

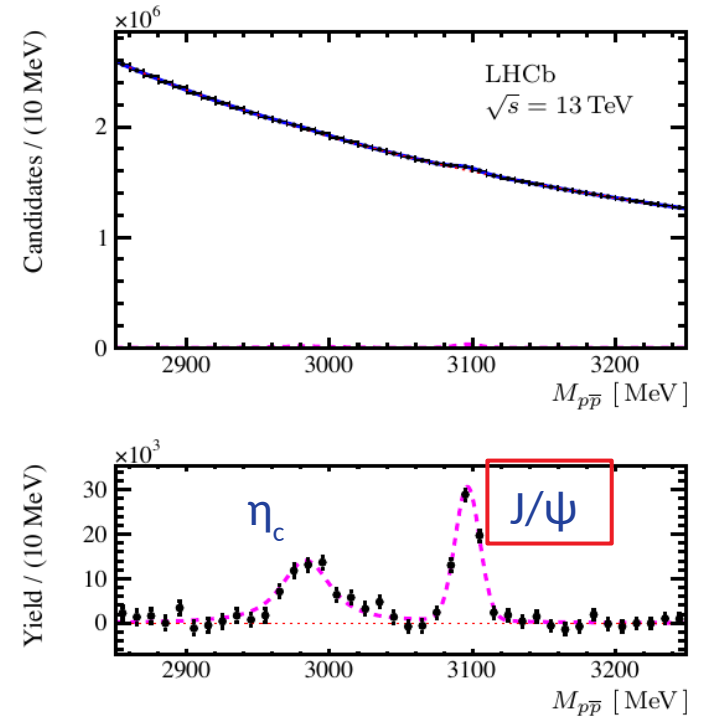
On reconstruction of inclusive η_c events via $\eta_c \rightarrow \Lambda \bar{\Lambda}$

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Inclusive η_c production

- From the perspective of theory the inclusive η_c production is the cleanest probe of the gluon structure (see talks by M. Nefedov).
- Very challenging experimentally. So far it has been observed only by LHCb.
- For the SPD energies the $p\bar{p}$ -mode has been studied by N. Trunov. For ideal conditions the S/B ratio is $\sim 10^{-4}$ (not feasible!).
- For $\eta_c \rightarrow \Lambda\bar{\Lambda}$ decay Λ can be reconstructed from the secondary vertex ($p\pi^-$), which should provide very strong suppression of non- Λ decays.



On simulation

- I simulate $J/\psi \rightarrow \Lambda\bar{\Lambda}$ not η_c ! The BFs are 1.89×10^{-3} and 1.06×10^{-3} . η_c is 100 MeV lighter and much wider.
- I assume inclusive J/ψ cross-section of 200 nb, ~400 nb can be expected for η_c
- Generated samples:
 - $J/\psi \rightarrow \Lambda\bar{\Lambda}$: 16K events
 - MB: ~25M events
- Simulation is based on the *examples/K0decay*

