Barrel TOF Layout (v0)

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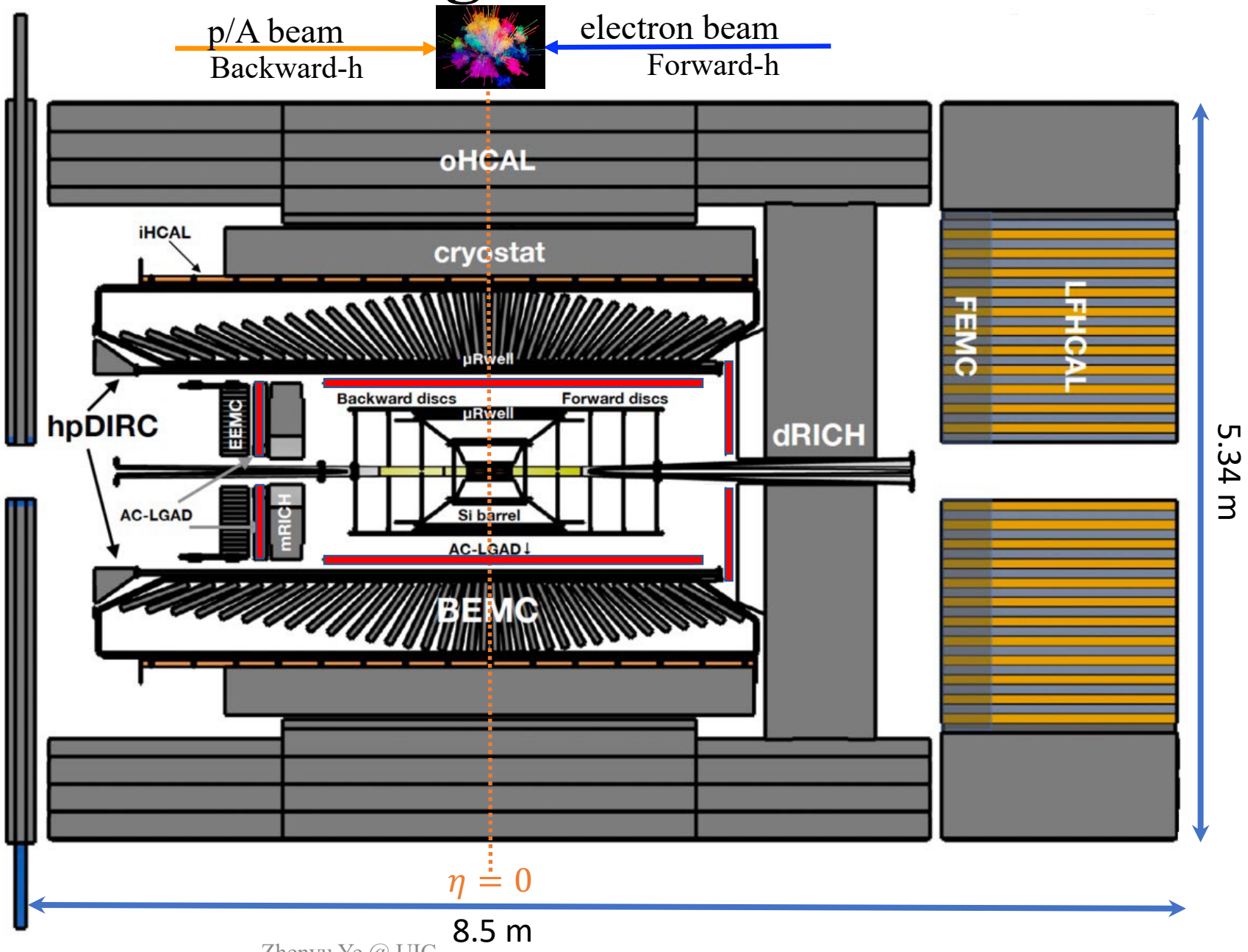
EIC Detector-1 Reference Design

Tracking:
- Si MAPS
- AC-LGAD
- µRWELL

PID:
- hp-DIRC
- mRICH
- dRICH
- AC-LGAD

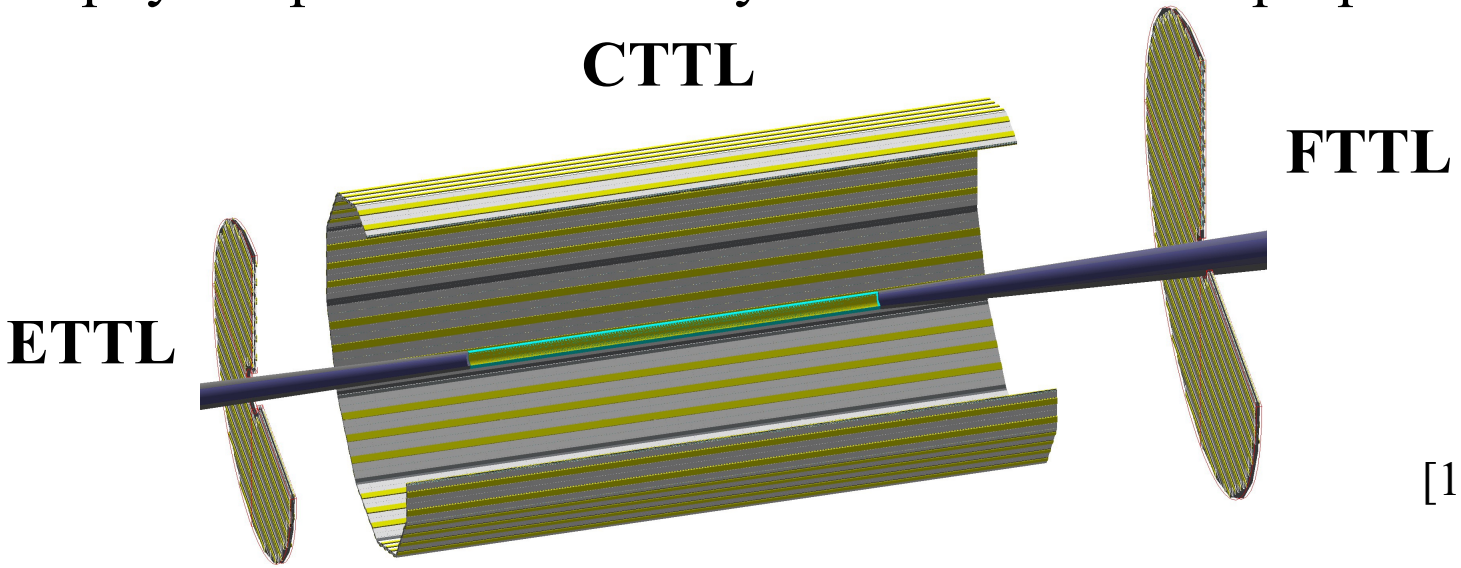
Calorimetry:
- SciGlass Barrel EMCal
- PbWO EEMCal
- Longitudinally separated EM+Hcal
- Inner HCal (instrumented frame)
- Outer HCal (sPHENIX re-use)

