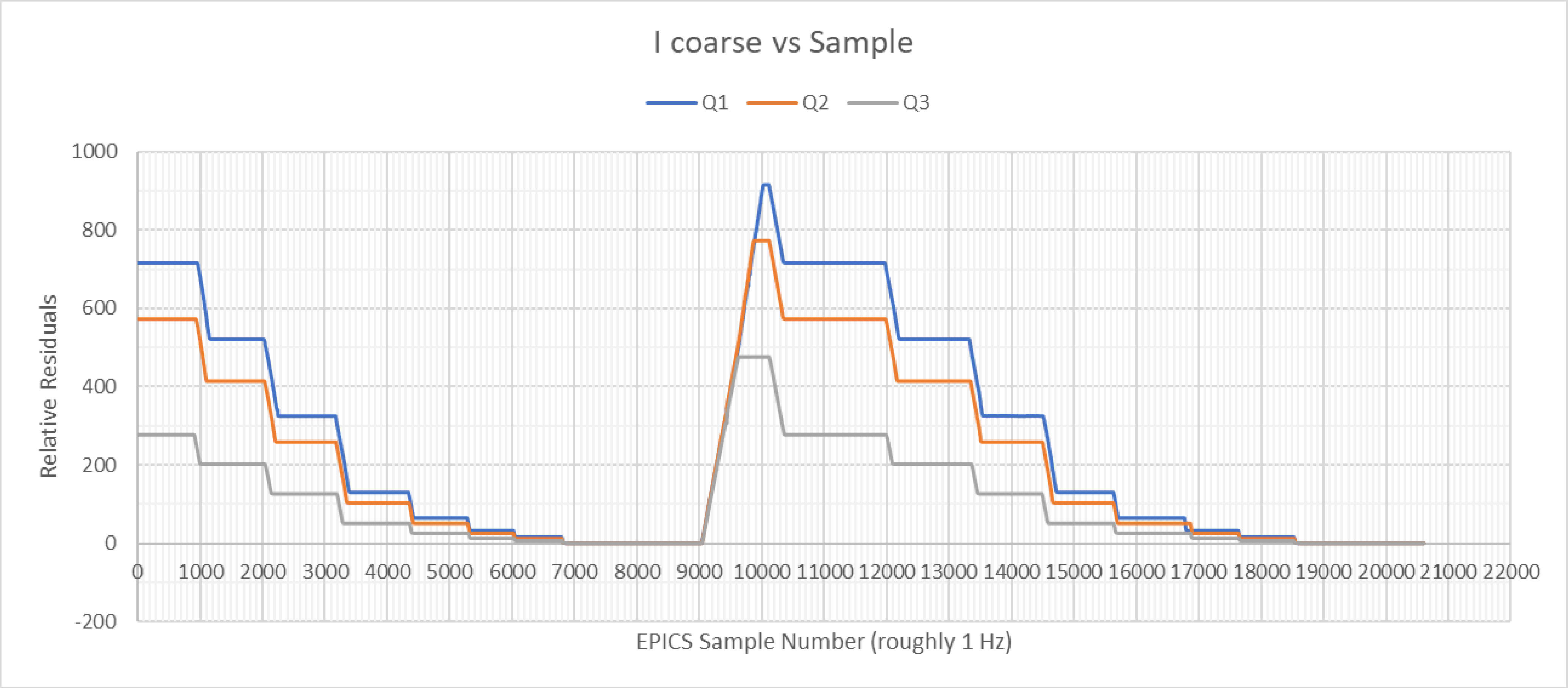
HMS quad power supplies were replaced. Field measurements were done to

1. Check general operability (Steve L)

2. Study reliability of the current readbacks (Dave M)

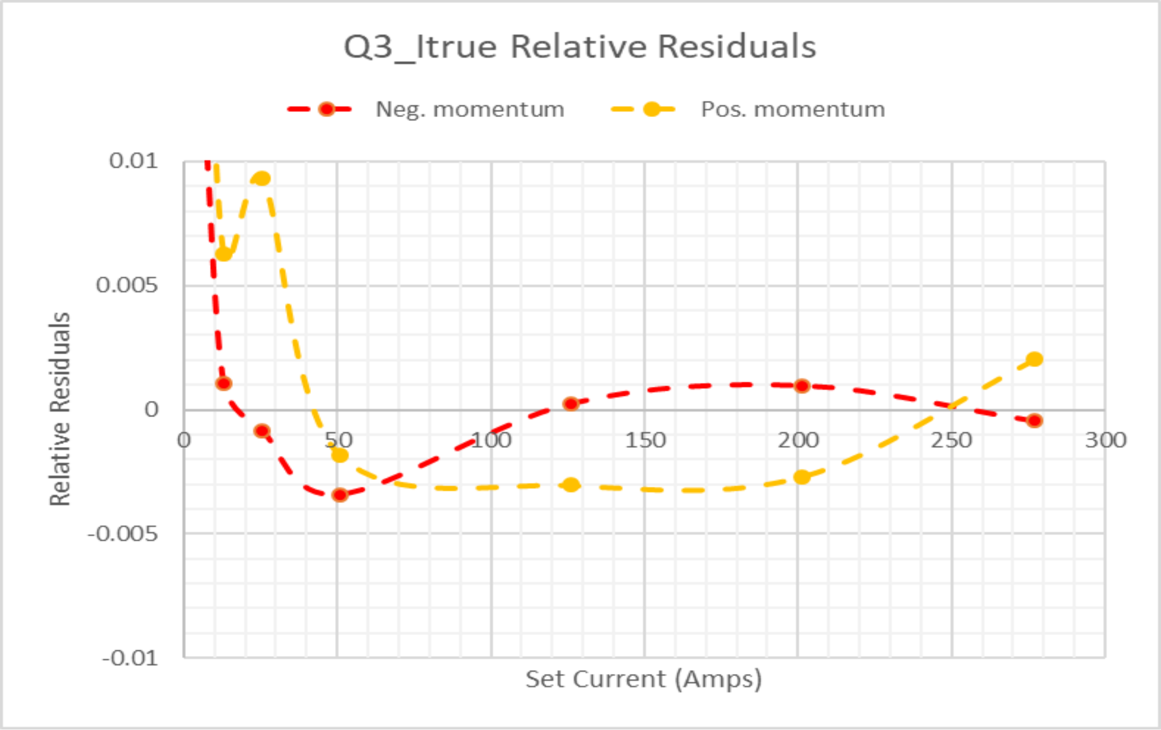
3. Determine whether to comment out an odd, legacy correction to Q3 in the tune program which was important below 2 GeV/c. (Mark J)

