KINEMATICS FROM GEM HITS FOR PVDIS

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WHAT CAN WE LEARN ABOUT RESOLUTION AND CALIBRATION FROM FOUR NUMBERS?

- Trajectory determined by vertex (x_v, y_v, z_v) and momentum (p, θ, ϕ). $x_v, y_v \approx 0$.
- Hits in 2 GEM chambers give 4 quantities x_1, y_1, x_2, y_2
- Can we invert the mapping? Yes, if we parameterize with the right combinations of x_1, y_1, x_2, y_2.

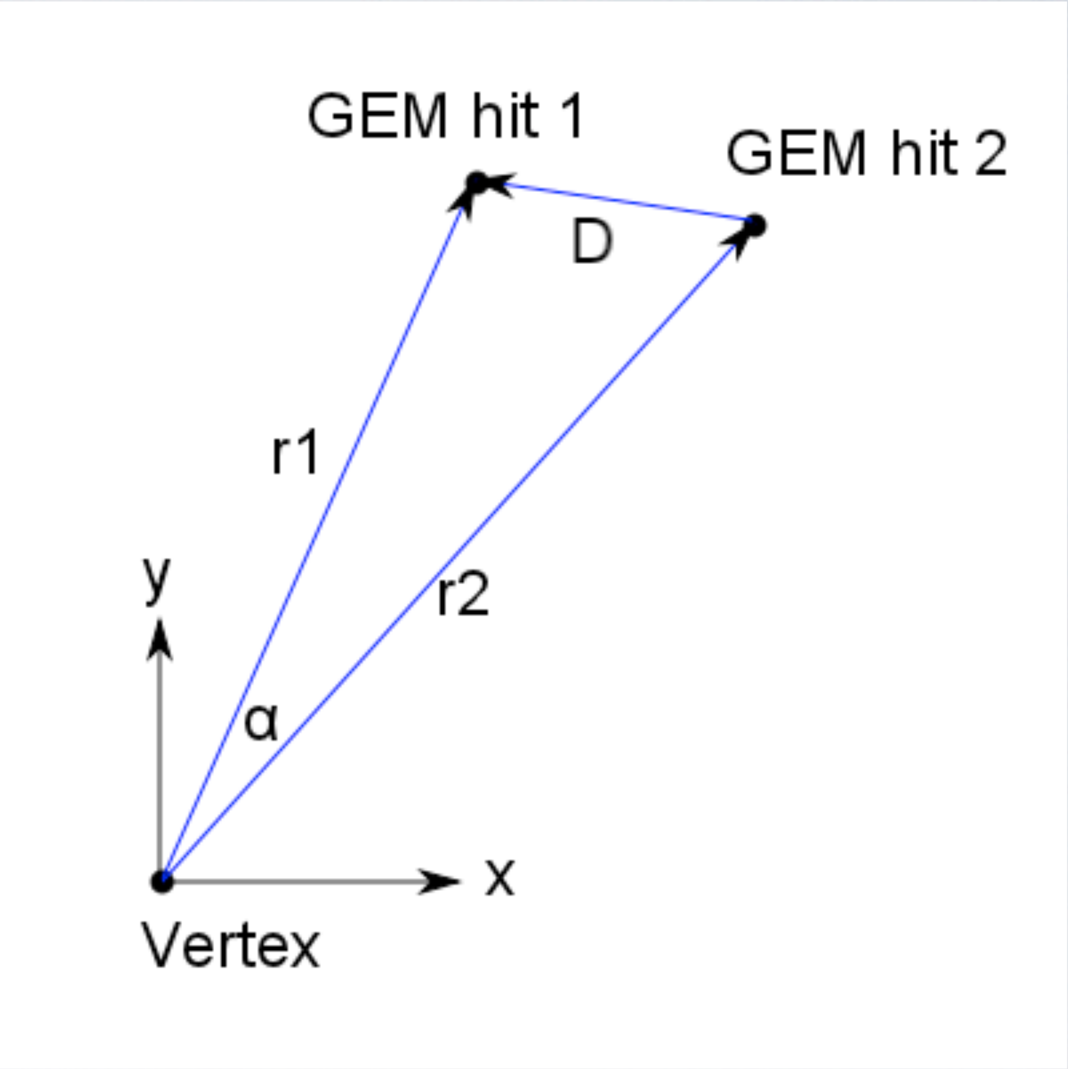
PARAMETERS

In x-y plane:

r_i = length of 2-vector r_i from vertex to hit i
D = distance between hits
α = angle between vectors

