Jet Calibration

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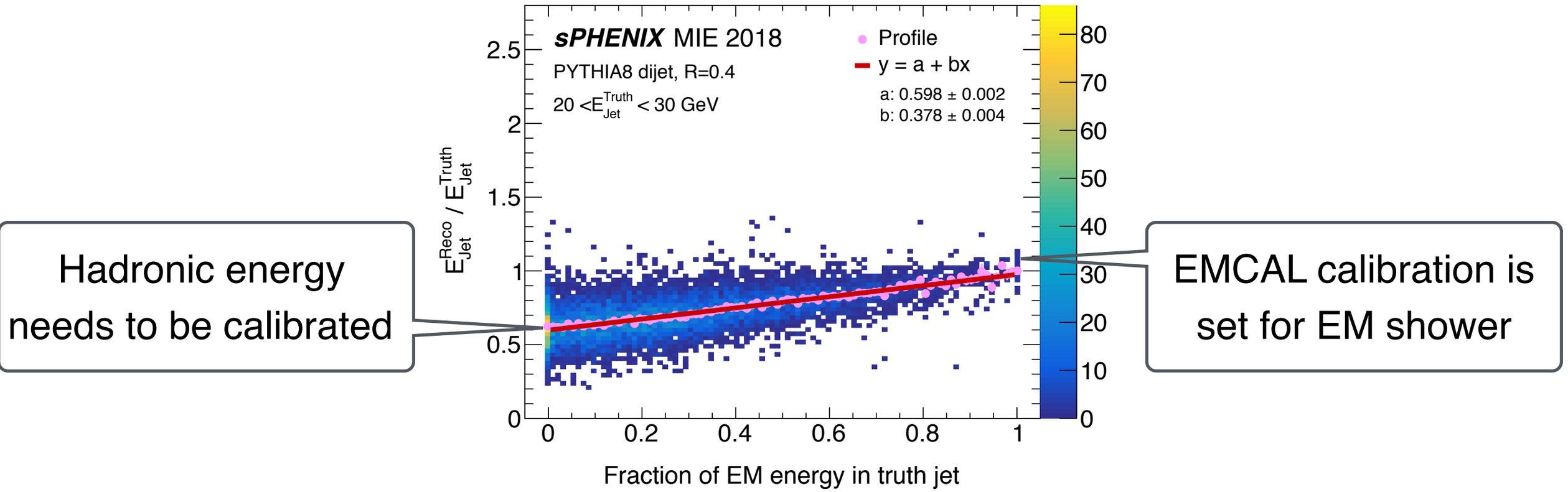
Motivation

- Calorimeter response to a jet depends on
  - Jet kinematics, fragmentation pattern, etc.
  - Longitudinal center of gravity of the showers
  - Fraction between electromagnetic (EM) and hadronic energy

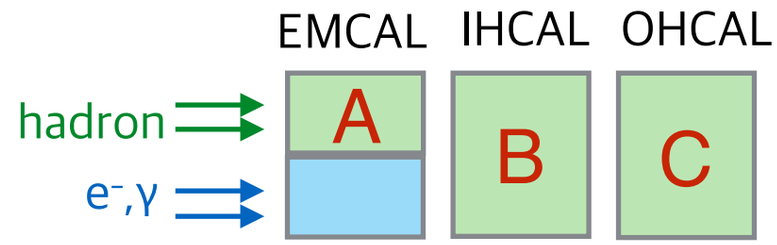


- Relative energy scales of different calorimetry segments, EMCAL, IHCAL, and OHCAL, needs to be adjusted

Calibration procedure 1/5

- EMCAL clusters with hadronic energy (E_{EMCal}^{had}) needs to be separated from those with EM energy (E_{EMCal}^{EM}) and calibrated individually

$$E^{RECO} = D \cdot (E_{EMCAL}^{EM} + A \cdot E_{EMCAL}^{had} + B \cdot E_{IHCAL} + C \cdot E_{OHCAL})$$



Calibration procedure 2/5

- EMCAL clusters with hadronic energy (E_{EMCal}^{had}) needs to be separated from those with EM energy (E_{EMCal}^{EM}) and calibrated individually

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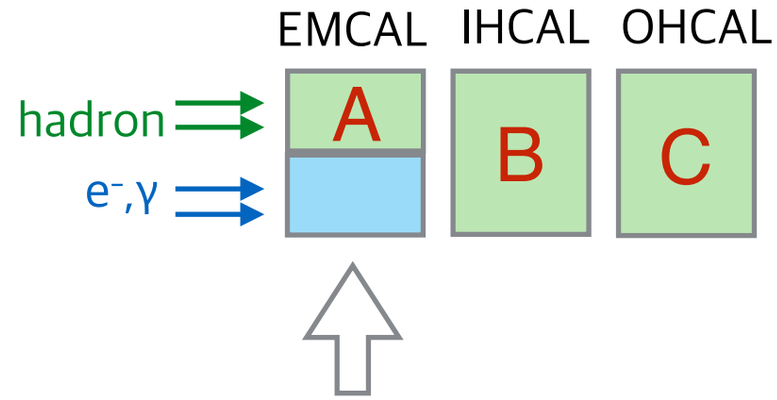
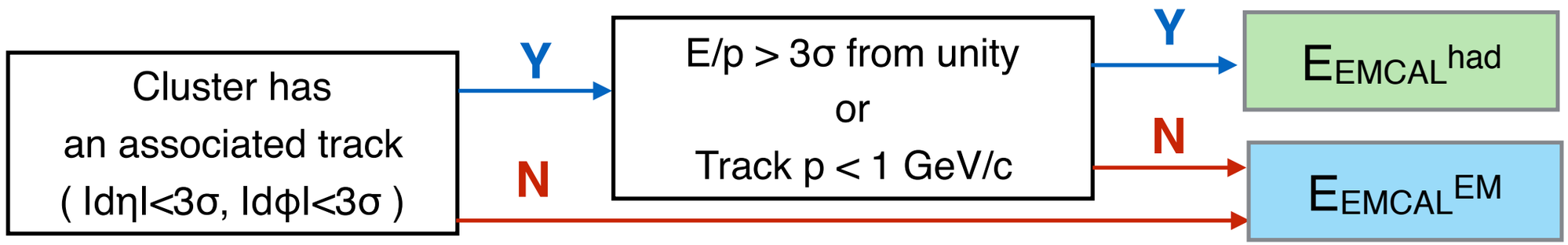


