ECAL and ES Alignment 2018
First Results

MoCa Meeting
9th May 2018

Tanvi Wamorkar[1], Pei-Rong Yu[2]

[1] Northeastern University
[2] National Taiwan University

Outline

- Datasets used to perform ECAL/ES alignment
- Comparison of 2017 and 2018 alignment values:
  - ECAL
  - Pre-shower (ES)
- Alignment validation plots
- Conclusion
- Review of ECAL and ES alignment procedure (in Backup)

Datasets

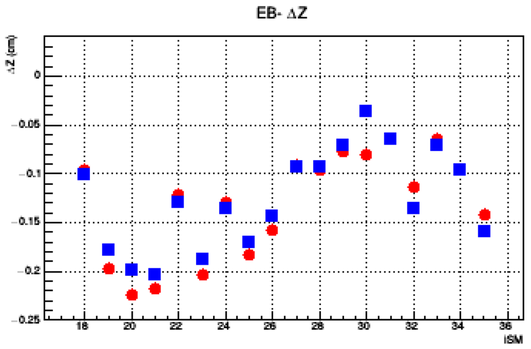
ECAL Alignment

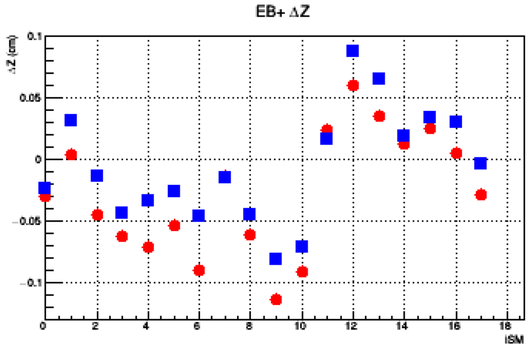
- CMSSW release used : CMSSW_10_1_2_patch2
- MC dataset used to extract bias values : /DYJetsToLL_M-50_TuneCP5_13TeV-madgraphMLM-pythia8/RunIISpring18MiniAOD-NZSPU40to70_100X_upgrade2018_realistic_v10-v2/MINIAODSIM
- Global tag used : 101X_dataRun2_Prompt_v9
- /EGamma/Run2018A-ZElectron-PromptReco-v1/RAW-RECO
- DCS JSON used

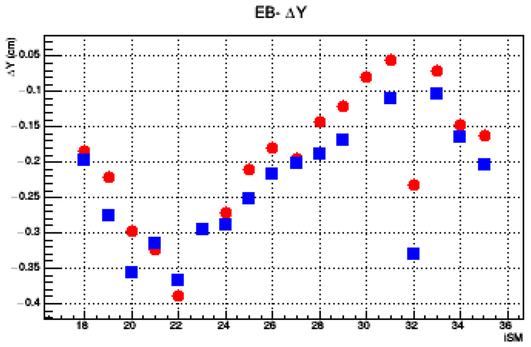
ES Alignment

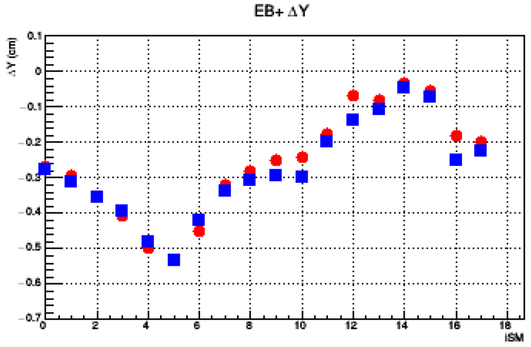
- CMSSW release used : CMSSW_10_1_2_patch2
- Global tag used : 101X_dataRun2_Prompt_v9
- /EGamma/Run2018A-EcalESAlign-PromptReco-v1/ALCARECO
- DCS JSON used

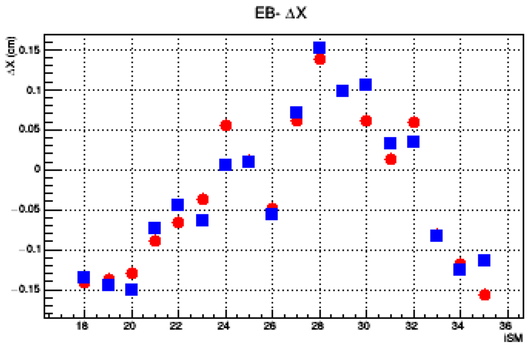
Alignment values : ECAL barrel

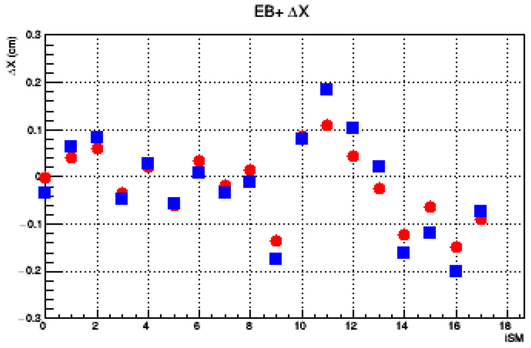












- Δx, Δy, Δz values for EB + and - compared for 2017 and 2018
- On y axis: Supermodule number

- Red circles : 2017 values
- Blue squares : 2018 values
- No significant change observed
  - Expected since during the winter shutdown, only the endcaps were opened and closed

- Alignment values are stored here:

/afs/cern.ch/user/t/twamorka/public/ECALalignment_2018/myEBAlignment_2018_combined_v0.txt

Alignment values : ECAL endcap

		ΔΦ	Δϕ	ΔΨ	Δx	Δy	Δz
EE -	Dee 0	0.00039112	0	0.00039112	-0.065725	-0.53779	-0.63415
	Dee 1	0.00046148	0	0.00046148	-0.03533	-0.64747	-0.46271
EE +	Dee 2	-0.00026845	0	-0.00026845	0.26558	-0.74857	0.43904
	Dee 3	-0.00045037	0	-0.00045037	0.32866	-0.84081	0.41354

2017 values

EE -	Dee 0	0.00039112	0	0.00039112	-0.093372	-0.62537	-0.66182
	Dee 1	0.00046148	0	0.00046148	-0.087034	-0.76022	-0.46897
EE +	Dee 2	-0.00026845	0	-0.00026845	0.07638	-0.79304	0.46977
	Dee 3	-0.00045037	0	-0.00045037	0.12154	-0.8734	0.4397

