CHUV Dosimetry challenges and infrastructure relevant to SwissElite project

Claude BAILAT and al

University Hospital and
University of Lausanne, Switzerland

Menu

- Who are we….
- What did UHDR dosimetry do to us….
- Where can we provide some input for this project….
- What do you need that I forgot….

Lausanne University Hospital in numbers

1'548
beds used

495'339
days of hospitalisation

79'545
emergency patients treated

3'154
births

2
billion (annual budget in Swiss francs)

53'964
patients hospitalised

12'675
employees

103
nationalities

- In 2023

Institute of Radiation Physics (IRA) in numbers

IRA: ~60 Collaborators

- Unluckily Nick Walter is not at IRA anymore, but he will remain involved from the sideline.

IRA provides expertise for CHUV and the galaxy in:

- **Medical physics**
- **Radiation protection**
- **Radiochemistry**
- **Radiopharmacy**
- **Radiometrology**

RADIOMETROLOGY ←→ **Gy, Sv, Bq**

FLASH Radiotherapy

FLASH radiotherapy

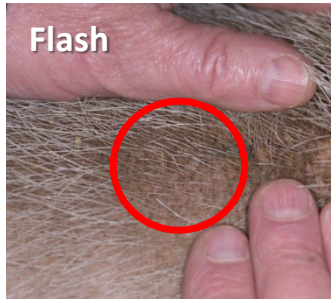
What are we talking about?

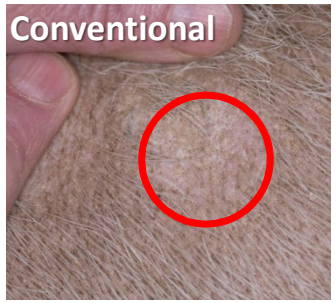
in very short:

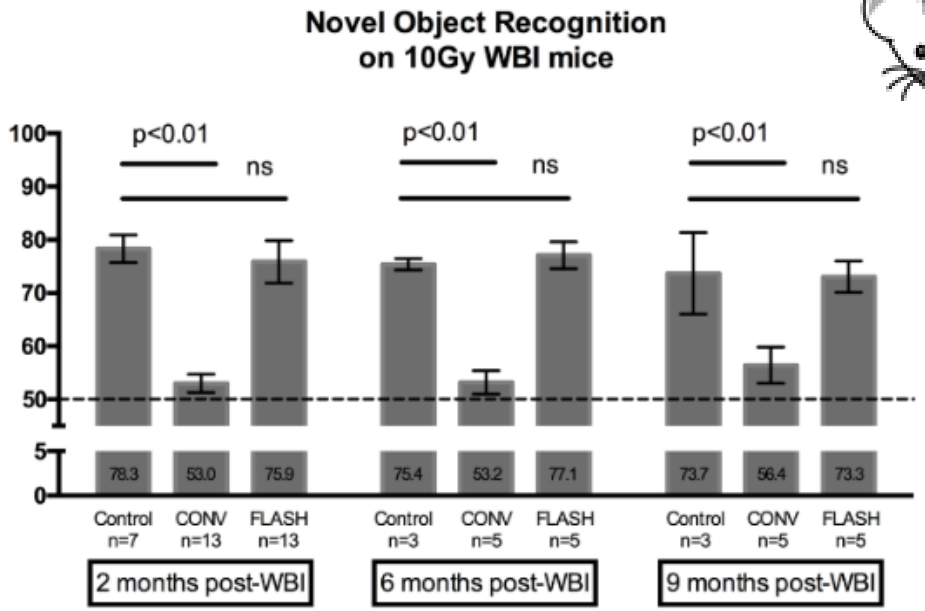
Irradiation at ultra high dose-rate (**UHDR**)

