Status of the Validation of the **CLIC_SID_CDR** Tracker Geometry in **DD4hep**

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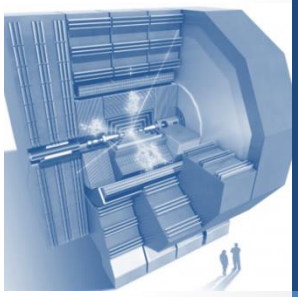
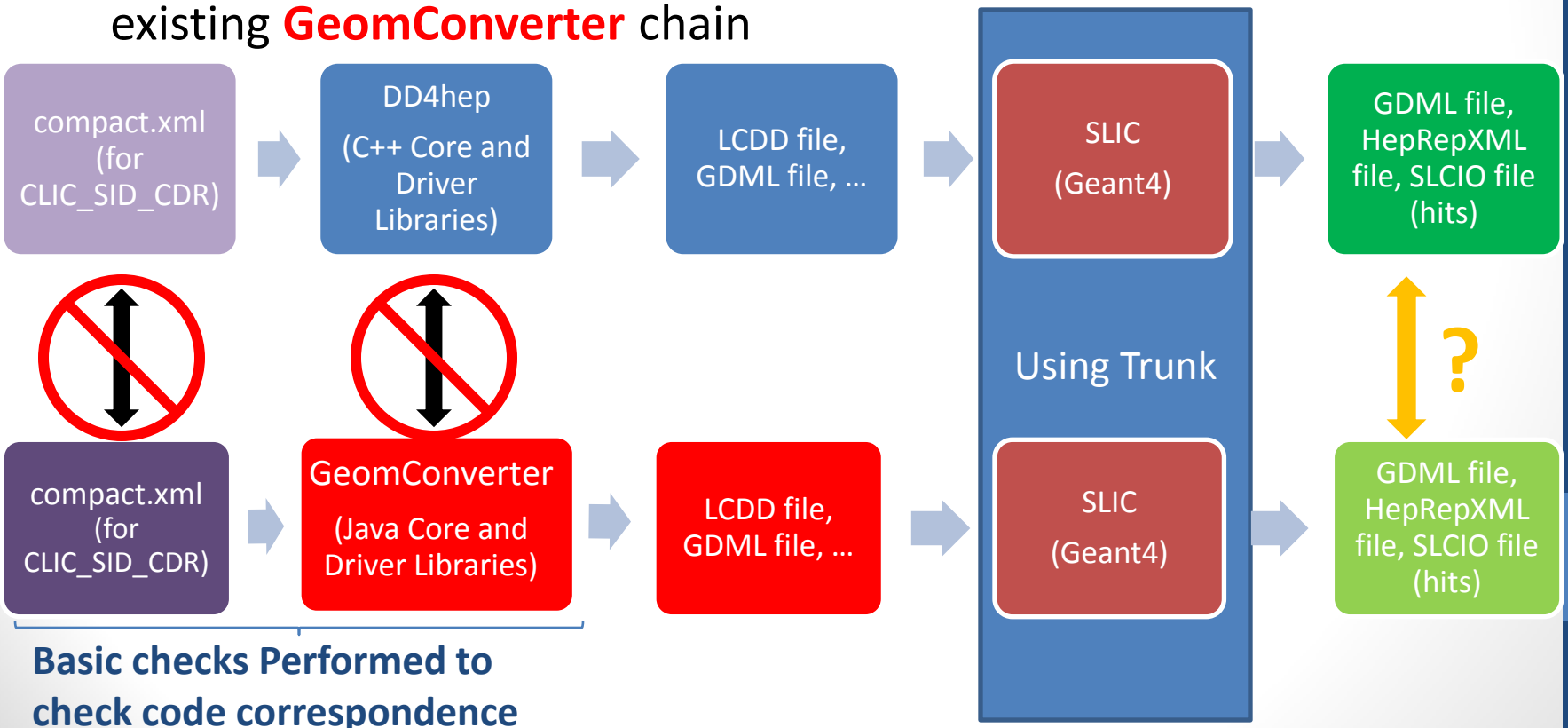


Introduction

- We have been working on *validating* the geometry description of the CLIC_SID_CDR detector model with **DD4hep**
- **Use DD4hep/examples/CLICSiD**
- Study limited on the tracker for now (also decreases the complexity of the validation problem)
- Performing various checks against the geometry provided by the existing **GeomConverter** chain



