Neutron analyses in LHCf Arm1

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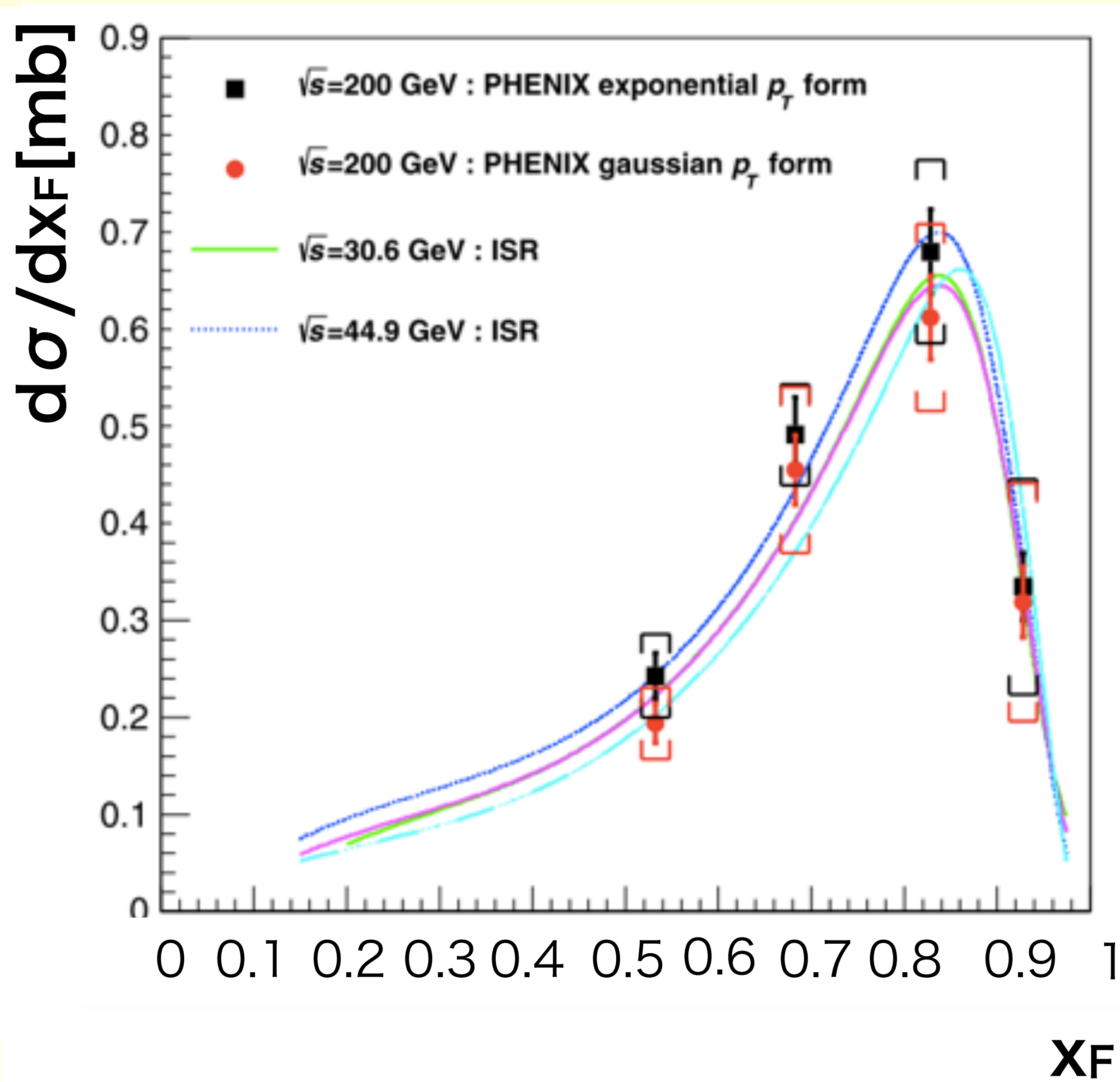
RHICf Japan meeting, Nagoya, 5-Apr-2017

Energy dependence of neutron spectrum



$$x_F = \frac{\text{particle energy}}{\text{beam energy}}$$

A. Adare. et al. (2013)

- The PHENIX experiment and ISR showed that the neutron energy spectrum with proton-proton collisions scaled by beam energy in lower energy.
  → Neutron spectrum have no energy dependence with √s < 200 GeV collisions.

