Update on TOF Mechanical Structures

12th December 2023

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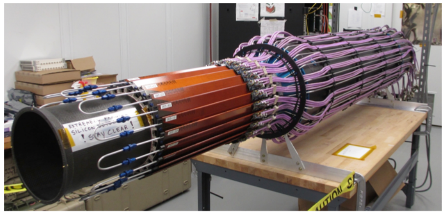
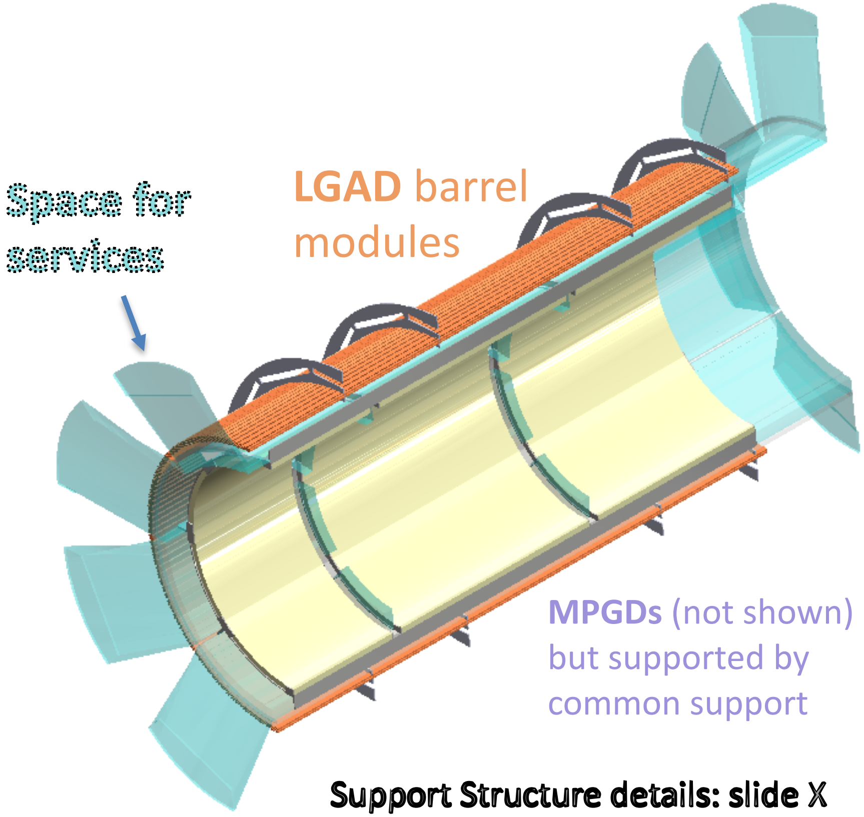
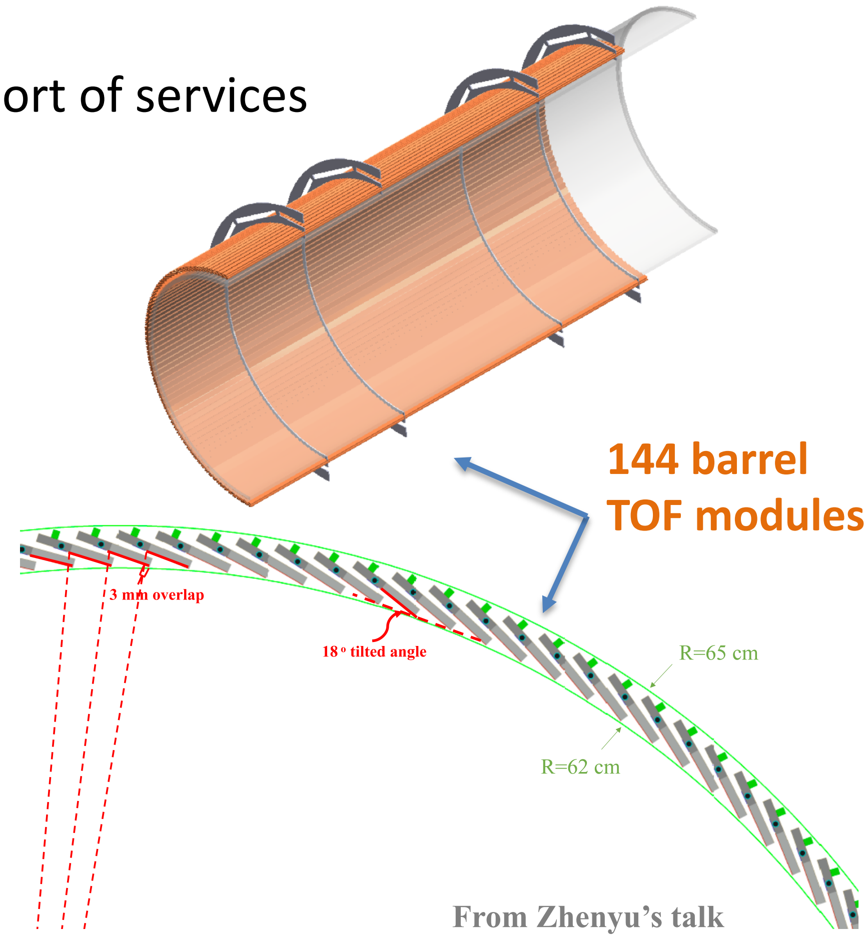
Barrel TOF



