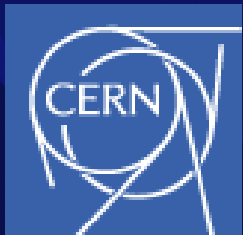


DD4hep Status

HEP detector description
supporting the full
experiment life cycle

M.Frank⁽¹⁾, F.Gaede⁽²⁾, N.Nikiforou^(1,3), M.Petric⁽¹⁾, A.Sailer⁽¹⁾
⁽¹⁾ CERN ⁽²⁾ Desy ⁽³⁾ now: UT Austin



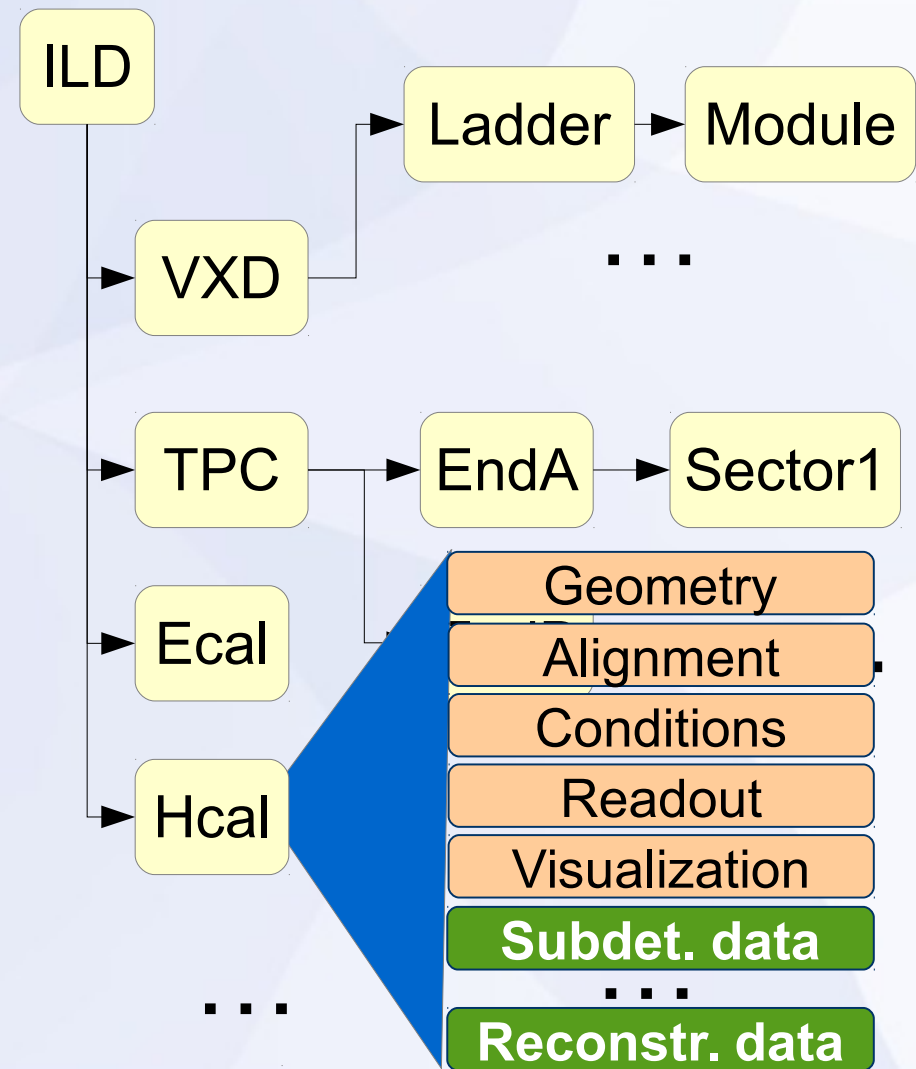
- **Motivation and Goals**
=> Introduction / Reminders
- Simulation
- Alignment and conditions support
- Miscellaneous
- Summary

Motivation and Goal

- **Develop a detector description**
 - **For the full experiment life cycle**
 - detector concept development, optimization
 - detector construction and operation
 - “Anticipate the unforeseen”
 - **Consistent description, with single source, which supports**
 - simulation, reconstruction, analysis
 - **Full description, including**
 - Geometry, readout, alignment, calibration etc.

What is Detector Description ?

