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# Performance of the oct14 pattern recognition for $\bar{p}p \to \bar{\Lambda}\Lambda$ at 4.0 and 1.64 GeV/c

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# Outline

- $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 4 GeV/c
  - Ideal *versus* realistic pattern recognition
- $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 1.64 GeV/*c*
  - Ideal *versus* realistic pattern recognition
  - Can condider special case when all tracks go to the target spectrometer
- Requirements on future tracking
  - MVD hits
  - Forward going tracks

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# $\bar{p}p \to \bar{\Lambda}\Lambda$ at 4 GeV/c

- Study by Jacek Biernat presented at the last meeting
  - Realistic PR in TS
  - Ideal PR in FS
  - Comparison between full and half solenoid field
- I wanted to check how much the results would differ if ideal PR is used in the whole detector.
- Oct14 release, external packages apr13p1
- Four cases:
  - Ideal PR in FS and TS, full solenoid field
  - Ideal PR in FS and TS, half solenoid field
  - Ideal PR in FS, real PR in TS, full solenoid field
  - Ideal PR in FS, real PR in TS, half solenoid field

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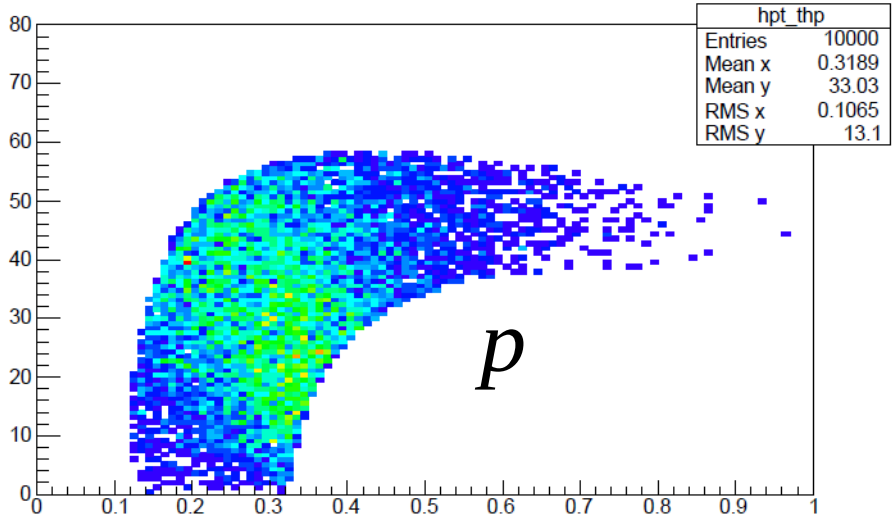
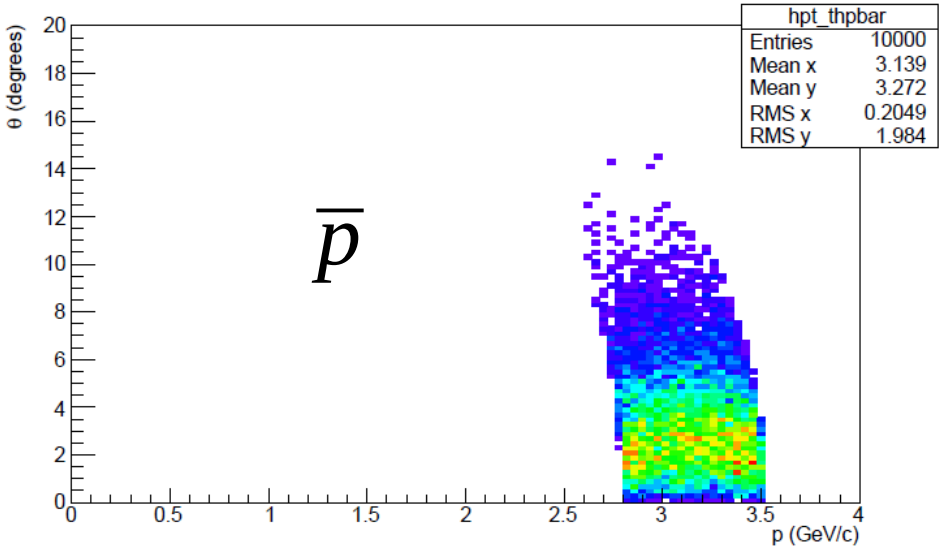
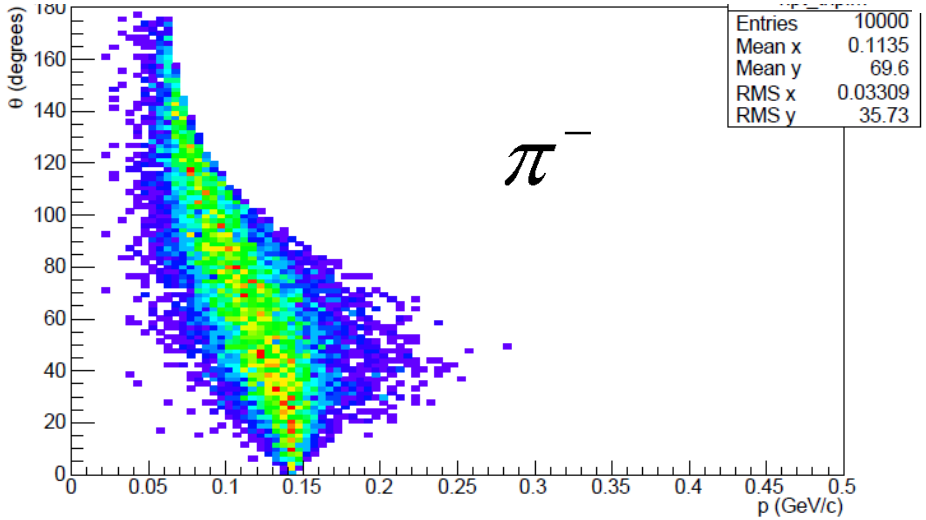
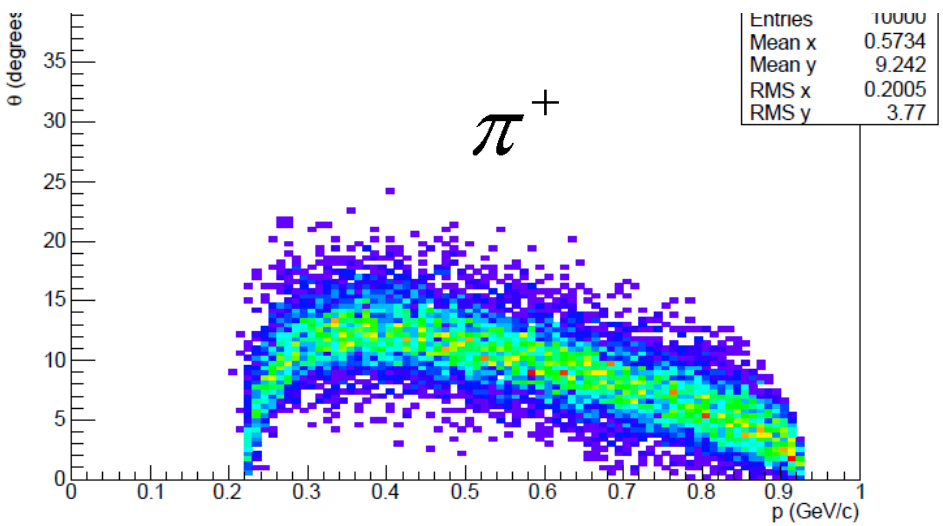
# Reminder: Phase space at 4 GeV/c



