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

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- Introduction and motivation
- Δ^{++} study (what has already been done)
- Δ^{+++} study (what has already been done)
- Experimental requirements
- Expected performance
- Conclusion and summary

Introduction and motivation Δ^{+++} study

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

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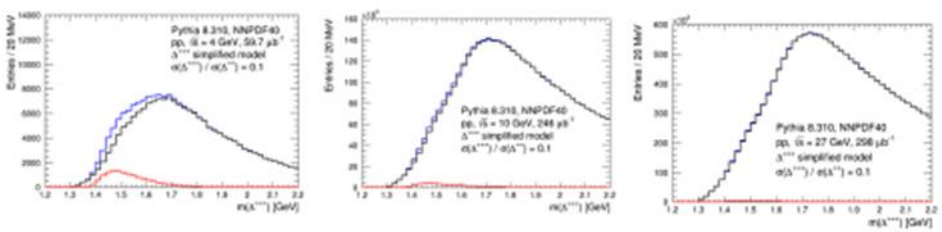
$\Delta^{+++} \rightarrow \Delta^{++} (\rightarrow p\,\pi^+)\,\pi^+$, **reconstructed mass**

combine proton with two positively charged pions

require ($1.14 < m(p\,\pi_1^+) < 1.32$) || ($1.14 < m(p\,\pi_2^+) < 1.32$) (~97% eff.)



data-driven background shape estimation is needed

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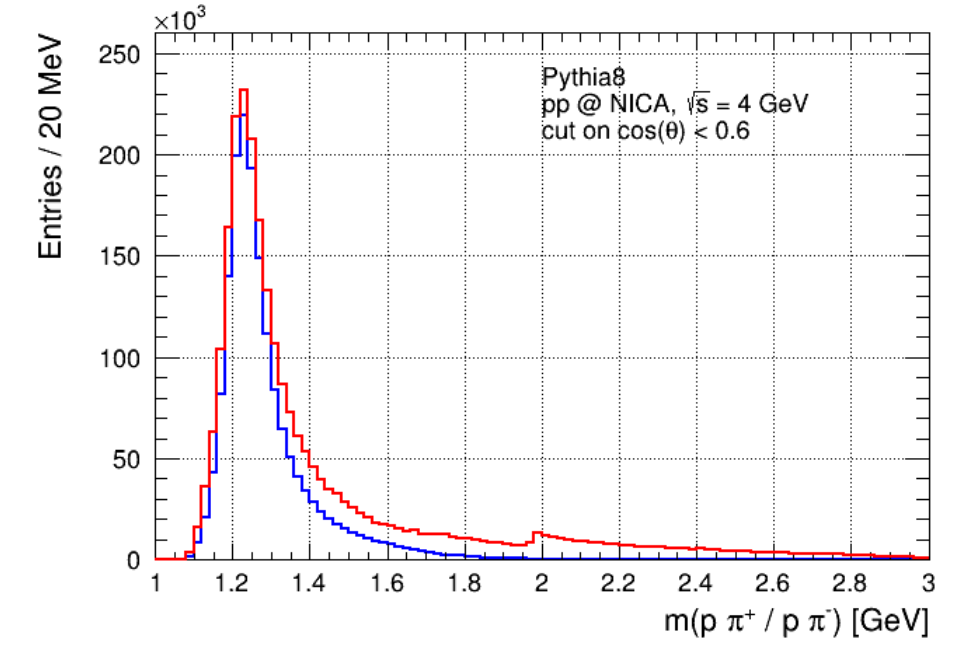
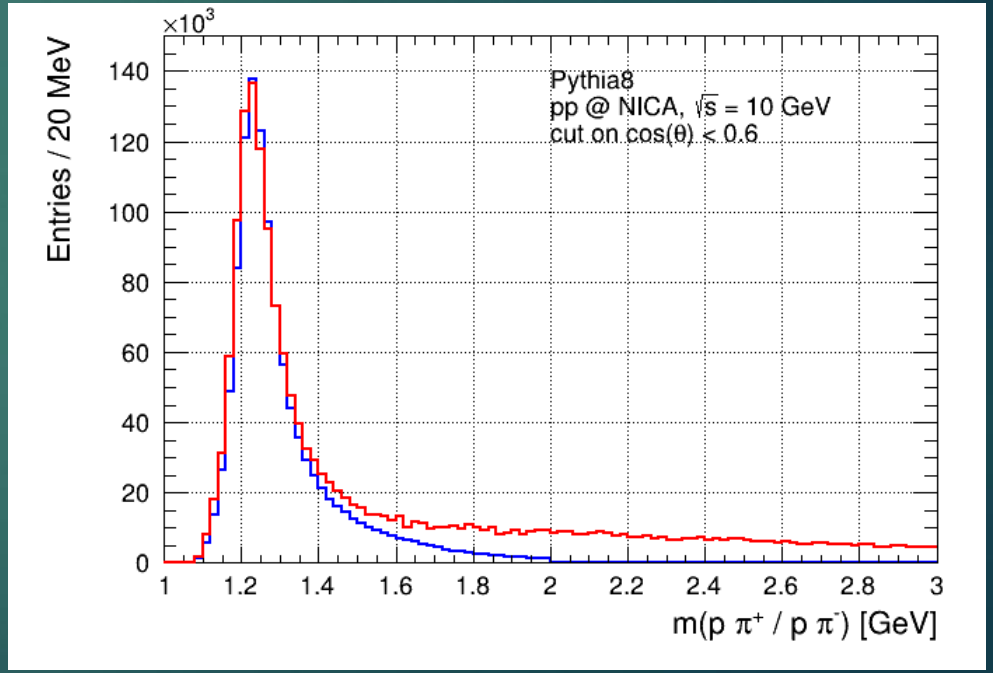
Introduction and motivation Δ^{++} study