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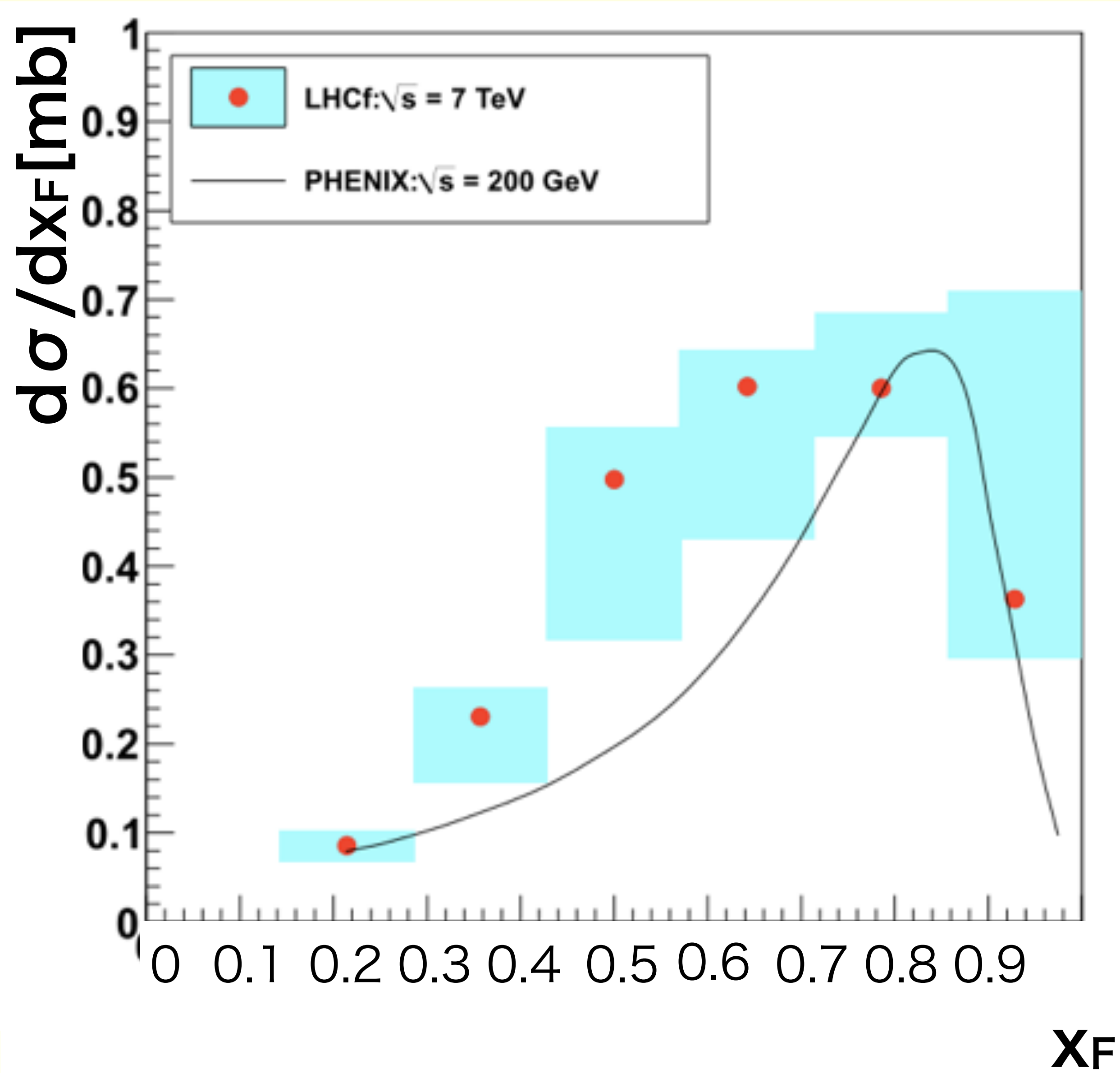

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  → Is there collision energy dependence in neutron spectra??

