INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI 2005–2010

RC-Specific Evaluation of INV – Inverse problems group

Seppo Saari & Antti Moilanen (Eds.)
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI 2005–2010

RC-Specific Evaluation of INV – Inverse problems group

Seppo Saari & Antti Moilanen (Eds.)
**Title:**

**Summary:**
Researcher Community (RC) was a new concept of the participating unit in the evaluation. Participation in the evaluation was voluntary and the RCs had to choose one of the five characteristic categories to participate. Evaluation of the Researcher Community was based on the answers to the evaluation questions. In addition a list of publications and other activities were provided by the TUHAT system. The CWTS/Leiden University conducted analyses for 80 RCs and the Helsinki University Library for 66 RCs. Panellists, 49 and two special experts in five panels evaluated all the evaluation material as a whole and discussed the feedback for RC-specific reports in the panel meetings in Helsinki. The main part of this report is consisted of the feedback which is published as such in the report.

Chapters in the report:
1. Background for the evaluation
2. Evaluation feedback for the Researcher Community
3. List of publications
4. List of activities
5. Bibliometric analyses

The level of the RCs’ success can be concluded from the written feedback together with the numeric evaluation of four evaluation questions and the category fitness. More conclusions of the success can be drawn based on the University-level report.

**RC-specific information:**

<table>
<thead>
<tr>
<th>Main scientific field of research:</th>
<th>Natural Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC-specific keywords:</td>
<td>Applied mathematics, inverse problems, industrial applications</td>
</tr>
<tr>
<td>Participation category:</td>
<td>1. Research of the participating community represents the international cutting edge in its field</td>
</tr>
<tr>
<td>RC’s responsible person:</td>
<td>Päivärinta, Lassi</td>
</tr>
</tbody>
</table>

**Keywords:**
Research Evaluation, Meta-evaluation, Doctoral Training, Bibliometric Analyses, Researcher Community

**Series title and number:**
University of Helsinki, Administrative Publications 80/66, Evaluations

<table>
<thead>
<tr>
<th>ISSN:</th>
<th>1795-5513 (Online)</th>
<th>ISBN:</th>
<th>978-952-10-7486-8 (PDF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of pages:</td>
<td>57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language:</td>
<td>English</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Additional information:**
Cover graphics: Päivi Talonpoika-Ukkonen
Enquiries: seppo.o.saari@helsinki.fi
Internet address: http://www.helsinki.fi/julkaisut/aineisto/rc_evaluation
Foreword

The evaluation of research and doctoral training is being carried out in the years 2010–2012 and will end in 2012. The steering group appointed by the Rector in January 2010 set the conditions for participating in the evaluation and prepared the Terms of Reference to present the evaluation procedure and criteria. The publications and other scientific activities included in the evaluation covered the years 2005–2010.

The participating unit in the evaluation was defined as a Researcher Community (RC). To obtain a critical mass with university-level impact, the number of members was set to range from 20 to 120. The RCs were required to contain researchers in all stages of their research career, from doctoral students to principal investigators (PIs). All in all, 136 Researcher Communities participated in this voluntary evaluation, 5857 persons in total, of whom 1131 were principal investigators. PIs were allowed to participate in two communities in certain cases, and 72 of them used this opportunity and participated in two RCs.

This evaluation enabled researchers to define RCs from the “bottom up” and across disciplines. The aim of the evaluation was not to assess individual performance but a community with shared aims and researcher-training activities. The RCs were able to choose among five different categories that characterised the status and main aims of their research. The steering group considered the process of applying to participate in the evaluation to be important, which lead to the establishment of these categories. In addition, providing a service for the RCs to enable them to benchmark their research at the global level was a main goal of the evaluation.

The data for the evaluation consisted of the RCs’ answers to evaluation questions on supplied e-forms and a compilation extracted from the TUHAT – Research Information System (RIS) on 12 April 2011. The compilation covered scientific and other publications as well as certain areas of scientific activities. During the process, the RCs were asked to check the list of publications and other scientific activities and make corrections if needed. These TUHAT compilations are public and available on the evaluation project sites of each RC in the TUHAT-RIS.

In addition to the e-form and TUHAT compilation, University of Leiden (CWTS) carried out bibliometric analyses from the articles included in the Web of Science (WoS). This was done on University and RC levels. In cases where the publication forums of the RC were clearly not represented by the WoS data, the Library of the University of Helsinki conducted a separate analysis of the publications. This was done for 66 RCs representing the humanities and social sciences.

The evaluation office also carried out an enquiry targeted to the supervisors and PhD candidates about the organisation of doctoral studies at the University of Helsinki. This and other documents describing the University and the Finnish higher education system were provided to the panellists.

The panel feedback for each RC is unique and presented as an entity. The first collective evaluation reports available for the whole panel were prepared in July–August 2011. The reports were accessible to all panel members via the electronic evaluation platform in August. Scoring from 1 to 5 was used to complement written feedback in association with evaluation questions 1–4 (scientific focus and quality, doctoral training, societal impact, cooperation) and in addition to the category evaluating the fitness for participation in the evaluation. Panellists used the international level as a point of comparison in the evaluation. Scoring was not expected to go along with a preset deviation.

Each of the draft reports were discussed and dealt with by the panel in meetings in Helsinki (from 11 September to 13 September or from 18 September to 20 September 2011). In these meetings the panels also examined the deviations among the scores and finalised the draft reports together.

The current RC-specific report deals shortly with the background of the evaluation and the terms of participation. The main evaluation feedback is provided in the evaluation report, organised according to the evaluation questions. The original material provided by the RCs for the panellists has been attached to these documents.
On behalf of the evaluation steering group and office, I sincerely wish to thank you warmly for your participation in this evaluation. The effort you made in submitting the data to TUHAT-RIS is gratefully acknowledged by the University. We wish that you find this panel feedback useful in many ways. The bibliometric profiles may open a new view on your publication forums and provide a perspective for discussion on your choice of forums. We especially hope that this evaluation report will help you in setting the future goals of your research.

Johanna Björkroth
Vice-Rector
Chair of the Steering Group of the Evaluation

Steering Group of the evaluation
Steering group, nominated by the Rector of the University, was responsible for the planning of the evaluation and its implementation having altogether 22 meetings between February 2010 and March 2012.

Chair
Vice-Rector, professor Johanna Björkroth

Vice-Chair
Professor Marja Airaksinen
Chief Information Specialist, Dr Maria Forsman
Professor Arto Mustajoki
University Lecturer, Dr Kirsi Pyhältö
Director of Strategic Planning and Development, Dr Ossi Tuomi
Doctoral candidate, MSocSc Jussi Vauhkonen
Panel members

CHAIR
Professor Jan-Otto Carlsson
Materials science in chemistry and physics, nanotechnology, inorganic chemistry
Uppsala University, Sweden

VICE-CHAIR
Professor Jan van Leeuwen
Computer science, information technology
University of Utrecht, the Netherlands

Professor Caitlin Buck
Probability and statistics, archeology, palaeoenvironmental science
University of Sheffield, Great Britain

Professor David Colton
Mathematics, inverse problems of acoustic and electromagnetic scattering
University of Delaware, USA

Professor Jean-Pierre Eckmann
Mathematics, dynamical systems, mathematical physics
University of Geneva, Switzerland

Professor Ritske Huismans
Geosciences, geodynamics
University of Bergen, Norway

Professor Jukka Jurvelin
Medical physics and engineering
University of Eastern Finland

Professor Lea Kauppi
Environmental sciences, water research
The Finnish Environment Institute, Finland

Professor Riitta Keiski
Chemical engineering, heterogeneous catalysis, environmental technology, mass and heat transfer processes
University of Oulu, Finland

Professor Mats Larsson
Experimental molecular physics, chemical dynamics, molecular spectroscopy, astrobiology
Stockholm University, Sweden

Professor Holger Stark
Medicinal, organic and pharmaceutical chemistry, pharmacology
Johann Wolfgang Goethe Universität, Germany

The panel, independently, evaluated all the submitted material and was responsible for the feedback of the RC-specific reports. The panel members were asked to confirm whether they had any conflict of interests with the RCs. If this was the case, the panel members disqualified themselves in discussion and report writing.
Added expertise to the evaluation was contributed by the members from the other panels.

**Experts from the Other Panels**
- Professor Barbara Koch, from the Panel of Biological, Agricultural and Veterinary Sciences
- Professor Peter York, from the Panel of Medicine, Biomedicine and Health Sciences

**EVALUATION OFFICE**
- **Dr Seppo Saari, Doc.,** Senior Adviser in Evaluation, was responsible for the entire evaluation, its planning and implementation and acted as an Editor-in-chief of the reports.
- **Dr Eeva Sievi, Doc.,** Adviser, was responsible for the registration and evaluation material compilations for the panellists. She worked in the evaluation office from August 2010 to July 2011.
- **MSocSc Paula Ranne,** Planning Officer, was responsible for organising the panel meetings and all the other practical issues like agreements and fees and editing a part the RC-specific reports. She worked in the evaluation office from March 2011 to January 2012.
- **Mr Antti Molianen,** Project Secretary, was responsible for editing the reports. He worked in the evaluation office from January 2012 to April 2012.

**TUHAT OFFICE**
- **Provision of the publication and other scientific activity data**
- **Mrs Aija Kaitera,** Project Manager of TUHAT-RIS served the project ex officio providing the evaluation project with the updated information from TUHAT-RIS. The TUHAT office assisted in mapping the publications with CWTS/University of Leiden.
- **MA Liisa Ekebom,** Assisting Officer, served in TUHAT-RIS updating the publications for the evaluation. She also assisted the UH/Library analyses.
- **BA Liisa Jäppinen,** Assisting Officer, served in TUHAT-RIS updating the publications for the evaluation.

**HELSINKI UNIVERSITY LIBRARY**
- **Provision of the publication analyses**
- **Dr Maria Forsman,** Chief Information Specialist in the Helsinki University Library, managed with her 10 colleagues the bibliometric analyses in humanities, social sciences and in other fields of sciences where CWTS analyses were not applicable.
Acronyms and abbreviations applied in the report

External competitive funding
AF – Academy of Finland
TEKES - Finnish Funding Agency for Technology and Innovation
EU - European Union
ERC - European Research Council
International and national foundations
FP7/6 etc. /Framework Programmes/Funding of European Commission

Evaluation marks
Outstanding (5)
Excellent (4)
Very Good (3)
Good (2)
Sufficient (1)

Abbreviations of Bibliometric Indicators
P - Number of publications
TCS – Total number of citations
MCS - Number of citations per publication, excluding self-citations
PNC - Percentage of uncited publications
MNCS - Field-normalized number of citations per publication
MNJS - Field-normalized average journal impact
THCP10 - Field-normalized proportion highly cited publications (top 10%)
INT_COV - Internal coverage, the average amount of references covered by the WoS
WoS – Thomson Reuters Web of Science Databases

Participation category
Category 1. The research of the participating community represents the international cutting edge in its field.
Category 2. The research of the participating community is of high quality, but the community in its present composition has yet to achieve strong international recognition or a clear break-through.
Category 3. The research of the participating community is distinct from mainstream research, and the special features of the research tradition in the field must be considered in the evaluation.
Category 4. The research of the participating community represents an innovative opening.
Category 5. The research of the participating community has a highly significant societal impact.