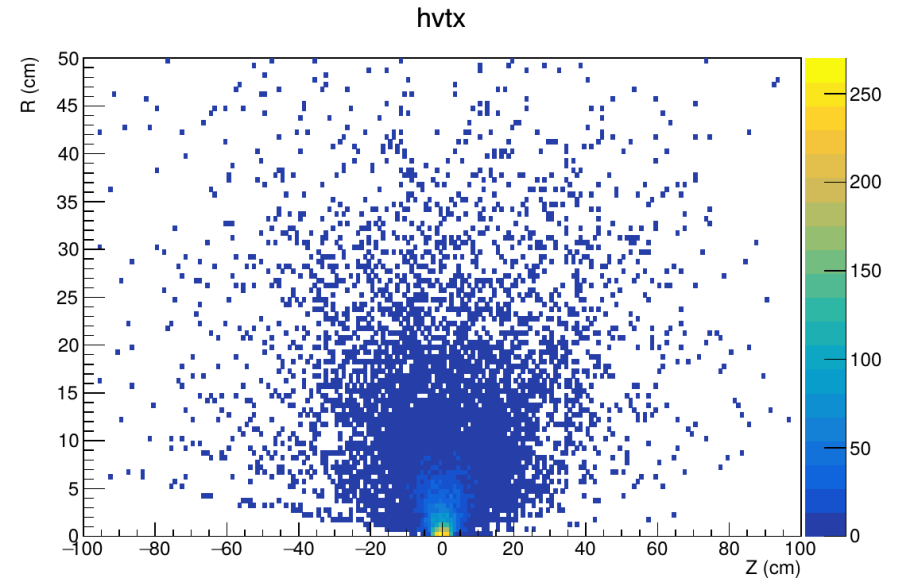
Separation of the secondary vertex

- Λ has $\tau=2.6 \times 10^{-10}$ s and flies large distance
- Reconstruction (RecoFull) script:

```
...
v0_finder->SetMinItsHits(0);
...
v0_finder->SetMinPVTrackChi2(2.0);
v0_finder->SetMaxTwoTracksChi2(2.0);
...
v0_finder->AddVertexCandidate(-211,211);
v0_finder->AddVertexCandidate(-321,321);
v0_finder->AddVertexCandidate(-321,211);
v0_finder->AddVertexCandidate(-211,321);
v0_finder->AddVertexCandidate(2212,-211);
v0_finder->AddVertexCandidate(-2212,211);
...
```

Use TOF to reduce combinatorial background?

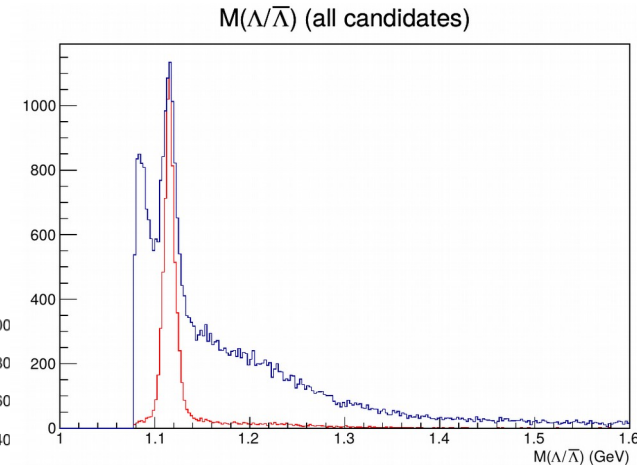
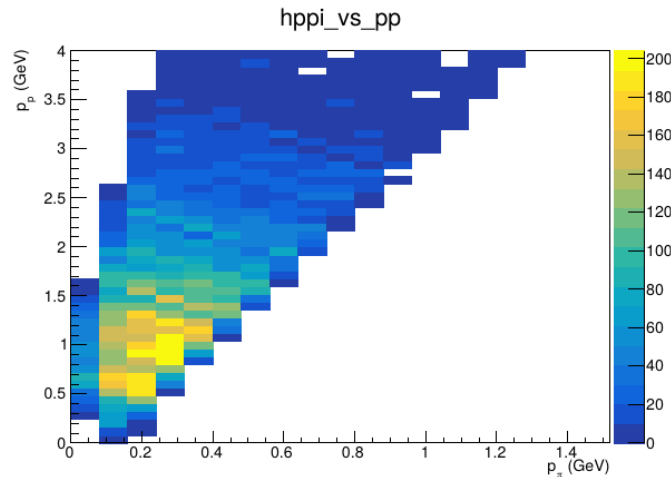
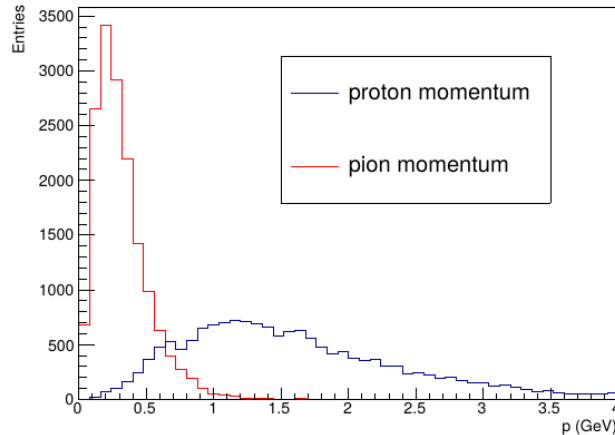
Missing in the output (?) : distance and its error.