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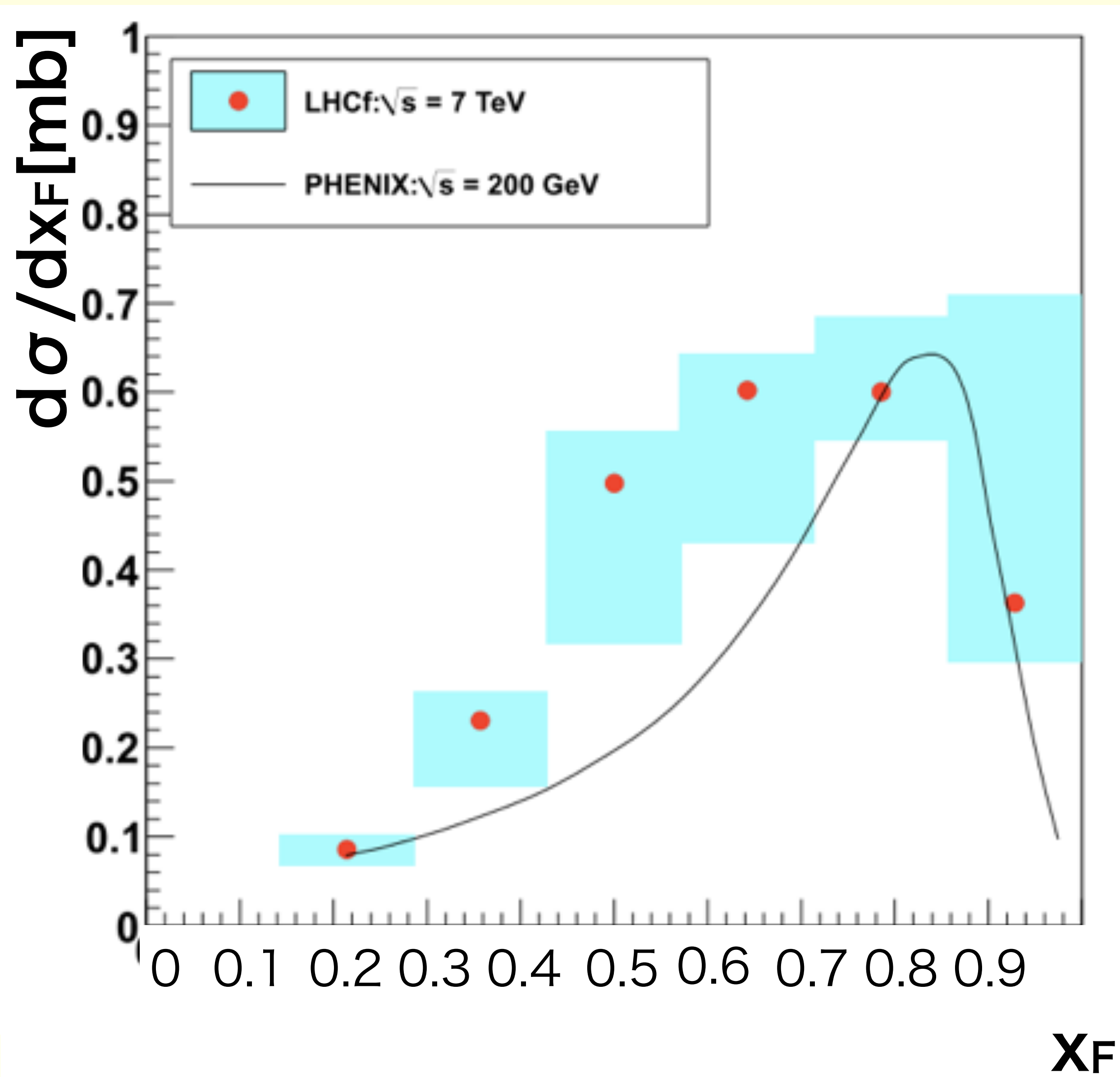

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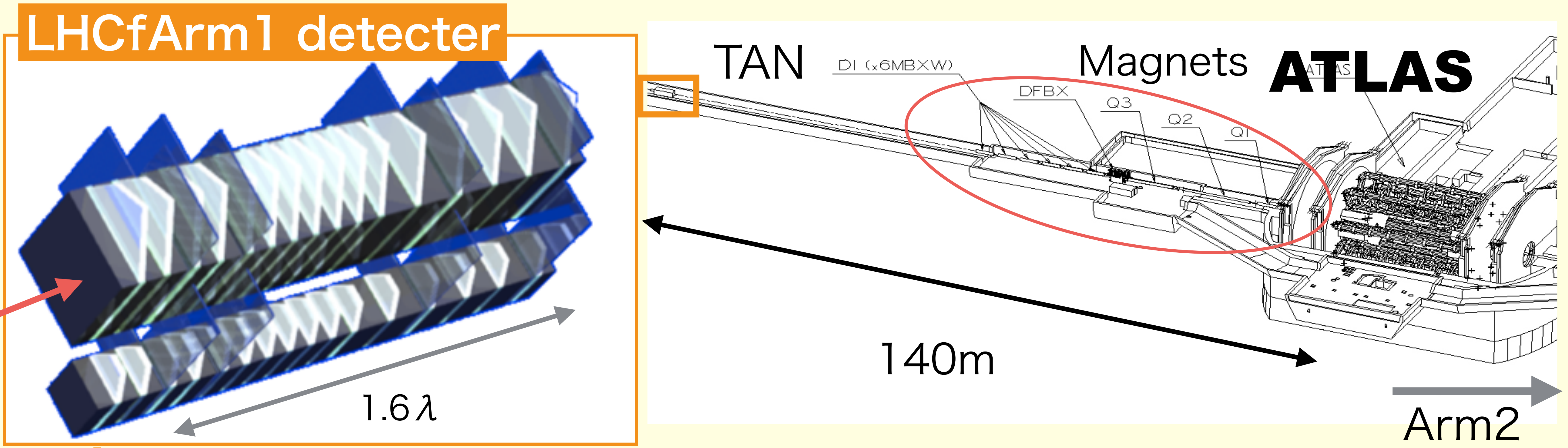
LHCf can check the neutron spectra with highest collision energy.

