ECAL ALIGNMENT 2017 - Update

5th July 2017

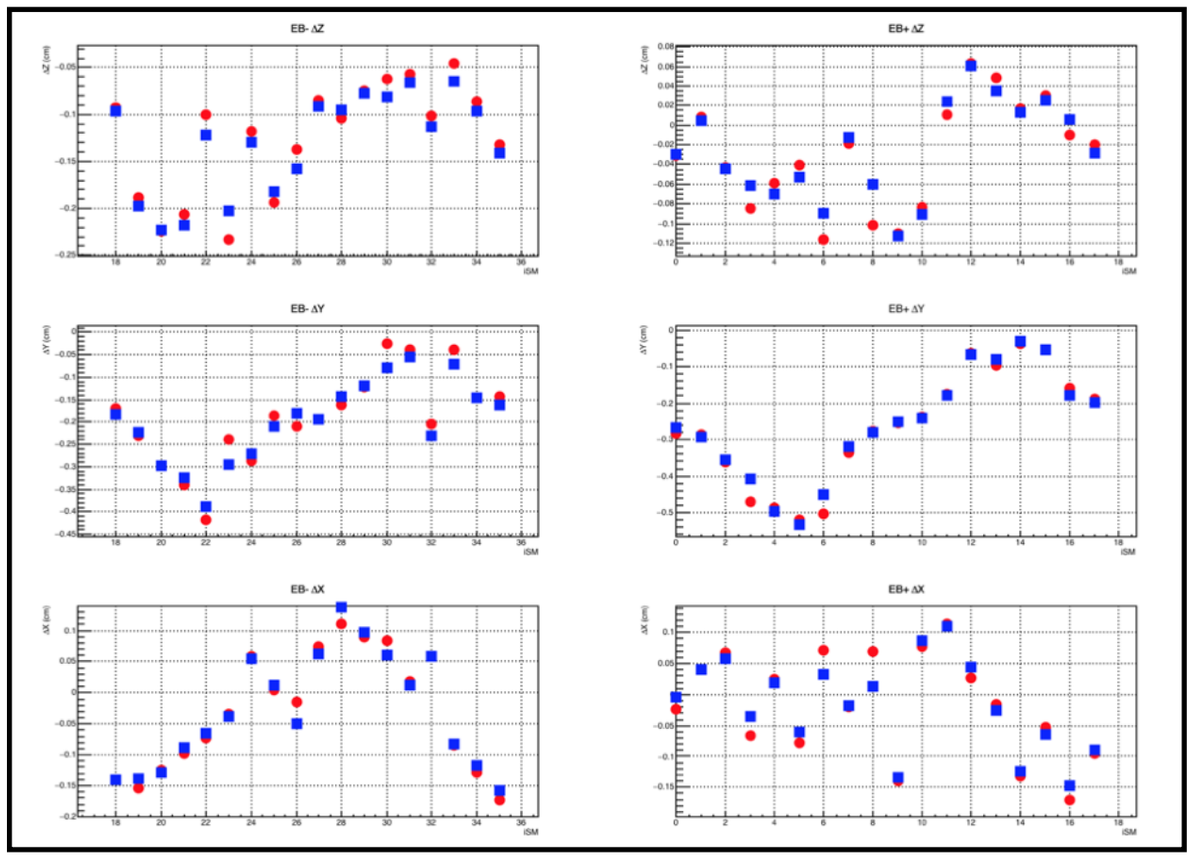
Tanvi Wamorkar
Northeastern University

MoCa Meeting

Changes since last presentation :
https://indico.cern.ch/event/648996/contributions/2638537/attachments/1484713/2304818/TanviWamorkar_MoCaJun28.pdf

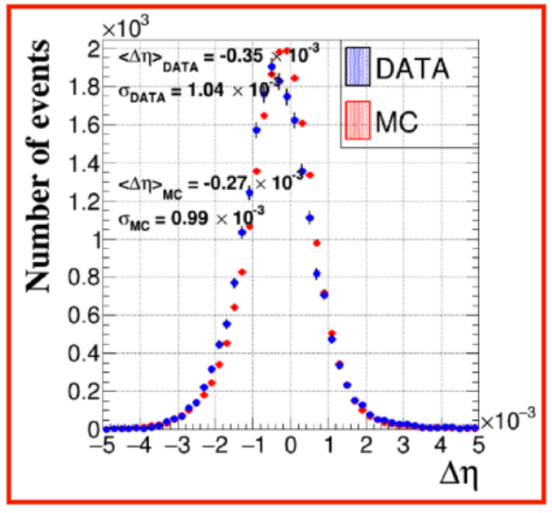
- **Huge increase in statistics - from 2.6 fb^{-1} to 4.6 fb^{-1}**