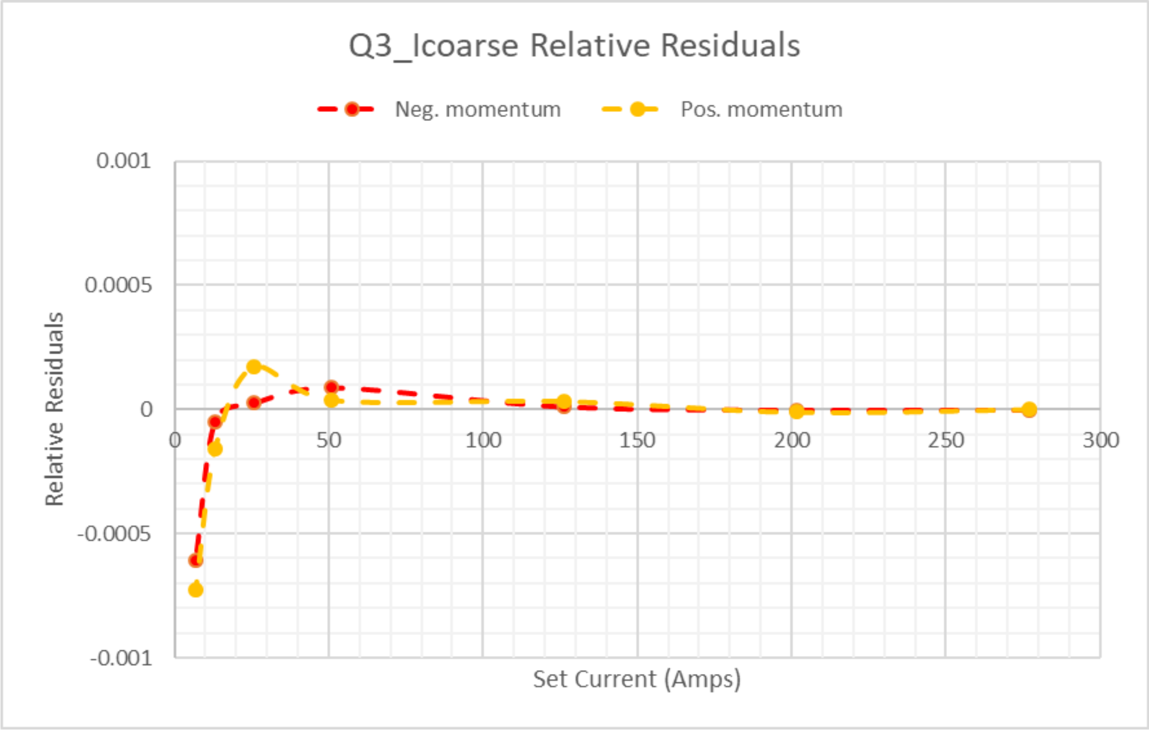


We did two hysteresis loops, one for electron polarity, and one for proton polarity.

Momenta were 5.5, 4, 2.5, 1, 0.5, 0.25, and 0.125 GeV/c.

(By the day after this test, Steve L was happy with the operability.)





To study the current readbacks relative to the set current, we plot the relative residuals (I_x – I_set)/I_set :

Left hand plot: the so-called “I_true” is OK for emergencies (vertical scale is +-1%)

Right hand plot: the so-called “I_coarse” is fantastic (vertical scale is +-0.1%)

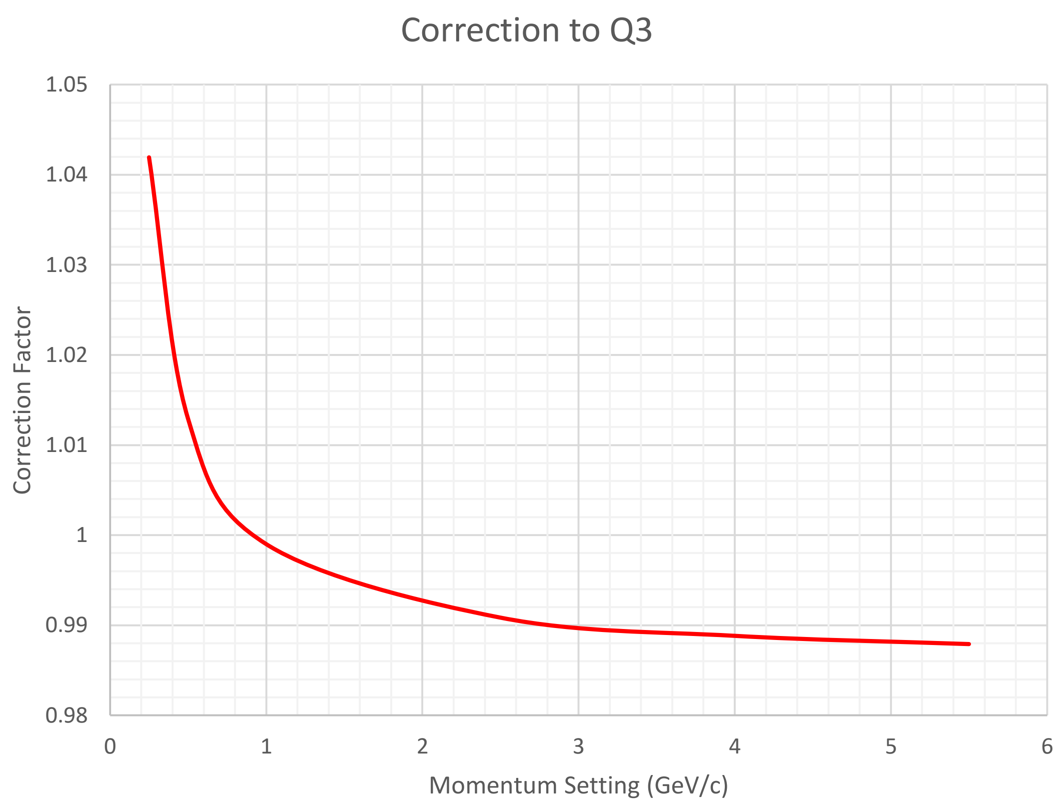
The set currents and I_coarse are usually consistent to 0.01%. (So Dave M was happy.)

