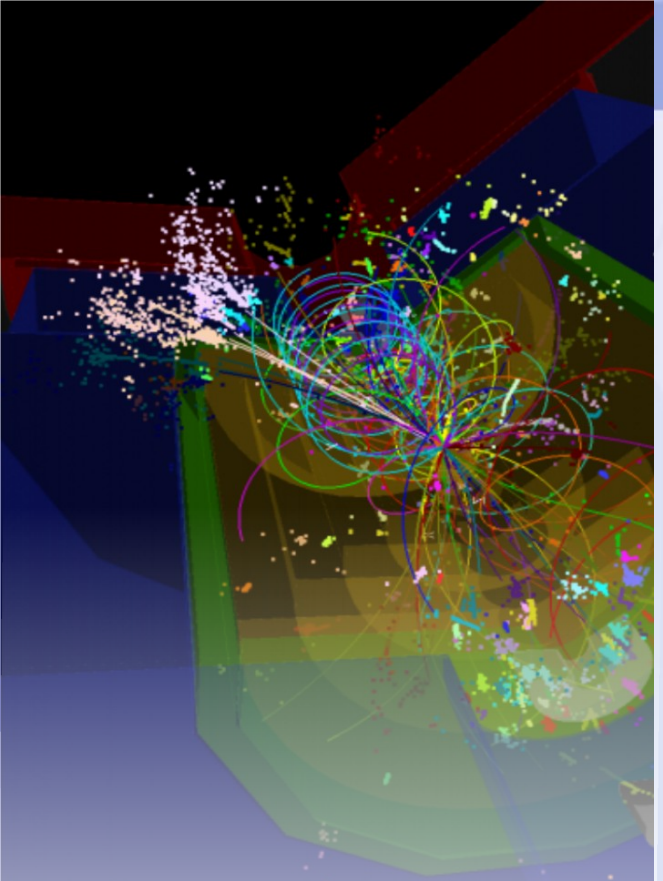


DD4hep

Saga in Five Episodes

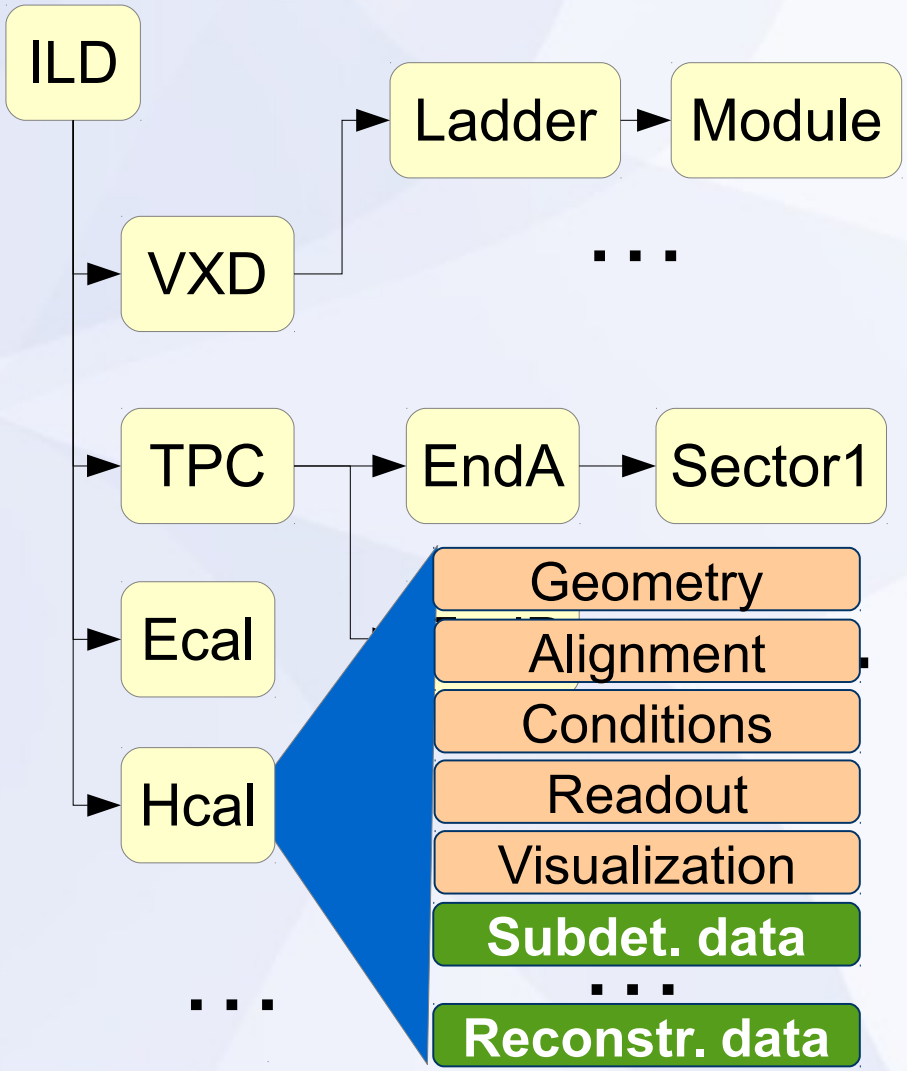
DD4hep work plan for AIDA 2020

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, single source of information, which supports**
