Energy calibration using absorption spectral benchmarks

The calibration in energy of spectra is done by measuring well known and calibrated spectral benchmarks present in the absorption spectrum of the monitor mirror. This document shows how to calibrate spectra in energy using experimental data and the relative program. The function shifts the energy axis so that the experimental energy benchmarks corresponds to calibrated benchmarks energies. The benchmarks have to be taken for G1200 with the same mirror deviation angle used in the experiment; in the case that the energy scan is done by changing continuously the deviation angle the benchmarks have to be taken with the same criterion. For GNIM the deviation angle is fixed.

The procedure is done by following these steps:

- Transform energy axis into wavelength;
- Define a polynomial law (in case of calibration with two spectral benchmarks the polynomial degree is 1) that gives the real wavelength as a function of the experimental wavelength:
  2 benchmarks:
  $\lambda_{NEW,REAL} = coeff1 \cdot \lambda_{EXP} + coeff0$ [1]

The coefficients coeff1 and coeff0 are found by imposing that the experimental benchmarks wavelengths will coincide with calibrated benchmarks. This is done by solving a 1st order equation.

The new wavelength axis is transformed into energies.

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In the case that only one benchmark is available, a simple rigid shift is done and the equation [1] becomes

$\lambda_{NEW,REAL} = \lambda_{EXP} + coeff0$ [2]

with coeff1 equal to 1.

In general, the user has to acquire 2 well known features (as the Si filter 1st tail and CK absorption) at the same deviation angle of measurements. The features have to be taken at two energies: the 1st one should be lower than the minimum of experimental data, the 2nd should be higher than the maximum.

List of benchmarks:

Benchmark edge	Channel	Photon Energy (eV)	Reference and position
SiO2 1st order	GNIM	7.75	SiO2 window cutoff FWHM
LiF 1st order	GNIM	11.82	LiF window cutoff FWHM
In 1st order	GNIM	16.55	In filter cutoff FWHM
Sn 1st order	GNIM	23.75	Sn filter cutoff FWHM
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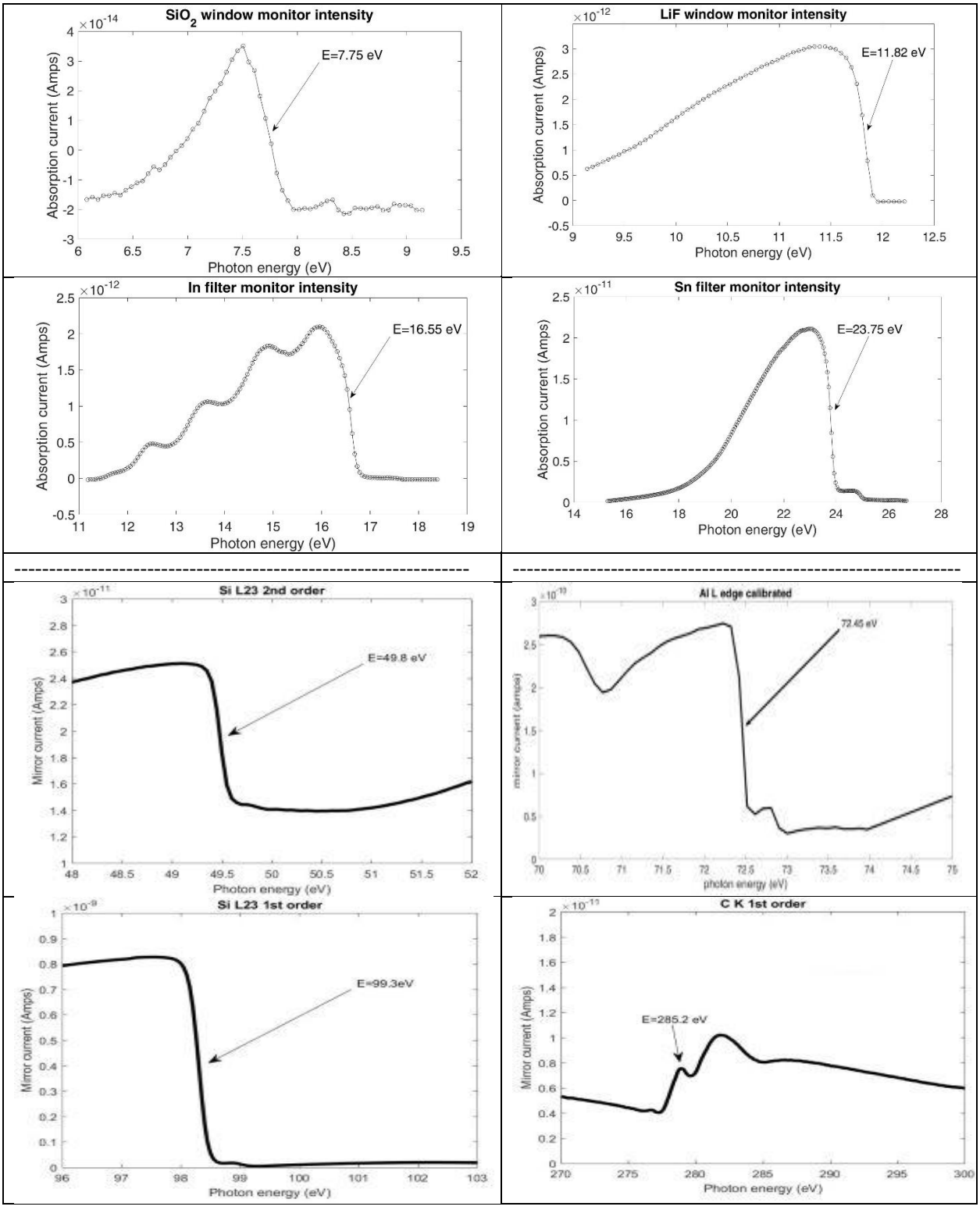
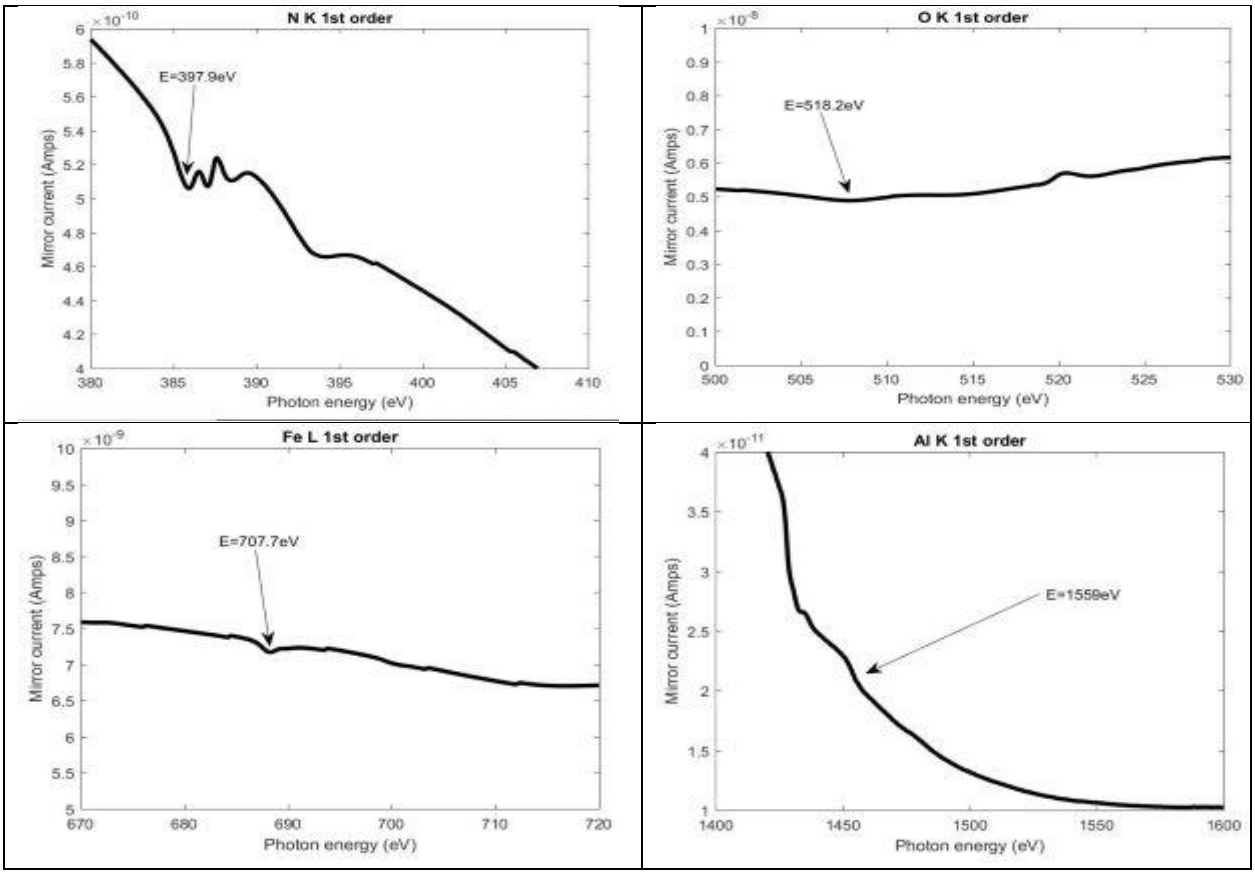
Si L23 2nd order	G1200	49.8	Si filter cutoff FWHM
Al L23 1st order	G1200	72.45	Al filter cutoff FWHM
Si L23 1st order	G1200	99.3	Si filter cutoff FWHM
C K 1st order	G1200	285.2	1st peak
N K 1st order	G1200	397.9	1st valley