2018 values

Units are cm

Biggest shift is seen in **y-direction in EE- ~1 mm**
x-direction in EE+ ~2mm

- Alignment values are stored here:

/afs/cern.ch/user/t/twamorka/public/ECALalignment_2018/myEEAlignment_2018_combined_v0.txt

Starting point & Final result

- Starting global coordinate of preshower with GlobalTag 101X_dataRun2_Prompt_v9

	Translation(cm)			Rotation(mrad)		
	x	y	z	α	β	γ
-Rear	-0.017	-0.56	-308.899	1	0.2	-0.2
-Front	0	-0.573	-304.259	0.9	0.4	0.3
+Front	0.218	-0.844	304.139	-0.9	-0.1	1.3
+Rear	0.226	-0.826	308.766	-1.2	0.3	1.1
After 10 iterations						
-Rear	-0.047	-0.656	-308.941	1	0.3	-0.4
-Front	-0.043	-0.667	-304.253	0.8	0.5	0
+Front	-0.008	-0.881	304.127	-1	0	1.5
+Rear	0.021	-0.856	308.816	-1.1	0.2	1.3

- Iterated 10 times alignment to make sure all the parameters are stable.

Alignment values : Pre-shower (ES)

- ES values:

Plus Side

Before ES alignment

-Front X: 0, Y: -0.573, Z: -304.259
-Rear X: -0.0173998, Y: -0.5603, Z: -308.899

After ES alignment

-Front X: -0.0437978, Y: -0.667463, Z: -304.253
-Rear X: -0.0472656, Y: -0.655722, Z: -308.941

Minus Side

Before ES alignment

+Front X: 0.2182, Y: -0.844501, Z: 304.139
+Rear X: 0.225601, Y: -0.825701, Z: 308.766

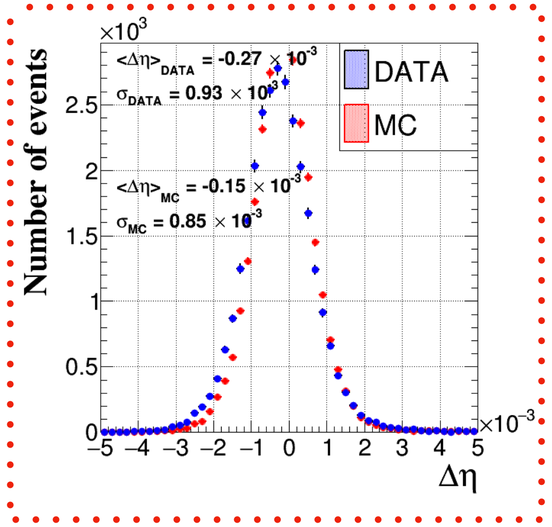
After ES alignment

+Front X: -0.00831555, Y: -0.880701, Z: 304.127
+Rear X: 0.0208182, Y: -0.855631, Z: 308.816

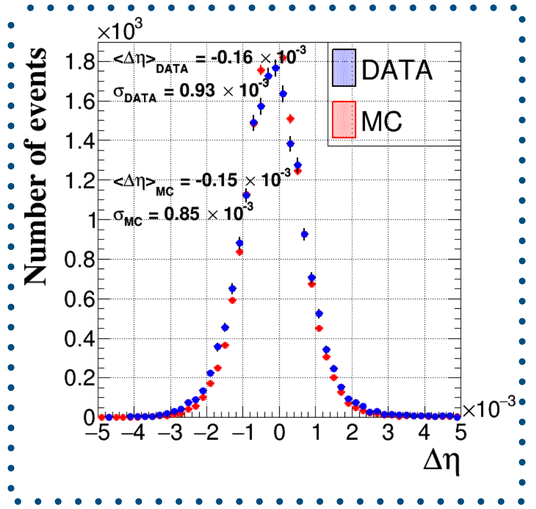
Consistent with the shifts seen in Ecal Endcap!