increases the differential response

between normal and tumor tissue







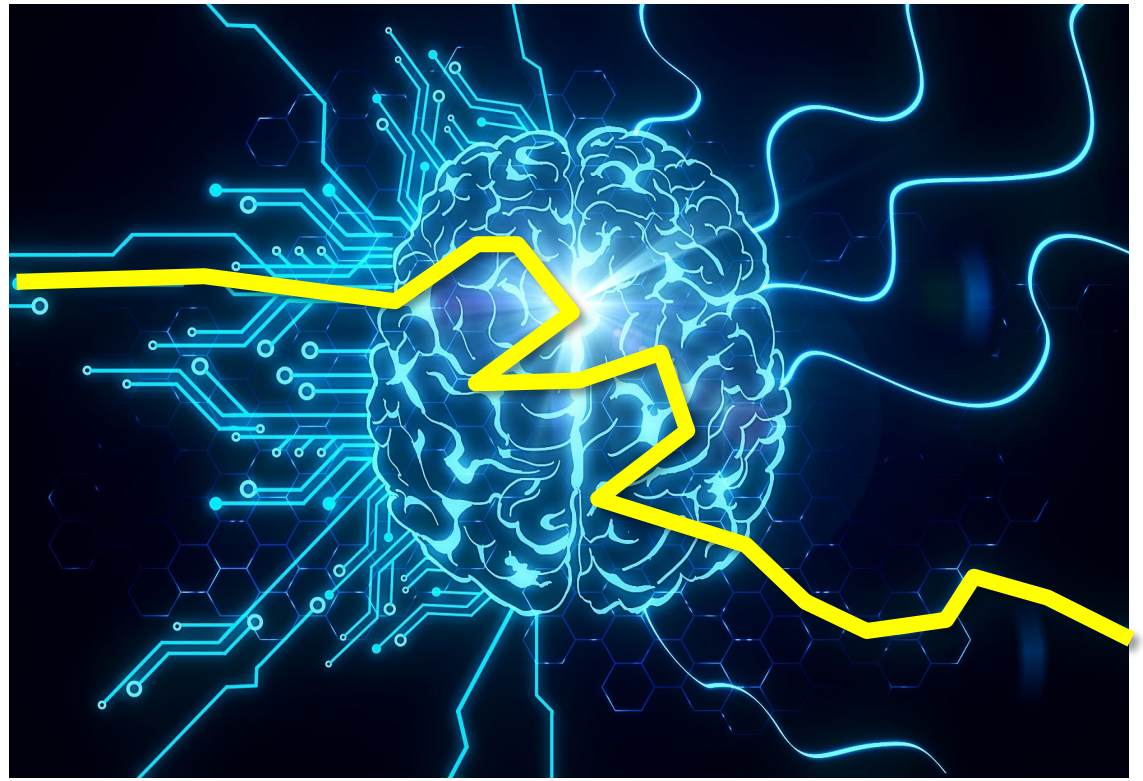
UHDR dosimetry - From point A to point B

A

Conventional radiotherapy

Well-crafted **codes of practice** for decades

Based on well **standardized beam** qualities and irradiation geometries



B

FLASH radiotherapy

Ultra high dose rate (**UHDR**)

