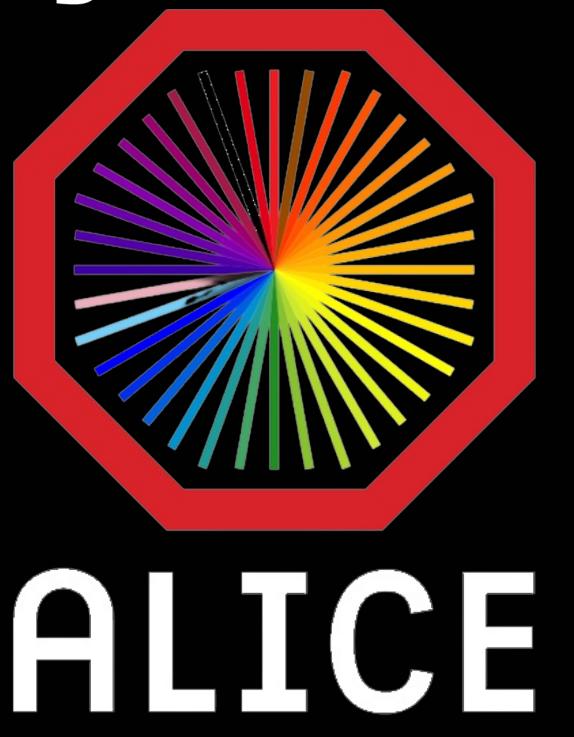
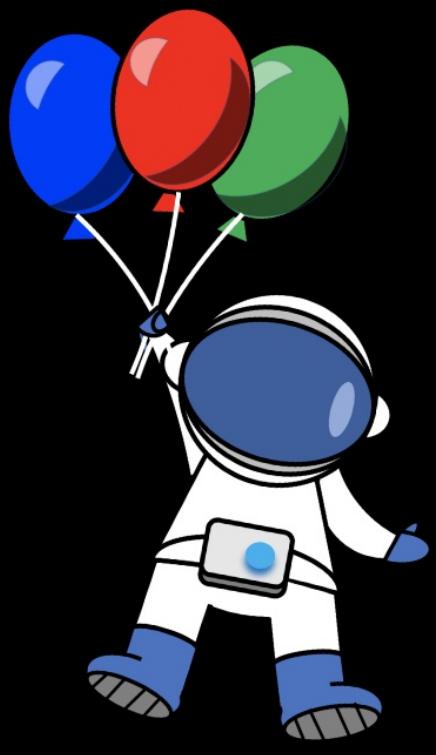


Measurement of light neutral meson production inside jets in pp collisions at $\sqrt{s} = 13$ TeV with ALICE