- Use similar concept of STAR IST (starting point)
- LGADs supported by “long staves”, next slide
- Common support structure
  - Barrel TOF, MPGDs, space & support of services



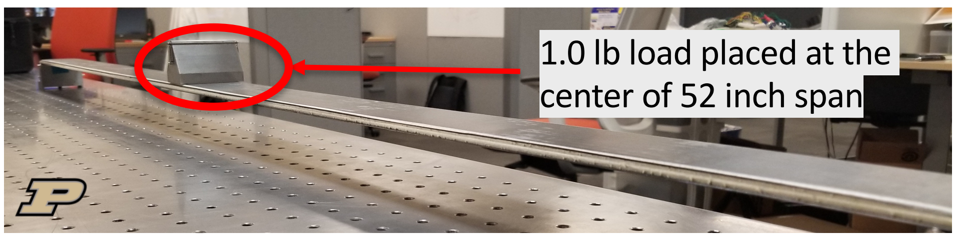
Support Structure details: slide X

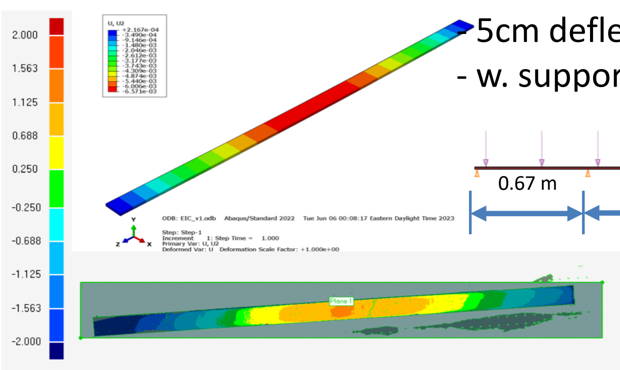


From Zhenyu’s talk
https://indico.bnl.gov/event/16765/

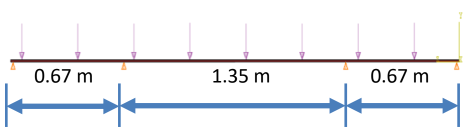
Barrel TOF

- Total of 144 barrel TOF modules
  - 9216 sensors, 18,432 ASICs, 2.4 M channels
  - Mass ~70kg and 4kW heat load
- 1st Preliminary stave structure made
  - FEA and prototype for full length
  - Deflection of 700 micron – further optimization possible



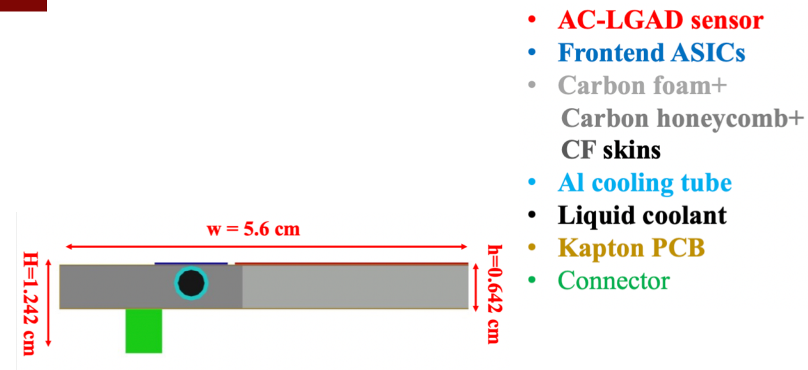


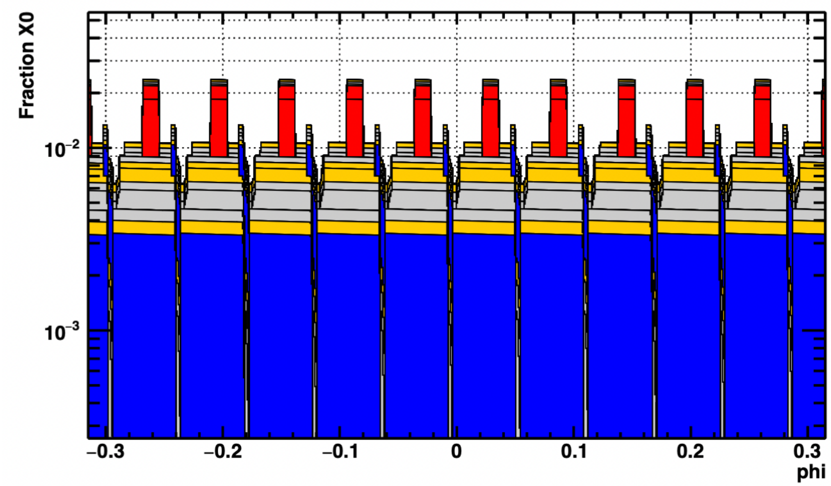
5cm deflection full length stave - w. supports down to 700μm

