Chi2 Minimization on H(e,e'p) e- singles Data

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#These H(e,e'p) SHMS e- singles data Uses the measured SHMS angles and momenta
#The HMS kinematics are calculated based on the SHMS kinematics required for elastics (The HMS is to set in SIMC)
#THe relative errors dEb/Eb, dEf,Ef are in %, while dth_e is in mr
#! kg[i,0]/ Run[i,1]/ particle[s,2]/ shms_P[f,3]/ shms_Angle[f,4]/ hms_P[f,5]/ hms_Angle[f,6]/ beam_e[f,7]/ data_W_mean[f,8]/ simc_W_mean[f,9]/ dEb_Eb[f,10]/ dEf_Ef[f,11]/ dth_e[f,12]/
-1          6621      e              3.007        21.13          1.4942      46.5132         3.8334       0.934978          0.942201 -0.0024020618556700886 0.0018842281003808516 1.6309524618686255
-1          6625      e              2.834        23.999         1.69665     42.7728         3.8334       0.934811          0.94242  -0.0026848976711362567 0.0019849220013565374 1.615757130035126
-1          6626      e              2.713        25.995         1.83319     40.4272         3.8334       0.935266          0.942802 -0.0027777368227054717 0.0019658788542807806 1.5512131082594014
-1          6629      e              2.583        28.19          1.97836     38.0652         3.8334       0.935866          0.942802 -0.0026852497096399672 0.0018093598372202315 1.391304594088231
-1          6632      e              2.478        29.999         2.09361     36.2739         3.8334       0.936599          0.943033 -0.0025964487489911555 0.0016784055929462312 1.2710642295404402
-1          6869      e              4.642        8.86           0.794142    64.1445         4.9309       0.92458           0.941402 -0.003623869021973288  0.003411547587661482  4.4770936543547615
-1          6873      e              4.436        11.86          1.08662     56.9869         4.9309       0.925             0.941418 -0.0037010820559062233 0.003329615283214019  3.4266918825998154
-1          6876      e              4.184        15.0           1.40218     50.5277         4.9309       0.925282          0.941976 -0.003989961759082209  0.003385588837737524  2.933425507050407
-1          7848      e              3.939        24.001         3.04592     31.7638         6.1909       0.936691          0.944464 -0.001973343488194951  0.001255552504482371  0.7352708183977409
-1          7853      e              3.709        26.001         3.28588     29.685          6.1909       0.936173          0.944271 -0.0021833378269075104 0.001308048910497659  0.7548113189822355
-1          7856      e              3.491        28.001         3.51306     27.8269         6.1909       0.937465          0.944504 -0.0020163276997994806 0.0011369913905894115 0.6508974008197914
-1          7860      e              3.284        30.001         3.72692     26.1584         6.1909       0.939585          0.94501  -0.0016519488428745294 0.0008762861619473671 0.5007124943240353
-1          7962      e              5.745        17.999         3.26718     32.9301         8.20883      0.918719          0.944432 -0.00447571801566581   0.0031323586917989628 1.6555838311748758
-1          7964      e              5.372        19.995         3.65404     30.1945         8.20883      0.921071          0.944539 -0.004368577810871177  0.002858872701712663 4 1.4602930797472722
-1          7966      e              5.013        21.999         4.02463     27.822          8.20883      0.922719          0.944809 -0.004406542988230607  0.0026910046864169475 1.3445868202964617
-1          7970      e              4.352        25.999         4.70041     23.9567         8.20883      0.923444          0.945853 -0.005149126838235292  0.002729865279217622  1.3426247980013355
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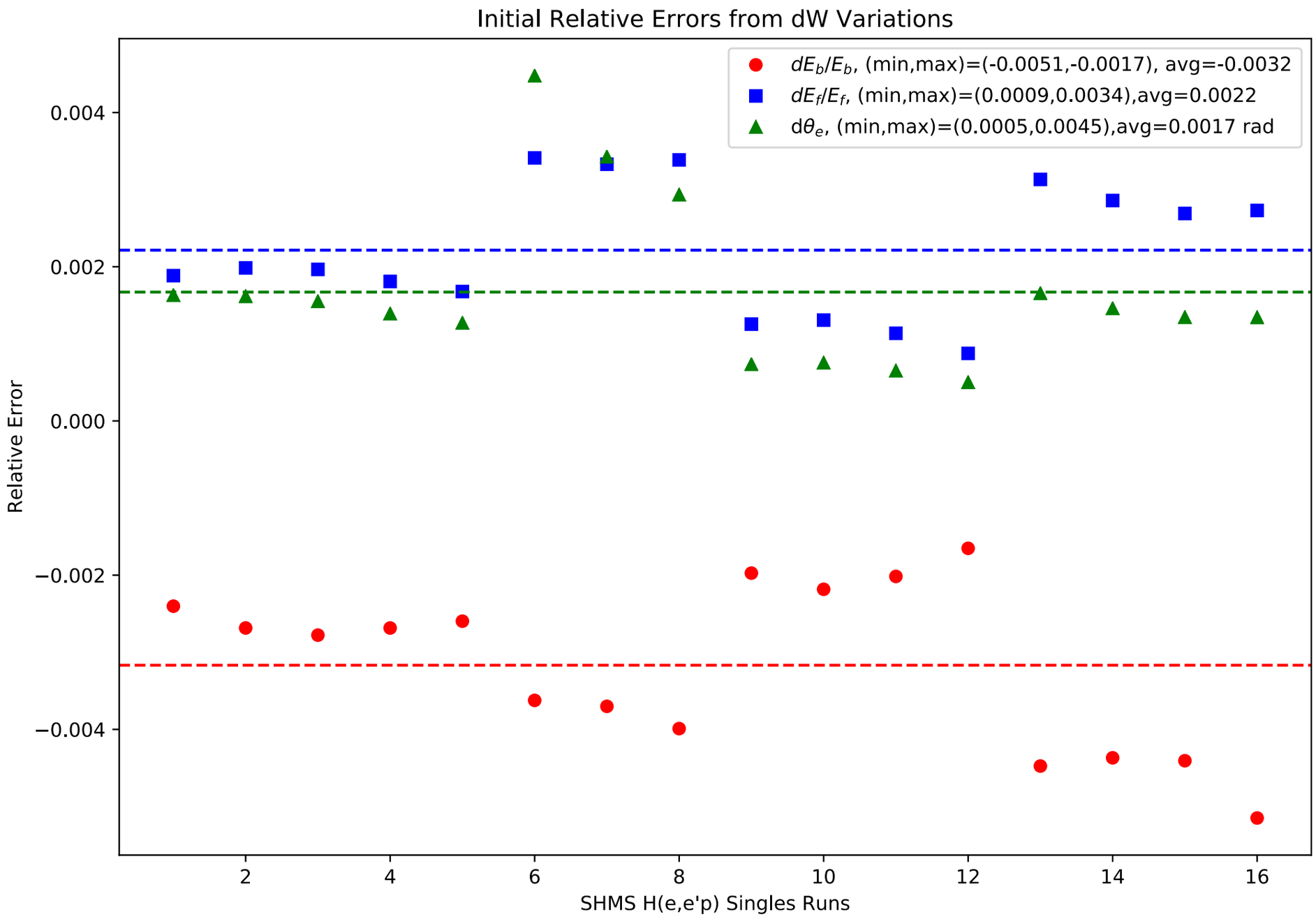
$$\chi 2 = \frac{\sum_i [dW_{obs} - dW_{pred}(p1, p2, p3; E_b, E', \theta_e)]^2}{\sum_i \sigma_i^2}$$