Δη Distributions : ECAL barrel

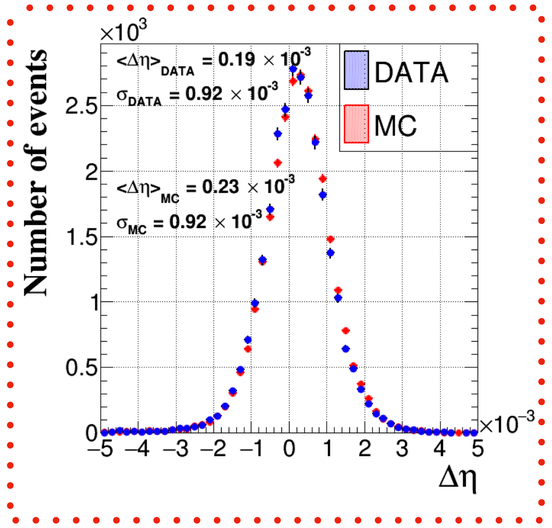
Pre-Alignment



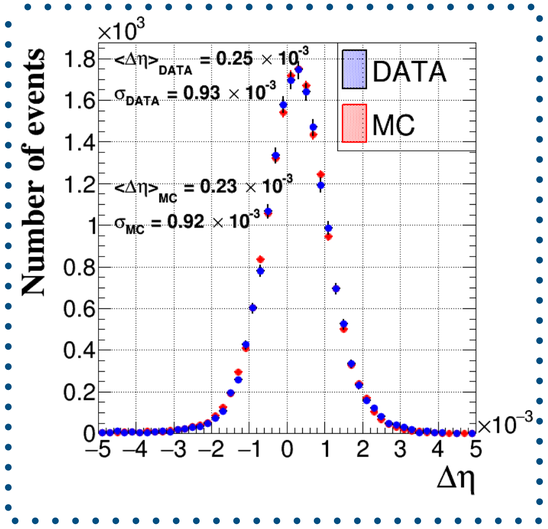
EB +



Post-Alignment

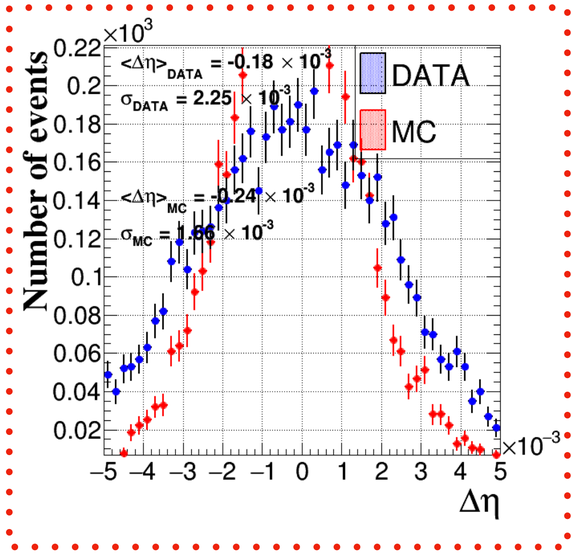


EB -

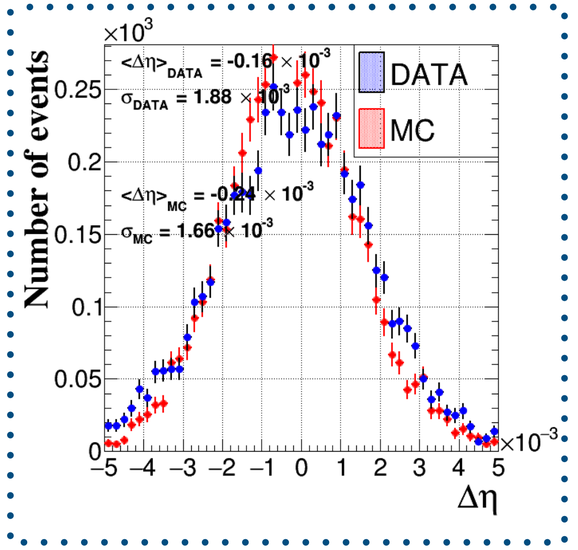


Δη Distributions : ECAL endcap

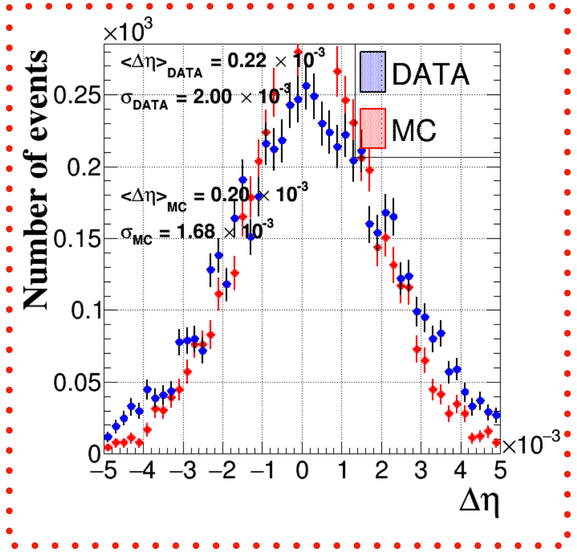
Pre-Alignment



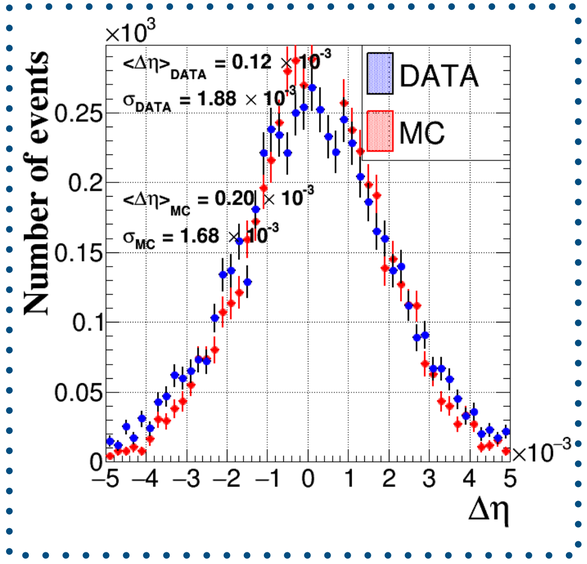
EE +



Post-Alignment

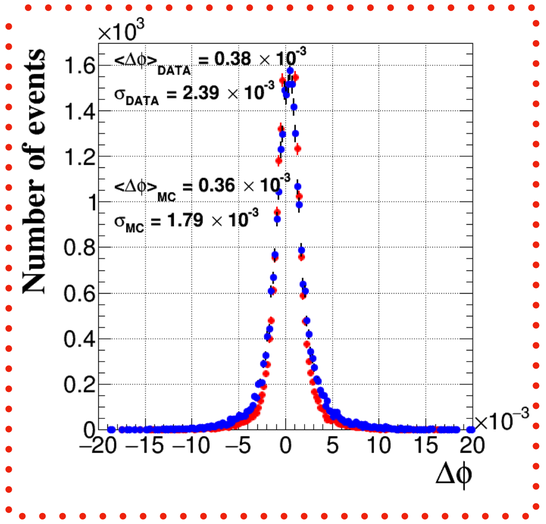


EE -

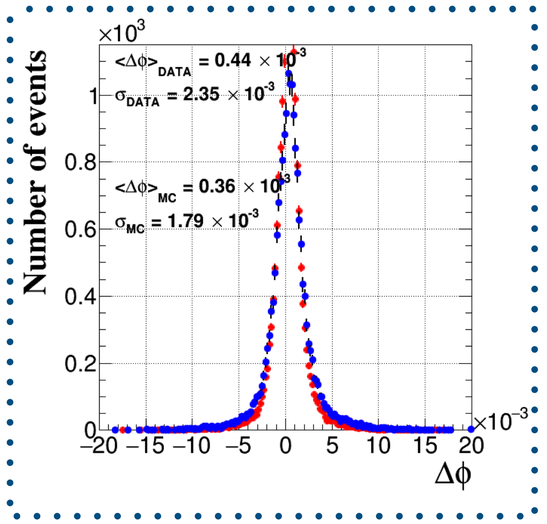


Δφ Distributions: ECAL barrel

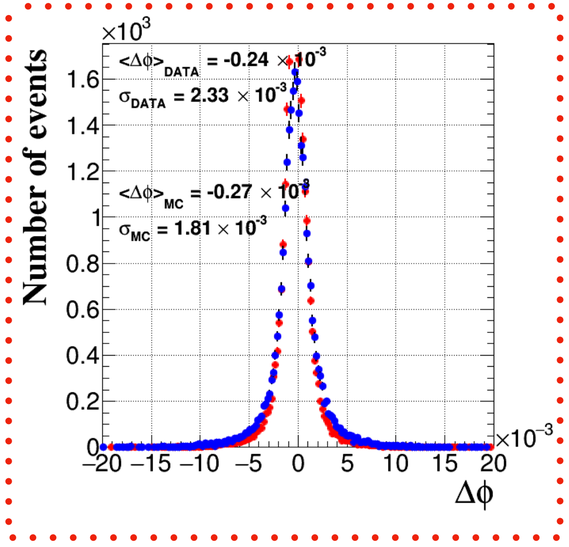
Pre-Alignment



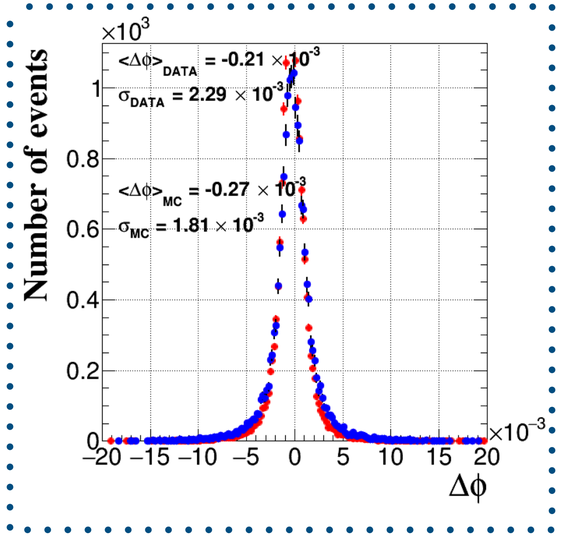
EB +



Post-Alignment



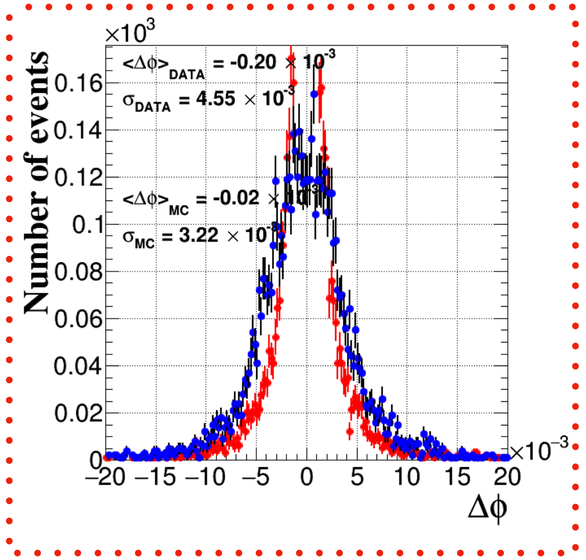
EB -

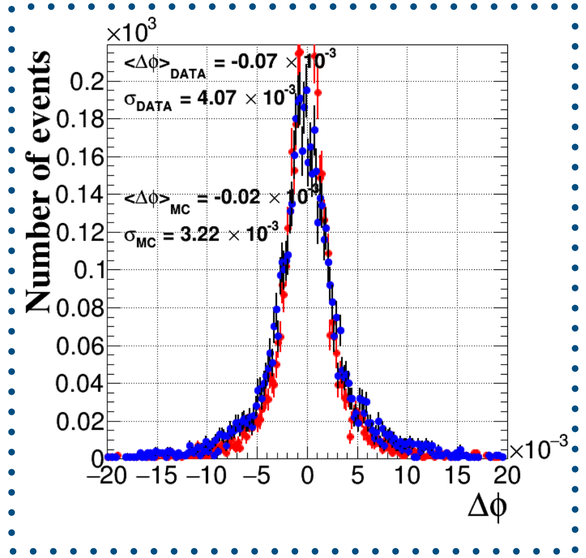


Δφ Distributions: ECAL endcap

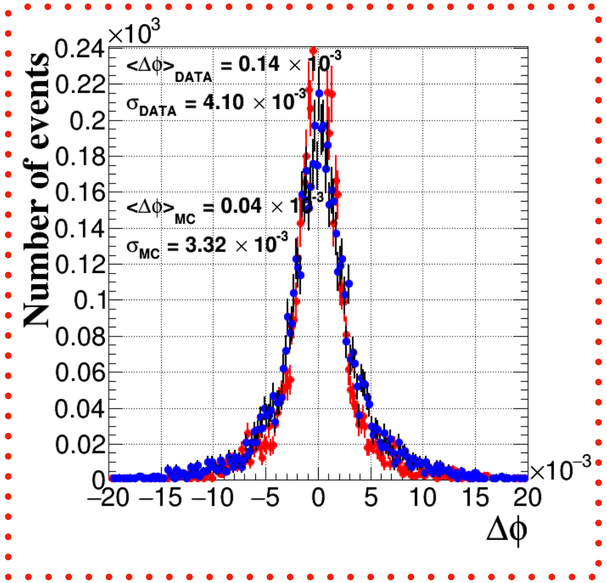
Pre-Alignment

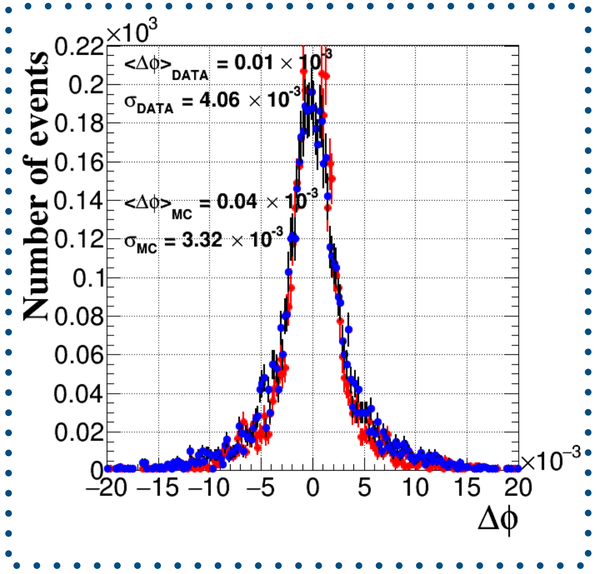
EE +





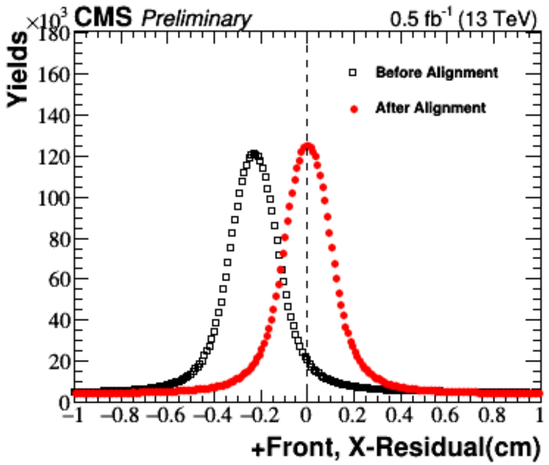
EE -

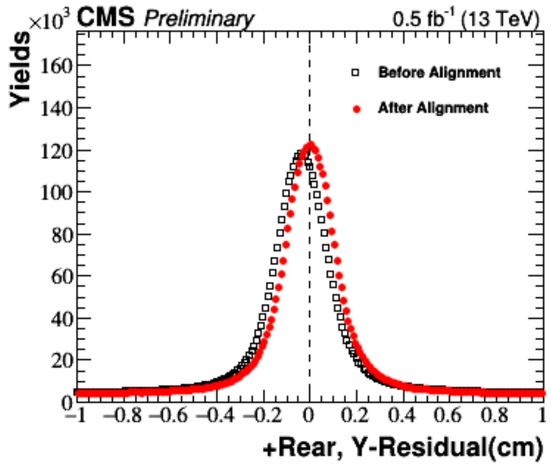


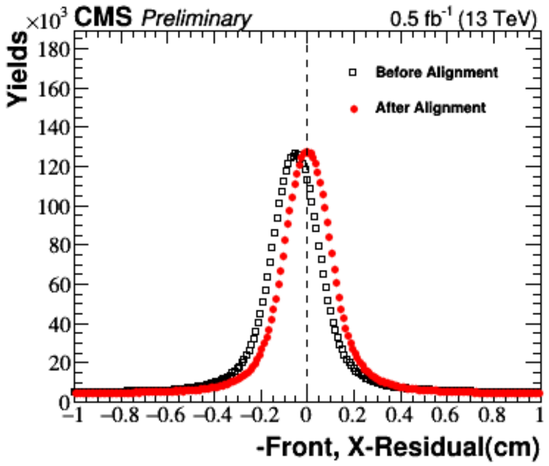


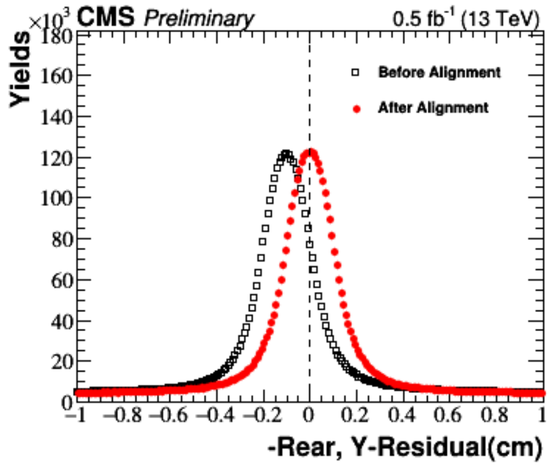
Post-Alignment