Others (not illustrated)
$\langle r \rangle = (r_1+r_2)/2$
$\Delta r = r_2 - r_1$

(and so on)



PARAMETERS

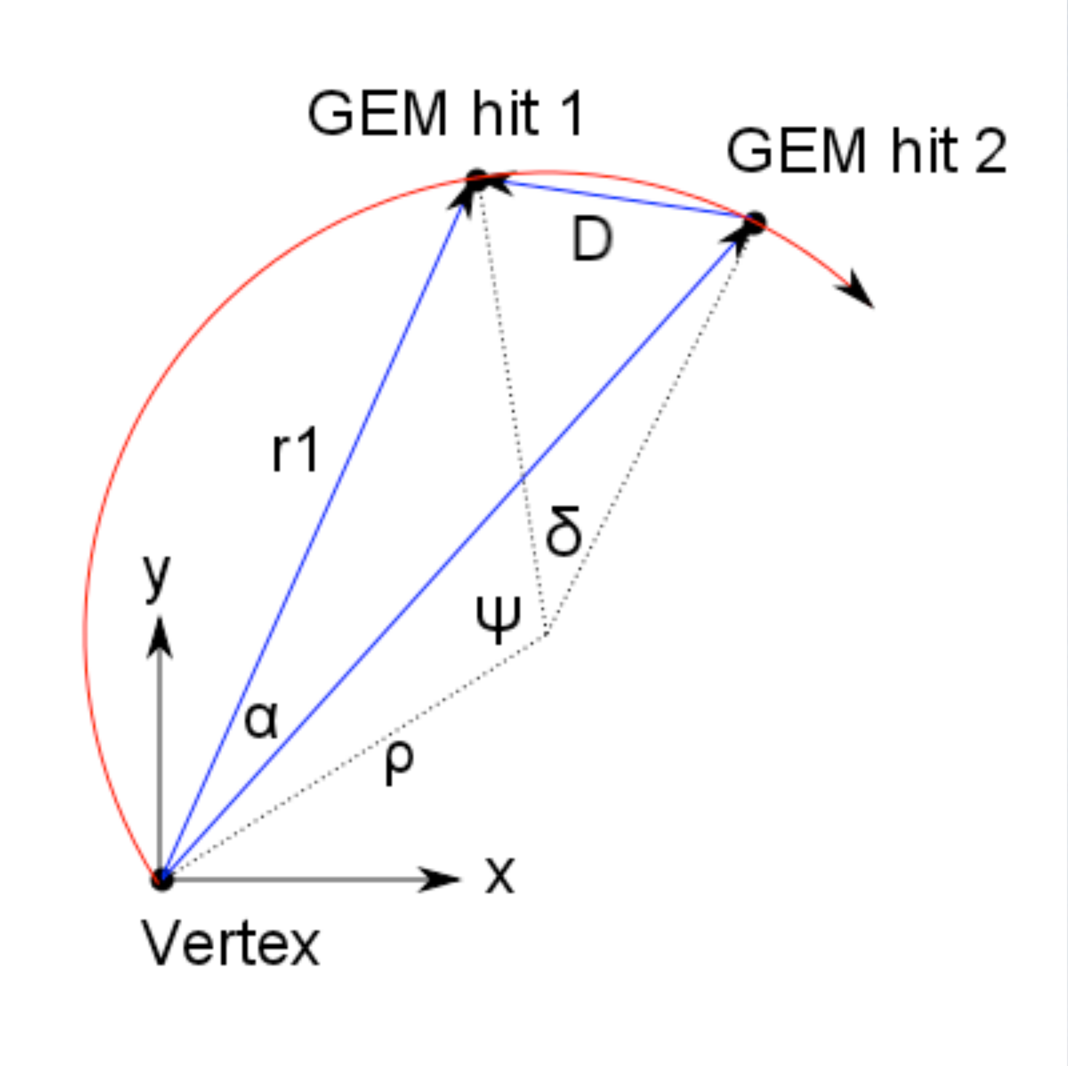
Uniform field:
Trajectory in x-y plane is a circular arc of radius $\rho \propto p_T$

$1/\rho \approx (\psi+\delta)/(r_1+D) \approx 2\alpha/D$

$\tan\theta \approx D/\Delta z$
($\Delta z = z_2 - z_1$, distance between GEM planes)

$z_1 - z_v \approx \Delta z\, r_1/D$

Approximations hold for small angles.