Increased statistics
Lesser statistics

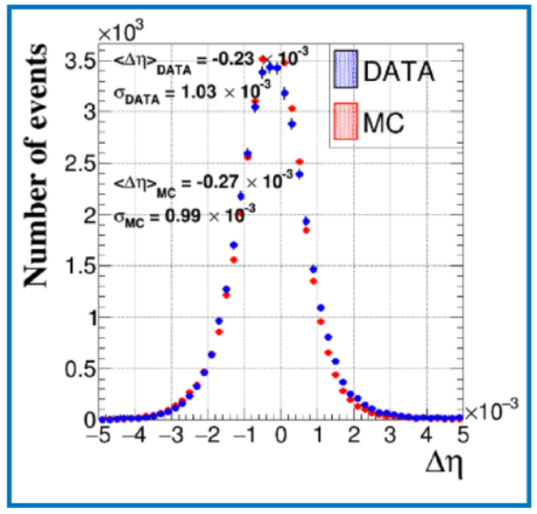


- **New ECAL DB produced**

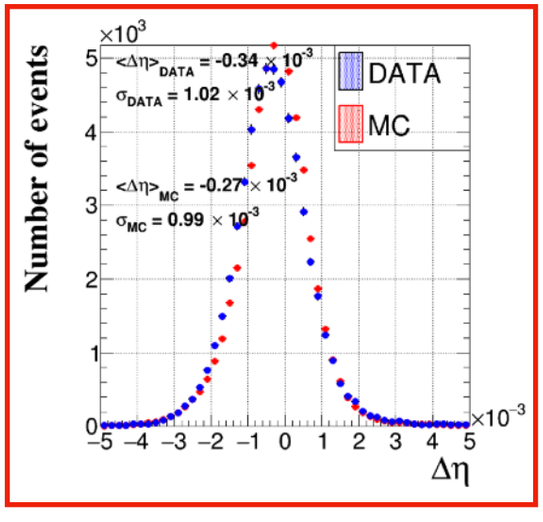
Pre-alignment

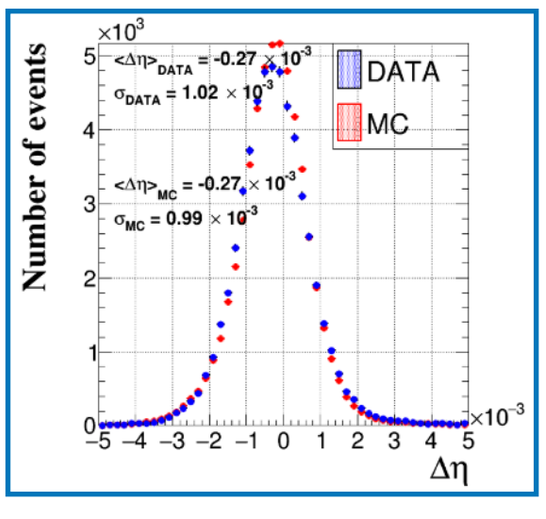


Post-alignment



- **Improved agreement between MC and Data**





Datasets

- CMSSW release used - CMSSW_9_2_1

- Dataset used for getting MC bias values:
- dataset=/DYJetsToLL_M-50_TuneCUETP8M1_13TeV-madgraphMLM-pythia8/PhaseISpring17MiniAOD-FlatPU28to62_902_90X_upgrade2017_realistic_v20_ext1-v1/MINIAODSIM

- Prompt GT used: 92X_dataRun2_Prompt_v4

- /DoubleEG/Run2017A-ZElectron-PromptReco-v2/RAW-RECO
- /DoubleEG/Run2017A-ZElectron-PromptReco-v3/RAW-RECO
- /DoubleEG/Run2017B-ZElectron-PromptReco-v1/RAW-RECO

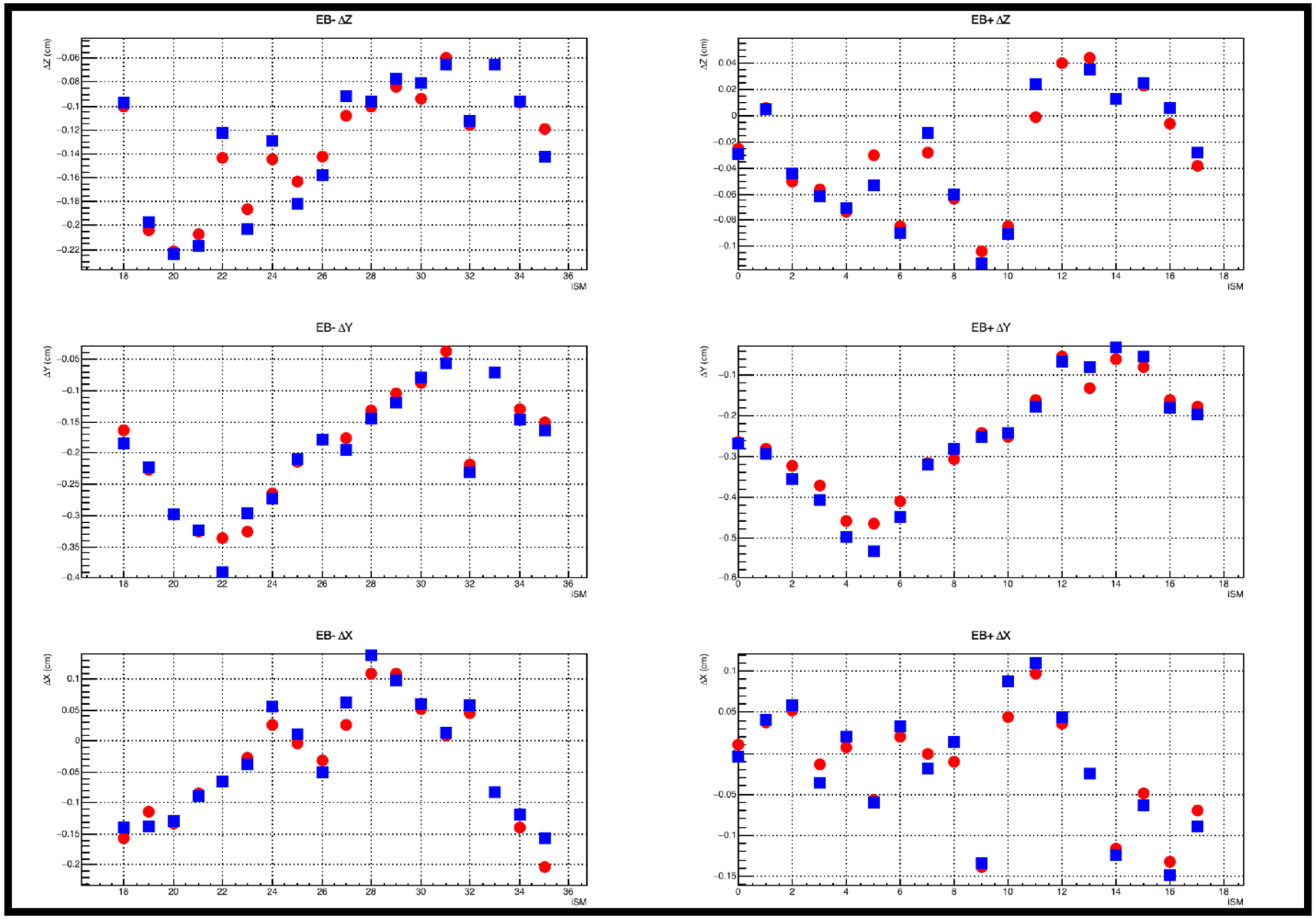
- The datasets correspond to 4.6 fb^{-1} integrated luminosity

- Only DCS JSON used

Alignment Values EB

2016 values

2017 values



Δx (cm)	Δy(cm)	Δz(cm)
-0.003	-0.267	-0.029
0.042	-0.293	0.005
0.059	-0.355	-0.045
-0.036	-0.409	-0.062
0.020	-0.498	-0.070
-0.061	-0.533	-0.053
0.033	-0.449	-0.089
-0.018	-0.319	-0.013
0.013	-0.281	-0.060
-0.134	-0.252	-0.113
0.087	-0.241	-0.091
0.110	-0.177	0.024
0.044	-0.067	0.062
-0.025	-0.080	0.036
-0.124	-0.032	0.013
-0.064	-0.055	0.025
-0.148	-0.180	0.006
-0.089	-0.198	-0.028
-0.140	-0.184	-0.097
-0.138	-0.222	-0.198
-0.129	-0.298	-0.223
-0.089	-0.324	-0.217
-0.066	-0.389	-0.122
-0.037	-0.296	-0.203
0.055	-0.273	-0.129
0.012	-0.210	-0.182
-0.049	-0.179	-0.158
0.062	-0.195	-0.091
0.139	-0.144	-0.096
0.098	-0.120	-0.077
0.061	-0.079	-0.081
0.013	-0.055	-0.066
0.059	-0.231	-0.113
-0.082	-0.071	-0.065
-0.118	-0.146	-0.097
-0.157	-0.163	-0.142

