Quantum sensing has emerged as a transformative measurement technology capable of achieving sensitivities and spatial resolutions beyond those of conventional sensors by exploiting quantum mechanical phenomena. Among various quantum sensing platforms, the nitrogen–vacancy (NV) center in diamond has attracted considerable attention owing to its long spin coherence time at room temperature and the ability to optically detect even a single electron spin. These unique properties enable highly sensitive measurements of magnetic fields, electric fields, temperature, and pressure, opening a wide range of scientific and technological applications.

The realization of high–performance quantum sensors critically depends on techniques for the precise creation and control of color centers in diamond. Quantum beams, including ion beams and electron beams, provide powerful tools for introducing impurities and defects with nanometer–scale precision, thereby playing a central role in the fabrication of quantum functional materials and devices. Recent advances in beam–based processing have enabled deterministic positioning and three–dimensional engineering of color centers, paving the way toward scalable quantum technologies.

In this talk, the fundamentals of diamond quantum sensing and the principles of quantum measurement will be introduced. Recent progress in color center engineering using quantum beams and accelerator–based technologies will be reviewed. Applications to nanoscale magnetic imaging, biological sensing, nuclear magnetic resonance (NMR), and quantum information devices will be presented. Finally, future opportunities arising from the convergence of quantum beam science and quantum sensing will be discussed, highlighting prospects for both fundamental research and real–world applications.