Alignment and track reconstruction for MUonE testbeam data

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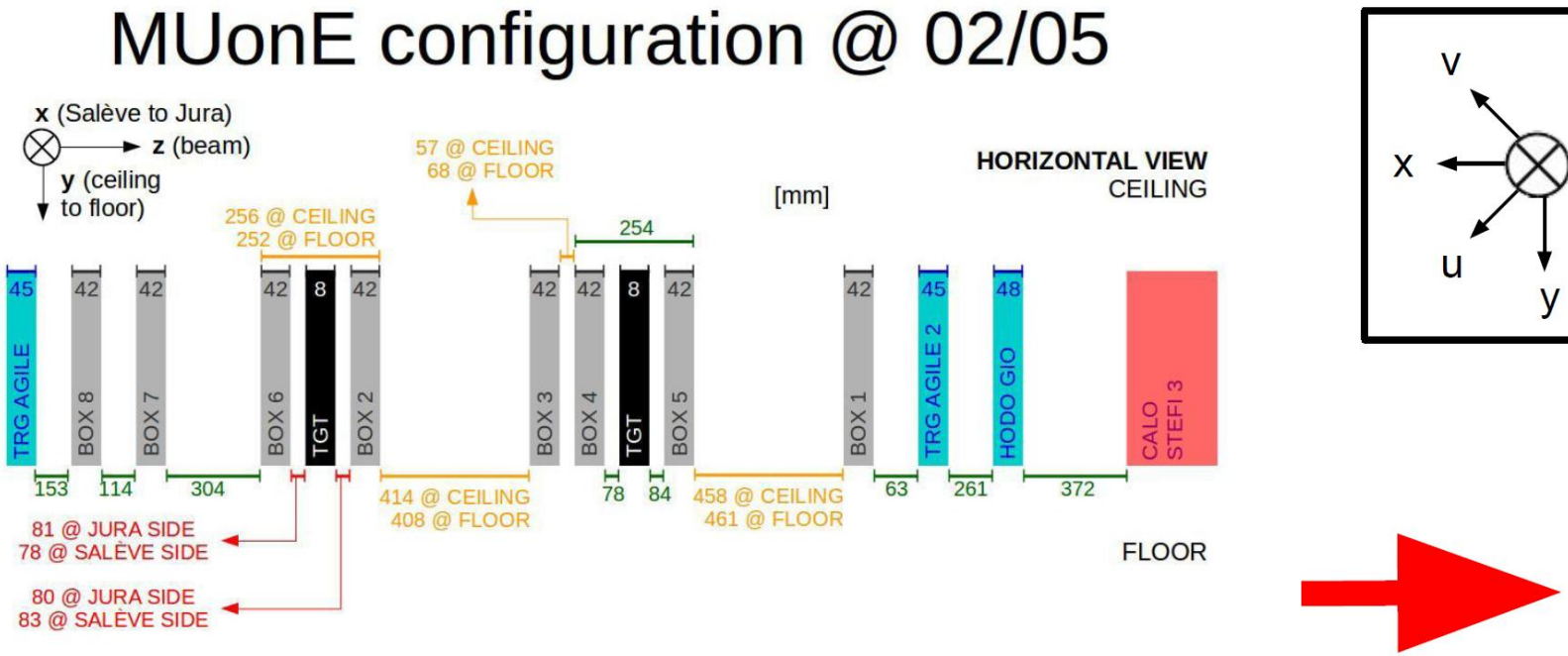
Testbeam data



from Mattia Soldani's presentation

- reference point taken as the bottom edge of BOX8
- muon_data_aligned files taken

testbeam layer naming:	8y	8u	8x	7y	7x	6y	6x	2y	2x	3y	3x	4y	4u	4x	5y	5x	5v	1y	1x
local layer naming:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Pattern recognition

Separately for *x* and *y* layers

PATTERN RECOGNITION

1. construct pairs from all the hits in 6 first *(x or y)* layers

   → to have a hit collection with at least 3 hits

   (e.g. 1-2, 1-4, 2-4, 3-6,…)

2. for each pair construct a 2D line *(xz or yz)* and collect all the hits within the 2 mm window

3. sort all the 2D lines according to the nr of hits collected

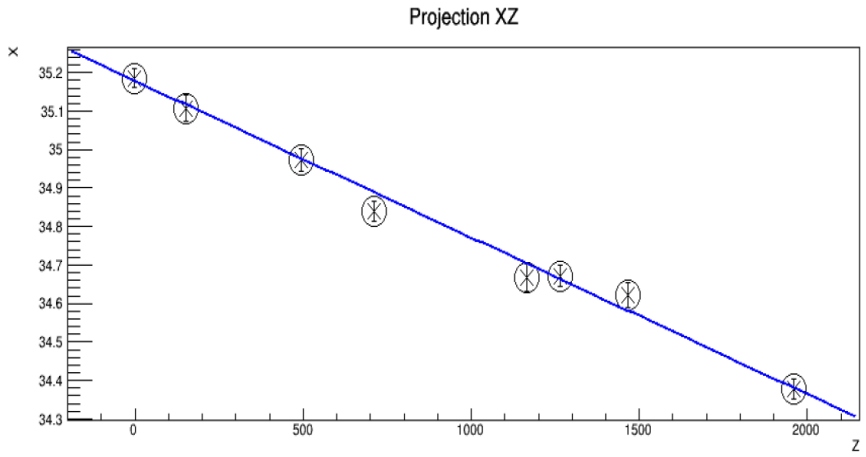
4. loop over such a set of lines and remove already used hits → to have unique 2D lines

