Status of multiplicity dependent Ξ_c^0 analysis

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KoALICE workshop

Jan. 5, 2022

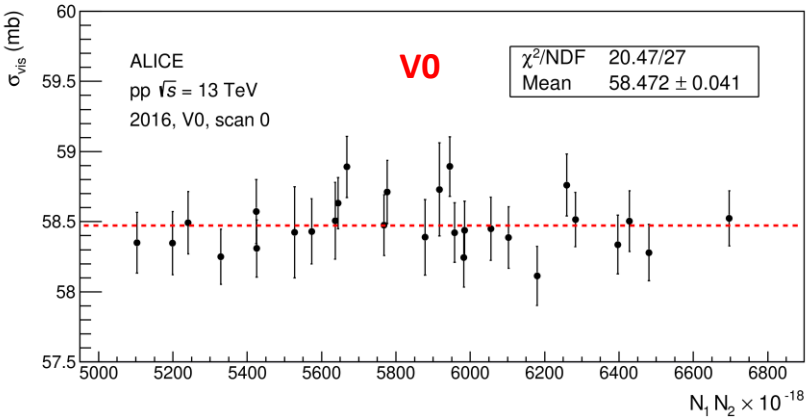
Outline

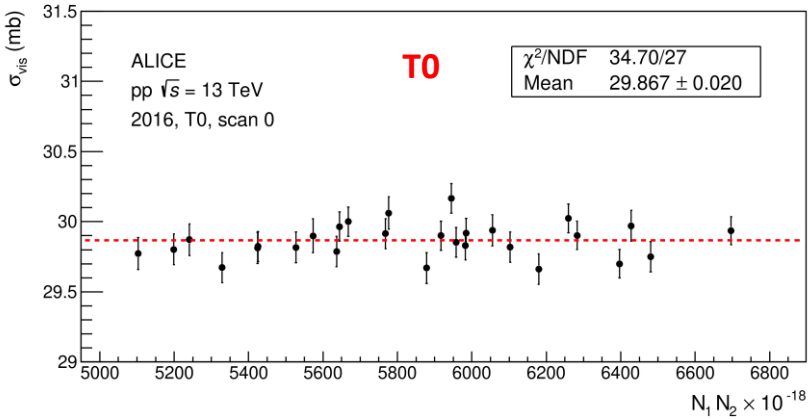
1. **Additional activity in 2021**
   - Contribution to the Luminosity group
2. **Multiplicity dependent Ξ_c^0 analysis**
   - Recap
   - Current status
3. **Schedule for 2022**

2021 Activity Contribution to the Luminosity group

- **vdM (van der Meer) analysis**
  - Goal: estimation of V0/T0 cross-sections, for LHC Run 2 pp √s = 13 TeV (2016-2018)
  - Main tasks:
    a. Cleanup/Debug/Update of existing libraries for vdM analysis
    b. Estimation of V0/T0 cross-section and its error
  - Results and Achievements:
    a. Task finished successfully (ALICE public note: link)
    b. Conferences talks: HADRON2021 (oral) and PANIC2021 (poster)

pp √s = 13 TeV
ALICE-PUBLIC-2021-005





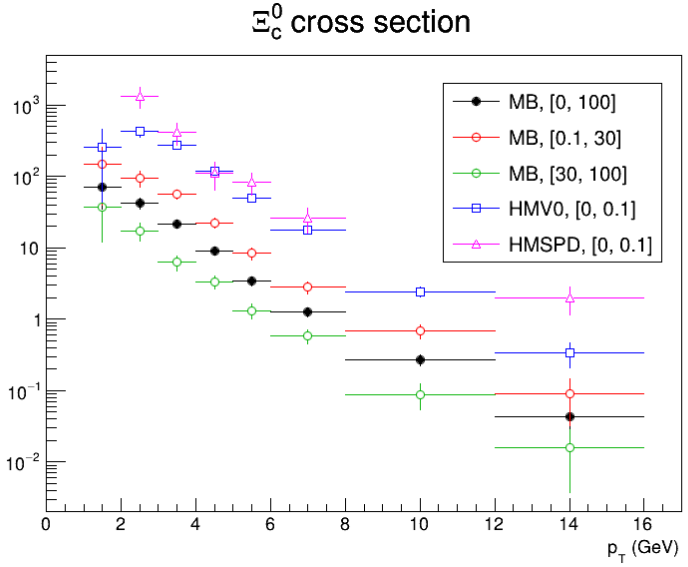
Ξ_c^0 Analysis Recap (1 of 3)

Analyzer	JSeo	SHLim/CKim	JBok
Dataset	RUN2 (2016 – 2018)		
Collision system	p + p		p + Pb
√s (TeV)	13		5.02
Triggers	MB	MB, HM	MB
Multiplicity	N	Y	Y
Status	Done	Ongoing	

