12C FRAGMENTATION IN CARBON - PROTON COLLISIONS. COMPARISON OF SRC DATA WITH DCM-SMM GENERATOR (STATUS OF WORK)

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for the BM@N-SRC Collaboration

5th BM@N Collaboration Meeting

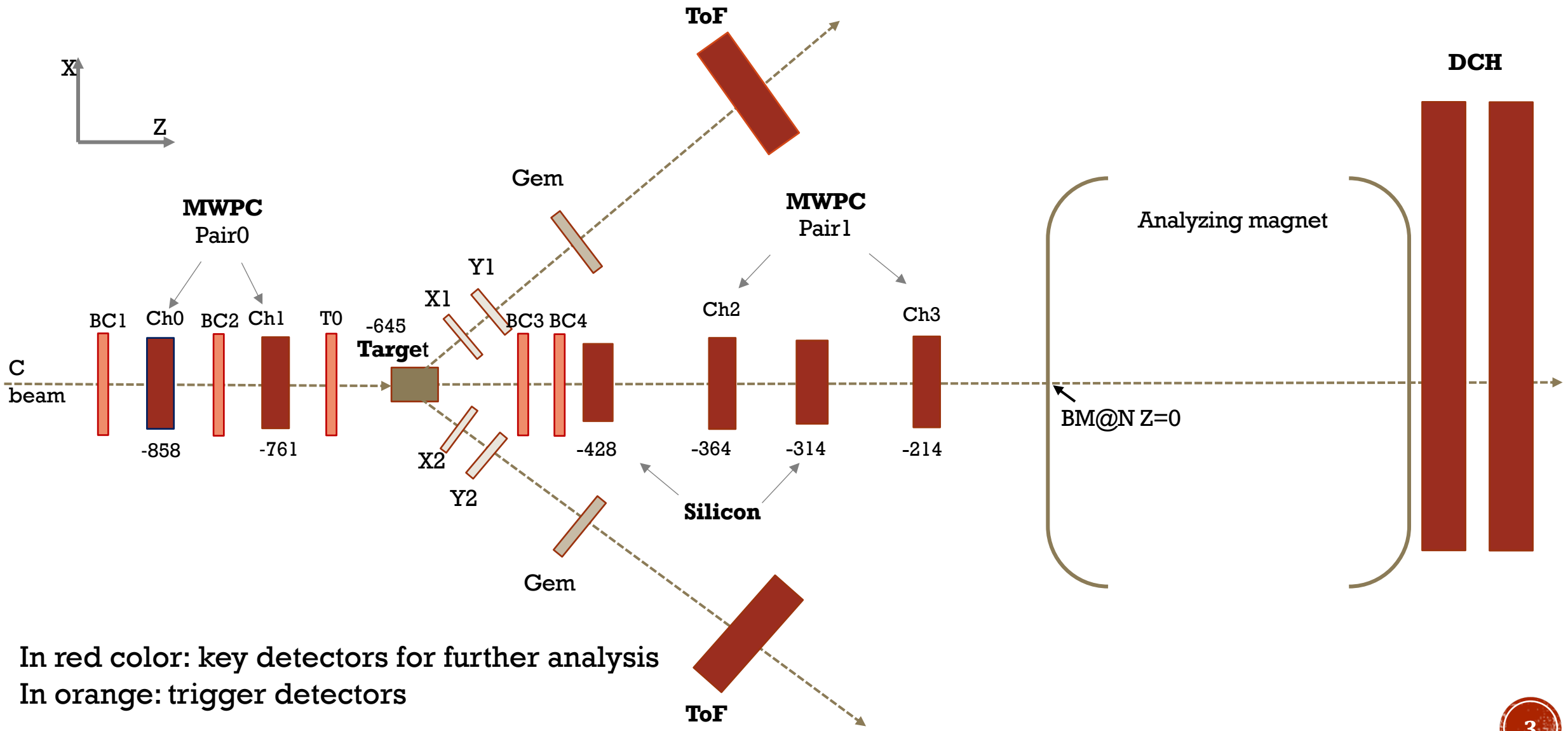
- April 20th, 2020

MOTIVATION

- Using the model we want to estimate production of fragmentation in carbon - proton collisions
- DCM-SMM generator is suitable for the beam energy of the BM@N experiment

- We start to compare the DCM-SMM model to 12C fragmentation data

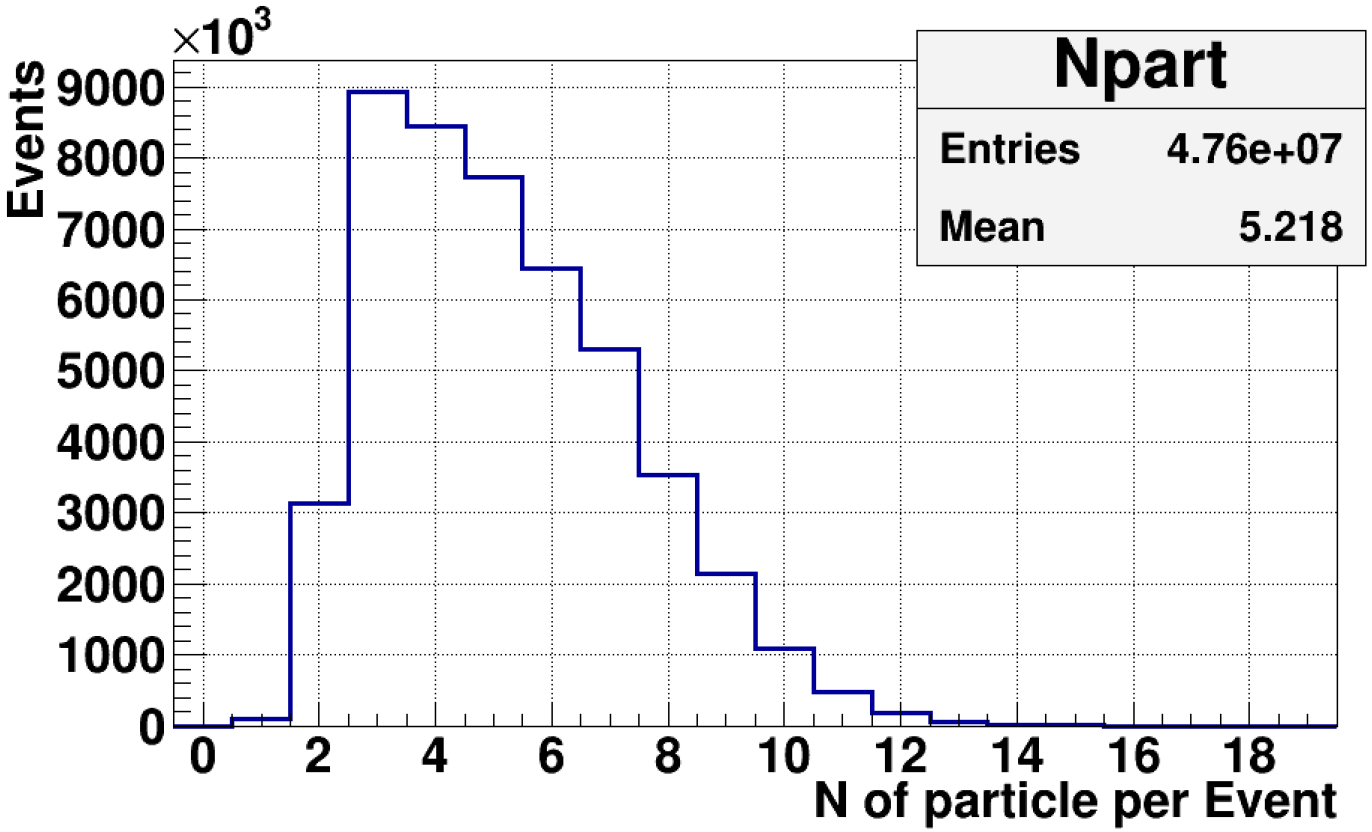
SRC RUN CONFIGURATION:



In red color: key detectors for further analysis
In orange: trigger detectors

DCM-SMM

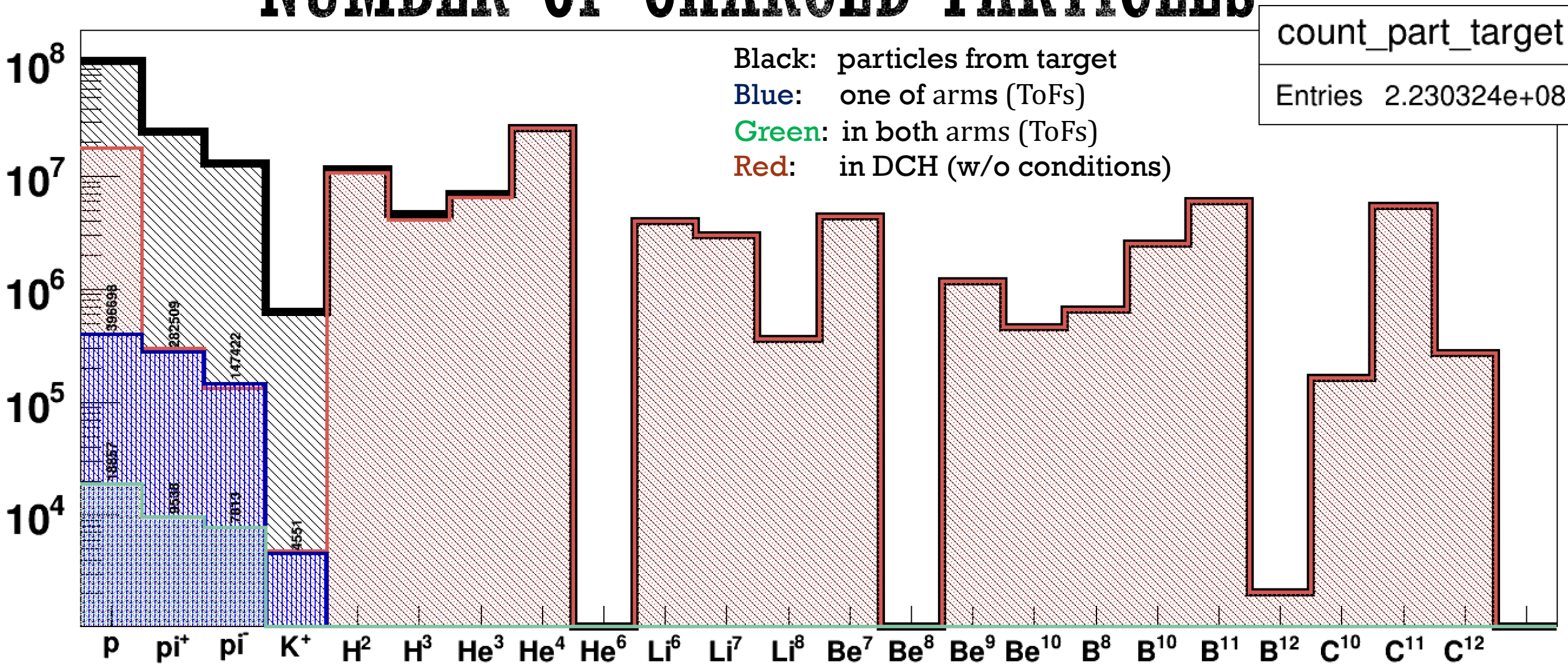
DUBNA CASCADE MODEL + STATISTICAL MULTIFRAGMENTATION MODEL (*)



