Center for
X-Rays in Swedish Material Science

Academic hosting of the Swedish Materials Science Beamline at PETRA III, Hamburg, Germany

2019 Organisational Report to The Swedish Research Council concerning grant 2018-6942

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Preface

Synchrotrons are considered to be a key research tool, which can enhance our understanding of material properties - both in basic and applied research.

Sweden has therefore invested significantly in such research infrastructures. Such investments include the MAXIV facilities in southern Sweden as well as at PETRA III, Hamburg, Germany.

The investments at PETRA III have been undertaken as part of contract between DESY and the Swedish Research Council (VR). This contract includes the building of a Swedish Material Science Beamline; and, from autumn 2019, provides Swedish organisations with 5300 hours per year of privileged access to beamlines at PETRA III.

The monitoring of Swedish access rights, and general safeguarding of Swedish interests at PETRA III, has been tasked to the host universities KTH and Linköping University - who have established the Center for X-Rays in Swedish Material Science (CeXS) for this purpose. CeXS ought to also undertake outreach and educational activities.

The inauguration of CeXS was held in August 2019. The Swedish Material Science beamline was commissioned and become fully operational during 2019.

This report provides information about Swedish interests and use of PETRA III as well as key CeXS activities during 2019.

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Summary

During 2019, 76 Swedish projects gained access to PETRA III. Of these 76 projects, 8 were friendly measurements during commissioning of the Swedish beamline and 6 were paid beam time contracts. Sweden's beam time access exceeded 6260 hours.

Many beamlines are of interest to Swedish researchers, with the Swedish Material Science beamline immediately attracting almost 20% of Swedish proposals and 1 paid Swedish project. At the Swedish beamline, 23 Swedish projects had at least 1714 hours of beam time access.

The Swedish material science beamlines also attracted non-Swedish users. People affiliated to organisations outside of Sweden led 10 projects, which had 930 hours of beam time access.

At PETRA III, submissions for Swedish beam time access were:

- Industry led in 1.4% of proposals, with industry being a co-applicant in 13.3% of proposals
- Research institutes led in 8.1% of proposals, with institutes being co applicants in 13.3% of proposals
- Universities led in 90.5% of proposals.

There were 200 Swedish users registered at Petra III. 12% are professors, 51% have a PhD and 32% have either the title of Mr, Ms or a MSc, Dipl. qualification.

Swedish researchers were co-authors of 60 papers published in 2019 with results from beam times at PETRA III. CeXS stimulated the publication of 3 outreach articles, collaborated with SWEDNESS in organising a PhD course, co-organised an industry workshop and held numerous talks at workshops and conferences.

A key issue to flag is the current plan to upgrade PETRA III to PETRA IV, where the Swedish beamline would be relocated. To avoid relocation, requires a 'scientific excellence' proposal by the end of 2020. CeXS is concerned about a lack of resources for such work.

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1. Background

The Swedish Research Council (VR) has invested in PETRA III at DESY in Hamburg. From autumn 2019, Swedish organisations have the contracted right to 5300 hours of privileged access to PETRA III; and, a Swedish material science beamline with two branches (P21:2 and P21:1) has been built.

In connection with these investments, The Swedish Research Council (VR) is also funding the hosting of the beamline, which is the task of this Center (CeXS).

VR has tasked CeXS with securing Swedish interests at PETRA III and collecting data about a) Swedish use of PETRA III and b) international's use of the P21 beam at PETRA III. CeXS should also arrange workshops and disseminate information about PETRA III opportunities to the Swedish material science community.

This report provides information relating to these tasks.

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2. Organisation

During 2019, a range of activities were undertaken in order to establish CeXS. The inauguration of CeXS was held in the morning the 14th of August 2019 at KTH. Two representatives from VR and most of the DESY management joined the inauguration. Around 70 participants from academia, institutes and industry attended.

The organisation of CeXS was also set in place.

