Offline Week

CERN, Oct 10th 2007

ITS alignment using Millepede and cosmics: status report

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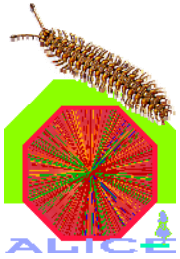

Contents

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  - status of the code
  - input/output
- **Short review of the first steps**
  - test with 160 detectors and 3 d.o.f.
  - test with 6 d.o.f. and more detectors
- **Test with full simulation**
  - problem with residuals in SPD
  - verification tests
- **Conclusions and next steps**

Status of the code

- Class **AliITSAlignMille** ready and working under aliroot version 4-06-Release
  → *sent to Massimo to be committed*

- Macro to run Millepede for ITS: **ITSAlignMille.C** ready but not yet committed

Input/Output

Ingredients to run AliITSAlignMille

Input configuration (***AliITSAlignMille.conf***) :

- list of modules to be aligned and free parameters
- starting geometry (*geometry.root*)
- expected range for free params (sigma's, fixed at the moment)
- set of tracks (*AliTrackPoints.N.root*)
  → list of ***points*** in global coordinates + ***their uncertainties***

Output :

- values of the free parameters with estimated stdev

Input/Output

Checking the results

Input:

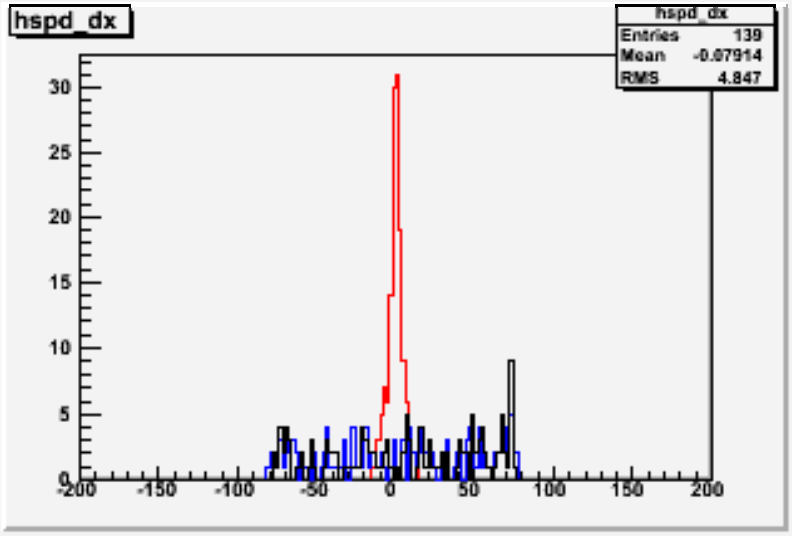
- used misalignment (*ITSMisalignment.root*)

Output

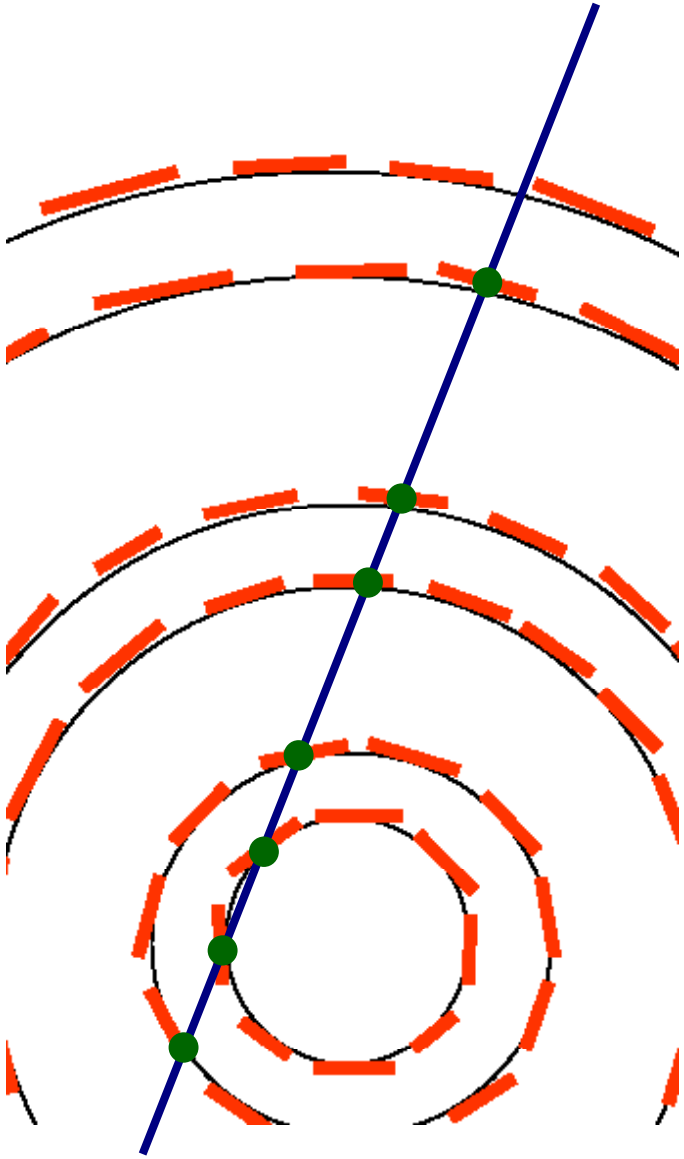
- distributions of alignment parameters: **real**, **mille**, **delta** (mille – real), **pull** (delta/err_mille)

- evaluation of **mean** and **rms** of delta distributions (the average “residual” misalignment)

example: delta(X_{LOC}) for SPD (see later)



Fast simulation with SimMille.C



1. A muon direction is generated
2. Intersection points with misaligned detectors are evaluated in local coordinate systems
3. Points are smeared with given σ's
4. Global coordinates are calculated using ideal geometry and written as AliTrackPointArray

Advantages w.r.t. standard sim:

1. faster
2. σ's of points passed to Millepede under control
3. no "unexpected" effects

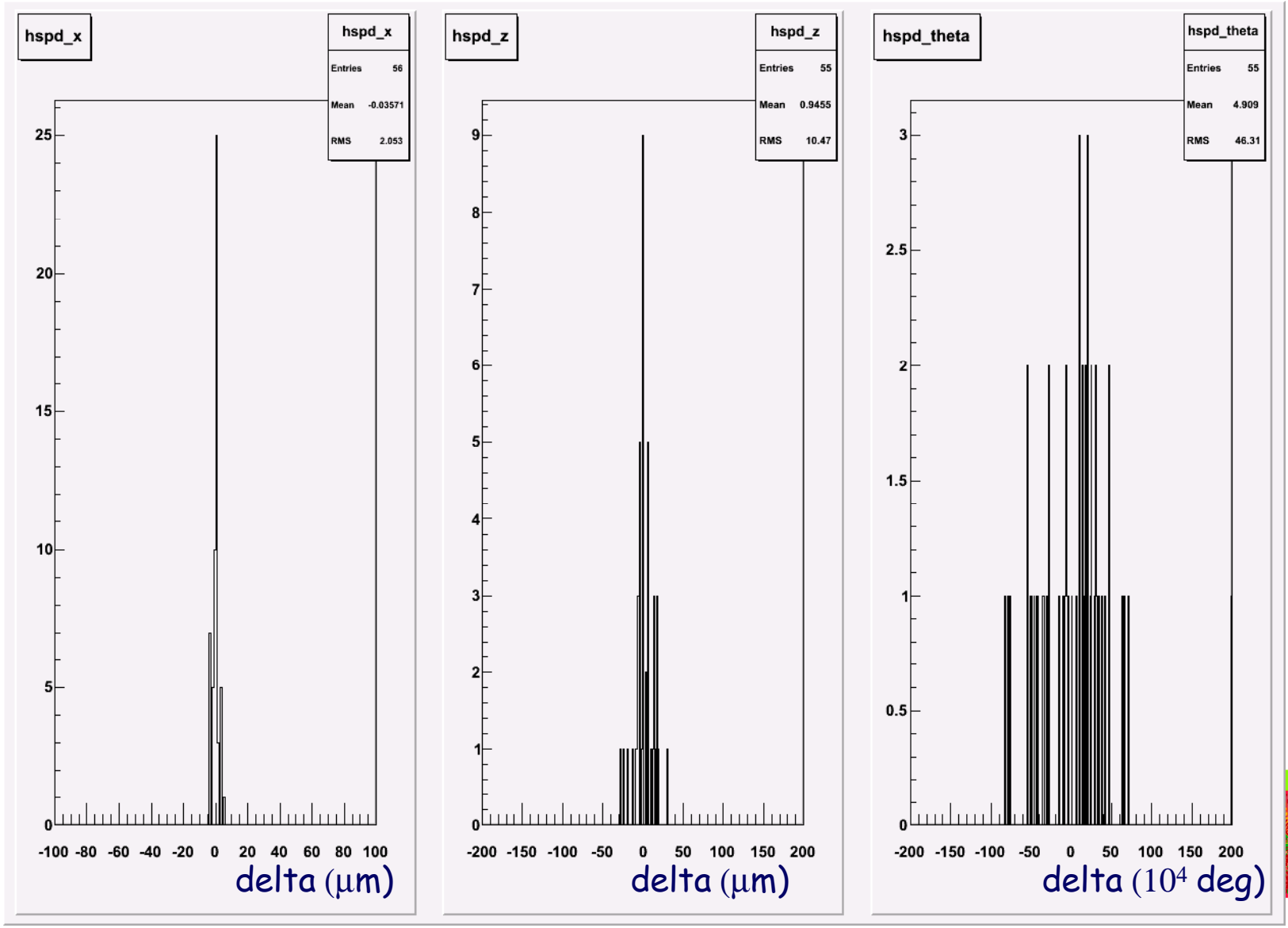
The 3 d.o.f. test case

Fast simulation of cosmic-like tracks

- realistic cosmic-like direction distribution (ACORDE)
- test with translations in the (x-z) local plane and rotation around Y_L (angle θ)
- selection of 164 modules with higher statistics (55 + 30 + 79)
- a total of 164x3 ~ **500 free alignment parameters**;