Compare with smaller statistics

Alignment Values EE

ΔΦ	Δϕ	ΔΨ	Δx (cm)	Δy(cm)	Δz(cm)
0.000782	0	0	-0.147	-0.539	-0.674
0.000923	0	0	-0.145	-0.650	-0.535
-0.000537	0	0	0.400	-0.744	0.445
-0.000901	0	0	0.410	-0.823	0.417

2016 values

0.000391	0	0.000391	-0.066	-0.538	-0.634
0.000461	0	0.000461	-0.035	-0.647	-0.463
-0.000268	0	-0.000268	0.266	-0.749	0.439
-0.000450	0	-0.000450	0.329	-0.841	0.414

2017 values

- With rotation in Phi turned off
- Samples also processed with rotation in Phi allowed - Phi change is very small ~ 0.05 mrad , confirmed with Re-Reco tests
- Can see shift in both EE and EB

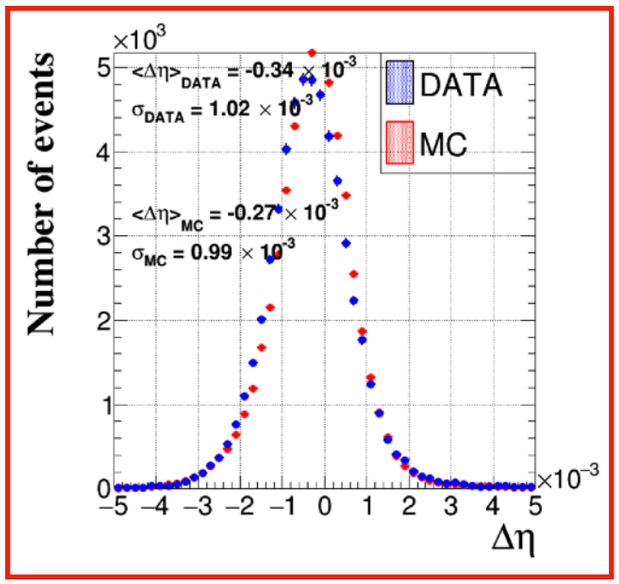
Alignment values stored :

- /afs/cern.ch/user/t/twamorka/public/ECALalignment_2017/myEBAlignment_2017_jul1_combined.txt
- /afs/cern.ch/user/t/twamorka/public/ECALalignment_2017/myEEAlignment_2017_jul1_combined.txt

