Δ^{++} *and triply charged pentaquark* Δ^{+++} *studies at the SPD NICA experiment*

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- Introduction and motivation
- Δ^{++} study
- Δ^{+++} study
- Conclusion and summary

Introduction and motivation

From L. Gladilin report at session of SNP DPS RAS (April 1-5, 2024) at JINR, Dubna.

Interesting options for NICA:

Triply charged pentaquarks: $(uuuu\bar{d}) = \Delta^{+++} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,\pi^+$

$(uuuu\bar{s}) = \Delta_s^{+++} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,K^+$

Pentaquarks with hidden strangeness: $(uuus\bar{s}) = P_s^{++} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,\phi\,(\rightarrow K^+K^-)$

$(uuds\bar{s}) = P_s^{+} \rightarrow p\,\phi\,(\rightarrow K^+K^-)$

$(udds\bar{s}) = P_s^{0} \rightarrow \Lambda^0 (\rightarrow p\,\pi^-)\,K^0_S\,(\rightarrow \pi^+\pi^-)$

Check for $(ud\bar{u}d\bar{s}) = \theta^+$: $\theta^+ \rightarrow K^0_S p$, $\theta^+ \rightarrow K^+ n$ (?)

and with charm at NICA II:

Charmed pentaquarks: $(uuuu\bar{c}) = \Delta_c^{++} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,\bar{D}^0 (\rightarrow K^+\pi^-)$

$(uuud\bar{c}) = \Delta_c^{+} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,D^- (\rightarrow K^+\pi^-\pi^-)$

Search for $(ud\bar{u}d\bar{c}) = \theta_c^0 \rightarrow \theta^+\pi^-, pK^0\pi^-, D^{(*)-}p, \ldots$

Pentaquarks with hidden charm $(uuuc\bar{c}) = P_c^{++} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,J/\psi\,(\rightarrow \mu^+\mu^-)$

$(uudc\bar{c}) = P_c^{+} \rightarrow p\,J/\psi,\ \Lambda_c^+ (\rightarrow K^-\,p\,\pi^+)\,\bar{D}^0 (\rightarrow K^+\pi^-)$

$(uddc\bar{c}) = P_c^{0} \rightarrow \Lambda_c^+ (\rightarrow K^-\,p\,\pi^+)\,D^- (\rightarrow K^+\pi^-\pi^-)$

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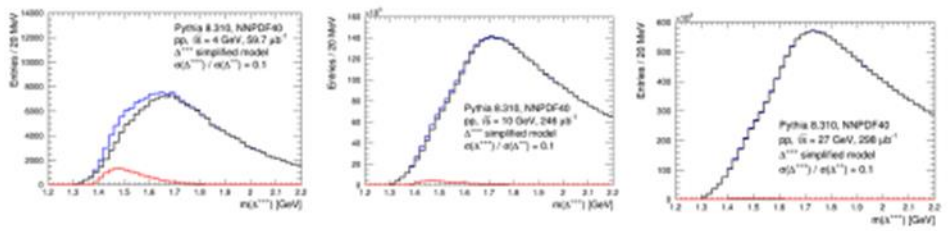
$\Delta^{+++} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,\pi^+$, reconstructed mass

combine proton with two positively charged pions

require (1.14 < m(p π_1^+) < 1.32) || (1.14 < m(p π_2^+) < 1.32) (~97% eff.)



data-driven background shape estimation is needed

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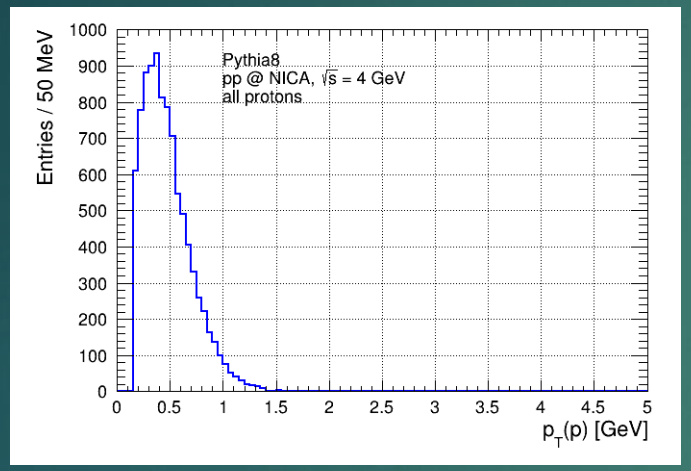
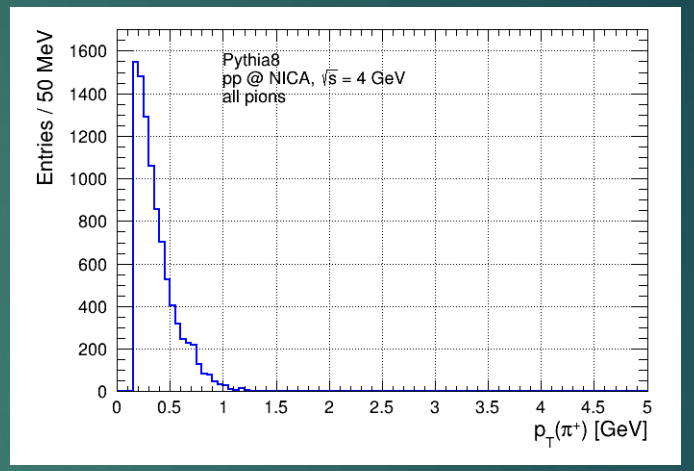
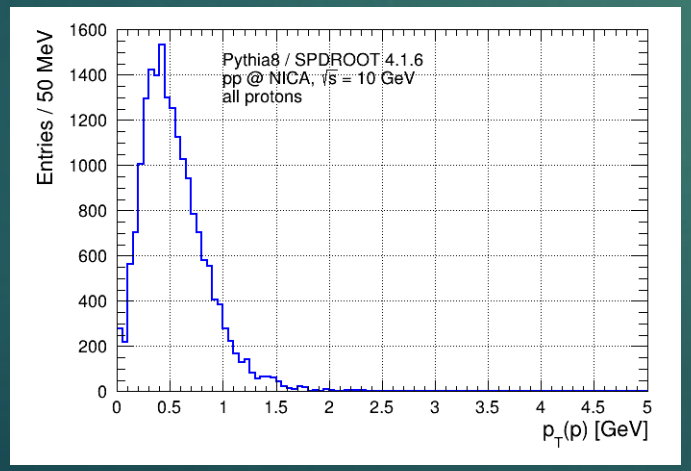
Δ^{++} study: Event simulation

