Diffractive EM Jet A_N at FMS with run 15 data updates and preliminary request

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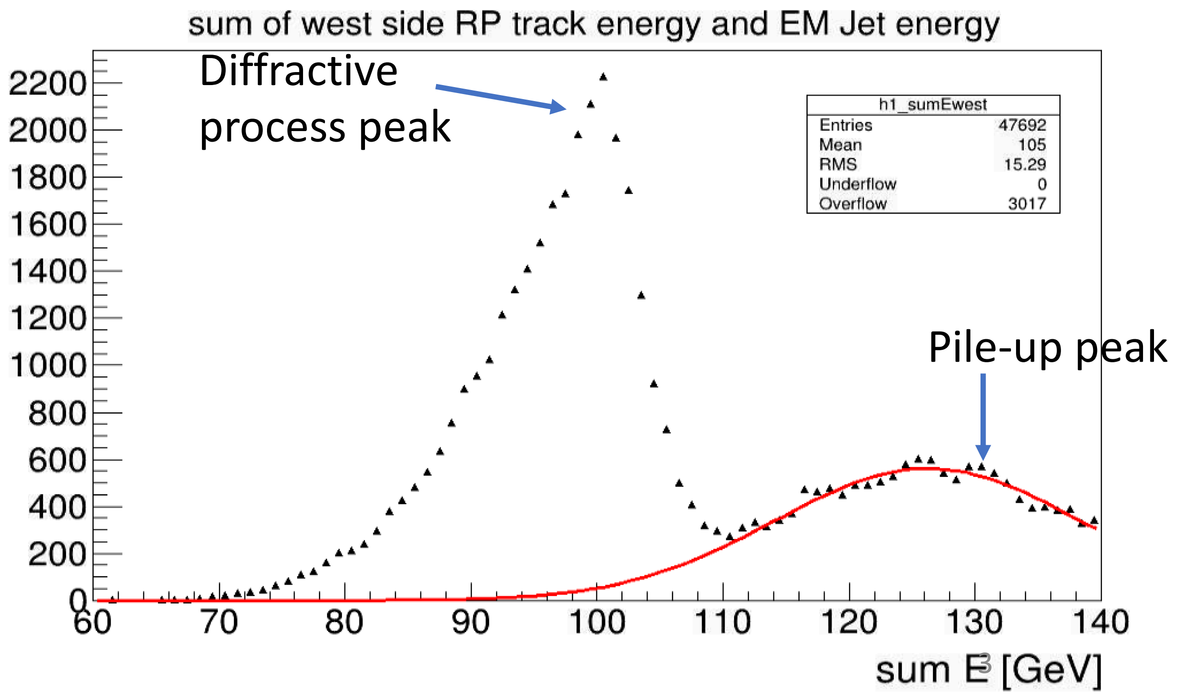
Outline

- Energy and background effect correction
- Systematic uncertainty study
- A_N vs E sum
- Preliminary request

Fraction of pile-up events in signal region

- Apply Gaussian fit for the pile-up peak with range [112, 140] GeV and record the fit results.
- Use the fit results to extend the Gaussian function, which assumes to be the residual background effect from the pile-up.
- Integrate the Gaussian function in [60, 108] GeV, which can be assumed to be the background contribution. (for sum E < 108 GeV cut, for example)
  - Background: 1263
  - Sum of the signal jets from [60, 108]: 30556
  - Fraction: $f = \frac{1263}{30556} = 4.13\%$



Consider residual background into A_N

- If we consider the residual background, we can based on the formula below to calculate the real A_N.
  - $A_N^{raw\ sig} = (1 - f_{bkg}) * A_N^{sig} + f_{bkg} * A_N^{bkg}$, where $A_N^{raw\ sig}$ is the signal A_N without residual background correction and A_N^{bkg} is the background A_N and A_N^{sig} is the signal A_N with correction.
  - $A_N^{sig} = \frac{A_N^{raw\ sig} - f_{bkg} A_N^{bkg}}{1 - f_{bkg}}$
  - For energy sum cut on 108 GeV, signal region is $E_{sum} < 108$ GeV and background region is $E_{sum} > 108$ GeV , f_{bkg} is 4.13%.

x_F	A_N^{bkg}	$A_N^{raw\ sig}$	A_N^{sig}
0.125	-0.095837	-0.0199271	-0.0166537
0.175	-0.018288	-0.0513098	-0.0527394
0.225	0.01129	-0.0252992	-0.026877
0.275	-0.116826	-0.0377742	-0.0343637

