SPD geometry description and GeoModel

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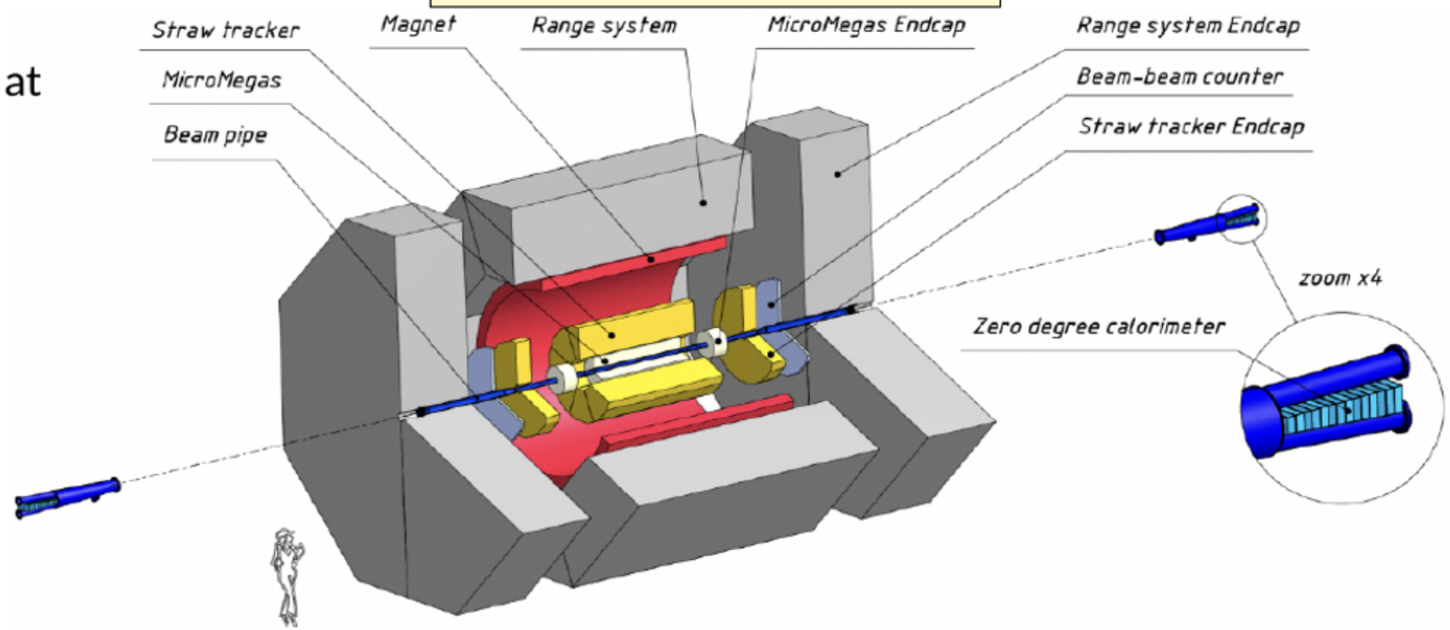
Aytadzh Allakhverdieva (DLNP JINR),28.10.24

SPD(the first stage)

The SPD TDR can be found at arXiv:2404.08317

- Polarized and unpolarized phenomena at **low energies** (3.4 GeV < $\sqrt{s_{pp}}$ < 9.4 GeV) and **reduced luminosity**
- p-p, d-d, and ion collisions (up to Ca)
- Simplified detector set-up
- Up to 2 years of data taking

