

Progresses in ITS Realignment with AliAlignmentTracks

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in collaboration with A. Dainese (INFN Legnaro)

thanks to Sandra and Marcello

Layout

- Toy Realignment test for AliTrackResidualFast minimizer
- Results for modules realignment with AliTrackResidualFast
 - $B=0.5$ T, misaligning only the module to be realigned
 - $B=0$, misaligning all volumes
 - Compare results with a “Fast Simulation”
- Time
- Open Problems
- Conclusions

Toy Realignment test for Res. Fast minimizer

Many problems in the case all the layers are misaligned

-> want to **test the Minimizer algorithm** with

- cosmic track “topologies”
- ITS resolution and (expected) misal. values

without the possible influence of

- fitter
- geometry

Procedure:

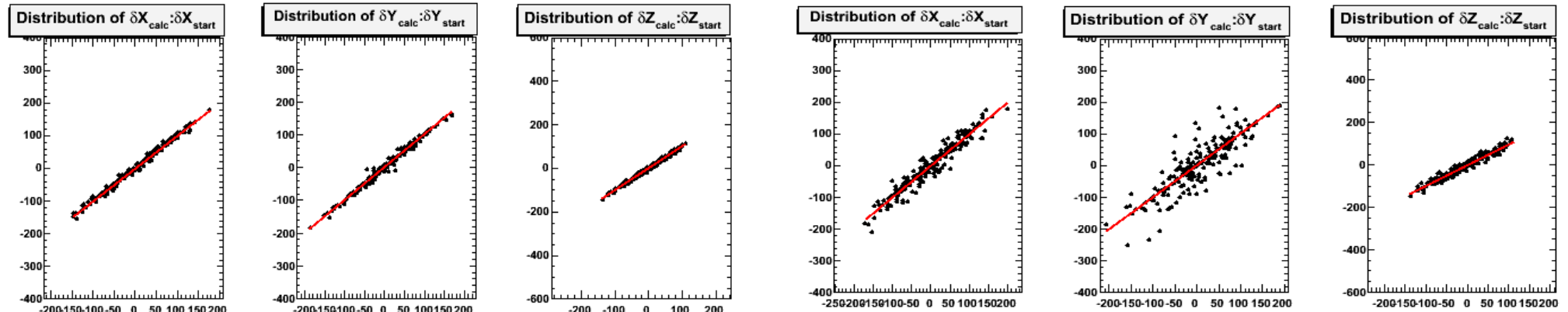
- 1- Generate a misalignment and a module position in space (ITS like)
 - 2- Generate (randomly but with cosmic-like distribution) a straight line and an intersection point inside a given module dimension
 - 3- Calculate the cluster position and then smear the clstr and the intersect. point independently
 - 4- Construct the 2 AliTrackPoint (cluster cov. matrix as is needed by ResFast)
- between step 1 and 2 simulate module inclination rotating cosmic track direction

Progress in ITSRealignment with AliAlignmentTracks - Andrea Rossi (Univ.Trieste)

Toy Realignment test for Res. Fast minimizer

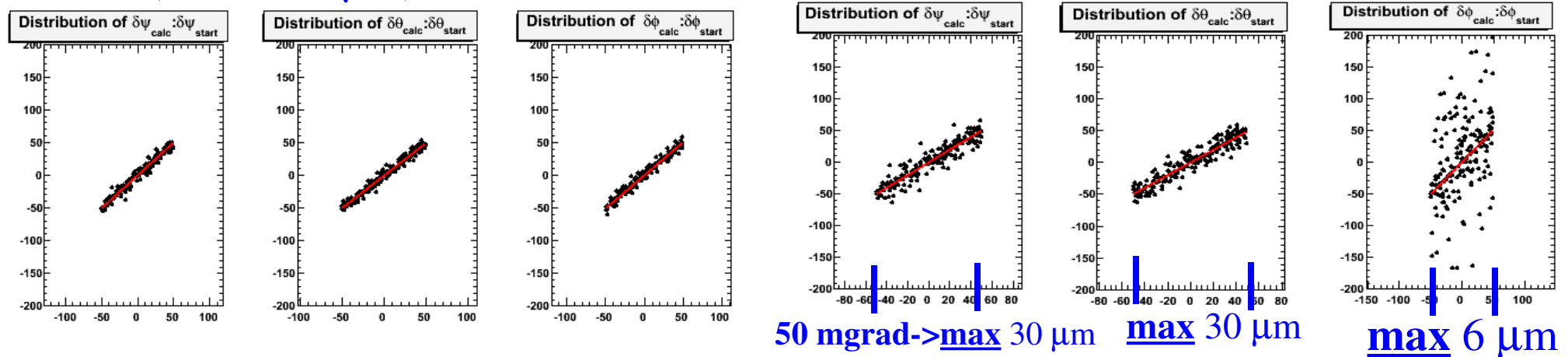
Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



small fit(30x,100z μm) error, Ideal module

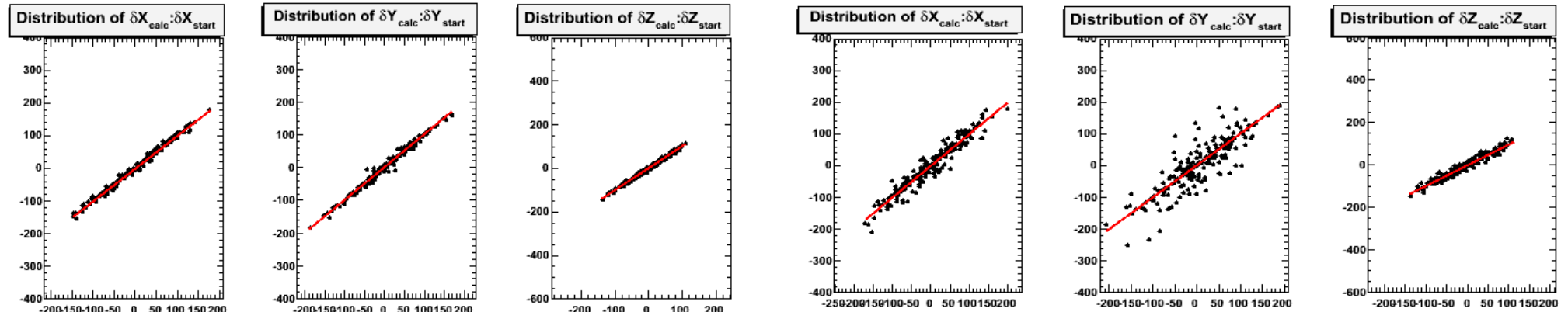
big (100 x,300 z) fit error, SPD1like



Toy Realignment test for Res. Fast minimizer

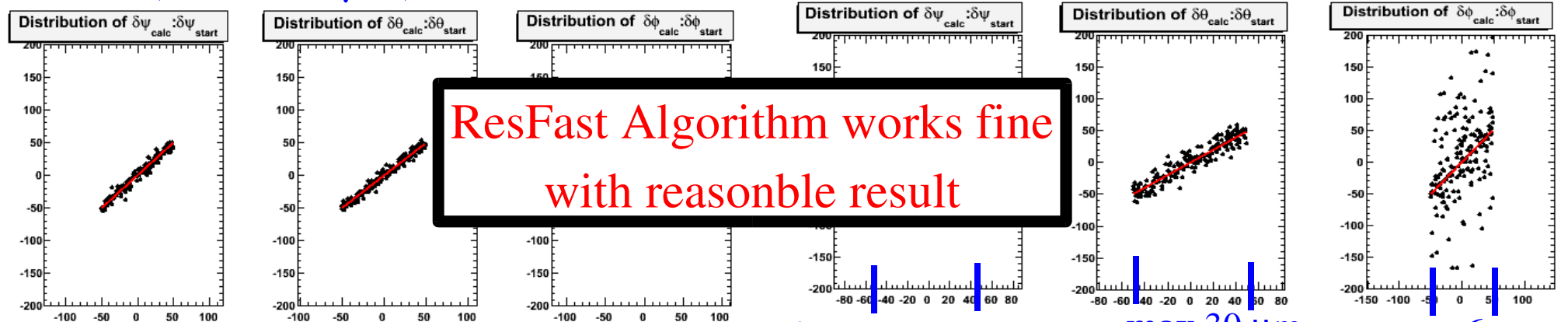
Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



small fit(30x,100z μm) error, Ideal module

big (100 x,300 z) fit error, SPD1like



ResFast Algorithm works fine
with reasonable result

50 mgrad \rightarrow max 30 μm max 30 μm

max 6 μm

Single Layer Misalignment (Uniform), $B=0.5T$
Fake Misalignment

“Uniform” Misalignment on single Layer

Many problems in the case all the layers are misaligned

- Consider a simpler case to clarify the situation:
 - misalign only the modules to be realigned (-> reduce errors due to fit)
 - consider **large misalignments** value with a **uniform distribution** (not gaussian!) so that original values are not centered around 0
- ✓ ~ 50000 tracks (~ 5 weeks data taking)

Misal. Values (local coord., micron and mgrad)

SPD: Tx, Ty: (-100,100) Tz (-120,120) Angles (-90,90)

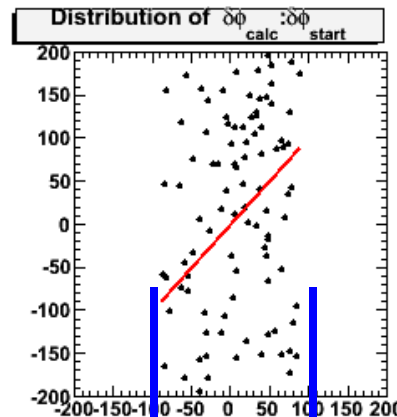
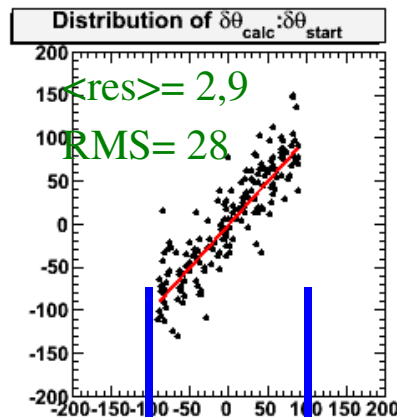
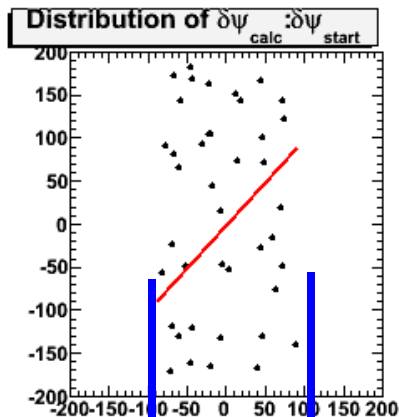
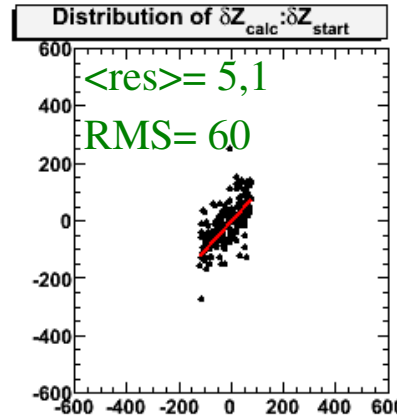
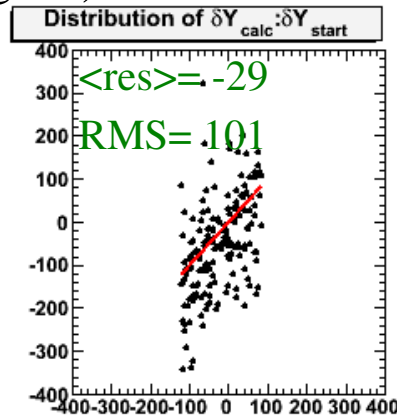
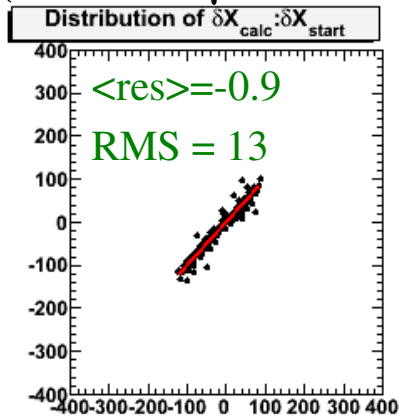
SDD: Tx, Ty: (-180,180) Tz (-180,180) Angles (-90,90)

SPD: Tx, Ty: (-120,120) Tz (-120,120) Angles (-90,90)

AliTrackResidualFast, SSD1

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 35 μm max 65 μm max 65 μm

B=0.5 T

Fake UniformMisal. on SSD1 only
(No misal on other layer)

- X, Z, θ better
- Y, ψ , ϕ worse

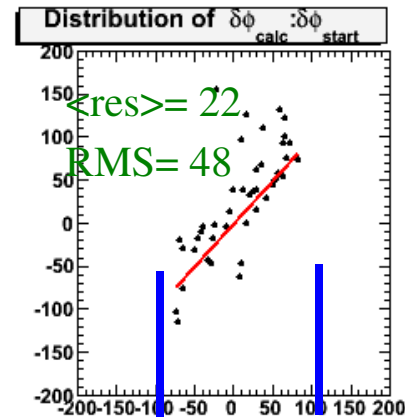
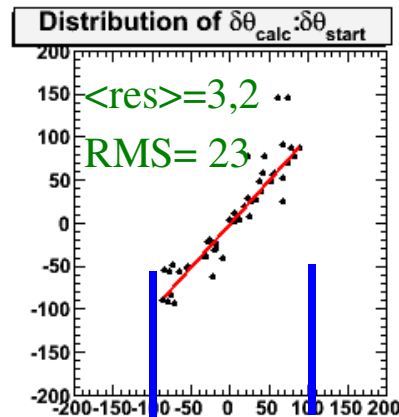
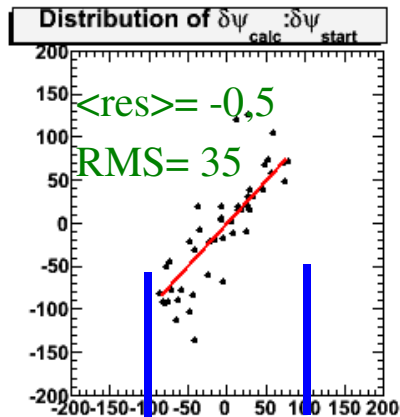
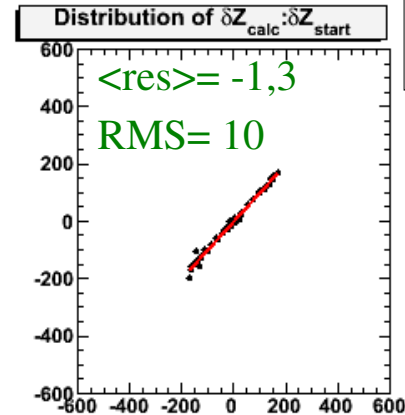
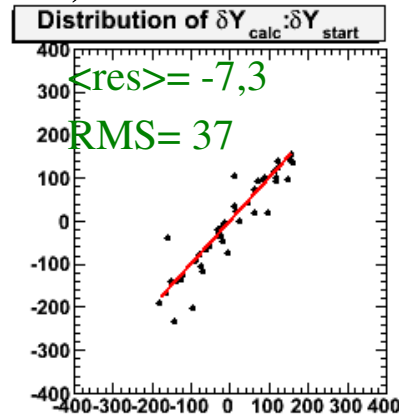
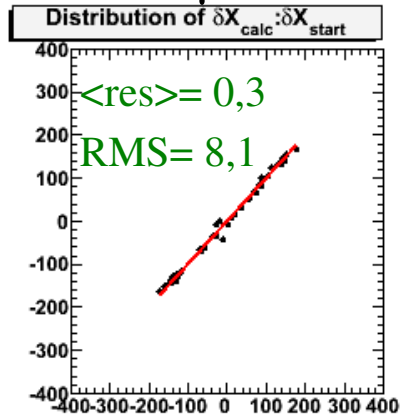
Possible explanation:

- not sensitive to misalignment along tracks direction
- Triggering on SPD1
- \rightarrow almost radial tracks for SSD
 - \rightarrow global y (\sim c.trk direction)
 - \sim local y

AliTrackResidualFast, SDD1

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 $\text{mgrad} \rightarrow$ max 65 μm

max 66 μm

max 65 μm

B=0.5 T
Fake UniformMisal. on SDD1 only
(No misal on other layer)

- results seem quite good
- ψ, ϕ better than other layers

Possible explanation:

