“Study of Λ - hyperon production in carbon collisions with solid targets (Run6)”

Speaker: Ksenia Alishina

Scientific adviser: Yu. Stepanenko

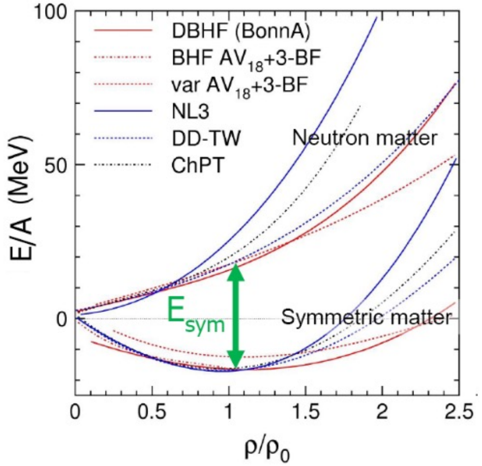
Scientific supervisor: M. Zavertyaev

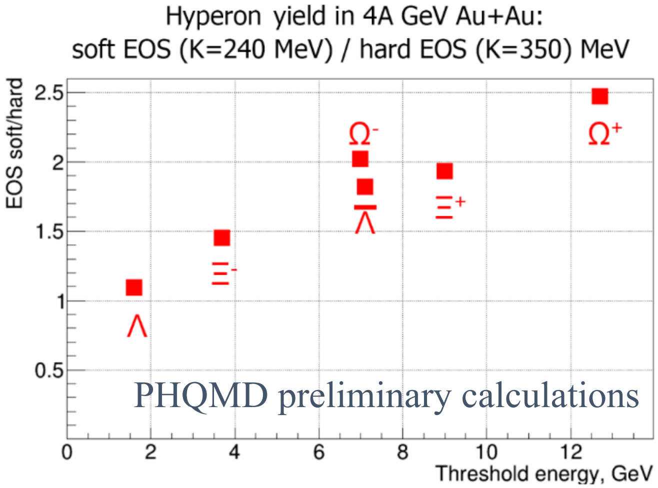
17.06.2024

Dubna, JINR

Physical motivation BM@N experiment

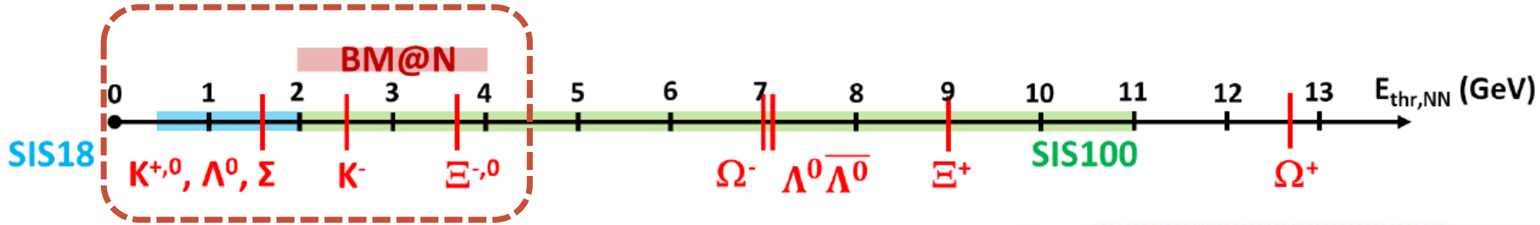
Ch.Fuchs, EPJA 30 (2006) 5

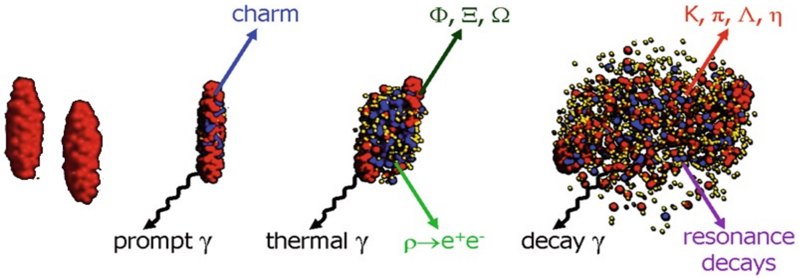




EoS study for symmetric matter at $\rho/\rho_0 = 3 - 5$, $\rho_0 = 0.16 fm^{-1}$:

- Elliptical flow of protons, mesons and hyperons;
- Sub-threshold production of strange mesons and hyperons extract nuclear;
- Incompressibility (K_{mn}) from the modeled data;



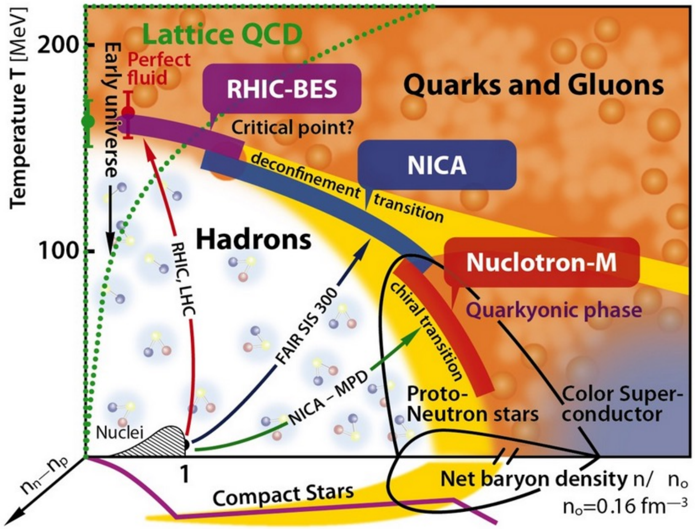


EoS: The relation between density, pressure, temperature, energy and isospin asymmetry.

$$E_A(\rho,\delta) = E_A(\rho,0) + E_A(\rho)\,\delta^2$$

$$\delta = (\rho_n - \rho_\rho)/\rho$$

Incompressibility of the nucleus: $K_{mn} = 9\rho^2 \frac{\partial^2}{\partial \rho^2}(E/A)|_{\rho=\rho_0}$



Analysis steps

1 Experiment accumulated data but statistic is not very rich. (N~6*10^5)

2 In differential distribution the signals are weeks and the fit is not stable. The results of the fit fluctuates.

3 To by pass this problem we decided to weight each event with high pression acceptance.

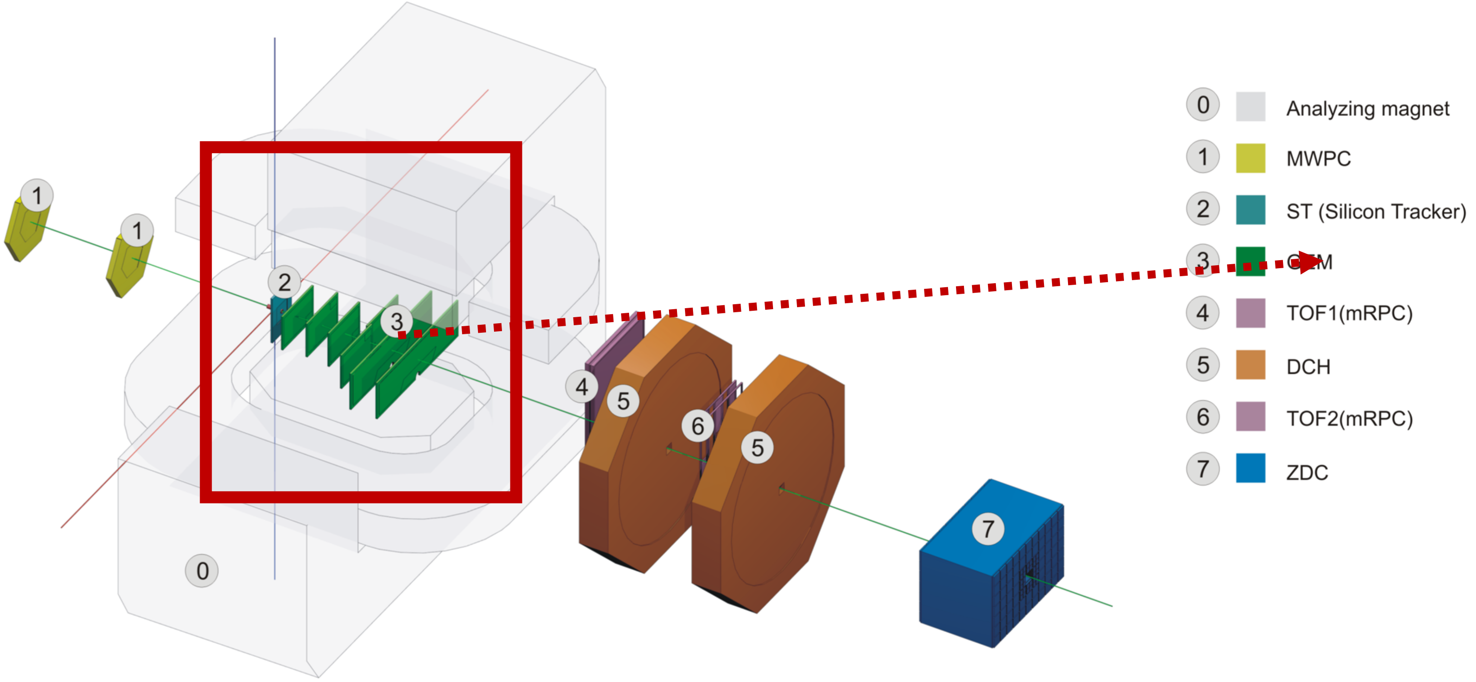
4 The high statistic MC data set was generated:10*N.
MC were tuned to data. After the MC reconstruction the acceptance was evaluated in (y-pT) cells.

5 For physical analysis weighted data were projected in corresponding kinematic ranges

Setup scheme (run-6)

C + A → X , A : C, Al, Cu, Pb

Energy beam = 4.0 AGeV, 4.5 AGeV



Central tracker:

- **One plane of a forward Si detector**
- **6 GEM stations**

Triggers: BD, BC_1, BC_2, T_0, VETO;

Gas Electron Multiplier (GEM) system:

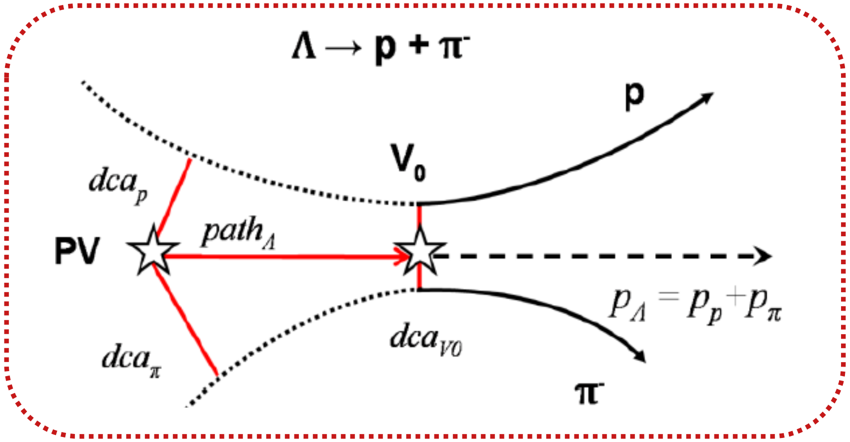
To measure momenta of a charged particle;

Event reconstruction in GEM in C+A interaction;

---

*K. A. Alishina, Yu. Yu. Stepanenko, A.Y Khukhaeva" Gem residuals corrections in monte-carlo simulation for the run 6 at the BM@N experiment", PEPAN letters – volume 19,part 5, 2022

Selection of events with Λ hyperon



Event topology:

PV – primary vertex

V0 – vertex of hyperon decay

dca – distance of the closest approach

path – decay length

Criteria for the selection of Λ - hyperons :

1 Each track has at least 4 of the 6 hits in (GEM);

2 $p_{pos} < 3.9(4.4)$ GeV/c for a beam energy of 4 (4.5) AGeV;

3 $p_{neg} > 0.3$ GeV/c;

4 dca < 1 cm;

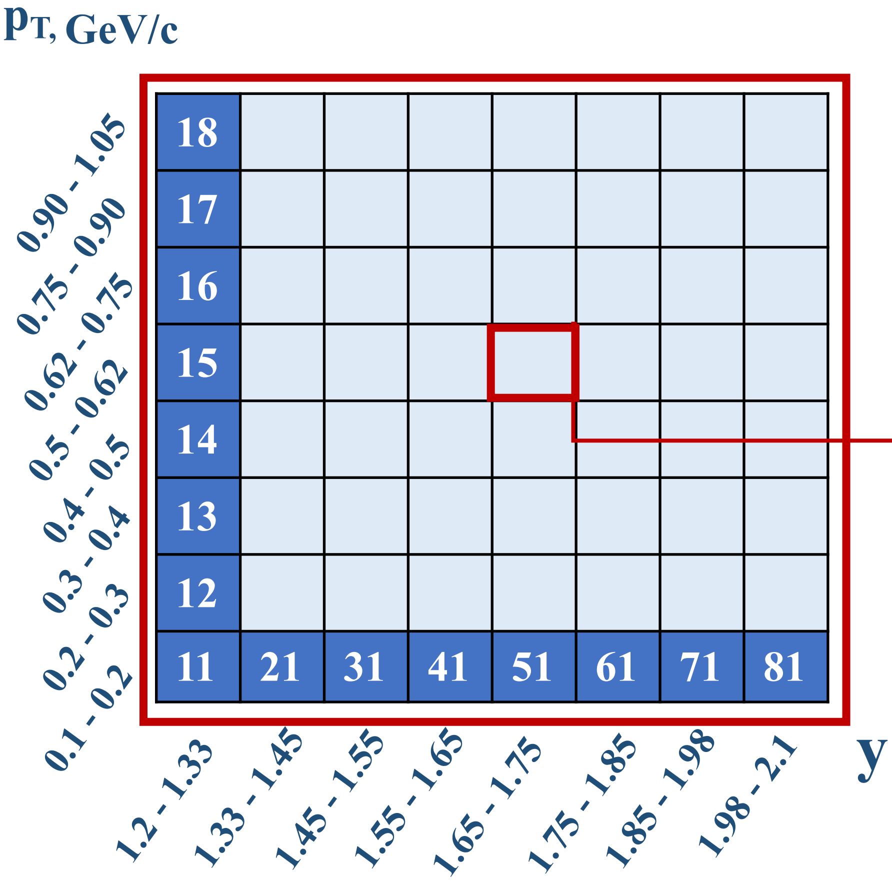
5 Distance between the decay vertex V_0 and the primary vertex: path > 2.0 – 2.5 cm (**target dependent**).