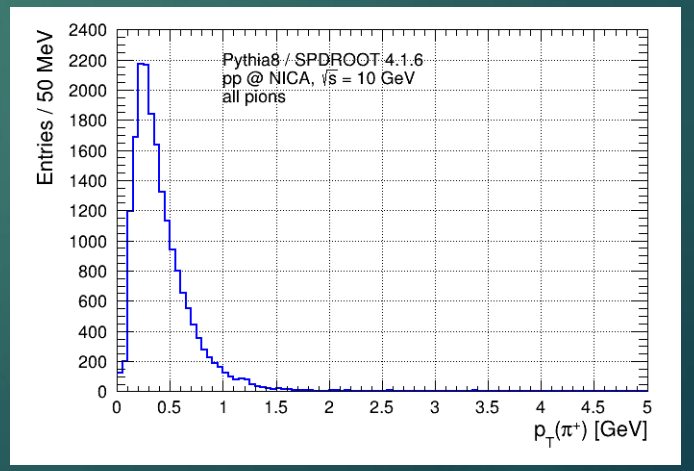
- SoftQCD:inelastic events have been generated within Pythia8 as signal / background
- 4GeV: $10^4\ events$; 10GeV: $10^4\ events$
- For 10GeV analysis was made within SPDROOT 4.1.6

Δ^{++} study:
pT values (total 4/10 GeV, p/pi)

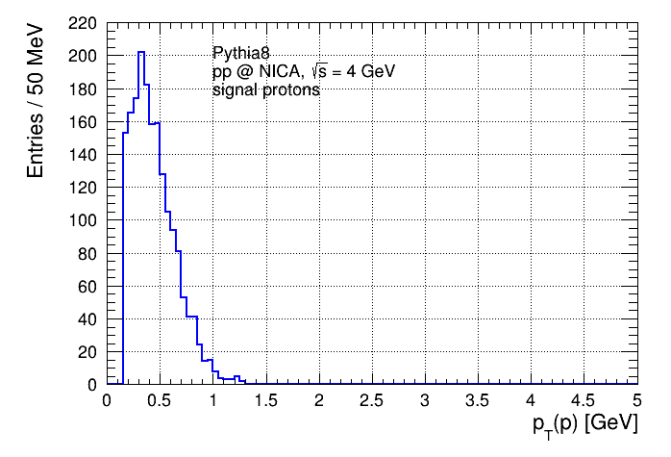


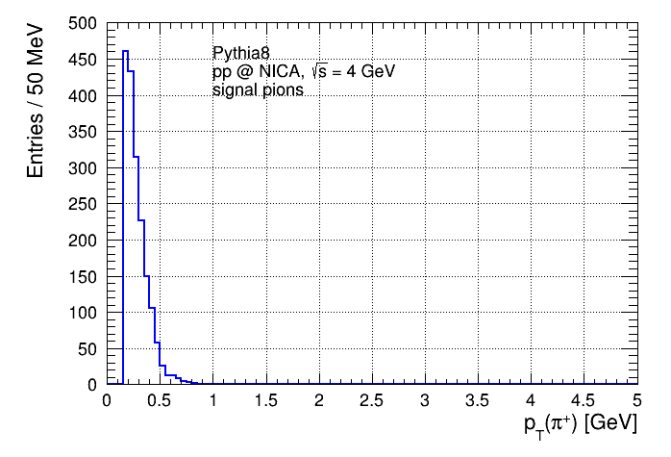


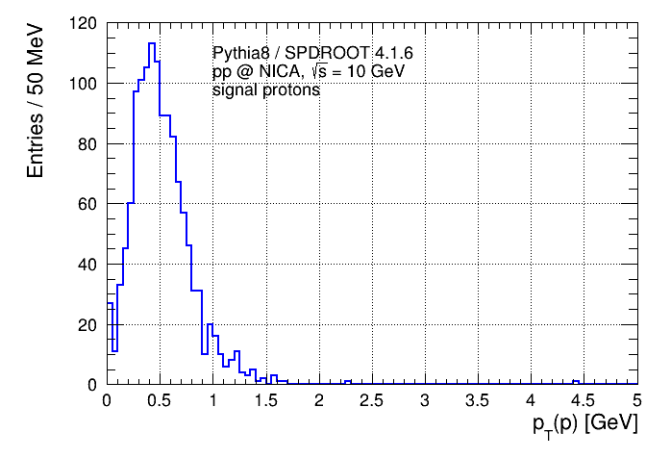


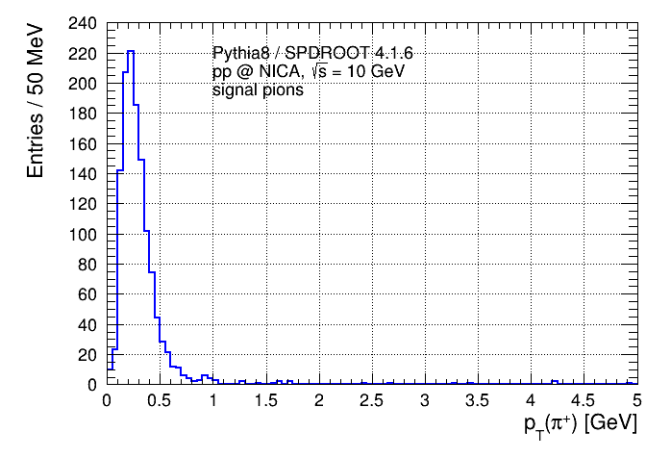


Δ^{++} study:
pT values (signal 4/10GeV, p/pi)

