Joint Institute for Nuclear Research

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Λ hyperon yields in carbon-nucleus interactions

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3rd BM@N Collaboration Meeting

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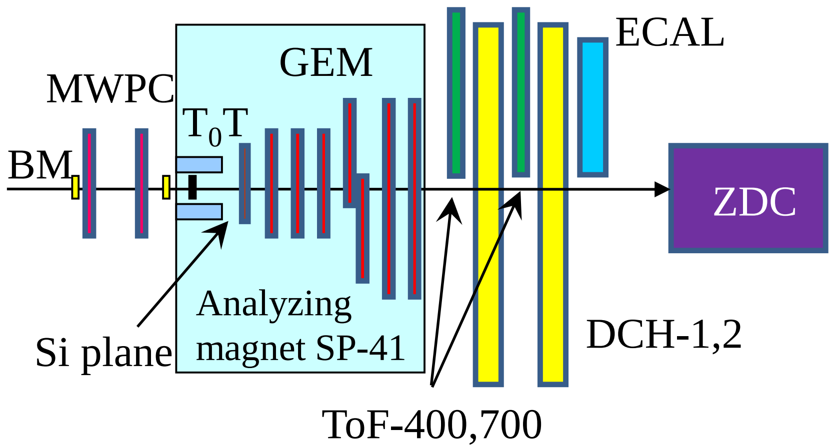
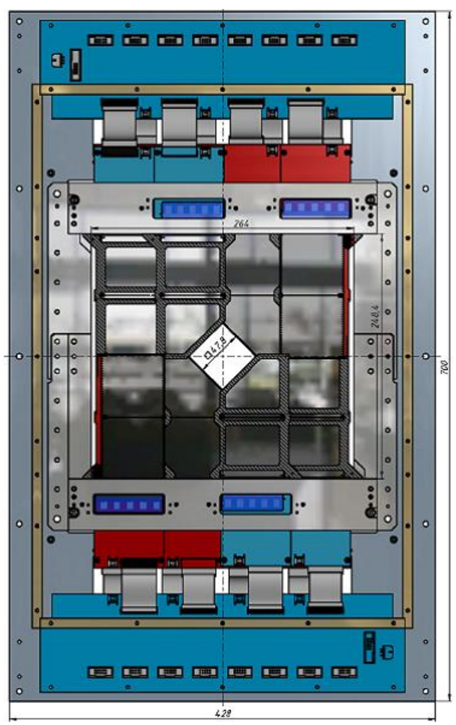
Outline

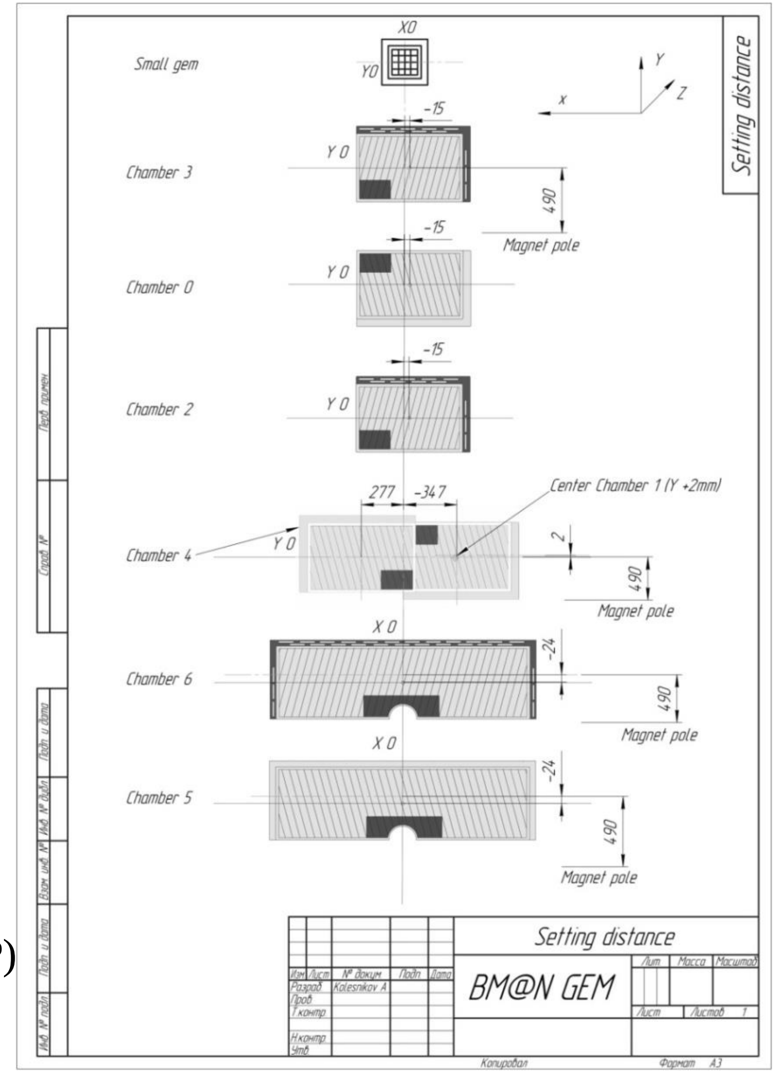
1. Technical run with carbon beam (March 2017)
   - ✓ BM@N detector set-up
2. Data-MC agreement
   - ✓ Multiplicity
   - ✓ Momentum spectra
3. Analysis of data (C+Cu and C+Al at 4A GeV)
   - ✓ Λ yield calculation
   - ✓ Efficiency estimates
   - ✓ dN/dY & dN/dP_T spectra
4. Summary

