Geometry

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Programme on Technologies for Future Experiments

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A. Salzburger (CERN) for the ACTS project

@SaltyBurger

CERN

Geometry - Surfaces

Surface class is the base component of all geometry objects

- Layers (may be dropped, see tomorrow) have approach surfaces
- Volumes are composed as set of boundary surfaces

This is a key element of the conceptual design:

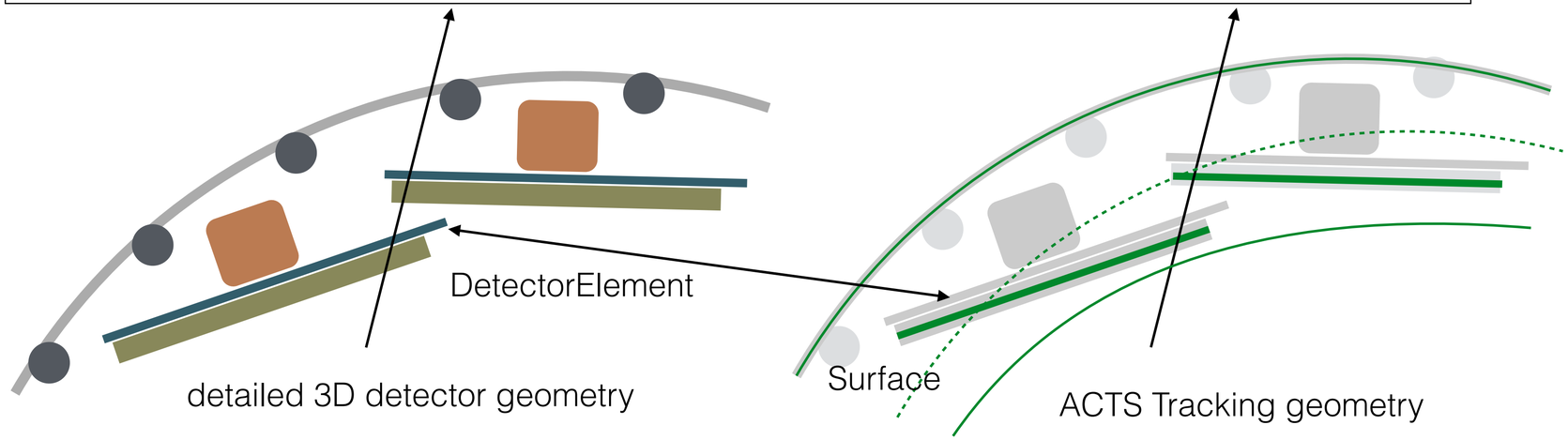
- makes all geometry objects compatible with the central Propagator module
- Bound surfaces act as measurement reference surfaces but also as navigation hooks and boundary surfaces (portals)

Geometry - DetElementBase

Binding the ACTS geometry to an existing Geometry model is done via declaration of a `Acts::DetectorElementBase` object

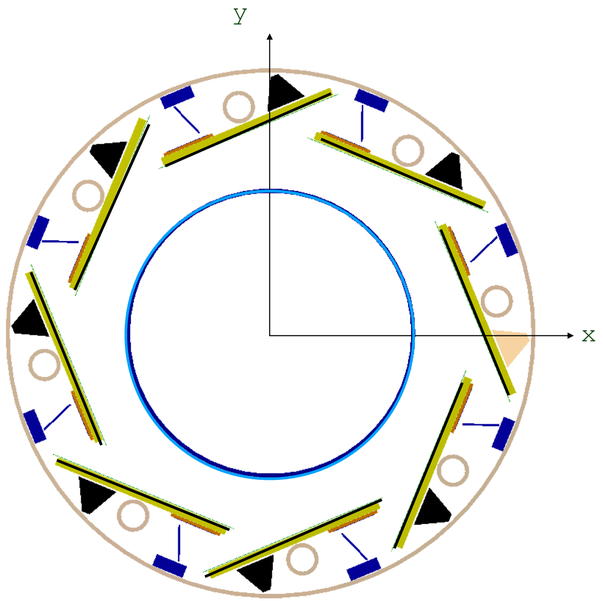
```
namespace Acts {
  /// doxygen documentation
  class DetectorElementBase {
   /// the according represented surface
    virtual const Surface& associatedSurface() const = 0;
  };
}
```

```
class MyDetectorElement {
  /// @copydoc DetectorElementBase::asscociatedSurface
   const PlaneSurface& associatedSurface() const;
 };
```



