Latest results on Trigger Rates, Momentum spread Particle Identification and Beam Composition

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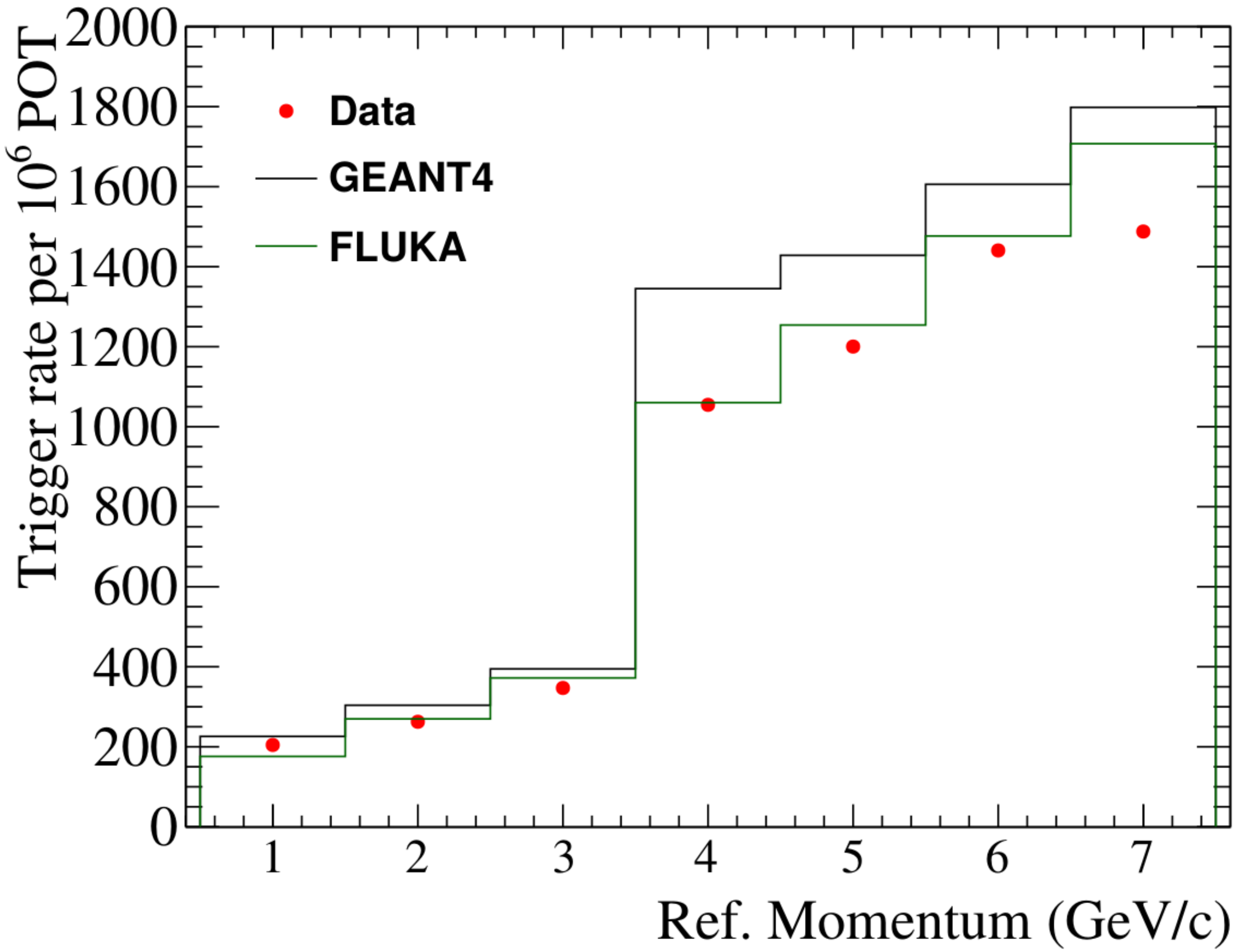
Updates on Trigger Rate and Momentum Spread Studies

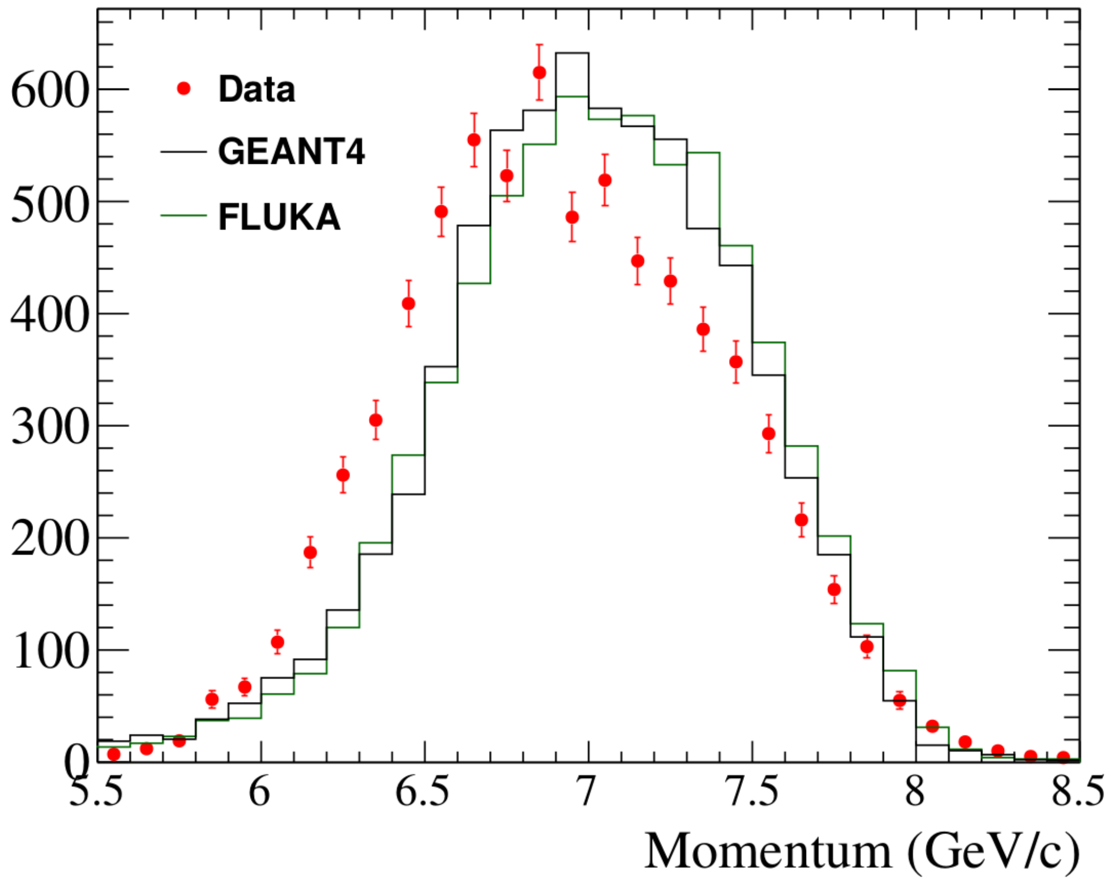
Trigger Rates

- Measured trigger rates have been compared to Geant4 and FLUKA simulations
- A 95% percent efficiency for each trigger plane has been assumed.
- The data has been normalized to 1 Mio. events on the secondary target (VLE-target)
  - 1-3 GeV/c tungsten
  - 4-7 GeV/c copper

