KoF/ÖB 2024

Faculty of Science and Technology

Research Program Self-Evaluation

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| Research Program: | Instrumentation and Accelerators |
| Department: | Department of Physics and Astronomy |
| Section: | Physics |
| Program Responsible Professor: |  |

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| **Goals:**   * Maintain and strengthen our **research quality**   + Through program and department self-reflection on strengths and weaknesses   + Through developing program and department priorities for the next 5 years   + Through internal and external feedback on our performance and plans * Strengthen our **collegial culture**   + By involving all research staff in the process and ensuring everyone is aware of the results   + By being respectful of everyone’s time at the faculty, department, and program levels   + By communicating clearly as to why we are doing this and how we expect everyone to contribute * Improve our **internal understanding**   + By collecting information on the different ways programs and departments are funded and operate   + By collecting explanations of why we work that way and how it supports our research * Improve our **resource usage**   + By generating bottom-up prioritized research plans at the program, department, section, and faculty-levels   + By allocating and re-allocating resources based our priorities and the potential to significantly improve research   + By identifying opportunities for intra- and inter-program/department/section collaboration and re-organization |

**Introduction**

Be sure to regularly [check the faculty KoF24 and ÖB webpage](https://www.uu.se/medarbetare/fakultet/teknisk-naturvetenskapliga/utvardering-av-fakultetens-forskning---kof) for updates, clarifications, details, timelines, and answers to common questions.

**Background on KoF and ÖB**

This evaluation combines two processes: the university-wide Quality and Renewal (KoF) process and the faculty-level Review of Base Financing (ÖB). These are being combined to avoid significant duplication of effort. However, they have different goals which makes combining them a challenge. For example, the first three goals above are KoF-focused while the last is ÖB-focused. Most importantly, KoF is a reflective process where we strive to identify both our strengths and weaknesses, while ÖB is an evaluative process where we strive to identify the best opportunities for using our resources.

This causes an inherent concern: will admitting to weaknesses in KoF make us less likely to get resources from ÖB? While there is no way to completely eliminate this concern, this evaluation has been designed with the ÖB portion focusing on identifying Priorities to improve/strengthen/broaden research while the KoF portion focuses primarily on reflecting on our processes.

This provides the ability to be open about weaknesses while ensuring prioritization of high-quality ideas, as

1. Using Priorities allows us to identify concrete opportunities to improve our research, thereby allowing reflection on not just where we are currently excellent but where we can become better, and,
2. Using an internal, bottom-up prioritization process at the program, department, section, and faculty-levels allows us to identify the most promising and high-quality proposal for potential funding at each level.

**Expectations**

There is understandably a strong focus on the “new” funds that will be allocated as part of the ÖB process. However, these funds are small in comparison to the yearly budget, and the Faculty strongly encourages everyone to look to the four goals listed on the first page for the main value of this process. Please be aware that this report will be a public document and will be placed on the faculty website for all employees to access.

**Time period**

This evaluation pertains to the period since the last evaluation: 2019-2023 inclusive. Descriptions provided by the programs should cover the full evaluation period. However, centrally provided statistics on bibliometrics (2017-2021/2022) and financial data (2022-2023) cover slightly different time periods.

**Responsibility**

The Head of Department (HoD) has the overall responsibility for the department self-evaluations and the Program Responsible Professor (PAP) has the overall responsibility for program self-evaluations. This includes ensuring that the information provided is both sufficiently accurate and not misleading. It is important to be open, even about activities that are not as successful as we may wish.

The HoD/PAP is responsible for coordinating meetings with the appropriate people, collecting input, leading appropriately broad and inclusive discussions, prioritizing among suggestions, and summarizing and producing the final text. Most economic and HR data will be provided centrally, but for the information that needs to be collected locally, the HoD/PAP is responsible for coordinating with the appropriate people. The HoD is responsible for ensuring that the programs provide drafts to the department early enough that the department can use them as input to the department’s self-evaluation.

**Panels**

The panels will provide input on how programs and departments can improve, provide new perspectives on potential organizational changes across programs and departments, help in identifying good examples that can be shared across the faculty, and place our research quality in the international context. While this input is extremely helpful for identifying directions, decisions and prioritization will be done within the faculty using the panel’s feedback as one input.

**Instructions**

**Base data**

Base data such as bibliometrics, HR and financial data will be provided centrally. Details on how the data was collected and how to interpret it will be found in the Base Data Information document on the Faculty KoF webpage.

**Note**

While it is understandable that every program and department will want to look as good as possible, this process is most valuable when everyone is open and honest. In particular:

1. Activities (funding, projects, publications, hires etc.) that ended before the evaluation period or started after it should not be included. If it is extremely important to include such, e.g., very recent recruitments that significantly affect future plans, the text must clearly indicate that the activity falls outside the evaluation period and why it is being included.
2. Cramming in more text by changing the font size, layout, margins, text box sizes, etc. will not be accepted. It is understood that the space limitations will lead to the need for careful prioritization.

The four answer sizes used are:

* Very short – 1.4cm tall box, approximately 250 characters
* Short – 3cm tall box, approximately 600 characters
* Medium – 4.7cm tall box, approximately 950 characters
* Long – 10cm tall box, approximately 2000 characters

Do not change the ordering or labeling of the questions in the document, as the final answers will be extracted from the document based on that ordering and labeling.

**Before submission**

[Check the KoF/ÖB webpage on the employee portal for any important updates](https://www.uu.se/en/staff/faculty/science-and-technology/research).

**Hide instructions**  
Modify the “Instructions” style so all colored text is hidden in the submitted document. First, check that you have the “Show/Hide Formatting Marks” turned off then right-click on the style “Instructions” in the ribbon at the top of the window. Then select “Modify” and then “Format” at the bottom left. Choose “Font” and turn on the “Hidden” option and click the OK button.