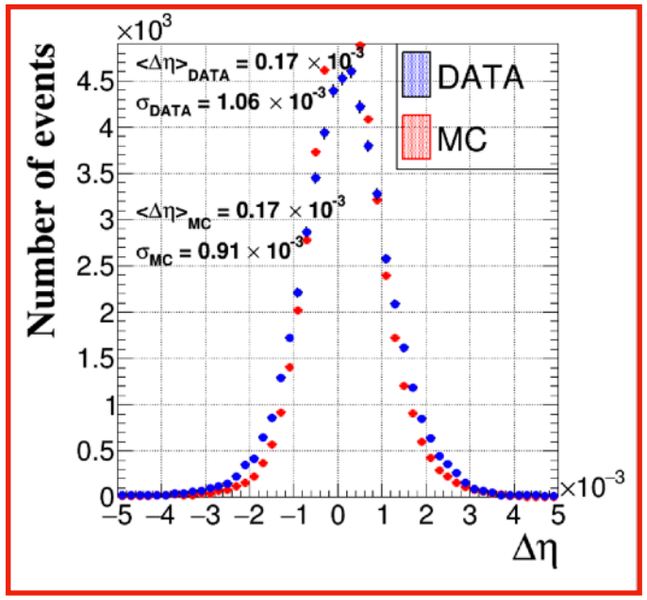
Eta Distributions

Pre-Alignment

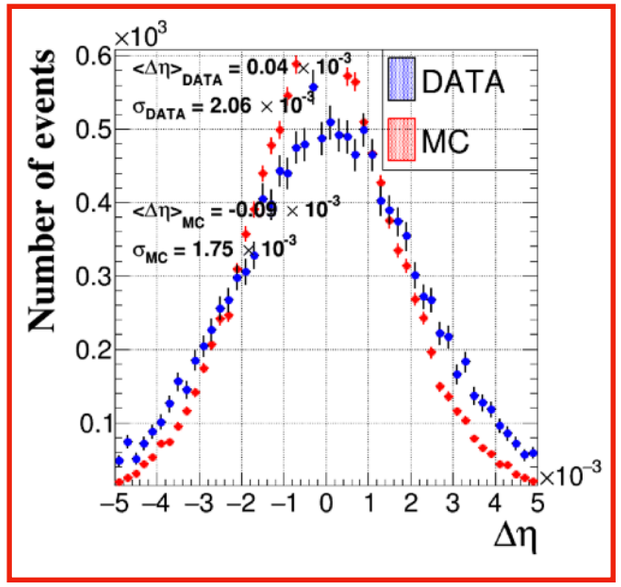
EB +



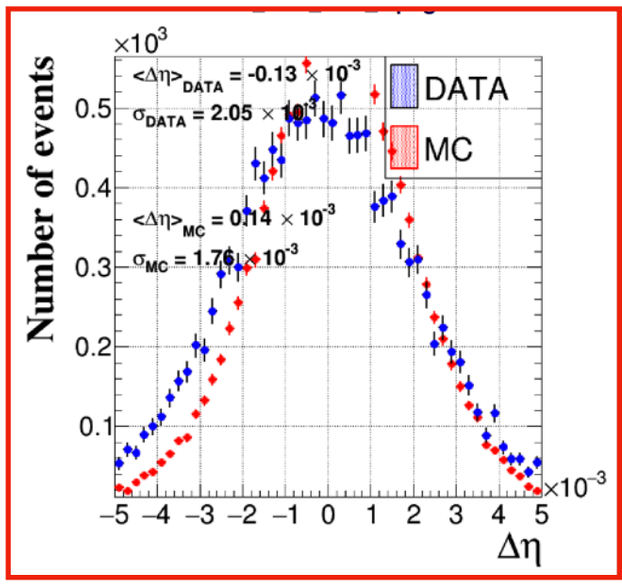
EB -



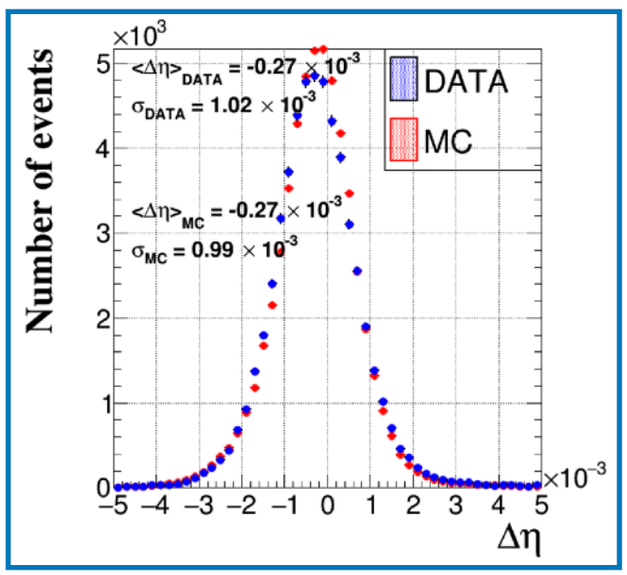
EE +

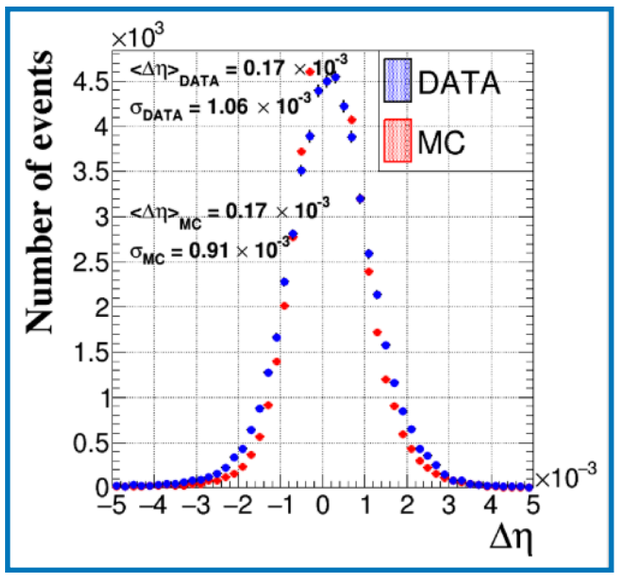


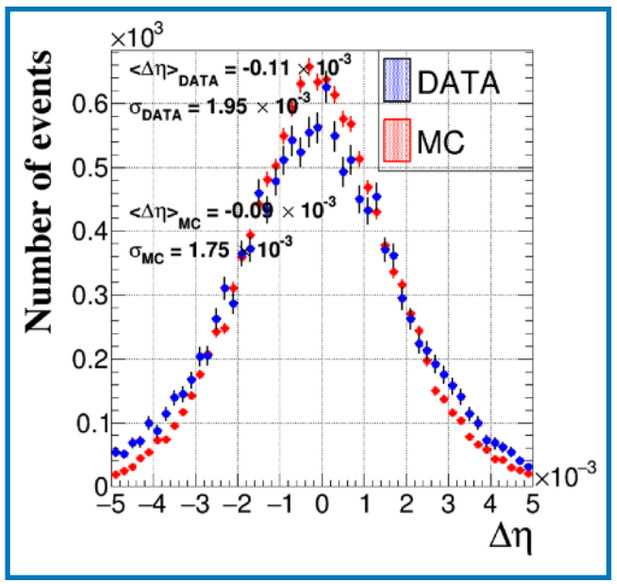
EE -

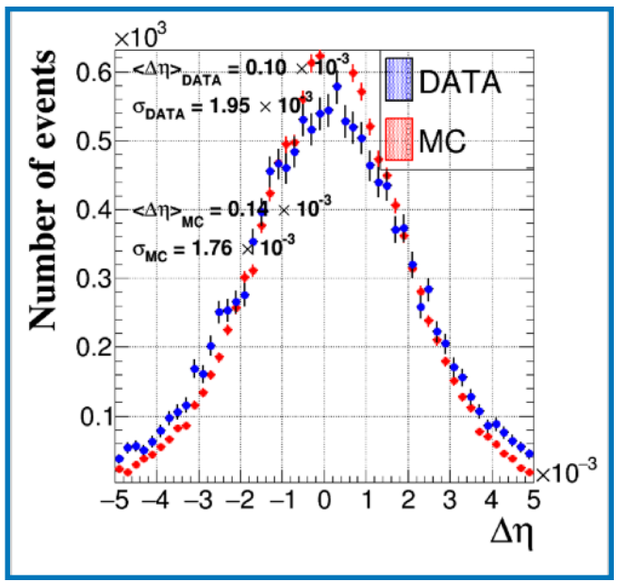


Post-Alignment









http://twamorka.web.cern.ch/twamorka/jul3_prealign/

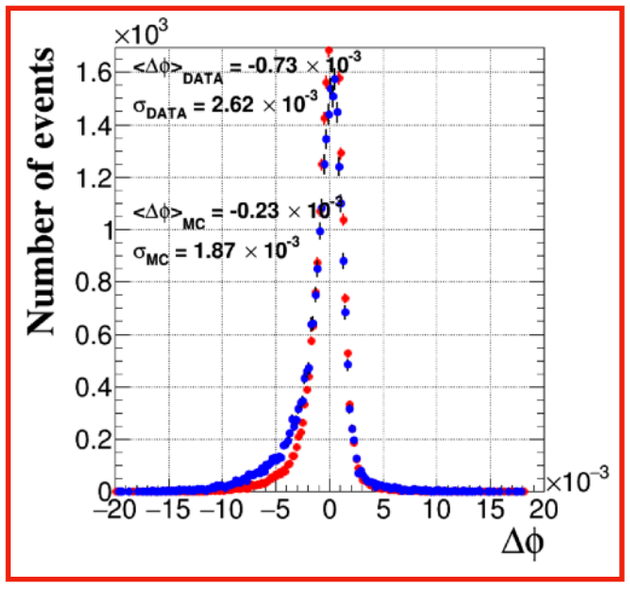
http://twamorka.web.cern.ch/twamorka/jul3_postalign/

