European Microkelvin Collaboration

MICROKELVIN

General Assembly

Meeting at the 36-month Review of the Microkelvin Grant Programme
Wednesday, 21 March, Red Saloon, Smolenice Castle, 20:00 – 22:00

Members present at the meeting:

George Pickett ULANC (Chair)
Rob Blaauwgeers BLUEFORS
Christian Enss HEID
Francesco Giazotto SNS
Henri Godfrin CNRS
Teun Klapwijk DELFT
Matti Krusius AALTO (Coordinator)
Tjerk Oosterkamp UL (represented by Andrea Vinante)
John Saunders RHUL
Thomas Schurig PTB (represented by Joern Beyer)
Peter Skyba SAS
Dominik Zumbuhl BASEL

Not represented: BLUEFORS and SNS

AGENDA

1. ***36-month review***. Summary and impressions from today's review proceedings; are further actions needed beyond the regular plan?
2. ***Microkelvin finances***. Summary of present fiscal situation at different partner institutions. Special attention is needed to accelerate financial résumés for the 36-month review report.
3. ***Milestones & deliverables for the last 12 months***. Summaries on all JRA's. Discussion about actions needed: are the goals going to be achieved or is an amendment request required?
4. ***Funding of JRA's***. Are transfers of funds between partners needed to make maximal use of available resources during the final grant period?
5. ***TNA services***. Summary of access months at the 3 access-giving sites. Are targeted visitor months going to be achieved during the last year? Are transfers of funds between access-giving sites needed?
6. ***Upcoming networking projects and their budgets***. Final workshop and review meeting in March 2013. Other meetings of the Microkelvin Collaboration. Meetings with Microkelvin sponsorship. Societal outreach projects.
7. ***Proceedings***. Annex I calls for published proceedings from two Microkelvin User Meetings. Which meetings will support published proceedings?

8. ***Development projects with industrial partners***. Commercialization projects have been suggested, such as a high-frequency cabling package with thermal filters and anchors for nano-electronics measurements in a dilution refrigerator, or a ready-to-use Coulomb-blockade thermometer package down to 10 mK temperatures, or thermometry services for temperatures below 10 mK. Reports from BlueFors and John Saunders. Proposals and initiatives for the last year?
9. ***Amendment proposal***. Formal decision about a possible amendment proposal and its contents.
10. ***Balancing of the grant budget***. Formal decision about how to balance the Microkelvin budget during the remaining grant period. Approval for transfer of funds between partner organizations has to be sought from the EU Project Office.
11. ***Succession of the Microkelvin programme.*** Discussion of available possibilities, actions, and organization of work.
12. ***Any other business.***
13. ***Closing of meeting.***

Matti Krusius
Coordinator

George Pickett
Chairman

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MINUTES OF GENERAL ASSEMBLY

1. **36-month review**. More than 70 % of the milestones and 80 % of the deliverables have been achieved at the 36-month deadline. The rest of the work is in good progress. No major deviations from the work plan have occurred, except for delays in equipment deliveries which have slowed down the construction of new refrigerators.

2. ***Microkelvin finances***. On the whole, the present financial state of the Microkelvin Collaboration follows the original plan. One request for a transfer of funds between partners has been made to the EU Project Office. This request concerned the transfer of 12 000 Euros from Aalto to Heidelberg for organizing the Low Temperature Detectors 2011 Conference in Heidelberg. The request was granted. A similar new request will be submitted to the EU Project Office to transfer close to 30 000 Euros from CNRS-Grenoble to SAS-Kosice for the board and lodging of the 88 participants of the Microkelvin 2012 Workshop in the Smolenice Castle.

   The trans-national access programme is lagging behind. Together the three access providing sites have hosted 41 months of visitor access, which is only half of the final 81-month target for the 4-year grant programme. Only Aalto with its 24 months of visitor time is approaching its 27-month target. The reason for the lag is partly the late start in the first payment of the Microkelvin grant money from Brussels (which should have occurred in April 2009 but actually happened in September 2009). The second reason is the unfamiliarity of both the CNRS and Lancaster laboratories with the difficulties in running their visitor programmes. To get the Microkelvin TNA programme finished at the targeted level appears challenging. The EU Project Officer notes that TNA is one of the three pillars in the Infrastructures Programme, a transfer of funds from TNA to JRA is not appropriate. However, to provide more opportunities to com-

plete the TNA programme according to plans, the consortium may decide to ask for a 6-month extension. This request would be approved by the EU Project Office.

3. ***Milestones & deliverables for the last 12 months***. The meetings of all four JRA groups earlier during the day had concluded that the outlook for the final year looked promising: most likely the presently unfinished milestones and deliverables will be achieved and the new ones will be completed more or less according to plans.