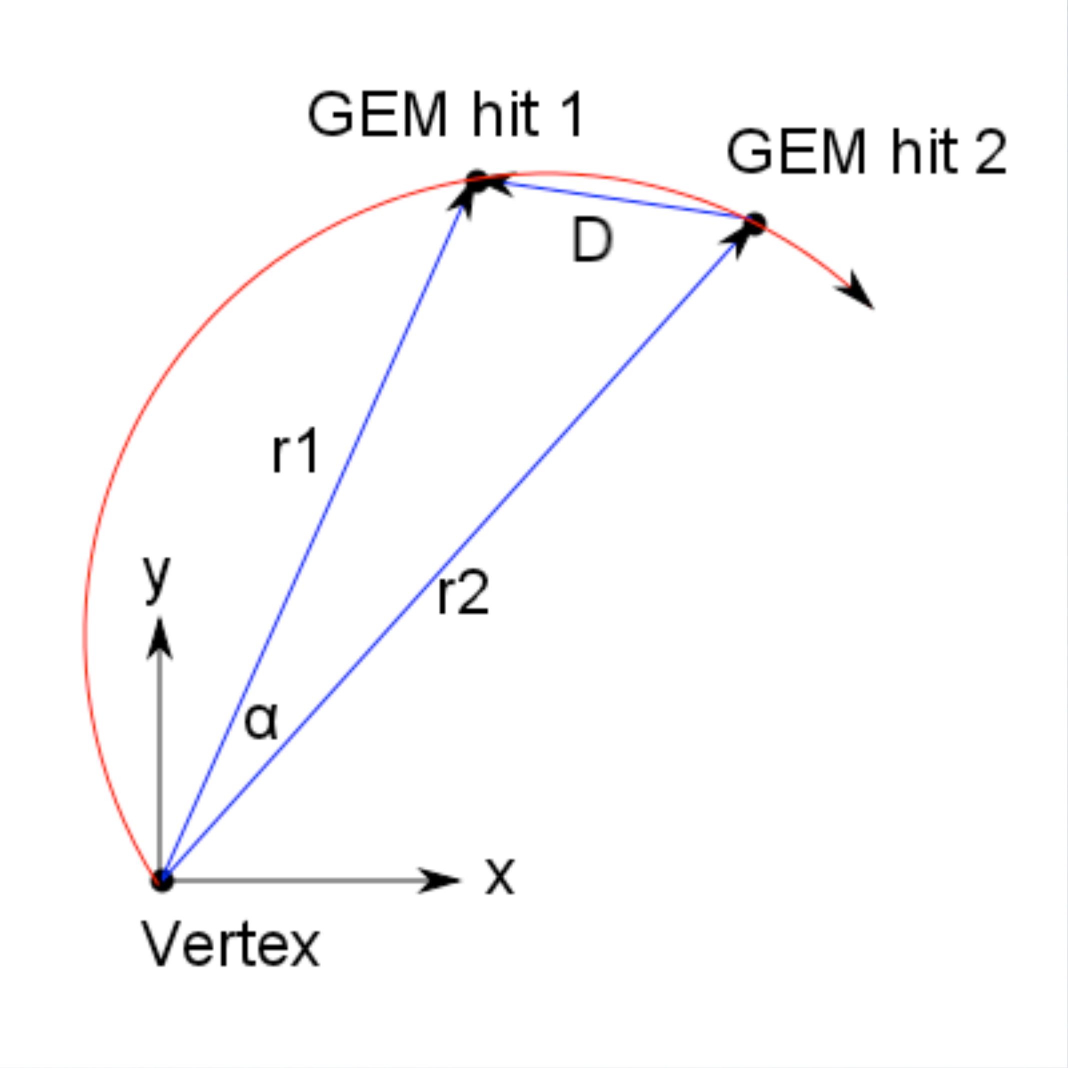
PARAMETERS

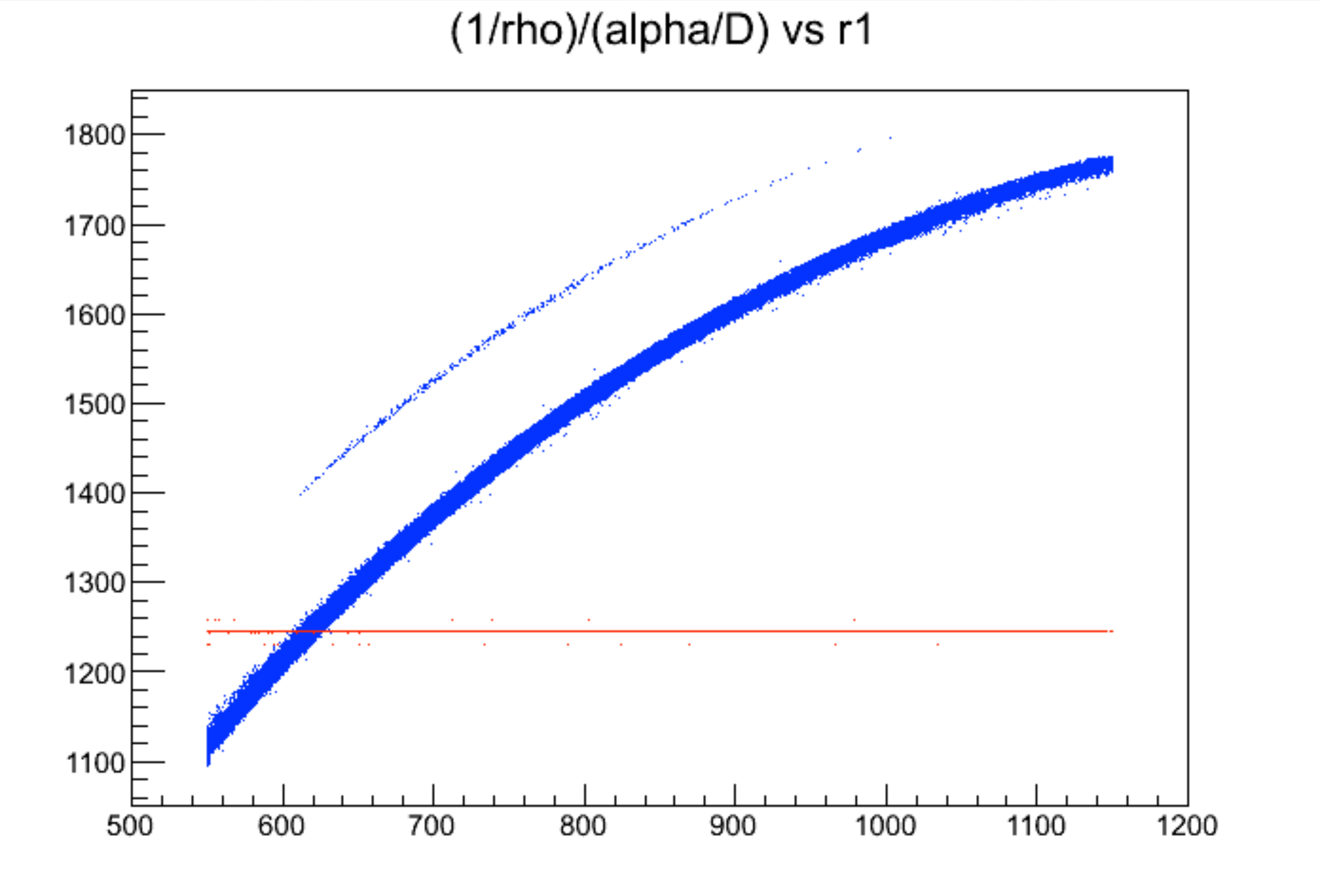
Realistic field:

$1/p_T = k\alpha/D(1 + F_\rho(...))$

$\tan\theta = D/\Delta z(1 + F_\theta(...))$
($\Delta z = z_2 - z_1$, distance between GEM planes)

