



FCC-hh DETECTOR

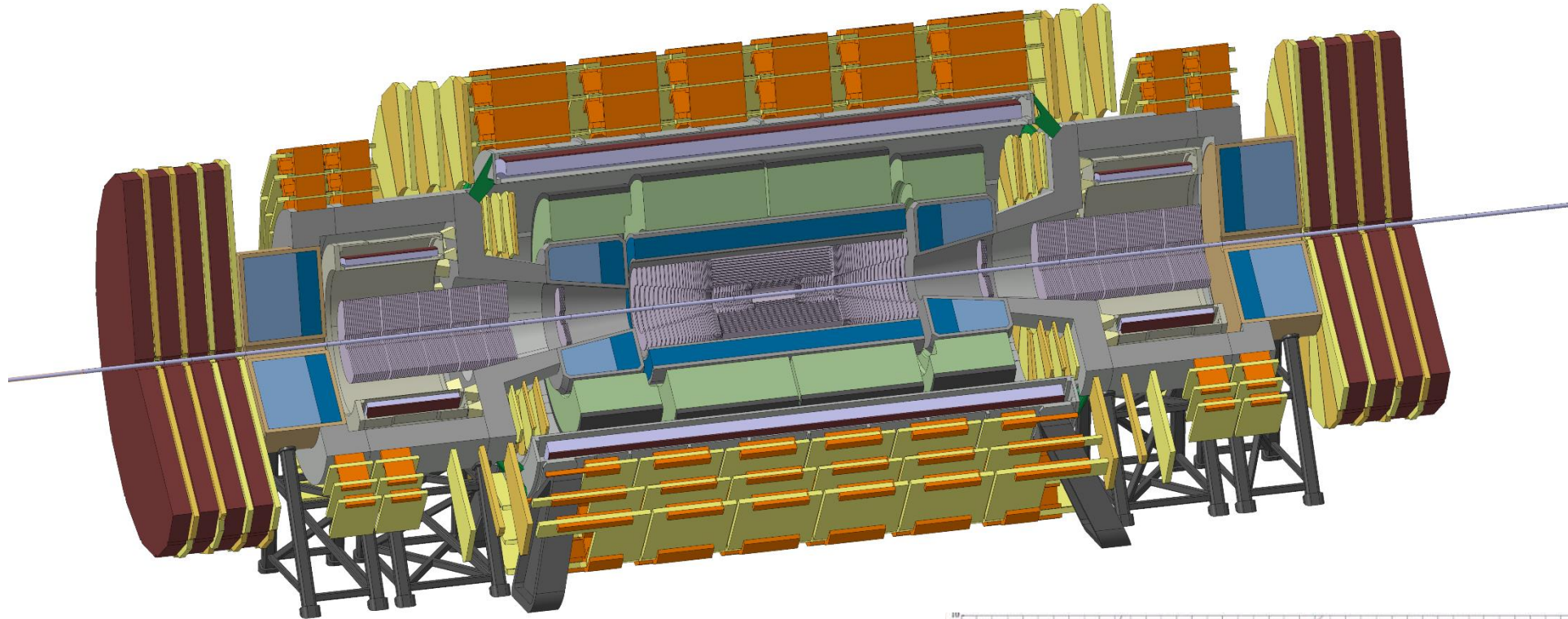
- INTEGRATION AND OPENING-CLOSING SCENARIOS -

Helder Filipe Pais Da Silva

for the FCC Detector Magnets Working Group

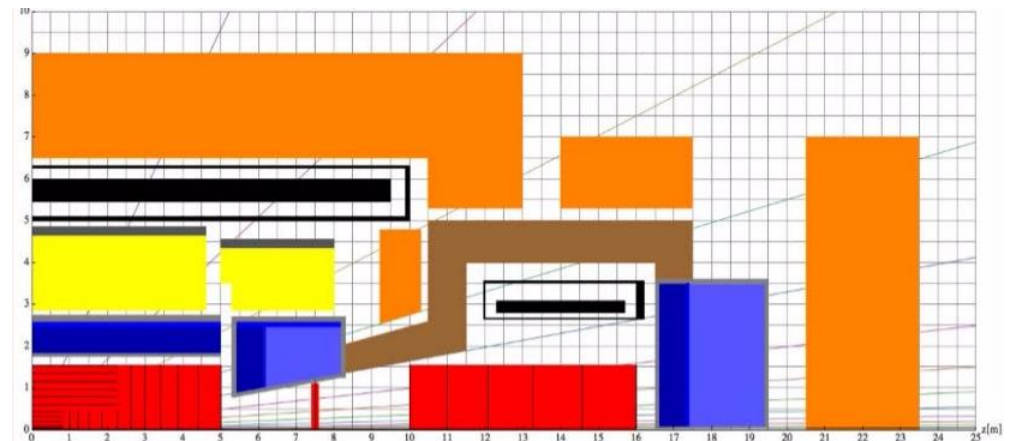
FCC Week, Berlin, May 30, 2017

FCC-hh DETECTOR OVERVIEW

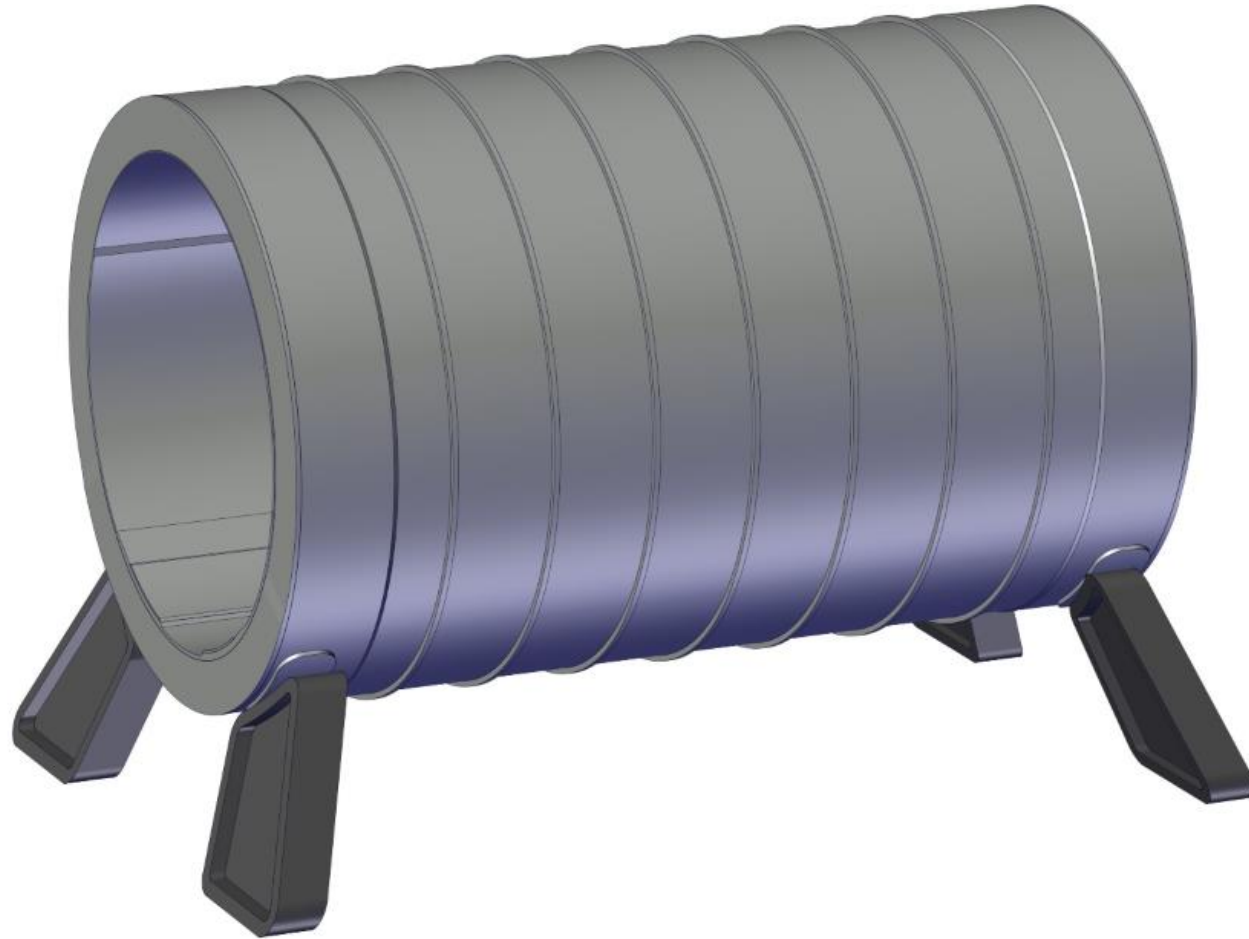


Base Line Design (see previous presentation for details)

- Iron-free design....
- But, the use of iron in between the muon chambers in the forward Muon Chambers is still under discussion

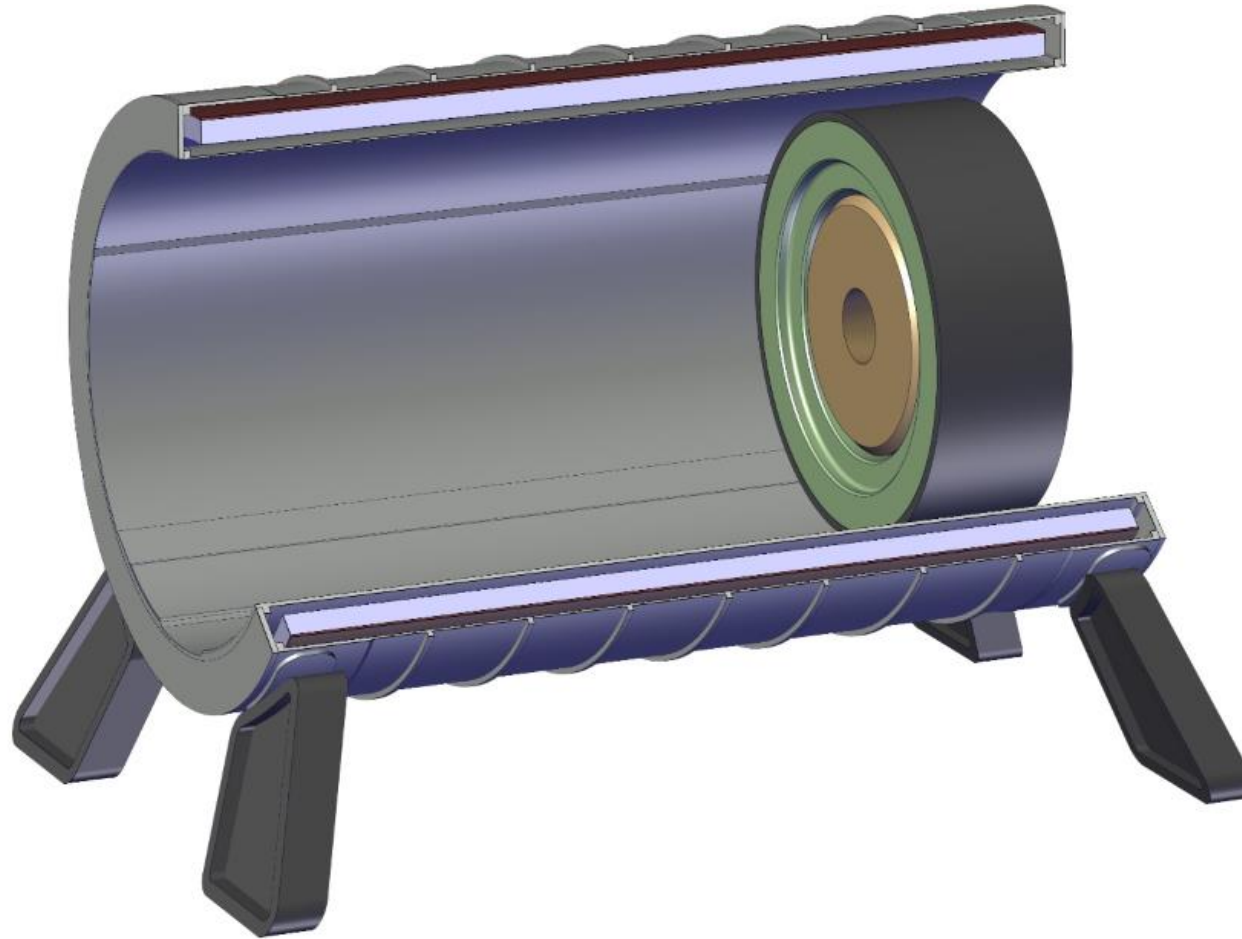


DETECTOR INTEGRATION



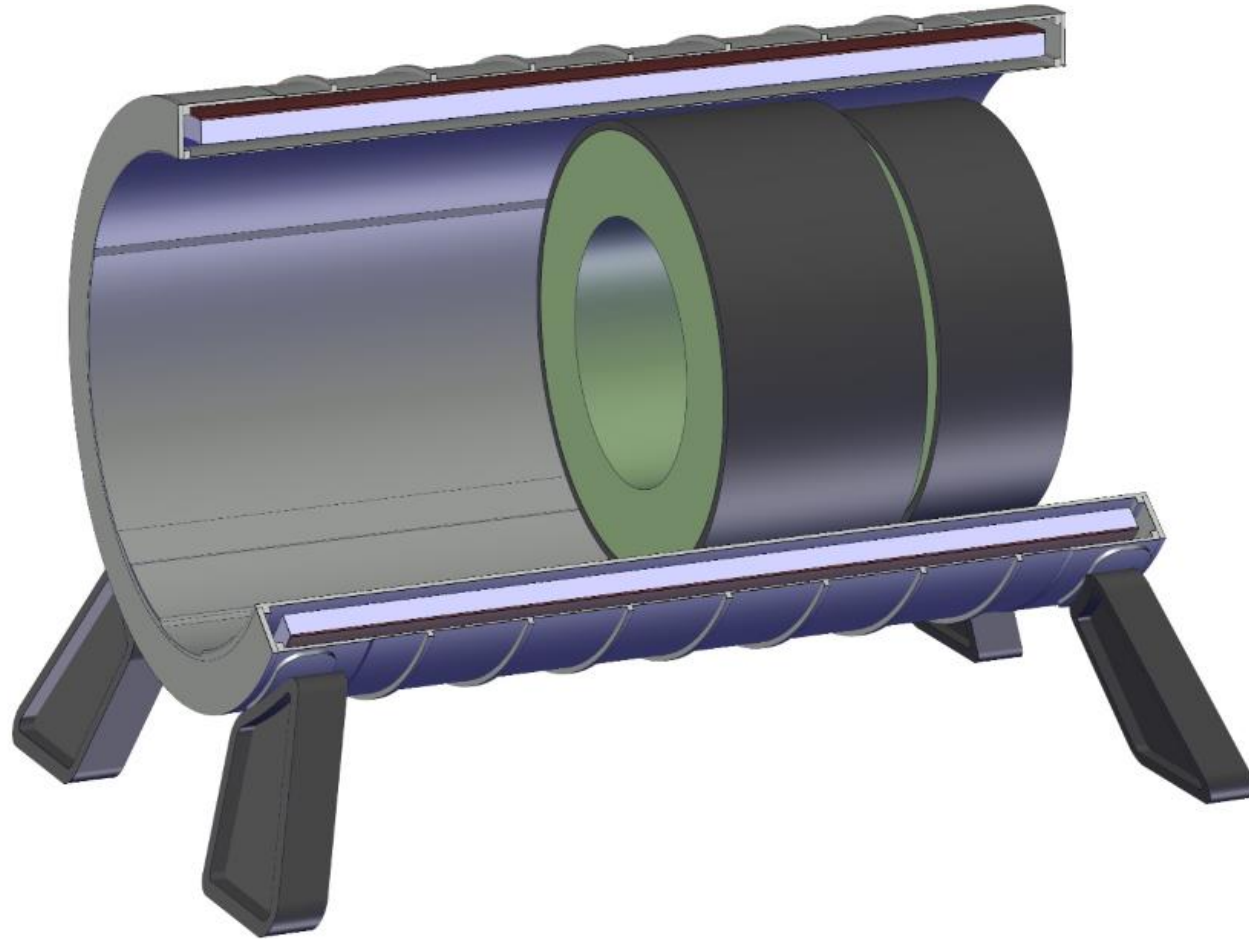
1 - Install Central Solenoid

DETECTOR INTEGRATION



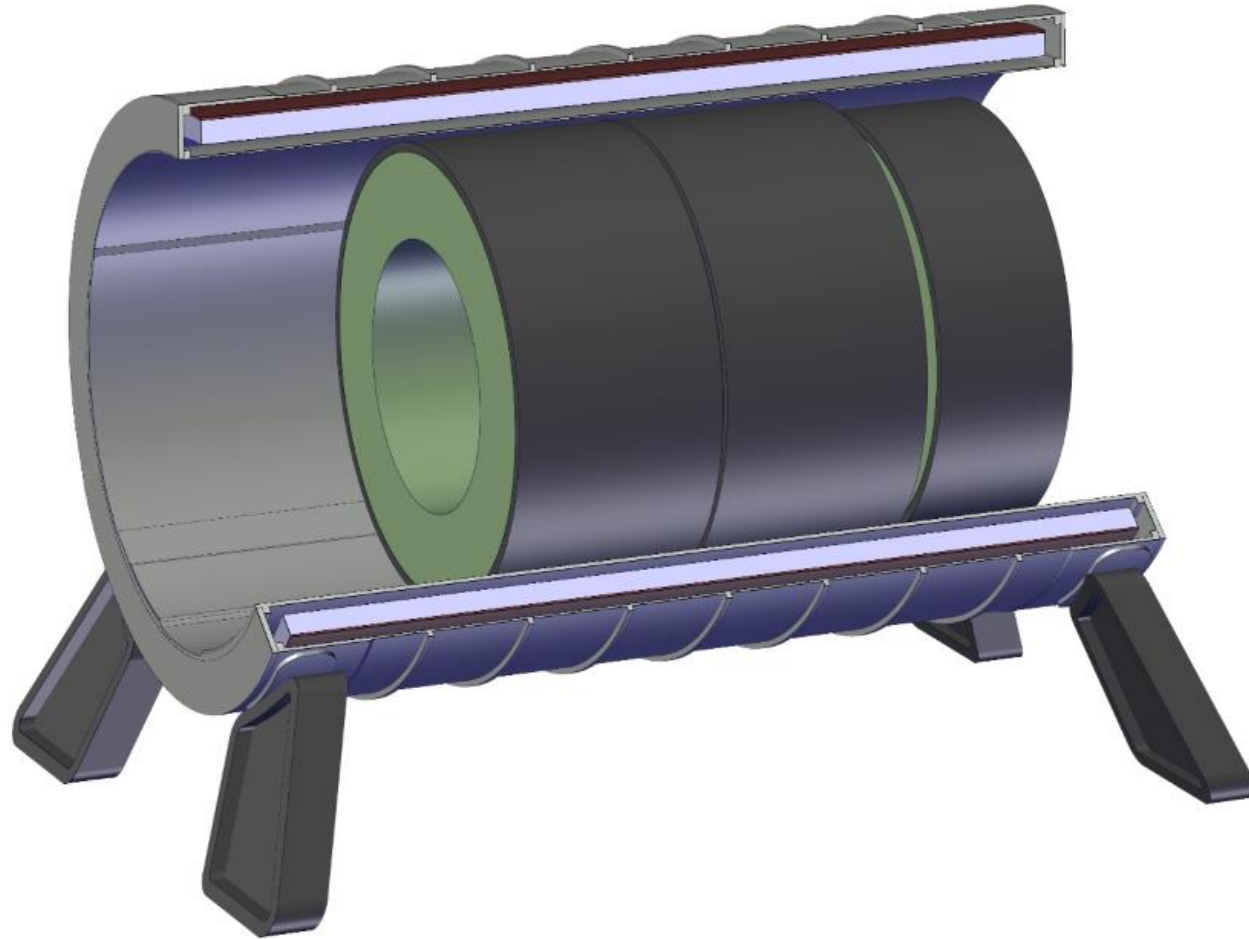
2 - Install 1st HCAL module with 1st ECAL Module

