Gas-monitor detectors for FELs.

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During the last years an impressive progress has been achieved in the development of powerful short wavelength coherent laser light sources like self-amplified spontaneous emission (SASE) free-electron lasers (FELs). The first source of this kind was Free-electron LASer in Hamburg (FLASH) which operates in the extreme ultra-violet (EUV) from 48 nm (25.8 eV) down to 4.3 nm (288 eV) [1]. In 2009, the X-ray FEL Linac Coherent Light Source (LCLS) in the United States has been put in exploitation, which provides radiation in the spectral range between 2.2 nm (564 eV) and 0.12 nm (10.3 keV) [2]. Recently, the new FEL for hard X-ray SACLA (SPring-8 Angstrom Compact free-electron Laser) in Japan has started operation at photon energies even beyond 10 keV [3]. Moreover, new hard x-ray FEL facilities in Germany and Switzerland (European XFEL and SwissFEL) are currently under construction which will deliver radiation with photon energies as high as 24 keV.

The absolute photon intensity of the FELs is a fundamental quantity, knowledge of which is mandatory for many user experiments. However, measurement of this quantity is a particularly challenging due to the laser's unique properties such as ultra-short femtosecond pulse length and extremely high peak power of up to few GW which can easily saturate or even destroy solid state detectors commonly used at synchrotron facilities. Moreover, due to the statistical nature of SASE, on-line pulse-resolved characterization of the photon intensity is essential. In order to monitor FEL radiation pulse intensity, sophisticated concepts have been developed at the different facilities [4-7]. At FLASH, the pulse resolved radiant power and beam position is measured on-line and non-destructively using calibrated gas-monitor detectors (GMDs) developed in close cooperation between DESY, PTB, and Ioffe Institute [4]. The GMDs are based on the atomic photoionization of rare gases at low pressures from 10^{-2} Pa to 10^{-4} Pa and the charge detection of photoions and photoelectrons by Faraday cups. The quantum efficiency of GMDs was calibrated in the laboratory of PTB in the VUV spectral range. This calibrated quantum efficiency can be extrapolated to the higher photon energy range using known photoionization cross sections.

Here we present recently developed upgrade version of GMD (so-called XGM) including a huge area open electron multiplier which enable increase dynamic range of the detector by more than seven orders of magnitude. The new GMDs will be permanently installed at the European XFEL and SwissFEL as a part of photon diagnostics for intensity and photon beam position monitoring.

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