Performance studies of LHCf + ATLAS ZDC

From works by Kondo-san and Kobayashi-san

Energy Reconstruction

- Sum dE in LHCf and ZDC

$$E_{LHCf} = \Sigma\, dE_i\, G_i\, Y_i(x, y)$$

dE_i ADC counts after pedestal subtraction

G_i Gain Calibration factor

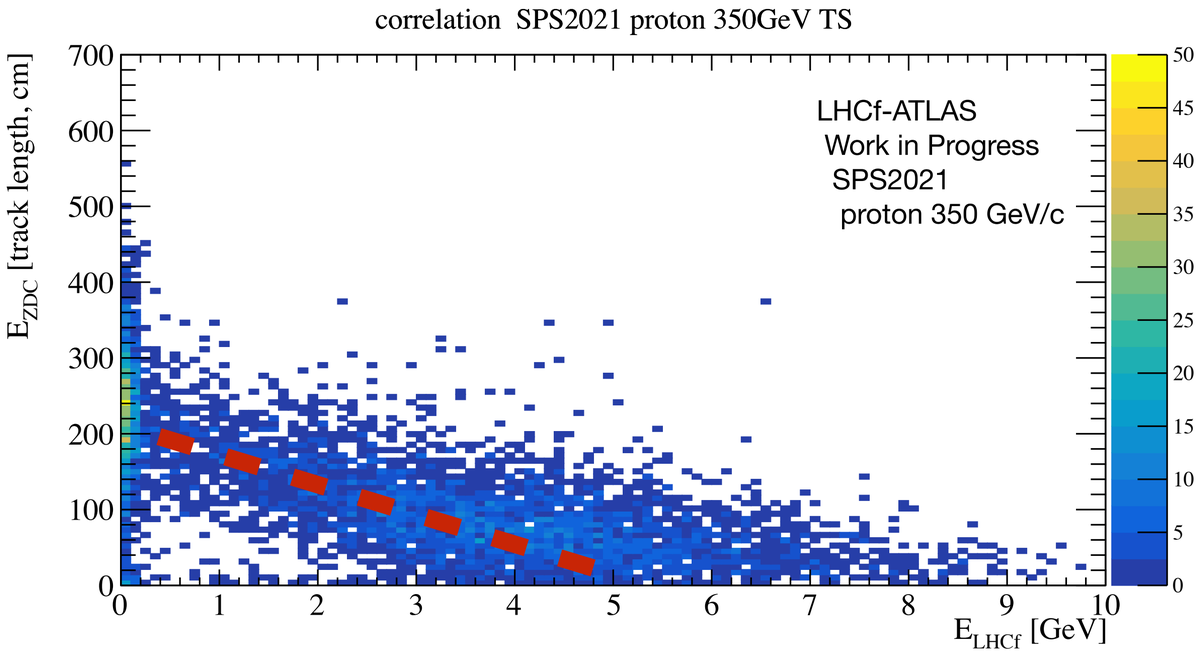
$Y_i(x, y)$ Position dependency of light yield