DETECTOR INTEGRATION



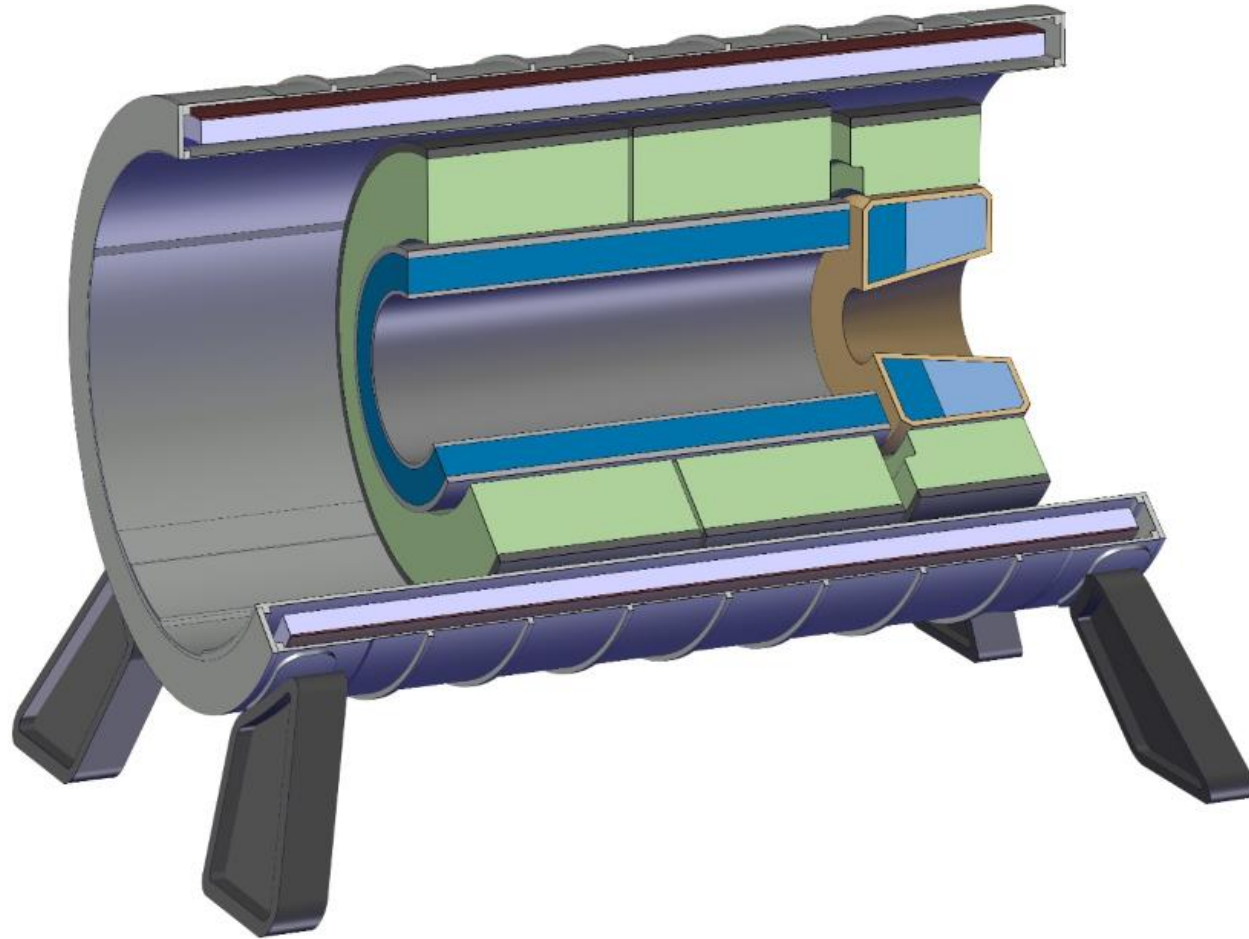
3 - Install 2nd HCAL module

DETECTOR INTEGRATION



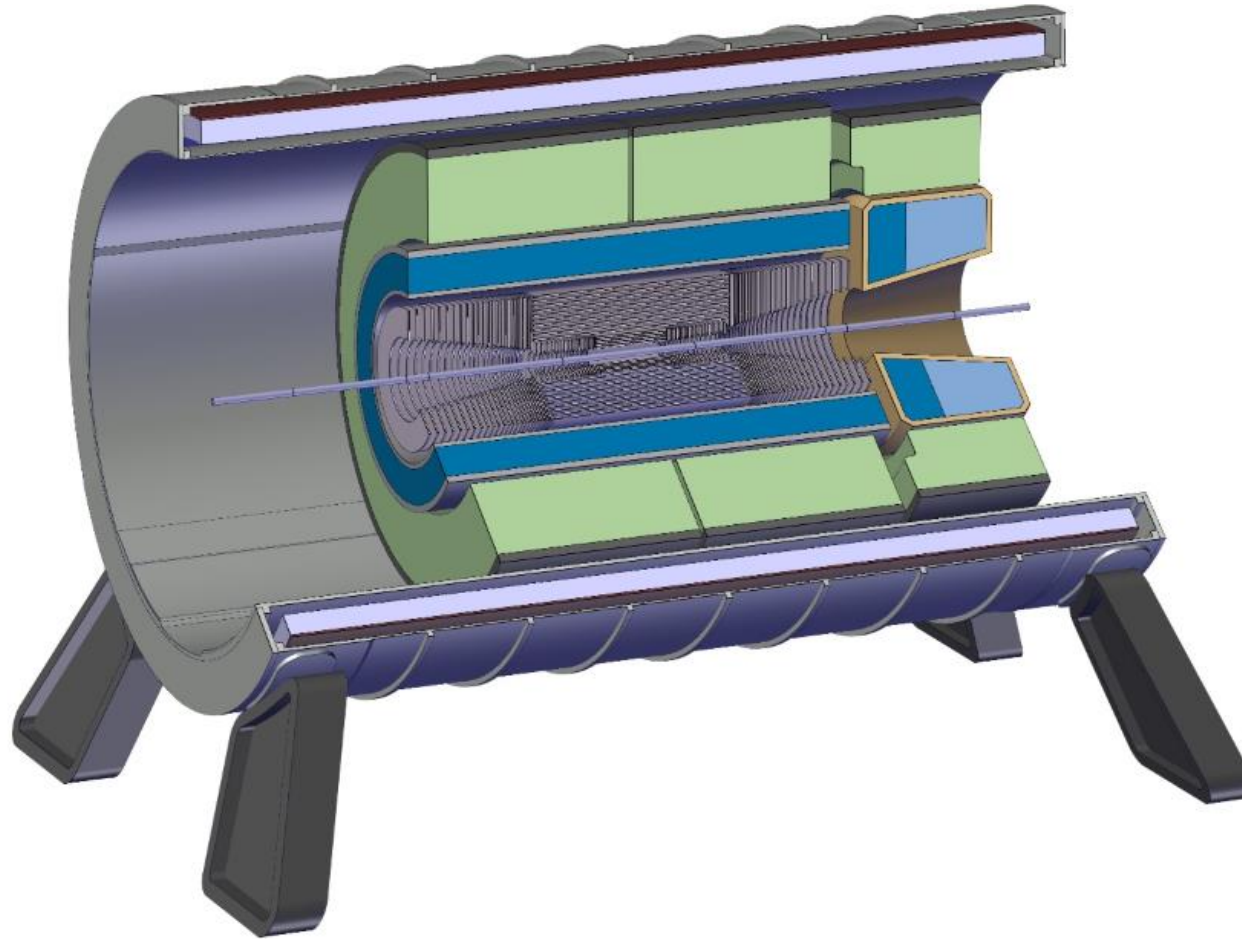
4 - Install 3rd HCAL module

DETECTOR INTEGRATION



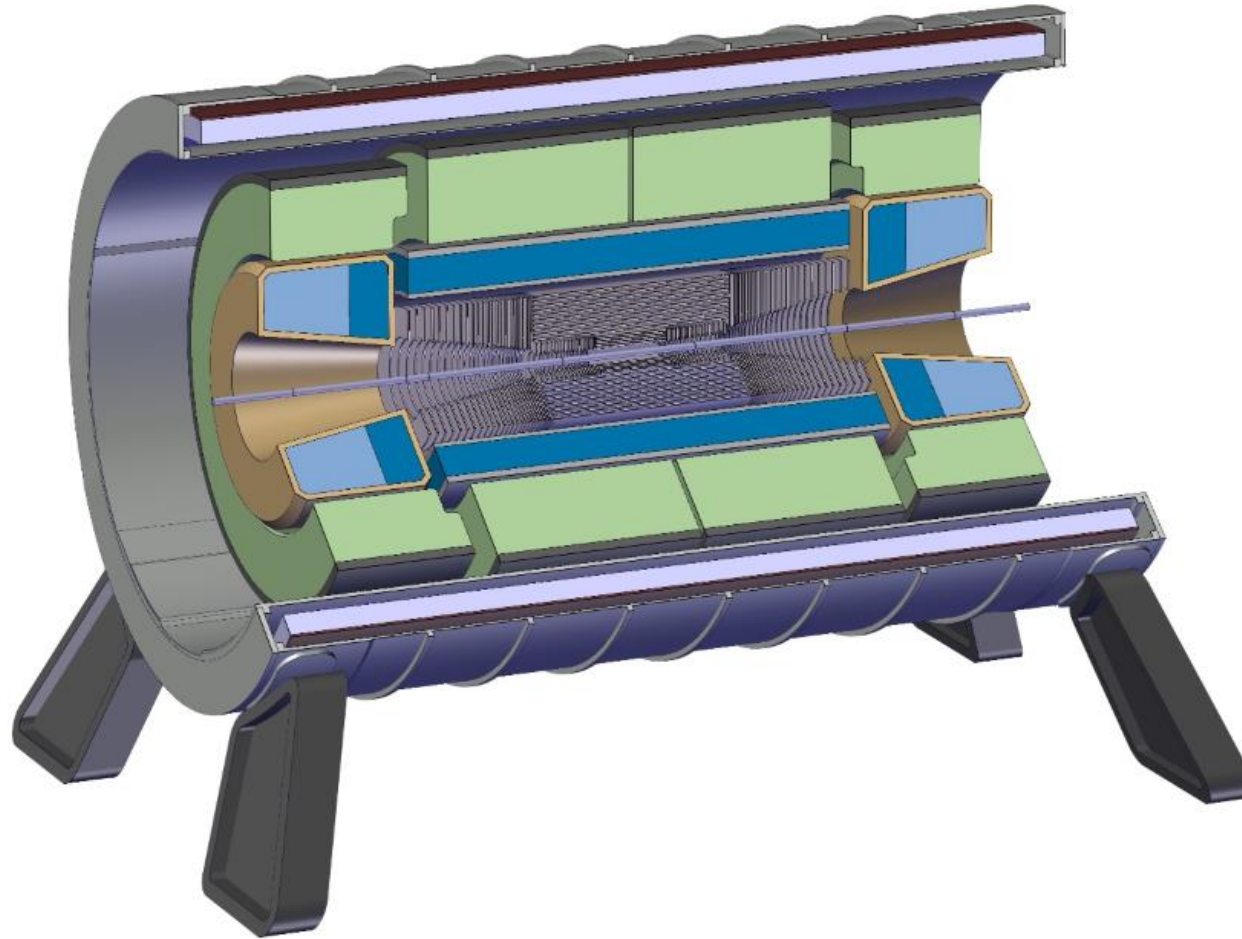
5 - Install 2nd ECAL module

DETECTOR INTEGRATION



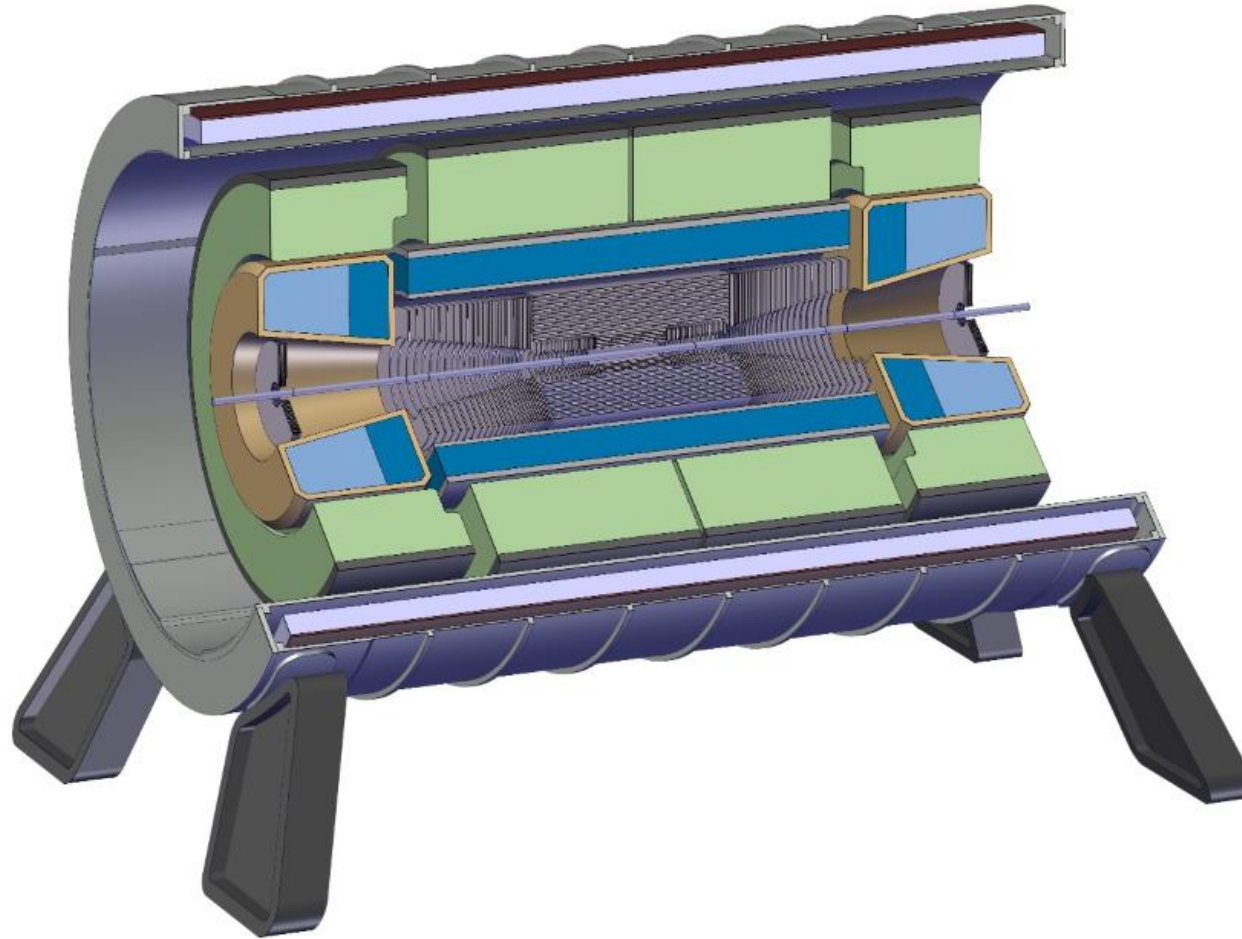
6 - Install Inner Tracker

DETECTOR INTEGRATION



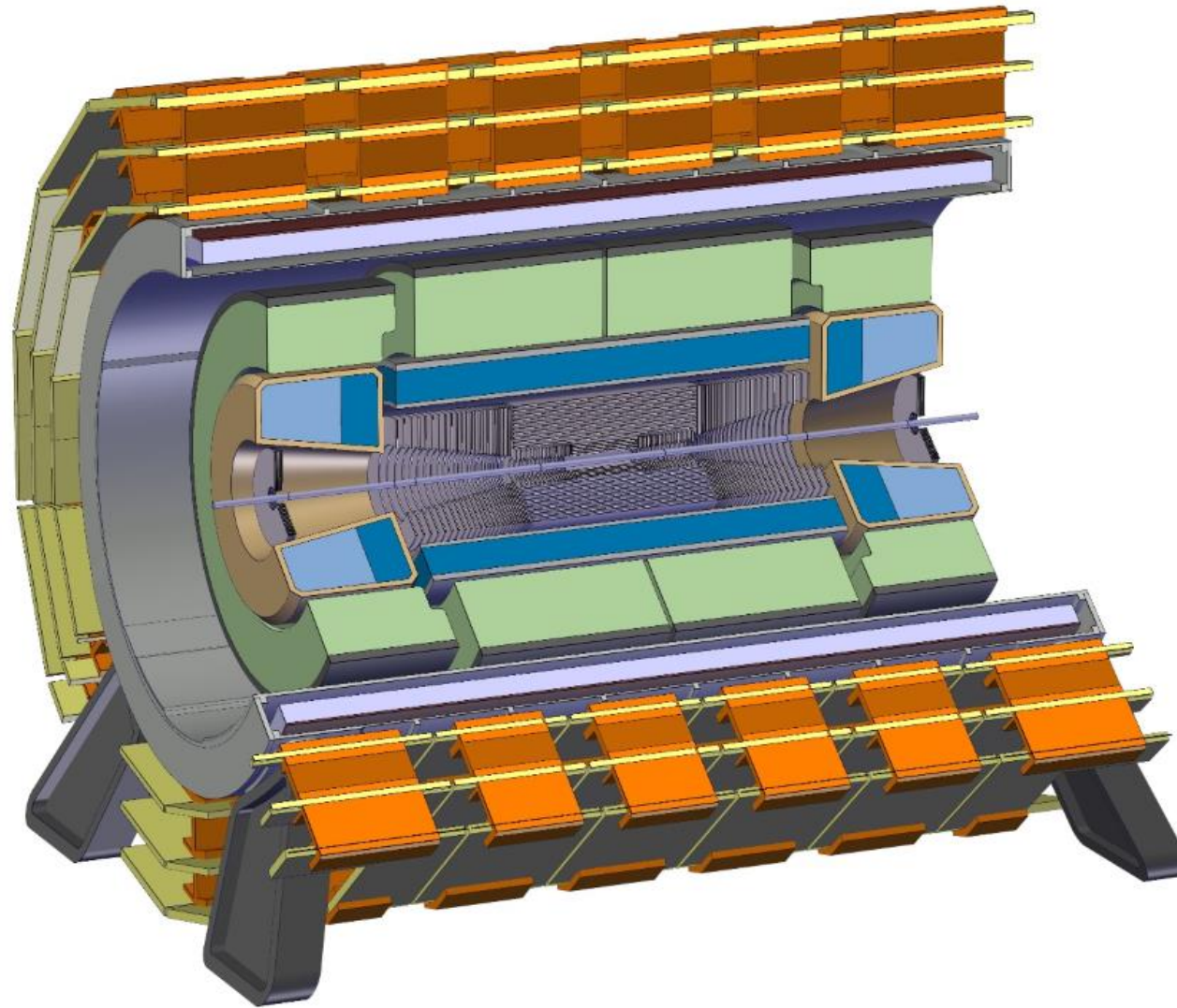
7 - Install the last ECAL and HCAL module

DETECTOR INTEGRATION



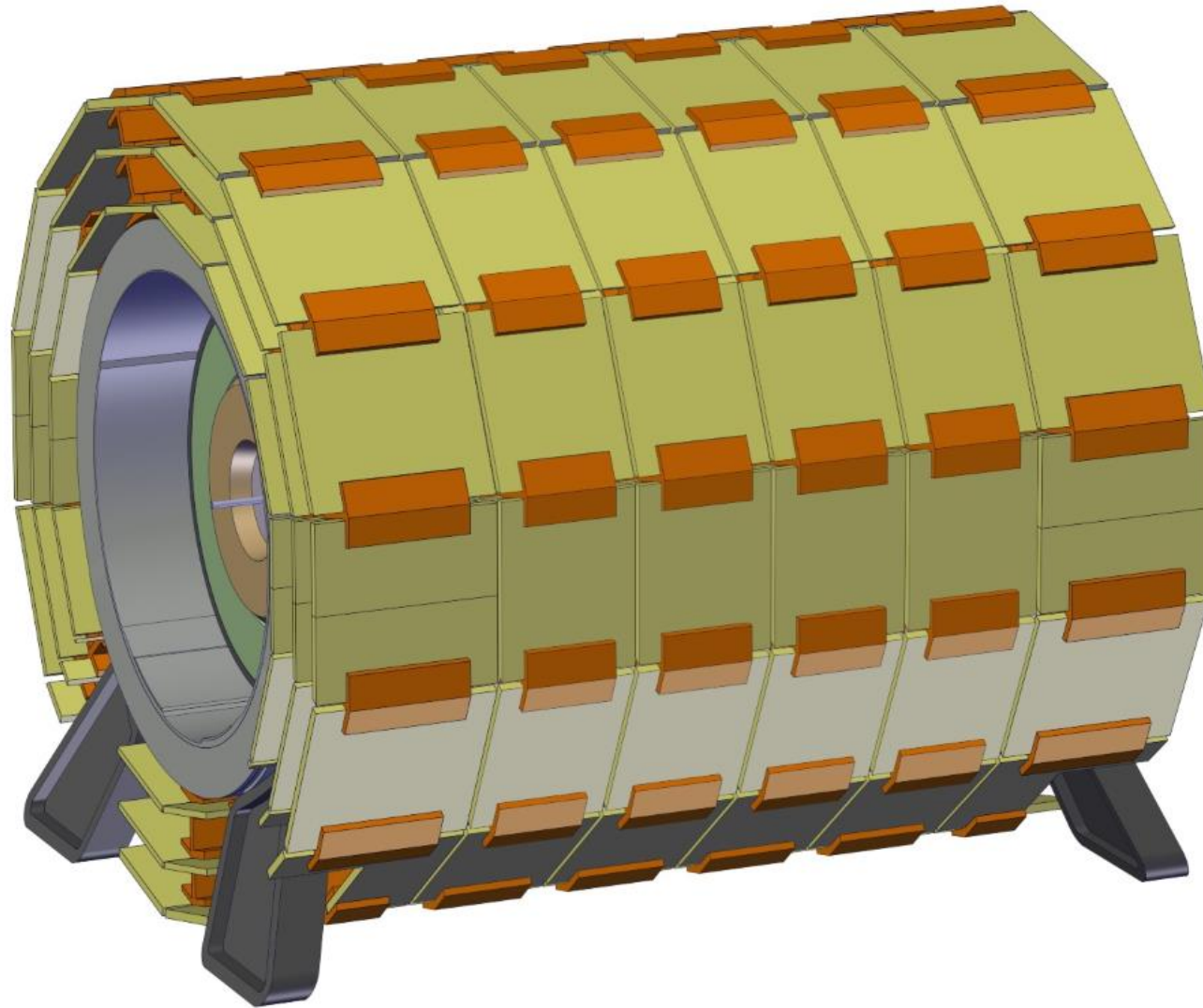
8 - Install Forward Tracker module

DETECTOR INTEGRATION



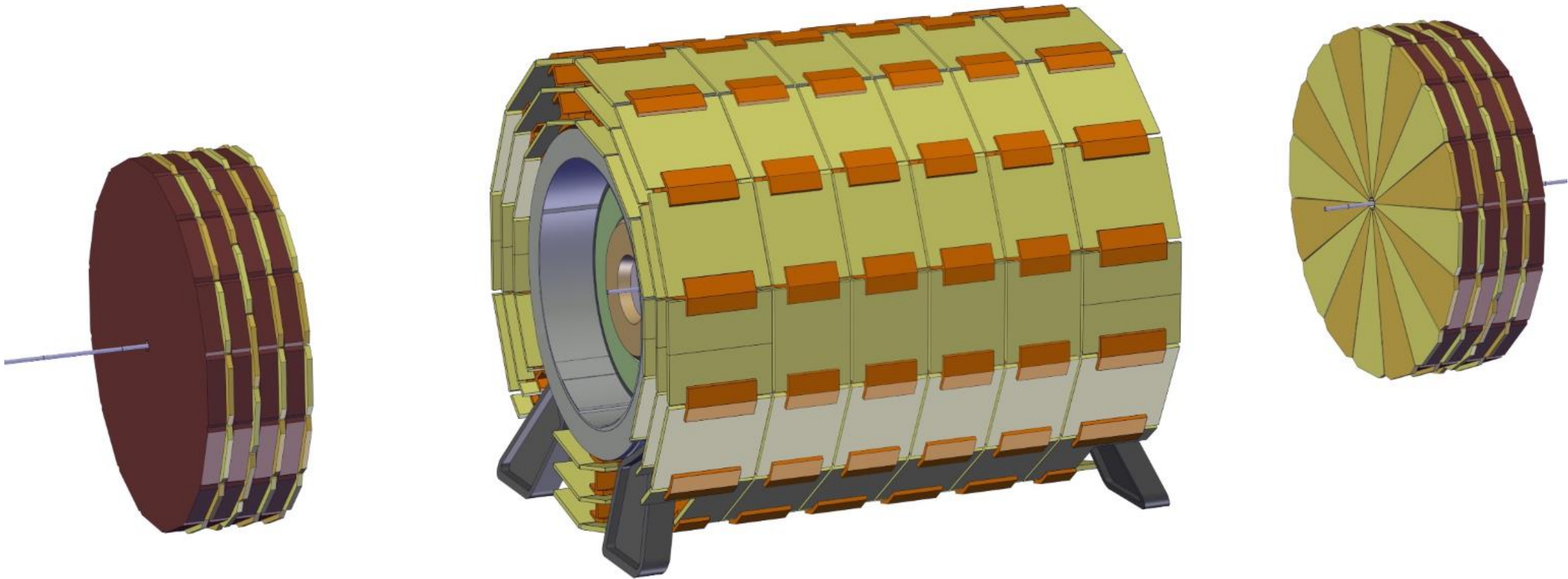
9 - Install Muon Chambers on the Solenoid

DETECTOR INTEGRATION



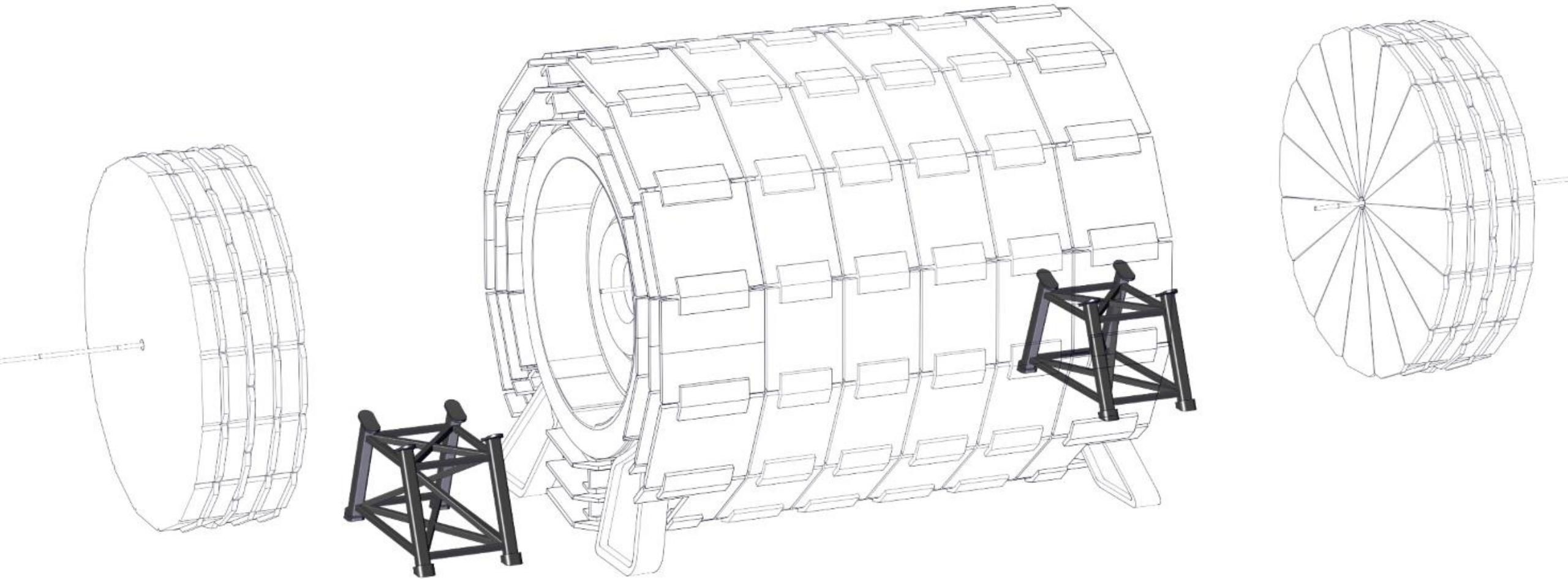
9 - Install Muon Chambers on the Solenoid

