KoF/ÖB 2024

Faculty of Science and Technology

Research Program Self-Evaluation

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| Research Program: | Condensed Matter Physics of Energy Materials |
| Department: | Department of Physics and Astronomy |
| Section: | Physics |
| Program Responsible Professor: | Håkan Rensmo |

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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
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# General information

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

## Process for creating this self-evaluation

**Instructions**: Describe the process to generate this self-assessment, how it was collegial, and list which categories of employees (e.g., Professors, ULs, BULs, postdocs, PhDs, researchers, etc.) were significantly involved.

Motivation: To emphasize that this is to be a collegial process and that all members of the program should be included.

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| 3 meetings with all members; contributions in open master document. 5 senior meetings to distribute and refine work for subsections. Weekly progress reports. Final draft meeting with all members. Priorities discussed across programs. The work builds on our biannual program kick-offs discussing subjects included. |

## Core of the research program

**Instructions**: Describe what makes the program a coherent research program. For example, shared methods, areas, questions, facilities, etc.

Motivation: To understand the essence of the program so that its plans and activities can be better understood in that context.

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| The research spans from fundamental to applied condensed matter physics, exploring atomic-level functionality for renewable energy solutions. Our strategy involves developing and implementing advanced X-ray photon science techniques, integrating them with emerging device research. |

## Personnel (data provided centrally)

**Instructions**: Postdocs who are on stipend should be listed separately in parentheses. (Example: if there are 4 postdocs on salary and 3 on stipend, please enter “4 (+3)”. )

Motivation: To understand the program’s personnel distribution by career stage and gender. This data shows the number of FTEs (full-time equivalent) employees in each category.

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made. Note that stipend postdocs are not present in the university salary system and will need to be manually accounted for if they are to be included. If this table is changed to add stipend postdocs, please note the changes in the “other important program-specific comments” section below as well.

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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 | 0.6 |  | 0.8 | 4.0 | 1.5 | 0.5 |  |  | 6.0 |
| **Male** | 1.9 | 3.0 |  | 4.9 | 3.8 | 0.3 (+1) | 6.0 | 0.2 |  | 11.3 |

## Finances

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

Motivation: To understand how a program is funded across the main sources of income. This data shows the long-term internal funding (FFF+SFO) vs. external (grant) research funding.

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made.

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| --- | --- | --- | --- | --- | --- | --- |
|  | **FFF+SFO Internal Research** | **Other Internal Research** | **Total Internal Research** | **External Research** | **Total Research** | **External Research %** |
| **2023** | 7.6  | 2.7  | 10.3  | 21.2  | 31.5  | 67% |
| **2022** | 7.5  | 2.5  | 10.0  | 15.8  | 25.8  | 61% |
| **Average** | 7.6  | 2.6  | 10.2  | 18.5  | 28.7  | 64% |

### Other internal research funding

**Instructions**: If the other internal resources category above is significant, describe where it comes from: e.g., co-funding for various grants, starting packages for Assistant professors, studiestöd, department resources given, special funds from the vice rector, etc.

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| Other internal research funding includes faculty support to PhD students (studiestöd of about 1.4 Mkr/year), ERC co-financing from the faculty and rector's funds and starting support to two lectures. |

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

**Instructions**: Explain the standard funding distribution between internal research funding (FFFs), external grants, and teaching that faculty (Assistant, Associate, Professor) and non-tenure staff (researchers, adjuncts) receive. Describe the policy for distributing internal resources (FFFs and other 210 funds, including studiestöd, startbidrags, and co-funding). Include a description of how faculty members at each level (Assistant, Associate, Professor) receive research support and are funded. Explain any implicit or explicit policies regarding holding external grants and allocation of internal resources. Include a brief overview of other uses of internal resources, for example: extra support for particular roles (e.g., PAP, FUAP), startup packages (for new faculty), allocation of studiestöd, department policies for FFFs or institution resources, funding of joint facilities/infrastructure, co-funding for grants, paying for PhDs/postdocs, etc.

Motivation: To understand how programs use their internal resources to support members and activities.

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| We offer 40% FFF support for all tenured faculty staff, 20% for the program professor and the division head, but none for dFUAP. Young researchers with grants like ERCs secure permanent positions. Starting packages are available for externally recruited faculty. "Studiestöd" strategically supports PhDs in areas utilizing and developing our infrastructure and engaging in interdisciplinary research. Under-financed grants with respect to overhead costs are typically covered by individuals using their allocated FFFs. We dedicate significant resources to develop new infrastructure and also allocate specific funding for laboratory duties running/developing the advanced infrastructures. PhDs and postdocs generally contribute to teaching (10%)  |

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

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

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Faculty Salary | Non-Faculty Salary | Other Personnel Costs | Premises | Equipment Depreciation | Overhead | Running Costs | Total |
| 2023 | 2.9 (34%)  | 1.7 (20%)  | 0 (0%)  | 0.5 (6%)  | 1.3 (16%)  | 1.4 (17%)  | 0.6 (7%)  | 8.4  |
| 2022 | 3.2 (35%)  | 2.4 (26%)  | 0 (0%)  | 0.4 (5%)  | 1.4 (15%)  | 1.5 (17%)  | 0.2 (2%)  | 9.1  |
| Average | 3 (35%)  | 2 (23%)  | 0 (0%)  | 0.5 (5%)  | 1.3 (15%)  | 1.5 (17%)  | 0.4 (5%)  | 8.7  |

### Personnel funding (data provided centrally)

Motivation: To understand how funding is used across different employment categories and genders. This data shows how staff are funded on average across internal and external research funding as well as teaching.

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made.

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| --- | --- | --- |
|  | Female | Male |
|  | Internal | External | Teaching | Internal | External | Teaching |
| Professor | 100% | 0% | 0% | 58% | 6% | 36% |
| Associate (UL) | 44% | 32% | 24% | 52% | 35% | 13% |
| Assistant (BUL) |  |  |  |  |  |  |
| PhD | 26% | 66% | 8% | 13% | 87% | 10% |
| Postdoc | 0% | 100% | 0% | 0% | 100% | 0% |
| Researcher | 90% | 0% | 10% | 23% | 77% | 0% |

### Major infrastructure usage

**Instructions**: Identify the five most significant research infrastructures used by the program. For this purpose, infrastructures are resources that are too expensive for an individual PI to afford and are therefore organized and funded as shared resources. Specify the level of sharing (program, department, university, national, or international) and whether it is located at Uppsala or elsewhere. Provide the approximate amount spent to pay for development of or access to the infrastructure each year, including both program funds and PI grant expenditures. Infrastructure costs should not include travel to the infrastructure (as travel for research is not infrastructure-specific) nor salary time while using the infrastructure (as research time is not infrastructure-specific), but can include salary costs of engineering staff and explicitly agreed upon in-kind salary contributions. If infrastructure is paid for outside of the program, specify who pays for it instead of the cost. (E.g., write “Faculty” or “VR”.) Note that it is not necessary to provide exact values, but please make an effort to be within ~10%.

Motivation: To understand what important infrastructure is being used and how much it costs and to support the faculty’s ongoing work on developing an infrastructure policy

Responsibility: PAP in discussion with program members, economic administrator for costs.

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| --- | --- | --- | --- |
| Infrastructure | Sharing | Location | Approximate Yearly Cost(MSEK) |
| HEILIOS Laser lab (in-house) | Program 80%, Department 20% | UU | 3 Mkr |
| HAXPES lab (in-house) | Programs 90%, Department 10% | UU | 3 Mkr |
| QUANTUM lab (in-house) | Program | UU | 3 Mkr |
| Uppsala Berlin joint Laboratory (UBjL, Bessy) | HZB/program | Berlin | 0.5 Mkr |
| Synchrotron work |  | Worldwide | 0.5 Mkr |

## Other important comments

**Instructions**: Explain any important issues not addressed above or misrepresented by the above data that need to be clarified for the panel to give valuable feedback. If the program has an important role in supporting the university or department, such as a mandate from the government or university, please describe it here. Please keep these precise and relevant.

Motivation: To bring important and special issues to the view of the panel and department.

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| 2 female UL recruited 22/23. We undertake significant leadership roles (e.g., dept. heads, deputy dept. heads, director of studies, div. head, unit head, education program leaders, large-scale facility management, WISE). This contributes to funding sources and affects distribution in 1.4.5. About 35 weeks/year beamtime. |

# Follow up on goals set in the last evaluation

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

## Reflections on accomplishments and setting goals this time

**Instructions**: Reflect on whether the goals from the last evaluation (ÖB Section D1 for programs and KoF17 Section 1b for departments) were appropriate in retrospect, what has been accomplished towards them since the evaluation, and what we can learn from them about setting effective goals this time. The previous evaluations [are available on the faculty KoF webpage](https://www.uu.se/en/staff/faculty/science-and-technology/the-facultys-research-evaluation---quality-and-renewal---kof24) to support this reflection for the programs, departments, and panels.

Motivation: Try to learn from what we did last time to be able to set more effective goals this time.

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| As per ÖB19, we aim to use large-scale X-ray sources (e.g., MAX IV) and in-house methods for atomic-scale control of matter, benefiting renewable energy systems. To focus our research, we split our previous research program into two programs. Our new program has effectively utilized this opportunity for recruiting 3 lecturers + 1 shared lecturer (3 female, 1 male) in battery, solar cell, catalysis, and quantum technology, including an ERC consolidator and a Wallenberg WISE fellow. Additionally, we have developed three in-house 15Mkr labs (HAXPES-interface analysis lab, HELIOS laser lab for ultrafast X-ray science, and QUANTUM lab for device physics) as well as established two beamlines on dynamics at the UBjL, Bessy. Bessy/Berlin. laboratory. |

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

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

## Main research areas

**Instructions**: List the largest research areas in the program, including approximately what percent of the program’s total research they cover, the approximate number of FTE faculty (Assistant/Associate/Professor, split according to their approximate activities and not double-counted), and whether the research is mostly Applied, Basic Science, or Mixed. These four areas combined should be broad enough to cover at least 75% of the program’s research activities.

Motivation: To understand the program’s research heterogeneity and how the program sees its own research profile and to help in assigning panel members.

