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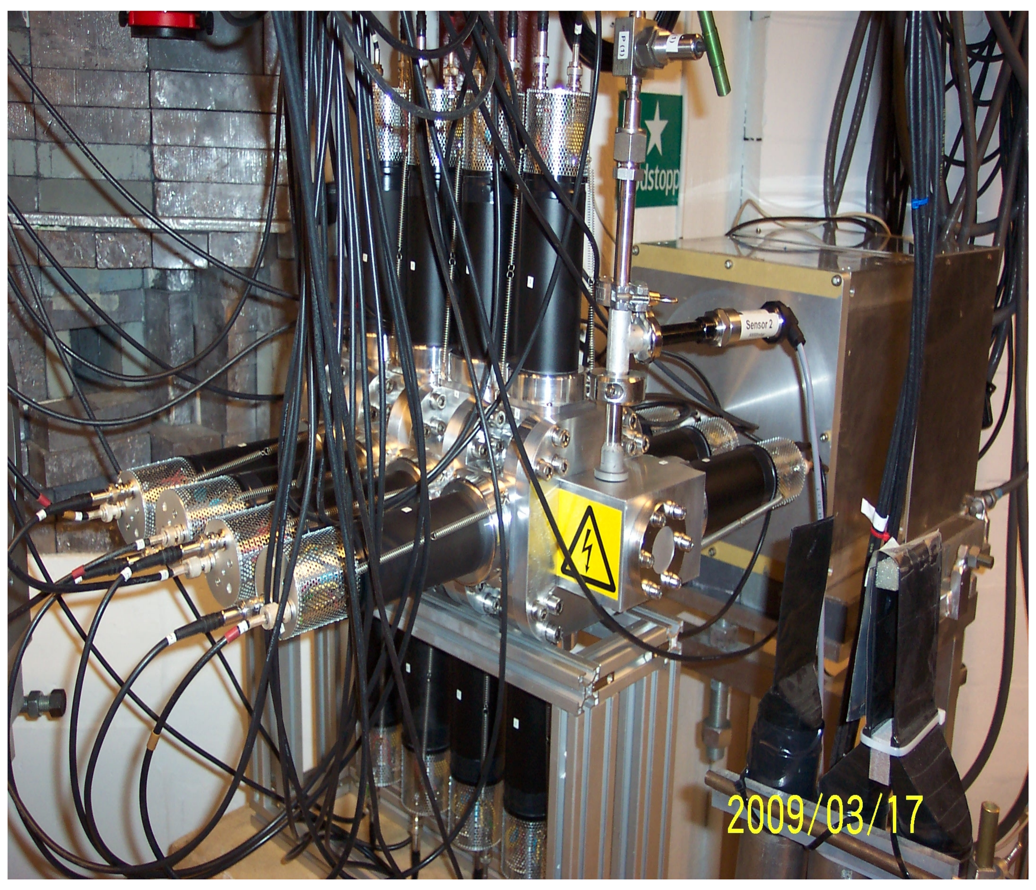
Measurement of the Total Photoabsorption Cross Section on ^{4}He using a Gas-Scintillator Active Target

university of glasgow's Nuclear Physics Group

The Helium Gas Scintillator Active Target



The Active Target is a helium gas scintillator where the target "Helium" also act as a detector of particles generated

