



LINEARITY OF DIAMOND DETECTORS IN ULTRA-HIGH DOSE PER PULSE ELECTRON BEAMS

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Disclosure

- ▶ Rafael Kranzer and Daniela Poppinga are PTW employees
- ▶ This project (18HLT04) has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme.
- ▶ Data in this presentation has been submitted for publication
- ▶ Prototypes produced at the Industrial Engineering Department of Rome Tor Vergata University

Investigation

▶ PTB research electron accelerator

- Energy 20 MeV
- PRF = 5 Hz, $t_{\text{pulse}} = 2.5 \mu\text{s}$
- Current transformer (Bergoz ICT) as beam monitor calibrated against alanine



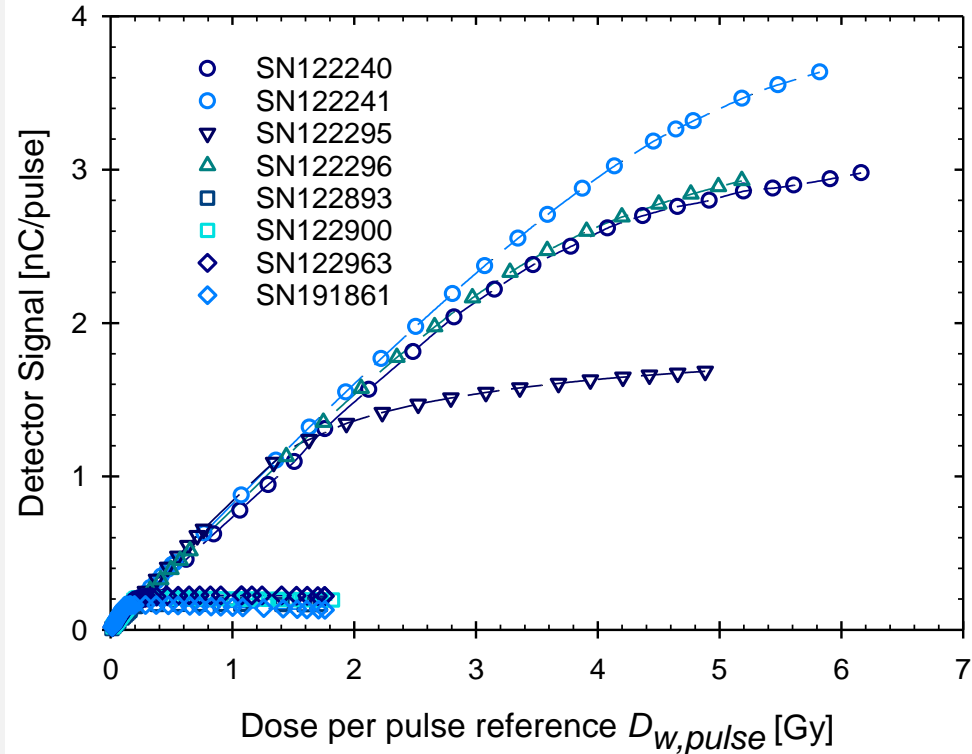
▶ Detectors

- Synthetic single crystal diamond Schottky diodes
- 8 commercially available microDiamonds type 60019
- 6 prototypes with varied thickness of the sensitive volume
- 2 prototypes with reduced area of the sensitive volume