- Flow chart for EMCAL cluster selection



Calibration procedure 3/5

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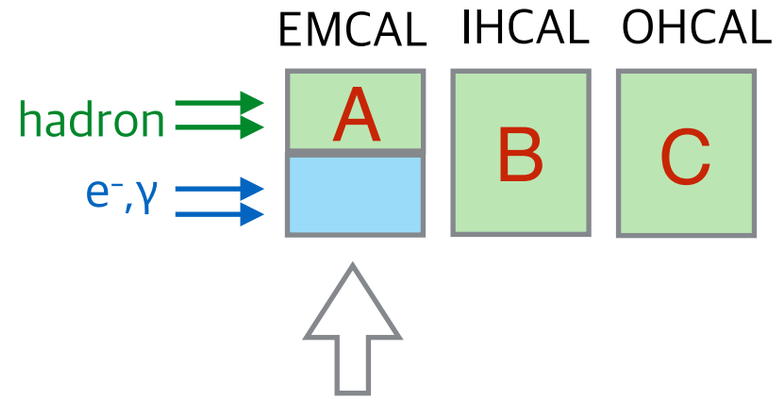

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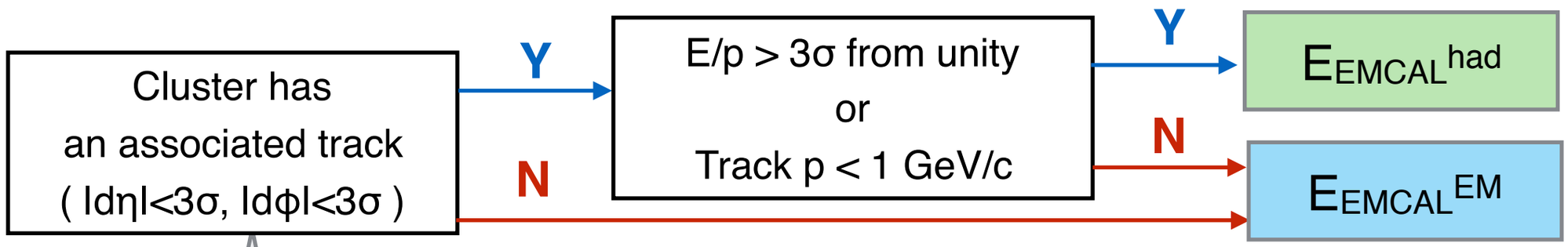
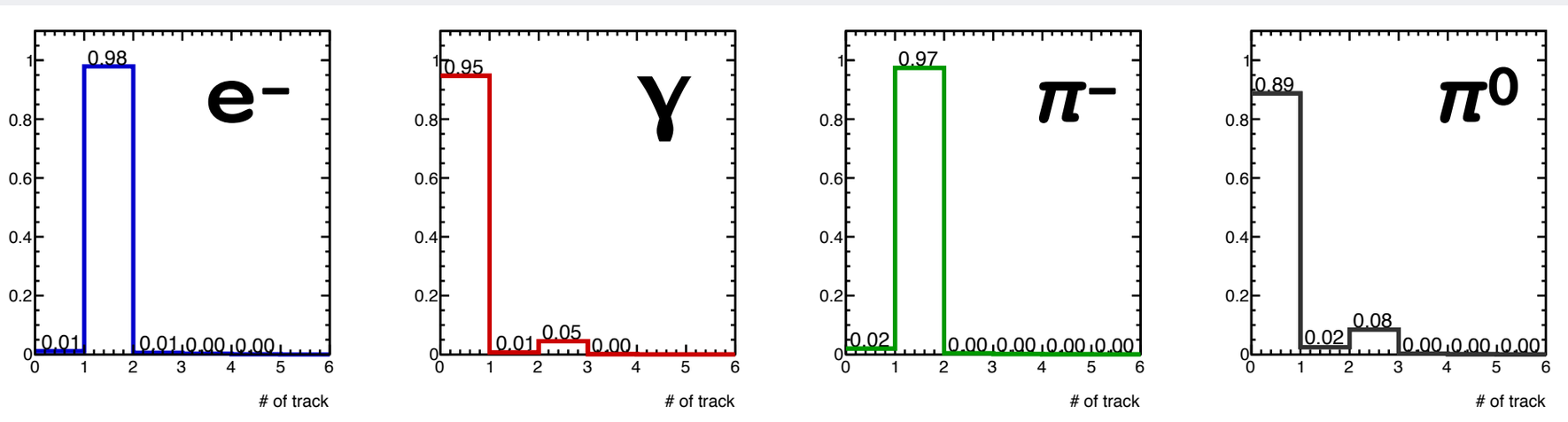


- Step 1) Track-cluster matching to separate e^-, π^- from γ, π^0

Number of track:



Calibration procedure 4/5

- EMCAL clusters with hadronic energy (E_{EMCal}^{had}) needs to be separated from those with EM energy (E_{EMCal}^{EM}) and calibrated individually