- Delta baryons itself was not studied, only as propagator in other particle events (according to PDG)

Δ^{++} study

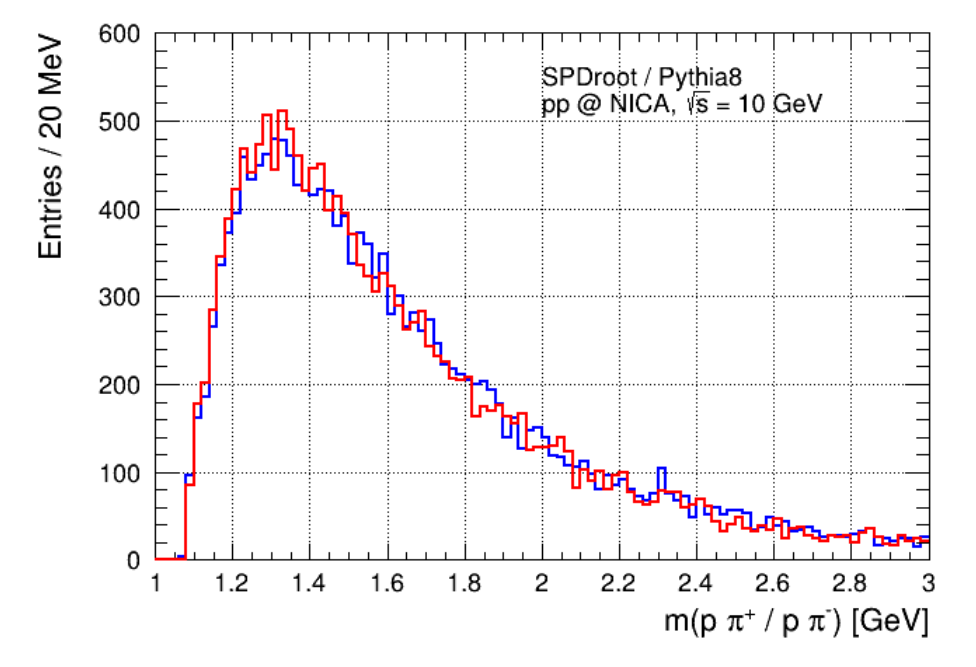
- Δ^{++} signal (blue histogram)
- Residual of Δ^{++} and Δ^{0} data (red one)