Phi Distributions

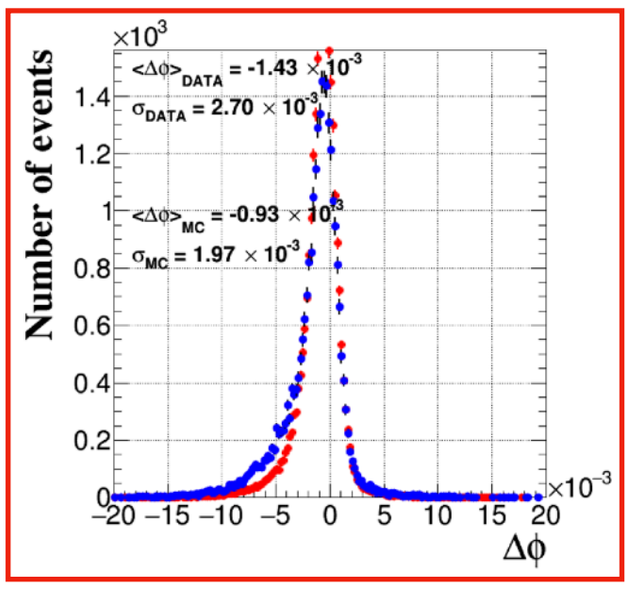
Electron

Pre-Alignment

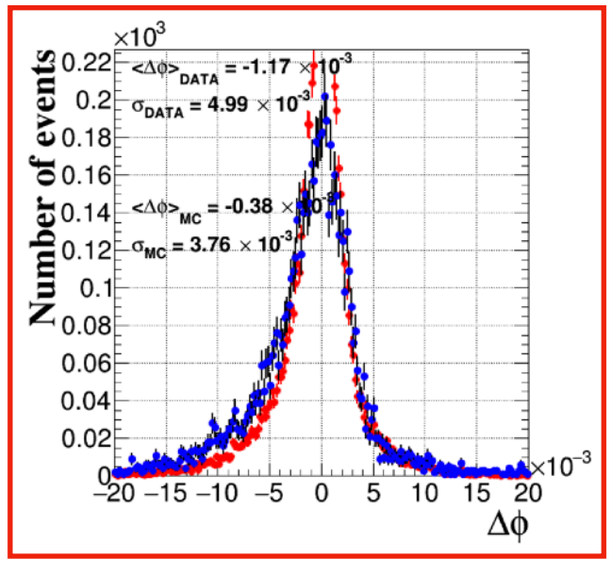
EB +



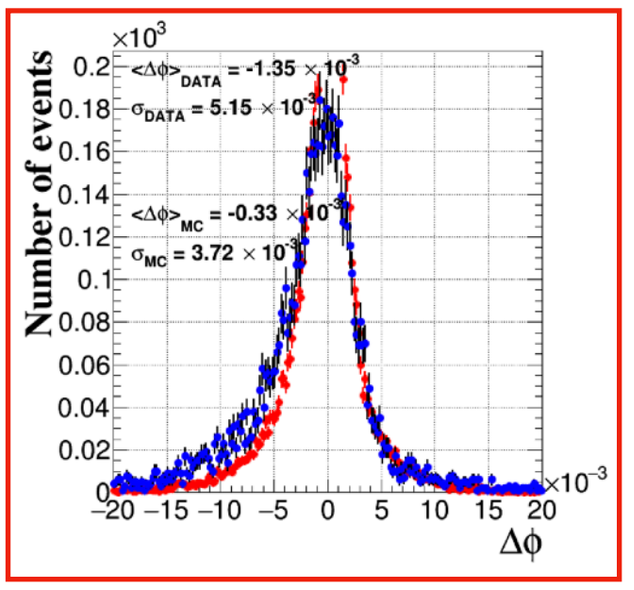
EB -



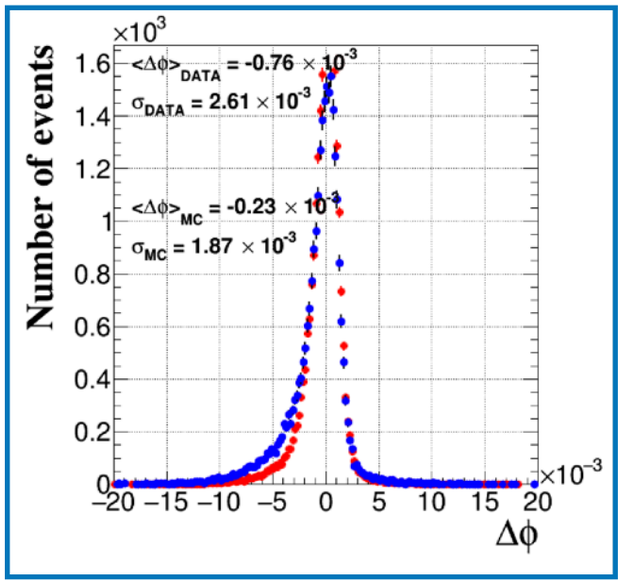
EE +

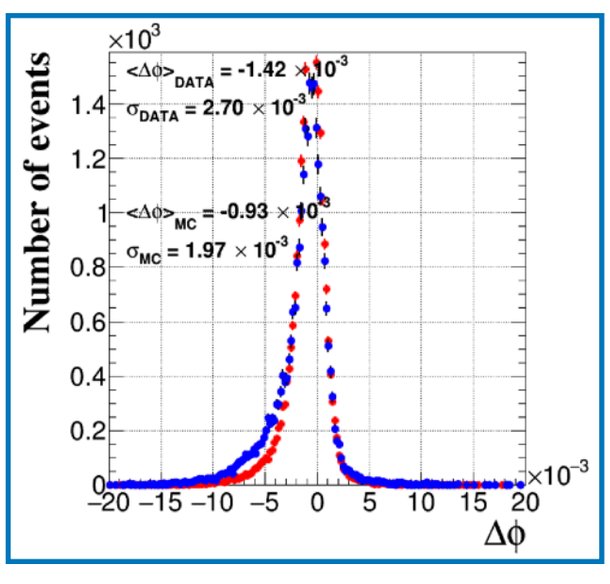


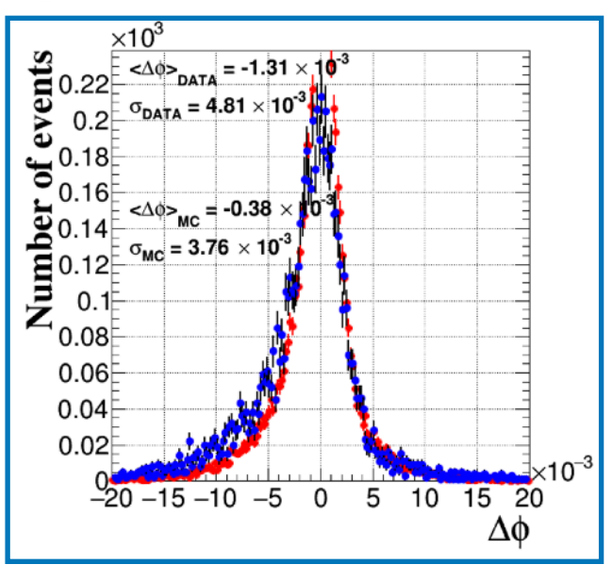
EE -

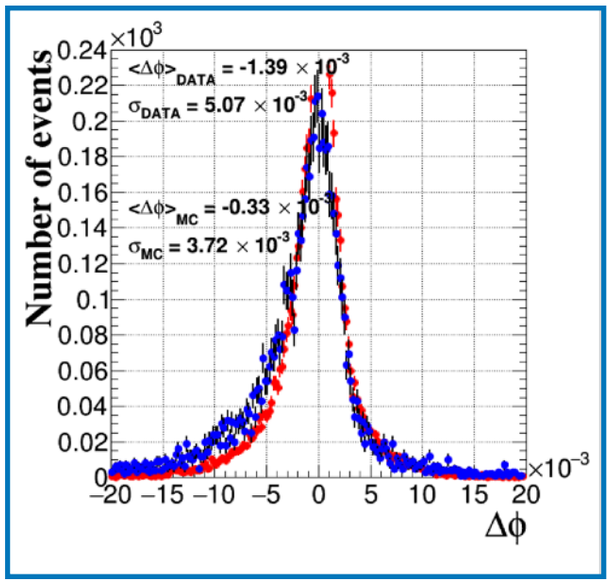


Post-Alignment









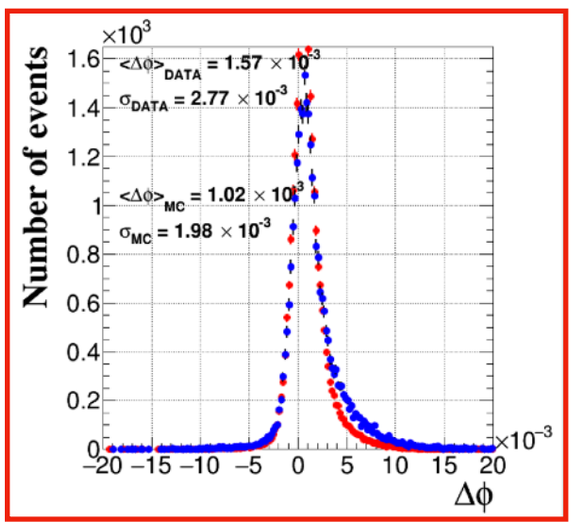
http://twamorka.web.cern.ch/twamorka/jul3_prealign/