2.1 Management Team

CeXS activities is now planned and implemented by the following people:

Director. Peter Hedström. KTH. 0.3 FTE
Vice Director. Fredrik Eriksson. LiU. 0.3 FTE
Manager. Denise McCluskey. KTH. 0.5 FTE

2.2 Board

The management team reports to a board, which sets the direction for CeXS. Board members are:

Jens Birch (LiU), Chair
Mikael Östling (KTH), vice Chair
Per Dannetun (LiU)
Annika Borgenstam (KTH)
Ulrich Lienert (DESY)
Conny Såthe (MaxIV)

2.3 Representation on PETRA III / Swedish beamline fora

The representative on the Swedish Material Science Beamline's Steering Committee will be Ulf Karlsson for a period of 2 years.

The representatives on the Swedish Material Science Beamline's Steering Group will be the director and vice director of CeXS. A per capcium decision will be made about the 3rd candidate. Gender diversity was a requested consideration by the Board.

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2.4 Processes

To establish the basis for meeting future obligations to VR, CeXS has learned about DESY's Review Process that allocates beam times, including how privileged beam time access is allocated (see here for the new process that will be instigated for the call that closed 1 March 2020)

CeXS also held discussions with DESY about providing the information needed to report data of interest to the Swedish Research Council.

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3. Data sources concerning Swedish use of PETRA III

DESY was open to releasing data of interest to Sweden in a way that was compliant with their GDPR obligations. Accordingly, the following data was provided for use in this report.

3.1 Available sources

1. A list of proposals from Swedish organisations

   This list includes proposals that were submitted for DESY's 1 Sept 2018, 1 April 2019 and 1 Sept 2019 deadlines. The reason for including proposals submitted Sept 2018 is that these were allocated beam time either in 2018 or 2019. Similarly, proposals submitted in Sept 2019 were allocated beam time in either 2019 or 2020.

   For accepted proposals, the scheduled beam time access dates and number of shifts at the beamline were also provided[1].

2. Commissioning access

   A list of projects that were granted friendly user access when commissioning the Swedish beamline was provided. The date of use, number of shifts and the names of users was provided.

3. Extract of proposals that had selected the "applying for privileged Swedish access" in the DOOR system

   This option became available during 2019. Extracts contained the name and organisation of the project leader, principal investigator and co proposers as well as the proposal's abstract, requested beamline and the method/experimental setup.

4. Number of instances where industry paid for access to PETRA III.

[1] Due to Covid-19, DESY closed its facilities from 23 March. At the time of writing, the opening date is unclear.

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5. A list of non-Swedish proposals that were allocated beam time at P21, the Swedish Material Science beamlines, during 2019.

   This data comprised the surnames of the project leader and principal investigator, the title of the proposal and the number of shifts allocated at P21.

   The list of organisations that obtained access was provided separately.

6. List of publications made by Swedish users in 2019

7. The number of Swedish users with particular qualifications/titles

   From the profile information that users provide to DESY, the number of users in 2019 with the title/qualification of Mr, Ms, BSc, DiplIng, MSc, PhD and Professor was provided.

3.2 Delimitations

The above data sources mean that there is limited or incomplete data concerning:

- Gender, especially comparison of gender distribution at the proposal stage and approval/use stage
- Academic discipline of the proposers
- Paid use of beamlines
- The affiliations of the project consortium (academic/research institute/industry) in proposals that did NOT select 'privileged access'

How the limitations in the data affect the analysis explained in the report below.

Note. For 2020 and beyond, CeXS will be invited to observe proposal review meetings, where proposal are ranked for use of the Swedish Material Science beamline. Such observations will entail additional access to data, which can address the above data shortcomings.

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4. Swedish applications and use of PETRA III

The DESY calls that enabled open research access to PETRA III during 2019 had deadlines in Sept 2018, March 2019 and Sept 2019. For these three call deadlines, a total of 218 Swedish proposals were submitted. Such proposals are evaluated on the basis of scientific excellence and the feasibility of the project.

For the Sept 2018 deadline, 84 Swedish proposals were submitted and 32 of these were accepted i.e. the success rate was 38.1%. For the 2019 deadlines, 134 proposals were submitted and 77 were accepted i.e. a success rate of 57.5%. Thus, the success rate of proposals increased by 19.4%[2].

More than half of the proposals, 74 out of 134, selected the "privileged Swedish access" option in the DOOR submission portal.