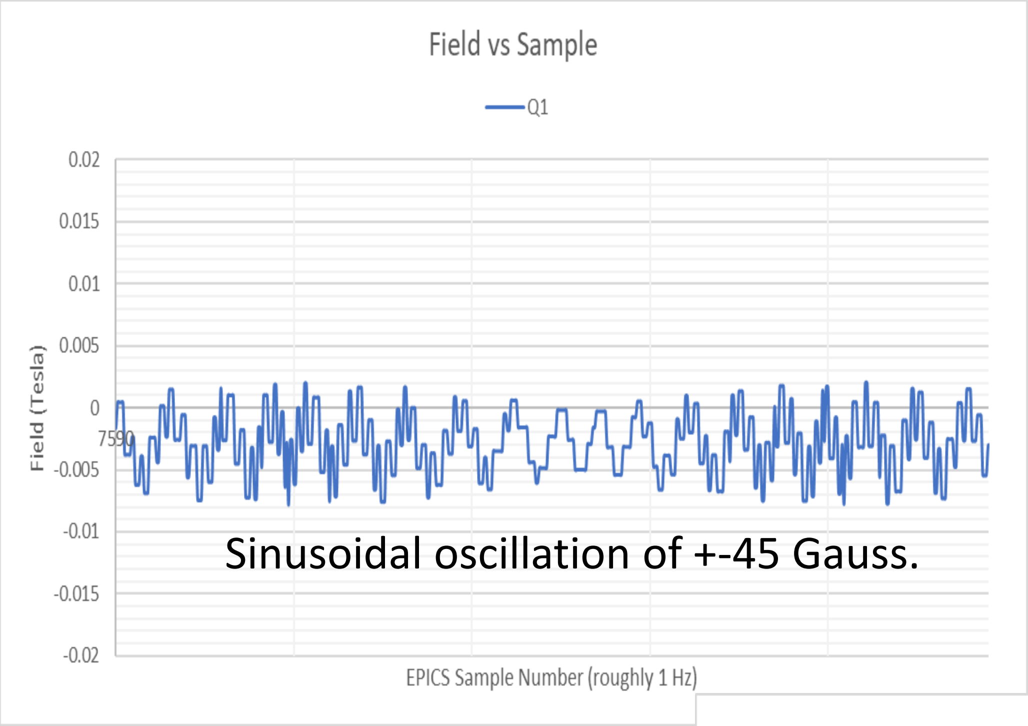
Now that the power supplies are replaced,
can we drop the odd, legacy correction
to the Q3 current?

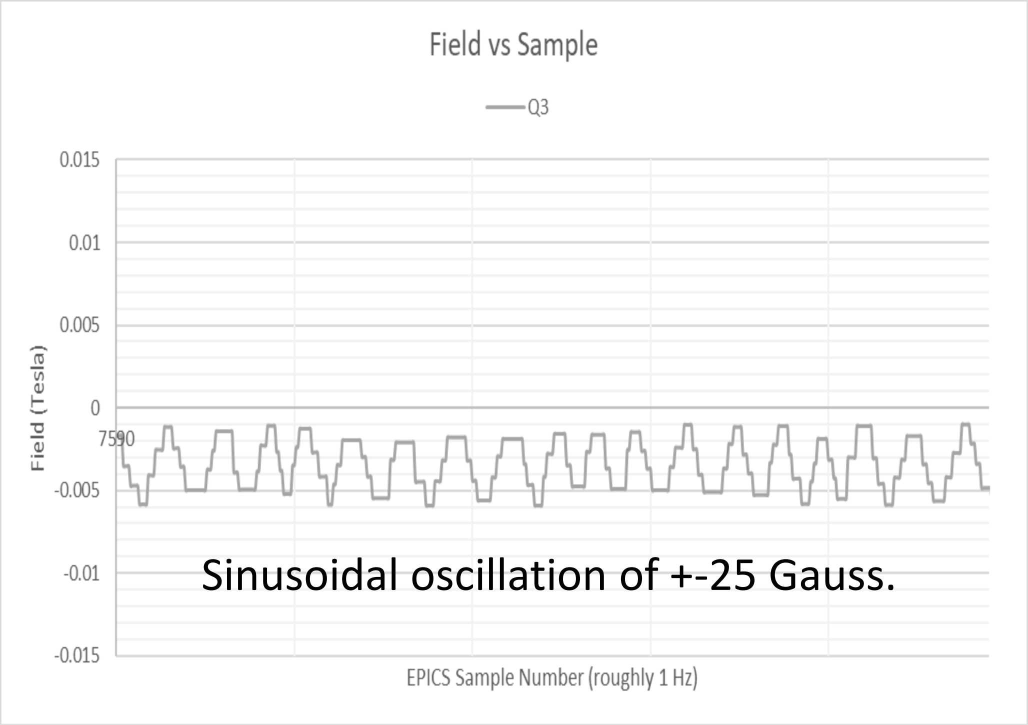
(Apparently the set current on the old
Q3 power supply was not reliable, so
Potterveld started using one of the readbacks.)

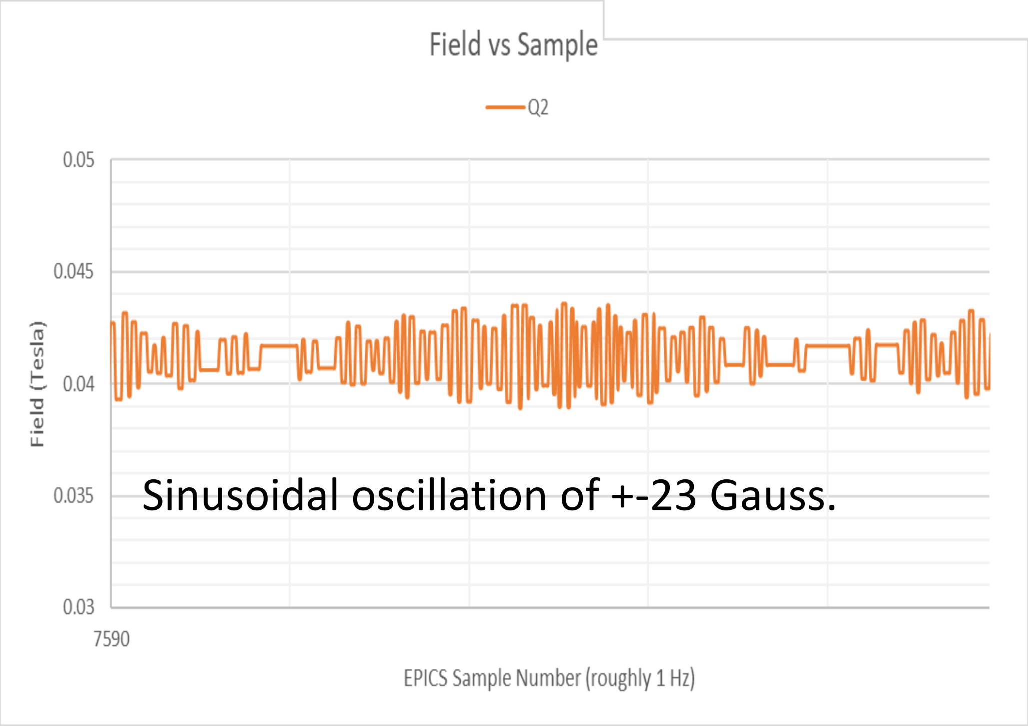
It's not a huge correction (see plot), but if we
get it wrong the optics will deteriorate fast below 2 GeV/c.