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| --- | --- | --- | --- |
| Main Research Areas | % of program | FTE Faculty | Type |
| 1 | Energy material physics and applications | 30 | 2 | Mixed |
| 2 | Quantum Materials & devices physics | 10 | 0.33 | Mixed |
| 3 | X-ray Methodologies & Instrumentation | 30 | 2 | Mixed |
| 4 | Fundamental research using X-ray photon science | 20 | 0.66 | Basic Scien. |

## Research Activities

**Instructions**: Describe the key research activities in the program. This should focus on the types of research done, with the important results described later in the Research Results section. Briefly describe how the research is important for science and society. Describe how the program balances incremental (e.g., safe, easy-to-publish) research with higher-risk projects with more potential for breakthroughs. Note that the limited space will require prioritizing the text based on the main research activities listed above.

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

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| Many condensed matter systems in renewable energy, electronics, catalysts, and fuel cells require atomic-level understanding and make use of quantum effects. Our approach utilizes X-ray photon science (mainly spectroscopy), which we combine with device research to develop such understanding. Together with the program ‘Chemical and Biomolecular Physics’ we form the ‘Division of X-ray Photon Science’ and are in the forefront of X-ray methodology/instrumentation development. **The X-ray tools are used to bridge fundamental molecular and condensed matter physics with applied physics research, targeting energy and quantum materials associated with device physics.** Examples include functional materials for opto-electronics, photovoltaics, batteries, catalysis, and quantum devices. Exemplified by our 4 recent lecturer recruitments (3 Female, 1 Male) we increasingly focus on structure/electronic-structure relationships, energy conversion mechanisms and electron/spin dynamics in systems where interfaces, dimensionality, and quantum properties are important, and we are also increasingly including sustainability concerns.  Scientific breakthroughs are often linked to new instrumentation. Despite inherent risks, we undertake such challenges and mitigate them by capitalizing on our expertise in utilizing existing facilities and fostering interdisciplinary collaboration. **Central to the research is bridging model to real systems and static to dynamic ones**. Our recent in-house developments include the establishment of large in-house laboratories for functional characterization and with a total investment of 5 MEuros we have developed a **HAXPES** lab for interface characterization, a **HELIOS** HHG Laser lab for ultra-fast science, and a **QUANTUM** lab including a dilution refrigerator facility for device physics. We pioneer the use of large-scale infrastructure for energy and quantum material electronic structure and surface/interface characterization. Currently, we have **35 weeks/year of beamtime** at synchrotron facilities for studies on energy and quantum materials which include development of operando capabilities at HAXPES, APPES, XAS, HERFD beamlines. We have initiated and established **2 new beamlines** at BESSY Berlin through the Uppsala Berlin joint Laboratory (UBjL). One of us is Director of the MAX IV synchrotron facility, and we lead HAXPES beamline development at **MAX IV**. |

## Research Results

### Contributions to the field

**Instructions**: Describe the research results that the program is particularly proud of that indicate the quality and breadth of the research. Explain the importance of the program’s contribution to the field in the international context.

Motivation: Identify the results the program is most proud of and provide the program’s perspective on how important they are. This allows the panel to see how the program sees itself and provide feedback to help the program better understand how it is viewed internationally.

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| We develop and enable X-ray methodologies for innovative energy and quantum material research, both fundamental and applied. For example:(i) Our HAXPES/APPES (Hard X-ray/Ambient pressure PES) development enabled operando measurements on PV interfaces (e.g. following light induced reversable electrical field distribution and interfacial mixing) and on battery systems (following interface chemistry and liquid dynamics) on solid/solid and solid/liquid systems in operando. (ii) Our HAXPES/UbjL/HELIOS development enabled electron/ion dynamics at surfaces (we cover the range as, fs, ns-ms, s-min). (iii) Our QUANTUM-lab/HELIOS enabled spin dynamics measurements on films and in devices (e.g. world-record in spin transport in Graphene). (iv) Our HERFD/RIXS development enabled understanding of excited state/thermalization mechanisms and novel battery chemistry (e.g. anionic redox). Much work has large impact with very high citations in areas such as battery, solar cell, catalysis, spin dynamics (see e.g. publ. in Nature Journals). The X-ray meth./device physics approach generates an increasing no. of external grants.  |

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

Motivation: Provide an overview of how the program is performing that is reasonably comparable to other programs and departments. (See the Base Data definitions file for the meaning of each statistic.)

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| --- | --- | --- |
|  | Type of Indicator | 2017-2022 |
| Number of publications, full publication set (full / fractional counts) | Quantity | 286 / 66 |
| Proportion of publication fractions at the Norwegian model level 2 (%) | Impact | 33% |
|  |  | 2017-2021 |
| Coverage (fractionalized): Proportion of publications from DiVA included in citation statistics, weighted by fractional counts | Coverage | 89% |
| Mean normalized number of citations per publication (MNCS) | Impact | 1.11 |
| Proportion of frequently cited publications (top 10%) (PP(top 10%)) | Impact | 12% |

### 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.

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| Channel | Number  | % of Total Publications |
| Physical Review B | 27 | 9.4 |
| The Journal of Physical Chemistry C | 22 | 7.7 |
| Physical Chemistry Chemical Physics | 15 | 5.2 |
| ACS Applied Energy Materials | 11 | 3.8 |
| ACS Applied Materials & Interfaces | 10 | 3.5 |
| Journal of Electron Spectroscopy & Related Phenomena | 10 | 3.5 |
| Scientific Reports | 10 | 3.5 |
| Nature Communications | 9 | 3.1 |
| Journal of Materials Chemistry A | 7 | 2.4 |
| Advanced Energy Materials | 6 | 2.1 |

### 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  |
| Physical Review B | 27 | 9.4 | 13 | 50 |
| The Journal of Physical Chemistry C | 22 | 7.7 | 11 | 50 |
| Physical Chemistry Chemical Physics | 15 | 5.2 | 8 | 60 |
| ACS Applied Energy Materials | 11 | 3.8 | 5 | 50 |
| ACS Applied Materials & Interfaces | 10 | 3.5 | 8 | 80 |
| Journal of Electron Spectroscopy & Related Phenomena | 10 | 3.5 | 8 | 80 |
| Scientific Reports | 10 | 3.5 | 5 | 50 |
| Nature Communications | 9 | 3.1 | 5 | 50 |
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### Publishing impact on the field

**Instructions**: Describe the impact of the program’s publishing on the field by elaborating on the provided bibliometrics, the most frequent publishing channels, and the self-identified most important publishing channels. Explain the importance of the program’s contribution to the field in the international context. (See the Base Data definitions file for the meaning of the bilbiometric statistics.)

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| Since our research spans disciplines, our program publishes broadly in physics, chemistry, and materials science journals to engage internationally. Over the past five years, we have prioritized instrumental and methodological development, while still maintaining a competitive publication rate with about 50 papers annually (see above), and with an increased presence in high-profile journals. Our members' work is highly cited, and over 15% of publications in journals with impact factors exceeding 9, such as Nature, ACS, RSC, and APS. While emphasizing top-tier journals, we recognize the importance of PRB, J. Electron. Spectrosc., and Appl Mat. Interf. for methodological advancements. (3.3.4 lead author and % total are estimates) |

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

**Instructions**: Describe how the program interacts with the larger field in terms of its participation (e.g., through collaborations, professional organizations, positions of trust, etc.), recognition (e.g., through awards, keynote presentations, etc.), and leadership (e.g., through steering positions in international organizations, professional bodies, etc.) in the field. Explain the importance of the program’s contribution to the field in the international context.

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| We have a pivotal role in international collaborations, lead collaborative efforts (ERC, VR funded), UBjL and lead work packages (KAW/FLAG-ERA EU projects). We participated as external in about 15 PhD/year outside UU, serve and beam time applications at synchrotrons (Diamond, HZB/Bessy, PETRA III). One member is the director of MAX IV. We've been a main driver for a conceptual design report for a HAXPES-beamline at MAX IV and are now preparing a TDR. Invited conferences talks, participation in conference advisory boards. External evaluations (Synchrotrons/KAW etc.), recruitment boards nationally/internationally, obtain prizes and prestigious grants. This allows us to make strategic decisions as well as shape the trajectory of our field.Thesis committees |

## Synergies within the research program

**Instructions**: List up to three examples of synergies (interactions that provide more value than the individual contributions alone) within the research program itself that can be seen through specific on-going collaborations. Synergies can include using similar or complementary methods, facilities, partners, goals, etc. Briefly describe the synergy and extent of the current collaboration. Due to the limited, programs will need to work internally to identify the collaborations that are most important to the program.

Motivation: Identify how the program’s diversity supports its research.

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| --- | --- | --- |
| 1 | Type of synergy | *Synergies from expertise in complementing X-ray spectroscopic with device physics techniques* for in depth understanding of the electronic structure in energy and quantum materials (such as 2D materials and perovskites) and their devices for (opto-)electronic, spintronics, neuromorphic components and energy conversion. |
|  | Specificcollaboration | We develop spectroscopic methods together and apply them to different scientific questions sharing common goals, i.e. understanding device function from (evolution of) electronic and geometric structure interplay: in this manner we learn techniques together and results e.g. on 2D material oxide interfaces stimulate progress in battery/solar cell research and vice versa. Our PhDs become naturally exposed to results in neighboring areas of inquiry. |
| 2 | Type of synergy | *Synergies arise by relating different X-ray spectroscopies (RIXS/XPS/XAS/EXAFS-experiments) on fundamental materials and model systems to those on real-world energy materials* thereby gaining crucial knowledge and advancing the field qualitatively.  |
|  | Specificcollaboration | Collaboration between program members to develop *operando* XAS/RIXS at synchrotrons to study battery cathodes, anodes, electrolytes as well as photoelectrodes and catalyzers. . |
| 3 | Type of synergy | *Synergies in expertise for using HAXPES on different systems for development of operando HAXPES with focus on material understanding* |
|  | Specificcollaboration | Collaboration between program members to develop operando HAXPES in home-lab, at the department and at synchrotron: Used for understanding charge migration over interfaces, material degradation mechanisms and devices such as solar cells batteries etc. |

## Synergies across research fields

**Instructions**: List up to three examples of synergies (interactions that provide more value than the individual contributions) the research program has with research fields other than those of the program itself. Synergies can include using similar or complementary methods, facilities, partners, goals, working across theory/experimental, grants together with people in different fields, etc. These synergies can be here in Uppsala or at other universities. Provide the university (cross-field synergies within Uppsala are fine) and the different field, and briefly describe what the synergy is and the extent of the specific current collaboration. Due to the limited space, programs will need to work internally to identify the collaborations that are most important to the program.