ES Alignment : Performance









- The plots on the left show the residual distribution before and after ES alignment for the four planes.

Work by Pei-Rong Yu (National Taiwan University) and Chia-Ming Kuo (National Central University, Taiwan)

Conclusion

- ECAL barrel and endcap plus Pre-shower (ES) alignment performed with 2018 data.
- New ECAL DB shows improved agreement between Data and MC.
- New ECAL EB and EE alignment values here:

/afs/cern.ch/user/t/twamorka/public/ECALalignment_2018/myEBAlignment_2018_combined_v0.txt
/afs/cern.ch/user/t/twamorka/public/ECALalignment_2018/myEEAlignment_2018_combined_v0.txt

- Shifts seen in ECAL EE and ES are consistent!
- ECAL and ES alignment validated and are ready to be deployed!

Approved by ECAL DPG


NORTHEASTERN UNIVERSITY
LVX
VERITAS
VIRTVS
FOUNDED
BOSTON, MASSACHUSETTS

Backup

Backup

0	0	0	-0.030205	-0.010513	0.0059165
0	0	0	0.020805	-0.019818	0.027511
0	0	0	0.024368	0.0021255	0.030943
0	0	0	-0.010725	0.015078	0.018728
0	0	0	0.0083447	0.018832	0.036616
0	0	0	0.0026953	0.0014639	0.027583
