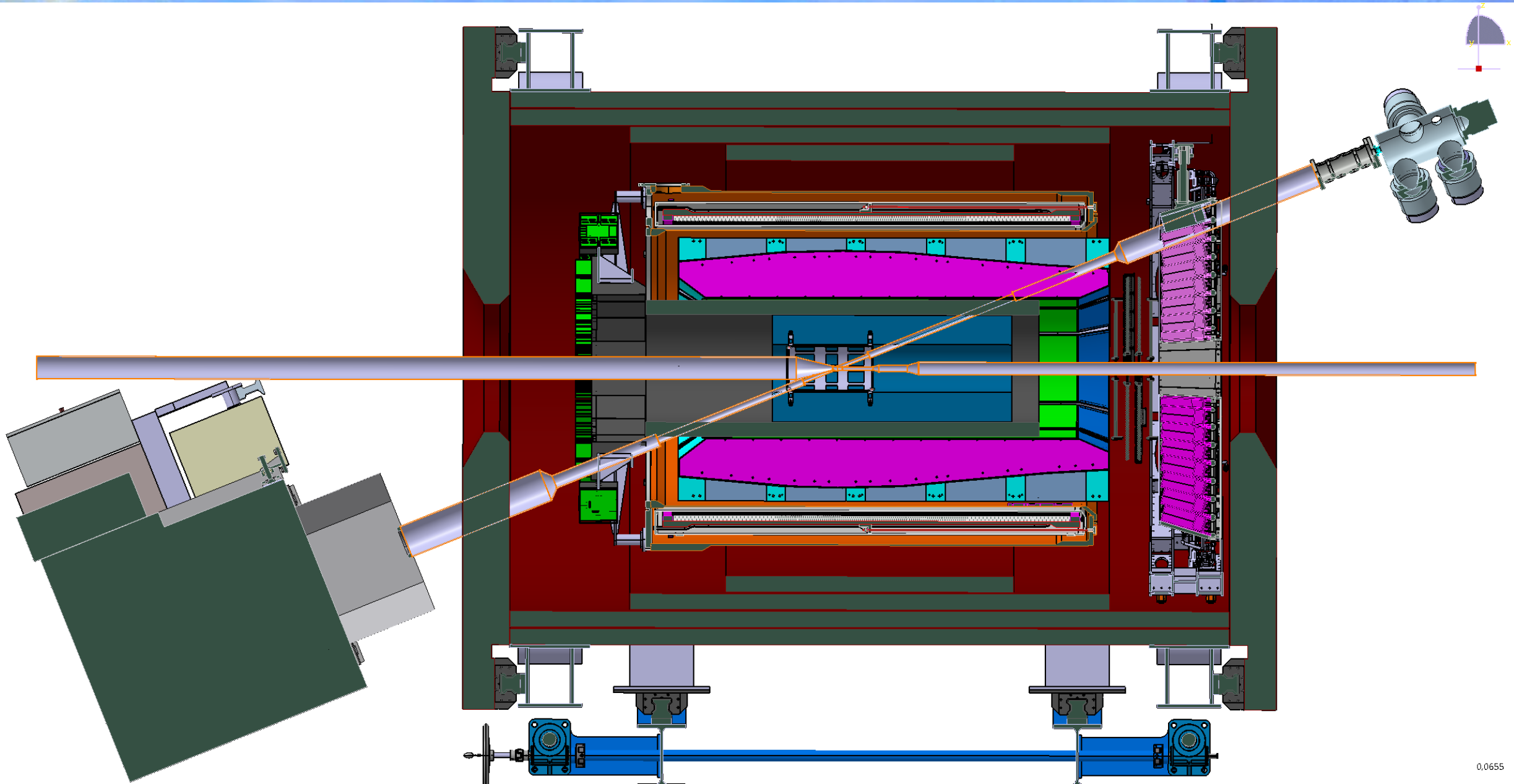
Early PANDA Setup



