RPROM

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Muon for ORCA_7_3_0

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Outline

- DDD geometry reading,
- new geometry architecture for DT,
- new numbering schema for wheels for DT,
- impact on Muon dependent packages,
- documentation,
- new readout and DAQ application,
- alignment,
- future,

Geometry reading for DDD

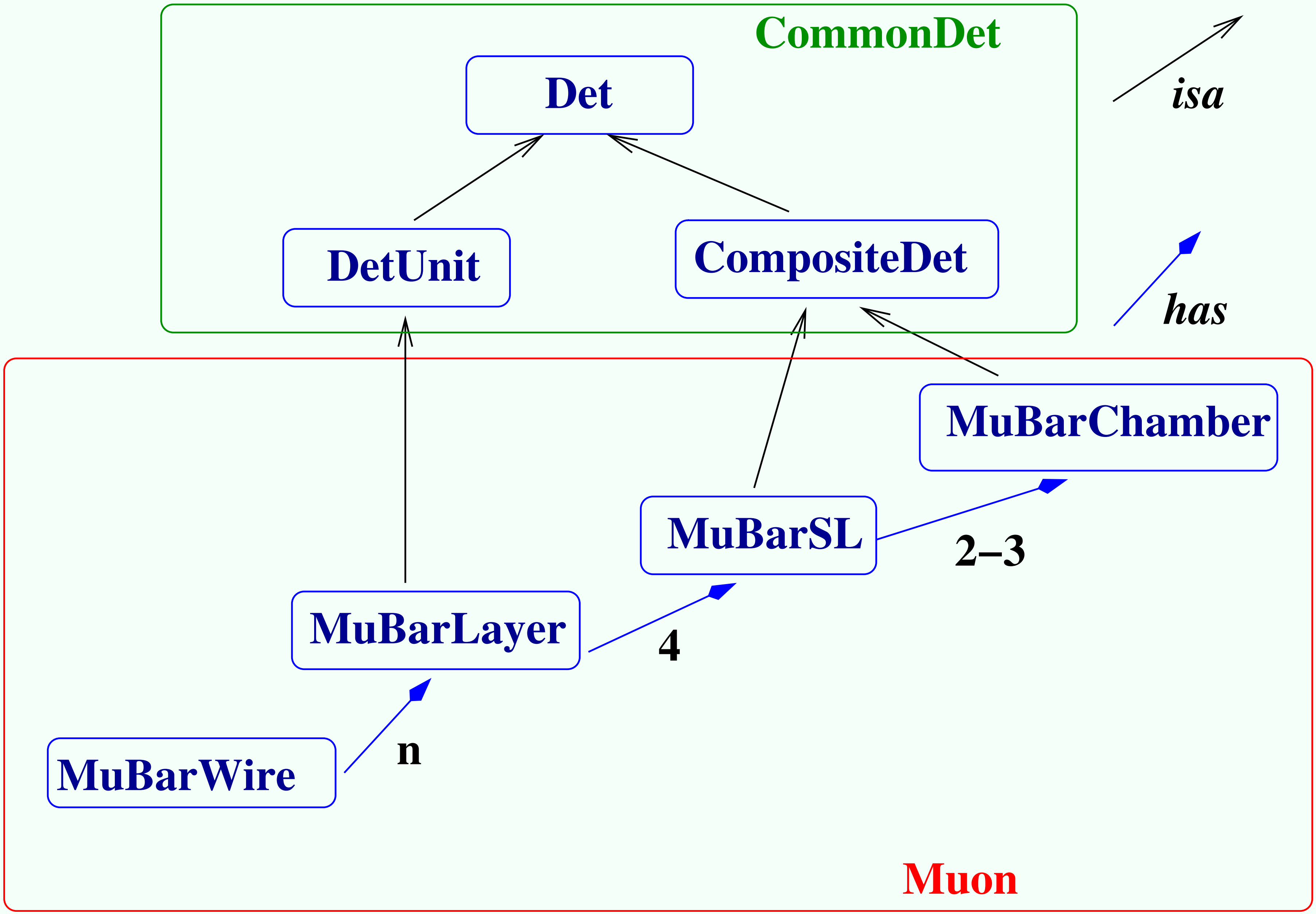
- Already present for CSC and RPC
  - Not so easy to switch between rz and xml reading
  - BuildFile driven, need to duplicate most of the groups
  - Probably easier if selected from `.orcarc`
  - Or just use DDD by default and require custom BuildFile if RZ required
- Ready for DT since some time
  - Implemented with new geometry architecture
  - Fully breaks backward compatibility
  - Not possible to use rz anymore
  - Obviously switched on by default