0	0	0	-0.024597	0.030849	0.04396
0	0	0	-0.014708	-0.016936	-0.0015252
0	0	0	-0.023765	-0.024946	0.016137
0	0	0	-0.038689	-0.042868	0.032129
0	0	0	-0.0063553	-0.056835	0.020229
0	0	0	0.074584	-0.021453	-0.0079159
0	0	0	0.059957	-0.067997	0.027082
0	0	0	0.046182	-0.026456	0.029626
0	0	0	-0.03922	-0.013426	0.0066461
0	0	0	-0.05598	-0.017511	0.0096386
0	0	0	-0.053563	-0.070452	0.024857
0	0	0	0.015049	-0.025962	0.024303
0	0	0	0.0058137	-0.012952	-0.0041128
0	0	0	-0.0083776	-0.052647	0.019064
0	0	0	-0.022586	-0.058122	0.024516
0	0	0	0.016053	0.0092857	0.014064
0	0	0	0.021024	0.021458	-0.0080467
0	0	0	-0.026797	0.00034987	0.014887
0	0	0	-0.04931	-0.017304	-0.0070399
0	0	0	-0.0037254	-0.040976	0.011542
0	0	0	-0.0072039	-0.037526	0.014459
0	0	0	0.0090411	-0.0068026	-0.0014003
0	0	0	0.01299	-0.044767	0.0031752
0	0	0	0.00010993	-0.048688	0.0058803
0	0	0	0.043883	0.065846	0.043642
0	0	0	0.018258	-0.05576	0.0013514
0	0	0	-0.024014	-0.10016	-0.022005
0	0	0	-0.0020234	-0.033327	-0.0059957
0	0	0	-0.0080323	-0.019199	-0.00031756
0	0	0	0.042269	-0.04066	-0.017216