DETECTOR INTEGRATION



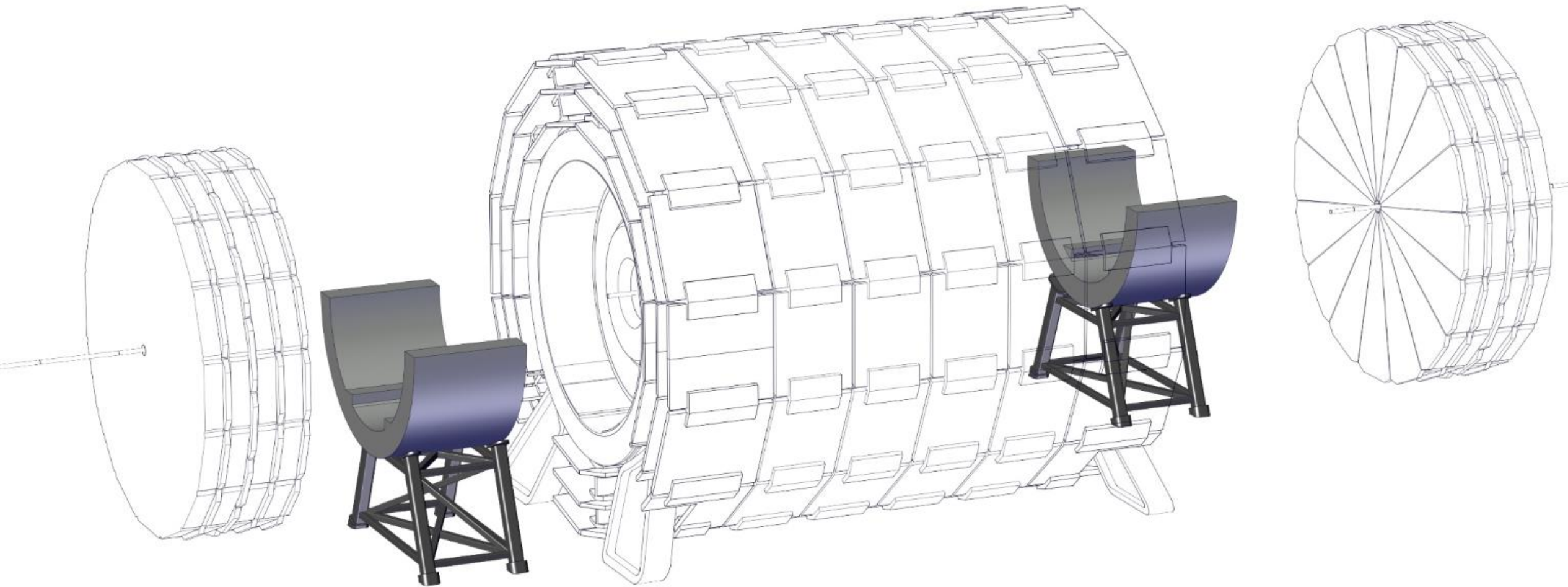
10 – Install Forward Muon Chambers

DETECTOR INTEGRATION



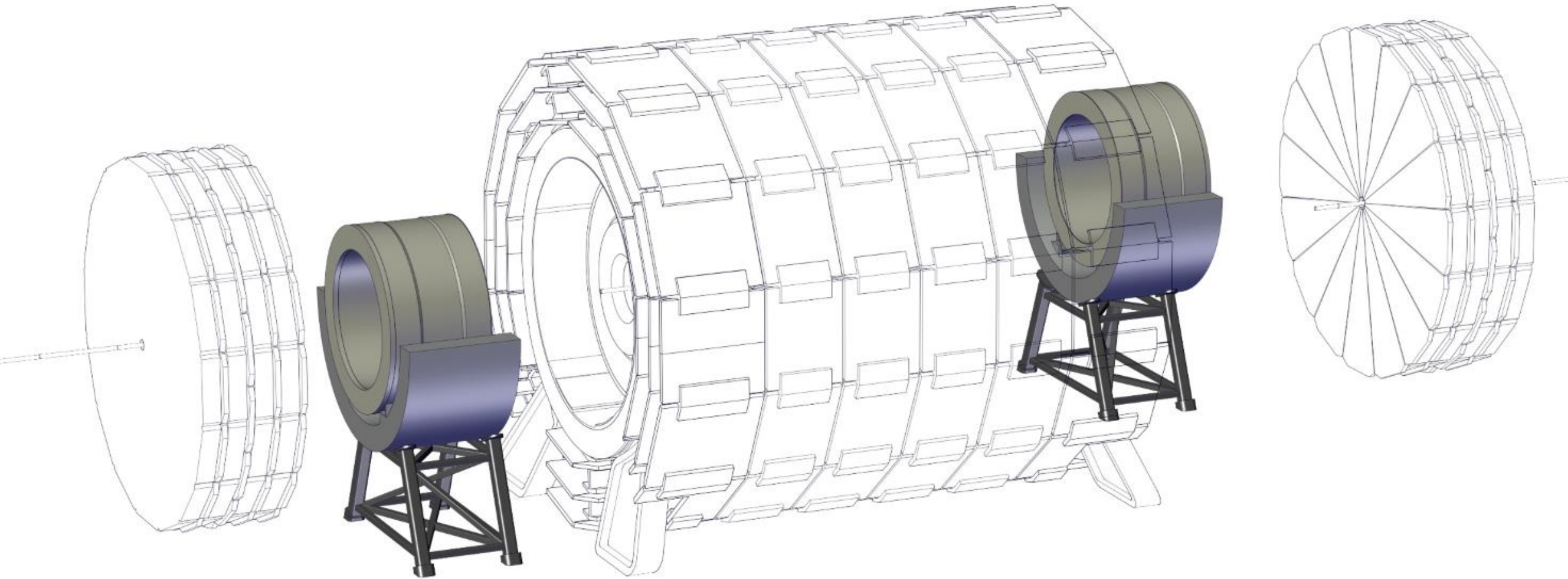
11 – Install the Forward Solenoid support structure

DETECTOR INTEGRATION



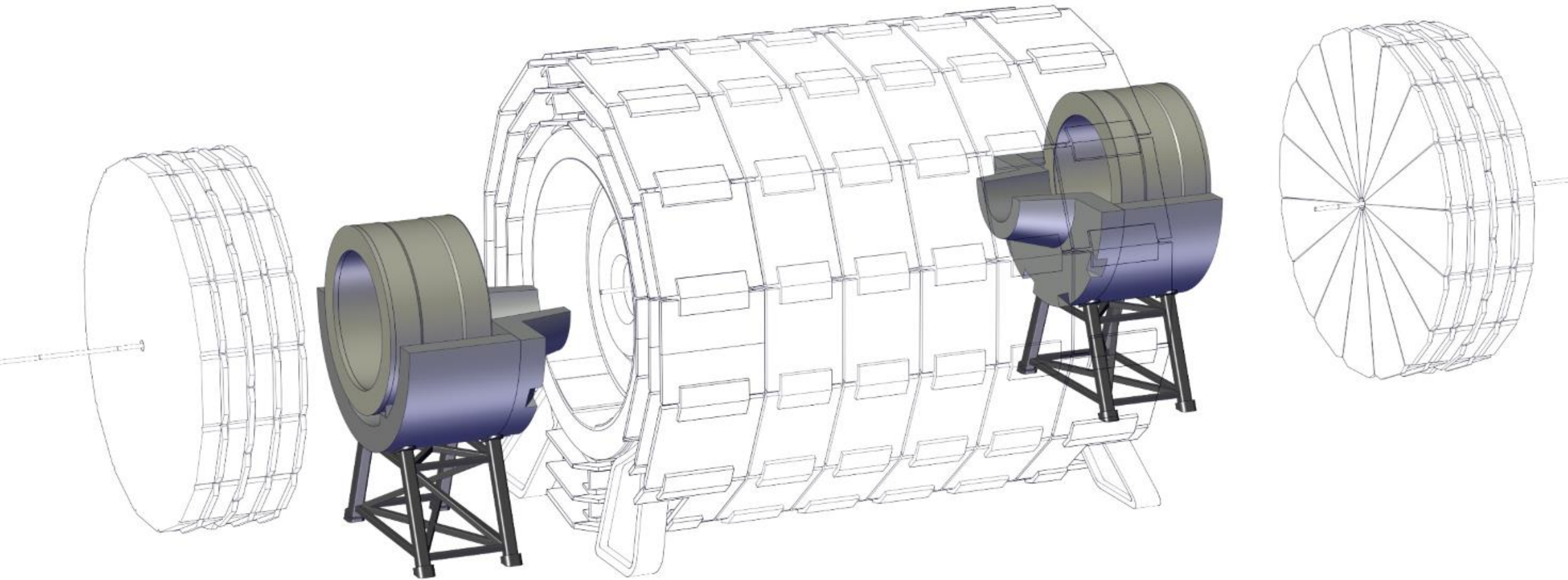
12 – Install bottom half of the Radiation Shield

DETECTOR INTEGRATION



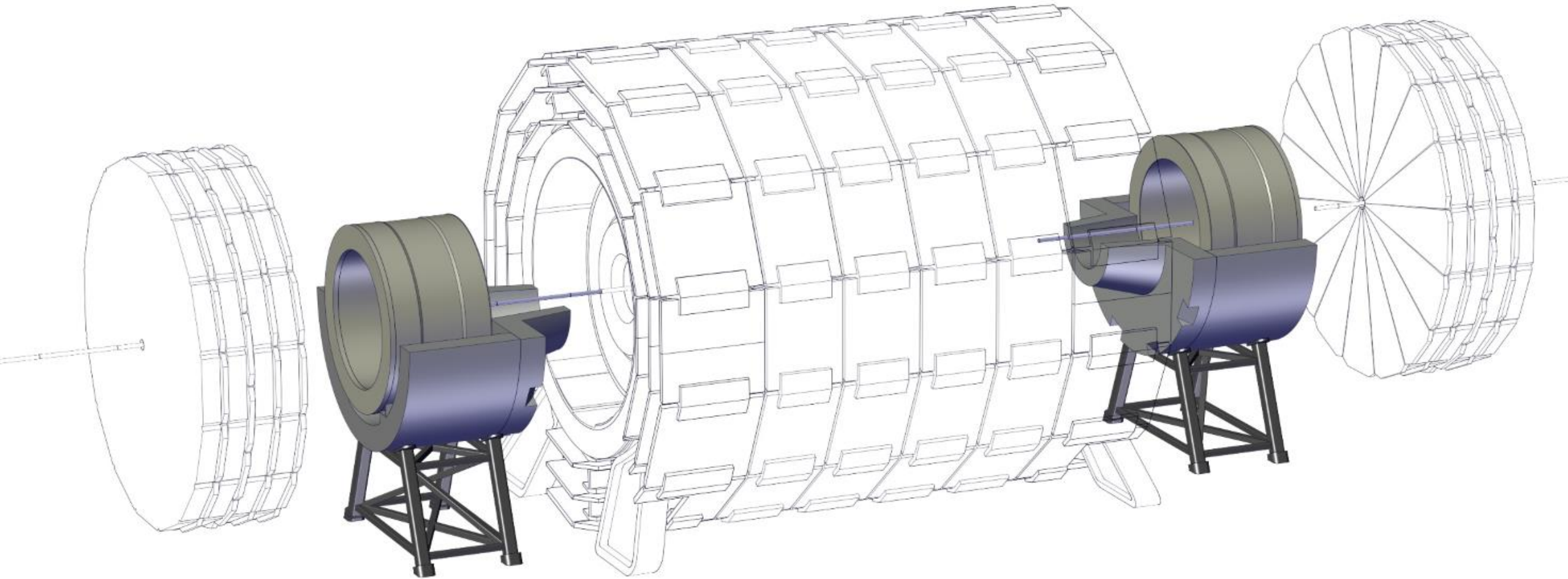
13 – Install Forward Solenoids

DETECTOR INTEGRATION



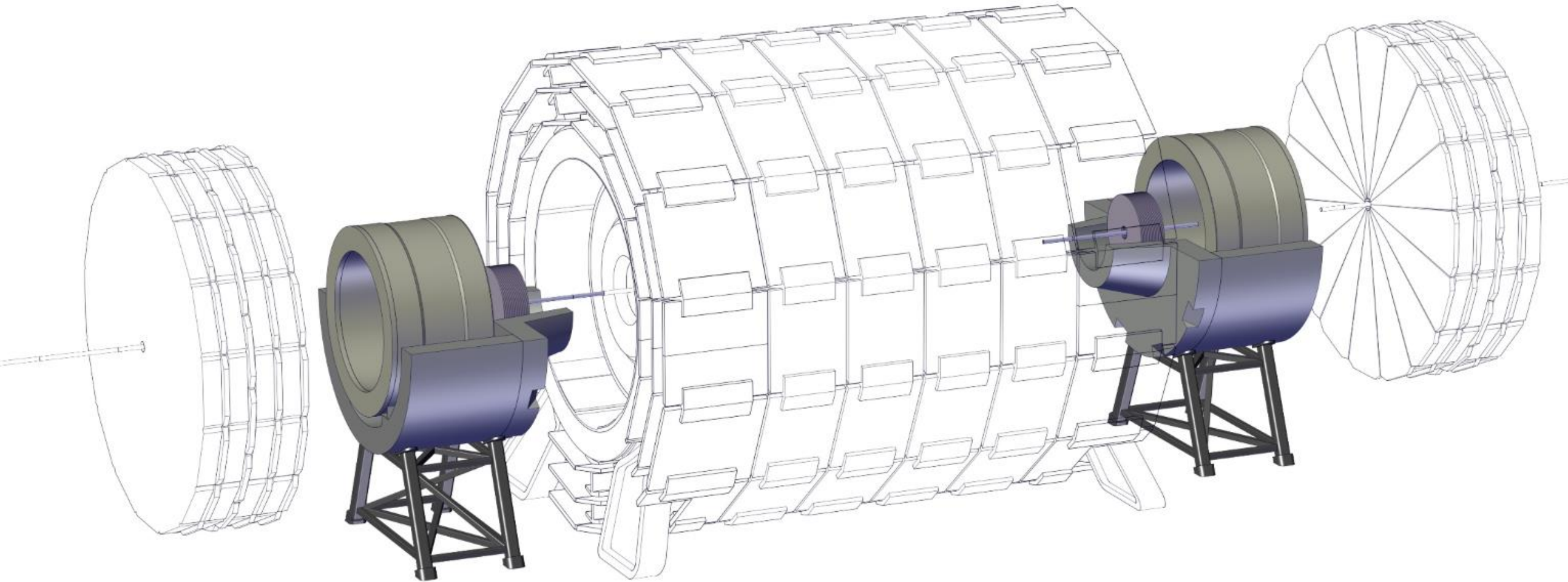
14 – Install bottom half of the radiation shield nose

DETECTOR INTEGRATION



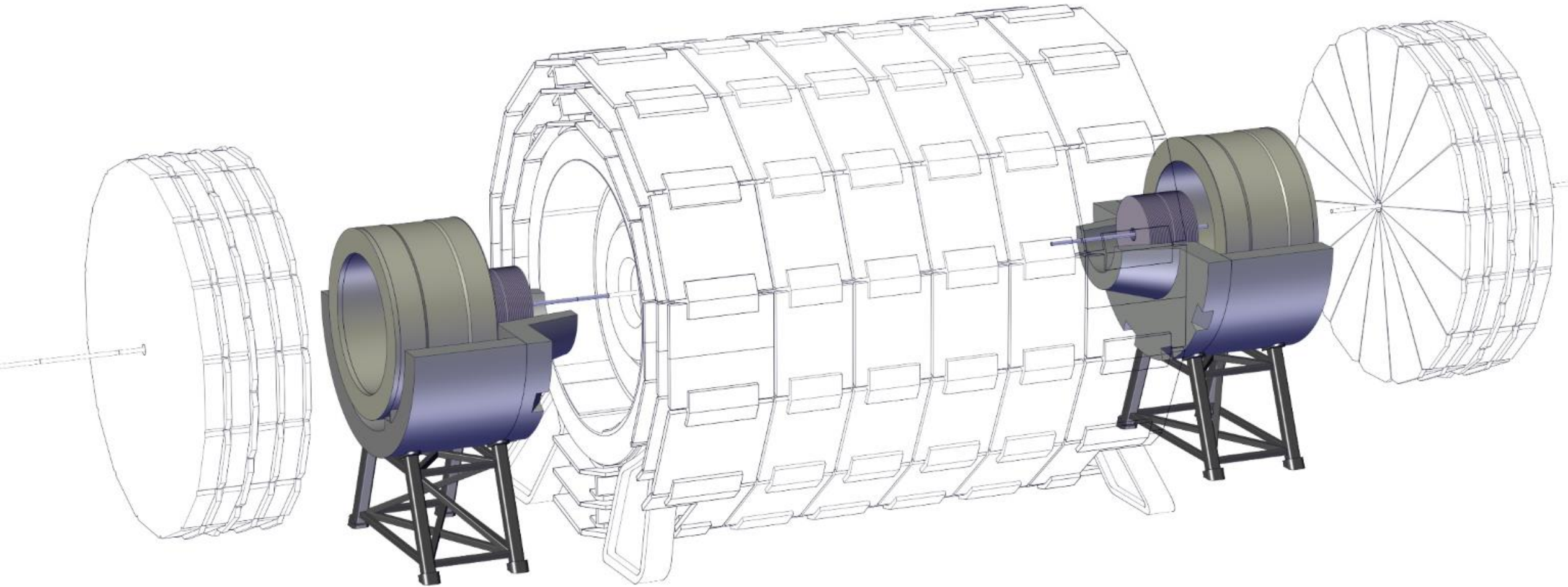
15 – Align forward solenoid with the experiment and install part of the beam pipe

