



New horizon in  
therapy & treatment

# FRPT

FLASH  
RADIOTHERAPY  
& PARTICLE  
THERAPY

# 2021

VIENNA & ONLINE

1-3 DECEMBER 2021

**MONITORING A FLASH BEAM:  
FOR PRECLINICAL STUDIES AND  
TOWARDS CLINICAL APPLICATIONS**

Sophie Heinrich

INSTITUT CURIE

Team “DNA Repair, radiations and innovative cancer therapies”

UMR 3347/U1021 – Signaling, Radiobiology and Cancer



FRPT-Conference.org

# Faculty Disclosure



Sophie Heinrich – Institut Curie Recherche

	No, nothing to disclose
X	Yes, please specify:

Company Name	Honoraria/ Expenses	Consulting/ Advisory Board	Funded Research	Royalties/ Patent	Stock Options	Ownership / Equity Position	Employee	Other (please specify)
SIT			X					
Varian			X					



NHS  
The Christie  
NHS Foundation Trust

MANCHESTER  
1824  
The University of Manchester

Biophysics



EMPIR  
EU  
EURANET  
The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States



InspireProject  
Horizon 2020  
Integrating proton research across Europe



MedAustron  
N

PTB  
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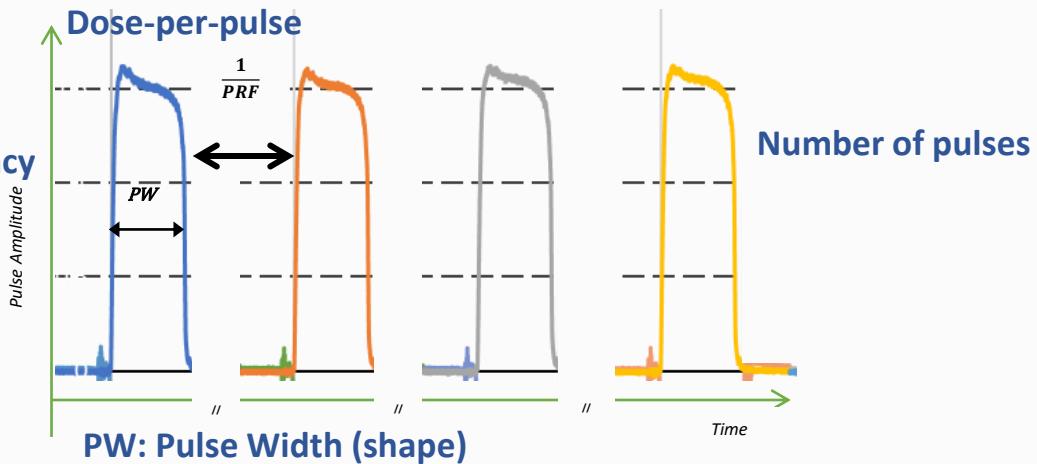
# MONITORING A FLASH ELECTRON BEAM

## Pulsed beam with Ultra-High Dose-per-pulse

- Goal: Monitor the delivered dose when changing the beam temporal parameters
- Define a “Monitor Unit” reflecting the charge output dose independently of those parameters
- Correlate this MU to absorbed dose into water

PRF:

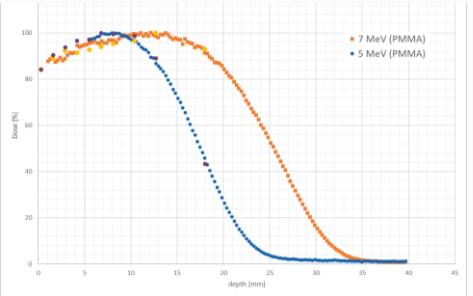
Pulse Repetition Frequency



# The ElectronFlash linac

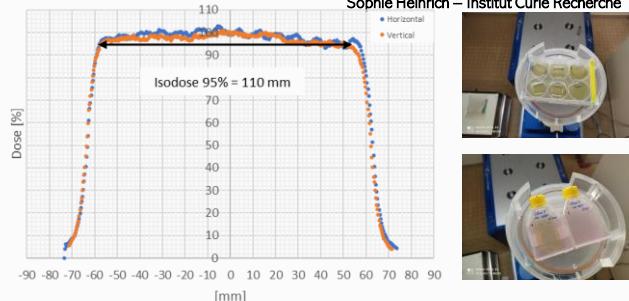


SIT S.p.A., R&D Dept., Aprilia, Latina, Italy  
<https://www.soit.org/flash-rt-technology/>