Checks on compact.xml

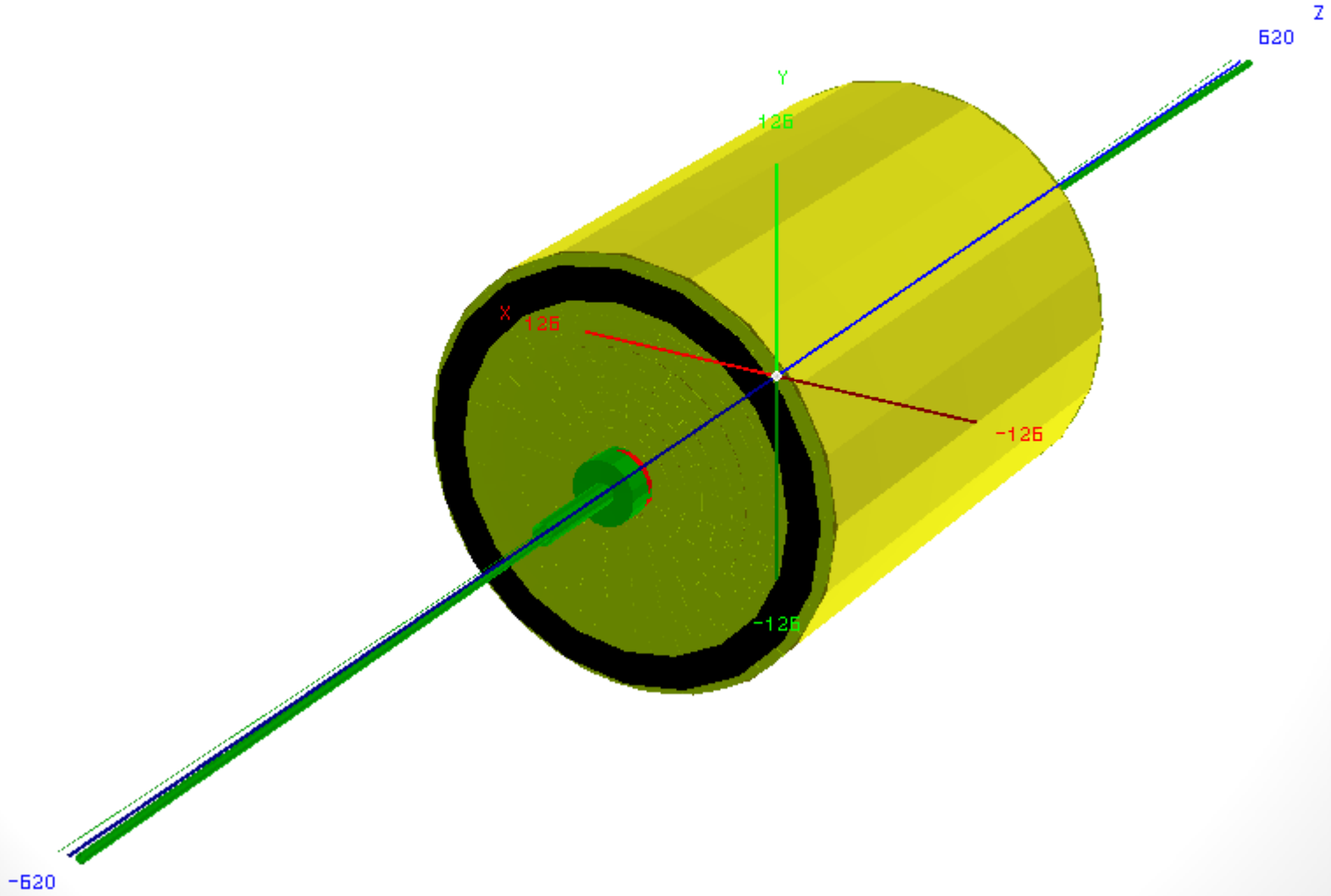
- Compact.xml for DD4hep based on definition for GeomConverter -> Both very similar
- Verified by visual inspection/ diff
- Not backward compatible. Changes in DD4hep compact file:
  - Changes in segmentation definitions
  - Require/assume explicit use of units
  - Require explicit use of reflect="true" if detector reflection about z=0 plane is required (was assumed by default true in GeomConverter chain)
- A few instances of discrepancies wrt the above were discovered and corrected (to be propagated to the DD4hep/examples/CLICSiD driver)