Initial set of cuts

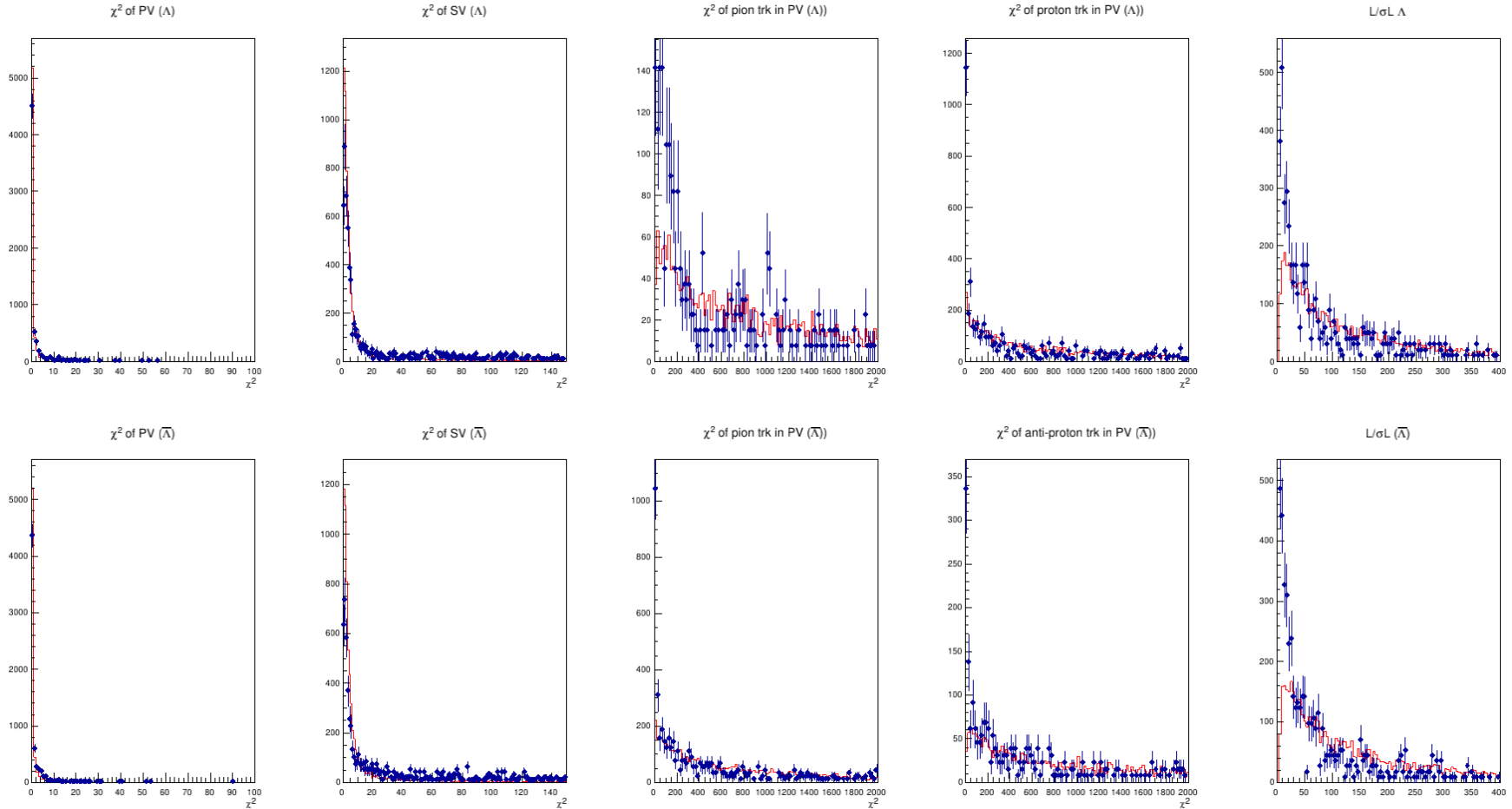
Lambda candidate:

- found secondary vertex
- particle with lower momentum is **required** to be pion (e.g. via $dedx$), the one with larger momentum is **assumed** to be proton
- $L > 2\text{cm}$ and $L/\sigma_L > 5$
- $\chi^2(\text{PV}) < 200$
- $\chi^2(\text{SV}) < 150$
- $M(\Lambda/\bar{\Lambda}) < 1.18\text{ GeV}$ (use mass and tracks from the vertex fit?)
- both Λ and $\bar{\Lambda}$ candidates are required

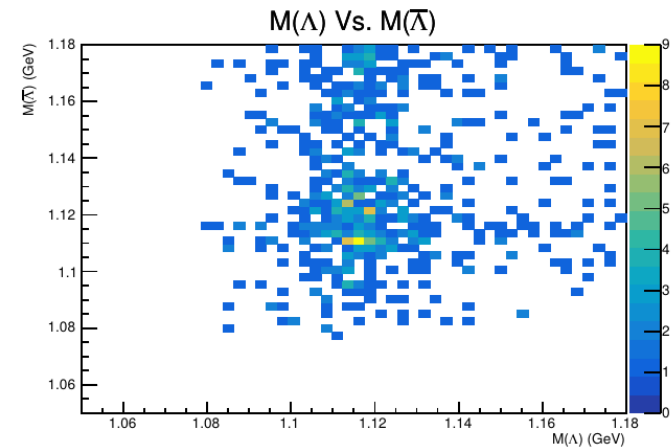
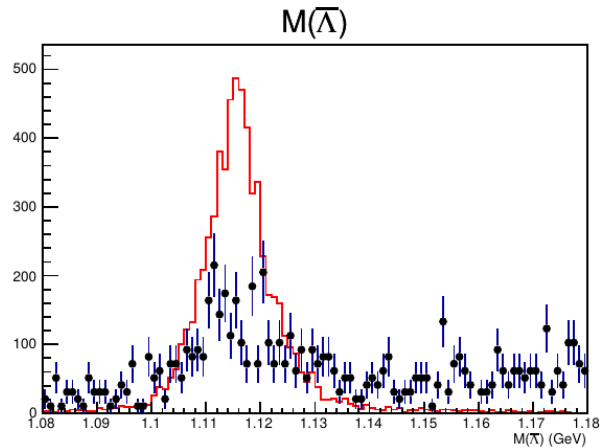
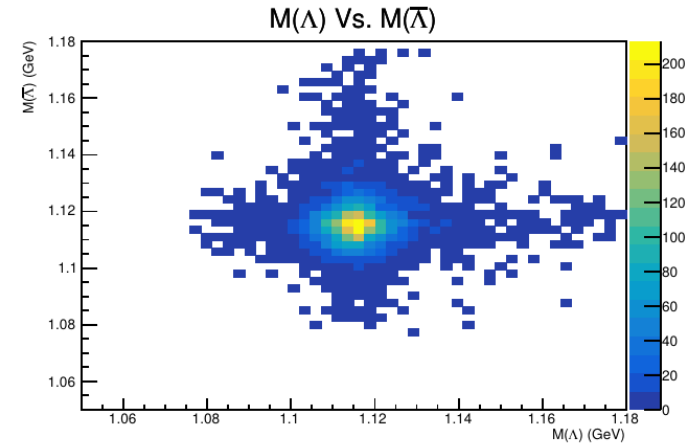
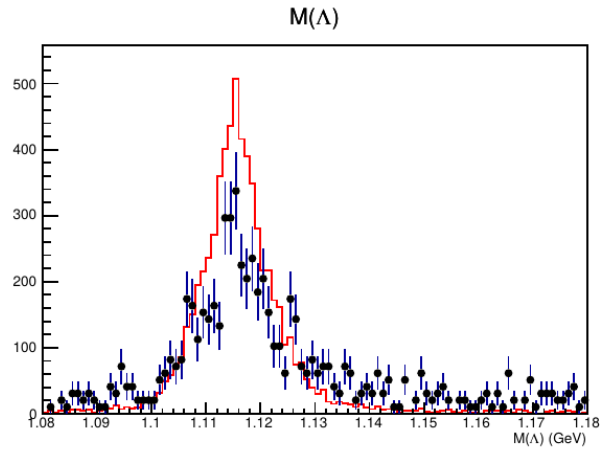