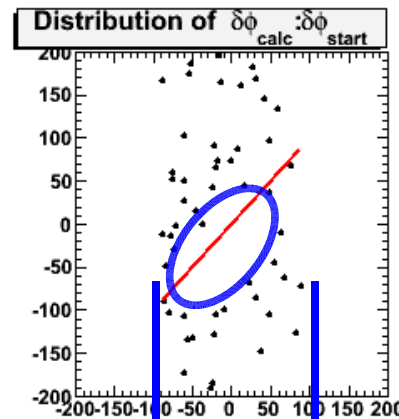
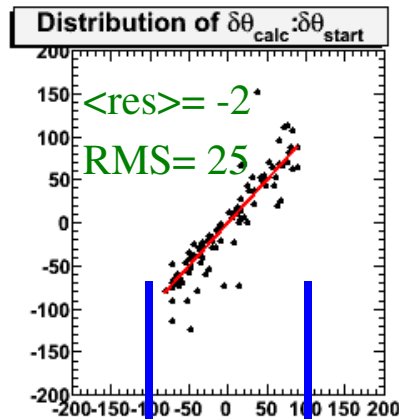
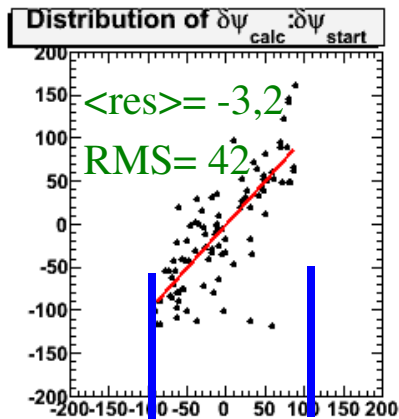
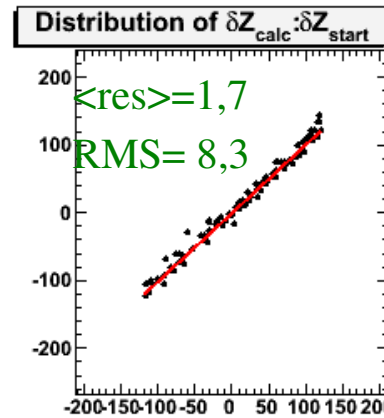
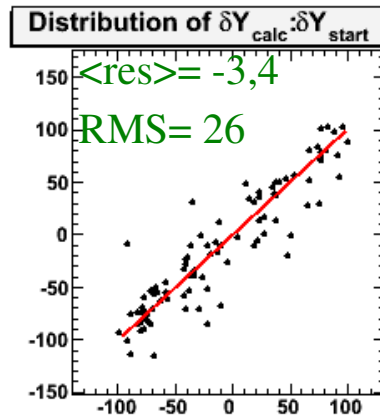
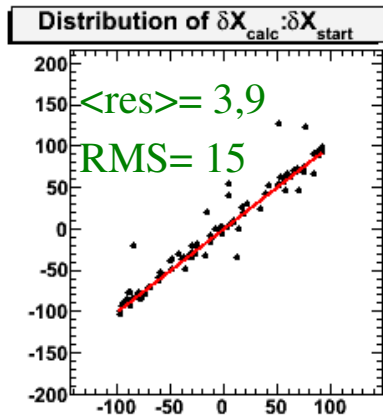
SDD modules are:

- larger
- \sim square
- in the “middle”
- \rightarrow sensitive to all angles
- \rightarrow less sensitive to fit deviation

AliTrackResidualFast, SPD2

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 61 μm max 61 μm

max 11 μm

B=0.5 T

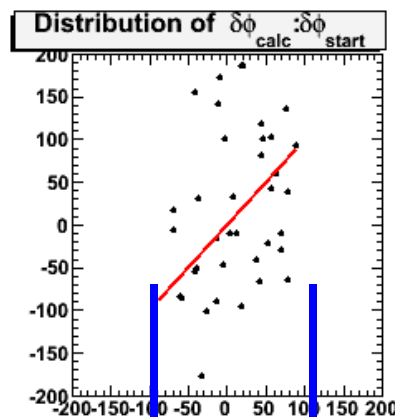
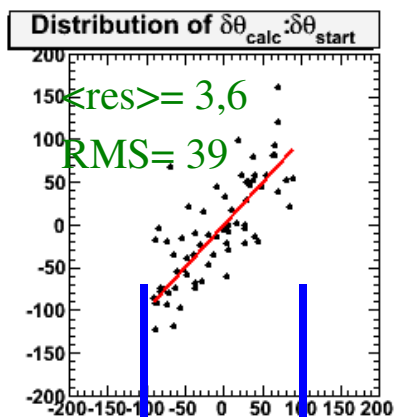
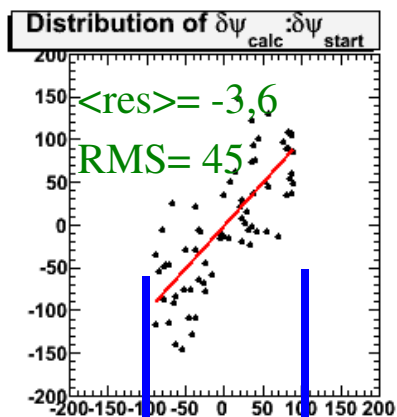
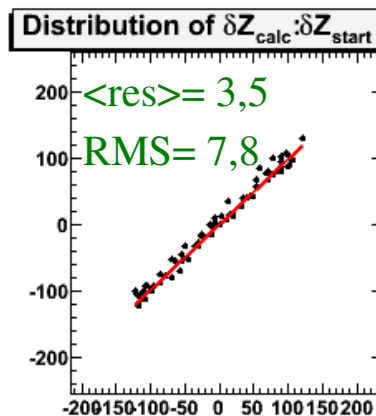
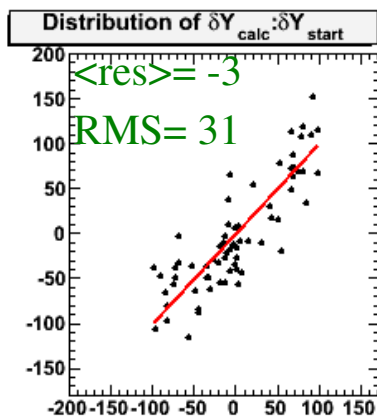
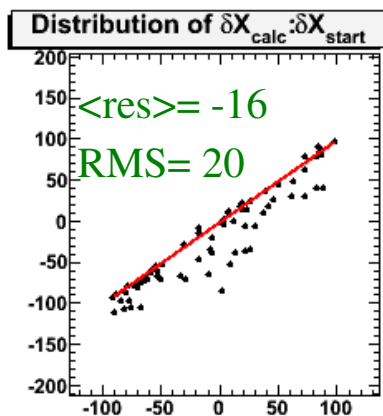
Fake UniformMisal. on SPD2 only
(No misal on other layer)

- X,Z, θ better
- ϕ problematic (but small influence)

AliTrackResidualFast, SPD1

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 61 μm max 61 μm max 11 μm

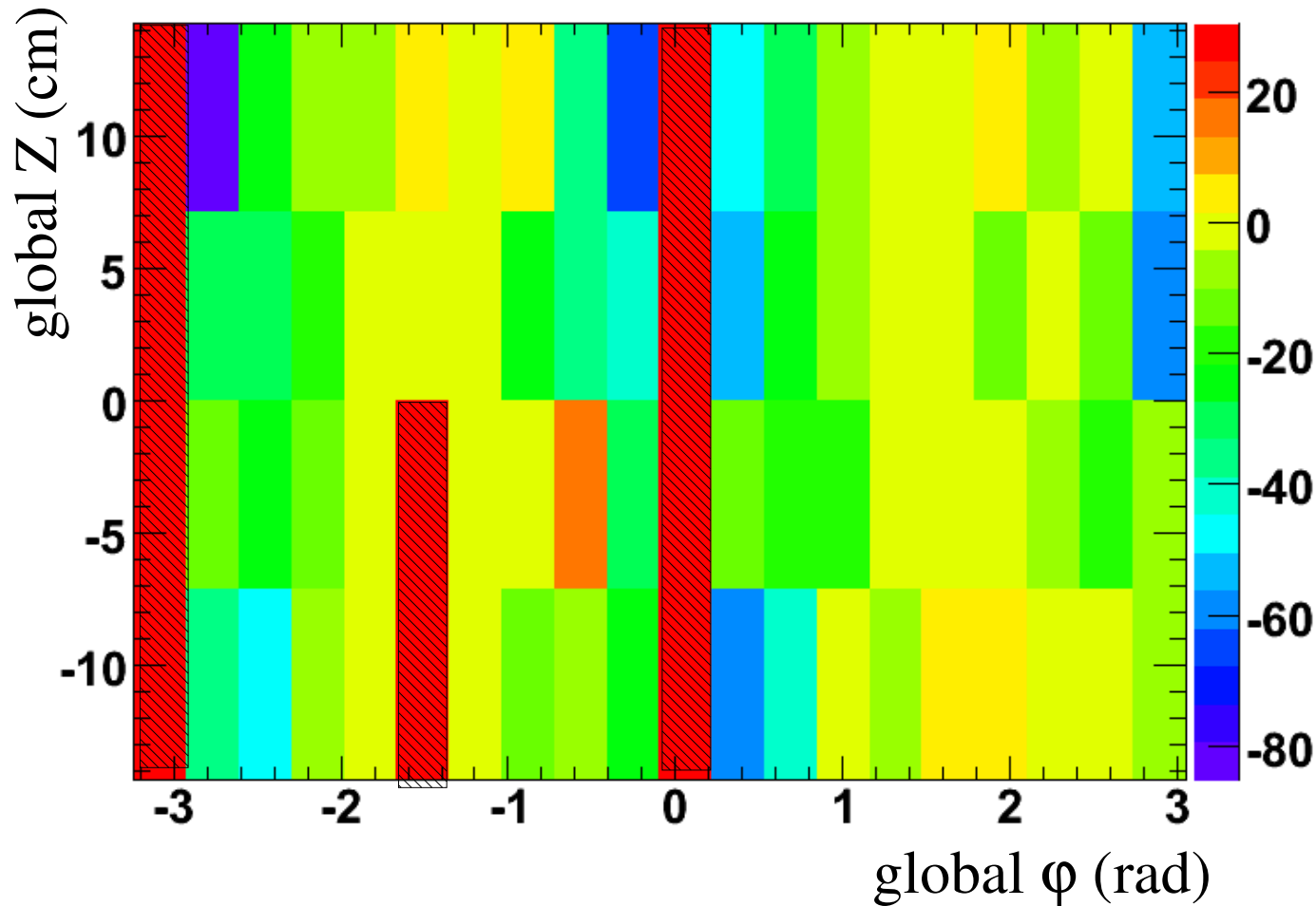
B=0.5 T
 Fake UniformMisal. on SPD1 only
 (No misal on other layer)

- **x underestimated**
- ϕ problematic (but small influence)
- z good
- ϕ, θ not so bad but worsen than SPD2

↑
 SPD1 more sensitive to fit deviation

AliTrackResidualFast, SPD1

δT_x calculated – δT_x true

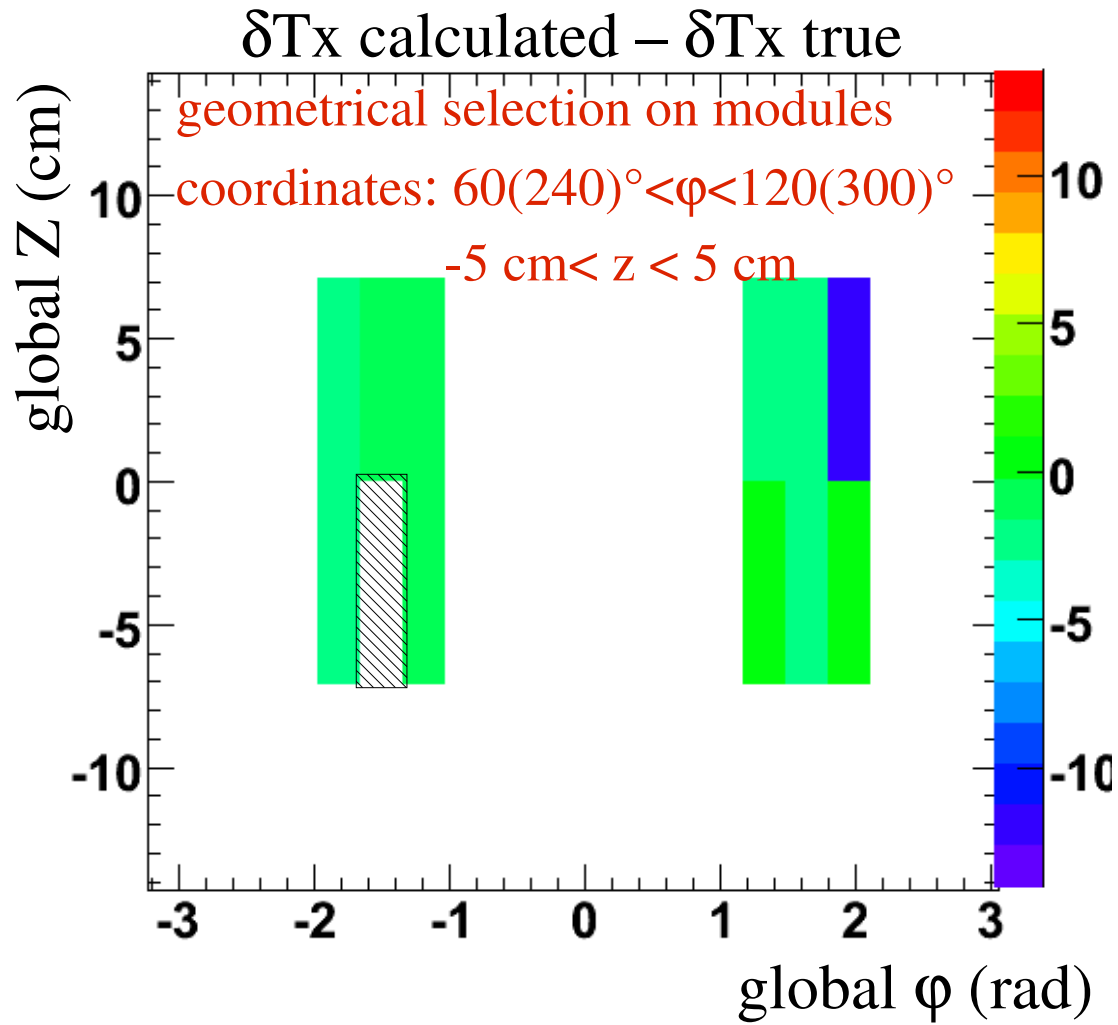


- systematic effect on δT_x correlated with global ϕ coord.

Geometrical Selection on modules coordinate

(-> see results only on modules on which cosmic tracks are not too inclined)

AliTrackResidualFast, SPD1

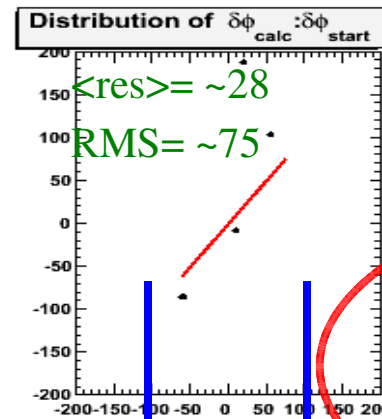
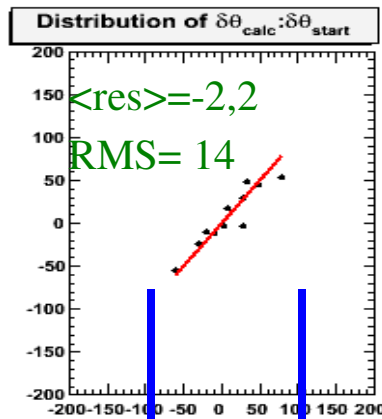
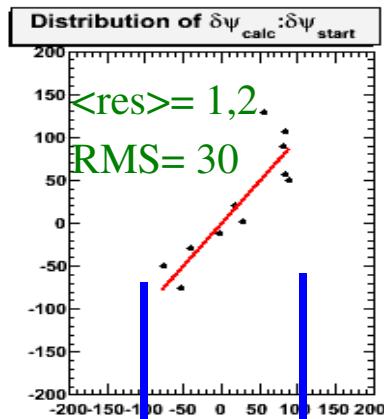
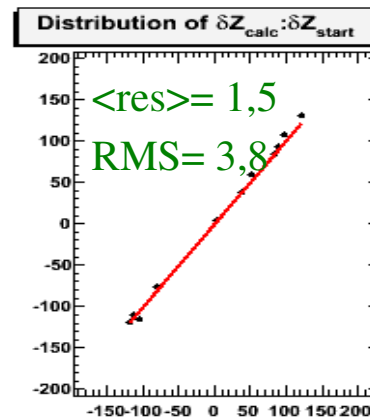
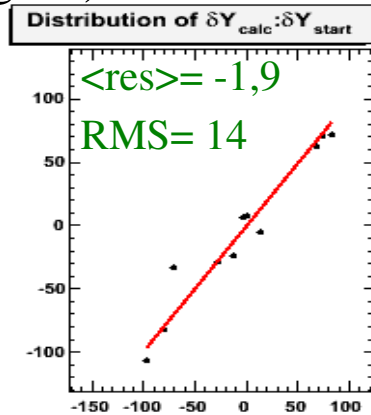
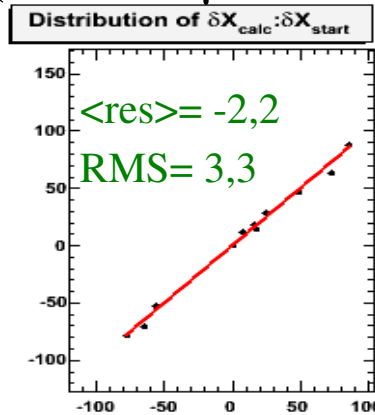


- systematic effect on δT_x correlated with global φ coord.
- absent for modules perpendicular to cosmic track

SPD1: geometrical selection

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 61 μm max 61 μm max 11 μm plane

B=0.5 T

Fake UniformMisal. on SPD1 only
(No misal on other layer)

geometrical selection on modules
coordinates: $60(240)^\circ < \phi < 120(300)^\circ$
 $-5 \text{ cm} < z < 5 \text{ cm}$

- systematic effect on δT_x correlated with global ϕ coord.
- absent for modules perpendicular to cosmic track

