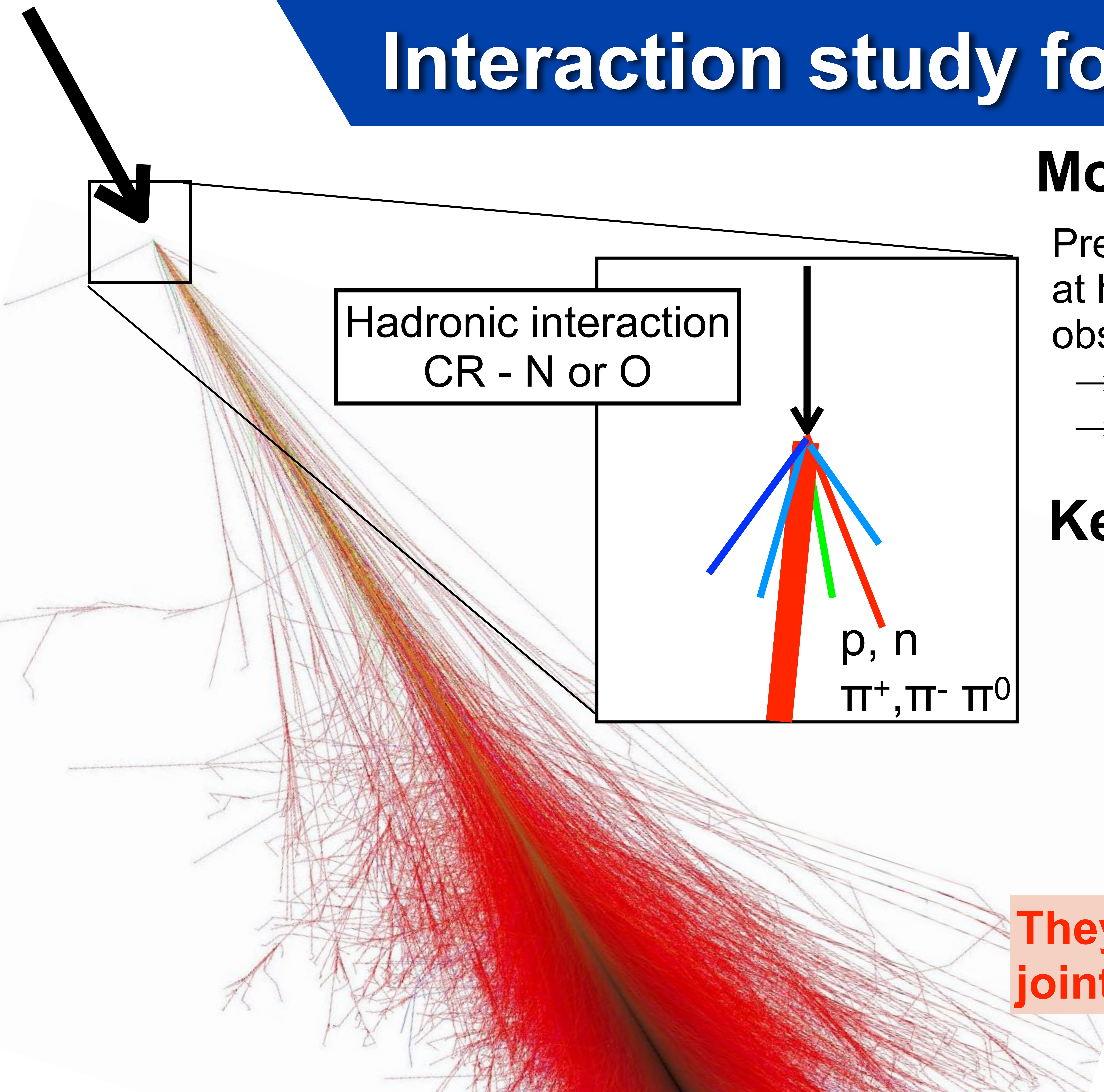
Physics cases of joint analysis (non-spin physics)

H. Menjo (RHICf), *Nagoya Univ*

Interaction study for cosmic-ray physics



Motivation:

Precise understanding of hadronic interaction at high energy is key to improve the cosmic-ray observation using air-shower technique.
→ CR composition (p, CNO, Fe) measurement
→ Muon deficit problem

Key items:

<u>Leading particle production</u>
- Diffractive collisions
- Remnant of interactions

<u>p-π interaction</u>

They can be addressed using joint analysis btw forward and central.

Physics cases

- Central (STAR) - Forward (RHICf) correlation
  - Studies of diffractive collisions

