

# Status of beamlines at MAX IV

August 2019



### ***Beamlines at MAX IV***

The first seven beamlines<sup>1</sup> at MAX IV were funded by the Knut and Alice Wallenberg Foundation (KAW) together with twelve Swedish Universities<sup>2</sup> 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, two beamlines received funding: 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 March<sup>3</sup> 2019. MAX IV accelerators are performing well, and all three deliver light to beamlines. Eleven beamlines are currently taking X-ray light, seven of which are in commissioning and four in general user operation. All five beamlines at the 1.5 GeV-ring now take light. Since the last report, the FinEstBeAMS beamline has joined the three beamlines BioMAX, Hippie and NanoMAX in general user operation. The SPECIES and FlexPES beamlines have both received permission from the Swedish Radiation Authority (SSM) to take beam and started commissioning. Two beamlines, Veritas and MAXPEEM, have had first expert users. During the next beamtime period starting in August - September, eight beamlines will accept general users. A call for proposals for general beamtime at ten beamlines from March to August 2020 will open 22 August. In total, 309 users (general as well as expert) made 371 user visits to MAX IV between 27 February<sup>4</sup> and 1 July when the summer shutdown started. Users came from 22 different countries and 79 different institutes or companies. The largest fraction of users during this period, almost 54 %, was from Sweden. Swedish users came from 22 different universities, research facilities and industries. The impact of MAX IV is starting to show as the first publications based on results from experiments made at the new facility are emerging.

As has been reported to VR during spring<sup>5</sup>, we must delay the schedule for FemtoMAX. The main reasons for this are to allow enough time to prepare the SSM permit application for 10 Hz, which requires more effort and time than was initially expected, and to schedule the accelerator commissioning and facility-wide radiological survey during an accelerator shutdown period. We are currently planning the commissioning and survey steps for the January 2020 shutdown and to begin commissioning of FemtoMAX in early 2020. However, there is still a significant risk in this schedule due to the expected complexity the SSM permit application for 10 Hz operation of the accelerators.

To strengthen project management at MAX IV, implementation of the central project office is progressing. The MAX IV project process is defined and will be implemented throughout the organisation during autumn 2019, the first steps being weekly activity project pulse, project milestone criteria and governance structure. For critical pooled resources, a resource-loaded time

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<sup>1</sup> Balder, BioMAX, Bloch, FemtoMAX, HIPPIE, NanoMAX and Veritas

<sup>2</sup> 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

<sup>3</sup> Status of beamlines at MAX IV, March 2019, DNR: 2019/362-1, submitted to VR via e-mail to J. Holmberg and N. Ottosson 1 March 2019

<sup>4</sup> Date for statistics in last report

<sup>5</sup> E-mail from Ian McNulty, MAX IV; to Niklas Ottosson (cc: Björn Halleröd and Johan Holmberg) at VR, 8 May 2019

plan is being used and continuously updated. Project risk work has started on three beamline projects and will be implemented during autumn.

The report from the second review of MAX IV project management performed by VR in February 2019, showed that considerable improvement in project management within MAX IV was made since the previous review in July 2018.

During the summer shutdown, which is currently on-going, maintenance and installation work takes place. The major projects planned for this summer are the installation of the DanMAX insertion device and corresponding beamline front-end, installation of an improved version of the multipole injection kicker in the 3 GeV-ring and the start of installation of a diagnostic line in the linac. Annual maintenance, such as personnel safety system (PSS) tests for the whole facility, will also be done.

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 estimations made under the current circumstances. There is some risk that these may change as MAX IV establishes a complete resource-loaded time plan. 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

August 2019

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## MAX IV beamlines

Beamline	Funding agency* (installation)	Phase	Accelerator	Status
Balder	KAW & Swe universities	Phase I	3 GeV	Commissioning
BioMAX	KAW & Swe universities	Phase I	3 GeV	User operation
Bloch	KAW & Swe universities	Phase I	1.5 GeV	Commissioning
CoSAXS	VR	Phase II	3 GeV	Installing
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	Designing
HIPPIE	KAW & Swe universities	Phase I	3 GeV	User operation
MAXPEEM	VR	Phase II	1.5 GeV	Commissioning
MicroMAX	NNF	Phase III	3 GeV	Designing
NanoMAX	KAW & Swe universities	Phase I	3 GeV	User operation
SoftiMAX	VR	Phase II	3 GeV	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

2019-07-30

Beamline	Risk	Status	First Expert Users	First User Call	First General Users
CoSAXS	High	Preparing SSM, installing	Q4 2019	Feb 2020	Q3 2020
FemtoMAX (10 Hz)	Very High	Preparing SSM permit	Q1 2020	Feb 2020	Q3 2020
SoftiMAX	Medium	Installing	Q1 2020	May 2020	Q4 2020
DanMAX	Medium	Installing	Q2 2020	Aug 2020	Q1 2021
ForMAX	Medium	Designing/Procuring	Q4 2021	Feb 2022	Q4 2022
MicroMAX	Medium	Designing/Procuring	Q4 2021	Feb 2022	Q4 2022
Bloch	Low	Commissioning			Q3 2019
Veritas	Low	Commissioning			Q4 2019
Balder	Low	Commissioning			Q3 2019
MAXPEEM	Low	Commissioning			Q3 2019
SPECIES	Low	Commissioning	Q3 2019	Aug 2019	Q1 2020
FlexPES	Low	Commissioning	Q3 2019	Aug 2019	Q1 2020
FemtoMAX (2 Hz)	Low	Commissioning		NA	NA
FinEstBeAMS		User operation			
NanoMAX		User operation			
Hippie		User operation			
BioMAX		User operation			

## Current status of individual beamlines

### **Balder**

During spring, the Balder team has focussed on commissioning the beamline with expert users. Start of general user operation at Balder is scheduled for the last week of September 2019.