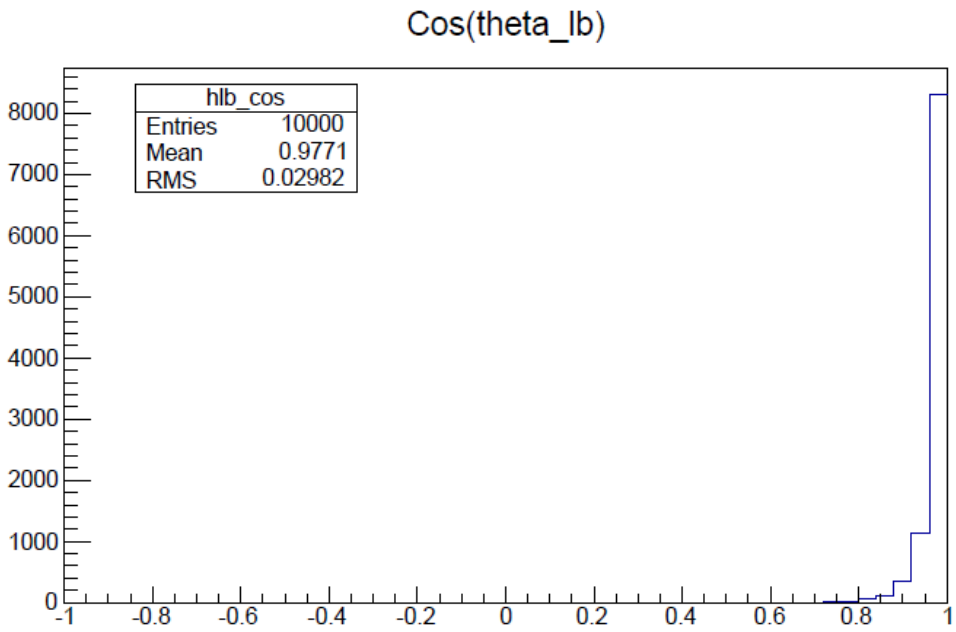



# Simulation input and selection criteria

- Forward peaking Λbar distribution
- Reconstructed track with a matching MC Truth object
- PID from MC Truth
- For Λ and Λbar, successful vertex fit is required.
- Λ →pπ decay considered



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# $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 4 GeV/c

Reconstruction efficiency for final state particles

| Particle | Real PR in TS, full field | Real PR in TS, half field | Ideal PR in TS, full field | Ideal PR in TS, half field |
|---|---|---|---|---|
| $\pi^+$ | 57 % | 52 % | 74 % | 67 % |
| $\pi^-$ | 38 % | 46 % | 49 % | 66 % |
| p | 31 % | 33 % | 30 % | 29 % |
| pbar | 68 % | 68 % | 68 % | 69 % |

Barely any difference for the anti-proton, which is because it is moving in the very forward direction

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# $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 4 GeV/c

Reconstruction efficiency for Λ and Λbar

| Particle | Real PR in TS, full field | Real PR in TS, half field | Ideal PR in TS, full field | Ideal PR in TS, half field |
|---|---|---|---|---|
| Λ | 8 % | 9 % | 8 % | 9 % |
| Λbar | 28 % | 17 % | 37 % | 24 % |
| ΛΛbar | 1.9 % | 1.7 % | 3.5 % | 3.3 % |

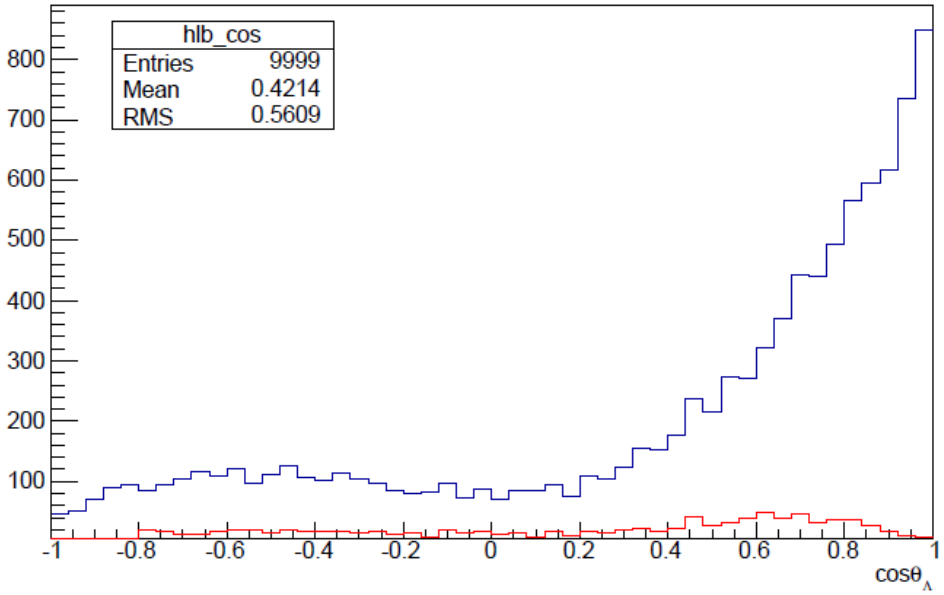
- Running with half solenoid field gives higher $\pi^-$ yield but lower $\pi^+$ and proton yield → total Λ yield about the same
- Results agree qualitatively but not quantitatively with Jacek's (but we haven't synchronised our input & selection criteria)
- Difference between real and ideal PR about a factor of 2, but all events have > 1 track in the FS (ideal PR).

# $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 1.64 GeV/c

- Weaker forward peak in Λbar angular distribution
  → possible to select events where all tracks go centrally

We can better quantify the performance of the central PR!

- **Blue: Generated distribution**
- **Red: reconstructed distribution**



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# $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 1.64 GeV/c

Reconstruction efficiency for final state particles

| Particle | Real PR | Ideal PR |
|---|---|---|
| $\pi^+$ | 28 % | 39 % |
| $\pi^-$ | 28 % | 42 % |
| p | 45 % | 53 % |
| pbar | 35 % | 44 % |

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# $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 1.64 GeV/c

Reconstruction efficiency for Λ and Λbar

| Particle | Real PR | Ideal PR |
|---|---|---|
| Λ | 18 % | 32 % |
| Λbar | 11 % | 23 % |
| ΛΛbar | 4 % | 13 % |

With the apr13p1 external packages and the oct14 release of pandaroot, Ideal pattern recognition is ~3 times better than realistic.

