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Auto Script for ACTS $^{v30+}$ Material Map

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EIC-ePIC tracking/track recon/vertexing meeting

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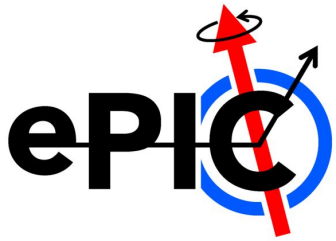
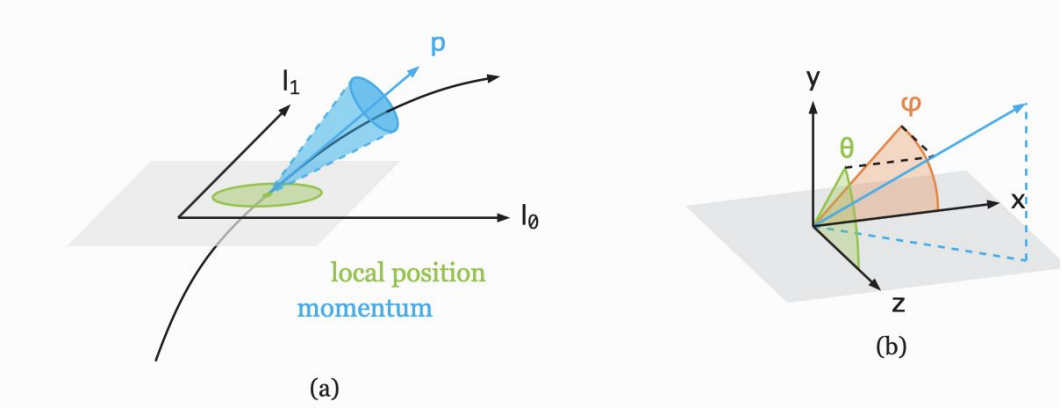


https://acts.readthedocs.io/en/latest/tracking.html

Material Effects in Track Propagation

Track parameter:

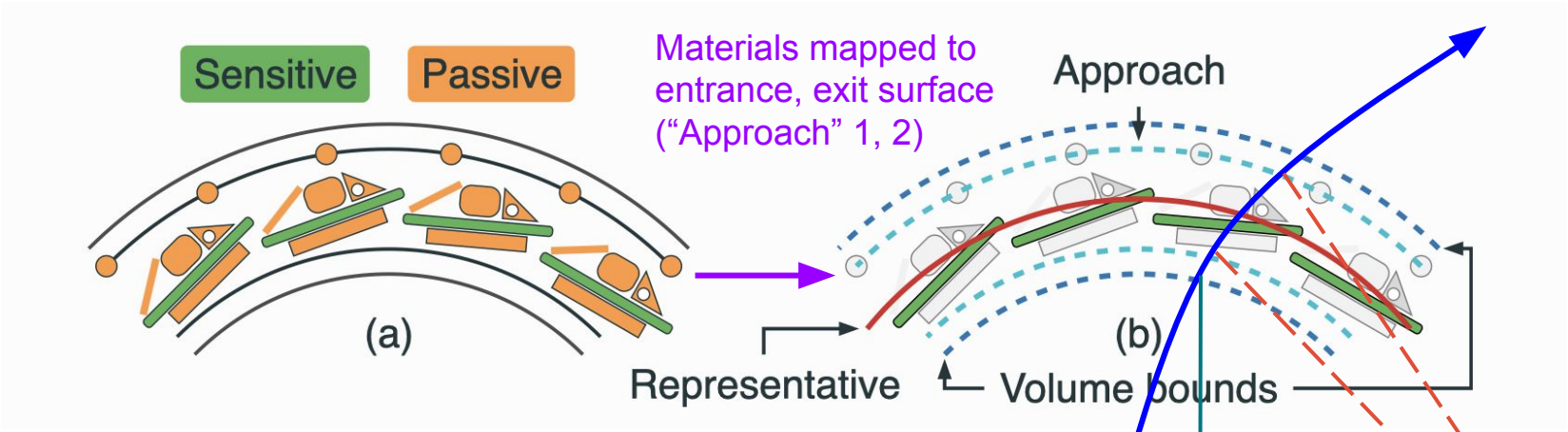
$$\vec{x} = (l_0, l_1, \phi, \theta, q/p, t)^T$$

