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FIRST CHARACTERIZATION OF SHORT-RANGE CORRELATIONS (SRC) IN AN EXOTIC NUCLEUS AT R^3B

ANDREA LAGNI

CEA/IRFU/DPHN

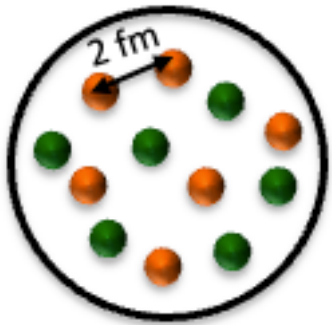
1 DECEMBER 2022

Journée du LABEX P2IO

SUPERVIORS: ANNA CORSI
ALDRIC REVEL



INDEPENDENT PARTICLES



$$\rho_0 = 0.16 \text{ nucleons} \cdot \text{fm}^{-3}$$

CLUSTERING



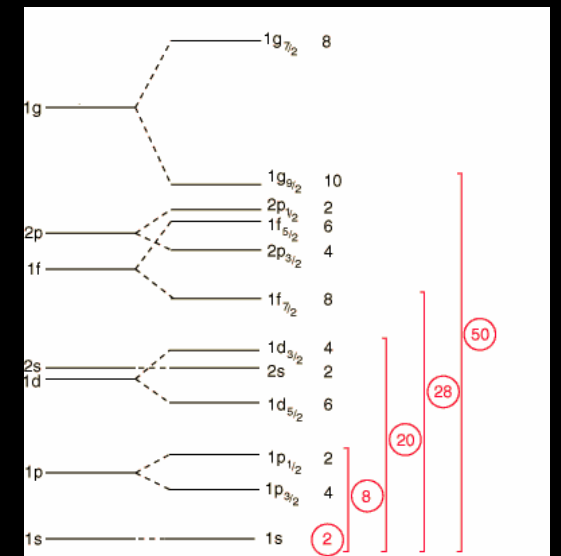
$$\rho \ll \rho_0$$

SHORT RANGE CORRELATIONS

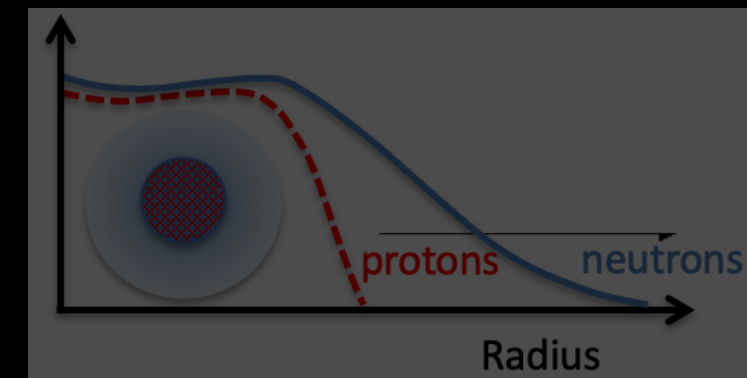


$$\rho \gg \rho_0$$

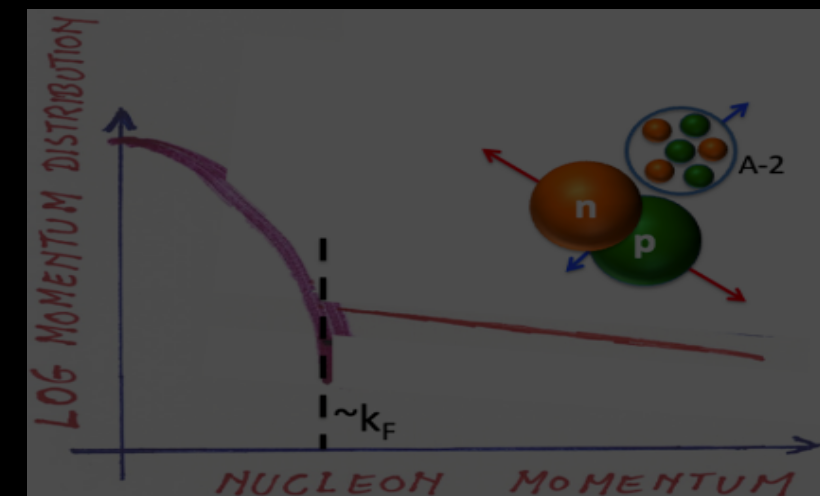
- Neutrons and protons move independently in well-defined quantum orbits;



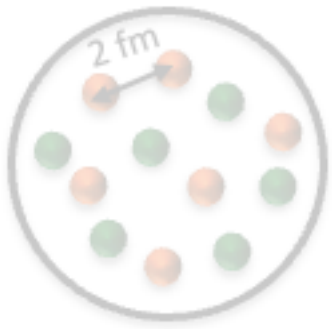
- Alpha clustering, Hoyle state;
- Neutron halo;



- High relative momentum and low centre of mass (c.m.) momentum pairs;