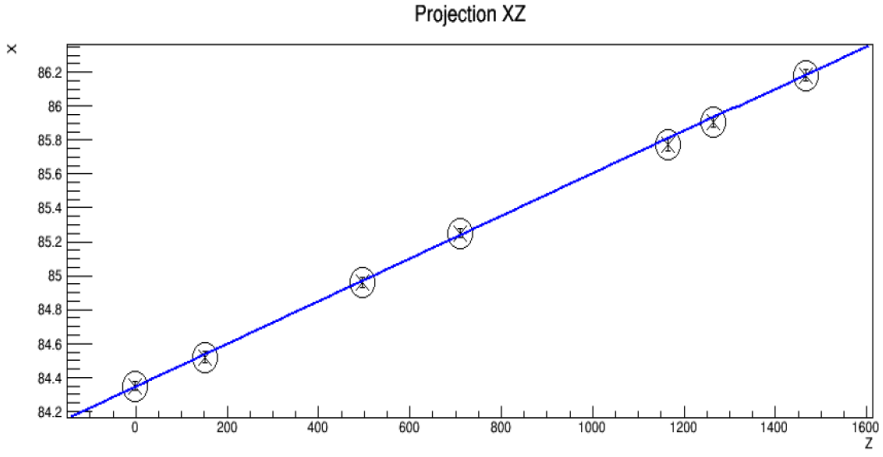
   → this cleans out the 2D lines which share the same hits with others

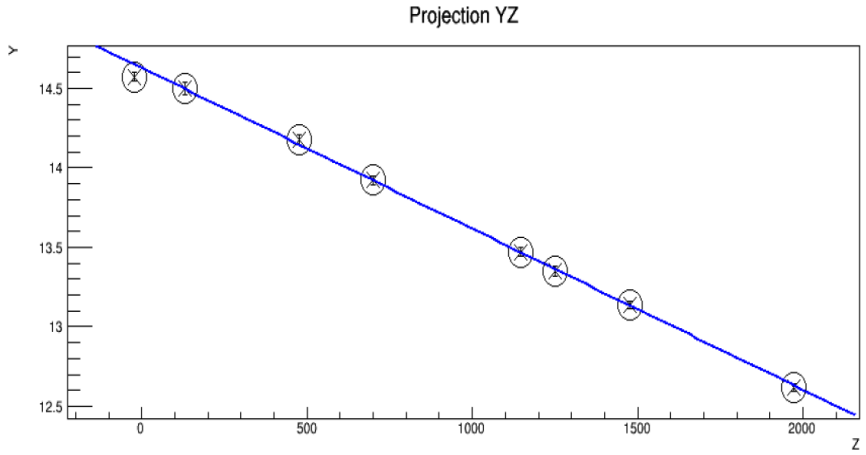
- simple event display for *XZ* and *YZ* planes separately → *next slide*