Kinematics of the verteces

For bg $2.9 \text{ GeV} < M(\Lambda\bar{\Lambda}) < 3.3 \text{ GeV}$



Mass distributions



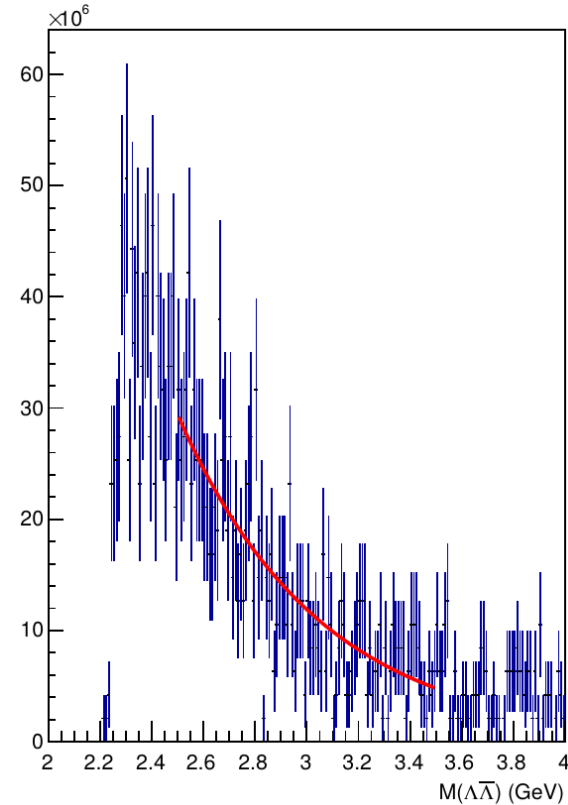
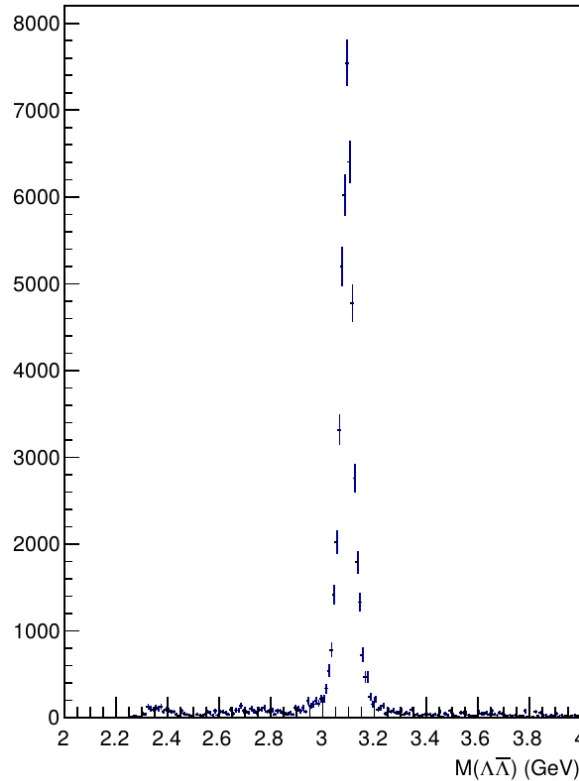
Additional selection

- χ^2 pion trk in PV > 20
- χ^2 (anti)proton trk in PV > 20
- $(\Delta M_{\Lambda}^2 + \Delta M_{\bar{\Lambda}}^2)^{\frac{1}{2}} < 20$ MeV
- $L/\sigma L > 15$

