Nanostructured materials exhibit a great variability of physical properties. These are originated from small crystallite sizes, often significantly below 100 nm and determined by microstructural and strain gradients formed during synthesis. Many modern technologies use these exceptional properties of nanostructured materials to achieve desired functionalities. In order to understand structure-property relationship, X-ray diffraction characterization is the method of choice to analyze phases, strains, crystallographic texture, crystal structure, and composition in nanomaterials. However, the lateral resolution of the X-ray experiments at nano-probe beamlines often limits the achievable results. Therefore, the information at the nano-scale gradients of the above-mentioned parameters is often not available.

Using Multilayer Laue lenses (MLL) leads to a significant improvement with respect to lateral resolution and X-ray intensity at the sample position compared to optics used at many beamlines today. MLLs are X-ray optics suited particularly for the use with hard X-rays. They are made from a depth graded thin film deposition on a flat substrate. Subsequent structuring by means of layer cutting and focused ion beam milling results in a one-dimensionally focusing element. Crossing two individual MLLs allows for point focusing and imaging.

During recent projects we made various MLL-pairs with different designs for synchrotron applications. Aiming at high resolutions for in-situ experiment setups we have achieved sub 25 nanometer focusing with a measured working distance of about three millimeter. For versatile use a "long-distance"-MLL design with a focal length of 45 mm allows placing even relatively large sample environments and tomographic setups in the focal plane. The design of some lens pairs was made in a way to allow switching between a point and line focusing mode. This allows for significantly improved statistics and leads to significantly reduced measurement times for certain types of samples.

Furthermore, pairs of crossed MLLs also demonstrated the capability for the use in full field imaging mode. Solid molybdenum and copper anodes as well as liquid metal jet setups served as X-ray sources in order to demonstrate the capabilities of MLLs for high resolution laboratory X-ray applications in combination with an adapted condenser optics. Now multilayer thicknesses well above 100 µm can be achieved routinely. This will lead to further increased resolutions in focusing as well as in imaging applications.