

DD4hep-Based Simulation

Nikiforos Nikiforou
CERN/PH-LCD

ILD Meeting 2014
Oshu City, September 8th, 2014



Introduction

- **DD4hep: Detector Description for HEP**
 - Part of AIDA Common Software Tools (<http://aidasoft.web.cern.ch/DD4hep>)
 - Main Developers:
 - M. Frank, F. Gaede, C. Grefe (core)
 - A. Gheata (TGeo)
 - A. Sailer, S. Lu, N. Nikiforou, P. Kostka, ... (driver development)
 - Interest and involvement by many groups and organizations:
 - CERN, DESY, SLAC, Cambridge, Glasgow, FCC, ...
- Very strong interest and involvement from **ILD** and **CLICdp**
 - Core code development, debugging, validation
 - Geometry development, checks and validation



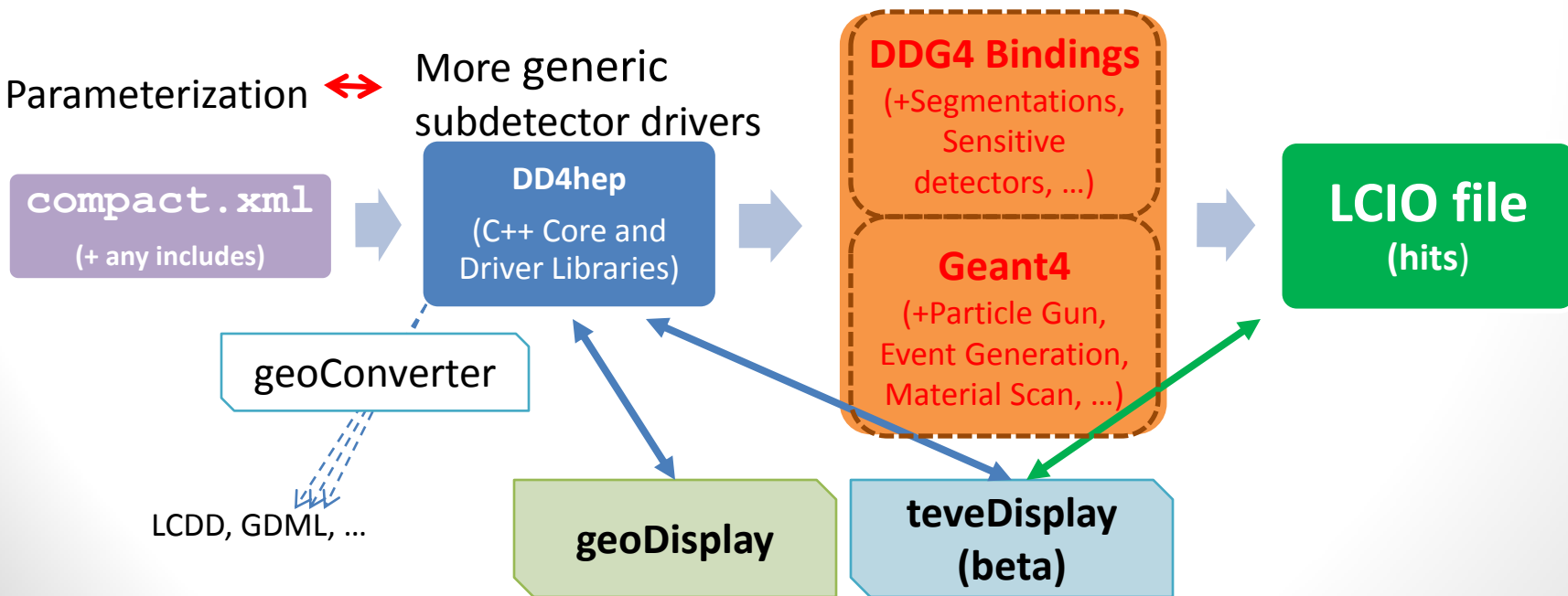
Introduction – continued

- Some DD4hep features:
 - Allows flexible parameterization and generic subdetector **driver sharing**
 - Build and visualize geometry based on ROOT/TGeo libraries
 - Interactive visualization with ROOT
 - Instantiate geometry in Geant4
- **For CLICdp: DD4hep with Geant4 bindings** (next slide) is going to be used for the **new CLIC detector simulation model**
 - Plan to have it ready by the end of this year