    - **simulation, reconstruction, analysis**
  - **Full description, including**
    - **Geometry, readout, alignment, calibration etc.**

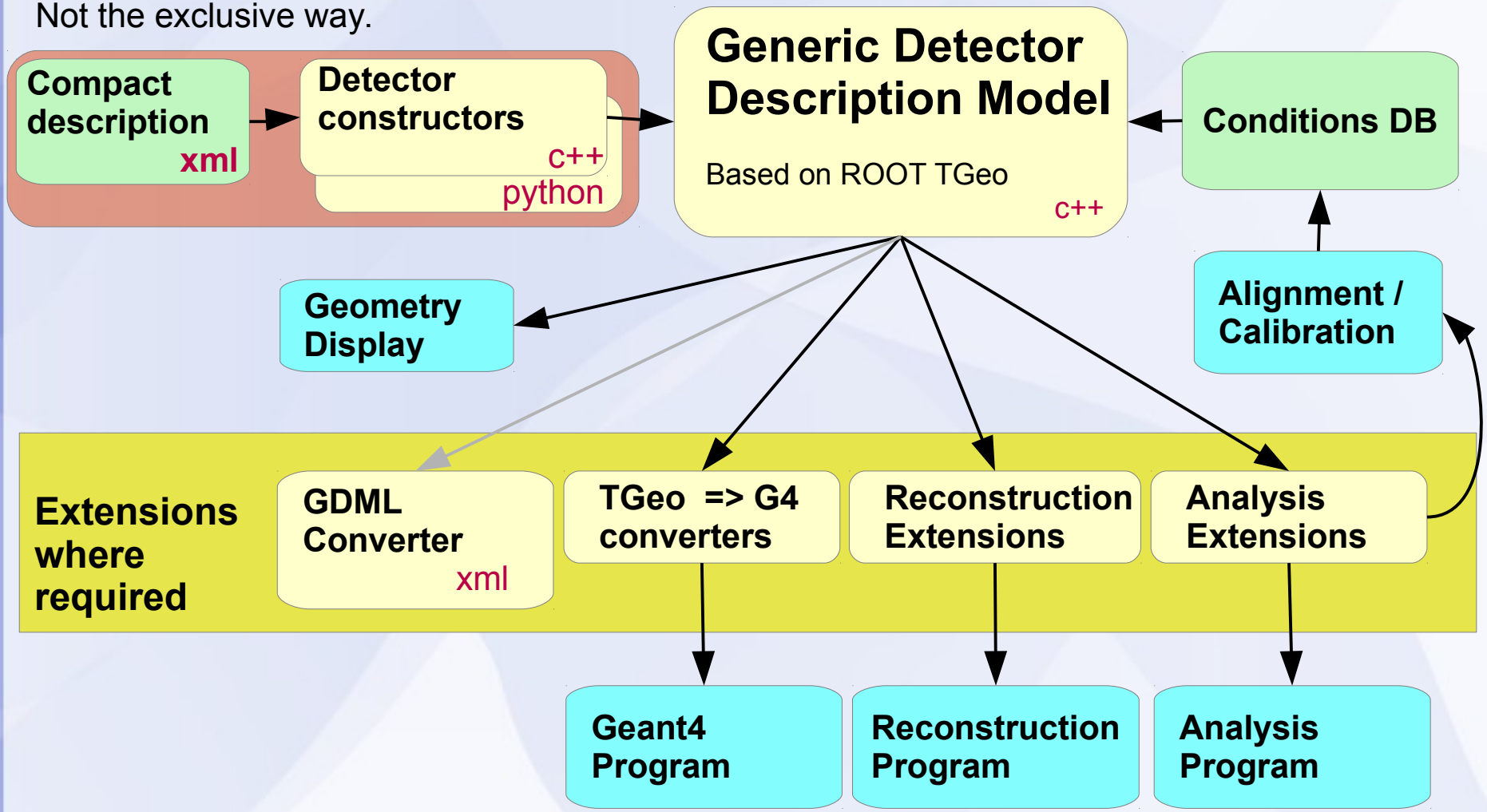
What is Detector Description ?