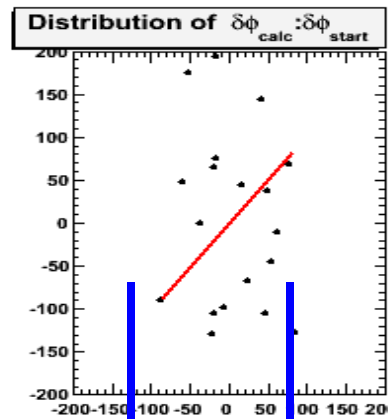
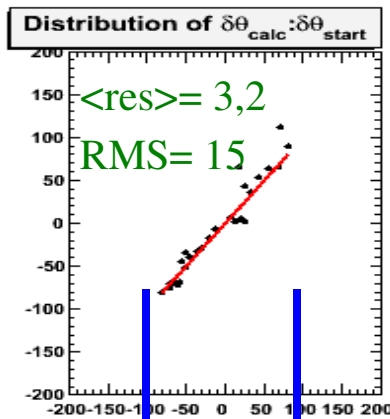
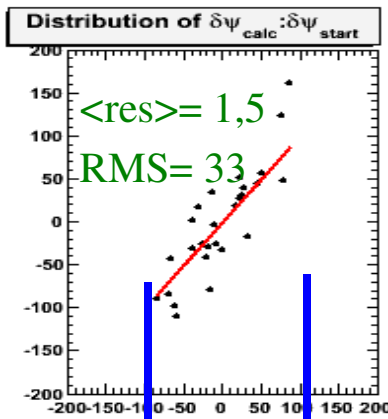
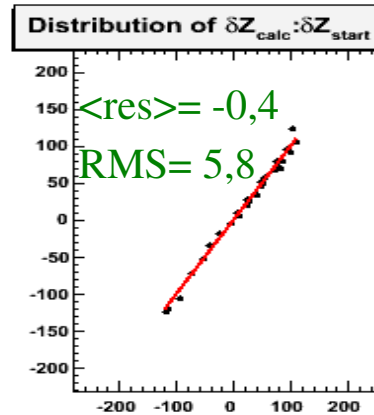
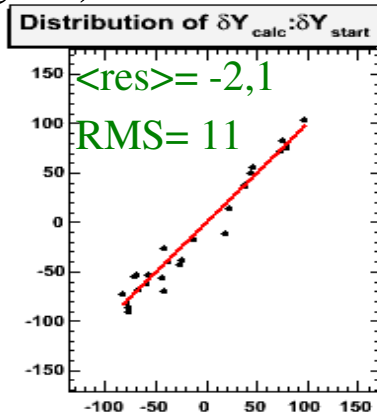
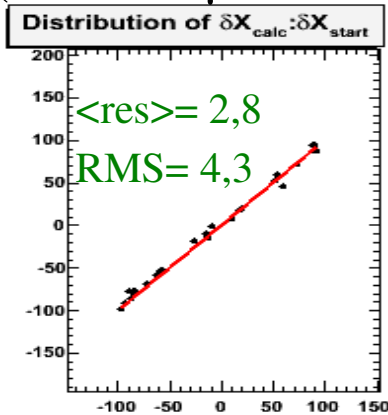
? clustering of very inclined tracks with respect to module

plane

Geometrical Selection: SPD2

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 61 μm max 61 μm max 11 μm

B=0.5 T

Fake Uniform Misal. on SPD2 only
(No misal on other layer)

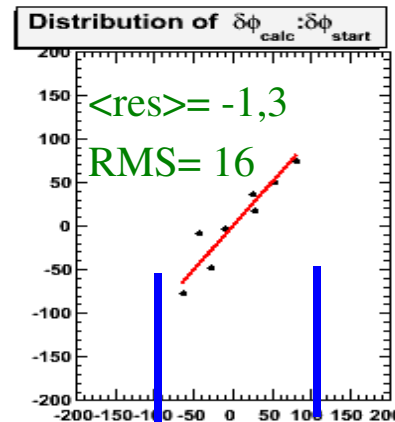
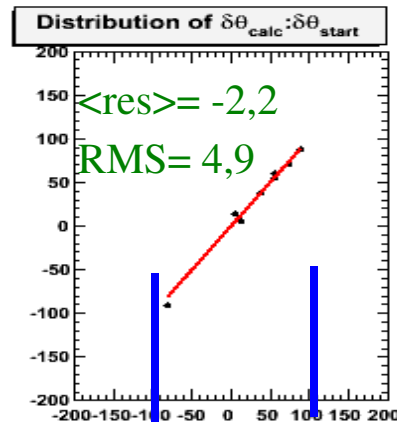
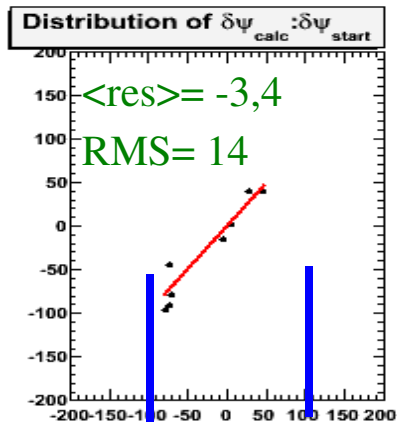
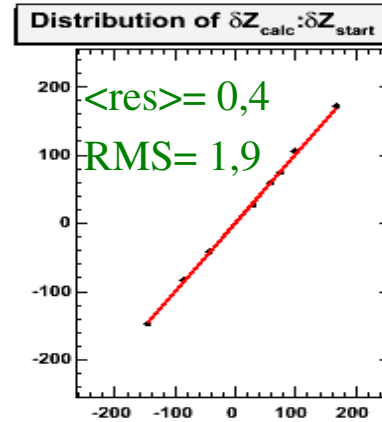
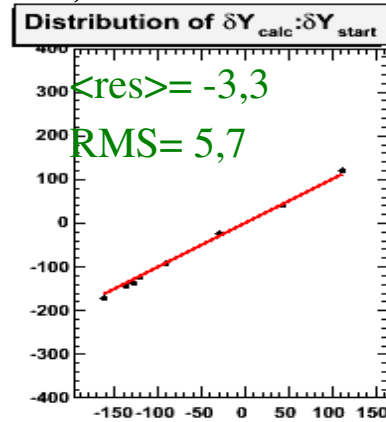
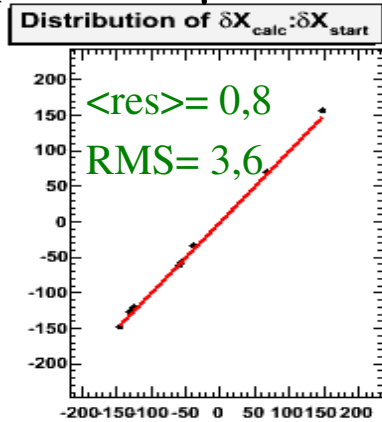
geometrical selection on modules
coordinates: $60(240)^\circ < \phi < 120(300)^\circ$
 $-5 \text{ cm} < z < 5 \text{ cm}$

- translation and θ ok
- ϕ better
- phi still problematic

Geometrical Selection: SDD1

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 65 μm

max 66 μm

max 65 μm

B=0.5 T

Fake Uniform Misal. on SDD1 only

(No misal on other layer)

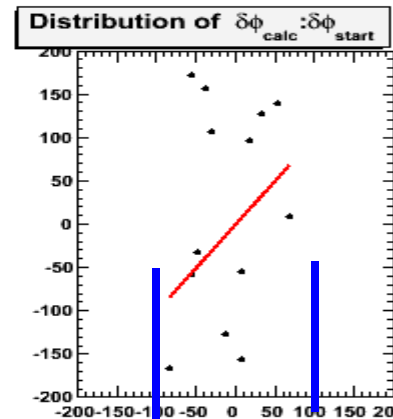
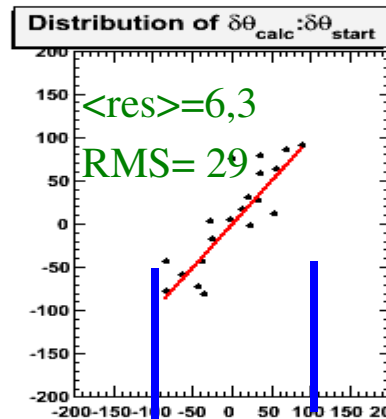
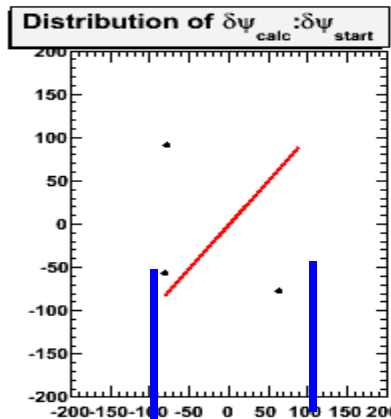
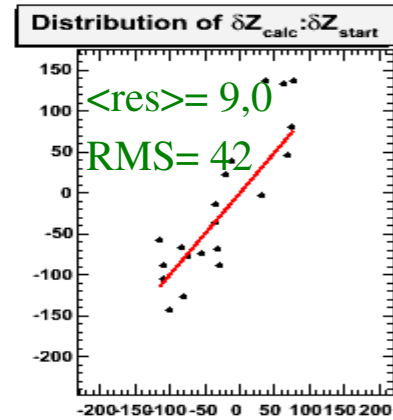
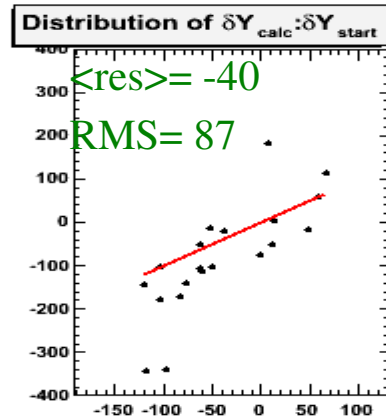
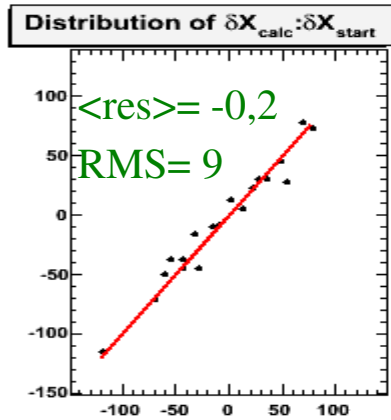
geometrical selection on modules
coordinates: $60(240)^\circ < \phi < 120(300)^\circ$
 $-5 \text{ cm} < z < 5 \text{ cm}$

- results improve
- all the angles seem to be recovered

Geometrical Selection: SSD1

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



B=0.5 T
Fake UniformMisal. on SSD1 only
(No misal on other layer)

geometrical selection on modules
coordinates: $60(240)^\circ < \phi < 120(300)^\circ$
 $-5 \text{ cm} < z < 5 \text{ cm}$

- good z, x, θ
- not a great improvements as for the other layers for angles

100 $\text{mgrad} \rightarrow$ max 35 μm

max 66 μm

max 65 μm

Summary of Unif. on Single Layer

Translations (units in μm)

All possible modules (>100 tracks)

Layer	dTx		dTy		dTz	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	-16	20	-3	31	3,5	7,8
SPD2	3,9	15	-3,4	26	1,7	8,3
SDD1	0,3	8,1	-7,3	37	-1,3	10
SSD1	-0,9	13	-29	101	5,1	60

• Results for the modules normal to cosmoics tracks muche better

Geometry Selection

Layer	dtx		dTy		dTz	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	-2,2	3,3	-1,9	14	1,5	3,8
SPD2	2,8	4,3	-2,1	11	-0,4	5,8
SDD1	0,8	3,6	-3,3	5,7	0,4	1,9
SSD1	-0,2	9	-40	87	9	42

Summary of Unif. on Single Layer

Rotations (units in mgrad)

All possible modules (>100 tracks)

Layer	dPsi		dTheta		dPhi	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	-3,6	45	3,6	39	NO	NO
SPD2	-3,2	42	-2	25	NO	NO
SDD1	-0,5	35	3,2	23	22	48
SSD1	NO	NO	2,9	28	NO	NO

- Results for the modules normal to cosmes tracks much better

Geometry Selection

Layer	dPsi		dTheta		dPhi	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	1,2	30	-2,2	14	~28	~75
SPD2	1,5	33	3,2	15	NO	NO
SDD1	-3,4	14	-2,2	4,9	-1,3	16
SSD1	NO	NO	6,3	29	NO	NO

All Layers Misaligned (Uniform), $B=0$
(same values as the ones used by Millepede)

The new 6 d.o.f. test case

The input misalignment

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

Double_t globalZ = 0.;

Double_t mechanicalPrec = 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**

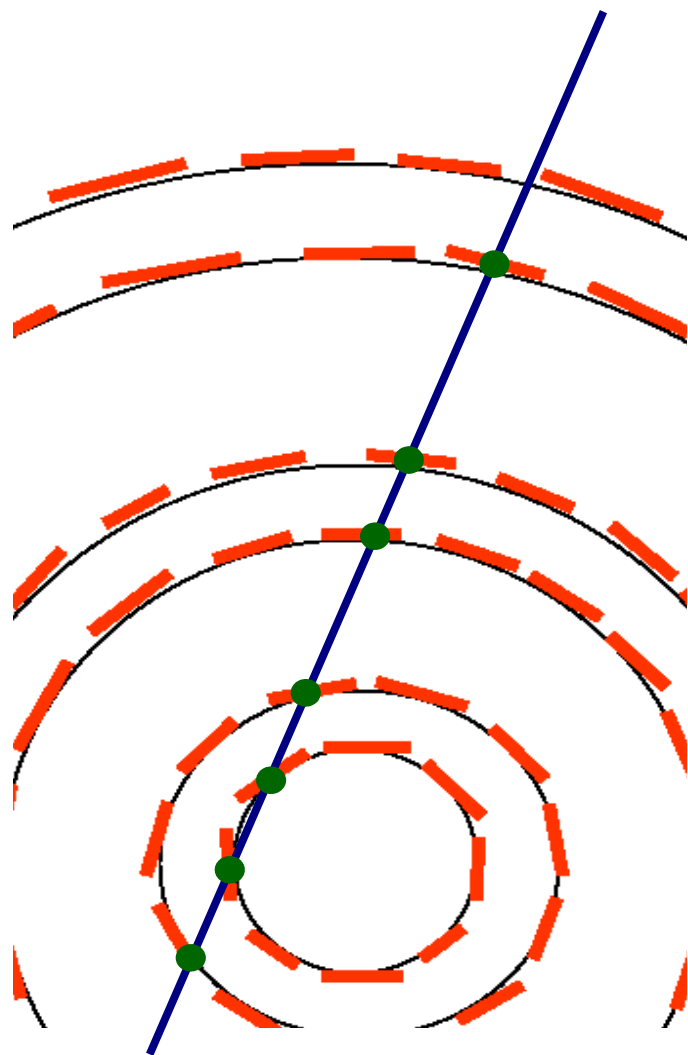
Double_t ssdZ = 0.0100; // **100 mu**

- 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**

M.Lunardon, 04/09
ITSAAlignment meeting

Statistic: ~ 160000 tracks

Fast simulation with SimMille.C



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

Riemann fitter present
No Clustering in simulation

Advantages w.r.t. standard sim:

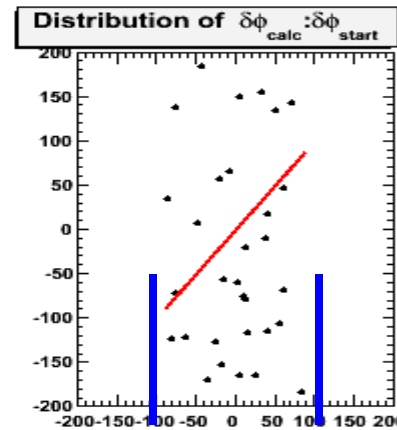
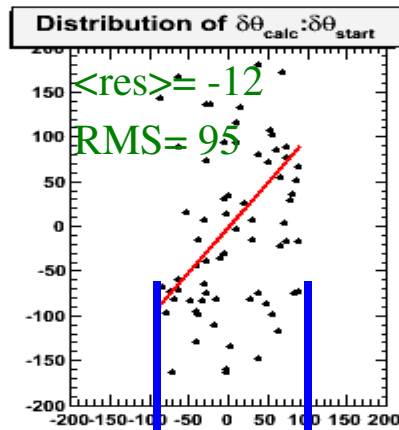
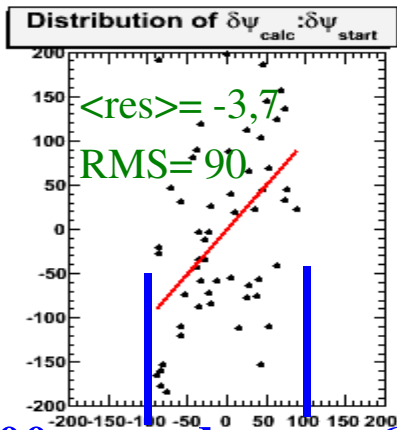
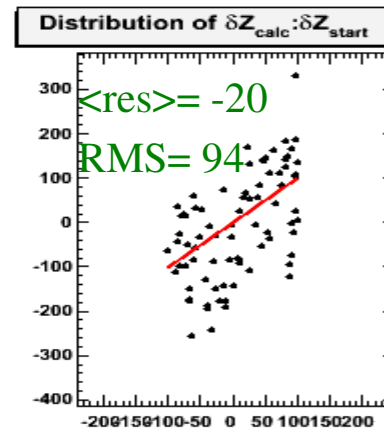
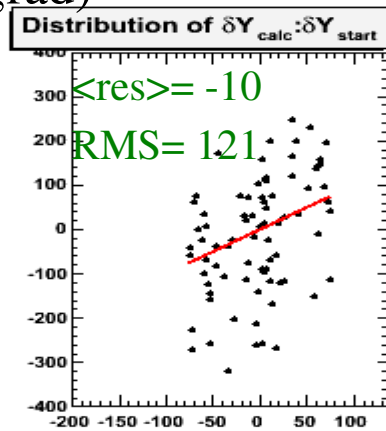
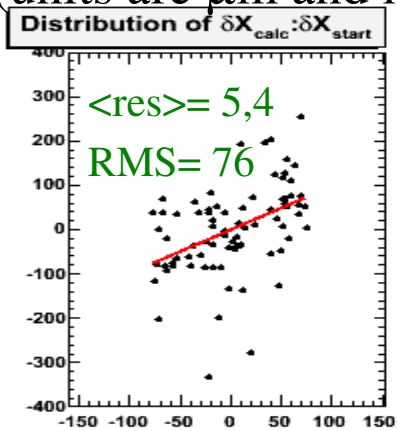
3. faster
5. σ 's of points passed to Millepede under control
7. no "unexpected" effects

with fast simulation: case MuBeam converges!