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# Requirements on future tracking

- Time reference for event building
- Which sub-detectors are needed for track reconstruction?

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# Time reference for event building

- Idea: use MVD for time reference
- Question: do we expect MVD hits in all events for the $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ channel
  - at 1.64 GeV/c ?
  - at 4 GeV/c ?

- For all tracks (MC truth matched with a given PID), get the PndPidCandidate and retrieve GetMvdHits.
  - In how many events do we have at least one MVD hit?
  - How many MVD hits arise from a given track?

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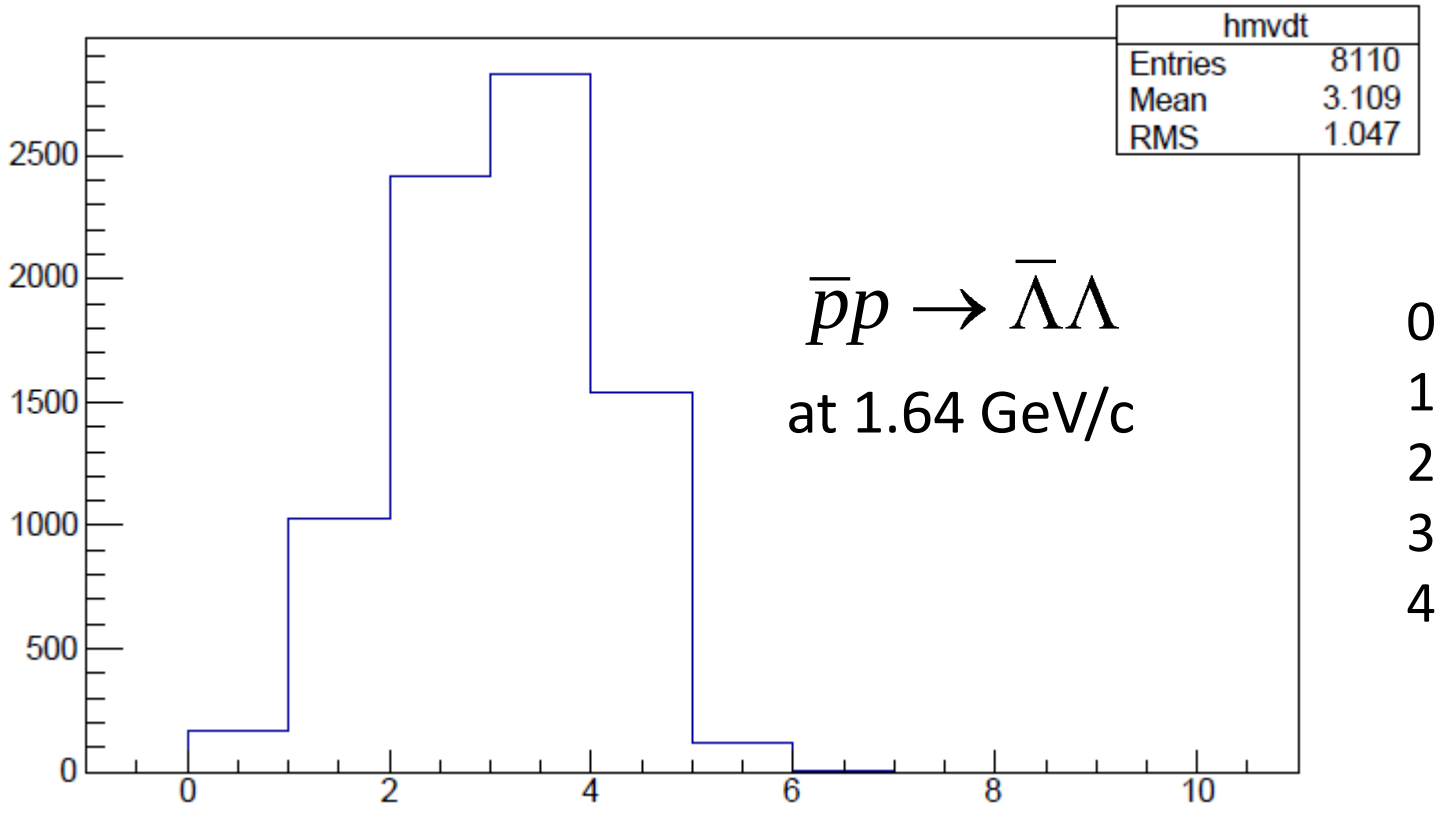
# How many tracks give rise to MVD hits ?




$\bar{p}p \rightarrow \bar{\Lambda}\Lambda$

at 1.64 GeV/c

0 tracks: 2 %
1 track: 13 %
2 tracks: 30 %
3 tracks: 35 %
4 tracks: 19 %

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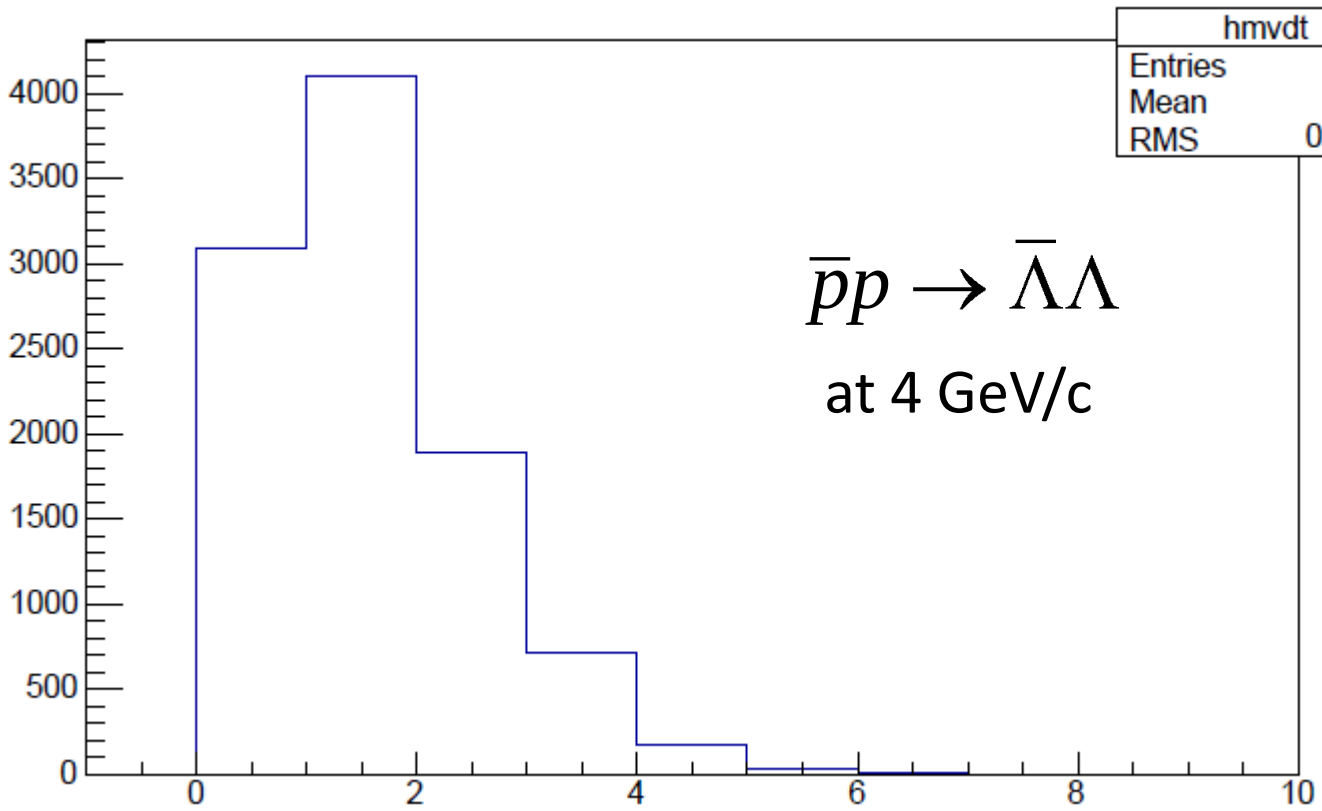
# How many tracks give rise to MVD hits ?