Geometry - Geometry building

(Current) geometry building follows a bottom up approach



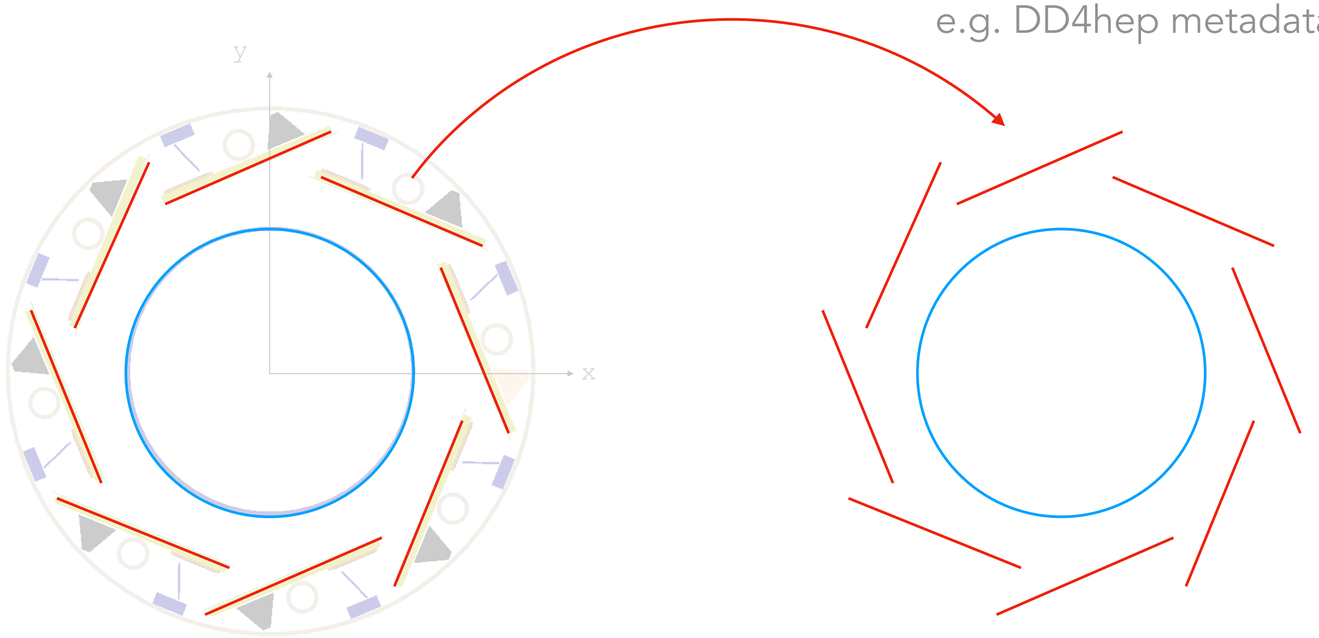
3D geometry model

(Plugin, e.g. GeoModel, DD4Hep, TGeo)

Geometry - Geometry building

(Current) geometry building follows a bottom up approach

collected through Plugin:
e.g. DD4hep metadata, TGeo naming, json files



3D geometry model + `PluginDetectorElement` + `PassiveLayer`
(Plugin, e.g. GeoModel, DD4Hep, TGeo)

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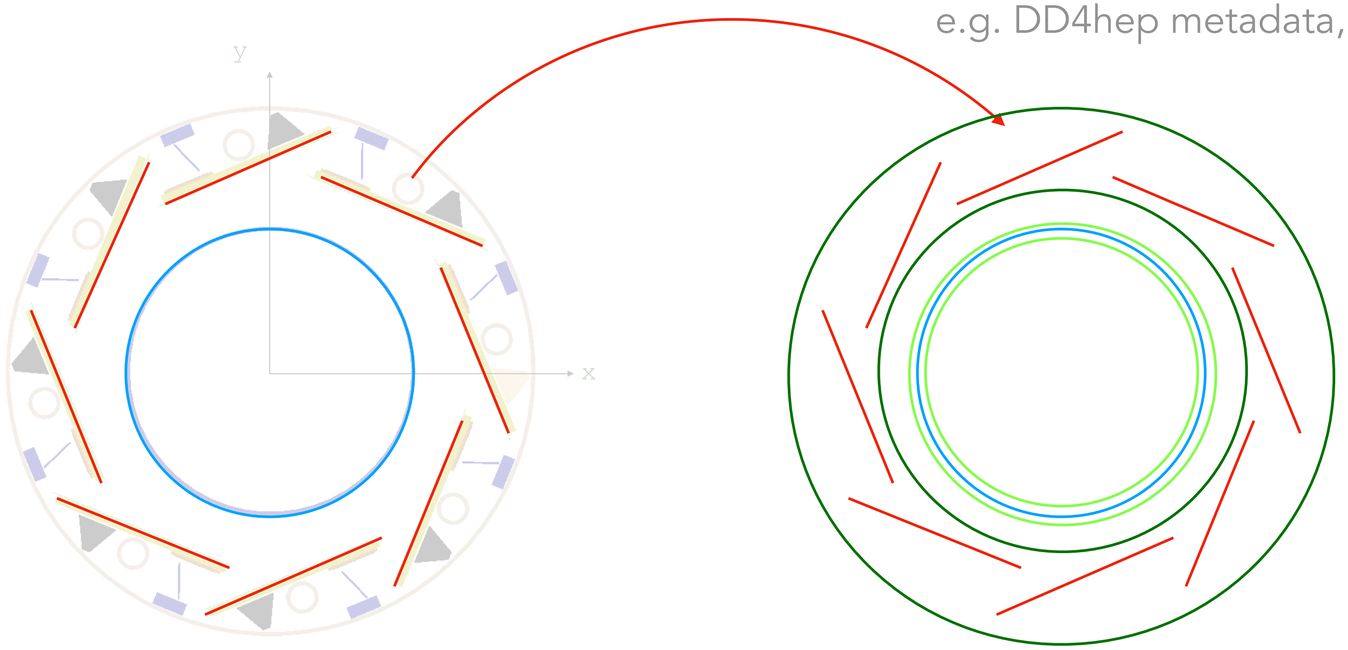