- **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**



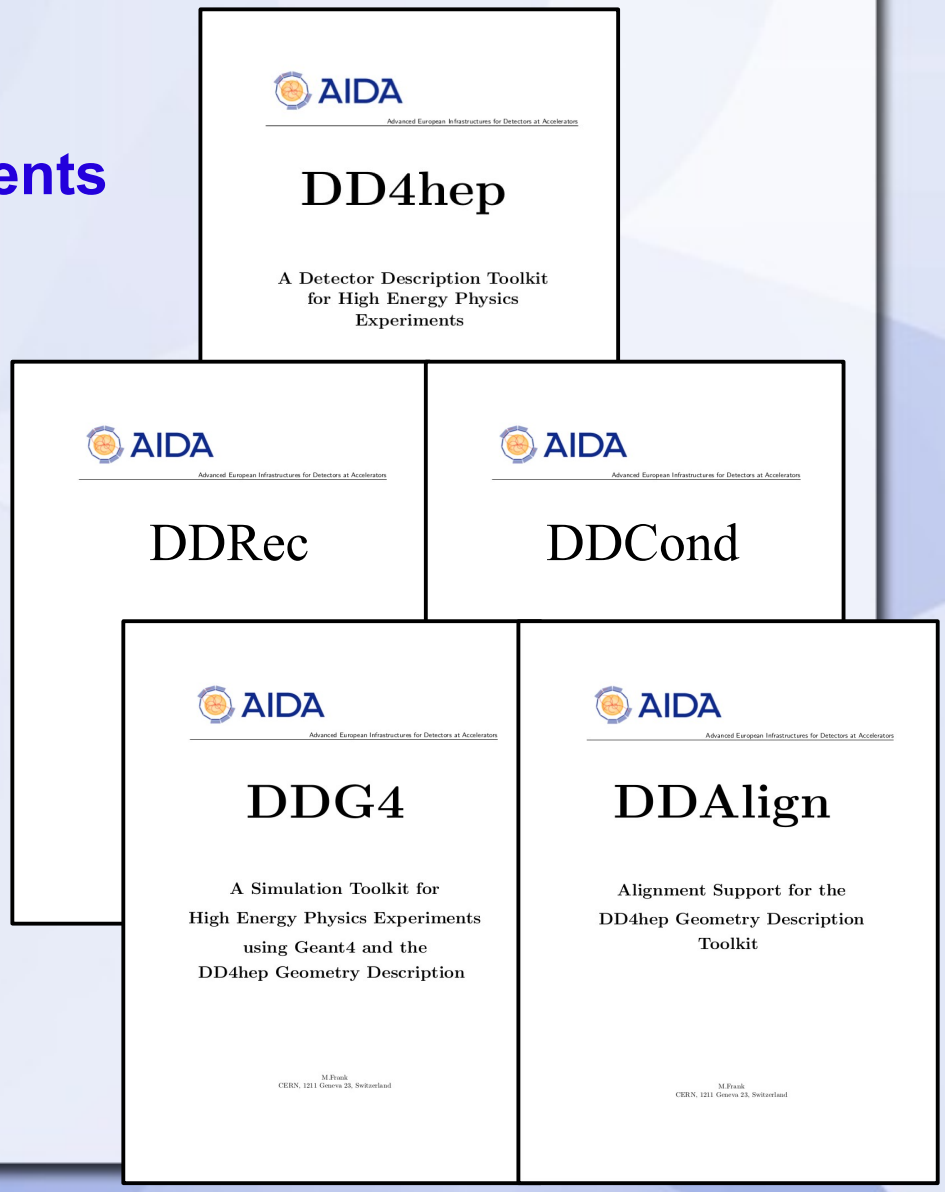
DD4Hep - The Big Picture

Note:
One way to populate DD4hep (plugin based)
Not the exclusive way.