$\bar{p}p \rightarrow \bar{\Lambda}\Lambda$

at 4 GeV/c

0 tracks: 31 %
1 track: 41 %
2 tracks: 19 %
3 tracks: 7 %
4 tracks: 2 %

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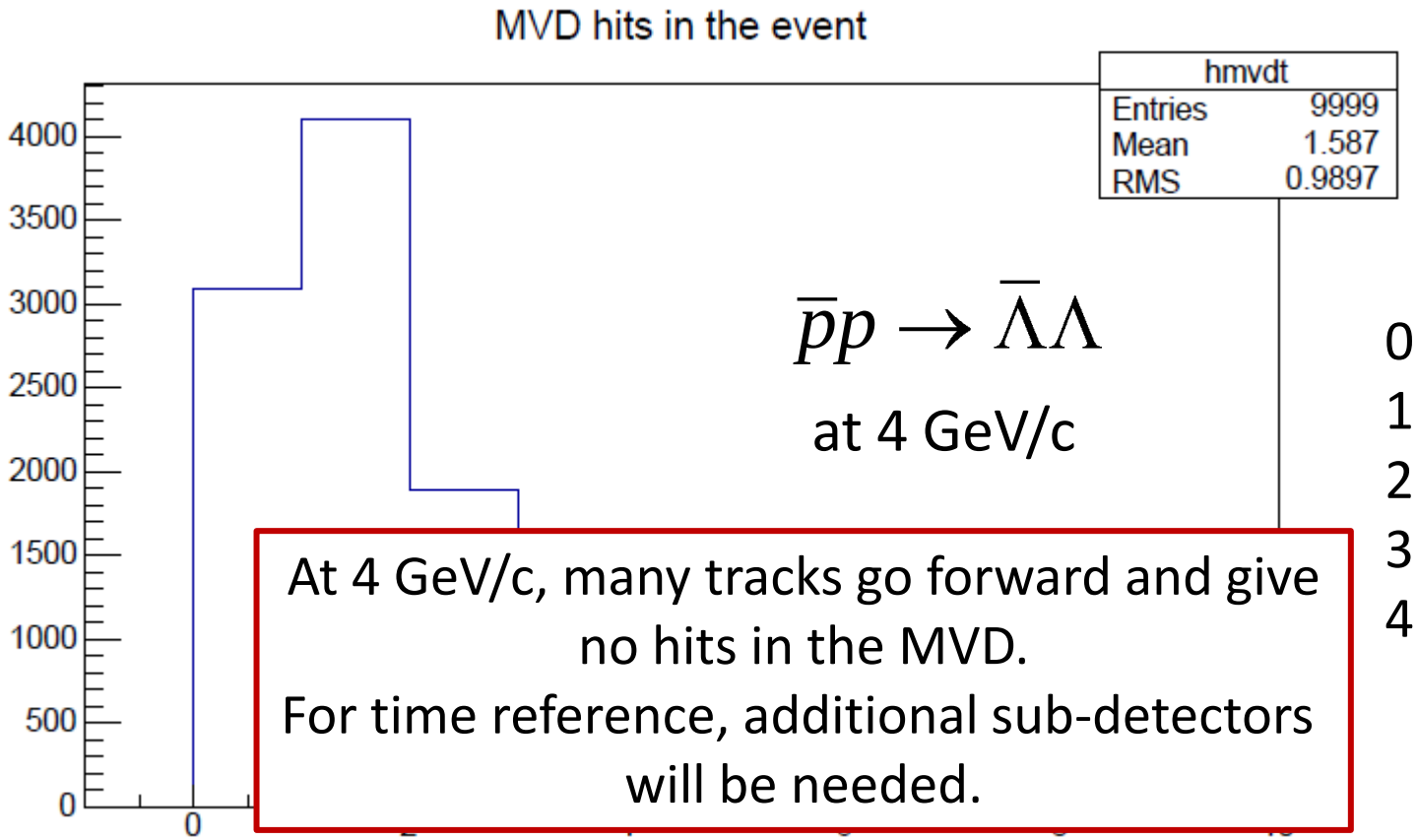
# How many tracks give rise to MVD hits ?