Checks on Driver Code

- DD4hep driver code was based on/influenced by the GeomConverter java driver code
- Performed basic visual inspection/comparison of classes
- Verified/checked cases where rotations/placements were ambiguous
- In DD4hep: moving towards using "**assemblies**" instead of "**envelope volumes**" of "vacuum" (aka very dilute air or H)
  - Envelope volumes can create overlaps and confuse Geant4
  - Need to use latest revision of Slic:
    - GDML_version = "v03-00-02" , LCDD_version = "v03-02-00", SLIC_version = "v03-01-03"
  - Initially not able to see hits from muons in Slic. Cause tracked down to use of envelope volumes
- Changes to be propagated to the example driver code

CLIC_SID_CDR Tracker with the DD4hep geoDisplay

Removed coil, calorimeters and muon system

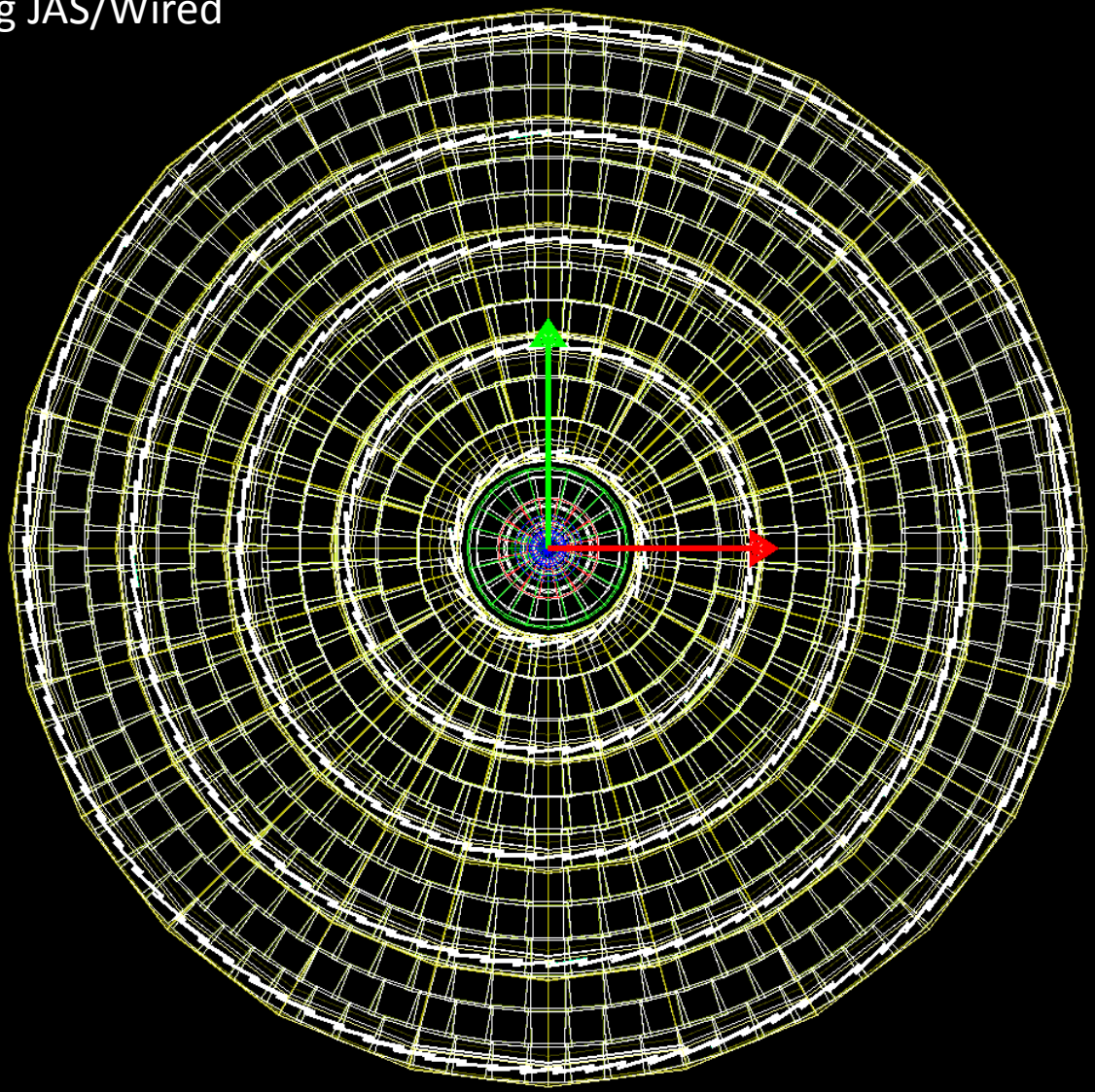