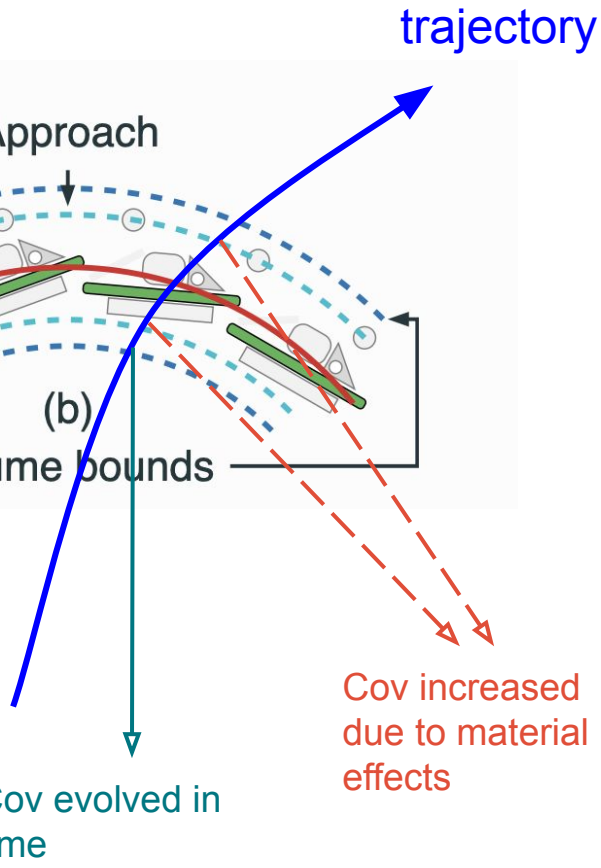


Covariance Matrix:

$$C = \begin{bmatrix} \sigma^2(l_0) & \mathrm{cov}(l_0, l_1) & \mathrm{cov}(l_0, \phi) & \mathrm{cov}(l_0, \theta) & \mathrm{cov}(l_0, q/p) \\ . & \sigma^2(l_1) & \mathrm{cov}(l_1, \phi) & \mathrm{cov}(l_1, \theta) & \mathrm{cov}(l_1, q/p) \\ . & . & \sigma^2(\phi) & \mathrm{cov}(\phi, \theta) & \mathrm{cov}(\phi, q/p) \\ . & . & . & \sigma^2(\theta) & \mathrm{cov}(\theta, q/p) \\ . & . & . & . & \sigma^2(q/p) \end{bmatrix}$$

Material Effects in Track Propagation





Material effects:

- Deflection and offset → averaged to 0, increased uncertainties
- Energy loss → reduced trajectory energy
- Hadronic process → disintegration etc.

Material mapping with ACTS v30+

For **existing** script with ACTS v21, see

instructions: https://indico.bnl.gov/event/20842/

code: https://eicweb.phy.anl.gov/EIC/benchmarks/detector_benchmarks/-/tree/material_map_script_ACTSv21/benchmarks/material_maps

Major **revision** of material mapping script: pre-compiled executable → python scripts

- flexible and easy to maintain
- user-friendly and transparent

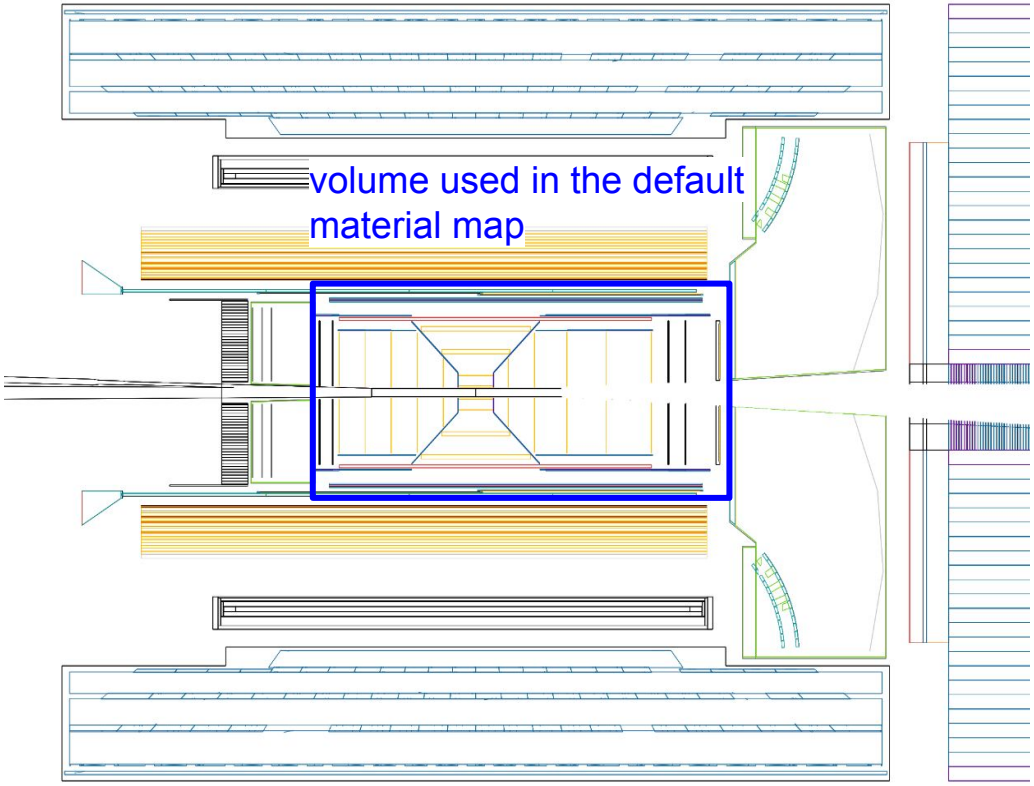
ACTS tutorial: https://acts.readthedocs.io/en/latest/examples/howto/material_mapping.html