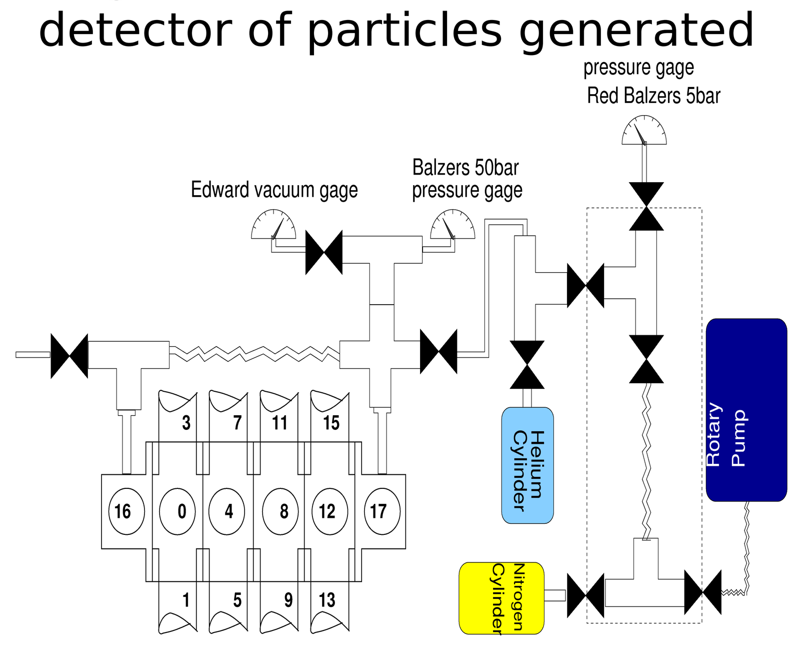
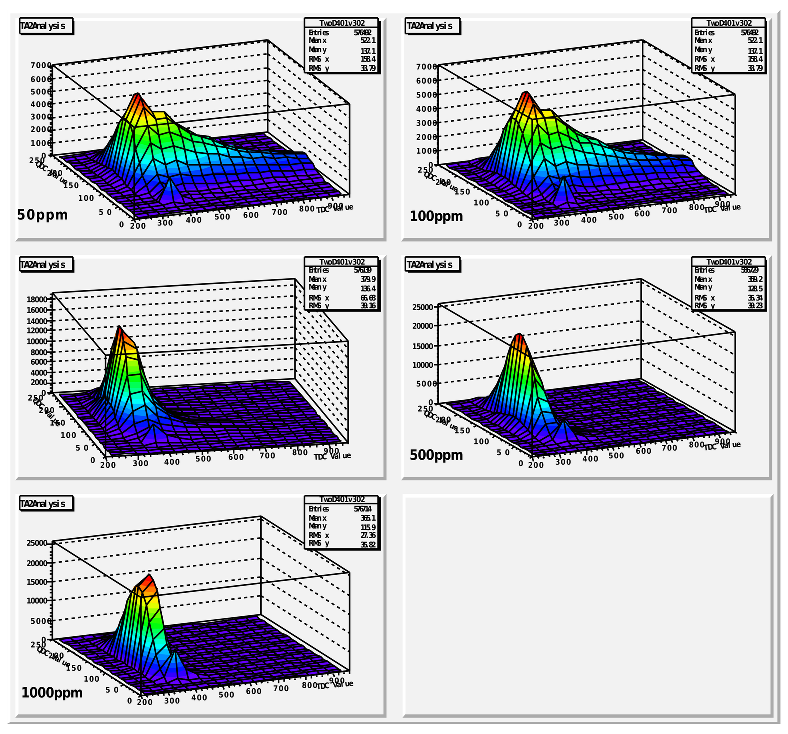
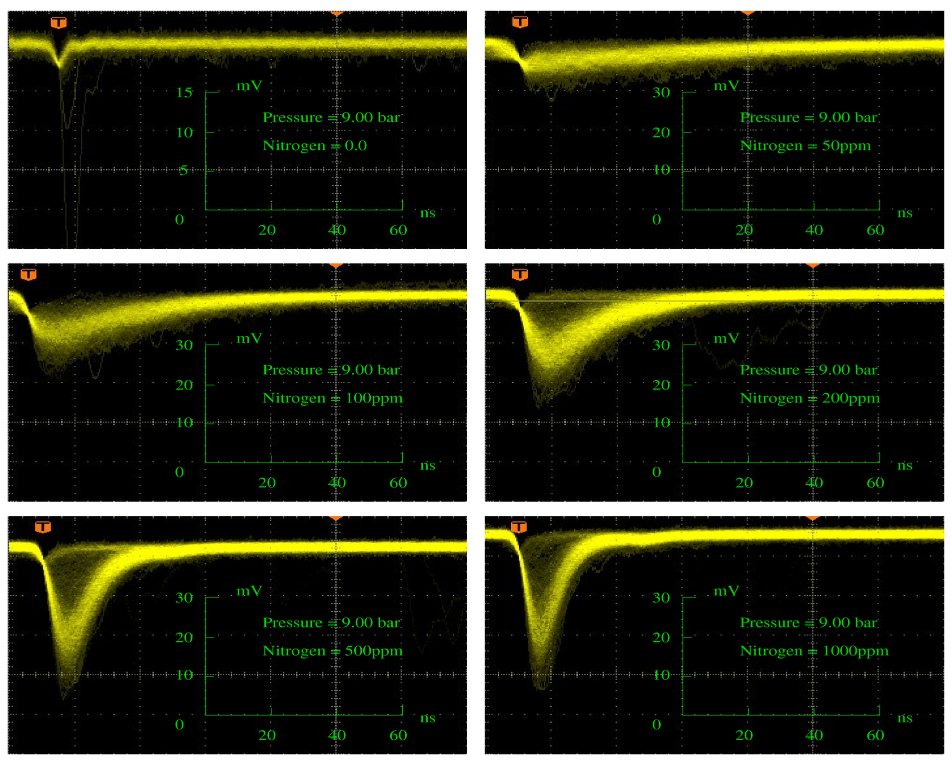