BM@N set-up in carbon run

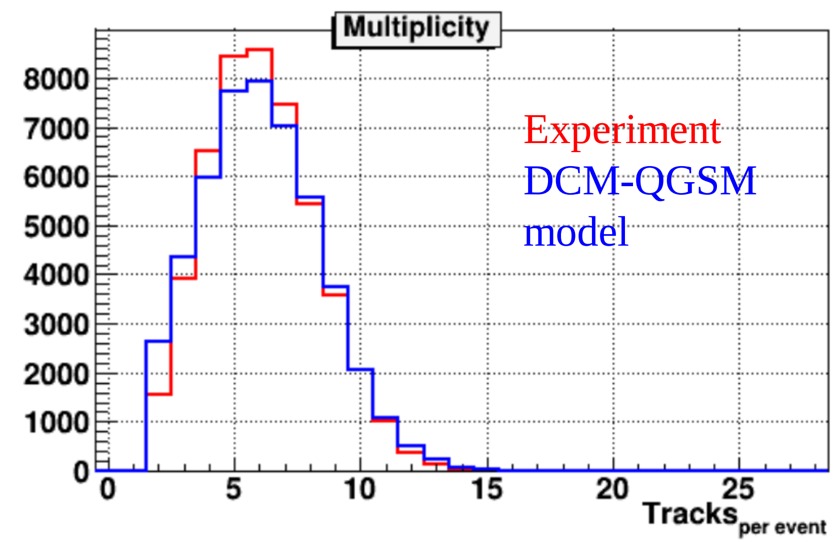


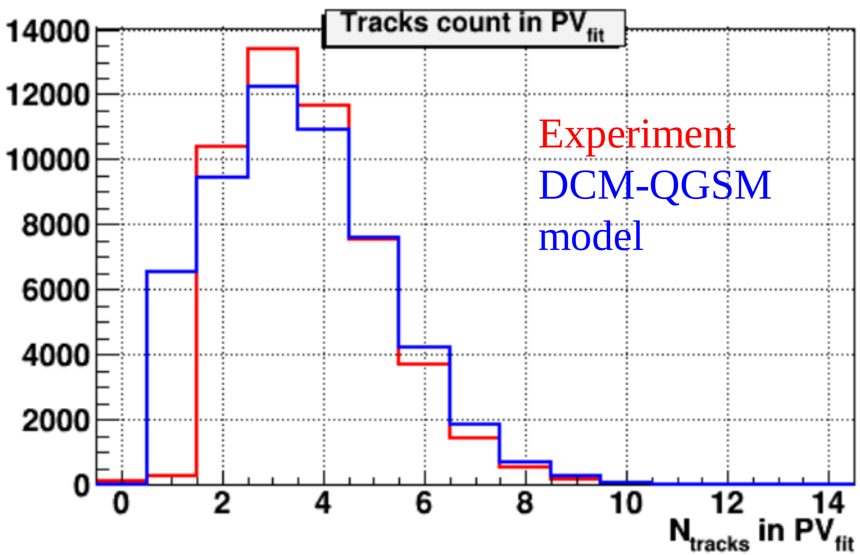


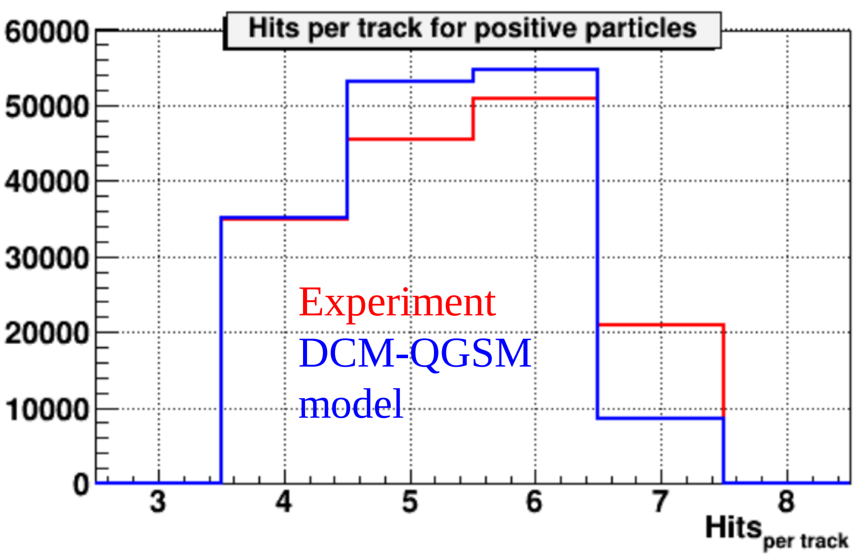
2-coordinate Si detector X-X'(±2.5°) with strip pitch of 95/103 μm, full size of 25 x 25 cm², 10240 strips