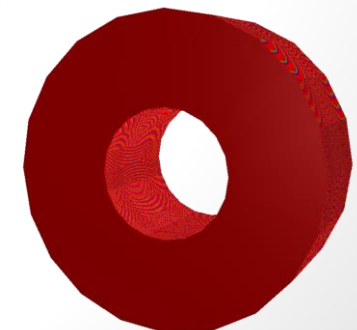
DD4hep use in CLICdp

- **DD4hep**: flexibility in splitting the detector description between:
 - “Compact description” (xml file)
 - Detector drivers (compiled C++ code)
- User decides the balance
- **Try to use the same drivers for all users if possible**
- Use **DDG4 bindings** to instantiate geometry in **Geant4** via in-memory transfer
- Tools available for independent, interactive visualization



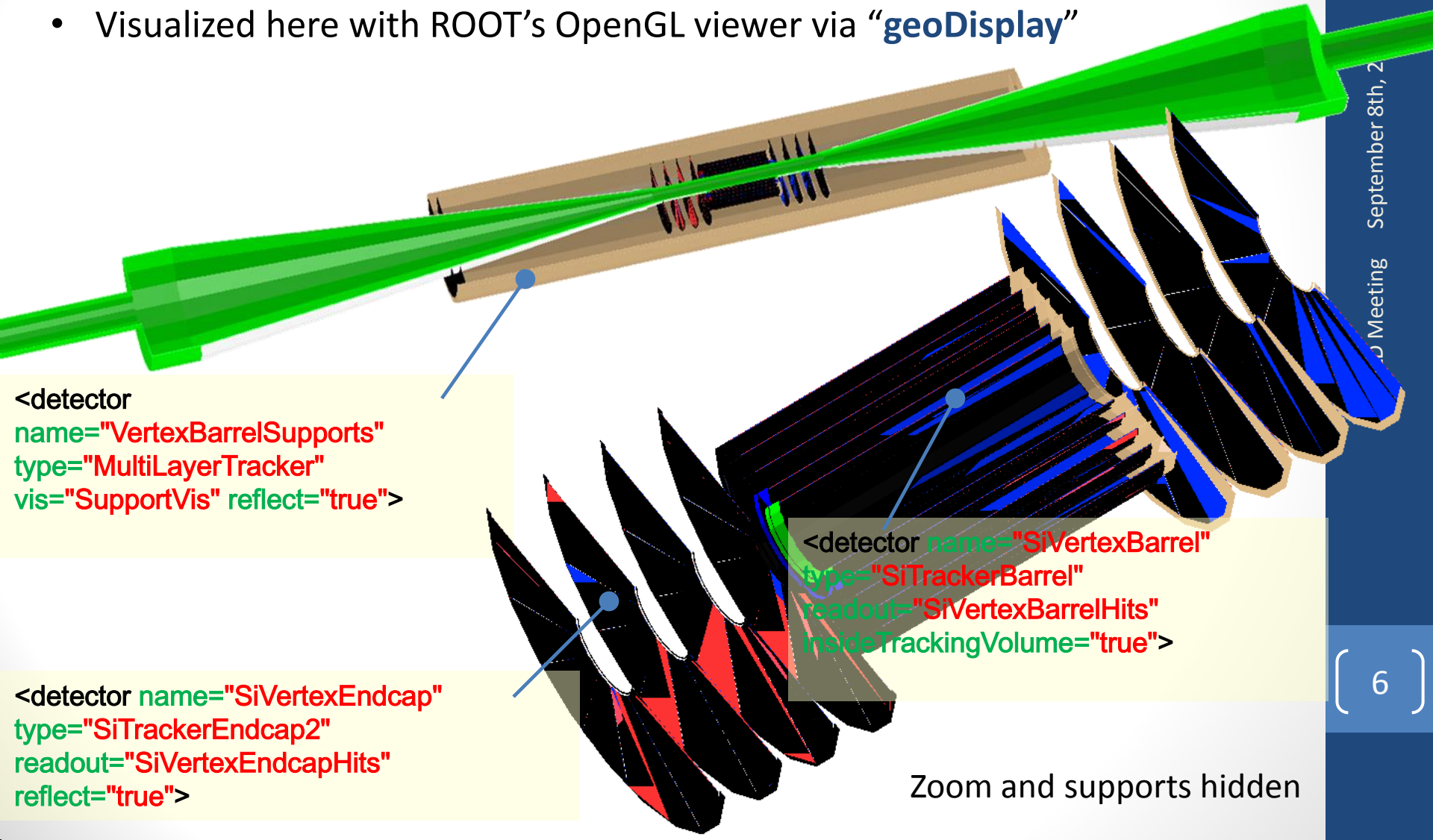
What's already there:

- **DD4hep/examples/CLICSiD** (other detector examples there too)
 - SiTracker/Vertex Detector (Barrel/Endcap)
 - Cylindrical Calorimeters [e.g. ECal, ...]
 - Polyhedral Calorimeters [e.g. HCal, Yoke, ...]
 - Supports, etc, ... [beampipes, tracker supports, ..]
- **Most of ILD already in DD4hep** (under DDSim/ILD)
 - Complete ILD model being ported from Mokka
 - Vertex Detectors, Silicon Trackers, TPC, ...
 - HCal, ECal, Barrel,Endcap, Rings, BeamCal, ...
- **DDSim**: Developing collection of geometries and example executables for binding to Geant4
- More specific subdetector drivers being developed and/or refined by various people
 - ECal, HCal, BeamCal, LumiCal, ...
 - Tracker/Vertex Detector for new CLICdp detector being adapted from CLICSid example
- **Additional driver examples in the following slides**



Vertex Detector and Supports

- Based on a generic silicon tracker model (also used on CLIC_SiD tracker, next slide)
- Modules include Carbon support and Silicon active layer
- Visualized here with ROOT's OpenGL viewer via **“geoDisplay”**



```
<detector
name="VertexBarrelSupports"
type="MultiLayerTracker"
vis="SupportVis" reflect="true">
```

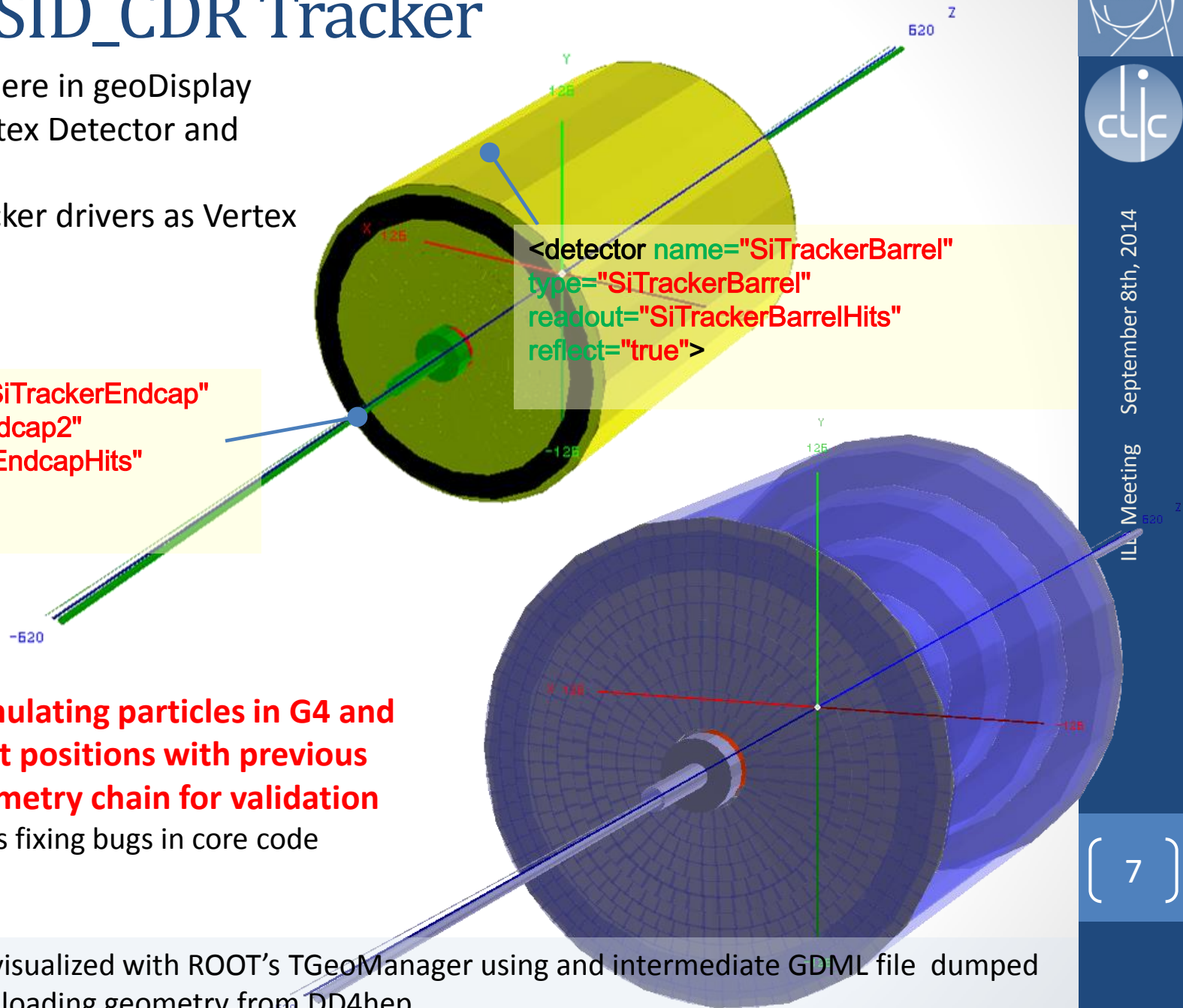
```
<detector name="SiVertexBarrel"
type="SiTrackerBarrel"
readout="SiVertexBarrelHits"
insideTrackingVolume="true">
```

```
<detector name="SiVertexEndcap"
type="SiTrackerEndcap2"
readout="SiVertexEndcapHits"
reflect="true">
```

