Effect of misalignment on tracks for MPOG Note and CRUZET endcap alignment results

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- Quantified effect of residual misalignment on tracks for MPOG Note, using CSA08 results

- Aligned CSC disks in CRUZETs 1&2
  - Status of CRUZET-3 and prompt AlCaReco for CRUZET-4

Misalignment Scenarios

- ▶ Estimated hardware-only alignment: Gaussian-distributed misalignments with sigmas on the order of those expected from hardware systems only (LAS in tracker, MHAS in muon system), also known as STARTUP scenario

- ▶ Estimated 10 pb^{-1} scenario: Gaussian-distributed misalignments with sigmas expected from inclusion of track-based alignment; used in some Monte Carlo samples

- ▶ Result of 10 pb^{-1} exercise: residual misalignments after CSA08 exercises (tracker and muon system), also known as S156
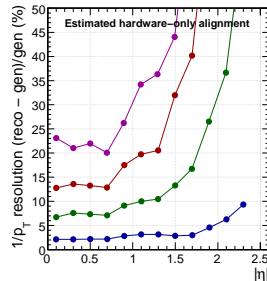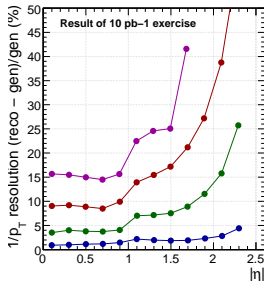
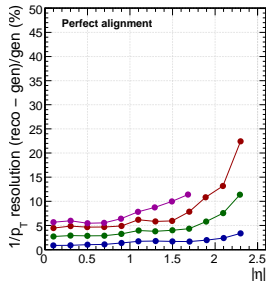- ▶ Perfect alignment, also known as ideal

(Fractional uncertainty in $1/p_T$ equals fractional uncertainty in p_T)
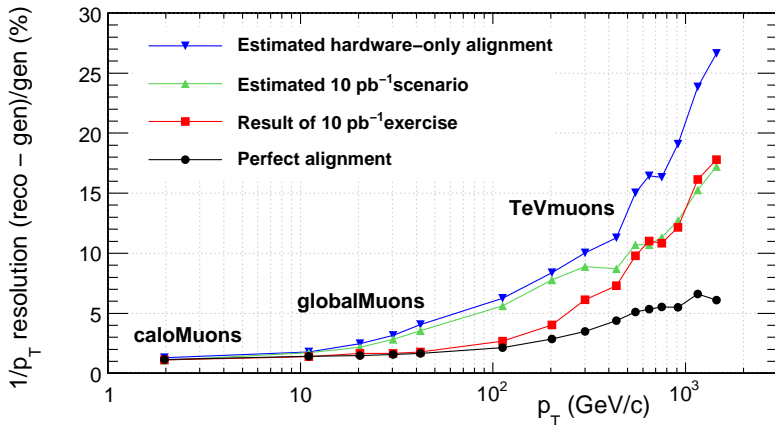
- ▶ caloMuons below 5 GeV, globalMuons below 50 GeV, TeVmu/firstHit above

- ▶ CSA08 tracker results much better than 10 pb^{-1} estimate because MinBias were more useful than expected
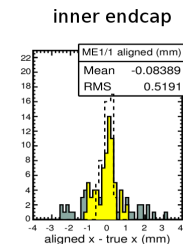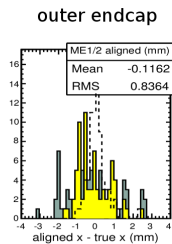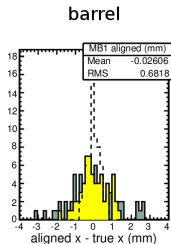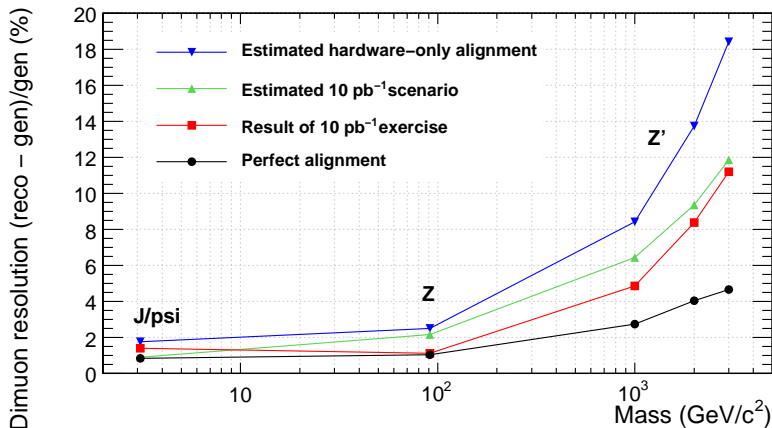
Split up by η