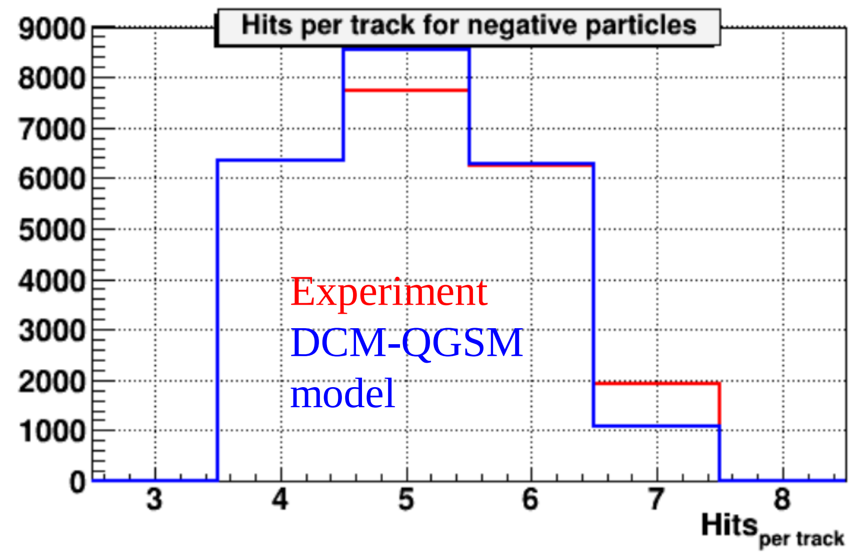


Data vs MC for C+Cu @ 4A GeV

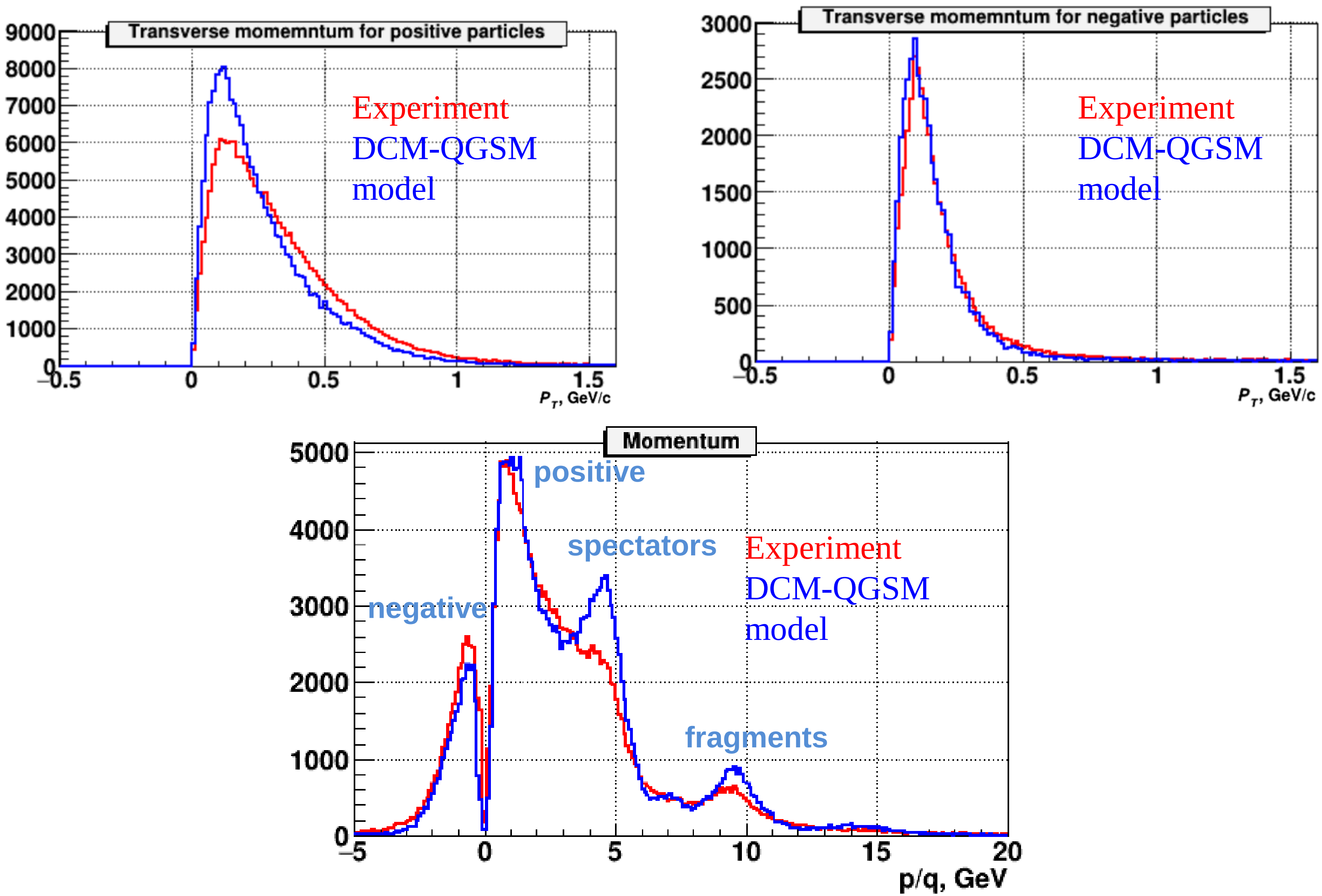




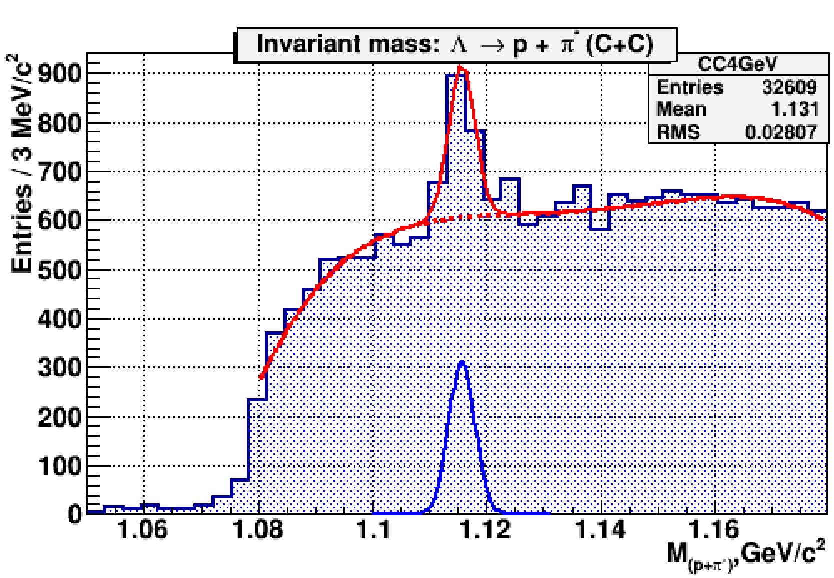


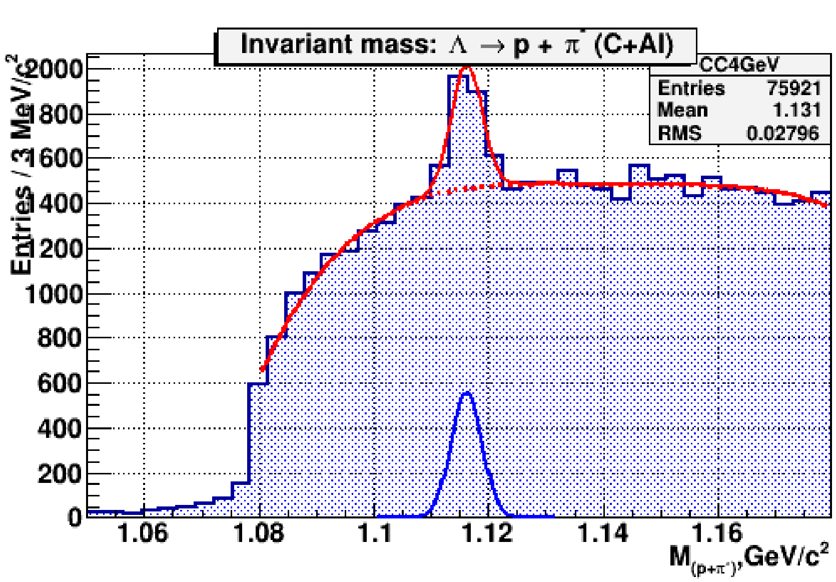


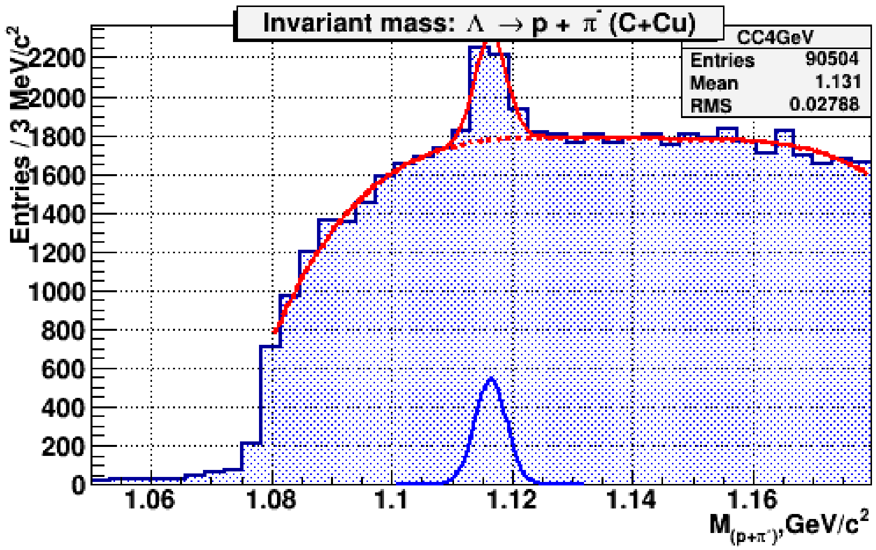
Momentum spectra: Data vs MC



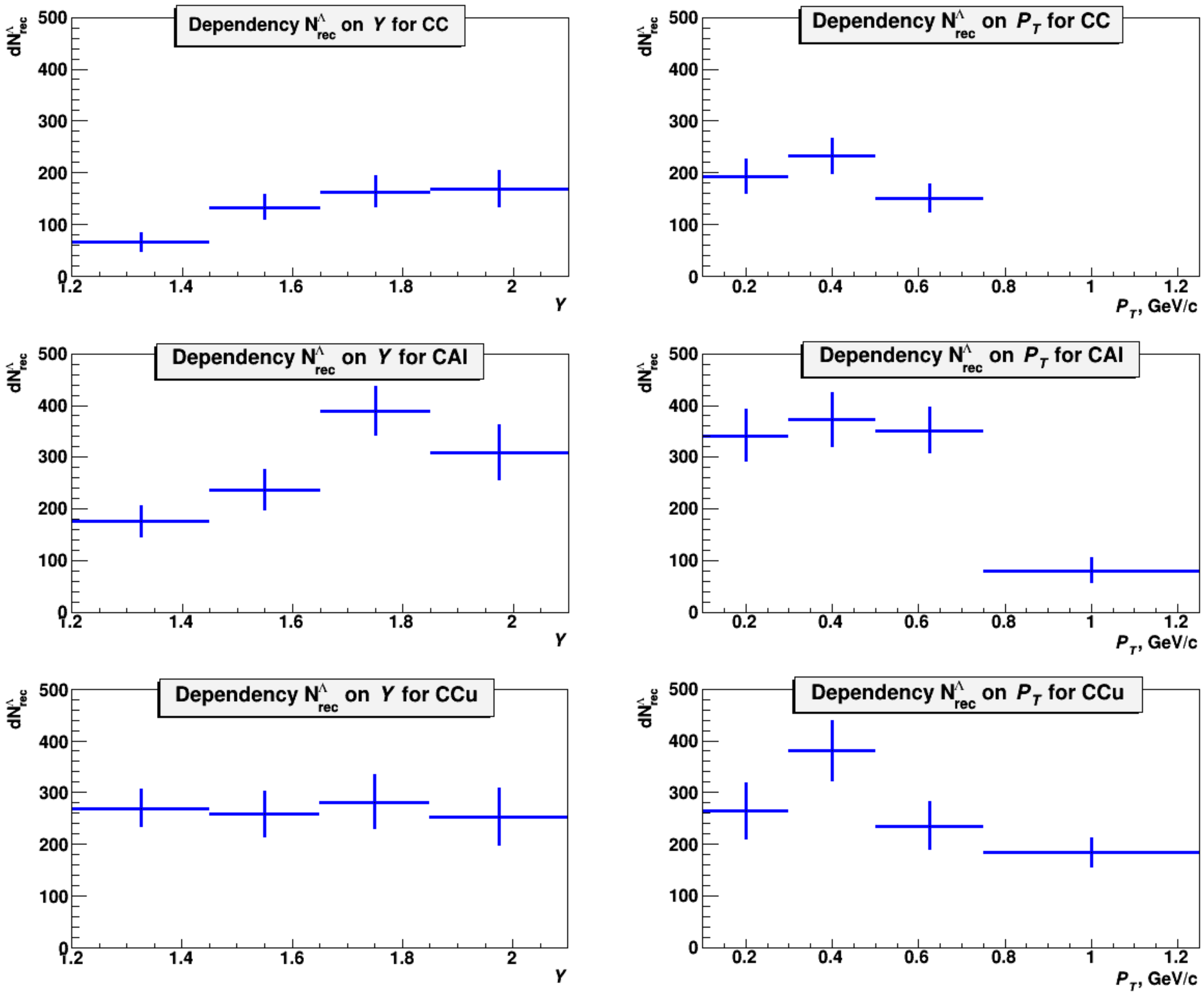
Λ signals on different targets







N of reconstructed Λ in Y and P_T bins



Λ yields calculation

Interaction cross section (QGSM)

$$\sigma_{\Lambda} = Y_{\Lambda} \cdot \sigma_{\text{in}}$$

Reconstructed Λ's from exp. data

$$\frac{N_{\Lambda}}{\varepsilon \cdot L}$$

$\varepsilon_{\text{total}}$

$$\sigma_{\text{in}}^{QGSM}(CC) = 911mb$$

$$\sigma_{\text{in}}^{QGSM}(CAl) = 1261mb$$

$$\sigma_{\text{in}}^{QGSM}(CCu) = 1790mb$$

Genis Musulmanbekov

Experimental luminosity

Target	C	Al	Cu
A, a.e.m	12	27	64
ρ, g/cm3	2.25	2.7	8.92
thickness, cm	1.2	1.2	0.5
L, 10^30 cm-2	**9.11**	**3.33**	**2.15**

