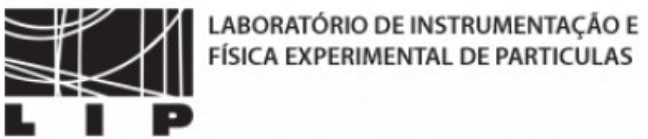
Nuclear Reactions with Radioactive Beams at Relativistic Energies

LIP - Summer Student Program 2019

Author: Ricardo Pires

Supervisor: Daniel Galaviz

NUC-RIA Group - NUClear Reactions Instrumentation and Astroparticles



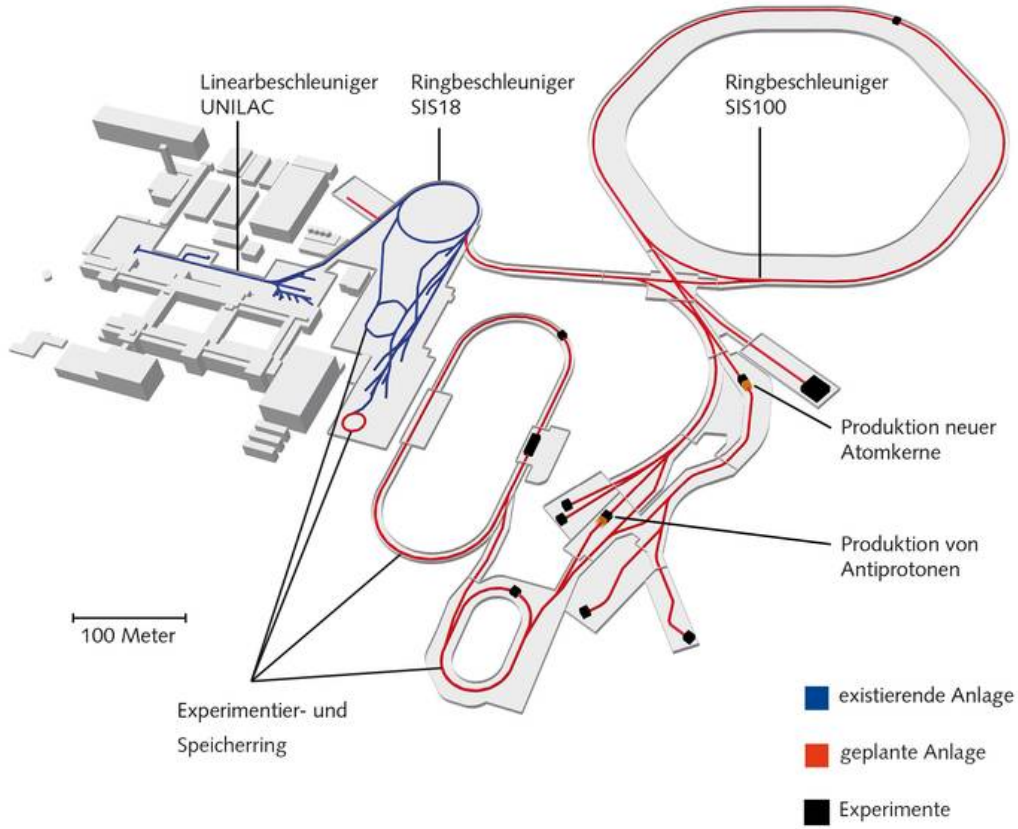
Objectives

- Get an insight at heavy ion collision physics;
- Present the experiment's big picture and experimental setup;
- Understand data measurements along beam path before and after the target;
- Look into data analysis procedure;
- The physics behind.

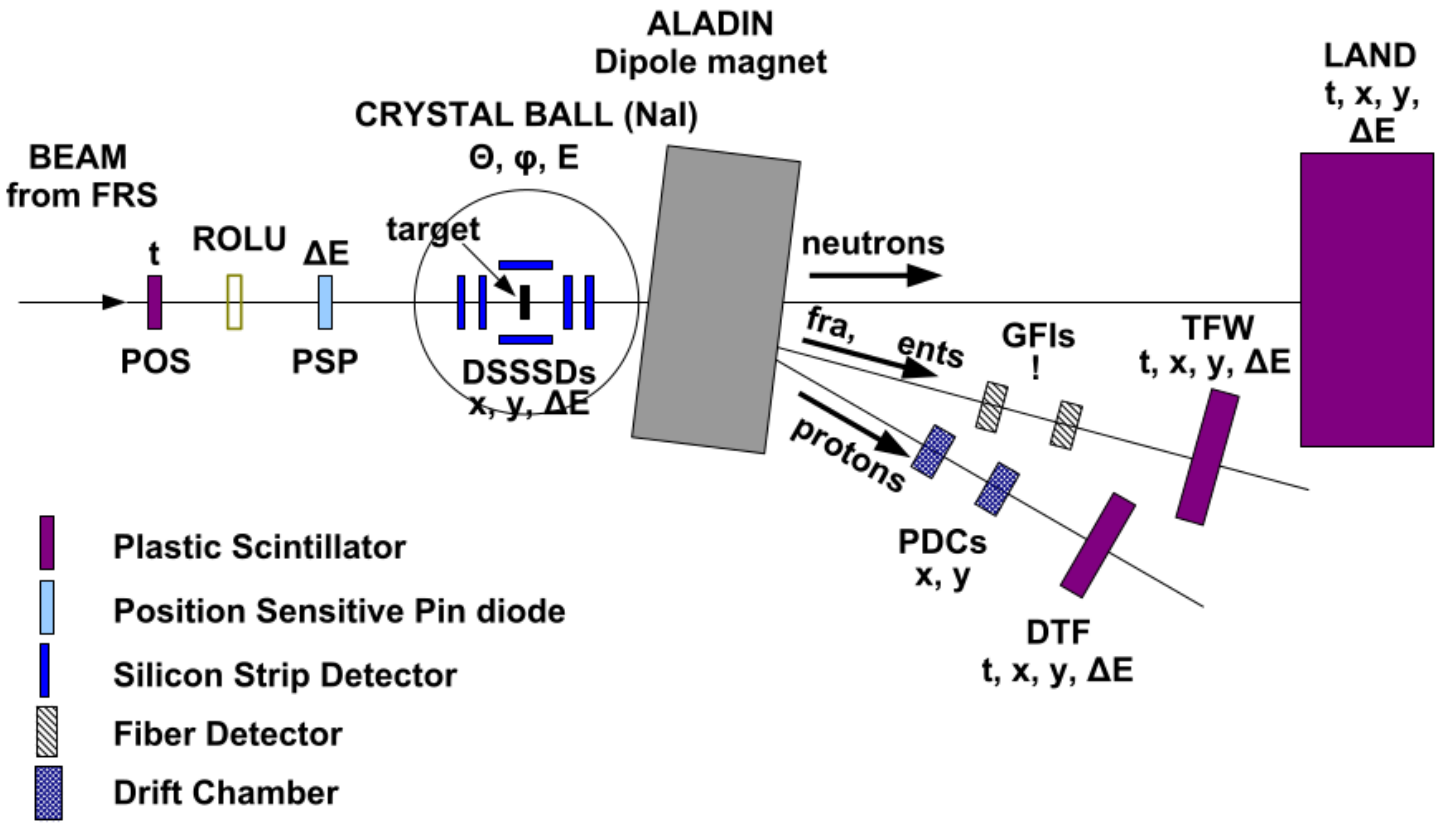
Heavy Ions Nuclear Reactions

- Heavy ions collision with fixed target experiments, inverse kinematics;
- Energies between some dozens to few cents of MeV/u;
- Allows the characterization of atomic nuclei and idnetification of exotic estructures (halo);