Photo-reaction observables are highly sensitive to the nuclear wavefunction and thus are an ideal tool to test theoretical calculations, where a nucleus is constructed ab initio using the best models of interactions between pairs and higher multiplets of nucleons. Recent big advances in theoretical techniques allow high precision calculations for A up to ~10, but existing data are of insufficient quality to offer a meaningful test, they are either inconsistent or conflicting. The Active Target has been designed and developed in Glasgow to make high accuracy measurements of photoreactions of ^{4}He.

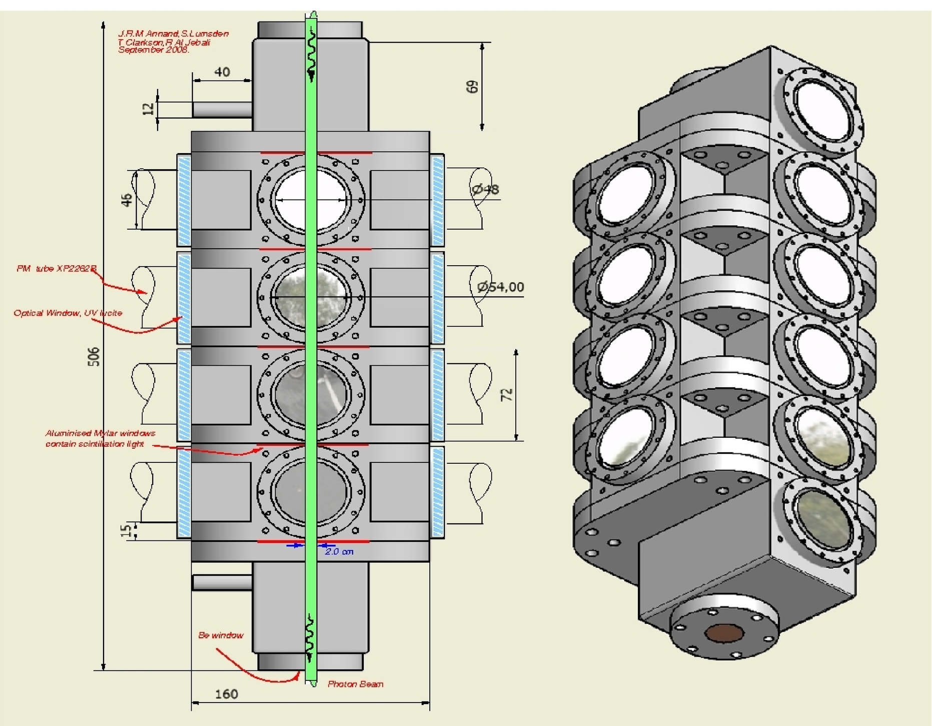
Enhancing The Scintillation Detection Quality