The LHCf Arm1 detecter



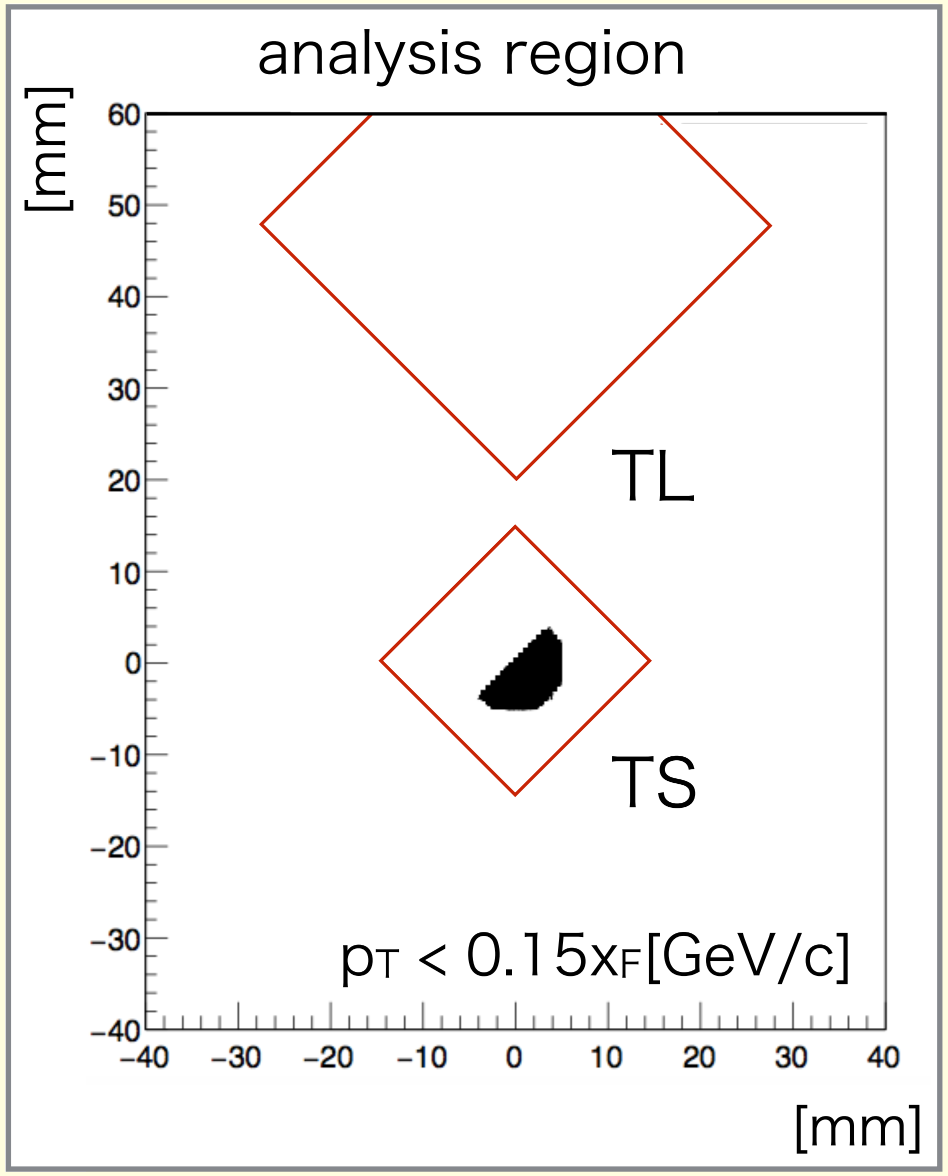
- Consisted by 2 calorimeters, 20mm×20mm & 40mm×40mm
- Each calorimeters has tungsten and 16 scintillators
- Energy resolution for hadronic showers ~ 41%
  Position resolution for hadronic showers ~ 1.0mm
  (these numbers are consistent with Arm2 detecter)

Neutron spectra analysis

- Data : 12-Jun-2015 — 13-Jun-2015
- The number of events : 2.1×10^6

Event selection criteria

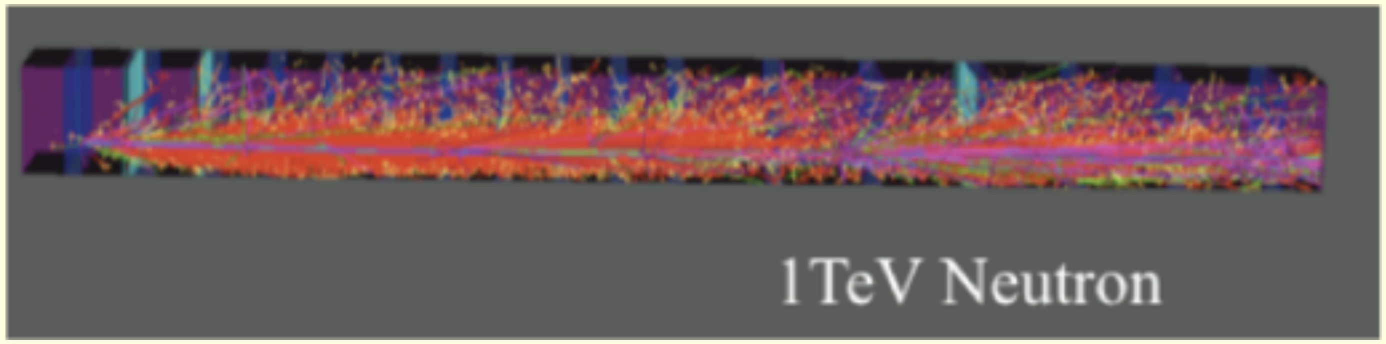
- Remove E < 250 GeV
- p_T selection:
  - (Compare with Arm2)
    - $p_T < 0.15 x_F$[GeV/c]
  - (Compare with $\sqrt{s}$=7TeV)
    - $p_T < 0.11 x_F$[GeV/c]
- Particle identification