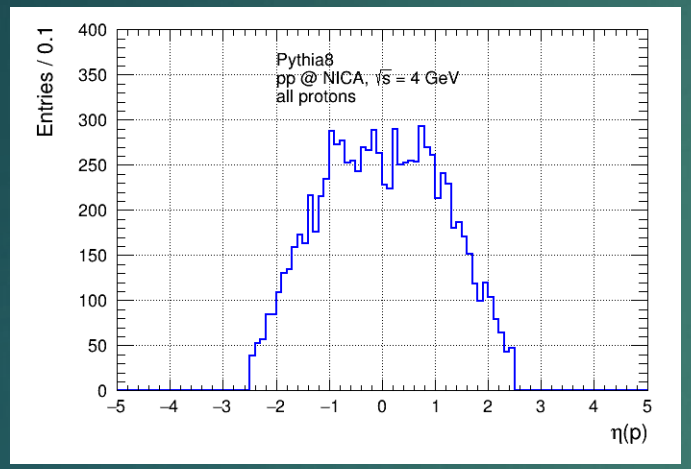


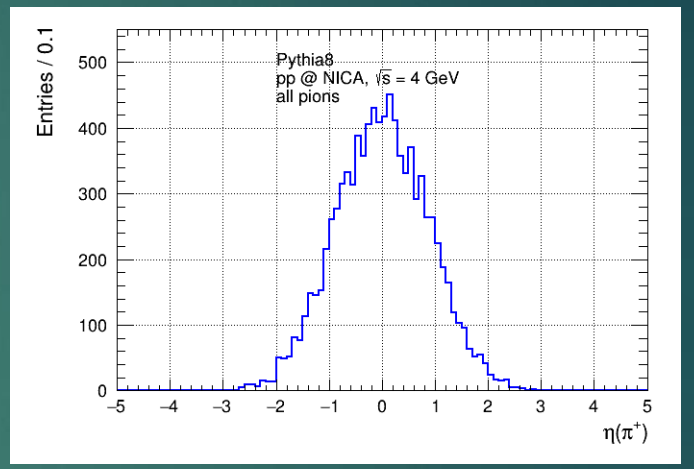


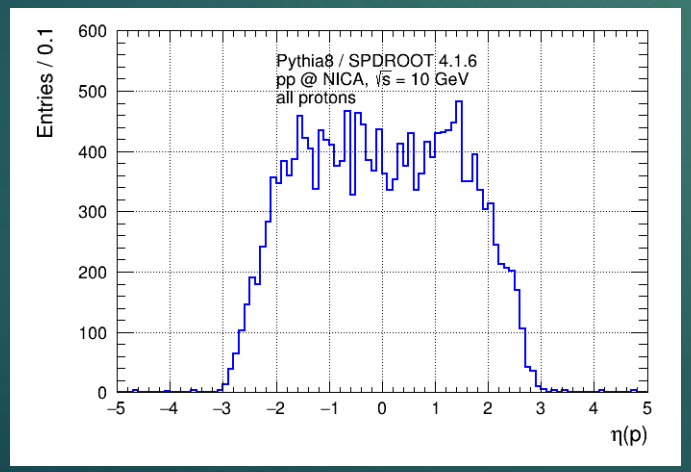


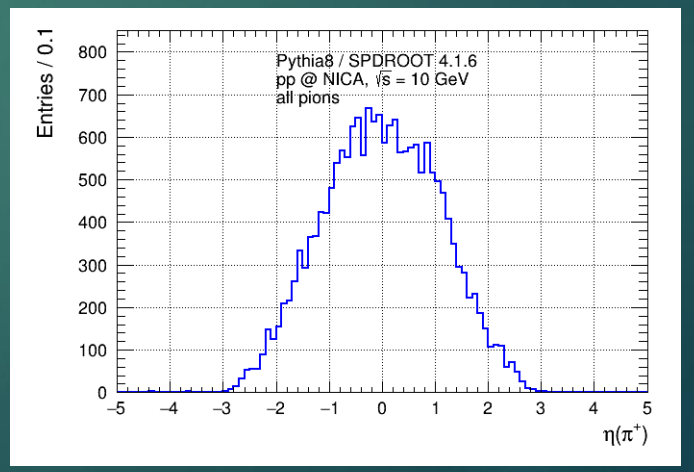


Δ^{++} study:
eta values (total 4/10GeV, p/pi)