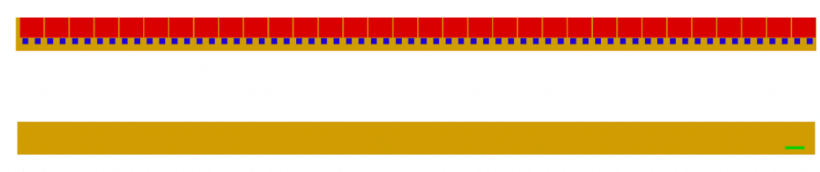


Unit: mm

Top down view of the loaded stave.





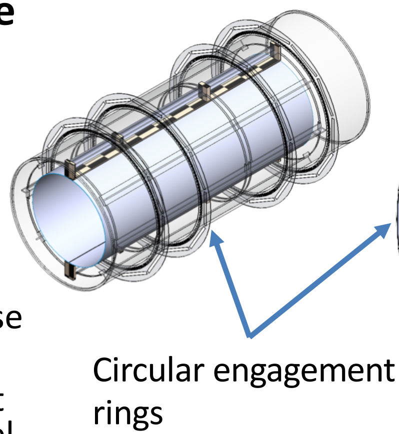


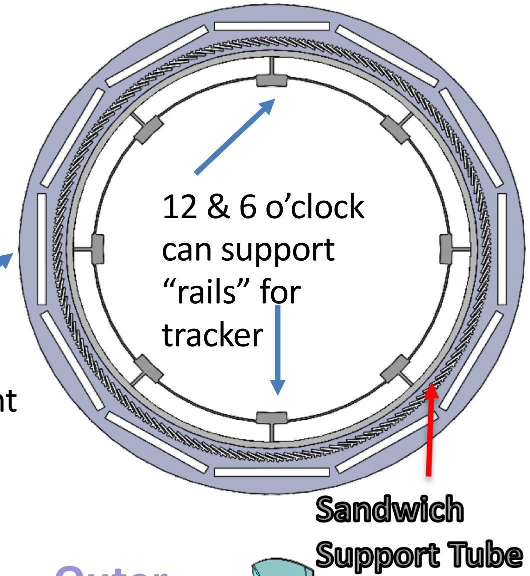
"Long stave" length ~ 2.4m

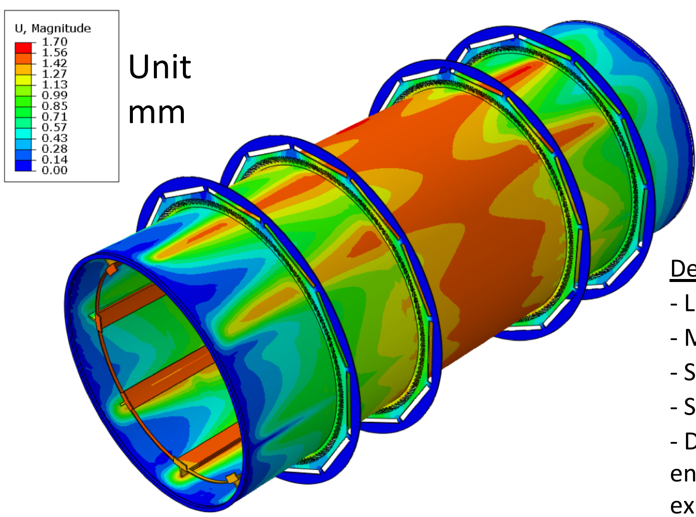
From Zhenyu's talk
https://indico.bnl.gov/event/16765/

Support structure for barrel TOF

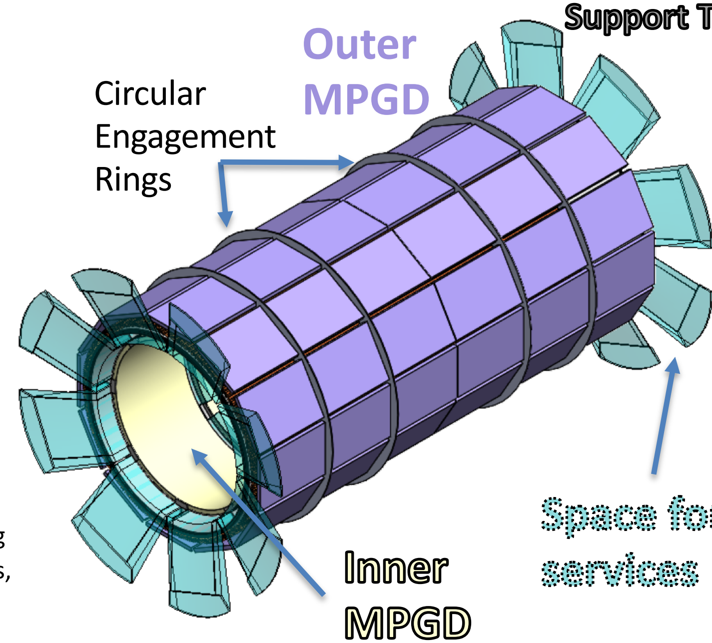
- **Concept idea of joined mechanics structure for barrel TOF, inner & outer MPGD layers, services, and even tracker**
  - 1+8+1 mm sandwich composite structure w "end-rings" to support beam pipe during installation & integration
- Integration
  - Move/Place end cap TOF closer to dRICH to ease access to inner tracking volume
  - "Rail" system (internal and external) to support half-cylinders for tracker installation after barrel TOF system is in place
- First preliminary FEAs for this design
  - 1.7mm deflection and weak regions at engagement rings – needs to be optimized!







