Quantitative Detection of Femtosecond X-ray Pulses

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FLASH Experimental Area at **DESY**







FLASH gas-monitor detectors

M. Richter et al., Deutsches Patent- und Markenamt, No. 102 44 303, München (2004)

M. Richter et al., Appl. Phys. Lett. 83, 2970 (2003)

A.A. Sorokin et al., AIP Conference Proceedings **705**, 557 (2004)

A. Gottwald et al., Proc. SPIE **5534**, 13 (2004)

K. Tiedtke et al. (TUPPH065): Online Photon Beam Position and Intensity Monitoring at FLASH **Rare-Gas Photoionization Detector for Monitoring VUV and EUV Free-Electron Laser Radiation**





PTB Laboratory at BESSY II



PB

Quantum Efficiency of the TTF 1 Gas-Monitor Detector: Ion-Current Signal of Xenon





- M. Richter et al., Appl. Phys. Lett. 83, 2970 (2003)
- M. Richter et al., AIP Conference Proceedings 652, 165 (2003)
- A. Sorokin, PhD Thesis, Russian Academy of Science (2000)

Photoabsorption Cross Section of Xenon



B.L. Henke et al., Atomic Data and Nuclear Data Tables 54, 181-342 (1993).

secondary ionization processes \rightarrow

- negative influence on the time resolution
- critical (non-linear) dependence of the sensitivity on the gas pressure

space-charge effects \rightarrow

non-linearities of the detector sensitivity

Ion Time-of-Flight Spectra of Neon: Line Broadening due to Space-Charge Effects







low target gas pressure low photon intensity high target gas pressure high photon intensity

A.A. Sorokin et al., submitted

X-ray Gas Monitor Detector (X-GMD)



PTB Laboratory at BESSY II

1

2

3a

3b

3C

50 eV to 1800 eV

1.75 keV to 10 keV

3 eV to 30 eV

four crystal monochromator

undispersed bending magnet radiation

deflected undispersed bending magnet

normal incidence monochromator

radiation, irradiation test station



- undispersed undulator radiation 4a
- 4b plane grating monochromator at undulator 30 eV to 1900 eV
- deflected undispersed undulator radiation **4c** metrology test station
- 5 normal incidence monochromator 3 eV to 30 eV



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Spectral Responsivity of the X-GMD



Stanford, January 2006



SPPS parameters:

photon energy:		9.4 keV
pulse frequency:	1 o	r 10 Hz
photon number per puls	se:	~ 10 ⁶

Stanford, January 2006



X-GMD at SPPS on January 28, 2006



X-GMD at SPPS on January 28, 2006



Photon Number per Pulse at SPPS on January 28, 2006



Photon Number per Pulse at SPPS on January 28, 2006



Summary and Outlook

Commissioning and use of current and future (soft) X-ray free-electron laser facilities require reliable online pulse intensity measurements.

In this context, the concept of the indestructible and transparent DESY/FLASH gas-monitor detectors (GMDs) has been extended from the vacuum ultraviolet into the X-ray regime.

A prototype X-GMD has successfully been characterized and calibrated in the PTB laboratory at BESSY II and tested at the SPPS.

Up to 10⁶ photons per pulse could measured at a photon energy of 9.4 keV.

Next developments and investigations refer to stability and linearity at high X-ray intensities for application at the future X-FEL facilities in Stanford and Hamburg.

The Bright Triangle in Berlin-Adlershof

