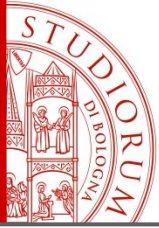


Worked example using MCSHAPE

Viviana Scot

*Laboratory of Montecuccolino-DIENCA
Alma Mater Studiorum University of Bologna*



MCSHAPE

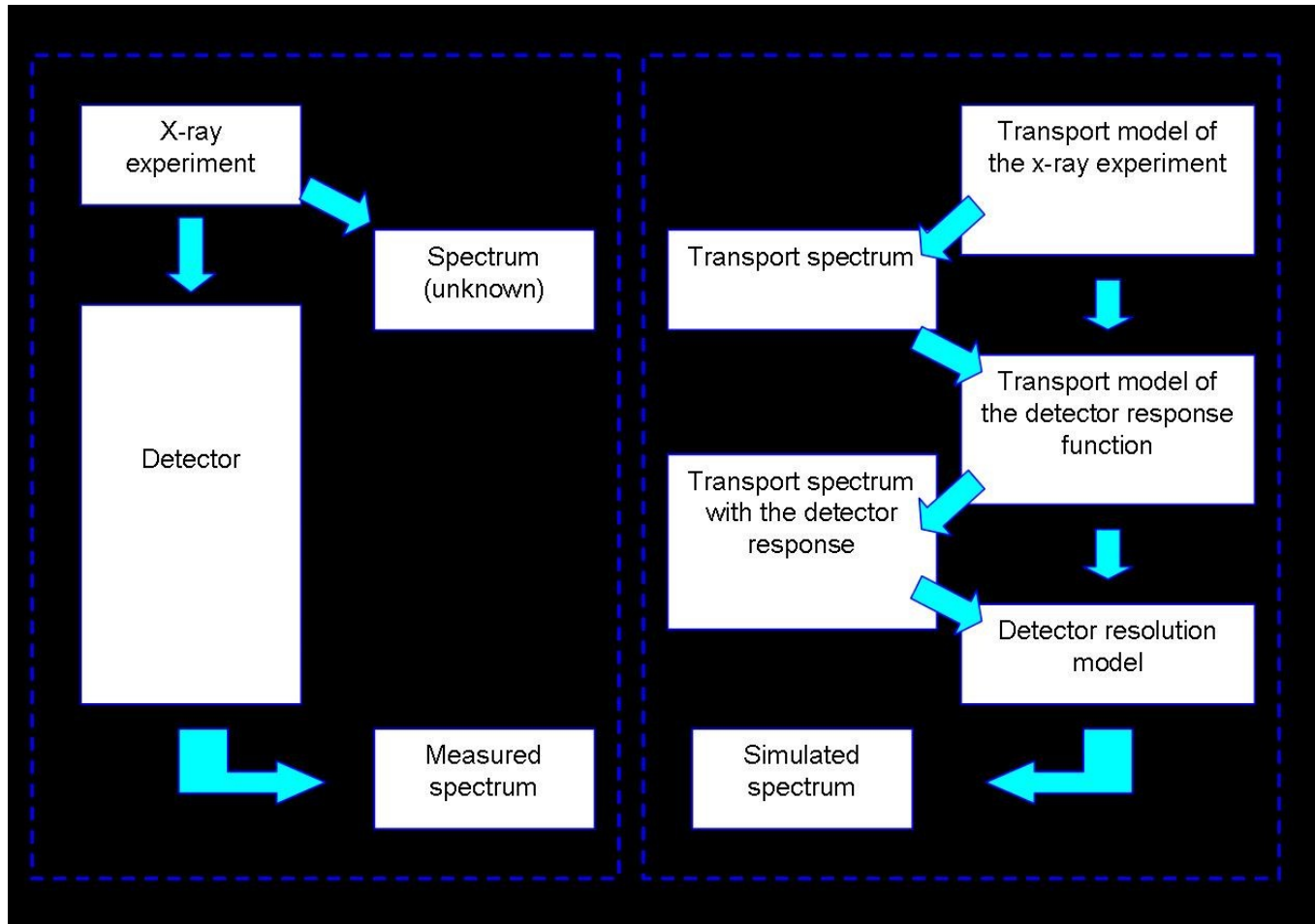
MCSHAPE is a Monte Carlo code developed at the University of Bologna which can simulate the diffusion of photons with arbitrary polarization state and has the unique feature of describing the evolution of the polarization state along the interactions with the atoms.

