TT 30: Superconductivity - Cryodetectors

Time: Thursday 17:00–19:00 Location: H20

TT 30.1 Thu 17:00 H20

Development of magnetic calorimeters with superconducting Re absorber for ν mass experiments — •L. Gastaldo, J.-P. Porst, S. Schaefer, M. Linck, A. Burck, S. Kempf, H. Rotzinger, A. Fleischmann, and C. Enss — Kirchhoff-Institut fuer Physik, Universitaet Heidelberg, INF 227, D-69120 Heidelberg, Germany

Direct measurement of ν_e mass is in principle possible by the analysis of the end point of β-spectra. Presently two different approaches are followed: the measurement of the tritium β-spectrum using a new generation mass spectrometer by the KATRIN (KArlsruhe TRItium Neutrino) experiment and the calorimetric detection of electrons from ^{187}Re proposed in MARE (Microcalorimeters Array for a Rhenium Experiment). The MARE detectors are micro-calorimeters running below 100 mK. They are composed by a superconducting rhenium absorber/source, in which the β-events release the energy, and a thermal sensor reading out the temperature variation. Currently TESs (Transition Edge Sensors) and MMCs (Metallic Magnetic Calorimeters) are expected to meet the requirements in term of energy resolution and time constants. We developed MMCs with single crystal Re absorber and paramagnetic Au:Er temperature sensor which are read by SQUIDs with meander shaped sensing inductance. This geometry minimizes the magnetic field in the region of the superconducting absorber and this keeps the trapped flux lines on a negligible level. A detailed analysis of the effects due to the superconducting rhenium absorber is reported, focusing on the influence that superconductive state can have on the detector response.

TT 30.2 Thu 17:15 H20

Microfabricated magnetic calorimeter with meander shaped pickup coil — •A. Burck, S. Kempf, M. Linck, H. Rotzinger, S. Schäfer, J. Porst, T. Wolf, A. Fleischmann, L. Gastaldo, and C. Enss — Kirchhoff-Institut für Physik, Heidelberg, Germany

Metallic magnetic calorimeters (MMC) combine the high spectral resolution of crystal spectrometer and the high quantum efficiency of solid state spectrometer. Recently we demonstrated an energy resolution of 2.7 eV for 6 keV photons. This makes MMCs a promising and powerful tool for many applications where photons or energetic massive particles have to be detected. However, in order to fulfill all requirements of these applications and to allow to reach the maximum resolving power a consequent microfabrication of the MMC detectors is needed.

We present our first fully microfabricated MMC which consists of an absorber, a 3 μm thick sputter deposited paramagnetic AuEr temperature sensor and a meander shaped niobium thin film pickup coil. Deposition of energy in the absorber causes a rise in temperature and results in a change of magnetisation of the paramagnetic sensor which is measured by a low noise high bandwidth dc-SQUID. By using a new optimized persistent current switch a large field current can be frozen in the pickup coil which produces an inhomogeneous magnetic field within the volume of the sensor. The sputter deposited AuEr films we report on are working well and show the properties of bulk material. The performance of our MMCs with such films agree well with the numerically simulated behavior.

TT 30.3 Thu 17:30 H20

Detectors for Calibration Measurements in CRESST — •Wolfgang Westphal, Christian Ciemniak, Chiara Coppi, Franz von Feilitzsch, Achim Gütlein, Christian Isaila, Jean-Côme Lanfranchi, Sebastian Pfister, Walter Potzel, Wolfgang Rau, Sabine Roth, and Michael Stark — Physik-Department E15, Technische Universität München, James-Franck-Straße, 85748 Garching

