

Two-photon quantum well infrared photodetectors in the THz-regime

C. Franke^{1,2}, H. Schneider¹ and M. Walther³

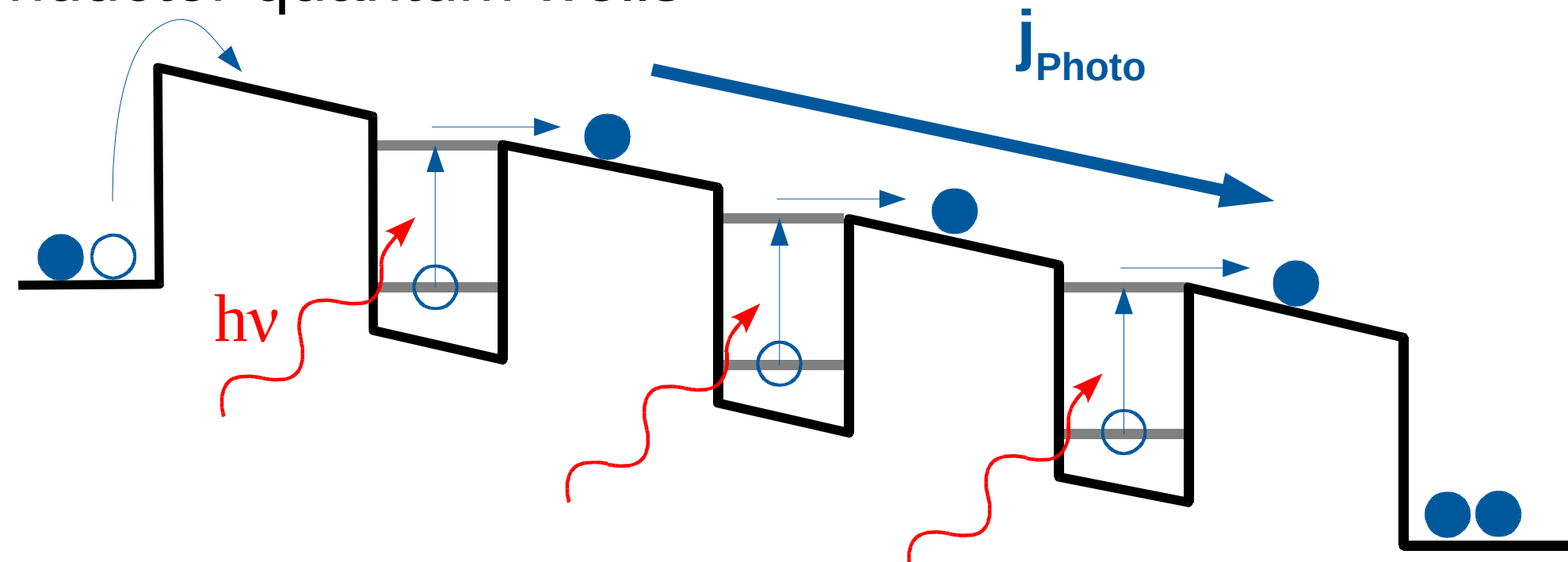
¹Helmholtz-Zentrum Dresden-Rossendorf; ²TU Dresden;

³Fraunhofer IAF Freiburg

Introduction

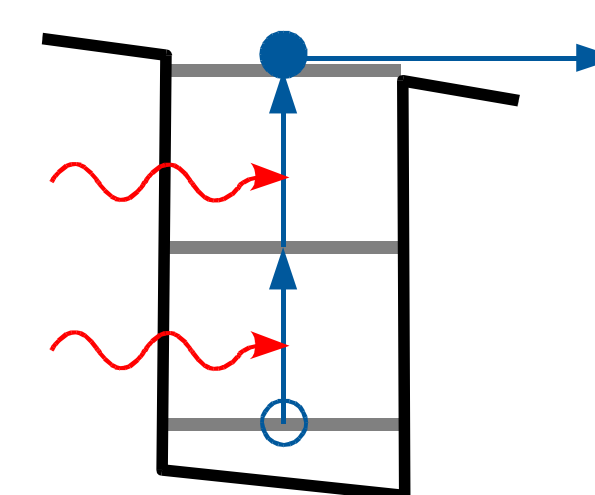
- Quantum well infrared photodetectors (QWIPs):

Photodetectors which are based on intersubband transitions in semiconductor quantum wells