**Navigation panel**

To quickly navigate through the document, you can use the Navigation panel. To see the Navigation panel, click the “View” tab in the ribbon and then check the “Navigation Panel” checkbox in the “Show” button group or choose “Sidebar🡪Navigation” from the “View” menu. In the Navigation Panel you can view the outline of the document and search for specific words or phrases.

**Submission**

Send this document as **a Word file** to your Head of Department latest April 15, 2024. It is important to submit the document as a Word file as we will be extracting text from the tables to put all answers in a database.

**Updates**

* V4
  + Clarified in table 3.9 that Top-10 external funding shows the amount spent on each financier during the year.
  + Corrected data for some programs with regard to “UL, promoted from an adjunct” being included in the category “Other Research”. Those concerned have been informed by e-mail.
  + Updated data for the Instrumentation Research Program including FREIA.
  + Added a box where the program can ask questions to the panel.
* V3
  + Revised bibliometrics table to have only one coverage statistic (3.3.2). This statistic reflects the proportion of DiVA publications used for citation statistics calculations by CWTS Leiden, instead of reporting the Web of Science coverage (WoS coverage). For WoS coverage statistics, see the base data document. The intended goal is to put increased focus on the impact indicators and their validity.
* V2
  + **3.10 External funding sources** - Changed to include all “active” grants during the evaluation period instead of just grants that “started” during the evaluation period. This change is done to make sure that grants that show up in the financial data for 2022 and 2023 will be listed even if they did not start during the evaluation period
* V1 (initial version)

# General information

## Process for creating this self-evaluation

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| The self-evaluation report has been jointly prepared primarily by the program professor, a lector, the head of the division and a researcher. All other employees have been invited to contribute to the report and their feedback was taken into account. |

## Core of the research program

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| The program is coherent and special in that its main research goal is to develop and operate new infrastructure for the strategic research areas in the department of physics and astronomy, performing research on new methods, instrumentation and accelerators as integrated part of these research projects. |

## Personnel (data provided centrally)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Faculty FTEs** | | | | **Non-Faculty FTEs** | | | | | |
|  | **Professor** | **Associate (UL)** | **Assistant (BUL)** | **Total** | **PhD** | **Postdoc** | **Researcher** | **Other**  **Research** | **Other** | **Total** |
| **Female** |  |  |  |  | 0.2 | 0.1 | 1.4 | 1.9 |  | 3.5 |
| **Male** | 1.0 | 2.3 |  | 3.3 | 3.6 | 0.8 | 5.2 | 11.4 | 2.9 | 24.0 |

## Finances

### Overall research funding in MSEK (data provided centrally)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **FFF+SFO Internal Research** | **Other Internal Research** | **Total Internal Research** | **External Research** | **Total Research** | **External Research %** |
| **2023** | 1.2 | 10.6 | 11.9 | 32.0 | 43.9 | 73% |
| **2022** | 1.2 | 13.2 | 14.4 | 36.6 | 51.0 | 72% |
| **Average** | 1.2 | 11.9 | 13.1 | 34.3 | 47.4 | 72% |

### Other internal research funding

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| When the research program was launched in 2018 it was awarded a start-up package from the Teknat faculty and the Department of Physics and Astronomy, to be used for building up an infrastructure for experimental activities such as the Ångström Femtosecond Laser Lab. |

### Basic funding expectations and policy for using internal resources

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| The internal funds are used for salaries for the program-responsible professor, an ass. prof. and for the researchers who run the Ångström Femtosecond Laser Lab. One associate professor receives part of his salary from internal funds. The other associate professor receives most of his salary from internal funds transferred from the high energy physics division. Teaching funds are distributed to teachers and researchers according to the allocation of teaching tasks. Studiestöd has been used for new PhD students.  Most researchers and other scientific staff receive their salaries from external funds, which also covers running costs and investments for projects and the research infrastructure. |

### Use of internal research funds in MSEK (data provided centrally)

Motivation: To understand how the program is using internal research funding.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Faculty Salary | Non-Faculty Salary | Other Personnel Costs | Premises | Equipment Depreciation | Overhead | Running Costs | Total |
| 2023 | 3.2 (19%) | 6.9 (40%) | 0.4 (2%) | 0.4 (3%) | 2.4 (14%) | 3.1 (18%) | 0.9 (5%) | 17.2 |
| 2022 | 3 (19%) | 2.3 (14%) | 0.7 (4%) | 7.8 (49%) | 0 (0%) | 1.6 (10%) | 0.5 (3%) | 15.9 |
| Average | 3.1 (19%) | 4.6 (27%) | 0.5 (3%) | 4.1 (26%) | 1.2 (7%) | 2.3 (14%) | 0.7 (4%) | 16.6 |

### Personnel funding (data provided centrally)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Female | | | Male | | |
|  | Internal | External | Teaching | Internal | External | Teaching |
| Professor |  |  |  | 100% | 0% | 0% |
| Associate (UL) |  |  |  | 37% | 37% | 26% |
| Assistant (BUL) |  |  |  |  |  |  |
| PhD | 100% | 0% | 0% | 48% | 50% | 2% |
| Postdoc | 100% | 0% | 0% | 20% | 80% | 0% |
| Researcher | 36% | 53% | 11% | 49% | 45% | 6% |

### Major infrastructure usage

|  |  |  |  |
| --- | --- | --- | --- |
| Infrastructure | Sharing | Location | Approximate Yearly Cost (MSEK) |
| Ångström femtosecond Laser Laboratory |  | Uppsala | 3 |
| FREIA Laboratory |  | Uppsala | 25 |
| CERN |  | Switzerland | 0 |
| European XFEL |  | Germany | 0 |
| MAXIV |  | Lund, SE | 0 |

## Other important comments

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| R&I forms links to all the research areas within the department and beyond, from high-energy particle physics to materials science, provides scientific leadership and a connection to industry in the creation of new research infrastructures and tools. |

