A new tool to perform controlled ion implantation for the creation of dense NV ensembles in diamond

Focused Ion Beam (FIB) is a key instrument in material science. This technology, whether configured as a single-beam or dual-beam microscope, is utilized in a wide range of material characterization and manipulation techniques. These include ion beam etching, microfabrication, ion microscopy, secondary ion mass spectrometry, lithography, and ion implantation.

A filtered FIB (ExB FIB) operating with a Liquid Metal Alloy Ion Source (LMAIS) or plasma source allows the use of a broad spectrum of ionic species, significantly improving its range of potential applications.

In this presentation, we will introduce a specialized implantation tool developed by Orsay Physics, called QuiiN. This tool provides access to a wide variety of species for implantation applications, offering precise control over the vertical and lateral positioning of the implanted ions by varying the energy of the beam. To perfectly control the dose of implanted atoms, a chicane mounted in the filtered FIB ensures that neutral species do not reach the surface of the sample.
This technique was applied to the creation of color centers in diamond single crystal films by implanting nitrogen atoms (either $^{15}N^{+}$ or $^{14}N^{+}$) at different doses and energies. The spin properties of the resulting NV (nitrogen-vacancy) defects were then assessed to optimize their creation yield and tune their distance from the surface. The ability to engineer such NV ensembles in diamond with long coherence times is crucial to the development of efficient quantum sensors based on this material.