DNR: STYR 2019/362-3

Status of beamlines at MAX IV

December 2019

Beamlines at MAX IV

The first seven beamlines[1] at MAX IV were funded by the Knut and Alice Wallenberg Foundation (KAW) together with twelve Swedish Universities[2] in 2011. In 2012 Estonia and Finland funded the construction of the eighth beamline, FinEstBeAMS. These eight beamlines constitute the Phase I beamlines. In 2013, KAW and the Swedish Research Council (VR) funded the Transfer Package, three beamlines (SPECIES, FlexPES and MAXPEEM) consisting of moved and upgraded instruments from MAX-lab. In addition, VR also financed two new beamlines, CoSAXS and SoftiMAX. These five beamlines represent the Phase II beamlines. The Danish Agency for Science and Higher Education, the Capital Region of Denmark and the Central Denmark Region fund together with the Technical University of Denmark, Aarhus University and the University of Copenhagen, the DanMAX beamline. In 2017 KAW granted funding for the construction of the ForMAX beamline, and the Novo Nordisk Foundation (NNF) granted funding for the MicroMAX beamline. Currently, MAX IV has sixteen funded beamlines.

Status of MAX IV

The last report on the status of beamlines at MAX IV was submitted to VR in August[3] 2019. MAX IV accelerators are performing well and all three deliver X-ray light to beamlines. Twelve beamlines are currently taking light, four of which are in commissioning and eight in general user operation. Since the last report, CoSAXS beamline has received permission from the Swedish Radiation Authority (SSM) to take beam and started commissioning. Three of the four beamlines in commissioning, FemtoMAX, Species and FlexPES, are hosting expert users. During the next beamtime period starting in March, ten beamlines will accept general users. In the autumn call for proposals, MAX IV received 223 proposals requesting beamtime on the ten beamlines that will be open for general users in March to August 2020.

The FemtoMAX beamline currently runs at a 2 Hz repetition rate, but to serve general users it needs at least 10 Hz. The analysis for 10 Hz operation is extensive because it must cover both rings, the linear accelerator, and FemtoMAX. Once the permit is approved, implementing 10 Hz operation requires commissioning and conducting a radiological survey of all the accelerator systems as well as FemtoMAX. These latter activities cannot be performed without interruption to user beam delivery and must thus be planned during an accelerator shutdown period. Two radiation safety teams are now working in parallel to prepare risk analyses and radiation safety permit applications to submit to SSM for approval. One team focuses on permits for new beamlines, currently SoftiMAX and DanMAX, and the other focuses on the 10 Hz permit. We have developed a detailed plan and schedule for the 10 Hz project, coordinated with MAX IV operations, that will not reduce planned delivery of user beam. However, delivery of 10 Hz capability on the current schedule is at very high risk due to the project complexity.

VR performed the third review of MAX IV project management in November 2019. The report has not yet been published, but at the summarising closeout session, the reviewers concluded that further improvement in project management at MAX IV has taken place since the previous review in February 2019.

Since September, Ian McNulty is formally Director of MAX IV. Conny Såthe, group manager for the Spectroscopy group, is serving as interim Physical Science Director.

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[1] Balder, BioMAX, Bloch, FemtoMAX, HIPPIE, NanoMAX and Veritas

[2] Chalmers University of Technology, Gothenburg University, Karlstad University, Karolinska Institutet, KTH Royal Institute of Technology in Stockholm, Linköping University, Luleå University of Technology, Lund University, Stockholm University, Swedish University of Agricultural Sciences (SLU), Umeå University and Uppsala University

[3] Status of beamlines at MAX IV, August 2019, DNR: 2019/362-2, submitted to VR via e-mail to J. Holmberg and N. Ottosson 1 August 2019

Appendix 1 lists the current status of individual beamlines and current beamline development priorities with estimated dates to deliver baseline beamline capabilities. This list is based on updated status information from each beamline, the anticipated availability of resources for installation and commissioning of the beamlines, and prioritisation by MAX IV Management based on the above and expected user need. The listed dates are based on estimates made under the current circumstances. There is some risk that these may change as MAX IV mitigates the risks in the project portfolio. We will update VR if and as soon as changes appear necessary.

Appendix 1
Current status of individual beamlines

Status of beamlines at MAX IV

December 2019

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MAX IV beamlines

Beamline	**Funding agency*** (installation)	**Phase**	**Accelerator**	**Status** (2019-11-20)
Balder	KAW & Swe universities	Phase I	3 GeV	User operation
BioMAX	KAW & Swe universities	Phase I	3 GeV	User operation
Bloch	KAW & Swe universities	Phase I	1.5 GeV	User operation
CoSAXS	VR	Phase II	3 GeV	Commissioning
DanMAX	Denmark & MAX IV	Phase III	3 GeV	Installing
FemtoMAX	KAW & Swe universities	Phase I	Linac	Preparing SSM permit 10 Hz, commissioning 2 Hz
FinEstBeAMS	Estonia & Finland	Phase I	1.5 GeV	User operation
FlexPES	VR	Phase II	1.5 GeV	Commissioning
ForMAX	KAW	Phase III	3 GeV	Procuring, installing
HIPPIE	KAW & Swe universities	Phase I	3 GeV	User operation
MAXPEEM	VR	Phase II	1.5 GeV	User operation
MicroMAX	NNF	Phase III	3 GeV	Designing, procuring
NanoMAX	KAW & Swe universities	Phase I	3 GeV	User operation
SoftiMAX	VR	Phase II	3 GeV	Preparing SSM permit, installing
SPECIES	VR & KAW	Phase II	1.5 GeV	Commissioning
Veritas	KAW & Swe universities	Phase I	3 GeV	Commissioning