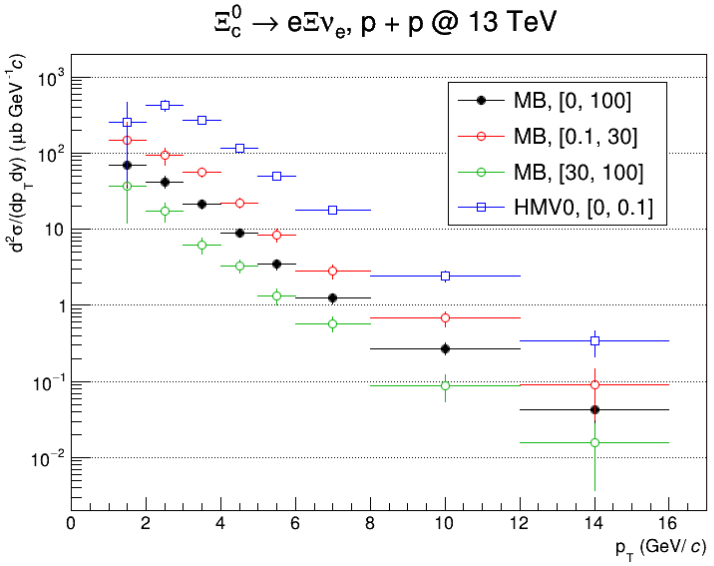
- **Multiplicity dependent Ξ_c^0 analysis**
  - $\Xi_c^0 \rightarrow e\Xi$ decay channel (BR 1.8 ± 1.2 %)
  - Based on the analysis by J.Seo
    a. Share the same:
       a-1. Analysis strategy
       a-2. Samples (both data and MC)
       a-3. Online event selection (*AliAnalysisTask*)
    b. Differences:
       b-1. Further classification by HM trigger and V0M multiplicity
            (e.g. MB inclusive vs. MB + [0, 100], MB + [0.1, 30], MB + [30, 100], and HMV0 + [0, 0.1])
       b-2. Use my own offline selection and analysis codes (based on Jinjoo's code, but wrote by myself again)
       b-3. Final observable: cross-section (of Ξ_c^0, Jinjoo) vs. baryon-to-meson ratio (Ξ_c^0/D^0, CKim)
  - Continual update & Exchange feedback via internal PNU – Inha weekly analysis meeting

Ξ_c^0 Analysis Recap (2 of 3)

KoALICE workshop (Feb. 17, 2021)

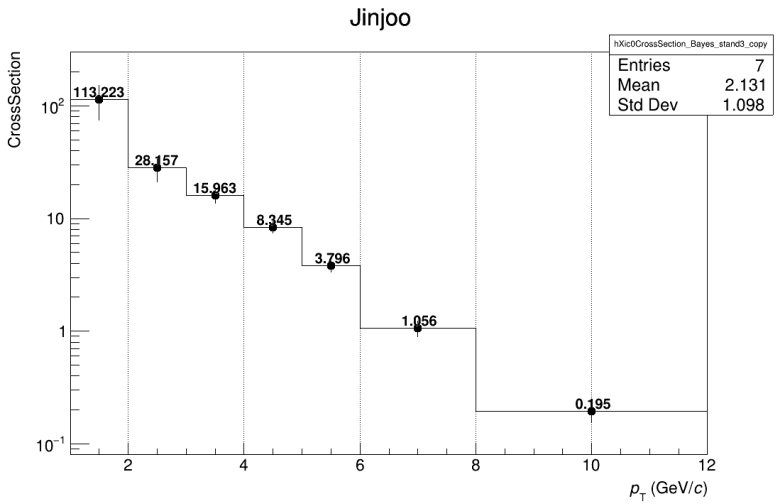


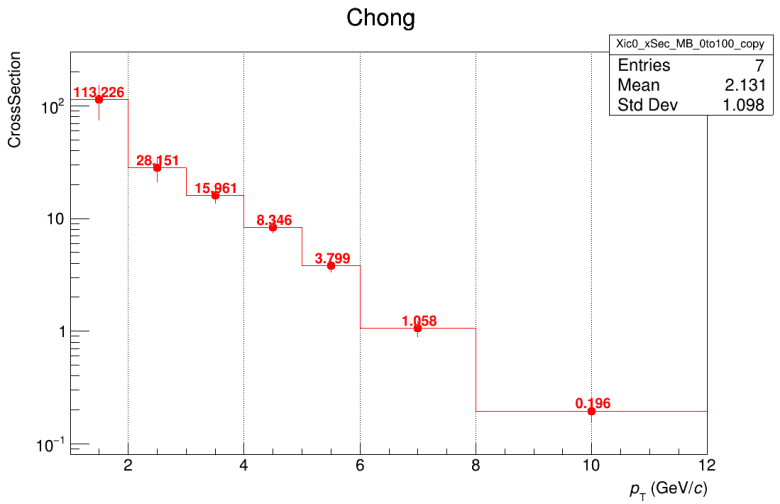
ALICE_D2H (Mar. 5, 2021)