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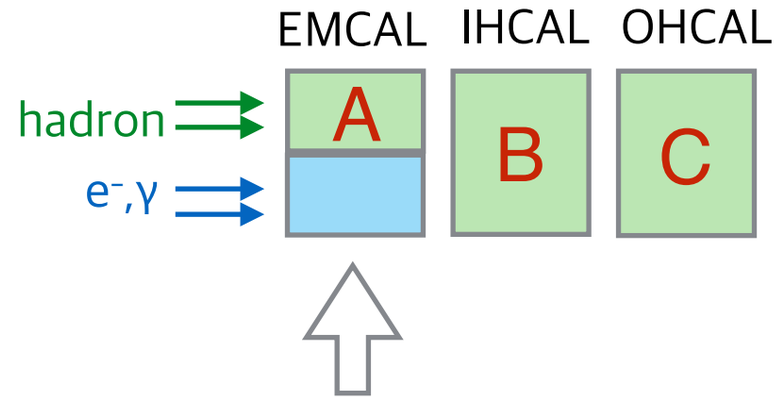
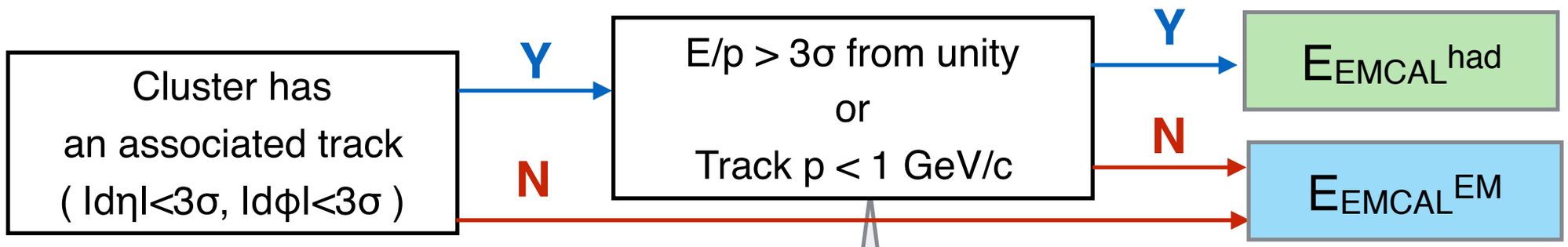
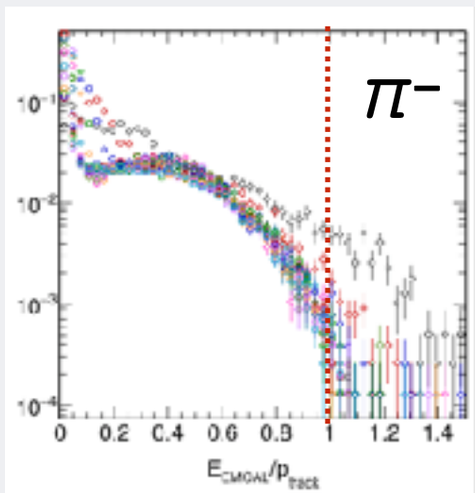
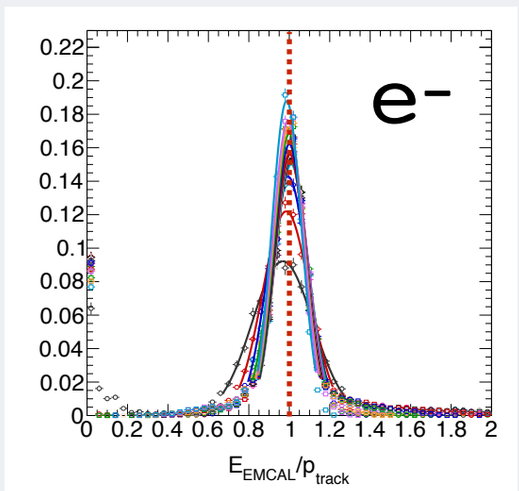


- Flow chart for EMCAL cluster selection



- Step 2) E/p ratios to separate π^- from e^-





0 < p < 1 GeV
1 < p < 2 GeV
2 < p < 3 GeV
3 < p < 4 GeV
4 < p < 5 GeV
…

Calibration procedure 5/5

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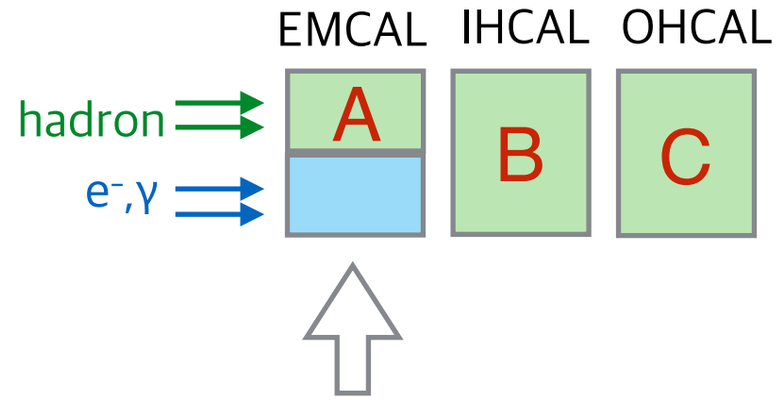
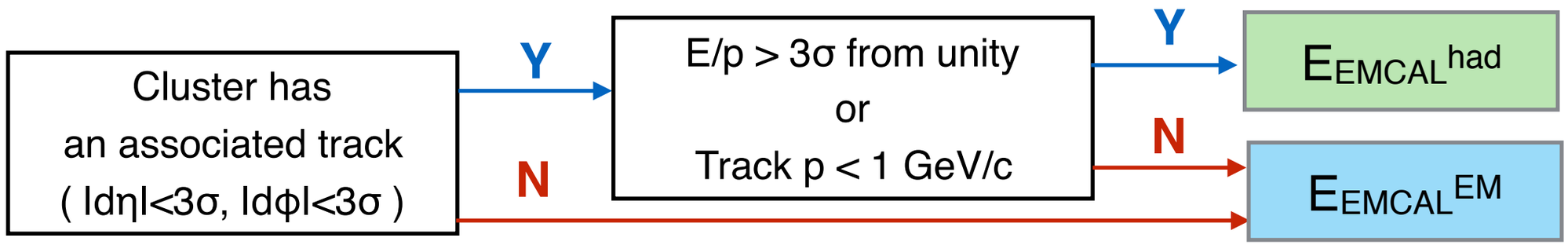