Of the 109 accepted open access proposals, 13 were allocated beam time access during 2018, 62 were allocated beam time during 2019 and 37 were allocated beam time for first half of 2020[1].

During 2019, in addition to the 62 open access projects, 8 Swedish projects gained access during the commissioning of P21 and 6 paid beam time contracts supported by VINNOVA were undertaken. That is, a total of 76 projects had access to the Swedish beamline and PETRA III.

During 2019, Swedish open access projects were allocated beam time for a total of 5862 hours. An additional 600 hours of beam time access was obtained for the 8 projects that took place during commissioning.

[2] Such an increase in success rate could be due to a number of factors. One possible factor could be the availability of the new Swedish beamline: new beamlines tend to have a higher success rate because they initially attract a fewer number of proposals. Another possible factor is that Swedish researchers may have focused on increasing the quality of proposals by delivering fewer proposals (84 proposals were submitted in Sept 2018, implying that 168 could be expected in 2019 - but only 134 proposals were submitted.)

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(There is no information about the beam time hours for paid use). Thus, Sweden's beam time access exceeded 6260 hours, which is 960 hours greater than contracted.

The percentage of accepted open access proposals that were allocated their requested beam time was 69.2% in 2018 and 59.7% in 2019. The median reductions were 2 hours in 2018 and 2019.

Many different beamlines at PETRA III are of interest to Swedish researchers. For the proposals submitted by the Sept 2018 deadline, the distribution of requested beamlines, normalised by the number of applications, is shown in Figure 1. The most requested beamlines were P22, P07, P03 and P64.

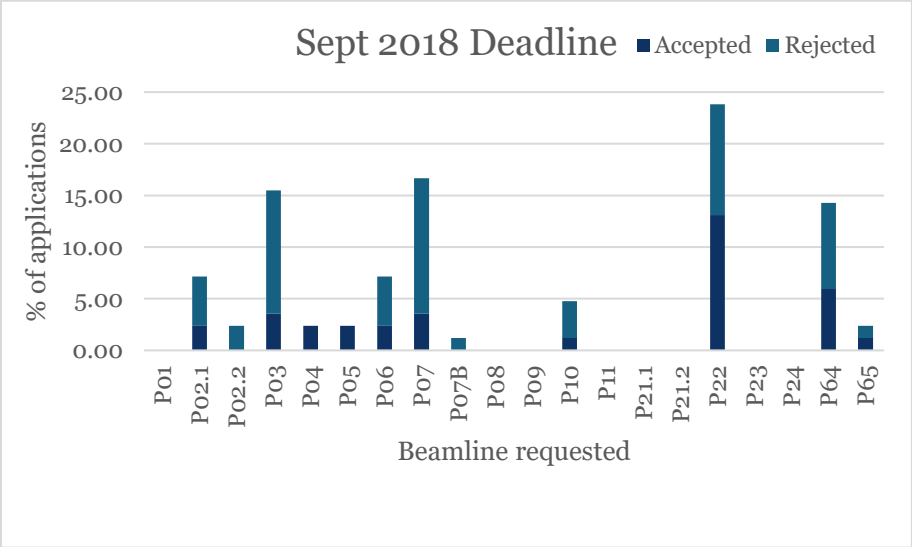

Figure 1. PETRA III beamlines requested by Swedish researchers in proposals submitted for the 1 Sept 2018 deadline. The number of proposals per beamline has been normalised by the total number of proposals submitted for the 1Sept deadline.

For the Swedish proposals submitted for both the 1 March and 1 Sept 2019 deadlines, the distribution of requested beamlines is shown in Figure 2. It is noteworthy that the Swedish Material Science beamlines (P21.2 and P21.1) became available during 2019.

Immediately, P21.2 became Sweden's most requested beamline at PETRA III. Almost 20% of all Swedish proposals applied to use this beamline, with 26.1% of the

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proposals that selected the "privileged access" option requested the Swedish beamlines.

P22 was the next most popular beamline, although requests for P22 declined by around 5% compared to Sept 2018. P03 was of interest for over 10% of proposals. Thereafter, other beamlines attracted less than 10% of requests for use by Swedish researchers.

