Magnetic field information from muon alignment

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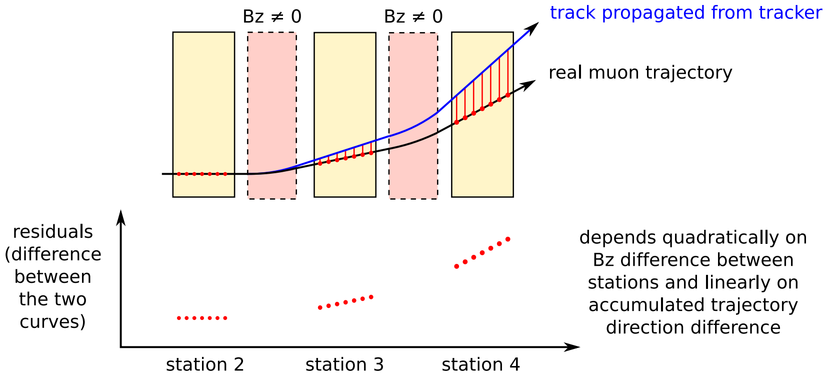
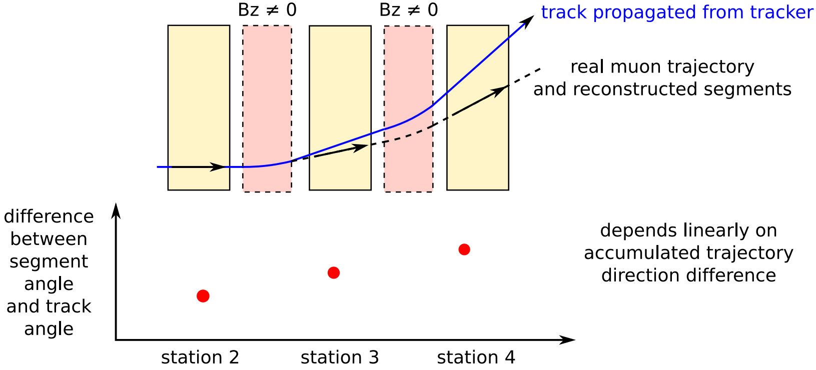


- Gap between propagted track and real muon grows quadratically in yoke when B_z is wrong
- Gap grows linearly elsewhere, dependent on history

(This is like a Physics I displacement problem with regions of acceleration)

Effect of B_z errors on segments



- Trajectory angle grows linearly in yoke when B_z is wrong

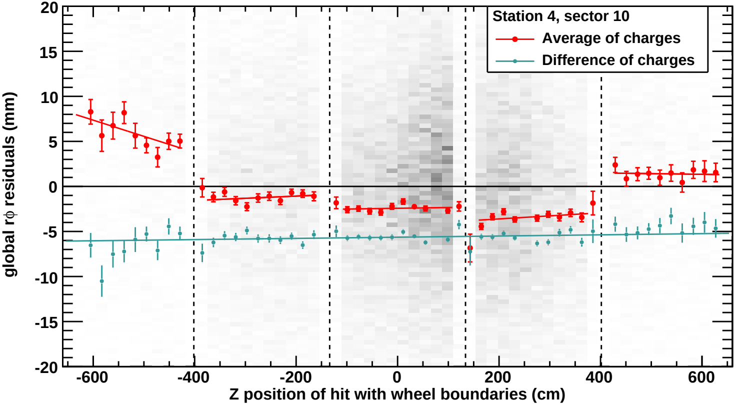
  (This is like a Physics I velocity problem with regions of acceleration)

- Difference in segment angles on the same track provides a direct measurement of B_z error

- Residuals method can provide a cross-check

Before correction

- Station 4 has the largest $\vec{B}$-field errors: plot residuals across barrel
- The misalignment breaks cleanly at the chamber boundaries
- The $\vec{B}$-field error is independent of chamber

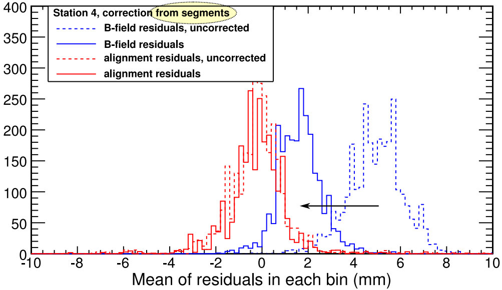


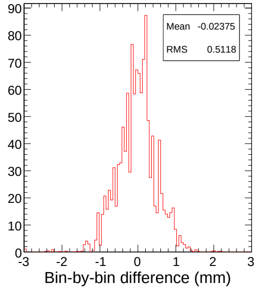
grey background is the raw 2-D residuals distribution

linear fits are only a guide for the eye: not used in alignment!