- Carbon beam energy ≈ 3.17 GeV/n
- H2 target
- Statistics: 47.6 M events

* https://arxiv.org/pdf/1912.09277.pdf

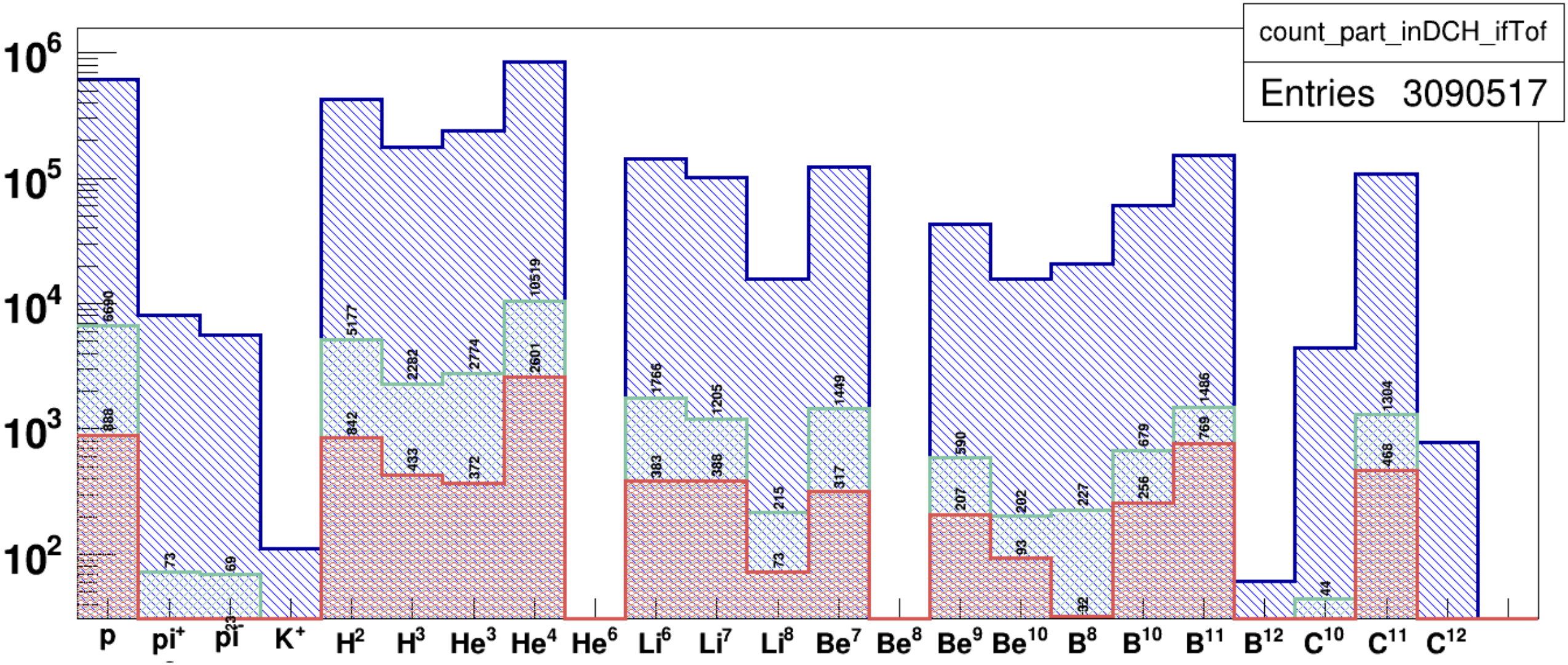
NUMBER OF CHARGED PARTICLES



Primary particles from target:
Z target ϵ [-665,-635] cm
Pz > 0

Protons and pions are separated in the arms
Protons are identified in the arms: main aim of SRC analysis

NUMBER OF CHARGED PARTICLES IN DCH

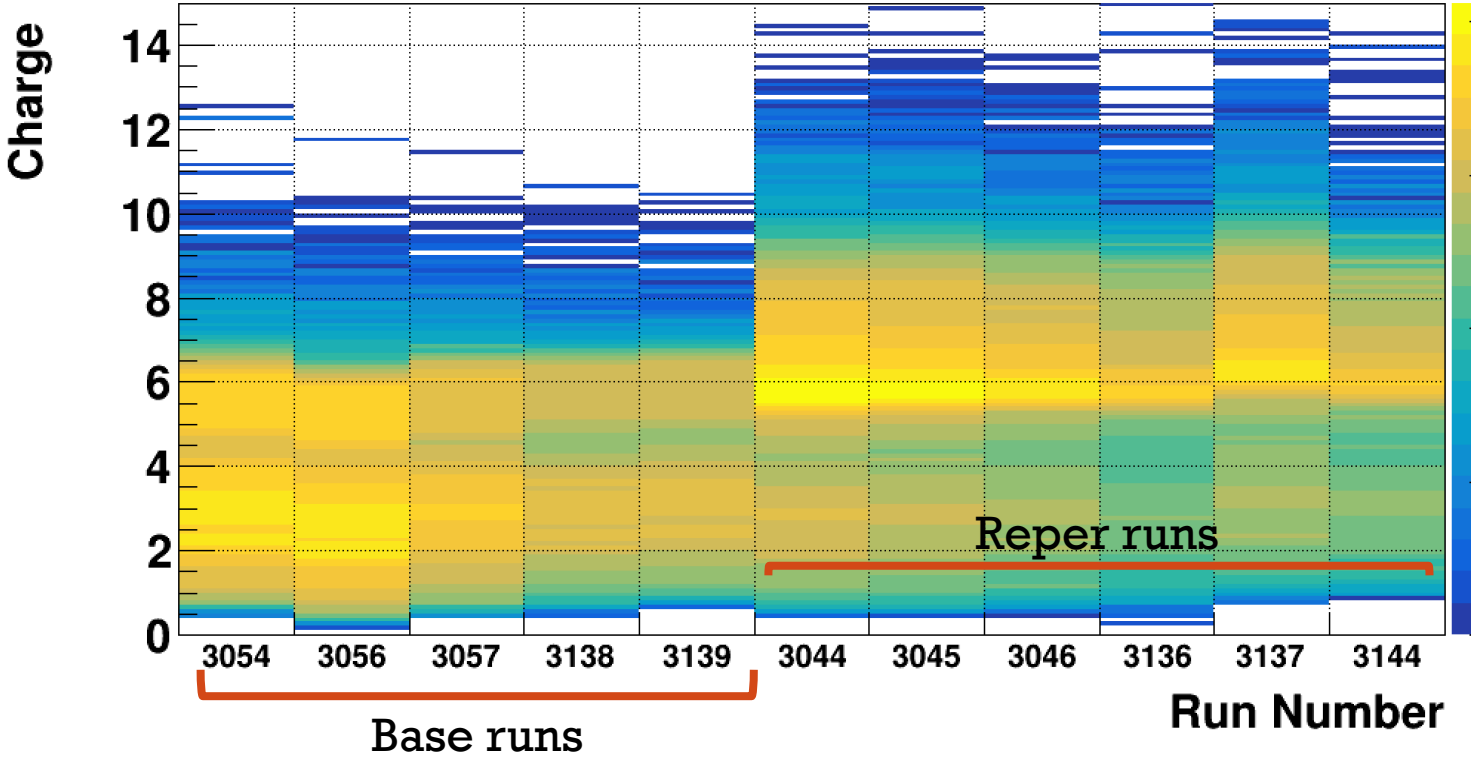


Blue: if fired one of Tofs

Green: if charged particles in both arms (left & right Tofs)

Red: if protons in both arms (left & right Tofs) - SRC mainstream of analysis

SRC MIN BIAS DATA (C BEAM)

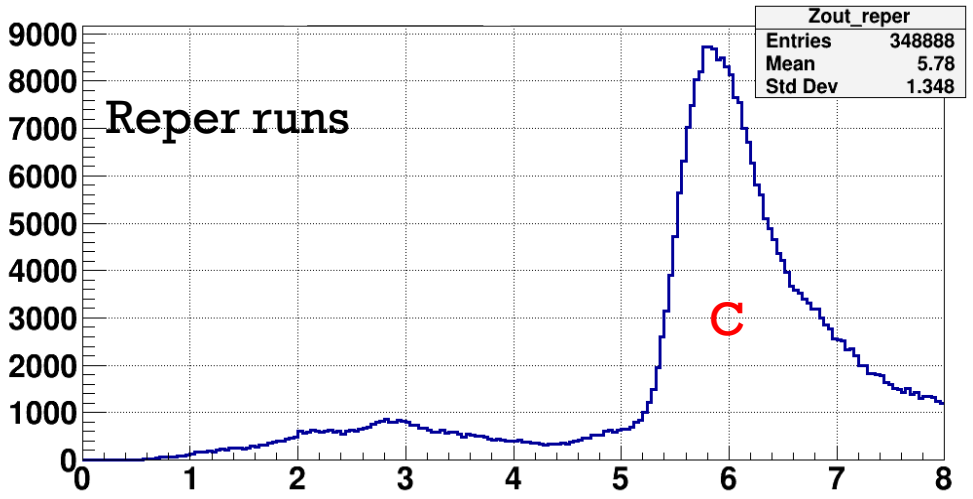


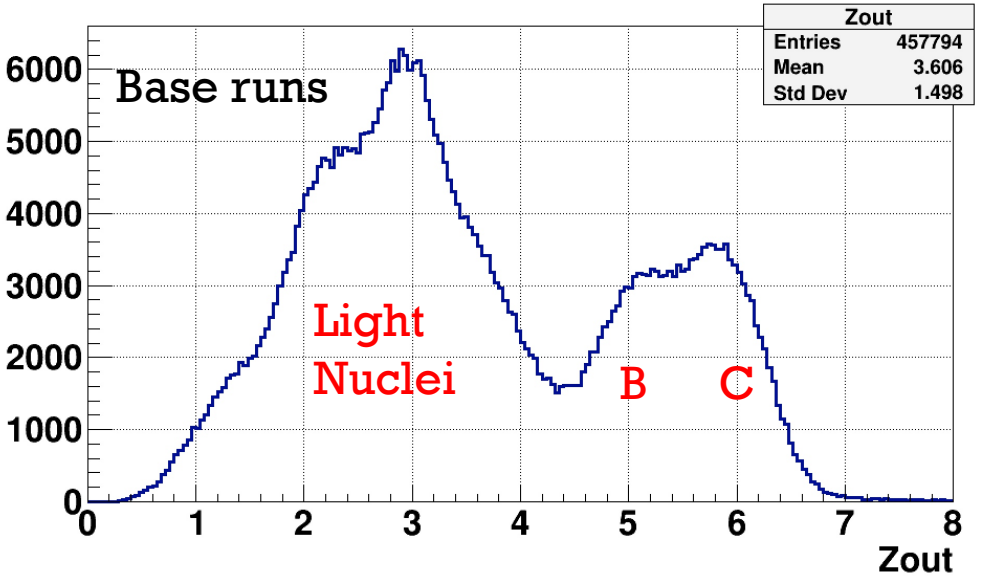
SRC IT(Interact Trigger) =
BC1 & BC2 & anti-BC3-Hi
& anti-VC

SRC BT (Beam Trigger) =
BC1 & BC2

BC1,2,3,4 – time cuts , T0 – One entry cut

BC3 & BC4 -> Zout
(Sum of particles charge per event)





VERTEX RECONSTRUCTION

- Vertex reconstruction is needed to select interactions on LH (liquid hydrogen target) and not on the walls of the target

- Methods:
  - Using arms : good vertex but very low statistics
  - MWPC(p0)-Silicon vertex reconstruction : very small track angles
  - One arm and (Upstream or Silicon) vertex reconstruction : optimal choice

