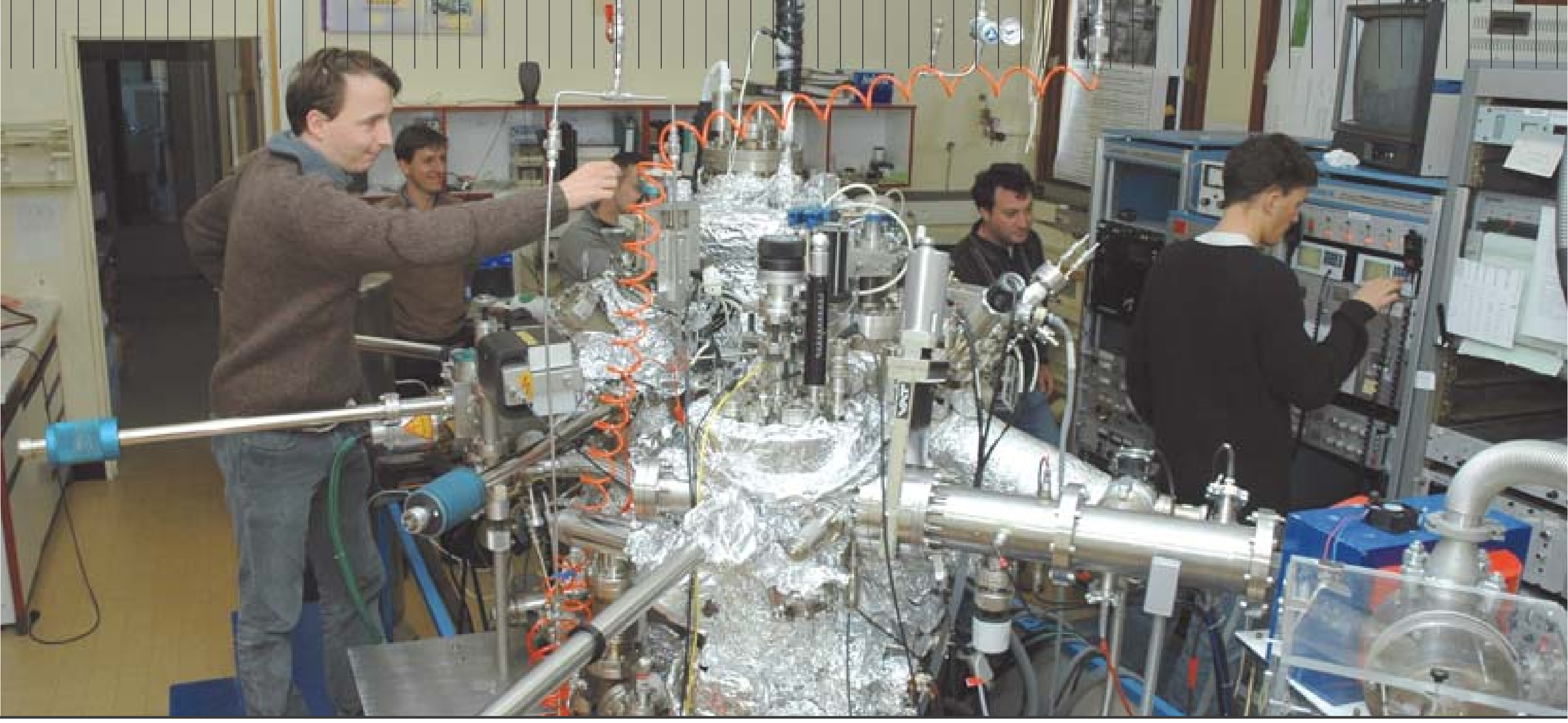

CEA

Epitaxy of magnetic layers with perpendicular anisotropy carried out at the Laboratory of Nanostructures and Magnetism, CEA Grenoble (Isère).

III. ULTIMATE MAGNETISM

Besides its purely theoretical interest, the study of nanometer-scale magnetism is driven by the expectation of achieving increasing data storage density. For storage, data can be written and conserved on the magnetic grains of a hard drive. However, when the grain size is of the order of only tens of nanometres, specific problems arise.

On this scale, a magnetic particle is a tiny magnet that can hold a unit of information. However, its small size makes the direction of magnetisation sensitive to thermal fluctuations. How can the direction be stabilised? By choosing materials with high magnetic anisotropy, i.e. in which magnetisation is especially stable in certain directions. Or by depositing the particle on a 'hard' magnetic material, in which the magnetic direction is difficult to reverse. The particle interacts with this material and its magnetisation is stabilised. The study of this interaction on the nanometre scale is thus of great importance.

In nano-ribbons, the magnetic structures are strings of oppositely magnetised domains, separated by walls of nanometric size. It should be possible to move these walls by means of an electric current to send information along the ribbon. This would be a nanometric equivalent of the old bubble memory concept. One of the questions that arises is how defects limit the speed of propagation of the walls. Advances in this area may make it possible to design new data storage devices.

In the magnetic semiconductors studied for applications in spintronics, the transport of current-carrying spins holds surprises. For example, how do these interact with the magnetisation of magnetic nanocolumns when they are propagated in an array of columns?

All these studies require progress in characterisation methods towards greater spatial resolution and sensitivity. Powerful computation resources are also needed to support new simulation tools associating ab initio and micro-magnetic calculations to handle a spatial scale ranging from atomic dimensions up to the micrometer. The challenges raised by advances in information technology are thus generating impressive progress in a large number of scientific domains, including materials (with, in particular, developments in GeMn and oxides) and microscopy, where magnetism is directly involved in transmission electron microscopy (TEM) and magnetic resonance microscopy.

Lastly, the study of 'frustrated' magnetism and spin glasses is an area of choice for the study of both ordered and disordered systems and their possible applications.