Detector alignment with muons

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CALICE Analysis Mtg.

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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

MuonAlignmentProcessor

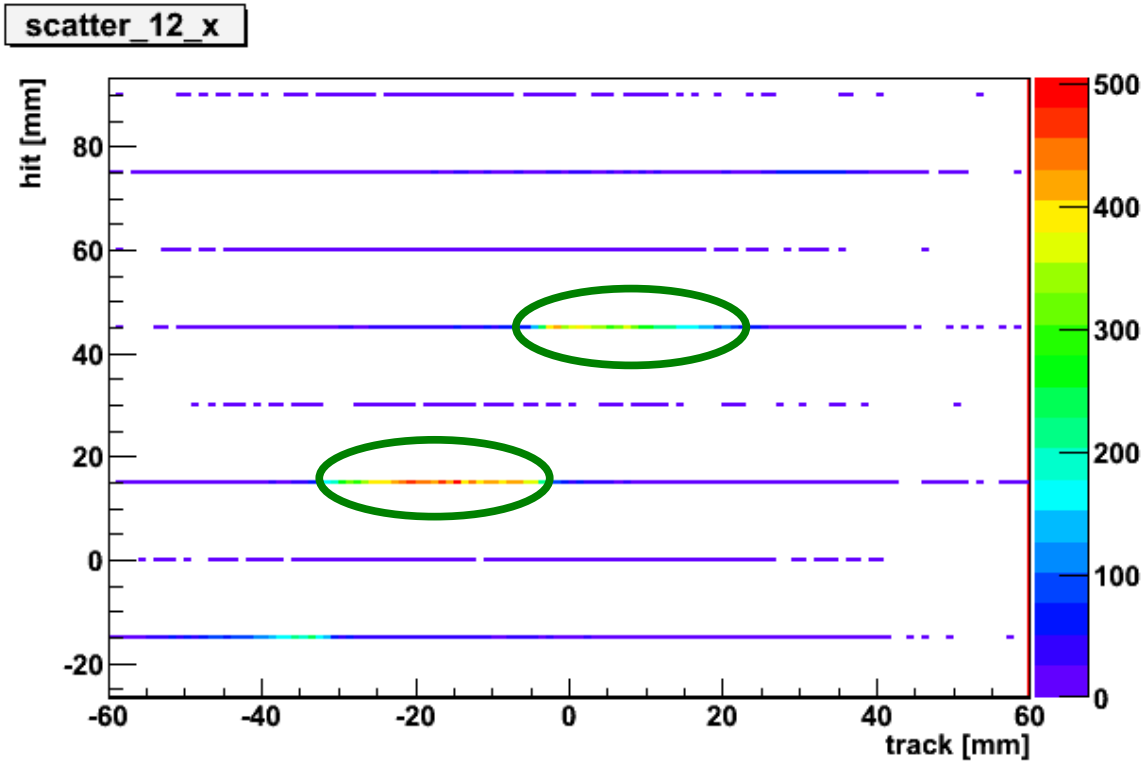
- Takes from LCIO events:
  - List of calorimeter hits (from any detector)
  - List of TBTrack fit results for x- and y-tracks
- Steering parameter to distinguish SiW-ECal and analogue HCal
- In each event, find best track in either dimension (highest fit probability)
- Fills any <track, calo-hit> pair 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

CADetectorData

- Data container managing layer-wise sub-containers of type **`CALayerData`**
- Inherited by **`AhcData`** and **`EmcData`**
  - **`AhcData`**: knows about 30 layers with 3x3cm^2 cells plus 8 layers with 6x6cm^2 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...

CALayerData

- 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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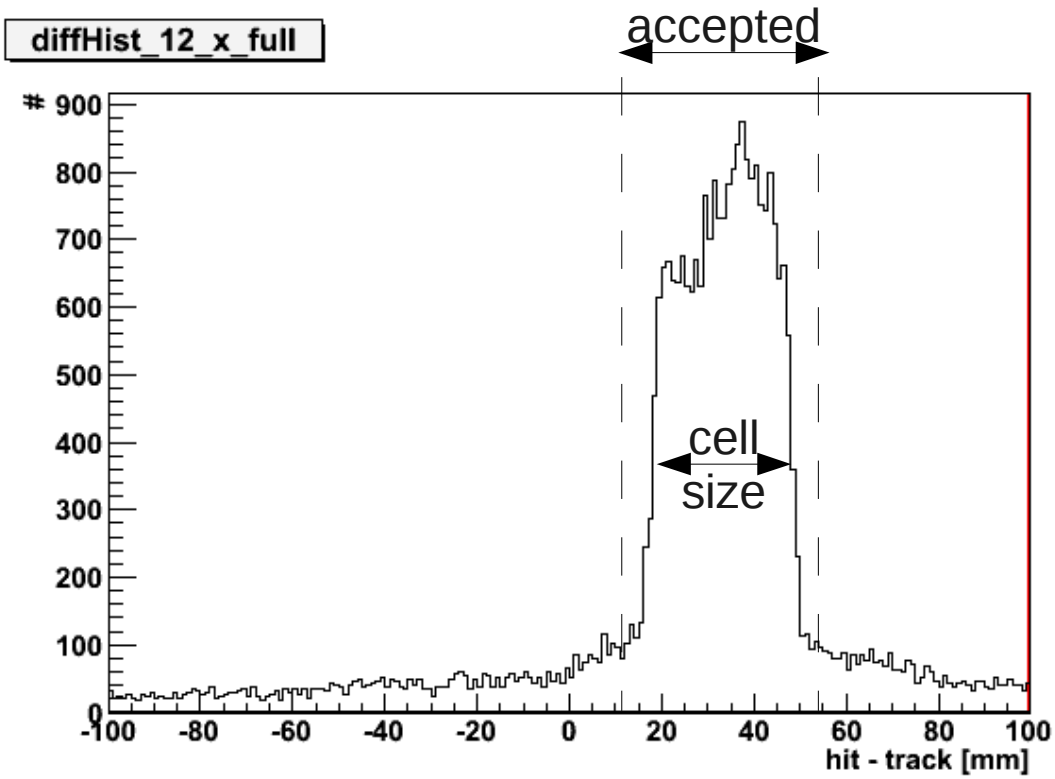