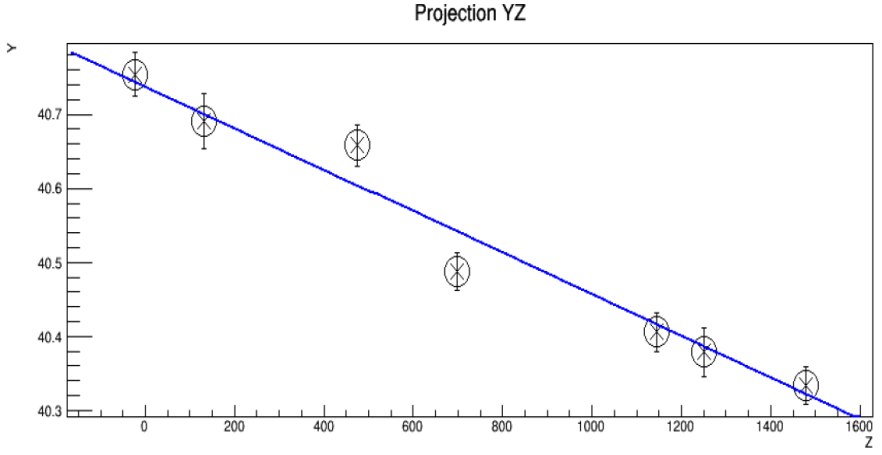
- mostly 1 track events

Event display in *XZ* and *YZ* - *one track*

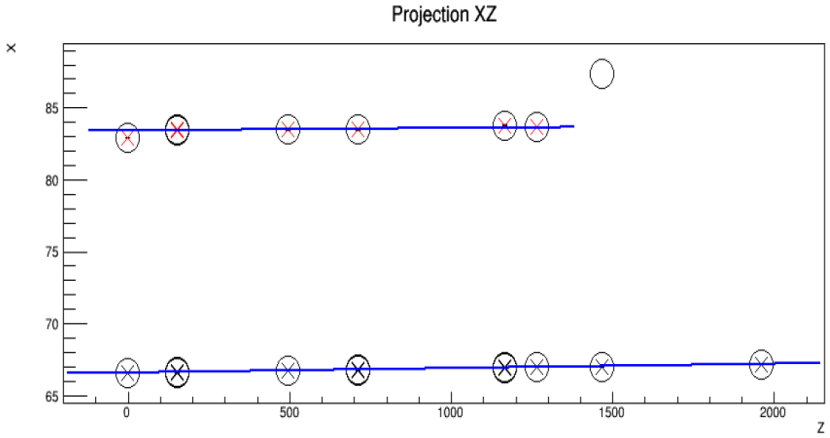


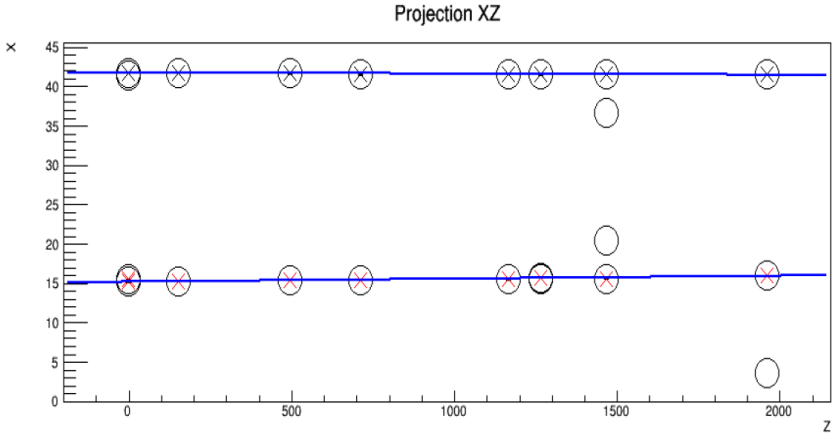


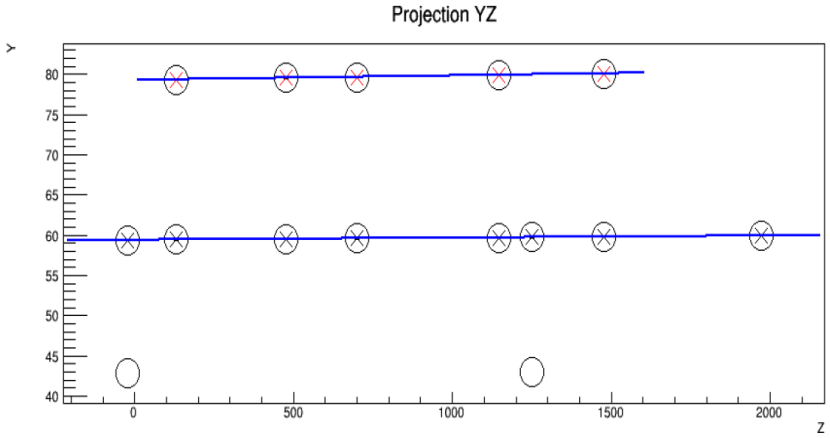


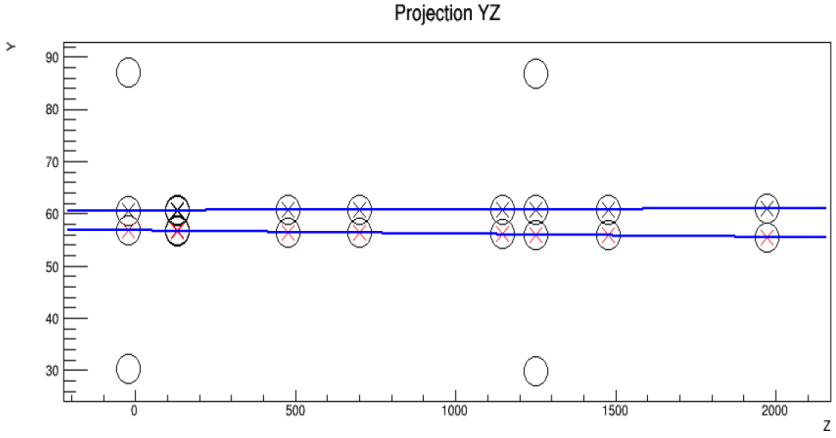


Event display in *XZ* and *YZ* - *two tracks*









Alignment

Starting with current alignment

→ muon_data_aligned files

→ **looks reasonable but *u,v* layers not aligned!**

→ we aligned first *u* and *v* and then re-aligned all the layers

- reference point taken as the bottom edge of BOX8

→ taken for all *x, y, u, v* layers

RE-ALIGNMENT (after *u,v* alignment)