2018 alignment values EB (Units are in cm)

ECAL Alignment : Quick Review

- Alignment of ECAL barrel and endcap with respect to tracking system.
- Measured using electrons from Z→ee events.
- The alignment procedure is based on a minimization of χ^2 (sum of χ_+^2 for positrons and χ_-^2 for electrons). $\chi^2 = \chi_+^2 + \chi_-^2$
- The is based on Δη and Δφ and it minimizes the differences b/w MC and Data for these variables. Under the assumption that in a perfectly aligned system MC and data should agree in these variables, by means of minimization we are effectively aligning ECAL.

$$\chi_{\pm}^2 = \sum_{lepton} \frac{(\Delta\varphi - \langle \Delta\varphi_{\pm}^{MC} \rangle)^2}{\varepsilon_{\varphi}^2} + \frac{(\Delta\eta - \langle \Delta\eta^{MC} \rangle)^2}{\varepsilon_{\eta}^2}$$

- More details on the alignment procedure can be found here:
  - CMS AN-2013/328 - CMS ECAL alignment in the LHC RUN1
  - CMS DN-2015/026 - CMS ECAL alignment in the LHC RUN II

ES Alignment : Quick Review

- Preshower (ES) sits between the strip tracker and ECAL endcap crystals.

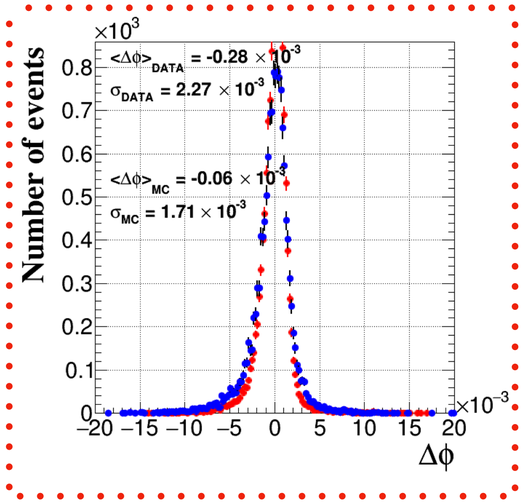
- Each side consists of 2 detect disks (front and rear) set to different directions. Thus, the front (rear) plane is sensitive to X (Y) axis.

- The coordinate of each plane are aligned with the tracker.
  - Done by matching the expected hit point of reconstructed tracks with trajectory extrapolation to data.
  - Minimization of χ^2 value is performed for several iterations until a stable final result is reached with respect to the tracker.

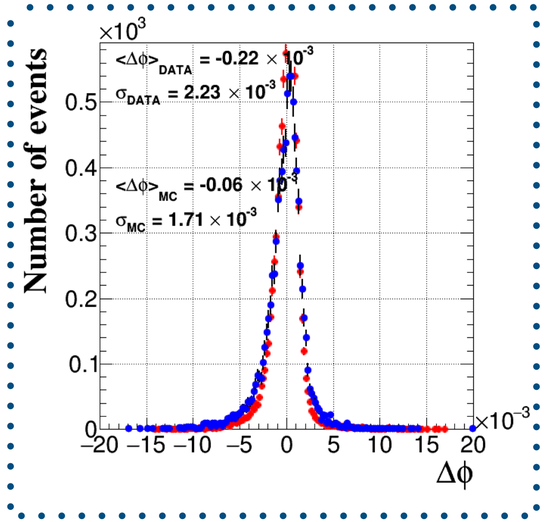
Work by Pei-Rong Yu (National Taiwan University) and Chia-Ming Kuo (National Central University, Taiwan)

Δφ Distributions: ECAL barrel (Electrons)