So we next we have to look at the magnetic fields.









The Hall probes have a strange sinusoidal noise, and the Hall probe offsets were huge, ranging from 30-400 Gauss.

Averaging reduces the noise to O(1) Gauss?

We can determine a stable Hall probe offset from symmetry if we take zero current data in both polarities:

$B^+ = B_{offset} + B_{remnant}$

$B^- = B_{offset} – B_{remnant}$

then

$B_{offset} = (B^+ + B^-)/2$

$B_{remnant} = (B^+ - B^-)/2$

Magnet	Hall probe offset (Gauss)	Remnant Field Magnitude (Gauss)
Q1	-31.5	3.4
Q2	+415.8	2.9
Q3	-37.3	3.0

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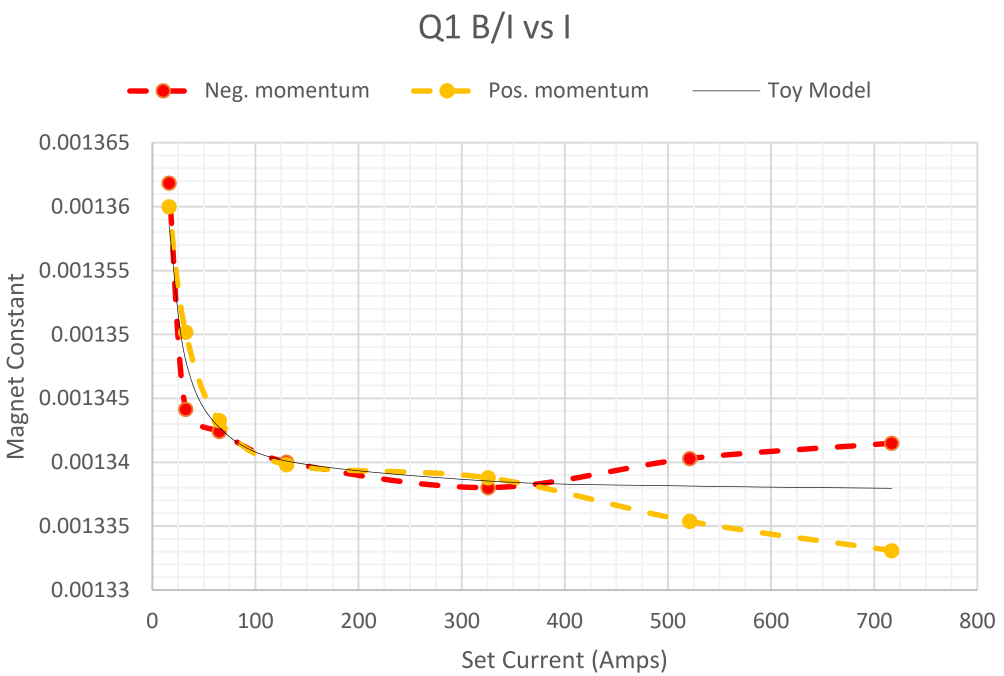
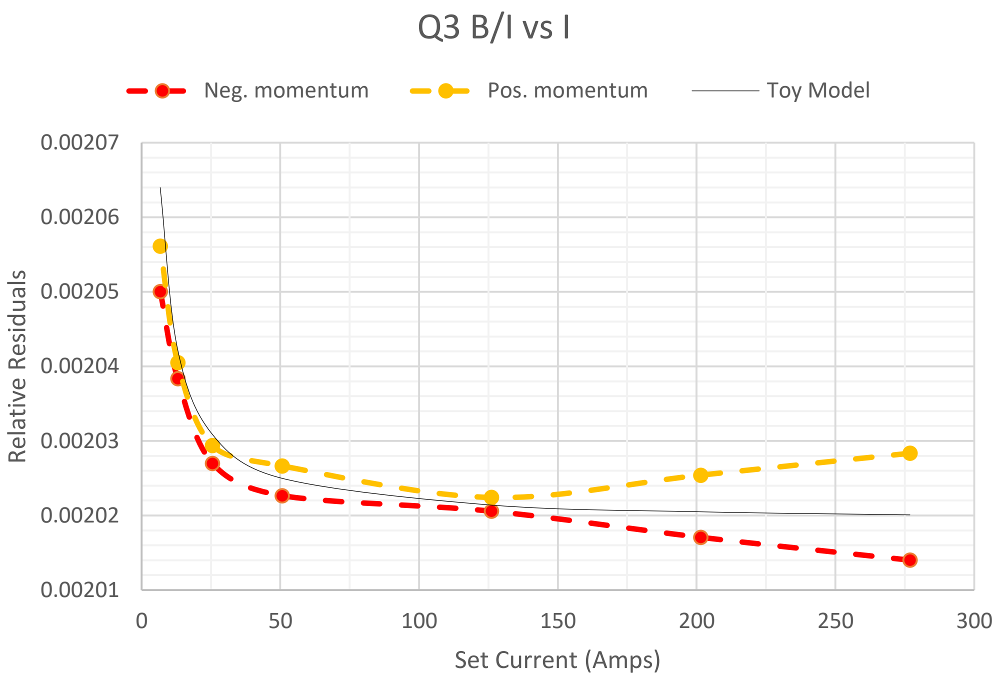
Seemingly reasonable numbers/consistency out of these crazy Hall probes.
One can indeed make a silk purse out of a sow's ear!

