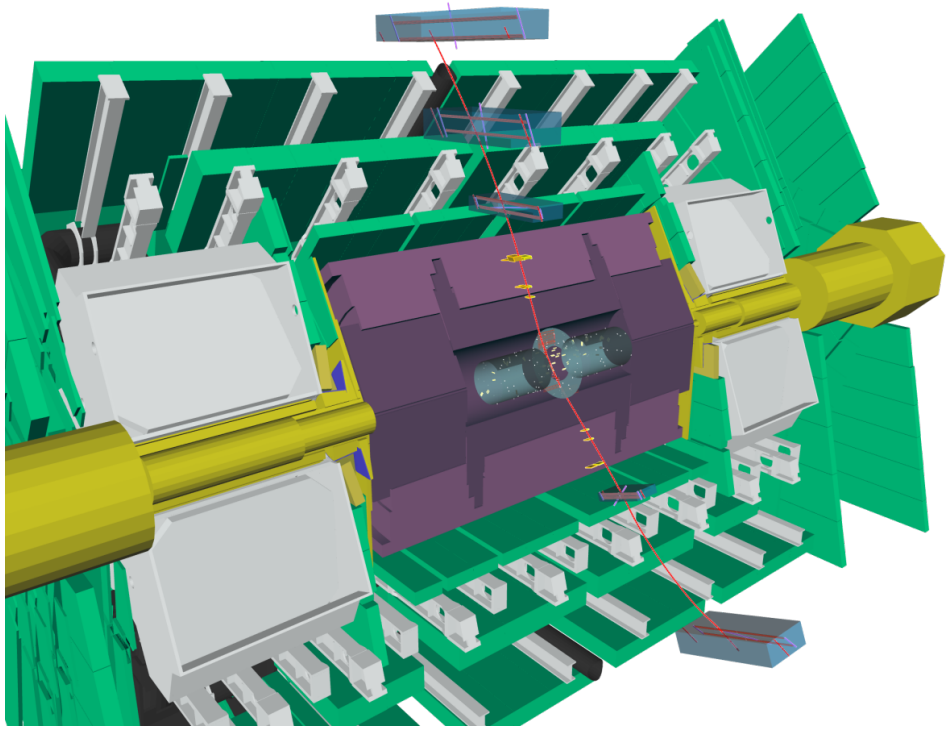
Combined studies with cosmic rays real and simulated data



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Introduction

- An update of the studies done with release 14.5.2.4 is presented.
- Motivation:
  - new calibrations for TileCal (previously overcalibrated)
  - improvements in TileMuonFitter

- COSMIC 08 DATA

- Samples analyzed → 4 “golden” runs: 91885, 91888, 91890 & 91891
- IDCosmic stream & **IDCOMM DPDs**
- DPDs from ESD2ESD Sept09 re-processing with release 15.3.1.20

- MC:

Re-run reconstruction with release 15.3.1.6 (in order to compare with data) over official ESDs produced with release 14.5.2.12 (valid2.108867.CosSimIDVolSolOnTorOn.recon.ESD.s540_d167_r676/)

Contents

PART A: ID reconstruction in cosmic MC
- Problems found

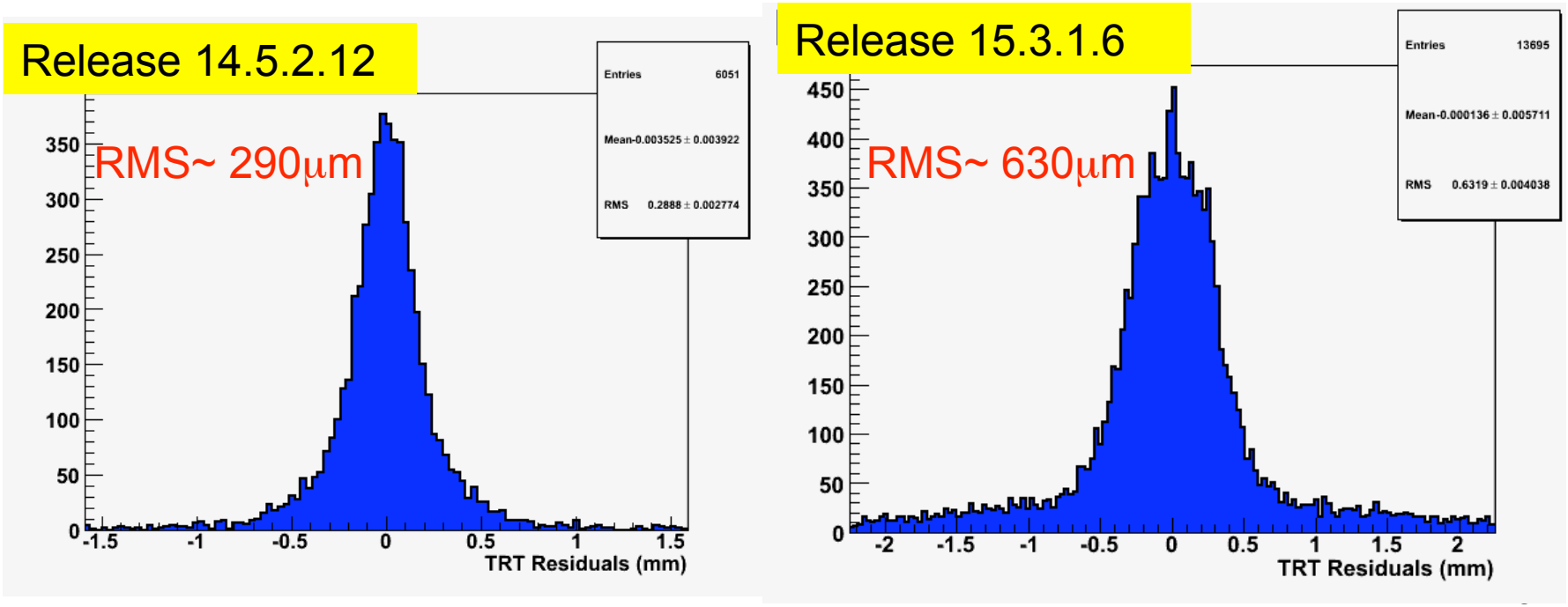
PART B: Update on combined studies for cosmic 08 data (ESD2ESD re-procesing output)
- Samples analyzed and reconstruction software used
- Event selection and track quality cuts
- Comparison ID and MOORE track parameters
- Performance of the combined tracking
- Energy loss studies

MC results

ID reconstruction in cosmic MC

→2 problems found (when running from RecExCommission with release 15.3.1.6):

1) TRT residuals are wider:



TRT calibration needs to be overriden by adding the following (thanks to Sasa Fratina & Thijs):

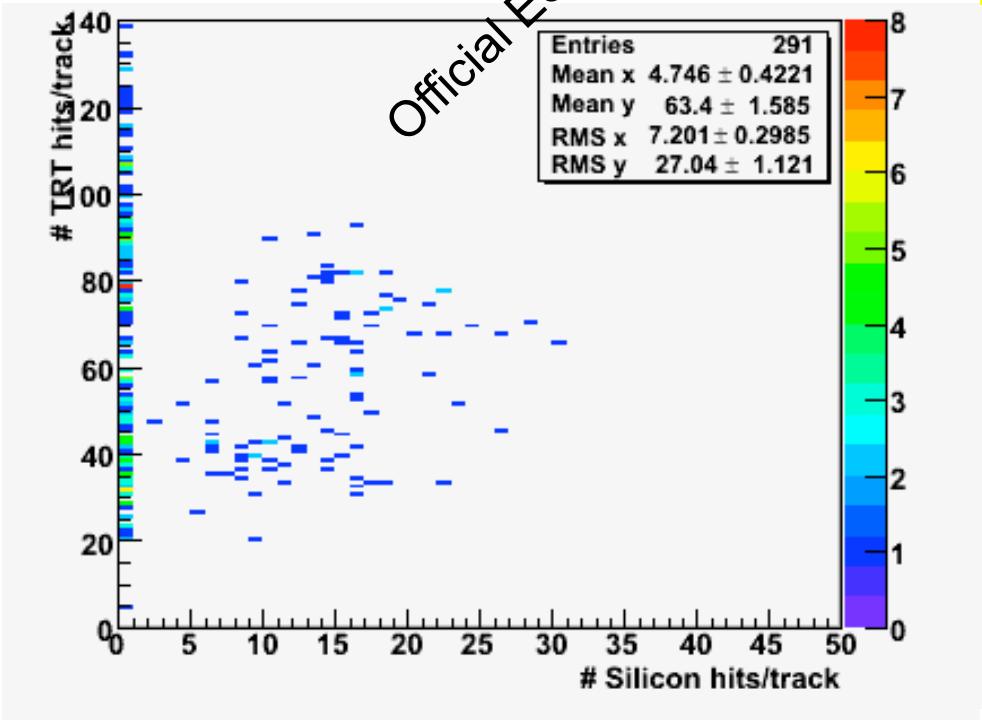
conddb.addOverride('/TRT/Calib/T0','TrtCalibT0-MCcos_NewEp-01')
conddb.addOverride('/TRT/Calib/RT','TrtCalibRt-MCcos_NewEp-01 ')

