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.

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► **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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European Microkelvin Collaboration

# MICROKELVIN Transnational Access Project Report

## 1. General information

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| **Project number:** | **AALTO24** | |
| **Project Title:** | **Biot-Savart tree-algorithm together with smooth wall boundary conditions at different geometries** | |
| **Lead scientist:**[1] | **Title:** | Prof. |
| | **First name:** | Carlo |
| | **Last name:** | Barenghi |
| | **Home institution:** | Newcastle University, UK |
| **Host scientist:**[2] | **Title:** | Dr. (Tech) |
| | **First name:** | Risto |
| | **Last name:** | Hänninen |
| | **Home institution:** | O.V. Lounasmaa Laboratory, Aalto University, Finland |
| **Project scientist:**[3] | **Title:** | Dr. |
| | **First name:** | Andrew |
| | **Last name:** | Baggaley |
| | **Birth date:** | 05/12/1983 |
| | **Passport number:** | |
| | **Research status/Position:** | Post-doctoral research associate |
| | **New User:**[4] | Yes |
| | **Scientific Field:** | Quantum and classical turbulence |
| | **Home institution:** | |
| | **Is your home institution MICROKELVIN partner?** | ☐ Yes ☒ No |
| | **Business address:** | School of Mathematics and Statistics |
| | Street: | Herschel Building |
| | PO Box: | |
| | City: | Newcastle Upon Tyne |
| | Zip/Postal Code: | NE1 7RU |
| | Country: | UK |
| | Telephone: | 0191 2225371 |
| | Fax: | |
| | E-mail: | a.w.baggaley@ncl.ac.uk |

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

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| **Please, give a brief description of project objectives:** (250 words max) | With the help of the new and faster tree algorithm for vortex filament calculations, the primary task is to mimic and interpret various experiments, first in simple rotating cases where the results can be tested. Later more complex applications will be included, where the direct visualization of quantized vortices is typically difficult. Such experiments are, for example, the propagation of the vortex front in a rotating cylinder or the decay of a vortex tangle after a sudden stop of rotation. It is expected, that the results obtained help us to better understand quantum turbulence. We are most interested in the zero temperature limit, where energy dissipation should occur at length scales shorter than the inter-vortex distance. Therefore a faster code is needed, in order to cover a wider range of length scales with improved resolution. Within this vortex filament formulation we can then also search for improved methods to identify possible coherent structures and to probe the cascade of Kelvin waves on the vortex. |
| **Technical description of work performed:** (250 words max) | The primary goal is to use the vortex filament model and combine two pre-existing numerical codes such that we can exploit the benefits from both programs. The tree-algorithm code by A. Baggaley, which is N*log(N) method (versus the standard N^2 method), allows a considerable speed-up and makes possible to use vortex line densities larger than before. So far this code is limited to periodic boundary conditions. Using the tree-algorithm as a basis, a new code will be implemented where experimentally feasible boundary conditions are taken into account. This will be done by using the code of R. Hänninen, where the geometry, i.e. a cube and a cylinder, are already implemented. During this first short visit our task is to discuss how to combine these two approaches so that a working code can ultimately be composed. |
| **Project achievements** (and difficulties encountered):[5] (250 words max) | During the two-week visit a new computer code was established which uses the tree-algorithm and takes into account smooth solid boundaries. The code makes it possible to simulate quantum turbulence in cubical and cylindrical geometries using parameters that are close to experimental ones. The code still needs some testing and additions before it can be used to large scale simulations. The image field is currently calculated using image vortices. In most cases this is enough, e.g. the vortex front motion is well described using this approximation. Routines to calculate the energy spectrum have not been done yet. The implementation of these routines need some re-thinking since solid boundaries, especially in cylindrical geometry, complicate the Fourier presentation. |
| **Expected publications and dates:** | Phys. Rev. B, Using tree-algorithm to simulate vortex front, end of 2012.<br>Phys. Rev. B, Decay of counter-flow turbulence when solid walls are present, end of 2012/ beginning of 2013 |
| **Submission date of user** | 17 May 2012 |

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| **group questionnaire:** | |

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