

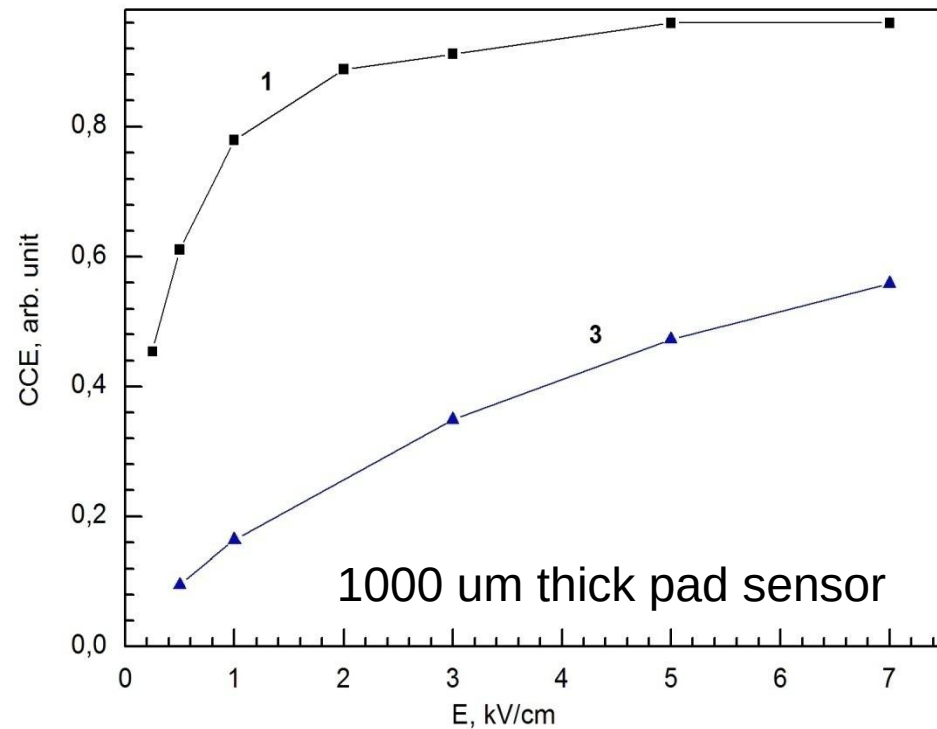
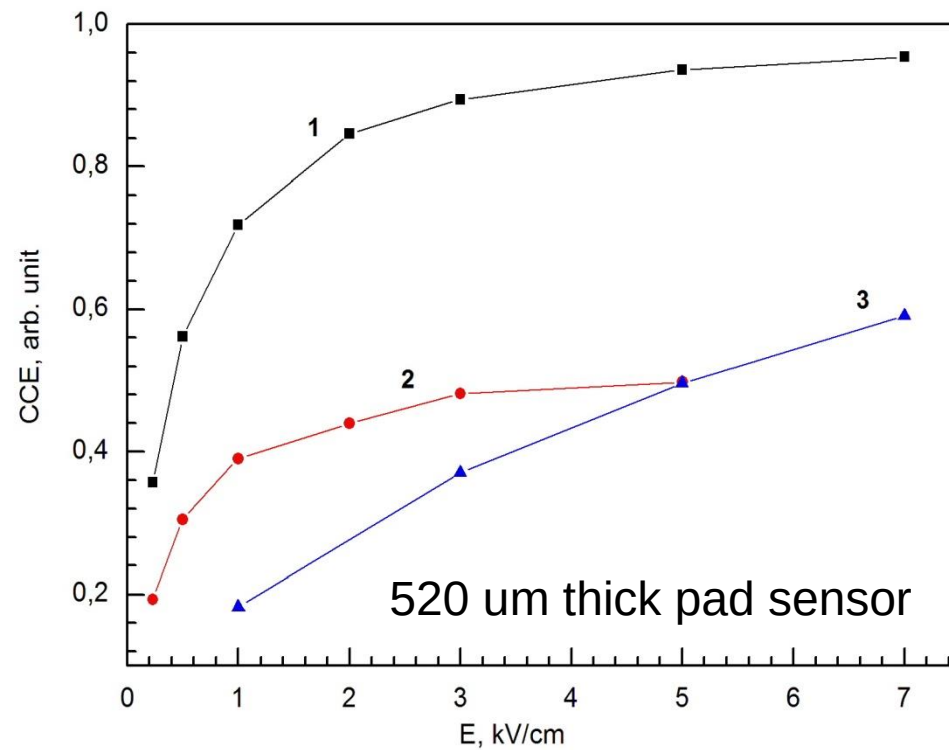


