Particle selection from BM@N data

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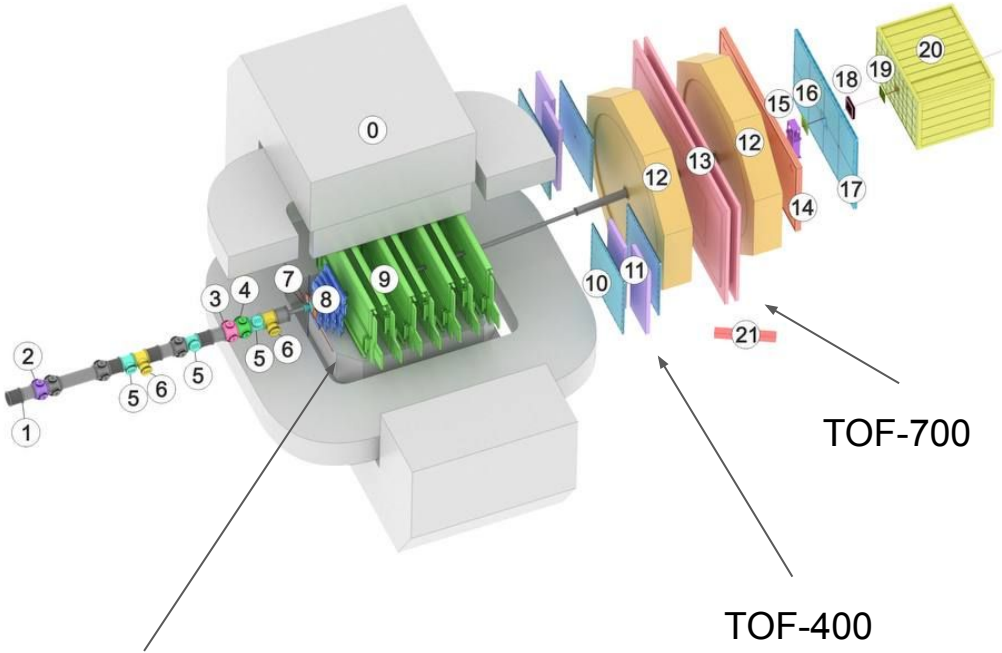
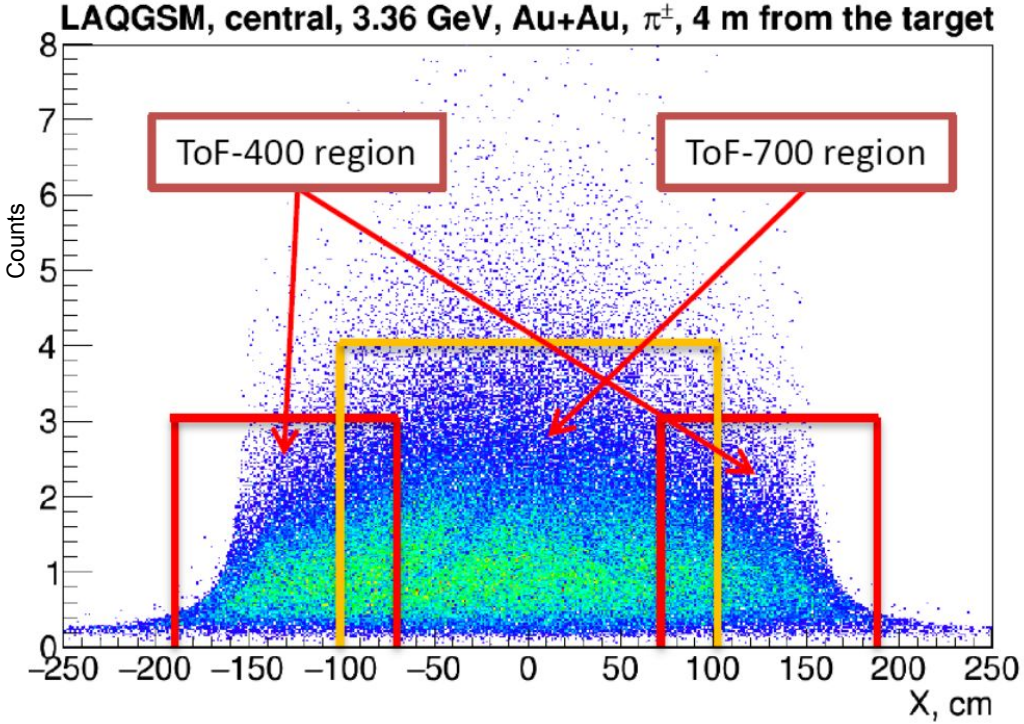
Baryonic Matter @ Nuclotron experiment



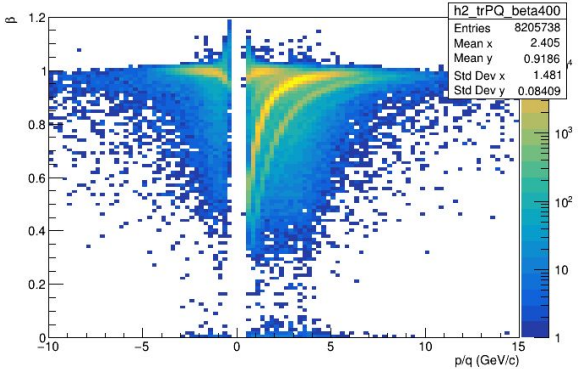
- DCMQGSM-SMM events, 8M
- Full GEANT4 simulation of all detector subsystems
- Experimental data from RUN8: Xe+Cs@3.8A GeV (VF-tracking)
- Time-of-flight information is taken from TOF-400 and TOF-700 detectors
- Tracks are reconstructed in tracking system within the magnetic field

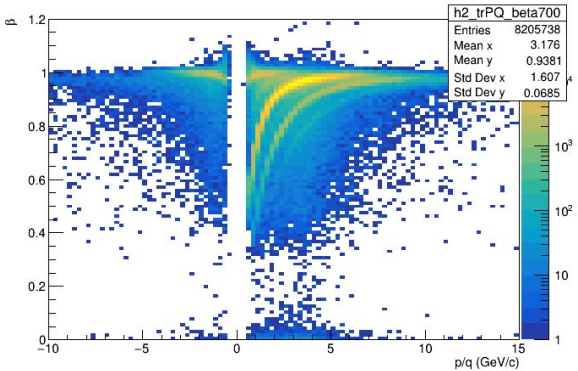
Time-of-flight system



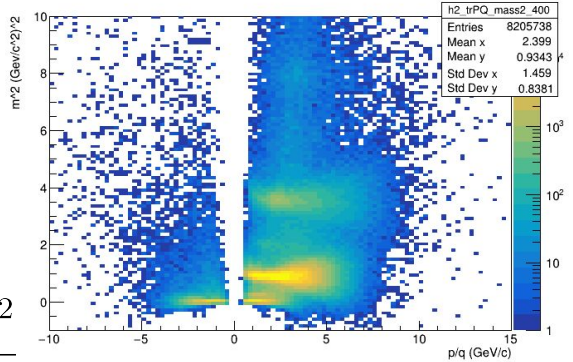
- Time-of-flight information is taken from TOF-400 and TOF-700 detectors
- The time-of-flight (ToF) system is based on the start time T0 detector near the target and two walls of multi-gap resistive plate chambers (mRPC)
- Time resolution of TOF-700 chamber ~60 ps
- Time resolution of ToF-400 chamber ~50 ps

DCM-QGSM-SMM Xe+Cs@3A GeV: □ vs p/q distribution for charged particles

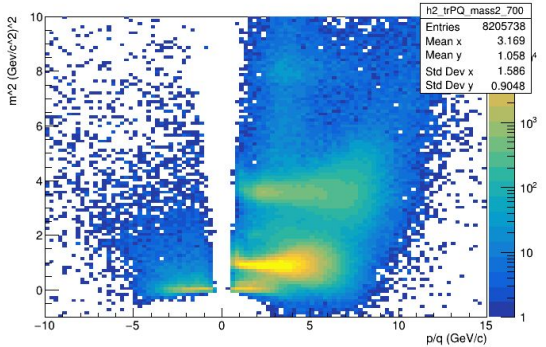




$$m^2 = \frac{(1-\beta^2) * p^2}{\beta^2}$$



ToF-400

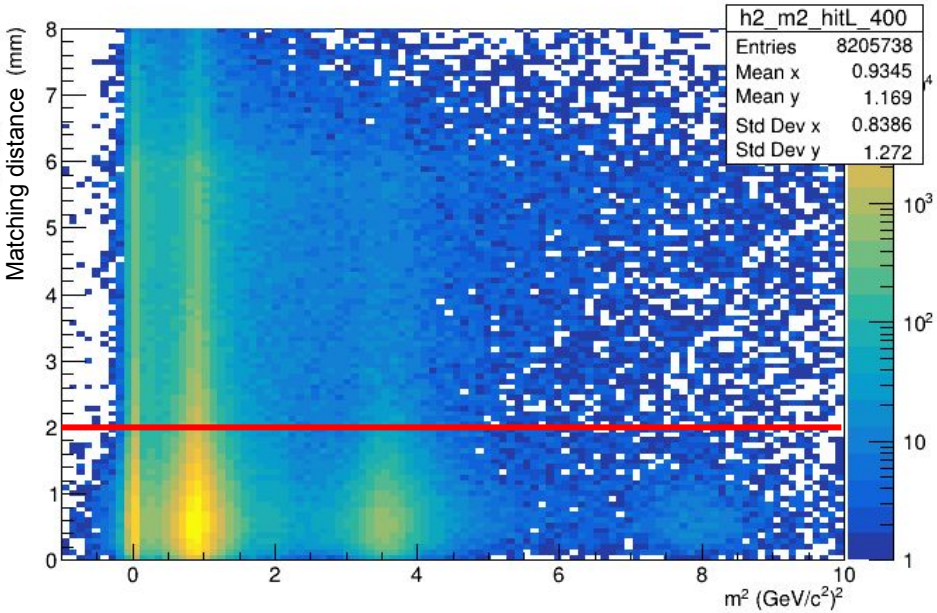


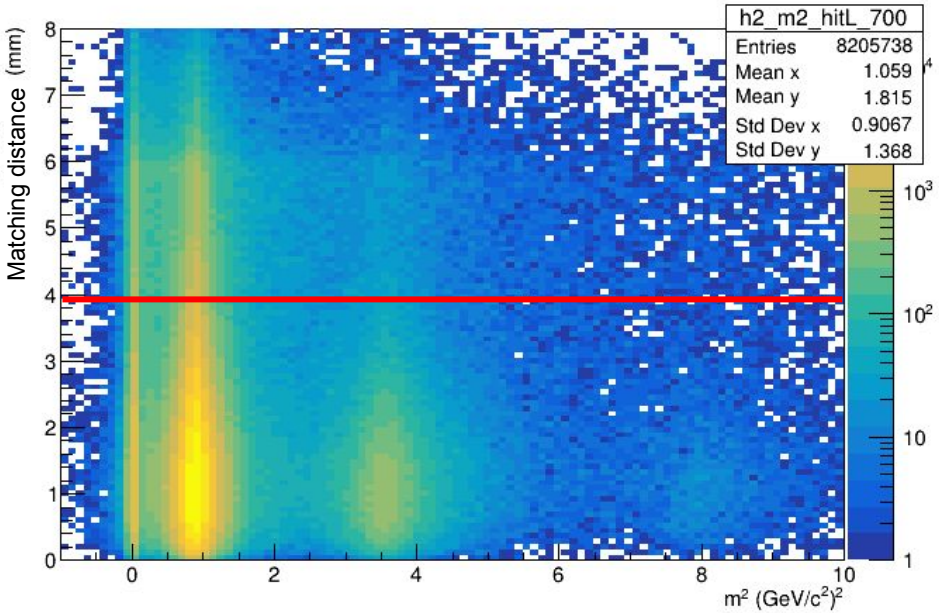
ToF-700

Momentum depends on □ with m2 as a parameter

Matching distance vs m² for all charged particles

Matching distance - distance from particles track to its hit in ToF.