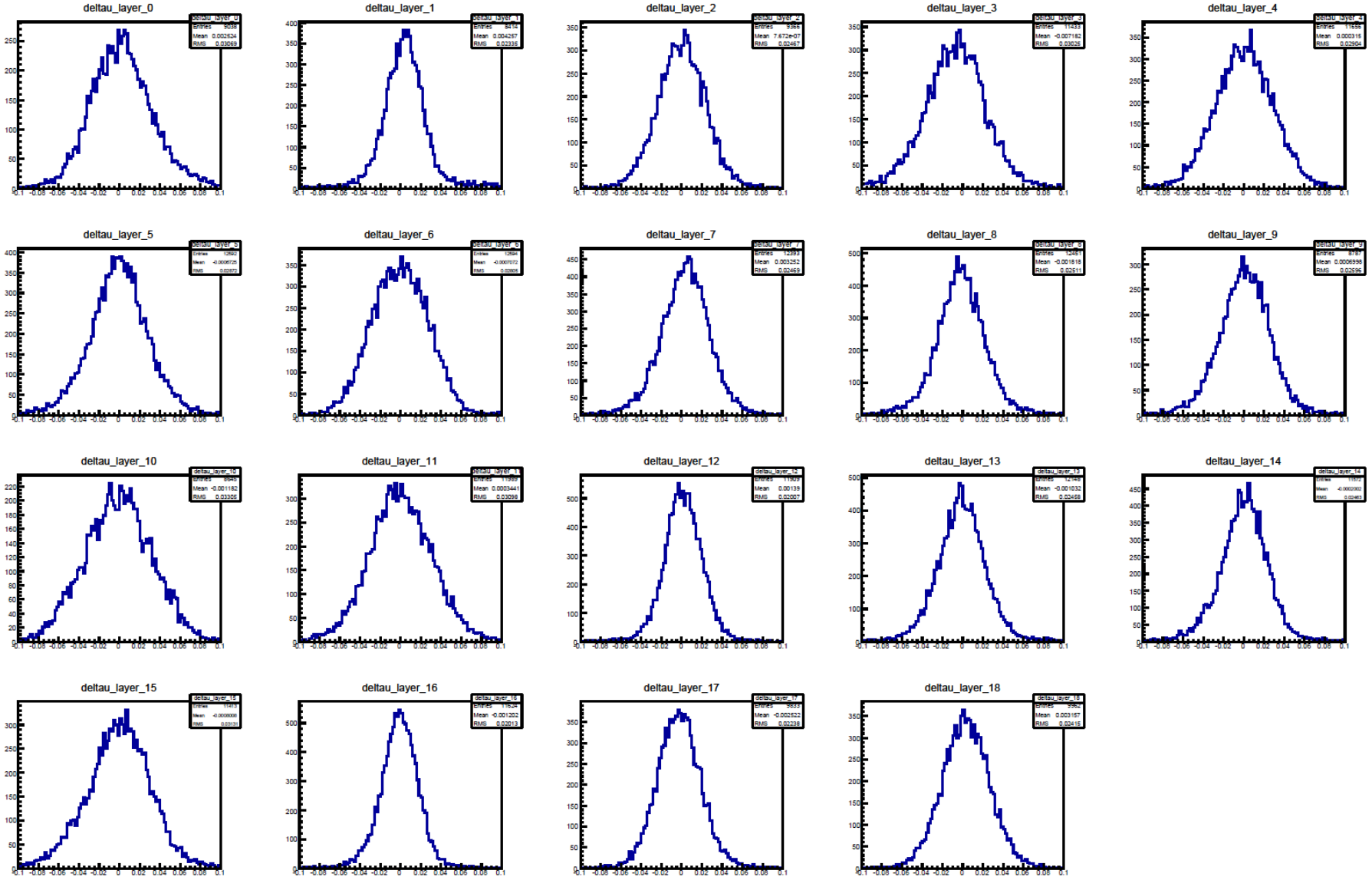
1. collect good quality tracks (at least 10 hits)
2. minimize residuals of every station on-by-one

→ loop over all the good quality tracks and minimize the sum of residuals *(χ^2)*

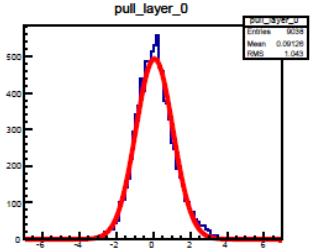
3. iterative procedure using MINUIT
4. align stations one-by-one

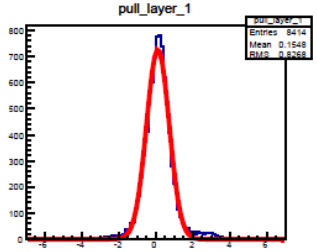
resolution and pull distributions *(fitted with a single Gaussian)* → *next slides*