Luminosity calculation for different targets using DAQ information

Efficiency decomposition

$$\varepsilon_{\text{total}} = \varepsilon_1^{acc} \cdot \varepsilon_2^{emb} \cdot \varepsilon_3^{vtx} \cdot \varepsilon_4^{trig}$$

$$\varepsilon_1^{acc} = \frac{N_{acc}^{\Lambda}(y, p_T)}{N_{gen}^{\Lambda}(y, p_T)}$$

- Λ acceptance in GEM

$$\varepsilon_2^{emb} = \frac{N_{acc}^{\Lambda,\varepsilon_{det}}(y, p_T)}{N_{acc}^{\Lambda}(y, p_T)}$$

- efficiency of embedded Λ reconstruction

$$\varepsilon_3^{vtx} = \frac{N_{vtx(cuts)}^{\Lambda}(y, p_T)}{N_{rec(MC_{full})}^{\Lambda,\varepsilon_{det}}(y, p_T)}$$

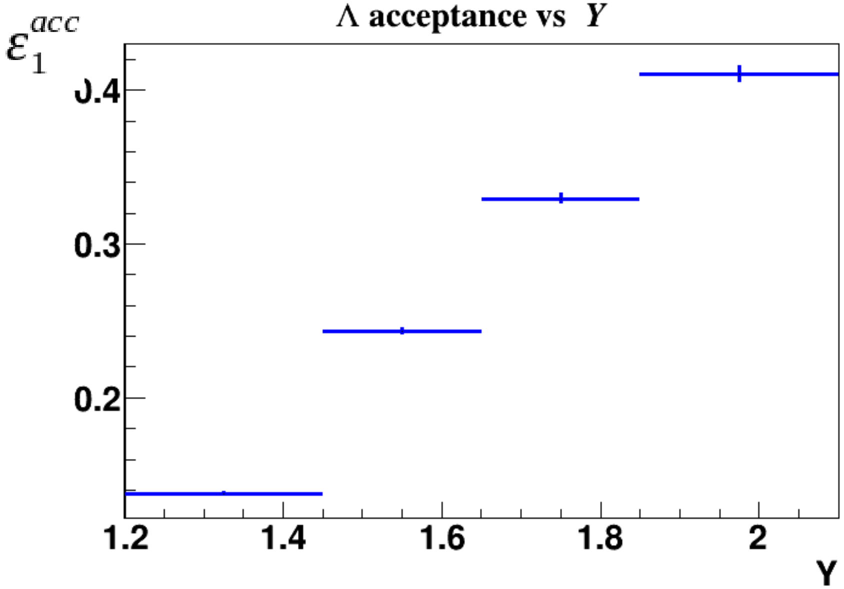
- efficiency of Λ event selection

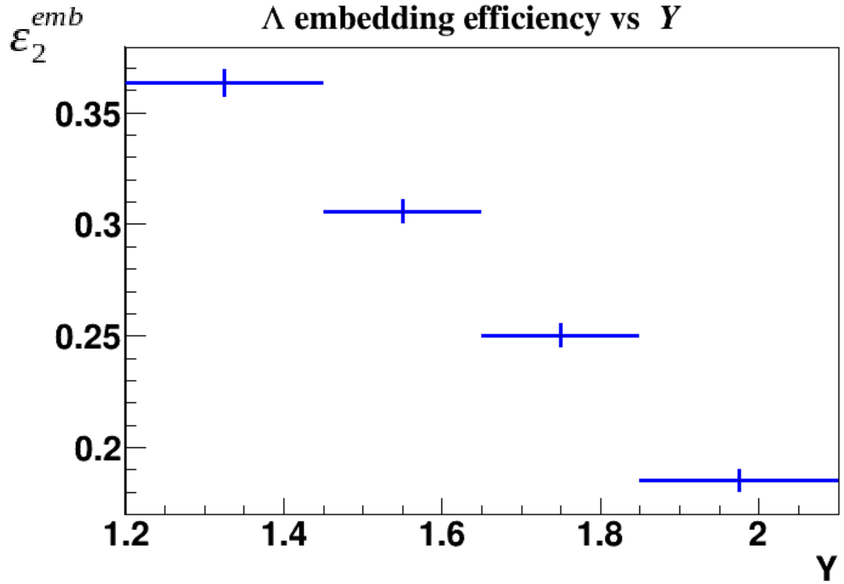
$$\varepsilon_4^{trig} = 1 - \frac{N_{BD(cuts)}^{\Lambda}(<=2)}{N_{BD(cuts)}^{\Lambda}(all_{>=3})}$$