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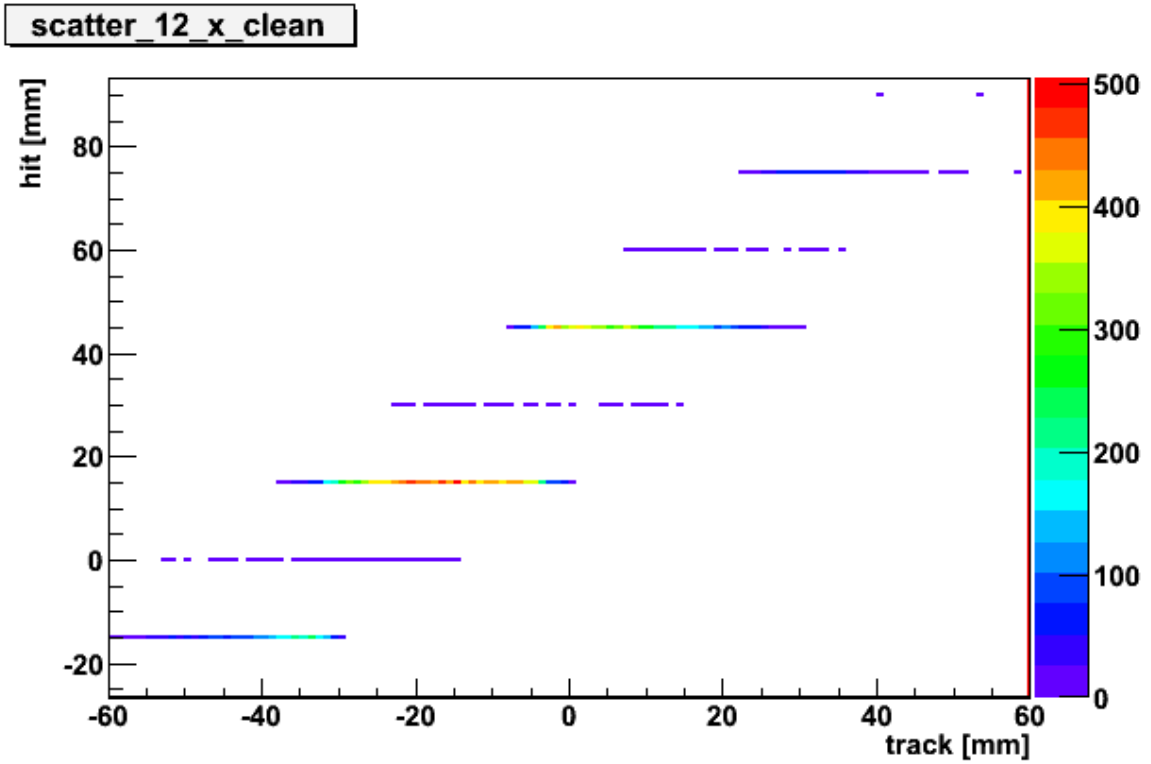

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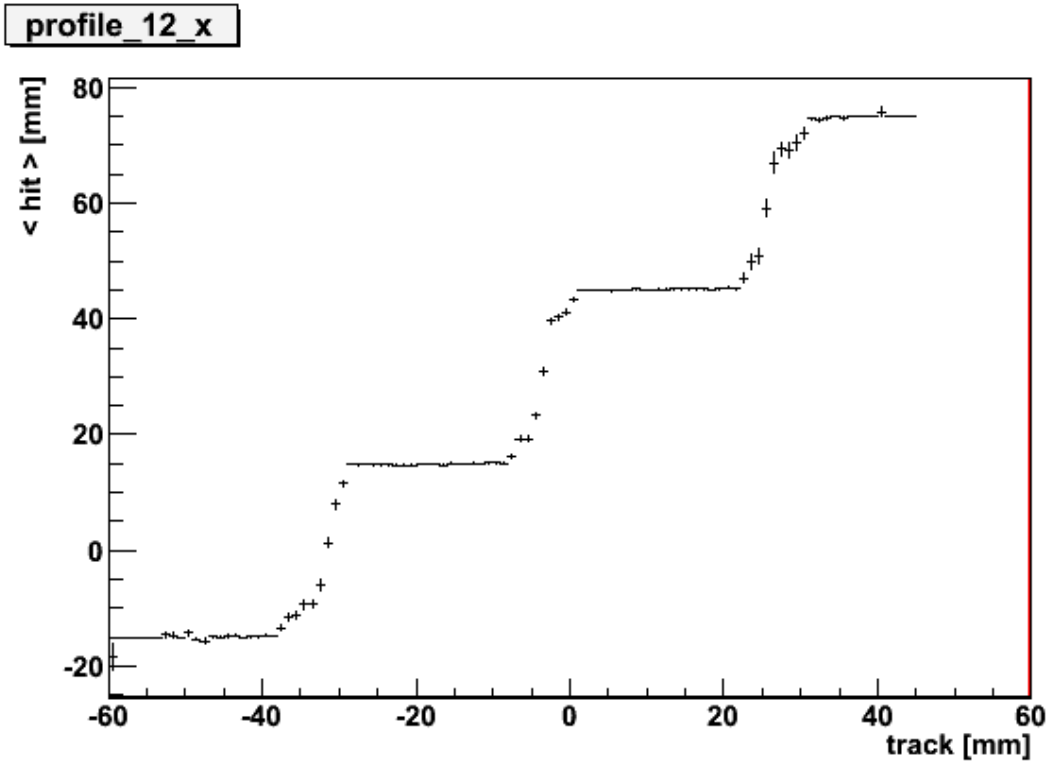