Research focus areas of the University of Helsinki
Focus area 1: The basic structure, materials and natural resources of the physical world
Focus area 2: The basic structure of life
Focus area 3: The changing environment – clean water
Focus area 4: The thinking and learning human being
Focus area 5: Welfare and safety
Focus area 6: Clinical research
Focus area 7: Precise reasoning
Focus area 8: Language and culture
Focus area 9: Social justice
Focus area 10: Globalisation and social change
1 Introduction to the Evaluation

1.1 RC-specific evaluation reports

The participants in the evaluation of research and doctoral training were Researcher Communities (hereafter referred to as the RC). The RC refers to the group of researchers who registered together in the evaluation of their research and doctoral training. Preconditions in forming RCs were stated in the Guidelines for the Participating Researcher Communities. The RCs defined themselves whether their compositions should be considered well-established or new.

It is essential to emphasise that the evaluation combines both meta-evaluation\(^1\) and traditional research assessment exercise and its focus is both on the research outcomes and procedures associated with research and doctoral training. The approach to the evaluation is enhancement-led where self-evaluation constituted the main information. The answers to the evaluation questions formed together with the information of publications and other scientific activities an entity that was to be reviewed as a whole.

The present evaluation recognizes and justifies the diversity of research practices and publication traditions. Traditional Research Assessment Exercises do not necessarily value high quality research with low volumes or research distinct from mainstream research. It is challenging to expose the diversity of research to fair comparison. To understand the essence of different research practices and to do justice to their diversity was one of the main challenges of the present evaluation method. Understanding the divergent starting points of the RCs demanded sensitivity from the evaluators.

1.2 Aims and objectives in the evaluation

The aims of the evaluation are as follows:

- to improve the level of research and doctoral training at the University of Helsinki and to raise their international profile in accordance with the University’s strategic policies. The improvement of doctoral training should be compared to the University's policy.\(^2\)
- to enhance the research conducted at the University by taking into account the diversity, originality, multidisciplinary nature, success and field-specificity,
- to recognize the conditions and prerequisites under which excellent, original and high-impact research is carried out,
- to offer the academic community the opportunity to receive topical and versatile international peer feedback,
- to better recognize the University’s research potential.
- to exploit the University's TUHAT research information system to enable transparency of publishing activities and in the production of reliable, comparable data.

1.3 Evaluation method

The evaluation can be considered as an enhancement-led evaluation. Instead of ranking, the main aim is to provide useful information for the enhancement of research and doctoral training of the participating RCs. The comparison should take into account each field of science and acknowledge their special character.

---

\(^1\) The panellists did not read research reports or abstracts but instead, they evaluated answers to the evaluation questions, tables and compilations of publications, other scientific activities, bibliometrics or comparable analyses.

\(^2\) Policies on doctoral degrees and other postgraduate degrees at the University of Helsinki.
The comparison produced information about the present status and factors that have lead to success. Also challenges in the operations and outcomes were recognized.

The evaluation approach has been designed to recognize better the significance and specific nature of researcher communities and research areas in the multidisciplinary top-level university. Furthermore, one of the aims of the evaluation is to bring to light those evaluation aspects that differ from the prevalent ones. Thus the views of various fields of research can be described and research arising from various starting points understood better. The doctoral training is integrated into the evaluation as a natural component related to research. Operational processes of doctoral training are being examined in the evaluation.

**Five stages of the evaluation method were:**
1. Registration – Stage 1
2. Self-evaluation – Stage 2
3. TUHAT\(^3\) compilations on publications and other scientific activities\(^4\)
4. External evaluation
5. Public reporting

### 1.4 Implementation of the external evaluation

**Five Evaluation Panels**

Five evaluation panels consisted of independent, renowned and highly respected experts. The main domains of the panels are:

1. biological, agricultural and veterinary sciences
2. medicine, biomedicine and health sciences
3. natural sciences
4. humanities
5. social sciences

The University invited 10 renowned scientists to act as chairs or vice-chairs of the five panels based on the suggestions of faculties and independent institutes. Besides leading the work of the panel, an additional role of the chairs was to discuss with other panel chairs in order to adopt a broadly similar approach. The panel chairs and vice-chairs had a pre-meeting on 27 May 2011 in Amsterdam.

The panel compositions were nominated by the Rector of the University 27 April 2011. The participating RCs suggested the panel members. The total number of panel members was 50. The reason for a smaller number of panellists as compared to the previous evaluations was the character of the evaluation as a meta-evaluation. The panellists did not read research reports or abstracts but instead, they evaluated answers to the evaluation questions, tables and compilations of publications, other scientific activities, bibliometrics and comparable analyses.

The panel meetings were held in Helsinki:

- On 11–13 September 2011: (1) biological, agricultural and veterinary sciences, (2) medicine, biomedicine and health sciences and (3) natural sciences.
- On 18–20 September 2011: (4) humanities and (5) social sciences.

---

\(^3\) TUHAT (acronym) of Research Information System (RIS) of the University of Helsinki

\(^4\) Supervision of thesis, prizes and awards, editorial work and peer reviews, participation in committees, boards and networks and public appearances.
1.5 Evaluation material

The main material in the evaluation was the RCs’ self-evaluations that were qualitative in character and allowed the RCs to choose what was important to mention or emphasise and what was left unmentioned.

The present evaluation is exceptional at least in the Finnish context because it is based on both the evaluation documentation (self-evaluation questions, publications and other scientific activities) and the bibliometric reports. All documents were delivered to the panelists for examination.

Traditional bibliometrics can be reasonably done mainly in medicine, biosciences and natural sciences when using the Web of Science database, for example. Bibliometrics, provided by CWTS/The Centre for Science and Technology Studies, University of Leiden, cover only the publications that include WoS identification in the TUHAT-RIS.

Traditional bibliometrics are seldom relevant in humanities and social sciences because the international comparable databases do not store every type of high quality research publications, such as books and monographs and scientific journals in other languages than English. The Helsinki University Library has done analysis to the RCs, if their publications were not well represented in the Web of Science databases (RCs should have at least 50 publications and internal coverage of publications more than 40%) – it meant 58 RCs. The bibliometric material for the evaluation panels was available in June 2011. The RC-specific bibliometric reports are attached at the end of each report.

The panels were provided with the evaluation material and all other necessary background information, such as the basic information about the University of Helsinki and the Finnish higher education system.

Evaluation material

1. Registration documents of the RCs for the background information
2. Self evaluation material – answers to the evaluation questions
3. Publications and other scientific activities based on the TUHAT RIS:
   3.1. statistics of publications
   3.2. list of publications
   3.3. statistics of other scientific activities
   3.4. list of other scientific activities
4. Bibliometrics and comparable analyses:
   4.1. Analyses of publications based on the verification of TUHAT-RIS publications with the Web of Science publications (CWTS/University of Leiden)
   4.2. Publication statistics analysed by the Helsinki University Library - mainly for humanities and social sciences
5. University level survey on doctoral training (August 2011)
6. University level analysis on publications 2005–2010 (August 2011) provided by CWTS/University of Leiden

Background material

University of Helsinki
- Basic information about the University of the Helsinki
- The structure of doctoral training at the University of Helsinki
- Previous evaluations of research at the University of Helsinki – links to the reports: 1998 and 2005

The Finnish Universities/Research Institutes
- Finnish University system
- Evaluation of the Finnish National Innovation System
- The State and Quality of Scientific Research in Finland. Publication of the Academy of Finland 9/09.

The evaluation panels were provided also with other relevant material on request before the meetings in Helsinki.
1.6 Evaluation questions and material

The participating RCs answered the following evaluation questions which are presented according to the evaluation form. In addition, TUHAT RIS was used to provide the additional material as explained. For giving the feedback to the RCs, the panellists received the evaluation feedback form constructed in line with the evaluation questions:

1. Focus and quality of the RC's research
   - Description of
     - the RC's research focus.
     - the quality of the RC's research (incl. key research questions and results)
     - the scientific significance of the RC's research in the research field(s)
   - Identification of the ways to strengthen the focus and improve the quality of the RC’s research

The additional material: TUHAT compilation of the RC’s publications, analysis of the RC’s publications data (provided by University of Leiden and the Helsinki University Library)
A written feedback from the aspects of: scientific quality, scientific significance, societal impact, innovativeness
   - Strengths
   - Areas of development
   - Other remarks
   - Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

2. Practices and quality of doctoral training
   - Organising of the doctoral training in the RC. Description of the RC’s principles for:
     - recruitment and selection of doctoral candidates
     - supervision of doctoral candidates
     - collaboration with faculties, departments/institutes, and potential graduate schools/doctoral programmes
     - good practices and quality assurance in doctoral training
   - Identification of the ways to strengthen the practices and quality of doctoral training, and the actions planned for their development.

The additional material: TUHAT compilation of the RC’s other scientific activities/supervision of doctoral dissertations
A written feedback from the aspects of: processes and good practices related to leadership and management
   - Strengths
   - Areas of development
   - Other remarks
   - Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

3. The societal impact of research and doctoral training
   - Description on how the RC interacts with and contributes to the society (collaboration with public, private and/or 3rd sector).
   - Identification of the ways to strengthen the societal impact of the RC's research and doctoral training.