Note) No shower leakage correction

$$E_{ZDC} = \Sigma\, dE_i\, G_i$$

dE_i ADC counts after pedestal subtraction

G_i Gain Calibration factor



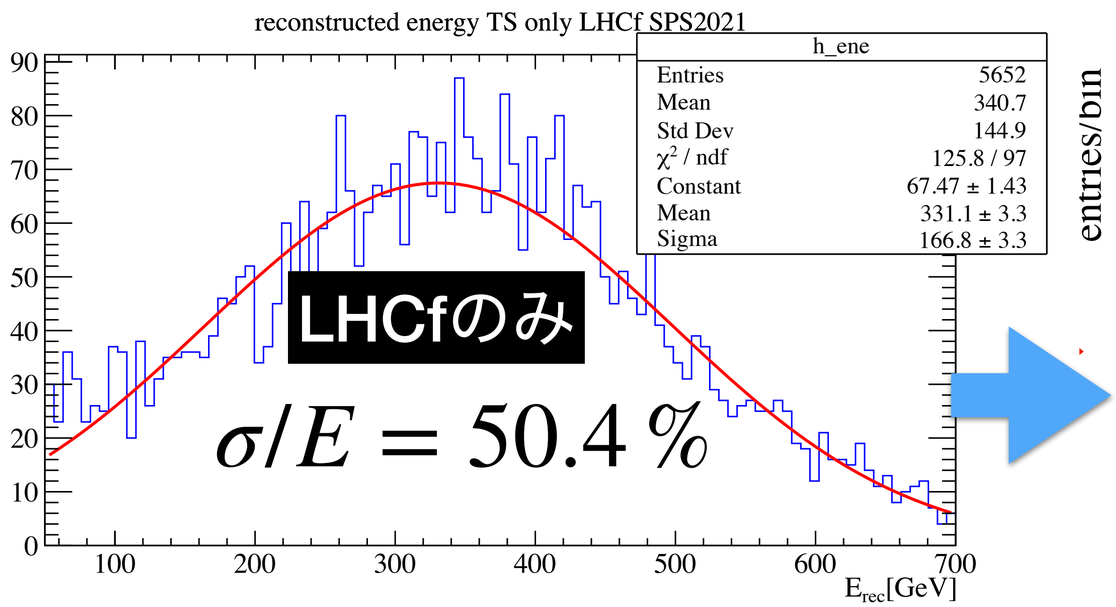
Correlation between E_LHCf and E_ZDC

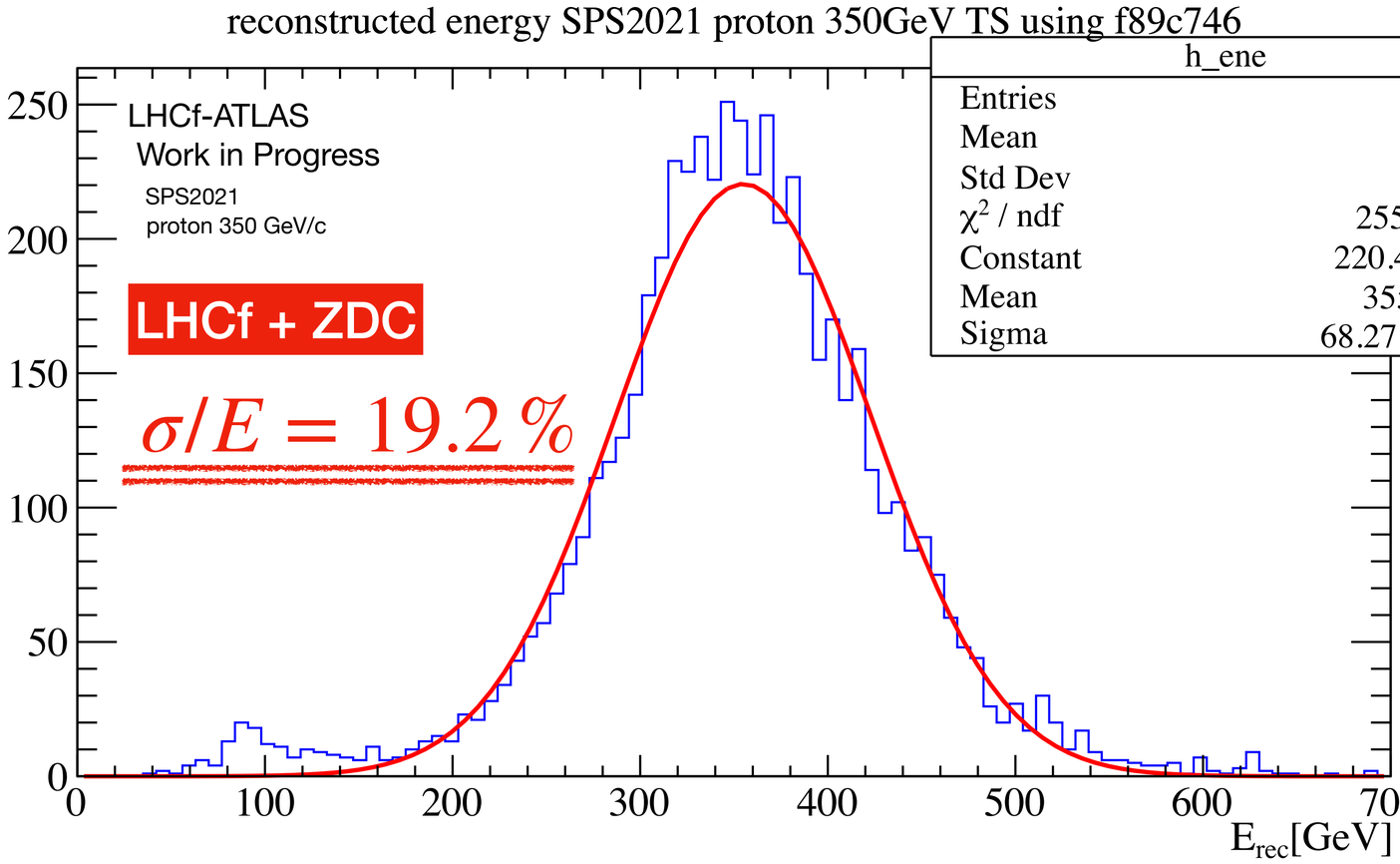
$$E_{est} = E_{LHCf} + \alpha E_{ZDC}$$

$$E_{rec} = f(E_{rec})$$

f: 2nd pol. function

Energy Resolution

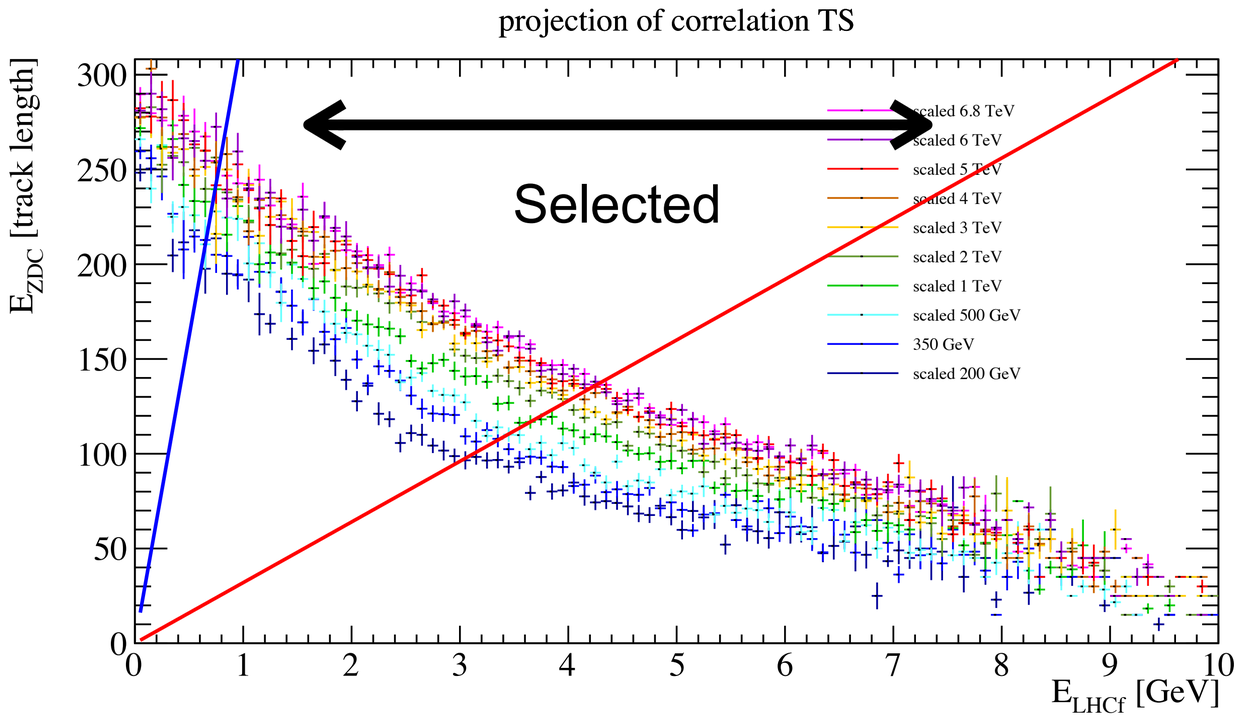