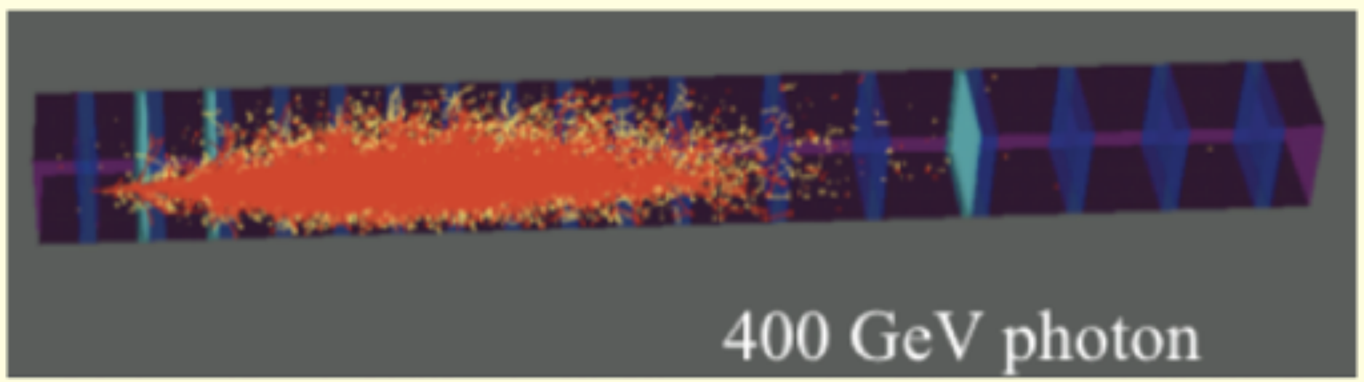
Particle identification

The difference of detecter response

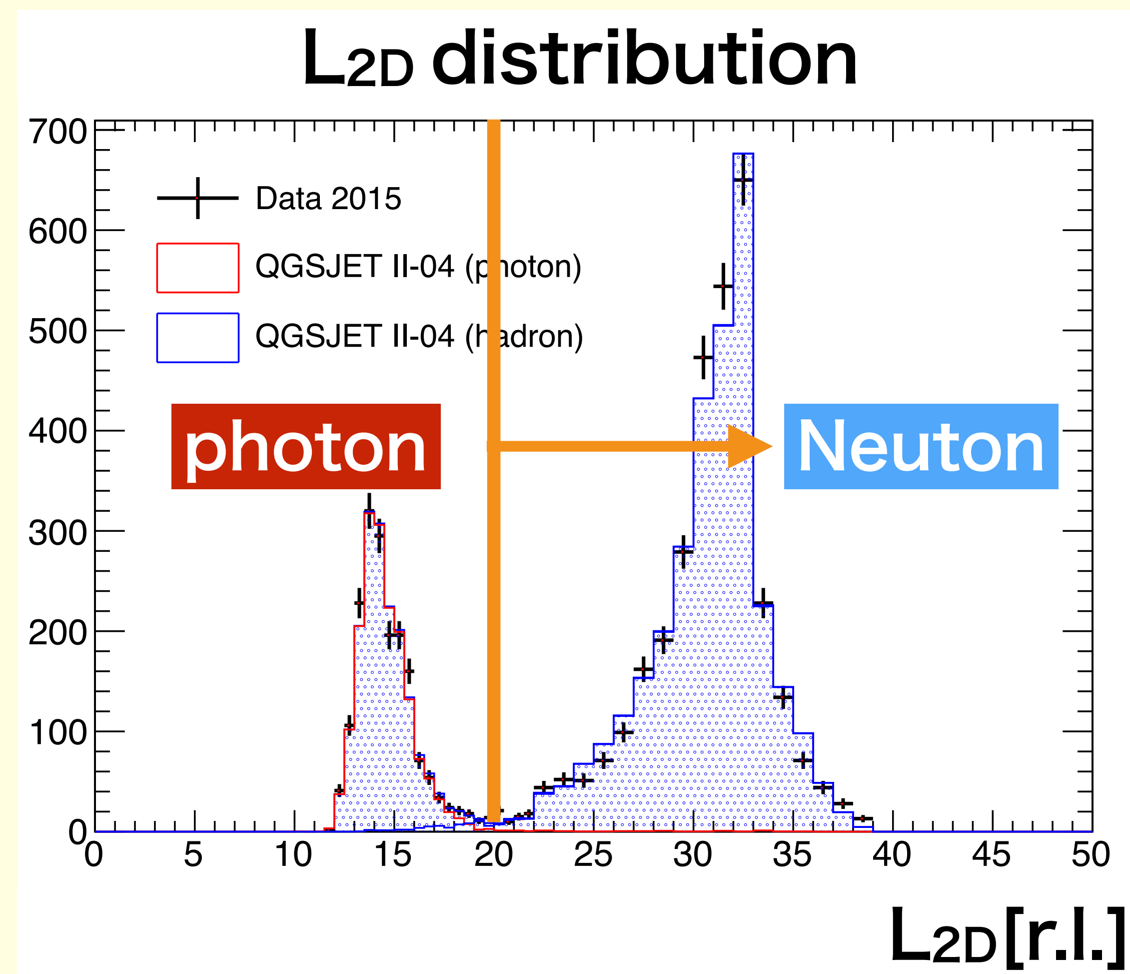
Hadronic shower: deep layers



EM shower: forward layers



- PID was performed using the difference of detecter response.