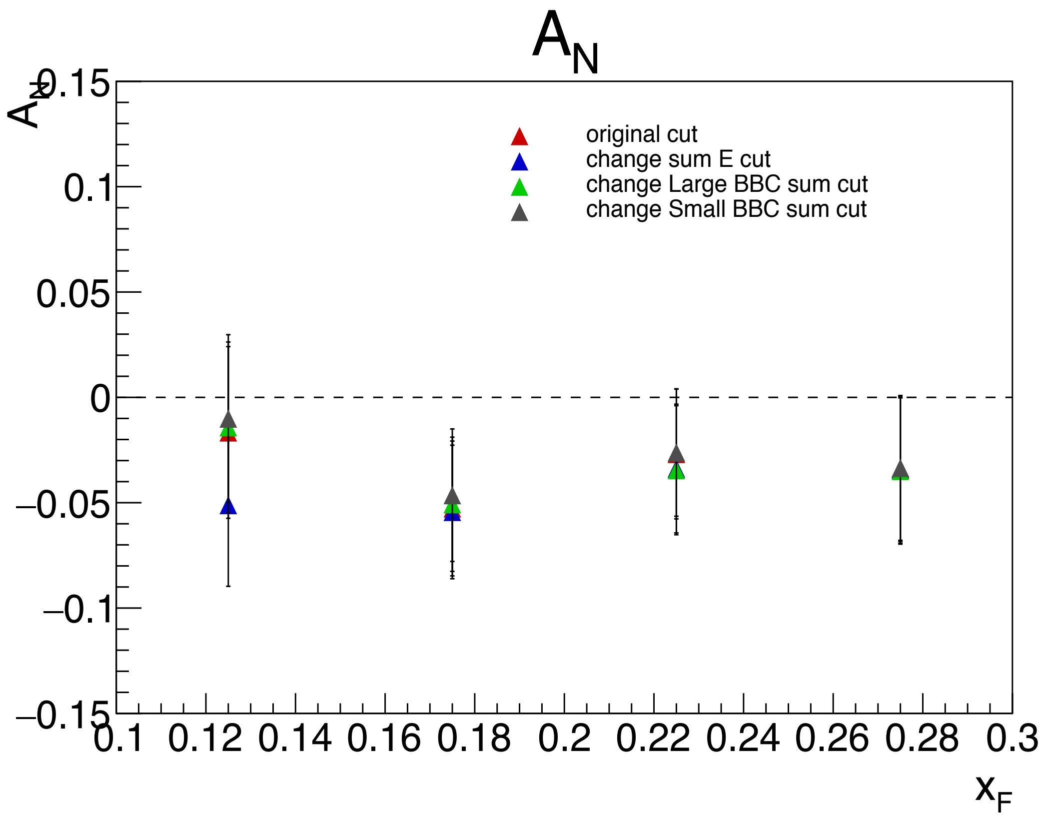
Statistics Error propagation

- Based on $A_N^{sig} = \frac{A_N^{raw\ sig} - f_{bkg} A_N^{bkg}}{1 - f_{bkg}}$,
- The uncertainty for signal is $dA_N^{sig} = \frac{\sqrt{(dA_N^{raw\ sig})^2 + (f_{bkg} * dA_N^{bkg})^2}}{1 - f_{bkg}}$, where $\mathrm{d}A_N^{raw\ sig}$ is the signal A_N uncertainty without residual background correction and dA_N^{bkg} is the background A_N uncertainty and dA_N^{sig} is the signal A_N uncertainty with correction.
- For energy sum cut on 108 GeV, signal region is $E_{sum} < 108$ GeV and background region is $E_{sum} > 108$ GeV , f_{bkg} is 4.13%.