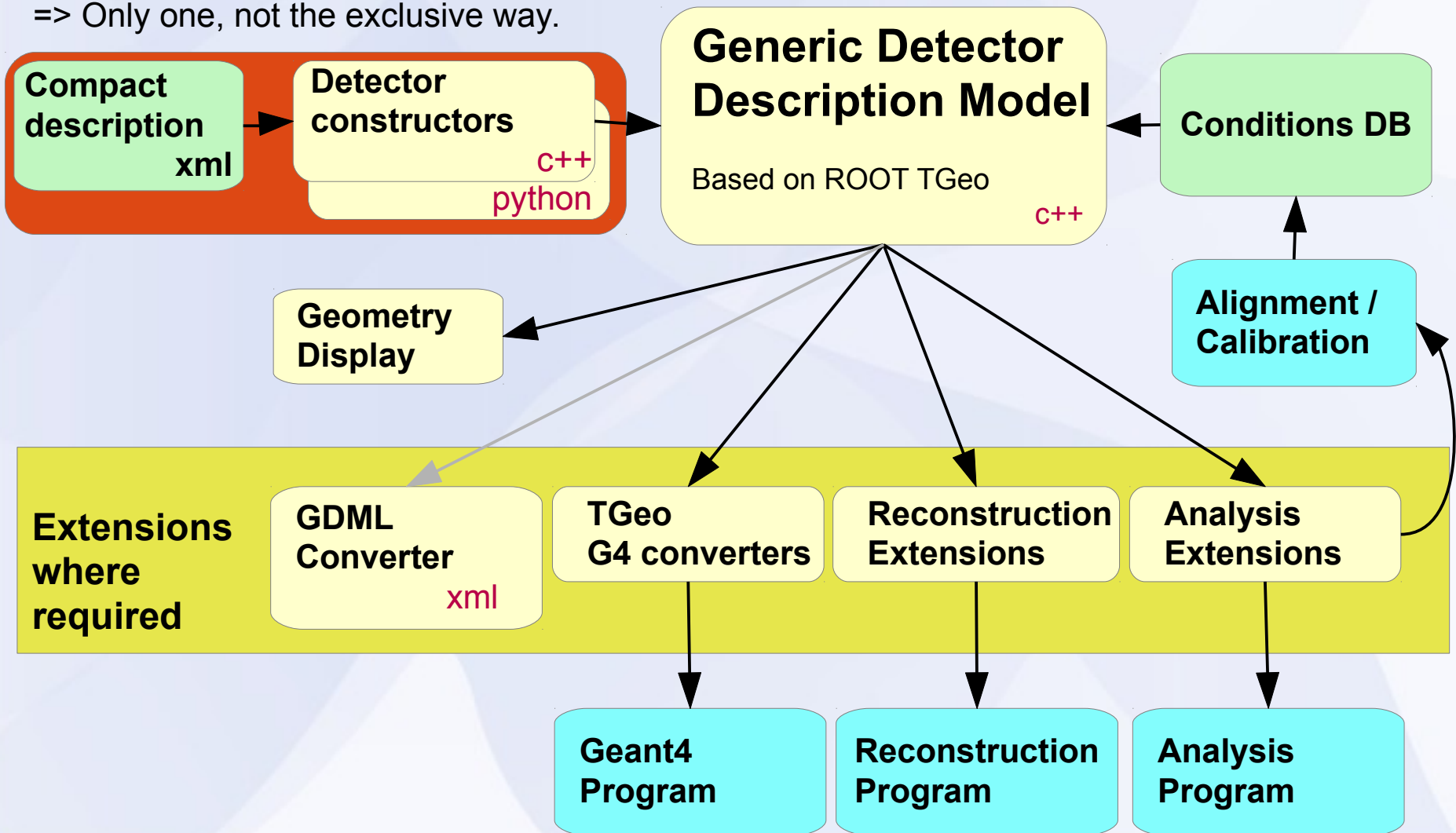
- **Description of a tree-like hierarchy of “detector elements”**
 - **Subdetectors or parts of subdetectors**
- **Detector Element describes**
 - **Geometry**
 - **Environmental conditons**
 - **Properties required to process event data**
 - **Optionally: experiment, sub-detector or activity specific data**



DD4Hep - The Big Picture

Note:

DD4hep population is plugin based
=> Only one, not the exclusive way.



