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Comparison of 35 and 50 μm thin HPK UFSD after neutron irradiation up to $6 \cdot 10^{15}$ neq/cm^2

JC-112

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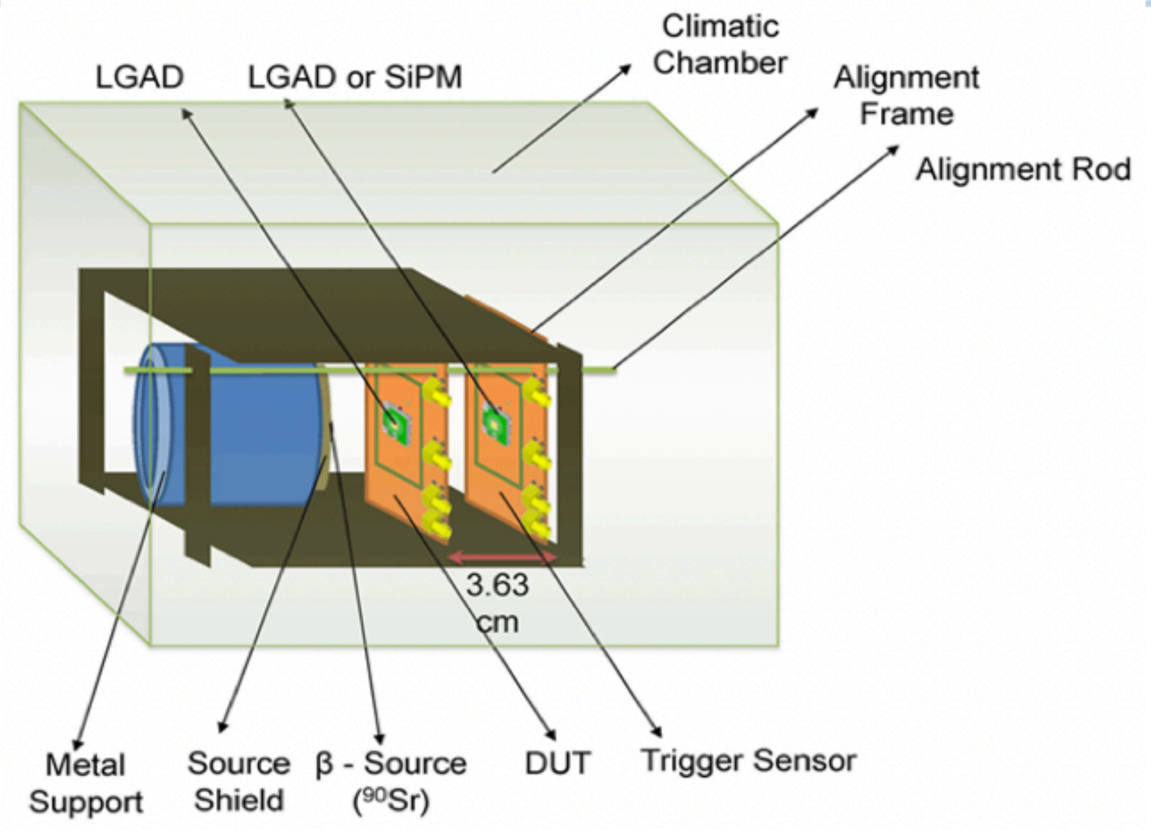
Outline

- Introduction
- Beta telescope setup
- Data analysis
- Result on irradiated 35um thick UFSD HPK B35
- Conclusion
- Question

Introduction

- Ultra-fast silicon detector (UFSD) produced by Hamamatsu Photonics (HPK): HPK UFSDs B35 (35um thick), comparing to 50D (50um thick)
- Irradiated with neutrons to fluences of 1e14, 1e15, 3e15,6e15 neq/cm^2.
- Test with minimum ionizing particle (MIPs) from a Sr-90 beta source.
- The leakage current, capacitance, internal gain and time resolution were measured as a function of bias voltage at -20℃ and -27℃。