Heavy Ions Nuclear Reactions - GSI, R3B Experiment



Experimental Setup

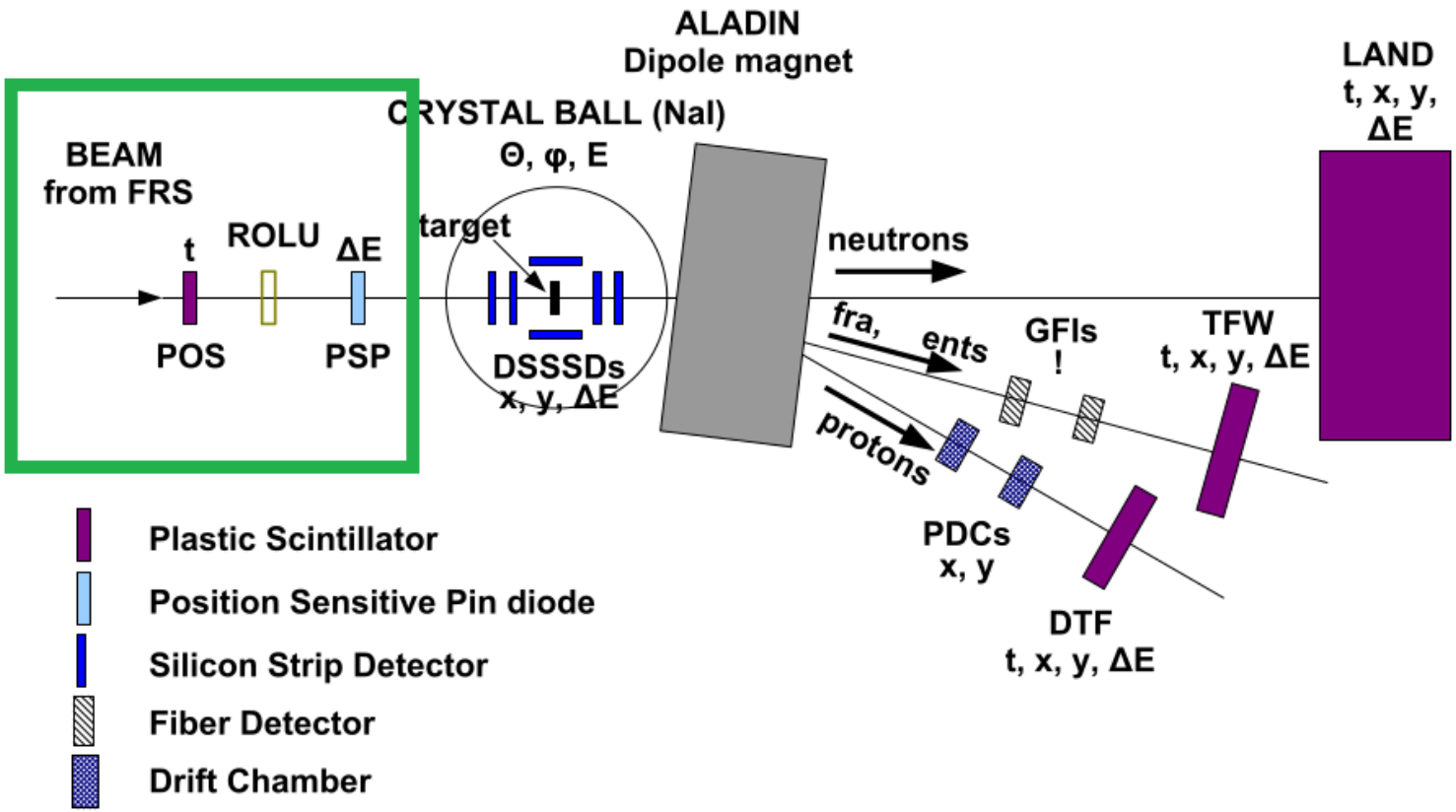


Beam characterization – Target – Fragments characterization

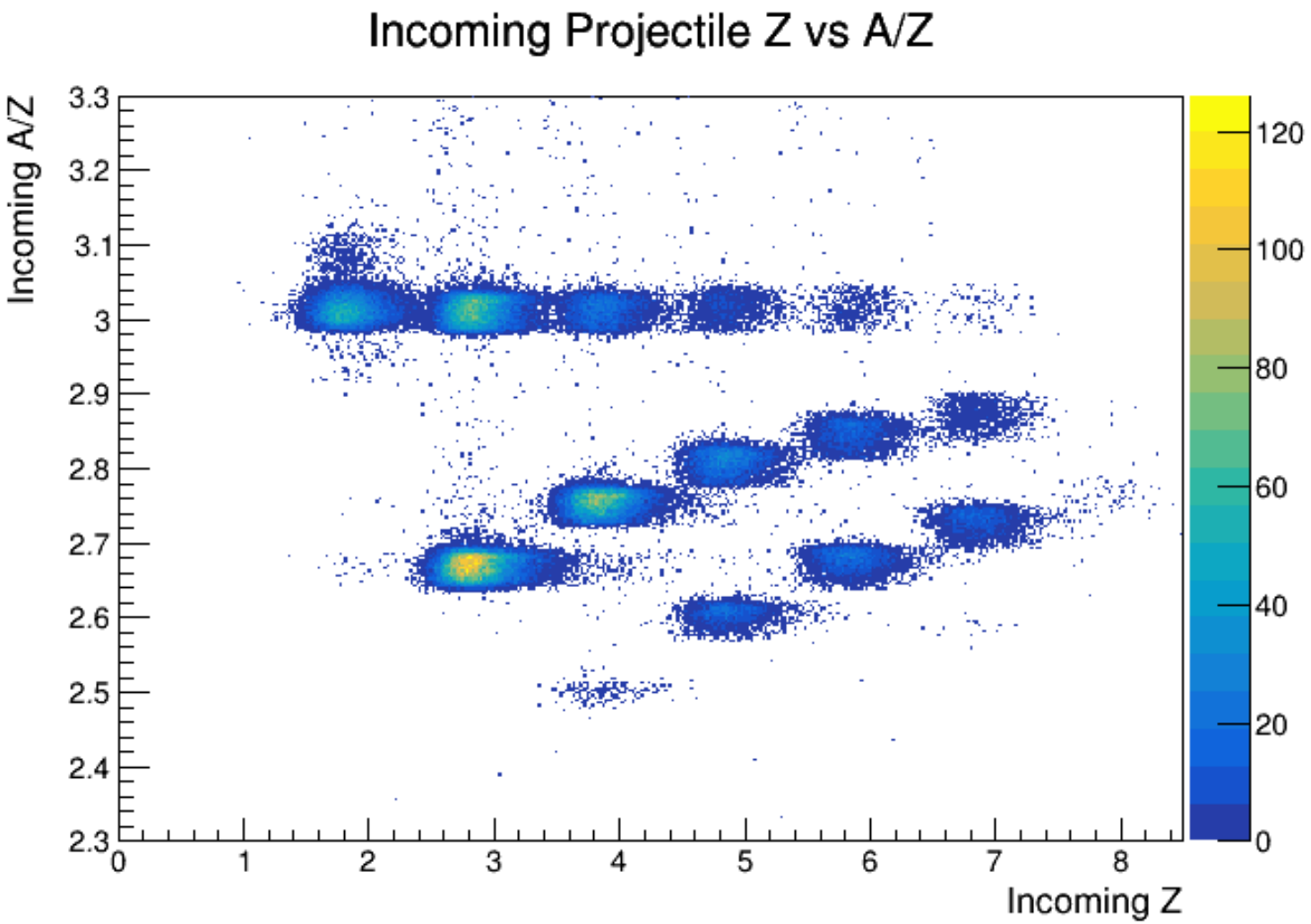
Data Aquisition and Processment

Local measurements – trigers – calibration – ROOT files

Nuclei Path and Data Analysis - Before the Target

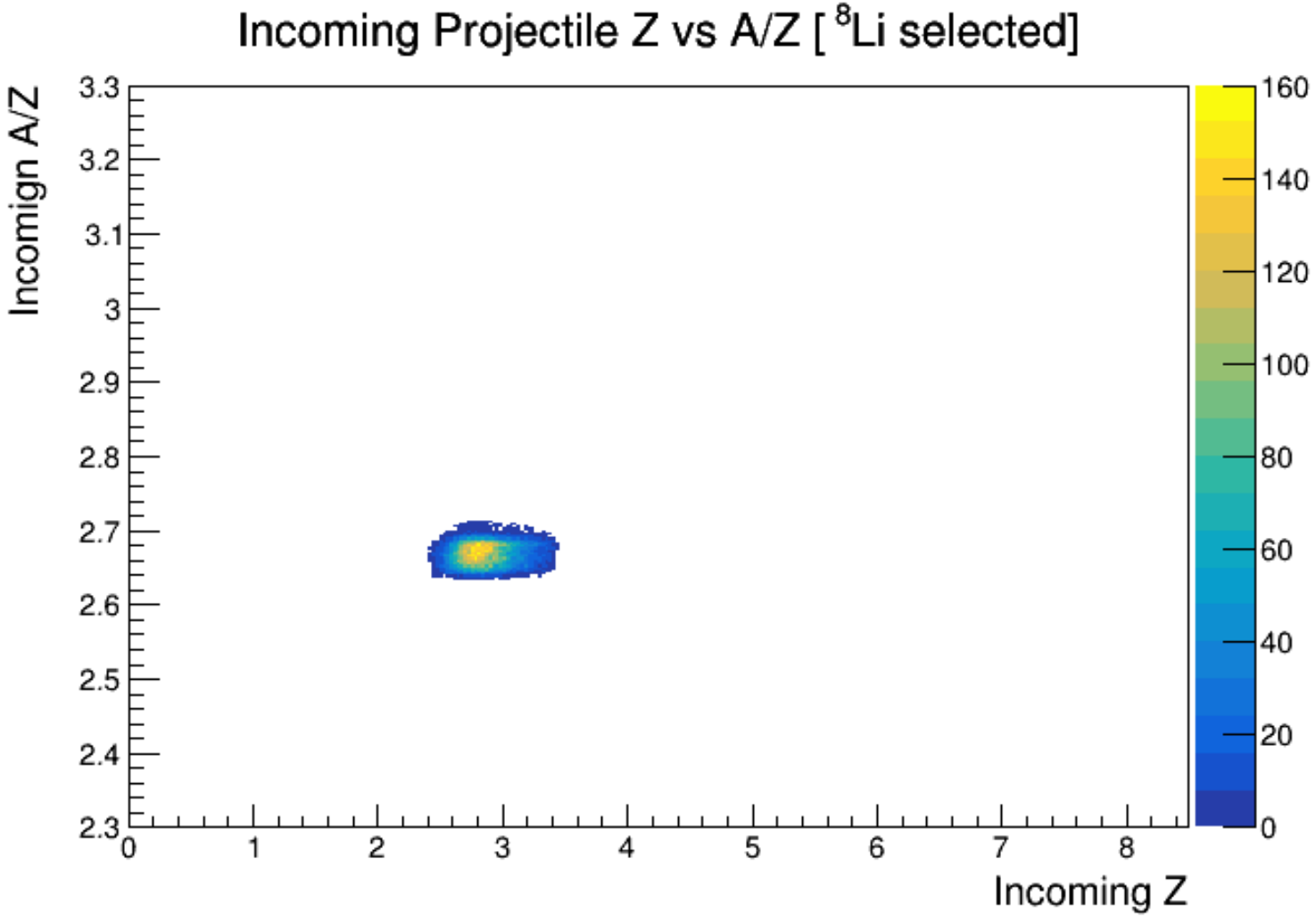


Nuclei Path and Data Analysis - Incoming Projectile



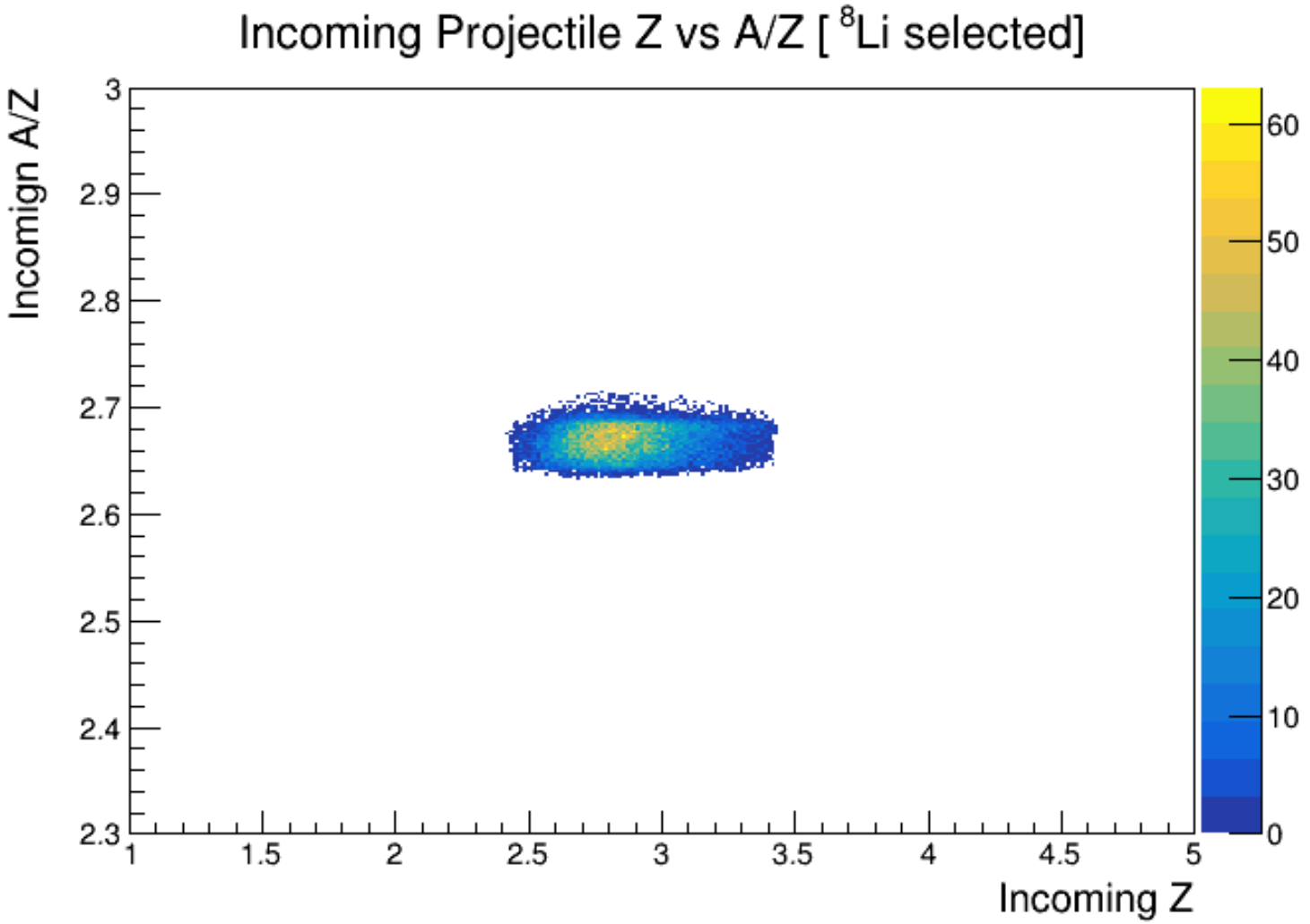
Incoming beam mixture – Selected nuclei

Nuclei Path and Data Analysis - Nuclei Selection

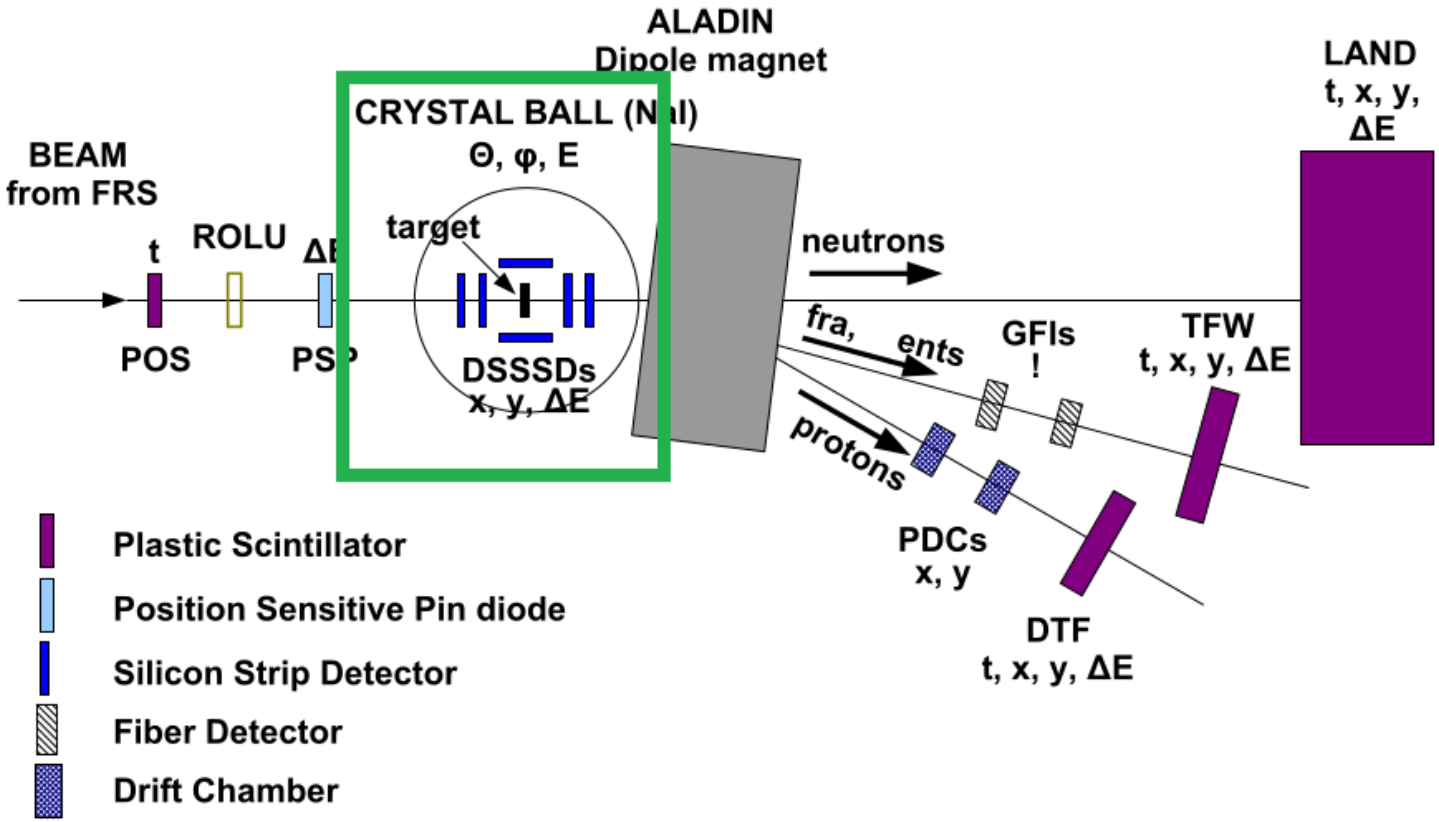


No selection

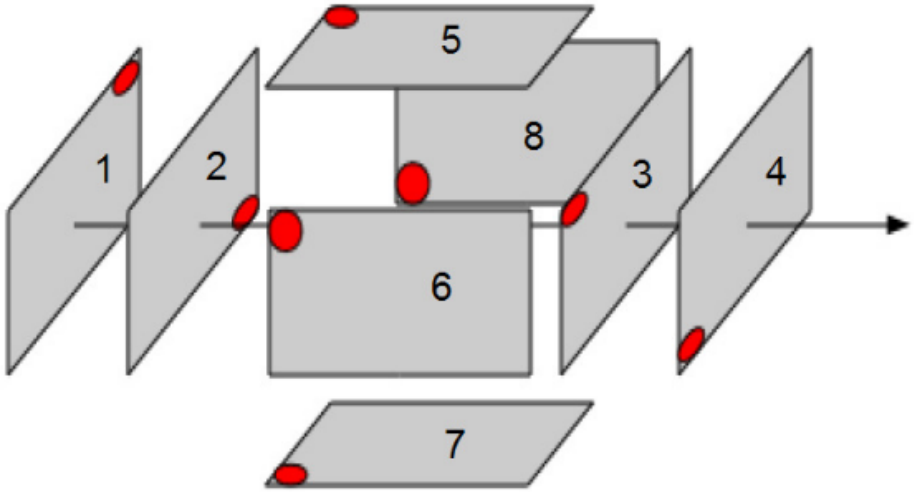
Nuclei Path and Data Analysis - Nuclei Selection