Saga in 5 Episodes: Sub-packages

- **DD4hep – basics/core**
 - Performance improvements
 - Few functional additions
- **DDG4 – Simulation using Geant4**
 - Under validation
- **DDRec – Reconstruction supp.**
 - Driven by LC community
- **DDAlign – Alignment support (*)**
- **DDCond – Detector conditions (*)**

(*) In work



- Motivation and Goals
- **Simulation**
=> **DDG4**
- Alignment and conditions support
- Miscellaneous
- Summary

Simulation: DDG4

- **Simulation = Geometry + Detector response + Physics**
- **Concept: Formalization of Geant4**
 - Automatic conversion from ROOT to Geant4
 - Instantiate objects palette:
Physics-lists, physics-constructors and sensitive detectors
 - Start simulating
- **Basic sensitive detectors in framework**
- **No extra (C++) user code necessary**
 - But not inhibited e.g. sophisticated sensitive detectors
- **Flexible configuration with python or Cint [, XML]**

DDG4: Status

- **Multi-threading support is implemented**
 - **Geant4 supports event based parallelism**
 - **Validation must be done**
- **Validation by Linear Collider community ongoing**
 - **Baseline**

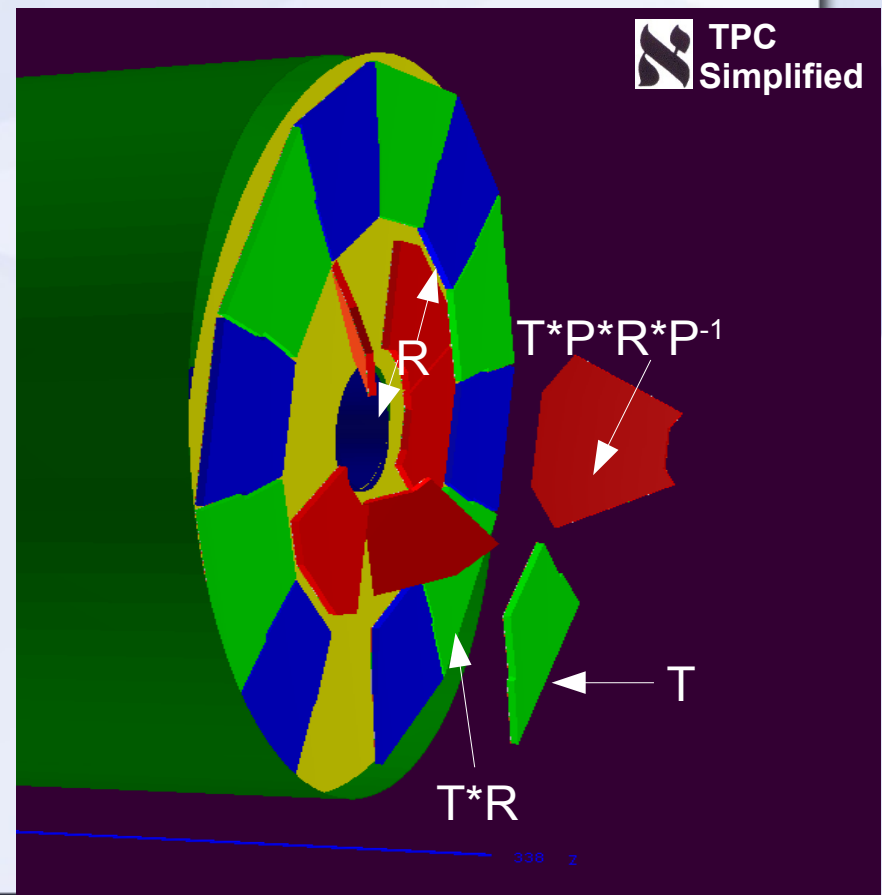
DDG4: Upcoming Developments

- **Support for fast and parametrized simulation**
 - **Speed-up by avoiding full Geant4 machinery**
 - **On the work-list**
- **Revisit integration into experiment frameworks**
 - **Depends on future requirements of FCC (Gaudi) and ILC (Marlin)**

- Motivation and Goals
- Simulation
 - => DDG4
- **Alignment and conditions support**
 - => **DDAlign & DDCond**
- Miscellaneous
- Summary

DDAlign: Detector Alignment

- **Fundamental functionality to interpret event data in the real and imperfect world**
 - **Must handle imperfections**
 - Geometry => (Mis)Alignment
 - **Anomalous conditions**
 - Pressures, temperatures
 - => Contractions, expansions
 - **Basic functionality present**
 - But no connection to persistency present (yet)



DDAlign: Status

- Clarification:

DDAlign does not provide *algorithms* to determine alignment constants and never will.

