Oscar Rondon Packing Fraction Method – Details For g2p

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Ratio Method seems unreliable at 2.5T so far

- Choice of fit region is fuzzy
- Seeming strong cut dependence at 2.5T
- No parts of 2.5T pf spectrum are especially flat, especially for tight cut
- Possibly some error in application of method that I haven’t caught yet

- 5T pf, dilutions agree well within error bars for different cut, so we are more confident that those results are finished.
- Will continue to study cut dependence of this method, but in mean time, may be worth our time to pursue if there are other options

Oscar Rondon PF method from RSS seems like a promising option

- Denominator of dilution factor can be taken as the total yield to relate yield and pf:

$$Y_T = I_b \mathcal{A}_{HRS}\left(\frac{\rho_{NH_3}}{M_{NH_3}} 3pf(3\sigma_P + \sigma_N) + \frac{\rho_{He}3(1-pf)}{M_{He}}\sigma_{He} + \frac{\rho_{He}z_{He}^{ext}}{M_{He}}\sigma_{He} + \frac{\rho_{Al}z_{Al}}{M_{Al}}\sigma_{Al}\right.$$

- This means that the yield and pf have a linear relationship:

$$Y_T = m\,pf + b$$

- Determining these fit parameters m and b allows to generate the packing fraction directly from an integrated yield

Start by scaling simulation to get good agreement with carbon data

- Create radiated model cross sections by using the Bosted-Christy model and radiating it
- Generate monte-carlo simulation (g2psim?) at pf=1 at all energy settings, compare to carbon data
- Pick a region where the ratio of simulation/data is flat, and integrate both the simulated yield and the carbon yield over that region
- Generate a scale factor s to improve the simulation's agreement with the data:

$$s = \frac{Y_T^C}{Y_T^{sim}}$$

- If simulation already agrees well the effect of this may be negligible

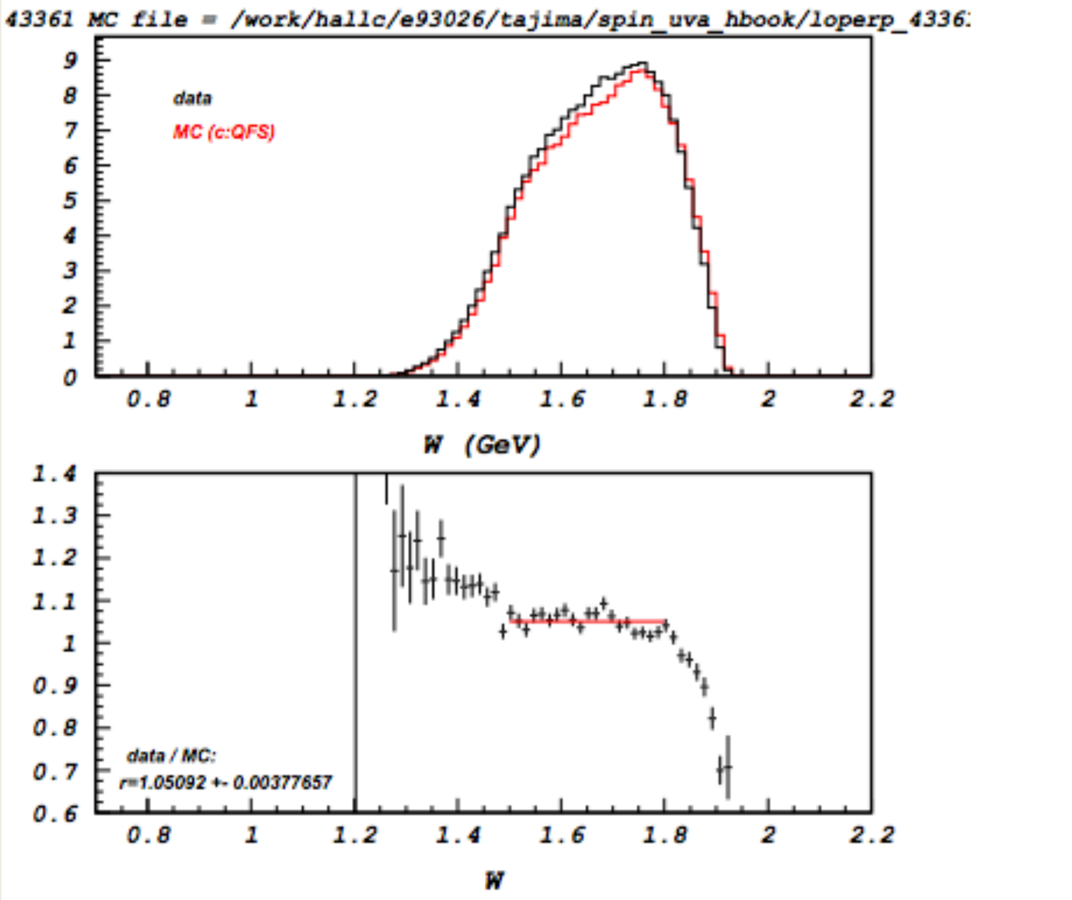
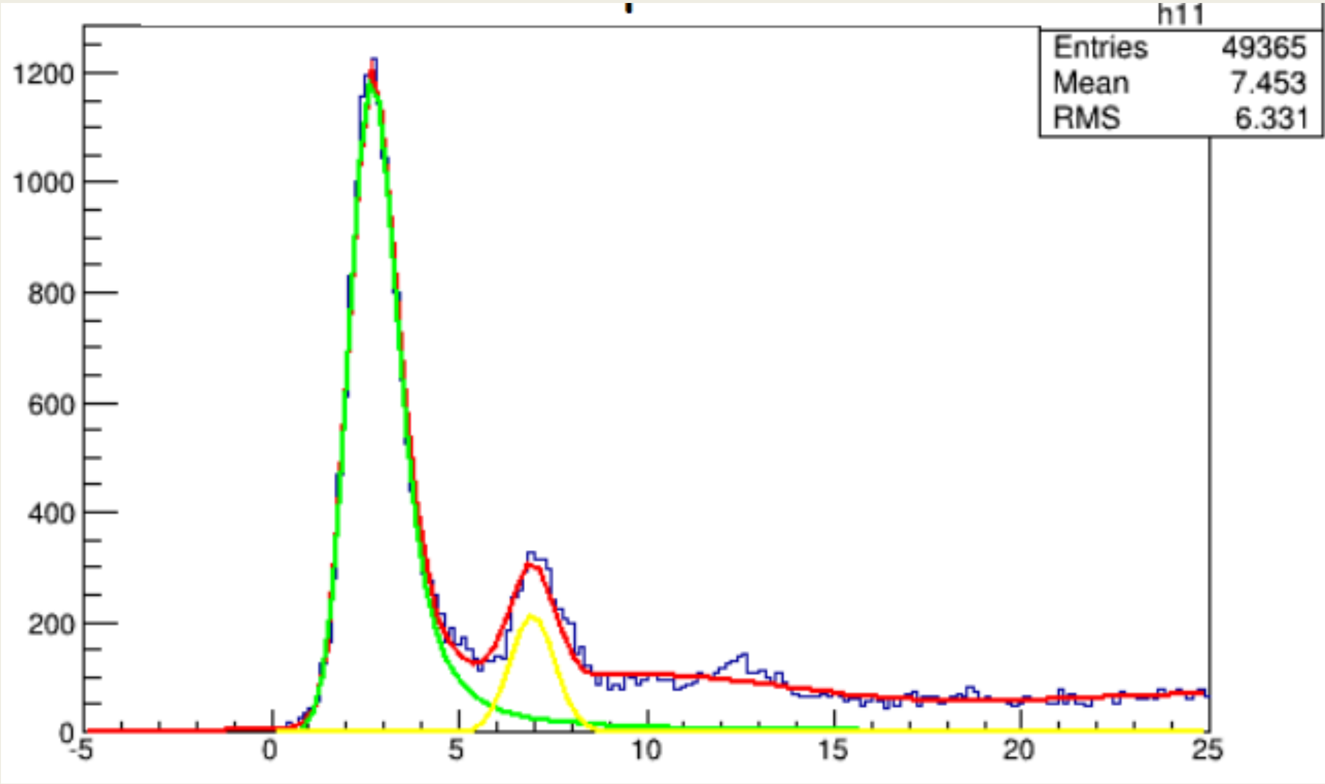


Figure 4: Perpendicular data and MC yields for C disk targets (top) and data/MC ratio, low HMS p.

