# The Quest for the perfect focus for high power density XUV and X-Ray beams: Experience from FLASH

K. Tiedtke
*Deutsche Elektronen-Synchrotron (DESY), Notkestrasse 85, 22607 Hamburg, GERMANY*

In mid 2005 the Free electron LASer in Hamburg (FLASH) has started regular user operation [1], providing uniquely intense, short-pulsed radiation that up to now was tuned from 47 nm to 7 nm. Peak and average brilliance of this new user facility exceed both modern synchrotron and laser plasma sources by many orders of magnitude. The XUV output possesses the unprecedented flux of $10^{13}$ photons per pulse with durations of 10-50 fs, that, when focused into a spot size of a few micrometers in diameter, can achieve peak irradiance levels of more than $10^{16}$ W/cm$^2$ [2]. Here, photon matter interaction is affected by non-linear processes. Generally, the key point in the understanding of such non-linear effects is their dependence on irradiance. Therefore techniques to measure the pulse energy, duration, temporal and lateral distribution of the focused radiation are mandatory.

Besides these challenging demands for photon diagnostics, the requirements for the optical components for beam transport and focusing are extreme in terms of figure errors, roughness, stability, and radiation hardness in order to preserve the time structure, coherence, and other important properties of the FEL beam.

This paper will report on concepts for focusing the FLASH beam down to µm or sub-µm dimensions as well as diagnostic tools to determine the lateral and temporal intensity distribution, and the pulse energy.

**References**

[1] Ayvazyan V et al., , Eur. Phys. J. D **37**, 297 (2006)
[2] A.A. Sorokin et al., Phys. Rev. Lett. **99**, 213002 (2007).

Kai.tiedtke@desy.de