code will be maintained at https://github.com/eic/snippets/tree/main/Tracking

Material mapping workflow

Step 0: determine the mapping envelope in DD4hep description file

- for performance purposes, a typical material map only contains the tracking envelope, e.g. epic_craterlake_tracking_only.xml
- all material mapping surfaces should be ACTS compatible (i.e. through DD4hep ACTS plugins)

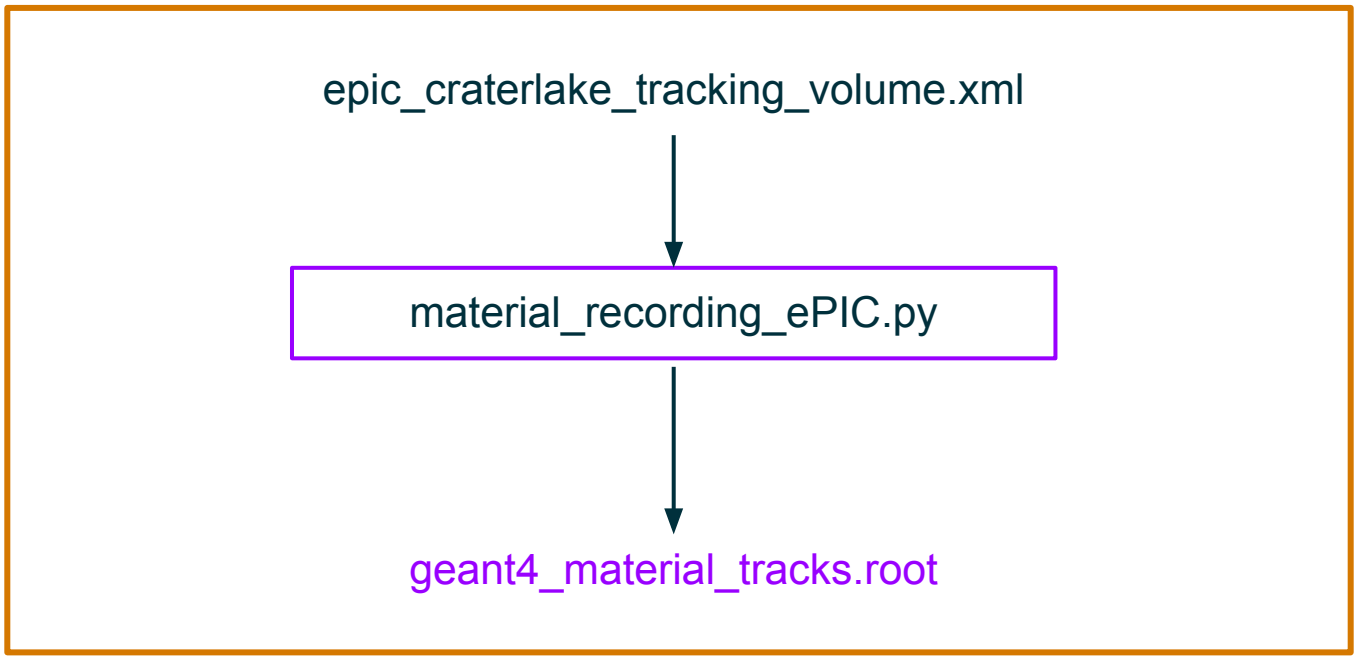