DDAlign supports hosting the results of such algorithms and applies the resulting imperfections

- **Basic prototype functional**
 - Supports simulation of misaligned geometries
 - For now: Single threaded applications
- **Alignment data are typically time-stamped**
 - Connected to conditions database

DDAlign: Status (2)

- Design document ready
 - Initial prototype ready
- But: Need 'real world' environment for testing
 - Idea: use LHCb detector description as guinea-pig
 - Need to interface to LHCb conditions database
 - Other concept than DD4hep compact description

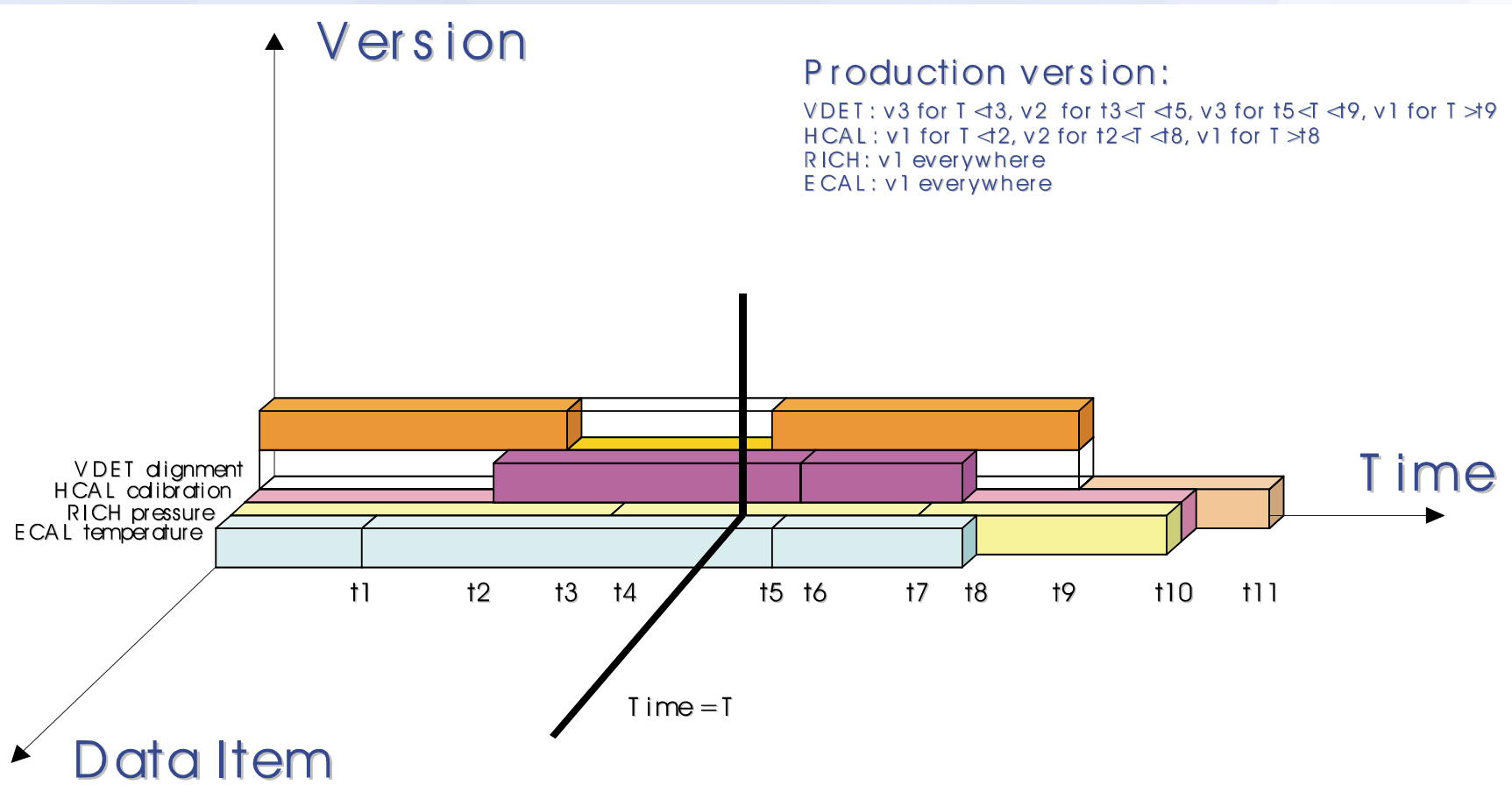
=> Need to advance interface to conditions



DDCond: Conditions Data

- **Time dependent data necessary to process the detector response [of particle collisions]**
- **Conditions data support means to Provide access to a consistent set of values according to a given time**
 - **Fuzzy definition of a “consistent set” typically referred to as “interval of validity”:**
time interval, run number, named period, ...
 - **Configurable and extensible**
- **Data typically stored in a database**

Conditions Data: Consistent Dataset



[Pere Mato / 2000]