The CRESST (=Cryogenic Rare Event Search with Superconducting Thermometers) experiment searches for dark matter particles (Weakly Interacting Massive Particles, WIMPs) via nuclear scattering using cryogenic detectors. The simultaneous measurement of the phonon signal and the scintillation light from the target $CaWO_4$ crystal allows to veto effectively background from βs and γs due to the different light output for electron and nuclear recoils. At the TU München we are performing calibration measurements for the better understanding of the detector response to various event types (e.g. neutrons scattering on different nuclei). For this purpose we are developing a special version of the CRESST detector optimized for higher count rates. These detectors consist of a smaller $CaWO_4$ crystal (10 – 38 g instead of 300 g) together with a cryogenic light detector, both equipped with Ir/Au transition edge sensors. We will report on the latest results of these developments. This work has been supported by funds of the DFG (SFB 375, Transregio 27: Neutrinos and Beyond), the Munich Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.4 Thu 17:45 H20

Optimization of the Czochralski Growth Process for $CaWO_4$ Detector Crystals — •Christian Ciemniak[1], Chiara Coppi[1], Andreas Erb[2,3], Franz von Feilitzsch[1], Christian Isaila[1], Jean-Côme Lanfranchi[1], Sebastian Pfister[1], Walter Potzel[1], Wolfgang Rau[1], Sabine Roth[1], and Wolfgang Westphal[1] — [1]Physikdepartment E15, Technische Universität München, James-Franck-Straße, 85748 Garching — [2]Walther-Meißner-Institut, Walther-Meißner-Straße 8, 85748 Garching — [3]Kristallabor, Technische Universität München, James-Franck-Straße, 85748 Garching

CRESST is an experiment for the direct detection of dark matter (WIMPs). The expected very low event rates and the low energy transfer in the keV range demand low background rates and sensitive detectors. Thus the need for detector crystals with good optical and phonon properties combined with high radioactive purity arises. To achieve these goals, the control over the raw materials and their processing, in particular the crystal growth, are important. In an ongoing effort at the Physikdepartment E15, the Czochralski Growth Process of $CaWO_4$ detector crystals is optimized to meet these requirements. We report on first results.

This work has been supported by funds of the DFG (SFB 375, Transregio 27: Neutrinos and Beyond), the Munich Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.5 Thu 18:00 H20

Cryogenic light detectors with Neganov-Luke amplification — •Christian Isaila[1], Oliver Boslau[2], Christian Ciemniak[1], Chiara Coppi[1], Franz von Feilitzsch[1], Achim Gütlein[1], Josef Kemmer[2], Jean-Côme Lanfranchi[1], Andreas Pahlke[2], Sebastian Pfister[1], Walter Potzel[1], Wolfgang Rau[1], Sabine Roth[1], Michael Stark[1], Wolfgang Westphal[1], and Florian Wiest[2] — [1]Technische Universität München, Physik Department E15, James-Franck Str., 85748 Garching — [2]Ketek GmbH, Hofer Strasse 3, 81737 München

For an active suppression of the background due to electron recoils in the CRESST experiment both phonons and scintillation light generated in a $CaWO_4$ crystal are detected simultaneously using cryogenic detectors based on transition edge sensors (TES). As only a small fraction (about 1%) of the energy deposited in the crystal is detected as light, very sensitive light detectors are needed. Following Neganov and Luke, the threshold of the light detector can be improved by drifting the electron-hole pairs generated by the scintillation photons in an electric field. Thus additional phonons are created leading to an amplification of the signal. For an efficient charge collection Si substrates with low trap densities are required. For this purpose and for electrical decoupling, the TES is glued onto the Si substrate. Results from measurements with Neganov-Luke amplification using glued TES will be presented. This work has been supported by funds of the DFG (SFB 375, Transregio 27), the Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.6 Thu 18:15 H20

Investigation of the properties of tungsten thin films produced with the rf-sputtering technique — •Sabine Roth[1], Christian Ciemniak[1], Chiara Coppi[1], Franz von Feilitzsch[1], Achim Gütlein[1], Christian Isaila[1], Jean-Côme Lanfranchi[1], Sebastian Pfister[1], Walter Potzel[1], Wolfgang Westphal[1], Dieter Hauff[2], Emilja Pantic[2], Federica Petricca[2], Franz Pröbst[2], and Wolfgang Seidel[2] — [1]Physik-Department E15, Technische Universität München, James-Franck-Straße, D-85748 Garching — [2]Max-Planck-Institut für Physik, Föhringer Ring 6, D-80805 München

