Update on EM-Jet A_N in FMS and EEMC

Using Run 15 Dataset

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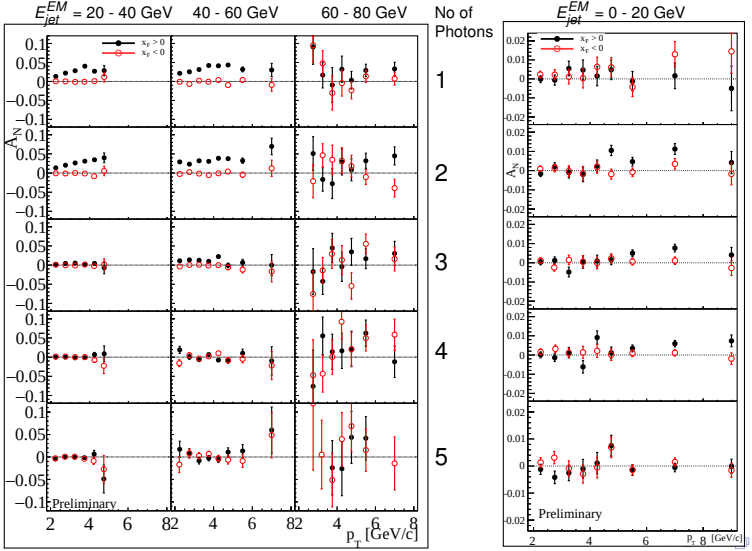
Reminder: FMS and EEMC EM-Jet A_N



EM-jet A_N Corrections and Systematic Uncertainties

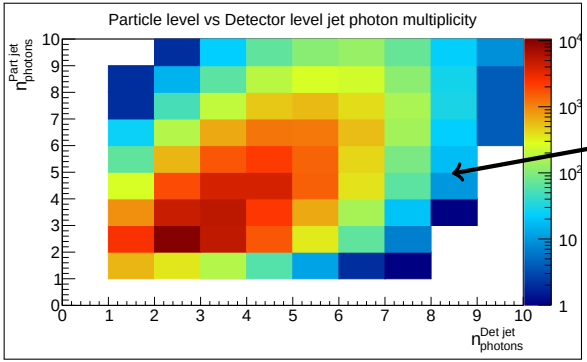
A_N Corrections and Uncertainties:

- Event Misidentification:
  - Misidentification of 1, 2 etc photons as other types (2, 1, etc)
- Background Uncertainty
  - Pile-up, Abort gap, Ring of fire
  - Underlying events
- Polarization Error

Energy or p_T Corrections and Uncertainties:

- Calibration uncertainty
- Energy or p_T correction
- Uncertainty due to radiation damage

Corrections: Unfolding for Event Misidentification



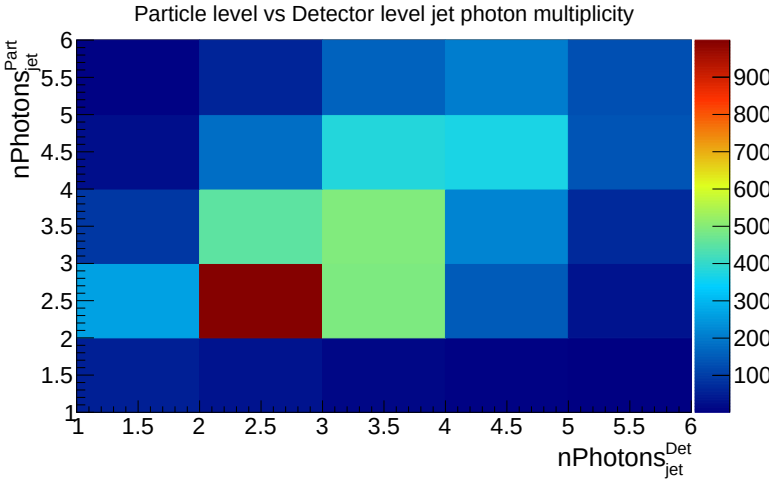
- The leading contributions come from A_N for EM-jets with photon multiplicity n < 6

