

## LETTER TO THE EDITOR

### Development of a proton scintillation spectrometer

Stoddart and Gove<sup>1)</sup> have shown that it is possible to construct thin crystal (NaI) scintillation spectrometers with an energy resolving power as good or better than that obtained by current absorption or nuclear emulsion techniques for the detection of protons or other heavy charged particles in the energy range of 1 to 10 MeV.

They did not use any window between target and crystal. Any changing of the target then necessitates the flushing of the whole target chamber with dry nitrogen because of the hygroscopic nature of the sodium iodide. But despite this precaution the crystal is bound to deteriorate after some time.

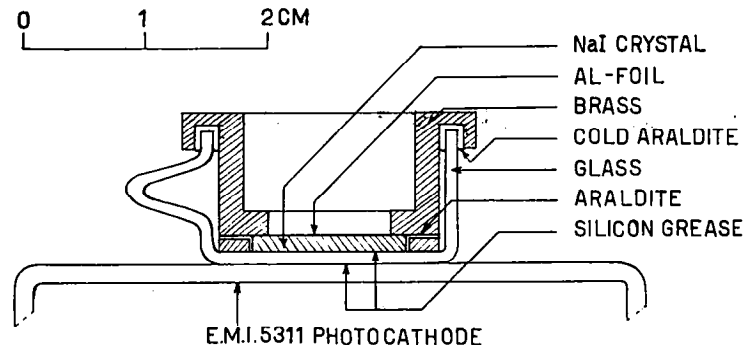


Fig. 1. Mounting of the NaI crystal on a EMI 5311 photocathode.

In the present paper a description is given of a crystal mounting which obviates this inconvenience. The NaI crystal is mounted on the bottom of a small glass cuvette, which is closed with a brass cap, containing a thin ( $15\ \mu$ ) aluminium foil window. The container is evacuated and sealed off. In principle a still thinner foil could have been used as atmospheric pressure on the foil is taken up by the crystal. The NaI-crystal is a round flat disc of 1 mm thickness and 14 mm diameter obtained by cleaving in a dry box.

It is essential that a small piece of sodium metal (not indicated in fig. 1) is enclosed in the crystal container. Without the sodium small white spots

appear on the crystal surface after some time presumably from vapours given off by the cold araldite cement.

In fig. 2 an example is given of the resolution obtained with a NaI crystal on a EMI 5311 photomultiplier tube. Crystal and multiplier were mounted in the evacuated target box. Protons originated from the  $^{10}\text{B}(d, p)^{11}\text{B}$  reaction at a deuteron energy of 0.5 MeV. They were detected at an angle of  $0^\circ$  with the incoming beam. An aluminium foil of  $110\ \mu$  thickness was interposed between the target and the detector to absorb low energy protons and alpha-particles from the  $^{10}\text{B}(d, \alpha)^8\text{Be}$  reaction. Pulses from the multiplier were fed into a Los Alamos model 200 amplifier and then through 10 m coaxial cable into a single channel differential discriminator.

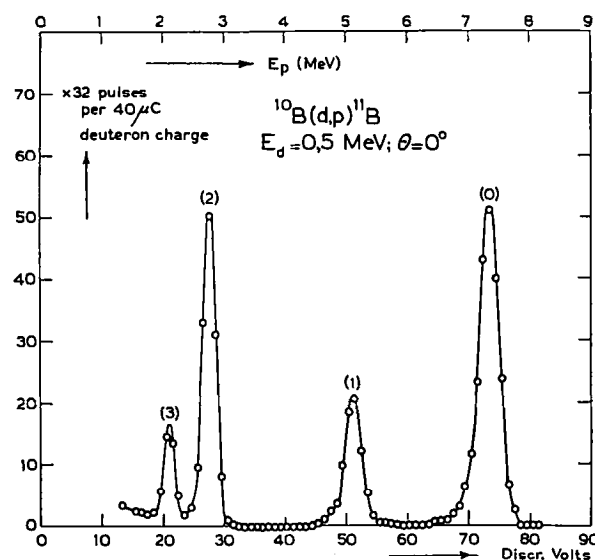


Fig. 2. Pulse analysis of protons from the  $^{10}\text{B}(d, p)^{11}\text{B}$  reaction.

The four proton groups seen in fig. 2 marked (0), (1), (2) and (3) correspond to transitions to the  $^{11}\text{B}$  ground-state and to excited states at 2.11, 4.46 and 5.03 MeV. The halfwidth of group (0) is 4.9%. Part of this is due to a spread in energy of the incoming protons caused by:

- a) deuteron energy spread (negligible);
- b) target thickness;
- c) dependence of proton energy on angle with the incoming deuteron beam (the detector subtends about  $16^\circ$ );
- d) statistical fluctuation of the energy loss in the aluminium absorber.

If the spread due to these causes and to the finite discriminator channel width (1 Volt) is subtracted there remains a halfwidth of group (0) of 4.1%. For the same proton energy (7.3 MeV). Stoddart and Gove report a half-width of 2.5%. It may be that their multiplier-tube (RCA 5819) had

a higher photosensitivity than our EMI 5311, which certainly was not a very good specimen.

As a conclusion one may say that the mounting described gives good resolution (which has not decreased over a period of some months), and that the handling of the crystal is easy as no dry gas flushing is necessary. It may be expected that in the future when better photo-multiplier tubes become available the resolution of the proton scintillation spectrometer will well surpass that obtainable by the usual absorption and nuclear emulsion techniques.

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Received: 25-9-53

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#### REFERENCE

- 1) Stoddart, H. F. and Gove, H. E., Phys. Rev. **87** (1952), 262.