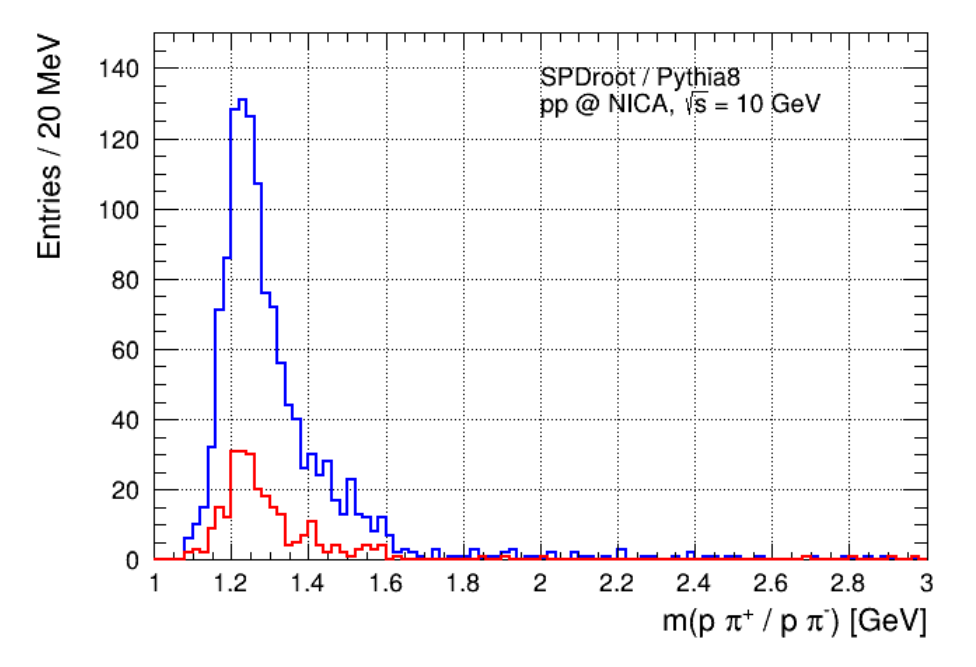




Δ^{++} study (SPDroot)

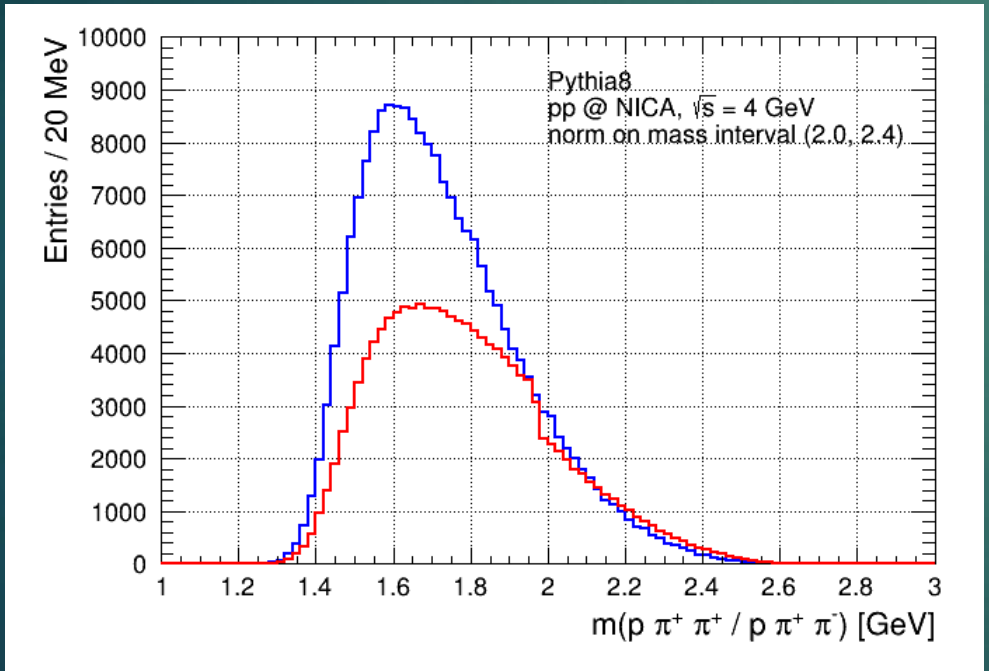
- Δ^{++} (blue histograms)
- Δ^{0} (red histograms)

