X-ray Imaging of Human Brain Tissue down to the Molecule Level

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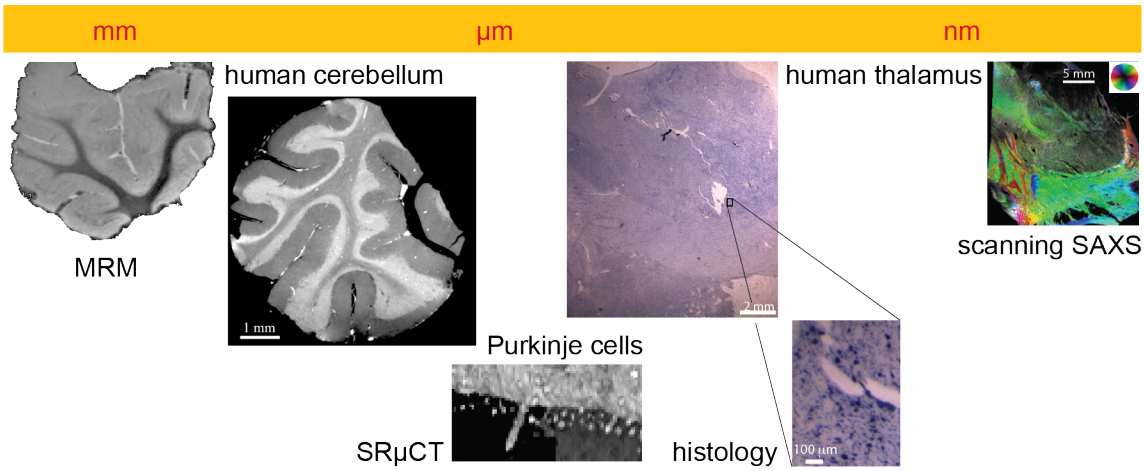
X rays have been used for medical imaging since Röntgen's fascinating discovery 125 years ago. The first radiographs of human hands was made public less than a month after his famous discovery [1], and conventional X-ray sources integrated into the CT machines of today's hospitals still rely on the same principles. Current research is often based on advanced X-ray sources including synchrotron radiation facilities, offering unique brilliance, polarization and pulsed time structure. Therefore, experiments such as phase-contrast imaging and spatially resolved small-angle X-ray scattering can be performed on biopsies or *post mortem* tissue. Within this talk, the unique options of synchrotron radiation-based experiments for the visualization of the human brain will be reported, see figure. Our team demonstrated that X-ray phase contrast of the human cerebellum yields better three-dimensional images than magnetic resonance microscopy [2]. Grating interferometry enabled us to visualize individual Purkinje cells in the non-stained cerebellum [3]. After embedding the cerebellum into paraffin, the cells were visible even using conventional instrumentation [4]. Hard X-ray nano-holotomography allows for label-free, three-dimensional neuroimaging beyond the optical limit, i.e. with a spatial resolution below 100 nm [5]. Spatially resolved small-angle X-ray scattering permits the localization of periodic nanostructures such as myelin sheaths on square-inch brain slices [6]. Further advances are required to three-dimensionally image the entire human brain with an isotropic spatial resolution below the previously achieved 20 µm [7]. The related challenges will be discussed in detail.



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