Magnetic field up to **1.2 T**



Range System
muon identification and coarse hadron calorimetry

Straw tracker:
- **σ ~ 150 μm**
- **σ(dE/dx) = 8.5%**

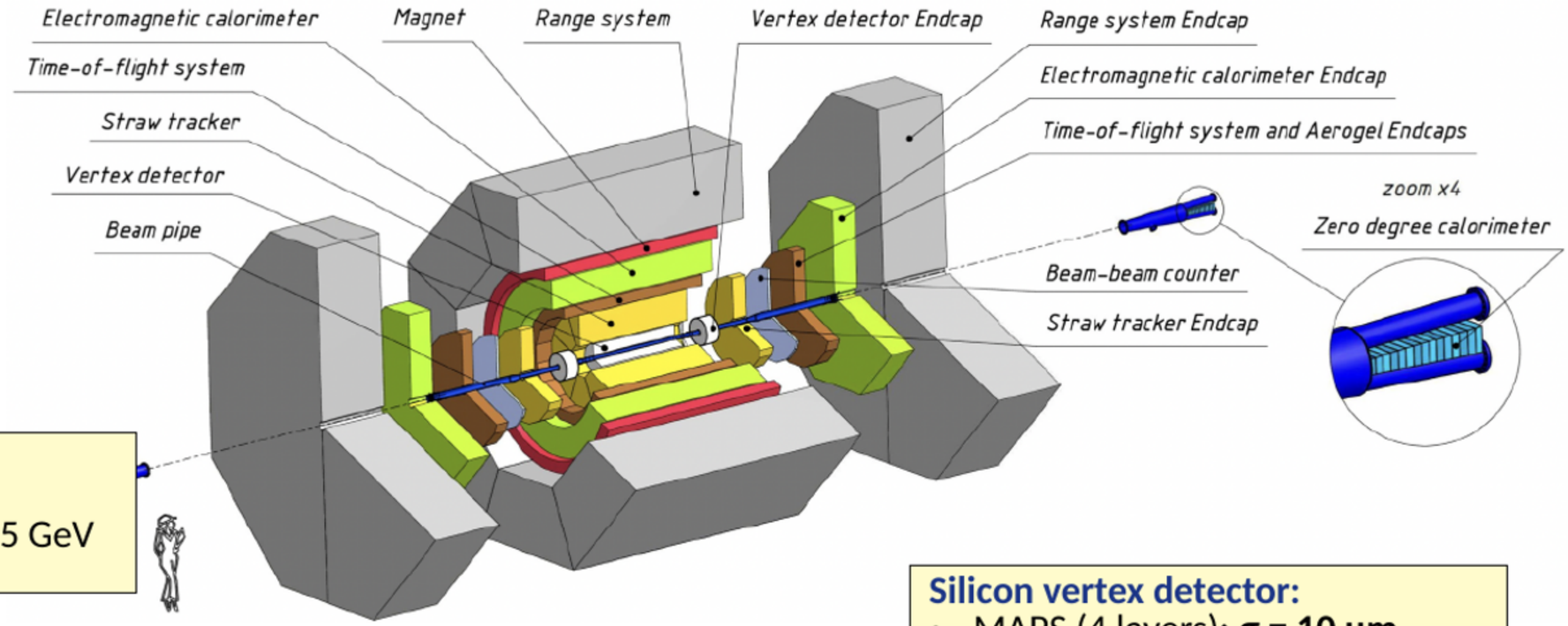
Micromegas central tracker:
σ ~ 150 μm

BBC and **ZDC** for online polarimetry

SPD(the second stage)

The SPD TDR can be found at arXiv:2404.08317

Electromagnetic calorimeter:
σE/E = 5%/√E ⊕ 1%



Time of flight system:
σ = 50 ps
3σ π/K separation for p < 1.5 GeV

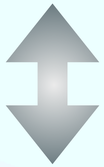
FARICH in *endcaps* for pion/kaon separation for particle momentum up to **5.5 GeV**

Silicon vertex detector:
- MAPS (4 layers): **σ = 10 μm**
- DSSD (3 layers): **σ_φ = 27.4 μm,**
  σ_z = 81.3 μm

A detector description toolkits

GeoModel(https://geomodel.web.cern.ch/home/)

- GeoModel has been used by the ATLAS experiment since 2004;
- A toolkit meets all requirements for SPD geometry description;
- A toolkit provides easy and transparent mechanism of converting GeoModel geometry description to Geant4 geometry description. Currently such type of mechanism is developing for comfortable ability using of GeoModel geometry description in reconstruction.
- It doesn’t contain magnetic field’ description tools;