The additional material: TUHAT compilation of the RC’s other scientific activities.
A written feedback from the aspects of: societal impact, national and international collaboration, innovativeness
   - Strengths
   - Areas of development
   - Other remarks
   - Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)
4. International and national (incl. intersectoral) research collaboration and researcher mobility
   - Description of
     - the RC’s research collaborations and joint doctoral training activities
     - how the RC has promoted researcher mobility
   - Identification of the RC’s strengths and challenges related to research collaboration and researcher mobility, and the actions planned for their development.
A written feedback from the aspects of: scientific quality, national and international collaboration
   - Strengths
   - Areas of development
   - Other remarks
   - Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

5. Operational conditions
   - Description of the operational conditions in the RC’s research environment (e.g. research infrastructure, balance between research and teaching duties).
   - Identification of the RC’s strengths and challenges related to operational conditions, and the actions planned for their development.
A written feedback from the aspects of: processes and good practices related to leadership and management
   - Strengths
   - Areas of development
   - Other remarks
   - Recommendations

6. Leadership and management in the researcher community
   - Description of
     - the execution and processes of leadership in the RC
     - how the management-related responsibilities and roles are distributed in the RC
     - how the leadership- and management-related processes support
       - high quality research
       - collaboration between principal investigators and other researchers in the RC
       - the RC’s research focus
     - strengthening of the RC’s know-how
   - Identification of the RC’s strengths and challenges related to leadership and management, and the actions planned for developing the processes

7. External competitive funding of the RC
   - The RCs were asked to provide information of such external competitive funding, where:
     - the funding decisions have been made during 1.1.2005-31.12.2010, and
     - the administrator of the funding is/has been the University of Helsinki
   - On the e-form the RCs were asked to provide:
     1) The relevant funding source(s) from a given list (Academy of Finland/Research Council, TEKES/The Finnish Funding Agency for Technology and Innovation, EU, ERC, foundations, other national funding organisations, other international funding organisations), and
     2) The total sum of funding which the organisation in question had decided to allocate to the RCs members during 1.1.2005–31.12.2010.
Competitive funding reported in the text is also to be considered when evaluating this point.
A written feedback from the aspects of: scientific quality, scientific significance, societal impact, innovativeness, future significance
   - Strengths
   - Areas of development
   - Other remarks
   - Recommendations

8. The RC’s strategic action plan for 2011–2013
   - RC’s description of their future perspectives in relation to research and doctoral training.
   - A written feedback from the aspects of: scientific quality, scientific significance, societal impact, processes and good practices related to leadership and management, national and international collaboration, innovativeness, future significance
   - Strengths
   - Areas of development
9. Evaluation of the category of the RC in the context of entity of the evaluation material (1-8)

The RC’s fitness to the chosen participation category
A written feedback evaluating the RC’s fitness to the chosen participation category
- Strengths
- Areas of development
- Other remarks
- Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

10. Short description of how the RC members contributed the compilation of the stage 2 material
Comments on the compilation of evaluation material

11. How the UH’s focus areas are presented in the RC’s research?
Comments if applicable

12. RC-specific main recommendations based on the previous questions 1-11

13. RC-specific conclusions

1.7 Evaluation criteria

The panellists were expected to give evaluative and analytical feedback to each evaluation question according to their aspects in order to describe and justify the quality of the submitted material. In addition, the evaluation feedback was asked to be pointed out the level of the performance according to the following classifications:
- outstanding (5)
- excellent (4)
- very good (3)
- good (2)
- sufficient (1)

Evaluation according to the criteria was to be made with thorough consideration of the entire evaluation material of the RC in question. Finally, in questions 1-4 and 9, the panellists were expected to classify their written feedback into one of the provided levels (the levels included respective descriptions, ‘criteria’). Some panels used decimals in marks. The descriptive level was interpreted according to the integers and not rounding up the decimals by the editors.

Description of criteria levels

Question 1 – FOCUS AND QUALITY OF THE RC’S RESEARCH

Classification: Criteria (level of procedures and results)

Outstanding quality of procedures and results (5)
Outstandingly strong research, also from international perspective. Attracts great international interest with a wide impact, including publications in leading journals and/or monographs published by leading international publishing houses. The research has world leading qualities. The research focus, key research questions scientific significance, societal impact and innovativeness are of outstanding quality.

In cases where the research is of a national character and, in the judgement of the evaluators, should remain so, the concepts of “international attention” or “international impact” etc. in the grading criteria above may be replaced by “international comparability”.

10
Operations and procedures are of outstanding quality, transparent and shared in the community. The improvement of research and other efforts are documented and operations and practices are in alignment with the documentation. The ambition to develop the community together is of outstanding quality.

**Excellent quality of procedures and results (4)**

Research of excellent quality. Typically published with great impact, also internationally. Without doubt, the research has a leading position in its field in Finland.

Operations and procedures are of excellent quality, transparent and shared in the community. The improvement of research and other efforts are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of excellent quality.

**Very good quality of procedures and results (3)**

The research is of such very good quality that it attracts wide national and international attention.

Operations and procedures are of very good quality, transparent and shared in the community. The improvement of research and other efforts are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of very good quality.

**Good quality of procedures and results (2)**

Good research attracting mainly national attention but possessing international potential, extraordinarily high relevance may motivate good research.

Operations and procedures are of good quality, shared occasionally in the community. The improvement of research and other efforts are occasionally documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of good quality.

**Sufficient quality of procedures and results (1)**

In some cases the research is insufficient and reports do not gain wide circulation or do not have national or international attention. Research activities should be revised.

Operations and procedures are of sufficient quality, shared occasionally in the community. The improvement of research and other efforts are occasionally documented and operations and practices are to some extent in alignment with the documentation. The ambition to develop the community together is of sufficient quality.

**Question 2 – DOCTORAL TRAINING**

**Question 3 – SOCIETAL IMPACT**

**Question 4 – COLLABORATION**

**Classification: Criteria (level of procedures and results)**

**Outstanding quality of procedures and results (5)**

Procedures are of outstanding quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are documented and operations and practices are in alignment with the documentation. The ambition to develop the community together is of outstanding quality. The procedures and results are regularly evaluated and the feedback has an effect on the planning.

**Excellent quality of procedures and results (4)**

Procedures are of excellent quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of excellent quality. The procedures and outcomes are evaluated and the feedback has an effect on the planning.

**Very good quality of procedures and results (3)**

Procedures are of very good quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and
management are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of very good quality.

**Good quality of procedures and results (2)**

Procedures are of good quality, shared occasionally in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of very good quality.

**Sufficient quality of procedures and results (1)**

Procedures are of sufficient quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are occasionally documented and operations and practices are to some extent in alignment with the documentation. The ambition to develop the community together is of sufficient quality.

**Question 9 – CATEGORY**

Participation category – fitness for the category chosen

The choice and justification for the chosen category below should be reflected in the RC's responses to the evaluation questions 1–8.

1. The research of the participating community represents the international cutting edge in its field.
2. The research of the participating community is of high quality, but the community in its present composition has yet to achieve strong international recognition or a clear break-through.
3. The research of the participating community is distinct from mainstream research, and the special features of the research tradition in the field must be considered in the evaluation. The research is of high quality and has great significance and impact in its field. However, the generally used research evaluation methods do not necessarily shed sufficient light on the merits of the research.
4. The research of the participating community represents an innovative opening. A new opening can be an innovative combination of research fields, or it can be proven to have a special social, national or international demand or other significance. Even if the researcher community in its present composition has yet to obtain proof of international success, its members can produce convincing evidence of the high level of their previous research.
5. The research of the participating community has a highly significant societal impact. The participating researcher community is able to justify the high social significance of its research. The research may relate to national legislation, media visibility or participation in social debate, or other activities promoting social development and human welfare. In addition to having societal impact, the research must be of a high standard.

**An example of outstanding fitness for category choice (5)**

The RC's representation and argumentation for the chosen category were convincing. The RC recognized its real capacity and apparent outcomes in a wider context to the research communities. The specific character of the RC was well-recognized and well stated in the responses. The RC fitted optimally for the category.

- Outstanding (5)
- Excellent (4)
- Very good (3)
- Good (2)
- Sufficient (1)

The above-mentioned definition of outstanding was only an example in order to assist the panellists in the positioning of the classification. There was no exact definition for the category fitness.

---

5 The panels discussed the category fitness and made the final conclusions of the interpretation of it.
1.8 Timetable of the evaluation

The main timetable of the evaluation:

1. Registration  November 2010
3. External peer review  May–September 2011
4. Published reports  March–April 2012
   - University level public report
   - RC specific reports

The entire evaluation was implemented during the university’s strategy period 2010–2012. The preliminary results were available for the planning of the following strategy period in late autumn 2011. The evaluation reports will be published in March/April 2012. More detailed time schedule is published in the University report.

1.9 Evaluation feedback – consensus of the entire panel

The panellists evaluated all the RC-specific material before the meetings in Helsinki and mailed the draft reports to the evaluation office. The latest interim versions were on-line available to all the panellists on the Wiki-sites. In September 2011, in Helsinki the panels discussed the material, revised the first draft reports and decided the final numeric evaluation. After the meetings in Helsinki, the panels continued working and finalised the reports before the end of November 2011. The final RC-specific reports are the consensus of the entire panel.

The evaluation reports were written by the panels independently. During the editing process, the evaluation office requested some clarifications from the panels when necessary. The tone and style in the reports were not harmonized in the editing process. All the reports follow the original texts written by the panels as far as it was possible.

The original evaluation material of the RCs, provided for the panellists is attached at the end of the report. It is essential to notice that the exported lists of publications and other scientific activities depend how the data was stored in the TUHAT-RIS by the RCs.
2 Evaluation feedback

2.1 Focus and quality of the RC’s research

- Description of
  - the RC’s research focus
  - the quality of the RC’s research (incl. key research questions and results)
  - the scientific significance of the RC’s research in the research field(s)
- Identification of the ways to strengthen the focus and improve the quality of the RC’s research

ASPECTS: Scientific quality, scientific significance, societal impact, innovativeness

The RC’s research focus is inverse problems and in this area they are one of the best in the world. Mainly through the efforts of Lassi Päivärinta, this group has been built up from scratch until now it is a central player in this rapidly expanding field of research with members of this group regularly giving plenary talks at major conferences throughout the world. A major addition was the appointment of Matti Lassas to a professorship and the area of industrial applications was significantly strengthened by the appointment of Samuli Siltanen. The excellence of this group has been acknowledged by the fact that the RC coordinates and forms a part of the Finnish Centre of Excellence in Inverse Problems Research. Further, prof. Päivärinta heads the graduate school on inverse problems. Prof Päivärinta was awarded an ERC advanced grant in 2010.

The past five years has witnessed major breakthroughs by this group, and have taken this RC to front line of this research area. The group has a constant output of high quality, with publications in top journals.

Among the scientific achievements particularly noteworthy is the solution of the Calderon problem in two dimensions by Astala and Päivärinta which had eluded researchers for over twenty years. This theoretical result is now being implemented for practical applications by Siltanen and his co-workers. The more recent results by Matti Lassas on cloaking and invisibility has also attracted international attention with a potential for revolutionary applications.