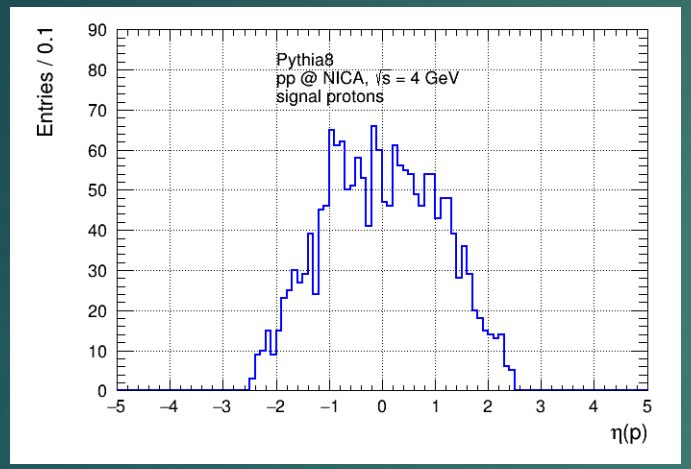


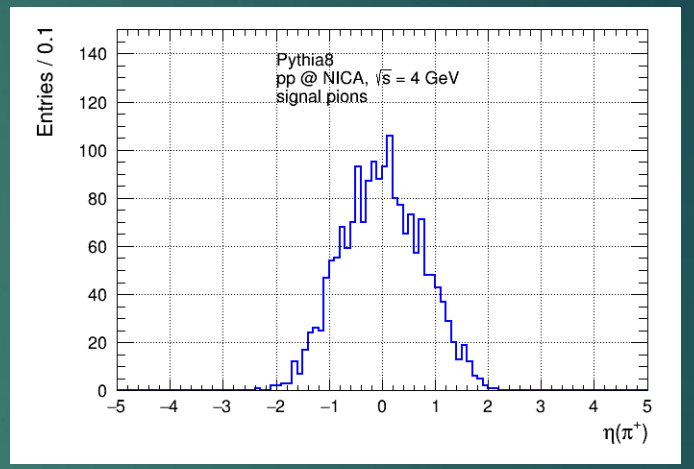


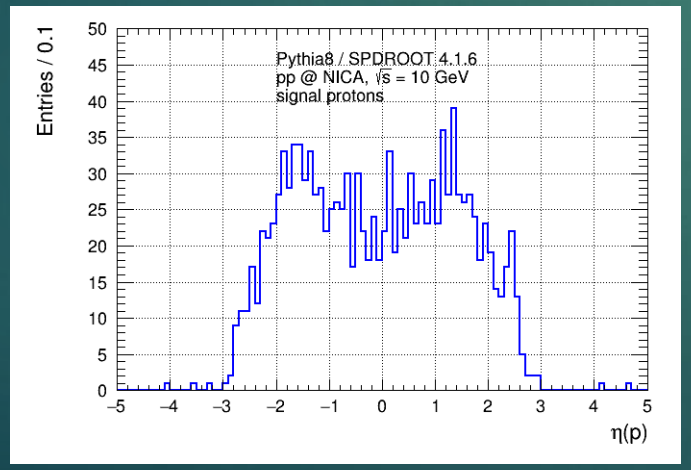


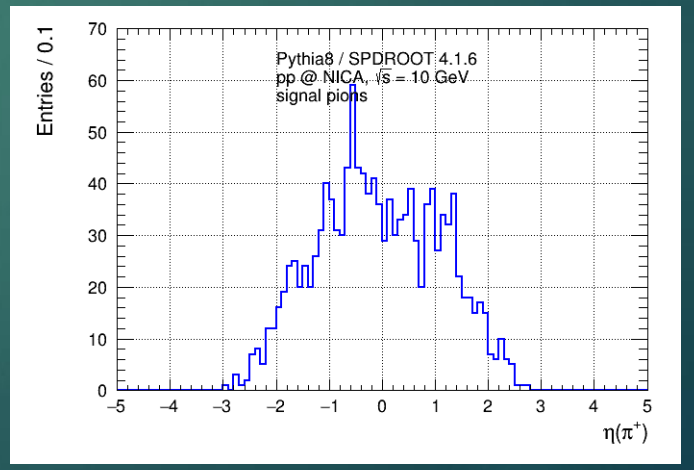


Δ^{++} study: eta values (signal 4/10GeV, p/pi)

