



BERKELEY LAB
Bringing Science Solutions to the World

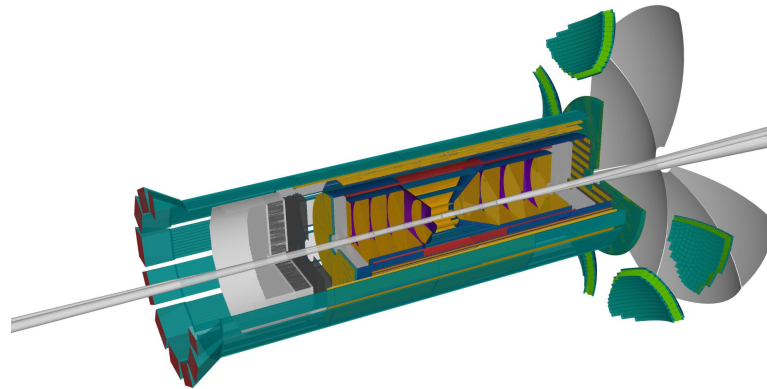


SVT Simulation Status

Shujie Li

ePIC Tracking WG meeting

Dec 14, 2023

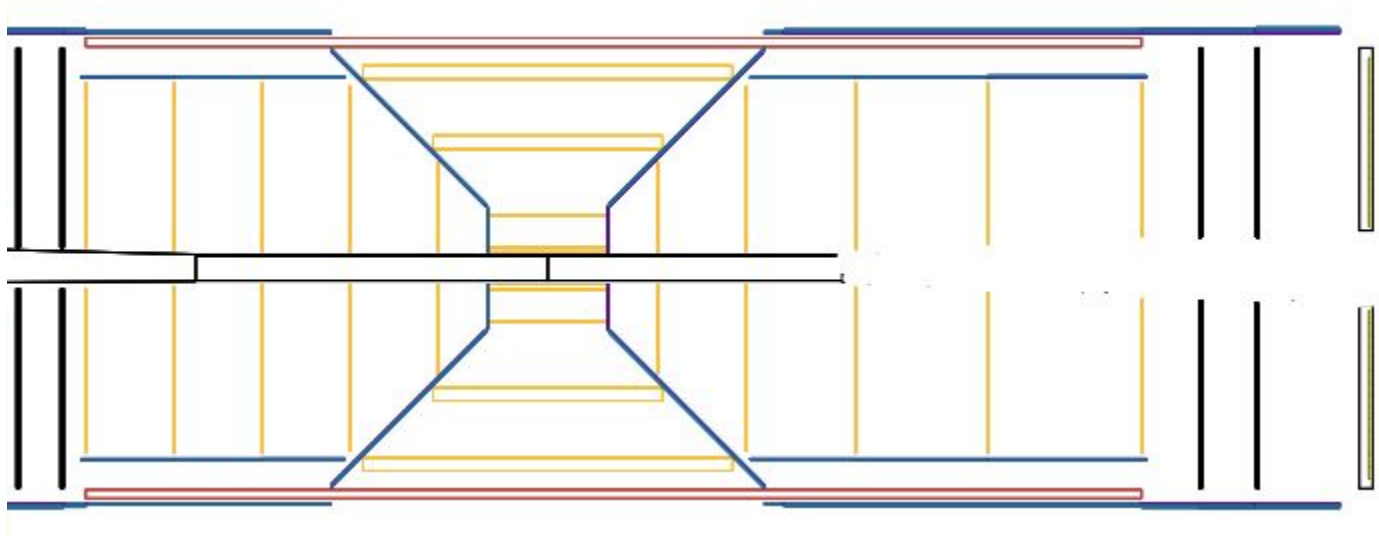


Craterlake Configuration

SVT geometry on GitHub:
[epic/compact/tracking/](https://github.com/epic/compact/tracking/)

Silicon trackers:

- 3 vertex barrels
- 2 outer barrels
- 5 disks (forward/backward)



Craterlake Configuration

ePIC geometry database

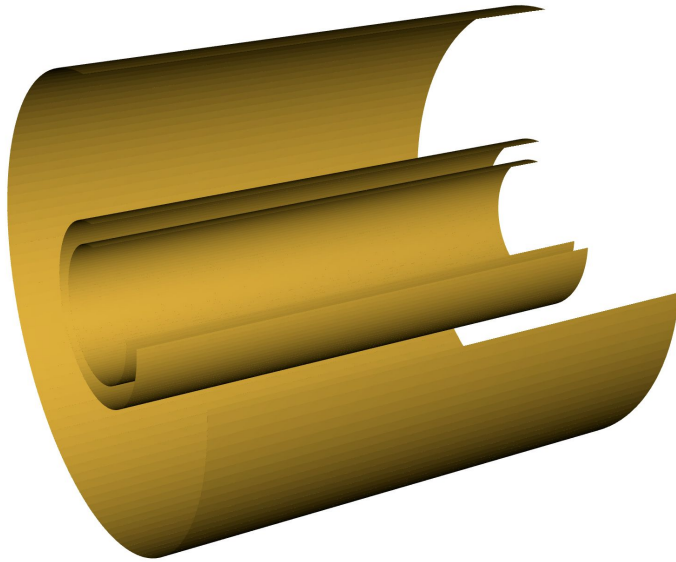
<https://eic.jlab.org/Geometry/Detector/Detector-20231031150001.html>

