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U.S. DEPARTMENT OF ENERGY
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# ATHENA Silicon Tracker Material Scan (DD4HEP)

Shujie Li
With Whitney Armstrong, Sylvester Joosten, Ernst Sichtermann

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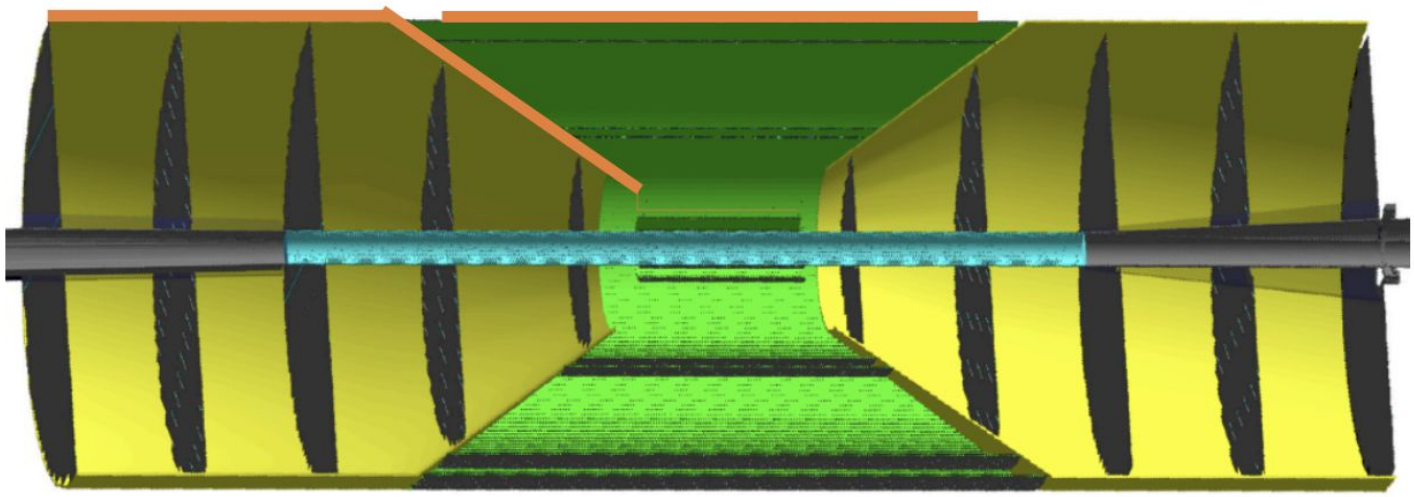
# Baseline Design Details at https://wiki.bnl.gov/athena/index.php/Tracking

- Silicon pixel: 10x10x40 um
- 3 groups of barrel layers:
  - 2 vertex layers (ITS3, 0.05% X0 / layer) + 0.3mm carbon fiber support shell
  - 2 inner barrel layers and 2 outer barrel layers (staves, 0.55% X0 /layer = silicon + aluminum + triangular carbon fiber frame)
- 5 disks on each side:
  - ITS3, 0.24% / disk = silicon + aluminum
- 2mm carbon fiber support frame along cone and outer barrel/disks (thick orange line)
- Service material (X/X0 = 0.022) along the cone and endcap outer support shell

