STATUS OF SESAME PROJECT

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Abstract

This paper reports on the progress of the construction of the SESAME project. The construction of the radiation shielding wall has been completed since April 2011. The tunnels are ready and the Booster will soon join the Microtron. The Booster upgrade plan is in progress; all the bending magnets vacuum chambers will be replaced by new ones, 7 BPM Libera Electronics have been purchased, and a new control system based on EPICS is under development as well as a new timing system and new electronics for tune measurement. The site acceptance test of the new power supplies of the Booster will take place in October 2011. On the other hand, the Storage Ring magnet system has been reviewed and the technical specifications are ready for a call for tender as well as the vacuum system. The water and air cooling systems are under installation together with additional electrical boards. Hoping that the construction budget of the Storage Ring will be secured soon by a few of SESAME Members, the schedule is to have the first experiment in 2015.

INTRODUCTION

Developed under the auspices of UNESCO and modelled on CERN, SESAME (Synchrotron-light for Experimental Science & Applications in the Middle East) is an international research centre under construction in Jordan [1]. The centrepiece of SESAME is a new 2.5 GeV 3rd generation light source which will provide very intense light from Infra-Red to hard X-rays for a wide range of studies. The Microtron and the Booster constituting the injector part were originally used at the former BESSY I but have been greatly upgraded and refurbished. The energy of the Microtron is of 22.5 MeV while the electrons can reach 800 MeV in the Booster. The 2.5 GeV new Storage Ring will have an emiitance of 26 nm.rad and 12 straight sections are available for Insertion Devices. The phase I scientific program has been finalized and it foresees 7 beamlines from Infra-Red to hard X-rays. The project is governed by a Council currently having nine Members (Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority, and Turkey). France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russia, Sweden, Switzerland, the UK and the USA are Observers. The project is beneficiating enormously from help and advice provided by some of the world's synchrotron laboratories (especially SOLEIL in France, but also ALBA in Spain, ELETTRA in Italy, the Swiss Light Source, Diamond in the UK and the Canadian Light Source). The technical and scientific staff number has grown reaching a total number of about 25 people [1]. The most recent progress was producing a beam with low energy from the Microtron for the first time [2]. The progress on the Booster equipment tests and the design status of the Storage Ring equipment were also reported in [2].

RADIATION SHIELDING WALL

The radiation shielding wall which is made of ordinary concrete with a density of 2.35 g/cm^3 has been completed since April2011 (see Fig 1.). It took almost one year and has been realized by a local Jordanian company. In addition to the concrete part, lead of 15 cm thickness will be added to all the ratchet walls. The design is based on normal and abnormal beam losses for injection and stored beams, as well as typical Storage Ring operation, and it also takes into account photons and neutrons from electron beam losses in the ring. The ALARA principle is applied guaranteeing the radiation limits for non-exposed workers to be 1 mSv/y which corresponds to 0.5 μSv/h for 2000 working days per year, except in the controlled areas where the access is forbidden during operation. The roof parts are movable to allow for the installation of the equipment using an 8 tons capacity crane. To be ready for the Booster power supplies acceptance tests, the Booster magnets have been installed in the service area as can be seen in Figure 1 and then will be transported inside the tunnel after the completion of the tests. A bridge and an access stairs to the service area are now available. Phase one radiation monitors will be installed and tested around the Booster tunnel. The design features of SESAME Personal Safety System (PSS) are based on fail safe, redundant, diverse, expandable and modular PLCs. The PSS is governed by IEC 61508 (International Electrotechnical Commission) and the safety integrity level required is SIL 3. The PSS call for tender document is being reviewed and will be published soon.

Figure1: SESAME Radiation shielding wall.

BOOSTER REFURBISHMENT

Booster Dipole Vacuum Chambers

Deep inspection and extensive vacuum tests have been performed on all old BESSYI Booster vacuum chambers. Unfortunately, irreparable cuts have been observed on two dipole chambers and leaks have been measured on five others. The reason of these defaults is not understood. It has then been decided to manufacture 13 new dipole vacuum chambers; the total number plus one spare. While the old BESSYI Booster dipole vacuum chambers were made of 0.3 mm corrugated stainless steel sheet to reduce eddy current instabilities since the Booster was operating with a repetition frequency of 10 Hz, the new ones will have 1 mm thickness and a simpler rectangular shape since at SESAME, the Booster will operate at 1 Hz repetition frequency. The choice of 1 mm thickness is a compromise between Eddy current sextupole field strength and mechanical rigidity. The new design shown in Figure 2 is being manufacture by FMB company and will be delivered to SESAME by November 2011.

