

# **2<sup>nd</sup> Review of MAX IV's Project Management**

Report by appointed audit committee to the  
Swedish Research Council, February 2019

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# PREFACE

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The Swedish Research Council (Vetenskapsrådet) is a governmental agency with the responsibility to support basic research of the highest scientific quality in all academic disciplines. It is also part of the authority's remit to evaluate research and assess its academic quality and success. The Council for Research Infrastructures (RFI) at the Swedish Research Council has the overall responsibility to ensure that Swedish scientists have access to research infrastructures of the highest quality. Specifically, RFI assesses the needs for research infrastructures in a regularly updated roadmap (where a new version was released in 2018), launches calls and evaluates applications, participates in international collaborations and works on monitoring and assessments. MAX IV is a synchrotron facility under construction and partial operation in Lund, Sweden, of which the Swedish Research Council/RFI is the largest funder. The laboratory is building on the success of its predecessor MAX-lab.

In the summer of 2018 RFI conducted a review of the project management structure within MAX IV in light of the, in some cases serious, delays in the beamlines projects. The report was in several ways critical of how the management and board dealt with the project management and eight recommendations with corrective actions were proposed. To follow up on the implementation of these recommendations, and to investigate the current status of the project management methodology at MAX IV, another review was performed in mid-February 2019. The expert members of the review committee were largely the same as last time and consisted of Thomas Allard (chair), Jonas Modéer, Zahid Hussain and Wolfgang Drube – the Terms of Reference issued to the committee is here attached as Appendix 1. I am happy to see that the committee concludes that significant progress has been made by MAX IV in addressing the previous recommendations, and while significant work remains to be done I am convinced that the project is now moving in the right direction.

I would like to take the opportunity to thank the review committee for their tireless and excellent work, which has resulted in this report. Furthermore, the efforts of the management and staff of MAX IV is highly appreciated, both for preparing material for the review and being available for presentations, discussions and in-depth interviews.

Stockholm, March 2019



*Secretary General for  
Research Infrastructures (RFI)*

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# TO THE SWEDISH RESEARCH COUNCIL

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The present document presents the views and assessments of the audit committee members. By signing they take full responsibility for the report. The Chairman and secretary confirms that the work was conducted in accordance with the statutes of the Swedish Research Council and that it was performed in an impartial manner.

Lund, February 2019



Thomas Allard  
*Chairman*



Wolfgang Drube



Jonas Modéer



Zahid Hussain



Niklas Ottosson  
*Secretary*



Björn Halleröd  
*Secretary General for  
Research Infrastructures (RFI)*

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## EXECUTIVE SUMMARY

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Since the last review of the project management structure at MAX IV in the summer of 2018, significant progress has been made in almost all areas that were previously critically addressed. Most importantly, MAX IV is currently in the process of establishing a healthy project management methodology for completion and construction of its beamline projects. The chain of command within the project organization has also improved considerably, which is essential for successfully completing the beamline projects. Furthermore it is found that communication procedures, both within the MAX IV organization and with external stakeholders and users, also has improved considerably. While many of the acute problems identified by the review committee in the summer of 2018 are now under way to being resolved there are some areas that need special attention: Firstly, the project organization structure needs to be further developed and made more simple and lean. Furthermore, some specific remarks are made regarding the development of control software at MAX that appear to often become a bottleneck in the beamline constructions. Most importantly though, the committee is concerned about the slow pace of hiring a new permanent director of MAX IV. Physical science director Ian McNulty has done an excellent job as interim director over the past few months but must urgently be relieved to again focus on the science strategies of MAX IV. This is critical for both the long-term expansion of the MAX IV facility and for effectively deploying an impactful science program with the beamlines currently underway.