Plot from "The packing fraction and dilution factor in RSS" by Oscar Rondon [1]

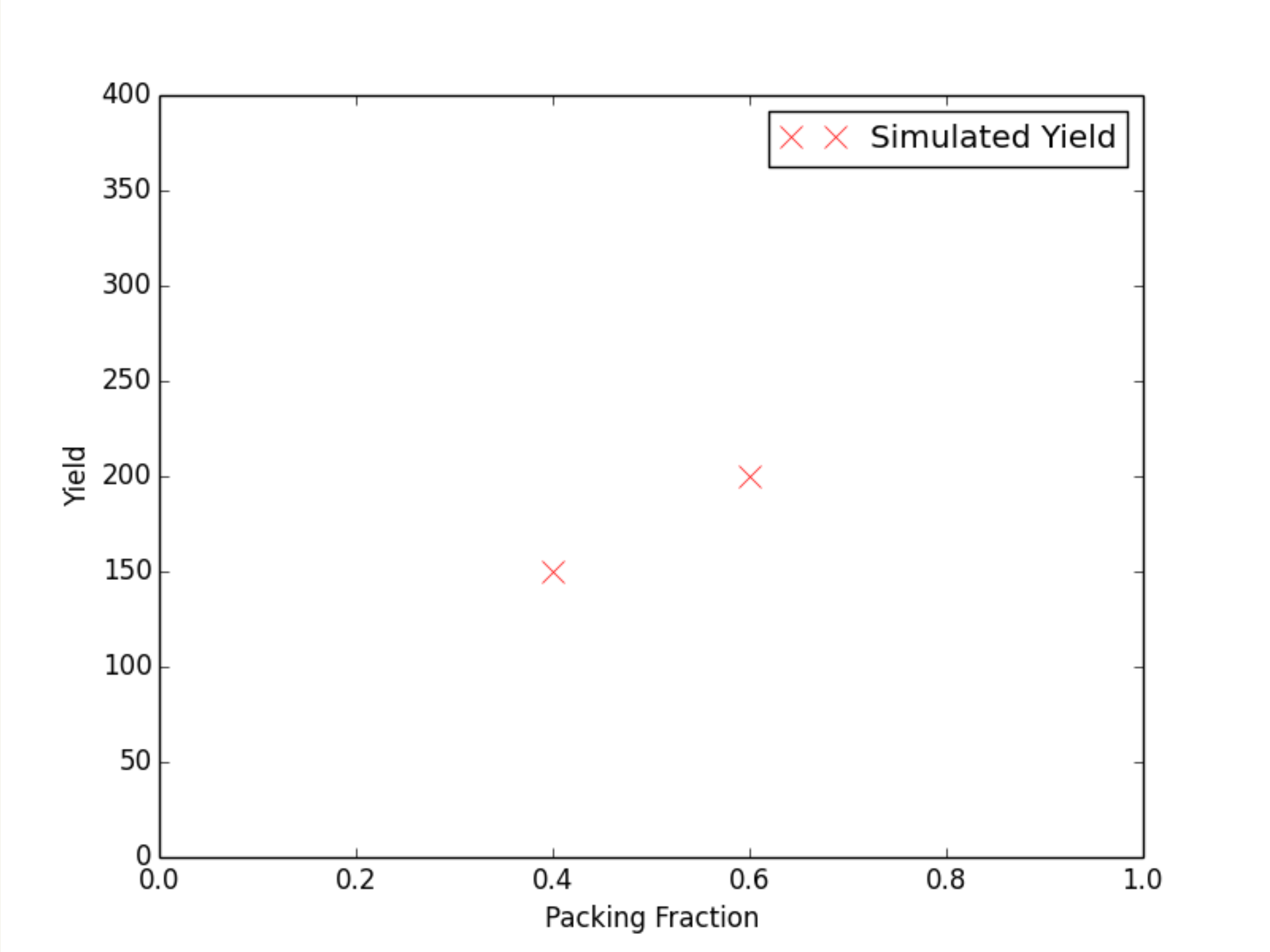
g2p data is more elastic than RSS, so fit region may need to be different