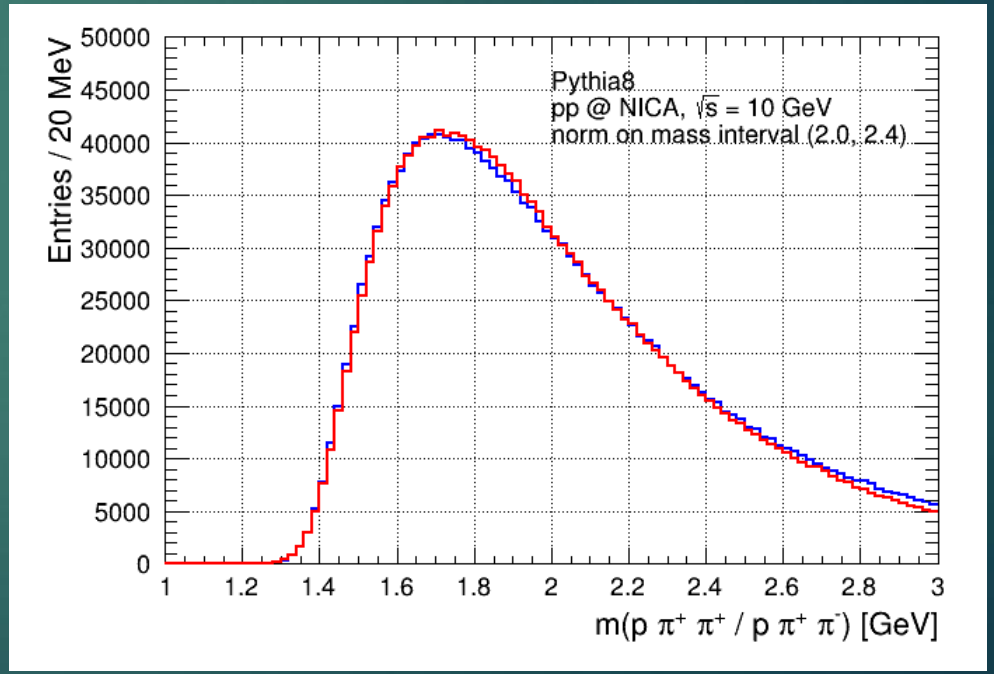




Δ^{+++} study
Background estimation

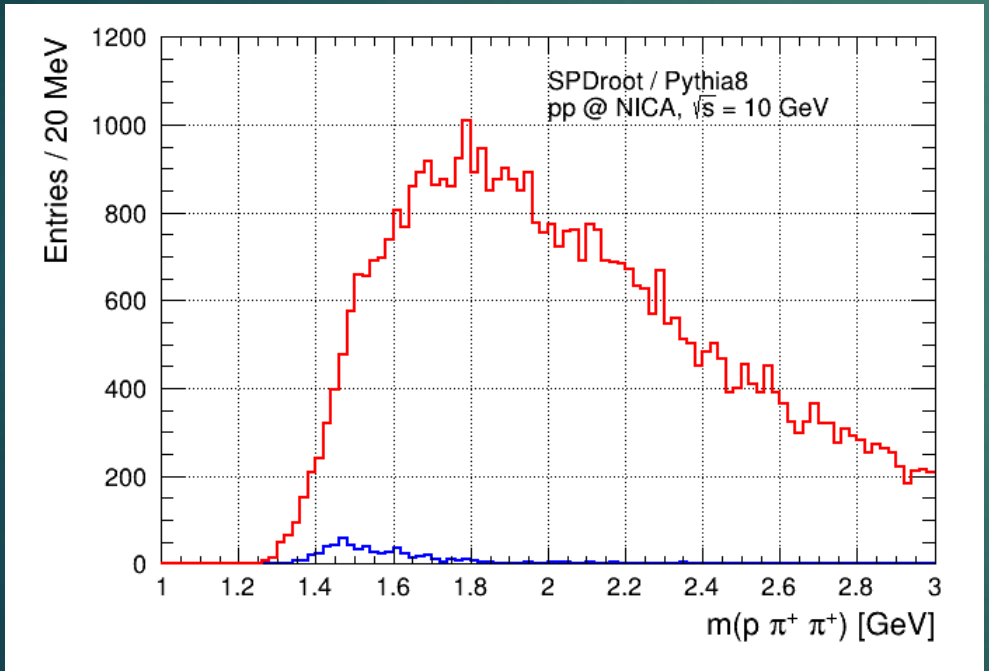
- $m(p\,\pi^+\pi^+)$ (blue histogram)
- $m(p\,\pi^+\pi^-)$ (red one)