Beta-source telescope setup



- House in a climate chammber
- The digital oscilloscope

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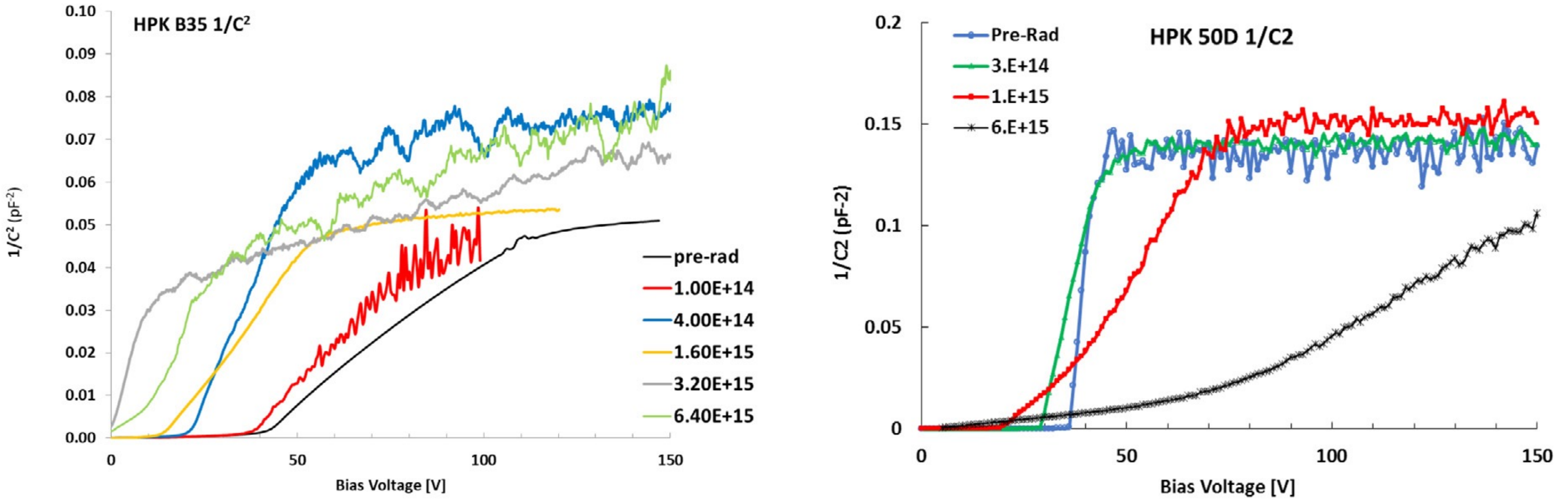

(a) (b)

Fig. 1. 1/C2 vs. bias voltage for the 35 µm thin B35 (a) and the 50 µm thin 50D (b) (from [14]) at room temperature before irradiation and at −20 ◦C after neutron irradiation to the fluences indicated.