Details:
- LGADs = 70 kg
- MPGDs = 24 + 24 kg
- Silicone tracker = 10 kg
- Services (smeared) = 100 kg
- Designed engagement rings, end rings following CMS experience at Purdue



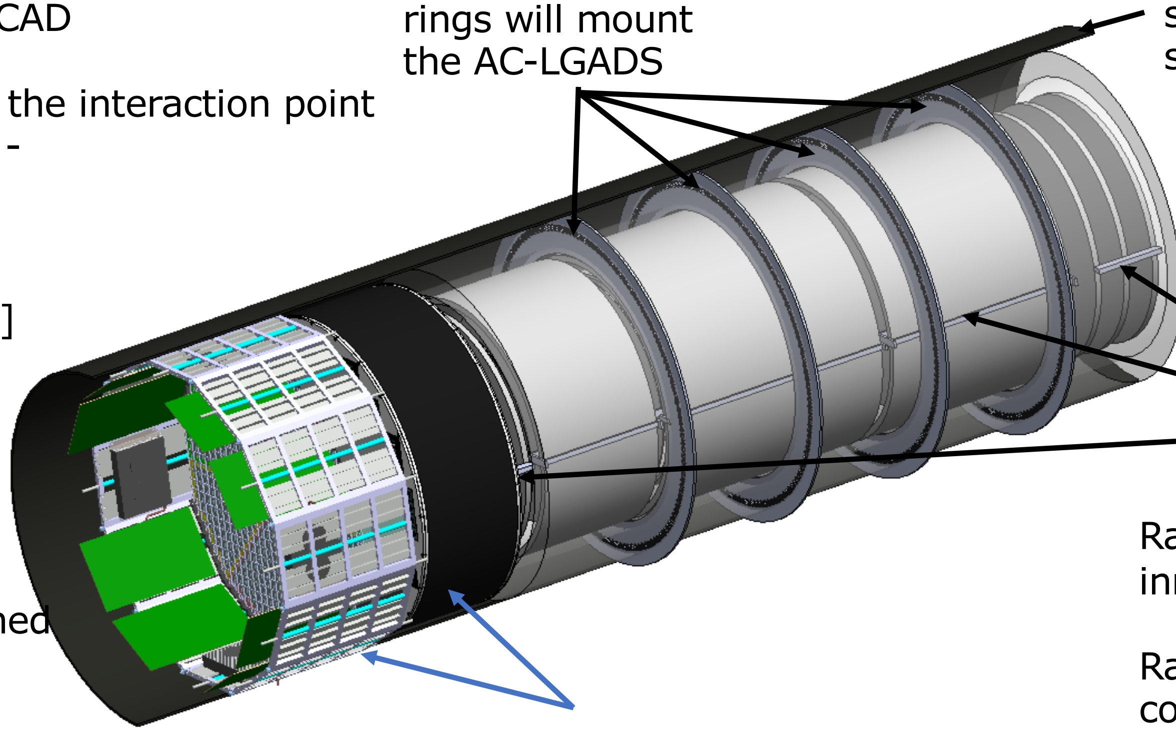
Latest status – Oct 2023

Center coordinates of the engagement ring as currently in CAD

Assuming [0,0,0] is the interaction point
CG of the Rings are -
Ring 1 – [0,0,655]
Ring 2 – [0,0,160]
Ring 3 – [0,0,-845]
Ring 4 – [0,0,-1340]

