R^3B Analysis Meeting

S522 Update:

-FOOT vertex reconstruction

-MDF tracking

-(*p,2p*) identification

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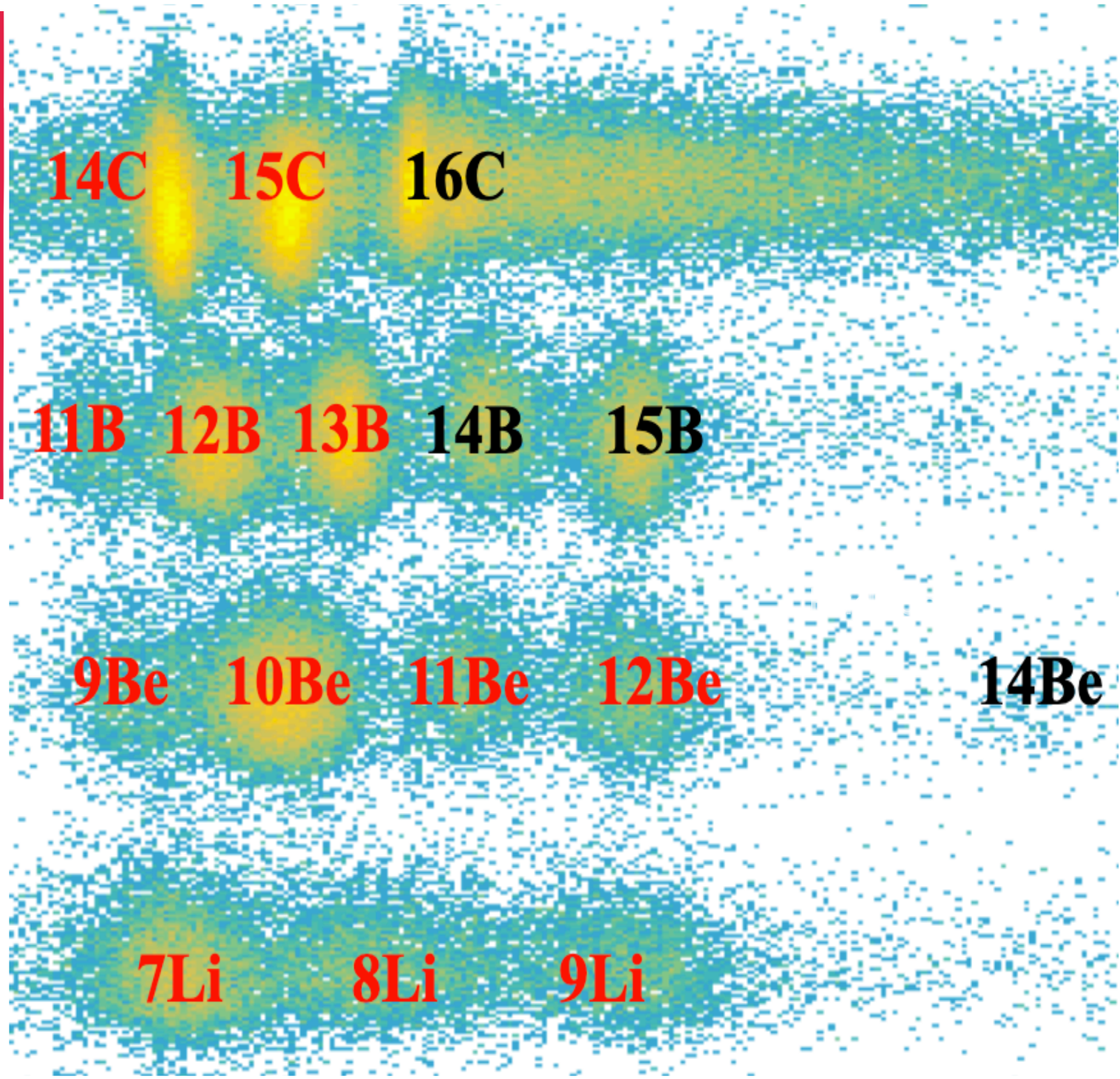
Supervisors

A.Corsi

A.Revel

Budapest

25th May 2023



Outline

Introduction

- Short Range Correlations (SRC);
- Motivation and goals of the experiment.

Experimental Set up

- R^3B Set up and (p,2p) kinematics.

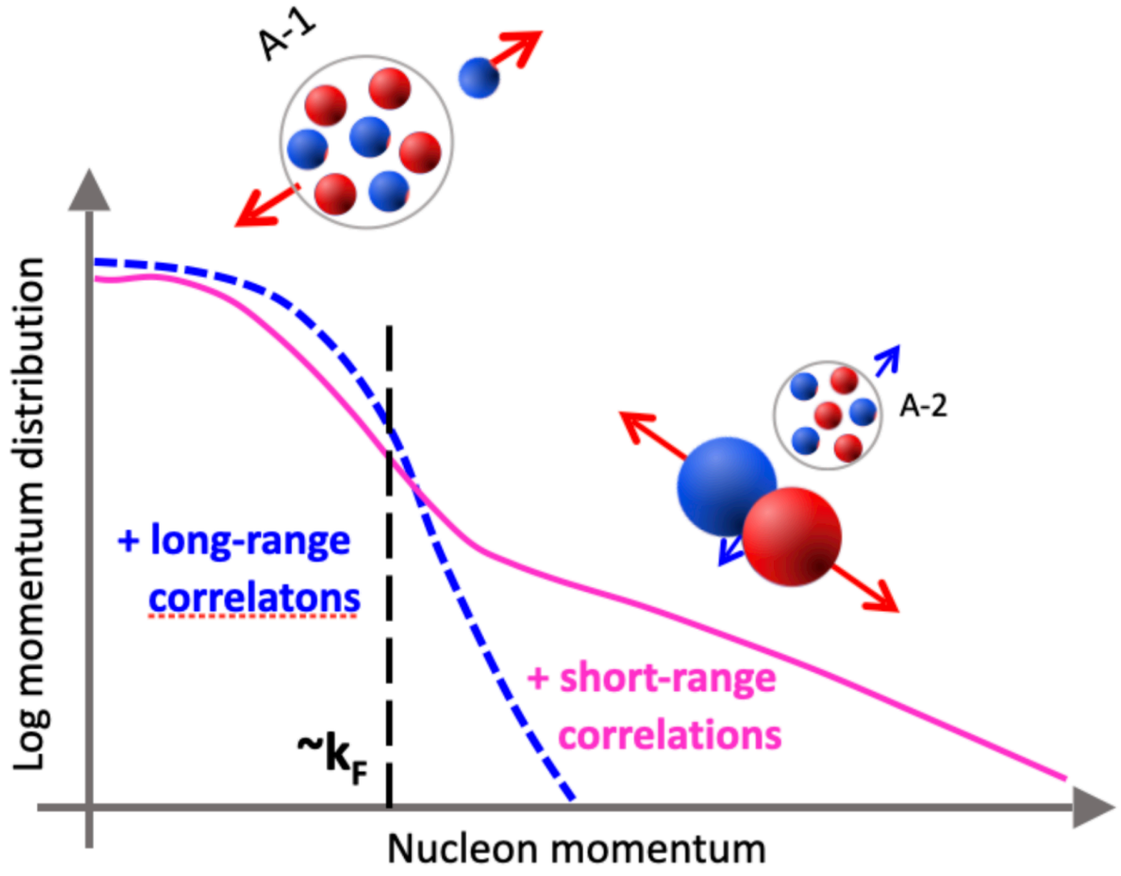
Calibration and analysis

- Vertex reconstruction FOOT-CALIFA
- Fragments identification with MultiDimensional Fit (MDF) functions;
- (p, 2p) analysis.

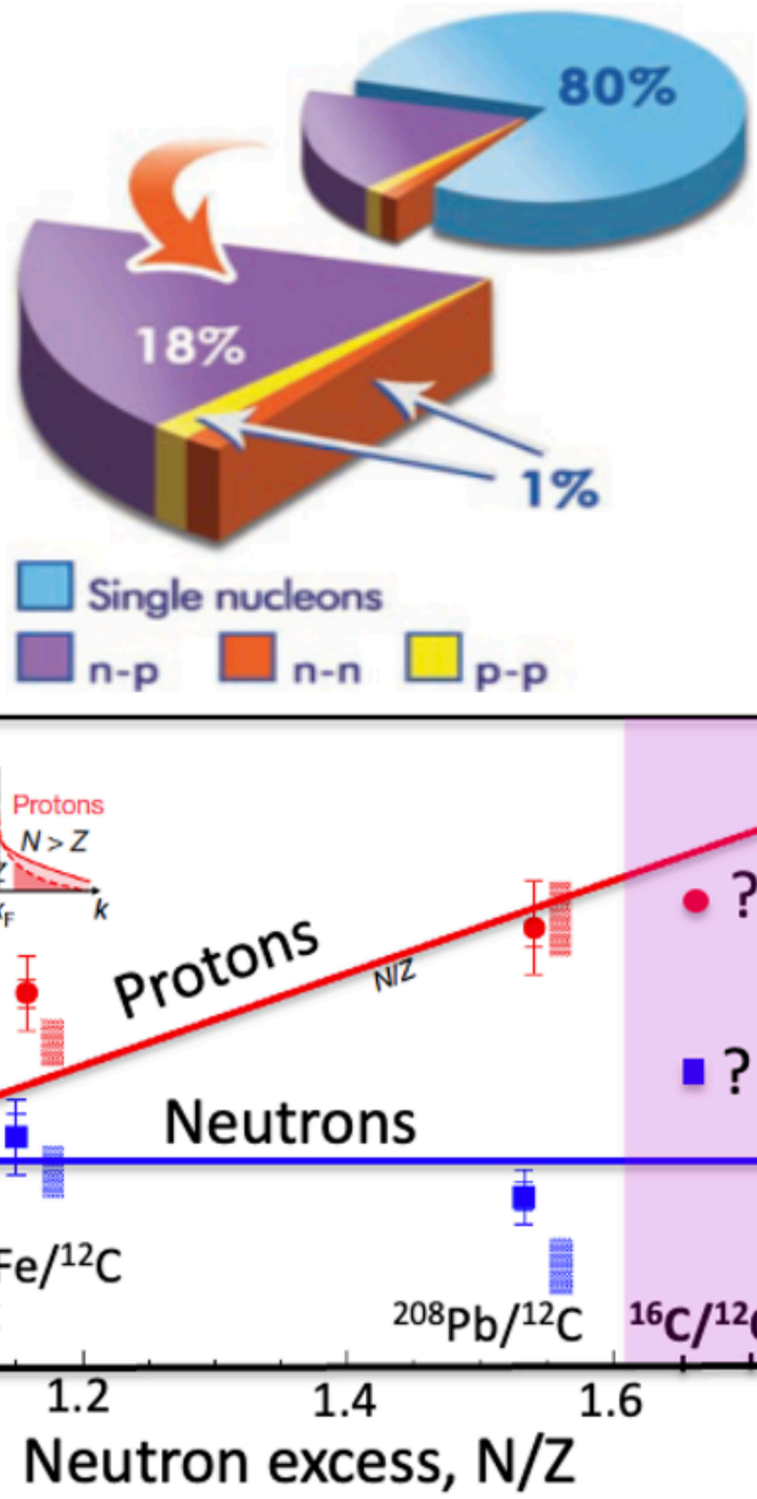
Perspectives

PROBING SRC

- **High relative momentum and low centre of mass (c.m.) momentum pairs**;
- SRC are mainly proton-neutron (pn) pairs;
- pp/pn ratio does not change with A;
- The fraction of high momentum protons increase with N/Z.



O. Hen et al. (CLAS Collaboration), Science, 346 (6209):614, 2014.



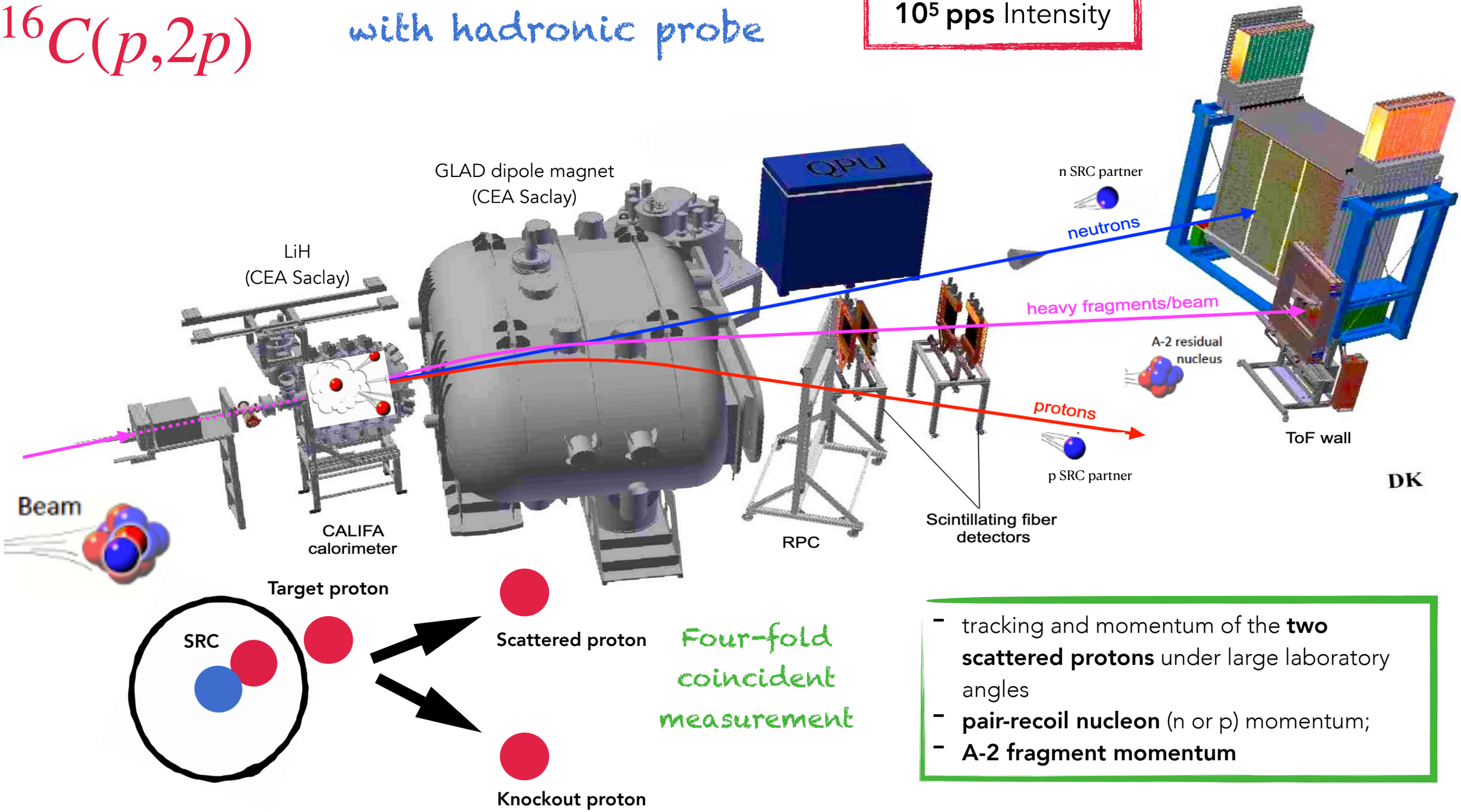
Adapted from M. Duer et al. (CLAS Collaboration), Nature, 560:617, 2018.