Material mapping workflow

Step 1: material recording

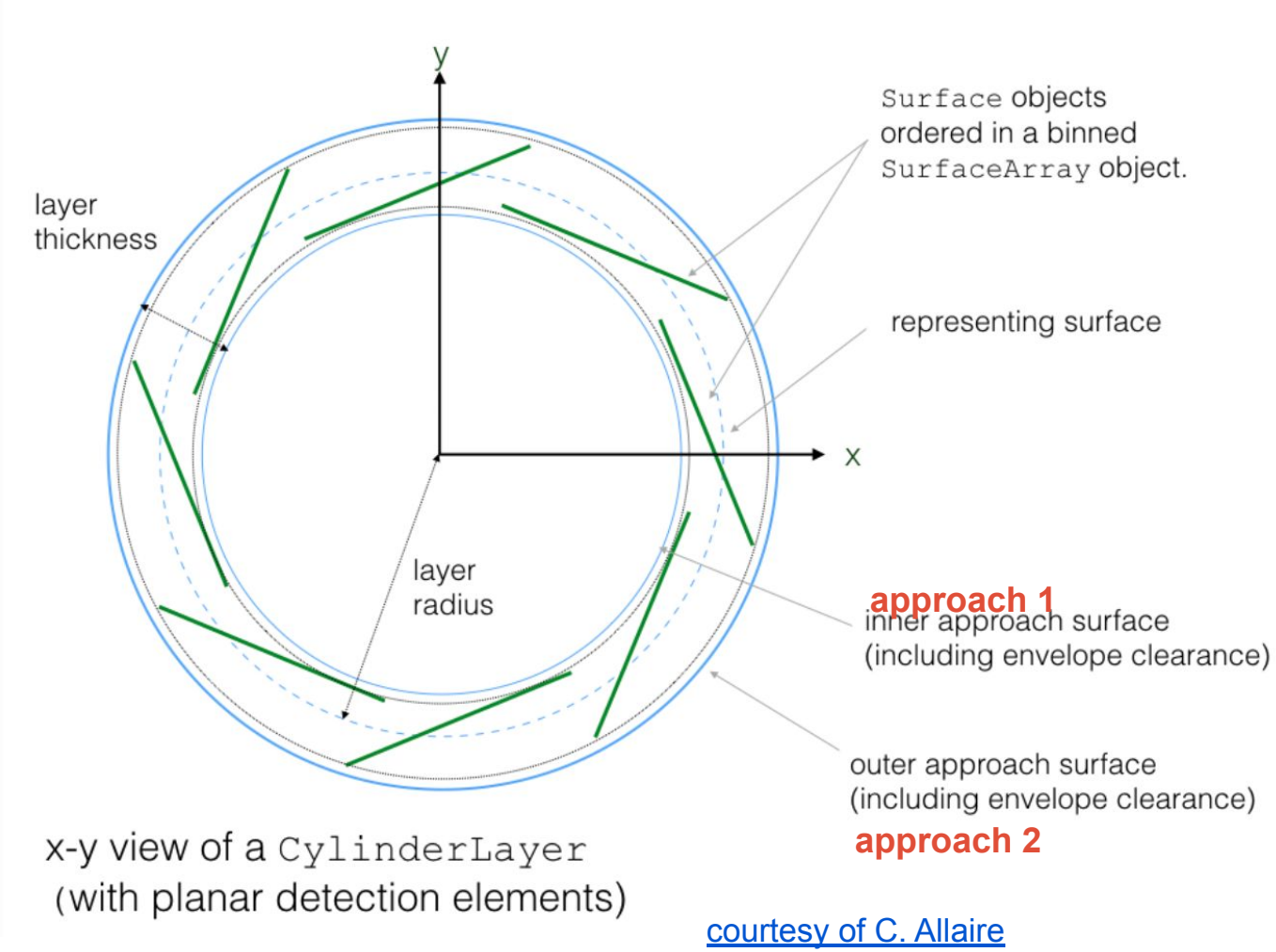
```
python material_recording_ePIC.py -i epic_xxx.xml  -n 1000 -t 1000
```

1) build DD4hep detector geometry
2) run DD4hep simulation with geantino, and record materials along the projective trajectories



Material mapping workflow

Step 2: configure mapping surfaces in geometry-map.json (see https://indico.bnl.gov/event/20842/)