The adopted transport model is derived from the so called Boltzmann-Chandrasekhar 'vector' transport equation. The polarization state of the photons is described by using the Stokes parameters I , Q , U and V , having the dimension of intensities and containing the physical information about the polarization state.

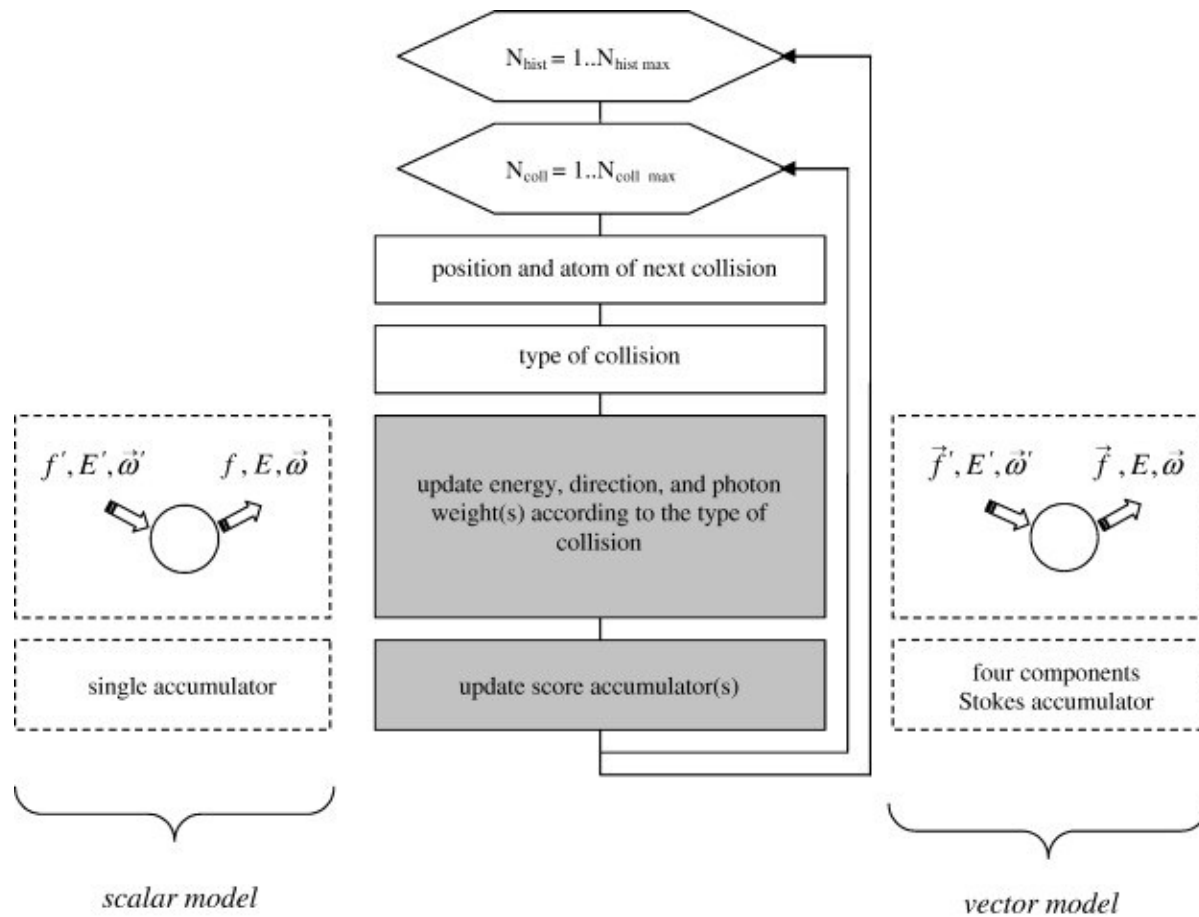
This code simulates the propagation in heterogeneous media of photons injected by either polarized (i.e., synchrotron) or unpolarized sources (x-ray tubes).