Inner engagement rings will mount the AC-LGADS

Half CF Tube shown – BTST like structure



Rails to mount the inner MPGDs

Rails will be coupled on the outside with the BTST like tube

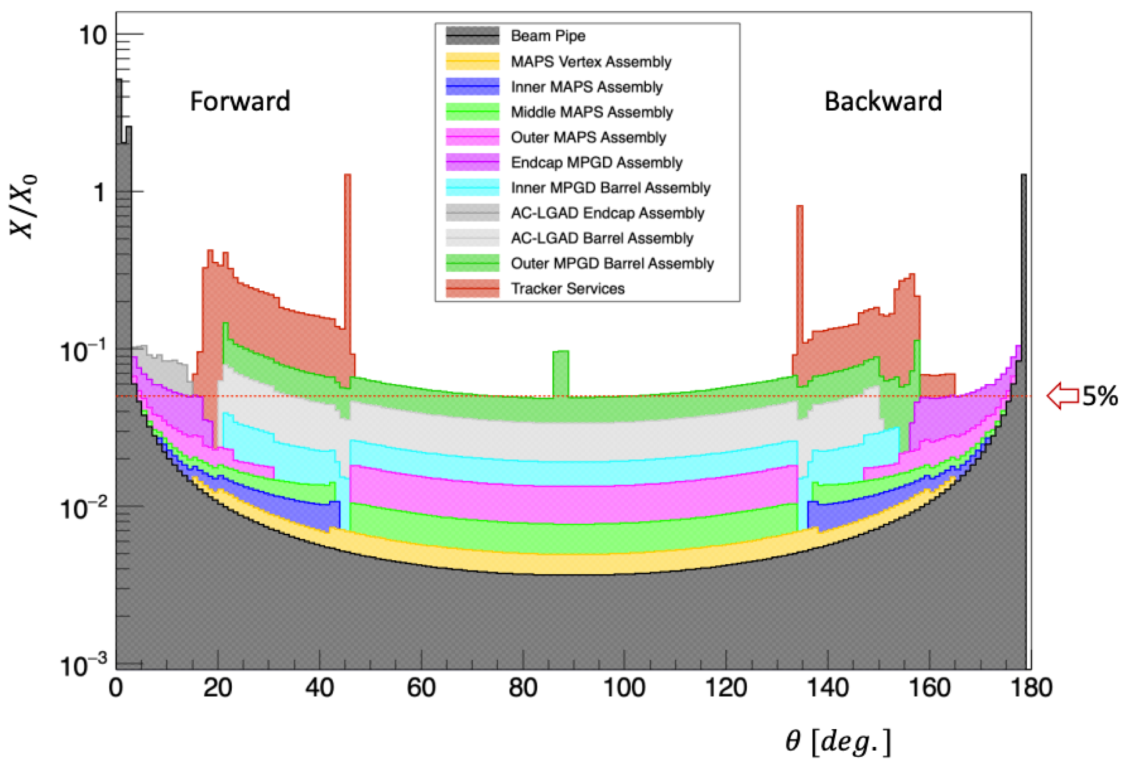
The rings are designed as 5 mm thick

Additional ring might need to be added on the ends to account for weight of the services – not in FEA model yet