- Idea: two-photon QWIPs as nonlinear detector for the investigation of ultrashort optical pulses with interferometric autocorrelation^[1]

[1] T. Maier, H. Schneider, M. Walther, P. Koidl and H.C. Liu, Appl. Phys. Lett. **84**, 5162 (2004)



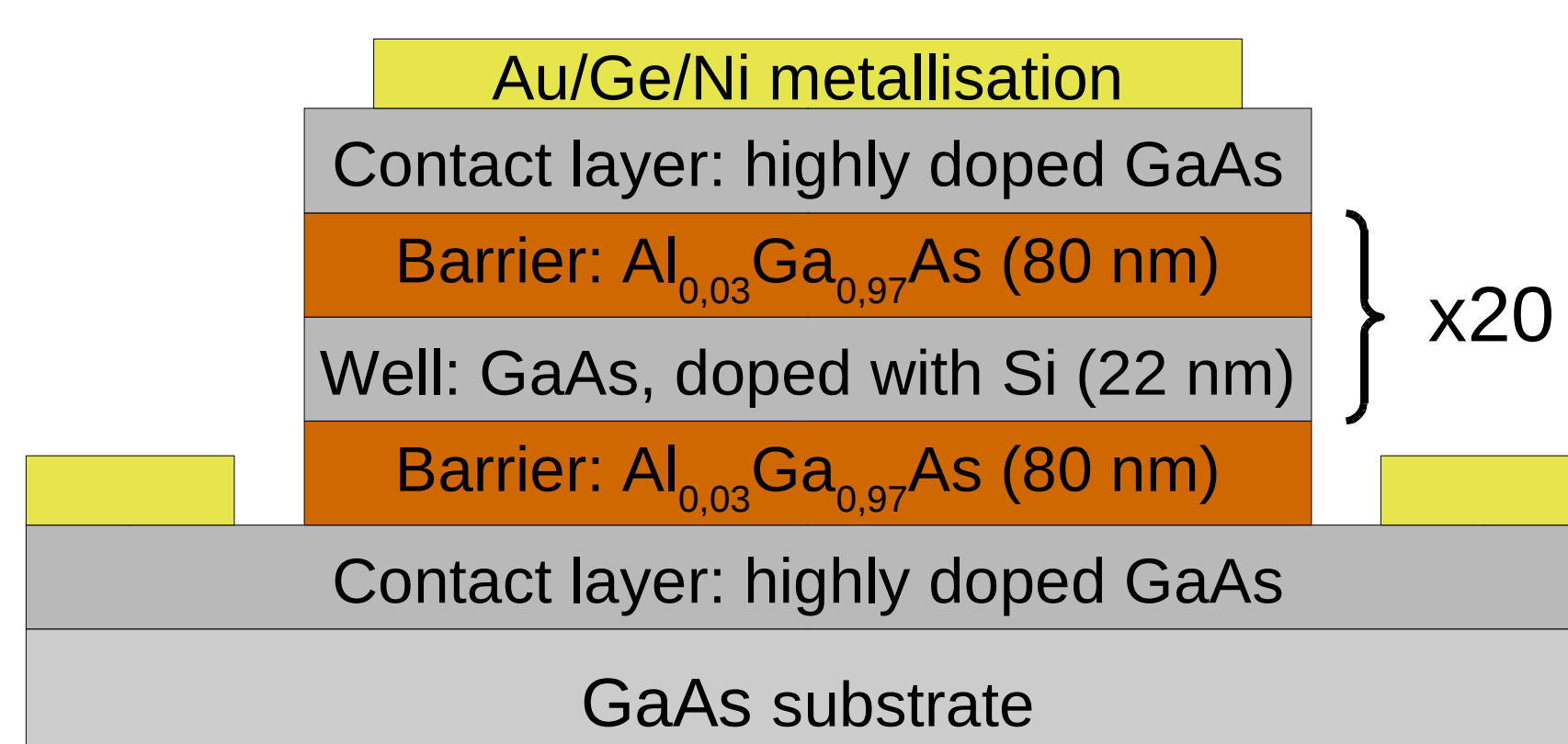
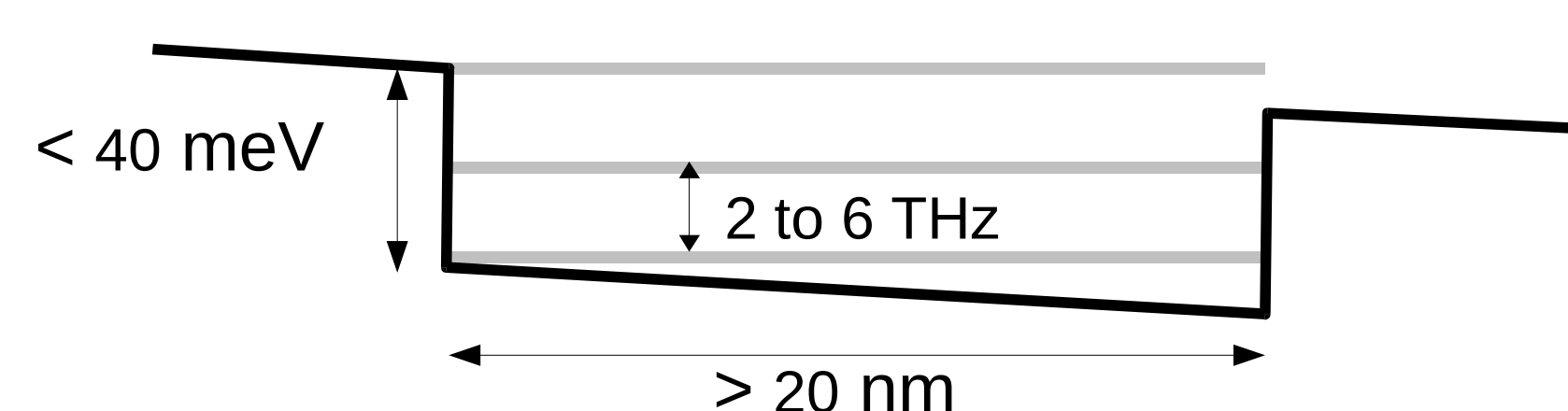
Three equidistant subbands in the quantum well