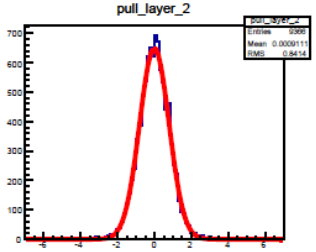
Alignment for *u* and *v*: resolutions

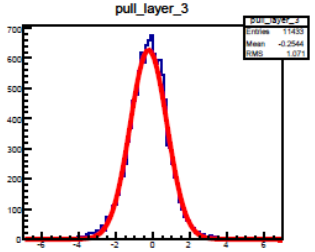


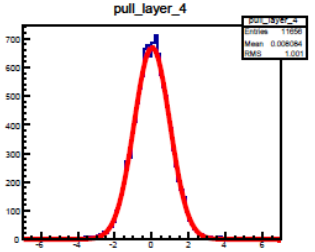
Alignment for *u* and *v*: pulls

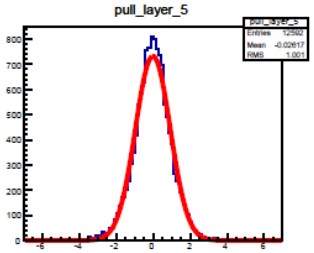


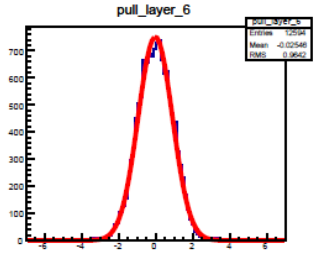


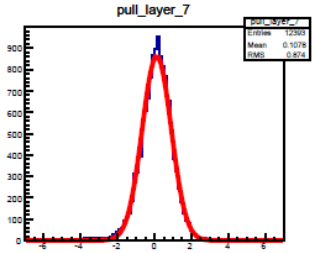


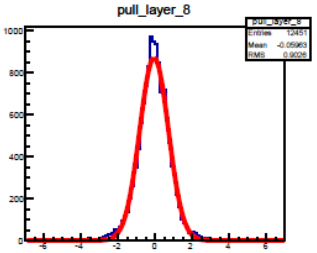


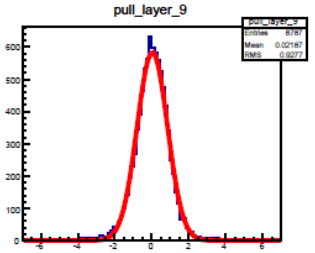


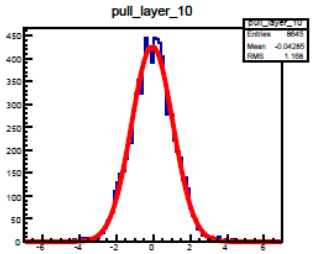


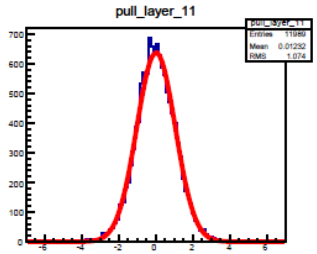


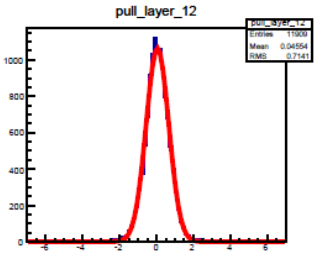


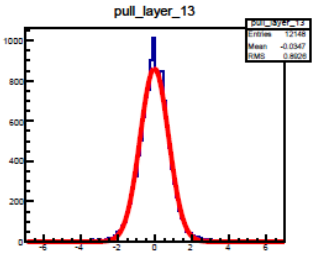


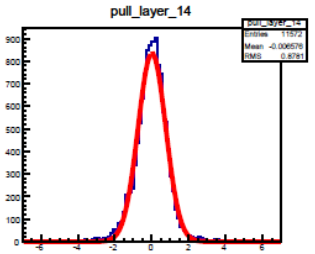


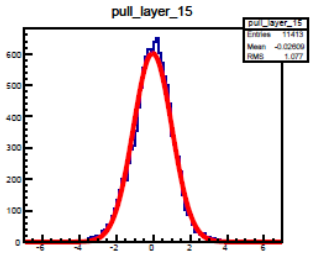


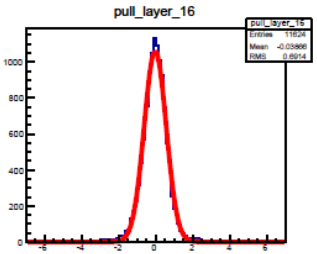


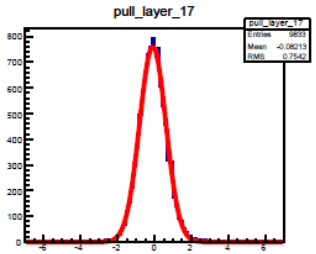


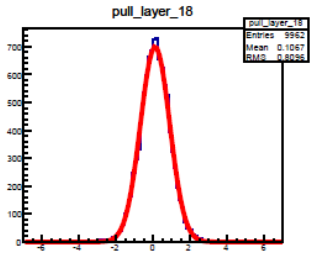












Track reconstruction

FIRST STAGE: separately for *xz* and *yz* planes

1. robust fit in *xz* and *yz* planes → 2D tracks
   (assumed 30 μm error for x,y hit position)
2. use u,v stereo hits for proper xz and yz 2D lines assignment
3. create 3D lines from xz and yz with the maximum number of stereo hits