O K 1st order	G1200	518.2	1st valley
Fe L3 1st order	G1200	707.7	1st valley
Al K 1st order	G1200	1559	Slope





Use of the program

Steps 1 a, b, c and d allows to find the coefficient coeff1 and coeff0 by loading the files taken for calibration. Steps 2 a and b allows to calibrate or single energy (step 2 a) or energy scans (step 2b).

Once that coeff1 and 0 are written in the main panel, the equation [1] is solved and the energy calibration can be done.

Instructions

- Launch the program PROGRAM FOR CALIBRATING ENERGY by clicking twice on the file 'Bear_energy_calibration.exe';
- Press button Step 1a: the window PROGRAM FOR LOADING BENCHMARKS 1 AND 2 opens. Select channel GNIM or G1200 to which calibration refers. Select Instrument where the monitor current is acquired.
- Press the button 'Load benchmark 1' and choose the file taken to calibrate the benchmark 1. The Benchmark1 graph shows the mirror current vs energy.
- Select the proper benchmark in the enumeration Benchmark 1 choice.
- Set the cursor of Benchmark 1 graph centered on the same position of the arrow shown in Benchmark 1 reference. Now, the indicator Benchmark 1 Real energy (eV) and the Benchmark 1 Experimental energy (eV) show respectively the correct benchmark 1 energy and the energy at which the benchmark 1 is.
- Set the cursor of Benchmark 2 graph centered on the same position of the arrow shown in Benchmark 2 reference. Now, the indicator Benchmark 2 Real energy (eV) and the Benchmark 2

Experimental energy (eV) show respectively the correct benchmark 2 energy and the energy at which the benchmark 2 is. In the case that only one benchmark is available, click on skip benchmark 2.

- Close window. The window 'PROGRAM FOR LOADING BENCHMARKS 1 AND 2' closes and the main program PROGRAM FOR CALIBRATING ENERGY reappears. The Benchmark 1 and 2 graphs show the mirror current vs energy plots.
- Press button Step 1b: benchmark 1 and 2 graphs show the mirror current vs wavelength plots.
- Press button Step 1c: benchmark 1 and 2 graphs show the mirror current vs wavelength plots calibrated and the indicators coeff1 and coeff0 show the calibration parameters found using real data.
- Press button Step 1d: benchmark 1 and 2 graphs show the mirror current vs energy now calibrated.

CASE 2a: calibration of single energy (example XPS).

- Write the nominal energy used for experiment in the box USED PHOTON ENERGY (eV). Press button Step 2a. The indicator CALIBRATED ENERGY (eV) shows the effective energy.

CASE 2b: calibration of energy scans (example XAS, Reflectivity).

- check/uncheck the checkbox 'Save new file with default file name'. If checked the calibrated file 'file.txt' will be saved with the file name 'file.txt(cal)'. If unchecked the program will ask the file name.
- Press the button Step 2b: the program asks the file to be calibrated.
- To see the calibrated/not calibrated data press the button Show Spectra. Once pressed the program shows Instrument 1, 2, and 3 as a function of energy (calibrated and not).