ID reconstruction in cosmic MC

2) TRT extension does not work → detected by looking at the number of associated hits

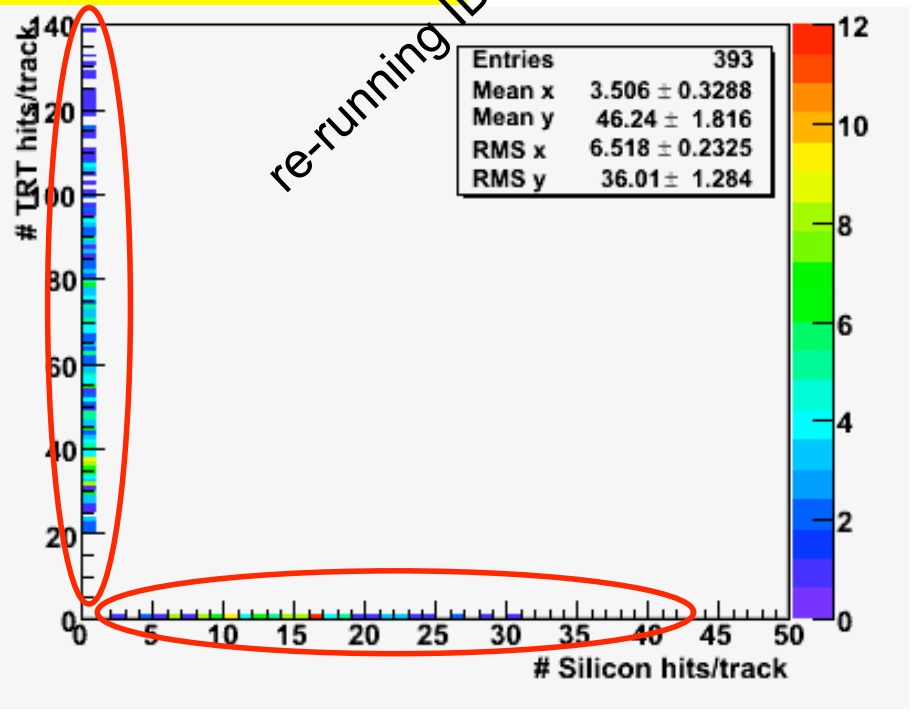
Release 14.5.2.12

Official ESDs



Release 15.3.1.6

re-running ID reco



Solved (thanks to Thijs) adding the following lines to my jobOptions:

from TrkDetDescrSvc.TrkDetDescrJobProperties import TrkDetFlags
TrkDetFlags.TRT_BuildStrawLayers.set_Value(True)

Combined studies
Cosmic 08 data
-update-

Samples and software used

COSMIC 08 DATA
• Samples analyzed:
Cosmic 08 runs: 4 “golden” runs
91885, 91888, 91890 & 91891
• IDCosmic stream & **IDCOMM DPDs**
• Software used:
DPDs from ESD2ESD Sept09 re-processing
(release 15.3.1.20)

Event selection & track quality cuts

• Initially: 442k events
• After all cuts: 9k “good” ID tracks, 10k MOORE tracks & 8K COMBINED tracks
• Matching ID-MOORE tracks: 6.5k events

• Kinematic cuts:
- d_0 < 30 cm, z_0 < 30 cm (**PROJECTIVE MUONS**) & p(ID)> 10 GeV

• ID track quality (MEDIUM) cuts:
>= 10 Silicon hits, >= 20 TRT hits (barrel only)

• MOORE track quality cuts:
tracks that cross 3 MS stations,>= 4 RPC hits

•Matching criteria (ID-MS at IP): distance on the cylinder:

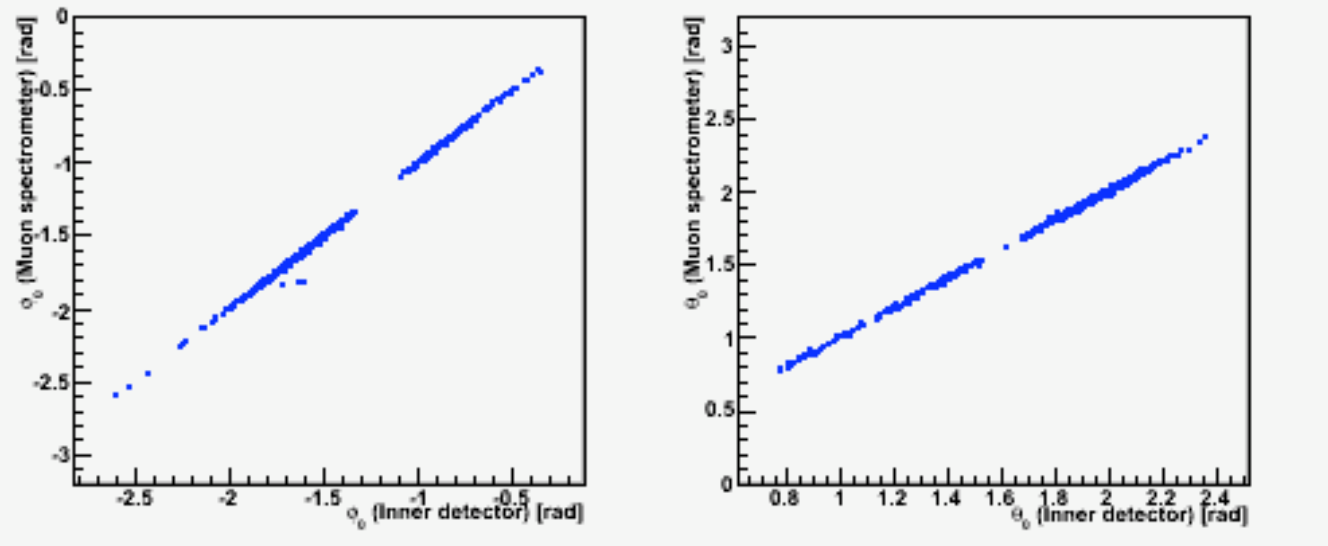
$$\Delta R = \sqrt{\Delta\phi^2 + \Delta\cos\theta^2} < 0.25$$

Number of reconstructed tracks

# tracks with hits in each sub-detector	**ID rel 14 10k tracks**	**ID Rel 15 9k tracks**	**Moore Rel 14 8.5k tracks**	**Moore Rel 15 10k tracks**	**Combined Rel 14 10k tracks**	**Combined Rel 14 8k tracks**
Pixels	4k	3.8k	-	-	4k	3k
SCT	10k	9k	-	-	9.7k	8k
TRT	10k	9k	-	-	9.7k	8k
MDT	-	-	8.5k	10k	9.7k	8k
RPC	-	-	8.5k	10k	9.7k	8k

→ less combined tracks reconstructed

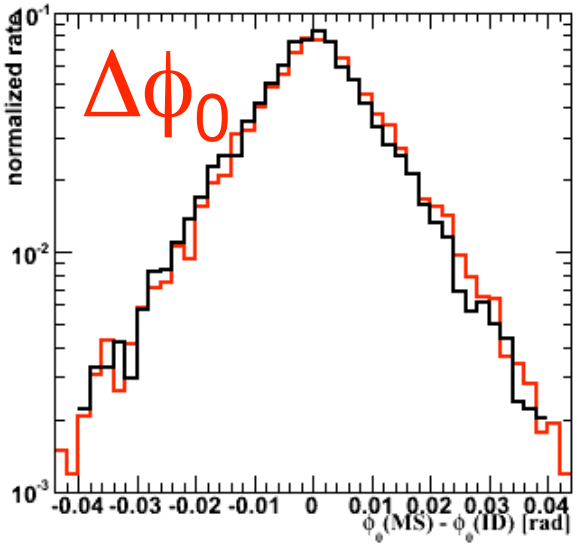
Inner Detector & Muon Spectrometer tracks comparisons