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# REPORT FROM AUDIT TEAM

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## Introduction

In the summer of 2018, the review committee was asked by the Swedish Research Council to review the project management structure of MAX IV, as a result of the significant delays in the beamline projects that had been unravelled. In our report “Review of MAX IV’s Project Management” from August 2018 we reported on significant deficiencies in the project applied management methodologies which did not allow for proper resource loaded schedules to be produced. This resulted in that neither time schedules, resource allocation plans to the different beamlines as well as costs were sufficiently known, causing considerable delays and friction within the organization. Therefore it is now, some 7 months later, very encouraging to find that significant progress has been made. A sound project management structure is being established for the construction of the beamlines, a clearer chain of command within the project organization is materializing and that communications, both internally within the lab and externally toward stakeholders and user, has increased in intensity and improved in quality. It is also noticeable that that the working morale has increased and the climate for discussion is more open since we last visited the facility. However, there are still areas that need special attention, which we address in the current report. First and foremost, the management team of MAX IV is understaffed, with physical sciences director Ian McNulty acting as interim director. As will be discussed below, this impairs the laboratory’s ability to act strategically in developing its scientific program and the board of MAX IV must urgently expedite the hiring of a permanent director. In parallel, the board must further assist the management to develop and finally decide on the new organizational scheme and procedures which further need to be developed –details will be elaborated on in the report below.

This report is structured as follows: First we comment on the corrective actions taken by MAX IV in response to the eight recommendations from our previous report. Thereafter we make some more detailed comments on the remaining deficiencies in the project management methodologies currently implemented. Finally, based on our findings, we give nine new recommendations to be considered by MAX IV, its board and its host, Lund University.

## Response to recommendations from the last review

The review committee acknowledges the significant progress MAX IV has made in several of the eight recommendations in our last report. Below we list each of the recommendations, followed by statements about how they have been followed up upon since August 2018.

- *First and foremost, a professional project management structure needs to urgently be put in place, along the lines explained above.*

We recognize that MAX IV is making significant progress towards implementing a professional project management structure. By interviewing staff it has however become apparent that the current model has its limitations and needs further refinement to become more simple and lean. The current proposed matrix organization is not sufficiently clear to the staff and needs to be refined and adequately communicated to and understood by the organization.

- *Proper resource-loaded schedules need to be developed. For the first 7 beamlines, where the majority of the projects are already executed, this should be done very rapidly which initially requires this to be done in a manual way. For the remaining long-term projects it should be done more thoroughly using best practices. Furthermore, weekly updates within the organization about the various project status is essential so that management and staff share the same picture about the current state of affairs.*

Significant progress has been made through the prioritization of the projects. For the phase I and phase II beamlines MAX IV has implemented a functional manual resource loaded-scheduling method. While highly useful it still needs to be further developed until fully resource loaded schedules can be established. For the phase III beamlines, fully resource loaded schedules according to best practices are currently being developed. The communication within the organization appears to have improved considerably so that staff and new management share the overall understanding of the situation.

- *When a lack of resources is identified to risk causing future delays the information must be taken through a clear chain of command, i.e. via the lab's management to the MAX IV board which needs to evaluate how required funds might be allocated.*

The chain of command within the MAX IV project organization has been made more explicit and the efficiency of communication has therefore improved. However, because of the remaining unclarity in the organizational structure (see above) the chain of command can be further clarified. The communication between management and the MAX IV board has also improved and the board is now more active in the interaction with the MAX IV management. The chain of command between the MAX IV board and the Lund University board should still be further clarified.

- *Implement software so that the actual spending per project can be followed. Currently the Swedish Research Council cannot be properly informed on what part of their operation support goes into the continued build-up of the delayed beamlines, which must change.*

This is not yet implemented and the review committee again recommends that MAX IV develops its financial system so that it accurately can keep track of spending versus work breakdown structure and schedules. This will allow for an accurate control of the full cost of the construction of a beamline at MAX IV.

- *Project (Beamline/s) management structure needs to be part of the organizational chart. Separate out operation (scientific staff, engineers, etc.) from beamlines development. Some staff may play role in both but it should be minimal and assignment for each section needs to be clearly defined.*

This is another area where significant progress has been made and a governance structure for managing project development is being developed. However, the review committee still wants to underline that the organization structure could be further refined to better meet the requirements of the new project management structure – for example, common pooled resources (e.g. engineering, KITS, etc.) could be placed under an own umbrella and not be spread out throughout the organization – the committee understands that such discussions are on-going.