New geometry architecture for DT

- Developed together with DDD reading
- Much more “CommonDet” aware
- Architecture already presented (RPROM 24/2, PRSμ 18/3)
- in short: every DT “detector” *is a* `Det`
- composite detector (chamber, superlayer) are `CompositeDet`
- MuBarLayer *is a* `DetUnit`

- Already used for May DT testbeam, with semi private ORCA version (based on ORCA_7_2_0_pre13)
- proper xml which place a single MB3 chamber in an empty world
- Geometry setup made in half an our!! (How much time if using rz $\rightarrow \infty$?)

Geometry architecture for DT (2)



Geometry architecture for DT (3)

- tested with geometry 1_2_3
- some problem (solved) with boolean solid created to avoid overlaps in OSCAR
- not so easy to access to the original solid from which a boolean one is created
- problem can become more serious if many boolean solid are needed (now just one)
- this boolean solid is a DT chamber, not a “real” solid, just an envelope of SL, layers and cell (which are real)
- So the problem is that we have solid which are not so “real”, but very useful, anyway
- possible solution: a DDD *envelope solid*, namely a simple (box, trap...) volume which fully contains a set of other solids (e.g. a DT chambers is defined as the smallest box which contains all the cells)

New numbering for DT wheels

- Since backward compatibility is broken, take chance to align the DT numbering schema
- barrel wheels numbering was $n_w \in [+1, +5]$
- now $n_w \in [-2, +2]$
- modification in `Profound`, so consistency guaranteed between ORCA-OSCAR (is that correct???)
- by product:
  - discovered that classes for MuBar numbering schema were present twice: one in Profound (ok) and one in the old muon place (Muon/MUtilities)!!!
  - now old one removed, and checked that the correct one are included eveywhere
  - take chance to simplify the classes
  - what about a automatic check that no classes is present more than once in ORCA/COBRA??

Documentation

- Yes, not cheating!! The new architecture is fully documented in UserGuide: description, some implementation detail, etc
- detailed example how to access the geometry in many different ways
- not yet complete, but a major step forward with restpect to the old “documentation”

Chapter 3

The Muon Subsystem

3.1 Introduction

The Muon subsystem is responsible for description and operation of the three type of detectors which are used for muon identification and measurement in CMS, namely Drift Tube Chambers (DT) in the barrel region, Cathode Strips Chambers (CSC) in the endcaps, and Resistive Plate Chambers (RPC) in both barrel and endcaps.

The functionalities which are provided for each of the three sub-detectors are:

- detector description and modelling, including frame transformation and ...
- interface with MonteCarlo objects, such as SimHits and digis
- digitization, namely the transformation of SimHits as simulated by the Monte Carlo tracking generated tracks through sensitive volumes, into digis, corresponding to the electronic signals which will be fetched by the DAQ in the real world [1]
- local reconstruction, namely the transformation of the digis into geometrical quantities, such as positions and directions (and times, . . .)

Moreover, the Muon package is also responsible for the regional reconstruction, i.e. the reconstruction of muon tracks using the muon detectors alone. To accomplish this goal, the outputs of the local reconstruction of the three detectors are used.