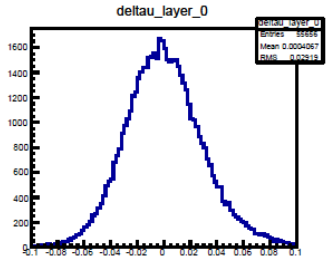
SECOND STAGE: final fit to 3d lines

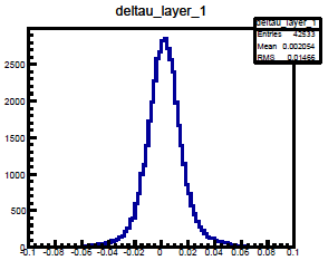
- fit using MINUIT collecting all the hits within 5 σ from the initial 3D line
- resolution and pull distributions *(fitted with a single Gaussian)*
  → can see different resolutions/pulls for different stations

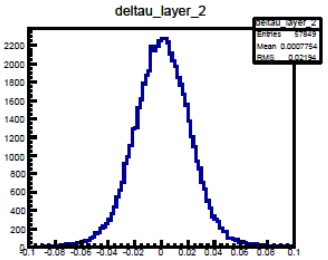
track multiplicity in the event → *next slide*

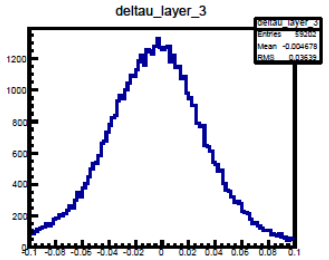
track chi2/ndof → *next slide*

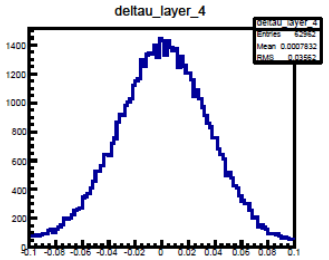
Resolutions (mm): σ = 20-35 μm

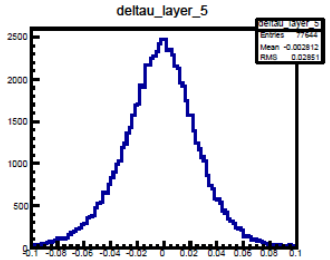


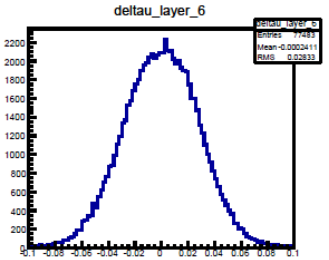


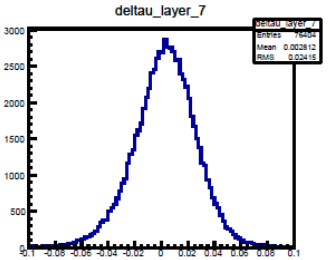


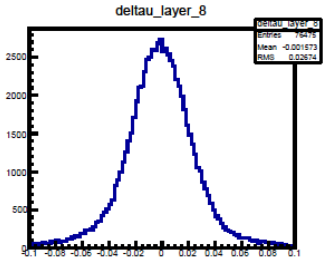


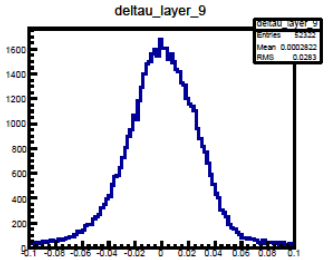


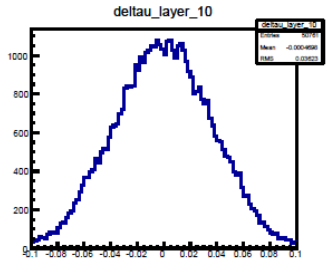


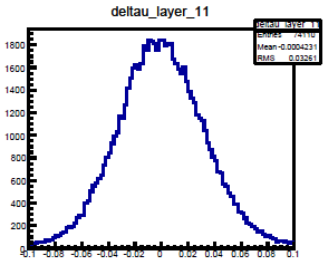