Component	Sub-Component	WBS	Length (cm)	Inner Radius (cm)	Outer Radius (cm)	Offset from Center (cm)	Physical Start (cm)	Physical End (cm)
Inner Tracker (Si Barrel)		6.10.03	80	3.6	42.5	0	-40	40
	<i>Si Layer 1</i>		27	3.6	4.1	0	-13.5	13.5
	<i>Si Layer 2</i>		27	4.8	5.3	0	-13.5	13.5
	<i>Si Layer 3</i>		27	12	12.5	0	-13.5	13.5
	<i>Si Layer 4</i>		54	27	27.5	0	-27	27
	<i>Si Layer 5</i>		80	42	42.5	0	-40	40
Inner Tracker (Si Disks)		6.10.03	242.5	3.676	43	15	-106.25	136.25
	<i>HD Disk 1</i>		2.5	3.676	23	25	23.75	26.25
	<i>HD Disk 2</i>		2.5	3.676	43	45	43.75	46.25
	<i>HD Disk 3</i>		2.5	3.842	43	70	68.75	71.25
	<i>HD Disk 4</i>		2.5	5.443	43	100	98.75	101.25
	<i>HD Disk 5</i>		2.5	7.014	43	135	133.75	136.25
	<i>LD Disk 1</i>		2.5	3.676	23	-25	-26.25	-23.75
	<i>LD Disk 2</i>		2.5	3.676	43	-45	-46.25	-43.75
	<i>LD Disk 3</i>		2.5	3.676	43	-65	-66.25	-63.75
	<i>LD Disk 4</i>		2.5	4.00614	43	-85	-86.25	-83.75
	<i>LD Disk 5</i>		2.5	4.63529	43	-105	-106.25	-103.75

Vertex Barrels

[epic/compact/tracking/vertex_barrel.xml](#)

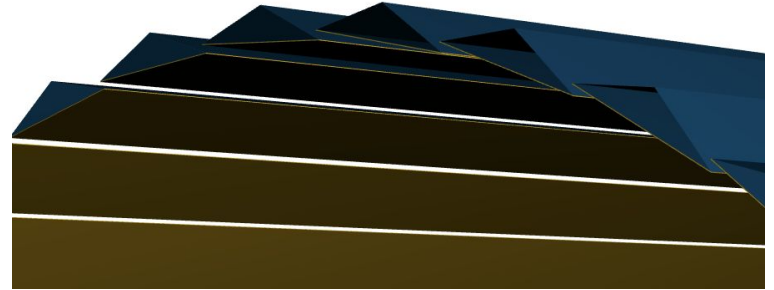
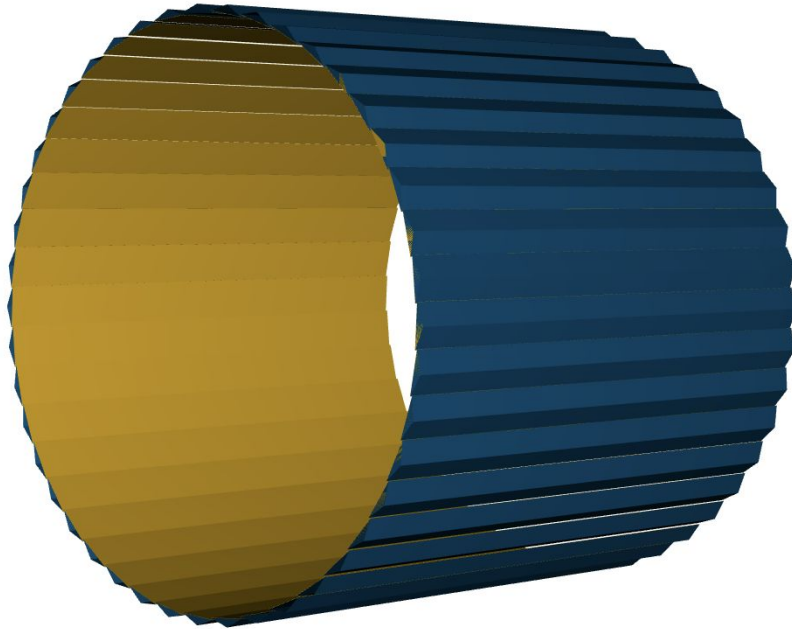
3 ITS3 silicon layers (40um thick, $r=3.6, 4.8, 12\text{cm}$) approximated with 128 staves



