Status update o $\Lambda_c \longrightarrow p\mu^-\mu^+$

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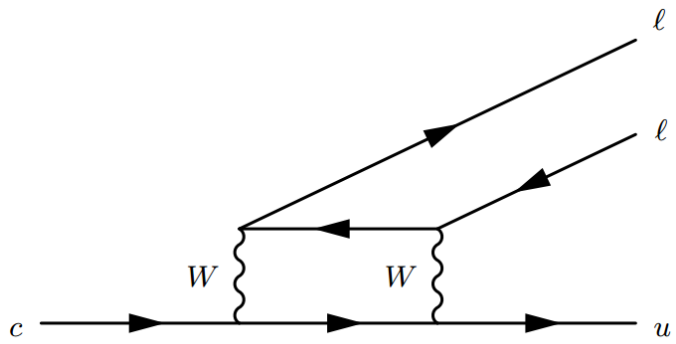
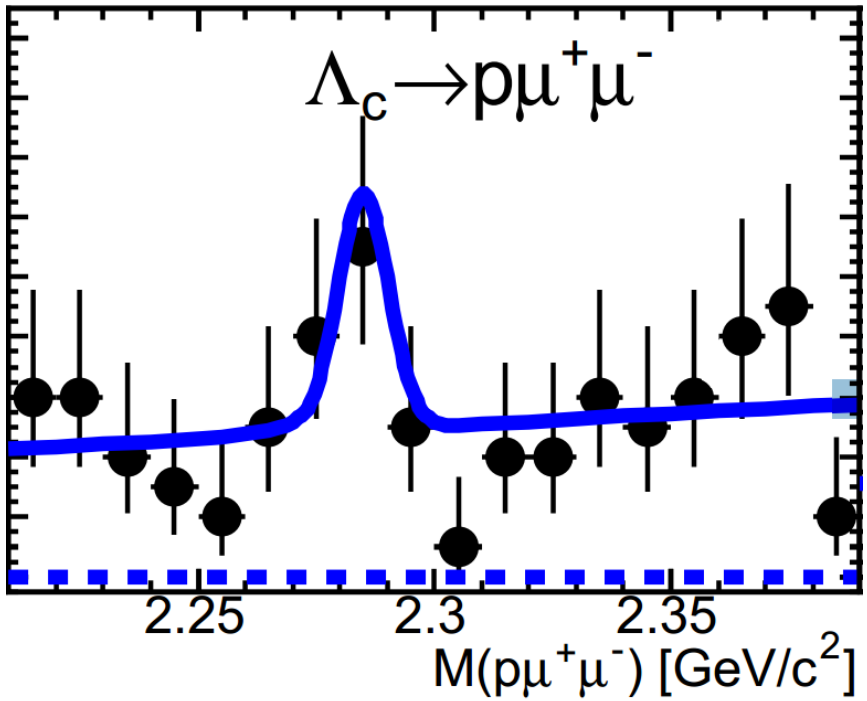
Why to search for $\Lambda_c \to p\mu^+\mu^-$?

- Decay of $\Lambda_c^+ \to p\mu^+\mu^-$ is a FCNC.
- Extremely suppressed in SM due to GIM mechanism.
- We will use the experience from $\tau \to p\mu\mu$.



$\mathcal{B}(\Lambda_c^+ \to p\mu^-\mu^+) < 4.4 \times 10^{-5}$
90% CL arXiv:1107.4465



Yield: $11.1 \pm 5.0 \pm 2.5$

We should easily beat Babar.

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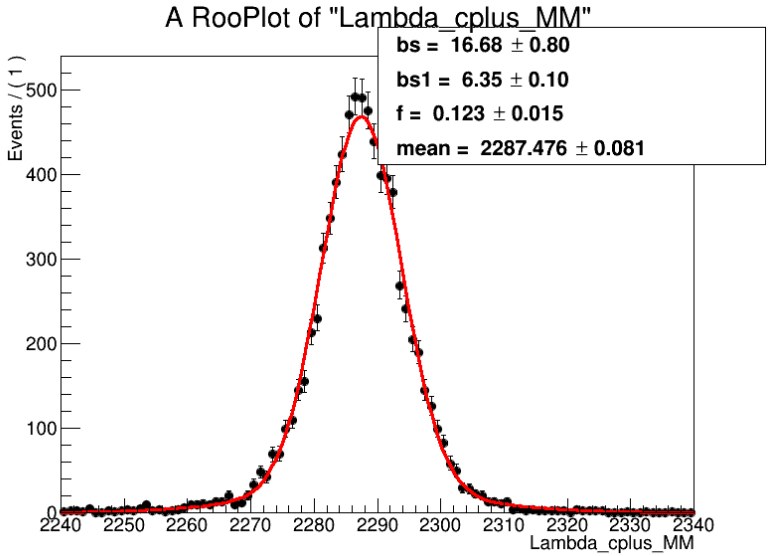
Preliminary selection