Resonant two-photon absorption for high sensitivity

Sample characteristics

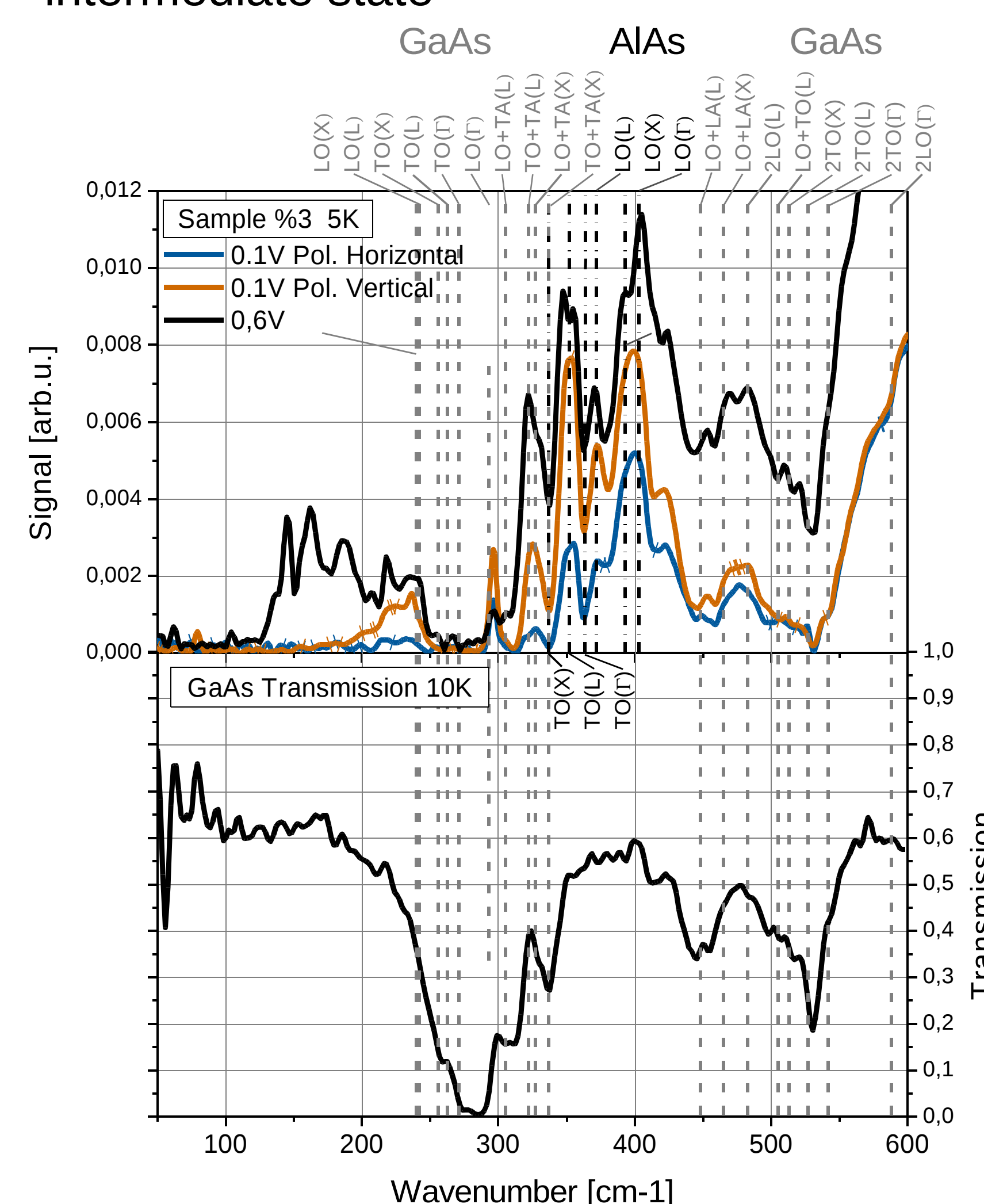
Investigated samples

- AlGaAs/GaAs QWIP samples with aluminum content lower than 5%, grown by MBE
- doped with silicon to 10^{17} cm^{-3} in the center of the well
- light coupling through standard 45° facet geometry