INDEPENDENT PARTICLES



$$\rho_0 = 0.16 \text{ nucleons.fm}^{-3}$$

CLUSTERING



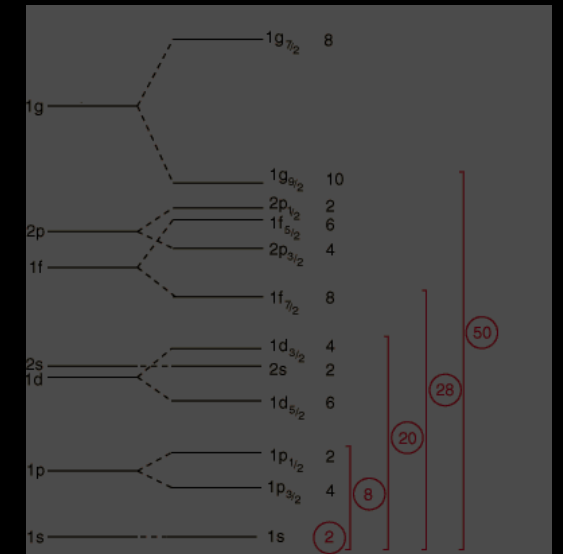
$$\rho \ll \rho_0$$

SHORT RANGE CORRELATIONS

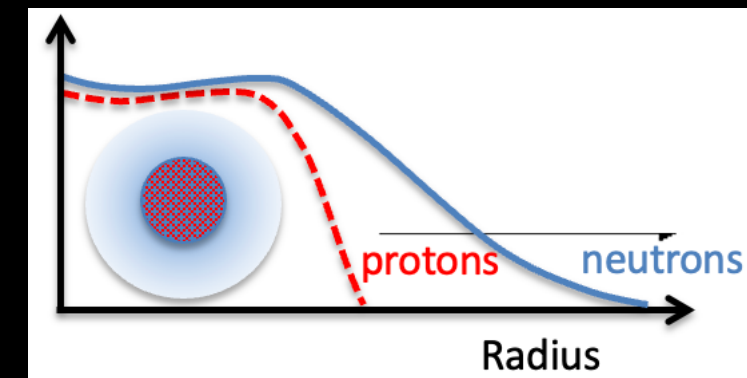


$$\rho \gg \rho_0$$

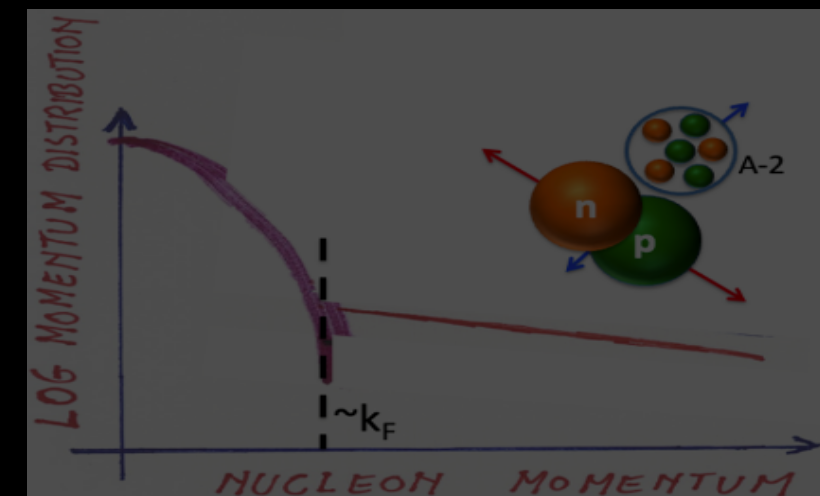
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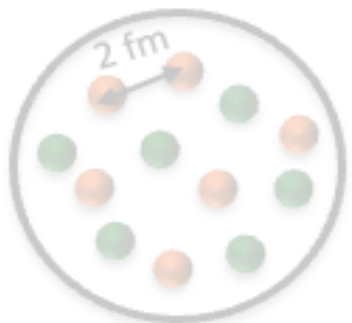
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INDEPENDENT PARTICLES



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CLUSTERING



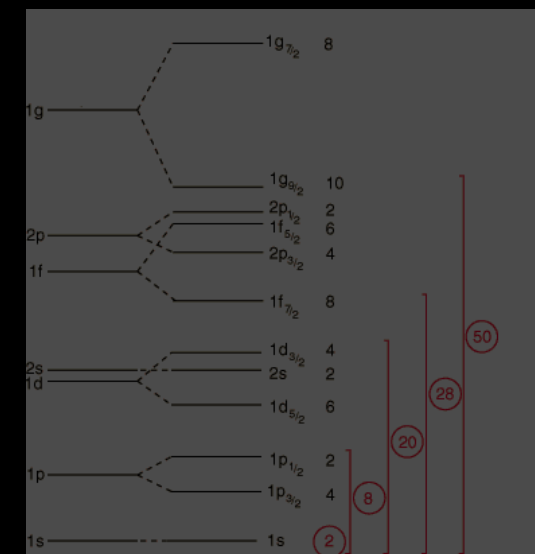
$$\rho \ll \rho_0$$

SHORT RANGE CORRELATIONS

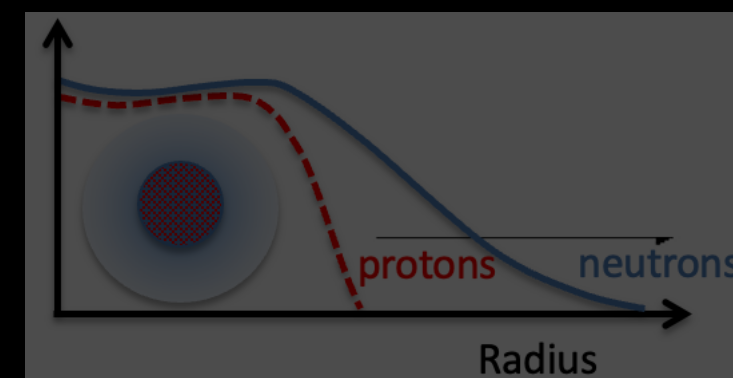


$$\rho \gg \rho_0$$

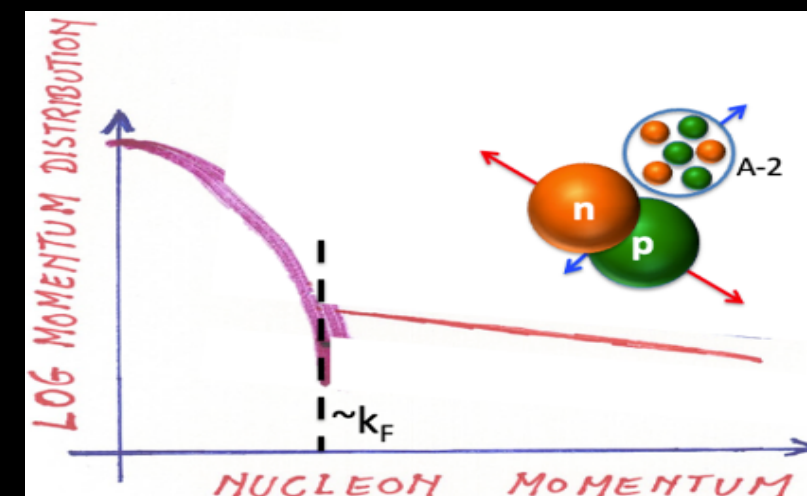
- Neutrons and protons move independently in well-defined quantum orbits;



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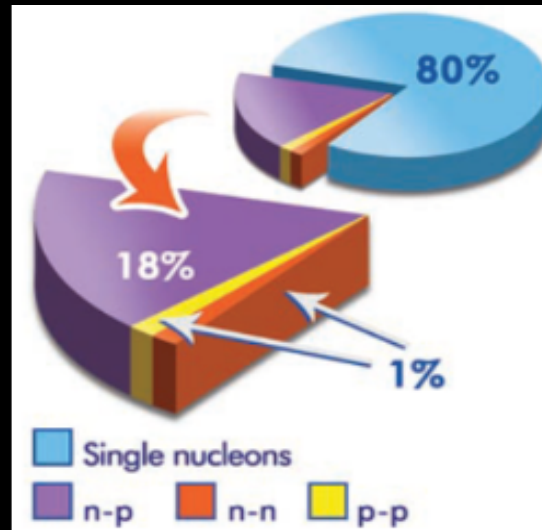


- High relative momentum and low centre of mass (c.m.) momentum pairs;



Electron scattering experiments:

- 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 .