ALL SVT parts are implemented as solid surfaces with segmentation size of 20x20um to mimic the pixel.
NO module, Periphery, or other mechanical details

Outer Barrels

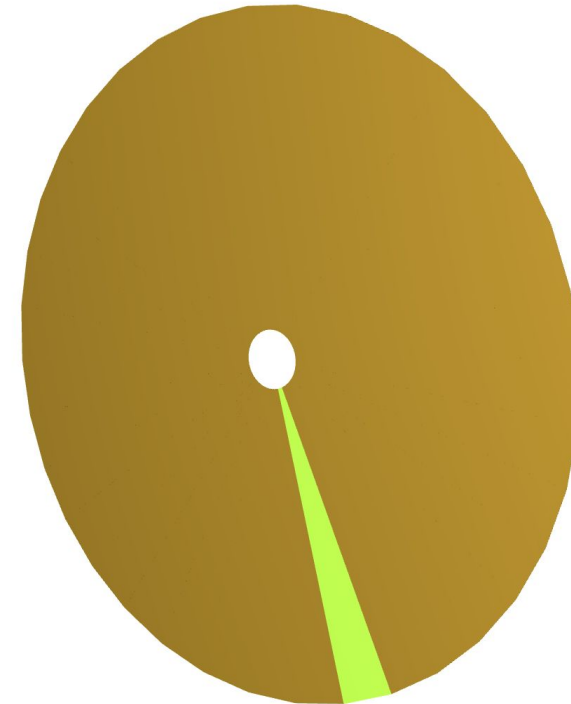
44 slightly tilt triangle staves (silicon + Al + carbon fiber plates. No truss structure etc.)



Disks

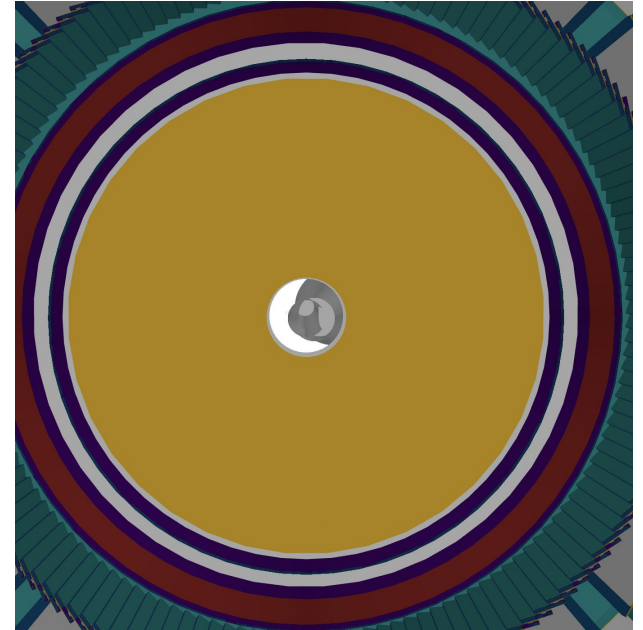
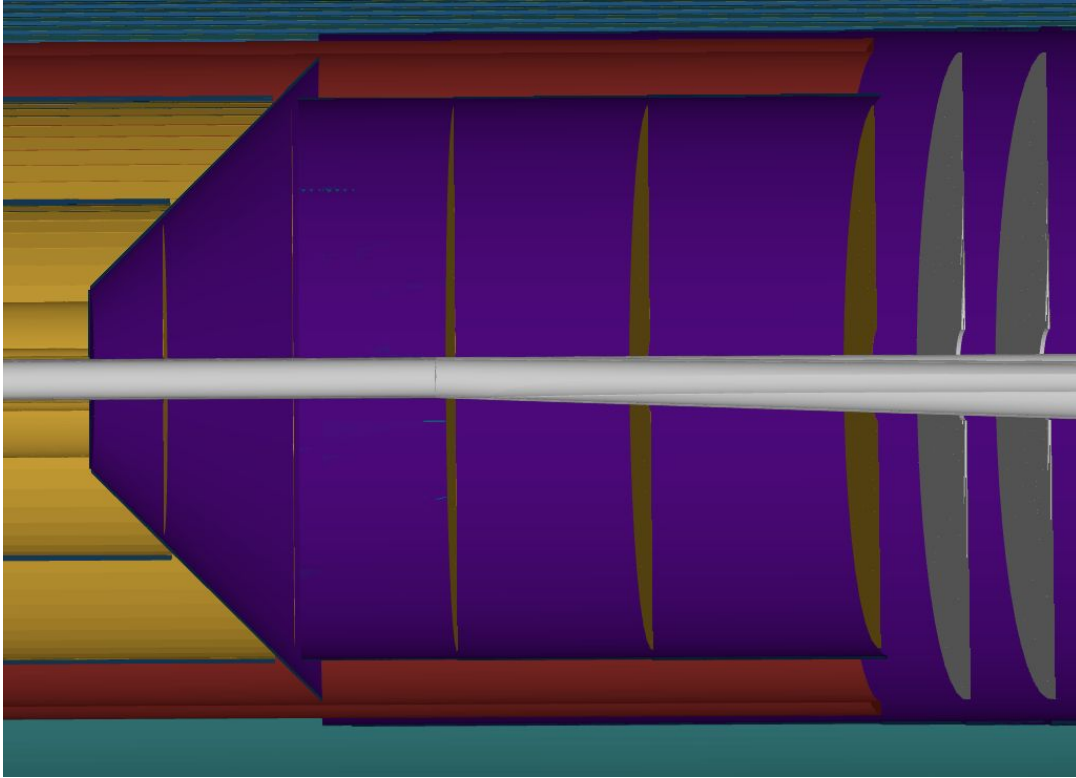
disk	Name in dd4hep	z pos (mm)	R_bpipe	x_offset	R_outer	R_inner_sym
5n	TrackerEndcapNDisk4	-1050	38.043	-3.310	430	46.3529
4n	TrackerEndcapNDisk3	-800	34.244	-0.817	430	40.0614
3n	TrackerEndcapNDisk2	-650	31.76	0	430	36.76
2n	TrackerEndcapNDisk1	-450	31.76	0	430	36.76
1n	InnerTrackerEndcapN	-250	31.76	0	230	36.76
1p	InnerTrackerEndcapP	250	31.76	0	230	36.76
2p	TrackerEndcapPDisk1	450	31.76	0	430	36.76
3p	TrackerEndcapPDisk2	700	32.86	0.6	430	38.42
4p	TrackerEndcapPDisk3	1000	40.58	7.85	430	53.43
5p	TrackerEndcapPDisk4	1350	49.12	16.02	430	70.14

