Central Detector Installation and Support

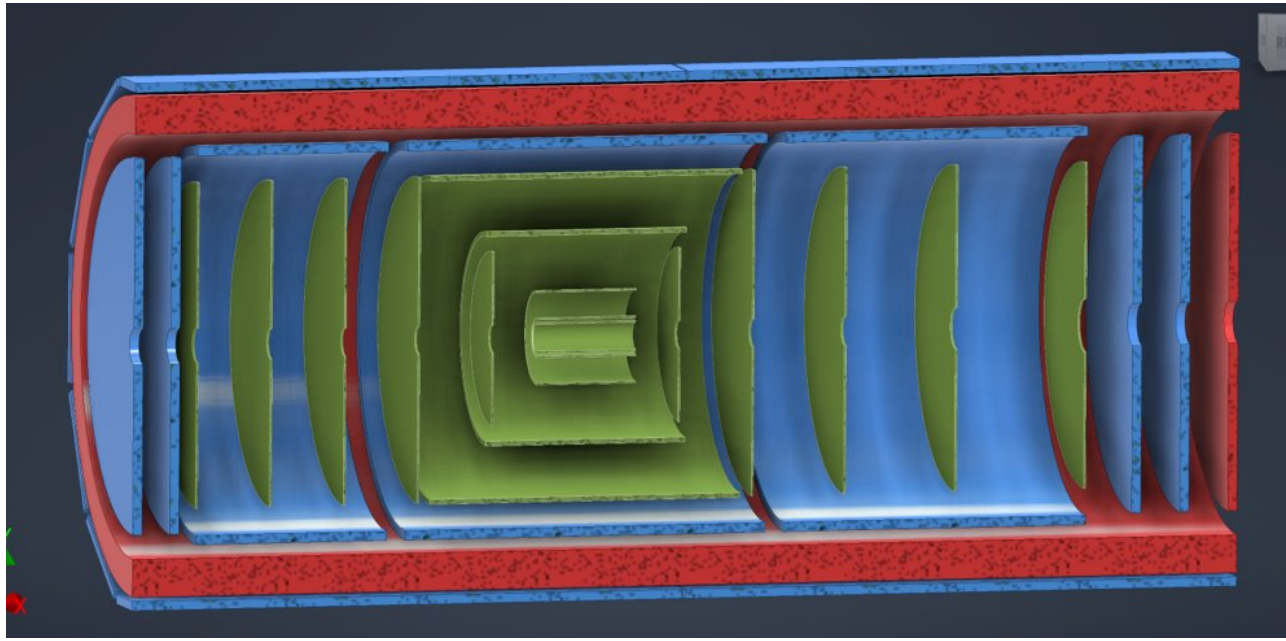
21st January 2025

Andreas Jung, Sushrut Karmarkar, Ben Denos, and UG student team

Global Support Tube / GST

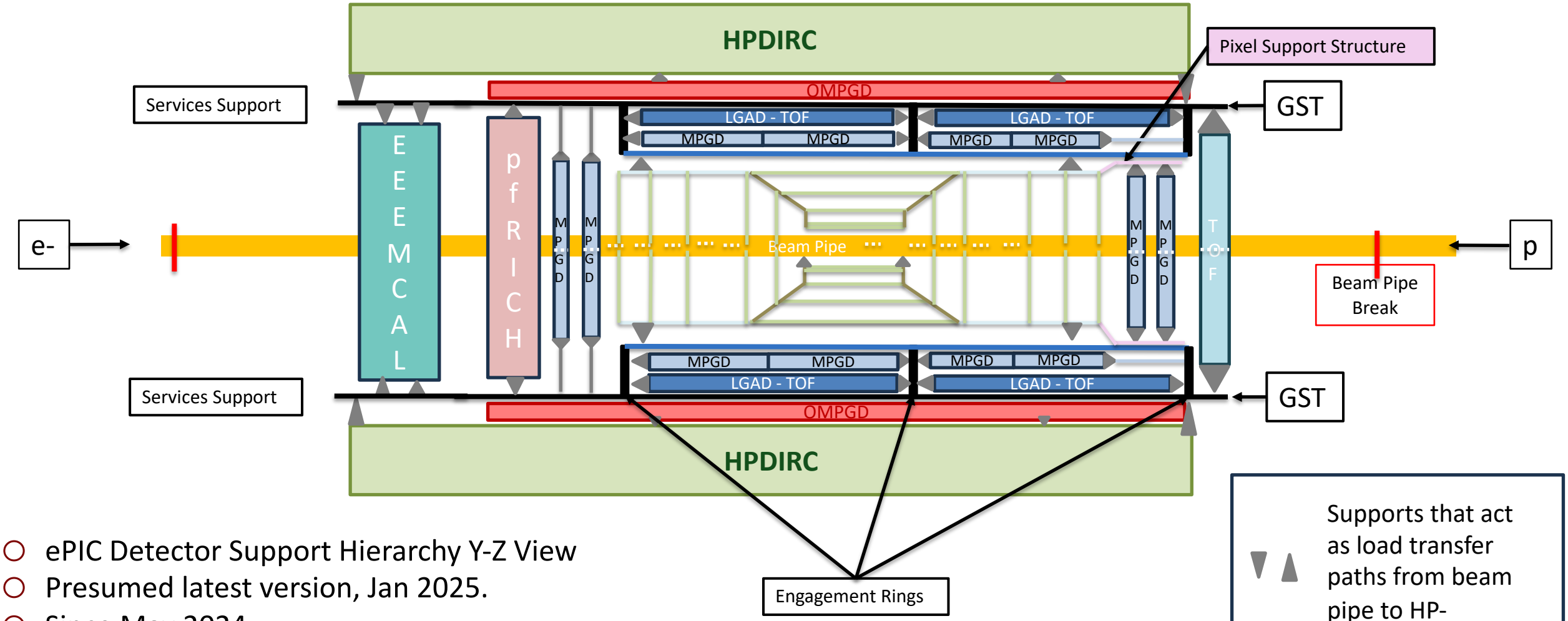
- Design of supports for inner detectors depends on support hierarchy and detector “integration” and assembly
  - Defined at the EPIC Mechanics workshop in May 2024
- Naturally, supports and interfaces are as light-weight as possible but services and “cooling” needs space and need to be considered
- Nomenclature: large global inner detector CF support tube or GST
- Lets first look at an integration sequence of **“inner detectors”**