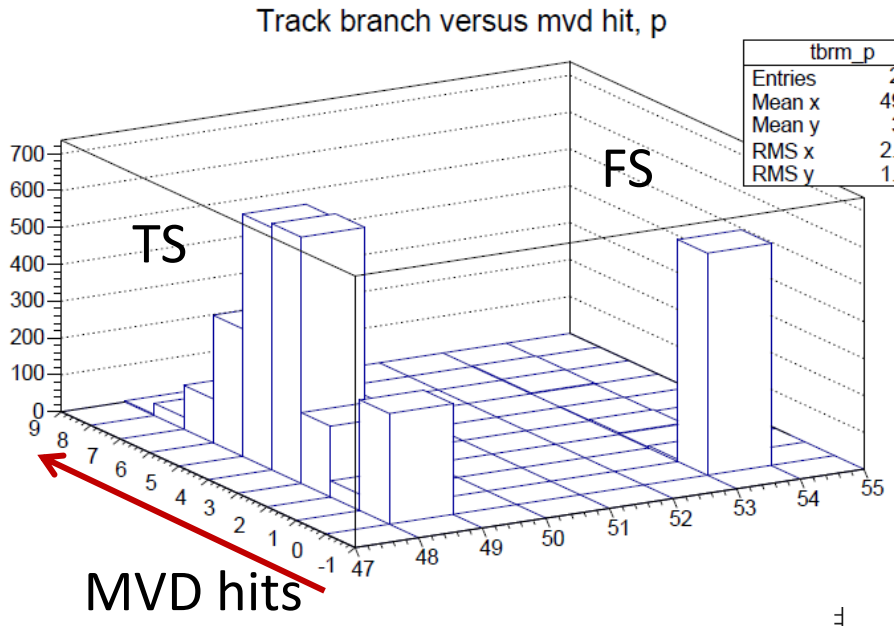

$\bar{p}p \rightarrow \bar{\Lambda}\Lambda$

at 4 GeV/c

0 tracks: 31 %
1 track: 41 %
2 tracks: 19 %
3 tracks: 7 %
4 tracks: 2 %

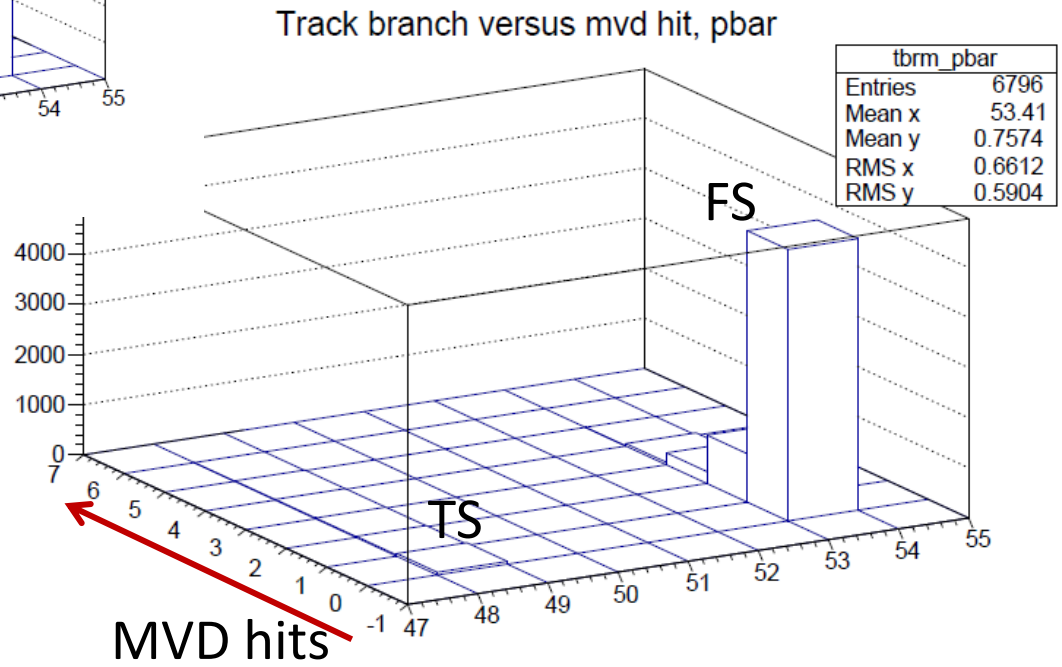
At 4 GeV/c, many tracks go forward and give no hits in the MVD.
For time reference, additional sub-detectors will be needed.

# Where do the tracks go when not to the MVD?



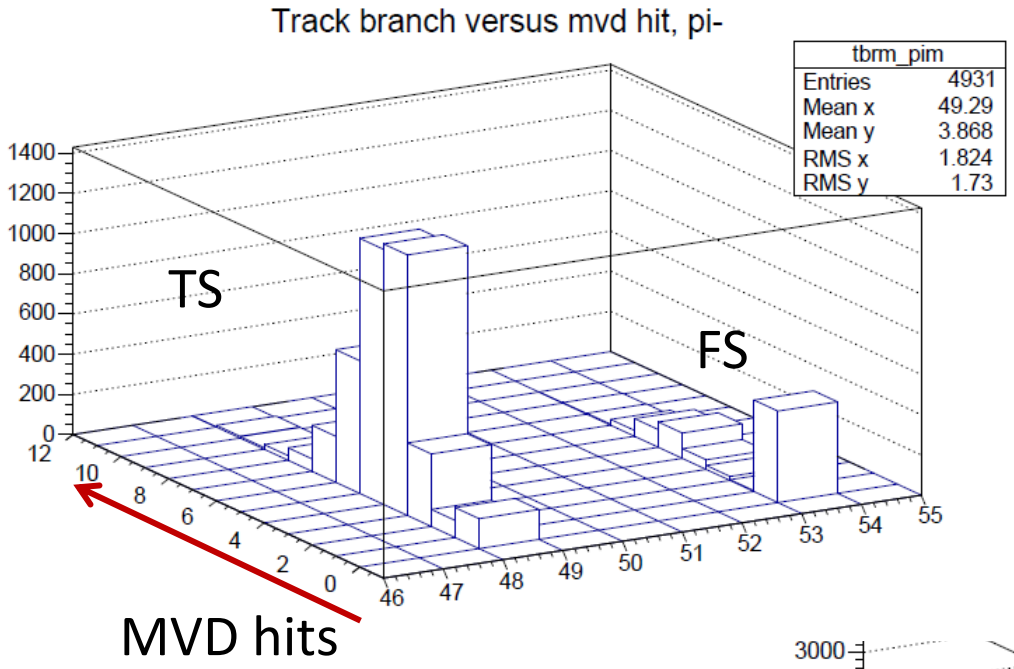

$\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 4 GeV/c

← Protons: most, but not all, tracks giving 0 MVD hits go to FS.