Different to LHC
- lower momentum
- lower occupancy
- less irradiation



AC-LGAD Layer for TOF PID + Tracking

- The goal is to conceive a reference layout and technical design (v0) as inputs to GD/I group to advance the detector integration (service routing etc.)
- However, there are still on-going studies to investigate the optimal channel granularity based on physics performance so by no means this is a proposal for final design.



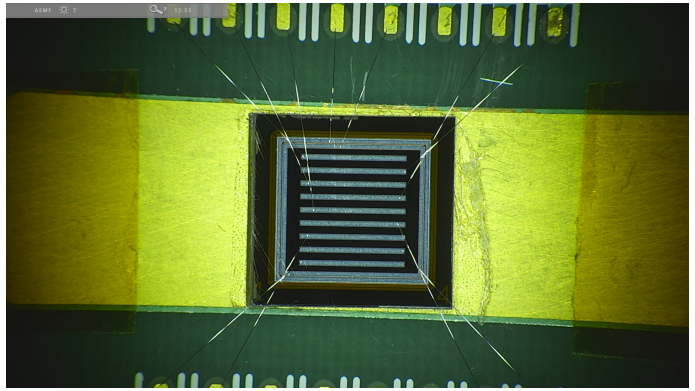
For v0 design, we propose:

- **Barrel: 0.5x10 mm² strips**
- **Endcap: 0.5x0.5 mm² pixels (same as RPs) [1]**

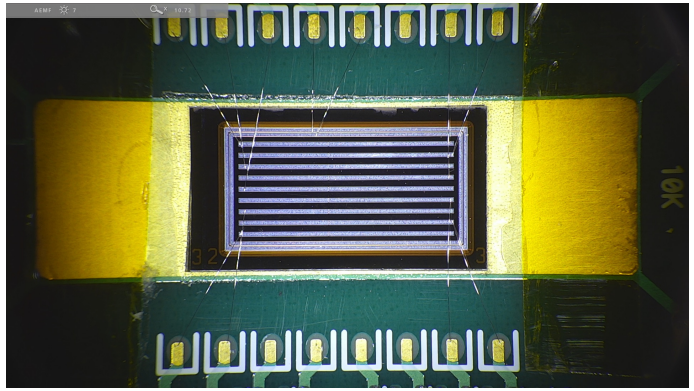
[1] Wei Li, TOF-PID WG Meeting Aug 29, 2022

	acceptance	Z (m)	Radius (m)	Area (m²)	Channel size (mm²)	# of Channels
ETTL	$-3.7<\eta<-1.74$	-1.61 to -1.71	0.12 to 0.63	1.20	0.5*0.5	4.8M
CTTL	$\|\eta\|<1.4$	-1.2 to 1.5	0.625 to 0.655	10.9	0.5*10	2.4M
FTTL	$1.5<\eta<3.5$	1.555 to 1.705	0.12 to 0.85	2.22	0.5*0.5	8.8M

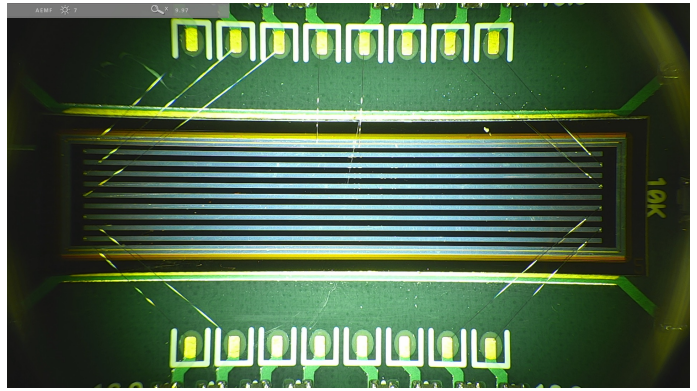
Test Beam Results of Strip AC-LGAD Sensors