Motivation: Identify current activities that are broader than the research programs to promote broader research initiatives and understand what is done across Uppsala vs. externally.

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| --- | --- | --- |
| 1 | University and Field | Condensed matter physics of Energy Materials (UU), Structural Chemistry (UU), Spectroscopy MAX IV (SR-facility, Lund), |
| Type of synergy | Joint research effort for deepening and developing operando spectroscopic tools for atomic level understanding of redox processes in liquid and solid-state polymer electrolyte batteries as well as electron dynamics in solar cell materials including 10 PhD-students funded from VR, Energy Agency, SSF, EC. This includes a shared University lector with the program Structural Chemistry at Chemistry - Ångström. |
| Specificcollaboration | Docent Maria Hahlin (shared), Professor Håkan Rensmo, Docent Andreas Lindblad, Docent Laurent Duda, Condensed Matter Physics of Energy Materials (UU), PhD. Robert Temperton, Alexander Föhlisch (HZB, Potsdam University), Ute Cappel (KTH until 2023), Prof DD Sarma (Indian Institute of Science), PhD Conny Såthe, PhD Andrey Shaworskiy LU and MAX IV (SR-facility, Lund), Prof Sam Stranks Cambridge |
| 2 | University and Field | Condensed matter physics of Energy Materials (UU), Solid State Physics (UU), Material Physics (UU), Materials Theory (UU), Electrical Engineering (UU) |
| Type of synergy | Spin, charge and orbital dynamics in quantum materials for their impact on next generation spintronics, orbital electronics and quantum matter. Interdisciplinary theory/experimental and X-ray/device physics projects. Projects funded by ERC, KAW, Energy agency, FORMAS, VR |
| Specificcollaboration | Venkata K. Mutta(UU), Andreas Lindblad(UU), Peter Oppeneer (UU), Olle Eriksson (UU), Annica Black-Schaffer (UU), Tomas Edvinsson (UU), Zhaojun Li (UU), Tapati Sarkar (UU), Biplab Sanyal (UU), Hari Srikanth, (University of south Florida), Andreas Rydh (SU), Olof Karis (MAXIV, LU,UU), Ronny Knut (UU). |
| 3 | University and Field | HAXPES at synchrotrons, LigHT platform at Tandem lab UU, ambient pressure XPS LiU, CTH |
| Type of synergy | Energy materials physics studied under varying ambient conditions and in operando using electron spectroscopies collaborative development UU, LiU, CTH, MAXIV via WISE |
| Specificcollaboration | Docent Andreas Lindblad, Docent Laurent Duda, Condensed matter physics of Energy Materials (UU), Prof. D. Primetzhofer, ion physics/tandem laboratory (UU); Prof. M. Fahlman, ITN, LiU; Doc. Julia Maibach, CTH |

### Reflections on synergies across research fields

**Instructions**: Reflect on the program’s initiatives and challenges with regards establishing research activities that cross between the program’s field and other fields. Are there particular benefits to such collaborations or particular costs? Describe the formal and informal initiatives the program takes to encourage these and the pros and cons of working within and outside of Uppsala.

Motivation: Understand how the program views its synergies across research fields.

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| We develop X-ray Synchrotron Radiation (SR) methods, collaborating within and between programs, introducing new users, exposing ideas to peer review and awarded competitively for about 35 weeks of beam time yearly. SR collaborations foster interdisciplinary idea exchange, and our in-house lab promotes cross-departmental collaboration, infrastructure development (LigHt at Uppsala University), and operando/ambient spectroscopy opportunities at MAX IV and BESSY. Shared strategies for X-ray-based and device physics infrastructure (e.g. with strong solar cell, battery, catalysis and magnetism groups) provide new opportunities and also support other program pursuits. |

## Reflections on ensuring good research ethics

**Instructions**: Reflect on the program’s initiatives and challenges with regards to ensuring good research ethics. Describe the formal and informal initiatives the program takes to teach and promote good research ethics across all research staff, and what particular challenges the program faces in these regards.

Motivation: Understand how the university’s priority for ensuring good research ethics is addressed.

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| Ethical and professional standards in research and education are actively discussed at kick-off meetings, covering topics such as data presentation, open data practices, reproducibility, author credit, and responsibility. Program meetings are also held to discuss new results and progress. |

## Reflections on creating and ensuring research freedom

**Instructions**: Reflect on the program’s initiatives and challenges to create and ensure research freedom. Describe the formal and informal initiatives the program takes to create opportunities for research freedom across all research staff, and what particular challenges the program faces in these regards.

Motivation: Understand how the university’s priority for ensuring research freedom is addressed.

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| Staff are encouraged to pursue independent research and initiatives while aiding in the development of common strategies. FFFs support offers tenured members some independence from external funds, and “studiestöd” reduces reliance on project grants. Interdisciplinary work is emphasized. |

## Reflections on research program size

**Instructions**: If the research program has 4 or fewer faculty (Assistant, Associate, Professor), describe the program’s process for ensuring a sufficient critical mass of faculty long-term, current and planned activities in this direction, and discuss whether there are other programs where collaboration could be of assistance. Similarly, if the research program has 10 or more faculty members, describe how the program works to develop a coherent research agenda and collaborations. If the program has between 5 and 9 faculty, describe if increasing or decreasing the size could be beneficial.

Motivation: A reasonable number of faculty members is required for research programs to achieve their purpose of providing a collegial environment that can develop and support diverse ideas and knowledge around a shared core research direction. For research programs with very few faculty, or very many, it is important to reflect on how this can be achieved.

|  |
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| 1 female+2 male Prof., 2.3 female+3 male Univ Lect. 3 permanent researchers (mainly for infrastructure), 2 senior Prof. 2 Postdocs and 14 PhD students. One Prof. is currently the director of MAXIV. Strategies are discussed and agreed upon yearly to enable us to contribute to the department strategy work. (See 4.1)  |

## Top external funding sources (data provided centrally)

Motivation: To see the amount spent on each financier during the year.

|  |  |  |  |
| --- | --- | --- | --- |
| Funding Agency | 2022 | Funding Agency | 2023 |
| Swedish Research Council (VR) | 5.9  | Swedish Research Council (VR) | 7.0  |
| Swedish Energy Agency | 5.0  | Swedish Energy Agency | 5.1  |
| European Research Council (H2020) | 3.1  | European Research Council (H2020) | 4.5  |
| Swedish Research Council for Sustainable Dev  | 0.7  | Carl Trygger Foundation | 1.5  |
| Carl Trygger Foundation | 0.6  | Wallenberg Foundation (KAW) | 1.2  |
| Swedish Agency for Innovation Systems (VINNOVA) | 0.3  | Swedish Research Council for Sustainable Development | 1.0  |
| Olle Engkvist Foundation | 0.1  | Swedish Agency for Innovation Systems (VINNOVA) | 0.3  |
| Wallenberg Foundation (KAW) | 0.1  | G Gustafssons stiftelse | 0.2  |
| Uppsala University Foundations  | 0.1  | Other private foundations | 0.2  |
| Other private companies (Swedish) | 0.0  | Olle Engkvist Foundation | 0.2  |

## External funding sources

**Instructions**: List the source and number of significant research grants to the program during the evaluation period. Include only grants that awarded at least 3M SEK to a program member and were active (used) during the evaluation period (2019-2023, inclusive). If a program member was awarded at least 3M SEK, but was not the PI on the grant, list the grant on a separate line and state “Co-PI”.

Motivation: This list complements the top external funding sources by providing consistent data for significant (>3M SEK) basic science grants available to all programs and by identifying the number of PIs vs. the total amount of funding. This is important as the absolute amount of money available to different fields varies enormously.

|  |  |
| --- | --- |
| 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 | 2 |
| KAW Project |  |
| KAW Scholar |  |
| WAF/WAFx | 1 (WISE) |
| VR Project | 9 |
| VR Starting | 2 |
| Other grants (may include field-specific grants and Co-PIs) |
| Swedish Energy Agency (PI, individual grants) | 5 |
| KAW Project (co PI) | 3 |
| Swedish Research Council for Sustainable Development | 2 |
| VR infrastructure (>8Mkr) | 2 |
| Swedish Energy Agency (large grants, co-PI) | 2 |
| The Swedish Foundation for Strategic Research (co-PI) | 1 |
| Swedish Energy Agency (co-PI) | 2 |
| WISE Academic projects for PhDs | 2 |
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## Reflections on external funding

**Instructions**: Reflect on what the program expects from its staff (Assistant, Associate, Professor, postdoc, and researcher levels) in regards to applying for and receiving external funding, how the program communicates those expectations, how the program supports staff in applying for funding through feedback and mentoring, and what opportunities and challenges the program sees in the future for continued and new external funding. Describe initiatives the program takes to form consortia to apply for larger grants.

Motivation: Connect how the program works with external funding to the achieved funding results.

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| Applying for funding, beamtimes, and other resources is expected from all program members. Strategies for such initiatives are discussed by all members at the biannual kick-offs: what is needed a) to maintain momentum, and b) for individuals to pursue research interests and develop careers.We conduct individual after-action reviews, especially after VR decisions, to enhance project presentation, planning, and research implementation. Additionally, we discuss strategies for larger consortia applications. Through these processes, we are collectively improving as observed by increase in external funding. |

## 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.

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| We open new research avenues in diverse collaborations across fields applying X-ray based methods to solve fundamental and applied problems. We continue developing applied research on PV, batteries, catalysis and have broadened our scope on quantum materials. We will continue X-ray studies of devices, and device relevant materials, in operando, under varying ambience, and evolution on different timescales (attoseconds-minutes). We have invested in QUANTUM Lab, HELIOS (laser pump-probe) and HAXPES-lab at home, UBjL abroad. These initiatives produce new science and enabling us to lead development of science cases for LigHt (with D. Primetzhofer, Ion Physics) and a HAXPES-beamline, MAX IV (in tech. design phase). Our strategy, formulated within the program, is updated yearly: new recruitments develop our directions. Thanks to this coherence we will produce new science based on our development of instrumentation/ methods for decade(s) to come. The goal to recruit (retain) female and international faculty has been successful and the ambition to further promote actions for improving the program gender balance remains. |

## 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 have identified areas where assistant professors need to be recruited. The process of identifying candidates needs to be underway (they are probably very early in their scientific career). Build networks/collaborations that attract more funding (e.g. European Funding) to execute scientific programs that are enabled by the infrastructure we have created (HAXPES-lab, QUANTUM lab, Laser lab) and will create in the short (LigHt) and mid-terms (HAXPES-beamline MAX IV). Elevate the competence around synthesizing/growing materials and combinations thereof so we can pursue lines of inquiry in parallel to our collaborators. The program needs to formalize and start new collaborations and deepen others (e.g. UBjL HZB/Berlin). For this we should look to ERC and other EU-funding where appropriate to grow there. With our industrial collaborations, shared PhDs and staff exchange should be sought to build stronger ties with longer time perspectives. |

# Area 2: Career Paths (evaluation of processes)

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

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

**Instructions**: Describe the implications of the current distribution of faculty across career stages (e.g., Assistant, Associate, Professor from Section 1) for the program currently and in the next 5 years. In particular, identify up-coming faculty retirements and/or recruitments and discuss and how the program plans to work with those changes to maintain the program’s core strengths as well as evolve in new directions.

