


Chamber-by-chamber alignments in 1_5_4

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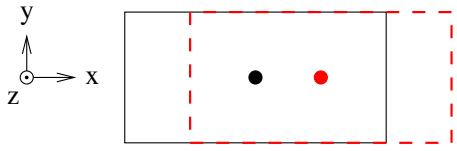
Preparing event samples

- I never heard back about the official 1_5_4 → AlCaRecoMu, so I filtered them myself
- `/castor/cern.ch/user/p/pivarski/AlCaRecoMu/ideal`
  35 good, 13 bad
- `/castor/cern.ch/user/p/pivarski/AlCaRecoMu/miscal`
  26 good, 13 bad

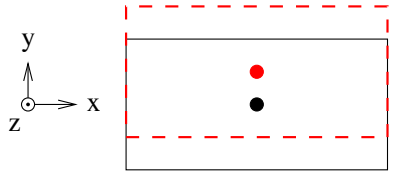
(that's an inefficiency)

- This project used the good `ideal` sample to search for optimum sets of alignment parameters
- Unknown number of events/tracks/hits, but very likely overkill
- Starting point is *after* disk-by-disk alignments

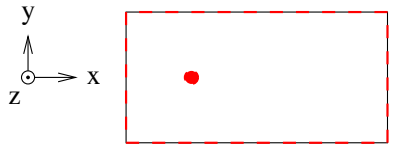
Theory: x, y, ϕ_z are 1^{st}-order; ϕ_x, ϕ_y are 2^{nd}-order to y, x; and z...



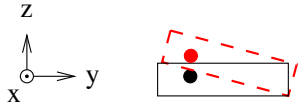
x: offset in r_x



y: offset in r_y

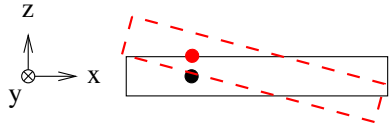


z: sensitive only through angled tracks



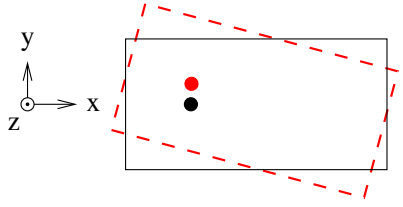
ϕ_x: r_y linear in y

(slope $\propto 1 - \cos\phi_x$)



ϕ_y: r_x linear in x

(slope $\propto 1 - \cos\phi_y$)

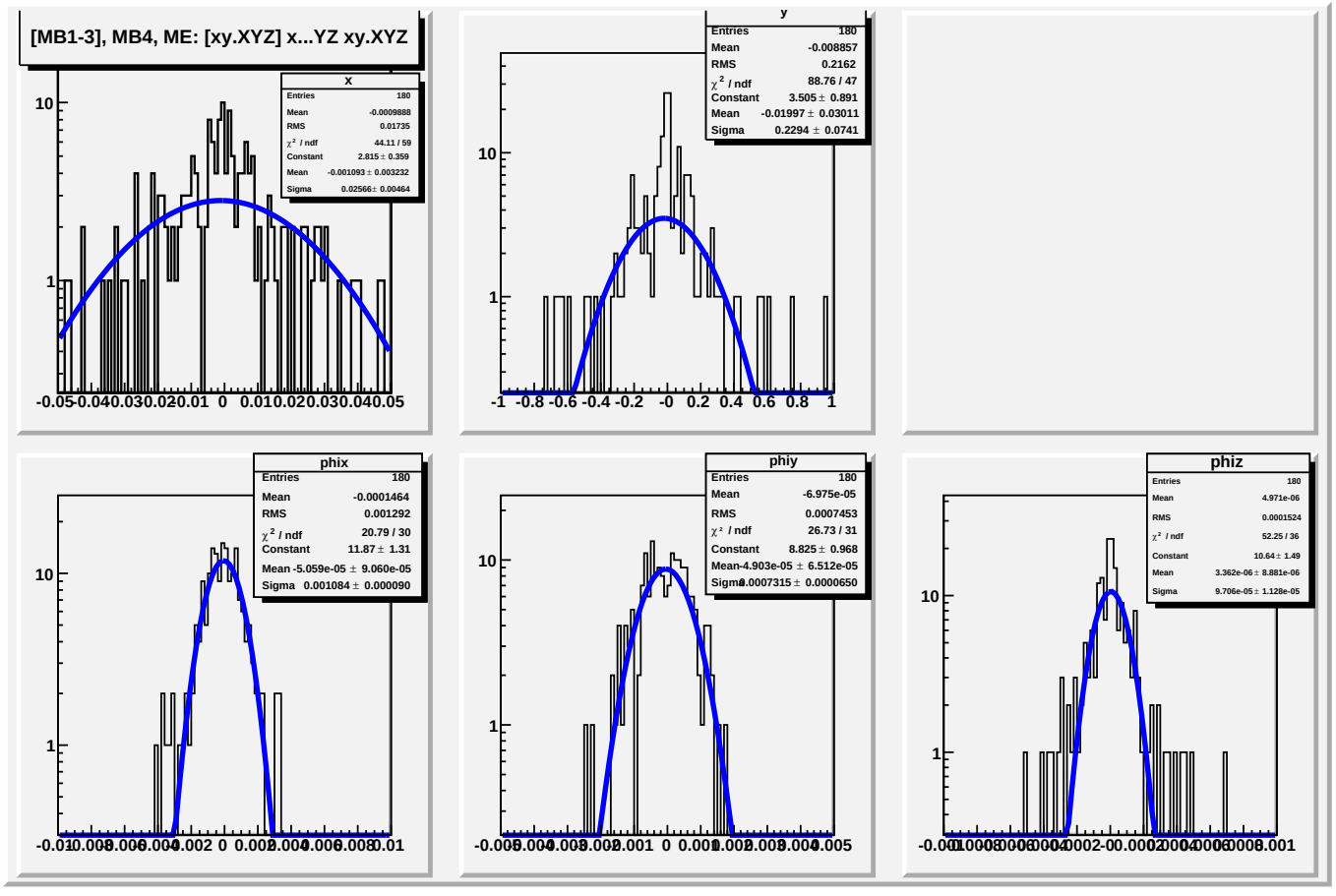


ϕ_z: r_x linear in y and r_y linear in x

(slope $\propto \sin\phi_z$)

z is important! (slide 1 of 2)

