SNO: Energy Calibration using ^{16}N

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The γ-rays resulting from the radioactive decay of ^{16}N will be used to provide an energy calibration of the Sudbury Neutrino Observatory (SNO). Each decay results in the emission of a β^-, while 74% of decays have a high energy γ-ray of either 6.1 MeV (68%) or 7.1 MeV (6%). A gas transport system has been developed to produce ^{16}N and transfer it to our tagged decay chamber. The stainless steel decay chamber contains a smaller cylindrical shell of plastic scintillator, inside which the majority of ^{16}N decays occur. The ^{16}N βs produce a trigger signal in the scintillator, used to trigger the SNO PMT array.

A detailed representation of the ^{16}N decay chamber has been incorporated into SNOMAN, the Monte Carlo simulation of SNO (Figure 1). The external container (CAN) is modeled as a solid cylinder, in which the other geometry regions are embedded. The upper (INSTR) and lower (GAP) chambers are separated by a stainless steel annulus (RING). The center of the annulus contains an acrylic optical window (OPT), through which light passes from the scintillator (SCINT) to the PMT. The decay of ^{16}N is primarily restricted to the GAS region. We have neglected the thin capillary which delivers the ^{16}N gas to the lower chamber.

The number of phototubes which observe Čerenkov light (NHIT) help establish the energy calibration of SNO. Our simulations of ^{16}N energy calibration have focussed on the influence of the decay chamber on the β and γ-rays . Ideally, there would be no contribution to NHIT from the β, while the γ-rays would be completely unaffected by the material of the decay chamber. SNO's energy calibration would then be determined by the ^{16}N γ-rays of 6.1 MeV and 7.1 MeV.

In practice, there will be attenuation of the γ-rays, which will shift the mean to lower values and broaden the peak of the NHIT distribution. There will also be optical shadowing of the Čerenkov light by the decay chamber. Finally, βs will be capable of producing bremstrahlung radiation as a result of interactions in the decay chamber. These processes have been carefully studied through use of the SNOMAN Monte Carlo simulations and have been supplemented by experiment with γ-ray sources.

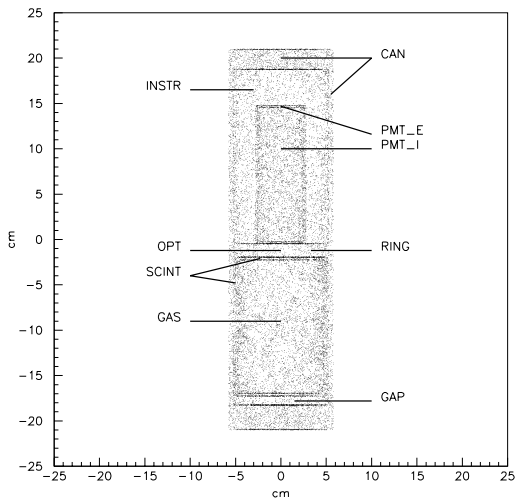

Figure 1: This is a map of the boundaries of the geometry regions of the ^{16}N decay chamber.

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