The 3 d.o.f. test case

Test: xz shifts – rot YL (θ) – 20000 tracks in SP (about 10 days) SPD X , Z, θ

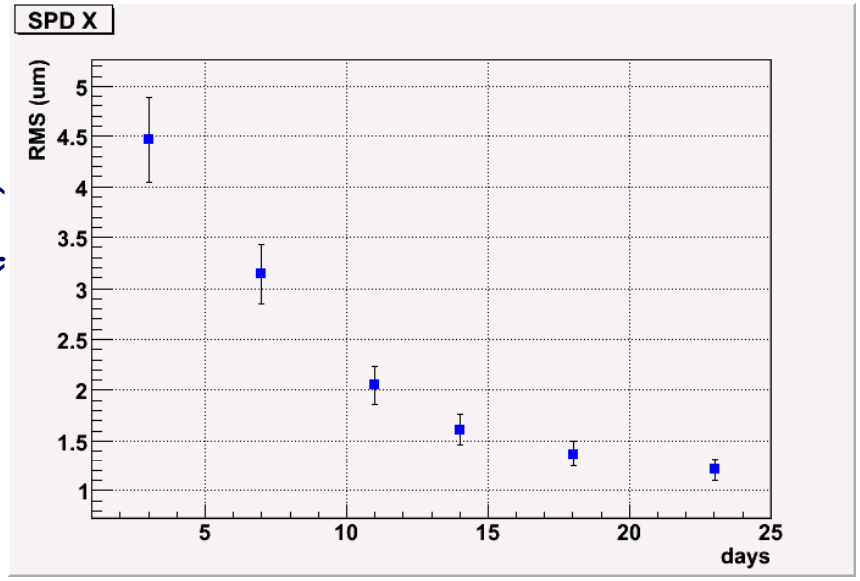


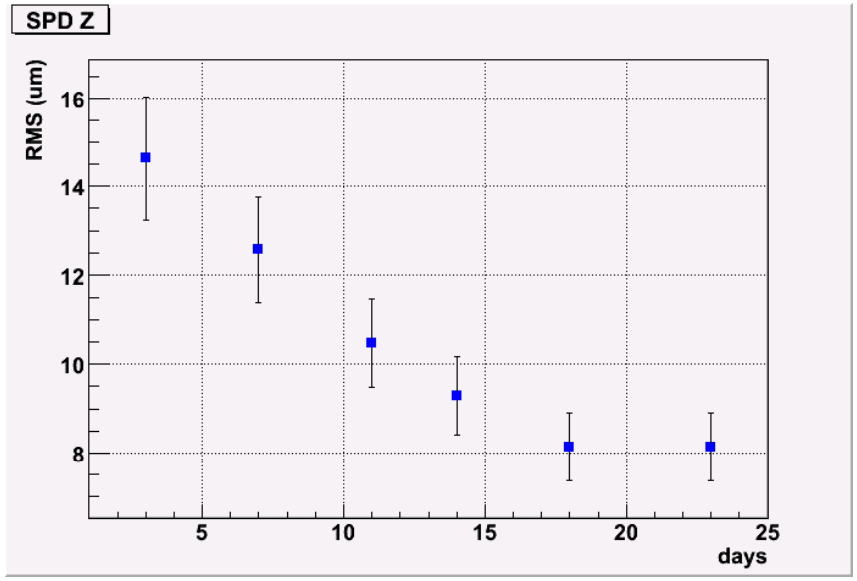
The 3 d.o.f. test case

SPD **X-SHIFT** (μm)

SPD **Z-SHIFT** (μm)

RMS (μm)





Conversion from **number of tracks** to **days**:

estimate of 1.8 cosmics per minute *crossing SPD0*

→ 1.8 x 60 x 24 ~ **2.6 kTracks per day**

The new 6 d.o.f. test case

Test case details

- fast simulation of cosmic-like events spread over the full ITS
- no magnetic field (straight tracks)
- full (random) misalignment (6 degrees of freedom)
- different sets of modules, **from 166 to 953**
- test with 12 points tracks (crossing SPD) and less points
- *no fixed detectors*
- *no global constraints*

The new 6 d.o.f. test case

The input misalignment

- significative uniform distributions
- **random** distributions (no correlations)

```
Double_t globalZ = 0.;
Double_t mecanicalPrec = 0.000;
Double_t resFact = 5.1;
Double_t spdXY   = 0.0015*resFact; // = 76.5 mu
Double_t sddXYZ  = 0.0030*resFact; // = 153 mu
Double_t ssdXY   = 0.0020*resFact; // = 102 mu
Double_t rot     = 0.0900; // deg -> psi,theta,phi in [-rot,rot]
Double_t spdZ    = 0.0020*resFact; // = 102 mu
Double_t ssdZ    = 0.0100; // 100 mu
```

- rot=0.09 corresponds, as maximum displacement:
  - **SPD: theta,psi: 55 mu phi: 10 mu**
  - **SDD: theta,psi: 59 mu phi: 55 mu**
  - **SSD: theta,psi: 31 mu phi: 57 mu**

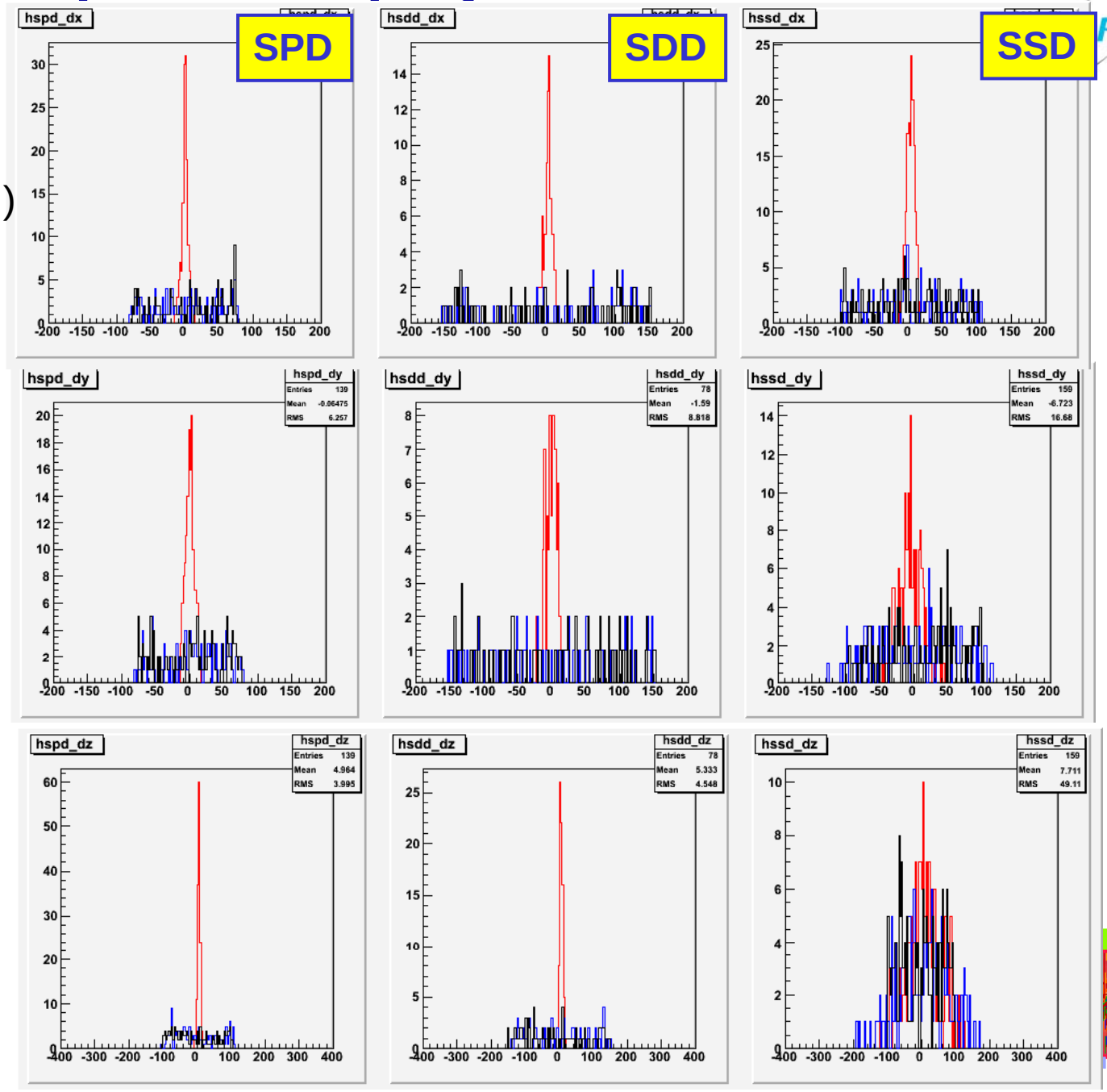
Typical results: 50 k tracks crossing SPD0

config “*test3*”
375 modules
(138 + 78 + 158)