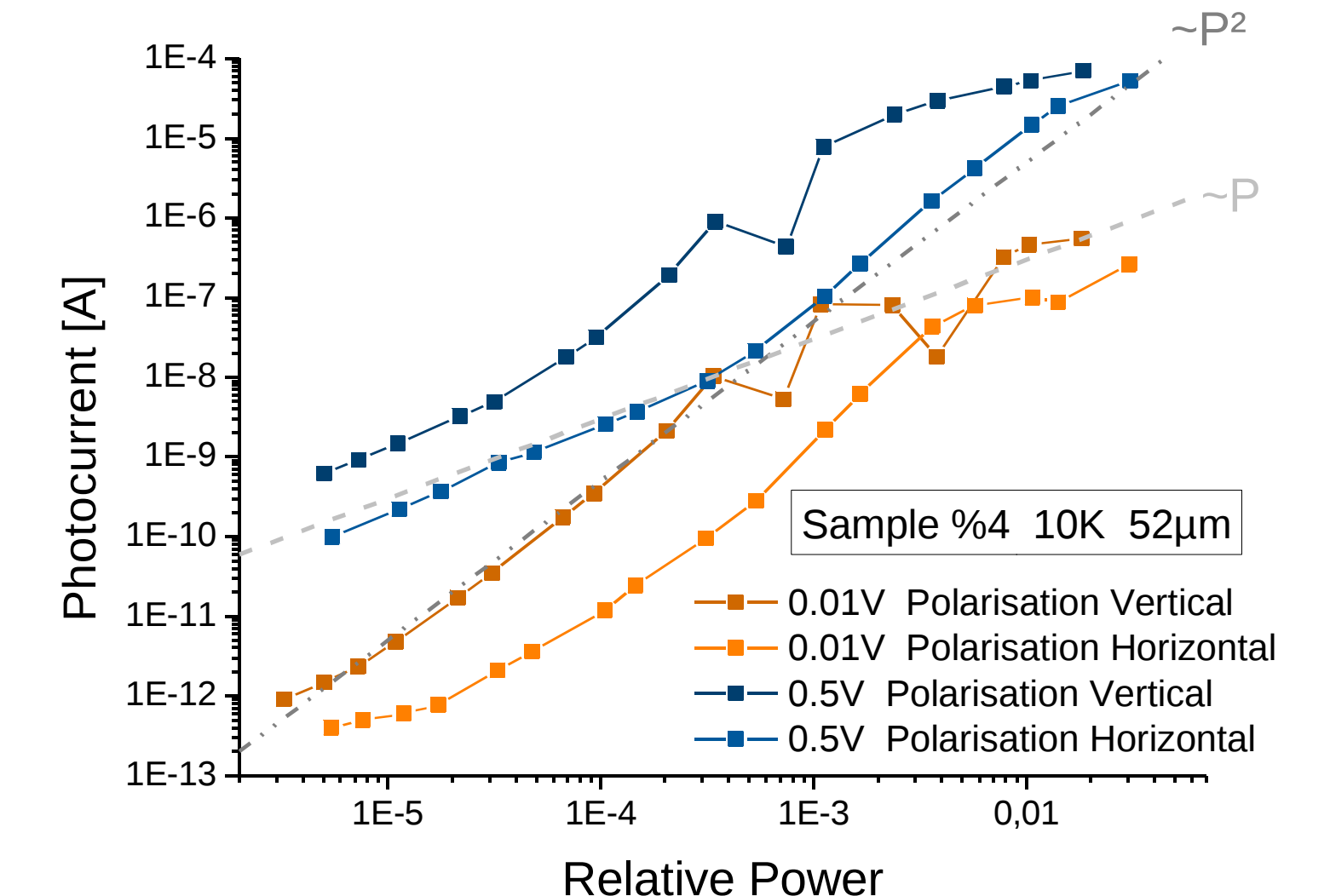