Based on very successful recent funding (e.g. ERC grant) this research group continues to grow and develop in an exemplary fashion, and we spur the RC to keep the present focus and quality of their research. Further, in a balanced way, opening of industrial applications should also be searched, and the resources for effective developments of new applications should be verified.

On the focus and quality of the RC’s research we rank this RC as outstanding (5).

Numeric evaluation: 5 (Outstanding)

2.2 Practises and quality of doctoral training

- Organising of the doctoral training in the RC. Description of the RC’s principles for:
  - recruitment and selection of doctoral candidates
  - supervision of doctoral candidates
  - collaboration with faculties, departments/institutes, and potential graduate schools/docotoral programmes
  - good practises and quality assurance in doctoral training
  - assuring of good career perspectives for the doctoral candidates/fresh doctorates
- Identification of the RC’s strengths and challenges related to the practises and quality of doctoral training, and the actions planned for their development.
- Additional material: TUHAT compilation of the RC’s other scientific activities/supervision of doctoral dissertations

ASPECTS: Processes and good practices related to leadership and management
The relatively low throughput of doctoral students per PI can be attributed to the recent expansion of the RC. Now, the RC has a well-developed and effective program established for the recruitment, supervision and financial support of graduate students in the area of inverse problems. A stimulating research environment is provided for doctoral candidates not only by the activities within the Department but also by the interaction of the research group in the Centre of Excellence on Inverse Problems and the support given by the Inverse Problems Graduate School. An important factor in this environment is the offering of summer schools in inverse problems given periodically at different Finnish universities as well as the Inverse Days Conference held every December in Lapland.

The field of inverse problems is a truly interdisciplinary field and the RC on inverse problems has taken particular care to prepare students for positions not only in academia but also in business and industry. This is evidenced by the participation of many members from industry in the Finnish Inverse Problems Society as well as the establishment of an annual Industrial Mathematics Day by Professor Siltanen. These efforts are complimented by the RC having many ongoing projects with industrial partners which doctoral students are involved in.

As is pointed out in the material that the RC has prepared for peer review, a weakness of the doctoral program is the low number of female graduate students. The RC is aware of this problem and are taking steps to improve the situation but this will take time.

For doctoral training, the future plan is convincing. Based on this, on the practices and quality of doctoral training we rank this RC as excellent (4).

**Numeric evaluation: 4 (Excellent)**

### 2.3 The societal impact of research and doctoral training

- **Description on how the RC interacts with and contributes to the society (collaboration with public, private and/or 3rd sector).**
- **Identification of the ways to strengthen the societal impact of the RC’s research and doctoral training.**
- **Additional material: TUHAT compilation of the RC’s other scientific activities.**

**ASPECTS:** Societal impact, national and international collaboration, innovativeness

For a group based in a mathematics department, the RC on inverse problems has made a significant effort in showing concern for problems in society, particularly in the field of imaging. A noteworthy example is their development, together with the inverse research group in University of Eastern Finland, headed by Prof. J. Kaipio, of a three-dimensional dental x-ray imaging device in collaboration with Palodex Group OY. Further examples include a funded project with ForestCluster SHOK on image based quality control technology, a four dimensional x-ray imaging device currently being developed in the Industrial Mathematics Laboratory run by the RC and ongoing collaboration with the Finnish Meteorological Institute. In addition, due to the RC’s emphasis on the application of the theory of inverse problems, a number of PhD’s from this group have found employment in both the public and private sectors outside of the university environment. The RC has also made serious efforts in public outreach, taking advantage of opportunities to present itself in the Finnish media.

The above efforts are exemplary for a mathematics based research centre and hence in the area of the societal impact of research and doctoral training we rank this RC as excellent (4).

**Numeric evaluation: 4 (Excellent)**

### 2.4 International and national (incl. intersectoral) research collaboration and researcher mobility

- **Description of**
  - the RC’s research collaborations and joint doctoral training activities
• how the RC has promoted researcher mobility
• Identification of the RC’s strengths and challenges related to research collaboration and researcher mobility, and the actions planned for their development.

ASPECTS: Scientific quality, national and international collaboration

The RC on inverse problems is truly international in its research program. Strong international contacts have been established with numerous universities in the United States and Europe, most notably Professors Päivärinta and Lassas with the University of Washington and the University of Delaware and Professor Siltanen with Colorado State University. These contacts have been developed and nurtured over the years with frequent visits going to and from the RC. Of particular note here is the close connection of the RC with the group of Professor Uhlmann at the University of Washington (now at the University of California at Irvine) which has resulted in several co-advised PhD students and postdocs. In addition, the RC has been closely involved with the organization of semester programs at the Mathematical Sciences Research Institute, the Isaac Newton Institute and the Institut Mittag-Leffler which further encourages international collaboration.

Inside Finland there is regular contact through the Centre of Excellence in Inverse Problems Research. These contacts have resulted in numerous joint publications as well as co-advised PhD students.

In the area of international and national research collaboration and researcher mobility we rank the RC as outstanding (5).

Numeric evaluation: 5 (Outstanding)

2.5 Operational conditions

• Description of the operational conditions in the RC’s research environment (e.g. research infrastructure, balance between research and teaching duties).
• Identification of the RC’s strengths and challenges related to operational conditions, and the actions planned for their development.

ASPECTS: Processes and good practices related to leadership and management

The University of Helsinki is the premier university in Finland and as such the RC in inverse problems has excellent facilities including a high quality computing infrastructure, a well-equipped library and excellent administrative help. However, the discussion of this evaluation question that was provided to us did not give any details (e.g., library budget, teaching duties of members of the RC, allocation of travel funds, etc.) and so we are not able to comment further.

The RC locates the industrial mathematics laboratory, maintained by Professor Siltanen and equipped for e.g., development of 4-D X-ray imaging modality. While this lab is designed for both computational and experimental research, as well as for teaching and education, the facilities should be updated as needed to match with new needs and applications in a balanced way.

2.6 Leadership and management in the researcher community

• Description of
  • the execution and processes of leadership in the RC
  • how the management-related responsibilities and roles are distributed in the RC
  • how the leadership- and management-related processes support
    • high quality research
    • collaboration between principal investigators and other researchers in the RC
    • the RC’s research focus
    • strengthening of the RC’s know-how
  • Identification of the RC’s strengths and challenges related to leadership and management, and the actions planned for developing the processes
ASPECTS: Processes and good practices related to leadership and management

The overall leader of the RC on inverse problems is Professor Päivärinta. Professor Lassas is the leader of the Inverse Problems Graduate School and manages doctoral training in the RC, Professor Siltanen is responsible for the societal impact and industrial research collaboration issues and Dr. Ola is in charge of budgeting and financial issues. A strong point of the management structure of the RC is that every member is involved in the management related process. This means that every member gains a general knowledge of the management structure and that the overall load for any particular member in the RC is lowered, thus leaving more time for research. A sense of community is maintained by weekly meetings of the entire RC in which members of different teams discuss new ideas and open problems. A topic noted in the report of the RC for peer review is the need to have more female faculty members. The achievement of this goal would also have an impact on the doctoral program of the RC which, as previously noted, has a low number of female doctoral students.

2.7 External competitive funding of the RC

- The RCs were asked to provide information of such external competitive funding, where:
  - the funding decisions have been made during 1.1.2005–31.12.2010, and
  - the administrator of the funding is/has been the University of Helsinki
- On the e-form the RCs were asked to provide:
  1) The relevant funding source(s) from a given list (Academy of Finland/Research Council, TEKES/The Finnish Funding Agency for Technology and Innovation, EU, ERC, foundations, other national funding organisations, other international funding organizations), and
  2) The total sum of funding which the organisation in question had decided to allocate to the RCs members during 1.1.2005–31.12.2010.

Competitive funding reported in the text is also to be considered when evaluating this point.

ASPECTS: Scientific quality, scientific significance, societal impact, innovativeness and future significance

The funding record of the RC on inverse problems is commendable. In particular, during the past five years the RC has received almost five million euros from the Academy of Finland, over one million euros from the Finnish Funding Agency for Technology and Innovation, almost two million euros from the European Union and over a million euros from the Ministry of Education. Attracting this large amount of money (for a RC based in a mathematics department) is a testament to the research reputation of the RC and in turn enables the RC to strengthen the research environment of the community.

2.8 The RC’s strategic action plan for 2011–2013

- RC’s description of their future perspectives in relation to research and doctoral training.

ASPECTS: Scientific quality, scientific significance, societal impact, processes and good practices related to leadership and management, national and international collaboration, innovativeness, future significance

International collaboration will remain the main focus of the RC on inverse problems. In particular, several foreign visitors will be invited each year to visit Helsinki for a period of one to six months and members of the RC will make similar visits abroad. It is recommended that in this regard particular efforts be made to invite female visitors in the same spirit that the RC is trying to increase the number of females in the faculty and doctoral program.

The overall research direction will also remain the same. In particular the RC will continue to study both highly abstract problems as well as very practical questions related to actual measured data. The RC also plans to continue their efforts to establish strategic partnerships between the RC and private high technology companies. Given the outstanding track record of the RC in pursuing the above goals in the
past five years, maintaining this direction for 2011-2013 makes good sense and is an appropriate strategy to pursue.

We find the documented action plan outstanding.

2.9 Evaluation of the category of the RC in the context of entity of the evaluation material (1-8)

The RC’s fitness to the chosen participation category.
Category 1. The research of the participating community represents the international cutting edge in its field.

Overall the RC for inverse problems is an outstanding group and one which gives the University of Helsinki an international reputation in the field of mathematics. The presentation by the RC of their accomplishments is convincing. In some issues, such as societal achievements, it remains a bit unclear if the accomplishments are solely by the RC, or actually fully or partly contributed by other Finnish groups of Center of Excellence. Of particular note is the breadth of their research which covers both theoretical issues as well as practical applications, their active involvement in the international mathematical community and the recognition that they have received in a relatively short period of time as being the leading centre for mathematical inverse problems in the world. This is a research community for which the University of Helsinki and Finland in general can truly be proud. The RC’s fitness to the chosen participation category is outstanding (5).

Numeric evaluation: 5 (Outstanding)

2.10 Short description of how the RC members contributed the compilation of the stage 2 material

The compilation of the stage two materials was distributed among RC members so that each question was assigned to one senior member. The answers were circulated through the whole group and discussed using e-mail.

2.11 How the UH’s focus areas are presented in the RC’s research

Focus area 7: Precise reasoning

The Finnish Centre of Excellence in Inverse Problems (COE) is part of the focus area of Precise Reasoning. As documented in the previous evaluation questions, the COE plays a central role in the growth and development of the RC’s research program. Since 2005 the COE has produced over 250 peer reviewed publications and 23 PhD’s in the field of inverse problems.