SPD1: B=0, all layers misaligned

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 61 μm max 61 μm

max 11 μm

UniformMisal. on ALL layers

B=0

!Riemann fitter works

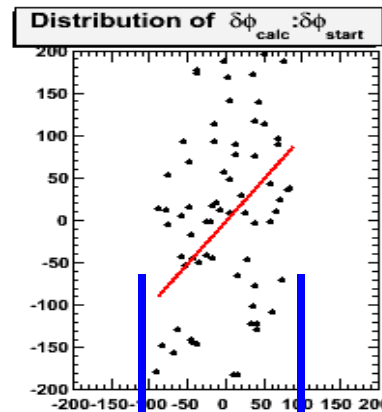
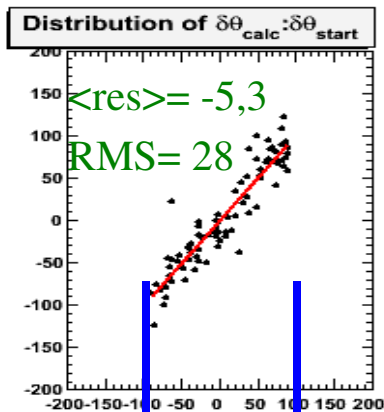
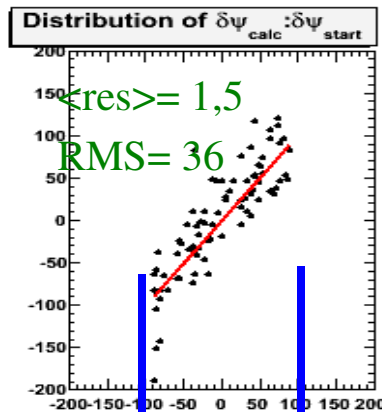
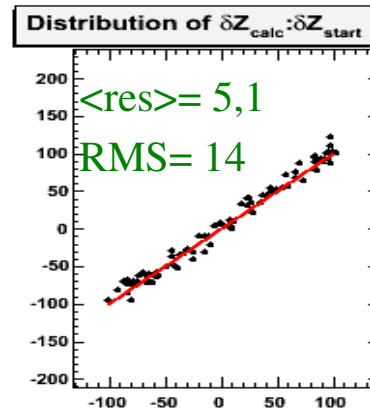
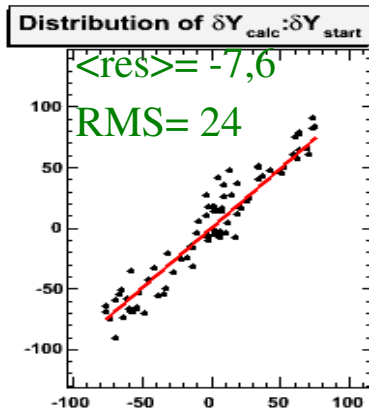
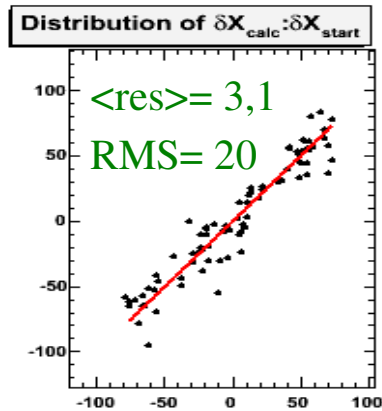
- systematic effect on δT_x seems to have disappeared
- now a “step” near 0 (but not evident)

Real Misalignment

SPD1: FastSimulation (see Marcello&Sandra talk)

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 61 μm max 61 μm max 11 μm

UniformMisal. on ALL Layers

$B=0$

!Riemann fitter works

- sistematic effect on δT_x and “step” around 0

Not present using “Fast Simulation”



? clustering of very inclined tracks with respect to module plane

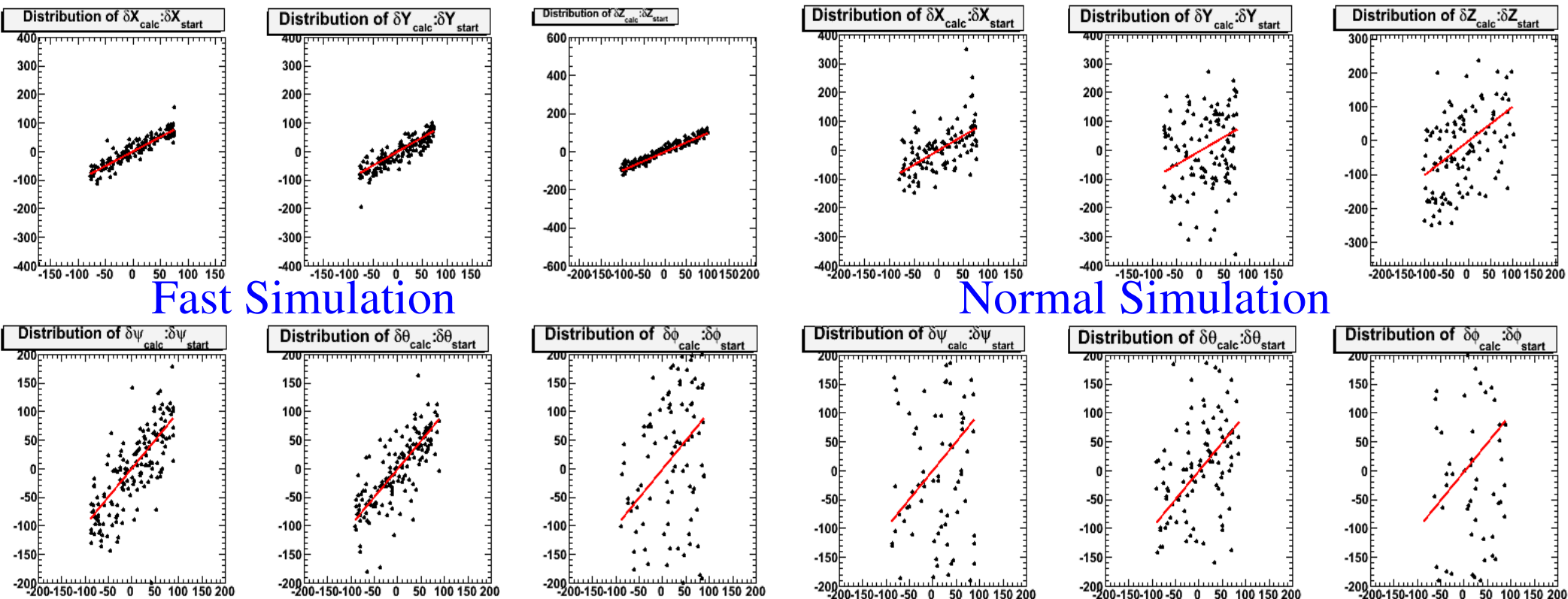
SPD2: B=0, all layers misaligned

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)

UniformMisal. on ALL layers

B=0



Fast Simulation much better than normal simulation

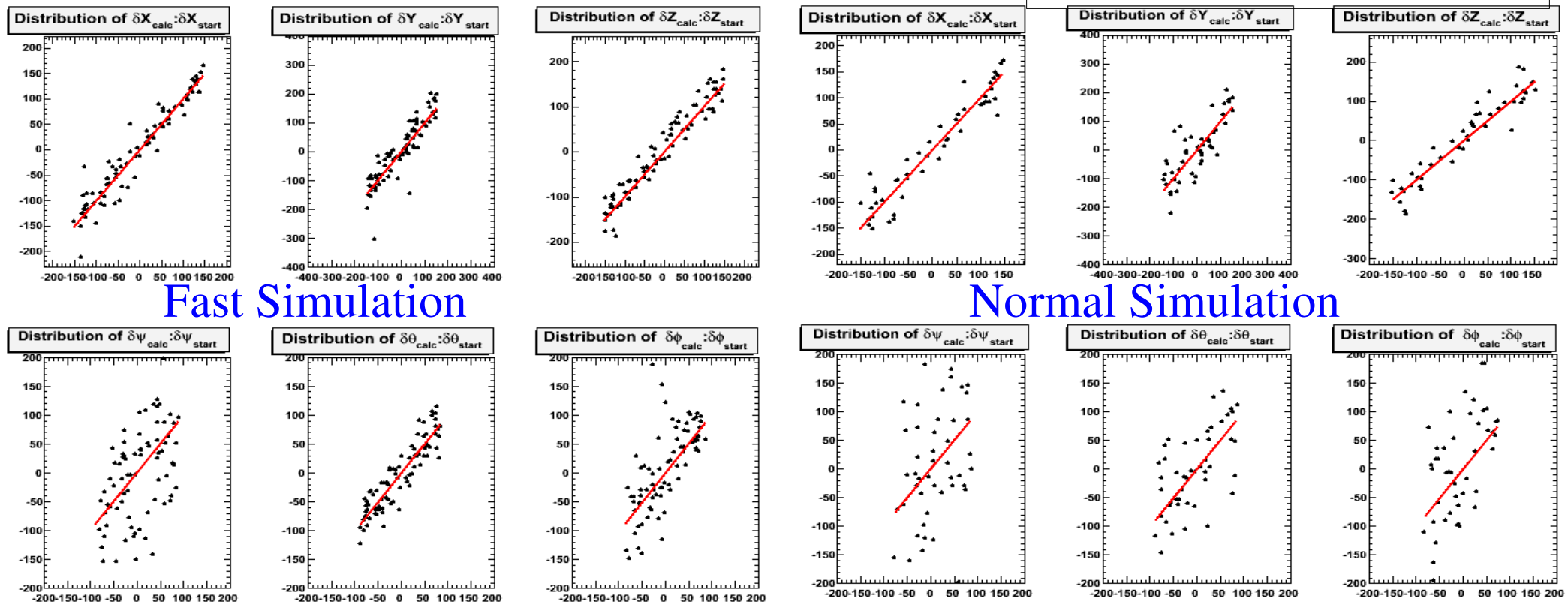
SDD1: B=0, all layers misaligned

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)

UniformMisal. on ALL layers

B=0



Fast Simulation better than normal but difference not as in the SPD case

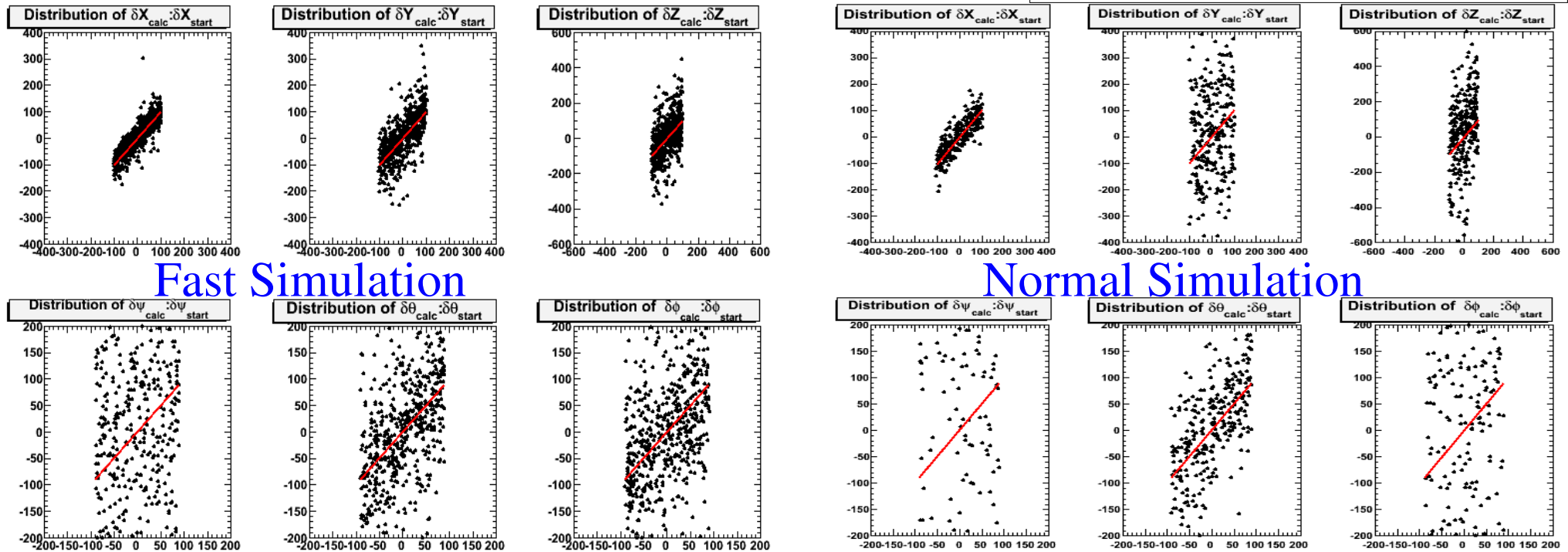
SSD1: $B=0$, all layers misaligned

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)

UniformMisal. on ALL layers

$B=0$



Fast Simulation much better than normal simulation

Summary Unif. Misal All Layers

Translations (units in μm)

Normal Simulation

Layer	dT _x		dT _y		dT _z	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	5,4	76	-10	121	-20	94
SPD2	-4	54	-6,8	126	-15	101
SDD1	-0,67	60	2,8	61	6,6	32
SSD1	3	38	18	165	32	189

- Fast Simulation results seem much better than in the Normal case

Fast Simulation

Layer	dtx		dT _y		dT _z	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	-0,8	14	0	16	4	9,7
SPD2	3,1	20	-7,6	24	5,1	14
SDD1	1,82	25,04	11	33	9,4	25,02
SSD1	2,4	34	5,7	63	5,6	97

Summary Unif. Misal All Layers

Rotations (units in **mgrad**)

Normal Simulation

Layer	dPsi		dTheta		dPhi	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	-3,7	90	-11,7	95	NO	NO
SPD2	0,4	97	-36	80	NO	NO
SDD1	-0,7	86	4	55	NO	NO
SSD1	NO	NO	4,4	67	NO	NO

- Fast Simulation results seem much better than in the Normal case
- Rotations are quite problematic in both cases

Fast Simulation

Layer	dPsi		dTheta		dPhi	
	Mean	RMS	Mean	RMS	Mean	RMS
SPD1	1,5	36	-5,3	28	-10,5	86
SPD2	-6,8	45	-3,4	39	NO	NO
SDD1	-7	68	0,2	24	0,6	50
SSD1	NO	NO	-1,7	74	-0,6	80

Open Problems

- sigmax value fixed to 1 cm but dependency of results on this parameter not well understood
 - checked that the minimizer algorithm works (but sensitive to global vector length)
 - Fast Simulation better than normal (-> Rimann fitter works good)
 - checked that covariance matrix of fitted point is reasonable (not shown)



Possible problem: - clusterization for cosmick tracks?
- something in the geometry? (esp. for SPD)

Time Consuming

Time per iteration requested to realign (~ 50000 cosmick track, ~5 wks of data taking)


Layer	time (sec)
SPD1	43
SDD1	39
SSD1	78
SSD2	84
all ITS	326

- Same result for Res. Fast as for Linear Fit.
- ~ 0.5 sec per module on SPD
(very rough estimate)

Conclusions

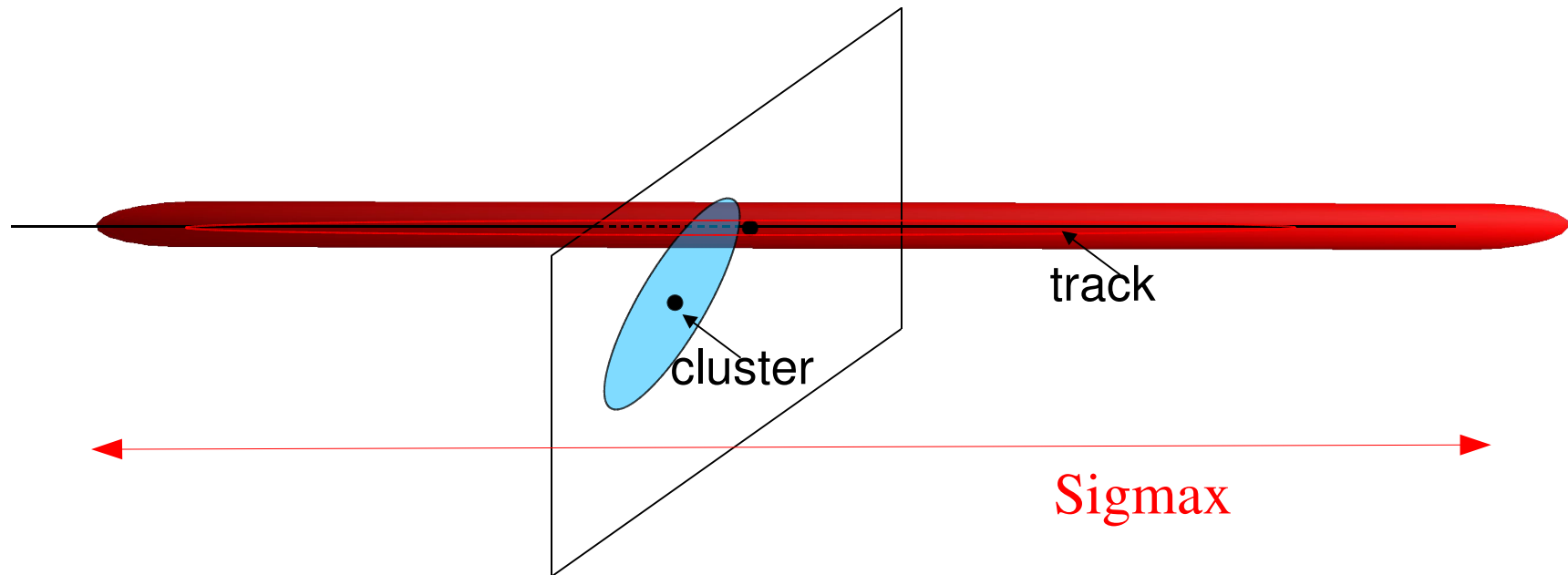
- Toy test of AliTrackResidualFast gave reasonable and expected result
- Fast Simulation better than “Real” simulation: maybe some problems are present somewhere (most probable: inclined tracks clustering)
- best result for SDD (internal, large and ~ square module)
- SPD1-> problems to be understood
- SSD -> not too good result with cosmic tracks pointing SPD1
- Riemann fitter works also without magnetic field (more checks are needed)