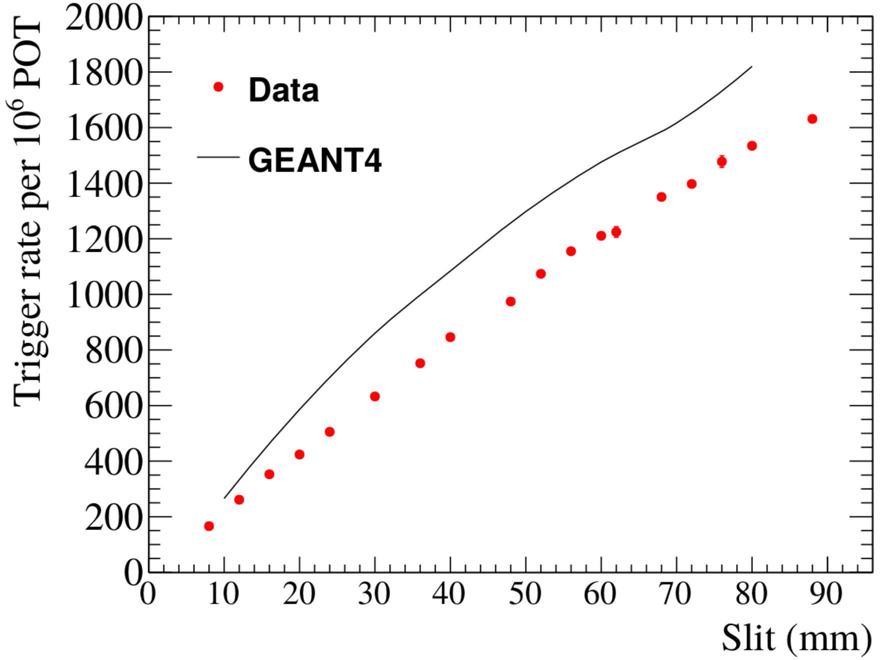


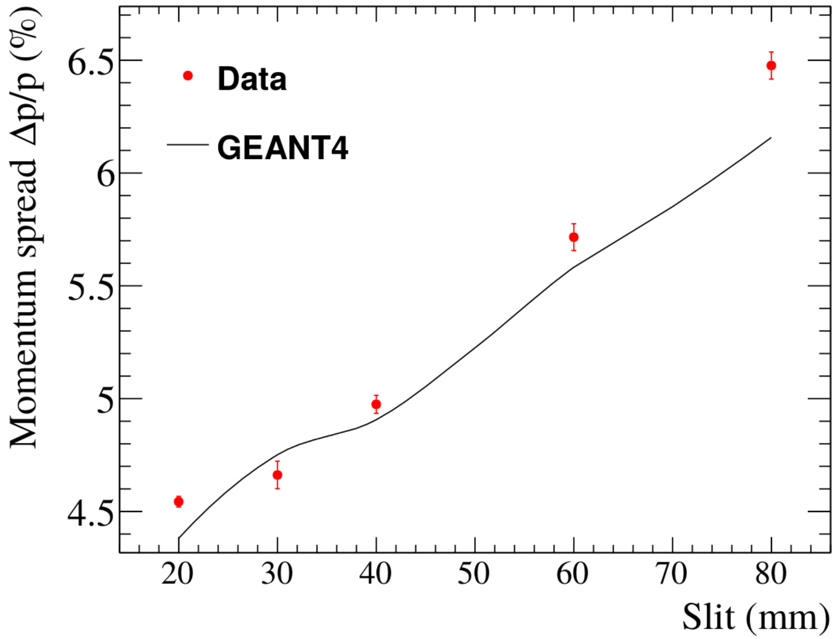
Momentum Spread

- Measured distribution for “7 GeV/c” has been compared to Geant4 and FLUKA
- Collimator opening: 88 mm.
- Data has been normalized to same integral between 6 and 8 GeV/c (arbitrary vertical axis)
- Systematic shift of 1.45mm in x has been applied to third spectrometer plane
  - See talk by A. Booth



Dependence on Collimator Slit

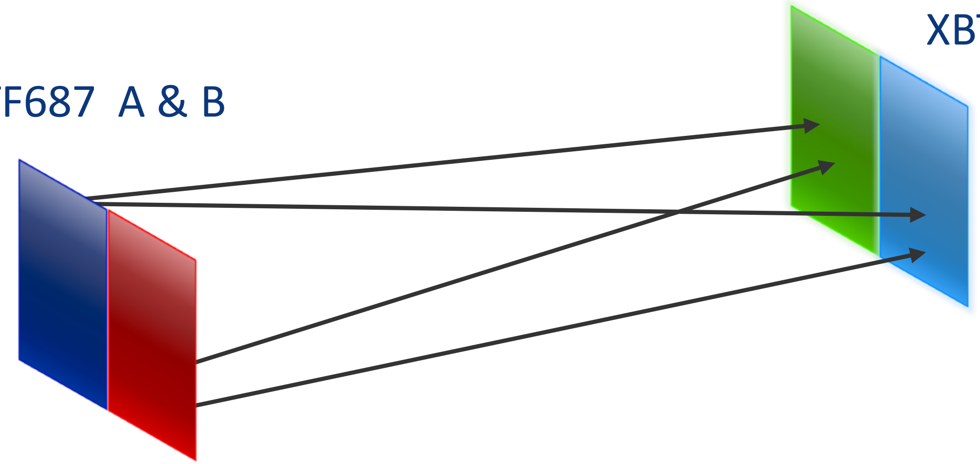




- Variation of trigger rate and momentum spread with respect to different collimator openings have been studied for 7 GeV/c (95% efficiency per trigger plane)
  - Expected trigger rate in Geant4 is slightly larger (normalization, misalignments, possible). MC simulates ideal beam line.
  - Observed momentum spread variation similar to simulated values.

Particle Identification

Overview of PID

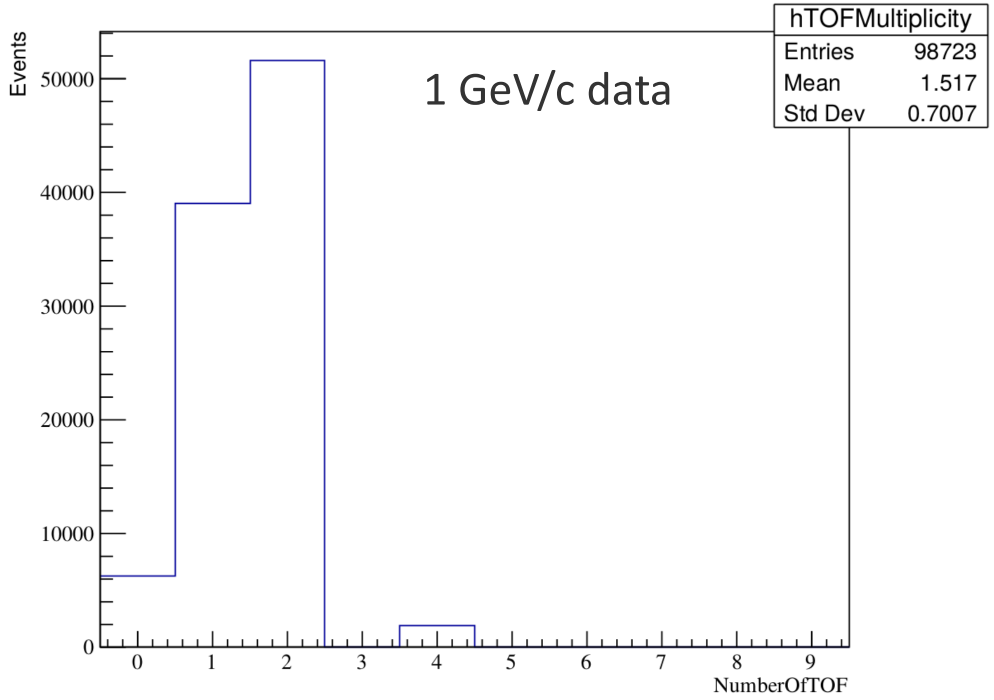


- Particle Identification based on:
  - Time-of-flight between XBTF687 and XBTF706
  - Cherenkov Signal in Cherenkov1 (C1, 713) and/or Cherenkov2 (C2, 716)
- TDC Timestamps of Cherenkov Signals and Hits in the four XBTF sections matched to a particle trigger in defined time window.
- Optimum case:
  - One possible TOF combination and one or no timestamp matched to each particle trigger

