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).”

welcome to the
European Microkelvin Collaboration

CAPACITIES

MICROKELVIN Transnational Access Project Report

1. General information

Project number:	Lancs09	
Project Title:	**Detailed study of quantum turbulence from vibrating objects in superfluid Helium-4**	
Lead scientist:[1]	**Title:**	Prof.
	First name:	Ladislav
	Last name:	Skrbek
	Home institution:	Faculty of Mathematics and Physics, Charles University in Prague, Czech Republic
Host scientist:[2]	**Title:**	Prof.
	First name:	Shaun
	Last name:	Fisher
	Home institution:	Lancaster University
Project scientist:[3]	**Title:**	Dr.
	First name:	David
	Last name:	Schmoranzer
	Birth date:	28/11/1981
	Passport number:	39058252
	Research status/Position:	Academic assistant
	New User:[4]	no
	Scientific Field:	Low Temperature Physics, Superfluidity
	Home institution:	Charles University in Prague
	Is your home institution MICROKELVIN partner?	☐ Yes ☒ No
	Business address:	
	Street:	V Holešovičkách 2
	PO Box:	-
	City:	Prague
	Zip/Postal Code:	18000 Prague 8
	Country:	Czech Republic
	Telephone:	+420 221 91 2716 (lab), +420 777 586 939 (mobile)
	Fax:	-
	E-mail:	david.sch@seznam.cz

[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.
[4] 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)	There has been much interest in quantum turbulence in recent years. It is interesting in its own right, as well as for its many analogies with classical turbulence and other less accessible systems. The simplest way to generate turbulence at very low temperatures is by vibrating objects at sufficiently large amplitudes. This project was aimed at studying the generation of quantum turbulence from different objects in normal and superfluid 4He over the full range of accessible temperatures, and over a very wide range of oscillation frequencies. The experiments were to be performed on the advanced refrigerator at Lancaster, allowing measurements below 3 mK. The objective was to acquire detailed measurements over the full temperature range and to study the effects of the turbulence generated from the different devices over a broad range of frequencies. Substantial amounts of detailed data analysis and modelling will be required to interpret the experimental results. Experiments over the whole temperature range are needed to compare different regimes: in the zero temperature limit there is no normal fluid so the behaviour is governed by quantum vortices in the pure superfluid; at intermediate temperatures we have coupled normal and superfluid turbulence; at high temperatures we have pure classical turbulence in a normal liquid. A low frequency vibrating wire also allows us to study the behaviour in the zero frequency limit and various tuning forks allow us to study frequency dependent behaviour expected at higher frequencies, as well as the interplay between turbulence and acoustic emission.
Technical description of work performed: (250 words max)	We have made comprehensive measurements of the drag forces from quantum turbulence produced by a low frequency (~ 60 Hz) vibrating wire and several quartz tuning forks covering a wide range of frequencies from a few kHz up to more than 100 kHz. Measurements were made in superfluid 4He over the full range of accessible temperatures, from just below the superfluid transition temperature ~ 2.2 K down to temperatures of just a few mK. We have detailed measurements for how the turbulent drag changes going from classical turbulence in normal liquid Helium above 2.2 K, through the two fluid regime at intermediate temperatures, to the pure quantum turbulence at the lowest temperatures. Measurements have been made on the low frequency wire and several tuning forks from velocities of order 1 mm/s up to around 1 m/s. This allows us to extract the dissipative drag coefficient which is dominated by turbulence at the highest velocities. Simultaneously we have measured the shift in the resonant frequency as a function of velocity which, together with similar measurements in vacuum, allows us to extract the non-dissipative inertial drag force for the different types of turbulence. For the tuning forks at higher frequencies, we see additional drag at low velocities due to acoustic emission, which was investi-

	gated in a previous access project.
Project achievements (and difficulties encountered):[5] (250 words max)	The project has been very successful. It has produced the first detailed measurements of the drag forces from quantum turbulence on a low frequency vibrating wire, together with a detailed comparison of the turbulent drag from tuning forks over a very wide frequency range. At the highest frequencies the drag is dominated by acoustic emission at low velocities, so we have also been able to investigate the possible interplay between acoustic emission and quantum turbulence. The measurements will take a substantial effort to analyse and interpret. This is will be done over the coming weeks and months. It will be particularly interesting to study the transitions from classical to two-fluid to pure quantum turbulence. In addition, the low frequency wire can be driven over a broad range of (low) frequencies using \`floppy wire' techniques which we developed in an earlier access project. This will allow us to study the frequency dependence of the turbulent drag from the same object (the drag may be sensitive to surface defects, so it is particularly valuable to study the same object at different frequencies). The classical fluid drag on a wire (which we can measure in normal liquid 4He) should show considerable frequency dependence at low and intermediate velocities. It will be interesting to discover whether there is a comparable dependence in the pure superfluid at the lowest temperatures and in the two-fluid regime at intermediate temperatures.
Expected publications and dates:	▪ This work is on-going. We hope to have the preliminary results ready for a poster presentation at the QFS 2012 Conference in Aug 2012 ▪ A paper will be prepared in due course, once the data has been analysed and interpreted. A possible publication date is late 2012 or early 2013
Submission date of user group questionnaire:	20/06/2012

Completed Project Reports should be returned to MICROKELVIN Management Office (Sari.Laitila@aalto.fi, Fax: +358 9 47022969).