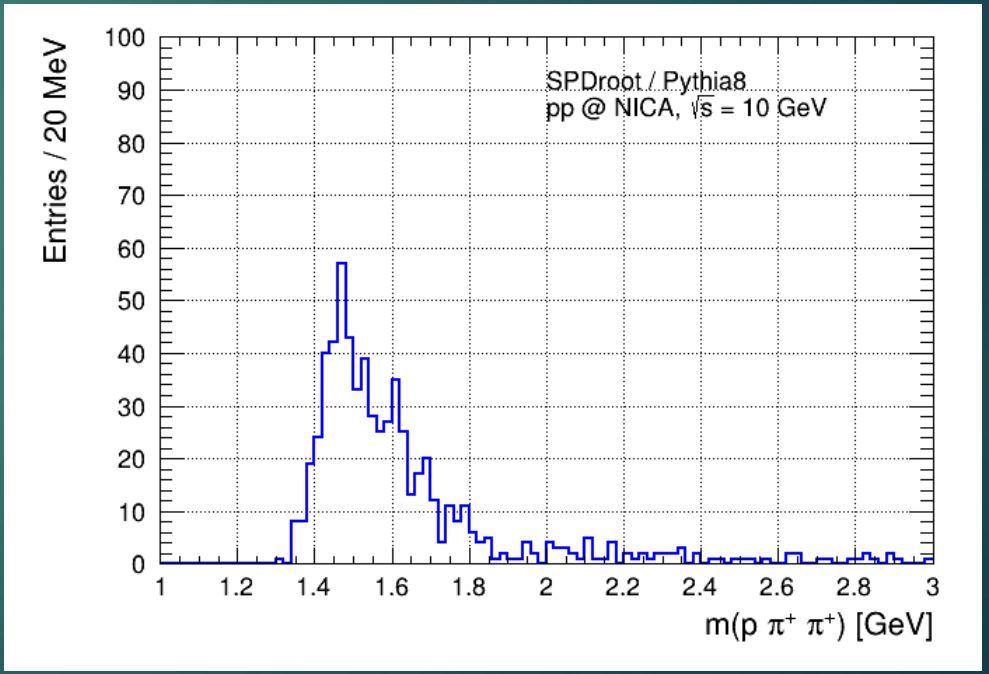




Δ^{+++} study (SPDroot)

- $m(p\,\pi^+\pi^+)$ signal (blue histogram)
- $m(p\,\pi^+\pi^+)$ background (red one)





Experimental requirements

- Beam species: pp
- Collision energy: 4-10 GeV
- Luminosity: $10^{31}\ cm^{-2}\ s^{-1}$
- Polarization: not necessary
- Involved SPD subsystems: MCT, Straw tracker
- Duration of data taking: $\frac{1}{3} * 10^{7}\ s$

Expected performance

- Simulation information used: Pythia8-based MC
- Total statistics: 10^7 for pp collisions at 4GeV / 10GeV
- Main sources of systematics: combinatorial background subtraction