Motivation: Provide perspective on the current status and future changes in personnel in the program.

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| See 3.8 on personnel distribution. KOF17 highlights gender imbalance as a challenge in the physics field. In five years, retirements and promotions in our program will bring parity to our professorial ranks. To maintain momentum, new recruits must cultivate existing strengths (X-ray methodology combined with energy materials) and explore emerging areas (sustainability, quantum device physics). Identifying key strategic areas ensures alignment with shared goals and readiness to seize opportunities (e.g., recruitment of a KAW WISE Fellow). Extending the BUL to 7 years post-PhD with a 6-year duration will enhance recruitment appeal at that level. Infrastructure support continues to be important for career development in our research field. |

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

**Instructions**: Pick a specific faculty-level recruitment during the evaluation period reflect on how the process of identifying the need for recruitment and focusing the research area worked. First describe the recruitment, e.g., Assistant/Associate/Professor-level and research area. Then discuss how the program worked to identify the need for a recruitment in this area, including discussing how the need was identified, how was it discussed and revised in the program, who was involved in the discussions, etc. For focusing the research area, describe how the balance between continuing existing areas vs. choosing new ones was discussed, who was involved in the discussions, what criteria were discussed to ensure that this direction would strengthen the program, etc. If the program has not done any faculty recruitments during the evaluation period, please reflect on how they would be undertaken.

Motivation: Explain how recruitments are currently motivated and decided

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| We develop renewal and recruitment strategies through (i) annual strategy discussions within the program and (ii) supporting candidates to apply for grants aligned with our strategies, securing permanent positions for successful ERC and Wallenberg fellow grant applicants. For instance, (i) we used opportunities in X-ray-based methods at MAX IV following a recent retirement. Emphasis was placed on encouraging strong female candidates, resulting in four women out of about 30 applicants being invited for interviews. (ii) Our international ERC and Wallenberg WISE fellow recruitments were developed as opportunities that aligned with our research strategies. |

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

**Instructions**: Describe:

* How the program defines what a top researcher/teacher is and how that is used in recruiting (criteria, descriptions, search groups, subject representative, addressing younger recruits who have the potential to become top, etc.),
* How the program balances recruiting external talent vs. promoting internal staff, and who is involved in these discussions and decisions,
* How gender and career stage balance is considered in program planning and recruitment decisions, and,
* What the program does to identify and encourage strong external recruits to join.

Motivation: Provide details as to what efforts are made to recruit and retain the best staff.

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| Search groups for tenured positions are mandatory. In our strategy document (reviewed annually in the program) we have identified areas for strengthening/change/grow. Positions are openly advertised allowing internal competition. We think: a top researcher/teacher have a clear profile, obtain grants and publishes based on experimental expertise, probably using SR methods. Young researchers: ability to plan experiments, obtain grants/beamtime, lead teams and deliver results are the keys. Teaching/pedagogical/ supervision ability are considered but the latter is not necessarily what young candidates have. We reach gender parity in 5 years. It is possible to identify external candidates that fit our strategies via collaborations. |

## Career support

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

**Instructions**: Describe the activities for supporting non-tenure-track (PhDs, postdocs, researchers, adjuncts, etc.) staff in their careers and development. For example: financial support for personal development, mentoring, grant assistance, feedback, career planning, help with job searches, etc.. Explicitly address what support is provided for obtaining the docent and distinguished teacher qualifications for post-PhD staff. Specify if activities are informal (e.g., expected as part of advising/mentoring) or formal (e.g., part of a regular process).

Motivation: Provide details as to how the program works with career development for non-tenured staff and encourage the program to reflect on whether it is providing the right type and amount of support.

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| Division kick-offs are partly devoted to career planning. Program members (PhDs, Postdocs, researchers, Assoc. Prof, Prof.) are expected to participate in processes that highlight important steps towards promotion (e.g. writing funding applications, strategy discussions). PhDs organize their own meetings, inviting alumni. Junior faculty (faculty level) activities focus on grant writing and career planning. Support for docent applications part of employment dialogue: a) pedagogical formal training, b) teaching volumes are built up effectively; non-tenured-track staff noneligible for distinguished teacher (DT) qualification, however basis for such can be laid earlier career stages. Informally, the DT in our program provides mentoring. |

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

**Instructions**: Describe the activities for supporting tenure-track staff (Assistant Professors) in their careers and development. For example: financial support for personal development, startup packages, mentoring, grant assistance, feedback, career planning, co-advising, etc. Include discussions of support for promotion (Assistant to Associate) as well as docent and distinguished teacher qualifications. Specify if activities are informal (e.g., expected as part of advising/mentoring) or formal (e.g., part of a regular process). If there are very few staff in this category, please reflect on why that is and if that is something that should be addressed.

Motivation: Provide details as to how the program works with career development for tenure-track staff and encourage the program to reflect on whether it is providing the right type and amount of support.

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| Guidance with supervision of PhD students (formally through supervision courses and informally through discussions with program professor), participation in strategy discussions as a preparation for future roles / positions, GU-coordinator aid to have a strategy to teaching experience and formal pedagogical development. Informal feedback and advice for docent and promotion applications from more senior program members. The change to 5 years after PhD instead of 7 for assistant professor positions made them a less viable option. The change back to 7 will make them a more attractive proposition in our planning. |

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

**Instructions**: Describe the activities for supporting tenured staff (Associate Professors and Professors) in their careers and development. For example: financial support for personal development, mentoring, grant assistance, feedback, career planning. Include discussions of support for promotion (Associate to Professor) as well as docent and distinguished teacher qualifications. Specify if activities are informal (e.g., expected as part of advising/mentoring) or formal (e.g., part of a regular process).

Motivation: Provide details as to how the program works with career development for tenured staff and encourage the program to reflect on whether it is providing the right type and amount of support.

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| Division biannual kick-offs include career planning sessions. Mentoring and planning for docentship/ associate professorship, professor and Distinguished Teacher (DT) roles part of employee dialogues as well during planning of the yearly work. DT qualification is supported by a TUR course; DT offers career support assistance. Grant writing feedback (individual) and after-action reviews (group) are organized for all academic levels. Participation in strategy processes and taking on trust positions are encouraged for career development. Informal collaboration is expected from senior members. Formal participation in leadership courses is encouraged. |

## 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.

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| Retreats involve everyone at our division where career planning is discussed at all levels; everyone is involved in program strategy discussions; we are clear that the balance between research, teaching, outreach and administration needs to be struck and constantly evaluated. These considerations are done in groups at the same academic level, sometimes in mixed groups to cultivate a culture of sharing and reflecting on experiences. Opportunities with regards to positions of trust within dept/elsewhere are discussed at bi-weekly division meetings. We enjoy a positive and open social climate with coffee (fika), kick-offs/wind downs and celebrates achievements together. All program members are involved in (and expected to) participate in strategy development at different levels, e.g. identifying/discussing research directions in this document. Division support opportunities for leadership in division and at the department/faculty. We created a shared UL with Chem-Ångström; thus created a sought precedent (p. 12 UFV 2018/1546, follow up KOF 17). We view this as a success and a possible way of fostering cross-disciplinary work.  |

## 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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| Reflect on career status with peers, and aided by seniors with insight into the process: as a start we plan a retreat focused on career planning for permanent staff (researchers, UL) tentatively autumn 2024 - this will provide directions and priorities that are individually tailored to each person, it will aid the head of division to identify e.g. teaching, positions of trust, time for formal training (e.g. 10 weeks pedagogical/didactic training), and importantly: who should not do certain things at their stage. We also gain in the equality sense by explicitly prioritizing this task both with time and participation by invited persons (e.g. head of department, director of studies) making sure that all co-workers at that level get the same information and can ask questions in a dedicated setting. This might be supplemented by similar retreats for non-permanent staff but for them initiatives exist at the faculty level (e.g. via Young Faculty). Staff exchange occurs, and could be expanded e.g. via STINT, Erasmus exchanges, sabbaticals. Create a (monthly) seminar to invite alumni, and collaborators. |

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

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

Collaboration and outreach (“samverkan” in Swedish) should be interpreted to mean activities that reach outside of the university to non-academic partners. Specifically, academic collaborations with other research organizations within academia should be considered part of our research and not collaboration and outreach for this evaluation. To help with this section, here is a partial list of the types of collaboration and outreach that we are striving to achieve:

* Joint research projects, student/PhD/postdoc/researcher/faculty exchanges/sabbaticals, etc.
* Advising/consulting, spreading research results/insights, popular science outreach and publications, press interviews, expert panels, etc.
* Interactions with industry, government, schools, society, media, etc.
* Academic entrepreneurship, including creating, joining, and advising startups and companies, etc.
* Feedback of external ideas, challenges, relevant questions, etc., into program(s) or departments.

## Specific collaboration and outreach examples

**Instructions**: Provide up to three specific examples of collaboration and outreach activities connected to the program’s research. Under “Example and connection” describe the activity and person or organization with whom the collaboration or outreach took place. (e.g., “Expert advice on SUBJECT for COMPANY”, “Popular science book on SUBJECT aimed at AUDENICE”, or “Interview on PROGRAM about SUBJECT”.) Specify the value to the program (e.g., “exposure to new challenges and issues that COMPANY experience on a practical level” or “making the SUBJECT expertise of our researchers visible to the nation”) and the value to the partner (e.g., “insight into how COMPANY can model the physical properties from the chemical composition” or “addressing public concern over the impact of SUBJECT on the environment”). Keep in mind the broad range of collaboration and outreach listed above.