No code of practice

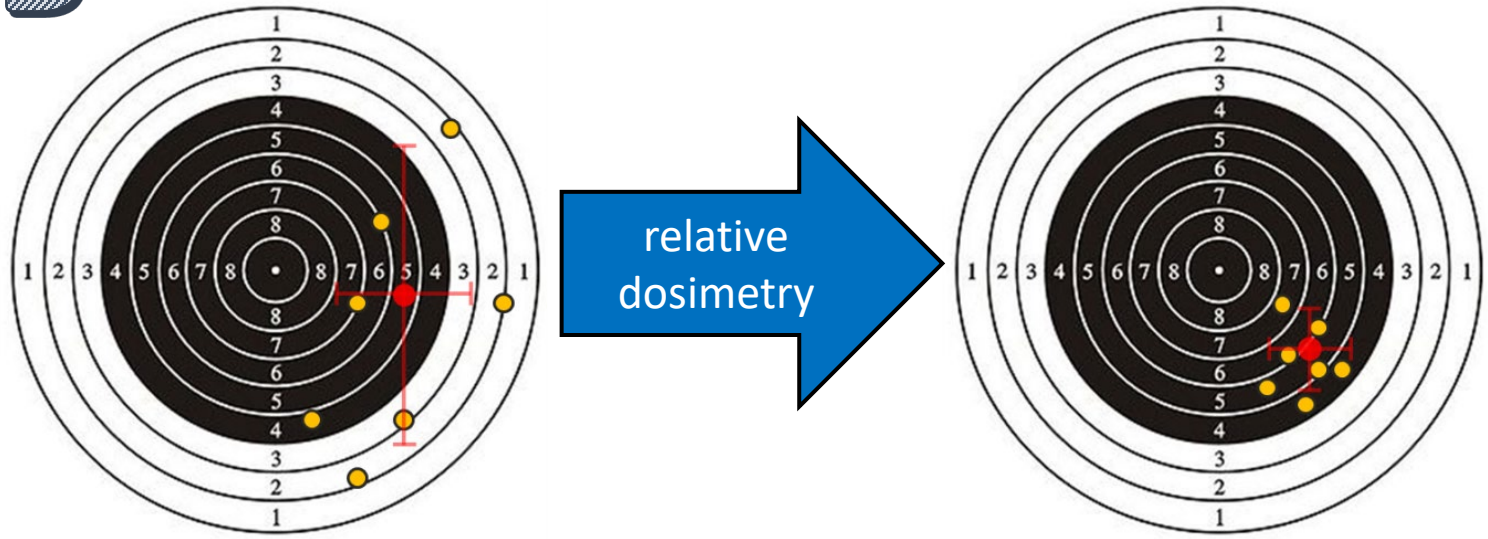
No standardized beam qualities

UHDR beam differs from reference beams

- Dose-rate
- Time structure (pulsed)
- Field size
- Energy spectrum
- Lateral beam profile
- → instruments
- …..

all that needs **correction factors** → **uncertainties**!

B



No absolute dosimetry

➔ **relative dosimetry**

+

repeatability

➔ *diagnostic + reliable set-ups*

Our strategy for accuracy

Take dosimeters with **different detecting principles**

Start with CONV beam parameters and **extrapolate to FLASH**

The dose rate dependency must be different

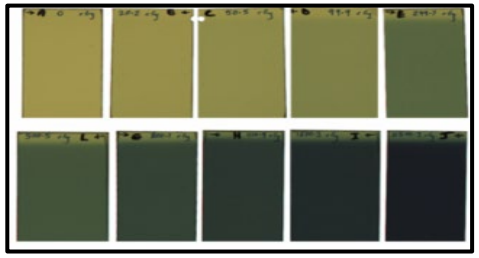
What we have to offer….. (somehow)