Experimental Set up

$^{12}C(p,2p)$
$^{16}C(p,2p)$

inverse kinematics
with hadronic probe

1.25 GeV/u
10^5 pps Intensity

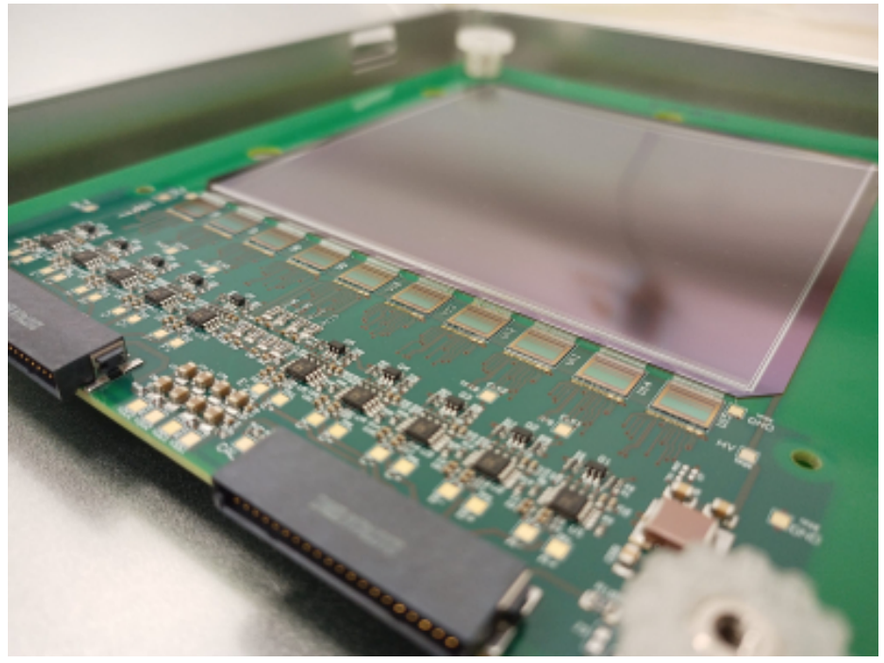


Four-fold
coincident
measurement

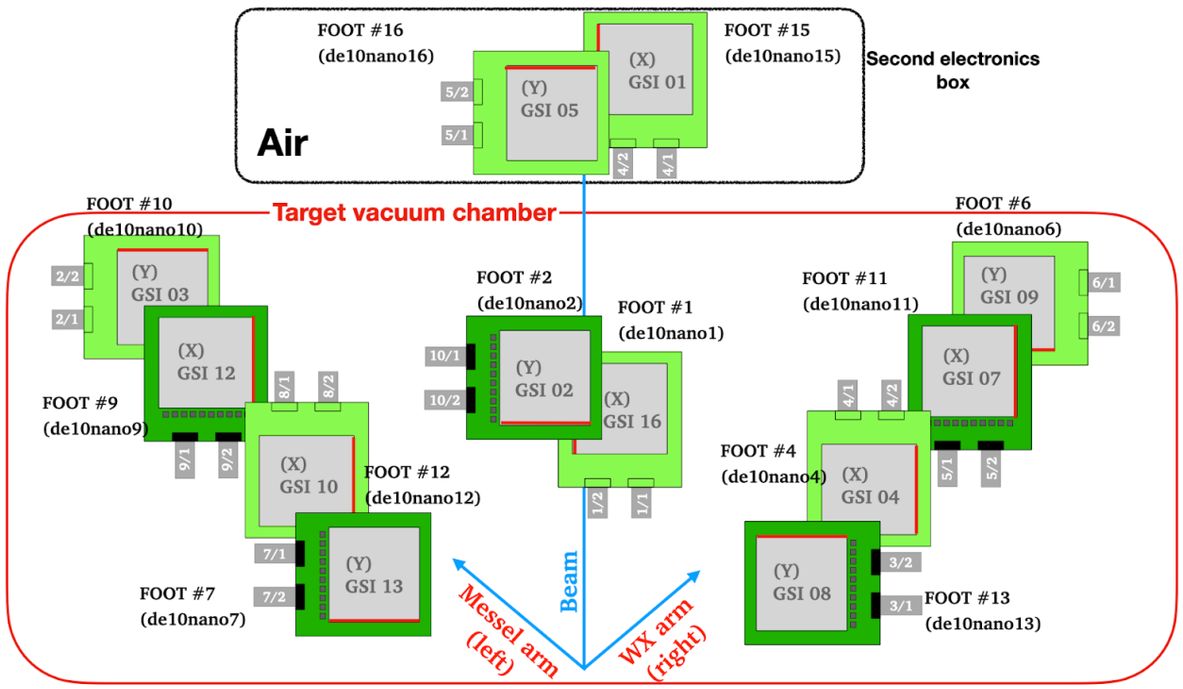
- tracking and momentum of the **two scattered protons** under large laboratory angles
- **pair-recoil nucleon** (n or p) momentum;
- **A-2 fragment momentum**

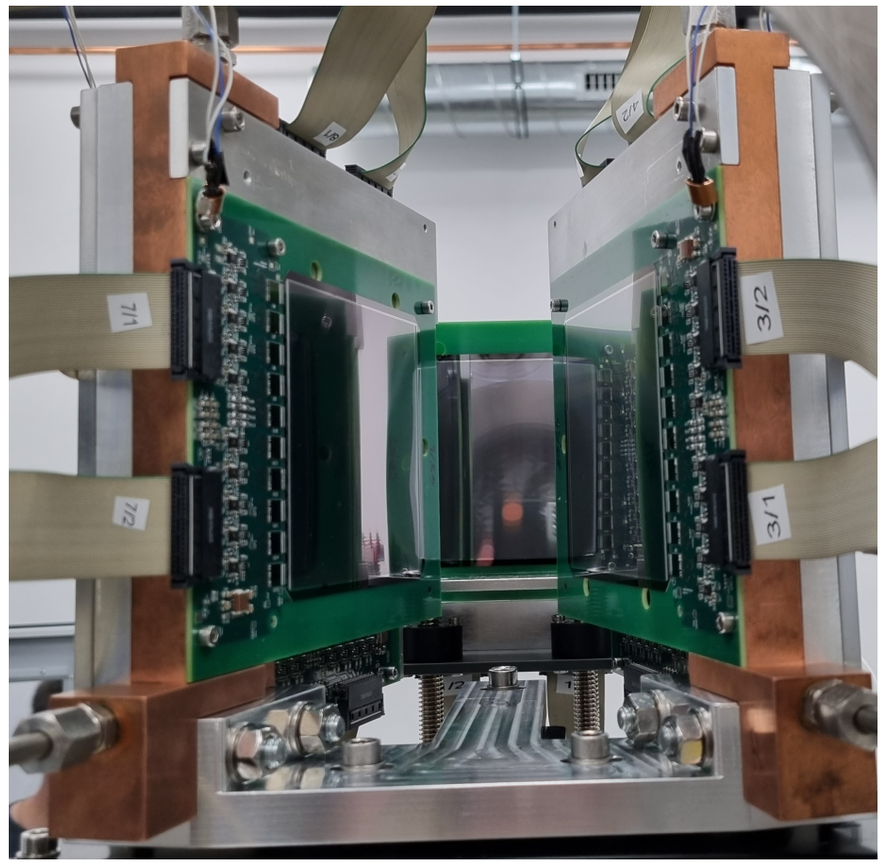
FOOT

- **New single-sided silicon tracking system** used for the first time in R^3B for proton tracking, fragments ID and vertex reconstruction ;
- 640 strips, 10x10 cm^2 active area;
- 150 um thick;



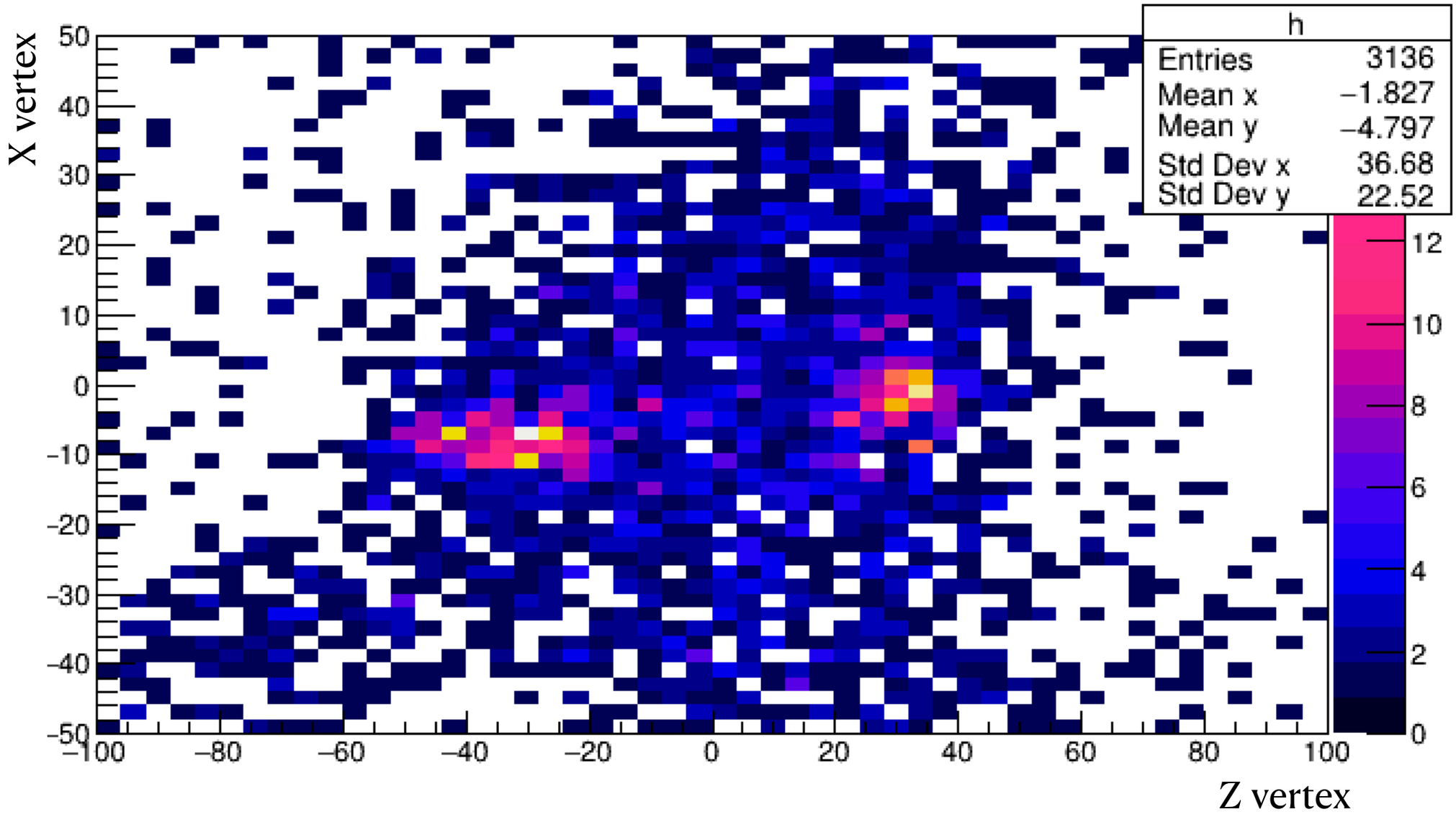
FOOT Mapping s509/s522





Previously…

Vertex situation at the R^3B Analysis Meeting in Catania (Nov 2022)

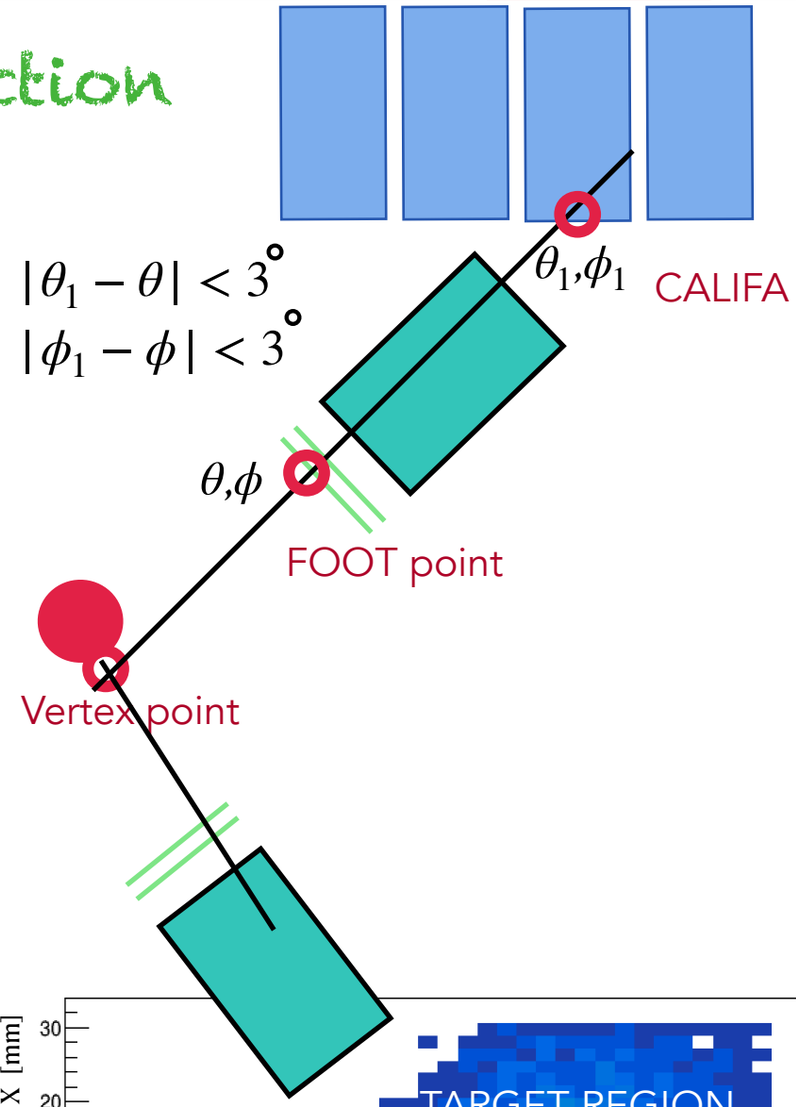


(p,2p): reaction vertex

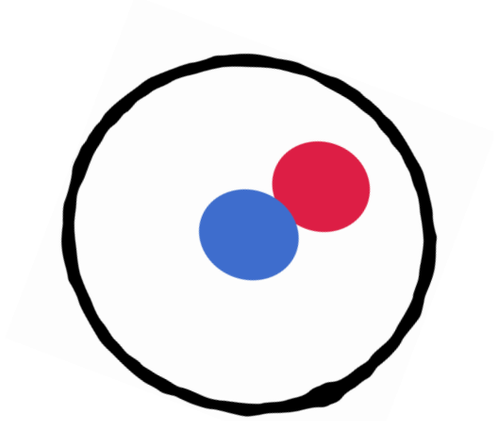
(p,2p) VERTEX reconstruction

Challenges

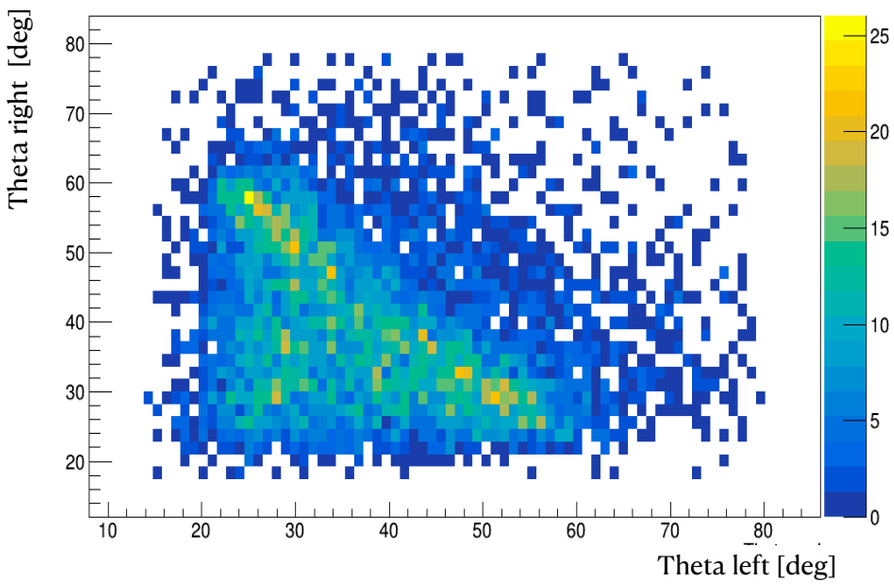
- High beam **energy** and **intensity**;
- High **background** and **noise** level (delta electrons and baseline fluctuations);
- Low proton **energy deposited**.