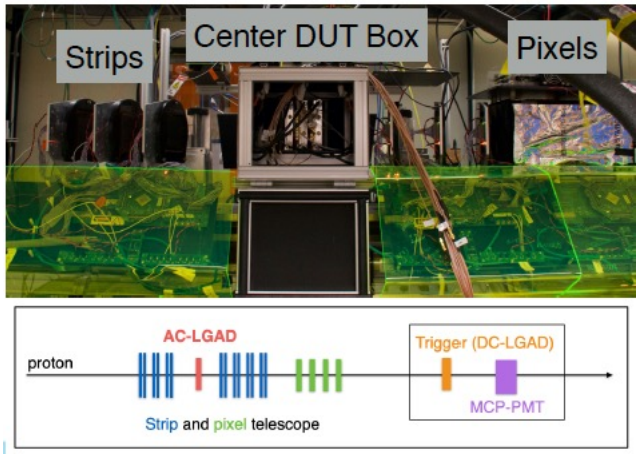
0.5*5 mm^2



0.5*10 mm^2



0.5*25 mm^2



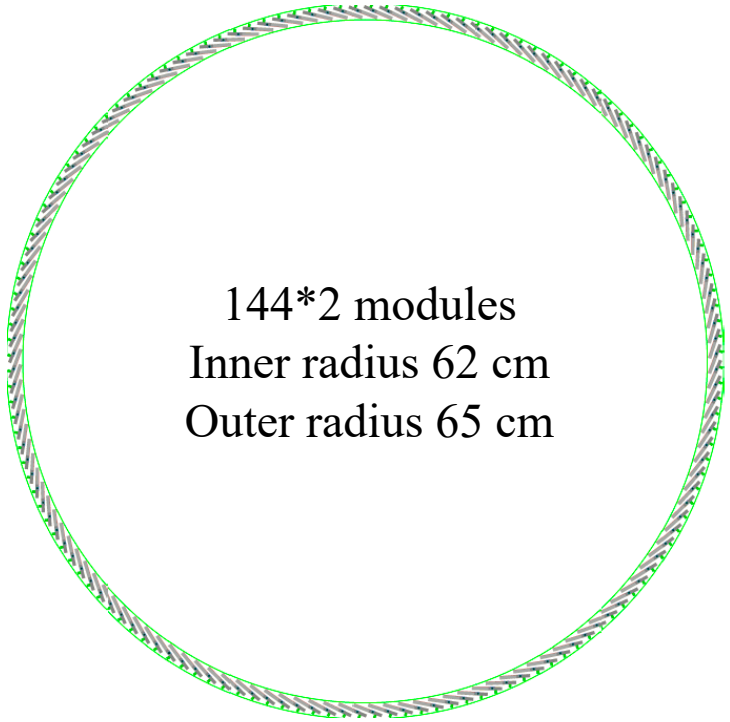
Preliminary Results	Time Resolution / hit	Position Resolution / hit
HPK-C2 Pixels 500 x 500 μm²	30 ± 1 ps	22 ± 1 μm
BNL Strips 500 μm x 5 mm	~ 30 ps (Hot spots)	< 15 μm
BNL Strips 500 μm x 10 mm	~ 32 ps (Hot spots)	< 20 μm
BNL Strips 500 μm x 25 mm	~ 53 ps (Hot spots)	< 40 μm

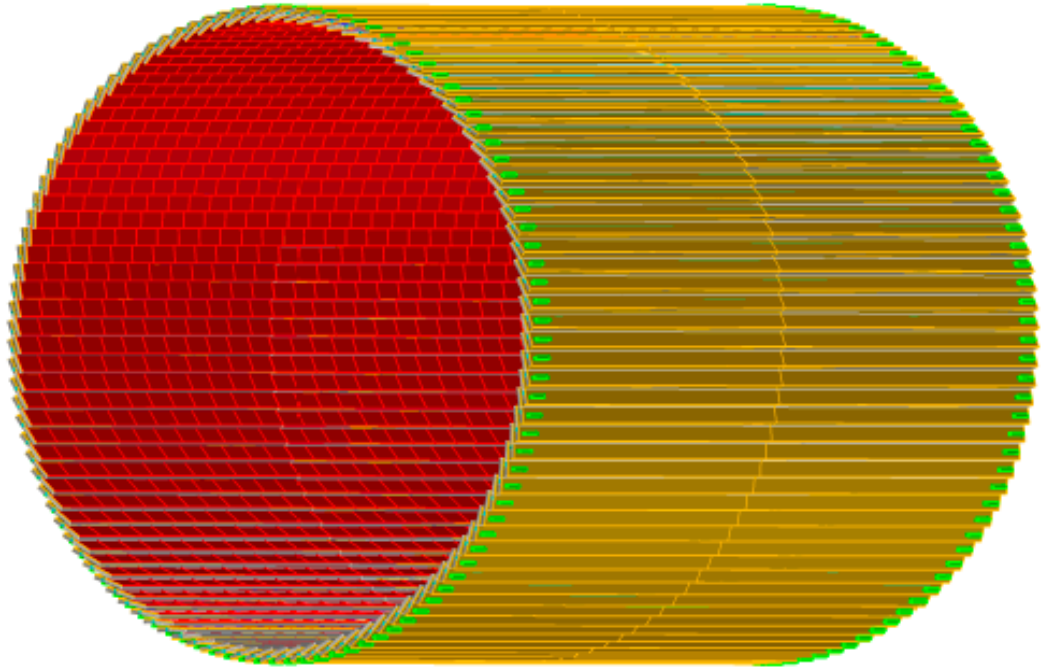
eRD112/LGAD Consortium meeting 8/3/2022 by Chris Madrid (FNAL)
https://indico.bnl.gov/event/16500/

Barrel TOF Layout and Specification

- **Single layer of strip AC-LGAD sensors**
  - 62<R<65 cm, 2.7 m long, ~11 m^2 area
- **Strip metal electrodes, with 500 μm pitch in rϕ and 1 cm* in z**
  - Minimal material budget and power consumption compared to pixels

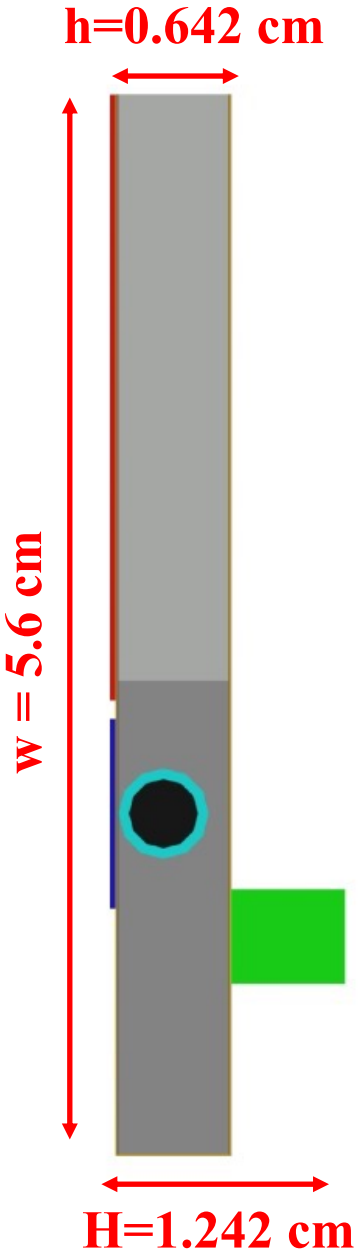
* Will look into longer strips with sensor R&D