Nuclei Path and Data Analysis - Around the Target

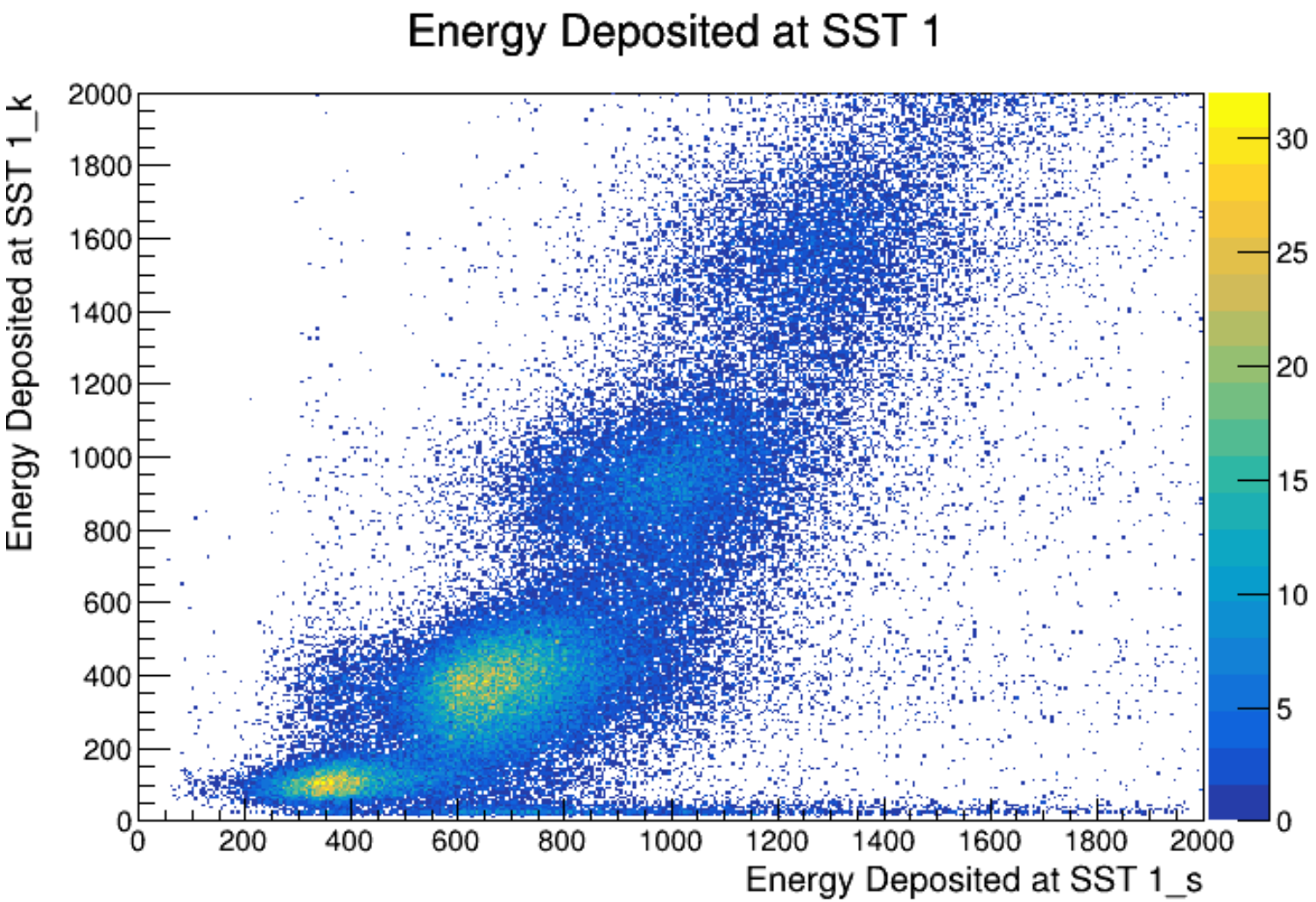


Nuclei Path and Data Analysis - SSD



Silicon strip detectors arrangement

Nuclei Path and Data Analysis - SSD



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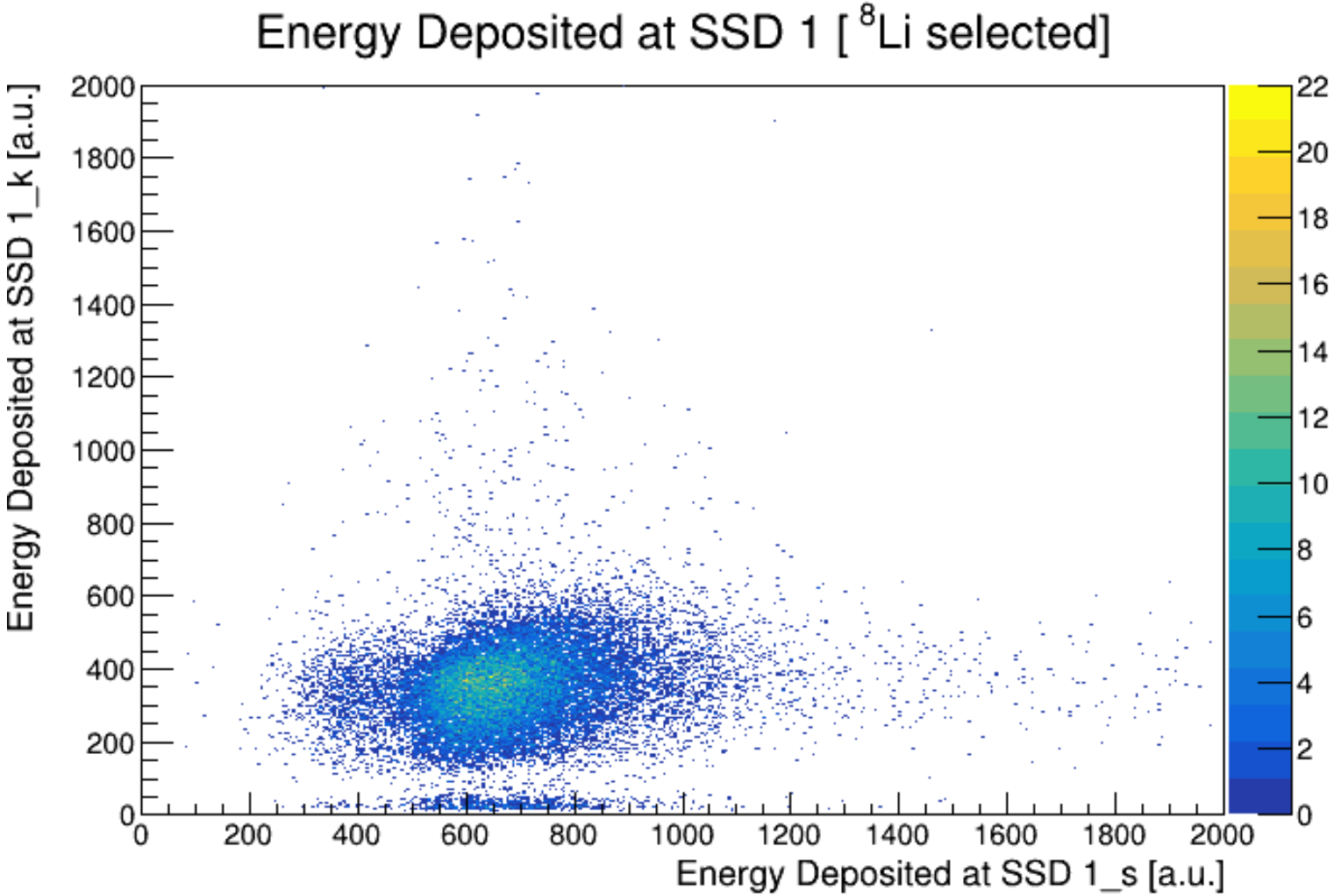
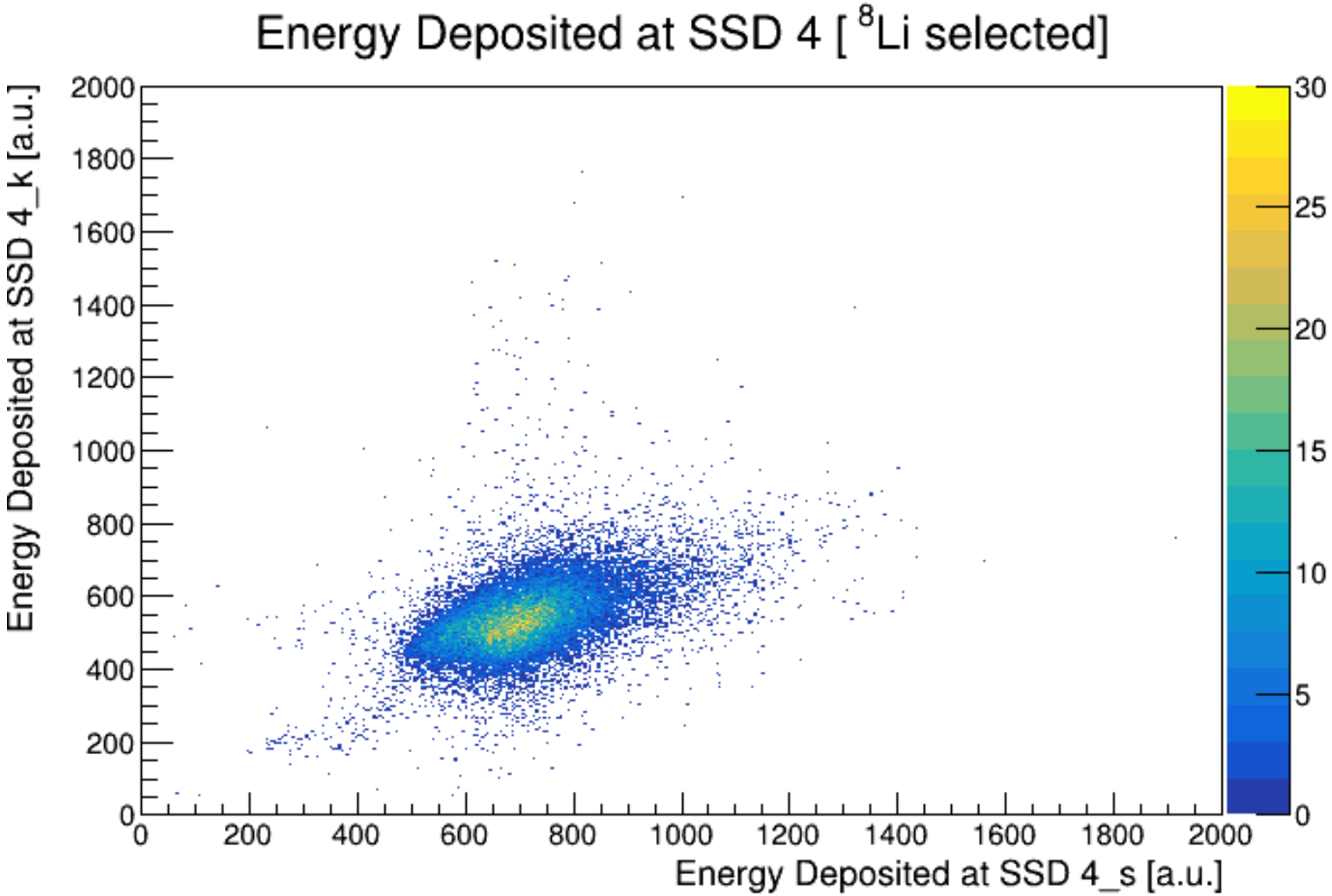
Nuclei Path and Data Analysis - SSD