- Two new field maps available:
    - scaling corrections from segments (data-based measurement)
    - new TOSCA simulation (consistent field lines)
- Opportunity to test correctness of new $\vec{B}(\vec{x})$ and insensitivity of alignment measure with tracks propagated through new field
    - left: histogram of bins from the previous plot (for all sectors)
    - right: how each bin changes when new field is applied

statistical errors in bins are $\mathcal{O}(0.5\text{ mm})$





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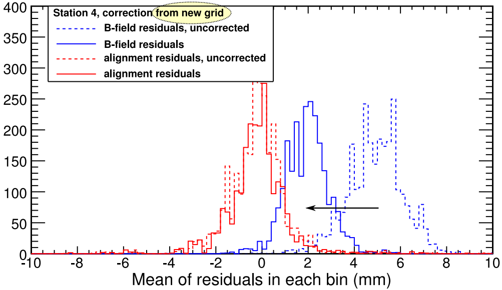
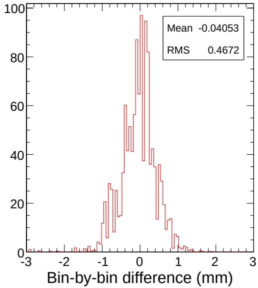
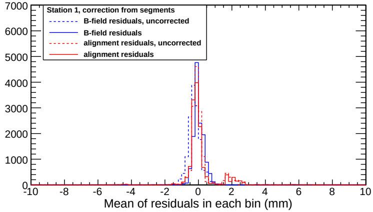


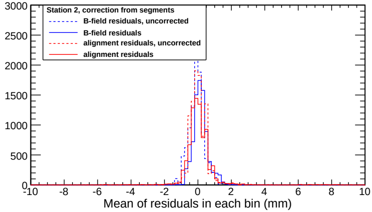


All four stations: scaling

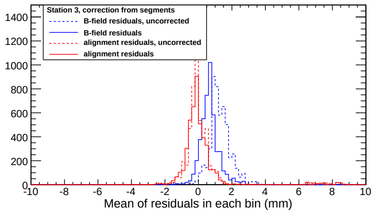
Station 1



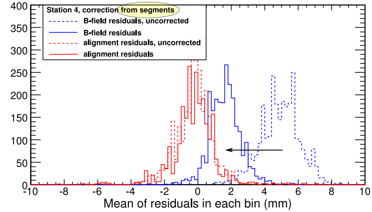
Station 2



Station 3

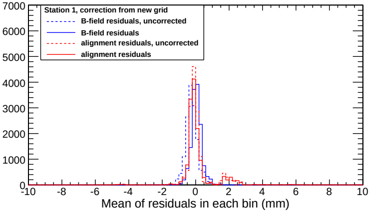


Station 4

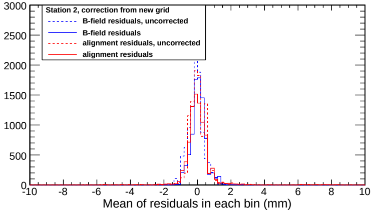


All four stations: new grid

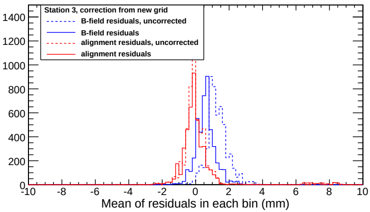
Station 1



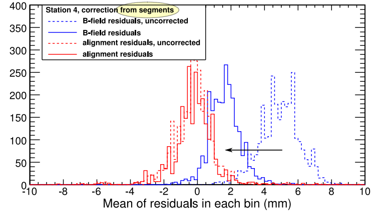
Station 2



Station 3



Station 4



- B_z error on residuals scales as q/p_T
- dE/dx error on residuals scales as $q\left(\frac{1}{p} - \frac{1}{p - \delta p}\right)$ where δp is a constant ($\sim$2 GeV/meter of iron if no dE/dx is taken into account, exact value will depend on how much is missing
- Cute feature: $\left(\frac{1}{P} - \frac{1}{P - \delta p}\right) / \left(\frac{1}{p} - \frac{1}{p - \delta p}\right)$ $\sim$independent of δp
- Cutting cosmic ray spectrum two different p_T values yields *approximately* similar distributions (differing only by scalar multiple)

