TRD alignment with AliAlignmentTracks

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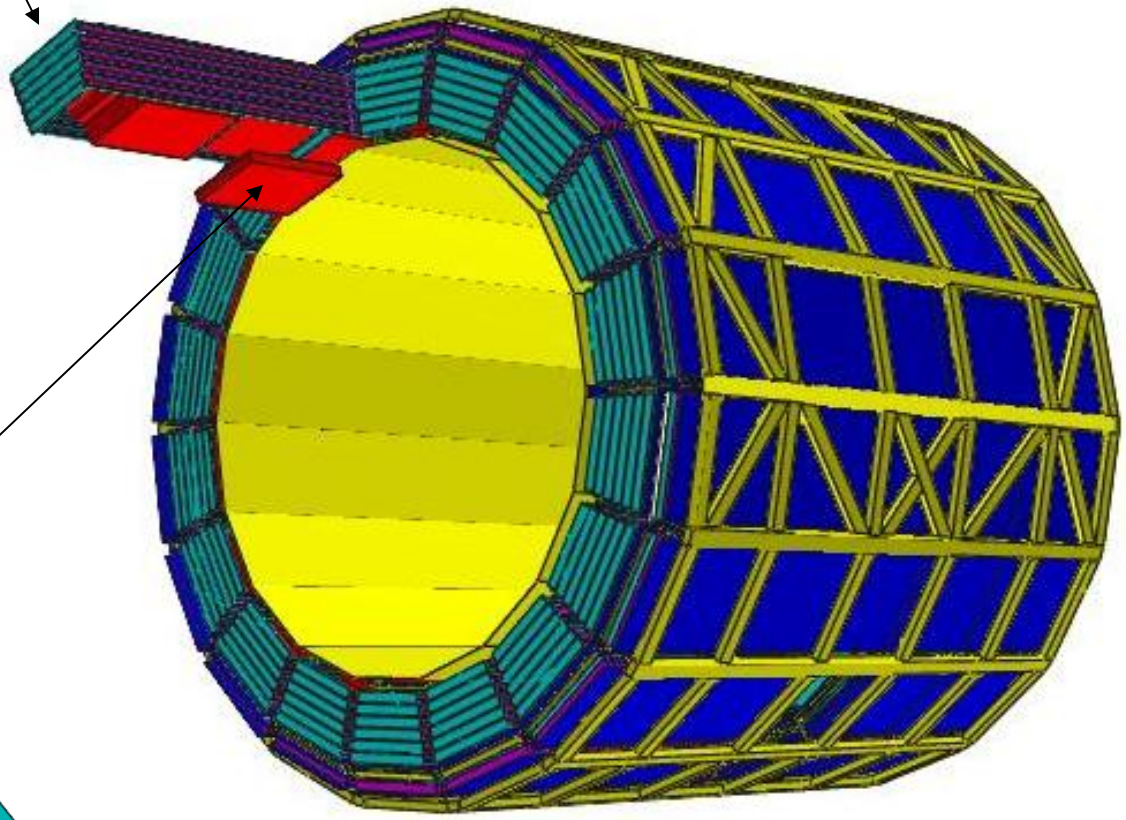
ALICE offline week, 10-Oct-2007

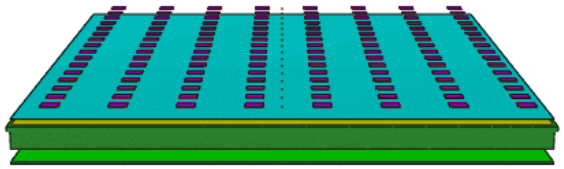
- *intro*
- *optimizing alignment procedure*
- *determination of residual resolution*
- *summary*

alignable objects in TRD

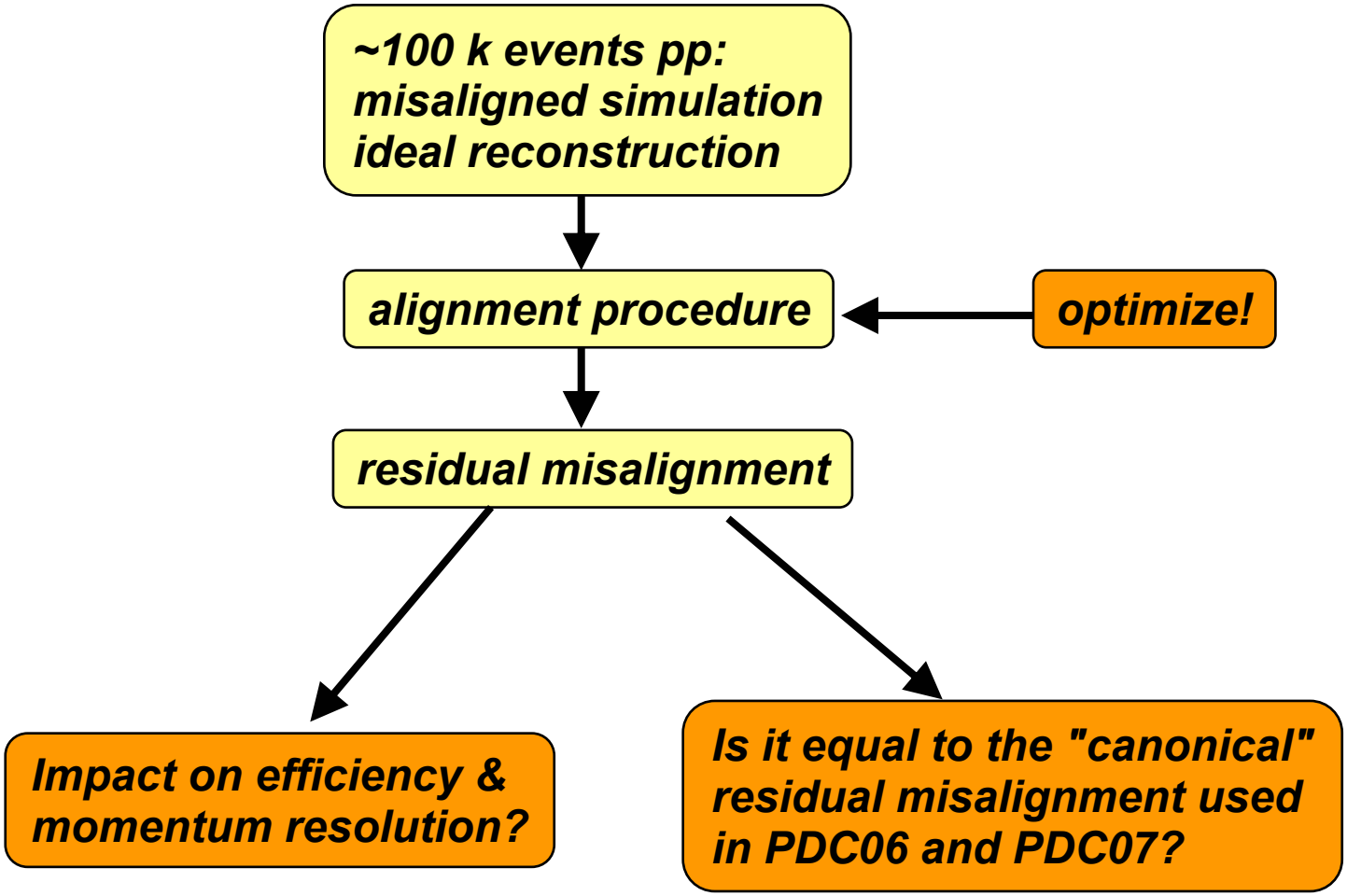
18 TRD supermodules
like /TRD/sm03
aligned by survey



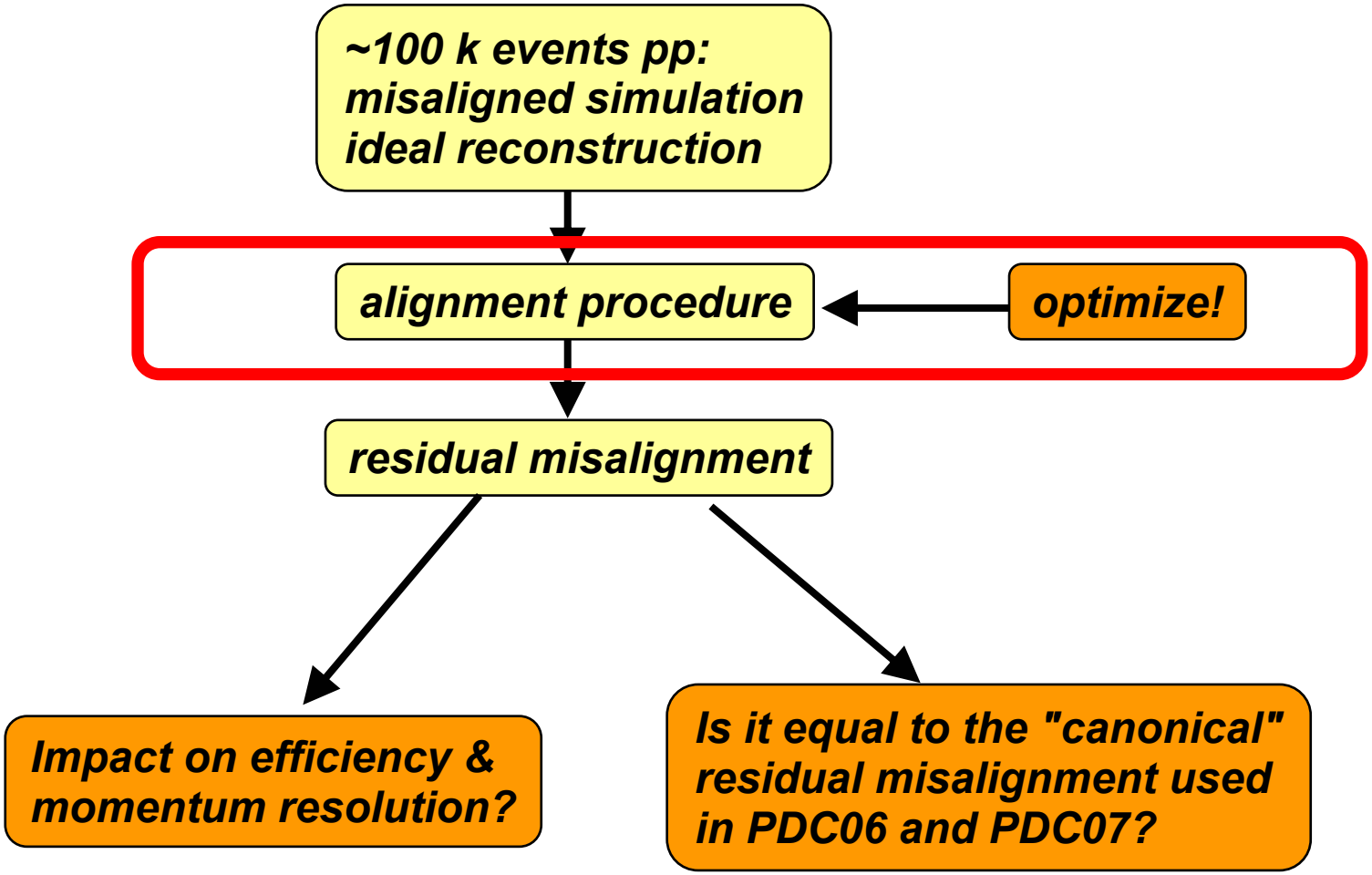
540 TRD chambers
like /TRD/sm03/st3/pl0
aligned with tracks



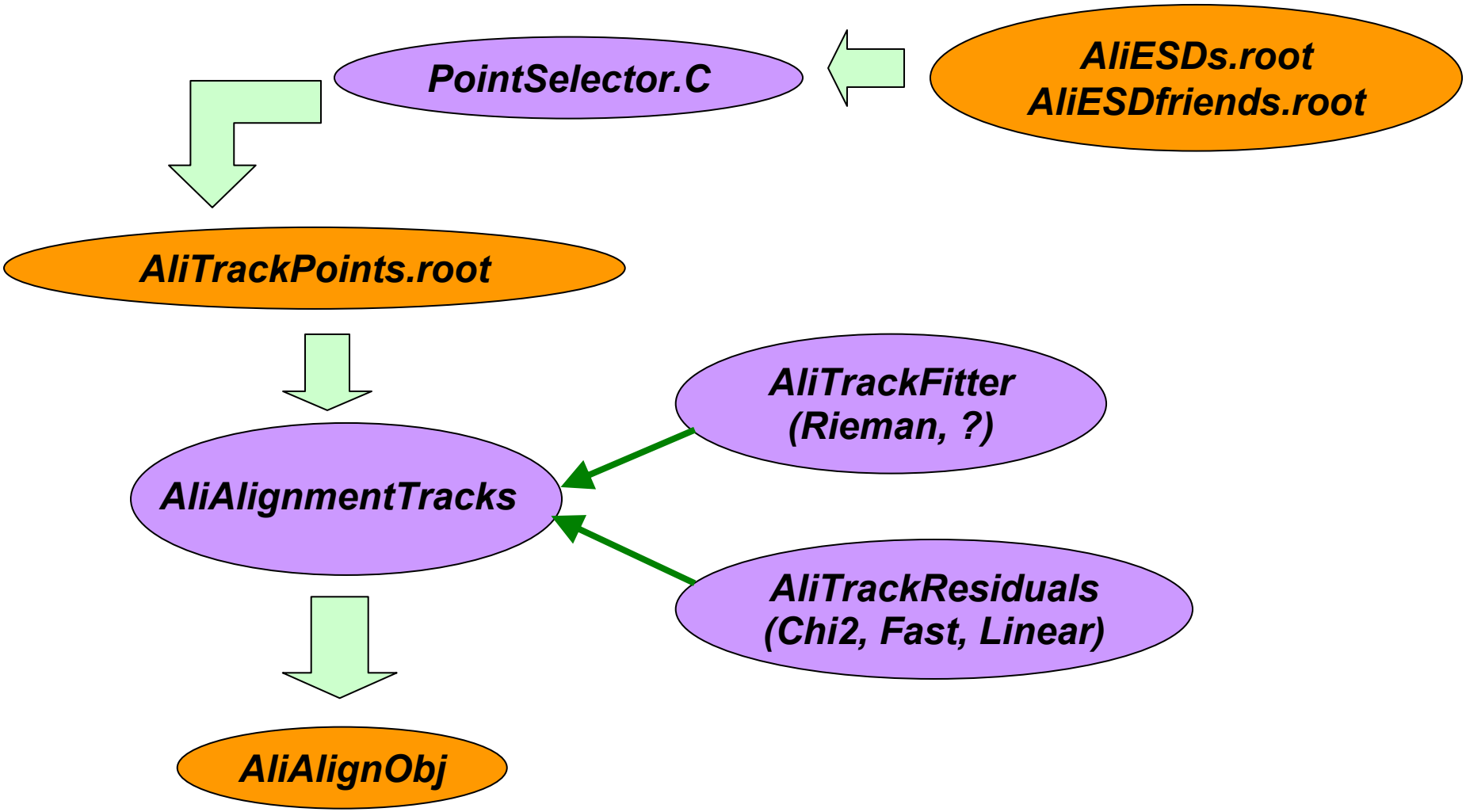
alignment study via simulation: general idea



alignment study via simulation: general idea



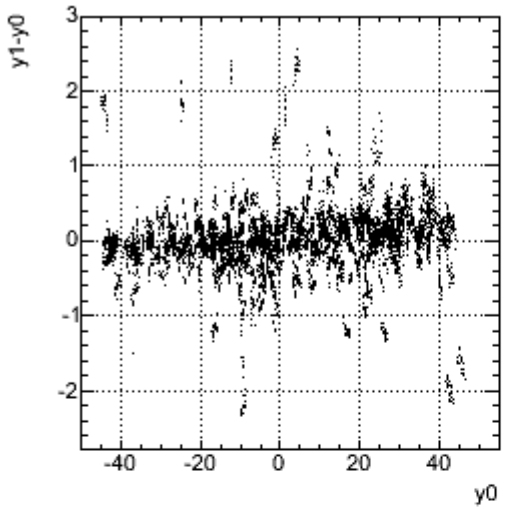
alignment procedure with AliAignmentTracks