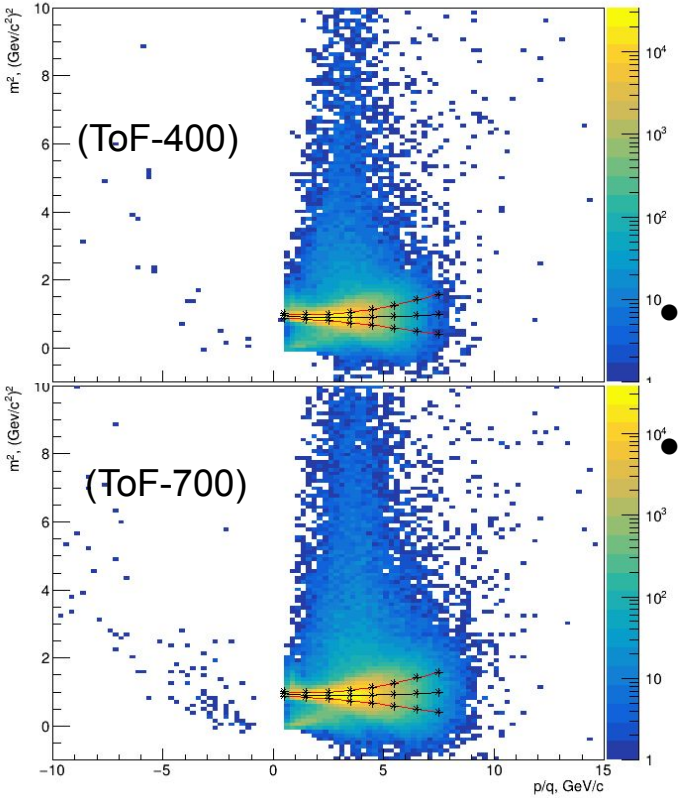




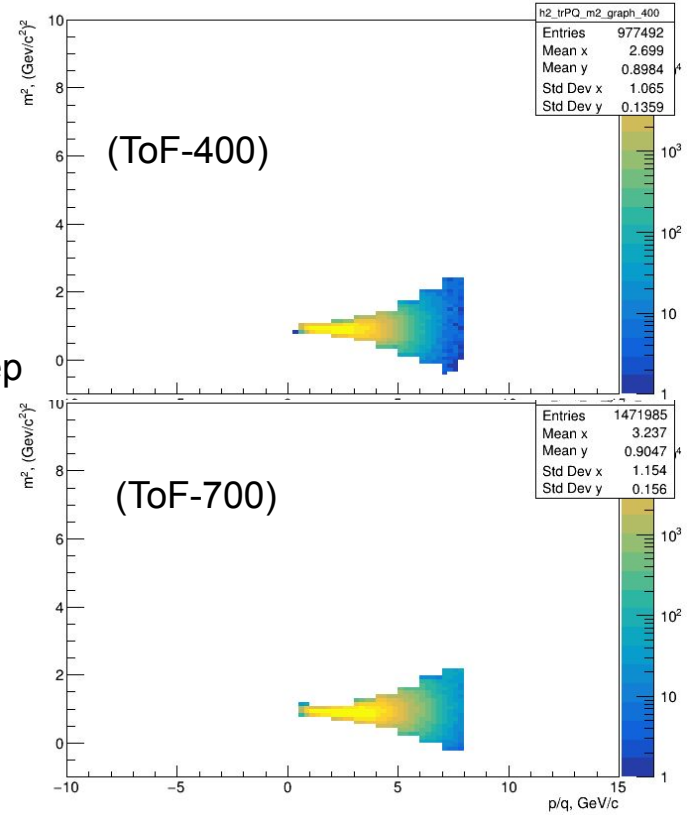
Cuts on Matching Distance: M dist <= 2 (for ToF-400) и M dist <= 4 (for ToF-700) - to reduce background.

m^2 vs p/q for selected primary protons

- $\langle m^2 \rangle$
- $\langle m^2 \rangle \pm \sigma$

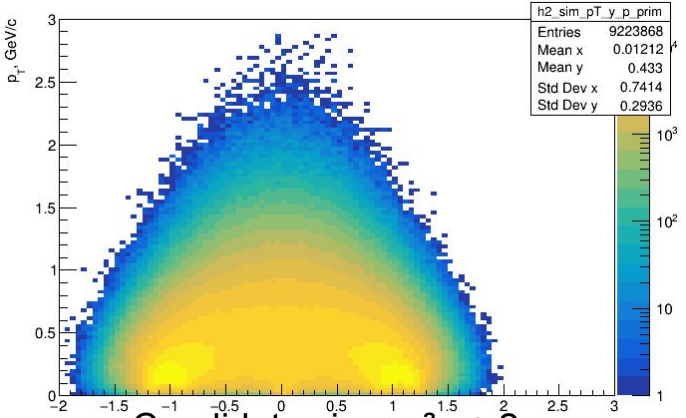


- Fit over m2 in narrow momentum ranges (with a step of 1GeV)
- <m2> and σ were extracted

