Collaborations

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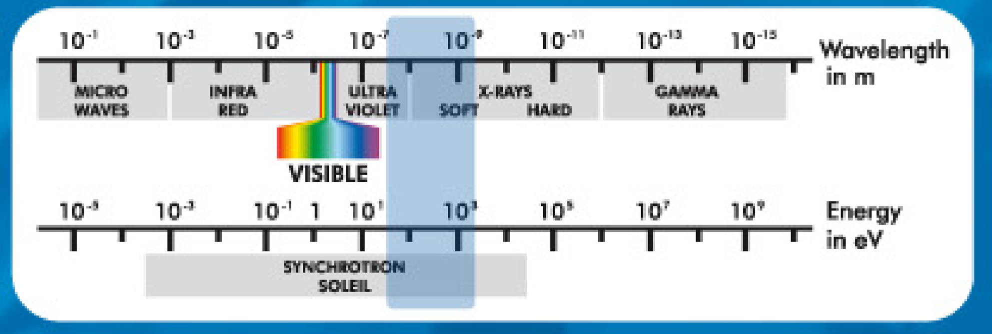
TEMPO

Time resolved Experiments on Materials with PhOtoelectron spectroscopy

Time Resolved Spectroscopy for Magnetism and Physical Chemistry

Energy range of TEMPO: 45-1500 eV



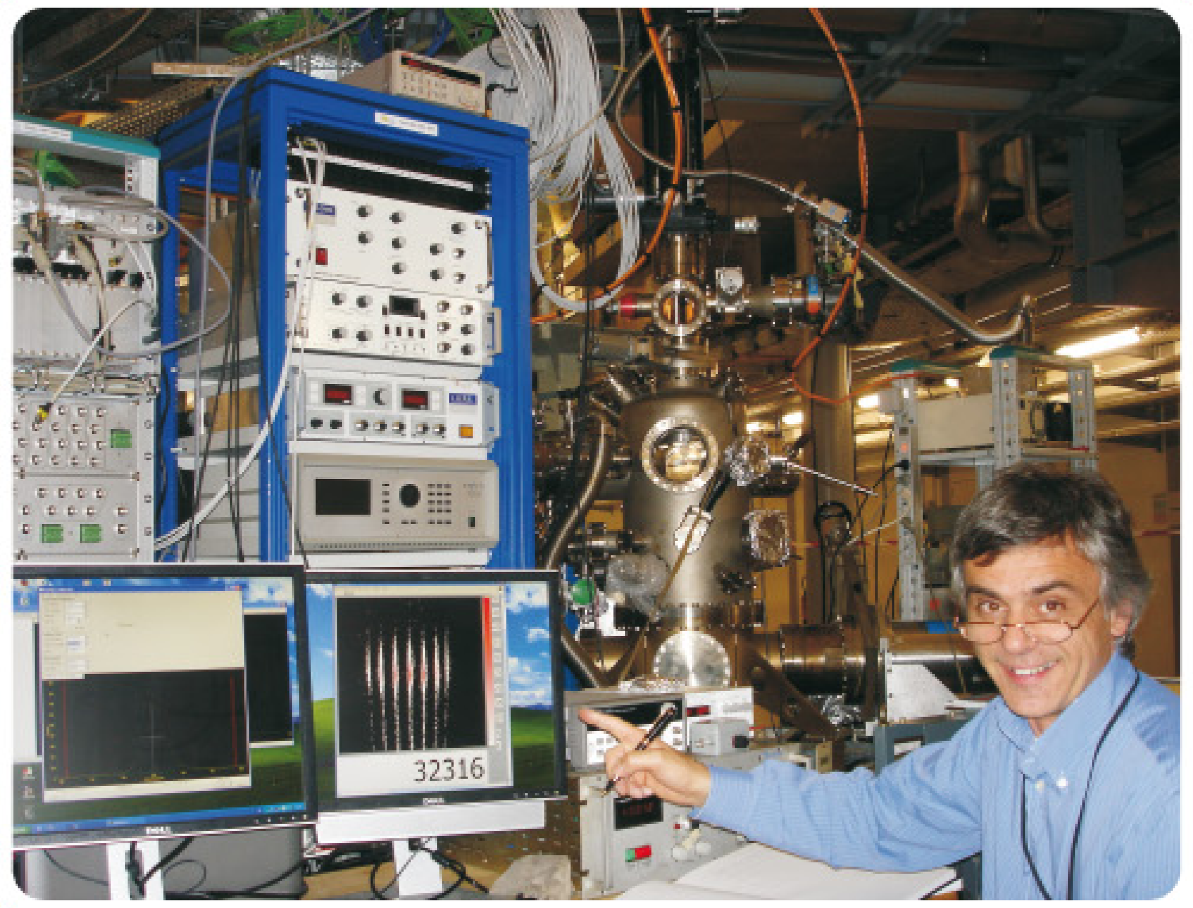
Synchrotron radiation is produced by two permanent magnet Apple II undulators, providing high photon flux and several types of polarization (direction of the radiation electric field): circular, linear – horizontal or vertical.

