welcome to the European Microkelvin Collaboration

CAPACITIES

Application Form for MICROKELVIN Transnational Access Project

1. General Information

Project number:	**AALTO35**	
Project Title:	**Cosmological analogue experiments on SQUID arrays**	
Lead scientist:[1]	**Title:**	Prof. Dr.
	First name:	Ralf
	Last name:	Schutzhold
	Home institution:	Univ. Duisburg-Essen
Host scientist:[2]	**Title:**	Dr.
	First name:	Sorin
	Last name:	Paraoanu
	Home institution:	Aalto Univ.
Project scientist:[3]	**Title:**	Prof. Dr.
	First name:	Ralf
	Last name:	Schutzhold
	Scientific Field:	low temperature physics, analog gravitational effects
	Home institution:	Univ. Duisburg-Essen
	Is your home institution MICROKELVIN partner?	No
	Business address:	
	Street:	Lotharstr. 1
	PO Box:	
	City:	Duisburg
	Zip/Postal Code:	47057
	Country:	Germany
	Telephone:	0049-203-379-4721
	Fax:	0049-203-379-4722
	E-mail:	kay.eibl@uni-due.de; ralf.schuetzhold@uni-due.de
	Curriculum vitae (18 lines max): 1990-1992 Abitur, Chemnitz University of Technology (Germany) 1992-1993 Civil service 1993-1998 Diploma in physics (with distinction) Dresden University of Thechnology (Germany) 1998-2001 PhD in physics (summa cum laude) Dresden University of Thechnology (Germany) 2001-2003 Postdoc at University of British Columbia, Vancouver (Canada) Feodor-Lynen fellow (Humboldt Foundation) 2003-2008 Research group leader at Dresden University of Thechnology Emmy-Noether fellow (German Research Foundation DFG) since 2008 Full Professor in Theoretical Physics University of Duisburg-Esen (Germany)	
	Five most recent publications:	
	1 - Hawking radiation from phase horizons in laser filaments? W. G. Unruh and R. Schuetzhold	

[1] The lead scientist indicated here is expected to participate in the campaign as a user of the infrastructure.

[2] The host scientist is supervising the work of the visiting project scientist at the infrastructure.

[3] The project scientist is the person who will be visiting the infrastructure.

	Phys. Rev. D **86**, 064006 . Published 4 September 2012		
	2 - Sauter-Schwinger-like tunneling in tilted Bose-Hubbard lattices in the Mott phase Friedemann Queisser, Patrick Navez, and Ralf Schuetzhold Phys. Rev. A **85**, 033625 . Published 21 March 2012		
	3 - Momentum dependence in the dynamically assisted Sauter-Schwinger effect Christian Fey and Ralf Schuetzhold Phys. Rev. D **85**, 025004 . Published 13 January 2012		
	4 - Quantum simulator for the Schwinger effect with atoms in bichromatic optical lattices Nikodem Szpak and Ralf Schuetzhold Phys. Rev. A **84**, 050101 . Published 22 November 2011		
	5 - Comment on Hawking Radiation from Ultrashort Laser Pulse Filaments Ralf Schuetzhold and William G. Unruh Phys. Rev. Lett. **107**, 149401 . Published 28 September 2011		
Other participating scientists:[4]	**Name:**	**Position:**	**New User:**
	1 - Pertti J. Hakonen	Professor	
	2 - G. Volovik	Professor	
	3 – P. Lähteenmäki	Ph.D. student	

[4] Please list all participating user group members. Expand the table, if necessary.

2. Project Information

Name of host infrastructure:	**O.V. Lounasmaa Laboratory, Aalto University**			
Access provider / Infrastructure Director:	**Name: Matti Krusius**		**E-mail address:** mkrusius@neur.hut.fi	
Planned project dates:	**Start date:**	**[02/04/2013]**	**Completion date:**	**[05/04/2013]**

Project description (12 lines max):

The connection between gravitation and condensed matter physics has long been established through the seminal work of Unruh and others, and an intense experimental effort has been put since into realizing experimentally various quantum-field effects in curved space-times in condensed matter systems. The field is sometimes called “analog gravity”. In particular, at the Microkelvin infrastructure of the O.V. Lounasmaa laboratory there is a strong tradition in this field, particularly through the use of superfluid He. This expertise is both theoretical (represented by scientists such as G. Volovik) and experimental, in the ROTA group. For example, the Kibble-Zurek effect (the creation of vortices by an ultrafast quench) has been first observed in the ROTA group.

In this project we aim at studying another condensed-mater system in which such effects can be realized, namely arrays of SQUIDs used as the signal line in a coplanar waveguide. These samples have been designed and fabricated recently at the host institution, and the aim of the project is to develop theoretical models for these devices.

Scientific objectives of the project (12 lines max):

The main objective of the project is to design samples and develop a theoretical model for an experiment on analog simulation of particle creation in an expanding Universe. The samples are superconducting circuit elements as described in the project description above. The expansion is simulated as a fast change in the Josephson inductance of the SQUIDs. In perspective, if successful, such experiments will open the way for the emulation of other cosmological effects in superconducting circuits. We emphasize that this project is strongly connected with measurements that are currently being done on similar samples using the low-temperature facilities of the cryohall at the host institution, in the NANO group in collaboration with the Kvantti group.

Technical description of work to be performed (20 lines max):

For the duration of this visit, which is only a few days, a realistic goal in terms of the work done is to write down the field-theoretical formulation of the problem in our specific system and with experimentally relevant parameters. We will write the Lagrangian of the system, the Euler-Lagrange equations of motion, and quantize the system. In particular, we will address the issue of correlations of the photons emitted as a result of the externally-induced change in the inductance of the SQUIDs. We would also want to calculate the total momentum of the emitted photons as a function of the length of the sample.

3. Joint Proposals / Funding

Is this project in collaboration with other (concurrent) projects at the infrastructure?	**No**
If yes, please specify:	

Is this proposal submitted to any funding programmes?	**No**
If yes, please specify:	

The completed Application Form should be submitted to MICROKELVIN Management Office (Sari.Laitila@aalto.fi, fax +358-9-47022969)