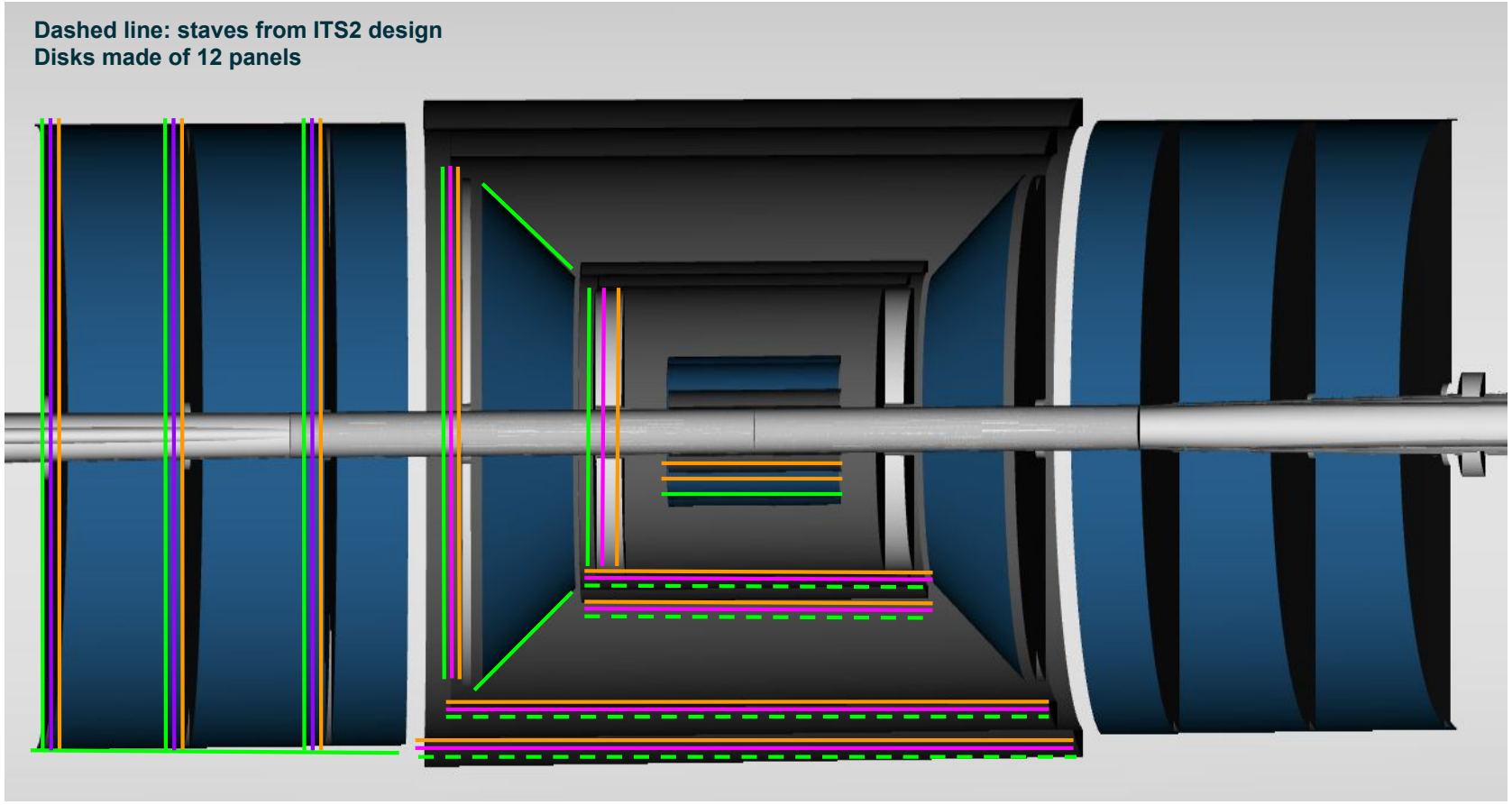


Courtesy of Ernst

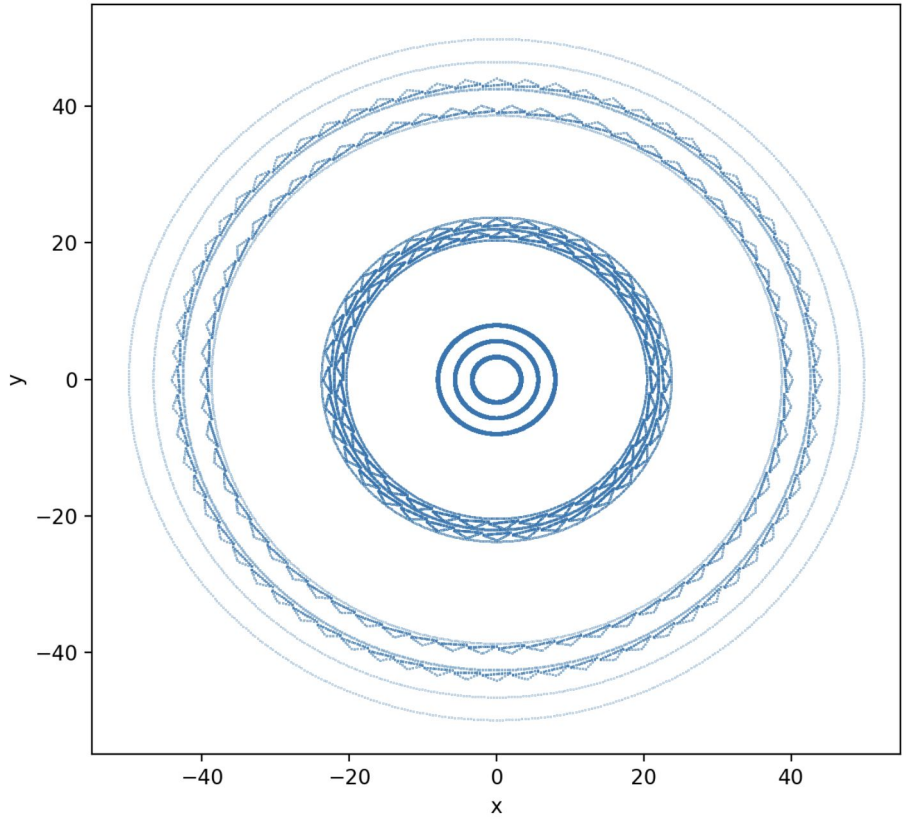
# Already Implemented (as of Aug 23)