TOMSK STATE UNIVERSITY

HR GaAs: Cr behavior at high X-ray flux

July 08, 2021
ECAL LUXE

Charge collection efficiency of HR GaAs:Cr sensors



- 1** - 60 keV gamma quanta (^{241}Am source);
- 2** - 1 MeV beta-particles (mip, ^{90}Sr source);
- 3** - 5.5 MeV alpha-particles (^{241}Am source).

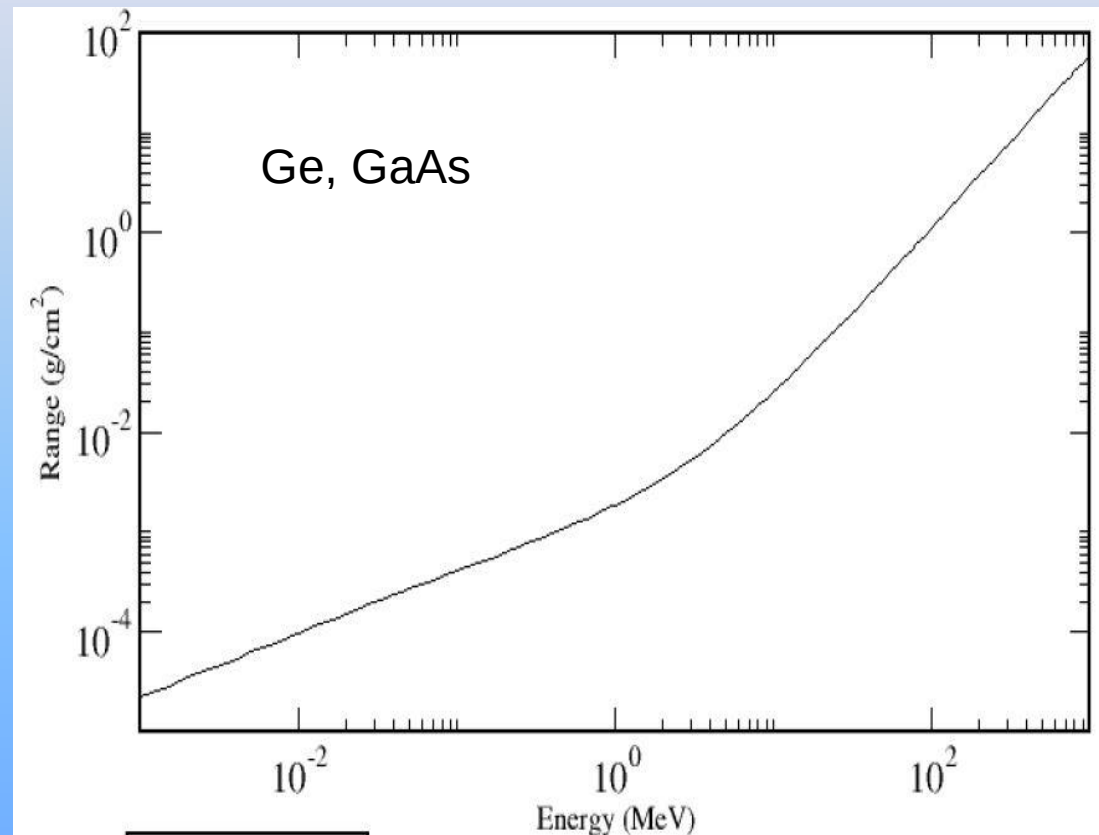
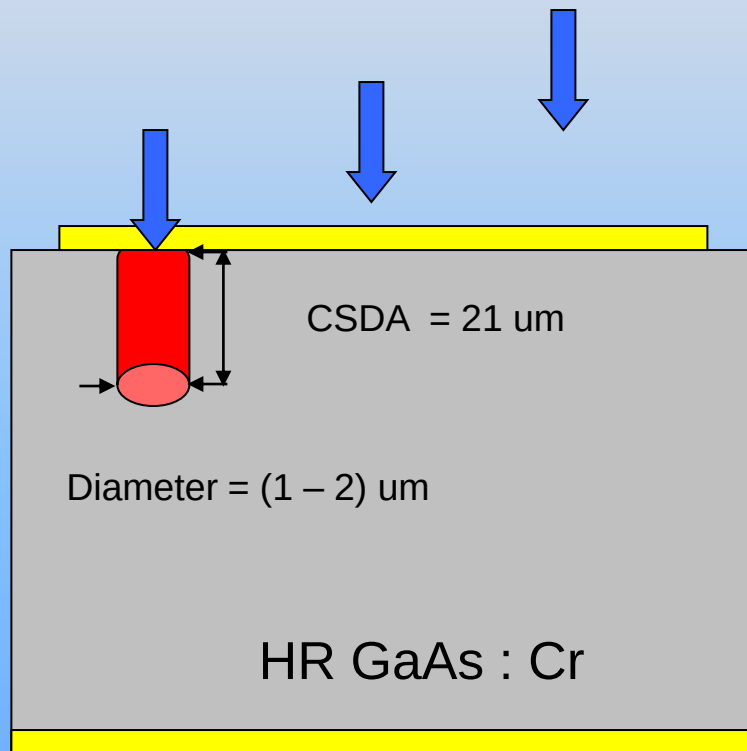
Values of mobility * lifetime products

