# NESSY

## A Neutron Energy Spectrometer for SecurityY

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## Introduction

A liquid scintillator (LS) fast neutron detector has been built at Sheffield Hallam University, which can improve neutron spectrometry for homeland security. The detector works through a principle called capture-gated neutron spectroscopy, illustrated below. Fast neutrons and γ-rays can be differentiated using standard pulse shape discrimination (PSD) techniques. After moderation in the EJ-331 LS, the thermal neutron is captured by gadolinium (0.5% concentration), which leads to γ-ray emission around 20μs after the initial pulse – hence the design of the NESSY logo. This provides an extra level of differentiation between neutrons and γ-rays in a security low count rate security environment.

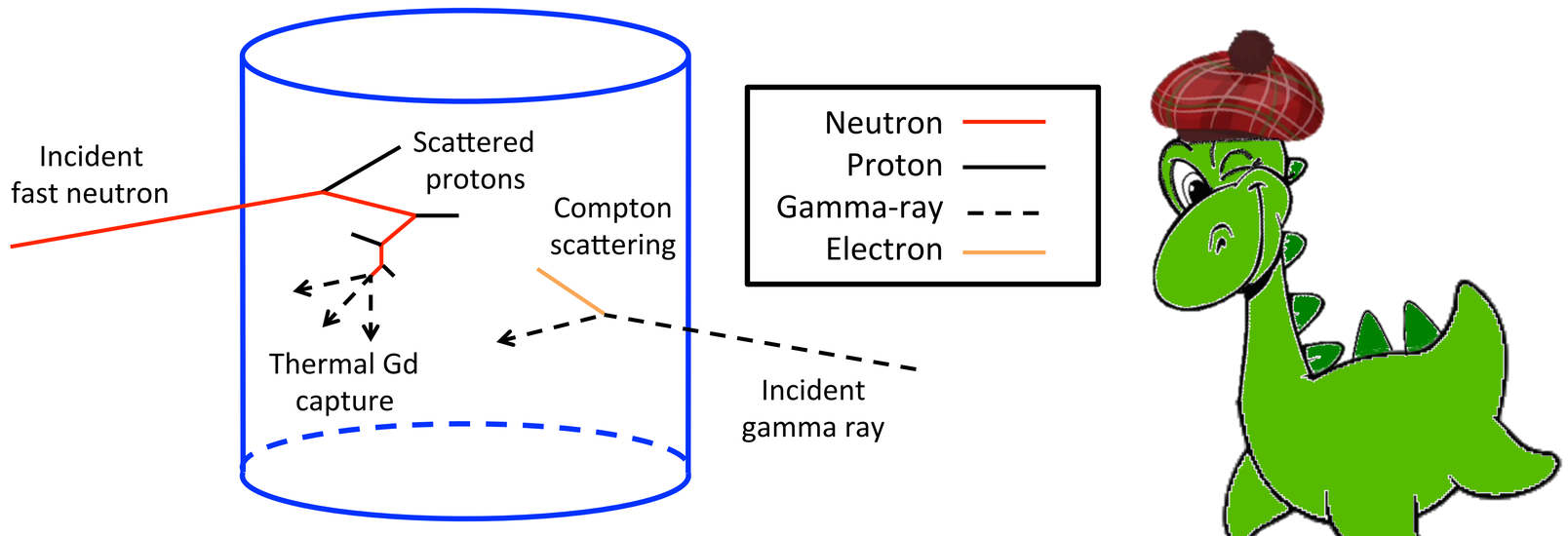


**Fig. 1.** Detection process schematic

## Detector and set-up

The detector has a 60cm-long active volume. The LS is contained in a borosilicate glass vessel. At each end, a Hamamatsu R14374 PMT is coupled via acrylic light guides to collect the scintillation light. In place of a traditional analogue pulse processing chain, the anode outputs from the PMTs are input to a CAEN DT5725B (14-bit 500 MS/s) desktop digitizer.

## Analysis and results

Since a neutron pulse has a different shape to that of a γ-ray, the two can be distinguished. The standard CAEN waveform firmware was run on the digitizer, so a Matlab pulse shape discrimination code was written to analyse the raw digitizer data. The pulse shape parameter is shown as a function of energy for simulated data in figure 2. The PSD method works well and is ready to test on real data.

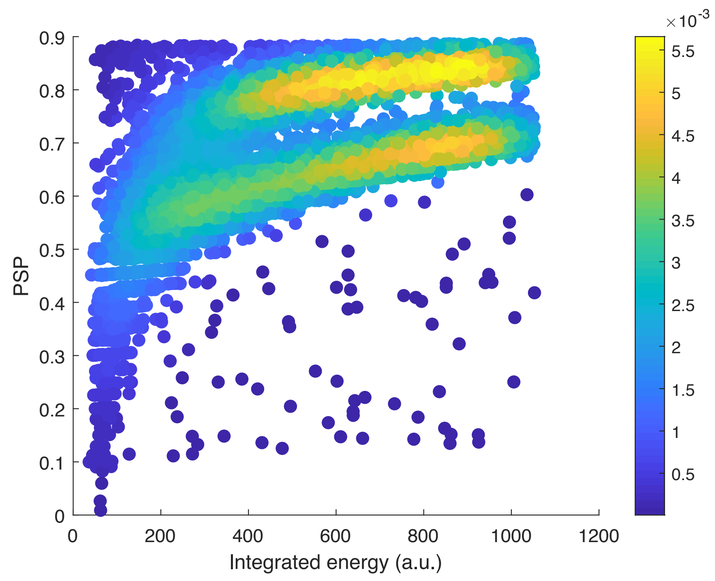


**Fig. 2.** Pulse shape parameter

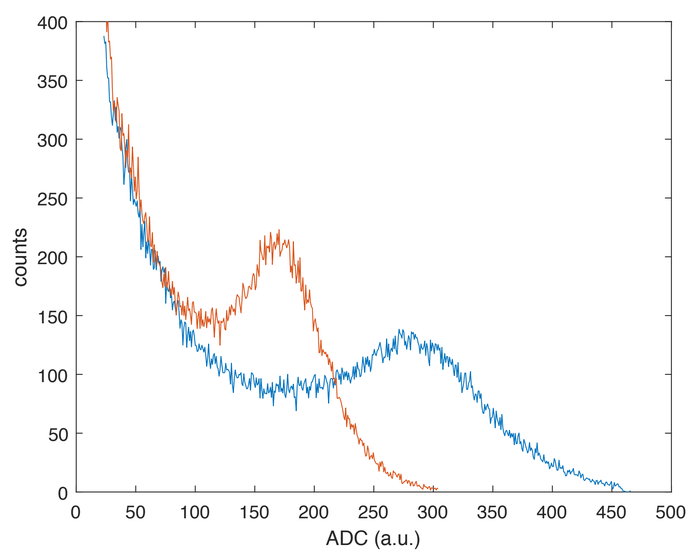


**Fig. 3.** The $^{137}$Cs pulse height spectra

The setup was experimentally tested with a $^{137}$Cs γ-ray source while a $^{252}$Cf source is purchased. The output from only one PMT was input to the digitizer. The resulting pulse height spectrum is shown in figure 3. Eventually, the outputs from both PMTs will be analysed in order to extract the interaction point of the incident radiation inside the detector.

## Detector photographs