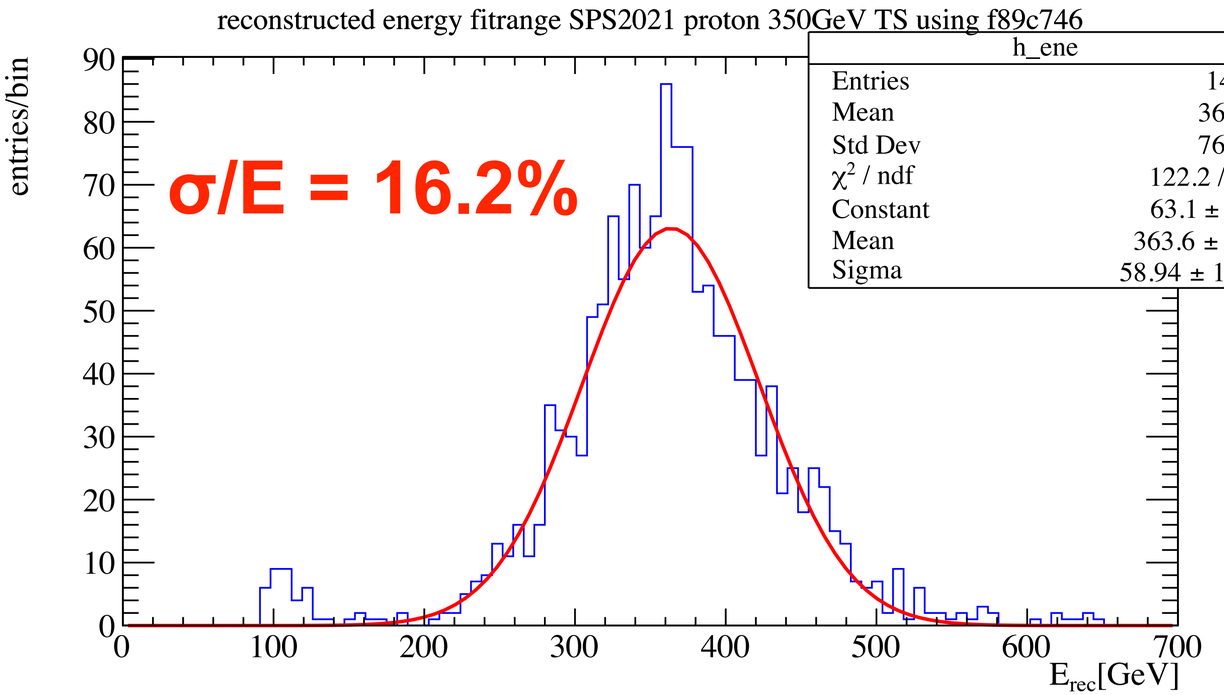
350 GeV proton beam
Arm1 TS Center (4x4mm²)

Event selection for farther improvement

- Correlation with several energies by MC



Reconstructed energy distribution w/ selection



The correlation is not perfectly linear.
Selected the region with better linear correlation and less energy scale dependency.

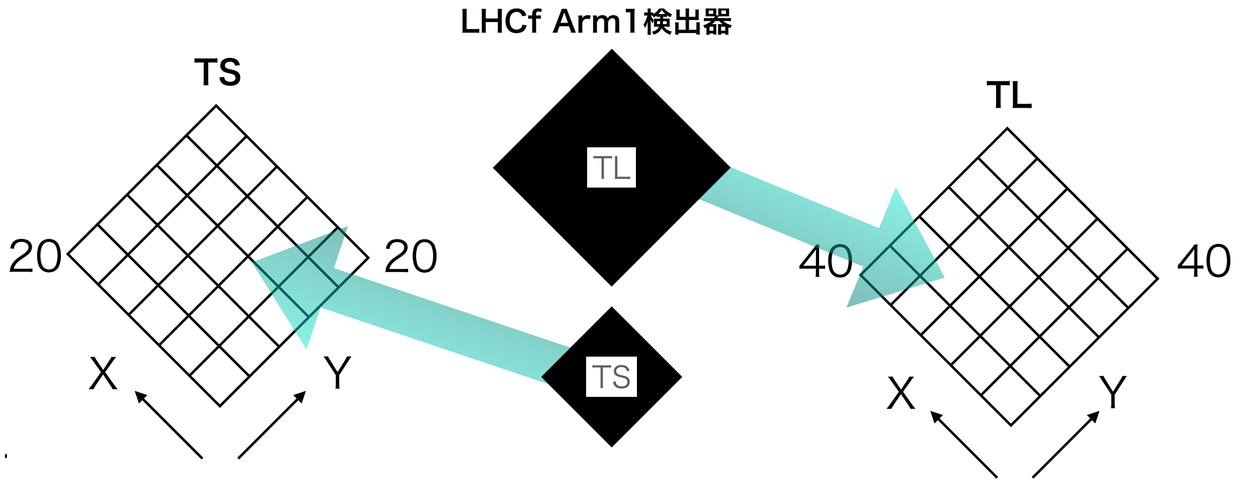
350 GeV proton beam
Arm1 TS Center (4x4mm²)
#selected event ~ 25%