# Follow up on goals set in the last evaluation

## Reflections on accomplishments and setting goals this time

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| The research program was launched in 2018 and was therefore not included in the evaluation KoF17. The FREIA division, however, was evaluated in KoF17. The comments raised in KoF17 are to a large part addressed at the department level by forming an infrastructure unit that contains former FREIA activities and is based on three pillars: (i) R&D for accelerator components; (ii) Swedish national accelerator and instrumentation laboratory and (ii) a materials platform. The program provides scientific leadership in these areas. |

# Area 1: Research Quality (evaluation of outcomes and processes)

## Main research areas

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| --- | --- | --- | --- | --- |
| Main Research Areas | | % of program | FTE Faculty | Type |
| 1 | Accelerator research and development (R&D) for particle physics and applied sciences | 50% | 1.3 | Mixed |
| 2 | R&D on accelerator-based photon sources from source to sample | 25% | 1 | Mixed |
| 3 | Methods and Instrumentation | 25% | 1 | Mixed |
| 4 |  |  |  |  |

## Research Activities

Motivation: Provide a more detailed view of the key research directions in the program.

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| The program has three main research areas:  **(1) Accelerator research and development (R&D) for particle physics and applied sciences**:  The ultimate goal is to push the frontier of contemporary science into uncharted territory by providing scientists with unique accelerator-based infrastructures for fundamental and applied science. With this goal in mind, we  (a) develop the physical principles of new methods of acceleration and control of charged particle beams;  (b) design, manufacture and test of components for particle accelerators;  (c) established Sweden’s only center for research and development in superconducting (SC) accelerators;  (d) carry out studies towards new accelerator facilities with reduced carbon footprint.  These activities also allow us to supply Uppsala University with cryogens.  **(2): The development of novel accelerator-based photon/particle sources** has been initiated by the Uppsala photon science community’s desire for a local medium-scale x-ray source. Identified science drivers range from material science over chemistry to biology. Based on the unique expertise available in the program, strengthened by a strategic faculty hire (Assoc. Prof.), we are currently focused on developing a femtosecond, high-repetition rate, compact x-ray source. These activities can be expanded towards compact neutron and other particle sources scientifically motivated in other programs.  **(3): Method and instrumentation development** is motivated by the need to strengthen scientific activities across programs. We are currently focusing our resources on building up a central femtosecond laser facility together with the x-ray science division, developing novel methods for x-ray photon science research and collaborating on neutron instruments for ESS. |

## Research Results

### Contributions to the field

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| Research area 1: We characterized superconducting cavities and accelerating modules for ESS, which enabled the construction of the world’s most powerful proton accelerator. It is worth pointing out that this also provided a very large part of our external funding.  Research area 2: Through a series of scientific workshops, we initiated and developed the scientific case and conceptual design for a compact femtosecond x-ray source, available at <https://indico.uu.se/event/1405/>. The proposed source is complementary to XFELs and synchrotrons.  Research area 3: We built a state-of-the-art laboratory for material science research - the Ångström femtosecond laser laboratory. This laboratory started its operation as a central facility for collaborating research groups. We also attracted a Röntgen Ångström Consortium to develop the use of coherence at Sweden’s MAX IV synchrotron and other facilities. |

### Bibliometrics for 2017-2021/2022 (data provided centrally)

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| --- | --- | --- |
|  | Type of Indicator | 2017-2022 |
| Number of publications, full publication set (full / fractional counts) | Quantity | 627 / 79 |
| Proportion of publication fractions at the Norwegian model level 2 (%) | Impact | 35% |
|  |  | 2017-2021 |
| Coverage (fractionalized): Proportion of publications from DiVA included in citation statistics, weighted by fractional counts | Coverage | 29% |
| Mean normalized number of citations per publication (MNCS) | Impact | 0.58 |
| Proportion of frequently cited publications (top 10%) (PP(top 10%)) | Impact | 2% |

### Most frequent publishing channels (raw data provided centrally)

**Instructions**: Using the provided raw data of publication frequency per channel (a channel is the name of a conference or journal) for each program, list the most frequent publishing channels with more than two publications during the evaluation period. This data can be found in the Base Data Excel document.

Motivation: To see where the program is most frequently publishing.

|  |  |  |
| --- | --- | --- |
| Channel | Number | % of Total Publications |
| Phys. Rev. Accelerators and Beams | 11 | 20.75 |
| Nuclear Instruments and Methods in Physics Research | 5 | 9.4 |
| IEEE Transactions on Applied Superconductivity | 4 | 7.5 |
| Phys. Rev. B | 4 | 7.5 |
| International Journal of Microwave and Wireless Technologies | 4 | 7.5 |
| IEEE Transactions on Microwave Theory and Techniques | 3 | 5.7 |
| The Journal of Engineering | 3 | 5.7 |
| Nature Communications | 3 | 5.7 |
| Phys. Rev. Lett. | 2 | 3.8 |
| Sci. Adv. | 2 | 3.8 |

### Most important publishing channels

**Instructions**: Provide the most important publishing channels (a channel is the name of a conference or journal) according to the program, the number of publications in each channel during the evaluation period, and the % of the total publications based on the centrally provided bibliometrics. For each channel, specify both the total number of publication and the number where a program member was the lead-author. (The lead-author is the primary driver of the particular publication, which is often denoted as the “corresponding” author or the first author in the publication list, and is typically the originator of the core idea of the work and/or the person who wrote the majority of the text in the publication.)

Motivation: Enable the program to indicate what publishing channels they see as most important and how much they publish in them for panel feedback.