$$dW_{obs} = W_{data} - W_{simc}$$

$$dW_{pred} = \frac{\partial W}{\partial E_b} E_b p1 + \frac{\partial W}{\partial E'} E' p2 + \frac{\partial W}{\partial \theta_e} p3$$

$$p1 = \frac{dE_b}{E_b}, p2 = \frac{dE'}{E'}, p3 = d\theta_e \qquad \sigma_i = \frac{E_b \cdot 8 \times 10^{-4}}{E'}$$



Initial Assumption: The observed variation in W is entirely due to either beam energy, e-momentum or e- angle. The relative uncertainties were determined under this assumption, using the W formula.

Initial Parameters for Minimization:

p1 = -0.0032
p2 = 0.0022
p3 = 0.0017 [rad]

Minimization Input Range:

p1_range: (-0.0032, 0.0032), step=0.00005
p2_range: (-0.0022, 0.0022), step=0.00005
p3: (-0.0017, 0.0017), step=0.00005

Minimum Chi2 Results:
p1 = -0.0032 —> dEb/Eb = -3.2 x 1e-3
p2 = -0.0003 —> dE'/E' = -3.0 x 1e-4
p3=0.0003 —> dth_e = 0.3 mr

Minimum reduced Chi2 = 12.4512

dW Variations [MeV]

dW [MeV]

−10
−20
−30
−40
−50
−60

2
4
6
8
10
12
14
16

SHMS H(e,e'p) Singles Runs

dW predicted (initial)
dW predicted (χ^2 Min.)
dW observed (DATA-SIMC)

Residuals from dW Variations

Calculated using minimum chi2 parameters

Calculated using initial averaged parameters

$dW_{pred} - dW_{obs}$ [MeV]

0
−10
−20
−30
−40

Initial Residuals (avg=-24.52)

1st χ^2 Min. Residuals (avg=0.08)

2
4
6
8
10
12
14
16

SUMS U(e,e'p) Singles Runs

SUMMARY

* **Beam Energy Uncertainty dEb/Eb is order 1e-3 (TOO LARGE)**

QUESTIONS:

1) Do we take the parameters p1, p2, p3 as our definitive relative error To determine the systematics?

2) Would it be better to use these minimized parameters to
- **-> correct for DATA**
- **-> replay it again with the improved W and compare to SIMC**
- **-> Hopefully get smaller dW variations and do 2nd Iteration of Chi2 Minimization**