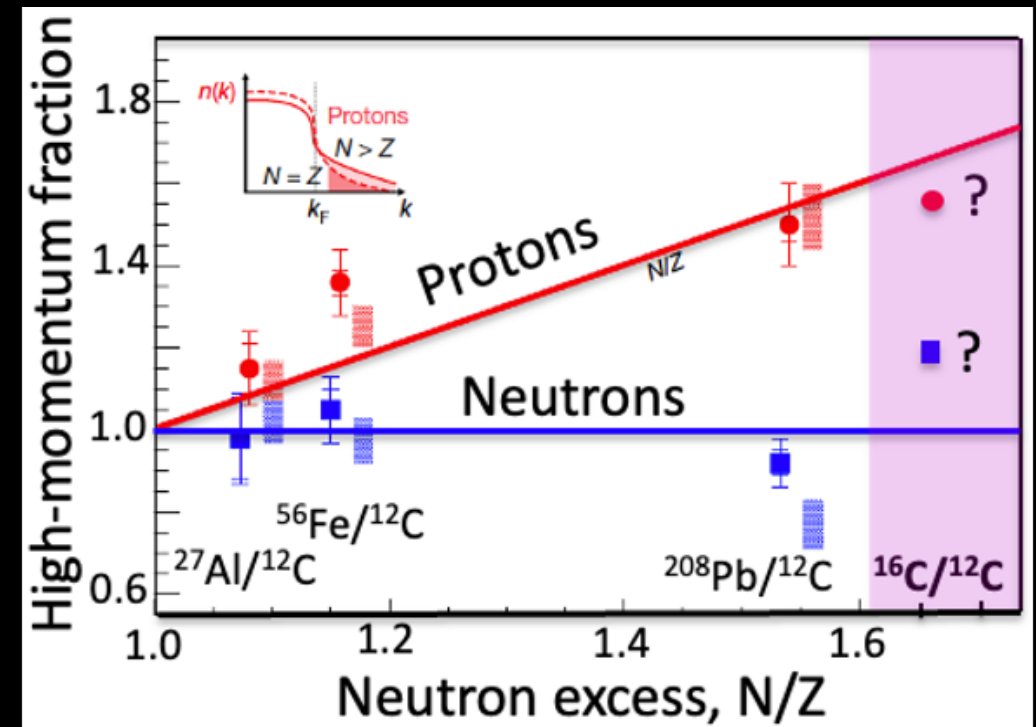
O. Hen et al. (CLAS Collaboration), *Science*, 346 (6209):614, 2014.

Proton scattering experiments:

- JINR experiment (2018);
- **R^3B Experiment (May 2022);**
 - Probe SRC in an isotopic chain.

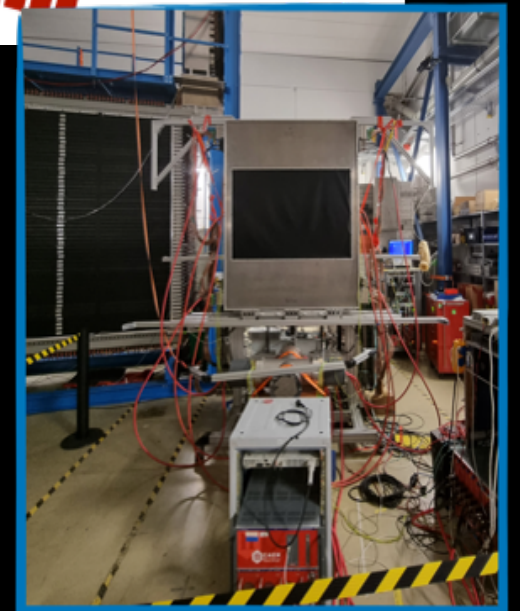
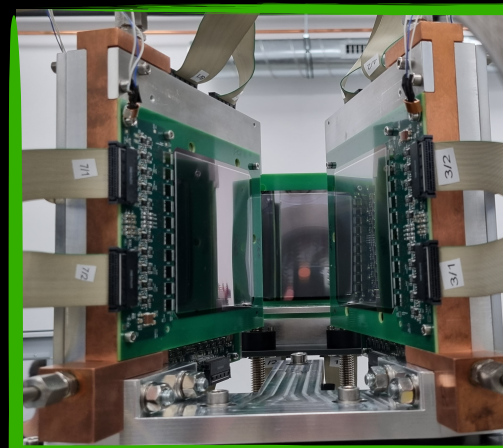
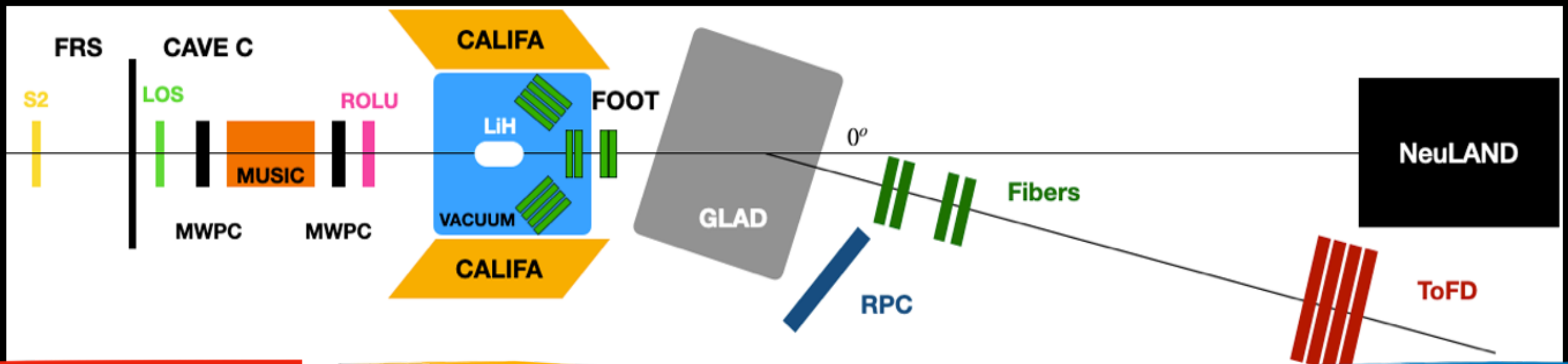
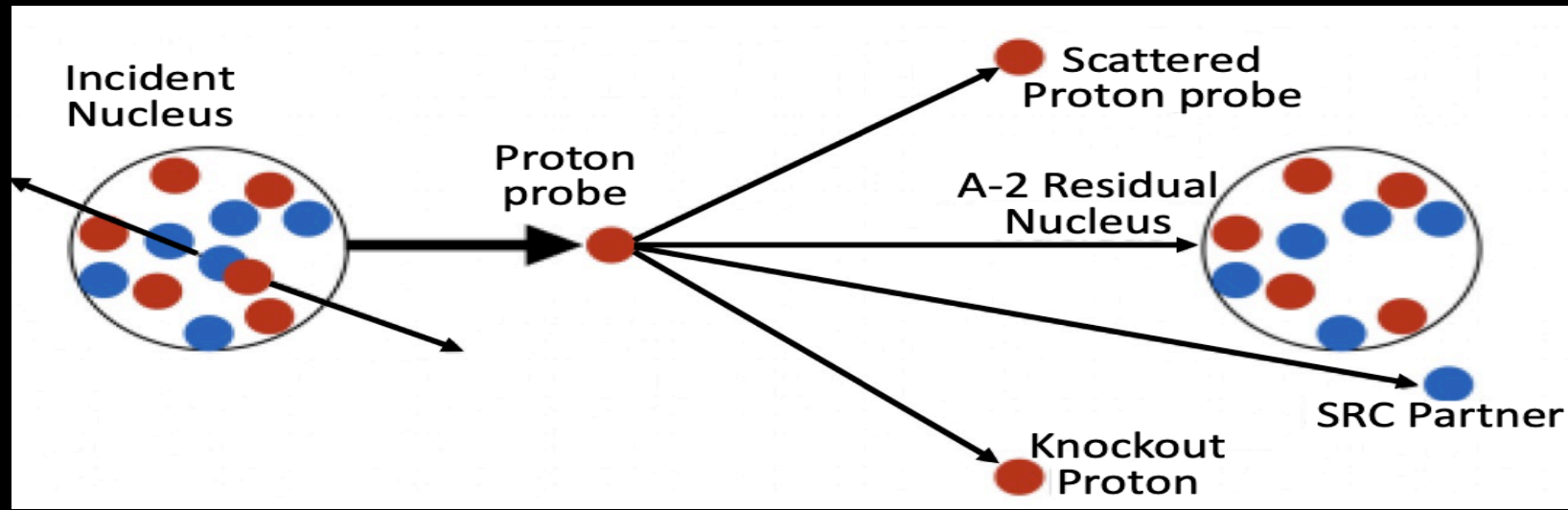
GOALS:

- Determine SRC properties (pair ratio, relative and pair center-of-mass momentum) in an exotic nucleus for the first time;
- **The analysis of ^{16}C will add a new measurement at $N/Z = 1.67$, above the largest available N/Z and at a much smaller mass.**



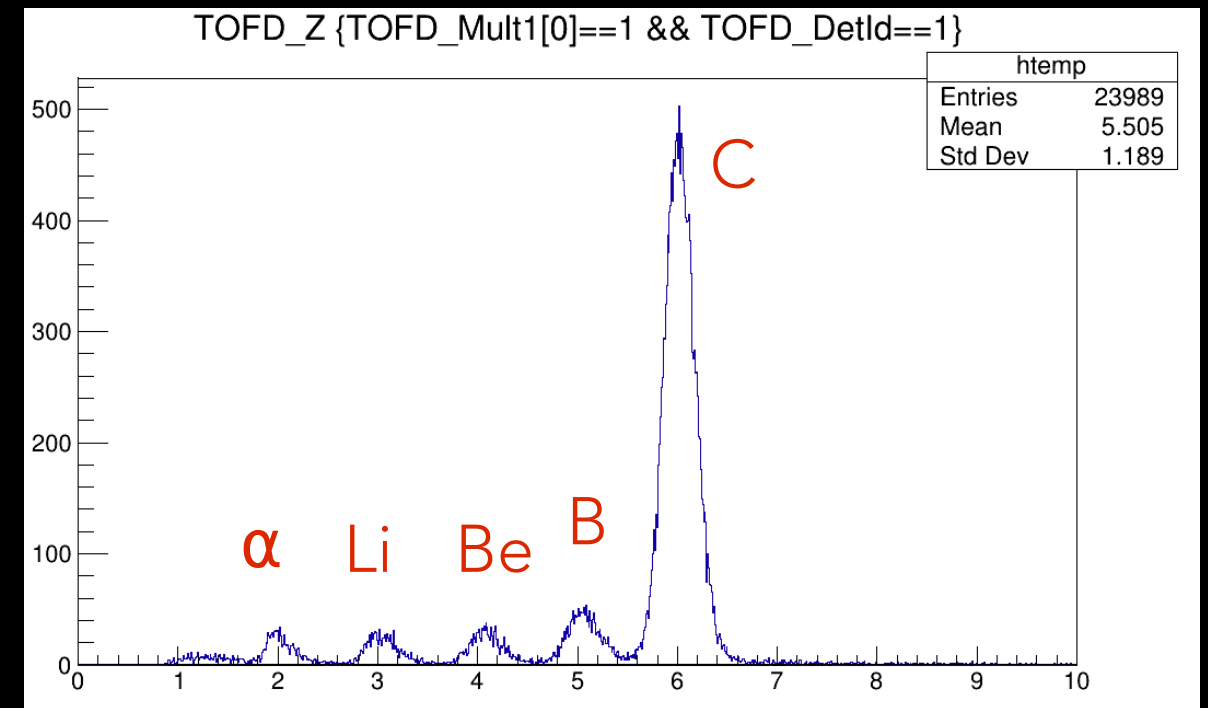
Adapted from M. Duer et al. (CLAS Collaboration), *Nature*, 560:617, 2018.