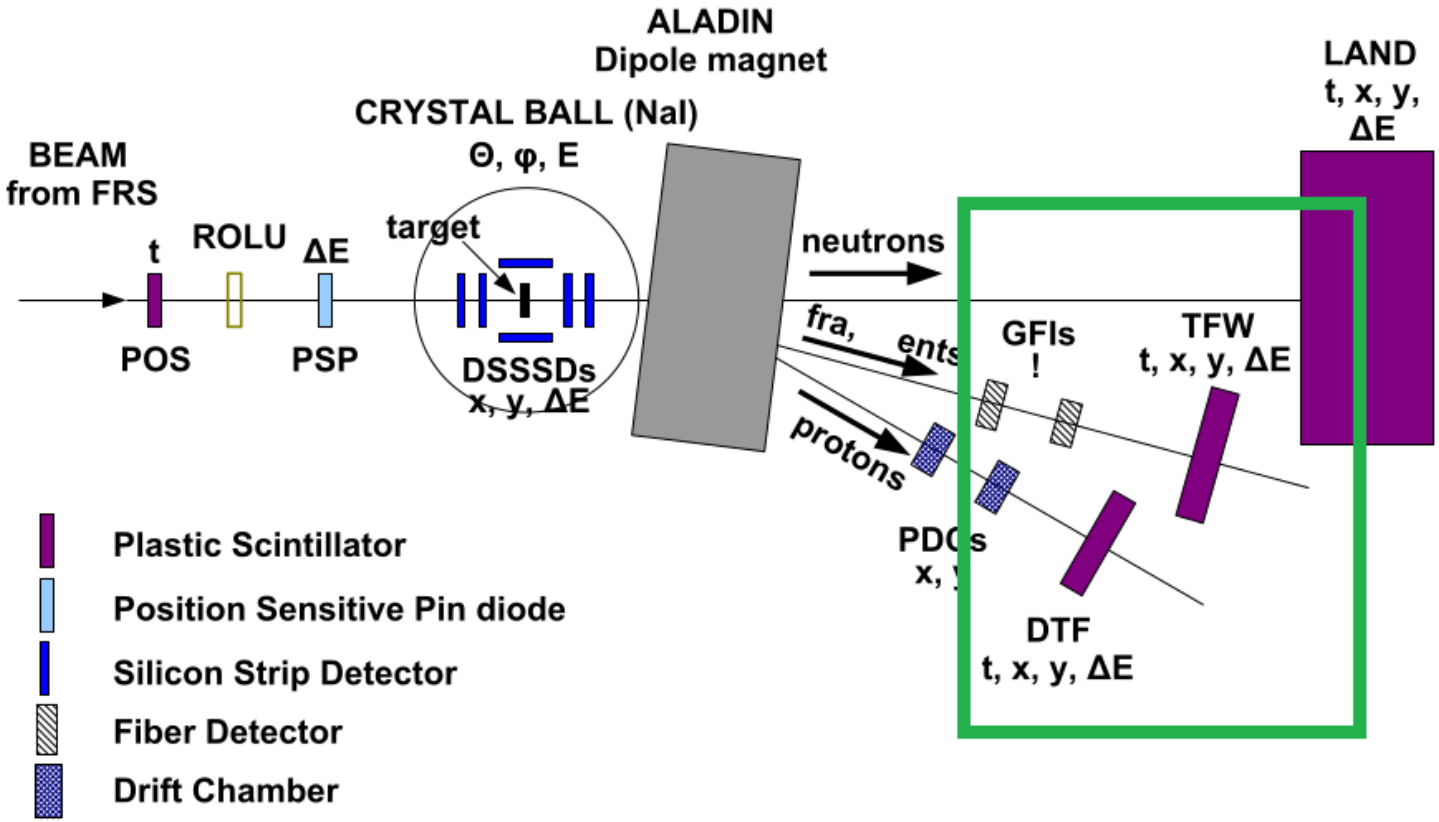


Nuclei Path and Data Analysis - SSD

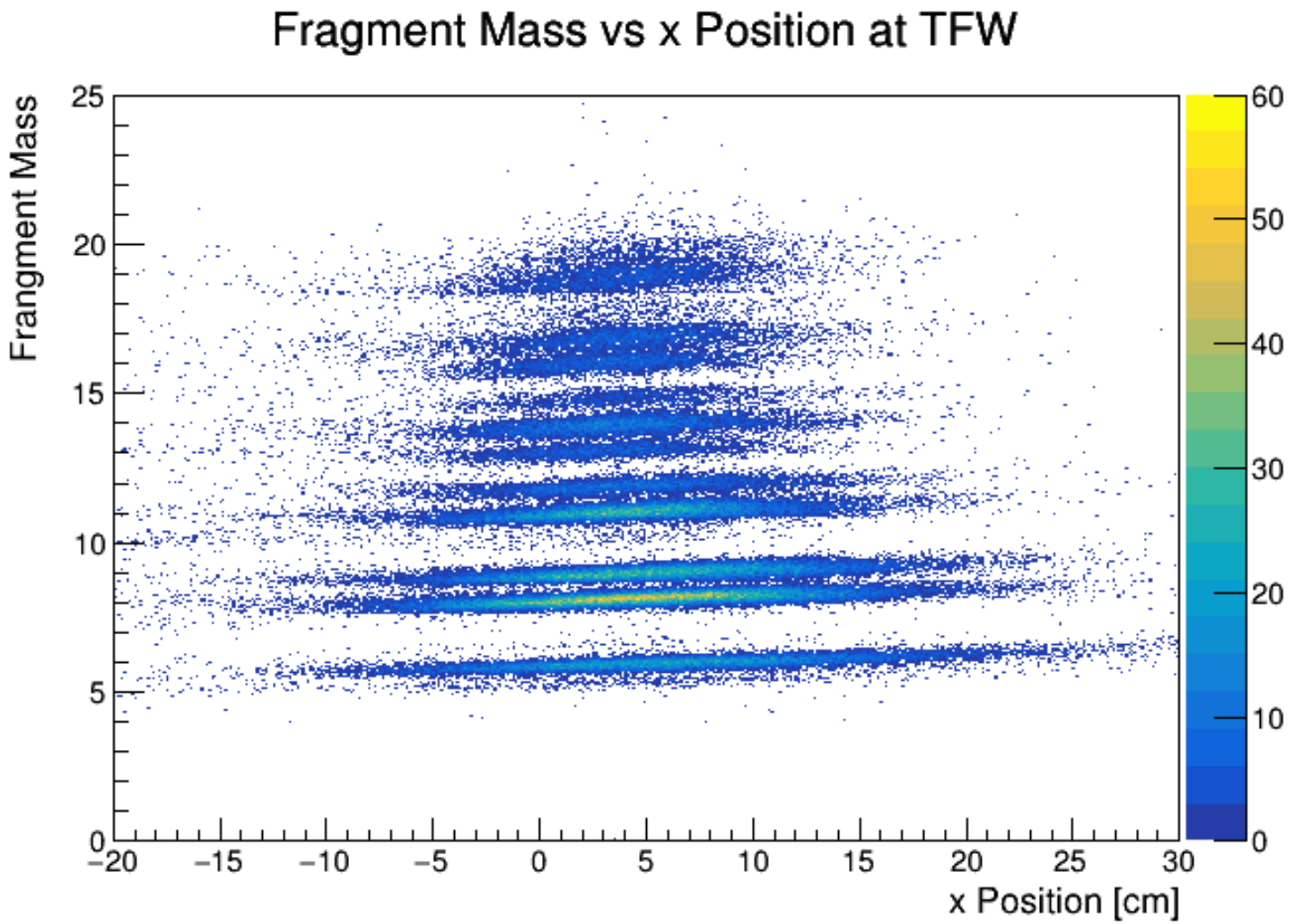


- Energy deposits proportional to ion charge
- Same kind of spot in SSD 4 and 1 meaning no charge lost