E sum<108	dA_N^{bkg}	$\mathrm{d}A_N^{raw\ sig}$	dA_N^{sig}
0.125	0.0848436	0.038896	0.040738
0.175	0.055936	0.0305909	0.0320012
0.225	0.0466397	0.0294627	0.030799
0.275	0.0421817	0.0333672	0.0348537

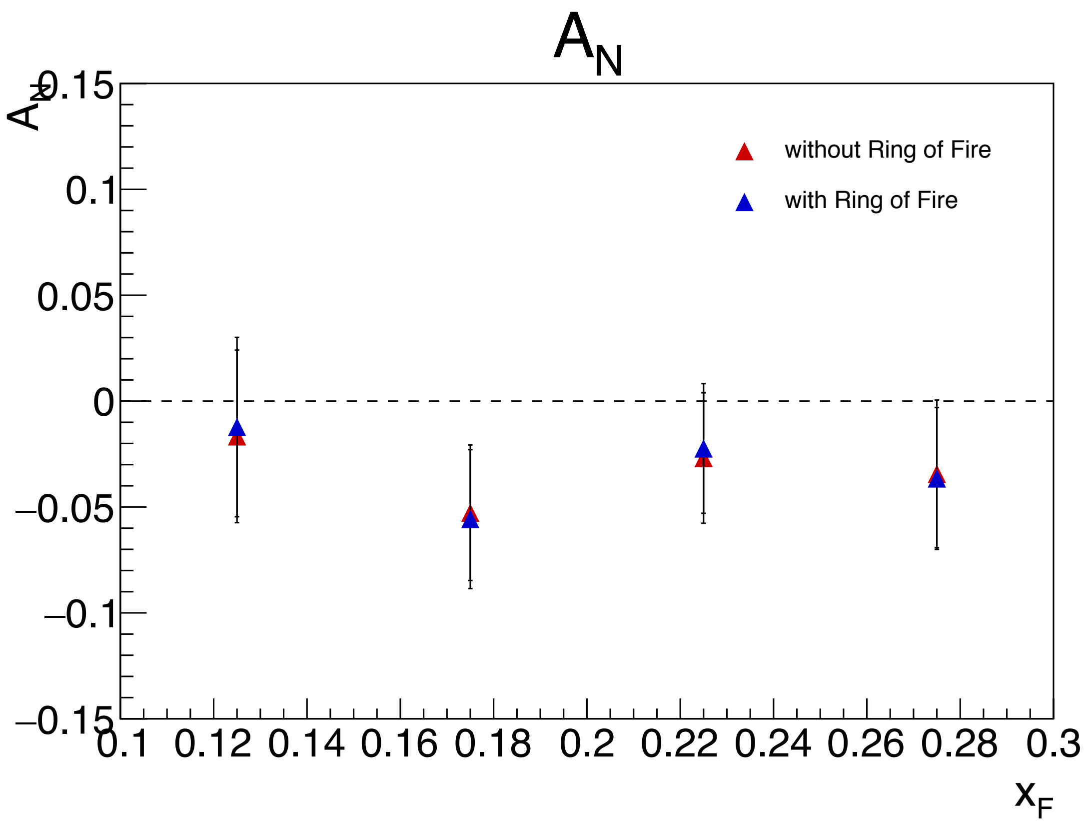
Systematic uncertainty (residual background effect)

- Systematic uncertainties for residual background effect mainly come from the cut for selecting signal from background.
  - Energy sum cut: change 108 GeV to 114 GeV to check the uncertainty.
  - Small BBC ADC sum cut: change 100 to 105
  - Large BBC ADC sum cut: change 60 to 65



Systematic uncertainty (Ring of fire)

- Ring of fire
  - Trigger: fms-sm-bs3
- Compare by with and without such trigger.



