



News on ITS alignment

+ comments on alignment “data production” for pp

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Validation of SSD survey with cosmics

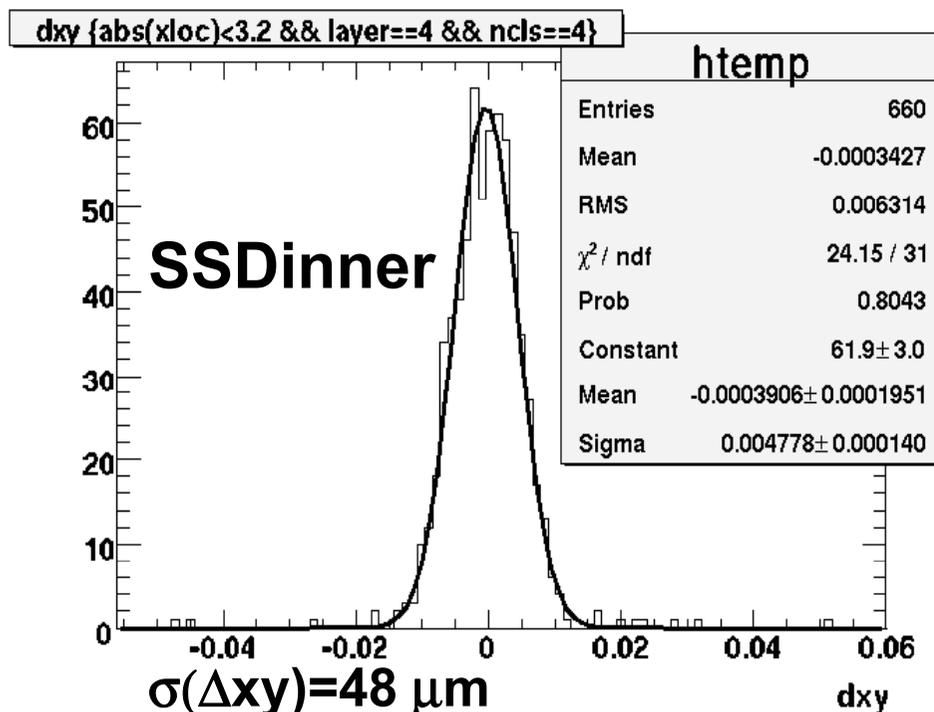


- ◆ SSD survey:
 - ⊕ Modules on ladders (critical: small stat on single modules)
 - Local shifts (x,z) of $\sim 10\text{-}20\mu\text{m}$ + rotations (θ)
 - ⊕ Ladders on cones (important, but not critical: stat allows alignment)
- ◆ Validation with cosmics
 - ⊕ Fit track on one layer (2 points) \rightarrow residuals on other layer
 - ⊕ Fit one track on outer layer, one on inner layer \rightarrow distance and angles between the two tracks
 - ⊕ Extra clusters from acceptance overlaps \rightarrow distance between two clusters from same track on contiguous modules on same ladder
- ◆ No TGeo overlaps produced
- ◆ Decided to put it in “Ideal” OCDB for MC prods and OCDB for raw data reco (being done by Raffaele)
 - ⊕ residual misalignment: smearing around survey with survey precision

Validation of SSD survey with cosmics (3)

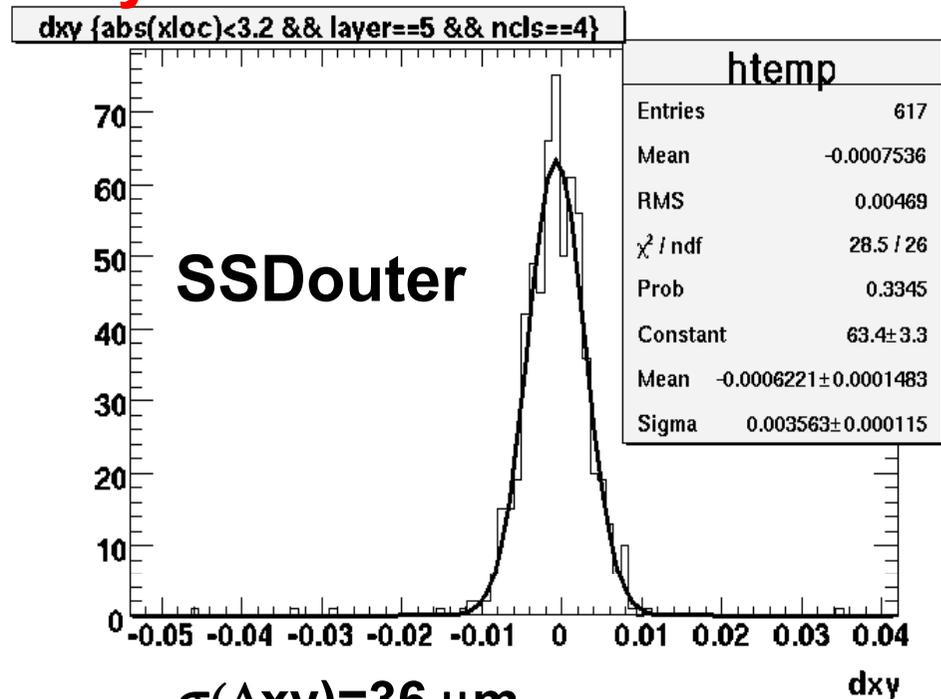
- Extra clusters from acceptance overlaps → distance between two clusters from same track on contiguous (overlapping modules on same ladder)