Joshua König for the ALICE collaboration

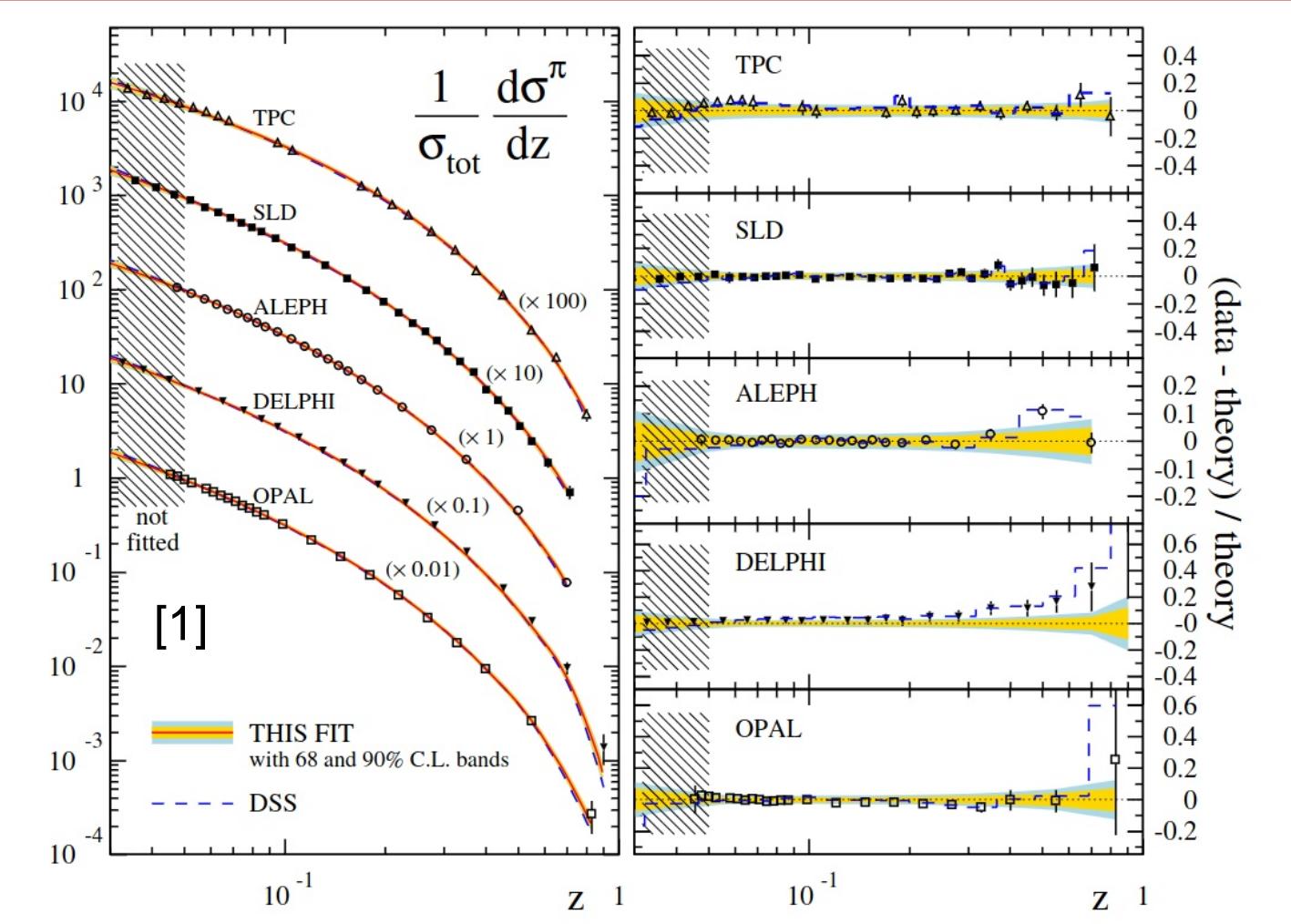
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Motivation

$$E \frac{d^3\sigma}{dp} = \sum_{a,b,c} \text{PDF}_a \otimes \text{PDF}_b \otimes d\sigma_{ab \rightarrow cX} \otimes \text{FF}_c^{H_c}(z_c, Q)$$