Summary for correction

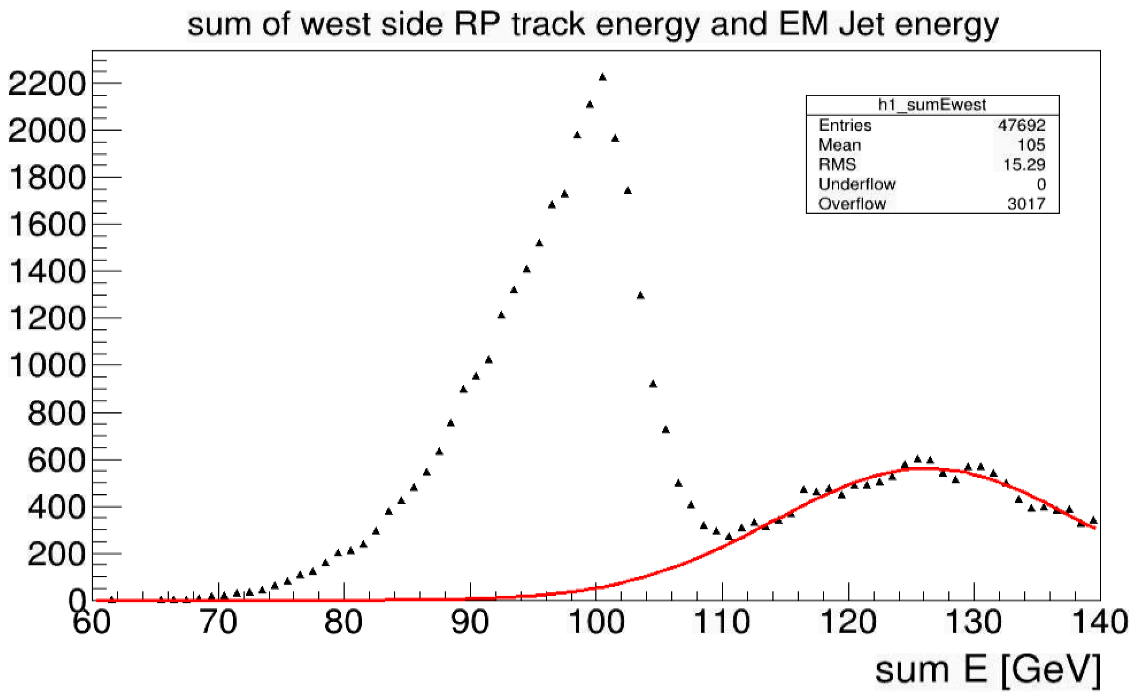
- Energy correction: detector level jet to particle level jet correction
  - Detector level jet ([5,10] GeV) use 6th order polynomial
  - Detector level jet ([10,65] GeV) use linear function
- Background (dilution) effect correction
  - Based on the background A_N from E_{sum} cut > 108 GeV, apply correction based on such background effect to the signal A_N.

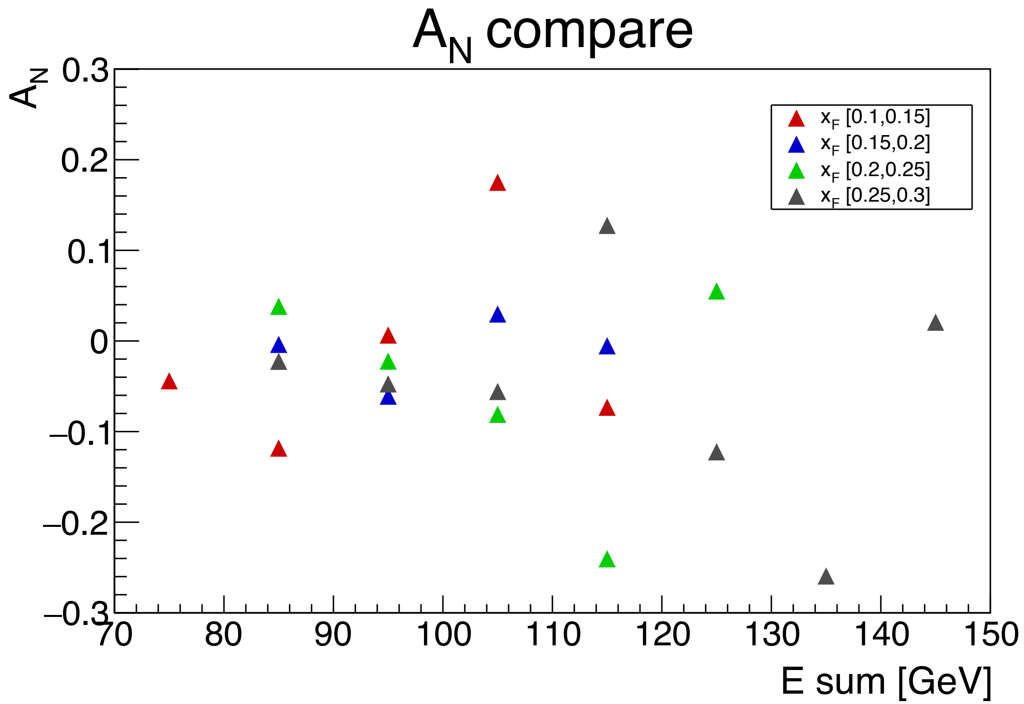
Summary for systematic uncertainty

- Analyze separately by different x_F bins.
- Energy uncertainty is accounted into x-axis (x_F, not shown in the preliminary plot)
- Systematic uncertainty terms accounted to Y-axis (A_N, shown in the preliminary plot)
  - Energy sum cut
  - Small BBC ADC sum cut
  - Large BBC ADC sum cut
  - Dilution effect (background correction)
  - Ring of Fire
- Polarization uncertainty (3.0%) seems reasonable.

