TT 55: Poster Session: Superconductivity 2

Time: Wednesday 15:00–19:00 Location: P2-OG3

TT 55.1 Wed 15:00 P2-OG3

Reduction of dissipation in rolled-up superconductor microstructures — E. A. Posenitskiy[1], R. O. Rezaev[1,2], and •V. M. Fomin[3] — [1]Tomsk Polytechnic University, Tomsk, 634050, Russia — [2]Moscow Engineering Physics Institute, Moscow, 115409, Russia — [3]IFW Dresden, Insitute for Integrative Nanosciences, D-01069 Dresden

Vortex dynamics in rolled-up superconductor microtubes [1] are influenced by the interplay between the scalar potential and the inhomogeneous magnetic field component normal to the surface in the presence of a transport current. A numerical solution of the time-dependent Ginzburg-Landau equation coupled with the Poisson equation for the scalar potential allowed us to analyze the potential induced by moving vortices as a function of the transport current. For rolled-up Nb superconductor tubes with radii from 350 nm to 550 nm, the energy dissipation decreases twice as compared to the unrolled planar structures of same dimensions.

The work was supported by the bilateral BMBF-Russia Grant 01DJ13009 and by the COST Action MP1201 "Nanoscale Superconductivity". E. A. P. was supported by the Science Office of the Institute of Physics and Technology at TPU.

[1] V. M. Fomin, R. O. Rezaev, O. G. Schmidt, Nano Lett. **12**, 1282 (2012)

TT 55.2 Wed 15:00 P2-OG3

Spin-Caloritronic Transport in Superconductor-Ferromagnet Tunnel Structures — •Ali Rezaei, Akashdeep Kamra, Peter Machon, and Wolfgang Belzig — Department of Physics, University of Konstanz, D-78457 Konstanz, Germany

We investigate the effect of an exchange field and spin-flip scattering on the pair potential and the spin Seebeck coefficient of superconductor (S) - ferromagnet (F) hybrid structures using the Green's function method. Such structures have been predicted to show giant charge Seebeck coefficient [1,2]. In the absence of spin-flip scattering, the pair potential of the S has been studied for different values of the exchange field. We show that the normal to S phase transition with decreasing temperature, changes character from second to first order above a certain value of exchange field. The density of states in energy, and spin Seebeck coefficient as a function of temperature have been computed for several values of spin-flip scattering time. We show that spin-flip scattering limits the enhancement in the spin Seebeck coefficient in realistic settings.

[1] P. Machon, M. Eschrig, and W. Belzig, Phys. Rev. Lett. **110**, 047002 (2013)
[2] A. Ozaeta, P. Virtanen, F. S. Bergeret, and T. T. Heikkilä, Phys. Rev. Lett. **112**, 057001 (2014)

TT 55.3 Wed 15:00 P2-OG3

Structural and Magnetic Properties of a Superconducting Spin-Triplet-MRAM Element — •Daniel Lenk[1], Vladimir I. Zdravkov[1,2], Roman Morari[2], Zakir Seidov[3], Yury Khaydukov[4], Aladin Ullrich[1], Günter Obermeier[1], Claus Müller[1], Anatoli S. Sidorenko[2], Hans-Albrecht Krug von Nidda[1], Siegfried Horn[1], Lenar R. Tagirov[1,5], and Reinhard Tidecks[1] — [1]Institut für Physik, Universität Augsburg, D-86158 Augsburg, Germany — [2]D. Ghitsu Institute of Electronic Engineering and Nanotechnologies ASM, MD2028 Kishinev, Moldova — [3]Institute of Physics, Azerbaijan National Academy of Sciences, AZ-1143 Baku, Azerbaijan — [4]Max-Planck-Institut für Festkörperforschung, D-70569 Stuttgart, Germany — [5]E.K. Zavoisky Physical-Technical Institute of RAS, 420029 Kazan, Russia

We investigated a $Co/CoO_x/Cu_{41}Ni_{59}/Nb/Cu_{41}Ni_{59}$ nanolayered heterostructure, which shows a superconducting transition temperature depending on the magnetic history of the sample. The observed magnetic random access memory (MRAM) element functionality arises from the triplet spin-valve effect, caused by the long-range odd-in-frequency triplet component of superconductivity, obtained at non-collinear relative orientation of ferromagnetic layers. In the present study, we investigate the structural and magnetic properties applying cross-sectional TEM analysis, SQUID magnetometry, FMR spectroscopy and Polarized Neutron Reflectometry (PNR).