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| --- | --- | --- | --- | --- |
| Channel | Number | % of Total Publications | Lead-author | Lead-author % of Total |
| Phys. Rev. Accelerators and Beams | 11 | 22.5 | 11 | 100% |
| Nuclear Instruments and methods A | 5 | 10 | 5 | 100% |
| Phys. Rev. B | 4 | 8 | 2 | 50% |
| IEEE Transactions on Applied Superconductivity | 4 | 8 | 3 | 75% |
| International Journal of Microwave and Wireless Technologies | 4 | 8 | 4 | 100% |
| Nature Communications | 3 | 6 | 2 | 67% |
| IEEE Transactions on Microwave Theory and Techniques | 3 | 6 | 3 | 100% |
| The Journal of Engineering | 3 | 6 | 3 | 100% |
| Phys. Rev. Lett. | 2 | 4 | 1 | 50% |
| Sci. Adv. | 2 | 4 | 2 | 100% |

### Publishing impact on the field

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| We publish in top ranked journals in our respective fields, e.g. Phys. Rev. Accelerators and Beams, Phys. Rev. Letters, Sci. Adv. Nat. Commun.  We contribute to the conceptual and technical design reports of large-scale projects: CLIC, ESS, CompactLight, ESSnuSB, AWAKE, FREIA Neutron Instrument. |

### Participation, recognition, and leadership in the field

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| We have given 12 keynote presentations & invited talks, organized and hosted 4 international conferences or workshops, chaired 4 Collaborations, served as member of 3 review panels, reviewed for 7 scientific journals, reviewed grants & beamtime for 11 entities, ollaborated with 8 major research infrastructures and laboratories, served as member of 11 International Consortia, taken initiative to form the Accelerator Physics section in the Swedish Physicist association. |

## Synergies within the research program

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| 1 | Type of synergy | Common goal: Ångström laser  Development & operation of accelerator-based photon sources |
|  | Specific  collaboration | Broad collaboration across the program utilizing expertise from photoinjection over acceleration and beamlines to experimental end stations |
| 2 | Type of synergy | Use of Methods/facilities: Infrastructure and methods for applied superconductivity in accelerator technology |
|  | Specific  collaboration | Use of superconducting technology both for high-gradient accelerating cavities and for superconducting magnets |
| 3 | Type of synergy |  |
|  | Specific  collaboration |  |

## Synergies across research fields

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| --- | --- | --- |
| 1 | University and Field | Uppsala, Physics Department, Chemistry Department, KTH, Materials Physics, SU, Physics Department |
| Type of synergy | Complementary laser facilities |
| Specific  collaboration | Develop and operate instrumentation |
| 2 | University and Field | UU, KTH, LU, LTH and 15 other European universities in fundamental particle physics at the intensity frontier |
| Type of synergy | Common use of the ESS accelerator to generate a uniquely intense muon and neutrino beam |
| Specific  collaboration | High power proton beam generation and compression, target, neutrino beam generation, large neutrino detectors |
| 3 | University and Field | CERN, High gradient research for linear accelerators, Luminosity upgrade of the LHC, Develop high field superconducting magnets for CERN present and future accelerators |
| Type of synergy | Comparison with RF spark material testing system at CERN, Common development of superconducting technology with CERN (Complementary methods) |
| Specific  collaboration | Operation of DC spark material testing system in Uppsala, Fabrication of superconducting cable equipment with Swedish industry, Develop and test of superconducting CCT magnets |

### Reflections on synergies across research fields

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| All research activities in the program’s research field cross with several other research fields. There is a strong benefit in such collaboration as different instrumentation and accelerator techniques developed for one field often are used in other fields after some adaptations. A project such as superconducting accelerator cavities is typically driven by the needs in one field (HEP), but soon finds its use also in other fields (material science, FEL). The program thus provides a significant constructive collaboration that benefits several fields. |

## Reflections on ensuring good research ethics

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| I&A follows all formal standards set by the university and its substructures. We have a collegial culture to share progress, results and methods, and scrutinize and provide constructive feedback on each other’s work in informal discussions. |

## Reflections on creating and ensuring research freedom

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| We encourage colleagues to explore new research projects which fit within the I&A scope and to apply for funding to support these. If funding allows it, scientific staff are offered the chance to work on “side” projects, according to their interest. |

## Reflections on research program size

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| We link with other programs to collaborate on common research drivers. We have identified strategically important research directions (see 9.) and the program would benefit from an expansion through the recruitment of an associate professor. |

## Top external funding sources (data provided centrally)

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| --- | --- | --- | --- |
| Funding Agency | 2022 | Funding Agency | 2023 |
| Other private companies (Swedish) | 23.1 | Other private companies (Swedish) | 15.1 |
| Swedish Research Council (VR) | 4.2 | Other non-profit (outside the EU) | 3.9 |
| EU Commission (Other) | 2.3 | Swedish Research Council (VR) | 3.9 |
| Marie Sklodowska-Curie (H2020) | 1.3 | Other private foundations | 2.0 |
| Stockholm University | 1.0 | EU Commission (Other) | 1.5 |
| EU commission (H2020) | 0.7 | Marie Sklodowska-Curie (H2020) | 0.8 |
| Other non-profit (within the EU) | 0.7 | Other non-profit (within the EU) | 0.8 |
| Övriga landsting | 0.6 | EU Commission (Horizion Europe) | 0.7 |
| Other non-profit (outside the EU) | 0.6 | Marie Sklodowska-Curie (H Eur) | 0.6 |
| Swedish Agency for Innovation Systems (VINNOVA) | 0.5 | EU commission (H2020) | 0.6 |

## External funding sources

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| --- | --- |
| Grant | Number of awards to PIs in the program |
| Basic science grants (available to all fields in the faculty) | |
| ERC-StG, ERC-CoG, ERC-AdG, ERC-SyG |  |
| KAW Project |  |
| KAW Scholar |  |
| WAF/WAFx |  |
| VR Project | 3 |
| VR Starting |  |
| Other grants (may include field-specific grants and Co-PIs) | |
| KAW project (Co-PI) | 1 |
| VR RÅC project (Co-PI) | 1 |
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## Reflections on external funding

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| I&A has 3.3 faculty FTE’s and 27.5 non-faculty FTE’s, most of which are paid from large grants for  R&D and testing for big science facilities. This indicates both the great success in receiving important external recognition for its research program and the precarious dependence on external financing. We consider applying for large external grants a collective effort, which consumes time, energy and effort, but which also is the only way to secure the future of this activity. |

## Reflections on what is working well

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| * Synergy within the program * Broad activities * High impact in selected fields * Collaborations across the department and international communities. * Integration in the departmental teaching activities * Specific impact on Teaching: Co-founding of new master program in quantum technologies * Successful testing of superconducting accelerator equipment for ESS and other labs has secured a new contract. |

## Reflections on what needs to be improved

**Instructions**: From the above, reflect on what needs to be improved over the next 5 years. Please focus on areas that need improvement and do not list areas that could be improved but where it is not needed.

