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Title of the poster: TES detector and array production for the HOLMES experiment.

ABSTRACT

The European Research Council has funded HOLMES, a new experiment to directly measure the neutrino mass. This project will perform a calorimetric measurement of the energy released in the decay of^{163}Ho. The calorimetric measurement eliminates systematic uncertainties arising from the use of external beta sources, as in experiments with beta spectrometers. HOLMES will deploy a large array of low temperature microcalorimeters with implanted ^{163}Ho nuclei. The resulting mass sensitivity will be as low as 0.4 eV. HOLMES will be an important step forward in the direct neutrino mass measurement with a calorimetric approach as an alternative to spectrometry. We outline here the project with its technical challenges and perspectives. The HOLMES experiment is aimed at directly measuring the electron neutrino mass using the EC decay of ^{163}Ho and an array of low temperature microcalorimeters. HOLMES optimal experimental

configuration has been defined through extensive Monte Carlo statistical analysis and it is based on the present knowledge of the ^{163}Ho decay parameters [1]. In its baseline configuration HOLMES will collect about 3 × 10^^{13}decays with an instrumental energy resolution ΔE of about 1 eV FWHM and a time resolution τ_R of about 1 µs. For 3 years of measuring time t_M , this requires a total Ho activity of about 3×10^5decay/s. With an array of 1000 detectors, each pixel must contain a ^{163}Ho activity of about 300 decays/s which gives a f_{pp} of about 3×10^{-4}. The total activity is given by about 6.5×10^{16} ^{163}Ho nuclei, or 18 µg, and each detector must therefore contain 6.5×10^{13} ^{163}Ho nuclei.

TES DETECTORS AND ARRAY

The detectors used for the HOLMES experiment will be Mo/Cu TES on SiNx membrane with bismuth absorbers (Fig. 1). The TES microcalorimeters will be fabricated in a two step process. The first steps will be carried out at the National Institute for Standard and Technology (NIST, Boulder, Co, USA) [5] where the devices will be fabricated up to the deposition of the bottom half of the absorber, i.e a 1.5 µm bismuth layer (Fig. 2). The devices will be further processed in the Genova INFN laboratory (Fig. 2). Here, the first step will be the deposition by means the ion implanter of a thin (few 100˚ A) layer of Au: ^{163}Ho, then the bismuth absorber will be completed with a deposition of a second 1.5 µm bismuth layer to fully encapsulate the ^{163}Ho source. GEANT4 simulations show that this bismuth thickness is enough for fully containing 99.99997% of the highest energy electrons (≈ 2 keV) emitted in the ^{163}Ho decay. The second step will be a Deep Reactive Ion Etching (DRIE) of the back of the silicon wafer to release the membranes with the TES microcalorimeters. The relatively high concentration of holmium ($J = 7/2$) could indeed cause an excess heat capacity due to hyperfine level splitting in the metallic absorber [3]. Low temperature measurements have been already carried out in the framework of the MARE project to assess the gold absorber heat capacity (< 150 mK), both with holmium and erbium implanted ions. Those tests did not show any excess heat capacity, but further more sensitive investigations will be carried out [4]. If necessary, dilution of the implanted ^{163}Ho concentration will be achieved by co-evaporation of gold during the implantation. The TES array is presently being designed with the aim of achieving an energy resolution ΔEFWHM of about 1 eV at the spectrum end-point and a time resolution τR as close as possible to 1 µs. This requires an optimal thermal design of all detector components. To minimize the stray electrical inductance L which limits the pulse rise time, the TES will be arranged in 2 × 32 sub-arrays. This arrangement allows also to maximize the geometrical filling factor and therefore the ^{163}Ho implantation efficiency.

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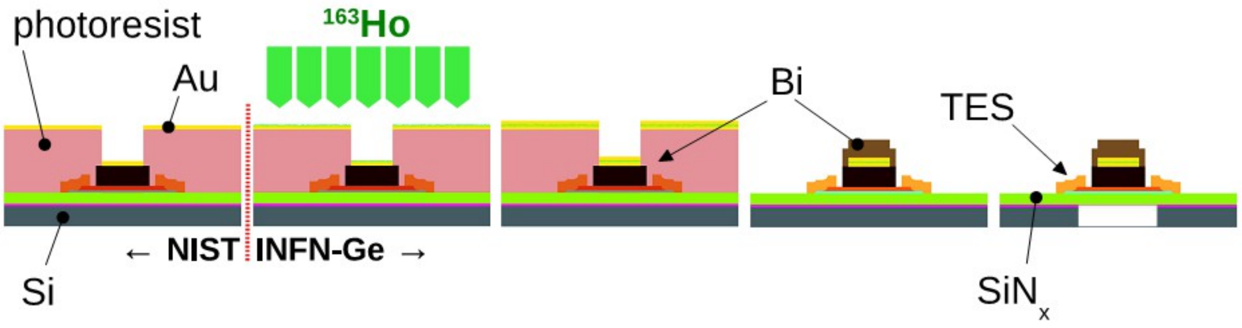

Figura 1:the two step TES fabrication process

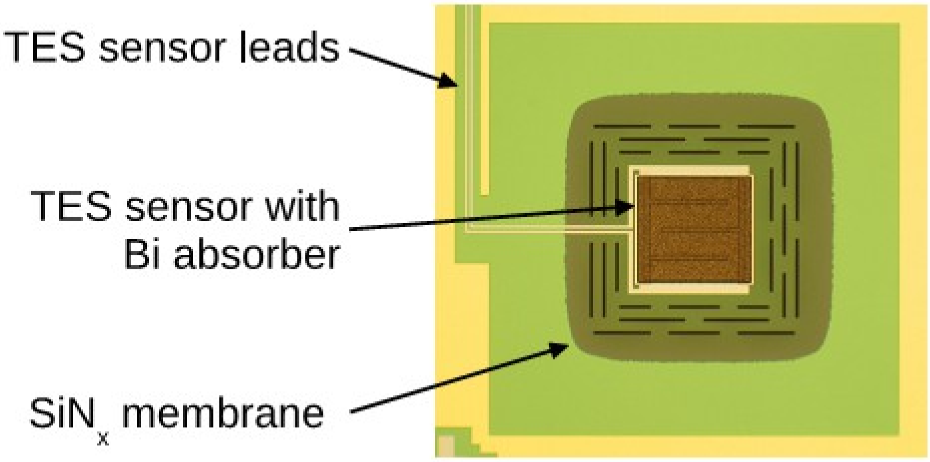

Figura 2: One TES with bismith absorber fabricated by NIST.