welcome to the European Microkelvin Collaboration

CAPACITIES

# Application Form for MICROKELVIN Transnational Access Project

## 1. General Information

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|---|---|---|
| **Project number:** | **CNRS8** | |
| **Project Title:** | **Local magnetization measurements using miniature Hall probes array** | |
| **Lead scientist:**[1] | **Title:** | Dr. |
| | **First name:** | Zuzana |
| | **Last name:** | Pribulova |
| | **Birth date:** | 25.05.1978 |
| | **Passport number:** | SL503806 |
| | **Research status/Position:** | Researcher |
| | **New User:**[2] | NO |
| | **Scientific Field:** | superconductivity |
| | **Home institution:** | Department of Low Temperature Physics, Institute of Experimental Physics, Slovak Academy of Sciences, Kosice, Slovakia |
| | **Is your home institution MICROKELVIN partner?** | YES |
| | **Business address:** | |
| | Street: | Watsonova 47 |
| | PO Box: | |
| | City: | Kosice |
| | Zip/Postal Code: | 040 01 |
| | Country: | Slovakia |
| | Telephone: | 00421 55 792 2300 |
| | Fax: | |
| | E-mail: | pribulov@saske.sk |
| | **Curriculum vitae (18 lines max):**<br><br>2006-present Department of Low Temperature Physics, Institute of Experimental Physics, Slovak Academy of Sciences (IEP SAS)<br>Current position: Scientific researcher, specialisation: superconductivity (spectroscopic, transport and thermodynamic measurements)<br><br>2005-2006 Université Joseph Fourier and CNRS, Grenoble, France<br>post-doc position, specialisation: ac-calorimetry and local magnetization measurements of superconductors<br><br>2004-2005 Department of Low Temperature Physics, IEP SAS<br>Position: Scientific researcher, specialisation: superconductivity – point-contact spectroscopy<br><br>2001-2004 PhD study at Department of Low Temperature Physics, IEP SAS<br>Thesis: Superconducting properties of boron and aluminium doped $MgB_2$<br><br>1996-2001 P.J. Safarik University, Kosice, Slovakia, Masters degree in Matematics and Physics | |

[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'.

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| | **Five most recent publications:** |
| | 1- Superconducting energy gap in $MgCNi_3$ single crystals: Point-contact spectroscopy and specific-heat measurements<br><br>Z. Pribulova, J. Kacmarcik, C. Marcenat, P. Szabo, T. Klein, A. Demuer, P. Rodiere, D. J. Jang, H. S. Lee, H. G. Lee, S.- I. Lee, and P. Samuely<br><br>Phys. Rev. B - Accepted Jan 27, 2011 |
| | 2- Specific heat measurements of a superconducting $NbS_2$ single crystal in an external magnetic field: Energy gap structure<br><br>J. Kačmarčík, Z. Pribulová, C. Marcenat, T. Klein, P. Rodière, L. Cario, and P. Samuely<br><br>Phys. Rev. B 82, 014518 (2010) |
| | 3- Strongly dissimilar vortex-liquid regimes in single-crystalline NdFeAs(O,F) and $(Ba,K)Fe_2As_2$: A comparative study<br><br>J. Kacmarcik, C. Marcenat, T. Klein, Z. Pribulova, C. J. van der Beek, M. Konczykowski, S. L. Budko, M. Tillman, N. Ni, and P. C. Canfield<br><br>Phys. Rev. B 80, 014515 (2009) |
| | 4- Upper and lower critical magnetic fields of superconducting $NdFeAsO_{1-x}F_x$ single crystals studied by Hall-probe magnetization and specific heat<br><br>Z. Pribulova, T. Klein, J. Kacmarcik, C. Marcenat, M. Konczykowski, S. L. Bud'ko, M. Tillman, and P. C. Canfield<br><br>Phys. Rev. B 79, 020508 (2009) |
| | 5- Evidence for two-gap superconductivity in $Ba_{0.55}K_{0.45}Fe_2As_2$ from directional point-contact Andreev-reflection spectroscopy<br><br>P. Szabó, Z. Pribulová, G. Pristáš, S. L. Bud'ko, P. C. Canfield, and P. Samuely<br><br>Phys. Rev. B 79, 012503 (2009) |

| **Other participating scientists:**[3] | **Name:** | **Position:** | **New User:**[2] |
|---|---|---|---|
| | 1-Dr. Peter Samuely | **Senior scientist** | No |
| | 2-Dr. Pavol Szabó | **Senior scientist** | No |
| | 3-Dr. Jozef Kačmarčík | **Senior scientist** | No |

