Examination of the universal behavior of the η/π^0 ratio in heavy-ion collisions
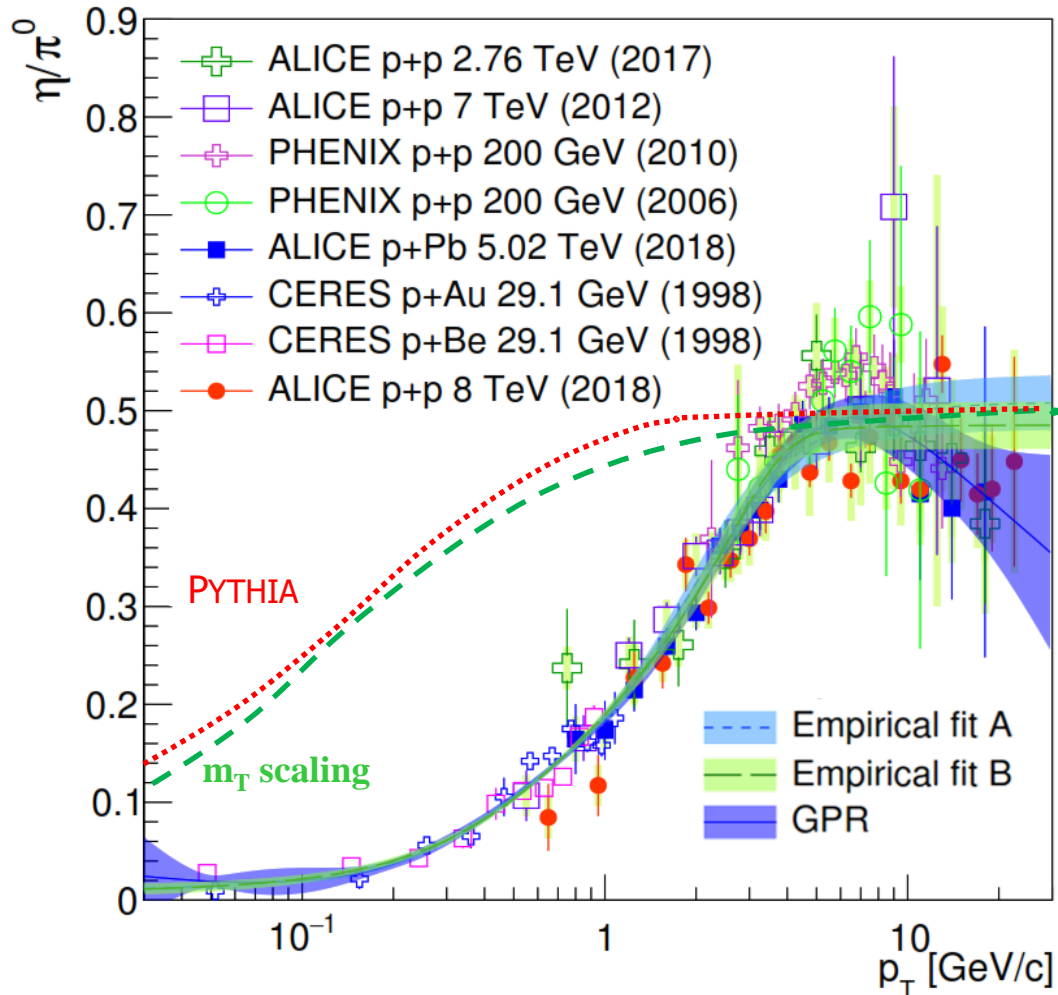
- **Universal η/π^0 Ratio as function of p_T**
  - **For p+p and p+A form $\sqrt{S_{nn}} = 29.1$ GeV to 8 TeV**
  - **Deviations from m_T scaling for $p_T < 3$ GeV/c**
- **Universal high p_T value of $\eta/\pi^0 = 0.487 \pm 0.024$**
  - **From p+p to A+A, across all beam energies, and collision centralities**
- **Effect of radial flow in A+A collision**
  - **Small at RHIC energies or below, maybe more significant at LHC energies**

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Universal η/π^0 Ratio

Master Thesis Yuanjie Ren, SBU 2020 – **Phys.Rev.C104 (2021) 054902**

- **Universal η/π^0**
  - **For p+p and p+A collisions**
  - **Covering factor ~300 in $\sqrt{s}$ from 29 GeV to 8 TeV**