Comparison of Geometry Visualizations

- Used Slic as a common processor to produce visualizations of the detector using the two different chains
  - Dumped HepRepXML files to be viewed with JAS/Wired
  - Dumper GDML files for viewing with ROOT (, …)
  - Inspection of model in G4 OpenGL viewer
- Files are several tens of thousands of lines long
  - Diff comparison/inspection infeasible/inefficient
    - Still was useful to track down specific discrepancies
- Employed visual inspection/overlay (especially wireframe)
  - Allowed to track down cases of misalignment or discrepancies in orientation
- The next few slides show and compare global tracker views
  - During the inspection we looked and compared individual subdetectors and modules as well

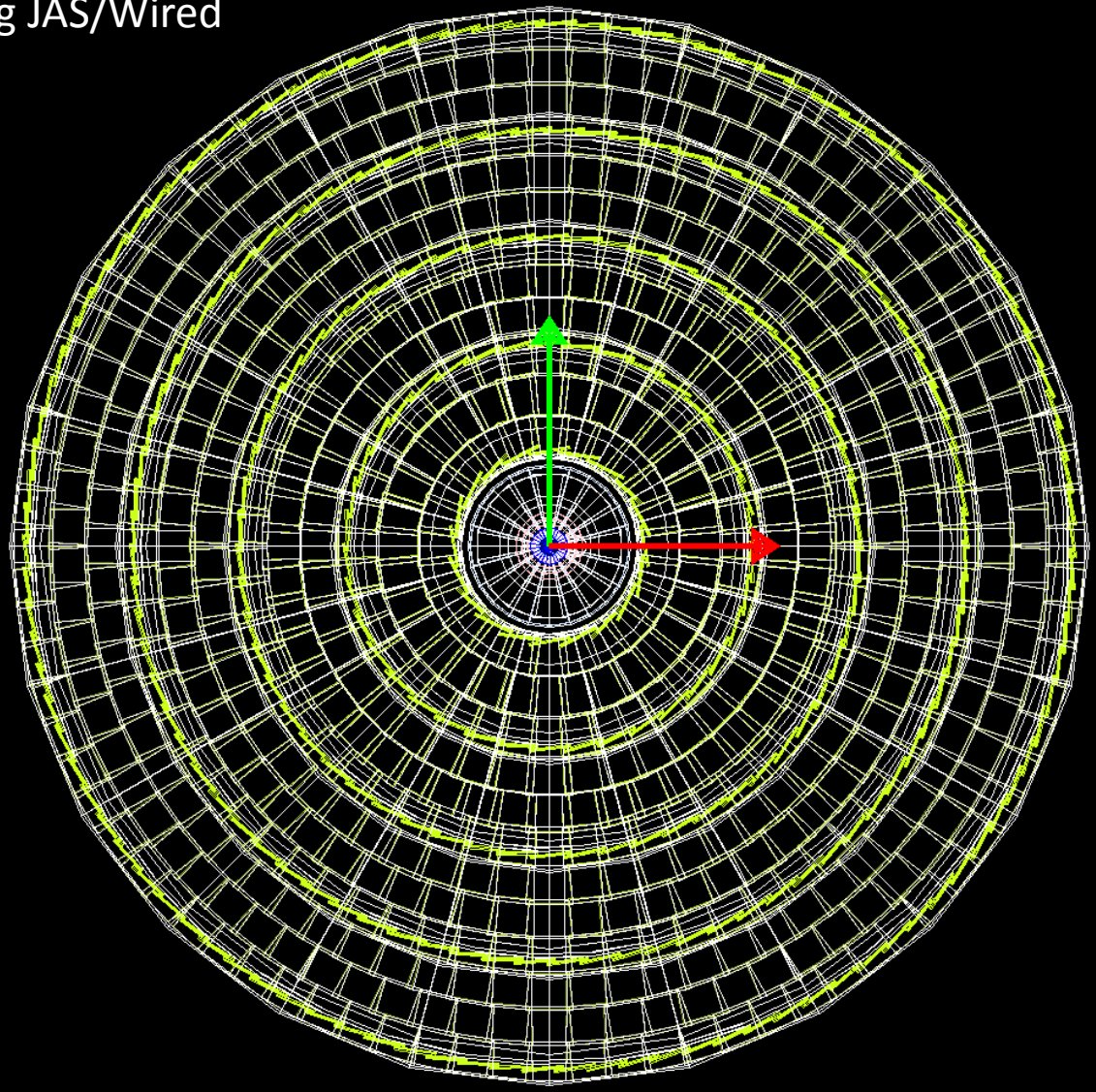
Compact.xml->**DD4hep**->slic->HepRepXML