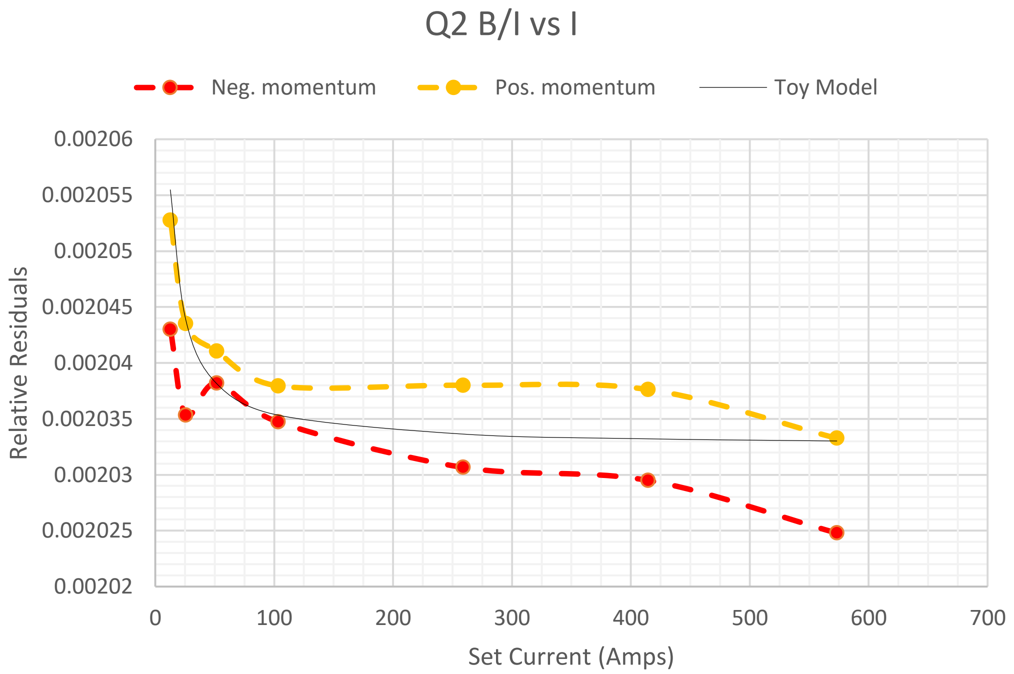
Toy model for the field of a non-saturating magnet:

$B = constant * I + B_{remnant}$

$B/I = constant + B_{remnant}/I$



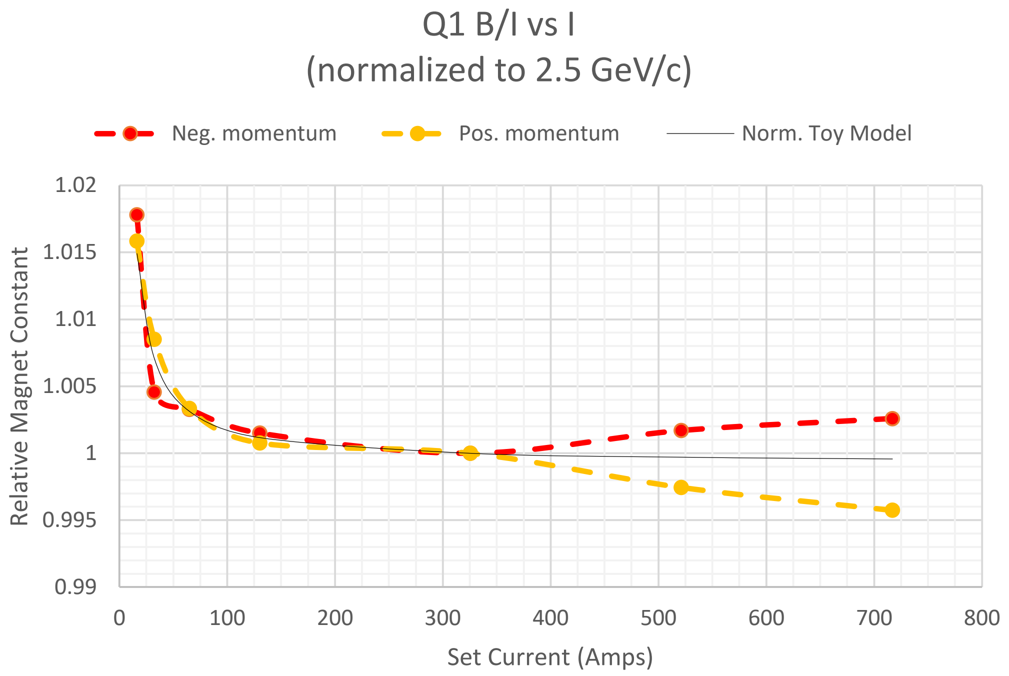


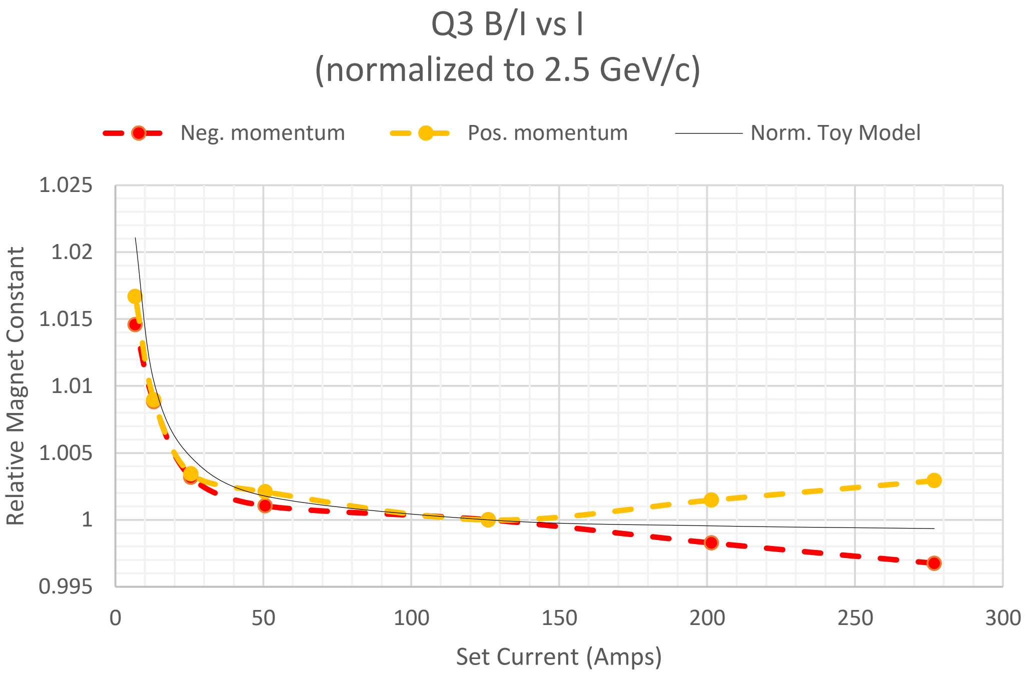


The toy model (black lines) does not stink.

We have a reasonable understanding of the nonlinearity at low momentum.