Station 4 from scaling

p_T cut	expected from $\vec{B}$ error	expected from dE/dx error	observed
20 GeV	1	1	1 (def)
40 GeV	0.5	0.24	0.71
80 GeV	0.25	0.06	0.46

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Station 4 from the new simulation

p_T cut	expected from $\vec{B}$ error	expected from dE/dx error	observed
20 GeV	1	1	1 (def)
40 GeV	0.5	0.24	0.69
80 GeV	0.25	0.06	0.46

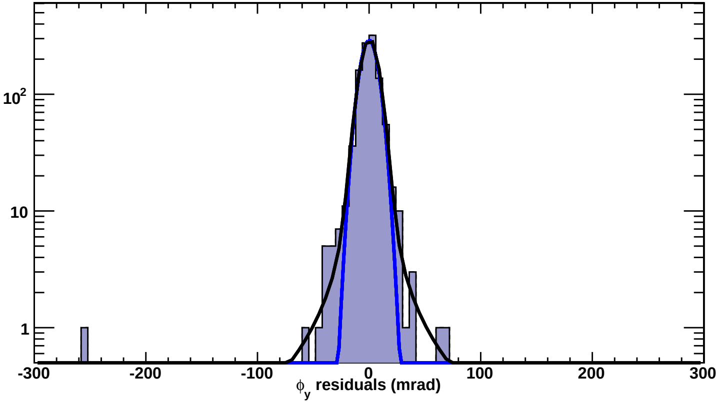
Conclusions

- Residuals method is rather different from segments method: more sensitive and more difficult to interperet
- Scaling from segments and new TOSCA map yield nearly the same improvement in residuals: corrected more than half of the effect
- Remaining effect is not dominated by dE/dx errors

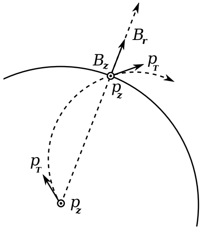
- Special feature! On the next four pages, I present some tools that will likely be useful for future $\vec{B}$ studies

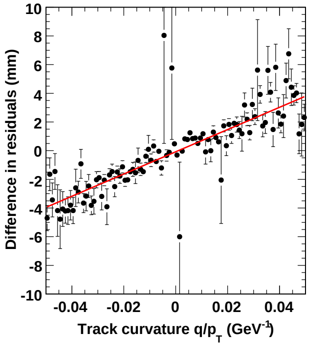
Motivation

- Residuals distributions have power-law tails due to single-scattering
- Especially angular distributions
- Peak-fit is more precise than mean
- ϕ_y is the angle with $\vec{B}$-field information (perfectly aligned MC below)



More motivation





- We know that $r\phi$ residuals from a B_z error are linear in q/p_T
- The same residuals are affected by B_r errors, linear in q/p_z
- In a region with both types of $\vec{B}$ error (endcap, especially), one would want to disambiguate them with a two-parameter fit
- Tools in CVS perform fits with Gaussian $\oplus$ tails *and* linear trends in the crest
- Example on the left is Gaussian $\oplus$ tails with a q/p_T slope (NOT a linear fit to the profile plot)

  source: cosmic ray difference between stations 3 and 4

State of the new tools

[CMSSW] / CMSSW / Alignment / MuonAlignmentAlgorithms / src

Repository: CMSSW Go

Index of /CMSSW/Alignment /MuonAlignmentAlgorithms/src

ViewVC

Files shown: 8 (Show 1 dead files)

Sticky Tag: Set

File ▲		Rev.	Age	Aut	
Parent Directory					
MuonCSCChamberResidual.cc		1.1	10 days	piv	ence
MuonDT13ChamberResidual.cc		1.1	10 days	piv	ence
MuonDT2ChamberResidual.cc		1.1	10 days	piv	ence
MuonResidualsAngleFitter.cc		1.2	16 hours	piv	
MuonResidualsFitter.cc		1.3	15 hours	piv	s
MuonResidualsFromTrack.cc		1.2	10 days	pivarski	expanded MuonAlignmentFromReference and made it more modular
MuonResidualsPositionFitter.cc		1.2	16 hours	pivarski	debugging fitter: many small changes

Calculate residuals using same method as alignment ("super-residuals", which are like segments but don't assume that track is linear inside chamber)

Performs simultaneous fits for residuals peak and q/pT trend

Organizes residual calculation to make it easier to take station-by-station differences

Significant B_r