Uniformity studies

- Energy reconstruction were applied for each position block (5 x 5 blocks in each tower), and checked the mean and resolution.

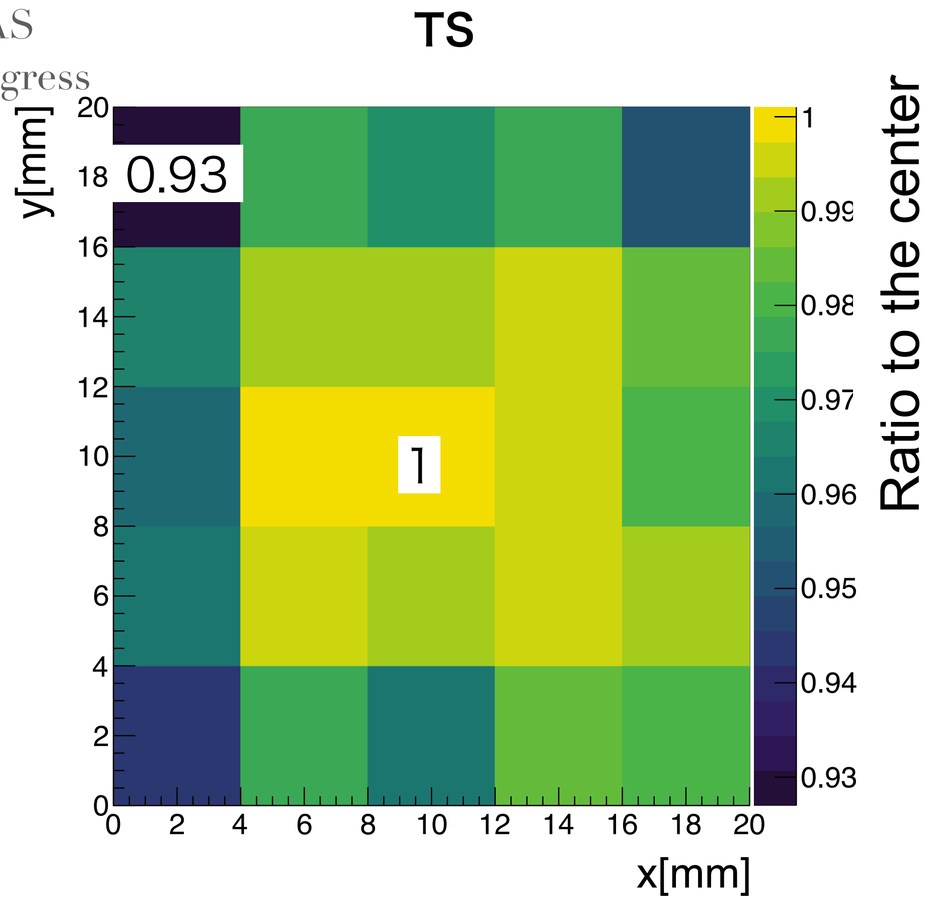
Possible source of non-uniformity
- Position dependency of light yield in LHCf and ZDC
- Shower leakage from the sides of LHCf towers

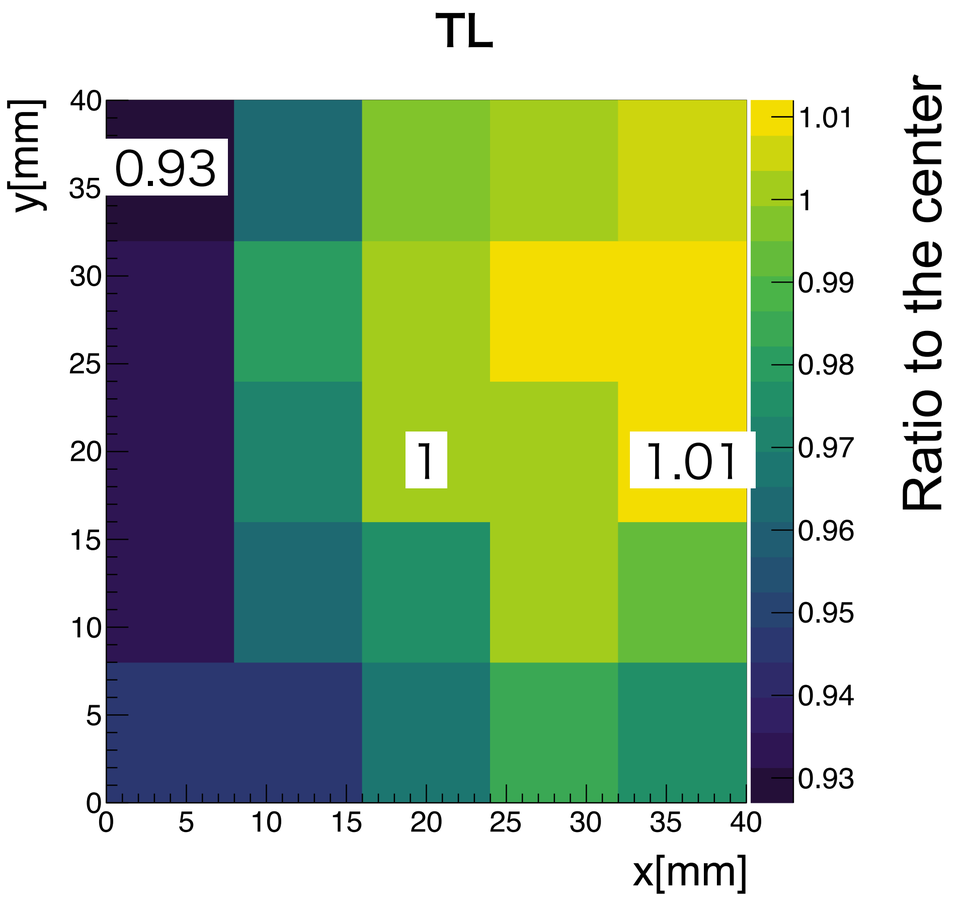
Analysis method
- 2mm edge cut
- No event selection