A_N vs E sum ranges

- Plot A_N as a function of west side RP track and EM jet sum energy.
- Energy range: [70, 80] , [80, 90], … , [140, 150] GeV (10 GeV range per bin, use the mid energy point for each range to show in x-axis.
- Some of the A_N are far too away from 0 so they can't show in the plot.



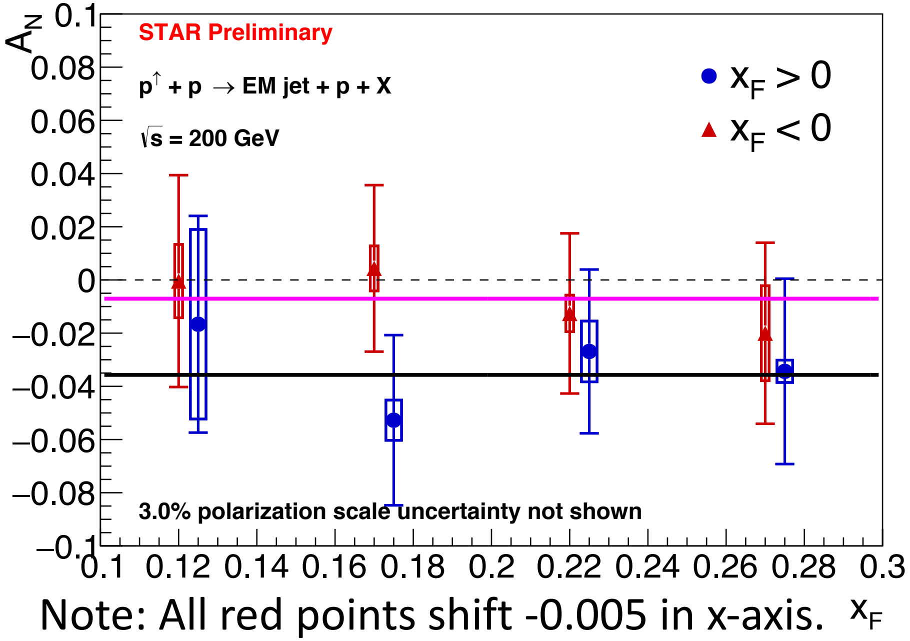


Preliminary request plot

- Diffractive EM jet A_N for run 15 FMS data.
- Statistics error and systematic error (in box) uncertainty are included for polarized and unpolarized beam A_N.
- Blue beam A_N is indicated to be non-zero (blue points), but with negative value. A constant fit (black line) is applied for blue beam A_N to indicate the negative value (-0.0357) for A_N .
- Yellow beam A_N is close to 0 (red points). Pink line is a constant fit for Yellow beam A_N .

Blue beam A_{N} with constant fit:-0.0356968+/-0.0182435
value/error ratio:1.95669

Yellow beam A_{N} with constant fit:-0.0070561+/-0.0175694
value/error ratio:0.401613



Note: All red points shift -0.005 in x-axis.