pfRICH and EMCal mounting as shown in previous presentations

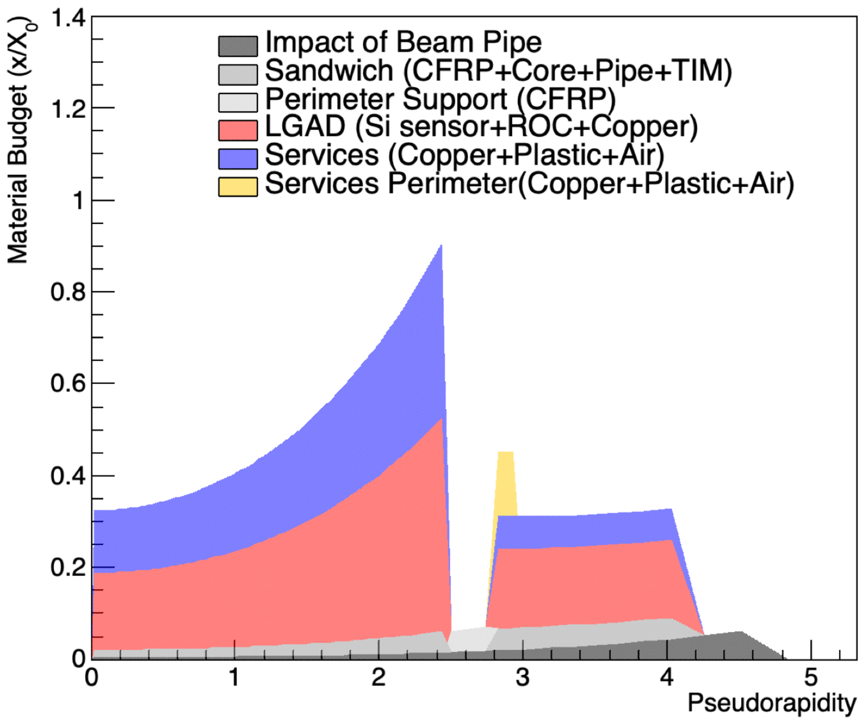
Translation to material budget

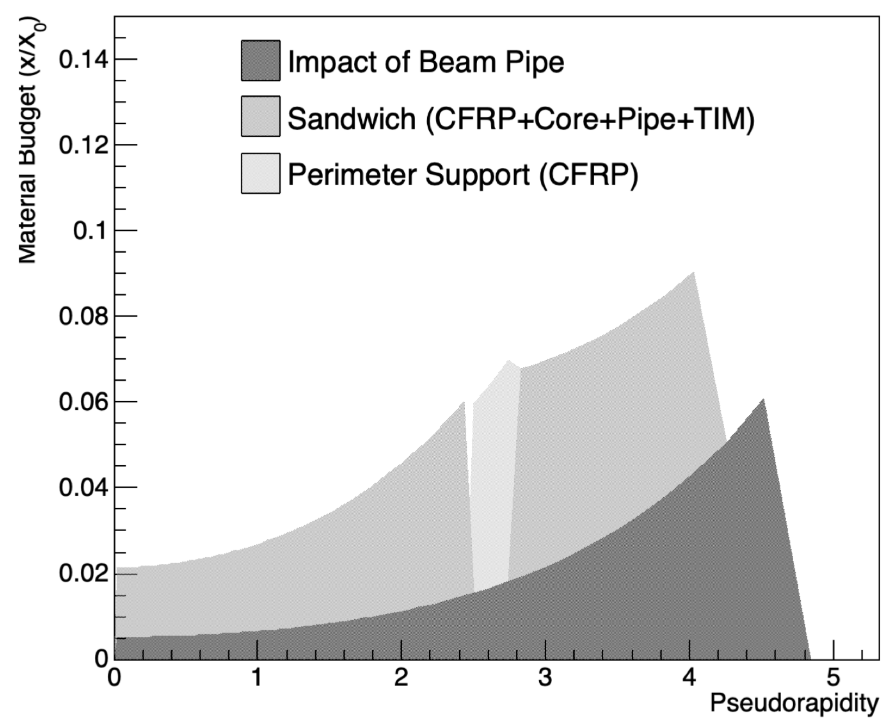
- Lots of "beginner" questions still:
  - Material of sensors in TOF barrel and endcap
  - Beampipe other items
  - Assumptions on services map with what is in the central spreadsheet, who is taking care of that ?



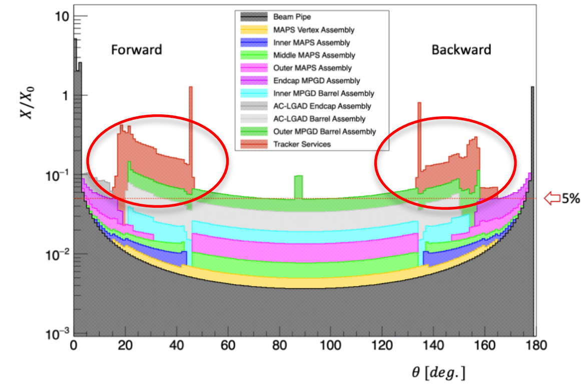
Translation to material budget

- **Assumptions:** silicon pixel devices material budget (~25g per 2x2 module, that's 4 by 4cm) – probably all layers in CMS here?!
- Structures are as proposed in PED request (sandwich core)
  - For Barrel see earlier slides and next talk by Sushrut
  - For endcap: standard "dee" sandwich core: ~5% X_0





Translation to material budget



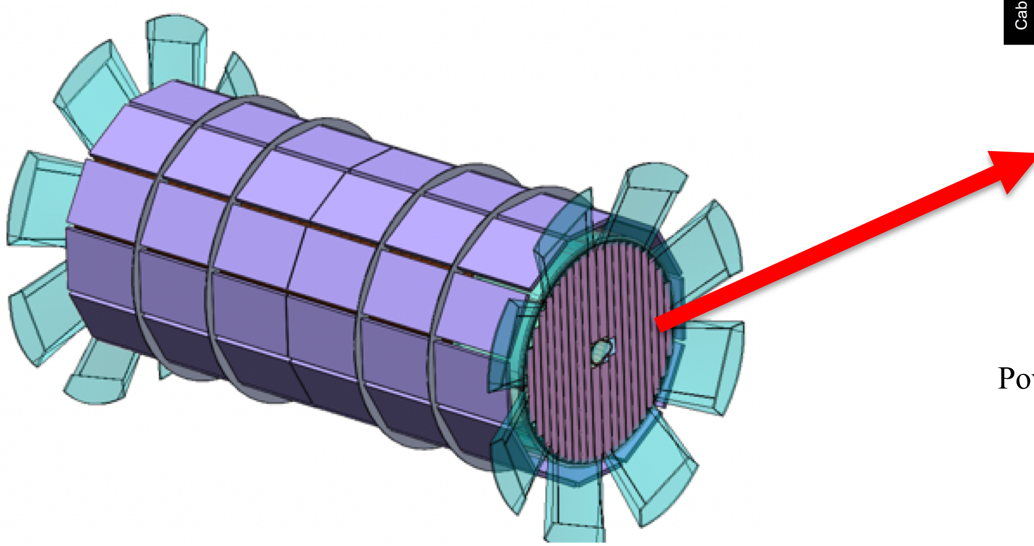
Next steps:

- Need to define realistic envelopes incl. services and have a map with volumes
  - Raised in "Rahul's global mechanics meeting"
- For design purpose of support structure in optimal way and with minimal mass
  - Gather average masses/materials from subdetectors and implement
  - Get to a realistic model so that we can design inside envelopes available
- Purdue has also responsibilities on SVT for global mechanics

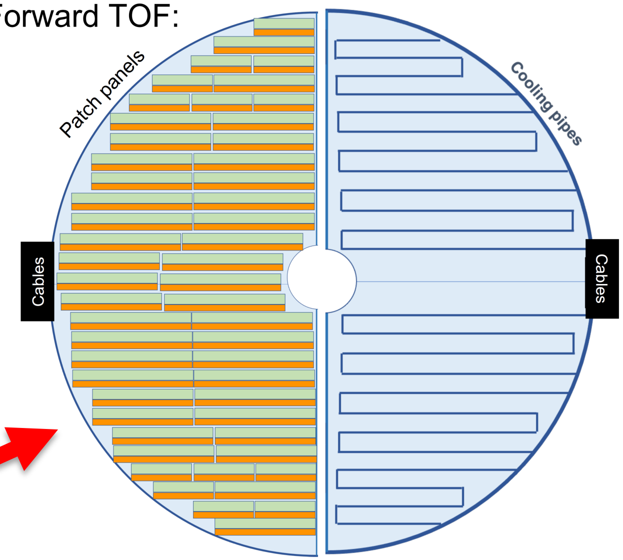
Endcap TOF

Endcap TOF

- Endcap TOF supported by common structure supporting barrel TOF system
- Under study: Integration & access to tracking volume eased if endcap TOF moved in front of dRICH



Forward TOF:



From the talk of Wei Li
https://indico.bnl.gov/event/16742/

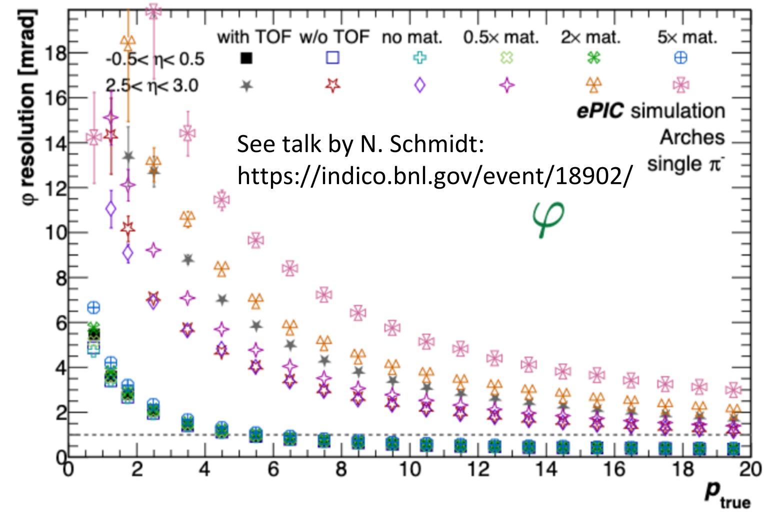
- "Clam shells" or DEEs
  - Convenient for installation/maintenance
  - Each is patched by TOF modules (one or more types) on both faces
  - No backward TOF

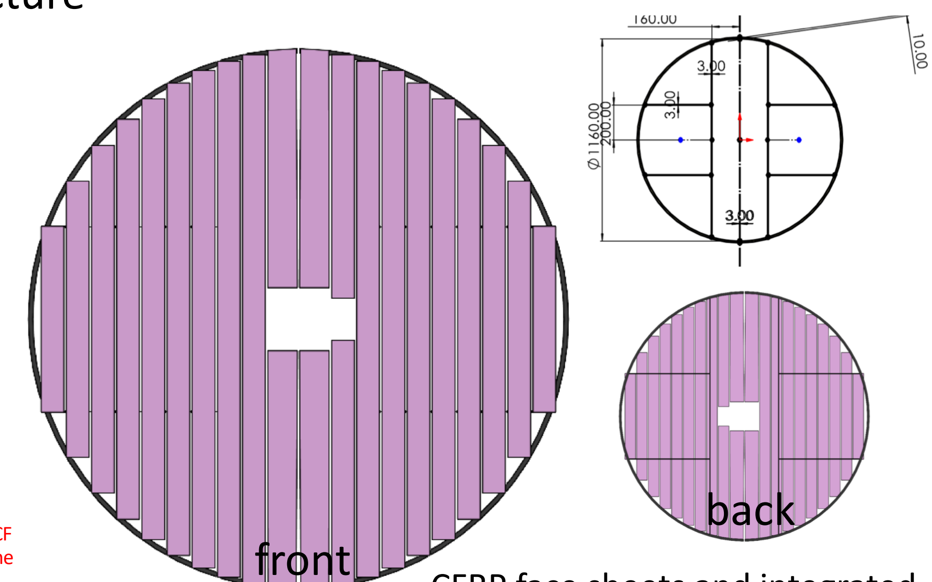
Power Budget

	Endcap TOF [kW]
Sensors	0.6
ASIC	8.5
DC-DC	3.5
lpGBT, VTRx+, SCA	0.5
Power cables	0.5
Total	13.6

