Measurement of ^{17}F breakup on ^{4}He using the pAT-TPC

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1. Introduction

^{17}F is a well-known proton halo nucleus (Sp = 0.6 MeV) that can be described as a ^{16}O core nucleus plus a weakly bounded proton. The ^{17}F breakup mechanism can be induced by electromagnetic and nuclear interactions. Previous experiments of ^{17}F breakup on ^{58}Ni and ^{208}Pb nuclei show a strong interference of Coulomb and nuclear breakup processes [1]. New experimental data of ^{17}F breakup on a ^{4}He target were measured using the prototype Active Target-Time Projection Chamber (pAT-TPC). The pAT-TPC is a detector that uses a gas volume as both target and tracking medium, covering almost a 4π solid angle. The detector system allows a particle tracking from where it is possible to extract the scattering angles and the reaction vertex with good precision.

2. Previous breakup experiments of ^{17}F

^{17}F breakup was measured in the past using ^{58}Ni and ^{208}Pb targets[2]. Contrary to the expectations, the breakup cross section was larger on ^{58}Ni than for ^{208}Pb. CDCC calculations including both Coulomb and nuclear contributions [1] indicate that not only the independent Coulomb and nuclear interactions are important, but the interference between them plays an important role.

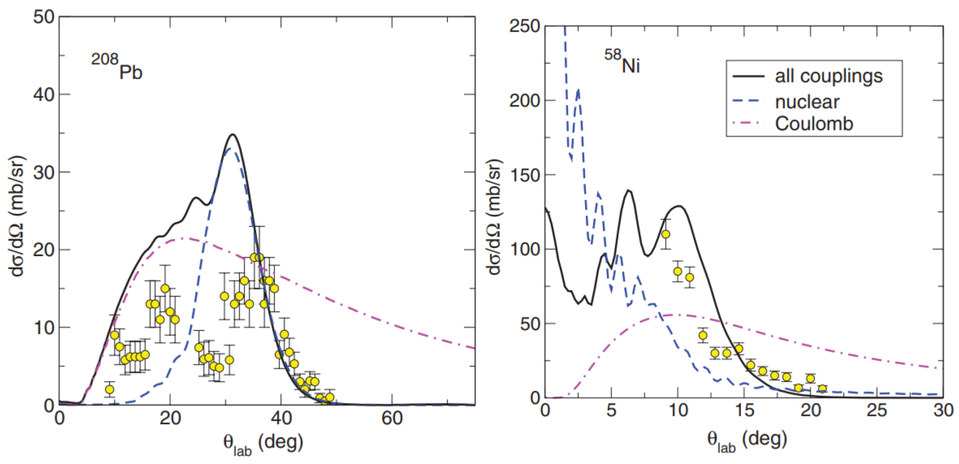

Figure 1: Nuclear (dashed) and Coulomb (dotdashed) contributions to the exclusive breakup cross section. The solid line is the full CDCC calculation, including both nuclear and Coulomb couplings [1, 2].

3. prototype Active Target - Time Projection Chamber (pAT-TPC)

The prototype Active Target - Time Projection Chamber (pAT-TPC) is a active-target detector that use a gas volume as both the target and tracking medium. Its large active volume and tracking capabilities provides good energy and angular resolution, which make the pAT-TPC detector well suited to work with low intensity exotic beams[3, 4]. The ^{17}F secondary beam was produced with the TWINSOL system[5].

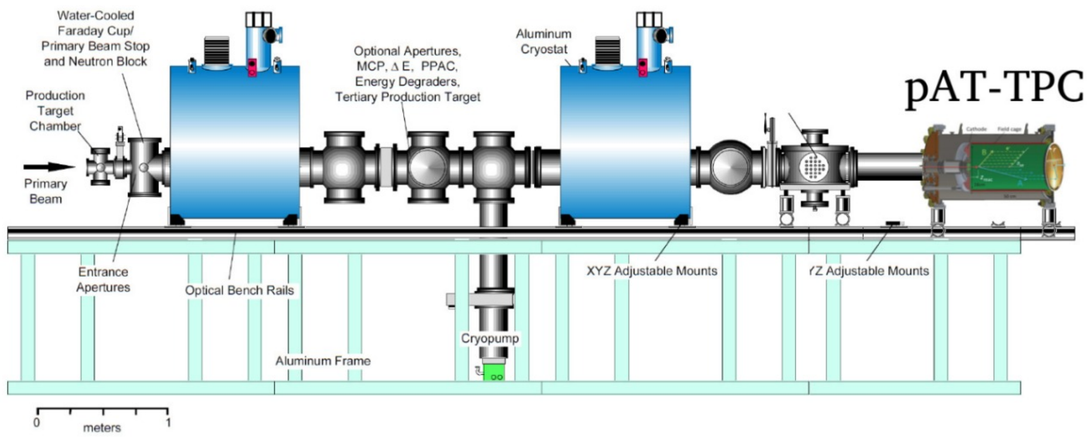

Figure 2: TWINSOL [5] facility on left, and the pAT-TPC on right.

The pAT-TPC allows particle tracking and complete kinematic measurements. Every hit in the gas produce electrons that are projected in the micromegas detector. Each pixel has an independent readout with digital signal processing[3]. The pulse shape analysis was performed with Machine Learning techniques. A point cloud of the reaction event can be reconstructed. Particle tracking algorithms based on RANSAC [6, 7] were used fit the tracks.