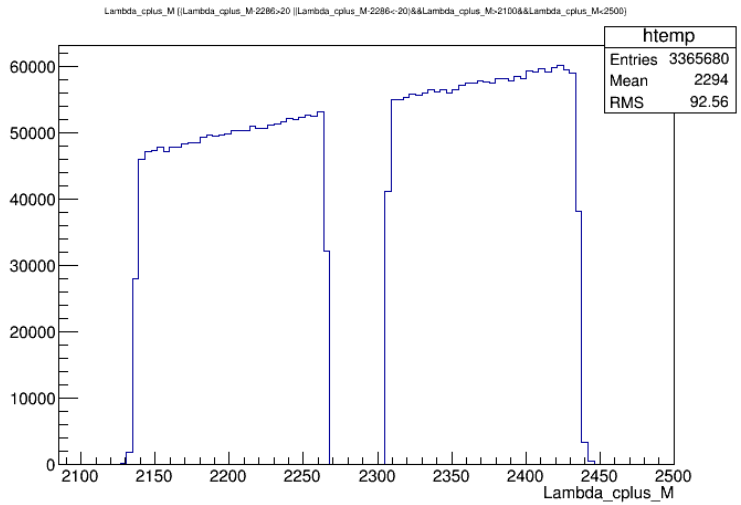
Stripping:

- $\mathrm{PID}(\mu) > -5$, $\mathrm{PID}(\mathrm{p}) > 10$
- $\mathrm{IPCHi2} > 9$, $\mathrm{PID}(\mu - \mathrm{K}) > 0$, $\mathrm{GHOST} < 0.3$, $\mathrm{PID}(\mathrm{p}) > 10$, $Pt > 300$
- $\Delta m < 150 MeV$
- $c\tau > 100 \mu m$
- $\mathrm{IPChi2} < 225$

Additional:

- Blind region $|m(p\mu\mu) - 2286.46| < 40 MeV$.
- ϕ, ω veto.





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Strategy

Follow the strategy of τ analysis:

- Take prompt Λ_c, separate approach to SL.
- Loose cut preselection.
- Train MVA on MC prompt signal and recalibrate on data.
- Calibrate on date.
- Normalize to $\Lambda_c^+ \to \mathrm{p}K^-\pi^+$, $\Lambda_c^+ \to \mathrm{p}\pi^-\pi^+$ or $\Lambda_c \to \mathrm{p}\phi(\mu\mu)$.
- Optimise the binning in MVA.
- CLs method for limit.