Silicon
Aluminum
CarbonFiber

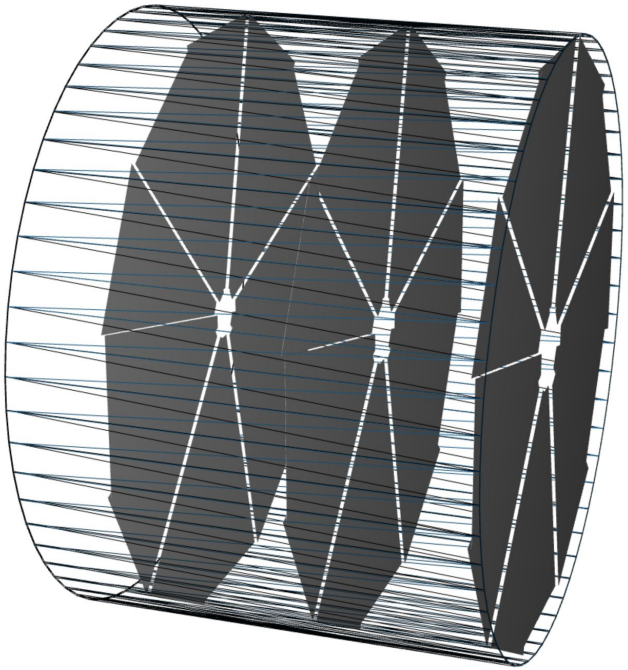
Tracking geometry viewer



Cross section of barrel region




Outermost three disks and the support frame



- Stave tilt angle 5 degree
- Number of staves optimized for full coverage
- 12 panels per Disk, to be optimized