Zoom and supports hidden

CLIC_SID_CDR Tracker

- Visualized here in geoDisplay
- Around Vertex Detector and beampipe
- Same SiTracker drivers as Vertex Detector



The same tracker visualized with ROOT's TGeoManager using an intermediate GDML file dumped from Geant4 after loading geometry from DD4hep

Calorimeters

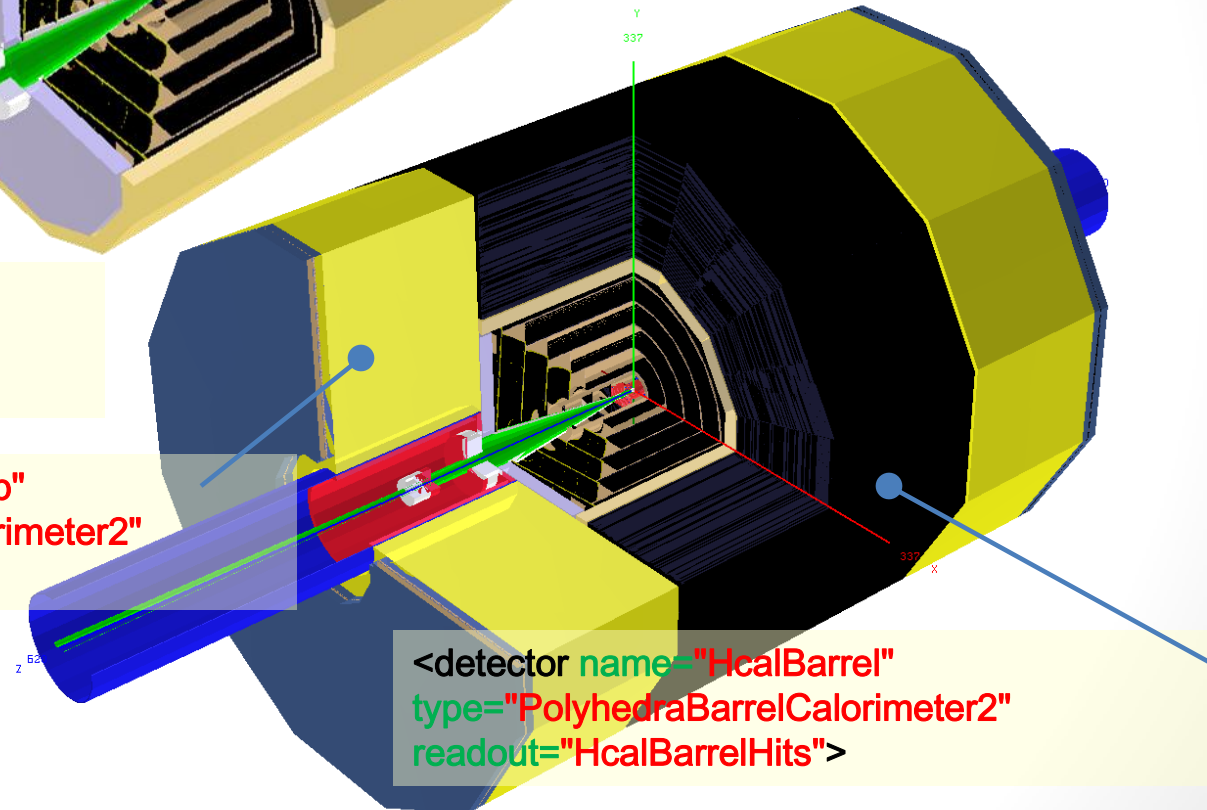
```
<detector name="EcalEndcap"
type="PolyhedraEndcapCalorimeter2"
readout="EcalEndcapHits">
```

```
<detector name="EcalBarrel"
type="EcalBarrel"
readout="EcalBarrelHits">
```