TT 55.4 Wed 15:00 P2-OG3

Investigation of Superconducting Proximity and Magnetic Stray Field Effects in Superconductor/Ferromagnet Heterostructures — •Vladimir I. Zdravkov[1,2], Daniel Lenk[1], Roman Morari[2], Zakir Seidov[3], Yury Khaydukov[4], Aladin Ullrich[1], Günter Obermeier[1], Claus Müller[1], Anatoli S. Sidorenko[2], Hans-Albrecht Krug von Nidda[1], Siegfried Horn[1], Lenar R. Tagirov[1,5], and Reinhard Tidecks[1] — [1]Institut für Physik, Universität Augsburg, D-86159 Augsburg, Germany — [2]D. Ghitsu Institute of Electronic Engineering and Nanotechnologies ASM, MD2028 Kishinev, Moldova — [3]Institute of Physics, Azerbaijan National Academy of Sciences, AZ-1143 Baku, Azerbaijan — [4]Max-Planck-Institut für Festkörperforschung, D-70569 Stuttgart, Germany — [5]E.K. Zavoisky Physical-Technical Institute of RAS, 420029 Kazan, Russia

We have experimentally studied $Nb/Cu_{41}Ni_{59}/nc - Nb/Co/CoO_x$ superconducting spin-triplet spin-valve structures. Due to the proximity effect between the superconductor and the ferromagnets, these structures show a superconducting transition temperature depending on the magnetic configuration of the ferromagnetic layers. Thus, the transition temperatures depend on the magnetic history of the samples, yielding functionality as spin-valves. We observed characteristic features in the magnetoresistance associated with different types of superconducting spin valve effects. To clarify possible influences of stray field effects from Co, we investigate the magnetoresistance of $Nb/Si/Co/CoO_x$ systems.

TT 55.5 Wed 15:00 P2-OG3

Non-equilibrium transport near the disorder-driven SIT — •Klaus Kronfeldner[1], Tatyana Baturina[2], and Christoph Strunk[1] — [1]Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany — [2]A. V. Rzhanov Institute of Semiconductor Physics SB RAS, Russia

We have measured the IV characteristics of square shaped TiN films on the superconducting and the insulating side of the superconductor-insulator transition. The superconducting IV characteristics display strong non-linearities including several jumps. The measured data was consistently reproduced in terms of electron heating models ("hotspot theory"), where the thermal conductivity in the superconducting parts of the film and the heat transfer coefficient per unit area to the substrate were used as free fitting parameters. On the basis of the hotspot theory, the obtained value for surface heat transfer coefficient seems to decrease drastically on approach of the disorder-driven SIT. At the same time, the thermal conductivity in the superconducting parts of the film appears to increase significantly on approach of the SIT. Independent thermal conductivity measurements are required to verify this interpretation. On the insulating side of the field-induced SIT the IV characteristics reveal a similar but dual non-linear behaviour. An analysis of the insulating IV characteristics in terms of selfheating in insulating microbridges is a future task.