2.12 RC-specific main recommendations

An effort should be made to increase the number of female faculty members and graduate students in the RC.

If not available, a detailed plan for development of industrial mathematics lab could be useful.
2.13 RC-specific conclusions

The RC on inverse problems is an outstanding research group at the University of Helsinki with an international reputation. The RC should be in research core of HU to encourage and support its future development.

2.14 Preliminary findings in the Panel-specific feedback

This RC is an example of research excellence in Finland, from a multitude of criteria. These show the international leading role of the RC. Any RC with these achievements should be in the core of HU research, and strategical support should be provided when possible also in the future.

2.15 Preliminary findings in the University-level evaluation

The significance of high international activity as demonstrated by this RC could be emphasized.
3 Appendices

A. Original evaluation material
   a. Registration material – Stage 1
   b. Answers to evaluation questions – Stage 2
   c. List of publications
   d. List of other scientific activities

B. Bibliometric analyses
   a. Analysis provided by CWTS/University of Leiden
   b. Analysis provided by Helsinki University Library (66 RCs)
NAME OF THE RESEARCHER COMMUNITY:
Inverse problems group (Inv)

LEADER OF THE RESEARCHER COMMUNITY:
Professor Lassi Päivärinta, Department of Mathematics and Statistics, Faculty of Science

RC-SPECIFIC MATERIAL FOR THE PEER REVIEW:

- Material submitted by the RC at stages 1 and 2 of the evaluation
  - STAGE 1 material: RC’s registration form (incl. list of RC participants in an excel table)
  - STAGE 2 material: RC’s answers to evaluation questions
- TUHAT compilations of the RC members’ other scientific activities 1.1.2005-31.12.2010
  (analysis carried out by CWTS, Leiden University)

NB! Since Web of Science(WoS)-based bibliometrics does not provide representative results for most RCs representing humanities, social sciences and computer sciences, the publications of these RCs will be analyzed by the UH Library
(results available by the end of June, 2011)
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI

RC-SPECIFIC STAGE 1 MATERIAL (registration form)

1 RESPONSIBLE PERSON

Name: Päivärinta, Lassi
E-mail: 
Phone: +358 9 191 51456
Affiliation: University of Helsinki
Street address: PL 68 (Gustaf Hällströmin katu 2b)

2 DESCRIPTION OF THE PARTICIPATING RESEARCHER COMMUNITY (RC)

Name of the participating RC (max. 30 characters): Inverse problems group
Acronym for the participating RC (max. 10 characters): Inv
Description of the operational basis in 2005-2010 (eg. research collaboration, joint doctoral training activities) on which the RC was formed (MAX. 2200 characters with spaces): Finnish Centre of Excellence in Inverse Problems Research is coordinated by the group. Moreover, the graduate school on inverse problems is also coordinated by the group. In addition, the research topic of inverse problems covers a wide spectrum between theory and applications, requiring teamwork.

3 SCIENTIFIC FIELDS OF THE RC

Main scientific field of the RC's research: natural sciences
RC’s scientific subfield 1: Mathematics, Applied
RC’s scientific subfield 2: --Select--
RC’s scientific subfield 3: --Select--
RC’s scientific subfield 4: --Select--
Other, if not in the list:

4 RC’S PARTICIPATION CATEGORY

Participation category: 1. Research of the participating community represents the international cutting edge in its field
Justification for the selected participation category (MAX. 2200 characters with spaces): Finnish center of excellence in inverse problems research is coordinated by the group. The responsible person is awarded by ERC Advanced grant.
5 DESCRIPTION OF THE RC’S RESEARCH AND DOCTORAL TRAINING

Public description of the RC’s research and doctoral training (MAX. 2200 characters with spaces): Inverse problems appear in several fields, including medical imaging, image processing, mathematical finance, astronomy, geophysics, nondestructive material testing and sub-surface prospecting. Inverse problems research concentrates on the mathematical theory and practical interpretation of indirect measurements. RC specializes in the theory, implementation and application of inversion methods. The objective is to create fundamentally new, efficient, and theoretically sound solutions to practical inverse problems. Doctoral students are educated on a regular basis.

Significance of the RC’s research and doctoral training for the University of Helsinki (MAX. 2200 characters with spaces): We conduct international research on applied mathematics and have strong interaction with industry. The RC conducts joint research e.g. with the ForestCluster SHOK Ltd.

Keywords: Applied mathematics, inverse problems, industrial applications

6 QUALITY OF RC’S RESEARCH AND DOCTORAL TRAINING

Justified estimate of the quality of the RC’s research and doctoral training at national and international level during 2005-2010 (MAX. 2200 characters with spaces): RC coordinates all activities of Finnish Centre of Excellence (CoE) in Inverse Problems Research. Since 2005 the CoE has produced over 250 peer-reviewed publications and 23 PhD’s. Research highlights include the complete solution of the Calderón problem in two dimensions, discovery of the accelerated rotation of asteroids due to sunlight, and construction of electromagnetic wormholes, published in venues such as Annals of Mathematics, Nature, Science and Physical Review Letters. Many of our results have been adopted by international research teams or commercialized, and several PhD’s have found positions in the industry or founded their own companies. As an example, our spin-off company Numcore was the winner of the national business plan competition Venture Cup in 2008.

Comments on how the RC’s scientific productivity and doctoral training should be evaluated (MAX. 2200 characters with spaces): We continue to publish our results in the highest level international journals. We continue to publish scientific monographs to help to spread our knowledge to younger researchers and postdocs.
# List of RC Members

**Name of the Researcher Community:** Inverse problems group

<table>
<thead>
<tr>
<th>Last Name</th>
<th>First Name</th>
<th>PI-status</th>
<th>Title of Research and Teaching Personnel</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Päivärinta</td>
<td>Lassi</td>
<td>x</td>
<td>Professor</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Lassas</td>
<td>Matti</td>
<td>x</td>
<td>Professor</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Siltanen</td>
<td>Samuli</td>
<td>x</td>
<td>Professor</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Krupchyk</td>
<td>Katya</td>
<td>x</td>
<td>University Researcher</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Ola</td>
<td>Petri</td>
<td></td>
<td>University Lecturer</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Salo</td>
<td>Mikko</td>
<td>x</td>
<td>University Researcher</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Lamberg</td>
<td>Lars</td>
<td></td>
<td>University Researcher</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Piironen</td>
<td>Petteri</td>
<td></td>
<td>Postdoctoral Researcher</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Blästen</td>
<td>Eemeli</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Laakso</td>
<td>Teemu</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Määttä</td>
<td>Matti</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Niemi</td>
<td>Esa</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Oksanen</td>
<td>Lauri</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Pohjola</td>
<td>Valter</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Vesalainen</td>
<td>Esa</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Ylinen</td>
<td>Lauri</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Haario</td>
<td>Heikki</td>
<td></td>
<td>Docent</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Tzou</td>
<td>Leo</td>
<td></td>
<td>Postdoctoral Researcher</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Määttä</td>
<td>Anu</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>Kalke</td>
<td>Martti</td>
<td></td>
<td>Doctoral candidate</td>
<td>Department of Mathematics and Statistics</td>
</tr>
</tbody>
</table>
Name of the RC’s responsible person: Päivärinta, Lassi

E-mail of the RC’s responsible person:

Name and acronym of the participating RC: Inverse Problems Research Group, INV

The RC’s research represents the following key focus area of UH: 7. Eksakti ajattelu – Exact thinking

Comments for selecting/not selecting the key focus area: According to the University of Helsinki target programme for the year 2011 to the key focus area of exact thinking (precise reasoning) encompasses, among other things, mathematics and information sciences as well as their applications in other fields. The national centres of excellence in this key focus area are the following: 1) the Finnish Centre of Excellence in Analysis and Dynamics Research, 2) the Finnish Centre of Excellence in Algorithmic Data Analysis Research, and 3) the Finnish Centre of Excellence in Inverse Problems.

The RC forms the central part of the Finnish Centre of Excellence in Inverse Problems, which is explicitly mentioned in the University of Helsinki target programme. The responsible person in RC, professor Lassi Päivärinta, is also the director of the Finnish CoE in Inverse Problems.

1 Focus and quality of RC’s research (max. 8800 characters with spaces)

- Description of the RC’s research focus, the quality of the RC’s research (incl. key research questions and results) and the scientific significance of the RC’s research for the research field(s).

Research focus

Inverse problems constitute an interdisciplinary field of science, concentrating on the mathematical theory and practical interpretation of indirect measurements. Applications are found in virtually every research field involving scientific, medical, or engineering data and mathematical modelling. The common feature is extreme sensitivity to measurement and modelling errors. Inverse problems methods make it possible to employ important advances in modern mathematics in a vast number of application areas.

The RC is the world’s leading unit in the mathematical theory of inverse problems and the implementation and application of inversion methods. Research highlights in 2005-2010 include the complete solution of the Calderón problem in two dimensions, discovery of the accelerated rotation of asteroids due to sunlight, and construction of electromagnetic wormholes, published in venues such as Annals of Mathematics, Nature, Science, and Physical Review Letters. Many of the results of the RC have been adopted by international research teams or commercialized. The research of the RC has been recognized in several ways, most recently by the ERC Advanced Grant awarded to Lassi Päivärinta in 2010. The RC also coordinates and forms a major part of the Finnish Centre of Excellence (CoE) in Inverse Problems Research, an interdisciplinary network of scientists with groups at five universities in Finland.

Inverse problems require practical inversion algorithms and efficient computational methods, and the development of these is one of our goals. However, what makes inverse problems a distinctly mathematical topic is the fact that precise mathematical analysis of the algorithms is also needed. There are two reasons for this: only a thoroughly understood algorithm is reliable, and rigorous mathematical knowledge can be transferred to different areas of application. An individual researcher can usually provide only a part of the intellectual bridge between theory, computation, practical measurement, and
interpretation of the results. Remarkably, the RC together with the CoE can deliver solutions covering the full span from theory to practice.

Quality of research
The RC operates at the forefront of international research in mathematics and its applications. The objective is to create fundamentally new, efficient, and theoretically sound solutions for real-world inverse problems. Our main application areas are medical and industrial imaging, geophysics and space research, and image processing. The methods employed in these are developed in inversion theory and mathematical techniques, including analysis, geometry, and stochastics, and in computational methods.

We briefly describe only a few sample research topics well representing the breadth, synergy, and potential of our research.