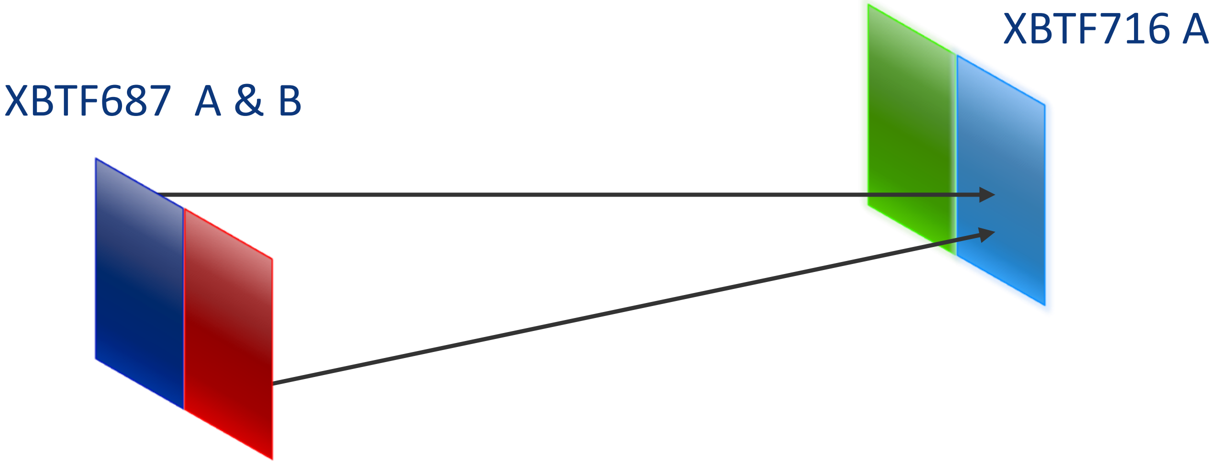
Time-of-Flight

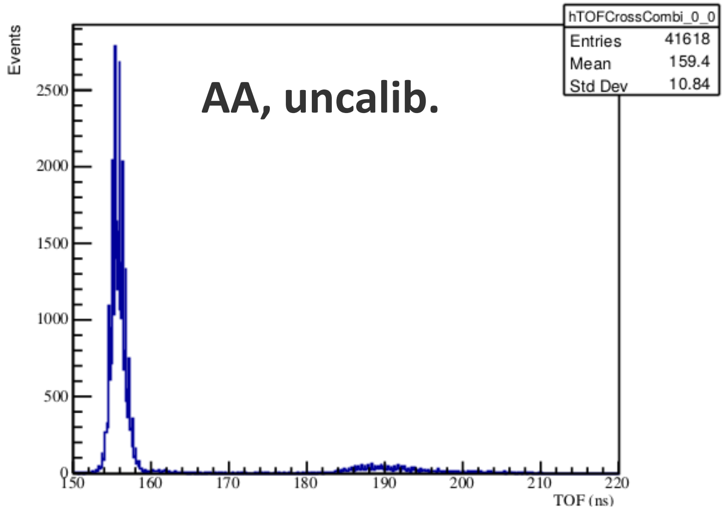
- Problem: observed that many trigger events allow for multiple possible TOF times in defined time window

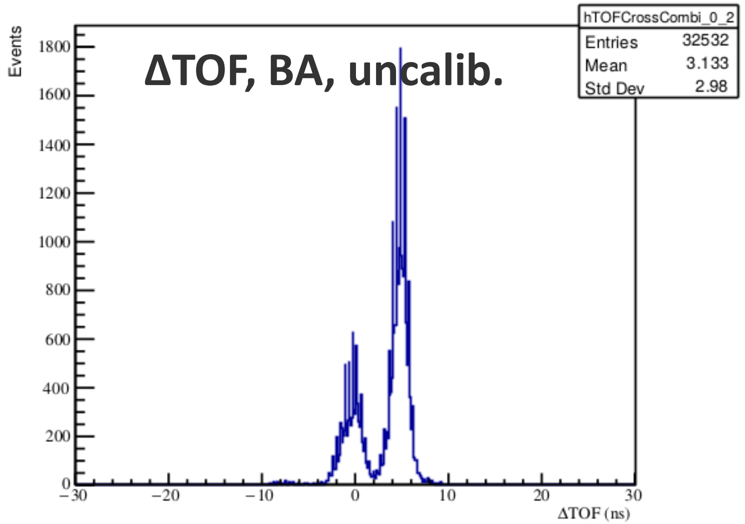
- Four channels: (XBTF687A, XBTF687B), (XBTF716A, XBTF716B)
  - 0/1 total timestamps → 0 TOF combinations
  - 1 timestamp, 1 timestamp → 1 TOF combination (golden)
  - 2 timestamp, 1 timestamp → 2 TOF combinations
  - 1 timestamp, 2 timestamp → 2 TOF combinations
  - 2 timestamp, 2 timestamp → 4 TOF combinations



Time-of-Flight (Channel-wise study)

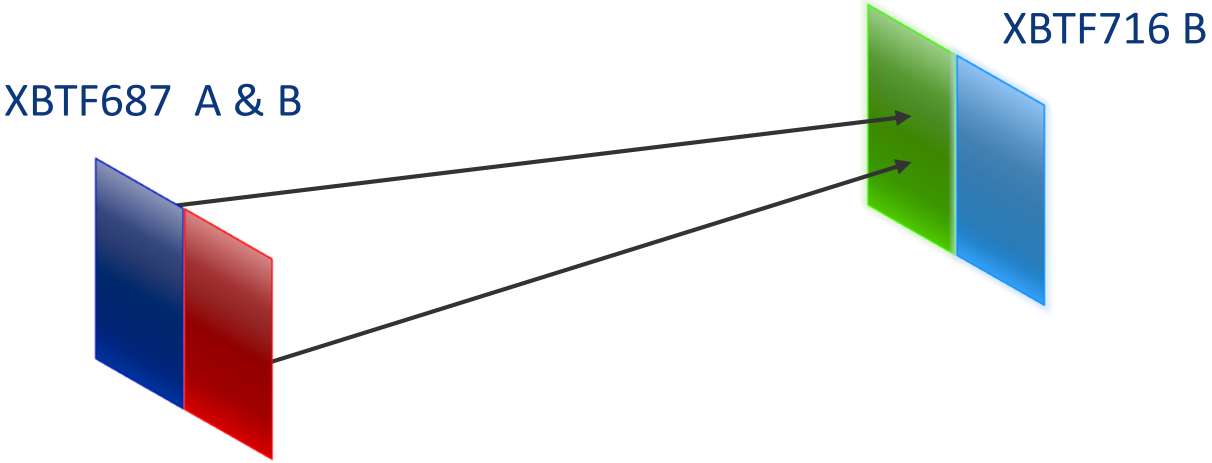


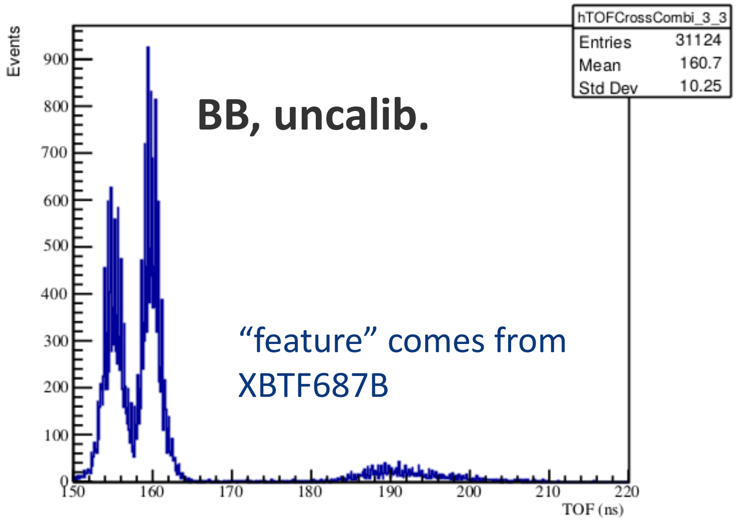


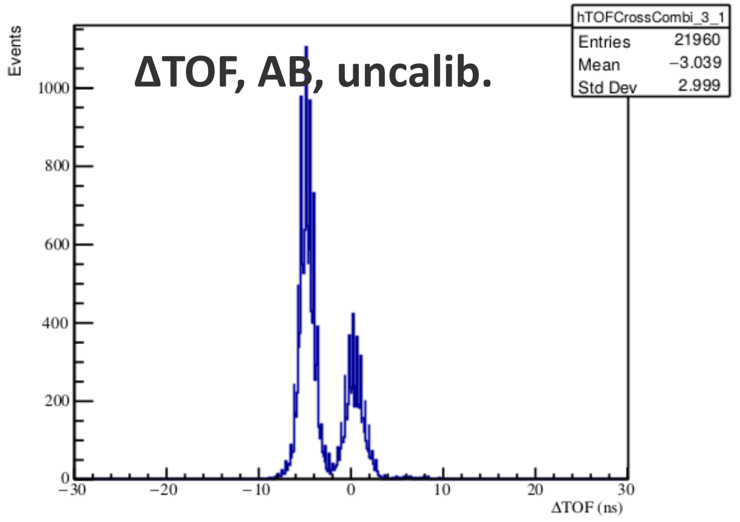


- Question: If AA has a valid TOF combination, does BA also provide a valid TOF combination for the same event?
- Answer: Very often, yes!
  - The timestamp in XBTF716A is usually the same for both calculated TOF.
  - The signal from XBTF687B comes simultaneous $\Delta TOF \approx 0ns$, or The signal from XBTF687B comes 4-5 ns earlier: $\Delta TOF \approx +4\text{-}5ns$ with respect to XBTF687A

Time-of-Flight (Channel-wise study)







