welcome to the
European Microkelvin Collaboration

CAPACITIES

Report on the Transnational Access Activity carried out within MICROKELVIN

The eligibility of transnational access to a MICROKELVIN TA site implies the submission of the following:

1) The Certification of visit

The form "Certification of visit" must be completed and signed by the access provider in charge of the infrastructure and the leader of the project.

2) A TA project report

The form for the TA project report is contained within this document. It should be completed after project end by the group leader of the project. You must respect the limited number of words specified, longer descriptions will be rejected. Figures/tables may be attached at the end of the document. The document must be submitted in an editable format (doc, rtf).

3) A User group questionnaire

To enable the Commission to evaluate the Research Infrastructures Action, to monitor the individual contracts, and to improve the services provided to the scientific community, each project leader of a user-project supported under an EC Research Infrastructure contract is requested to complete a "user group questionnaire". The questionnaire must be submitted once by each user group to the Commission as soon as the experiments on the infrastructure come to end.

The user group questionnaire is not part of this document and must be completed on-line. It is accessible at:

http://cordis.europa.eu/fp7/capacities/questionnaire_en.html.

► **Please note that any publications resulting from work carried out under the MICROKELVIN TA activity must acknowledge the support of the European Community:**

> **"The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 228464 (MICROKELVIN)."**

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MICROKELVIN Transnational Access Project Report

1. General information

Project number:	**Lancs05**	
Project Title:	**Design of quartz tuning fork array for quantum turbulence research**	
Lead scientist:[1]	**Title:**	Prof.
	First name:	Ladislav
	Last name:	Skrbek
	Birth date:	September 5, 1955
	Passport number:	
	Research status/Position:	Leader of the Low Temperature Group
	New User:[2]	yes
	Scientific Field:	
	Home institution:	Faculty of Mathematics and Physics, Charles University in Prague, Czech Republic
	Is your home institution MICROKELVIN partner?	☒ Yes ☐ No
	Business address:	
	Street:	V Holešovičkách 2
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	Telephone:	+420 22191 2558
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[1] The lead scientist indicated here is expected to participate in the campaign as a user of the infrastructure.

[2] Indicate 'Yes' only if the user has never visited the infrastructure before this specific project, otherwise write 'No'.

2. Project information

Please, give a brief description of project objectives: (250 words max)	Turbulence impacts on virtually every aspect of our everyday experiences, with enormous scientific and technological implications, but is still quite poorly understood. Superfluid He3 below 0.3Tc provides a unique environment for studying the fundamental principles of turbulence. Quantum turbulence in a superfluid consists of a tangle of vortex lines. In superfluid 3He, vortices can be non-invasively probed by ambient thermal excitations using Andreev reflection. Following its discovery 10 years ago, a great deal of progress has been made in this system. We now hope to extend these studies with turbulence visualisation measurements. For this purpose, large numbers of sensors are essential. Quartz tuning forks are well suited for this since they have very low intrinsic dissipation, small size and can be manufactured to tailored specifications. The ULT group at Lancaster has the necessary infrastructure and extensive expertise in studies of quantum turbulence in superfluid 3He, whilst the Prague group has vast experience with quartz tuning forks. In this project, professor Skrbek will utilise this expertise to investigate tuning fork arrays for low temperature applications, such as ULT turbulence visualisation techniques.
Technical description of work performed: (250 words max)	The Lancaster ULT group has recently purchased some prototype arrays of custom-manufactured quartz tuning forks which cover a wide range of frequencies from 6 kHz to 160 kHz. Substantial progress has been made in developing the required measurement techniques to simultaneously drive and measure large numbers of forks in a single array. Such arrays are ideal for making a systematic study of the properties of tuning forks in quantum fluids, including sound emission. In this project, we investigated the detailed properties of the individual tuning forks in the arrays. We studied their current – voltage characteristics, resonant frequencies and their intrinsic low temperature dissipation / quality factors. In particular we looked at the frequency dependences of these quantities and compared measurements in vacuum and in liquid Helium to investigate the effects of sound emission. The tuning fork arrays were cooled to temperatures of around 1.5 K in a 4He glass cryostat. Our experiments showed that sound emission becomes the dominating damping mechanism at resonant frequencies above 100 kHz in liquid 4He. Comparison of the experimental data with the various theoretical models showed that three a dimensional model of sound emission described our data well.
Project achievements (and difficulties encountered):[5] (250 words max)	We mounted tuning fork arrays on the experimental test probe and cooled the forks to liquid He temperatures. We made characterization measurements in vacuum at 4.2K and various detailed measurements in normal 4He at 4K and in superfluid 4He down to 1.5K. We analysed experimental results from damping measurements using a program written in Matlab. Experimental results on tuning

	fork damping at frequencies below 100 kHz are in very good agreement with hydrodynamic models. Experimental data at higher frequencies suggest that acoustic emission becomes the main damping mechanism and that the measured damping in helium can be described using a three dimensional sound emission model. Our results show that sound emission plays a significant role in the damping of the tuning forks in helium and requires similar studies to be conducted in normal and superfluid 3He. Such studies will be carried out in the near future.
Expected publications and dates:	▪ A scientific paper summarising measurements and their analysis has been submitted to PRB.
Submission date of user group questionnaire:	29/09/2011

Completed Project Reports should be returned to MICROKELVIN Management Office (laitila@neuro.hut.fi, Fax: +358 9 47022969).