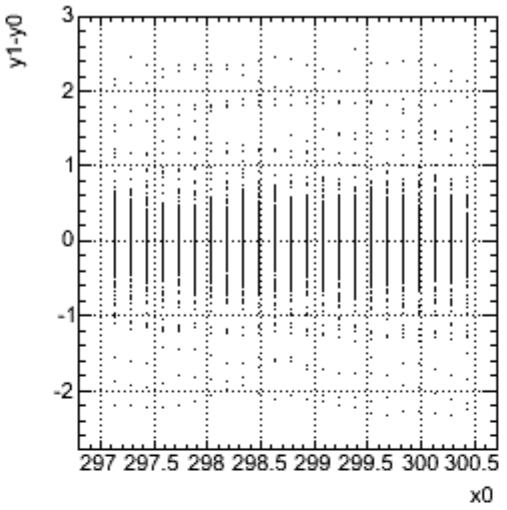


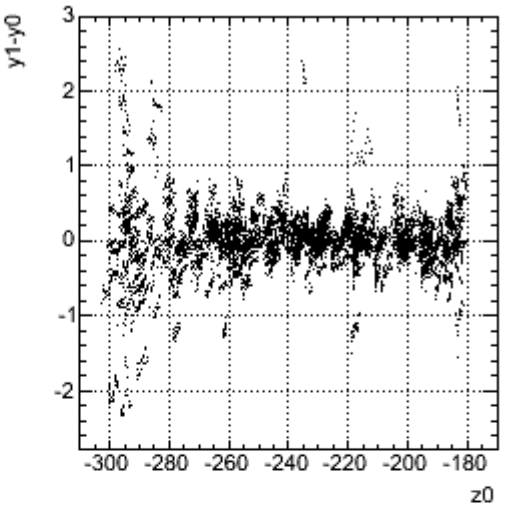
practicing the alignment procedure with AliAlignmentTracks

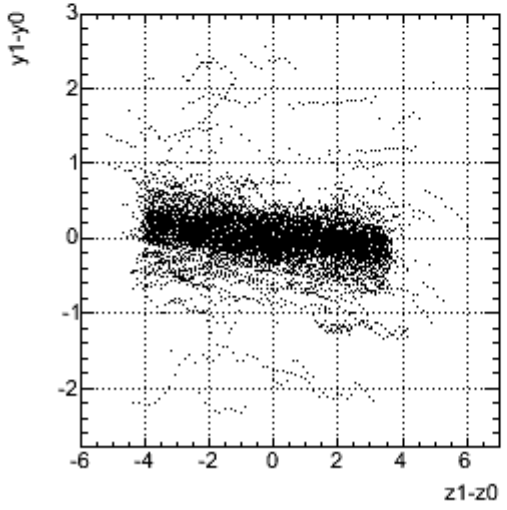
- ***30 k pp events with ideal alignment (Silvia Masciocchi's production)***
- ***~ 300-400 tracks with pt > 0.8 GeV in each TRD chamber***
- ***pick one particular TRD chamber and align it to TPC***
- ***look at the residuals along phi***
- ***the peak should be at zero and as narrow as possible***

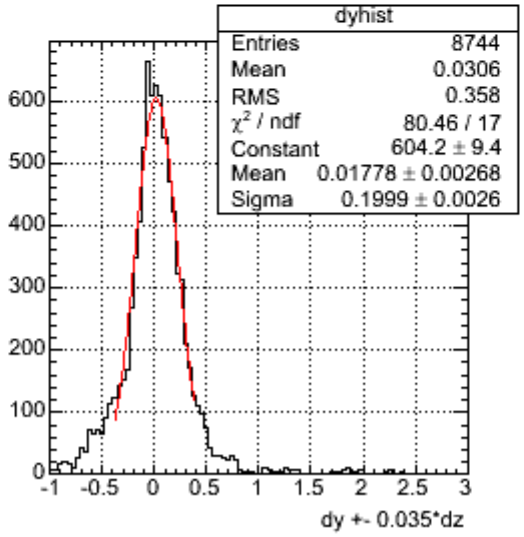
AliAlignmentTracks with AliTrackResidualsChi2











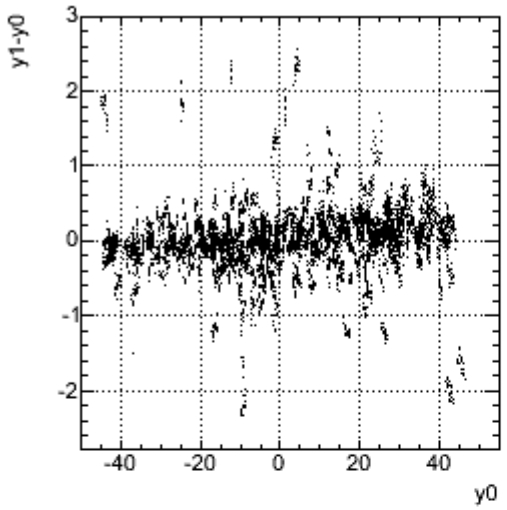
data/1054/AliTrackPoints.root
AliTrackResidualsChi2

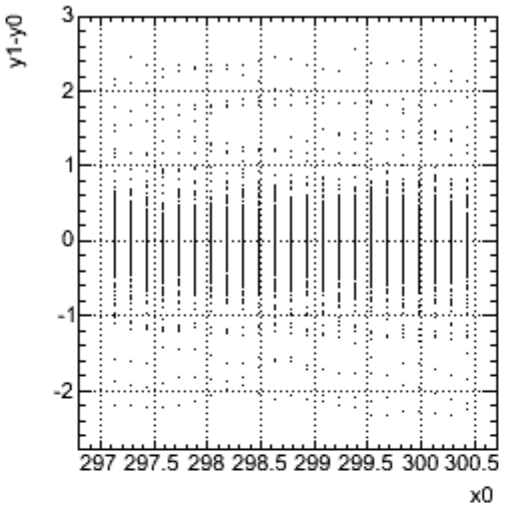
Aligning volumes
18446 (TRD/sm02/st4/pl0)
to reference volumes
14338 (TPC/EndcapA/Sector3/InnerChamber)
14356 (TPC/EndcapC/Sector3/InnerChamber)
16386 (TPC/EndcapA/Sector3/OuterChamber)
16404 (TPC/EndcapC/Sector3/OuterChamber)

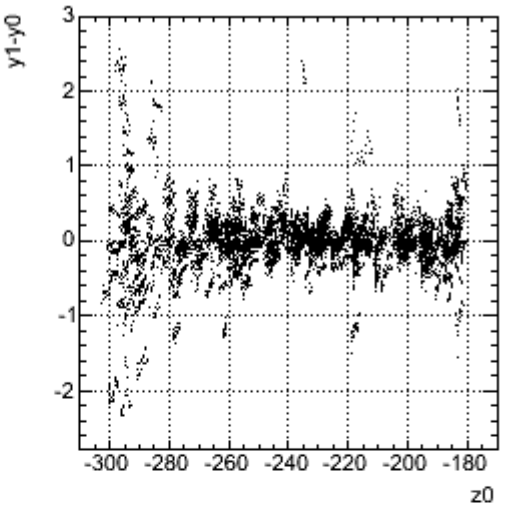
Result

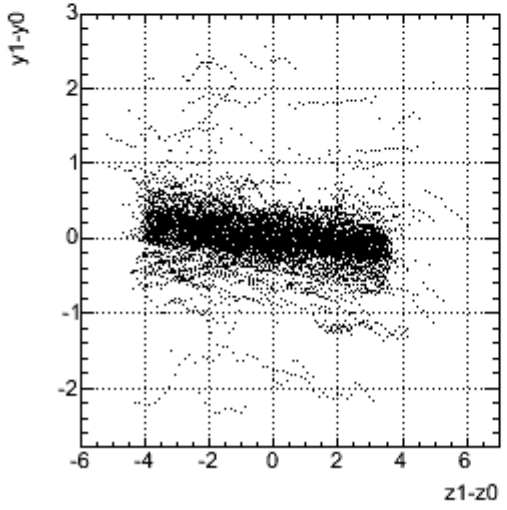
shift in phi	0.029
shift in z	0.036
shift in r	0.235
tilt in phi	0.2477
tilt in z	-0.0135
tilt in r	0.0283

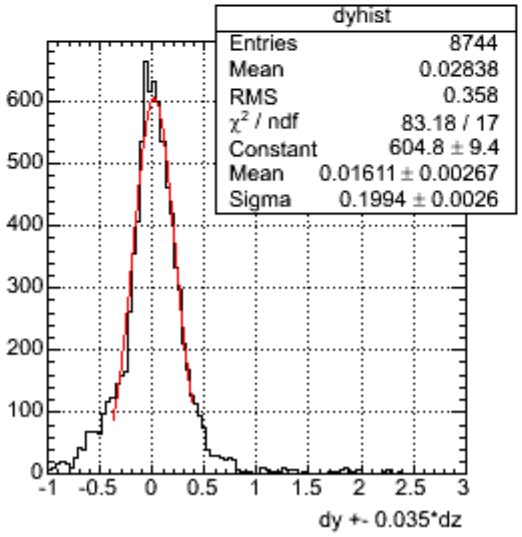
AliAlignmentTracks with AliTrackResidualsFast











data/1054/AliTrackPoints.root
AliTrackResidualsFast

Aligning volumes
18446 (TRD/sm02/st4/pl0)
to reference volumes
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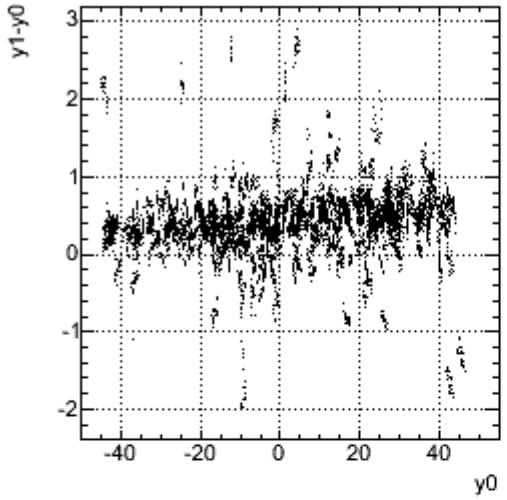
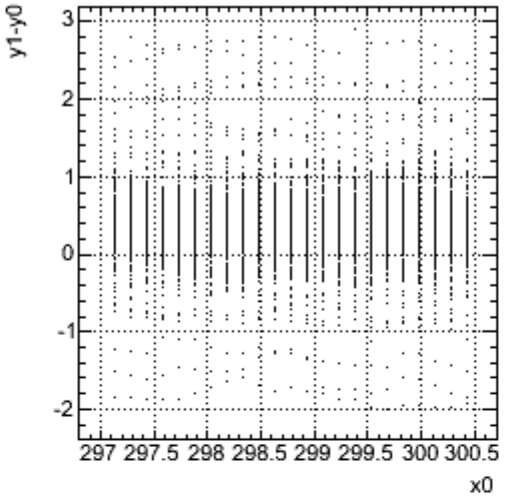
14356 (TPC/EndcapC/Sector3/InnerChamber)
16386 (TPC/EndcapA/Sector3/OuterChamber)
16404 (TPC/EndcapC/Sector3/OuterChamber)

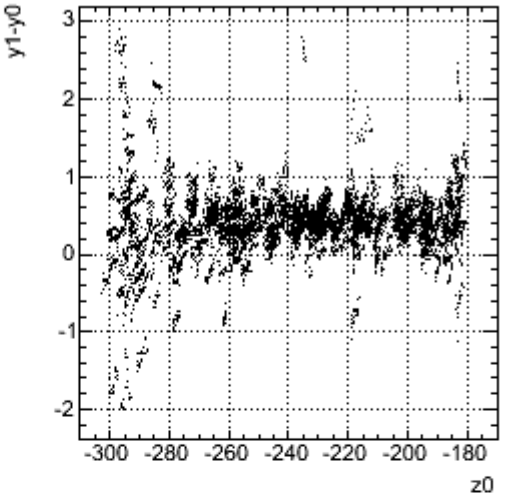
Result

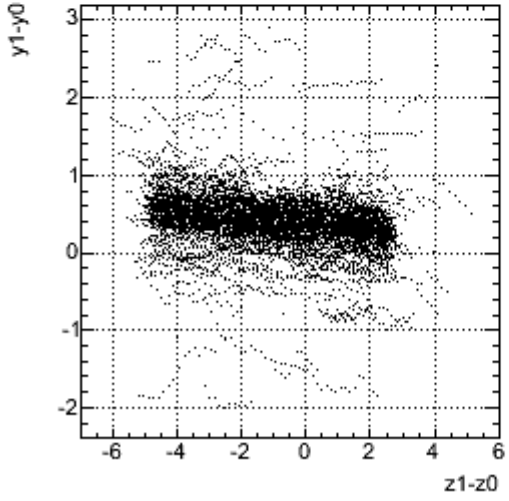
shift in phi	0.027
shift in z	0.037
shift in r	0.233
tilt in phi	0.2464
tilt in z	-0.0022
tilt in r	0.0284