X_{LOC}

Y_{LOC}

Z_{LOC}

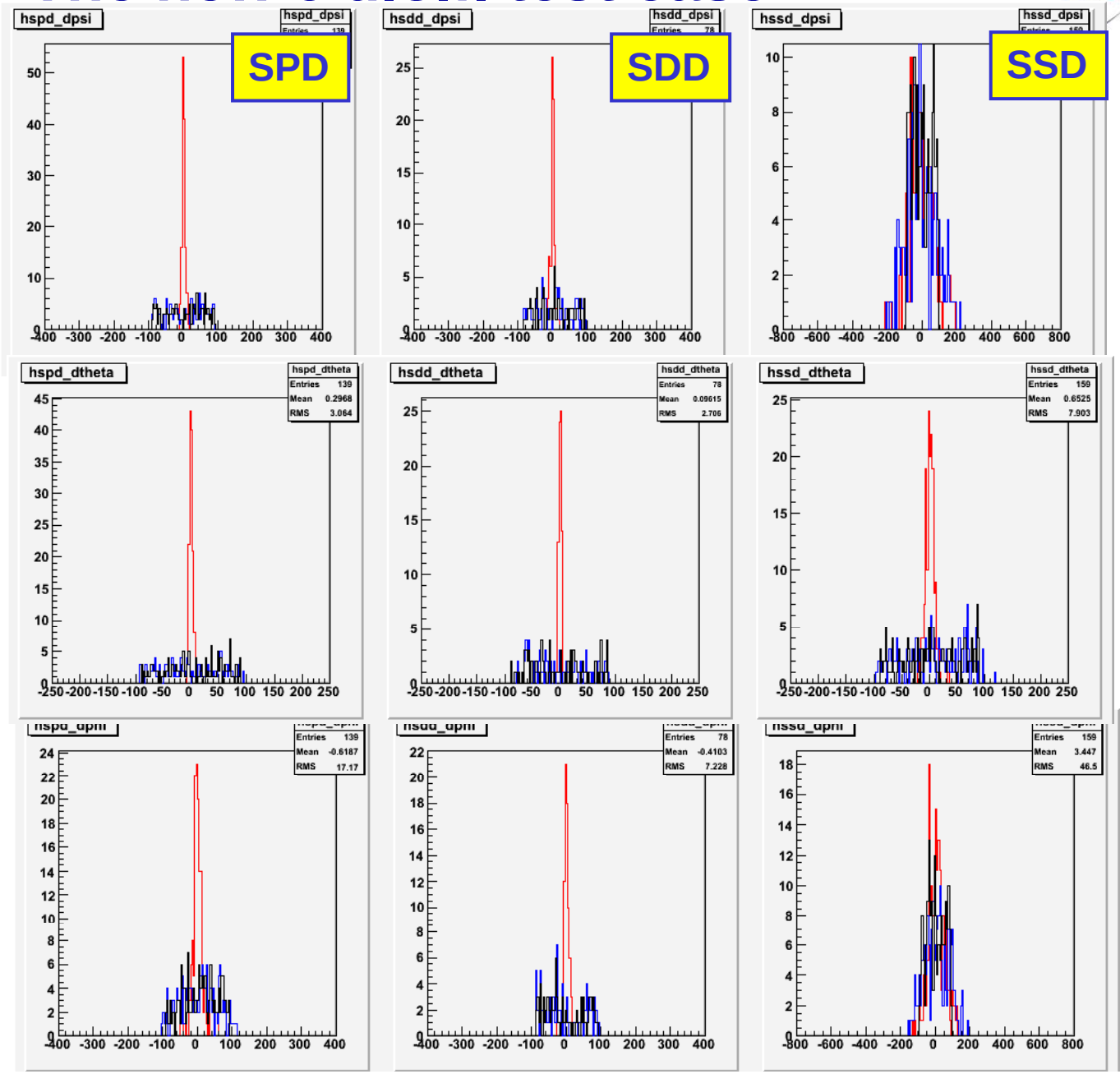


The new 6 d.o.f. test case

psi_{LOC}

$theta_{LOC}$

phi_{LOC}

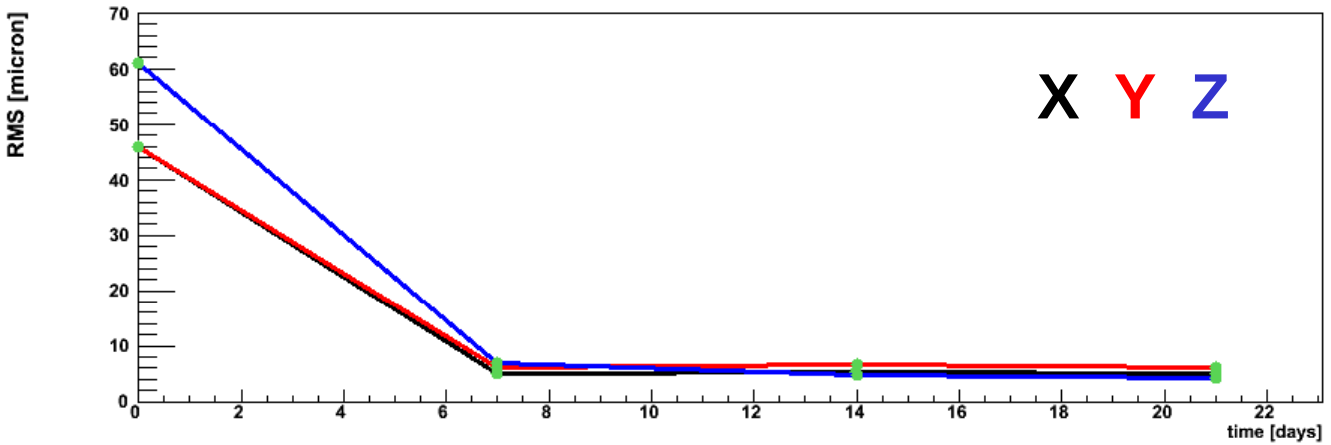


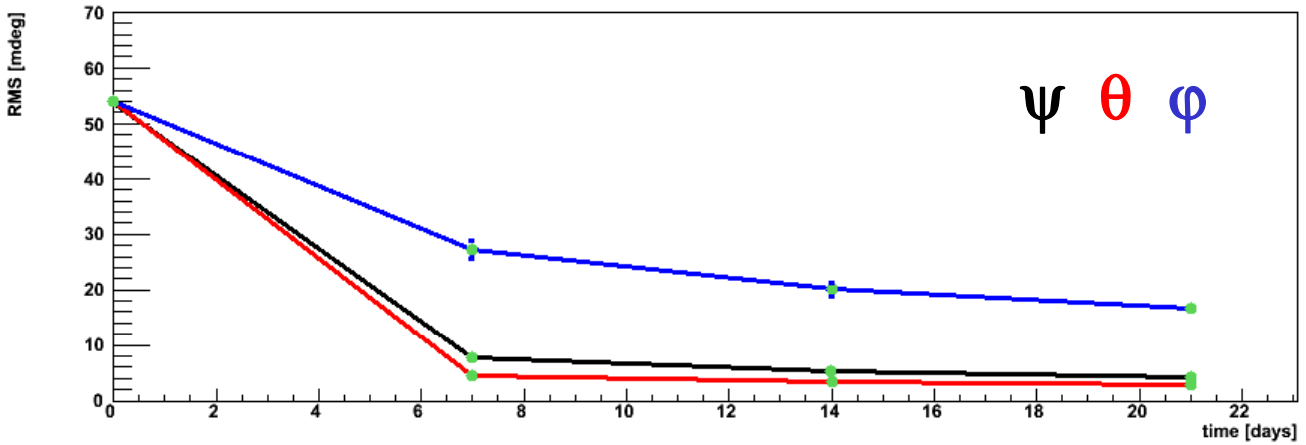
The new 6 d.o.f. test case

1) Test as a funtion of statistics

config "*test3*" : 375 modules (138 + 78 + 158)

SPD



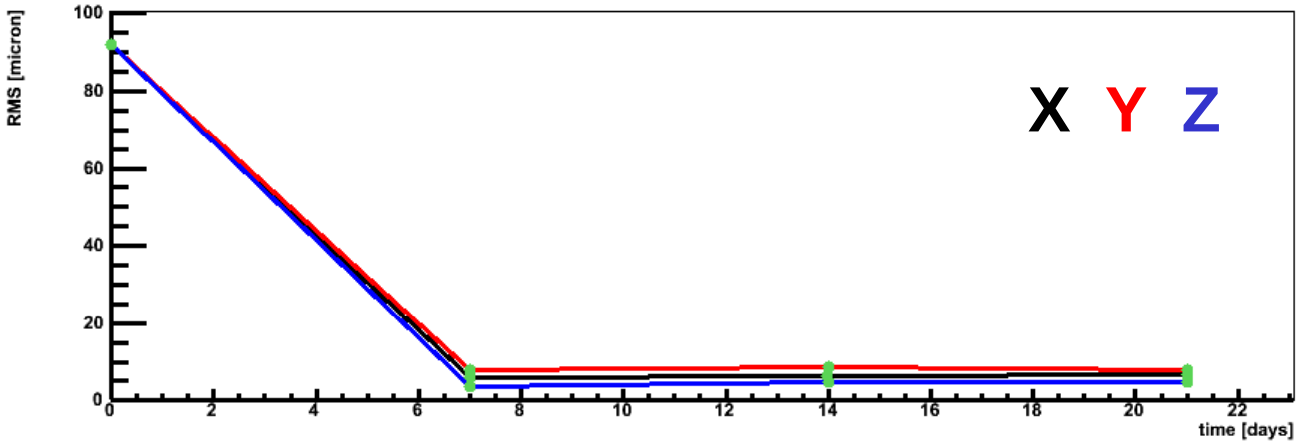


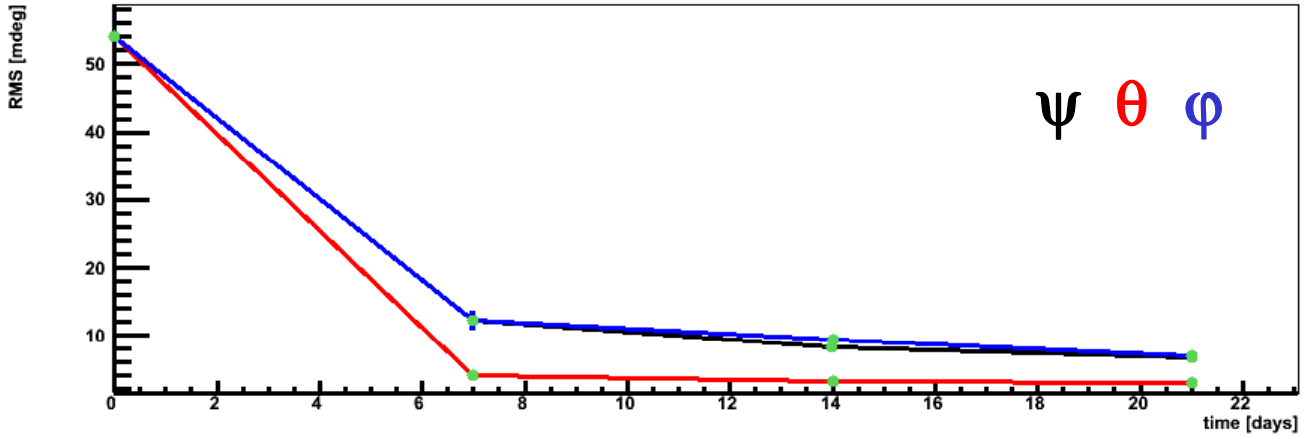
The new 6 d.o.f. test case

1) Test as a funtion of statistics

config "*test3*" : 375 modules (138 + 78 + 158)

SDD





The new 6 d.o.f. test case

1) Test as a funtion of statistics

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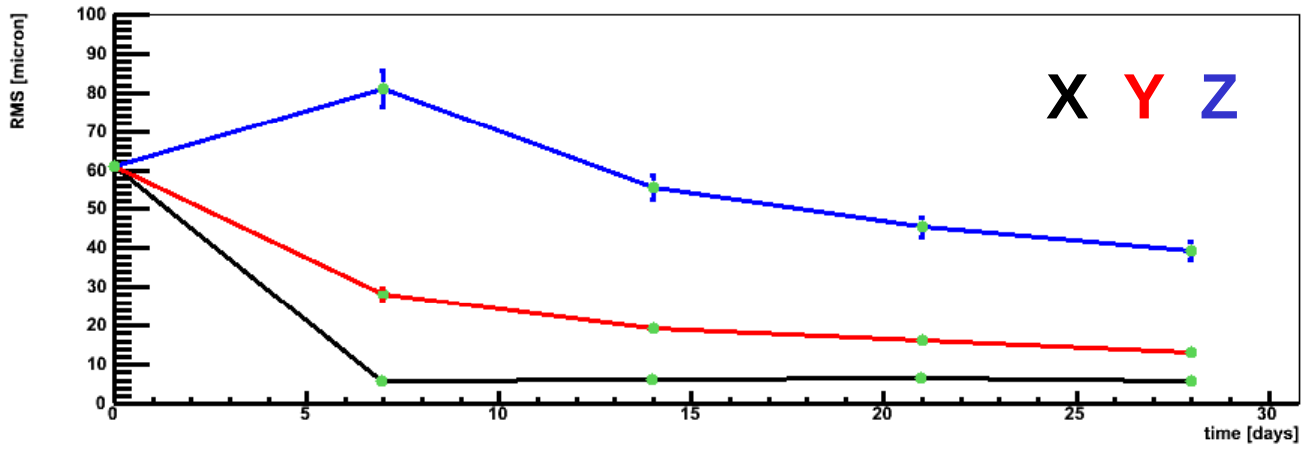
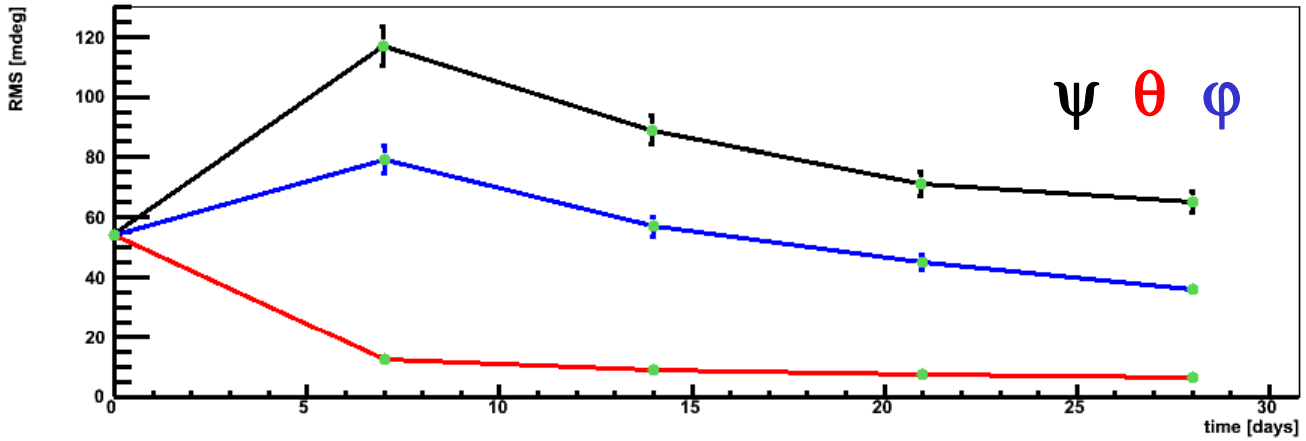