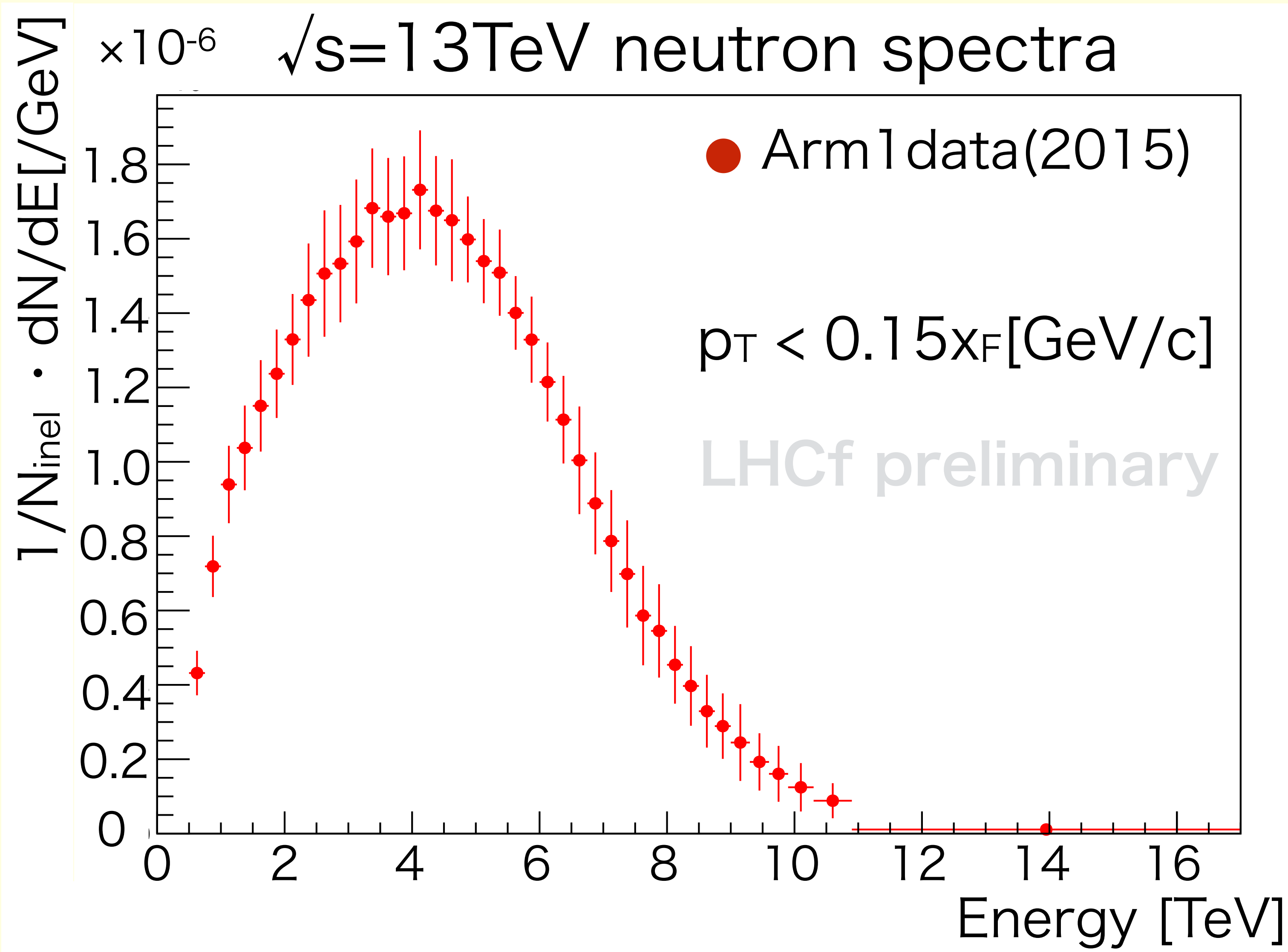


L_{2D} is a parameter:

$$L_{2D} = L_{90\%} - 0.25 \times L_{20\%}$$

$L_{X\%}$: the calorimeter depths containing 20 % and 90 % of the total deposited energy in the detecter