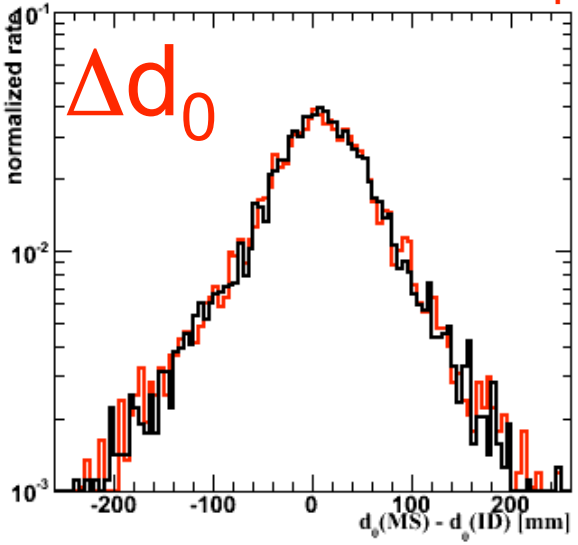


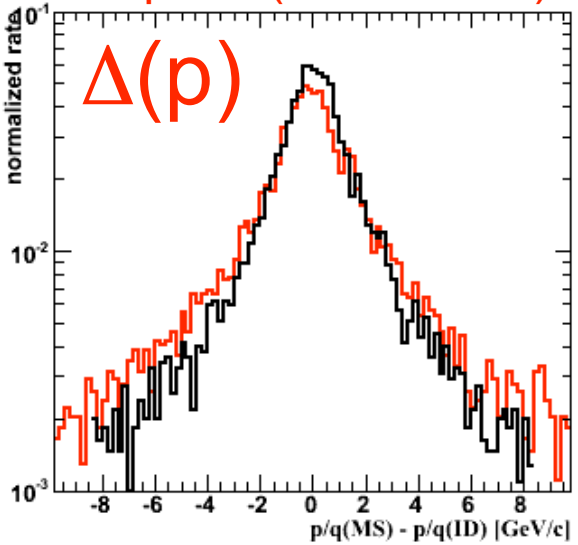
Difference ID-MOORE track parameters

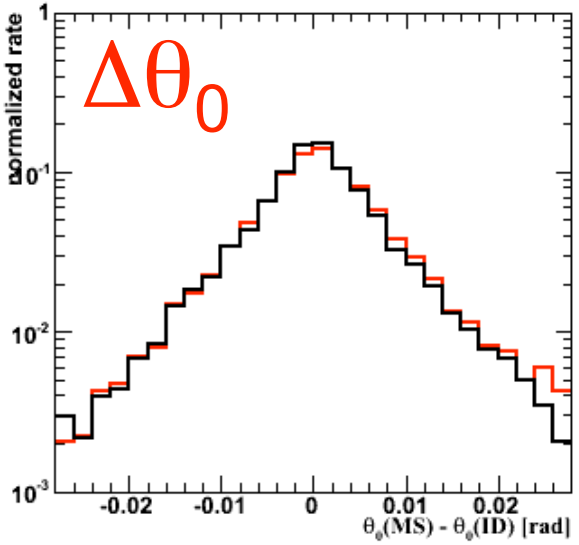
ESD2ESD re-proc. (rel 15.3.1.20)

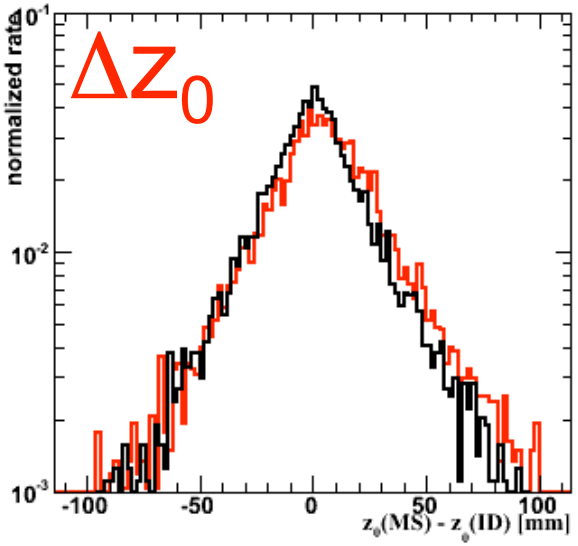
Spring 09 re-proc. (rel 14.5.2.4)





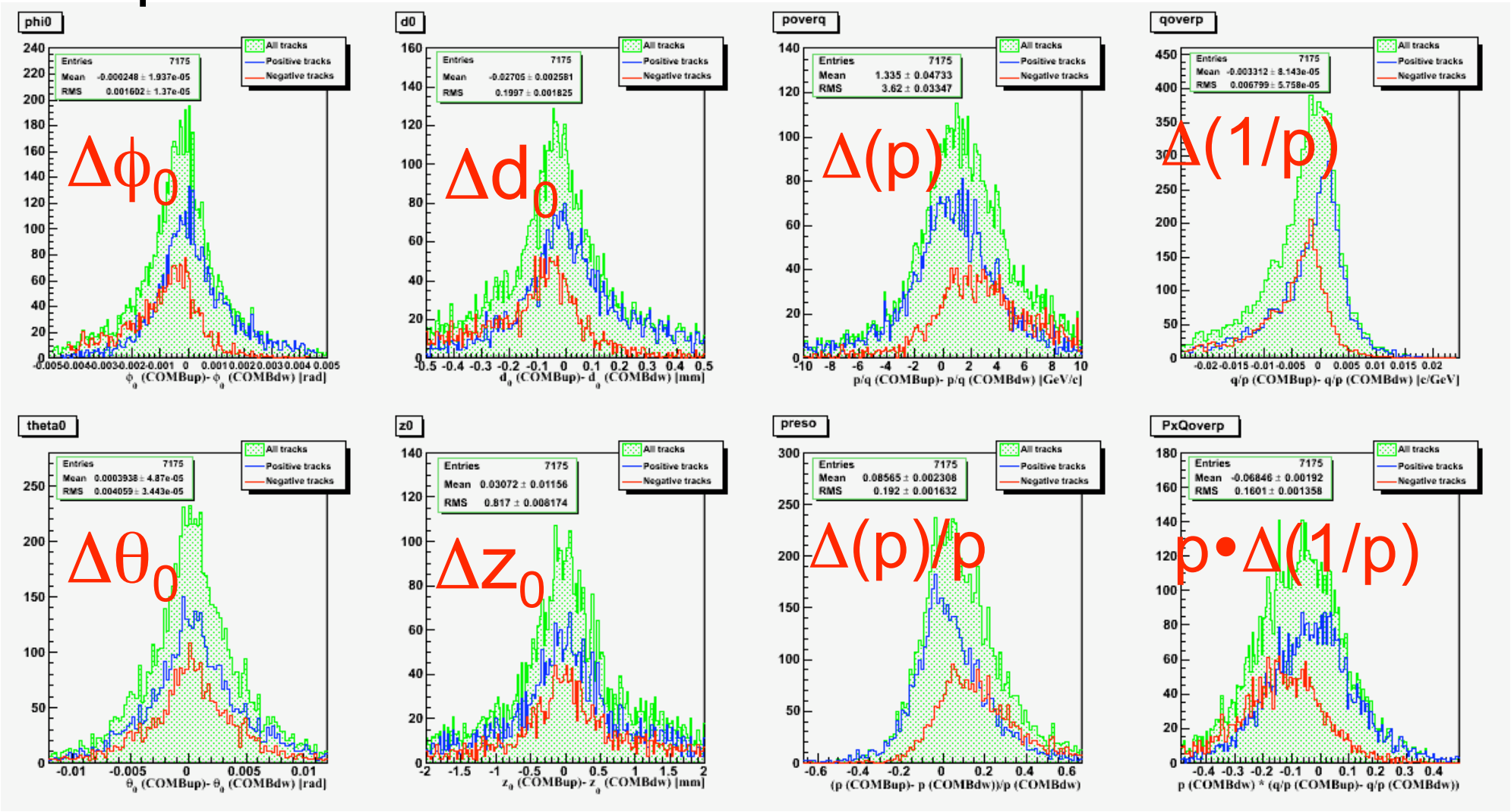






- Some improvements in p/q and z0 distributions.

Difference upper & lower combined track parameters



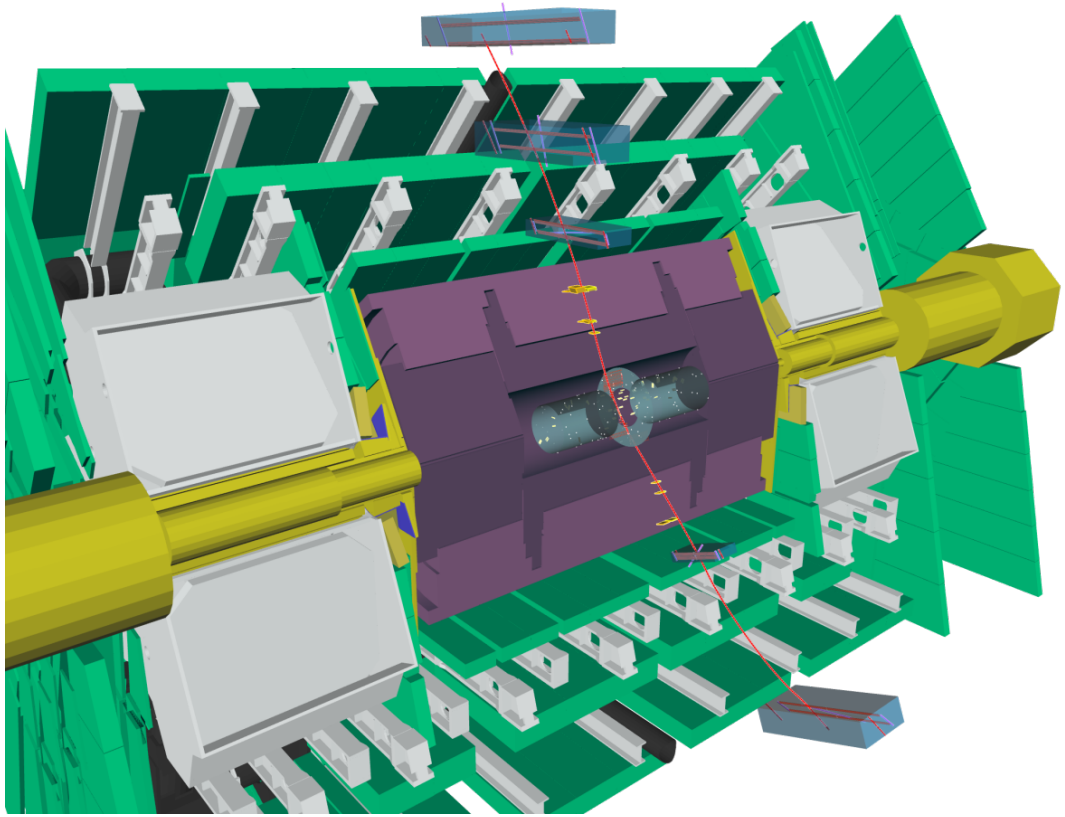
- Positive and negative tracks have different distributions.

