SOLARIS
NATIONAL SYNCHROTRON
RADIATION CENTRE

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SOLARIS Synchrotron – New Light for Polish Science

SOLARIS Synchrotron is a unique source of electromagnetic (synchrotron) radiation emitted by circulating relativistic electrons.

The main assets of synchrotron radiation are:

- extreme intensity (10^9 higher than the intensity of the sun);
- controlled polarisation;
- strong collimation;
- broad spectrum range from infrared to X-ray;
- time structure.

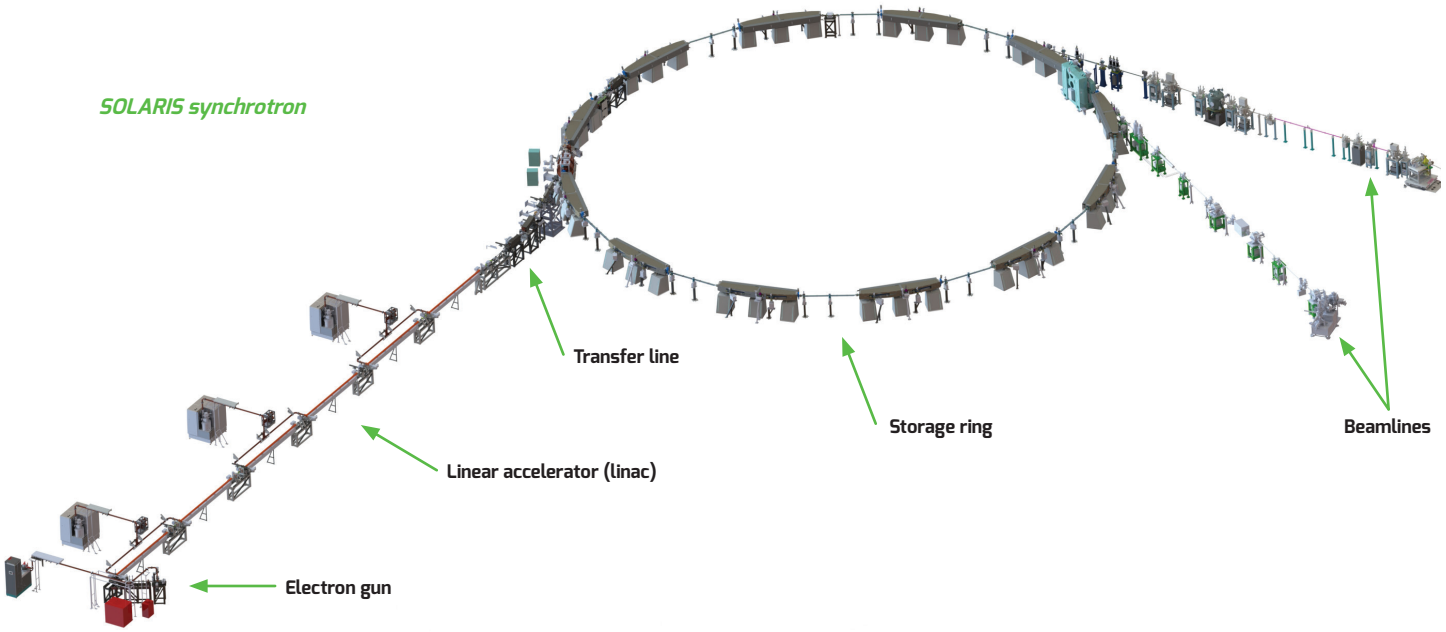
These properties of synchrotron radiation make the synchrotron a unique tool which allows for very precise studies in a competitively short time.

The main components of the SOLARIS machine are: an electron gun, a linear accelerator (linac), a transfer line and a storage ring.

