STATUS OF THE FRONT ENDS PROJECT AT MAXIV

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Abstract

The MAX IV laboratory is a Swedish national laboratory for synchrotron radiation hosted by the Lund University. It will operate two storage rings to produce synchrotron light of very high intensity and quality over a broad wavelength range. A linear accelerator will feed these storage rings in topping up mode as well as serve as an electron source for a short pulse facility built on its extension. The storage rings have different sizes and operate at different energies: the MAX IV 1.5 GeV ring has 12 straight sections optimized for soft x-rays; while the MAX IV 3.0 GeV ring, has 20 straight sections, optimized for harder x-rays. In the initial stage of the project, five beamlines are foreseen to operate on the 3.0 GeV storage ring and an additional five on the 1.5 GeV ring. Each beamline requires a front end to interface the different characteristics in terms of vacuum level, heat loads, radiation safety, beam size and position, with respect to the storage ring. This paper describes the status of the different Front Ends project at MAXIV.

A BRIEF PROJECT OVERVIEW

As of May 2016, a total of eleven Front Ends (FE) are installed at the MAXIV Laboratory facility (Fig. 1). Five of them are installed in the 3.0 GeV ring and has entered commissioning phase; and five more are in installation phase in the 1.5 GeV ring. The Short Pulse Facility (SPF) also has its own FE, but that is part of the SPF project, as it differs substantially from the ones required by the Beamlines (BL) on the storage rings and it is not part of the Front Ends project. Regarding the facility itself, the 3.0 GeV ring is in commissioning phase, and current values reached approximately 100 mA. The 1.5 GeV is in late installation phase, still missing the ring injection and the transfer line. The linear accelerator (LINAC) is in late commissioning phase, as it has been able to deliver beam to both the 3.0 GeV ring and the SPF. Finally, the SPF is in commissioning phase, having received its undulator during the beginning of 2016.

Beamlines at MAXIV

On the 3.0 GeV ring, the two beamlines in the most advanced state are NanoMAX and BioMAX; both of them entered commissioning phase. VERITAS, HIPPIE and BALDER are in late installation phase. Additional BL projects have been approved and financed: DanMAX, CoSAXS, SoftiMAX.

On the 1.5 GeV ring, ARPES, SPECIES, FinEstBeaMS, MaxPEEM, FlexPES are about to enter installation phase. An additional number of BL is being discussed in the Beamline Project Office (BPO), together with several Swedish and international potential partners.

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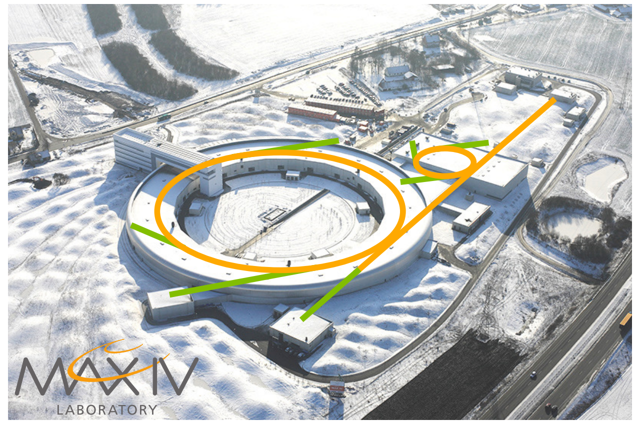

Figure 1: The MAXIV laboratory.

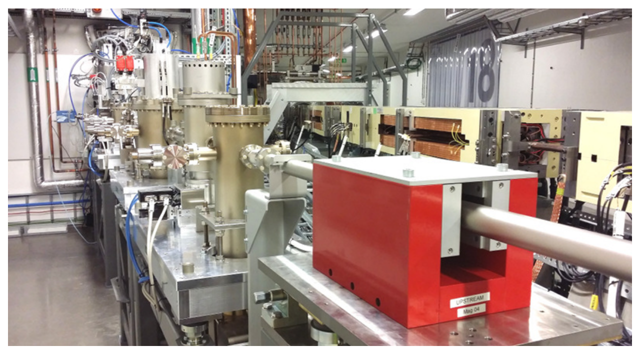

Figure 2: A Front End installed on the 3.0 GeV ring.

