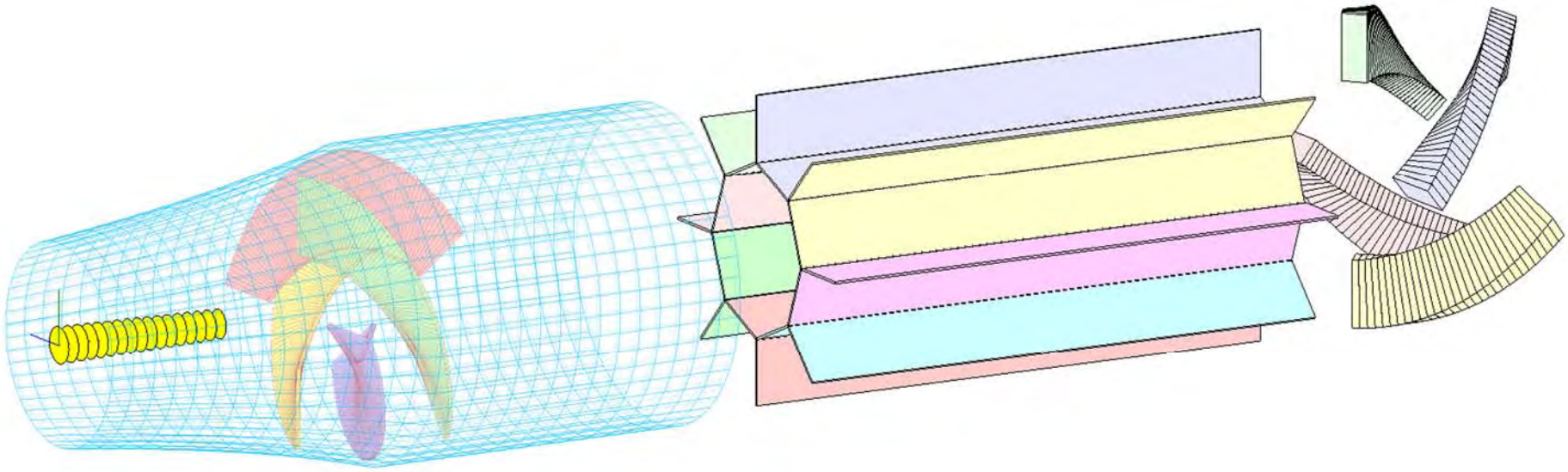
Rethinking the Proton Absorber Geometry



Daniel Pershey

Motivation for Changing Proton Absorber Geometry:

- Current detector design includes a cylindrical absorber
- By symmetry – a cylinder hurts signal e^- as much as background p^+
- Is there an absorber geometry that cuts out p^+ but leaves signal e^- alone?

What asymmetries are there?