- RSS region: 1.5 GeV < W < 1.8 GeV
- Best region for g2p:
  - Inelastic data? (W> 1.5 GeV)
  - Super-elastic region of nitrogen peak? (ν < ~ 2 MeV)
  - Somewhere else?
- Nonzero slope in ratio indicates model is under/over-radiated in that region



Plot from ”Status Update” by Chao Gu [2], circa 2017

Next step is to generate simulated yield at two different packing fractions for each material/setting

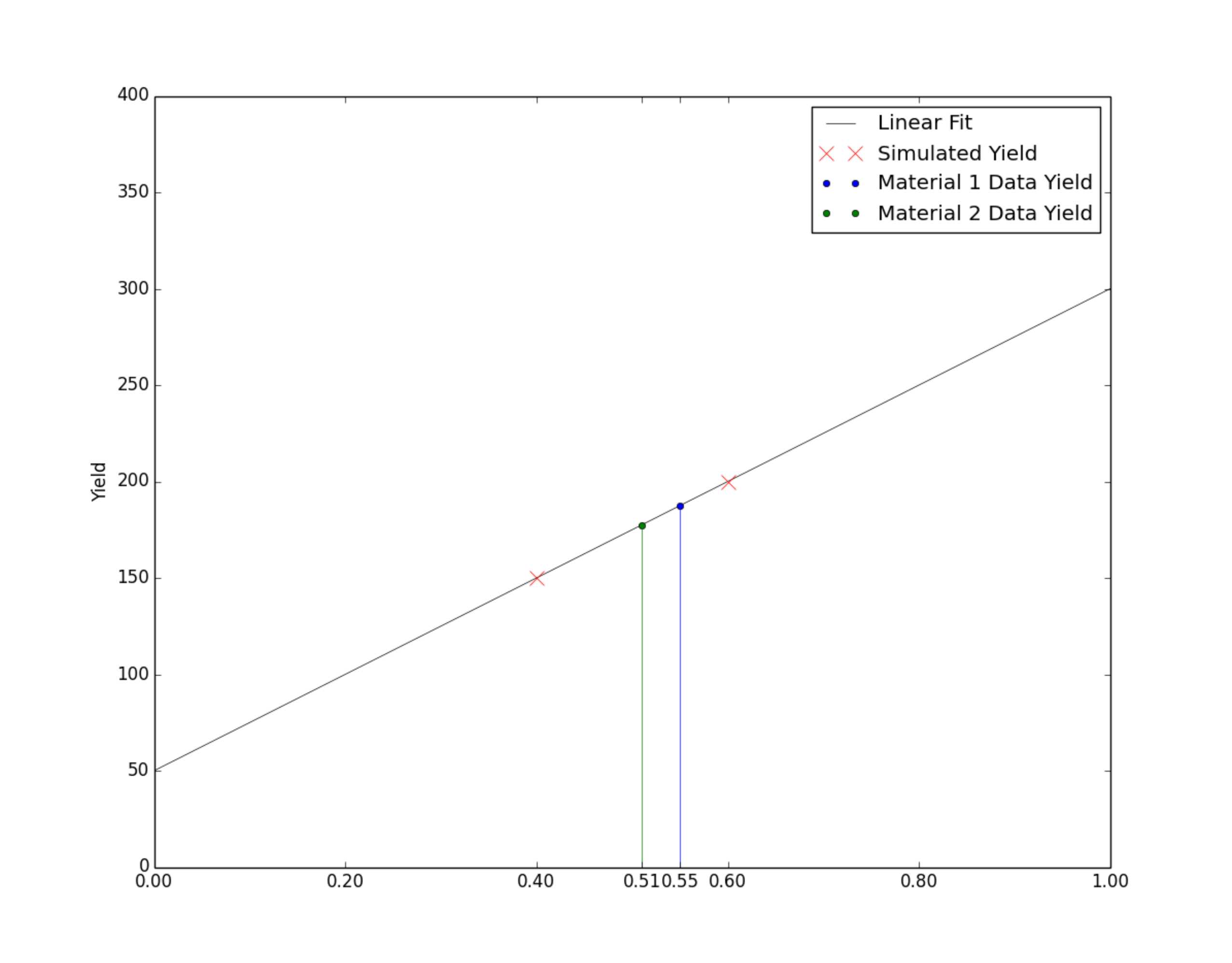


- Scale simulated yields by scaling factor s
- Integrate scaled simulation over region of choice