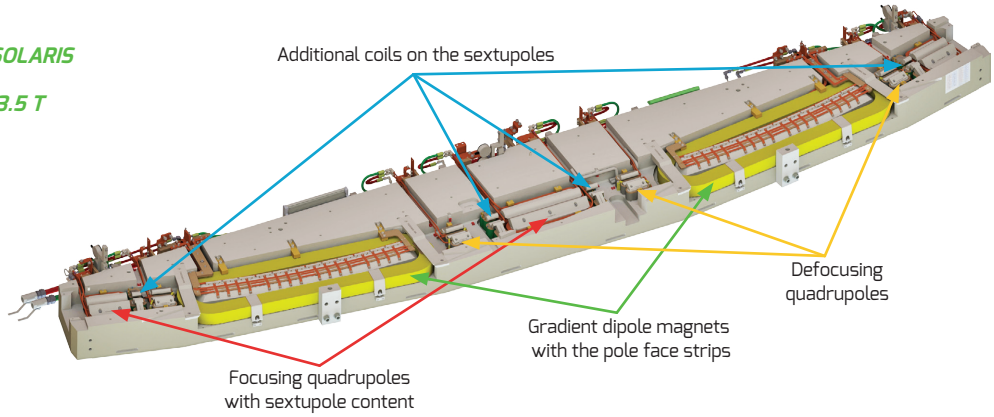
The thermionic electron radio frequency (RF) gun is a 3 GHz RF cavity fed by a high power electromagnetic field. The source of the electrons is BaO cathode heated up to c.a. 1000°C. The pulsed electric field bunches an electron beam and accelerates it up to 2.8 MeV.

The linear accelerator (linac) consists of six five-meter long S-band travelling wave accelerating structures combined in three accelerating units. Each accelerating unit contains one SLED (SLAC Energy Doubler) cavity and two linac structures and is powered by an RF amplifier. Between the linac structures, quadrupoles, steering magnets and diagnostics instruments are placed to focus and guide the beam. The total length of the linac is 40 metres and the maximum energy of the electron beam is 600 MeV.

The transfer line efficiently transports the beam from the linac to the storage ring. The main components of the transfer line are the dipoles with a total bend angle of 27 degrees, which bend the beam in the vertical plane, as well as six focusing quadrupoles. The last element is a septum magnet, which connects the injector with the storage ring.



The lower part of the SOLARIS storage ring magnet, length: 4.5 m, weight: 3.5 T



The SOLARIS storage ring has two functions:

- to ramp the electron beam from injection to its final 1.5 GeV energy;
- to store the circulating beam for many hours on a fixed stable orbit.

The storage ring consists of 12 identical Double-Bend Achromat (DBA) cells. The typical DBA cell contains two bending magnets flanked with strong focusing quadrupoles and sextupoles. In order to reduce the number of magnets, a few magnet functions have been combined and integrated in one solid iron block within a cell. This innovative technology makes it possible to obtain a very low emittance electron beam circulating in the machine of a relatively small size.

DBA cells are separated by 3.5 m long straight sections, of which ten are reserved for various insertion devices (ID).

The twelfth section is fully equipped with two 100 MHz main cavities for an energy boost which compensates for the energy losses of the circulating electrons, and two passive Landau cavities for bunch elongation, which improves the beam lifetime.

Experimental beamlines are aligned to extract the synchrotron radiation out of the storage ring. The beamlines are equipped with optical elements, i.e. monochromators, mirrors, gratings, etc., to focus and select appropriate wavelengths for particular research studies. Future plans include over a dozen beamlines equipped in total with around 20 end-stations at the SOLARIS experimental hall.

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The SOLARIS storage ring parameters

Energy	1.5 GeV	Natural chromaticity ξ_x, ξ_y	-22.96, -17.4
Max. current	500 mA	Corrected chromaticity ξ_x, ξ_y	+1, +1
Circumference	96 m	Electron beam size (straight section centre) σ_x, σ_y	184 µm, 13 µm
Main RF frequency	99.91 MHz	Electron beam size (dipole centre) σ_x, σ_y	44 µm, 30 µm
Max. number of circulating bunches	32	Max. number of IDs	10
Horizontal emittance (without IDs)	6 nm rad	Momentum compaction	3.055×10^{-3}
Coupling	1%	Total lifetime of electrons	13 h
Tune Q_x, Q_y	11.22, 3.15		

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

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