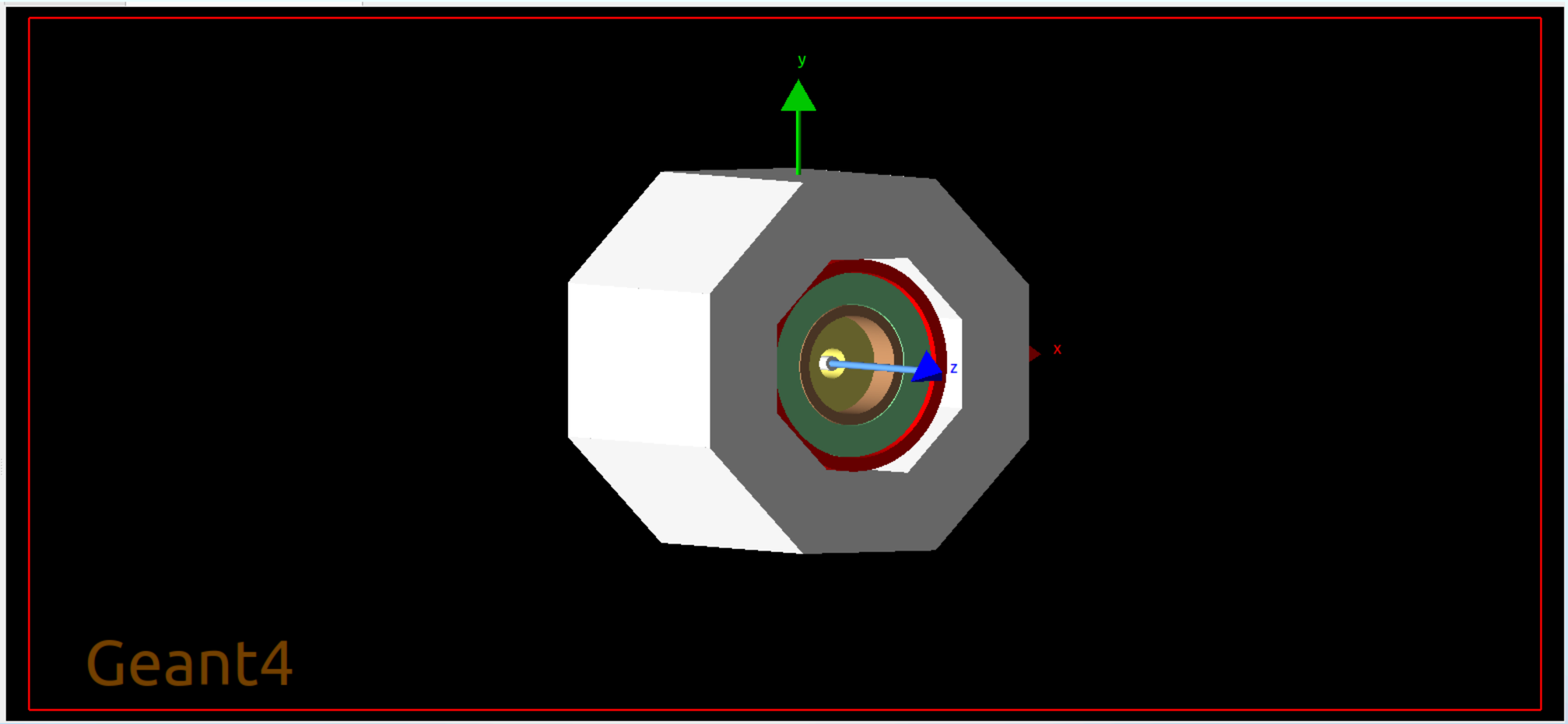


We chose GeoModel package.