- Website: <http://shape.ing.unibo.it>

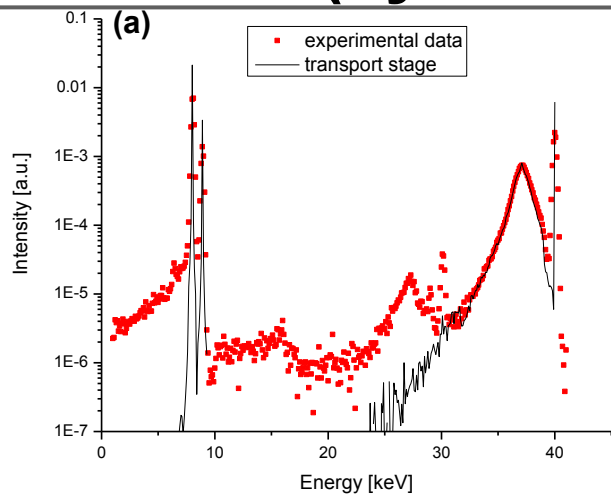
Schematic diagram of a simulation with MCSHAPE, compared with the experimental steps for a spectrum measurement.



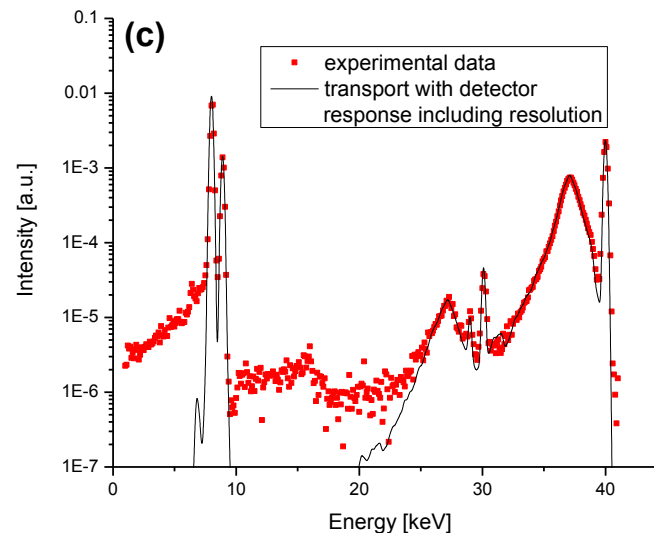
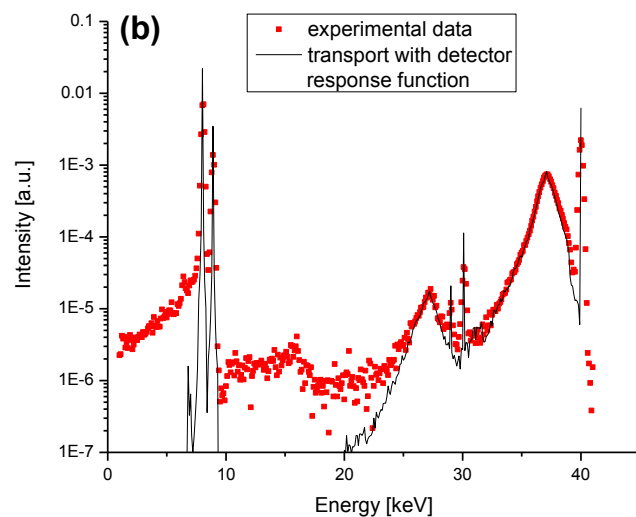
Differences between the computational structures of scalar and vector MC models

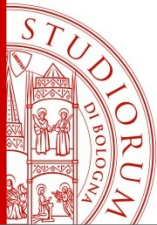


Comparison with experimental data (synchrotron experiment)



- Sample: Cu
- Energy: 40 keV
- Linearly polarized source with polarization degree $P = 0.885$
- Scattering angle: 90°





Simulation of the x-ray tube spectrum

Hamamatsu Tube
with glass window
operated at 50 kV

Glass Composition:

- SiO₂ (silice) 70%
- Na₂CO₃ (soda) 15%
- CaO (calce) 10%
- B₂O₃ (altro) 5%

X-ray tube V1.10

File Help Exit

X-ray tube properties

Voltage [kV] - max 100 kV	50.000	Tube current [mA]	1.0000
Anode atomic number (1-92)	74	Electrons incidence angle [DEG]	90.000
X-rays take-off angle [DEG]	30.000	Be window thickness [cm]	0.0000
Solid angle [RAD]	1.0000	Distance in air [cm]	5.0000