Uniformity (mean)

LHCf. ATLAS
Work in progress



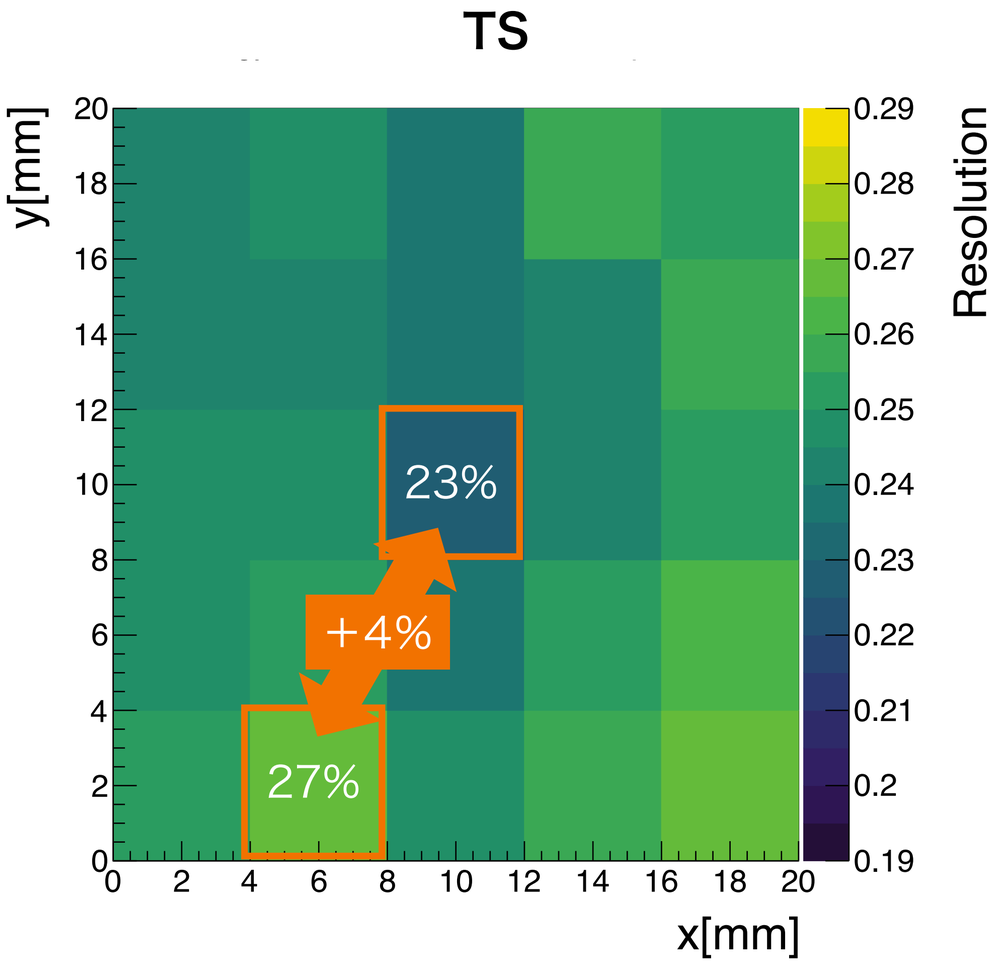


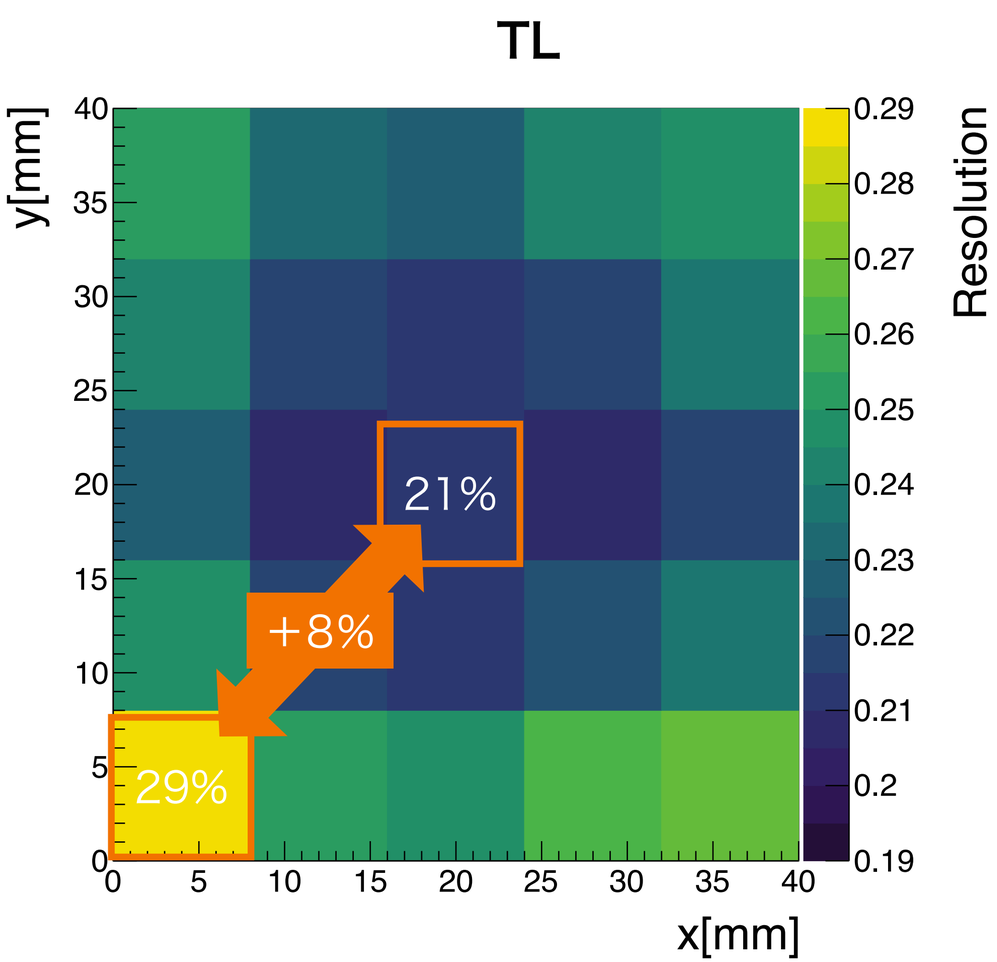
Center : E_rec = 323 GeV