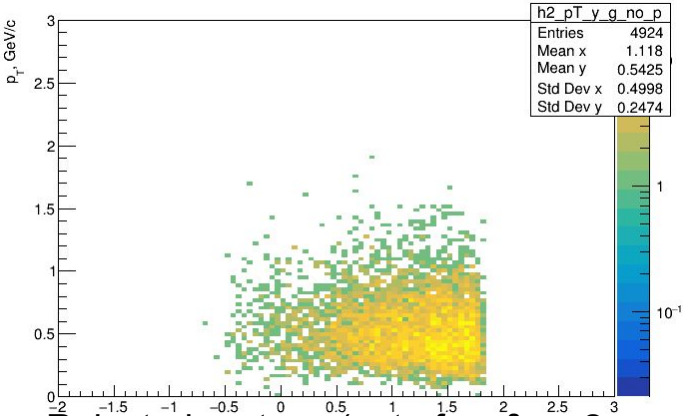


Results for applying the selection criteria based on m²

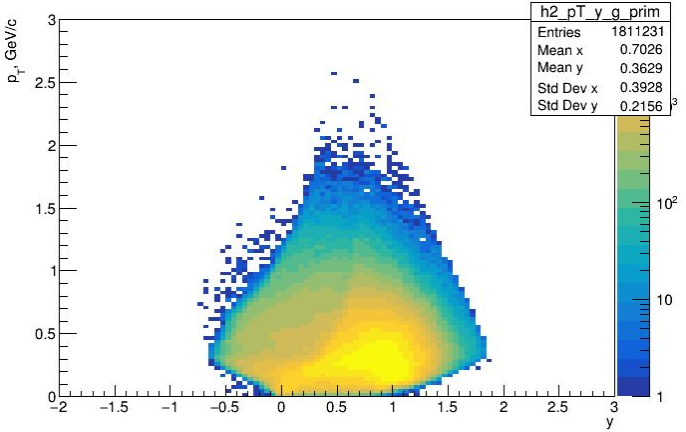
All protons from model



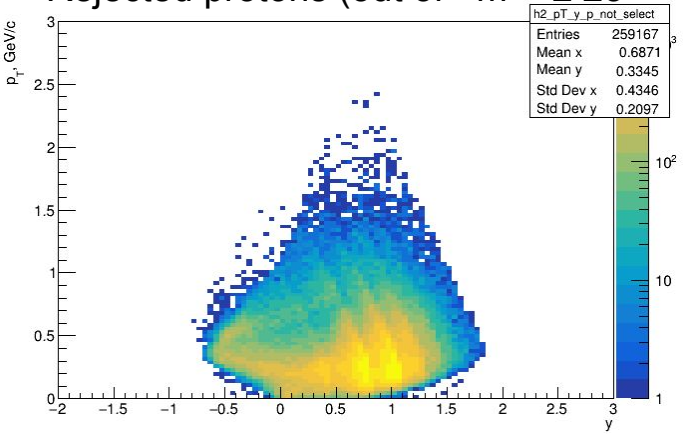
Misidentification



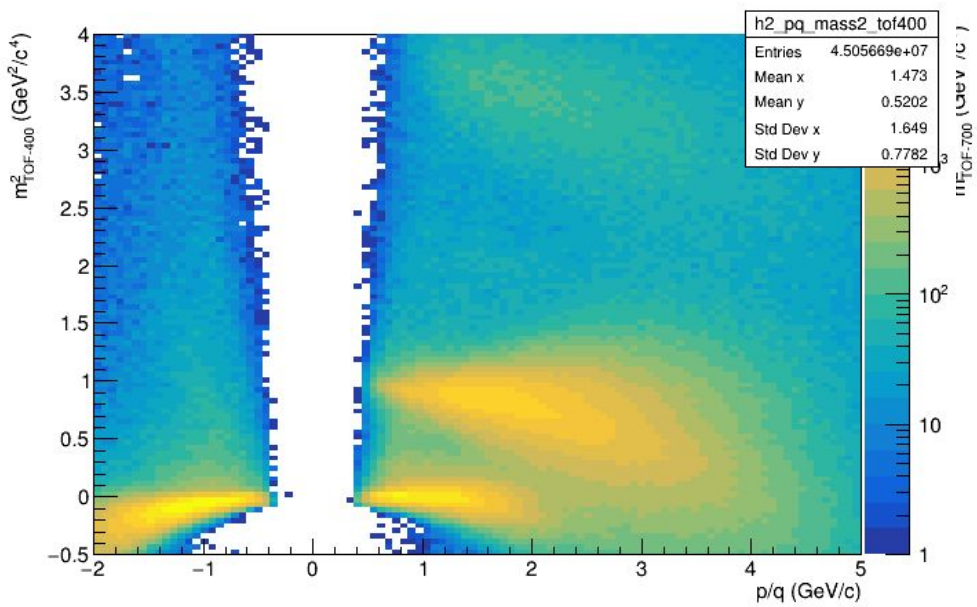
Candidates in <m²> ± 2σ

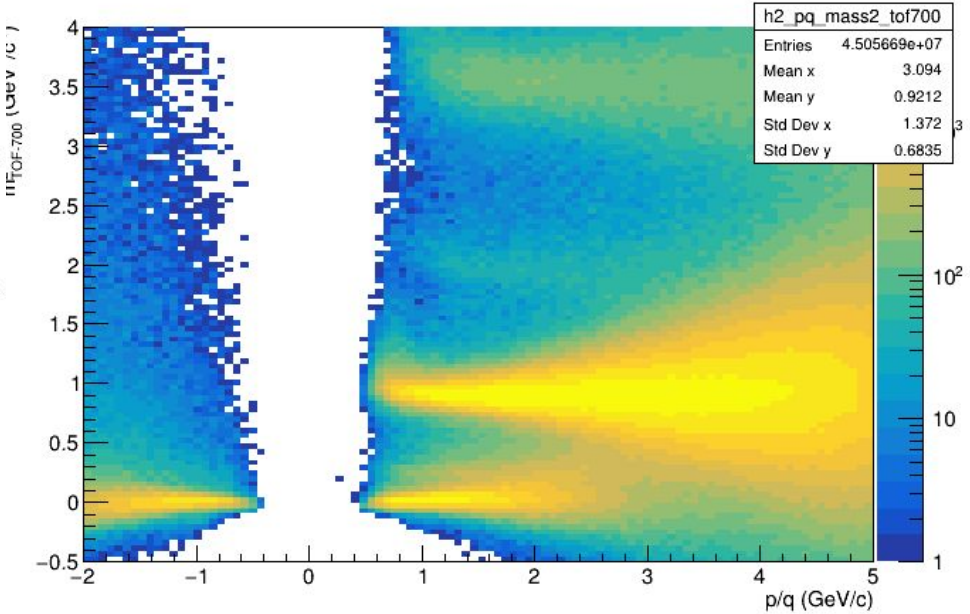


Rejected protons (out of <m²> ± 2σ



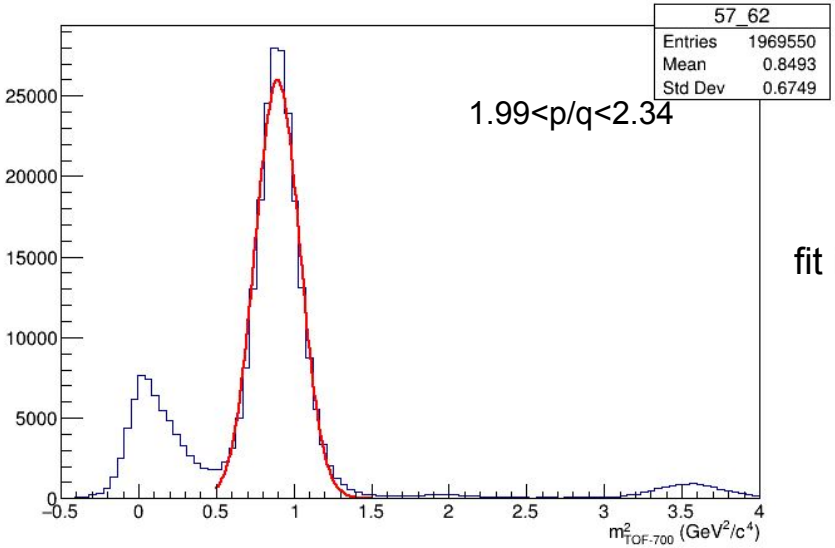
RUN8 Data: m2 vs p distribution for charged particles





- <m2> depends on momentum
- The width of the distributions for each species is rather large
- Further calibration of TOF-data is required

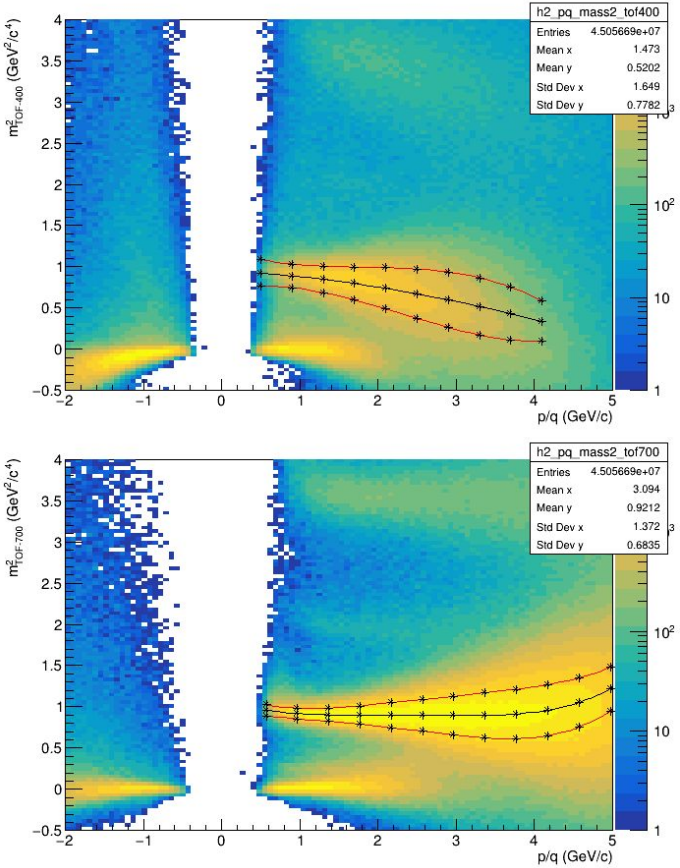
Fitting the mass distribution in narrow p/q ranges for protons



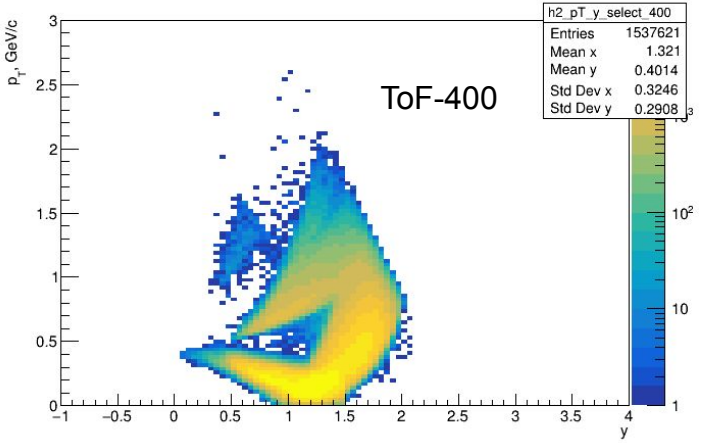
<m2> depends on momentum

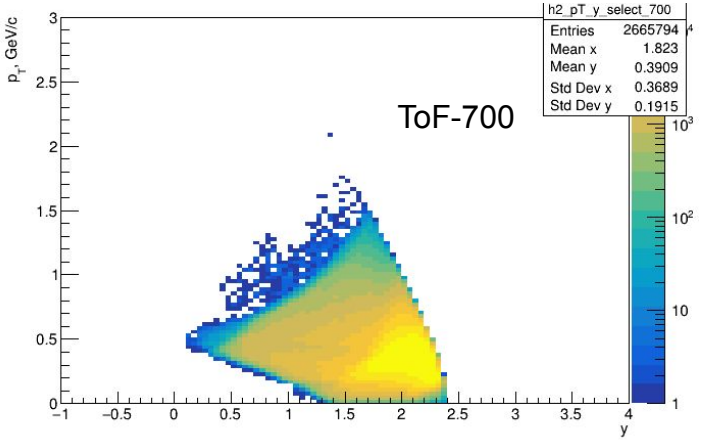
fit in narrow ranges of p/q

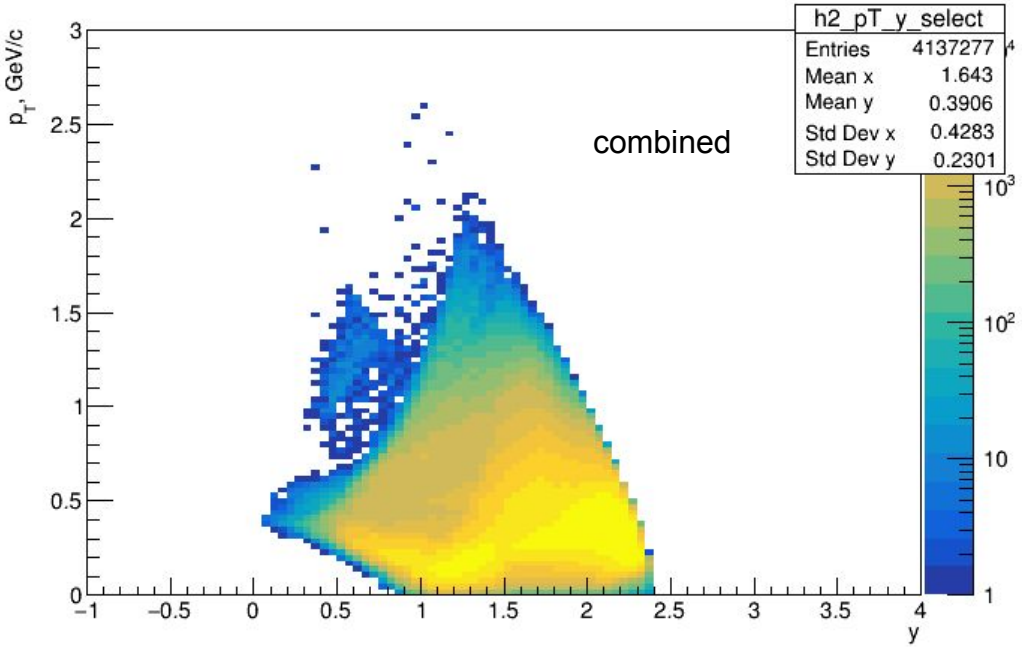
- <m²>
- <m²> ± σ



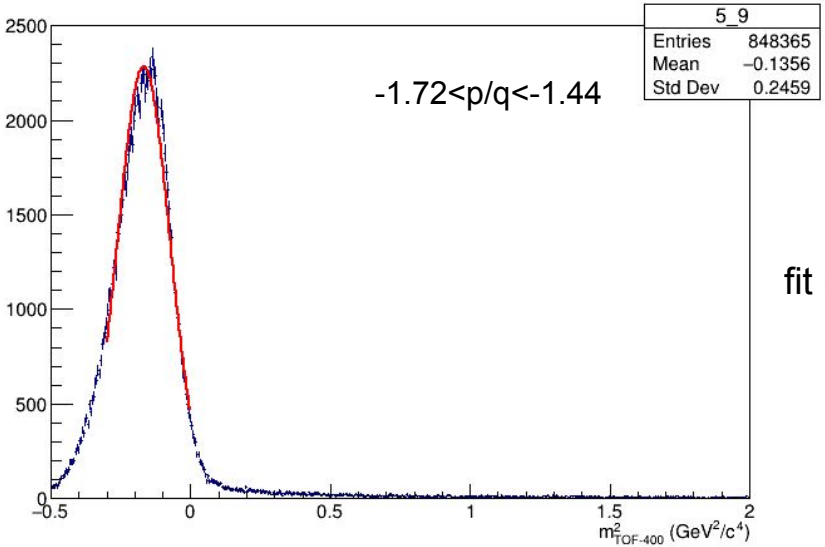
RUN8 Data: proton candidates p_T vs y







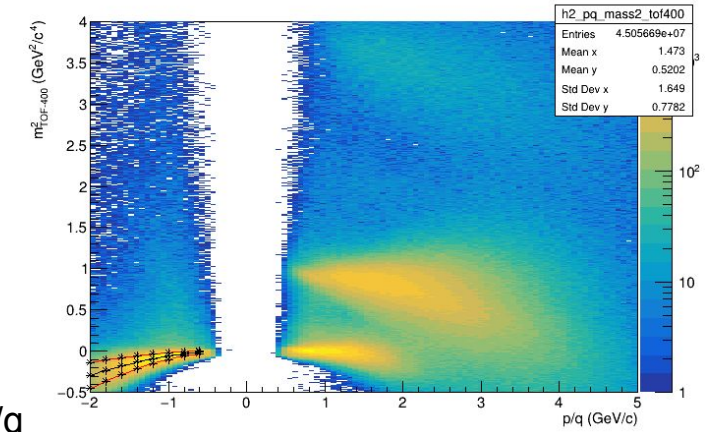
Fitting the mass distribution in narrow p/q ranges for π-

