



Detector alignment with muons

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Introduction

- Idea: use muon data to align calorimeters w.r.t. tracker
- Stand-alone package available from CVS: calice_tools/alignment
- Meant to be easy-to-apply tool to evaluate correction factors from arbitrary run (as long as it contains enough muons) from arbitrary test beam setup



- Takes from LCIO events:
 - List of calorimeter hits (from any detector)
 - List of TBTrack fit results for x- and y-tracks
- Steering parameter to distinguish SiW-ECal and analogue HCal
- In each event, find best track in either dimension (highest fit probability)
- Fills any <track, calo-hit> pair into data container of type
 CADetectorData
 'track' = extrapolated position at z of calo-hit
- Allows to dump data container at end of run, auto-processing not yet implemented





- Data container managing layer-wise sub-containers of type CALayerData
- Inherited by AhcData and EmcData
 - AhcData: knows about 30 layers with 3x3cm² cells plus 8 layers with 6x6cm² cells
 - EmcData: knows about 30 layers with 1x1cm2 cells and only accepts <track, hit> pairs where hit is in central wafer
 - New detector? Create new inheriting class and add option to MuonAlignmentProcessor
- Allows to create .ps-file with reasonable control plots
- Still missing: extract simple set of correction factors. This development can be parallelized with large-scale data processing, though...





- Data container for <track, calo-hit> pairs in one dimension and one alignment unit (e.g. one layer) e.g. HCal, layer 12, X, run 331584
- Some robust methods using only cellsize as free parameter:
 - calo-noise suppression







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 - robust estimate on number and position of steps (using bin-wise differential of profile, part of CARootFuncs)

profile_12_x_differential







- Convenient class for fitting profile from **CALayerData** and interpretation of results
- Two pre-fixed parameters:
 - number of steps
 - distance in y between plateaus (= cell size)
- Four fit parameters:
 - x-position of first step
 - y-position of highest plateau
 - distance in x between two steps
 - factor in step exponential





- Auto-fits profile if constructed from **CALayerData** object
- Finds straight line through middle of plateaus (incl. fit error propagation)
- Interpretation:
 - offset != 0 is misalignment of calorimeter
 - slope != 1 is wrong scale of tracker





createPlots

• Any possible plot from whole run in one ROOT file with small program **createPlots** (reads ASCII dump of **CADetectorData**)

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alignmentControlPlots

- Create .ps-file of control-plots with simple program from ASCII dump of content of **CADetectorData**
- Contains one page per layer and dimension with all important information of one step at one view





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- Contains one page per layer and dimension with all important information of one step at one view
- Plus summary page of straight-line offset/slope versus layer





Some impressions

• Layer-wise misalignment in x and y (here: HCal)





Tracker Scale

• Unit of tracker system is ~5% off the mm scale, consistent in ECal and HCal (for run 331584)



scale y

30

layer



• ECal mapping issues (or even manufacturing mistake?)





- Machinery works out-of-the-box for HCal fine / coarse modules and for SiW ECal (if restricted to central wafer)
- Robust (at least for HCal):
 - no significant changes for missing 'bad hit rejection ' in tracker
 - independent on calorimeter amplitude works even zero suppression by means of 3-sigma-above-pedestal cut
- Conventient tools and interfaces for analysis of one run available
- Still missing: interpretation of results
 - overall detector position
 - layer-wise mis-alignment
 - correction of tracker alignment parameters (TDC-to-mm, offset)



Job opening

- We should find somebody to evaluate the alignment
- Finalize feedback loop, get together with tracking experts (Paul Dauncey, Daniel Jeans)
- Work on pion runs
 - steering template (muon selector)
 - how many runs needed?
- Process large chunks of data (remember: package calice_run)
- Extract correction factors and update data base entries
- Expect hick-ups, but not too many...