$\mu \cdot \tau$	CCE_α	CCE_β	CCE_γ
$(\mu \cdot \tau)_n$, cm^2/V	$6.8 \cdot 10^{-6}$	$6.0 \cdot 10^{-5}$	$7.6 \cdot 10^{-5}$

Alpha particle penetration depth in GaAs

CSDA range of 5.5 MeV alpha-particle

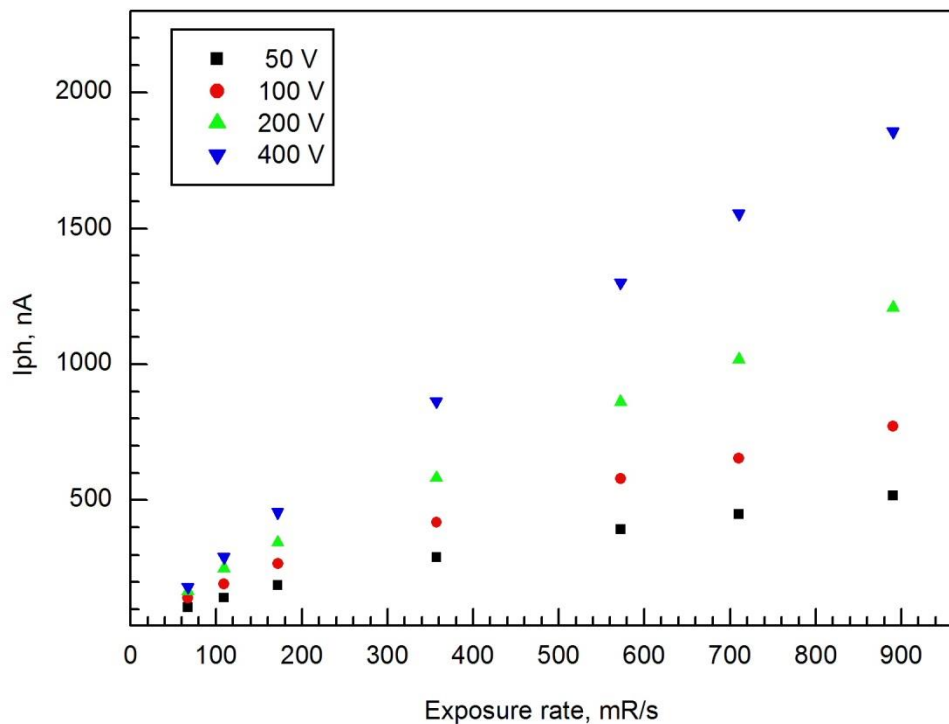
5.5 MeV alpha-particles



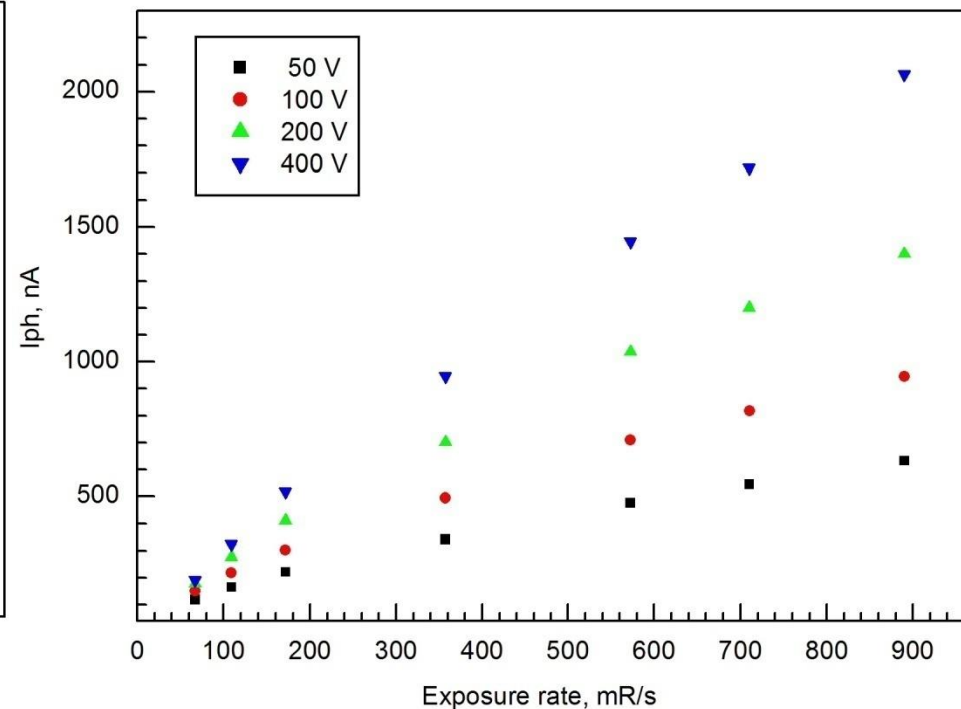
Electron-hole pairs deposited by single particle: 1.3×10^6