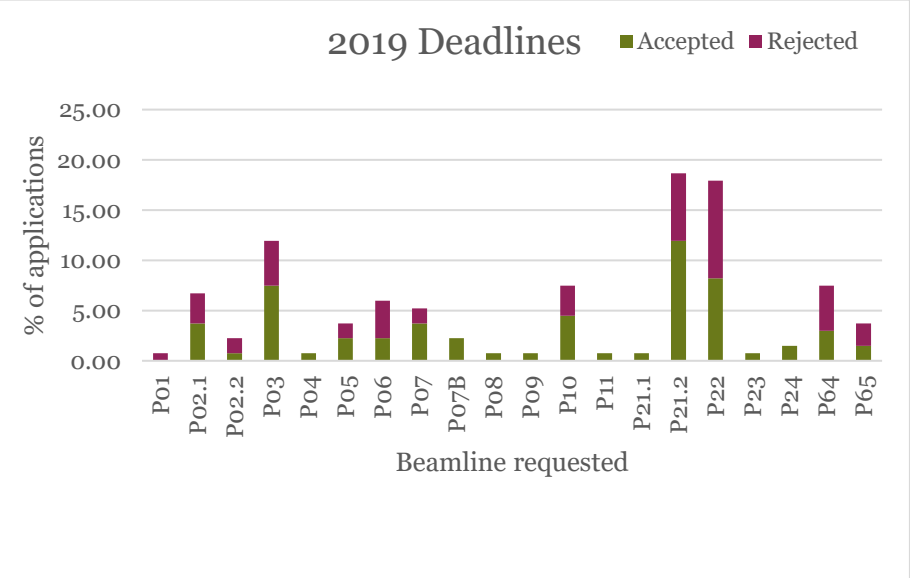

Figure 2. PETRA III beamlines requested by Swedish researchers in proposals submitted by 1 Sept 2018. The number of proposals per beamline has been normalised by the total number of proposals for 2019.

Accordingly, the Swedish beamline's introduction had an immediate impact on Sweden's use of the PETRA III facilities.

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5. The Swedish Material Science Beamlines at PETRA III

Commissioning of the Swedish Material Science beamline started in 2018 and included friendly user tests. Such friendly user tests started in December 2018 and took place during the first part of 2019. Thereafter, this beamline was under regular operations and has been judged to have functioned well by both the beamline manager and Swedish researchers[3].

5.1 Swedish open access interest and use of P21

During commissioning in 2019, 8 Swedish projects gained friendly access (1 project had already gained access in 2018).

35 (26.1%) of the 134 open access projects submitted in 2019 requested use of the Swedish Material Science beamlines, with 17 of these 35 proposals being granted access. Access for 10 such projects occurred during 2019 and it is planned that 7 projects will gain access during 2020.

In 2019, the 17 Swedish open access projects were allocated 1114 hours of beam time and the 8 Swedish commissioning projects were allocated 600 hours of beam time. Accordingly, Swedish use of the Swedish beamline was at least 1714 hours (hours for paid use is not available).

5.2 Paid industry use of P21

Paid access to the Swedish Material Science beamline took place during one project in 2019.

5.3 International use of P21

The Swedish Material Science beamlines also attracted non-Swedish users. 10 projects led by people affiliated to organisations outside of Sweden were granted access for a total of 930 hours.

These 10 international projects involved 21 universities, 11 institutes and 3 companies. The companies are suppliers of equipment/services related to large facilities. All organisations were located in Europe.

[3] As reported by Swedish users during the discussions at the Swedish P21 Users Workshop on 30 January 2020.

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Note. The average beam time use of non-Swedish projects was 93 hours (11.625 shifts), compared to an average of 68.56 hours (8.57 shifts) for Swedish projects.

The longer beam time use, and more diverse range of co-applicants, may indicate that the non-Swedish project proposals were of a more complex, scientific nature than the Swedish proposals.

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6. Industry, Research Institute and Academic use

Due to GDPR concerns, there is limited data about the distribution of academic, research institute and industry use of PETRA III.

The data in this section was obtained from the extracts of 74 proposals submitted in 2019 that selected the "privileged Swedish access" option in the DOOR submission portal. Since there were a total of 132 proposals submitted in 2019, the extracts represents 56% of all proposals. This issue of limited sampling will be resolved in reporting for 2020 by CeXS observing the proposal review and selection process.