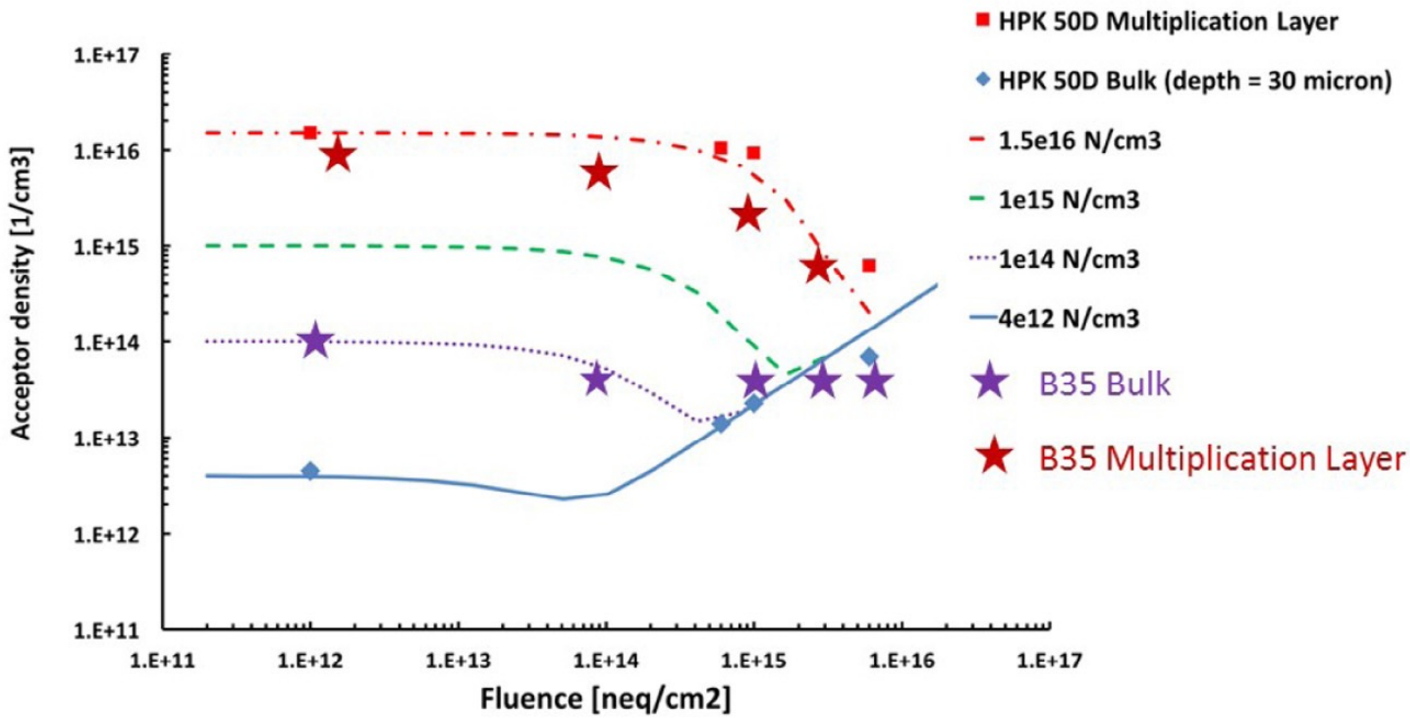

Fig. 2. The fluence evolution of the doping concentration in the multiplication layer and the bulk for the 35 µm thick B35 and 50 µm thick 50D (taken from [15]). The curves are simulations described in [1] based on data of [16].