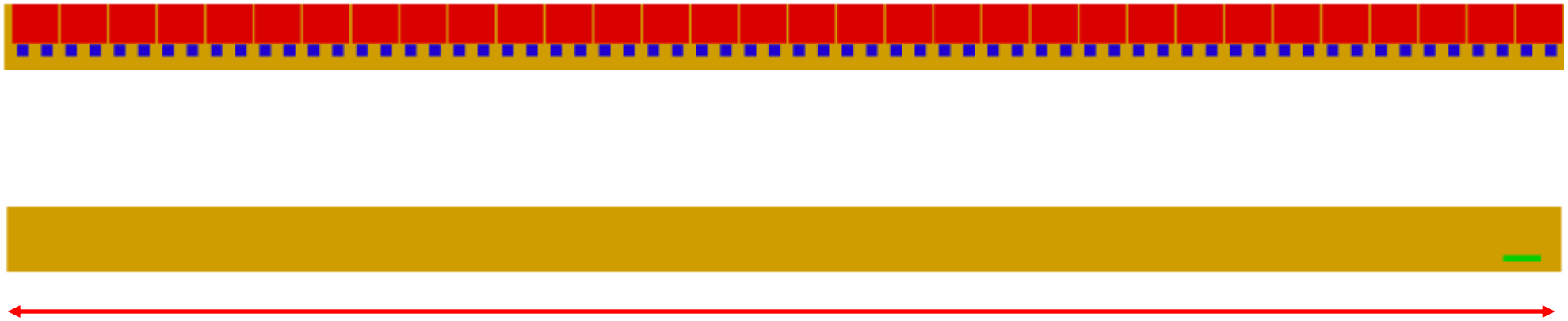




EPIC Barrel TOF Module

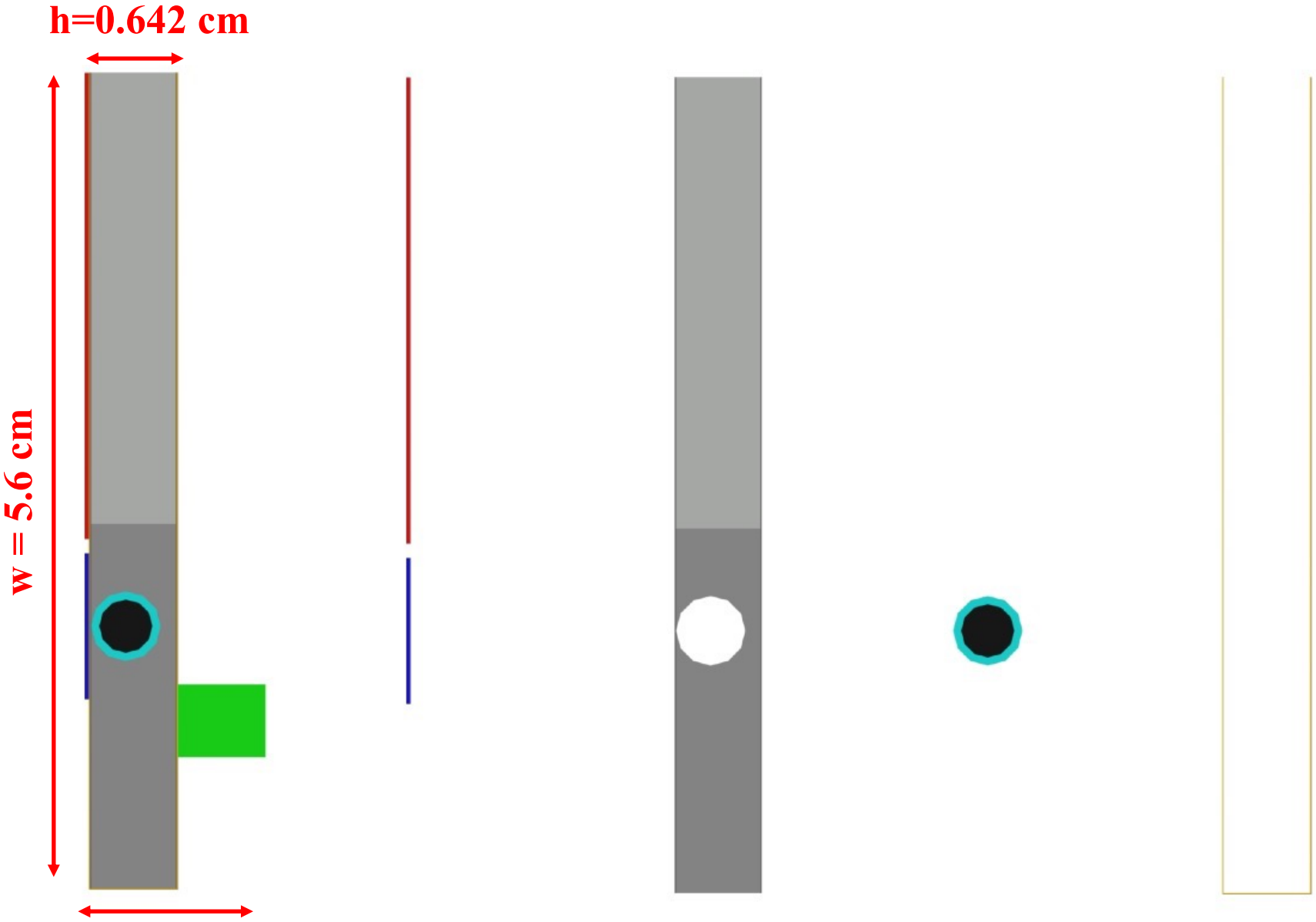
>95% coverage in Z





- **32 AC-LGAD sensors**, each 3.2*4 cm^2 read out by **2 ASICs**
- **Low mass flexible Kapton PCB** distributes power and I/O signals from a low mass connector(s) at the edge
- **Liquid coolant** in **Al cooling tube** takes away heat from the ASICs

