Towards on-line Reconstruction of Electron Holograms
Tatiana Latychevskaia (NCCR - December 2001 until December 2002) and Hans-Werner Fink

Background and related activities

Holography with Low Energy Electrons: efforts towards a possible new tool for structural biology
University of Zurich - Experimental Physics

Improving interference resolution

Field ion microscope - Cornel Andreati - for investigating novel electron sources.

Dedicated micro- and nano-structures for interfacing molecules
Commissariat in collaboration with Delft University Technologies

Ac magnetic field shielding and high resolution detection of low energy electrons

Visually imaged with an LEEM microscope in transmission
Erich Öhme / Zair

First efforts for preparing proteins for investigation by low energy electron holography
with Andreas Kuschnig and Peter Lindner - Biochemistry Zurich and the NCCR

Controlling DNA in liquids
DNA dynamics - Conrad Escher

Numerical hologram reconstruction

Besides the above vital experimental aspects to obtain high resolution electron holograms, the holographic record, containing all information about the object wave - front reacts to be reconstructed. Reconstruction means - back-propagating the waves to the location where the object was placed. This can be done by replacing the time t by 4t, which is best done by employing a computer. Mathematically, it implies solving the Helmholtz-Kirchhoff integral.

On-line reconstruction boils down to fast data acquisition and a fast numerical routine to approximate the Fresnel-Kirchhoff integral to display the reconstructed image within an acceptable time.

Testing numerical routines with visible light

Current performance on a standard PC between 2 and 3 seconds for a 1024 * 1024 pixel hologram

The objects here are 1 micron diameter latex spheres imaged with a green laser

Current and future issues

Solving the twin-image problem inherent to Gabor In-line holography

An algorithm for eliminating the twin image problem has been developed by Dave Tong, at Hongkong University. It requires the acquisition of holograms at different energies. Experimentally, this is feasible and has already been demonstrated. Dave Tong shall assist us in the implementation

Acquiring all relevant data, wave length, x-distance from the instrument on-line, not just the hologram information

Hardware acceleration of the numerical routines.

Numerical Filters for accounting for strong forward scattering of low energy electrons

Removal of statistical noise

2003 Site visit