- $X/X_0=0.24\%$
- silicon + carbon fiber + aluminum plates
- 36 sections of



Disks

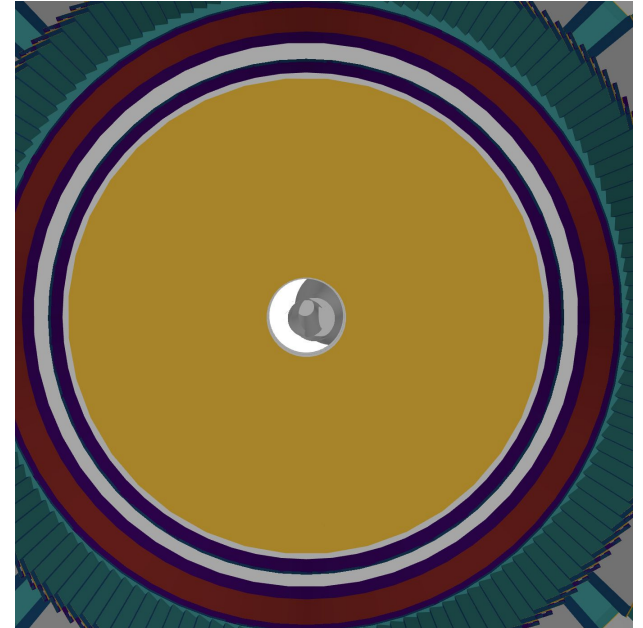
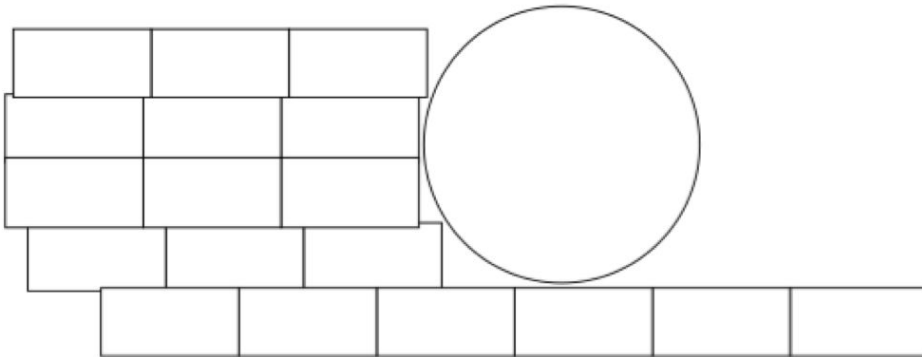
Now: use larger centered hole to accommodate beampipe fan-out