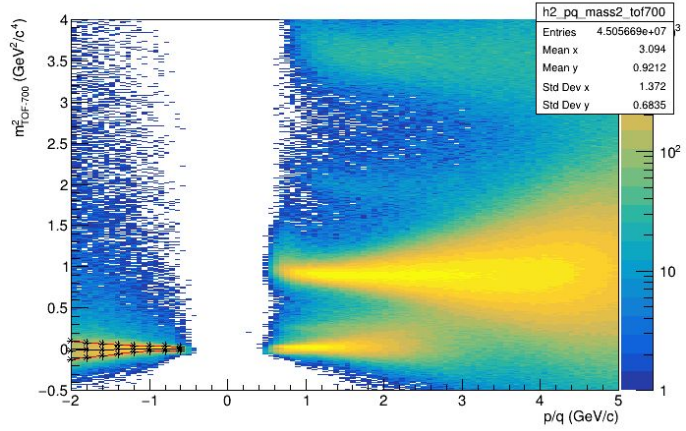


<m2> depends on momentum

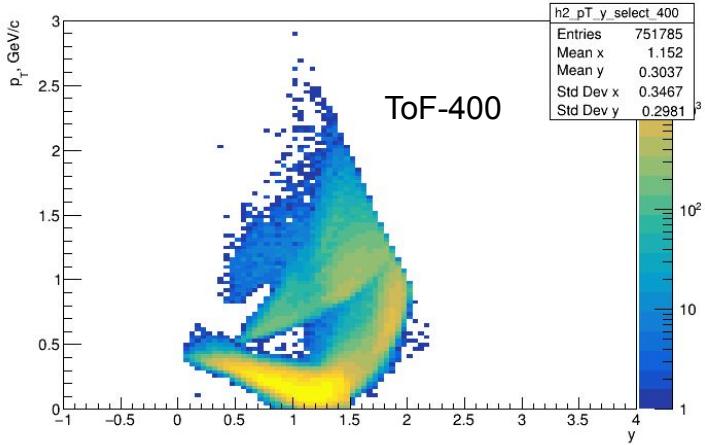
fit in narrow ranges of p/q

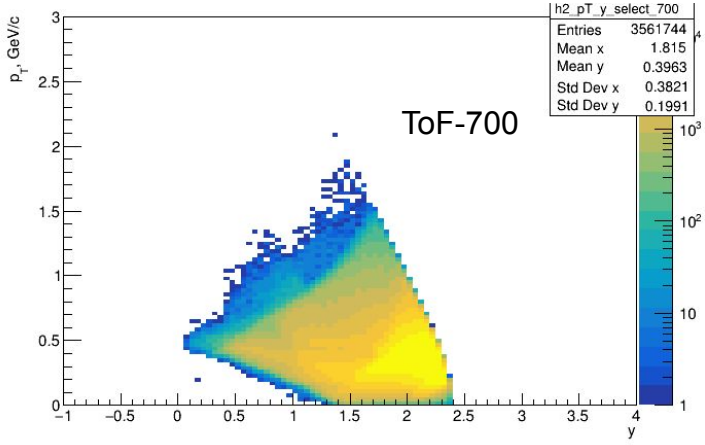
- <m²>
- <m²> ± σ

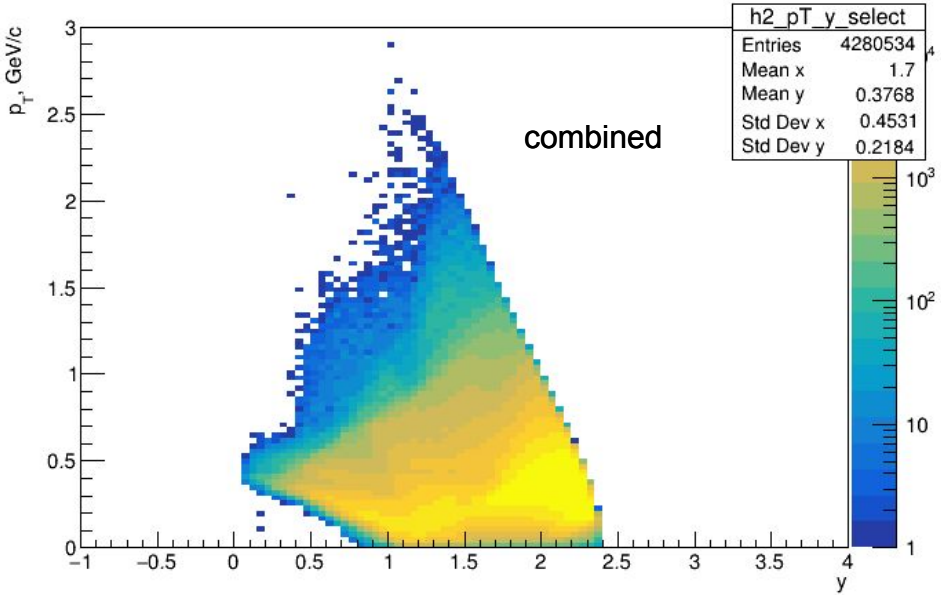




RUN8 Data: π- candidates p_T vs y





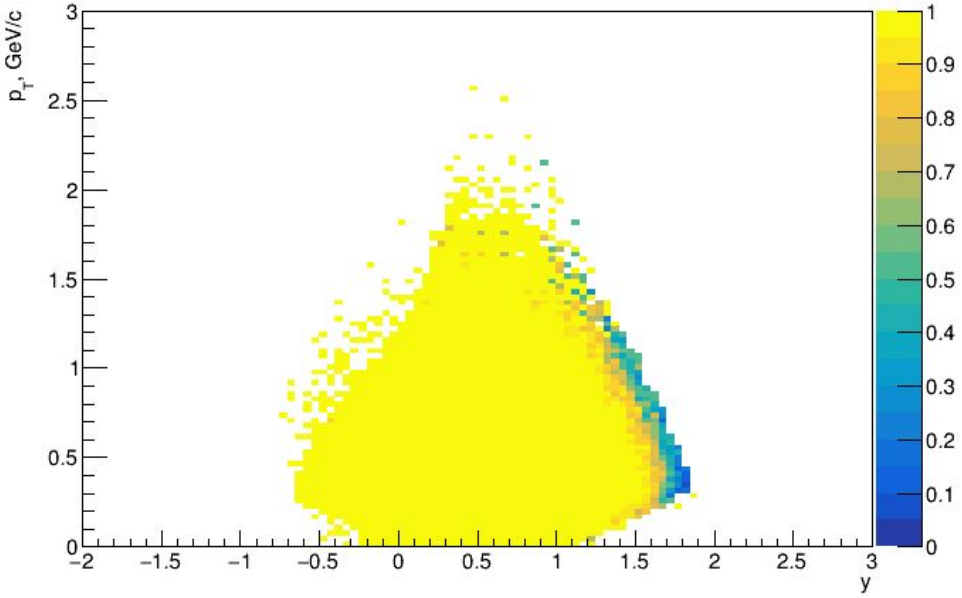


Summary

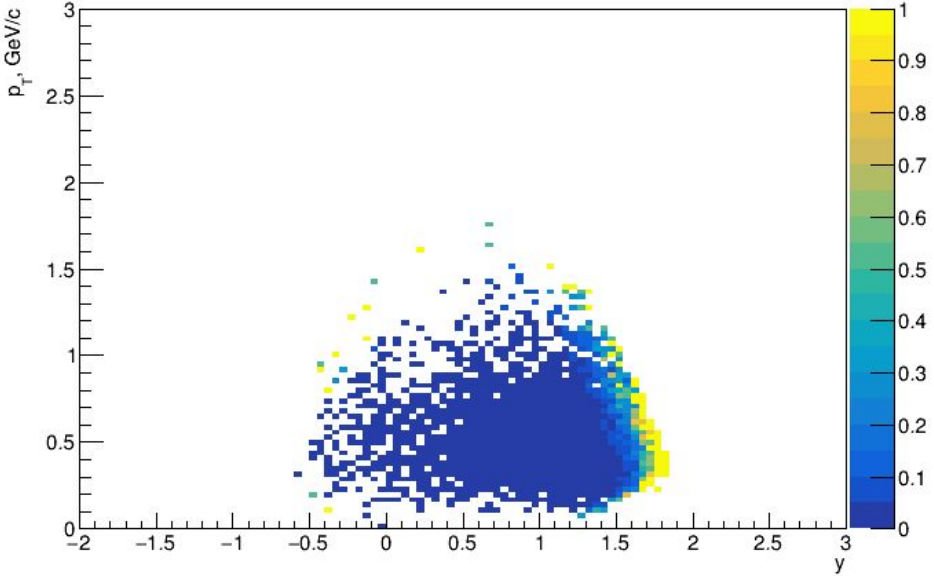
- Proton identification procedure was tested on MC-simulation of BM@N experiment based on GEANT4 model and DCMQGSM-SMM Xe+Cs@3.0AGeV events as an input
  - Misidentification ratio is found to be below 1%
- Charged hadrons identification was performed for recent physical run of the BM@N experiment in Xe+Cs@3.8A GeV collisions:
  - Rather wide distribution of m2 was observed for all particle species, further calibration of TOF-data is required
  - Protons and negatively charged pions were selected using via fitting the m2 distribution in narrow momentum ranges
- TODO:
  - Compare the results for different tracking
  - Check the run-by-run systematics

p_T vs y for proton identification performance

Ratio of true protons to candidates (2σ)



Misidentification ratio (2σ)

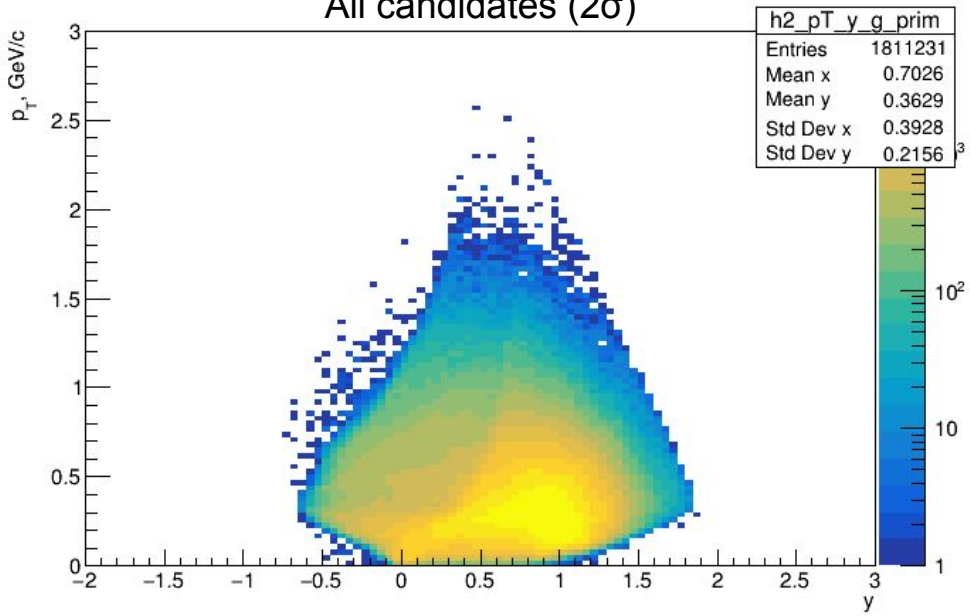


Misidentification of protons in the selection is mostly under 1%.