3.1.1 Package structure

Due to the twofold responsibility of this package, two distinct groups of subpacakges can be identified. The first is related to a single detector, with no cross dependency, and performs the task which are local: detector modelling, simhit and digis access, digitization and local reconstruction. Some basic funcionality is shared via inheritance from common classes, which can be viewed as a Muon specialization of some classes in the CommonDet package. The second task is the reconstruction, which is global in the ambit of the muon system, and so is performed with subpackages which depend on all three subdetectors. In principle it would be better to split the whole package in two, and also to optimize (reduce) the dependency on other ORCA packages. The first task does not need to

[1]The ORCA package, strictly responsible for the reconstruction in CMS, is not the correct place in which to simulate detector response. The reason we currently have the digitization, which is a task for a simulation package, in ORCA is both historical and technical. In some future version this responsibility is likely to be moved to OSCAR

31

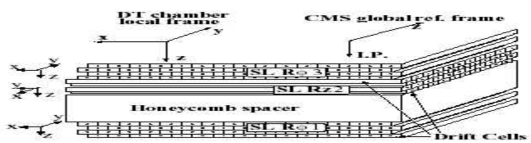


Figure 3.3: Definition of reference frames for DT detectors

3.2.6 DT readout

DT digitization

3.2.7 DT local reconstruction

The three main problems to be confronted by the local reconstruction in the barrel drift tubes are:

- the variation in the relationship between drift time and drift length in presence of inclined tracks and/or magnetic field (Fig. ??);
- the intrinsic left-right ambiguity for drift tubes;
- the presence of electromagnetic debris accompanying high energy muons.

The first of these problems is addressed by a parametrization of the drift time which takes into account the track angle and the magnetic field at the appropriate position, as described in Sec. ??. The left-right ambiguity is resolved by building segments within a superlayer. As shown in Sec. 3.2.9, the segment building uses both internal criteria, in particular a χ^2 goodness-of-fit, and external criteria, in particular the direction pointing to the interaction region, to resolve the left-right ambiguity. Finally, the effect of low energy electrons is mitigated by the fact that layers of tubes inside the same chamber are at least partially decoupled by the 2 mm thick wall of the drift tubes.

The track angle cannot be determined on the basis of a single hit. Similarly, the magnetic field is defined only up to the variation along the wire. As a consequence, the drift time parametrization cannot be decoupled from the segment building: an initial parametrization serves to define the hits used to find segments, allowing the position to be refined to finally obtain the best fit for the segment. As individual hits are ill-defined, the results of the local reconstruction for the barrel drift tubes are the superlayer segments, measuring position and direction in both the $R-\phi$ and the $R-Z$ direction [3].

3.2.8 DT Hit Building

The reconstruction of a DT hit is based on the conversion from the drift time (the raw measurement output) to the drift space (the position of the hit with respect to the wire). This conversion requires knowledge of the drift velocity, which in general depends on the magnetic field $\vec{B}$, and on the angle of incidence of the muon with respect

[3]In ORCA, these segments are sometimes referred to as “clusters”.

Impact on Trigger etc

- DT Trigger depends heavly from Muon
- Need to adapt for the new geometry architecture and interfaces
- Already have a working version of Trigger, compiling and linking
- first “naïve” test are ok, need some more detailed one (by a trigger expert)
- Other muon dependent packages (Example, Visualization) probably just need to update the way they access the MuBarChambers, DetUnits, and so one
- current interface is **much** simpler and flexible
- High level package (as MuonReco and MuonAnalisys) should not depends on such low level details of Muon...

New readout and DAQ application

- Presented by Giacomo (RPROM 24/2, PRSμ 18/3)
- Uniform framework for CSC, RPC, DT digi access: `MXXXPersistentDigiSetUp`
- DAQ application:
  - raw data (un)formatting: `MXXXDataFormat`
  - raw data production: `MXXXDaqWriterFromDB`
  - raw data reading for Daq applications (on-line and/or off-line): `MXXXDaqDigiSetUp`

(Mis)-alignment

- Work by Celso and Francisco, `CMS IN-2002/049`
- new sub-package: `MuonAlignment`
- already in CVS
  - check for dependency
  - need documentation
  - only some movement is foreseen
  - but a good starting point for further development

Future

- Work in progress on new DT digitizer
  - Garfield simulation in good shape
  - Work to be done to include new cell parameterization in ORCA
  - treatment of soft delta-ray, multi hits, ...
  - comparison with may 2003 test beam results
- Test beam analysis will be done with up-to-date software (ORCA 7, last year with ORCA 3!)
  - Good chance to check robustness of the algos
  - improve functionalities of DT local reconstruction
- muon reconstruction
  - CPU time improvement: work on new magnetic-field, propagator going on
  - performances for very high p_t muon $\sim TeV$ to be studied