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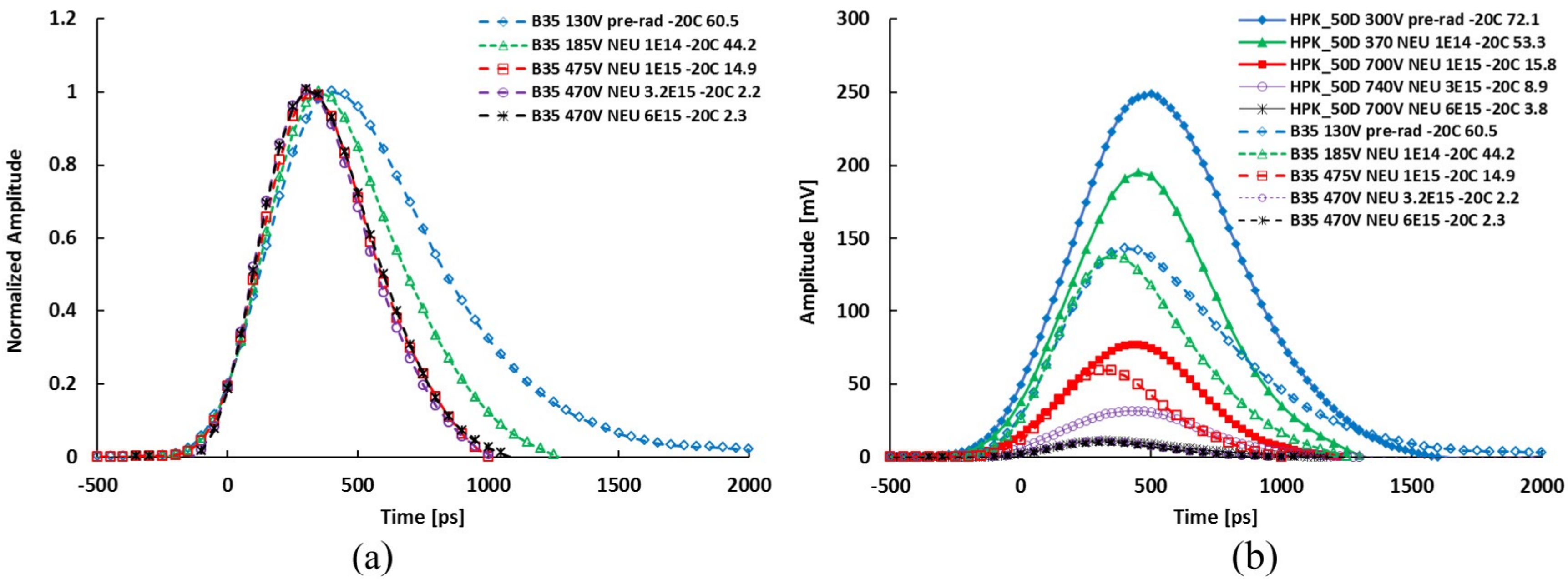
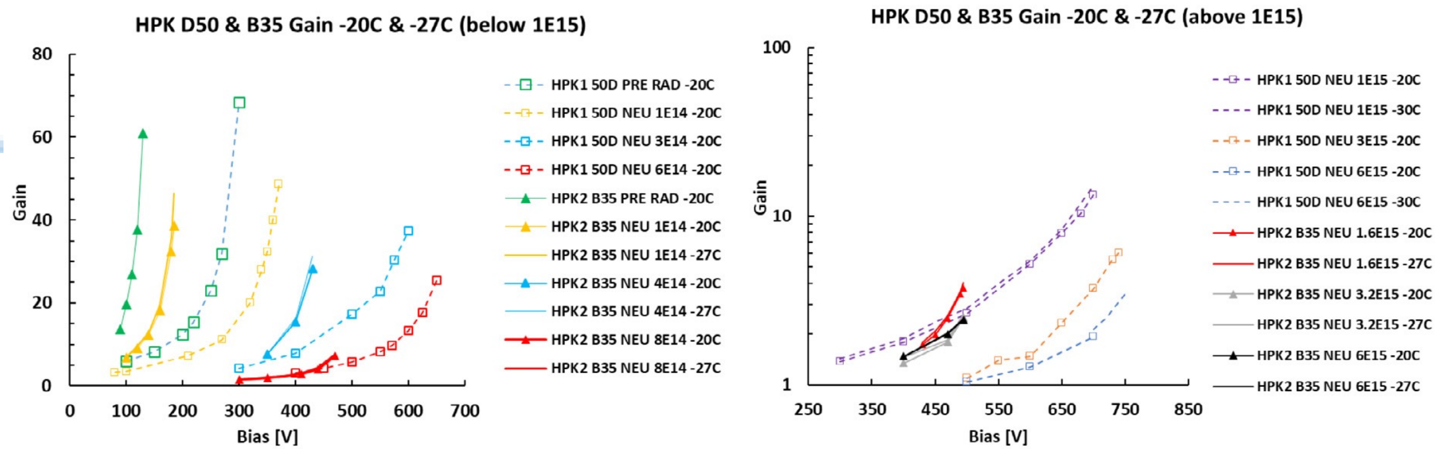
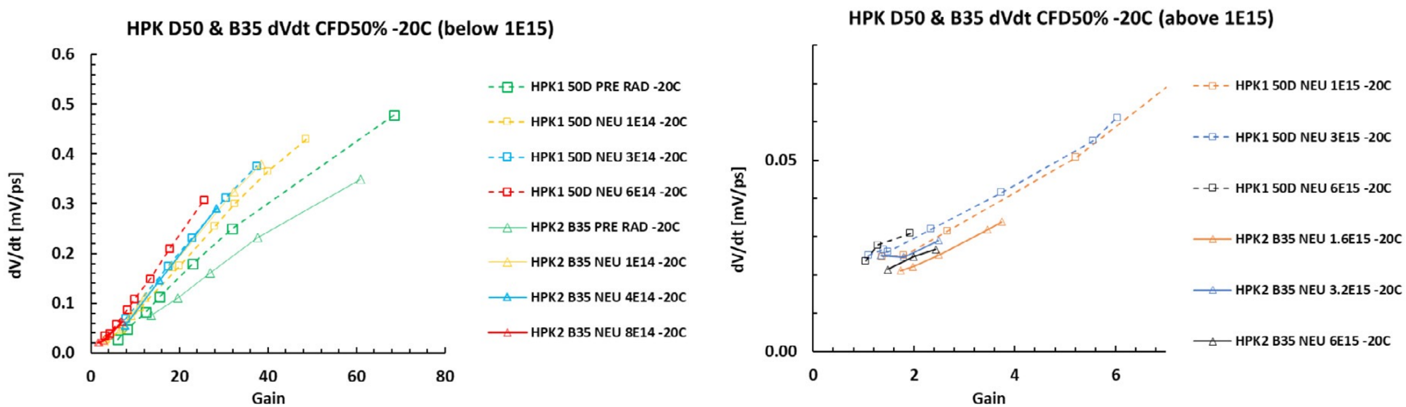


Fig.3.
AveragenormalizedpulseshapeforB35(a)andaveragepulseshapesforB35and50Dsensors(b).Sensorsname,biasvoltagefluence,temperatureandgainareindicatedinthe legend.