“Inner detectors” = inside of the large global CF support tube



Global Support Tube / GST

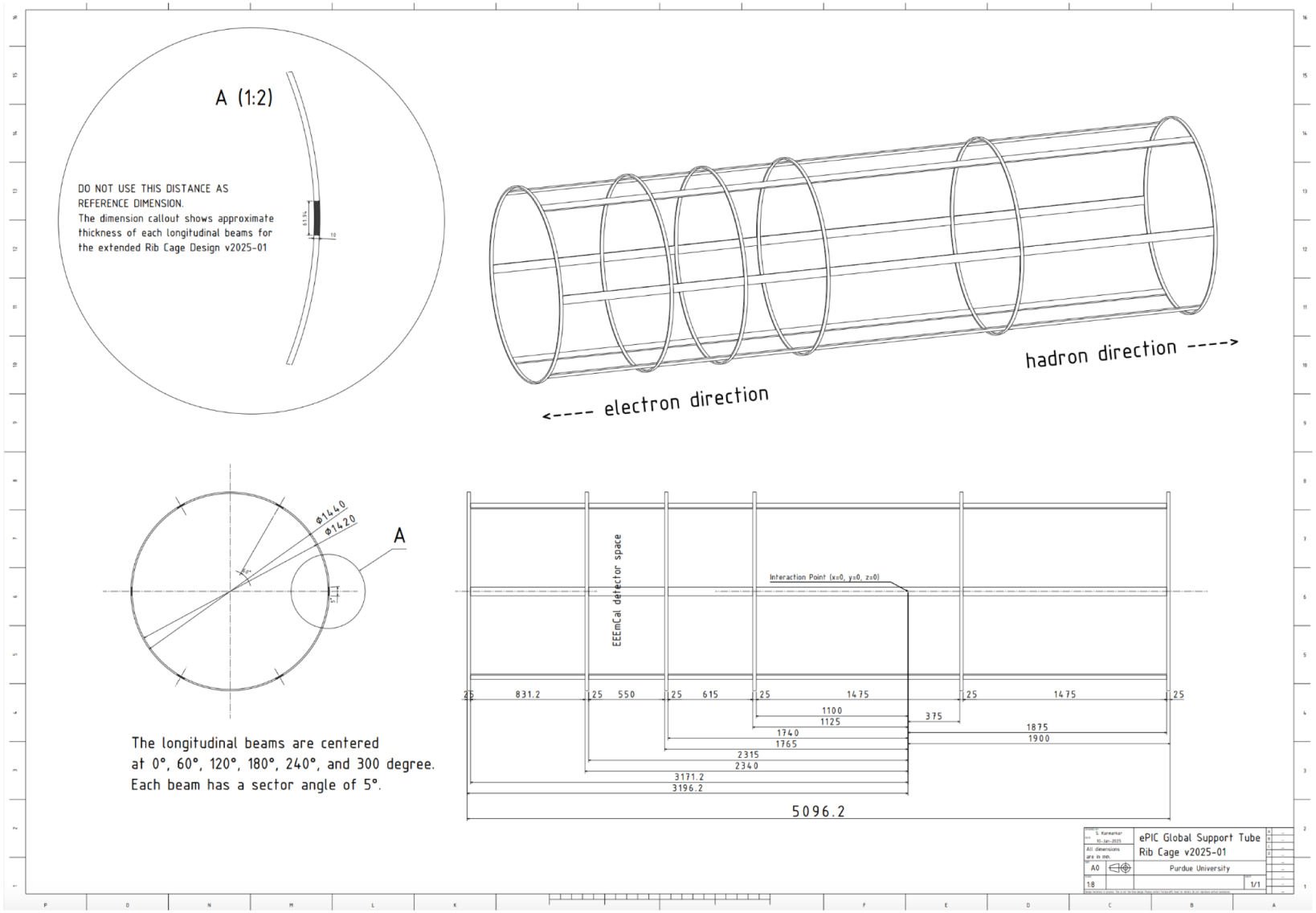
Working Draft – NOT TO SCALE



- ePIC Detector Support Hierarchy Y-Z View
- Presumed latest version, Jan 2025.
- Since May 2024:
  - GST extended beyond EEEMCal, support discussed

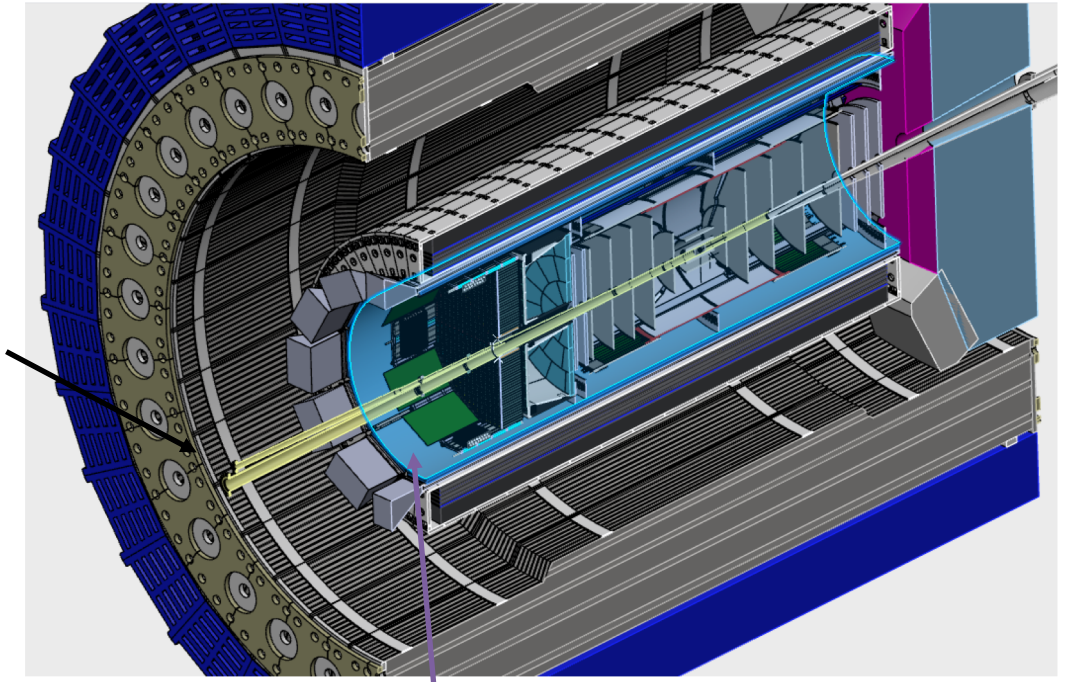
Global Support Tube / GST

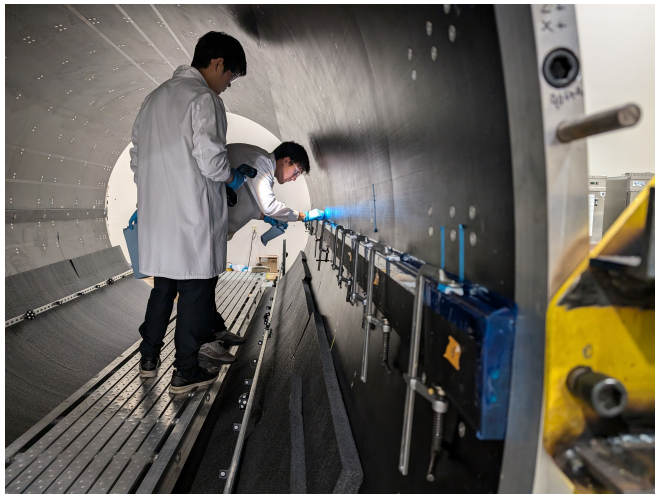
- GST is a composite sandwich structure with 1mm face sheet over a honeycomb core
- It has internal structure to be able to support the weight
- CMS example: only end rings
- ATLAS example: more structure but outside = needs more space
- For EPIC: minimize space needs while maximizing ability to support mass

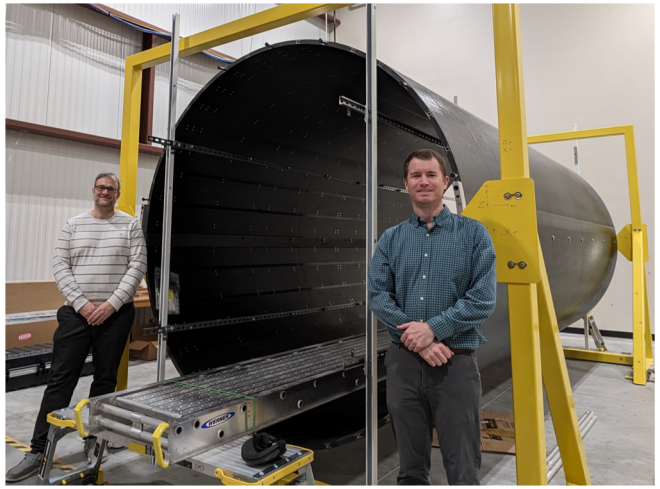


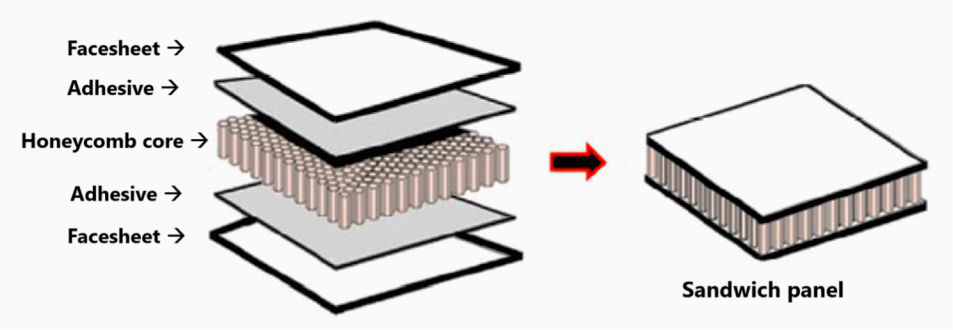
Global Support Tube / GST

- GST extended beyond EEEMCal
- Specific support of EEEMCal being under discussion
- Experience from our CMS activities
  - Quick remark on grounding: yes, it is needed
  - Can be realized with a co-cured copper mesh with taps for detector grounds to connect