    → Require no-track or large rapidity gap in STAR

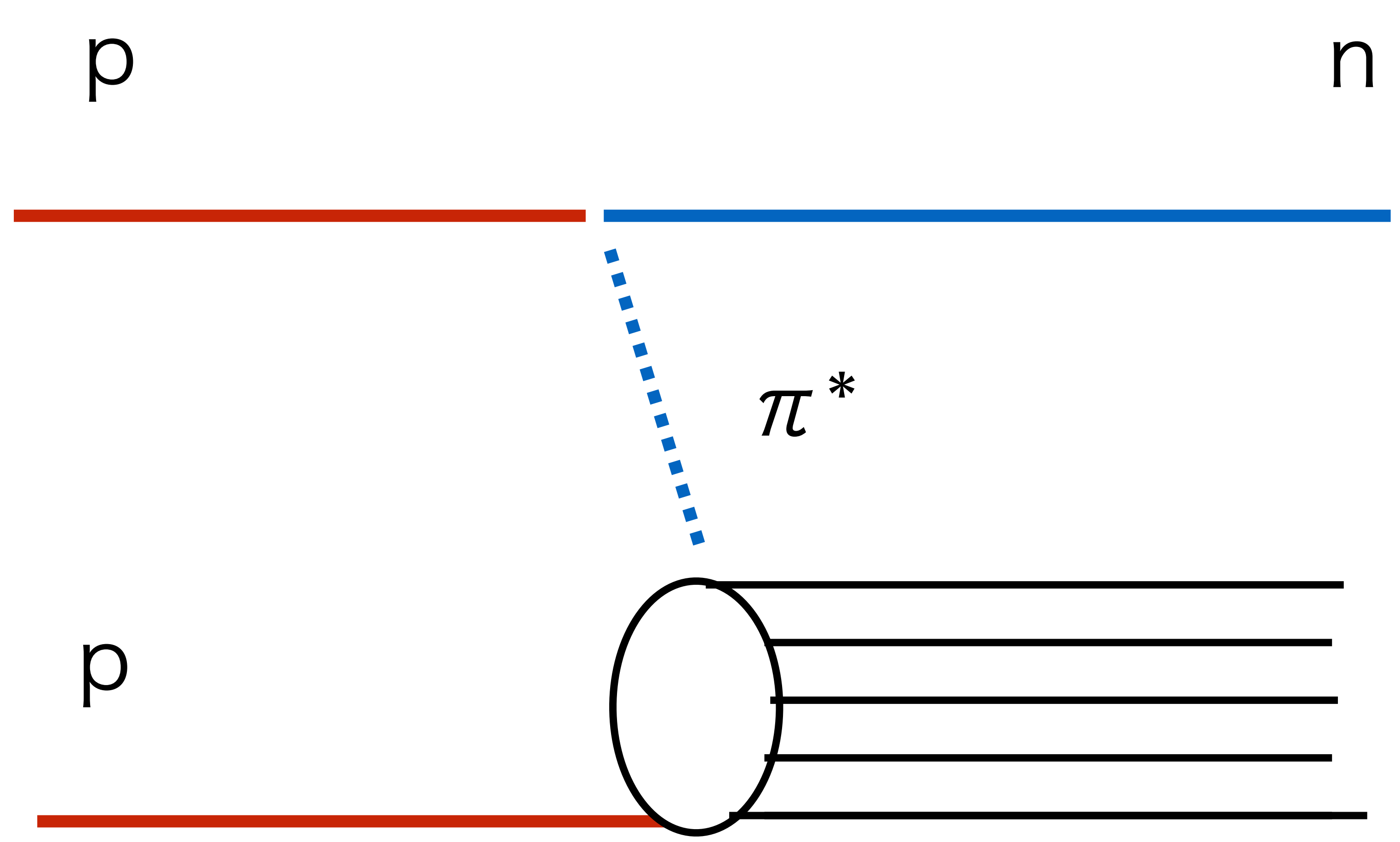
    → Measure particles in RHICf for studying very-low mass diffractive
  - Study of MPI modeling

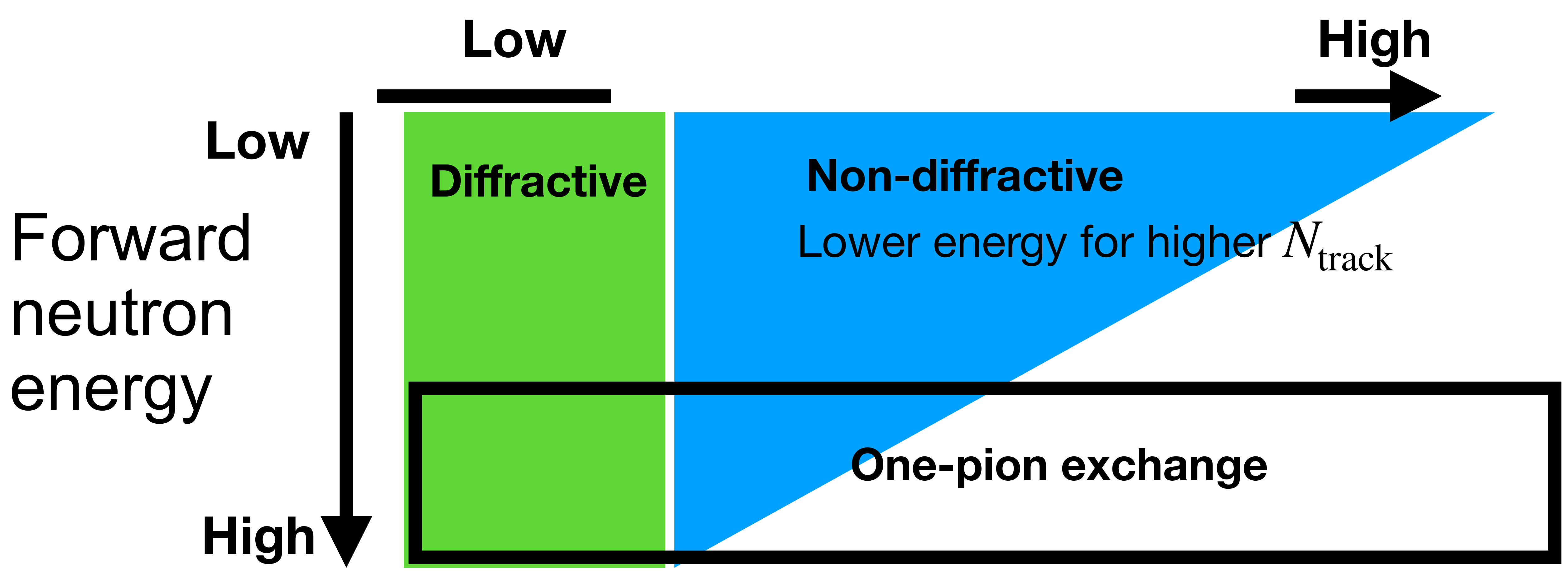
    → Estimate number of MPIs from STAR tracks

    → Measurement of beam remnant (high energy neutron) in RHICf
  - p-π collision via One-Pion exchange