R³B EXPERIMENTAL SET UP



TOFD:

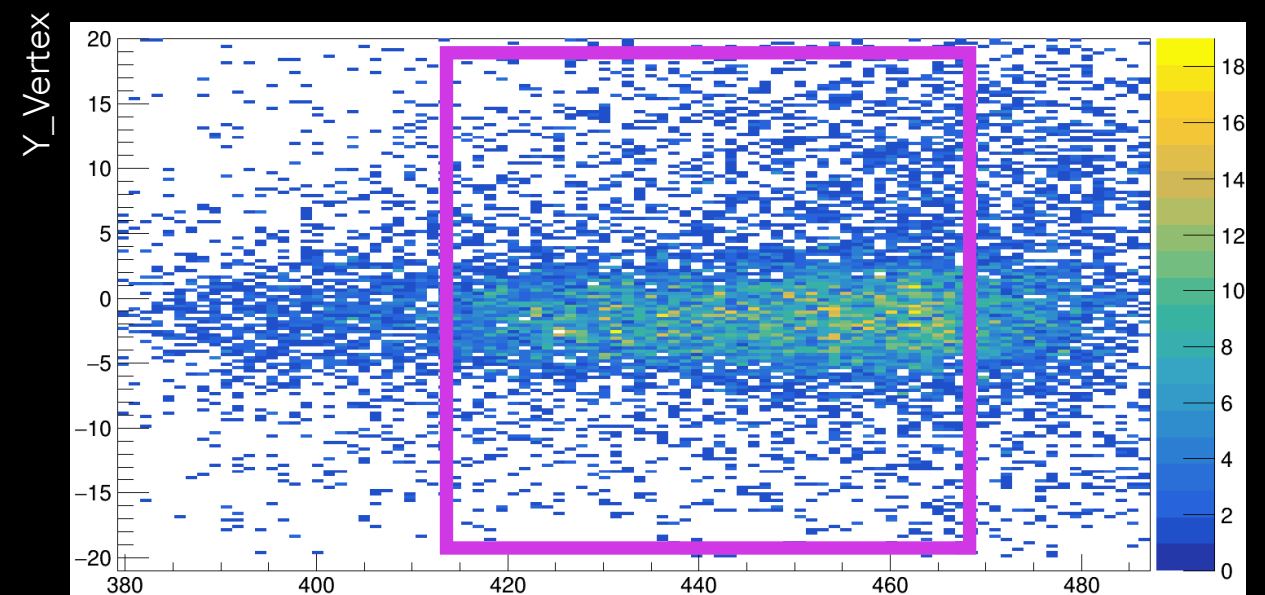
- Prepared and tested the detector for the experiment;
- Charge **calibration** of the detector;



Q

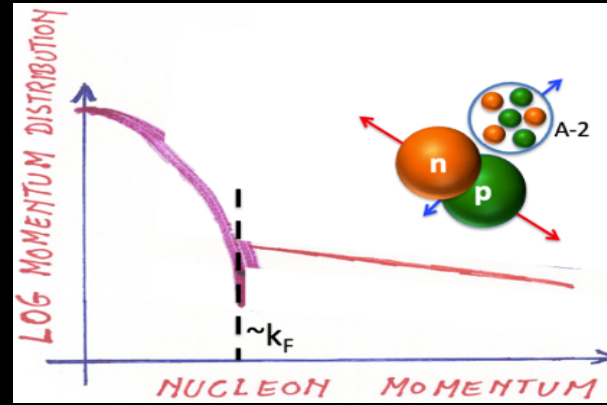
FOOT:

- Tested the electronics at CEA-Saclay (Jan-Feb 2022);
- Tested the detector for the experiment at GSI;
- Energy calibration and protons tracking;
- **Vertex** reconstruction.

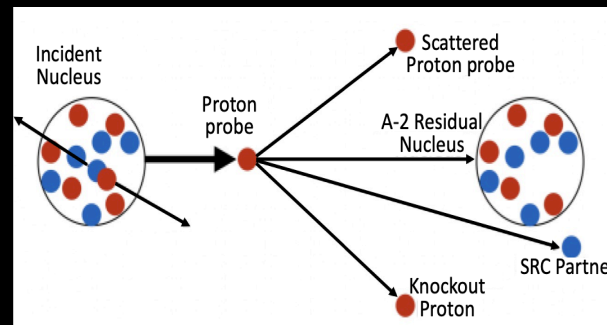


Z_Vertex

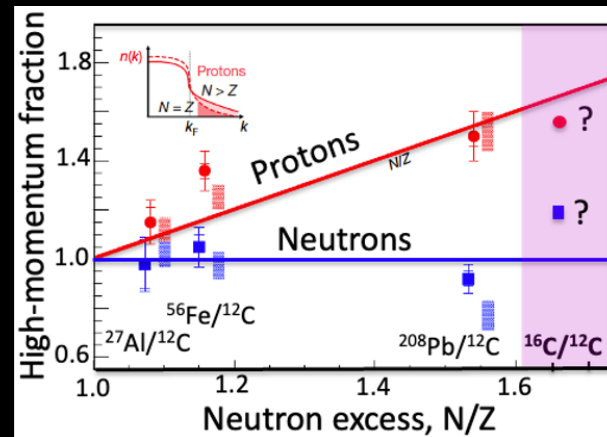
- Nucleon pairs that are close together in the nucleus;
- High relative momentum and low centre of mass (c.m.) momentum.



- Proton scattering in inverse kinematics;

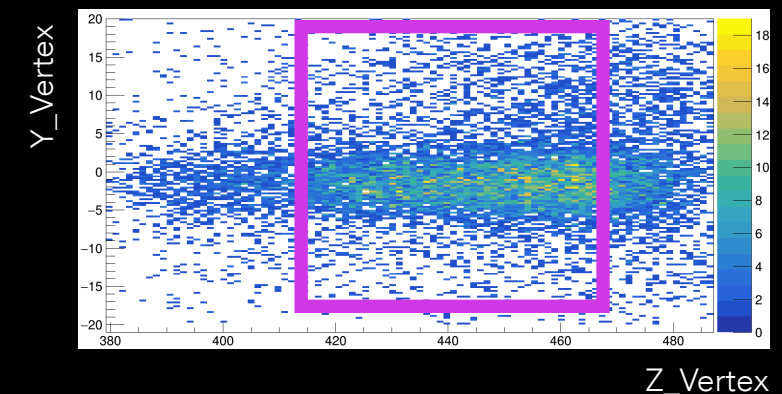
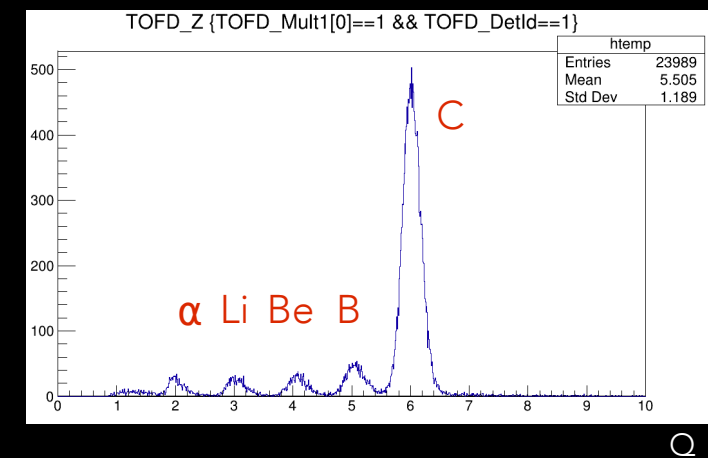


- Add a new measurement at $N/Z = 1.67$, above the largest available N/Z and at a much smaller mass.