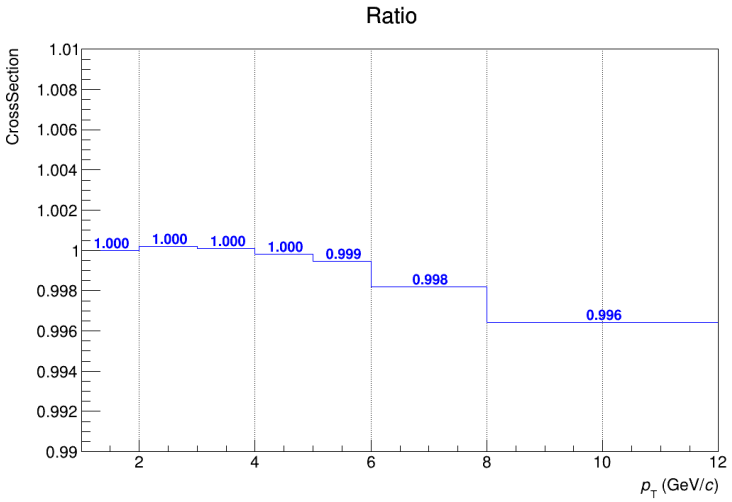


- **Since the last report**
  - Drop HMSPD configuration: poor statistics (main), no uniqueness compared to HMV0
  - Major comments received from D2H:
    a. 1-to-1 direct comparison to Jinjoo's "MB inclusive xSec" result (next page)
    b. Investigate drop-like behavior of "HMV0 + [0, 0.1]" around 1 < pT < 2:
    → It turns out the reason is BG abundance (study by Prof. Lim) (* backup)

Ξ_c^0 Analysis Recap (3 of 3)

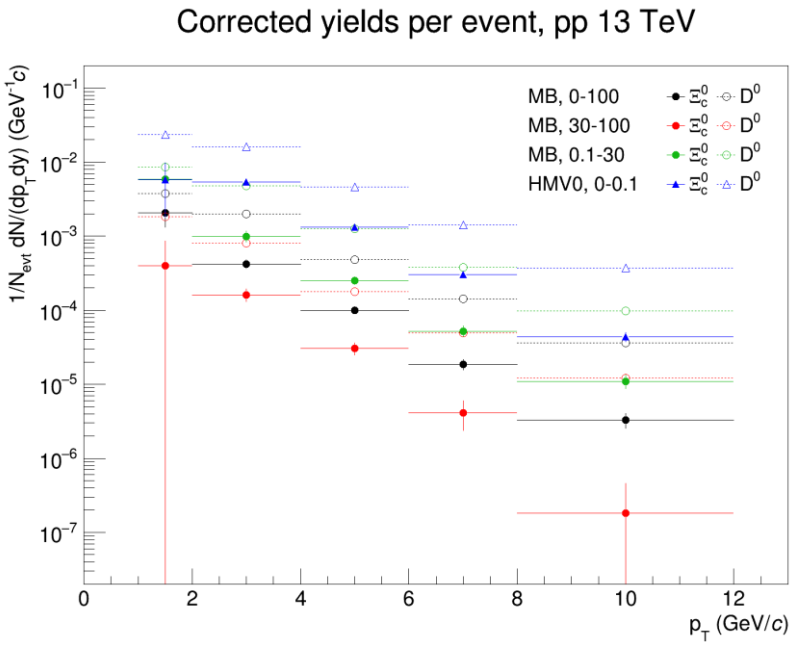


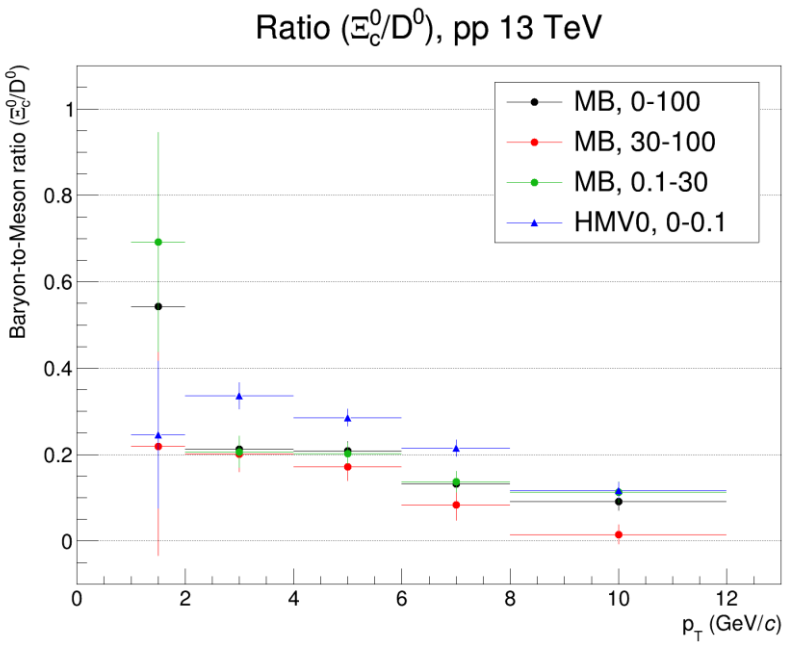




- **Comparison to Jinjoo's result**
  - Conditions:
    a. Target: MB inclusive cross-section
    b. Same: sample (train level), cuts, and analysis routines
    c. Different: offline analysis codes and a few minor cuts
  - Proof of general sanity of the current analysis

