OVERVIEW OF THE SOLARIS FACILITY*

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Abstract

The Polish synchrotron light source Solaris is under construction in Krakow. The project is based on the MAX IV light source being built in Lund, Sweden. The 1.5 GeV storage ring for Solaris and part of the injector complex are identical to that of MAX IV, although both are housed in buildings that differ from those of MAX IV. Ground breaking on the green field site at the Jagiellonian University campus occurred at the start of 2012. A detail description of the facility infrastructure, services and construction choices is given together with the latest project developments for main accelerator systems.

INTRODUCTION

Solaris [1] will be a replica of the 1.5 GeV light source which is part of the MAX IV project [2,3]. The source of electrons will be a 550 MeV S-band linac fed by a thermionic RF gun identical to that used for MAX IV. Solaris is being built on the new campus of the Jagiellonian University in Krakow. The land has been donated by the university and has approximately 22,000 m^2 of which 5,160 m^2 will be used for the initial buildings. An additional 1,800 m^2 is reserved for future development of the facility. Ground breaking of the green-field site was started in January 2012. The site is 220 m above sea level with a geology of compact clay. The surface layer of earth has been removed and the foundations have been constructed on the clay. The lowest level of the building is above the water table.

FACILITY OVERVIEW

Buildings and Facility Layout

The facility building is composed of three distinct zones, the linac and klystron gallery, the experimental hall zone that houses the storage ring and an office area that will house the control room, laboratories and an auditorium, see figure 1. The total floor space of the facility is 7300 m^2. The linac tunnel and adjacent klystron gallery is being constructed at a level 7.7 m below the surface and the experimental hall at a level 3.2 m below the surface. Both the linac and the experimental hall are planned to be isolated from cultural noise by a 30 mm layer of anti-vibration material (Calenberg Cibartur mats) on which the floors will be placed. This material will also be used on the side of the building isolating it from the surrounding earth (20 mm Calenberg Civesco).

At the lowest level, the linac tunnel and adjacent klystron gallery are approximately 110 m long. Figure 2 shows a cross-section of the linac and klystron gallery. The linac tunnel will have two alcoves, one at the beginning of the tunnel and a second midway that allow the placement of the thermionic gun. The initial configuration of the linac will use only part of the tunnel, although services and access points through the shielding will be in place for a full energy injector in the future. Both tunnels have cranes with capacities of 3.2 and 1.6 tons, klystron and linac tunnels respectively. The klystron gallery is separated from the linac tunnel by a 1.5 m thick shield wall. This wall is in two parts, a 0.9 m thick wall of normal concrete (density 2.3 g/cm^3) on the side of the klystron gallery and a 0.6 m thick wall of heavy concrete (barite, density 3.2 g/cm^3) on the side of the linac tunnel. The roof of the linac tunnel is also in heavy concrete with a thickness of 1.4 m. The shielding has been adjusted for eventual continuous operation of the linac at 1.5 GeV, 100 Hz repetition and 200 pC with 0.3 W losses. Access to the linac tunnel, for installation of heavy equipment, is through two areas (2 by 6.5 m^2) that have removable slabs. Similarly access to the klystron gallery will be done via two access holes (2.5 by 3.5 m^2). Above the linac and klystron gallery is a zone for laboratories and storage area. This zone has a crane along its length with a capacity of 8 tons.

The floor of the experimental hall is concrete slab of normal concrete 50 by 60 m^2. The thickness is 1 m away from the linac and 0.4 m thick above the klystron gallery. The shielding of the storage ring resides on the slab. The thickness of the slab in the inner side of the ring is 0.5 m thick. This area, the storage ring service gallery, is isolated from the main slab and will house equipment racks for the storage ring. The shielding of the ring has a ratchet shape and is composed of both normal (side walls 0.7 m thick) and heavy concrete (forward walls 0.8 m thick). The roof of the storage ring tunnel (1 m thick) is removable for installation of the accelerator and insertion devices. The thickness of the inner wall is 0.6 m and composed of normal concrete. Two chicanes, on the inner side, allow access to the ring. The entire experimental floor area, including the ring, is covered by an 8 ton crane. This crane shares an overlap zone with the crane over the linac and klystron area for the handling and transport of materials. The crane supports will be isolated from the ground with vibroisolation mats 12 mm thick.

