FRIDA, INFN Pisa

Update on plastic scintillator dosimeter development (WP3)

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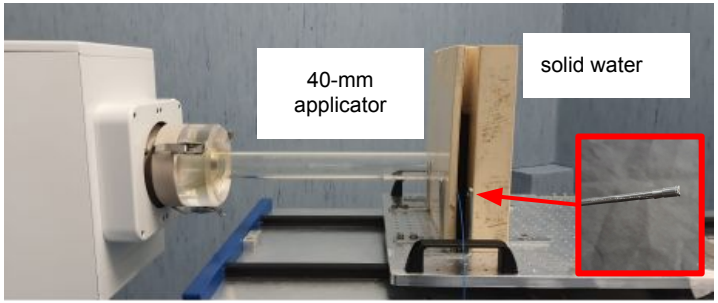
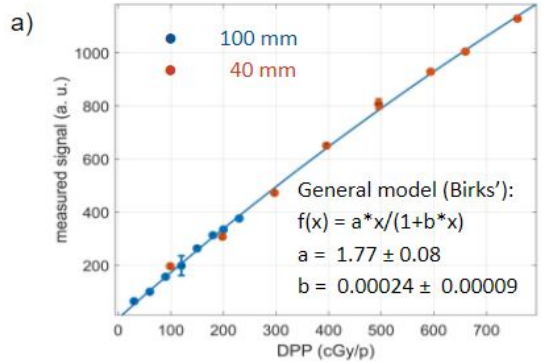
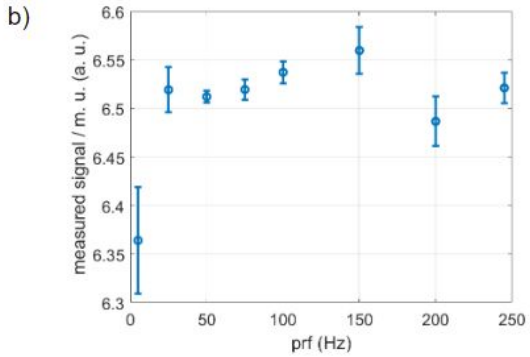
Second GM, 29-30 March 2023

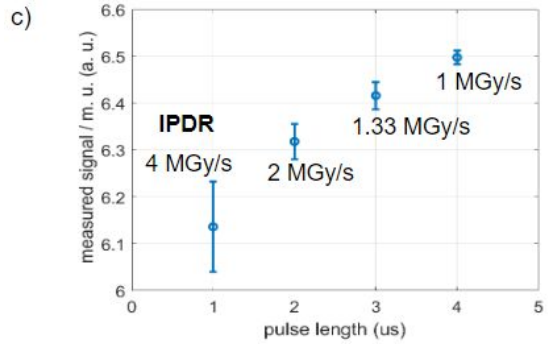
Quick recap

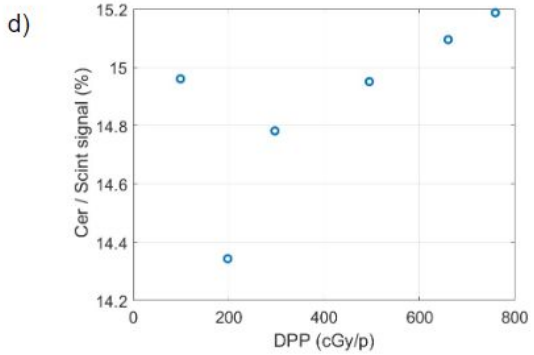
Plastic scintillator - Kuraray SCSF-78J, 10 mm length and 1 mm diameter
Clear optical fiber - Thorlabs, 1 mm diameter and 25 m long
Optical coupling - Cyanoacrylate glue in **Peek tube**