Ξ_c^0 Analysis Current status





- Up-to-date results
  a. Left: yields (normalized by # of events, w/o V0 xSec) for Ξ_c^0 (this analysis) and D^0 (from L_c / D^0 analysis)
  b. Right: baryon-to-meson (Ξ_c^0 / D^0) ratio, calculated from the left
- Current analysis status
  a. All analysis routines are prepared and a systematic error study is underway
     * It seems intensive study is needed for largely fluctuating points before finalization…
  b. Currently writing the analysis note

Schedule for 2022

- **Schedule of my interest**
  - QM22 (Ξ_c^0 analysis, poster)
    a. Jan. 10: analysis note due to the PWGHF-D2H conveners (personal)
    Jan. 24: abstract notifications by QM organizers (official by PWGHF-D2H, link)
    b. Feb. 07-11: HF preview (official)
    Feb. 14-22: ALICE preview (official)
    c. Mar. 07-11: HF approval (official)
    Mar. 14: ALICE approval (official)
    d. Apr. 04-10: QM2022 (official)
  - Finalization of the Ξ_c^0 analysis
    a. Finalize the results during the 2nd half of 2022
    b. Publish (at least reach the draft preparation level) in 2022
  - ALICE service works

    No solid plan yet – perhaps a further contribution to the Luminosity group?

Summary

- **2021 Activities**
  - vdM analysis for Luminosity group as service work for ALICE collaboration
  - Multiplicity dependent Ξ_c^0 analysis
- **Multiplicity dependent Ξ_c^0 analysis**
  - Rather slow progress - the crosscheck took more time than expected

    (I didn't mention all the technical details in this slide)
  - Most of analysis steps are prepared and under systematic study, but
    a. Currently writing an analysis note (clock's ticking…)
    b. Need to modify some routines: in general, they're designed for MB inclusive
    c. Require intensive study for some heavily fluctuating data points
  - Finalization plan: plan to finish this analysis within this year (2022)

Backup Analysis strategy

- **Analysis strategy**
  - Ξ^0_c semi-leptonic decay mode (BR 1.8 ± 1.2 (%))

    $\Xi^0_c \rightarrow e^+ \Xi^- \nu_e \rightarrow e^+ (\pi^- \Lambda) \nu_e \rightarrow e^+ (\pi^- (p\ \pi^-)) \nu_e$ or its charge conjugate, i.e.,

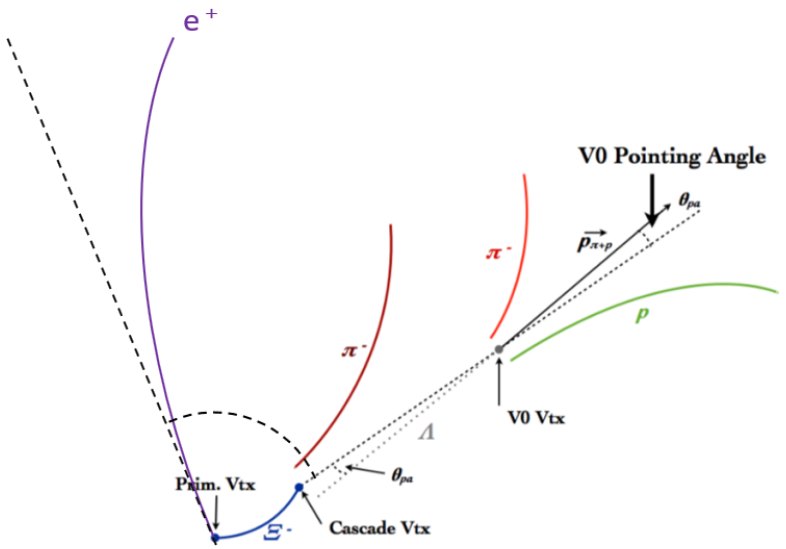
    $\Xi^0_c \rightarrow e^- \Xi^+ \nu_e \rightarrow e^- (\pi^+ \Lambda) \nu_e \rightarrow e^- (\pi^+ (p\ \pi^-)) \nu_e$
  - Cross-section analysis steps
    1. Get candidates of e and Ξ
    2. Get distributions of:

       2 - a. RS (right sign = unlike sign)

       2 - b. WS (wrong sign = like sign)

       2 - c. Raw signal by RS – WS
    3. Correct prefilter efficiency
    4. Correct over-subtracted $\Xi_b \rightarrow \Xi^0_c$ yields

       * Valid only for MB + [0, 100]
    5. Convert " e – Ξ pair's p_T " to " Ξ_c^0 p_T " by unfolding
    6. Correct acceptance x efficiency
    7. Estimate cross-section
    8. Assign systematic error