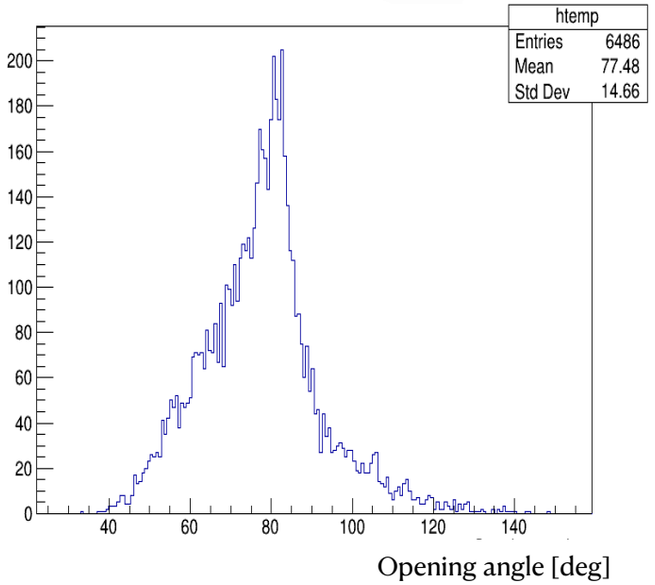


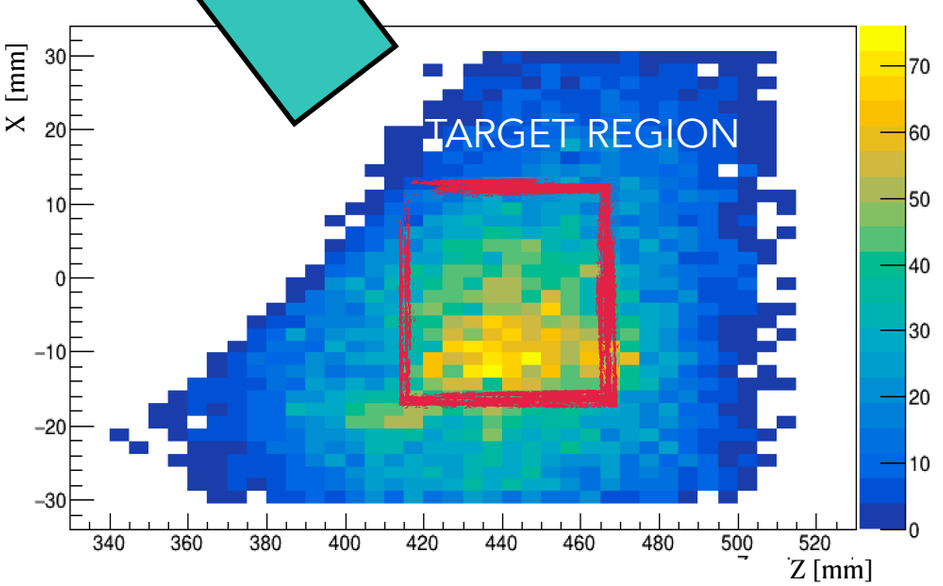
- ✓ **Minimum distance** between al possible combinations of FOOT tracks from the left arm and right arm;
- ✓ Matching with **CALIFA angles**.



p,2p kinematical region







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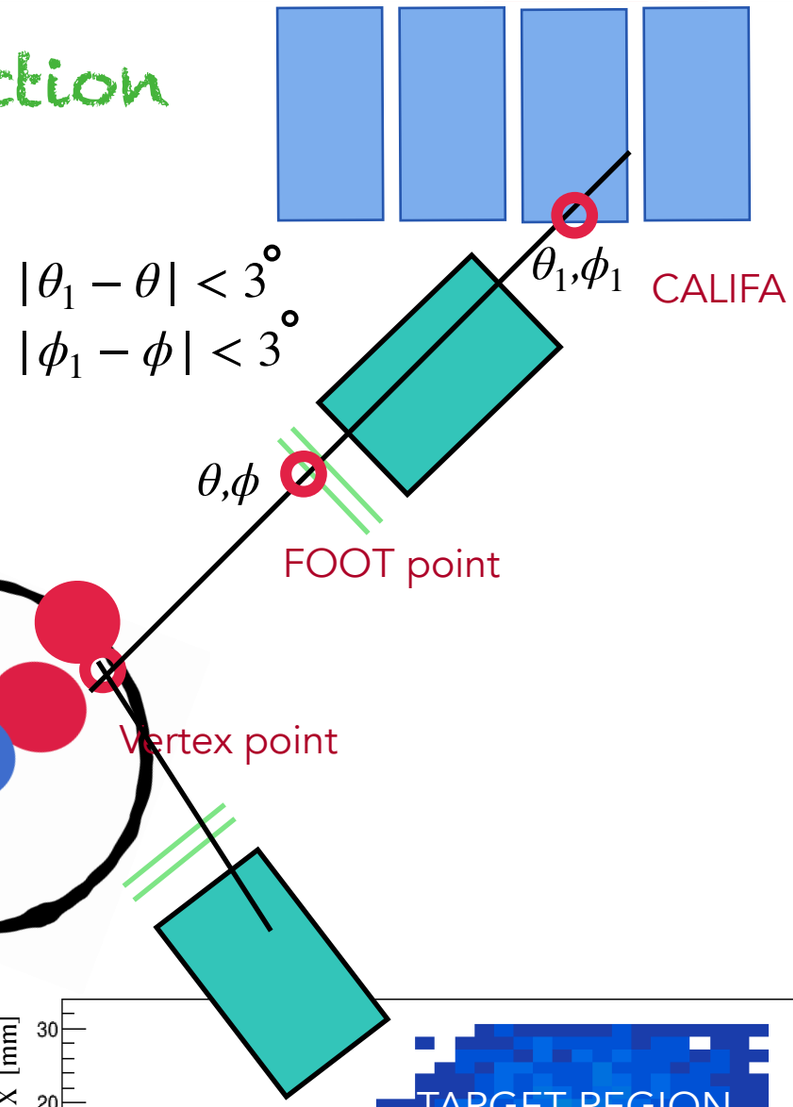

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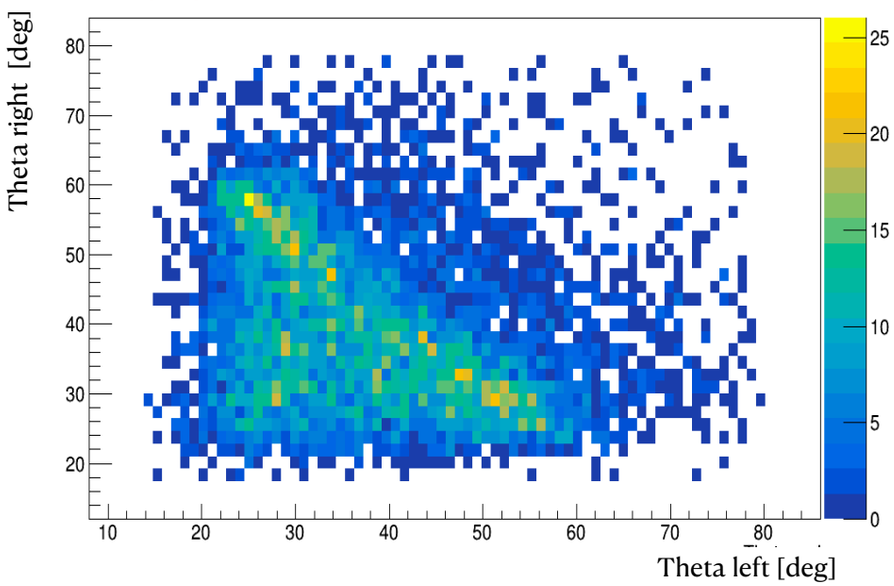

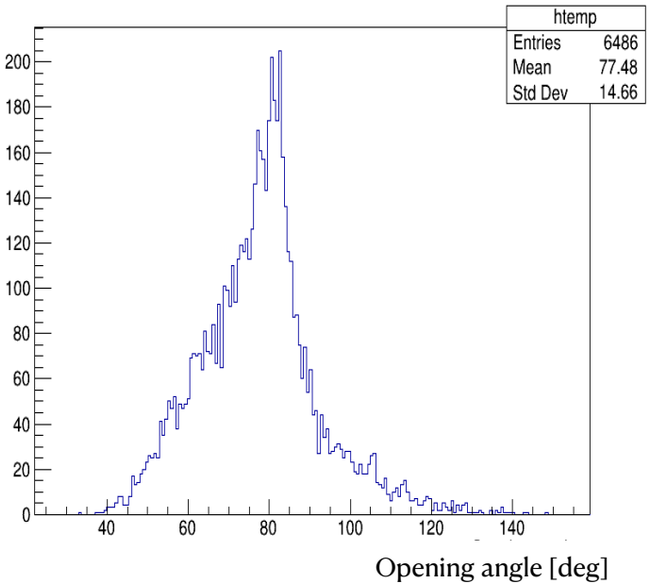

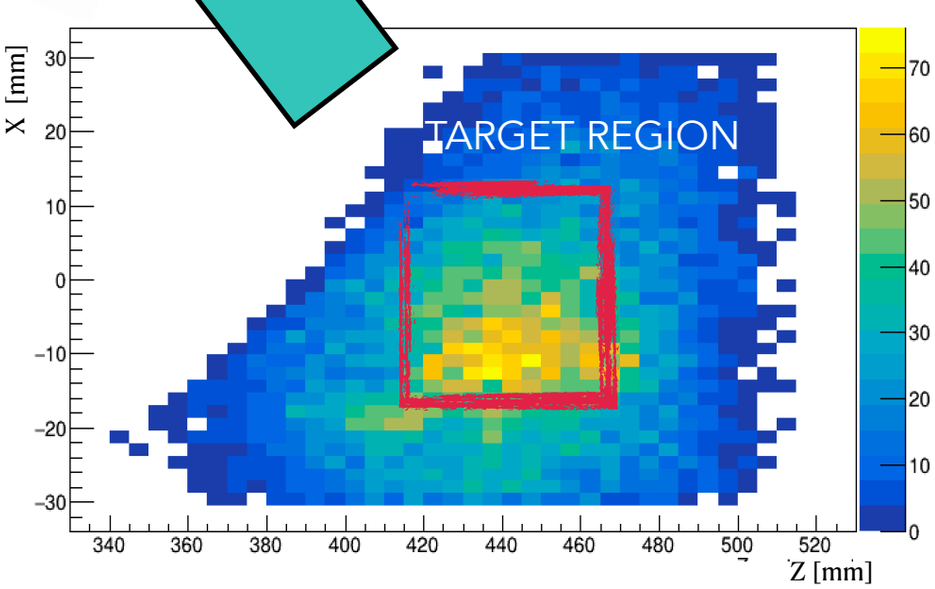

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(p,2p) VERTEX reconstruction

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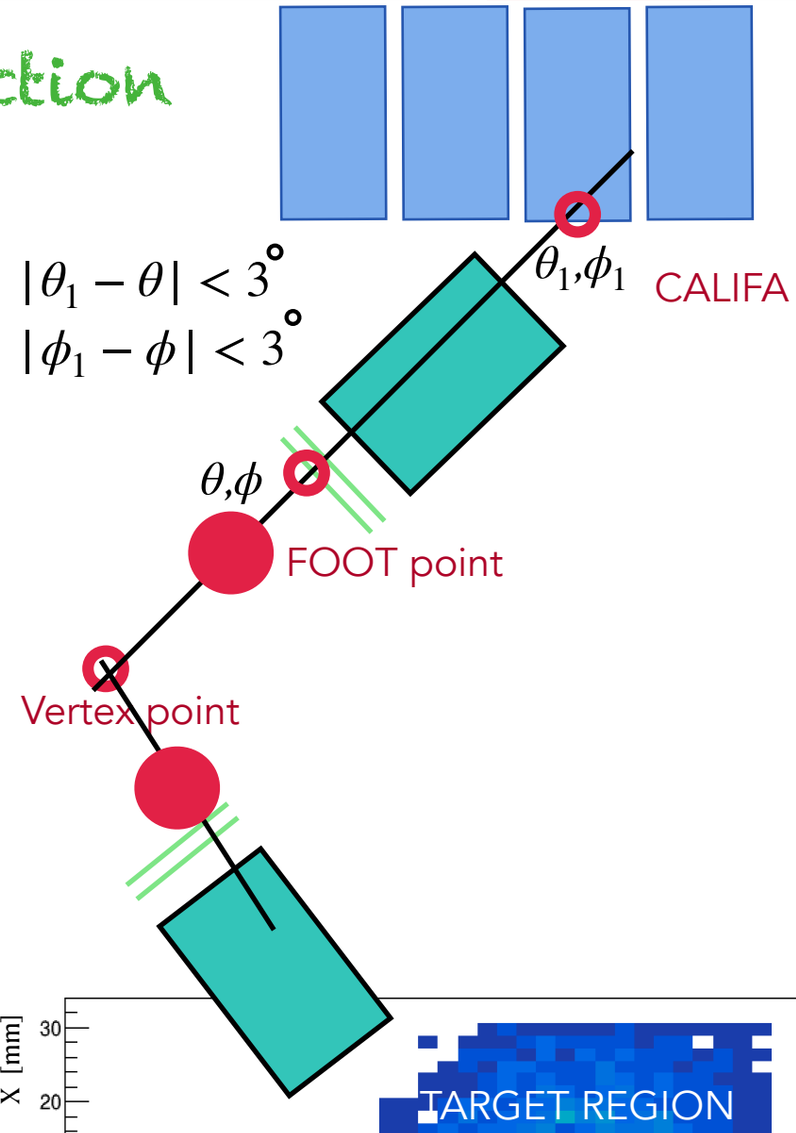