$$X \xrightarrow{A} e$$

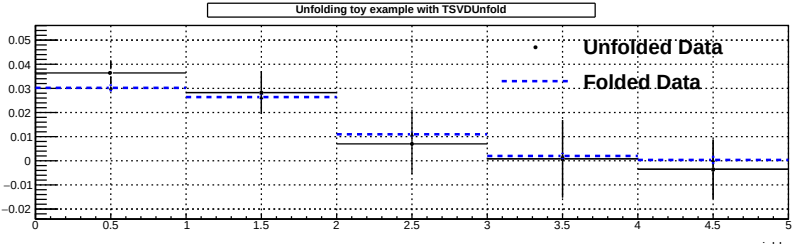
$$\begin{pmatrix} A_N\,(1\text{ph-true}) \\ A_N\,(2\text{ph-true}) \\ A_N\,(3\text{ph-true}) \\ A_N\,(4\text{ph-true}) \\ A_N\,(5\text{ph-true}) \end{pmatrix} = \begin{pmatrix} A_N\,(1\text{ph-data}) \\ A_N\,(2\text{ph-data}) \\ A_N\,(3\text{ph-data}) \\ A_N\,(4\text{ph-data}) \\ A_N\,(5\text{ph-data}) \end{pmatrix}$$

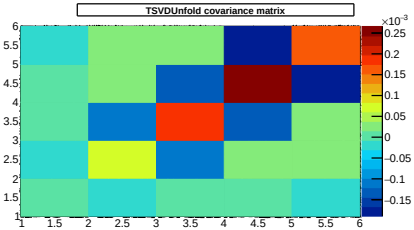
- Solve a set of five linear equations with five variables for each energy and p_T bin
- Decompose A_N as a linear composition of A^i_N corresponding to n_i photons
- Use SVD for the unfolding procedure (e.g. TSVDUnfolding class)

Corrections: Unfolding for Event Misidentification

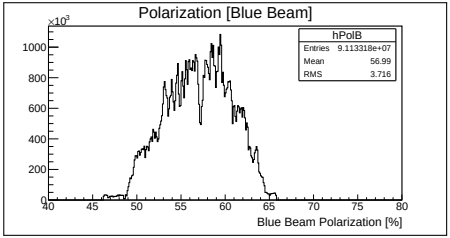


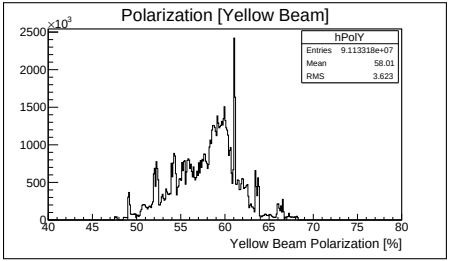
Corrections: Unfolding for Event Misidentification

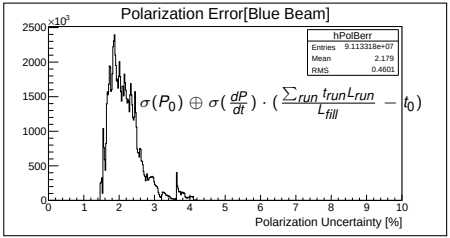


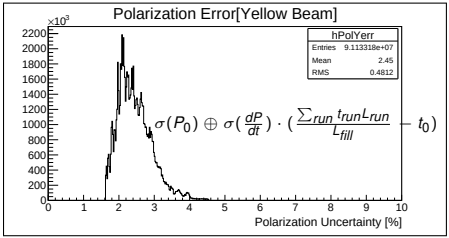


Polarization Uncertainty









Polarization Uncertainty

$$\sigma(P_{set}) = P_{set} \cdot \frac{\sigma(scale)}{P} \oplus \sigma_{set}(fill - to - fill) \oplus P_{set} \cdot \frac{\sigma(profile)}{P}$$

- $\frac{\sigma(scale)}{P} = 3\%$ (For Run 15 pp 200 GeV SSA from Ref. 1)
- $\frac{\sigma(profile)}{P}$ = 2.2 % / $\sqrt{M}$ (From Ref. 1)
- σ_{set} (fill-to-fill) = $\sqrt{1 - \frac{M}{N}} \frac{\sum_{fill} L_{fill} \sigma(P_{fill})}{\sum_{fill} L_{fill}}$
- For Run 15 pp 200 GeV,
  N = 142 (No. of fills in the entire run period from Ref. 1)
  M = 53 (No. of fills used in this analysis)

Ref. 1: RHIC Polarization for Runs 9 - 17 By W.B. Schmidke

Ref. 2: Example Calculation of fill-to-fill polarization By Z. Chang

Polarization Error: Fill-to-fill Polarization Uncertainties

$$\sigma_{set}(fill-to-fill) = \sqrt{1-\frac{M}{N}}\frac{\sum_{fill} L_{fill}\sigma(P_{fill})}{\sum_{fill} L_{fill}}$$

$$\sigma(P_{fill}) = \sigma(P_0) \oplus \sigma(\frac{dP}{dt}) \cdot (\frac{\sum_{run} t_{run} L_{run}}{L_{fill}} - t_0) \oplus \frac{\sigma(fill-to-fill)}{P} \cdot P_{fill} \text{ (from Ref. 2)}$$