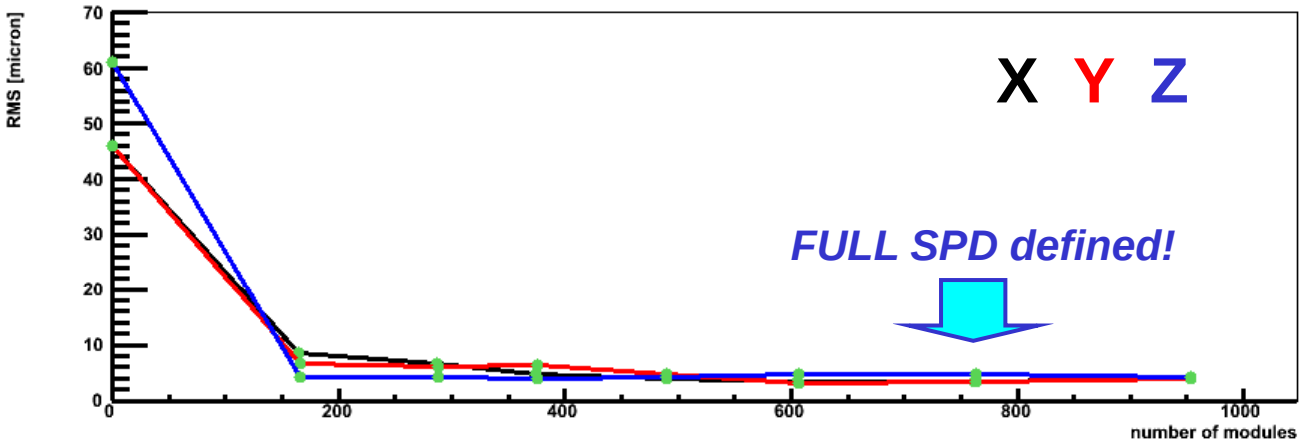


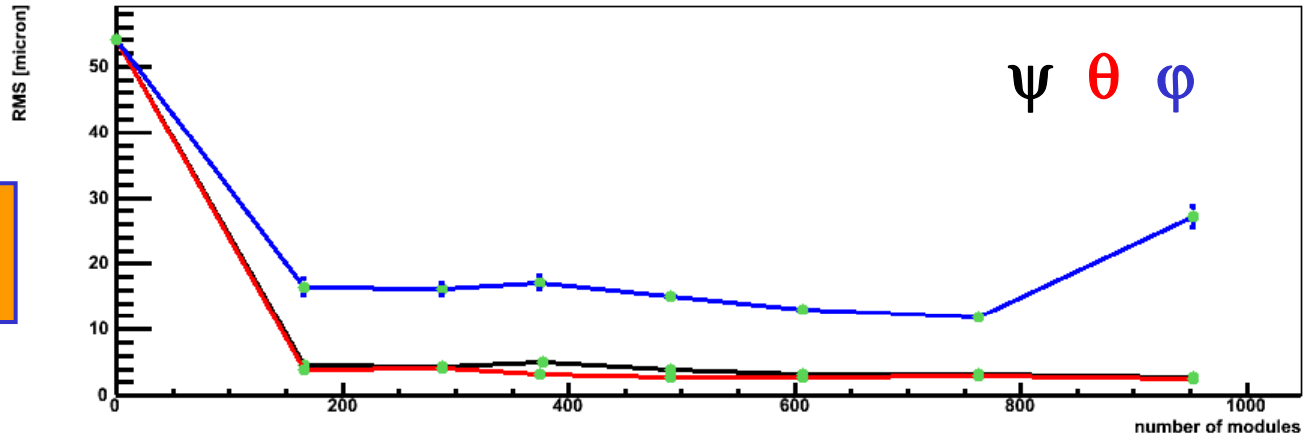
The new 6 d.o.f. test case

2) Test as a funtion of number of modules

50000 tracks crossing SPD0

PIXEL





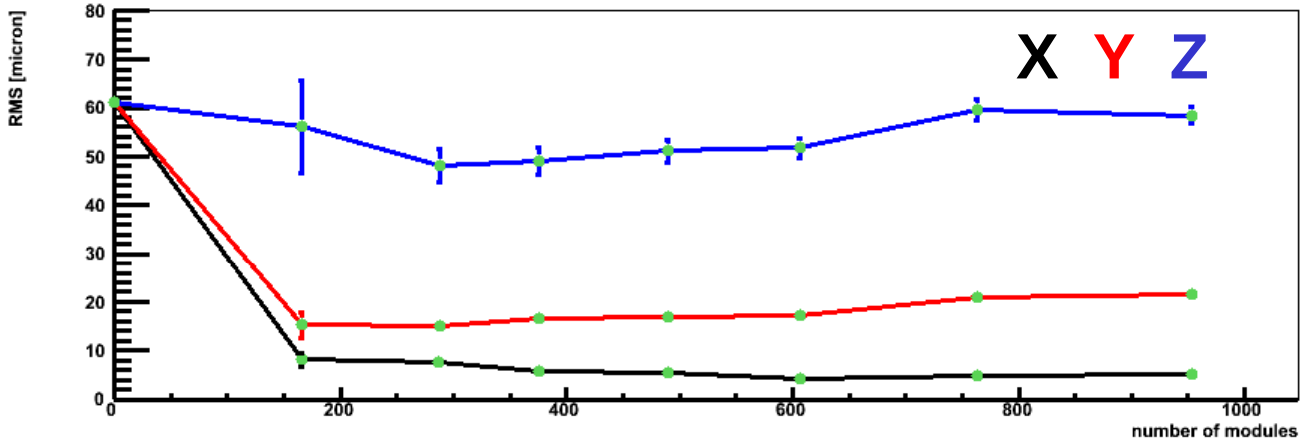
DRIFT similar to SPD

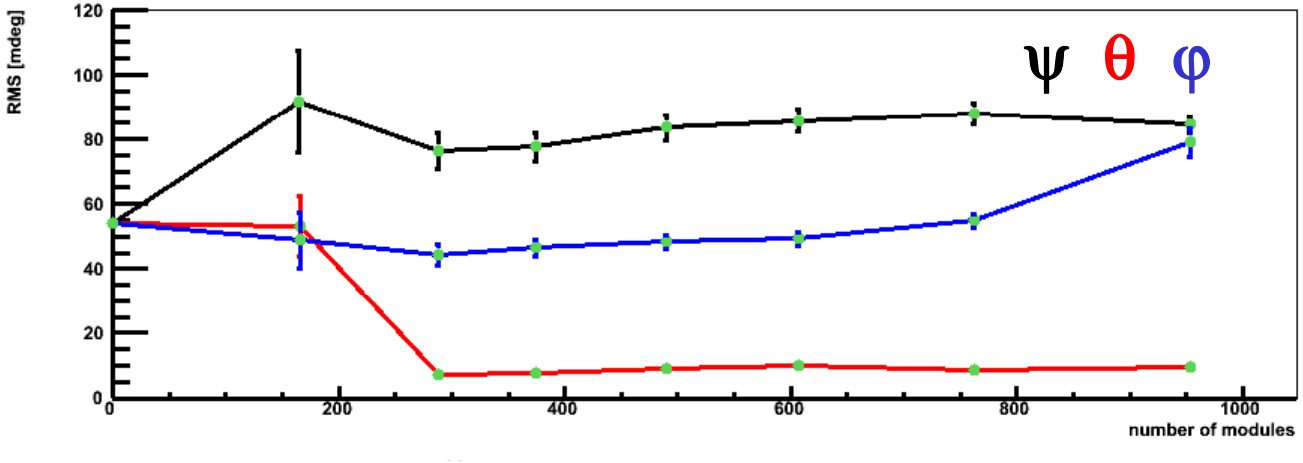
The new 6 d.o.f. test case

2) Test as a funtion of number of modules

50000 tracks crossing SPD0

STRIP



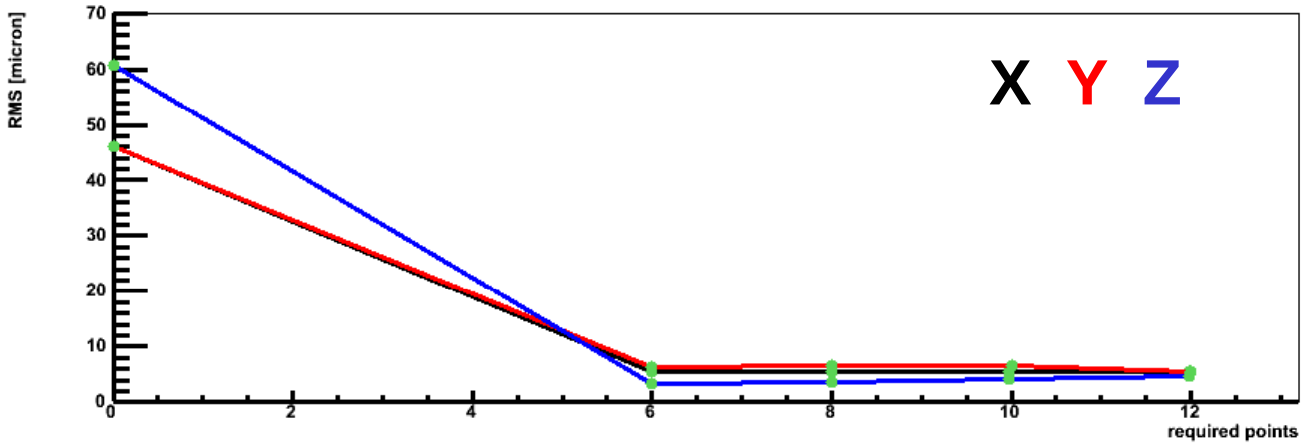


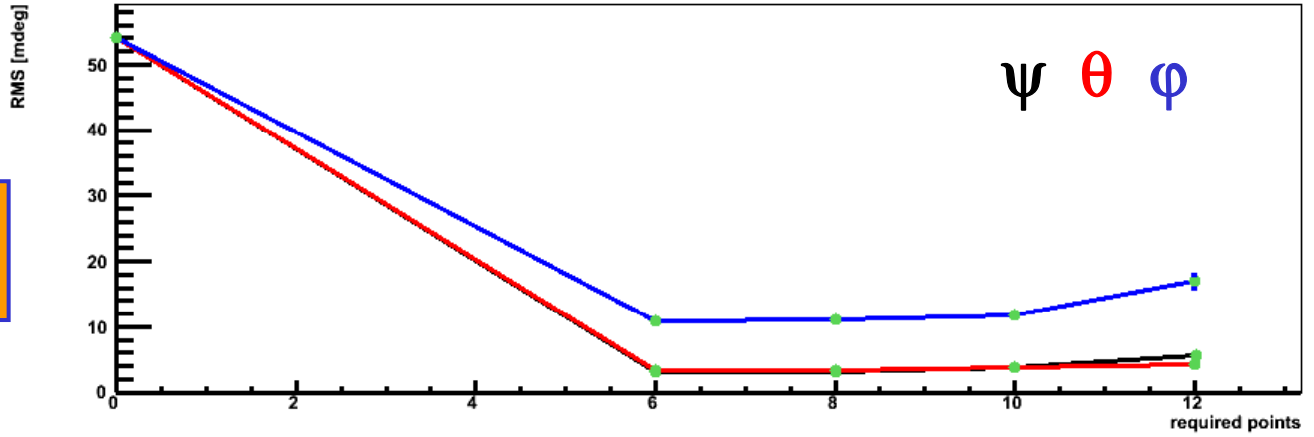
The new 6 d.o.f. test case

3) Test as a funtion of number of required layers

stat corresponding to 50000
12 pts. tracks crossing SPD0

PIXEL





DRIFT similar to SPD

The new 6 d.o.f. test case