Saga in 5 Episodes: Sub-packages

- Detector description usage
- DD4hep – basics/core
  - Stable, bug-fixes, enhancements
- DDG4 – Simulation using Geant4
  - Validation and enhancement
- DDRec – Reconstruction supp.
  - Not covered here
  - Driven by LC community
- DDAlign – Alignment support
  - In work, needs DDCond
- DDCond – Detector conditions
  - Basically non-existant



DD4hep Core and Multi-Threading

- Multi-threading during initialization
  - Limited pressure. Speed issues may be solved by loading initialized persistent images
- While processing events
  - Normally detector description data are read-only
  - Multi-threading by construction
- Problematic are updates: Conditions, Alignment
  - Multi-threading often uses event parallelism
  - On update the event pipeline MUST be drained to avoid inconsistent detector views
  - This can only be steered by the processing framework
    [lesson learned from Gaudi-Hive]

Simulation: Generic Geant4 Gateway

- **Simulation =**
  Geometry + Detector response + Physics
- **Attempt for formalization of Geant4**
  - **Ideally: configuration without extra (C++) user code**
- **DDG4**
  - **Bootstrap Geant4 from DD4hep in memory geometry**
  - **Configure using XML, python or Cint (ROOT 5)**
  - **Configure Geant4 actions, physics-list, processes, particle constructors, sensitive actions, I/O etc using module palette**

Simulation: DDG4

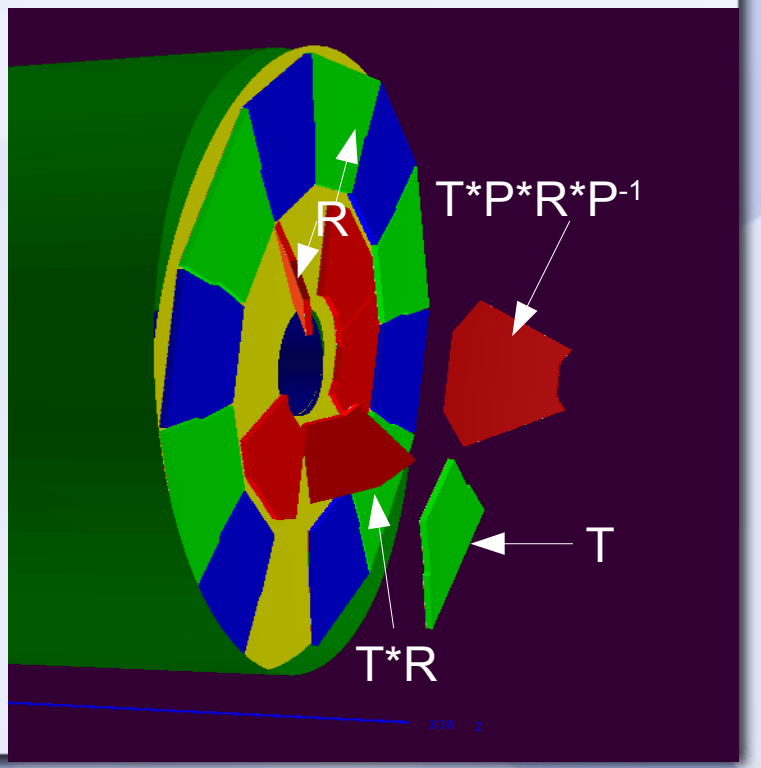
- Concept
  - Walk through the geometry and convert on the fly from ROOT to Geant4
  - Instantiate sensitive detectors from palette
  - Instantiate physics list, -constructors and -processes
  - Start simulating
- Palette of sensitive detectors
  - Basic concepts implemented
- Processing chain is implemented
  - Validation in progress – time consuming process

DDG4 Work List: Keep The Boys Off the Street

- Support for fast and parametrized simulation
  - Speed-up by avoiding full Geant4 machinery
  - Workshop @ CERN this autumn
- Heterogenous simulation
  - Full, fast and parametrized simulation depending on sensitive region
- Multi-threading support
  - According to Geant4 rules
  - Multiple instances of elements handling actions during energy deposits while tracking