Helium Scintillates photons in the VUV range with wavelength lying at (60nm-100nm) and with very long decay time, Therefore, to detect and measure the scintillation signals efficiently a wavelength shifting (WLS) technique has to be used. One technique is to add traces of a fluorescent gas such as Nitrogen,Xenon,Neon, Argon or a mix. Adding Xenon and Nitrogen have been investigated for various concentrations and pressures. The scintillation response has been enhanced by adding trace Nitrogen. With good results obtained at 500 ppm. Standard operation was 1 MPa pressure and 500 ppm N2. The fast response gives good timing,

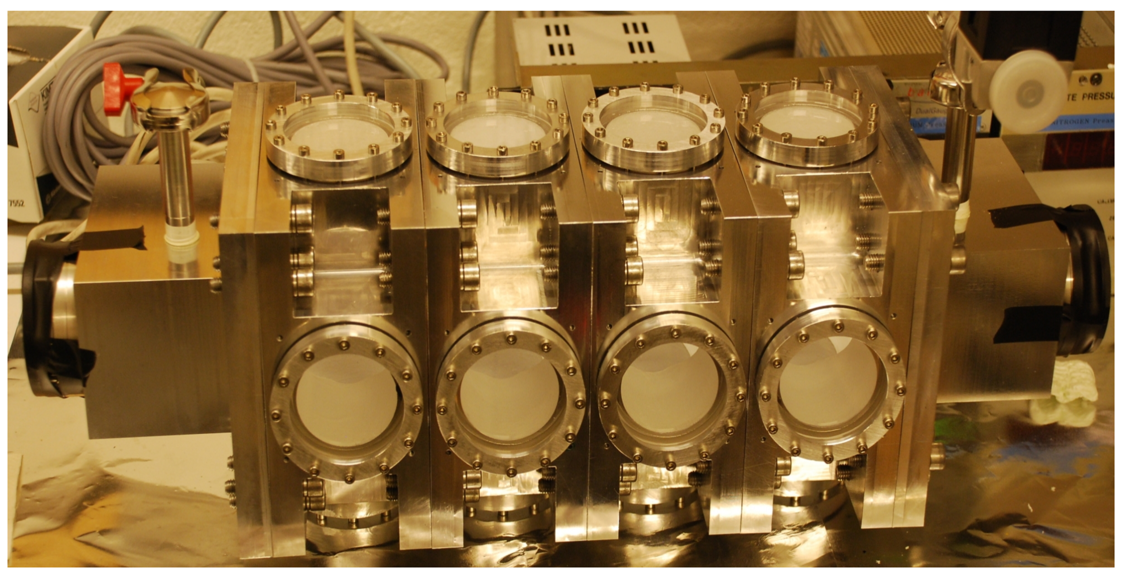




Upgraded Multi-Cell Active Target

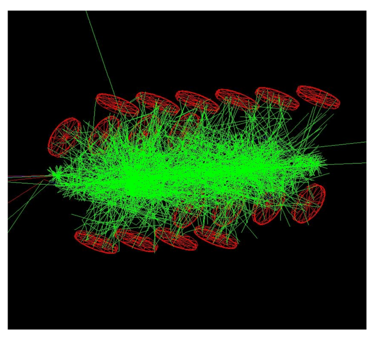