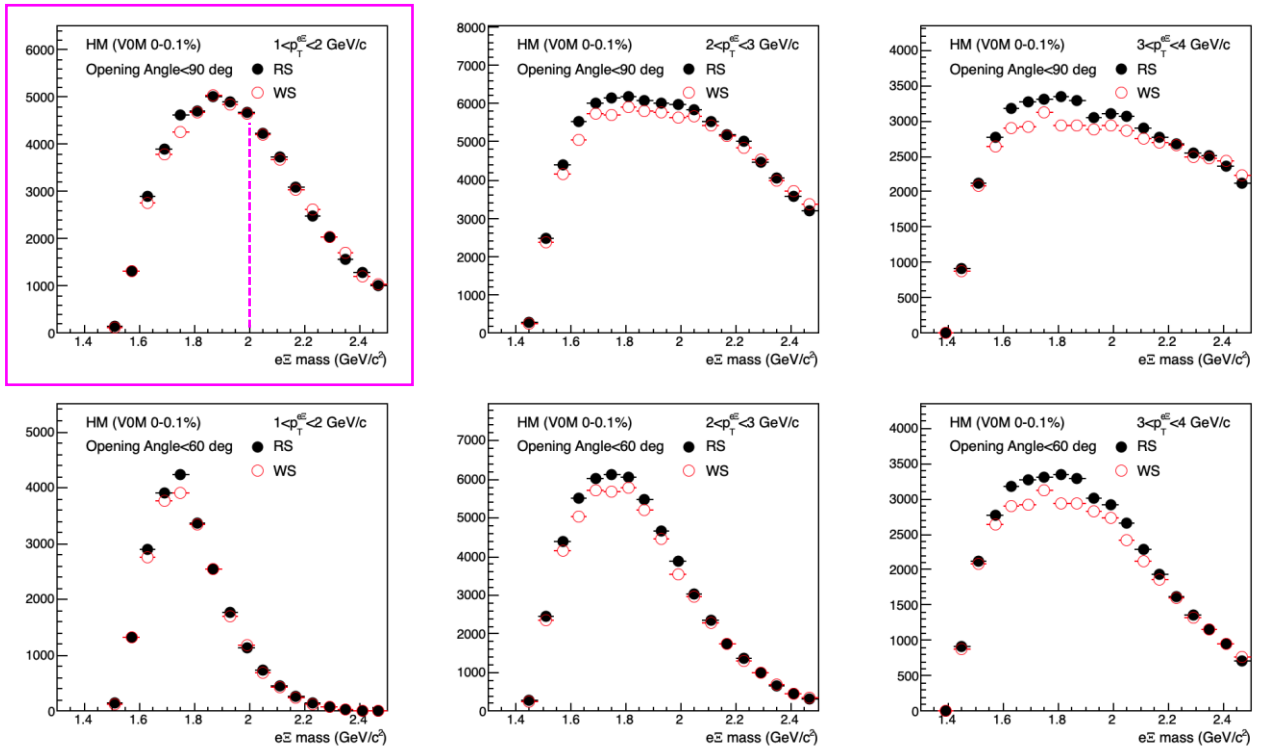


Backup Timeline

- **Milestones before & after March 2021**
  - Before March 2021:
    - AliAnalysisTask update:
      a. Accept events in the "OR" condition of multiple triggers (MB, HMV0, and HMSPD)
      b. Added variables on the ROOT Tree for offline analysis: trigger, multiplicity, etc
    - WDK (weak decay finder) update on AODs
    - LEGO train run (hereafter Feb. train) → Jinjoo's final report and my Mar. 5 update
  - After March 2021:
    - AliAnalysisTask update:
      a. Added multiple ANC objects for each trig + multiplicity (e.g., MB + [0, 100])
      b. Added variable for offline analysis: INEL>0
    - LEGO train run (hereafter May train)
    - Pileup cut update (*fEvt->IsPileupFromSPD(…)* → *fEvtCuts ->IsEventRejectedDueToPileup()*)
    - LEGO train run (hereafter Nov. train) → current up-to-date train output
    - Crosscheck with Jinjoo (MB inclusive cross-section)