Folded neutron spectra in Arm1



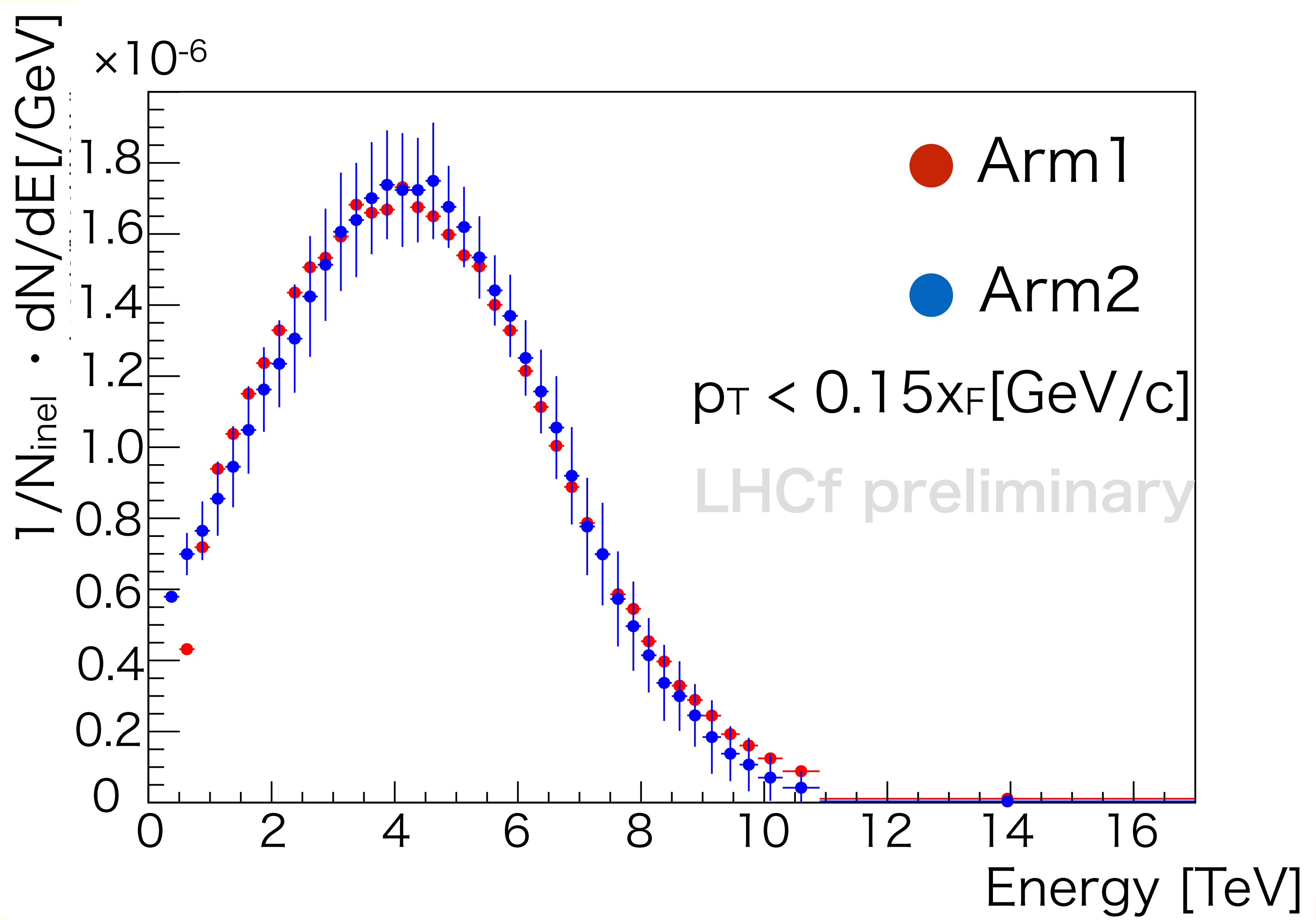
*error: Arm2 systematic + statistic

- Compare with Arm2 ($p_T < 0.15x_F$[GeV/c])

- Compare with $\sqrt{s}$=7TeV(Arm1) ($p_T < 0.11x_F$[GeV/c])