Preliminary

MWPC(P0)-SILICON VERTEX

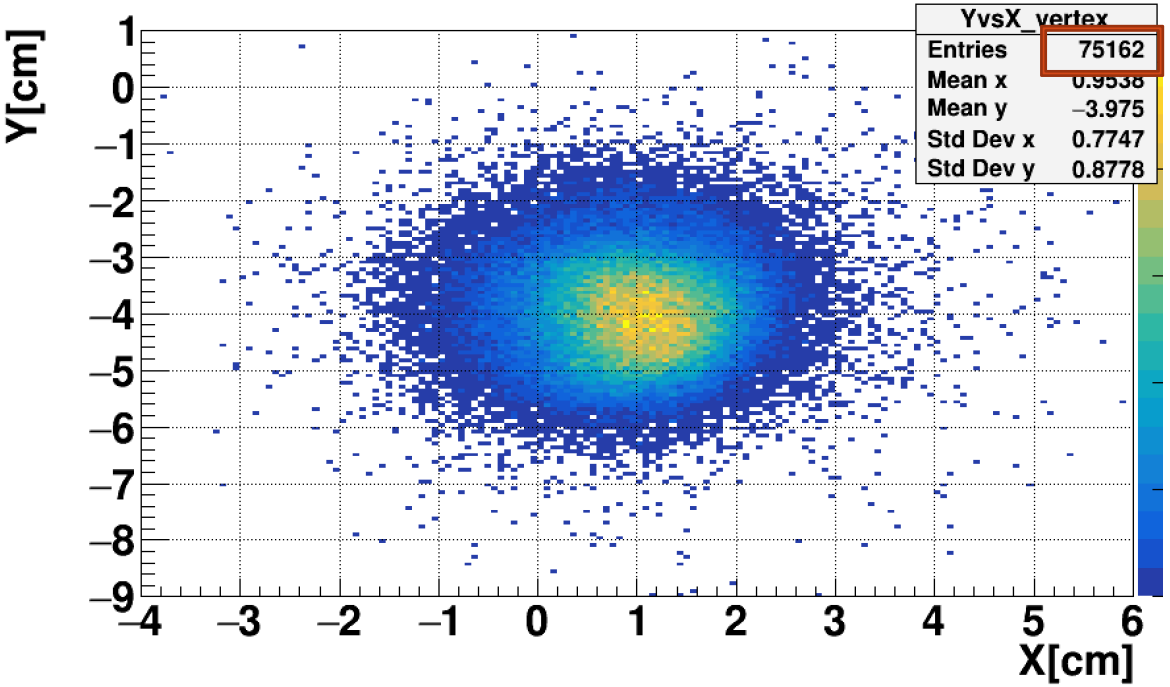
MWPC(pair0)track — Si-track1 / Si-track2 — > 6 mrad

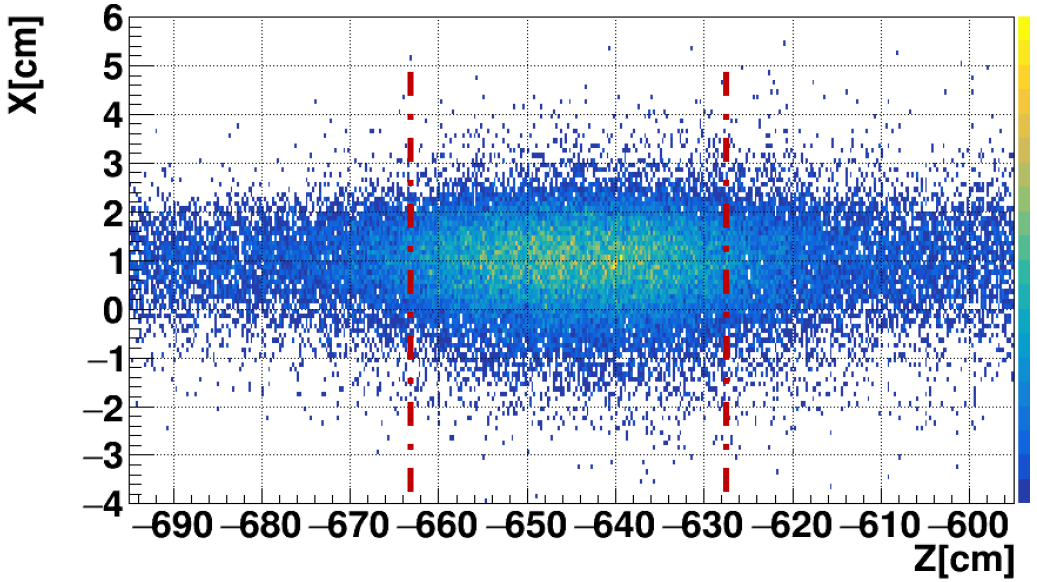
Min: 2 Si-tracks

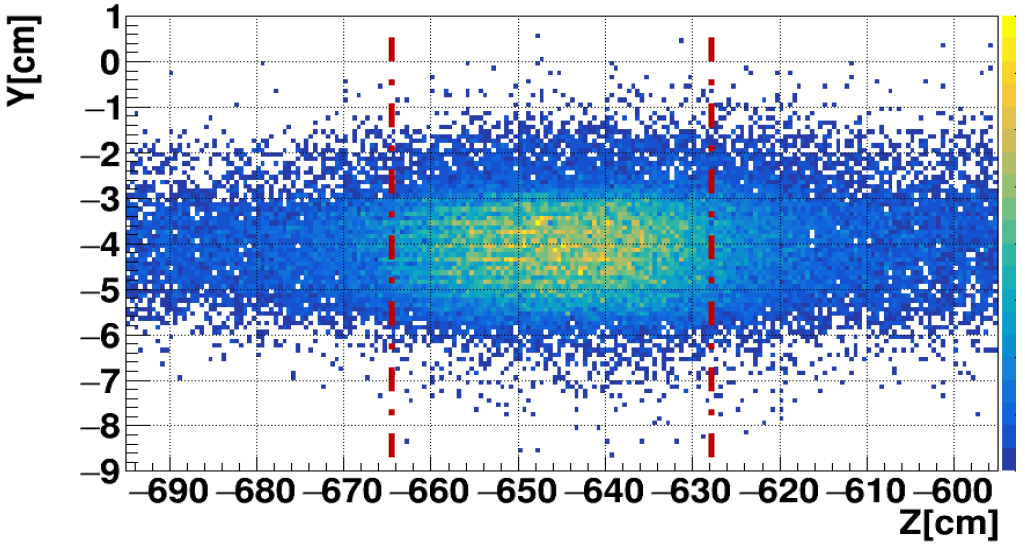
SRC data

75 K events with vertex

out of = 377 K "good" trigged events







Resolution is not good enough

We will try another method : one arm and (Upstream or Silicon) tracks

SRC data

BC3 TRIGGER EFFICIENCY FOR BASE RUNS

Base Runs	Ampcut for BC3 [ADC]	Nevents Zout<4.4, BC3< ampcutBC3	Nev Zout<4.4	Knorm= Ni(ampl)/ Nreper(ampl)	Eff= Ni(zcut)/ (Nreper(zcut)*K)
3054	1100	51880	63090	8.5	0.176
3056	1100	54740	66550	9.0	0.176
3057	1100	26400	31950	4.3	0.177
3138	1100	11 940	14 980	2.0	0.178
3139	1100	12520	15540	2.1	0.176
Reper		6080	42040		
3054	1100	84930	103700	8.4	0.178
3056	1100	89900	107300	8.9	0.174
3057	1100	43150	52220	4.3	0.175
3138	1100	*19780*	24610	2.0	0.177
3139	1100	20280	25100	2.0	0.181
Reper		10100	69350		

BC1,2,3,4 – time cut
!VETO - time cut
T0 – One entry cut

BC3 Efficiency =18%
Low efficiency w/o vertex conditions

BC1,2,3,4 – time cut
~~!VETO - time cut~~
T0 – One entry cut

SRC data

BC3 TRIGGER EFFICIENCY FOR BASE RUNS

Base Runs	Ampcut for BC3 [ADC]	Nevents Zout<4.4, BC3< ampcutBC3	Nev Zout<4.4	Knorm= Ni(ampl)/ Nreper(ampl)	Eff= Ni(zcut)/ (Nreper(zcut)*K)
3054	700	8299	10070	8.98	0.45
3056	700	8825	10730	9.5	0.45
3057	700	4240	5106	4.6	0.44
3138	700	1918	2368	2.07	0.46
3139	700	1999	2471	2.16	0.46
Reper		924	2506		~0.452

BC1,2,3,4 – time cut
!VETO - time cut
T0 – One entry cut
With vertex conditions

BC3 Efficiency =45%
With vertex conditions

3054	700	13970	16970	9.1	0.44
3056	700	14870	17880	9.7	0.44
3057	700	7091	8543	4.6	0.44
3138	700	*3272*	4007	2.1	0.45
3139	700	3279	4056	2.1	0.46
Reper		1542	4205		~44.6

BC1,2,3,4 – time cut
~~!VETO - time cut~~
T0 – One entry cut
With vertex conditions

Preliminary

BORON SEPARATION

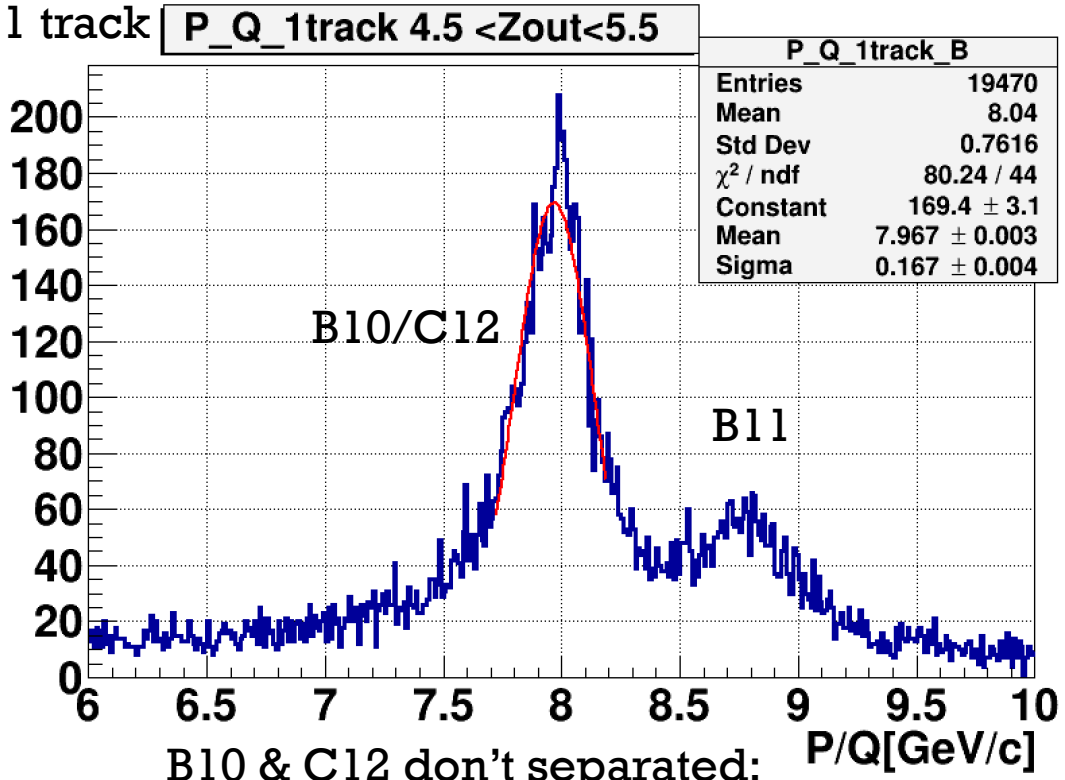
Only **base** runs
BC1,2,3,4 – time cut
~~!VETO - time cut~~
T0 – One entry cut
With vertex conditions