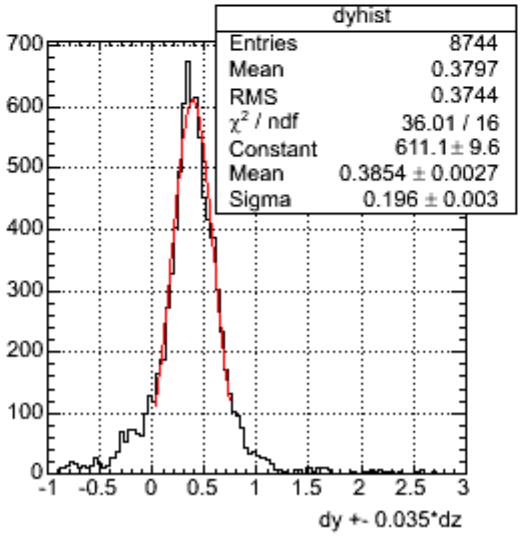
AliAlignmentTracks with AliTrackResidualsLinear











data/1054/AliTrackPoints.root
AliTrackResidualsLinear

Aligning volumes
18446 (TRD/sm02/st4/pl0)
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16386 (TPC/EndcapA/Sector3/OuterChamber)
16404 (TPC/EndcapC/Sector3/OuterChamber)

Result

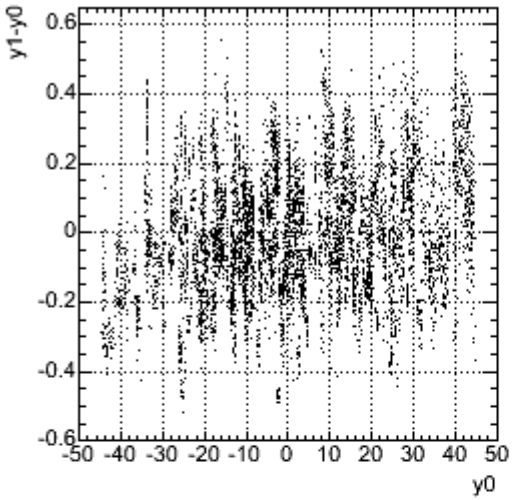
shift in phi	0.418
shift in z	-0.830
shift in r	0.400
tilt in phi	-0.0701
tilt in z	-0.1370
tilt in r	-0.0157

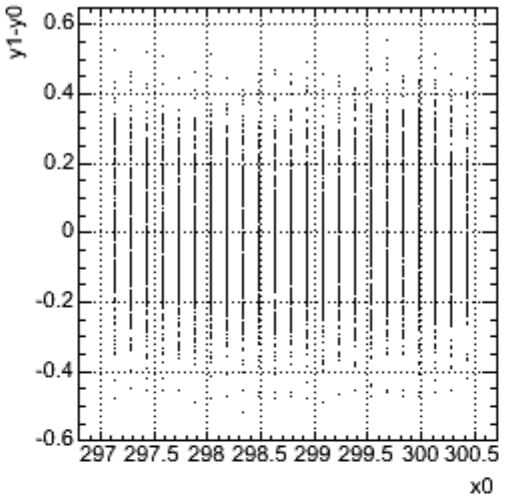
AliTrackResiduals daughters compared

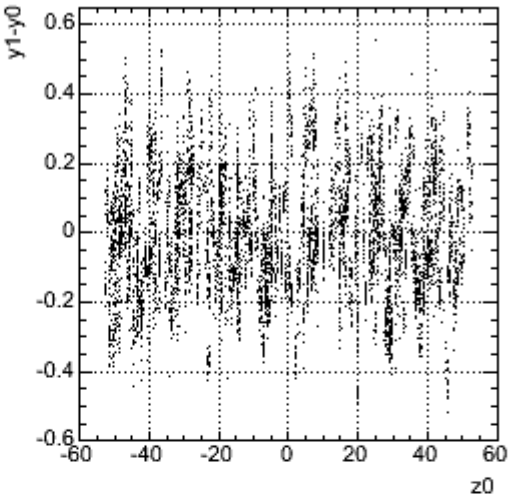
	time per ch	fixing params	ignoring outliers	working?
AliTrackResidualsChi2	34 s	+	–	+
AliTrackResidualsFast	3 s	–	–	+
AliTrackResidualsLinear	8 s	+	+	–*

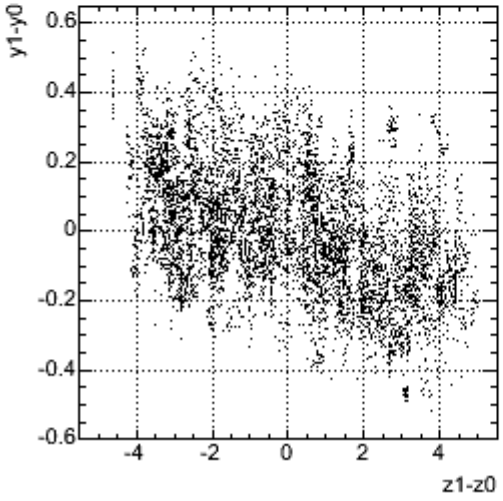
* setting fraction to 100% does not help
changing σ_x from 100 to 1 cm does not help

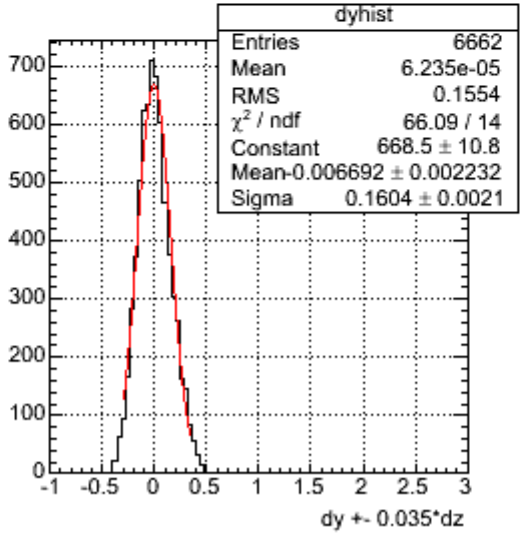
external (to AliTrackResiduals) removal of outliers











data/1054/AliTrackPoints.root
AliTrackResidualsFast

Aligning volumes
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to reference volumes
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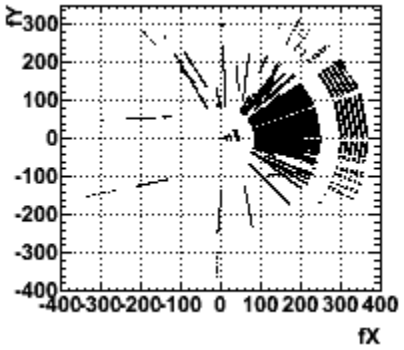
14356 (TPC/EndcapC/Sector3/InnerChamber)
16386 (TPC/EndcapA/Sector3/OuterChamber)
16404 (TPC/EndcapC/Sector3/OuterChamber)

Result

shift in phi	-0.031
shift in z	0.330
shift in r	0.276
tilt in phi	-0.0019
tilt in z	0.1338
tilt in r	-0.0110

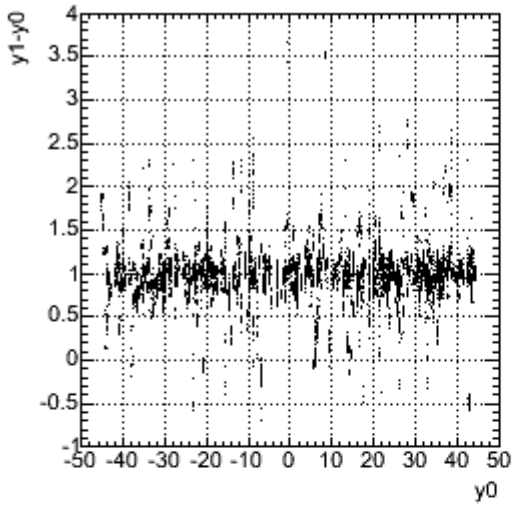
Does it work for non-zero initial misalignment, too?

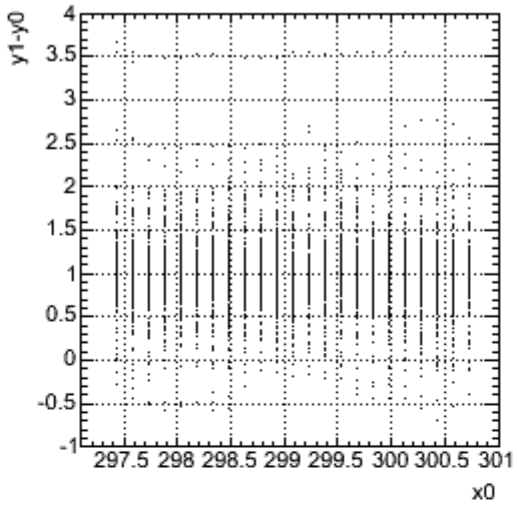
- *use 10 events with 200 particles with pt > 1 GeV sent in the direction of one particular stack → 400 tracks used to align one chamber*

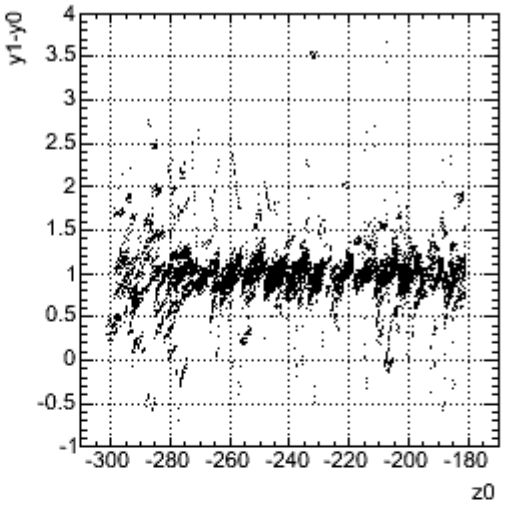


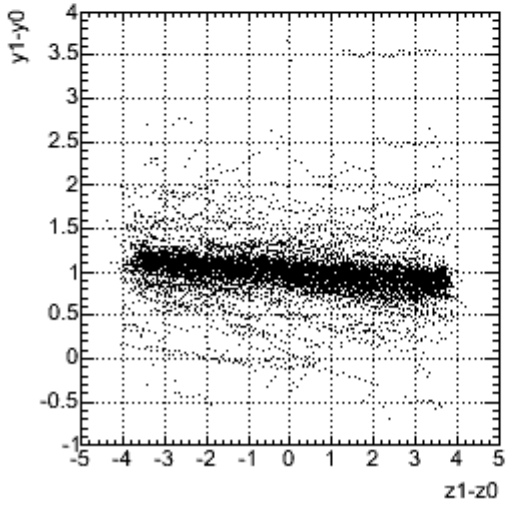
- *introduce misalignment at the beginning of the alignment procedure*
- *look at the residuals before alignment (just to get some feeling)*
- *look at the residuals after alignment – are they zero centered?*

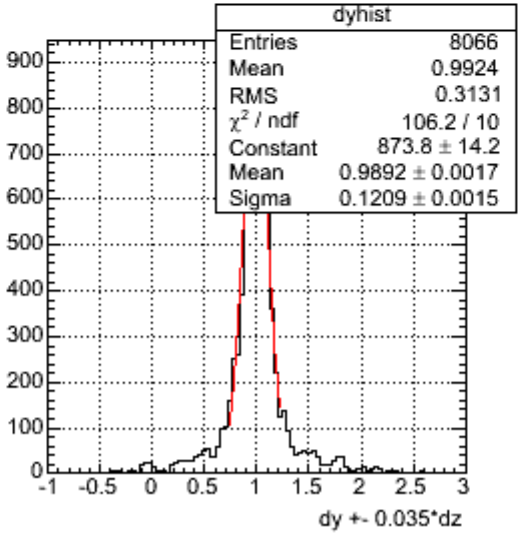
1 cm shift in phi – before alignment











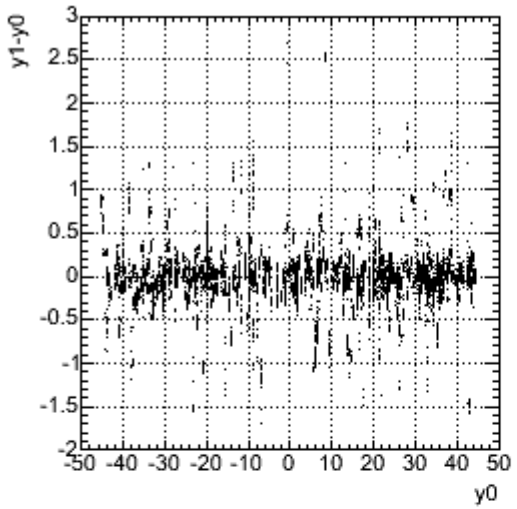
data/1051/AliTrackPoints.root
AliTrackResidualsFast

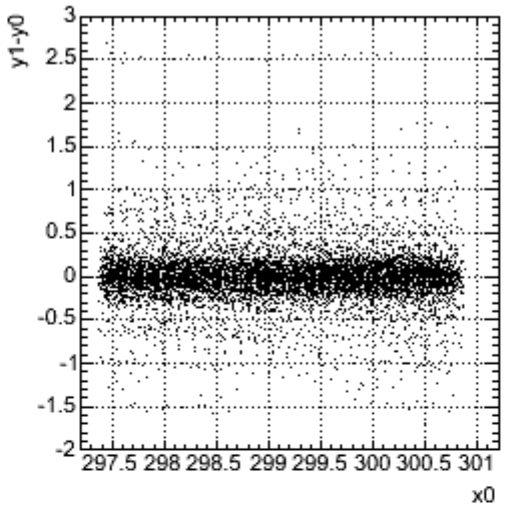
Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