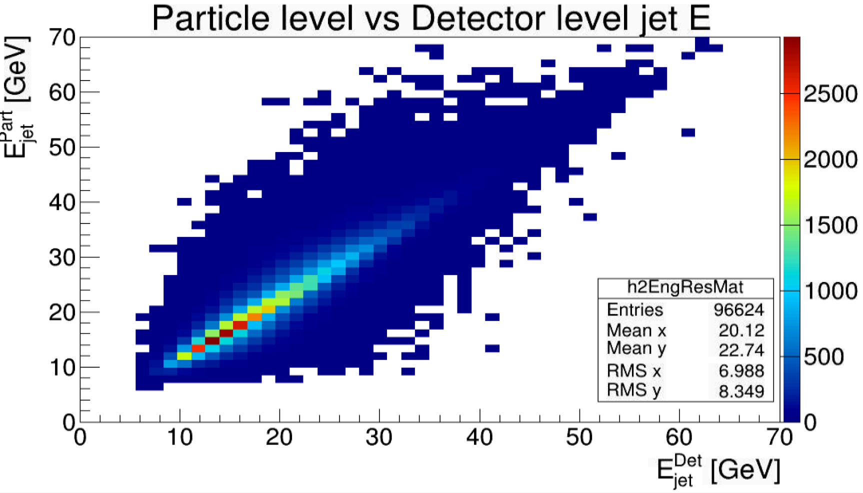
Preliminary request page

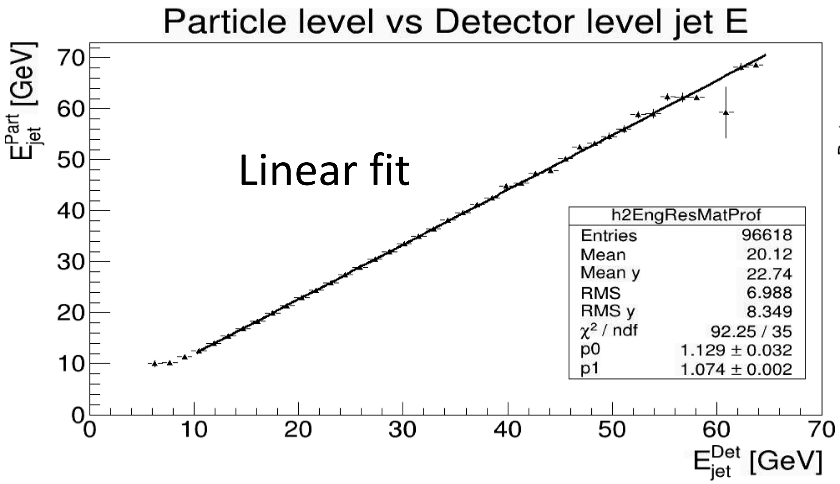
- Drupal page for preliminary request: https://drupal.star.bnl.gov/STAR/blog/liangxl/Run-15-diffractive-EM-jet-preliminary-request-0
  - Will update once preliminary request approved!

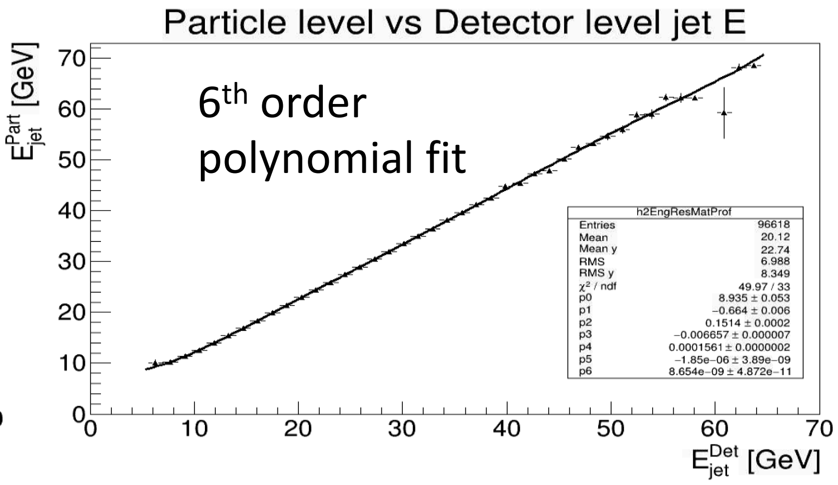
Back up

Apply energy correction from simulation

- Detector level to particle level EM jet energy correlation from simulation.
  - Use 6th order polynomial to fit range [5,65] GeV, but apply [5, 10] GeV into correction.
  - Use linear fit for range [10, 65] GeV, but apply [10, 65] GeV into correction