3D geometry model + `PluginDetectorElement` + `PassiveLayer` + `LayerBuilders`

(Plugin, e.g. GeoModel, DD4Hep, TGeo)

Geometry - Geometry building

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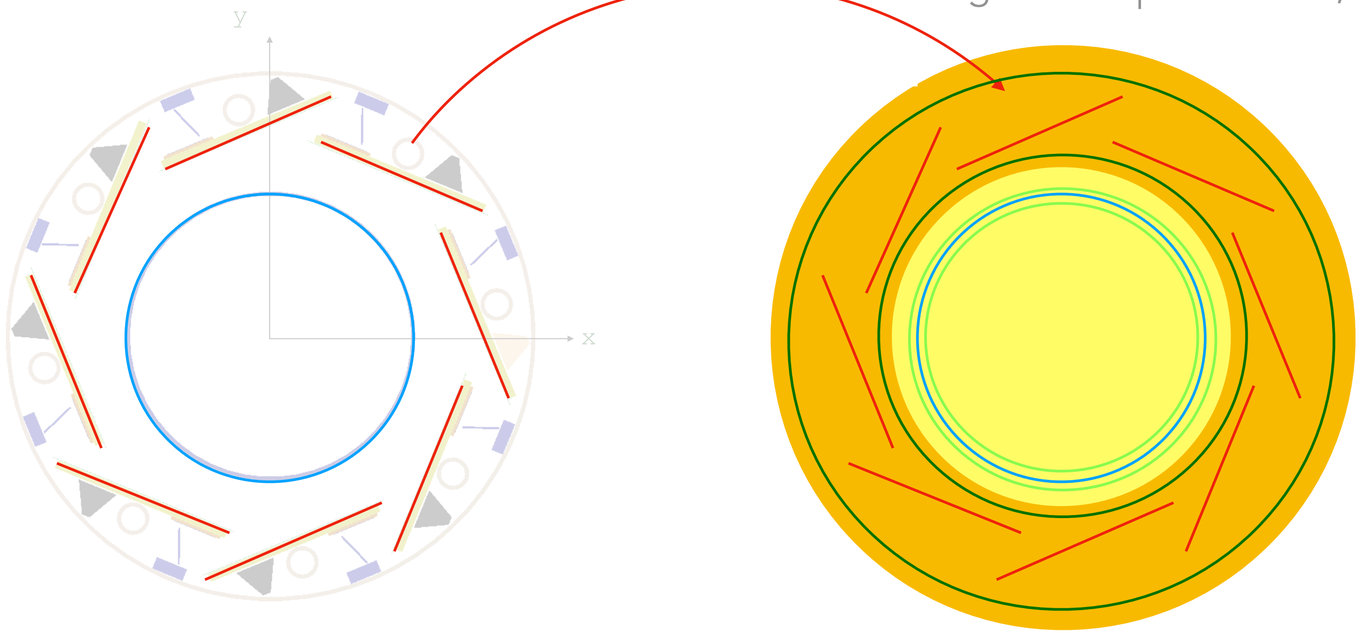
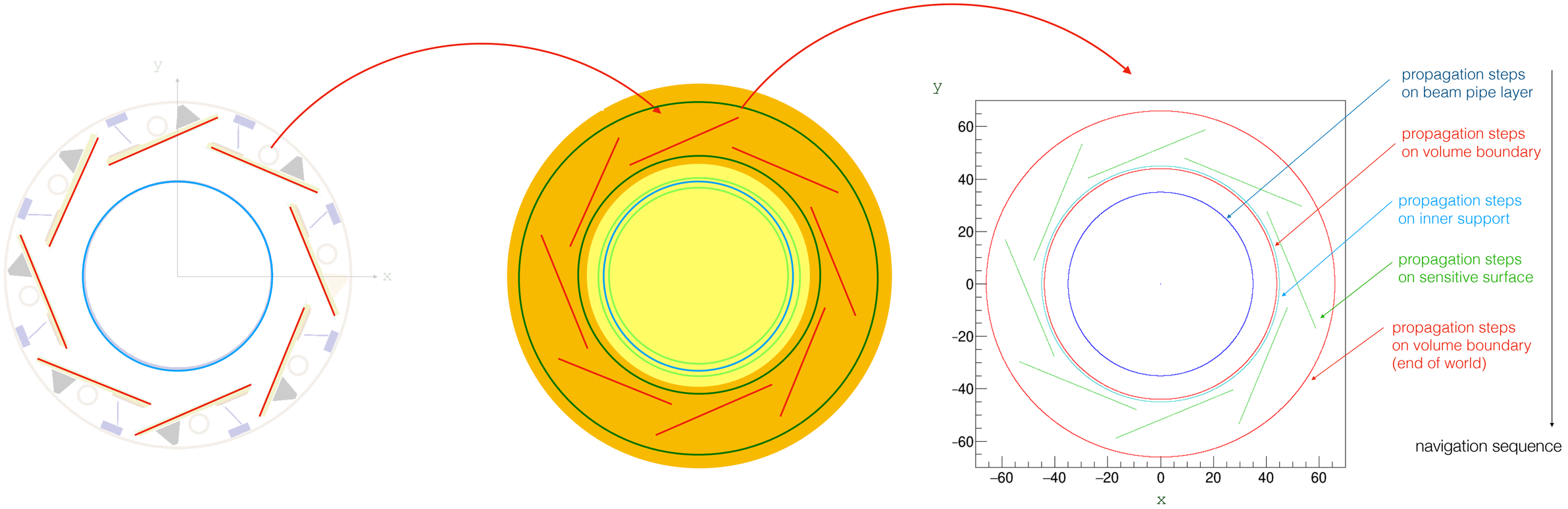