- First general users: Q3 2019

### **BioMAX**

BioMAX is in general user operation. Since 1 March, until the summer shut down, BioMAX has delivered 147 shifts\* to 140 general user groups.

### **Bloch**

The Bloch beamline has during spring taken expert users finalising the ARPES endstation for general user operation. Installation of the SPIN-ARPES endstation is ongoing, commissioning of this endstation is planned for 2020. Bloch will start general user operation at the end of August 2019.

- First general users: Q3 2019

### **CoSAXS**

Beamline installation activities continue in order to have the beamline ready for commissioning as soon as the radiation permit is approved by SSM. The radiation safety team is currently working on this application, which is planned to be submitted in August.

- SSM permit submission: planned for Q3 2019
- Start of commissioning: Q4 2019
- First expert users: Q4 2019
- First general users: Q3 2020

### **DanMAX**

The construction of the conventional infrastructure for DanMAX is completed and was handed over to MAX IV in March. The detailed design of the endstation was successfully reviewed in March 2019. During the summer shutdown installation of the DanMAX insertion device is planned.

The dates below apply for the powder X-ray diffraction (PXRD) station. The Imaging station will follow approximately six months behind.

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

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\* 1 shift = 4 hours

### **FemtoMAX**

FemtoMAX needs 100 Hz for the full scope of user experiments; however, some experiments can be performed at lower repetition rates. For user calls to be published, at least 10 Hz operation needs to be established. The approach for SSM permit application for 10 Hz operation differs from that of beamline applications and requires more effort and time than initially expected. Once this permit is approved, we will need to commission the accelerator and perform an extensive radiological survey of the entire facility for operation in 10 Hz mode. This is planned for the January 2020 shutdown. The schedule for general user operation at FemtoMAX has thus been delayed as was communicated to VR in May<sup>†</sup>. Meanwhile, technical commissioning activities and feasibility tests with expert users at 2 Hz continue.

- Commissioning 2 Hz: on-going
- SSM permit 10 Hz submission: planned for Q4 2019
- Start of commissioning, 10 Hz: Q1 2020
- First expert users, 10 Hz: Q1 2020
- First general users: Q3 2020

### **FinEstBeAMS**

FinEstBeAMS has since the last report in March combined general user operation with commissioning with expert users. Since March, a total of 332 shifts<sup>‡</sup> were allocated to twelve user groups. The vast majority of these (240 shift) were allocated to general user groups, five at the gas-phase endstation (150 shifts) and four at the photoluminescence endstation (90 shifts).

### **FlexPES**

In May, the FlexPES SSM permit was approved and commissioning started. Commissioning will continue during autumn together with commissioning expert users. The first call for general users at FlexPES will open in August. Beamtime from this call will be allocated from March to August 2020.

- Commissioning on-going
- First expert users: Q3 2019
- First general users: Q1 2020

### **ForMAX**

The contract for the insertion device was signed in April 2019 with planned delivery late 2020. Procurements for optics are ongoing. The installation of the experimental station and infrastructure is planned to start autumn 2019. A review of the detail design for the scattering experimental station is planned for September 2019.

- Start installation: Q3 2019
- Start of commissioning: Q2 2021
- First expert users: autumn 2021
- First general users: autumn 2022

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<sup>†</sup> E-mail from Ian McNulty, MAX IV; to Niklas Ottosson (cc: Björn Halleröd and Johan Holmberg) at VR, 8 May 2019

<sup>‡</sup> 1 shift = 4 hours

### **HIPPIE**

HIPPIE is in general user operation. Since mid-February 576 shifts<sup>‡</sup> were allocated to a total of fifteen user groups, both general (including industrial users) and in-house user groups. The vast majority of the shifts, 306, were allocated to general and industrial users.

### **MAXPEEM**

The MAXPEEM beamline started commissioning in February and commissioning with expert users was carried out during spring. MAXPEEM will enter general user operation by the end of August.

- First general users: Q3 2019

### **MicroMAX**

The MicroMAX optics detailed design report (DDR) was successfully reviewed by external evaluators in March 2019. The design of the infrastructure has been completed, and optics design is on-going, as is the procurement of front-end and radiation safety hutches.

- Start installation: Q4 2019
- 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. Since the last report in March, a total of 455 shifts<sup>‡</sup> were allocated for experiments. 270 of these were for general user experiments, 30 for expert users, and 153 for in-house experiments. Twelve shifts were allocated for educational beamtime.

In August 2018, MAX IV Management decided to put the development of the NanoMAX FZP-endstation on hold for a year. The development work will resume in September 2019.

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

### **SoftiMAX**

The SoftiMAX STXM-station design is finished, all parts for the endstation have been ordered, and installation is underway. The design of the second experimental station, the CXI-station, is on-going.

- SSM permit submission: planned for Q4 2019
- Start of commissioning: Q4 2019
- First expert users: Q1 2020
- First general users: Q4 2020

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<sup>‡</sup> 1 shift = 4 hours

### **SPECIES**

The SSM permit application for SPECIES was approved in March and commissioning started in April. Commissioning will continue during autumn together with commissioning expert users. The first call for general users at SPECIES will open in August, beamtime from this call will be allocated from March to August 2020.

- Commissioning on-going
- First expert users: Q3 2019
- First general users: Q1 2020

### **VERITAS**

At the Veritas A branch line, the first expert users for NEXAFS measurements were received during spring. Installation of the spectrometer optics is ongoing and in final stages.

The Veritas B branch line (the open port branch) is in later stages of commissioning. The Veritas B branch line accepted its first proposals in the March user call and will start general user operation later this year.

- Commissioning with expert users on-going
- First general users: Q4 2019