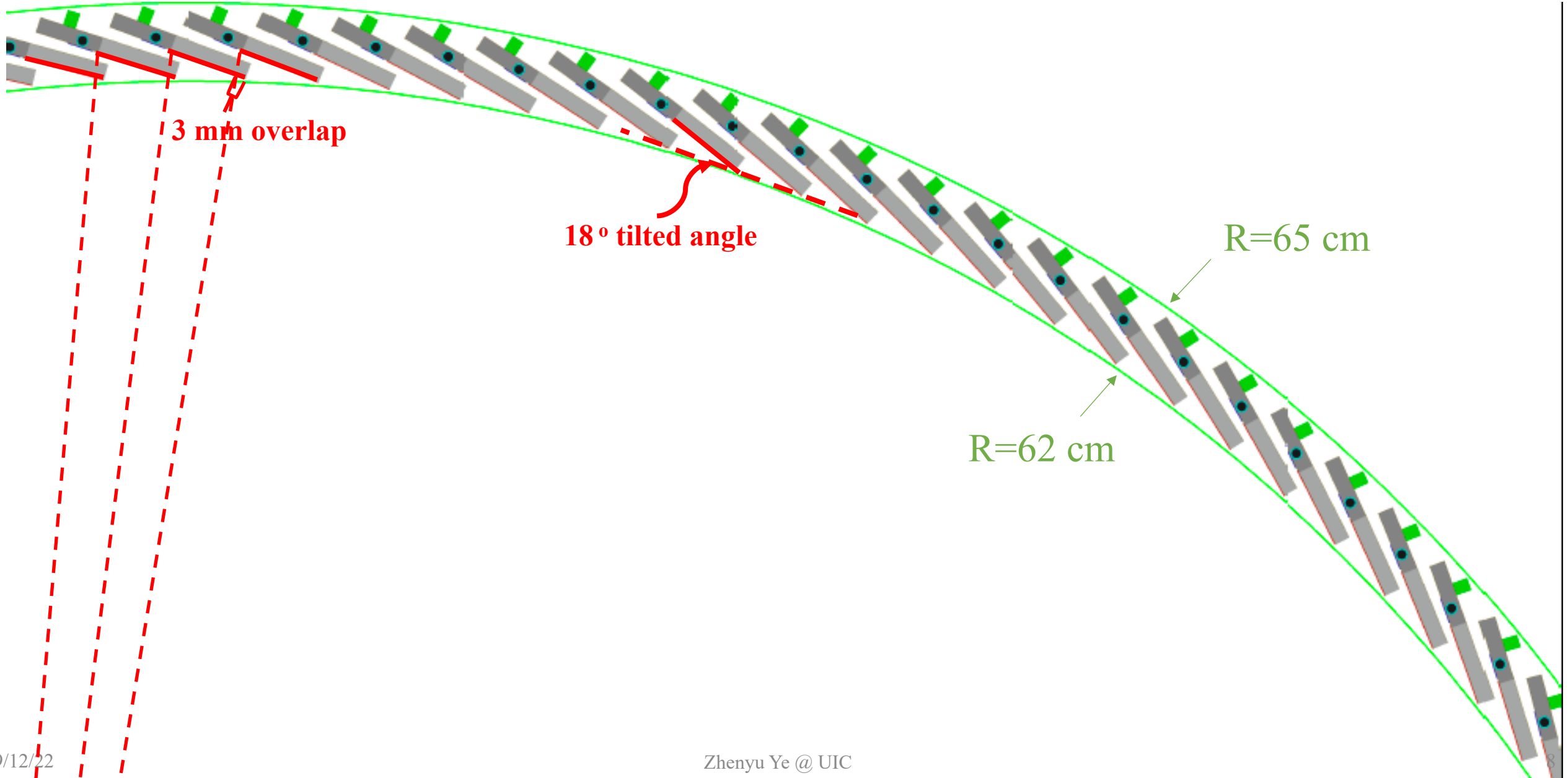
EPIC Barrel TOF Module



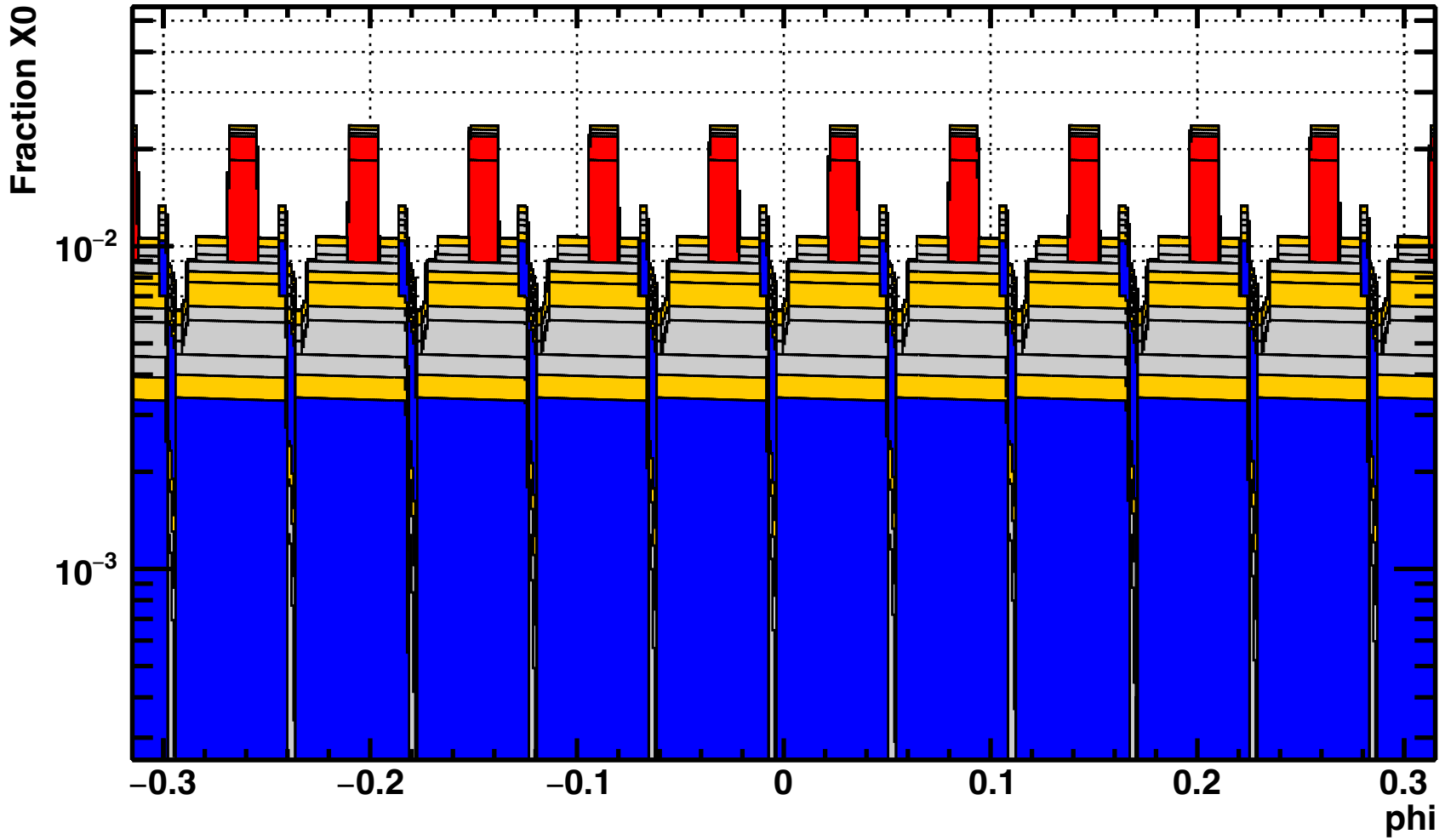
- AC-LGAD sensor
- Frontend ASICs
- Carbon foam+
  Carbon honeycomb+
  CF skins
- Al cooling tube
- Liquid coolant
- Kapton PCB
- Connector