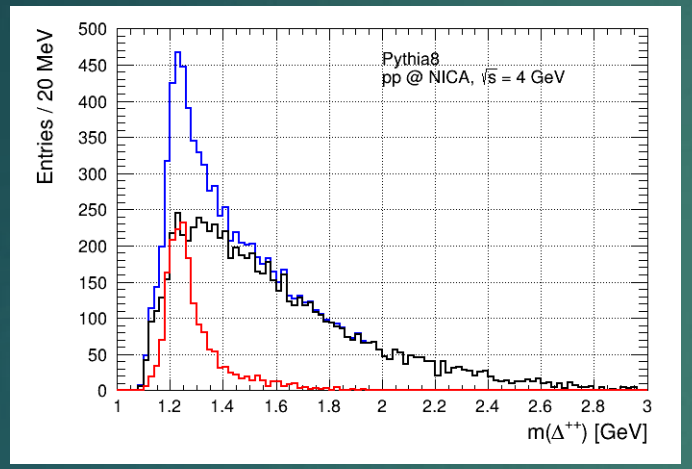


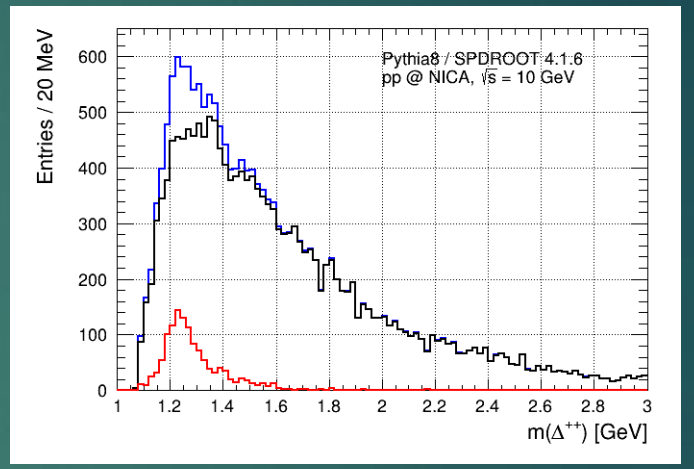


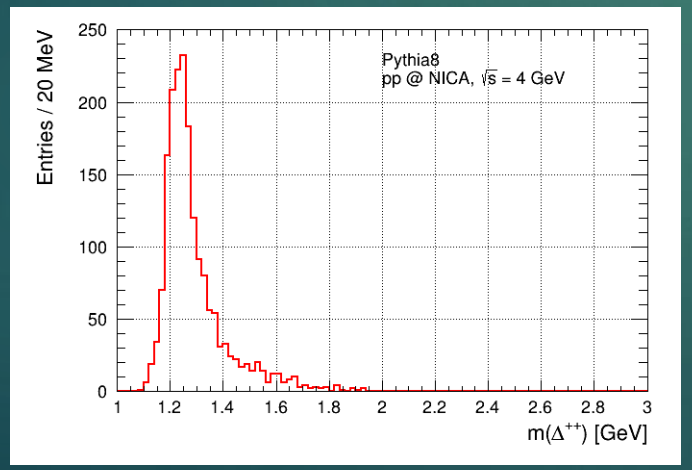


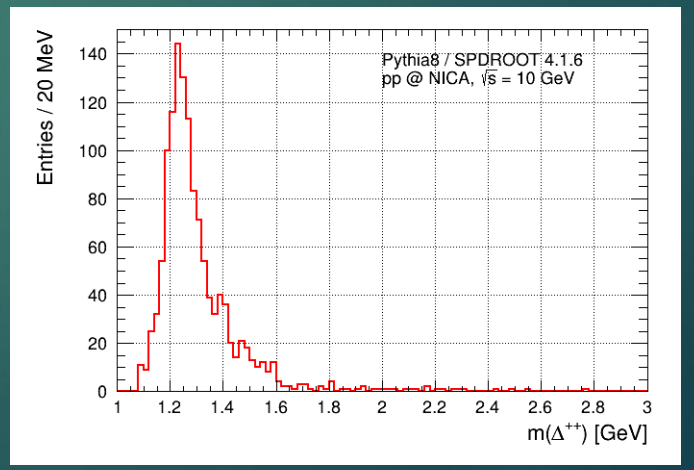


Δ^{++} study: Invariant mass spectrum









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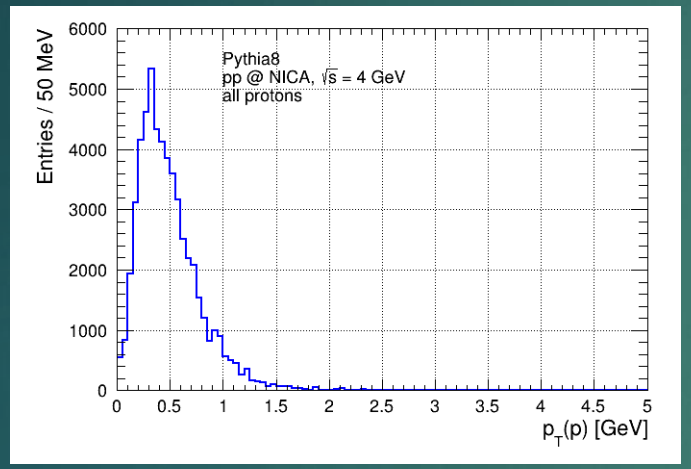
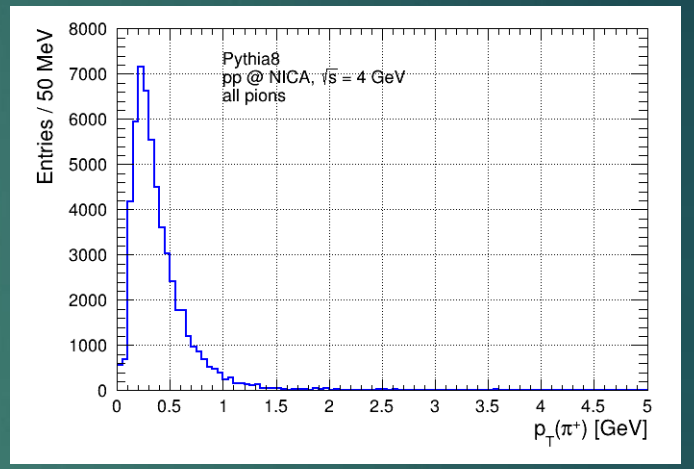
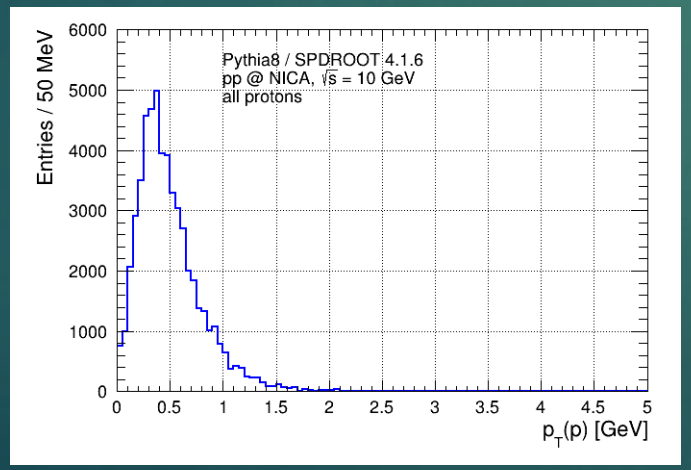
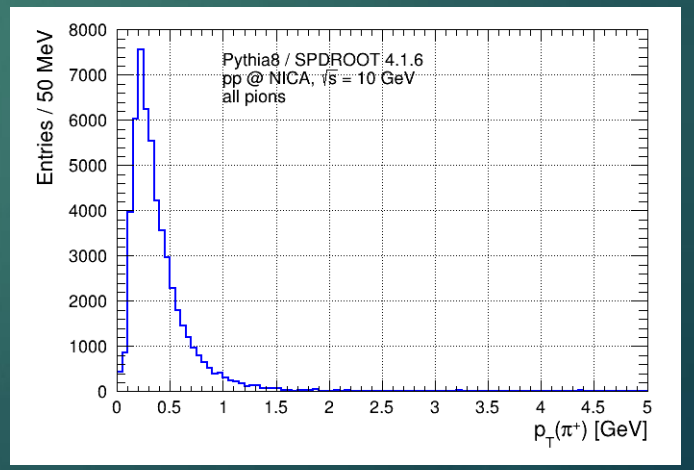
Δ^{+++} study:
pT values (total 4/10 p/pi)

