

Flash





Conventiona

The challenges of Ultra high dose rate dosimetry for preclinical irradiation

VHEE2020

C. Bailat, PhD

Marie-Catherine Vozenin François Bochud Raphael Moeckli Patrik Jorge Thierry Buchillier Veljko Grilj

EBT3 film

Primary



2 µm

Vaud















Who are we.....

- one of five university hospitals.
- Connected to the biology and medicine department of UNIL
- Over 11'000 employees
- Over half a million annual hospitalization-days.

FLASH-team at CH

Institute of Radiation Physics (IRA)



IRA: ~60 Collaborators

IRA provides expertise in:

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





Our point of view.....

- one of five university hospitals.
- Connected to the biology and medicine department of UNIL
 - Over 11'000 employees
- Over half a million annual hospitalization-days.

Institute of Radiation Physics (IRA)



IRA: ~60 Collaborators

IRA provides expertise in:

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

METROLOGY means traceability

Traceability refers to an unbroken chain of comparisons relating an instrument's measurements to a known standard.



How do we build a chain of traceability?



METROLOGY means traceability

Traceability refers to an unbroken chain of comparisons relating an instrument's measurements to a known standard.



How do we build a chain of traceability?



...backward in fact

















Building a chain of traceability Highest level International prototype of accuracy **Primary national** standard Secondary standards Needs to set this value pragmatically level of the investigated effect, tools, time, ... Working standards Calibrations \rightarrow instruments Preclinical Lowest level U = ? of accuracy **FLASH-RT**

Canton de Arta Saudo















We identified **physical parameters**, which leads to **biological observations** of FLASH effect

	Conventional	FLASH
Dose rate	~10 ⁻¹ Gy/s	~10 ⁷ Gy/s
Dose per pulse	~10 ⁻⁴ Gy	~10 Gy
Time for dose delivery	~ 10² s	~10 ⁻¹ s
	FLASH	NO FLASH
	EFFECT	EFFECT

Tanton de Vaude



FLASH-RT timeline: from effect to RT









How do you guarantee prescribed dose



These requirements are on dosimetric measurements → finding detectors, designing procedures and set-ups,

• For example: absolute dosimetry, relative dosimetry, standardized procedures, holders,



These requirements are on dosimetric measurements

 However, the beam characteristics need to be up to standard as well!

- Normally, preclinical beams are so predictable, that the work load is on the measurement technology.
- This is not easy with VHEE facilities!





BEAM CONTROL: OUTPUT, SIZE, ENERGY, ...

→ PREDICTIVE POWER NEED TO BE UP TO BIOLOGICAL EXPECTATIONS

FLASH EFFECT ~15 %, UNCERTAINTY PRESCRIBED DOSE < 5 % TEMPORAL STABILITY

6 5

- short (minutes)
- medium (hours)
- long (days)









- 5 % unc. on delivered dose \rightarrow Output stability <1 %

- Beam size:

For example:

- We need beams larger than 2 mm to test mice!
 → 25 mm (95 % flatness)
- We need prescribed dose (D) accuracy around 5 %:
 - absorbed dose to water goes (1/beam diameter)²
 - Example: beam of 5 mm diam., $\Delta d \sim 0.1 \text{ mm} \rightarrow \Delta D \sim 4 \%!$
- Energy, geometry, monitoring, dosimetry....



Message to the VHEE community (from somebody who is still learning the hard way):

- Run! Biologists are coming....
- Do not state your beam performance as the best ever
 - Keep it safe and try to find stable conditions
- We need flexible irradiation facilities to explore beam parameters
 - Exploration of clinically relevant parameters for FLASH effect (field size, scanning, etc....)
- We need biology friendly environment
 - Access with biological samples
 - Ease to do multiple irradiations (one sample a day is not enough!)
 - Understanding for another scientific field
- You need to follow as close as possible medical physics protocols, use clinical tools, define well your vocabulary → clinical transfer
 - You won't be able to impose your ways to the large clinical community

