# X-ray Sources for High Throughput and High-Resolution Imaging

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The liquid-metal-jet technology has developed into fully operational and stable X-ray tubes running in many labs over the world. The fundamental limit for the X-ray power generated from a given spot size is when the electron beam power is so high that it locally melts the anode. The liquid-metal-jet anode (MetalJet) technology solves this thermal limit by replacing the traditional anode by a thin high-speed jet of liquid metal. Melting of the anode is therefore no longer a problem as it is already molten, and significantly (currently about 10x) higher e-beam power densities can therefore by used. The applications include X-ray diffraction and scattering, but recently several publications have also shown very impressive imaging results using liquid-metal-jet anode technology, especially in 2-D or 3-D phase-contrast imaging and X-ray microscopy. MetalJet source also shows its applicability extending to industrial imaging applications.

Phase-contrast imaging achieves a significant improvement on the contrast and resolution of soft-issue with hard X-rays, however, the imaging quality, has been compromised by the low flux and brilliance using traditional microfocus tubes or adding optical elements. Therefore, the high brilliance liquid-metal-jet technology paves the way for the development of laboratory-scale phase-contrast imaging, especially its biomedical applications, by enabling shorter exposure time, higher imaging resolution and contrast. Besides, the high stability of the source at its top performance perfectly matches the requirement of the associated phase-contrast imaging techniques. The Kα line of gallium, which is just above the absorption edge of copper, makes MetalJet beneficial for imaging copper with high contrast. Therefore, its advantage in electronic imaging, i.e., imaging copper in obsolete silicon materials, has also been shown.

Besides the high brightness microfocus MetalJet tube, based on the advanced electron beam technology, a new nanofocus x-ray tube, with tungsten-coated diamond-transmission target, has been published and reached an extreme resolution of 150 nm line-spacing. Additionally, the unique features of the nanofocus tube also consists in the internal calibration of the current focal spot size before each scan and the high stability for long-time, comparative investigations. The extreme small, true round focal spot of the Nanotube can be used for non-destructive, sub-µm resolution 2-D and 3-D imaging investigation.

## References

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