4. ***Funding of JRA's***. The use of the grant money within the work packages of the JRA projects is proceeding according to the original plans. No transfers of funds between partners are needed during the final grant period.

5. ***TNA services***. As noted in #2, the Trans-National Access Programme has reached the half-way point, but to provide the remaining 40 months of access, a 6-month extension of the grant programme is advisable. A request for the extension will be made to the EU Project Office.

6. ***Upcoming networking projects and their budgets***. Several outreach projects are planned for the final year: **1)** The final User Workshop and Review Meeting of the Microkelvin Collaboration will be conducted in March or September of 2013, depending on the outcome of the 6-month extension request. This workshop will be organized in Helsinki or Lancaster. **2)** A meeting of the Microkelvin General Assembly will be organized during the QFS 2012 Conference in Lancaster in August. **3)** One or two sessions in a Microkelvin sponsored minisymposium are planned for the Meeting of the Condensed Matter Division of the European Physical Society in September 2012 in Edinburgh. **4)** A meeting with industrial liaisons is planned for next fall, possibly in Paris, to be organized by Henri Godfrin. A roadmap for the collaboration with our about 20 industrial partners is needed. It will become valuable when the continuation of the Microkelvin Collaboration becomes a timely issue under the Horizons 2020 framework (presumably in 2014, see #11).

7. ***Proceedings***. Annex I calls for published proceedings from two Microkelvin User Meetings. Proceedings will be prepared about the final User Meeting in 2013.

8. ***Development projects with industrial partners***. Commercialization projects have been suggested, such as a high-frequency cabling package with thermal filters and anchors for nano-electronics measurements in a dilution refrigerator, or a ready-to-use Coulomb-blockade thermometer package down to 10 mK temperatures, or thermometry services for temperatures below 10 mK. John Saunders reported that no new suggestions were received. This matter will be discussed in the meeting with industrial partners in the fall of 2012, to be organized by Henri Godfrin possibly in Paris. It was concluded that the present budget does not allow additional development work for commercial purposes and that therefore such plans will be postponed to a possible continuation of the Microkelvin concept under the Horizons 2020 framework.

9. ***Request for changes in the programme.*** **1)** A request will be submitted to the EU Project Office about granting a 6-month extension for the entire programme, from March 31 to September 30 in 2013 without any additional extra funding. **2)** In addition, permission is needed for transferring funds between partners, to pay the bill from the 2012 Workshop in Smolenice Castle. **3)** The Aalto administration notes that it had designed the entire programme to wind down on March 31, 2013. If the programme is continued for another 6 months, then the coordination budget at Aalto needs to be in-

creased by 32 500 Euros. This can be done by a transfer of funds within the Microkelvin coordination budget.

In all the above cases it would be practical to avoid the regular route of an Amendment Proposal, since its processing might not be finished before the current closing deadline of 31 March 2013. Instead, these requests, which do not involve major budgetary changes, can perhaps be handled by the EU Project Office.

10. ***Balancing of the grant budget***. Current Microkelvin budgeting follows the original plans and, except for some smaller adjustments within the coordination budget, no major balancing is needed. With a six-month extension of the grant period the TNA programme has a chance to get completed at the targeted level.

11. ***Succession of the Microkelvin programme.*** Rumour has it that there may not be any more calls within the current FP7 framework where one could expect a continuation of the Microkelvin programme to fit in. However, the first calls within the new framework Horizons 2020 might make it possible to submit an application which is not too dissimilar from the present concept. It was decided that the chairman prepares a one-page expression of intent, to lobby for a bottom-up call in a programme for Infrastructures. This common statement of the Microkelvin Partners comes attached to these Minutes of the General Assembly. Horizons 2020 is expected to pay special attention to research excellence and to industrial leadership, particularly among small and medium-size enterprises. Both aspects are already important features of the current Microkelvin programme and will be further strengthened in the new application.

    The General Assembly unanimously supported a motion to draft a formal agreement for establishing a European Microkelvin Laboratory without walls which would include all present Partners with μK refrigeration access. The form and contents of this agreement will be discussed in the next General Assembly in August 2012 in Lancaster, after the Partners have had a chance to enquire about such an approach at their home institutions.

    The possibility to offer μK access to users from outside the EU countries was discussed. For instance, with the dismantling of many American low-temperature laboratories, facilities with μK temperatures are in short supply in the Americas, in particular for nanophysics measurements. Perhaps the American National Science Foundation could be interested to support such visits.

12. ***Any other business.*** The absence of the Advisory Board Members from the Review Meeting was discussed. It was decided that an effort should be undertaken to engage and activate the Members of the Advisory Board. The 36-month periodic review report will be sent to them with the polite request that the Collaboration would greatly appreciate their comments.