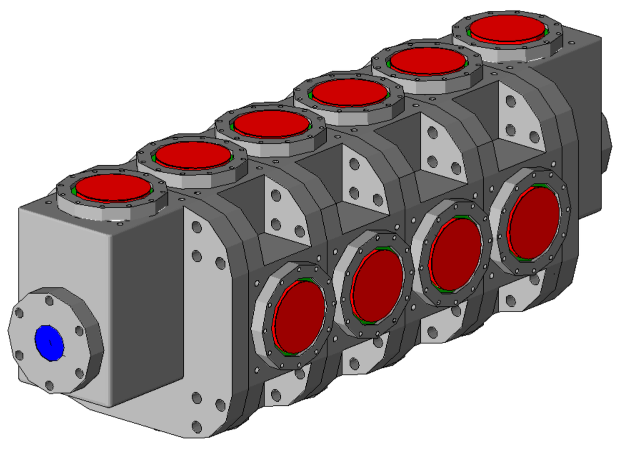
The prototype Active Target constituted of only one cell capable of withstanding 1MPa. The new upgraded Multi-Cell Active Target has been extended to four cells each can withstand twice the previous pressure (2MPa or roughly 20atm).



Geant4- Monte Carlo Simulation

GEANT-4 the CERN Monte Carlo library is used to design and model The Active Target. The simulation will assist the detection efficiency and will hugely increase our understanding of the underlying physics of of the Active target

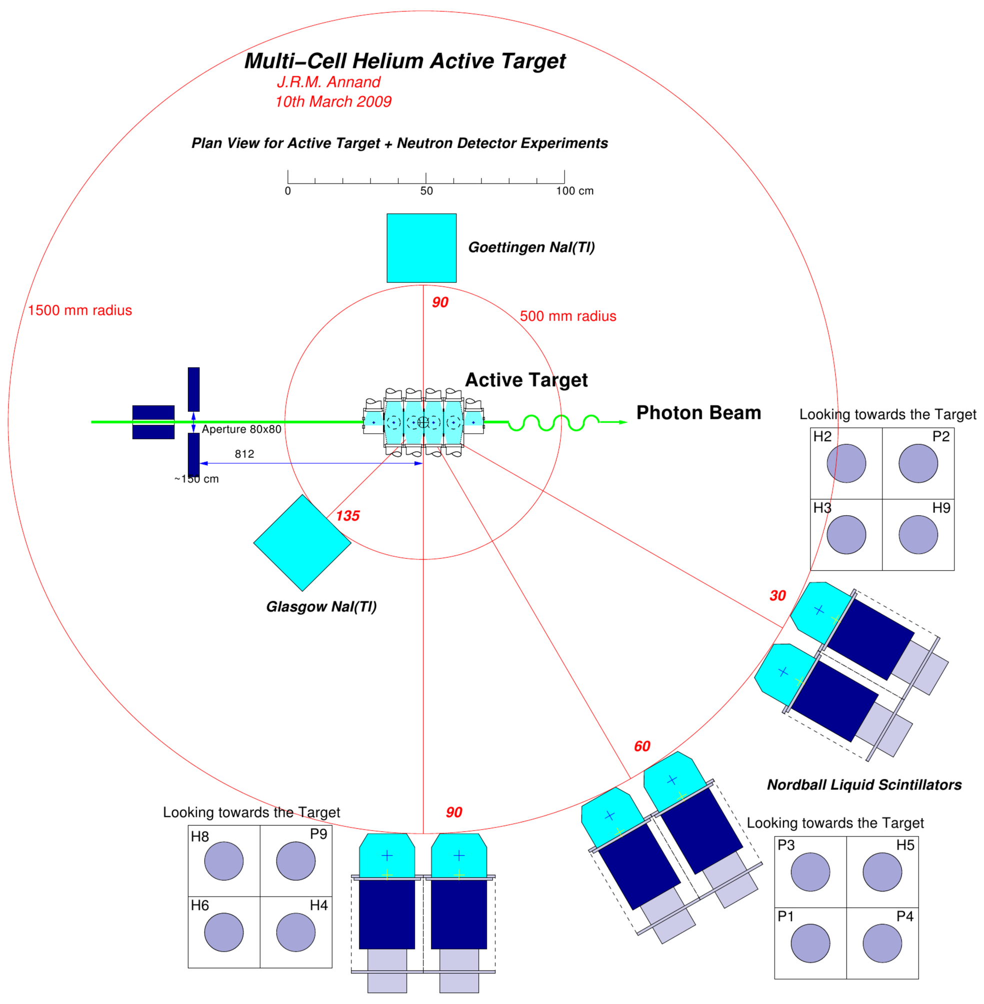




The Geometry has been derived and fed into GEANT-4 from the CAD files used in the actual machining of the target components.