Protons have much higher momentum

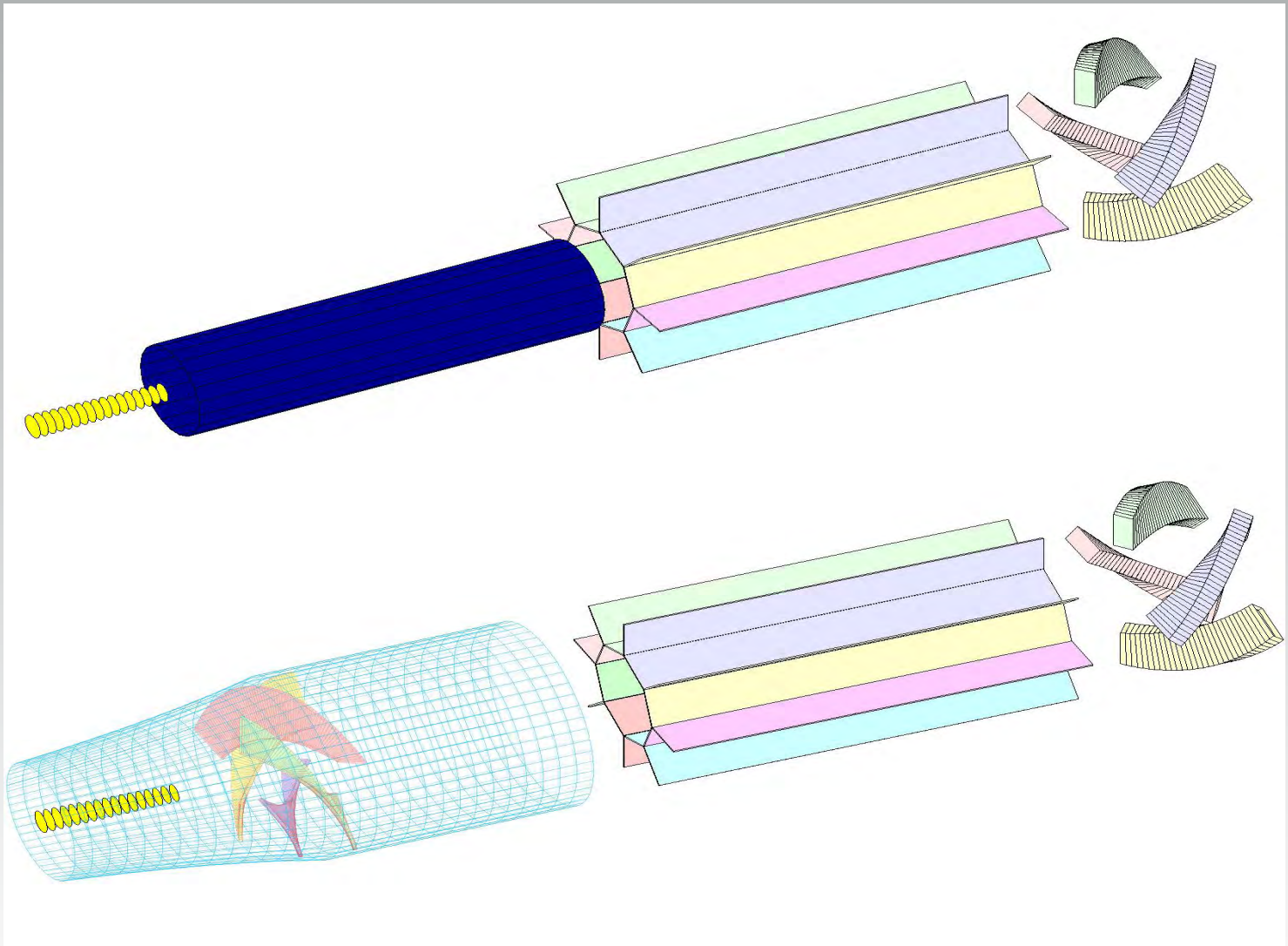
140-300 MeV/c vs. 105 MeV/c

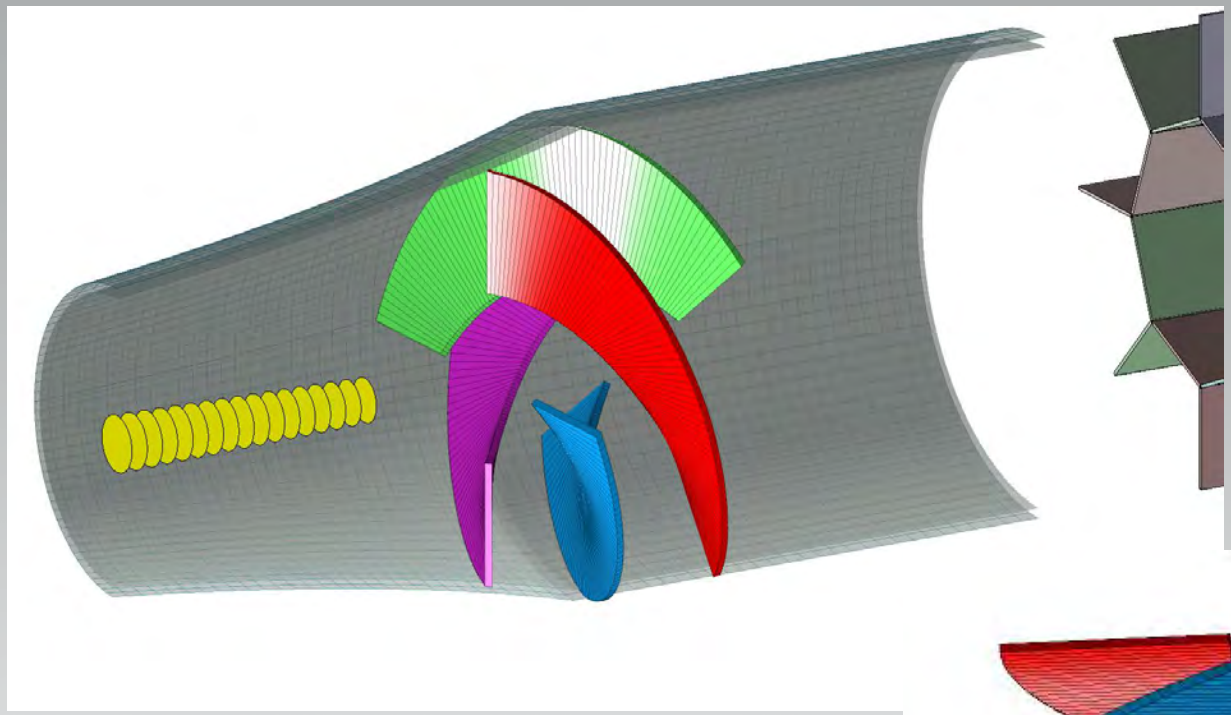
$$r = \frac{p_{\perp}}{300 \cdot |q| \cdot |\vec{B}|}$$