NEXT

- look for any problem before minimization (fitter, geometry)
 - try to put “residual” misal. info inside fit
 - prepare an iteration scheme (ready)
 - test the realistic misal.
 - use Align Obj. cov. Matrix for AliTrackPoi global coordinate
- 

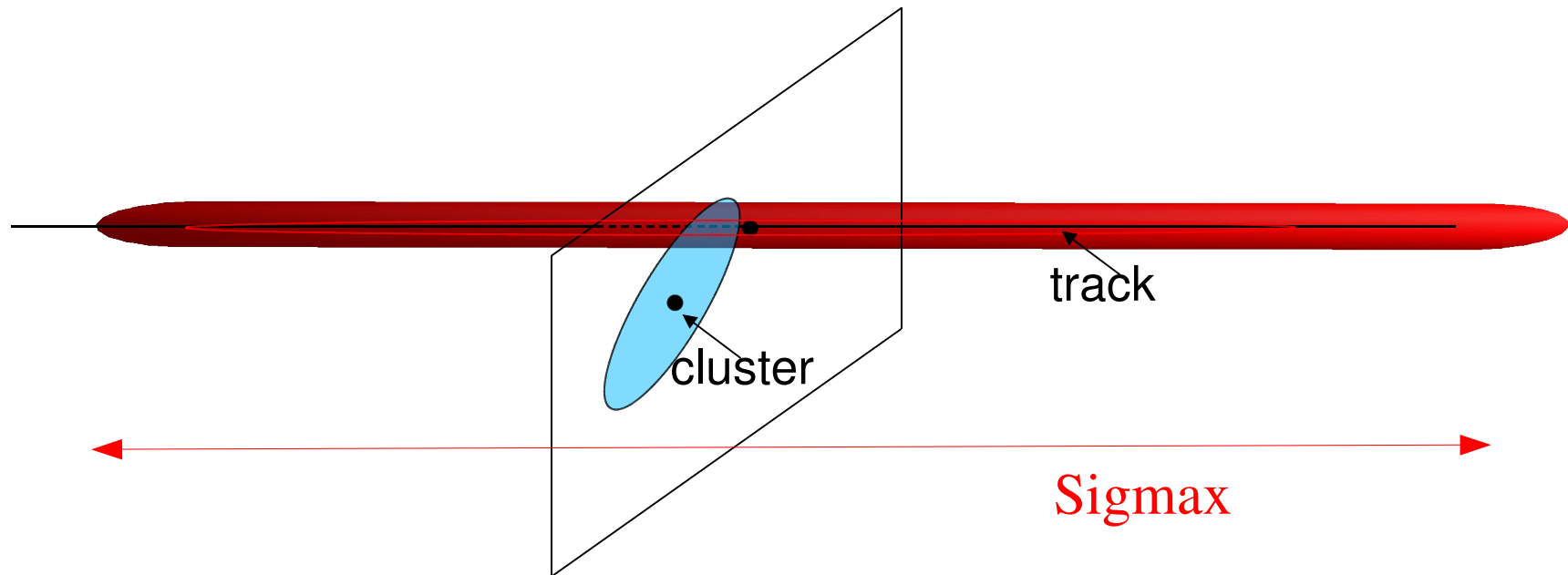
Backup

SigmaX Variable



- Take the intersection between the fitted track and the module
- Minimizers - > look for the Vol. reference frame transformation that minimize the distance between the ellipse and the cylinder
- Considering the point as a cylinder of “length” **Sigmax** needed because you don't know where the cluster real position along the track

Sigma_x Variable

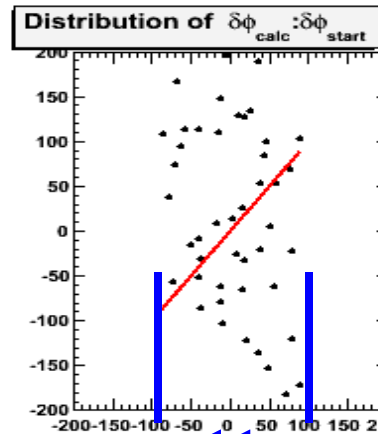
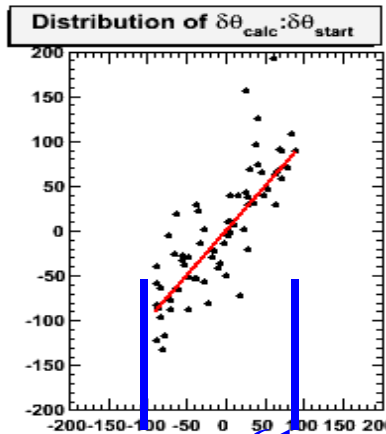
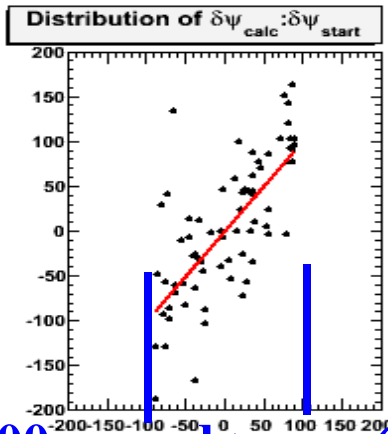
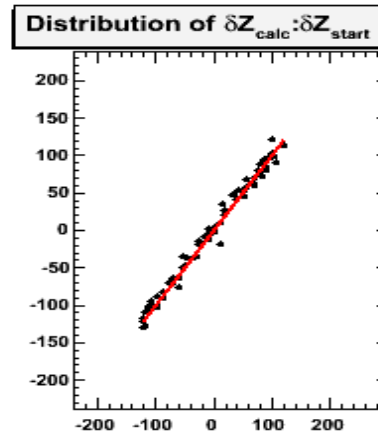
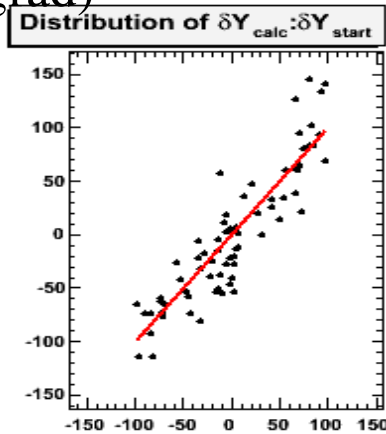
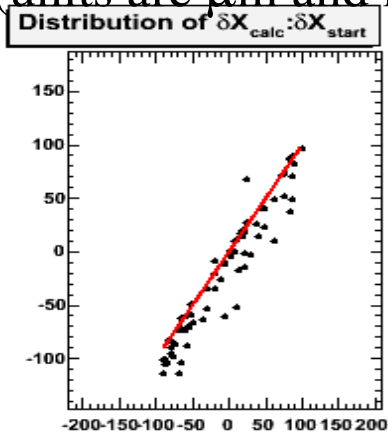


- Σ_x ~ allows the intersection point to move along the track
 - Default Value = 100 cm
 - ITS precision ~ order of microns/hundreds of microns \rightarrow factor 10^5
 - Expected (initial) Misalignment of the order of microns/hundreds of microns
- **for ITS a so large Σ_x is not needed!** (results should be independent but...)

SPD1: B=0, all layers misaligned

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)



100 mgrad \rightarrow max 61 μm max 61 μm max 11 μm

UniformMisal. on ALL layers
Fake Misalignment $B=0$

!Riemann fitter works

~ same results as $B=0.5$ T
case

- systematic effect on δT_x correlated with global φ coord.

old (HEAD060607)

AliRoot Version

Fake Misalignment

- FAST WAY to see if misalignments can be recovered



Move the cluster positions instead that simulate with misaligned geometry

!NOT THE SAME : USEFULL FOR FAST TEST

- Clusterization
- Avoid all possible problems present in a real simulation
- ✓ equivalent to consider a different ideal geometry (next slide)

Fake Misalignment

!! local vector \vec{l}_m is the "measured" position

→ always due to real (not ideal) geometry

Real Simulation case:

$$\vec{g}_{\text{ideal}}^{\text{sim}} = G \vec{l}_m$$

Misal. described by introducing δL and δG :

$$\vec{g}_{\text{real}}^{\text{sim}} = G(\delta L) \vec{l}_m \equiv (\delta G) G \vec{l}_m = (\delta G) \vec{g}_{\text{ideal}}^{\text{sim}}$$

Fake Misal case:

$$\vec{g}_{\text{real}}^{\text{fake}} \equiv \vec{g}_{\text{ideal}}^{\text{sim}}$$

$$\vec{g}_{\text{ideal}}^{\text{fake}} \equiv (\delta G) G \vec{l}_m = (\delta G) \vec{g}_{\text{real}}^{\text{fake}}$$

$$\vec{g}_{\text{real}}^{\text{fake}} = (\delta G)^{-1} \vec{g}_{\text{ideal}}^{\text{fake}}$$

Fake Misalignment

!! local vector \vec{l}_m is the "measured" position

→ always due to real (not ideal) geometry

Real Simulation case:

$$\vec{g}_{\text{ideal}}^{\text{sim}} = G \vec{l}_m$$

Misal. described by introducing δL and δG :

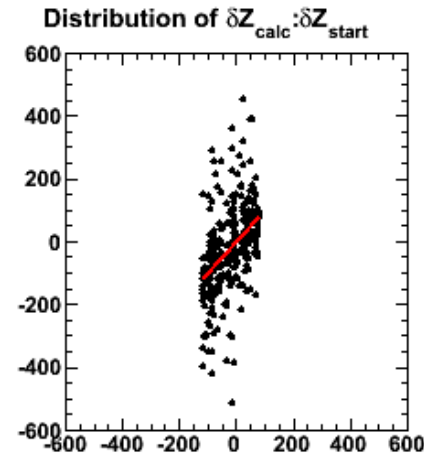
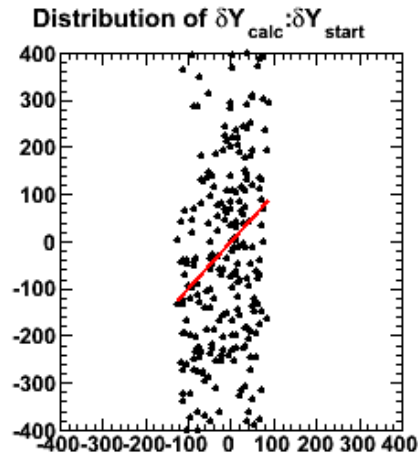
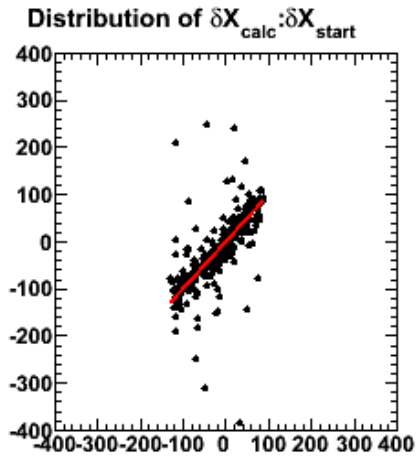
$$\vec{g}_{\text{real}}^{\text{sim}} = G(\delta L) \vec{l}_m \equiv (\delta G) G \vec{l}_m = (\delta G) \vec{g}_{\text{ideal}}^{\text{sim}}$$

Fake Misal case:

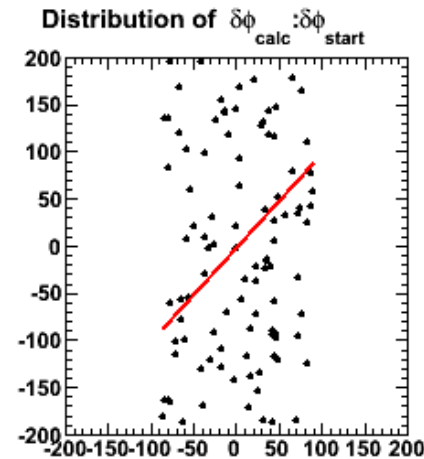
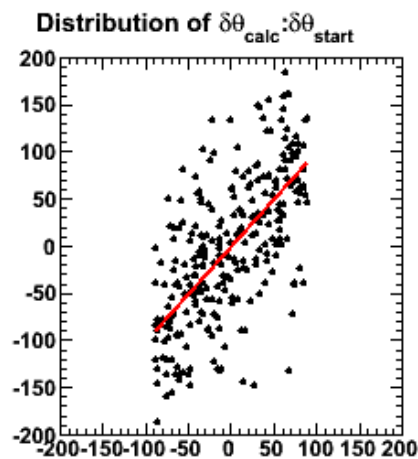
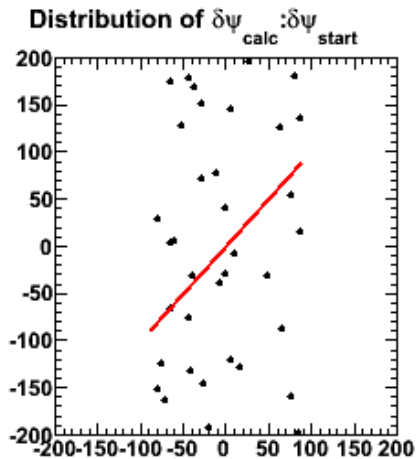
$$\begin{aligned} \vec{g}_{\text{real}}^{\text{fake}} &\equiv \vec{g}_{\text{ideal}}^{\text{sim}} \\ \vec{g}_{\text{ideal}}^{\text{fake}} &\equiv (\delta G) G \vec{l}_m \equiv (\delta G) \vec{g}_{\text{real}}^{\text{fake}} \\ \vec{g}_{\text{real}}^{\text{fake}} &= (\delta G)^{-1} \vec{g}_{\text{ideal}}^{\text{fake}} \end{aligned}$$

Equal to consider a
different Ideal
Geometry

Linear Minimizer: SSD2



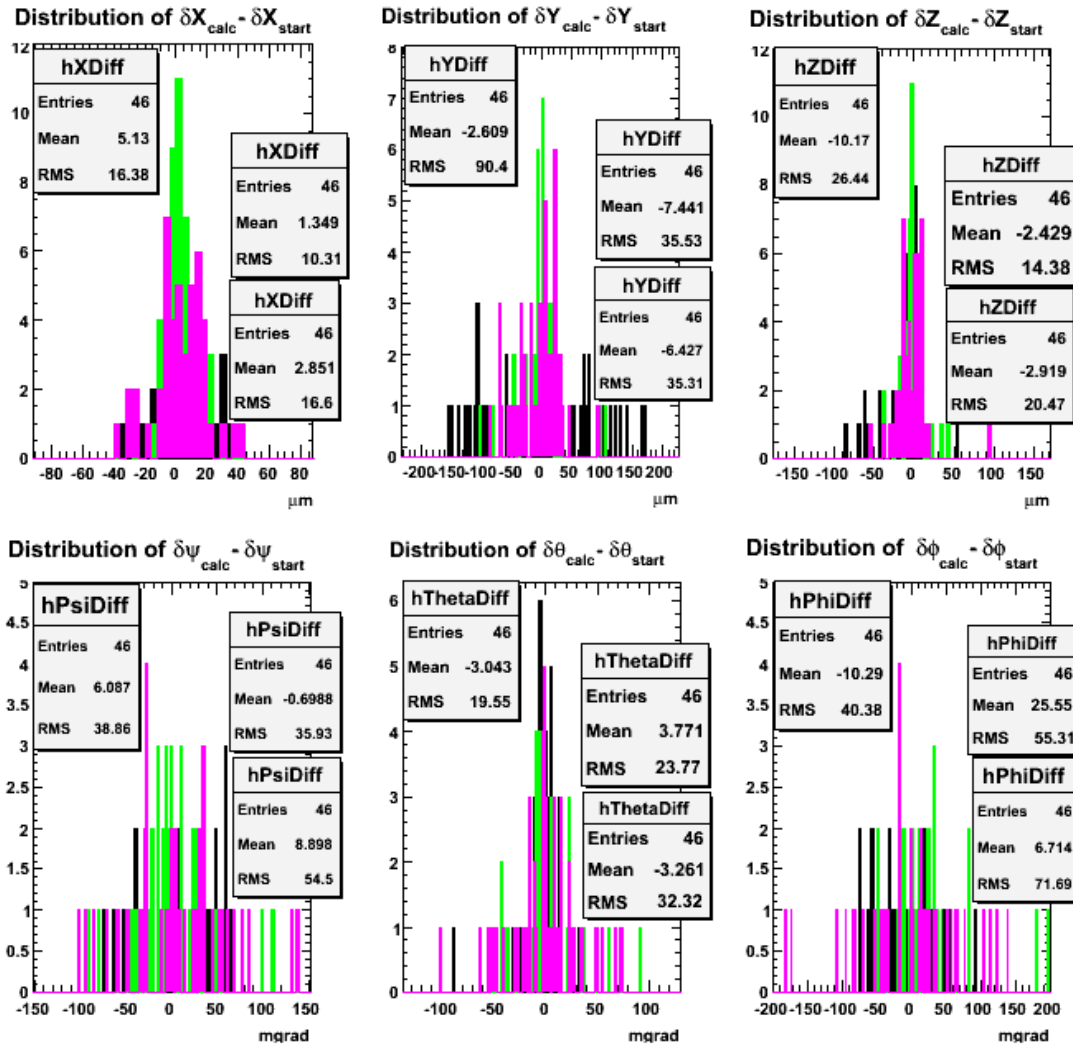
Linear Minimizer
SigmaX=1 cm
 UniformMisal. on SSD2



Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)