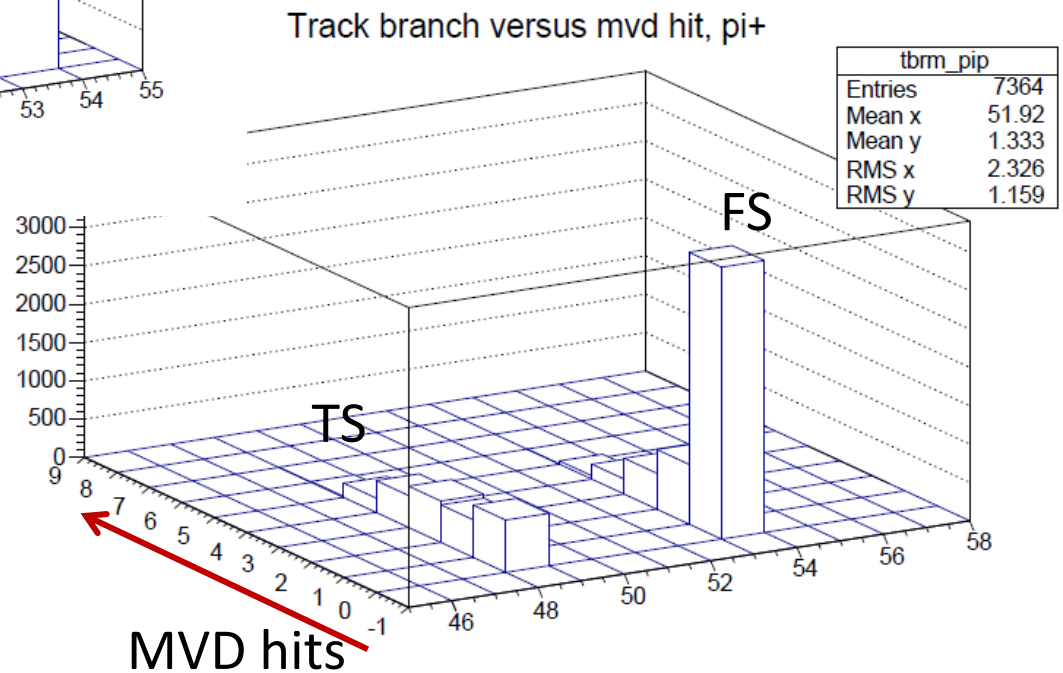

Anti-protons: all tracks giving 0 MVD hits go to FS →

# Where do the tracks go when not to the MVD?




$\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 4 GeV/c

← $\pi^-$: most, but not all, tracks giving 0 MVD hits go to FS.




$\pi^+$: most, but not all, tracks giving 0 MVD hits go to FS →

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# What do we learn from this?

**Time reference for event building**

- At 1.64 GeV/c, the MVD is sufficient for time reference.
- At 4 GeV/c, ~30 % of the events have no MVD hit due to
  - Forward going particles (mainly anti-protons)
  - Hyperons decaying outside the MVD
- Since all anti-protons go to the FS, time reference could be taken from FS subdetectors when no MVD hit.

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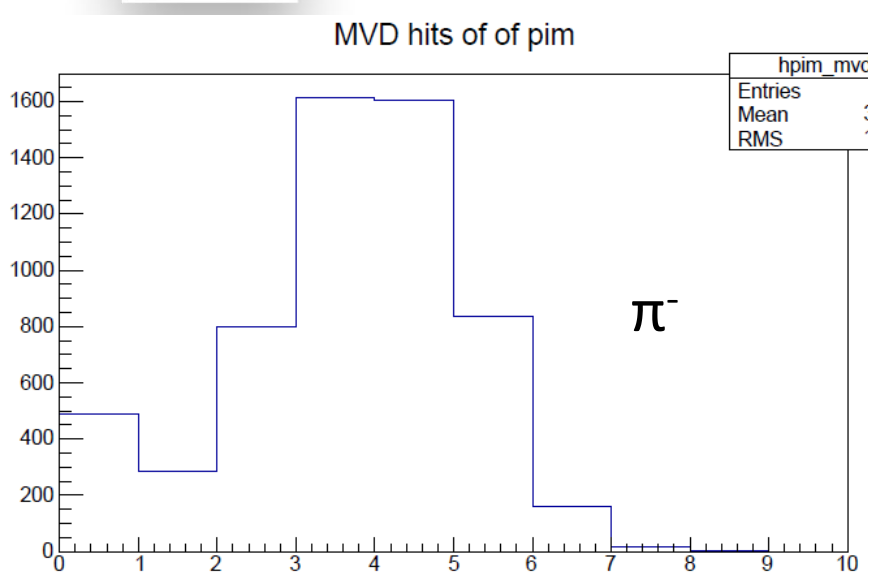
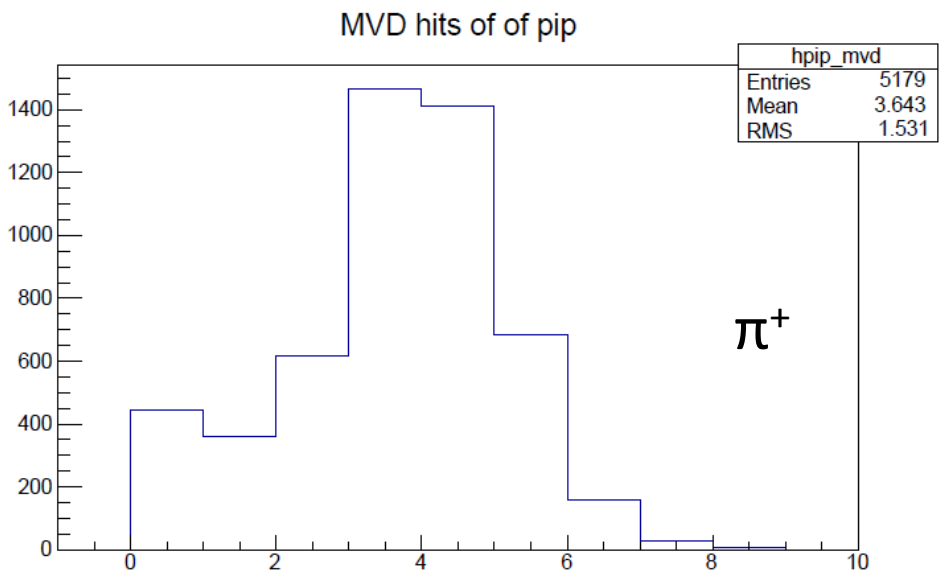
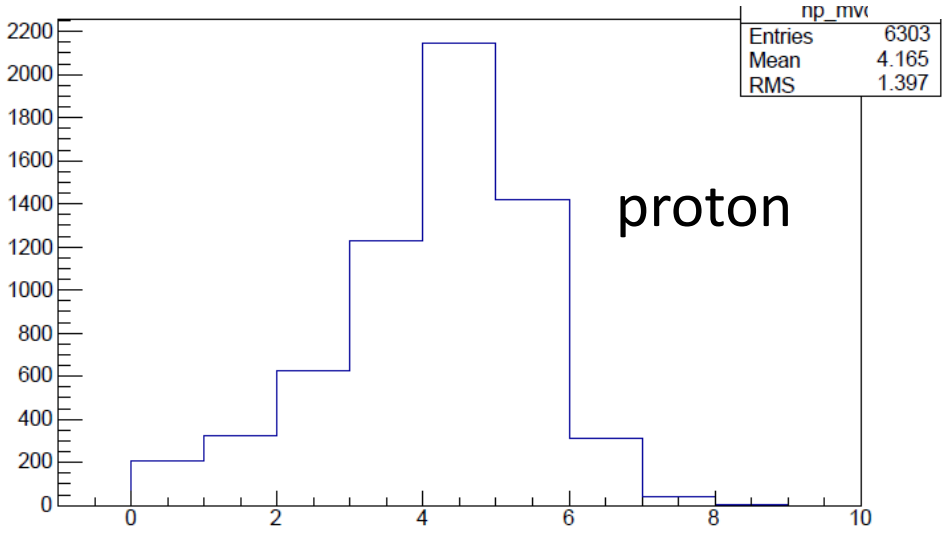
# Which sub-detectors are needed for tracking?