Motivation: Provide a list of specific examples of collaboration and outreach activities to motivate the self-reflection below and to serve as a source of examples for others.

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| --- | --- | --- |
| 1 | Example and connection | International Science Programme (ISP) at UU: to assist low-income countries to strengthen research and education capacity in Physics. ISP has also a special program to promote girls’ access to higher education. |
| Value to the program | International collaborations and knowledge-exchange, getting new perspectives of challenges in different environmental and social contexts. |
| Value to the partner | Knowledge-exchange to build sustainable capacity for education and research activities resulting in a sustainable development of the country, alleviation of poverty and improving quality of life for many. |
| 2 | Example and connection | Education-related outreach:  BASE online workshop to highlight opportunities at large scale facilities for battery research and industry. |
| Value to the program | Creating new collaborations outside academia. |
| Value to the partner |  Knowledge in synchrotron-based research. |
| 3 | Example and connection | Collaboration with the Swedish steel industry via a joint project with Alleima and SWERIM. |
| Value to the program |  Industrially relevant materials and research questions. |
| Value to the partner |  Advanced atomic level information about their materials. |

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

**Instructions**: Use the above examples, as appropriate, to reflect on the program’s overall aims and strategies for collaboration and outreach and discuss what enabled the above examples (e.g., how were they first identified and initiated? How did they fit into the overall aims and strategies? etc.) and what it takes to keep them functioning well (e.g., staff, networking, meetings, equipment/labs/supplies, etc.).

Motivation: Understand what we need to create and maintain collaboration and outreach

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| Through our strong link with ISP, we support low and lower-middle income countries in enhancing research capacity in physics, thus promoting societal change and international collaborations. Our outreach approach is also exemplified by our participation in events like Uppsala's cultural night, a responsibility shared across the program. In addition, we have an outspoken strategy to increase our collaboration with industry. See example 2 above, where we drive some industrial research collaborations at MAXIV and example 3 where participation in a similar workshop was the first step to the industry collaboration. |

## Support for outreach and collaboration

**Instructions**: Describe the specific support resources and processes available to program members for outreach and collaboration towards non-academic actors, such as collegial discussions, meetings with external actors, etc. Describe whether the activities are formal or informal and whether they are managed by the research program, department, or faculty.

Motivation: Understand what support the program has for outreach and collaboration.

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| All outreach and collaboration activities are highly encouraged in the program, and we are prepared to invest time and resources on this, as illustrated in the examples above. The work with ISP is naturally of formal character. Other activities are driven via discussions during e.g. program meetings. We have one appointed faculty staff who coordinate the outreach activities in the program, especially focusing on reaching the society. Several PhD students are particularly engaged in these activities and coordinate outreach activities with support from the appointed staff. |

## 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.

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| Our connection with ISP is well developed and have led to a recent EU-application with partners in Laos and Cambodia. We are good at using opportunities, be they visits to schools (*e.g.* “Gymnasieambassadör”), hosting study visits in our labs, giving popular science lectures (e.g. Uptown Tech), explaining Nobel prices to journalists, or organizing courses for a wider audience (*e.g.* CeXS Introduction to x-ray and electron spectroscopy), promote science at Culture Night and SciFest. Our strategy to further industrial outreach confirmed that Swedish industry is interested in our advanced experimental techniques. This we know from: hosting online seminars, participation: AIM day, via inventory project funded by Tillväxtverket, via Vinnova projects with industry. We have performed proprietary measurements for companies at synchrotrons and in our HAXPES-lab and have ongoing collaborations with Alleima and SWERIM. Of particular interest to the Swedish industry is HAXPES, visible in the HAXPES beamline at MAX IV CDR, which several of us contributed to, one staff member is one (of two) spokesperson for the project as a whole. |

## 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 have a long-term collaboration related to the Swedish steel industry and we would like to find long-term collaborations with other industrial partners as well, for example within the areas of photovoltaics or batteries. For this reason, we are actively reaching out to industry, for example via the workshop in example 2 above. When we develop new instruments and methods we should integrate the knowledge from efforts in neighboring physics fields, especially time-resolved detectors and signal processing hardware. We have recently been interviewed about instrumentation needs for industrial users – the ideas there needs to be developed at both beamlines and in-house laboratories (HAXPES-lab, LigHt).  To facilitate and further develop this work we need to continue to support one appointed staff member that coordinates/supports outreach activities, keeps track of collaborations and continuously updates the webpage to increase our visibility. It is great that the outreach activities engage the PhD-students and we want to foster that initiative. |

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

Responsibility: PAP to communicate with all program members and the director of studies, discuss, prioritize, and collate. All program members to report and discuss.

The types of connections between research and teaching that we are striving to achieve include, but are not limited to:

* Activities that lead to a scientific approach and student progression in learning how to apply the scientific method within courses and throughout education programs
* Teachers who are active researchers take opportunities to develop their pedagogical skills
* Researchers who are active teachers and take opportunities to develop their pedagogical skills
* Students being trained to find, use, and evaluate research results
* Students being active in on-going research projects
* Integration of research results, methods, and facilities in teaching

## Main teaching areas

**Instructions**: List up to four teaching programs, course packages, or contract/continuing education that the research program’s members contribute to. Specify the level (e.g., bachelor’s or master’s), how much the members of the research program contribute to the teaching program based on the number of full courses taught and whether the teaching program is managed (e.g., the program coordinator/director is in the research program) by members of the research program (yes/no). For the number of courses taught, exact values are not needed. Instead estimate the teachers’ contribution in terms of full courses taught (e.g., 1.0 means the teacher taught the equivalent of one full course) and use the ranges of: <1, 1-5, >6 to simplify accounting.

Motivation: To show what subjects the program primarily teaches in.

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| --- | --- | --- | --- |
| Teaching program, course package, or contract/continuing education | Level | Courses Taught | Managed |
| Quantum technology program | Master | 1-5 | Yes |
| Engineering physics / Engineering programmes | Bachelor | 1-5 | Yes |
| Bachelor Physics Program | Bachelor | 1-5 | No |
| Surface Phys., Appl. Mol. Phys., Semiconductor Electrochemistry, Adv. Materials Analysis master courses | Master | >6 | Yes |

## Infrastructure use in teaching

**Instructions**: Please list any major research infrastructures that are used in teaching, the courses that use it, the education level, and the approximate number of students who use it each year.

Motivation: To understand what infrastructure is being used in teaching and to support the faculty’s ongoing work on developing an infrastructure policy

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| --- | --- | --- | --- |
| Infrastructure | Courses | Level | Students |
| HAXPES-lab | Adv mat analysis; surface physics; cond mat phys; intro to X-ray and Electron Spectrosc. (Contract education) | Master/Master / Bachelor | 40 |
| MAX IV / HZB | Synchrotron radiation; Adv. Mat. Analysis | Master | 30 |
| Quantum Lab | Appl. Mol. Phys., Surface Phys.; Cond Mat Phys., Spin based technology-I and II | Master | 5-15 |
| STM in the Quantum Lab | Surface Physics | Master | 5-15 |
|  |  |  |  |

## Specific teaching/research connections

**Instructions**: Provide up to four specific examples of how the program’s research has been incorporated into teaching activities or strengthened courses, and/or how teaching activities have been incorporated into the program’s research activities or strengthened the program’s research. Under “Example” describe the connection (e.g., “lab exercise using the facility X that exposes students to research technique Y”). Under “Course Info” specify the course name, program, level (introduction/advanced), and the approximate number of students taking it each year. Describe the value to the teaching experience from the research connection (or vice versa).

Motivation: Provide a list of specific examples of teaching/research connections to motivate the self-reflection below and to serve as a source of examples for others.

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| --- | --- | --- |
| 1 | Example | Lab exercises using the HAXPES-lab to analyze depth distributions using two X-ray energies. |
| Course Info | Surface Physics (Master Phys.), Adv. Materials Analysis (Engineering. Phys with Mat. Sci.). Atomic Measurements (Master Quantum Tech.) (all advanced level) |
| Value to teaching/research | Our PhD students get to supervise lab activities giving them the opportunity to reflect on and structure their knowledge and practical communication skills; such activities aslo gives the students access to research equipment where we have provided examples from our own research on how it has been used. Doing experiments in real settings adds depth to the course contents that cannot be replaced by a zoom-visit or literature studies. The students also need to be critical about the data analysis, understanding and curve fitting. |
| 2 | Example | Conductivity/Resistivity dependence on temperature in the Quantum Lab |
| Course Info | Condensed Matter Physics (physics bachelor program) |
| Value to teaching/research | The students in the course visit the lab and obtain data on conductivity vs. temperature measured on a 2D TMD-sample; besides getting insight into how it is practically done in a research laboratory they can compare the results to what is given in the course literature on ideal semi-conductors/metals. It gives PhD-students the opportunity to explain physics to bachelor students and it gives the students insight into what a experimental PhD-project could contain early in their education. |
| 3 | Example | AFM and STM in the Quantum lab, demonstrations |
| Course Info | Surface Physics (advanced level) |
| Value to teaching/research | The students have seen a lot of excellent AFM, STM pictures in literature and in courses with us they get a peek behind the curtain. The students get a demo of the AFM; The STM is in air and one needs to cut the tip oneself with a tool: if the STM-tip is not properly cut artefacts show up, if the tip is crashed into the sample one needs to start over. It is a great way to connect experimental physics to the theory of AFM and STM. |
| 4 | Example | Electron spectrometer / Mass spectrometer as examples of instruments where the Lorenz force from electromagnetism govern the function. |
| Course Info | Electromagnetism 1 (introductory level), engineering physics. |
| Value to teaching/research | This provides first year students examples of real advanced instrumentation that is used by teachers in the course for research. It highlights that the physics they know have very broad applicability and it is a good conversation starter about what kind of results we try to produce with such instrumentation. |

### Reflections on overall aims and strategies for connections

**Instructions**: Use the above examples, as appropriate, to reflect on the program’s overall aims and strategies for teaching and research connections and discuss what enabled the above examples (e.g., How were they first identified and initiated? How did they fit into the overall aims and strategies? etc.) and what it takes to keep them functioning well (e.g., staff, networking, meetings, equipment/labs/supplies, etc.).