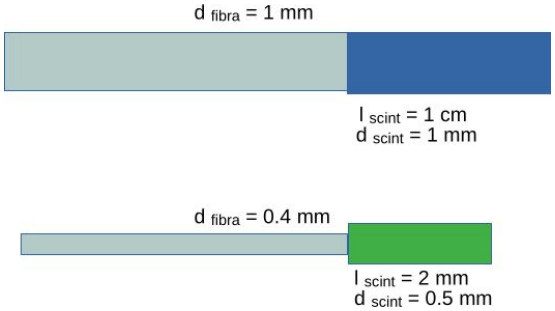


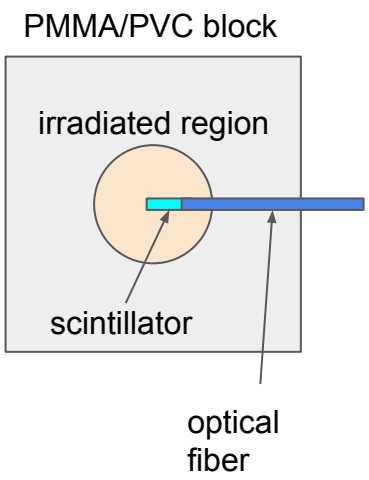


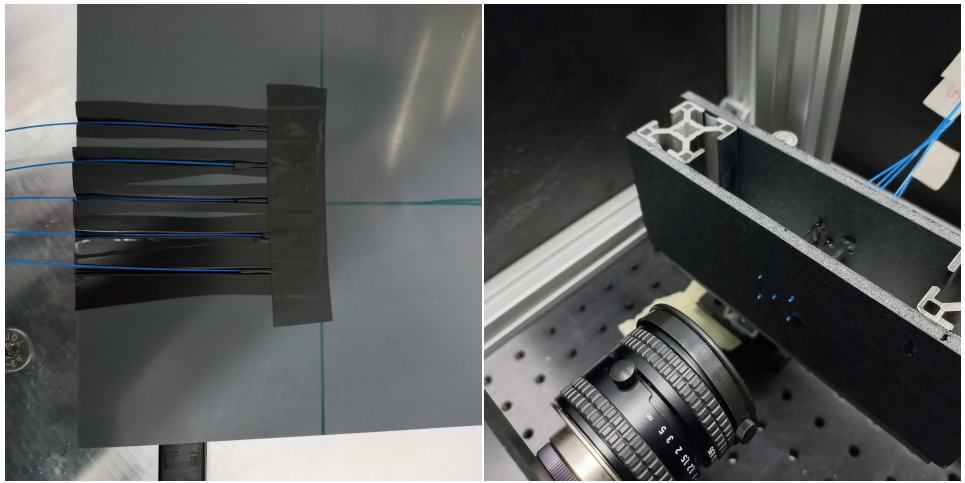
Performance of the first dosimeter. a) Linearity of the signal with the dose per pulse (DPP), for the two tested collimators, 100-mm diameter (blue) and 40-mm diameter (red). b) Dependence on the pulse repetition frequency (prf). c) Dependence on the intra-pulse dose rate (IPDR). d) Ratio of Cerenkov to total scintillator signal at different dose per pulse values.

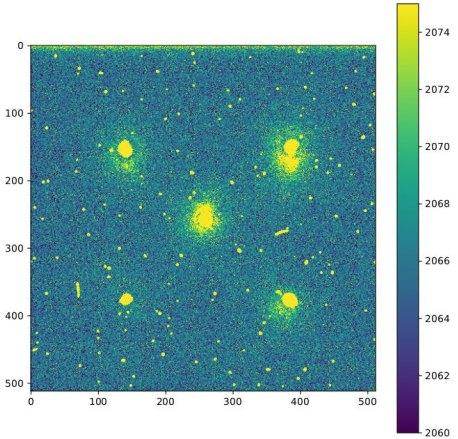
Updates

- **Plastic scintillators (Kuraray)**
  - 10 mm length, 1 mm diameter (blue, 450 nm)
  - 2 mm length, 0.5 mm diameter (green, 530 nm)
- **Clear optical fiber** - 25/10 m long, matching the scintillator diameter
- **Optical coupling** - Thorlabs F120 optical glue in **carbon tube**
- Readout by a **CCD camera** (image of the fiber output) or by a fast **photodiode** (waveform)