- Flow chart for EMCAL cluster selection

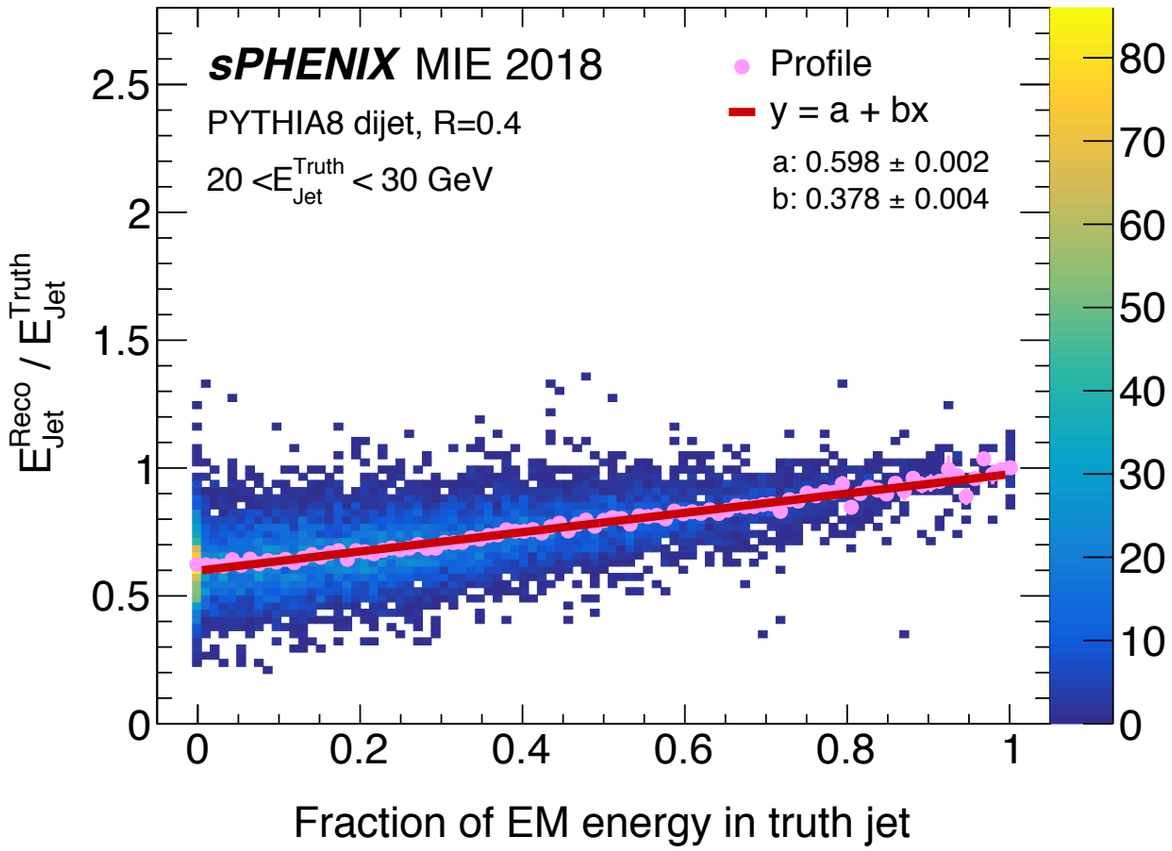


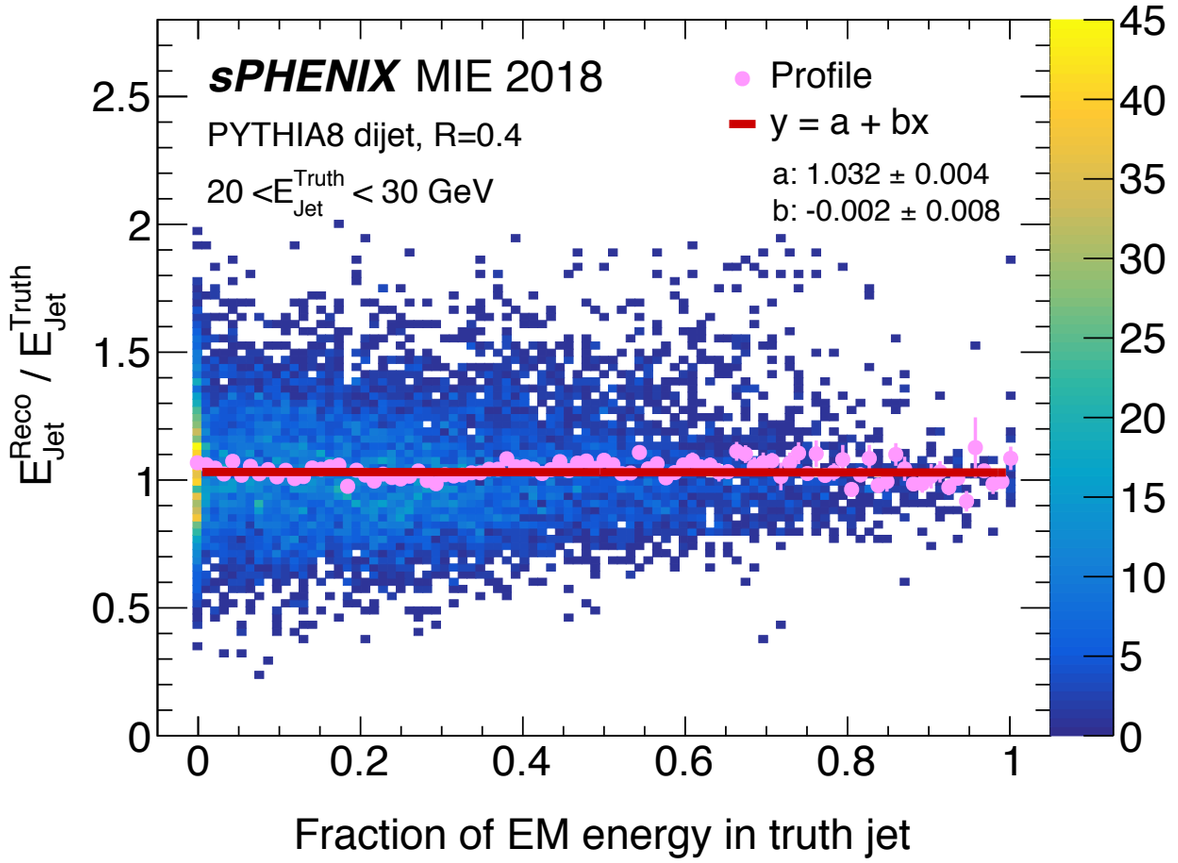
- A, B, and C are simultaneously determined using MINUIT by minimizing the quantity

$$\Sigma_{i=1}^{N}(E_{\mathrm{Jet},i}^{\mathrm{Reco}} - E_{\mathrm{Jet},i}^{\mathrm{Truth}})^2/(E_{\mathrm{Jet},i}^{\mathrm{Truth}})^2$$