    → Event selection with high energy neutrons in RHICf

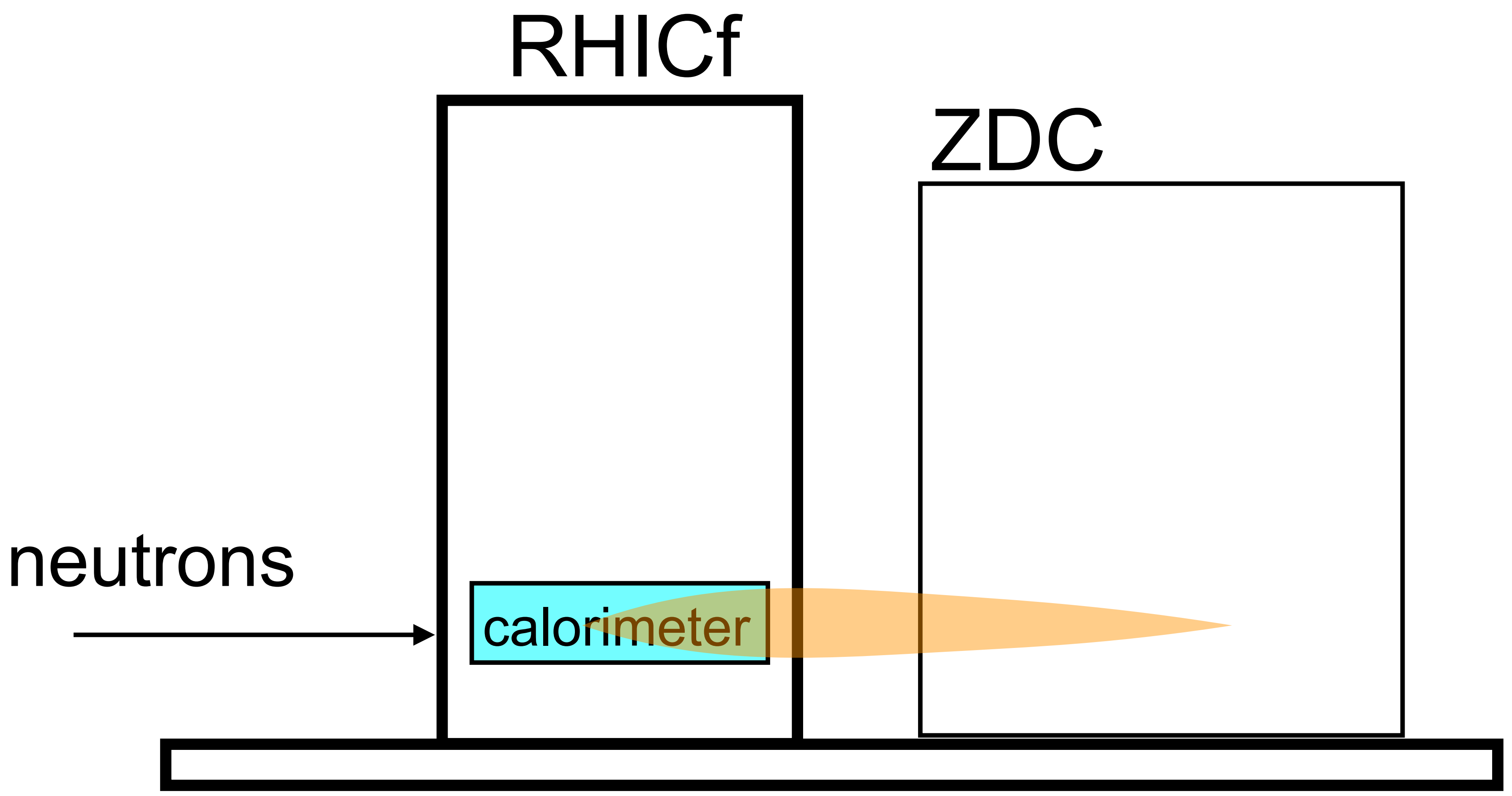
    → Measure the multiplicity in STAR





Physics cases

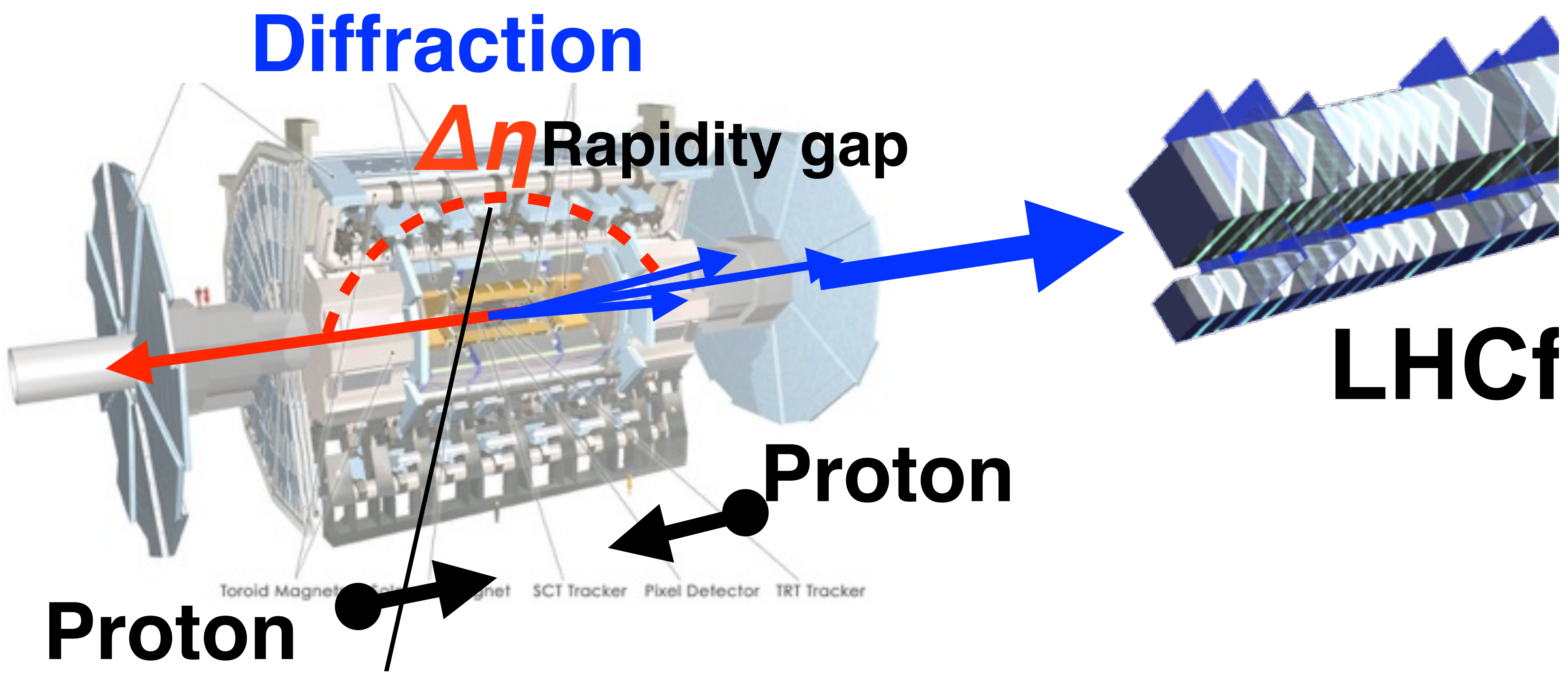
- Forward (STAR-ZDC) - Forward (RHICf)
  - Improvement of neutron measurement
    - Good energy resolution: 20% (⇔ RHICf only 40%)
    - Good position resolution: < 1mm (⇔ ZDC only 1cm)