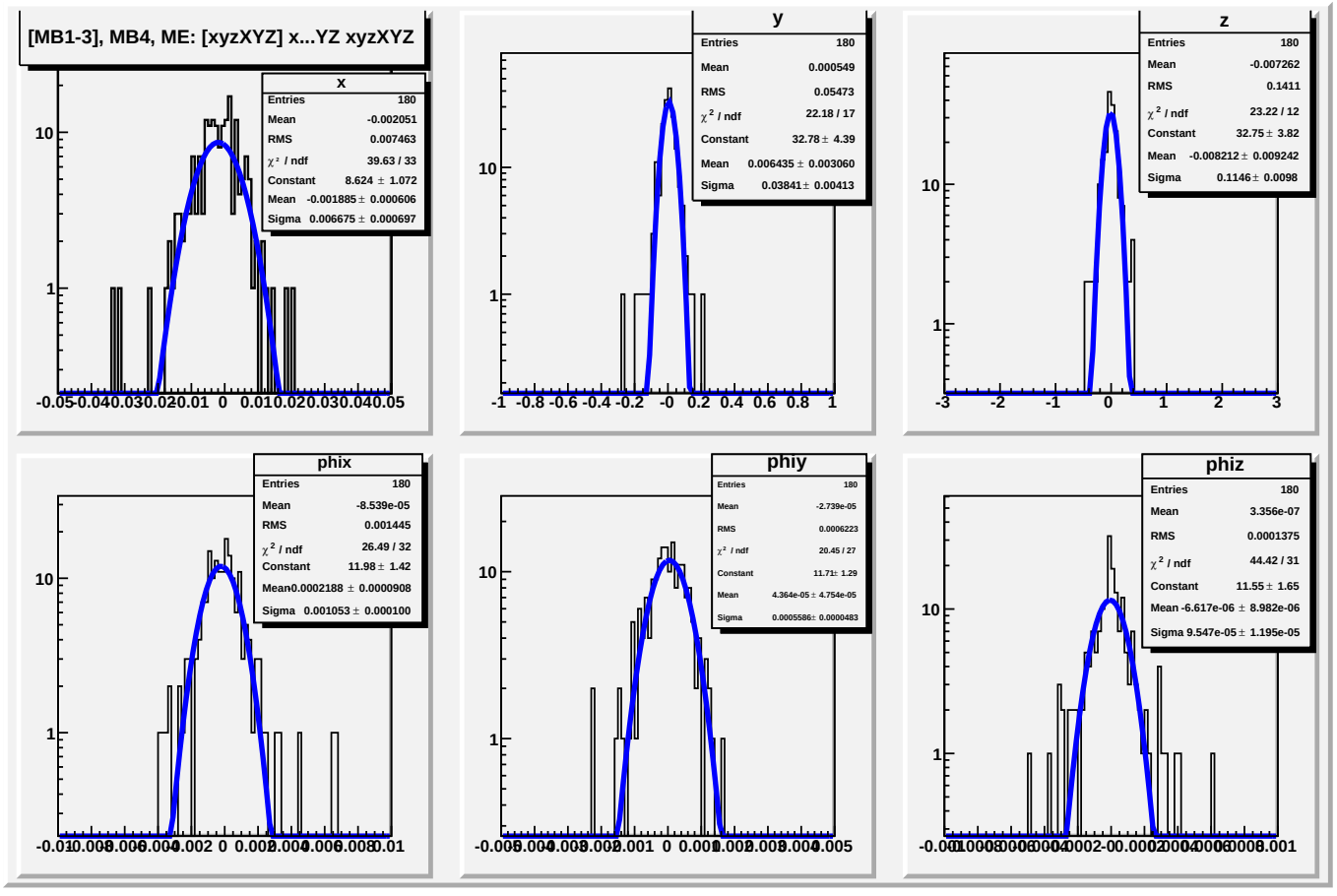
Barrel stations 1–3: z is fixed (and misaligned)



All plots are aligned positions minus correct positions (MC)

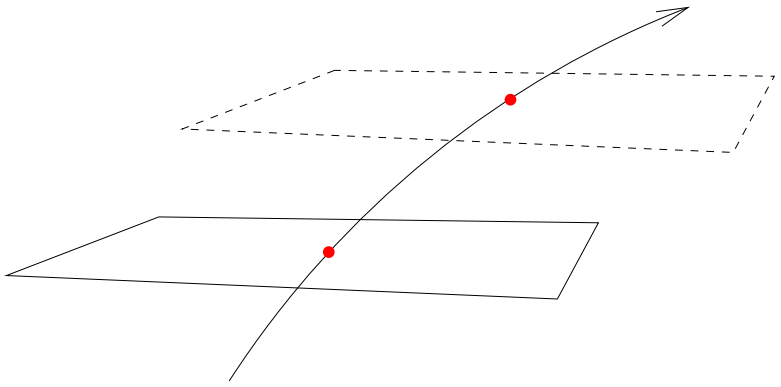
z is important! (slide 2 of 2)

Barrel stations 1–3: z is allowed to float in alignment

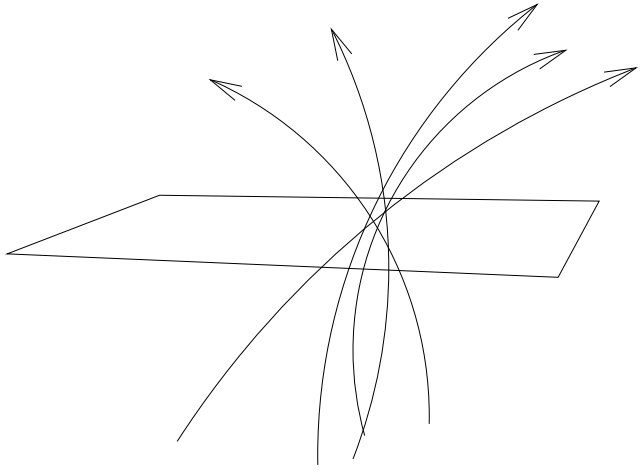


All plots are aligned positions minus correct positions (MC)

Why is that?



Single track:
x−z or y−z position is degenerate
with track intersection point

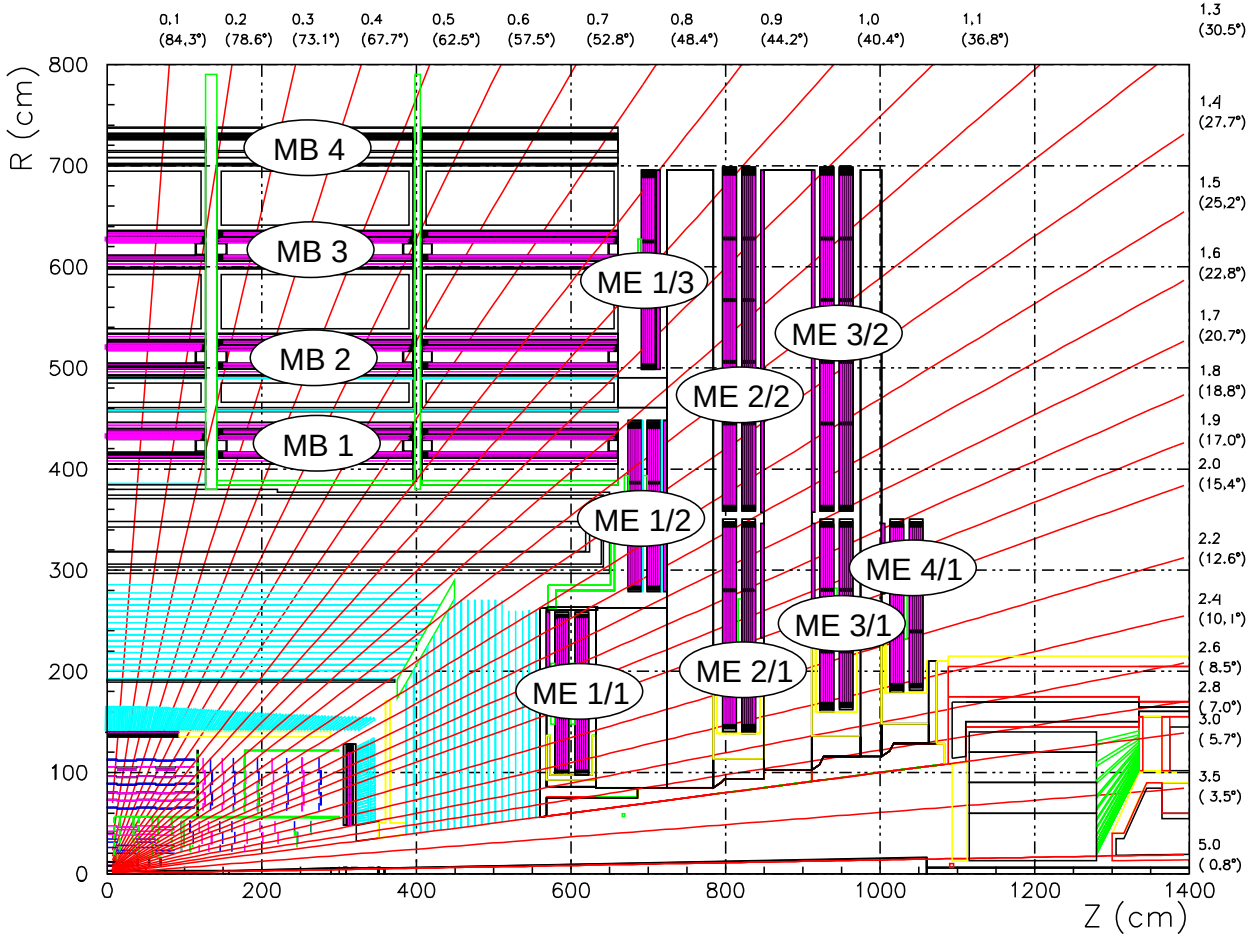


Many tracks:
complementary measurements
can't be degenerate with all of them!