Particle production at LHC energies

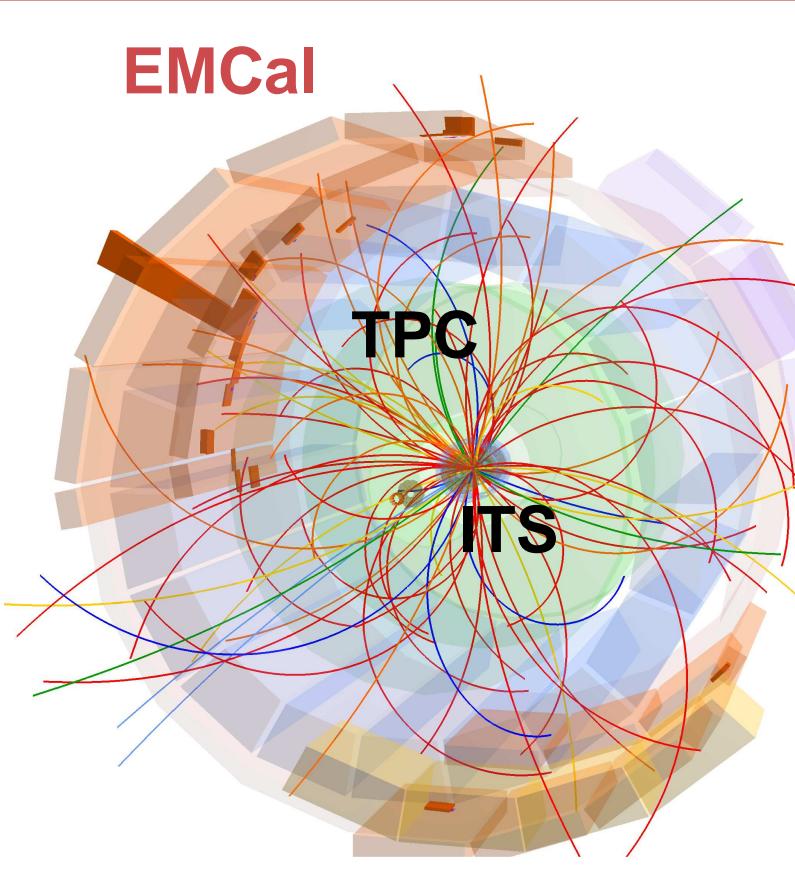
- Fragmentation function (FF) primarily constrained by data from e^+e^- collisions [1][2]
 - Mostly contains $q(\bar{q}) \rightarrow h + X$ FF
 - large uncertainties for $g \rightarrow h + X$ FF
- In pp collisions at LHC: $g \rightarrow h + X$ one of the dominant contributions to hadronization
- Hint at modification of FF in pp collisions compared to e^+e^- [3]
- Scarcity of LHC results as function of momentum fraction $z = \frac{\vec{p}_{\text{part}} \cdot \vec{p}_{\text{jet}}}{|\vec{p}_{\text{jet}}|^2}$



Detector setup

Electromagnetic calorimeter (EMCal)

- Large acceptance
- Trigger detector for jets
- Single cluster measurement up to $E = 200$ GeV
- Photon and neutral jet measurement