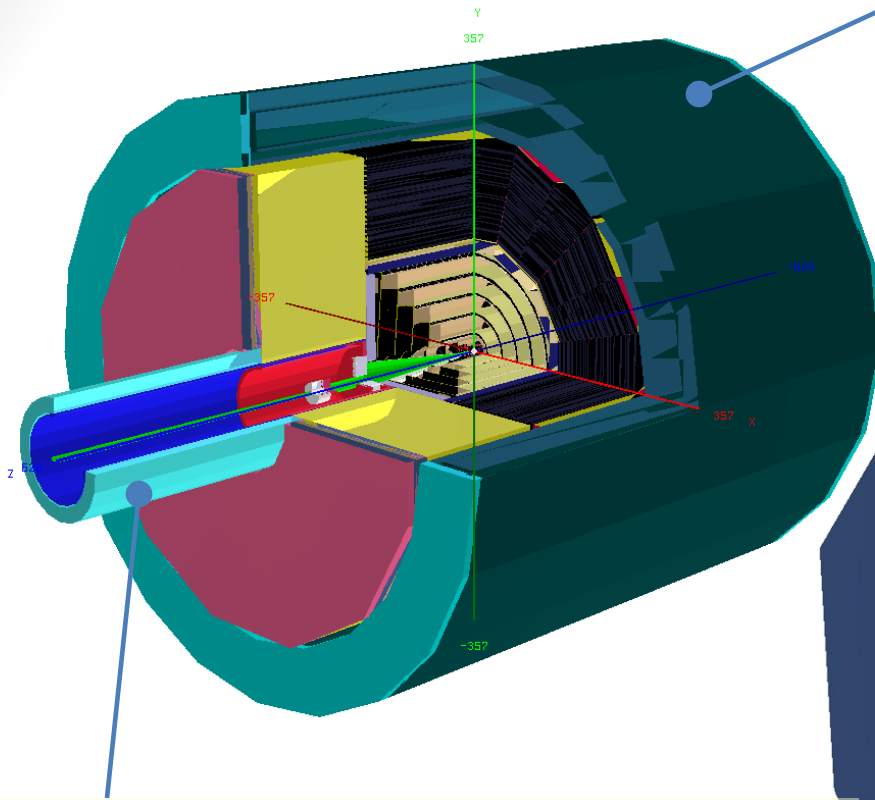
```
<detector name="BeamCal"
type="ForwardDetector"
readout="BeamCalHits">
```

```
<detector name="HcalEndcap"
type="PolyhedraEndcapCalorimeter2"
readout="HcalEndcapHits">
```

