A large area light detector for scintillators in Rare Event Searches developed in the LUMINEU context

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A highly sensitive metallic magnetic calorimeter (MMC) based light detector has been tested for use in the LUMINEU Neutrino-less Double Beta Decay (0γ-DBD) research and development project. 0γ-DBD is a theorised nuclear transition that would violate the standard model of particle physics and would determine the nature of the neutrino (Dirac or Majorana) and help fix the mass hierarchy of the neutrino mass eigenvalues. The simultaneous light and heat measurement of a scintillating bolometer containing 100Mo as the 0γ-DBD candidate element can offer a virtually zero background environment. These MMCs could also be useful in achieving extremely low thresholds in the heat channel of hybrid low-temperature detectors for direct dark-matter searches, such as those used in the EDELWEISS experiment.

Tests have been conducted on a large area (5 cm^2) scintillation light detector, which uses a unique combination of a 2" silicon wafer absorber and Ag:Er MMCs combined with Au phonon collector films. The detector's spatial, temporal and energy characteristics were investigated at milli-Kelvin temperatures by stimulation from an Fe-55 X-ray source, five LED fed optical fibres and a 1 cm^3 $ZnMoO_4$ scintillator crystal excited by 3.72 MeV α particles from a Pb-210 source. For the prototype light detector at 11 mK we obtained a rise time of 20 μs and a decay time of 4.2 ms with the X-ray source. The response is much faster than that achieved by the semiconductor thermistor readout used in the LUMINEU baseline approach, helping to resolve random coincidences that are among the most serious background sources. Furthermore it also

opens up the advantageous possibilities of using faster scintillating crystals featuring different DBD isotopes to reduce the pile-up background.

The heat channel reading the $ZnMoO_4$ crystal also used an MMC and had a rise time of 1.8 ms and a decay time of 10 ms at 11 mK. The MMC was patterned onto a silicon chip, which was glued onto the crystal with clear Stycast. This crystal, the fibre optics, X-ray source and detector mounting will be described followed by the results using a 2-stage SQUID to readout the light detector. These results will be presented in the context of a next generation 0γ-DBD experiment.