Center : E_rec = 336 GeV

Difference is only 8% at maximum.

Uniformity (Resolution)



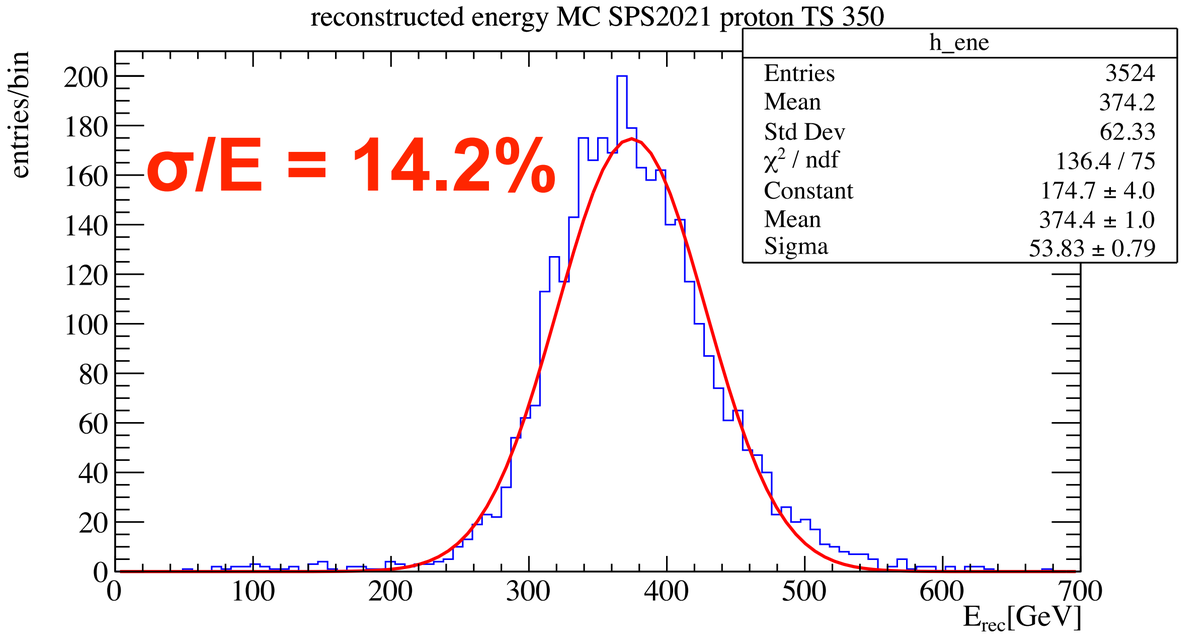


Mostly flat response in resolution.