DD4HEP(https://dd4hep.web.cern.ch/dd4hep/)

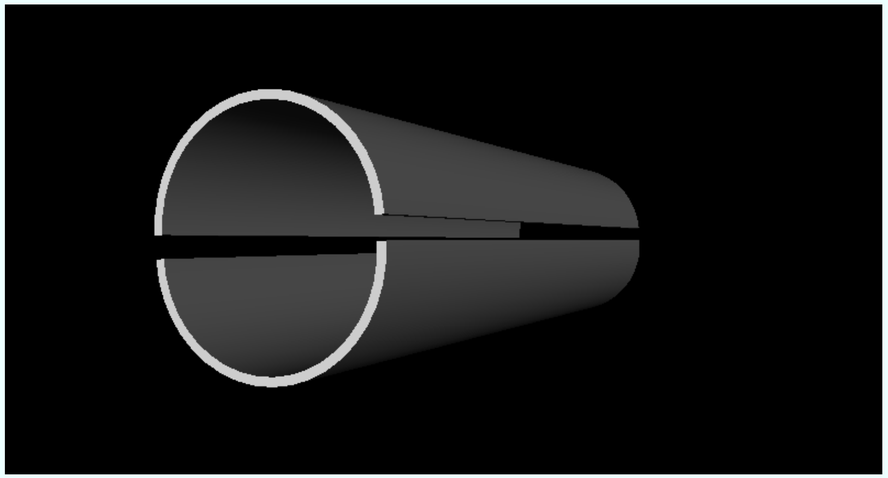
- DD4HEP has been used by CMS experiment. Mainly used for simulation of future experiments.
- DD4HEP provides a high level flexibility for the users. It’s from one side - advantage, from other side it makes the package more cluttered due to the large number of tools that aren't directly useful in geometry and material description.
- The mechanism of converting DD4HEP geometry description to Geant4 geometry description is more complicated. The same can be said about the code. It looks large and tricky with respect to GeoModel code.

First step to the full SPD geometry description

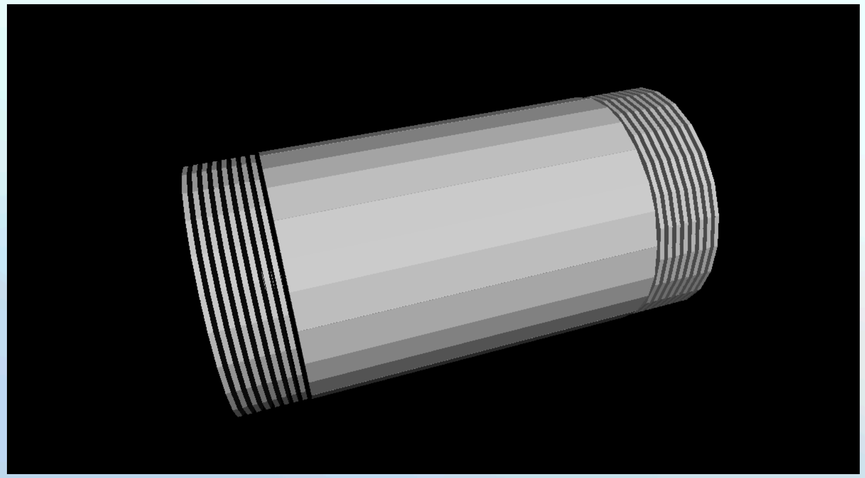


SPD geometry description on subsystems' level.