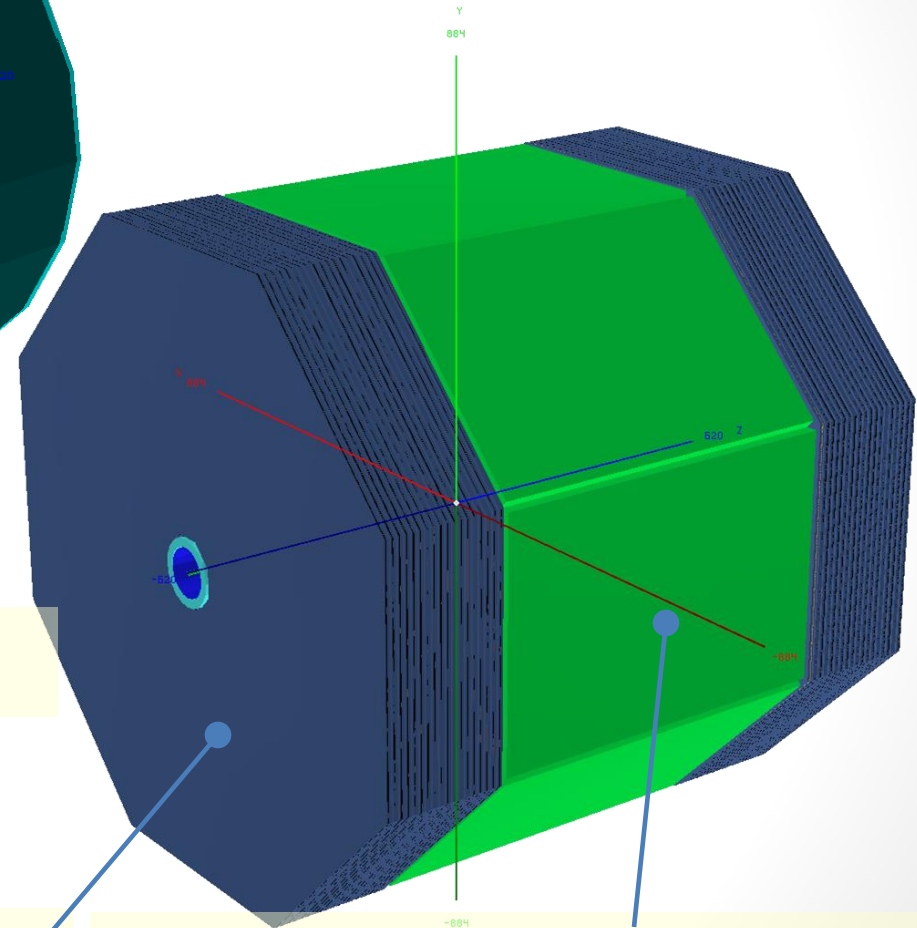
```
<detector name="HcalBarrel"
type="PolyhedraBarrelCalorimeter2"
readout="HcalBarrelHits">
```



Magnets and Muon Systems



```
<detector name="SolenoidCoilBarrel"
type="MultiLayerTracker">
```



```
<detector name="MuonBarrel"
type="PolyhedraBarrelCalorimeter2"
readout="MuonBarrelHits">
```

```
<detector name="AntiSolenoid_Forward"
type="PolyconeSupport">
```

```
<detector name="MuonEndcap"
type="PolyhedraEndcapCalorimeter2"
readout="MuonEndcapHits">
```

Readouts and Segmentation



```
<readout name="HcalBarrelHits">  
<segmentation type="CartesianGridXY" grid_size_x="3.0*cm" grid_size_y="3.0*cm"/>  
<id> system:8,barrel:3,module:6,layer:8,slice:5,x:32:-16,y:-16</id>  
</readout>
```

- In DD4hep “**Sensitive Detectors**” and “**Segmentations**” are separated:
 - Mix any Sensitive Detector with any Segmentation
 - Facilitates access to Segmentation during reconstruction
- Currently, most calorimeter readouts in the CLICSiD example assume a CartesianGridXY segmentation
- More available/being developed (see DDSegmentation)
 - CartesianGridXZ, CartesianGridXYZ
 - ProjectiveCylinder
 - ...
- Tracking detectors are not generally segmented

ILD_o1_v05 in DD4hep

```
<detector name="HcalEndcap"
type="SHcalSc04_Endcaps"
readout="HcalEndcapsCollection">
```

```
<detector name="Coil"
type="SCoil02">
```