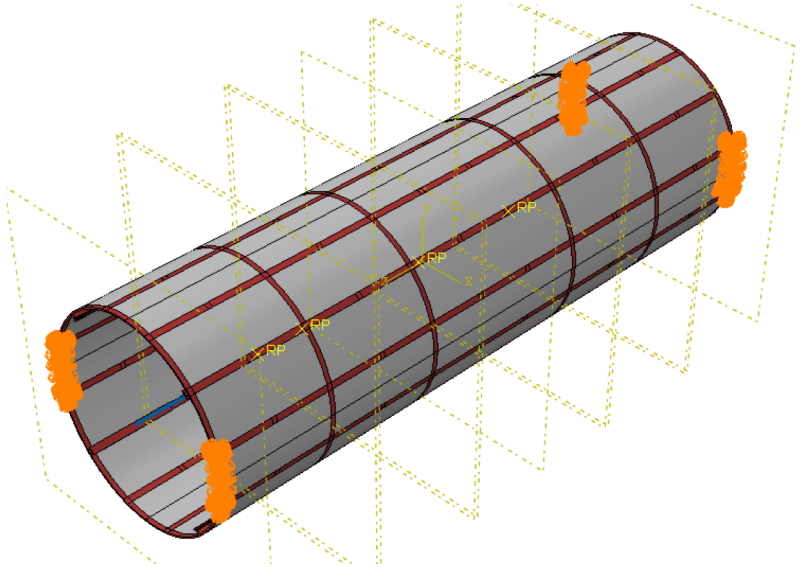






Global Support Tube / GST

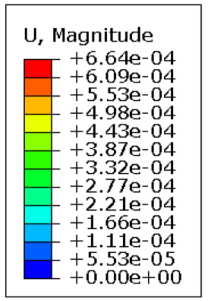
- Looking at the first run results –
  - We can reduce the honeycomb face sheet all the way down to 1 mm (this run is currently on-going)
  - Need more granular run
  - Need subdetector masses updated & more precise service accounting
  - 1st Design works, puts mass where other support mass already exists

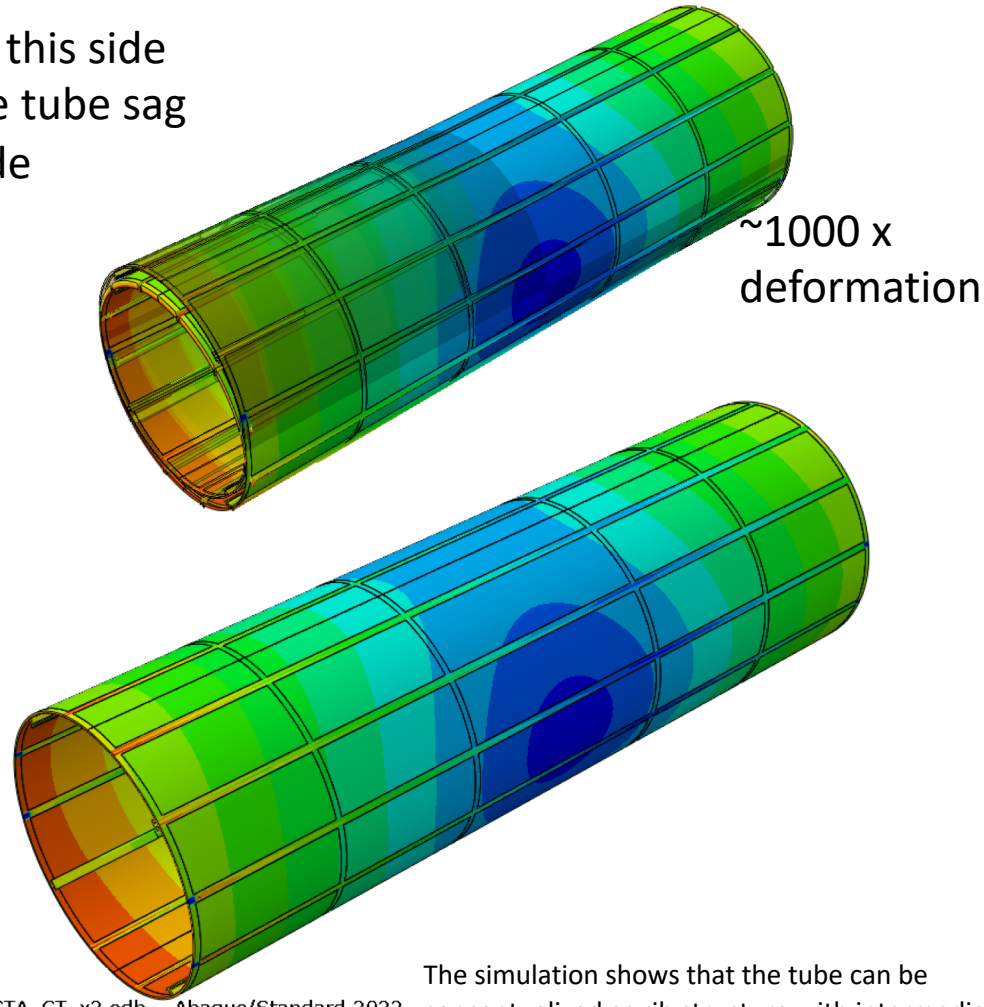


EMCal on this side makes the tube sag on this side

~1000 x deformation

Unit: m





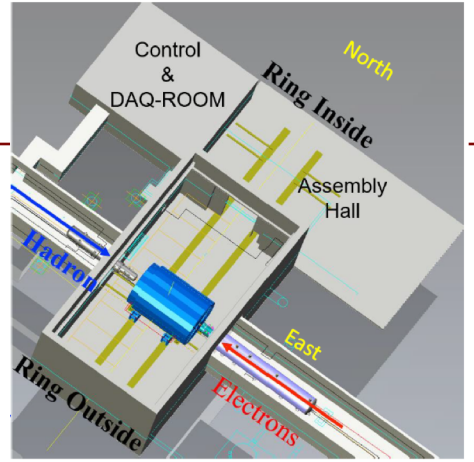
Y
Z X

ODB: GTA_CT_v2.odb Abaqus/Standard 2022

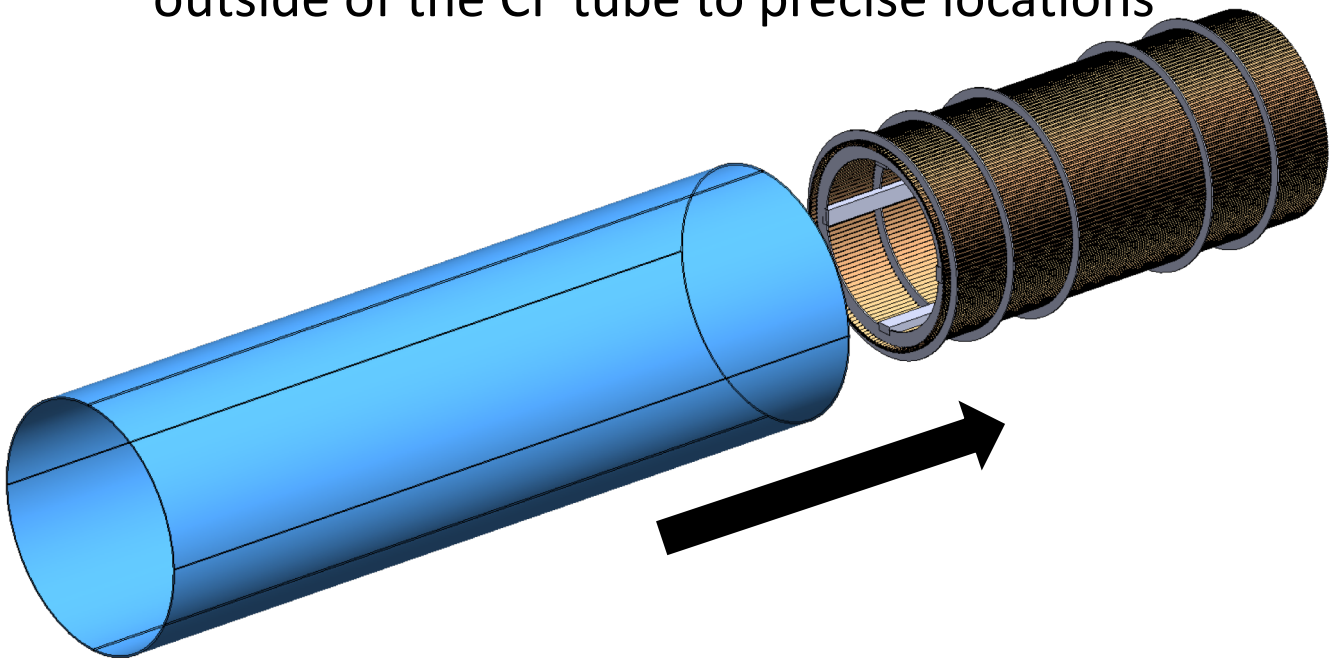
Step: Step-1
Increment 1: Step Time = 1.000
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.00e+01

The simulation shows that the tube can be conceptualized as rib structure with intermediate planes