$z_1 - z_v = \Delta z\, r_1/D(1 + F_z(...))$

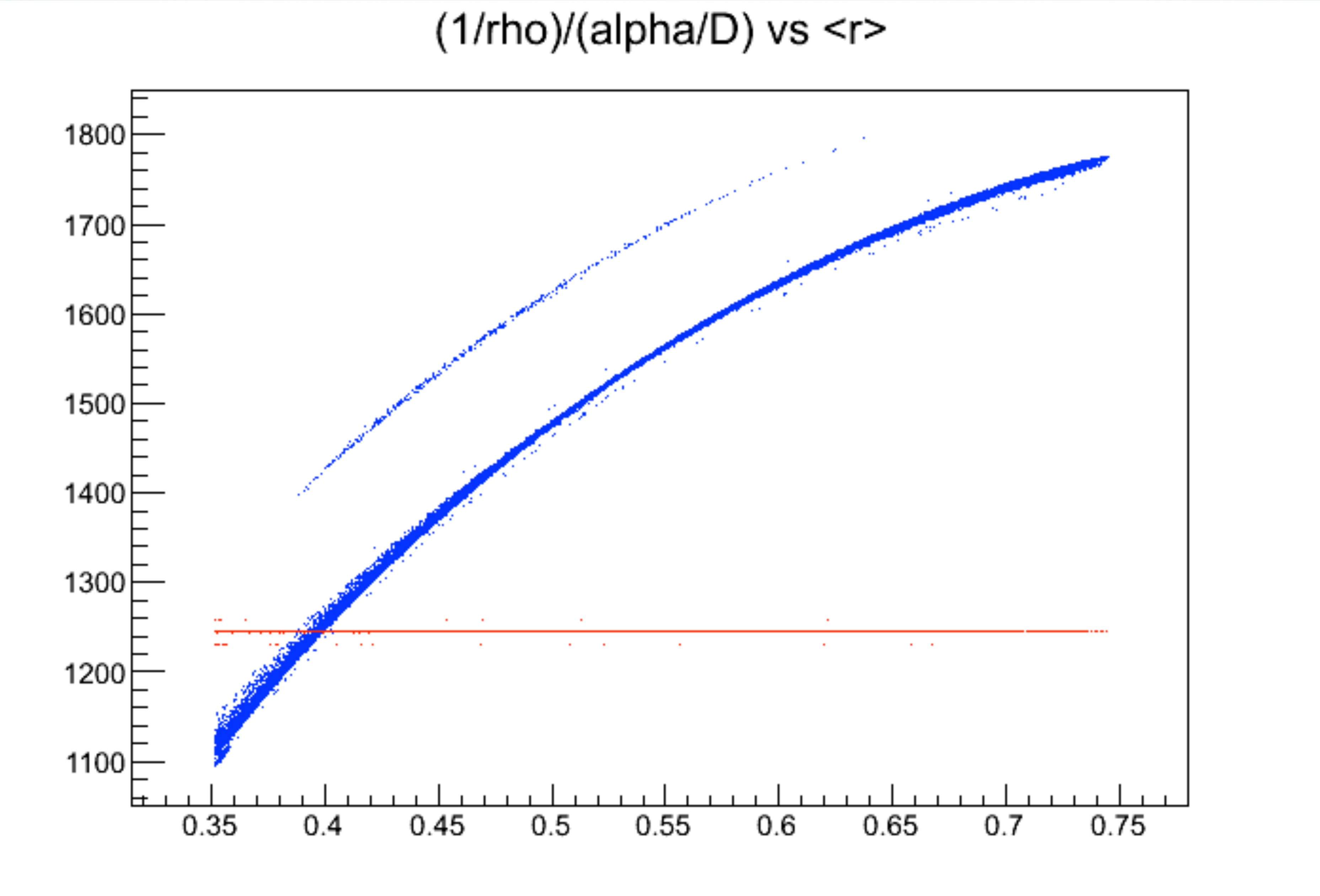