FRONT ENDS ON THE BIG RING

The majority of the components for the Front Ends on the 3.0 GeV ring have been provided by FMB Berlin [1]; and installation began immediately after delivery in July 2015. Two months were required to perform a site acceptance test, move the FE in the ring, align them, and finally mount, bake and leak check the vacuum chambers. Figure 2 shows a fully installed FE in the 3.0 GeV ring tunnel, in front of one of the MAXIV Achromats.

FRONT ENDS ON THE SMALL RING

The majority of the components for the Front Ends on the 1.5 GeV ring have been provided by TOYAMA [2], and they have been delivered to site in January 2016. After a successful site acceptance test, in which the FE were checked for vacuum leaks and motion control, they have been moved into the 1.5 GeV ring tunnel, where they are ready for align-

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Figure 3: A Front End installed on the 1.5 GeV ring.

ment. Figure 3 shows a FE being installed in the 1.5 GeV ring.

COMMISSIONING OF THE BIG RING FRONT ENDS

The commissioning of the FE basically consists of into shining light on the various components, monitoring any increase in pressure and/or temperature, and verifying beam position and therefore alignment of the components. For the first tests, also a radiation monitoring has been in place, to ensure the correct functioning and position of the shutters. The first kind of light allowed to reach the FE components was bending magnet radiation. An immediate increase in pressure was visible on all the exposed components, in strong correlation with the ring current. The FE has been running under these condition for about a month, with current in the ring reaching up to 100 mA and slightly different orbits.

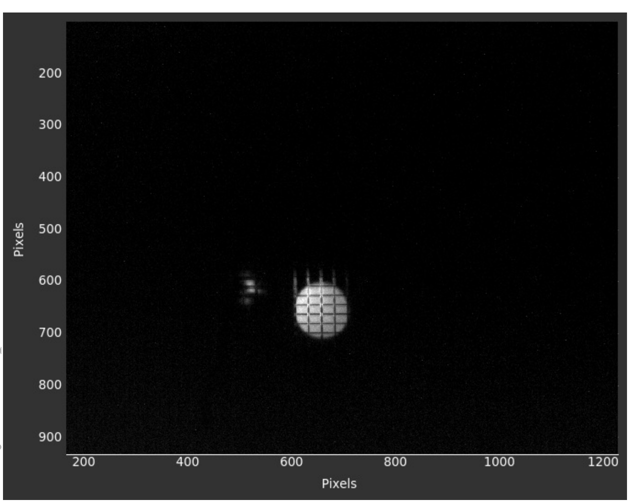

Figure 4: Dipole light on the Nanomax FE fluorescence screen.

Bending Magnet Light Delivered to the Beamlines

The next step was to open the heat absorber and let the bending magnet light reach the beamline components. This was firstly achieved in the Nanomax BL, and Fig. 4 shows the bending magnet light been observed on the FE fluorescent screen (YAG screen).

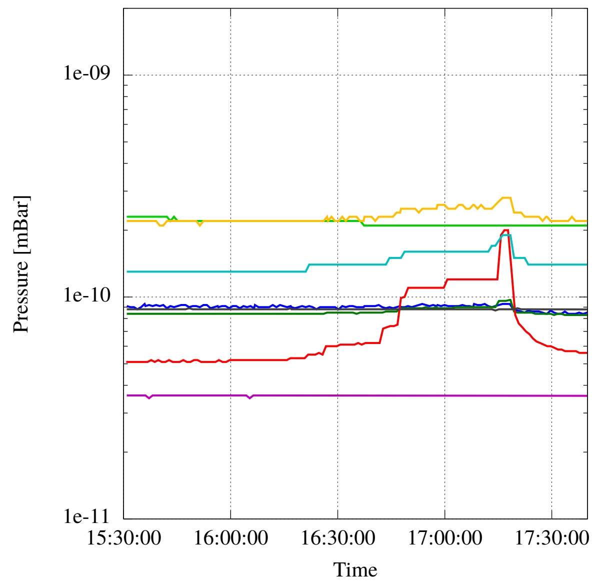

Figure 5: Front End pressures during ID gap closure.

Insertion Device Light Reaches the Front Ends

The next step was to shine Insertion Device (ID) light on the closed FE heat absorber. Such test has been performed with a ring current of 0.5 mA. Pressure increased in all the FE components that were supposed to be exposed to light at this stage, while stayed constant in the parts hidden by the heat absorber, confirming the good relative alignment of the FE components. Furthermore, the fluorescent screen was monitored to ensure that no light could pass through the absorber, and the camera could not pick up any signal. Figure 5 shows the increase in pressure along the FE at constant ring current: the progressive increase follows the ID gap closure.