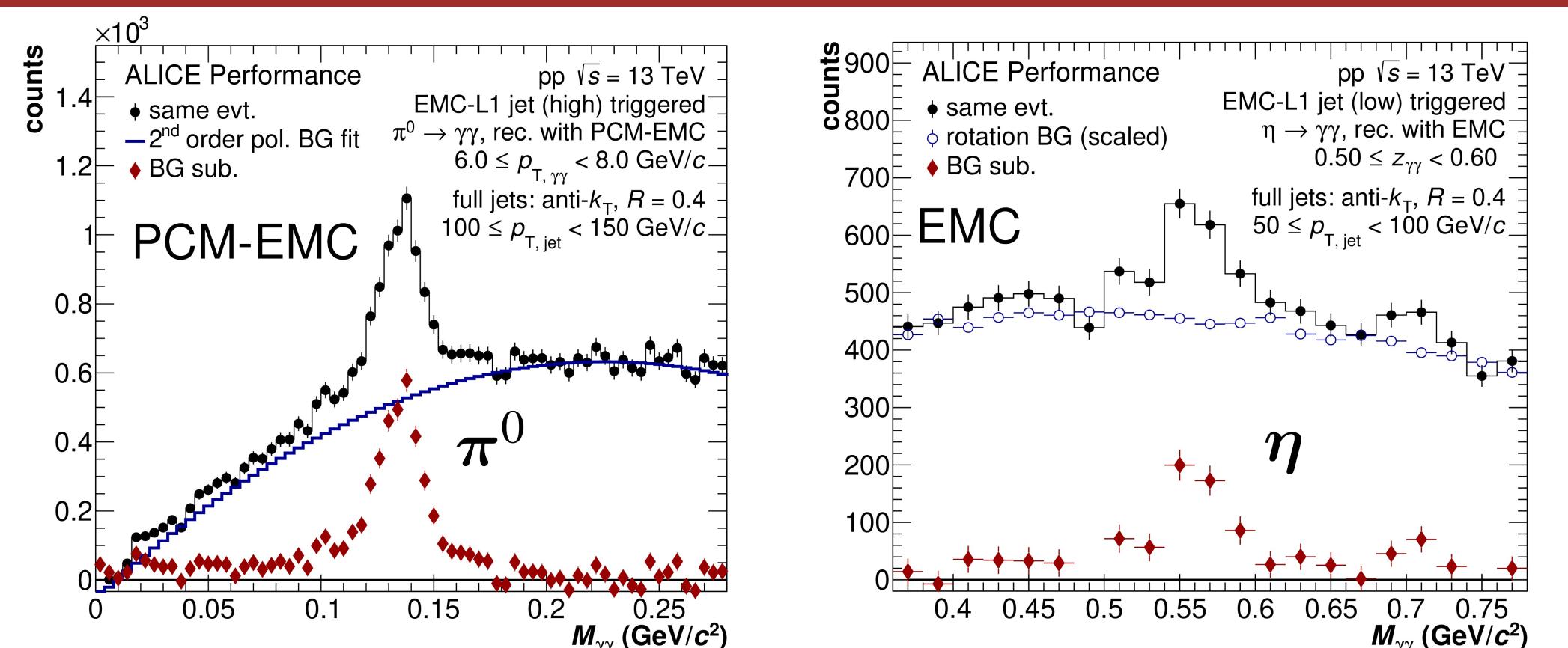
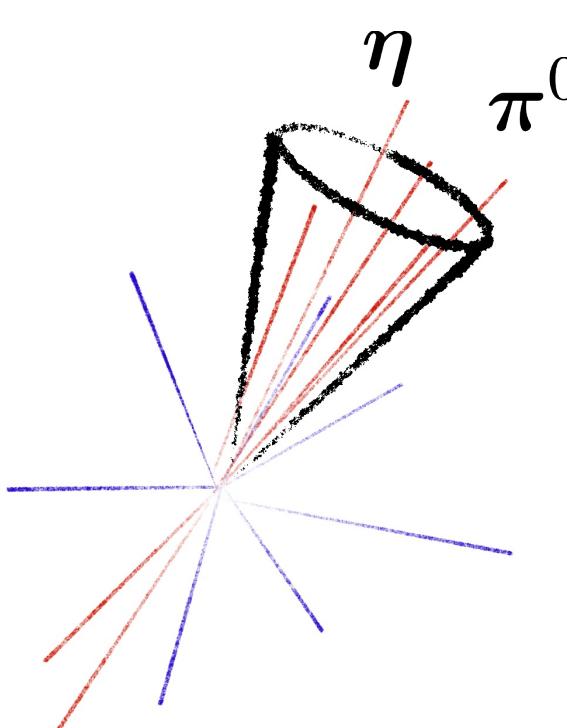
Photon conversion method (PCM)

- Utilizing e^+e^- tracks from converted γ in central tracking detectors
- γ measurement down to $p = 150$ MeV/c

Central tracking system

- Charged particle tracks measured in ITS and TPC
- Charged track and jet measurement