Response after calibration

- Jet response vs. EM fraction flattened after calibration





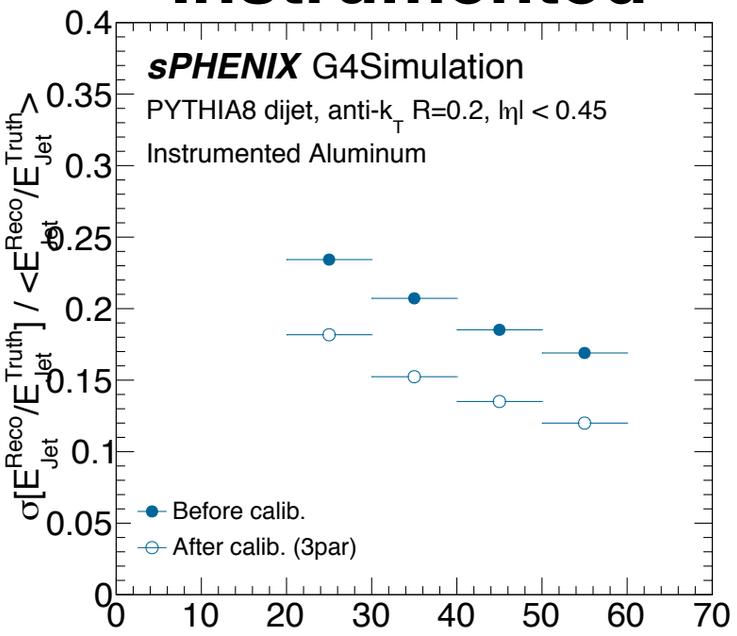
JER in pp

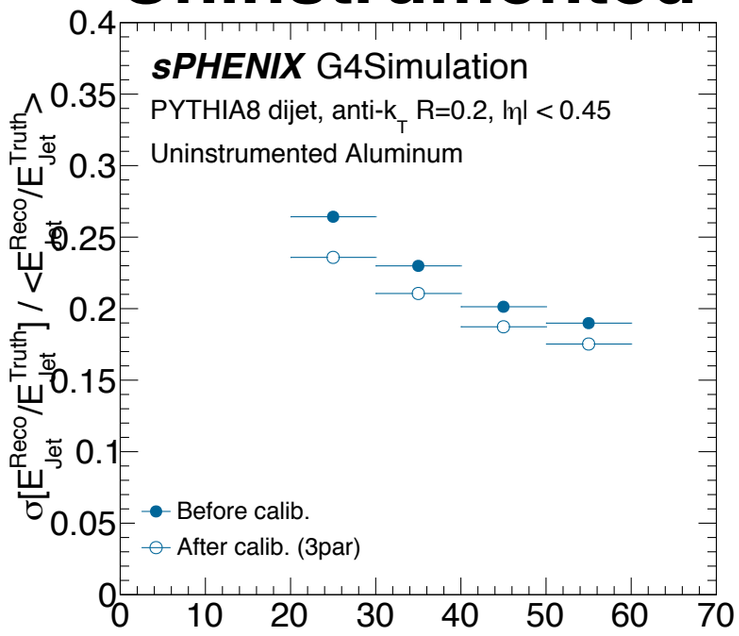
- JER improved in all cases
- Smaller improvement when uninstrumented