Electrical impedance tomography
The Calderón problem forms the basis for Electrical Impedance Tomography (EIT), which is an imaging modality with potential applications in biomedical imaging and nondestructive testing. Our researchers have made essential contributions to EIT. For example, the first computational EIT (D-bar) method applicable to practical finite-precision data was published by us and collaborators. In 2006 we provided a complete theoretical solution which is nowadays known as the Astala-Päivärinta method, and we are now designing correspondingly enhanced computational EIT algorithms. Similarly, we will develop efficient computational approaches based on our theoretical results on shape-deforming reconstruction.

Four-dimensional X-ray tomography
In previous work we have shown that three-dimensional X-ray imaging is feasible using only 5–10 directions of projection data. This can be expanded to four dimensions (time development) by placing 5–10 X-ray sources and the same number of flat panel X-ray detectors around the. This arrangement represents a new kind of tomographic device capable of imaging of the beating heart, enhanced angiography, and small animal imaging in biology and veterinary medicine. The research will consist of equipping the previous three-dimensional reconstruction methods with regularization in time evolution and finding computationally efficient solution methods by using Bayesian inversion and the level set method. We will obtain the test data in the Industrial Mathematics Laboratory run by the RC.

Visibility and invisibility
Since 2005 there has been a wave of serious theoretical proposals in the physics literature as well as tentative physical experiments for cloaking devices - structures that not only make an object invisible but also undetectable to electromagnetic waves, thus making it cloaked. Developing realistic invisibility cloaks requires the study of inverse problems for degenerate materials such as superconductors, and involves a surprising tunneling effect in classical electrodynamics. International collaboration is rapidly increasing in this new field where progress not only leads to the development of new invisibility cloaks, but also to other electromagnetic and acoustic devices such as field concentrators, field rotators, and electromagnetic holograms. Our objective is to push the known visibility results beyond physical materials into the exotic regime, with the goal of obtaining a complete characterization of the borderline between visibility and invisibility.

Scientific significance
The RC has made breakthrough contributions in many areas in inverse problems, both theoretical and computational. As examples we mention again the complete solution of the Calderón problem in two dimensions [Astala-Päivärinta, Annals of Mathematics 2006], discovery of the accelerated rotation of
asteroids due to sunlight [Kaasalainen et al., Nature 2007], and construction of electromagnetic wormholes [Lassas et al., Physical Review Letters 2007].

The work of the RC has been published and widely reported in international top mathematical journals (Annals of Mathematics, Duke Mathematical Journal, Inventiones Mathematicae), applied mathematics journals (SIAM journals SIAP, SICON, SIMA, SIREV, SISC), top science journals (Nature, Science, Physical Review Letters) as well as in international media (works of Kaasalainen and Lassas in BBC, CNN, New York Times, Scientific American, National Geographic). The ERC Advanced Grant awarded to Lassi Päivärinta in 2010 is a major recognition for the RC. This is the fourth such grant for physical sciences and engineering in Finland. Matti Lassas was awarded the Calderón prize of the Inverse Problems International Association in 2007, the first time this prize was given out. His work on invisibility was quoted when the AMS Bôcher prize in 2011 was awarded to Gunther Uhlmann, a long time collaborator of the RC.

The Finnish Centre of Excellence (CoE) in Inverse Problems Research, coordinated by the RC, is strongly interdisciplinary in its wide range of applications studied with the common mathematical methodology of inversion theory. Typical application fields under one mathematical umbrella are medical imaging, remote sensing, geophysical prospecting, image processing, quantum scattering, finance, astronomy, and process monitoring and control. Also, the selection of mathematical techniques employed in the research is quite varied, including aspects of geometry, stochastics, analysis, numerical analysis, and functional analysis. The task force is unique in the global inverse problems research community: while making use of a wide range of mathematical tools in various applications, significant theoretical advances have been made in inverse problems in each of these fields as well.

- Ways to strengthen the focus and improve the quality of the RC's research.

The RC will pay special attention to researcher training and the careers of young scientists. We strongly encourage mobility of researchers between different universities in Finland and also internationally. For the details, we refer to section 2.

One of our central aims is to increase general awareness of inverse problems. In the scientific community, our purpose is to help researchers in both academia and industry to recognize an inverse problem when they encounter one, and encourage them to turn to the RC for assistance. Also, to increase inverse problems awareness, generally accessible textbooks will be written helping to reduce the use of suboptimal methods in applications. Such a monograph is under preparation by J. Mueller and S. Siltanen.

### 2 Practises and Quality of doctoral training (max. 8800 characters with spaces)

- How is doctoral training organised in the RC? Description of the RC’s principles for recruitment and selection of doctoral candidates, supervision of doctoral candidates, collaboration with faculties, departments/institutes, and potential graduate schools/doctoral programmes, good practises and quality assurance in doctoral training, and assuring good career perspectives for the doctoral candidates/fresh doctorates.

The RC pays special attention to researcher training and the careers of young scientists. The research training is organized in a close collaboration with two national networks: the Center of Excellence on Inverse Problems Research (CoE) funded by Academy of Finland and the Inverse problems graduate school (IPGS), a doctoral programme funded by the Ministry of Education. Several postgraduate students are also supported by the Finnish doctoral programme in computational sciences (FICS).
Recruitment and selection of doctoral candidates

The positions of graduate students and postdoctoral researchers are filled by using scientific competence as the primary criterion. In filling the positions equal opportunities are given to all students independent of gender, nationality, ethnic origin, or disability. The openings will be advertised internationally, for example in the mathjobs.org server, the EMS bulletin, the web pages of the Inverse Problems International Association, and the inverse problems net newsletter.

Supervision of doctoral candidates

To ensure successful supervision of graduate studies, we pay special attention on the practices of the supervision. The meetings of graduate students and supervisors are held on regular basis. In particularly, we ensure that the students get involved in the wider research community, find stable financial support during the graduate studies, and finally help them in finding a position after graduation, either in postdoctoral positions in academia or jobs in industry.

Collaboration with other departments and doctoral programmes

We strongly encourage mobility of researchers both between different sites of CoE on Inverse Problems research in Finland and also internationally. There are several regular venues, such as summer schools, lecture series, and the Inverse Days conference organized every December, where students and postdocs studying inverse problems from all around Finland come together and have the opportunity to meet and exchange ideas. On the international level, substantial long-term visits in partner universities have been routine events in the careers of our postdocs. In the future, this trend will be pushed even further by systematically arranging shorter visits in top universities already in the postgraduate phase.

Good practices and quality assurance in doctoral training

All of our graduate students are members of one of the above mentioned graduate schools. The boards of the graduate schools have quality control of theses by systematic supervision procedures where the graduate students produce progress reports at regular intervals. Feedback from students about the supervision methods and working conditions is also collected.

Assuring good career perspectives

Careful attention is paid to realistic and focused PhD thesis plans. In particular, special attention is paid to the planning of the graduate education so that the student has good possibilities to pursue an industrial career after graduation if this is his/her intention. A part of this planning is the graduate student's participation in small-scale projects in industry. An internal website dedicated to career advice for postgraduate students and postdocs has been in function since 2006, and this website will be continued and expanded. In the genuinely interdisciplinary field of inverse problems, and also acknowledging the fact that not all postgraduate students or postdocs can find positions in Finnish universities, we encourage a broad spectrum of career paths in the academia, business, and industry. For example, the Finnish Inverse Problems Society has numerous members from the industry (GE Healthcare, Elekta Neuromag, Palodex Group, Vaisala, and our spinoff companies) and from research institutes (Finnish Meteorological Institute) that have high visibility in the annual Inverse Days conference. We also have the annual Industrial Mathematics Day, organized by prof. S. Siltanen, where representatives of companies interact with university students and researchers.
RC’s strengths and challenges related to the practises and quality of doctoral training, and the actions planned for their development.

Strengths: RC has close collaboration with all main international research groups working on inverse problems and related areas. Also, we have many ongoing projects with industrial partners. This makes it possible to train PhD’s who are able to transfer their expertise to industry and research laboratories, and to train a new generation of researchers who are able to take the research within inverse problems into new areas. As an example, several of our graduate students and postdocs have paid long-term visits (ranging from three months to one year) to international centres of inverse problems research in the US, the UK and Japan.

Challenges: Equal opportunities in employment and the role of female researchers are actively taken into consideration in RC. This action has met with moderate success: At this moment we have only few female graduate students. We are working hard on improving the situation. As part of this, our CoE has maintained a webpage “Opportunities for Women” and has invited female mathematicians to give lectures.

Description of how the RC interacts with and contributes to the society (collaboration with public, private and/or 3rd sector).

Professor Päivärinta shapes Finnish science policy as a member of the Research Council for Natural Sciences and Engineering of the Academy of Finland.

The societal impact of inverse problems research stems from novel technology for interpreting indirect measurements. For example, the RC developed in 2001-2008 a new-generation three-dimensional dental X-ray imaging device in collaboration with its manufacturer, Palodex Group OY.

Within the next 5-10 years, there will be several breakthroughs. (1) Image-based quality control technology developed with funding from ForestCluster SHOK will find applications in papermaking industry through Metso Automation. (2) A new four-dimensional X-ray imaging modality will be developed in the Industrial Mathematics laboratory, finding applications in non-destructive testing and veterinary medicine. (3) Joint research with Finnish Meteorological Institute improves weather forecasts. (4) Shape-deforming reconstruction in electrical impedance tomography paves the way for harmless monitoring of heart and lungs in intensive care units in hospitals. (5) Enhanced glottal inverse filtering enables speech prostheses with emotional voice.

Within the next 10-20 years, more long-term technological applications will be introduced. The invisibility studies of the RC lead to new cloaking materials, with uses in creating invisible fiber optic cables as components for optical computers, and also scopes for MRI imaging devices. A hybrid medical imaging modality will be commercialized, based on electrical excitation and thermal boundary measurements.

PhD’s from the RC have found positions in the public sector (National Institute for Health and Welfare) and in the private sector (financial and insurance: Varma and OP Bank). Also, technology companies make use of the teaching of the RC; for example engineers of GE Healthcare Finland took part in the RC’s international Summer school on computational inversion in 2010.
Public outreach is important; the RC’s research has been widely reported in national and international media (e.g. Aamulehti 26.8.2009). Also, the RC organizes Industrial Mathematics Day twice a year.

- **Ways to strengthen the societal impact of the RC’s research and doctoral training.**

  General awareness of inverse problems will be increased by intensifying the publication of articles aimed at general audiences and industrial research and development engineers. This helps people in application areas recognize a inverse problems when they encounter them, and turn to the RC for assistance. Also, a generally accessible academic textbook is under preparation by professor Siltanen, with expected publication in the end of 2011.

