

Design and Optimization of the THz/IR Beamline SISSI 2.0 at the Elettra Synchrotron Facility

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Abstract: The optical layout of the future THz/IR beamline SISSI 2.0 at the upgraded Elettra 2.0 is presented. The design of the optics has been developed through numerical simulations to characterize the synchrotron radiation emitted by the new Diffraction Limited Storage Ring

Synchrotrons are storage rings designed to produce high-brightness radiation over a broad frequency range from the Infrared (IR) to the X-rays. In the third generation of these machines, the introduction of Insertion Devices (IDs), alongside with the more conventional bending magnets, have ensured the possibility of generating radiation with extraordinary properties, providing access to a great variety of experimental techniques and paving the way for new science and technological innovations. Elettra is one of the first European third-generation light sources in the soft X-ray, featuring a 259.2 m storage ring, operation energies of 2 and 2.4 GeV, and 28 beamlines available to external users. A major upgrade is currently underway at the facility for the realization of the new Diffraction-Limited Storage Ring (DLSR) Elettra 2.0. This upgrade is intended to reduce the horizontal emittance of the particle beam by an order of magnitude, reaching the amazing target of 212 pm-rad, which will allow to deliver radiation with improved brightness and with an almost full degree of transverse coherence up to 0.5 keV. The main work on the structure consists in the upgrade of the magnetic optics, which will be replaced with a new modified multi-bend achromat lattice type with reverse bends and longitudinal gradient dipoles named S6BA-E (symmetric six bend achromat enhanced), without changing the basic features of the accelerator [1,2].

This upgrade will involve all the beamlines and specifically SISSI (Synchrotron Infrared Source for Spectroscopy and Imaging), which is dedicated to the collection of Terahertz/Infrared (THz/IR) radiation emitted by magnetic dipoles from a wide vertical angle, difficult to achieve in DLSR accelerators. In the early 2000, SISSI has been planned and developed through the collaboration between the Department of Physics of Sapienza, IOM-CNR Institute and Elettra Synchrotron. Nowadays, through the same collaboration, the SISSI 2.0 project is devoted to the design and commissioning of an upgraded beamline which is intended to transport the THz/IR radiation emitted from the new source up to a laboratory dedicated to optical and IR micro-spectroscopy experiments. The future beamline, which is presented in Fig.1 is based, in its preliminary version, on three main sections dedicated respectively to the following tasks:

- Aberration correction and beam focalization
- Beam reshaping and beam collimation

- Beam-spot size reduction through a telescope

To achieve these goals, the beamline is equipped with a sophisticated sequence of twelve mirrors, including non-conventional optical components such as a conical mirror. This optical layout has been specifically designed to deliver optimal beam characteristics at the experimental hall, enabling the ambitious scientific program envisioned for SISSI 2.0. In particular, it will support advanced IR sub-diffraction nano-spectroscopy experiments with improved signal-to-noise ratio and enhanced long-term stability.

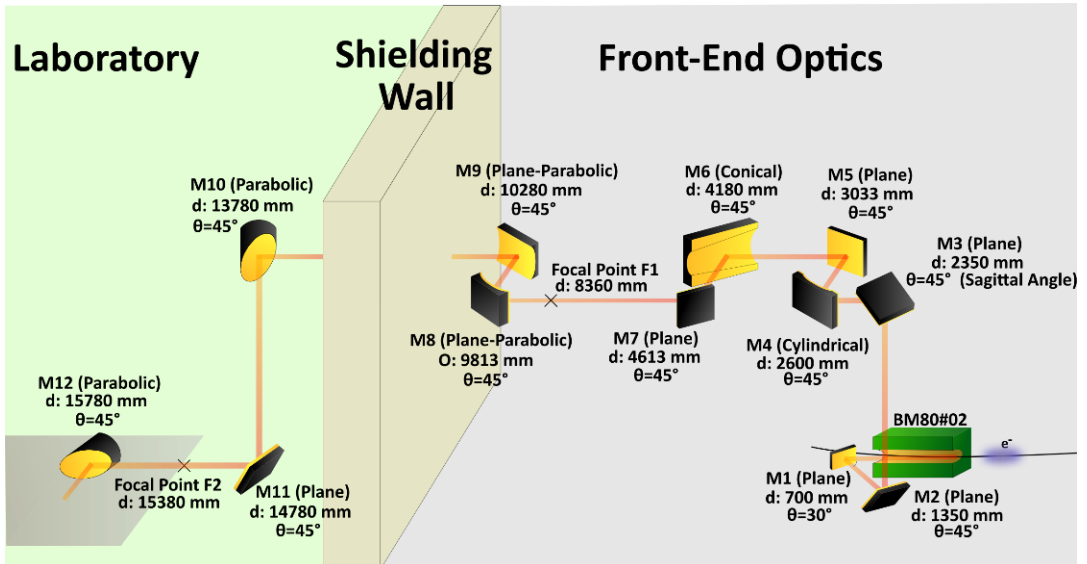


Figure 1 | SISSI 2.0 beamline design

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