SRC data

$$P/Q = 0.3\frac{\int Bdl}{\alpha_{out}-\alpha_{in}}$$

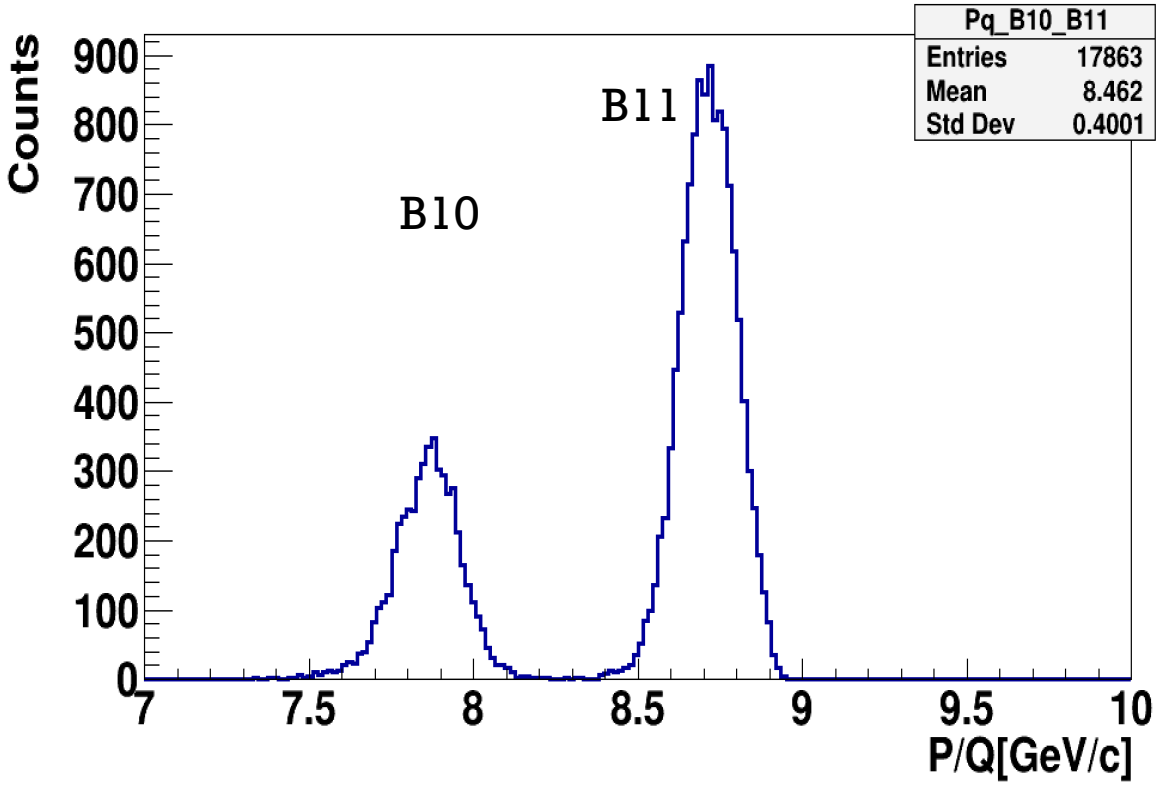
α_{in} = TgX of Silicon-track
α_{out} = TgX of DCH-track