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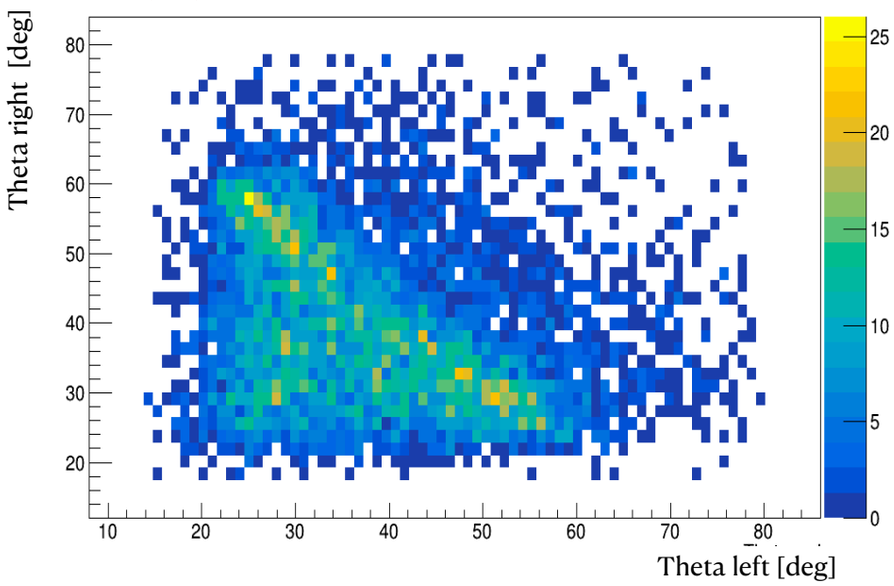
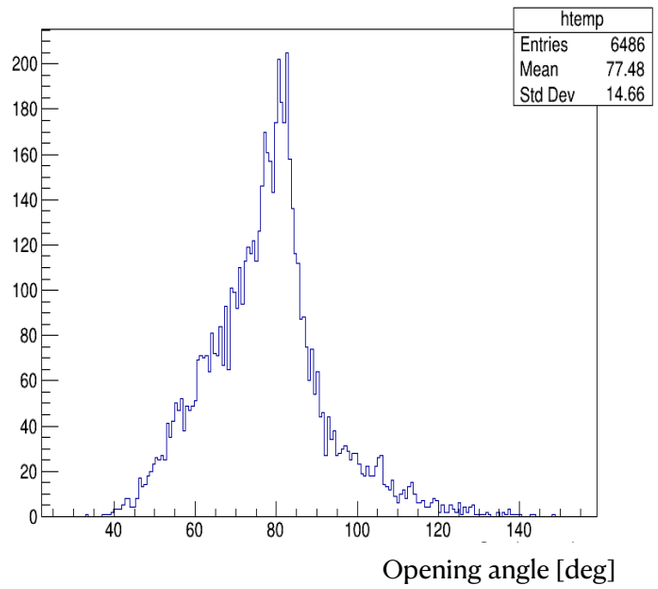
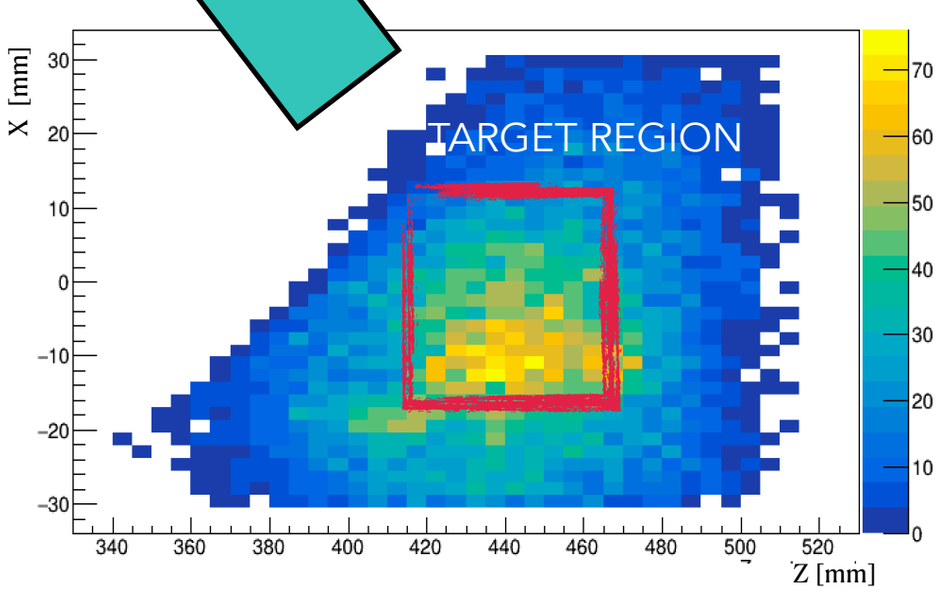
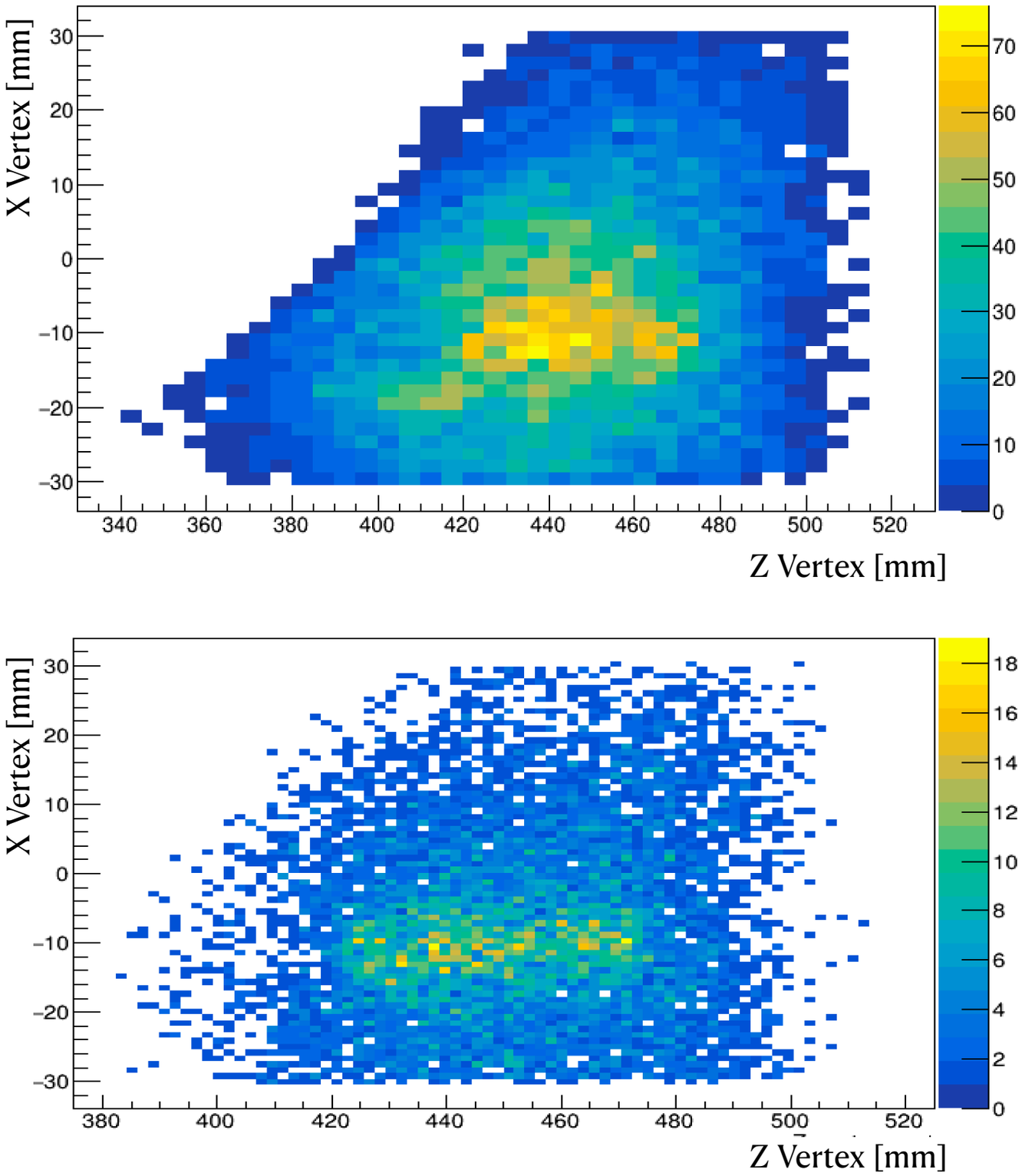






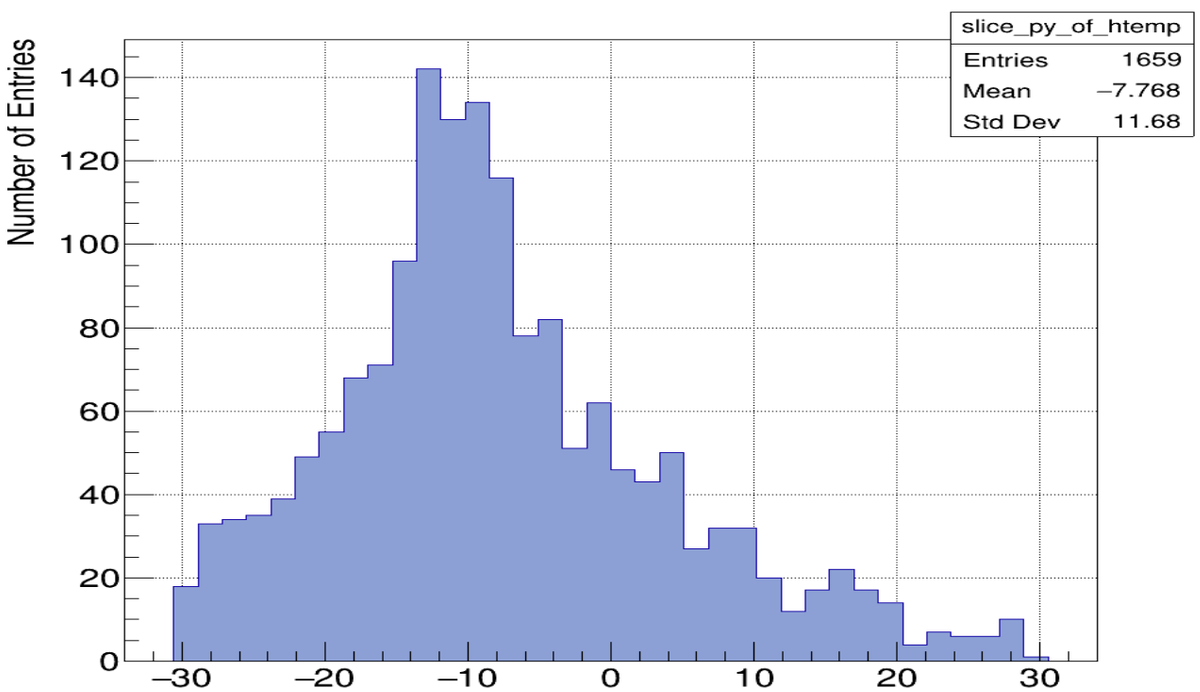
Vertex ^{16}C



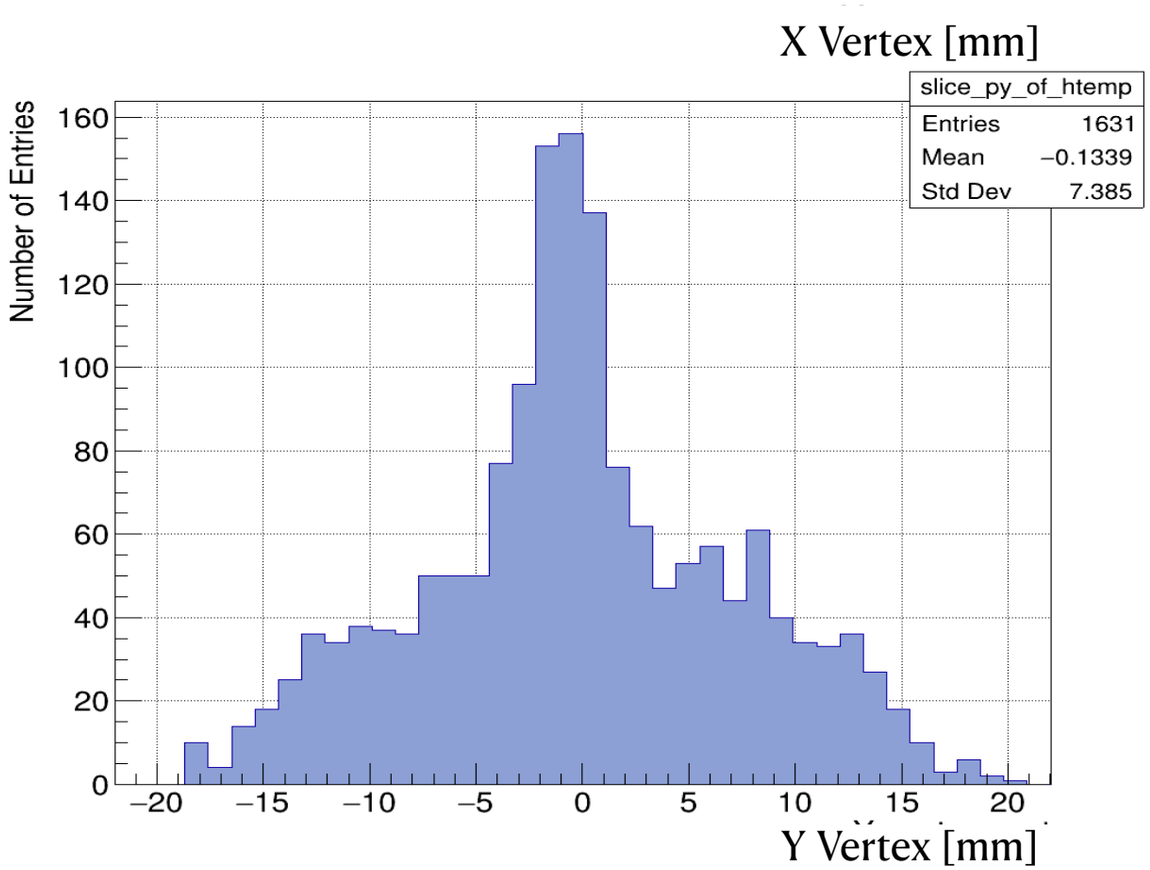
- X-Z correlation;
- No conditions applied;
- Beam was very close to the ring of the target.