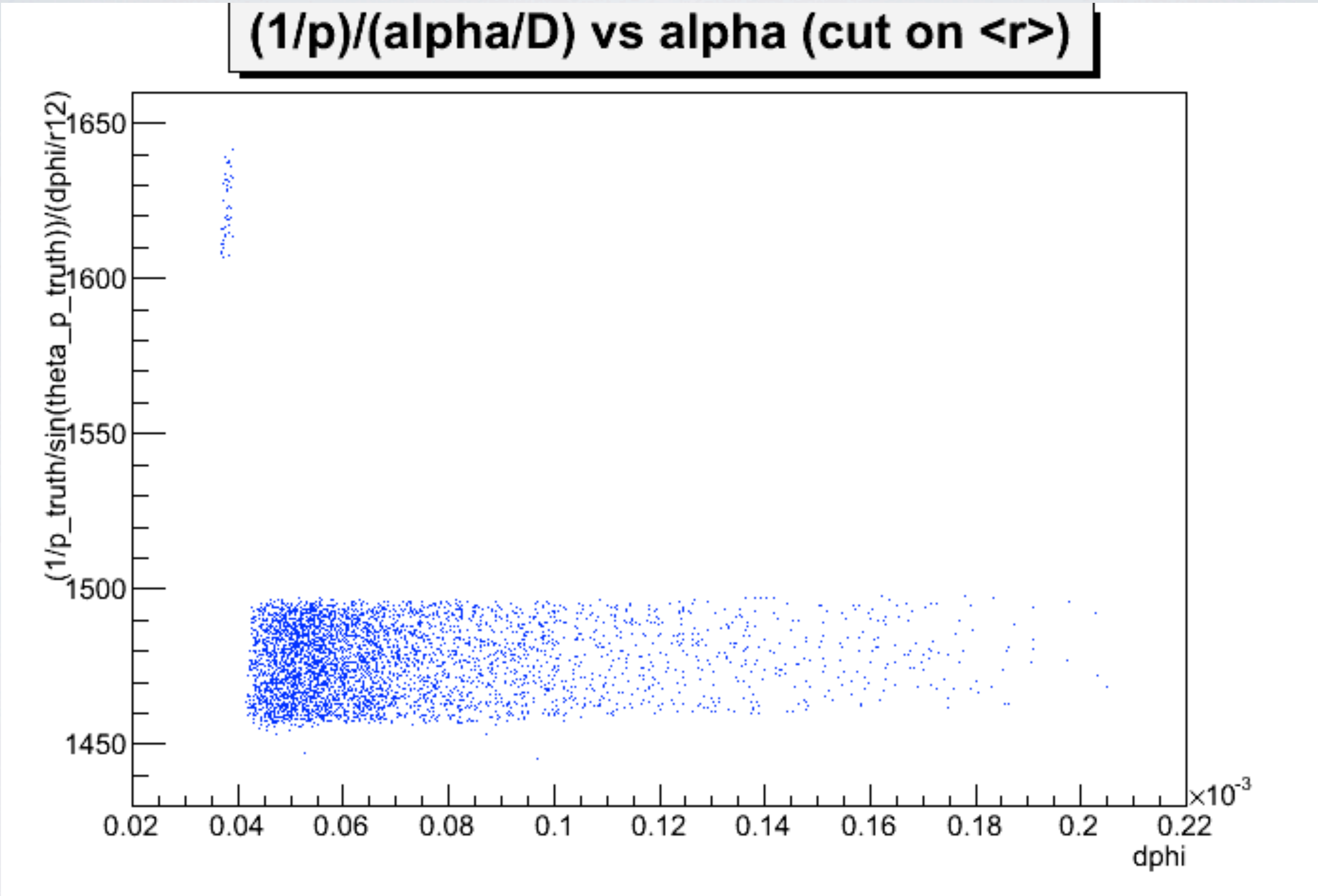
PVDIS geometry, 1st 2 GEMs (inside magnet)