View

Filters

#1 #2 #3 #4

Mixture of compounds

EL	Z	Conc
Si	14	0.32720
O	8	0.50373
Na	11	0.65072E-0
C	6	0.16999E-0
Ca	20	0.71469E-0

Density [g/cm³] 2.1300
Thickness [cm] 0.20000

Density [g/cm³] 0.0000
Thickness [cm] 0.0000

Density [g/cm³] 0.0000
Thickness [cm] 0.0000

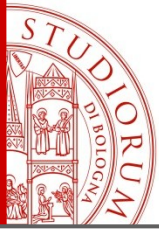
Density [g/cm³] 0.0000
Thickness [cm] 0.0000

Continuum resolution

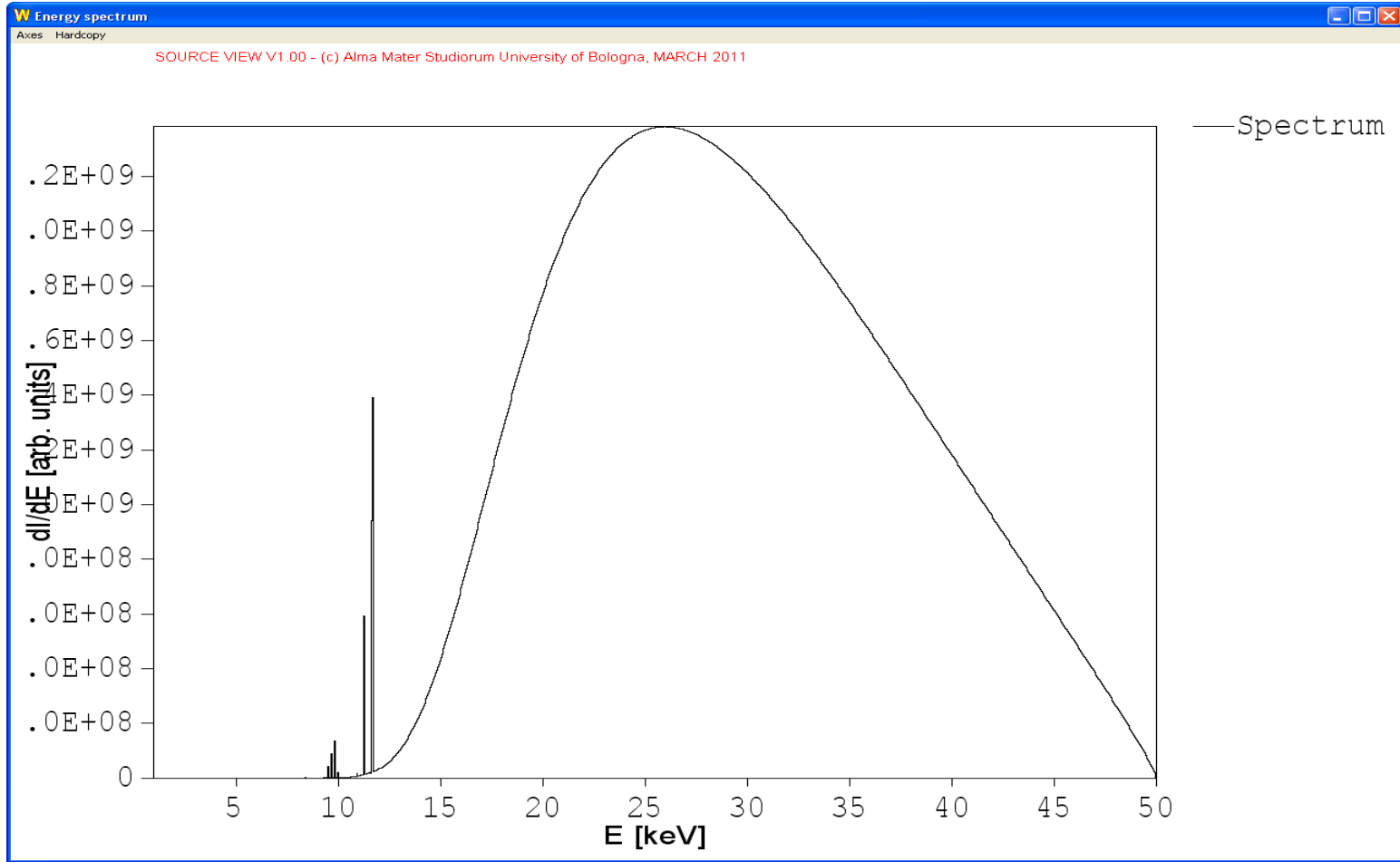
Energy [keV] 0.50000E-01
Lambda [Å] 0.10000

