European Project "MetroBeta" on MMCs/SQUIDs for Beta Spectrometry with Unprecedented Precision

July 21, 2016 (HE109). This announces the start of the new European Project "MetroBeta" on MMCs/SQUIDs for Beta Spectrometry with Unprecedented Precision. Metallic magnetic calorimeters (MMCs) in combination with Superconducting Quantum Interference Device (SQUID) sensors reading out the MMCs can be used for energy dispersive detection of radiation or particles. In recent years, MMC detectors made from dilute alloys of erbium in noble metals, thermally coupled to mostly metallic radiation absorbers, and superconducting flux transformer circuits that operate at temperatures below 50 millikelvin have been demonstrated to enable spectroscopy in the soft-X ray to gamma ray energy range with very high resolving powers. In addition, MMCs outperform other low-temperature detectors, for instance the currently more widely used superconducting transition edge sensors, in terms of linearity. This feature is of particular importance for spectroscopic applications that span wide energy ranges. Beta spectrometry is an example: in order to precisely determine the nearly entire spectral shape of beta emitters a measurement technique is required that allows one to measure electron energies between a low-energy threshold, a few tens of eV, and end-point energies of hundreds of keV with highest resolution and close to 100% detection efficiency. The combination of their excellent energy resolution, high linearity and low power dissipation makes MMC detectors particularly suitable for beta spectrometry.

A collaboration of research groups at four European metrology institutes - Laboratoire National Henri Becquerel, Česky Metrologicky Institut, Physikalisch-Technische Bundesanstalt, Institut de Radiophysique Lausanne -, the Ruprecht-Karls-Universität Heidelberg and the Maria Curie-Skłodowska University Lublin as well as an industrial partner, Gonitec BV Delft, recently started the project "MetroBeta" within the framework of the European Metrology Programme for Innovation and Research. The activities of the 3-year project aim at investigating and improving MMC-based beta spectrometry, theoretical calculation of beta spectra from different types of beta decay and improving several secondary detection techniques. Precise knowledge of beta spectra is needed for radionuclide metrology, namely for the realization of the legal unit of the activity - the Becquerel - of pure-beta emitting isotopes. Activity measurements with lowest uncertainties are important for research and industrial applications where precise radioactivity measurements matter, in particular, nuclear medicine and nuclear power applications. Precisely determined mean beta energies, which can be deduced from the spectral shape combined with the end-point energies, will, e. g., improve the calculation of the residual decay heat in nuclear reactors, which is in large part due to beta emitters after shutdown of a reactor.

The MetroBeta consortium combines expertise in design and fabrication of MMC detectors and SQUID sensors, existing experimental expertise in MMC-based beta spectrometry and expert knowledge needed for calculations of beta spectra. The main scientific and technological objectives of MetroBeta are measurements of spectra of both low endpoint energy (< 300 keV) and medium endpoint energy (< 1 MeV) beta emitters with unprecedented precision using improved MMC beta spectrometers as well as improved theoretical calculation of beta spectra. Within the project, new MMC detectors will be developed that are optimized with respect to the resolving power for the given energy ranges. Efficient coupling of radioactive sources to the MMC detectors is mandatory both to achieve complete and rapid thermalization of the beta energy and ultimate detection efficiency. Therefore, improved source and detector preparation techniques are required. In addition, SQUID sensors and data acquisition techniques will be optimised for high-resolution-MMC

readout. The components will be developed for the operation of modern MMC beta spectrometers in commercial and easy-to-use millikelvin refrigerators. Comparison with calculations as well as validation by conventional experimental techniques will complement the MMC-based beta spectra measurements.

Further detailed information on the project activities as well as on events for interested parties can be found at the MetroBeta website http://metrobeta-empir.eu/ .