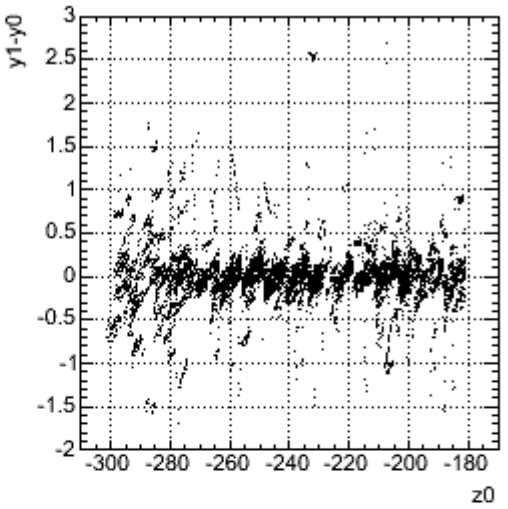
Result

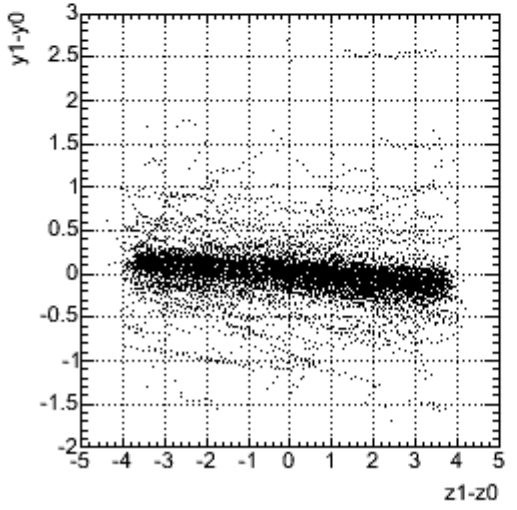
shift in phi	0.014
shift in z	-0.024
shift in r	0.048
tilt in phi	-0.0535
tilt in z	-0.0823
tilt in r	0.0001

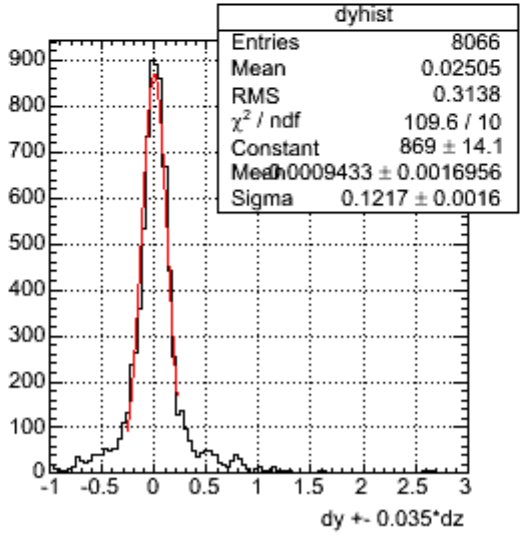
... after alignment











data/1051/AliTrackPoints.root
AliTrackResidualsFast

Aligning volumes
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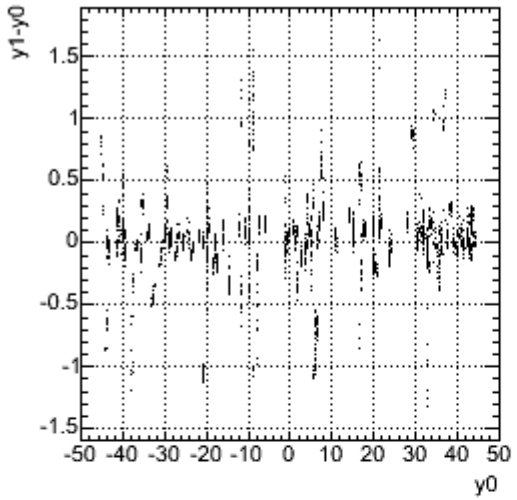
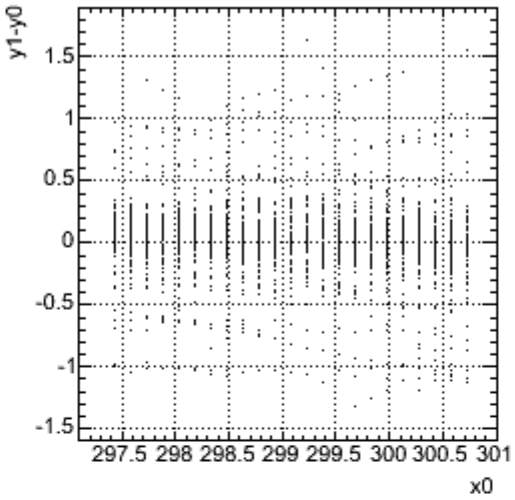
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

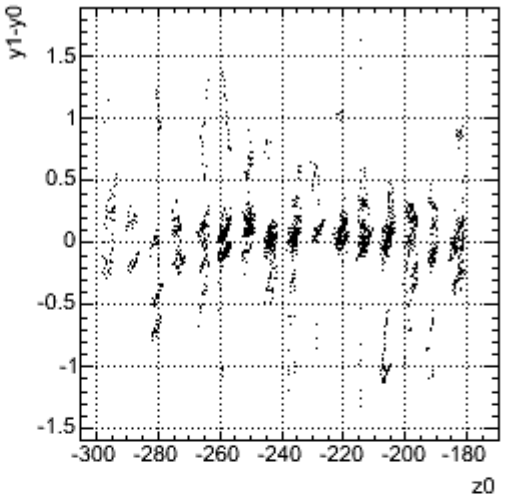
Result

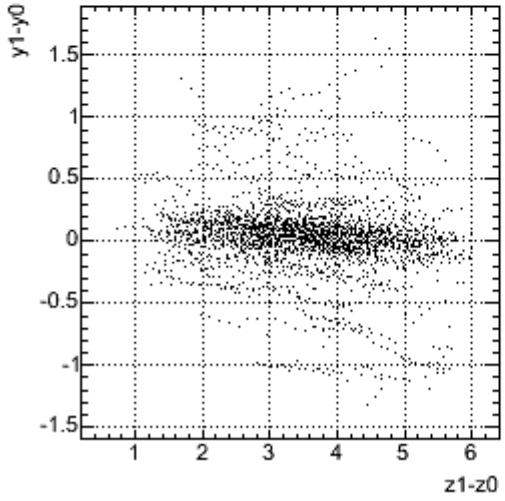
shift in phi	0.014
shift in z	-0.024
shift in r	0.048
tilt in phi	-0.0536
tilt in z	-0.0837
tilt in r	0.0000

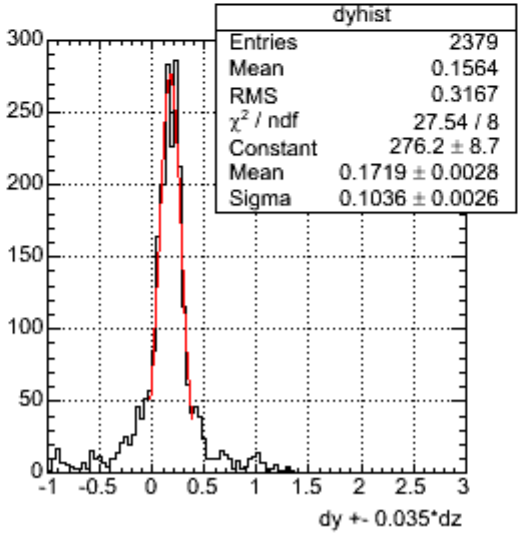
5 cm shift in z – before alignment











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AliTrackResidualsFast

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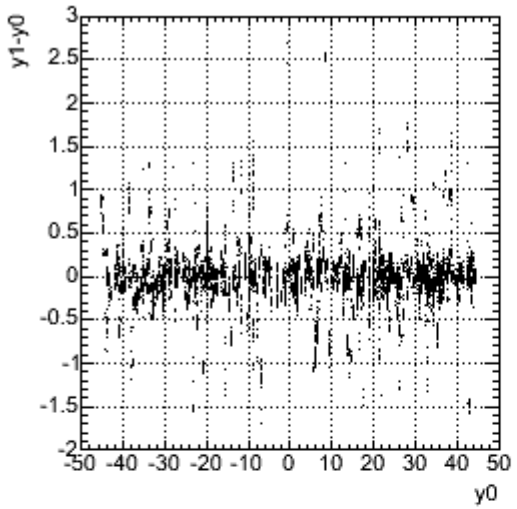
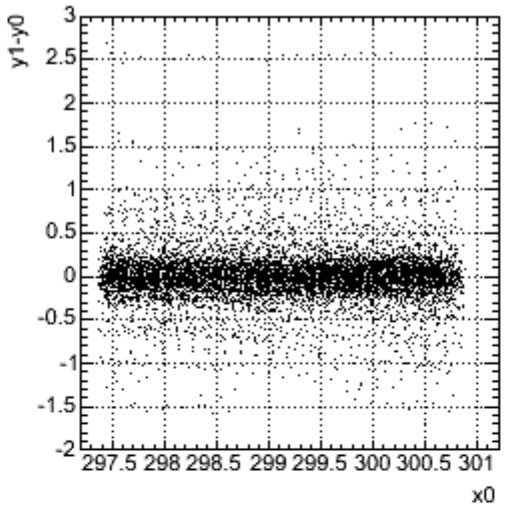
16402 (TPC/EndcapC/Sector1/OuterChamber)

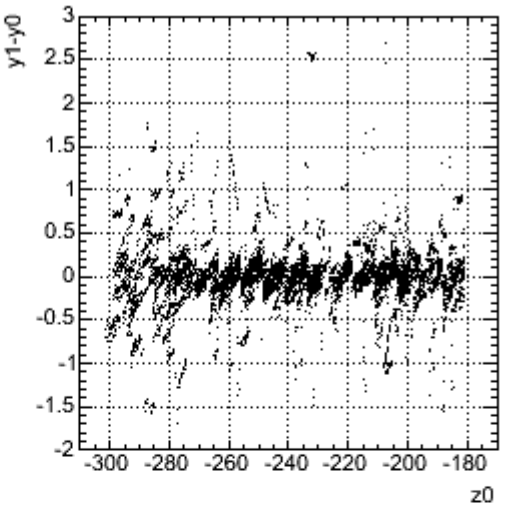
Result

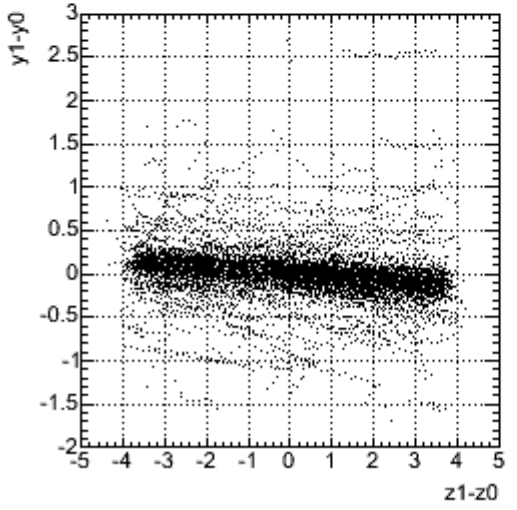
shift in phi	-0.025
shift in z	1.114
shift in r	0.468
tilt in phi	0.1196
tilt in z	0.0205
tilt in r	-0.0436

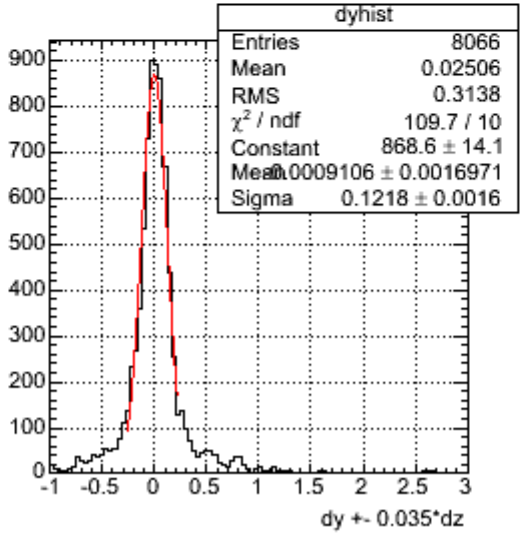
... after alignment











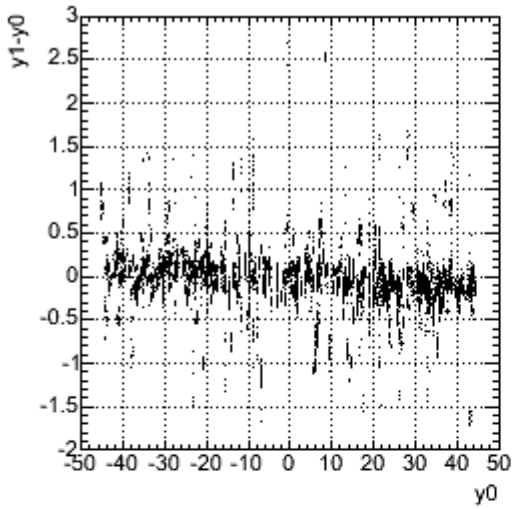
data/1051/AliTrackPoints.root
AliTrackResidualsFast

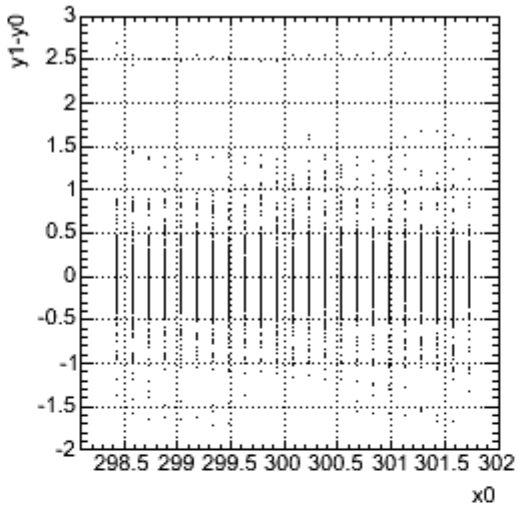
Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