- Detectors

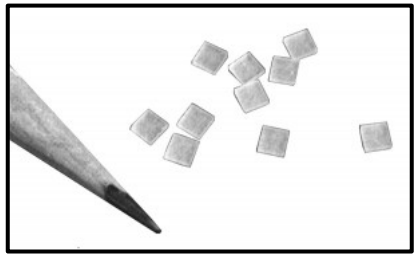
- Testing facilities

Established relative dosimetry for UHDR

alanine



films



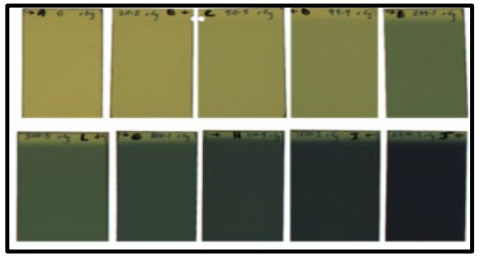
TLD

ionization chamber

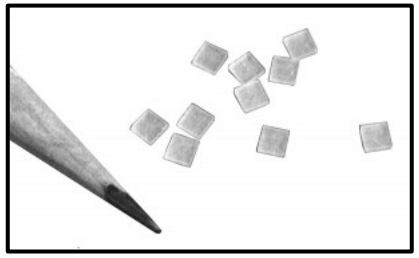
what we currently use in Lausanne

Established relative dosimetry for UHDR

alanine



films



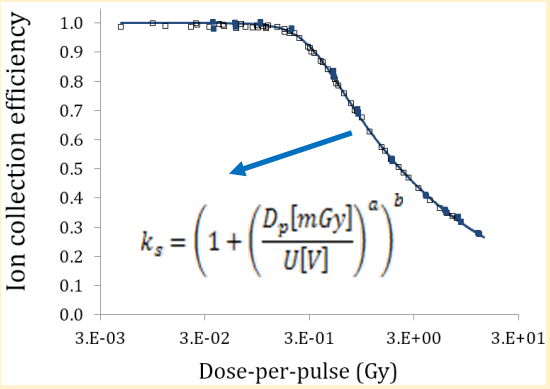
TLD

dose rate **"independent"**

ionization chamber

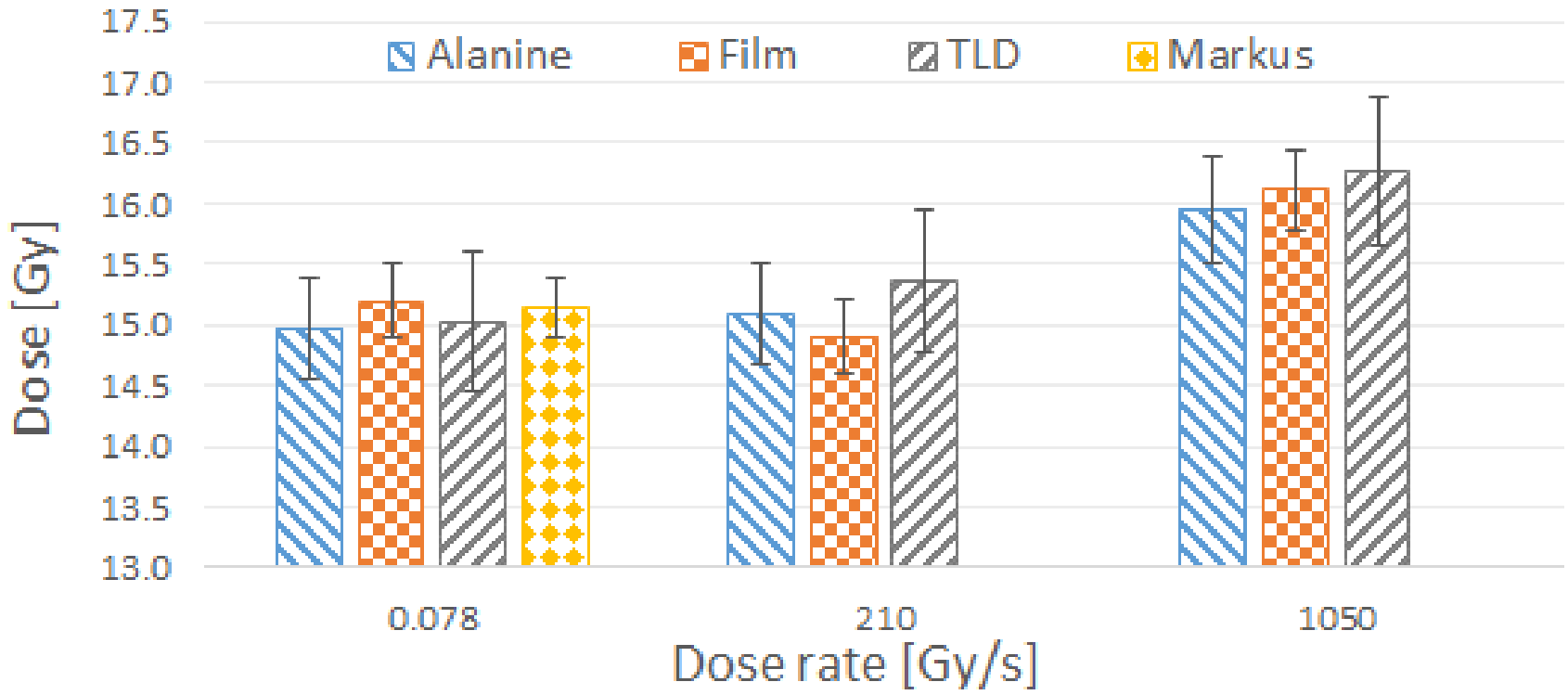
corrected for dose rate

High dose-per-pulse
→ Saturation



increased uncertainty because correction factor in a steep part of the curve

Work in progress……



Redundancy of dosimetric measurements

≈ traceability (kind of)