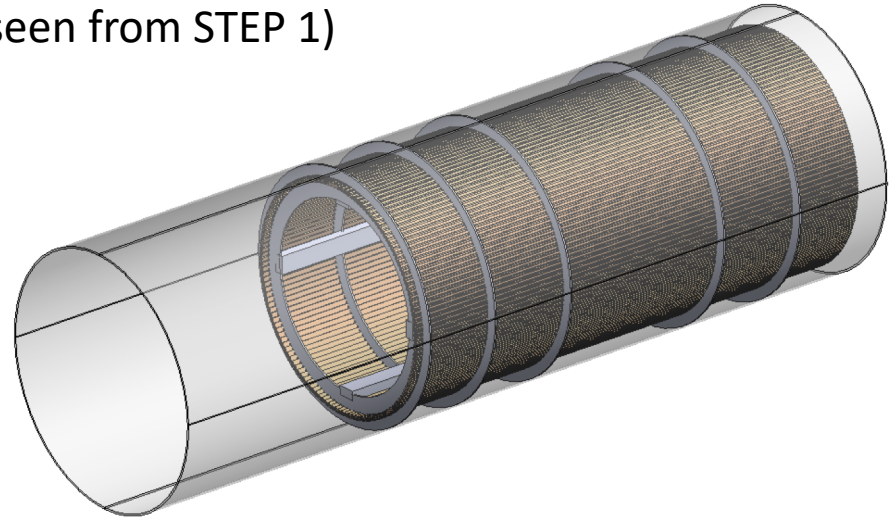
Integration sequence



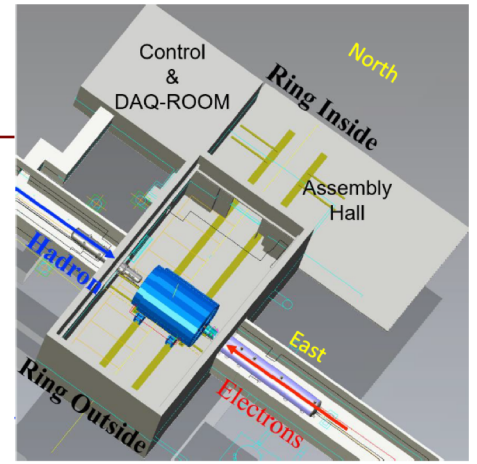
3. Slide in the CF support tube using temporary rails and other supports that can be removed later.
   - Installation “jig” and support for this task
4. Detailed FEA currently in process which may reveal adding “low-mass beams” connecting engagement rings
5. Fasten the engagement rings in place from outside of the CF tube to precise locations



- Through-holes / threaded inserts allow to mount engagement rings
- Likely want to “de-couple” as much as possible
- Fasten the engagement rings and remove temporary inner supports (as seen from STEP 1)

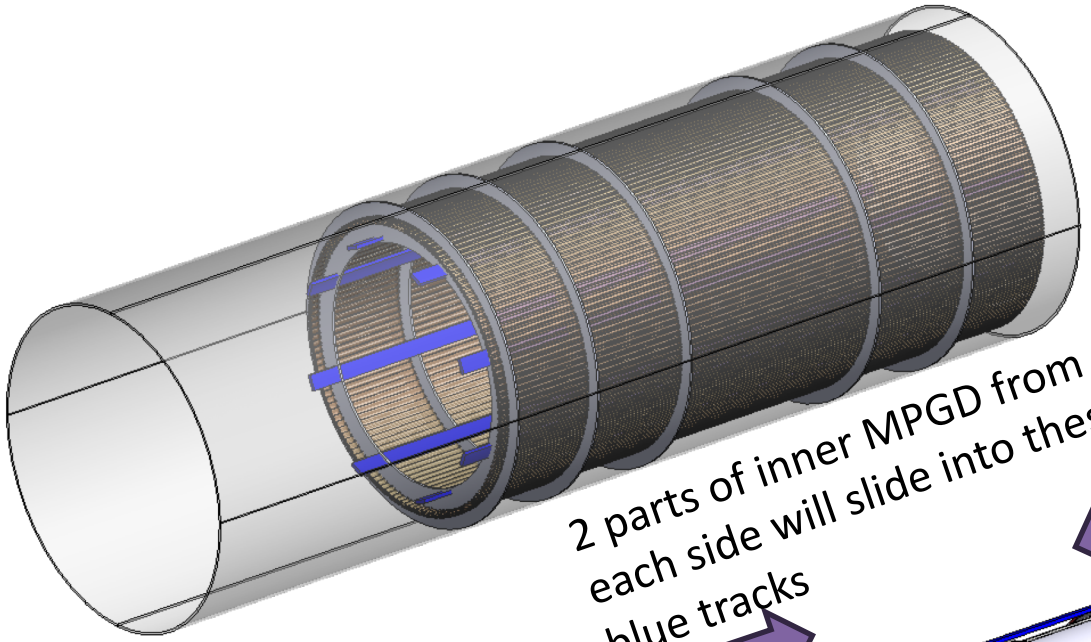


Integration sequence

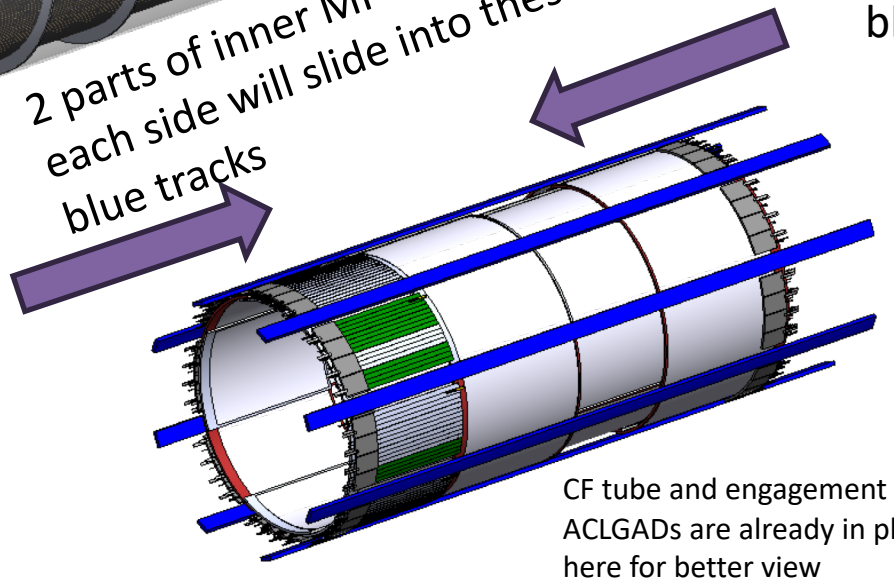


5. Mount the blue inner MPGD supports on the engagement rings

(Outdated only 3 engagement rings now)



2 parts of inner MPGD from each side will slide into these blue tracks



The MPGDs interface with the red supports from MPGD design onto this blue tracks that are load bearing

Temporary extension to blue tracks will be built to get those lengths all the way outside the CF tube

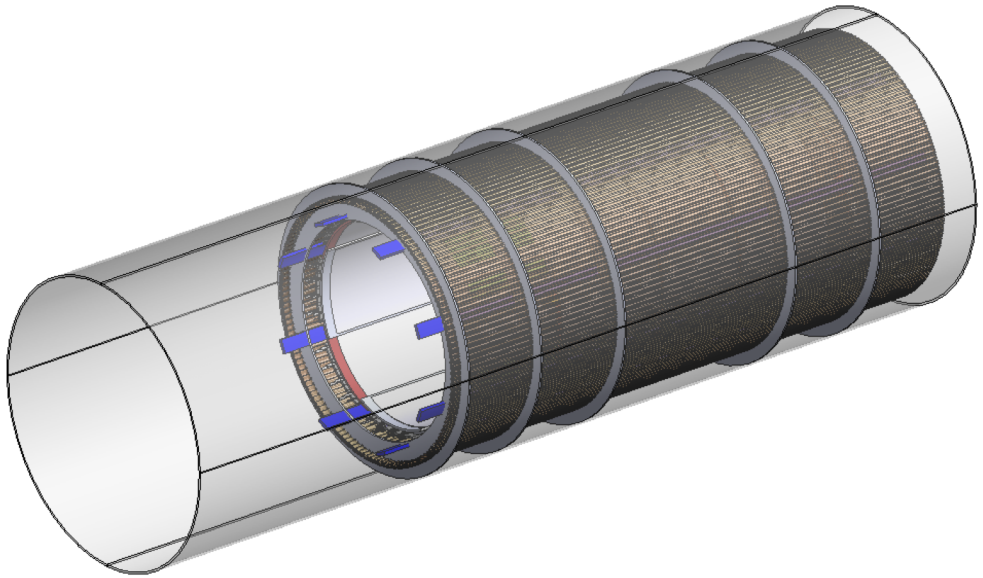
Note – this is barrelv4 – we are in the process of updating the CAD to barrelv3 – insertion concept will remain same