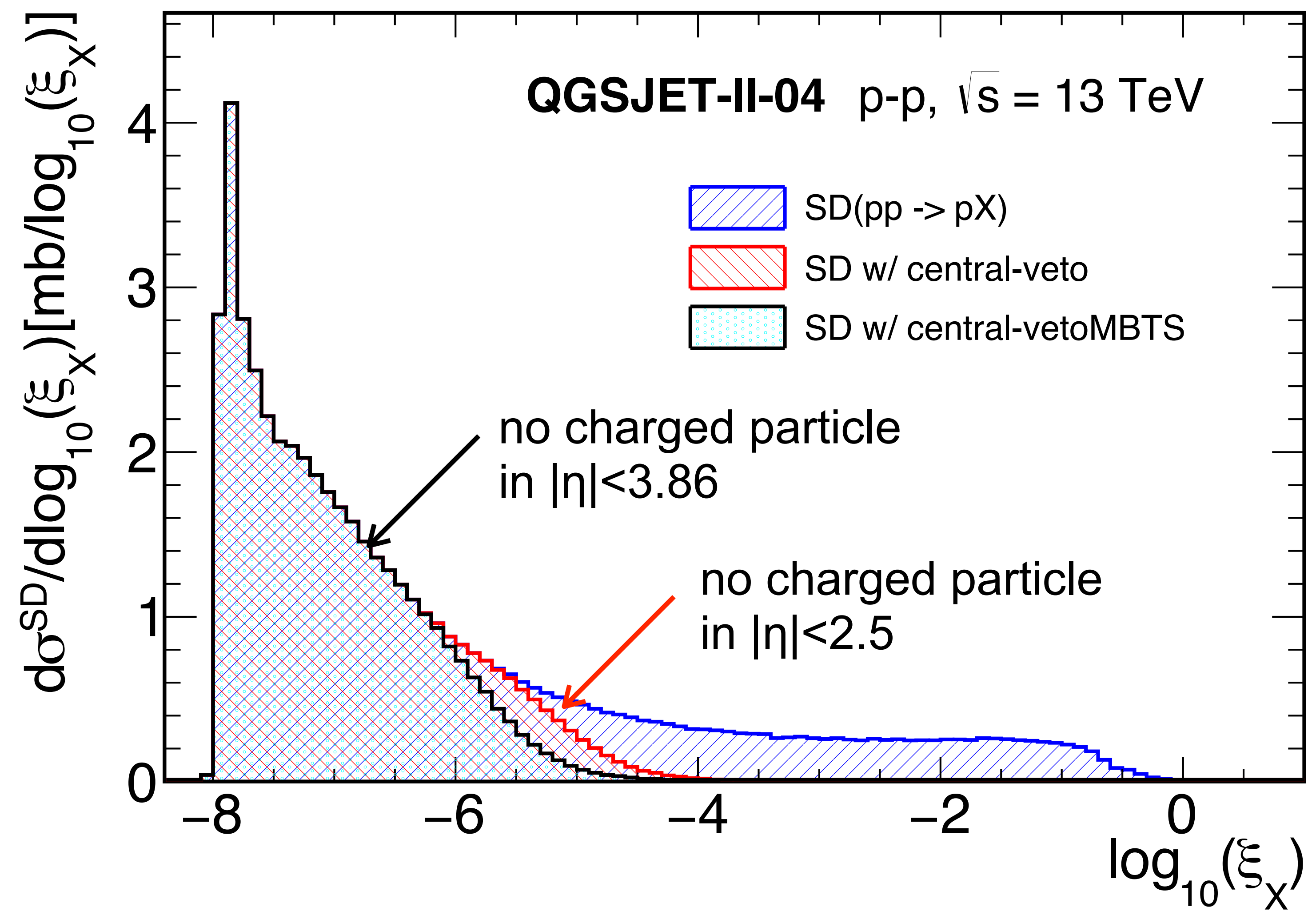
- Forward (STAR-RomanPot) - Forward (RHICf)
  - Detail study of single diffractive interaction
    - Measurement of ξ by RP
    - Measurement of dissociation in RHICf
  - Measurement of resonances
    - Δ resonance → p in RP + π^0 in RHICf