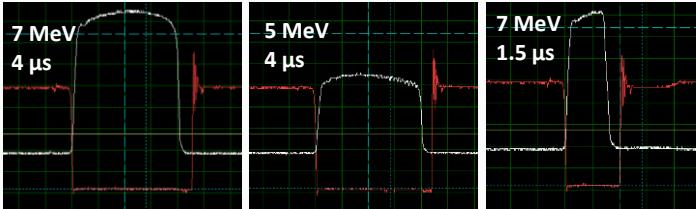


- Beam orientation: 0° and 90°

- 2 nominal energies (5 and 7 MeV)



- Homogeneous field 95% = 11 cm @ 3 Gy/p



- Dose-per-pulse adjustement:

- Variation of pulse width (factor 4)
- Variation of energy (factor 2 / 10)
- Variation of applicator (factor 10)

- Mean dose-rate adjustement:
  - Variation of PRF (factor 250)

∅ applica- tor (mm)	Dose/pulse (Gy/p) @ 7 MeV @ 5 μs		Mean Dose-rate (Gy/s) @ 7 MeV @ 5 μs		
	UHDR	CONV	UHDR (100 Hz)	UHDR (250 Hz)	CONV (10 Hz)
120	2,8	0,07	275	688	0,7
100	4,1	0,06	413	1032	0,6
50	10,9	0,14	1092	2731	1,4
40	14,0	0,18	1402	3505	1,8
30	16,8	0,24	1677	4193	2,4
10	24,9	0,2	2494	6235	2

# MONITORING SYSTEMS

Prof. Marco Marinelli &  
Gianluca Verona Rinati  
Università "Tor Vergata"

Presentation  
G. Verona on  
the 02/12

**FLASH**  
Diamond detector

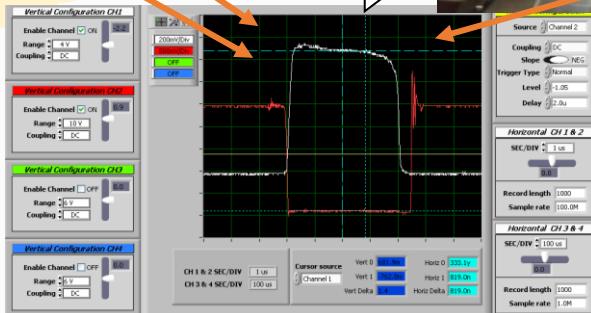
+  
Pulse shape diamond  
detector

Faraday  
cup  
collimator

Integrated value



Rafael Kranzer  
PTW dosimetry

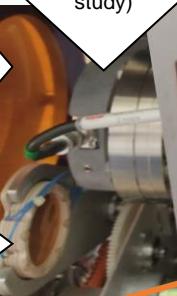


fD + EBT-XD films  
→ Calibration of toroid  
signal in Monitor Units

New  
toroid  
(under  
study)