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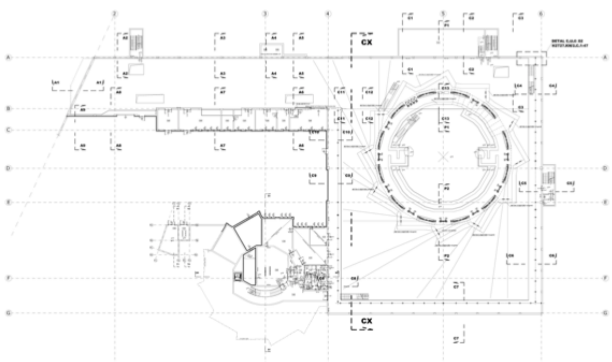

Figure 1: Overview of the Solaris facility.

The facility will be enclosed in a steel structure with a height of approximately 11 m. The supporting pillars have foundations outside the experimental hall slab and isolated from the linac floor. All machinery will be isolated from experimental and accelerator floors.

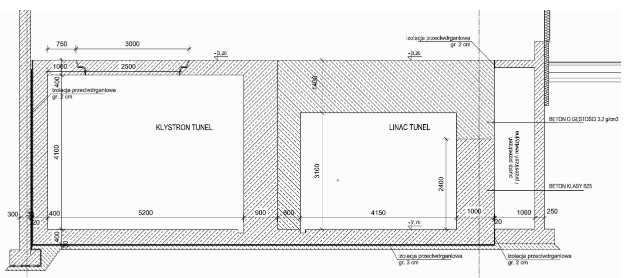

Figure 2: Cross-section of the klystron gallery and the linac tunnel showing the use of concretes of different density.

HVAC and Water Cooling

The heating, ventilation and air conditioning system is composed of four independent systems capable of handling 25000 m^3/h. The water cooling system uses three chillers capable dissipating 2.5 MW and a heating installation with a capacity of 0.5 MW which is based on the utilization of waste heat. Both the klystron and gallery and the experimental hall will be stabilized at 22±2°C. The linac and storage ring will be based on a passive system using heat from accelerator components and electrical oil heaters with precise thermostats. The temperature in the linac and storage ring tunnels will be 28±0.3°C. The primary cooling circuit for accelerator components will be at 25°C with a maximum conductivity of 2 μS/cm at 45°C and 6 bar. A UV system will be used for disinfection. The water will be filtered with a 325 mesh for a maximum particle size of 50 microns. All piping will be in stainless steel and will be supported by anti-vibration supports and joints. Figure 3 shows a schematic of the water cooling system.

Electricity and Grounding

The facility will be provided with 3 MW peak electrical power from a 15 kV line. The facility will have two 15 kV transformers rated at 1600 kVA. Medium voltage electrical power will be distributed in the klystron gallery, linac tunnel, storage ring and on the outside of the experimental hall by bus-bars. Two uninterruptible power supply lines with a rating of 75 kW each will be provided for computer equipment and control system racks and servers.

Grounding will use iron/zinc strips a thickness of 40 by 5 mm^2 that are connected to the foundation and its steel reinforcement at intervals no greater than 2 m. A grounding bar of flat copper (30 by 4 mm) will be provided in all technology areas. The facility will be protected against lightning to a protection level III. It will have a grid of horizontal air terminals connecting to ground.

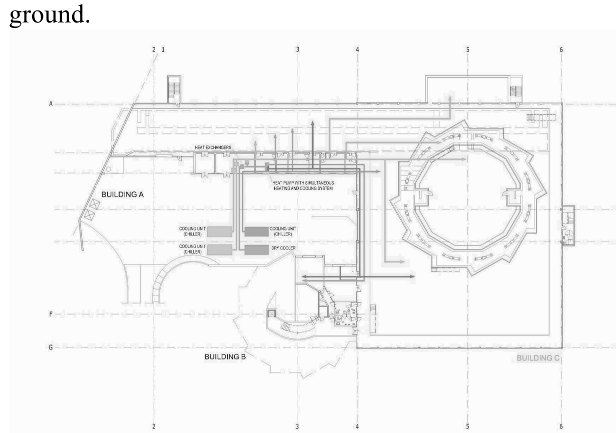

Figure 3: Schematics of the water cooling system.