Meson and jet reconstruction



Full-jet reconstruction

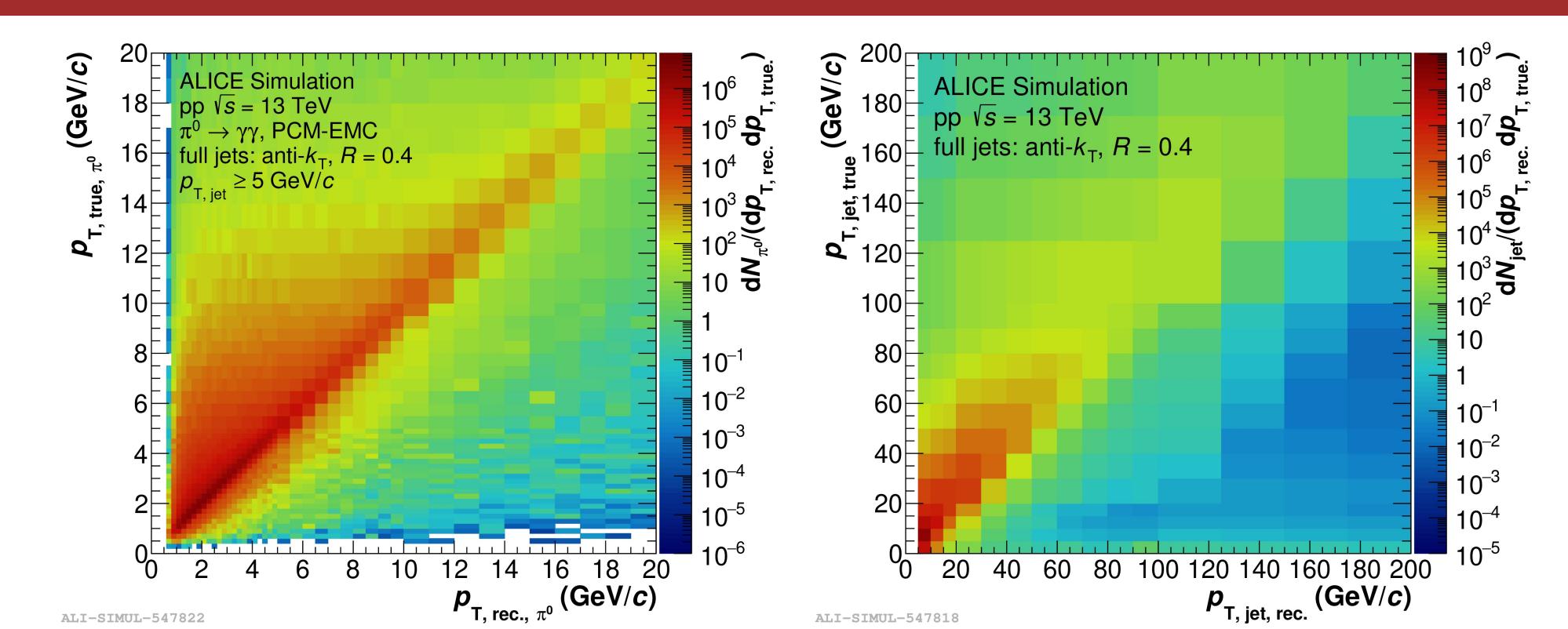
- Charged tracks ($p_{\text{T}, \text{track}} \geq 0.15$ GeV/c)
- Neutral clusters ($E_{\text{clus}} \geq 0.3$ GeV)
- Jet acceptance: $|\eta_{\text{jet}}| < 0.7$
- Anti- k_{T} -algorithm, $R = 0.4$
- Geometrical matching of detector-level jets to MC-level jets

Meson rec: Invariant mass based

- Signal obtained by pair-wise combination of reconstructed photons
- Accept meson candidate if inside jet cone
- Background description using rotation method or param.
- 3 partially independent meson reconstruction methods (EMC, PCM, PCM-EMC)

Corrections

- Signal extraction efficiency (ϵ_{se})
- Secondary π^0 from K_s^0, K_l^0, Λ
- Momentum resolution (ϵ_{res})
- Simultaneous 2-dimensional unfolding of meson and jet momentum
 - Using iterative Bayesian unfolding
- Jet and meson finding efficiency (ϵ_f)
- Branching ratio (BR)