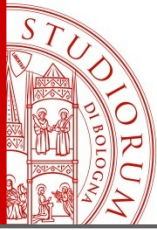
Calculate

Exit



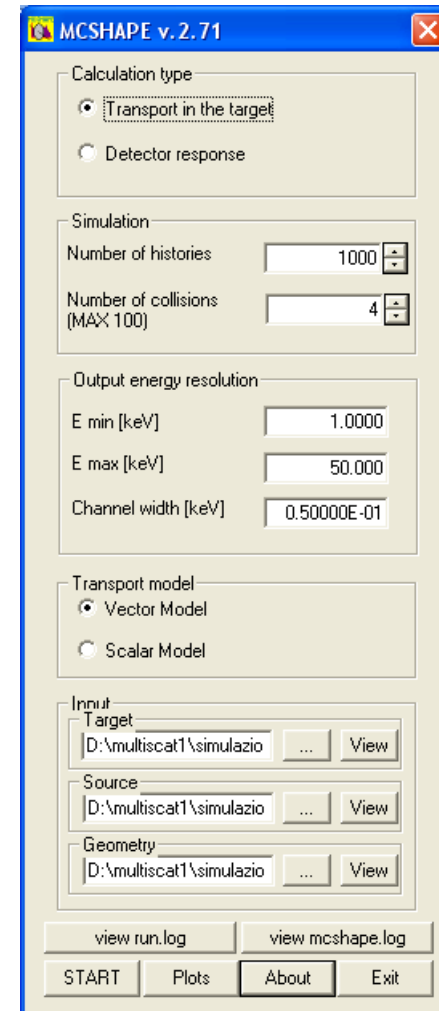
X-ray source

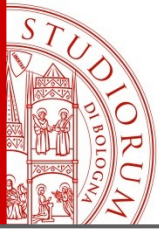




Simulation of transport in brass

- Source: SpectrumS_MCSHAPE.dat
Hamamatsu x-ray tube at 50kV
- Target: brass_2012
 - Cu 64 %
 - Zn 36 %
 - density 8.5 g/cm³
 - thickness 0.05 cm
- Geometry: geo45_45.DAT
scattering angle 90 degrees