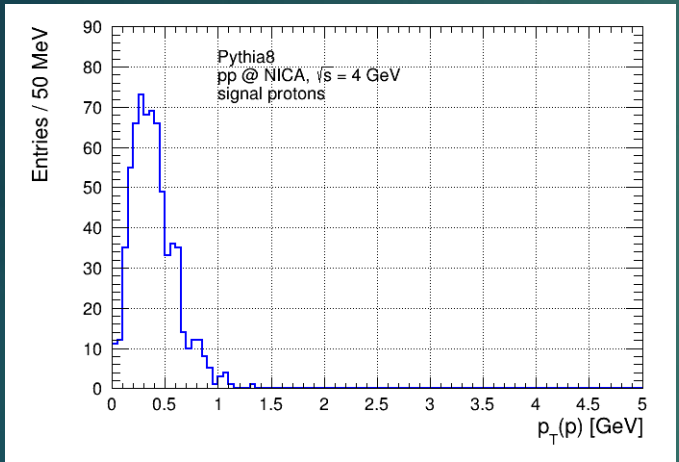


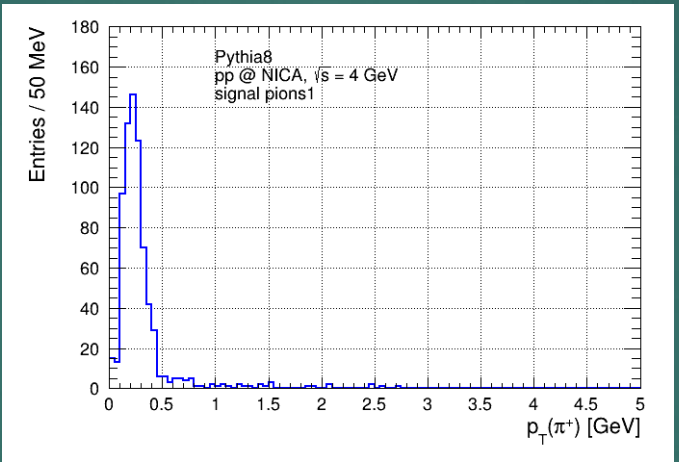


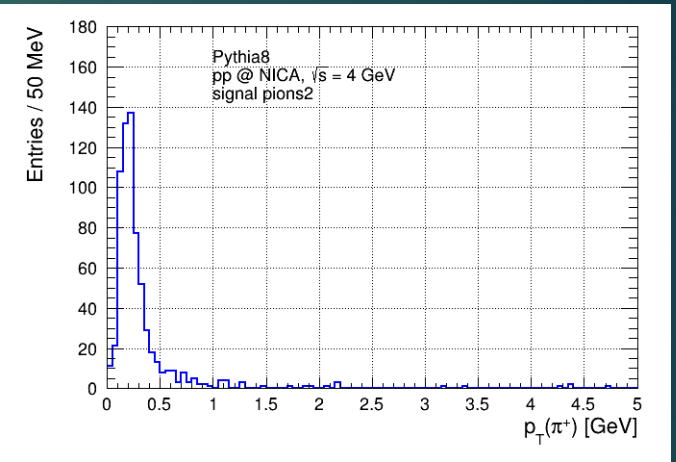


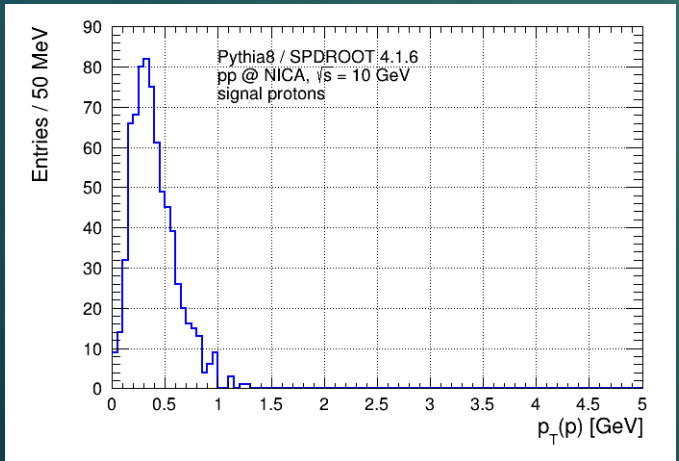


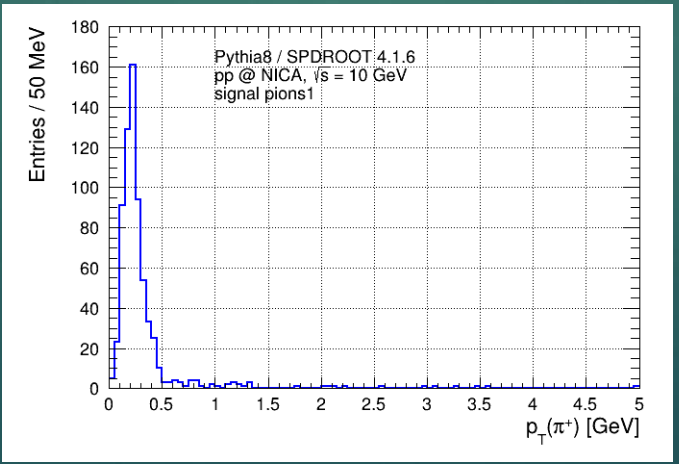
Δ^{+++} study: pT values (signal 4/10 p/pi1/pi2)

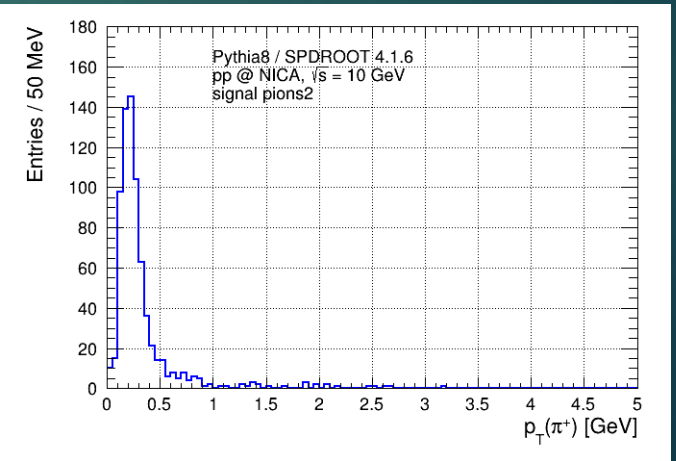












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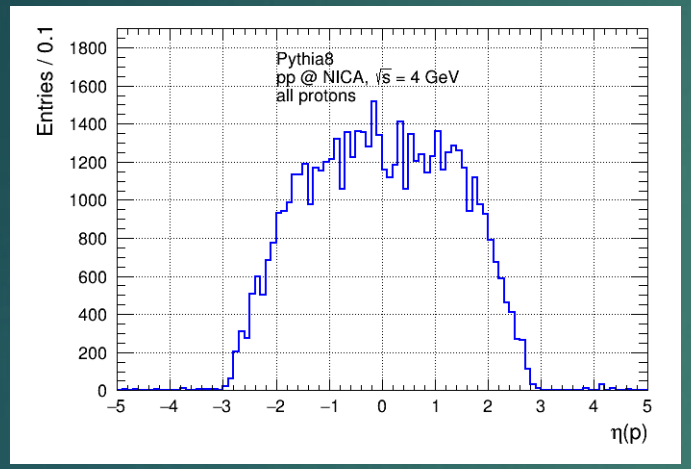