Exit  
window

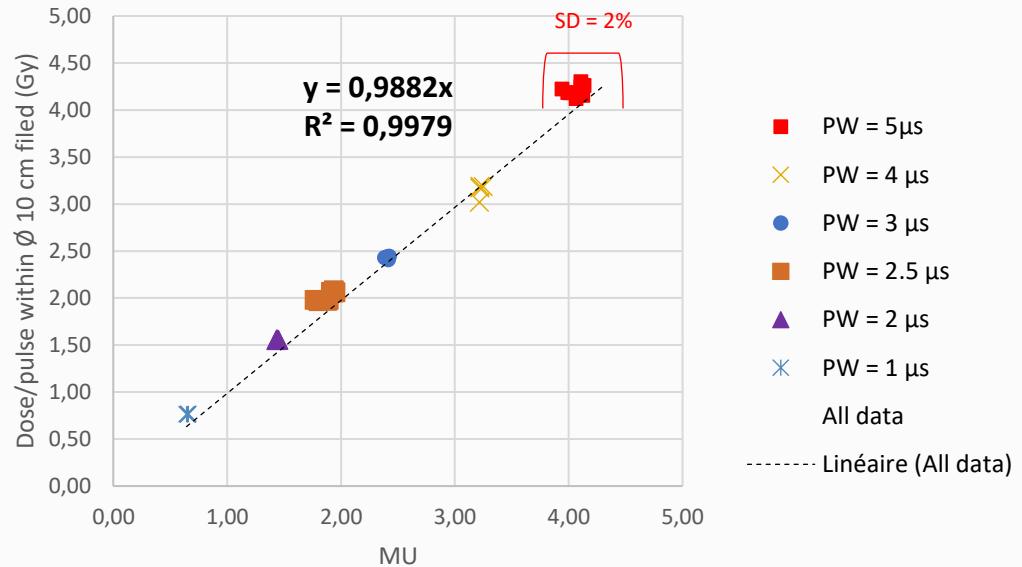
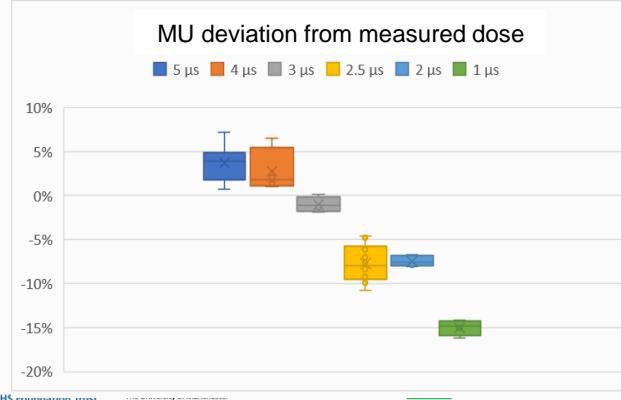
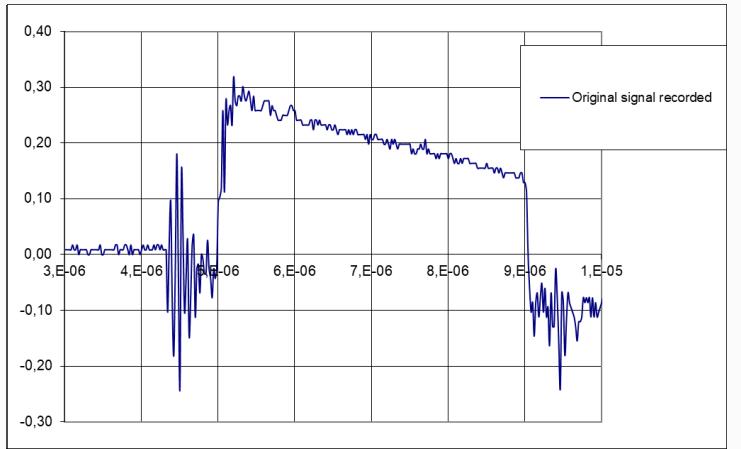
monitor  
chambers