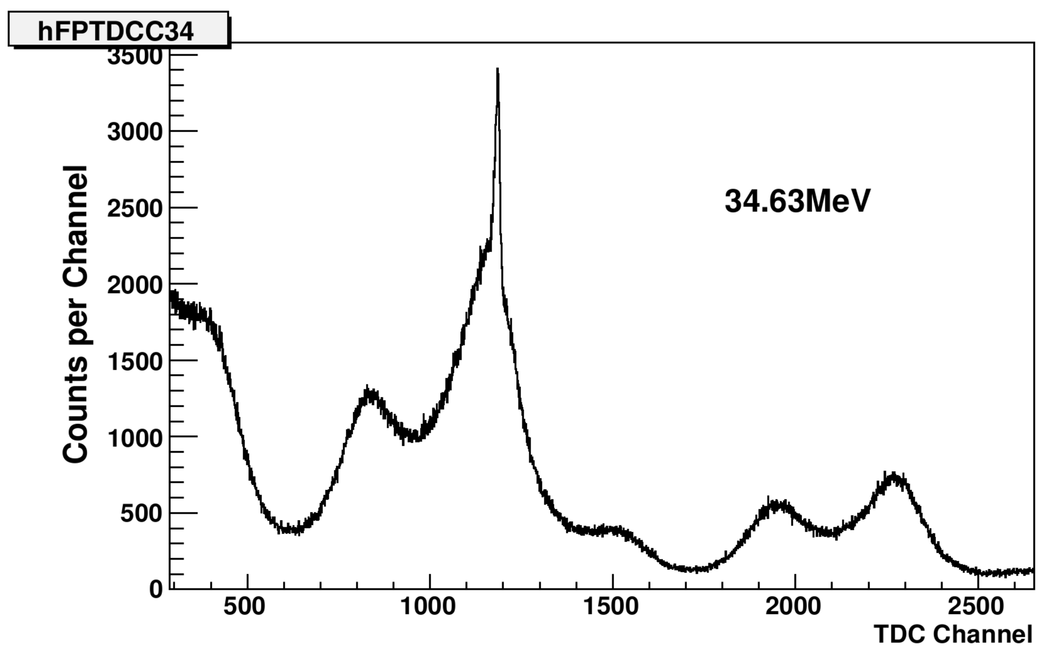
In Beam Measurements

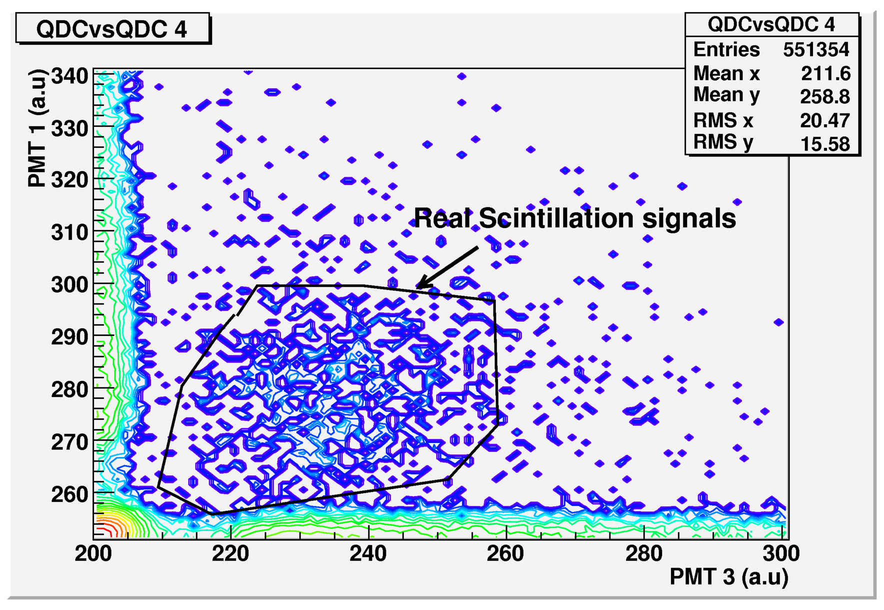
At Max-Lab in Sweden, the Active Target was placed on the photon beam line 3873 mm (2171 mm downstream of the bremsstrahlung radiator). The 4.5 mm diameter collimator was used so that the 10mm beam spot fell comfortably within the 25mm diameter of the entrance/exit windows.