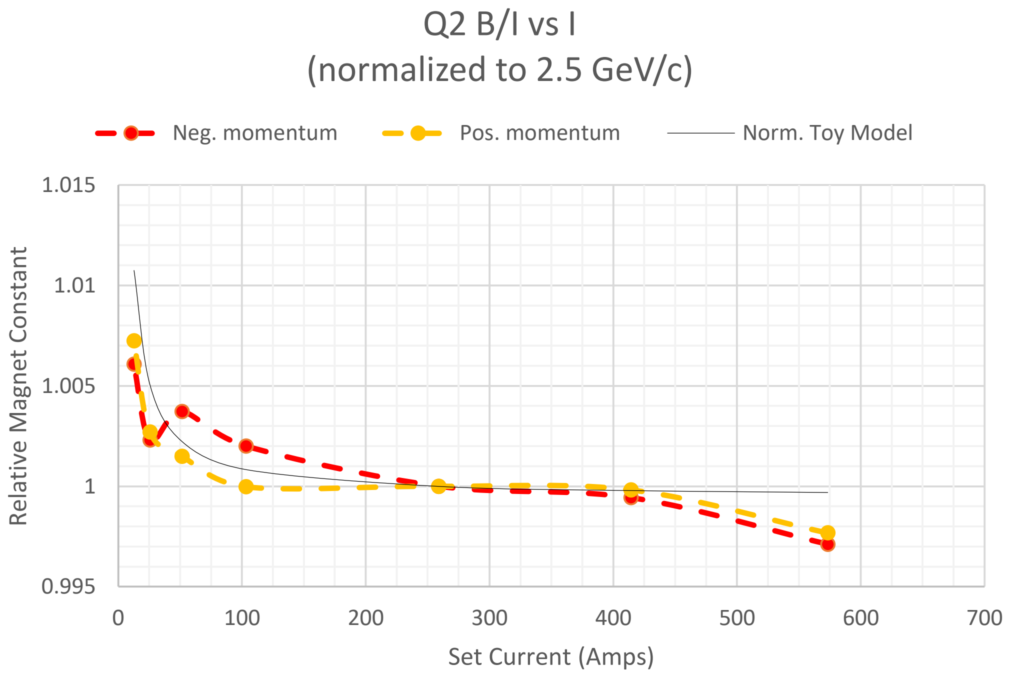
What I call the “polarity asymmetry” was not so great for Q2, reaching ~0.5%. (Q2 also had the Hall probe with the huge Offset.)





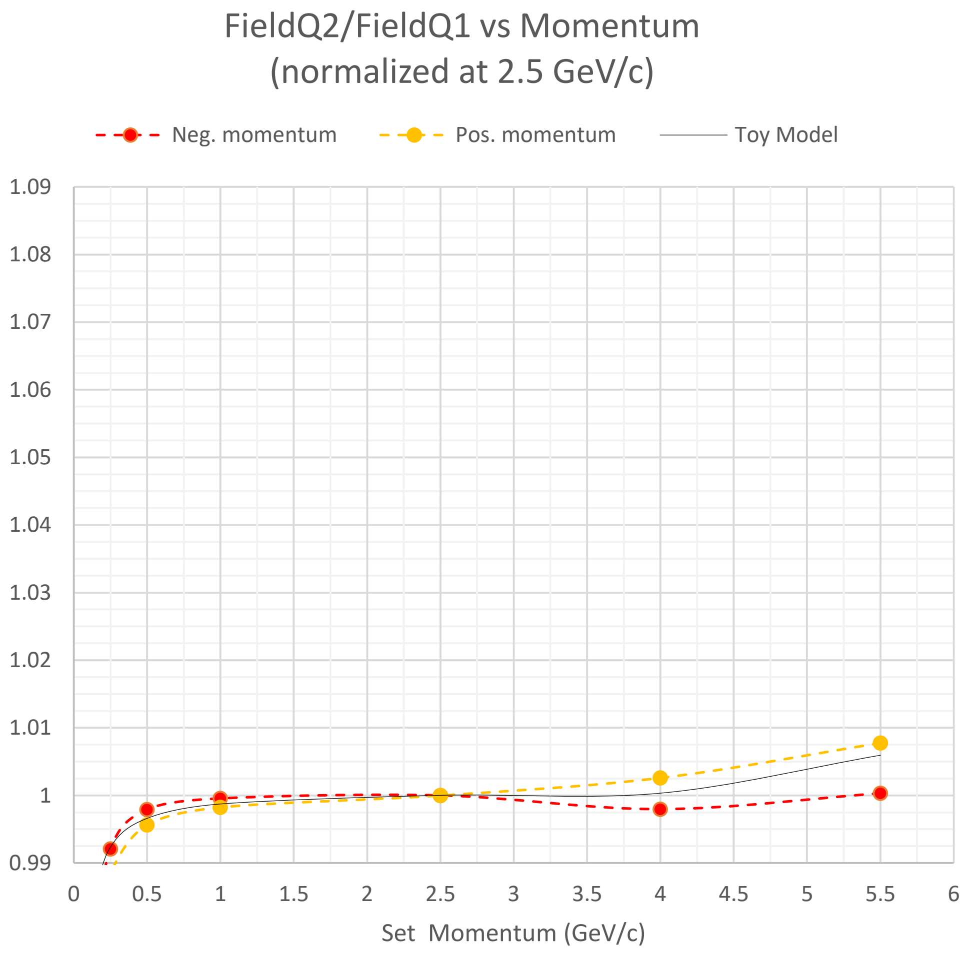
Same plot but normalized to 1 at 2.5 GeV/c.

Now you can better see the nonlinearity at low fields is only O(1)%.



Tune Proxy Field Ratio Q2/Q1 *

This should be the "control" that tests whether our measurements and the set momenta are consistent. Indeed, it's nicely flat from 0.5-4 GeV/c.



*Equating the fields to the tune or momentum setting assumes Leff is constant when the magnet is below the saturation regime.