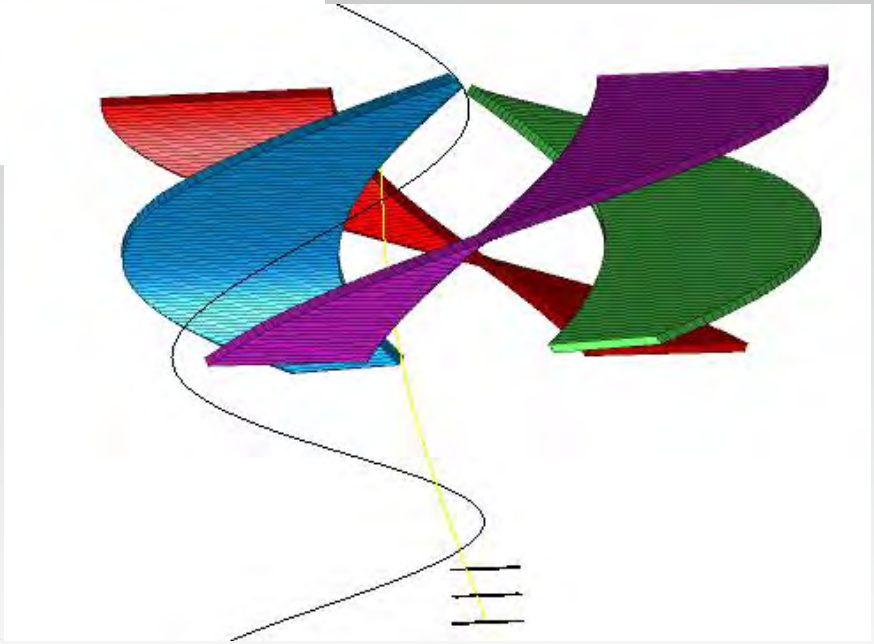
They have different charges

$$\vec{F} = q \cdot \vec{v} \times \vec{B}$$

Result:







How much better does this do?

	% p^+ that hit the tracker	% e^- make it through untouched	% e- too beat up to use*
Helical Absorber	2.8	52.9	8.3
Cylindrical Absorber	14	0	13

*loosing >5MeV/c of momentum

Monte Carlo based on 5000 particles

Fluctuations in Energy Loss

- Proton energy loss fits a Gaussian
  - $2 \cdot \sigma_p / p_{lost} < 1\%$
  - Small effect, so fluctuations ignored for p^+
- Electrons are fitted to a Landau Distribution
  - Want precision measurement for e^-, can't ignore the width.

What About Momentum Resolution?

	$\sigma_{absorber}$	$\sigma_{tracker}$	σ_{total}
Helical Absorber	267/190	170	317/255
Cylindrical Absorber	356	170	395
Past Calculation[1]	343	170	383

