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:	**CNRS 19**	
Project Title:	**Specific heat measurements of disordered films across the superconductor-insulator-transition**	
Lead scientist:[1]	**Title:**	Prof.
	First name:	Aviad
	Last name:	Frydman
	Home institution:	Bar-Ilan University, Ramat Gan, Israel
Host scientist:[2]	**Title:**	Dr
	First name:	Olivier
	Last name:	Bourgeois
	Home institution:	Institut Néel CNRS
Project scientist:[3]	**Title:**	Mr
	First name:	Shachaf
	Last name:	Poran
	Birth date:	Nov. 20th 1984
	Passport number:	
	Research status/Position:	PhD student
	New User:[4]	
	Scientific Field:	Superconductivity in disordered systems
	Home institution:	Bar-Ilan University
	Is your home institution MICROKELVIN partner?	No
	Business address:	Bar-Ilan University
	Street:	Max and Anna Webb st.
	PO Box:	
	City:	Ramat-Gan
	Zip/Postal Code:	5290002
	Country:	Israel
	Telephone:	972-3-531-8102
	Fax:	
	E-mail:	Scf1984@gmail.com

[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)	The interplay between disorder and superconductivity has intrigued physicists for decades. Experimentally it was found that superconductivity in 2D thin films can be destroyed by a sufficiently large degree of disorder. Once superconductivity is destroyed the sample undergoes a transition to an insulating state across a superconductor insulator transition (SIT), a fundamental manifestation of a quantum phase transition at T=0. Recently this field was revived due to the experimental observations of a number of dramatic features near the SIT such as simple activated temperature dependence of the resistance on the insulating phase, a large peak in the magneto-resistance and traces of superconductivity at temperatures above Tc and in the insulating phase. Current experiments, focused on transport and tunneling methods, seem to have reached saturation and new techniques are needed in order to shed light on the physics behind the superconducting transition in disordered films. In this respect, thermodynamic heat capacity measurements may provide important information towards solving some of the puzzles of the field. The plan is to study the heat capacity as a function of temperature of disordered ultra-thin lead films undergoing the SIT. These films can be produced by quench condensation at low temperature directly in the calorimeter. As the number of atomic layers increases, the Pb films encounter the insulator to superconducting transition. Depending on the substrate, we can produce and study either granular or uniform Pb films. Ultra-thin Pb films will thus be quench condensed in situ in the calorimeter directly on the membrane sensor. We use the facilities at the Néel Institute, especially a specific experimental probe for thin-film characterization as well as the nanofabrication facilities of NANOFAB. Quench condensation allows fabrication of granular lead films. The highly sensitive Cp measurement must be performed at very low temperature in order to follow the appearance of a peak versus temperature as the layer is grown in situ. The major advantage of this method is to be able to measure the Cp signature versus the thickness of the thin film without being obliged to open the system. All the Cp measurements have to be performed down to the lowest temperature of the cryostat. A characterization of the superconducting layer by regular resistive measurement is the first step. The second step is the actual measurement of heat capacity. The overheating during the evaporation of the materials in the quench condensation is estimated and measured with the thermometer on the membrane. Detection of signs for superconductivity in the insulating phase or at temperatures smaller than 1K (down to 0.3K) requires precise temperature control and monitoring.
Technical description of work performed:	Several technical issues with the measurement system were addressed and fixed at the beginning of the visit. The fabrication of the sensor was achieved using regular clean room facilities, especially the very thin

(250 words max)	membrane sensor. The heat capacity of several different samples of quench-condensed granular Pb films was measured and the results are currently being examined. Electrodes have been installed directly on the membrane allowing the concomitant measurement of the resistance of the evaporated sample as well as its heat capacity.
Project achievements (and difficulties encountered):[5] (250 words max)	Several specimens were used to measure the heat capacity of ultrathin granular Pb films. I was able to build several working membrane sensors. The heat capacity as well as the resistance of the sample was measured between 2 and 10 K. The insulator to superconducting transition was followed with the resistive measurement, and the heat capacity was measured from the insulating to the superconducting side. Measurements in magnetic field were also performed up to 2 Tesla.The data are currently analyzed in order to publish the techniques of heat capacity measurement in the evaporation chamber as well as the scientific results on the thermal signature of an insulator to superconducting transition.
Expected publications and dates:	Publications in Review of Scientific Instrument and Physical Review are planned.
Submission date of user group questionnaire:	24 Sep, 2013

Completed Project Reports should be returned to MICROKELVIN Management Office

(mari.kaarni@aalto.fi , Fax: +358 9 47022969).

Please complete and sign the form and send it by email or fax to the MICROKELVIN Management Office (leena.meilahti@tkk.fi, Fax No.: +358 9 4512969)

CERTIFICATION OF VISIT
at MICROKELVIN Transnational Access Site

I herewith confirm that the following project was carried out at our Transnational Access Site

CNRS Grenoble

in the context of MICROKELVIN Transnational Access:

CNRS 19: Specific heat measurements of disordered films across the superconductor-insulator-transition

The amount of access[1] delivered to the project group (project users) is as follows:

	Participant name	Duration of stay (start – end date)	Amount of access[2]
Project leader:	Schachaf PORAN	6/6 – 4/9/2013	90
Project user 1:			
Project user 2:			
Project user ...:[3]			
Total amount of access delivered to project group:			**90 days**

Grenoble, September 20th, 2013

Location and date — Signature of access provider

Tel Aviv, September 23d, 2013

Location and date — Signature of project leader

Completed Certification of Visit should be returned to MICROKELVIN Management Office
(mari.kaarni@aalto.fi), fax: +358 9 47022969)

[1] TKK Helsinki, CNRS Crenoble, or Lancaster University

[2] The amount of access is defined as the time, in days, spent by the user at the infrastructure for this project, including weekends and public holidays (e.g., a scientist who spent 5 days at the infrastructure must indicate '5'). The total amount of access of the project group is the sum of access days of each project user.

[3] Please, expand if necessary.