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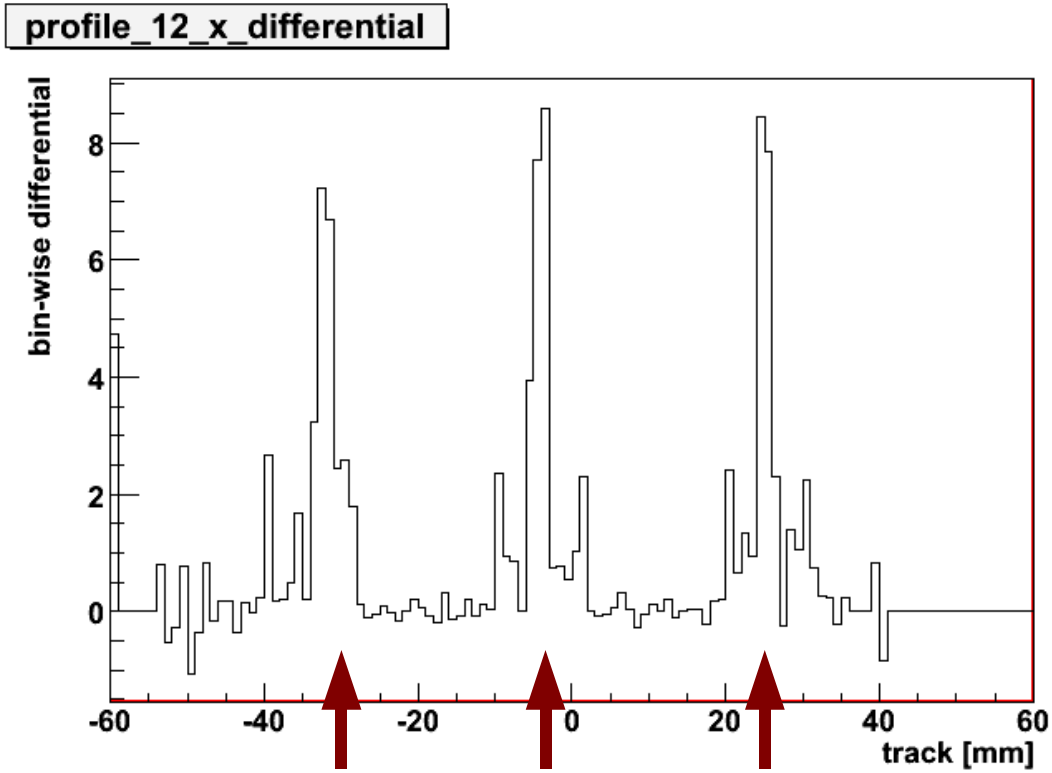
- Some robust methods using only cellsize as free parameter:
  - calo-noise suppression by auto-investigation of distance between calo-hit and track
  - create profile of accepted entries
  - robust estimate on number and position of steps (using bin-wise differential of profile, part of **`CARootFuncs`**)