Comparison with the Arm2 spectra

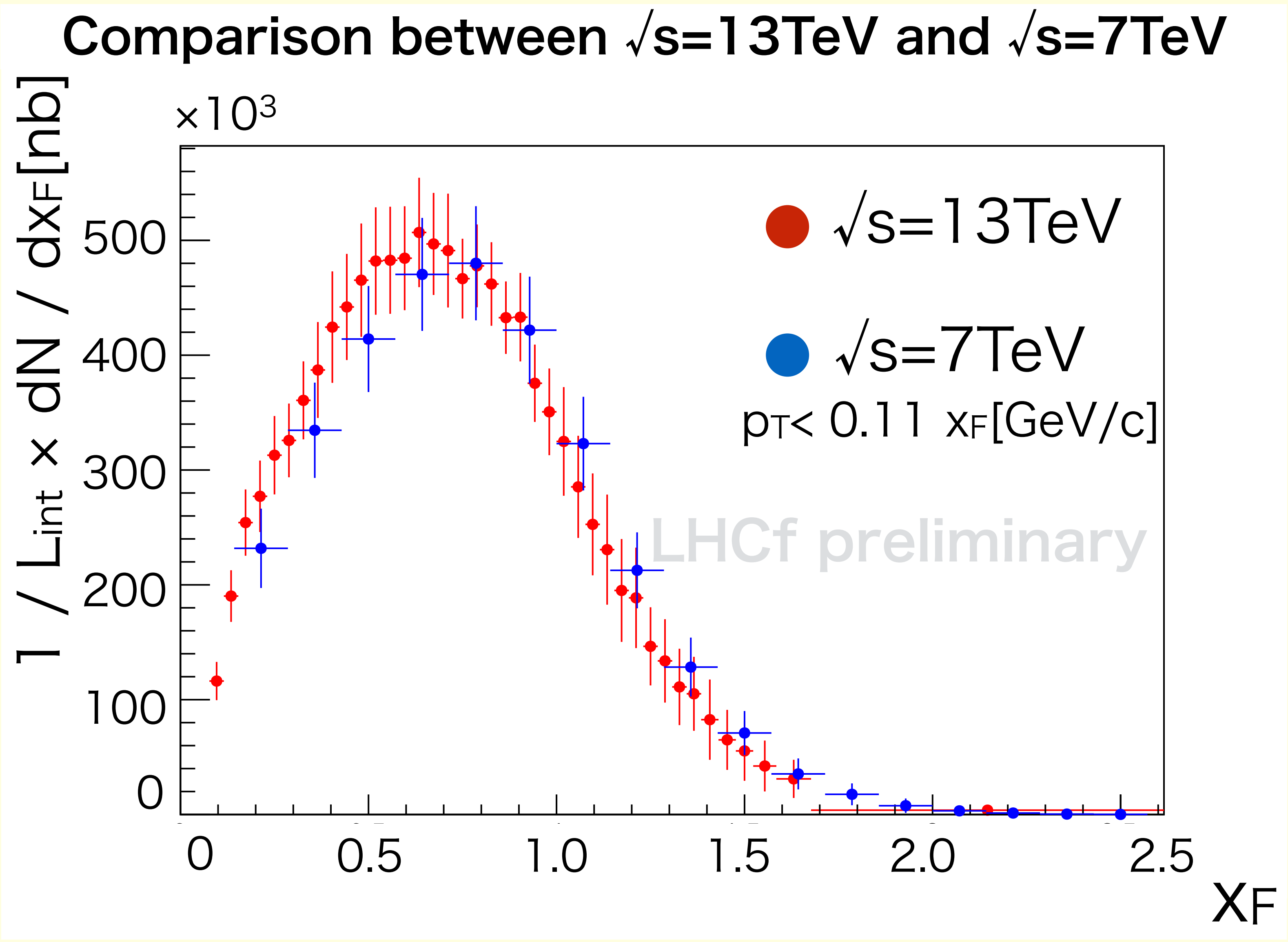
Obtained folded spectra was compared with Arm2 folded spectra.



・Arm1 spectra was consistent with Arm2 spectra in systematic error.

Comparison with √s=7TeV neutron spectra

Obtained √s=13TeV spectra was compared with √s=7TeV spectra.



- √s=13TeV spectra looks like shift to lower x_F.
- √s=13TeV spectra is consistent with √s=7TeV spectra in systematic error.

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Summary

- Neutron energy spectra with $\sqrt{s}$ < 200 GeV p-p collisions are scaled by beam energies.
- But LHCf $\sqrt{s}$ = 7 TeV neutron spectra suggested the possibility of energy dependence with high energy p-p collisions.

- Analyzed LHCf $\sqrt{s}$=13 TeV data and obtained folded neutron energy spectra.
→This result supported the possibility of energy dependence in highest energy collisions.

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The Arm1 neutron analysis is ongoing.
We will obtain the unfolded spectra and combine Arm1 result to Arm2 result.