No survey



$$\Rightarrow \sigma(\text{point}) = 48 / \sqrt{2} = 34 \mu\text{m}$$

$$\Rightarrow \sigma(\text{misal}) = 27 \mu\text{m}$$



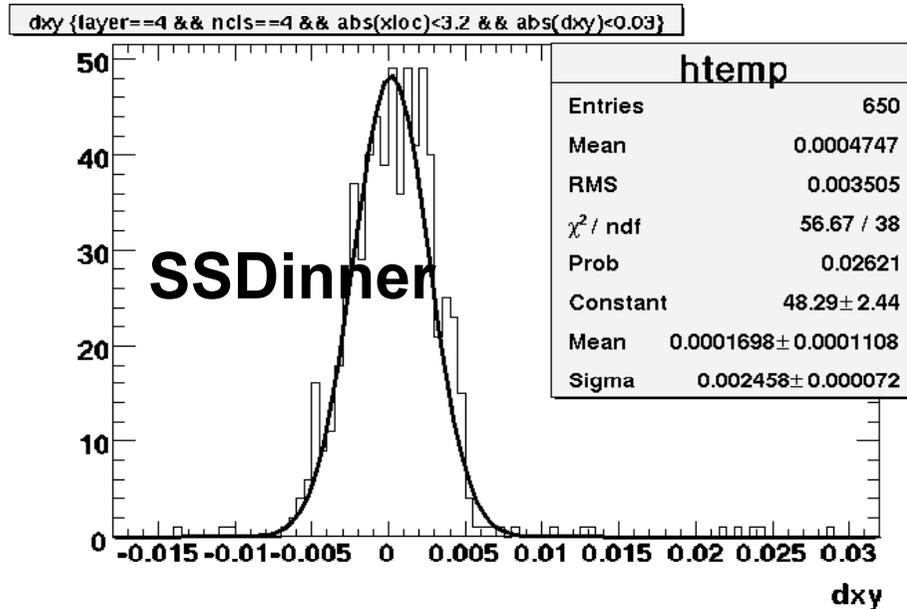
$$\Rightarrow \sigma(\text{point}) = 36 / \sqrt{2} = 25 \mu\text{m}$$

$$\Rightarrow \sigma(\text{misal}) = 15 \mu\text{m}$$

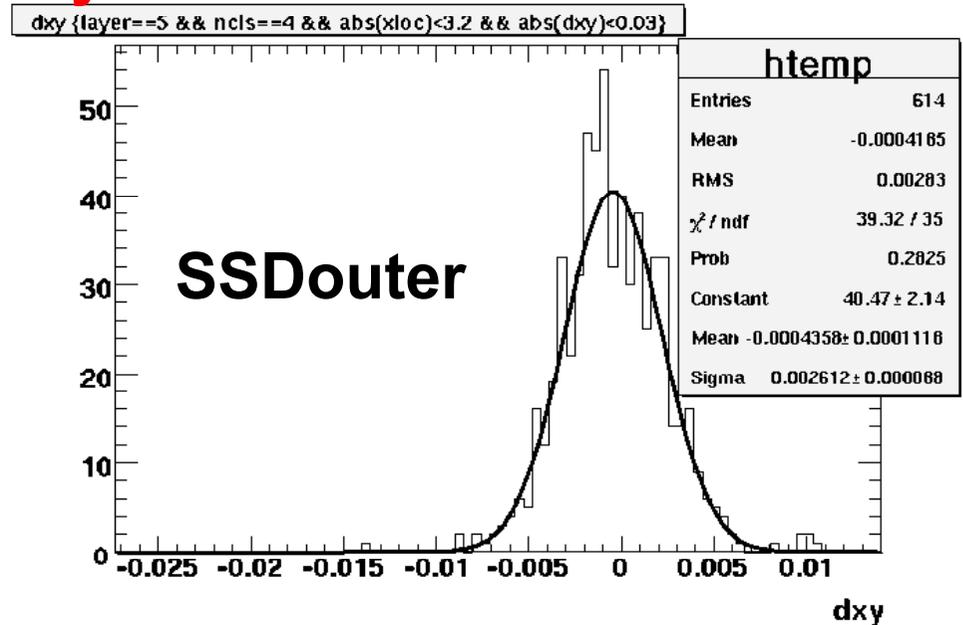
Validation of SSD survey with cosmics (3)

- Extra clusters from acceptance overlaps → distance between two clusters from same track on contiguous (overlapping modules on same ladder)

With survey



$\sigma(\Delta xy) = 25 \mu\text{m}$ (was 43)
 $\Rightarrow \sigma(\text{point}) = 25/\sqrt{2} = 18 \mu\text{m}$
 $\Rightarrow \sigma(\text{misal}) = 0 \mu\text{m}$ (was 27)



$\sigma(\Delta xy) = 26 \mu\text{m}$ (was 34)
 $\Rightarrow \sigma(\text{point}) = 26/\sqrt{2} = 18 \mu\text{m}$
 $\Rightarrow \sigma(\text{misal}) = 0 \mu\text{m}$ (was 15)