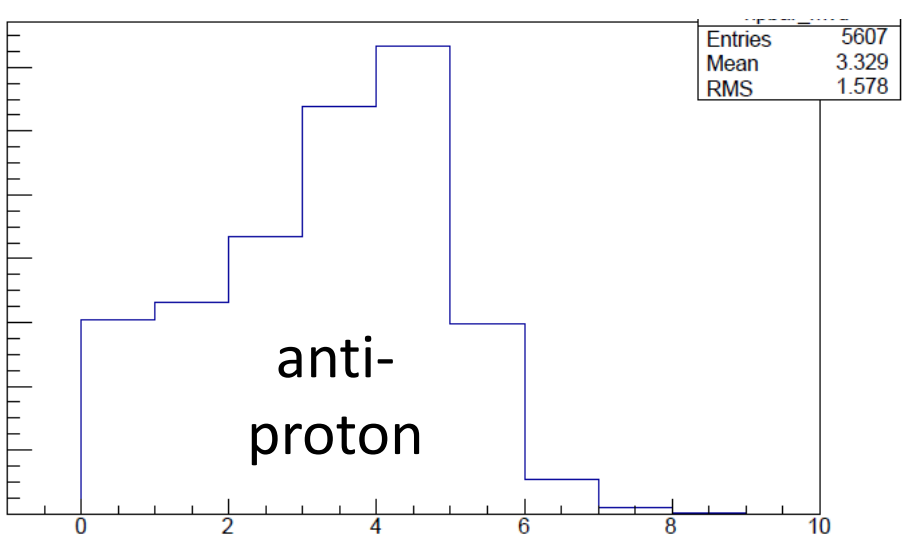
- Question: is the MVD sufficient for track reconstruction in the Target Spectrometer?
  - This means: Do the centrally going particles give sufficient  hits in the MVD?

# MVD hits for $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 1.64 GeV/c



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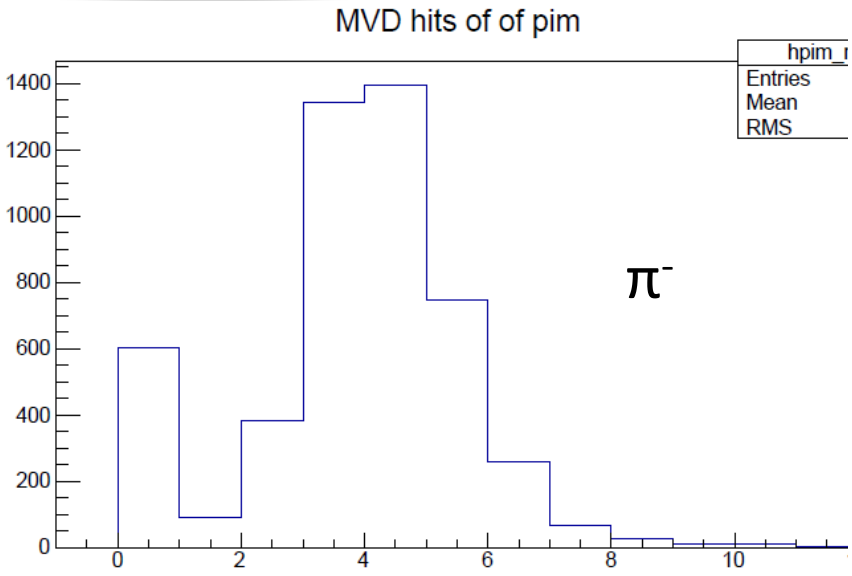
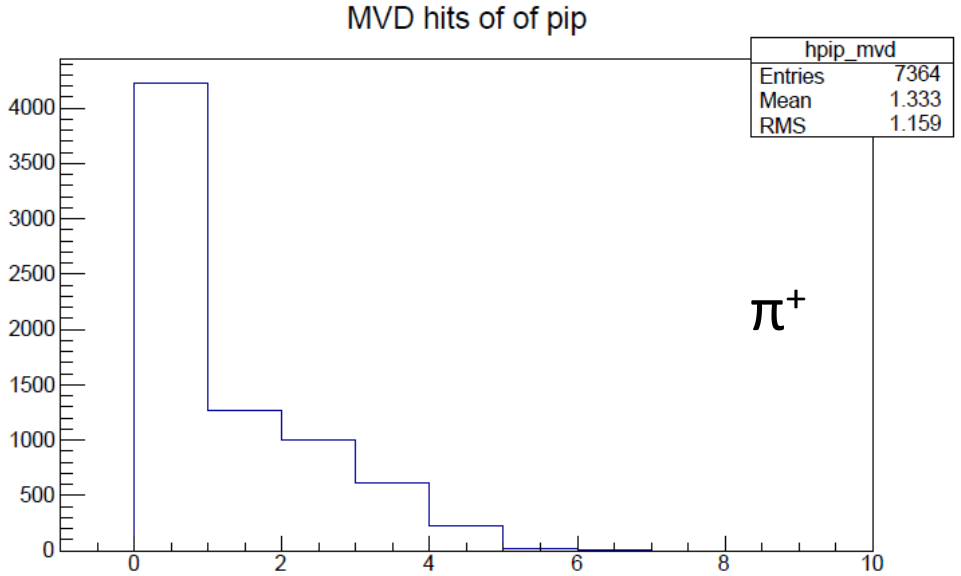
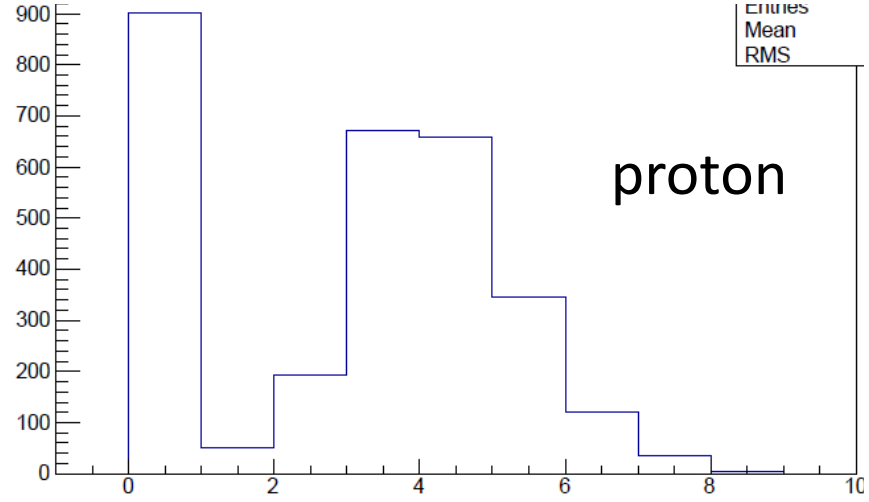
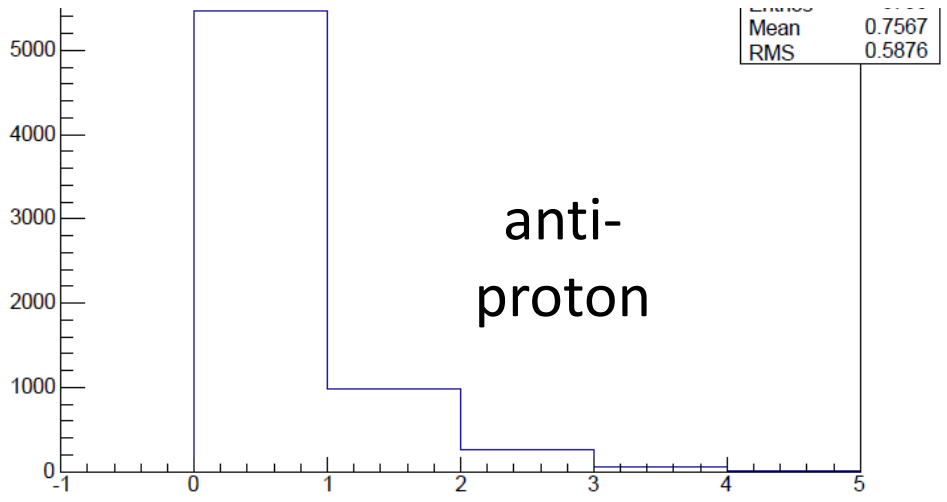
# MVD hits for $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 4 GeV/c