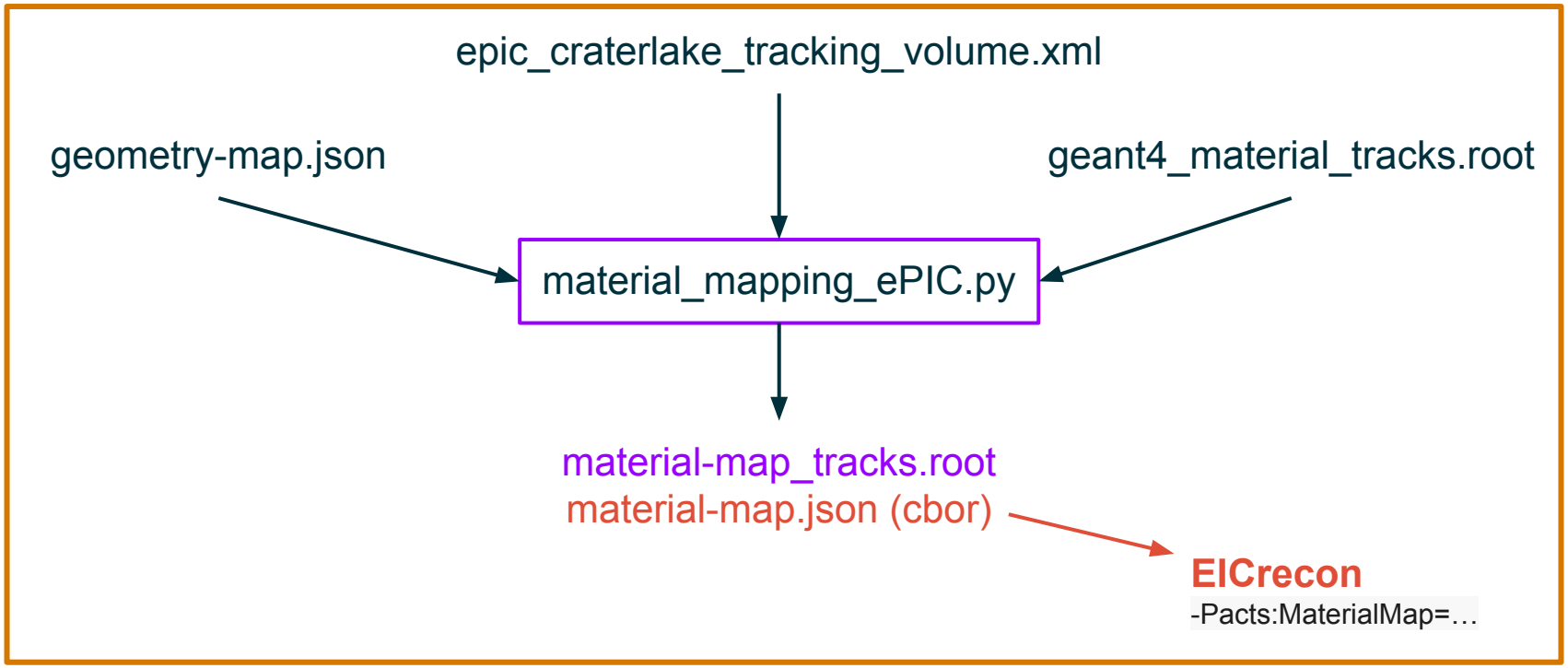
courtesy of C. Allaire

Material mapping workflow

Step 3: material mapping

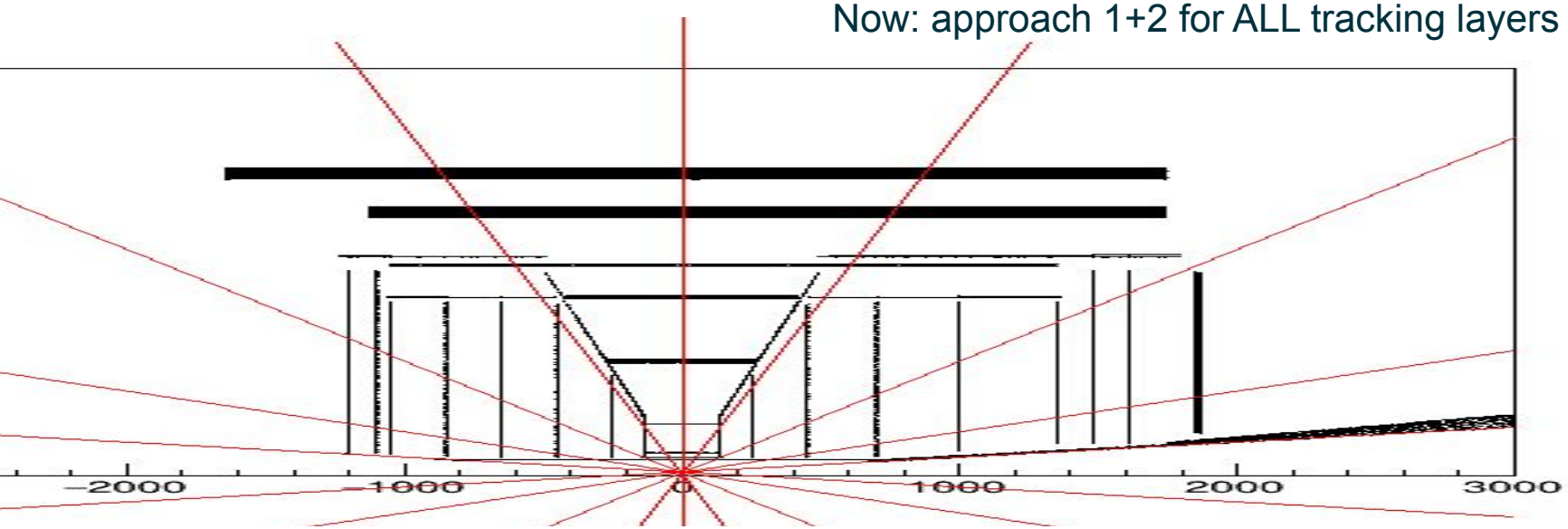
```
python material_mapping_ePIC.py --xmlFile epic_craterlake_matmap.xml -v
```