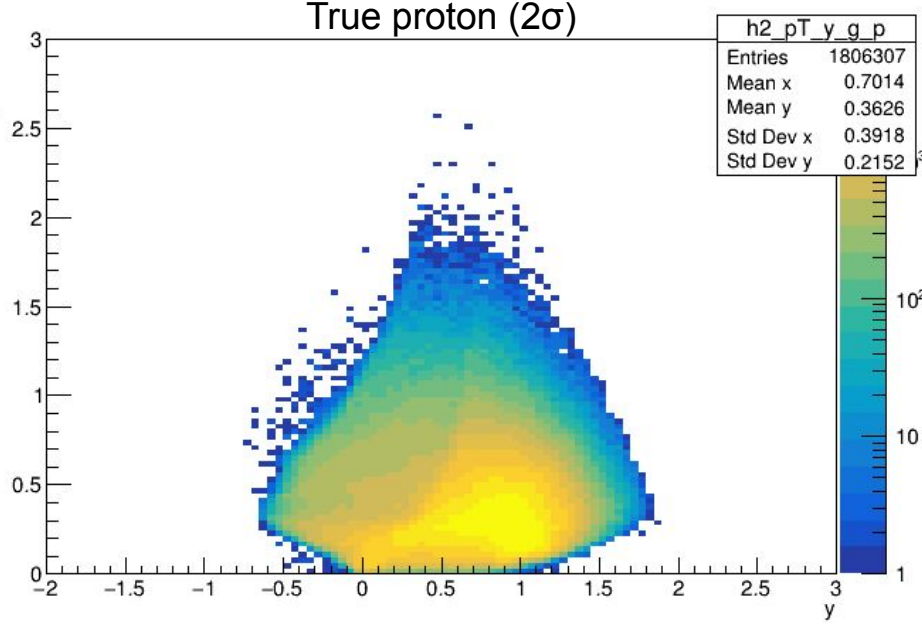
p_T vs y for proton candidates

$$y = \frac{1}{2} \ln \frac{E + p_z}{E - p_z}$$

All candidates (2σ)



True proton (2σ)

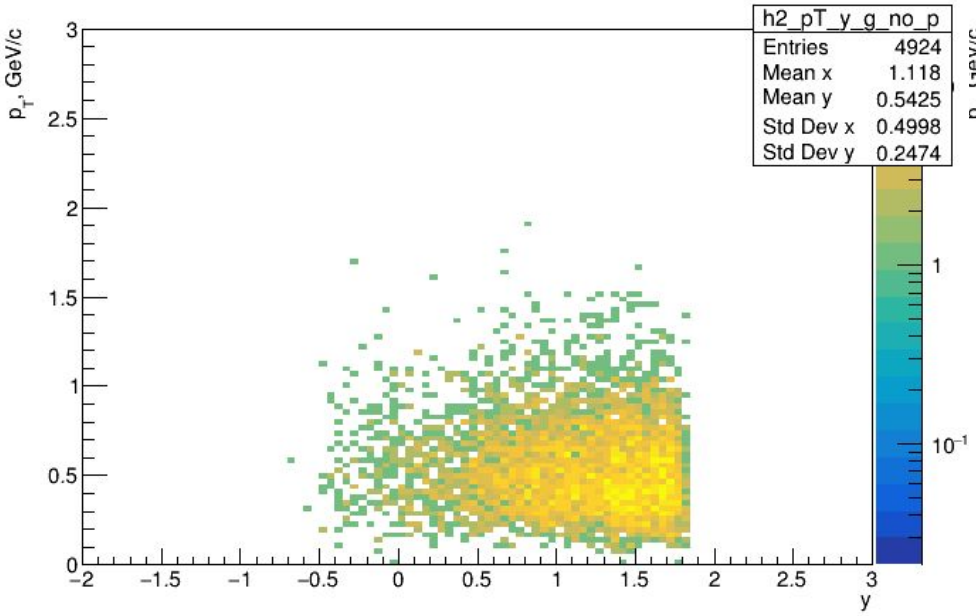


All candidates - all particles that passed the selection.
True proton - particles that passed the selection and are protons.

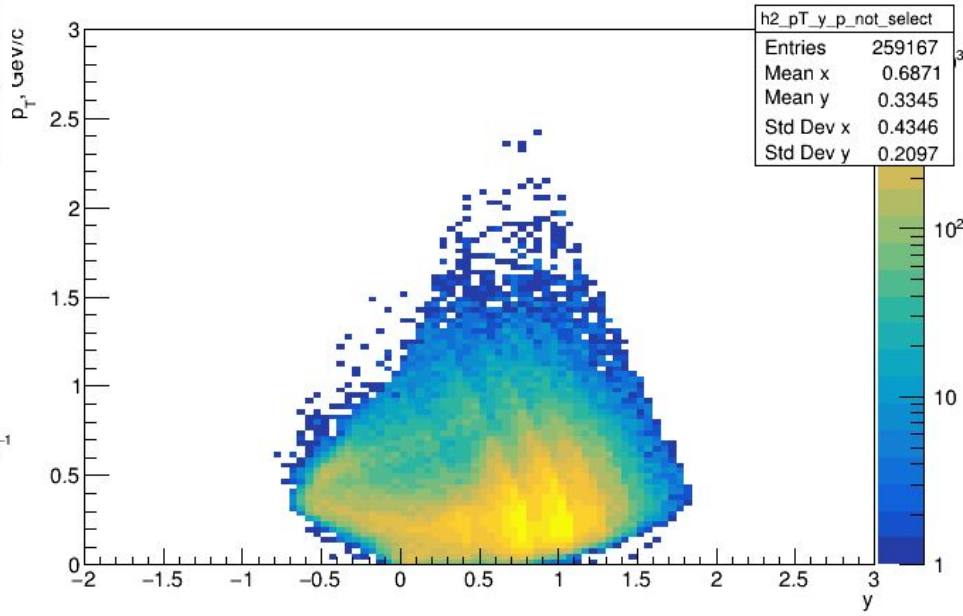
Most of the selected particles are protons.

p_T vs y for proton candidates

False candidates (2*σ)



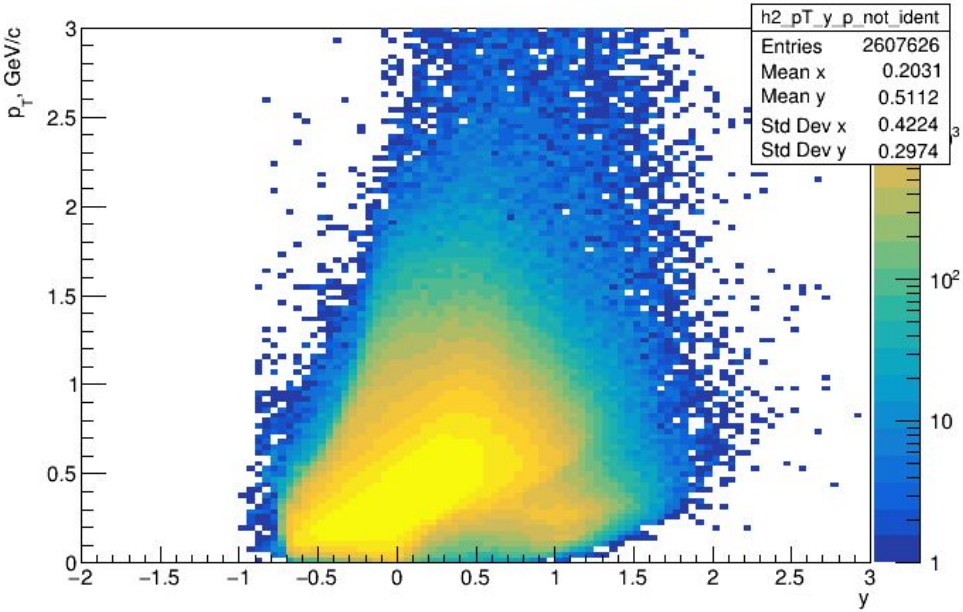
True Protons out of <m²> ± 2σ



False candidates - particles that passed the selection, but are not protons

p_T vs y for primary protons without hit in ToF

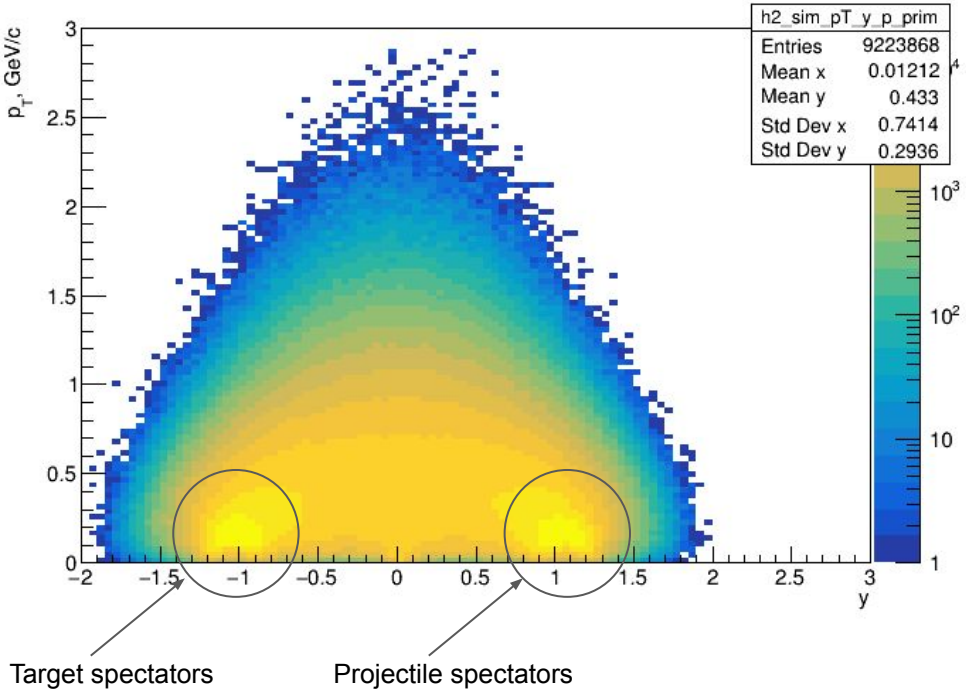
Particles without hit in ToF-system are unidentifiable.