(Also, chambers are not 2-D surfaces but 6–12 layers thick.
However, the above is a more important part of the explanation.)

Important distinction among barrel chambers

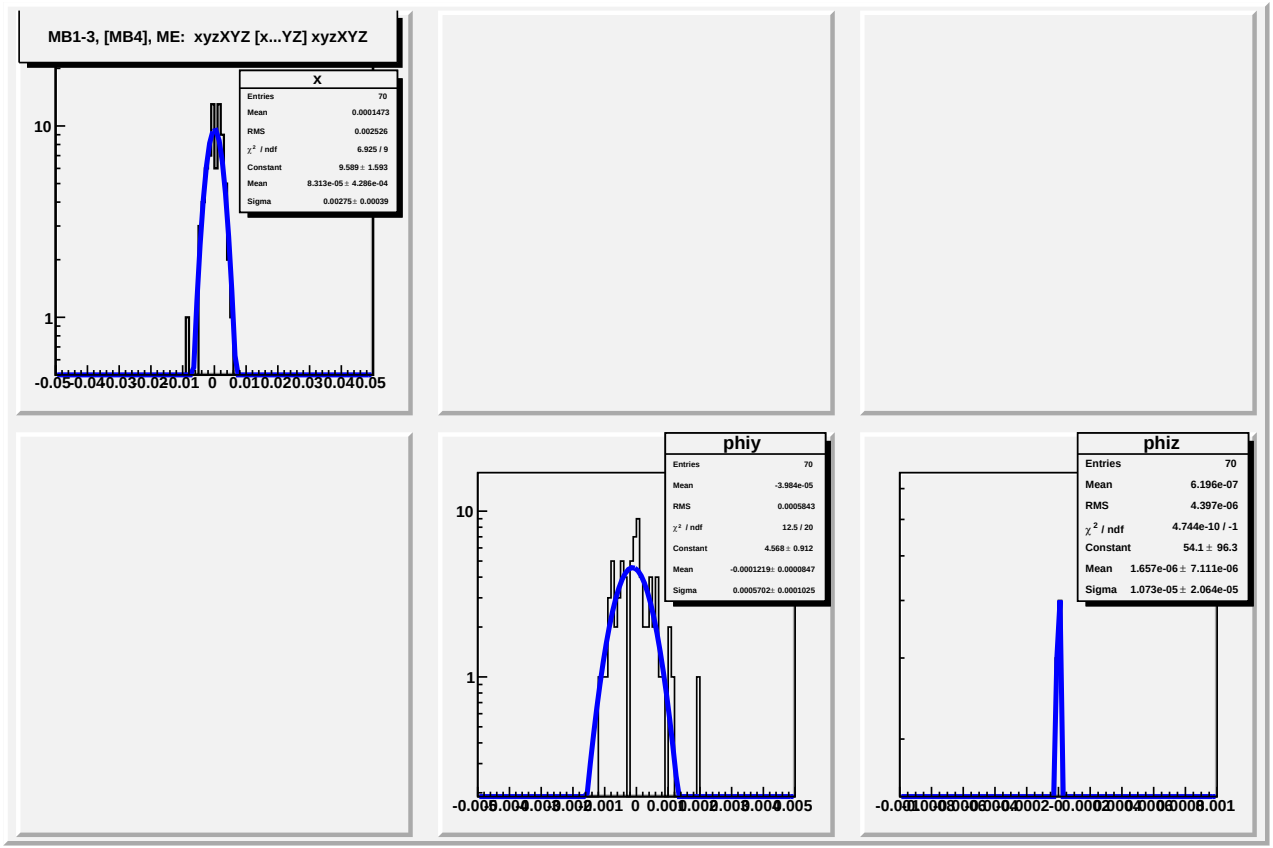
- Stations 1–3: full x-y measurement (stereo superlayers)
- Station 4: x only (purely one-dimensional!)



Barrel station 4 (outermost chambers)

Super-precise x and ϕ_z (better intrinsic resolution???)

y, ϕ_x are off-limits (cause divergences through numerical error)



what about z? hmmm. . . I didn't try that. . .

Barrel alignment results

Stations 1–3

x	67 μm	1.05 mrad	ϕ_x
y	384 μm	0.56 mrad	ϕ_y
z	1.15 mm	0.095 mrad	ϕ_z

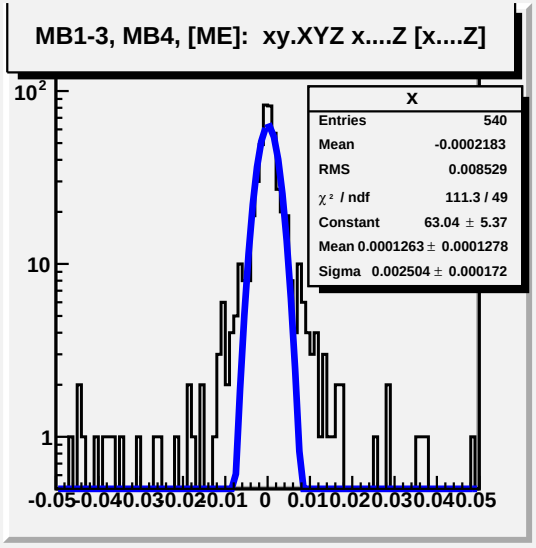
. . . and very Gaussian!!! Few outliers (see p. **??**)!

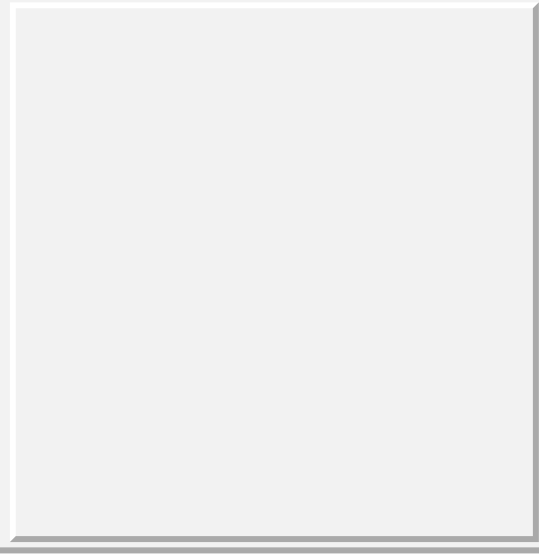
Station 4

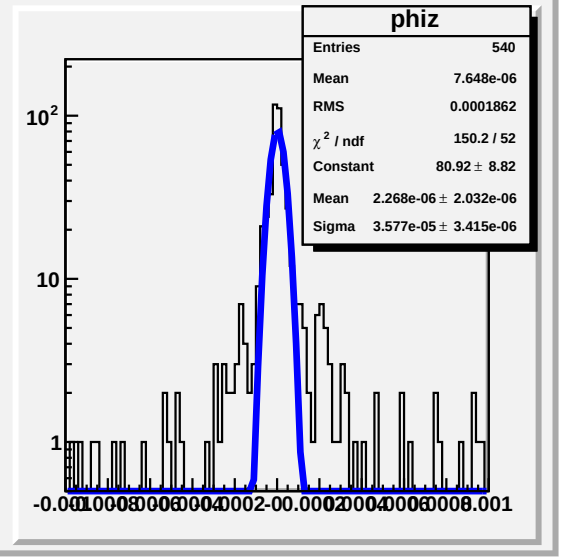
x	28 μm		
		0.57 mrad	ϕ_y
		0.004 mrad	ϕ_z

