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High speed microwave rf-SQUID multiplexing read-out for the HOLMES experiment

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HOLMES is an experiment with the aim to directly measure the neutrino mass. HOLMES will perform a precise calorimetric measurement of the end point of the Electron Capture (EC) decay spectrum of ^{163}Ho in order to extract information on neutrino mass with a sensitivity below 2 eV. In its final configuration, HOLMES will deploy 1000 detectors of low temperature microcalorimeters with implanted ^{163}Ho nuclei.

The baseline sensors for HOLMES are Mo/Cu TESs (Transition Edge Sensors) on SiN_x membrane with gold absorbers. The TES detectors are designed to have an energy resolution of few eV FWHM at the 2.8 keV ^{163}Ho end-point and to be fast enough to assure a time resolution of 3 μs, in order contain systematics coming from unresolved pile-ups. Considering the large number of pixels and an event rate of about 300 Hz/pixel, a large multiplexing factor and a large bandwidth are needed.

A promising readout candidate that can fulfill this requirement is the microwave multiplexer, which offers several gigahertz of readout bandwidth per pair of coaxial cables. The TESs are coupled to rf-SQUIDs embedded in superconducting microwave resonators, which are probed via a common microwave feedline and read out at room temperature using GHz signals carried on coaxial cables. This form of multiplexing moves complexity from the cryogenic stages to room temperature hardware and digital signal processing firmware which must synthesize the microwave tones and process the information contained within them. In this contribution we present the basic theory and the considerations of a microwave SQUID multiplexer designed to match HOLMES requirements. Finally the status of the development and the performances currently obtained, in terms of noise, time and energy resolutions, are presented.

Less than 5 years of experience since completion of Ph.D

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Student (Ph.D., M.Sc. or B.Sc.)

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Author: GIACHERO, Andrea

Co-authors: BECKER, Daniel (National Institute of Standards and Technology); BENNETT, Doug (NIST); BIASOTTI, Michele (GE); BORGHESI, Matteo (Istituto Nazionale di Fisica Nucleare); DE GERONE, Matteo (GE); Mr FAVERZANI, Marco; Mrs FERRI, Elena; FOWLER, Joseph (NIST); Dr GARD, Johnathon (NIST); HILTON, Gene (NIST-Boulder); MATES, John (National Institute of Standards and Technology); GALLUCCI, Giovanni (GE); NUCCIOTTI, Angelo Enrico Lodovico; PESSINA, Gianluigi Ezio (MIB); PUIU, Andrei (MIB); REINTSEMA, Carl (NIST); Dr SCHMIDT, Daniel (NIST); SWETZ, Daniel (NIST); ULLOM, Joel (NIST/University of Colorado); VALE, Leila (NIST); GATTI, Flavio (GE)

Presenter: GIACHERO, Andrea

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