TT 55.6 Wed 15:00 P2-OG3

Fast and highly sensitive read out electronics for micro-SQUIDS — •Sandra Gottwals[1], Andreas Müller[2], and Georg Schmidt[1,3] — [1]Martin-Luther-Universität Halle-Wittenberg, Institut für Physik, Fachgruppe Nanostrukturierte Materialien, Halle — [2]Martin-Luther-Universität Halle-Wittenberg, Institut für Physik, Abteilung Elektronik, Halle — [3]Martin-Luther-Universität Halle-Wittenberg, Interdisziplinäres Zentrum für Materialwissenschaften, Halle

We want to use Nb-based micro-SQUIDS [1] to measure the Spin-Nernst-effect [2]. For this purpose we need to read out the SQUIDS with high resolution and keep current induced heating as low as possible. We have developed a new electronics setup for readout which is based on two separate digital-to-analog converters (DACs) running at high speed but with different scaling. The first converter is used to run a current ramp which gives a course measurement of the critical current. In a second measurement the second DAC creates a ramp close to the critical current at very high resolution. Once the critical current is established this way it can be measured using a high resolution voltmeter or analog-to-digital converter. The dual setup allows to automatically detect a wide range of critical currents, and immediate

shut-down when critical current is reached while at the same time giving a high resolution reading. The resolution is mainly determined by the final read-out device rather than by the resolution of the DACs.

[1] Wernsdorfer, Supercond. Sci. Technol. 22 (2009)
[2] Cheng, et. al., Phys. Rev. B 78 (2008)

TT 55.7 Wed 15:00 P2-OG3

Broadband acoustic measurements on the metallic glass $Zr_{59}Ti_3Cu_{20}Ni_8Al_{10}$ — •Alexander Prieschl, Sebastian Eisenhardt, Markus Döttling, Saskia Meissner, Arnold Seiler, and Georg Weiss — Physikalisches Institut, KIT Karlsruhe

Atomic two-level tunneling systems (TS) dominate the properties of disordered solids at low temperatures. While the standard tunneling model successfully describes thermodynamic properties of insulating glasses, it fails to predict the elastic properties of metallic glasses correctly. To explore the influence of conduction electrons on the density of states and the dynamics of TS ultrasonic experiments are performed. In superconducting glasses the interaction can be switched on and off by means of a magnetic field which suppresses superconductivity and therefore enables electrons to interact with TS.

Here we present measurements of the internal friction and the sound velocity of the superconducting bulk metallic glass $Zr_{59}Ti_3Cu_{20}Ni_8Al_{10}$ from 10 mK to room temperature. Low frequency acoustic measurements at 1 kHz are performed by using the vibrating reed technique, whereas frequencies up to 2 GHz are obtained by thin film piezoelectric transducers.

TT 55.8 Wed 15:00 P2-OG3

Superconducting qubit as a detector of atomic tunneling systems toggling on time scales spanning six orders of magnitude — •Saskia Meissner, Arnold Seiler, Jürgen Lisenfeld, Alexey V. Ustinov, and Georg Weiss — Physikalisches Institut, Karlsruher Institut für Technologie

AlO_x is a common material used for the production of Josephson junctions in superconducting qubits. It is known that the mostly disordered thin-film AlO_x contains atomic tunneling systems. Coherent tunneling systems couple strongly with their electric dipole moment to the qubit, giving rise to level repulsion in its spectrum. Slowly fluctuating tunneling systems are also observable if they are located close to the coherent ones and cause a local distortion of their potentials. Thus they are visible by telegraphic noise of the energy splitting of the coherent tunneling systems which can be measured on time scales from hours to minutes. The high-resolution single-photon spectroscopy measurement protocoll for the detection of coherent tunneling systems also allows us to determine fluctuation rates on a time scale of milliseconds by a special statistical analysis of the measured qubit states.

TT 55.9 Wed 15:00 P2-OG3

Coherence properties of superconducting qubits in large in-plane magnetic fields — •Andre Schneider, Jochen Braumüller, Marco Pfirrmann, Alexey V. Ustinov, and Martin Weides — Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany

We intend to directly interface thin film ferromagnets with planar superconducting qubits to study the quantum dynamics within the magnet. To achieve this, superconducting qubits have to be placed in or close to a strong static magnetic field.

As a first step, we experimentally study the coherence properties of superconducting qubits under the influence of an external magnetic field which is oriented in parallel to the plane of the chip. The qubit is a superconducting concentric transmon having a microstrip geometry [1] showing up to 10 μs coherence times T1 and T2 at zero magnetic field. Qubit properties such as relaxation and dephasing times, as well as flux noise, are measured in an external field up to the mT range at temperatures below 50 mK.