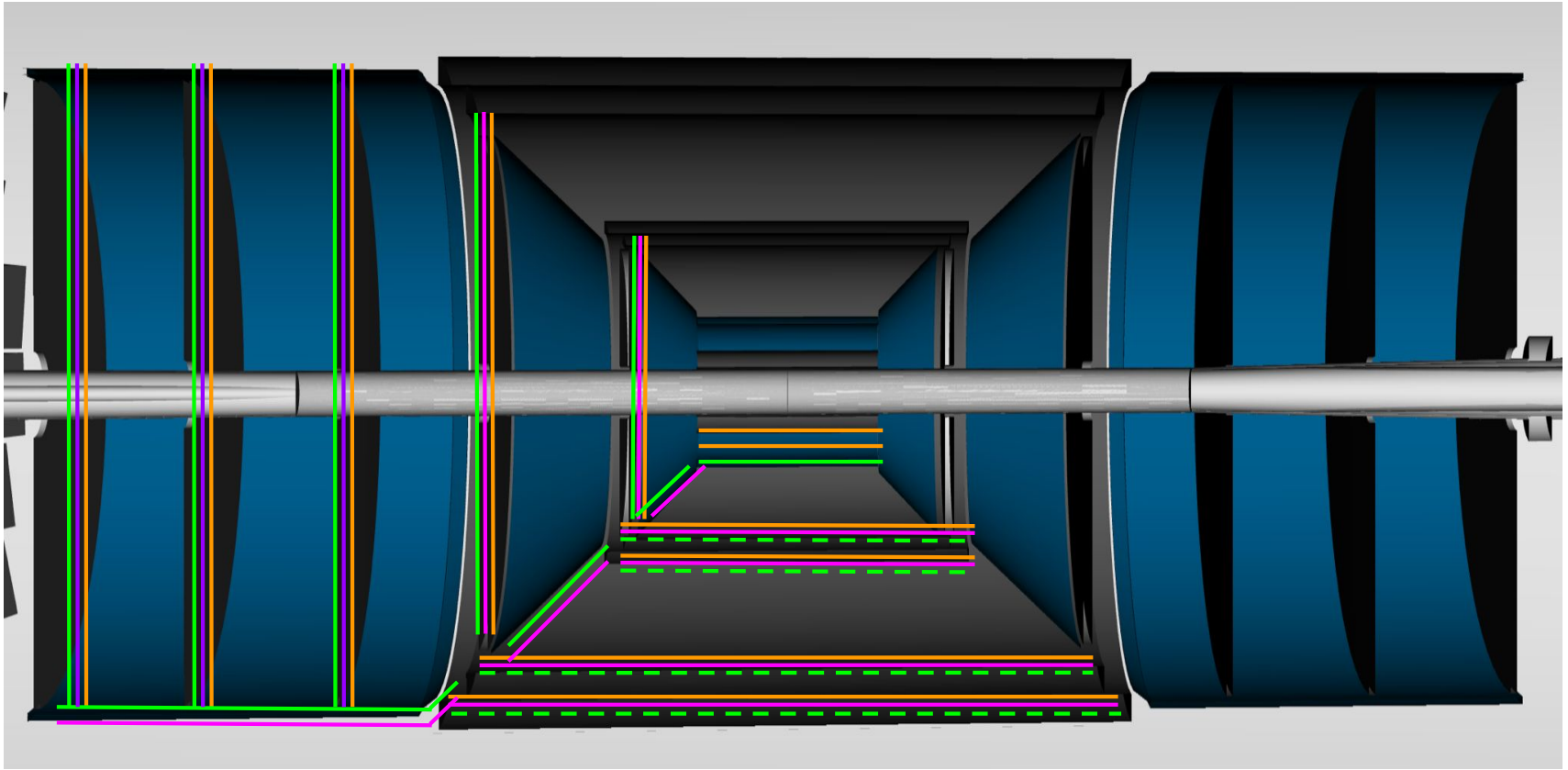
# Updates in Progress

**Silicon**
**Aluminum**
**CarbonFiber**

**Dashed line: staves from ITS2 design**
**Disks made of 12 panels**

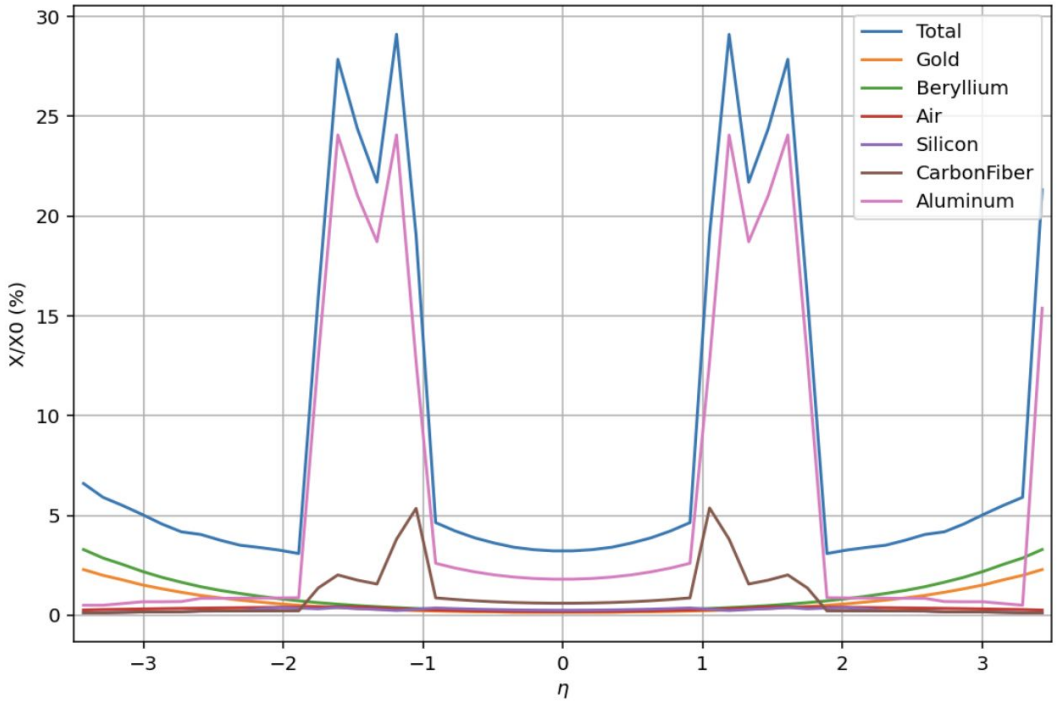
To do:

- 2mm carbon shell around the outer barrel
- Disk-like connection b/w the end of vertex layer and the cone
- flush the cone