DETECTOR INTEGRATION



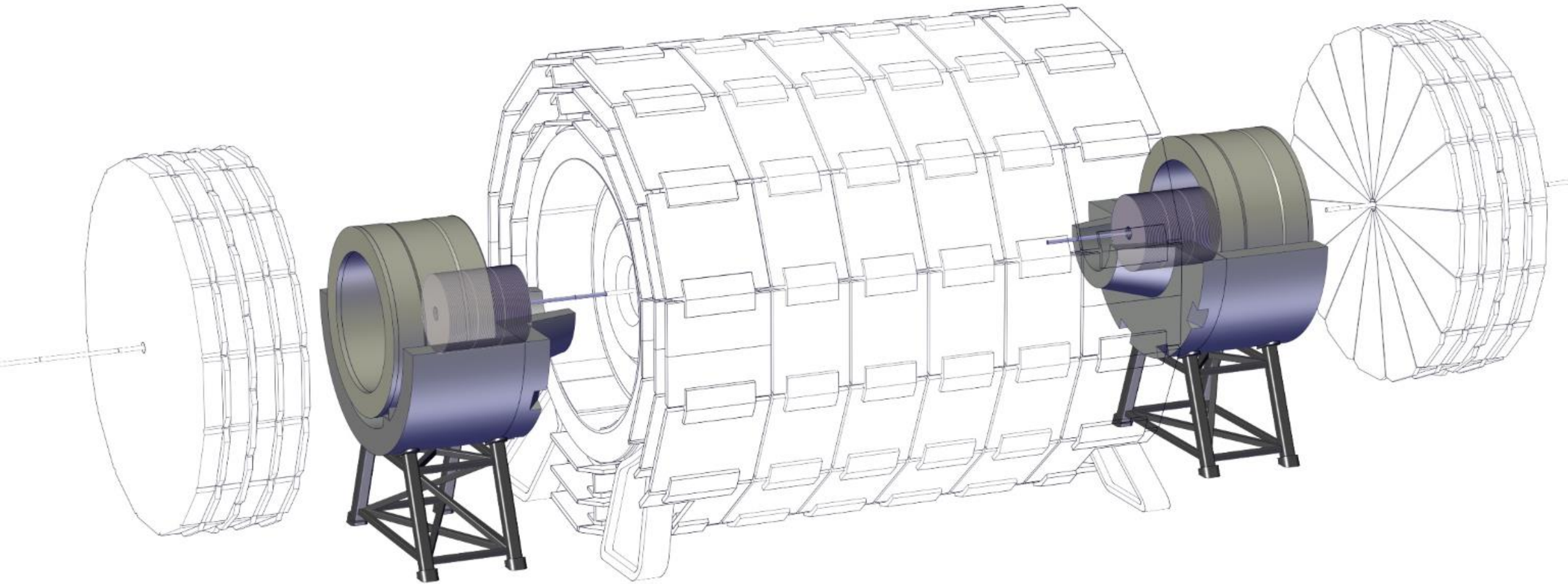
16 – Install Forward Trackers

DETECTOR INTEGRATION



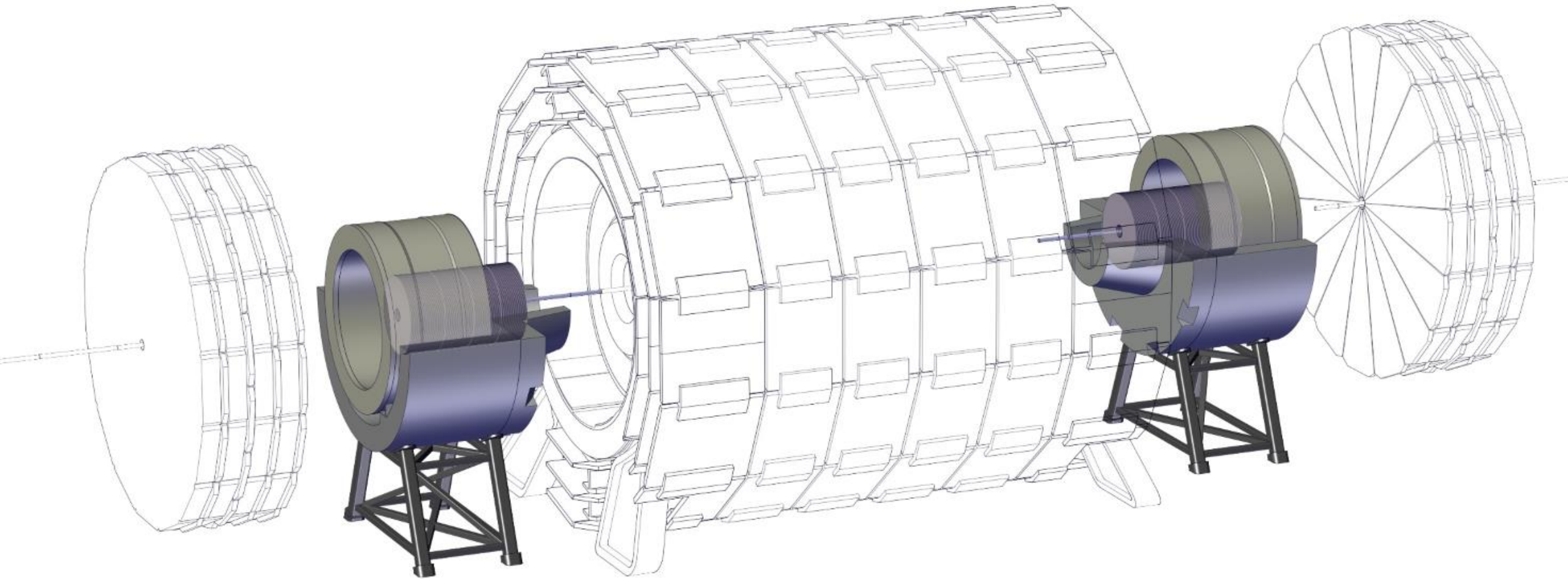
16 – Install Forward Trackers

DETECTOR INTEGRATION



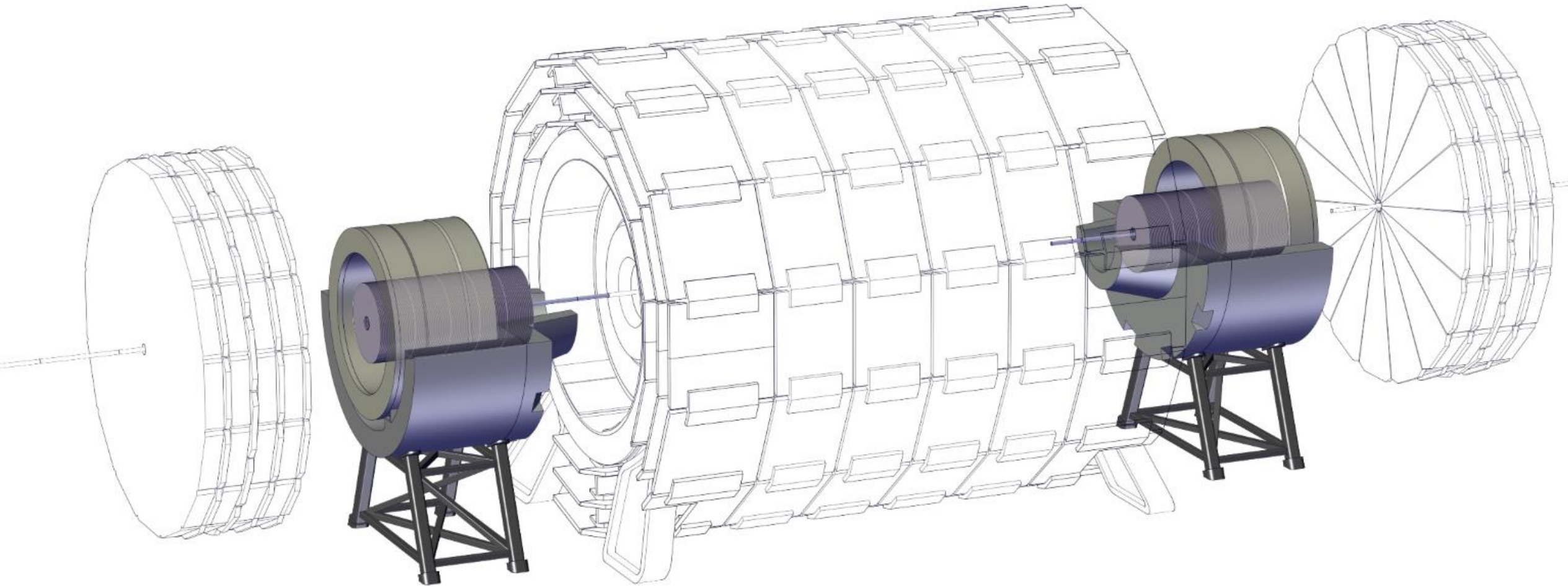
16 – Install Forward Trackers

DETECTOR INTEGRATION



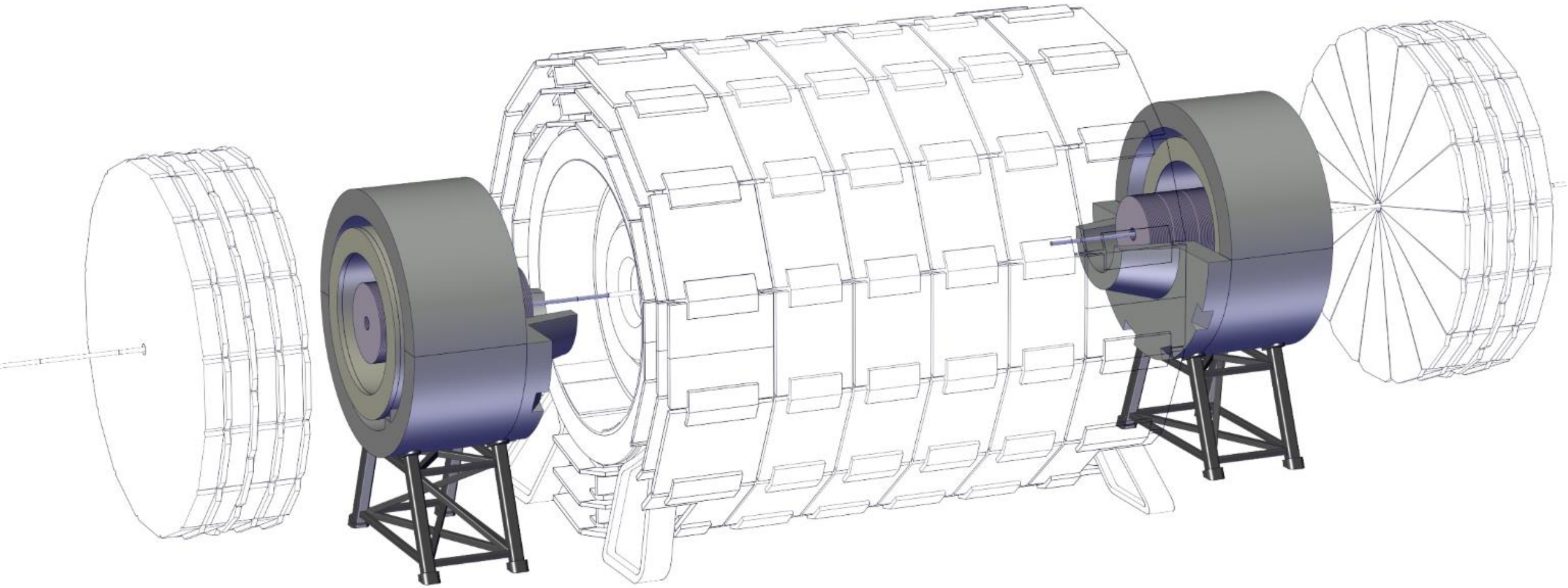
16 – Install Forward Trackers

DETECTOR INTEGRATION



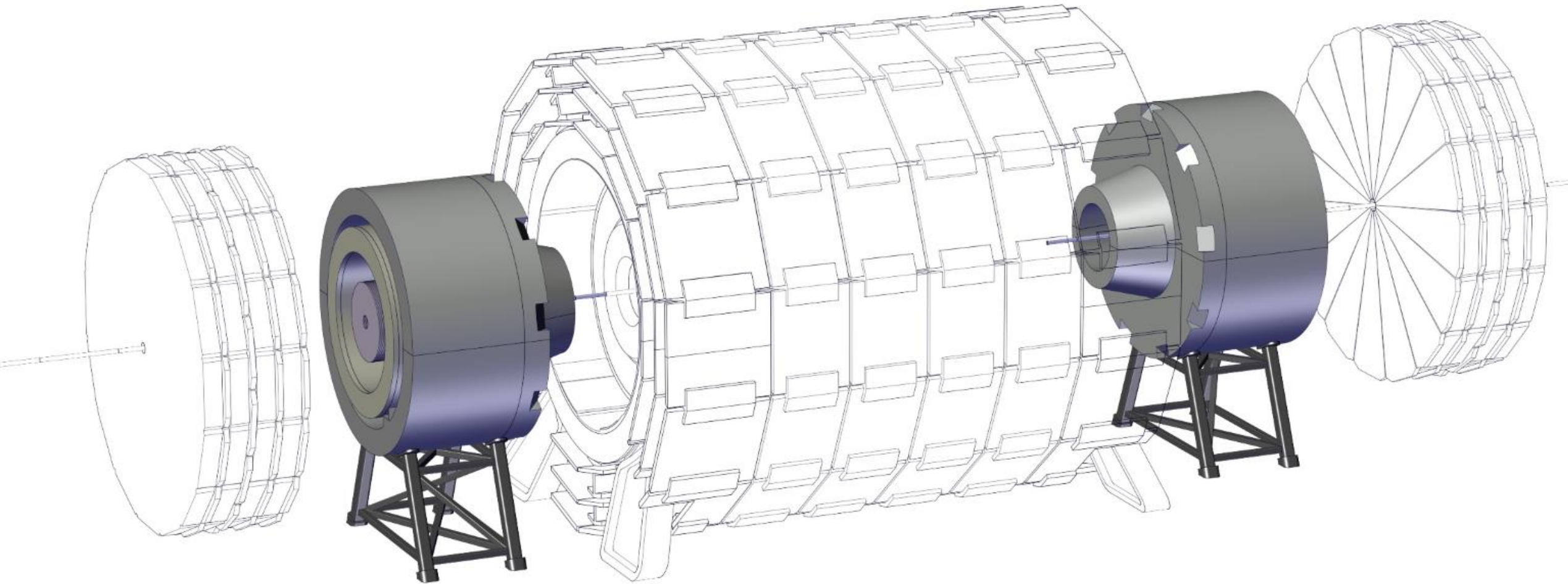
16 – Install Forward Trackers

DETECTOR INTEGRATION



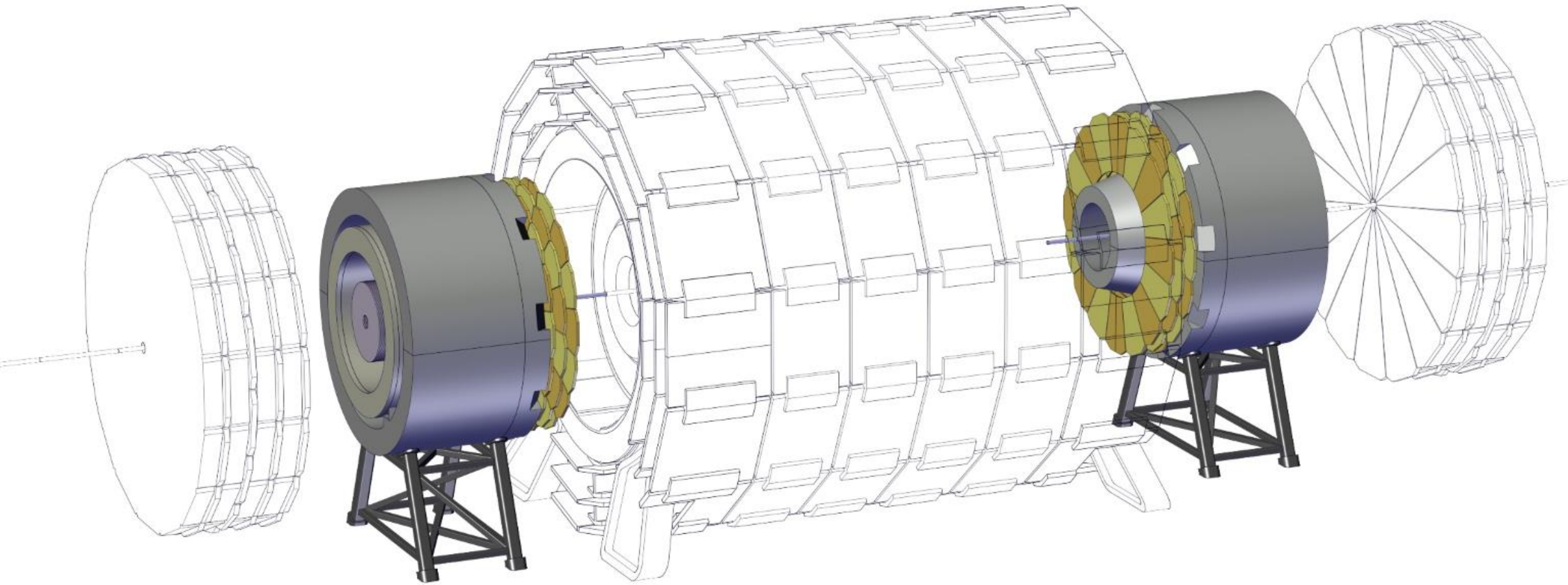
17 – Install top half of the Radiation Shield

DETECTOR INTEGRATION



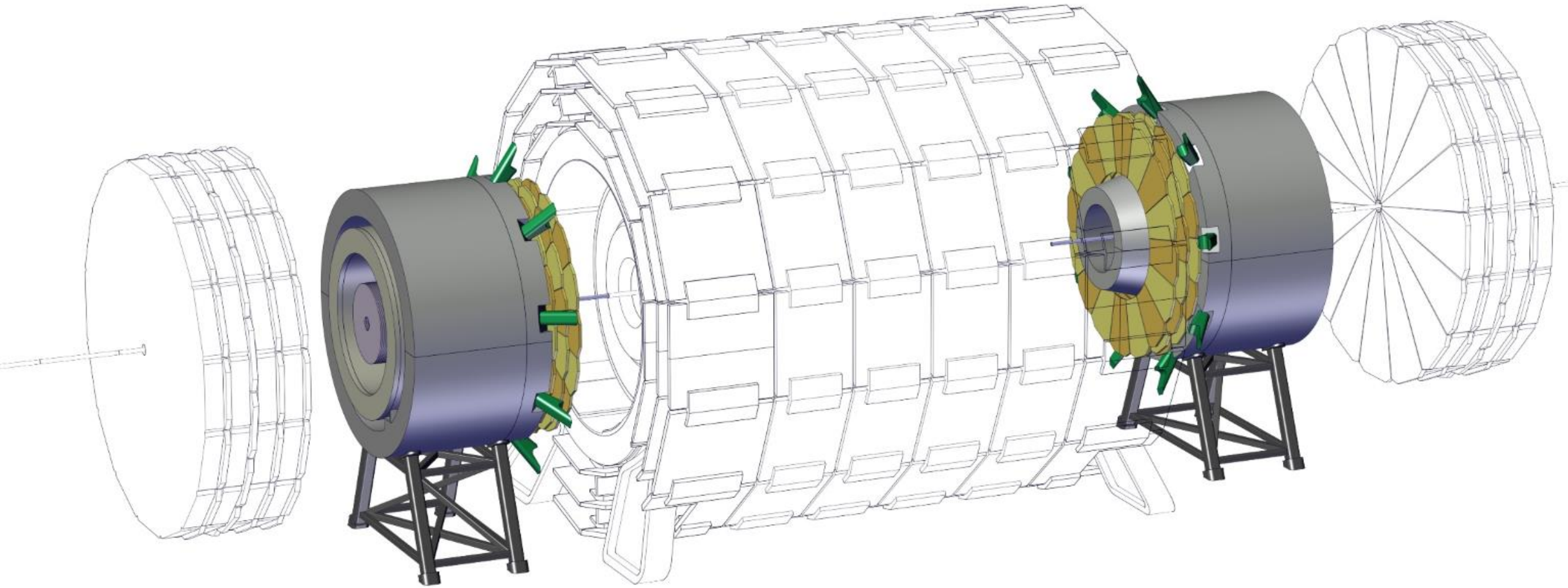
18 – Install top half of the Radiation Shield nose

DETECTOR INTEGRATION



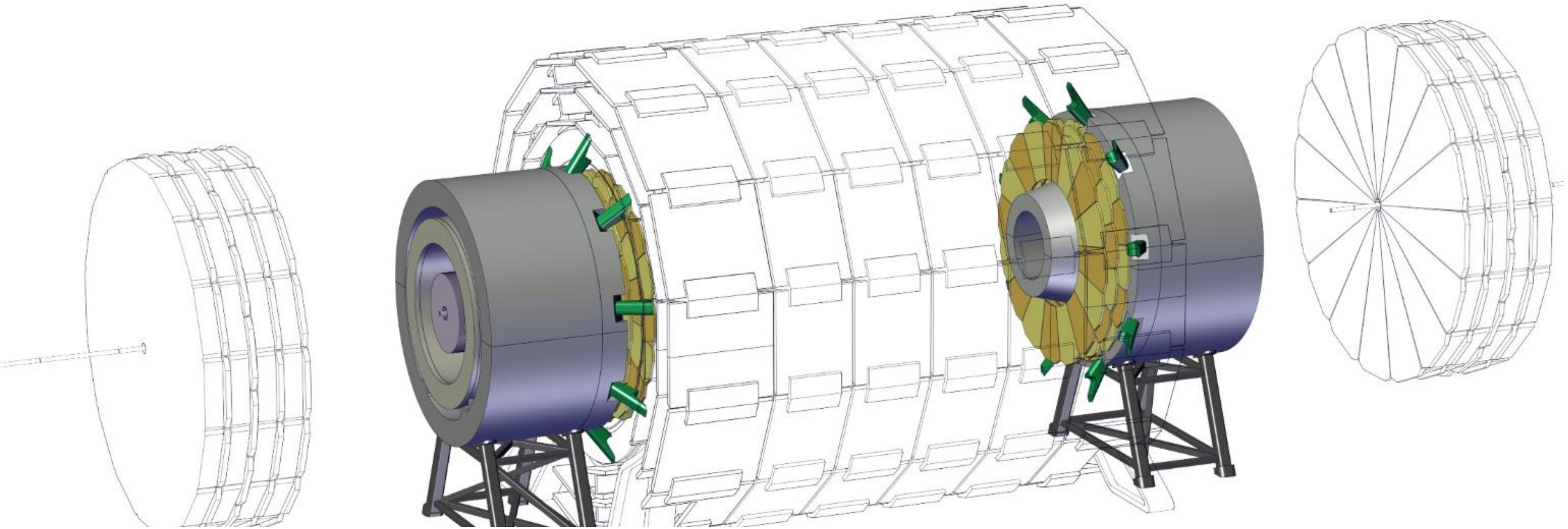
19 – Install Muon Chambers

DETECTOR INTEGRATION



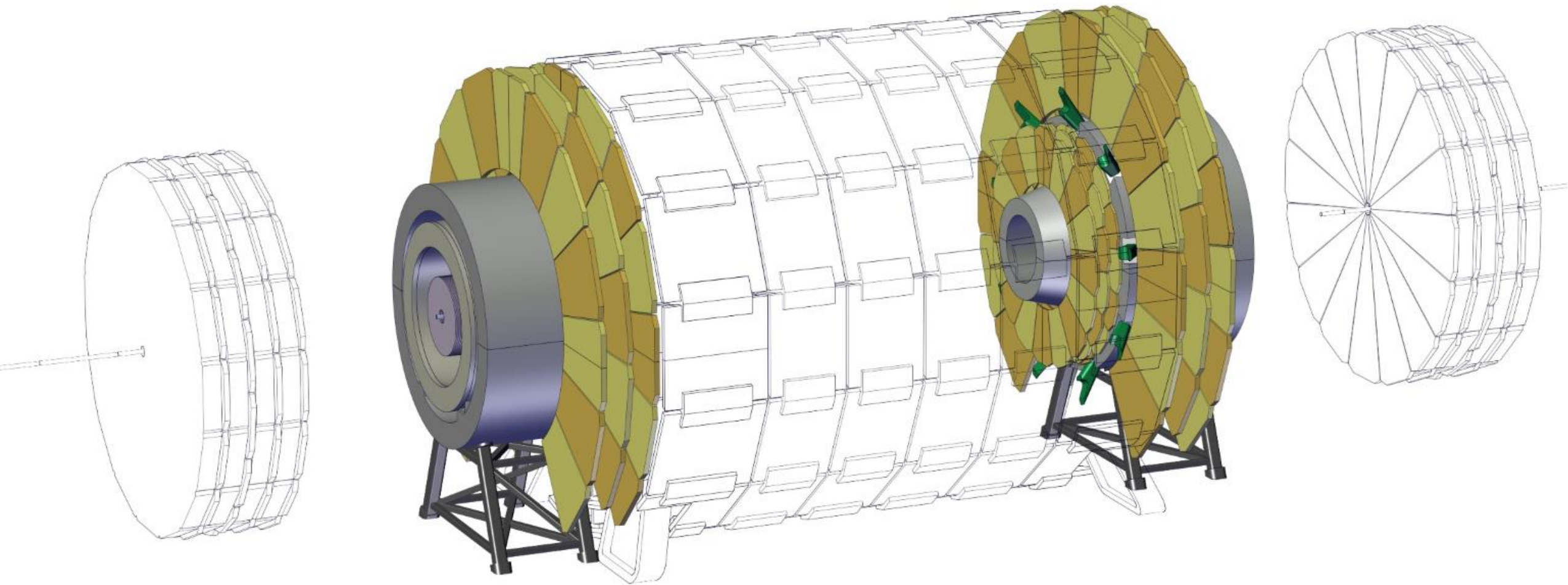
20 – Install Spokes

DETECTOR INTEGRATION



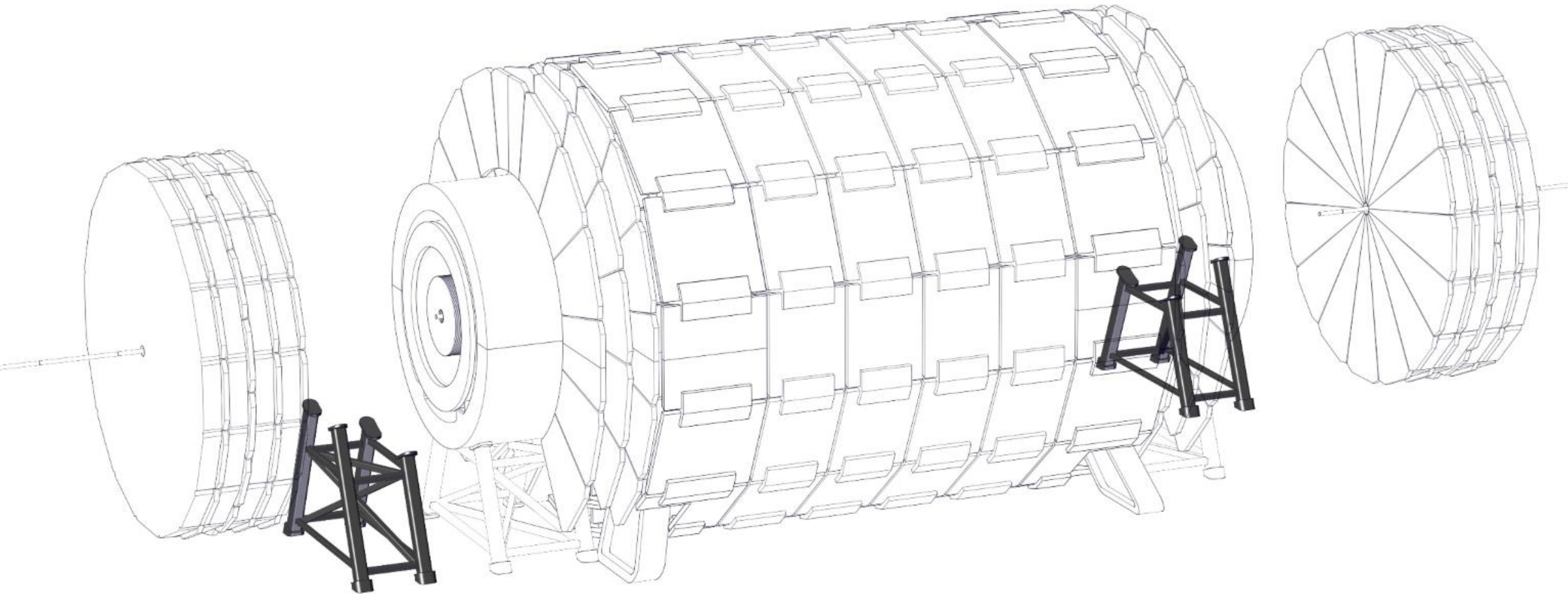
21 – Connect Spokes to main cryostat

DETECTOR INTEGRATION



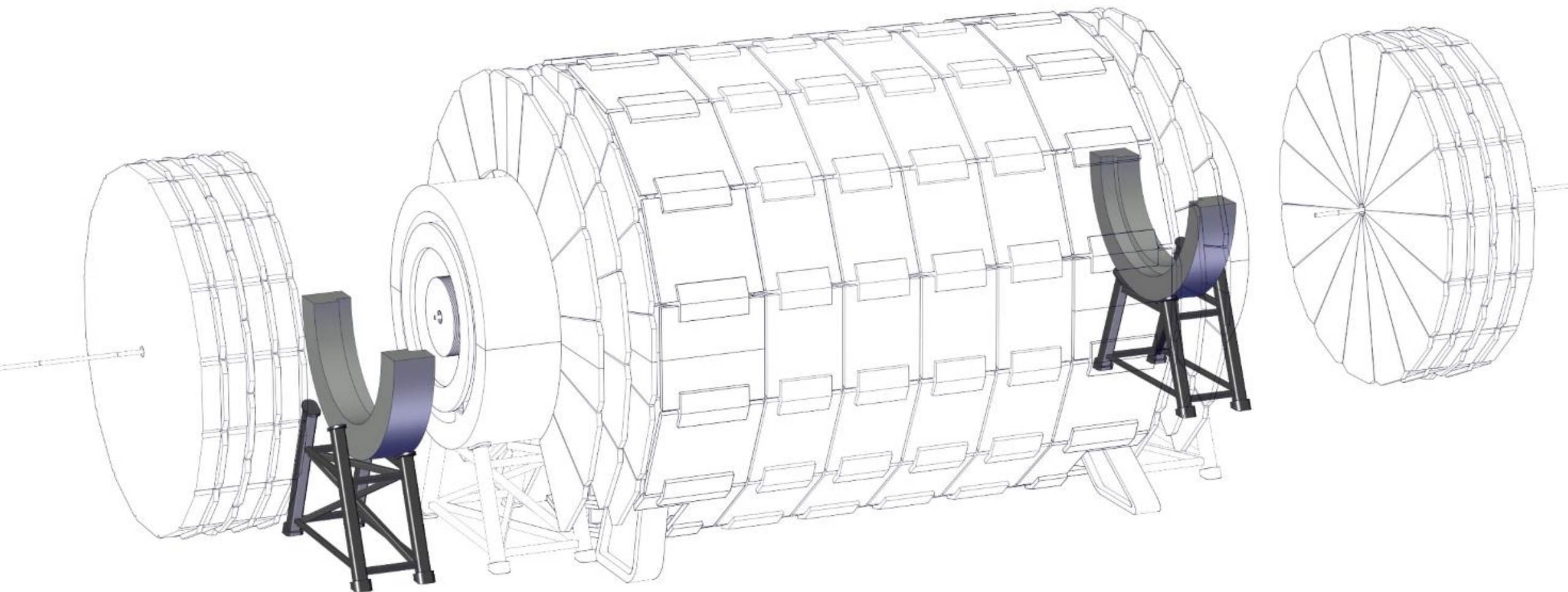
22 – Install Muon Chambers

DETECTOR INTEGRATION



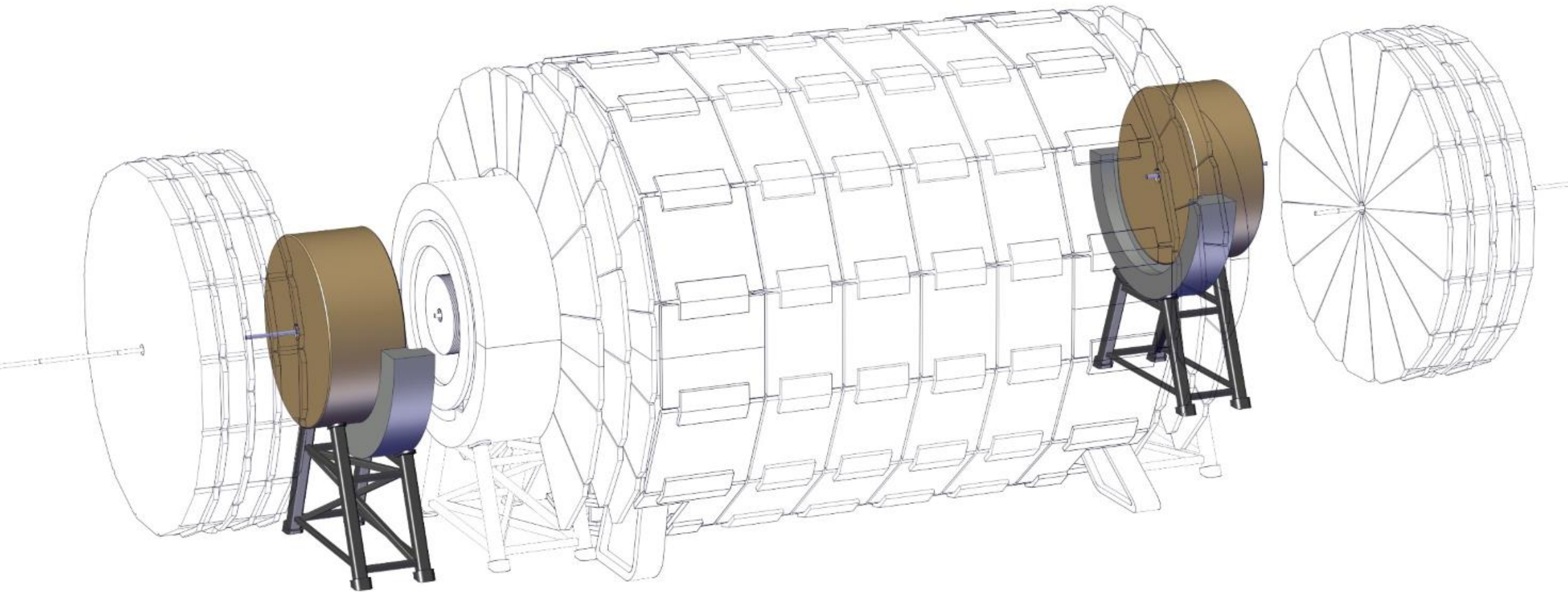
23 - Install Forward ECAL support structure