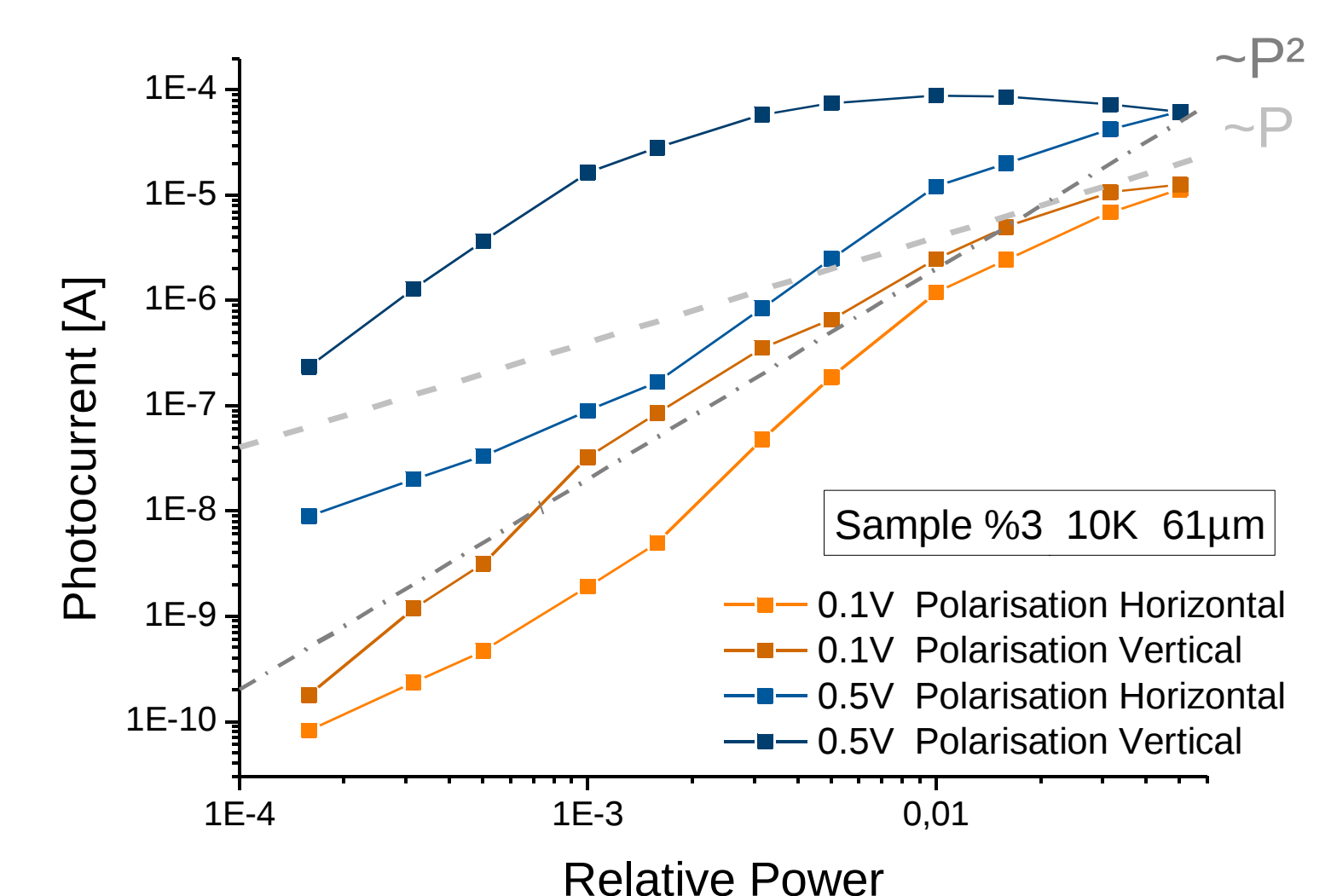
Spectrum