ACCELERATORS

Linac and Injection

The linac is composed of six 5 m long S-band accelerating sections and will have a thermionic gun as its source. The gun is design and constructed by MAX-lab [4]. The linac will be power by three solid state modulators feeding three SLED cavities (200 MW peak power). The first modulator will have a waveguide distribution also to the gun. This branch will contain a circulator and phase shifter. For the low level RF signal distribution a 10 W amplifier after the 3 GHz generator will feed three identical drive amplifiers (100-300 W) to the klystrons. The injection energy will be 550 MeV and the beam will be transported to the storage ring via a vertical transfer line composed of top and bottom 10° septum magnets and top and bottom 17° dipoles. Whereas MAX IV will use twos kicker magnets to deflect the beam into the lower septum, Solaris will not at the first stage. Injection into the storage ring and accumulation will be performed by a vertical Lambertson septum magnet and a single pulsed dipole kicker. This scheme will disturb the stored beam but is of no consequence since the beam will be ramped to the final energy. A pulsed multipole magnet will replace the dipole kicker once the injector is upgraded to full energy injection and top-up mode is enabled.

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Storage Ring

The storage ring is an identical copy of the MAX IV 1.5 GeV storage ring and its parameters are given in table 1. The ring is composed of twelve achromats. Each achromat, containing two dipole with gradients, quadrupoles and sextupoles, is constructed from two solid ARMCO iron blocks. The dipole will have pole face strips for varying the vertical focusing and compensating the effects of insertion devices [5]. Radiation will be extracted from the centre of the first dipole (7.5°) and from insertion devices (0°). The vacuum chamber is made from stainless steel and is built in three sections. Both the magnet and the vacuum chamber are at the final design stage. Each achromat will have three beam position monitors. A schematic of a magnet with the vacuum chamber is shown in figure 4. The accelerator will use two 100 MHz RF cavities and two 300 MHz Landau cavities. The Landau cavities are optimized MAX-lab cavities. The cooling system for the RF cavities will be housed in the inner side of the storage ring. Power supplies to the magnets will be house in a building outside the experimental halls. Cables piping will brought into the inner side of the storage ring over the roof of the ring shielding in proximity of the injection region.

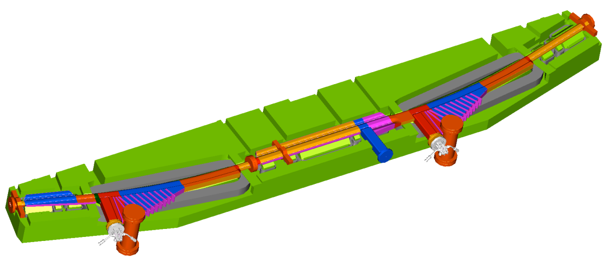

Figure 4: View of the achromat magnet (lower half) with vacuum chamber inserted (missing the two photon beam ports from the first gradient dipole) [6].

Table 1: 1.5 GeV Storage Ring Parameters

Current	500 mA
Circumference	96 m
Periodicity	12
Straight Section Length	3.5 m
Horizontal emittance (bare lattice)	5.98 nm rad
Coupling	1%
Tunes Q_x, Q_y	11.22, 3.15
Natural chromaticities ξ_x, ξ_y	-22.9, -17.1
Momentum compaction	3.055 x 10^{-3}
Momentum acceptance	4%
Beam lifetime	13 hrs

SUMMARY

Construction of Solaris is progressing and civil design activities will be finalized by the end of may and those for services by the end of July. The casting of concrete structures will be performed during the summer of 2012. The building will be closed to the environment by the end of the year. Linac and klystron tunnels will be ready by April 2013 and the hand over of the building will be done by the end of August 2013. Construction of the accelerators is progressing with tenders for achromat magnets and vacuum system to be released in the coming months.

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REFERENCES

[1] C.J. Bocchetta, et al., "Project Status Of The Polish Synchrotron Radiation Facility Solaris", IPAC'11, San Sebastian, Sept. 2011, THPC054, p. 3014 (2011); http://www.JACoW.org

[2] S. C. Leemann, "Recent Progress on the MAX IV 1.5 GeV Storage Ring Lattice and Optics", TUPPP024, these proceedings.

[3] The MAX IV Detailed Design Report, available at http://www.maxlab.lu.se/maxlab/max4/DDR_public/index.html

[4] S. Werin, "An Electron Gun Test Stand to Prepare for the MAX IV Project", TUPPD065, these proceedings.

[5] A. Wawrzyniak, et al., "Solaris Storage Ring Lattice Optimisation With Strong Insertion Devices", TUPPC025, these proceedings.

[6] Courtesy of J. Ahlbäck, MAX IV.

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