http://twamorka.web.cern.ch/twamorka/jul3_postalign/

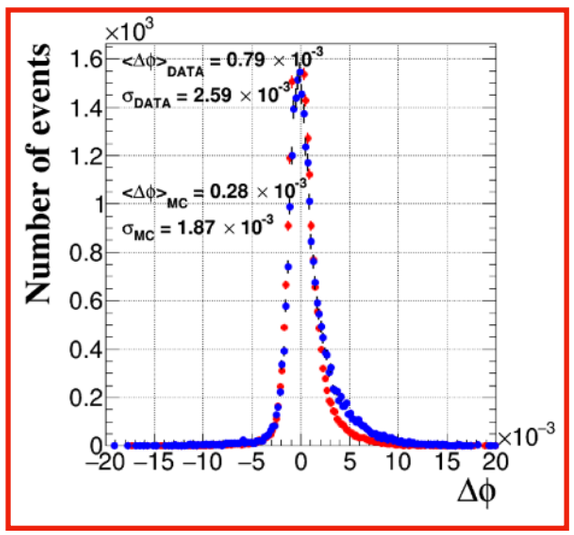
Positron

Pre-Alignment

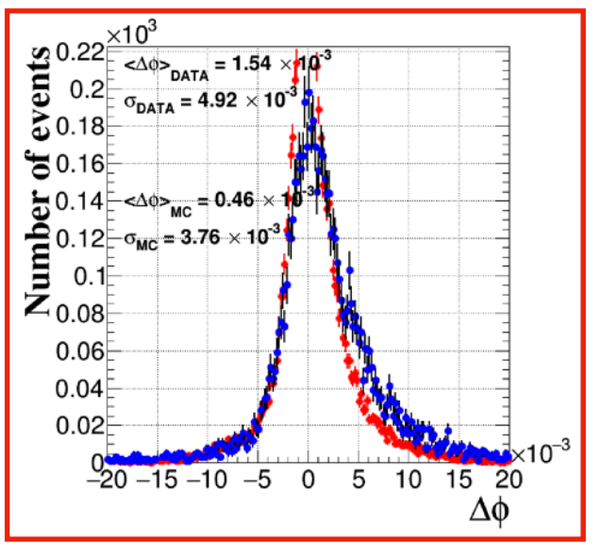
EB +



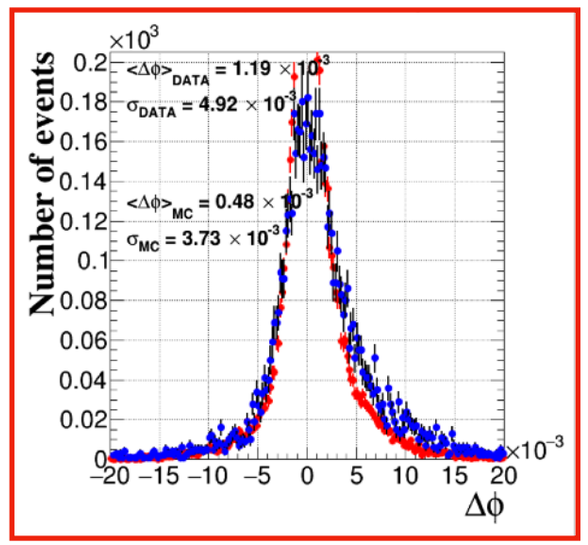
EB -



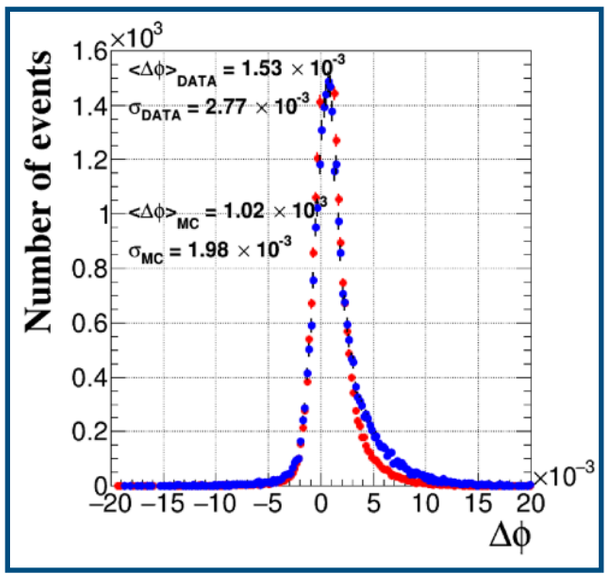
EE +

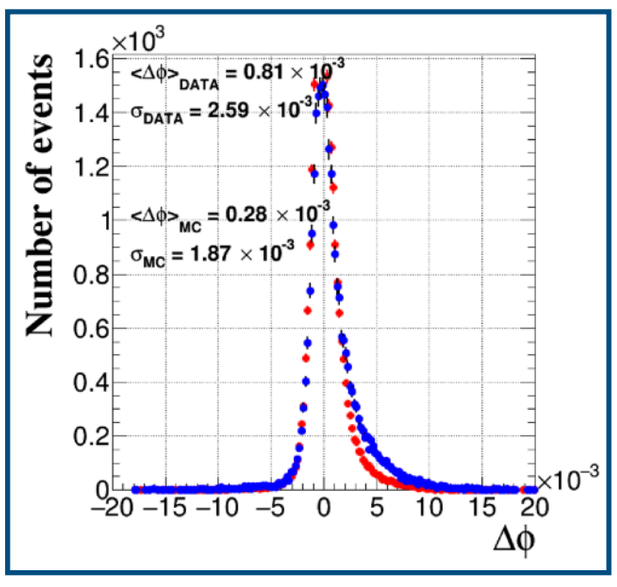


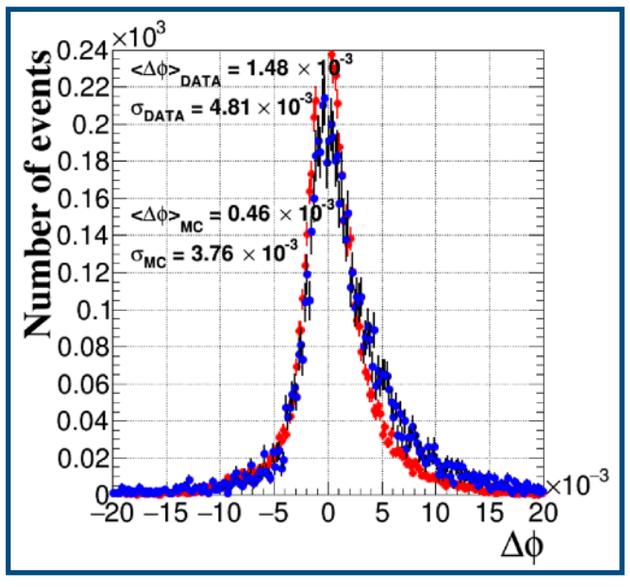
EE -

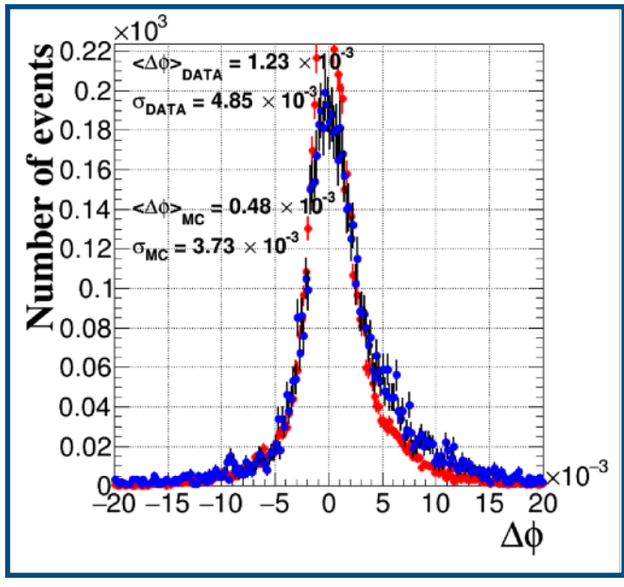


Post-Alignment









http://twamorka.web.cern.ch/twamorka/jul3_prealign/

http://twamorka.web.cern.ch/twamorka/jul3_postalign/

CONCLUSIONS

- For reference - Details of the Alignment procedure:

CMS AN-2013/328 - CMS ECAL alignment in the LHC RUN1
CMS DN-2015/026 - CMS ECAL alignment in the LHC RUN II

- New ECAL DB shows agreement between Data and MC

- New ECAL alignment values available:
  - **/afs/cern.ch/user/t/twamorka/public/ECALalignment_2017/myEBAlignment_2017_jul1_combined.txt**
  - **/afs/cern.ch/user/t/twamorka/public/ECALalignment_2017/myEEAlignment_2017_jul1_combined.txt**

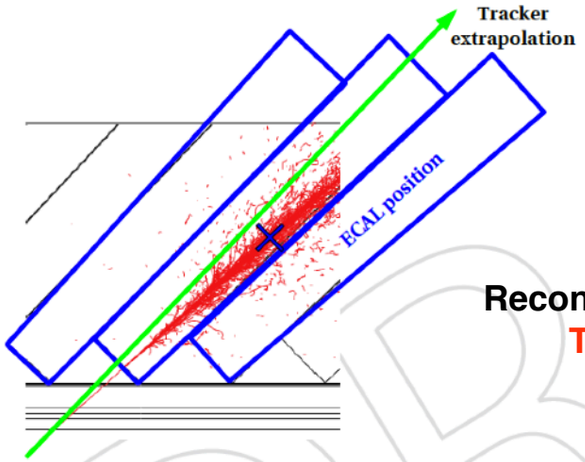
Validation of ECAL conditions :
https://hypernews.cern.ch/HyperNews/CMS/get/calibrations/3050.html

BACK UP

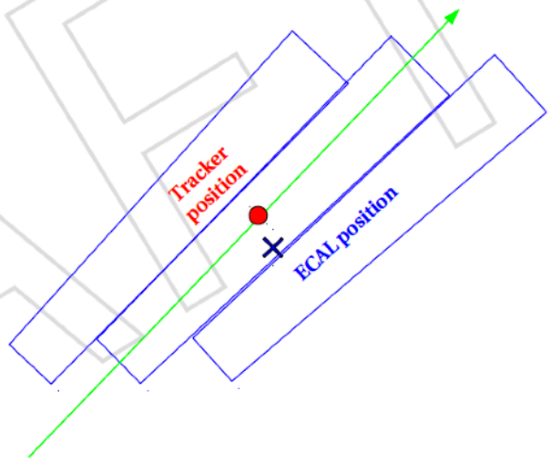
(Quick Review of the Alignment Procedure)