[1] Braumüller *et al.*, APL **108**, 032601 (2016)

TT 55.10 Wed 15:00 P2-OG3

Investigation of a Josephson junction based parametric amplifier — •Patrick Winkel[1], Ivan Takmakov[2,3], Alexandre Karpov[3], Ivan Khrapach[2,3], Martin Weides[1,4], and Alexey V. Ustinov[1,3] — [1]Physikalisches Institut, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany — [2]Moscow Institute of Physics and Technology, Moscow, Russia — [3]Russian Quantum Center, National University of Science and Technology MISIS, Moscow, Russia — [4]Material Science in Mainz, Johannes Gutenberg-University Mainz, 55128 Mainz, Germany

We design, fabricate and experimentally investigate a parametric amplifier based on the nonlinear inductance of Josephson junctions embedded into a superconducting resonator. The conventional design is based on a strongly coupled coplanar waveguide quarter-wave resonator terminated by a single SQUID. The weakly non-linear resonator is driven close to a bistable state where the system's response is highly sensitive to small perturbations. We performed four-wave-mixing experiments and obtained signal gain of up to 20 dB. The measured device performance is compared with theoretical expectations.

TT 55.11 Wed 15:00 P2-OG3

Electric transport and noise properties of Nb-HfTi-Nb Josephson Junctions — •Julian Linek[1], Benedikt Müller[1], Viacheslav Morosh[2], Thomas Weimann[2], Oliver Kieler[2], Reinhold Kleiner[1], and Dieter Koelle[1] — [1]Physikalisches Institut and Center for Quantum Science (CQ) in LISA$^+$, Universität Tübingen, Germany — [2]Fachbereich Quantenelektronik, Physikalisch-Technische Bundesanstalt, Braunschweig, Germany.

Nb-HfTi-Nb based superconductor-normal metal-superconductor (SNS) Josephson junctions offer high critical current density ($> 10^5$ A/cm^2) and non hysteretic current-voltage characteristics, which makes them highly suitable for their use in strongly miniaturized nanoSQUIDs. The high sensitivity of nanoSQUIDs can e.g. be used to detect the magnetization reversal of individual magnetic nanoparticles. To optimize the sensitivity of the devices and for increasing the range of operation temperature and magnetic field, a detailed understanding of the properties of the Nb-HfTi-Nb junctions as a function of their size and operation temperature is essential. Here we present an experimental study of the electrical transport and noise properties of single Nb-HfTi-Nb junctions. In particular, we have investigated the scaling of the resistance, critical current and noise level of the junctions with temperature (down to 300 mK) and junction size (down to $\sim$ 100 nm). Simulations of the current-voltage characteristics based on the RCSJ model have been compared to the experimental results, to check whether this model is appropriate for the description of these SNS Josephson Junctions.

TT 55.12 Wed 15:00 P2-OG3

Development of Nb nanoSQUIDs based on SNS junctions for operation in high magnetic fields — •Viacheslav Morosh[1], Benedikt Müller[2], Julian Linek[2], Maria Jose Martinez-Perez[2], Oliver Kieler[1], Thomas Weimann[1], Jörn Beyer[3], Thomas Schurig[3], Alexander Zorin[1], Reinhold Kleiner[2], and Dieter Koelle[2] — [1]Fachbereich Quantenelektronik, Physikalisch-Technische Bundesanstalt (PTB), Braunschweig — [2]Physikalisches Institut and Center for Quantum Science (CQ) in LISA$^+$, Universität Tübingen — [3]Fachbereich Kryophysik und Spektrometrie, Physikalisch-Technische Bundesanstalt (PTB), Berlin