K. A. Alishina, Yu. Yu. Stepanenko, “Study of Λ–hyperon production in collisions of heavy ions with solid targets in the BM@N experiment” ,PEPAN letters – volume 21,part 4, 2024

Acceptance evaluation procedure (QGSM)

Kinematic measuring range (4, 4.5 AGeV):

$0.1 < p_T < 1.05$ GeV/c
$1.2 < y_{lab} < 2.1$



1 Divide the kinematic measuring range by y, p_T into (8x8) cells in the MC simulation

2 To get the number of events generated by the MC

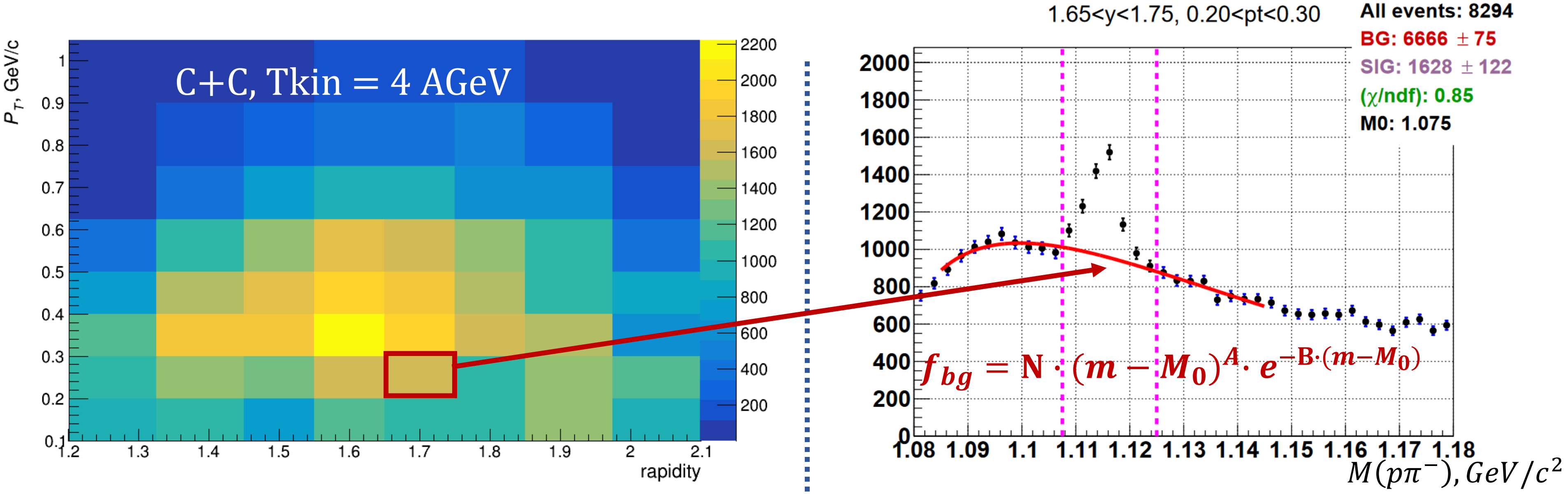
3 In each cells the invariant mass distribution fit with

$$f_{bg} = \mathrm{N} \cdot (m - M_0)^{A} \cdot e^{-\mathrm{B}\cdot(m-M_0)}$$

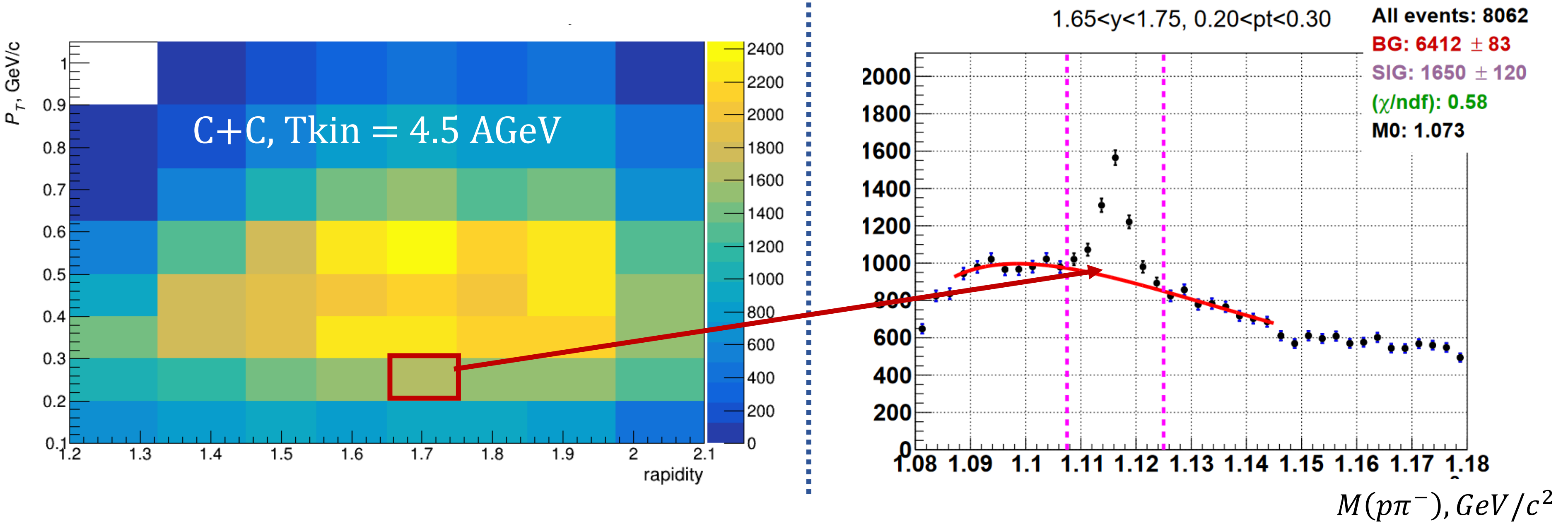
N, A, B are free parameters,
$\mathrm{M}_0 = 1.078$ ГэВ/c^2 is the threshold limit, m is the mass value.

4 Each event is weighted with $\omega_i = MC_{rec\_i}/MC_{gen\_i}$,
MC_{rec_i} is evaluated number of Λ,
MC_{gen_i} is the number of Λ generated;

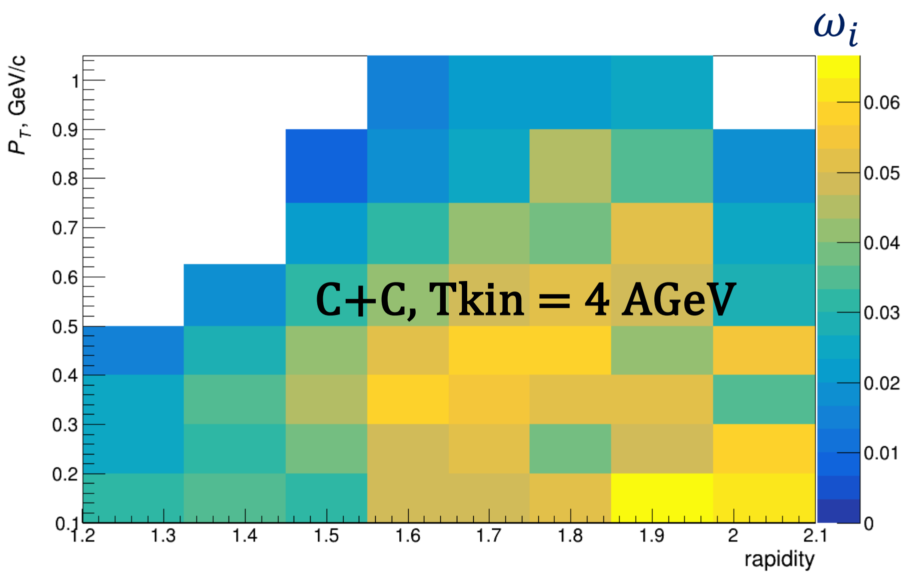
Distribution of the reconstructed signal in the MC

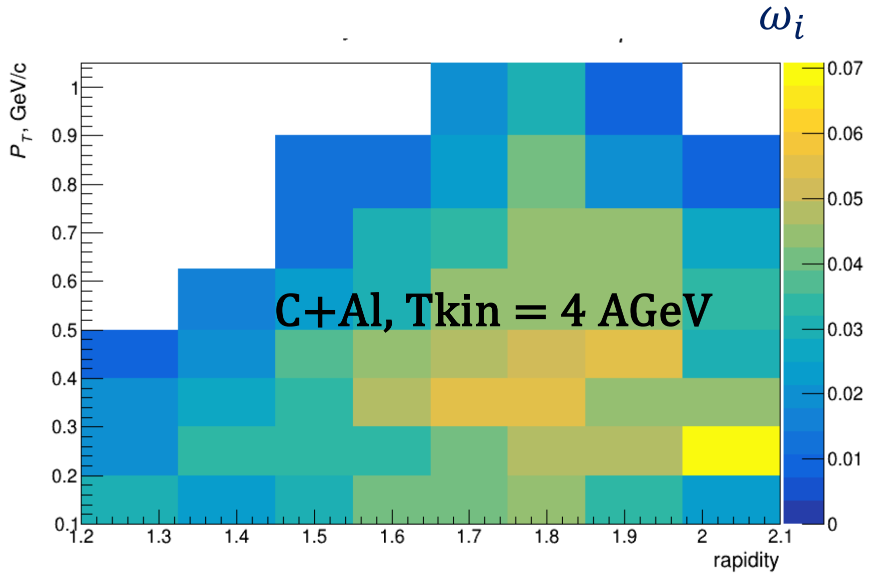


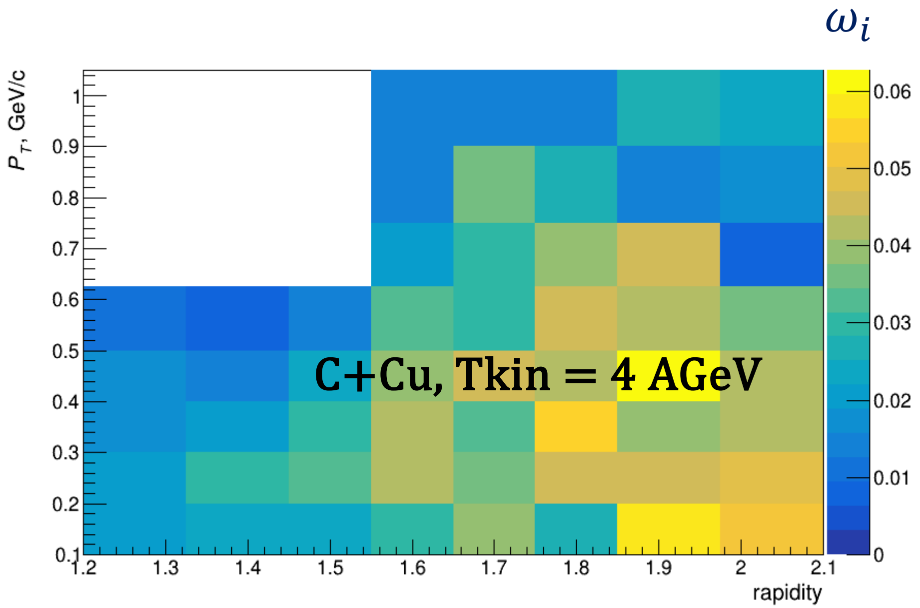
$$f_{bg} = \mathrm{N} \cdot (m - M_0)^A \cdot e^{-\mathrm{B} \cdot (m - M_0)}$$