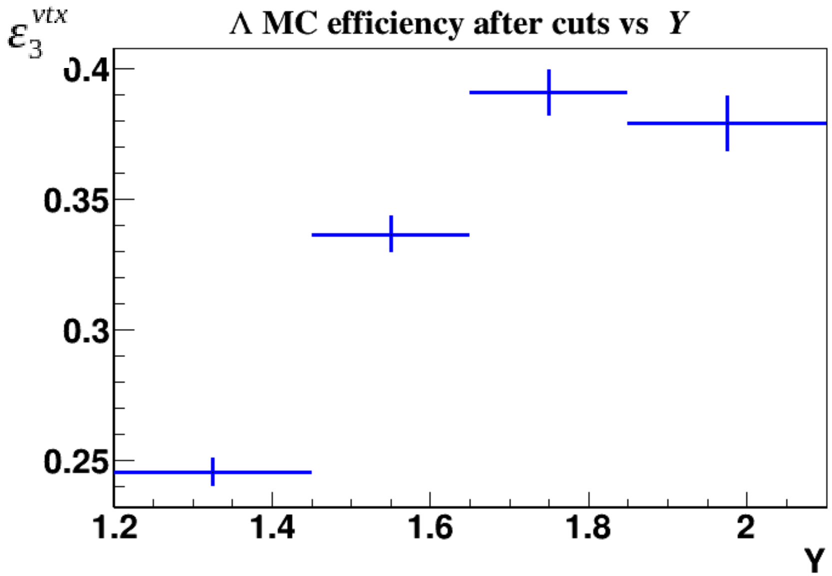
- trigger efficiency from Λ data

Target	C	Al	Cu
ε_4^{trig}	**0.9**	**0.95**	**0.95**

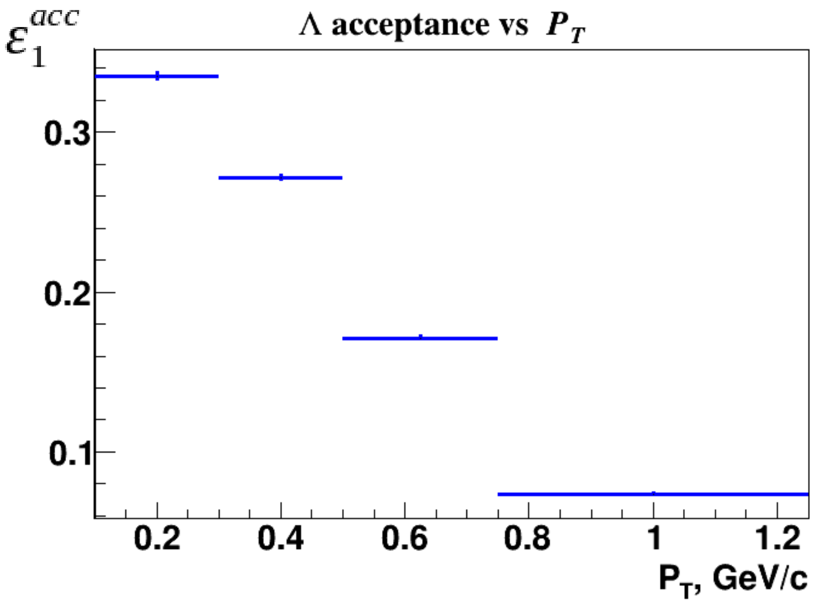
Efficiency dependence on Y

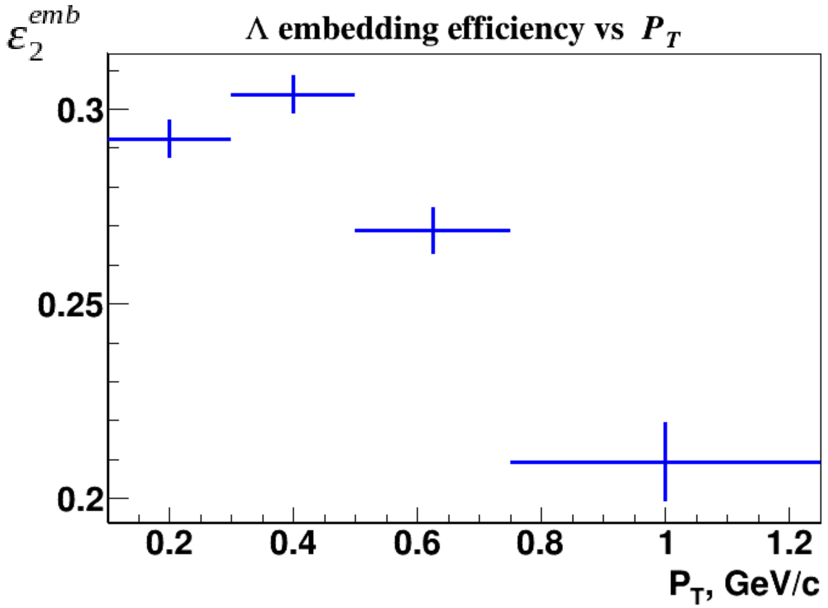


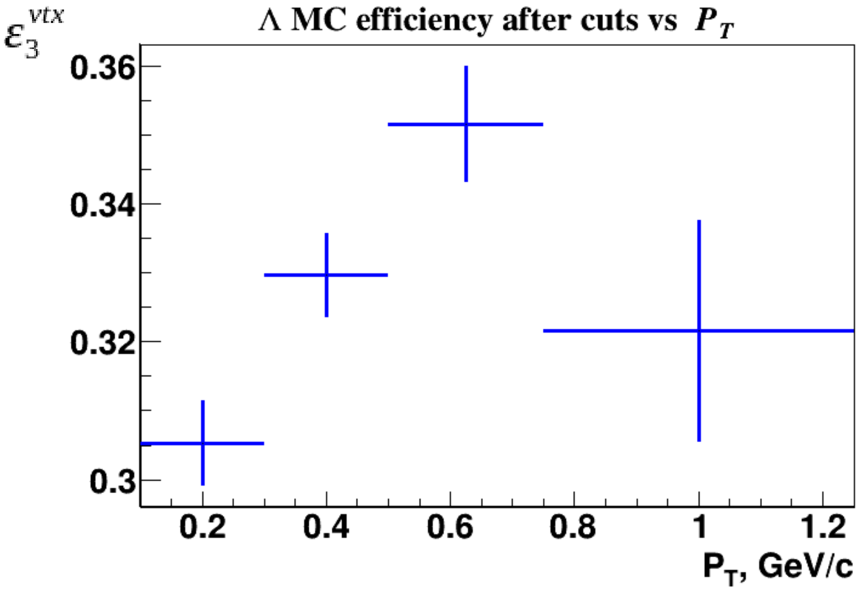




Efficiency dependence on P_T

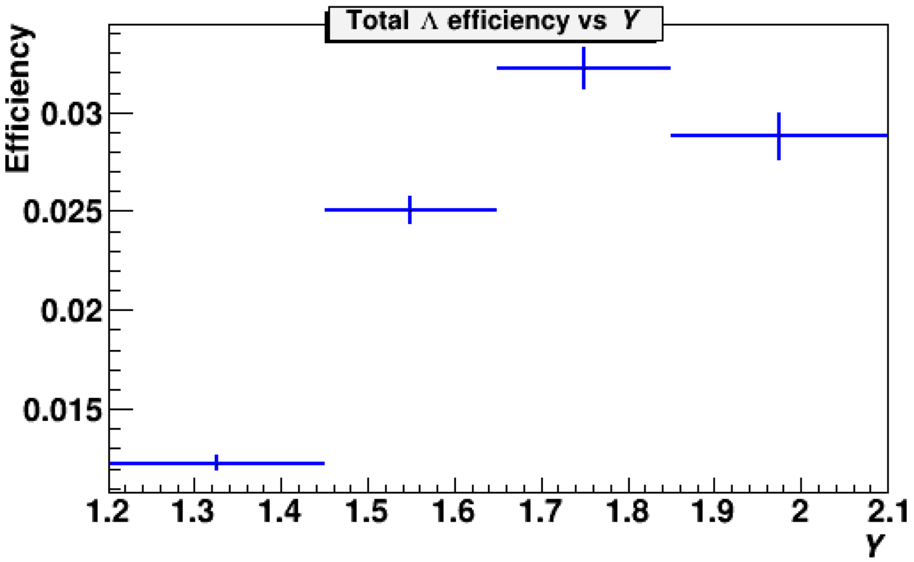


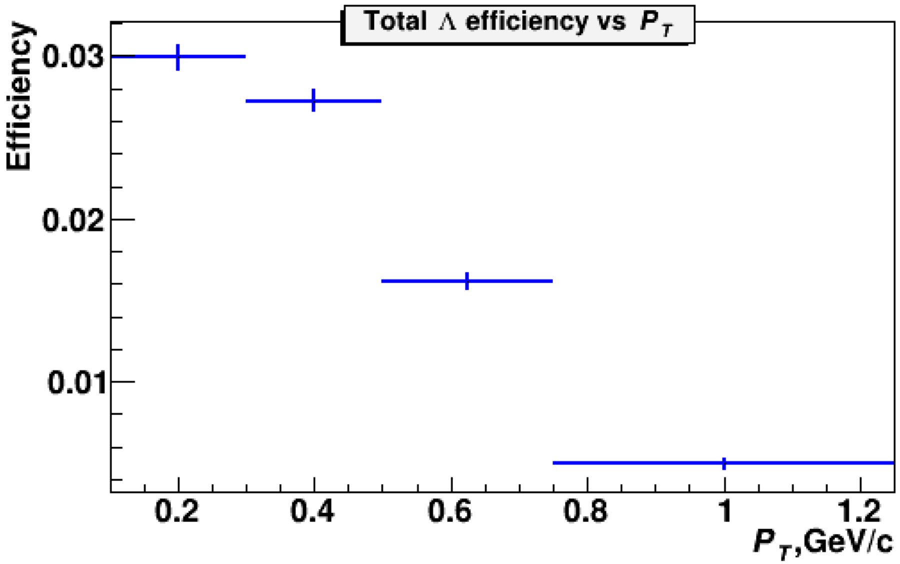




Total efficiency for C+Cu

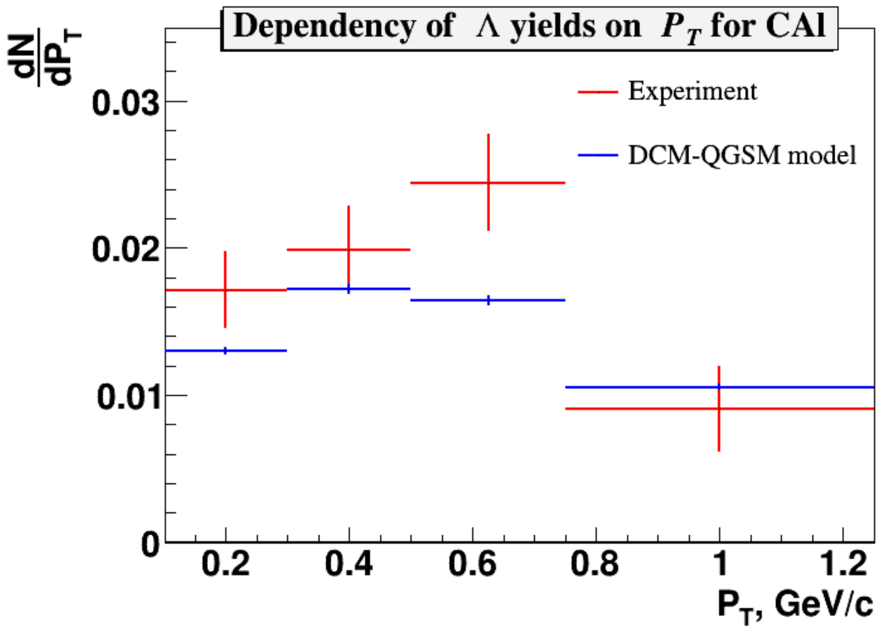
Summary efficiency of Λ

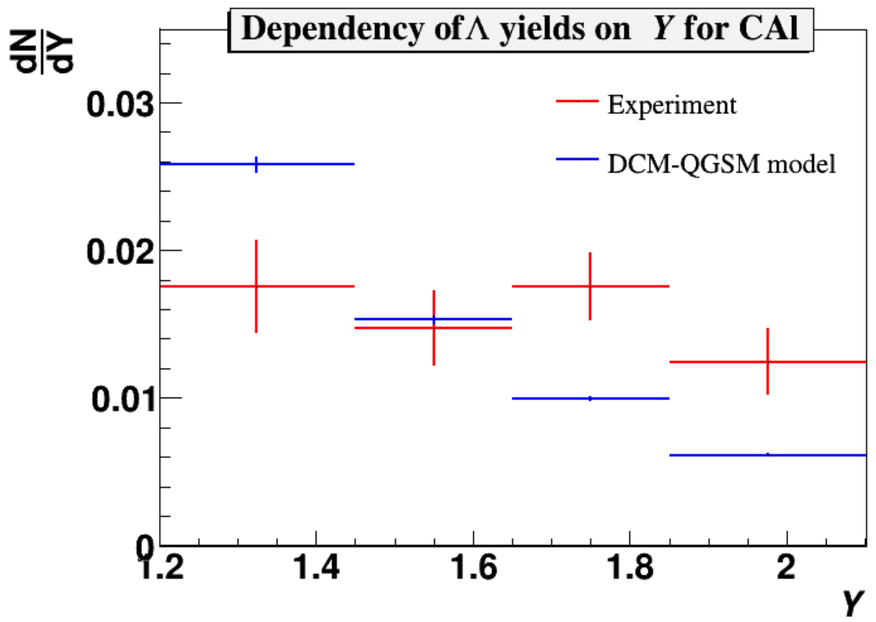




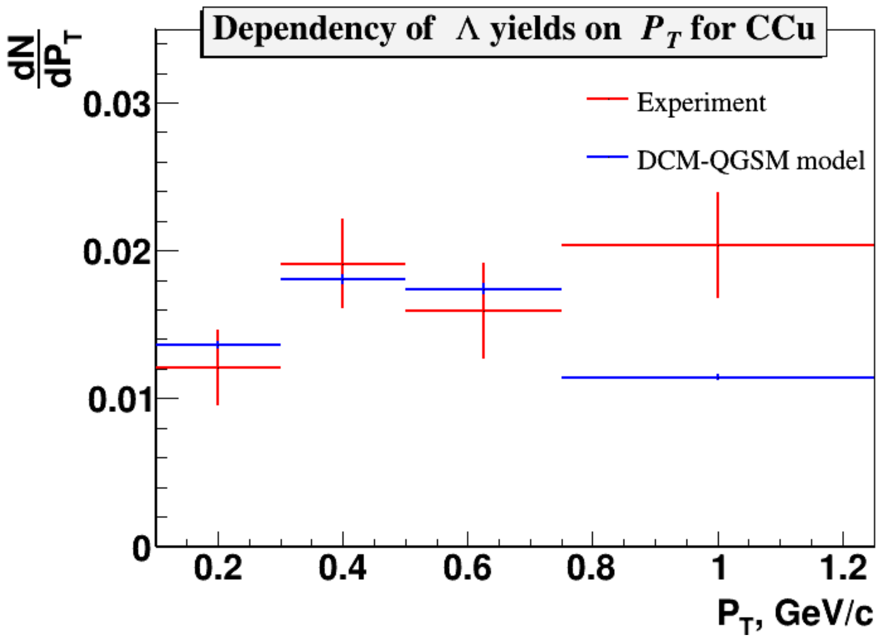
Without ε_4^{trig} efficiency