Track parameters bias and resolutions

	Combined tracks (ID-MOORE splitting)	Combined tracks (top-bottom splitting)	ID tracks (top-bottom splitting)
$\Delta\phi_0$ (mrad)	μ~ -0.2 RMS~ 13.0	μ~ -0.2 RMS~ 1.6	μ~ -0.06 RMS~ 0.6
$\Delta\theta_0$ (mrad)	μ~ +0.3 RMS~ 7.6	μ~ +0.4 RMS~ 4.1	μ~ -0.02 RMS~ 2.1
Δd_0 (mm)	μ~ +5.7 RMS~ 73	μ~ -0.03 RMS~ 0.2	μ~ -0.008 RMS~ 0.120
Δz_0 (mm)	μ~ +0.7 RMS~ 28	μ~ +0.03 RMS~ 0.82	μ~ -0.03 RMS~ 0.36
Δp (GeV/c)	μ~ +0.03 RMS~ 2.5	μ~ +1.3 RMS~ 3.6	μ~ -0.02 RMS~ 1.3
$\Delta p/p$	μ~ +0.004 →0.4 % RMS~ 0.01 →10%	μ~ -0.09 →9% RMS~ 0.19 →19%	μ~ 0.00 RMS~ 0.05 →5%
$\Delta(1/p)$ (c/GeV)	μ~ $-1.2\cdot10^{-4}$ RMS~ $42\cdot10^{-4}$	μ~ $-33\cdot10^{-4}$ RMS~ $68\cdot10^{-4}$	μ~ $-0.3\cdot10^{-4}$ RMS~ $19\cdot10^{-4}$
$p\bullet\Delta(1/p)$	μ~ -0.004 → 0.4% RMS~ 0.098 → 10%	μ~ -0.07→ 7% RMS~ 0.16 → 16%	μ~ 0.00 RMS~ 0.06→ 6%

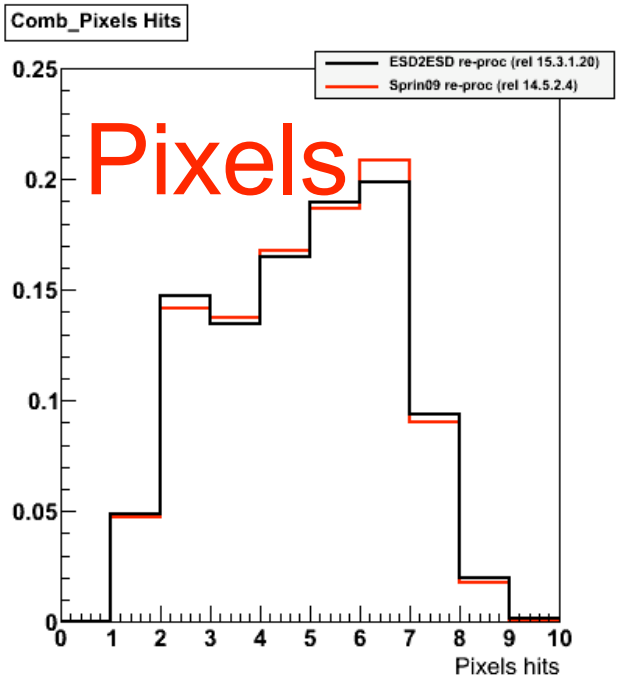
- The bias and resolutions obtain for the combined track parameters depend on the method used.
- Need to check with truth once new simulation (with truth info at perigee) available.

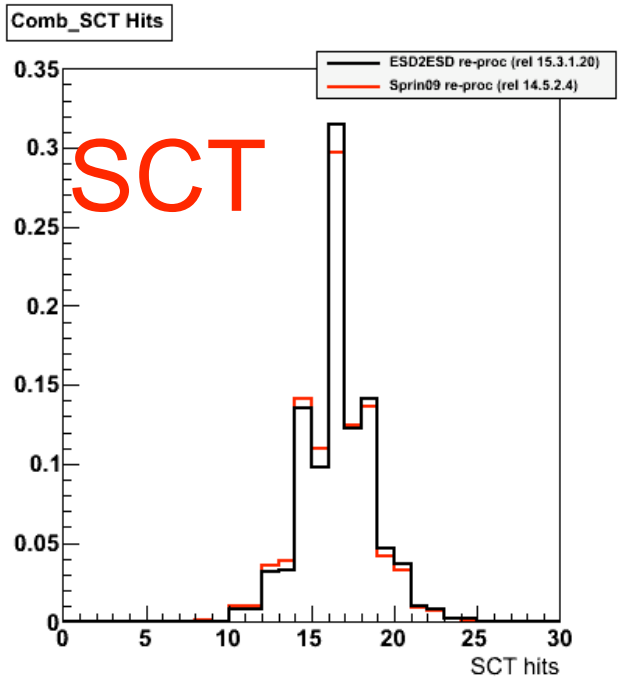
Performance of the COMBINED TRACKING (Inner Detector + Muon Spectrometer)

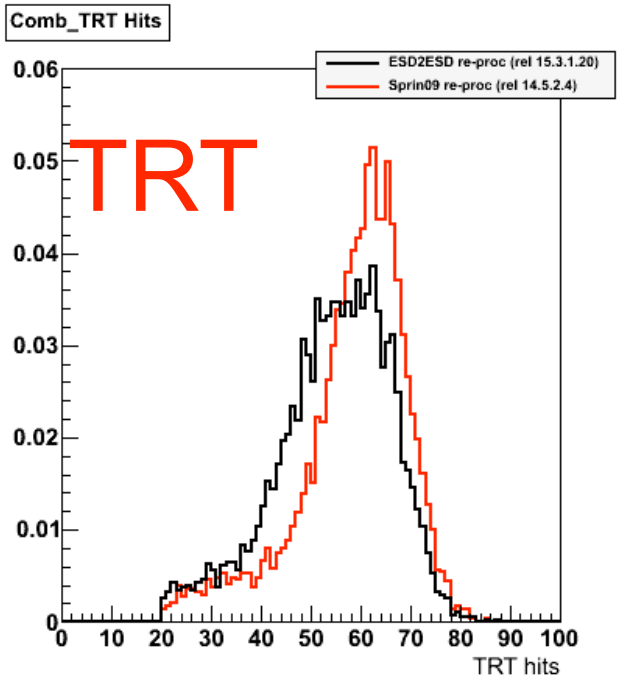


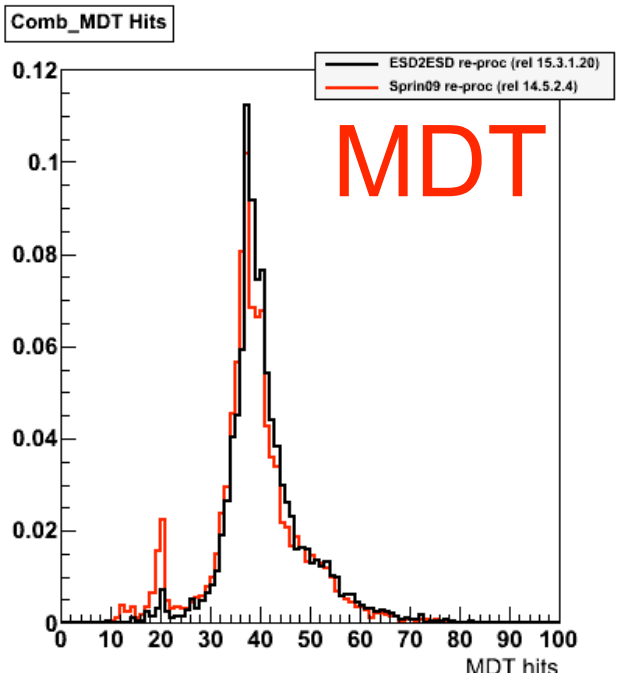
Hits on combined tracks

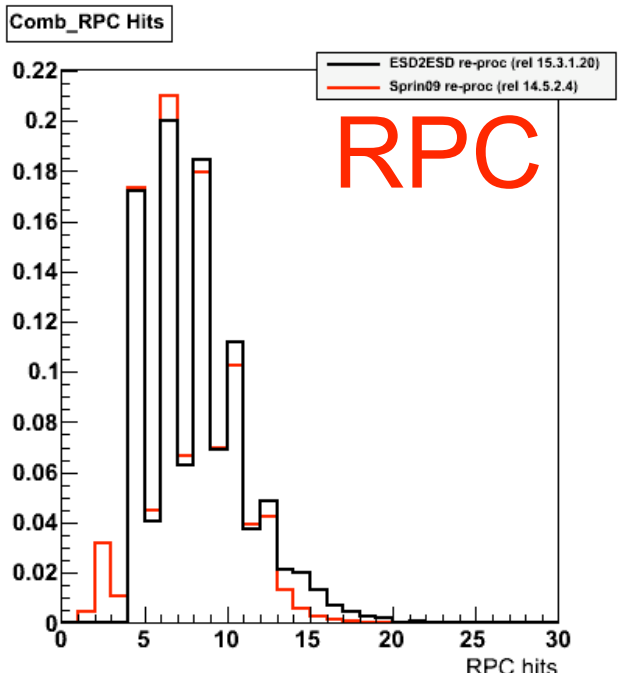
ESD2ESD re-proc. (rel 15.3.1.20)
Spring 09 re-proc. (rel 14.5.2.4)







