Performing crucial experiments over a decade, scientists conceived and committed to research in the years to come. These experiments have transformed the landscape of solid-state spectroscopy, particularly with unprecedented energy resolution, applicability to small sample volumes under extreme conditions, and the observation of collective modes of electronic excitations. The advantages of the Resonant Inelastic X-ray Scattering (RIXS) technique, recently demonstrated with the ERiXS spectrometer at the ESRF, have taken the field of solid-state spectroscopy to new heights.

Recently, Lucio Braicovich and Giacomo Ghiringhelli, along with Claudia Dallera and others, have pioneered the development of both key hardware and scientific concepts. The AXES spectrometer, designed and constructed by Giacomo Ghiringhelli and Thorsten Schmitt in 2006, has been instrumental in advancing the field of RIXS. The AXES spectrometer, installed at the European Synchrotron Radiation Facility (ESRF) and the Swiss Light Source (SLS), has allowed researchers to systematically enhance resolution by implementing new components and improving their alignment over time. By 2002, the attained resolution of 0.5-0.8 eV allowed unprecedented momentum- and polarization-dependent studies of crystal-field excitations in Mott-insulating manganates, nickelates, and cuprates with photons at the L- and M-absorption edges of the transition metal ions.

Braicovich and Ghiringhelli then designed and constructed the Super-AXES (SAXES) spectrometer, installed at the Swiss Light Source in collaboration with staff scientists Thorsten Schmitt and others. The modular design of SAXES allowed them to systematically enhance resolution by implementing new components and improving their alignment over time. By 2002, the attained resolution of 0.5-0.8 eV allowed unprecedented momentum- and polarization-dependent studies of crystal-field excitations in Mott-insulating manganates, nickelates, and cuprates with photons at the L- and M-absorption edges of the transition metal ions.

The discoveries made using RIXS have fundamentally changed the discourse on the electronic structure of the cuprates. Notably, Braicovich and Ghiringhelli and their collaborators showed that dispersive high-energy spin excitations may persist well into the cuprates’ overdoped regime. The greatly enhanced sensitivity of the SAXES spectrometer was crucial in the discovery of a charge density wave (CDW) phase in moderately doped cuprates. High-resolution RIXS was also used to detect momentum-dependent, collective orbital excitations (“orbitons”) in cuprates, titanates, and vanadates. The possibility to directly address orbital degrees of freedom is truly groundbreaking, and represents a qualitative advance over prior experiments that had probed these excitations at zero momentum transfer.

Recently, Braicovich and Ghiringhelli (again with Nick Brookes) have commissioned the ERIXS spectrometer at the ESRF, and have conducted the first experiments that take advantage of its unprecedented resolution of 0.03 eV (at the Cu L-absorption edge). These concern detailed, quantitative comparisons of magnon dispersions in different families of cuprates; the measurement of phonons and the electron-phonon interaction; and the discovery of collective modes of charge density waves.

The advantages of the RIXS technique – measurement of the entire Brillouin zone, unprecedented energy resolution, applicability to small sample volumes under extreme conditions – have led to advances and discoveries inconceivable just a few years ago, that have transformed the landscape of solid-state spectroscopy, inspired a new generation of scientists now entering the field, and will continue to very significantly impact condensed matter research in the years to come. This revolutionary development is due to the vision, the commitment, and the determination of Lucio Braicovich and Giacomo Ghiringhelli, who conceived and worked on high resolution RIXS with great determination for well over a decade, have pioneered the development of both key hardware and scientific concepts, and performed crucial experiments.