3D geometry model + `PluginDetectorElement` + `PassiveLayer` + `LayerBuilders` + `VolumeBuilders`

(Plugin, e.g. GeoModel, DD4Hep, TGeo)

Geometry - Geometry building

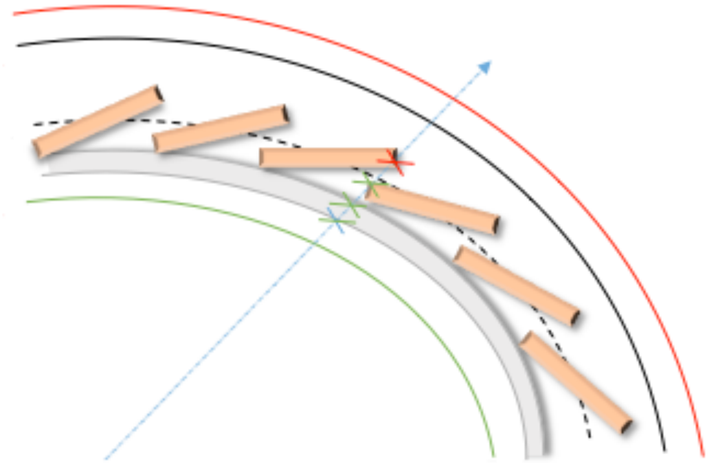
(Current) geometry building follows a bottom up approach