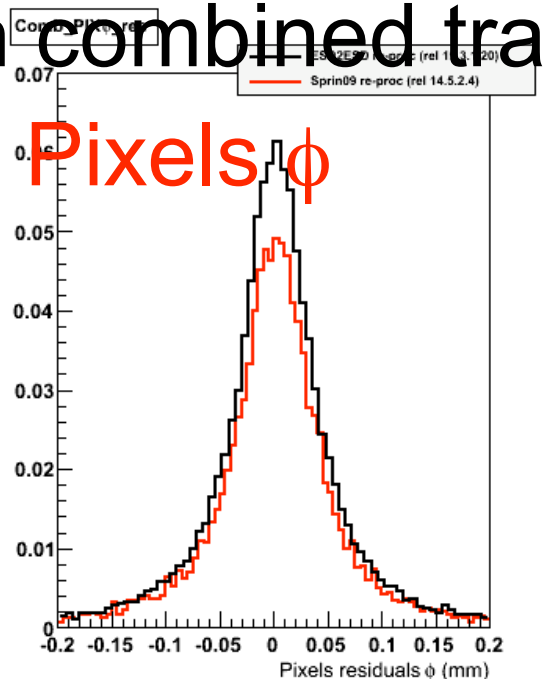


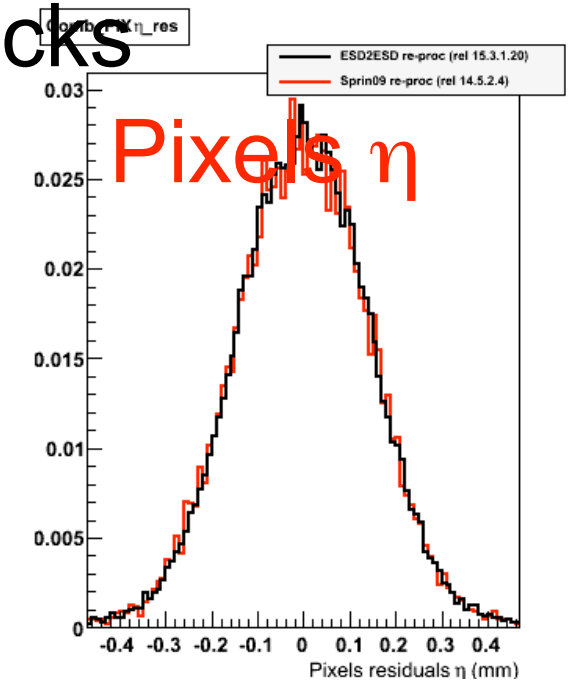


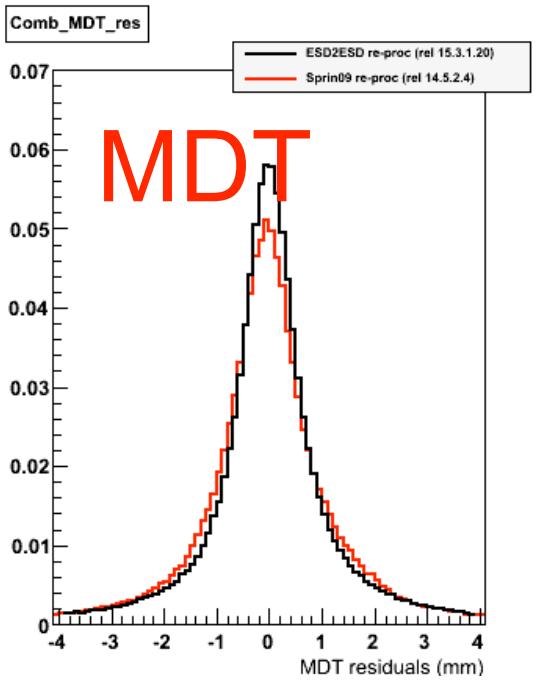
- Decrease in the amount of TRT associated hits in last (ESD2ESD re-processing). Why?

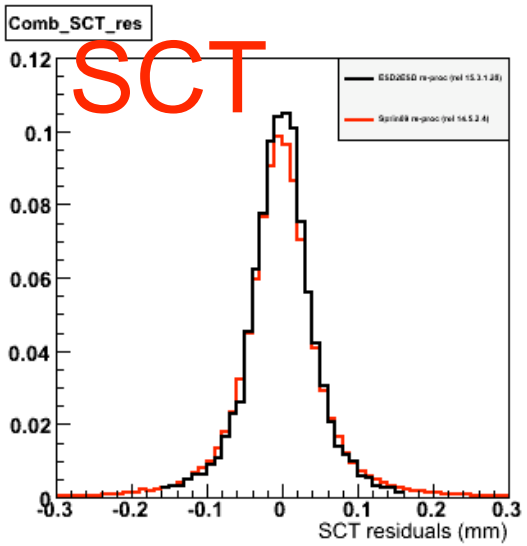
Residuals distributions in combined tracks

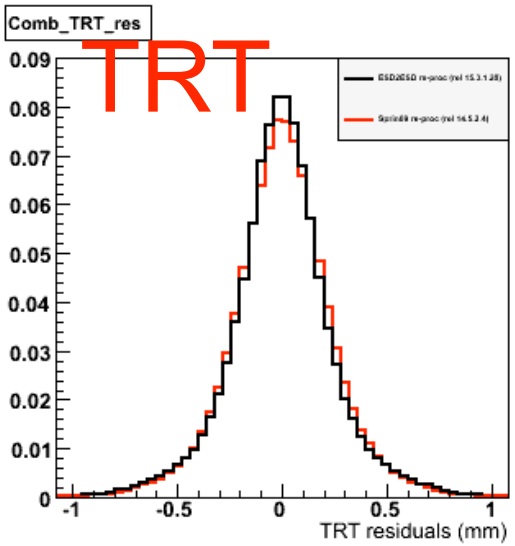
ESD2ESD re-proc. (rel 15.3.1.20)
Spring 09 re-proc. (rel 14.5.2.4)

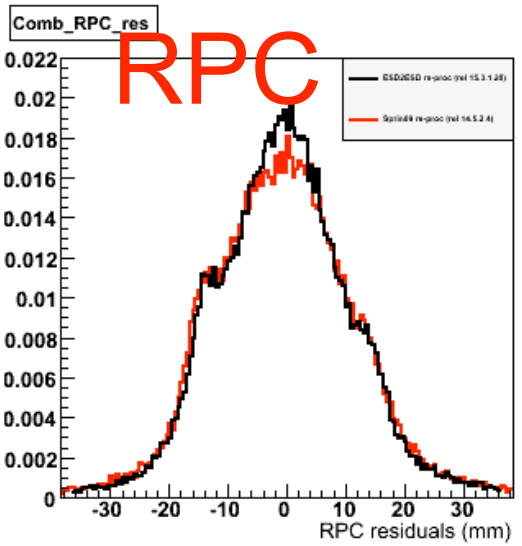












- Residuals distributions are very similar; improvements specially for MDTs.

E loss studies

- E calorimeters (LArMuid & TileMuonFitterHT)

- ID-Moore momentum difference

• The energy deposited in the calorimeters is expected to be lower than the ID-MS momentum difference because there is a significant amount of dead material not taken into account:

- ID + cryo~ 1.6 X0
- TileCal girder and cross-bars~ 13.4 X0

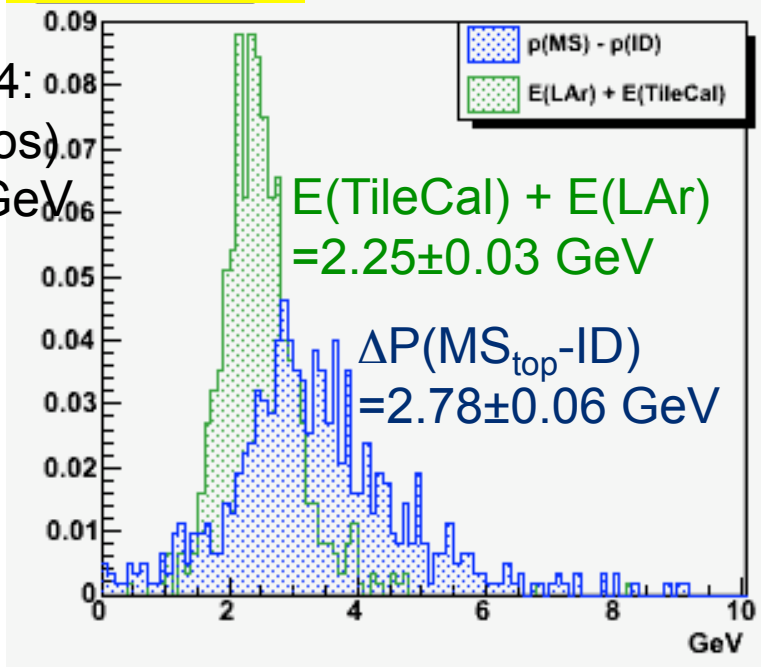
Taking into account the total length of LAr(24 X0) and TileCal(68 X0), one can expect a difference of ~17%.