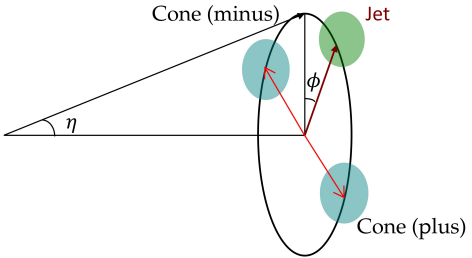
- $\sqrt{1-\frac{M}{N}}$ is the correction for over-counting.
- $\frac{\sigma(fill-to-fill)}{P} = 0$ (For Run 15 pp 200 GeV from Ref 1.)

$$\boxed{\sigma(P_{set}) = 3.46\%}$$

Ref. 1: RHIC Polarization for Runs 9 - 17 By W.B. Schmidke

Ref. 2: Example Calculation of fill-to-fill polarization By Z. Chang

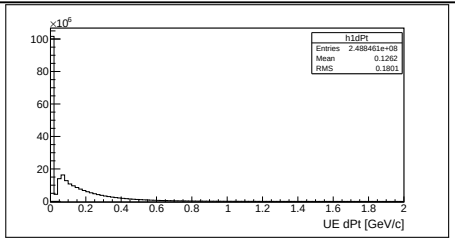
Corrections: Underlying Event (UE)

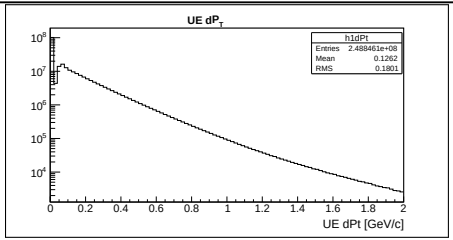


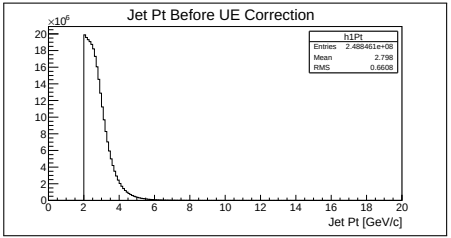
Phys Rev D **91** 112012 (2015), ALICE Collaboration

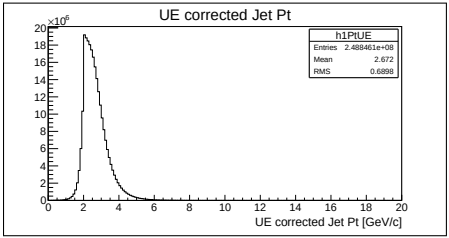
- EM-jet p_T values are corrected for contaminations from underlying events (UE) using off-axis cone method
- Correction to jet Pt, dp_T = Underlying Event Density x Area
- Corrected jet $p_T = p_T - dp_T$

UE Corrections (Data)

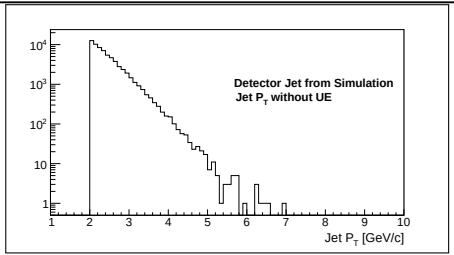


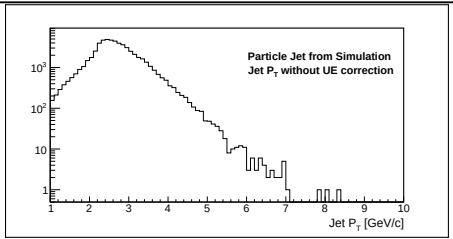


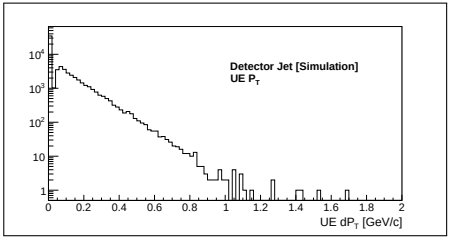


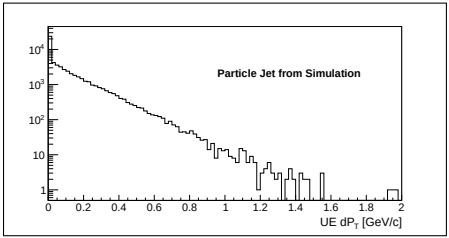


UE Corrections (Simulation)

