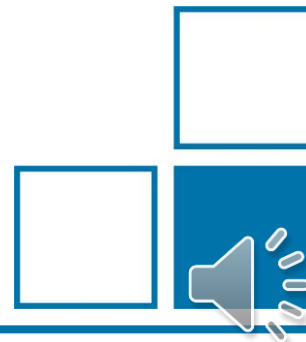


# Towards primary and secondary standards for dosimetry in Flash radiotherapy

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- The total prescribed radiation dose is delivered with **ultra-high dose rate (UHDR)** in less than a second
- Studies support the hypothesis that this significantly reduces the adverse side effects on the healthy tissue for equal dose delivery
- The ultra-high dose rate is challenging, both for delivery and dosimetry

The UHDpulse project aim to develop reliable dosimetry methods for Flash modality and guidance for CoPs.



- Metrological Electron Accelerator Facility (MELAF) at PTB, Germany



- Tests carried out at 20 MeV, 5 Hz PRF, pulse width of 2.5  $\mu\text{s}$
- Dose varied between 0.5 Gy and 2.0 Gy per pulse
- Detector response compared to beam current monitor



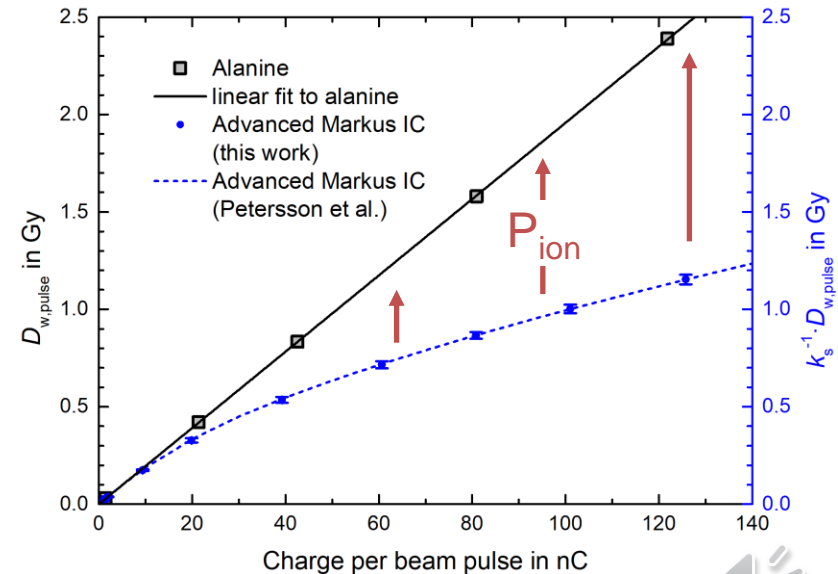
- Alanine is considered to be the reference
- 3 parallel plate ionization chamber model
  - PPC05 (sensitive volume depth of 0.6 mm)
  - Advanced Markus (sensitive volume depth of 1mm)
  - PPC40 (sensitive volume depth of 2.0 mm)

