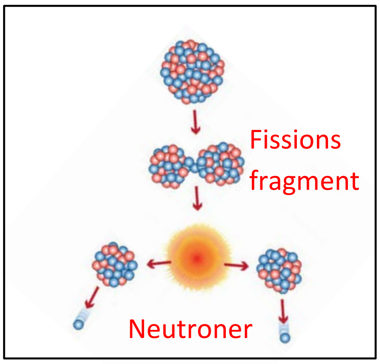
Master project in Applied Nuclear Physics

Analysis of nuclear experiments for detector characterization

Engineering Programme / Master in Physics - Degree Project (Exjobb) 30 credits (20 weeks)



Fission is a fascinating topic in nuclear physics, in where the interplay between the fundamental forces of nature give rise to exciting quantum phenomena. Fission fragment mass distributions, neutron evaporation and γ-ray emission may help to understand how exotic nuclei are formed and how their internal structures are. In order to study the properties of fission fragments, one needs accurate and well-characterized detectors. In this work, you will gain general knowledge about fission physics, nuclear de-excitation and learn more about solid-state silicon detectors.

In the framework of a granted VR (Swedish Research Council) project on Generation IV nuclear technology systems, Uppsala University is part of a research project to develop a large silicon detector array at the Joint Research Centre of the European Commission in Belgium. The state-of-the-art nuclear instrument (VERDI) stands for "VElocity foR Direct particle Identification". When a fission event occurs, both fission fragments escape back-to-back and are detected in each Time-Of-Flight (TOF) arm. By measuring the velocities and energies of both particles, one can reconstruct the masses of the particles using the kinematics of the reaction. In order to obtain precise mass measurements, both fragment velocities must be determined in great precision.

One main challenge currently is to deduce the correct time-of-flight from the Si detector signals. The so-called Plasma delay time (PDT) in Si detectors give rise to time delays which deteriorate the mass resolution. To mitigate this problem we recently performed dedicated PDT measurements at the TANDEM accelerator facility of Ångström laboratory in Uppsala (see fig. 2). By measuring the "true" time-of-flight with the aid of 2 Micro Channel Plates we could compare the PDT-affected time-of-flight to the true one. The data were performed with digital data acquisition systems.

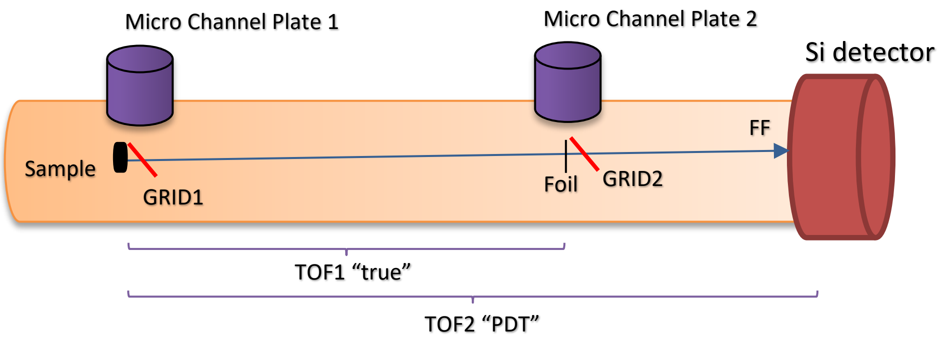


Fig 2: The setup used for the plasma delay time studies, at the TANDEM facility in Ångström lab.

The purpose of this master project is to analyse the data which were done both on α particles and on bromine and iodine ions of 44 MeV, scattering on gold samples. The analysis involves:

1. Learn and perform data signal processing
2. Learn and perform energy loss corrections
3. Implement a correction of Pulse Height defects
4. Calibrate and validate the spectra
5. Investigate the time delay and compare with literature values.
6. Correlate the measured times with the energies measured in the Si detector.
7. Study and evaluate the uncertainties in these measurement

This is a unique opportunity to participate in a nuclear experiment analysis, improve the detection capabilities and to ultimately help pushing the limits of nuclear sciences. The analysis will be based on the ROOT package developed at CERN, which requires C++ skills. We welcome your applications to the following email address:

Start date: As soon as possible, upon agreement.

Supervisors: Ali Al-Adili (Ali.Al-Adili@physics.uu.se) & Diego Tarrío
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