CREDO – Creative Research Equipment for Diffraction

CREDO is a small-angle X-ray scattering (SAXS) instrument, planned, constructed and operated by the Research Group of Biological Nanochemistry of the Institute of Materials and Environmental Chemistry, RCNS HAS. This instrument is unique in the country and the region.

The facility was realized in cooperation of the RCNS HAS and Gedeon Richter Plc, co-founded by a projekt of the Hungarian National Scientific Research Fund (CNK 81052) of the Hungarian National Innovation Office.

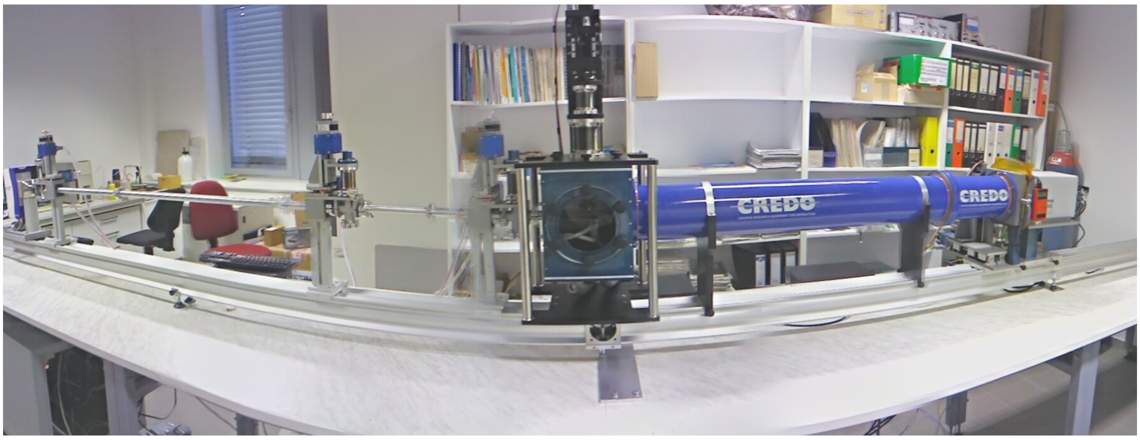
More information on the instrument can be found on its homepage: http://credo.ttk.mta.hu.

1. Aims of the instrument

The method of small-angle X-ray scattering is a unique tool for structural studies in the size range from a few nanometres up to tenths of micrometers. Based on our many years of experience with synchrotron SAXS beamlines, we endeavoured the construction of a „state-of-the-art” laboratory instrument, with the possibility of making our research more effective: either by removing the need for synchrotron measurements, or by valuable preliminary measurements to the latter, thus increasing our productivity and decreasing risks.