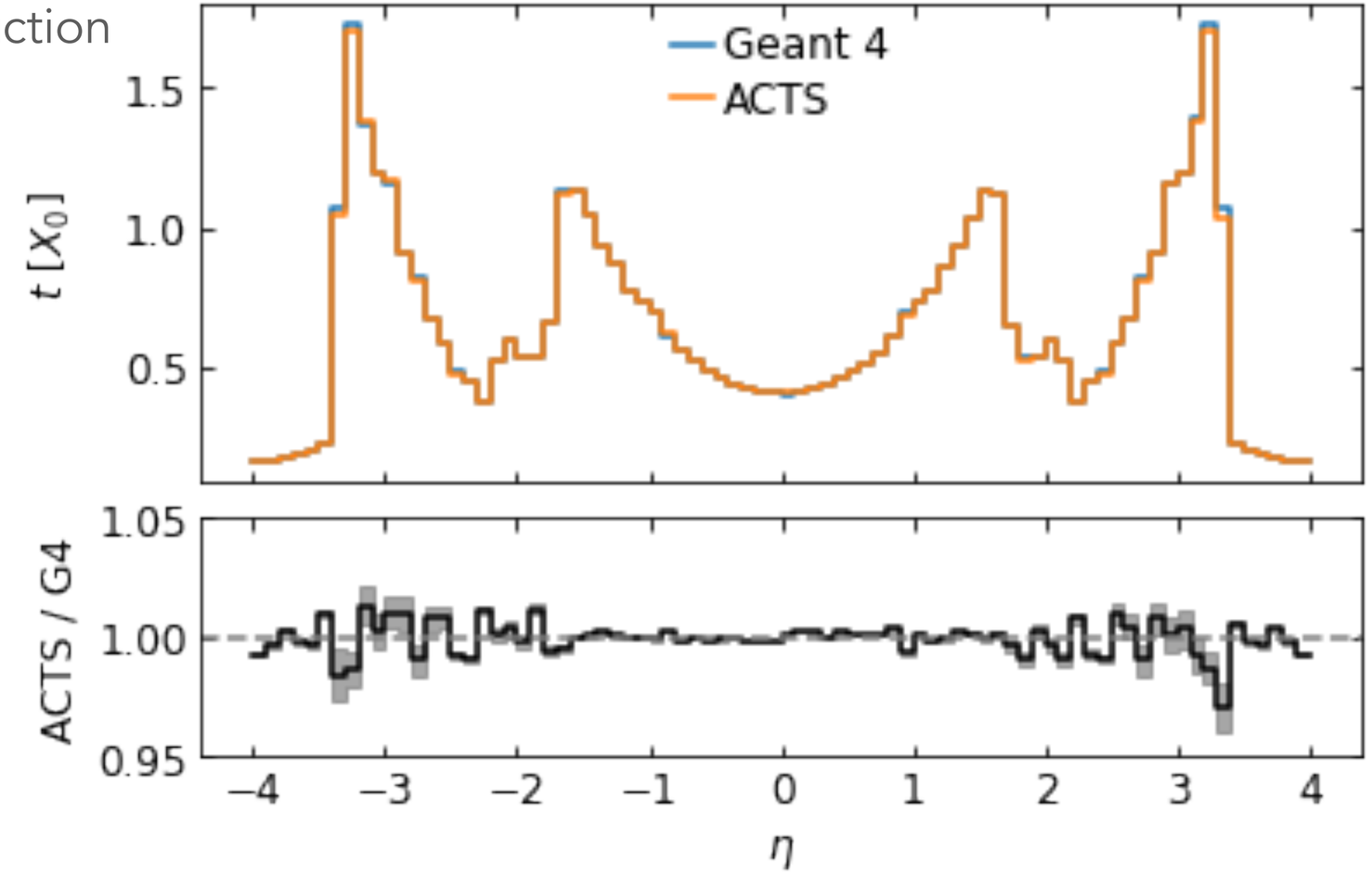


Geometry - Material description & mapping

Surface based and Volume based material exist

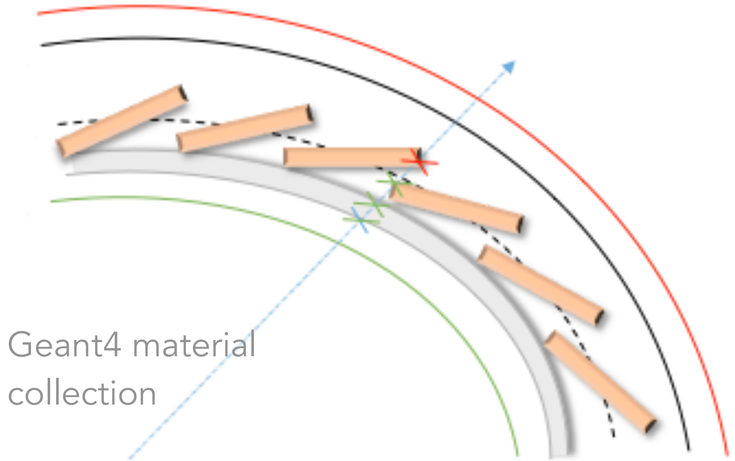
- both rely on simplification from full (Geant4) material to reconstruction description
- Some auto-translation has been I tried in the past