CF tube and engagement rings and ACLGADs are already in place – hidden here for better view

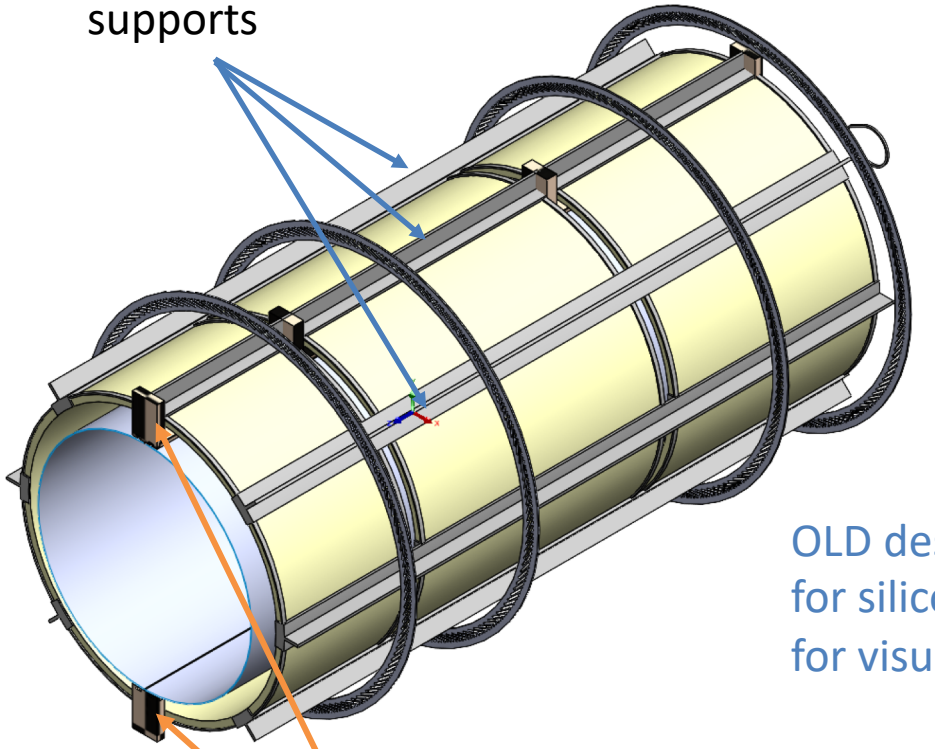
Integration sequence

6. Wire up the inner MPGDs on electron and hadron side

- Temporary service supports might be needed



MPGD tray supports that connect to the engagement rings and “red” MPGD supports



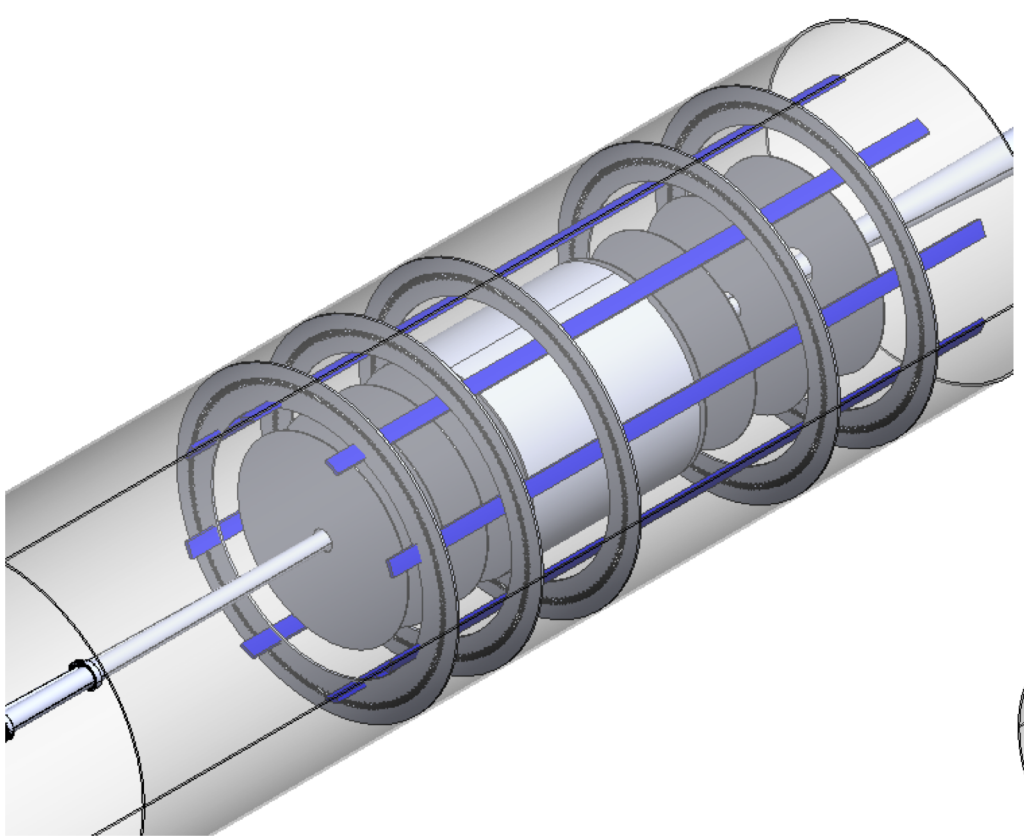
OLD design of the rails for silicon tracker – just for visualization

7. The rails and support structure for vertex comes next
8. and 9. SVT integration aspect discussed in Thursday’s SVT session

Silicon tracker can be mounted on rails to de-couple it from the MPGD support structure

Integration sequence

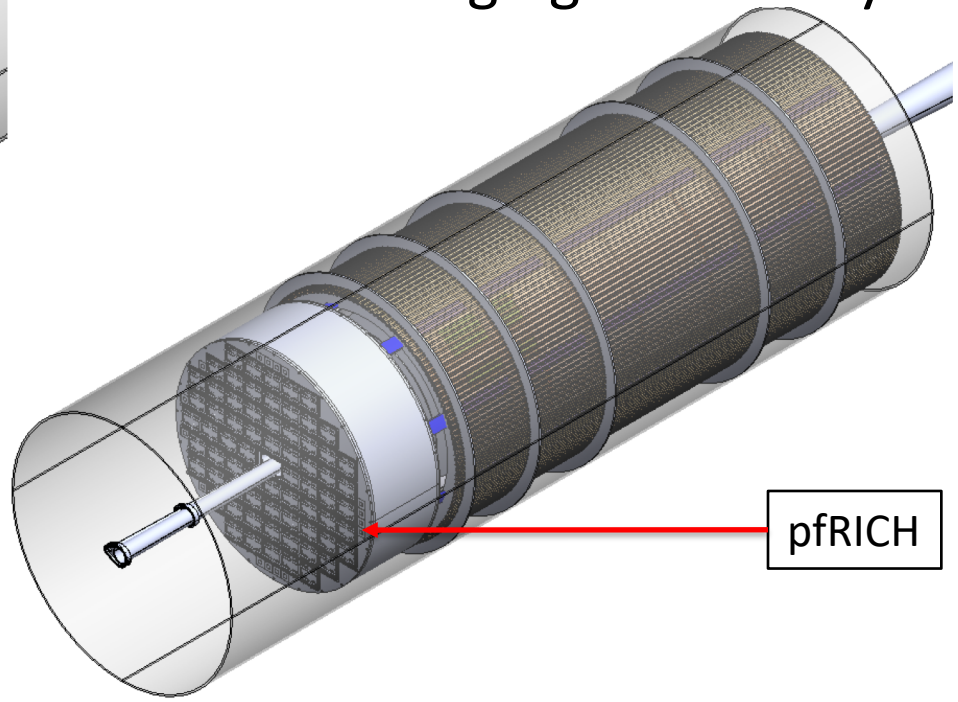
10. The outer discs of MPGDs come in next