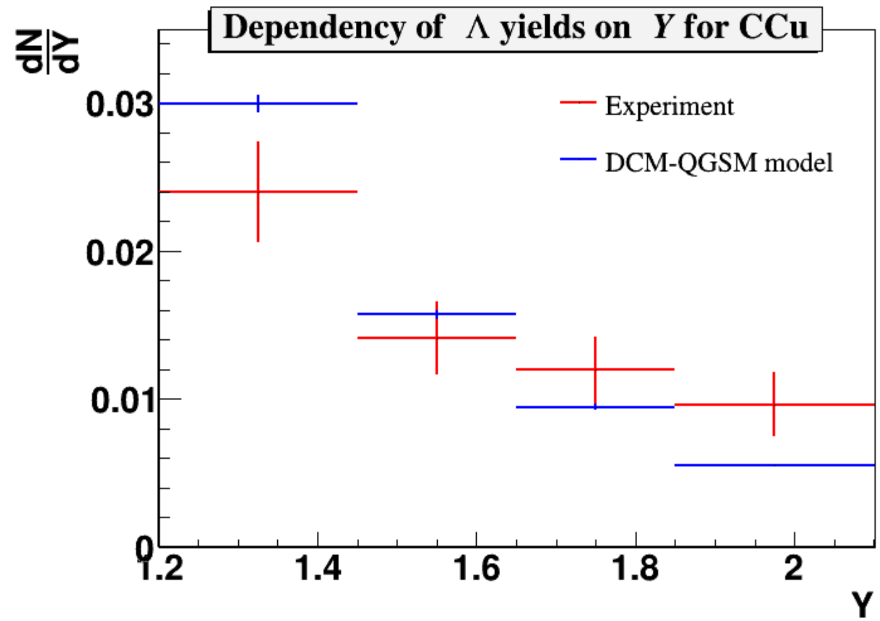
Λ yields in C+Al @ 4A GeV





Λ yields in C+Cu @ 4A GeV





Summary

- ✓ Reasonable agreement between data and MC has been achieved after taking into account features of set-up.
- ✓ Λ efficiencies have been extracted from data using embedding technique.
- ✓ Λ yields have been calculated for two targets and compared with DCM-QGSM simulated data.
- ✓ Carbon target data analysis is in progress.

Thank you for attention!

Backup

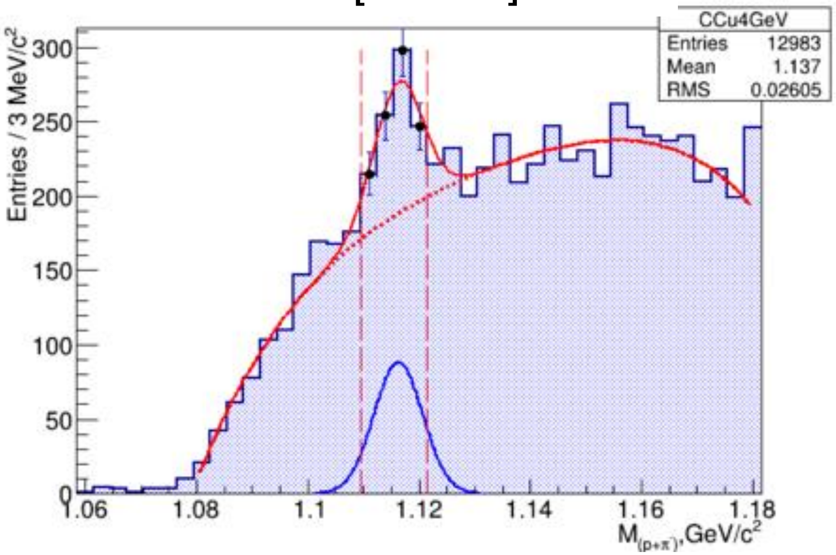
Experimental Data

Signals with errors according to P_T and Y intervals.