•For this study, it is required that muon tracks have the same charge and p(ID)<25 GeV.

Momentum difference ID-MS & energy loss

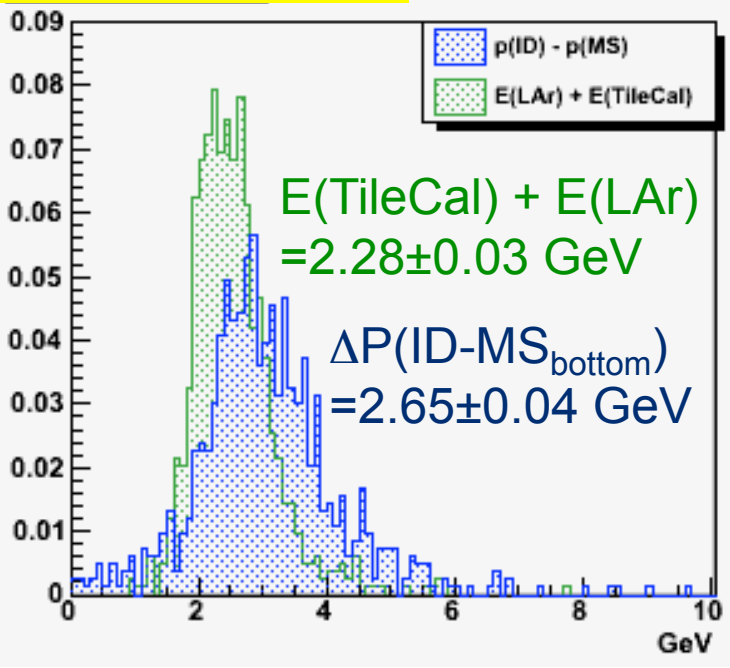
TOP tracks

Rel 14: E(calos) 2.44GeV



BOTTOM tracks

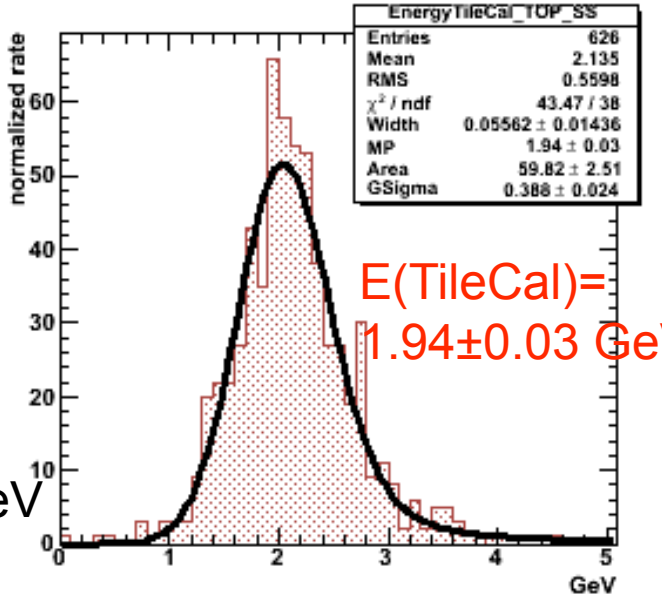
Rel 14: E(calos) 2.43GeV



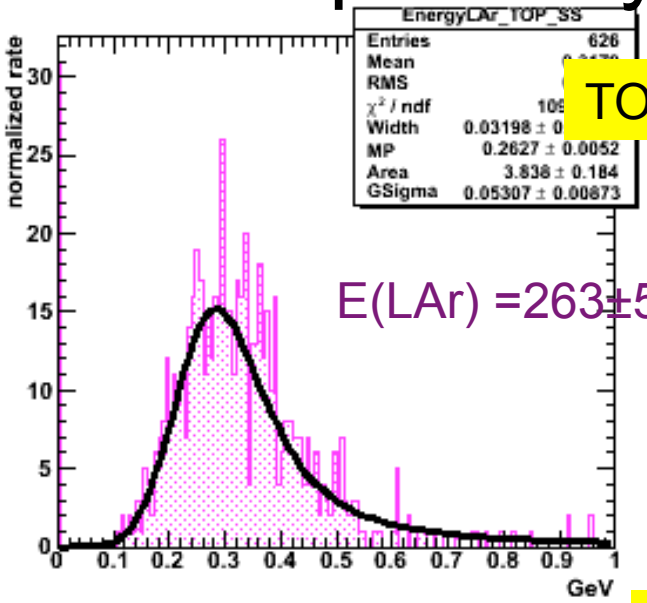
- After correction the energy in the calorimeters by the e/mu ratio (0.9), the difference |Δp-Ecalos|/Δp is:
  - top tracks: 27%
  - bottom tracks: 23%
- In release 14, the difference is ~17%.
- The difference between release 15 and 14 is due to the new calibrations for TileCal (previuosly overcalibrated ~18%) and improvements in TileMuonFitter (higher energy response: ~11%).
- Dead material not taking into account in energy measured in calorimeters is ~20% accoriding to CSC note (would like to check with experts).

Energy loss in TileCal and LAr separatelly

TOP tracks



E(TileCal)= 1.94±0.03 GeV

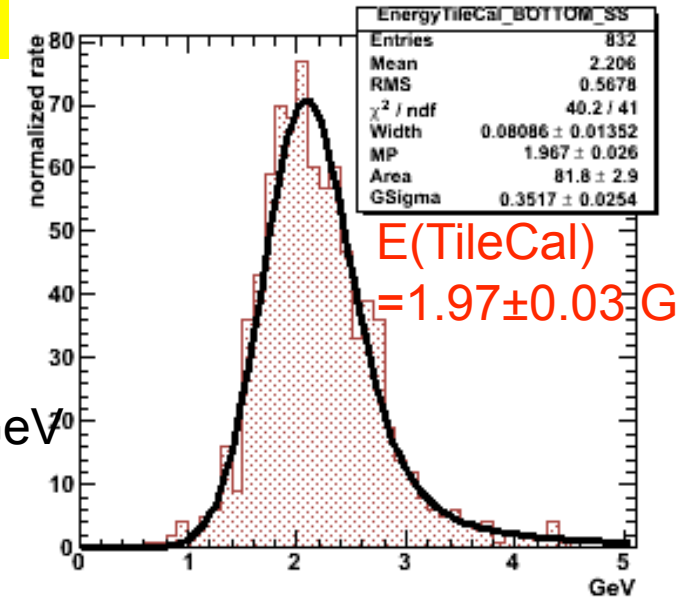


TOP tracks

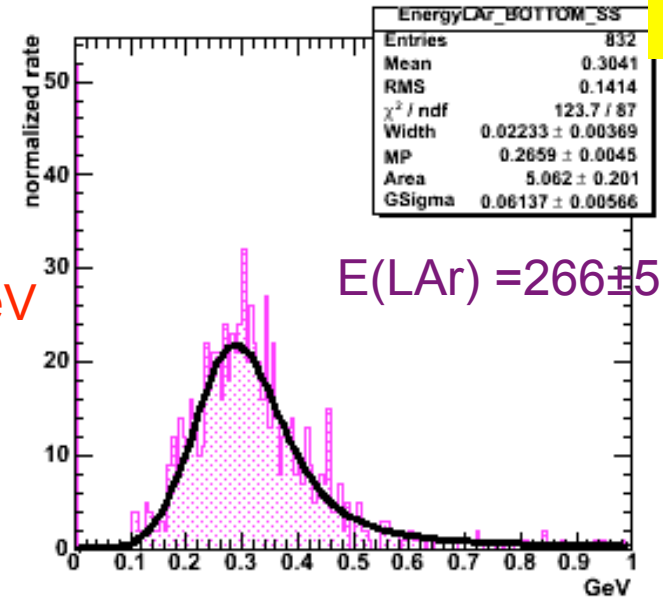
E(LAr) =263±5 MeV

Release 14:
E(TileCal)=
2.11±0.04 GeV

BOTTOM tracks



E(TileCal) =1.97±0.03 GeV



BOTTOM tracks

E(LAr) =266±5 MeV

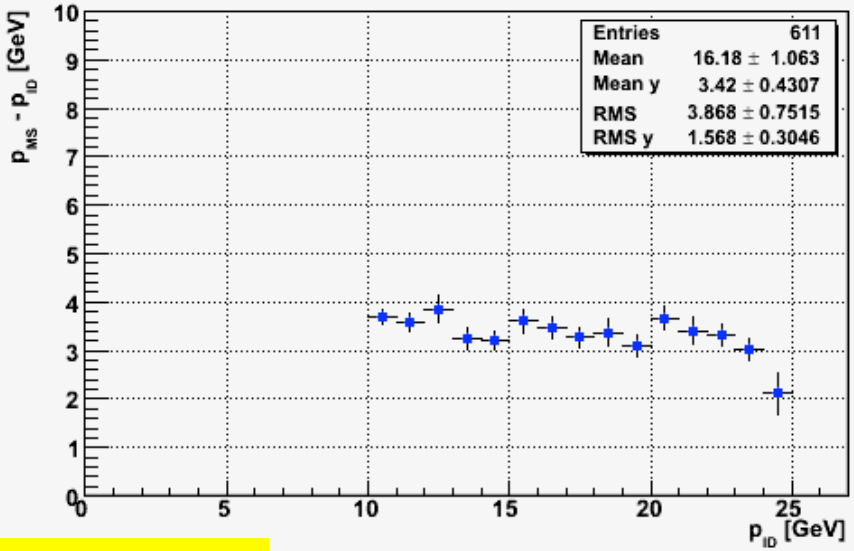
Release 14:
E(TileCal)=
2.16±0.03 GeV

- The energy in the TileCal is ~150-200MeV smaller than in release 14.