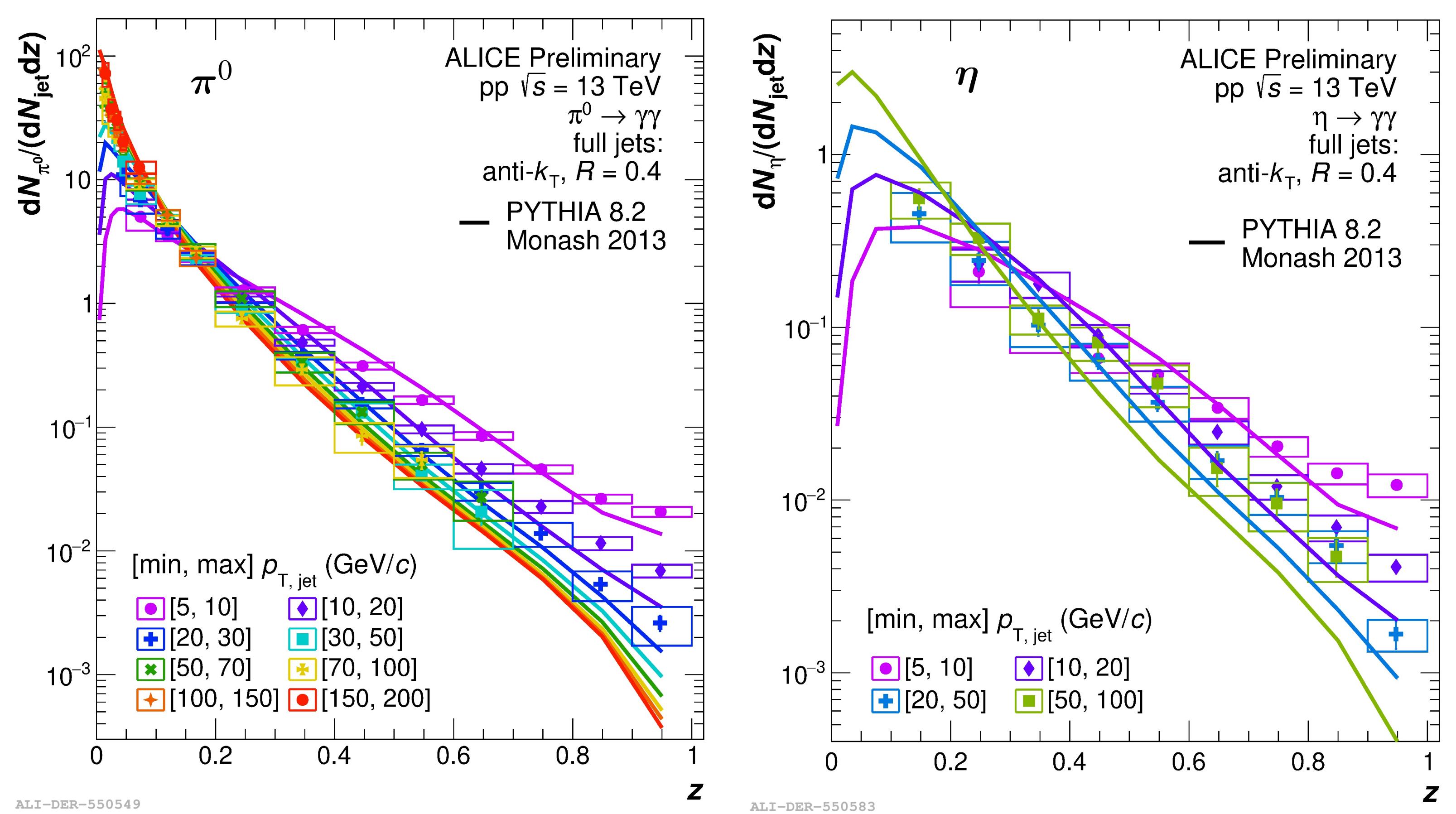
Invariant yield: Normalized per event

$$E \frac{d^3N_{\pi^0, \eta}}{dp^3} = \frac{1}{2\pi N_{\text{evt}}} \frac{1}{\epsilon_{\text{se}} \cdot \epsilon_{\text{res}} \cdot \epsilon_f \cdot BR} \frac{N_{\pi^0, \eta} - N_{\pi^0, \eta}^{\text{sec.}}}{p_{\text{T}} dp_{\text{T}} dz}$$