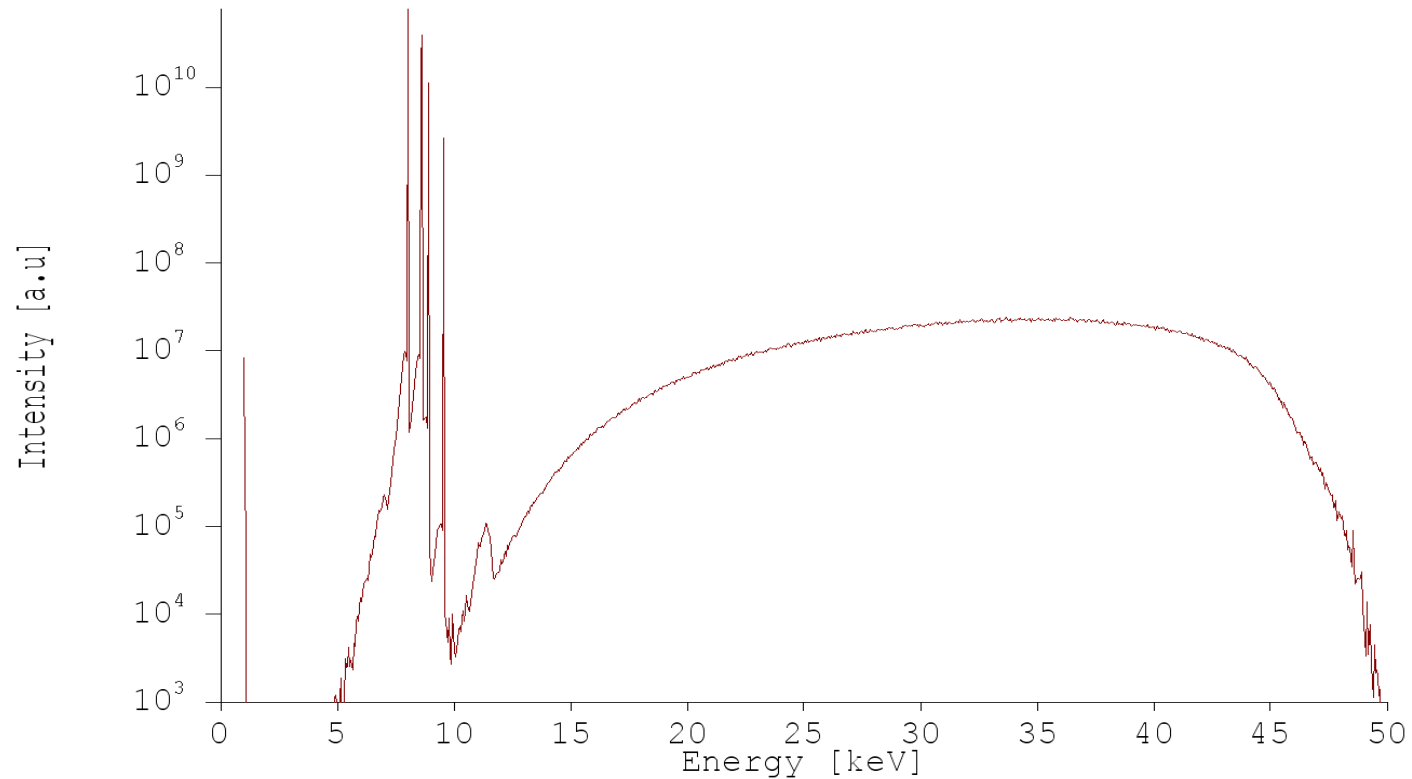


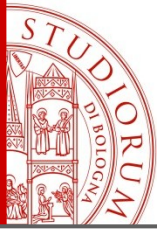
Transport in brass

Graphic Window
File Select Plot Axes

MCSHAPE v.2.71 (c) University of Bologna, April 2012

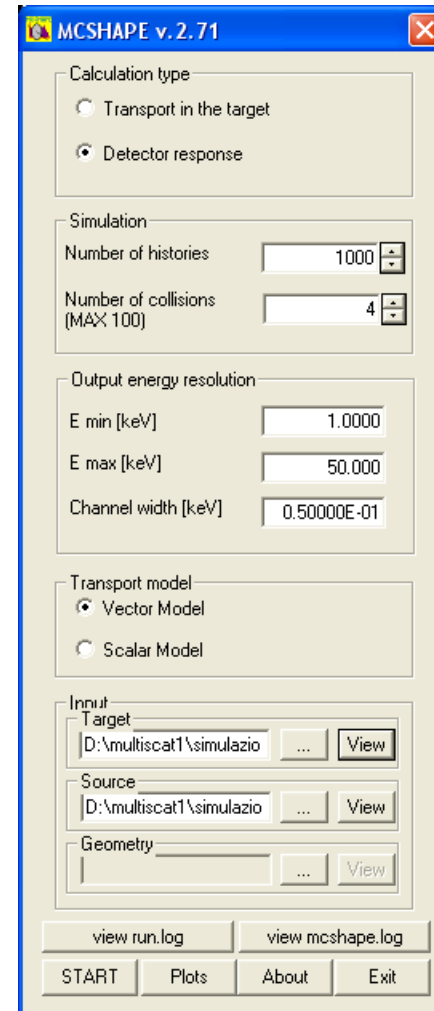
Sample: ottone_2012 (SPECTRUM.DAT - FIRST COMPONENT)

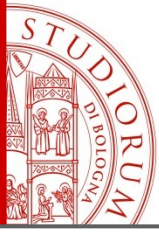




Computation of the detector response

- Source: S_ottone_2012.dat
- Target: Si_05mm
Si 100 %
density 2.33 g/cm³
thickness 0.05 cm
- Geometry: photons undergone normal to the detector