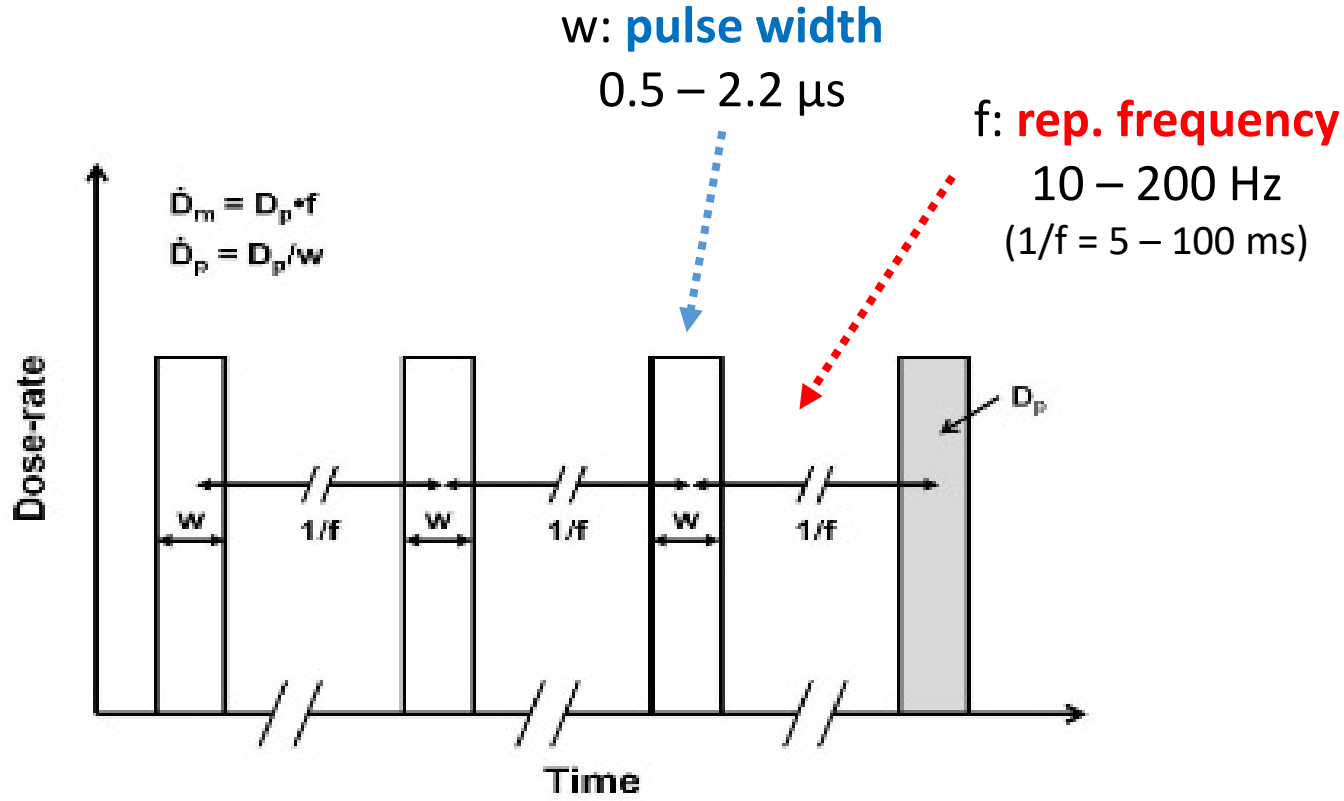
Agreement

within **2 %** for **CONV**

within **3 %** for **FLASH**

- Under investigation:
  - Microdiamond chamber (PTW) is in the routine, but still stress-tested (1 year of stability, 1 year of redundant radiobiol dosimetry → to be published)
  - Plastic scintillator (MedScint)
  - H*(10) detectors from ELSE (Nausicaa)
  - Neutrons….. Tested LB6411, issues with pulsed beams, but hard to know!!!!
  - Using various H*(10) and K in pulsed beams (fluoroscopy is pulsed as well)