- *It is essential that specifically for all delayed beamlines there are strict control of any change in scope (of course, reducing the scope is fine if the user and stakeholder agree to it). The science continues evolving and as time passes project scientists are easily tempted to add new capabilities. This should be contained and left as future upgrades.*

The review committee has the impression that this recommendation is being implemented. It is good to see that baseline specifications are being defined for each beamline. However, it is important that at the start-up of the user program, at least minimal experimental capabilities are available for doing *impactful* science.

- *All significant changes to the project scope and delays need to be effectively and timely communicated to both the funding agencies, other stakeholders, and present as well as future users.*

The communication around the MAX IV project has significantly improved, both internally and externally. The review committee note that the head of the communication department is not part of the management team, which is something that MAX IV could consider in order to facilitate an efficient flow of information.

- *The board should be very active in the near future and have a mix of members that can judge the progress from both scientific and MAX IV-development point-of-view.*

We recognize that the board has been much more active since the last review. The board must however give clearer strategic guidance to management and we encourage the board to meet more often during this critical transition period in getting the beamline suite into operation. Furthermore it is essential for the success of the MAX IV project that the board quickly relieves the hardly pressed and understaffed management team, both in providing the right guidance regarding specific questions and by expediting the process of finding a new permanent director of the laboratory in order to facilitate a renewed focus on a visionary scientific program of MAX IV (see new recommendations below).

## Project management in the beamline projects at MAX IV

The development of a project organization suited to manage the challenges is on its way to be implemented at MAX IV. The organization should however be able to rapidly respond to deviations from the planning and we therefore find the proposed organizational structure a bit too complicated and recommend simplifying and shorten the communication lines by including the Central Project Office (CPO) in the Management Team. One uncertainty factor was the distinction between Beamline Manager and Project Manager for a beamline project, which should further be elaborated on – overall the nomenclature within the project organization should be simplified and be better established within the laboratory. For the beamlines entering commissioning phase the previously recommended quick and straight forward project planning method with “pen and pencil” has proven to yield a good result. For use in planning of future beamline projects (including the Phase III beamlines DanMAX, ForMAX and MicroMAX), programs like Microsoft Project were mentioned, which in our opinion should be sufficient for the size of these projects. Other areas to be improved are the Work Break Down Structures (WBS) when planning the projects. This allows the finance department to easily follow the cost of the projects and be transparent to funding organizations over the spending profile. This would however imply that a suitable program for tracking cost to time and resources through a WBS would need to be implemented as the current methodology does not allow this.

## Changes required to minimize impact of delays

As it is understood from the presentations by and in the subsequent interviews with the MAX IV staff, a reoccurring bottleneck in the project completions is related to software development, primarily in the control systems. Although the review committee does not have strong specific recommendations on how to address these issues, we recommend MAX IV to take this matter most seriously and try to develop mitigation strategies. One possible way of speeding up the process could be to benchmark the process against other institutions to investigate if there are more standardized software/procedures rather than developing most functionality from scratch.

## Current timeline for beamline projects

The reliability of the presented schedule of MAX IV has significantly improved due to the good work done so far within the organization. There are still some considerable uncertainties but the awareness and openness to the problems is better. The review committee is pleased to hear that several additional beamlines are now coming into operation or entering commissioning phase. However it is understood that most of the beamlines have only reached a baseline technical configuration, meaning that only a limited range of functionalities are available. We therefore assume that there will be considerable pressure from the user community to further develop and complete the beamline programs. We urge the organization to clearly define the baseline capabilities for the beamlines and start to make clear and transparent plans for the upcoming upgrades needed in order to make the best use of the coherence of the beams delivered by the pioneering MAX IV accelerators.