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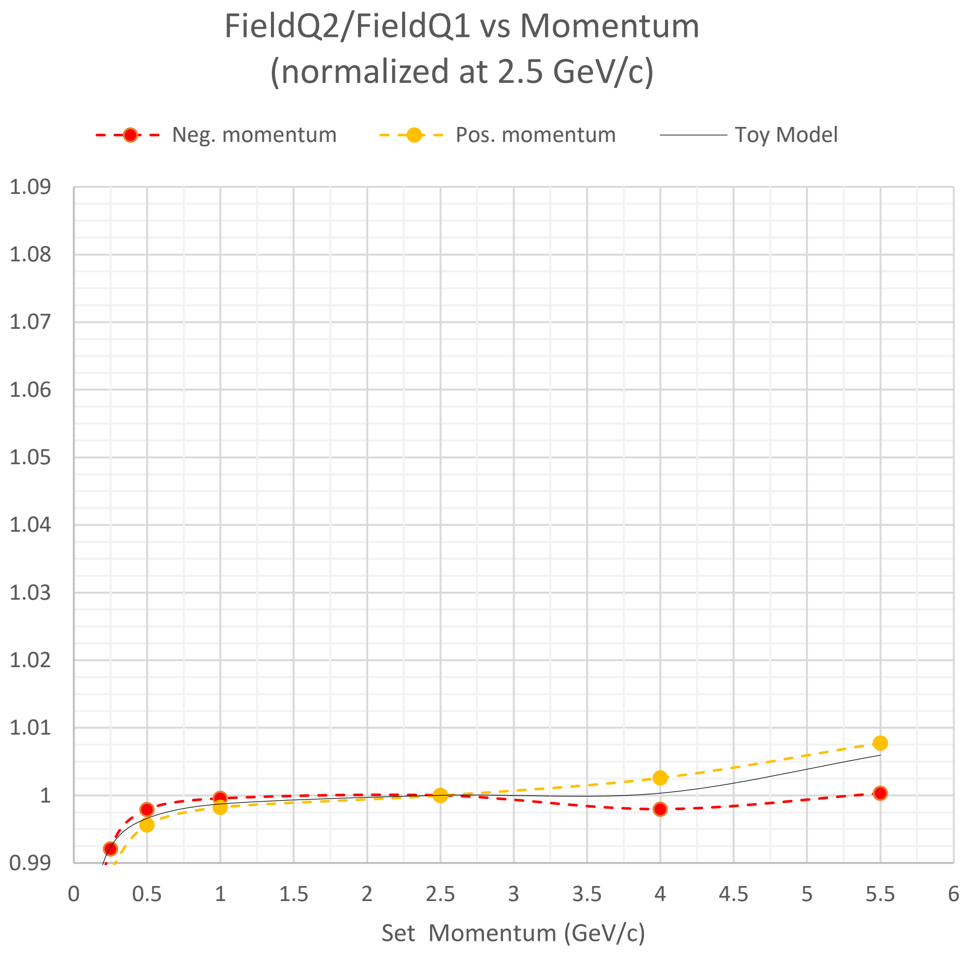

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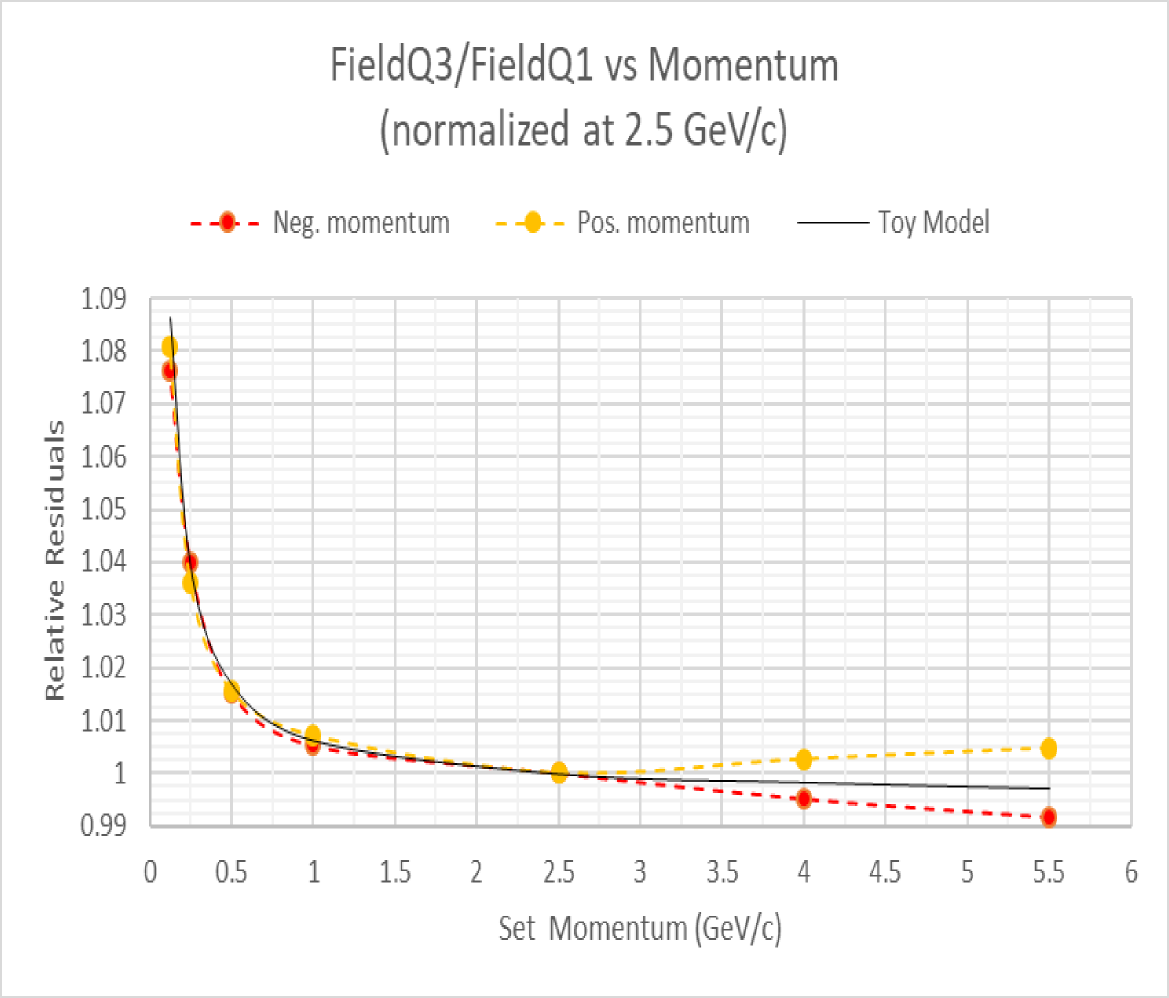
Tune Proxy Field Ratio Q3/Q1

Given that the control made sense, then Q3/Q1 should test whether Q3 is set appropriately.
Looks like Q3 is over-driven by ~1.7% at 500 MeV/c.