If ϕ_y is fixed, $x \rightarrow 12$ μm
(unnecessary ultraprecision)

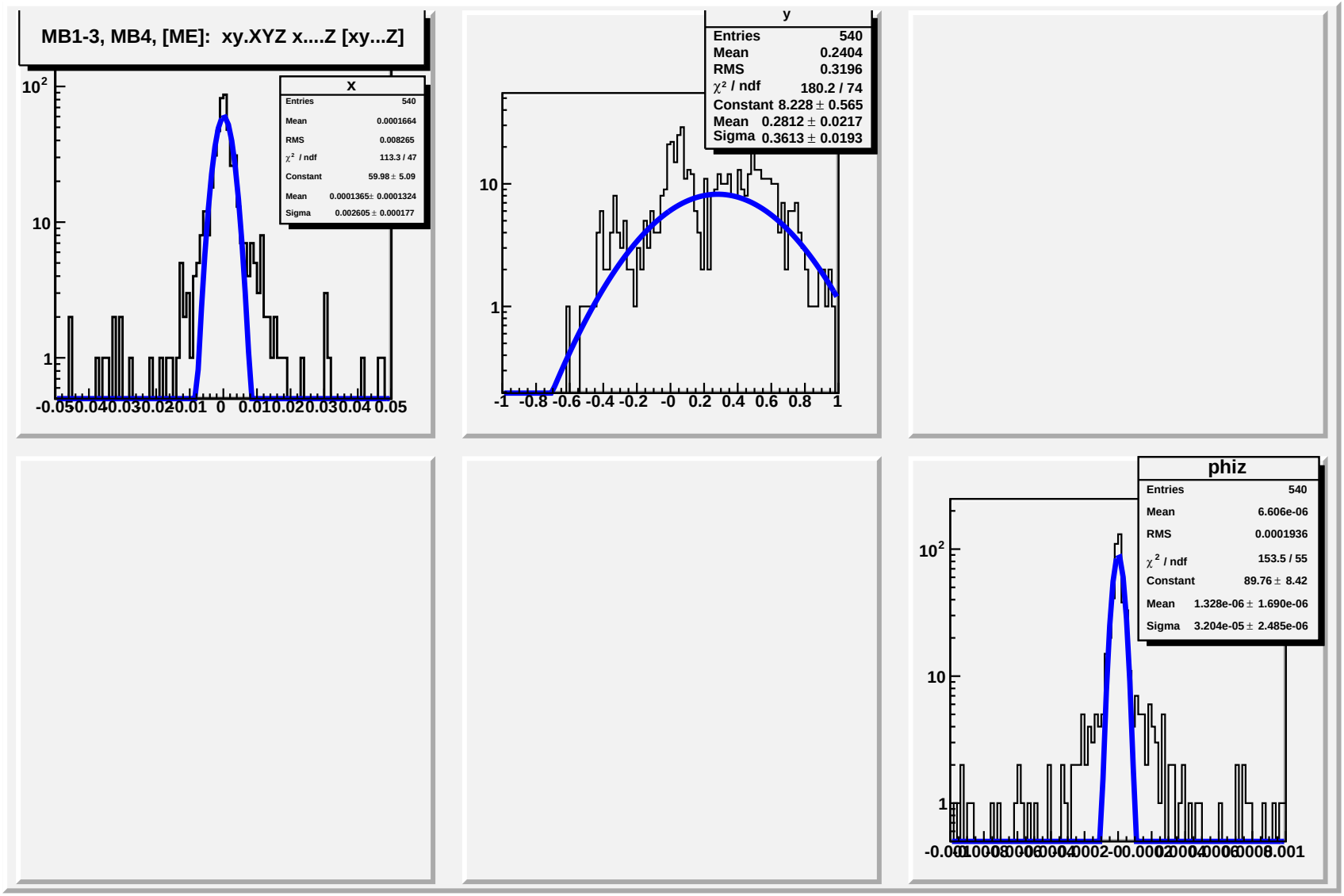
Full evolution of endcap: x....ϕ_z (1/5)