Efficiency ~ 30%

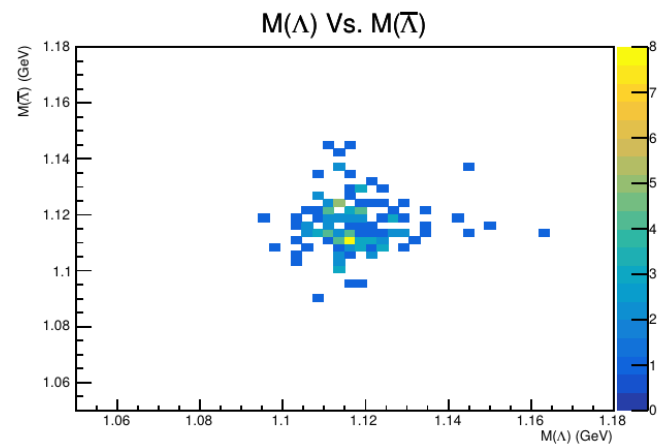
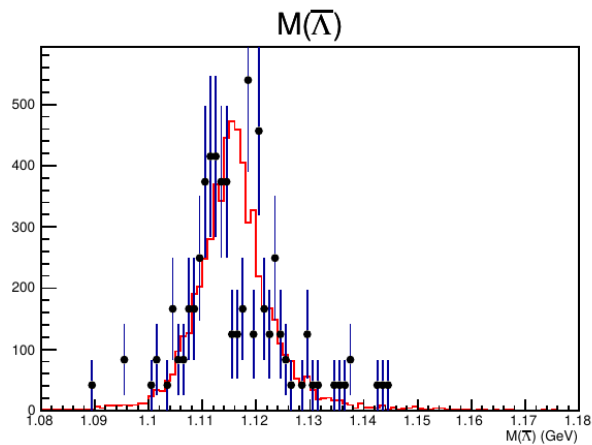
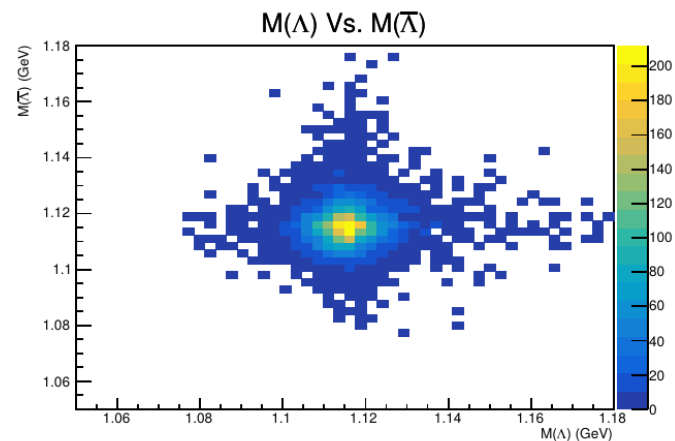
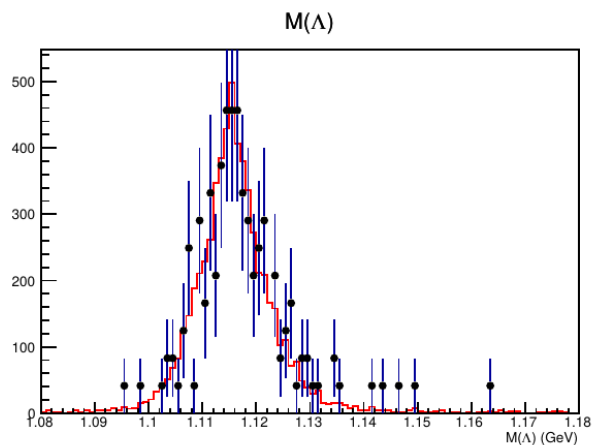
Signal to background ratio in the peak
(for the shown binning) ~ 7.6×10^{-4}

Statistics ~ 50K η_c events



Normalized to one year of data taking

Mass distributions (for ideal PID)