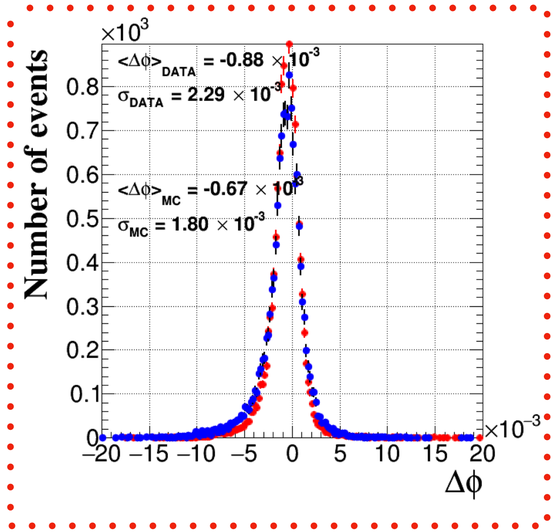
Pre-Alignment



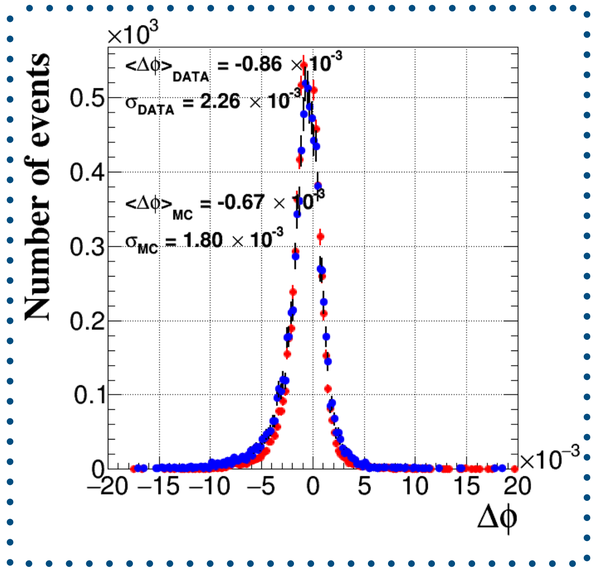
EB +



Post-Alignment



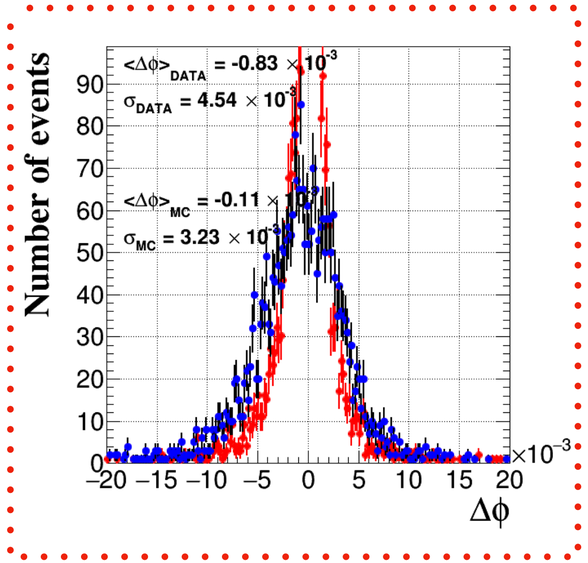
EB -

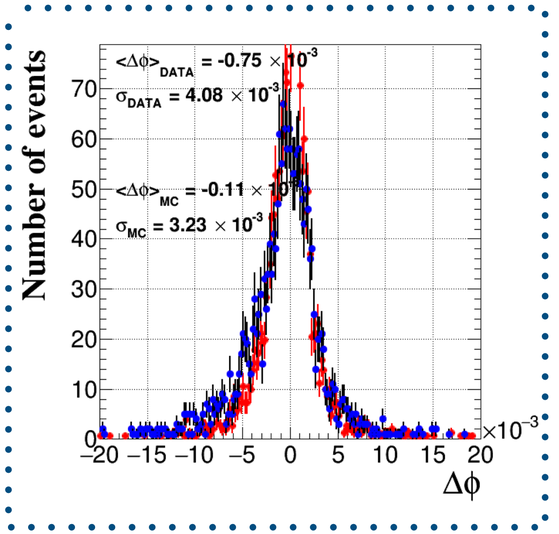


Δφ Distributions: ECAL endcap (Electrons)

Pre-Alignment

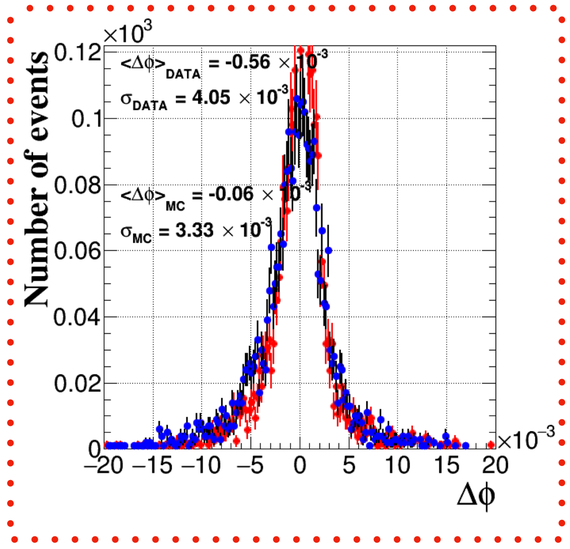
EE +

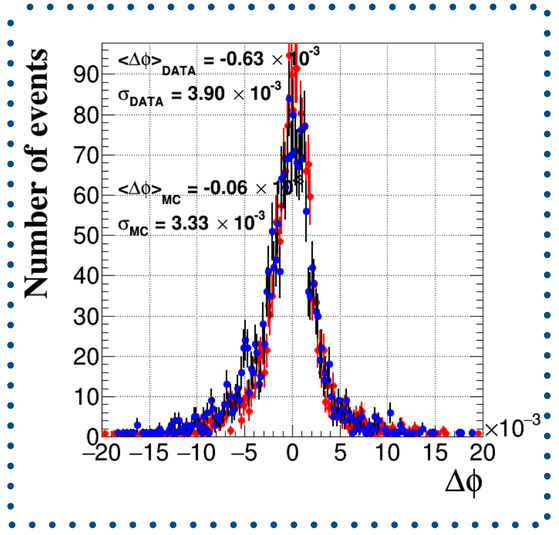




Post-Alignment

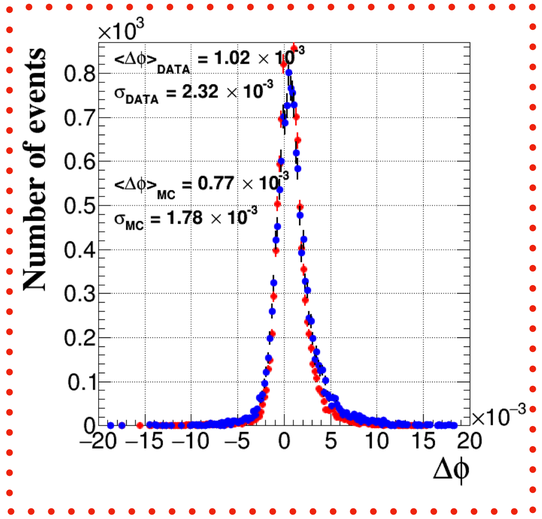
EE -



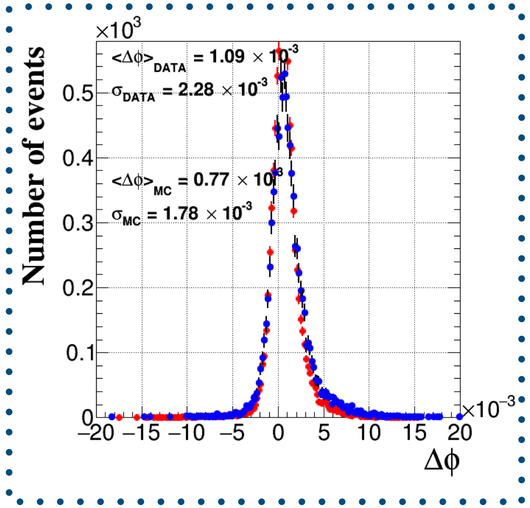


Δφ Distributions: ECAL barrel (Positron)