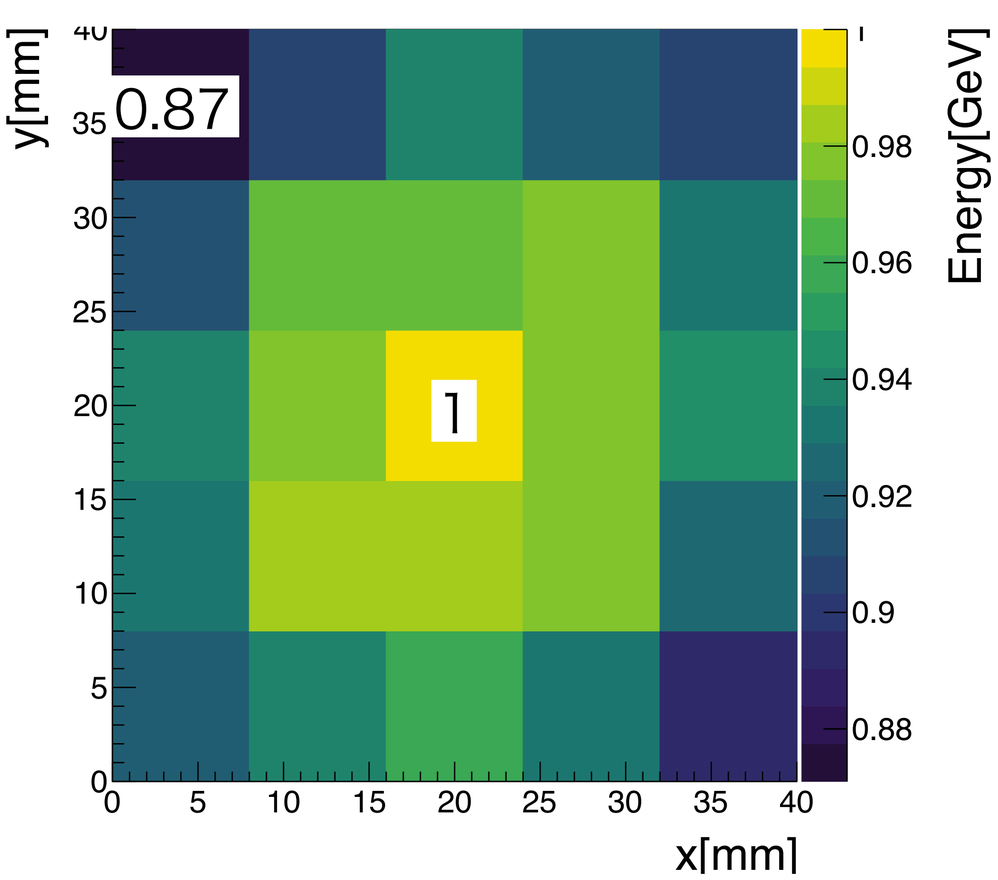
Status of beam-test study

- Analysis of data is mostly completed, but the performance is not perfectly consistent with MC yet.

Energy distribution w/o event selection



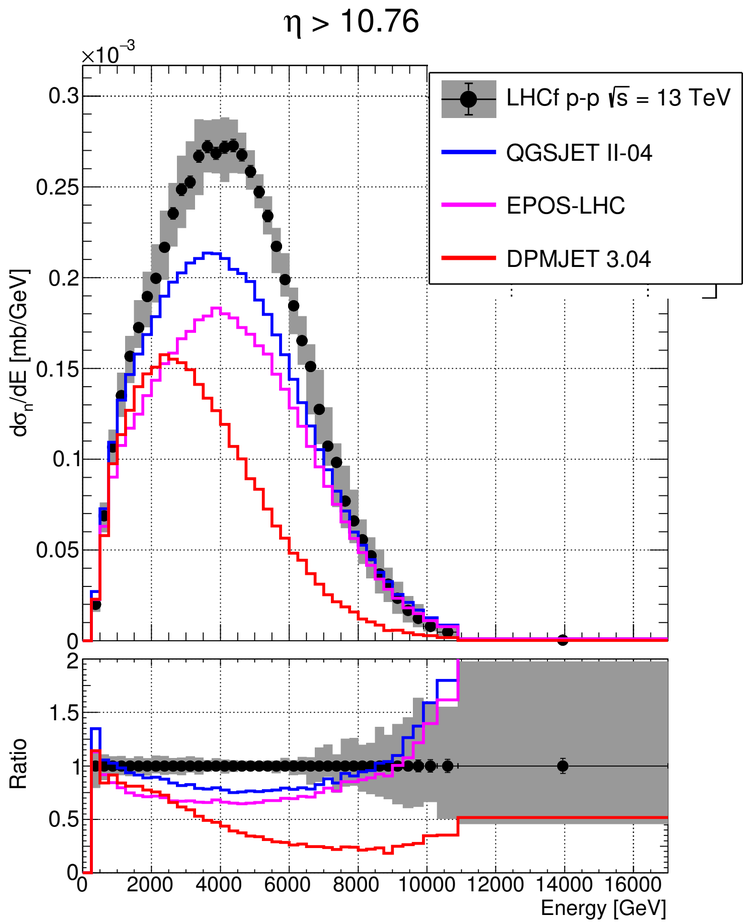
Uniformity of Mean (MC)