6.1 Industry

Of the 74 privileged access proposals, industry led 1 (1.4%) proposal; and, industry employees were co applicants in 10 projects (13.3%). Of the 10 projects that had an industry co applicant, 9 projects were led by a university and 1 by a research institute.

Industry also paid for beam access in 6 projects at PETRA III, where 1 of these projects was conducted at the Swedish Material Science Beamline.

Industry was a user in one of the projects that took place during commissioning of the Swedish Material Science beamline.

6.2 Research Institutes

Swedish research institutes led 6 (8.1%) of the 74 open access projects, and were co applicants in 10 projects (13.3%).

During commissioning of the Swedish Material Science beamline, research institutes led 4 (44.4%) of the 9 friendly use projects.

6.3 Universities

Universities led 66 (89.2%) of the 74 open access projects, were the principal investigator in 2 of the institute led proposals and a co applicant in the industry led proposal.

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During commissioning of the Swedish Material Science beamline, universities led 5 (55.6%) of the 9 friendly use projects.

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7. Users' qualifications

In 2019, there were a total of 200 Swedish users registered at PETRA III, DESY. Each user provides their own data about qualifications or use the title Mr/Ms.

- 24 beam time users (12%) report they are professors
- 102 beam time users (51%) report they have a PhD
- 74 beam time users (32%) report a Masters, Bachelor, Diploma or use the title Mr or Ms

It is assumed that the latter 74 users are Masters/PhD students.

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8. Gender

The user qualifications section above illustrates that CeXS and PETRA III operations are undertaken by professionals with level 2 and above degrees. The concern about gender inequality within the university sector as a whole**Error! Bookmark not defined.** is also a relevant concern to our activities.

In the choice of university education, there is a clear gender segregation across two divides: the care-technical divide and the humanistic- scientific divide.[4] Popular fields of study for women in Sweden are stereo-typically 'female' i.,e within the "Health and welfare" and "'Teaching, Training and education science" disciplines.**Error! Bookmark not defined.** In Science & Engineering, less than 40% of students are women. Accordingly, women are underrepresented in the recruitment base for material scientists.

Government reports show that within the education system women tend to be segregated into teaching related duties and are underrepresented in research roles**Error! Bookmark not defined.**[,4,5].

Thus, a typical overall gender pattern is that women are:

- More than 60% of the undergraduate population
- Less than 40% of the under graduate population in science & engineering
- 40% of post graduate student population
- 20% of professors

However, we currently lack data about gender representation in material sciences in general and in the specialisation of high energy X-ray measurements. This is an issue that we will tackle during 2020 (see our Strategy and Implementation Plan).

[4]https://www.researchgate.net/publication/307864282_HORIZONTAL_AND_VERTICAL_GENDER_SEGREGATION_IN_HIGHER_EDUCATION_EU_28_UNDER_SCRUTINY
[5]http://www.aka.fi/globalassets/awanhat/documents/tiedostot/liitetiedostot/tasa_arvosuunnitelma_2010_2013_sv.pdf

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8.1 Board

In this context, with a board membership at professor level, one in six (16.7%) of the Board are female. This representation reflects the level of gender inequality in Science & Engineering disciplines within the Swedish University sector.

8.2 Management team

One in three (33.3%) of the CeXS Management team is female. This representation reflects the level of gender inequality in Science & Engineering disciplines within the Swedish University sector.

8.3 Applicants and Users

We currently lack such data and will tackle this issue during 2020 (see our Strategy and Implementation Plan).

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9. Education and training provided by CeXS during 2019

CeXS participated in the education of PhD students as well as outreach and training for industry users.

9.1 PhD education

Both CeXS partners, KTH and LiU, are 2 of the 6 partners in the SwedNess graduate school for neutron scattering. On 24-25th of May in Stockholm, a module in the graduate course "Neutrons for engineering" was held. CeXS contributed via lectures and laboratory exercises on the complementarity of X-rays. Ulrich Lienert, the manager of the Swedish beamline at PETRA III, was a guest lecturer.