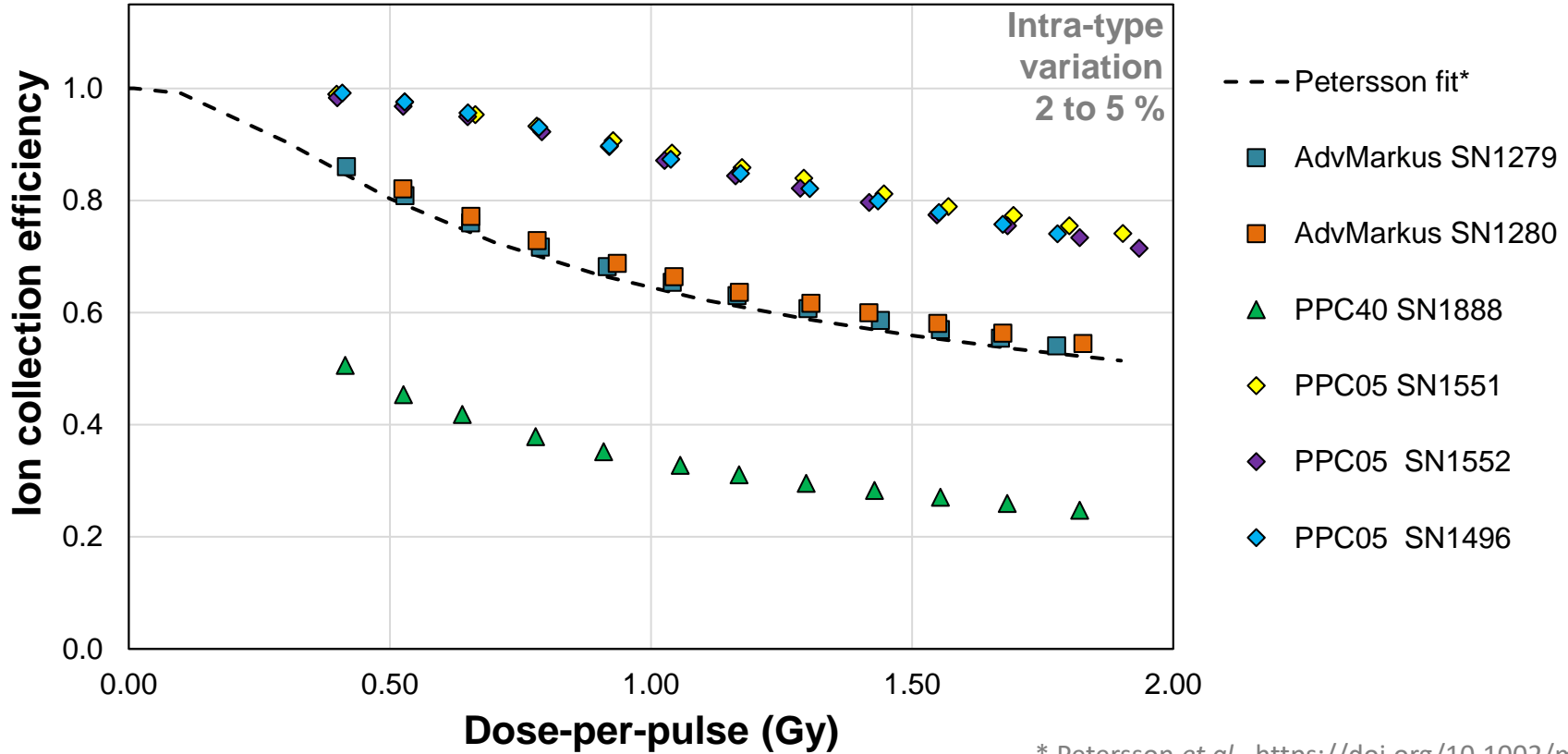


- A probe-type graphite calorimeter; Aerrow
  - Developed at McGill University
  - Provided by SunNuclear
  - Quasi-adiabatic mode



- Standard dosimeter for external beam reference dosimetry is the ionization chamber
- The ultra-high dose rate means that ion recombination is very large > 50% !
- Do not follow currant model (Boag)
- Integrating dosimeters such as alanine can be use to measure the ion recombination





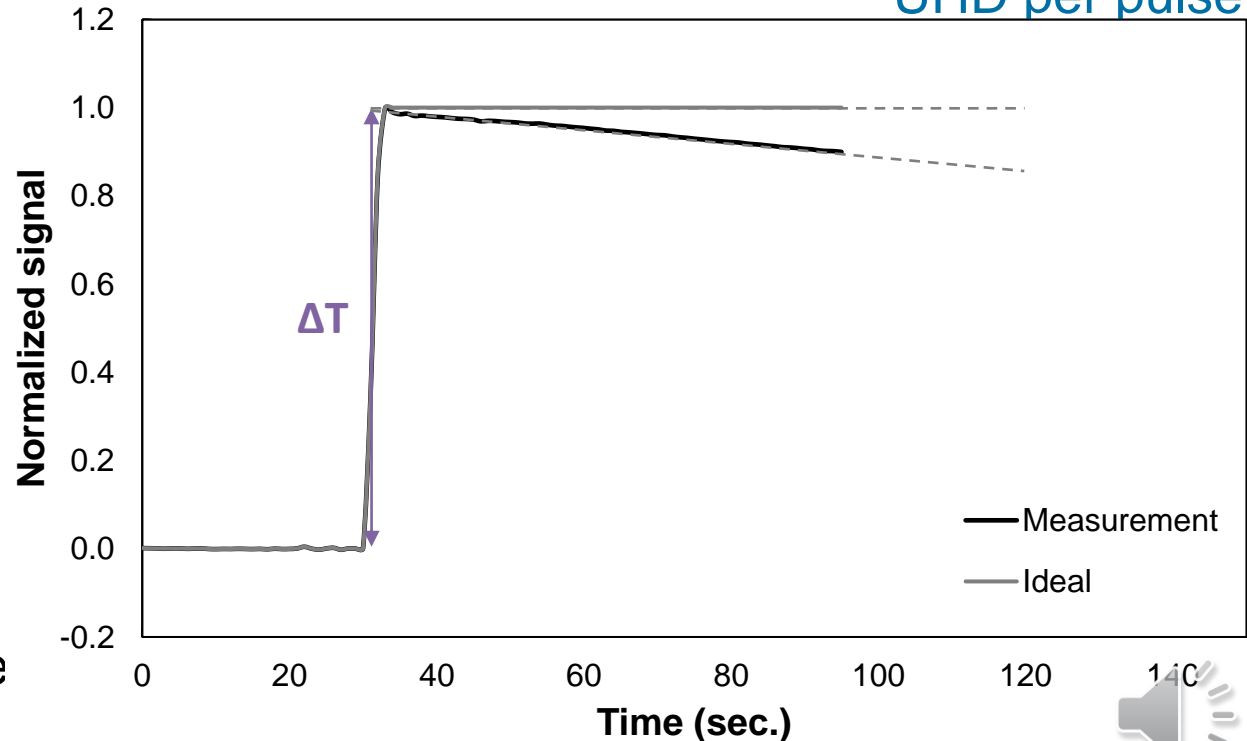
\* Petersson *et al.*, <https://doi.org/10.1002/mp.12115>