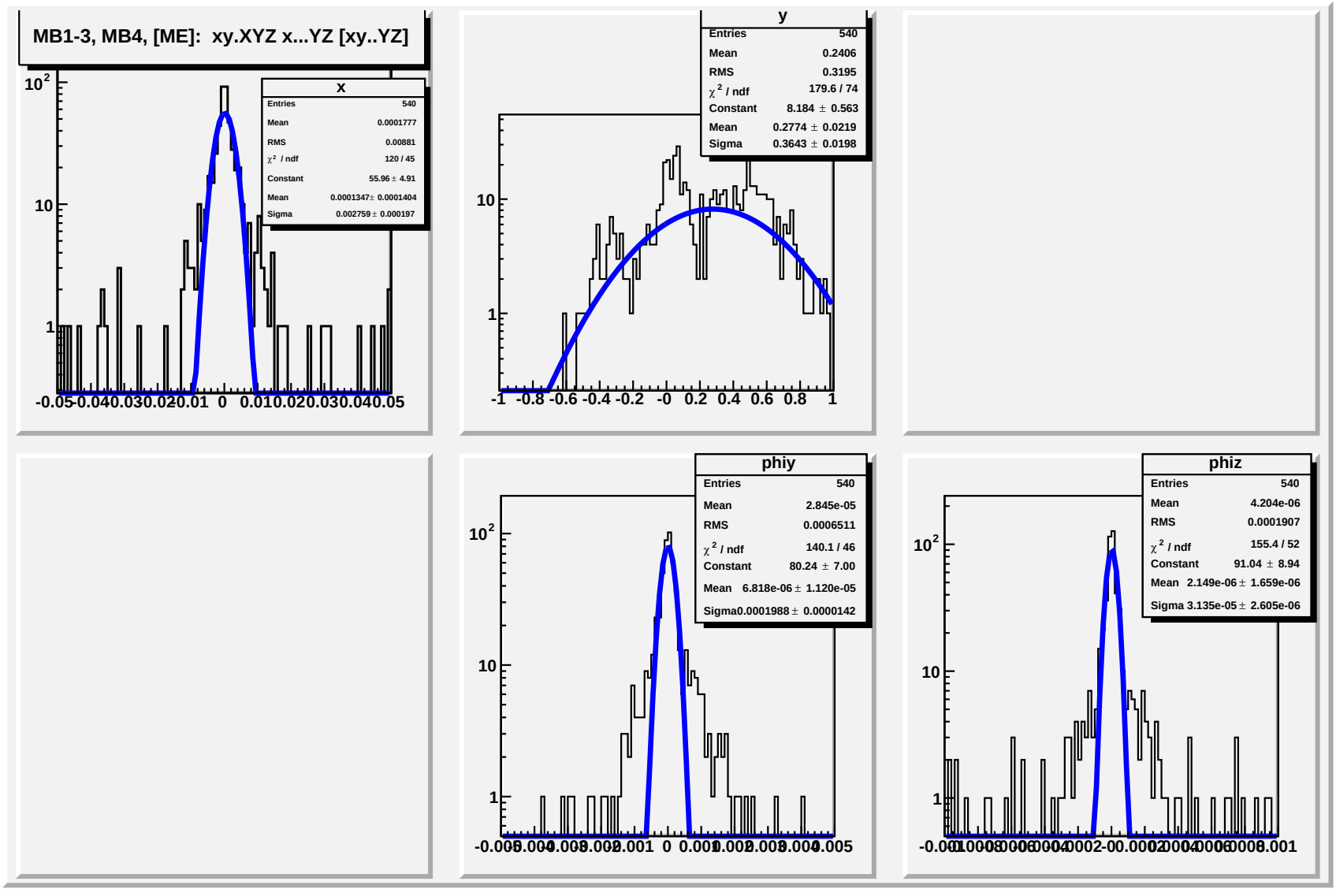




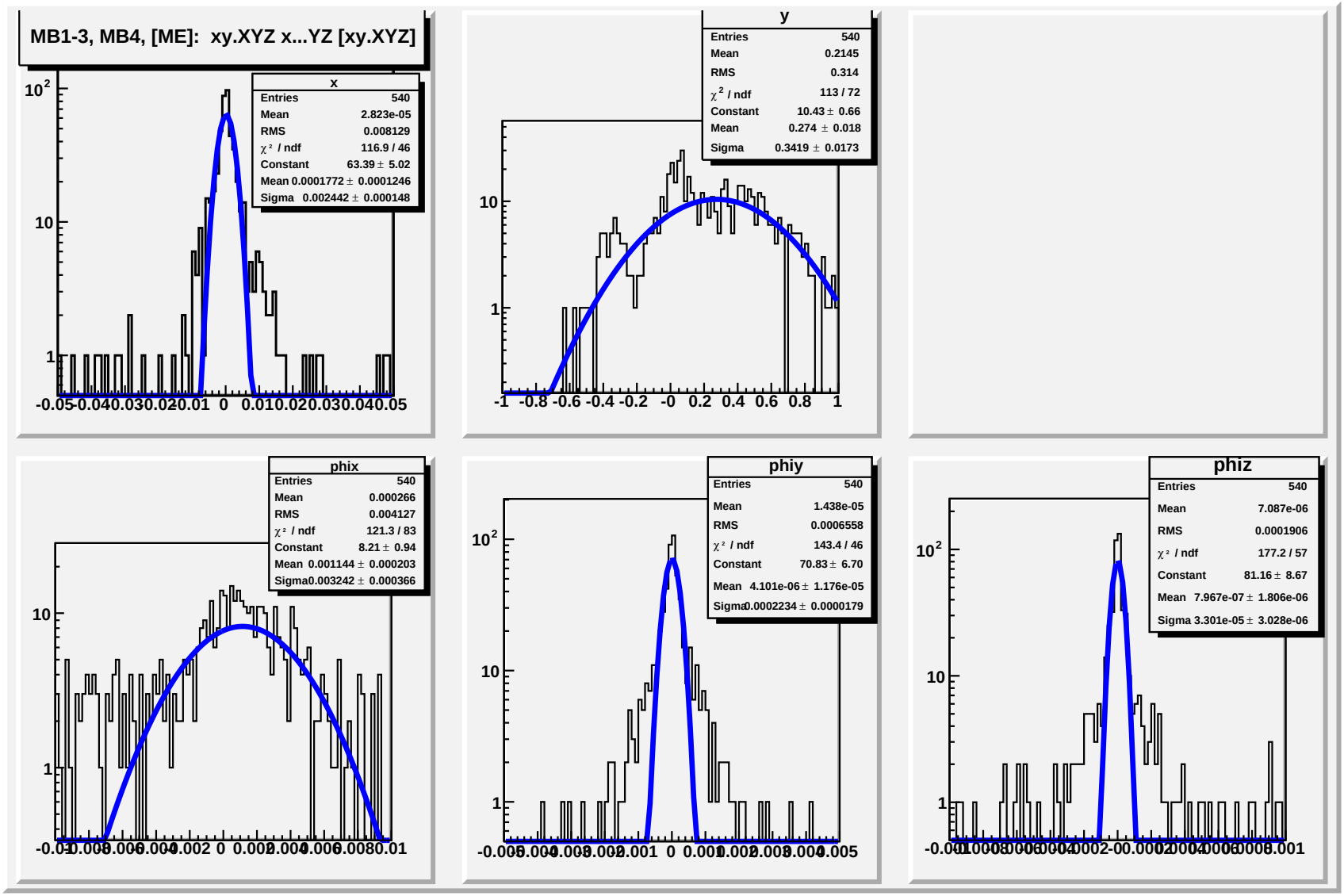
Full evolution of endcap: $xy \ldots \phi_z$ (2/5)



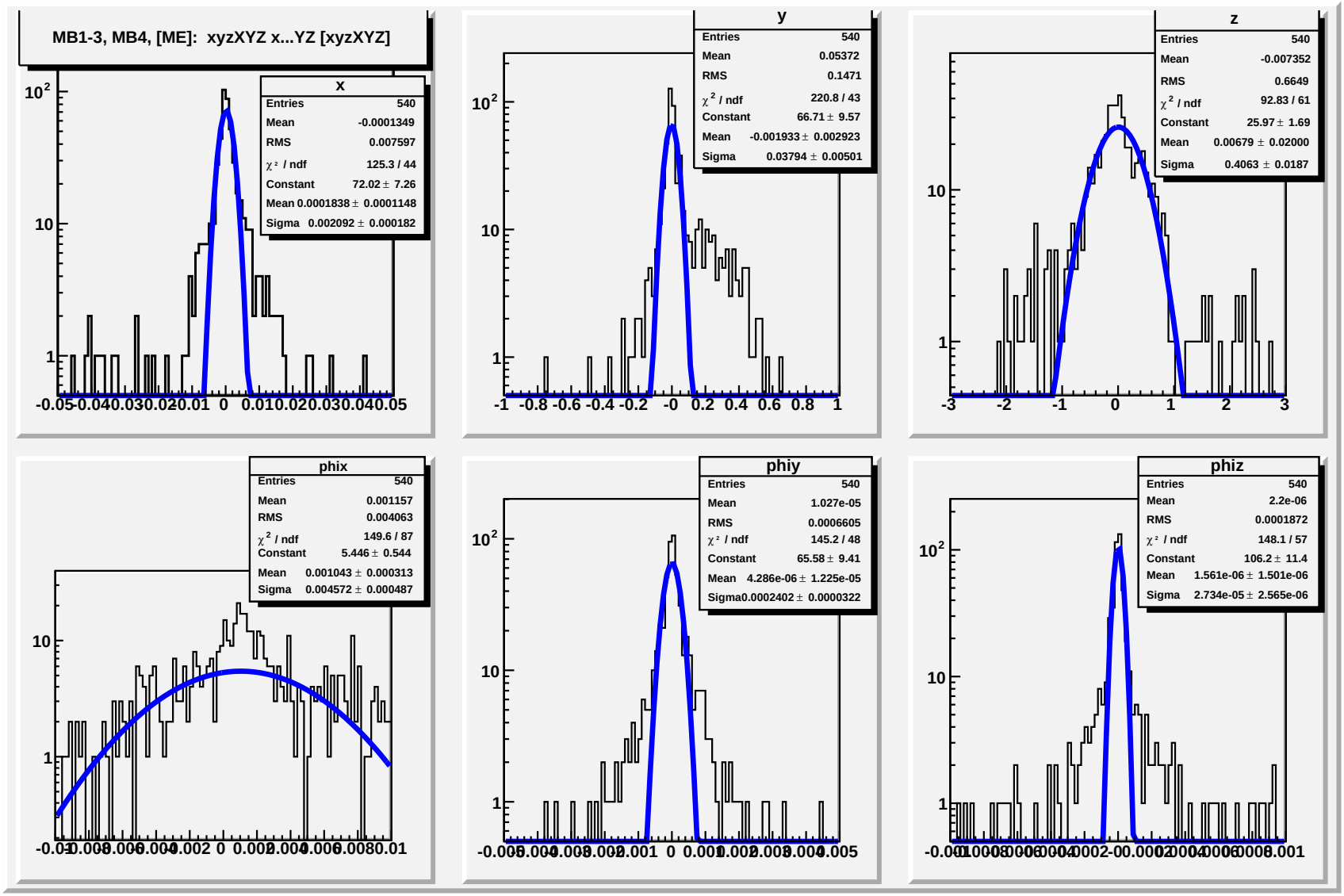
Full evolution of endcap: $xy..\phi_y\phi_z$ (3/5)



Full evolution of endcap: $xy.\phi_x\phi_y\phi_z$ (4/5)