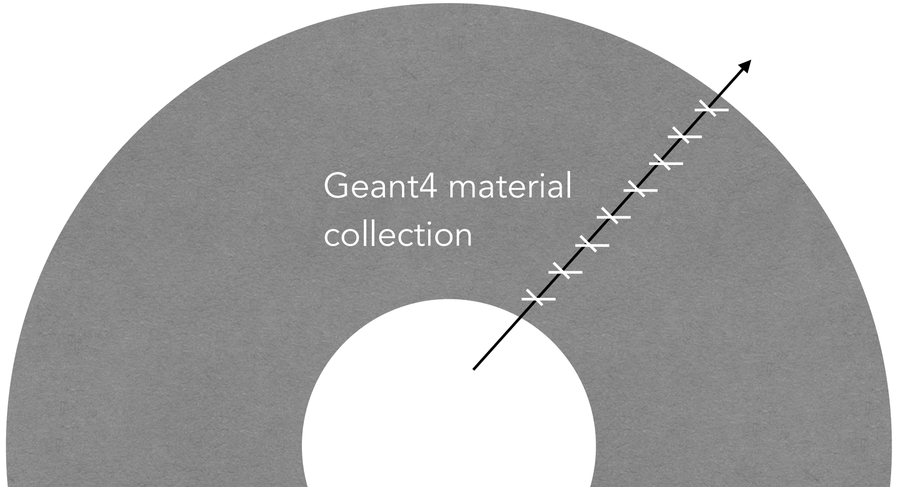


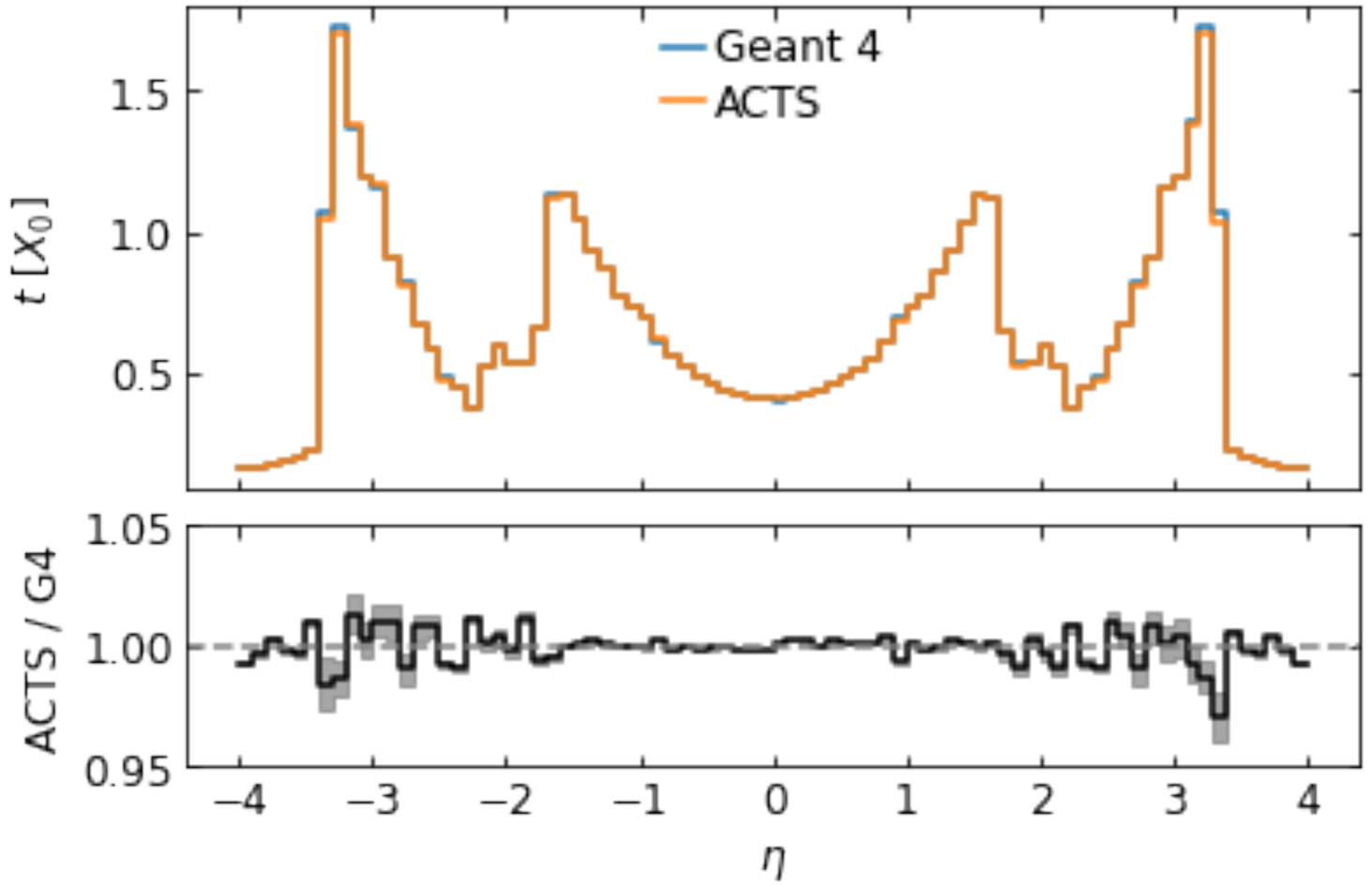
Geometry - Material description & mapping

Surface based material mapping



Volume based material mapping





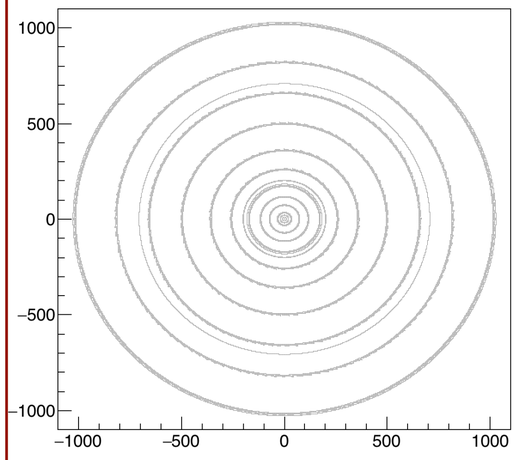
Example: Open Data Detector, surface based

Tutorial on Wednesday in context of auto-tuning.

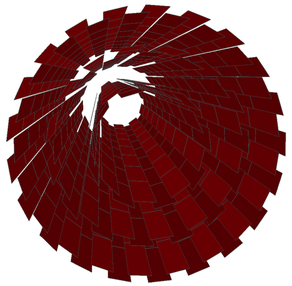
Geometry - Examples

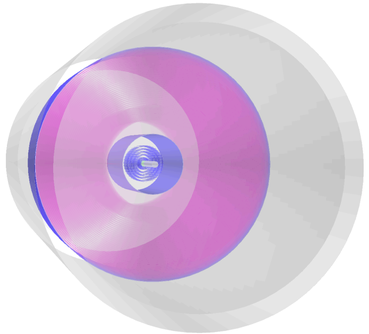
Flexibility to interface with detector **SW & Plugin** mechanism