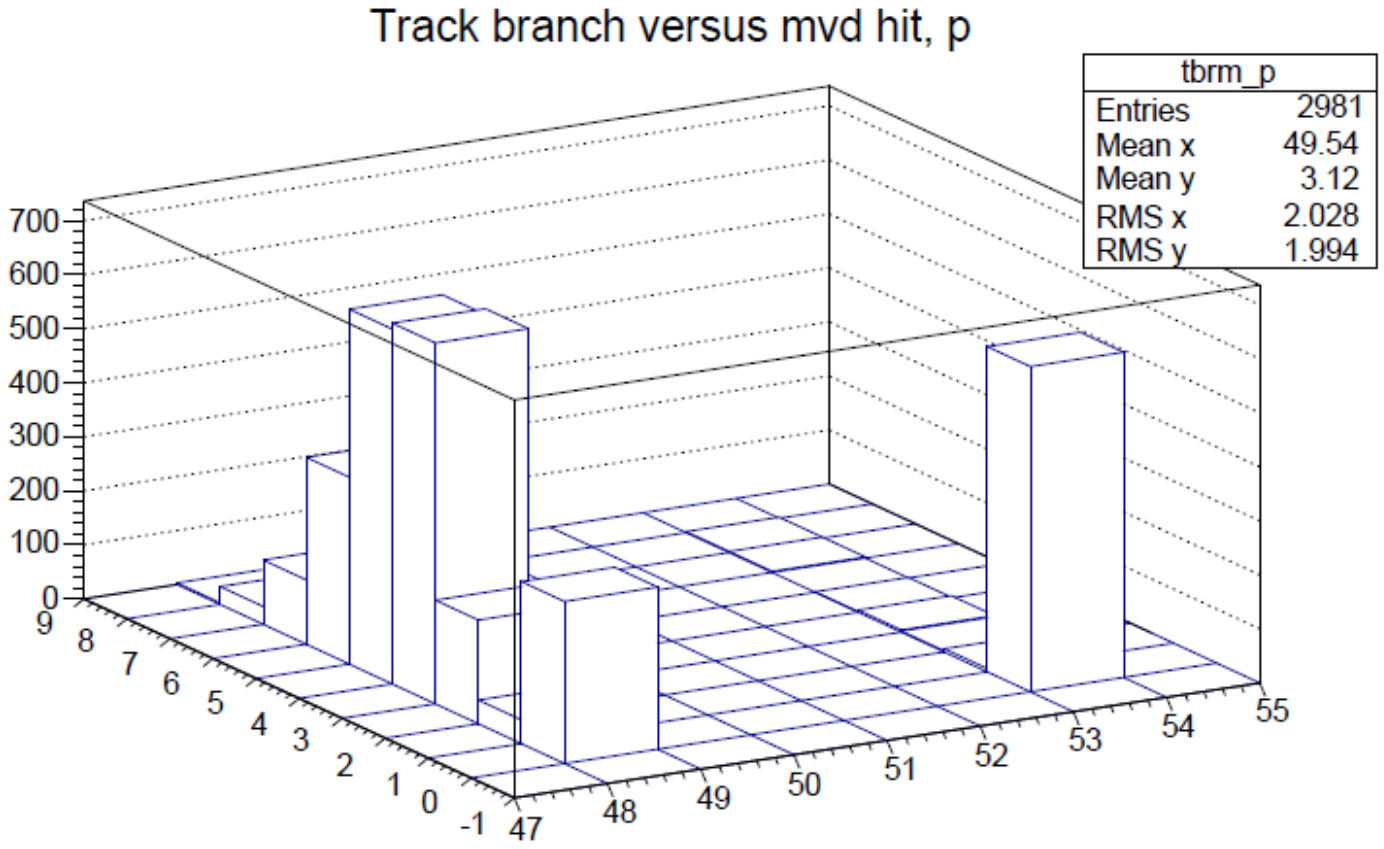


# MVD hits for $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ at 4 GeV/c




We know that:

- Anti-protons go forward and have to be reconstructed in the FS
- Many centrally going protons and pions do NOT hit the MVD.

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# What do we learn from this?

Sub-detectors needed for track reconstruction

- Many tracks give no or few hits in the MVD.
- For anti-protons, in particular at 4 GeV/c, the FTS is needed to reconstruct the tracks.
- In particular protons at 1.64 GeV/c as well as at 4 GeV/c, give no hits neither in the MVD nor in the FTS.

→ The reconstruction will rely on the STT. Need for *e.g.* skewed straws.

(Walter Ikegami Andersson)

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# Summary

- For $\bar{p}p \to \bar{\Lambda}\Lambda$ at 4 GeV/c, ideal PR in the TS gives about a factor of 2 better reconstruction efficiency than realistic one – but every event contains at least one FS track.
- Running with half solenoid field does not improve the total reconstruction efficiency at 4 GeV/c.
- For $\bar{p}p \to \bar{\Lambda}\Lambda$ at 1.64 GeV/c, and only considering events where all tracks go to the TS, ideal PR is a factor of ~3 better than the realistic PR using the oct14 release.
- The MVD will not be sufficient for time reference at 4 GeV/c.
- Many tracks at 1.64 GeV/c and 4 GeV/c go through the TS without giving MVD hits. The tracking then relies on the STT.