Fragmentation function: Normalized per jet

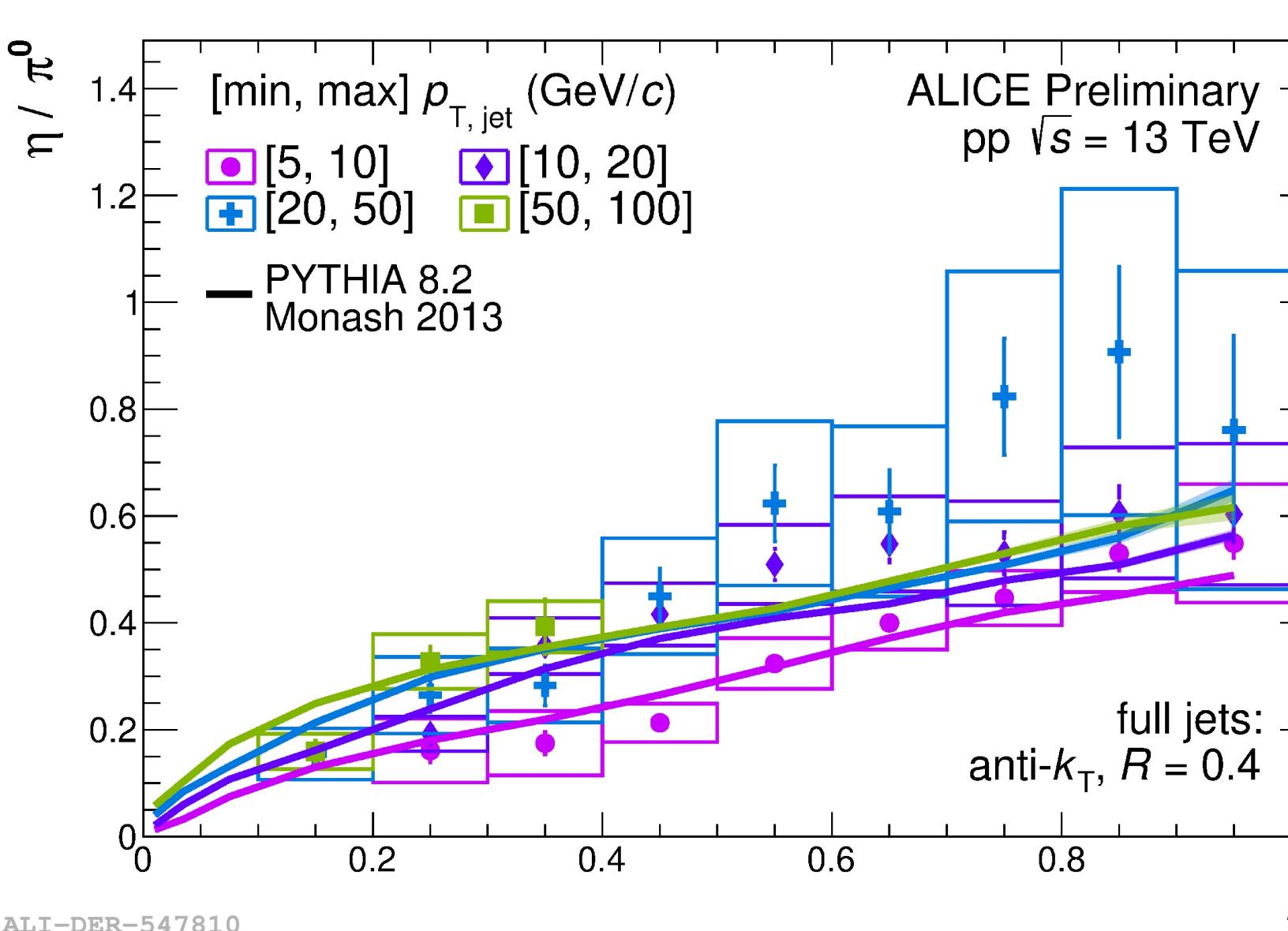
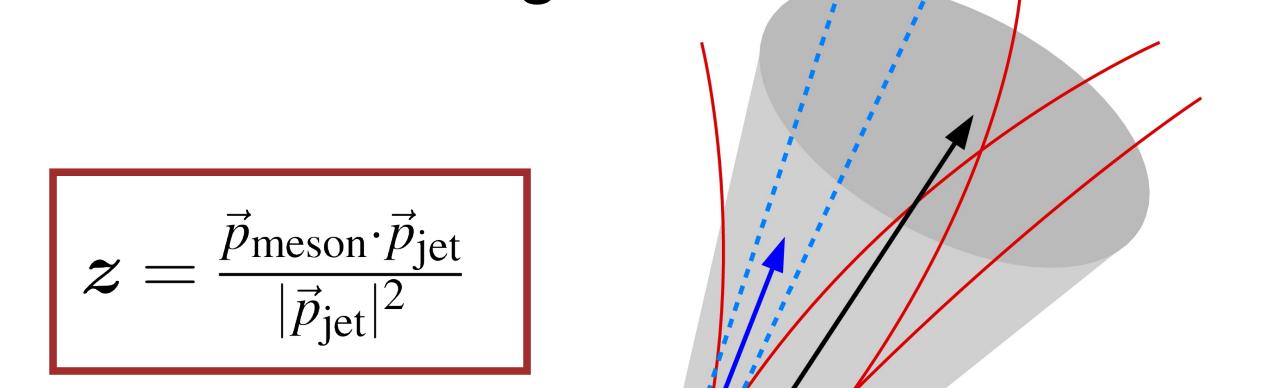
$$FF(p_{\text{T}, \text{jet}}, z) = \frac{1}{N_{\text{jet}}(p_{\text{T}, \text{jet}})} \frac{1}{\epsilon_{\text{se}} \cdot \epsilon_{\text{res}} \cdot \epsilon_f \cdot BR} \frac{N_{\pi^0, \eta} - N_{\pi^0, \eta}^{\text{sec.}}}{dz}$$

