# Tests and simulations of GEM foils for use in an active target gaseous detector

*Reactions with well defined radioactive ion beams were previously not possible at the energies now available. The new higher energies enable physicists to get more information on e.g. nuclear structure and reaction rates in stars.*

The higher reaction energies are made possible by a new post accelerator at HIE-ISOLDE at CERN. To study these reactions a new detector is currently under development, which will have the possibility to track the positions of particles travelling through a gas volume. When particles travel through gas they create electrons by interactions with the gas atoms. The electrons are drifted, by an applied electric field, towards a segmented PCB board where they induce signals. The signals can be used to get a 2D-position of the particles in the gas, but are very weak and difficult to measure. To improve this the number of electrons needs to be multiplied. This is done by the gas electron multiplier (GEM). The GEM consists of thin foils with a lot of tiny holes. Applying a voltage difference of a few hundred volts to the different sides of the foils will accelerate electrons drifting through the holes enabling them to produce more electrons. If a dust particle settles in one of the tiny holes it can lead to a short circuit, which can damage the GEM and stop it from functioning. To prevent this all handling of the foils were done in a clean room. The aim of the thesis work was to investigate the use of GEM foils in the detector under development and get experience of the handling of the foils. This was done by assembling and testing a small prototype GEM detector, which can be seen in the figure during a measurement. It was found that the foils are quit robust, but can nevertheless easily be destroyed if handled carelessly. Since the need to handled the foils in the clean room made the process of changing and replacing foils very time consuming simulations on how the GEMs work under different conditions are needed.

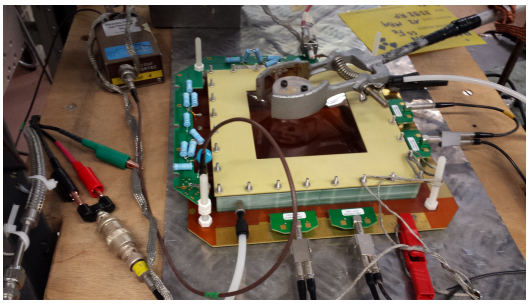

Figure 1: Picture of the GEM prototype during measurements

The simulations were done with the package Garfield++. It was found that the simulations modelled the detector well. This was done by comparing the gain, or amplification, for different gas mixtures, both from measurements on the prototype and from simulations. Other measurements were done to further characterize the detector, including testing how the detector would react to a gradual leak and charge up effects during long time measurements. This showed that the gain increases during the first hours of operation.

Simulations on size of the electron cloud when it reaches the readout board resulted in a size of $\sim$ 1 mm. The package was also used to simulate how an induced signal could look like. This gave the time during which the signal was induced and how long it takes for electrons to drift through the detector before starting to induce a signal.

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