Instrumented

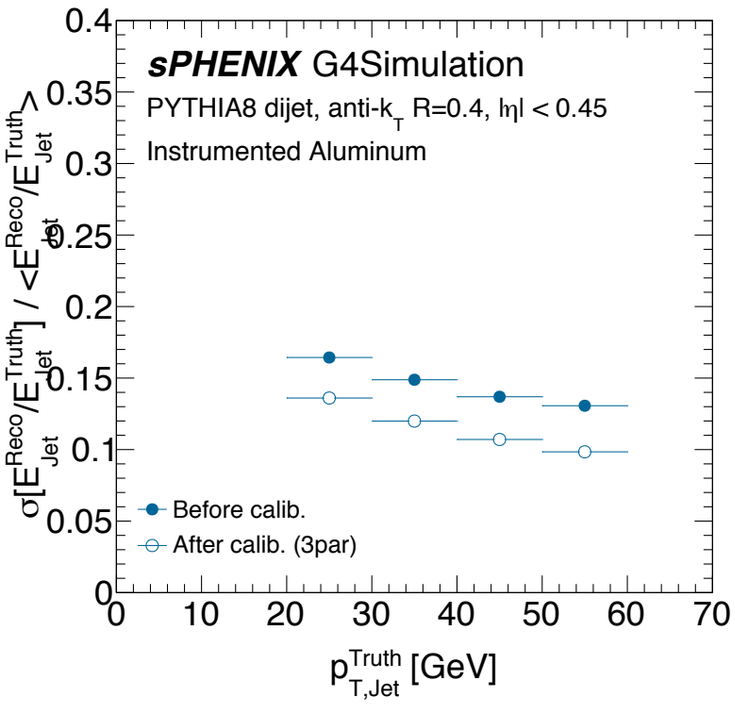
Uninstrumented

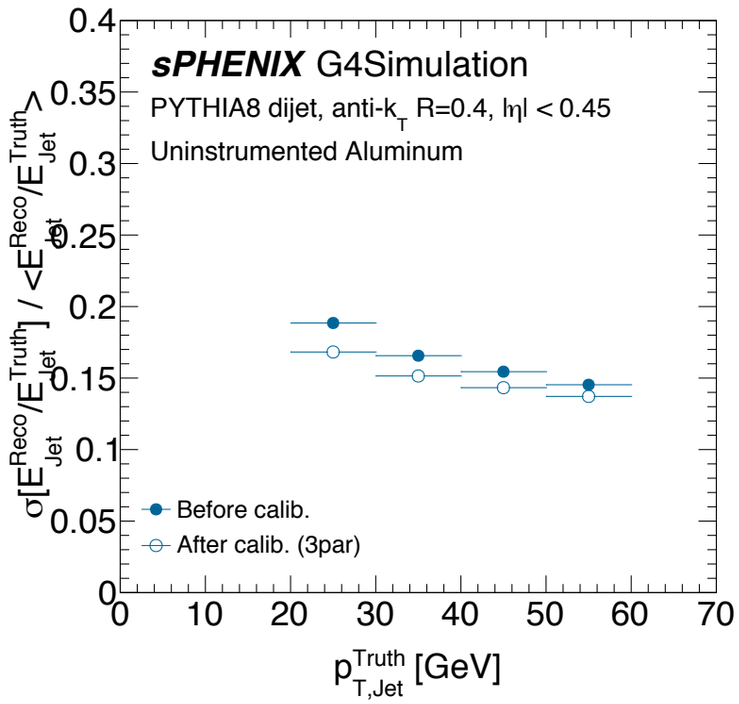
R=0.2





R=0.4

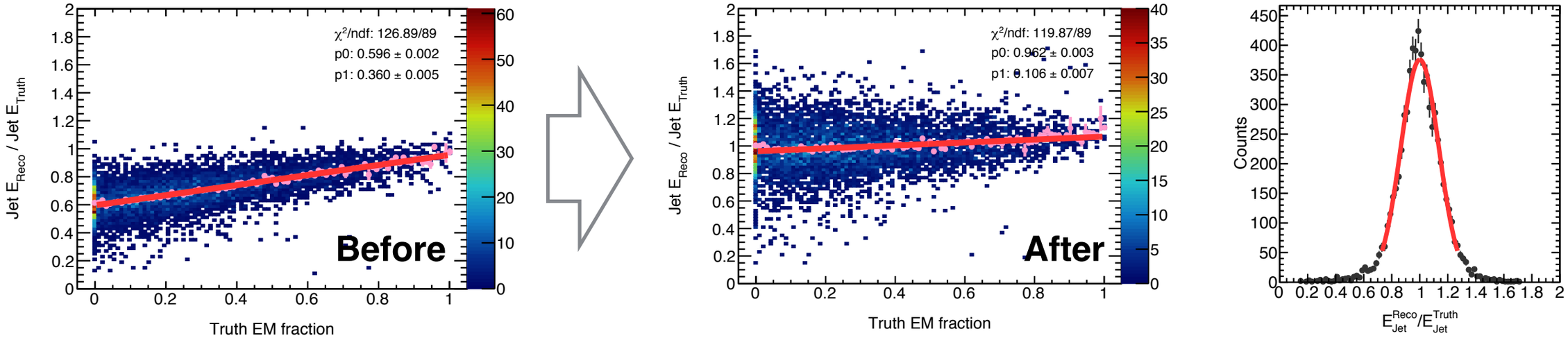




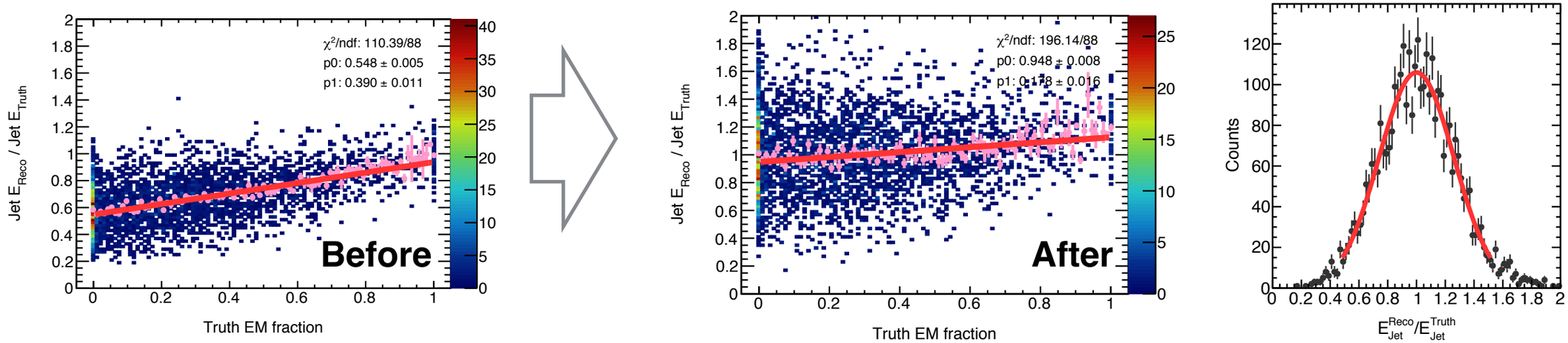
Calibration in HI

- Only IHCAL and OHCAL constants are applied
  → EM vs. hadronic energy in EMCAL is not separated
- Final $E^{RECO} = D \cdot (E_{EMCAL} + B \cdot E_{IHCAL} + C \cdot E_{OHCAL})$

- 50 - 60 GeV, b= 4-8 fm, R=0.2, instrumented Al



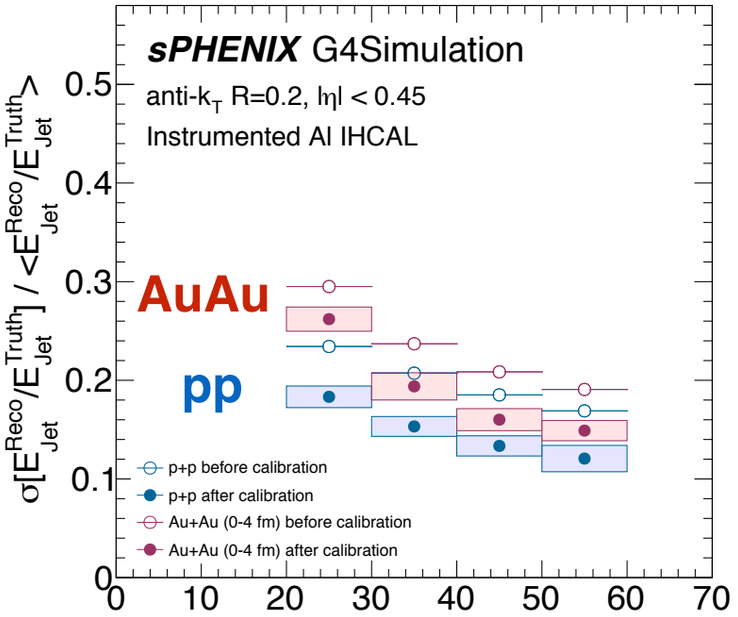
- 20 - 30 GeV, b - 0-4 fm, R=0.2, instrumented Al