Fragmentation function



First measurement of light neutral meson fragmentation function at LHC energies

- Large z coverage for most $p_{\text{T}, \text{jet}}$ intervals
- FF gets softer with rising jet momentum
- Comparison to PYTHIA:
 - Qualitatively describes ordering and shape of data
 - Slightly softer spectra than data



- Extracted in four $p_{\text{T}, \text{jet}}$ intervals
- $p_{\text{T}, \text{jet}} > 10$ GeV/c:
 - Hint at uniform behavior
- $p_{\text{T}, \text{jet}} \leq 10$ GeV/c:
 - Decrease of η spectrum for $z < 0.8$ due to η mass (for $p_{\text{T}, \eta} < 4$ GeV/c)
- Increase in η/π^0 -ratio with rising z :
 - Less feed-down to π^0 spectrum at large z
- Comparison to PYTHIA:
 - Shape and ordering described

Summary

First measurement of π^0 and η mesons inside full jets at LHC energies

- p_{T} spectra: Compatible with inclusive measurement above $p_{\text{T}, \text{jet}}$ threshold
- Modification of η/π^0 -ratio as function of p_{T}
- FF: Measured over large z -range for most $p_{\text{T}, \text{jet}}$
- Softer with rising $p_{\text{T}, \text{jet}}$

Outlook

- Larger p_{T} and z reach for π^0 with purity based merged cluster analysis (up to $p_{\text{T}, \pi^0} = 200$ GeV/c)
- Measurement of angular distribution of π^0 and η mesons with respect to jet axis
- Measurement of neutral mesons and photons in LHC run 3
 - Increased statistics compared to LHC run 1 and run 2
 - New trigger possibilities thanks to offline trigger selection

Quark Matter 2023
Houston, Texas

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Erforschung von
Universum und Materie

HGS-HIRe for FAIR
Helmholtz Graduate School for Hadron and Ion Research

[1] Parton-to-pion fragmentation reloaded: Phys. Rev. D 91, 014035 (2015)

[2] Fragmentation Functions in e^+e^- , ep, and pp collisions: Prog. Theor. Exp. Phys. 2020, 083C01 (2020)

[3] Charm production and fragmentation fractions in pp collisions: Phys. Rev. D 105, L01103 (2022)