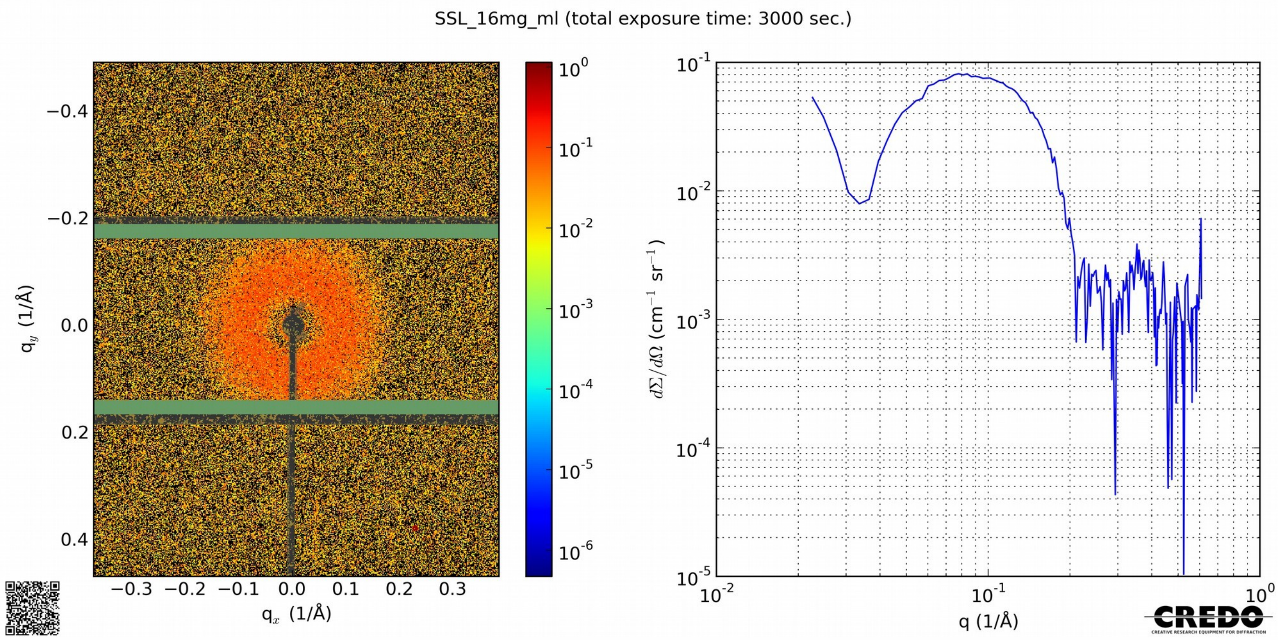
2. Technical data

- Xenocs GeniX^{3D} Cu ULD integrated beam delivery system with a 30W microfocus X-ray tube and the integrated parabolic (collimating) multilayer optics
- Dectris Pilatus-300k two-dimensional CMOS hybrid pixel detector (487×619 pixel, 172 μm pixel size, 2.3 ms readout time, 20 bit dynamic range)
- Home-made collimating system: three pin-hole stages with individual motorized XY positioning using six independent stepper motors
- Home-made sample stage: motorized XY positioning (35 mm × 75 mm), several sample holders and different sample environments can be accommodated
- Vacuum system: ~ 0.02 mbar from source to detector
- Home-made instrument control and data reduction software. Measurement is fully automatized. On-line data reduction, corrections, calibrations.
- Sample-detector distance: adjustable
- Certified by the Institute of Reference Materials and Measurement, Joint Research Centre of the European Commission