11. All the services and wiring is pulled out till the ends of CF tubes

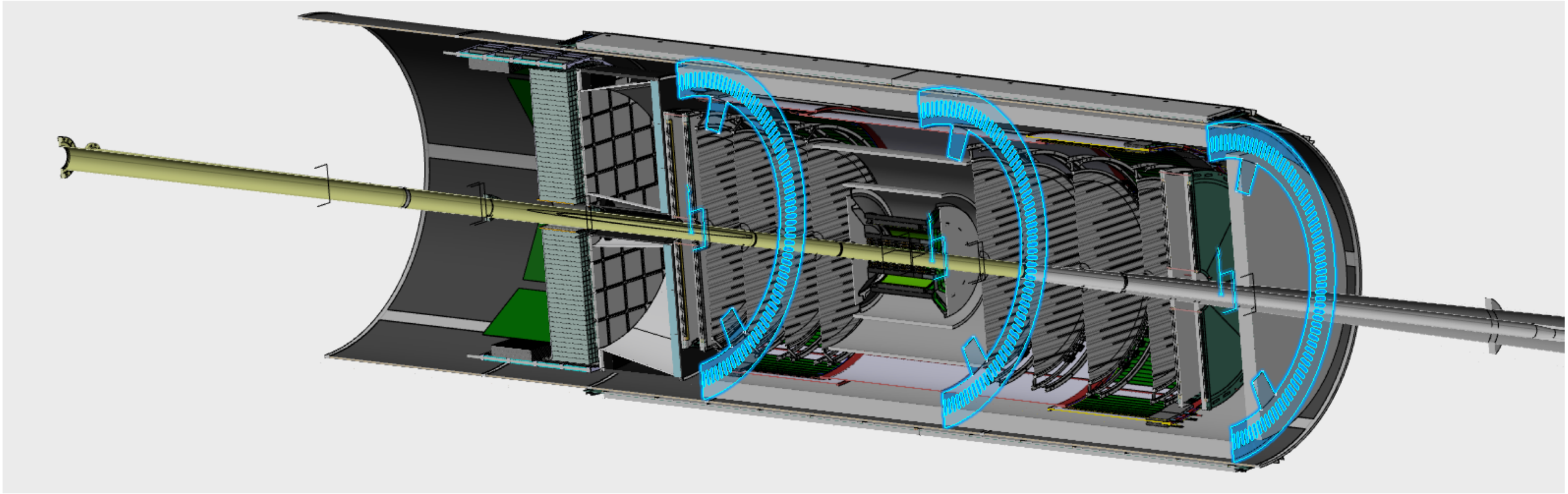
12. pfRICH and EMCAL in installed in the CF tube

- Needs “blocks” & brackets to avoid damaging the GST by EMCAL



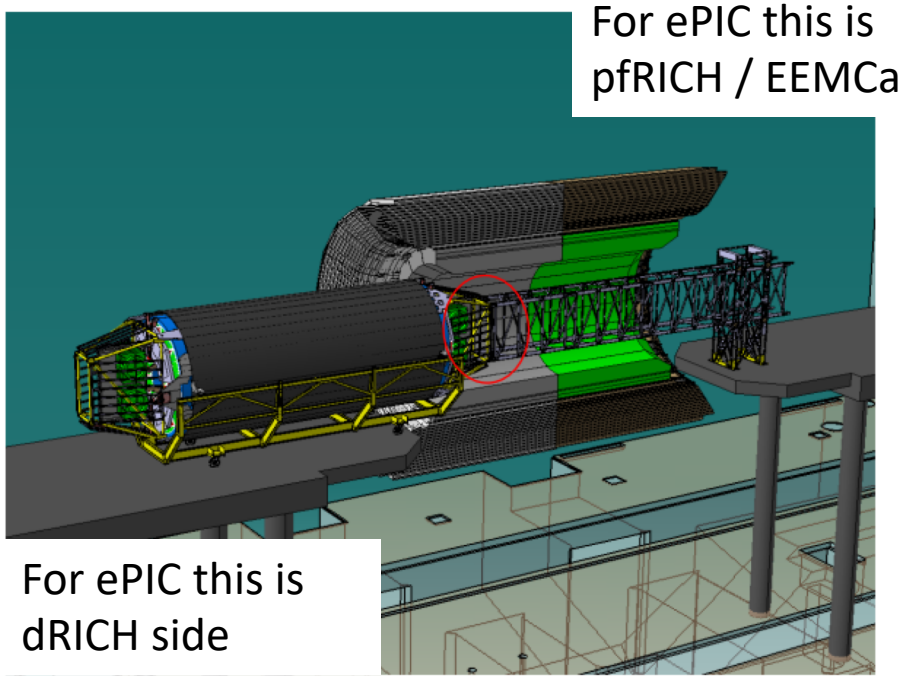
Integration sequence

- Central detector fully assembled and ready for insertion into EPIC



Adopt CMS solution to EPIC

- Suggested when I joined integration efforts back in 2023 I think
- Draws from example of CMS which has similar challenges and has developed good solution – Purdue is involved in many aspects on CMS side
- EPIC space situation: more space on dRICH side, little on EEEMCal/pfRICH side
- Modular pull-through assembly will need to be disassembled on pfRICH as inner detector move in



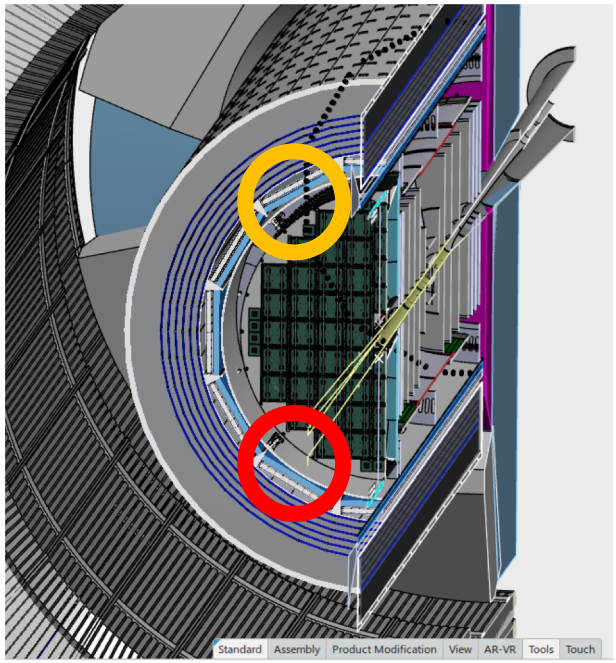
For ePIC this is pfRICH / EEMCal side

For ePIC this is dRICH side

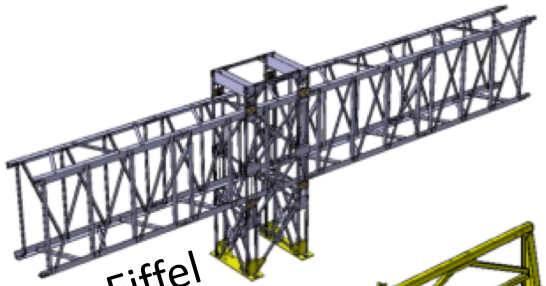
Rail location under discussion, more then one option

This is redundancy/safety rail

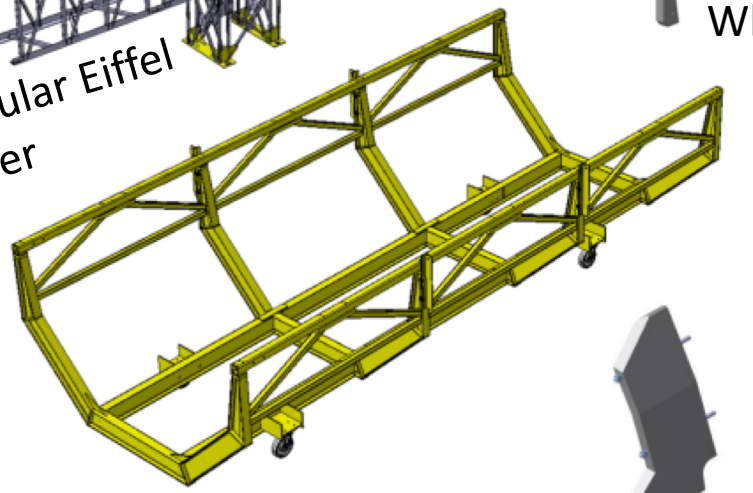
This is the load bearing rail for installation