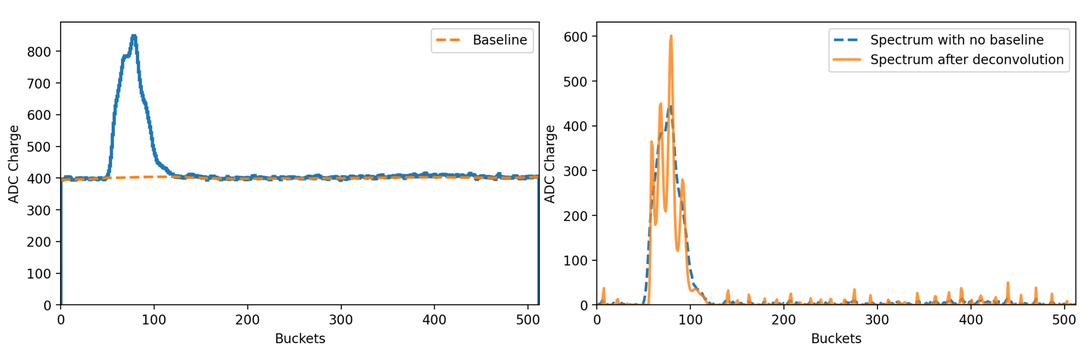

Figure 3: Example of signal of the pAT-TPC. On left the raw signal and the dashed baseline. On right the spectrum with no baseline and the spectrum after the deconvolution.

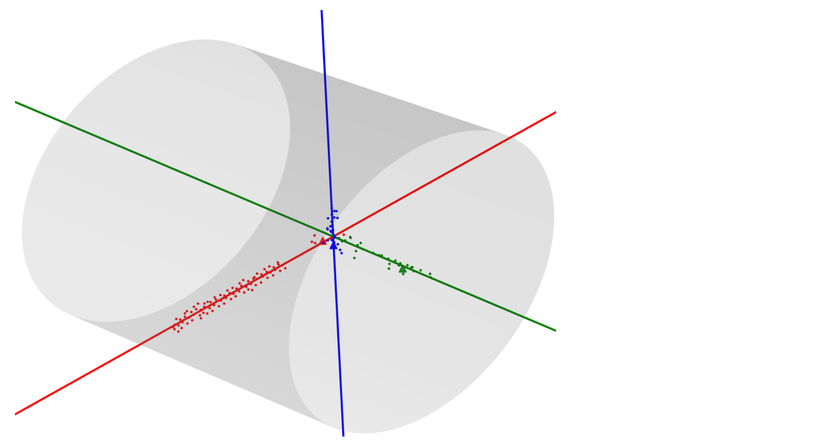

Figure 4: Example of an reconstructed event. The lines shows different particles.

4. Preliminary results

Preliminary results of the ^{17}F breakup on ^{4}He can be seen in figure 5. The top left figure shows coincidences of proton and ^{16}O measurements (θ_{lab} vs Track length). Both particles have the same vertex. The other three figures show the inclusive and exclusive breakup cross section for different energies.

Exclusive ^{17}F breakup on ^{4}He present relatively large cross sections in comparison with the previous experiments. In the present, case the Coulomb interaction is smaller than for ^{208}Pb and ^{58}Ni targets. These results are a possible evidence of the nuclear and Coulomb breakup interference with light target nuclei.

Theoretical calculations are in preparation. This will help us to understand the reason of the relatively large breakup cross sections.

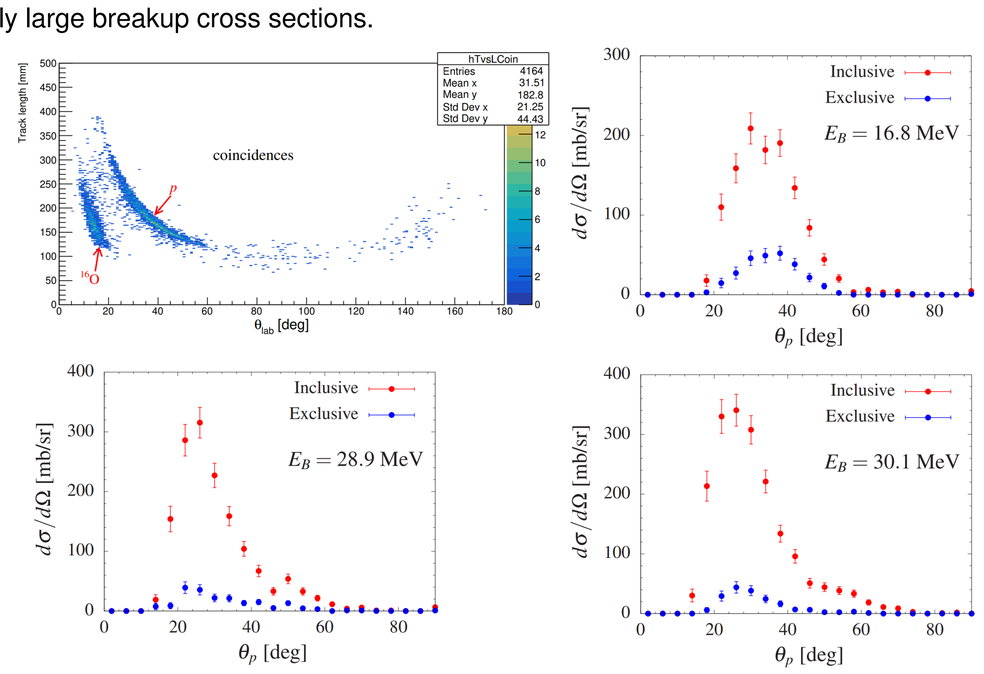

Figure 5: Proton production (inclusive) and breakup events in coincidence with ^{16}O particles (exclusive) for different energies. E_B is the beam energy in the laboratory frame.

5. Acknowledgements

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