DDCond: Persistency

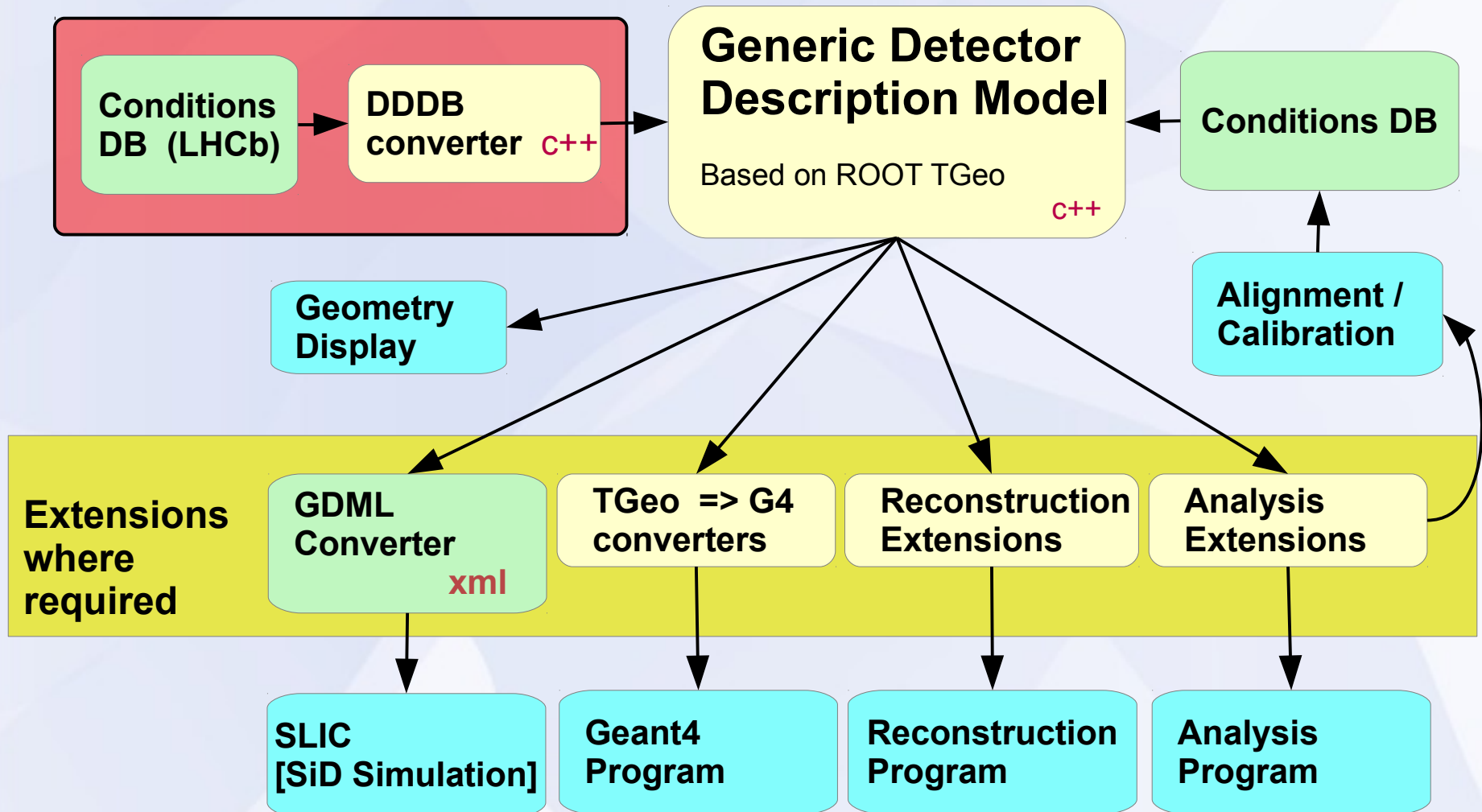
- **The LHCb exercise showed that**
 - **Different detector description schemata (not LCDD-compact based) are relatively painless to integrate**
 - **Collary: other persistent solutions can easily be adopted**
- **Persistent detector description are strongly influenced by experiments**
 - **New development ongoing in Atlas/CMS (G.Govi et al.)**

DDCond: Persistency (2)