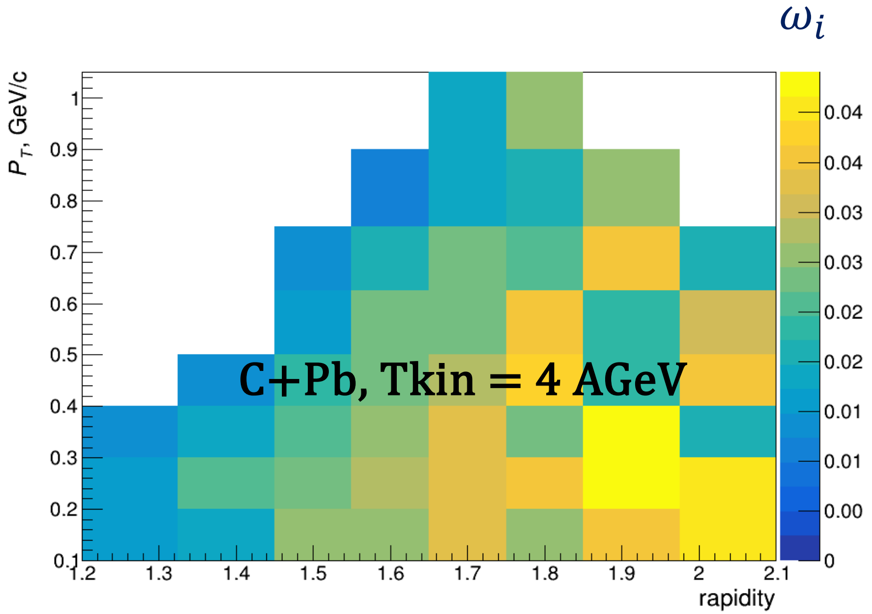


Spectrometer acceptance ω_i for Λ in $(y - P_T)$cells



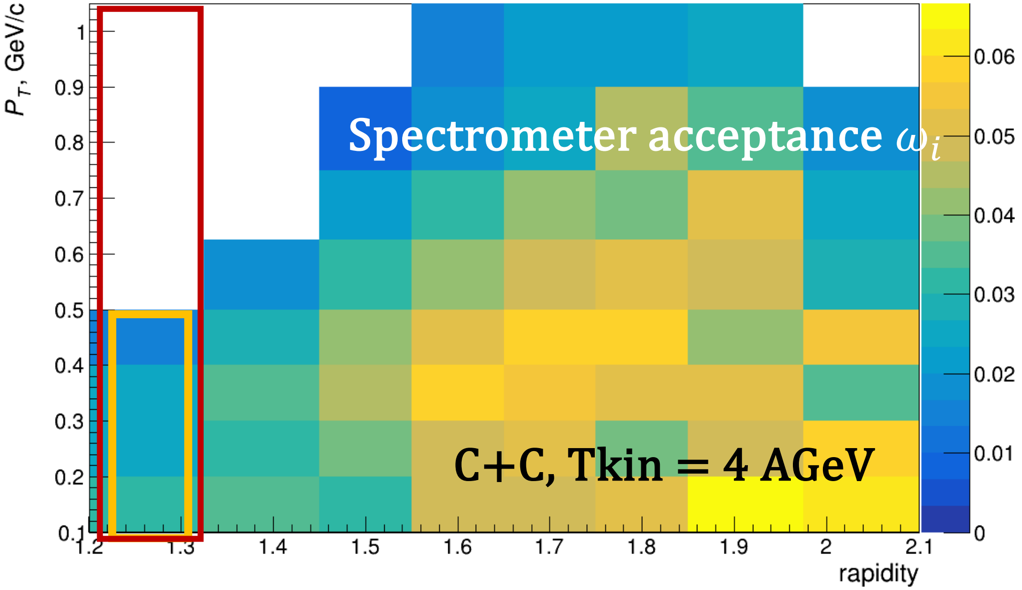




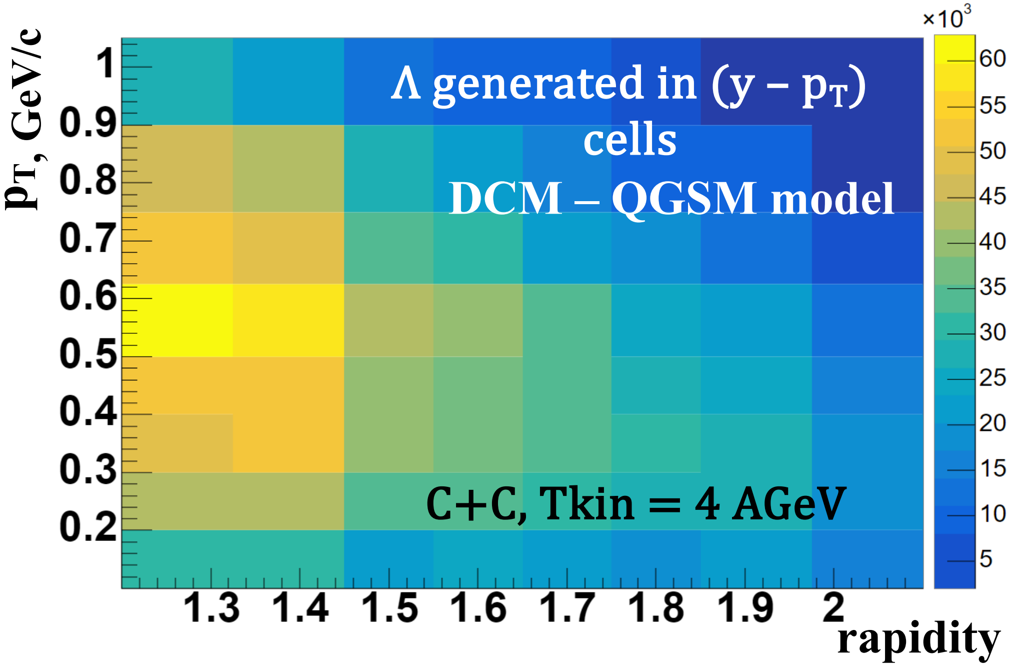


White area corresponds to acceptance below **0.01**

Extrapolation to low acceptance (y-pT) cells



$\omega_i = MC_{rec\_i}/MC_{gen\_i}$

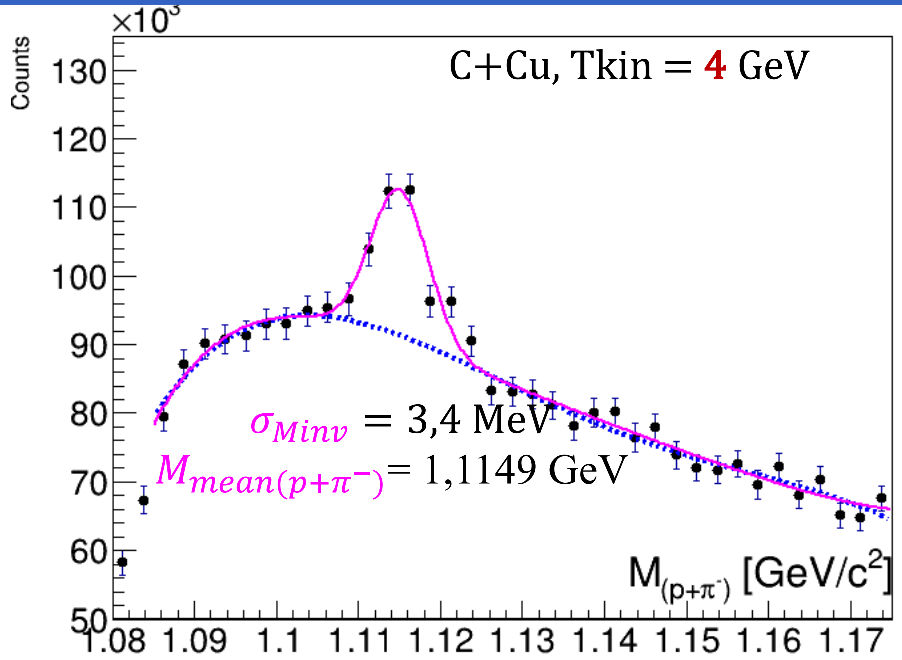


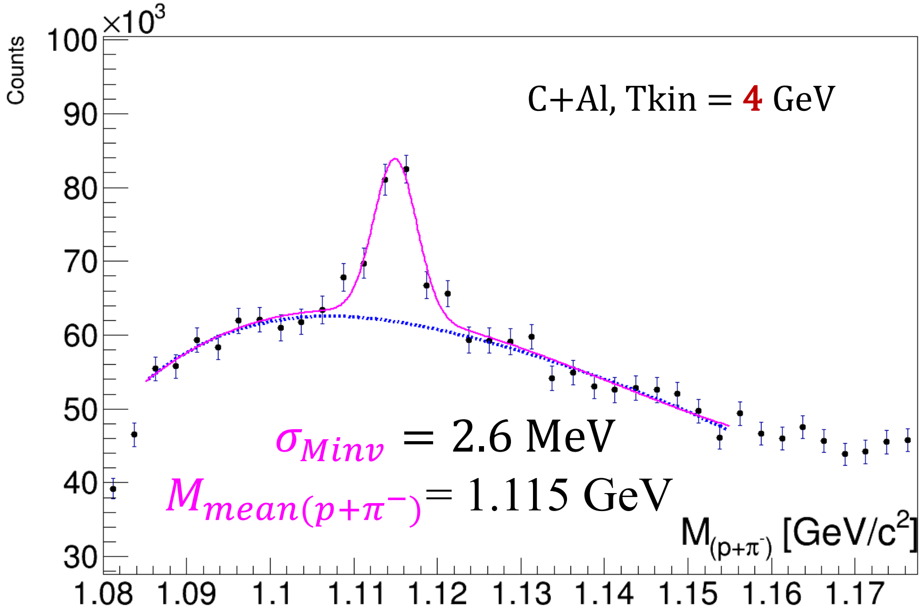
1) **Extrapolation based on the DCM – QGSM model.**

2) **Extrapolation factor is calculated $f_{extr} = {}^{N_{all}}/_{N_{con}}$, N_{all} – sum of all generated events; N_{con} – sum of generated events in cells with high acceptance;**

3) **f_{extr} - is used for evaluation of production cross section in full kinematic range;**

Mass distribution of the $\Lambda \to p\pi^-$(DATA)





Procedure in DATA C+A → X

1) Split (y, pT) area in small cells for MC/DATA (8x8);
2) To each event assigned the weight ω_i;
3) Sum the cells by $\sum_{ij} y_{ij}$ and by $\sum_{ij} pT_{ij}$

Interaction C+Cu	**signal $N_{rec}^{\Lambda}(p_T/y)$**
4.0 AGeV	76295±2895

Interaction C+Al	**signal $N_{rec}^{\Lambda}(p_T/y)$**
4.0 AGeV	63047±5005

$0.1 < p_T < 1.05$
or
$1.2 < y_{lab} < 2.1$

- ○ Λ signal width ~ 2.0 - 4 MeV;
- ○ **Signal** = hist – Background in **1107,5 - 1125** MeV/c²;
- ○ **Background** → $F(M_{p\pi^-})_{bg} = p_0 + p_1 M_{p\pi^-} + p_2 M_{p\pi^-}{}^2 + p_3 M_{p\pi^-}{}^3 + p_4 M_{p\pi^-}{}^4$ → 4th polynomial(**Blue dashed**);
- ○ $err(stat) = \sqrt{\sum w_i^2}$;

Cross sections $\sigma_\Lambda(y/p_T)$ of the $\Lambda \rightarrow p\pi^-$

The inclusive cross section $\boldsymbol{\sigma_\Lambda}$ and $\mathbf{Y_\Lambda}$ of Λ hyperon in C+A interactions are calculated in bins of (y - p_T) according to the formula:

$$\sigma_\Lambda(p_T) = [\overbrace{\sum_y N_{rec}^{\Lambda}(y,p_T)/\varepsilon_{rec}(y,p_T)}^{\text{weighted signal}}]/\boxed{[\varepsilon_{trig}\cdot\varepsilon_{pileup}\cdot L]}$$

$$\sigma_\Lambda(\mathrm{y}) = [\sum_{p_T} N_{rec}^{\Lambda}(y,p_T)/\varepsilon_{rec}(y,p_T)]/[\varepsilon_{trig}\cdot\varepsilon_{pileup}\cdot L]$$

L is the luminosity, $\boldsymbol{N_{rec}^{\Lambda}}$ is the number of recontacted Λ-hyperons,
$\boldsymbol{\varepsilon_{rec}}$ is the combined efficiency of the Λ - hyperon reconstruction,
$\boldsymbol{\varepsilon_{trig}}$ is the trigger efficiency, $\boldsymbol{\varepsilon_{pileup}}$ is the suppression factors of reconstructed events.

Table 1. Trigger efficiency ε_{trig}

4 AGeV	C	Al	Cu	Pb
ε_{trig}(BD≥2)	0.80±0.02	-	-	-
ε_{trig}(BD≥3)	-	0.87±0.02	0.92±0.02	0.95±0.02

4.5 AGeV	C	Al	Cu	Pb
ε_{trig}(BD≥2)	0.80±0.02	-	-	-
ε_{trig}(BD≥3)	-	0.83±0.02	0.91±0.02	0.94±0.02

Table 2. ε_{pileup} suppression factors

Selection	4AGeV	4.5AGeV
T0==1	+	+
BC2==1	+	+
Veto ==0	+	+
C	0,67	0,53
Al	0,74	0,62
Cu	0,78	0,62
Pb	0,78	0,69

Yields of the Λ → pπ⁻

The **Y_Λ** of Λ hyperon in C+A interactions are calculated in bins of (y - p_T) cells according to the formula:

$$Y_\Lambda(y - p_T) = \sigma_\Lambda(y - p_T)/\boxed{\sigma_{inel}}$$

$\boldsymbol{\sigma_{inel}}$ is the cross section for minimum bias inelastic C+A interactions(model).