Motivation: Understand what we need to create and maintain connections

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| Opening advanced lab infrastructure has enabled us to integrate our research activities into courses, engaging students and recruiting thesis candidates. Activities range from smaller, yet advanced setups to exposure to facilities like MAXIV. For instance, the in-air STM, funded by the program and department, is now utilized in multiple courses. Combined educational/research visits to MAXIV are done in projects where such resources are available. We have to remain active in promoting laboratory work to course responsible teachers. Students’ experiences are dependent on staff and PhDs ability to convey physics and hands-on skills. Here an ongoing discussions and reflections on didactics and pedagogy needs to be maintained. |

## Support for integrating teaching and research

**Instructions**: Describe the support resources and processes for integrating teaching and research available to program members such as collegial discussions, meetings with students, course reviews, teaching follow-up, etc. Describe whether the activities are formal or informal and whether they are managed by the research program, department, faculty, or teaching program. If there are no such resources or processes in the research program, then please reflect on whether that is something the research program or department should address under reflections below.

Motivation: Explain what support there is for improving the research and teaching connection.

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| Formally this is included in goals for teaching at the dept. Course reviews are organized at the dept. level with director of studies giving feedback on course reports. Educational programmes gives feedback to the dept. on courses. Didactic courses given at faculty level are a formal way to develop parts of courses - we encourage teachers to attend such courses as part of career development; at the div there are 3 distinguished teachers (1 in this program) that also serve as informal channels to discuss ideas. We look forward to develop and staff energy materials courses (fundamental to device physics) in the Master Materials, Quantum Tech., Phyisics and engineering programmes (F, Q) as part of e.g. the COMPEL initiative.  |

## 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.

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| We enjoy several formal positions of trust related to teaching: director of studies, program responsible master program, deputy program responsible for the engineering physics program. We have one distinguished teacher. Senior staff thus lead by example in prioritizing teaching. Teaching/outreach are seen as ways of communicating research as discussed between all members and related to career development. The scientific focus of our program lends itself to content creation in several physics courses. There is an informal exchange of ideas within the program especially supported by the outreach activities where a dialogue exists of what to show and how it can be demonstrated. It is natural for a researcher to consider what parts of one's research to utilize as examples. We engage in many courses at different levels and manage to allow PhD students to contribute developing new course content. This provides role models that can serve as informal mentors/leaders introducing new students to teaching particulars. The students also meet regularly and invite the director of studies to discuss teaching. |

## 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 need to evaluate if the master level courses specific to our program remain aligned to our strategic directions, but also fit into the students’ education under given resource constraints. We should identify introductory/intermediate courses important to the program and strive to attain more responsibility in these to increase visibility of the program to students and also become better at teaching those aspects of our field. The effort will then be more coherent. Course responsibility with several members joining the same courses: larger cross section for feedback, we can learn together and retain knowledge better. Introduce a formal channel to effectively do reflective practice: an after-action review should be done using the course report (that anyway need to be submitted) where course responsible persons report to the program (it can be 5 minutes at the bi-weekly meeting) about improvements implemented, how they were received and if changes need to be done. In this way we would learn as a collective from the efforts made by members in the program. |

# 5-year Priorities

**Instructions**: Identify, describe, and motivate specific Priorities that have a high likelihood of meaningfully strengthening or meaningfully broadening research over the next 5 years. The Priorities should be well-motivated and have sufficiently developed plans that it is clear what needs to be done to accomplish them and how to evaluate if they are successful. The Priorities can cover a wide range of activities with the overall goal of strengthen research, and do not need to require additional expenses. These can include, but are not limited to:

* Strengthening existing areas (e.g., to adapt to future challenges in the field or are necessary to maintain high quality, including by investing in new equipment, facilities, or staff, etc.)
* Investing in new areas (e.g., to adapt to changes in the field or new developments, by including investing in new equipment, facilities, or staff, etc.)
* Changing research organization by splitting, merging, closing, or moving research programs/departments (e.g., to improve collaboration or use of facilities or resources, etc.)
* Changing research policies (e.g., to address funding/co-funding, multi-disciplinary work, or recruiting, etc.)
* Changing research support (e.g., to improve grant success rates, recruiting, management, adoption of new techniques/technologies, etc.)

Building upon existing strategic plans is encouraged and co-funding/support from the program or department is expected to demonstrate commitment to the plan. There will be a yearly lightweight follow up process to see what progress has been made for each Priority with an opportunity to revise/change them as needed. The goals are to both ensure that we follow up on our stated Priorities and that we always have clear Priorities at each level in the faculty.

Each program is allowed to propose 3 Priorities: one that can be fully accomplished within the program, one that may require support at the department level, and one that may require support at the faculty level. This done to ensure that all programs will have at least one Priority they can work on as the very limited faculty funding available means only a few programs will receive additional resources.

Prioritization at the department level: Each department will review the Priorities from all of its programs and consider which to include in the department’s own list of Priorities, along with department’s own Priorities.

Motivation: Identifying Priorities encourages strategic analysis and medium-term planning within the program, and makes it easier for the department and panel to understand the programs’ own assessments of their needs and opportunities. Requiring two of the Priorities to be able to be accomplished within the program and the department emphasizes the need to work locally as well as at the faculty level.

Responsibility: PAP in discussion with program members.

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

## Description of the Priority

**Instructions**: Provide the department name (since these will be collected at the section/faculty level) and the program name (if this is a program Priority), the title of the Priority, and whether it may require department support (Yes/No) and/or faculty support (Yes/No).

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| Department: | Department of Physics and Astronomy |
| Program: | Condensed Matter Physics of Energy Materials |
| Title: | Developing and implementing advanced X-ray photon science methodologies, integrating them with emerging device research |
| Support: | May require department support: | [Yes] | May require faculty support: | [Yes] |

### Goal

**Instructions**: Specify the goal of the Priority, for example, to strengthen a specific existing activity or start a new one.

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| Strengthen the connection between fundamental and applied physics by developing and implementing advanced X-ray photon science methodologies, integrating them with emerging device research in the areas of energy materials (e.g. batteries) and quantum technologies. |

### Expected meaningful research improvement

**Instructions**: Provide a description of the research that investing in this Priority will accomplish over the next 5 years. Explain how it has the potential to significantly strengthen or broaden the program for program proposals or department for department proposals. Specifically, this should go beyond continuing or slightly enlarging current activities by having a clear description of what change it will accomplish.

Motivation: The overall goal is to strengthen our research. As a result, the Priority should deliver meaningful improvements in research quality and/or breadth.

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| Energy and quantum materials research is advancing rapidly on a global scale, with significant progress being made in understanding their properties at the atomic level. Current developments in X-ray facilities, exemplified by MAXIV, offer significantly improved performance, contributing to this advancement. Building upon our pioneering contributions to X-ray methodology, we aim to further strengthen the connection between fundamental and applied condensed matter physics, specifically exploring atomic-level functionality for renewable energy solutions. Enabled by our forefront accomplishments, our strategy involves developing and implementing advanced X-ray photon science methodologies and directly integrating them with emerging device research. We are planning to open two BUL/UL positions, which bridge fundamental and applied research in two key areas: (i) Applied battery physics with support from X-ray photon science tools. (ii) Quantum technology device development with support from X-ray based spectroscopy. The positions and implementation of (i) and (ii) is described in 8.1.3 below. |

### Implementation plan

**Instructions**: Provide a brief description of specifically what is planned to be done over the next 5 years to realize the potential of this Priority. For example: new hires, investments in equipment, starting collaborations, closing down existing activities, moving resources from existing activities, etc. Use the limited space provided here to discuss the most important aspects of how this activity will be carried out.

Motivation: For a Priority to be credible, there must be a plausible plan and what needs to be accomplished must have been thought through. It is understood that these plans will change over the next 5 years, however.

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| (i) Targeting applications in battery technology and electrification, we aim to strengthen our connection to MAXIV. Through the governmentally supported 200 Mkr COMPEL platform (COMPetitiveness for the ELectrification of the Transport System), we plan to open a BUL/UL position specifically focusing on new in-situ characterization opportunities at large-scale facilities like MAXIV. Additionally, we intend to hire shared (between programs) postdocs and PhDs to specifically address such opportunities within our HAXPES lab, MAXIV and the LigHt research platform initiative.(ii) This includes magnetism as well as spin-based charge transport applications. We have recently developed two major infrastructures in this area including a device physics QUANTUM lab (15 Mkr) and a HELIOS HHG laser lab (15 Mkr). Initially we will open a new program supported PhD position in this area that will be a collaboration between us and the Materials physics program. In the future we are aiming at attracting a BUL/UL that can bridge X-ray spectroscopy opportunities and device physics. |

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

**Instructions**: Describe what recent (last 5 years) accomplishments make it clear that the there is a good chance of success in this project. Use specific examples (e.g., grant X, collaboration Y, paper Z) and explain how those recent accomplishments are evidence of having the competencies needed to be successful in this project.

Motivation: For a Priority to be credible, the expertise and track record needed to support it must be present.

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| During the last few years, we have graduated a large number of PhD students and worked with postdocs in the area of energy and quantum material physics, bridging fundamental and applied research using X-ray spectroscopy. We have also successfully recruited lecturers in specific areas, including two focusing on X-ray studies for solar cell and hydrogen applications, and one specializing in device physics for quantum technology. In terms of battery research, we have been at the forefront of in-situ characterization and we work closely with the Uppsala battery group. Similarly, we are well integrated into the current Quantum Materials initiatives. |

## Current status of the area at Uppsala University

Instruction: Describe the current status of the area at Uppsala University as a whole. Include any existing funding, support, staff, and success in this area. Explicitly identify any overlap with other existing activities at the program(s), department, section, faculty, and/or university levels.

Motivation: To avoid duplicating efforts, it is important to understand the local Uppsala context when enhancing existing activities or starting new efforts. As part of the evaluation process, the panel will try to identify synergies between proposed Priorities.

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| The program has a unique standing in enhancing beamline & home lab methods and in integrating X-ray & device physics. In energy materials, we excel in X-ray characterization and collaborate closely with Uppsala battery research. Our device physics initiatives are deeply engaged in Quantum Materials projects. |

### Current and planned contributions to support the initiative

**Instructions**: Describe the current (already in-place and on-going) and planned contributions to this goal from the local level (from the program for program proposals, from the department for department proposals, and from both the program(s) and department, as appropriate, for program proposals selected by the department). For example, co-funding, in-kind support, shared funding of facilities, transfers of FFFs, etc.