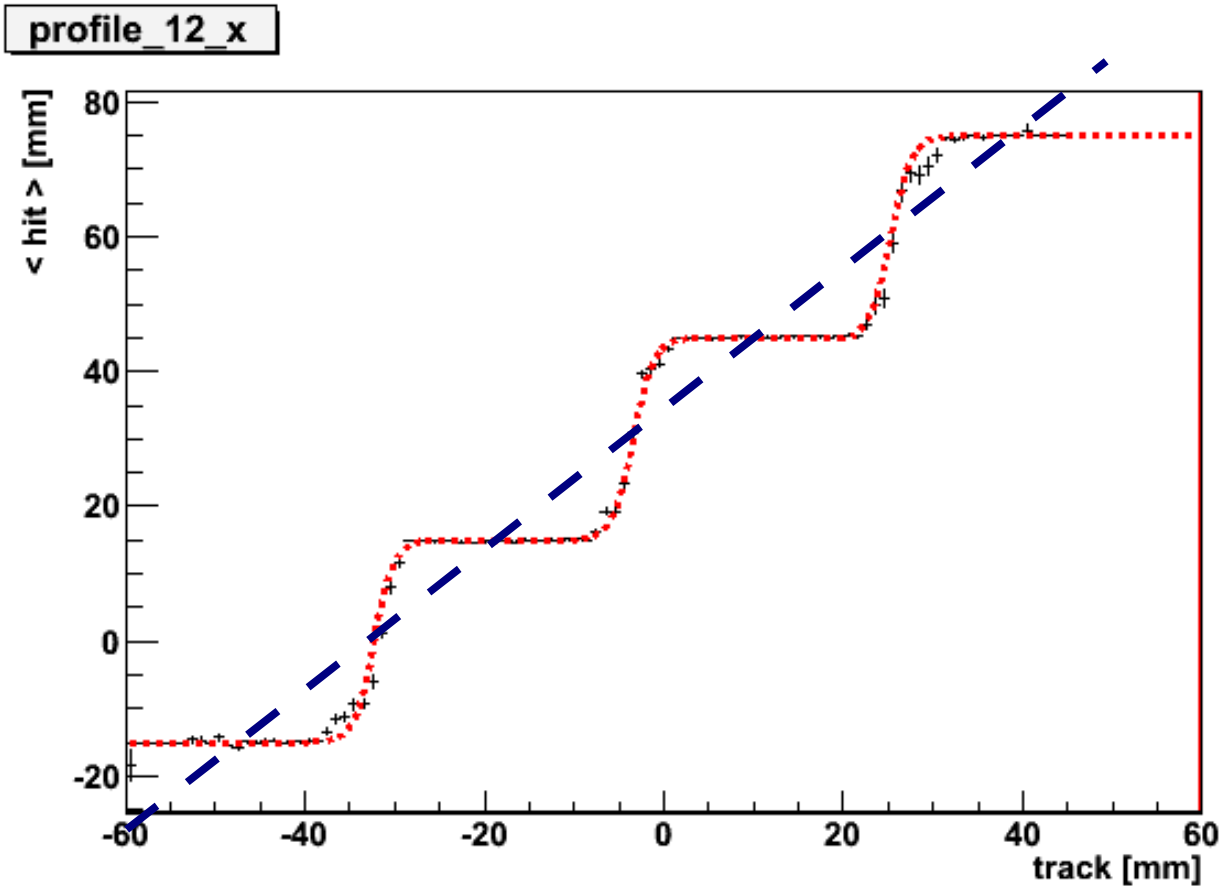


CAStepFunction

- 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

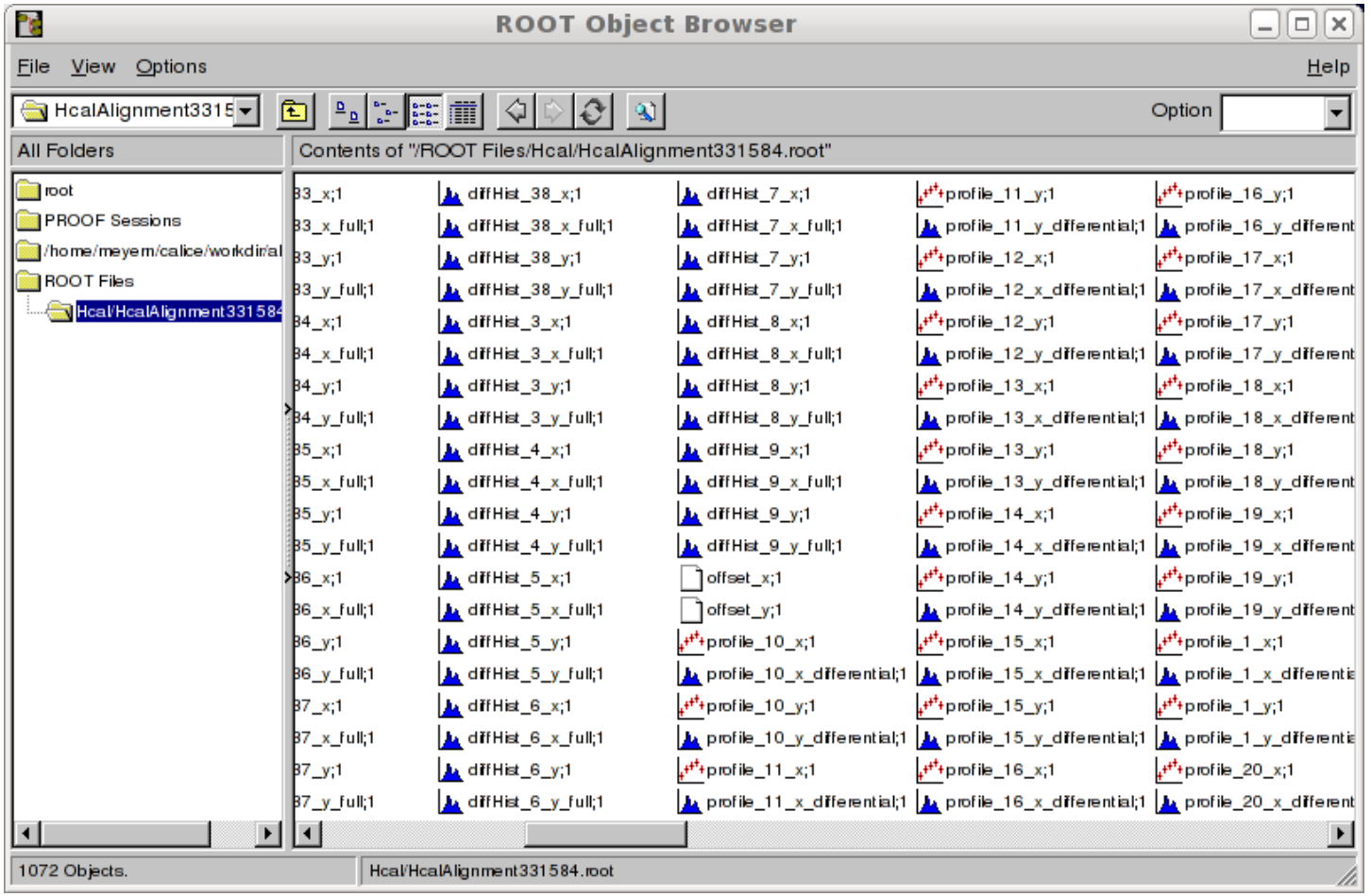
CAStepFunction

- 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