  New PhD's with interest in applications will be encouraged to find positions in private companies (the extensive industrial contact network of the RC is helpful here). Computational inversion techniques provide engineers with a novel toolbox for solving problems by algorithmic means instead of mechanical or electronic solutions. These new tools enable efficient and environment-friendly new products.

- **Description of the RC’s research collaborations and joint doctoral training activities and how the RC has promoted researcher mobility.**

  The RC is a remarkably international unit in terms of its broad research programme. The network of international contacts is extensive and covers top-level universities all around the world, and collaboration with international coauthors is routine procedure in all of the teams in the unit. Of the many international collaborators, we only mention here a number of universities where the RC has a long-standing connection:

  - University College London (Y. Kurylev)
  - Tsukuba University (H. Isozaki)
  - University of Toronto (A. Nachman)
  - Colorado State University (J. Mueller)
  - Rensselaer Polytechnic Institute (D. Isaacson)
  - University of Chicago (C. Kenig)
  - University of Delaware (D. Colton)
  - University of Rochester (A. Greenleaf)
  - University of Washington and University of California, Irvine (G. Uhlmann)

  Researcher mobility is carried out via frequent visits or longer stays at collaborating universities and at conferences. An example of strategic international collaboration is the RC’s role in organizing three semester programmes in inverse problems at distinguished mathematical institutes around the world. Several researchers from the RC are participants in these programmes at Mathematical Sciences Research Institute (Berkeley, USA, 2010), Isaac Newton Institute (Cambridge, UK, 2011), and Institut Mittag-Leffler (Stockholm, Sweden, 2013). We remark that the only person besides Lassi Päivärinta who belongs to the organizing committees of all three programmes is Gunther Uhlmann, an internationally leading researcher in theoretical inverse problems. The RC has a particularly close connection with the...
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI

**RC-SPECIFIC STAGE 2 MATERIAL**

The national collaboration of the RC is naturally organized via the Centre of Excellence (CoE) in Inverse Problems Research, with groups at Aalto University, Lappeenranta University of Technology, University of Eastern Finland, University of Oulu, and Sodankylä Geophysical Observatory. The inverse problems group at the Tampere University of Technology also takes part in the activities of the CoE. The collaboration between the RC and other groups in the CoE rests on a solid basis, with joint publications and researcher mobility (also co-advised PhD students) between the groups occurring frequently. Our joint doctoral training activities and related researcher mobility are described in more detail in item 2. The RC has strategic national collaboration with the national strategic centre (SHOK) Forestcluster, joint research projects with the Finnish Centres of Excellence in Analysis and Dynamics Research and in Systems Neuroscience and Neuroimaging, and project work with the Finnish Meteorological Institute. Our close connection with two national centres of excellence is particularly important in broadening our project repertoire as well as in exporting the inverse problems know-how to other significant networks.

- **RC’s strengths and challenges related to research collaboration and researcher mobility, and the actions planned for their development.**

  The interdisciplinary nature of inverse problems is both a strength and a challenge for research collaboration. Moreover inverse problems draw on different areas of mathematics including branches of analysis, probability theory, scientific computing, statistics, etc. This gives excellent opportunities for transfer of ideas and researcher mobility.

  The RC plans to take full advantage of these opportunities. Our goal is to bring together leading researchers from both the pure and applied sides of inverse problems and to encourage their collaboration. We also want to disseminate new breakthroughs and problems throughout the inverse problems community.

  To achieve these goals, the RC will actively invite foreign researchers to Helsinki for long stays and the members of the RC will make similar visits abroad. Moreover the RC will organize, with foreign colleagues, long term programs on inverse problems in top scientific centers where the right people are brought together. Accessible textbooks will be written to facilitate transfer of ideas. For the details, we refer to sections 4.1 and 8.

**5 OPERATIONAL CONDITIONS (MAX. 4400 CHARACTERS WITH SPACES)**

- **Description of the operational conditions in the RC’s research environment (e.g. research infrastructure, balance between research and teaching duties).**

  Operating at the leading university in the country, the RC enjoys modern facilities, including a top quality computing infrastructure, well-equipped libraries, and efficient administrative services.

  The Inverse Problems group at the university is identified as a key research center of international importance, and as such it has recently played a leading role in organizing three semester programs in Inverse Problems at distinguished mathematical institutes around the world. Many researchers from the RC have participated in the program at the Mathematical Sciences Research Institute (Berkeley, USA, 2010), and further participation is planned for the programs at the Isaac Newton Institute (Cambridge, UK, 2011), and the Institut Mittag-Leffler (Stockholm, Sweden, 2013).
The RC is part of the Finnish Center of Excellence in Inverse Problems Research, headed by Lassi Päivärinta. The Academy of Finland, which is an expert organisation in research funding and science policy, assigned this Center of Excellence to the inverse problems consortium in Finland for the period 2006-2011. Lassi Päivärinta is also the head of Graduate School in Inverse Problems with five government funded doctoral student positions and with approximately 25 doctoral students as a whole.

The RC has numerous international and domestic collaborators at universities and in industry, many of them longstanding. In particular, numerous scientific visits longer than a month were made abroad by the researchers of the RC, and the visits from both international leading experts, as well as young bright researchers, were hosted. The list of international visitors is impressive and includes G. Uhlmann (University of Washington, USA), Y. Kurylev (UCL, UK), D. Colton (University of Delaware, USA), and C. Guillarmou (ENS, France). All the members of the RC are strongly linked to each other and have several projects in common. The guiding principle of the RC is to produce significant added value from this strong scientific cohesion.

The members of the RC regularly have teaching duties across a broad range of topics in pure and applied mathematics, in the form of seminars and advanced courses.

- **RC’s strengths and challenges related to operational conditions, and the actions planned for their development.**

  The strengths of the RC include the ability to bring together people working on different aspects of inverse problems to appraise the current status of developments and to encourage interaction between mathematicians and scientists working directly with the applications. We have been successful in attracting talented young mathematicians to this field and in introducing them to the main problems, so that they will be able to contribute to our further progress.

  Our challenges are concerned with continuing to increase the number of international students and postdocs and the general mobility of researchers (especially students and postdocs), with bringing together leading researchers from both the pure and applied side of inverse problems, and with encouraging interdisciplinary collaboration. We also aim to increase the awareness of new mathematical breakthroughs to the applied mathematical community and to bring interesting new problems to the attention of the theoreticians and help define mathematical structures yet to be understood.

---

### Leadership and Management in the Researcher Community (Max. 4400 Characters with Spaces)

- **Description of the execution and processes of leadership in the RC, how the management-related responsibilities and roles are distributed in the RC and how the leadership- and management-related processes support high quality research, collaboration between principal investigators and other researchers in the RC, the RC’s research focus and strengthening of the RC’s know-how.**

  Responsible person of the research community is professor Lassi Päivärinta. Päivärinta leads a theoretical team comprising 2 senior researchers, 3 postdocs, and 3 PhD students as well as the Finnish CoE of Inverse Problems Research. The research community has two other professors. Professor Matti Lassas is a versatile researcher whose team, consisting of 1 senior researcher, 1 postdoc and 3 PhD students. Professor Samuli Siltanen leads a team of 2 postdocs and 3 PhD students.
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI

RC-SPECIFIC STAGE 2 MATERIAL

The overall leader and main hub of the RC is professor Päivärinta. Most of the connections to and from the RC goes thru him. He makes the initial assessment of the resources needed to fulfilling the requests. However, most of the typical management responsibilities have been distributed, so that one person does not have to take responsibility for everything.

Professor Lassas is the leader of the Inverse Problems Graduate School and manages doctoral training in the RC.

Professor Samuli Siltanen is professor in industrial mathematics and he his responsible for the societal impact and industrial research collaboration issues. The role is naturally suited since Siltanen has an extensive experience in industrial medical imaging, based on his earlier career at GE Healthcare and continued collaboration with GE Healthcare and Palodex Group.

The budgeting and financial issues in the RC go thru docent Petri Ola. The other senior researchers and postdocs take part in application preparations, reporting and general project issues. Every PhD student in the RC assist the leaders and second level in the running issues connected with the management processes.

The natural flow of responsibility distribution removes the management load from higher up in the RC. The faster execution of smaller management related tasks support high quality research by releasing more time for research from the leadership processes. The natural flow follows the already established collaboration chains between principal investigators and other researchers and creates trust between collaborators. Every member of RC is involved in management related processes, thus every member in the RC gains general knowledge of management processes. This can lead to new initiatives to reduce the load further.

The RC is in a period of expansion due to recent increases in external funding. A stable team structure will be established by creating teams comprising a senior researcher as a leader, 1-2 postdoctoral scholars, 2-5 graduate students and 2-5 undergraduate students.

The management strategy of the RC is to choose state-of-the-art research topics to every team. The topics are chosen such that in the long-term they link together to form major breakthroughs in the research field.

Interaction between the teams is and will be very intensive, driven by a research seminar and frequent joint projects crossing team boundaries. Know-how is spread over the RC with weekly gatherings, in which, the members of different teams discuss new ideas and open problems. This effectively eliminates time spent on working with solved problems and enables solution of new problems with known strategies.

**RC’s strengths and challenges related to leadership and management, and the actions planned for developing the processes.**

The main strength of the distributive management in RC is that leaders are very experienced and they can quickly allocate the time and needed resources for tasks that are not immediately connected with the research.

The distributive management is possible since the leaders can trust that every member in RC will carry their share of the responsibilities they are given. This enables fast reactions and for instance can shorten
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI

RC-SPECIFIC STAGE 2 MATERIAL

the data handling and reporting times immensely. Also the overall load for any particular member in RC is lowered and this leaves more time for research for the RC members.

One management challenge is skewness of sex distribution in the RC. To overcome this challenge the RC is actively balancing the distribution with its recruiting policy.