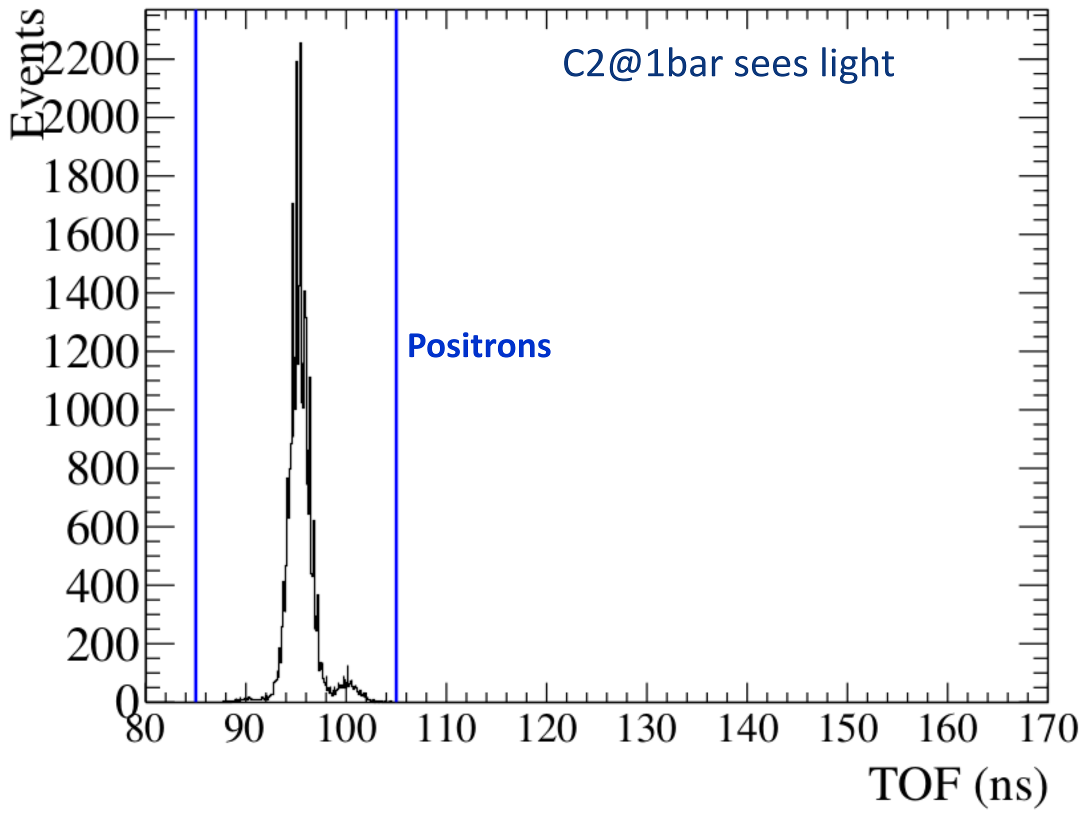
- Question: If BB has a valid TOF combination, does AB also provide a valid TOF combination for the same event?
- Answer: Very often, yes!
  - The timestamp in XBTF716B is usually the same for both calculated TOF.
  - The signal from XBTF687B comes simultaneous ΔTOF ≈ 0ns, or The signal from XBTF687B comes 4-5 ns earlier: ΔTOF ≈ +4-5ns with respect to XBTF687A

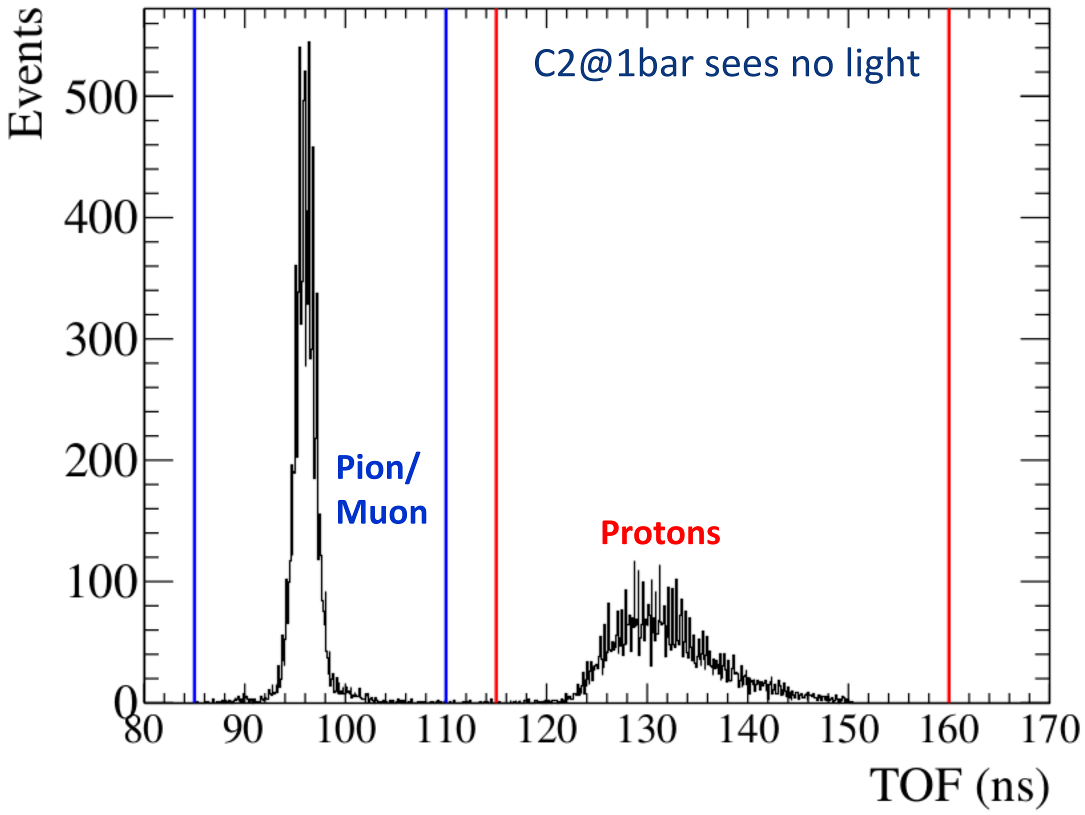
Mitigation

- Combine TOF information with Cherenkov information:
  - Example: 1 GeV/c: C1 not used, C2 @ 1bar for positron tagging
    - If C2 sees light, assume the particle is a positron:
      - In case of multiple TOF, check if valid calib. TOF between 85-110 ns exists → Positron
    - If C2 doesn't see light, assume particle is either pion/muon or proton.
      - Proton significantly slower (calib. TOF: 115ns – 160ns)
      - In case of multiple TOF, check if valid calib. TOF between 115ns – 160ns exists → Proton
      - ELSE: In case of multiple TOF, check if valid calib. TOF between 85-110 ns exists → Pion/Muon

Results for 1 GeV/c

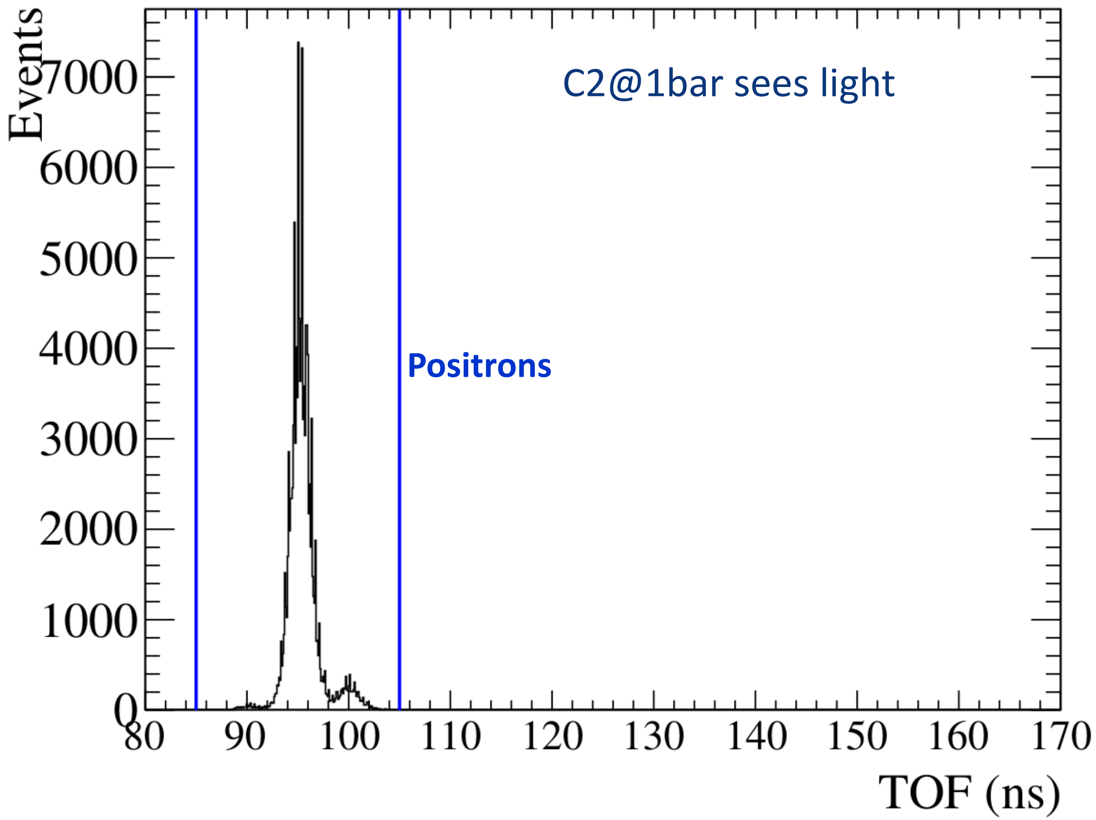
- Calibration of TOF depending on channel AA, AB, BA, BB:
  - Between 65.5-66.5ns subtracted from each channel