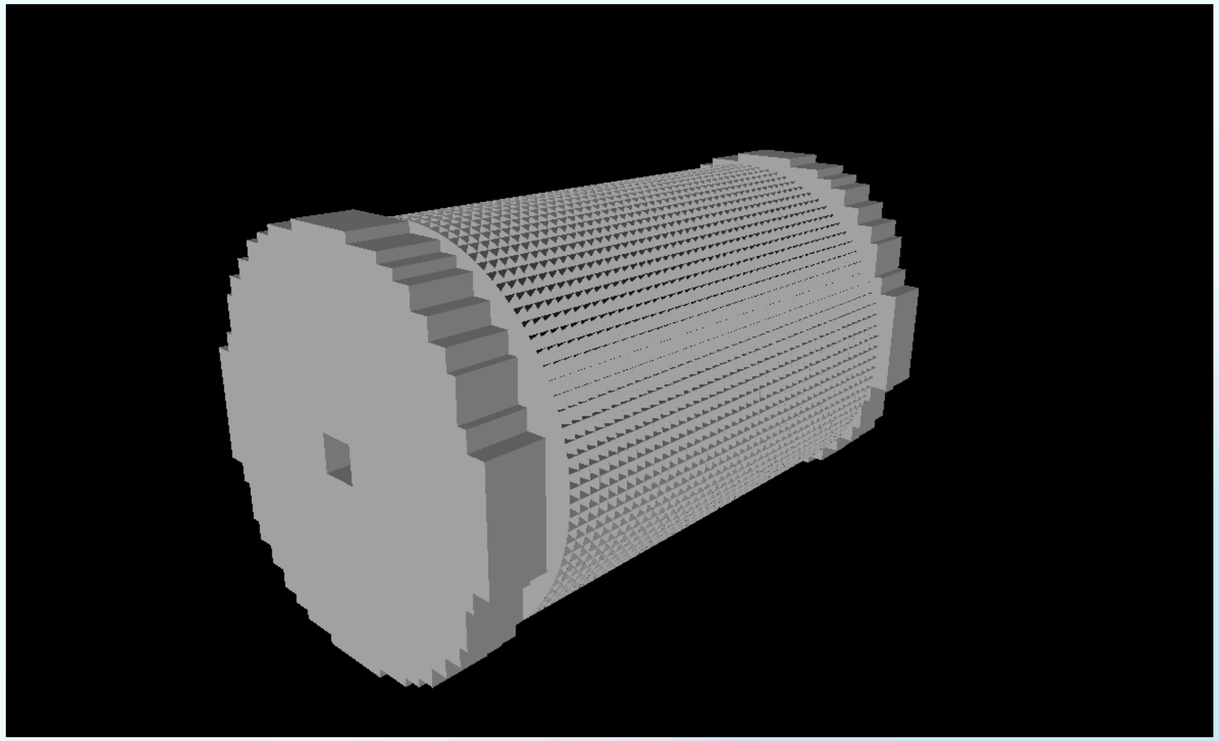
Second step to the full SPD geometry description