### 7 EXTERNAL COMPETITIVE FUNDING OF THE RC

- **Listing of the RCs external competitive funding, where:**
  - the funding decisions have been made during 1.1.2005-31.12.2010, and
  - the administrator of the funding is/has been the University of Helsinki

- **Academy of Finland (AF)** - total amount of funding (in euros) AF has decided to allocate to the RC members during 1.1.2005-31.12.2010: **4730000**

- **Finnish Funding Agency for Technology and Innovation (TEKES)** - total amount of funding (in euros) TEKES has decided to allocate to the RC members during 1.1.2005-31.12.2010: **1170000**

- **European Union (EU)** - total amount of funding (in euros) EU has decided to allocate to the RC members during 1.1.2005-31.12.2010: **0**

- **European Research Council (ERC)** - total amount of funding (in euros) ERC has decided to allocate to the RC members during 1.1.2005-31.12.2010: **1800000**

- **International and national foundations** – names of international and national foundations which have decided to allocate funding to the RC members during 1.1.2005-31.12.2010, and the amount of their funding (in euros).
  - names of the foundations: -
  - total amount of funding (in euros) from the above-mentioned foundations: **0**

- **Other international funding** - names of other international funding organizations which have decided to allocate funding to the RC members during 1.1.2005-31.12.2010, and the amount of their funding (in euros).
  - names of the funding organizations: -
  - total amount of funding (in euros) from the above-mentioned funding organizations: **0**

- **Other national funding** (incl. EVO funding and Ministry of Education and Culture funded doctoral programme positions) - names of other national funding organizations which have decided to allocate funding to the RC members during 1.1.2005-31.12.2010, and the amount of their funding (in euros).
  - names of the funding organizations: **Ministry of Education**
  - total amount of funding (in euros) from the above-mentioned funding organizations: **1200000**

### 8 RC’S STRATEGIC ACTION PLAN FOR 2011–2013 (MAX. 4400 CHARACTERS WITH SPACES)

- **Description of the RC’s future perspectives in respect to research and doctoral training.**

The RC is in a period of expansion due to recent increases in external funding (Academy of Finland projects, ERC Advanced Grant). It is now clear that a critical mass is achieved in the RC for intensive and
productive inverse problems research activity. A stable team structure will be established by creating teams comprising a senior researcher as a leader, 1-2 postdoctoral scholars, 2-5 graduate students and 2-5 undergraduate students. Interaction between the teams is and will be very intensive, driven by a research seminar and frequent joint projects crossing team boundaries.

International collaboration remains as the main focus of the RC. In 2011 we organize a Finnish-Japanese-Korean conference in Helsinki and take part in organizing theme years in 2011 Isaac Newton Institute (Cambridge) and in 2013 in Mittag-Leffler Institute, and the SIAM Imaging Science conference in 2012. Several foreign researchers (ranging in expertise from graduate student to professor) will be invited each year to visit Helsinki for a period of 1-6 months. Likewise, the members of the RC will make similar visits abroad. This activity keeps the idea pool fresh and helps maintaining the focus of research in the most interesting problems.

The strategy of the RC in choosing and prioritizing research topics remains the same as thus far. Namely, the efforts of the RC are actively spread out according to two separate conceptual axis.

One axis connects theory and applications. It is in the heart of the scientific approach of the RC to study both highly abstract problems and very practical questions related to actual measured data, always keeping in mind a “fast track” of ideas from theory to practice and vice versa. The RC will continue to answer mathematical uniqueness questions as well as to collect and interpret photographic and tomographic data.

Another axis is between mid-term and long-term research goals. On the other hand, we work with topics that are expected to yield working prototypes of novel measurement devices within a year or two and possible commercialization within a 5 year period. Also, some of the theoretical research goals can be reasonably expected to be solved before year 2013. However, we keep in mind long-term goals as well, related for example to blueprints of meta-materials whose production is not yet in sight, or to algorithms that may be inefficient now but will change computational science when computers develop for another 15 years.

There are also some fundamental programmes related to inverse problems research that have been either initiated or significantly advanced by the RC. One example is the use of nonlinear Fourier transforms and complex geometric optics. This methodology has proven extremely fruitful in both theoretical and practical studies of nonlinear inversion. We believe that proper utilization of these techniques has barely started, and many scientific rewards await in their future.

Another long-term programme is Bayesian inversion, which provides a flexible and powerful paradigm for the interpretation of indirect measurements. We will keep providing new theorems and algorithms and practical application cases, which will all promote and enhance the use of Bayesian inversion in practice. It is already clear that medical imaging, weather forecasts, estimation of tropical carbon sinks, and image processing will all be greatly advanced by the use of Bayesian inversion.

The RC will keep these two programmes in mind all the time and contributes to them either directly or as a by-product of shorter-term research work.

Strategic partnerships between the RC and private high-technology companies will be strengthened further. In addition to ongoing joint projects, new funding will be actively applied for. One important tool is a systematic quest for Master’s thesis, whose topics come from industry. Several companies, including Sandvik and Thinglink, have contacted the RC and offered thesis topics. Application-oriented
new PhD’s will be supported in looking for jobs in industry, leading in new collaborations in the future. It is the goal of the industrial strategy of the RC to promote the use of new computational inversion methods as alternatives to expensive and environmentally problematic engineering solutions.

The compilation of the stage 2 materials was distributed among RC members so that each question was assigned to one senior member. The answers were circulated through the whole group and discussed using email.

The responsible persons were
Mikko Salo: questions 1 and 4,
Matti Lassas: question 2,
Samuli Siltanen: 3 and 8,
Katya Krupchyk: 5,
Lassi Päivärinta: 6 and 7.
### 1 Analysis of publications

Field: Inv/Päivärinta


<table>
<thead>
<tr>
<th>Publication type</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>Total Count 2005 - 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Refereed journal article</td>
<td>8</td>
<td>13</td>
<td>12</td>
<td>8</td>
<td>9</td>
<td>12</td>
<td>62</td>
</tr>
<tr>
<td>A2 Review in scientific journal</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>A3 Contribution to book/other compilations (refereed)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>A4 Article in conference publication (refereed)</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>B1 Unrefereed journal article</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>D1 Article in professional journal</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>
2 Listing of publications

A1 Refereed journal article

2005

2006

2007
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI

RC-SPECIFIC TUHAT COMPILATIONS OF PUBLICATIONS DATA 2005-2010

Inv/Päivärinta


2009


2010
Inv/Päivärinta


2006


2007


2010


Inv/Päivärinta

B1 Unrefereed journal article

2008

D1 Article in professional journal

2005

2006

2007
1 Analysis of activities 2005-2010

<table>
<thead>
<tr>
<th>Activity type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor or co-supervisor of doctoral thesis</td>
<td>3</td>
</tr>
<tr>
<td>Prizes and awards</td>
<td>1</td>
</tr>
<tr>
<td>Editor of research journal</td>
<td>8</td>
</tr>
<tr>
<td>Peer review of manuscripts</td>
<td>7</td>
</tr>
<tr>
<td>Membership or other role in national/international committee, council, board</td>
<td>8</td>
</tr>
<tr>
<td>Membership or other role in public Finnish or international organization</td>
<td>3</td>
</tr>
<tr>
<td>Participation in interview for written media</td>
<td>2</td>
</tr>
</tbody>
</table>
2 Listing of activities 2005-2010

Supervisor or co-supervisor of doctoral thesis
Lassi Päivärinta,

Matti Lassas,
Supervisor of doctoral thesis, Matti Lassas, 2005, Finland
Supervisor of doctoral thesis, Matti Lassas, 2010, Finland

Prizes and awards
Matti Lassas,
Calderon prize, Matti Lassas, 2007, United States

Editor of research journal
Lassi Päivärinta,
Journal of Inverse and Ill-posed problems, Lassi Päivärinta, 01.01.2005 → 31.12.2005

Matti Lassas,
Inverse Problems and Imaging, Matti Lassas, 2006 → ..., United States
Journal of Mathematical Biology, Matti Lassas, 2010 → 2011

Mikko Samuli Siltanen,
International Journal of Mathematics and Computer Science, Mikko Samuli Siltanen, 2006 → ..., Lebanon

Mikko Salo,
Inverse Problems, Mikko Salo, 01.01.2007 → 31.12.2007
Inverse Problems, Mikko Salo, 01.01.2008 → 31.12.2008
Inverse Problems and Imaging, Mikko Salo, 01.01.2008 → 31.12.2008

Peer review of manuscripts
Mikko Salo,
Reviewer for Inverse Problems, Mikko Salo, 2007
Reviewer for Inverse Problems, Mikko Salo, 2008
Reviewer for Inverse Problems and Imaging, Mikko Salo, 2008
Reviewer for Inverse Problems and Imaging, Mikko Salo, 2009
Reviewer for Journal of Mathematical Analysis and Applications, Mikko Salo, 2009
Reviewer for Journal of the American Mathematical Society, Mikko Salo, 2009

Membership or other role in national/international committee, council, board
Matti Lassas,
Finnish Inverse Problems Society (FIPS), Matti Lassas, 2004 → 2010, Finland
Graduate school on applied Electromagnetism (National graduate school), Matti Lassas, 2004 → 2008, Finland
Inverse problems graduate school, Matti Lassas, 2004 → 2009, Finland
Finnish Mathematical Society, Matti Lassas, 2005 → ..., Finland
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI

RC-SPECIFIC TUHAT COMPILATIONS OF OTHER SCIENTIFIC ACTIVITIES 2005-2010

Inv/Päivärinta

Inverse Problems International Association (IPIA), Matti Lassas, 2007 → 2010, United States
Inverse Problems International Association (IPIA), Matti Lassas, 2009 → ..., United States
Inverse Problems International Association (IPIA), Matti Lassas, 2010 → ..., United States
Inverse problem graduate school (National doctoral programme), Matti Lassas, 2010 → ...

Membership or other role in public Finnish or international organization
Matti Lassas,
Inverse Problems Center of Excellence of the Academy of Finland, Matti Lassas, 2006 → ..., Finland
Doctoral program in Inverse Problems (National graduate school), Matti Lassas, 2010 → ..., Finland
Inverse problems graduate school, Matti Lassas, 2010 → ...

Participation in interview for written media
Petteri Piiroinen,
Yliopisto -lehti (12/2005) s. 48, Petteri Piiroinen, 01.01.2005 → 31.12.2011, Finland
Research Group: Päivärinta L

Basic statistics
Number of publications (P)  60
Number of citations (TCS)  327
Number of citations per publication (MCS)  5.45
Percentage of uncited publications 27%
Field-normalized number of citations per publication (MNCS)  3.50
Field-normalized average journal impact (MNJS)  1.85
Field-normalized proportion highly cited publications (top 10%)  4.10
Internal coverage .63

Trend analyses

Collaboration

Performance (MNCS) by collaboration type
INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING
AT THE UNIVERSITY OF HELSINKI
by CWTS, Leiden University, the Netherlands

Research profile

<table>
<thead>
<tr>
<th>Category</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATHEMATICS, APPLIED</td>
<td></td>
</tr>
<tr>
<td>MATHEMATICS</td>
<td></td>
</tr>
<tr>
<td>PHYSICS, MATHEMATICAL</td>
<td></td>
</tr>
</tbody>
</table>

Threshold: P ≥ 2