Bottom-to-top: < 50 GeV (blue), < 500 (green), < 1000 (red), above (purple)

Muon alignment:

Alignment accuracy a little better at high η, but radial lever arm for measuring p_T is several times smaller

barrel   outer endcap   inner endcap

Grey: hardware-only, yellow: 10 pb^{-1} track-based, dashed: same with perfect tracker
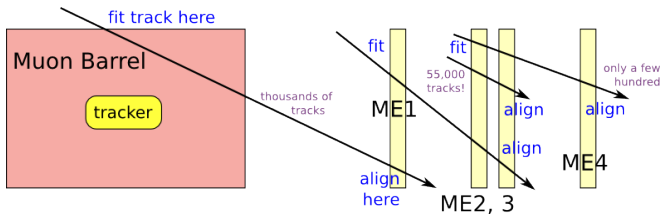
- Δp_T is smaller at low masses
- $\Delta\phi$, $\Delta\eta$ are smaller at high masses

CRUZET Alignments

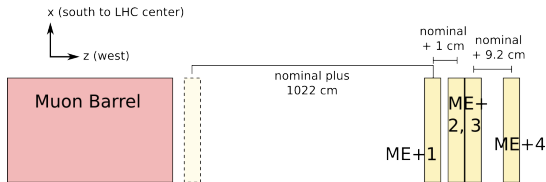Endcap disk alignment for CRUZETs 1&2 (no tracker)

Method:

- ▶ Muon barrel is the (aligned) reference
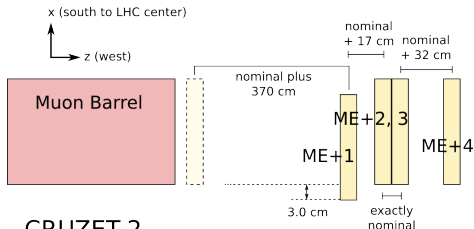- ▶ Fit tracks in one tracking volume (barrel or a CSC disk), align a more-distant disk using those tracks

- ▶ Allows for internal cross-checks: compare direct MB → ME2 against MB → ME1 + ME1 → ME2 (etc.)
- ▶ Uses standard alignment framework in a non-standard way

CRUZET-1

CRUZET-2

Tags for CSCAlignmentRcds in database (with IOVs):

`CRUZET1-CSCStation-xyz-2mmRadialFix_v1`

`CRUZET2-CSCStation-xyzphiz-2mmRadialFix_v2`

from MB to ME1	
Entries	19791
Mean	373.5
RMS	30.14
χ^2 / ndf	5.862e+04 / 12
Constant	2.219e+05 ± 224
Mean	374.2 ± 0.2
Sigma	7.019 ± 0.006
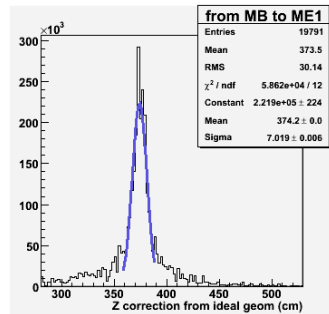
Requires approx. position of endcap; displacements between disks are new

Details (soon): https://twiki.cern.ch/twiki/bin/view/CMS/MuonAlignment

Comparison	x (mm)	y (mm)	z (mm)	ϕ_z (mrad)
$(MB{\rightarrow}2) - (MB{\rightarrow}1{\rightarrow}2)$	-12.8	6.4	39.9	-4.75
$(MB{\rightarrow}3) - (MB{\rightarrow}2{\rightarrow}3)$	-3.4	-8.7	-15.3	-1.06
$(MB{\rightarrow}4) - (MB{\rightarrow}3{\rightarrow}4)$	0.4	6.0	10.3	2.8

$$\sqrt{\frac{1}{N-1}\sum(x_i - \bar{x})^2} = \begin{cases} 7.8 \text{ mm for } x \text{ and } y \\ 28 \text{ mm for } z \\ 3.8 \text{ mrad for } \phi_z \end{cases}$$

Some values verified with physical measurements (tape measure)

Follow-ups:

▶ Apply same procedure to CRUZET-3 after re-reco (status?)

▶ Validate CRUZET-4 prompt AlCaReco

▶ Use tracker in CRUZETs 3&4 as a reference

▶ Depending on statistics and quality of tracker tracks, apply chamber-by-chamber alignment procedure

- ▶ MPOG Note estimates of momentum resolution based on from CSA08 alignment exercises

- ▶ Aligned CRUZETs 1&2 disks, same procedure ready for 3&4

- ▶ Tracker-to-muon and chamber-by-chamber alignments will also be possible in 3&4

- ▶ CRUZET-4 will also test prompt AlCaReco (StandAloneMuons and GlobalMuons)