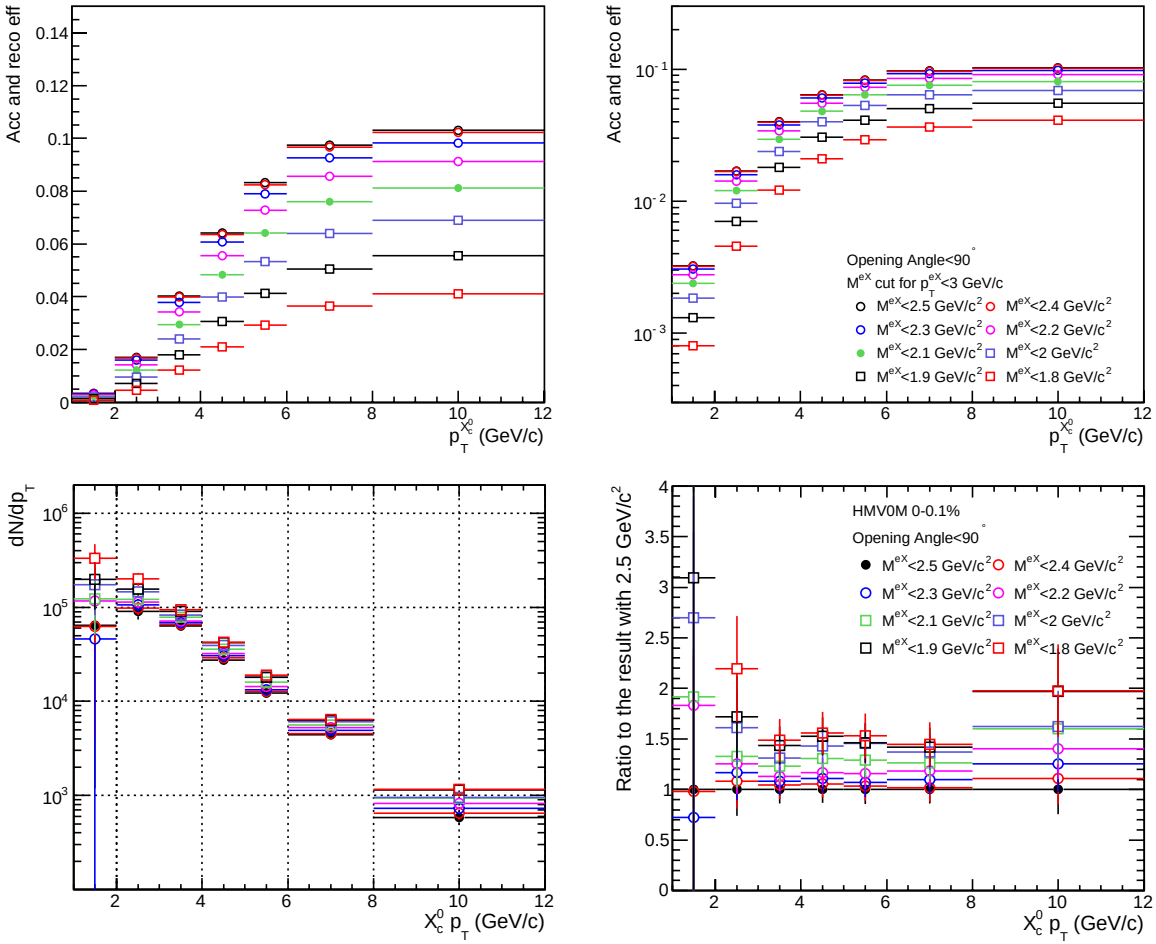
Backup HMV0 point drop

- **Drop like behavior of $1 < p_T < 2$ in HMV0 + [0, 0.1]** / 1 of 3
  - Mass distribution by RS or WS
    a. It's difficult to expect plenty excess yields (RS – WS) in $1 < p_T < 2$, unlike the other bins
    b. BG dominant in mass > 2 GeV : setting a tight cut might helpful (* standard analysis cut: $1.3 < M_{eXi} < 2.5$)



Backup HMV0 point drop

- **Drop like behavior of $1 < p_T < 2$ in HMV0 + [0, 0.1]** / 2 of 3



– Scan M_{eXi}

a. Opening angle = 90˚ (fixed)

b. Checked:

b-1. Acc x Eff, by MC (top)

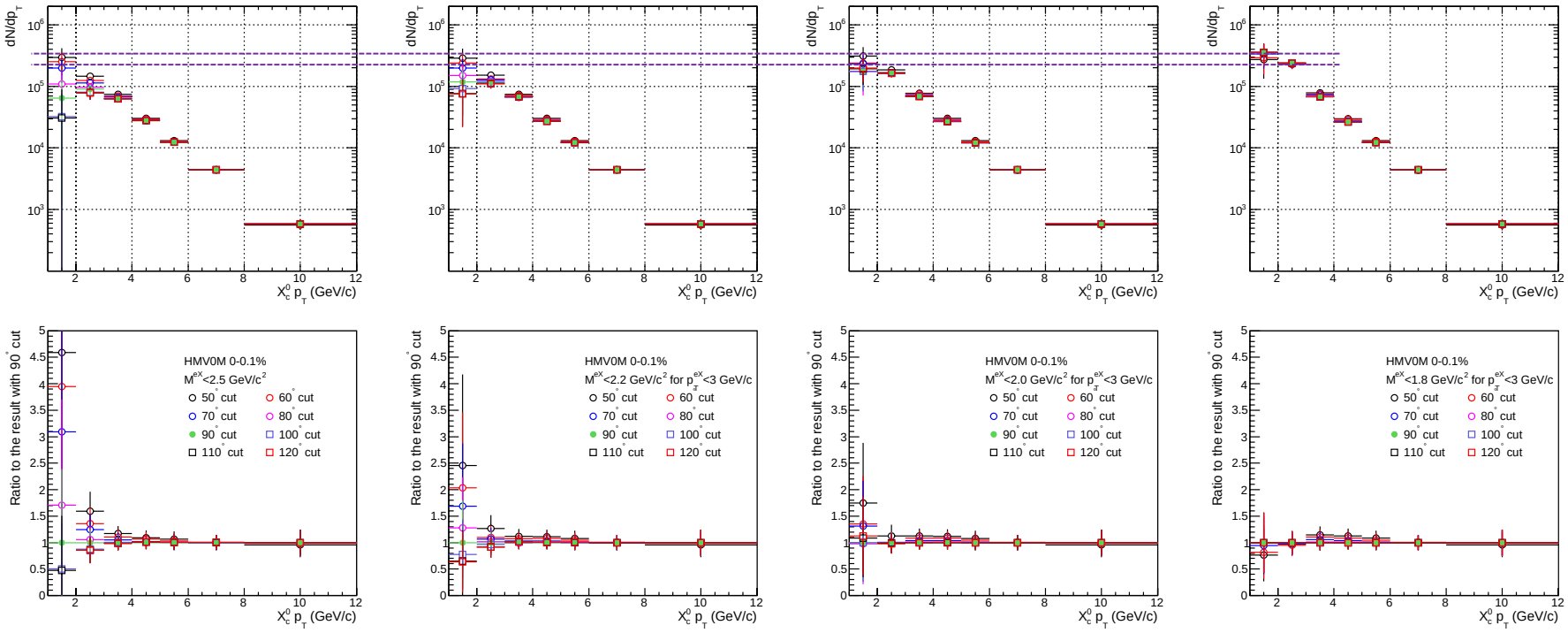
b-2. dN/dp_T (bottom left)