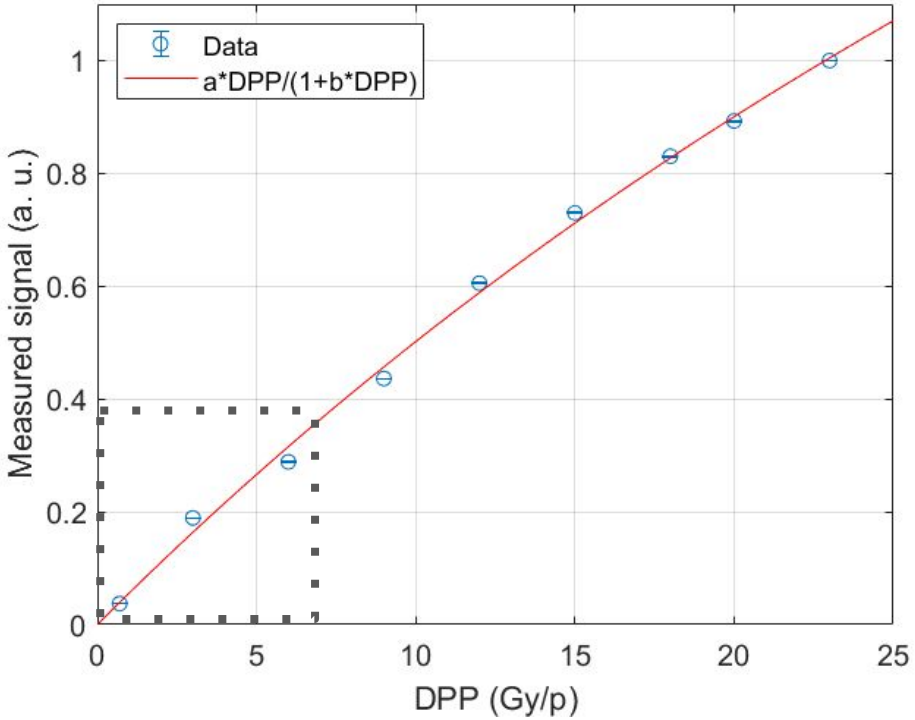


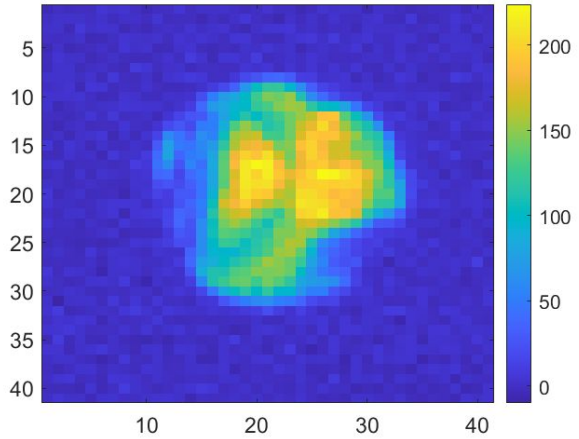




1. Linearity of the blue scintillator

No monitor unit correction (see later)





General model:

fitresult(x) = a*x/(1+b*x)

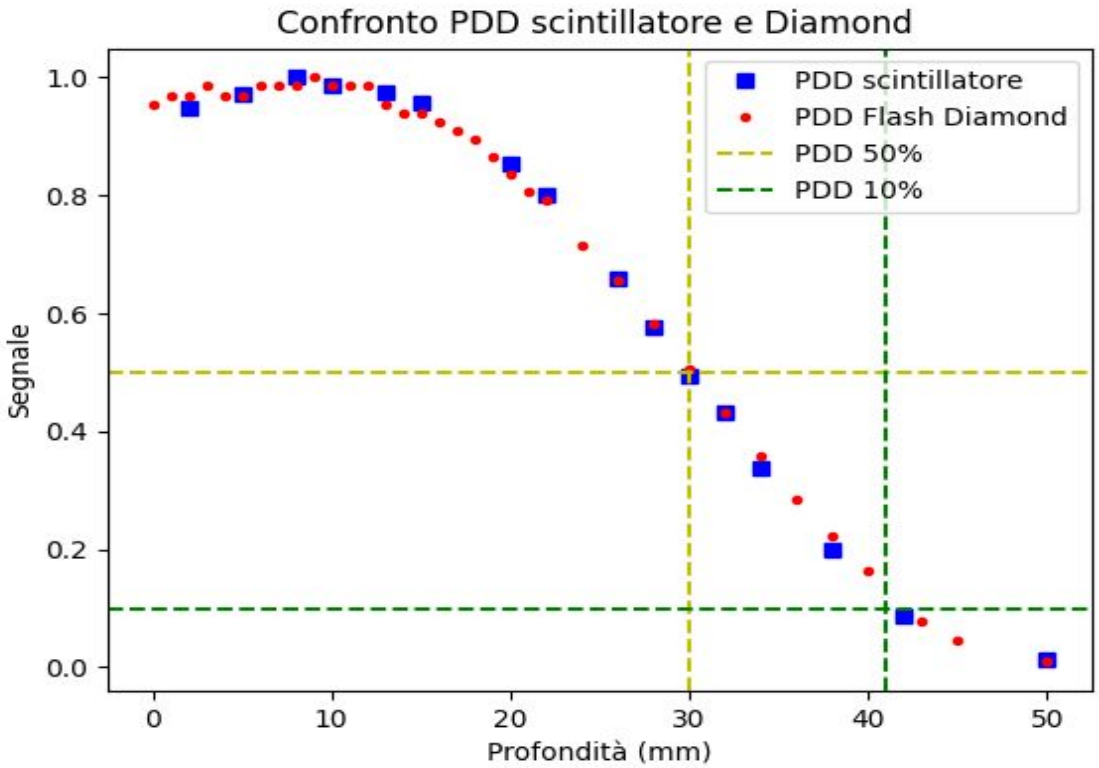
Coefficients (with 95% confidence bounds):