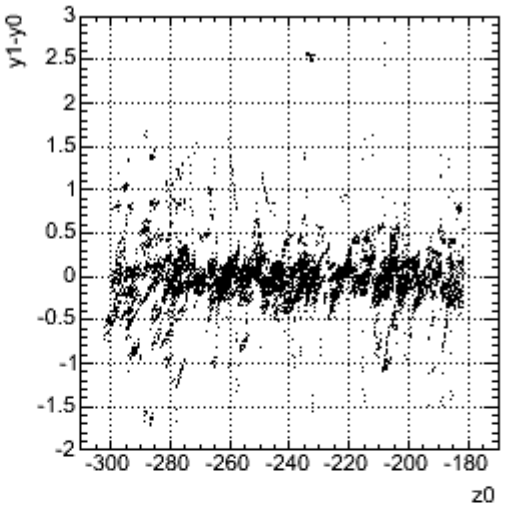
Result

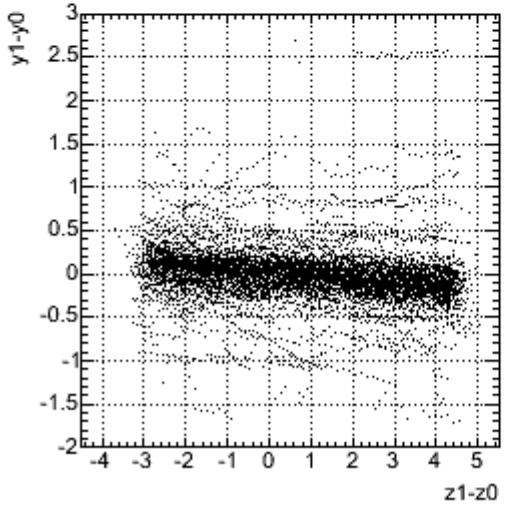
shift in phi	0.014
shift in z	-0.024
shift in r	0.048
tilt in phi	-0.0535
tilt in z	-0.0836
tilt in r	0.0000

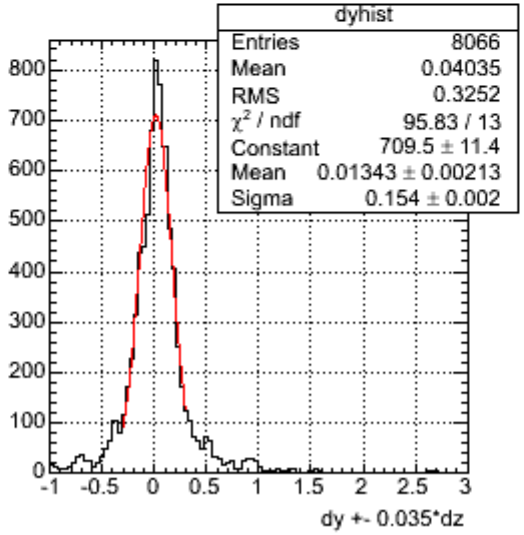
1 cm shift in r – before alignment











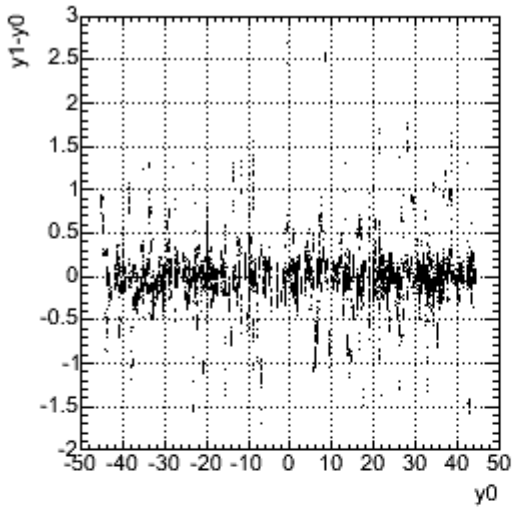
data/1051/AliTrackPoints.root
AliTrackResidualsFast

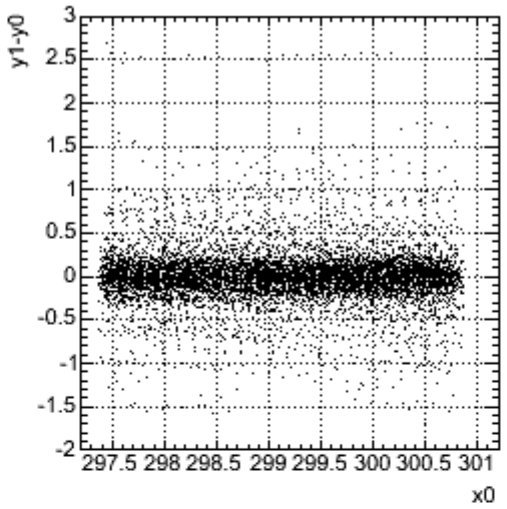
Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

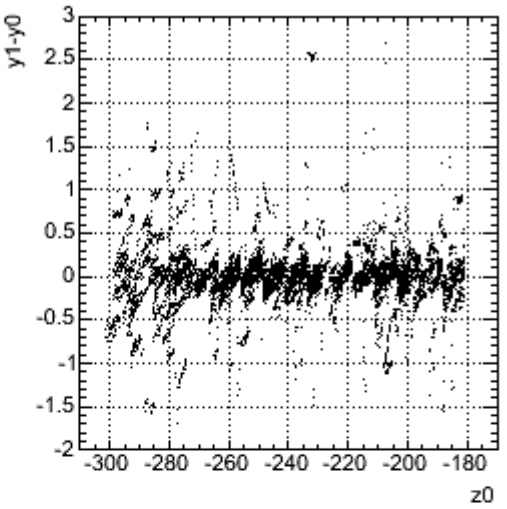
Result

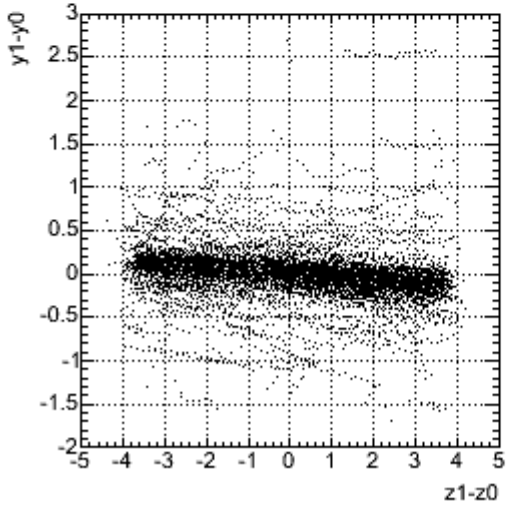
shift in phi	0.014
shift in z	-0.025
shift in r	0.048
tilt in phi	-0.0543
tilt in z	-0.0830
tilt in r	0.0001

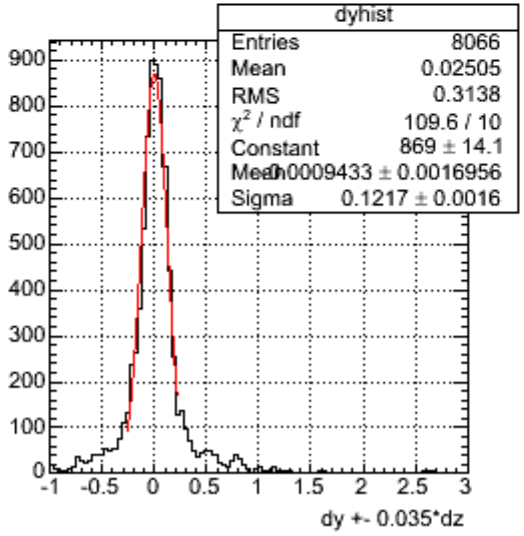
... after alignment











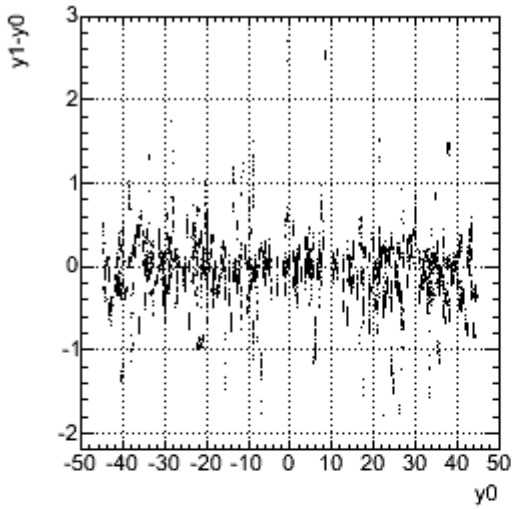
data/1051/AliTrackPoints.root
AliTrackResidualsFast

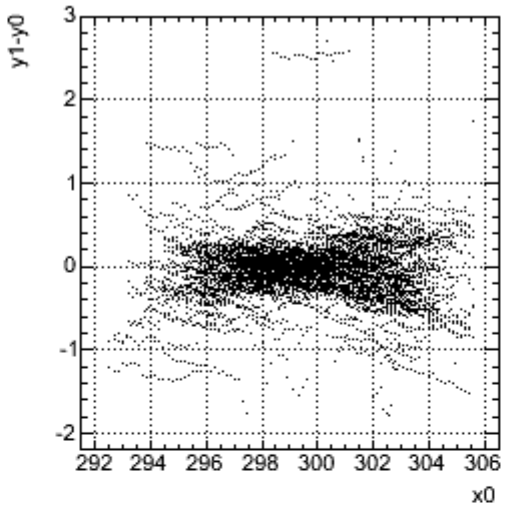
Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

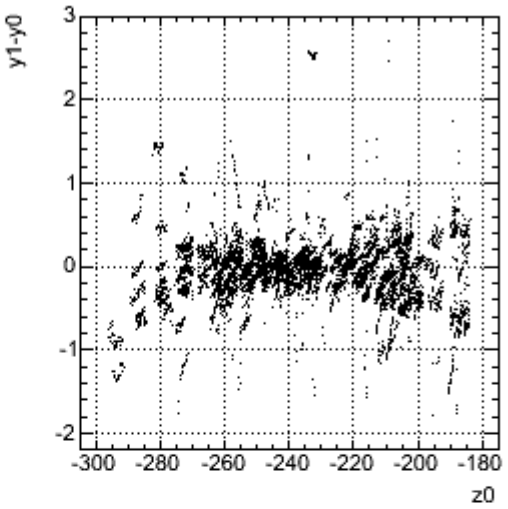
Result

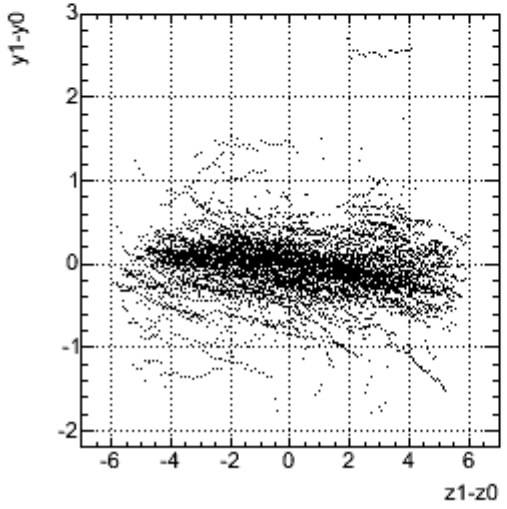
shift in phi	0.014
shift in z	-0.024
shift in r	0.049
tilt in phi	-0.0536
tilt in z	-0.0837
tilt in r	0.0000

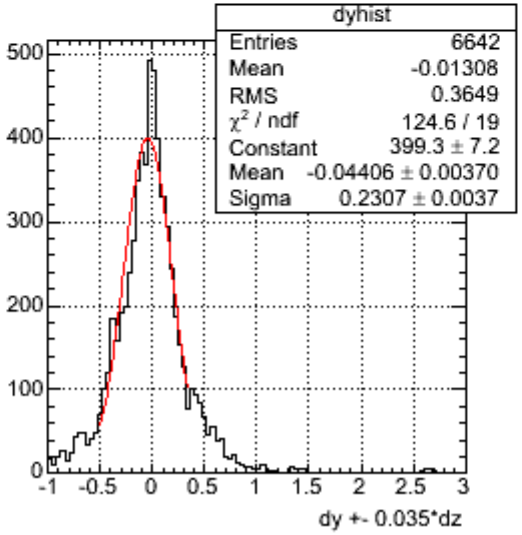
5 deg tilt in phi – before alignment











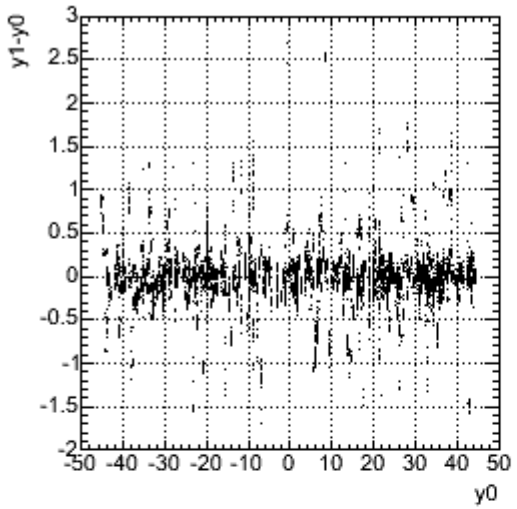
data/1051/AliTrackPoints.root
AliTrackResidualsFast

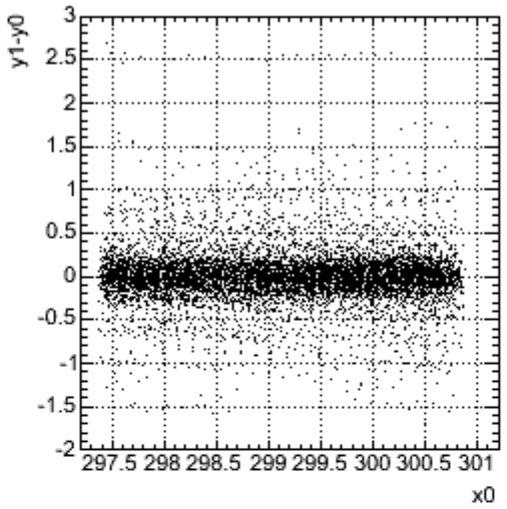
Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