## Outlook toward the upcoming science program at MAX IV

MAX IV has pioneered modern synchrotron accelerator technologies through the development of a novel concept of magnetic structures in the storage rings, known as multi-bend achromat (MBA) lattice. This technology provides near-diffraction limited synchrotron radiation with very high brilliance and coherence. MAX IV is currently operating with the lowest emittance of any storage ring in the world and is thus providing the highest coherent power of synchrotron radiation. This puts MAX IV in a unique position to facilitate a new and truly revolutionary class of science. The review committee believes that MAX IV must capitalize on their pioneering development for doing innovative science before other light sources that have already started adapting the same MBA concept will do so first (see Appendix 3 for an example of the type of science that the review committee considers would be highly suitable to be conducted at MAX IV). The Science Advisory Committee (SAC) of MAX IV is also stressing this point as stated in their 2018 report, “Finally, it should be pointed out that the next couple of years represent a window of opportunity for MAX IV as a unique diffraction limited source. Currently, several synchrotron facility development programmes towards diffraction limited sources are under implementation or in planning, including the ESRF upgrade programme. ESRF will close down in December 2018 for 20 months. After the upgrade, ESRF will become an extremely bright source with four new state-of-the-art beamlines fully

exploiting the brilliance and coherence of the upgraded light source in addition to the already upgraded beamline program, presenting strong competition for MAX IV.” We strongly share this view expressed by the SAC.

## Summary and recommendations

To conclude, the audit committee would like to put forward the following new recommendations to MAX IV and its board:

- MAX IV should formalize a procedure for clearly and consistently defining the baseline (“day one”) capabilities of each beamline going into operation, which need to be shared with the stakeholders and communicated to the user community. The timeline for the completion of the beamlines to the full specifications should further be defined.
- We recognize that the acting director holds a two-folded portfolio in his hands. Because of the urgency in completing the delayed beamlines the scientific management has been more occupied with organizational and project development and therefore could focus less on establishing the scientific program. However, it is essential that the MAX IV management now pays full attention to the scientific program as this will be crucial for the future success of the facility.
- The review committee has been informed that the MAX IV board has appointed a search committee and opened up the position for a permanent director of MAX IV. The committee strongly urges the board to expedite this process as this is delaying the establishment of the scientific program of MAX IV.
- MAX IV needs to develop a visionary scientific strategic plan which makes the best use of the coherence of the beams delivered by the pioneering MAX IV accelerators. The time-window of opportunity is narrow and there is an urgency to add experimental capabilities that fully utilize this coherence. This should be done with full engagement of the MAX IV user community, e.g. through dedicated workshops or individual interactions.
- We encourage MAX IV to further improve the proposed scheme for dealing with the matrix organization in the project management in order to make the whole organization aware of how the projects are managed.
- The board of MAX IV should take a more active role in communication with the laboratory’s management in setting up the new project organization and finally approve a new model.
- The head of the newly established Project Office should be part of the management team.
- A communication officer ought to be closely associated with the management team in order to facilitate effective communication, both internally and externally.
- MAX IV should look for best practices for a more efficient development of relevant software/control systems as it still is a bottleneck in the completion of projects.

The audit committee suggest that the Swedish Research Council periodically follow up on the implementation of these recommendations.

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# APPENDIX 1: TERMS OF REFERENCE

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## Background

MAX IV is the single largest commitment in the field of scientific infrastructures by the Swedish Research Council. Beyond large investment in the construction of the facility the Swedish Research Council is allocating 310 MSEK/year for the operations budget of MAX IV. During the summer of 2018 an audit team, on the request of RFI, reviewed the project management structure at MAX IV relating to the construction of the beamline park. This work resulted in a report containing a list of 8 recommendations to the laboratory and its board.

## Purpose and scope

The group should review the project management at the MAX IV facility, again with special attention to the beamline projects. The purpose of the review is twofold: Firstly, the Swedish Research Council and other stakeholders need to understand how the previously identified delays in the beamline projects are being dealt with and how the recommendations from the previous review are being implemented. Secondly, MAX IV should be given principle advice on how to deal with any potential problems identified during the review.