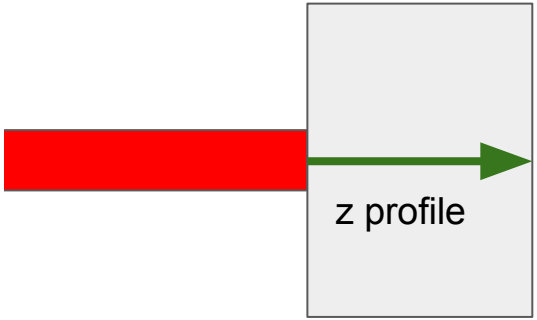
a = 0.057± 0.006

b = 0.013±0.007

2. Percentage-depth-dose (PDD) curve

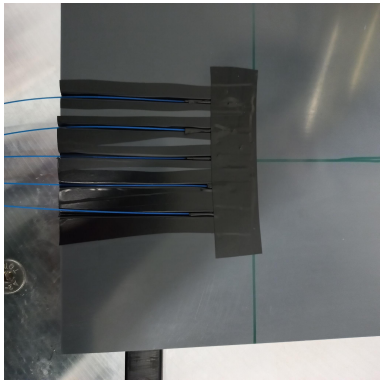
Reconstruction of the dose profile at variable depth in solid water

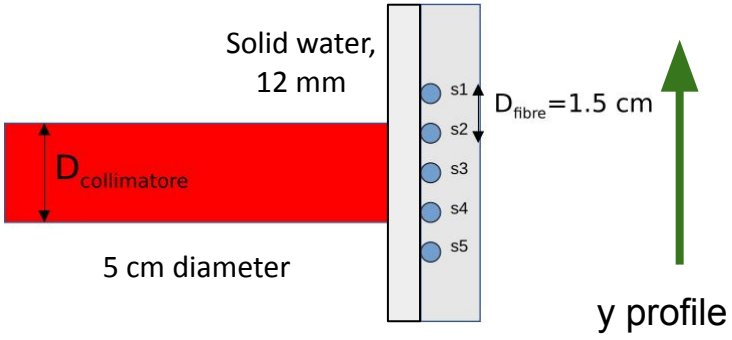




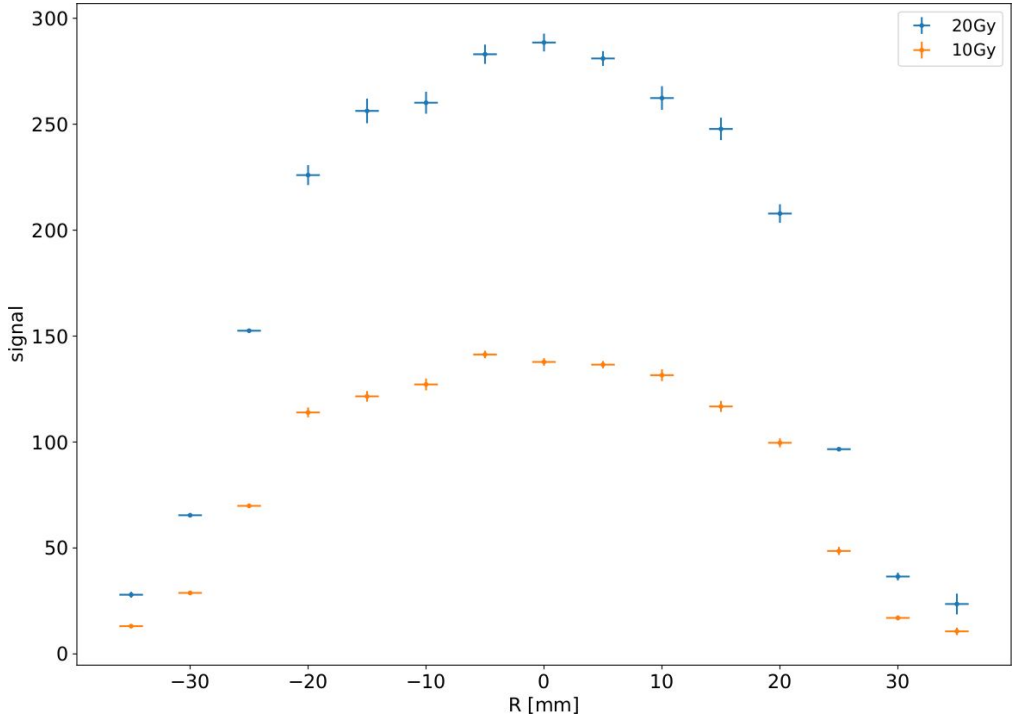
3. Beam spatial profile

Lateral beam profile at fixed depth in solid water

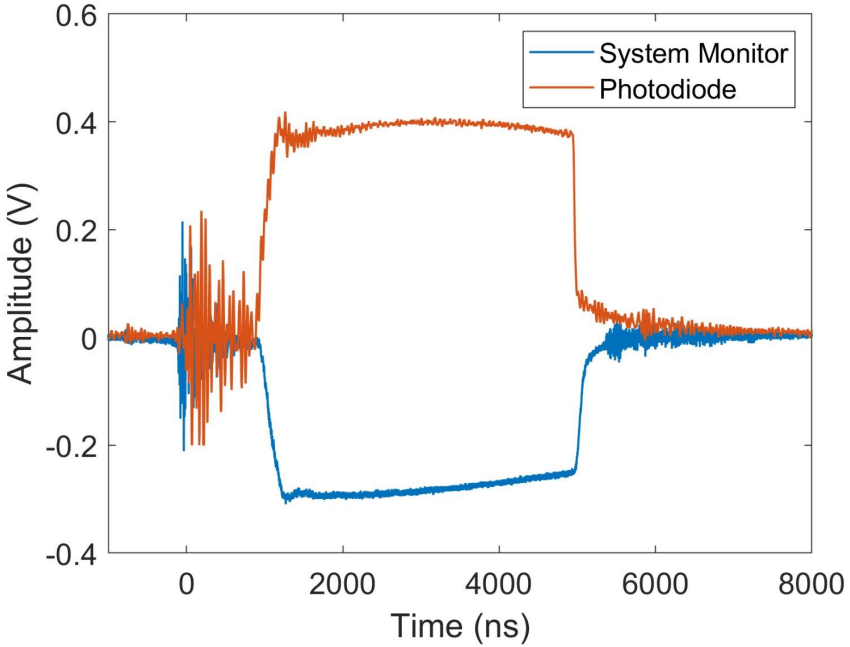


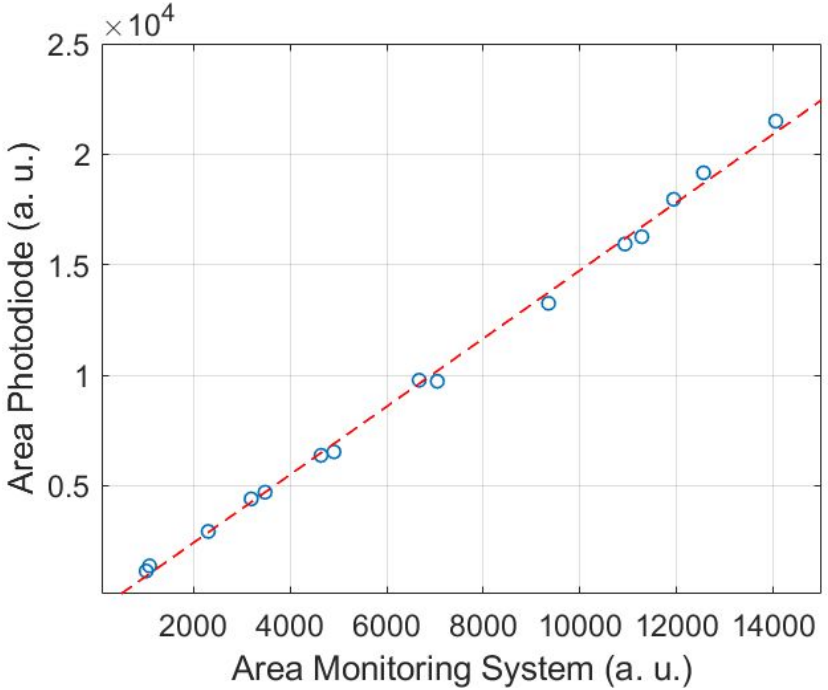


50-mm applicator