- **Significant deviation from m_T scaling below 2-3 GeV p_T**

- **High p_T value:** $\dfrac{\eta}{\pi^0} = 0.487 \pm 0.024$

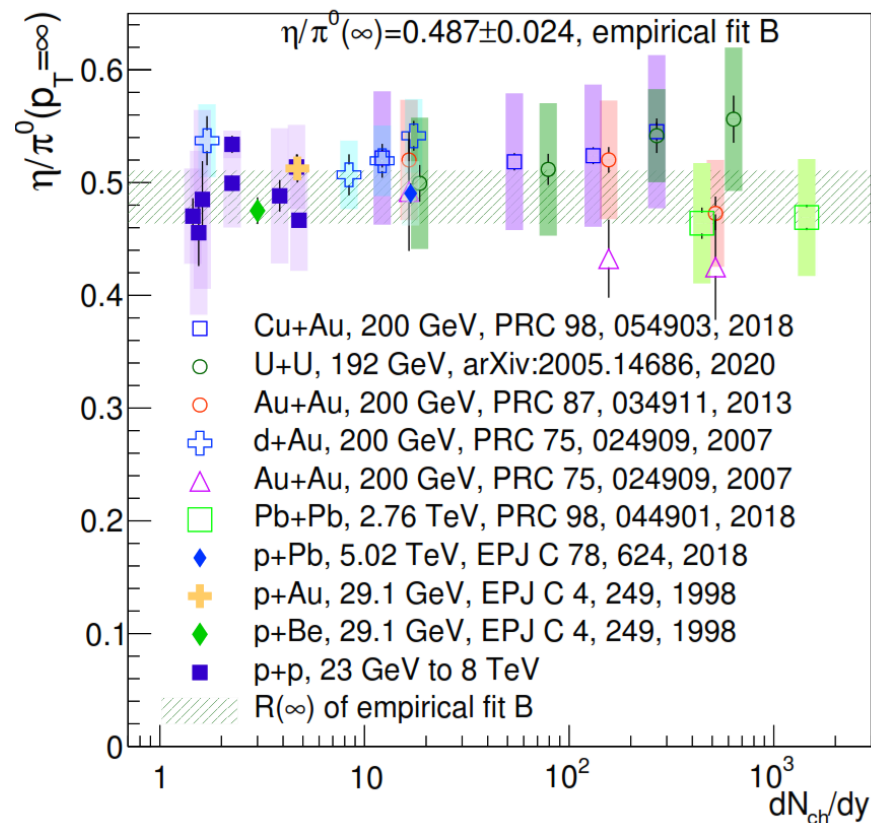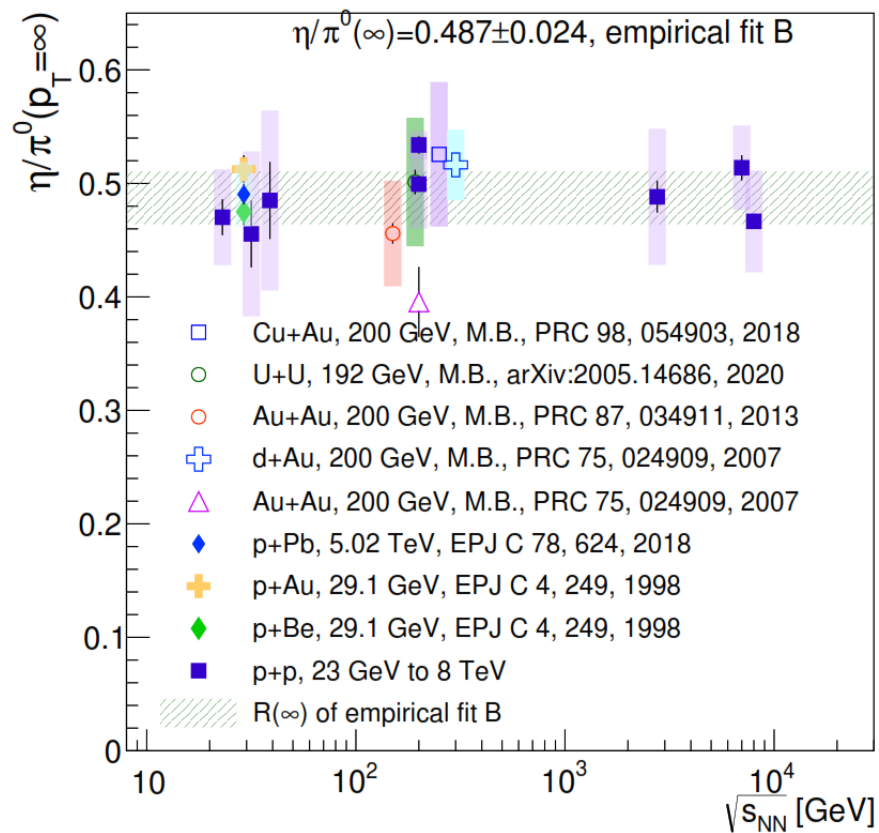- **Use empirical description for all collision systems:**

$$\frac{dN_\eta}{dp_T} = \left(\frac{\eta}{\pi^0}\right)^{universal} \left(\frac{dN_{\pi^0}}{dp_T}\right)^{data}$$

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Test of Universality of η/π^0 Ratio

- **Fit all available data (with empirical fit B)**
  - **Independent of $\sqrt{s}$, particle multiplicity, and centrality**