eRT6 UHDR linac – beam characteristics

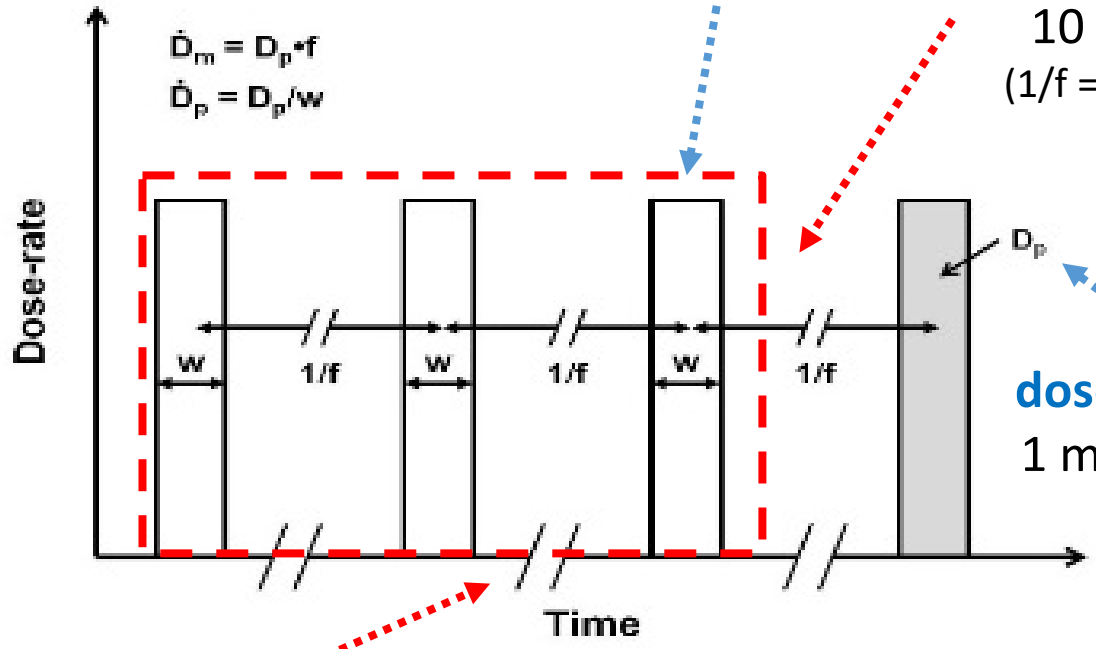


microseconds pulses in a millisecond cadence

eRT6 UHDR linac – beam characteristics

w: **pulse width**
0.5 – 2.2 µs

f: **rep. frequency**
10 – 200 Hz
(1/f = 5 – 100 ms)