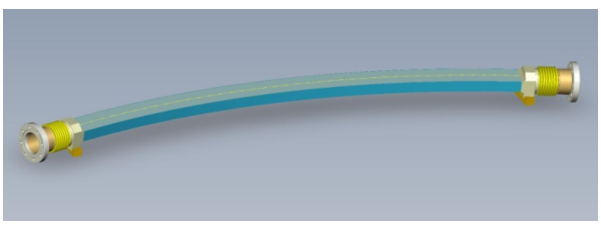

Figure2: New Booster vacuum chamber design.

Booster Control System

SESAME control system is based on EPICS toolkit for both Machine and Beamlines control. The Booster control system is under development. It will be a distributed type, controlling magnets, power supplies, vacuum system, cooling system, diagnostics, RF system and others. Mainly VME and PLC are used to interact with the Booster subsystems. The EPICS servers will be distributed among using Soft IOC and VME IOC. The VME crate is used to represent the EPICS core. It will host the CPU MVME5500 module. The common operating system for the VME is Vxworks 6.9 Workbench 2.3, which is real-time operating system that is used in embedded applications. The PLC used is SIEMENS brand S7-300 based on CPU315-2 DP and different I/O modules for digital and analog signals. Mainly the Interlock signals will be connected to the PLC from different subsystems (vacuum, cooling, etc). EPICS is directly connected to the PLC through the Ethernet port. Many Devices have a serial port such as power supplies, gauges and ion pumps and they are connected to EPICS through Moxa terminal servers. Two 16 ports Moxa servers for the Booster are being used. Soft IOC or Soft EPICS server will play the same role of the VME CPU, but this server will host Linux OS and run over it EPICS kernel. The softIOC is common used to control such devices that have slow signals and a well-defined communication interface like serial, parallel, Ethernet or USB. EPICS client tools will be used to monitor and control the Booster. EDM is used as a GUI beside other client tools such as ALH, Probe, HistTool …etc. and the GUI will depend on the subsystem that this panel is used for.

Booster Timing System

SESAME Booster timing system is based on the global event system, which was developed in APS and widely used in many light source facilities such as APS, SLS, Diamond and others. The Booster timing system has been designed and developed by Babak Kalantari from PSI and all the hardware used is from Micro-research Finland. In SESAME Booster timing system one event generator and three event receivers will be used in order to cover and complete all the events sequences to operate the Booster. Figure 3 shows a schematic of the Booster timing system. It will be delivered to SESAME site in October to be tested before its deployment.

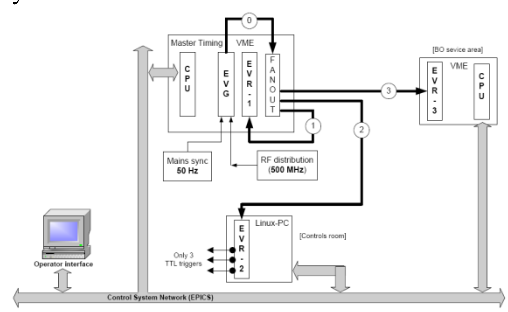

Figure 3: Booster timing system.

Booster Diagnostics

The pneumatic mechanisms to push up and down the 3 fluorescent screens available around the Booster have been refurbished and the cameras video have been renewed. While there was no tune measurement in the old BESSYI Booster, it is planned to have such a system at SESAME. It will use a noise function generator of 4 MHz bandwidth and two 5W RF amplifiers to drive the $\lambda/4$ stripline in horizontal and vertical planes. The betatron tunes will be given by a spectrum analyser or by the BPM read-out electronics (I-Tech Libera electron) after an FFT of the turn by turn data.

BOOSTER ALIGNEMENT PREPARATION

The geodesic network of the Booster, consisting of four wall brackets and brass nails on the ground is ready. The installation of the girders which are not identical is not easy. The following preliminary actions have been taken: new measurement after the completion of the shielding work of the vertical level of the slab, digging of the highest areas regarding the vertical level, adjusting the girder at its location with respect to the brass nails and tracing the holes of the girder feet. The original quadrupole and bending magnets fiducialization has been reviewed. In the case of the quadrupole, a pair of small squares per quadrupole fixed on its upper face allows to manage 5 degrees of freedom. The last degree of freedom which is the quadrupole tilt will be adjusted with a special gauge as shown in Figure 4. In the case of the bending magnets, the idea is to use the existing survey monuments after measuring them since there is no information about their location.