Visualized using JAS/Wired



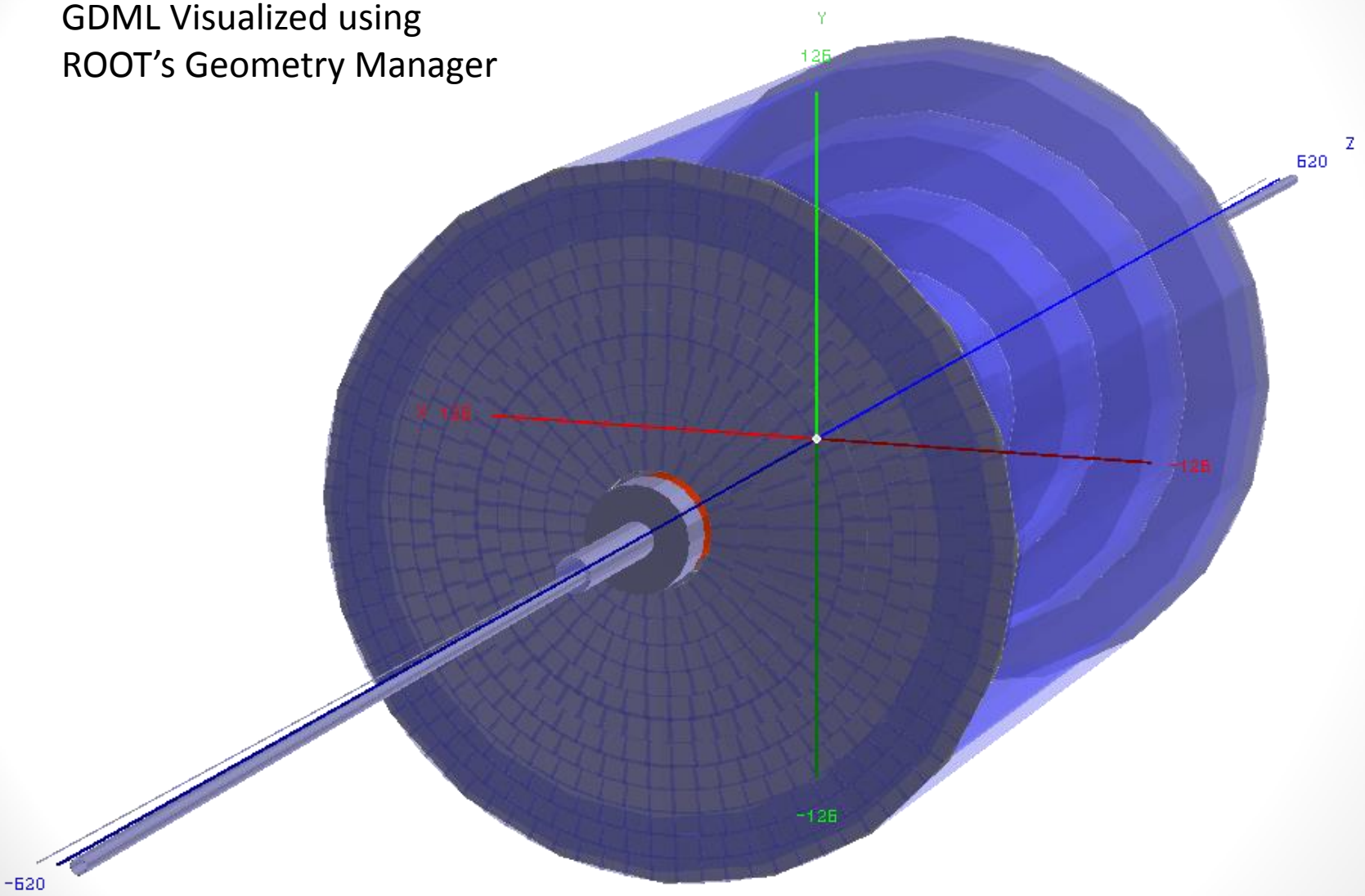
Compact.xml->**GeomConverter**->slic->HepRepXML