DETECTOR INTEGRATION



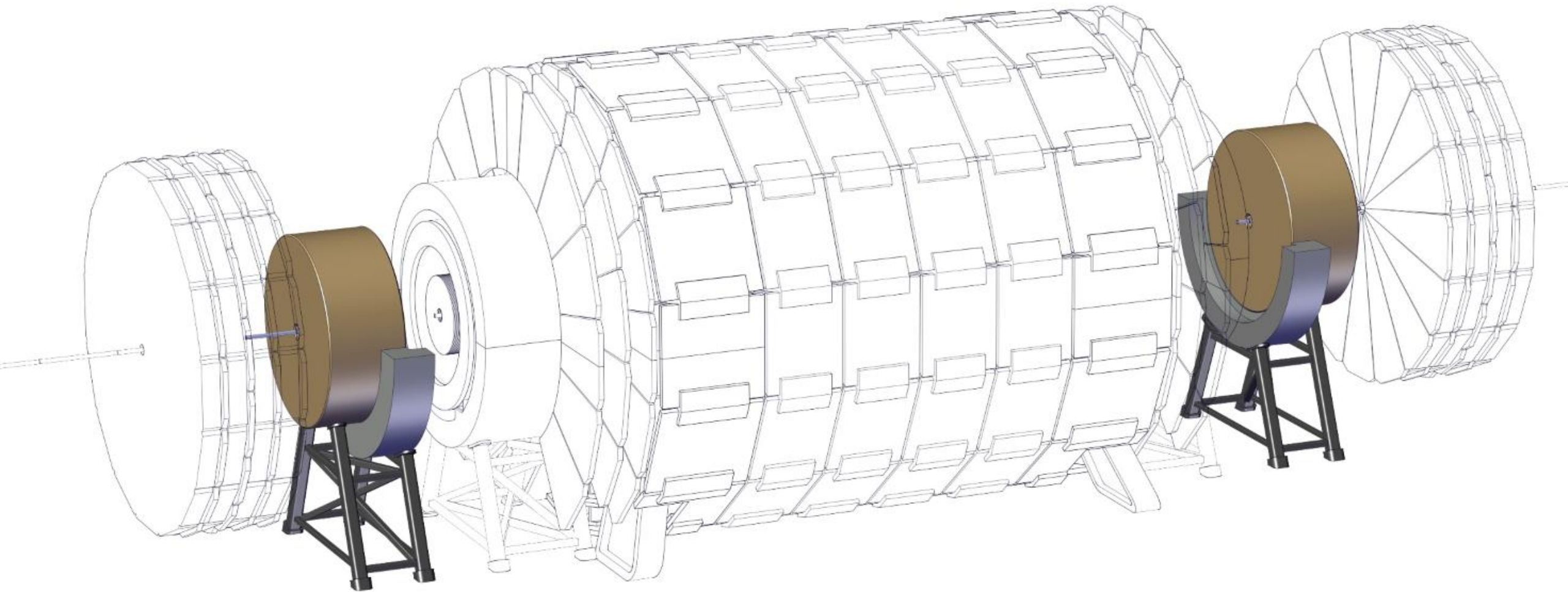
24 - Install bottom half of the ECAL Radiation Shield

DETECTOR INTEGRATION



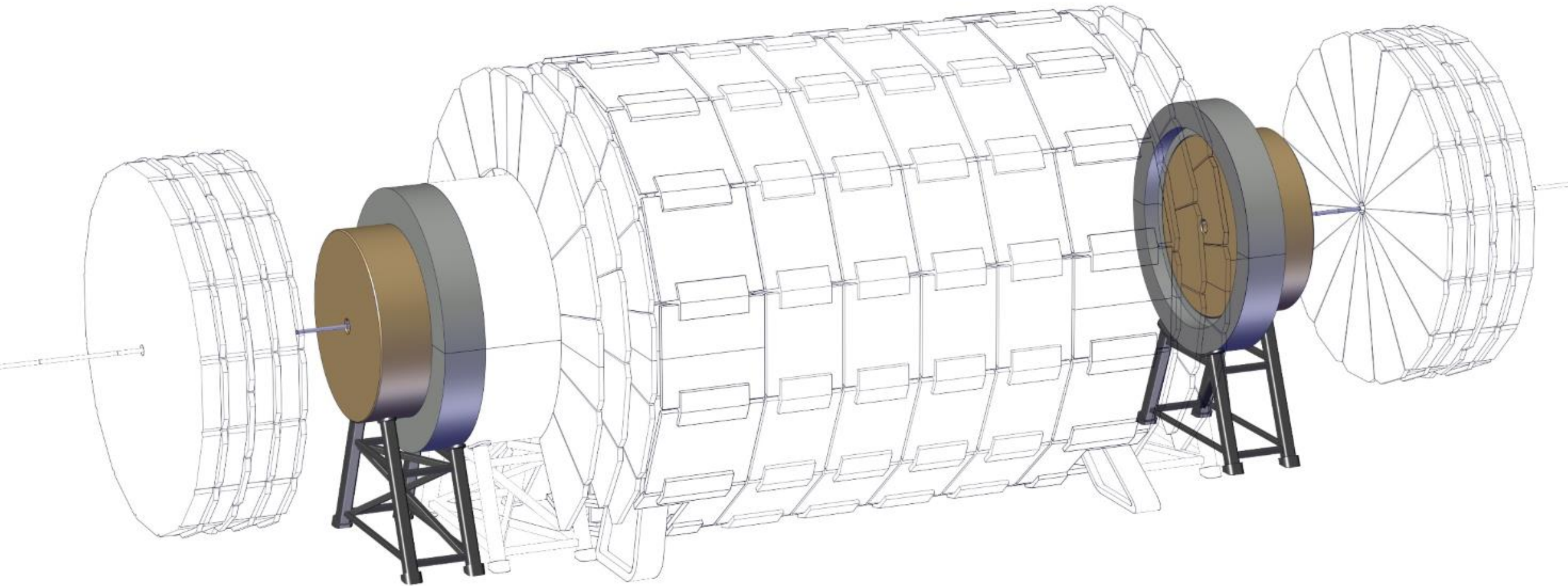
25 - Install Forward ECAL

DETECTOR INTEGRATION



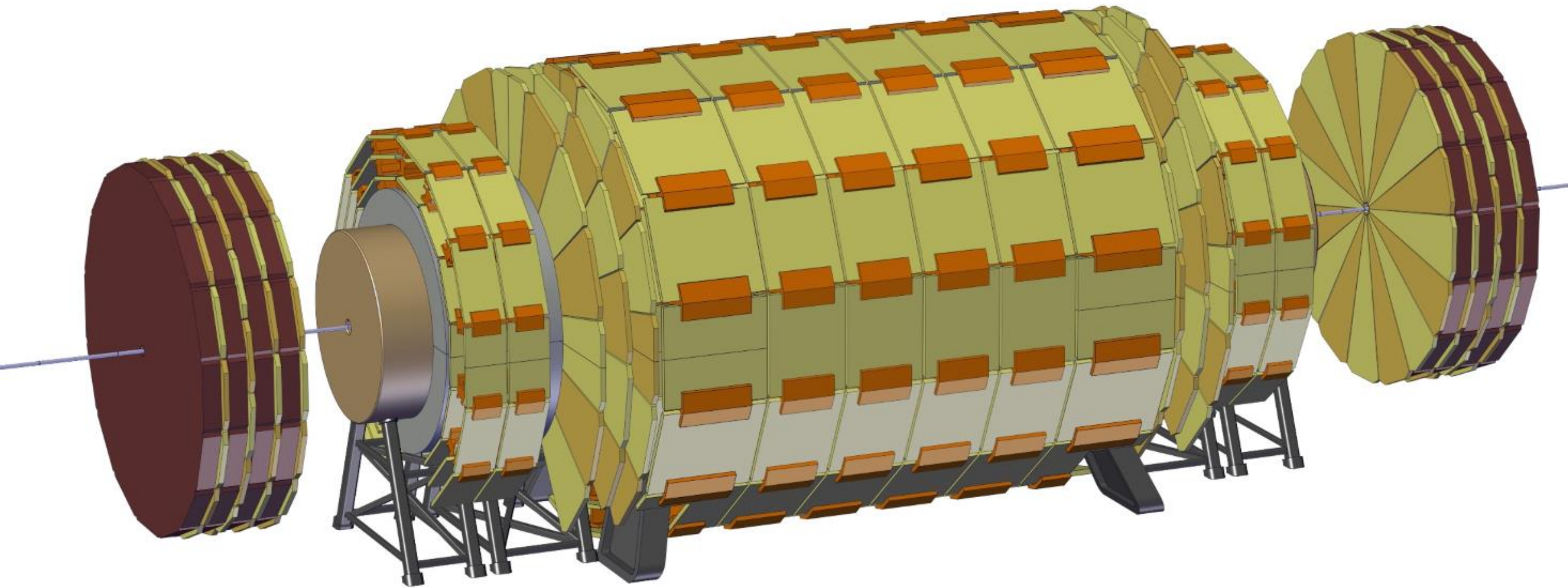
26 – Align the off-centered ECAL with the experiment and close Beam Pipe

DETECTOR INTEGRATION



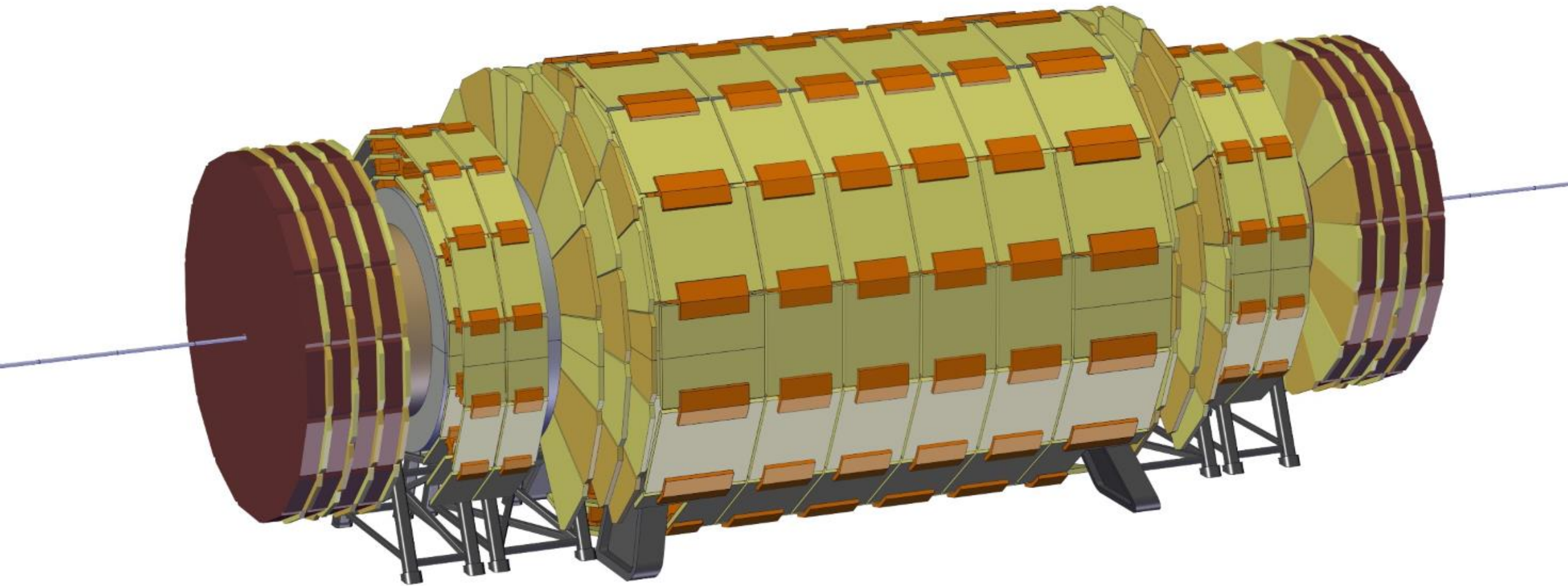
27 – Install the top half and close the radiation shield

DETECTOR INTEGRATION



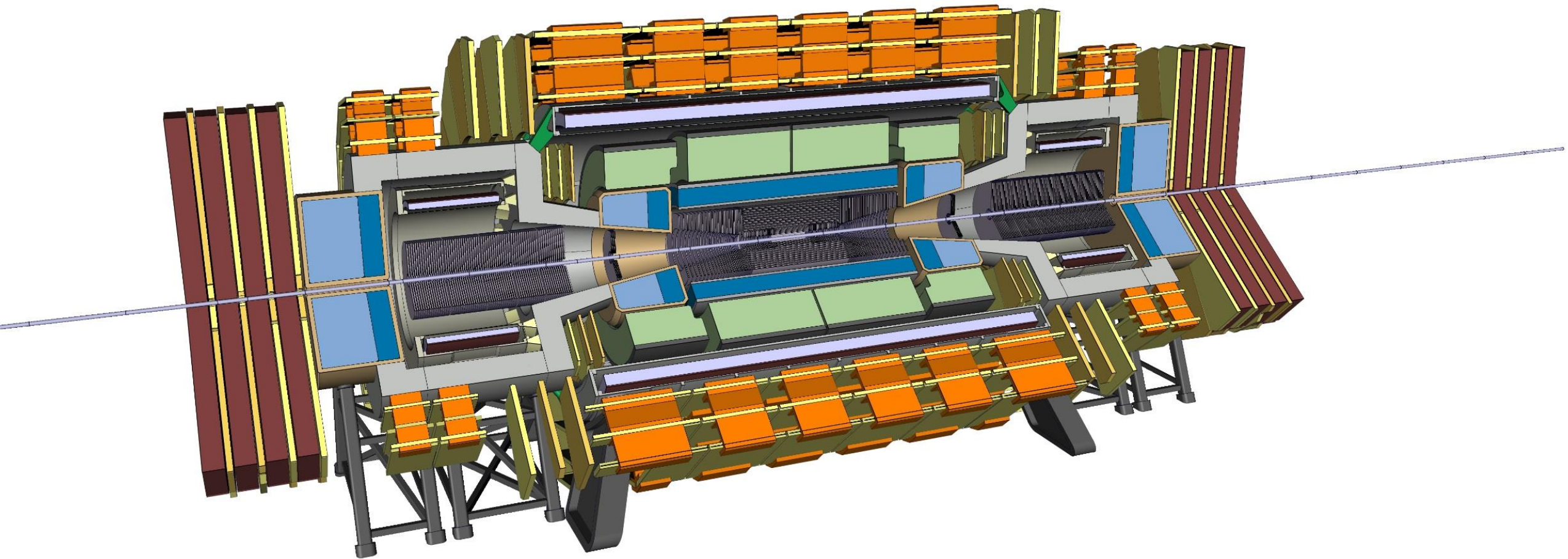
28 – Install remaining Muon Chambers

DETECTOR INTEGRATION



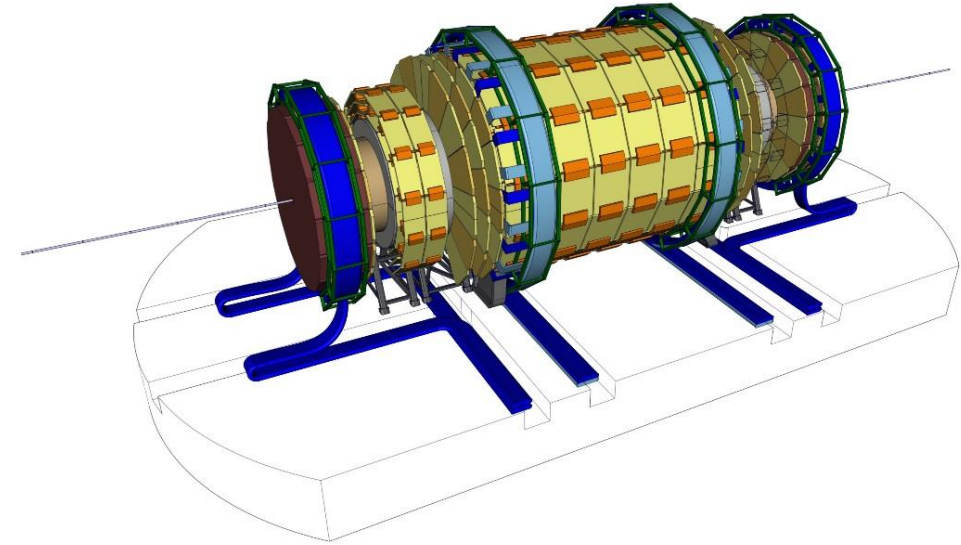
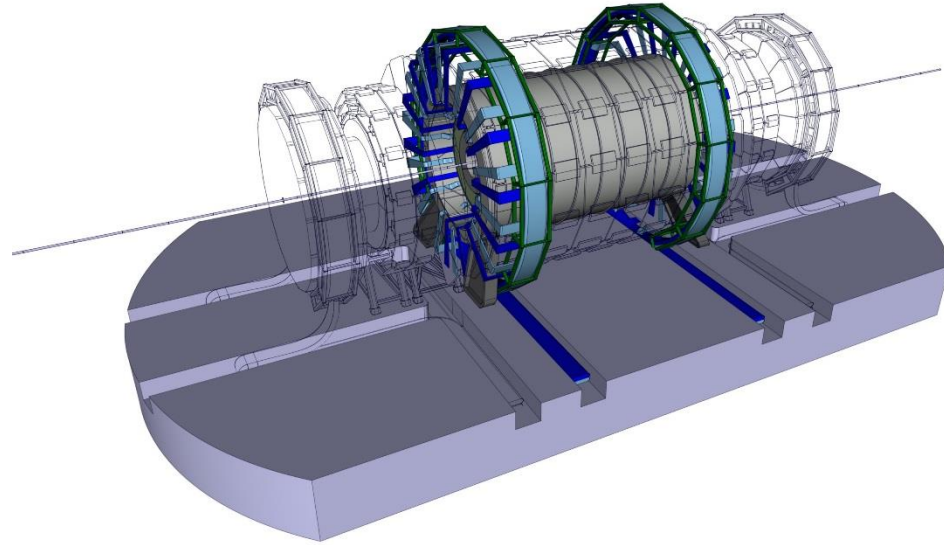
29 – Move Forward Muon Wheels to their final position

DETECTOR INTEGRATION



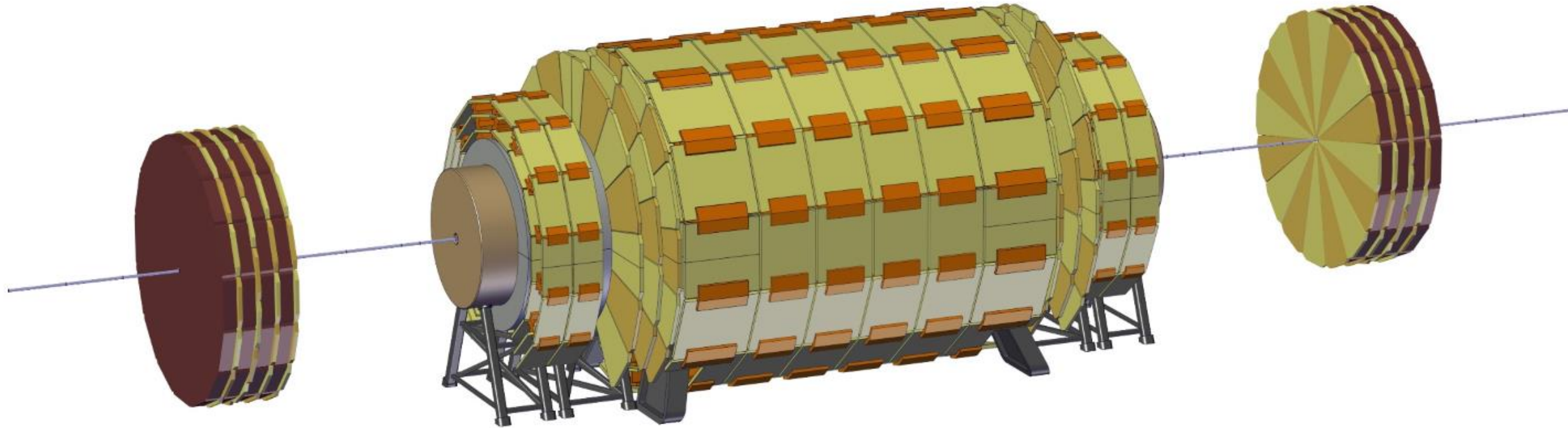
COMPLETE ASSEMBLY

ROUTING OF SERVICES



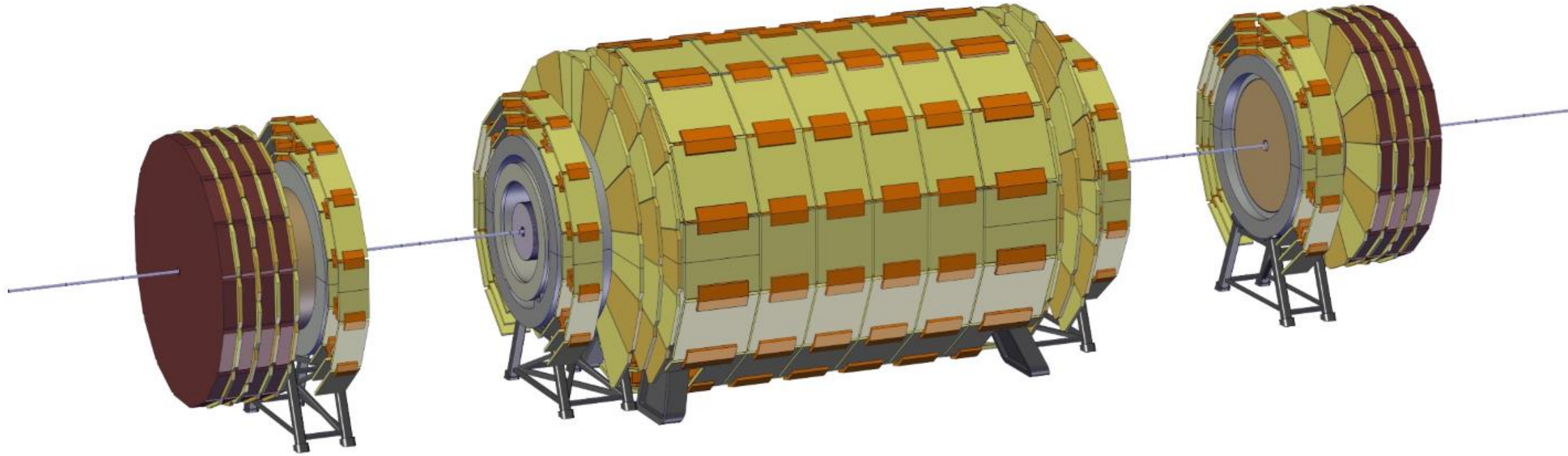
- Inner detectors cables and services are routed to the exterior of the detector and then to a side cavern.
- Forward detectors will make use of flexible chains that will be placed on trenches allowing only for longitudinal movements.
- For simplicity, only the services routing of the muon chambers in the forward direction are shown in the pictures above.