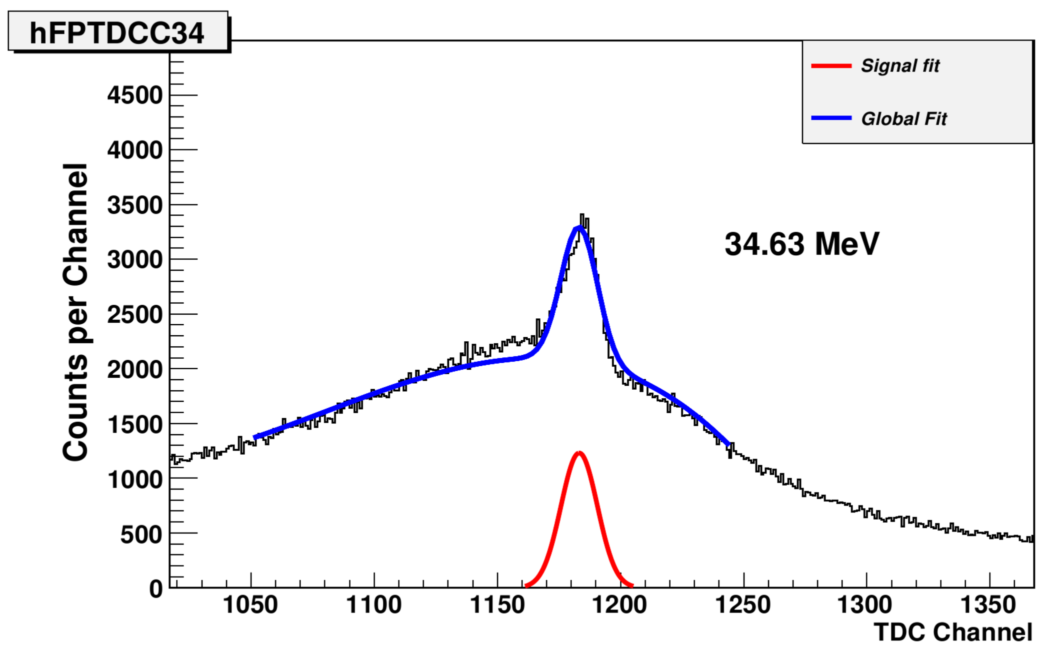


12 Nordball liquid scintillators were placed around the Active Target to detect neutrons coincident with charged recoils in the target. They were placed a flight path of ~ 1.5 m.

The Trigger signals, generated by an OR of 16 separated PMT channels have a spread of around 10 ns which can be seen in the target-tagger coincidence spectrum below. The times (relative to the trigger) of all the active target signals are recorded so that the true coincidence resolving time (~1 ns) can in principle be recovered. This will boost the signal to random background ratio. Random subtraction is non-trivial due to the sinusoidal character of the latter.







Real scintillation signals can be seen in a correlation plot above. Where the background can be seen as separated bands parallel to the axes . The scintillation response sits on a background from non-scintillations events, such as direct electron interaction in PMT dynodes.

Target-Tagger coincidences are used to extract the yield which will be used to obtain the Cross Section at the final stage. The basic idea behind the yield analysis is to identify the real photodisintigration events, then the extraction achieved by fitting the signal peak and the background in target-tagger coincidence spectra using an appropriate function and then integrating the subtracted resulting signal distribution to obtain the net yield