Alignment methods: Millepede

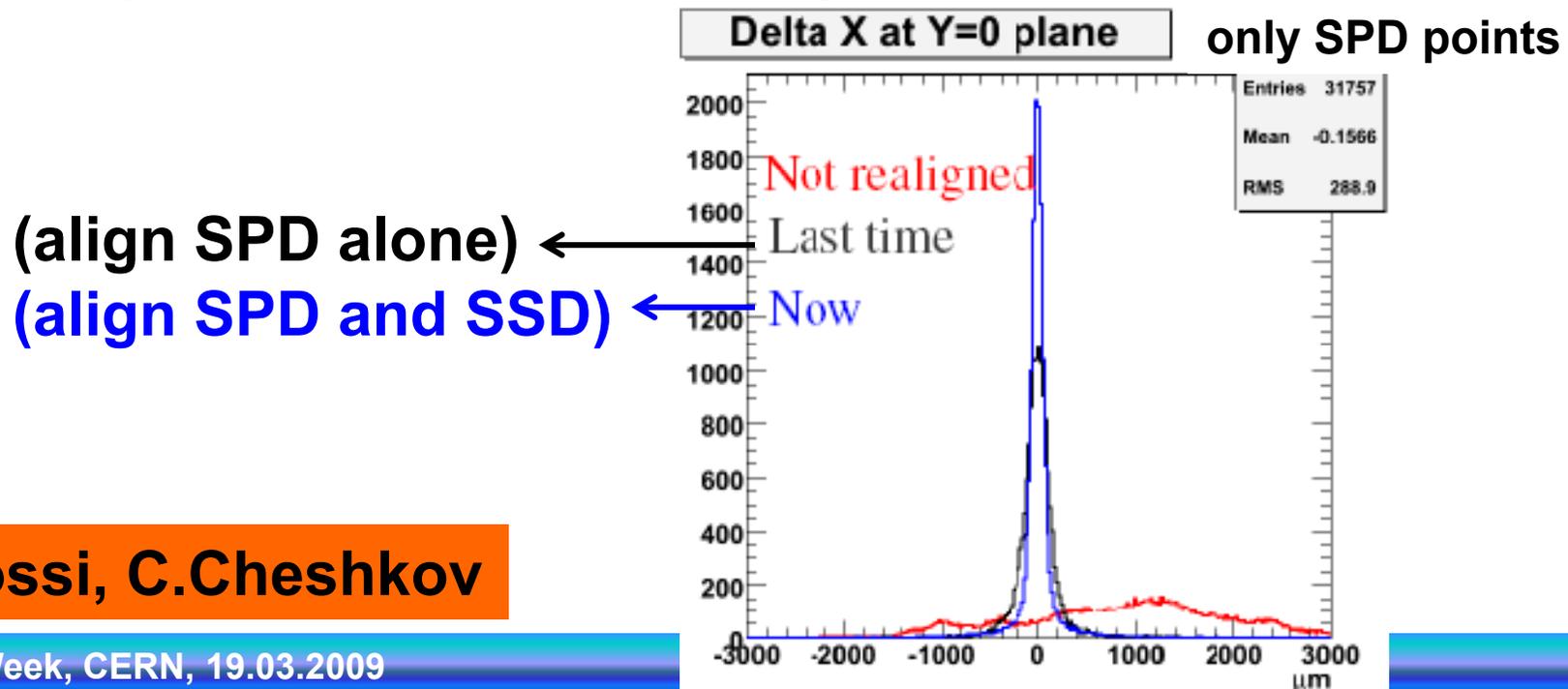


- ◆ Untill now used Millepede 1
- ◆ Transition to Millepede 2 (much faster, needs less memory, better treatment of constraints, hierarchical alignment in one go) is ready → **Ruben**
- ◆ Alignment is performed in a hierarchical way:
 - SPD sectors (10)*
 - optionally: SPD staves (~55)*
 - SPD half-staves (~110)*
 - SPD ladders (sensitive volumes) (~220)*
 - SPD barrel w.r.t. to SSD barrel*
 - SSD ladders (~55 for now)*

M.Lunardon, S.Moretto
R.Shahoyan

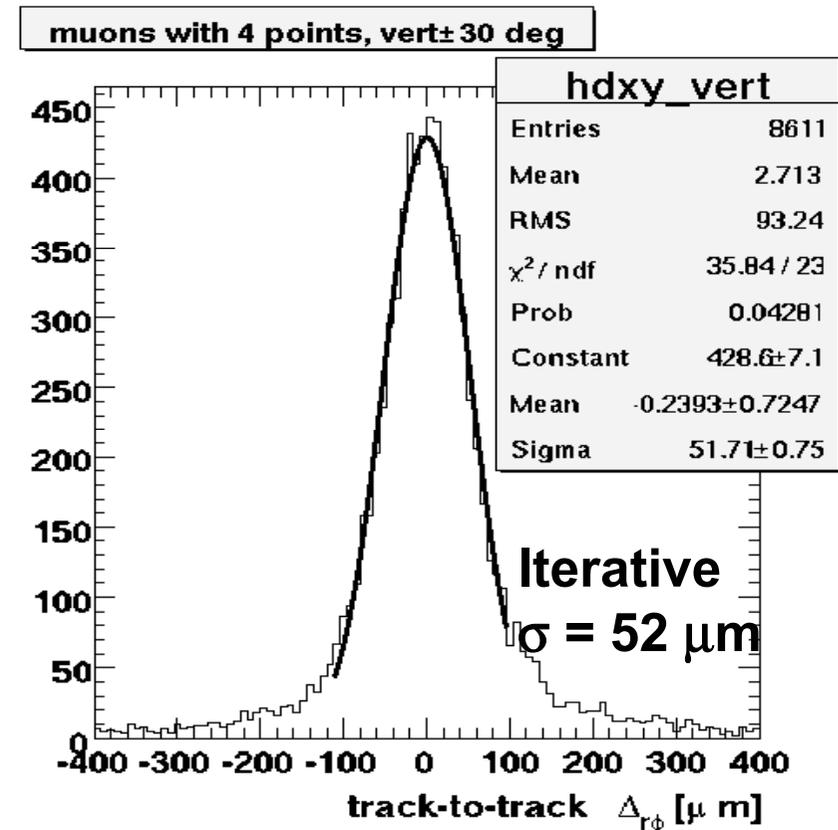
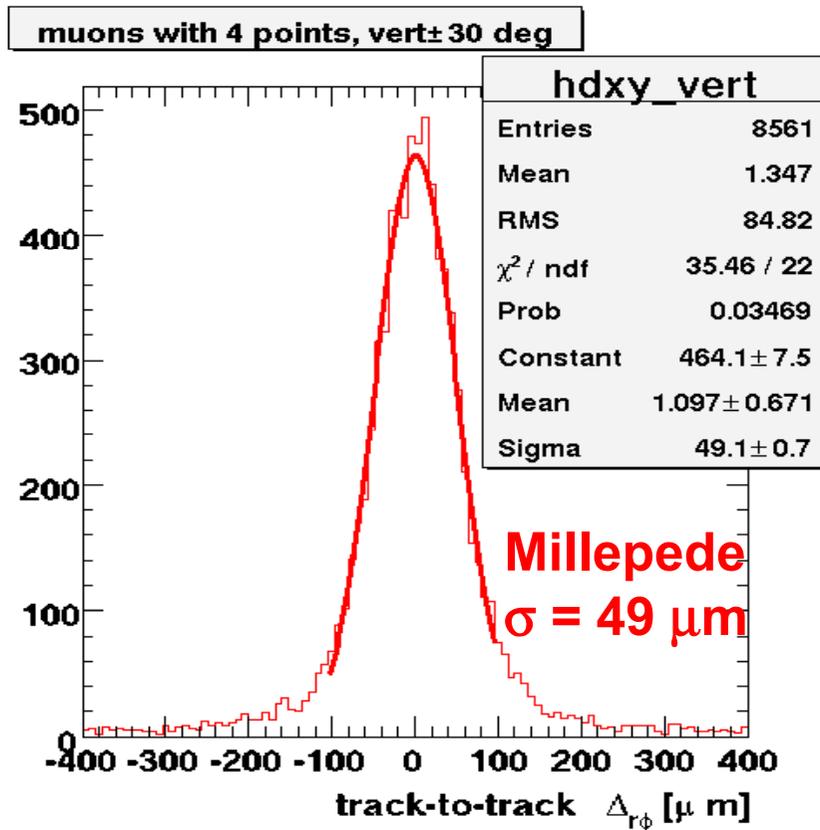
Alignment methods: Iterative local approach

- ◆ Alignment params from minimization of residuals
- ◆ Local: works on a module-by-module basis
- ◆ Iterations are used to take into account correlations between the alignment params of different modules
 - ⊕ difficult with SPD alone: only 4 points (modules) per track
 - ⊕ large improvement when including also SSD