SHORT OPENING SCENARIO



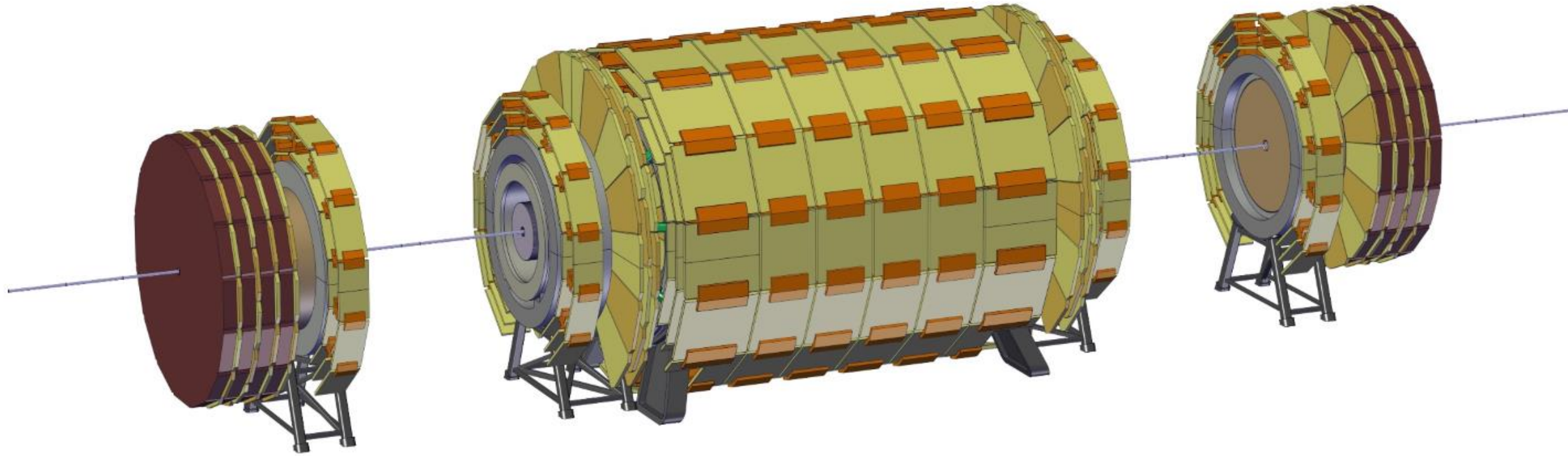
1 – Slide the Forward Muon Chambers away from the experiment

SHORT OPENING SCENARIO



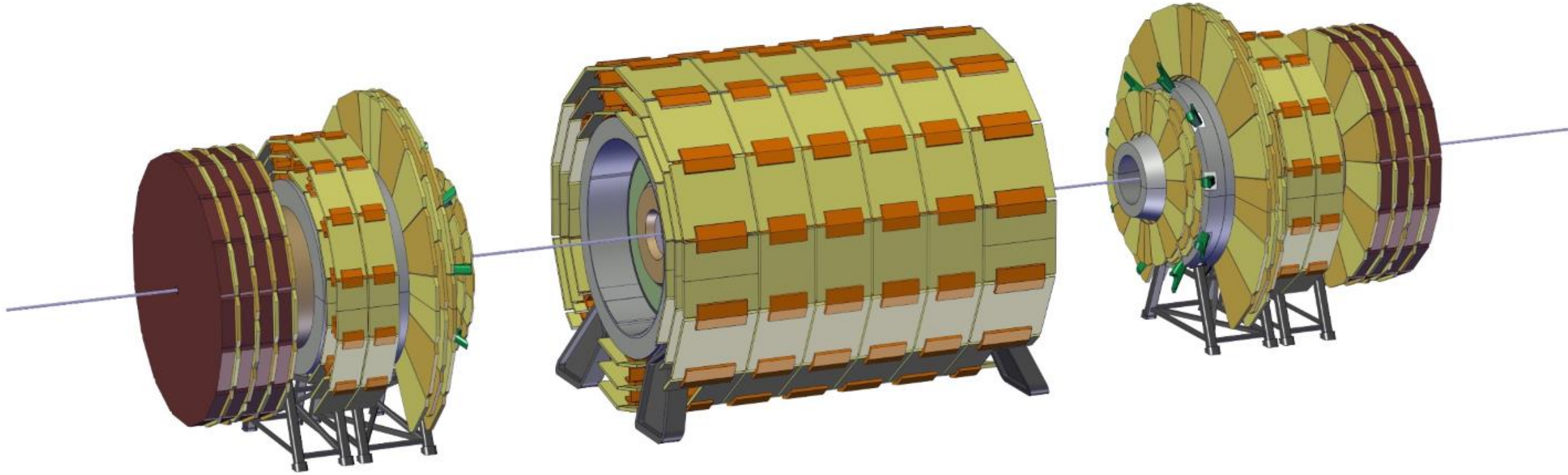
2 – Open Radiation Shield

SHORT OPENING SCENARIO



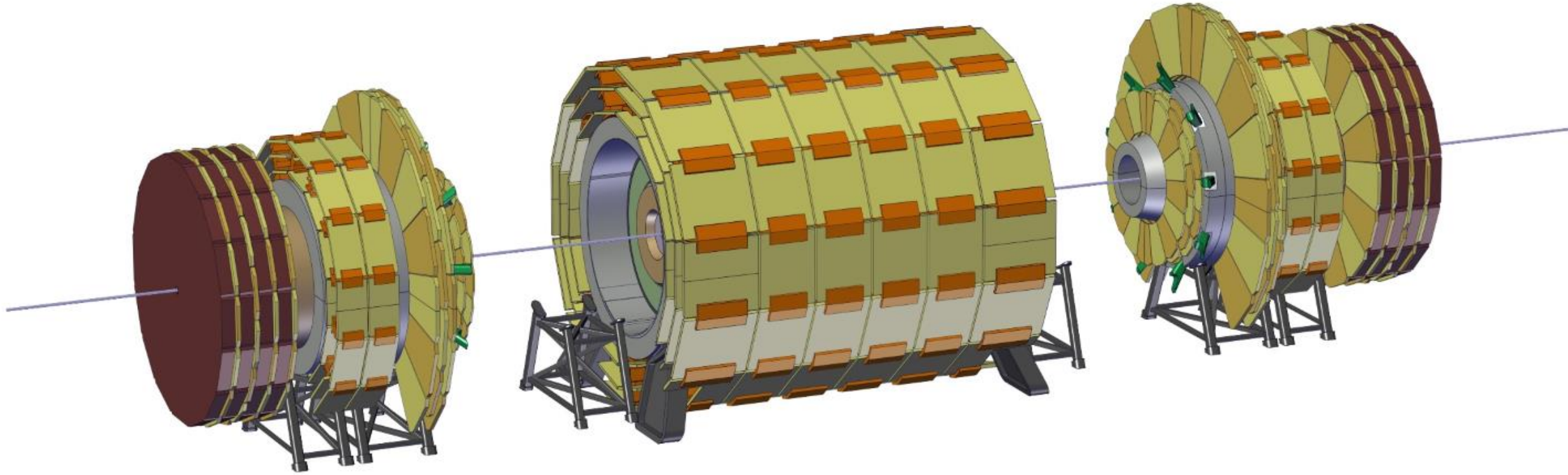
3 – Compact Muon Chambers and disconnect Spokes

SHORT OPENING SCENARIO



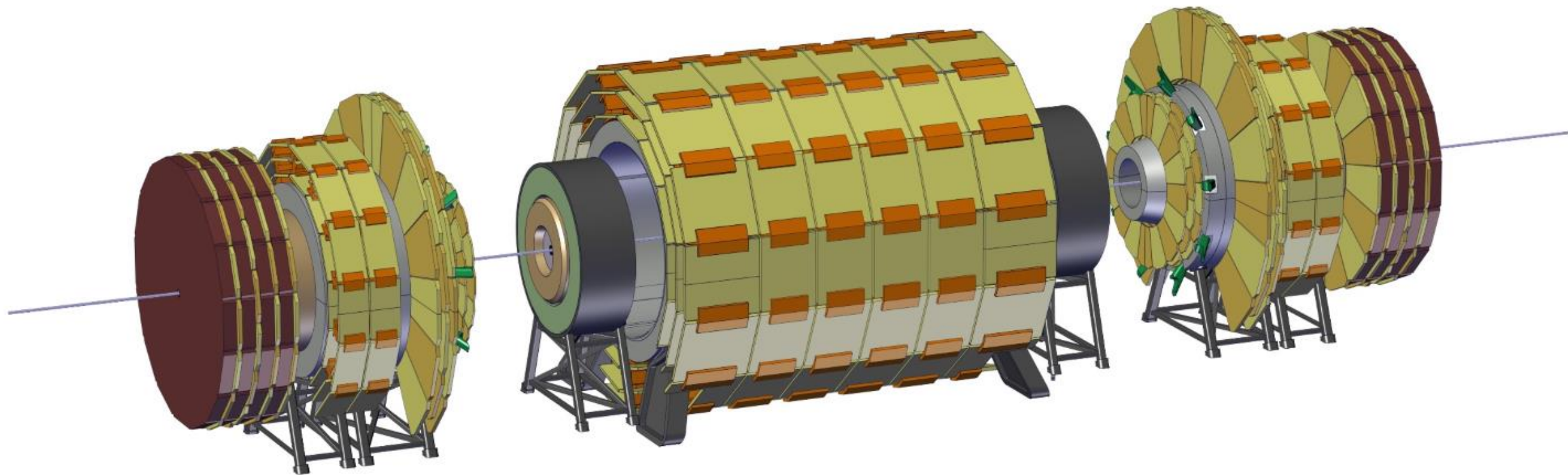
4 – Move Forward Solenoid close to Forward ECAL

SHORT OPENING SCENARIO



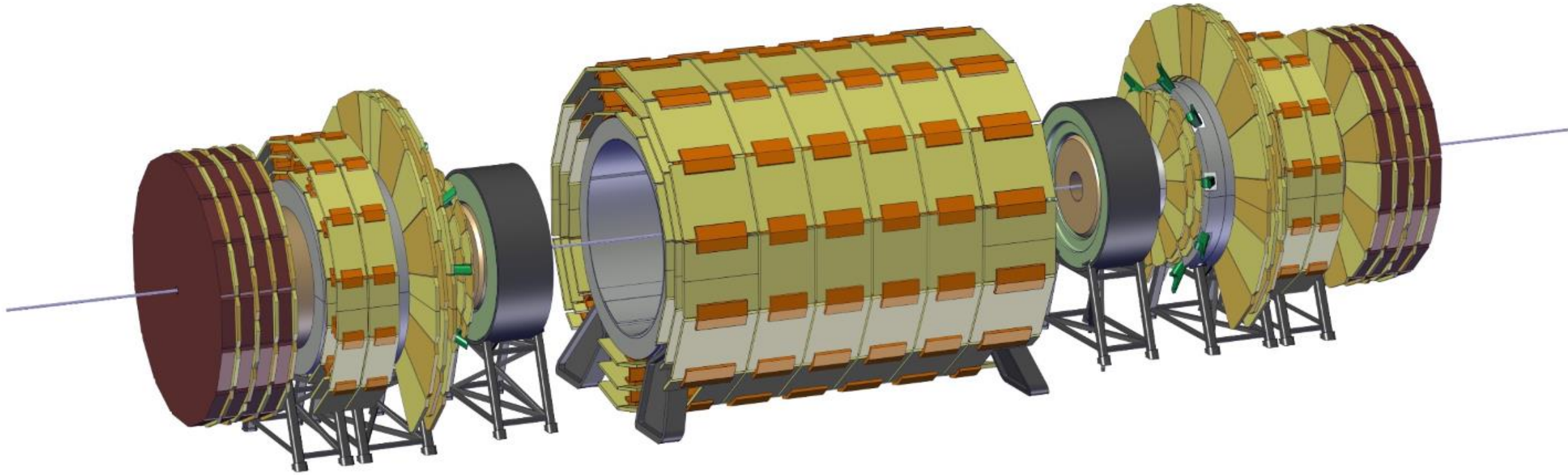
5 – Install support for HCAL

SHORT OPENING SCENARIO



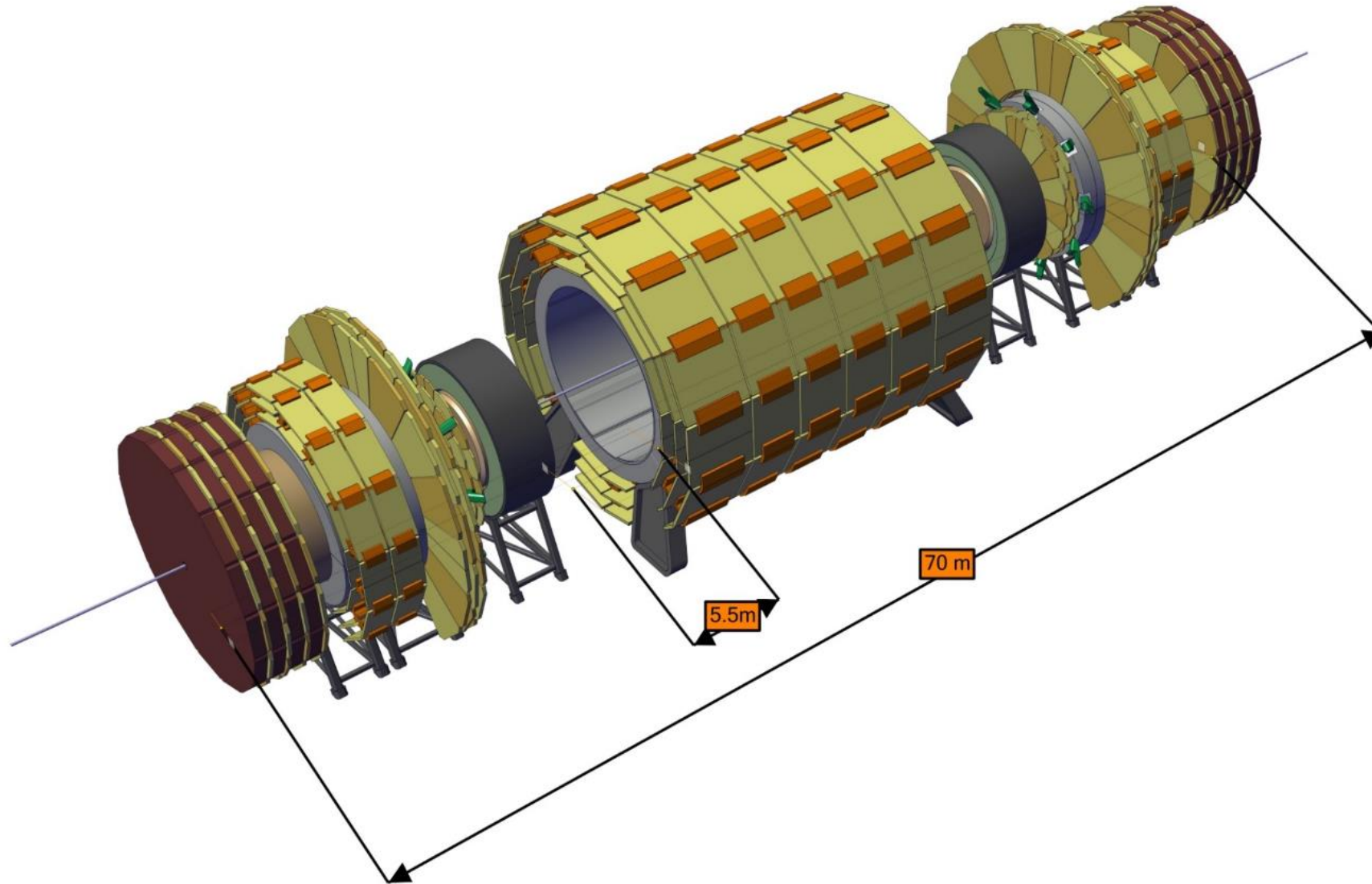
6 – Slide HCAL outwards

SHORT OPENING SCENARIO



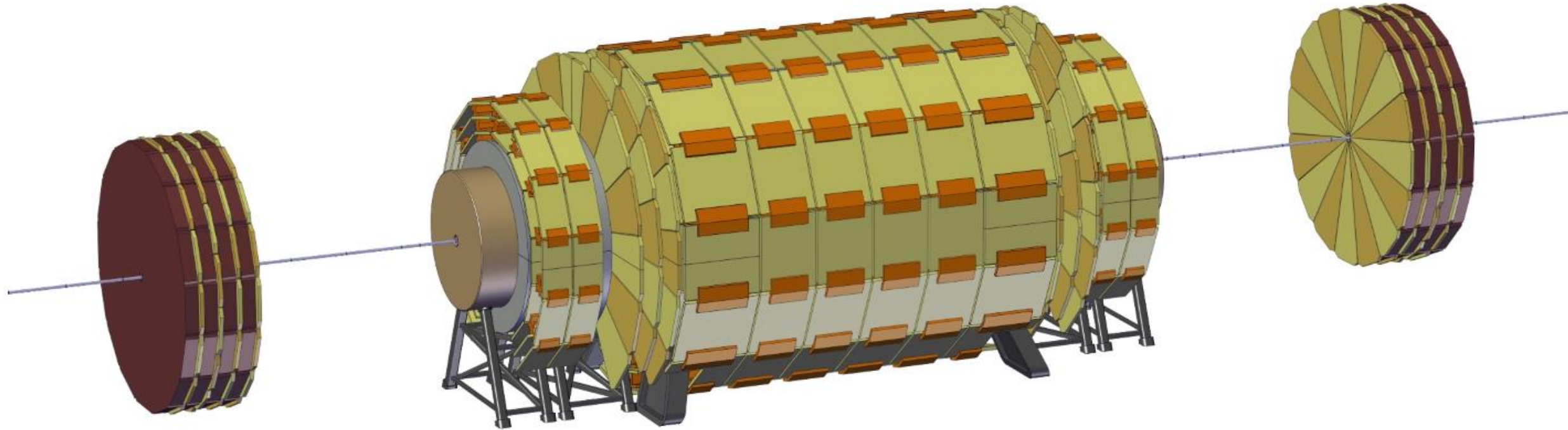
6 – Slide HCAL outwards

SHORT OPENING SCENARIO



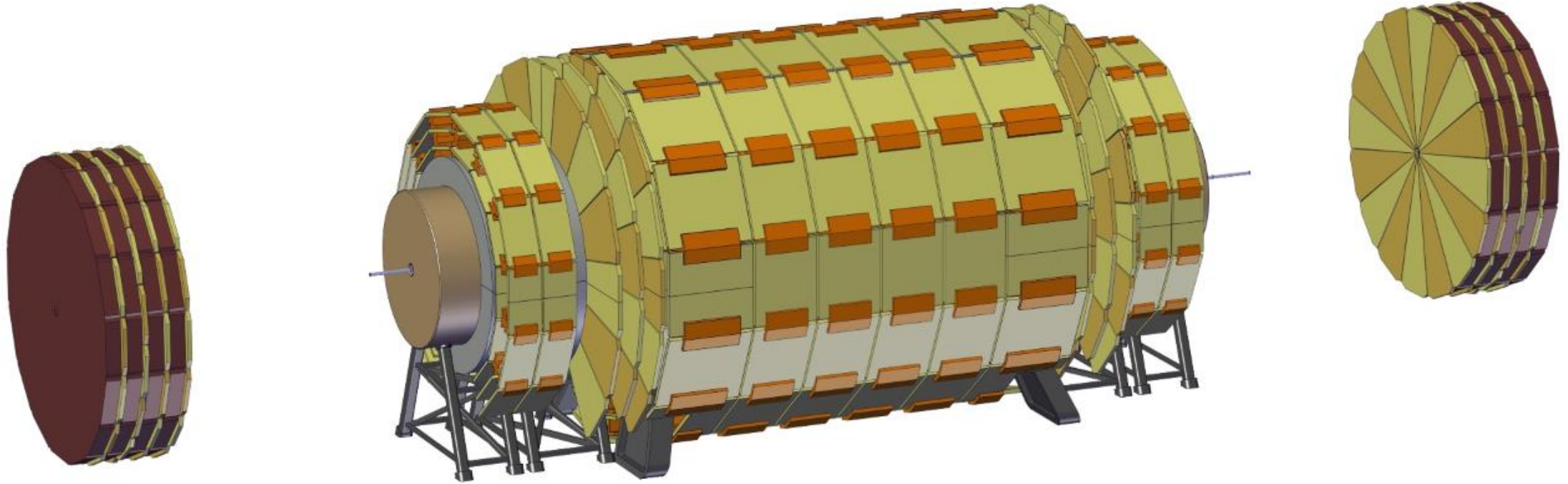
Short Opening final layout

LONG SHUTDOWN SCENARIO



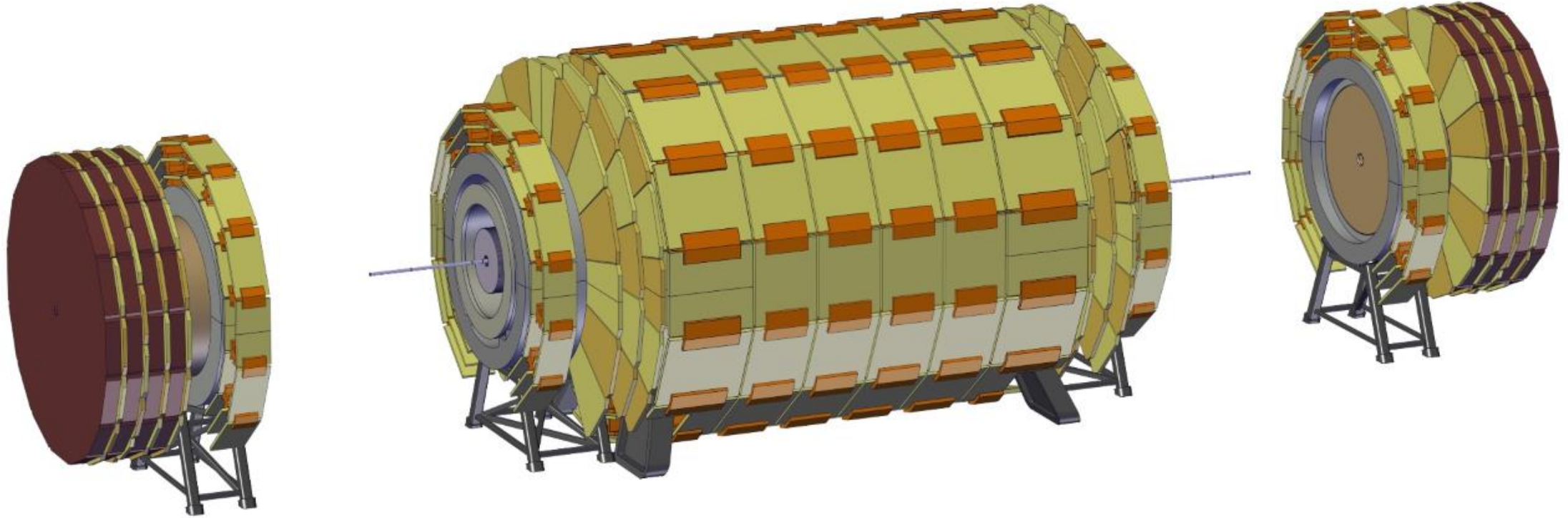
1 – Slide the Forward Muon Chambers 13.5 m away from the Forward ECAL

LONG SHUTDOWN SCENARIO



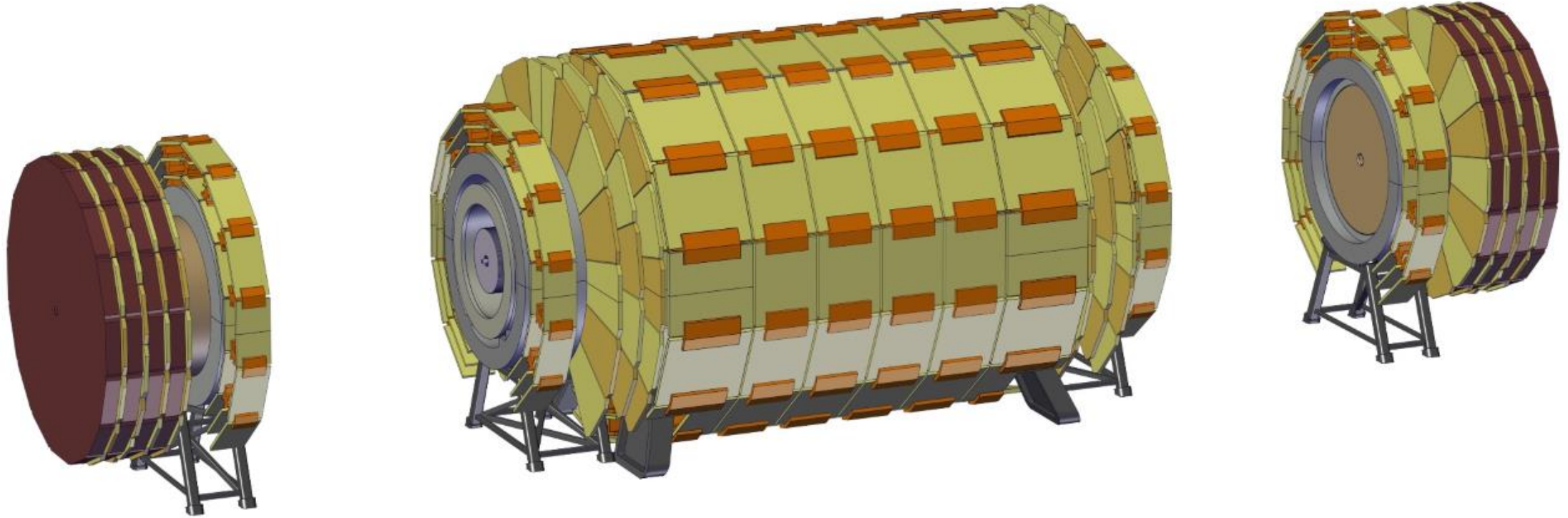
2 – Remove part of the Beam Pipe

LONG SHUTDOWN SCENARIO



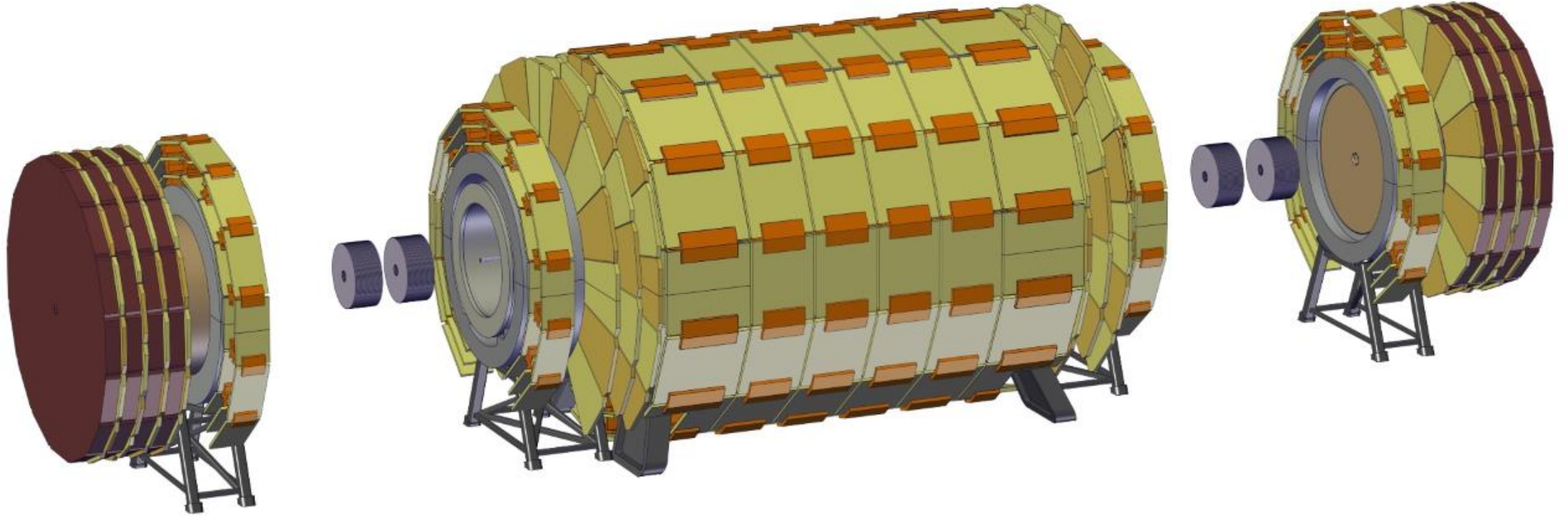
3 – Slide the Forward ECAL Structure

LONG SHUTDOWN SCENARIO



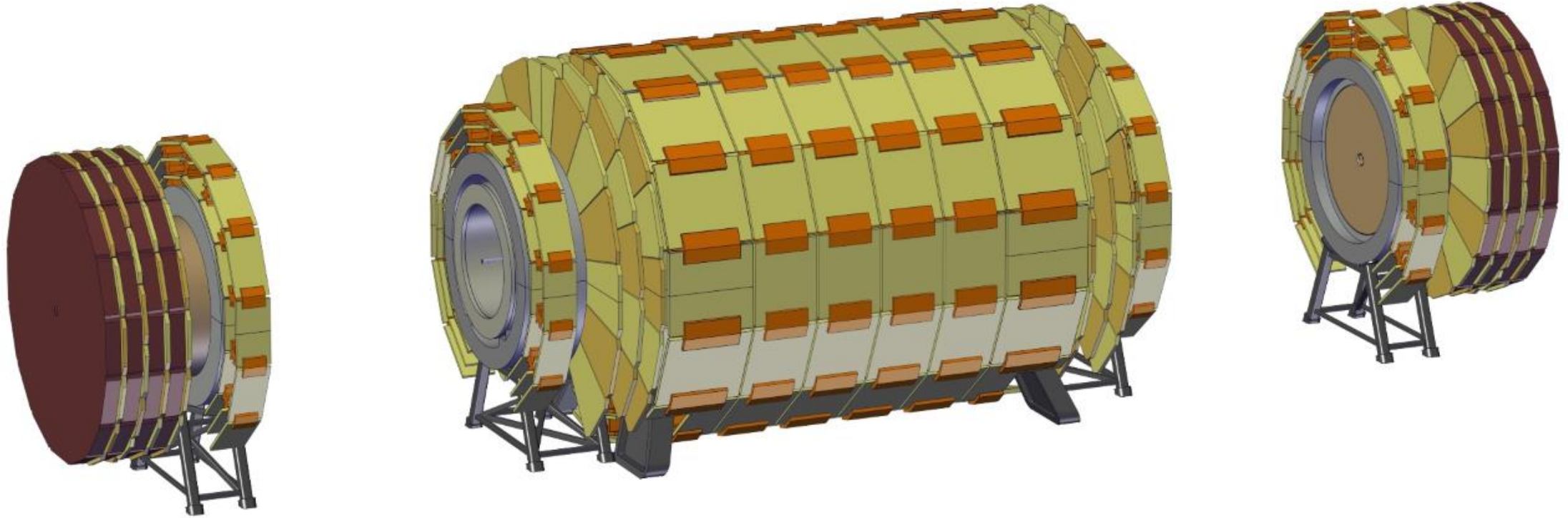
4 – Remove another portion of the beam pipe