3) Test as a funtion of number of required layers

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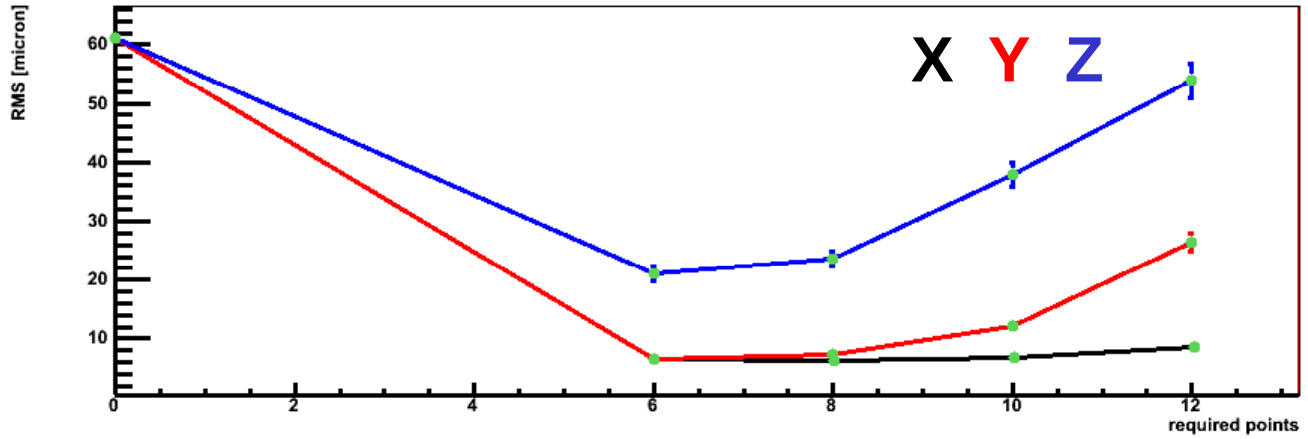
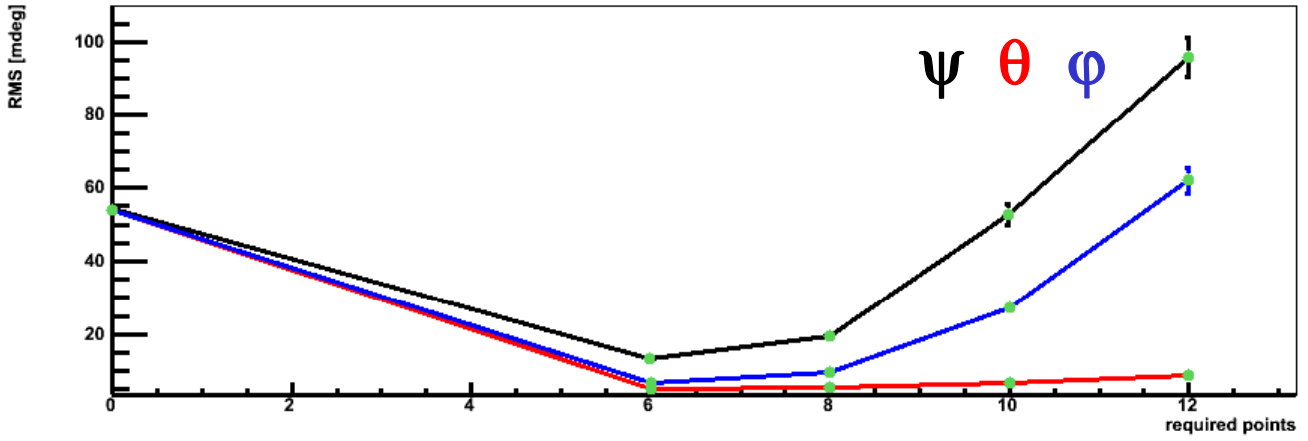
STRIP





significant improvemet!

The 6 d.o.f. test case with full simulation

if we compare full simulation Millipede results with fast simulation ones:

Coordinates	Misalignm. RMS	FAST	FULL
x	47 um	**5**	**10**
y	45 um	**6**	**22**
z	62 um	**5**	**8**
Psi	53 mdeg	**8**	**26**
theta	51 mdeg	**6**	**12**
phi	50 mdeg	**28**	**50**

54000 tracks

12 points

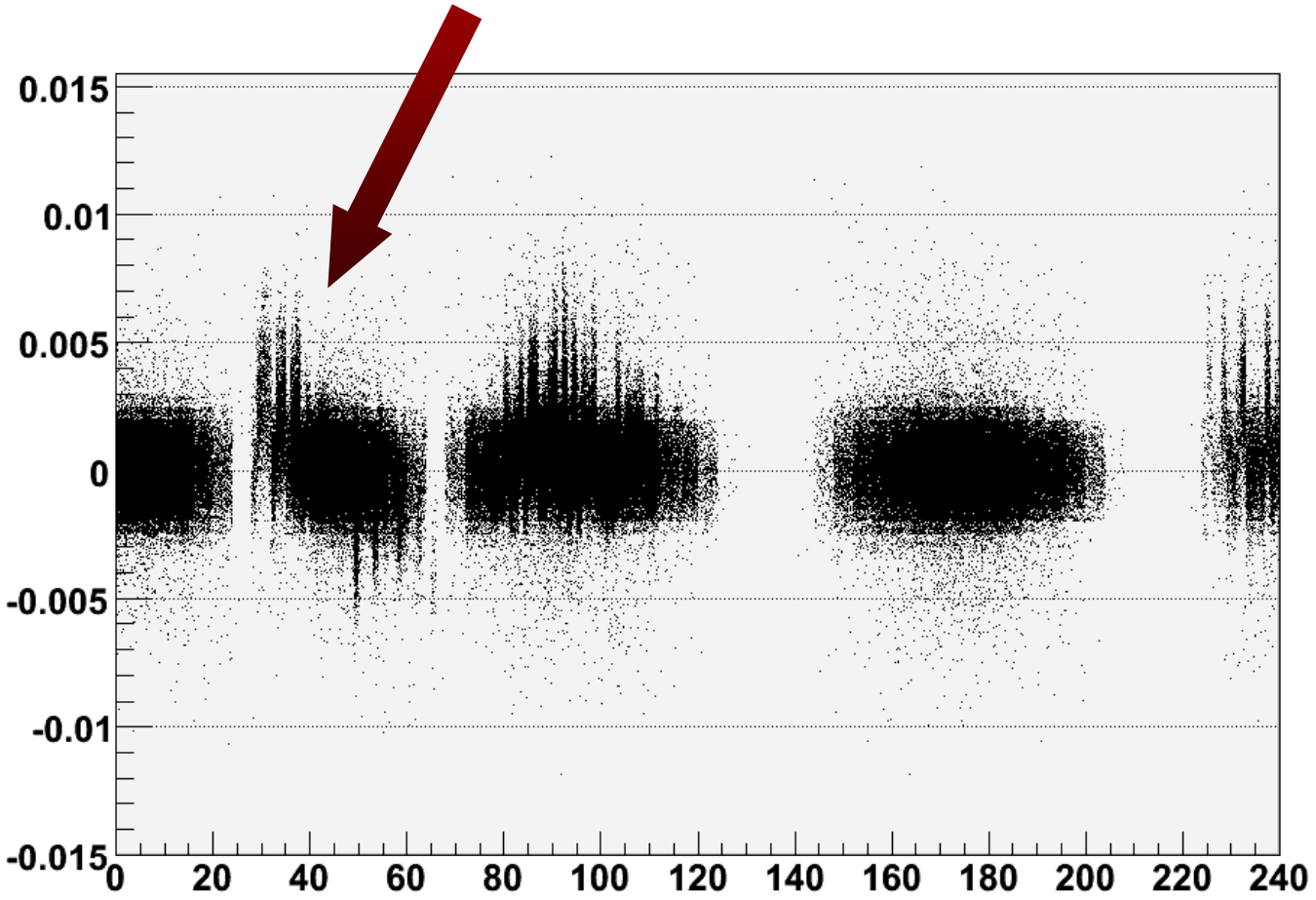
incident angle < 60^{o}

to be understood

check of residuals in full simulation (cosmic muons)