(a)



(b)

Fig. 4. (a) Gain as a function of bias and (b) slope dV/dt (at CFD 50%) as a function of gain for HPK sensors B35 and 50D for different fluences. As seen in Fig. 1(a), Fig. 3(a) for the B35 sensor before irradiation the bias voltage is too low to achieve saturated drift velocity in the bulk.

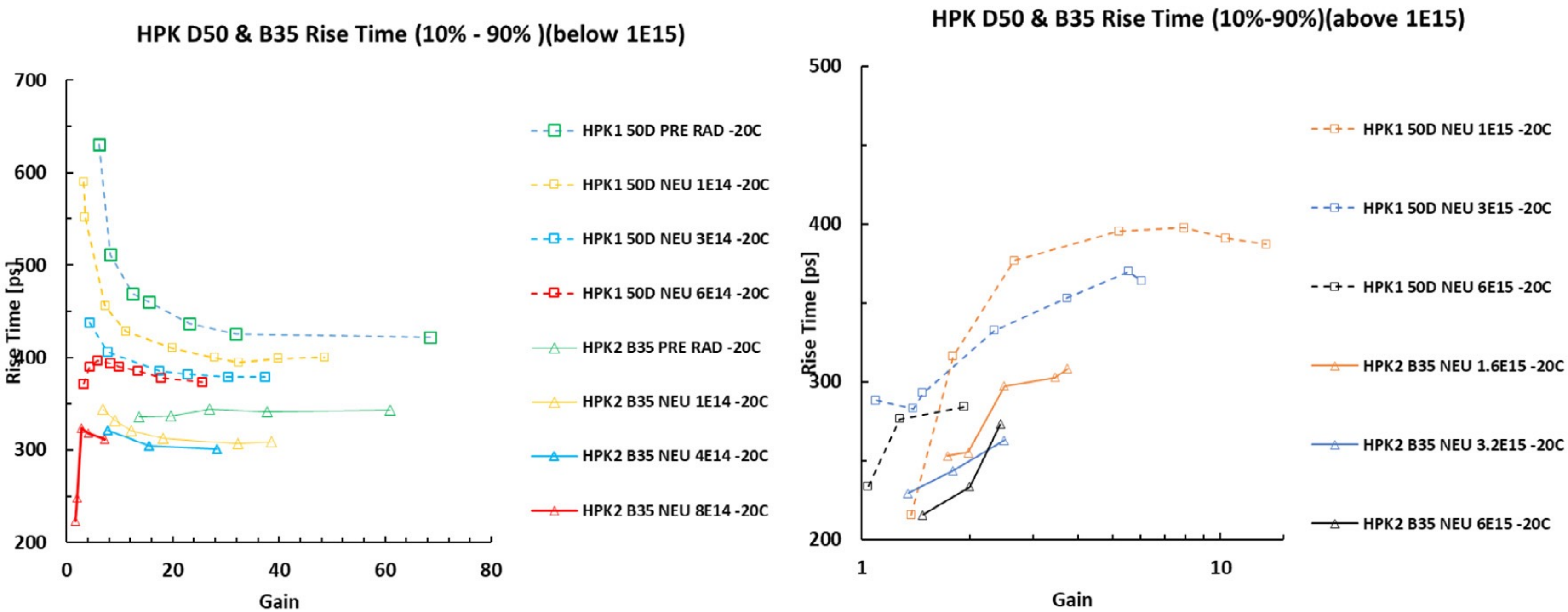


Fig. 5. Rise time as a function of gain for sensors B35 and 50D (−20 C).

