First measurement of Infrared Synchrotron Radiation at ELETTRA

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InfraRed Synchrotron Radiation (IRSR) is now considered by the scientific community as a powerful tool for spectroscopy and spectromicroscopy. Its importance in several fields of research is confirmed by the huge increase of IRSR beamlines routinely working on second generation storage rings. Presently, infrared ports have been also developed on the third generation rings of ALS and SPring-8.

In order to study the feasibility of an infrared beamline on the third generation storage ring ELETTRA, we have measured the intensity and the electron beam dependence of IRSR collected from the 12.2 bending port of ELETTRA. This port is used for diagnostic purposes on the electron beam in the visible spectral region. Therefore the optical elements as well as the solid angle of collection are not optimized for the operation with infrared radiation. In particular, the solid angle subtained by the extraction optics is limited to 6 mrad in the horizontal plane (i.e. electron beam orbit plane) by means of a cooled vacuum diaphragm. This diaphragm, 18 mm wide and located at 300 cm from the source point, is used to reduce the heat load of the synchrotron radiation on the extraction mirror. In the vertical plane the total aperture is 10 mrad.

In existing IRSR beamlines instead, the full collection angle is of the order of 50 mrad in both horizontal and vertical planes. However, measurements of intensity and divergence of IRSR radiation from the 12.2 port may provide useful information on the photon beam stability and on spurious effects due to the fluctuations of the electron beam.

The optics of the electron beam diagnostic beamline adopts two plane mirrors. The first cooled mirror, made of GLIDCOP, is housed in a vacuum chamber in the same UHV vacuum of the storage ring and it is located at 350 cm from the bending magnet source point. This mirror deflects downward by 104 degrees the radiation from IR to the near-UV. The second plane mirror is located at atmospheric pressure 50 cm after the first one being separated from the ultra-high vacuum by a UV-graded Quartz window. This mirror reflects the radiation by 90 degrees outwards respect to the storage ring tangent line. Finally a Suprasil-quartz lens focuses the light onto the entrance of a rapid-scan Michelson interferometer. The transmittance of the interferometer beamsplitter and of the beamline quartz windows confined the investigated spectral region in a frequency range of 3000 - 8000 cm^{-1}.

In Fig.1 we show the collected spectra as a function of the e-current for an energy of the beam of 2 GeV.

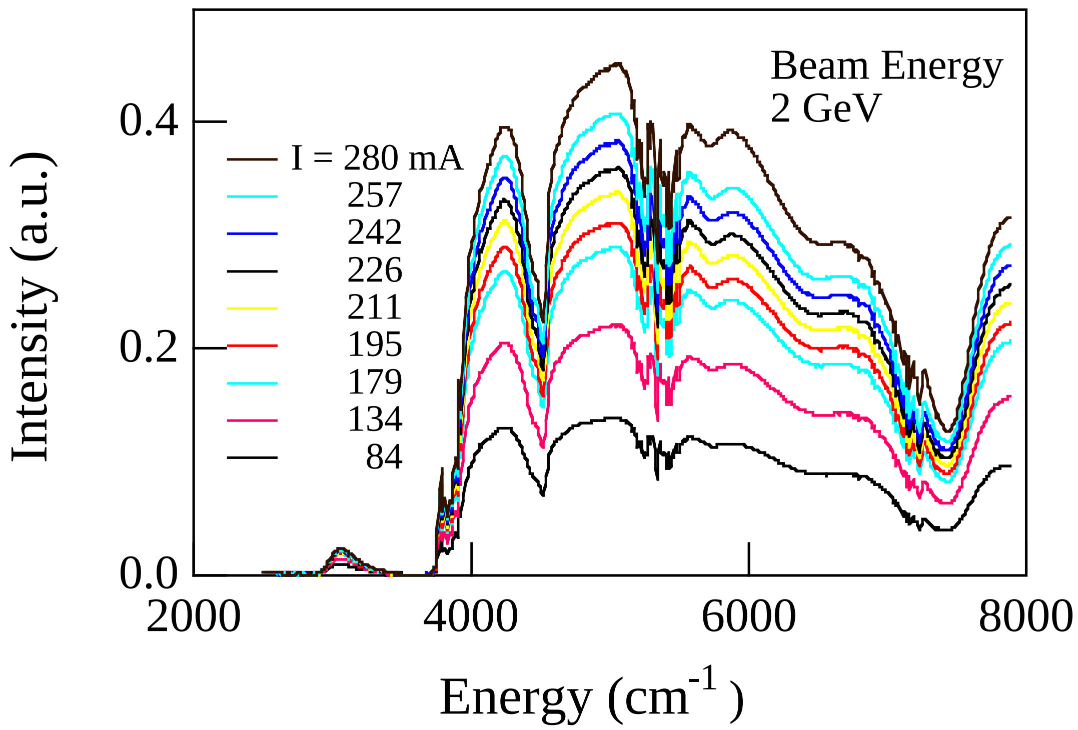

Figure 1. Mid-Infrared spectra at different values of e-beam current, measured with a Michelson interferometer at the 12.1 exit port of ELETTRA.