EPIC Barrel TOF Detector Layout

Full azimuthal coverage



Barrel TOF Material Budget

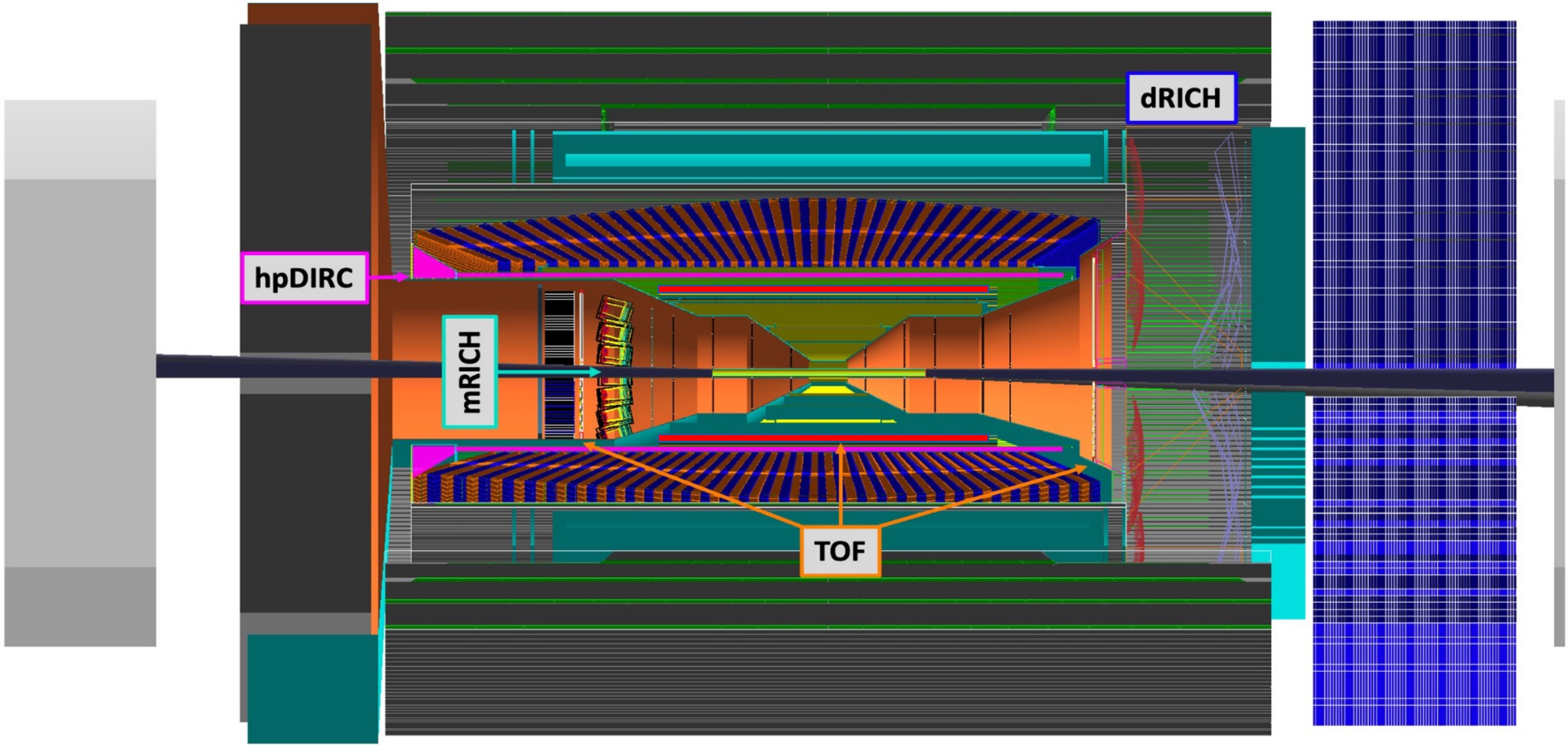


Average material budget ~1% X_0

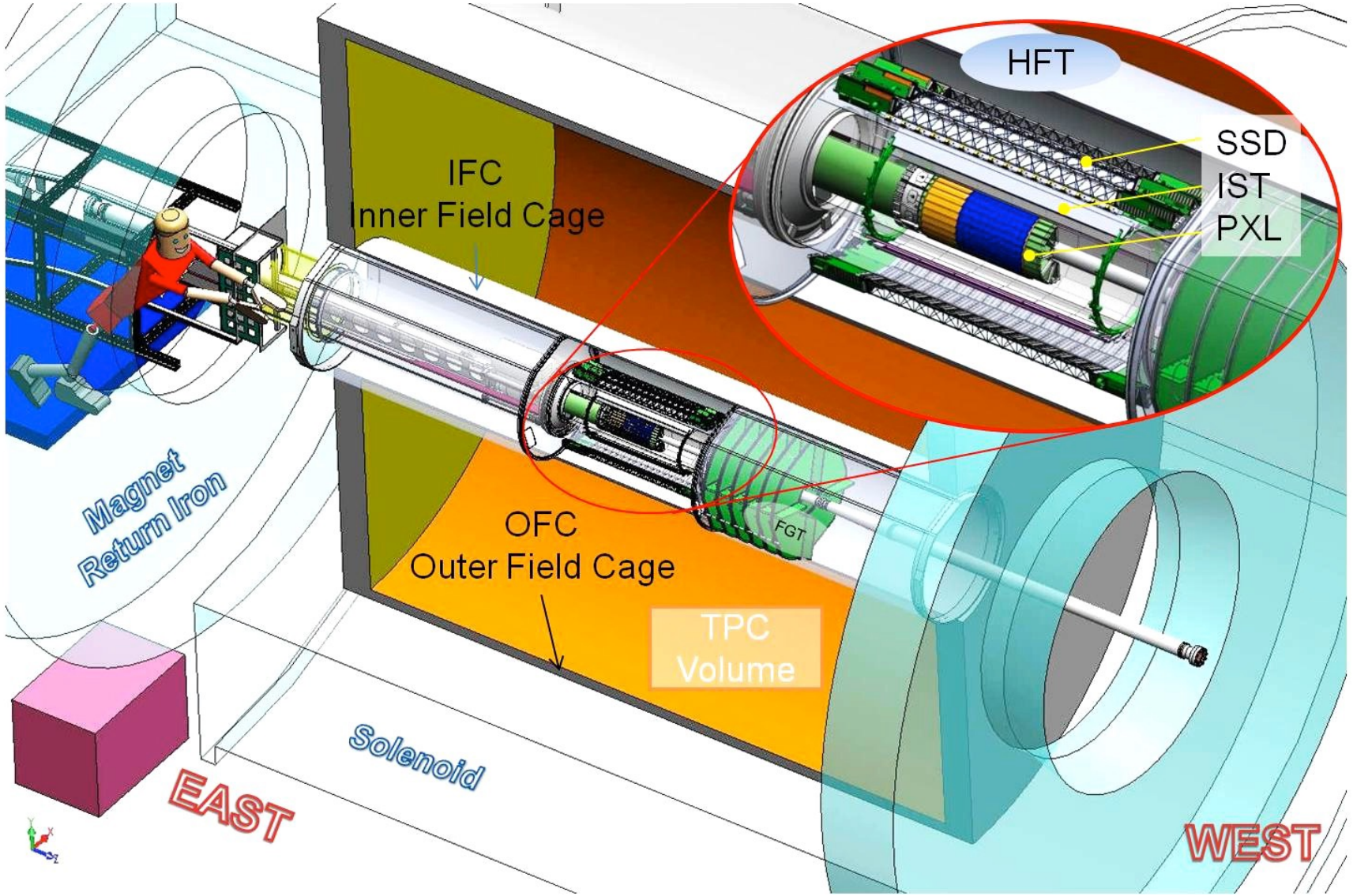
Services

- In total 288 modules,
  - 9216 sensors, 18,432 ASICs, 2.4 M channels
  - ~70 kG, ~4 kW