Visualized using JAS/Wired



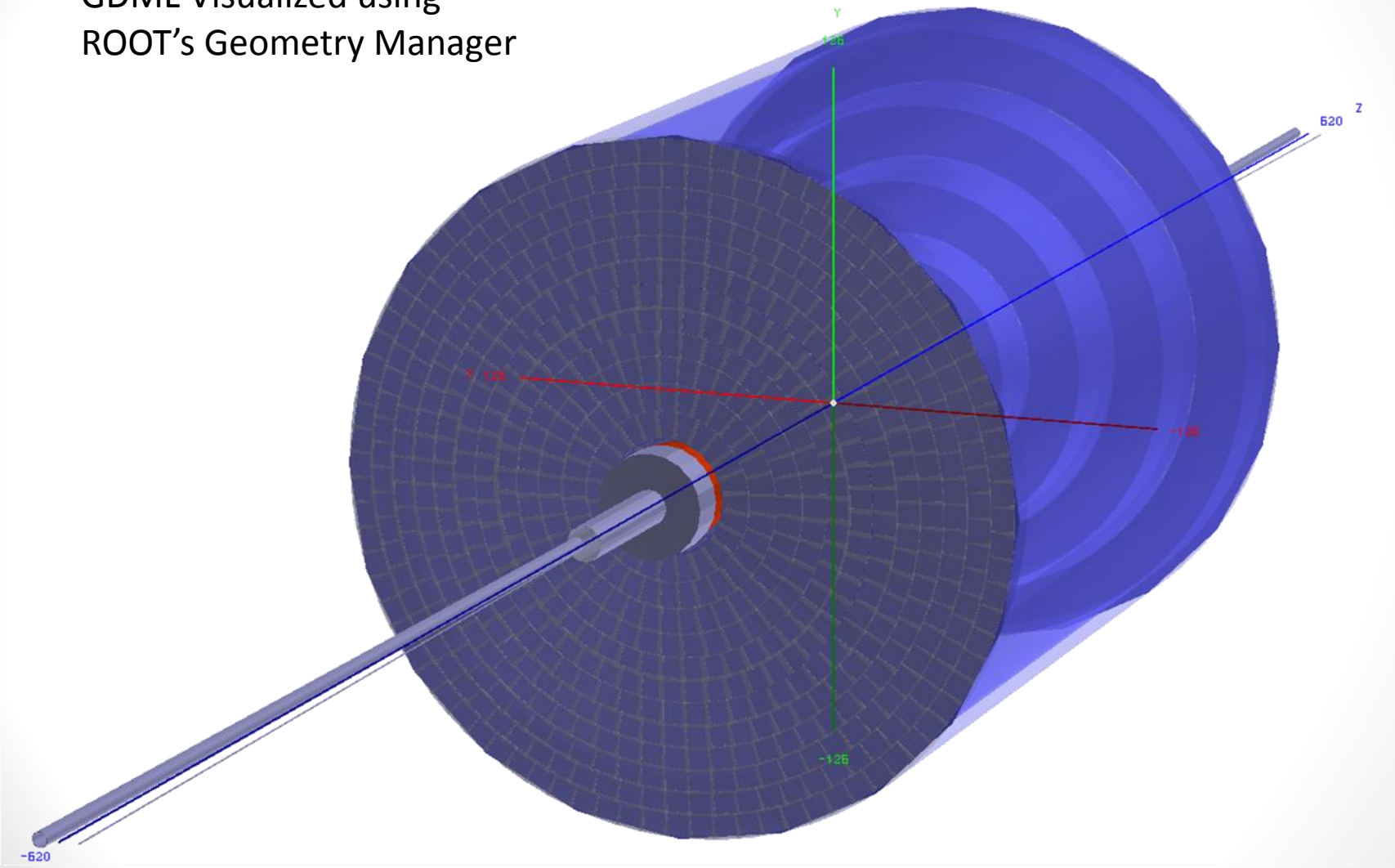
Compact.xml->**DD4hep**->slic->GDML

GDML Visualized using
ROOT's Geometry Manager



Compact.xml->**GeomConverter-**>slic->GDML

GDML Visualized using
ROOT's Geometry Manager



Check on Position of Simulated Hits

- Used Slic/Geant4 to generate Muons with exactly the same parameters and compared the properties of the simulated hits in the two realizations of the model
- Observing the same number of hits but with differences in their positions
  - Differences appear to depend on muon energy and Magnetic field -> **possibly differences in the field definition** (?)

With the field **OFF** there are still some discrepancies -> **Investigating**

GeomConverter
```
Printing hits in SiVertexBarrelHits
0. x=0.000100, y=27.329005, z=-49.9999, R=27.329, ϕ=1.57
1. x=0.000127, y=38.355969, z=-49.9999, R=38.356, ϕ=1.57
2. x=0.000157, y=51.210000, z=-49.9998, R=51.210, ϕ=1.57
3. x=0.000194, y=65.042294, z=-49.9999, R=65.043, ϕ=1.57
4. x=0.000231, y=77.980000, z=-49.9997, R=77.980, ϕ=1.57
Printing hits in SiTrackerBarrelHits
5. x=0.000629, y=226.579967, z=-49.9990, R=226.578, ϕ=1.57
6. x=0.001219, y=476.796534, z=-49.9977, R=476.797, ϕ=1.57
7. x=0.001440, y=722.833060, z=-49.9962, R=722.833, ϕ=1.57
8. x=0.001796, y=973.200726, z=-49.9946, R=973.201, ϕ=1.57
9. x=0.001773, y=982.415081, z=-49.9946, R=982.415, ϕ=1.57