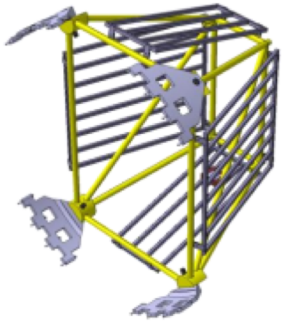


Adopt CMS solution to EPIC


Modular Eiffel Tower

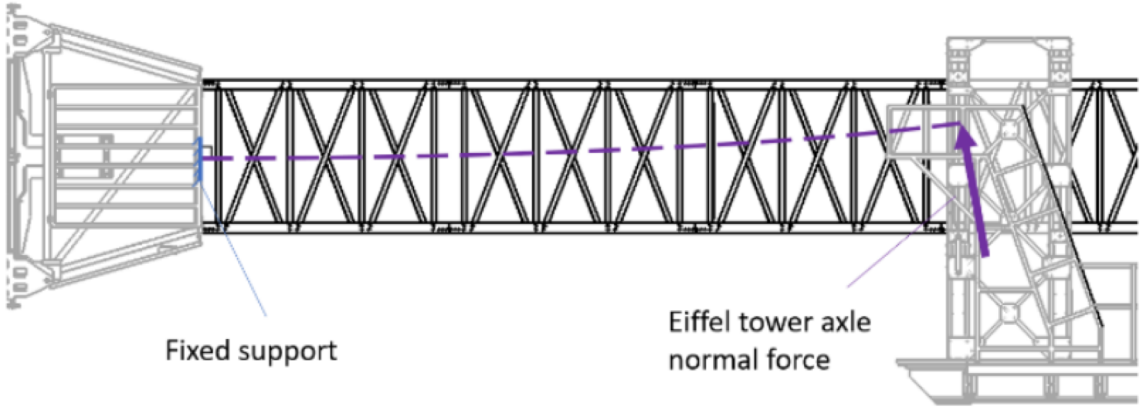

Wheels/Rails


Support cradle already in design for ePIC

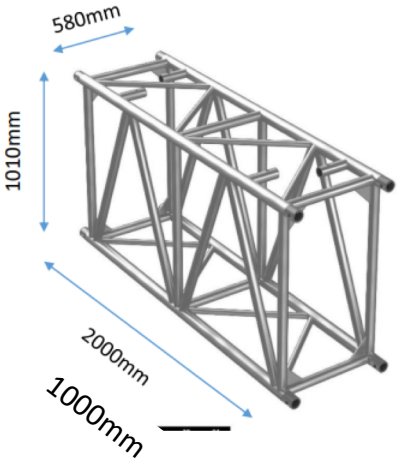

Pull interface that attaches to the GST End Ring


Bananas

- Solution needs variety of temporary supports



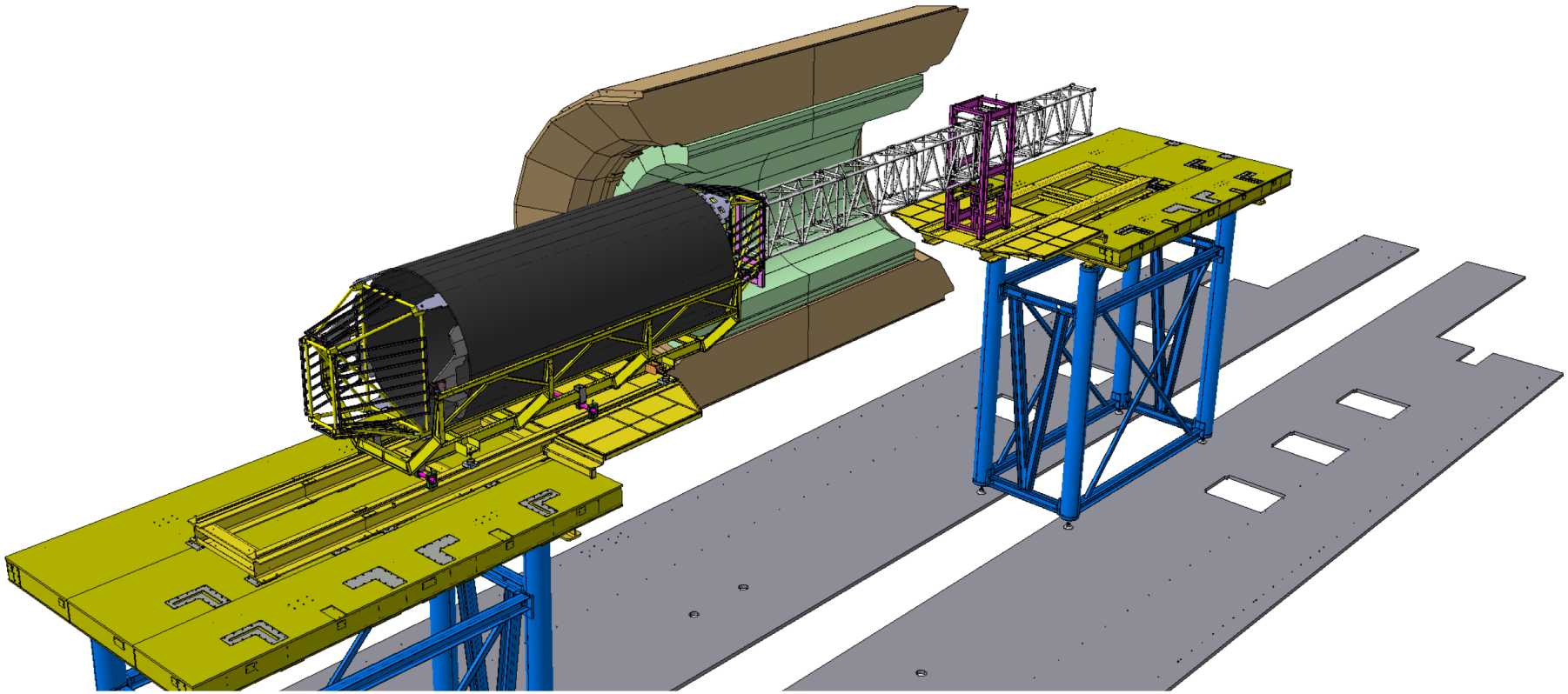
Modular structural design that is able to be mounted as the structure is pushed / removed since there is not enough space on the platform on electron side



Pictures from M. Barinoff – CMS CERN ; indico 1112851

Installation procedure in CMS

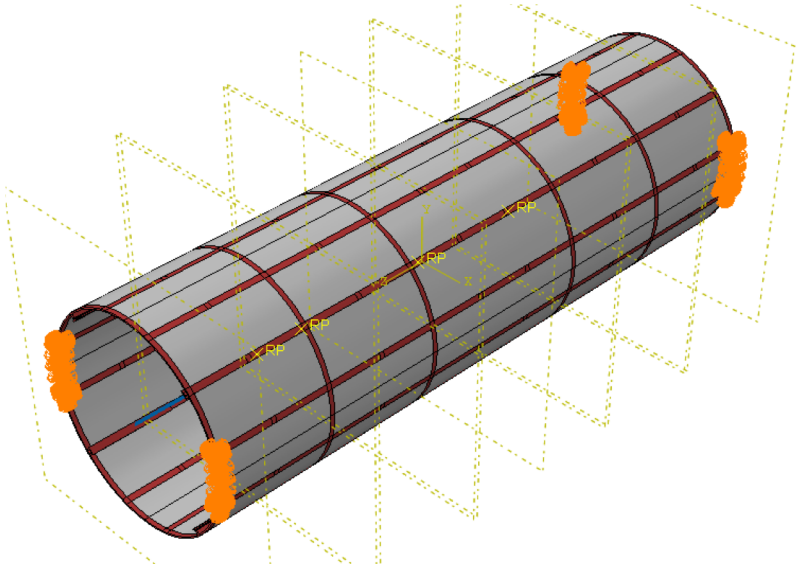
Concept from CMS for installation and removal for the Tracking detector



(video)

Discussion / Next steps

- 1st design of GST exists and currently FEA work continues to adjust for up-tp-date masses
- Integration sequence and interfaces need to be finalized and drafted, i.e.
  - Support interfaces to inner MPGD
  - Support interfaces to SVT (see talk on Thursday)
  - Support interfaces (engagement rings) to TOF (see talk earlier this morning)
  - pfRICH and EEEMCal
- Prepare for upcoming reviews and document all information