The cross sections for inelastic C+Al, C+Cu, C+Pb interactions calculated by the formula (DCM-QGSM): $\sigma_{inel} = \pi R_0^2 (A_P^{1/3} + A_T^{1/3})^2$

R_0 = 1.2 fm is an effective nucleon radius, A_P and A_T are atomic numbers of the beam and target nucleus [1]. The **uncertainties** for C+Al, C+Cu, C+Pb inelastic cross sections are estimated by formula: $\sigma_{inel} = \pi R_0^2 (A_P^{1/3} + A_T^{1/3} - b)^2$ with R_0 = 1.46 fm and b = 1.21 [2].

Table 4. Inelastic cross sections $\boldsymbol{\sigma_{inel}}$ for carbon-nucleus interactions

Interaction	**C+C**	**C+Al**	**C+Cu**	**C+Pb**
Inelastic cross section, mb	830±50	1260±50	1790±50	3075±50

---

[1] Kalliopi Kanaki “Study of A hyperon production in C+C collisions at 2 AGeV beam energy with the HADES spectrometer”.
[2] H.Angelov et al., P1-80-473, JINR, Dubna.

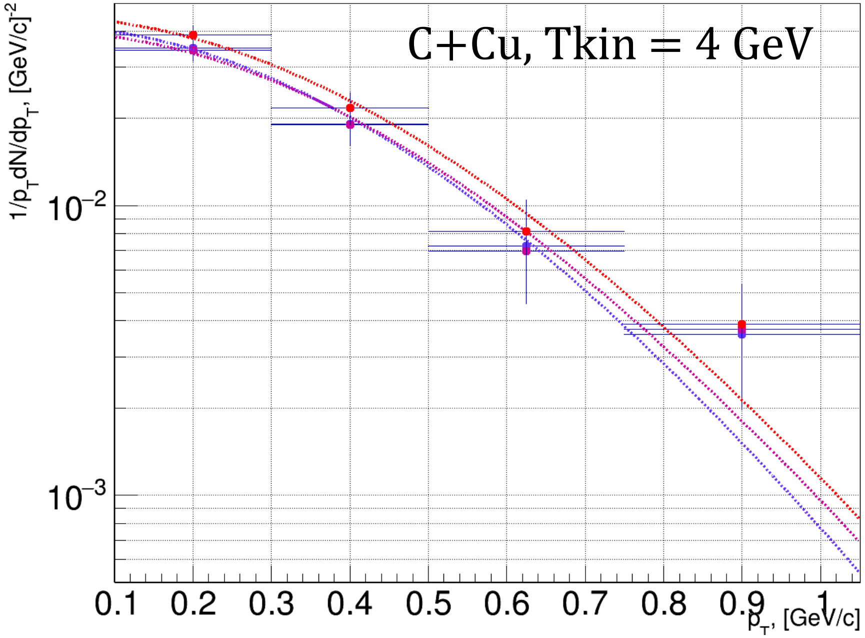
Integrated yields (Preliminary) of the $\Lambda \to p\pi^-$

Full data statistics

The data were collected by periods(I and II)

Target	Full (yields ± stat ± sys)	I period (yields ± stat ±sys)	II period (yields ± stat ±sys)
		Yields total, 4.0 AGeV	
C + C	**0,011±0,003±0,002**	0,011±0,004±0,0008	0,011±0,003±0,0009
C + Al	**0,026±0,007±0,002**	0,028±0,008±0,005	0,029±0,011±0,008
C + Cu	**0,030±0,006±0,003**	0,035±0,009±0,002	0,0273±0,009±0,007
C + Pb	**0,039±0,015±0,002**	0,039±0,015±0,002	-
		Yields total, 4.5 AGeV	
C + C	**0,013±0,004± 0,002**	0,012±0,006±0,001	0,012±0,005±0,001
C + Al	**0,023±0,006±0,007**	0,022±0,008±0,007	0,023±0,007±0,008
C + Cu	**0,037±0,007±0,006**	0,035±0,011±0,005	0,035±0,009±0,003
C + Pb		**will done…**	

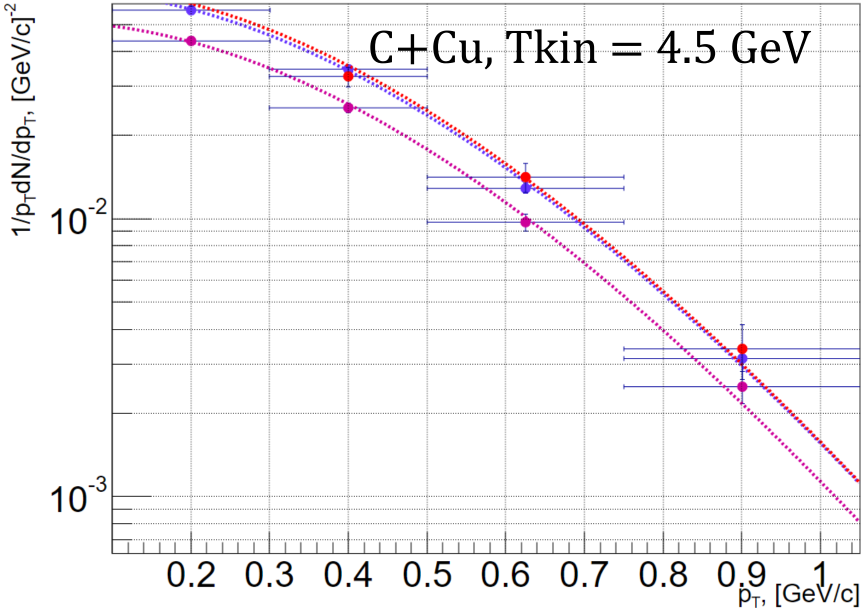
Determination of slopes from momentum spectra



$T_0 = 96{,}1 \pm 13{,}8$ MeV;

$T_1 = 102{,}9 \pm 19$ MeV;

$T_2 = 104{,}5 \pm 16{,}3$ MeV;



The measured spectra of the Λ yields in p_T are parameterized by the formula:

$$1/p_T\, d^2N/dp_T dy = N \cdot \exp(-(m_T - m_\Lambda)/T)$$

The transverse mass $m_T = \sqrt{m_\Lambda^2 + p_T^2}$,

The N normalization,

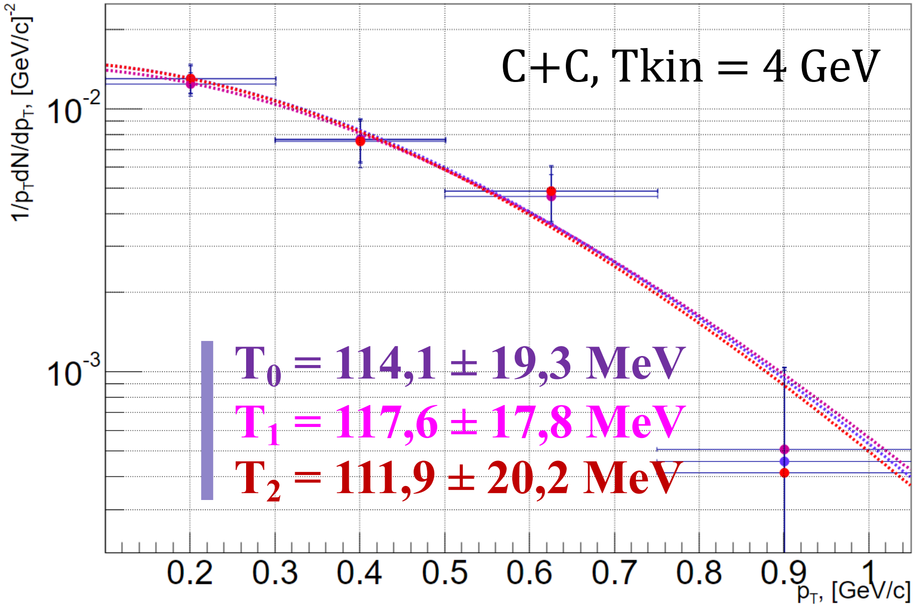
The inverse slope parameter T are free parameters of the fit;

$T_0 = 101{,}1 \pm 2{,}6$ MeV;

$T_1 = 100{,}1 \pm 3{,}8$ MeV;

$T_2 = 100{,}3 \pm 6{,}7$ MeV;

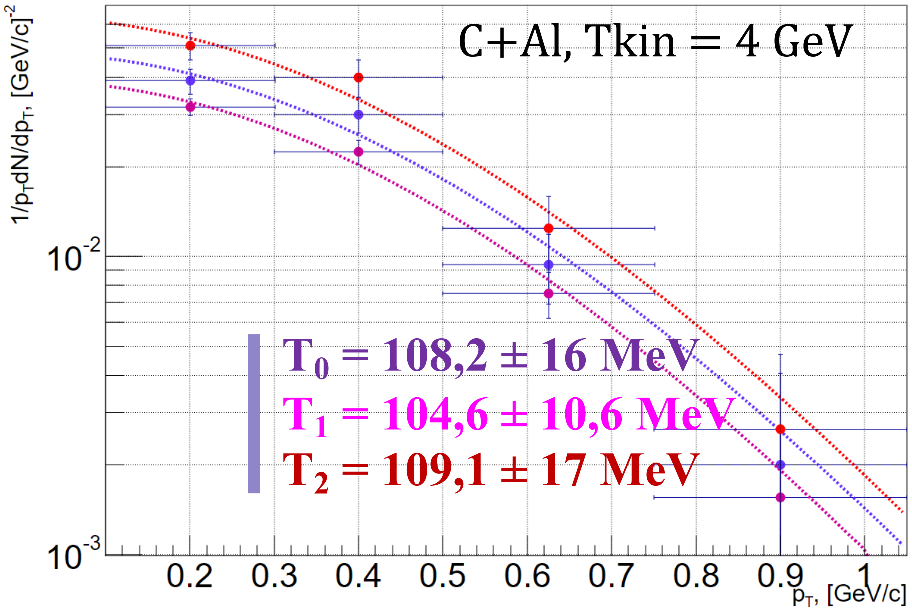
Determination of slopes from momentum spectra


C+C, Tkin = 4 GeV

T_0 = 114,1 ± 19,3 MeV

T_1 = 117,6 ± 17,8 MeV

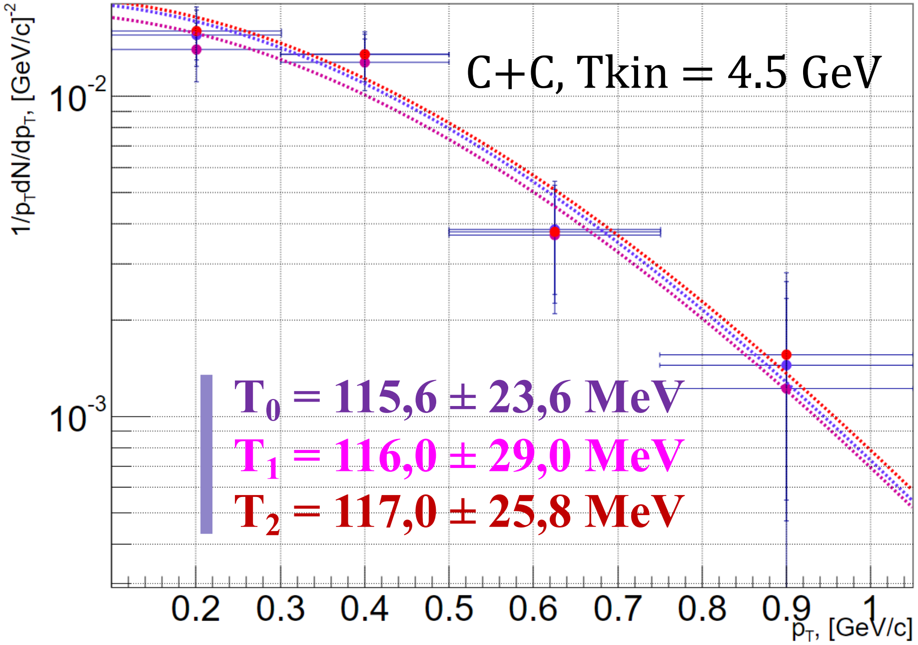
T_2 = 111,9 ± 20,2 MeV


C+Al, Tkin = 4 GeV

T_0 = 108,2 ± 16 MeV

T_1 = 104,6 ± 10,6 MeV

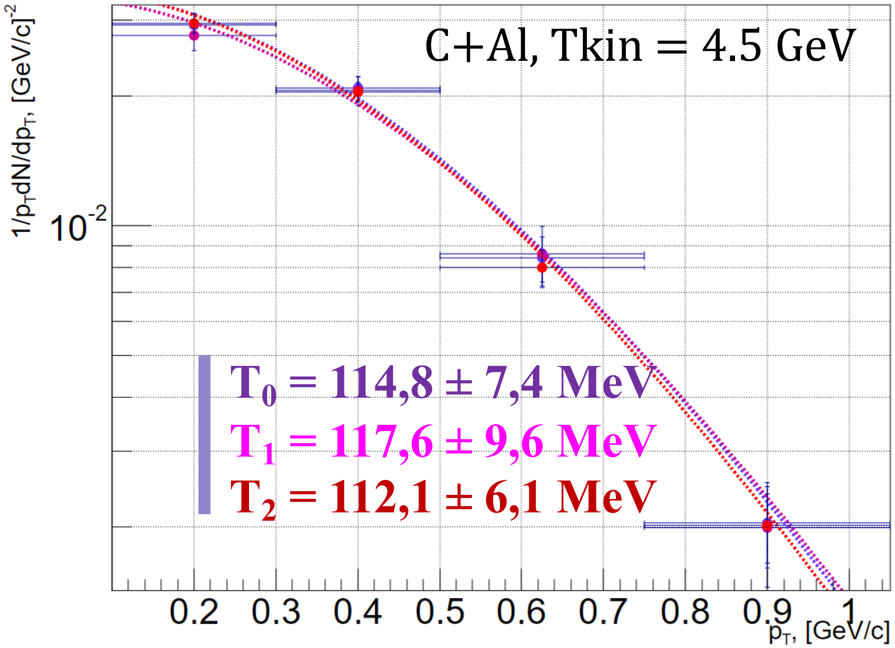
T_2 = 109,1 ± 17 MeV


C+C, Tkin = 4.5 GeV

T_0 = 115,6 ± 23,6 MeV

T_1 = 116,0 ± 29,0 MeV

T_2 = 117,0 ± 25,8 MeV


C+Al, Tkin = 4.5 GeV

T_0 = 114,8 ± 7,4 MeV

T_1 = 117,6 ± 9,6 MeV

T_2 = 112,1 ± 6,1 MeV

SLOPE RESULTS (Preliminary)

