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INFRARED SPECTRA NORMALIZATION AT SINBAD

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Abstract

In the long wavelength region the Synchrotron Radiation emission has peculiar properties. However, the Infra Red Synchrotron Radiation flux is linearly dependent on the beam current I . At DAΦNE, an $e^+ - e^-$ collider, because of the short beam lifetime, infrared data acquisition performed using a Fourier Transform Infrared spectrometer is strongly affected by this dependence, which has to be corrected by post-acquisition normalization. Here is presented NORMA[®], an original software package developed using OPUS[®] macros and VB scripts, which automates this procedure for data acquisition using both the interferometer and the microscope.

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INTRODUCTION

Synchrotron Radiation (SR) emitted in the InfraRed (IR) region is one of the most promising sources of radiation for optical and spectroscopic applications. SINBAD (Synchrotron Infrared Beamline At DAΦNE) is the first Italian IRSR beamline designed to work at IR wavelengths from about 10 to 10000 cm⁻¹. It collects the radiation emitted by DAΦNE, a collider that is designed to work at 0.51 GeV with a beam current of more than 1 A.

DATA NORMALIZATION PROCEDURE AT SINBAD

SINBAD¹⁻³⁾ is the IR beam line working in parasitic regime at DAΦNE^{4,5)}, the electron-positron collider operational in Frascati. Storage ring parameters are optimized to achieve the highest luminosity for high-energy experiments: KLOE and FINUDA. The DAΦNE operation is based on e⁺ and e⁻ injections occurring around every thirty minutes. Actually the injection process is an alternate refilling of the e⁺ and e⁻ bunches that last a few minutes (2-3 min).

The SR photon flux is linearly dependent on the beam current I . The source brilliance, which is the main figure of merit for a SR source, is defined as the photon flux normalized to the solid angle and to the source area and is related to the beam current I and to the electron energy E by the equation

$$\frac{d^2 F}{d\Omega dA} = 1.327 \times 10^{19} E^2 I \left(\frac{\lambda_c}{\lambda} \right)^2 K_{2/3}^2 \left(\frac{\lambda_c}{2\lambda} \right) \quad (\text{photons/mrad}^2/\text{sec}) \quad (1)$$

where λ_c is the critical wavelength for the DAΦNE bending magnet and K is a modified Bessel function⁶⁾. After the DAΦNE topping up process the electron beam current I decreases from more than 1 A to around 400 mA. Such a strong difference in the initial and final values of the current influences in a critical way the data acquisition, and makes necessary the normalization of each spectrum to the instantaneous value of the beam current. Each spectrum is based on a typical acquisition of 100 or 200 scans which can be stored in a variable time from 100 s to 300 s.

Because at DAΦNE the electron current exhibits a fast decreasing behavior, intensity normalization has to be performed. Every single spectrum must be properly normalized to the value of the circulating current in the ring, and then averaged in order to obtain the final result. In the average procedure each spectrum is weighted with the inverse standard deviation, which is a function of the beam current.

OPUS-NT®: THE ACQUISITION SOFTWARE

Data acquisition and processing are performed under OPUS-NT® Bruker software⁷⁾. OPUS® embodies several interfaces for data exchange with other software, which must be able to communicate with OPUS®. Basically, there are two categories of external software:

- programs designed by users to perform a specific calculation or data manipulations

- any other third-party package, which can be launched and controlled by OPUS[®].

However, external software have to be written to run on the Windows NT platform, because upon the launch of the program, system functions are called directly.

USING OPUS[®] AS A DDE CLIENT

Any communication between OPUS[®] and an external program occur with the **D**ynamic **D**ata **E**xchange (DDE) protocol. OPUS[®] acts as a client for the external program, which in turn must function as a server. In this case the external program is a Visual Basic Script (VBScript). Data acquisition is performed in several steps, each of them based to an OPUS[®] macro or to a VBScript operation.

THE NORMA SOFTWARE PACKAGE

NORMA is the Visual Basic software package that performs the data acquisition and normalization using the computer controlling the FTIR acquisition of the instrumentations available at SINBAD. The interface is reported in Fig. 1, while the meaning of each of the left button, representing a step for the normalization procedure, are outlined below.