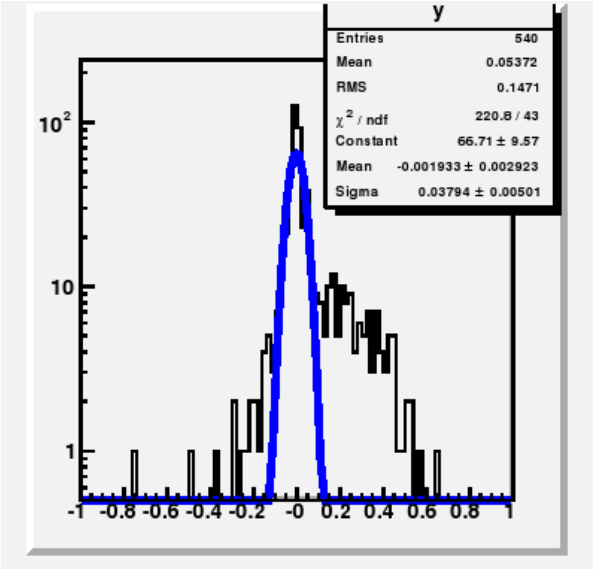


Full evolution of endcap: $xyz\phi_x\phi_y\phi_z$ (5/5)



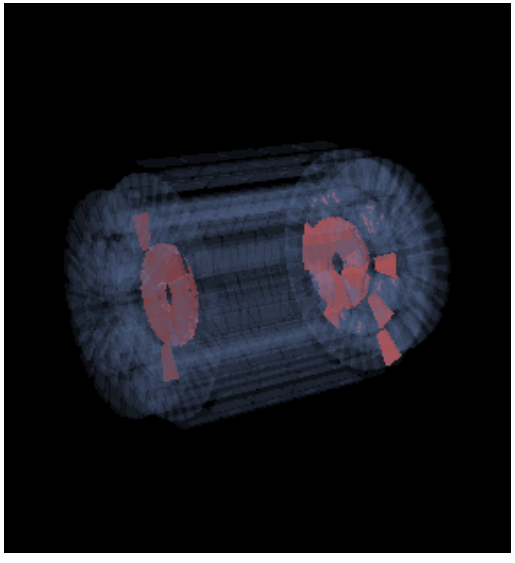
Wow! What's going on?

Allowing z to float helps y enormously, though there's a strange asymmetric secondary distribution.

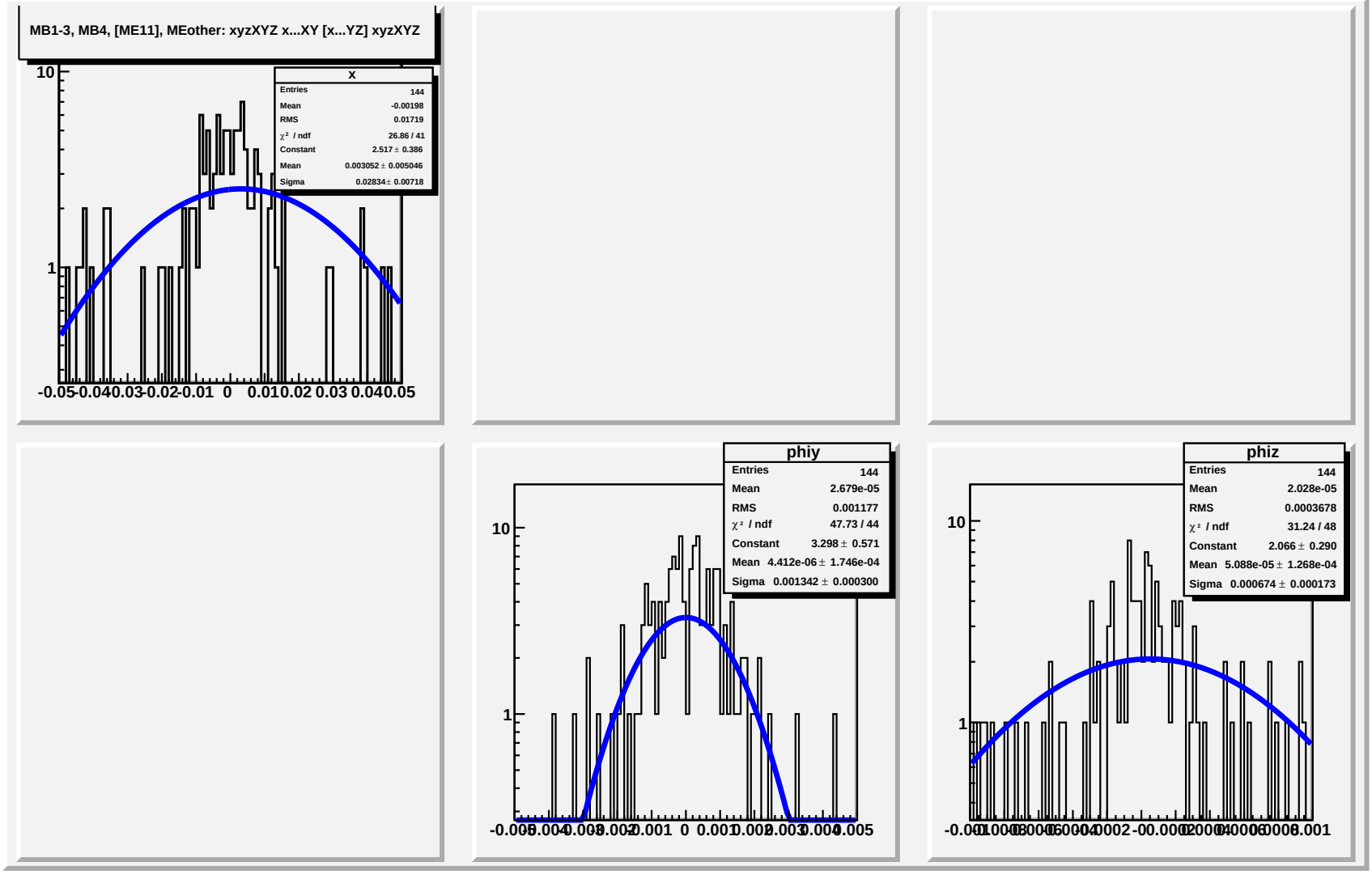


I asked our spiffy analysis tool which chambers have $y_{\text{misalign}} > 2$ mm