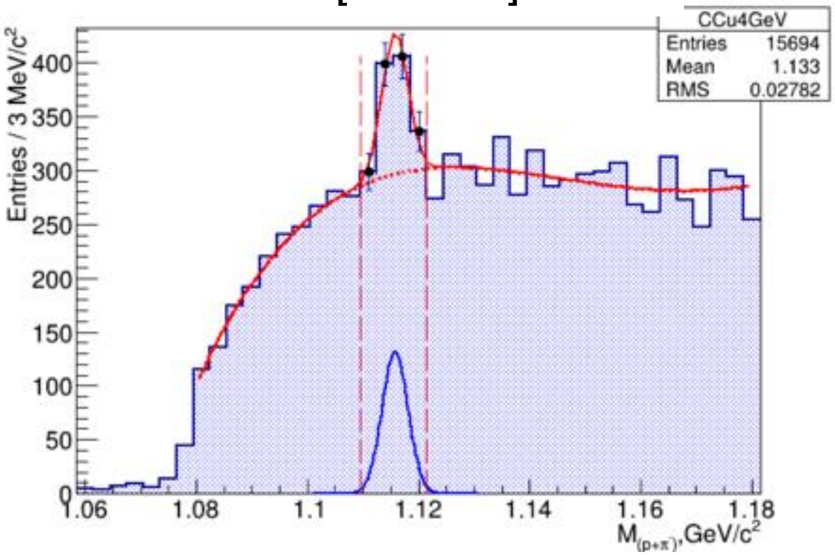
	Y			*P*$_T$			
Target Interval	*C*	*Al*	*Cu*	Target Interval	*C*	*Al*	*Cu*
1.2-1.45	65±20	176±31	269±37	0.1-0.3	193±34	341±51	264±54
1.45-1.65	133±25	236±40	258±45	0.3-0.5	232±35	372±54	380±59
1.65-1.85	163±31	389±49	281±53	0.5-0.75	150±28	351±45	235±47
1.85-2.1	169 ±36	308±54	253±56	0.75-1.2	no	81±25	184±28
Total Total_{fit}	**530±57** **530±58**	**1109±89** **1099±89**	**1061±97** **1025±97**	Total Total_{fit}	**575±56** **530±58**	**1145±90** **1129±90**	**1063±97** **1025±98**

The error approximation formula $\Delta = \sqrt{(S+B)_{hist} + \frac{B_{fit}}{2}}$

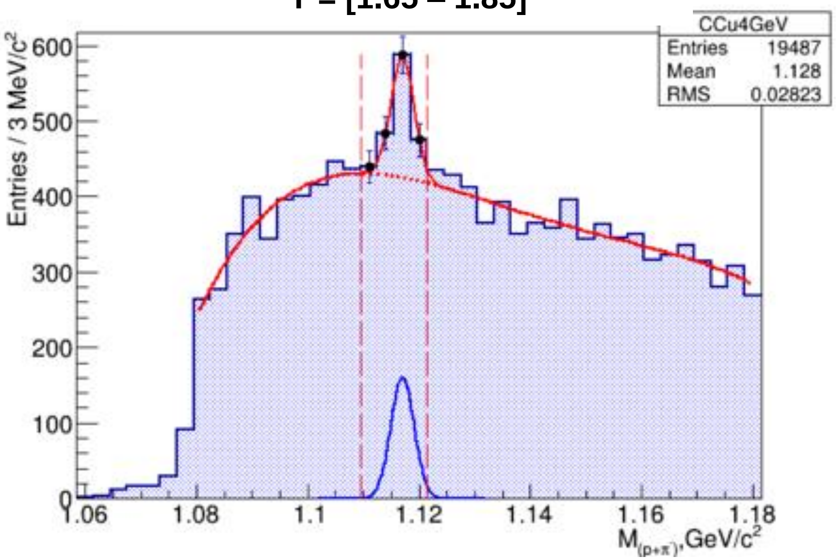
Y = [1.2 – 1.45]



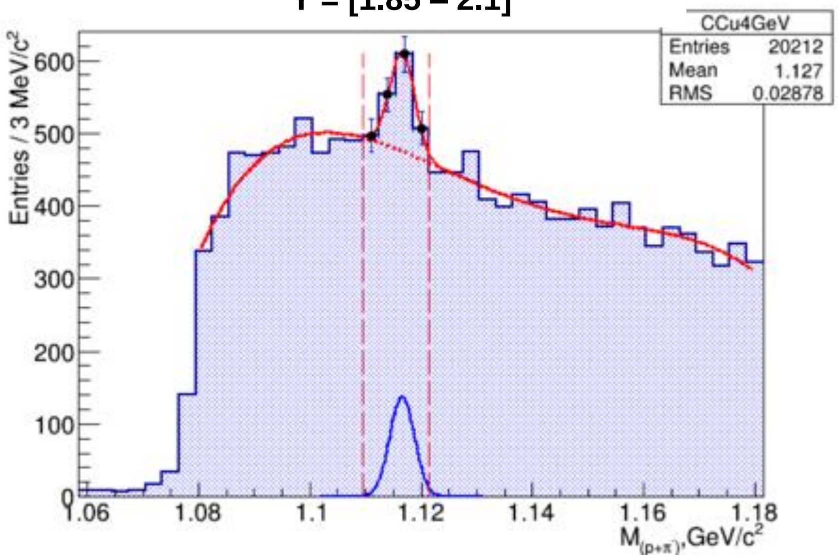
Y = [1.45 – 1.65]



Y = [1.65 – 1.85]

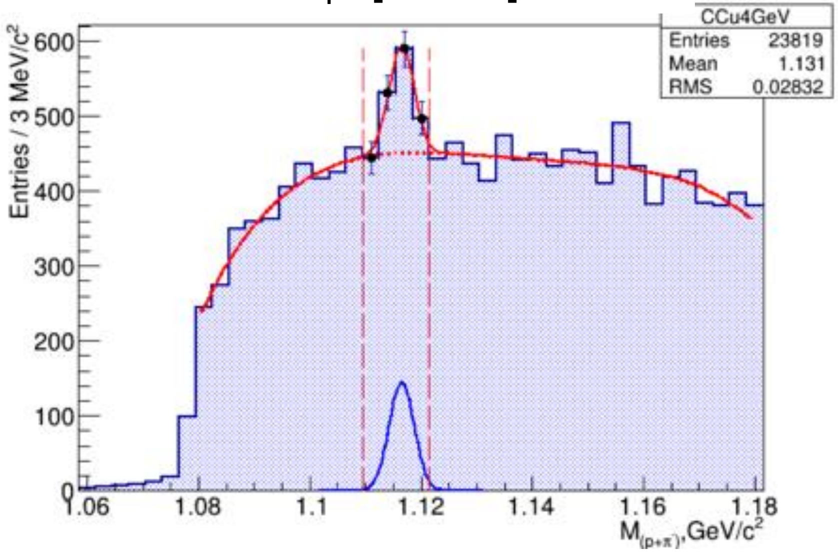


Y = [1.85 – 2.1]

