# A thin-wide plastic scintillator for separation of $\alpha$ and $d$ in $dd$ capture experiment

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In our measurements of $^2$H($d$,$^3$He)$\gamma$ reaction at $E_d$=200MeV [1] and $E_d$=140MeV[2], we found a relation of $A_{xx} \approx A_{yy}$ and a large discrepancy in $A_{xx}$ between the measurement and calculations. The $A_{xx} \approx A_{yy}$ relation has been found also at $E_d$=17.5MeV[3]. This relation in $dp$ radiative capture is curious. As far as we know, a completely different relation of $A_{xx} \approx -A_{yy}$ roughly holds in existing data of other reactions and scatterings induced by deuterons. In order to see whether the relation of $A_{xx} \approx A_{yy}$ holds also in $dd$ radiative capture or not, we planed to measure $A_{xx}$ and $A_{yy}$ in $dd$ capture at $E_d$=200MeV.

Cross section of $dd$ capture is extremely small, for example, 2.5nb/sr at the maximam at $E_d$=95MeV[4]. To obtain high-detection efficiency, we use a liquid deuterium target and use LAS(large acceptance spectrometer composed of Q and D magnets) to detect $\alpha$ recoils which are concentrated within 8° in the laboratory system.

In the $dd$ capture experiment, the largest backgrounds(BG) are deuterons of the same magnetic rigidity as the $\alpha$ recoils. In our previous $dp$ capture experiments, $d$-BG were completely separated from $^3$He recoils by using times of flight(TOF). In the $dd$ capture experiment we detect $\alpha$. Unfortunately $\alpha$ and $d$ of the same magnetic rigidity have the same velocity, and we can not separate $\alpha$ and $d$ by TOF. Energies of $\alpha$ and $d$ of the same magnetic rigidity differ by $\sqrt{2}$ times. However, separation of them in energy spectrum is not sufficient, because the number of $d$ is several orders of magnitude larger than the number of $\alpha$ recoil.

For the present $dd$ capture experiment, we developed a thin and wide plastic scintillator shown Fig.1. Thickness of the scintillator is 2mm, which is necessary to stop $\alpha$ recoils and to pass $d$-BG. Another plastic scintillator (veto) is placed behind the thin scintillator, and signals from the veto scintillator were used to reject the events produced by $d$ and $p$.

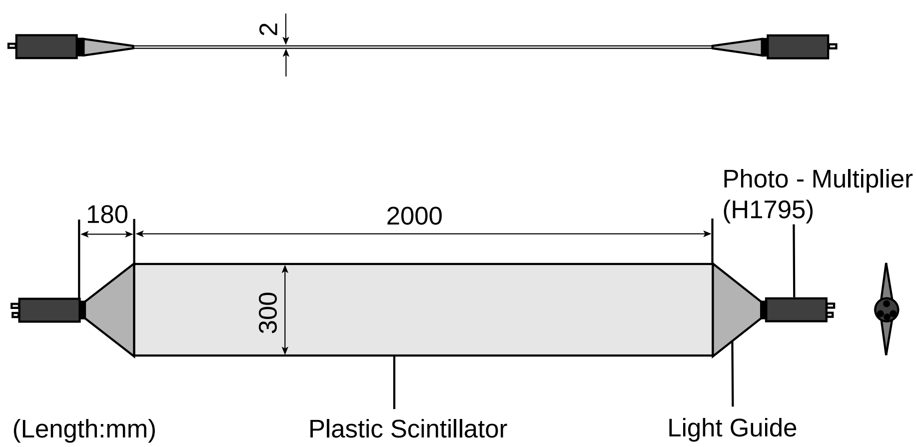


Figure 1: A thin-wide plastic scintillator for separation of $\alpha$ and $d$

Production of a scintillator of 2mm in thickness and of considerable width(300mm× 2,000mm) was the first try for NE Co. Ltd(USA). The try needed three months and was succeeded.

It was not sure whether light output from such a thin-wide scintillator is sufficient to detect particle or not. There were many negative comments before the test measurement.

Fig.2 shows two-dimensional spectrum of energy lass ($\Delta$E) in the thin-wide scintillator (sum of left- and right-PMT outputs) and x position on a vertical drift chamber(VDC) placed in front of the scintillator. The thin scintillator worked well, $\alpha$ events were clearly seen, and $d$ events were almost completely rejected by the veto method.

By the veto method, we succeeded in separating $\alpha$ events from enormous $d$-BG. Our next step is to separate $\alpha$ recoils from $dd$ capture reaction from $\alpha$ events from ($d$,$\alpha$) reaction in window foils of liquid deuterium target.

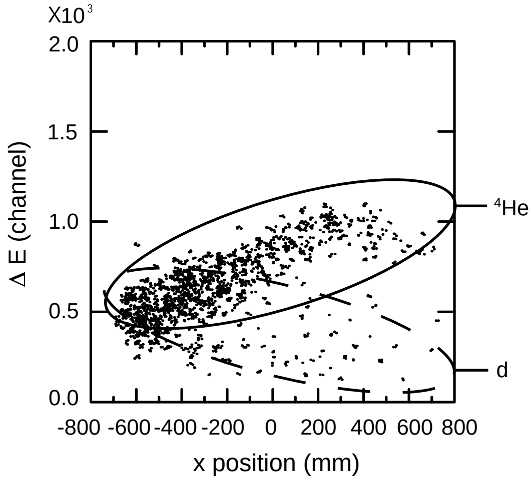


Figure 2: $x$ position on VDC versus ΔE in the thin scintillator

## References


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