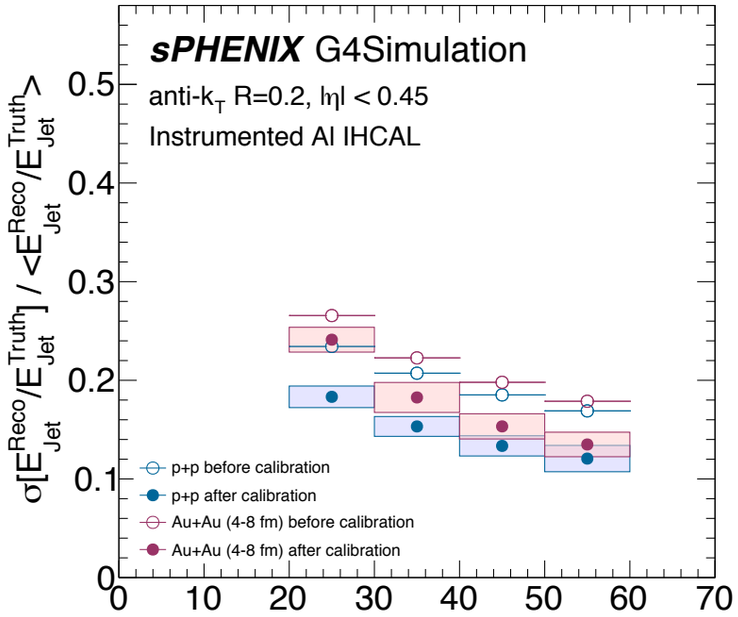


JER in pp vs. HI

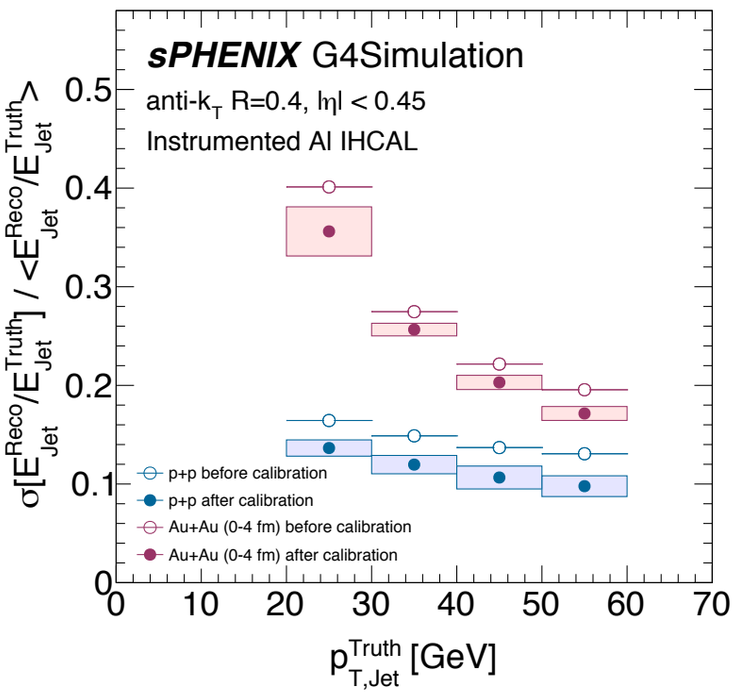
- Improvement in JER after calibration both in pp and HI
- Larger JER for larger R jet at lower p_T in HI
- Shaded boxes represent uncertainties in the scaling constants

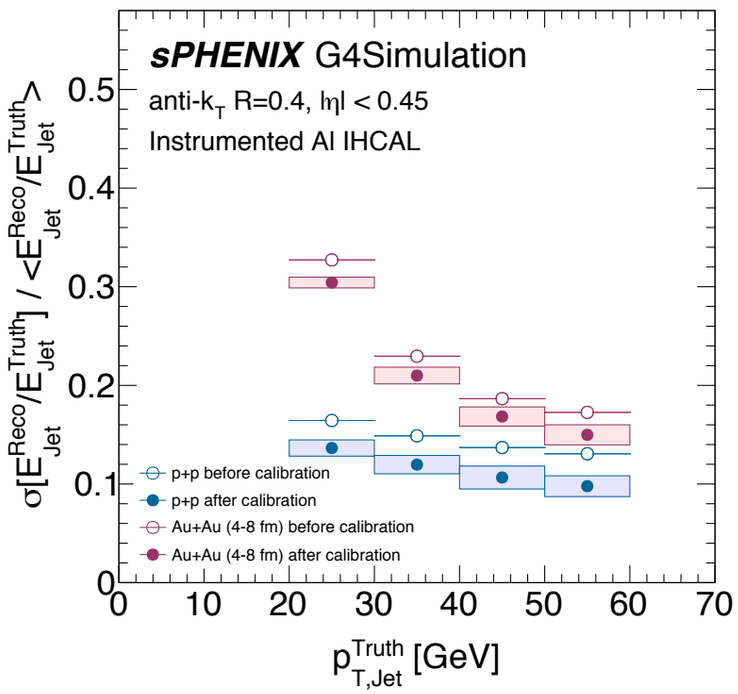
R=0.2





R=0.4



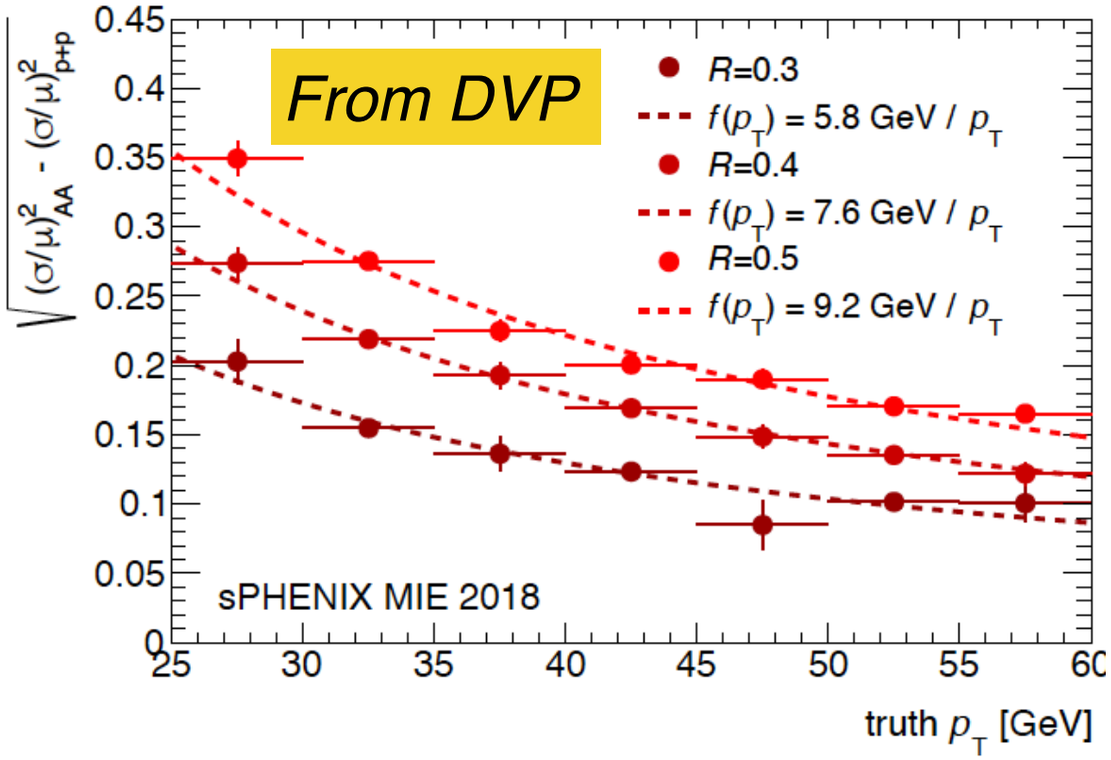


Decomposition of JER

$$\frac{\sigma_{p_{\mathrm{T}}}}{p_{\mathrm{T}}} = \frac{n}{p_{\mathrm{T}}} \oplus \frac{s}{\sqrt{p_{\mathrm{T}}}} \oplus c$$

Noise Stochastic Constant

- UE fluctuation enters into noise term
- Factorize UE component by $[\sigma_{pT}/p_T]^{AA} \ominus [\sigma_{pT}/p_T]^{pp}$