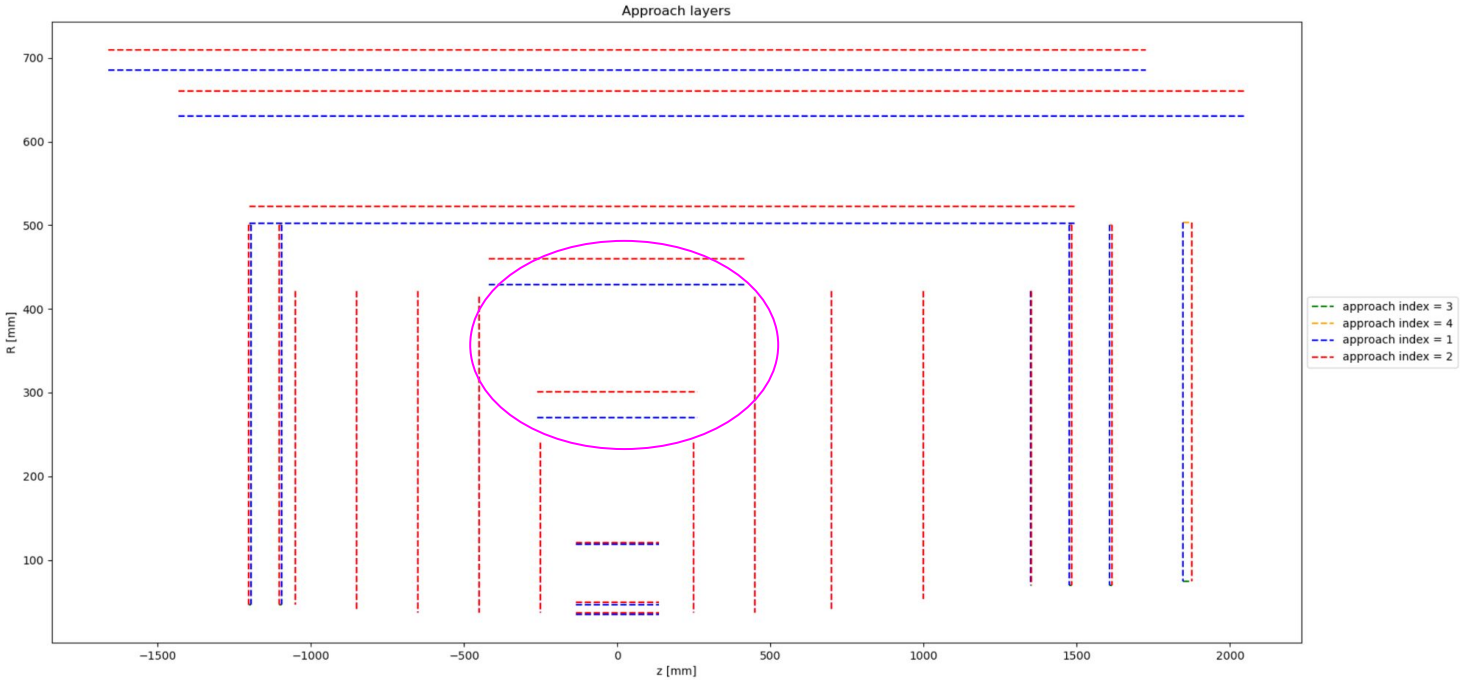
1) extract geometry map (volume and surface info) from DD4hep detector geometry
2) define mapping surfaces
3) propagate the recorded geant4 materials linearly and map materials onto selected surfaces