4.0 AGeV	T_0, MeV, C+C	T_0, MeV, C+Al	T_0 MeV, C+Cu	T_0 MeV, C+Pb
Exp data	114.1±19.3±2.85	108.2±16±2.25	96.1±13.8±0.8	Due to low statistics
DCM - QGSM	125,9	120,2	133,2	130,2
UrQMD	107,3	128,0	132,8	135,5
PHSD	86,6	100,0	105,4	98,2

4.5 AGeV	T_0, MeV, C+C	T_0, MeV, C+Al	T_0, MeV, C+Cu	T_0, MeV, C+Pb
Exp data	115.6±23.6±0.5	114.8±7.4±2.8	101.1±2.6±0.1	Due to low statistics
DCM - QGSM	132	133	135	142
UrQMD	122	128	130	134
PHSD	101	106	109	108

Summary and plans

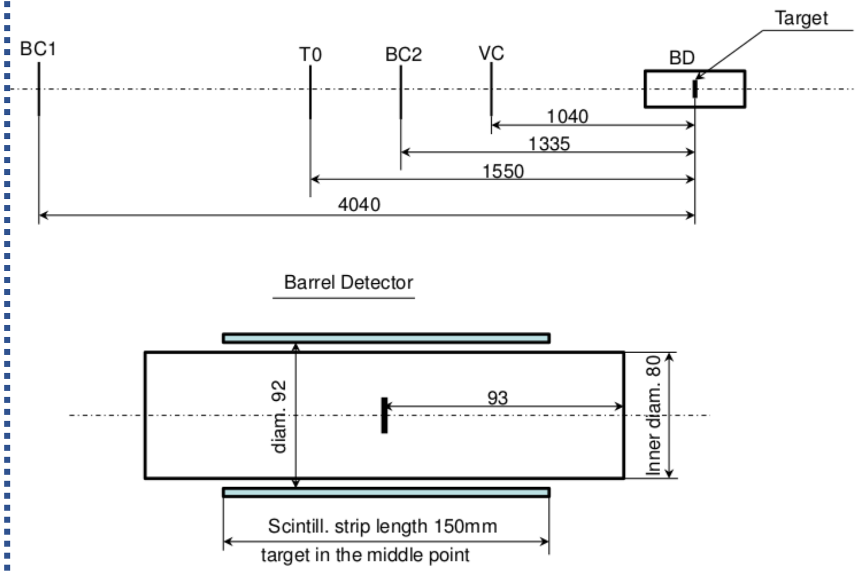
1 **PRELIMINARY RESULTS OF YIELDS AND CROSS SECTIONS**

2 **PRELIMINARY THE SLOPES FROM THE p_T SPECTRA**

3 **PREPARE PAPER DRAFT**

Back up

Event selection criteria

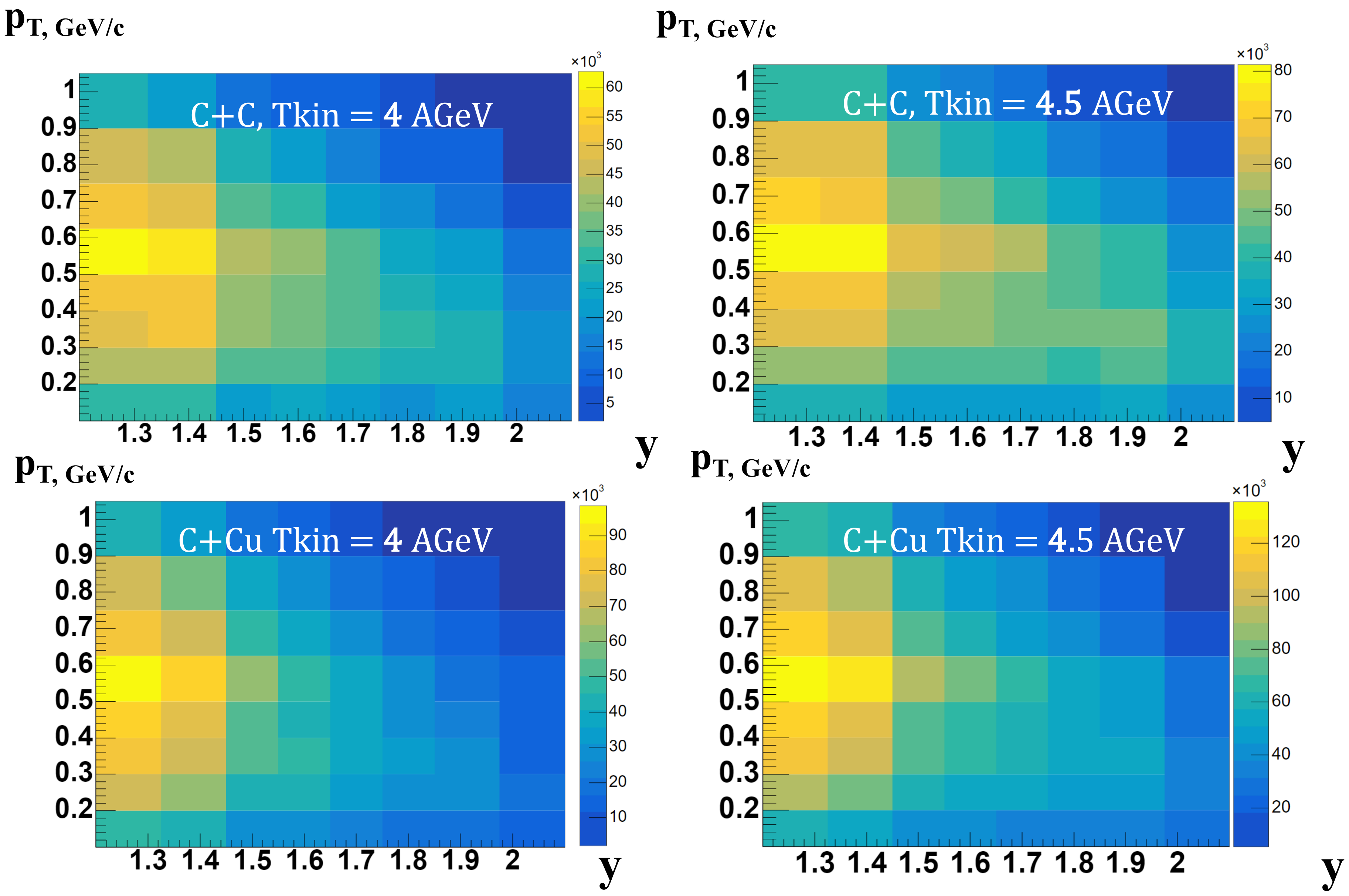


Schematic view and positions of the beam counters, barrel detector and target

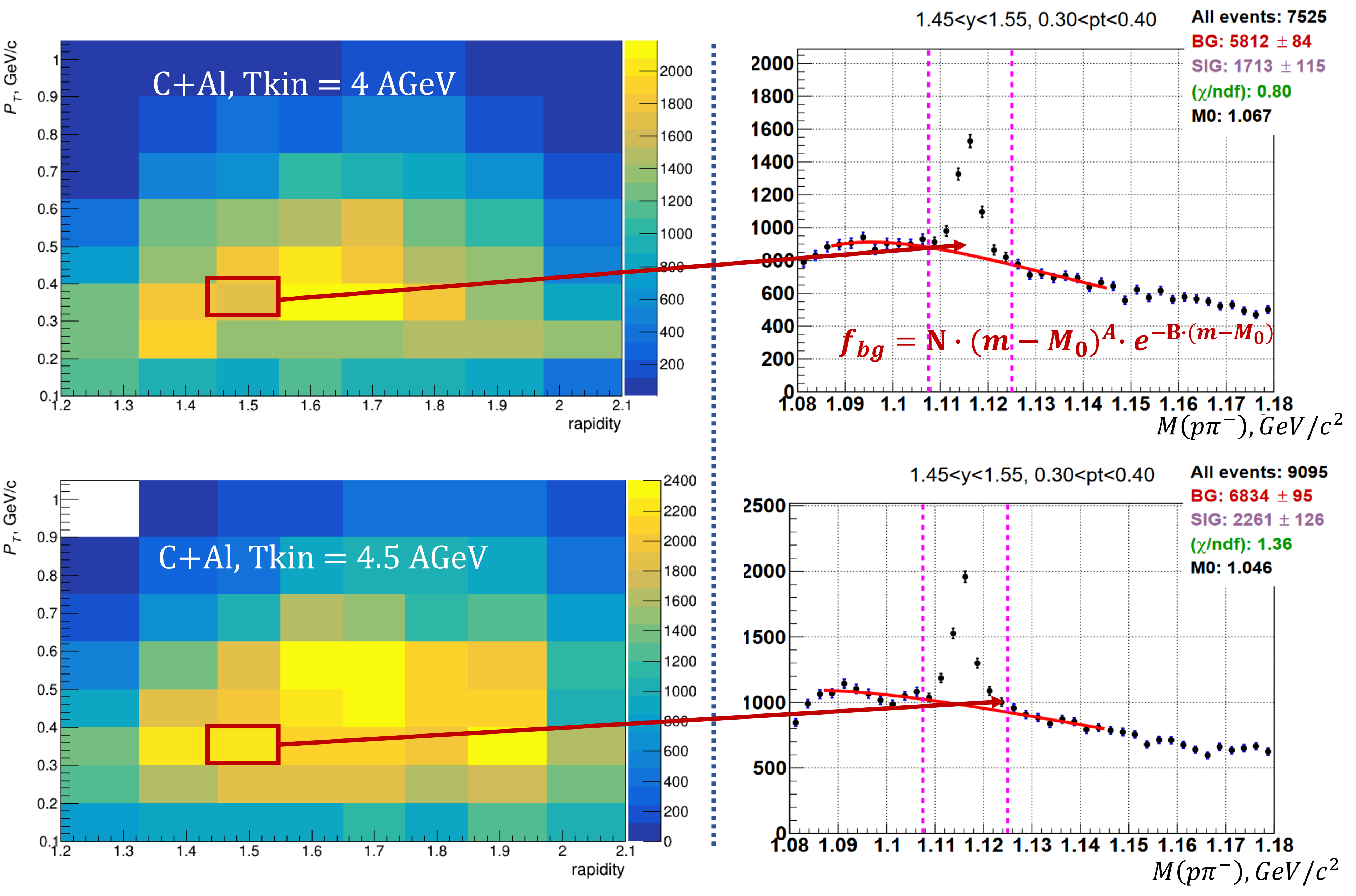
1. Number of tracks in selected events: positive>=1, negative>=1;
2. Number of signals in the start detector: T0=1,
3. Number of signals in the beam counter: BC2=1,
4. Number of signals in the veto counter around the beam: Veto=0;
5. Trigger condition in the barrel detector: number of signals BD>=2 or BD>=3 (run dependent);

The suppression factors of reconstructed events ε_{pileup} due to selection **criteria 2** applied to eliminate beam halo and pile-up events in interactions of the 4.0 and 4.5 AGeV carbon beam with the C, Al, Cu, Pb targets.