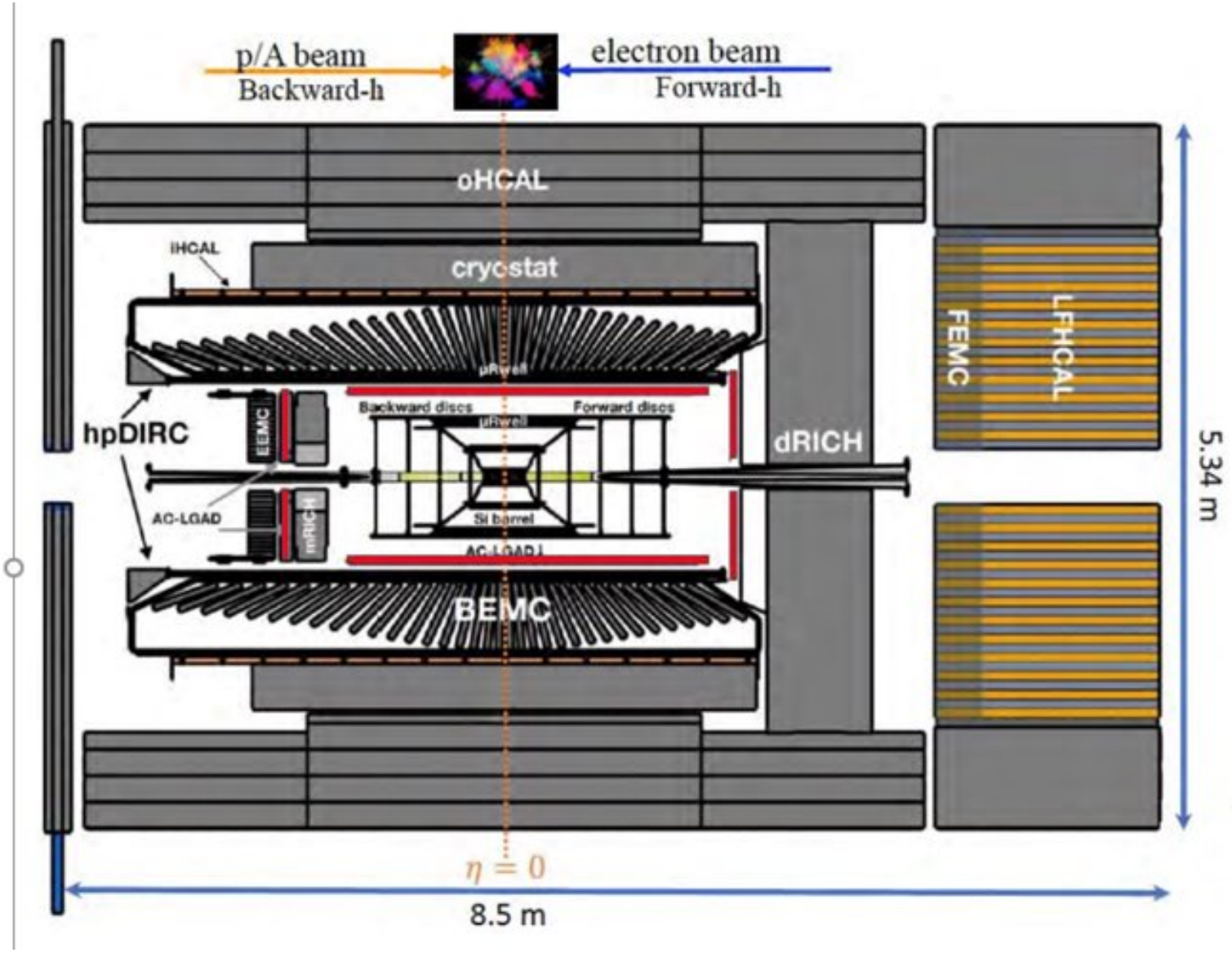
Backup

TOF stave production – initial thoughts

- **Stave prototyping activities – happening now!**
  - Stave pathfinder institute for prototyping is Purdue + FEA baselining
  - Module thermal FEAs, activities between Santa Cruz, ORNL, and Purdue
  - Thermal testing + limited FEAs at NCKU
- **Production of staves**
  - Parts of raw material via Purdue and production via NCKU, ship back to US
- **Module assembly**
  - Purdue has experience & capacity for wire bonding, limited PED between Purdue & Santa Cruz
  - ORNL has also experience and capacity, I do not know details

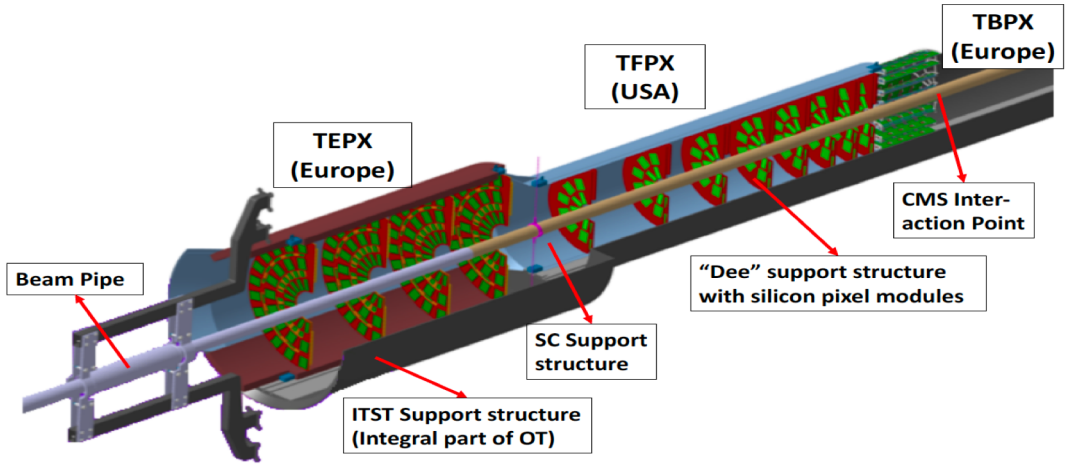
- **Stave system tests**
  - Only Stave thermal testing, see above
  - Fully equipped Stave's with mock heaters or somewhat more real heaters
    - ORNL: details to be confirmed
    - Purdue can do system integration, we do have chiller for up to -10 C tests or soon (few weeks) also CO2 test setup that can be used as a facility
- **Stave integration**
  - Likely gantry supported
  - My biased view:
    - CMS pixel experience is with high TC grease for workability, screws and a CF clamp for good contact to stave
- **TOF assembly**
  - Global support tube at Purdue, limited mounting tests at Purdue. Ensure all is OK, then ship to BNL
  - At BNL

Discussion

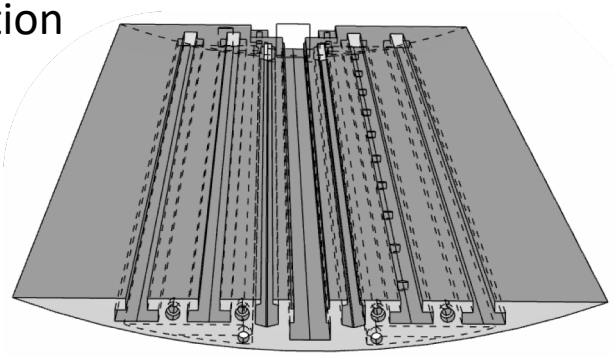

p/A beam
Backward-h
electron beam
Forward-h
oHCAL
cryostat
iHCAL
μRwell
Backward discs
Forward discs
μRwell
hpDIRC
EEMC
AC-LGAD
mRICH
Si barrel
AC-LGAD
BEMC
dRICH
FEMC
LFHCAL
5.34 m
$\eta = 0$
8.5 m

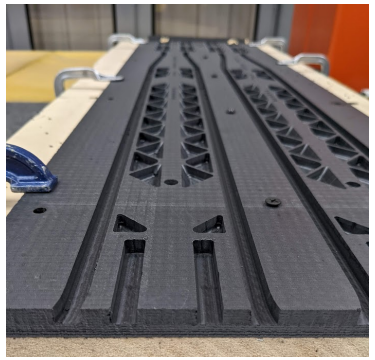
Supporting & Integration of SVT

- Design concept is to insert “half SVT” at a time
  - Requires reasonably rigid structure, at least temporarily supported with external structures

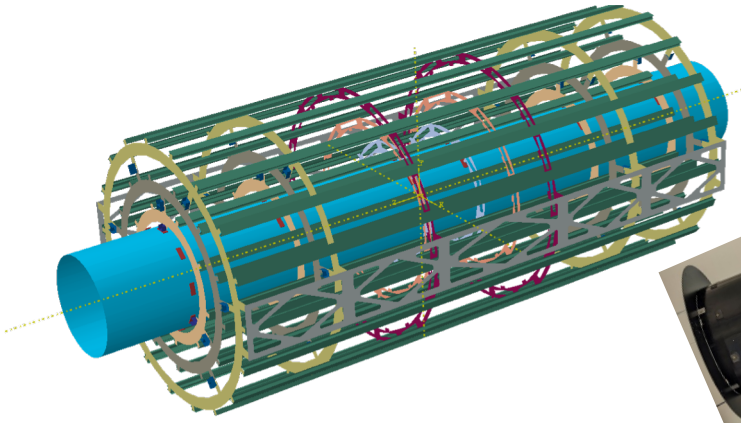


- Example “track” from CMS for SC support and insertion, incl. dry-gas injection





- Example from CMS, which is “inverted”
- The GST is outermost and engagement rings go inside with support rods as needed to provide enough support
- Low mass “tracks” to allow integration of SVT half-dectectors
- Reduces number of cylinders to 1 global (GST), none inside and no real half-cylinders either (if needed low mass, aka w lots of holes)



Example: IT pixel supports in CMS