- photocurrent spectrum strongly influenced by optical phonons
- intersubband-related polarisation dependence
- bias-dependent signal, especially below GaAs reststrahlen band due to tunneling out of intermediate state



Power dependence

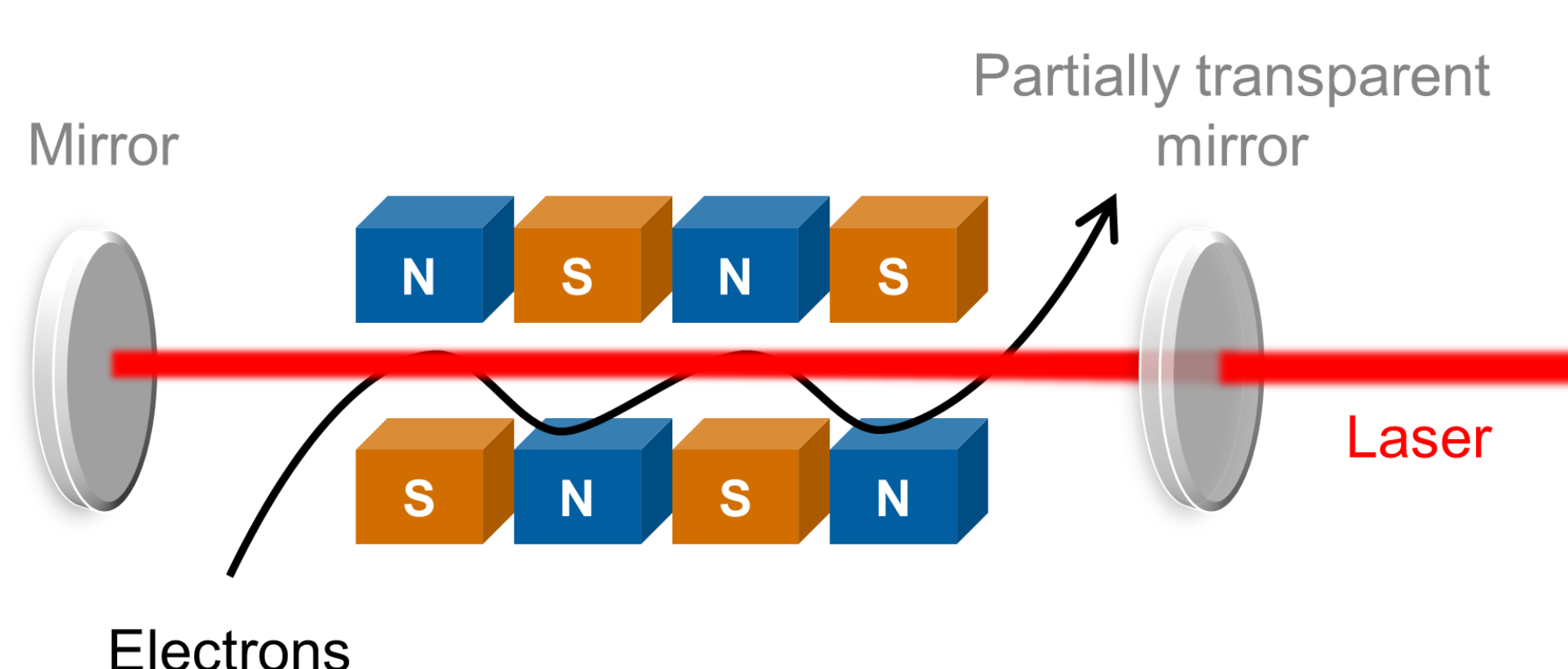
- the photocurrent in the samples shows indeed a quadratic dependence on the power of the THz radiation until saturation is reached
- saturation power decreases with increasing applied bias