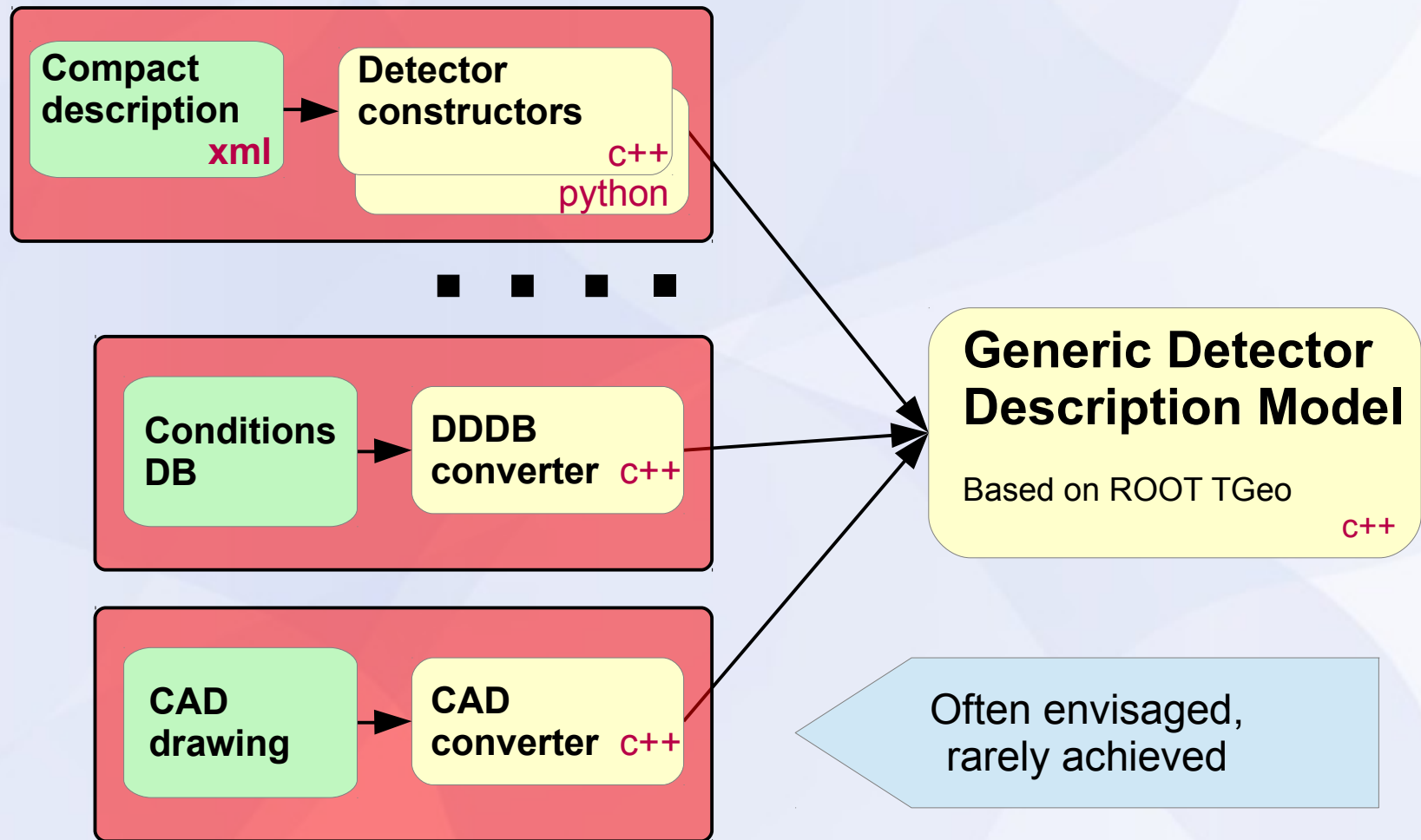
- **External solutions possible, but unlikely perfect**
 - **Better interface to the experiments database**
 - **Do not impose 'external' DB schema resulting in collateral restrictions**
 - **Ensure users do not have to give up flexibility**
- **Will provide an example implementation**
 - **Show recipe how to interface to conditions DBs**
 - **LHCb - DDDDB is one example**
 - **Will provide a toy xml example**
Not for real use, but rather for illustration

- **Motivation and Goals**
- **Simulation**
=> **DDG4**
- **Alignment and conditions support**
=> **DDAlign & DDCond**
- **Miscellaneous**
- **Summary**