Disks

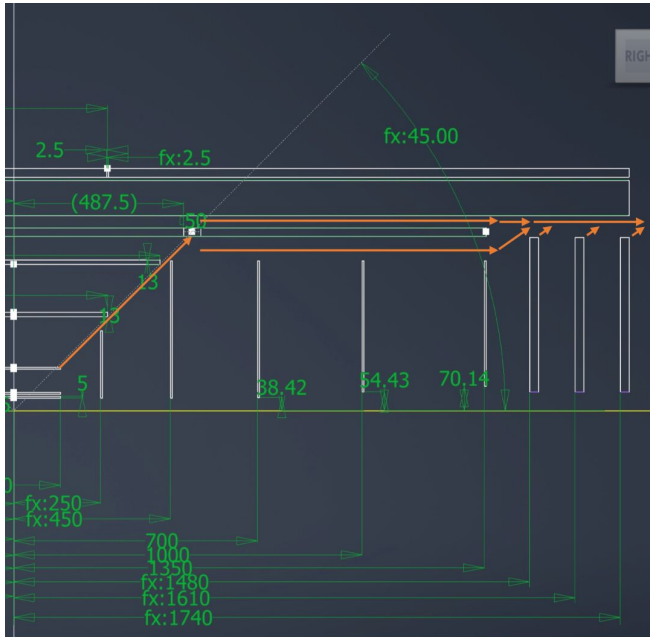
Work in progress: assemble disks with staves

Status: initial DD4hep module created by Stephen Maple (U. of Birmingham) but didn't pass all ACTS geometry test. See <https://github.com/eic/epic/issues/118>

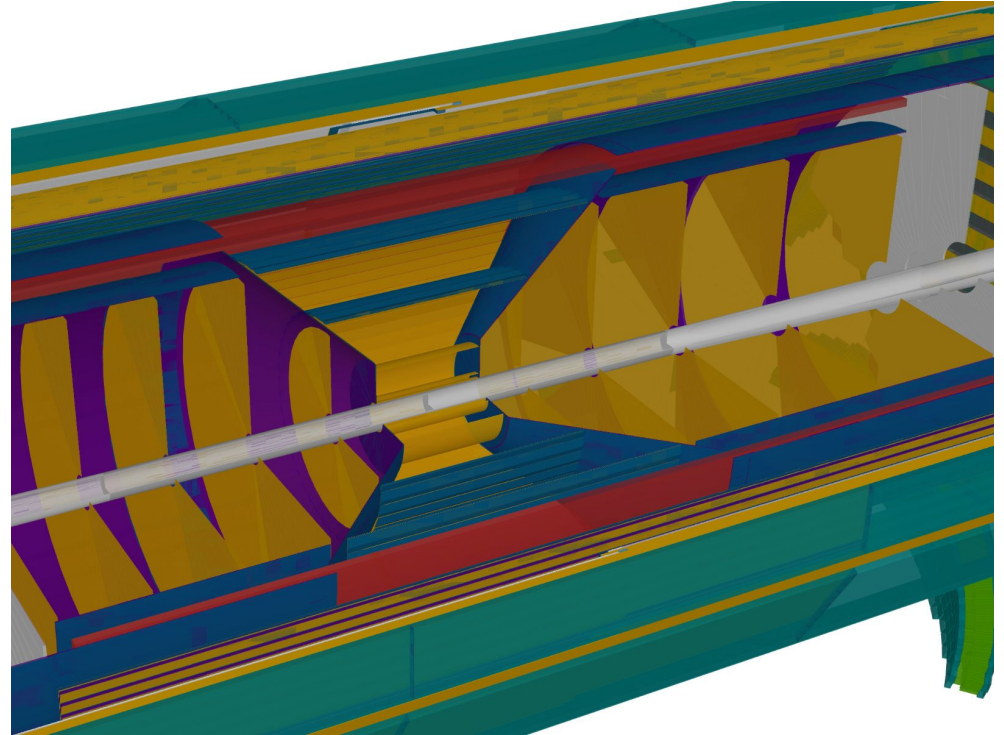


Service cables and Supporting Structure

Cables guided out along the carbon supporting cone



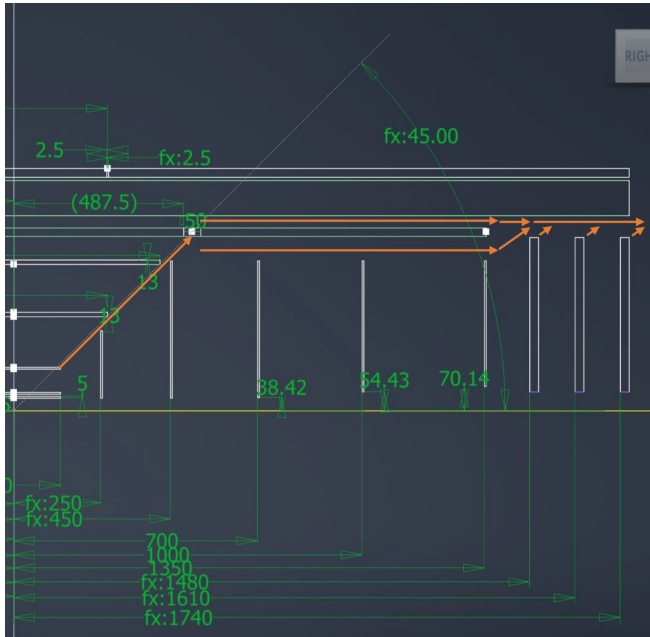
Courtesy of E. Sichtermann



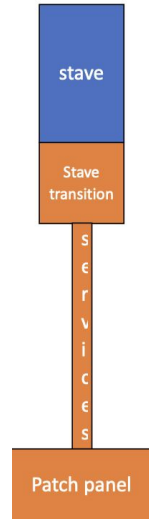
Service cables and Supporting Structure

Cables guided out along the carbon supporting cone

Cables treated as uniform aluminum layers with effective area thickness proportional to silicon surface size.