Λ generated in ($y - p_T$) cells

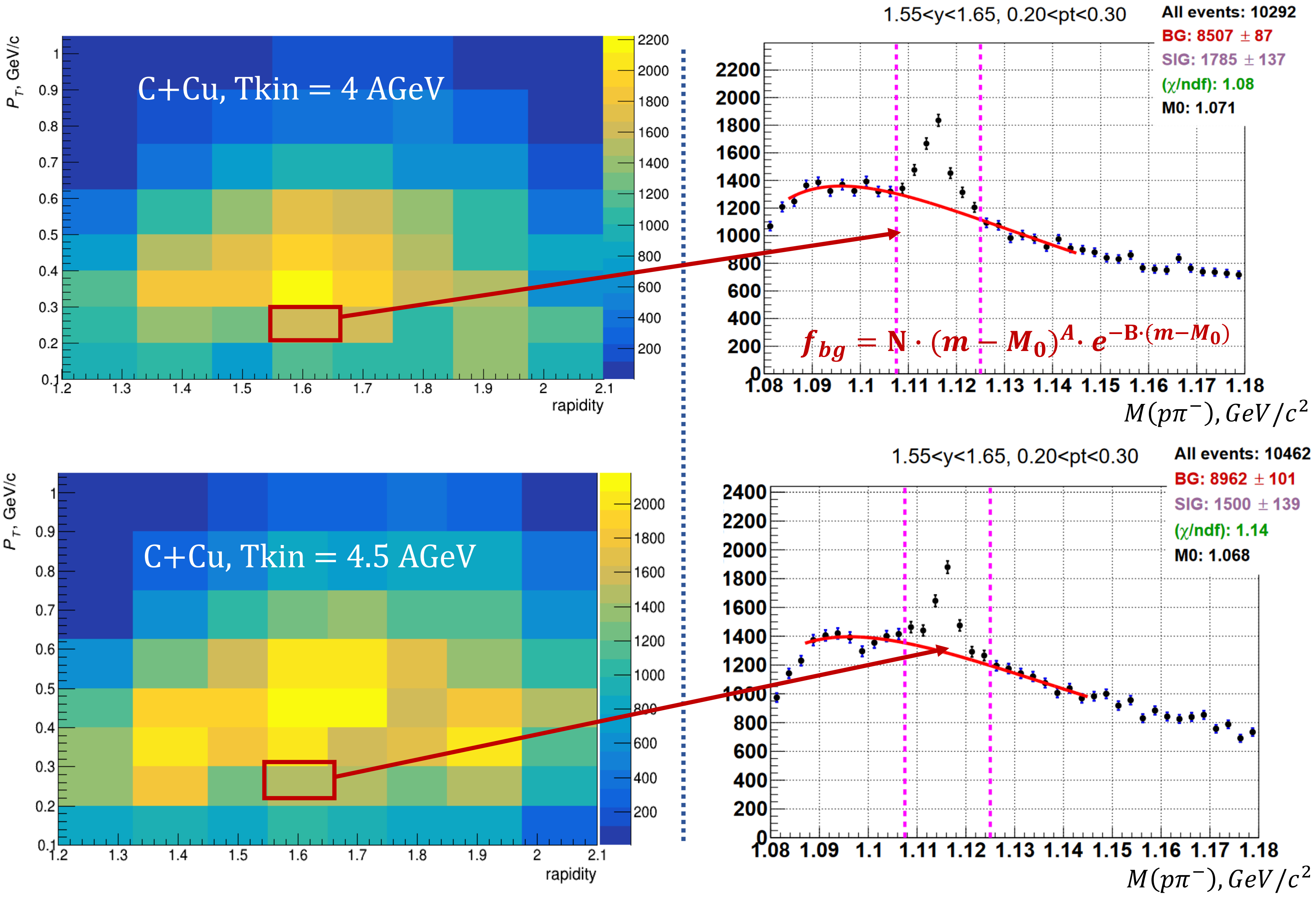


Distribution of the reconstructed signal in the MC



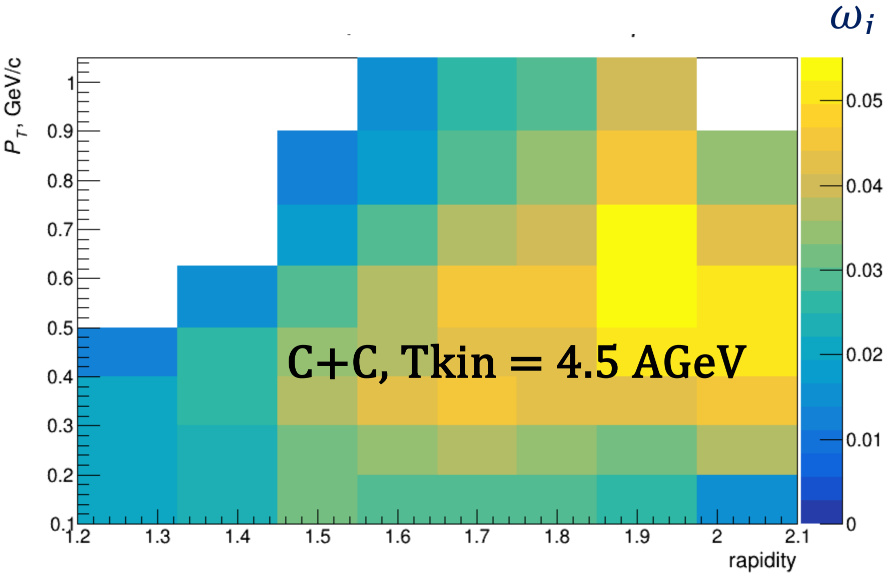
$$f_{bg} = \mathrm{N}\cdot(m - M_0)^{A}\cdot e^{-\mathrm{B}\cdot(m-M_0)}$$

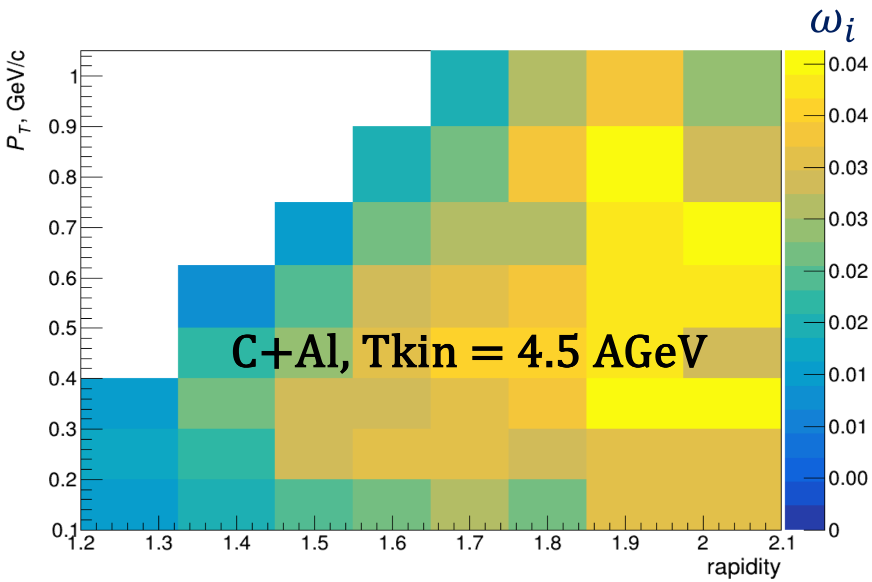
Distribution of the reconstructed signal in the MC

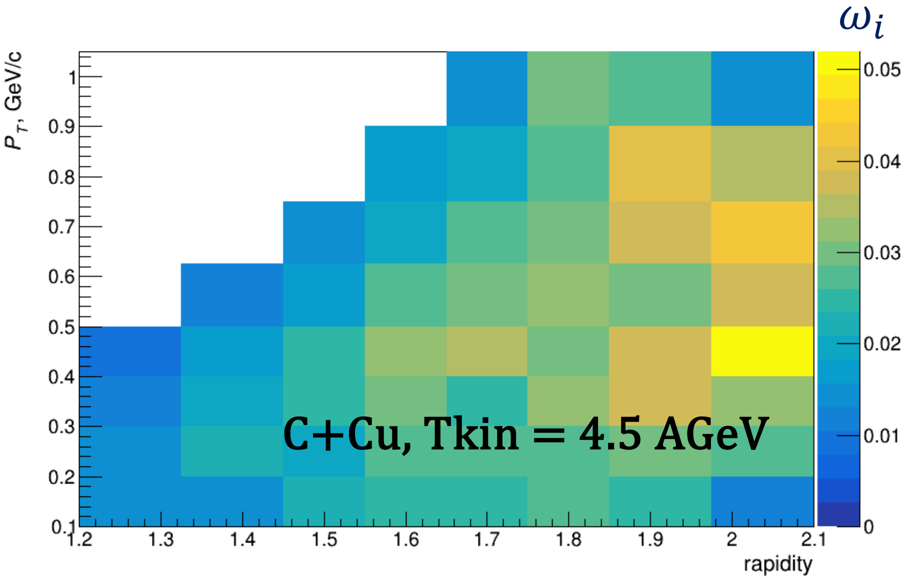


$$f_{bg} = \mathrm{N} \cdot (m - M_0)^{A} \cdot e^{-\mathrm{B}\cdot(m-M_0)}$$

Spectrometer acceptance ω_i for Λ in $(y - P_T)$cells







ω_i

C + Pb, Tkin = 4.5 AGeV
Very low statistic

White area corresponds to acceptance below **0.01**

Reconstruction efficiency Λ's for (y-pT)

	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+C(4.5AGeV)							
0.90 - 1.05	**0.00**	**0.08**	**0.52**	1.51	2.63	2.78	3.96	**0.95**
0.75 - 0.90	**0.03**	**0.33**	1.12	1.89	2.86	3.36	4.53	3.34
0.62 - 0.75	**0,13**	**0.85**	1.89	2.95	3.84	4.13	5.25	4.33
0.50 - 0.62	**0.63**	1.65	2.83	3.73	4.44	4.48	5.51	5.06
0.40 - 0.50	1.36	2.66	3.50	3.82	4.24	4.39	5.21	5.06
0.30 - 0.40	2.18	2.69	3.62	4.26	4.45	4.40	4.38	4.43
0.20 - 0.30	2.00	2.24	3.20	3.51	3.73	3.53	3.28	3.65
0.1 - 0.20	2.00	2.34	3.17	2.81	2.95	3.00	2.56	1.53
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+C(4.0AGeV)							
0.90 - 1.05	**0,02**	**0,07**	**0,40**	1,50	2,25	2,31	2,48	**0,83**
0.75 - 0.90	**0,01**	**0,31**	**0,93**	1,85	2,64	4,49	3,35	1,89
0.62 - 0.75	**0,20**	**0,82**	2,16	3,04	4,14	3,69	5,05	2,51
0.50 - 0.62	**0,58**	1,72	3,13	4,24	4,78	5,18	4,87	2,91
0.40 - 0.50	1,41	2,90	4,20	5,20	5,80	5,82	4,21	5,46
0.30 - 0.40	2,36	3,55	4,42	5,82	5,53	5,30	5,16	3,34
0.20 - 0.30	2,55	3,29	3,75	4,82	5,16	3,78	4,81	5,72
0.10 - 0.20	3,08	3,62	3,29	4,65	4,88	5,20	6,67	6,18
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

Reconstruction efficiency Λ's for P_T(y)

	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+Al(4.5AGeV)							
0.90 - 1.05	**0,00**	**0,08**	**0,36**	0,79	2,06	3,08	3,84	2,94
0.75 - 0.90	**0,04**	**0,31**	**0,82**	1,86	2,67	3,86	4,41	3,35
0.62 - 0.75	**0,14**	**0,72**	1,47	2,73	3,06	3,07	4,24	4,63
0.50 - 0.62	**0,47**	1,28	2,36	3,35	3,68	3,80	4,19	4,25
0.40 - 0.50	**0,98**	2,11	3,00	3,48	4,04	4,12	4,17	3,31
0.30 - 0.40	1,53	2,59	3,38	3,33	3,65	3,81	4,63	4,44
0.20 - 0.30	1,76	2,29	3,32	3,56	3,57	3,45	3,59	3,66
0.1 - 0.20	1,49	1,93	2,52	2,54	3,16	2,64	3,50	3,52
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+Al(4.0AGeV)							
0.90 - 1.05	**0,02**	**0,02**	**0,50**	**0,77**	1,80	2,85	1,00	**0,57**
0.75 - 0.90	**0,04**	**0,25**	1,13	1,23	2,35	4,22	1,83	1,05
0.62 - 0.75	**0,12**	**0,72**	1,37	2,98	3,45	4,39	4,29	2,58
0.50 - 0.62	**0,51**	1,63	2,38	3,06	4,26	4,35	4,40	3,32
0.40 - 0.50	1,04	2,08	3,61	4,53	4,84	5,00	5,48	2,97
0.30 - 0.40	1,93	2,80	3,53	4,71	5,35	5,55	4,52	4,45
0.20 - 0.30	2,04	3,44	3,40	3,49	3,93	4,95	4,91	7,08
0.10 - 0.20	2,89	2,43	2,93	4,22	3,92	4,38	3,48	2,41
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

Reconstruction efficiency Λ's for $P_T(y)$

	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+Cu(4.5AGeV)							
0.90 - 1.05	**0,01**	**0,06**	**0,43**	0,97	1,45	3,01	2,68	1,42
0.75 - 0.90	**0,02**	**0,27**	**0,76**	1,58	1,92	2,82	4,06	3,57
0.62 - 0.75	**0,08**	**0,53**	1,45	2,05	2,66	3,01	3,85	4,18
0.50 - 0.62	**0,42**	1,04	1,79	2,64	2,95	3,19	2,98	3,81
0.40 - 0.50	1,01	1,79	2,54	3,18	3,41	3,10	3,87	5,20
0.30 - 0.40	1,24	1,99	2,46	3,04	2,55	3,25	3,80	3,31
0.20 - 0.30	1,47	2,20	2,04	2,66	2,77	2,76	3,07	2,80
0.1 - 0.20	1,34	1,54	2,10	2,54	2,52	2,66	2,51	1,09
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