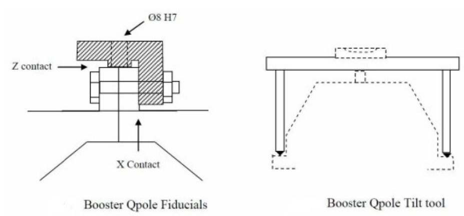

Figure 4: Booster quadrupole fiducials.

STORAGE RING MAGNETS AND GIRDERS

The mechanical design of the Storage Ring magnets has been finalized taking into account all the details regarding the cooling and electrical connections. The 3D mechanical design of the quadrupole is given in Figure 5.

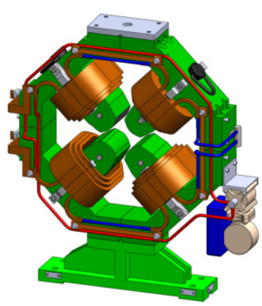

Figure 5: 3D mechanical quadrupole design.

Two design concepts of the girder system for SESAME have been studied so far. The first one was the ANKA concept and the second one was the ALBA concept. The best result is obtained with the latter where the first eigenfrequency of the girder is of 23 Hz and the maximum vertical static deformation is of 35 µm. The study is still going on in order to reach the goal of 40 Hz for the first natural frequency while the girder is loaded with all the magnets and equipped with the pedestals for fixation and alignment.

FRONT ENDS FIRST STUDIES

Front Ends (FE) at SESAME are divided into two types: Insertion Device, and bending magnet FE. The insertion device FEs have 2 locations, either from a long or from a short straight section with available distances of 5.66 m and 7.534 m respectively. For bending magnet FEs the available distances are either 6.319 m or 4.438 m. Five FEs are available at SESAME as donation from Daresbury (SRS) and SLS. One of the SRS FEs will be used for the XRF-XAFS Beamline which will be a day one beamline from a bending magnet. Because of the difference in energy, beam current and beam sizes between SRS and SESAME, some modifications or new components are going to be on the FE. The modifications will concern the fixed mask, the filter and the slits. A new stopper design is needed for the XRF-XASF FE. The same work is going on for the other FEs of the phase 1 beamlines.

VISIBLE LIGHT DIAGNOSTICS BEAMLINE

A preliminary design for a Visible Light Diagnostics (VLD) beamline of SESAME Storage Ring is proposed and shown in Figure 5. The source point will be taken at 6.5° downstream the entrance of the bending magnet where the RMS electron beam sizes are 232.3 µm and 81 µm in horizontal and vertical plane respectively. The relatively large vertical beam size could make it possible to measure the beam size to a good accuracy using the visible light at 500 nm. A primary half mirror is proposed. Preliminary calculations taking into account the inherent photon diffraction and depth-of-field effects show that the beam image sizes at the camera are 244.2 µm and 86 µm in horizontal and vertical plane respectively. Using a UV light (350 nm) for better accuracy is also an option. On the other hand, using the X-ray for beam size measurement, as it is the case in many light sources, is also under investigation.

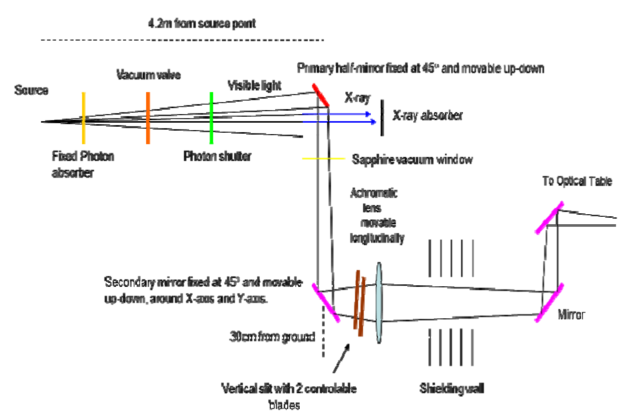

Figure 5: First proposal for a visible light diagnostics beamline.

REFERENCES

[1] www.sesame.org.jo.
[2] A. Nadji et al., IPAC'10 proceedings.