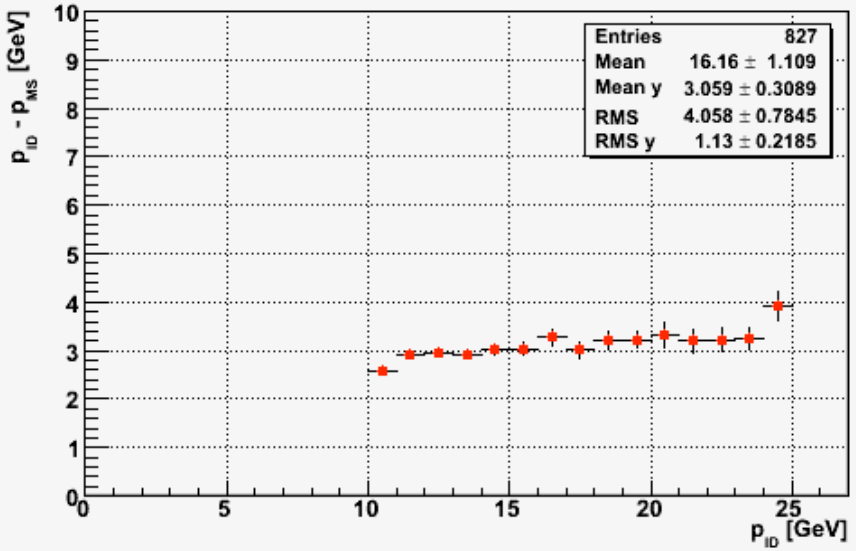
Energy loss & momentum difference ID-MS

TOP tracks

Δp Vs p (ID)

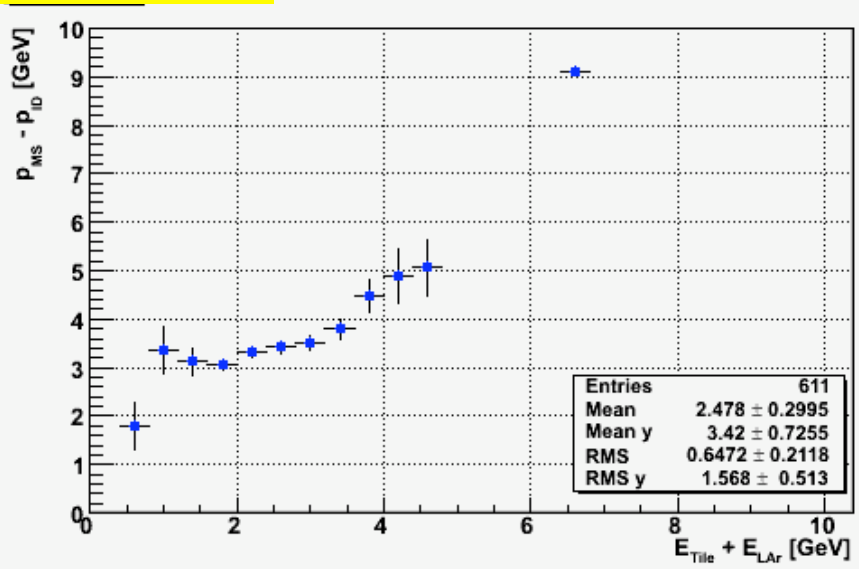


BOTTOM tracks

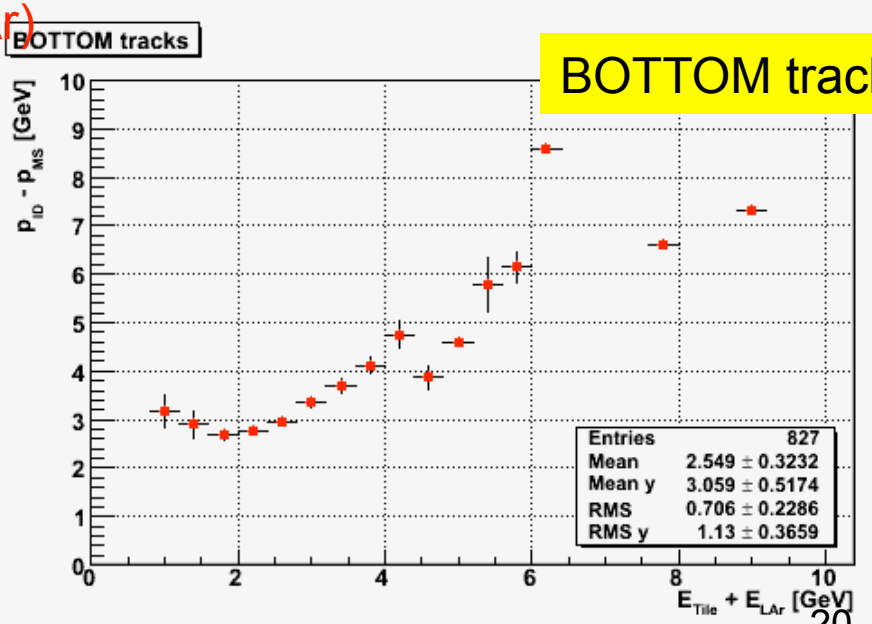


TOP tracks

Δp Vs E(TileCal+LAr)



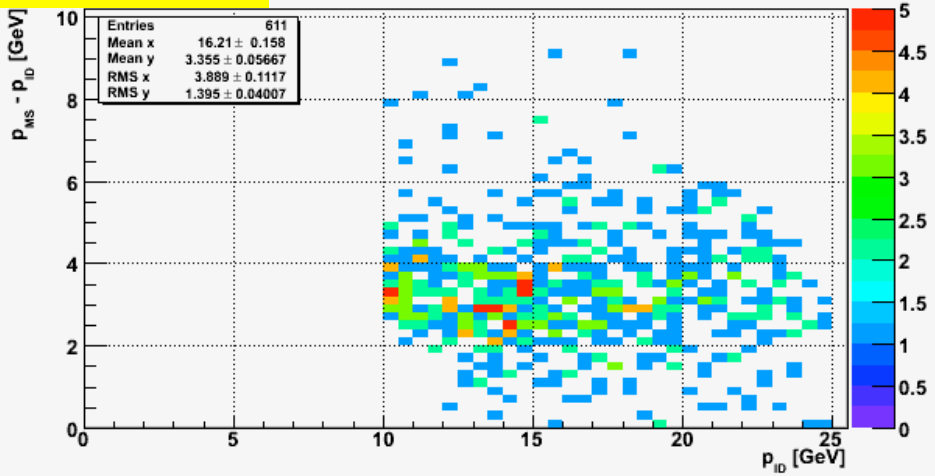
BOTTOM tracks



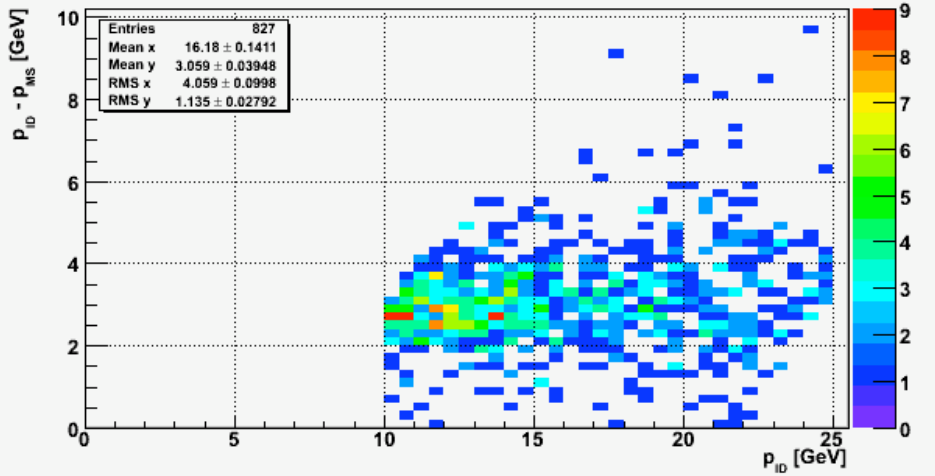
Energy loss & momentum difference ID-MS

Δp Vs p (ID)