DC nanoSQUIDs (nSQs) with overdamped SNS sandwich-type (Nb/HfTi/Nb) Josephson junctions (JJ) developed for the investigation of small spin systems will be presented. Our smallest nSQs have JJ with linear dimensions $\leq$ 100 nm, effective loop areas $< 0.03\,\mu$m^2 and a distance between the JJ of $\sim$ 30 nm. Nb feeding strip lines of width $\sim$ 100 nm and thicknesses 160 nm/200 nm have been realized. Due to narrow line widths these nSQs show stable operation in external magnetic fields at least up to $\pm$0.25 T, which allows manipulating the spins of investigated objects over a wide field range. A magnetic moment sensitivity of a few tens of $\mu_B/\mathrm{Hz}^{1/2}$ has been demonstrated. Results achieved with different nSQ geometries and for single sub-μm JJ up to very high critical current densities ~ 1 MA/cm^2 will be presented. The noise properties including voltage noise of single JJ and flux noise of nSQs will be discussed.

This work was supported by the DFG (KI 698/3-1, KO 1303/12-1, SCHU 1950/5-1).

TT 55.13 Wed 15:00 P2-OG3

$YBa_2Cu_3O_7$ nanoSQUIDs for scanning SQUID microscopy — •Katja Wurster, Benedikt Müller, Jianxin Lin, Reinhold Kleiner, and Dieter Koelle — Physikalisches Institut and Center for Quantum Science (CQ) in LISA+, Universität Tübingen, Germany

The minuaturization of SQUID structures down to the sub-micron scale (nanoSQUIDs) is highly promising for their application in high-resolution scanning SQUID microscopy (SSM). Following recent achievements with nanoSQUIDs from conventional metallic superconductors, we are developing nanoSQUIDs based on the cuprate superconductor $YBa_2Cu_3O_7$ (YBCO) for SSM. We present here our efforts to develop YBCO nanoSQUIDs based on grain boundary Josepshon

junctions, grown on bicrystal $SrTiO_3$ substrates. These SQUIDs have to be fabricated on structures wich are suitable for implementation of their use in SSM. This includes in particular the development of structures which allow for the approach of the YBCO nanoSQUIDs to very small distances from the sample surfaces to be investigated. The use of YBCO offers operation over a wide range of temperature and magnetic field, which can significantly enhance the range of application of nanoSQUIDs for SSM-based nanoscale magnetic sensing and thermometry.

Technical support by R. Löffler and M. Turad from LISA$^+$ is gratefully acknowledged.

TT 55.14 Wed 15:00 P2-OG3

$YBa_2Cu_3O_7$ nanoSQUIDs for the investigation of single magnetic nanoparticles over a wide range of temperature and magnetic field — •Dennis Schwebius[1], Benedikt Müller[1], Maria José Martínez-Pérez[1], Jianxin Lin[1], Dana Korinski[1], Reinhold Kleiner[1], Javier Sesé[2], and Dieter Koelle[1] — [1]Physikalisches Institut and Center for Quantum Science (CQ) in LISA$^+$, Universität Tübingen, Germany — [2]Laboratorio de Microscopías Avanzadas (LMA), Instituto de Nanociencia de Aragón (INA), Universidad de Zaragoza, Spain

NanoSQUIDs based on the cuprate superconductor $YBa_2Cu_3O_7$ (YBCO) are promising devices for the investigation of single magnetic nanoparticles (MNPs), as they offer high spin sensitivity down to a few Bohr magnetons/$\sqrt{\text{Hz}}$, combined with the possibility to operate them over a wide range of temperature (up to $\sim 80\,\text{K}$) and magnetic field (up to the Tesla range). Here, we present our efforts to optimize the performance and reliable operation of YBCO nanoSQUIDs, based on grain boundary Josephson junctions, in strong magnetic fields applied in the plane of the SQUID loop and perpendicular to the grain boundary plane. Special care has to be taken on the precise alignment of the external magnetic field. Moreover, we present first results on the characterization of the magnetic properties of Co MNPs, grown by focused electron beam induced depostion directly on top of the SQUID loops, demonstrating the feasibility of using YBCO nanoSQUIDs for single MNP measurements.