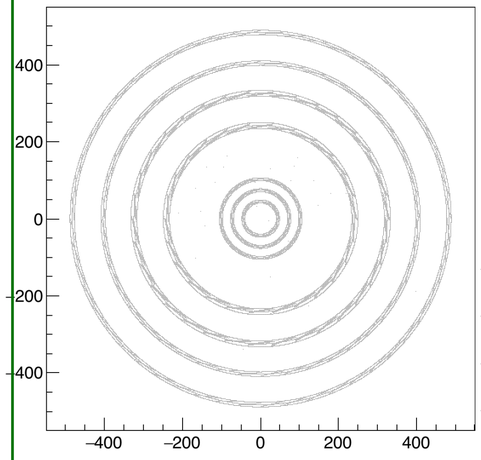
```
// BARREL :
// 4 pixel layers
// configure the central barrel
plbConfig.centralLayerBinMultipliers = {1, 1};
plbConfig.centralLayerRadii          = {32., 72., 116., 172.};
plbConfig.centralLayerEnvelopes
    = {pcEnvelope, pcEnvelope, pcEnvelope, pcEnvelope};
// material concentration always outside the modules
plbConfig.centralLayerMaterialConcentration = {1, 1, 1, 1};
plbConfig.centralLayerMaterialProperties
    = {pcmbProperties, pcmbProperties, pcmbProperties, pcmbProperties};
plbConfig.centralModuleBinningSchema = {{16, 14}, {32, 14}, {52, 14}, {78, 14}};
plbConfig.centralModuleTiltPhi       = {0.14, 0.14, 0.14, 0.14};
plbConfig.centralModuleHalfX         = {8.4, 8.4, 8.4, 8.4};
plbConfig.centralModuleHalfY         = {36., 36., 36., 36.};
plbConfig.centralModuleThickness     = {0.15, 0.15, 0.15, 0.15};
plbConfig.centralModuleMaterial
    = {pcMaterial, pcMaterial, pcMaterial, pcMaterial};
// pitch definitions
plbConfig.centralModuleReadoutBinsX = {336, 336, 336, 336};
plbConfig.centralModuleReadoutBinsY = {1280, 1280, 1280, 1280};
plbConfig.centralModuleReadoutSide  = {-1, -1, -1, -1};
plbConfig.centralModuleLorentzAngle = {0.11, 0.12, 0.12, 0.12};

// no frontside/backside
plbConfig.centralModuleFrontsideStereo = {};
plbConfig.centralModuleBacksideStereo  = {};
plbConfig.centralModuleBacksideGap     = {};
```