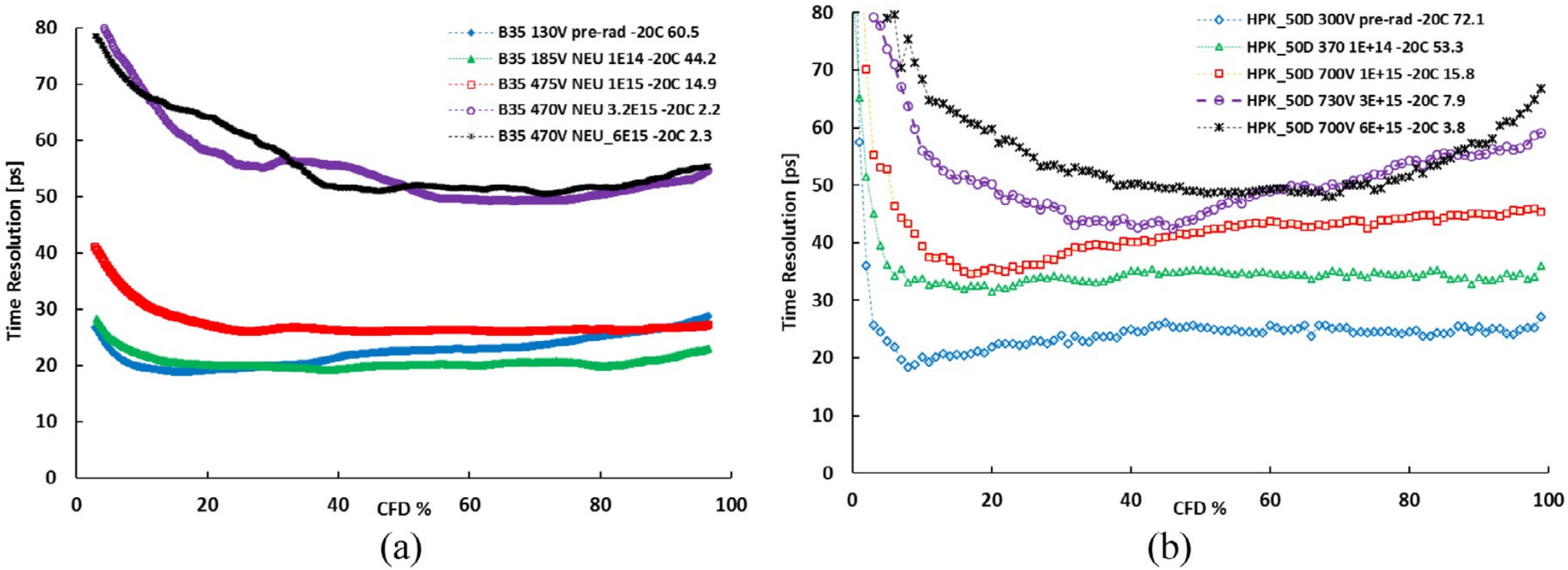
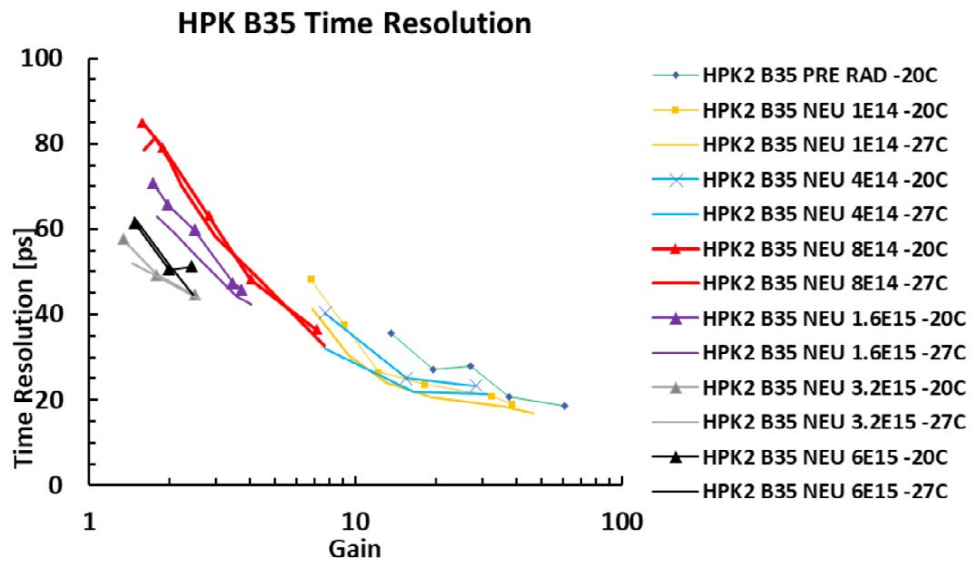
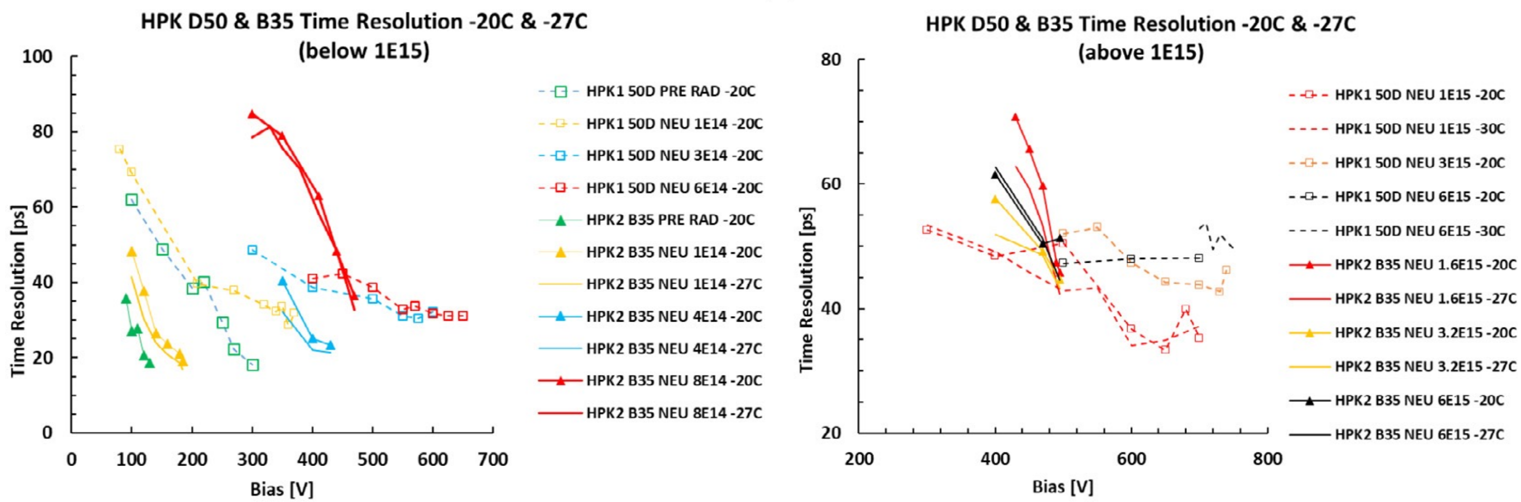