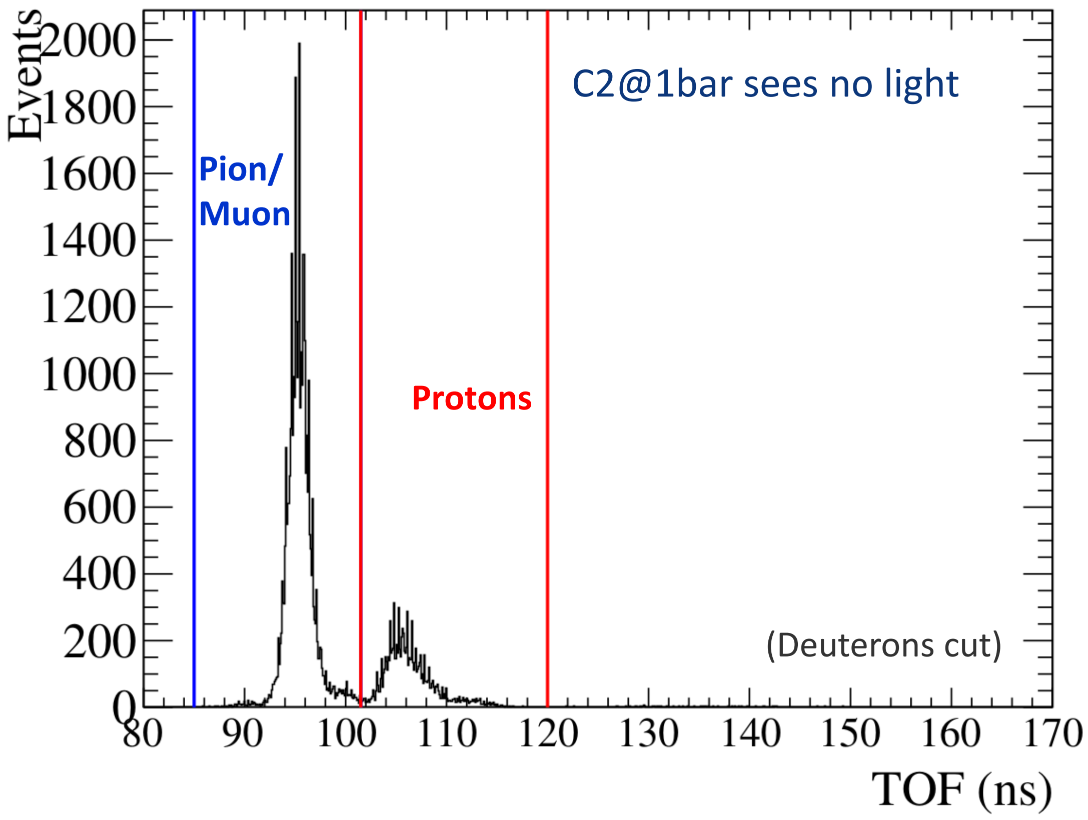




Results for 2 GeV/c

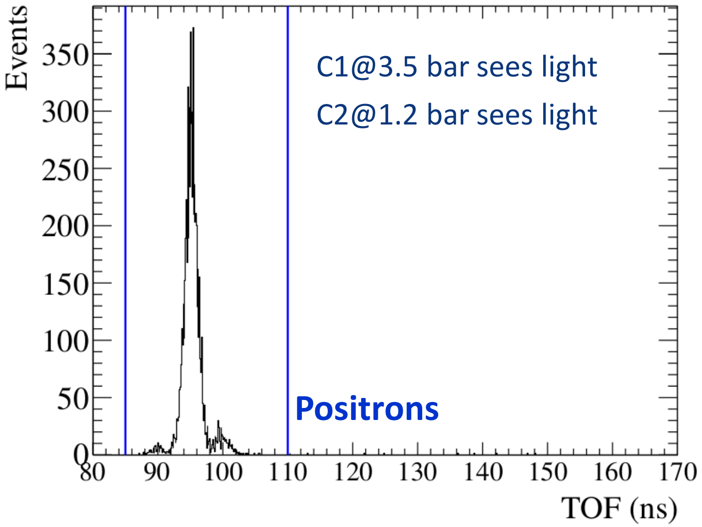
- C1 is not used, C2 sees light only for positrons.

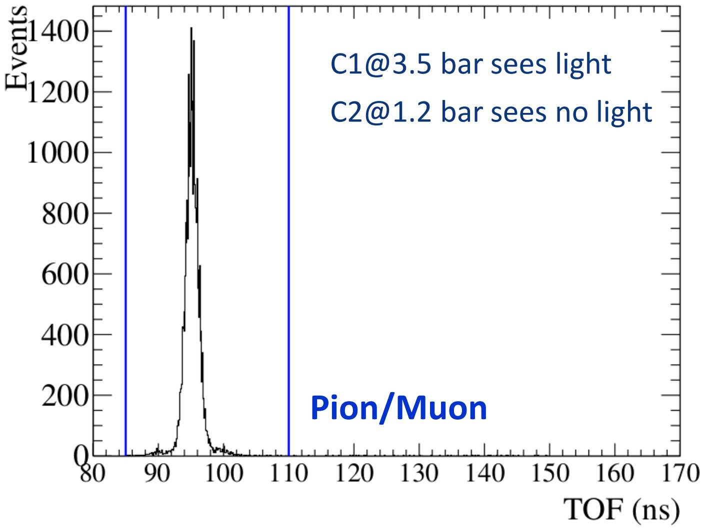


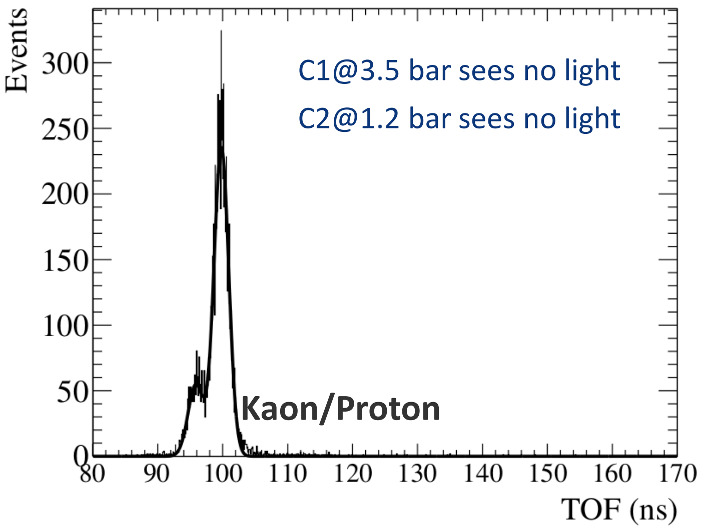


Results for 3 GeV/c

- C1 (high pressure) sees light for positrons, pions and muons
- C2 (low pressure) sees light only for pions