A.Rossi, C.Cheshkov

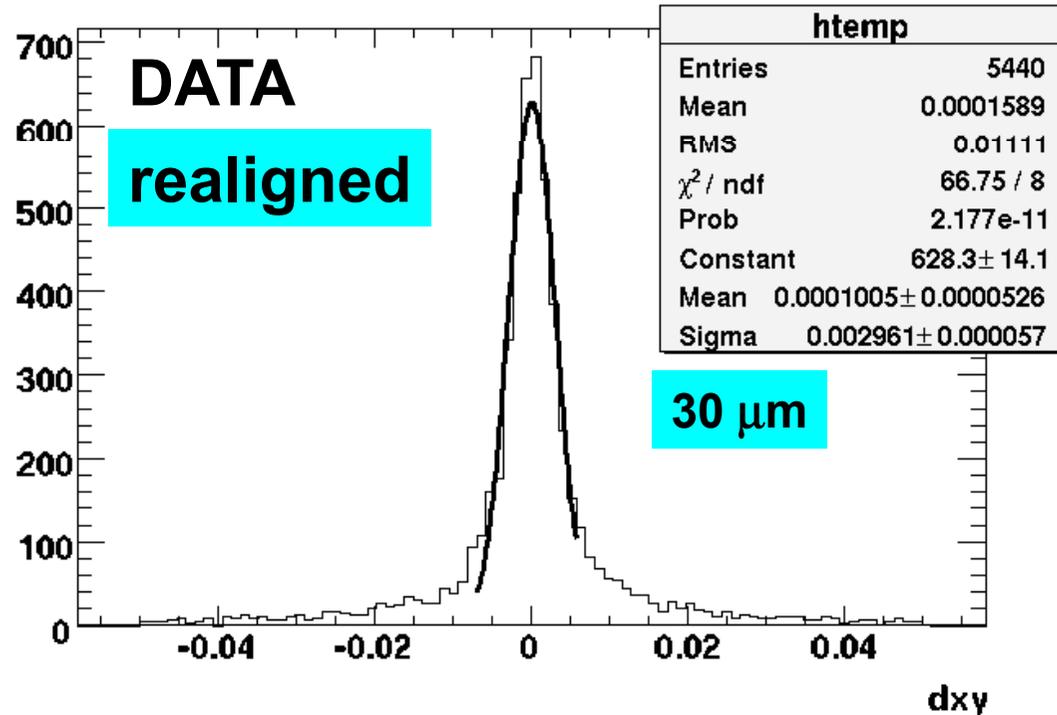
Millepede VS Iterative: track-to-track Δ_{xy} at $y = 0$ (SPD only)



Millepede SPD-SSD realignment: Δxy at $y=0$

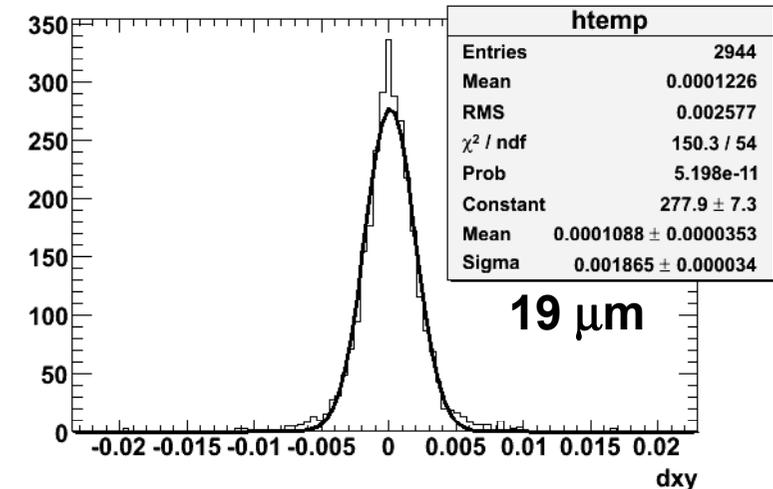
SSD at ladder level + Survey for modules

`dx {abs(dxy)<.05 && ncls1==4 && ncls2==4 && abs(d0mu)<1}`



Sim, ideal geom:

`dx {abs(dxy)<.02 && ncls1==4 && ncls2==4 && abs(d0mu)<1}`

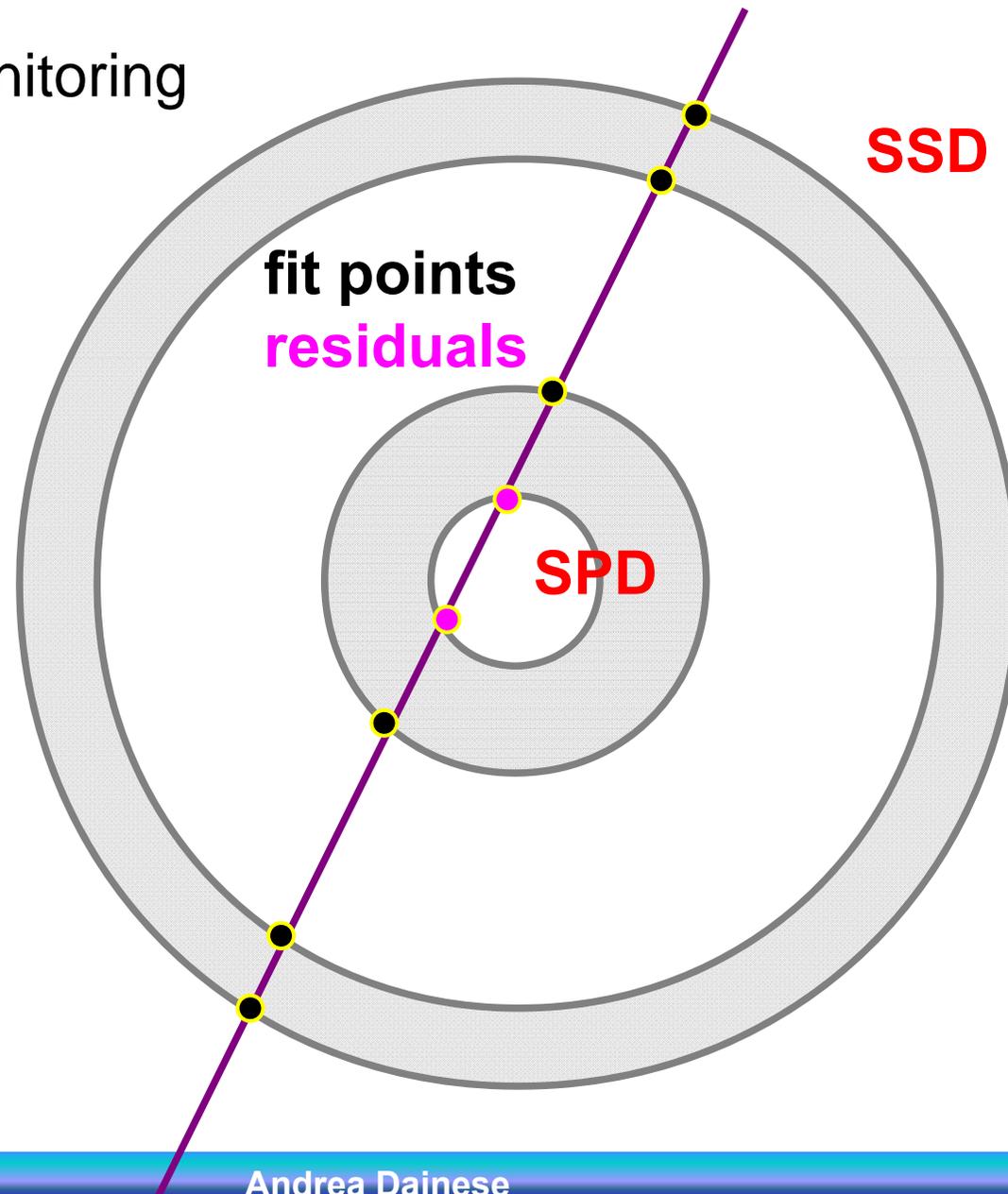


→ single track impact parameter resolution $30/\sqrt{2} \sim 21 \mu\text{m}$
but p_t “unknown” → difficult to conclude...

M.Lunardon, S.Moretto

Cross checks with *B-on* runs

- ◆ ITS alignment monitoring





Alignment “data production” for pp



The main questions are:

(preliminarily discussed with Chiara and Cvetan, see Chiara’s talk later)

- ◆ *How to extract the alignment data (e.g. AliTrackPoints)? grid? CAF? “calibration train”?*
- ◆ *Where and how to run the offline alignment/calibration?*
- ◆ *How often?*
- ◆ *How to update the OCDB?*
- ◆ *How does this enter in the “data production scheme” (the various reco passes)?*



Input data for ITS alignment



- ◆ Alignment data: AliTrackPointArrays, extracted from tracks, stored in ESD friend
- ◆ The same data are used also for:
 - ⊕ SDD and SSD charge calibration (in principle doesn't need frequent updates)
 - ⊕ SDD time zero calibration (will require updates for sure when trigger conditions change)
- ◆ Not all tracks can be used for alignment → filtering
- ◆ For cosmics, up to now, events with SPD trigger reconstructed (many times... learning process...) interactively and data filtered locally with a macro
- ◆ Cannot work for pp
- ◆ Need “automatic” procedure (to be tested on cosmics asap)



ITS alignment strategy with pp



- ◆ Will start from alignment with cosmics + survey
- ◆ B-on or B-off?
 - ⊕ technically alignment with B-on data works (Millepede)
 - ⊕ B-on has the advantage of allowing high- p_t selection (low scattering)
 - ⊕ however, potential biases with curved tracks (radial bias...)
 - ⊕ B-on data are instead optimal to check alignment quality (p_t sel.)
- ◆ First alignment with B-off data (first physics sample ~500k events; enough for alignment?)
- ◆ Afterwards (when we are well-aligned), general idea (under discussion):
 - ⊕ continuous check of alignment quality (monitoring) with B-on (especially when conditions change: field, temp?)
 - ⊕ request dedicated B-off run if alignment deteriorates
 - ⊕ use any B-off run to accumulate statistics for alignment
 - ⊕ of course, we will also try to align with B-on data (needs validation)

Production of alignment data

- ◆ Since “ESD friends do not exist” (= not stored):
- ◆ Filtering of alignment data on the fly at the end of the reco job (ESD friends are there)
 - ⊕ keep tree with AliTrackPointArray (only the ITS points) for selected tracks (e.g. ≥ 4 ITS points, $p_t > p_t^{\min}$)
 - ⊕ could be done in a kind of “calibration train”, then put together output from diff chunks/runs (→ Chiara)
 - ⊕ these data used by experts –locally, at least for a while-- for:
 - validation of current alignment
 - re-alignment (Millepede) → new OCDB object
- ◆ Perform part of the validation of the alignment as QA (ESD part of ITS Rec QA) → saved as expert histograms
 - ⊕ done automatically for all data
 - ⊕ easier to inspect (AliQAManager to merge QA from xml)
 - ⊕ can compare to reference (this will need time ...)

Summary

- ◆ SSD survey validated with cosmics
 - ⊕ being included in the “Ideal” geometry (for both MC and RAW-reco)
- ◆ Most of SPD realigned to $\leq 10 \mu\text{m}$
 - ⊕ need cross-checks with pp, especially on the sides
- ◆ With SPD+SSD \rightarrow track d_0 resolution $\sim 20 \mu\text{m}$ (+ tails), difficult to conclude because p is unknown

- ◆ Started preparation of strategy for pp
- ◆ To do:
 - ⊕ train-able filtering of alignment data from ESD friend (Task)
 - ⊕ alignment monitoring in QA framework
- ◆ Can be exercised with a new reco pass on old cosmics (needed anyway: survey, updated calib, use data with ACORDE trigger)