Motivation: Evidence of financial commitment from the local environment strongly supports the proposal as being important. Conversely, if the local environment is unable or unwilling to support it, the importance to the environment as a whole is much weaker.

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| We are further strengthening internal PhD base funding in the described direction. With recent retirements and substantial external funding, we have additional support. Specifically, we are currently developing opportunities linked to the COMPEL initiative (see above). |

## Strategic value

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

Instruction: Describe the importance of the area in the global context. For example: fundamental challenges in research; new developments in research; societal challenges and priorities; global impact and importance.

Motivation: To ensure consideration of the larger context.

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| Materials and renewable energy are crucial for global development. Understanding materials and interfaces at the atomic level is essential for progress in these fields. Additionally, electronic structures are pivotal for the functionality of both energy and quantum materials. |

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

Instruction: Describe the importance of the area to the department (for program proposals) and for the section and faculty (for department proposals). For example: synergies with other activities, connections to teaching and collaboration, both currently and potential for new ones, etc. Explain the value of this activity beyond any overlapping ones identified above.

Motivation: To ensure that there is awareness of where this activity fits in at the next level up in the organization. This is particularly important if support is to be requested at that level.

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| 'Sustainable materials and material flows', and 'Fossil-free Energy' are among the 7 strategic areas at our faculty. Our approach is integrated into interdisciplinary research initiatives with shared grants, PhD students, and leadership in publications. |

## Contributions needed for success

**Instructions**: Identify what contributions are needed for success in terms of time, expertise, resources, facilities, staff, etc. Explicitly include estimates of financial resources needed and where they will come from.

Motivation: To ensure the costs and resources required have been thought through, and that they are reasonable given the scope of the benefit.

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| Running and further developing our in-house and large-scale infrastructures initiatives are of utmost importance, areas where we bear significant resource responsibilities. Without support for such infrastructure activities, it is challenging to sustain these developments. |

### Success indicators

**Instructions**: Describe specific results that will indicate success in 5 years. For example: increases in publications in top venues X and Y, publications in new field Z, strengthened or new collaborations with university A, new hires in B, new grants from C, etc.

Motivation: To ensure that the local- and faculty-levels will be able to assess whether this Priority was successful at the next evaluation so that we develop a positive cycle of following up on our strategic planning.

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| Indicators include continued leadership development, strengthening the connection between research, education, and societal impact, as well as achieving improved gender balance. Also enhance our presence in top-tier venues and continue to produce papers with enduring citation frequency. |

### First steps that can be taken today

**Instructions**: Describe the first concrete steps needed to move in this direction that can be taken today. These should be clear enough that they can be followed up on in a year to see what progress has been made. Identify initial activities that can be started locally to enable progress to help motivate further support for the larger goal. In the exceptional case where no steps can be taken today, explain why a Priority has been chosen that cannot be started.

Motivation: To ensure that there is a clear idea of how to get started and enable easy follow-up of how the Priority is progressing.

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| We are seeking candidates for positions in the field and are currently hiring researchers/postdocs associated with the new infrastructures. We are utilizing available resources to recruit PhD students who will specialize in linking X-ray and device physics in the aforementioned areas. |

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

## Description of the Priority

**Instructions**: Provide the department name (since these will be collected at the section/faculty level) and the program name (if this is a program Priority), the title of the Priority, and whether it may require department support (Yes/No) and/or faculty support (Yes/No).

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| Department: | Department of Physics and Astronomy |
| Program: | Condensed Matter Physics of Energy Materials |
| Title: | Instrumentation development platform. |
| Support: | May require department support: | [Yes] | May require faculty support: | [Yes] |

### Goal

**Instructions**: Specify the goal of the Priority, for example, to strengthen a specific existing activity or start a new one.

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| Strengthen the instrumentation and methodology development in-house and at large-scale facilities, particularly incorporating X-ray-based tools and functional materials/device physics advancements. |

### Expected meaningful research improvement

**Instructions**: Provide a description of the research that investing in this Priority will accomplish over the next 5 years. Explain how it has the potential to significantly strengthen or broaden the program for program proposals or department for department proposals. Specifically, this should go beyond continuing or slightly enlarging current activities by having a clear description of what change it will accomplish.

Motivation: The overall goal is to strengthen our research. As a result, the Priority should deliver meaningful improvements in research quality and/or breadth.

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| Scientific breakthroughs often arise from advances in instrumentation/methodology. Leveraging our strong tradition in developing X-ray spectroscopy tools, we aim to strengthen the connection between such X-ray tool development and functional materials/device physics. Our focus lies on renewable energy solutions such as batteries, PV, catalysis and IoT applications utilizing spin/magnetic properties.  Infrastructure developments will enhance our ability to thoroughly understand the conversion of energy among light, electrical (including spin), and chemical forms. X-ray based tools here contribute with element/atom specific information elucidating insights in electronic structure including interfacial energy matching, charge/spin dynamics and chemistry of outmost importance in the conversion process. This understanding facilitates the design of materials and devices within our program, the unit, and in collaboration with partners at Uppsala University and internationally. |

### Implementation plan

**Instructions**: Provide a brief description of specifically what is planned to be done over the next 5 years to realize the potential of this Priority. For example: new hires, investments in equipment, starting collaborations, closing down existing activities, moving resources from existing activities, etc. Use the limited space provided here to discuss the most important aspects of how this activity will be carried out.

Motivation: For a Priority to be credible, there must be a plausible plan and what needs to be accomplished must have been thought through. It is understood that these plans will change over the next 5 years, however.

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| **Instrumentation development platform:** Developing instrumentation and methodologies is often high-risk in terms of time and output. It still requires dedicated personnel. Therefore, long-term initiatives in this regard require shared responsibility within the department (and/or faculty) level. Our program needs include: (i) Develop the three large (5 million Euros investment to date, majority from external funding) in-house labs for functional characterization (HAXPES-interface analysis lab, a HELIOS Laser lab for ultrafast X-ray science, and a QUANTUM lab for device physics). (ii) Establishing a department/faculty-wide materials platform for studying light elements in materials, facilitating sustainable materials development and fossil-free energy opportunities. (iii) Developing operando capabilities at HAXPES and XAS/RIXS beamlines - of particular significance is our advancement of the MAX IV HAXPES beamline for operando studies of gas/liquid/solid interfaces, where we lead development as the foremost group in Sweden. Needs: (i) operation of larger in-house labs and (ii) resources for beamline development at MAXIV (1 FTE/year) |

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

**Instructions**: Describe what recent (last 5 years) accomplishments make it clear that the there is a good chance of success in this project. Use specific examples (e.g., grant X, collaboration Y, paper Z) and explain how those recent accomplishments are evidence of having the competencies needed to be successful in this project.

Motivation: For a Priority to be credible, the expertise and track record needed to support it must be present.

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| The Division of X-ray photon science, containing us and the Chemical and Biomolecular Physics program, pioneers cutting-edge X-ray spectroscopy tools across diverse research fields (e.g., AMO, Biophysics, Ultrafast Spectroscopy, Condensed Matter and Energy Material Physics). Recent development includes high-resolution RIXS/XAS at MAXIV, beamlines at BESSY II for high transmission/time-resolved measurements and an imaging RIXS spectrometer at European XFEL. We have also developed ambient measurement tools, tools for dynamic and operando measurements in-house and at large scale facilities. Significant progress has also been made in device physics. These efforts are supported by ERC, VR, SSF, FORMAS and KAW. |

## Current status of the area at Uppsala University

Instruction: Describe the current status of the area at Uppsala University as a whole. Include any existing funding, support, staff, and success in this area. Explicitly identify any overlap with other existing activities at the program(s), department, section, faculty, and/or university levels.

Motivation: To avoid duplicating efforts, it is important to understand the local Uppsala context when enhancing existing activities or starting new efforts. As part of the evaluation process, the panel will try to identify synergies between proposed Priorities.

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| The department, including us (The Division of X-ray Photon Science), has a strong tradition in instrument development (incl. beamline development at synchrotrons), tightly integrated with UU research on energy materials and quantum matter at the faculty, including collaborations with The Centre for Photon Science. |

### Current and planned contributions to support the initiative

**Instructions**: Describe the current (already in-place and on-going) and planned contributions to this goal from the local level (from the program for program proposals, from the department for department proposals, and from both the program(s) and department, as appropriate, for program proposals selected by the department). For example, co-funding, in-kind support, shared funding of facilities, transfers of FFFs, etc.

Motivation: Evidence of financial commitment from the local environment strongly supports the proposal as being important. Conversely, if the local environment is unable or unwilling to support it, the importance to the environment as a whole is much weaker.

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| The program commits substantial resources to instrument/methodology development, including depreciation and running costs (15% of internal research funding and 20% of the total budget). We seek to share responsibility for instrumentation development initiatives at the department/faculty level. |

## Strategic value

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

Instruction: Describe the importance of the area in the global context. For example: fundamental challenges in research; new developments in research; societal challenges and priorities; global impact and importance.

Motivation: To ensure consideration of the larger context.

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| Access to and development of world-class facilities lay the foundation for strengthening UU’s position as an internationally leading and attractive university. Infrastructure is a strategic priority at the faculty and its development enables providing scientific foundations for solving global challenges locally and internationally |

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

Instruction: Describe the importance of the area to the department (for program proposals) and for the section and faculty (for department proposals). For example: synergies with other activities, connections to teaching and collaboration, both currently and potential for new ones, etc. Explain the value of this activity beyond any overlapping ones identified above.

Motivation: To ensure that there is awareness of where this activity fits in at the next level up in the organization. This is particularly important if support is to be requested at that level.

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| Our strategy and department goals include ensuring access to qualified research infrastructure, consolidating local facilities, and enhancing Swedish instrumentation at international research facilities. This enables new opportunities in e.g. energy and quantum materials development. |

## Contributions needed for success

**Instructions**: Identify what contributions are needed for success in terms of time, expertise, resources, facilities, staff, etc. Explicitly include estimates of financial resources needed and where they will come from.

Motivation: To ensure the costs and resources required have been thought through, and that they are reasonable given the scope of the benefit.