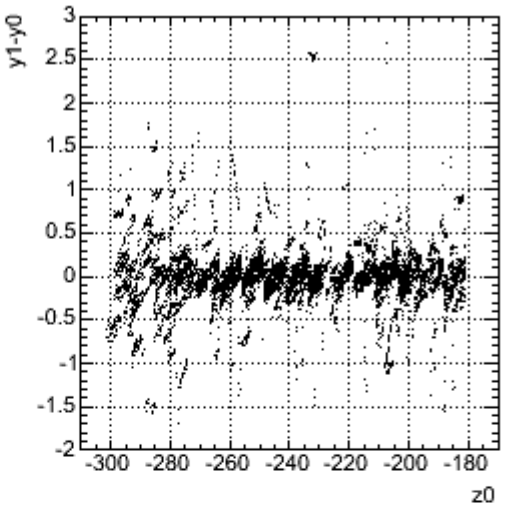
Result

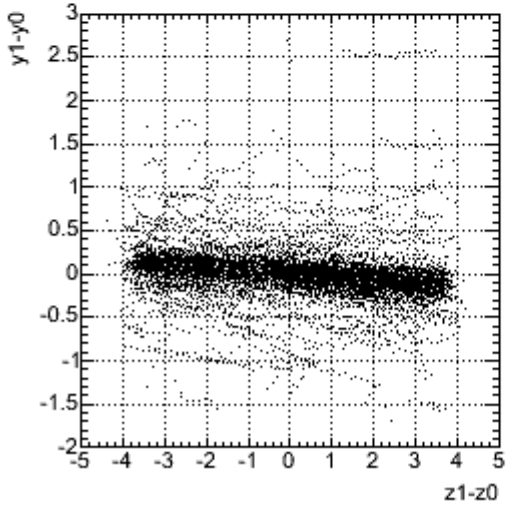
shift in phi	-0.206
shift in z	0.841
shift in r	-1.208
tilt in phi	-0.1587
tilt in z	-0.0231
tilt in r	0.0158

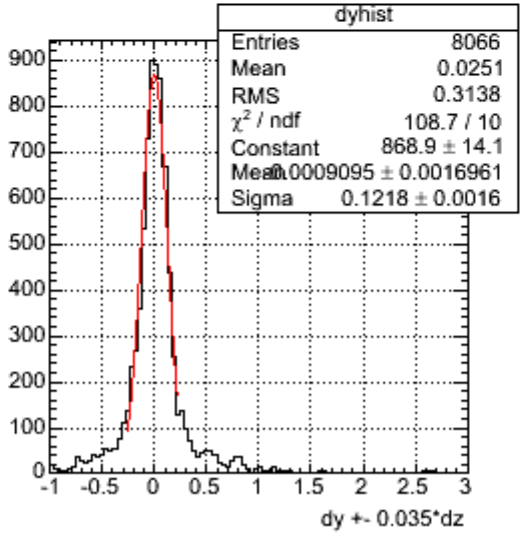
... after alignment











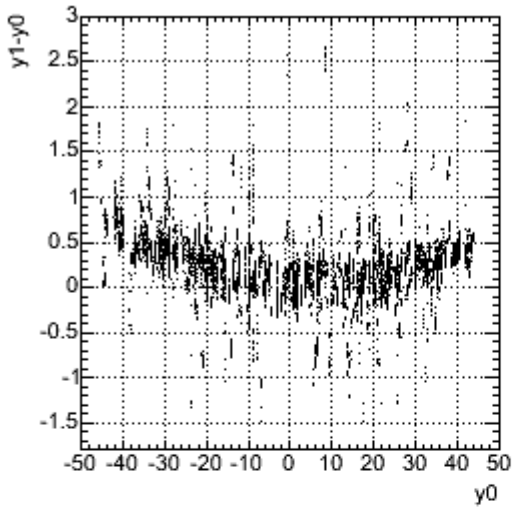
data/1051/AliTrackPoints.root
AliTrackResidualsFast

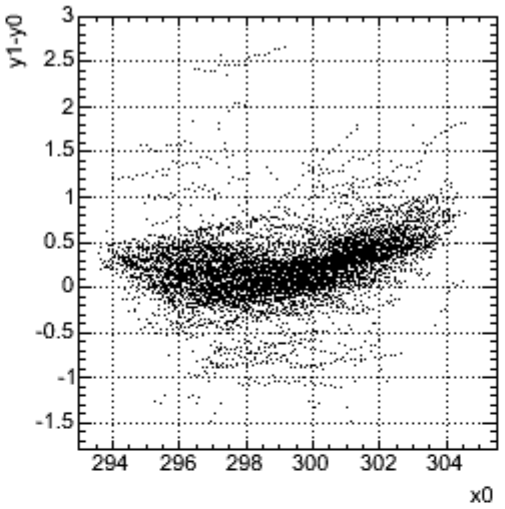
Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

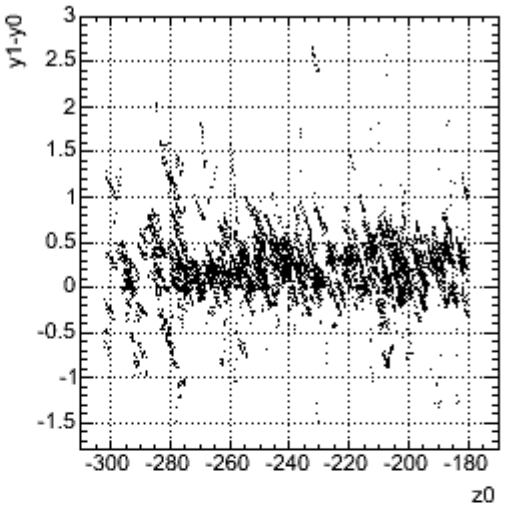
Result

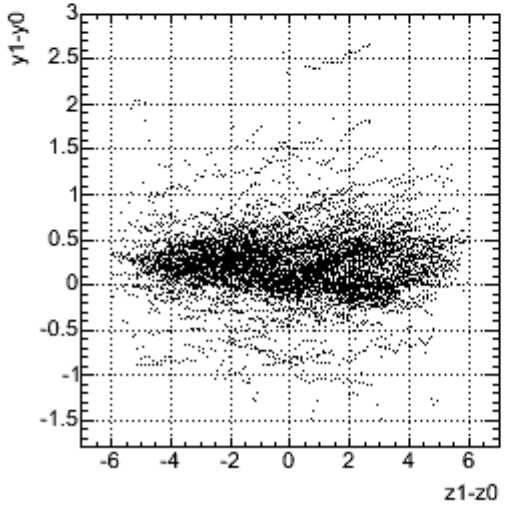
shift in phi	0.014
shift in z	-0.024
shift in r	0.048
tilt in phi	-0.0535
tilt in z	-0.0836
tilt in r	0.0000

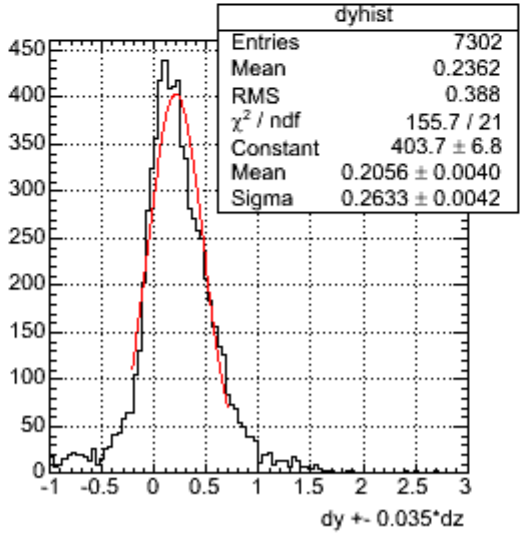
5 deg tilt in z – before alignment











data/1051/AliTrackPoints.root
AliTrackResidualsFast

Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
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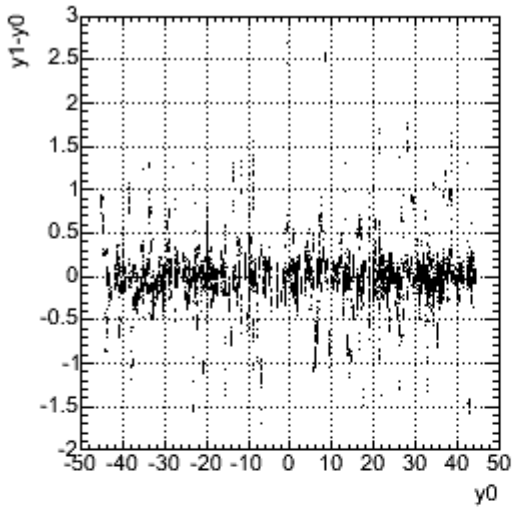
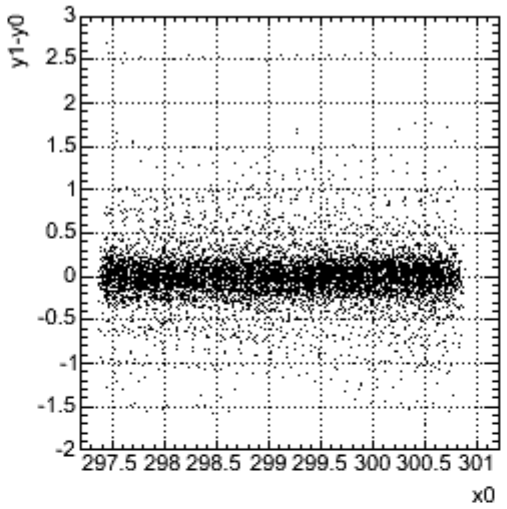
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

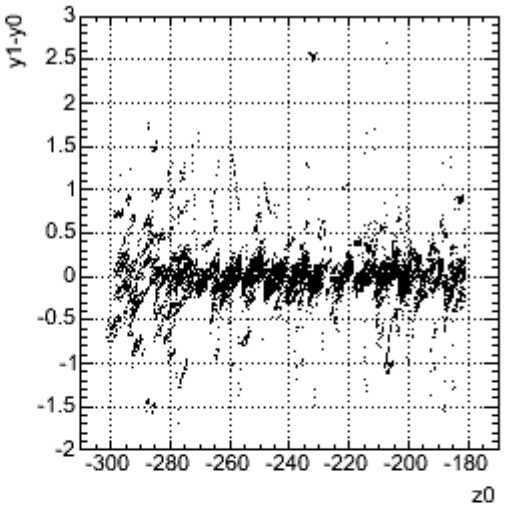
Result

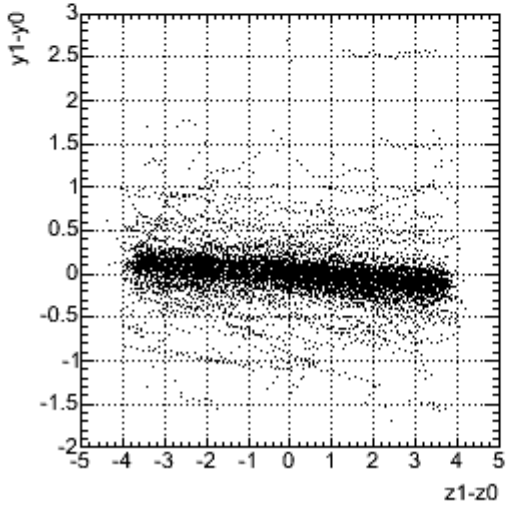
shift in phi	0.025
shift in z	-0.789
shift in r	-0.001
tilt in phi	0.1708
tilt in z	0.2926
tilt in r	-0.0048

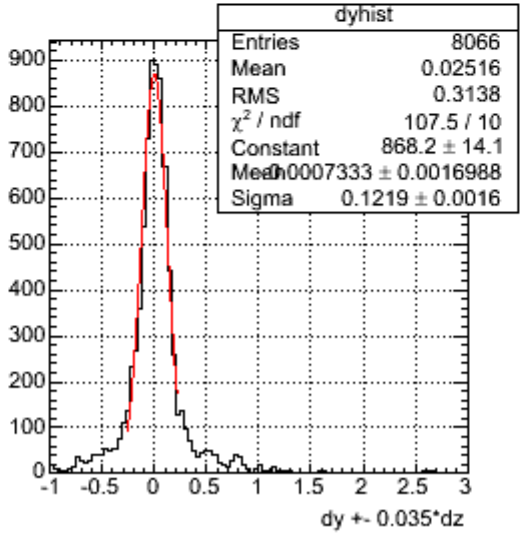
... after alignment











data/1051/AliTrackPoints.root
AliTrackResidualsFast

Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
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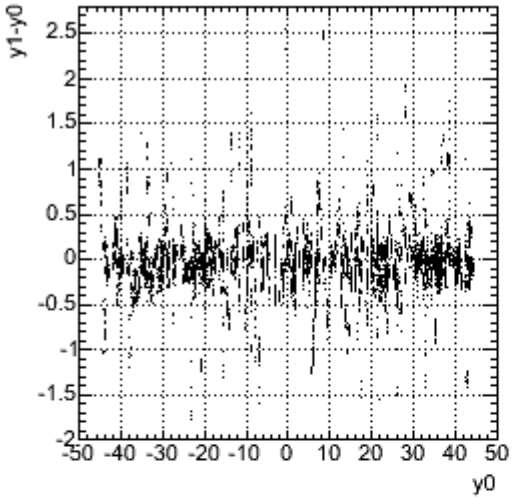
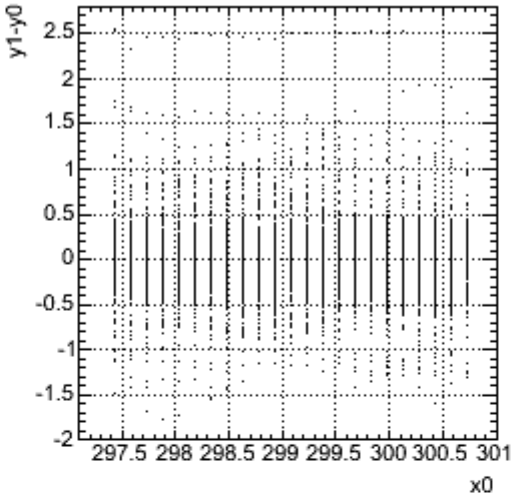
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