Courtesy of E. Sichtermann

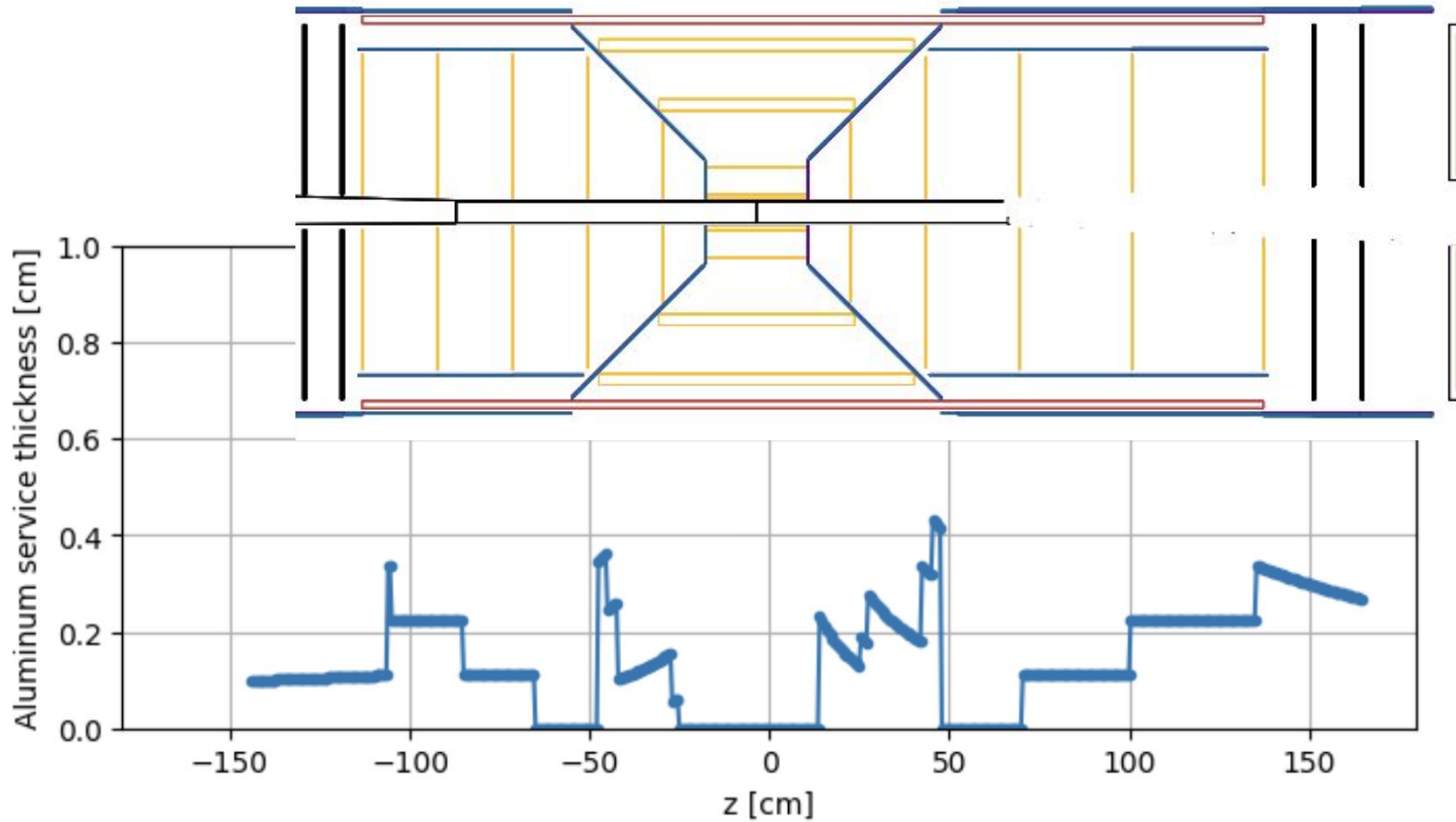


Summary of ITS3 like Si tracking

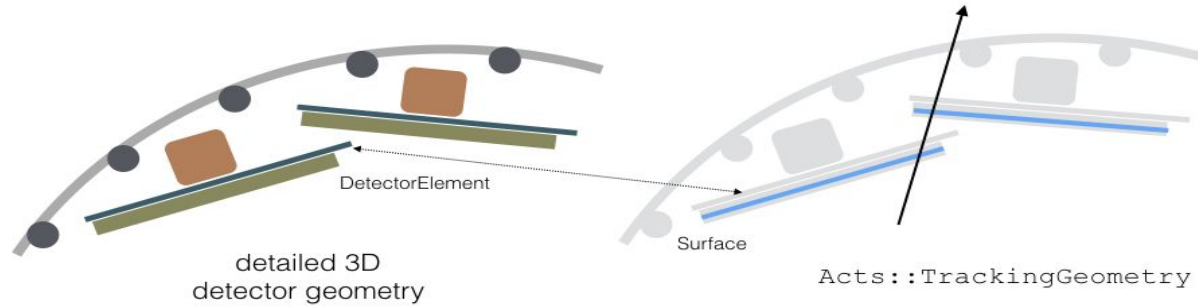
	Stave X/X0	Stave transition (per 100 cm ² of Si surface)*	Services (per 100 cm ² of Si surface)*	Patch panel (per 100 cm ² of Si surface)*
ITS3 like vertexing	~0.1%	6.66 cm ³ of material with X/X0 of 0.0684 per traversed cm	2.96 cm ² cross section with X/X0 of 0.022 per traversed cm	4.32 cm x 1cm x 1 cm with 0.102 X/X0 per traversed cm
ITS3 like barrel (up to 1.5m length)	0.55 %	4.286 cm ³ of material with X/X0 of 0.0684 per traversed cm	1.905 cm ² cross section with X/X0 of 0.022 per traversed cm	2.778cm x 1cm x 1 cm with 0.102 X/X0 per traversed cm