13. ***Closing of meeting.***

Smolenice March 23, 2012

Matti Krusius
Coordinator

George Pickett
Chairman

Addendum: Promotion for the need of bottom-up calls in Framework Horizons 2020

THE CASE FOR THE EUROPEAN "MICROKELVIN" NETWORK

The ever-increasing complexity of current electronics is rapidly bringing us to the limit when typical component sizes finally reach atomic dimensions and no further miniaturization is possible. At that point we will need something entirely new.

Electronics based on coherent electron behaviour promises to provide the new way forward. In nanocircuits, the electrons can behave coherently over the circuit dimension and thus follow the quantum rules of wave motion rather than Ohm's law. This will open up a whole range of new devices based on quantum electronics.

The major difficulty standing in way of this advance is the achievement of the coherence needed. The electrons must be able to move through the circuit without scattering. But to achieve scattering lengths larger than the sample size, we need to minimise both impurity scattering and thermal scattering. The former demands extremely high purity materials which we already have the technology to produce. The latter, to limit *thermal* scattering, requires low temperatures. For this, even at the more easily accessible millikelvin temperatures, the circuits need to be of nanoscale.

This severe size restriction provides the motivation for exploiting the implicit imperative in nanoscience that there are enormous advantages to be gained by working at much lower microkelvin temperatures. Despite this clear demand, nanoscience in general is inhibited from advancing below the millikelvin temperature regime by a lack of appropriate expertise and facilities.

In Europe we *already* have the greatest concentration of microkelvin infrastructure and expertise in the world, developed by our quantum-fluids community. Over the last three years the MICROKELVIN network has been putting this existing infrastructure at the disposal of the wider nanoscience community, developing together new techniques to bring coherent structures into a completely new temperature regime. This is leading to the creation of a European microkelvin "laboratory without walls" to exploit this necessary work. The activity is also encouraging European commercial interest in the opportunities in this new emerging area which should give European technology a lead.

The UK has two microkelvin facilities intimately associated with this work, and both taking leading roles in the endeavour. (Replace with your own appropriate "national" comment to suit).

We are asking you, as a decision maker in influencing the programme of Horizons 2020, to be aware that this vitally important activity is continued by being included in the future road map.

The advance toward smaller sizes and lower temperatures is inevitable in the long term, but the European lead in the microkelvin field gives us now the opportunity to be first with this new development.

The infrastructure is now coming together. The need is manifest. We simply have to ensure that the opportunities continue in Europe.

Background Information

Research at the frontier near absolute zero has long been a powerhouse for generating ideas in physics and beyond, from concepts in particle physics to practical ultrasensitive devices for application in technology and medicine. One in four Nobel prizes over the last century has gone to a low-temperature physicist. In the same period the lowest accessible temperatures have fallen by 10 orders of magnitude (4 K to 100 pK) far exceeding the rate of miniaturization of microcircuits (Moore's law) over recent decades. Today some 250 (1000) low temperature research groups (researchers) in Europe work at sub-Kelvin temperatures. Ten major companies and 15 SME's have cryoengineering groups. Their total annual turnover is about 1 000 000 000 € and 50 000 000 €, respectively. There is a European need for around 100 low temperature scientist and cryoengineers per year.

While Europe is the current world leader in microkelvin physics, in terms of research workers, records held and research output, the effort is fragmented between universities and government laboratories and lacks the critical mass for high quality research and training programs. Industrial exploitation is also very low with no commercially available refrigerators able to reach the microkelvin regime. Only 20 laboratories worldwide can build their own microkelvin refrigerators with 12 located in Europe, almost all of which are involved in this action. Many current world low temperature records are held by partners of the MICROKELVIN collaboration.

Recently interest in the sub 10 mK regime has increased, with the emergence of two frontiers, nanoscale dimensions and microkelvin temperatures. Nanocircuits behave as quantum objects which can be incorporated *directly* into conventional electronic circuits, thus allowing engineering to tap directly this whole new range of quantum possibilities with clearly very great economic implications. To make full advantage of such systems we need to increase the coherence time of the nanocircuits. This obviously requires increased purity of the materials, improved architecture of the circuits, but also a large reduction in the influence of the surrounding thermal 'outside world'. Consequently, operation at lower temperatures has a great impact on this field.

In summary, more efficient research work in the microkelvin regime, although demanding, will open new opportunities. This demands a higher level of networking and integration of the European low-temperature community. The MICROKELVIN Collaboration is opening the microkelvin temperature regime to a wider range of scientists. It will counteract European fragmentation, bring nanoscience into the microkelvin arena, and stimulate industrial entry into the field.