Fig. 6. CFD scan at optimum operating voltage for sensors B35 (a) and 50D (b). The legends are bias, fluence, temperature, gain.

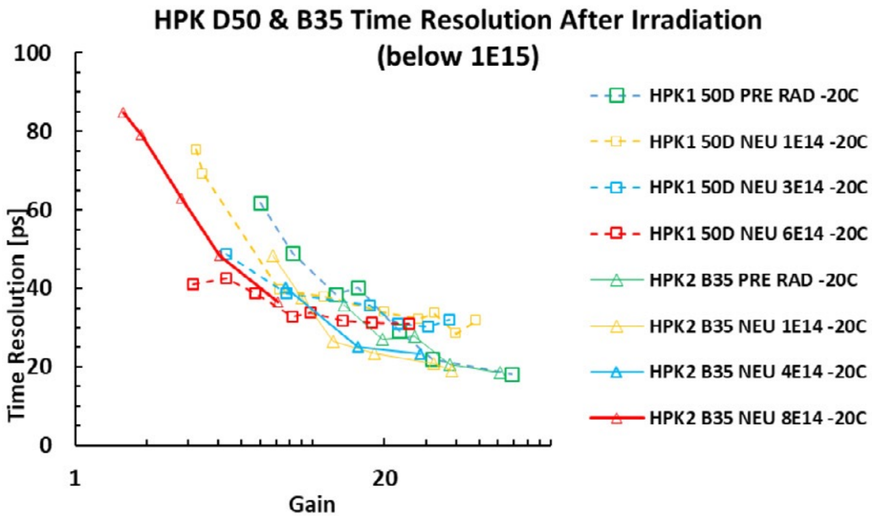


(a)