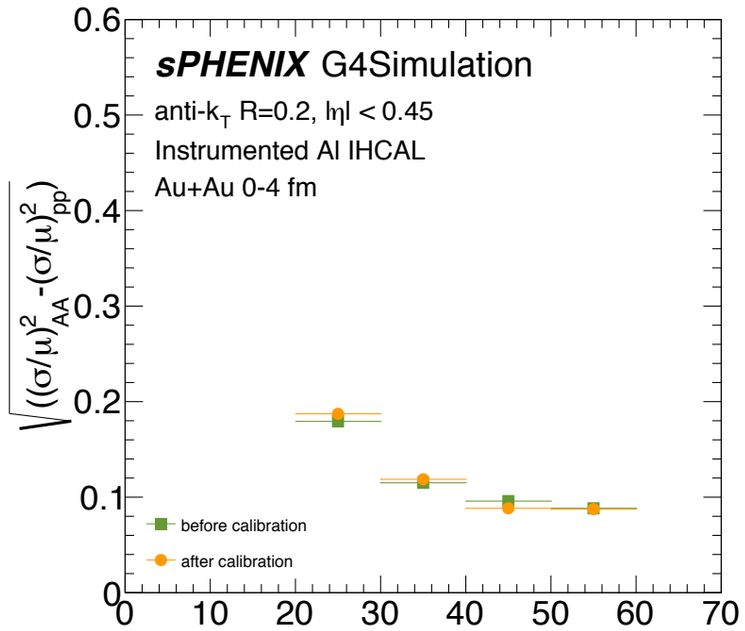
- Fit with n/p_T gives reasonable description in different R before calibration

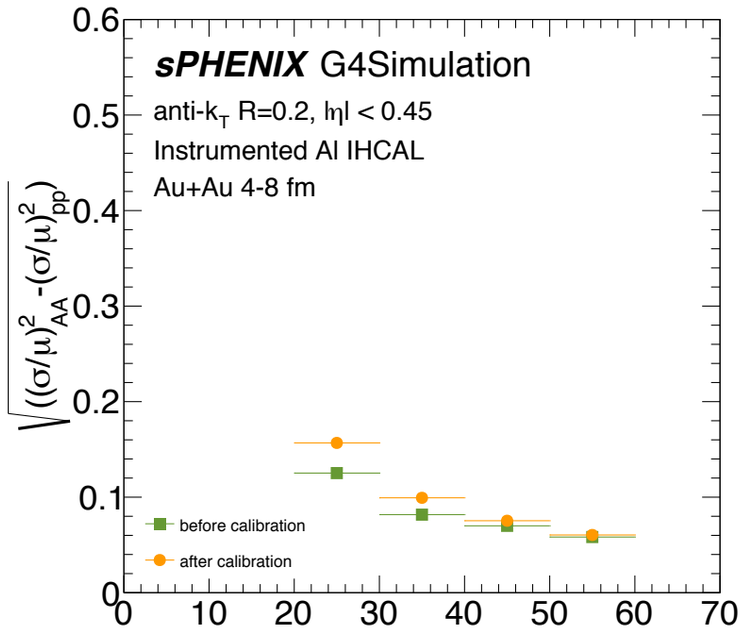
- Calibration procedure is expected to only improve the pp-like part of the resolution, and not improve the part of the resolution coming from the UE
  → UE part remains the same after calibration? (next slide)

Decomposition of JER

- Decomposed resolution coming from the UE fluctuation is similar between before and after calibration as expected

R=0.2





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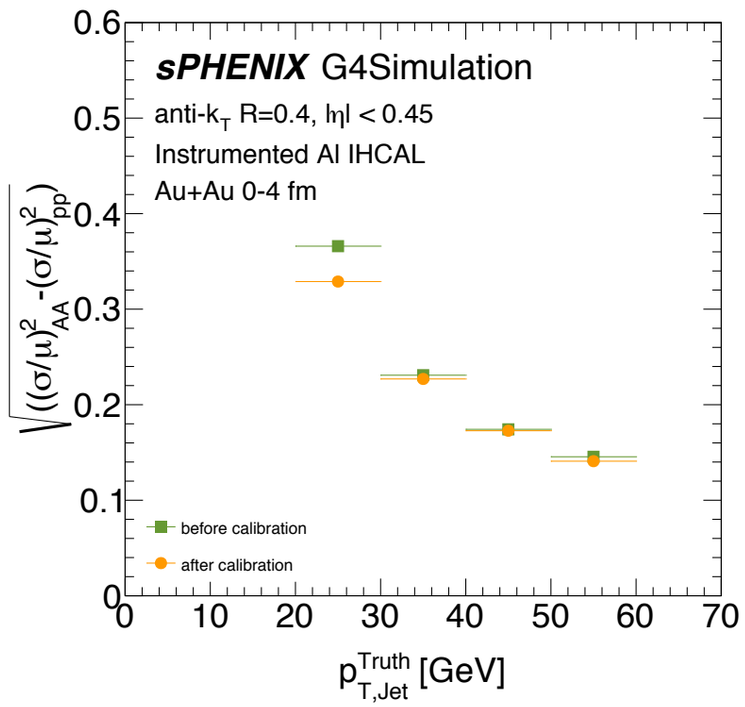

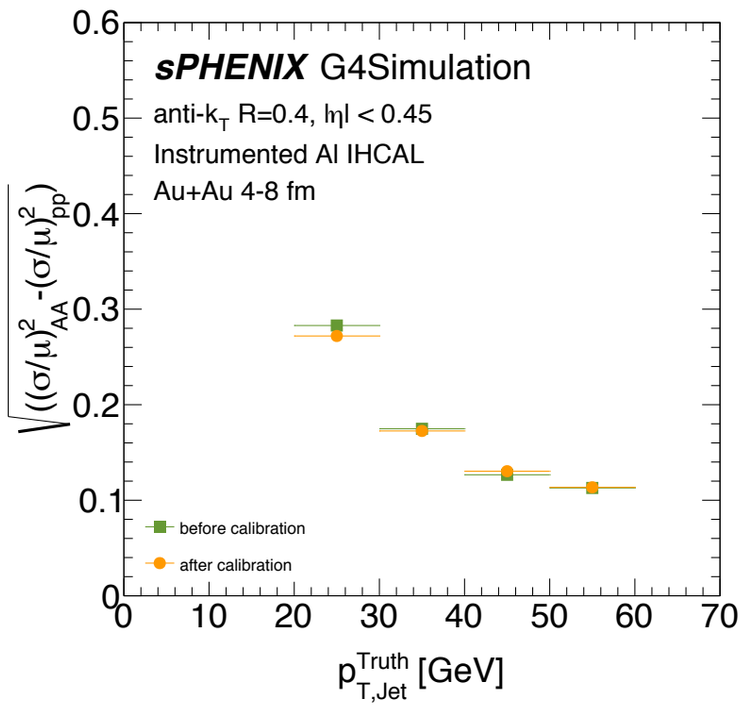

Backups