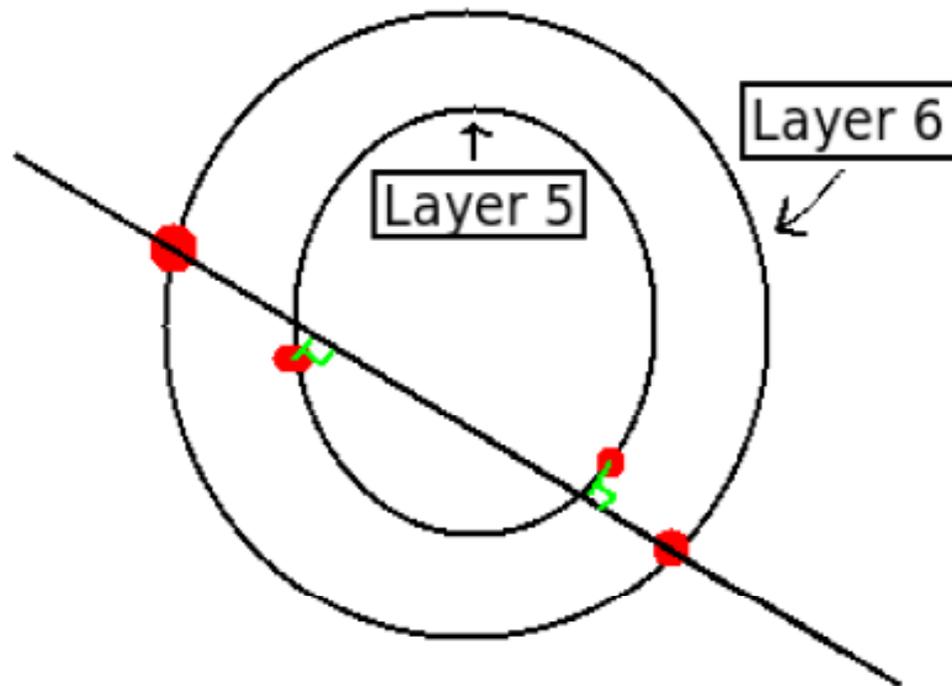


EXTRA SLIDES

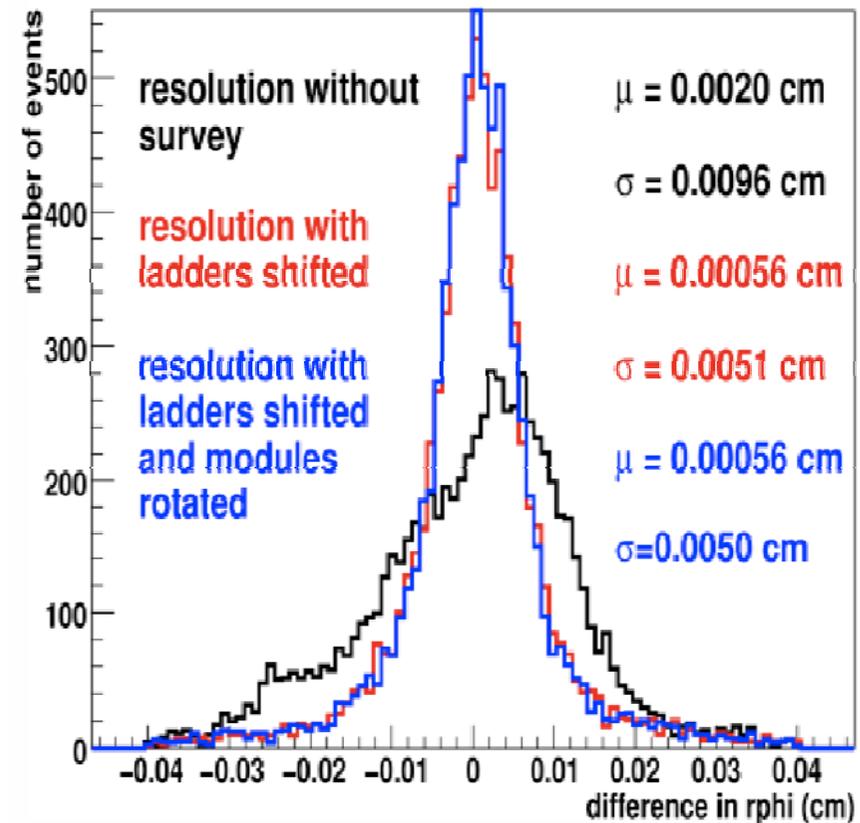


Validation of SSD survey with cosmics (1)

- Fit track on one SSD layer (2 points) → residuals on other SSD layer



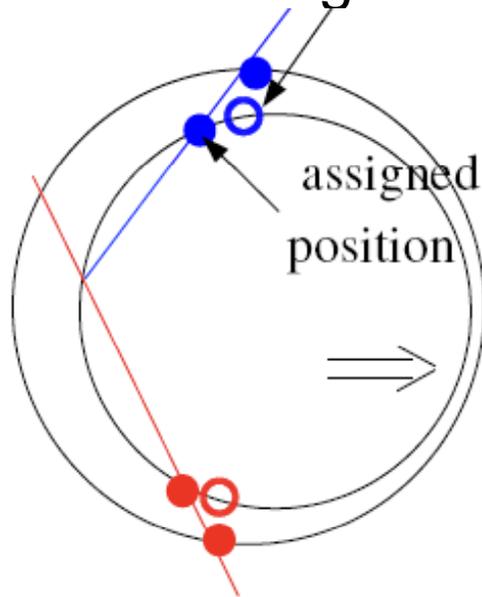
rphi resolution on layer 5



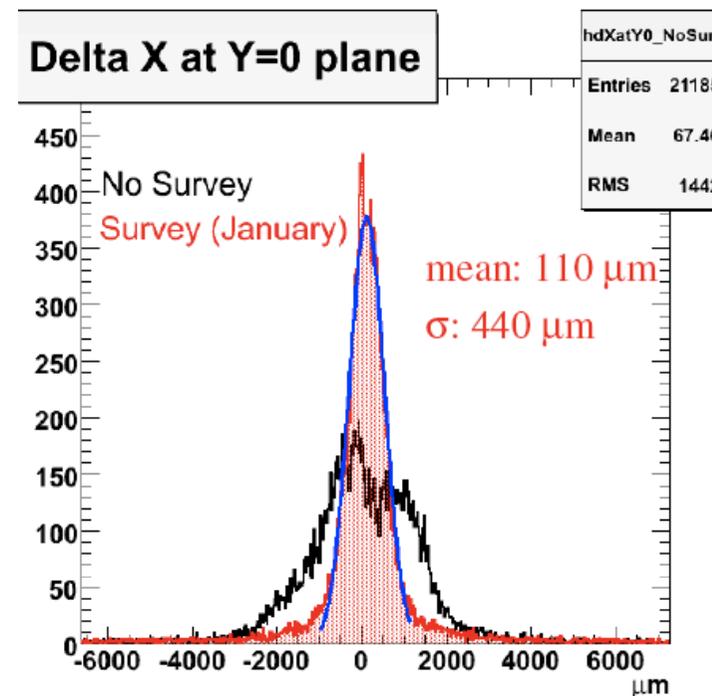
N.Vermeer, M.van Leeuwen

Validation of SSD survey with cosmics (2)