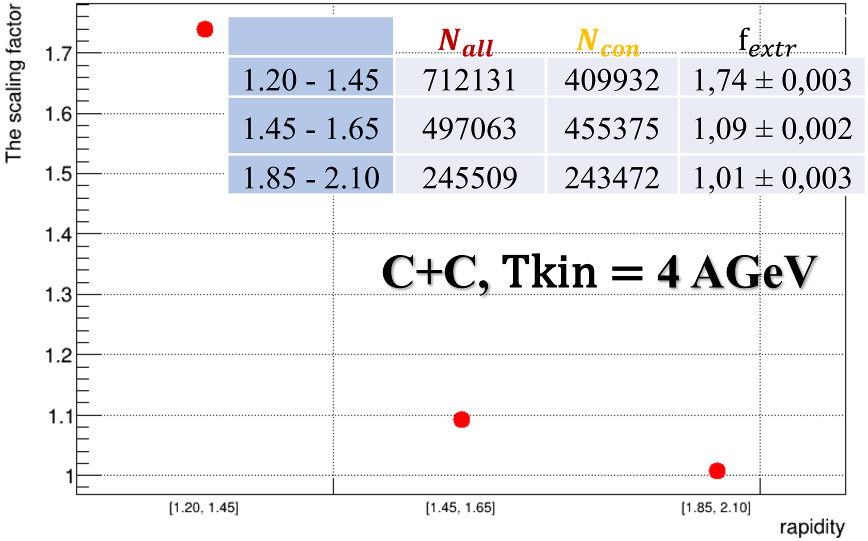
	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+Cu(4.0AGeV)							
0.90 - 1.05	**0,02**	**0,02**	**0,04**	1,35	1,38	1,46	2,57	2,35
0.75 - 0.90	**0,20**	**0,13**	**0,18**	1,26	3,53	2,77	1,53	1,84
0.62 - 0.75	**0,61**	**0,86**	**0,70**	2,19	3,00	3,79	4,54	**0,90**
0.50 - 0.62	1,11	1,34	1,26	3,35	2,96	4,49	4,19	3,67
0.40 - 0.50	1,91	1,56	2,22	3,92	4,68	4,27	6,27	4,19
0.30 - 0.40	1,80	1,97	2,89	4,36	3,36	5,34	3,86	4,28
0.20 - 0.30	1,88	3,00	3,42	4,38	3,55	4,43	4,40	4,83
0.10 - 0.20	2,01	2,37	2,22	2,89	3,98	2,58	5,70	5,02
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

Reconstruction efficiency Λ's for P_T(y)

	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+Pb(4.5AGeV)							
0.90 - 1.05	**0,00**	**0,04**	**0,27**	**0,93**	1,62	2,55	2,56	**0,77**
0.75 - 0.90	**0,02**	**0,17**	**0,49**	1,20	1,88	2,22	2,40	2,57
0.62 - 0.75	**0,07**	**0,34**	**0,95**	1,52	1,81	1,85	2,55	3,23
0.50 - 0.62	**0,30**	**0,83**	1,54	2,15	2,36	2,64	2,93	3,16
0.40 - 0.50	**0,59**	1,42	2,06	2,24	2,66	2,45	2,94	3,36
0.30 - 0.40	**0,98**	1,39	2,28	2,09	2,33	2,59	2,61	2,81
0.20 - 0.30	**0,80**	1,66	2,08	2,20	2,26	2,14	2,55	2,85
0.1 - 0.20	**0,94**	1,25	1,34	1,59	1,53	1,74	2,01	1,25
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

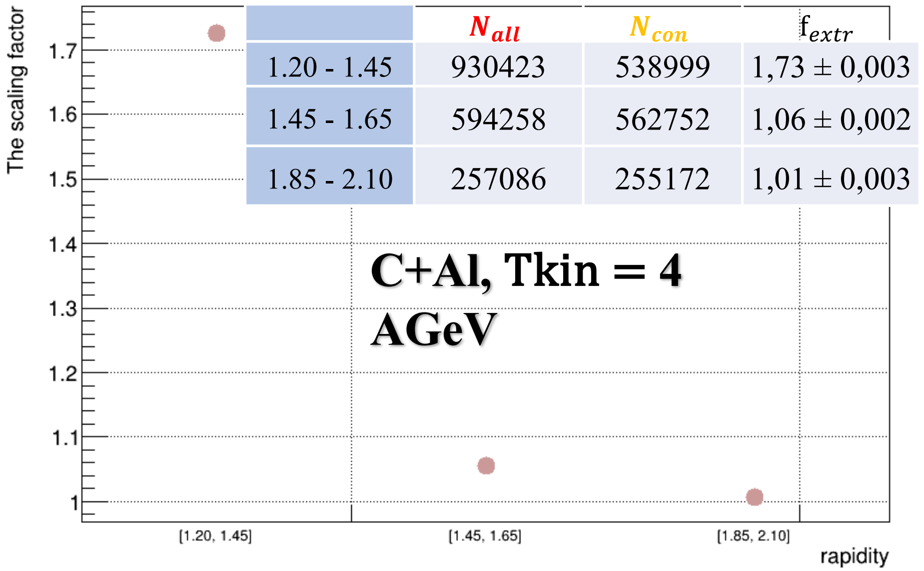
	$\omega_i = MC_{rec\_i}/MC_{gen\_i}$ (%), C+Pb(4.0AGeV)							
0.90 - 1.05	**0,05**	**0,09**	**0,30**	0,65	1,91	3,07	**0,72**	**0,75**
0.75 - 0.90	**0,04**	**0,16**	**0,56**	1,16	1,77	2,00	2,96	**0,56**
0.62 - 0.75	**0,15**	**0,53**	1,35	2,02	2,89	2,45	4,13	2,02
0.50 - 0.62	**0,35**	**0,89**	1,50	2,93	2,86	3,94	2,24	3,59
0.40 - 0.50	**0,78**	1,48	2,37	2,88	3,28	4,27	2,34	4,03
0.30 - 0.40	1,27	1,73	2,57	3,13	3,71	2,80	4,84	1,99
0.20 - 0.30	1,66	2,54	2,77	3,27	3,79	4,09	4,90	4,43
0.10 - 0.20	1,49	1,77	3,13	3,02	3,88	3,06	4,05	4,55
y	1.20-1.33	1.33 - 1.45	1.45 - 1.55	1.55 - 1.65	1.65 - 1.75	1.75 - 1.85	1.85 - 1.98	1.98 - 2.1

Extrapolation factor f_{extr}



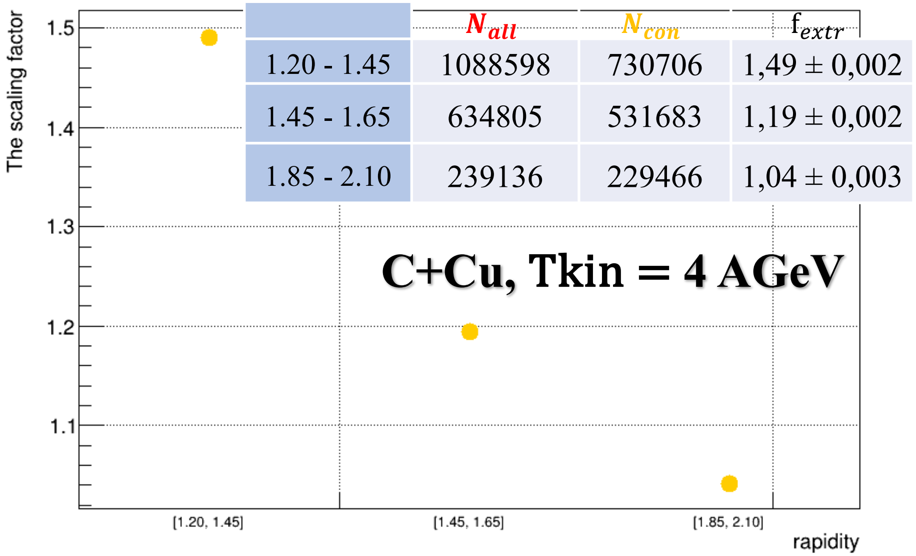
C+C, Tkin = 4 AGeV

	N_{all}	N_{con}	f_{extr}
1.20 - 1.45	712131	409932	1,74 ± 0,003
1.45 - 1.65	497063	455375	1,09 ± 0,002
1.85 - 2.10	245509	243472	1,01 ± 0,003



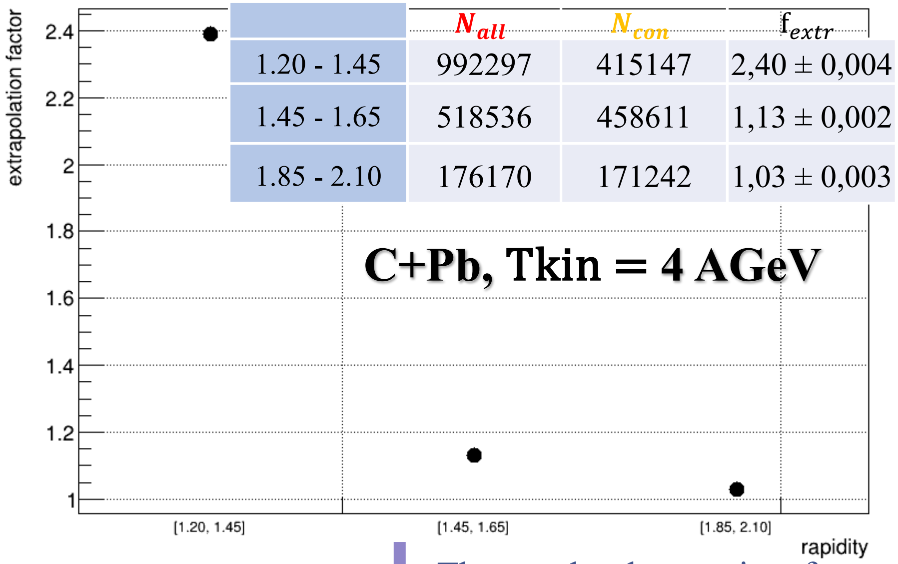
C+Al, Tkin = 4 AGeV

	N_{all}	N_{con}	f_{extr}
1.20 - 1.45	930423	538999	1,73 ± 0,003
1.45 - 1.65	594258	562752	1,06 ± 0,002
1.85 - 2.10	257086	255172	1,01 ± 0,003



C+Cu, Tkin = 4 AGeV

	N_{all}	N_{con}	f_{extr}
1.20 - 1.45	1088598	730706	1,49 ± 0,002
1.45 - 1.65	634805	531683	1,19 ± 0,002
1.85 - 2.10	239136	229466	1,04 ± 0,003



C+Pb, Tkin = 4 AGeV

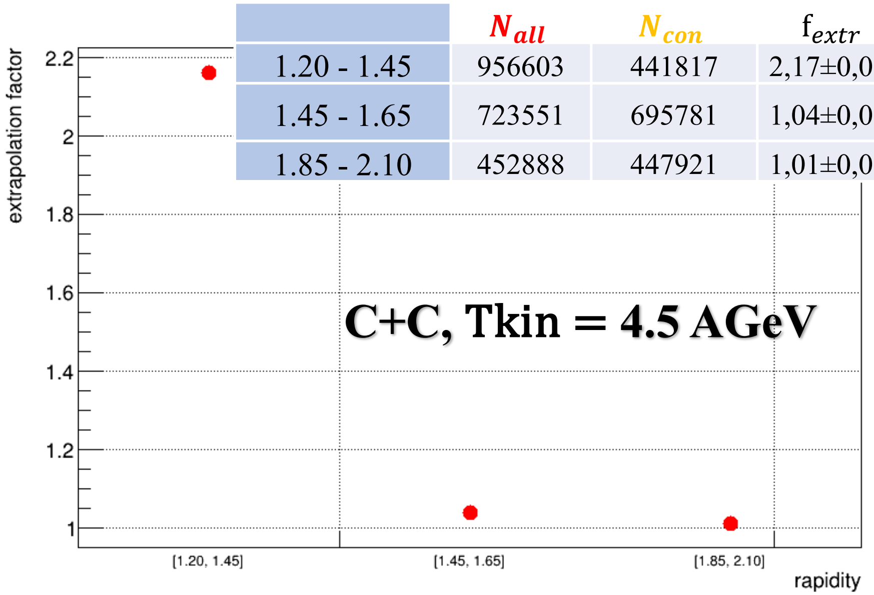
	N_{all}	N_{con}	f_{extr}
1.20 - 1.45	992297	415147	2,40 ± 0,004
1.45 - 1.65	518536	458611	1,13 ± 0,002
1.85 - 2.10	176170	171242	1,03 ± 0,003

1 Done for all targets separately.

2 Done on DCM-QGSM model data.

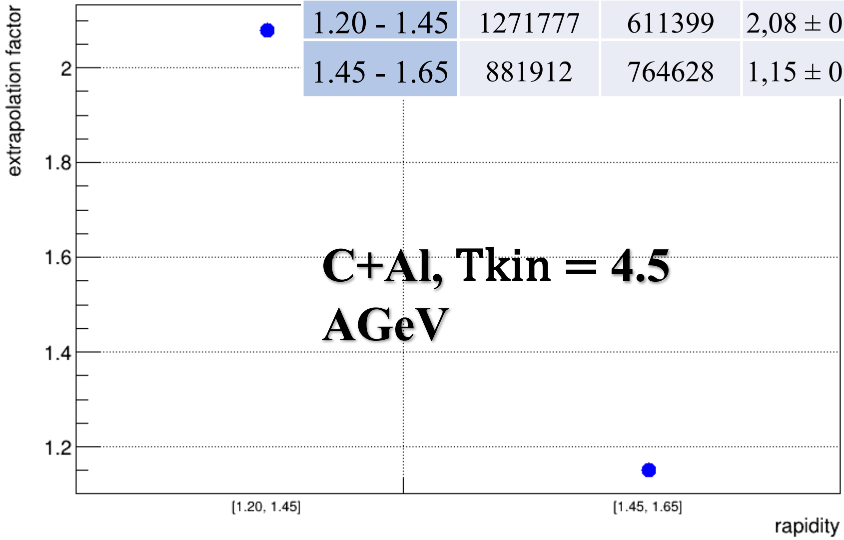
3 The graphs show points from cells($\omega_i \geq 0.01$).