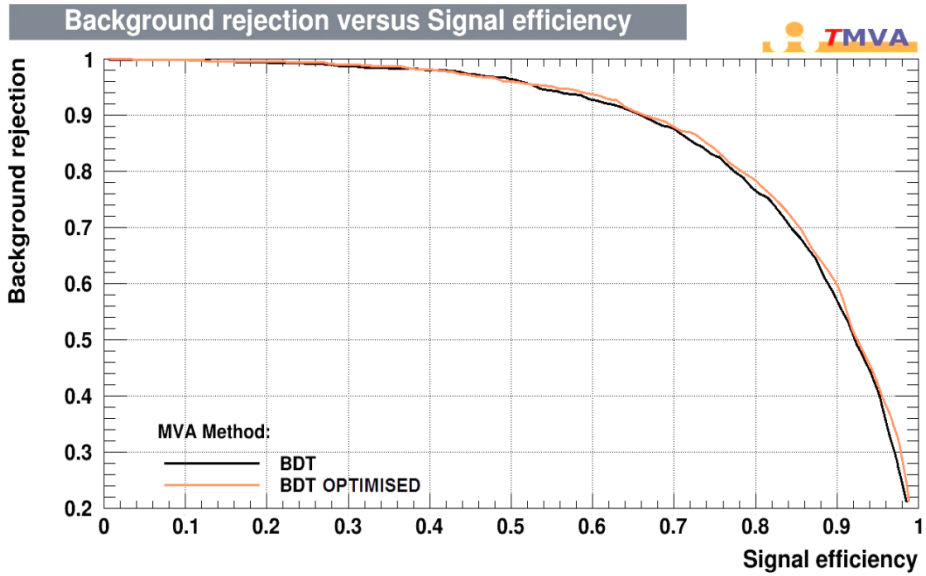
Normalization channel

- We have 3 candidates for normalization channel.
  1. $\Lambda_c \rightarrow \mathrm{p}\phi(\mu\mu)$, $BR = (2.4 \pm 0.8) \times 10^{-7}$
  2. $\Lambda_c^+ \rightarrow \mathrm{p}K^-\pi^+$, $BR = (5.0 \pm 1.3) \times 10^{-2}$
  3. $\Lambda_c^+ \rightarrow \mathrm{p}\pi^-\pi^+$, $BR = (3.5 \pm 2.0) \times 10^{-3}$

  From above list $\Lambda_c \rightarrow \mathrm{p}\phi(\mu\mu)$ is a perfect candidate for normalization. However Br is a bit low.

Optimising the selection

- Last time for studies we used BDT that was trained on the fly.
- Now a student produced a new optimised BDT
- I include his thesis as attachment to this presentation.



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Comments about the BDT

- From historical reasons we are training this classifier on MC vs MC
- Problematic part is that we have limited MC background sample.
- We have how ever the opposite sign (OS) channel: $\Lambda_c^+ \to \overline{p}\mu^+\mu^+$
- The obvious idea was to use this as an background extrapolation and use it for training and optimisation.