The detection principle of the CRESST experiment (Cryogenic Rare

Event Search with Superconducting Thermometers) is based on the 'phonon-light technique', suppressing the background due to electron recoils by the simultaneous measurement of the phonons and the scintillation light generated in a $CaWO_4$ crystal. For both channels cryogenic particle detectors based on Transition Edge Sensors (TESs) are employed. To ensure high sensitivity of the experiment, low working temperatures of the detectors are required. For this reason TESs consisting of tungsten thin films, with transition temperatures of about 10 mK, acting as the thermometers, are used. The manufacturing process of tungsten thin films with an rf-sputtering cathode in a vacuum facility will be discussed and characteristical properties of these films will be presented. This work has been supported by funds of the DFG (SFB 375, Transregio 27), the Cluster of Excellence (Origin and Structure of the Universe) and the Maier-Leibnitz-Laboratorium (Garching).

TT 30.7 Thu 18:30 H20

First experiments for precise Lamb shift measurements on hydrogen-like heavy ions with low temperature calorimeters — V. Andrianov[1,2], K. Beckert[1], P. Beller[1], •A. Bleile[1,2], P. Egelhof[1,2], A. Gumberidse[1], S. Illieva[1,2], C. Kilbourne[3], H.-J. Kluge[1], S. Kraft-Bermuth[1,2], D. McCammon[4], J.P. Meier[1,2], U. Popp[1], R. Reuschl[1], T. Stöhlker[1], and S. Trotsenko[1] — [1]Gesellschaft für Schwerionenforschung, Darmstadt, Germany — [2]Universität Mainz, Germany — [3]Goddard Space Flight Center, Greenbelt, USA — [4]Univ. of Wisconsin, Madison, USA

The precise determination of the Lamb shift in hydrogen-like heavy ions provides a sensitive test of quantum electrodynamics in very strong Coulomb fields, not accessible otherwise. To increase the accuracy of the Lamb shift measurement on stored heavy ions at the ESR storage ring at GSI, a calorimetric low temperature detector for hard X-rays was developed. The experimental requirements for the detector are the high absorption efficiency and a relative energy resolution of about 10^{-3} for 50-100 keV X-rays. A prototype array consisting of 8 pixels with silicon thermistors and Sn or Pb absorbers was recently applied in first experiments with stored $^{238}U^{91+}$ and $^{208}Pb^{81+}$ ions interacting with an internal gas-jet target. A total detection efficiency of $1x10^{-7}$ for the Lyman-α lines was reached and an energy resolution of 150 eV was obtained under the present experimental conditions. The results on the absolute energy determination of the Lyman-α lines will be discussed and the design of a new 32-pixel detector for future experiments will be presented.

TT 30.8 Thu 18:45 H20

Einkopplung von FIR-Laserstrahlung in ein Rastermikroskop mit $YBa_2Cu_3O_7$ Josephson-Cantilever — •Christian Brendel, Felix Stewing und Meinhard Schilling — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig, Hans-Sommer-Strasse 66, 38106 Braunschweig

Wir erzeugen mit einem optisch gepumpten Ferninfrarotlaser THz-Signale und koppeln diese in THz-Antennen zur Weiterverarbeitung ein. In unserem Rastermikroskop setzen wir Josephson-Cantilever aus $YBa_2Cu_3O_7$ auf Bikristallsubstraten ein, um gleichzeitig die Leistungsverteilung auf einer Leitung und deren Topologie zu messen. Der Josephson-Kontakt dient dabei als Mischer und Detektor, um die Signale mit Frequenzen bis in den Terahertz-Bereich mit höchster Empfindlichkeit zu detektieren. Diese Messmethode erlaubt den quantitativen Nachweis elektromagnetischer Strahlung im Nahfeld mit Mikrometerauflösung an Proben bei Raumtemperatur, obwohl die Josephson-Cantilever selbst mit einem Kleinkühler auf 30 K gekühlt werden.