Motivation: Require programs to identify where they feel that they need to invest. This will both provide the panels with insights into our own self-assessment as well as help us improve.

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| We see that junior colleagues (PhDs, postdocs, young researchers) lack experience in writing scientific papers and funding applications. We will set up a system for training for enhancing writing skills. Specifically,   * experienced colleagues will give seminars and share their tips and tricks on writing. * A set of top-class papers and applications will be scrutinized and discussed by participants during seminars. * Junior colleagues will peer-review each other’s manuscripts and grant applications. * Senior colleagues will give individual feedback.   I&A would like to increase the number of faculty staff. Partly, this can be achieved by attracting top-class funding such as KAW and ERC grants. |

# Area 2: Career Paths (evaluation of processes)

## Career stage distribution implications and plans for the next 5 years

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| We suggest recruiting an Assoc. Prof. specialized in accelerator physics for high-energy physics as replacement of the Assoc. Prof who will retire in 2024. That can be achieved through the strategic initiative (see 9.) with support from high energy physics to form a team working on future particle colliders.  The program professor retires in 4-5 years, and we suggest that an internationally recognized scientist is recruited to continue the leadership of the program. Goals specified in 9-11 aim at creating a strong research environment attractive for internationally recognized scientists. |

## Reflections on the process for identifying recruitment needs and focusing areas

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| In 2020 the program and FREIA division leadership in discussion with the department management identified the need to recruit an Assoc. Prof with expertise in compact accelerator-based X-ray sources and accelerator-based neutron sources for material science. |

### Initiatives to recruit and retain top researchers/teachers

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| We define top researchers as those who can take initiative on and lead new developments, attract funding, and establish collaborations at the local and international level. Top teachers are defined as people able to take responsibility for existing courses, establish new relevant courses, and provide high-quality teaching. Here, continuous pedagogic development is expected. The program encourages its teachers and researchers to develop their skills through teaching and supervising students, through competence development and to apply for promotion. |

## Career support

### Career support activities for non-tenure-track staff (beyond standard employee dialogs)

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| Most of the program staff falls within this category. Researchers are encouraged to participate in teaching and supervising students, pedagogical development courses, mentorship programs and grant writing workshops. The competence development of other scientific staff occurs through e.g., participation in international schools, or through in-house training. When the funding situation allows it, scientific staff are offered the chance to work on “side” projects according to the interest of the individual. |

### Career support activities for tenure-track staff (beyond standard employee dialogs)

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| There are currently no tenure-track staff in the program. If there were, the program would offer similar career support as for researchers, with additional help through courses and guidance in scientific leadership, how to manage project economy, etc. |

### Career support activities for tenured staff (beyond standard employee dialogs)

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| Career support by the program is in line with the core values of Uppsala University such as quality culture, collegiality and academic freedom. Tenured staff is given time and space for their own academic research within the program's limited funding. All tenured staff can access a wide variety of competence development courses provided by the university, for example pedagogy, economy, leadership, and management. Furthermore, sabbatical periods and research exchange with universities abroad are offered. Mentoring via collegial discussions of strategic research developments is offered. Advice and support are offered for applications for promotions. |

## Reflections on what is working well

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| I&A has built upon a long tradition in accelerator physics at Uppsala and is poised for the future with the establishment of Sweden's only center for superconducting accelerator technology. We have successfully retained and rejuvenated a substantial team of scientific staff to operate and maintain the facilit, and support ongoing research projects.  During the previous evaluation period, the FREIA division had engaged in scientific and academic activities, albeit with an uncertain future. However, since 2018, the I&A research program has incorporated the FREIA division, resulting in the development of a long-term strategic plan.  The program actively engages in teaching and supervising student projects. Moreover, since 2018, we have seen the graduation of three PhD students and eight are currently being enrolled in the doctoral program. The distinctive nature of our PhD education program is valued and will be sustained moving forward. |

## Reflections on what needs to be improved

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| --- |
| The program is successful in attracting external funding in the form of contracts to the amount of 30 MSEK per year, whereas the long-term internal funding is only 0.5 FFF. This imbalance makes the program vulnerable to fluctuations in the incoming external funding. Furthermore, the strong dependence on external funding makes it challenging to maintain the right competence in the transition periods between large projects. Furthermore, the lack of internal funding makes it difficult to plan and execute long-term strategic initiatives while the critical mass of personnel must be maintained. This will turn critical in four years when the program start-up funds end. The program needs diversification of funding sources. |

# Area 3: Collaboration and Outreach (evaluation of processes)

## Specific collaboration and outreach examples

|  |  |  |
| --- | --- | --- |
| 1 | Example and connection | University - Industry innovation collaboration on superconducting magnets, 2020-2023 |
| Value to the program | Development/ expansion of new research area, new and expanded network with CERN and industry |
| Value to the partner | Connections to big science facilities, universities and companies, competence, and technology development |
| 2 | Example and connection | Invited talk about Knowledge transfer from academia to industry at the Swedish Big Science Forum in Lund, January 2024 |
| Value to the program | Visibility of the research activities at FREIA, new research connections and projects with Big Science Facilities and Swedish industry |
| Value to the partner | Possibilities to learn about collaborative projects and how to get involved with Big Science through FREIA |
| 3 | Example and connection | An interview to the Swedish largest newspaper Dagens Nyheter in connection with the announcement of the Nobel Prize in Physics in 2023. |
| Value to the program | Visibility of research on attosecond pulse generation. |
| Value to the partner | Awareness of the public about cutting-edge research on attosecond pulse generation in Sweden. |