Linear Minimizer:SDD1

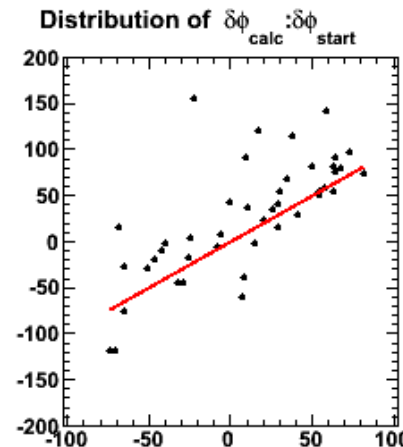
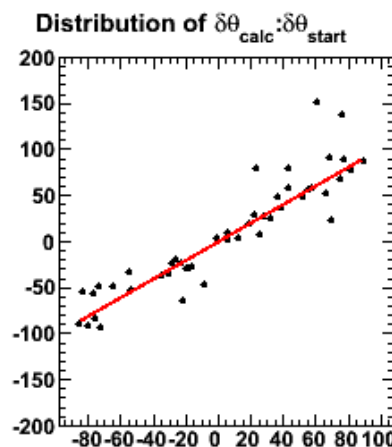
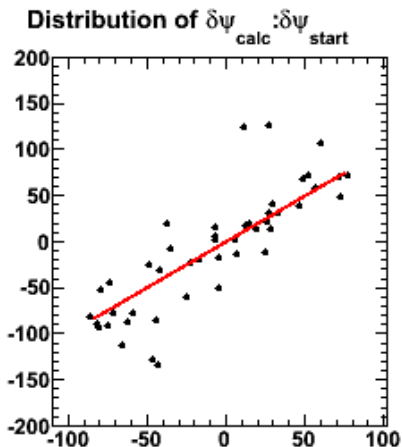
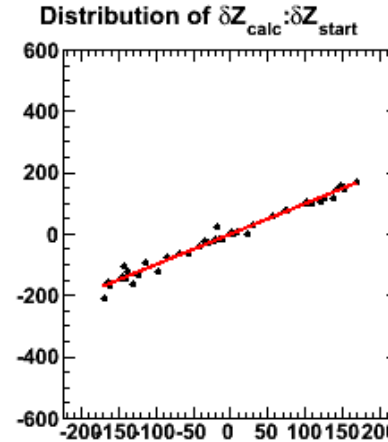
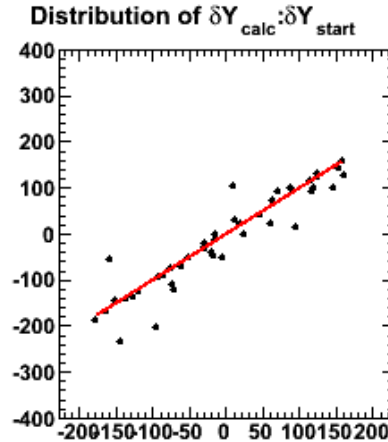
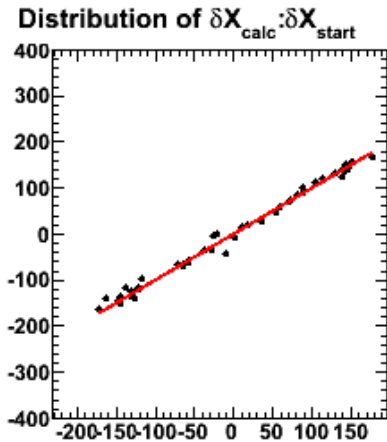


— SIGMAX=0.01
 — SIGMAX=1
 — SIGMAX=100

Similar to Res. Fast

- Not strong dependence on SigmaX value
- seems quite good results (at least for translations)
- SigmaX = 1 cm seems the best case

Linear Minimizer: SDD1



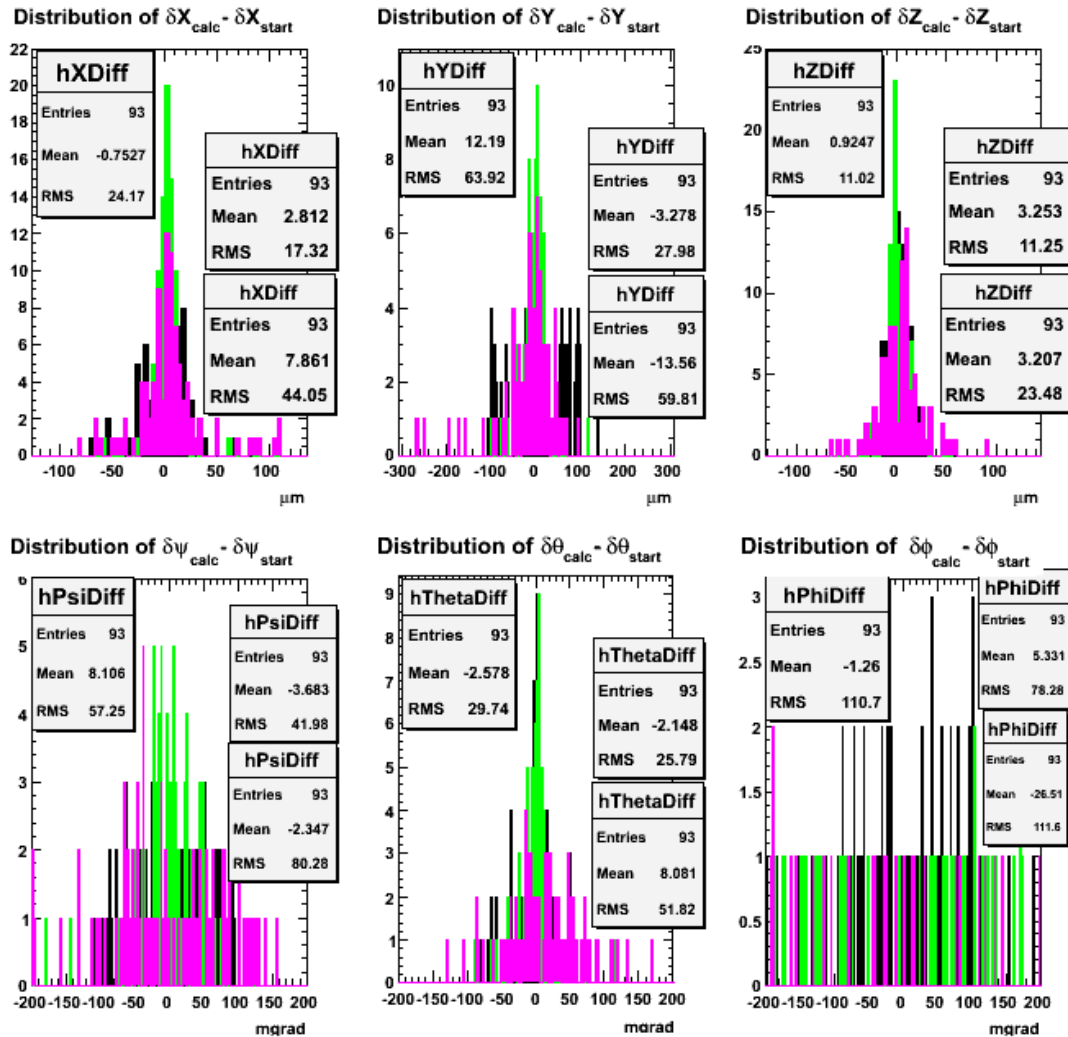
Linear Minimizer
SigmaX=1 cm
 UniformMisal. on SDD1

- promising results
- translations much better than rotations

Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)

Linear Minimizer: SPD2

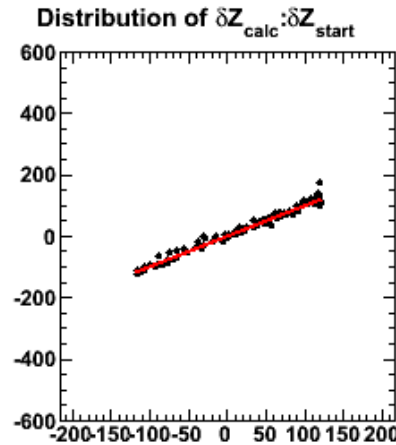
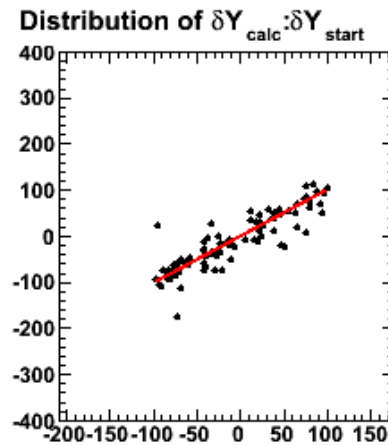
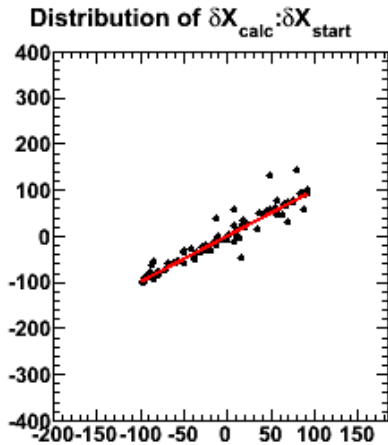


— SIGMAX=0.01
 — SIGMAX=1
 — SIGMAX=100

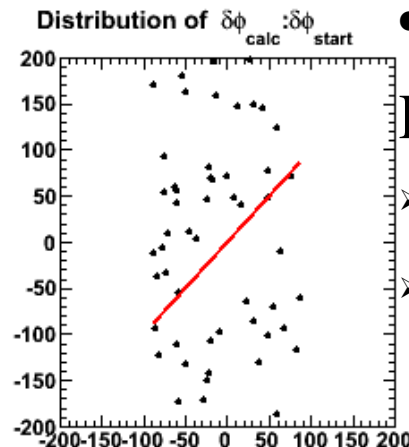
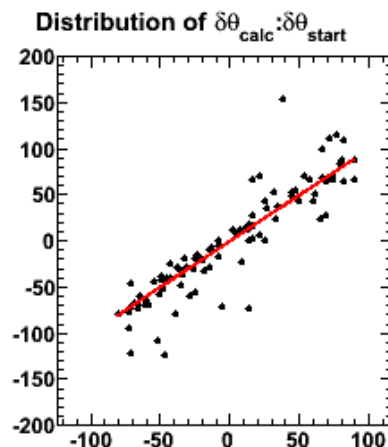
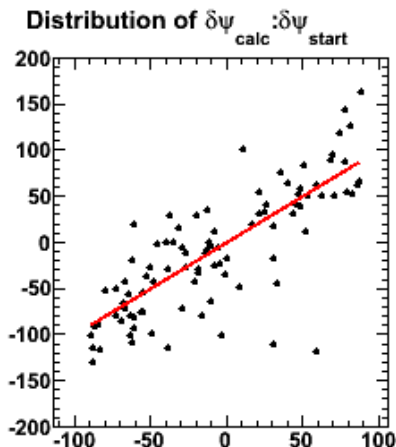
Similar to Res. Fast

- Not strong dependence on SigmaX value
- seems quite good results (at least for translations)
- SigmaX = 1 cm seems the best case
- Phi is quite problematic

Linear Minimizer: SPD2



Linear Minimizer
SigmaX=1 cm
 UniformMisal. on SPD2

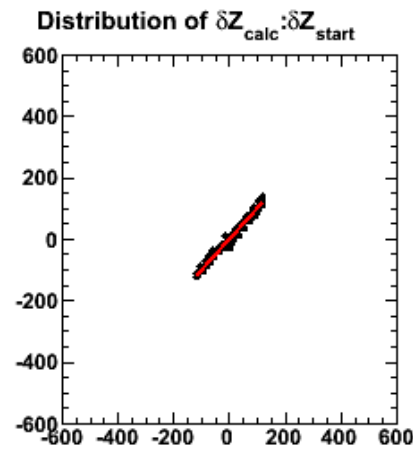
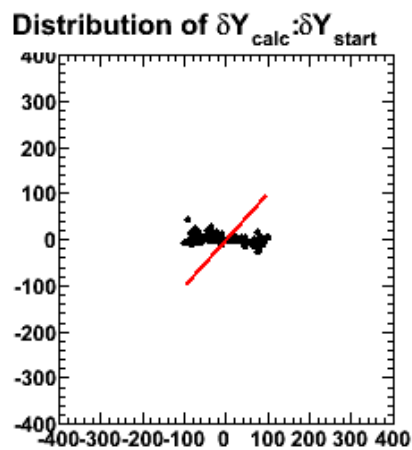
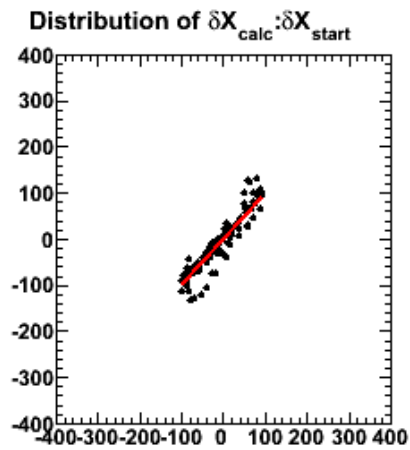


- similar to SDD in the ResidualFast case
 - quite good X, Y, Z, Theta
 - Phi is problematic

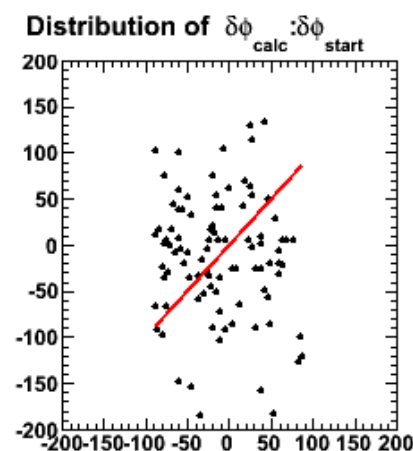
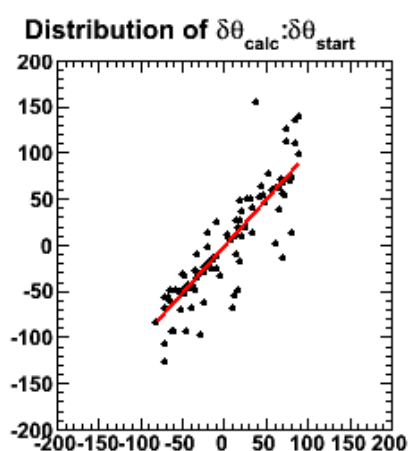
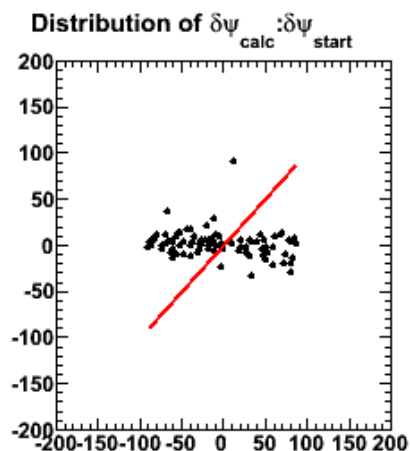
Red Line is $y=x$ line (perfect realignment case)

(units are μm and mgrad)

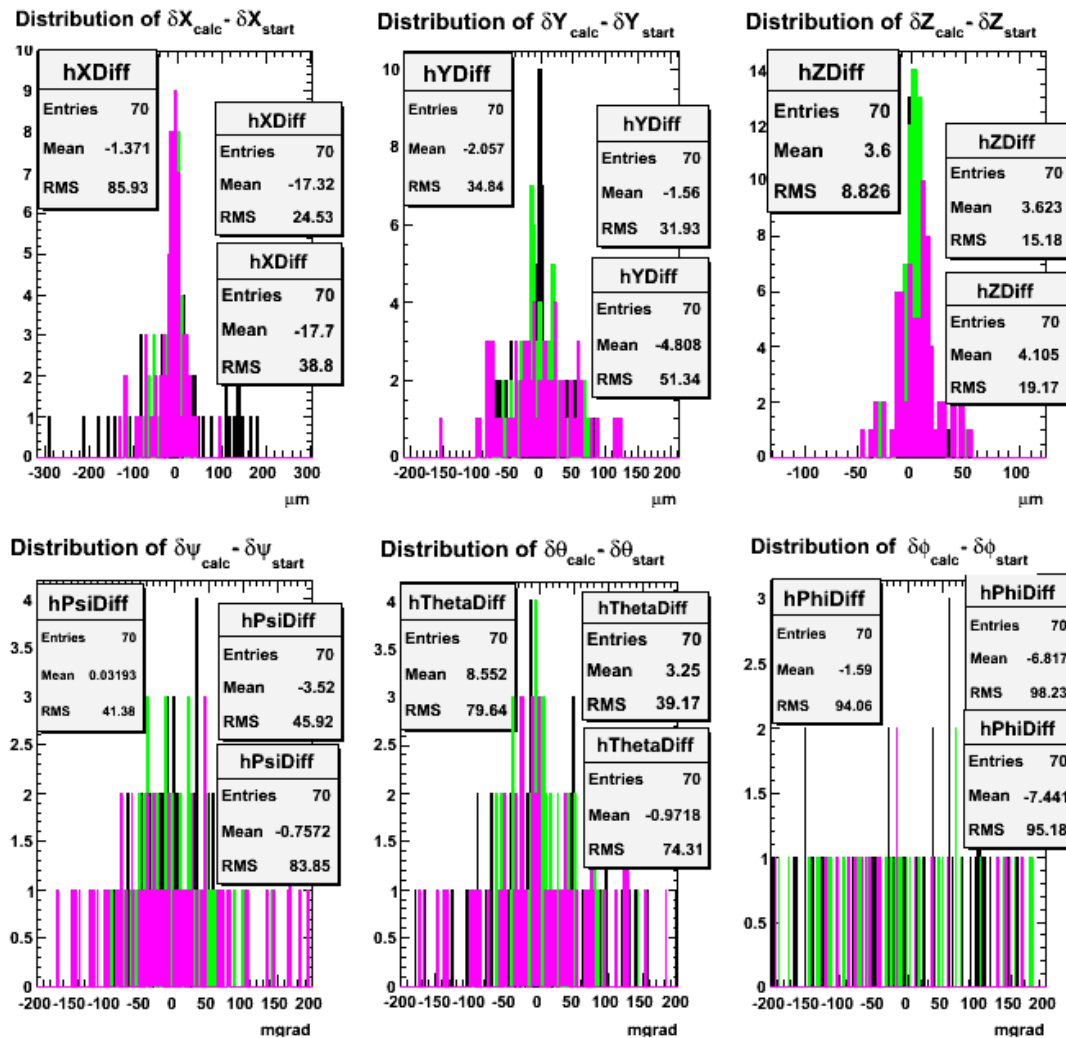
Linear Minimizer: SPD2



Linear Minimizer
SigmaX=0.01 cm
UniformMisal. on SPD2



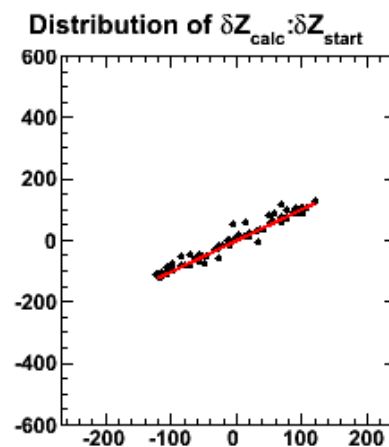
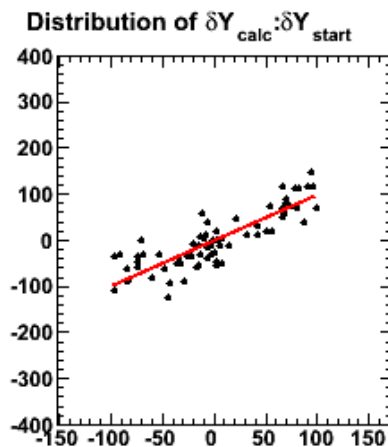
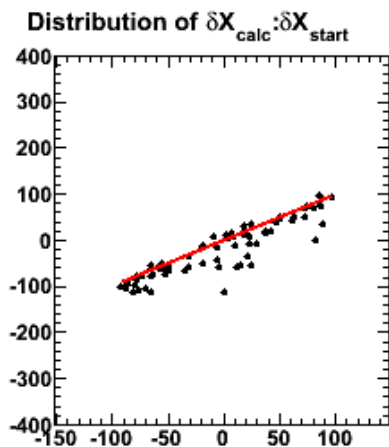
Linear Minimizer: SPD1