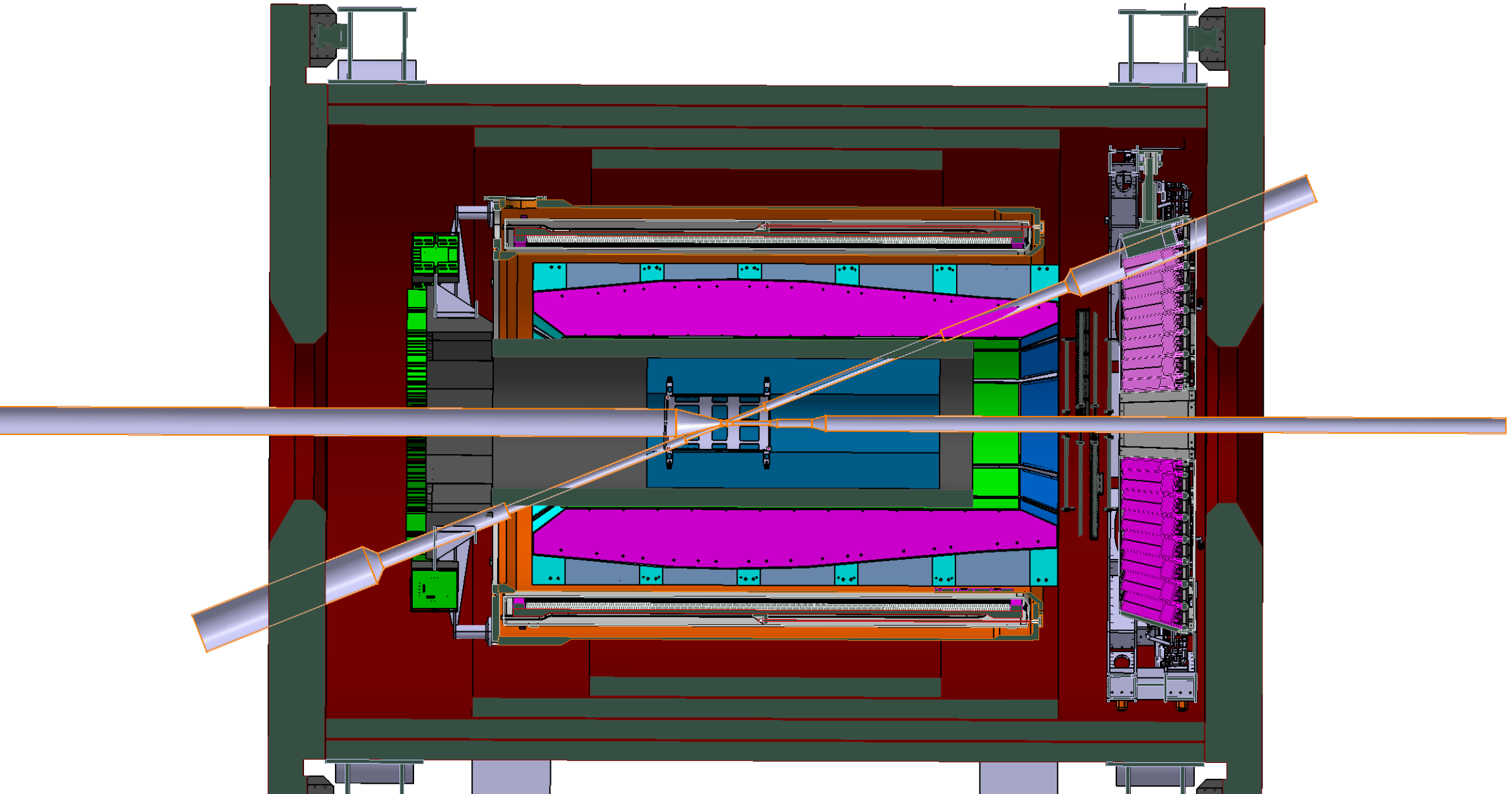
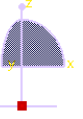
0,0663 \sqrt{x}