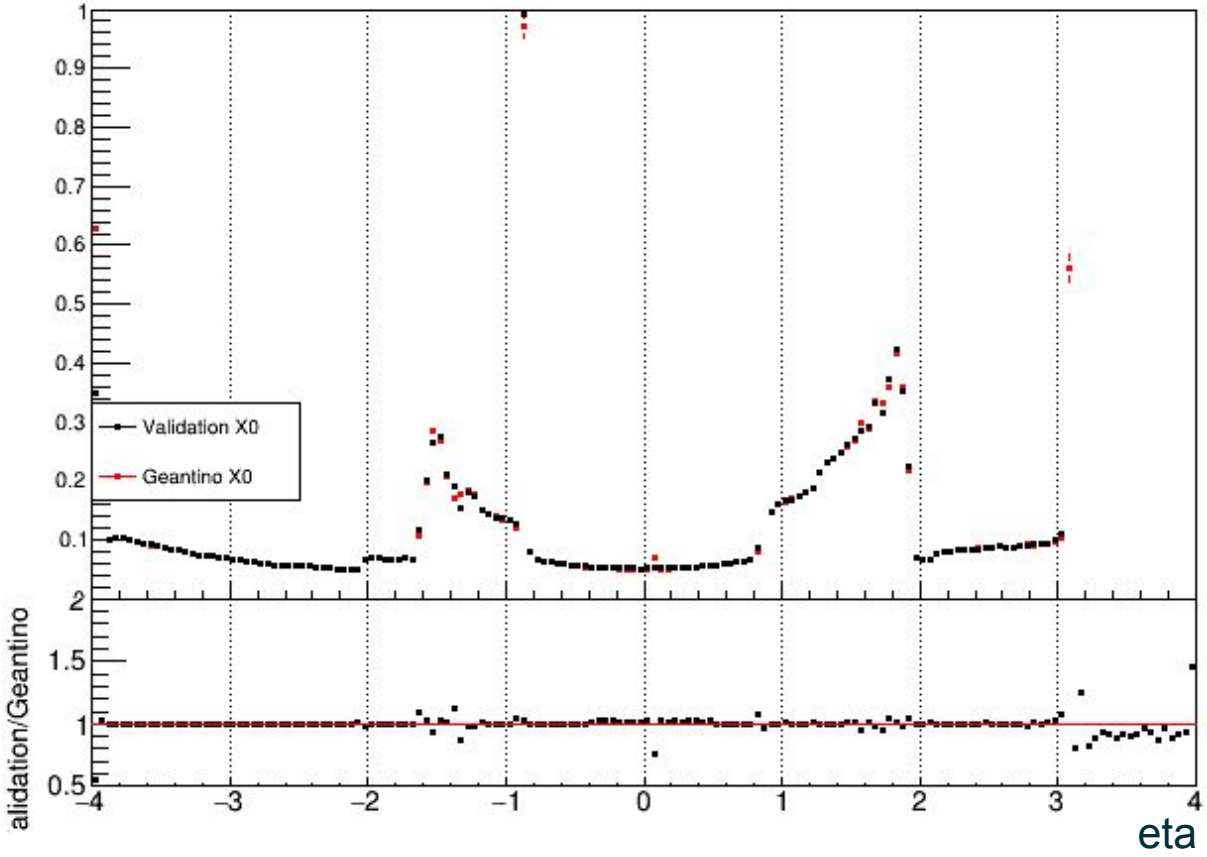
Choice of mapping surfaces

Before: approach 1 for barrels and approach 1+2 for disks
Now: approach 1+2 for ALL tracking layers