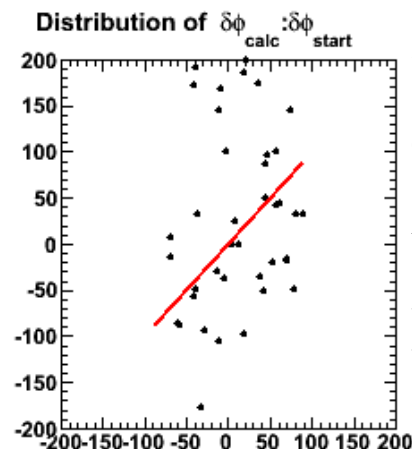
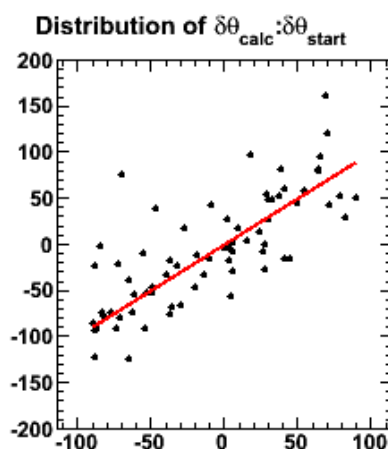
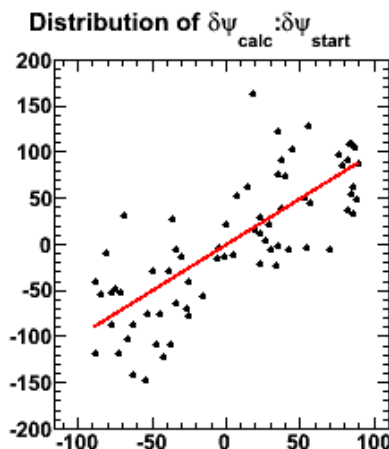
— SIGMAX=0.01
 — SIGMAX=1
 — SIGMAX=100

- Translations much better than Rotations
- Results not clear (X underestimated as in the Res. Fast case)

Linear Minimizer: SPD1



Linear Minimizer
SigmaX=1 cm
 UniformMisal. on SPD2



- Translations much better than Rotations
- Results not clear (X underestimated as in the Res. Fast case)

Covariance Matrix

Covariance Matrix not present in Residual Fast minimizer

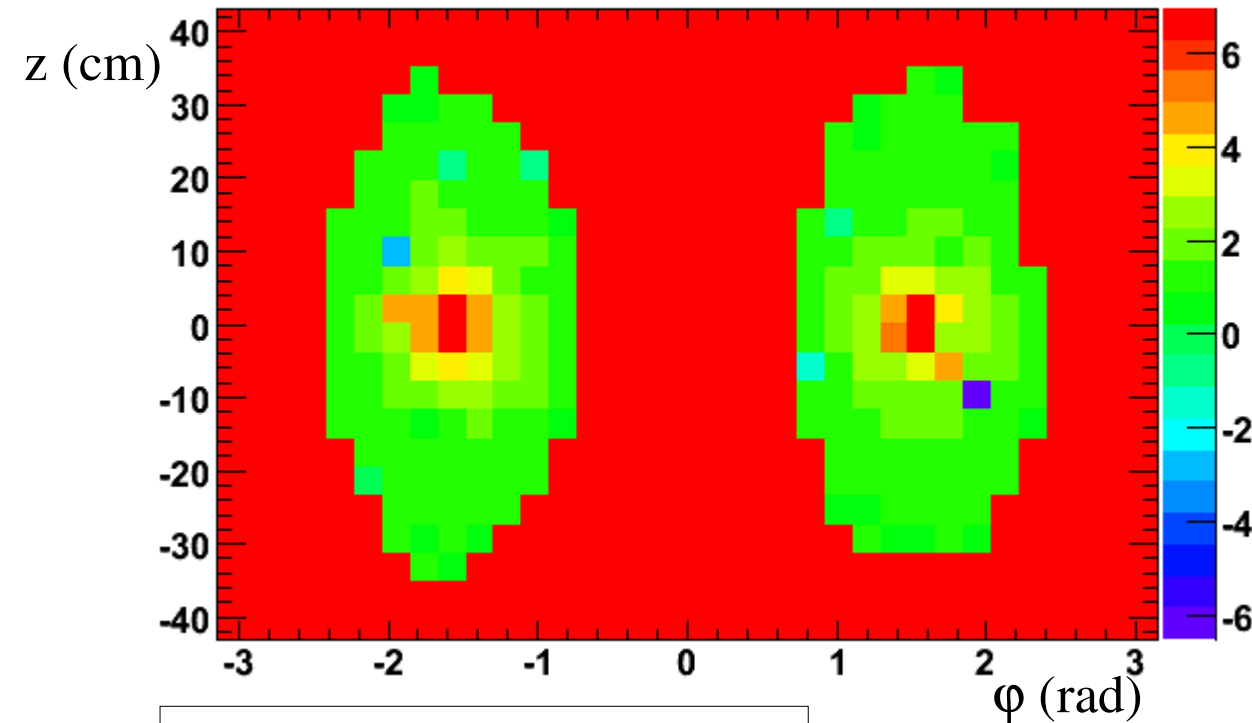
- Weighted average: $(\sum_i C_i^{-1}) \langle \vec{x} \rangle \equiv W^{-1} \langle \vec{x} \rangle = \sum_i C_i^{-1} \vec{x}_i$

$$\langle \vec{x} \rangle = W \sum_i C_i^{-1} \vec{x}_i, \text{ W is taken as the Cov. Matr. of } \langle \vec{x} \rangle$$

Looking at Cvetan code and minimizer procedure

- similar equations are present where
 - W is a 6x6 matrix
 - \vec{x}_i and $\langle \vec{x} \rangle$ are 6 dimensional vector (3 translations and 3 rotations)
 - \vec{x}_i can be thought as the “single track” estimation of the realignment parameters
 - **MATRIX IS IN GLOBAL COORDINATE(->Rotation very important!)**

Cov. Matrix., Res. Fast: $\sigma_{\delta T_x} / \sigma_{\delta T_y}$



SSD1

SigmaX=100 cm

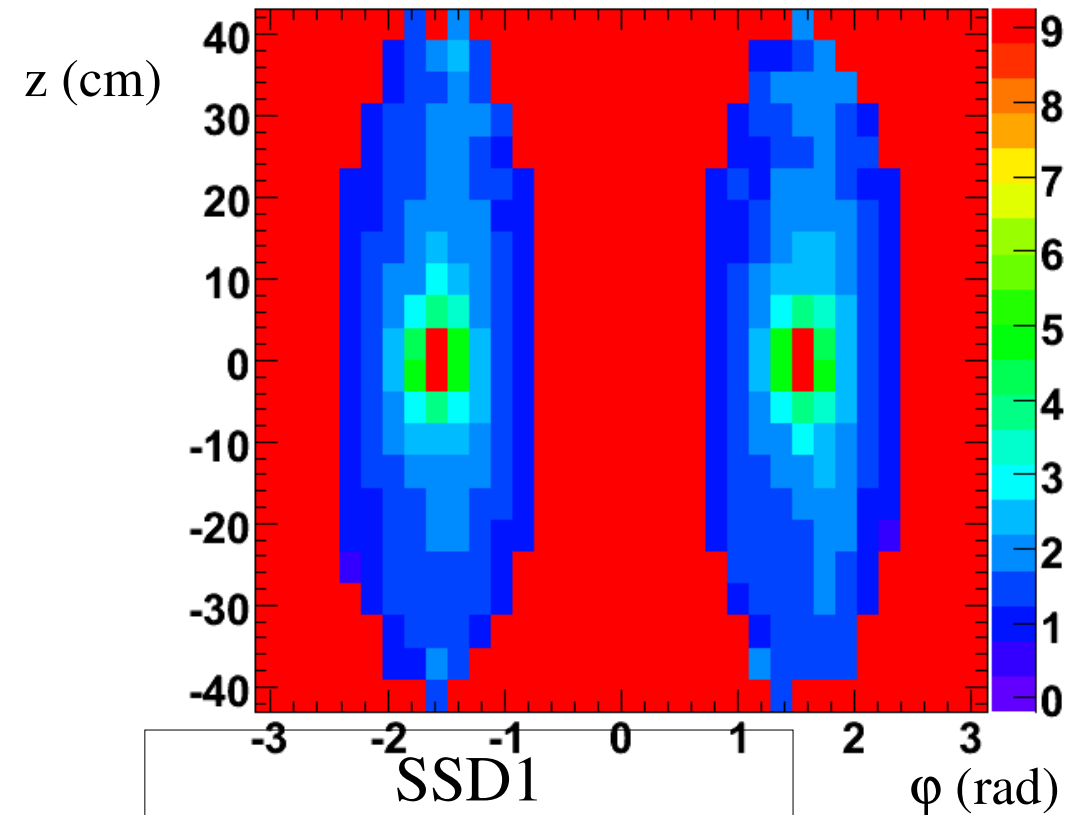
UniformMisal. on SSD1

- SigmaX along track direction
- $\sigma_{\delta T_x} / \sigma_{\delta T_y} \ll 1$ is expected
- the effect should increase for modules with $Z \sim 0$ and $\varphi \sim \pi/2$



- exact the opposite:
- $\sigma_{\delta T_x} / \sigma_{\delta T_y} > 1$ (but same order of magnitude)