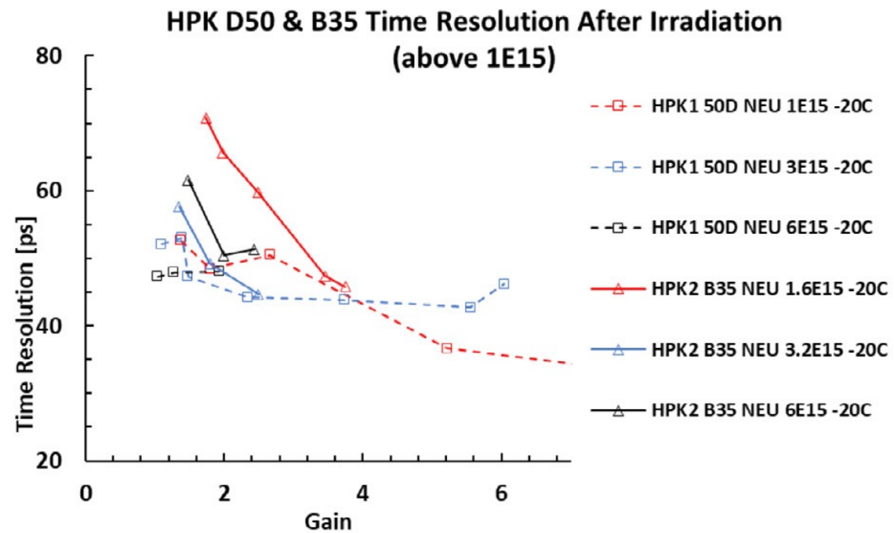


(b)

Fig. 7. Time resolution as a function of gain for B35 (a) and bias voltage (b) for sensors B35 and 50D. The values are for the CFD optimized for the optimal time resolution.



(a)



(b)

Fig. 8. Time resolution as a function of gain for B35 and 50D for low (a) and high (b) irradiation.

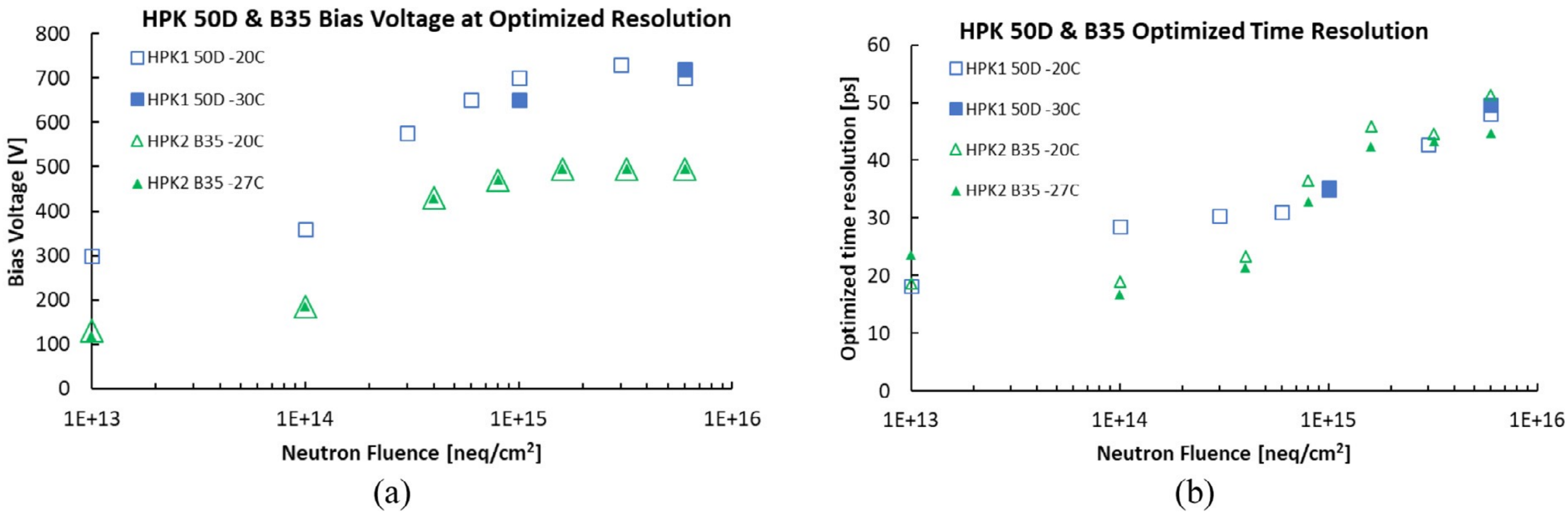


Fig. 9. (a) Optimum operating voltage and (b) time resolution as a function of fluence for sensors B35 and 50D.

Question