ITS3 like disc (up to 60 cm diameter)	0.24%	6.66 cm ³ of material with X/X0 of 0.0684 per traversed cm	2.96 cm ² cross section with X/X0 of 0.022 per traversed cm	4.321 cm x 1cm x 1 cm with 0.102 X/X0 per traversed cm

* Corrected 2021_03_13

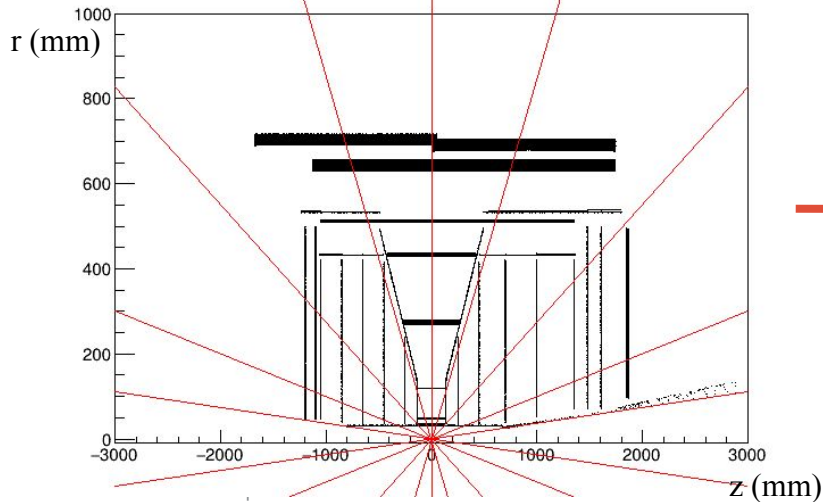
Service cables and Supporting Structure



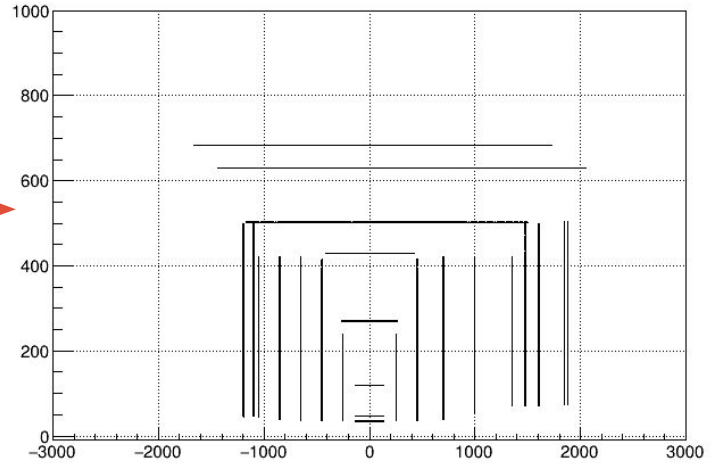
Simplified geometry in ACTS



Central tracker side view
projective lines: $\eta=0, 1, 2, \dots$



Project materials to surfaces



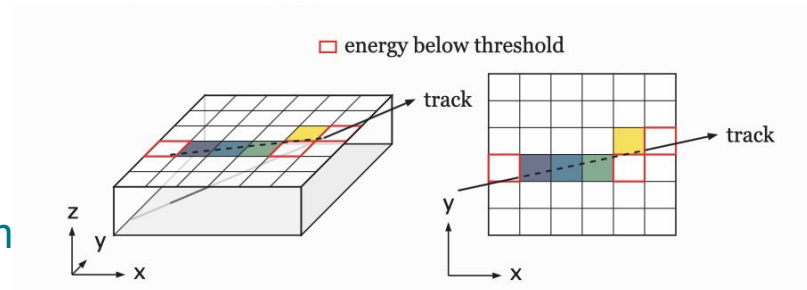
Digitization Scheme [\(ePIC digitization model\)](#)