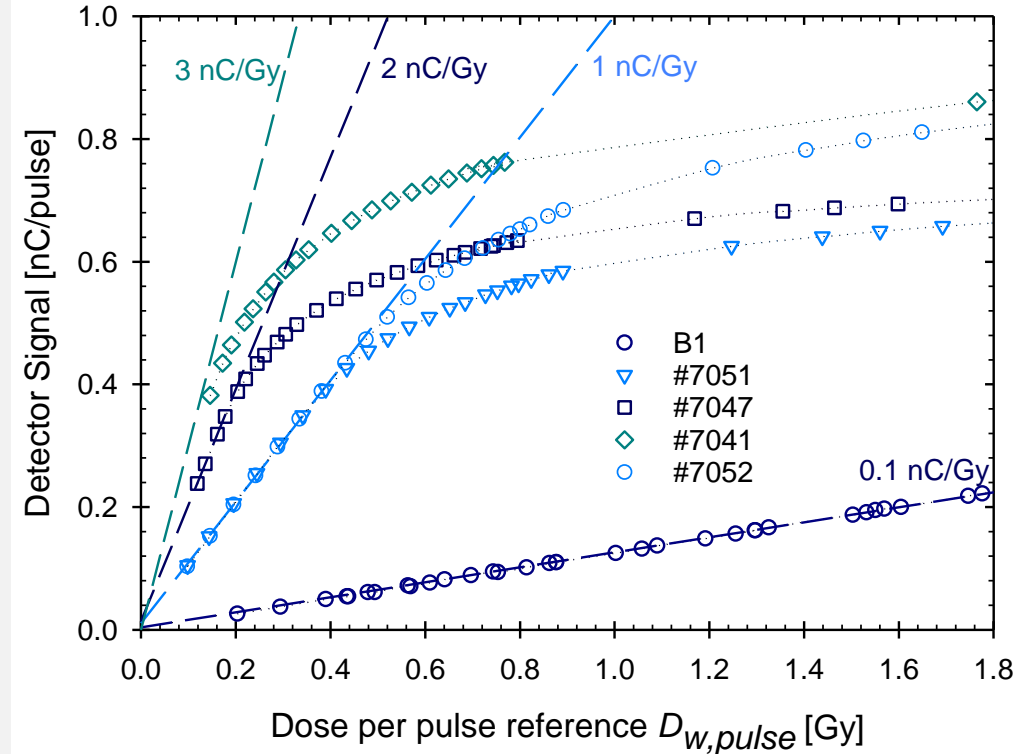
Results

Detector signal vs reference dose per pulse

microDiamonds (Sensitivity ≈ 1 nC/Gy)