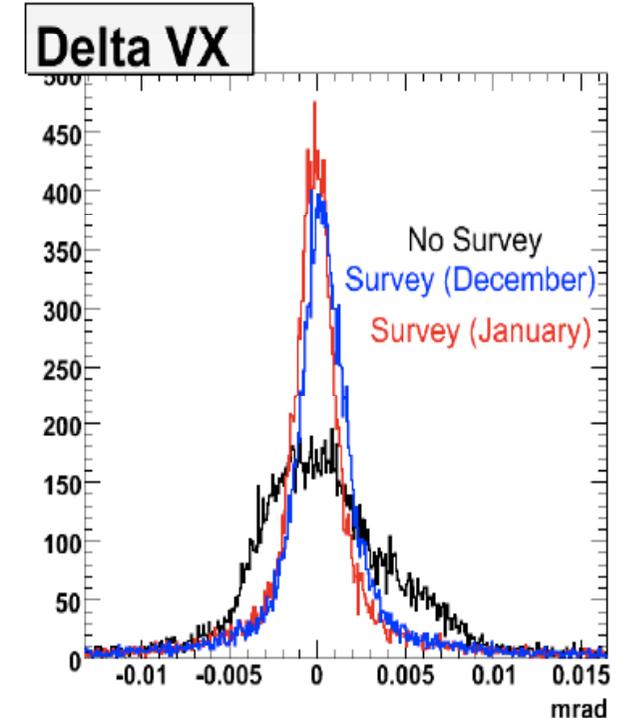
- Fit one track on **top** “half barrel”, one on **bottom** → distance and angles between the two tracks



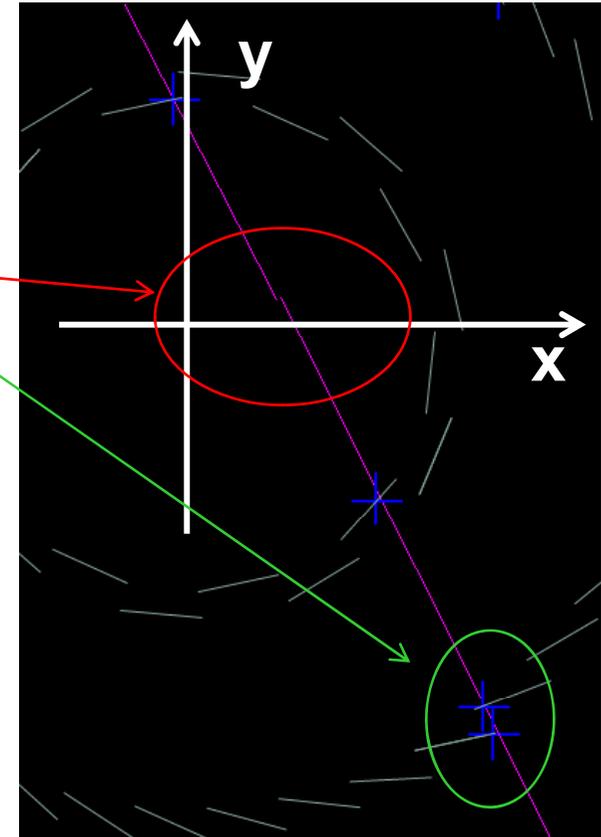
UpToDown: ΔX at $Y=0$ plane



UpToDown: $\Delta\phi$

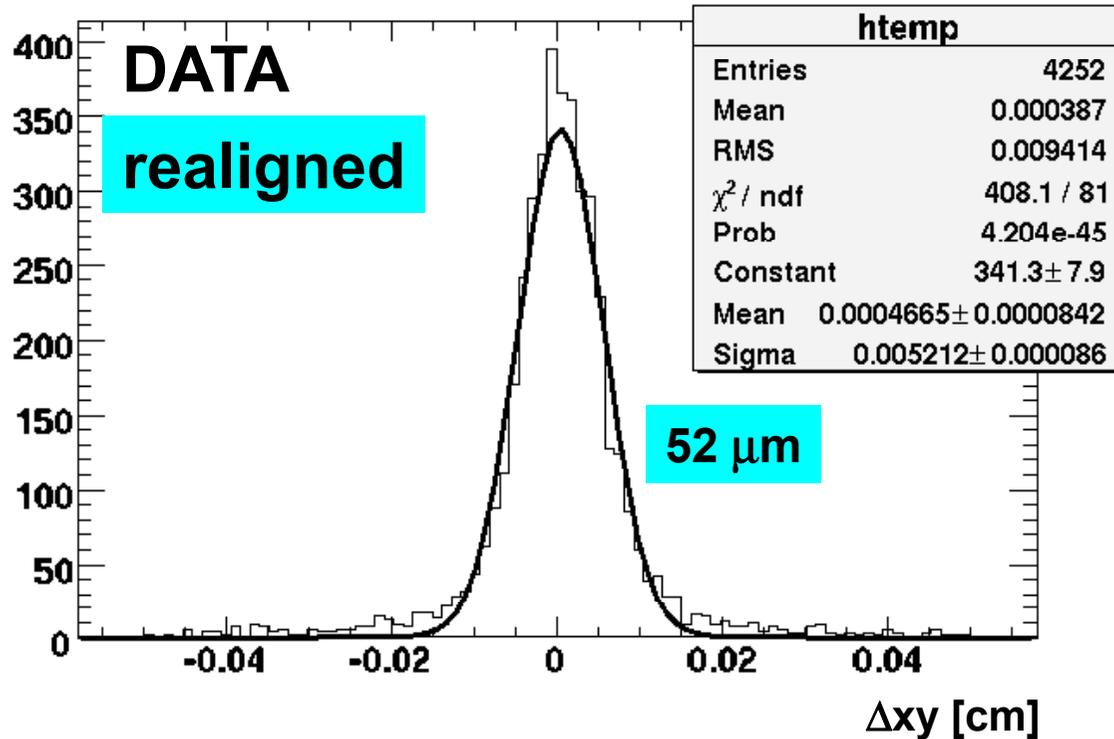


- ◆ Select muons with DCA to $(0,0) < 1$ cm
- ◆ Main variable: track-to-track Δxy at $y=0$
- ◆ Acceptance overlaps \rightarrow “extra” clusters
- ◆ Alignment monitoring tool