## 2. Project Information

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| **Name of host infrastructure:** | **Institut Néel, CNRS, Grenoble, France** | | | |
| **Access provider / Infrastructure Director:** | **Name:**<br>**Dr. Henri Godfrin** | | **E-mail address:**<br>**henri.godfrin@grenoble.cnrs.fr** | |
| | | | | |
| **Planned project dates:** | **Start date:** | **[20/06/2011]** | **Completion date:** | **[03/07/2011]** |

**Project description (12 lines max):**

The proposed project has two important scopes: a technical and a scientific one. The technical part is the transfer of knowledge and expertise in local magnetisation measurements using miniature Hall probes arrays for future use in an apparatus in Kosice as well as testing of Hall probes in collaboration with an expert (Thierry Klein). The scientific goal of the project is the experimental study of iron based superconductors by complementary methods down to 0.3K. Combination of local magnetization measurements with ultra-sensitive ac-calorimetry as well as tunnelling spectroscopy has proven to be a powerful tool to uncover effects that would otherwise stay undiscovered – for example existence of new states of vortices in superconduc-

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

tors. Lately for example, in our collaboration we have showed by combination of different techniques performed on the same crystals that the phase diagram of different high-temperature pnictides families differ significantly. While in one family a vortex-liquid phase occupies a large portion of the mixed-state phase diagram, this is not the case in another family (publications 3,4).

**Scientific objectives of the project (12 lines max):**

The recent discovery of superconductivity at unusually high temperature in rare earth iron oxypnictides has been the focus of a tremendous number of theoretical and experimental work in the past two years. The possible coexistence of superconductivity with a complex magnetic structure makes this system particularly fascinating and a nonconventional pairing mechanism associated with multigap superconductivity in electron and hole pockets has been suggested by different groups. However, there are numerous open questions to be answered and properties yet to be uncovered. Within this project we would like to study the phase diagram Temperature vs Magnetic field and magnetic relaxation in iron based superconductors. To do this, local magnetization measurements using Hall probes is an excellent choice. We will study the first penetration field (related to the lower critical field $H_{c1}$) into the sample up to very low temperatures and for different orientations of the field in respect to crystallographic structure of the material. The resulting anisotropy of $H_{c1}$ will be addressed as well.

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

For a detailed experimental research of novel superconductors it is essential to have several complementary techniques applicable to the same crystal of the material. Moreover, often it is very difficult to prepare novel superconductors thus the resulting single-crystals have minute dimensions. Experimental study of such crystals is not possible using commercially available measurement systems and construction of unique experimental equipment is highly desirable. For decades the scientific research in the Centre of low temperature physics IEP SAS was performed using such “home-made” devices and equipment. Lately, in collaboration with our colleagues from CNRS Grenoble, the technique of ac-calorimetry was introduced in the low temperature laboratory in Kosice and has already shown its impact (see publications 1,2). Recently we are working on implementation of a new technique of experimental research – local magnetization measurements using miniature Hall probes. This work is done in collaboration with several research institutions. First of all the probes are produced at Institute of Electrical Engineering in Bratislava and second the know-how comes from CNRS, Grenoble. There, Dr. Thierry Klein is well recognized specialist with long-standing expertise in the field. The technique will in the end highly improve the research infrastructure available in Kosice. The proposed project will open an opportunity not only to test the new probes with an experienced professional but also to transfer the knowledge and practice toward applicant who will be responsible for its implementation later in Kosice.

The array of Hall probes will be tested in different magnetic fields up to 8T and temperatures down to 300 mK. We will test their sensitivity, stability and reliability while performing research of superconducting properties of one type of pnictides.

## 3. Joint Proposals / Funding

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

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

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The completed Application Form should be submitted to MICROKELVIN Management Office (Katariina@neuro.hut.fi, fax +358-9-47022969)