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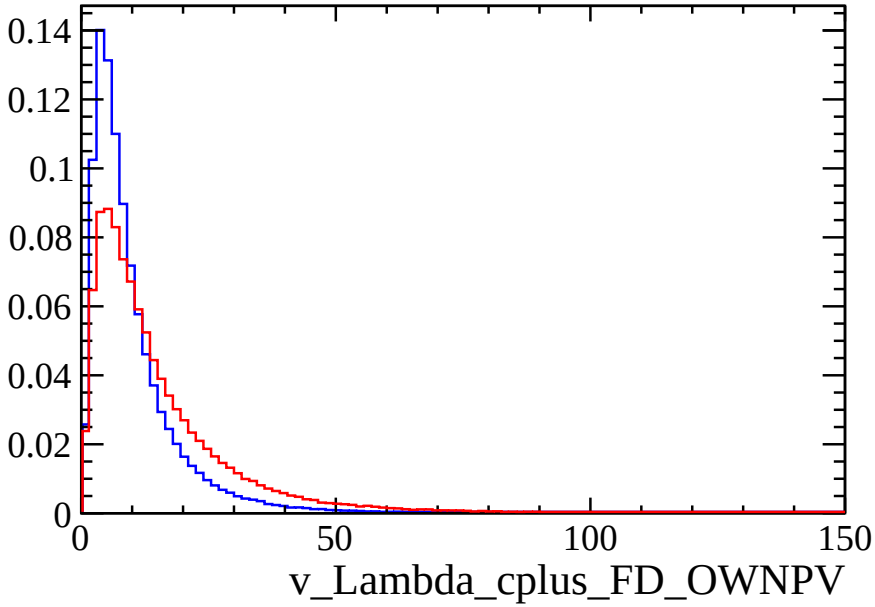
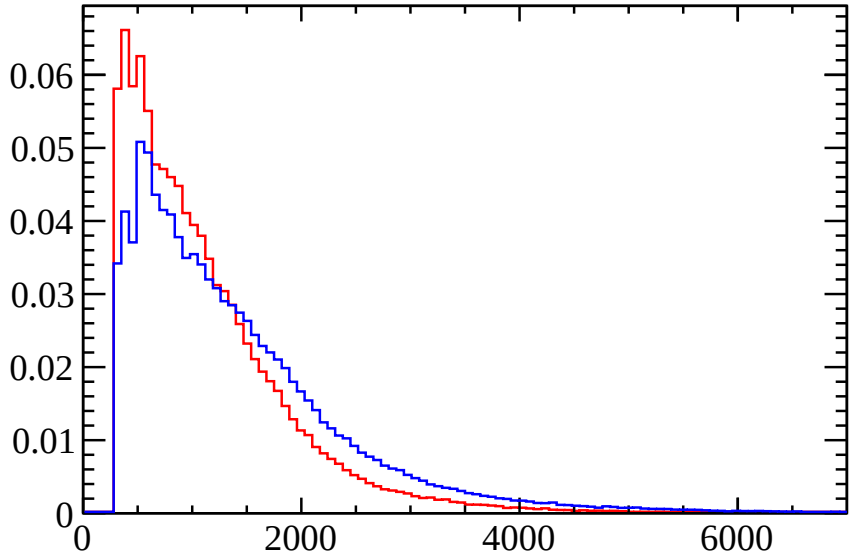
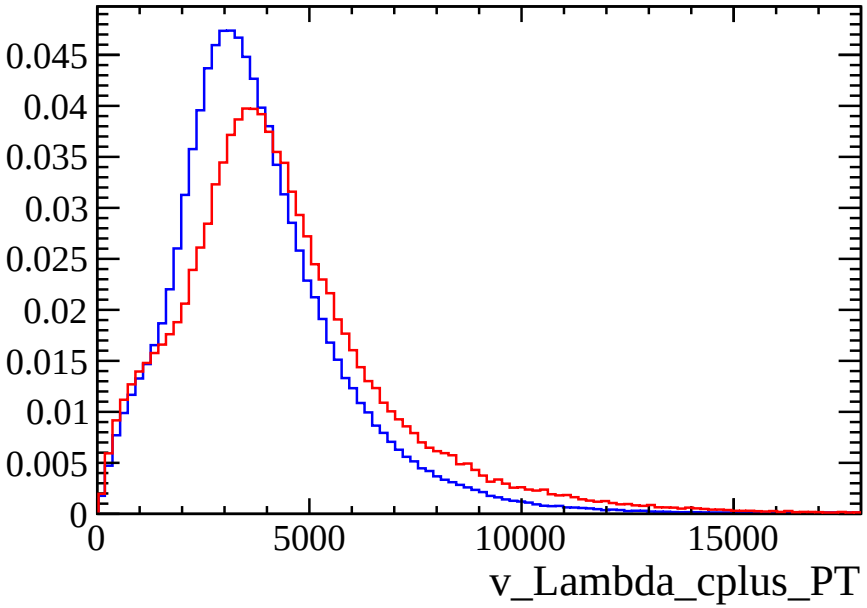
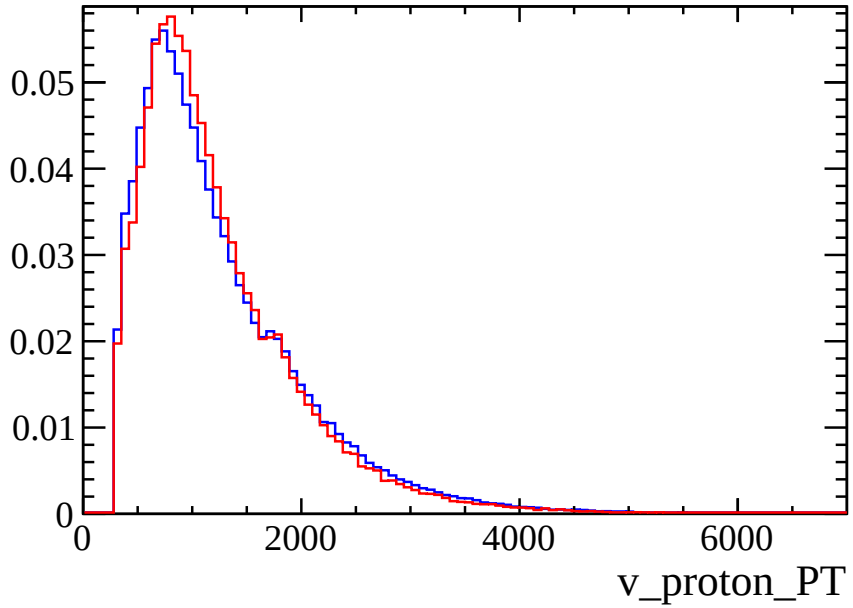
Differences between SS and opposite sign data