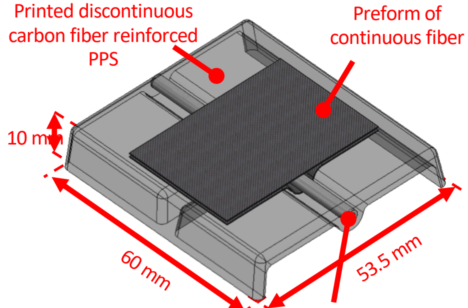
Endcap TOF

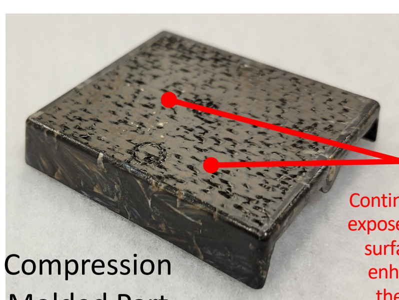
- Material budget critical for performance of dRICH
  - Heat load: 13.6 kW (Aim for 1mW / channel)
  - 5% material budget and possible to reduce to 2.5% w advanced composites
  - Detailed X_0 studies under way
- Following two design choices
  - More "traditional" composite structure with sandwich + metal thin pipes
    - Re-use "staves" or wedges
  - Cutting-edge: "no-pipe" design





CFRP face sheets and integrated cooling stave structure



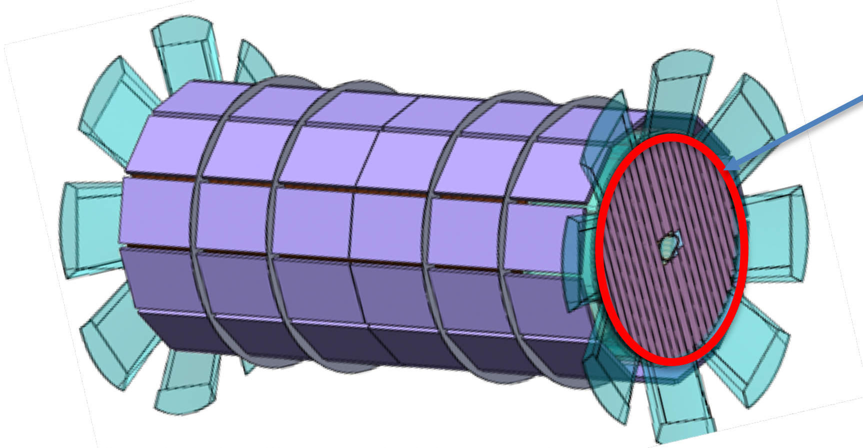


Compression Molded Part

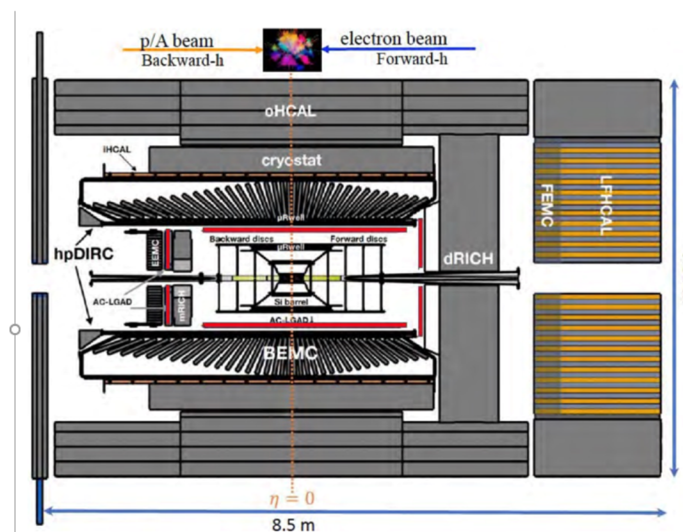
Continuous CF exposed at the surface for enhanced thermal conduction.

Support structure for endcap TOF

- Barrel TOF support structure allows for support of endcap TOP
  - Design for "end-rings" to support endcap TOF and temporarily support beam pipe during installation



End ring structure on either ends to temp. support beam pipe and endcap



  - Design of the "end-rings" follows CMS experience at Purdue
  - But, to ease access mounting at/near dRICH is being investigated

Summary – endcap TOF

- Material budget of endcap TOF critical
  - Two design choices: “standard” composite vs cutting edge ”no-pipe” design
  - Aim to reduce material budget: 5% to 2.5%
  - Barrel TOF support structure allows for support of endcap TOF
- Integration
  - Supported directly by barrel TOF structure or – to ease access to tracker volume – move closer to dRICH
- First larger prototype of standard composite support within next 12 months
  - On schedule to meet CD2 schedule