TT 55.15 Wed 15:00 P2-OG3

Emission of terahertz radiation from intrinsic Josephson junctions in $Bi_2Sr_2CaCu_2O_{8+x}$ stacks — •Johannes Hampp[1], Olcay Kizilaslan[1,2], Raphael Wieland[1], Fabian Rudau[1], Xianjing Zhou[3,4], Min Ji[3,4], Ya Huang[3,4], Luyao Hao[3,4], Nickolay Kinev[5], Oleg Kiselev[5], Peiheng Wu[3], Valery Koshelets[5], Huabing Wang[3,4], Dieter Koelle[1], and Reinhold Kleiner[1] — [1]Physikalisches Institut and Center for Quantum Science (CQ) in LISA$^+$, Universität Tübingen, Germany — [2]Inonu University, Department of Biomedical Engineering, Faculty of Engineering 44280, Malatya, Turkey — [3]National Institute for Materials Science, Tsukuba, Japan — [4]Research Institute of Superconductor Electronics, Nanjing University, China — [5]Kotel'nikov Institute of Radio Engineering and Electronics, Moscow, Russia

Josephson junctions (JJs) offer a natural way to convert a dc-voltage into high-frequency electromagnetic radiation. The high-T_c superconductor $Bi_2Sr_2CaCu_2O_{8+x}$ intrinsically forms stacks of JJs. Such stacks can be used as generators for electromagnetic radiation of frequencies in the sub-THz and low-THz regime. Radiation power and frequency strongly depend on the electric and thermal parameters of the stack. To systematically investigate this dependence we vary these parameters in-situ by changing the charge carrier density via current injection. Experimental results and theoretical simulations will be presented.

TT 55.16 Wed 15:00 P2-OG3

On quantum features of a driven swept-bias Josephson junction — •Harald Losert[1], Karl Vogel[1], Benjamin Neumeier[2], Rosina Menditto[2], Edward Goldobin[2], Dieter Kölle[2], Reinhold Kleiner[2], and Wolfgang P. Schleich[1,3] — [1]Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany — [2]Physikalisches Institut, Universität Tübingen, D-72076 Tübingen, Germany — [3]Texas A&M University, College Station, TX 77843

Josephson junctions are a well-known model system for the observation of quantum tunneling. The phase difference in a current-biased junction behaves like the position of a particle in a tilted washboard potential. The escape of this phase-particle corresponds to the voltage switching of the associated junction.
The escape from the potential can be explained quantum mechanically by tunneling from the ground state, or an excited state. However, in the presence of a periodic driving field, it has been shown [1][2], that even classical calculations reproduce the experimental data for quantum mechanical key features, e.g. Rabi oscillations.
Resuming this discussion, we focus on Josephson junctions with large critical currents and consider a swept-bias experimental setup. We compare the switching current distributions of our recent experiments with numerical results for both quantum mechanical as well as classical time evolution.

[1] Marchese *et al.*, *Eur. Phys. J. Special Topics* **147**, 333 (2007)
[2] Blackburn *et al.*, *Phys. Rev. B* **85**, 104501 (2012)

TT 55.17 Wed 15:00 P2-OG3

Current contributions in a superconducting SET due to Josephson transport — •Susanne Sprenger, Thomas Lorenz, and Elke Scheer — Universität Konstanz, 78467 Konstanz, Deutschland

When measuring superconducting transport trough two tunnel junction separating a small island from the leads, Coulomb blockade effects can be observed. Using orthodox theory [1, 2] one can identify the contributions to the current through this all superconducting single electron transistor (SSET).

We investigate a SSET formed by one oxide barrier and one mechanically controllable break junction (MCBJ). We present measurements on samples, differing in the transparency of the oxide barrier, either allowing only tunneling or in addition Josephson transport, whereas the MCBJ is broken to form a mere tunnel contact. In the Josephson regime additional contributions to the current in the superconducting gap can be observed, giving first evidence for coherent transport. The measurements are compared with the predictions of orthodox theory.