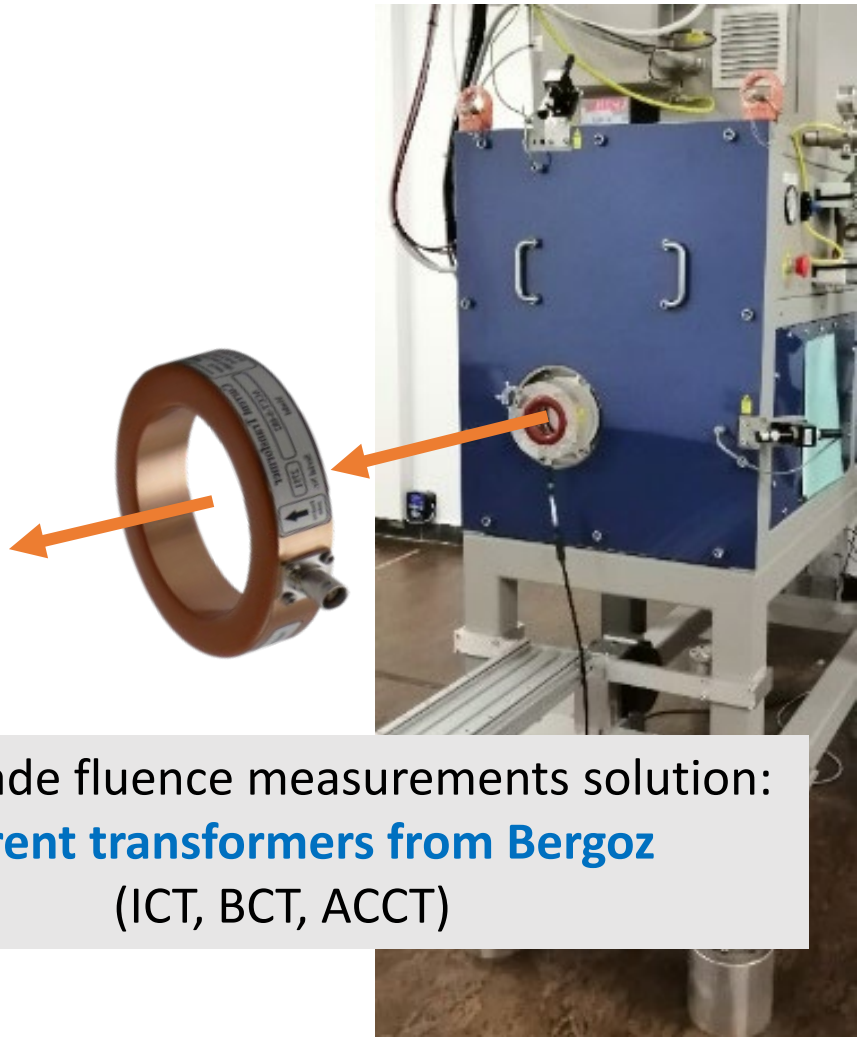


dose per pulse
1 mGy – 10 Gy

mean dose rate
10 mGy/s – 1 kGy/s

dose rate in pulse
1 kGy/s – 5 MGy/s

Other measurements



Home-made fluence measurements solution:
Current transformers from Bergoz
(ICT, BCT, ACCT)

- We are in charge of RP around all these facilities…..
  - Doserate meters + Monte Carlo

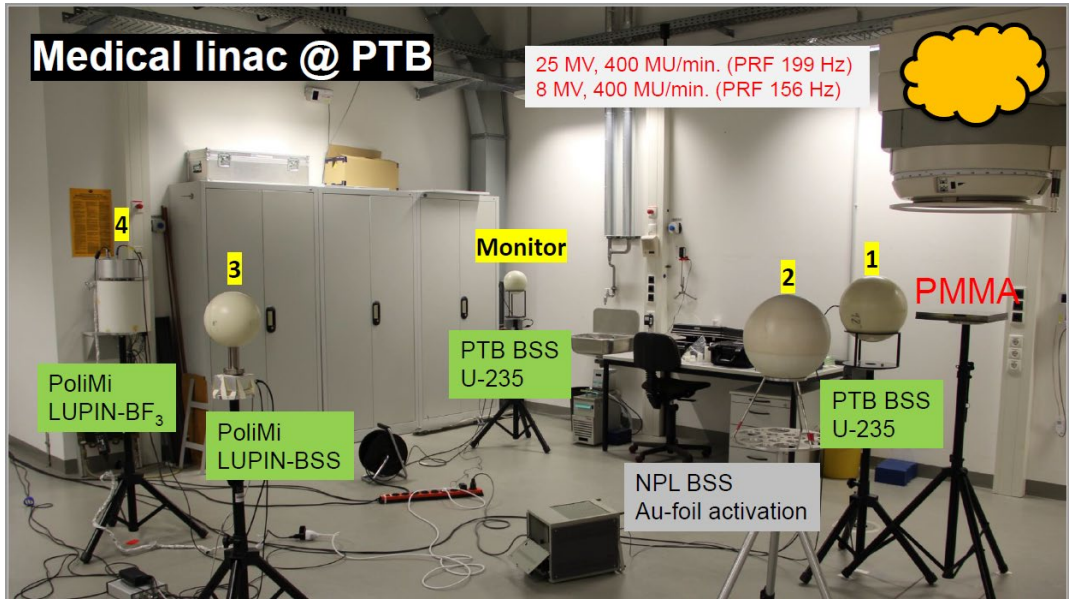
Others irradiators as well….

- 6-15 MeV, Beam similar to eRT6, a bit less flexibility,
- FK coming and going
- Others within a VHEE project

Others irradiators as well….

- Calibration lab (gamma, XR, electrons)

- Clinical linacs
  - 4-20 MeV
  - Photons, electrons
  - Large beam
  - Highly controlled
  - Neutrons….. (UHDpulse → …)



- We have always mixed fields, electrons, bremsstrahlung, MeV photons, neutrons.

Neutrons at IRA

- Bonner Sphere Spectrometer maintained within the Nuclear Inspectorate agreement.
- Doserate meters for RP (standard)
- VHEE project will bring more neutrons in our life (!)
- (We can provide radionuclides for energy calibration for example)

Acknowledgements

Thanks to my colleagues at IRA

And all my colleagues at CHUV and elsewhere

Nick Walter

What do you need that I forgot….