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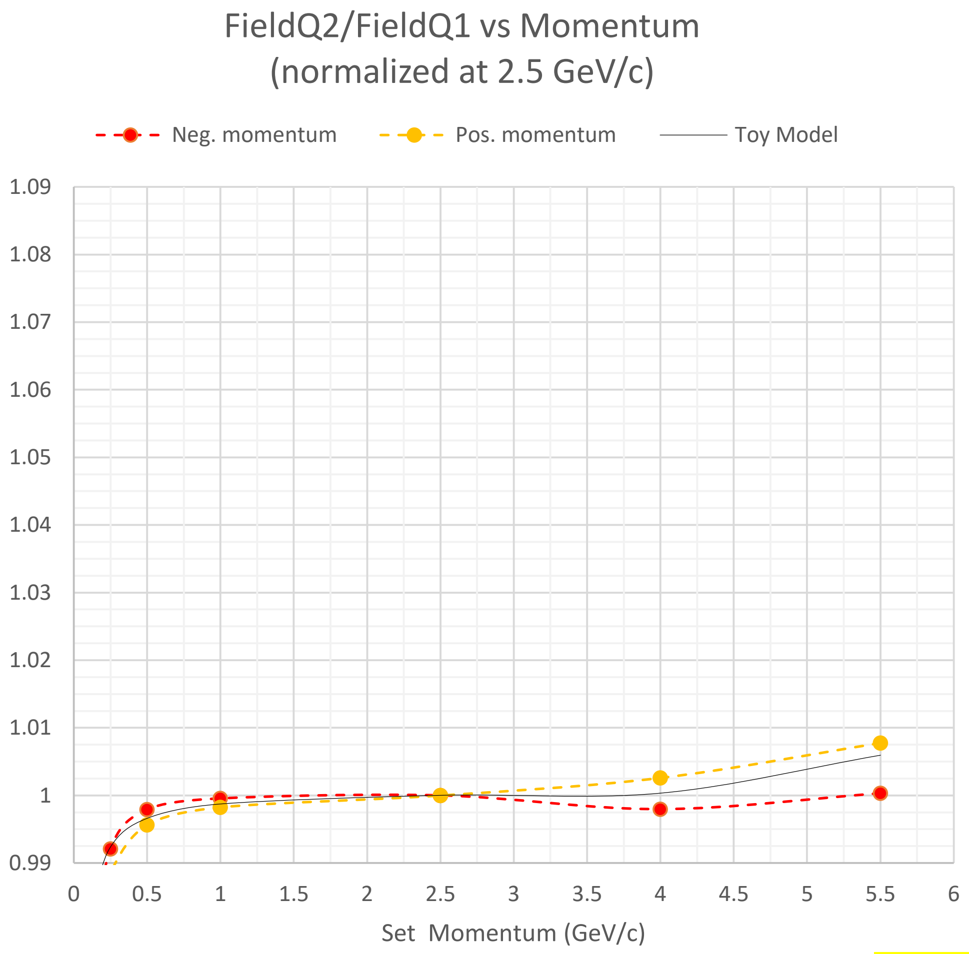

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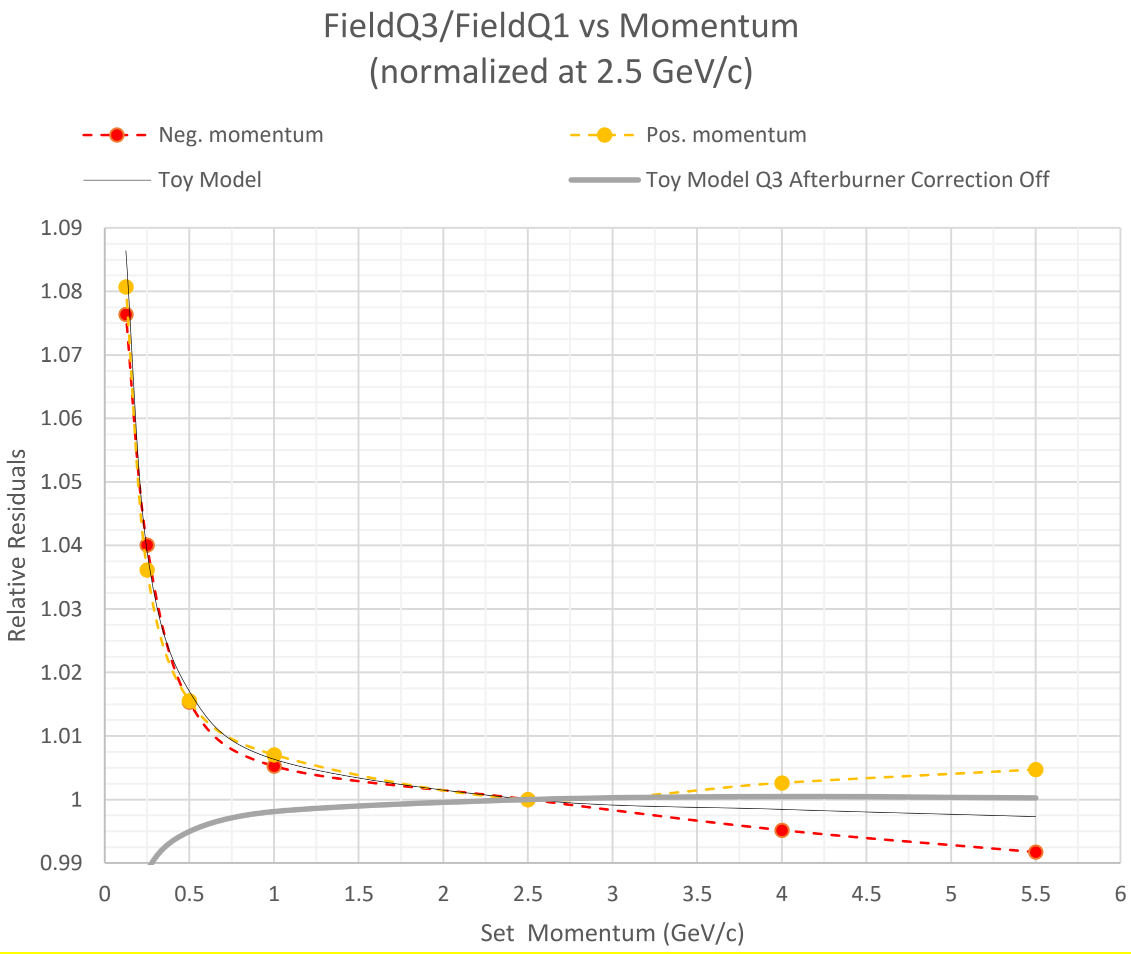

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If the afterburner correction to Q3 is removed (**dark gray line above**):
Q3 will be under-driven by only 0.5% at 500 MeV/c, which is impressive given that the control wasn't perfect, and the Q3 current is 2.5x lower than the Q1 current. I think doing any better would require revisiting/revising all 3 Quad offset parameters in the tune code.

Extras

If Mark J gives the go-ahead then we would ask Holly (as owner of the tune code) to:

Comment out the Q3 after-burner correction

Remove the statement that sets Q2(?) to 10 A when the momentum is set to zero.