Micromegas-based Central Tracker

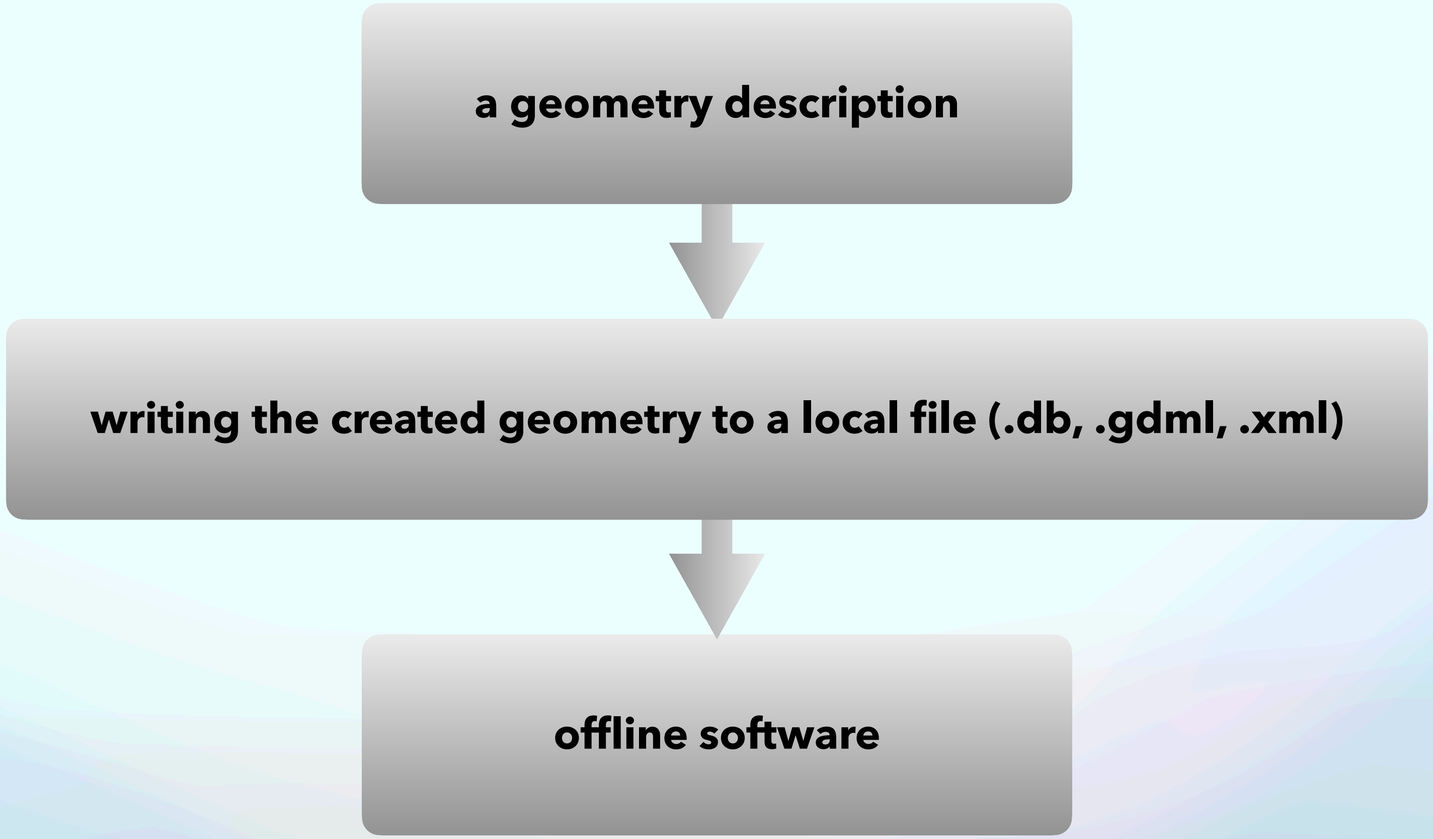


Straw Tracker



Electromagnetic calorimeter

The mechanism of interaction with geometry description



Converting GeoModel data to a Geant4 geometry

- **reading input geometry from local file**

```
static const std::string path = "/path to db file/spd.db";

GMDBManager* db = new GMDBManager(path);

GeoModelIO::ReadGeoModel readInGeo = GeoModelIO::ReadGeoModel(db);

GeoVPhysVol* world = readInGeo.buildGeoModel();
```

- **building the Geant4 logical volumes using this builder and input data**

```
ExtParameterisedVolumeBuilder* builder = new ExtParameterisedVolumeBuilder("SPD");

G4LogicalVolume* g4World = builder->Build(world);

G4VPhysicalVolume* physWorld = new G4PVPlacement(0, G4ThreeVector(), g4World, "World", 0, false, 0, true);
```

Sensitive volume in Geant4

- The detector contains a large number of elements. Some of which are necessary to support the facility.
- Sensitive detector is used to distinguish detecting elements from others in Geant4. It is a way to declare a geometric element sensitive to the passage of particles.
- GeoModel doesn’t know what sensitive volumes are. –> **Need to be developed.**

Sensitive detector in Geant4

adding a flag «_sens» + «_type of sensitive volume» to GeoModel logical volume name

creating of Geant4 geometry from GeoModel geometry

getting logical volume store, filtering volumes

adding selected volumes into sensitive detectors

adding a «_type of sensitive volume» to GeoModel logical volume name

writing sensitive volumes names into external file

creating of Geant4 geometry from GeoModel geometry

getting from logical volume store volumes with names from external file

adding selected volumes into sensitive detectors

Navigation system

- Geant4 tools provide navigation among geometry objects in simulation.
- Navigation among geometry objects in reconstruction. –> **Need to be developed.**
- Navigation system:

  - creating of unique identifier for each detector element;

  - providing access to data via identifier.

```
Database has been opened successfully!
ID is founded!
Printing info from: 67852.
Volume with ID: 67852 is on straw tracker in barrel in octant # 4 in layer # 4 with angle = -5 with tube number = 0
```

Example: the employment of navigation mechanism to extract information about the straw tube.

Summary

- SPD geometry description on subsystems' level and descriptions of the inner structure of Micromegas-based Central Tracker, Straw Tracker and Electromagnetic calorimeter were obtained.
- The mechanism of sensitive volumes' declaration has been developed.
- The first stage of navigation system' developing is completed.

Thank you for your attention!