Analysis:

- TOFD charge calibration;
- FOOT protons tracking and vertex reconstruction.



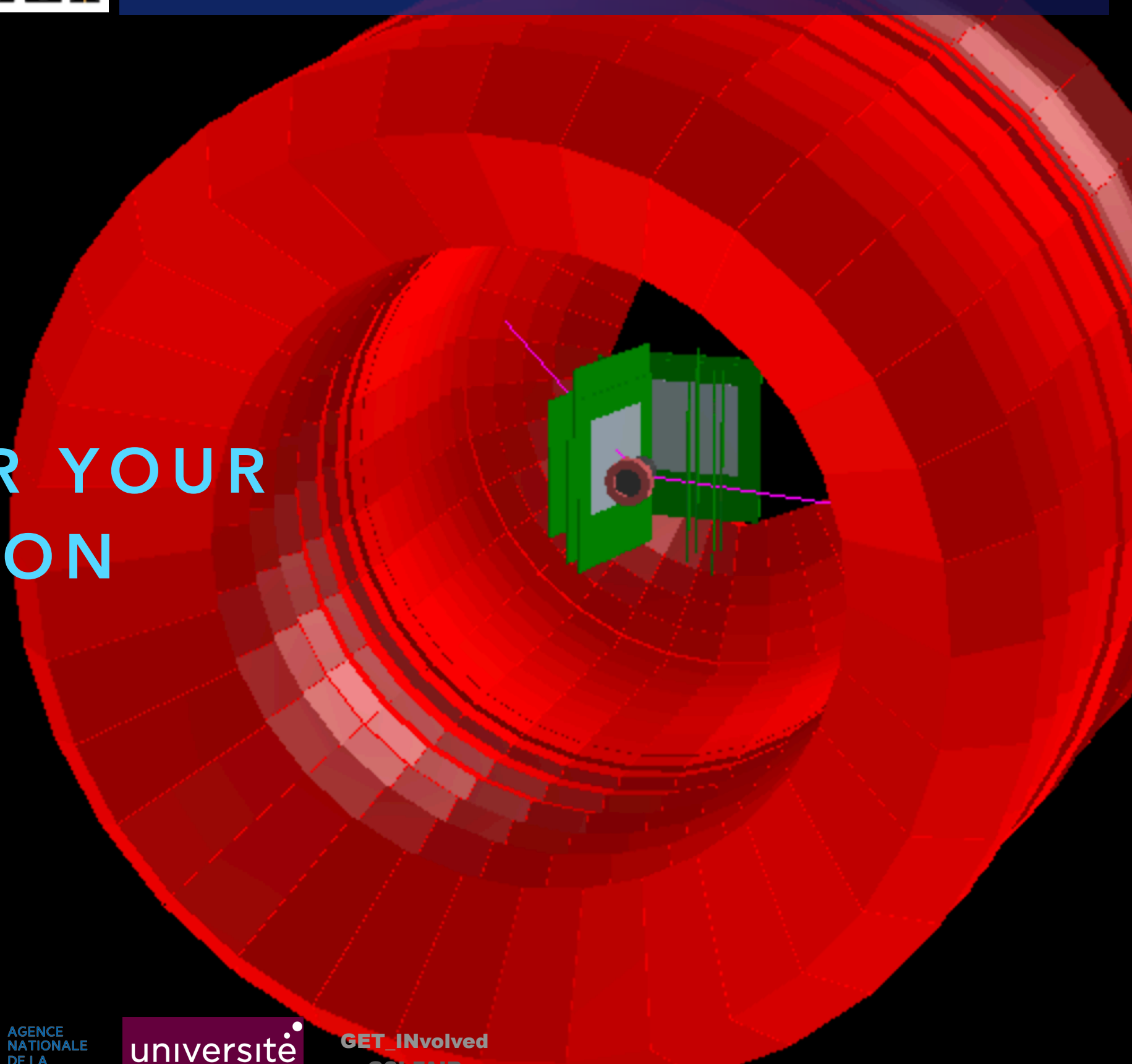
Z_Vertex

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THANKS FOR YOUR