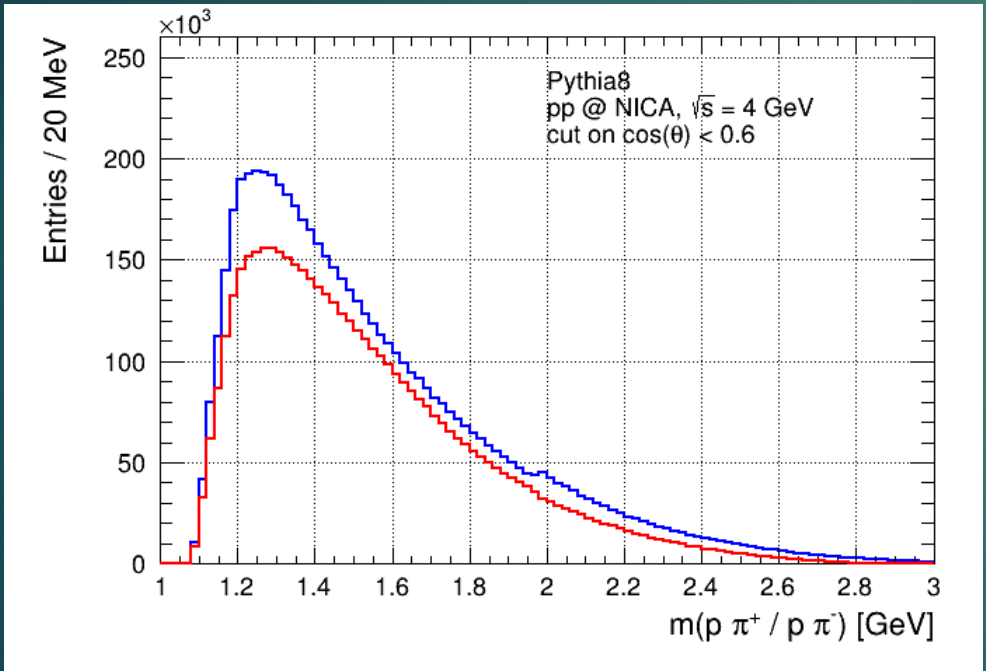
Conclusion and summary

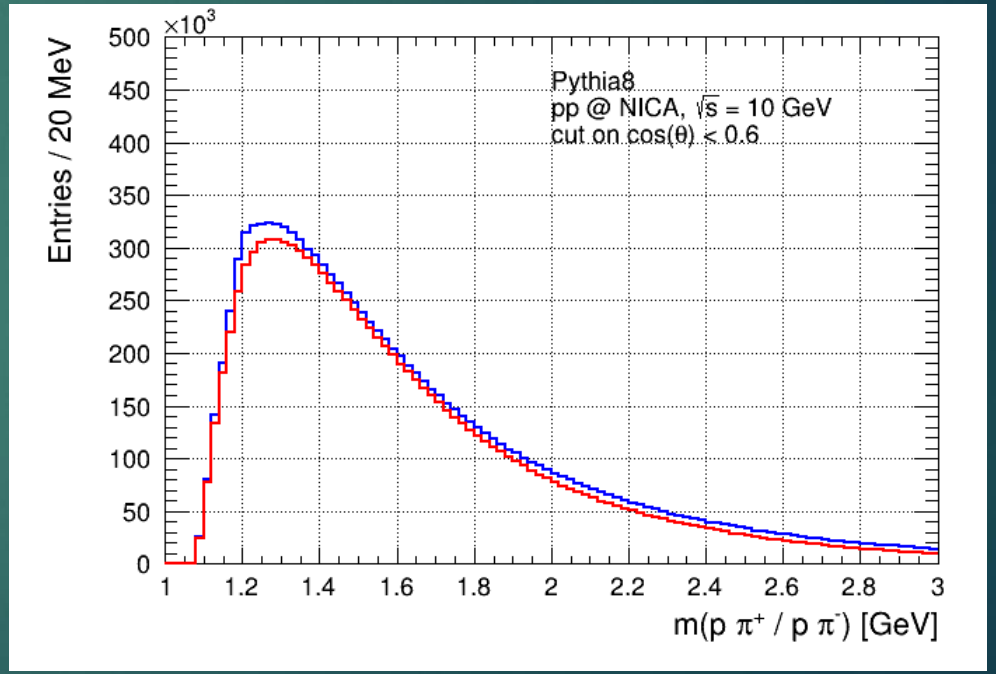
- Δ^{++} and Δ^{+++} can be studied on the first stage of SPD experiment

Thank you for your attention!