p_T vs y for primary sim protons

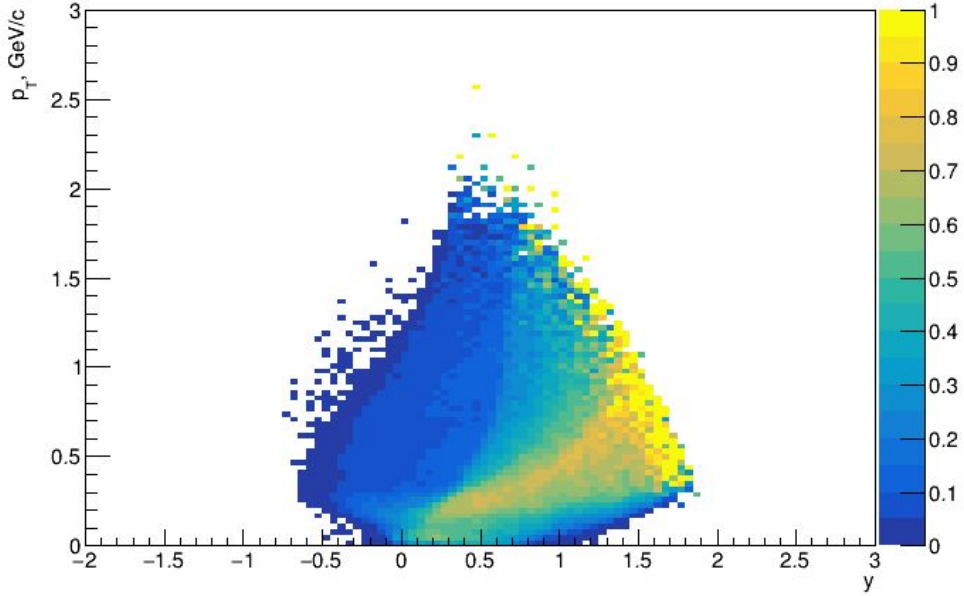
Sim protons - protons from GEANT4 simulation.

Identification ratio - ration true and false proton candidates to all candidates - demonstrate selection efficiency.



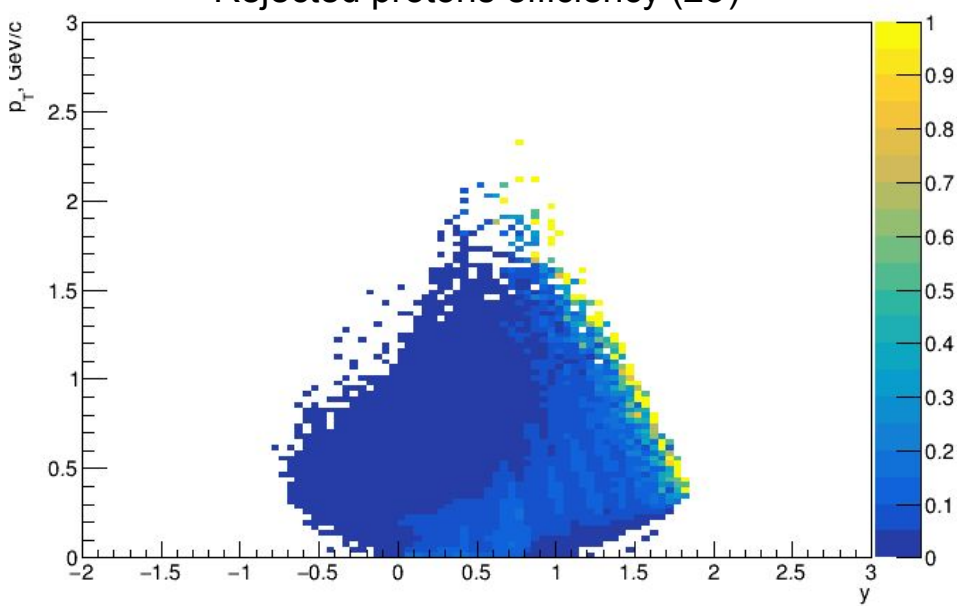
p_T vs y for proton identification efficiency

Accepted protons efficiency (2σ)



True proton candidates divided by sim protons

Rejected protons efficiency (2σ)

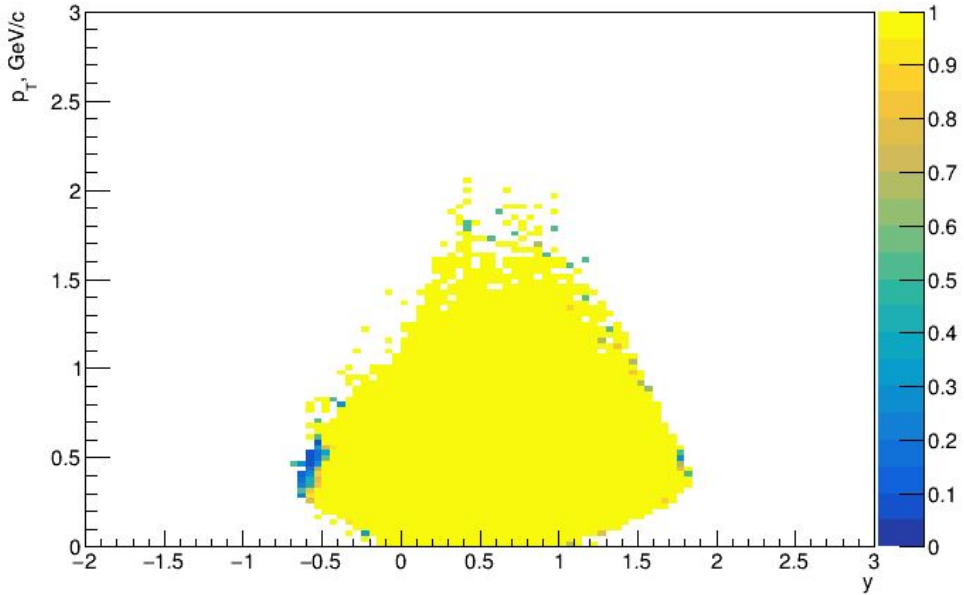


Protons out of <m²> +- 2σ divided by sim protons

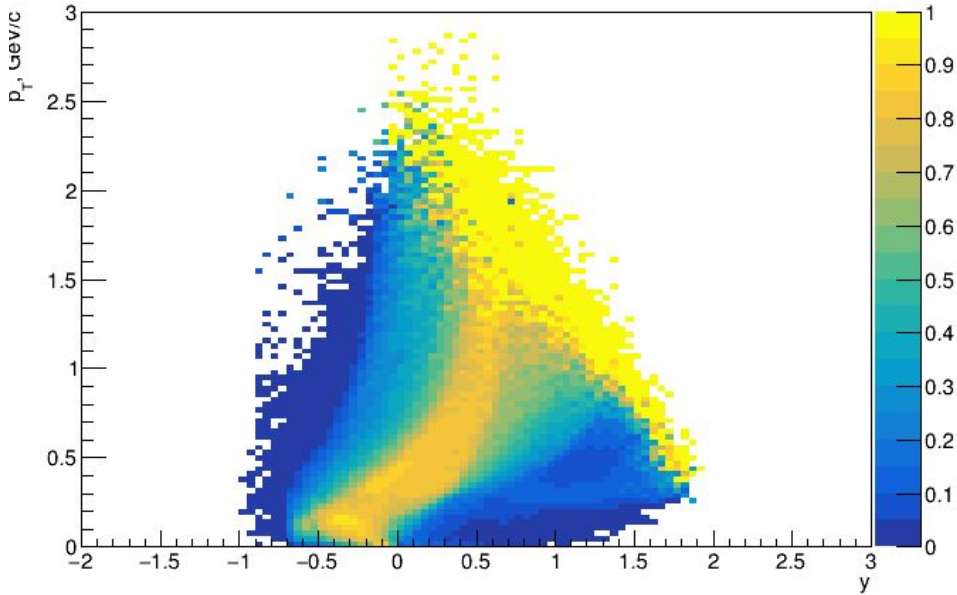
Most of the protons were selected using the ToF-method

p_T vs y for proton identification performance

Ratio of true proton candidates to protons out of range (2σ)



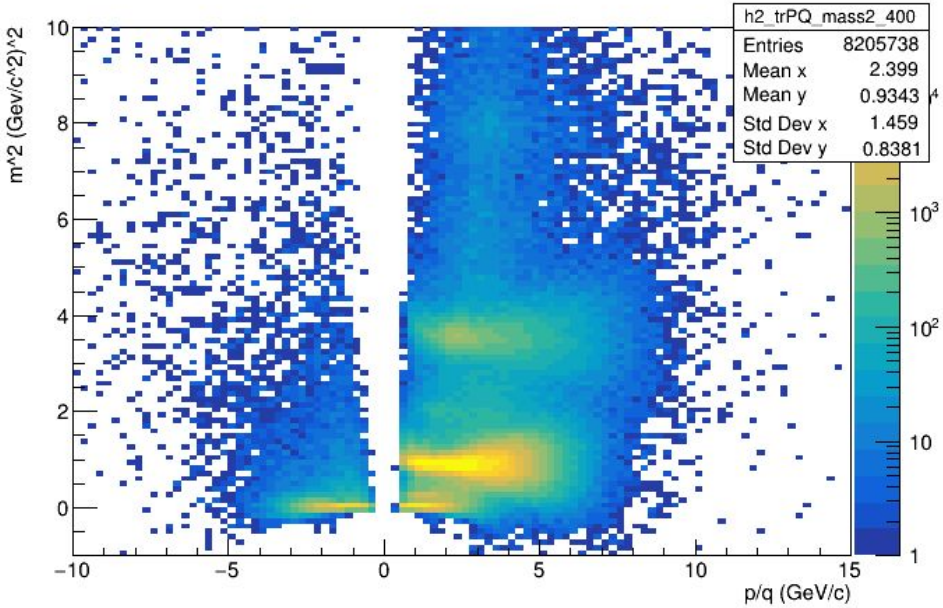
Proportion of unidentifiable protons



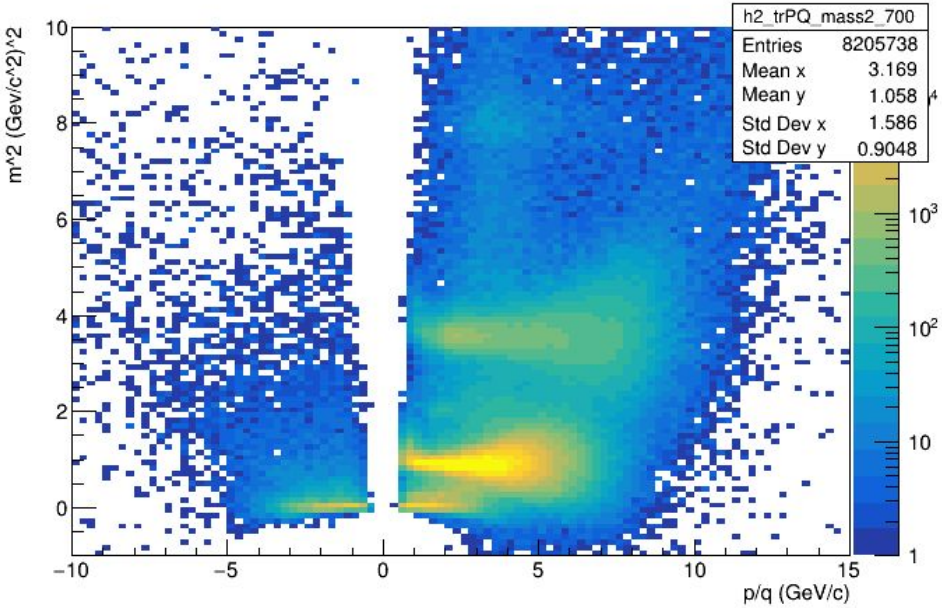
Protons without hit in ToF divided by sim protons