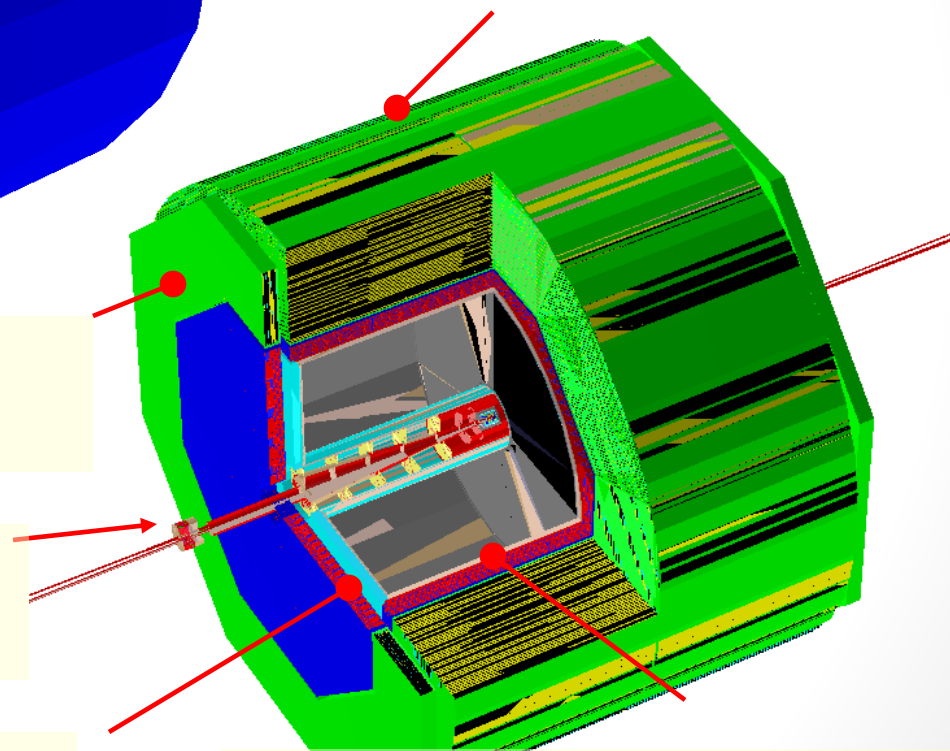
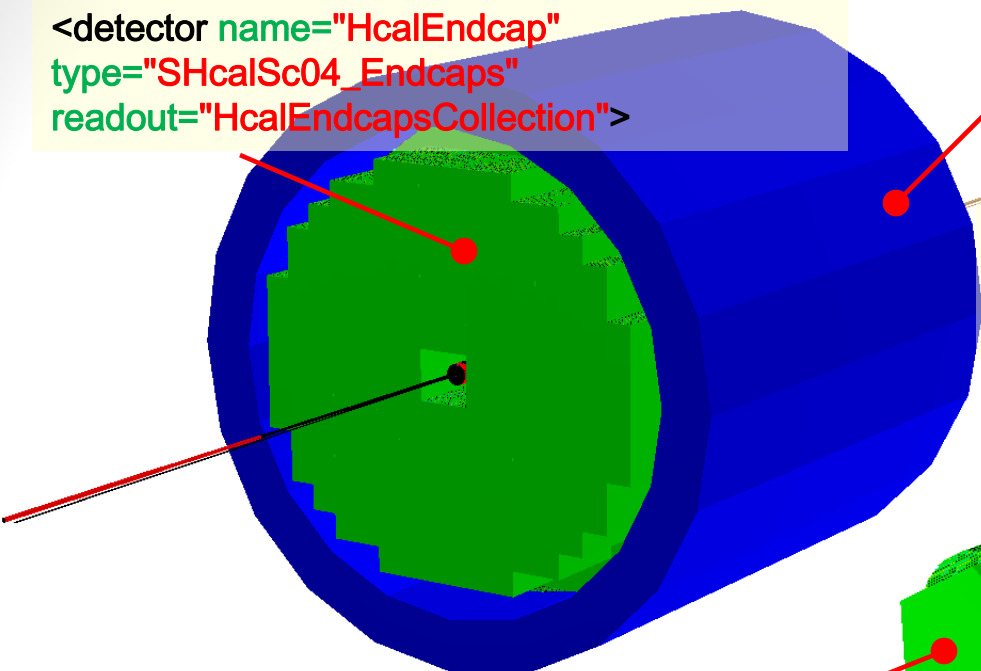
```
<detector name="HcalBarrel"
type="SHcalSc04_Barrel"
readout="HcalBarrelRegCollection">
```

```
<detector name="HcalEndcapRing"
type="SHcalSc04_EndcapRing"
readout="HcalEndcapRingCollection">
```

```
<detector name="BeamCal"
type="BeamCal"
readout="BeamCalCollection">
```