ATTENTION

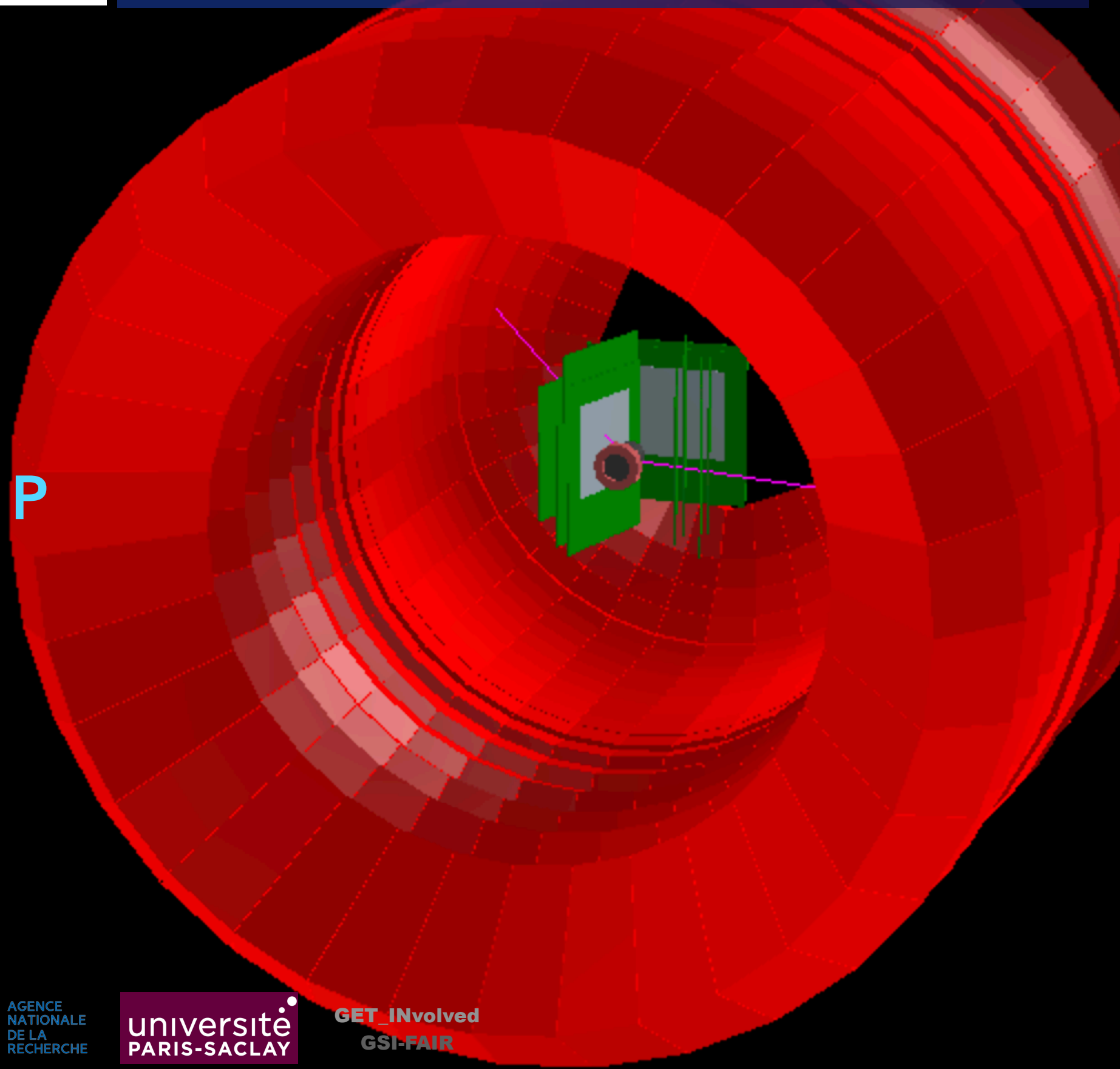


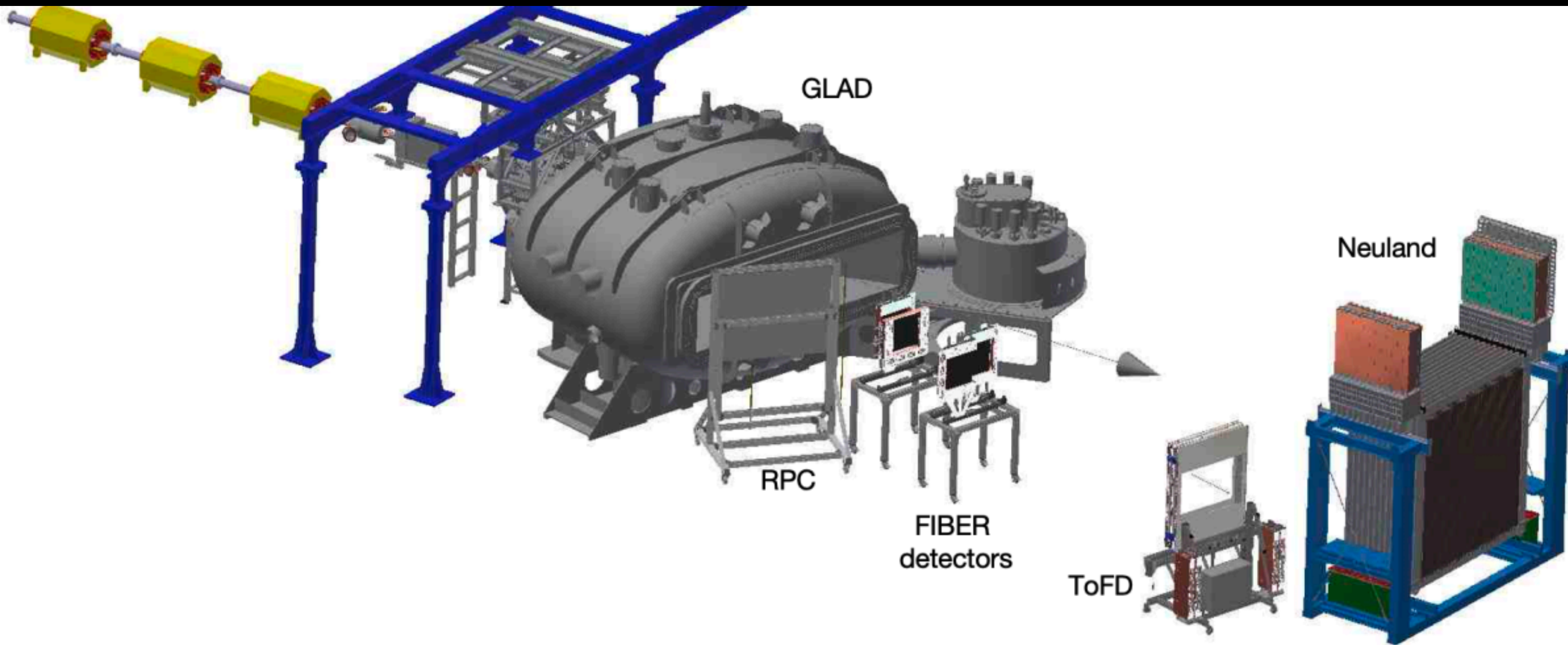
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BACKUP