- On each module:
  - 32 sensors, 64 frontend ASIC
  - Powered and read out by 1 service board
  - 1 fiber to DAQ
  - 1 LV+HV cable
  - 1 liquid cooling line

Backup



STAR Intermediate Silicon Tracker



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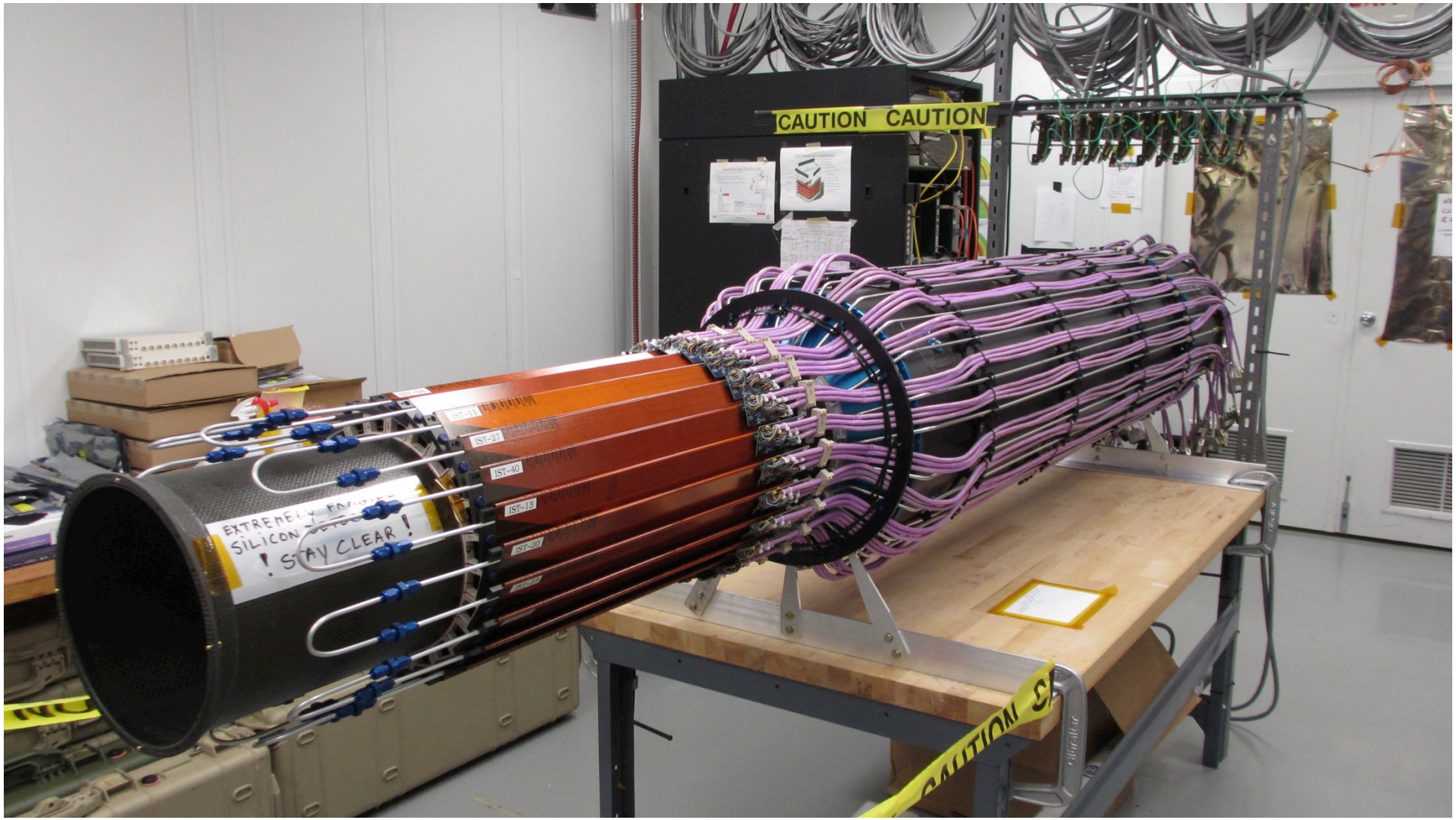