Universality of η/π^0

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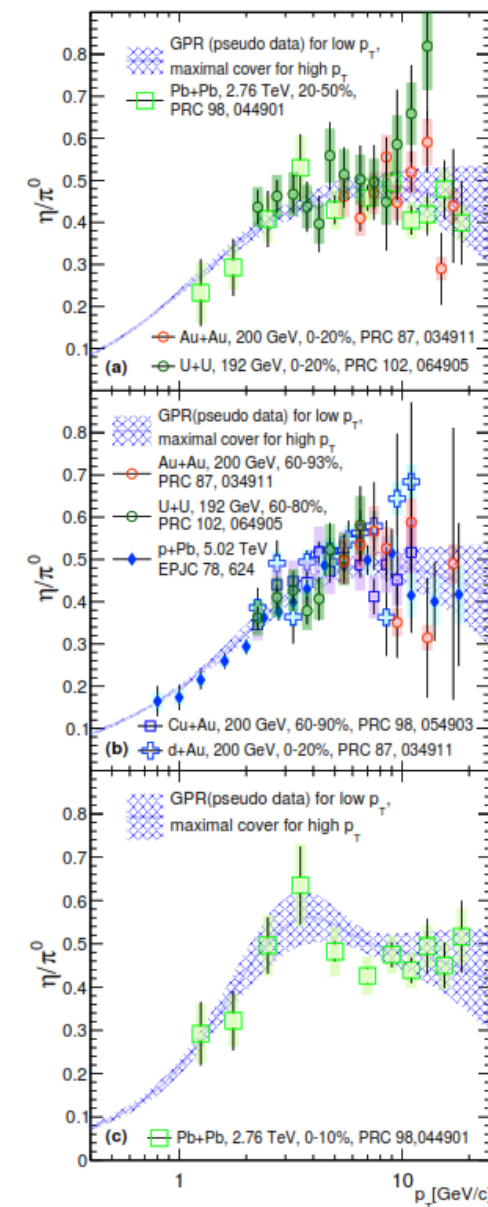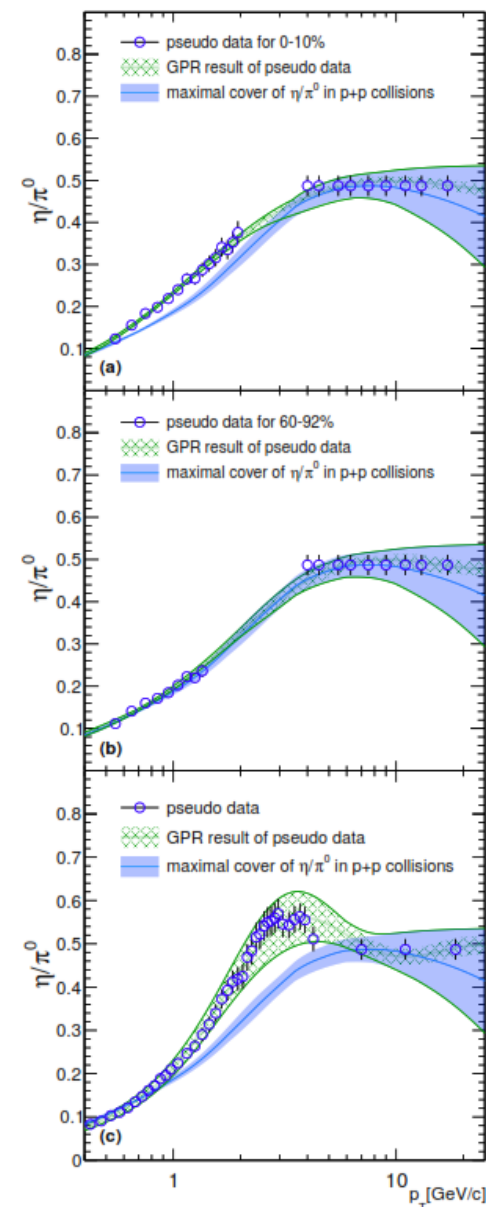
What about Radial Flow at Low p_T?

● **Approximate η with K meson at low p_T**

  ○ **Similar mass**
  ○ **More complete low p_T data**

$$R_{flow} \equiv \frac{\left(\frac{\eta}{\pi^0}\right)_{C_i}}{\left(\frac{\eta}{\pi^0}\right)_{p+p}} \approx \frac{\left(\frac{K^\pm}{\pi^\pm}\right)_{C_i}}{\left(\frac{K^\pm}{\pi^\pm}\right)_{p+p}} \equiv \frac{\left(R_{AA}^{K^\pm}\right)_{C_i}}{\left(R_{AA}^{\pi^\pm}\right)_{C_i}}$$

● **Apply correction to universal η/π^0**

RHIC: small correction
LHC: more substantial correction

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Improved Photon Contribution from η Meson

- **Significant improvement of uncertainties on η/π^0 Ratio at RHIC**
  - Smaller contribution below 10 GeV compared to m_T scaling assumption
  - Partially compensated in central collisions be flow effect
  - Consistent with previous estimate within quoted systematic uncertainty

- **Use new empirical η/π^0 Ratio moving forward:**

$$\frac{dN_\eta}{dp_T} = \left(\frac{\eta}{\pi^0}\right)^{universal} \left(\frac{dN_{\pi^0}}{dp_T}\right)^{data}$$

  - Applicable to all collision systems
  - Does not require η data at low p_T
  - Requires K meson data at low p_T

- **m_T scaling based on η meson for heavier mesons**

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