LONG SHUTDOWN SCENARIO



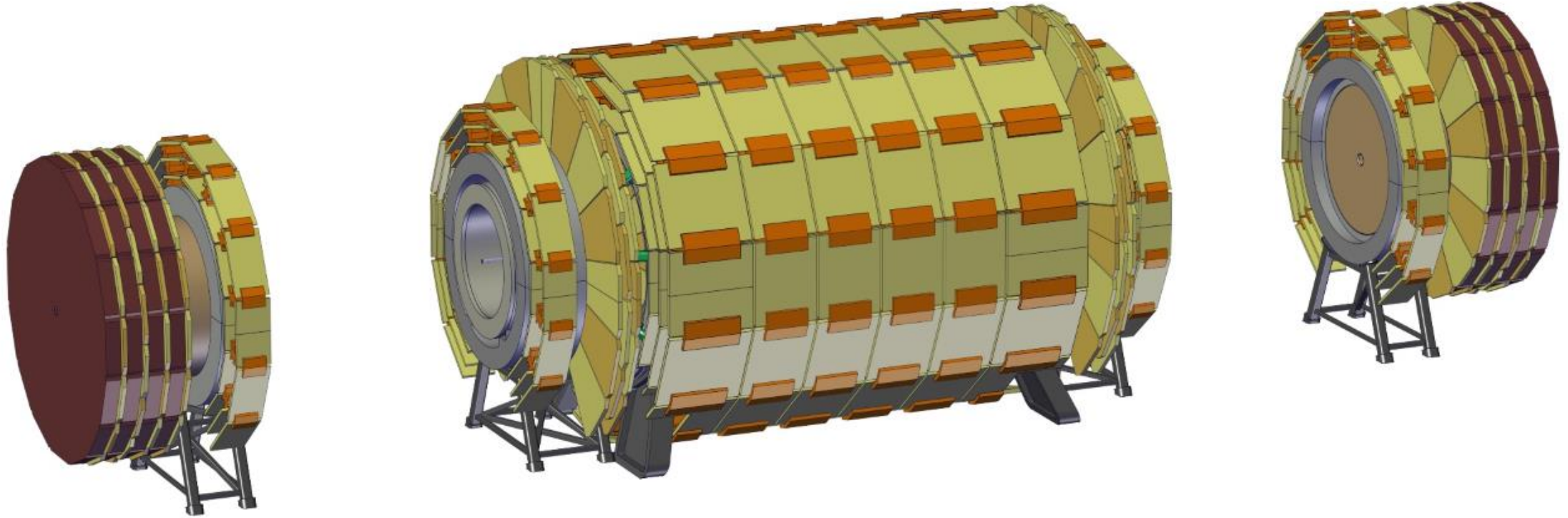
5 – Remove forward trackers if necessary

LONG SHUTDOWN SCENARIO



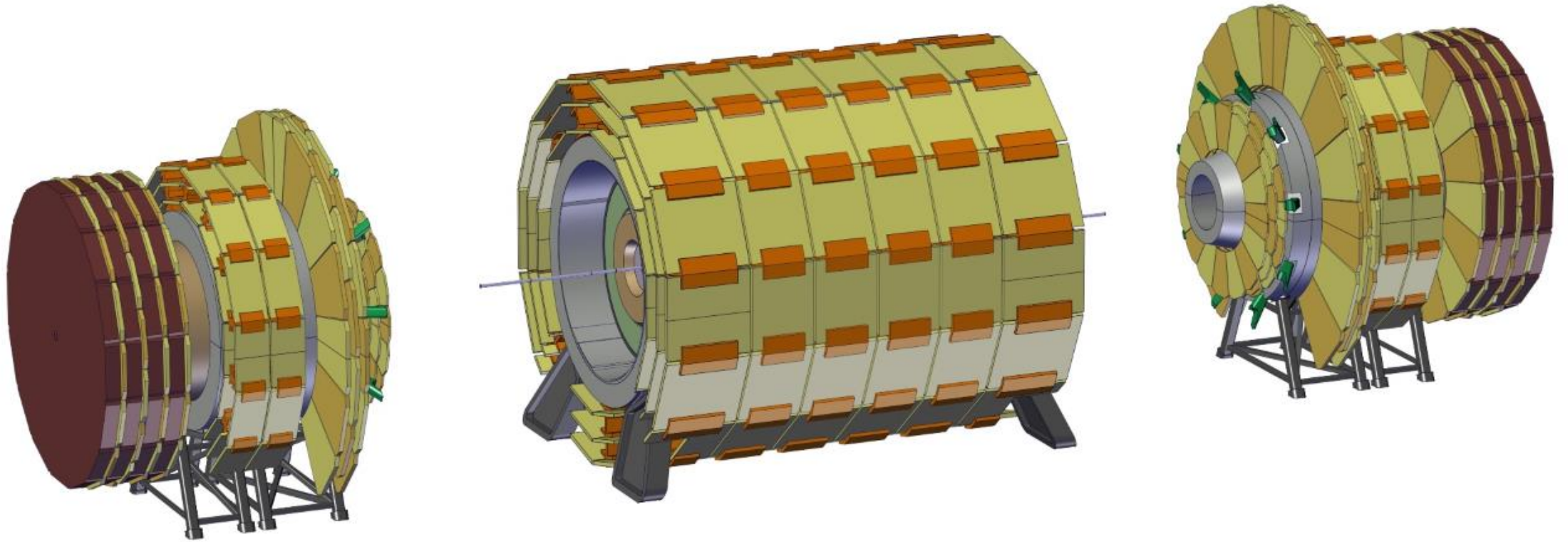
5 – Remove forward trackers if necessary

LONG SHUTDOWN SCENARIO



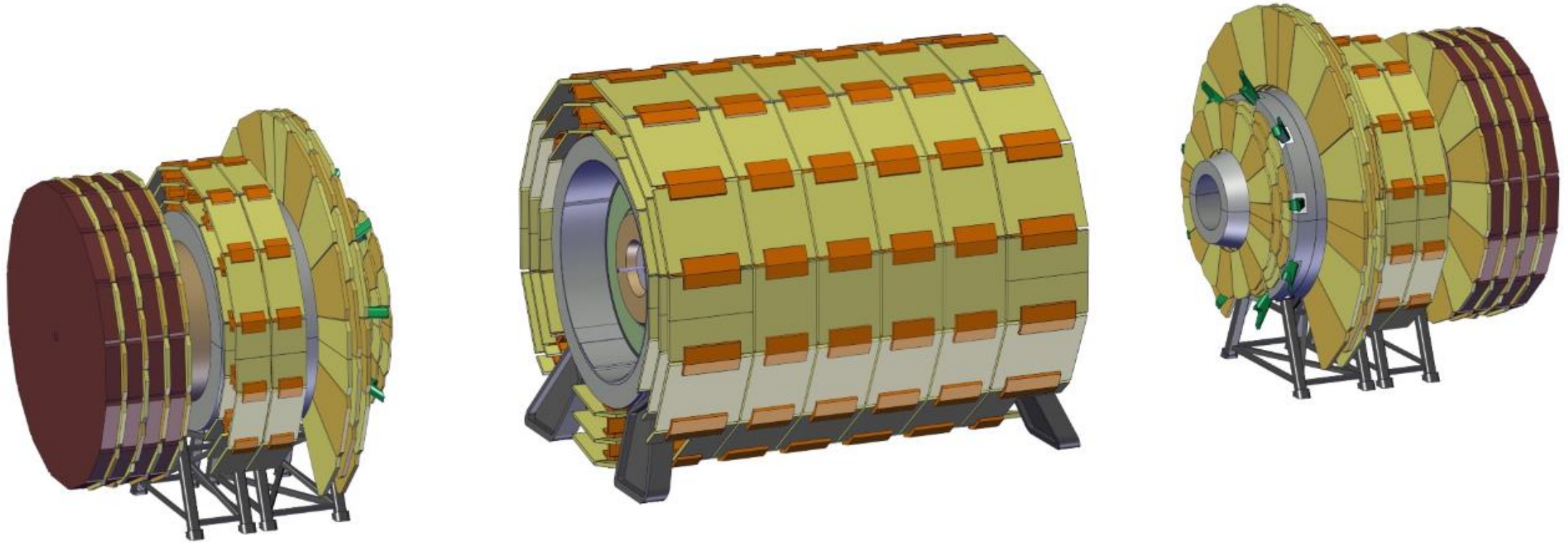
6 – Compact Muon Chambers and disconnect the spokes

LONG SHUTDOWN SCENARIO



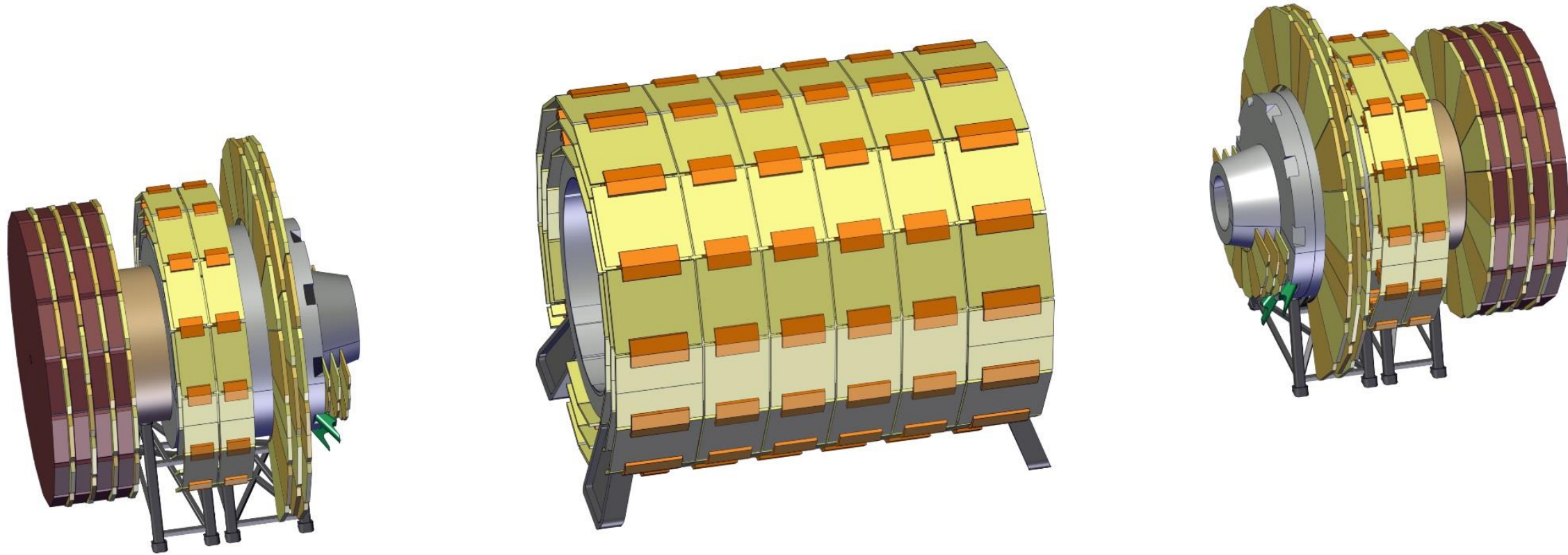
7 – Move Forward Solenoid towards the forward ECAL

LONG SHUTDOWN SCENARIO



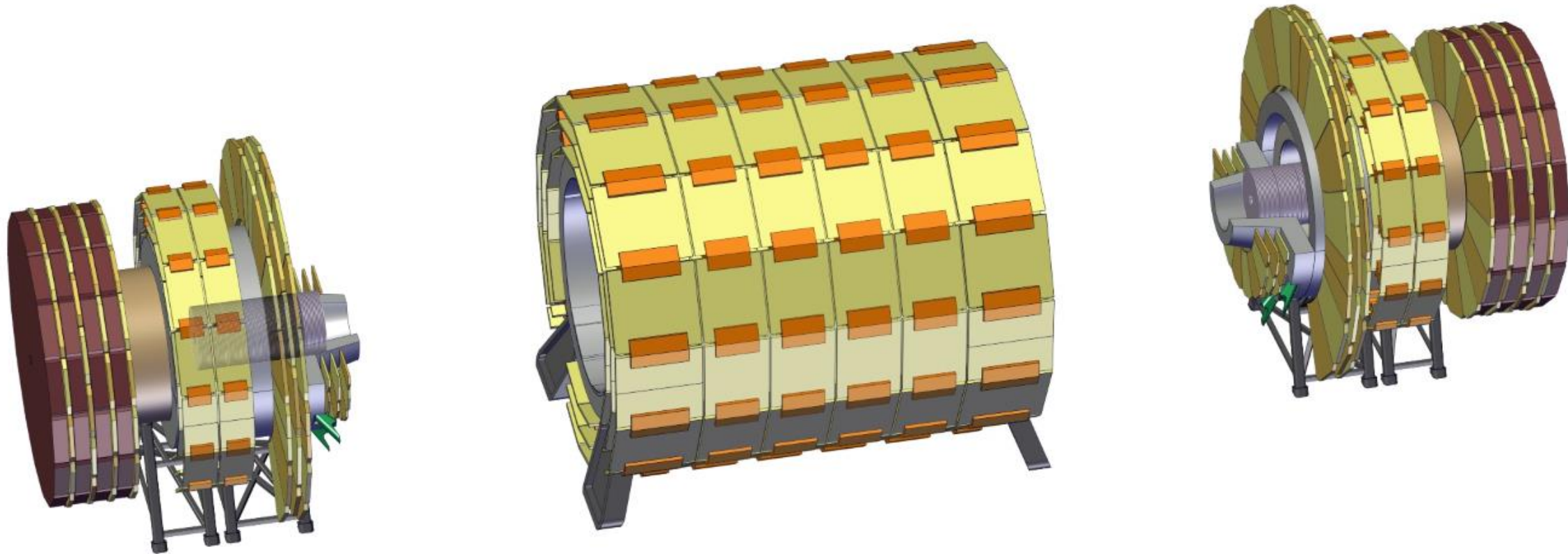
8 – Remove another portion of the beam pipe

LONG SHUTDOWN SCENARIO



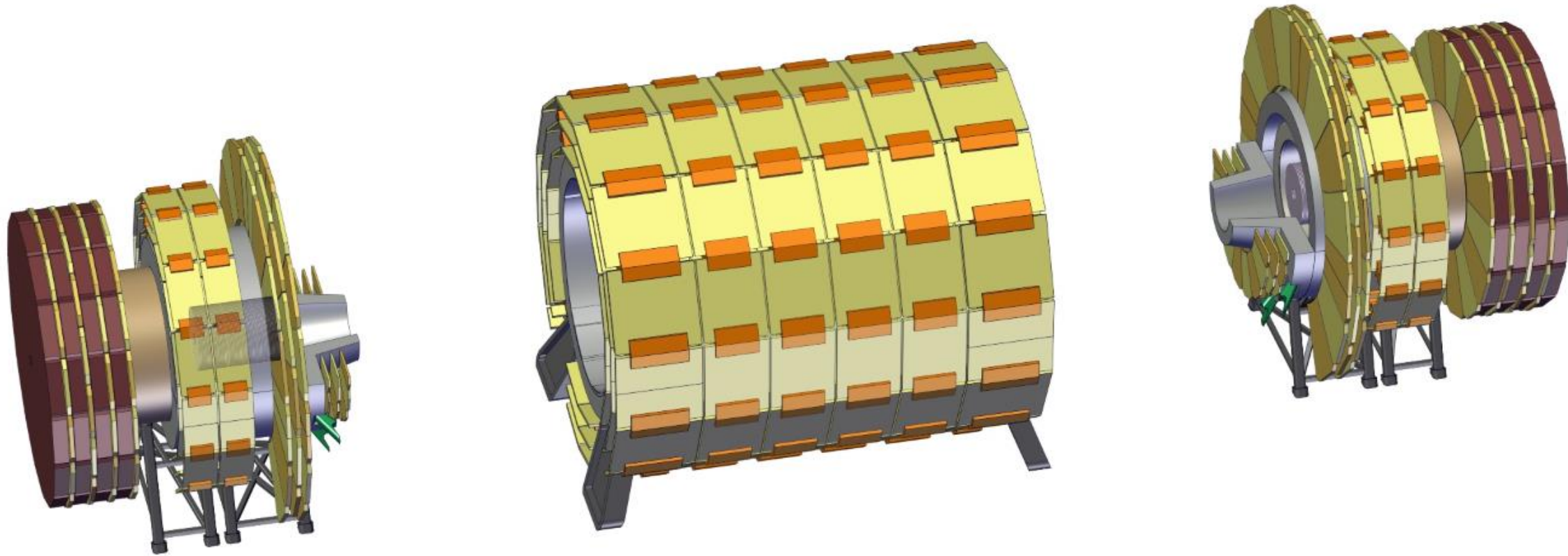
9 – Remove top Muon chambers on the radiation shield nose

LONG SHUTDOWN SCENARIO



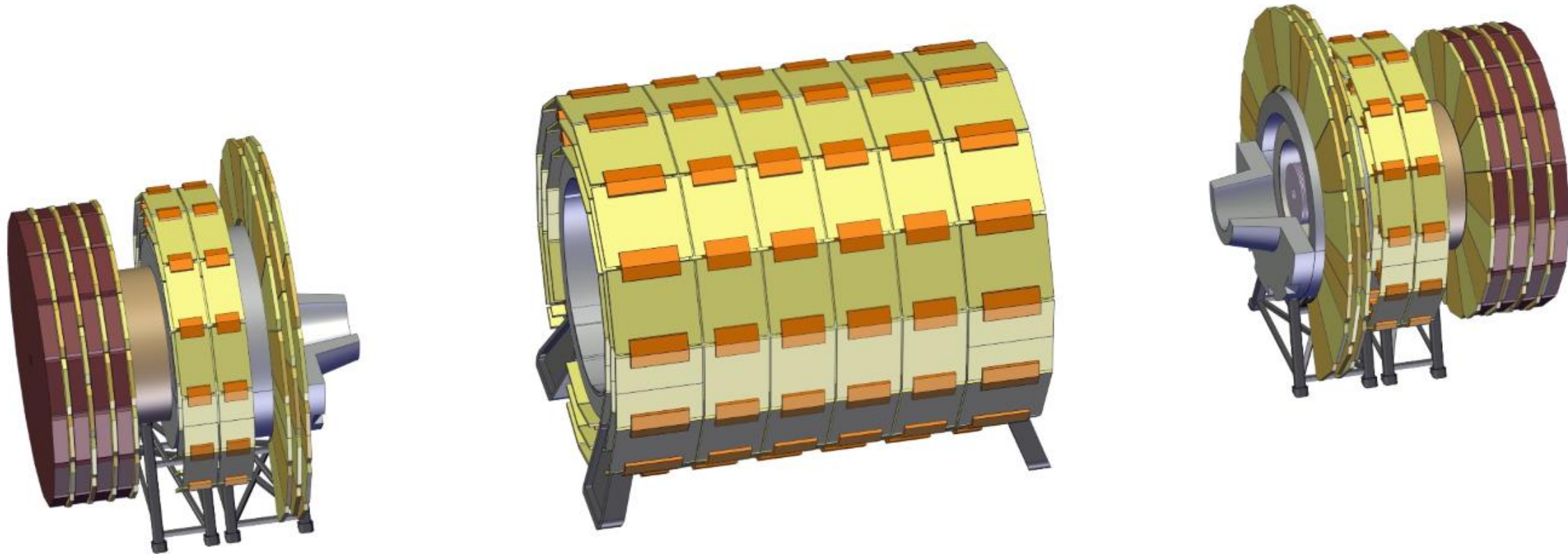
10 – Remove top part of radiation shield nose

LONG SHUTDOWN SCENARIO



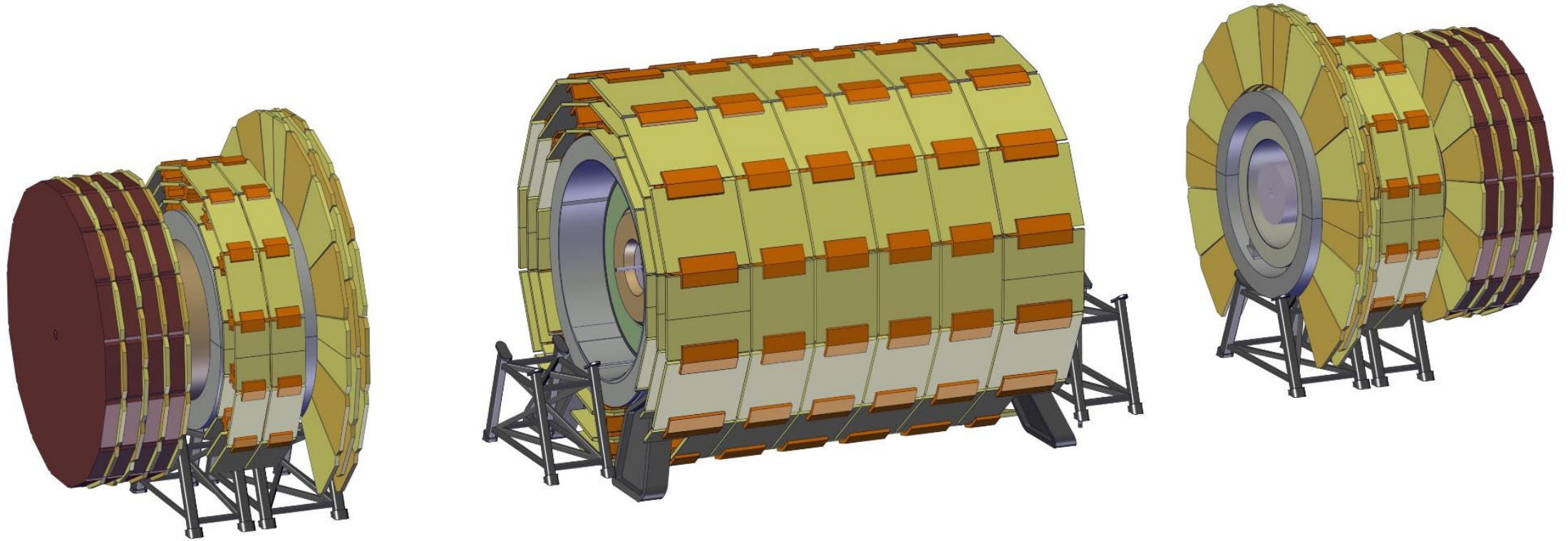
11– Remove two tracker modules in the forward direction