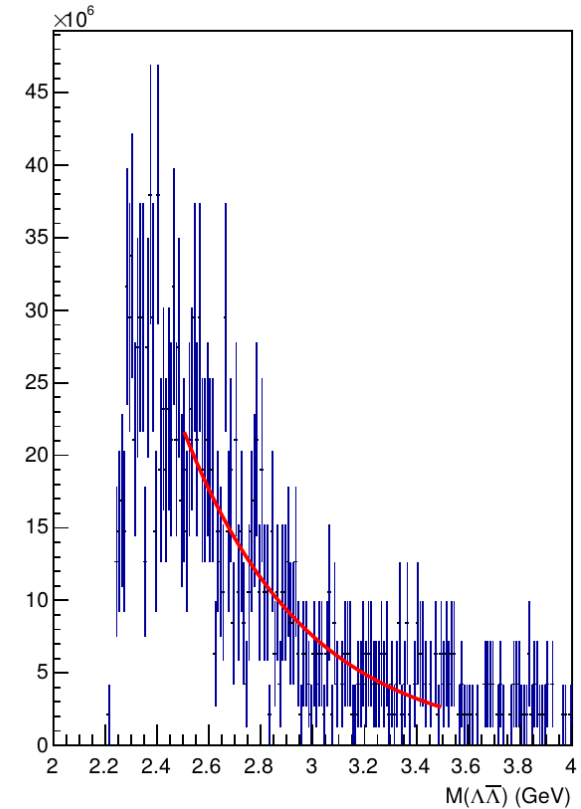
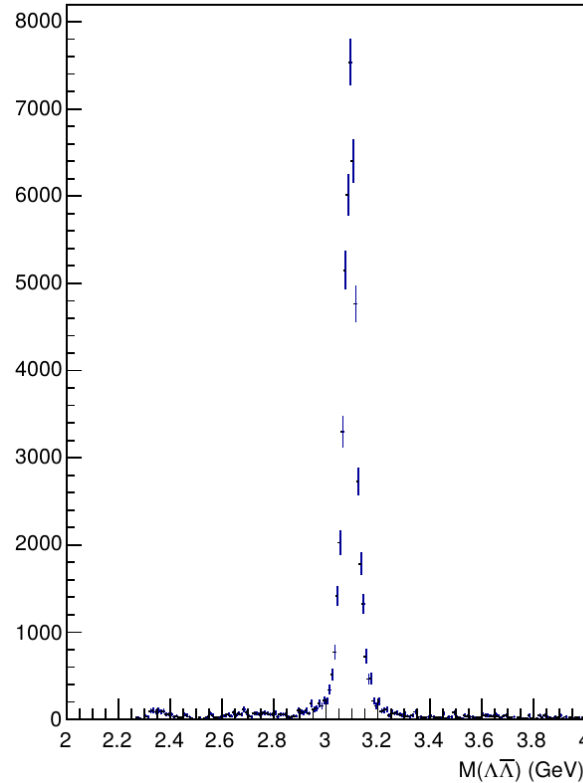
Additional selection + ideal PID

- χ^2 pion trk in PV > 20
- χ^2 (anti)proton trk in PV > 20
- $(\Delta M_{\Lambda}^2 + \Delta M_{\bar{\Lambda}}^2)^{1/2} < 20$ MeV
- $L/\sigma L > 15$

Efficiency ~ 30%

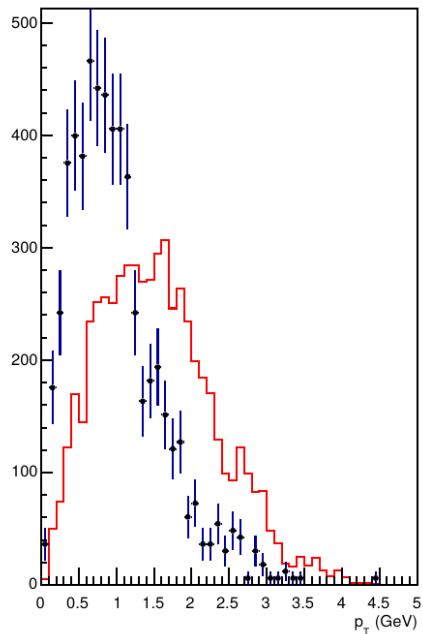
Signal to background ratio in the peak
(for the shown binning) ~ 1.2×10^{-3}