1 track



B10 & C12 don't separated:
need PID procedure – see next slide

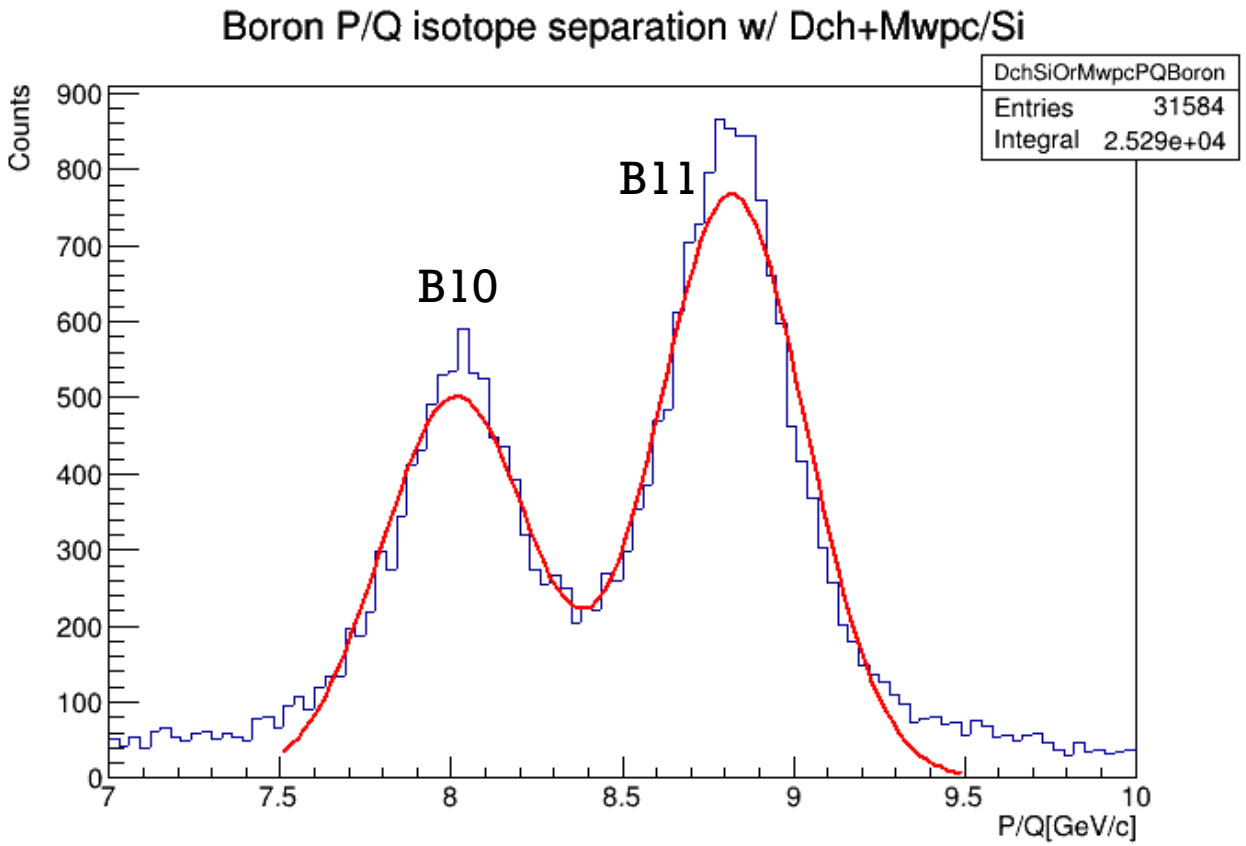
DCM-SMM simulation in DCH



Preliminary

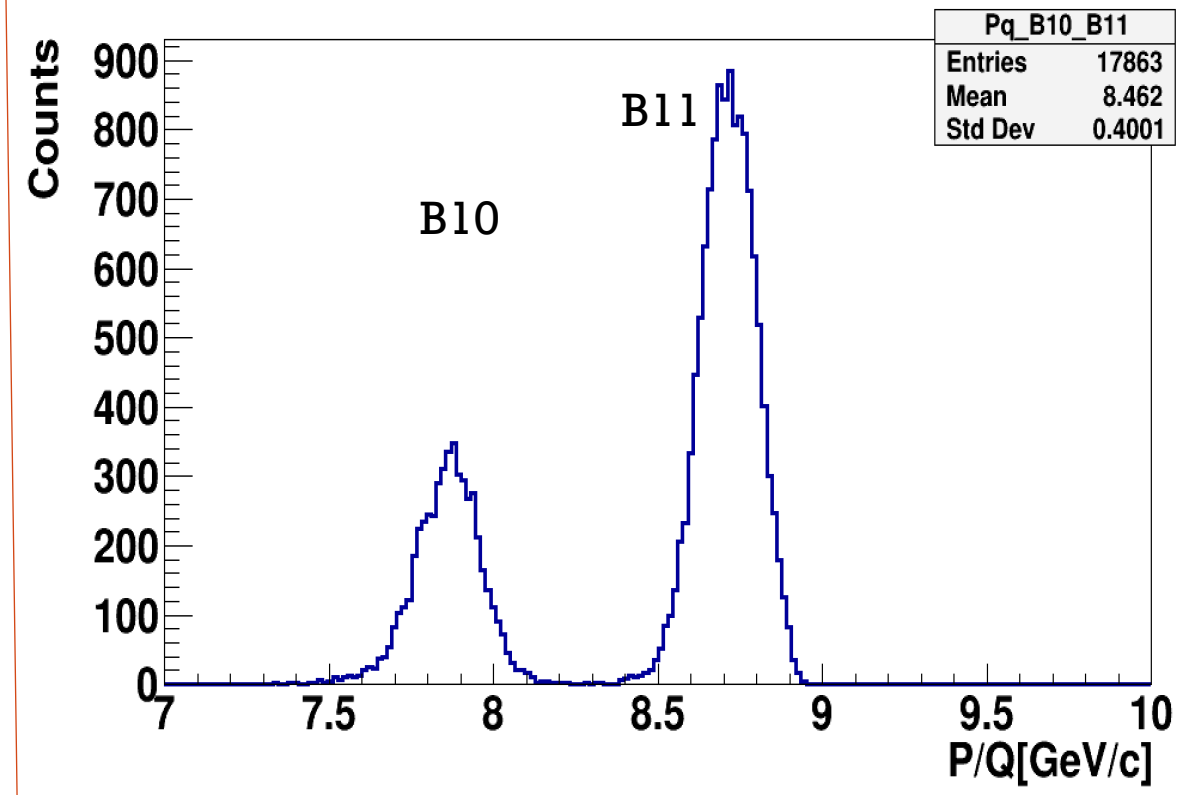
BORON SEPARATION

SRC data



Data: G.Johansson

DCM-SMM simulation in DCH

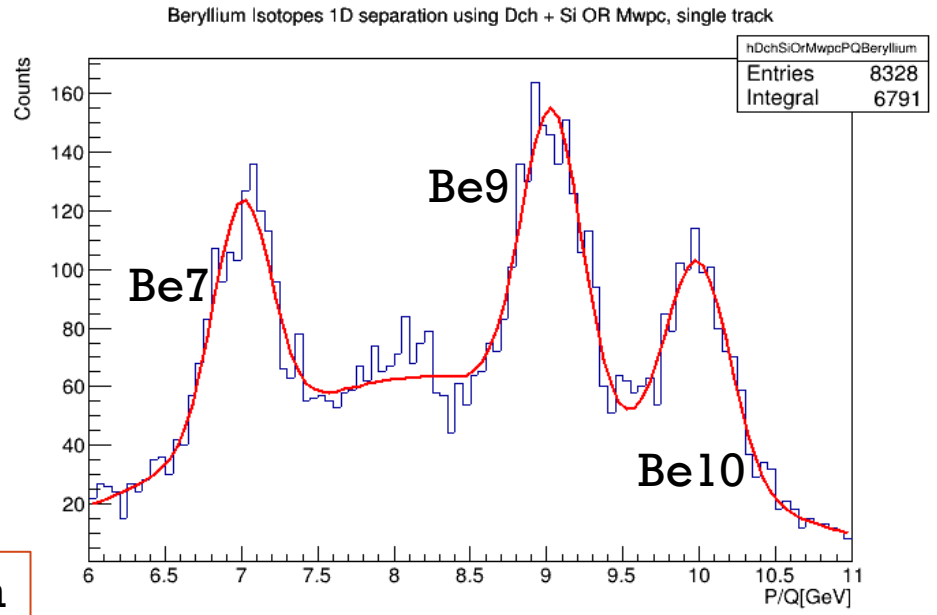


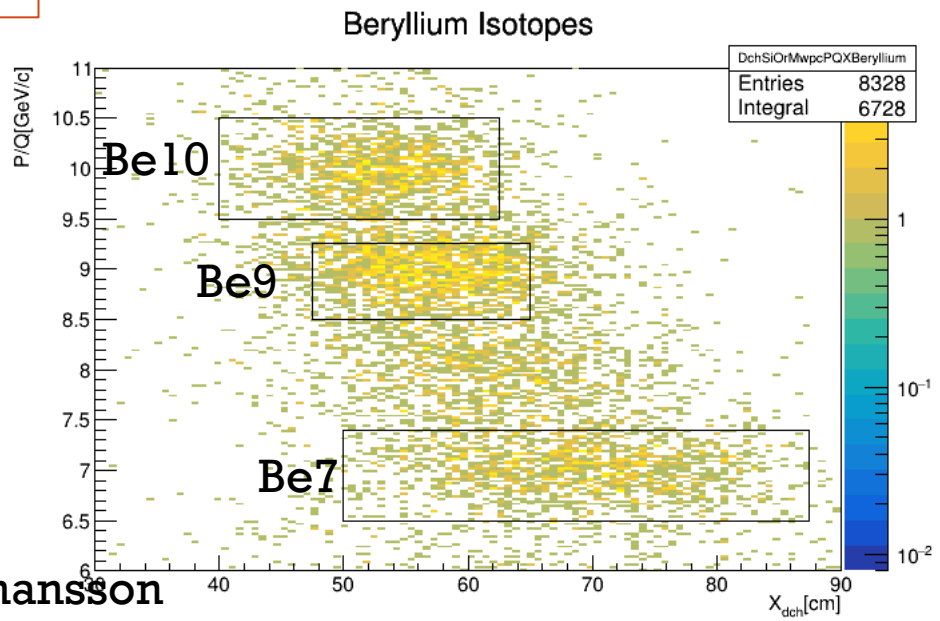
Good agreement between simulation and data

Preliminary

BERYLLIUM SEPARATION

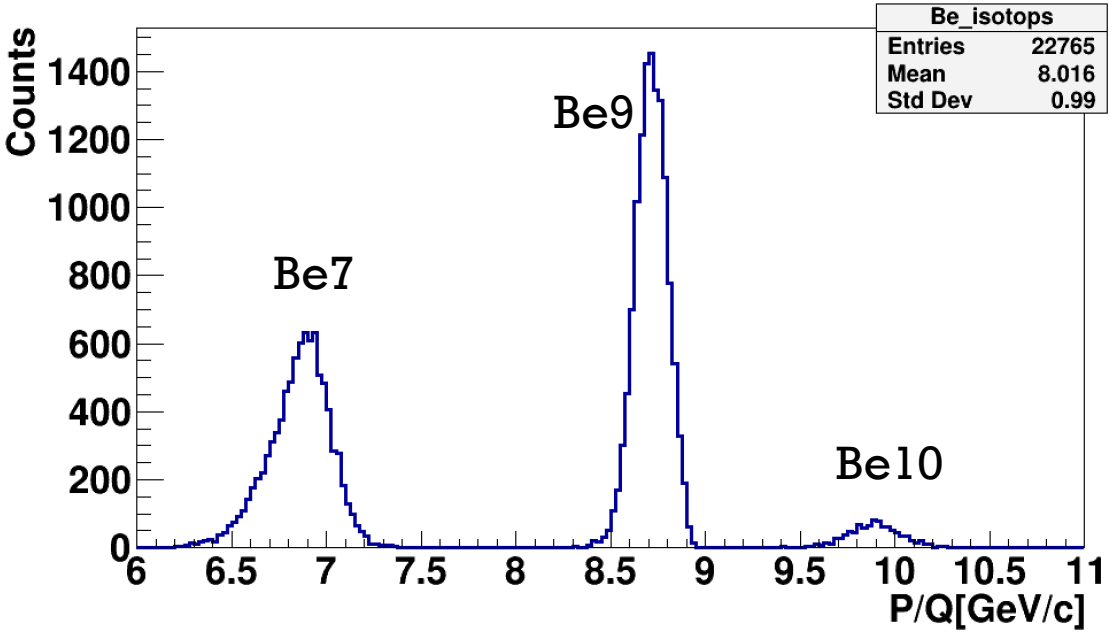
SRC data





Data: G.Johansson

DCM-SMM simulation in DCH



Good agreement between simulation and data

Preliminary

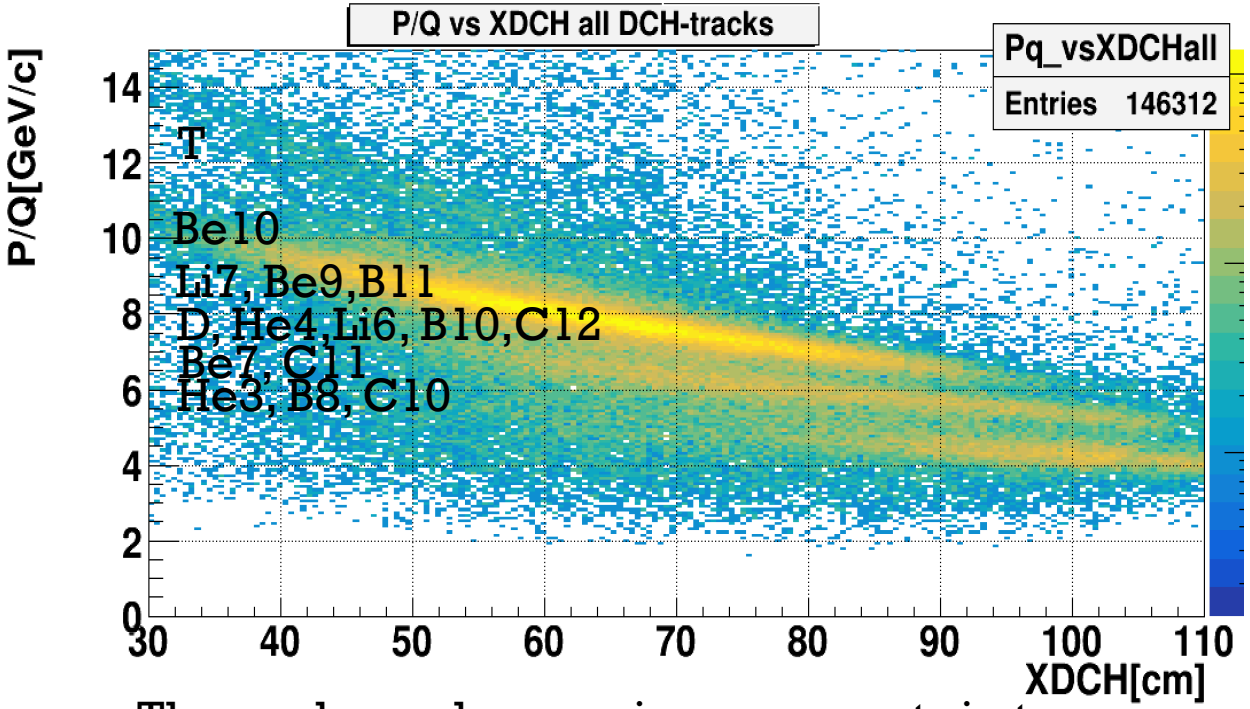
P/Q VS XDCH:

SRC data

Base runs
BC1,2,3,4 – time cut
~~!VETO - time cut~~
T0 – One entry cut

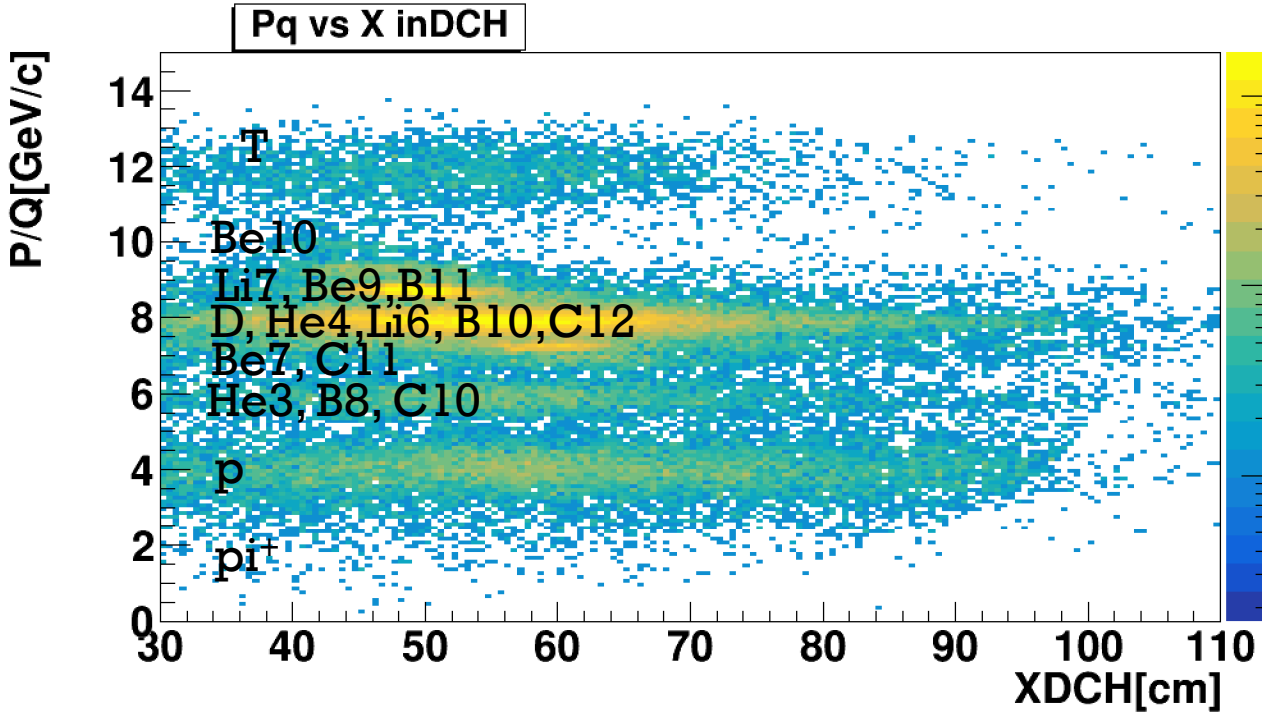
$P/Q = 0.3\frac{\int Bdl}{\alpha_{out}-\alpha_{in}}$

With vertex conditions
$\alpha_{in} = 0$
α_{out} = TgX of DCH-track



The work needs some improvements in terms of details and data processing.
That is to be done in the nearest future.