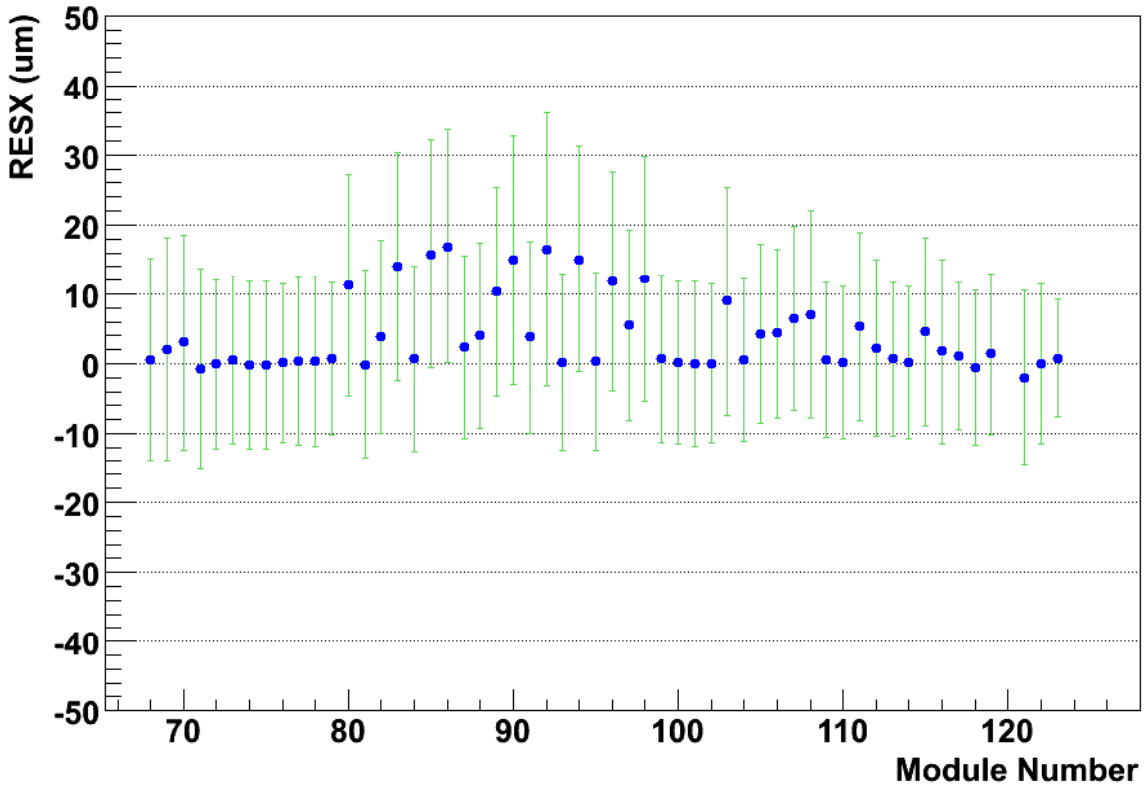
Residuals in full simulation with 6 d.o.f

observation of non-zero residual distributions in some SPD modules



Residuals in full simulation with 6 d.o.f

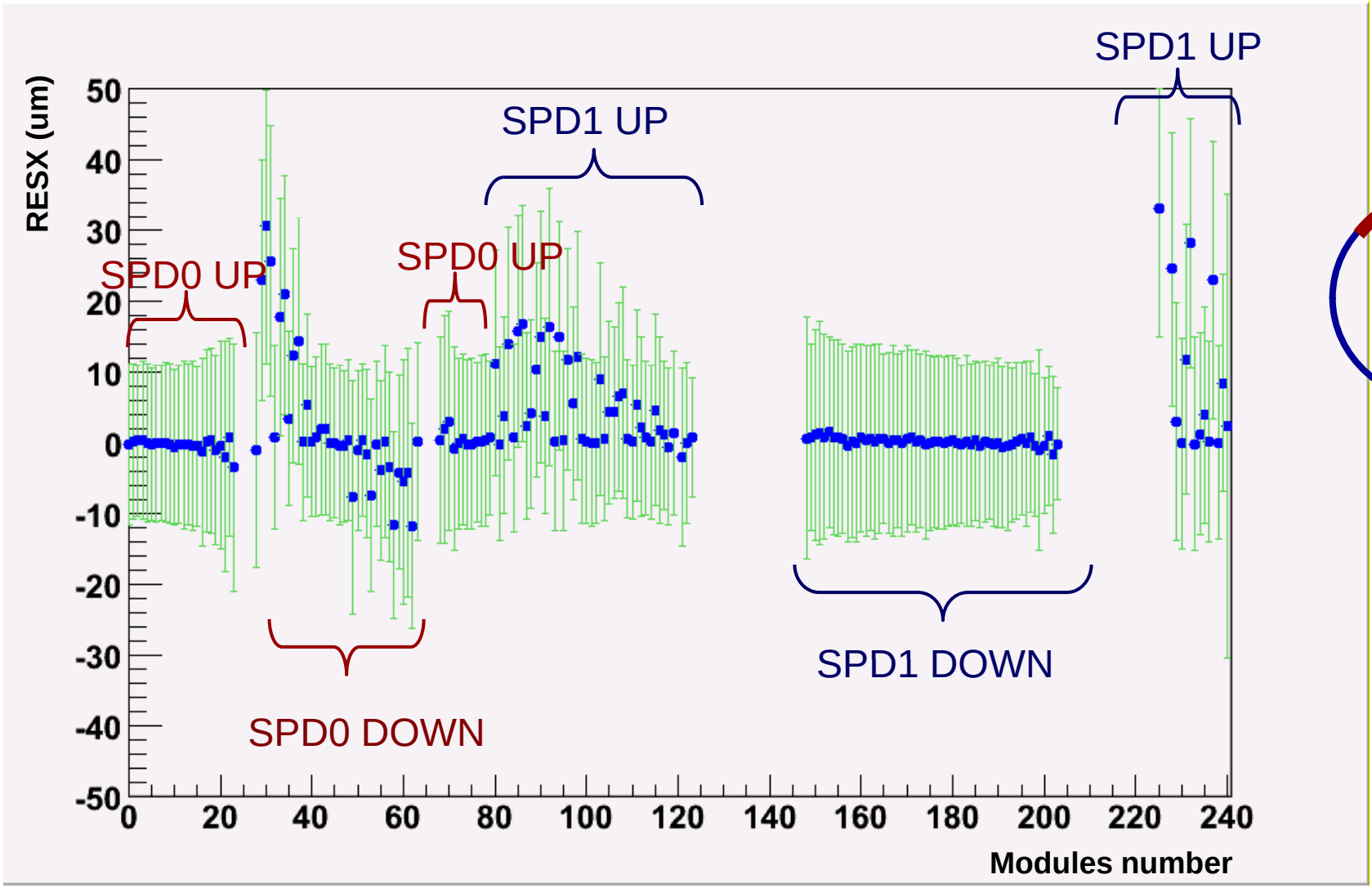
observation of non-zero residual distributions in some SPD modules

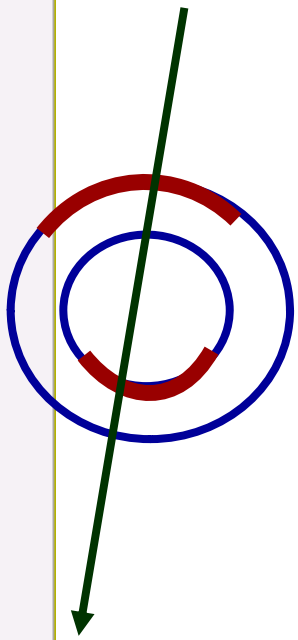


residual distribution centroids

Residuals in full simulation with 6 d.o.f

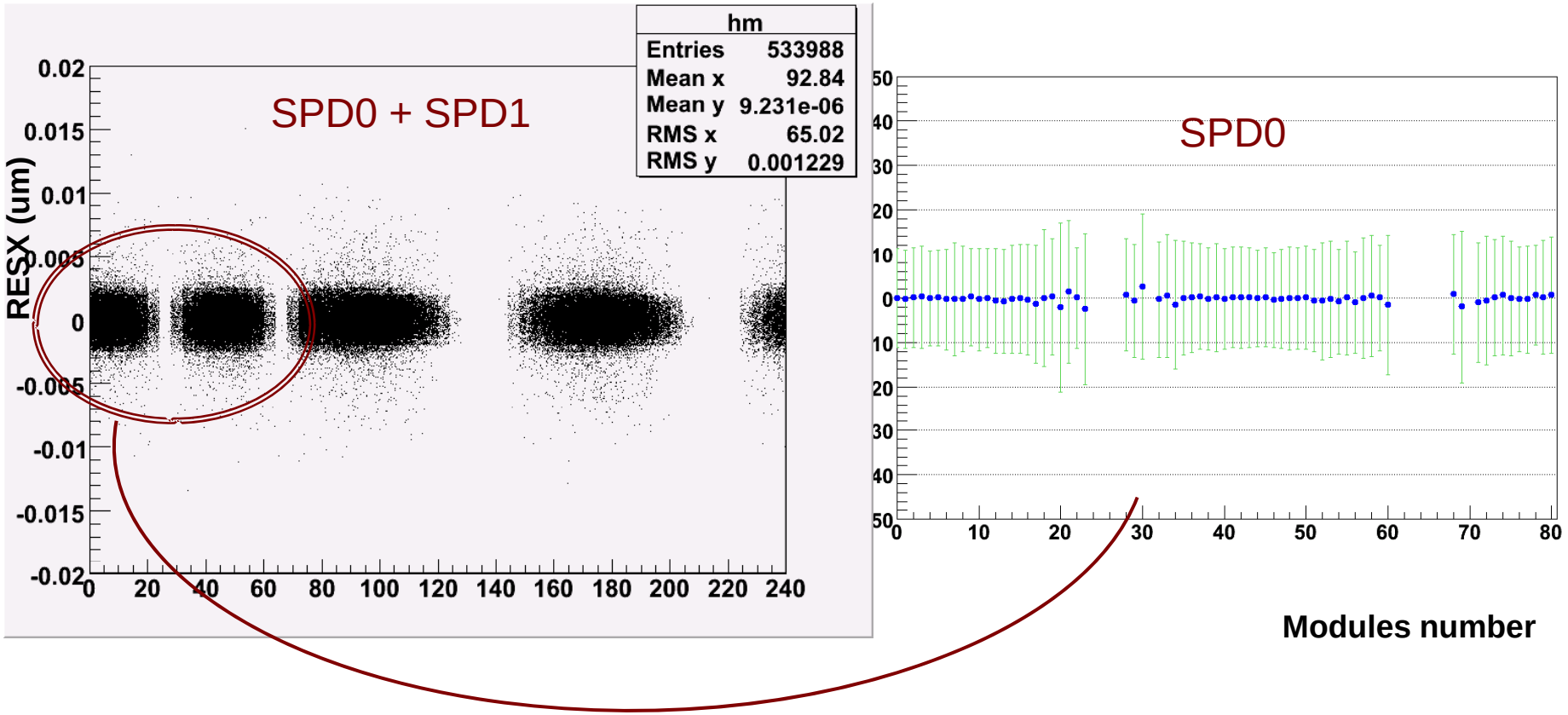
residual distributions for the whole SPD modules





Residuals in full simulation with NULL misalignment

residual distributions for the whole SPD modules



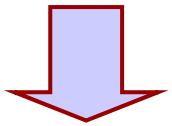
Zero residual distribution.