b-3. Ratio WRT the standard cut (bottom right)

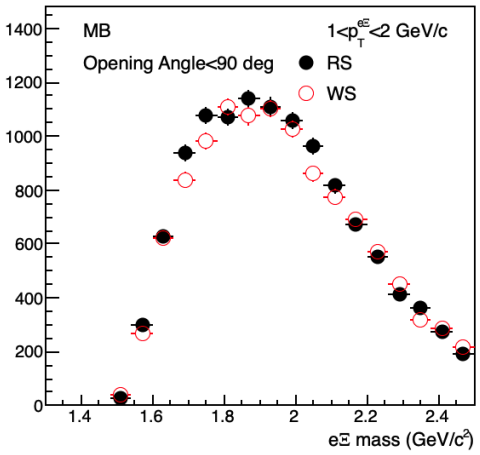
c. Large fluctuation in all p_T bins, especially in $1 < p_T < 2$

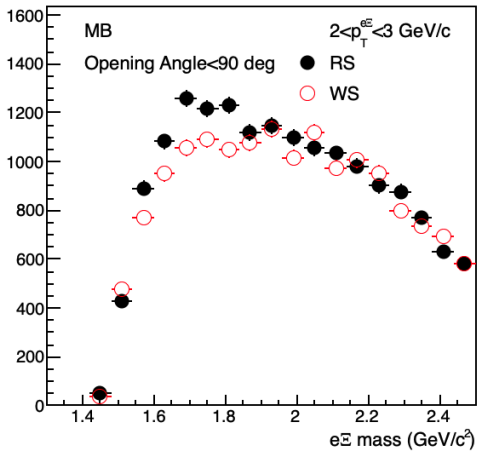
Backup HMV0 point drop

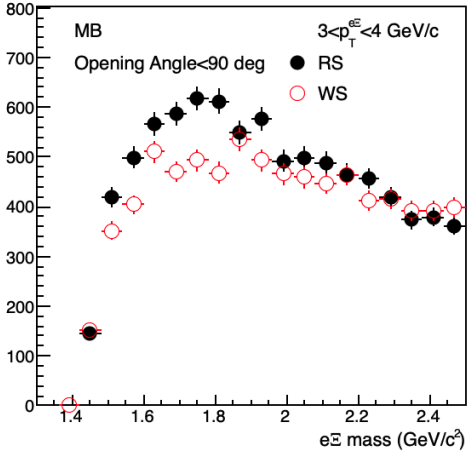
- **Drop like behavior of $1 < p_T < 2$ in HMV0 + [0, 0.1]** / 3 of 3
  - Scan opening angle w/ fixed M_{eXi} (* Backup)
    a. The points are relatively stable vs. opening angle, except $1 < p_T < 2$ ($2 < p_T < 3$ either, in $M_{eXi} < 2.5$)
    b. $1 < p_T < 2$ also settles down with tighter cut (left to right columns), but not sure if this is a valid approach