Next step is to generate simulated yield at two different packing fractions for each material/setting

- Simple linear fit to both points to interpolate for any packing fraction
- Integrate a clean yield for each material/energy setting over the region chosen
- Use the slope and intercept from the fit to the simulation to determine the packing fraction

$$pf = \frac{Y_T - b}{m}$$

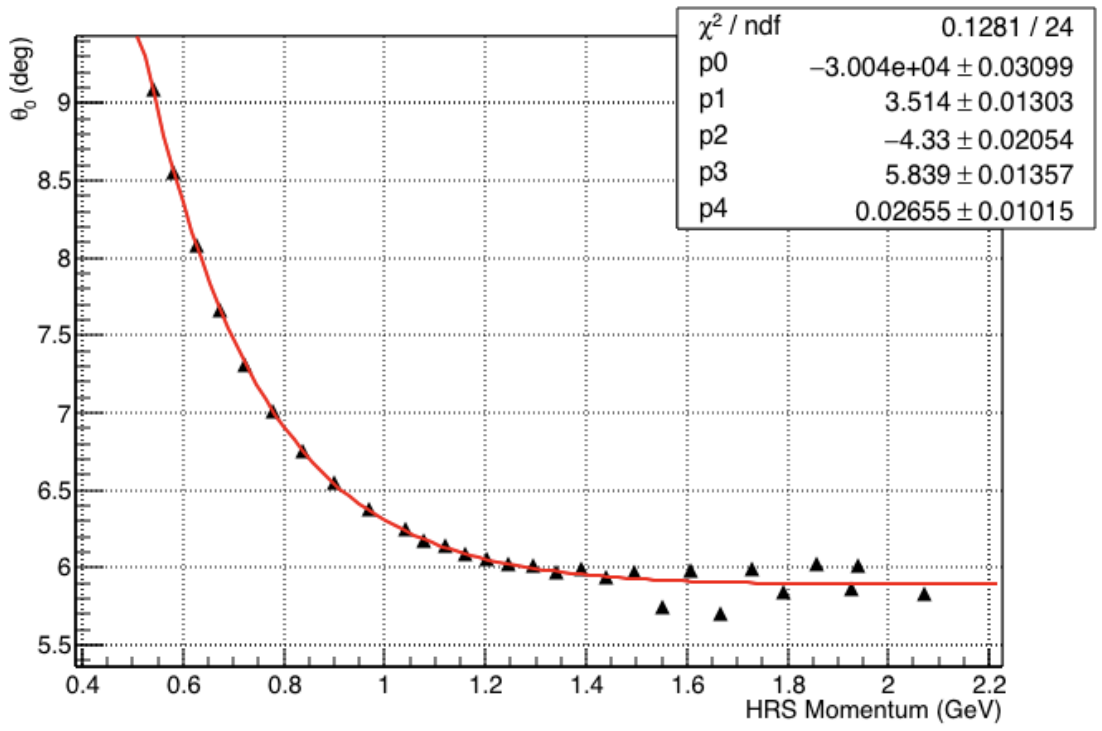


Error is determined by flatness of scale factor and how good simulation agrees with data