m² vs p/q distribution for all charged particles

ToF-400



ToF-700



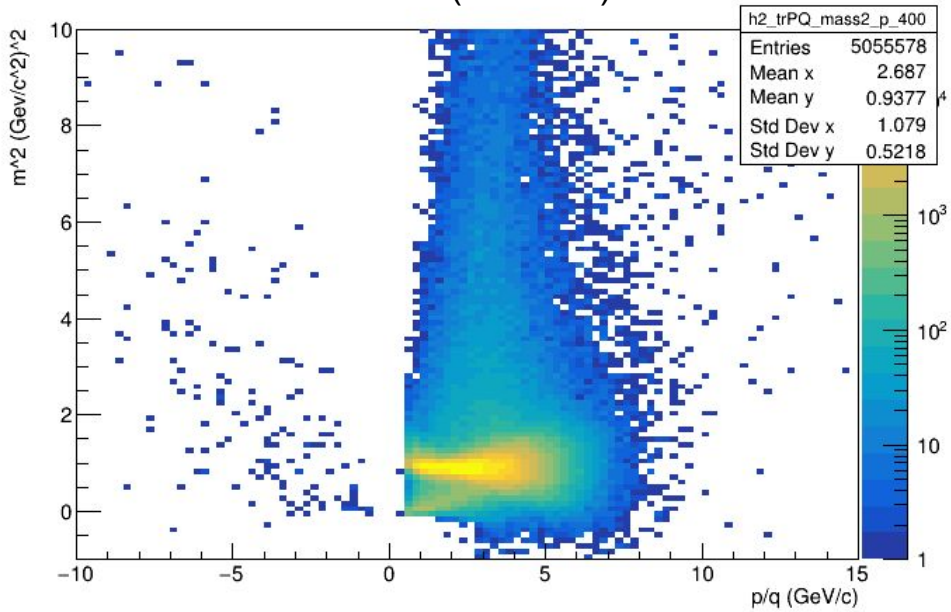
$$m^2 = \frac{(1-\beta^2) * p^2}{\beta^2}$$

- No significant dependency of <m2> on momentum is observed
- We observe wider band for each particle species with larger momentum

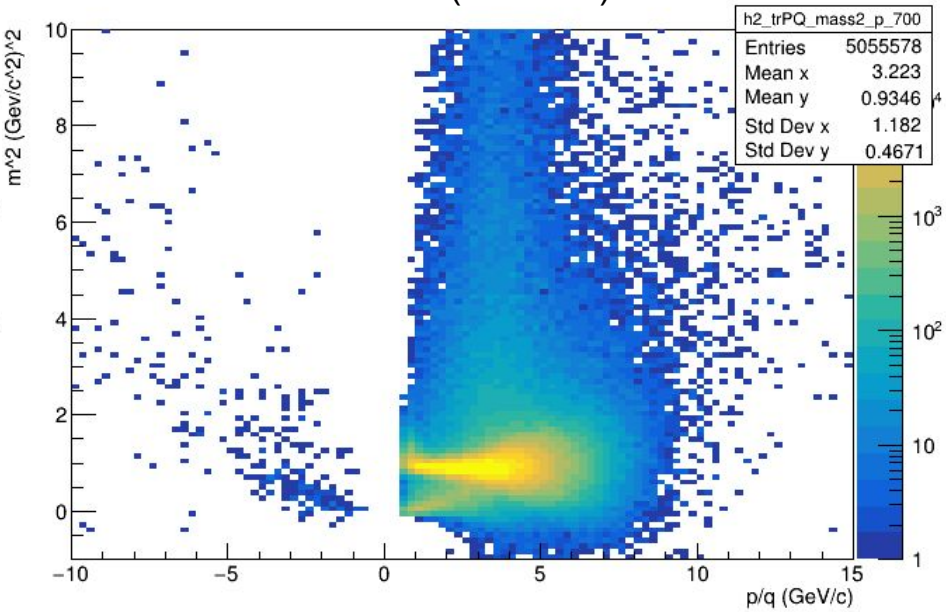
m² vs p/q for all reconstructed protons

Protons were selected via PDG code of sim particle associated with track

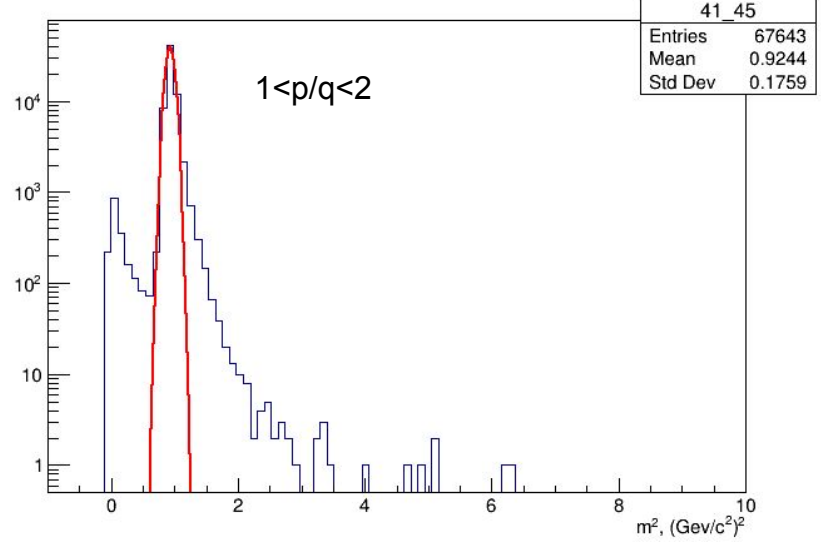
Protons (ToF-400)

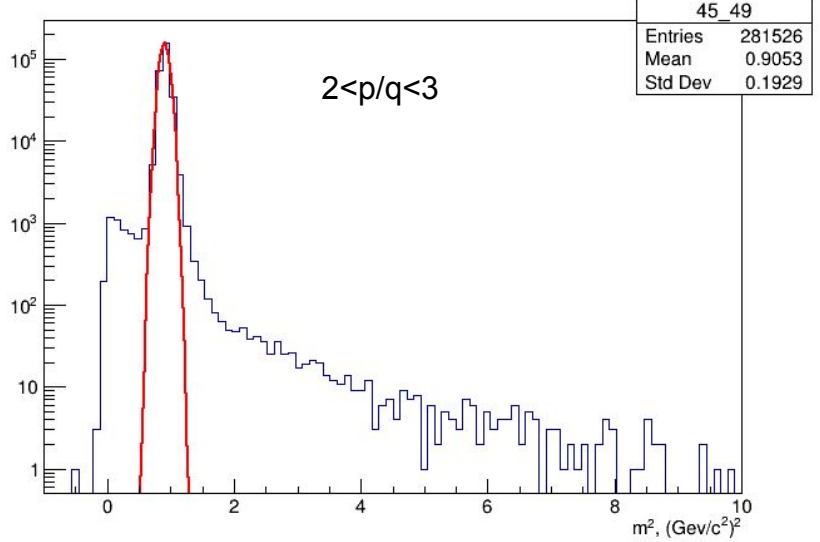


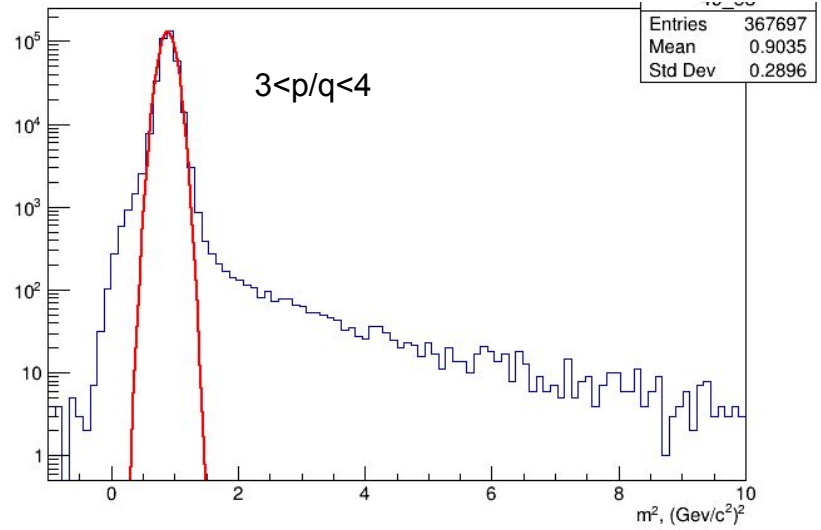
Protons (ToF-700)

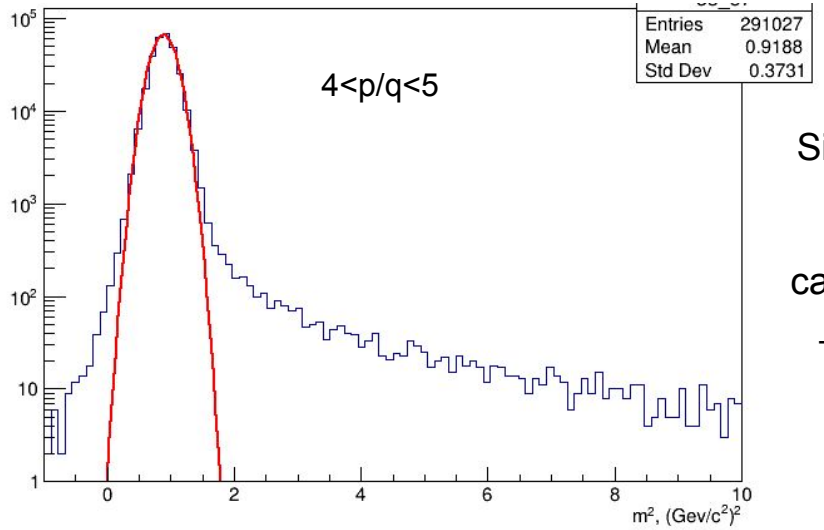


Cut on PDG code was used to suppress contribution from other particle species.