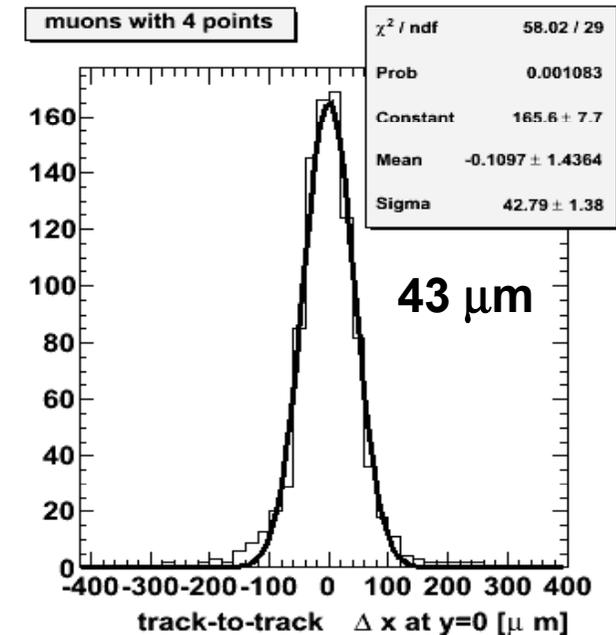


Millepede SPD realignment: Δxy at $y=0$

`dxy {abs(dxy)<.05 && abs(d0mu)<1 && ncls1==2 && ncls2==2}`



Sim, ideal geom:



Expected spread

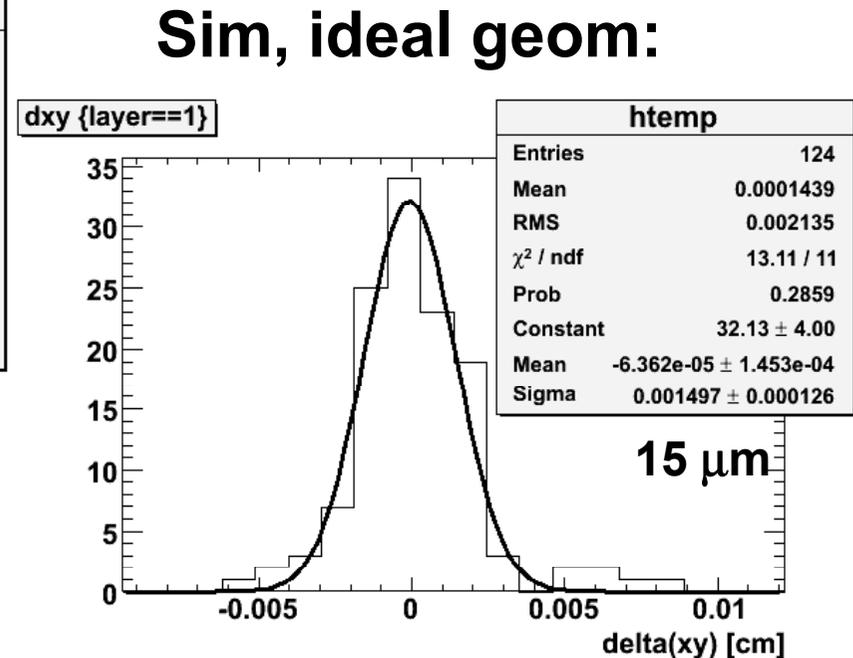
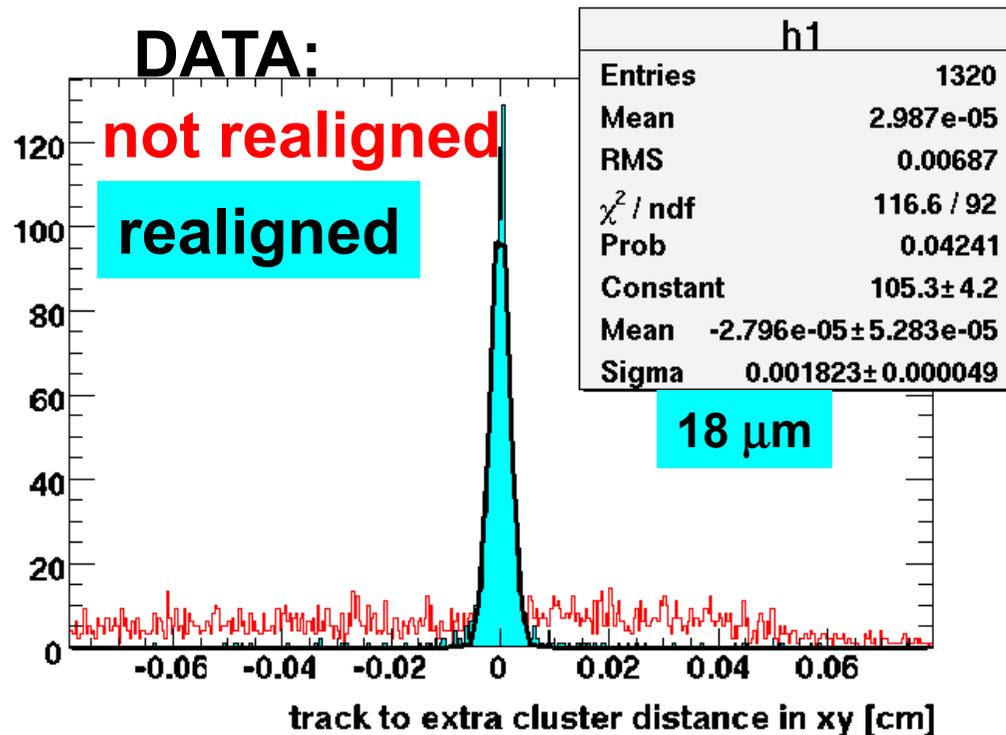
$$\sigma_{\Delta x}^2 = 2 * (r_{SPD2}^2 + r_{SPD1}^2) / (r_{SPD2} - r_{SPD1})^2 * \sigma_{spatial}^2$$

→ $\sigma_{spatial} = 14 \mu m$ → $\sigma_{misal} \sim 9 \mu m$

→ $\sigma_{spatial} = 11 \mu m$ (Sim)

M.Lunardon, S.Moretto

Millepede realignment: SPD “extra” clusters



Expected
spread

sigma \sim spatial resolution $\times \sqrt{2}$

$\rightarrow \sigma_{\text{spatial}} = 14 \mu\text{m} \rightarrow \sigma_{\text{misal}} \sim 9 \mu\text{m}$

$\rightarrow \sigma_{\text{spatial}} = 11 \mu\text{m}$ (Sim)