Nuclei Path and Data Analysis - After the Target

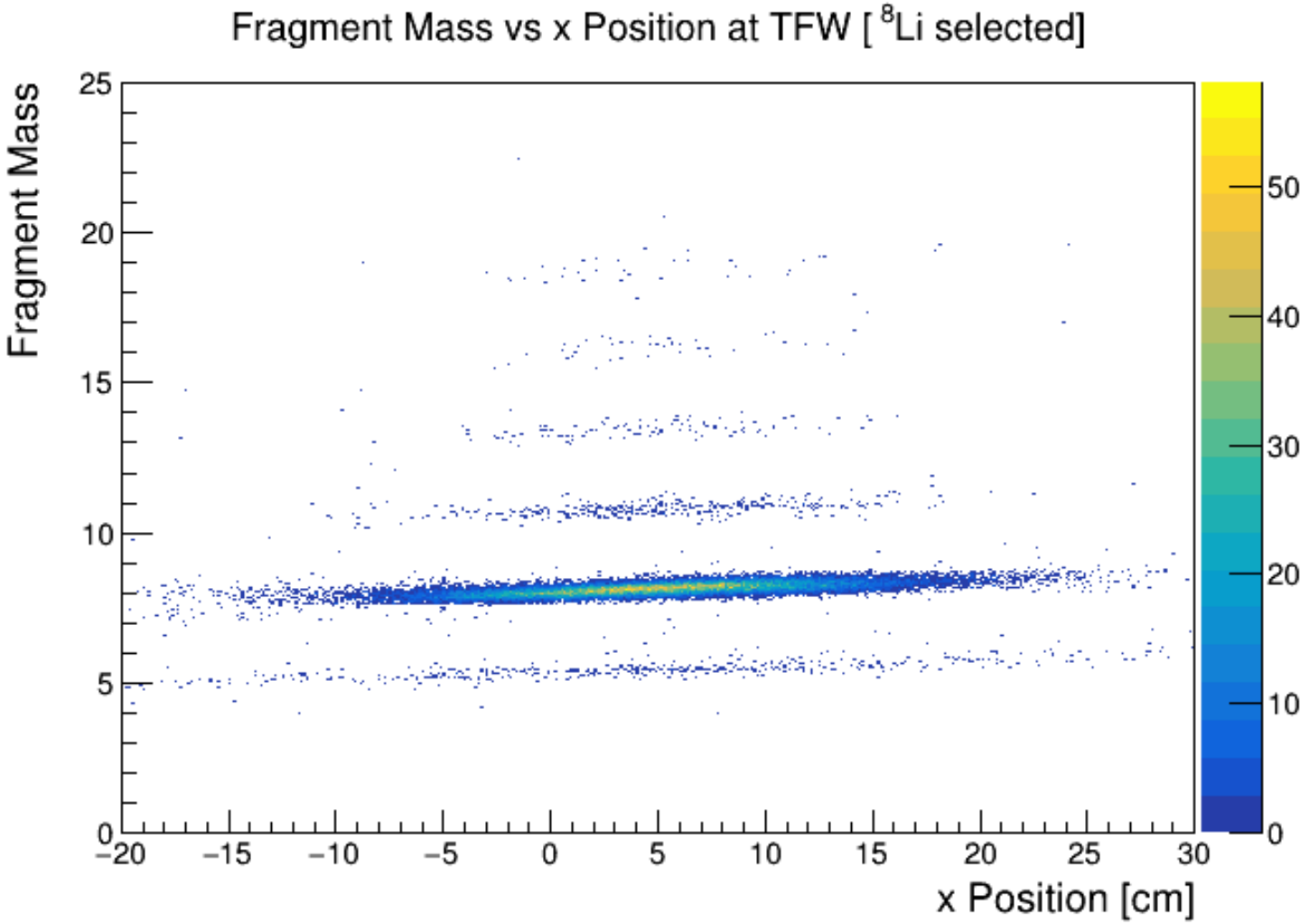


Nuclei Path and Data Analysis - TFW



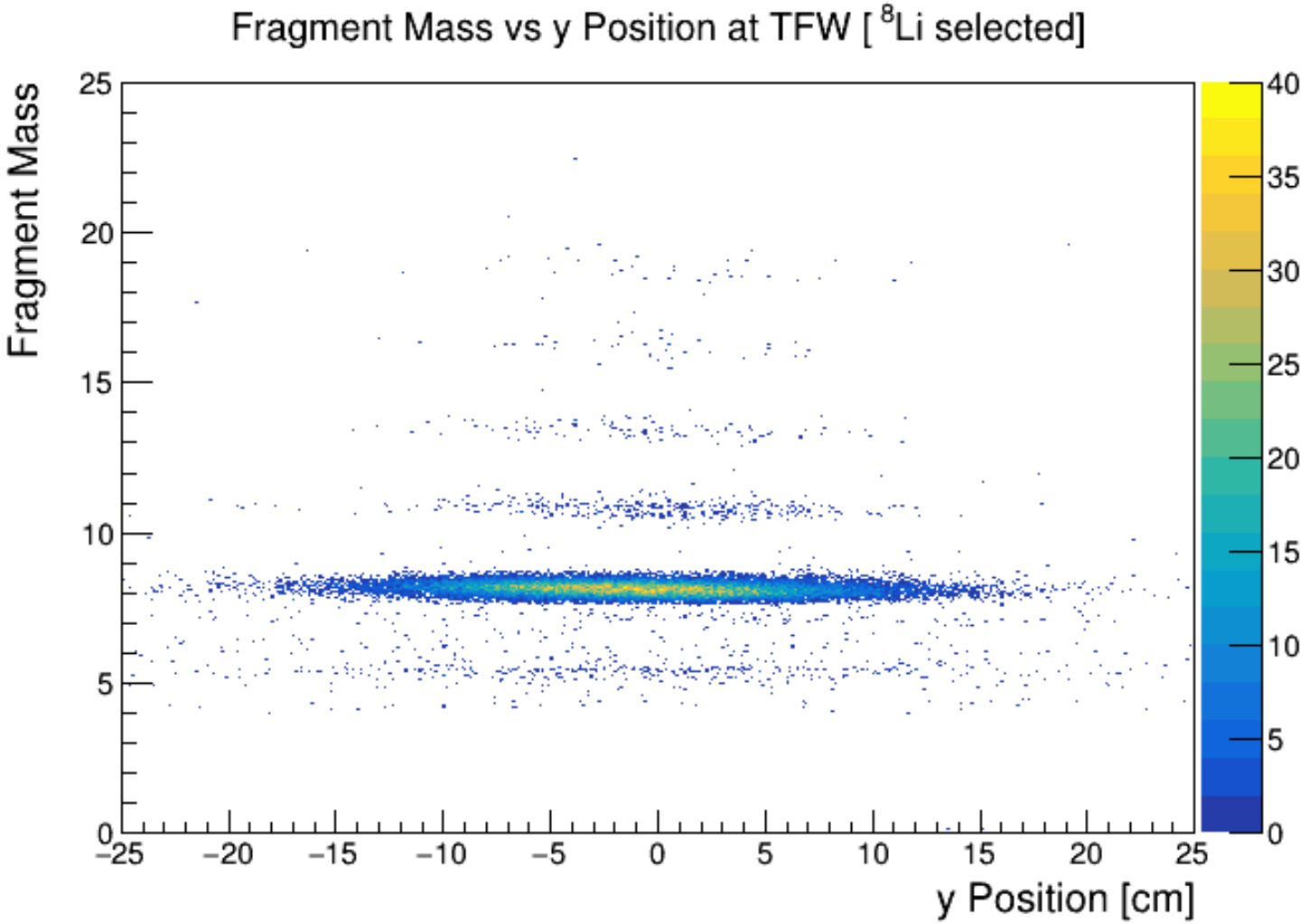
No selection

Nuclei Path and Data Analysis - TFW



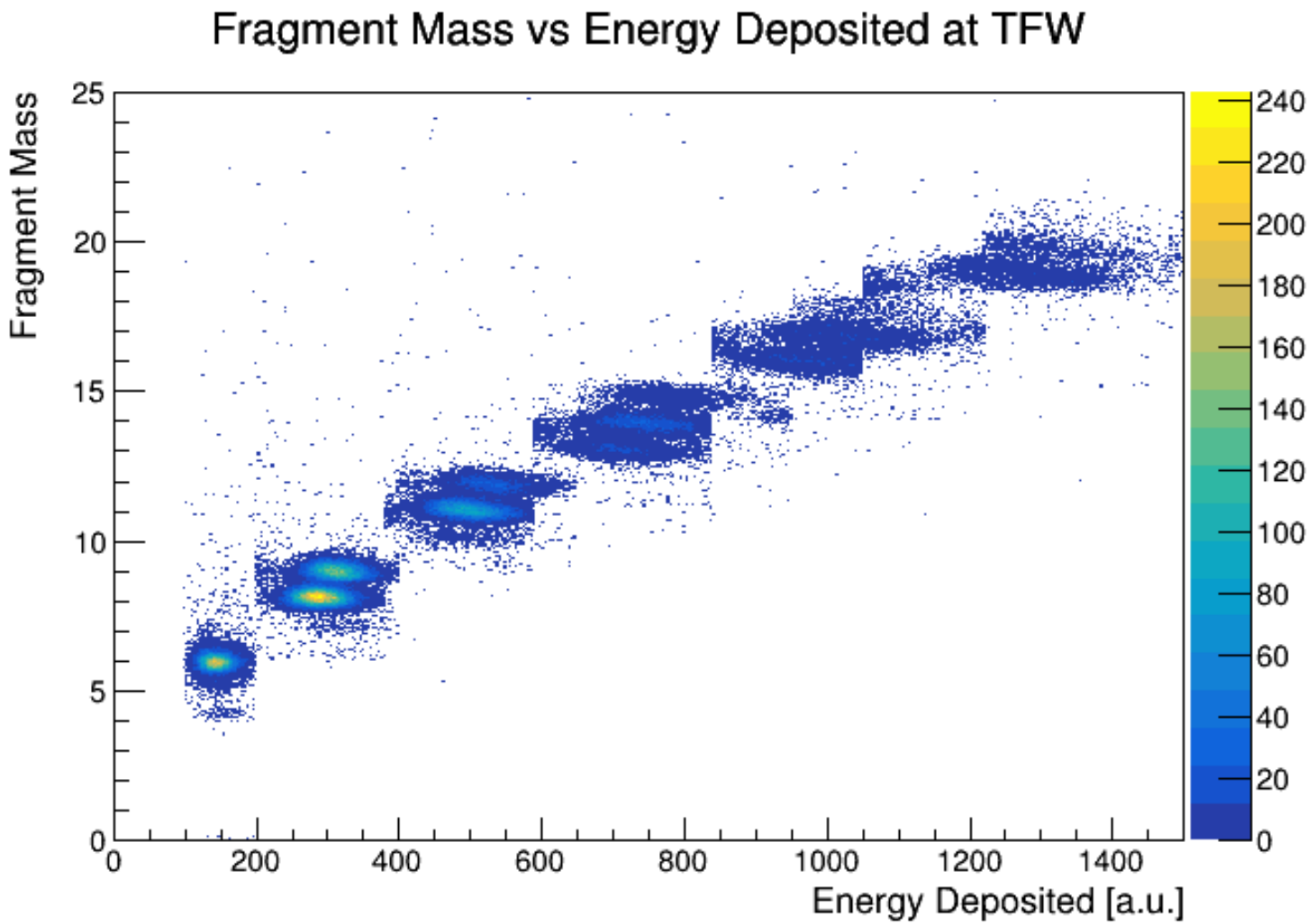
Mass distribution along x may not be centered at zero – charge deflection