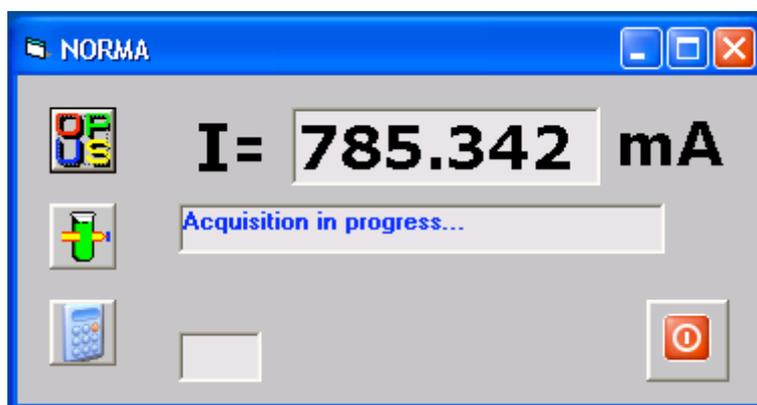


FIG. 1: The NORMA working window.



Load OPUS[®].



Starts the *Advanced Measurement*: An UDP connection is established, through the VB Script, with a remote machine in order to obtain the instantaneous value of the beam current (I) and save it in the text file: “*corrente.txt*”. The current value, in mA units, is also displayed

in the main window of NORMA. When the first current value change occurs, VB calls the OPUS[®] macro which starts the data acquisition. The acquisition consists of N scans at fixed resolution, according to the optical parameter set saved in the *.XPM file. The result is a spectrum called “*spec.0*”. The measurement status is reported in a second window: **(Acquisition in progress...)**.

The obtained spectrum is then saved in the ascii format (“*spec.ascii.0*”) and imported in the VBScript.



The file “*corrente.txt*” contains all the current values, from the beginning to the end of the acquisition. The first operation performed by the VBScript is to average the current values and register the mean value I_m . The file *spec.ascii.0* is normalized to 1 A by scaling it by the factor $1 \text{ A}/I_m$ (see Fig. 2 and 3).

In order to keep memory of I_m in the final data file it is possible to write it on an “Info” block, which is added to the main file block in OPUS[®]. To perform this operation the file has first to be saved in a special OPUS[®] format (*jcamp*), which allows introduction of external text information. In this way, just by selecting with the mouse the icon on the loaded file, it is possible to read its I_m value. The final step of the process is to transform the *jcamp.dx* file in an OPUS[®] file and save it with the desired path and filename.



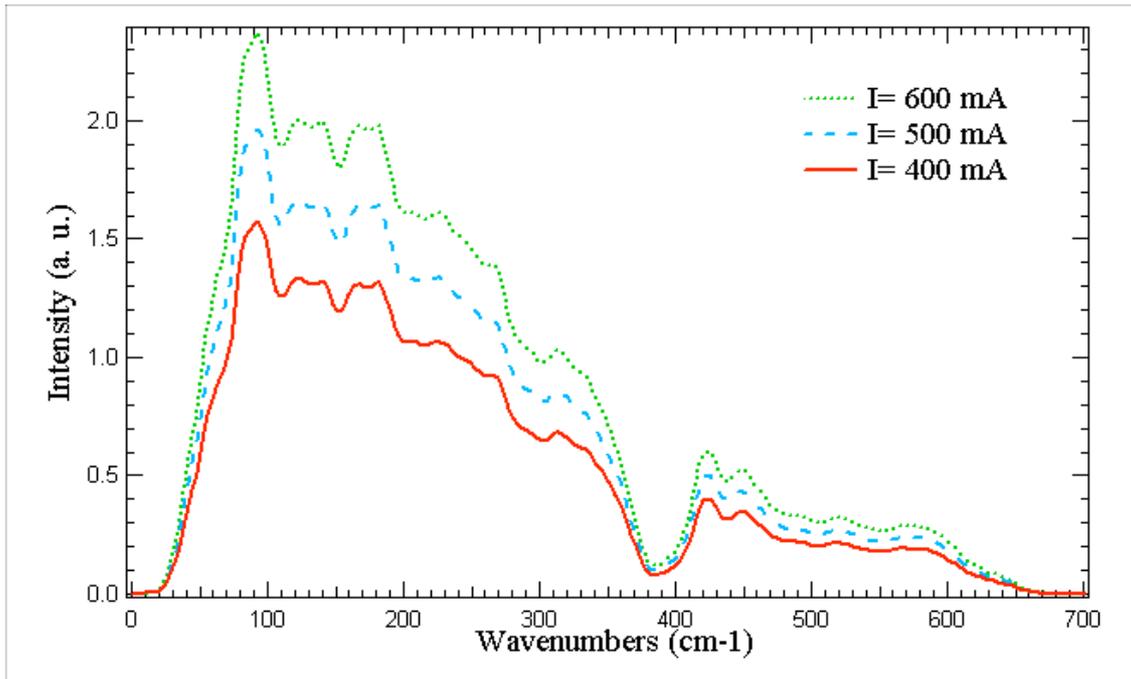


FIG. 3: FIR spectra taken with three different current values.