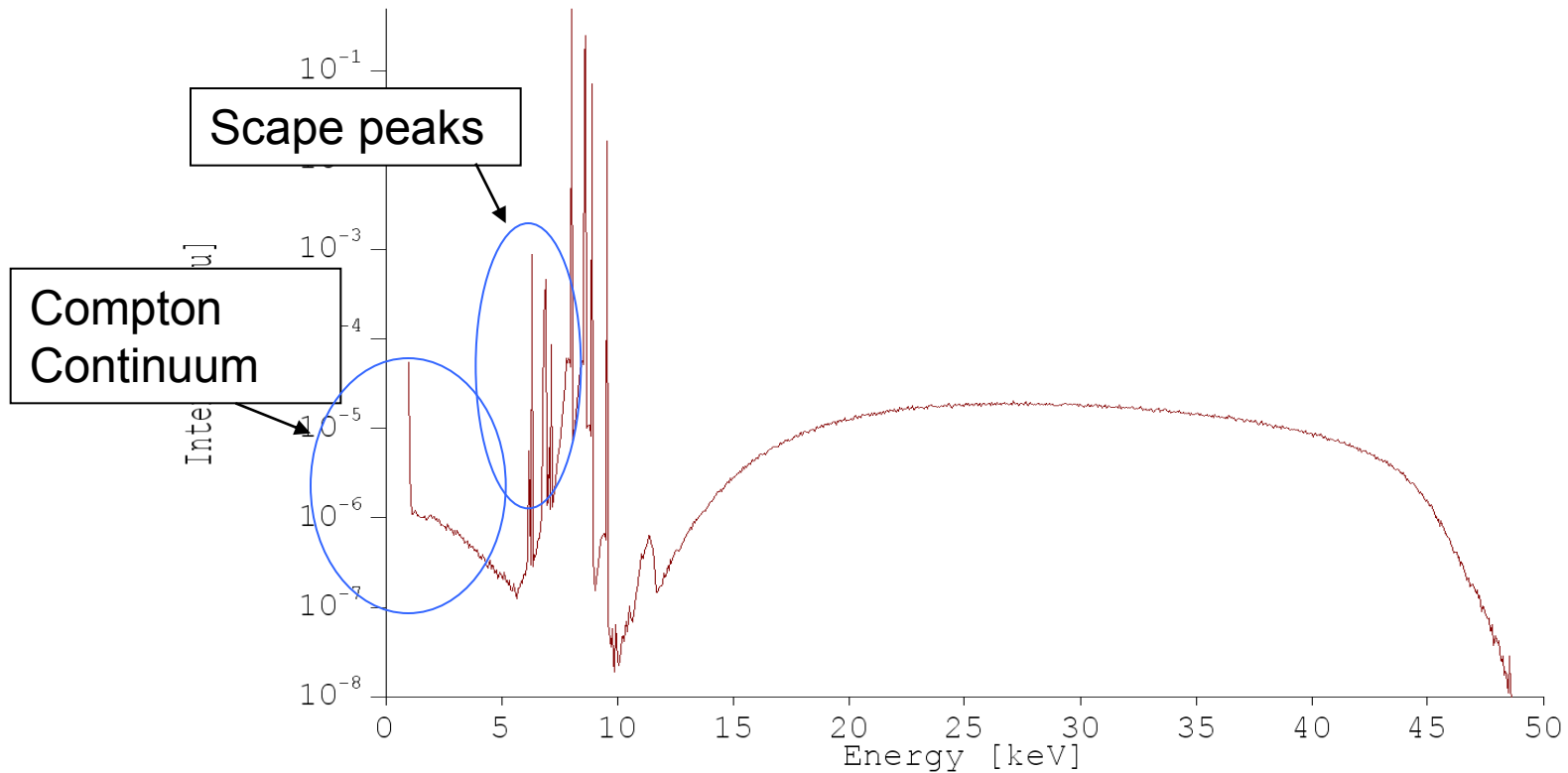




Let us analyse the detector response

Graphic Window
File Select Plot Axes

MCSHAPE v.2.71 (c) University of Bologna, April 2012
Sample: Si_05mm (RESPONSE_TOTAL.DAT)



Detector Resolution

Detector resolution v.1.0

Detector type
 Gas proportional coun SSD Scintillator

Set FWHM parameters

Import detectors param Save detector param

$W =$ average energy to produce a ion pair [keV]

$F =$ Fano factor

$\alpha =$ semi-empirical constant [keV]