### Reflections on overall aims and strategies for collaboration and outreach

|  |
| --- |
| Our outreach program includes student internships, visits, and projects, public seminars and events like Sci-Fest, seminars for and collaboration with industrial partners. Through these activities we expand our networks and create an awareness of our research field.  I&A, particularly for Big Science, are high tech fields, so we constantly seek opportunities to collaborate with industrial partners, locally and globally. Here, we use Big Science Sweden who can find suitable matches with companies as well as point to new research projects together with the Big Science facilities. |

## Support for outreach and collaboration

|  |
| --- |
| There are centrally organized outreach opportunities such as the SciFest science festival and popular science seminars. In addition, there are frequent requests from within the university or from the outside (high schools etc.) for guided tours of the FREIA laboratory. Generally, it is up to each and every one to engage in outreach activities, but we do encourage everyone, in particular young researchers, to join. Within the program, there are informal, open announcements when there are specific opportunities, so that those interested can join. |

## Reflections on what is working well

**Instructions**: From the above, reflect on what is working well and should be continued over the next 5 years.

Motivation: Require programs to identify where current activities are successful. This will provide the panel with insights into our own self-assessment.

|  |
| --- |
| I&A has strong interactions with Big Science Sweden which constitutes a link between research, Big Science facilities, and industrial partners willing and able to contribute to Big Science, as well as with students interested in a career in Big Science.  Within I&A we conduct several research projects in collaboration with industry.  There is significant interest in the FREIA laboratory, and we frequently give guided tours, which are immensely popular.  Researchers in the program are frequently involved in outreach towards the public and school students, e.g., public lectures, student projects in the lab, internships, and science fairs.  Our researchers make recurring appearances in public media, both TV, radio, and newspapers, which gives attention to our research field. |

## Reflections on what needs to be improved

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| --- |
| There are only a few people in the program who have the proper overview of the FREIA laboratory to be able to guide tours. We need to expand this group by holding a small workshop for those who can learn the essentials to take on the role as a guide.  Some research grants do not financially support outreach. In such cases, we request that there should be specific funds to pay for the time and additional costs associated with the outreach. |

# Area 4: Connection between Research and Teaching (evaluation of processes)

## Main teaching areas

|  |  |  |  |
| --- | --- | --- | --- |
| Teaching program, course package, or contract/continuing education | Level | Courses Taught | Managed |
| Mechanics | bachelor | 1 |  |
| Waves and Optics; Photonics and Quantum Optics | bach&ms | 2.5 | 2 |
| Electromagnetism | bachelor | 0.2 |  |
| Accelerators physics | master | 1.5 | 1 |

## Infrastructure use in teaching

|  |  |  |  |
| --- | --- | --- | --- |
| Infrastructure | Courses | Level | Students |
| Quantum optics laboratory | Photonics and Quantum optics | master | 10 |
| FREIA laboratory | Accelerator physics, Project in physics | Bachelor master | 6 |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Specific teaching/research connections

|  |  |  |
| --- | --- | --- |
| 1 | Example | Students taking the course study experimentally the key concepts of quantum optics like the first- and second-order coherence, coherence time and coherence radius, photon bunching and anti-bunching, generation of entangled photons, single-photon sources, and detectors. |
| Course Info | Photonics and Quantum Optics, master program in Quantum Technologies, 10 students |
| Value to teaching/ research | Unique for Uppsala research-teaching nexus in quantum optics that give students an opportunity to get ‘feeling’ for quantum optics. A Swedish company was interested in hiring the student that developed a source of entangled photons. |
| 2 | Example | Degree projects in FREIA |
| Course Info | Degree project courses and courses in applied physics projects |
| Value to teaching/ research | The students get to experience work in a real research lab and the researchers receive help with solving specific problems, testing new methods, or making new implementations. |
| 3 | Example | A master project together with CERN on optimizing an accelerator using software also used at CERN |
| Course Info | Master's degree project course |
| Value to teaching/ research | Research group get to explore new techniques and form connections to new groups at CERN |
| 4 | Example | Guest lecture on particle accelerators in the Electromagnetism course |
| Course Info | Electromagnetism, engineering programs, bachelor level, 200 students |
| Value to teaching/ research | Students get to see how a basic course is applied in advanced research and the researcher finds new ways of presenting the research in an understandable and appealing way. |

### Reflections on overall aims and strategies for connections

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| --- |
| I&A aims to introduce students to contemporary research in accelerator physics, instrumentation, and quantum technologies. The expectation is that students will be able to continue their education at the PhD level or perform research at a laboratory in industry or a university. For example, on the initiative of a teacher, a basic quantum optics lab started, and equipment was acquired using different funding sources. The Department provided premises for hosting the quantum optics laboratory. Overall, it is the enthusiasm of the teachers that makes research-teaching connection functioning. |

## Support for integrating teaching and research

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| --- |
| “Researcher lunches” in the department allow students to interact with the research divisions. This is an excellent opportunity for researchers to get in contact with students who may be interested in integrating our research with their education. Departmental calls for researchers aim at developing student projects integrating teaching and research. UU provides annual funding for enhancing the quality of teaching. I&A has obtained a grant (200 kSEK) for enhancing students learning by embedding elements of research in modern optics into educational materials. |

## Reflections on what is working well

|  |
| --- |
| The program has several running research projects in accelerator physics, instrumentation and modern optics ranging from magnet development to lasers and single-photon sources. Various degree projects are offered and tailored to students’ needs. Several experienced supervisors are available. We provide access to and training in a laboratory environment which offers vast opportunities for experimental projects for students at both bachelor and master level.  A program member was active in establishing the new master program in Quantum Technologies. |

## Reflections on what needs to be improved

|  |
| --- |
| Throughout the years we have developed a few courses related to particle accelerators together with teachers from other research programs. We have noticed that the number of students attending each course is limited and we must now look at how we can combine the courses into one or two courses that can attract more students and be managed in a more resource effective manner.  The FREIA-lab facility, with the existing infrastructure there, could be a valuable teaching resource for other courses in the department. Wider information campaign could make the other program more aware of this possibility. |