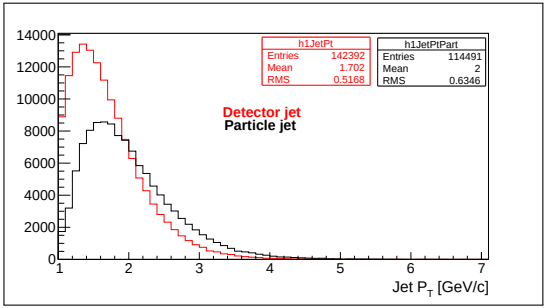


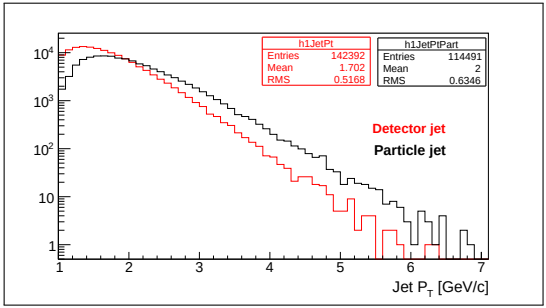




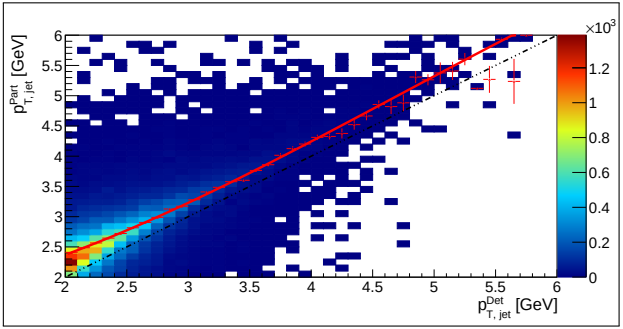


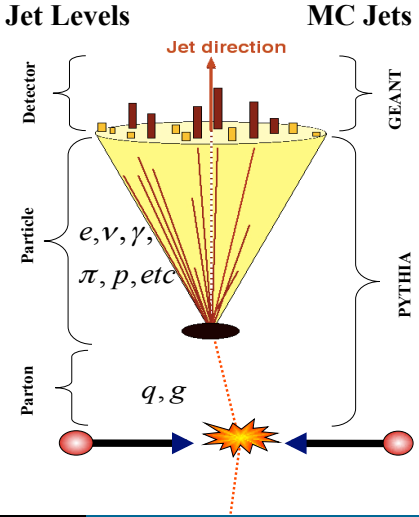
UE Corrections (Simulation)





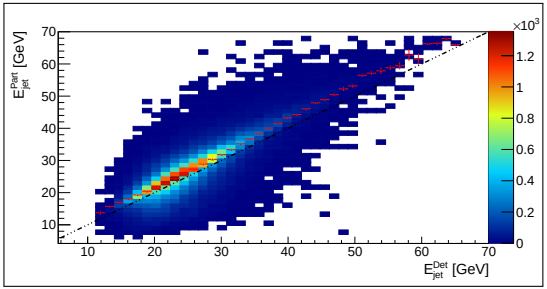
EM-Jet p_T Corrections from Simulation

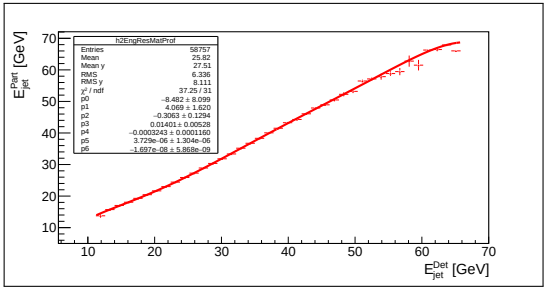




- UE correction is applied for both detector jet and particle jet

EM-Jet E Corrections from Simulation





Energy and p_T Uncertainty

$$\frac{\sigma_{p_T}}{p_T} = C \oplus G \oplus E$$

- C: Calibration uncertainty
- G: Uncertainty from non-linear response and radiation damage
- E: Uncertainty from energy resolution and corrections

$$\boxed{\frac{\sigma_{p_T}}{p_T} \sim 5\%}$$

Ref. 1: Run 11 and 15 $\pi^0 A_N$ Analysis Note By Zhanwen Zhu

Ref. 2: Run 12 and 13 $\pi^0 A_{LL}$ Analysis Note By Christopher Dilks

Summary

- **Corrections:**
  - Event misidentification
  - Underlying event correction
  - Detector to particle level jet p_T or energy corrections
- **Systematic Uncertainty:**
  - Event misidentification
  - Polarization
  - Uncertainty in energy or p_T