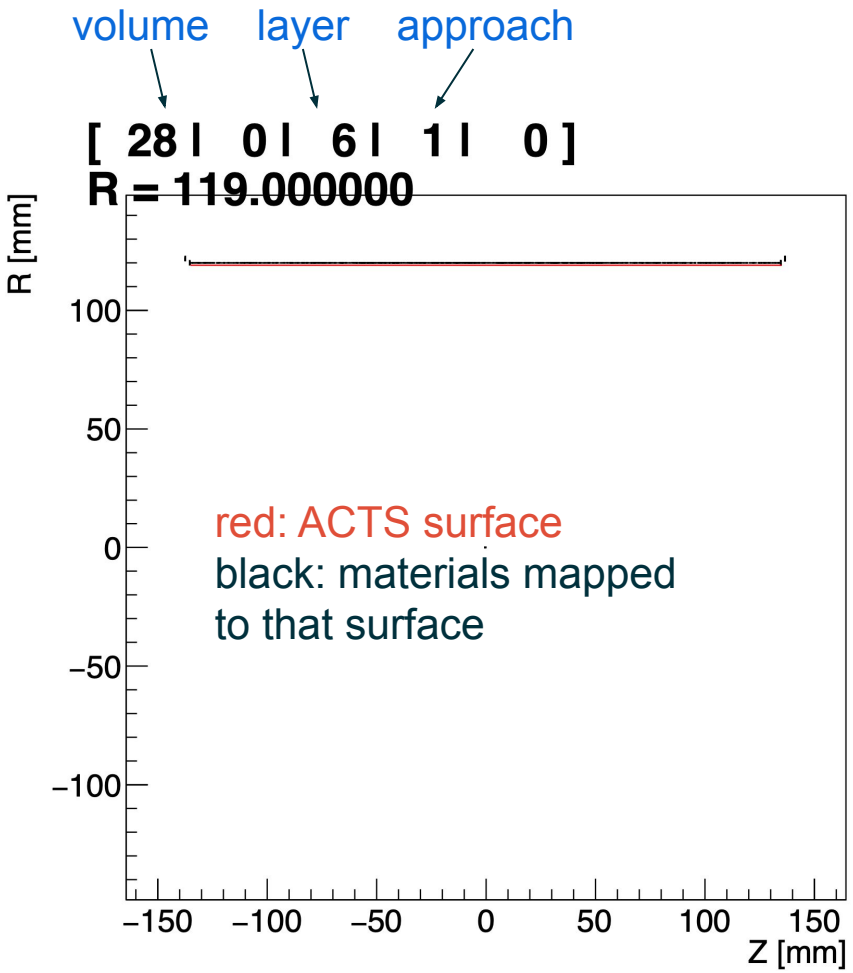


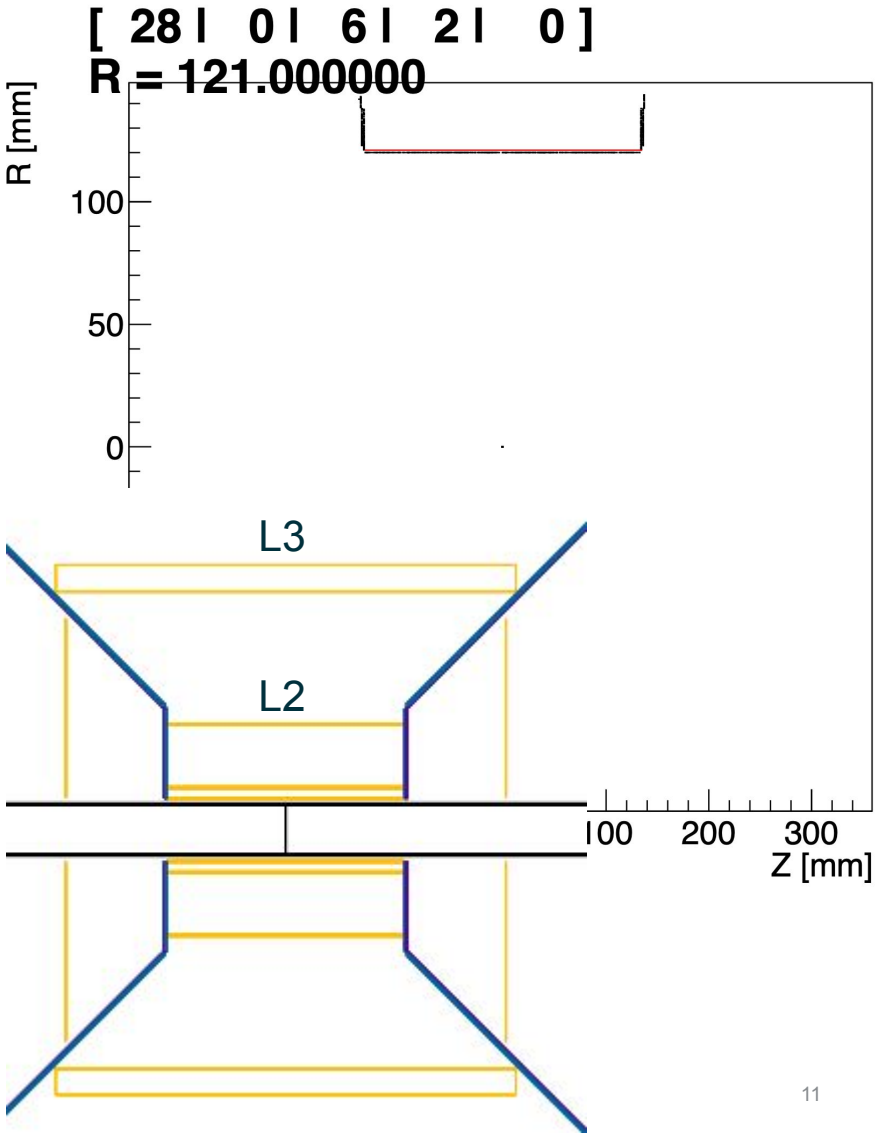


Material thickness: Geant4 v.s. ACTS map



R = 120mm: L2 (the third vertex layer)





R = 270mm: L3 (the first stave barrel)