TOP tracks

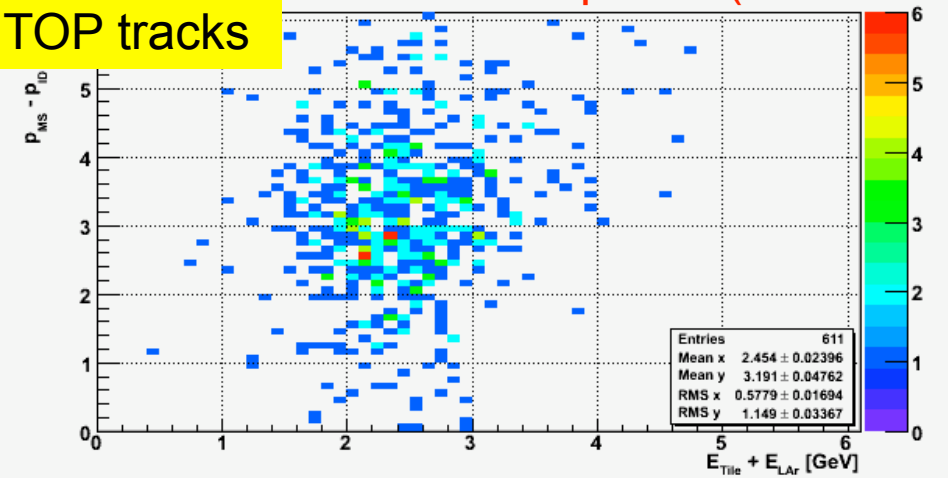


BOTTOM tracks

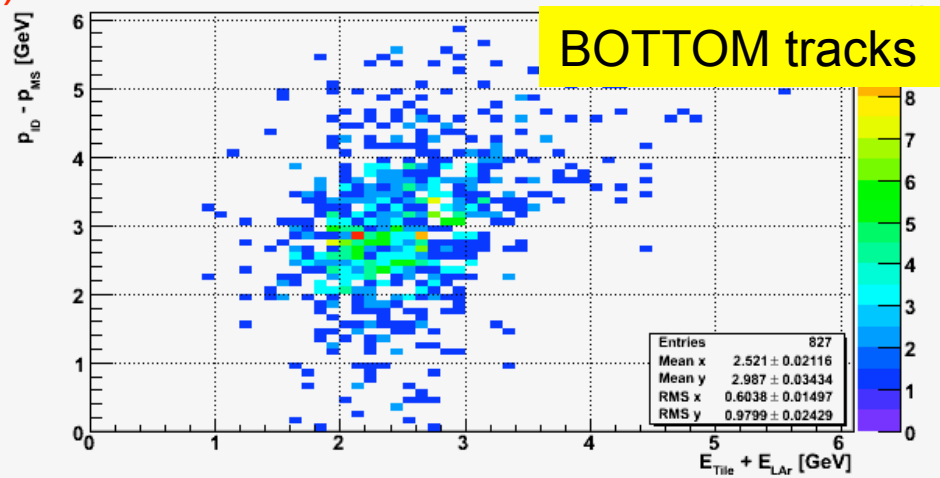


Δp Vs E(TileCal+LAr)

TOP tracks



BOTTOM tracks



Conclusions

• The analysis has been re-done using data from the last re-processing with release 15.3.1.20:
→ less combined tracks reconstructed
→ less TRT associated hits in combined tracks
→ change in the energy reconstructed in the calorimeters.

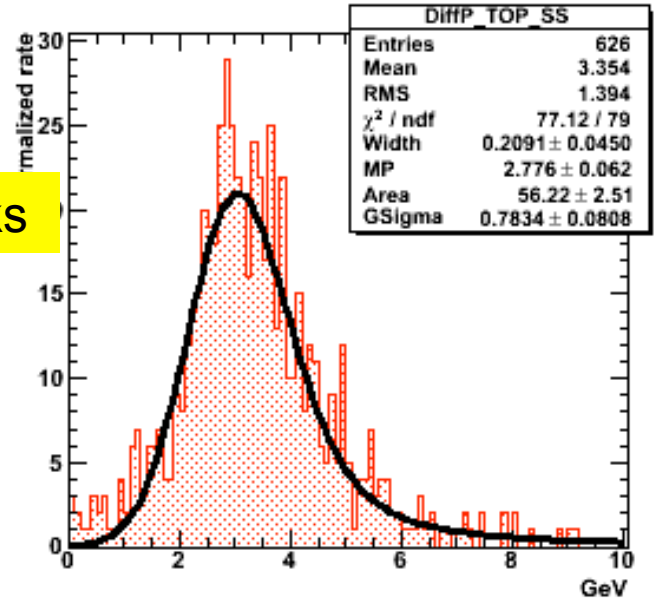
• Problems found in the ID reconstruction when reconstructin with release 15.3.1.6 the MC data (EDSs) produced with release 14.5.2.12.
Is 15.3.1.6 the release used for next cosmic MC production?
If so, these issues need be taken into account!

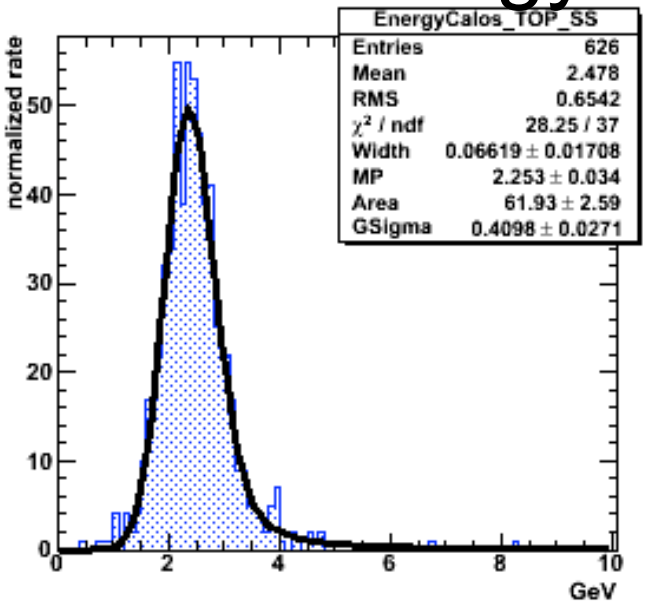
BACK-UP

Momentum difference ID-MS & energy loss

DATA

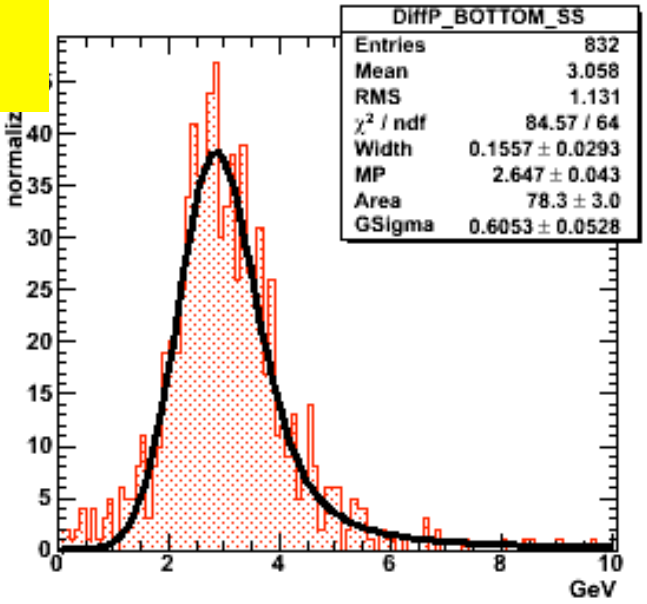
TOP tracks

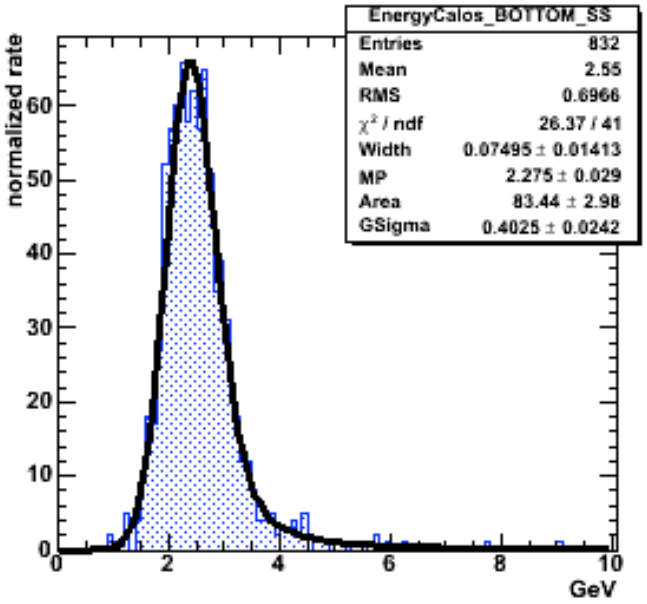




TOP tracks

BOTTOM tracks





BOTTOM tracks