Insertion Device Light Reaches the Beamlines

The following step of the commissioning, the latest to be performed so far, consisted in opening the heat absorber in presence of ID light and let x-rays through the FE, towards the BL. This test allowed for the first time at MAXIV to observe x-rays produced by an ID. A picture of the fist ID light, observed at the Biomax BL, is shown in Fig. 6.

Pressures and temperature were controlled and archived throughout the entire test, and radiation survey has been enforced. While no relevant increase in temperature was noticeable at such values of current, Fig. 7 shows the different values recorded by the ion pump drivers. Increases were small but extremely well correlated to the various sub-activities of the test, such as moveable mask operation, fluorescent screen insertion, progressive ID gap closure.

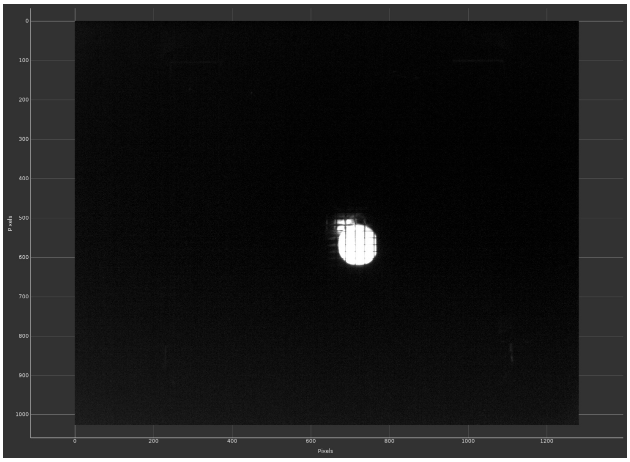

Figure 6: ID light on the Biomax FE fluorescence screen.

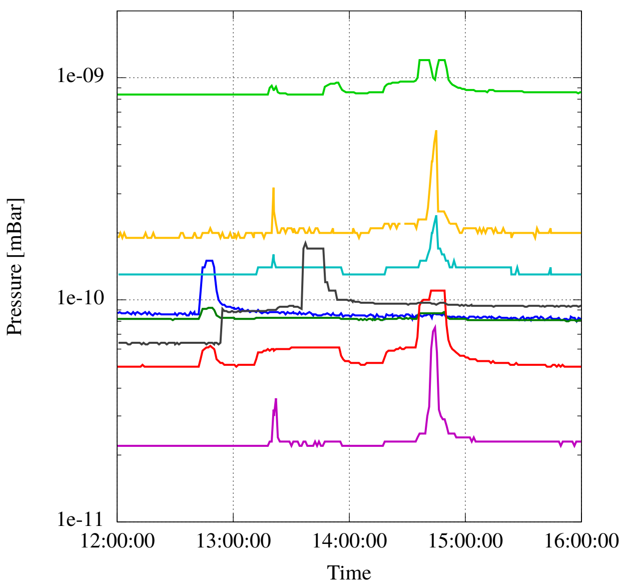

Figure 7: Front End pressure during various tests at 10 mm gap and 0.5 mA ring current.

CONCLUSIONS AND NEXT STEPS

In conclusion, The machine and insertion devices at MAXIV have produced synchrotron light for the first time at the newly constructed MAXIV laboratory. Two of the Beamline Front Ends are already operational and they delivered successfully light to the BL optics.

For the future there are still several directions to go. Firstly it is important to obtain a definitive and robust orbit in the ring, that would allow us to proceed in the alignment checks, starting from the ID position, FE components and finally BL optics. To obtain that, the feedback of the FE instruments is an essential tool.

After that, an increase in current will be pursued, which will for the first time put some stress in the cooling capabilities of the FE components.

Also, more and more FE will enter commissioning phase, so new devices will be commissioned as the MAXIV laboratory will be populated.

Finally, a long conditioning phase will begin, in which the photon induced outgassing will be handled by the FE vacuum system.

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A special thanks goes also to our suppliers, FMB Berlin and TOYAMA. Communication with them has always been prompt and the quality of the components delivered is impressive.

REFERENCES

[1] FMB Berlin website, `http://fmb-berlin.de/en`.

[2] TOYAMA website, `http://www.toyama-en.com`.