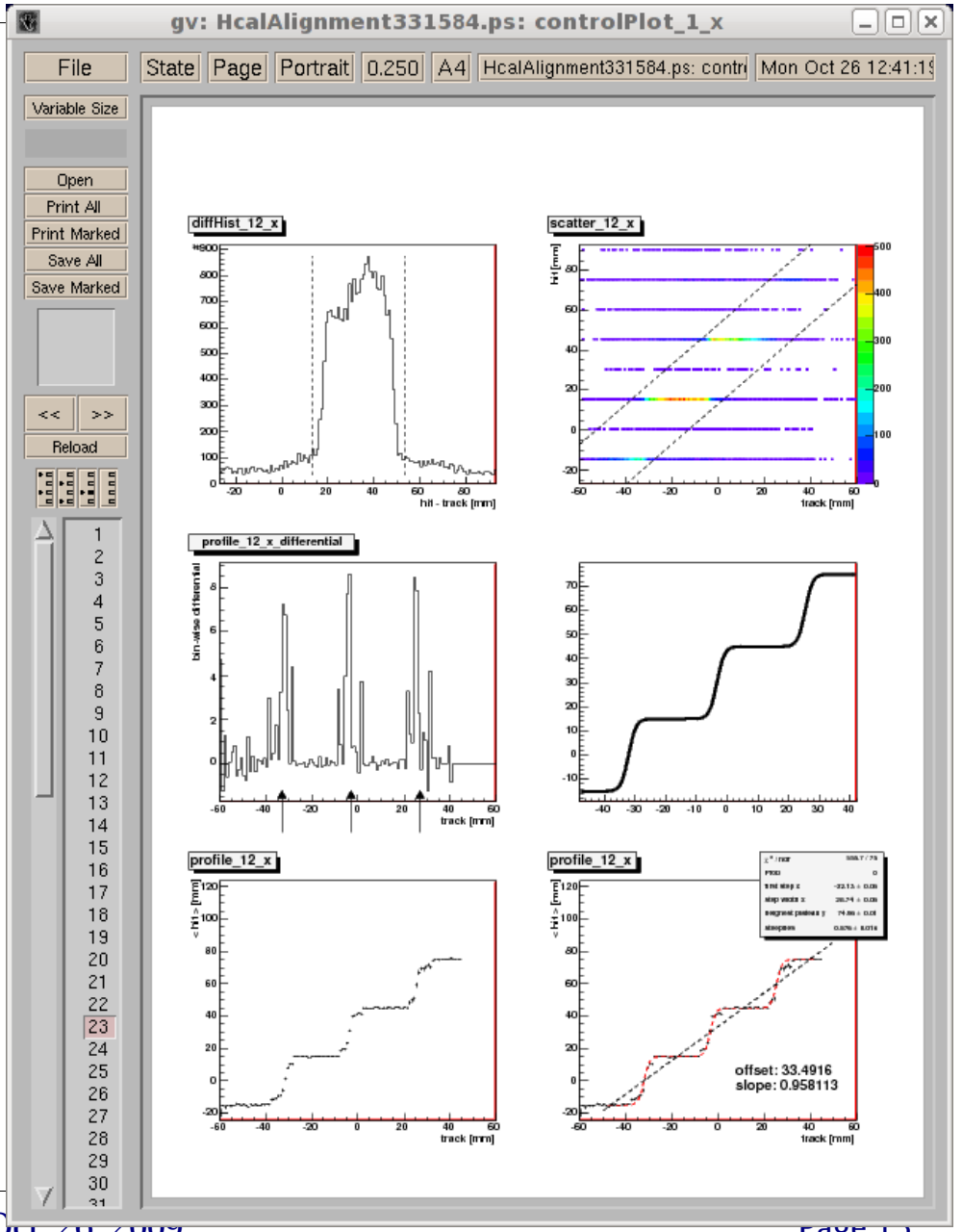
createPlots

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



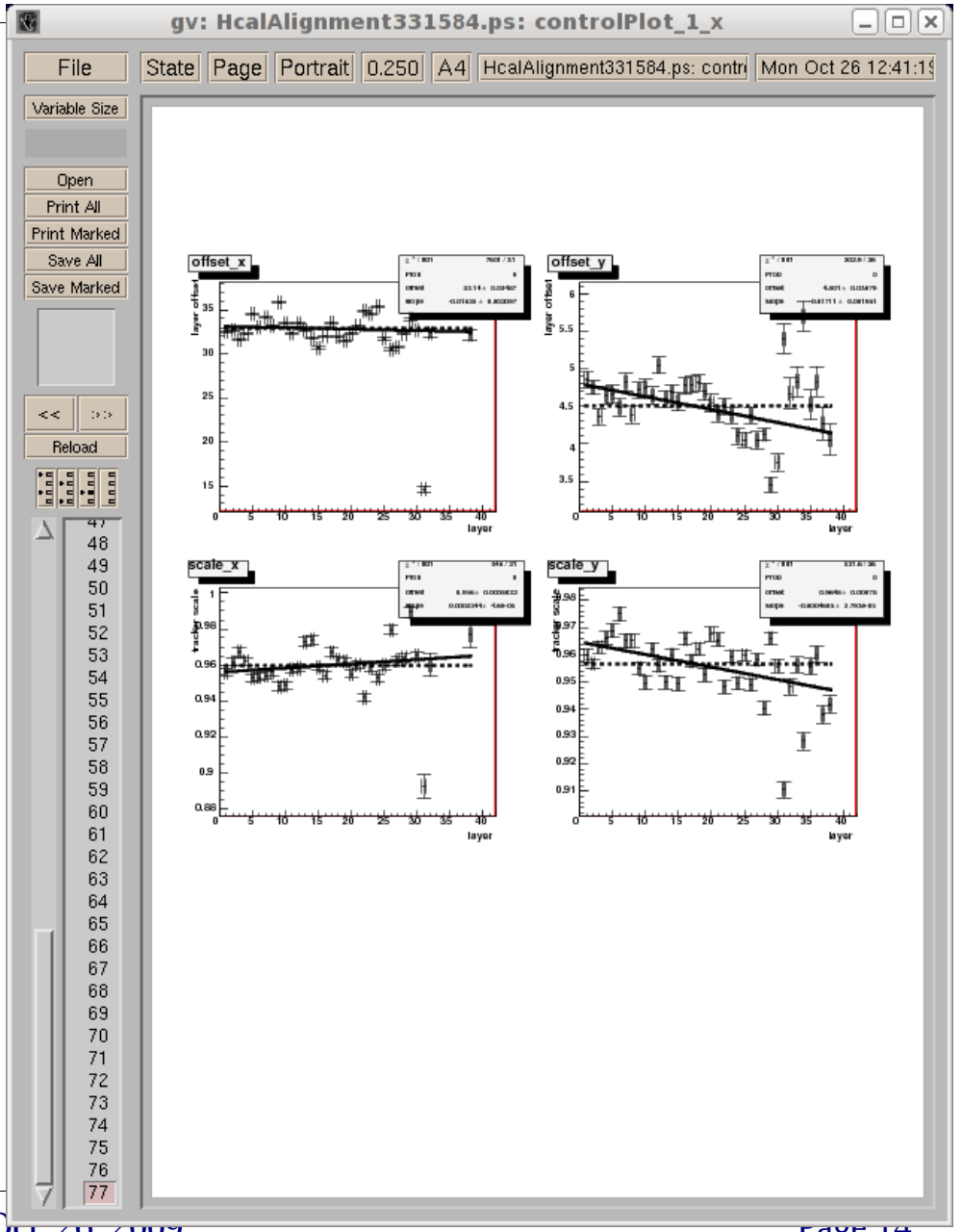
alignmentControlPlots

- 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