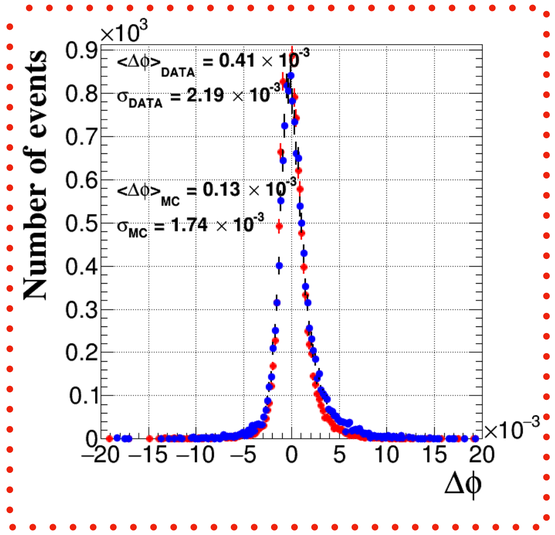
Pre-Alignment



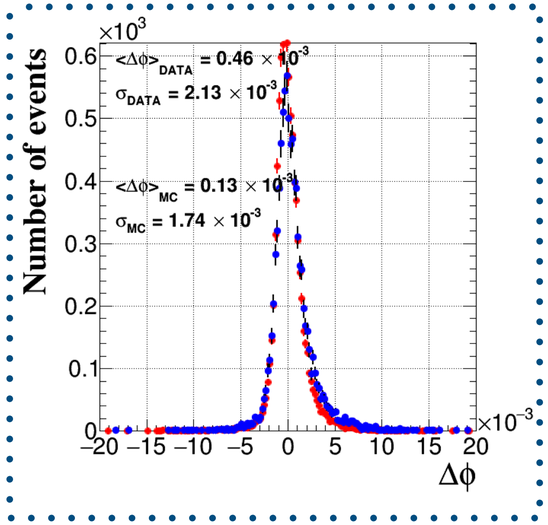
EB +



Post-Alignment



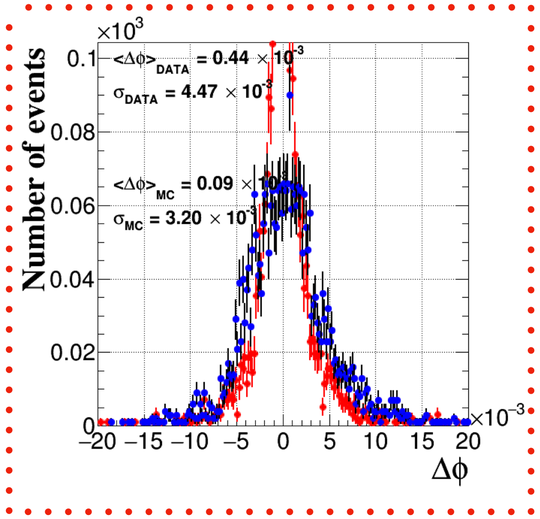
EB -

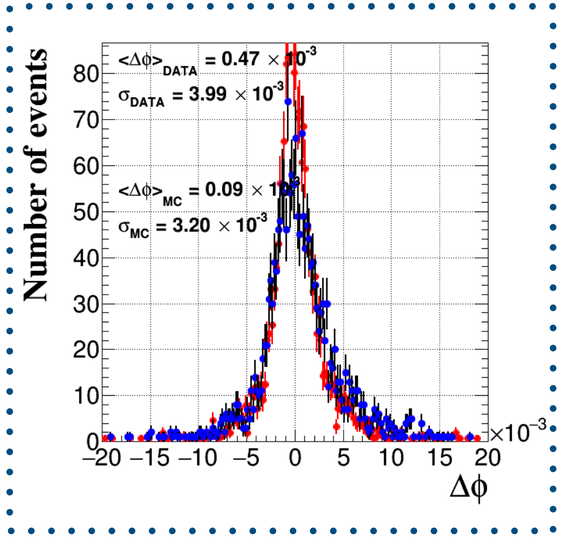


Δφ Distributions: ECAL endcap (Positron)

Pre-Alignment

EE +





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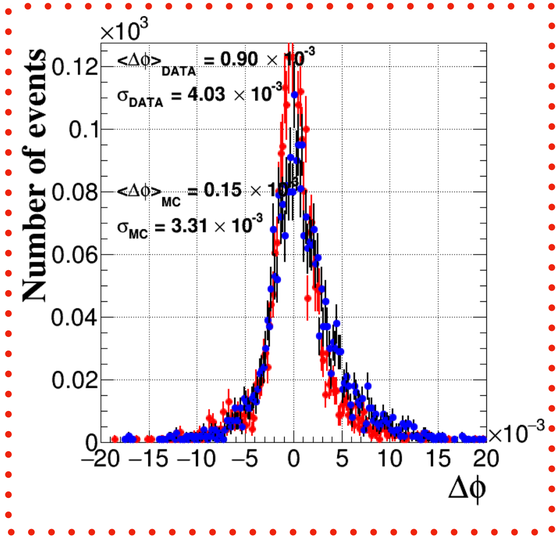

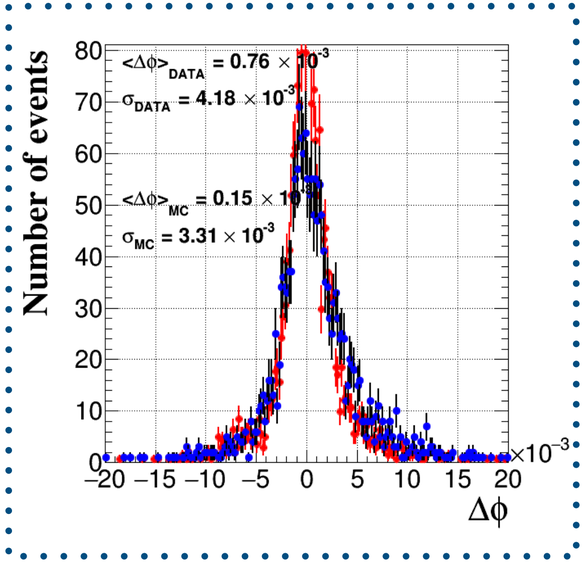

Post-Alignment