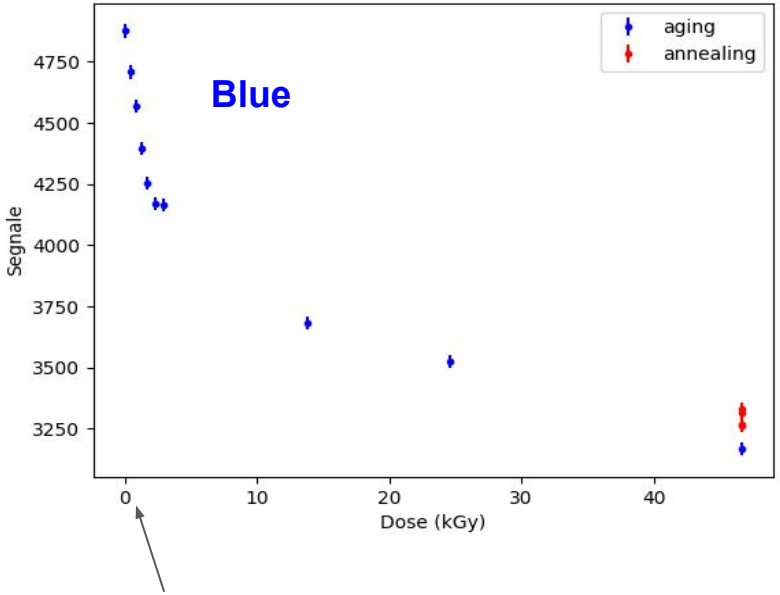
4. Beam time profile



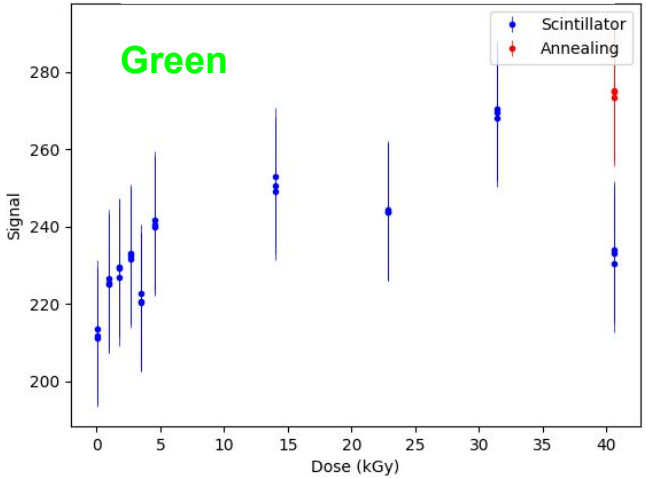


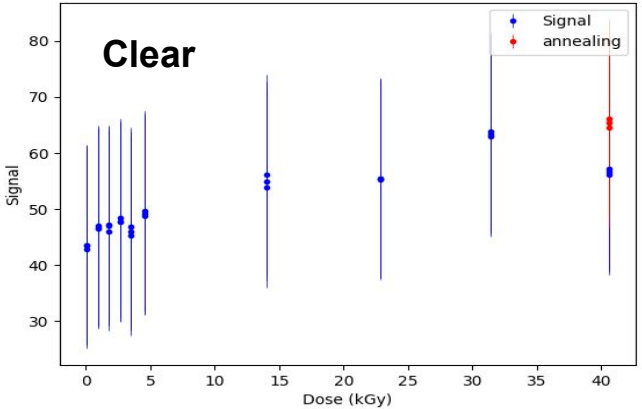
5. Dosimeter aging

- We take a reference measurement @12 Gy/p
- We deliver several kGy
- We repeat
- Monitor unit correction applied!



+1 kGy approximately, due to previous irradiations





Future plans

- **Aging** of the plastic scintillator dosimeters @ CPFR and annealing with our X ray tube, by monitoring the scintillator output over time (minutes? days? weeks?)
- **Beam monitoring** with plastic scintillator sheet imaged by CCD camera
- Use of plastic scintillator dosimeters to measure the **entrance dose *in vivo*** with our colleagues of CNR Pisa

Papers and conferences in 2023

- Proffered paper at ESTRO 2023, Vienna, May 15th “Plastic scintillator-based dosimeters for FLASH radiotherapy”, session on Flash and proton measurements
- Paper in preparation for the Frontiers Special Issue “Multidisciplinary Approaches to The FLASH Radiotherapy”, deadline @end of April 2023