No strange behavior observed!

Full simulation with 6 d.o.f

Test on “strange” modules 84 and 85 (same SPD1 UP region, 84 with a shift and 85 no shift):

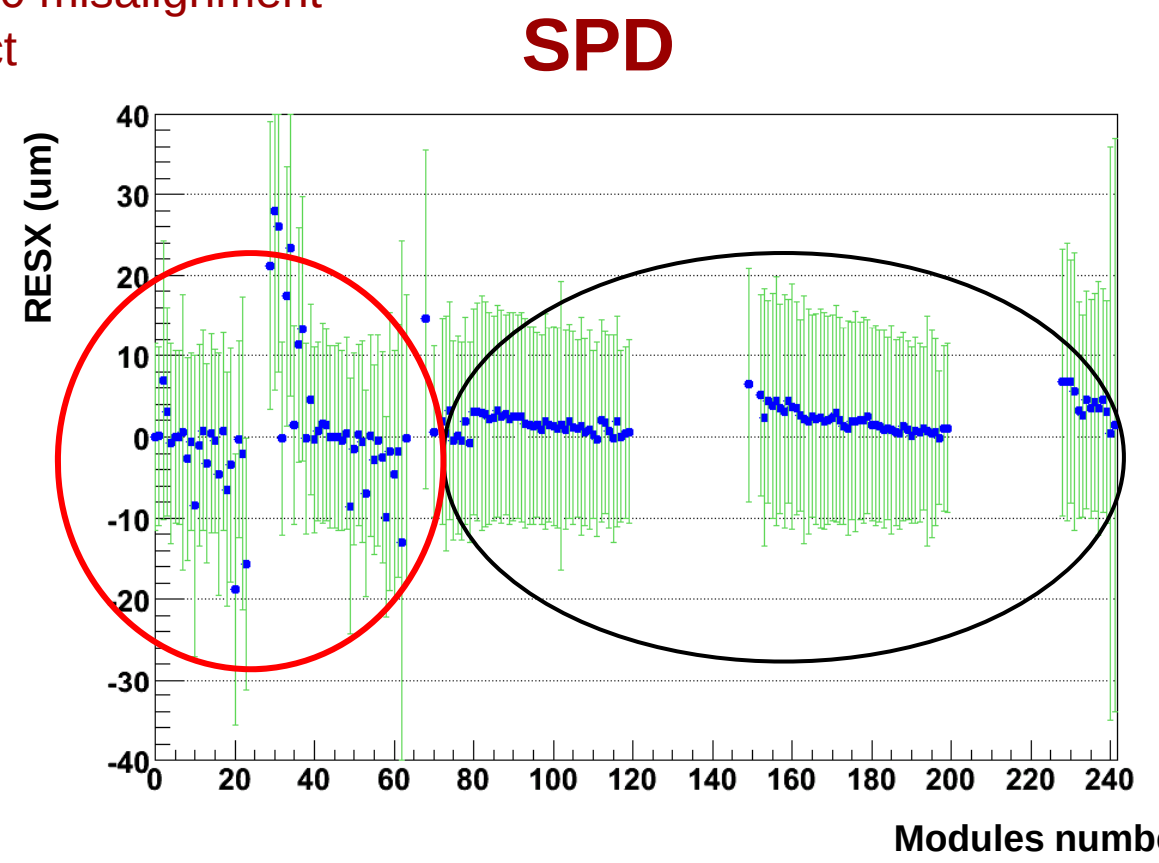
1. only rotations: no shifts
2. only translations misalignment: same behavior
   - only x translation: no shifts
   - only y translation: shift in 84 module (negative dy)
   - only z translation: no shifts



The shift is associated with Y misalignment opposite to the Yloc module axis

Test: 6 d.o.f full simulation: muons from the center Back2Back

SPD0 misalignment effect

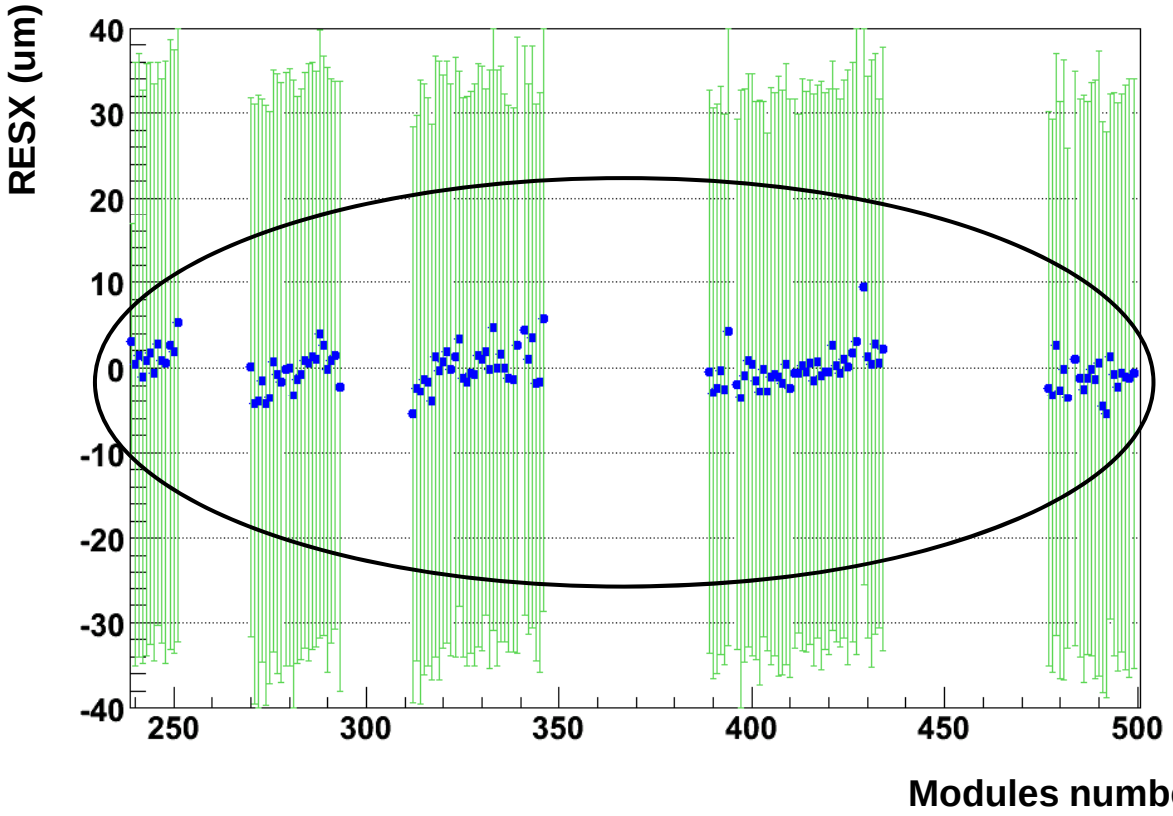


SPD1 residual effect (non random)

NOT present with NULL misalignment test!

Test with a full simulation with 6 d.o.f: muons from the center Back2Back

SDD

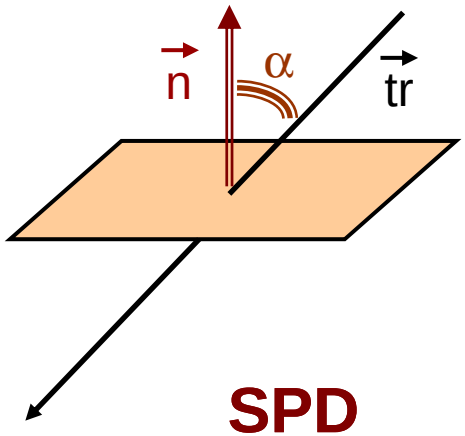


Small non random effect in SDD

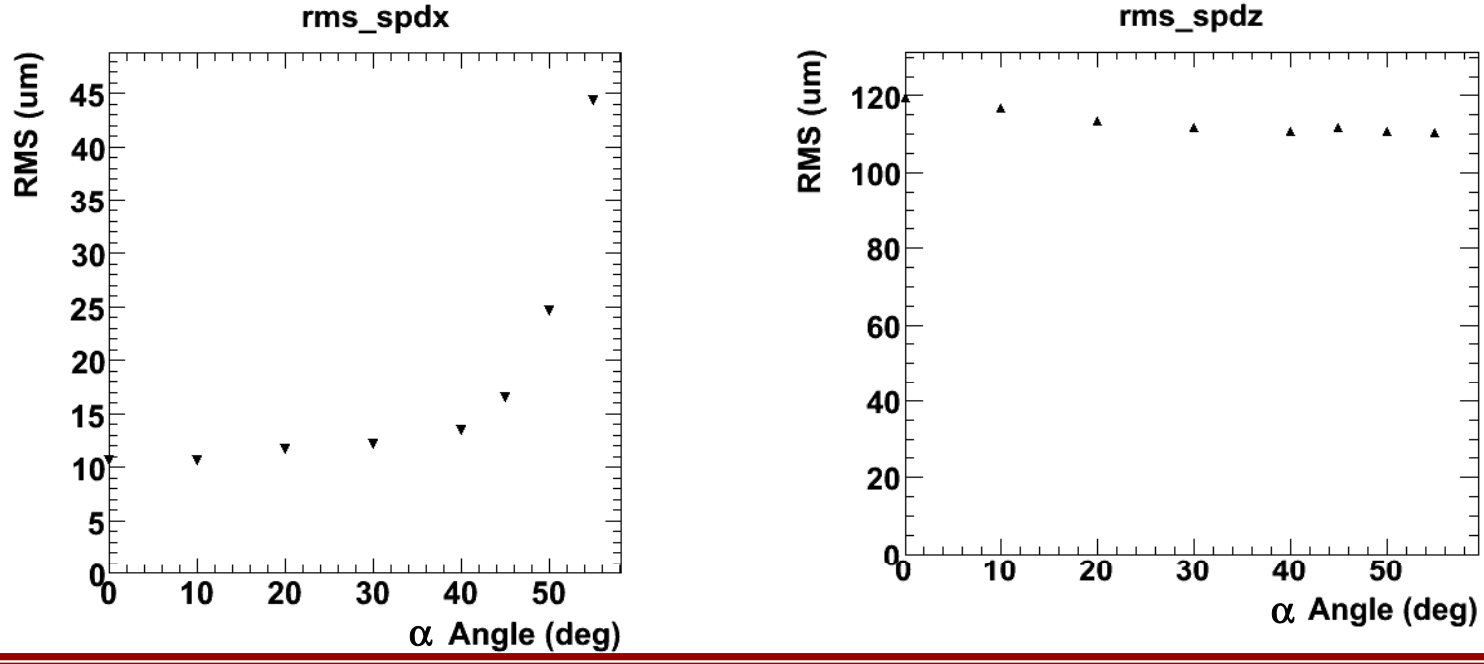
same in NULL & misall.