9.2 Industry courses and support

CeXS was invited to hold a presentation at SSAB Borlänge. An "Introduction to synchrotron x-ray characterization for steels" was made on 1 October.

KTH coordinated a project application to EIT Raw Materials for a life-long learning project METALSF. This project aims to engage the metals industry in research utilizing synchrotron and neutron facilities. This application was granted and the project starts 2020.

CeXS initiated discussions with DESY and MAX IV industry offices on how to support Swedish industry.

CeXS initiated discussions with RISE and SWERIM on how to support Swedish industry.

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10. Publications and dissemination

During 2019, PETRA III users had scientific articles published and CeXS had outreach articles published.

10.1 Publications by users of Petra III

The number of peer review publications involving measurement data at PETRA III, where one of the authors was affiliated to a Swedish organisation, was 60 papers in 2019 and 53 papers in 2018.

DESY has flagged two concerns regarding publications:

- Users fail to register publications in their database
- It is taking a longer time to get from the beam time measurements to a publication. This is due to the time and expertise required to analyse the large volumes of data produced during the beam time experiments. That is, publications in 2019 most probably reported data captured in 2018 or earlier.

10.2 CeXS outreach publications

- Article about the inauguration of CeXS "Invigning av svenskt centrum för synkrotronljus" was published in the periodical Bergsmannen, 2019/05.
- Article about the SMS "Synkrotronljus ger unika möjligheter för materialkarakterisering" in the periodical Bergsmannen, 2019/03.
- Communication at the different KTH web platforms.

10.3 Workshops/conferences

- CeXS participated in the Swedish Neutron week 6th to 10th of May, Stockholm, and gave an invited presentation on "The Swedish beamline at PETRA III and the CeXS center".
- Invited presentation on "metallography using lab-scale and large-scale infrastructure", SWERIM's membership day 7th of November, Kista.
- CeXS gave an invited presentation "Synchrotron x-rays and neutrons for characterization of steels: introduction and examples" on Svenska Föreningen för Materialteknik (SFMT) annual workshop, Stockholm.

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- CeXS gave an invited presentation "Synchrotron X-rays for materials science and engineering: Introduction, Swedish beamline at PETRA III and research examples" at Luleå University of Technology, Luleå, on the 20th of December.
- CeXS started the engagement as part of the Swedish organising committee for the RACIRI 2020 Summer School, "X-rays and Neutrons for a Sustainable Future - Advanced Materials, Environment, Human Health", 23-30th of August 2020, Varberg.
- CeXS participated in the MAX IV user meeting 23rd to 25th of November, Lund.
- CeXS gave invited presentation on "High-energy X-ray characterization of metallic materials" for the LIGHTER Arena network on the 3rd of June, Lund.

10.4 Social media platforms

The web portal cexs.kth.se was launched. This included basic information about the Swedish beamline, proposal procedure, CeXS, etc. During 2020, CeXS will make increased use of social media platforms for community building purposes.

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11. Issues to flag

11.1 Suspension of measurements at PETRA III

Covid-19 virus concerns have led to the temporary suspension of beam time at PETRA III from Monday 23 March for an unforeseen duration.

This closure directly affects up to 36 Swedish projects that were planned between now and summer. Proposals submitted for the March 2020 deadline are likely to be indirectly affected depending on the duration of the closure.

When DESY is planning its reopening, CeXS will liaise with DESY about allocation of Swedish beam time hours.

11.2 Issue with revenues from purchased beam time

There is an issue with purchased use of beam time at the Swedish beamline: revenues are currently allocated to DESY - not the Swedish beamline.

CeXS activity: The Chair will contact DESY with a view of ensuring such revenues become available to the Swedish beamline.

11.3 PETRA IV planning - relocation of the Swedish beamline!

There is currently an ambitious proposal to upgrade DESY's PETRA III synchrotron to the 4th generation, namely PETRA IV. It is planned that this upgrade will occur from 2026.

The time taken to upgrade the synchrotron will be at least 2 years. Thereafter, beamlines will be commissioned based on their 'scientific excellence' priority.

A key issue is that the Swedish Material Science beamline currently has a low scientific priority. And, faces relocation. Thus, the closure period of the Swedish beamline is likely to be more than 2 years.