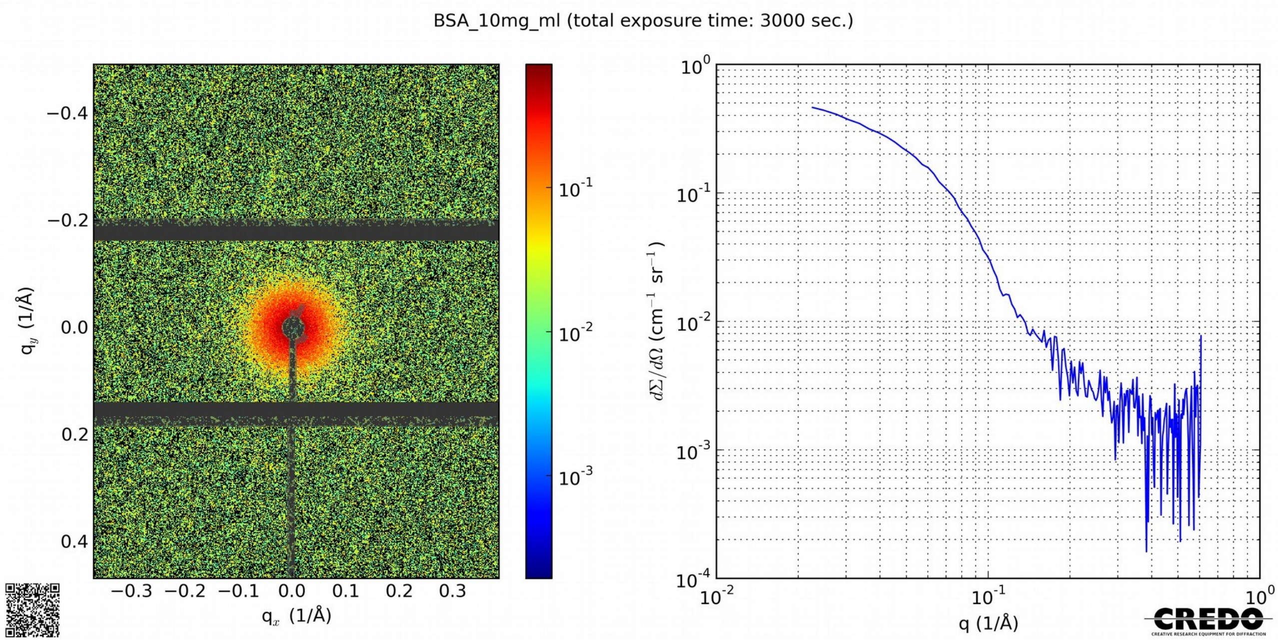
3. Examples

3.1. *Sterically stabilized unilamellar phospholipid vesicles*



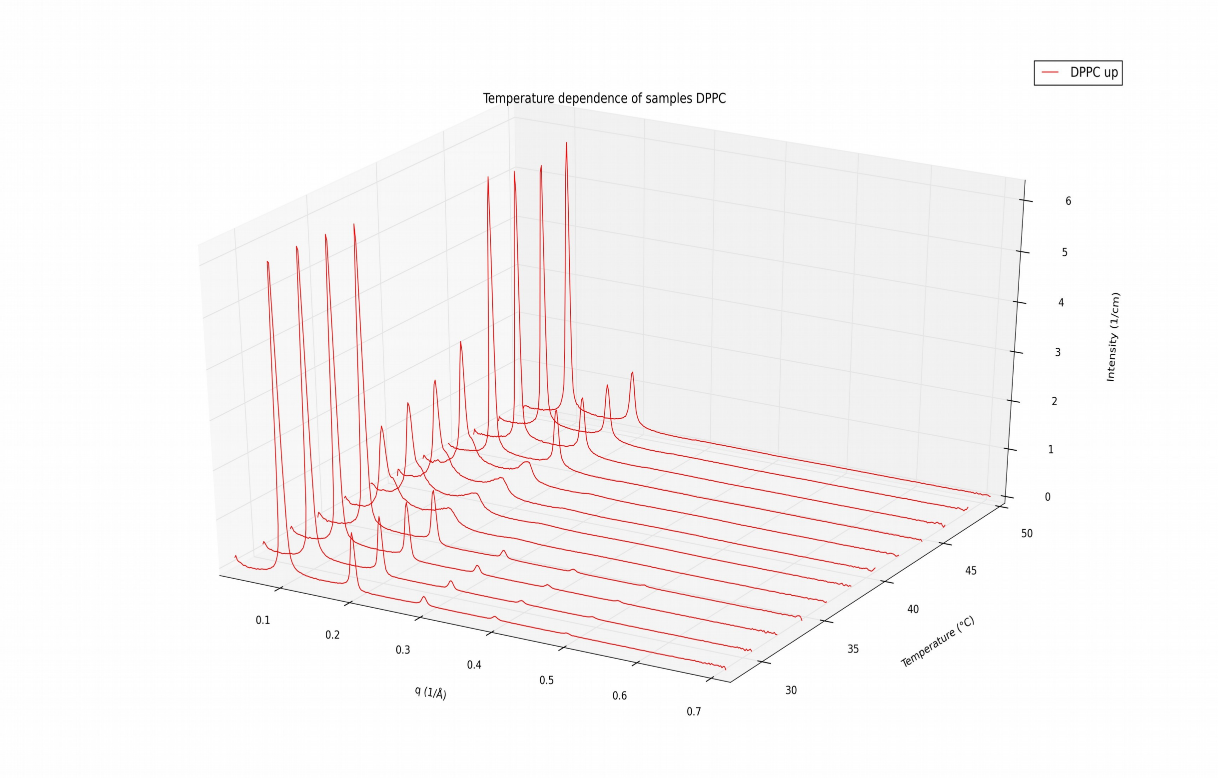
The scattering curve shows the form factor of the phospholipid bilayer, which carries information on the electron density distribution along the bilayer normal. The profile of the bilayer can be deduced via a least-squares fit.