1. Setup segmentation in geometry description file. Each SimHit has a cell ID on the detector surface

```
<readouts>
  <readout name="SiBarrelHits">
    <segmentation type="CartesianGridXY" grid_size_x="0.020*mm" grid_size_y="0.020*mm" />
    <id>system:8,layer:4,module:12,sensor:2,x:32:-12,y:-20</id>
  </readout>
</readouts>
```

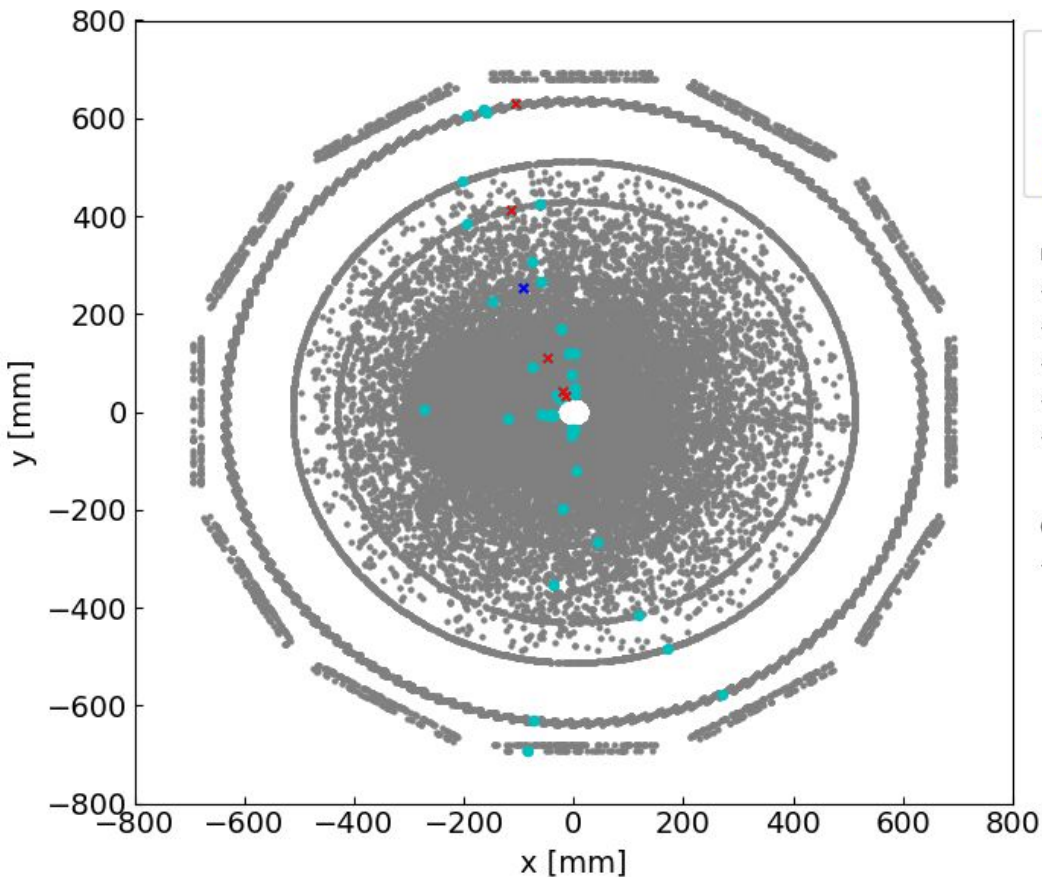
2. Digitization in ElCrecon:

- 1) read in SimHit (cell ID, edep, tim
- 2) apply energy threshold (0.54 keV)
- 3) put hit at the center of each cell, resolution = pixel size / sqrt(12)
- 4) Digitized hit → tracking measurement



To do: clustering and noise

Tracking Study with DIS Events



on-going:

- tracking performance study with background+DIS
- Dedicated study on number of hits and chi2

to do:

- use timing info for signal/background separation
- project trajectory to various detector surface/volumes

Summary

- The Craterlake SVT configuration is implemented in DD4hep with limited details. It serves the purpose of preliminary simulation study.
- Looking forward, efforts are needed to make the SVT geometry description (staves, disks, cables etc) more realistic.
- Digitization and reconstruction studies are also on-going