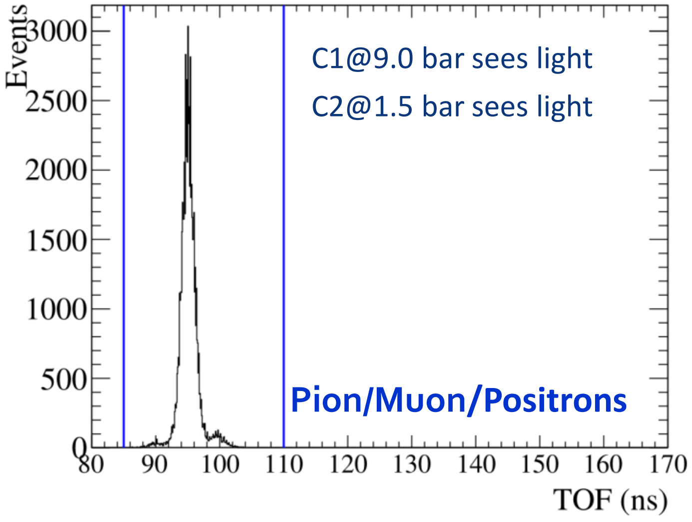


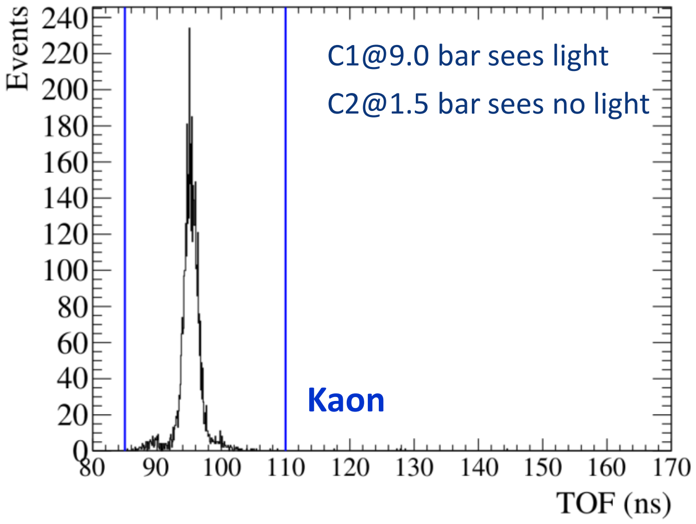


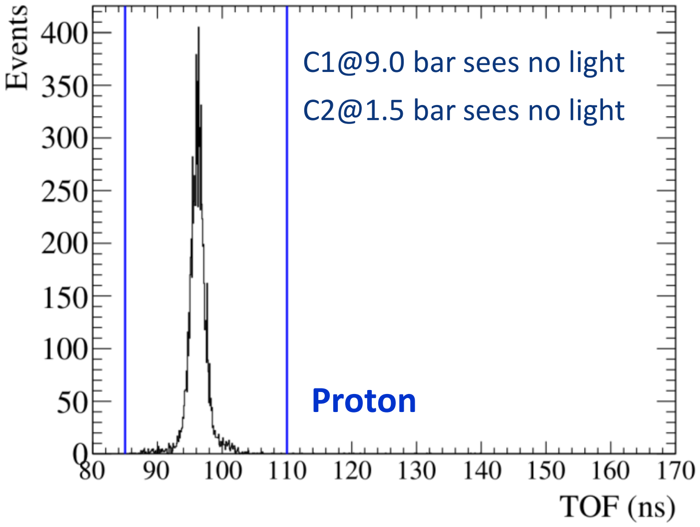


Results for 6 GeV/c

- C1 (high pressure) sees light for pions, muons, positrons and kaons
- C2 (low pressure) sees light for pions, muons and positrons

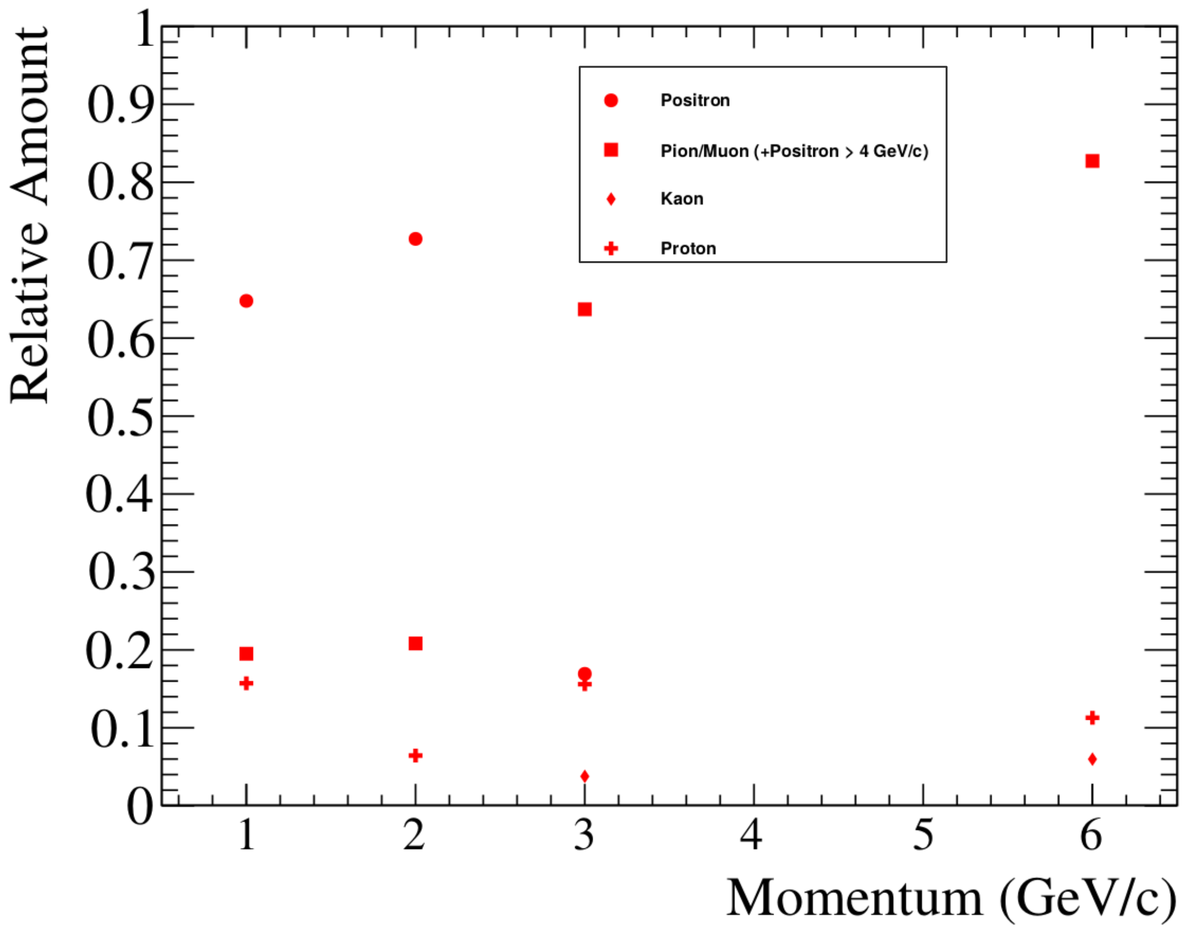


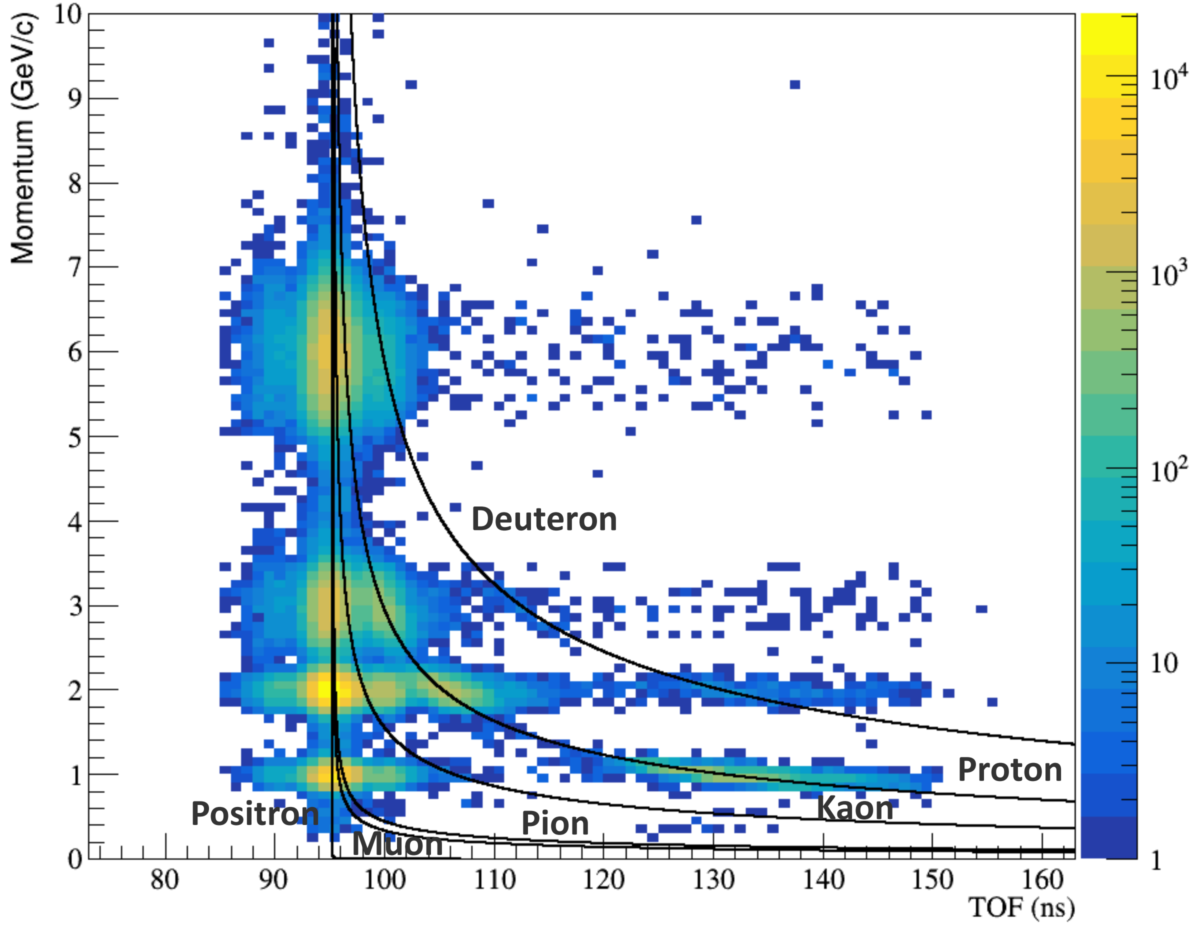




Summary of Compositions

- Default target: W for 1-3 GeV/c, Cu for 4-7 GeV/c (measured data for 2 GeV/c was taken with Cu target)