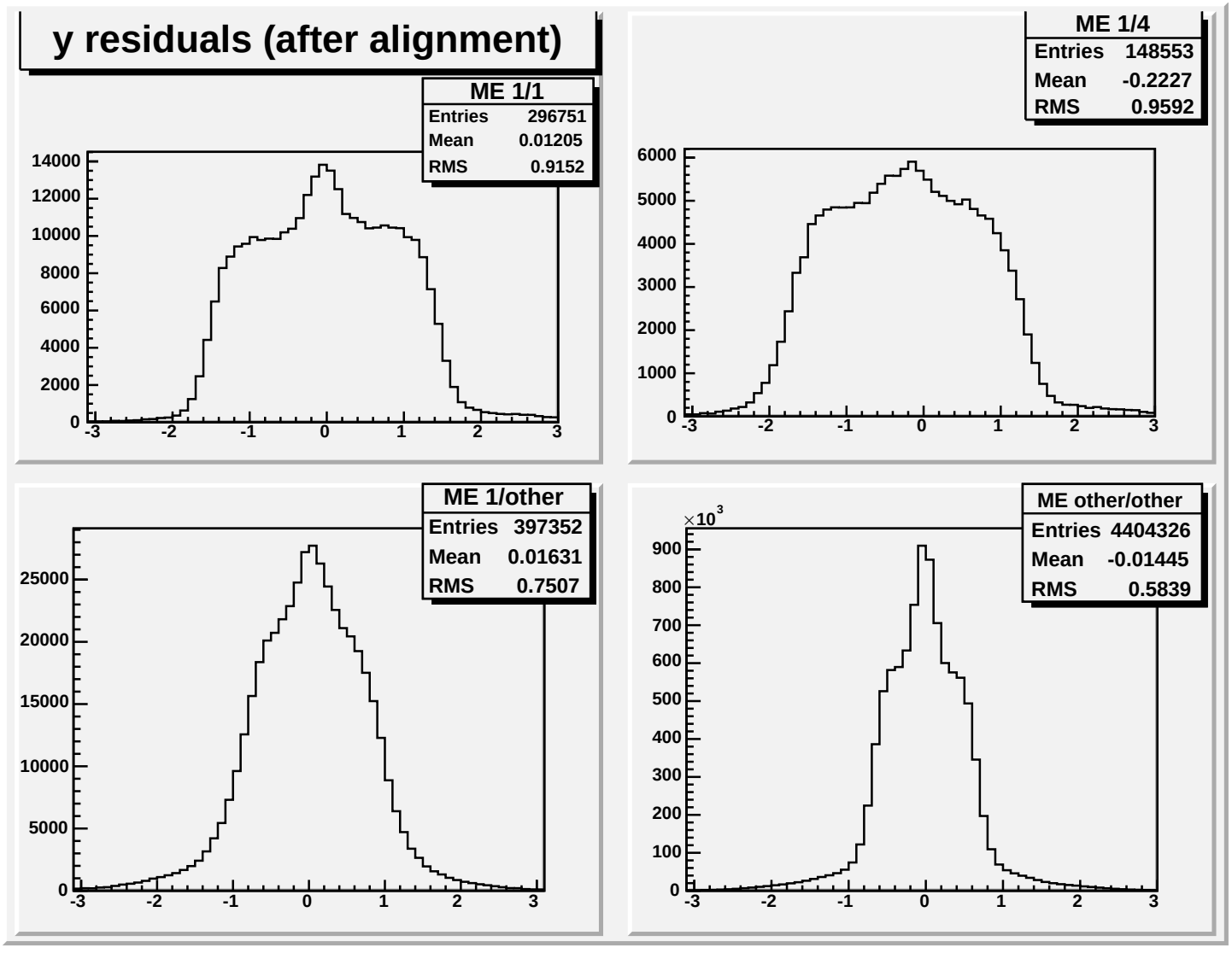
They're (almost) all in ME1/1!



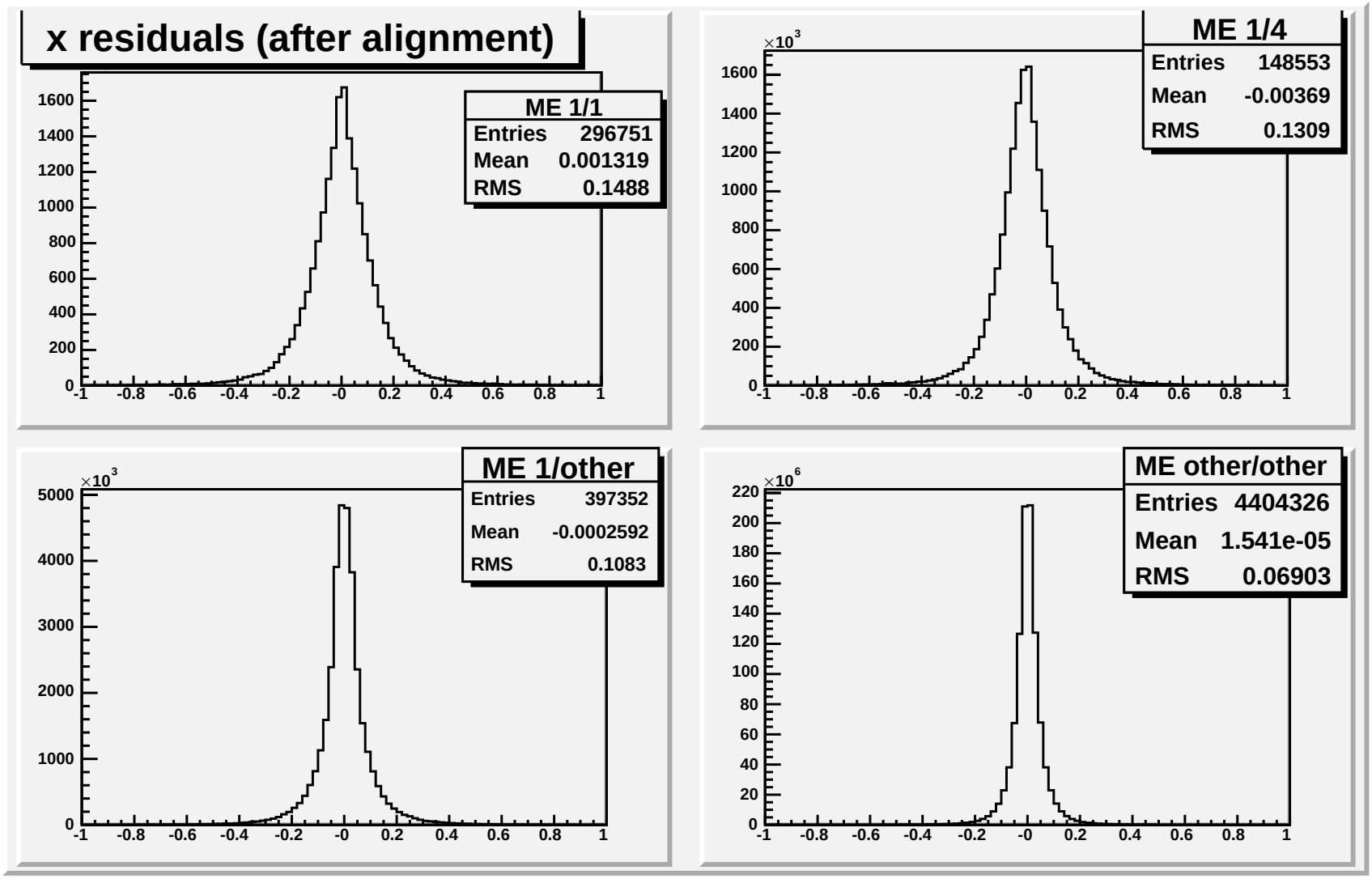
Is ME1/1 one-dimensional? NO. (I didn't think so.)