# 5-year Priorities

# Priority 1 of 3: An activity that can be accomplished within the program

## Description of the Priority

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Department: | Physics and Astronomy | | | |
| Program: | Instrumentation and Accelerators | | | |
| Title: | Applied superconductivity (SC) research for accelerators | | | |
| Support: | May require department support: | No | May require faculty support: | No |

### Goal

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| --- |
| To expand and strengthen the existing R&D program on applied superconductivity for accelerators with focus on electro-magnets, radio-frequency cavities, and cryogenic components which are core components of particle accelerators and multiple modern medical equipment. |

### Expected meaningful research improvement

|  |
| --- |
| The main pillars of this activities and research improvements for each of them are:   * Superconducting cavity characterization and superconducting magnet development and testing * Improved methodology * Stronger link to industry * Sustainability research by improved operation and powering scheme. * Research into phenomena limiting the accelerating gradient in cryogenic normal-conducting and superconducting accelerating cavities * Expand tests with different superconducting materials * Expand surface characterization test-stand with RF instrumentation. |

### Implementation plan

|  |
| --- |
| This activity has previously attracted a substantial amount of funding through the cryomodule testing for ESS. This research will continue with a new project with SCK CEN (2.88 MEUR/year from 2024 to 2028) and will include planned expansion into new power sources (based on solid-state technology) that have been under research and development at FREIA.  This new major activity will bring a certain investment in equipment and open for collaboration with other academic and industrial partners in Europe. We plan primarily to use local experts for the activities, but new recruitment is also likely.  The test-stand for the research into RF vacuum breakdowns will be upgraded with new equipment where performance degradation of the superconducting cavities, related e.g. to multipacting and surface field emission, can be studied. |

### What previous accomplishments indicate a high likelihood of success?

|  |
| --- |
| We previously built a test-stand and characterize SC cavities and accelerating modules for ESS accelerator, built a test-stand and characterized SC magnets for CERN, developed and built together with industry the first SC accelerator magnet in Sweden, built a cryogenic test-stand for research into high-gradient accelerating cavities, developed and prototyped high-power RF amplifiers for ESS,  We are currently developing cryostats for the new LHC High-Luminosity upgrade and are developing and building high-precision measurement probes for superconducting magnets |

## Current status of the area at Uppsala University

|  |
| --- |
| I&A host’s Sweden’s only center for research in SC accelerators and as such provides scientific leadership for activities related to applied SC research and instrumentation. We also supply the university with cryogens needed by many departments outside ours. |

### Current and planned contributions to support the initiative

|  |
| --- |
| Most of FREIA personnel are committed to this activity and are supported by the commissioned research projects within this activity. |

## Strategic value

### Strategic value of the area in the global context

|  |
| --- |
| The activity addresses directly development of superconducting core components of modern medical equipment and particle accelerators and the sustainability issues related to building and running large scale particle accelerators |

### Strategic value of the area at the next level

|  |
| --- |
| The activity on applied superconductivity is driven by the needs in high energy physics, but is applicable to other activities in the department and faculty in need of more efficient and accessible accelerators |

## Contributions needed for success

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| --- |
| The activity will continue with external funding from industry that has already been secured by our program. The required expertise exists within the program and through collaborations. |

### Success indicators

|  |
| --- |
| Successful characterization of SC cavities, test of components for high-luminosity upgrade for LHC , upgrade of the cryogenic test-stand, new research grants securing continuation of the activities and new connections with industry. |

### First steps that can be taken today

|  |
| --- |
| Define direction of the development of SC instruments in collaboration with industry, set milestones.  Secure extension of the K-contract with CERN on the upgrade of the cryogenic test stand, set milestones. |

# Priority 2 of 3: An activity that may require department support

## Description of the Priority

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Department: | Physics and astronomy | | | |
| Program: | Instrumentation and Accelerators | | | |
| Title: | Accelerator research and development towards future particle colliders | | | |
| Support: | May require department support: | Yes | May require faculty support: | No |

### Goal

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| --- |
| Strengthen existing activities towards future particle colliders by aligning the work on accelerator research and development with the activities in the High Energy Physics (HEP) program. |

### Expected meaningful research improvement

|  |
| --- |
| The upcoming European strategy for particle physics will set the direction towards the next high-energy collider facility and define the future of the research field for decades to come.  Uppsala has had a leading role in the development of the Compact Linear Collider (CLIC) and has been part of the build-up of the feasibility demonstrator facility at CERN. The I&A program contributes to the design of the proton driver for a Muon Collider complex and, to the high-luminosity upgrade of the LHC (HL-LHC) by developing and testing superconducting magnets, and the delivery of cryostats.  Currently, the HEP program plays a key role in the physics studies for future colliders. By aligning the activities in accelerator and particle physics research we will create a coherent environment that will be best equipped to tackle the upcoming challenges at the next major accelerator for high-energy physics research. |

### Implementation plan

|  |
| --- |
| We will soon launch the recruitment of an Assoc. Prof. specialized in accelerator development for particle physics, in collaboration with the high energy physics program. Before the recruitment process is complete, we will form a team of existing researchers involved in accelerator development for particle physics and physics studies at future colliders. The team will set priorities and goals for its work, aligned with the European roadmap for future colliders. In this process, we will reinforce our collaborations within the field, and identify sources of external funding that can be used to expand the team further. The infrastructure for superconducting accelerator technology (see priority 1 of 3 in section 8) is expected to play a vital role in this activity, through its capacity for R&D and testing of accelerator equipment. |

### What previous accomplishments indicate a high likelihood of success?

|  |
| --- |
| The I&A program has been at the forefront of the HL-LHC through magnet development, testing of superconducting equipment, and delivery of cryostats. It has a key role in the development and feasibility studies of CLIC (high-gradient, beam instrumentation and dynamics), and designs a proton driver for the muon collider complex. The HEP has leading positions within physics prospect studies for both HL-LHC and the FCC. This illustrates the broad dedication of both our research program and the HEP program to future collider projects, and the existence of the necessary expertise. |