Experimental techniques:

- Time Resolved X-ray Photoelectron Spectroscopy
- X-ray Absorption Spectroscopy
- Magnetic Linear and Circular Dichroism
- Spin polarisation

TEMPO will enable dynamic studies of electronic and magnetic properties of materials to be carried out, using several time resolved spectroscopy techniques.

Zoom: Main experimental station



TEMPO comprises 2 experimental stations working alternatively and providing micron size X-ray beams.

The main experimental station has a 10x40 μm^2 beam and is designed for time resolved experiments using a new double delay line detector developped in collaboration with the Italian Elettra synchroton electronics department:

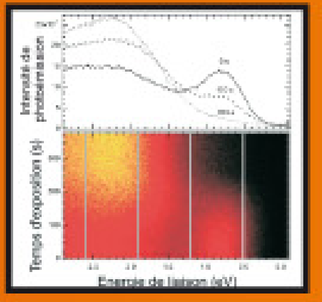
- as a CCD camera, the detector records the impact location of electrons photo-emitted by the sample subjected to the X-ray photons. This provides the emission angle of these electrons (spatial information) and their energy.
- In the "counting" mode, the detector records each electron impact and the exact time of this impact. Time resolved information obtained based on the frequency at which electron pulses are sent on the sample and on the pulse width (about 30 ps, i.e. 30x10^{-12} sec) is used for kinetic and spatial studies and to monitor time dependence of sample properties.

The second station has a 100x100 μm^2 beam and it will be used at first for experiments of external users. Expected projects: X-ray microscopy using a Fresnel lens and high pressure photoemission.

Topics and applications

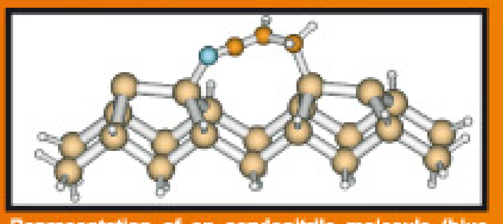
→ **Kinetics of surface and interface chemical reactions (millisecond time scale: 10^{-3} s)**

- Studies of surface atoms chemical environment variation.
- Surface reaction kinetics: molecular dissociations and interactions.



Kinetic study using rapid photoemission – of the order of 1 millisecond – of the reaction between an adsorbat (acrylonitrile) and a silicon Si(001) surface. Si electronic states (around 0.8 eV) disappear with time and are replaced by those of acrylonitrile (around 2.25 eV)

Applications to material science (new magnetic materials), to surface science (functionalised ultra thin films), to micro-nano-electronics (semiconductors)

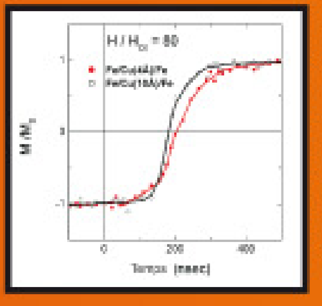


Representation of an acrylonitrile molecule (blue and red atoms) attached to the Si surface.

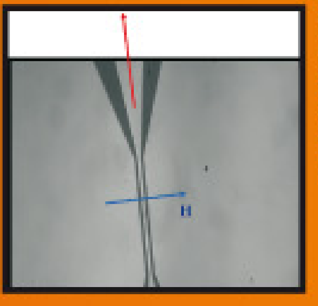
→ **Magnetisation dynamics of magnetic materials (ten picosecond time scale: 10^{-11} sec)**

- Magnetisation reversal studies in nanostructures.

Applications in nanotechnology and microelectronics



Magnetisation dynamics measurements at the surface and at the interface between different materials. Here, copper layers "sandwiched" between iron layers. Inserting additional copper atomic layers between the iron layers increases surface magnetisation reversal speed.



Magnetisation dynamics on the picosecond scale (10^{-12} s) will be studied using circuits processed by lithography.

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