- Condition on TOFD charge 5;
- Condition on minimum distance < 0.5 mm;

Vertex ^{16}C

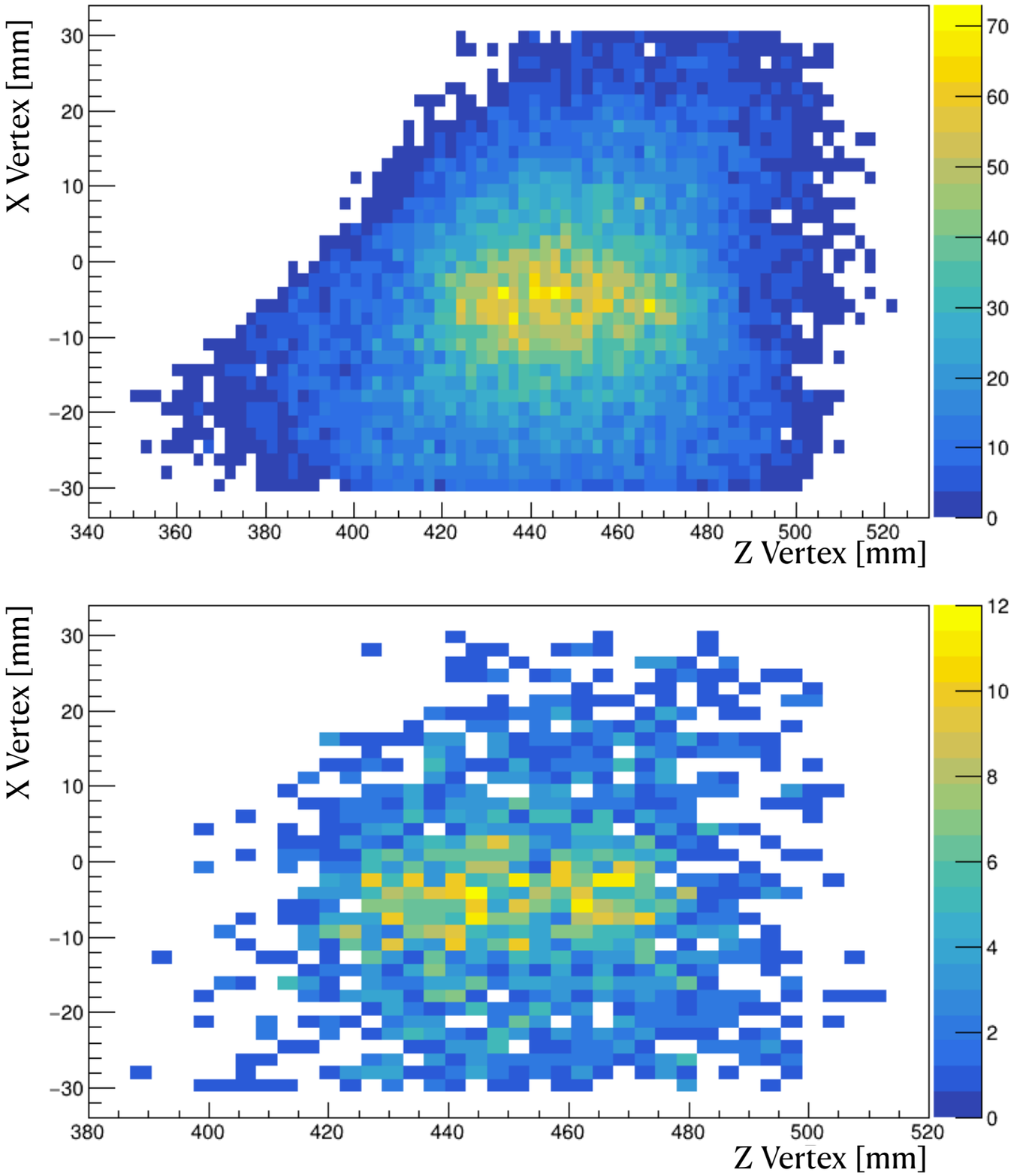


- Condition on TOFD charge 5;
- Condition on minimum distance < 0.5 mm;
- X vertex distribution centered at -10.01 mm;
- Ring of the target starts at -15 mm.



- Condition on TOFD charge 5;
- Condition on minimum distance < 0.5 mm;
- Y vertex distribution centered at -3.09 mm;

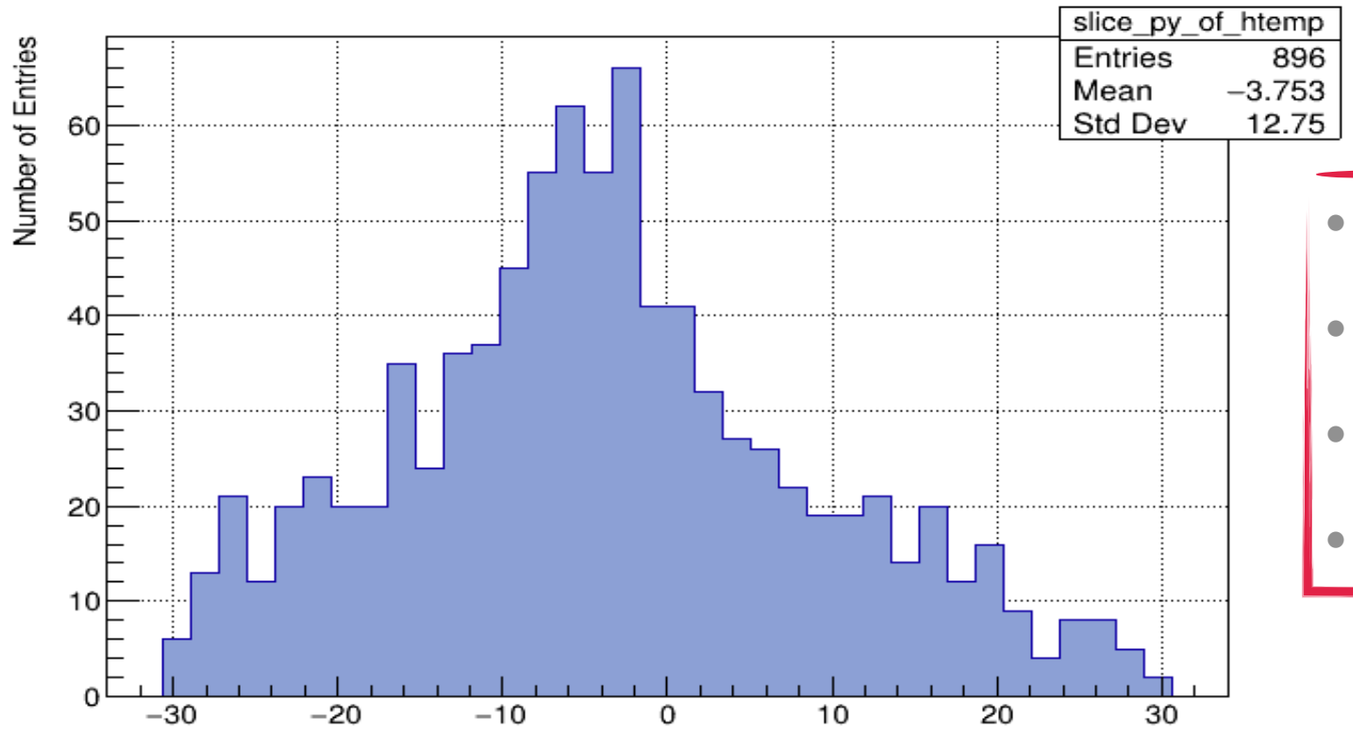
Vertex ^{12}C



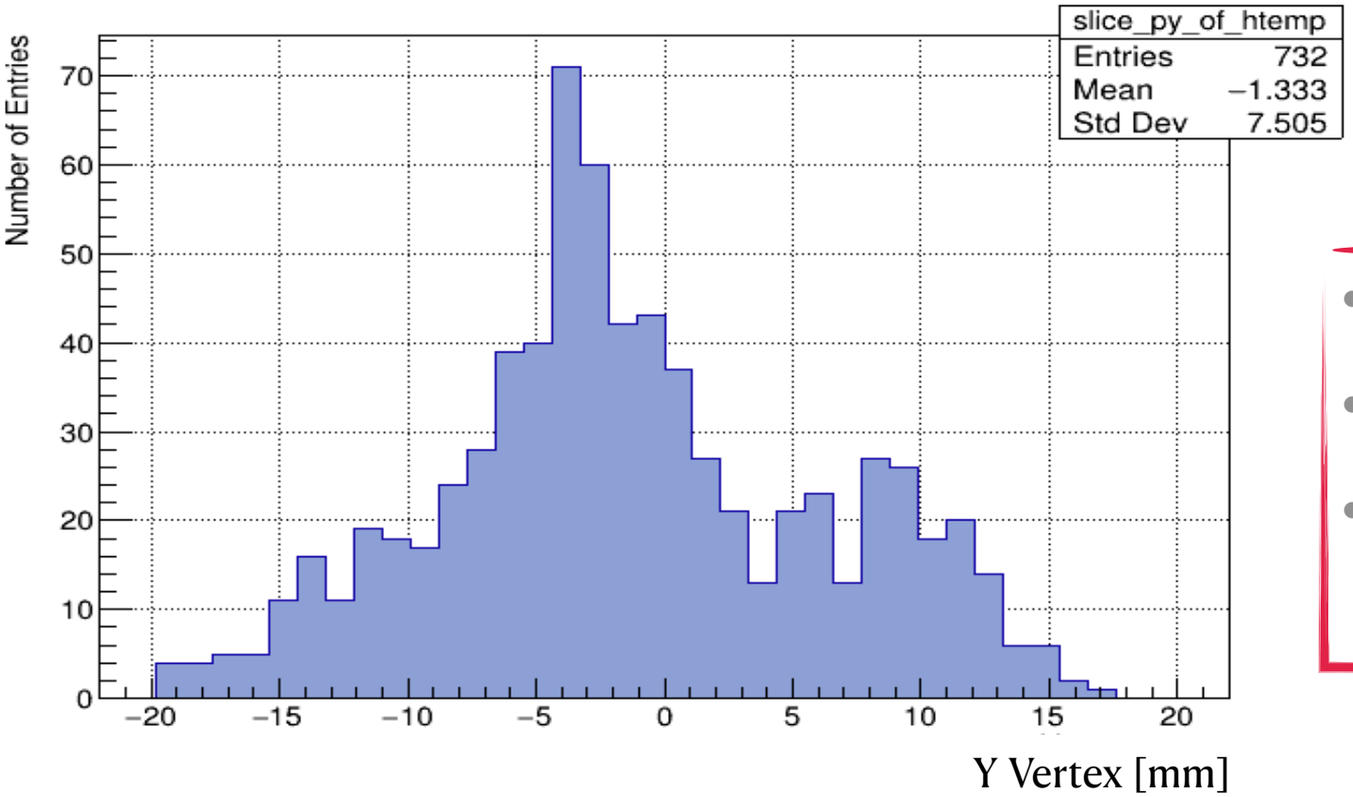
- X-Z correlation;
- No conditions applied;
- Beam was more centred at the centre of the target.

- Condition on TOFD charge 5;
- Condition on minimum distance < 0.5 mm;

Vertex ^{12}C



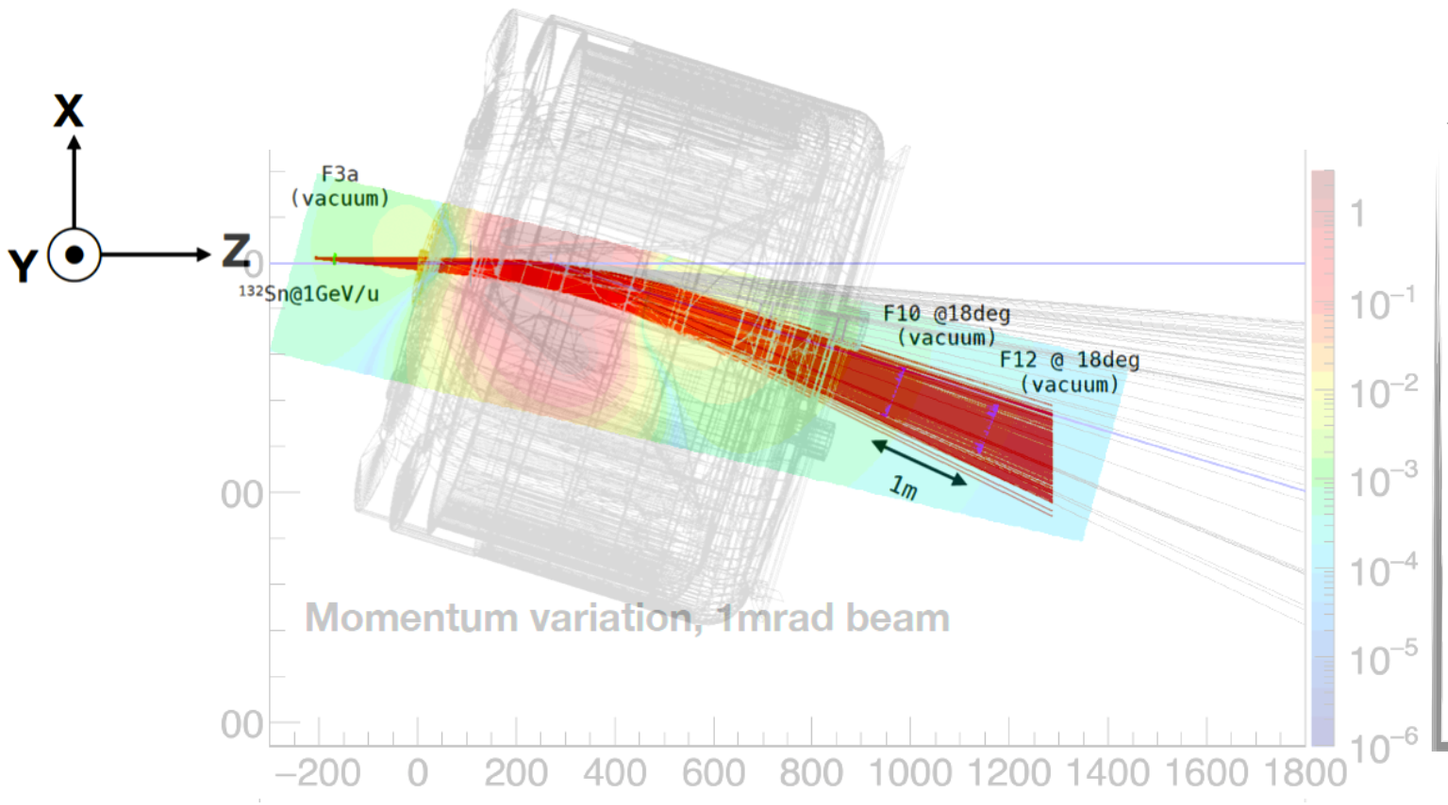
- Condition on TOFD charge 5;
- Condition on minimum distance < 0.5 mm;
- X vertex distribution centered at -3.03 mm;
- Ring of the target starts at -15 mm.