DCM-SMM simulation in DCH



Simulation shows us possibilities for different fragments identification:
adequate detector hits smearing is required

CONCLUSIONS

- Simulation shows us possibilities for different fragments identification
- 11B & 10B and Be isotopes can be separated
- BC3 Trigger efficiency for “base runs” is estimated

NEXT PLANS

- Adequate detector hits smearing for simulation is required
- To develop vertex reconstruction algorithm with one arm and one (Upstream or Silicon) tracks
- To study data with at least one arm
- Correct track angles before the magnet for PID are required
- To use implemented PID algorithm (G.Johansson and V.Panin)

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Thank you for your attention

BACK UP

Base runs
BC1,2,3,4 – time cut
~~!VETO - time cut~~
T0 – 1 pic cut

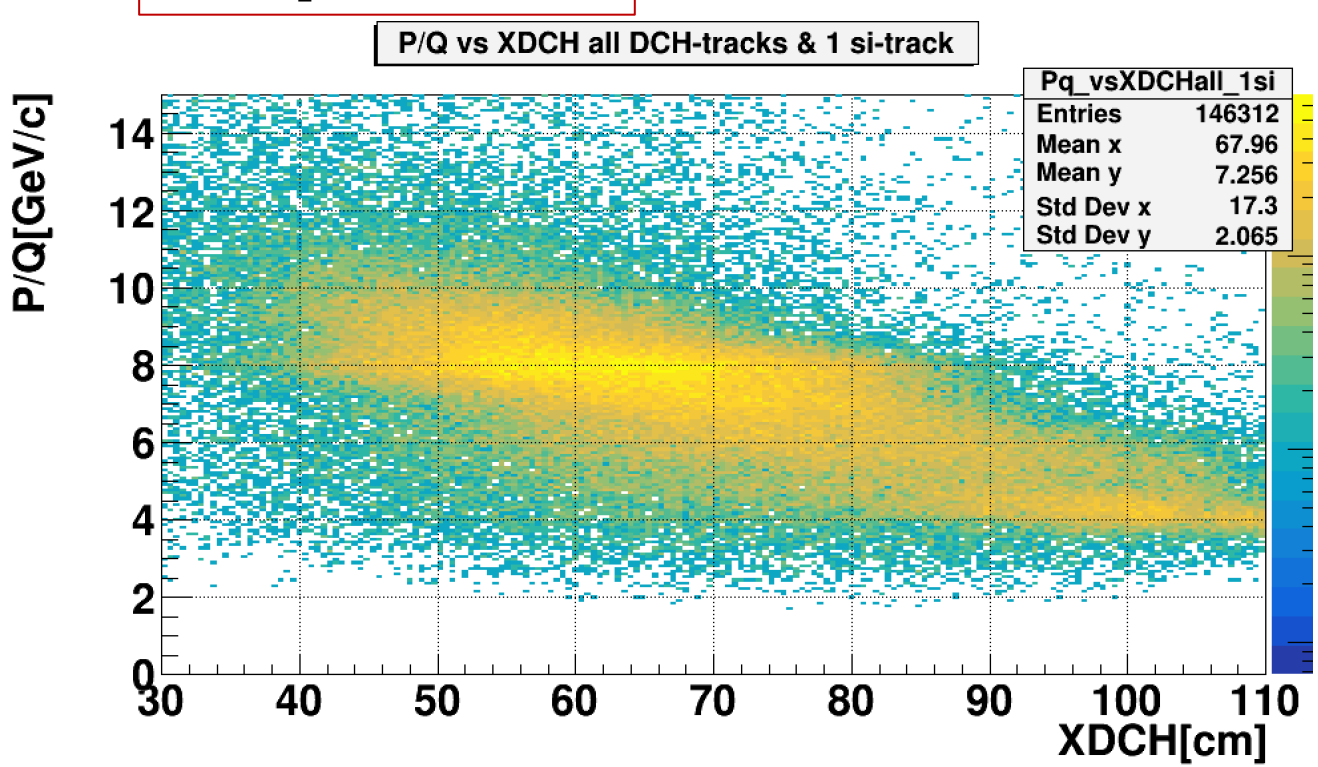
$P/Q = 0.3\frac{\int Bdl}{\alpha_{out}-\alpha_{in}}$