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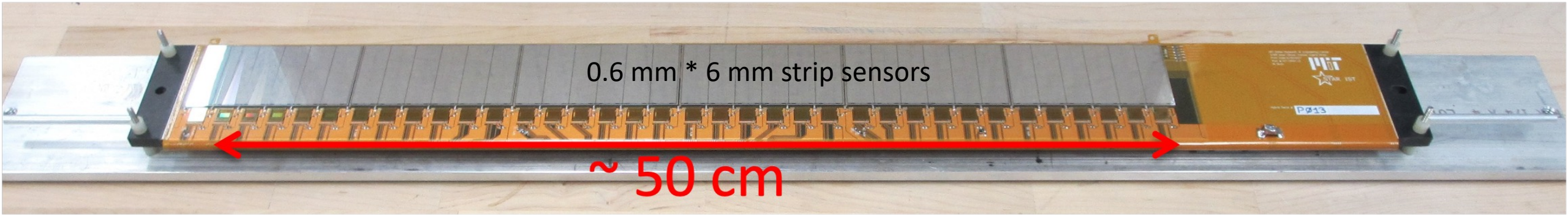

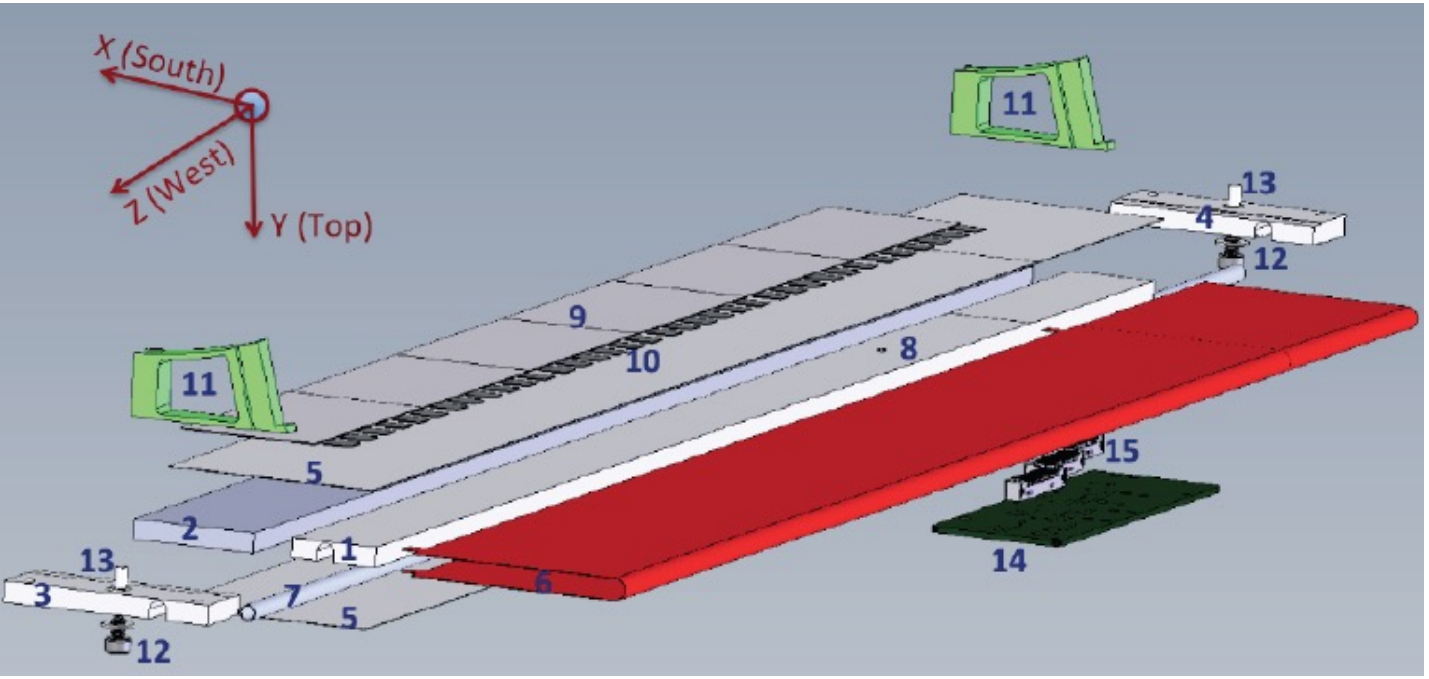

1) carbon foam 2) carbon honeycomb 3) west carbon end-cap 4) east Al end-cap 5) carbon fiber skins 6) Kapton hybrid 7) Al cooling tube with cooling liquid inside 8) thermal sensor 9) silicon sensors 10) APV chips 11) support blocks 12) screws with washers 13) spacers 14) transition board 15) readout connectors.

STAR Intermediate Silicon Tracker

Material budget <1% X_0