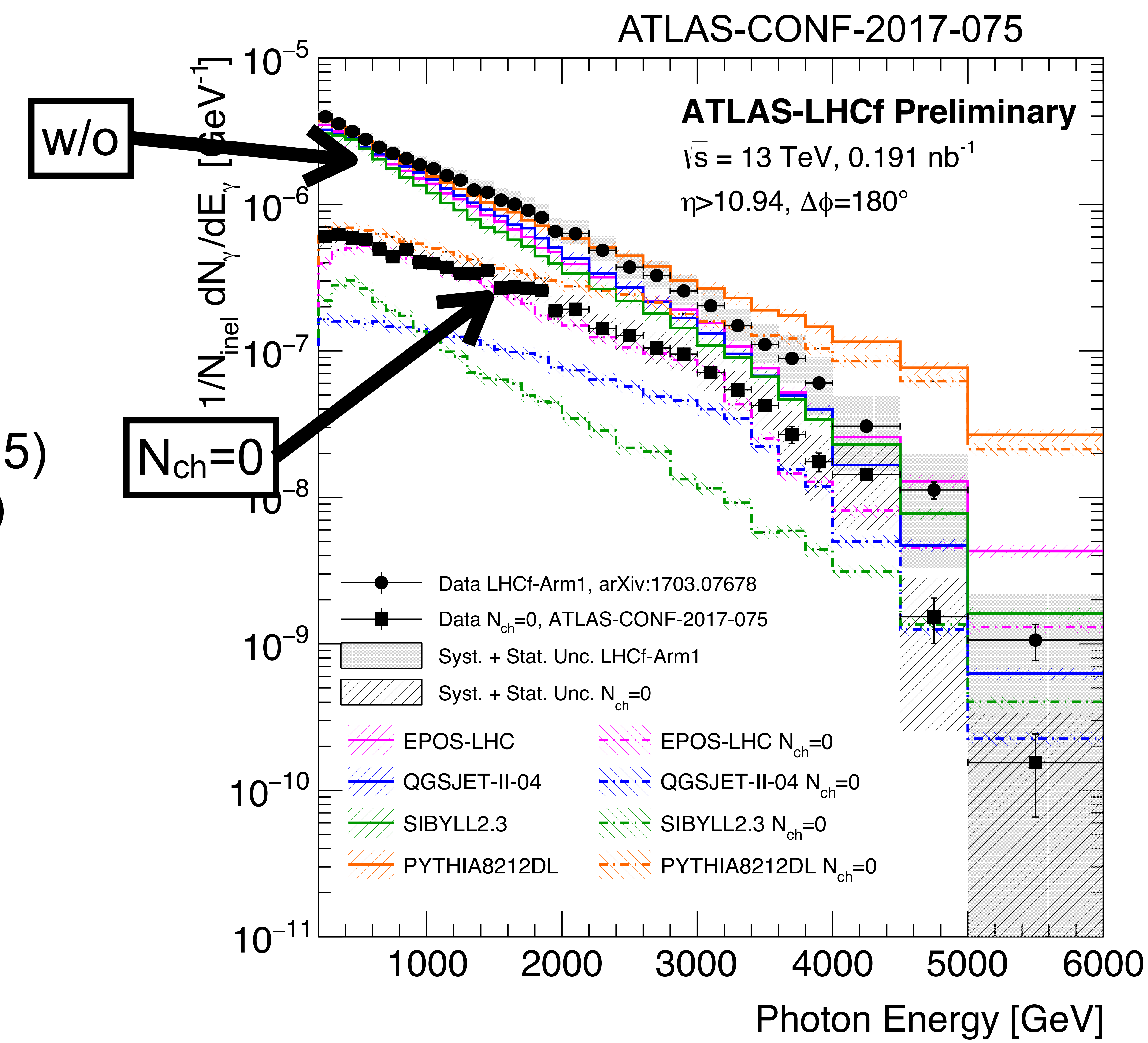
Example: LHCf-ATLAS joint analysis

Measurement of very low-mass diffractive interaction



- require no particle in ATLAS tracker (|η| < 2.5)
  → pure low-mass diff. sample ($\log_{10}\xi$ < -5.5)





Advantage of RHICf+STAR

- Higher statistics than LHCf+ATLAS
  - ~100 M events are available (w/ TPC ~ 30%)
    ⇔ 7 M events of LHCf+ATLAS (pp, $\sqrt{s}$=13TeV)
  - Large π^0 samples

- Experience of LHCf-ATLAS joint analysis
  - Developed method can be applied to RHICf + STAR analyses too.

- Availability of ZDC, RPs
  - ZDC was located behind of RHICf
  - RP was installed in one of the 5 Fills