Poster: L. Giuliano

Recorded with LabVIEW  
virtual oscilloscope

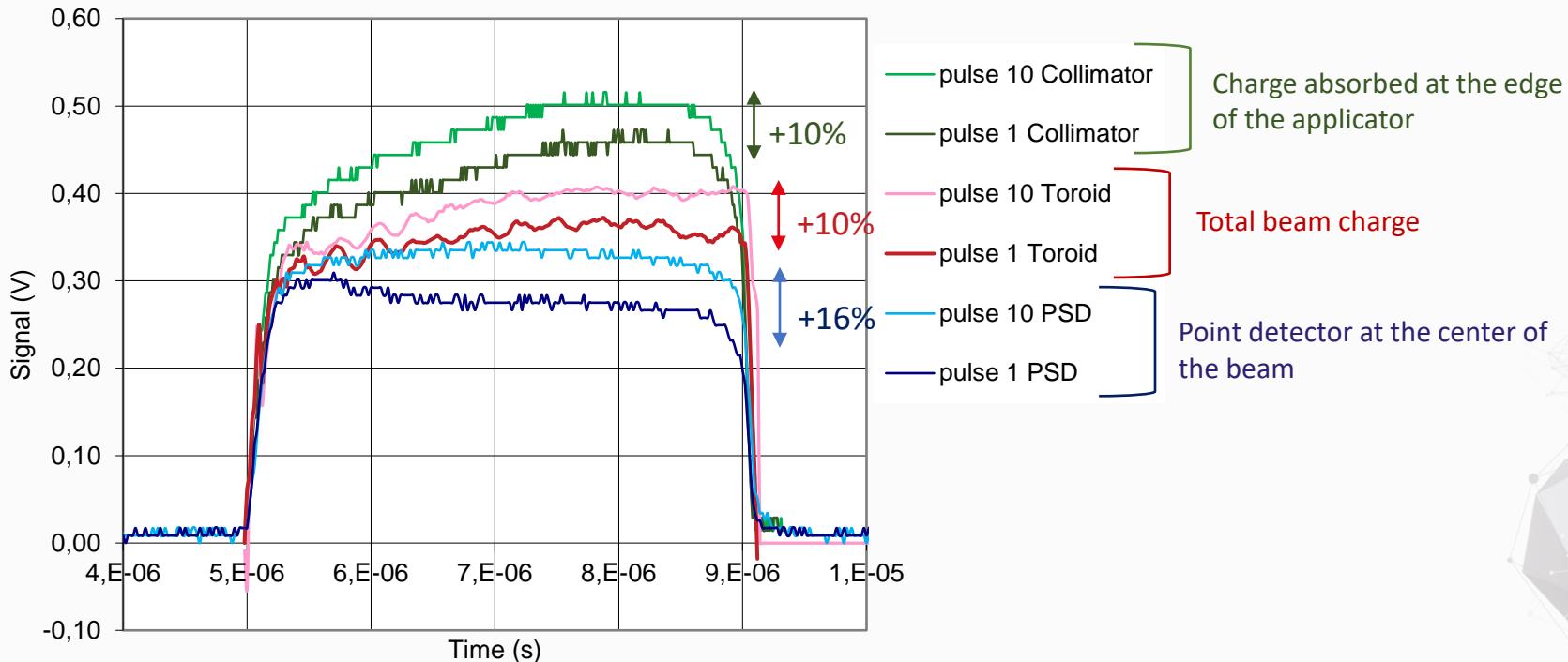
# TOROID CALIBRATION



1 MU = charge output delivering 1 Gy in the reference conditions:  
at the depth of the maximum in a PMMA phantom in a 10-cm field.

# Signals comparison

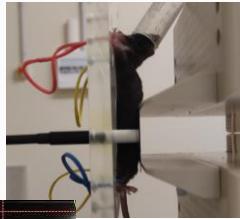
Under degraded conditions, the AFC takes a few pulses to adjust, and the first pulses are not stable.



# PROS AND CONS OF TOROID MONITORING

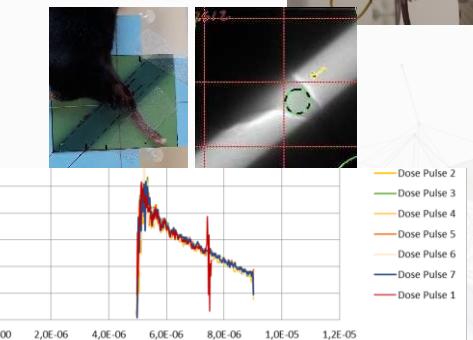


- Currently requires a PW dependent calibration
  - Currently requires a posteriori corrections
  - Is not usable in CONV mode
  - Give only the output charge and not the dose to the animal
- Should be set with the new version
- Use of the FLASH Diamond for in vivo monitoring
- Use of the FLASH Diamond for in vivo dosimetry



- Is always available in combination with other detectors
- Is non-destructive
- Reflects the number of pulses
- **Can effectively terminate the beam!**

- The ElectronFLash allows a sequence of pulses with 2 different PWs
- A “total dose” pulse could be compensated for variations with a sequence smaller pulses terminated by the monitoring system.
- Biological consequences of unequal pulses can be investigate at the biological level



Presentation M. Dubail  
on the 02/12

# Acknowledgments



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A Siemens Healthineers Company



NHS  
The Christie  
NHS Foundation Trust

MANCHESTER  
1824  
The University of Manchester

Biophysics



EMPIR  
EUROPEAN UNION  
research and innovation programme and the EMPIR Participating States  
UiOpulse

InspireProject  
Integrating proton research across Europe  
Horizon 2020

institutCurie

MedAustron

PTB  
Endorsed by  
ESTRO

## Team “DNA Repair, radiations and innovative cancer therapies”

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AMERICAN ASSOCIATION  
of PHYSICISTS IN MEDICINE

**ESTRO**

## Task Group No. 359 –

*Dimitris Mihailidis*

FLASH (ultra-high dose rate) radiation dosimetry