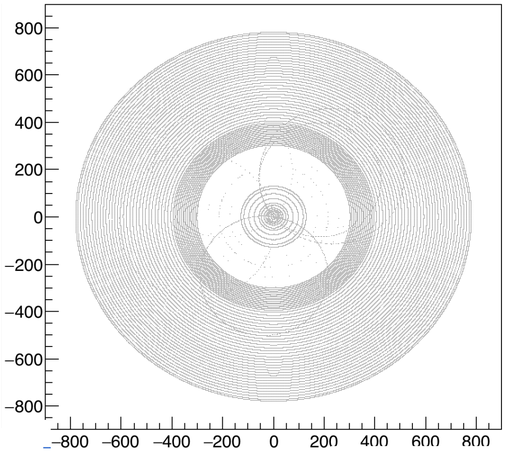


TrackML Detector



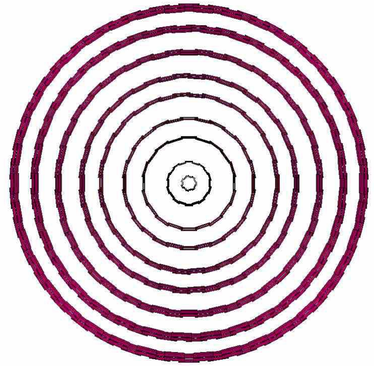


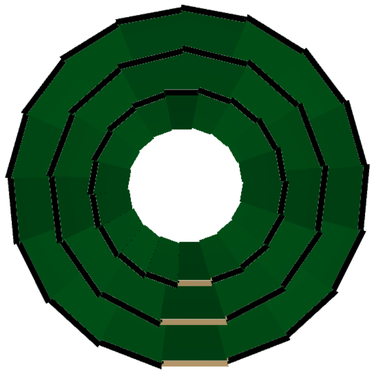


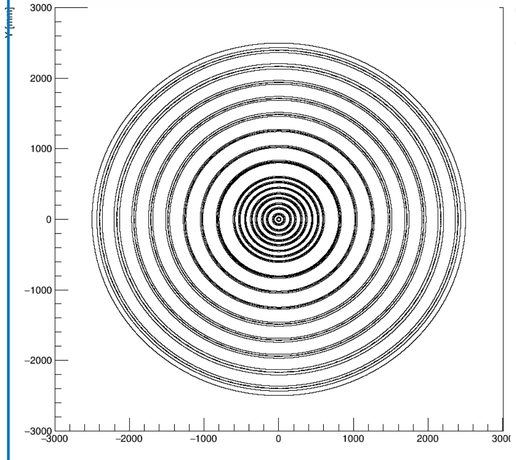


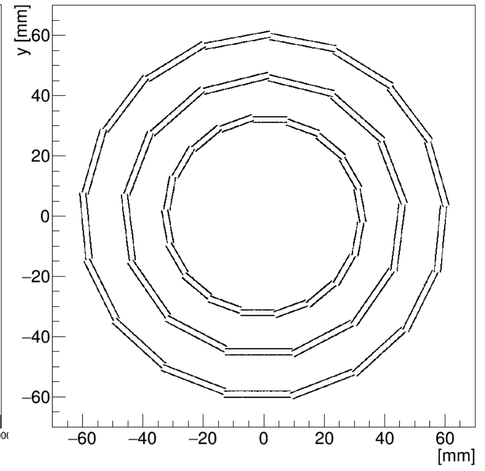
CMS Pixel & SVX

sPhenix









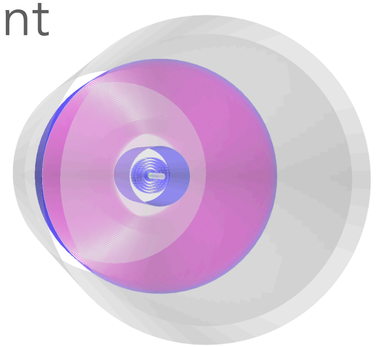
FCC-hh

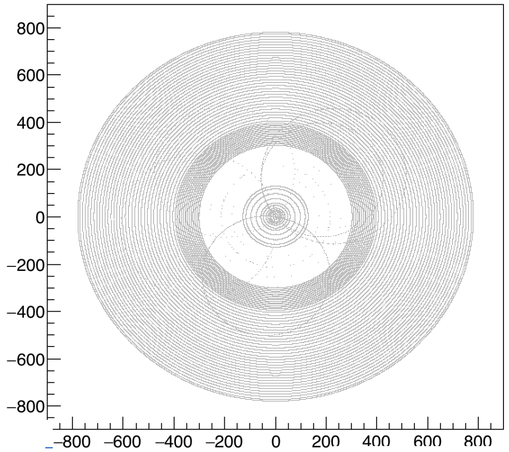
CLIC Vertex

Geometry - Development: TPC & straw detectors

Weakness in drift chamber description

- sPHENIX models TPC with many cylinders
- Not optimal from a computational point of view
- prototype solution by Fabian Klimpel to have 3D measurements and a 3D-based Kalman filter (not integrated into the code yet)





sPhenix

12:00

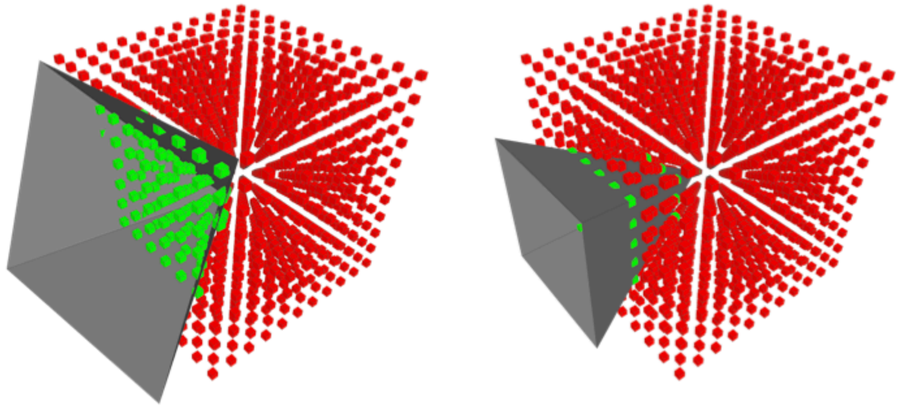
Discussion: Drift Chambers and non-planar detectors *Andreas Salzburger et al.*

31/3-004 - IT Amphitheatre, CERN 11:50 - 12:10

Geometry - Development: Calorimeter & MS geometry description

Prototype development for Calorimeter / chamber type geometry description

- In ATLAS called static (ID, layer like), detached (floating objects)
- Frustum-based navigation prototype exists that allows to navigate to practically all geometry objects



(a) (b)

Figure 7.32.: Visual representation of the automated tests of the frustum-box intersection logic. (a) and (b) show two different frustums that are tested against a grid of cubes. Cubes which intersect are shown in green, if they do not intersect they are shown in red.

Not yet integrated into the Navigator module, but tested to some extend in ATLAS Calorimeter & Muon System (will touch upon it on the ATLAS breakout day)

https://cds.cern.ch/record/2771309/files/CERN-THESIS-2021-060.pdf

Geometry - Next developments

Development Proposal:

Change navigation to volume delegate model, i.e. allow to attach different navigation strategies to the volume itself and abstract the actual call.

Tuesday

Geometry: Proposal for geometry without layers *Andreas Salzburger*

31/3-004 - IT Amphitheatre, CERN 09:30 - 09:50