LONG SHUTDOWN SCENARIO



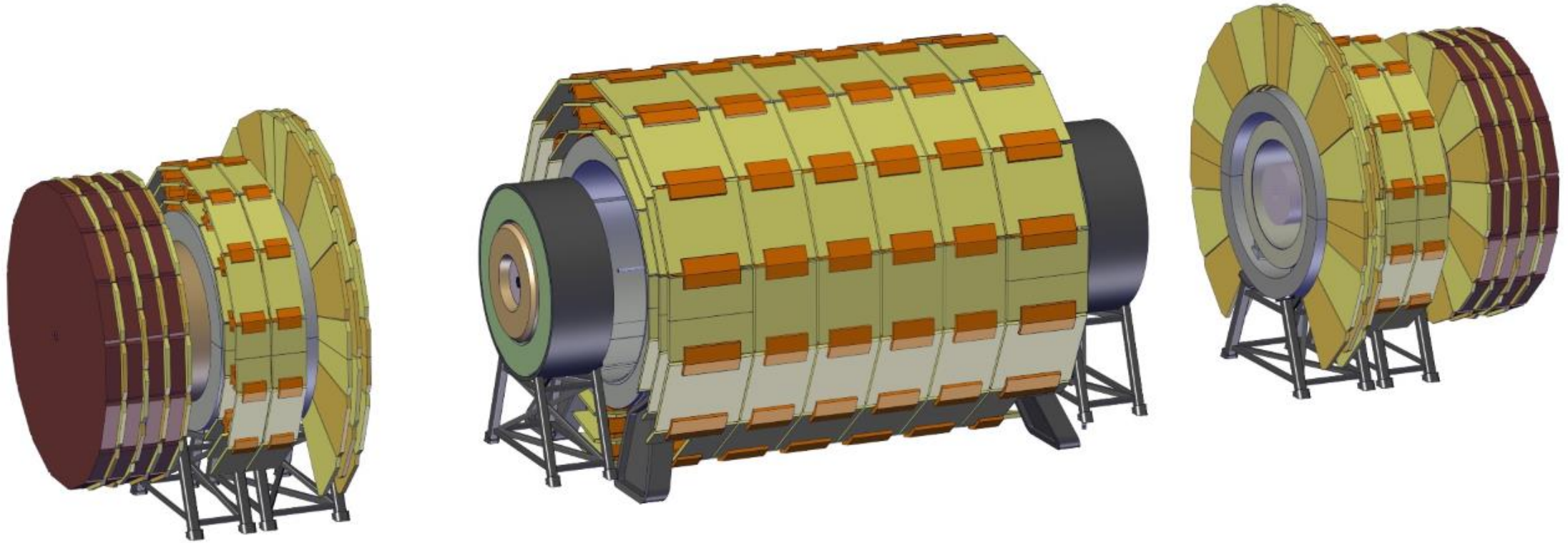
12 – Remove bottom Muon Chambers on the radiation shield nose

LONG SHUTDOWN SCENARIO



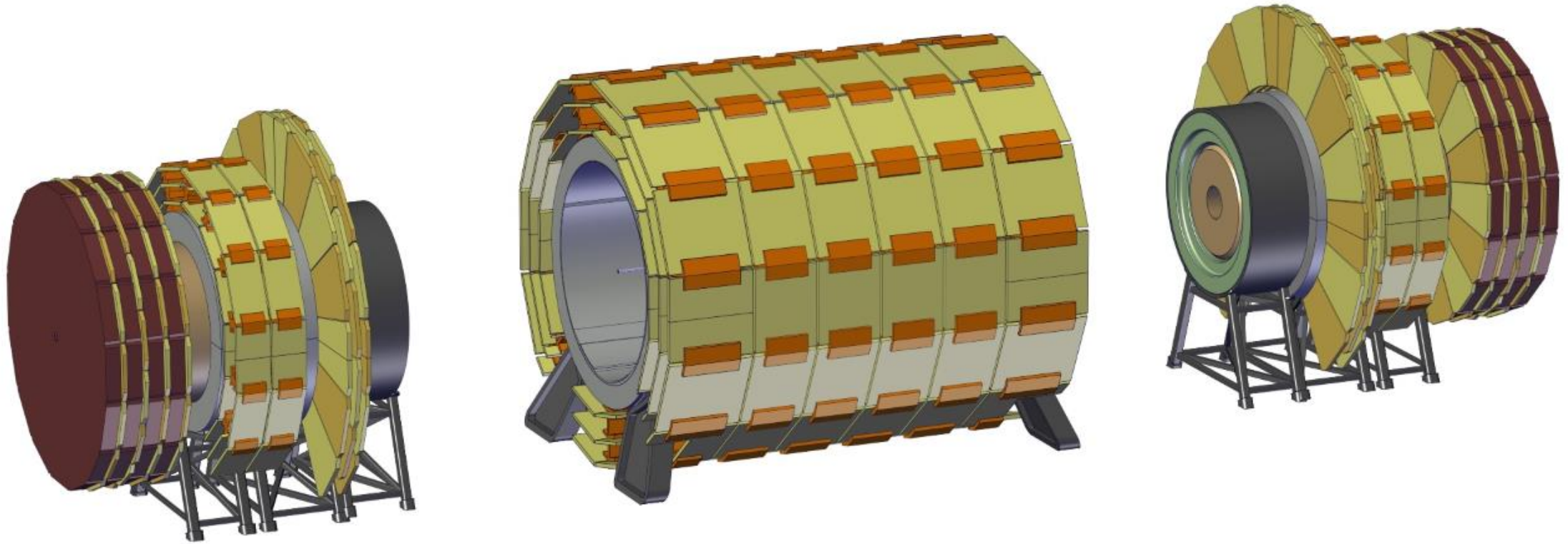
13 – Install temporary support for HCAL and ECAL Modules

LONG SHUTDOWN SCENARIO



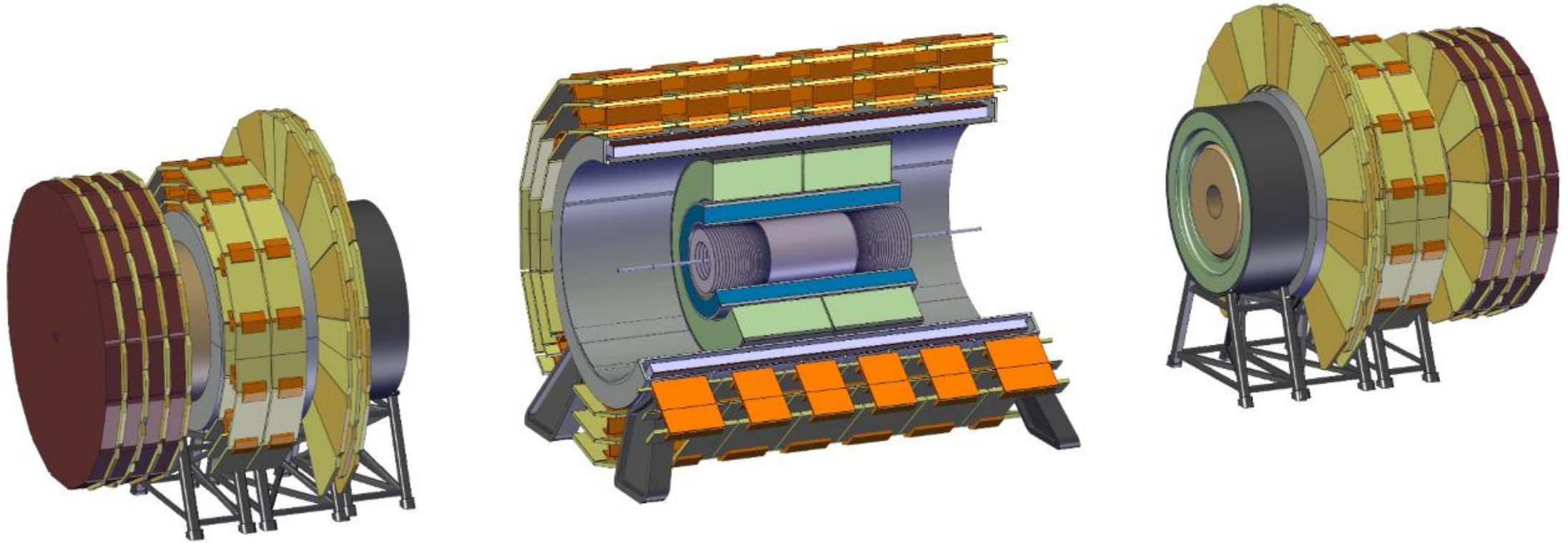
14 – Remove HCAL and ECAL module

LONG SHUTDOWN SCENARIO



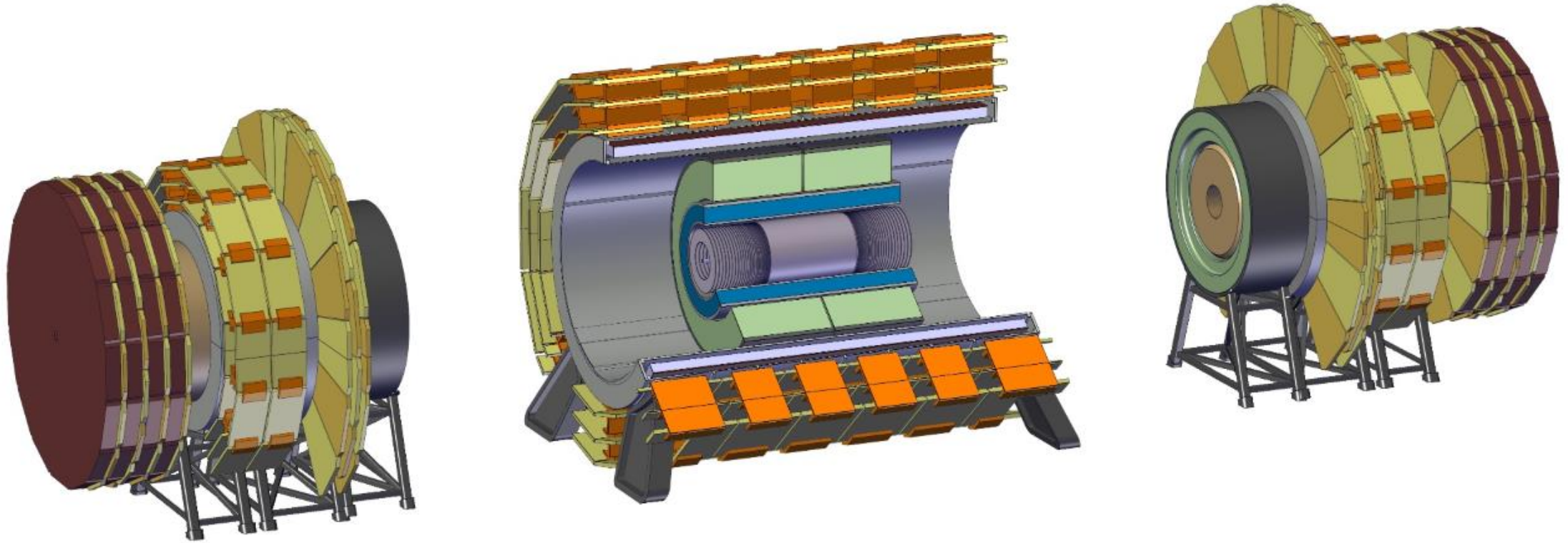
15 – Move HCAL and ECAL module next to the forward solenoid

LONG SHUTDOWN SCENARIO



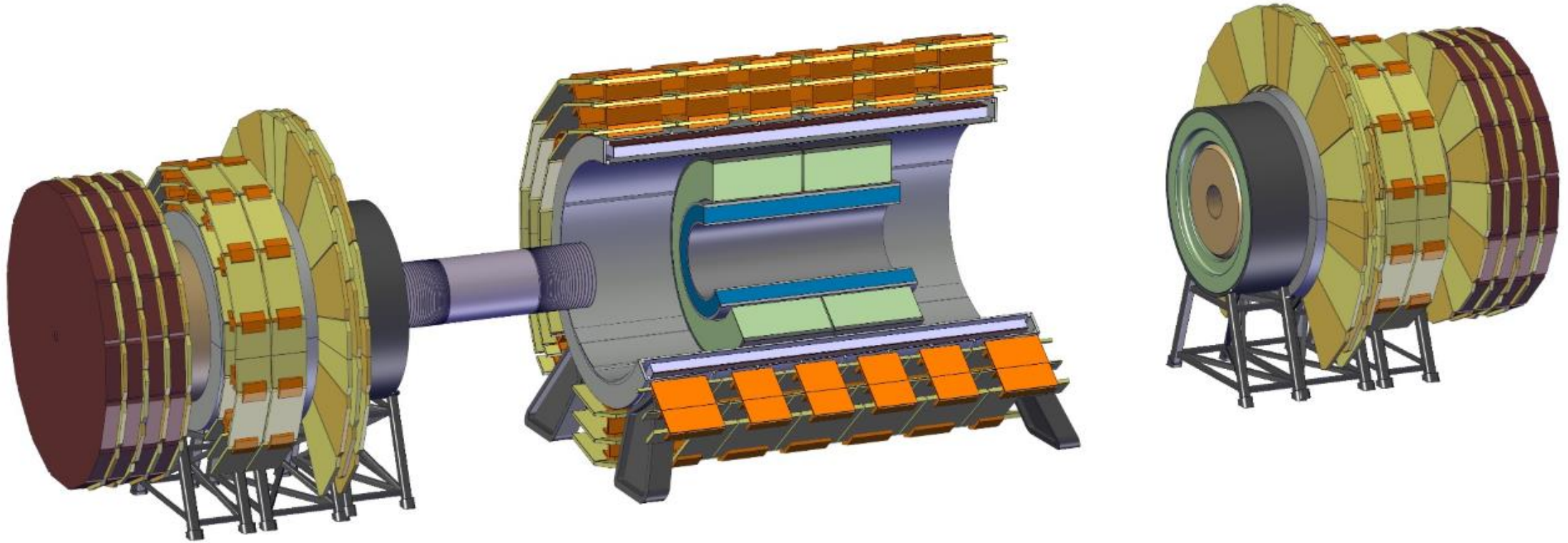
15 – Move HCAL and ECAL module next to the Forward Solenoid

LONG SHUTDOWN SCENARIO



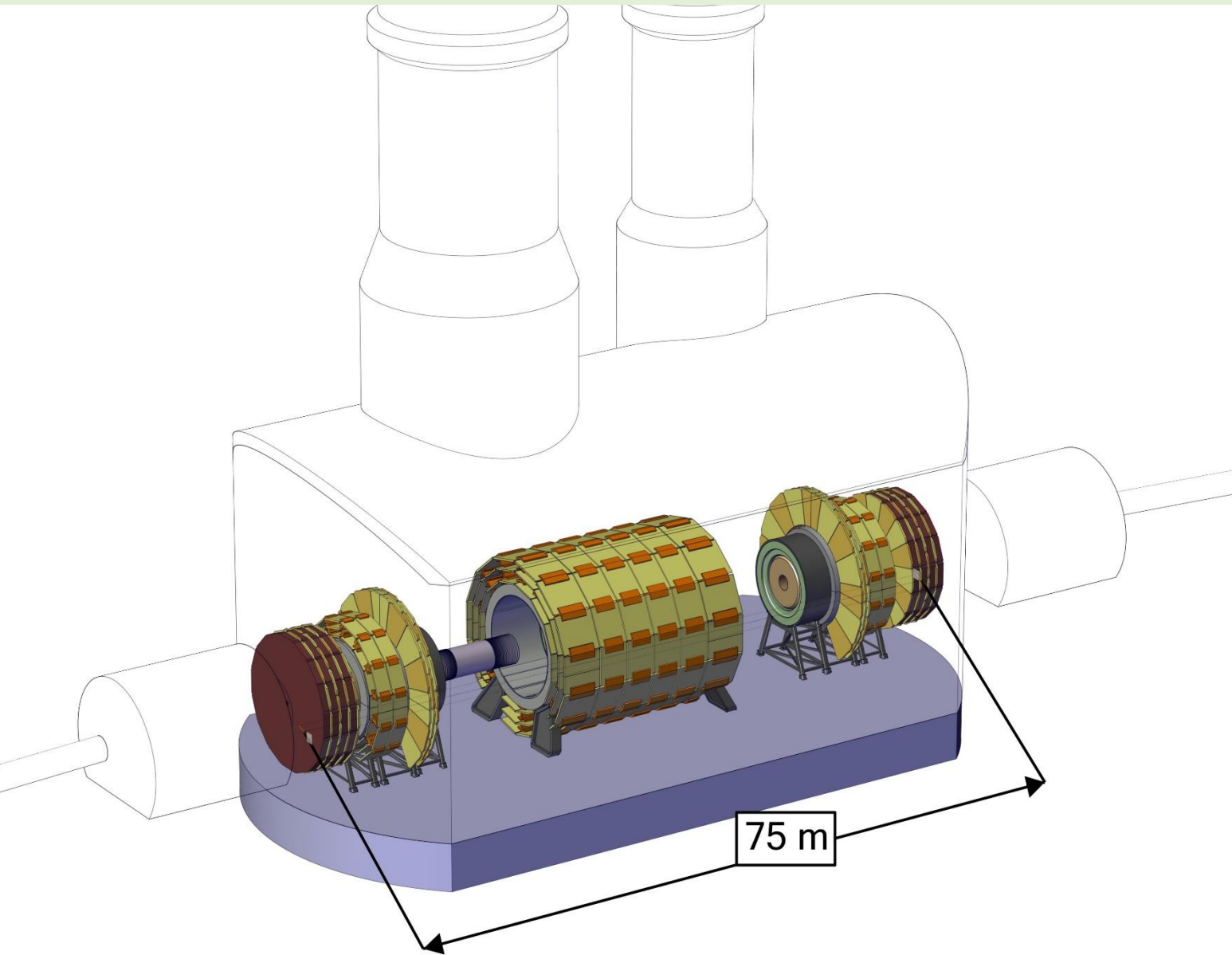
16 – Remove another portion of the beam pipe

LONG SHUTDOWN SCENARIO



17 – Extract inner trackers

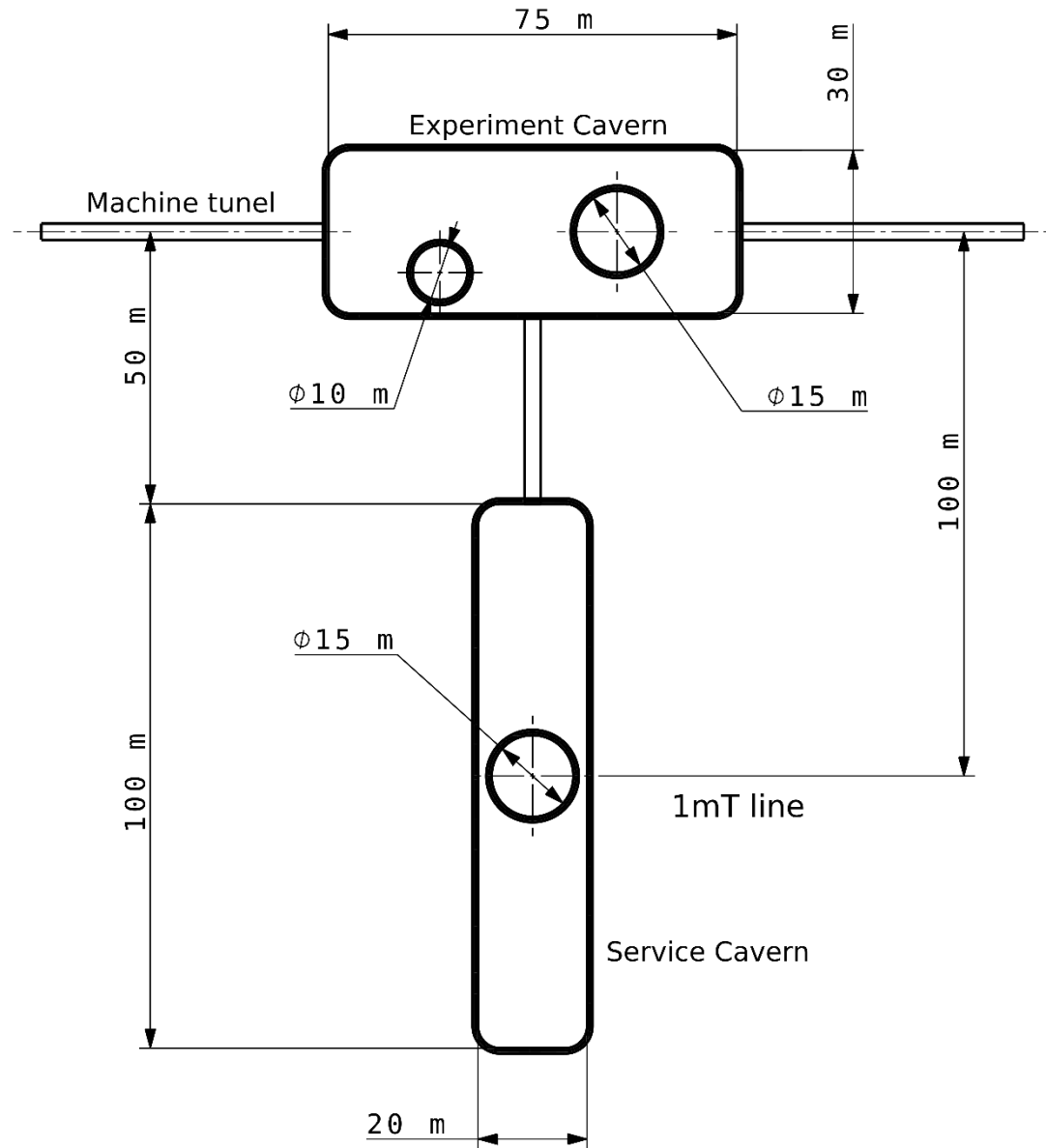
CAVERN DIMENSIONS



Maximum length experiment	*75m
Cavern Size (L x W x H) [m ³]	75 x 30 x 35
Main Shaft diameter [m]	15
Secondary shaft diameter [m]	10
Main shaft crane requirement [kt]	2 or 3 (depends on HCAL modularity)
Secondary shaft crane requirement [kt]	0.6

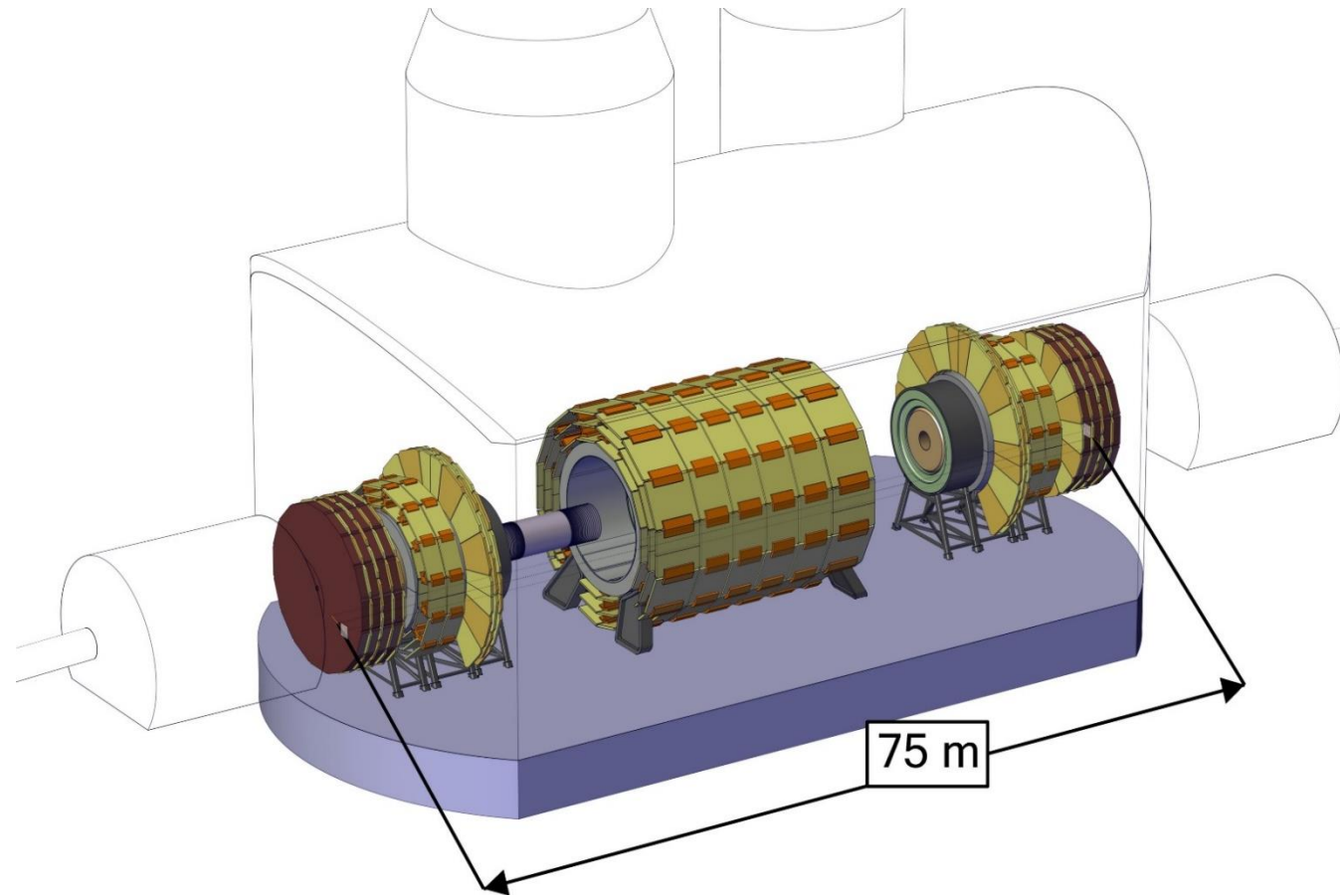
* Depending on the compromises made, the open experiment length may vary from 70 m to 80m.

CAVERN DIMENSIONS



- Experiment cavern has two shafts
- Secondary shaft is off-center
- Service cavern is perpendicular to the experiment
- Service cavern dimensions are $15 \times 20 \times 100 \text{ m}^3$ (HxWxL)
- 1mT line is at half length of the service cavern
- Most sensitive electronics can be placed further from the magnet system

CONCLUSION



1st Installation Scenario of the Baseline Detector Completed