DDAlign: Alignment and Detector Conditions

- **Fundamental functionality to interpret event data in the real world**
  - **Selling argument for existing experiments**
  - **Necessity to handle imperfections**
    - **Geometry => (Mis)Alignment**
  - **Anomalous conditions**
    - **Pressures, temperatures**
      => Gains, refractive indices
      => Contractions, expansions



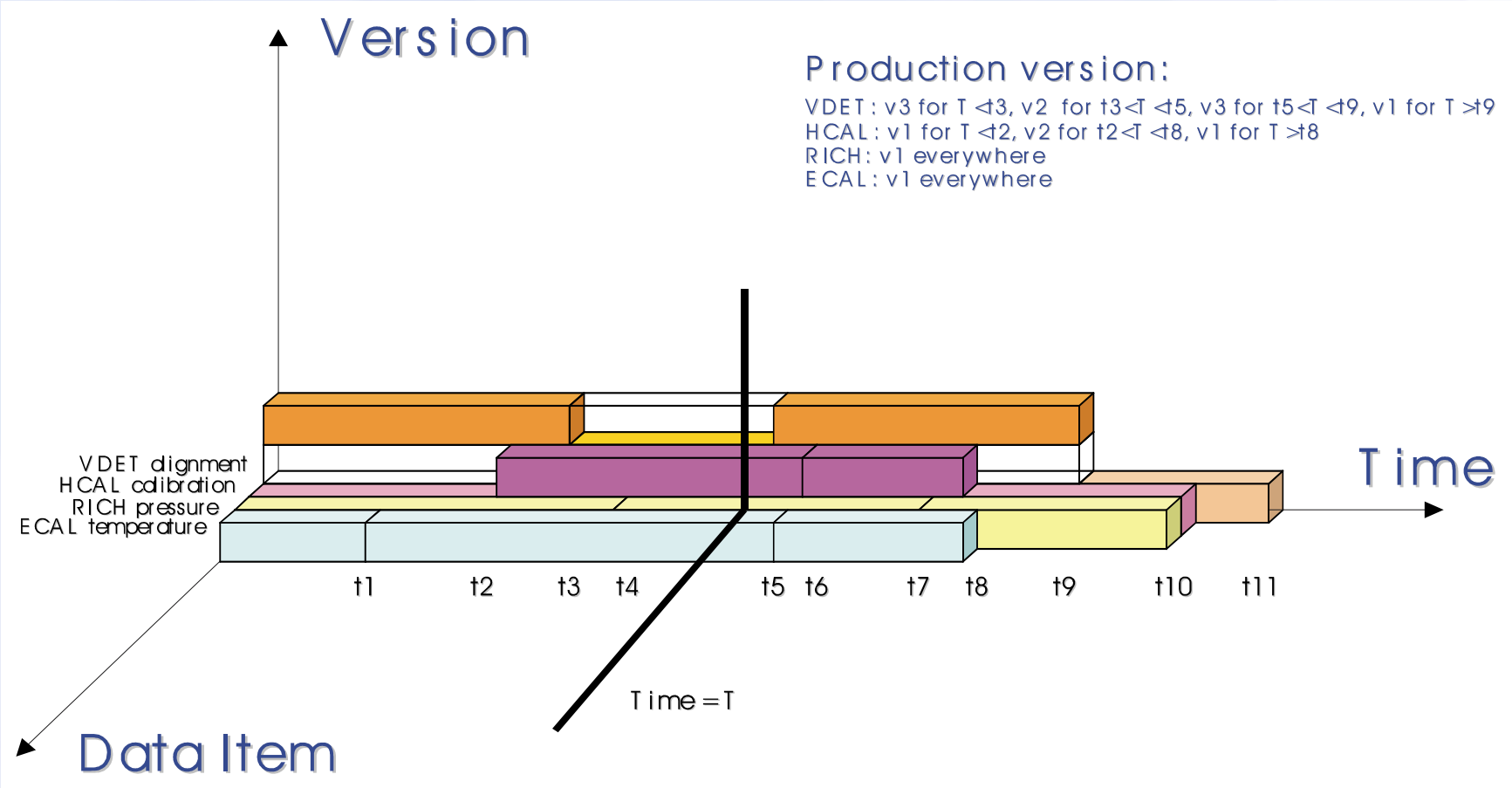
DDAlign: Status and Plans

- **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 functionality under development**
- **Alignment data are typically time-stamped**
  - **String connections to conditions database**
  - **Persistency needs to be integrated with DDCond**
  - **Cannot complete without DDCond**