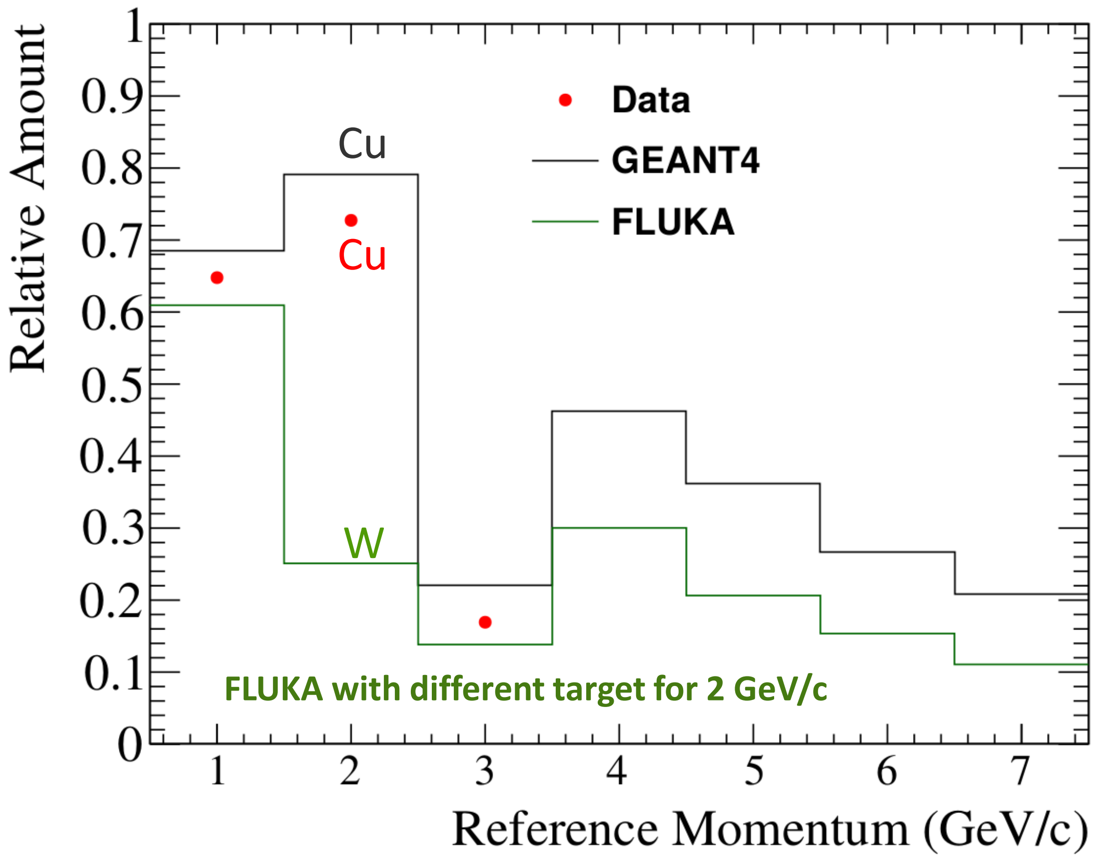




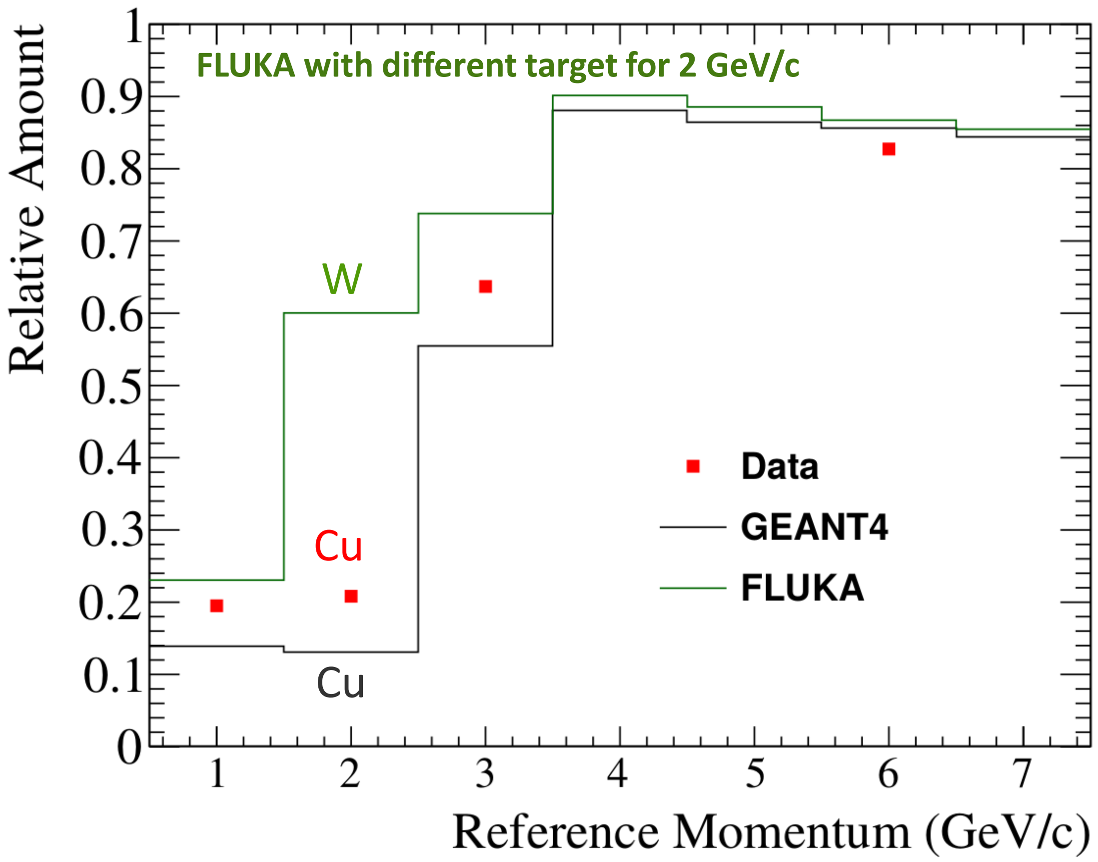
Comparison to MC

- Default target: W for 1-3 GeV/c, Cu for 4-7 GeV/c (measured data for 2 GeV/c was taken with Cu target)

Positrons



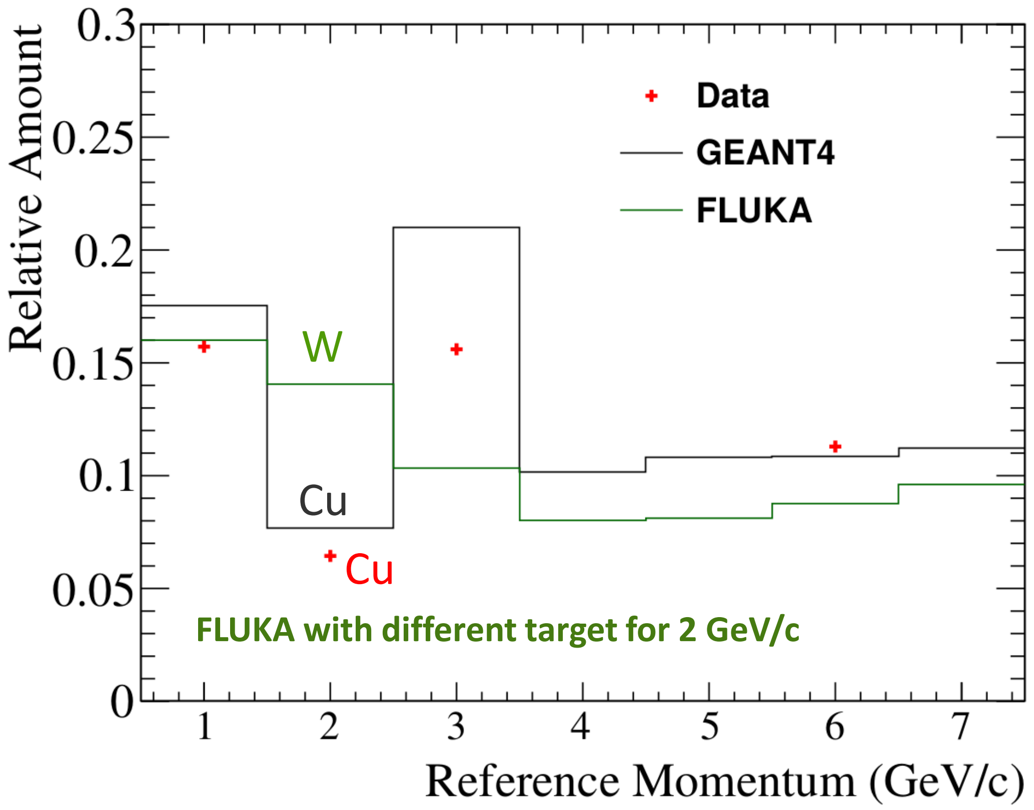
Pions/Muons (+Positrons >4 GeV/c)