3.2. *Solution of bovine serum albumine*



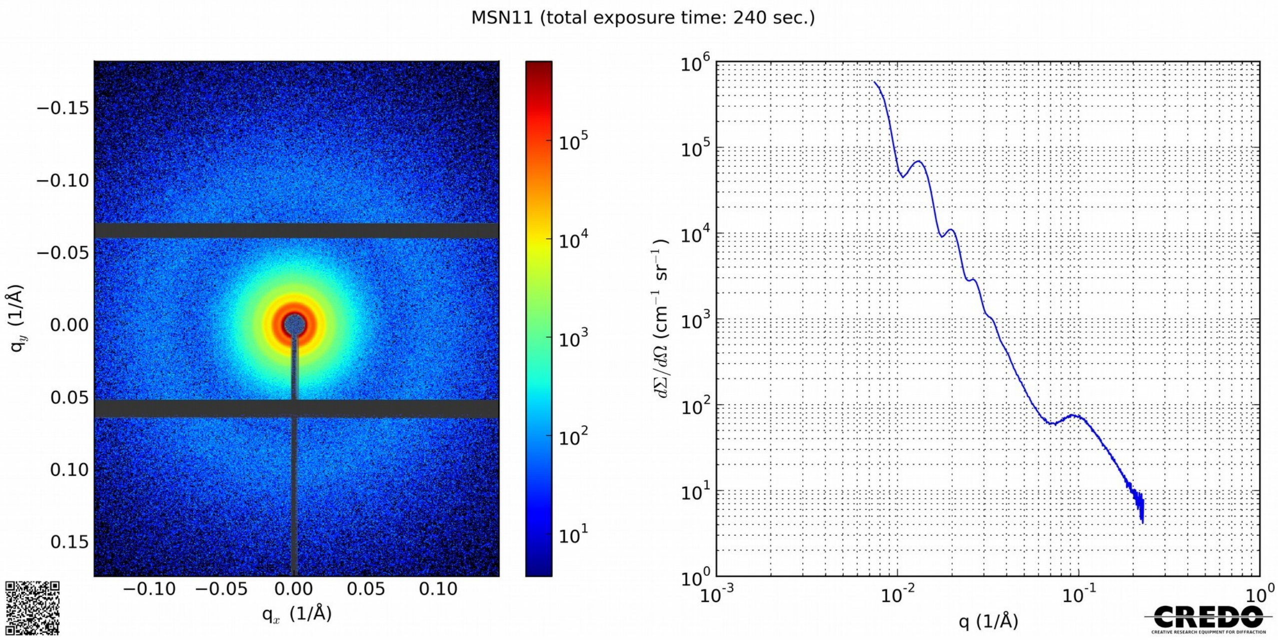
The information, which is the easiest to deduce from the scattering of proteins in solution is the radius of gyration, by using the Guinier-approximation. But in a more ideal case (good scattering contrast, higher concentration) the enveloping shape of the proteins can also be obtained using a coarse-grained model.

3.3. Structural changes in a multilamellar DPPC-water vesicle during thermotropic phase transition



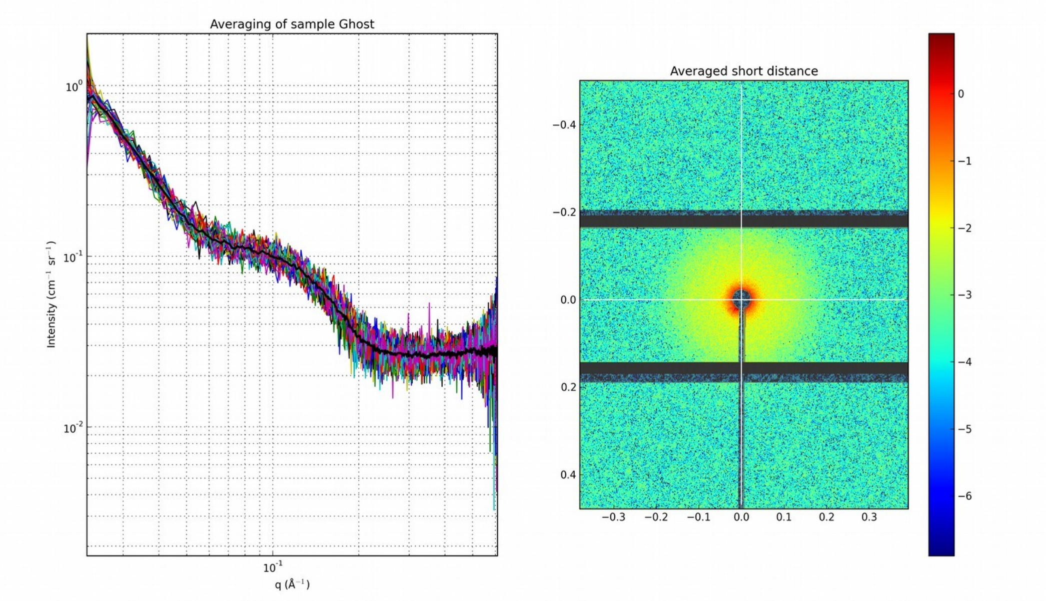
The curves visualize the changes in the layer stacking of a multilamellar liposome, due to the increase in temperature. The changes in the Bragg-peaks signify the changes in the radial periodicity. Decomposing the peak profiles can yield more detailed information.