Backup

Physics 3: Multi-parton interaction

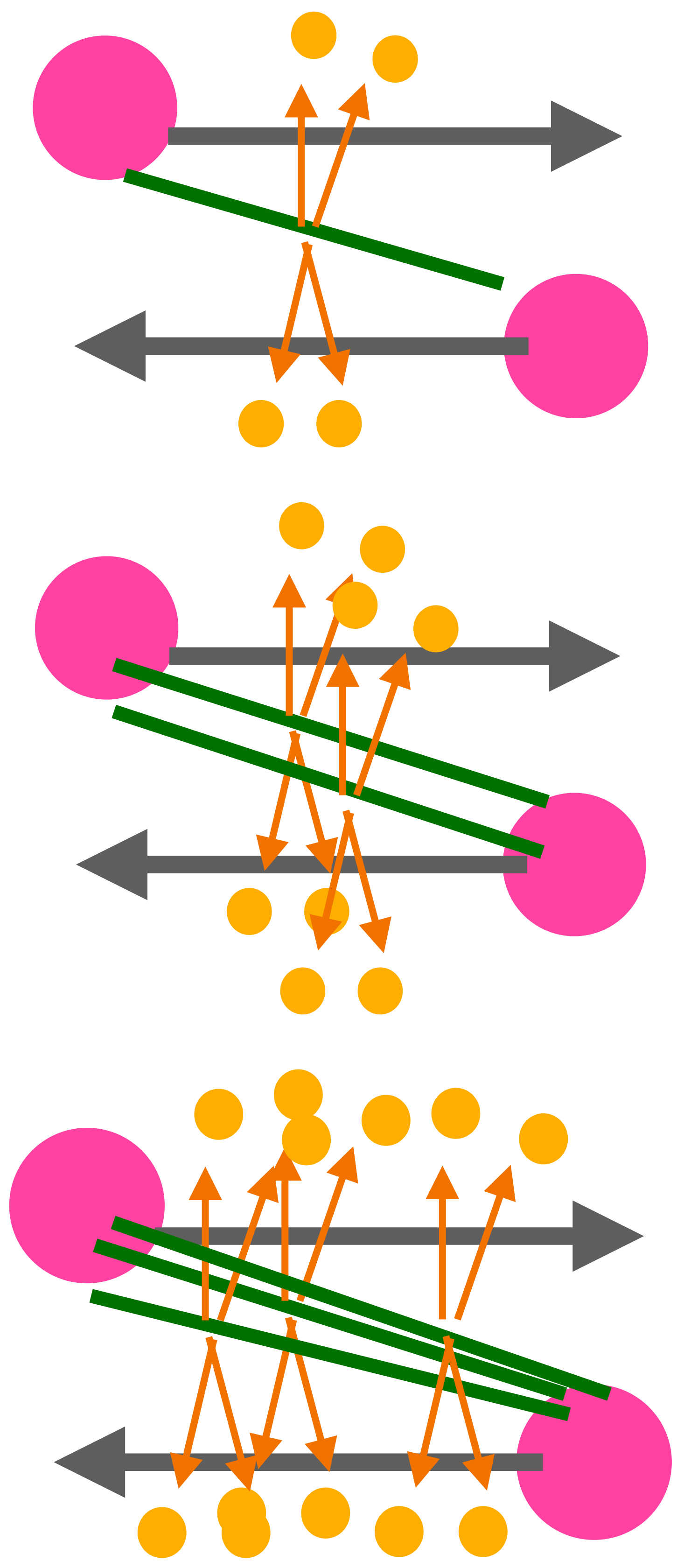
<u>Multi-parton interaction</u>

The number of multi-parton interaction

$N_{MPI} = 1$

$N_{MPI} = 2$

$N_{MPI} = 3$



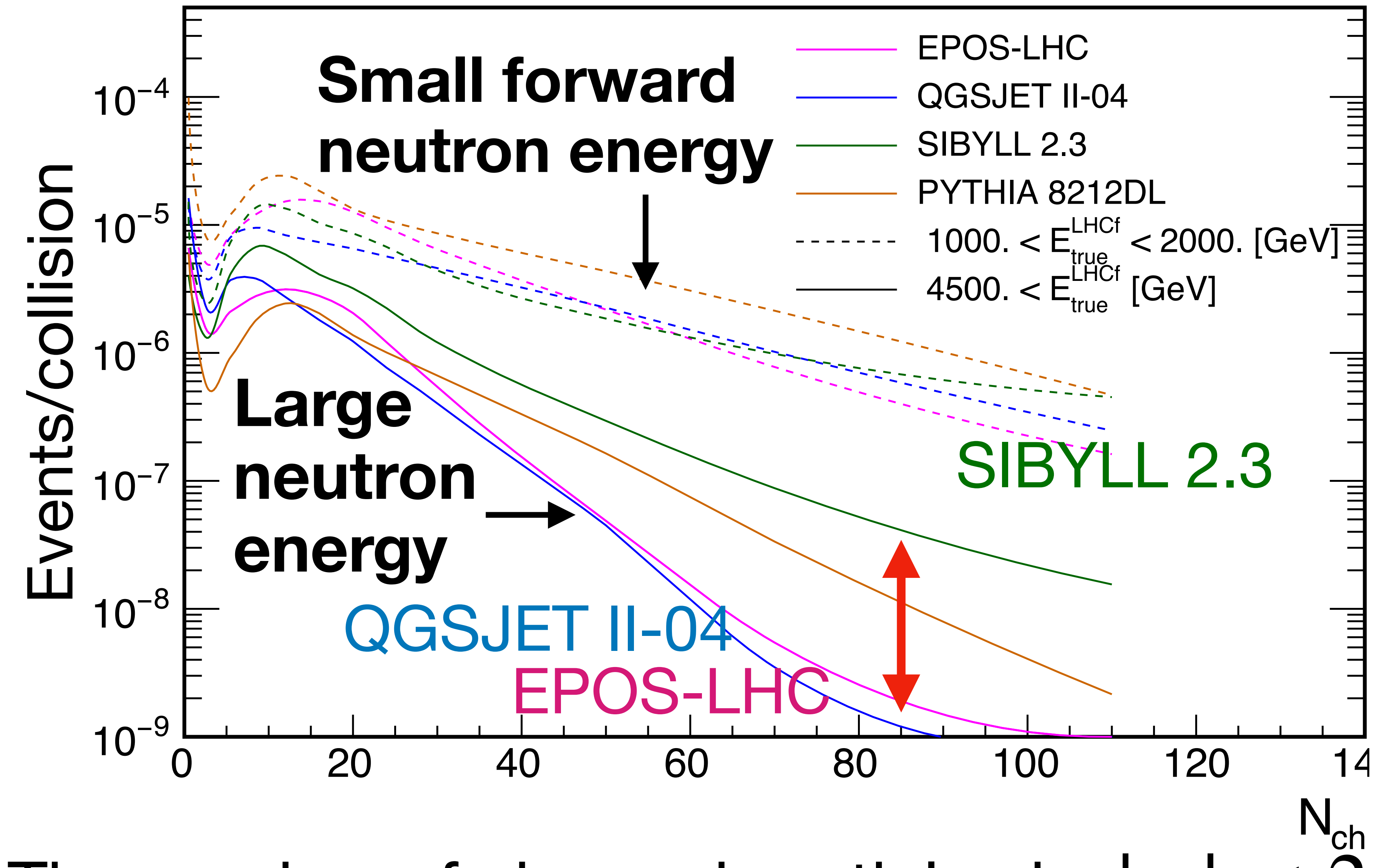
Energy of very forward neutron/ π^0

Large

Small

Large number of particles in central detectors ~ large N_{MPI}

Simulation (LHC, p-p $\sqrt{s} = 13$ TeV)