Electron-hole pair density: 1.9×10^{16} eh pair/cm³

X-ray sensitivity dependence on bias



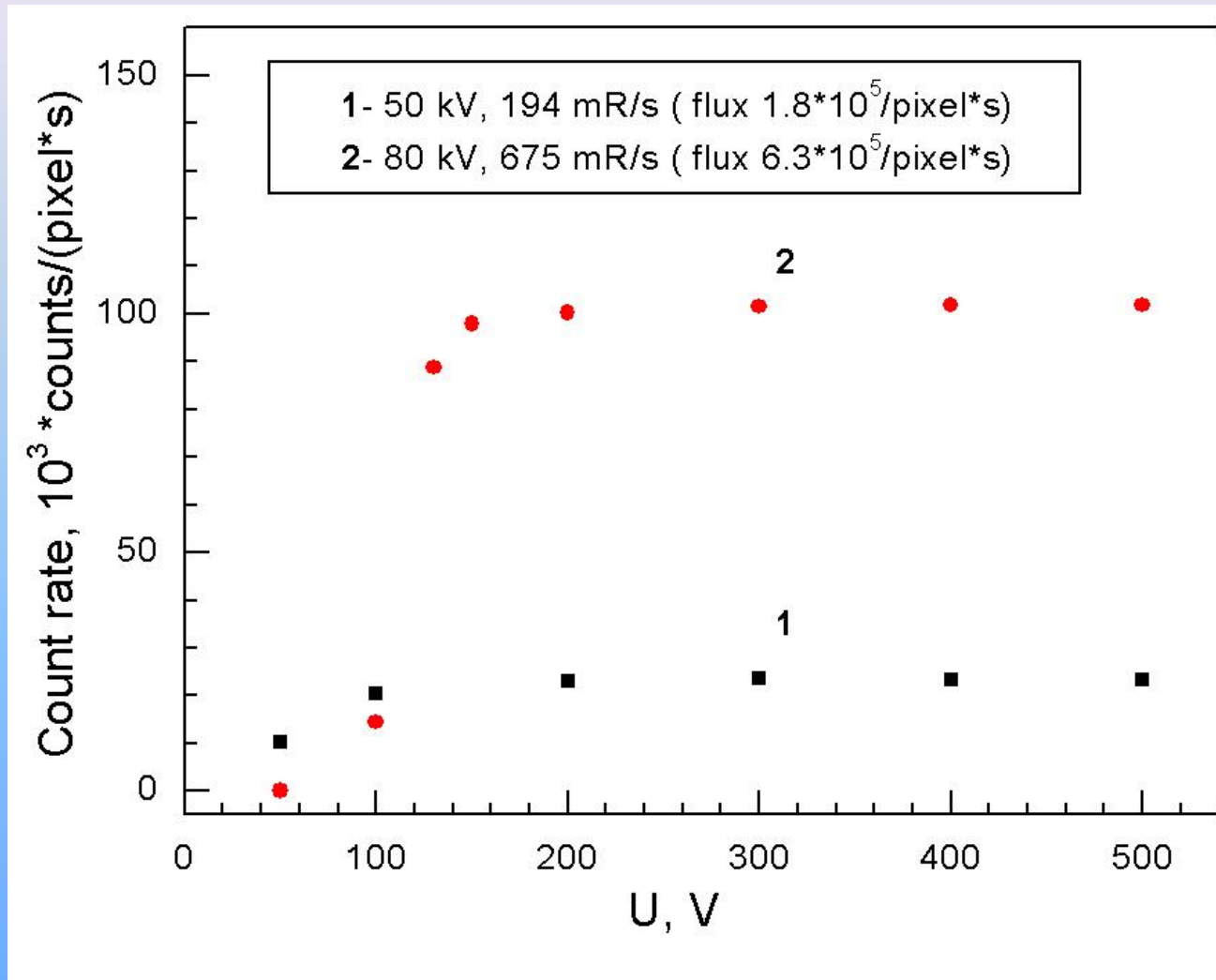
Anode irradiation



Cathode irradiation

W anode X-ray tube, 4 mm Al filter, 80kVp. 500 um thick HR GaAs:Cr pad
X-ray sensors