Autocorrelation experiments

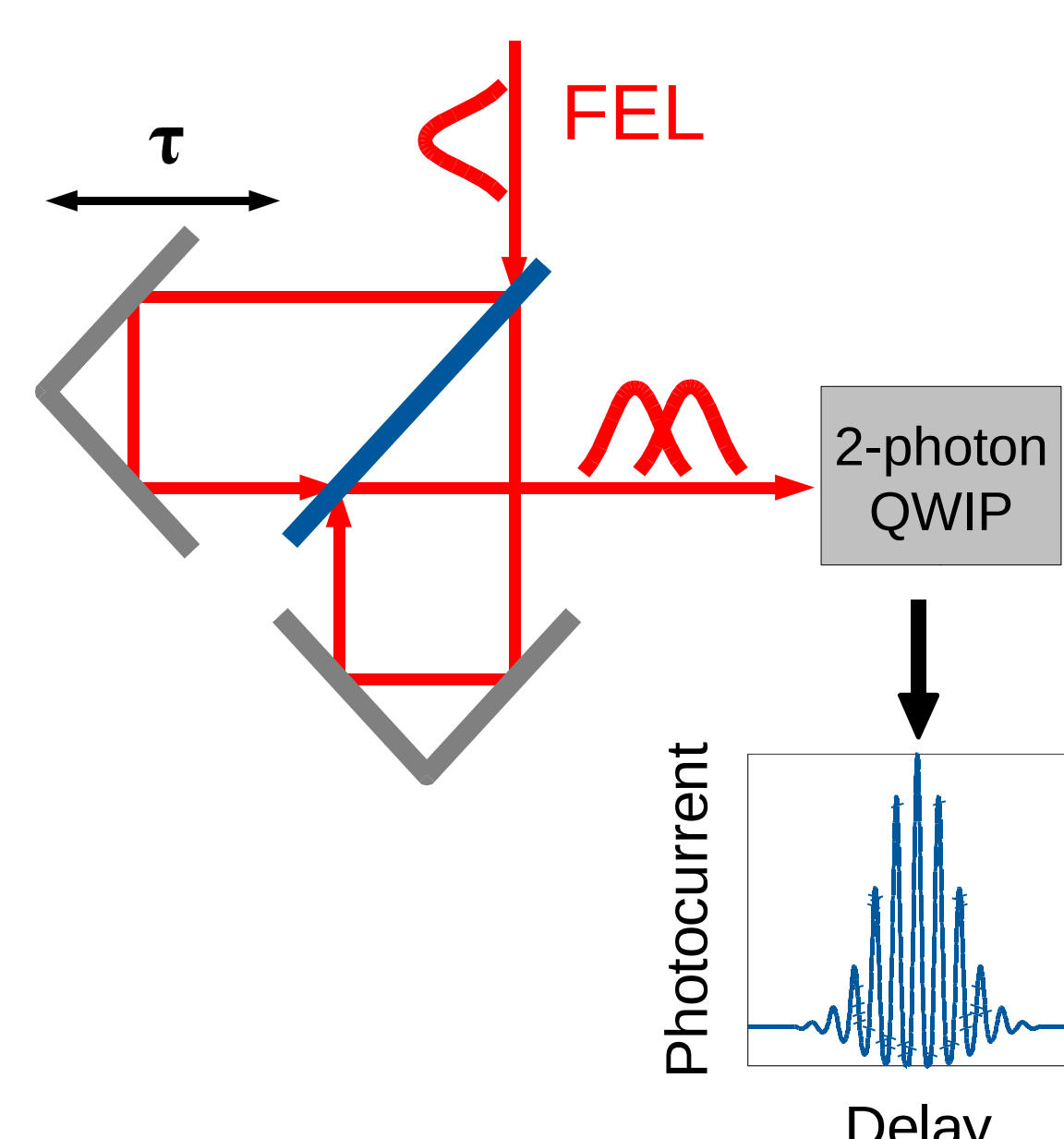
Light source

- Free electron laser (FEL) of the HZDR provides mid-infrared and THz picosecond laser pulses over a broad wavelength range (4...230µm)
- FEL pulse duration is expected to be short enough to resolve the relaxation dynamics in the samples



Setup

- Interferometric autocorrelation: Michelson interferometer setup with a QWIP sample as detector



Results

Autocorrelation with sample %4 at 52 µm (5,7 THz) at 7K

- nonlinear interferogram observed, but not yet with the expected quadratic behavior
- temporal behavior still determined by FEL pulse, not by detector