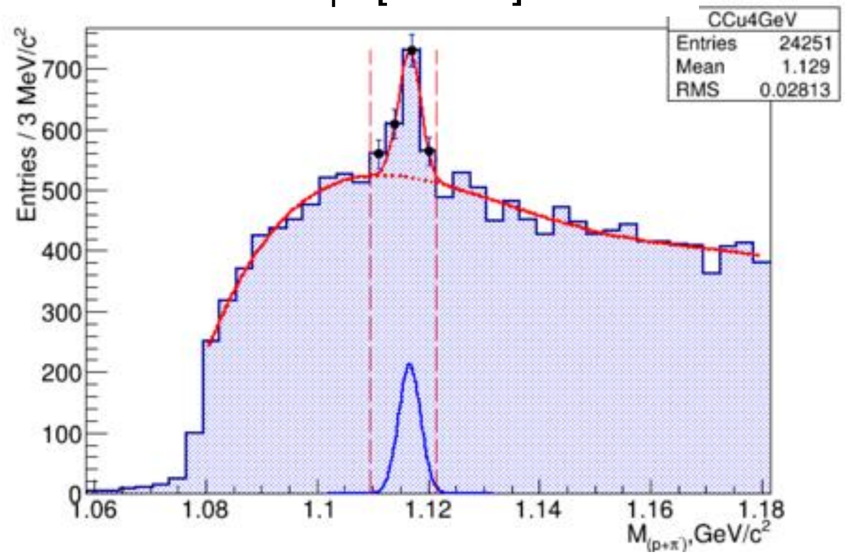


Invariant mass in P_T-bins (C+Cu @ 4A GeV)

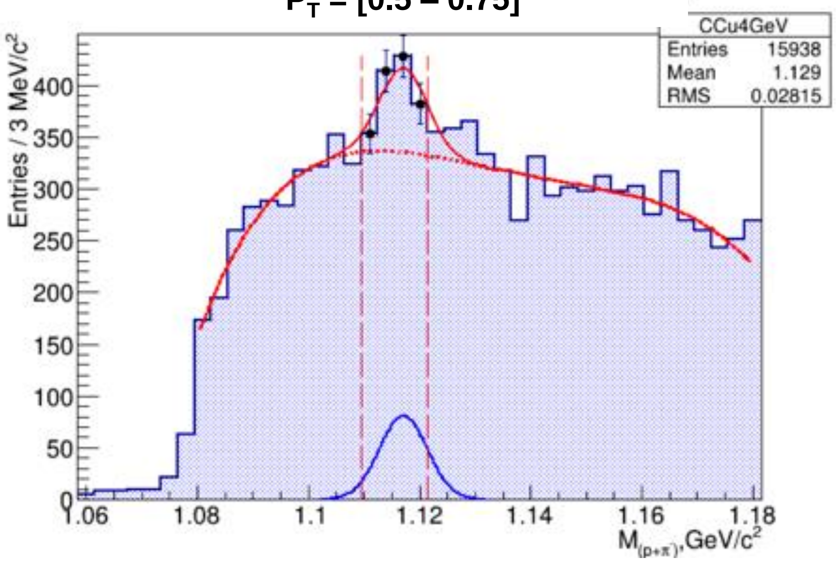
P_T = [0.1 – 0.3]



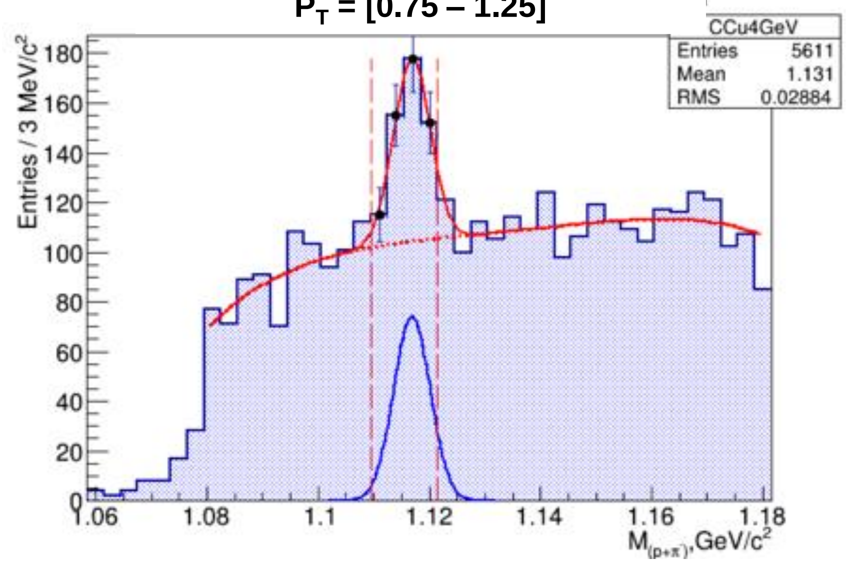
P_T = [0.3 – 0.5]



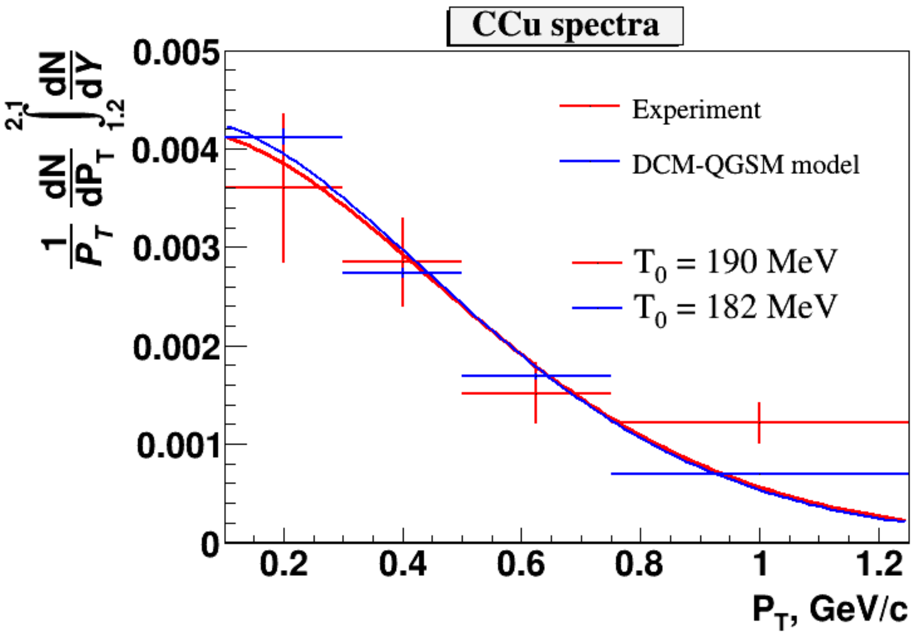
P_T = [0.5 – 0.75]

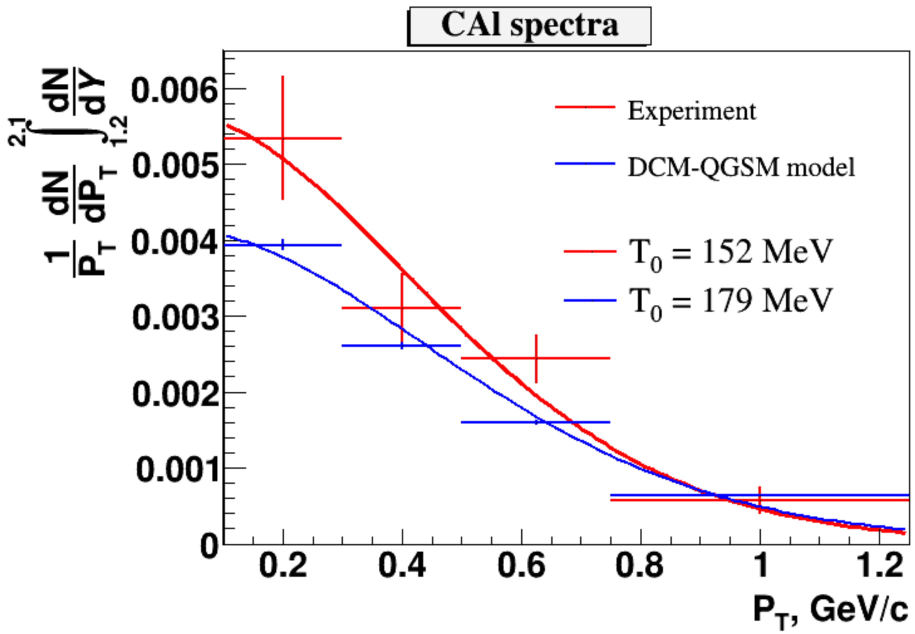


P_T = [0.75 – 1.25]



dN/dP$_T$ spectra





Without center-bin correction!
Without systematic errors (only statistical)!

Phase space of Λ