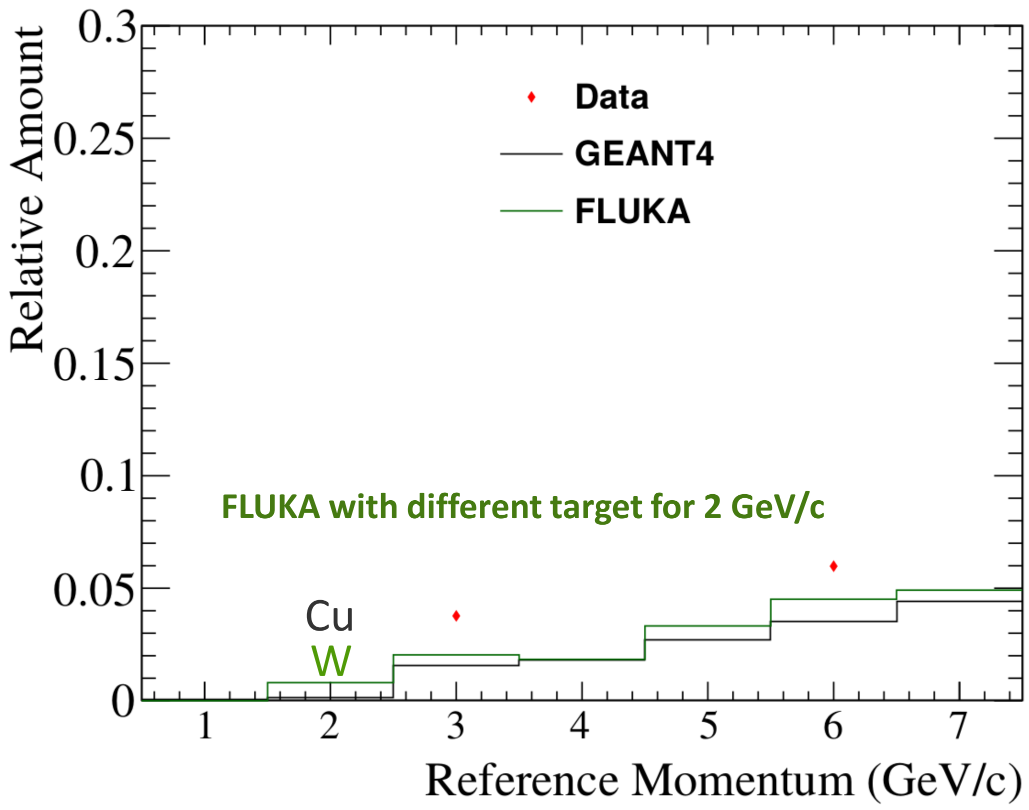
Comparison to MC

- Default target: W for 1-3 GeV/c, Cu for 4-7 GeV/c (measured data for 2 GeV/c was taken with Cu target)

Protons



Kaons



Summary

- Advanced study of observed trigger rates, momentum spread and particle identification analysis

- PID analysis combines the results from Cherenkov detectors and time-of-flight on an event-by-event basis.
  - A 4-5 ns problem could be identified, which is probably related to the XBTF687B detector/TDC channel.
    - Often (but not always) simultaneous TOF events in combinations AA&BA or AB&BB. (2 TOF per event)
    - TOF reconstruction in channels BA or BB often 4-5 ns longer than in AA/AB.
  - For analyzed data mitigated using the combination of TOF and Cherenkov data to identify the particle species for each trigger

- Measured trigger rates, momentum spread and beam composition similar to expected values from GEANT4 and FLUKA simulations

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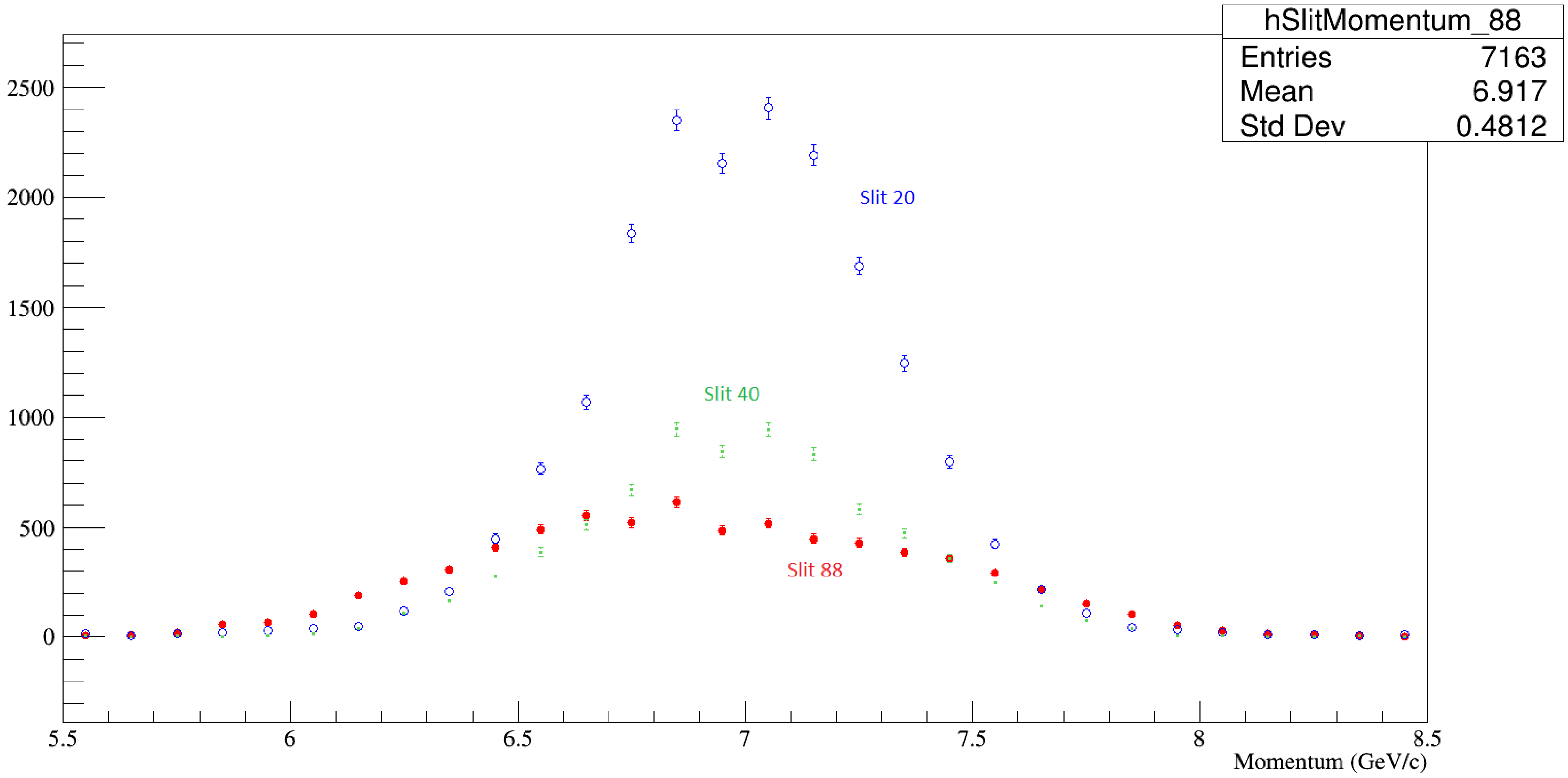
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Mean 6.917
Std Dev 0.4812
Slit 20
Slit 40
Slit 88
2500
2000
1500
1000
500
0
5.5
6
6.5
7
7.5
8
8.5
Momentum (GeV/c)