The number of charged particles in $|\eta| < 2.5$

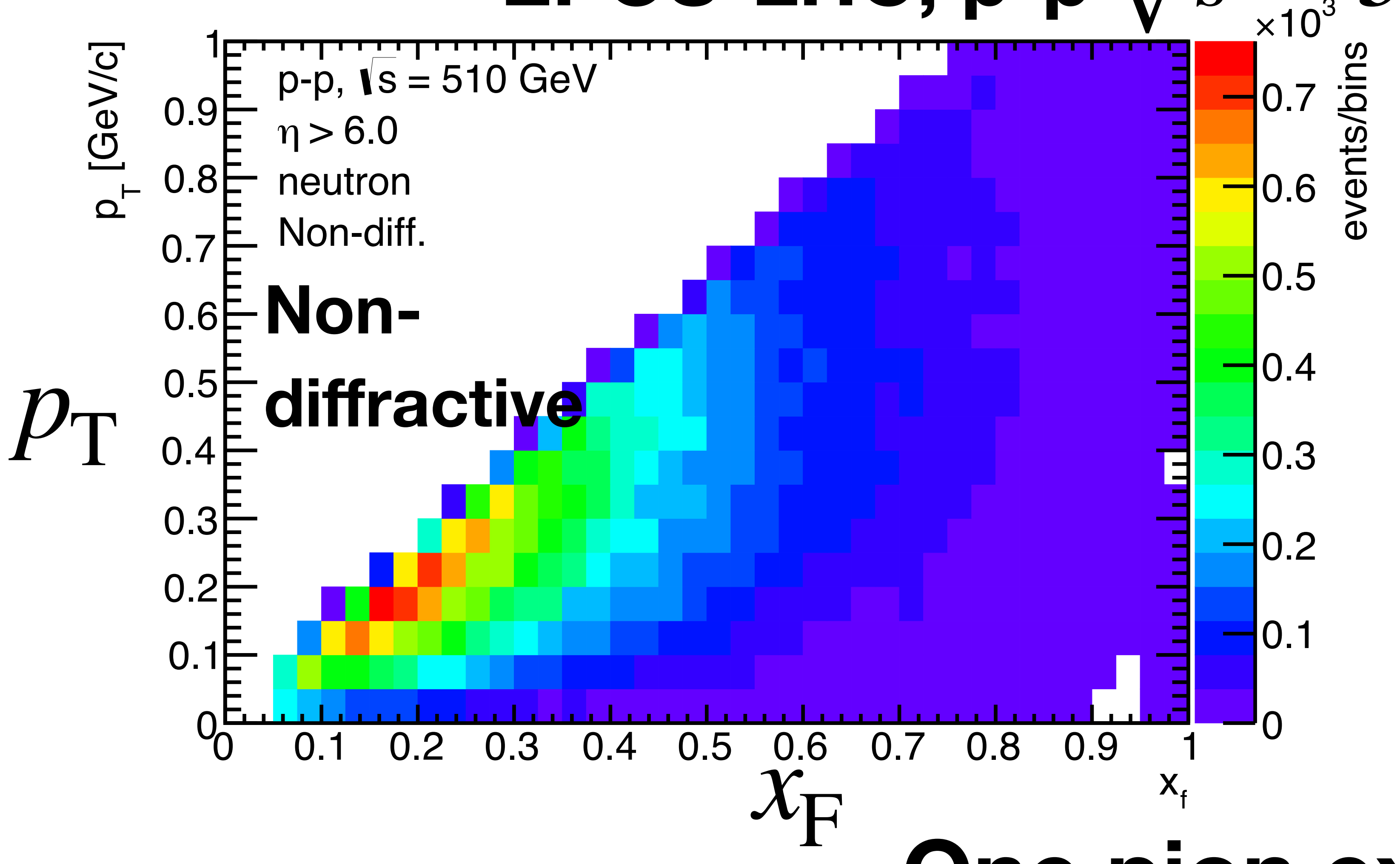
Large difference among models

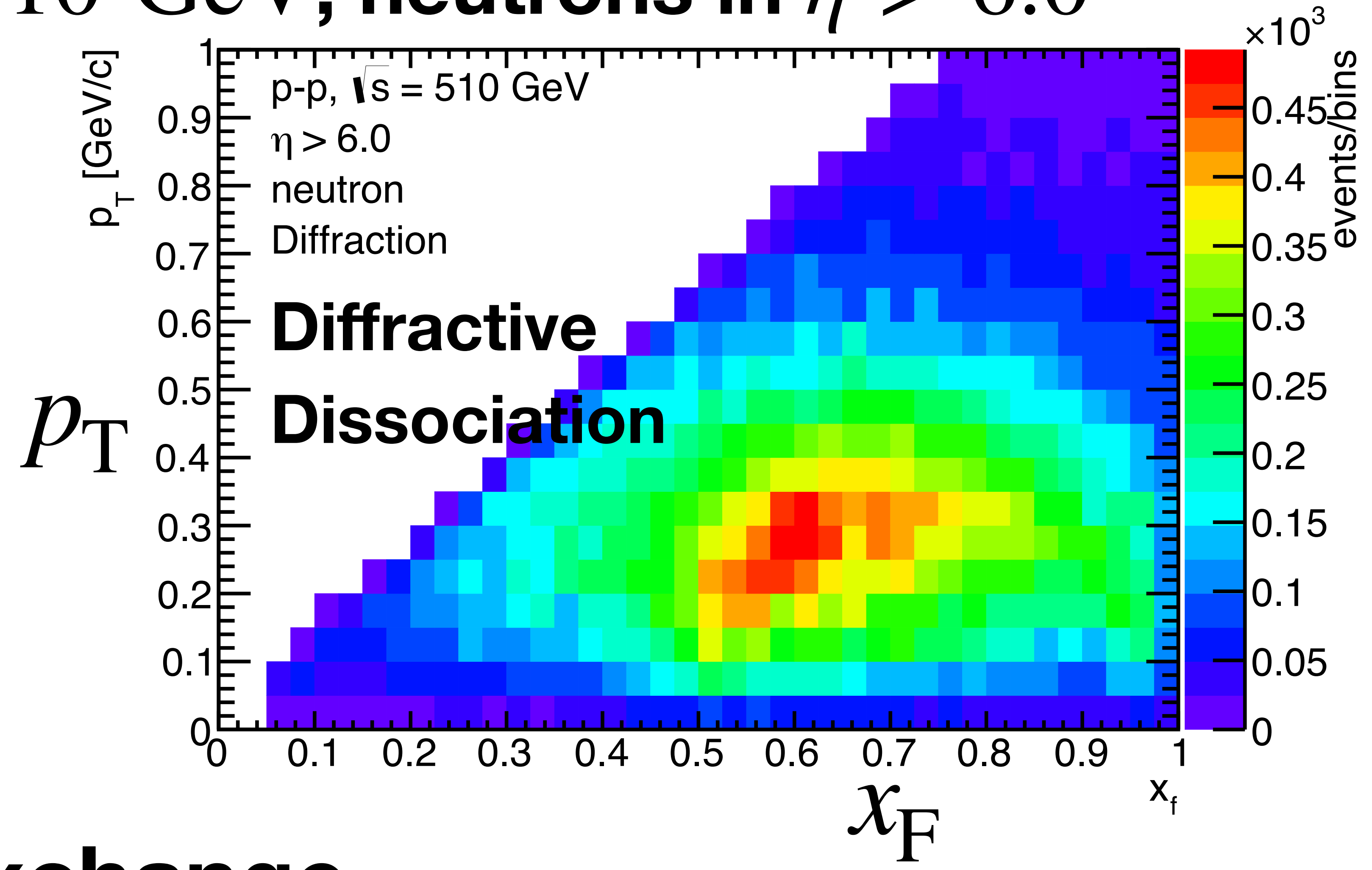
Modeling of MPI makes large difference for high neutron energy & high N_{MPI}

Distributions for each cases

Distributions of forward neutrons