The intensity of the spectra shown in Fig. 1 decreases proportionally to the circulating current in the machine. Moreover, it is worth noticing that during the collecting time of each single spectrum spectrum (about 5 minutes with a spectral resolution of 8 cm^{-1}), we did not observe any major effects directly related to possible e-beam instabilities. In other term, in this spectral region (3000-8000 cm^{-1}), the ratio between two consecutive spectra linearly scales with the current ratio, and the reproducibility of a pair of spectra is better than 2 %.

In Fig. 2, we plot the integrated intensities of the spectra as a function of electron current.

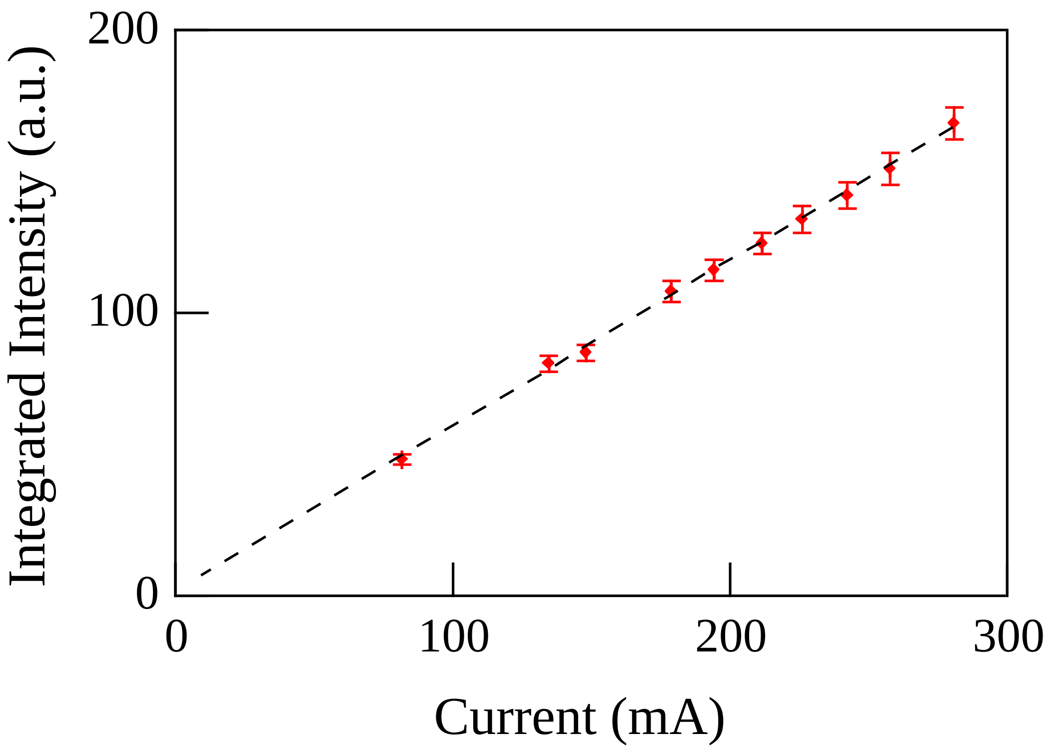

Figure 2. The integrated intensities of spectra as a function of e-current (solid points). The linear fit of data (dashed line), has a zero intercept.

The zero intercept of the integrated intensity obtained by a linear fit indicates the absence of IR radiation coming from other spurious sources. In particular the Black-Body radiation emitted from the first mirror heated by x-ray absorption.

Similar spectra have been also collected with an elecron beam stored at 2.4 GeV. The data (not shown here) confirm the results obtained at 2 GeV.

In conclusion, the results here reported demonstrate the feasibility of a new infrared beamline at ELETTRA, and strongly support the scientific case proposed by our group and accepted by the Scientific Committee in June 2000.