Red points: Uniform field

Blue points: Realistic field



Red points: Uniform field
Blue points: Realistic field



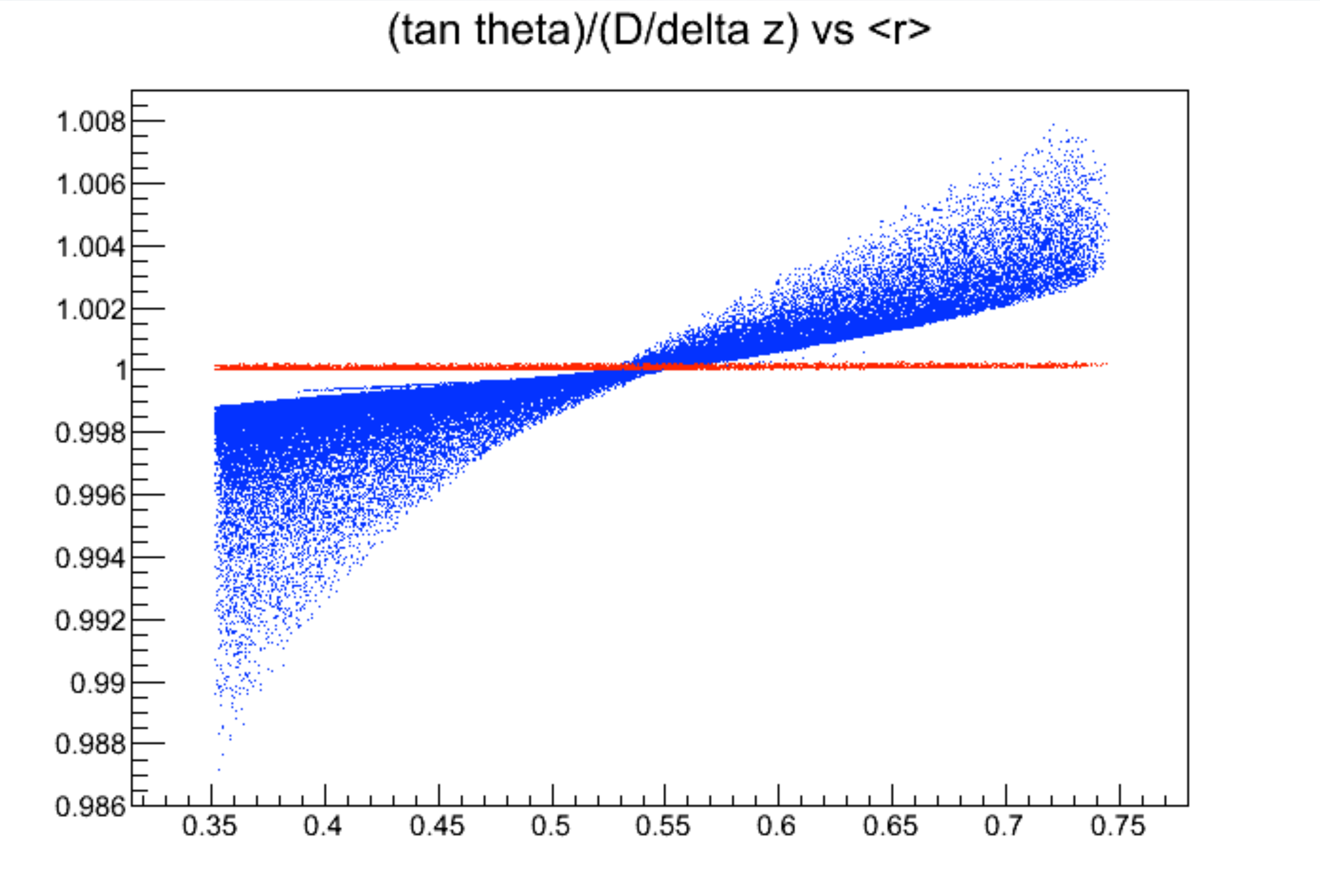
Momentum correction F_ρ is not a function of α.

RESOLUTION

- Calibrate by fitting against truth values to obtain F_ρ, F_θ, F_z
- Using these reconstruct p, θ, z and compare to truth values
- Resolution (using MC with target, window, GEM materials):
  - p: 0.86%
  - Q^2: 1.23%
  - θ: 0.36%
  - x: 0.71%
  - z_v: 7.8 mm

CALIBRATING REAL DATA

- For real data we have no truth values; how do we calibrate?
- Elastics: p is correlated with θ
- θ calibration is not very sensitive to details of B field



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CALIBRATING REAL DATA

- Use MC (field map accurate to 1%) to get θ calibration
- Use θ calibration and elastic data to get p calibration
- This has been demonstrated using e.g. (90% CLEO + 10% uniform) field MC to stand in for real data

SUMMARY

- Hits in 2 GEM chambers can be used to reconstruct scattering kinematics
- Resolution with multiple scattering and detector resolution is $<1\%$ for p, $<0.5\%$ for θ
- θ can be adequately calibrated with MC; p can then be calibrated with elastic data