Nuclei Path and Data Analysis - TFW



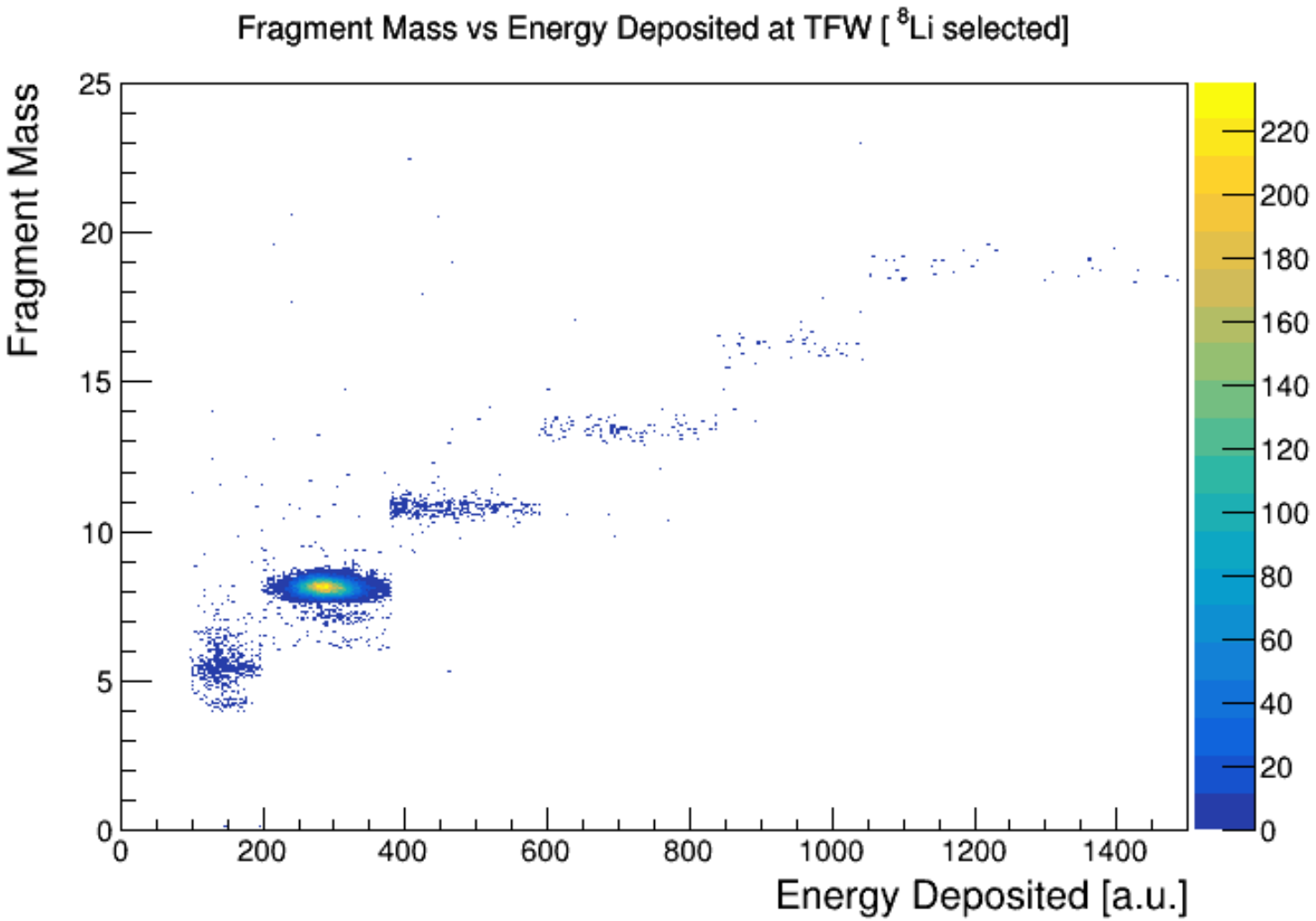
No deflection along y direction

Nuclei Path and Data Analysis - TFW

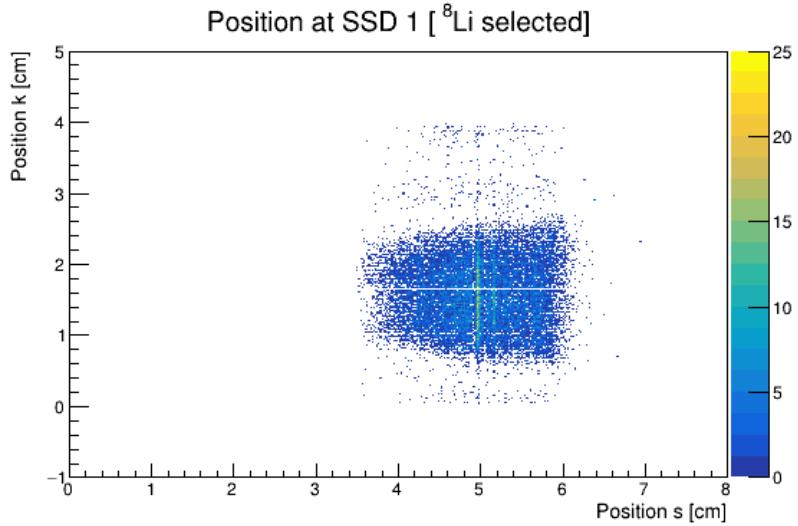


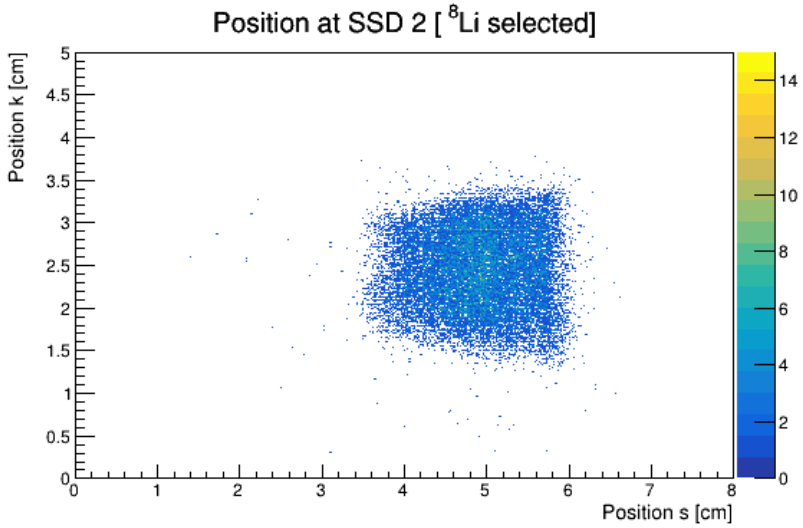
No selection

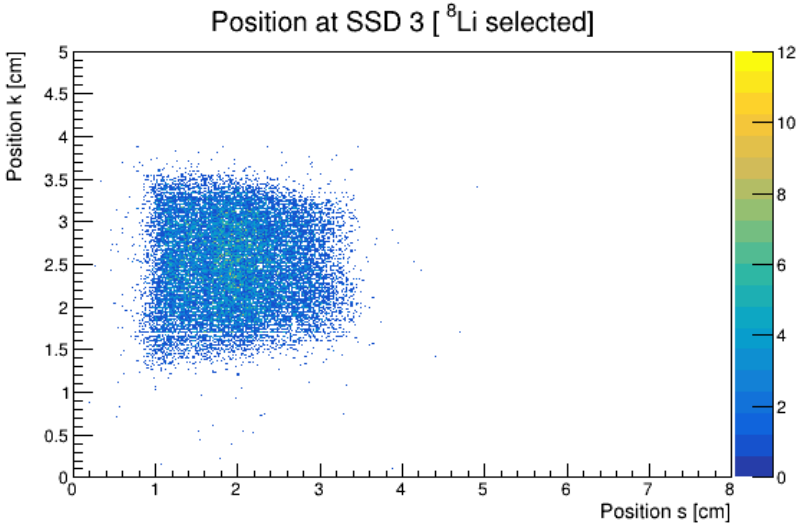
Nuclei Path and Data Analysis - TFW

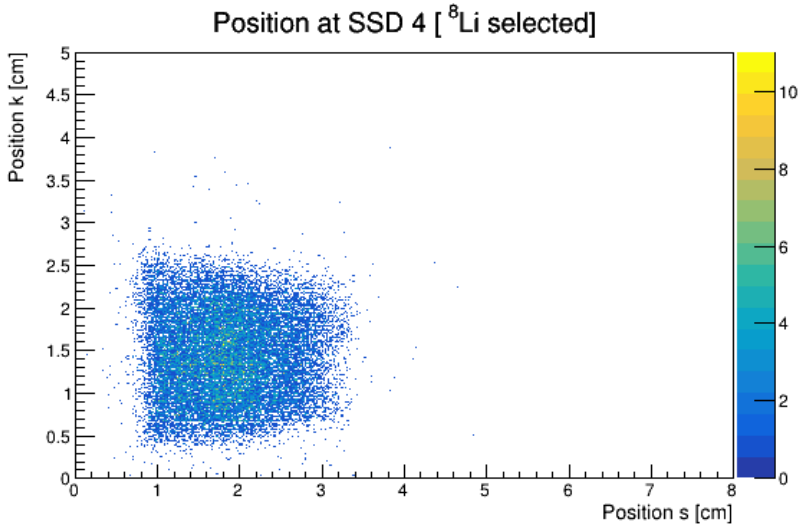


Angles - Incoming and Outcoming Trajectories