- Condition on TOFD charge 5;
- Condition on minimum distance < 0.5 mm;
- Y vertex distribution centered at -4.03 mm;

Data analysis: MDF Tracking

MDF

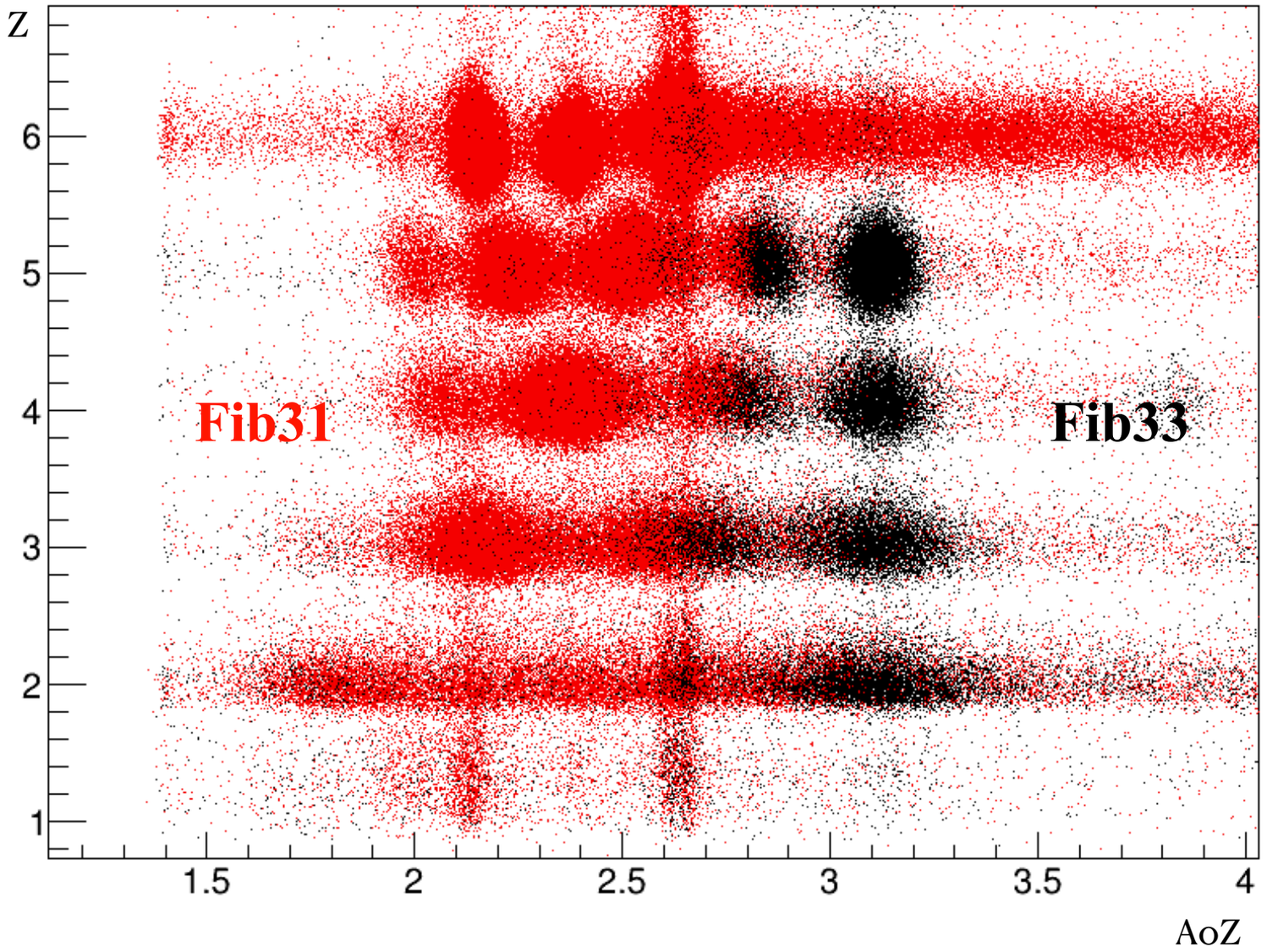


- Find an expression to correlate the independent observables (positions) with dependent quantity(momentum) with a **least squares fitting procedure**.
- The function can then be used to compute the quantity of interest (**PID, momentum, angles …**);

MDF Tracker

S522 fragments tracker

- Developed Tracker code for S522;
- Initially incoming with FOOT detectors-> High humber of global tracks multiplicity;
- Input vertex given by MWPC to have a view of the fragments detected and have an idea on the number of fragments;
- Put together tracks from Fib31 and Fib33;
- Alignment in progress.