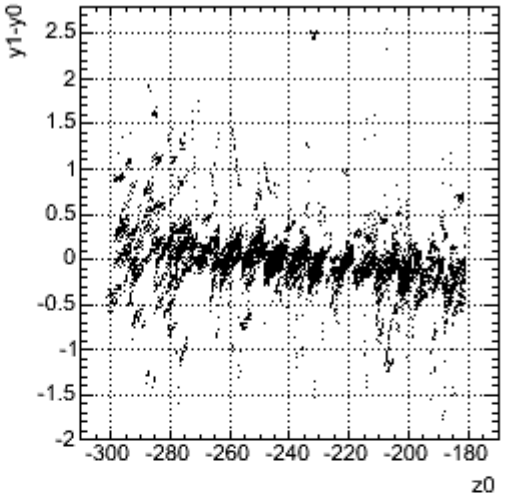
Result

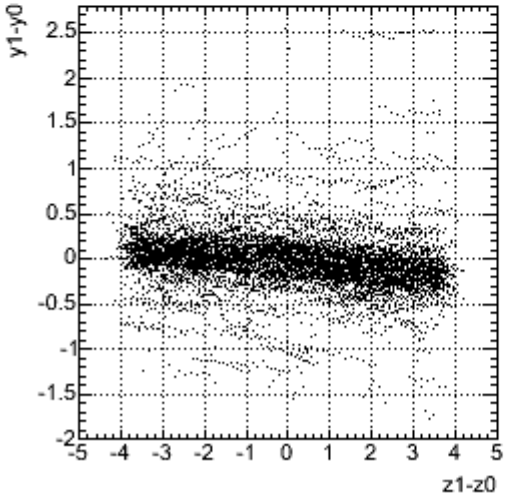
shift in phi	0.014
shift in z	-0.024
shift in r	0.048
tilt in phi	-0.0536
tilt in z	-0.0836
tilt in r	0.0000

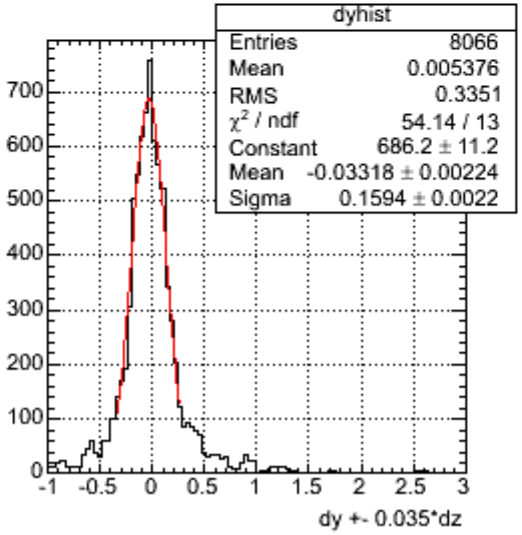
0.2 deg tilt in r – before alignment











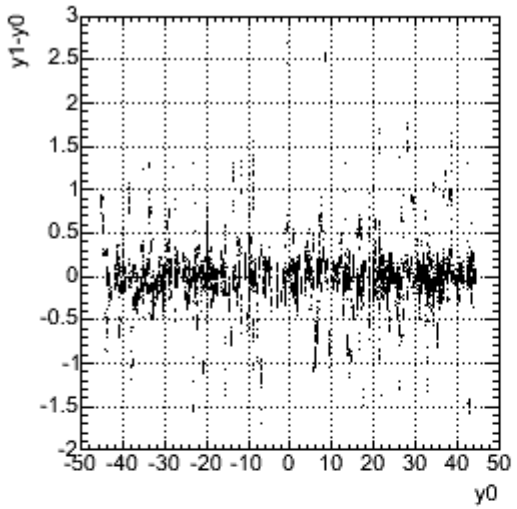
data/1051/AliTrackPoints.root
AliTrackResidualsFast

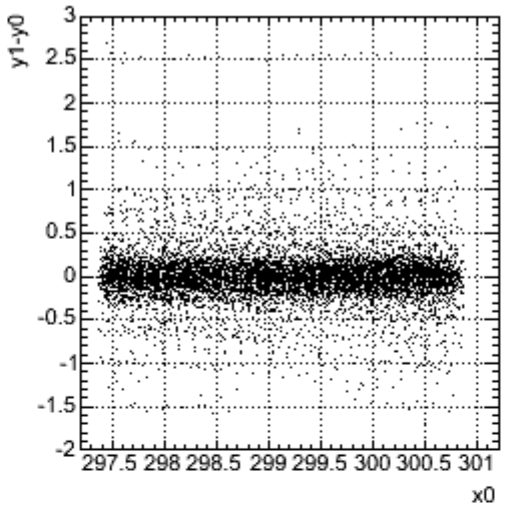
Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
14336 (TPC/EndcapA/Sector1/InnerChamber)
14354 (TPC/EndcapC/Sector1/InnerChamber)
16384 (TPC/EndcapA/Sector1/OuterChamber)
16402 (TPC/EndcapC/Sector1/OuterChamber)

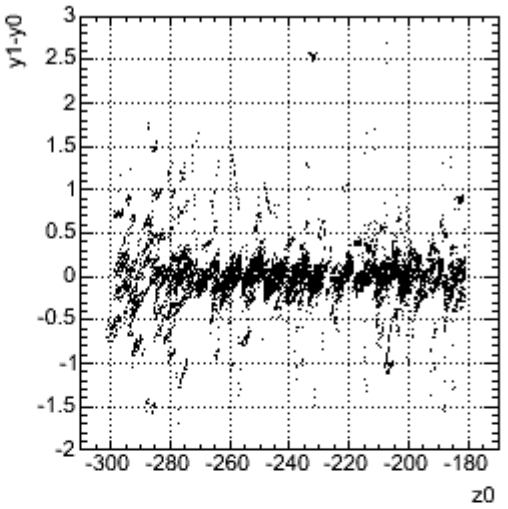
Result

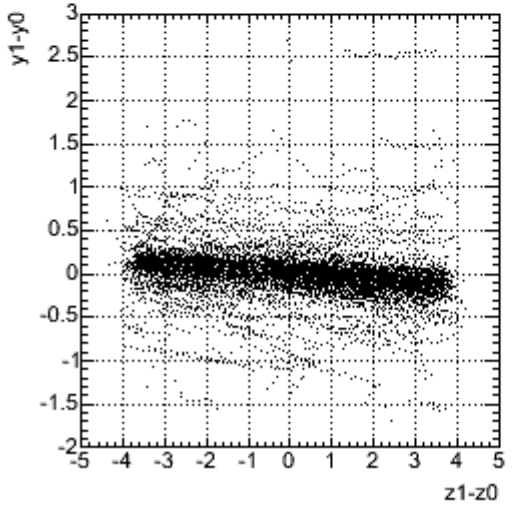
shift in phi	0.015
shift in z	-0.023
shift in r	0.050
tilt in phi	-0.0534
tilt in z	-0.0822
tilt in r	0.0001

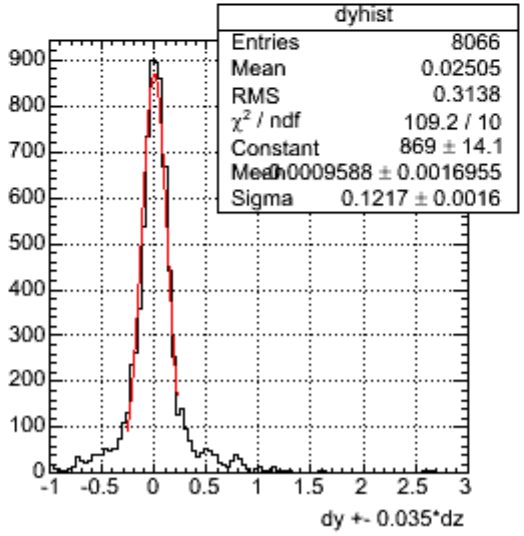
... after alignment











data/1051/AliTrackPoints.root
AliTrackResidualsFast

Aligning volumes
18436 (TRD/sm00/st4/pl0)
to reference volumes
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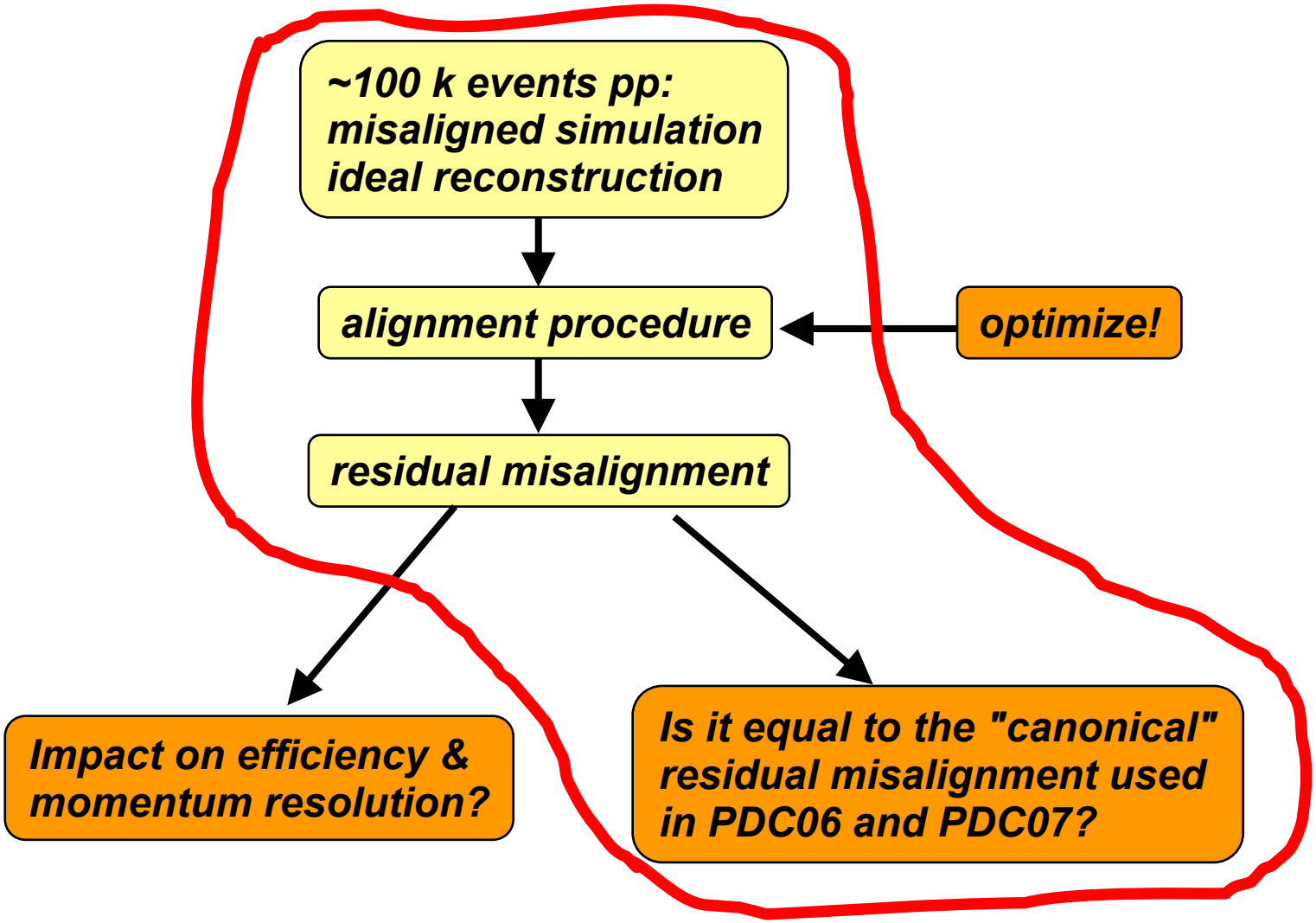
16402 (TPC/EndcapC/Sector1/OuterChamber)

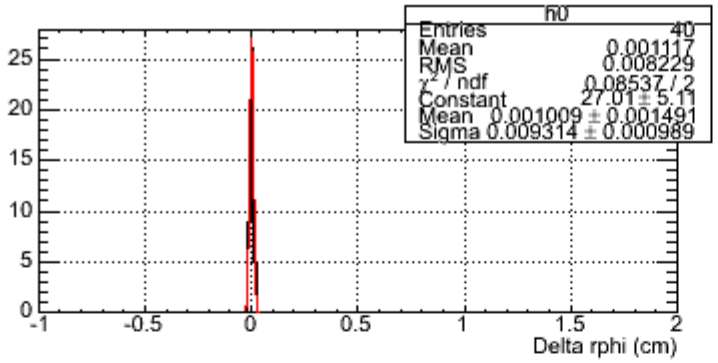
Result

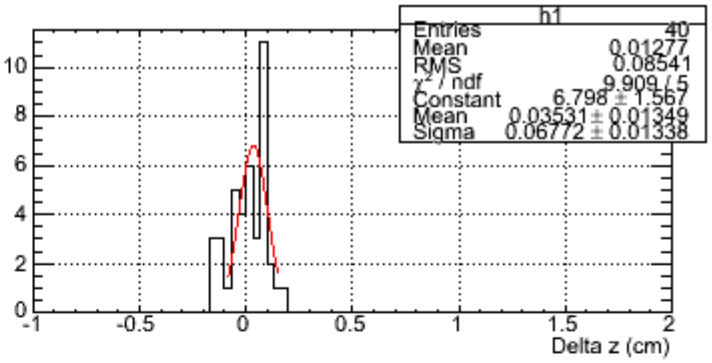
shift in phi	0.014
shift in z	-0.024
shift in r	0.049
tilt in phi	-0.0536
tilt in z	-0.0837
tilt in r	0.0000

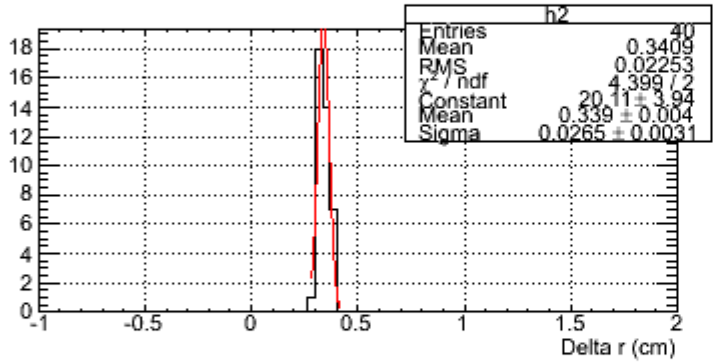
alignment study via simulation: general idea