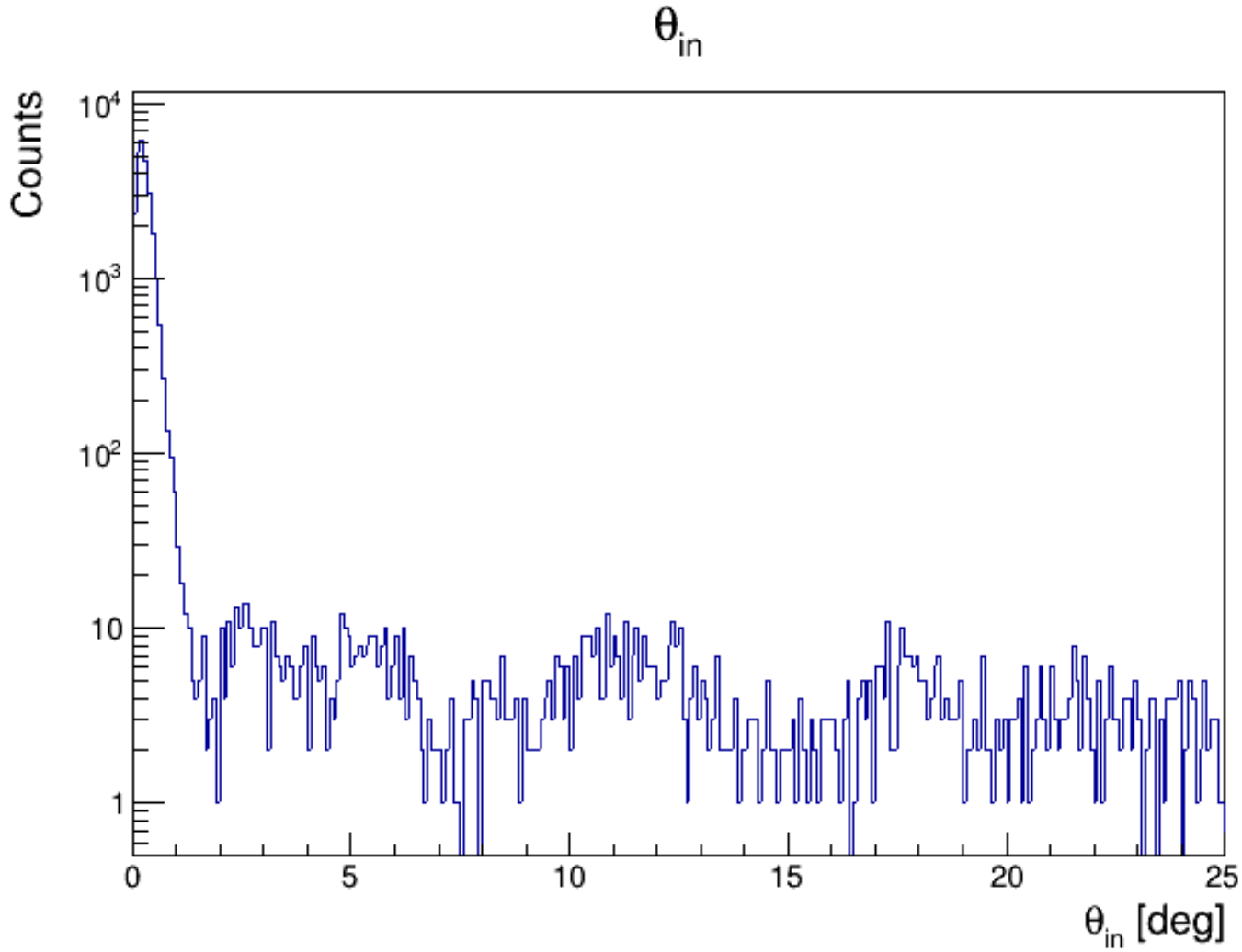




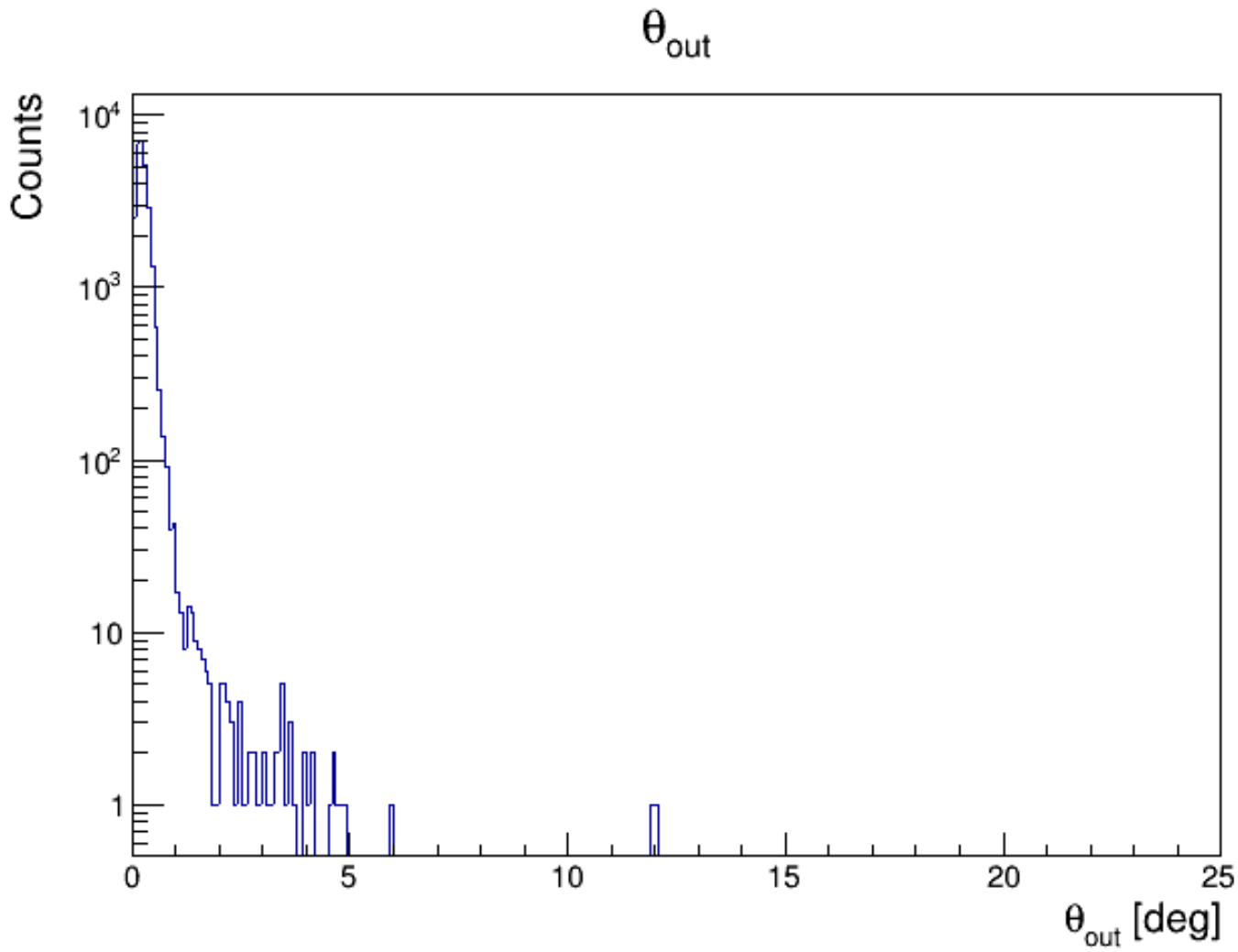




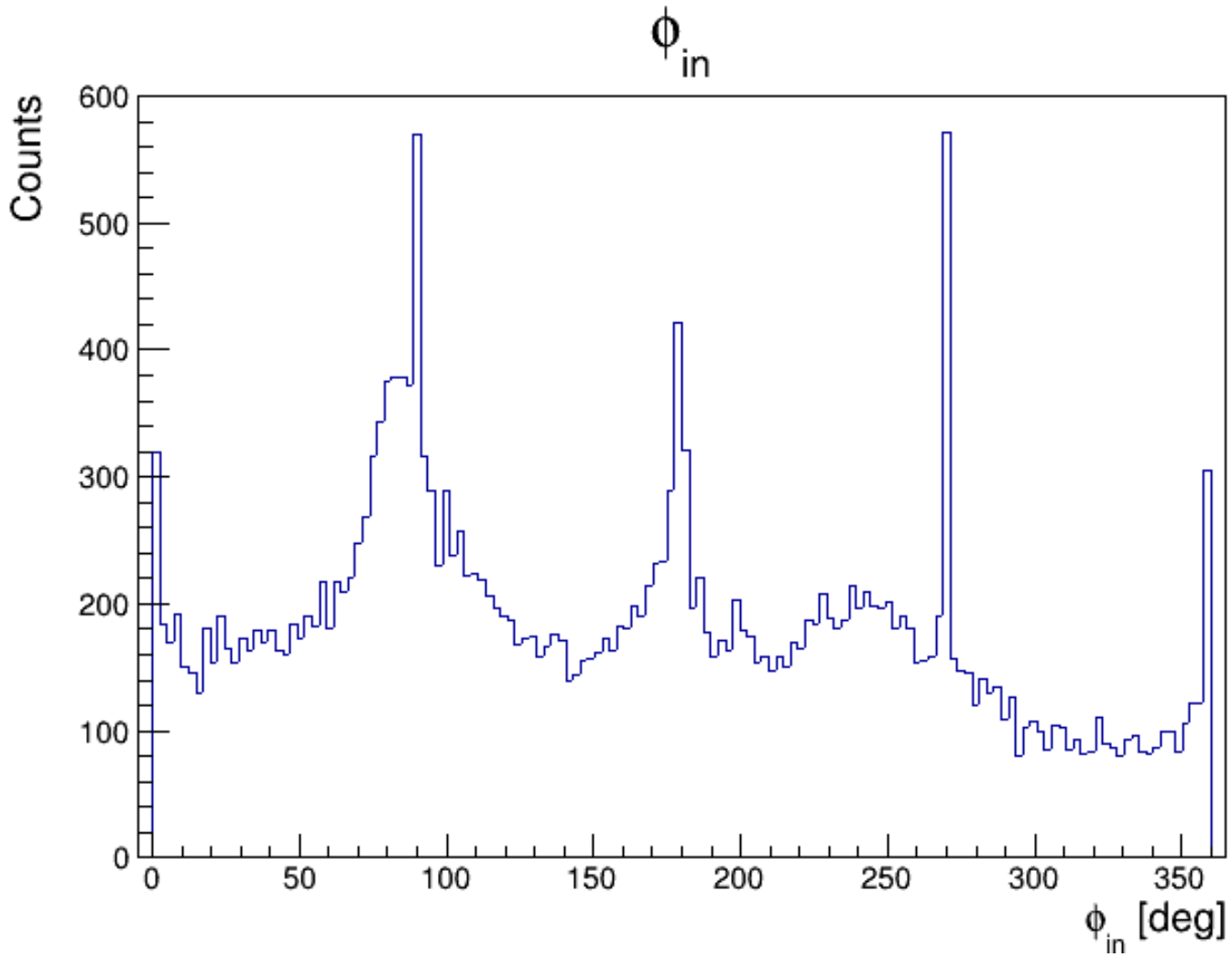
Angles - Polar In



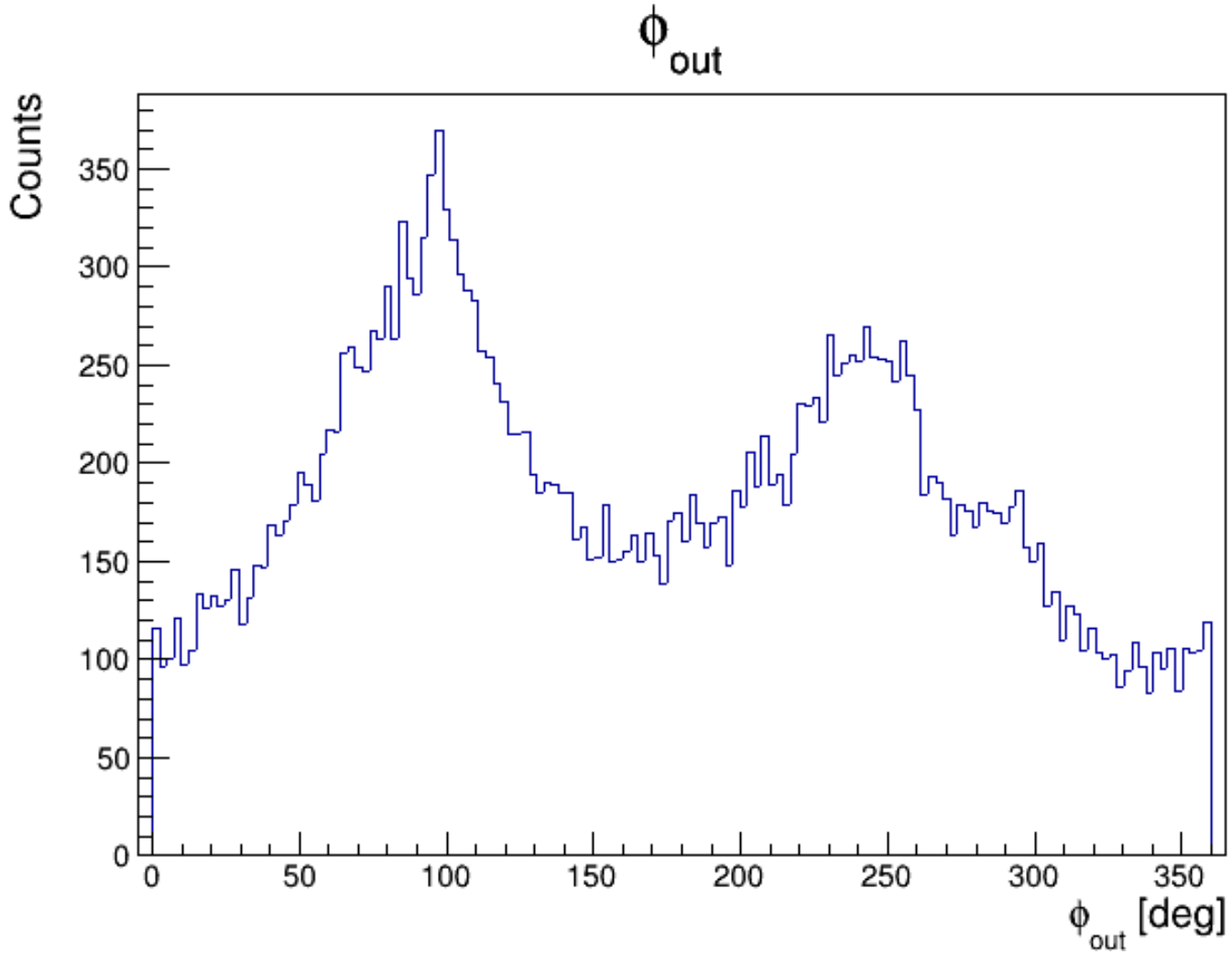
Angles - Polar Out



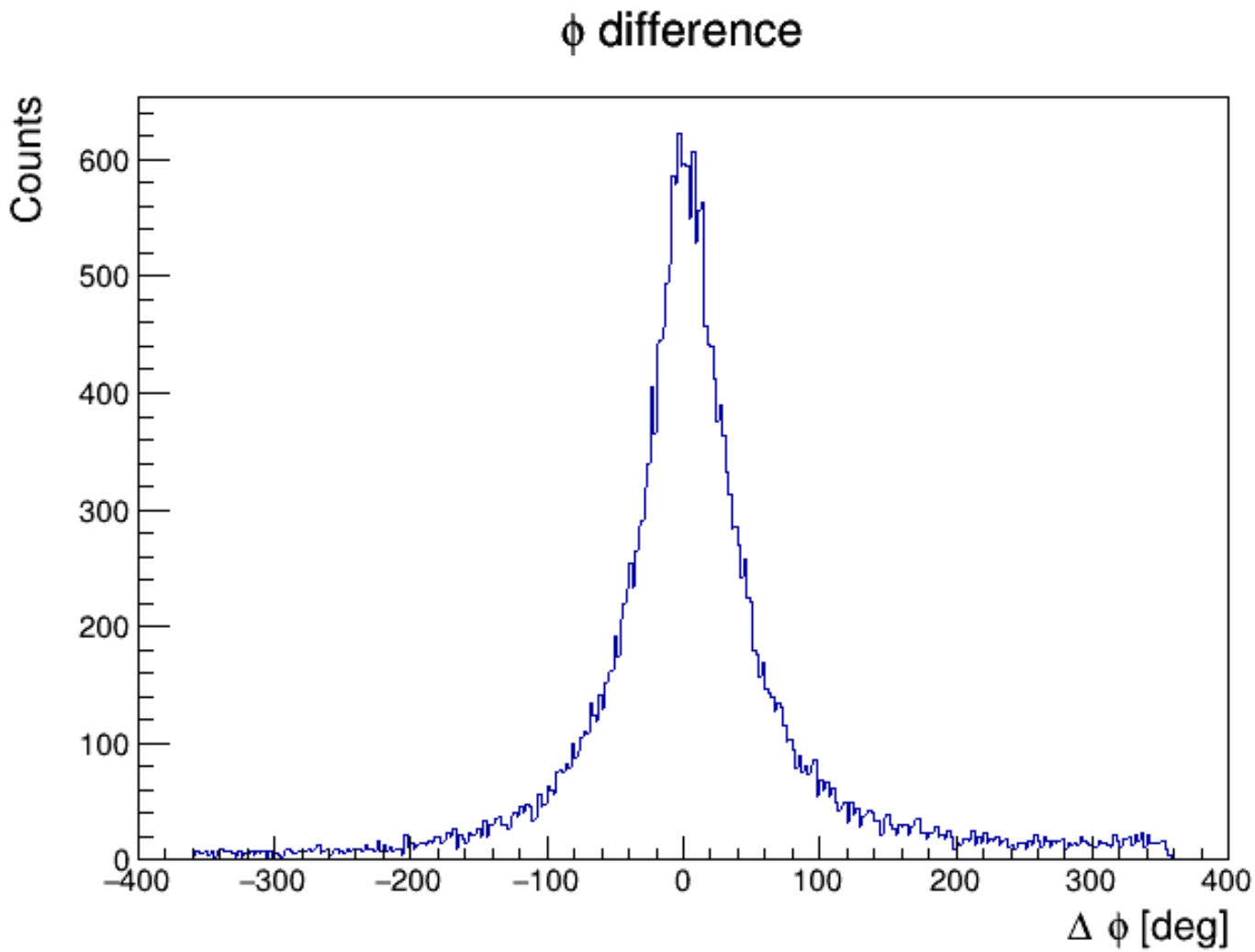
Angles - Azimutal In



Angles - Azimutal Out

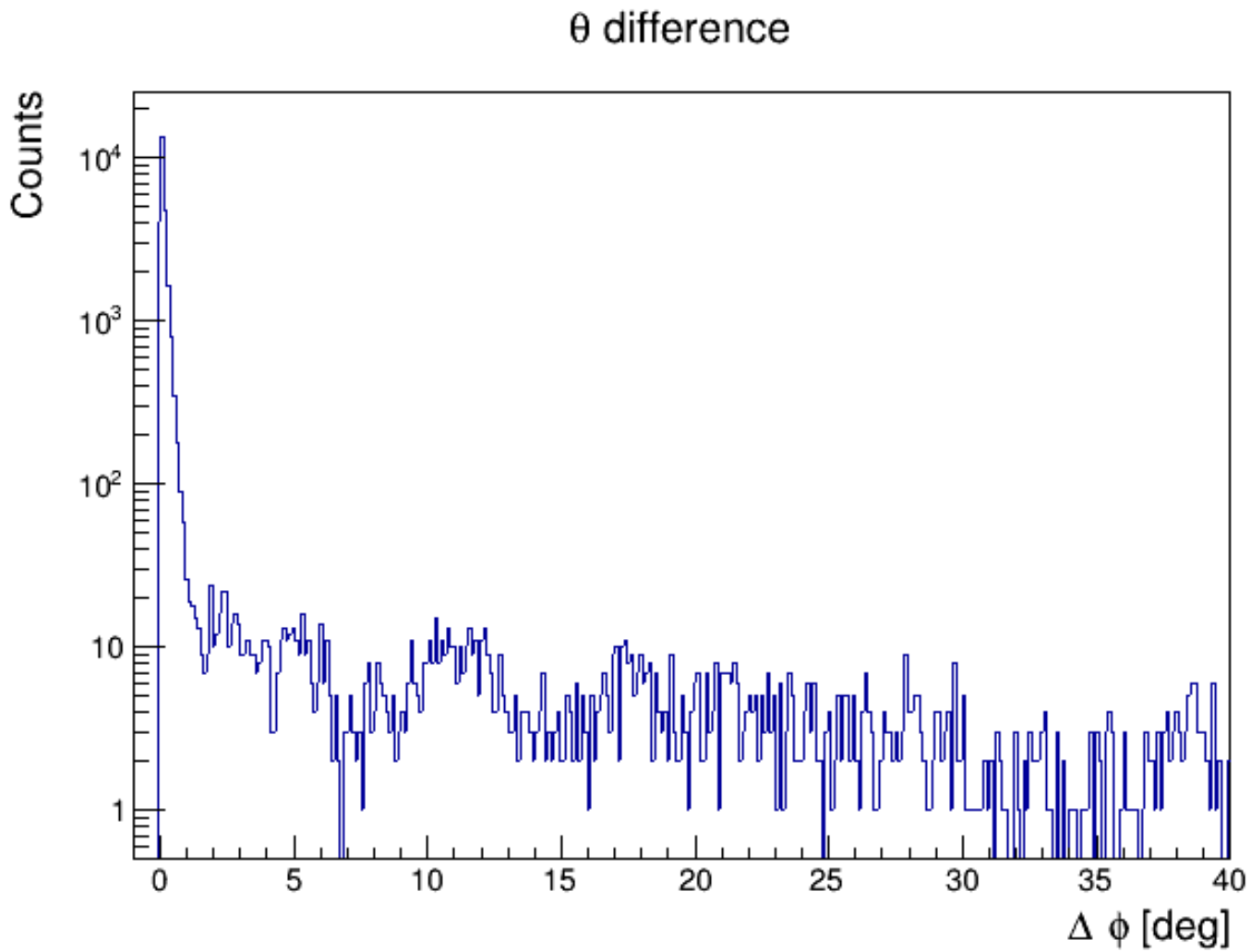


Angles - Azimutal Diference In-Out



No diference in ϕ defines a plane in which collision occurs

Angles - Polar Diference In-Out



Nuclear interaction – interference model

Resume

- Verify of coerence between experimental results in direct and inverse kinematics (angular momentum destribution, cross section...);
- Study of nuclear structure and exotic nuclei which don't exist naturaly on Earth;
- Interesting insight in astroparticles physics and astrophysics events;