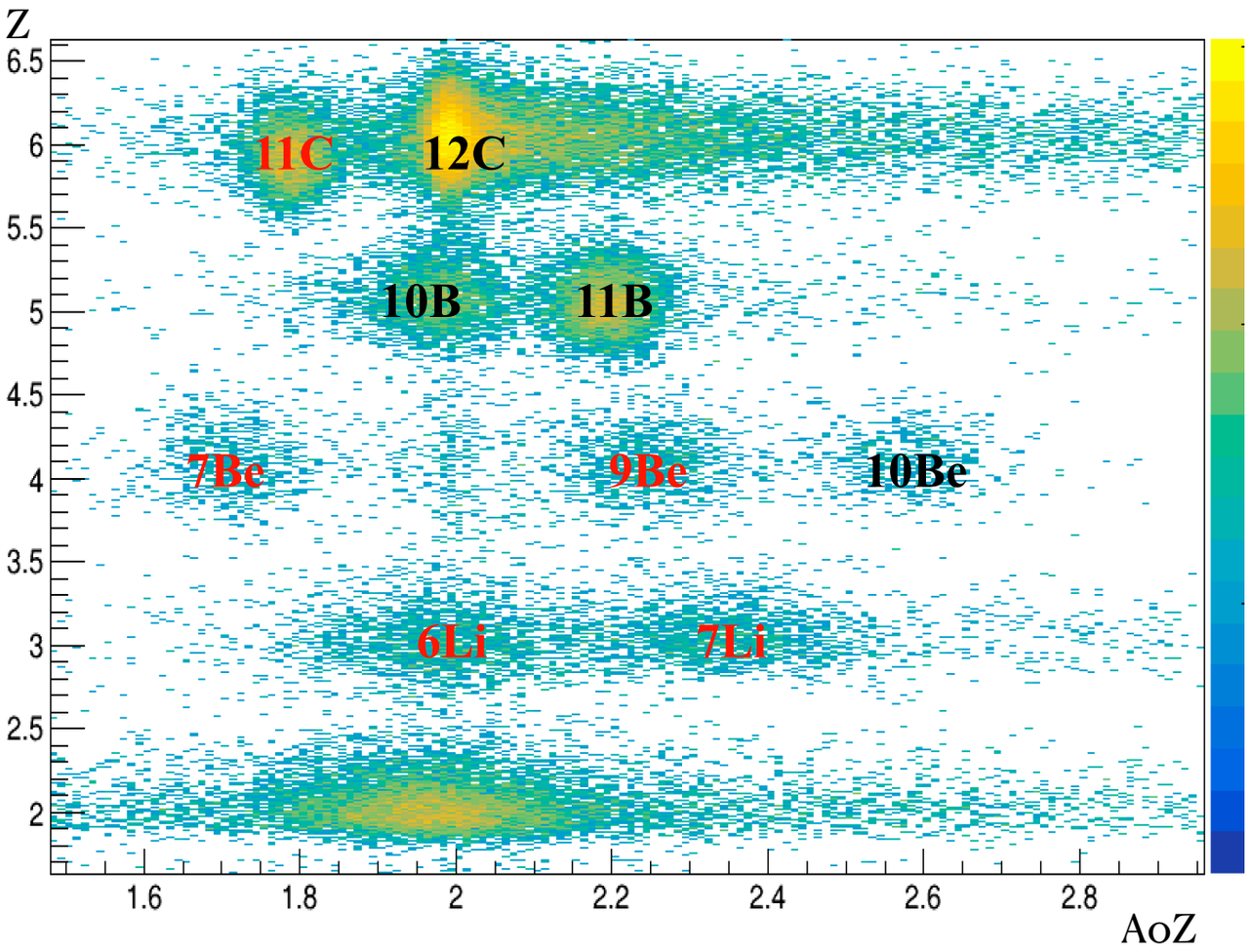
Fragments PID

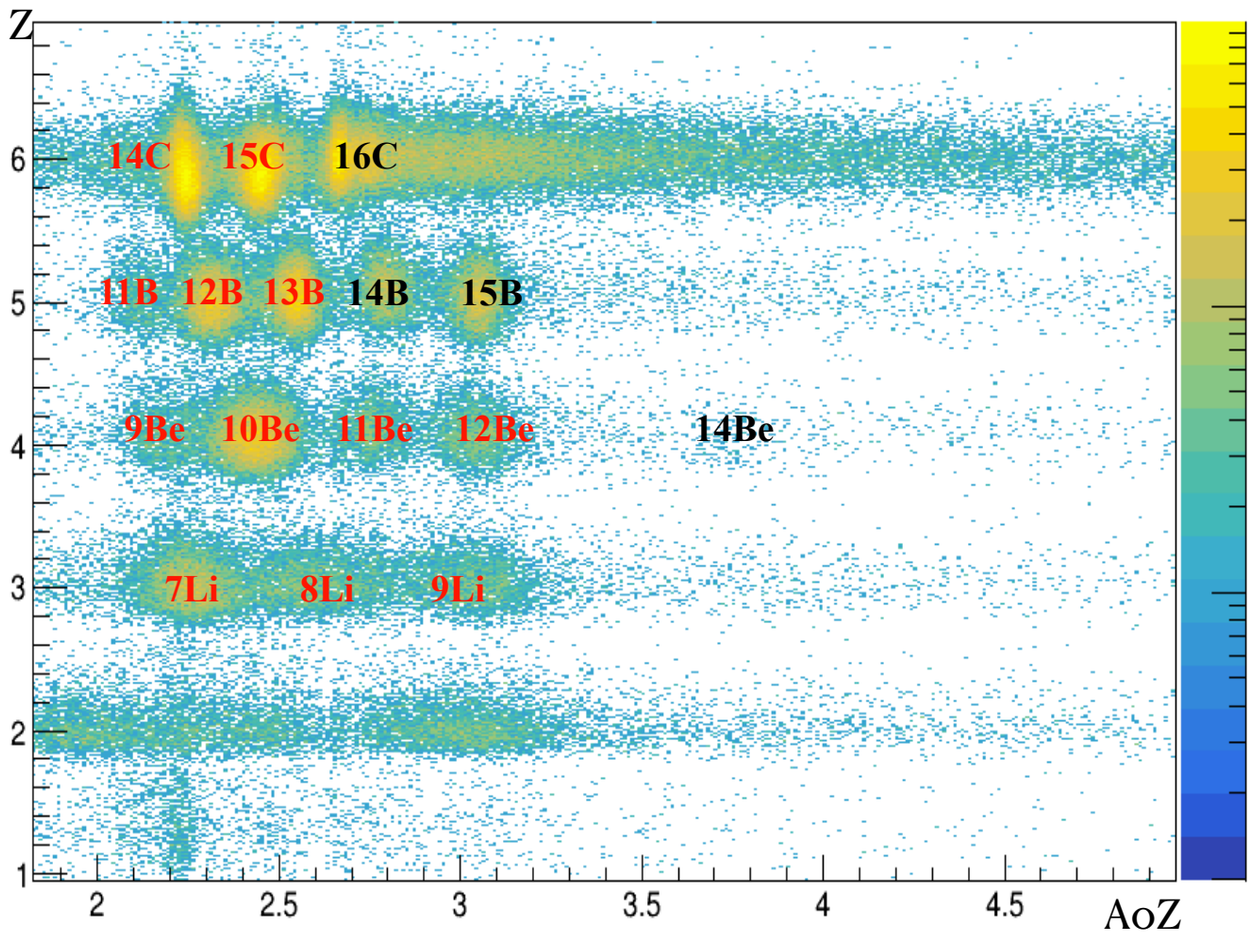
12C Fragments PID

% 10B	17%
% 11B	34%
% 10Be	4%

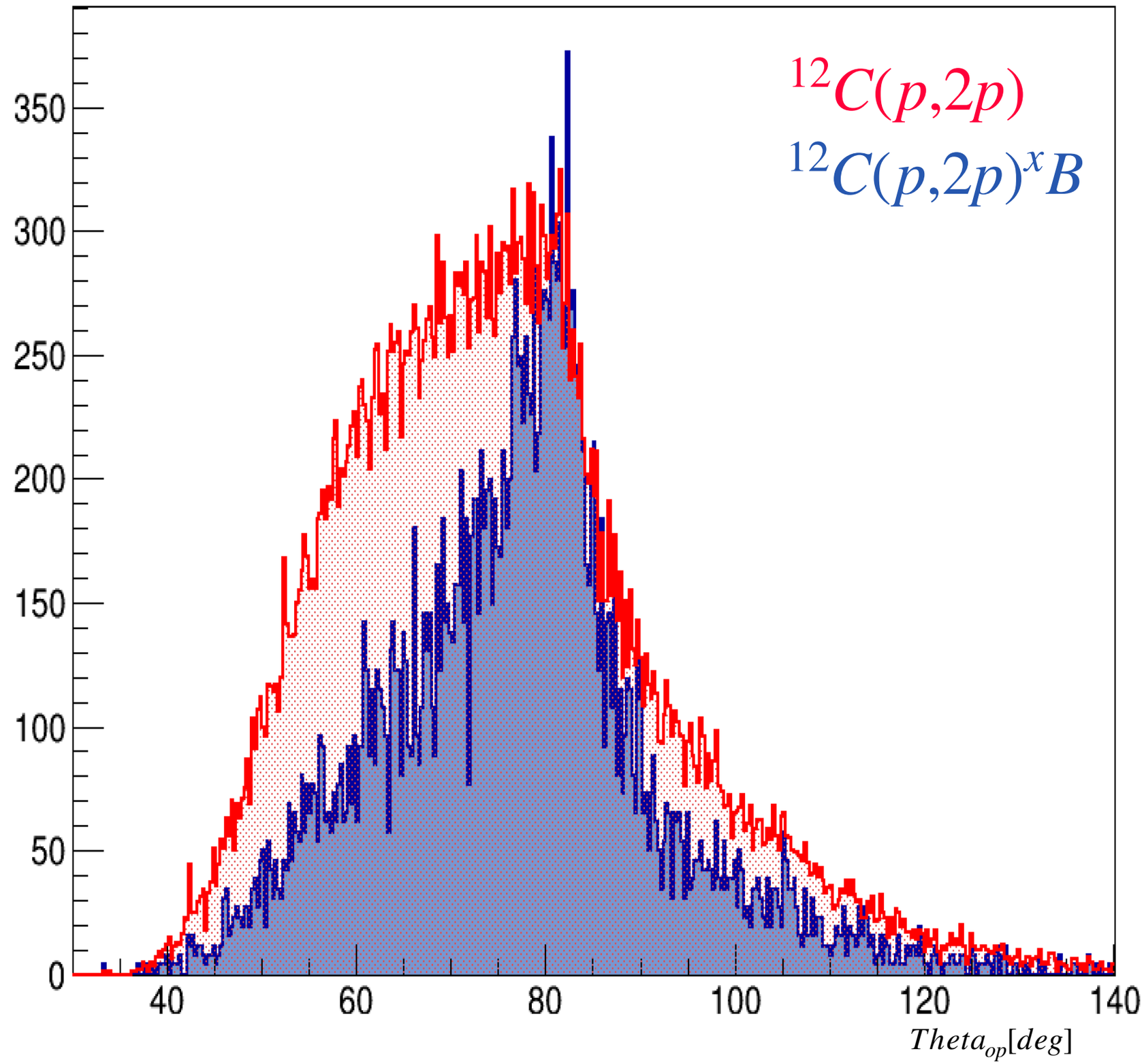
16C Fragments PID

% 14B	8%
% 15B	5%
% 14Be	0.4%





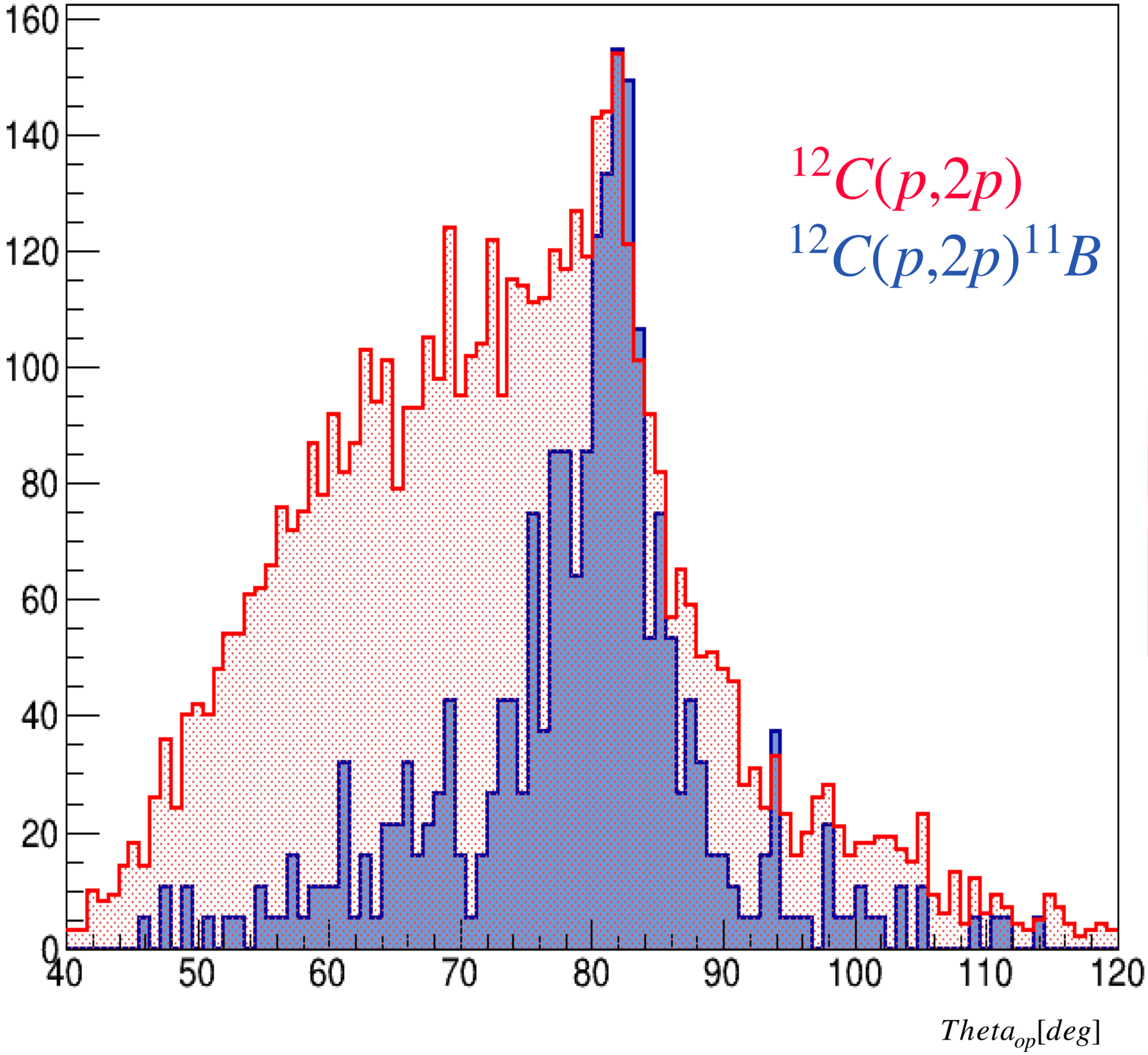
(p,2p) analysis for ^{12}C



Opening Angle

- PID for ^{12}C with vertex;
- Select the ^{x}B isotope;

(p,2p) analysis for ^{12}C



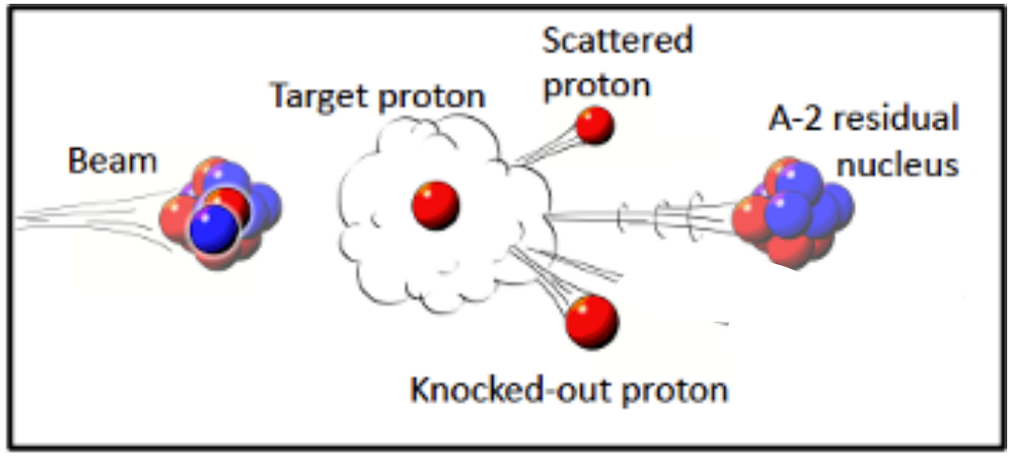
$^{12}C(p,2p)$

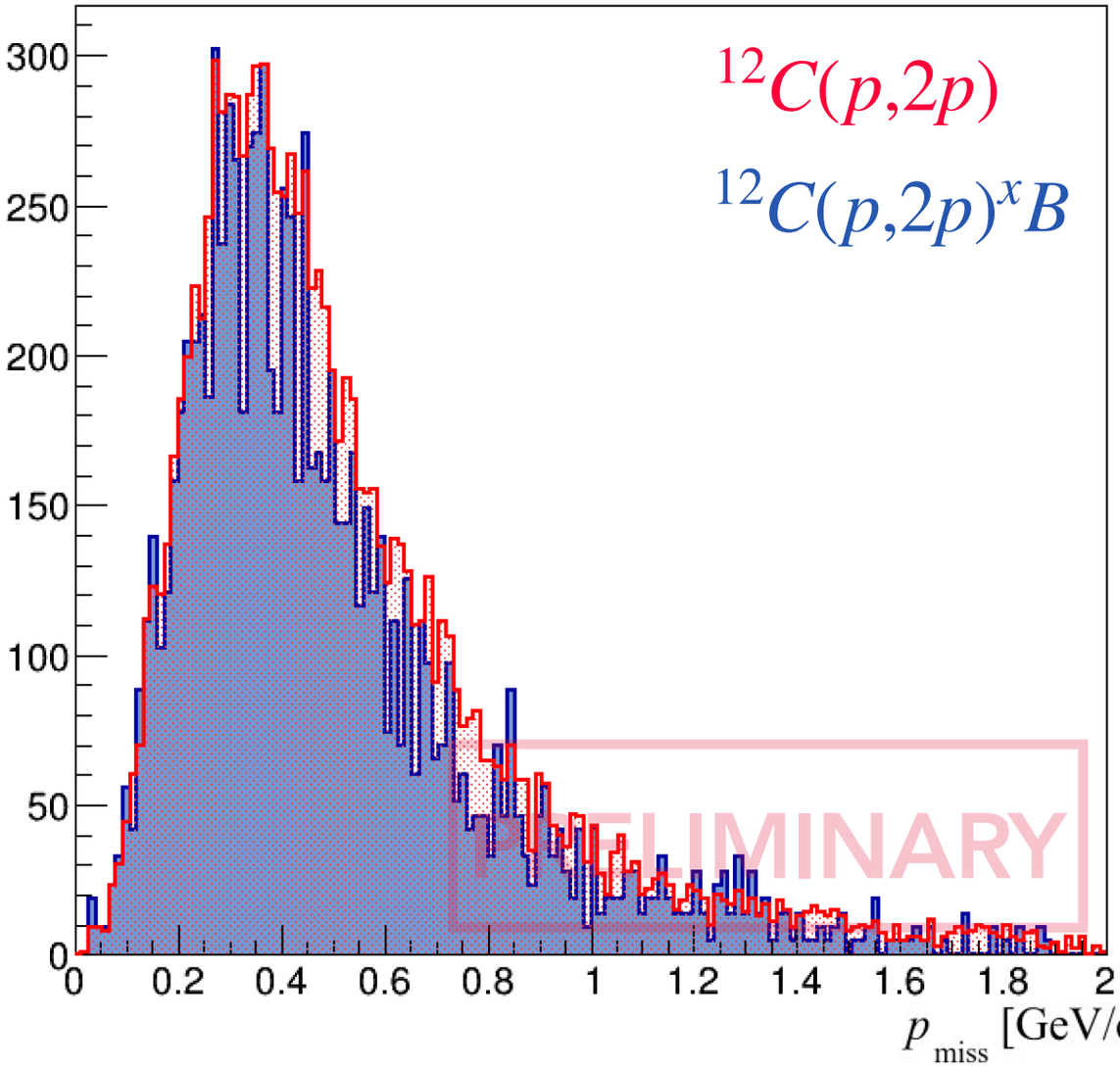
$^{12}C(p,2p)^{11}B$

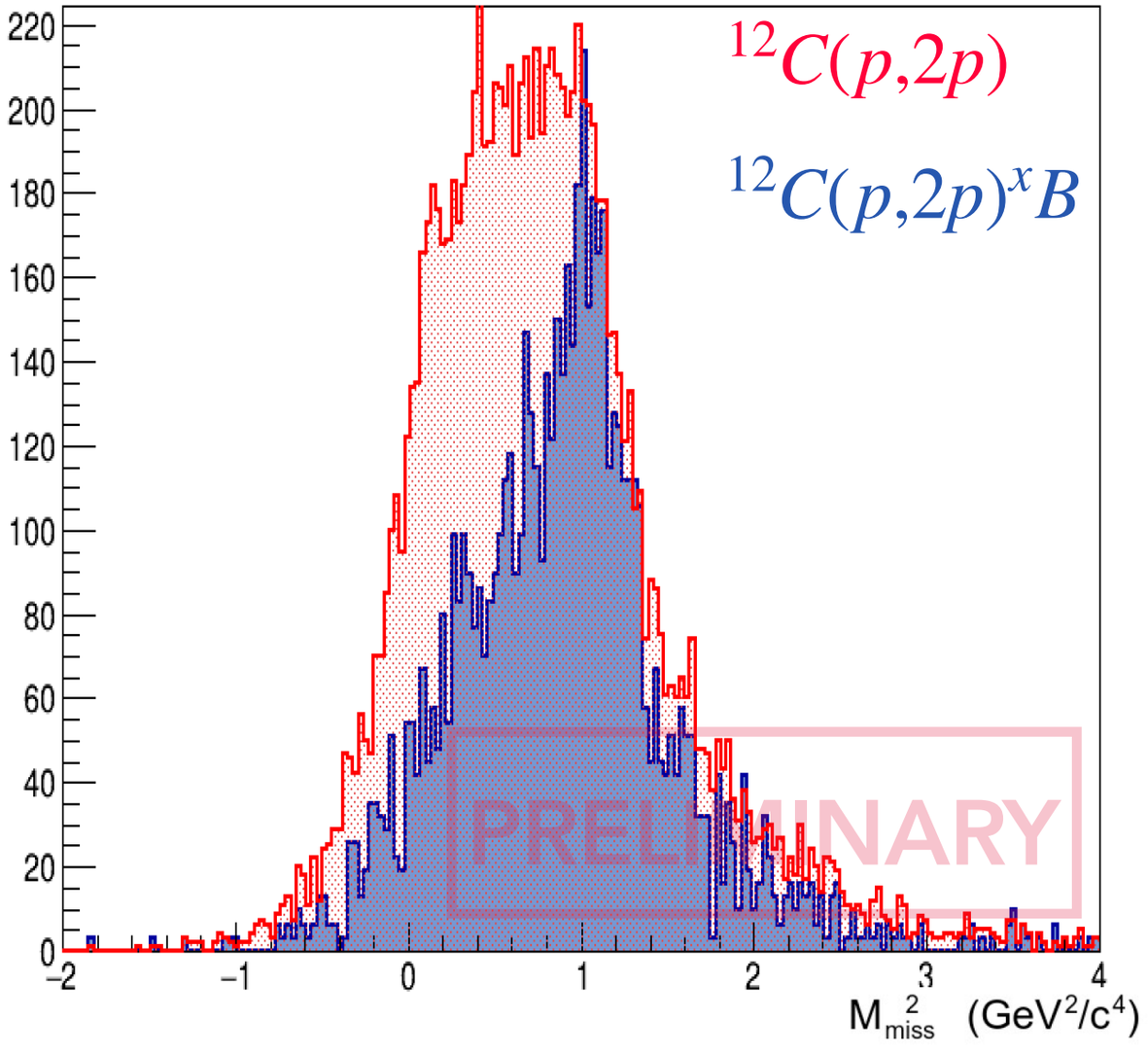
- PID for ^{12}C with vertex;
- Select the ^{11}B isotope;
- Very strong effect of the fragment selection in the opening angle.