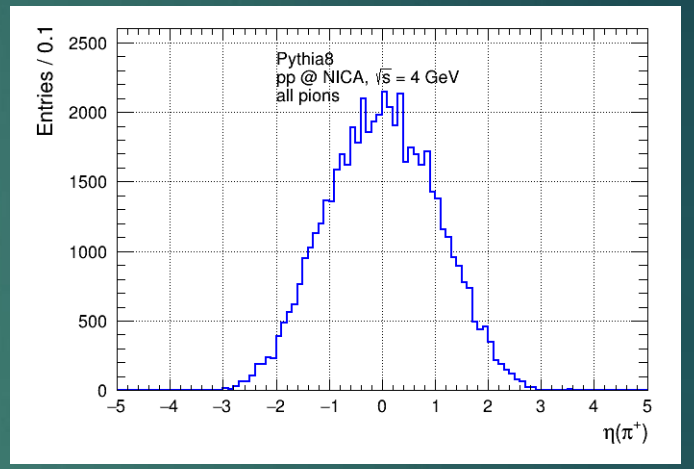

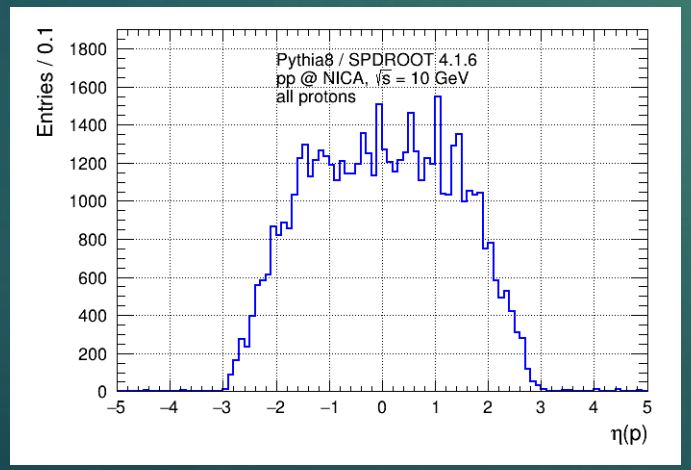

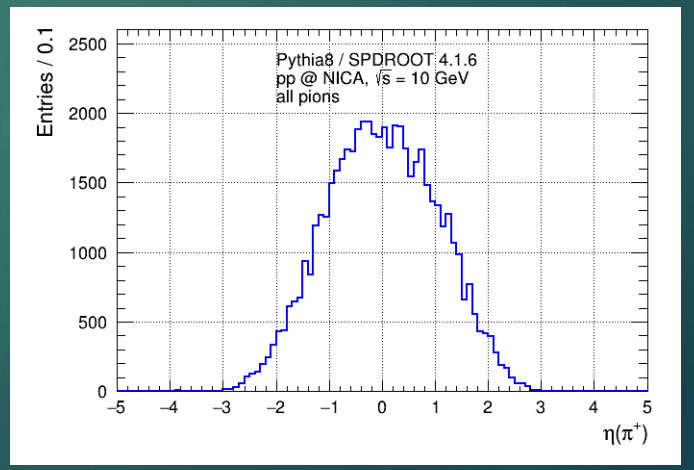

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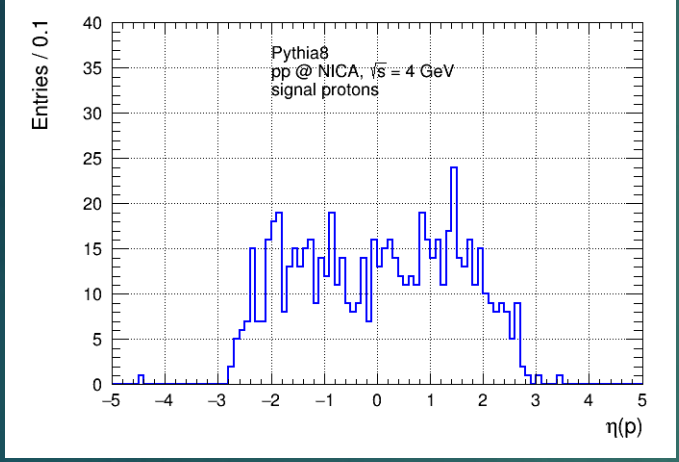