10. x=0.000884, y=1220.739507, z=-49.994, R=1220.74, ϕ=1.57
```

DD4hep
```
Printing hits in SiVertexBarrelHits
0. x=0.000098, y=26.877269, z=-49.9999, R=26.877, ϕ=1.57
1. x=0.000142, y=37.934349, z=-49.9999, R=37.934, ϕ=1.57
2. x=0.000196, y=50.789984, z=-49.9998, R=50.790, ϕ=1.57
3. x=0.000263, y=64.622135, z=-49.9998, R=64.622, ϕ=1.57
4. x=0.000329, y=77.559984, z=-49.9997, R=77.560, ϕ=1.57
Printing hits in SiTrackerBarrelHits
5. x=0.001046, y=224.254509, z=-49.9993, R=224.255, ϕ=1.57
6. x=0.002344, y=474.488246, z=-49.9984, R=474.488, ϕ=1.57
7. x=0.003805, y=720.527110, z=-49.9976, R=720.527, ϕ=1.57
8. x=0.005287, y=970.903662, z=-49.9973, R=970.904, ϕ=1.57
9. x=0.005357, y=980.096554, z=-49.9973, R=980.097, ϕ=1.57
10. x=0.006977, y=1218.43834, z=-49.997, R=1218.44, ϕ=1.57
```

Summary - Conclusions

- Validation of CLIC_SID_CDR geometry ongoing
  - Study presented limited to tracker -> can provide the starting point for a CLICdp detector Silicon Tracker geometry model
- Visual validation complete
  - Any discrepancies were fixed/resolved and will be propagated to the CLICSiD example driver
- Currently checking position of hits from Simulated muons
- A good exercise in implementing a detector geometry in DD4hep
- Study also serves in identifying and fixing possible issues in the **`compact->DD4hep->LCDD->SLIC`** chain