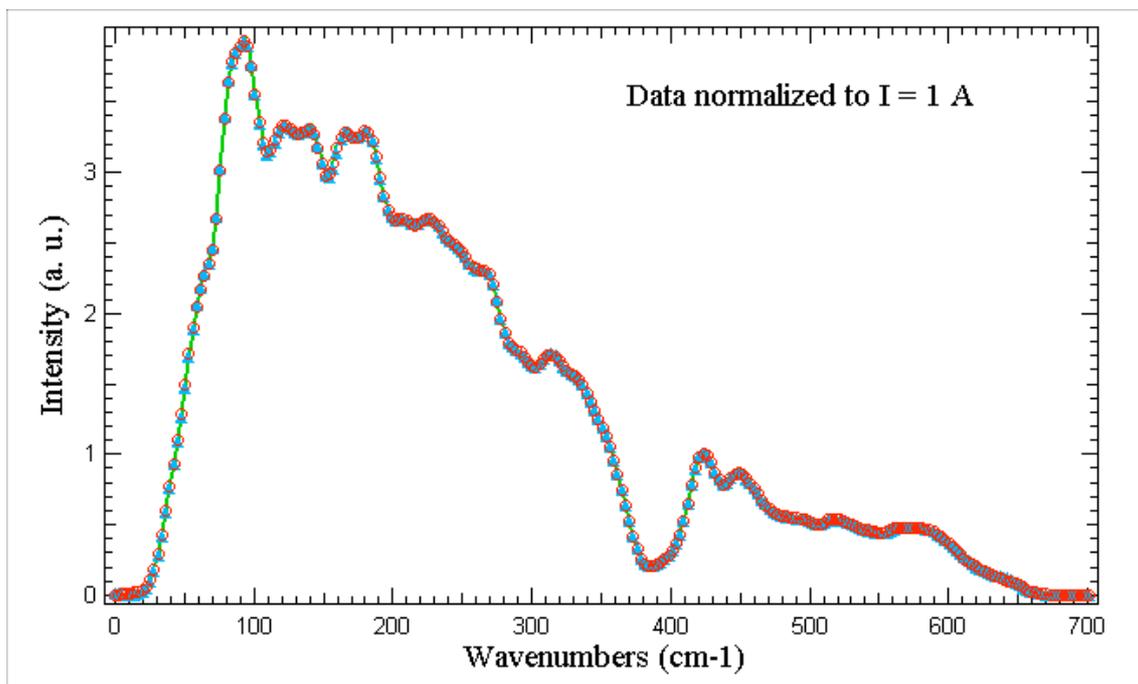


FIG. 4: FIR spectra after normalization to $I = 1 \text{ A}$.

STOPPING DATA ACQUISITION WHEN TOPPING UP OF ELECTRON OCCURS

A control on the beam injection is also performed at the beginning of the spectrum normalization procedure. This check allows interrupting the measurement when $I=I_{\text{injection}}$ without losing the whole data acquisition. A message with the “injection” information is displayed.

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REFERENCES

- (1) A. Marcelli, E. Burattini, C. Mencuccini, A. Nucara, P. Calvani, S. Lupi and M. Sanchez del Rio, *Proceed. SPIE Meeting* **3153**, 21 (*San Diego, 1997*)
- (2) A. Marcelli, E. Burattini, A. Nucara, P. Calvani, G. Cinque, C. Mencuccini, S. Lupi, F. Monti and M. Sanchez del Rio, *Nuovo Cimento D*, **20**, 463 (1998)
- (3) E. Burattini, *Synch. Rad. News* **16** (2), 28 (2003)
- (4) M. Bassetti, M.E. Biagini, C. Biscari, S. Guiducci, M.R. Masullo and G. Vignola, DAΦNE Technical Note L1. LNF, Frascati, Italy (1991)
- (5) A. Drago, D. Alesini, G. Benedetti, M.E. Biagini, C. Biscari, R. Boni, M. Boscolo, A. Clozza, G. Delle Monache, G. Di Pirro, A. Gallo, A. Ghigo, S. Guiducci, F. Marcellini, G. Mazzitelli, C. Milardi, L. Pellegrino, M.A. Preger, P. Raimondi, R. Ricci, C. Sanelli, M. Serio, F. Sgamma, A. Stecchi, C. Vaccarezza, M. Zobov, *100 Bunches DAΦNE Operation*, Presented at PAC2003, Portland, Oregon, May 12-16, 2003; see <http://www.lnf.infn.it/sis/preprint/pdf/LNF-03-12%28P%29.pdf>
- (6) S.L. Hulbert and J.M. Weber, *Nucl. Instrum. Methods A*, **319** (1992) 25
- (7) OPUS[®] Bruker software.