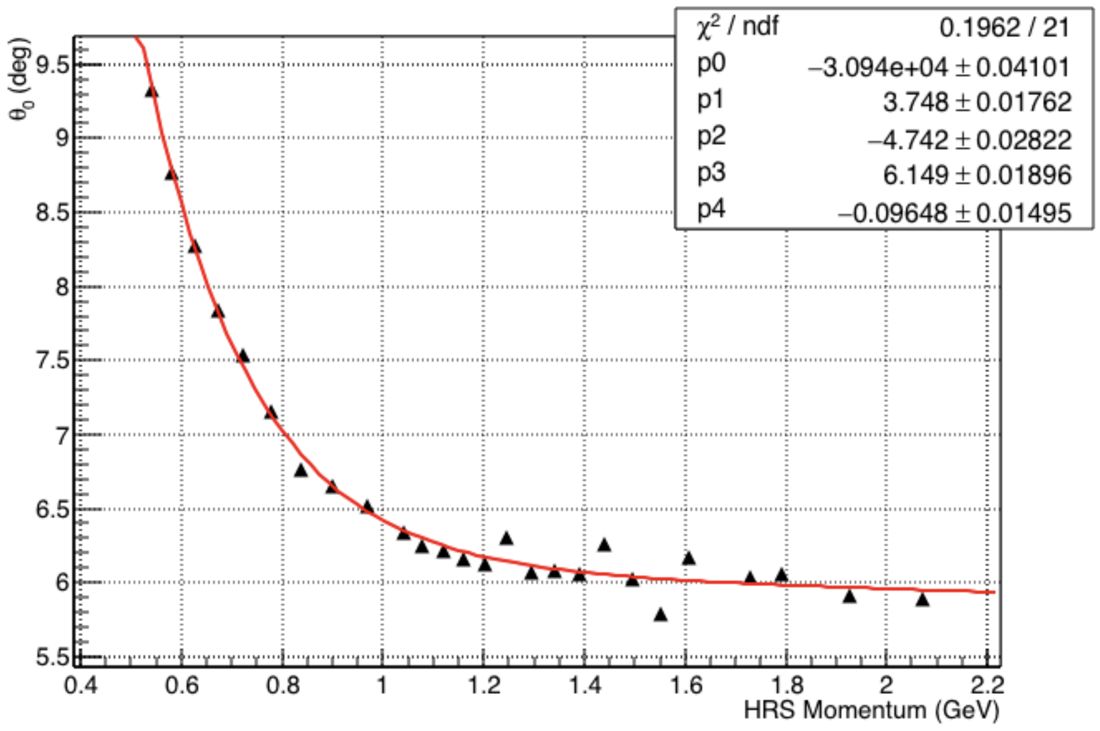
- Can solve equation for pf to obtain statistical uncertainty:

$$\Delta pf = -\frac{Y_T \Delta s}{m_{unscaled} s}$$

2.5T 2.2GeV Scattering Angle Fits

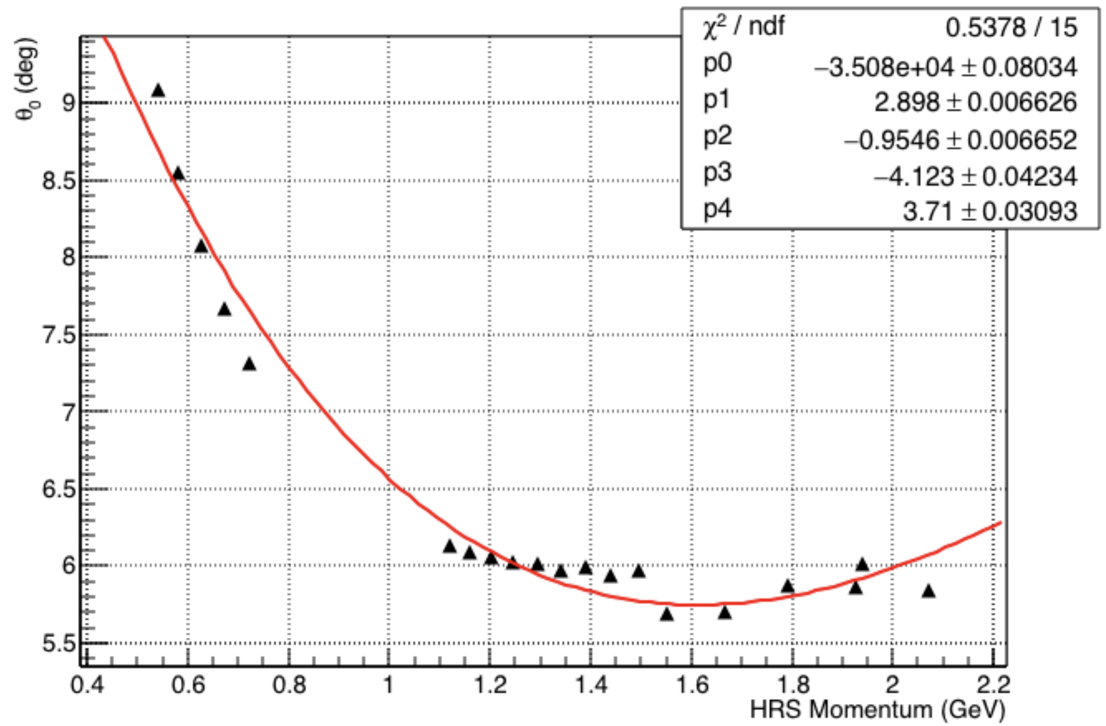


All Production Data

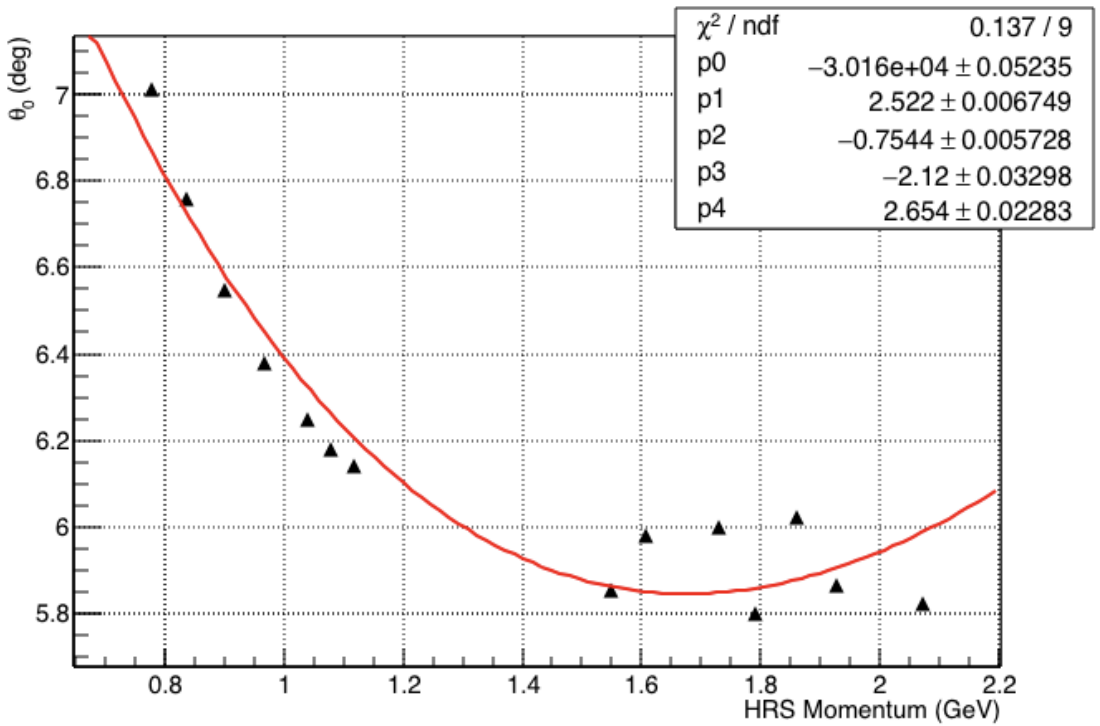


All Carbon Data

2.5T 2.2GeV Scattering Angle Fits



Material 7 Data



All Carbon Data

Ryan Questions

- 1. What is the plan for cross sections? I'm highly skeptical of any plan that involves g2p data cross sections for all of our kinematic settings, given the publication timeline (by the end of the year). Although, I suppose I can always be convinced. If our data isn't good enough to include the final results (i.e. discontinuities), is it still good enough to be a check on the systematic error of the Bosted model? See my thesis for comparison to existing low Q2 data. Not bad agreement at our Q2 settings (as low as 2.5 T 2.2 GeV/ 5 T 2.2 GeV long). Probably can push this uncertainty to 10%. Maybe better?

- 2. What is the plan for the hyperfine paper? Are we going to include ChiPT calculations or other theorists (Carl Carlson). For Delta2 we still need to figure out the low Q2 contribution. Most likely requires theorist here. High Q2 contribution is heavily suppressed by kinematic weighting but can also use existing data to to help with this (SANE? RSS, SLAC).

- 3. What is going to be published first? Moments, hyperfine?

References

- Rondon, Oscar, “The packing fraction and dilution factor in RSS”, RSS T.N. # 2005-03, January 26, 2006
- Gu, Chao, “Status Update”, g2p Analysis Presentation, March 17, 2017