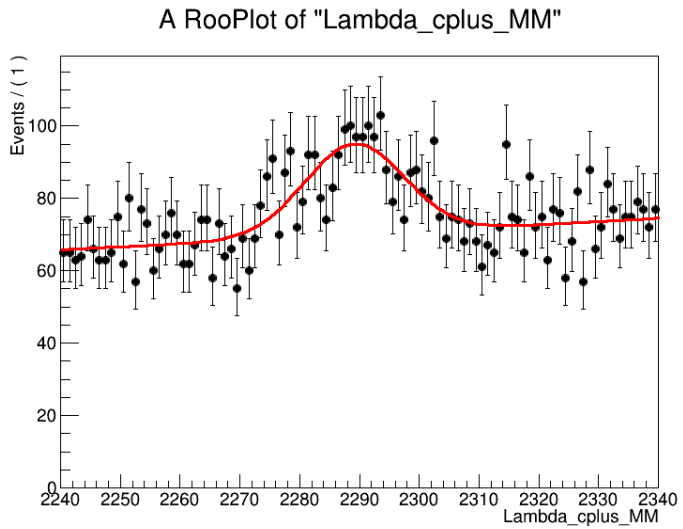


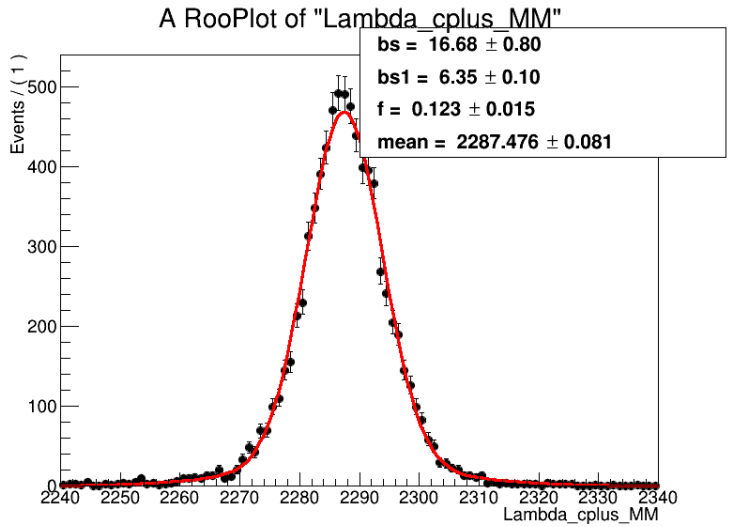




Normalization channel

- $\mathcal{O}(500)$ events in pour dataset.
- Can be used for normalization!
- With the new BDT we also see small peak of ω
- Will veto that.





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Possible background

Resonance	$\mathcal{B}(\Lambda_c \to pX)$	$\mathcal{B}(X \to \mu\mu)$
η	UNKNOWN	$(5.8 \pm 0.6) \times 10^{-6}$
ρ^0	UNKNOWN	$(4.55 \pm 0.28) \times 10^{-5}$
ω	UNKNOWN	$(9.1 \pm 3.0) \times 10^{-5}$
$f(980)$	$(2.8 \pm 1.9) \times 10^{-3}$	UNKNOWN
ϕ	$(8.2 \pm 2.7) \times 10^{-4}$	$(2.89 \pm 0.19) \times 10^{-4}$
Resonance	$\mathcal{B}(\Lambda_c \to pX)$	$\mathcal{B}(X \to \mu\mu\gamma)$
η	UNKNOWN	$(3.1 \pm 0.4) \times 10^{-4}$

Summary

- Looks like we will have limits $\mathcal{O}(10^{-8})$
- We already see a new $\Lambda_c \longrightarrow \omega p$ decay, needs separate analysis
- Normalization channel is still open, but we are converging towards $\Lambda_c^+ \longrightarrow p\pi^-\pi^+$
- We have one tight cut on the stripping (flight distance), we are considering several solutions.