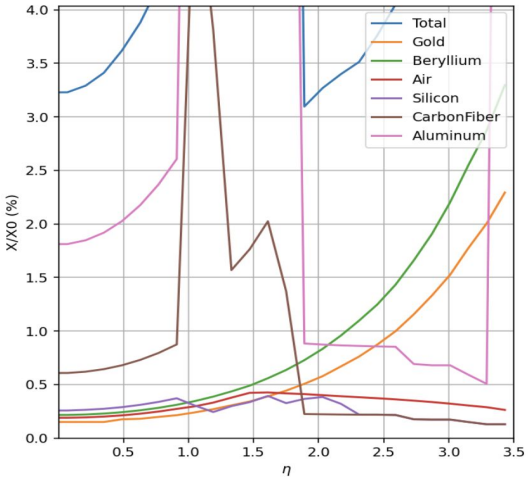


# Material Scan

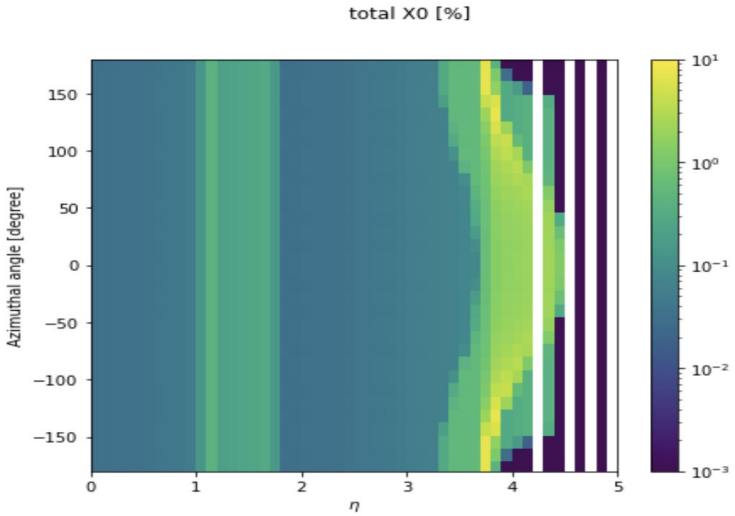
Based on TGeometry
DD4hep command line utility: materialScan
Code: run_matscan.sh (to be added in benchmark)




Zoom in eta>0

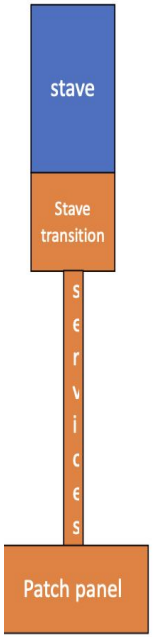



2D view



# Service Material

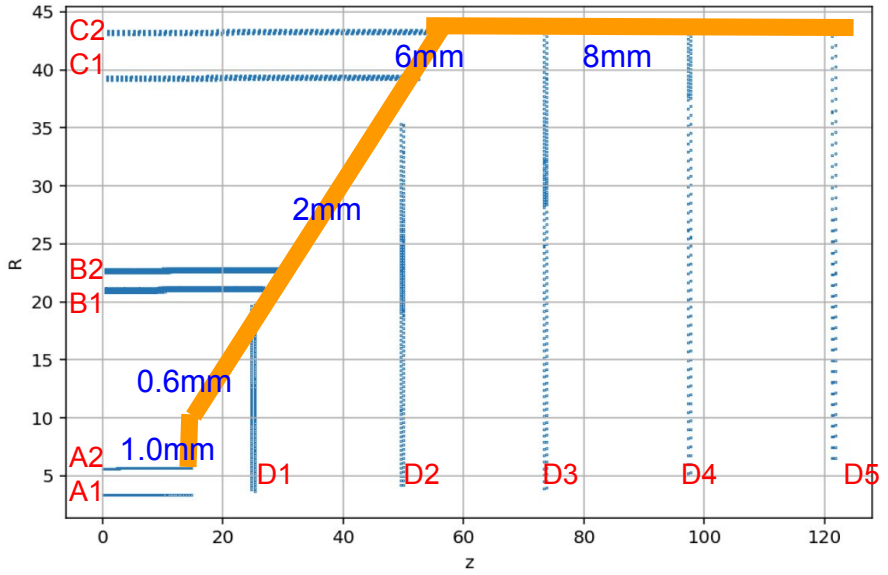
X0 = ⅕ Aluminum ⇒ use equivalent aluminum thickness in simulation




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




Aluminum Thickness wrt z