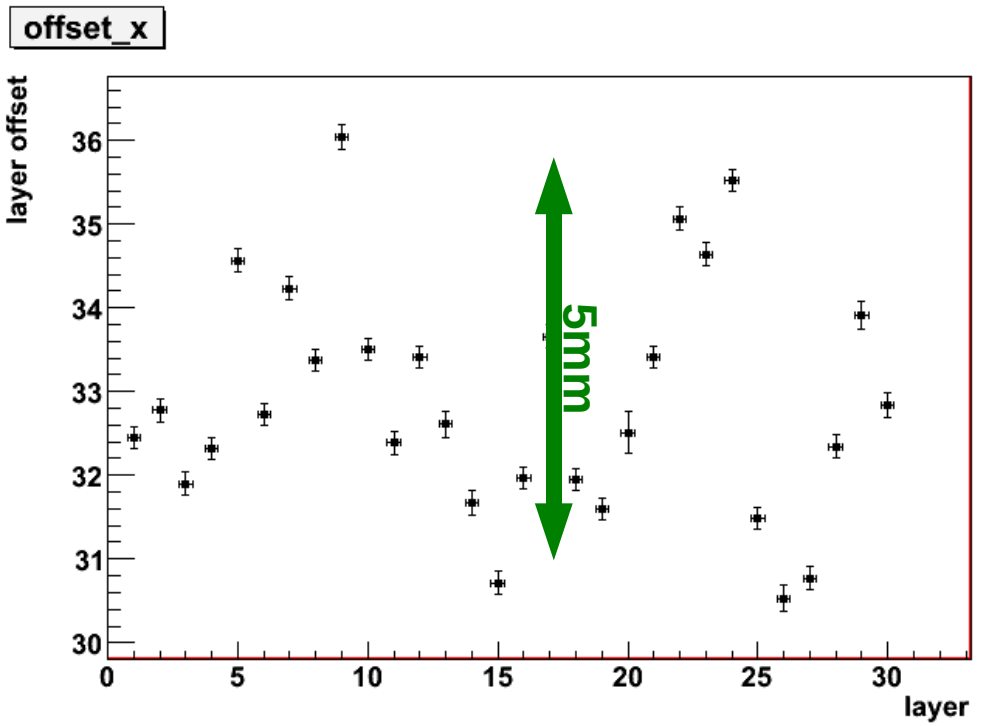
alignmentControlPlots

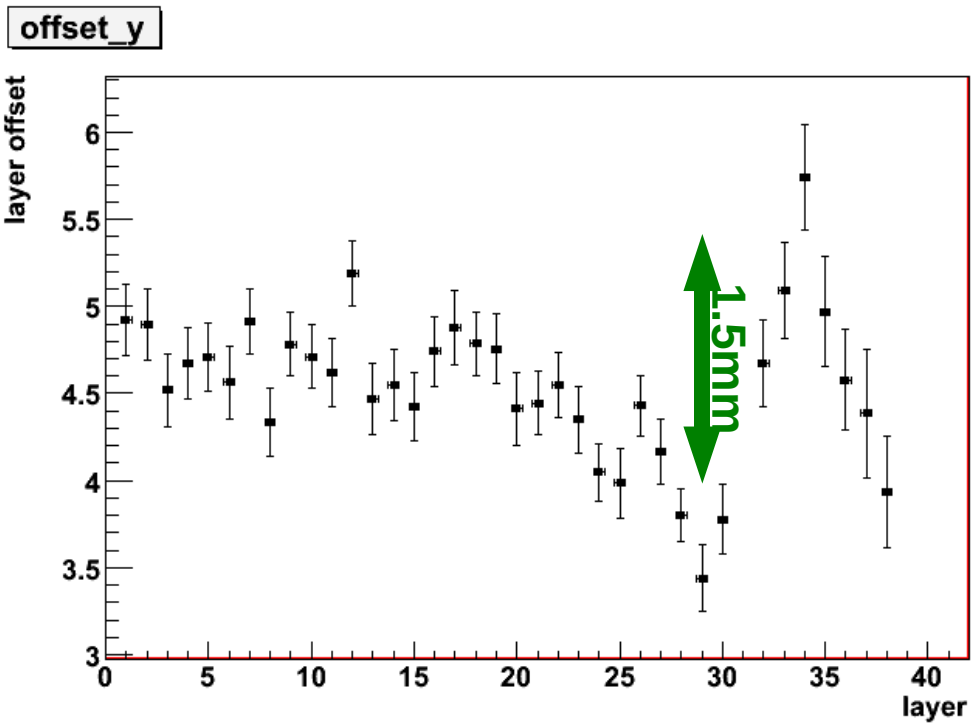
- Create .ps-file of control-plots with simple program from ASCII dump of content of **`CADetectorData`**
- Contains one page per layer and