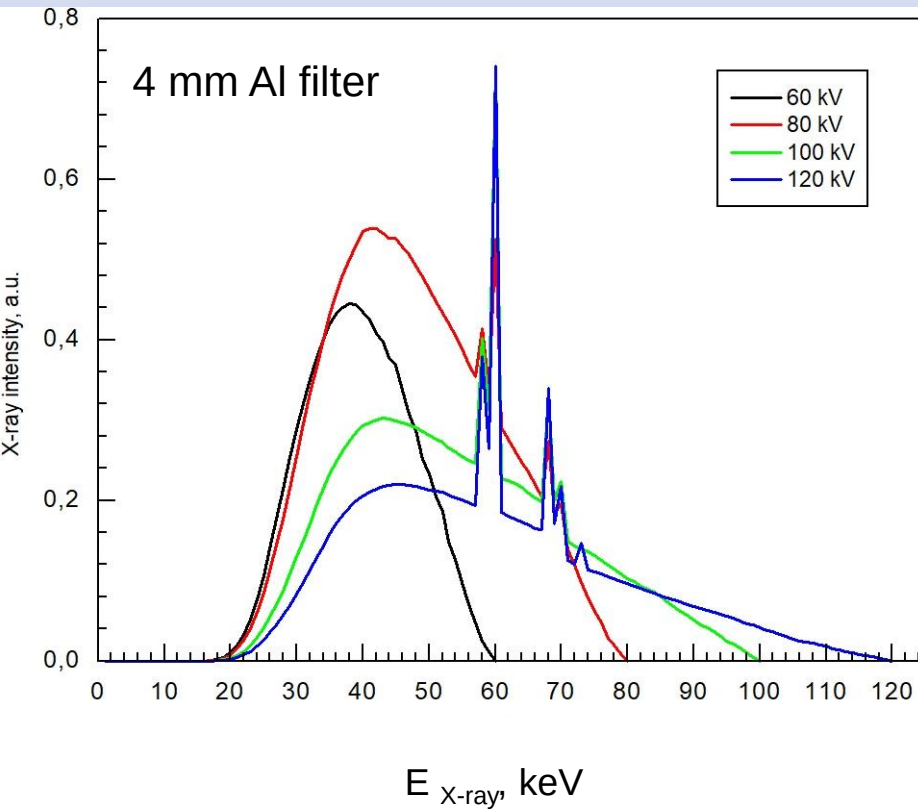
Count rate dependence on bias voltage



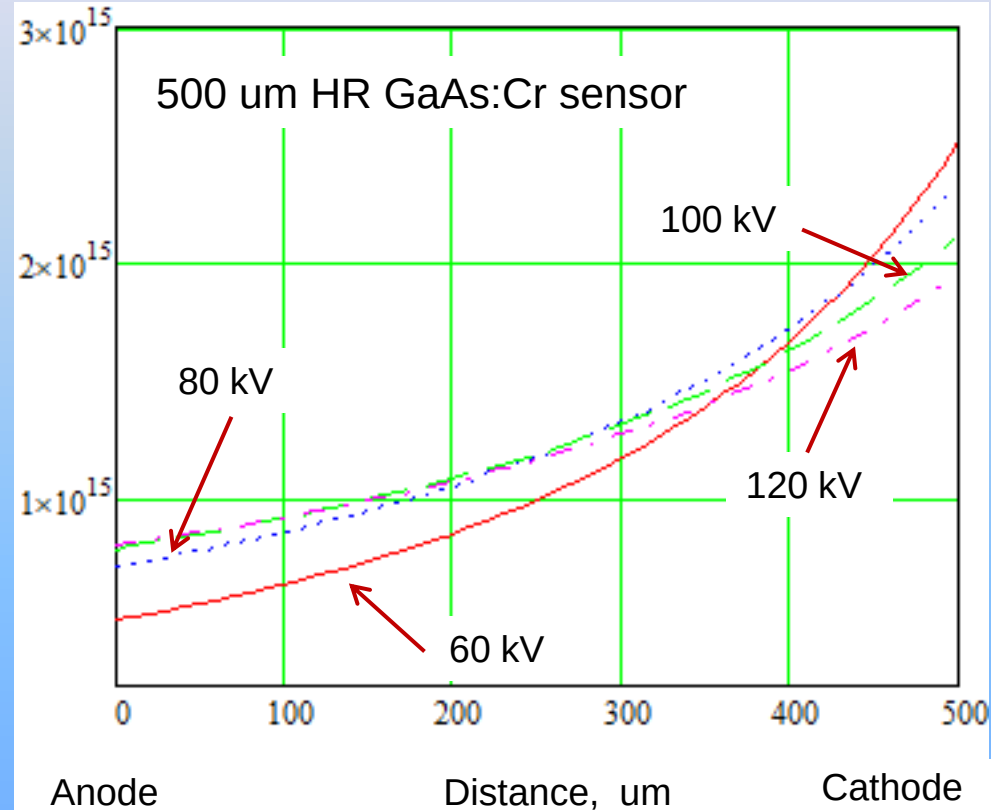
500 μ m HR GaAs:Cr TPX detector@ 80kV X-ray tube voltage