Extrapolation factor f_{extr}



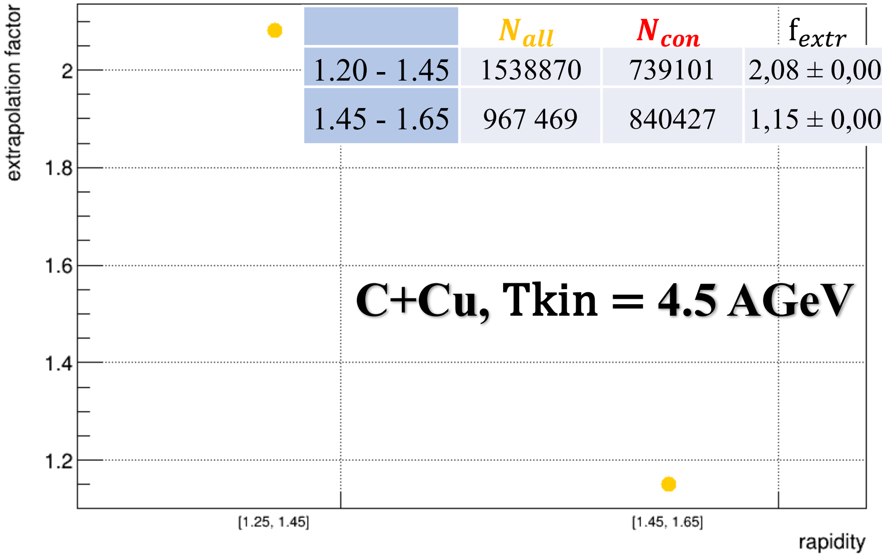
	N_{all}	N_{con}	f_{extr}
1.20 - 1.45	956603	441817	2,17±0,004
1.45 - 1.65	723551	695781	1,04±0,002
1.85 - 2.10	452888	447921	1,01±0,002

C+C, Tkin = 4.5 AGeV



	N_{all}	N_{con}	f_{extr}
1.20 - 1.45	1271777	611399	2,08 ± 0,003
1.45 - 1.65	881912	764628	1,15 ± 0,002

C+Al, Tkin = 4.5 AGeV

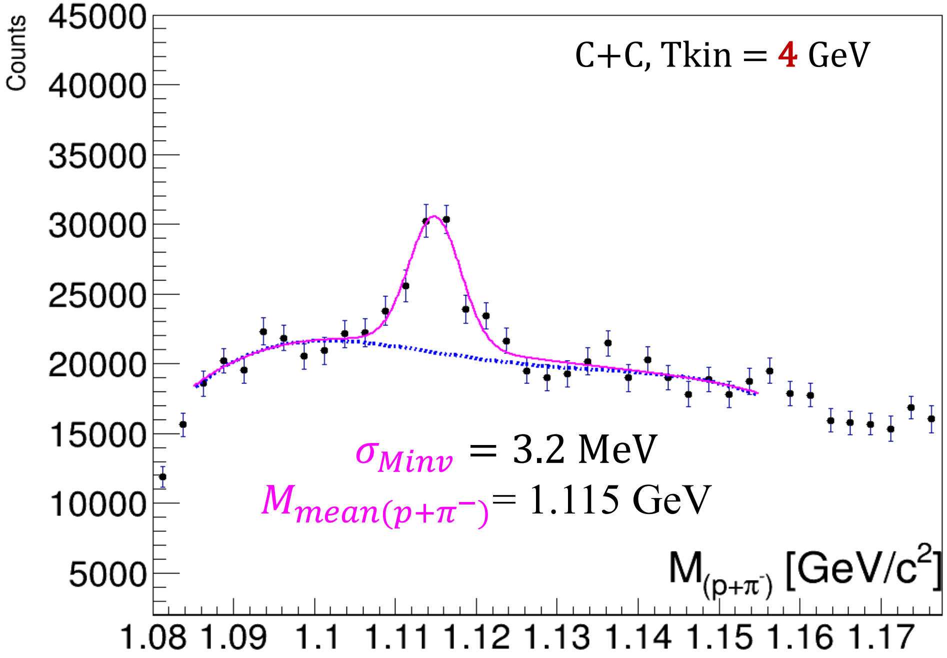


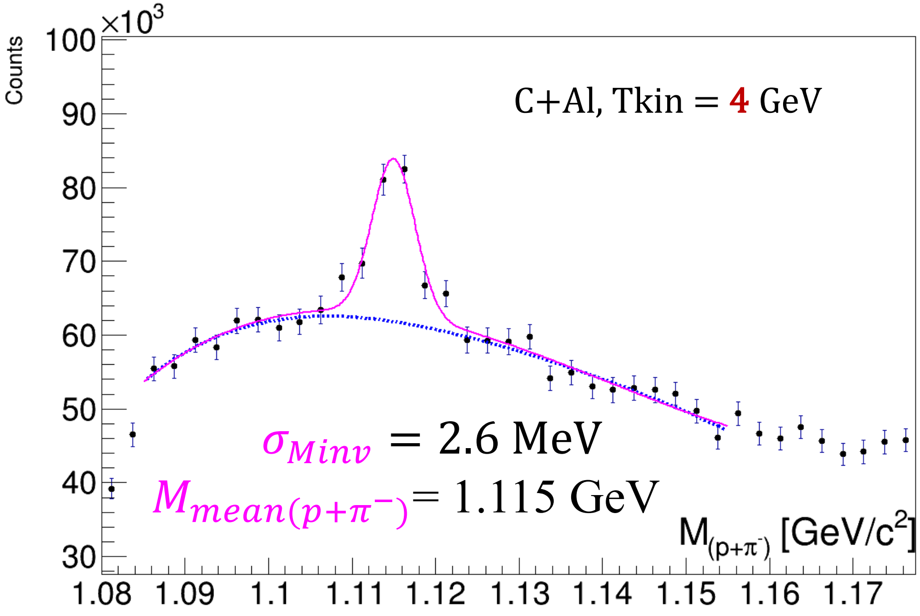
	N_{all}	N_{con}	f_{extr}
1.20 - 1.45	1538870	739101	2,08 ± 0,003
1.45 - 1.65	967 469	840427	1,15 ± 0,002

C+Cu, Tkin = 4.5 AGeV

C + Pb, Tkin = 4.5 AGeV
Very low statistic

Mass distribution of the $\Lambda \to p\pi^-$(DATA)





Procedure in DATA C+A → X

1) Split (y, pT) area in small cells for MC/DATA (8x8);
2) To each event assigned the weight ω_i;
3) Sum the cells by $\sum_{ij} y_{ij}$ and by $\sum_{ij} pT_{ij}$

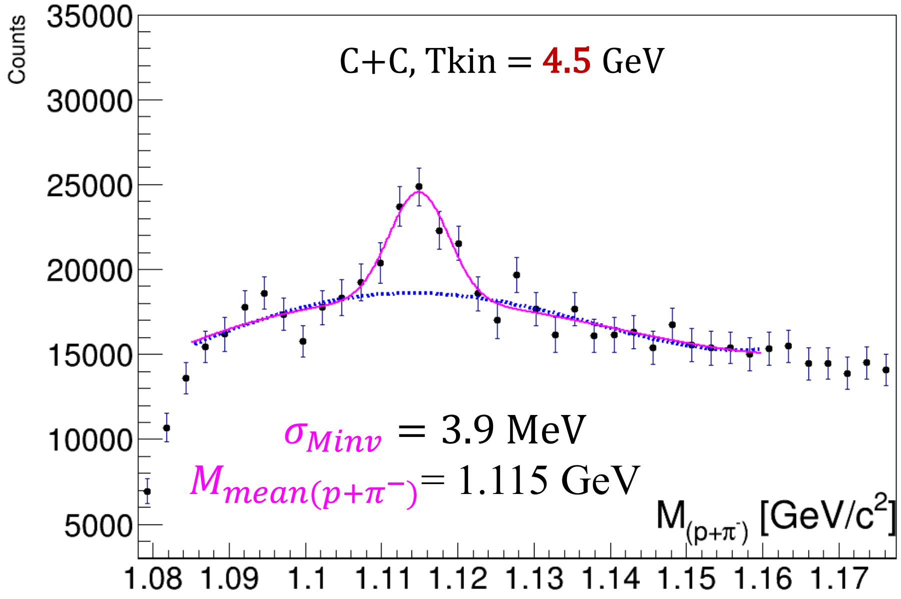
Interaction C+C	signal $N^{\Lambda}_{rec}(p_T/y)$
4.0 AGeV	33957±2753

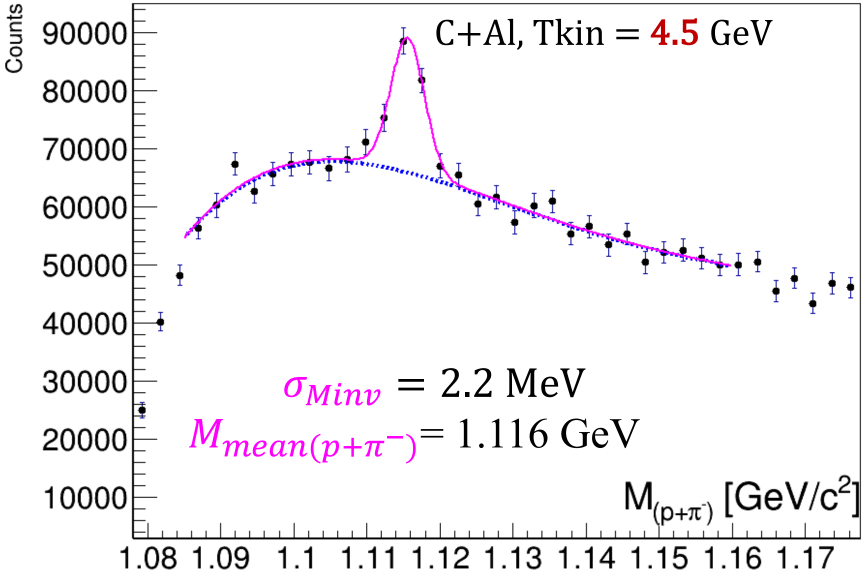
Interaction C+Al	signal $N^{\Lambda}_{rec}(p_T/y)$
4.0 AGeV	63047±5005

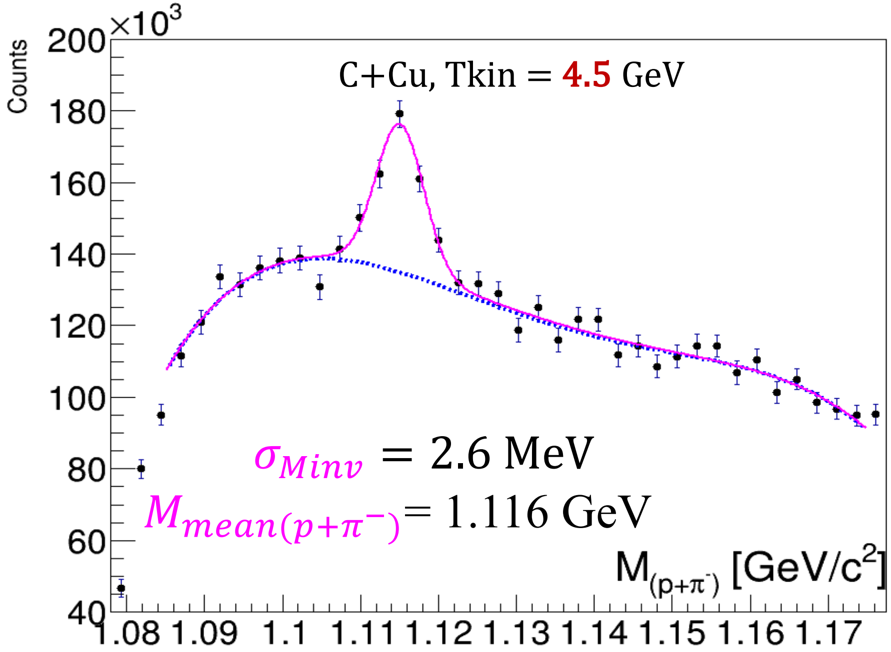
$0.1 < p_T < 1.05$
or
$1.2 < y_{lab} < 2.1$

- ○ Λ signal width ~ 2.0 - 4 MeV;
- ○ **Signal** = hist – Background in **1107,5 - 1125** MeV/c^2;
- ○ **Background** → $F(M_{p\pi^-})_{bg} = p_0 + p_1 M_{p\pi^-} + p_2 M_{p\pi^-}{}^2 + p_3 M_{p\pi^-}{}^3 + p_4 M_{p\pi^-}{}^4$ → 4th polynomial(**Blue dashed**);
- ○ $err(stat) = \sqrt{\sum w_i^2}$;

Mass distribution of the $\Lambda \rightarrow p\pi$ (DATA)







C+Pb, Tkin = **4.5** GeV

will done…

$0,1 < p_T < 1,05$

Luminosity

Table 3. Integrated **luminosities** collected in interactions of the carbon beam of 4.0 and 4.5AGeV with different targets.

Interactions, target thickness		Integrated luminosity/ 10^{30} cm^{-2}		Integrated luminosity/ 10^{30} cm-2
C+C (9 mm)	**4 AGeV**	6.06	**4.5 AGeV**	4.69
C+Al (12 mm)		2.39		3.60
C+Cu (5 mm)		2.00		3.06
C+Pb (10 mm)		0.22		0.84