The review will be conducted during February the 19<sup>th</sup> of 2019, in agreement with the management of MAX IV. The background material will consist of relevant documents that MAX IV will be submitting on request of the Swedish Research Council (beamline status reports, Lund University KIA report on PRCC, comments on previous review outcome etc.), along with current updated resource plans – the material will be sent to the group when available, but no later than one full week before the review. The bulk of the work will be done at MAX IV, based on the interviews with management and other parts of the organization as the group sees fit. The findings of the group should be formulated in a brief report to the Swedish Research Council, addressing the questions listed below:

## Questions and perspectives

The following list of questions should be addressed by the group:

- How have the recommendations from the last review been followed up upon?
  - What recommendations have been properly addressed?
  - What recommendations, if any, have not been properly dealt with?
  - How could MAX IV better work with implementing the review recommendations?
- Project management in the beamline projects at MAX IV
  - How well is the new project management structure suited for the current situation?
  - How far in the establishment of proper resource loaded scheduling is the project? Is the overall construction and installation schedule detailed at a sufficient level to understand critical paths? (i.e. resource needs, critical paths for each beamline as well as for the full program in full user mode, critical allocations of resources during parallel installations of beamlines)?
  - What measures are being put into place to more accurately follow up the individual sub-projects?
- Changes required to minimize impact of delays
  - Are there still organizational changes that need to be implemented in order to deal with the delays in the beamline projects?
  - Should particular parts of the organization be strengthened (within existing budget)?
  - Are resources effectively used in all parts of the organization or could resources be redirected?
  - Are the recently steps taken at MAX IV to reprioritize resources suitable to deal with the issues at hand?
- Current timeline for beamline projects
  - How reliable is the current timeline given the present project management structure?
  - Are the plans for producing proper resource-loaded schedules realistic?
  - What additional procedures, if any, should be put in place in order to ensure that the current timeline for the beamline projects is kept?

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## APPENDIX 2: SOURCES OF INFORMATION

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The conclusions drawn in this report were based on three main sources of information, namely; i) a set of documents provided by MAX IV beforehand to the audit committee, ii) presentations given by the laboratory management during the audit session with following discussions, and iii) interviews with a number of critical persons in the laboratory staff. The list of interviewees, which in part was compiled by the lab and in part by the Swedish Research Council, is:

- Marianne Sommarin, Chair of Board
- Mugeni Nuamu, Portfolio Manager (Consultant)
- Annika Jerrebo, BO Group
- Marianne Helgertz, Finance Department
- Katarina Norén, Group Manager Safety
- Darren Spruce, Head of Controls & IT
- Conny Sâthe, Group Manager Spectroscopy I and VERITAS Beamline Manager
- Thomas Ursby, MicroMAX Beamline Manager
- Samuli Urpelainen, SPECIES Beamline Manager
- Marjolein Thunissen, Life Science Director
- Ian McNulty, Interim Director

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## APPENDIX 3: EXAMPLE OF POSSIBLE SCIENCE UTILIZING THE HIGHLY COHERENT BEAMS OF MAX IV

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The fundamental characteristics of coherent radiation is that the wavefront is uniform which provides the ability of probing the systems that are incoherent, i.e. systems that are heterogeneous and/or going through random thermally-driven spontaneous fluctuating motions (dynamical changes). Scattering of a coherent wavefront by an incoherent sample encodes the instantaneous heterogeneity into the scattered wave fronts through a speckle pattern which could be detected with a fast (down to nanosecond) time stamped detector. Such a measurement allows the study of dynamical fluctuation with a timing resolution down to nanoseconds (time of arrival of two consecutive photon pulses in SR). This timing resolution could be approximately 10,000 times better at MAX IV than what has been achieved so far. As a result, these experiments with a relevant time resolution of interest would allow the study of many system important phenomena, such as:

- Dynamics and kinetics in materials for studying the flow of energy and charges in chemical systems, ranging from simple atoms, clusters, liquids, solvated systems or more complex systems such as solid-liquid interfaces. All of these are important for developing a better understanding of energy-harvesting materials, artificial photosynthesis processes and for energy-storing capacity of batteries, only to name a few examples.
- Emergent phenomena in quantum systems, which may include unravelling dynamics and inhomogeneities of high temperature superconductors (an unsolved mystery for the last 25 years), topological orders in numerous class of topological materials that have potential applications in quantum computing and much more.