Density of electron-hole pairs

W anode X-ray tube spectra



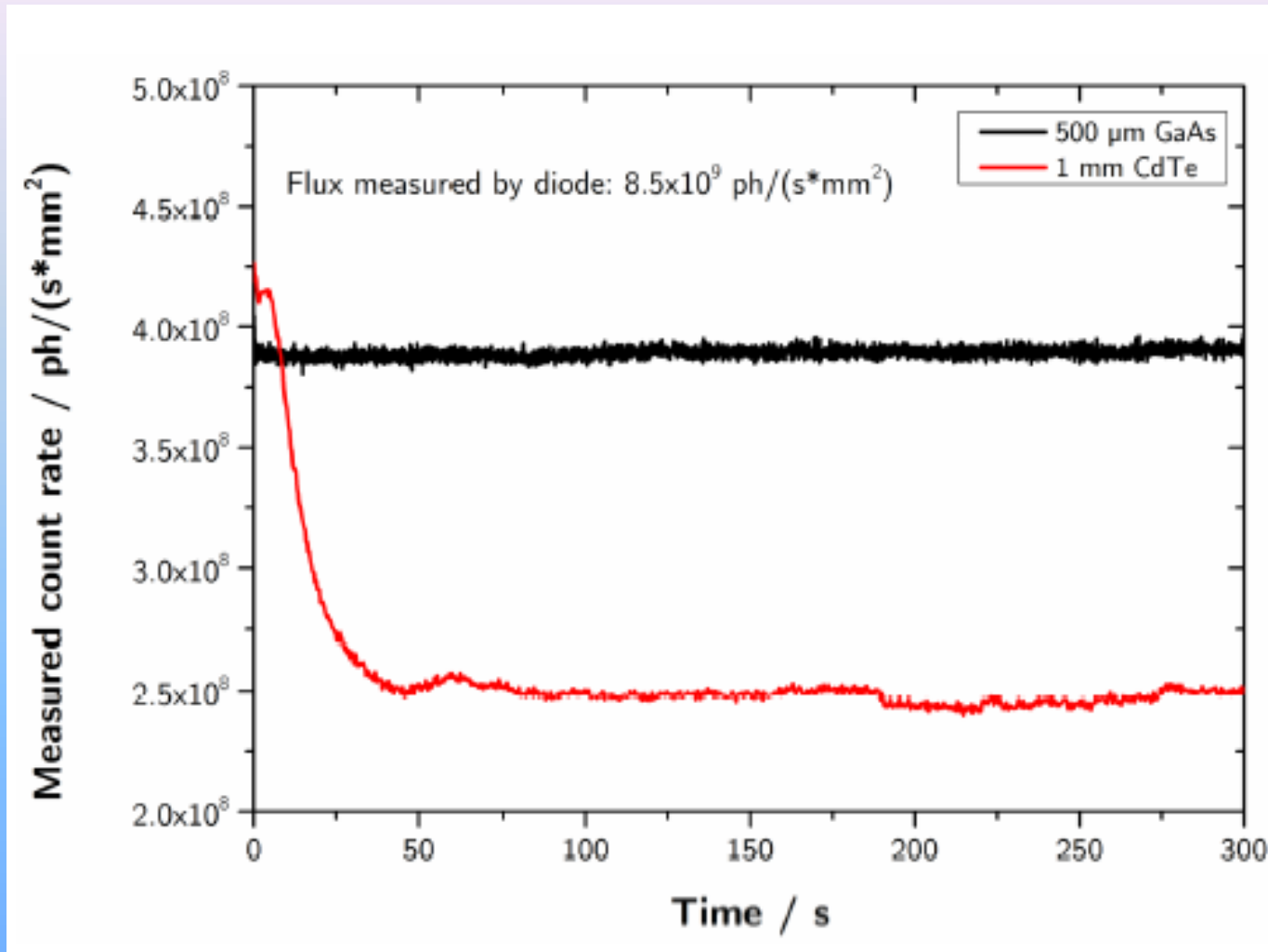
Generation rate@500 mR/s, eh pair/(cm³ × s)



Average generation rate in 500 um GaAs sensor@500 mR/s dose rate:

$$1.2 \times 10^{15} \text{ eh pair}/(\text{cm}^3 \times \text{s})$$

Stability of count rate under high flux



Count rate comparison of the 500 μm thick GaAs and the 1 mm thick CdTe assembly for a flux of $8.5 \times 10^9 \text{ ph}/(\text{s} \cdot \text{mm}^2)$ of 16 keV X-ray

Procured by E. Hamann (IPS, Karlsruhe Institute of Technology, Germany)

Conclusion

High density of electron-hole pairs leads to decrease of CCE and photocurrent values in HR GaAs:Cr sensors

The decrease can be compensated by increase of bias on sensors

Thank you for your time !