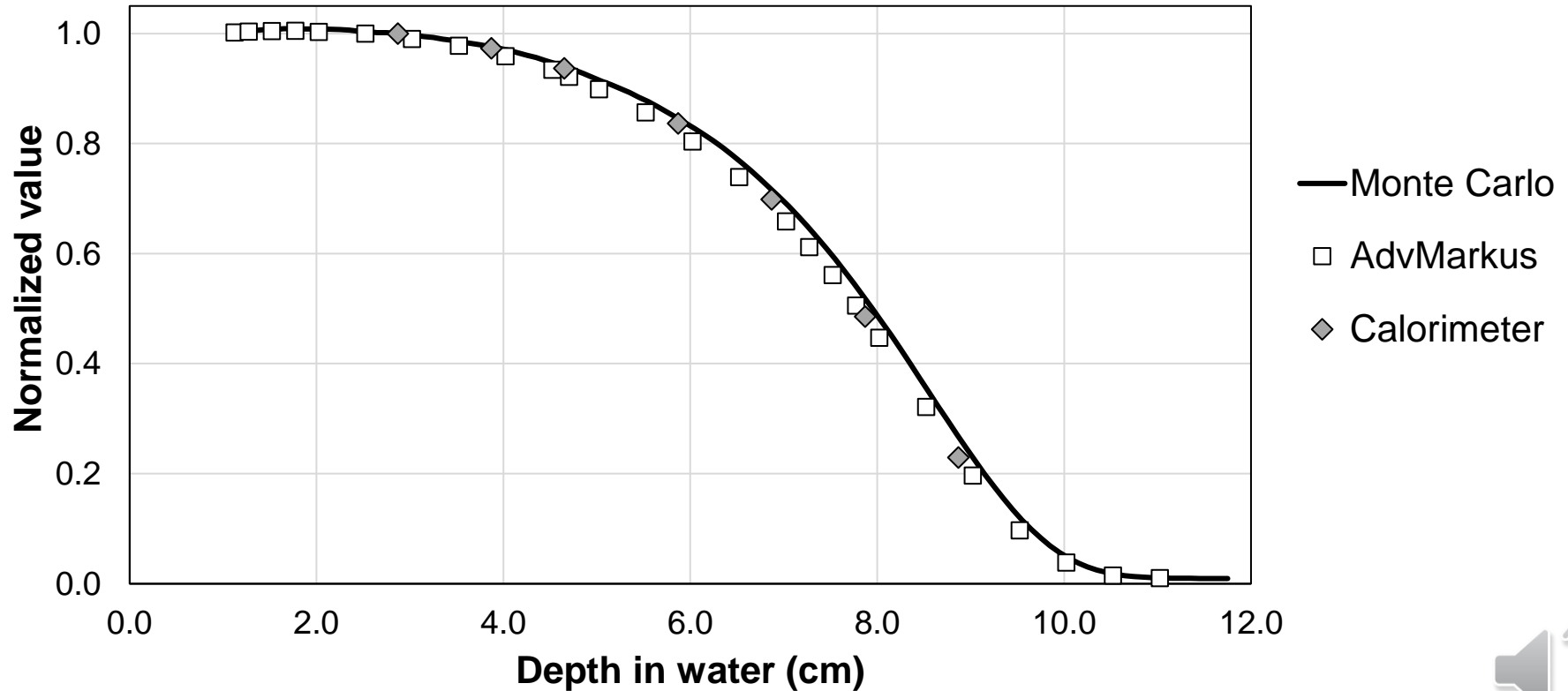
- Gives absorbed dose directly from a measure of the radiation-induced temperature rise UHD per pulse

- $D = c \cdot \Delta T \cdot k_{nc}$

- Time constant should be unaffected by dose-rate

- Simpler compared to conventional dose rate







- Calorimetry is showing promising results for NMI and clinical use
  - Gets simpler at Flash
  - Advanced insulation is not required, nor the use of a heat lost correction factor
  
- Ionometry
  - Intra-type variations in the 2-5% range
  - Development on theory/model to explained the observed ion recombination
  
- For relative measurement
  - Plastic scintillators, diodes, or diamond detectors are under investigation





Merci  
Thank you  
Danke schön

<http://uhdpulse-empir.eu/>

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