(p,2p) analysis for ^{12}C

- Selectivity of the QF mechanism: **proton missing mass M_{miss} and missing momentum P_{miss};**
- Missing momentum important to constrain SRC kinematical region;







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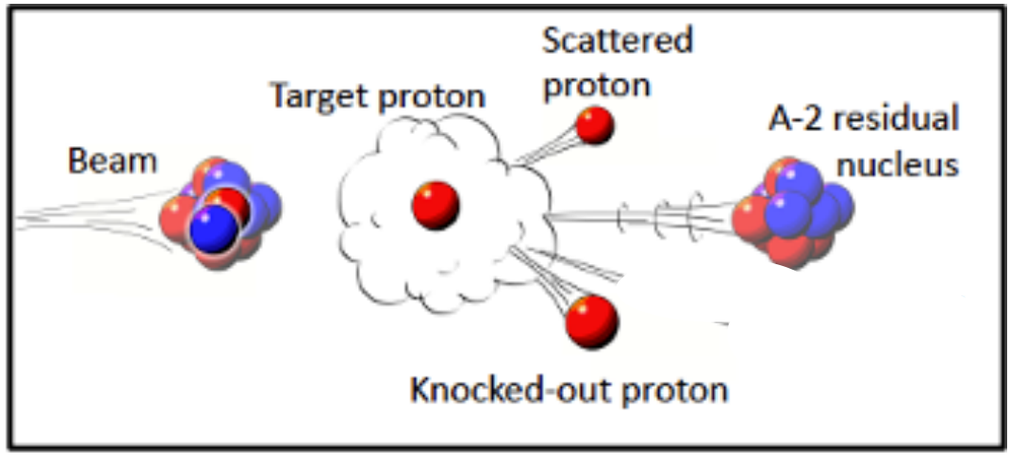
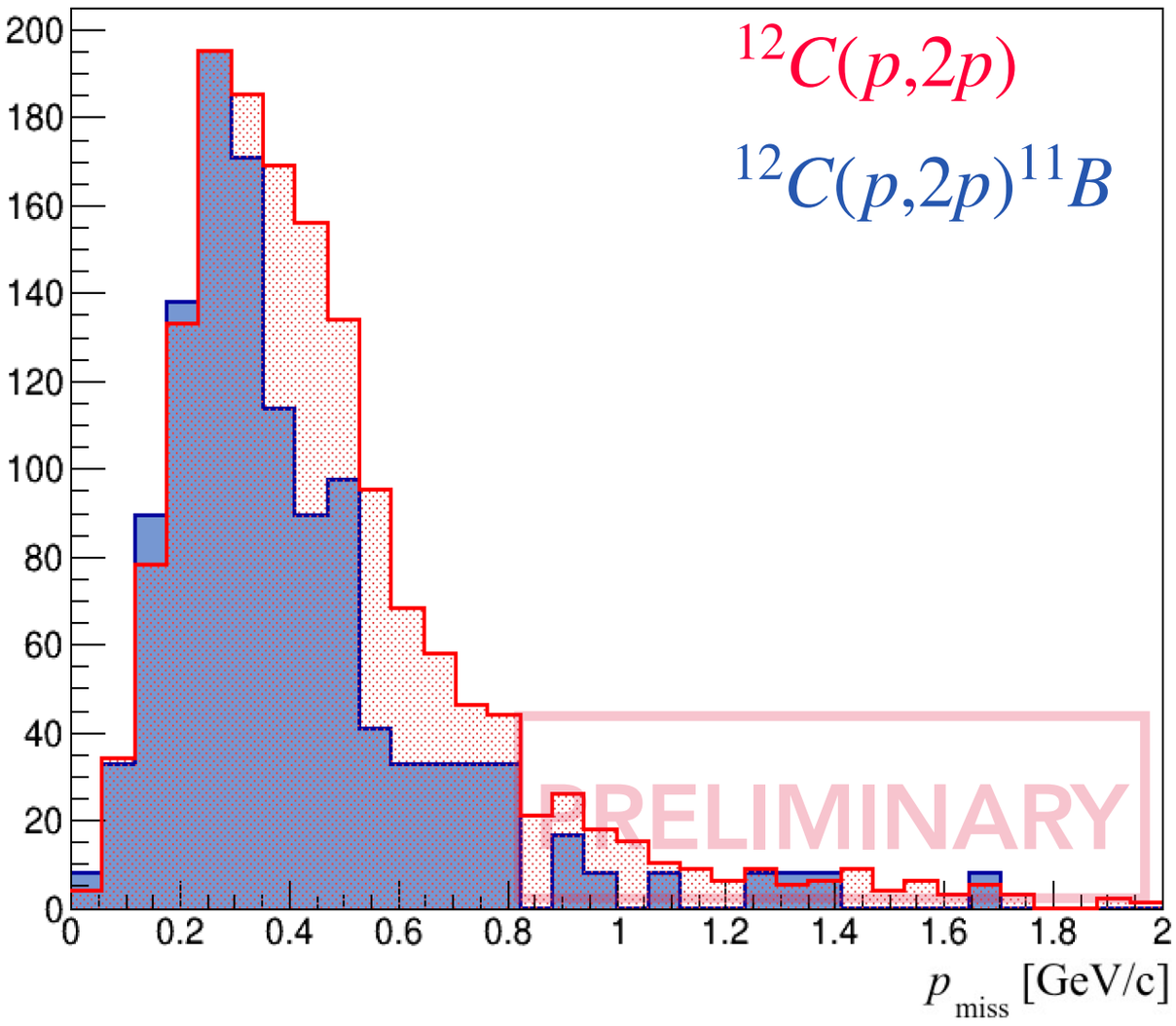
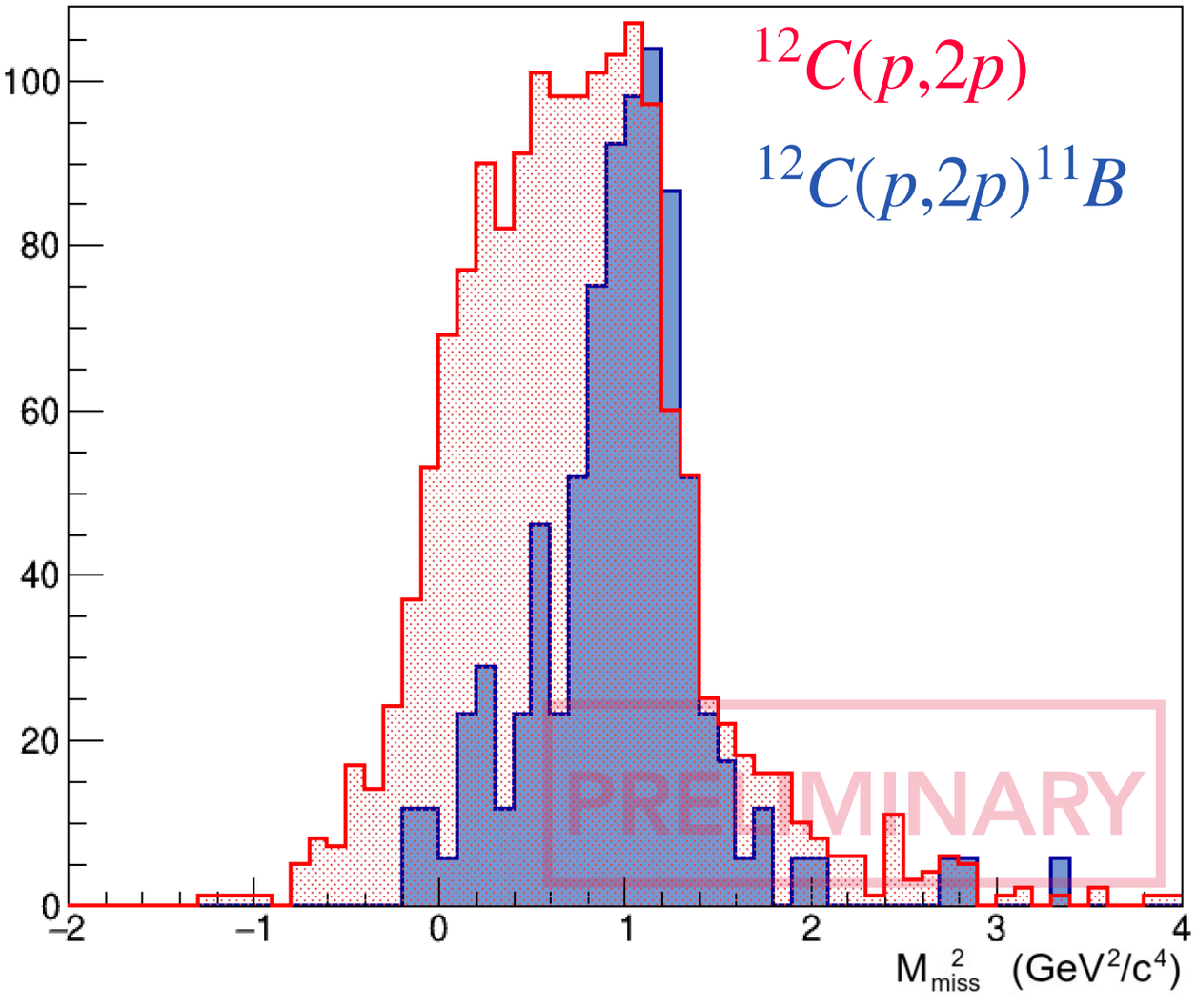
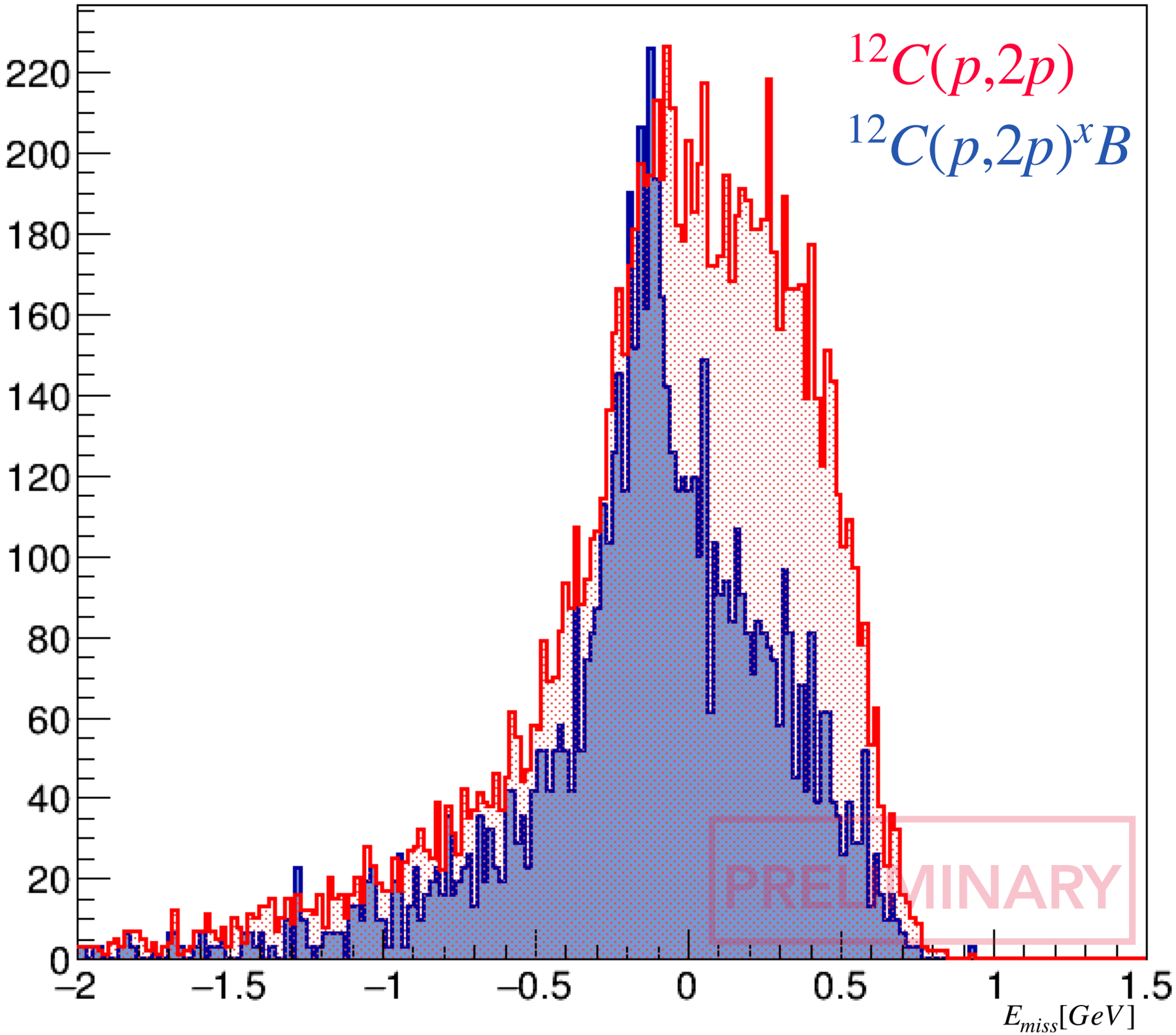






(p,2p) analysis for ^{12}C

Missing Energy



(p,2p) analysis for ^{12}C

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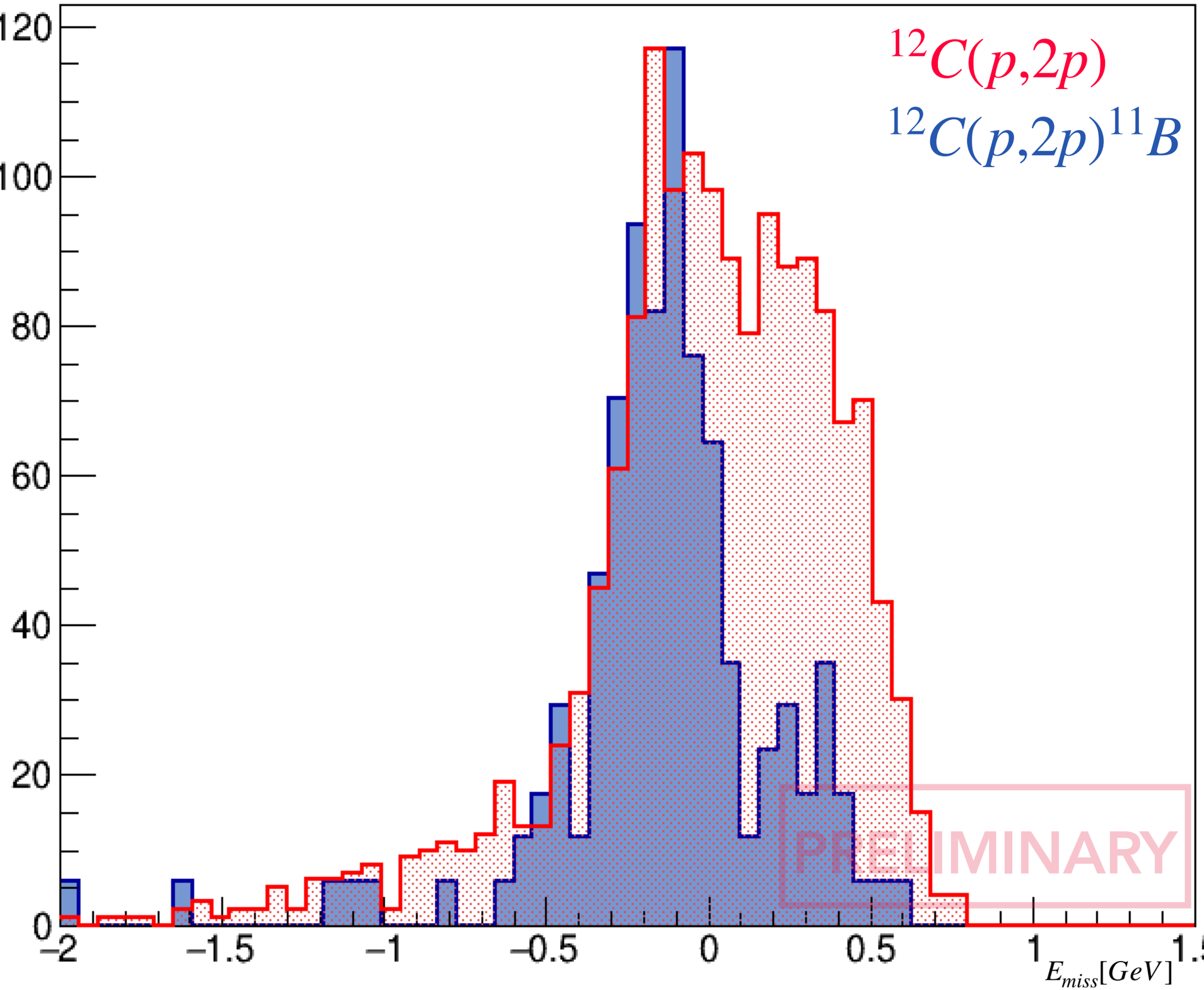

Perspectives

- **Detector alignment with the tracker and fragment momentum;**
- **Proton (RPC) and neutron (NeuLAND) identification and momentum reconstruction;**
- **QE scattering selection, IE + FSI rejection;**
- **Identification of SRC using P_{miss} and A-2 fragment selection;**

Thanks for your attention