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”
  - May be time interval, run number, named period, ...
  - Configurable and extensible
- Data typically stored in a database

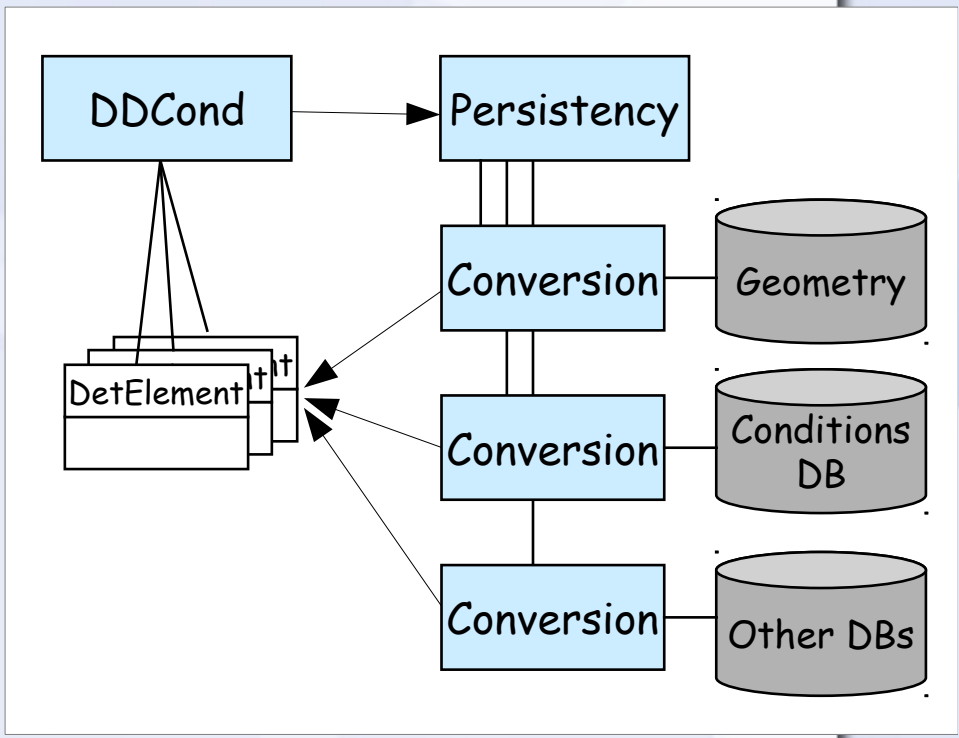
Conditions Data: Consistent Dataset



[Pere Mato / 2000]

DDCond: Workplan

- **The transient implementation**
  - **Flexible definition and handling of intervals of validity ==> Key point**
- **Persistent implementation**
  - **Define interface/ABC**
  - **Proof of concept using one XML, SQLite, Oracle, ...**



Toolkit Users

Users are mandatory for feedback to avoid developments in thin air (i.e. purely academic)

- ILD: F. Gaede et al., ported complete Mokka model ILD_o1_v05
- CLICdp: starting new design after CDR
- FCC-eh: P. Kostka et al.
- FCC-hh: starting, A.Salzburger et al.

DD4hep	DDG4
X	X
X	X
X	X
X	

Summary and Outlook

- The DD4hep toolkit (+extensions) start to become accepted: Client validation has started
- Basic DD4hep API essentially stable
- Simulation kit DDG4 being validated
- Alignment support implemented
  - Requires conditions support for full functionality

    => DDCond: extension to be developed
- Validate, verify, enhance and document

Work Plan

- The DD4hep toolkit (+extensions)
  - API basically stable
  - Client validation has started
- Simulation kit DDG4 being validated
  - Geant4 multi-threading
  - Fast simulation
- Support alignment and conditions handling
  - Main work items
- Validate, verify, enhance and document

Backup

Standard Detector Palette: DDDetectors

- Mostly arose from the SiD model
  - Layer based detectors
  - Tracker barrel & endcap
  - Several calorimeter constructs
- Partially with measurement surfaces

  (see also talk by F. Gaede)
- Plugin mechanism to enhance detector elements
  - Neat mechanism to attach user defined optional data

    => Proof that 'anticipate the unforeseen' works
  - NOT intrusive to detector constructors
  - Flexible definition of the measurement surface