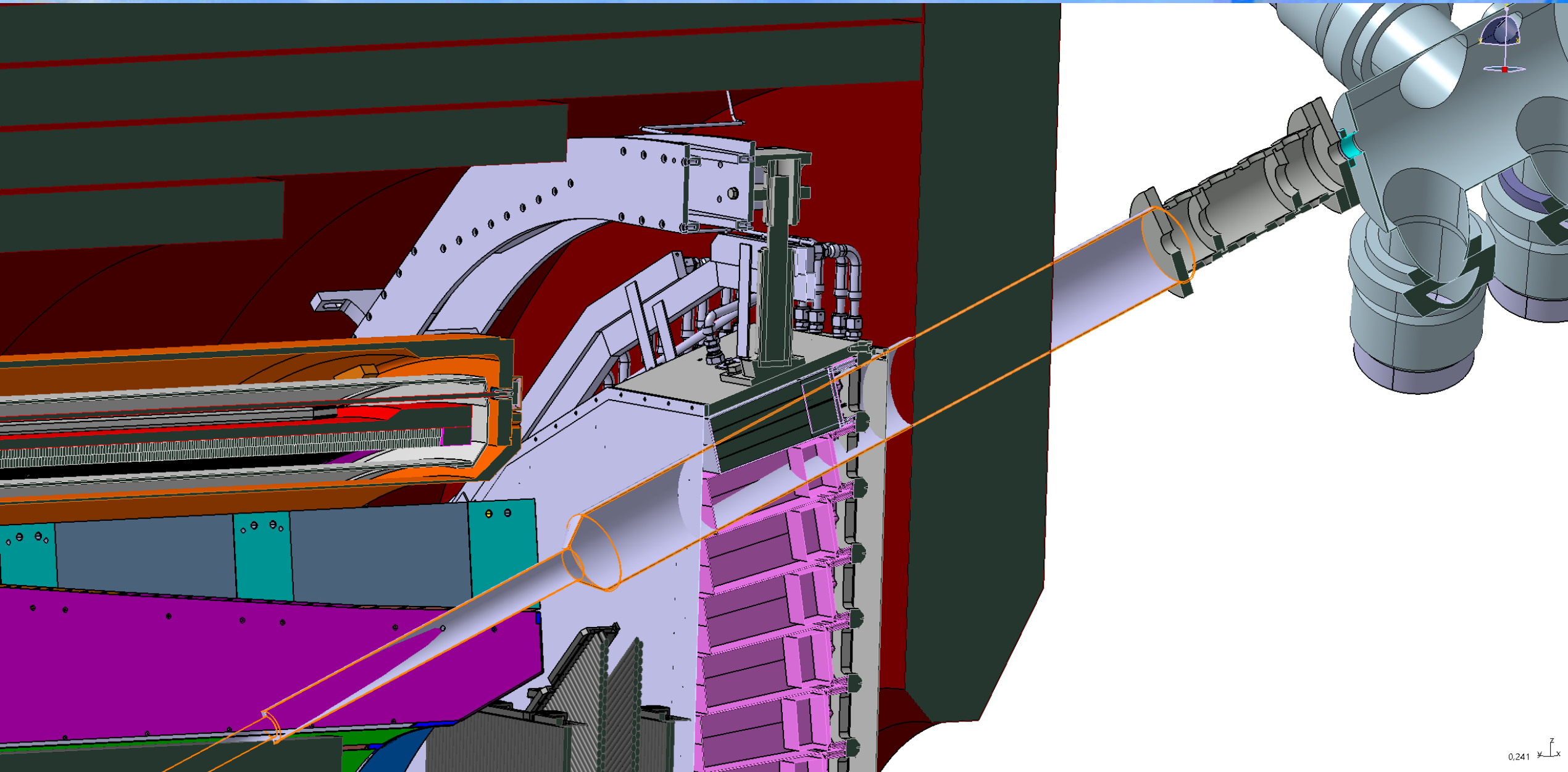
Early PANDA Setup



Early PANDA Setup



Early PANDA Setup



Strategy of RedPANDA

- Usage of ready detectors
- Continuation of detectors in construction
- Integration of all TS detectors in construction
- Testing with beam at GSI Cave C
- Alternative: physics program together with CBM

Magnet

- Long term: SC cable development with CERN
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- **ECE recommendation:** evaluate ZEUS for PANDA

PANDA with Antiprotons

- Development of missing systems in parallel
- *PANDA Hall before 2030:* start with PANDA based on ZEUS
- *PANDA Hall after 2034:* longer physics program with RedPANDA