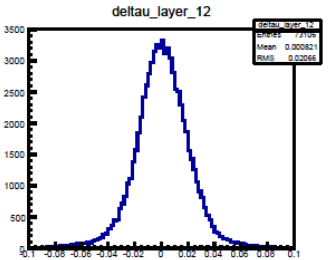


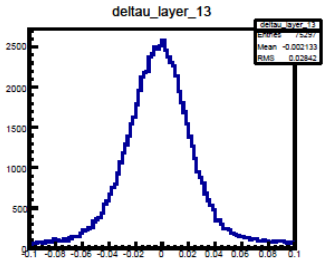


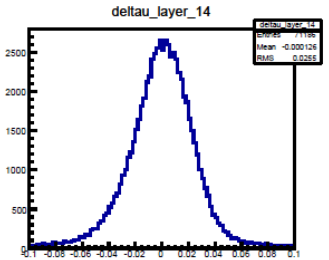


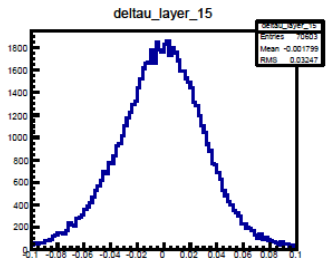


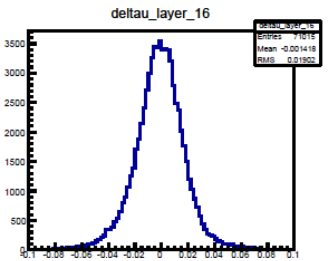


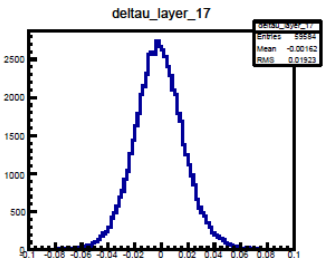


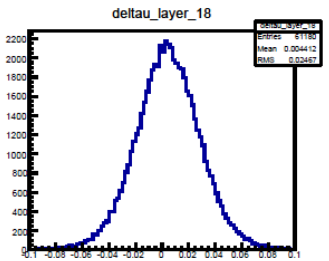




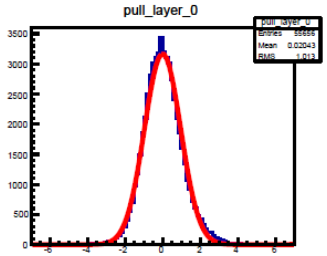


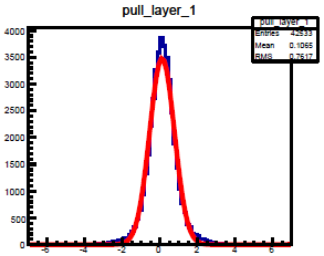


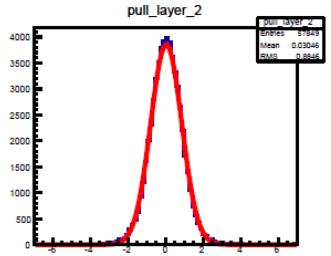


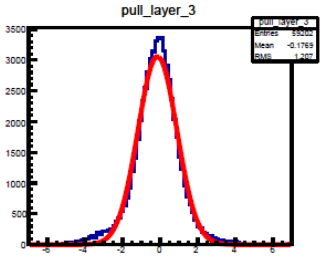


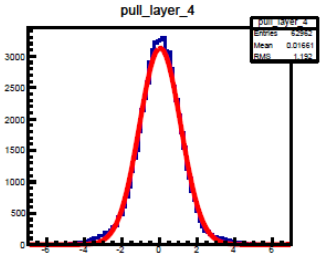
Pulls *(fit using single Gaussian)*

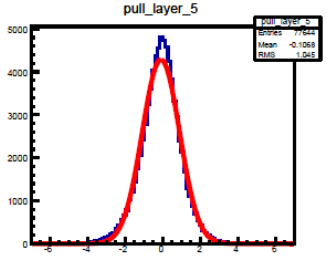


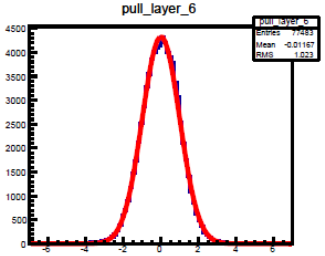


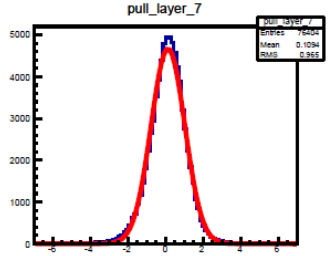


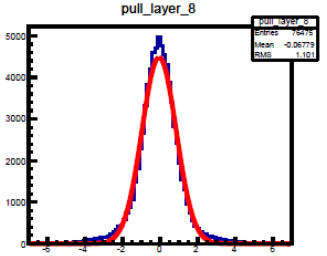


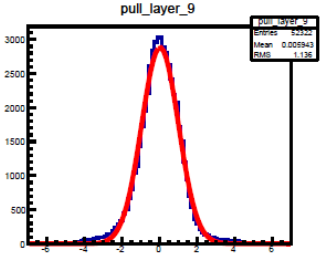


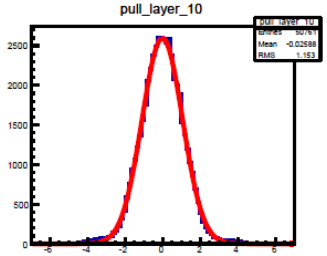


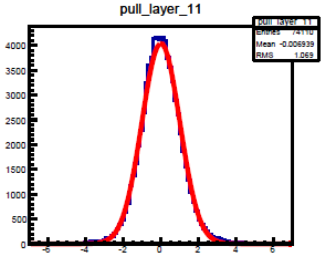