Cov. Matrix., Res. Fast: $\sigma_{\delta T_x} / \sigma_{\delta T_y}$



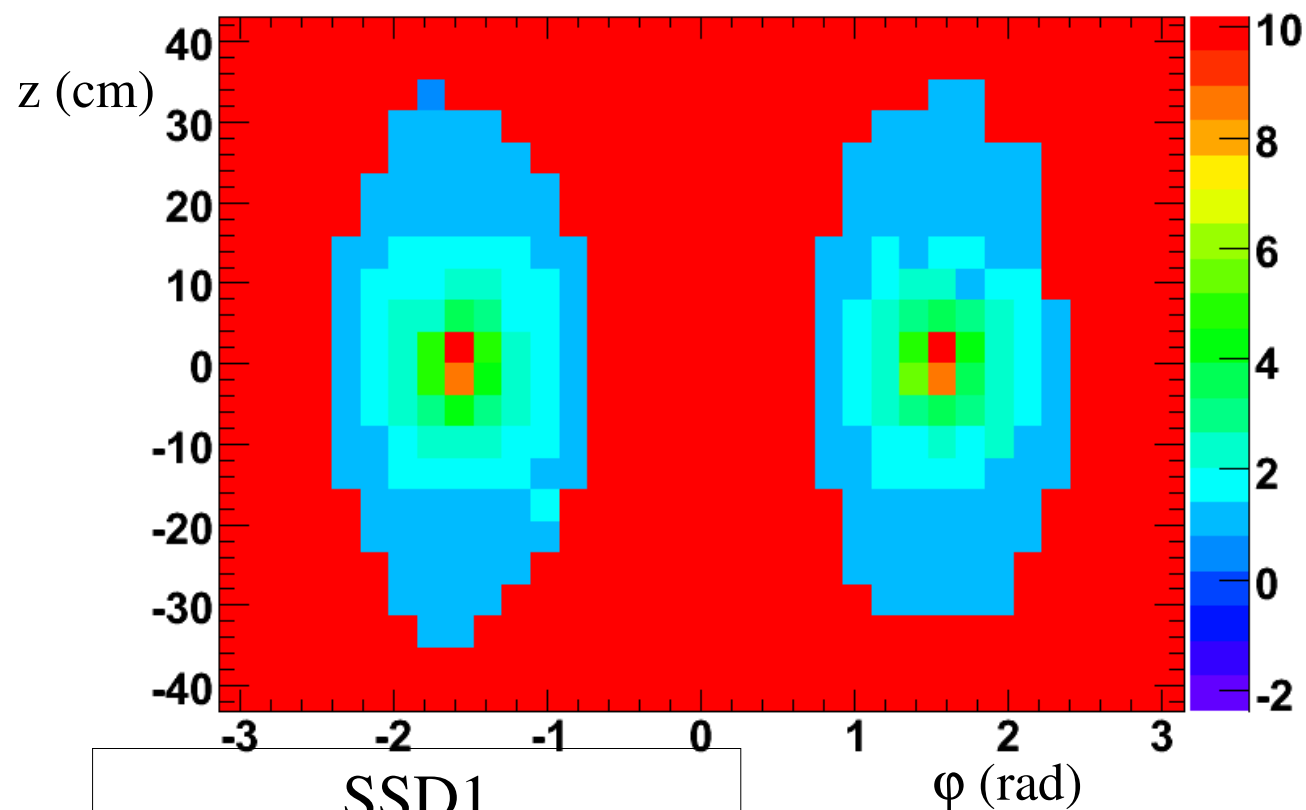
SigmaX=0.01 cm
UniformMisal. on SSD1

- the effect is independent from SigmaX value



!To Be Understood

Cov. Matrix., Linear: $\sigma_{\delta T_x} / \sigma_{\delta T_y}$

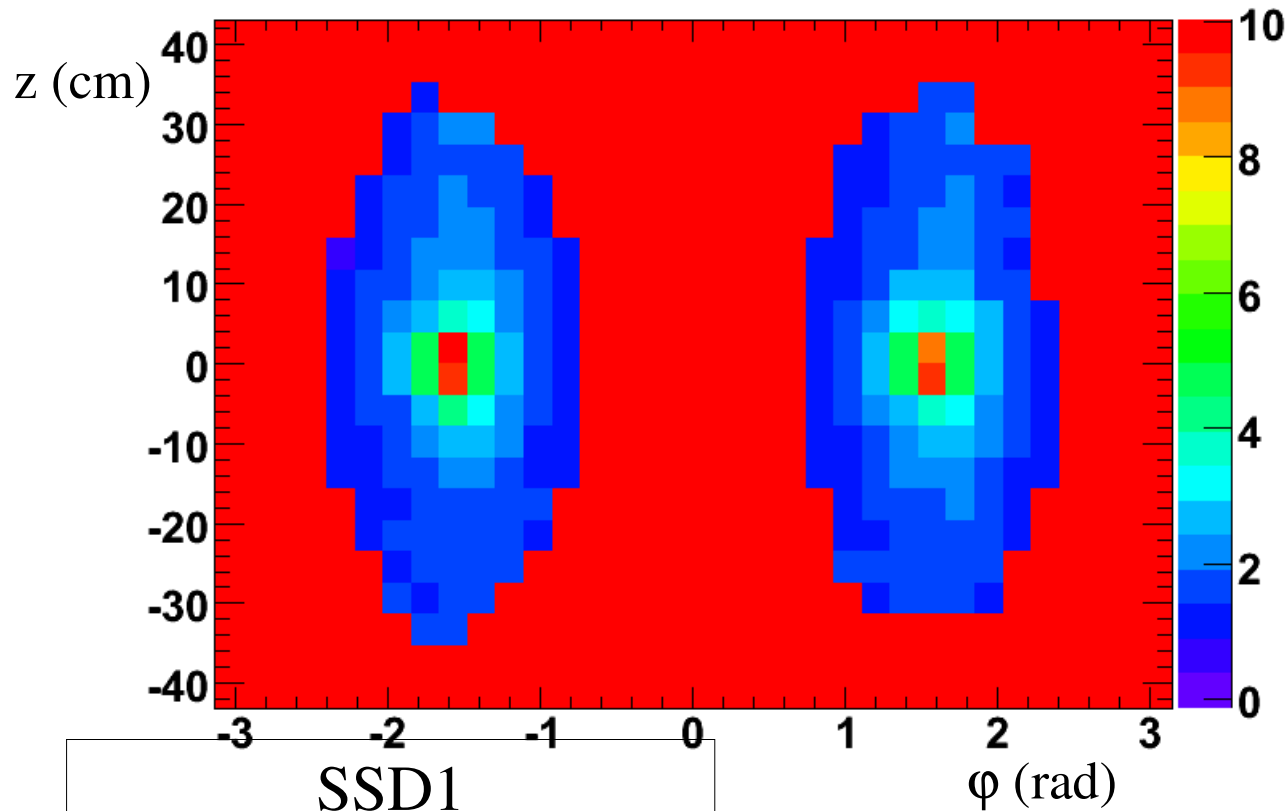


SSD1

SigmaX=100 cm

UniformMisal. on SSD1

Cov. Matrix., Linear: $\sigma_{\delta T_x} / \sigma_{\delta T_y}$



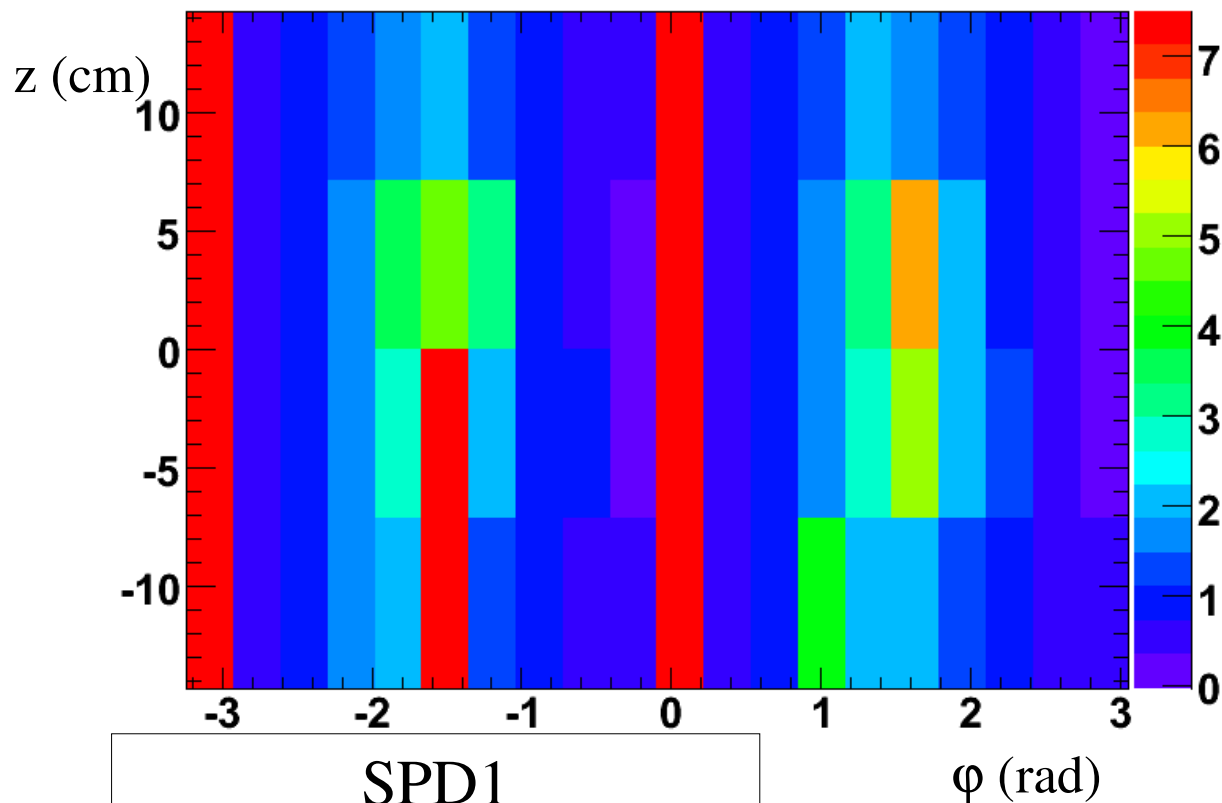
- Linear Minimizer shows the same behaviour

SSD1

SigmaX=0.01 cm

UniformMisal. on SSD1

Cov. Matrix., Res. Fast: $\sigma_{\delta T_x} / \sigma_{\delta T_y}$



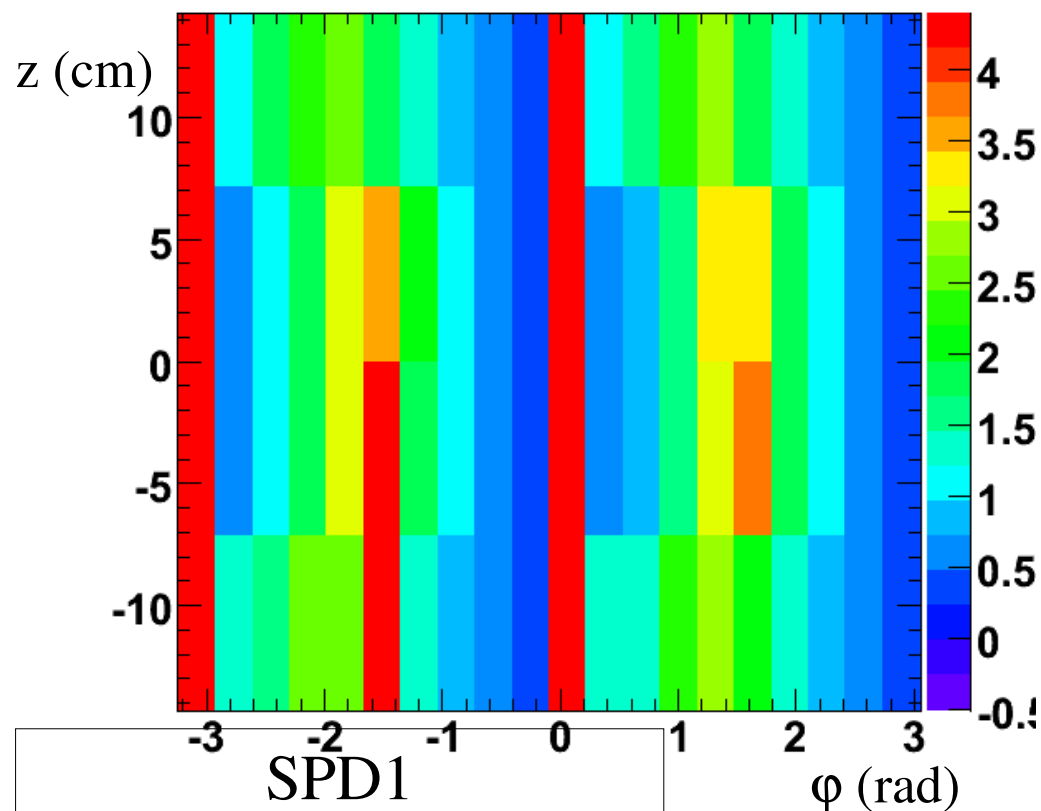
- Effect present in all Layers

SPD1

SigmaX=100 cm

UniformMisal. on SPD1

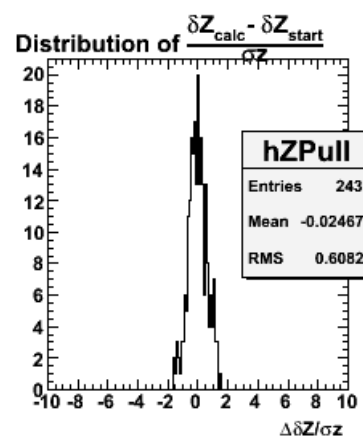
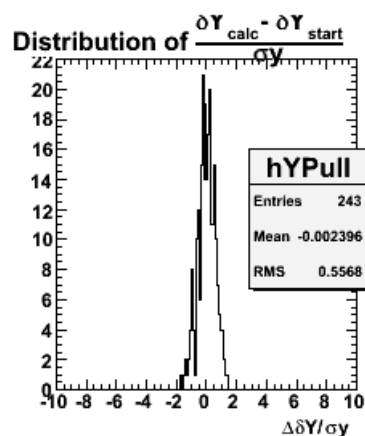
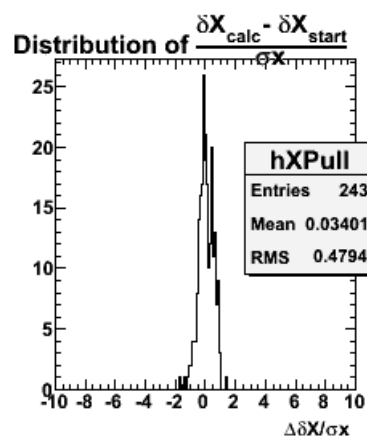
Cov. Matrix., Res. Fast: $\sigma_{\delta T_x} / \sigma_{\delta T_y}$



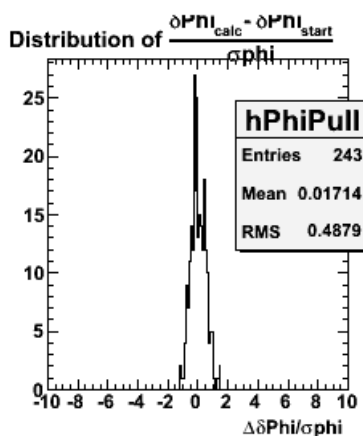
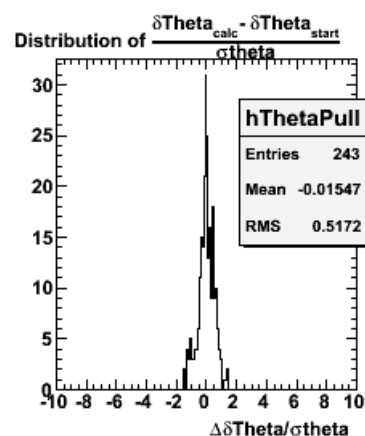
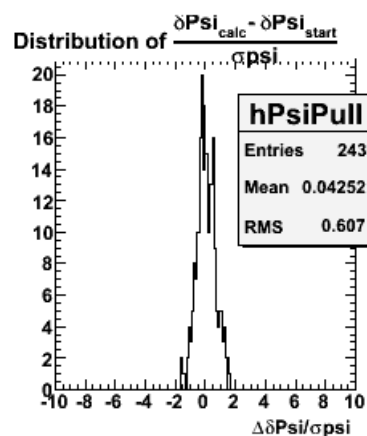
- Effect present in all Layers

SigmaX=0.01 cm
UniformMisal. on SPD1

Pull: Residual Fast



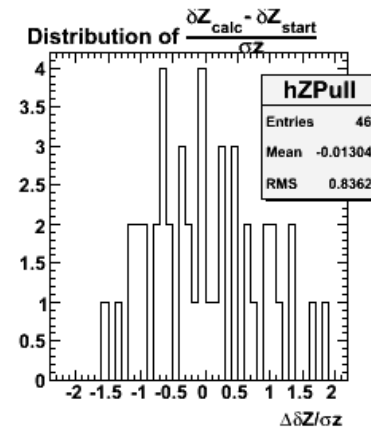
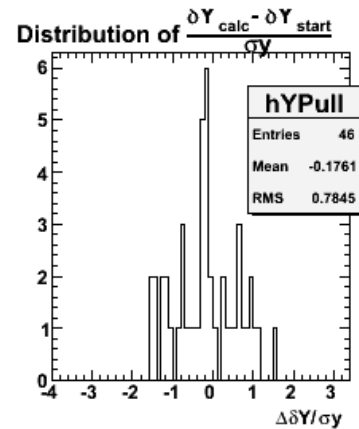
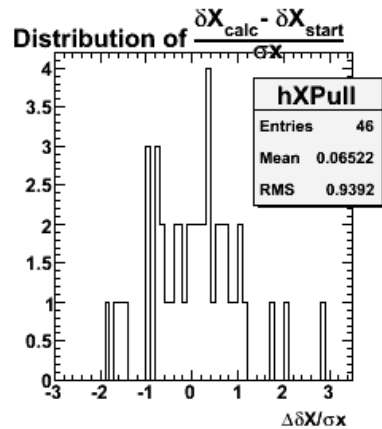
SSD1
 SigmaX=1 cm
 UniformMisal. on SSD1



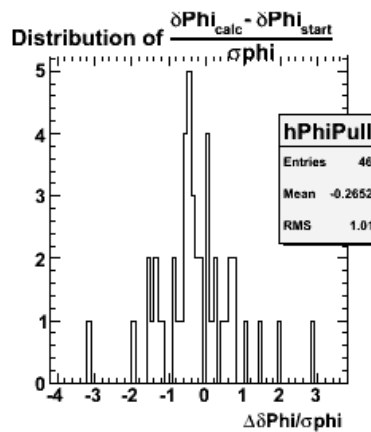
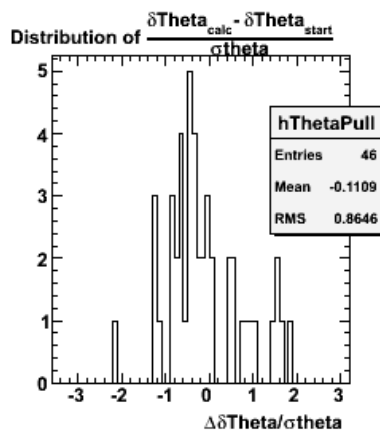
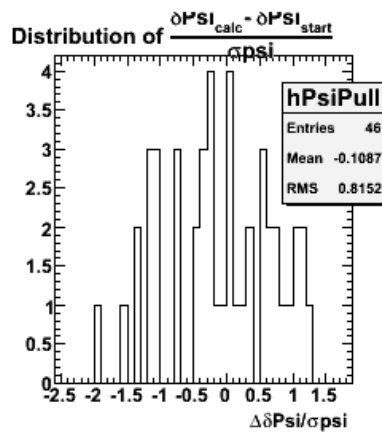
- RMS are always lower than 1

!Global Coordinate

Pull: Residual Fast



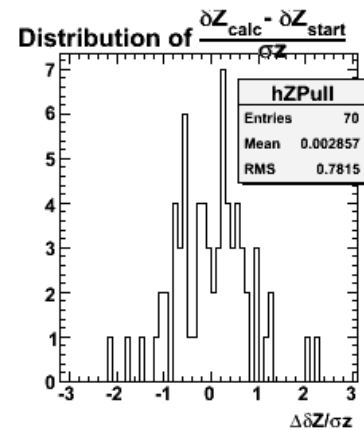
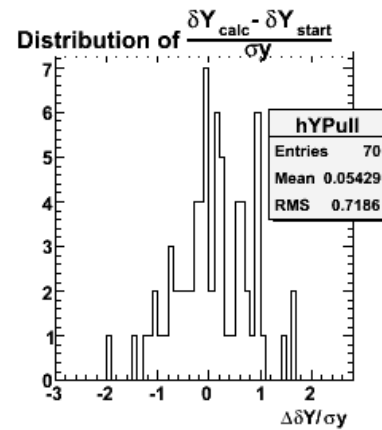
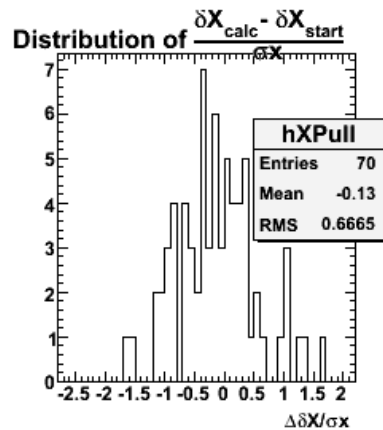
SDD1
SigmaX=1 cm
UniformMisal. on SDD1



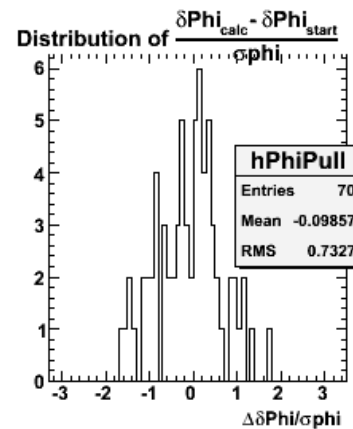
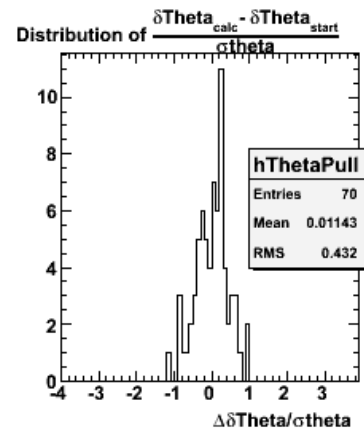
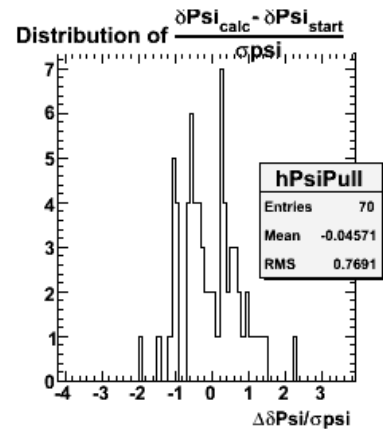
- quite good values
- SDD1 was the best realigned detector

!Global Coordinate

Pull: Residual Fast



SPD1
SigmaX=1 cm
UniformMisal. on SPD1



- Order of magnitude is not bad
- RMS always lower than 1

!Global Coordinate

Summarize Cov. Matrix

- Cov. Matrix for Residual Fast works
- Some negative variances are present
- $\sigma_{\delta Tx} / \sigma_{\delta Ty} > 1$ whether the opposite was expected, independently from
 - Minimizers
 - SigmaX
 - Layer
- Pulls are SigmaX dependent with still not understood behaviour

maybe some problem in the Cov. Matrix construction

—————▶ it might be the key also for the SigmaX problem (I hope...)