3.4. Mesoporous silica nanoparticles



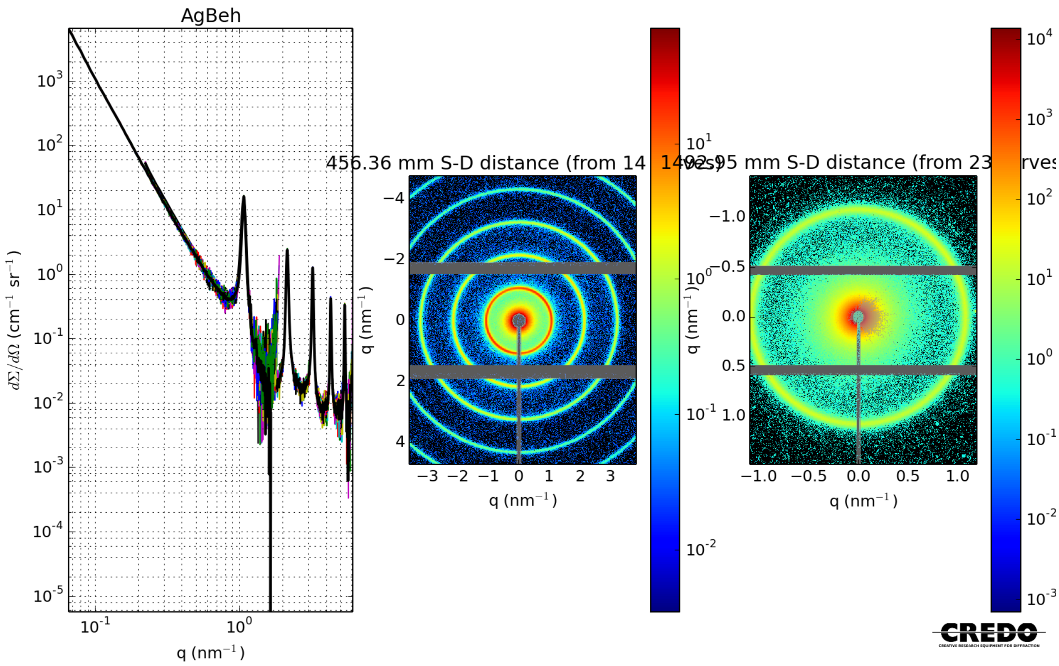
The measurement was made on freeze-dried nanoparticles (powder state). The oscillating range at the start of the curve originates from the form factor of the spherical nanoparticles, and makes an exact determination of the size distribution of the particles possible. The broad peak at the end gives information on the ordering and typical distance of the mesopores. Note that the measurement took only four seconds.

3.5. Erythrocyte ghost



The measurement was made on human erythrocyte ghost. The full exposure time was 12000 s, i.e. 3 h 20 min, in 300 s exposures. The left image shows the scattering curves obtained from the individual exposures, along with their average (black line). The shoulder in the middle is the consequence of the form factor of the membrane parts, like in the case of the sterically stabilized vesicles presented above. The averaged two-dimensional scattering pattern is shown on the right side, with logarithmic color scale.

3.6. Silver behenate



The images show the scattering of silver behenate, the best-known calibrant material for the abscissa of SAXS measurements. The middle image correspontds to short (~ 46 cm), the right to long (~150 cm) sample-to-detector distance.

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