Quick Review of the Alignment Procedure

Reconstructed by ECAL



Reconstructed by Tracker



- Distance along Φ and η directions are used to construct χ^2

$$\chi^2 = \chi^2_+ + \chi^2_-$$

Positrons Electrons

$$\chi^2_\pm = \sum_{lepton} \frac{(\Delta\varphi - \langle \Delta\varphi^{MC}_\pm \rangle)^2}{\varepsilon^2_\varphi} + \frac{(\Delta\eta - \langle \Delta\eta^{MC} \rangle)^2}{\varepsilon^2_\eta}$$

- The alignment procedure is based on minimization of χ^2

Measure (for every SM in EB and Dee in EE)
- **3 Translations Δx, Δy, Δz**
- **3 Rotations(Euler angles) Δϕ ,Δθ ,Δψ**

- ΔΦ and Δη are used to construct χ^2 and the difference between these variables for Data and MC is minimized in order to effectively align the ECAL with the tracker

All alignment related variables are required to be same in MC and Data

Chi 2 minimization : EB SM =5

```
Chi2 minimization
 Chi2 = 22378.7 / 970 = 23.0708 - 0 mm: 0 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22378.7 / 970 = 23.0709 - 7.30461e-05 mm: 0 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22378.7 / 970 = 23.0708 - -7.30461e-05 mm: 0 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22379 / 970 = 23.0712 - 0.000730461 mm: 0 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22378.4 / 970 = 23.0705 - -0.000730461 mm: 0 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22378.7 / 970 = 23.0709 - 0 mm: 7.30461e-05 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22378.7 / 970 = 23.0708 - 0 mm: -7.30461e-05 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22379.1 / 970 = 23.0712 - 0 mm: 0.000730461 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22378.3 / 970 = 23.0704 - 0 mm: -0.000730461 mm: 0 mm: 0 : 0 : 0
 Chi2 = 22378.7 / 970 = 23.0708 - 0 mm: 0 mm: 7.30461e-05 mm: 0 : 0 : 0
 Chi2 = 22378.7 / 970 = 23.0709 - 0 mm: 0 mm: -7.30461e-05 mm: 0 : 0 : 0
 Chi2 = 22378.4 / 970 = 23.0705 - 0 mm: 0 mm: 0.000730461 mm: 0 : 0 : 0
 Chi2 = 22379 / 970 = 23.0711 - 0 mm: 0 mm: -0.000730461 mm: 0 : 0 : 0
 Chi2 = 22269.5 / 970 = 22.9583 - -0.24986 mm: -0.401947 mm: 0.141554 mm: 0 : 0 : 0
 Chi2 = 22242.1 / 970 = 22.93 - -0.172574 mm: -0.277618 mm: 0.0977685 mm: 0 : 0 : 0
 Chi2 = 22242.5 / 970 = 22.9304 - -0.170152 mm: -0.277618 mm: 0.0977685 mm: 0 : 0 : 0
 Chi2 = 22241.8 / 970 = 22.9297 - -0.174995 mm: -0.277618 mm: 0.0977685 mm: 0 : 0 : 0
 Chi2 = 22242.1 / 970 = 22.93 - -0.172574 mm: -0.274831 mm: 0.0977685 mm: 0 : 0 : 0
 Chi2 = 22242.1 / 970 = 22.93 - -0.172574 mm: -0.280405 mm: 0.0977685 mm: 0 : 0 : 0
 Chi2 = 22242.6 / 970 = 22.9305 - -0.172574 mm: -0.277618 mm: 0.0996222 mm: 0 : 0 : 0
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 Chi2 = 22225.1 / 970 = 22.9125 - -0.275969 mm: -0.311146 mm: 0.026412 mm: 0 : 0 : 0
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 Chi2 = 22220.6 / 970 = 22.9078 - -0.262563 mm: -0.353306 mm: -0.00105986 mm: 0 : 0 :
0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209479 mm: -0.520245 mm: -0.109842 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.20706 mm: -0.520245 mm: -0.109842 mm: 0 : 0 : 0
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 Chi2 = 22212.5 / 970 = 22.8995 - -0.207065 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.211903 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.517358 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.522924 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.107938 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.111642 mm: 0 : 0 : 0
```

```
Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.207065 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.211903 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.517358 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.522924 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.107938 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.111642 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209968 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209388 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209581 mm: -0.520141 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.519584 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520698 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.52003 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520252 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.10942 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.11016 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.109716 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.520141 mm: -0.109864 mm: 0 : 0 : 0
 Chi2 = 22212.6 / 970 = 22.8995 - -0.207065 mm: -0.517358 mm: -0.10979 mm: 0 : 0 : 0
 Chi2 = 22212.6 / 970 = 22.8995 - -0.207065 mm: -0.520141 mm: -0.107938 mm: 0 : 0 : 0
 Chi2 = 22212.5 / 970 = 22.8995 - -0.209484 mm: -0.517358 mm: -0.107938 mm: 0 : 0 : 0
 FCN=22212.5 FROM MIGRAD    STATUS=CONVERGED      65 CALLS          66 TOTAL
                     EDM=1.98178e-12    STRATEGY= 1      ERROR MATRIX ACCURATE
  EXT PARAMETER                                   STEP         FIRST
  NO.   NAME      VALUE            ERROR          SIZE      DERIVATIVE
   1  DX           -2.09484e-04   3.46070e-05   4.83799e-05   6.11909e-04
   2  DY           -5.20141e-04   6.39978e-05   5.56663e-05   1.80702e-03
   3  DZ           -1.09790e-04   4.29115e-05   3.70397e-05  -4.02696e-04
   4  DPHIe         0.00000e+00     fixed
   5  DTHETAe       0.00000e+00     fixed
   6  DPSIe         0.00000e+00     fixed
iSM = 5 DPhi   = 0 +/- 0
iSM = 5 DTheta = 0 +/- 0
iSM = 5 DPsi   = 0 +/- 0
iSM = 5 DX =     -0.000209484 +/- 3.4607e-05
iSM = 5 DY =     -0.000520141 +/- 6.39978e-05
iSM = 5 DZ =     -0.00010979 +/- 4.29115e-05
```

Smaller statistics