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| Consolidating a platform requires a 5 year 1 FTE/program initiative, with support evenly distributed among program, department, and faculty. Within departmental research program activities in experimental/applied physics as well as the FREIA-lab and the workshop, we possess the facilities. |

### Success indicators

**Instructions**: Describe specific results that will indicate success in 5 years. For example: increases in publications in top venues X and Y, publications in new field Z, strengthened or new collaborations with university A, new hires in B, new grants from C, etc.

Motivation: To ensure that the local- and faculty-levels will be able to assess whether this Priority was successful at the next evaluation so that we develop a positive cycle of following up on our strategic planning.

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| Developing HAXPES-beamline CDR via TDR a beamline at MAX IV, opening user facility opportunities for ultrafast photon and device physics characterization: 2 program PhDs contribute yearly to publications. Creating a science CDR for a compact neutron source or other instrumentation. |

### First steps that can be taken today

**Instructions**: Describe the first concrete steps needed to move in this direction that can be taken today. These should be clear enough that they can be followed up on in a year to see what progress has been made. Identify initial activities that can be started locally to enable progress to help motivate further support for the larger goal. In the exceptional case where no steps can be taken today, explain why a Priority has been chosen that cannot be started.

Motivation: To ensure that there is a clear idea of how to get started and enable easy follow-up of how the Priority is progressing.

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| Consolidating current activities involve knowledge transfer through in-house and international collaborations. We facilitate shared supervision of PhD students utilizing the infrastructures and optimize infrastructure running costs. This makes us competitive in applying for funding and beamtime already. |

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

## Description of the Priority

**Instructions**: Provide the department name (since these will be collected at the section/faculty level) and the program name (if this is a program Priority), the title of the Priority, and whether it may require department support (Yes/No) and/or faculty support (Yes/No).

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| Department: | Department of Physics and Astronomy |
| Program: | Condensed Matter Physics of Energy Materials |
| Title: | Sustainable materials science – enabled by the LigHt infrastructure |
| Support: | May require department support: | [Yes] | May require faculty support: | [Yes] |

### Goal

**Instructions**: Specify the goal of the Priority, for example, to strengthen a specific existing activity or start a new one.

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| Strengthening a sustainability materials science platform (**LigHt**) for H or Li based clean energy systems, circular materials, and new technology solutions with young tenured staff. |

### Expected meaningful research improvement

**Instructions**: Provide a description of the research that investing in this Priority will accomplish over the next 5 years. Explain how it has the potential to significantly strengthen or broaden the program for program proposals or department for department proposals. Specifically, this should go beyond continuing or slightly enlarging current activities by having a clear description of what change it will accomplish.

Motivation: The overall goal is to strengthen our research. As a result, the Priority should deliver meaningful improvements in research quality and/or breadth.

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| We aim to accelerate materials design relevant to clean energy, circular materials, and sustainable technologies - enabled by use of the recently initiated **LigHt**-infrastructure. The **LigHt** infrastructure also complements the program’s research both in-house and at large-scale facilities, it will also connect to the dept. ultra-fast x-ray initiatives. The research will partly focus on systems involving light elements, H and Li, and will address concerns such as corrosion, catalysis, and recyclability as well as ion insertion in materials for energy storage, where dynamics at interfaces and surfaces are key for performance. The **LigHt**-infrastructure introduces unprecedented experimental methods combining advanced spectroscopy and spectrometry, along with integrated combinations for use on a wide range of inorganic and organic systems under in operando conditions. By applying methodologies and fundamental physics concepts, this platform facilitates the design of materials and device physics and strengthens research and collaborations within our program, the unit, as well as with partners at UU and internationally. |

### Implementation plan

**Instructions**: Provide a brief description of specifically what is planned to be done over the next 5 years to realize the potential of this Priority. For example: new hires, investments in equipment, starting collaborations, closing down existing activities, moving resources from existing activities, etc. Use the limited space provided here to discuss the most important aspects of how this activity will be carried out.

Motivation: For a Priority to be credible, there must be a plausible plan and what needs to be accomplished must have been thought through. It is understood that these plans will change over the next 5 years, however.

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| We are seeking long- and short- term additional resources from the faculty to consolidate sustainability themes in physics and broadly over the faculty. The **LigHt** infrastructure, integrated with the tools available at the TANDEM lab, includes SIMS, XRD, as well as extended pressure HAXPES, allowing simultaneous studies of element concentration, chemical state, and structure. (i) With a budget of 40 Mkr and 32.5 Mkr secured we seek co-financing for the platform. The platform will be available for all researchers at the faculty, necessitating dedicated researchers to run the facility. (ii) Consolidating applied surface physics on energy storage and heterogeneous catalysis requires support for a new assistant lecturer position (0.5 FFF).Importantly, this position complements initiatives from the Materials Physics program on hydrogen in materials and can benefit initiatives on catalysis using ultrafast spectroscopy. Additionally, the platform serves as an important asset in the research of our recent recruitments (3 female ULs) in the area of condensed matter physics of energy materials. |

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

**Instructions**: Describe what recent (last 5 years) accomplishments make it clear that the there is a good chance of success in this project. Use specific examples (e.g., grant X, collaboration Y, paper Z) and explain how those recent accomplishments are evidence of having the competencies needed to be successful in this project.

Motivation: For a Priority to be credible, the expertise and track record needed to support it must be present.

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| The Div. X-ray photon science, i.e. our program and Chemical and Biomolecular Phys., pioneer and leads the advancement of cutting-edge X-ray spectroscopy across a wide range of domains, including surface and interfacial physics. Recent developments (see e.g. 3.3.1, 3.3.5) include beamline development at MAX IV (Veritas, HAXPES-beamline CDR) and HZB/BESSY (CoESCA, LowDosePES). We have pioneered tools for ambient pressure, dynamic and operando XPS. In collaboration with Material Physics and Ion Physics/TANDEM lab we succeeded in obtaining a KAW WISE-platform: **LigHt**. Additionally, our senior staff leads projects in the intended domain that currently have support from ERC, VR, SSF, FORMAS, and KAW. Foundation. |

## Current status of the area at Uppsala University

**Instruction**: Describe the current status of the area at Uppsala University as a whole. Include any existing funding, support, staff, and success in this area. Explicitly identify any overlap with other existing activities at the program(s), department, section, faculty, and/or university levels.

Motivation: To avoid duplicating efforts, it is important to understand the local Uppsala context when enhancing existing activities or starting new efforts. As part of the evaluation process, the panel will try to identify synergies between proposed Priorities.

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| UU are strong both on clean energy and materials science. Our department has a strong tradition in instrument development, our division notably in X-ray methodology. We and our collaborators at UU to solve sustainability challenges by combining materials science with state-of-the-art X-ray analysis methods. |

### Current and planned contributions to support the initiative

**Instructions**: Describe the current (already in-place and on-going) and planned contributions to this goal from the local level (from the program for program proposals, from the department for department proposals, and from both the program(s) and department, as appropriate, for program proposals selected by the department). For example, co-funding, in-kind support, shared funding of facilities, transfers of FFFs, etc.

Motivation: Evidence of financial commitment from the local environment strongly supports the proposal as being important. Conversely, if the local environment is unable or unwilling to support it, the importance to the environment as a whole is much weaker.

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| The program has always committed resources to methodology development, including depreciation and running costs (currently 15% internal, 20% of total program budget). We have large activities in sustainability materials science including new initiatives within **LigHt**. We have to date provided 20% FTE in-kind to **LigHt**. |

## Strategic value

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

**Instruction**: Describe the importance of the area in the global context. For example: fundamental challenges in research; new developments in research; societal challenges and priorities; global impact and importance.

Motivation: To ensure consideration of the larger context.

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| Our department's goals include ensuring access to research infrastructure and this platform contributes with atomic level research of reactions and storage. Specifically, we aim to use the **LigHt** infrastructure to accelerate materials and device development and to contribute to sustainable technologies. |

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

**Instruction**: Describe the importance of the area to the department (for program proposals) and for the section and faculty (for department proposals). For example: synergies with other activities, connections to teaching and collaboration, both currently and potential for new ones, etc. Explain the value of this activity beyond any overlapping ones identified above.

Motivation: To ensure that there is awareness of where this activity fits in at the next level up in the organization. This is particularly important if support is to be requested at that level.

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| Access to and development of world-class facilities lay the foundation for strengthening UU position internationally and infrastructure is a strategic priority at the faculty. Research for sustainable societal development is also prioritized. This open facility will attract researchers from all over the world to UU. |

## Contributions needed for success

**Instructions**: Identify what contributions are needed for success in terms of time, expertise, resources, facilities, staff, etc. Explicitly include estimates of financial resources needed and where they will come from.

Motivation: To ensure the costs and resources required have been thought through, and that they are reasonable given the scope of the benefit.

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| The program seeks faculty funds (0.5 FFF) for an BUL position to develop the combination of materials and sustainability themes at LigHt. The constellation seek time-limited support to complete the platform for optimal operation (prog., depart. and faculty share costs of 7,5 MSEK depreciation+2,5 MSEK personnel) MSEK(personnel). |

### Success indicators

**Instructions**: Describe specific results that will indicate success in 5 years. For example: increases in publications in top venues X and Y, publications in new field Z, strengthened or new collaborations with university A, new hires in B, new grants from C, etc.

Motivation: To ensure that the local- and faculty-levels will be able to assess whether this Priority was successful at the next evaluation so that we develop a positive cycle of following up on our strategic planning.

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| Cutting-edge H/Li-related research using the platform, 2 program PhDs/yearly. Results on sustainability themes in top tier journals. Increased advanced grant success rate. Attract international recruitments /collaborators to our activities. Fertilize H/Li-related research at large-scale facilities. |

### First steps that can be taken today

**Instructions**: Describe the first concrete steps needed to move in this direction that can be taken today. These should be clear enough that they can be followed up on in a year to see what progress has been made. Identify initial activities that can be started locally to enable progress to help motivate further support for the larger goal. In the exceptional case where no steps can be taken today, explain why a Priority has been chosen that cannot be started.

Motivation: To ensure that there is a clear idea of how to get started and enable easy follow-up of how the Priority is progressing.

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| Merging the groups' clean energy, circular materials, and sustainable technologies research activities. Technical designs of the instrumentation and procurement of parts started. Cross-department collaborations start up their first projects. Information campaigns towards industry. |

# 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.

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