**KAW: Knut and Alice Wallenberg Foundation; NNF: the Novo Nordisk Foundation; Swe Universities: Chalmers University of Technology, Gothenburg University, Karlstad University, Karolinska Institutet, KTH Royal Institute of Technology in Stockholm, Linköping University, Luleå University of Technology, Lund University, Stockholm University, Swedish University of Agricultural Sciences (SLU), Umeå University and Uppsala University; VR. Swedish Research Council;*

Development priorities for individual beamlines

2019-10-25

Priority	**Risk**	**Beamline**	**Status**	**First Expert Users**	**First User Call**	**First General Users**
1	Very High	FemtoMAX (10 Hz)	Preparing SSM permit	Q2 2020	May 2020	Q3 2020
1	High	SoftiMAX	Preparing SSM, installing	Q1 2020	May 2020	Q4 2020
2	High	DanMAX	Installing	Q2 2020	Aug 2020	Q1 2021
3	Medium	ForMAX	Procuring, installing	Q4 2021	Feb 2022	Q4 2022
4	Medium	MicroMAX	Designing/procuring	Q4 2021	Feb 2022	Q4 2022
5	High	CoSAXS	Commissioning	Q4 2019	Feb 2020	Q3 2020
6	Low	Veritas	Commissioning			Q4 2019
7	Low	SPECIES	Commissioning			Q1 2020
8	Low	FlexPES	Commissioning			Q1 2020
9	NA	FemtoMAX (2 Hz)	Commissioning		NA	NA
10		Balder	User operation			
11		Bloch	User operation			
12		MAXPeem	User operation			
13		FinEstBeAMS	User operation			
14		NanoMAX	User operation			
15		Hippie	User operation			
16		BioMAX	User operation			

Current status of individual beamlines

Balder

Balder entered general user operation in September.

BioMAX

BioMAX is in general user operation.

Bloch

The Bloch beamline entered general user operation in August beginning with the ARPES endstation. Installation of the SPIN-ARPES endstation is ongoing. Commissioning of this endstation is planned for the first half of 2020.

CoSAXS

The CoSAXS radiation permit was approved by SSM in October. The beamline took first light and started optics commissioning at the end of that month.

Final beamline installation activities have started, and a beamline project risk analysis has been made in collaboration with CPO and support groups.

- Commissioning: on-going
- First expert users: Q4 2019
- First general users: Q3 2020

DanMAX

Front end installation is ongoing, and preparations for optics installation is progressing. The X-ray optics are in SAT and FAT with final optics delivery in November.

The dates below apply for the powder X-ray diffraction (PXRD) station and assume that there are no delays in the tight schedule. The Imaging station will follow approximately six months behind.

- Start of commissioning: Q2 2020
- First expert users: Q2 2020
- First general users: Q1 2021

FemtoMAX

FemtoMAX needs 100 Hz for the full scope of user experiments; however, some experiments can be performed at lower repetition rates. At least 10 Hz operation needs to be established for user proposal calls to be published,. The SSM permit application for 10 Hz operation is being prepared and submission is planned for March 2020. Once this permit is approved, we will need to commission the accelerator and perform an extensive radiological survey of the entire facility to operate it in 10 Hz mode. This is planned for May 2020. Meanwhile, technical commissioning activities and feasibility tests with expert users at 2 Hz continue.

- Commissioning 2 Hz: on-going
- Start of commissioning, 10 Hz: Q2 2020
- First expert users, 10 Hz: Q2 2020
- First general users: Q3 2020

FinEstBeAMS

FinEstBeAMS gas-phase and photoluminescence endstation are in general user operation. The solid state endstation is installed and waiting for PLC installation.

FlexPES

Commissioning of FlexPES is ongoing, and both branches have had expert users. FlexPES is scheduled to go into general user operation in March 2020.

- First general users: Q1 2020

ForMAX

The contract for the front end was signed in July 2019 with planned delivery June 2020. Contracts for X-ray optics are signed, delivery is expected in October 2020. The installation of the experimental station and infrastructure started in October according to plan. The review of the detail design for the scattering experimental station in September 2019 was successful.

- Start of commissioning: Q2 2021
- First expert users: Q4 2021
- First general users: Q4 2022

HIPPIE

HIPPIE is in general user operation.

MAXPEEM

MAXPEEM entered general user operation in August.

MicroMAX

The design of the infrastructure is complete and the finalisation of drawings is on-going. The contracts for front-end and radiation safety hutches are signed. Procurement for optics is planned to start at the beginning of December.

- Start installation: Q1 2020
- Start of commissioning: Q3 2021
- First expert users: Q4 2021
- First general users: Q4 2022

NanoMAX

The NanoMAX KB-station is in general user operation.

The development work of the NanoMAX FZP-endstation resumed in September 2019 after a year on hold. Design work is on-going with tests of the tomography prototype stage planned for December.

- Start of commissioning: Q2 2021
- First expert users: Q2 2021
- First general users: Q4 2022

SoftiMAX

The beamline vacuum system is installed, and PLC tests are planned at both the STXM- and CXI-endstation before the end of this year. The SSM permit application for SoftiMAX is being prepared and submission is planned for January 2020.

- Start of commissioning: Q1 2020
- First expert users: Q1 2020
- First general users: Q4 2020

SPECIES

During autumn the Species has been in commissioning with expert users at the APXPS end-station to prepare it for general user operation. First general users are scheduled for March 2020.

- First general users: Q1 2020

VERITAS

Veritas B branch line (open port branch) will enter general user operation in December. The Veritas A branch line is in commissioning with expert users.