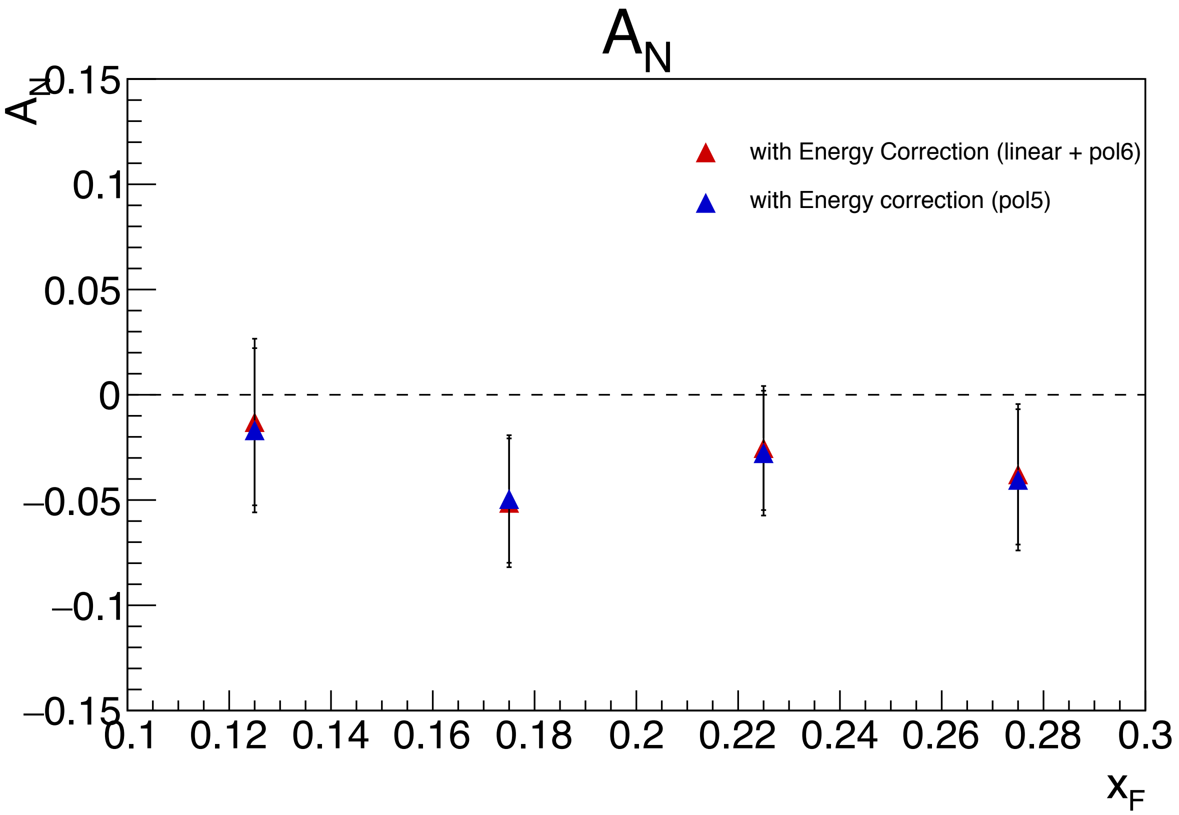






Energy correction uncertainty study

- Change energy correction function to 5^{th} order polynomial for systematic uncertainty study for this time.



EM jet energy uncertainty

- $\sigma_E = C \oplus R \oplus E$
  - C: Calibration uncertainty (2.5%)[1]
  - R: Radiation damage and non-linear response uncertainty (0.5%)[1]
  - E: Energy resolution and correction uncertainty (separate by different x_F bins)

After Energy correction x_F range	EM jet Energy uncertainty (%)	x_F uncertainty
0.1- 0.15	15.64%	0.0196
0.15 - 0.2	4.34%	0.0076
0.2- 0.25	9.89%	0.0223
0.25 - 0.3	7.41%	0.0204

[1] Z. Zhu , Measurement of Transverse Single Spin Asymmetry for pi0 at Forward Direction in 200 and 500 GeV Polarized Proton-Proton Collisions at RHIC-STAR

Polarization uncertainty

- $\sigma(P_{set}) = P_{set} \cdot \frac{\sigma(scale)}{P} \oplus \sigma_{set}(fill\ to\ fill) \oplus P_{set} \cdot \frac{\sigma(profile)}{P}$
- $\frac{\sigma(scale)}{P} = 3\%$ [1]
- $\frac{\sigma(profile)}{P} = \frac{2.2\%}{\sqrt{M}} = 0.3\ \%$ [1]
- $\sigma^2{}_{set}(fill\ to\ fill) = (1 - \frac{M}{N}) \frac{\sum_{fill} L_{fill}{}^2 \sigma^2(P_{fill})}{(\sum_{fill} L_{fill})^2}$
  - $\sigma_{set}(fill\ to\ fill)$ = 0.3%
  - $\sigma(P_{fill}) = \sigma(P_0) \oplus \sigma(\frac{dP}{dt})(\frac{\sum_{run} t_{run} L_{run}}{L_{fill}} - t_0) \oplus \frac{\sigma(fill\ to\ fill)}{P} P_{fill}$ [2]

Close to 0

- so $\sigma(P_{set}) = 3.0\%$

[1] W. B. Schmidke, RHIC polarization for Runs 9-17

[2] Z. Chang Example calculation of fill-to-fill polarization uncertainties