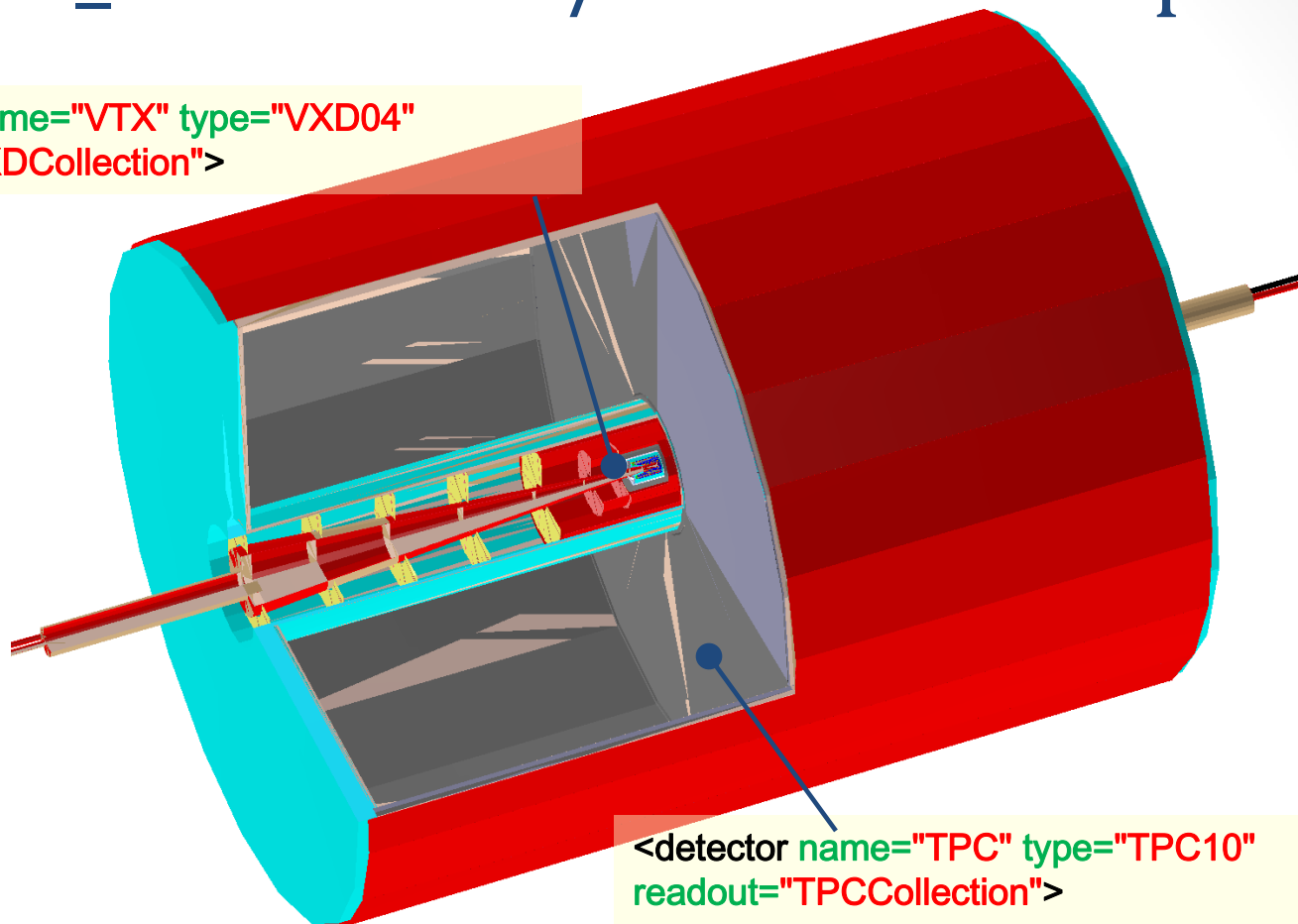
```
<detector name="EcalEndcap"
type="SEcal04_Endcap"
readout="EcalEndcapCollection">
```

```
<detector name="EcalBarrel"
type="SEcal04_Barrel"
readout="EcalBarrelCollection">
```



ILD_o1_v05 Tracker/VXD in DD4hep

```
<detector name="VTX" type="VXD04"  
readout="VXDCollection">
```



```
<detector name="TPC" type="TPC10"  
readout="TPCCollection">
```

And even more sub-parts which I won't describe here

Summary

- **DD4hep is being actively developed and used**
- **Contributions from CERN, DESY, SLAC and others**
- **DD4hep with DDG4 Geant4 bindings is going to be used by CLICdp for the new detector simulation model**
- Many different subdetector models and generic drivers are already available
- Several groups are developing/refining drivers
- Complete detector examples (**ILD, CLIC_SiD, ...**) are already there or are being ported to DD4hep
 - **Try to reuse subdetector drivers where possible**
 - For available drivers, validation against previously used geometry chains is ongoing