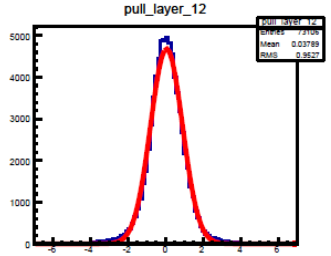


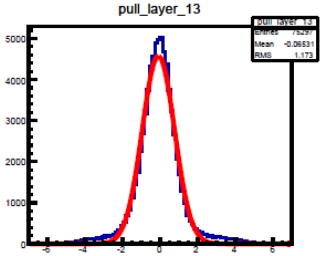


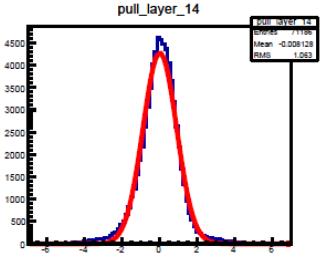


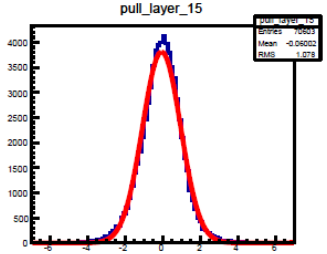


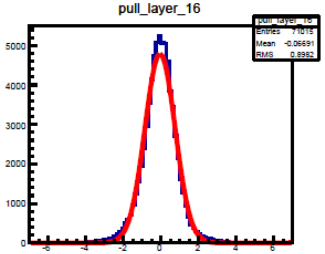


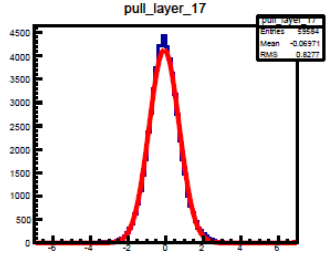


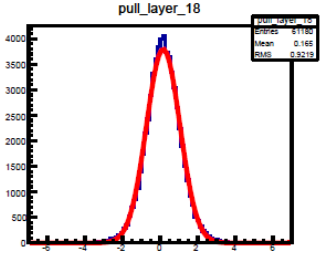




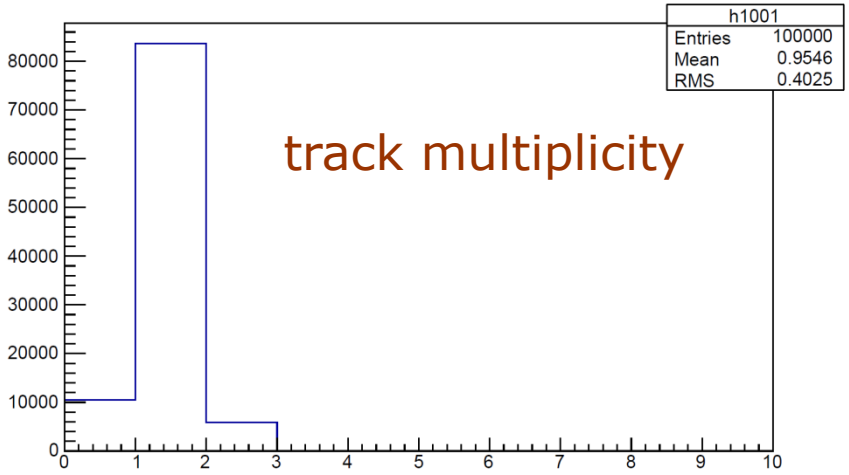


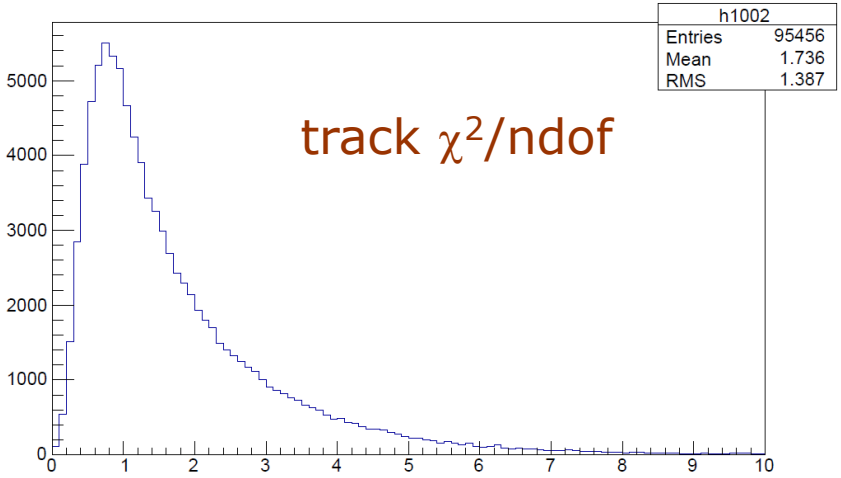






Track multiplicity and χ^2/ndof





Summary and plans

First version of package for alignment and track reconstruction ready

→ testbeam data

→ TrackRecMUonE package

→ track χ^2, slopes, ndof, nr of hits, etc.

→ produces ntuples with reconstructed tracks

final resolution: 20-35 μm

PLANS

- add particle ID (**HODO2** pulse height hodoscope channels
timeSpectrum peaking time, 0÷8 (calo), 9÷15 (hodo))

- better treatment of very close tracks