Appendix

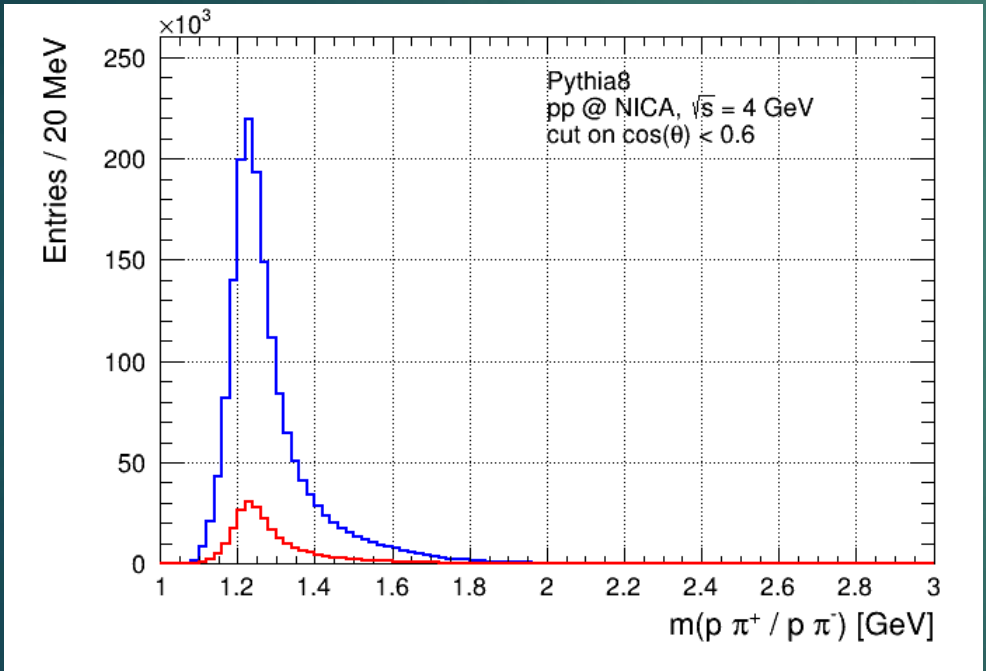
- Δ^{++}(blue) and Δ^{0}(red) background comparison

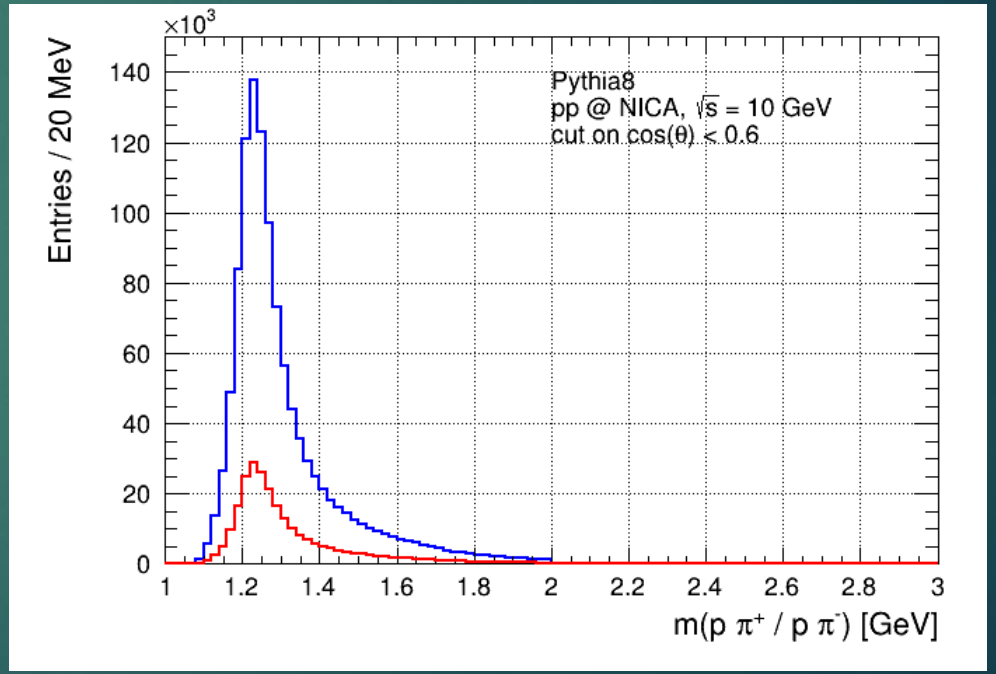




Appendix

- Δ^{++}(blue) and Δ^{0}(red) signal comparison





Appendix

- $m(p\,\pi^+\pi^+)$ (blue) and residual of $m(p\,\pi^+\pi^+)$ and $m(p\,\pi^+\pi^-)$ (red)