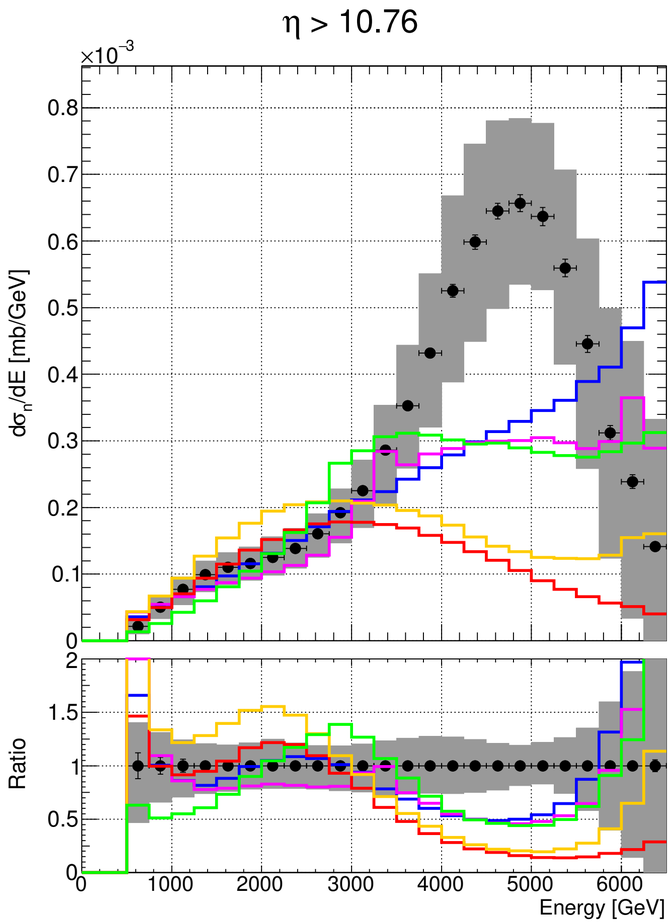
Neutron measurement at 2022 pp

- Reminder: Neutron measurement with 2015 pp data

Before unfolding

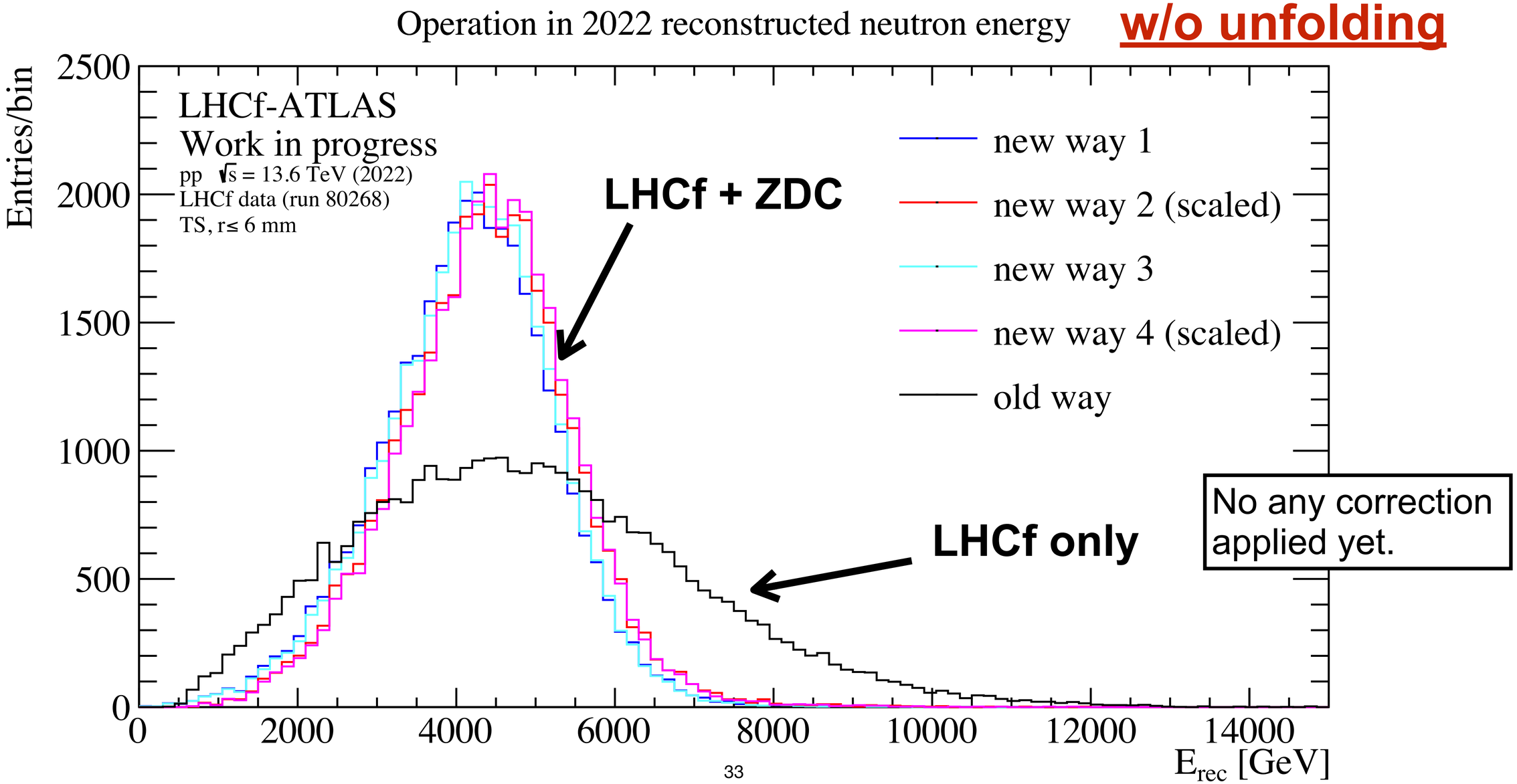


After unfolding



Resolution for neutrons : 40%

Very preliminary result



Summary and discussion

- Joint operation has rich physics cases. These can be in STAR and RHICf also in addition to spin asymmetry analysis with STAR (already very nice preliminary results from Minho and Seunghwan).
- Confirmed good energy reconstruction performances with LHCf + ATLAS ZDC for hadronic shower (neutron) measurement.
- RHICf + ZDC should have a similar performance.
  How to confirm it is a key for this joint analysis.
  - Believe MC ?
  - Using mass peak of Λ from $n + \pi^0$? (Need to develop the reconstruction method)
  - Using OPE peak on neutron spectra ? (=measurement target. Loose independency)