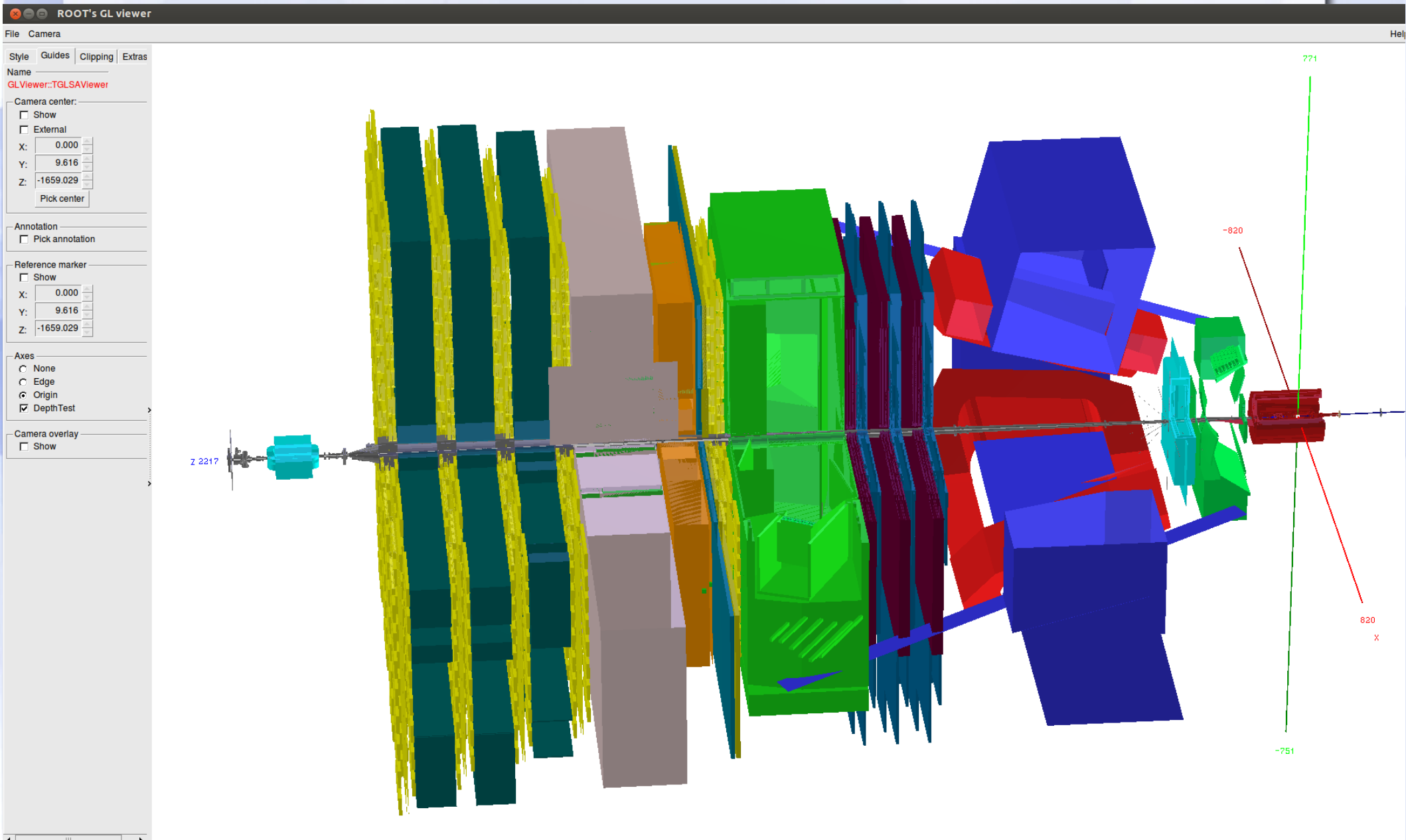
DD4Hep - Interface LHCb Conditions



Side-Result: Proof of Concept to Integrate Multiple Input Sources



LHCb Detector



LHCb Detector in Cavern

ROOT's GL viewer

File Camera

Style Guides Clipping Extras

Name

GLViewer:TGLSAViewer

Clip Type

None Plane Box

Clip away inside

Auto update clip

Edit In Viewer

Show In Viewer

Center X 3001.2

Center Y 2509.09

Center Z 2255.57

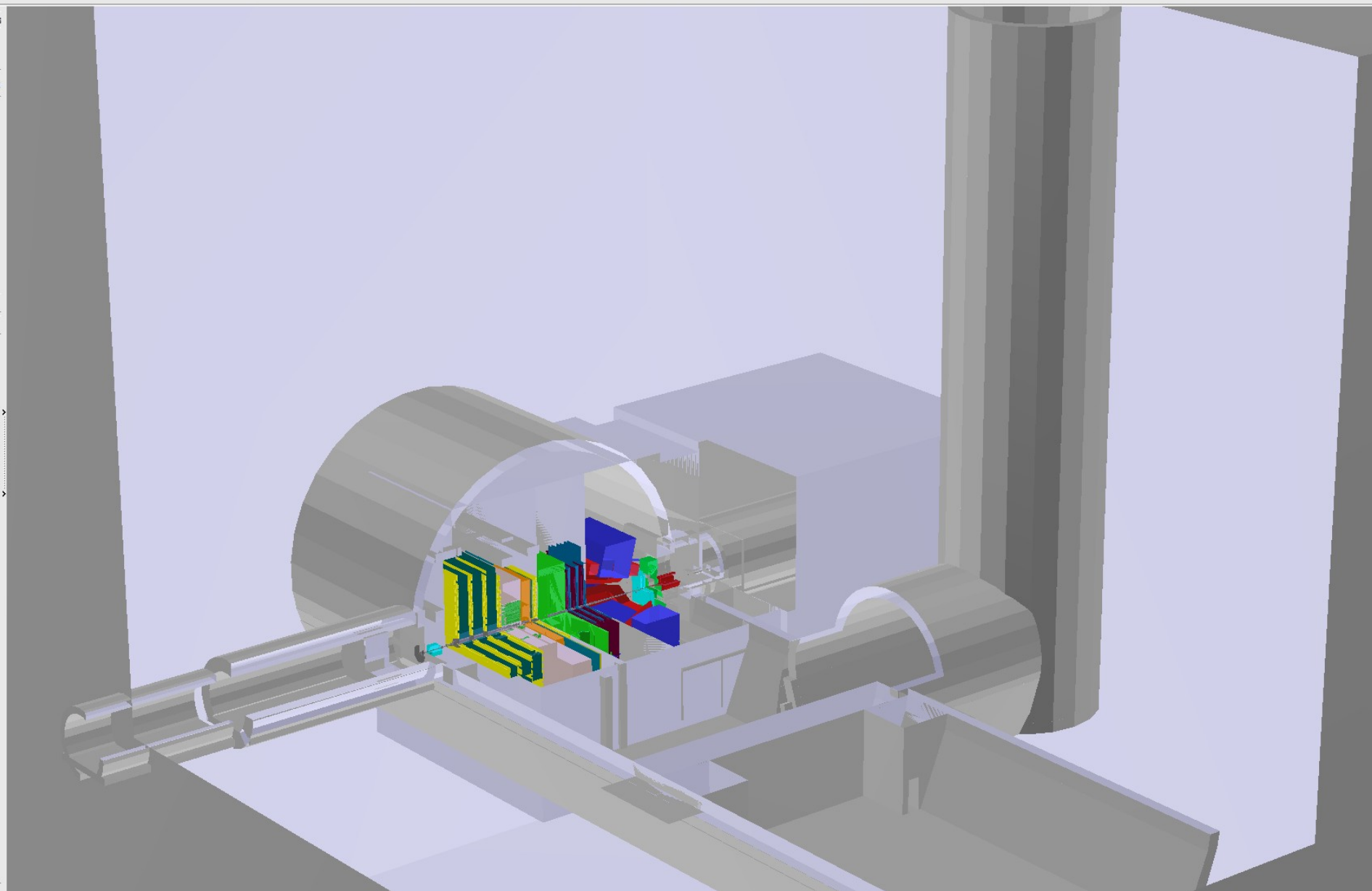
Length X 6002.4

Length Y 5018.18

Length Z 5195.11

Apply

Reset



Toolkit Users

Users are mandatory for feedback to avoid purely academic developments in thin air...

		DD4hep	DDG4
• ILC	F. Gaede et al.	X	X
• CLICdp	A. Sailer et al.	X	X
• FCC-eh	P. Kostka et al.	X	X
• FCC-hh	A. Salzburger et al.	X	
• SiD	Decision to use DD4hep taken at LCWS 2015		
• CALICE	Calorimeter R&D, 280 persons: Started		
• FCC-ee	Some interest		
• LHCb	Some interest for upgrade (but legacy)		

- **Motivation and Goals**
- **Simulation**
=> **DDG4**
- **Alignment and conditions support**
=> **DDAlign & DDCond**
- **Miscellaneous**
- **Summary**

Summary

- **DD4hep core: consolidated**
- **Simulation toolkit DDG4**
 - **Validation by LC community**
- **DDAlign:**
 - **prototype implemented**
 - **Design document written**
 - **Need interface to conditions data**
- **DDCond:**
 - **Interfaced to LHCb's conditions database**
 - **Now need to connect and process alignment conditions**

Questions and Answers