dimension with all important information of one step at one view
- Plus summary page of straight-line offset/slope versus layer



Some impressions

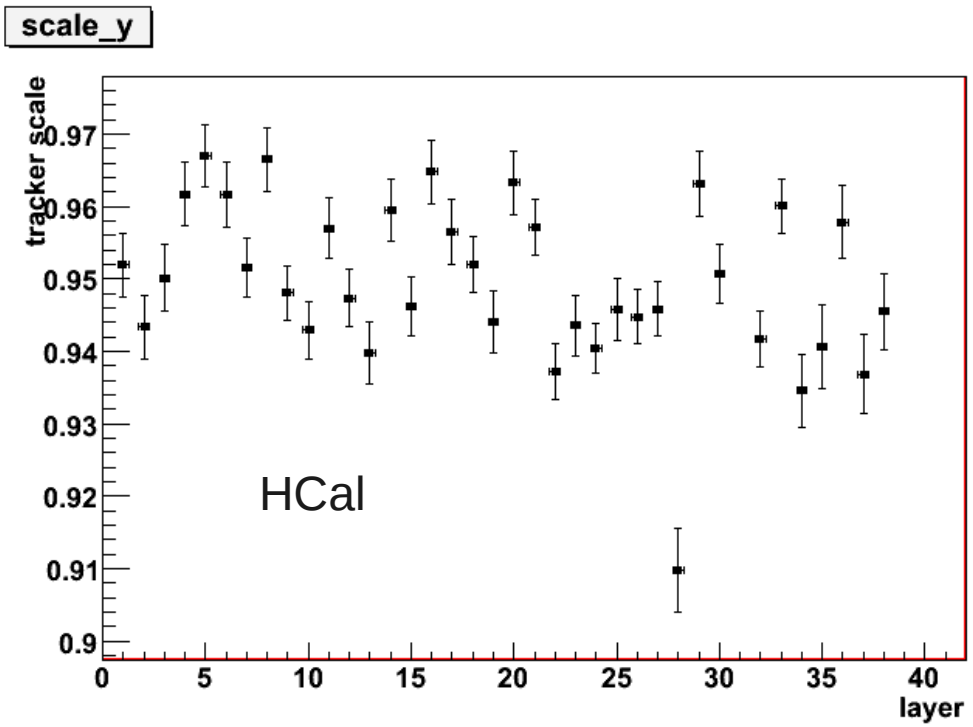
- Layer-wise misalignment in x and y (here: HCal)