## Current status of the area at Uppsala University

|  |
| --- |
| I&A possesses strong expertise in accelerator physics towards future colliders, while the users of such facilities are in the HEP program. A strategical alignment of will generate something larger than the sum of the two contributions. |

### Current and planned contributions to support the initiative

|  |
| --- |
| We propose to enhance available funds for a joint re-appointment of an Assoc. Prof. in accelerator physics through cofounding for a second recruitment to form a team that can make a substantial impact in the field. |

## Strategic value

### Strategic value of the area in the global context

|  |
| --- |
| The European strategy for particle physics towards the next high-energy collider will require worldwide commitments. We have the expertise and infrastructure to benefit from this initiative. |

### Strategic value of the area at the next level

|  |
| --- |
| The cross-fertilization in the proposed I&A and HEP collaboration is considerable and will improve the coherence of the research programs in the Department. Priority 8 will provide expertise and infrastructure for technological developments. |

## Contributions needed for success

|  |
| --- |
| The existing FFF enables the scientific alignment with the European strategy for particle physics while an additional FTE would enable us to form a team that can be visible as a major player in the field. |

### Success indicators

|  |
| --- |
| Two recruitments in accelerator physics towards future colliders; strong presence and leadership in the international accelerator community; increase scientific output; establish new funding channels |

### First steps that can be taken today

|  |
| --- |
| Integrate scientific staff with HEP community, establish joint seminars. Set up common goals and a viable strategy for the involvement of Uppsala in the international efforts towards future colliders. |

# Priority 3 of 3: An activity that may require faculty support

## Description of the Priority

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Department: | Physics and Astronomy | | | |
| Program: | Instrumentation and Accelerators | | | |
| Title: | Establish a Materials Instrumentation Platform | | | |
| Support: | May require department support: | No | May require faculty support: | Yes |

### Goal

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| --- |
| Provide competitive instrumentation and methods development in materials science |

### Expected meaningful research improvement

|  |
| --- |
| Scientific breakthroughs often arise from advances in instrumentation and methodology. The Wallenberg Initiative Material Science for Sustainability (WISE) provides Sweden with a 10+ year perspective for enabling sustainable technologies. The platform aims at enhancing the department’s competitiveness for grant applications across programs in this and other fields. Based on identified strategic areas in the department such as ultrafast processes, quantum materials, photovoltaic materials, solar energy harvesting, hydrogen in materials, the platform will bring together expertise to use and develop techniques, instrumentation and light/particle sources. This provides a critical link between programs now reorganized into the materials science and theory units as well as partner within Uppsala University and (inter)nationally. |

### Implementation plan

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| --- |
| The development of instrumentation and methods is often high-risk in terms of time and output. It requires dedicated personnel. Therefore, long-term initiatives in this regard require shared responsibility within the department.  We plan to support materials growth and characterization tools, operate a central laser user facility (established with department and faculty funding), exploit the use of coherence and high spectral resolution at MAX IV and, on a 10-year timescale develop, build and operate a unique, medium-scale ultrafast x-ray user facility (https://indico.uu.se/event/1405/). A completed strategic I&A faculty hire in the latter research area will also benefit the development of other compact particle sources such as neutrons. Long term support of platform activities requires about 1 FTE/year per participating program from the department/faculty. |

### What previous accomplishments indicate a high likelihood of success?

|  |
| --- |
| We are developing and operating a central laser facility complementary the materials unit. These activities (funded by program, departmental and faculty) successfully attracted KAW funding to study light-matter interaction (PI at KTH theory in collaboration with I&A, theory & materials units). I&A is also leading a Röntgen-Ångström Cluster (incl. materials unit) to establish x-ray spin correlation spectroscopy at MAX IV. I&A has been active to utilize the European XFEL for materials research and we strive to attract new Swedish user groups to this growing research area via collaborations. |

## Current status of the area at Uppsala University

|  |
| --- |
| The department, including I&A and the materials unit, has a strong tradition in instrumentation development, tightly integrated with UU research on functional materials at the faculty, including collaborations with the UU Center for Photon Science. |

### Current and planned contributions to support the initiative

|  |
| --- |
| The I&A program commits substantial resources to this research area. We plan to continue strengthening this initiative with external funding in developing the methodology for utilizing ultrafast processes for sustainable materials science. |

## Strategic value

### Strategic value of the area in the global context

|  |
| --- |
| The strategic research goals within the department include ensuring access to qualified research infrastructure, consolidating local and enhancing Swedish instrumentation at international research facilities enabling new scientific opportunities. |

### Strategic value of the area at the next level

|  |
| --- |
| Access to and development of world-class facilities lays the foundation for strengthening our position as an internationally leading and attractive university. Infrastructure development is a strategic priority at the faculty. |

## Contributions needed for success

|  |
| --- |
| Consolidating the platform requires an additional 1 FTE for each of the participating programs, during a 5-year period. With I&A and materials unit programs, as well as the FREIA-lab and the Ångström Workshop we possess the necessary facilities. |

### Success indicators

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| --- |
| Success indicators for existing infrastructures will be the corresponding scientific output and new collaborations initiated by proof-of-principle studies leading to grant applications or infrastructure fund allocations. |

### First steps that can be taken today

|  |
| --- |
| The operation of the central laser facility is currently covered by the program professor’s startup funding and external grants. Beyond 2028 1 FTE/year support will be required. |

# Questions to the panel

The panel will provide feedback on research quality, strengths and opportunities for improvement, and comment and give feedback on staffing, funding, and at least one priority area.

**Instructions**: If you have specific questions for the panel that are not covered by those areas, please list up to three of them here. Please note that due to time constraints during the visit, not all questions may be answered.

|  |
| --- |
| (approximately 600 characters)  Question 1:  Question 2:  Question 3: |