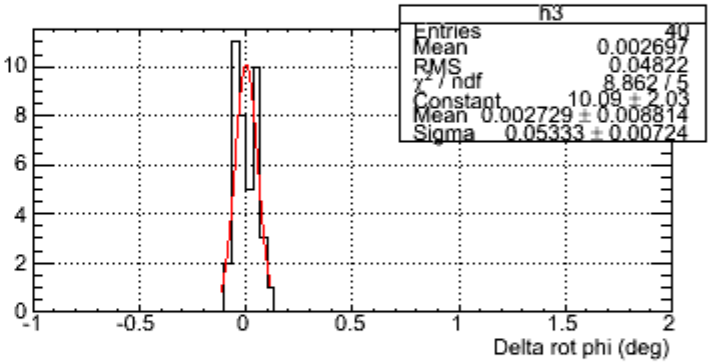


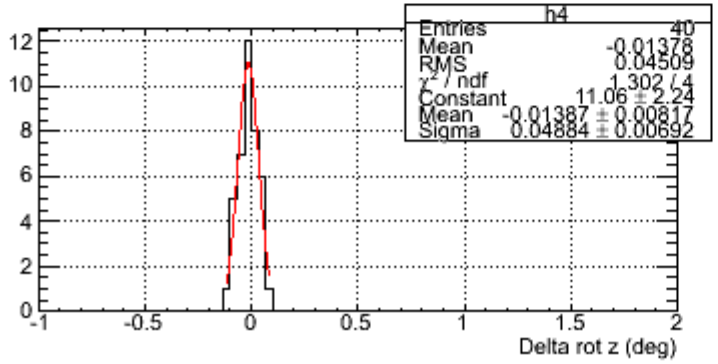
resolution: results of running alignment on ideal data

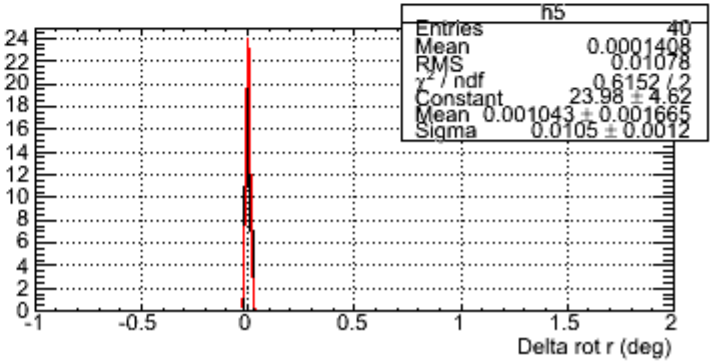












... and how they compare to our "canonical" values

canonical values for PDC06:

rdphi (mm)	dz (mm)	dr (mm)	rot phi (mr)	rot z (mr)	rot r (mr)	
3	3	3	0.4	2	0.4	supermodule initial
1	1	1	1	1	0.7	chamber initial
0.02	0.03	0.07	0.3	0.3	0.1	chamber residual

resolution observed when aligning 40 TRD chambers using 100 k events simulated with ideal geometry

0.09	0.70	0.25	0.8	0.8	0.2

factor

5	25	4	3	3	2

summary and next steps

- *AliAlignmentTracks with AliTrackResidualsFast works reasonably*
- *residual misalignment probably somewhat larger than guessed*
- *alignment resolution related to the width of the residual → in many cases playing with one chamber is sufficient*

under investigation

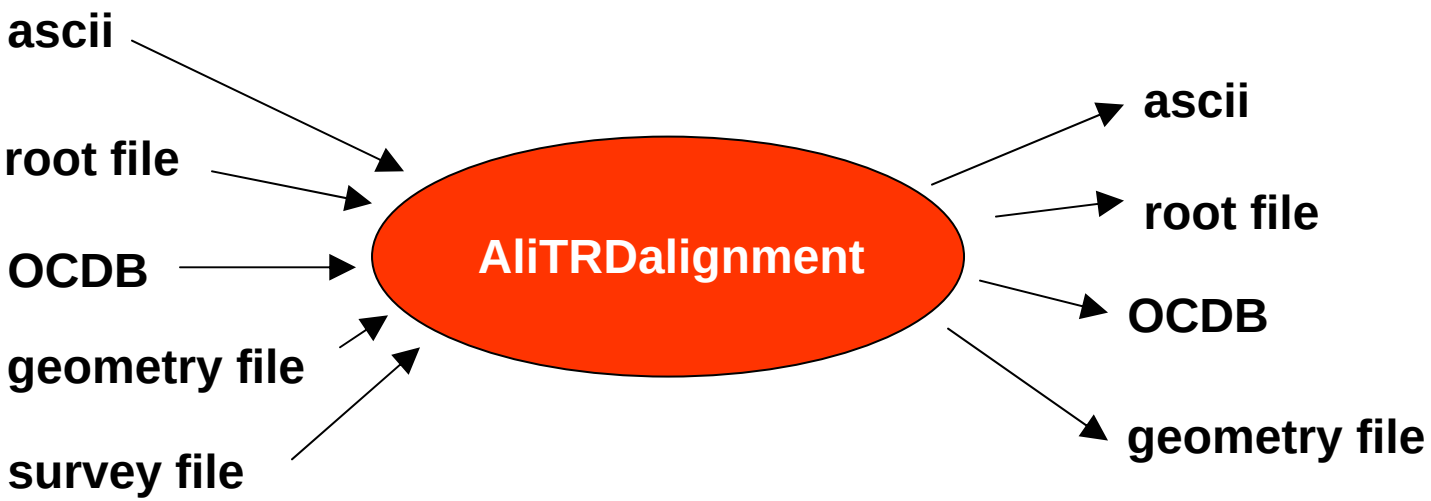
- *more optimization: pt cut, B field, scaling with statistics...*
- *impact on efficiency and momentum resolution*

related subjects

- *AliAlignObj storing local misalignment rather than global*

backup

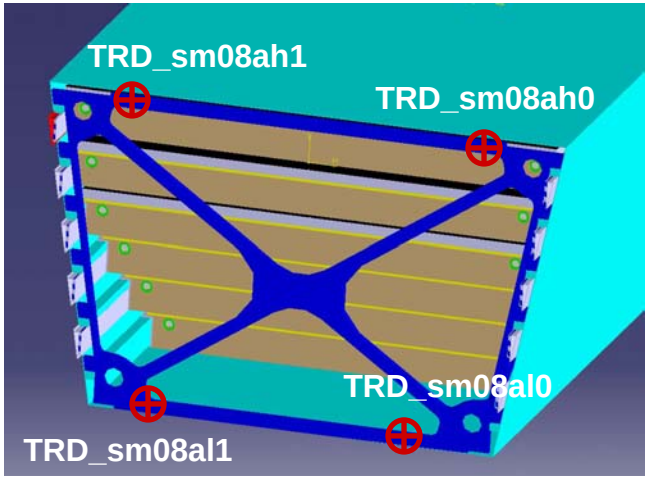
AliTRDalignment class – tool to manipulate TRD alignment sets



- *converting between different file formats*
- *generating random sets for simulation*
- *reporting and visualization*

processing survey data with AliTRDalignment

- *What is being surveyed?*
  Four survey points at each end of each supermodule. Unique names:
  TRD_ sm08 a/c l/h 0/1
  sm# z r phi



- *Survey file - ascii file in Alice-wide standard format*

```
> Title:
ALICE - TRD Measurement of the first inserted TRD Supermodule 08
> Date:
14/12/2007
...
> Data:
TRD_sm08ah1 -3.6504 0.3337 3.5311 M 3
TRD_sm08ah0 -3.5451 0.9294 3.5306 M 3
```

processing survey data with AliTRDalignment

- *AliTRDalignment a*

  create alignment object

- *a.ReadSurveyReport("Alice_TRD_5061.txt")*

  parse survey standard ascii file, decode and store the survey x, y, z, error

- *a.SurveyToAlignment(8,"111000");*

  find such values of the 6 alignment parameters that, when applied to supermodule 8, minimize the chi-squared between the nominal and the measured positions of survey points.

processing survey data with AliTRDalignment

comparison of Dec-2006 survey with nominal positions of survey points in local sm frame

	sm	z	r	phi	rphi	z	r
local survey	8	0	1	0	-29.968	353.060	35.213
local ideal					-30.250	351.000	37.450
difference					0.282	2.060	-2.237
local survey	8	0	1	1	30.525	353.110	35.239
local ideal					30.250	351.000	37.450
difference					0.275	2.110	-2.211

chi2 = 208.27

phi: 0.3 cm off

z: 2.1 cm off

r: 2.2 cm off

processing survey data with AliTRDalignment

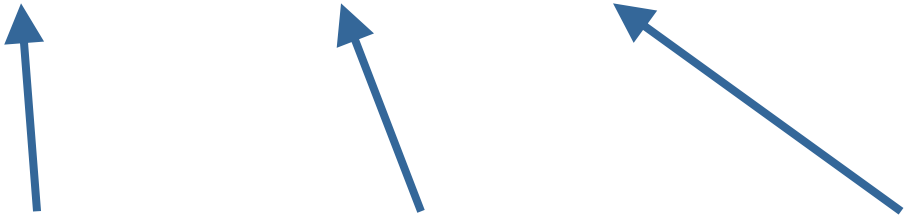
alignment params of supermodule 08 deduced from Dec-2006 survey

phi-shift	z-shift	r-shift	phi-rot	z-rot	r-rot
0.279	2.085	-2.224	0.000	0.000	0.000
±0.300	± 0.300	±0.300	±0.000	±0.000	±0.000

(only translations)

0.295	2.085	-2.224	0.000	-0.025	0.000
±0.477	±0.300	±0.300	±0.000	±0.568	±0.000

(translations and z-rot)



phi: 0.3 cm to larger phi i.e. downward

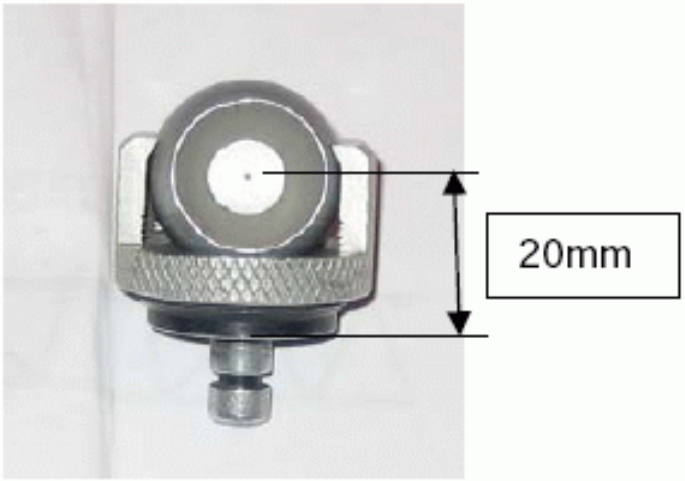
z: 2.1 cm away from muon arm

r: 2.2 cm inward

processing survey data with AliTRDalignment

shift in z – caused by the survey target offset

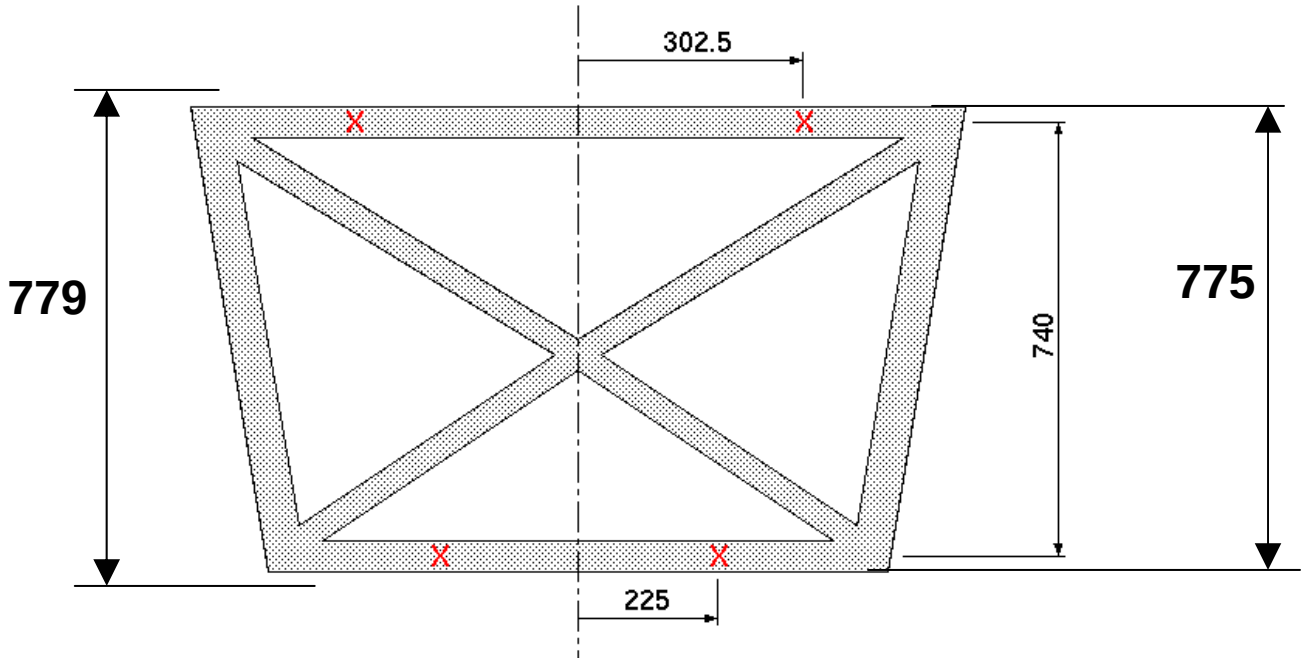
The coordinates given in this report are given for the center of the survey target and not for the contact surface. The following survey target has been used for the measurement of the TRD reference holes:



→ **nominal positions of the survey points in AliTRDalignment modified to account for the survey target offset of 20 mm**

processing survey data with AliTRDalignment

"r"-coordinate of the two surveyed points:

365.25 cm **from survey**
365.75 cm **from drawings (Bernd)**
367.10 cm **from offline (my guess, based on BTRD being 779 mm thick)**

needs to be understood