EPOS-LHC, p-p $\sqrt{s} = 510$ GeV, neutrons in $\eta > 6.0$



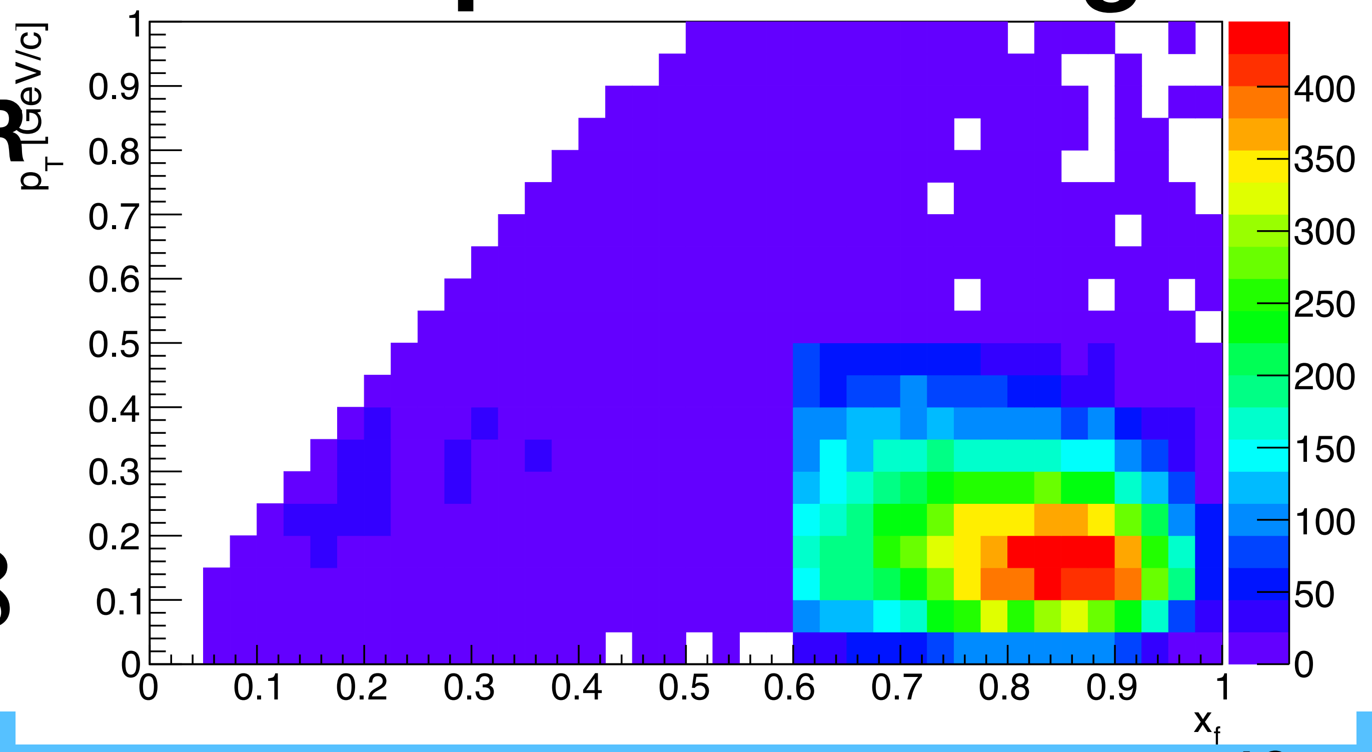


One pion exchange

simulated by MonChER
(arXiv: 1106.2076)

p-p $\sqrt{s} = 13$ TeV

Neutrons in $\eta > 8.8$



For example, for ATLAS-LHCf,

most of neutrons from OPE are in $\eta < 9.5$.

Note: this generator only support
for $\sqrt{s}$ = 900-14000 GeV