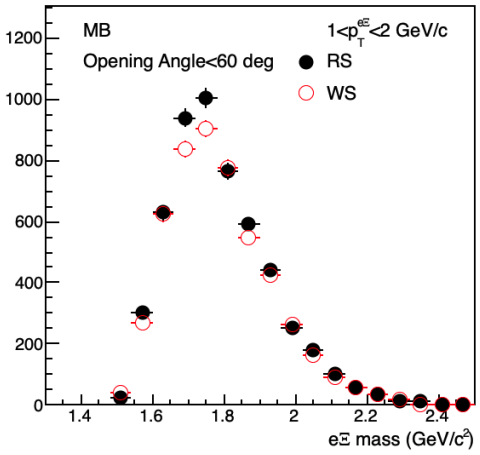


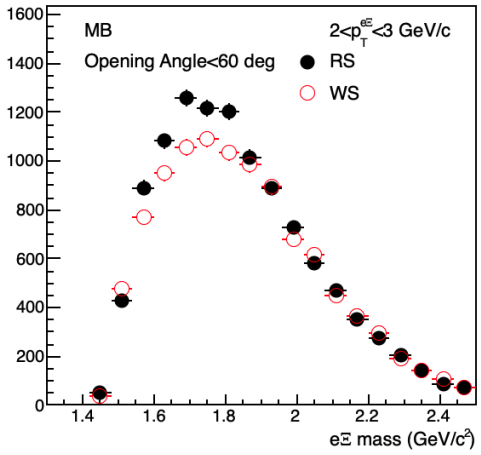
Backup eXi pair mass distributions, MB

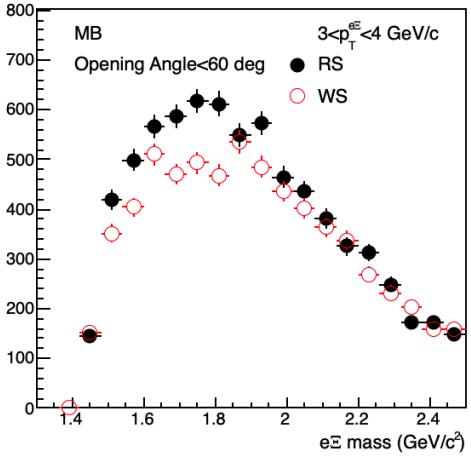












Backup eXi pair opening angle distributions, MB

Quote from Ξ_c^0 analysis note (link)

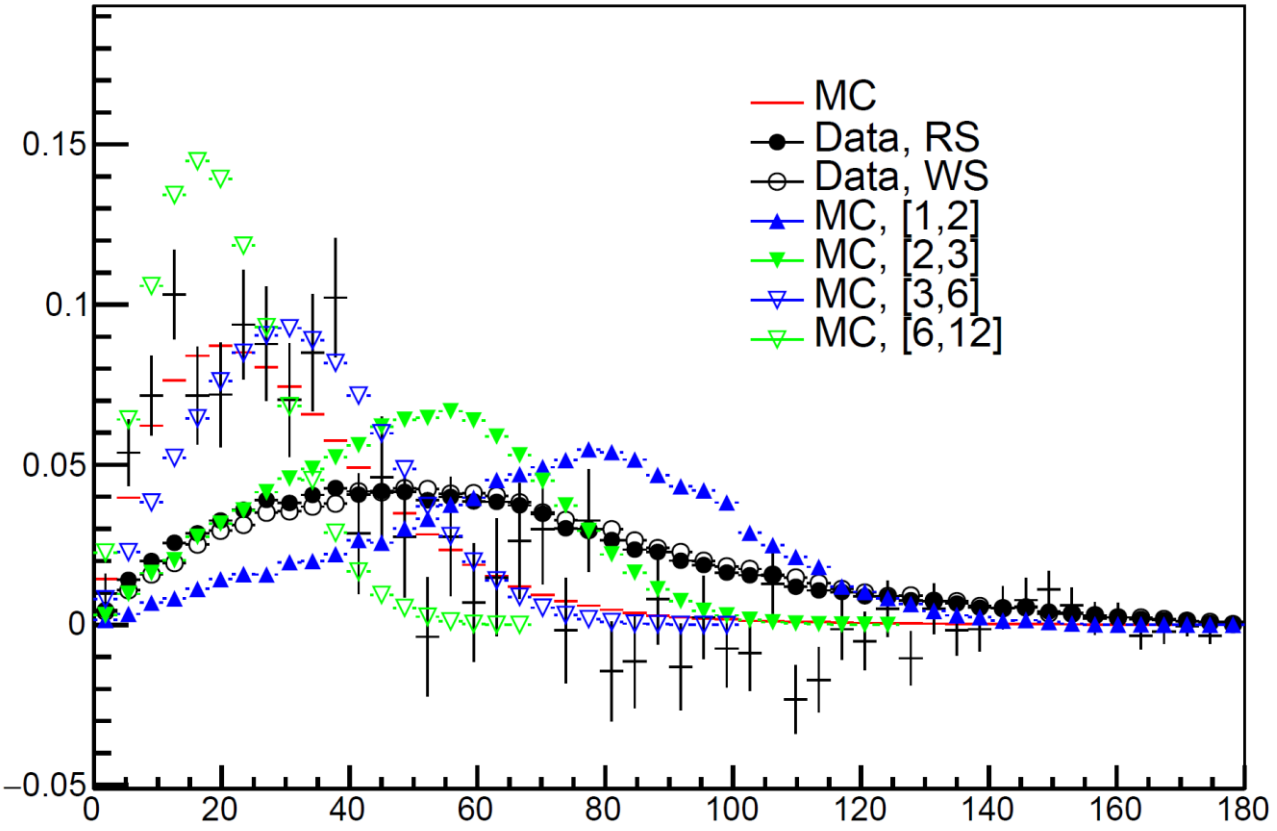


Fig. D.1: The opening angle distributions of eΞ pairs.