$b =$ semi-empirical constant

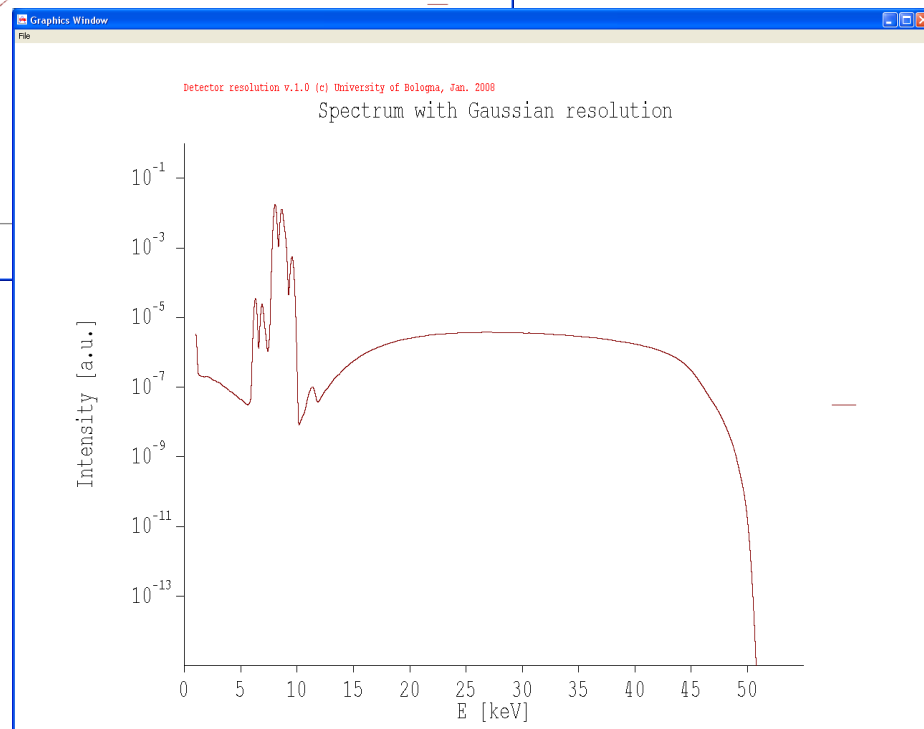
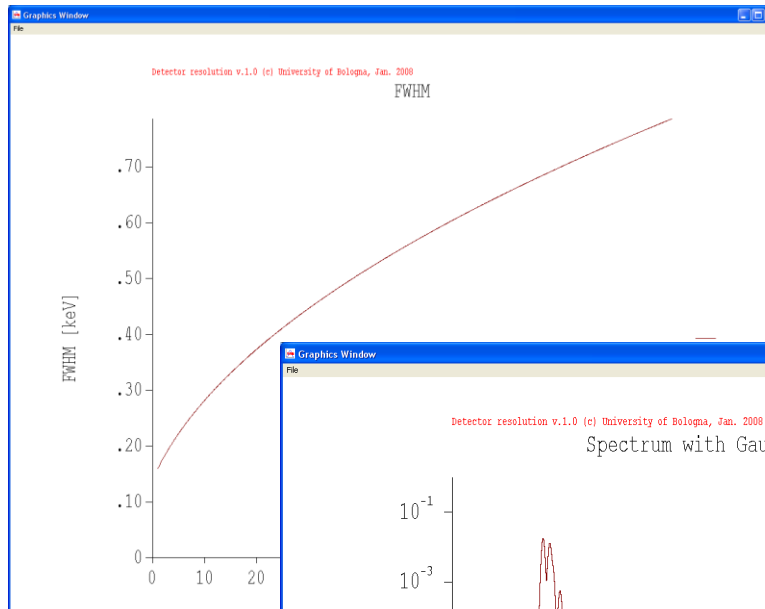
$\Delta E_{elec} =$ electronic noise contribution

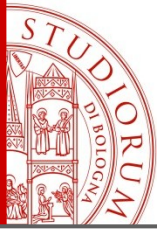
$$E_{FWHM} = \sqrt{8 \ln 2 (WFE + aE^b) + \Delta E_e^2}$$

Plot FWHM Help

Spectrum

About Exit





Comparison with a measured spectrum

Very good agreement for the peak ratio

The background is slightly greater in the measurement...

Perhaps the wood support behind the brass is missing!

