Simulation of the R^3B-LAND Response for Proton Channels using R3BROOT

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In order to conclude the analysis presented in [1, 2] we have set up an R3BROOT-based simulation to determine the *response* of the experimental setup, in particular the *relative-energy* dependent *acceptance* and *resolution*. The presented work is based on several upgrades of the definition of the R^3B-LAND setup within R3BROOT, including, e.g., the reaction targets, the helium filling of the Aladin magnet, and the proton drift chambers. We have developed the following procedure to determine the setup's response:
1) Simulation of a c.o.m. phase-space decay of the fragment+proton (f+p) system at a given relative energy.
2) Lorentz boost of the f+p system into the lab system. The experimental ^{17}Ne *beam profile* and *reaction vertex* are randomised. Spatial and momentum components of fragment and proton are stored in an event-based text file.
3) Input of the text-based events to R3BROOT and corresponding MC transport via Geant3. *Energy loss* and *straggling* may be activated or not.
4) Digitisation of the Monte-Carlo data to an experiment-identical "h509" HIT-level tree, with detector-internal data in terms of PID, position, time, and energy loss.
5) Experiment-identical *tracking* of the simulated HIT data. Particle trajectories are determined, and physics observables such as masses, momenta, and also the f+p relative energy are reconstructed.
Fig. 1 shows the relative-energy resolution of the R^3B-LAND setup for the decay of ^{15}O+p produced via 1p-knockout from ^{17}Ne at 500 AMeV. The major contributions to the resolution are straggling and the detector resolution. The total resolution varies from about 50 keV at 100 keV to about 400 keV at 5 MeV. A first test of the performance of this simulation framework in a comparison to experimental data is shown in Fig. 2. The black data points

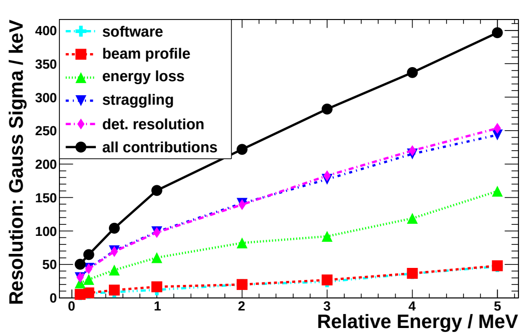

Fig. 1: Relative-energy resolution for ^{15}O+p decay at about 500 AMeV beam energy. Shown are different contributions to the resolution: software and tracking (light-blue), beam profile (red), energy loss (green), straggling (blue), detector resolution (pink), total resolution (black).

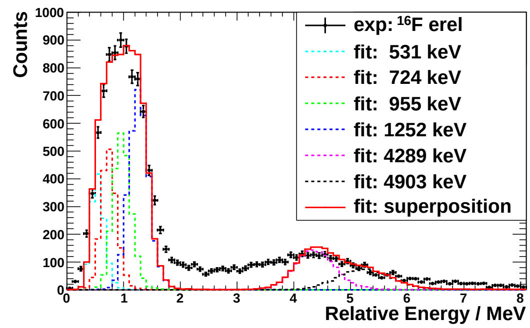

Fig. 2: Carbon-target experimental ^{16}F relative energy (black markers) compared to the simulated response for the four low-lying and six (2+4) high-lying ^{16}F resonances (dashed lines). The first two (pink) and last four (black) high-lying resonances have been merged into one response each. The six components have been linearly combined to fit (red solid line) the experimental data.

show the relative energy of ^{15}O+p (= ^{16}F) stemming from ^{17}Ne breakup on the carbon target. The response of the first ten ^{16}F resonances is represented in the six dashed-line histograms, where the two high-lying ones combine two and four states, respectively. These response spectra have been fitted to the data in a linear superposition, shown as the red solid line. The fit does not describe the data very well. For the low-energy peak (0-2 MeV), supposed to be populated via knockout of halo-protons from ^{17}Ne [3], the tails are under-produced, while the central region is overproduced. The valley region (2-3 MeV) is not reproduced at all, and the high-energy bump (3-6 MeV) slightly overshot. Therefore, further contributions to the observed experimental spectrum, such as non-resonant background and mis-identified ^{15}O+2p events, will be added the fit.

References

[1] Felix Wamers, GSI Scientific Report 2010.
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[3] L. V. Grigorenko et al., Phys. Rev. C **71** (2005) 051604.