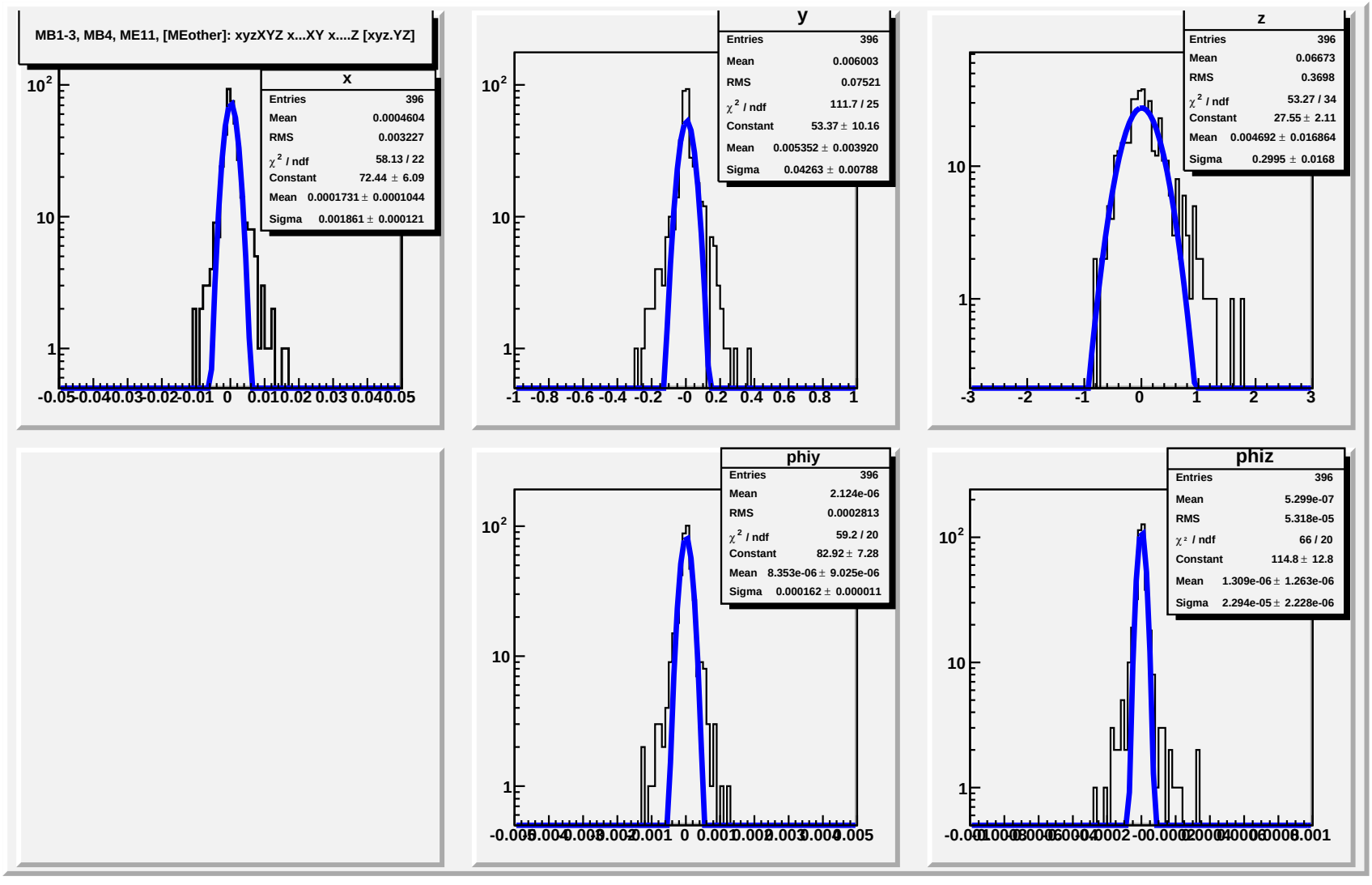
The *y* residual distributions are a *little* asymmetric. . .



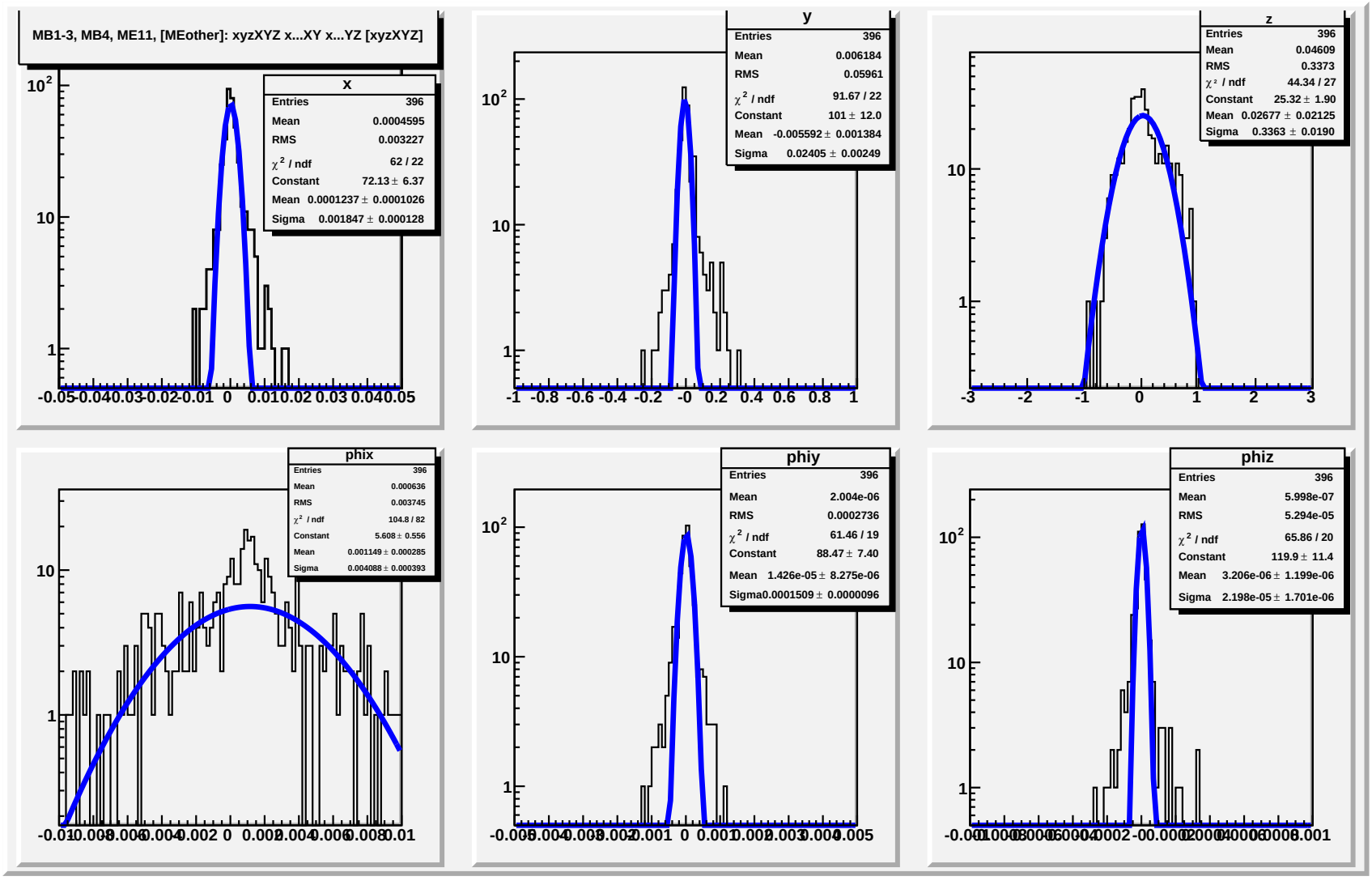
The x residual distributions, for completeness



Endcap without ME1/1: $xyz.\phi_y\phi_z$



Endcap without ME1/1: $xyz\phi_x\phi_y\phi_z$



Endcap without ME1/1 results

Resolution is nearly Gaussian— the long tails are gone

	fitted core	standard deviation
x	19 μm	32 μm
y	240 μm	596 μm
z	3.0 mm	3.7 mm
ϕ_x	*4.1 mrad*	*3.7 mrad*
ϕ_y	0.16 mrad	0.28 mrad
ϕ_z	0.03 mrad	0.05 mrad

After alignment ϕ_x is worse than before. However, excluding ϕ_x from the fit broadens y resolution to 240 μm core, 596 μm stdev. Tie breaker: momentum resolution. Coming soon.

And these include internal layer-by-layer misalignments (100's of μm, as measured by Karoly)!

Summary, conclusions, and questions

- With high-statistics, no miscalibration, no tracker misalignment: we see beautiful resolution in all but ME1/1
- Presumably we can get ME1/1 right by applying some physical insight (worked for MB4), but I think I'm lacking knowledge of the system

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- Presumably we can get ME1/1 right by applying some physical insight (worked for MB4), but I think I'm lacking knowledge of the system
- For instance, "ME1/1" and "ME1/4" (in software) describe two parts of some kind of "double-chamber" system. How does that work exactly?
- Alignment software allows "ME1/1" and "ME1/4" to float independently, which is probably wrong. Is it disastrously wrong?

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- Alignment software allows "ME1/1" and "ME1/4" to float independently, which is probably wrong. Is it disastrously wrong?
- ME1/1 y distribution has the same asymmetry as the rest of the endcap did when z was misaligned and not allowed to float...