Test with full simulation: "Null misalignment case"

5) RMS dependencies on the track angle wrt module direction

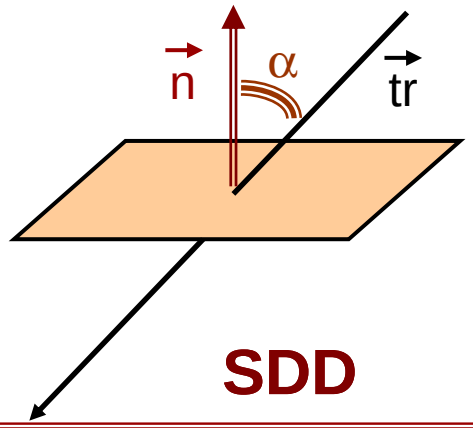


SPD



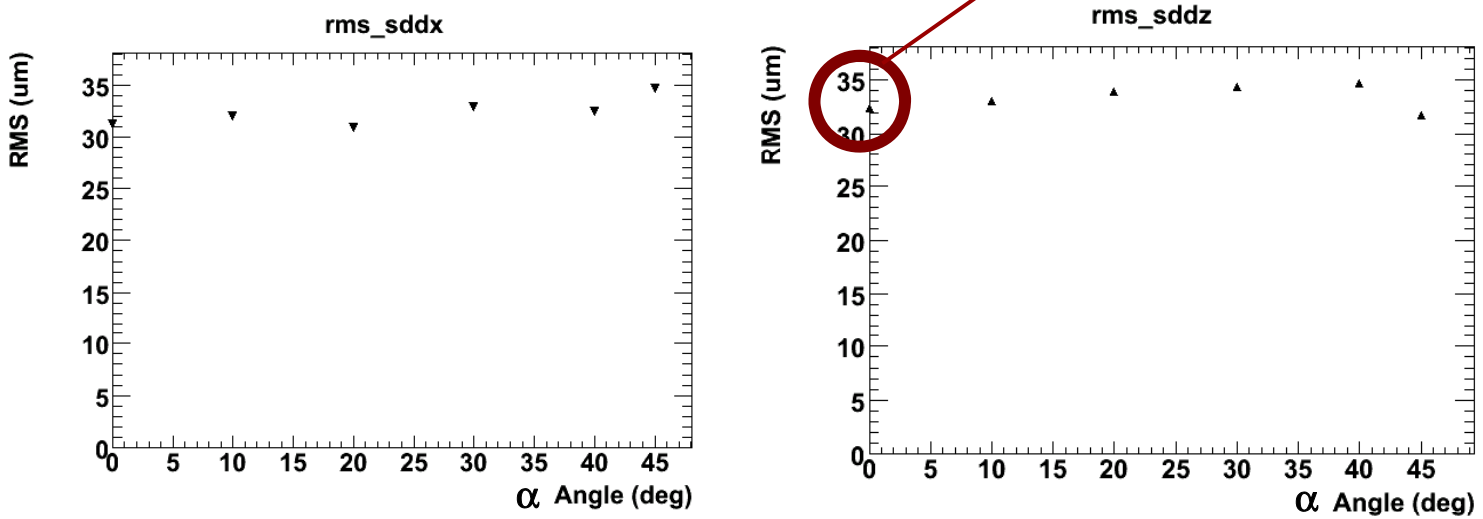
The null simulation case:

5) RMS dependencies on the track angle wrt module direction



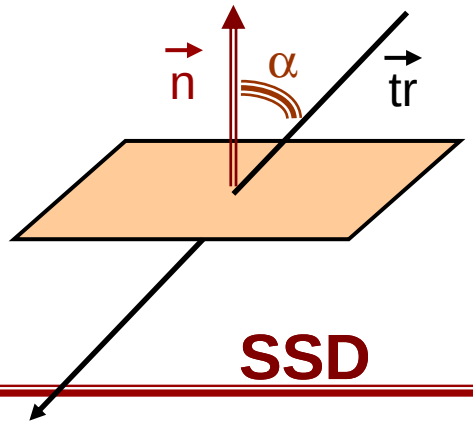
SDD

20 um in AliTrackPoints



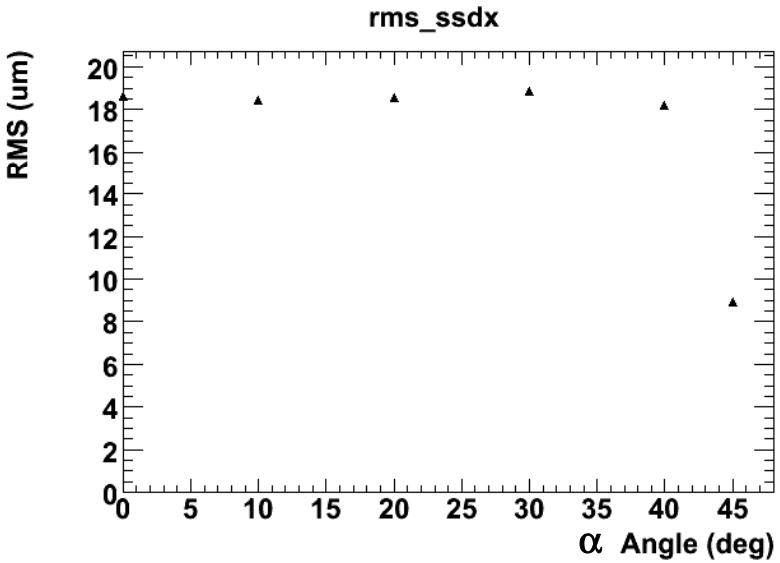
The full simulation: “null” case

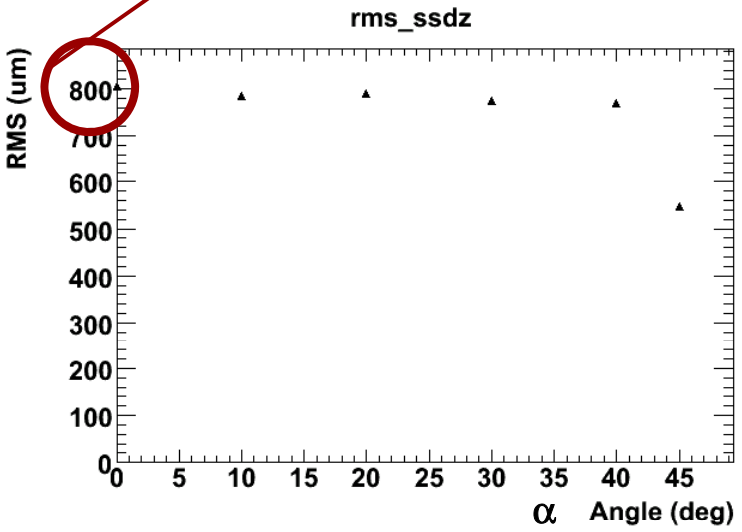
5) RMS dependencies on the track angle wrt module direction



SSD

1100 um in AliTrackPoints





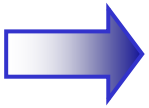
Conclusions

- Found a problem in residual distributions for the SPD with misalignment in FULL simulation.

- From analysis of residual distribution:
  - SPD: incident angle dependence of σ_x
  - SDD: σ_z = 20um
  - SSD: σ_z = 800 um
  - No explicit dependency of RMS on the number of digits in y and z direction

What Next:

- Change in the AliAlignmentTracks::ProcessESDCosmics to obtain AliTrackPoints with the correct sigmas and the points selection as a function of the incidence angle.



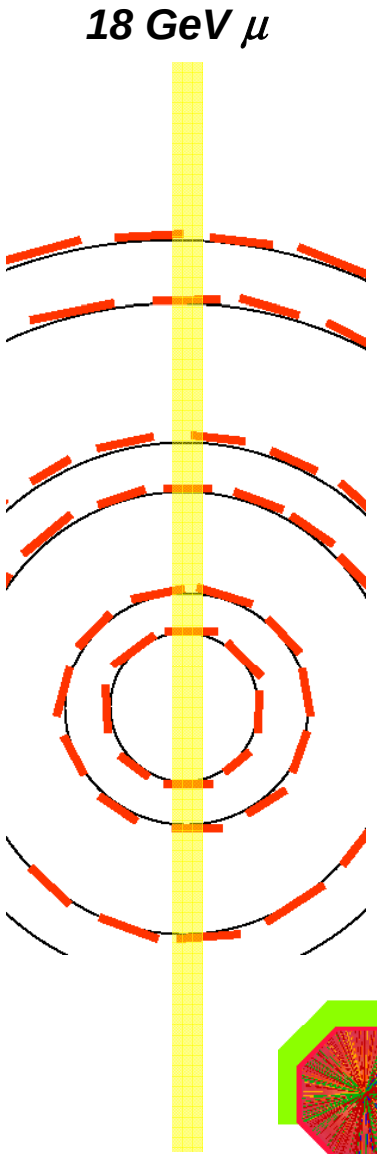
significant check with the fast simulation using exactly the same conditions!

- Millepede:
  - configuration parameters: to be invastigated
  - define optimal set of detectors to be aligned and optimal set of tracks.

The MuBeam simple test case

First Test

- standard (full) simulation of cosmic-like events
- a narrow beam of parallel 18 GeV muons along the vertical axis → 16 modules involved (4 SPD + 8 SDD + 4 SSD)
- no magnetic field (straight tracks)
- simple misalignment: only translations in the x-z local plane
- 1 fixed detector w/o misalignment (SPD #7)
- a total of 15x2 = 30 free alignment parameters



The simple MuBeam test case

MODULE IDX	LAYER	Local X-SHIFT (μm)	MILLE PARAM	Delta
7	1	0.0	0.0 ± 0.0	0.0
47	1	-20.0	-20.0 ± 0.0	0.0
95	2	-122.0	-123.0 ± 0.0	-1.0
175	2	53.0	51.0 ± 0.0	-2.0
244	3	52.0	24.0 ± 0.0	-28.0
280	3	-214.0	-184.0 ± 0.0	30.0
322	3	31.0	48.0 ± 0.0	17.0
329	3	-114.0	-141.0 ± 0.0	-27.0
409	4	120.0	145.0 ± 0.0	25.0
417	4	-19.0	-46.0 ± 0.0	-27.0
497	4	-108.0	-84.0 ± 0.0	24.0
513	5	-17.0	-19.0 ± 0.0	-2.0
887	5	-146.0	-148.0± 0.0	-2.0
1687	6	56.0	53.0 ± 0.0	-3.0
2162	6	-52.0	-56.0 ± 0.0	-4.0

A lot of tracks!

The simple MuBeam test case

Why this SDD bad result?

- Problem with SDD clustering

  - solved later

- Problem with cluster uncertainties:

  - in AliTrackPointArray from reco:
    fixed nominal values

	SPD	SDD	SSD
X_{LOC}	14	30	25

PRELIMINARY! (low stat)

- from residuals (cluster-hit) :

	SPD	SDD	SSD
X_{LOC}	11-20	30-60	15-70

- from tracking : again different (see Andrea's plots)