Statistics ~ 50K η_c events

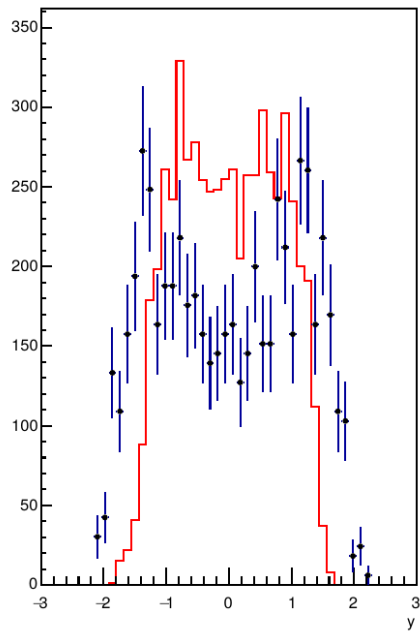


Normalized to one year of data taking

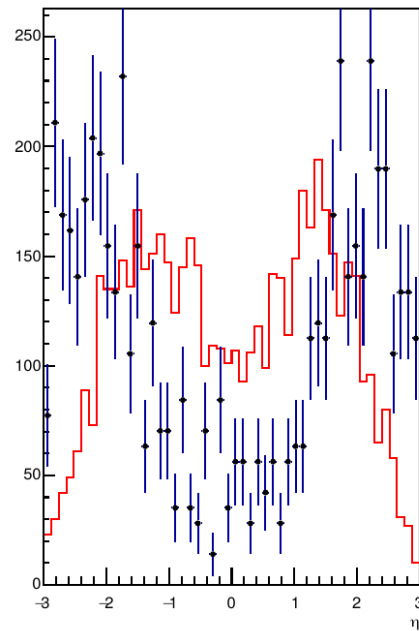
hetac_pt



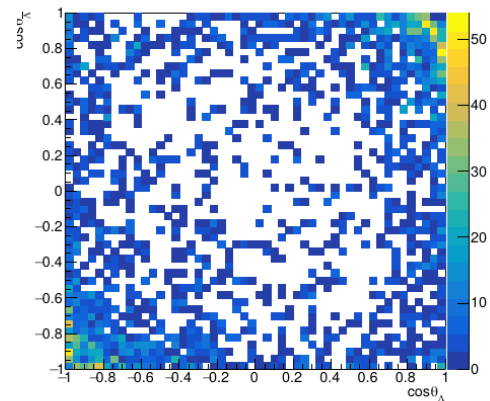
hetac_y



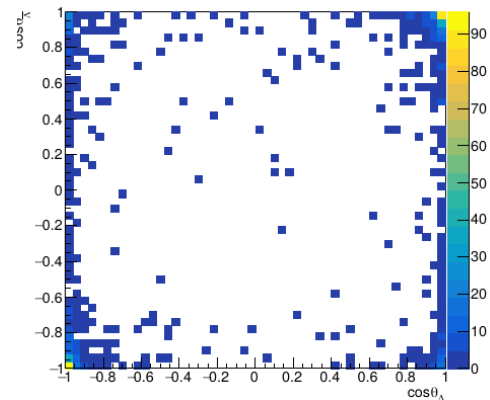
hetac_eta



hCosLamCosLamb



hCosLamCosLamb



- For the moment $\eta_c \rightarrow \Lambda \bar{\Lambda}$ decay seems to provide the best S/B ratio.
- The $J/\psi \rightarrow \Lambda \bar{\Lambda}$ S/B ratio for idealized case is 15 times smaller than for LHCb. The expected statistics is comparable to one shown in the LHCb paper.
- Study of $\eta_c \rightarrow \Lambda \bar{\Lambda}$ might not be realistic, but upper limit for its production may still be an important measurement.