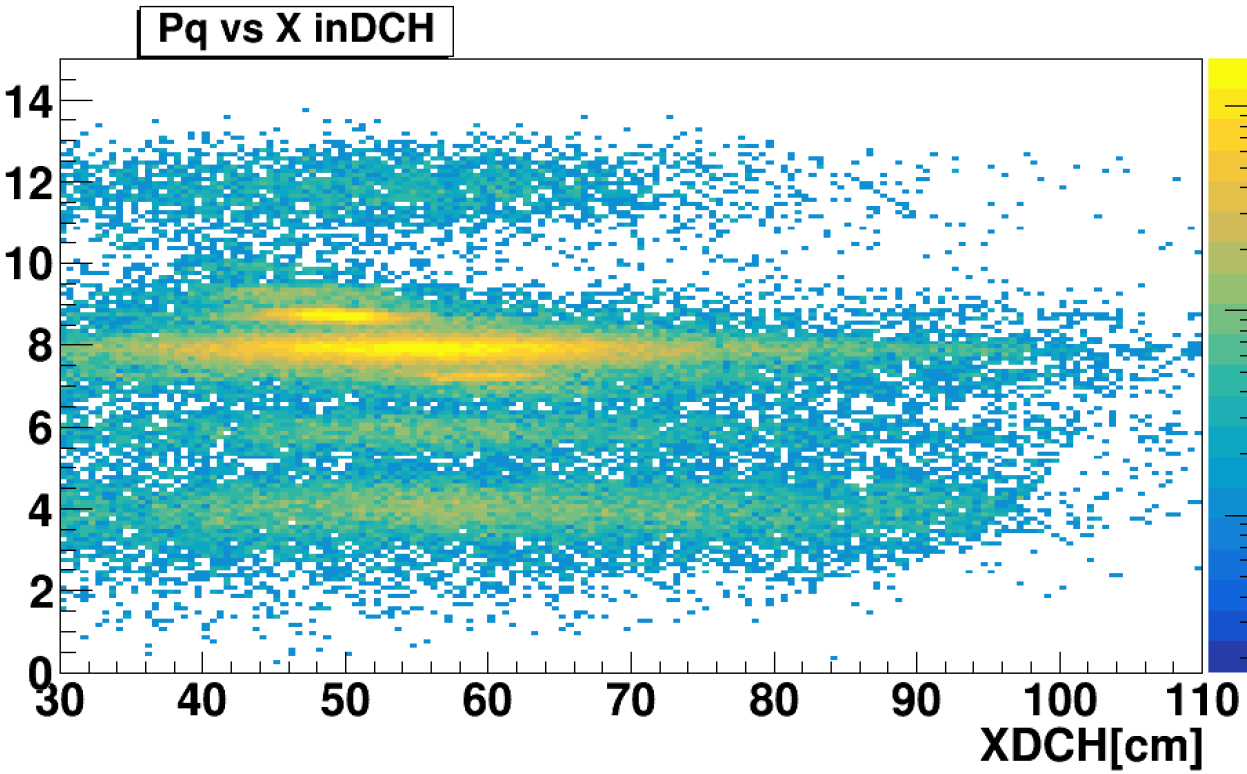
With vertex conditions

α_{in} = TgX_si-track

DCM-SMM simulation in DCH

Average Xdch



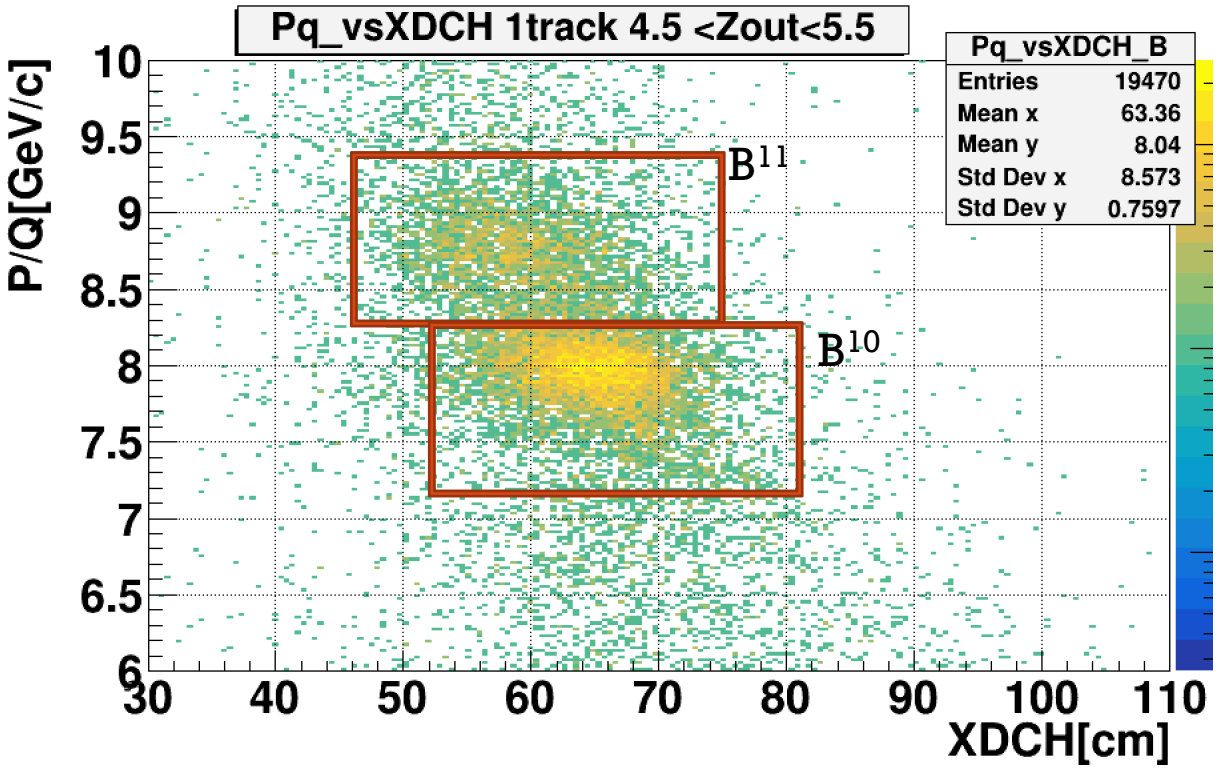


Preliminary

BORON SEPARATION

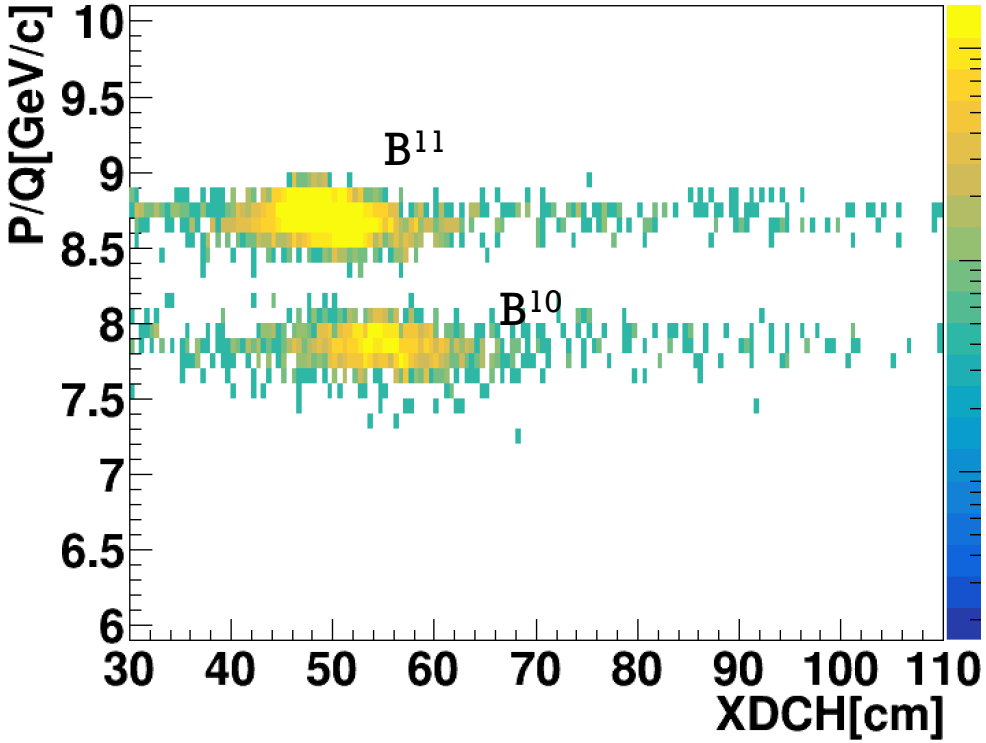
Base runs

SRC data



B10 & C12 don't separated

DCM-SMM simulation in DCH

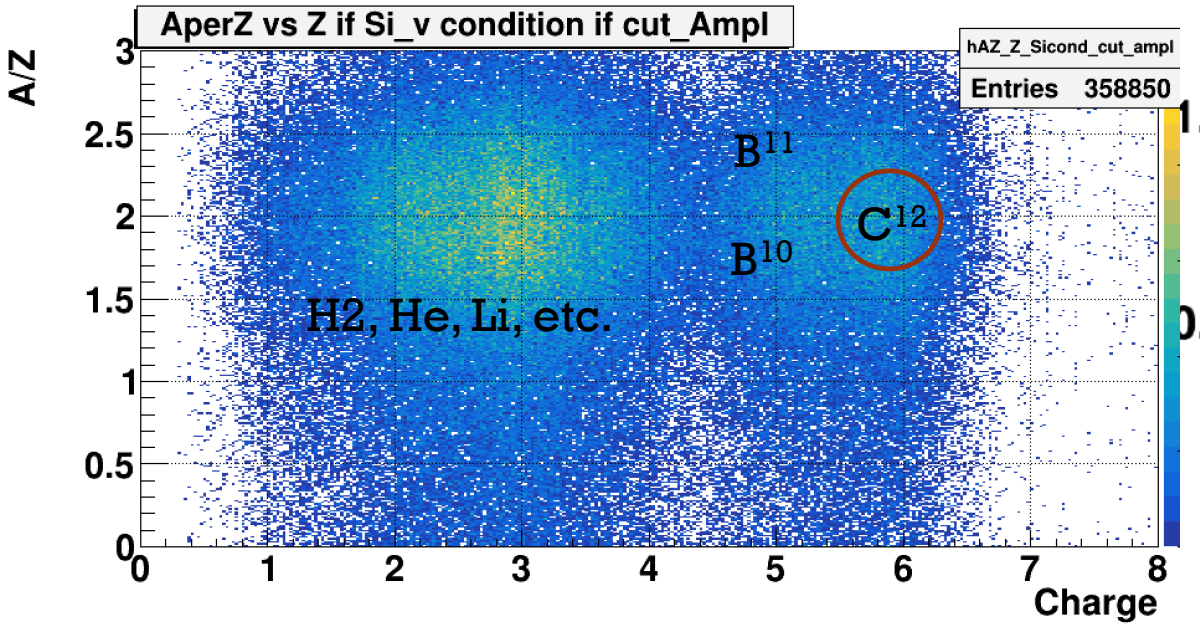


Preliminary

A/Z VS Z:

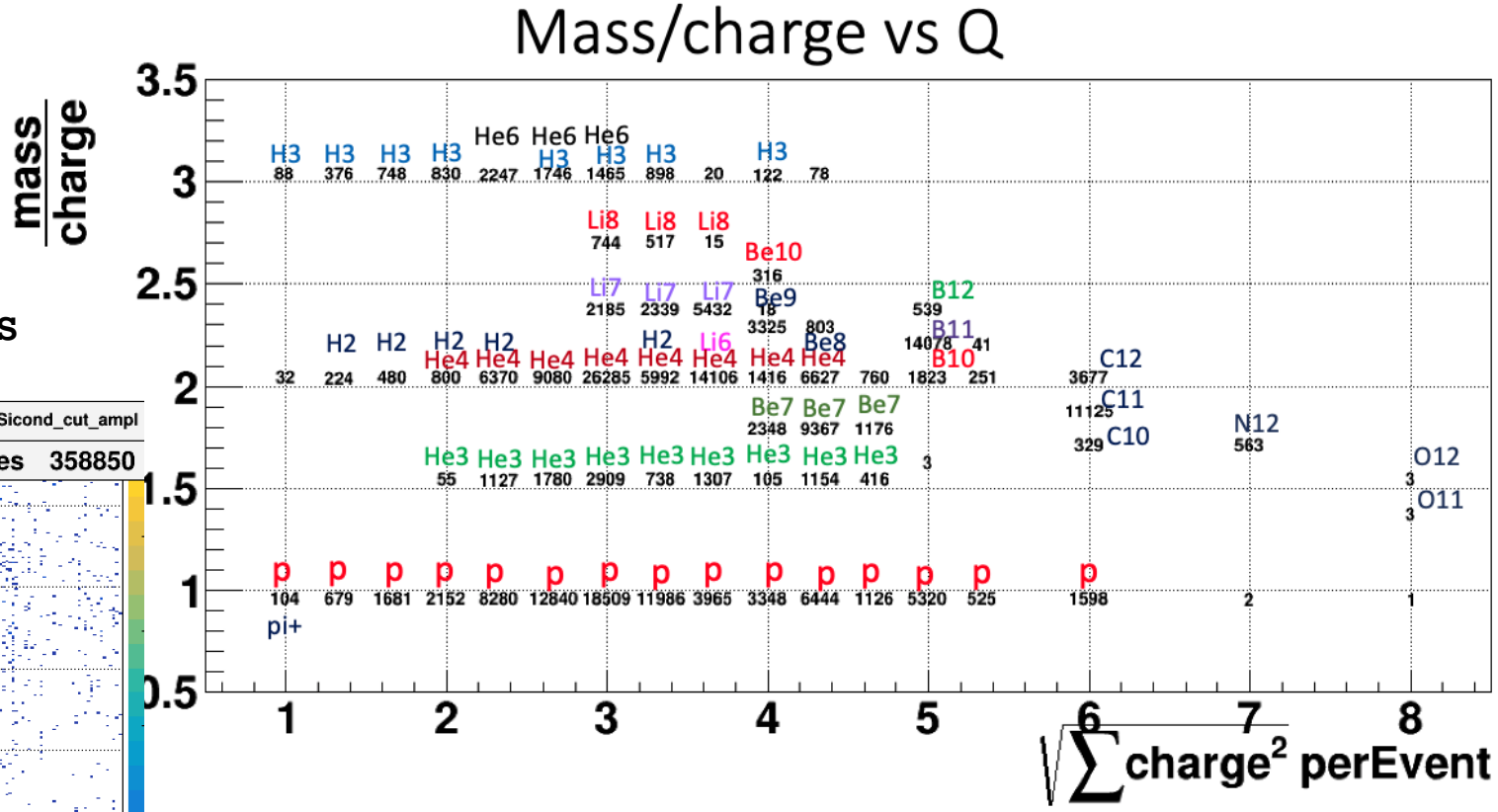
Base runs
BC1,2,3,4 – time cut
T0 – 1 pic cut

With vertex conditions

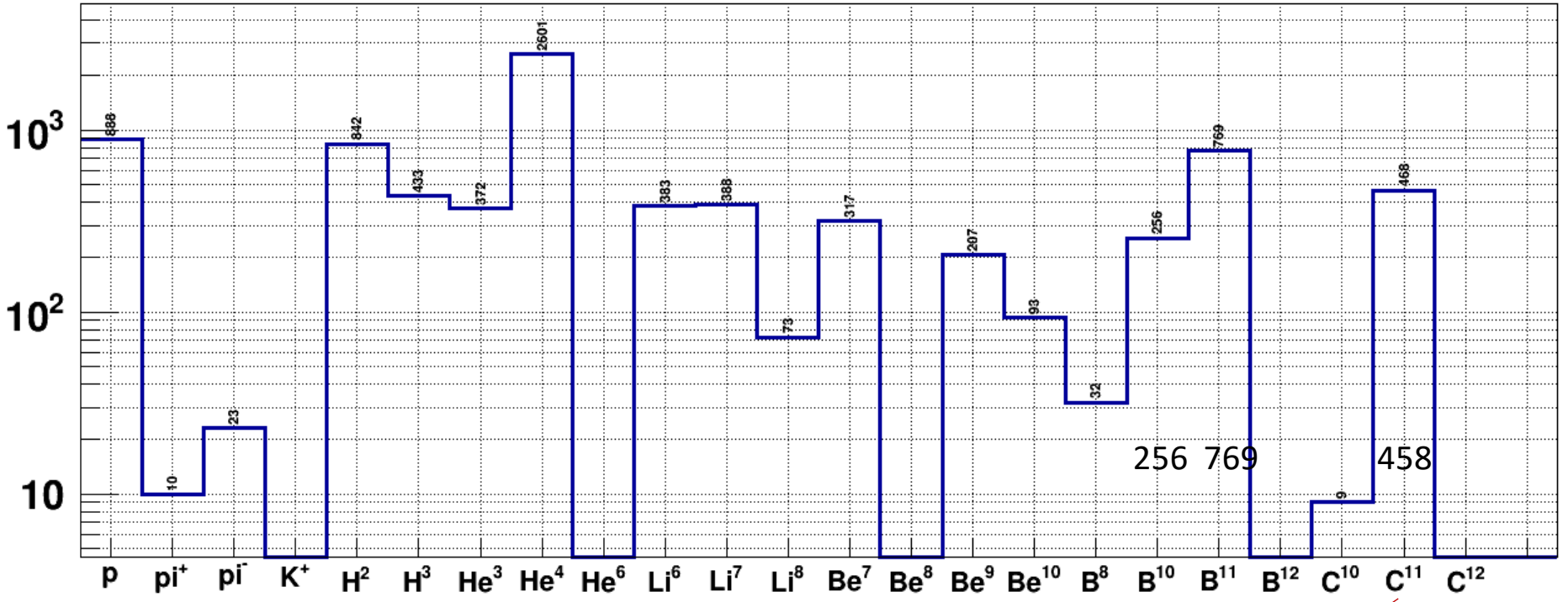


A/Z = (xDCH +(tgX(Si)-tgX(DCh)*k1)*k2 +k3
k1 = 1470.88, k2 = 0.026106, k3 = 4.33385 +0.18;

DCM-SMM simulation in DCH



Number of particles in DCH if **protons** in both arms (left & right Tofs)



$$\frac{B^{10}}{B^{11}} = 0.33$$

Generator author checked source files :
For example event 68445: 12C + p -> 11C + p + p + pi-
Reaction where a neutron interacts with a proton : n + p -> p + p + pi-

^{11}B

$p + {}^{12}C \rightarrow {}^{11}B + 2p + X$

elastic: $pp \rightarrow pp$

inelastic: $pp \rightarrow ppX$:

$\rightarrow p\Delta^{+} \rightarrow pp\pi^{0}$

$\rightarrow pp\ \pi^{0}$

^{11}C

$p + {}^{12}C \rightarrow {}^{11}C + 2p + X$

inelastic: $pn \rightarrow ppX$

$\rightarrow p\Delta^{0} \rightarrow pp\pi^{-}$

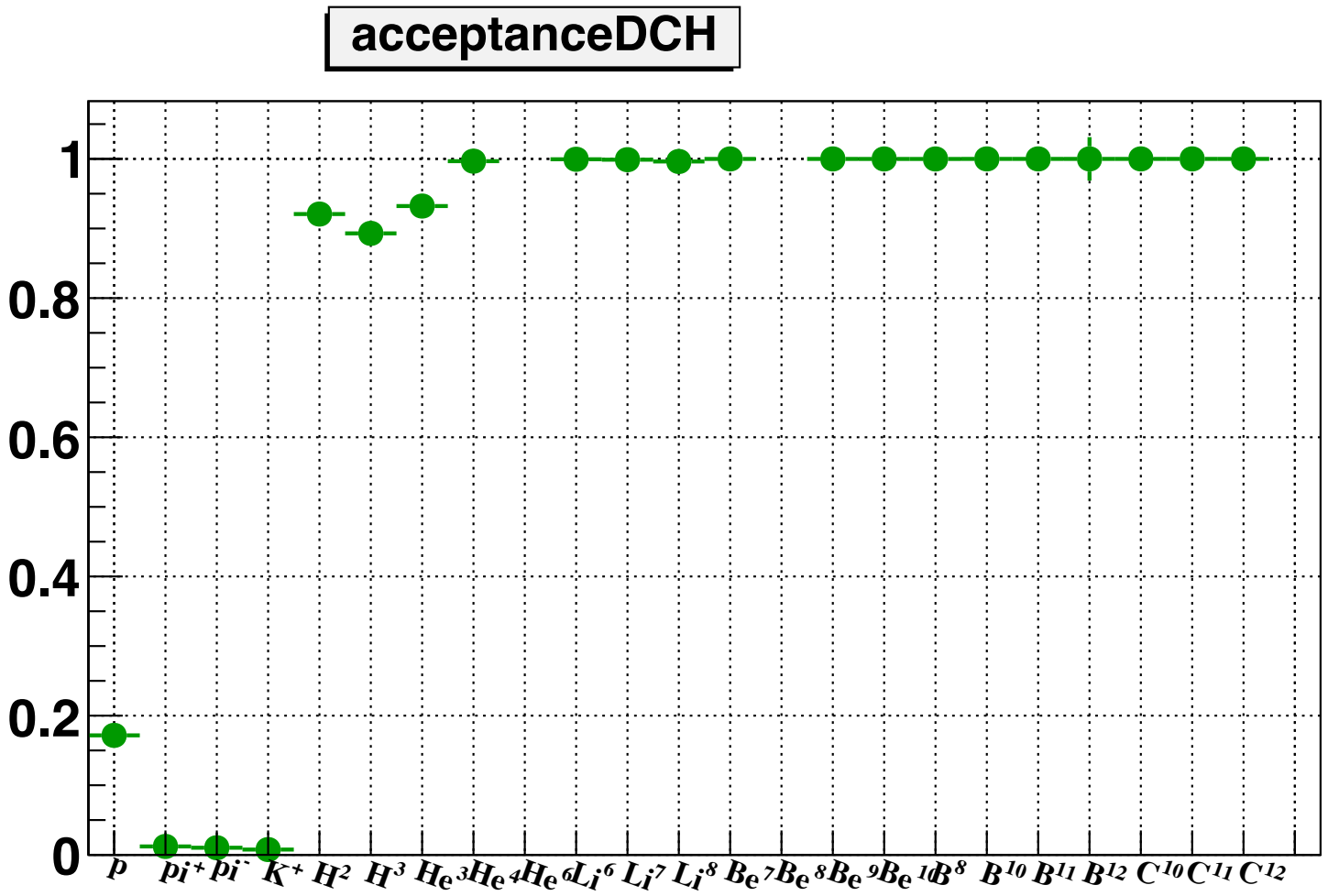
$\rightarrow\ \Delta^{+}\Delta^{0} \rightarrow pp\pi^{-}$

$\rightarrow\ \Delta^{++}\Delta^{-} \rightarrow pp\pi^{-}$

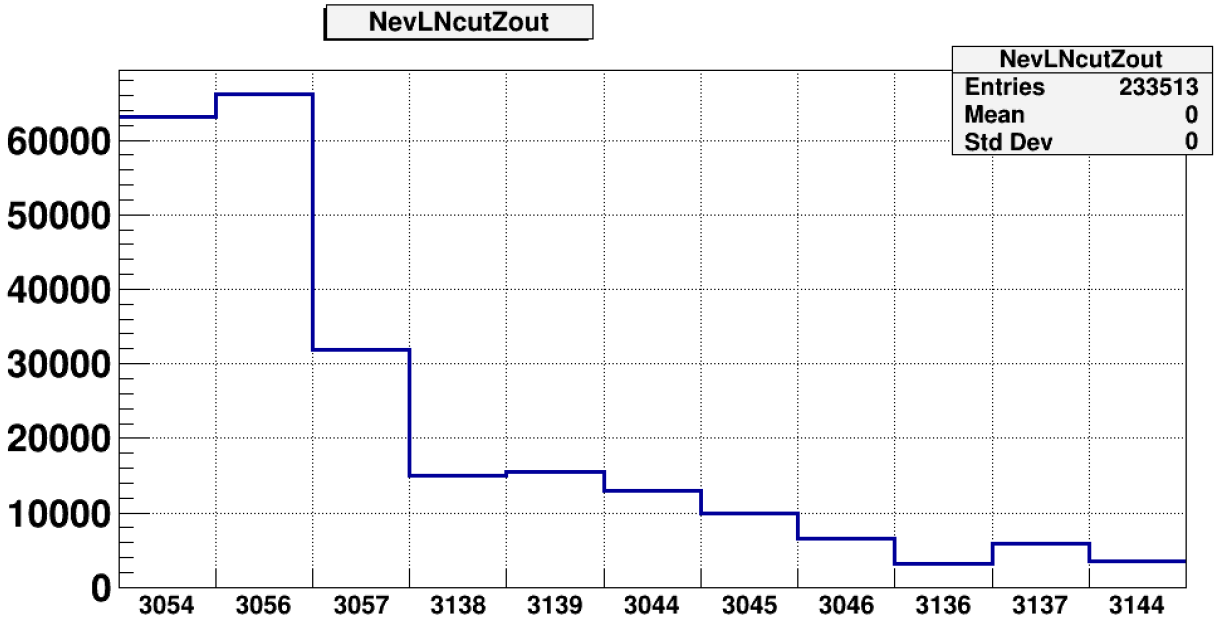
$\rightarrow\ pp\ \pi^{-}$

Cross sections ratio

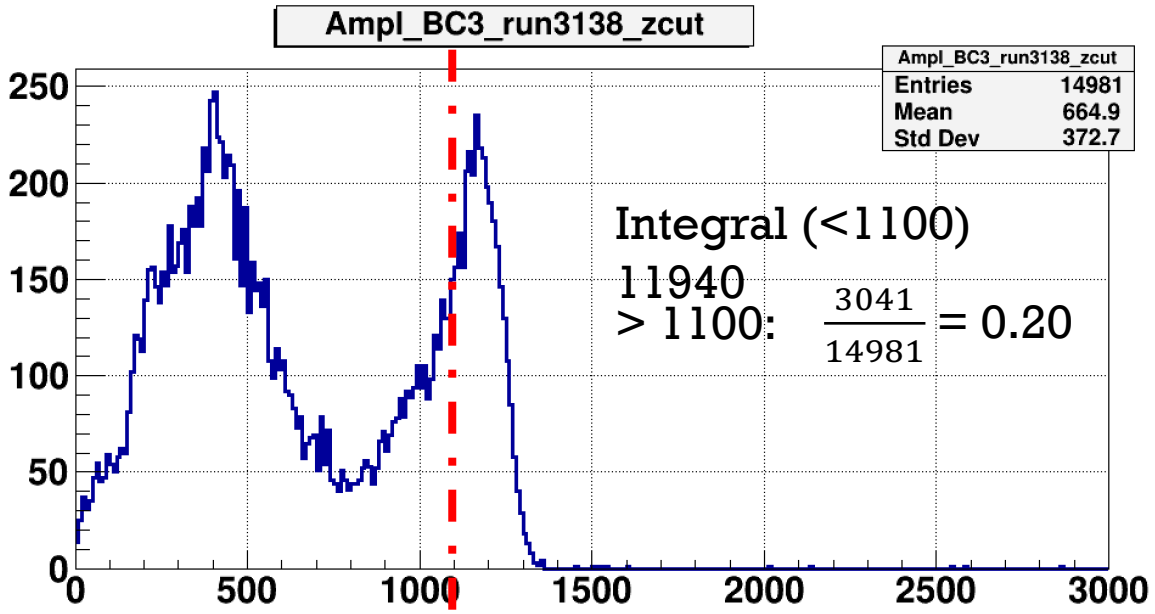
$\sigma_{el}/\ \sigma_{in} = 0.46$

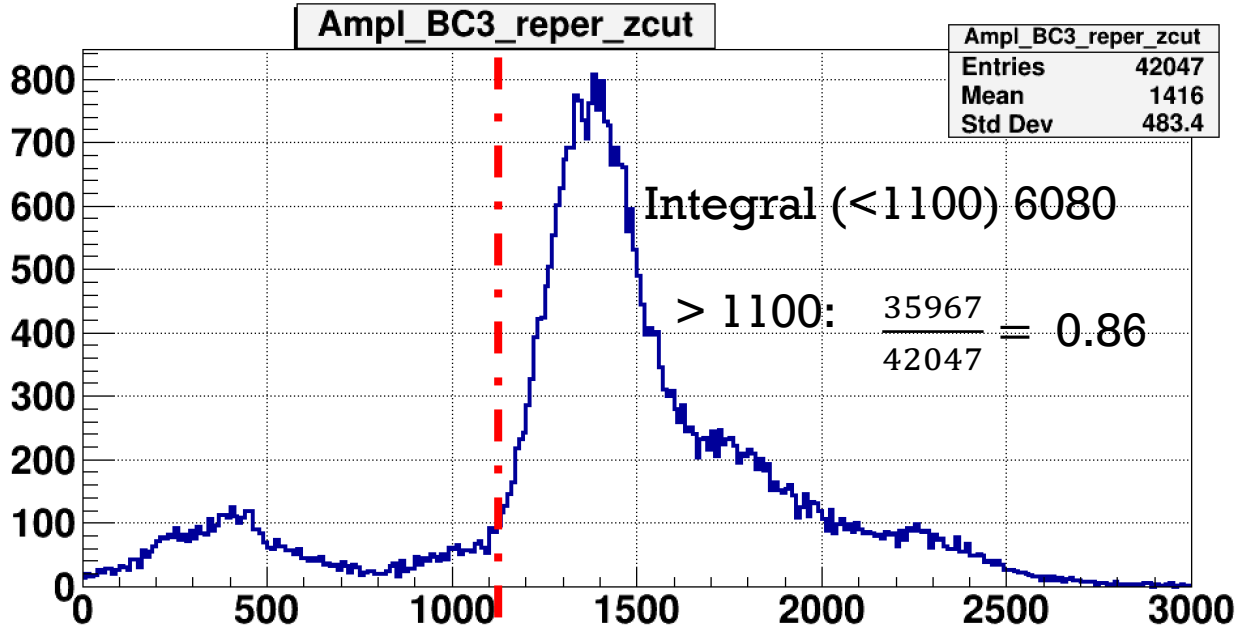


$$\frac{\text{Number of particles in } \textbf{DCH} \text{ w/o conditions}}{\textbf{Number of particles in the target region}}$$



BC1,2,3,4 – time cut
!VETO - time cut
T0 – 1 pic cut
Zout < 4.4





K = 2.0(!)

AMPCUT FOR BC3 = 1100