[1] K. K. Likharev, Proc. IEEE 87, 606 (1999)
[2] R. J. Fitzgerald, Phys. Rev. B 57, R11073(R) (1997)

TT 55.18 Wed 15:00 P2-OG3

MOCCA: A 4k-pixel molecule camera for the position and energy resolving detection of neutral molecule fragments at the Cryogenic Storage Ring CSR — •S. Allgeier[1], C. Enss[1], A. Fleischmann[1], L. Gamer[1], L. Gastaldo[1], S. Kempf[1], C. Krantz[2], O. Novotný[2], D. Schulz[1], and A. Wolf[2] — [1]Heidelberg University — [2]MPIK Heidelberg

The Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics in Heidelberg is designed to prepare and store molecular ions in their rotational and vibrational ground states. A key requirement for the study of electron-ion interactions within CSR is the identification of reaction products. The use of metallic magnetic calorimeters (MMCs) allows for identifying all neutral products since the deposited kinetic energy of incident particles into MMC absorbers can be used as a measure of the particle mass. To actually resolve the full reaction kinematics, a position sensitive coincident detection of multiple reaction products is necessary.

For these measurements we designed MOCCA, a 4k-pixel molecule camera based on MMCs with a detection area of 45 mm×45 mm, which is segmented into 64×64 absorbers and read out using only 32 SQUIDs. We discuss the detector design and its microfabrication as well as its multi-hit capability, cross-talk and expected energy resolution for photons and massive particles. In addition, we outline our plans for integrating MOCCA and its ^{3}He/^{4}He dilution refrigerator into CSR.

TT 55.19 Wed 15:00 P2-OG3

dc-SQUIDs for readout of metallic magnetic calorimeters — •Daniel Richter, Felix Herrmann, Anna Ferring, Andreas Fleischmann, Loredana Gastaldo, Sebastian Kempf, and Christian Enss — Kirchhoff-Institute for Physics, Heidelberg University, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany

Two-stage current-sensing dc-SQUIDs are presently the devices of choice to read out single-channel metallic magnetic calorimeters (MMCs). However, it is well known that parasitic inductances in the input circuitry lead to a reduction of the detecor signal size and that SQUID noise can cause a significant contribution to the energy resolution. In addition, parasitic mutual inductances between the input and feedback coil degrade the detector performance. In order to minimize these effects, we are currently developing two-stage current-sensing dc-SQUIDs that are optimized for MMC readout.

We discuss our different SQUID designs including single SQUIDs forming the front-end to the detector as well as N-SQUID series arrays providing signal amplification for the front-end SQUID at low temperatures. Our front-end SQUIDs are second-order parallel gradiometers,

have an input coil inductance of about 1 nH and show a particularly small parasitic coupling between the input and feedback coil. Our N-SQUID series arrays provide an on-chip bias resistor and include all circuitry that is required for easily building two-stage SQUID setups. We will show that our two-stage SQUID setups exhibit a very good noise performance reaching values down to the quantum limit. This makes it ideally suited for readout of high-resolution MMCs.

TT 55.20 Wed 15:00 P2-OG3

Solid State Physics and Engineering to Push the Resolving Power of Magnetic Calorimeters Beyond 10 000 — •M. Krantz, J. Geist, M. Keller, D. Hengstler, C. Schötz, F. Mücke, S. Kempf, L. Gastaldo, A. Fleischmann, and C. Enss — Kirchoff-Institute for Physics, Heidelberg University