Prototypes with different sensitivities



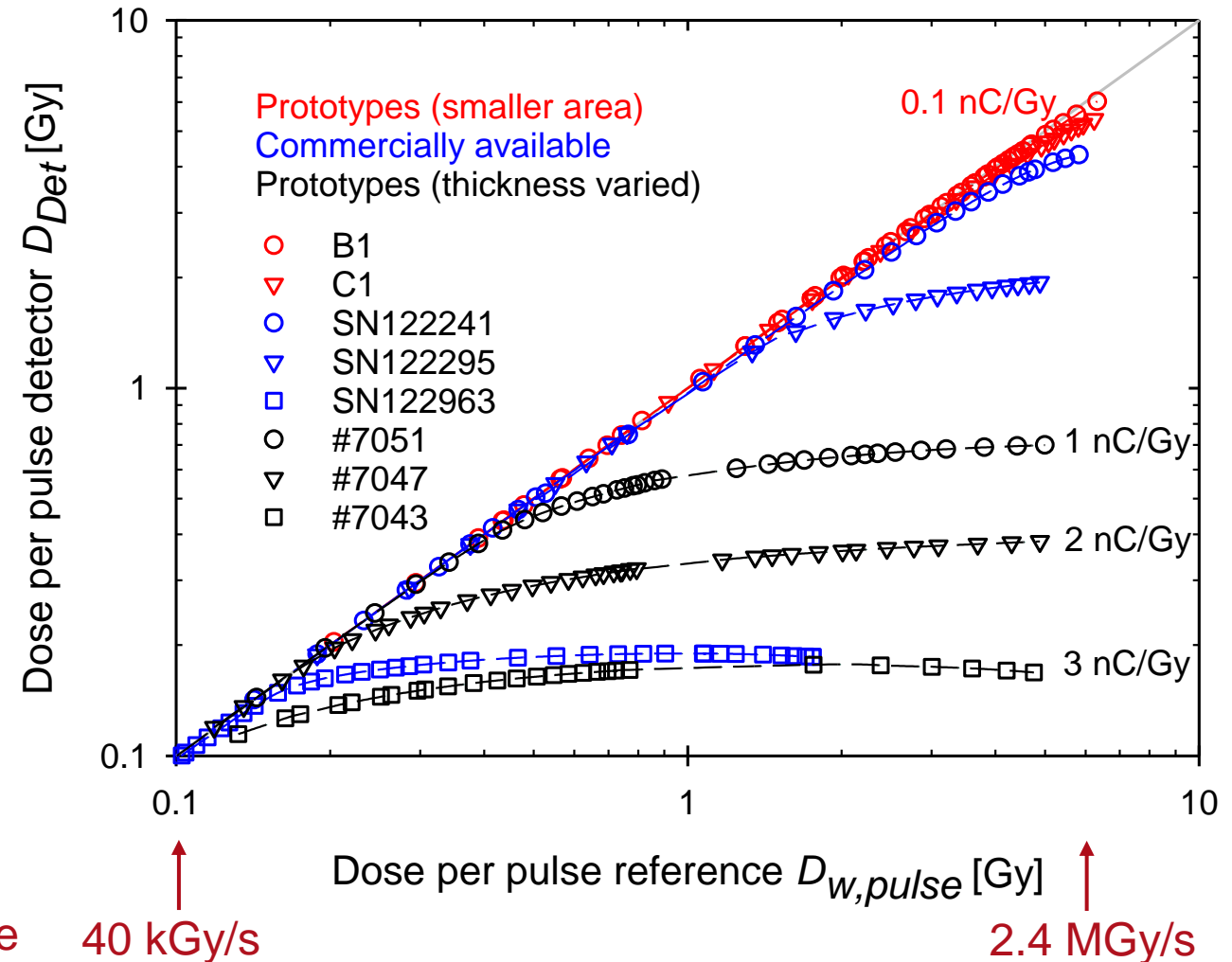
Results

Measured dose vs reference dose per pulse

- ▶ Conversion to absorbed dose to water

$$D_{Det} = (M - M_0) * N'_{Co60 Dw} * k_{cross}$$

- ▶ Deviation of the prototype B1 smaller than 3% up to 6 Gy per pulse



Instantaneous dose rate during pulse

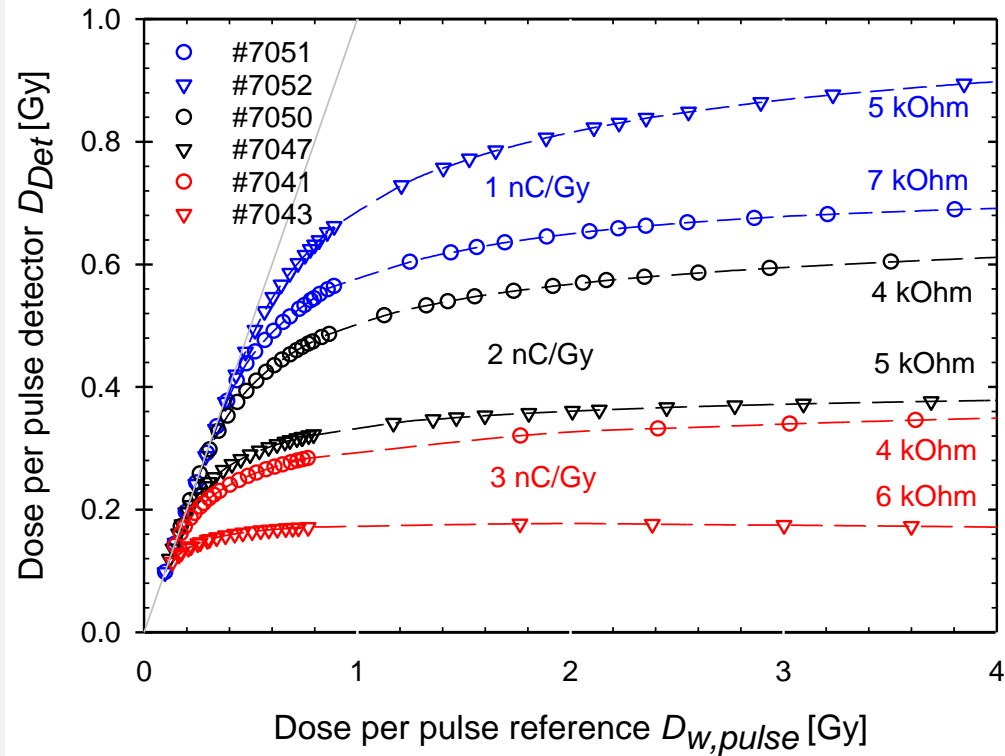
40 kGy/s

2.4 MGy/s

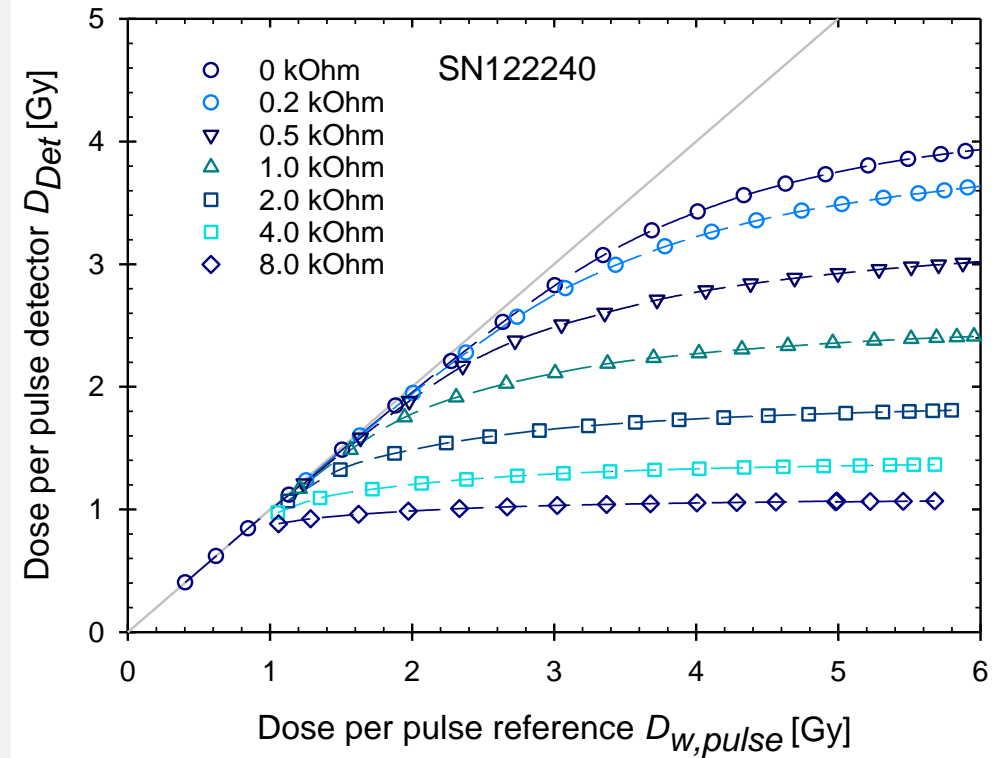
Results

Measured dose vs reference dose per pulse

Comparison of sensitivity and series resistance



Variation of the series resistance



Conclusion

- ▶ The microDiamond type 60019 is not generally applicable for ultra-high dose per pulse
- ▶ But: In principle diamond detectors based on a Schottky diode are able to respond linearly also at ultra-high dose per pulse. In this investigation up to 5 Gy per pulse
- ▶ The linear range can be extended by reduction of sensitivity and resistance
- ▶ Optimizations in progress (see talk of G. Verona Rinati)
- ▶ The microDiamond works in quasi-continuous radiation at ultra-high dose rate (see poster of L. Stolarczyk)
- ▶ Advantages of such a diamond detector
 - Can be used for the measurement of absolute dose and dose distributions
 - Easy to use with common electrometers and automated water phantoms

Thank you!
Any Questions?