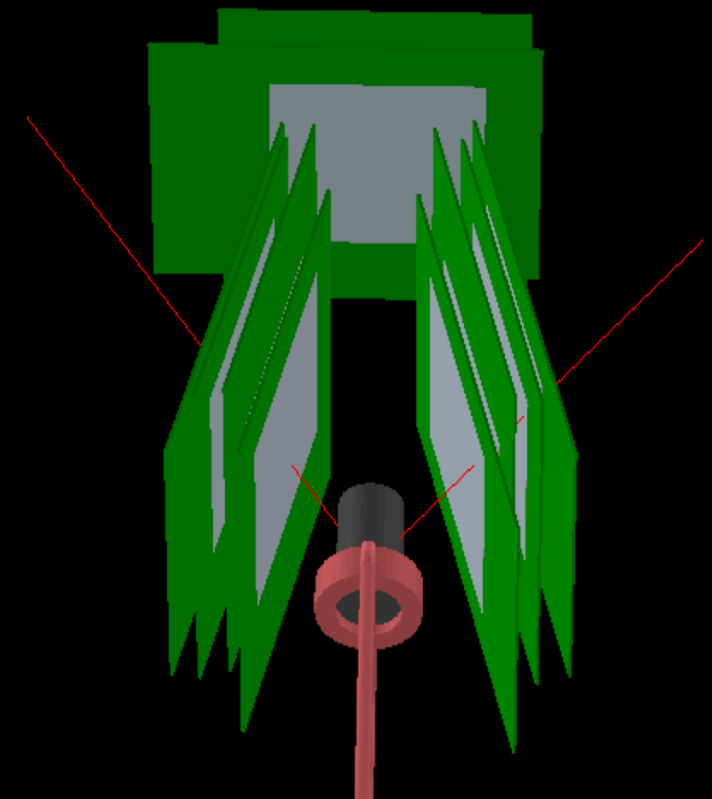
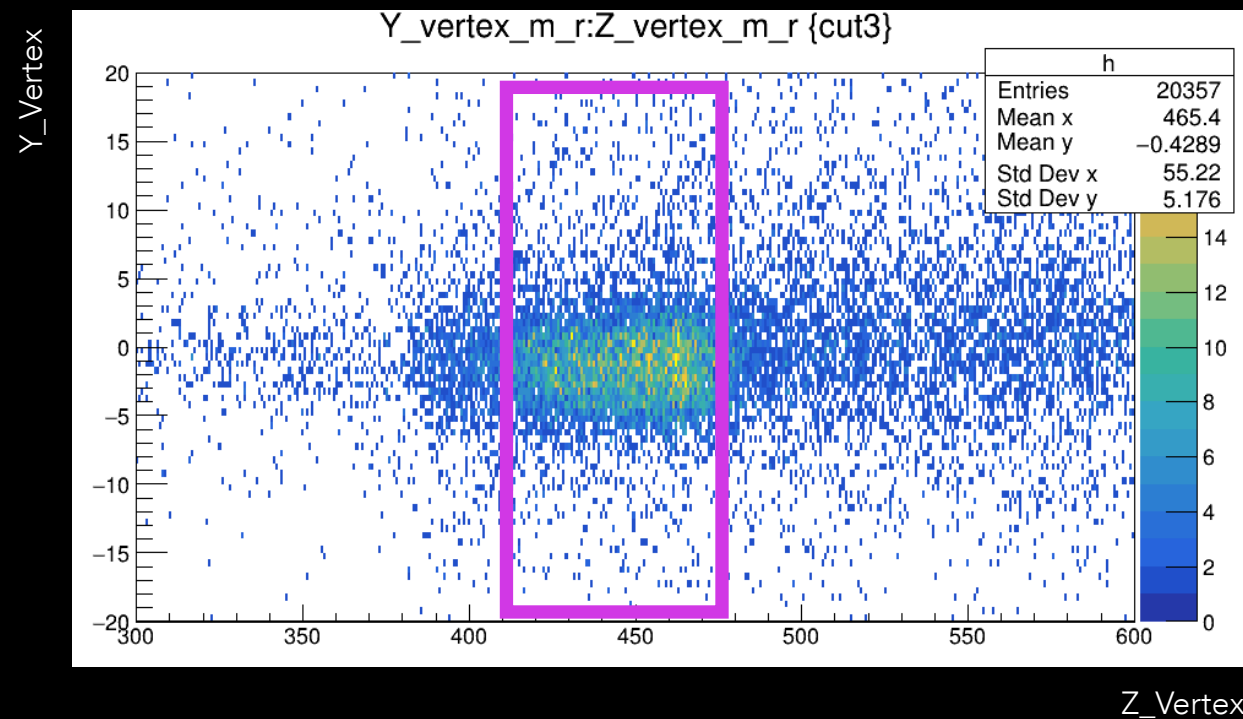
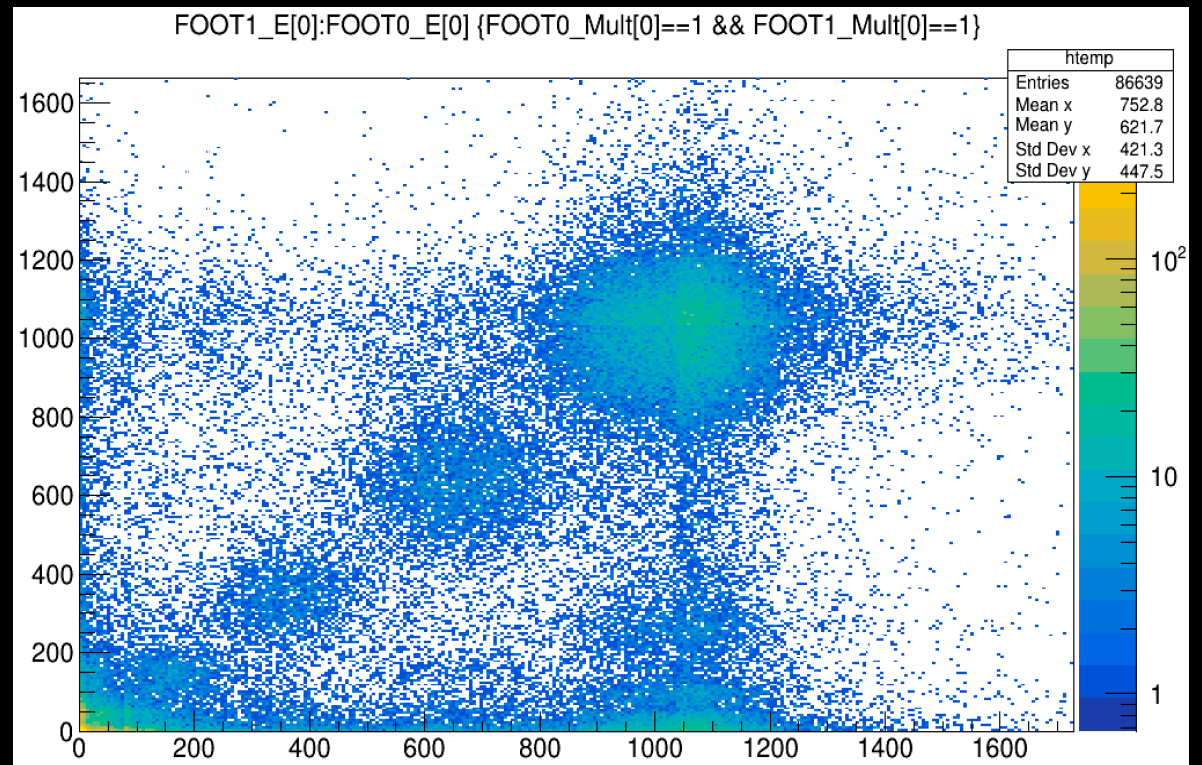


Target tracking FOOT:

- **Position correlations** with incoming detectors (MWPCs);
- **Energy calibration and energy correlation;**

Vertex reconstruction:

- Minimum distance between all possible combinations of FOOT tracks from the left arm and right arm;



Target tracking CALIFA:

- Calibration of the crystals with ^{22}Na source;
- Selection of the **(p,2p)** events;
- **Opening angle** between two protons.