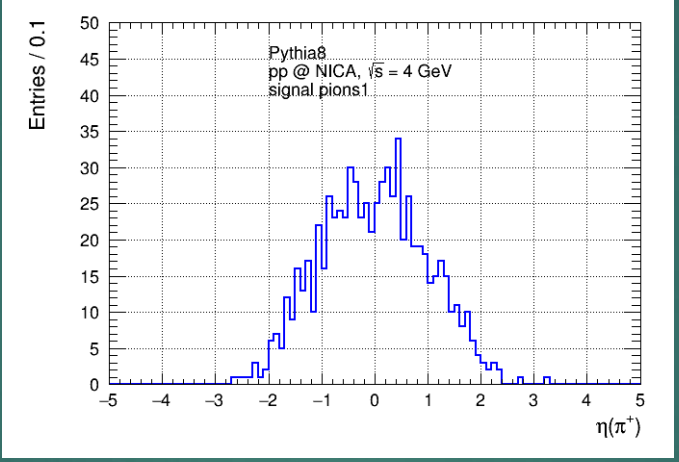

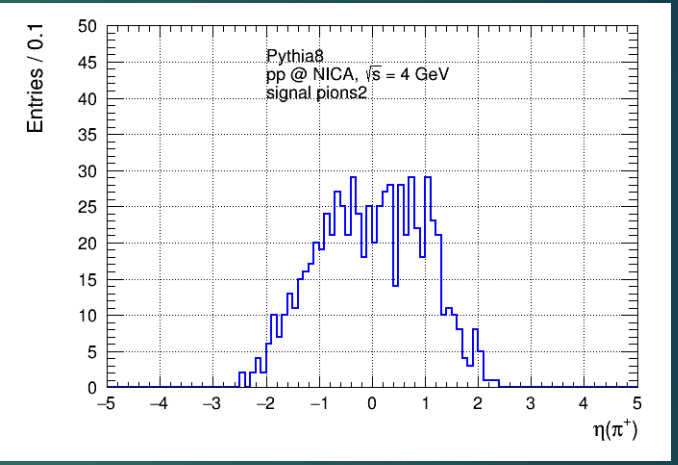

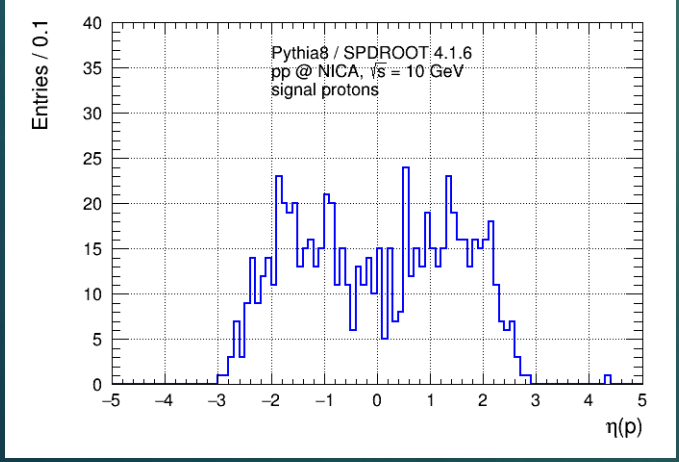

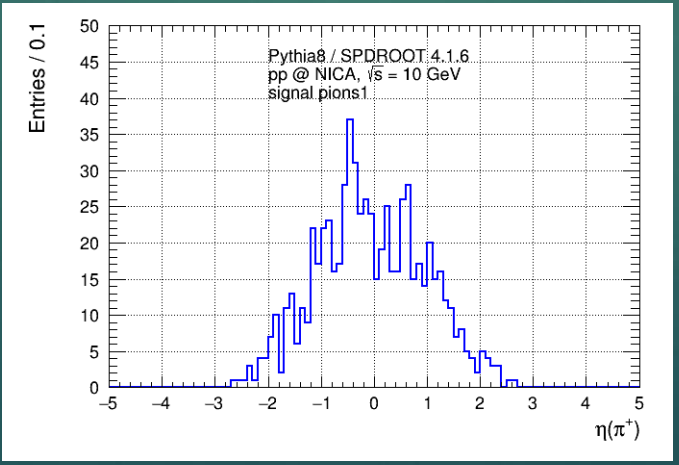

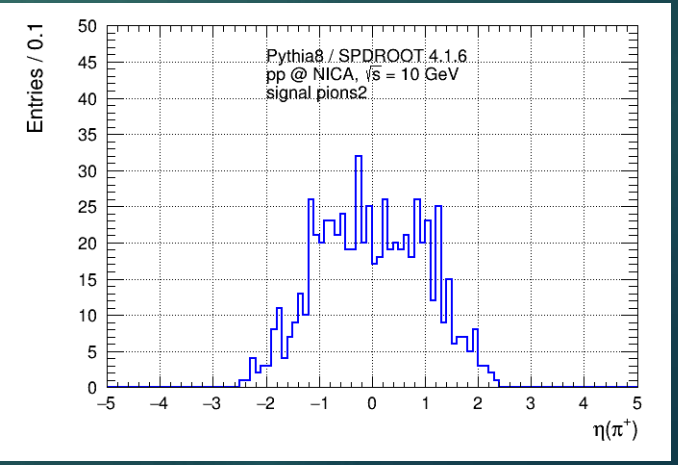

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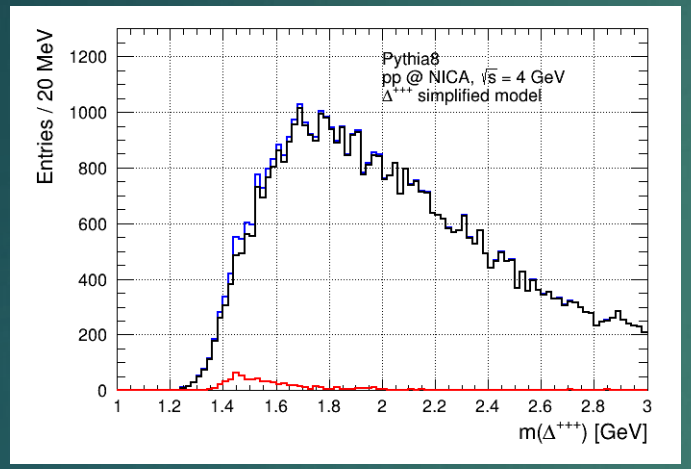

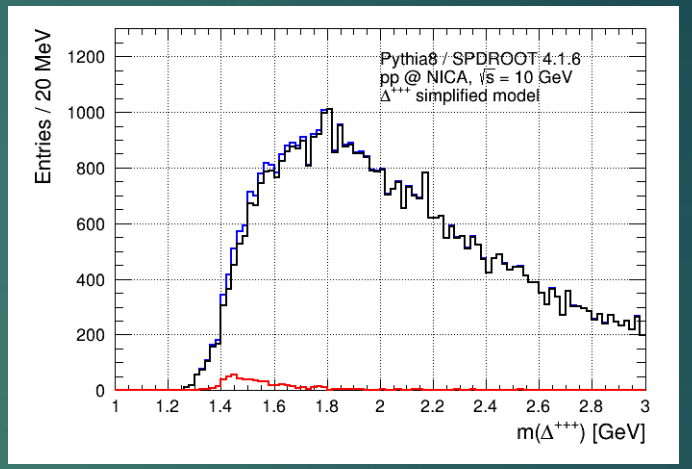

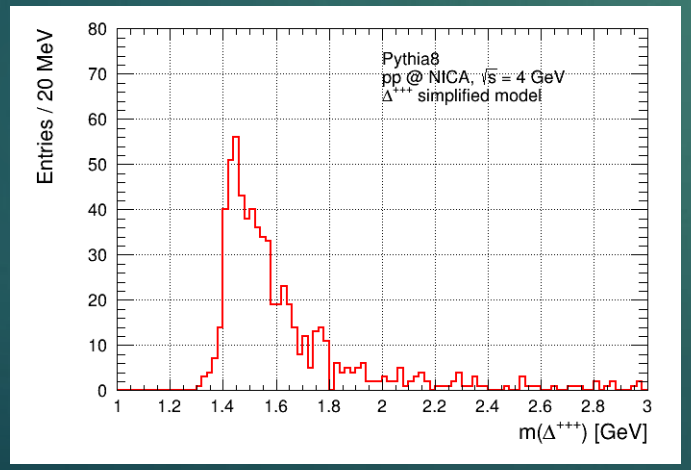

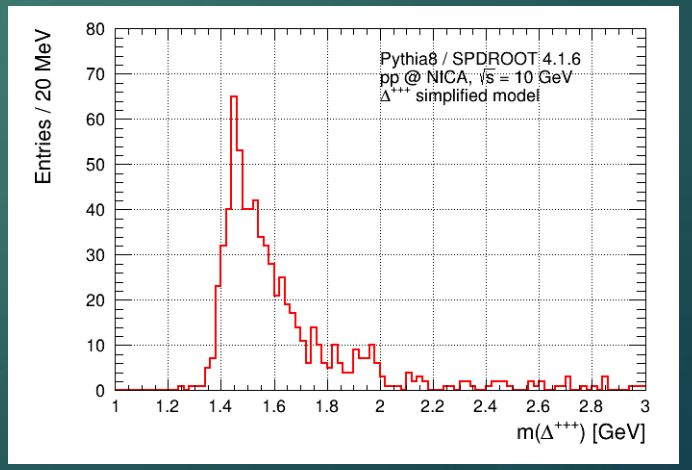

Conclusion and summary

Summary:

- Both $\Delta^{++} \rightarrow p\pi^{+}$ and $\Delta^{+++} \rightarrow (\Delta^{++} \rightarrow p\pi^{+})\pi^{+}$ decays analysis was made for 4GeV and 10GeV

What need to be done:

- Statistics increase
- Background estimation
- Problem with SPDroot threshold for energy 10GeV

This study was carried out within the project “Production of baryons and phi mesons at the first stage of the NICA SPD experiment: simulation and perspectives of registration” supported by JINR

Thank you for your attention!