Metallic magnetic calorimeters (MMC's) are energy dispersive particle detectors operated below 100 mK which excel in energy resolution, dynamic range and linearity. They use a paramagnetic temperature sensor to convert the energy deposited by means of photon absorption into a magnetic flux change in a SQUID, which is read-out as a voltage signal with low noise and large bandwidth. During the last decade we have been optimizing the signal size of MMCs by numerical optimizations and by the consequent use of micro-fabrication techniques, while lowering the readout noise close to quantum limit. The combination of both rewarded us with a world record instrumental linewidth of 1.6 eV (FWHM) for 6 keV X-rays, measured with our maXs-20 detector, a 1x8 pixel array. We summerize the physics of MMCs focusing on solid state effects, we present application-oriented microfabrication processes and cryogenic setups and we show recent results of our X-ray detectors. This includes the maXs-30 detector, an 8x8 pixel array optimized for X-rays up to 30 keV and a new design, which places the temperature sensor directly in a SQUID for maximized signal coupling with an expected instrumental linewidth below 1 eV (FWHM) for X-rays up to 10 keV. Our detectors are operated in a cryogen free 3He/4He-dilution refrigerator at the tip of a 40 cm long cold finger at $T = 20$ mK.

TT 55.21 Wed 15:00 P2-OG3

Polar-maXs: Micro-calorimeter based X-ray polarimeters — •Christian Schötz[1], Daniel Hengstler[1], Jeschua Geist[1], Sebastian Kempf[1], Loredana Gastaldo[1], Andreas Fleischmann[1], Christian Enss[1], and Thomas Stöhlker[2,3,4] — [1]KIP, Heidelberg University — [2]Helmholtz-Institute Jena — [3]GSI Darmstadt — [4]IOQ, Jena University

We are presently developing the x-ray detector system Polar-maXs, which will combine for the first time the high energy resolution, large dynamic range and excellent linearity of magnetic micro-calorimeters with the sensitivity to polarization caused by polarization-dependent Compton or Rayleigh scattering in an array of scatterers.

Polar-maXs consists of two layers. The first layer comprises a 4 x 4 array of x-ray scatterers behind a corresponding array of collimator holes. Depending on the energy range of interest and whether Compton or Rayleigh scattering is to be used, these scatterers are fabricated from low-Z or high-Z material. The scattered x-rays are detected by an array of 576 x-ray absorbers read-out by paramagnetic temperature sensors as metallic magnetic micro-calorimeters (MMC). Each absorber covers an area of 0.5mm x 0.5mm and is made of 10 micrometer thick gold, to guarantee high stopping power for x-ray with energies up to 20 keV and an energy resolution of better than 20eV (FWHM) in the complete energy range. We discuss general design considerations as well as the results of Monte-Carlo simulations for a variety of detector designs. We present the results of first measurements with the Hydra-principle.

TT 55.22 Wed 15:00 P2-OG3

Superconducting nanowire single-photon detectors with multi-photon resolution for integrated quantum photonics on GaAs — •Eric-René Reutter[1,2], Ekkehart Schmidt[1], Mario Schwartz[3], Hannes Rotzinger[2], Konstantin Ilin[1], Michael Jetter[3], Peter Michler[3], Alexey V. Ustinov[2], and Michael Siegel[1] — [1]Institut für Mikro- und Nanoelektronische Systeme (IMS), Karlsruher Institut für Technologie, Karlsruhe, Germany — [2]Physikalisches Institut (PHI), Karlsruher Institut für Technologie, Karlsruhe, Germany — [3]Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), Universität Stuttgart, Stuttgart, Germany

Integrated quantum photonic devices are one of the most promising fields for future information processing technologies. Superconducting nanowire single-photon detectors (SNSPDs) can function as the perfect on-chip detection part, with low dark count and high event count rates, as well as picosecond timing resolution, high detection efficiency and excellent scalability. Their drawback is not having intrinsic energy and photon-number resolution (PNR). Quasi-PNR can be achieved using multi-pixel arrays in which SNSPDs are parallel shunted by resistors [1]. We have demonstrated quasi-PNR functionality of SNSPDs made of 4.9 nm thick and 100 nm wide NbN nanowires on GaAs. The detectors were shunted by 50-60 Ω palladium resistors forming 4-pixel arrays. We investigated multi-photon resolution capability of such detectors being excited by a fs-pulse NIR laser. Details on the dependence of the detector response on light intensity will be presented and discussed.

[1] S. Jahanmirinejad *et al.*, Opt. Express **20** 2012, 5017-5028