To reduce the closure period, and make the case for keeping the Swedish beamline at its current location - minimising the duration of the disruption as well as the

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'negative' image - a 'scientific excellence' proposal would be needed by the end of this year (2020).

CeXS will raise this issue with Swedish beamline community with the view of capturing Swedish needs and desired scenarios for the future. However, we're concerned that we do not have the resources to drive the writing of a scientific excellence proposal for the future of the Swedish beamline.

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12. Conclusions and discussion

12.1 Conclusions

Our conclusions are that Sweden's beam time access exceeded 6260 hours, which is 960 hours greater than contracted.

The newly commissioned Swedish Material Science beamline immediately attracted 20% of Swedish proposals and 1 paid project - changing Swedish use at PETRA III.

Industry has paid for beam time use for 6 projects, led 1.4% of proposals and been a co applicant in 13.3% of proposals. Research institutes led in 8.1% of proposals and were co applicants in 13.3% of proposals. Universities are the largest user of PETRA III facilities, leading 90.5% of proposals.

There were 200 Swedish users registered at PETRA III. 12% are professors, 51% have a PhD and 32% are likely to be students.

Swedish researchers were co-authors of 60 articles published during 2019. CeXS stimulated the publication of 3 outreach articles, collaborated on a PhD course, and held numerous talks at industry partners, workshops and conferences.

12.2 Reflections on access to data

DESY has shared a significant amount of data that concerns Swedish interests at PETRA III.

Limitations in the data arose because of DESY's legitimate concerns that they also need to honour GDPR commitments to users/project applicants. Such limitations in data can be avoided in the future by CeXS participating in the proposal review process. DESY will open the review process to CeXS for observations, enabling more transparency in the process – and thereby enabling more trust that Swedish interests are safeguarded.

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DESY also took independent action to flag a potential misuse of the 'privileged access' by one proposal. DESY withdrew that proposal from the privileged access category and informed CeXS. (That project was not selected on the basis of scientific excellence.)

DESY will open the review process to CeXS for observations, enabling more transparency for safeguarding Swedish interests in the process for selection of projects for beam time use.

Accordingly, it is concluded that DESY is acting with integrity with regards to honouring their contractual commitments to VR.

12.3 Discussion of the flagged issues

Regarding the issue of revenue flows from paid beam time at the Swedish Material Science beamline, CeXS is confident that by raising this issue within DESY an agreement can be reached where revenues flow to the Swedish beamline.

Regarding the issue of Covid-19 disruptions of beam time, CeXS is confident that when the epidemic is over the Swedish research community will work together with DESY staff to re plan beam time access. Nonetheless, we will need to negotiate in order to minimise the extent of the reduction in beam time hours for Sweden.

Regarding DESY's plans to upgrade PETRA to its 4th generation - and move the Swedish Material Science beamline. CeXS considers that Sweden ought to support the upgrade to PETRA IV otherwise we will have a beamline that is no longer state-of-the-art. Nonetheless, the upgrade would be a significant disruption to the Swedish research community during the proposed rebuilding of PETRA – especially if the beamline is relocated.

To prevent the relocation, a 'scientific excellence' proposal would be needed by the end of this year (2020). However, to prepare a proposal that is both well anchored and would be well received at DESY requires a significant amount of work. The challenges that we see include:

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- The diversity of interests within the Swedish community with regards needs of PETRA facilities

- The privileged access proposals predominately stated that they are applied research proposals - and conventional epistemology tends to regard applied knowledge as something that is distinct from scientific knowledge

The opportunity is:

- Nascent findings are the applied research is generating new scientific knowledge.

However, numerous examples needs to be thoroughly documented and the corresponding paradigmatic change in perspective about the nature of knowledge needs to become more widely accepted.

Accordingly, CeXS is concerned that we do not have the resources to engage in a paradigmatic discussion about the nature of knowledge as well as drive the writing of a scientific excellence proposal.

12.4 Way forward

CeXS will initiate discussions about the PETRA IV plans and implications for Sweden - and aim to secure additional resources to drive a scientific excellence proposal.

CeXS will continue to work with increasing awareness and competences in high energy X-ray measurements amongst the Swedish R&D community at universities, research institutes and industry.

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