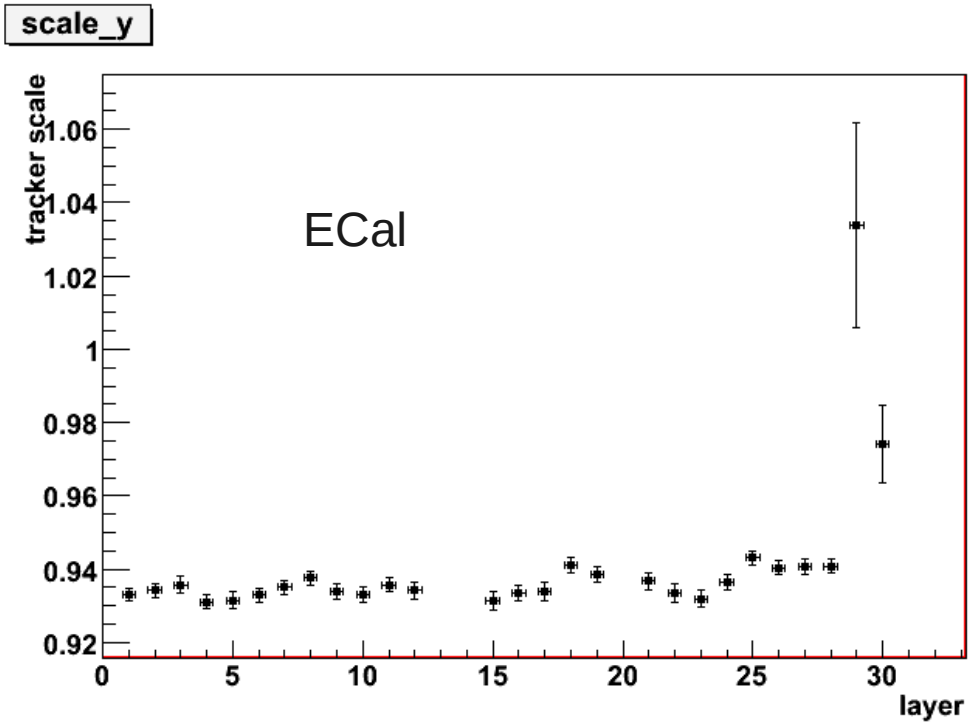




Tracker Scale

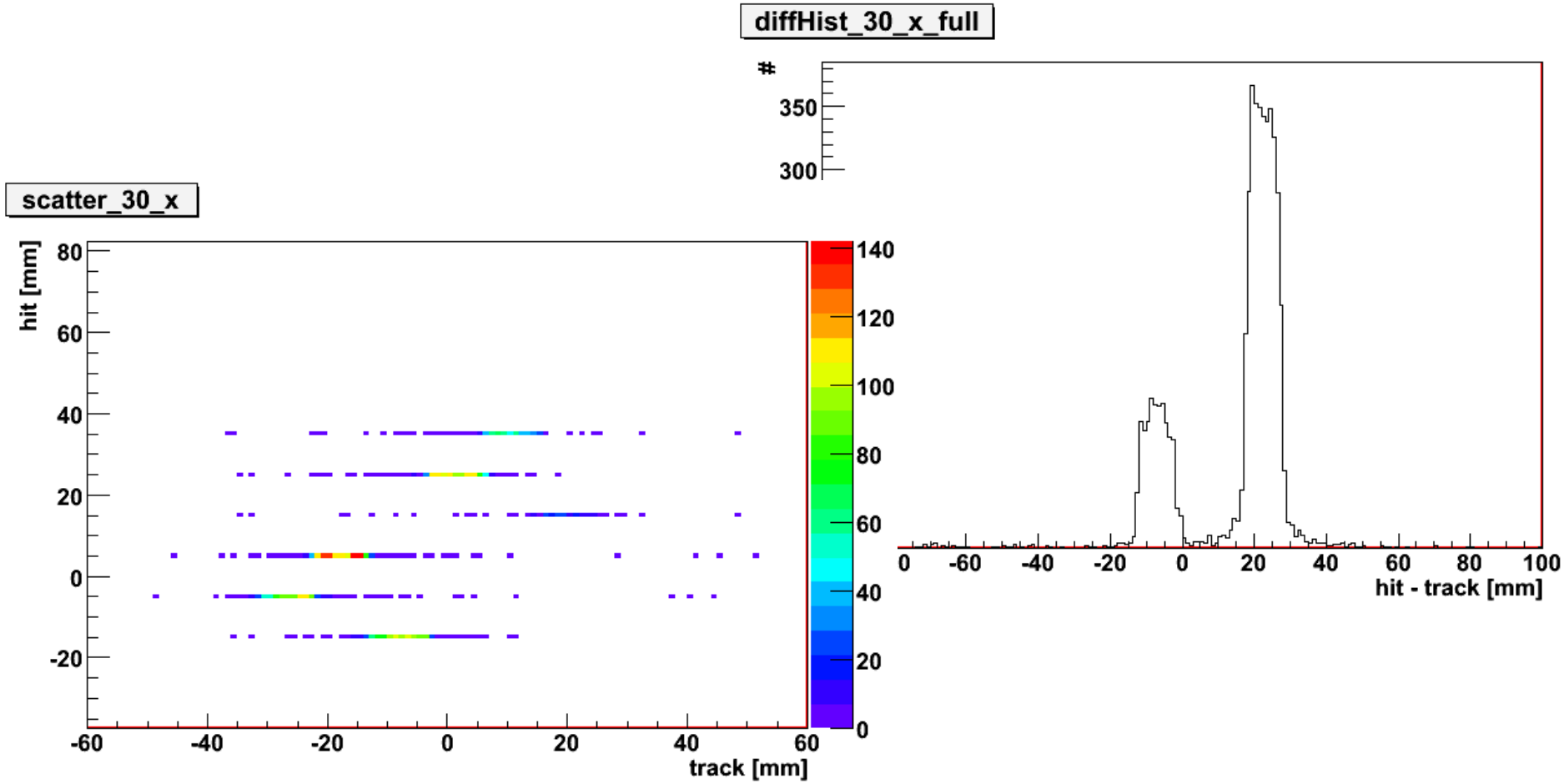
- Unit of tracker system is ~5% off the mm scale, consistent in ECal and HCal (for run 331584)





Some impressions

- ECal mapping issues (or even manufacturing mistake?)



Status / next steps

- 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...