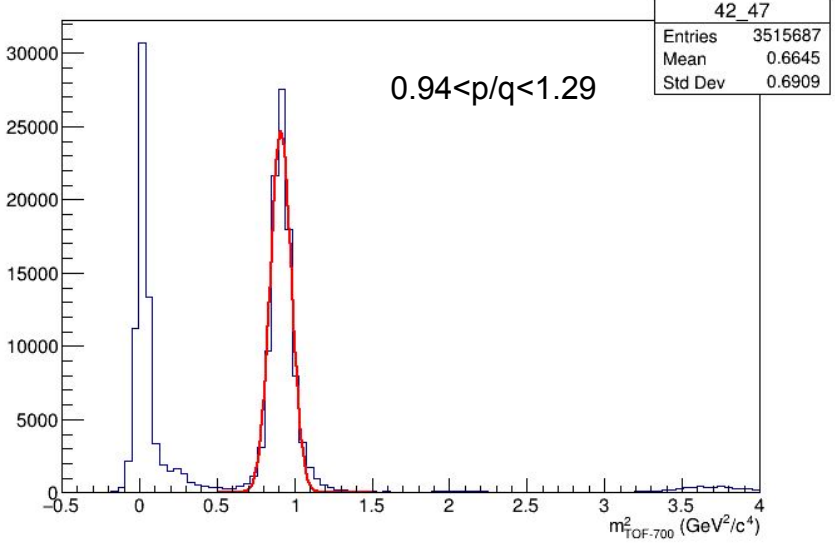


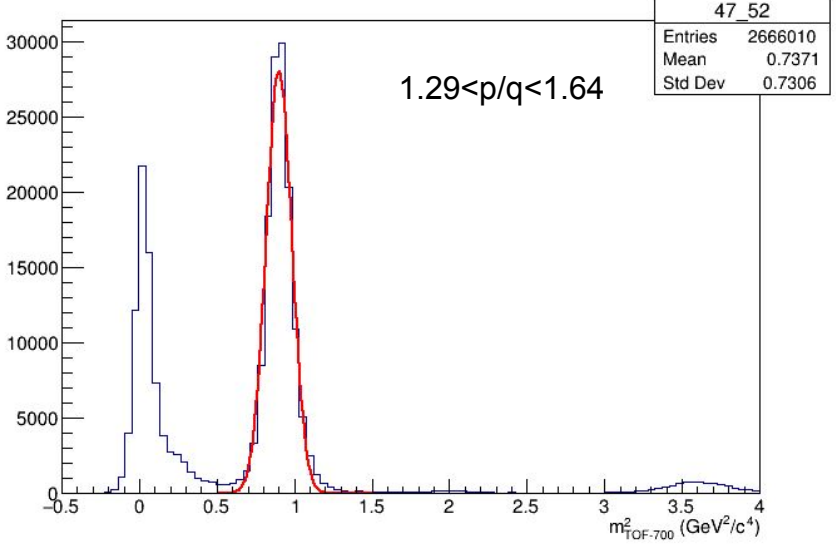


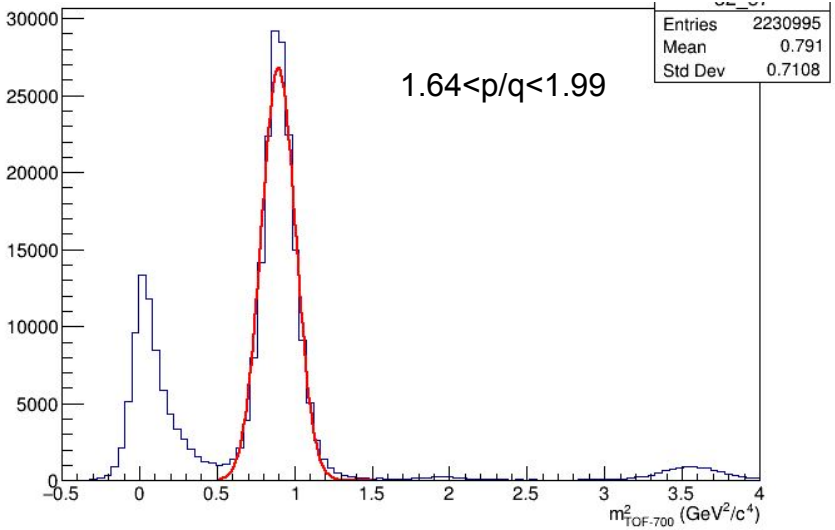
Simulation

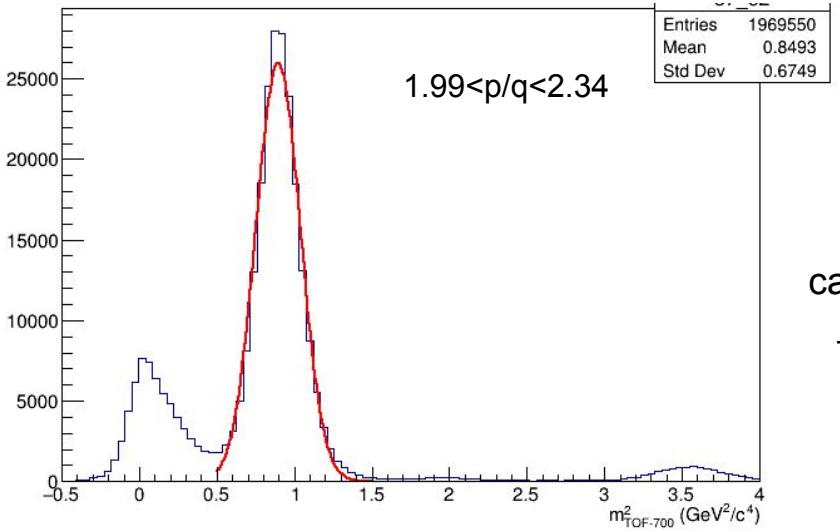
Proton candidates

ToF-400



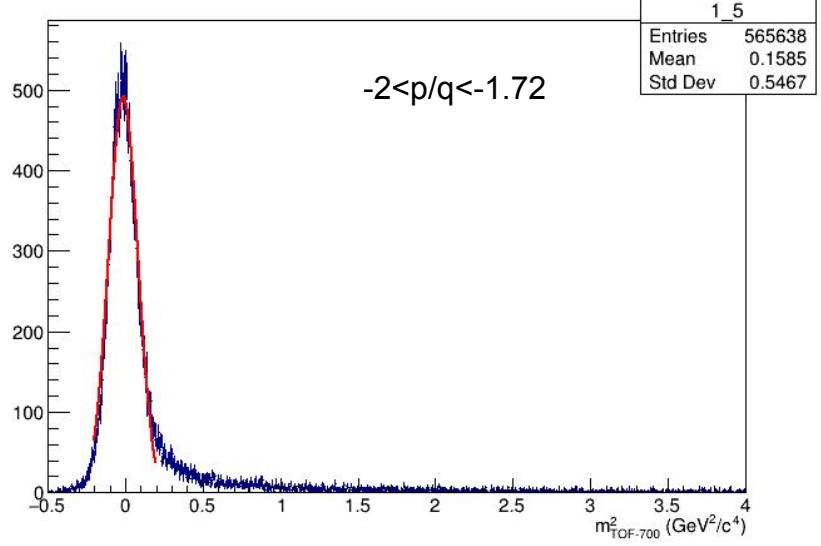


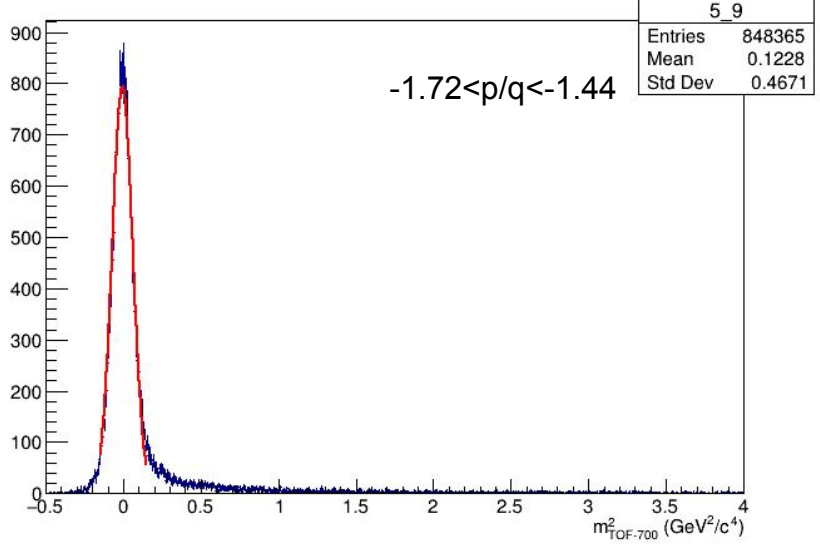


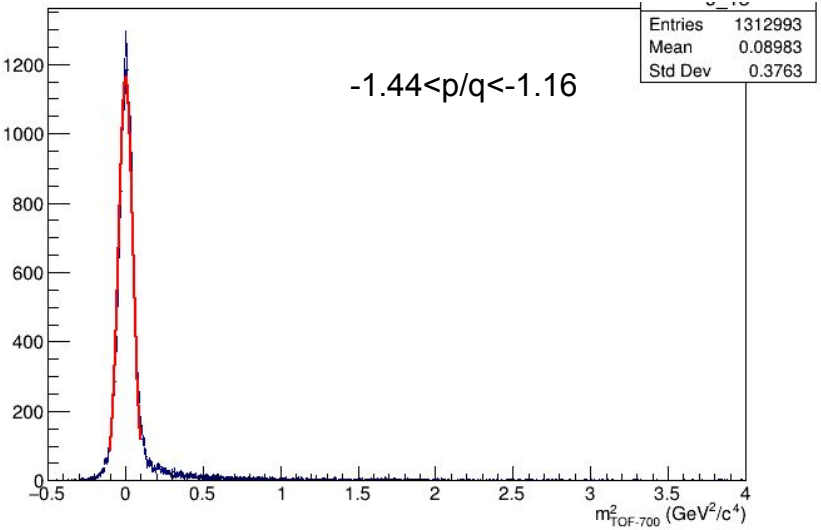


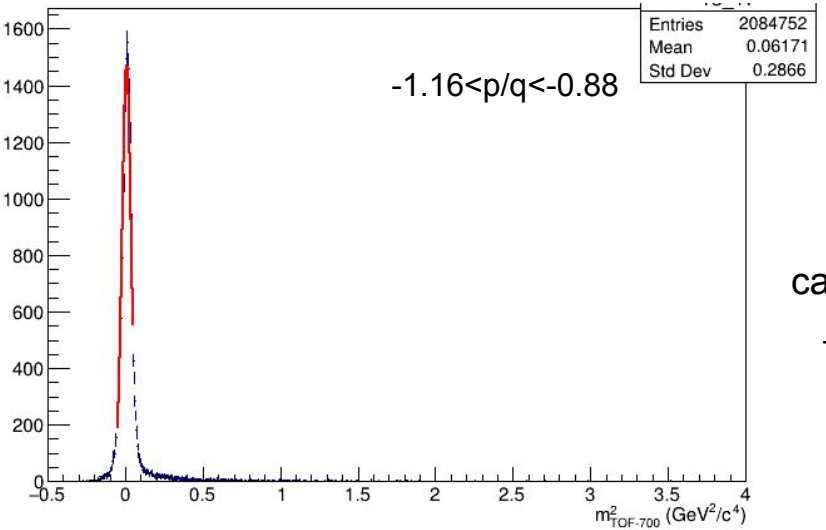
Proton candidates

ToF-700









π- candidates

ToF-700