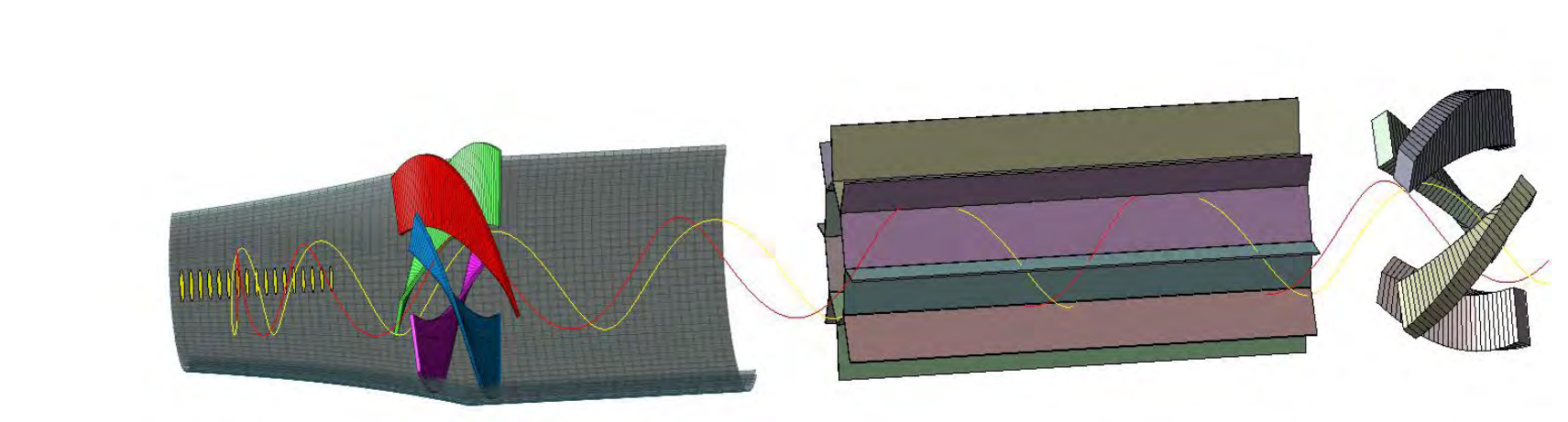
Monte Carlo based on 2000 particles

[1]Kammel, Peter. Mu2e Test Run at PSI July 09.

Effects on an In Situ Calibration

- If we shoot in an e^- from the upstream end, its trajectory is the same as a p^+ from the target
- So, calibration e^-'s travel through a lot of material.

4 Places e^- Lose Energy



Hits tracker twice

Hits absorber going upstream, sometimes while going downstream

Total Resolution for Calibration Electrons:

- Going upstream through a helical absorber gives a resolution of 204 keV
- Helical absorber:

$$\sigma_{total} = \sqrt{170^2 + 204^2 + 267^2 + 170^2} = 413\, keV$$

- Cylindrical Absorber:

$$\sigma_{total} = \sqrt{170^2 + 356^2 + 356^2 + 170^2} = 558\ \ keV$$

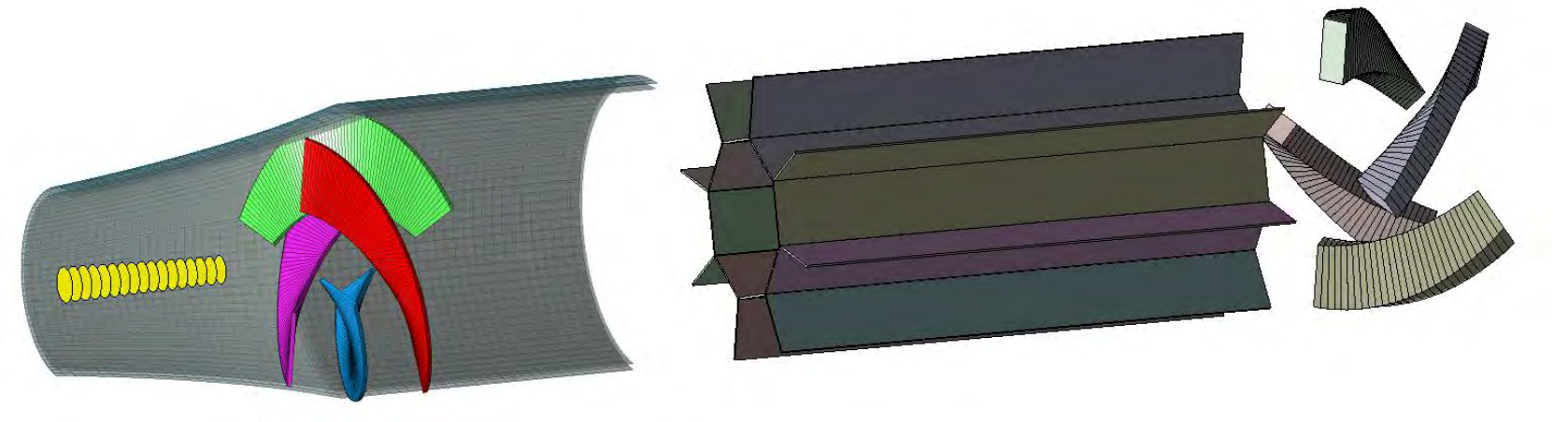
- In situ calibration works even better!

Financial Benefit?

Cylindrical absorber – ends 3.35 m downstream

Helical absorber – ends 1.75 m downstream

Could we move up the tracker ~1.6 m? This would reduce length of the solenoid



Conclusions:

- New geometry looks like a better absorber
  - p^+ background reduced
  - ½ of signal e^- don't hit the absorber
  - Better momentum resolution
  - Still allows for an in situ calibration
  - Possible financial benefit