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UHDpulse

EMPIR EURAMET

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

EMPIR project UHDpulse (18HLT04)

Christian Kottler
on behalf of the UHDpulse consortium

Project Overview

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

- Title: "Metrology for advanced radiotherapy using particle beams with ultra-high pulse dose rates"
- Project acronym: UHDpulse
- EMPIR Call: 2018 / Health
- Type: Joint Research Project
- Coordinator: Andreas Schüller (PTB)
- Start date: September 1st, 2019
- Duration: 36 months
- Budget: 2.1 Mio. €
- Web site: http://uhdpulse-empir.eu/
- Logo: UHDpulse

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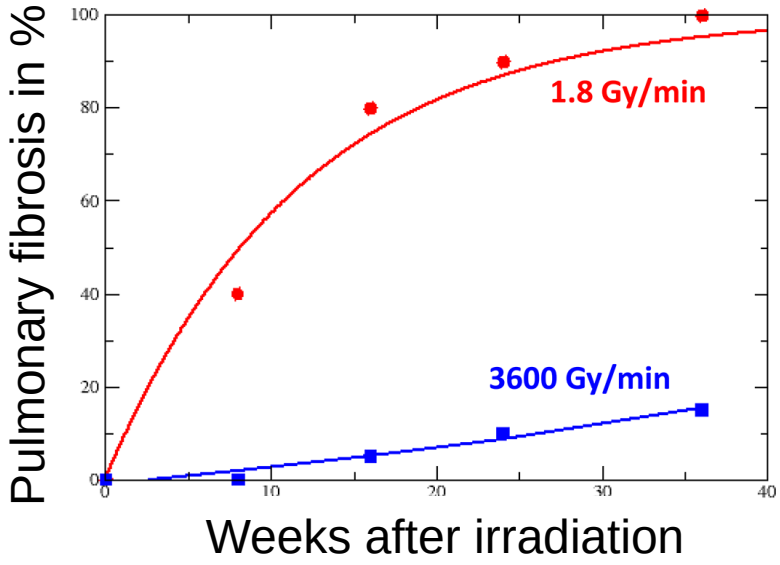
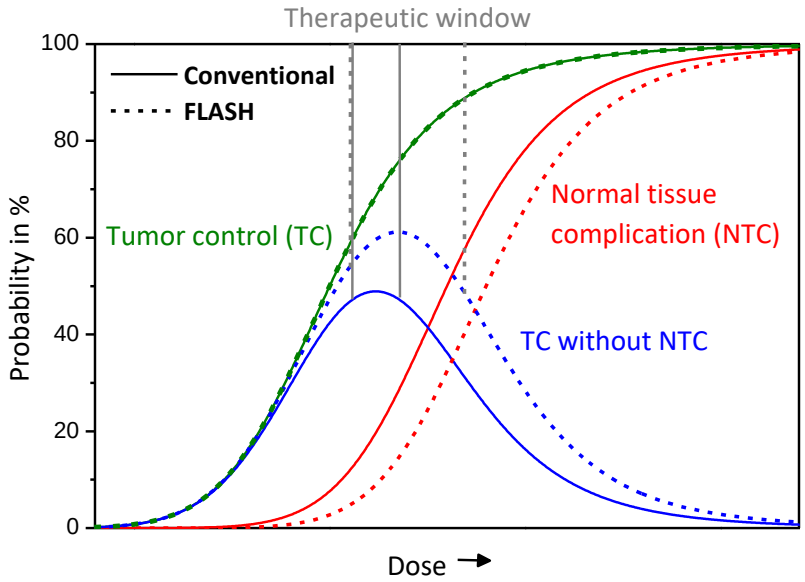
FLASH-Effect

"Irradiation at ultra high dose-rate increases the differential response between normal and tumour tissue"

thorax irradiation of mice (17 Gy)





Favaudon et al., Sci Transl Med 6 (2014) 245ra93
DOI: 10.1126/scitranslmed.3008973

institutCurie

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FLASH-RT

before FLASH

7 month after FLASH

nasal carcinoma not eligible for surgery

Vozenin et al., Clin Cancer Res 25 (2019) 35
DOI: 10.1158/1078-0432.CCR-17-3375

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FLASH-RT

Reduced pig skin toxicity with FLASH-RT

Irradiation with 22 - 34 Gy

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Vozenin et al., Clin Cancer Res 25 (2019) 35
DOI: 10.1158/1078-0432.CCR-17-3375

36 weeks post-RT:

Conventional (5 Gy/min)

necrotic lesions

FLASH (300 Gy/s)

normal appearance of skin

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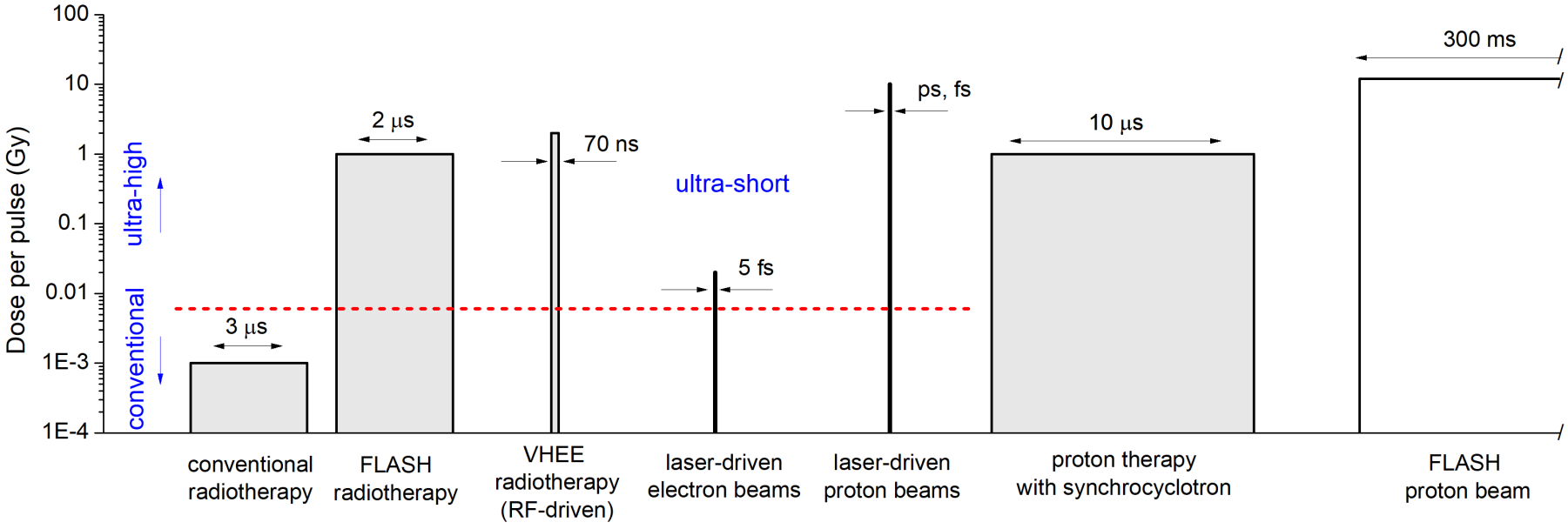
Beams with **U**ltra-**H**igh **P**ulse **D**ose **R**ates

UHPDR:

- ultra-high dose per pulse
- ultrashort pulse duration
- both



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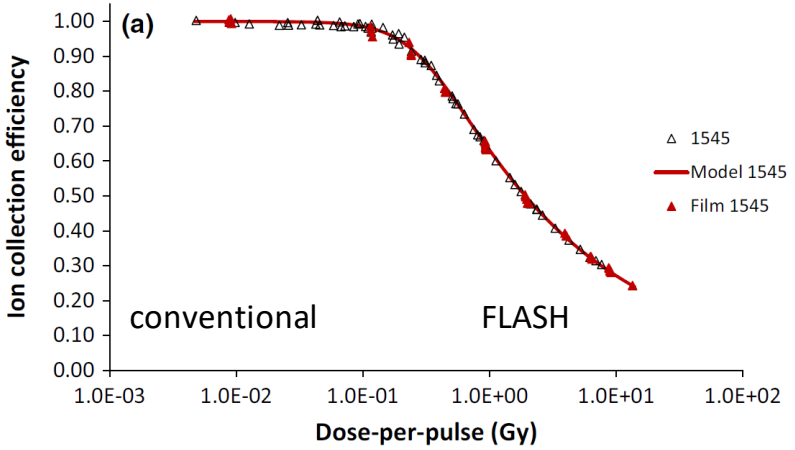
Metrological challenges

	FLASH	conventional
dose per pulse	1 – 10 Gy	0.3 mGy
pulse width	1 -2 us	3 us
dose rate during pulse	10^6 Gy/s	10^2 Gy/s
pulse repetition frequency	10 – 100 Hz	200 Hz
mean dose rate	40 – 1000 Gy/s	0.05 Gy/s
time for dose delivery	**100 ms**	**4 min**



typical behavior of ordinary ionization chambers

Petersson et al., Med Phys 44 (2017) 1157
DOI: 10.1002/mp.12111

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The ultimate goal of the project is…

…to provide the metrological tools needed to establish traceability in absorbed dose measurements of UHPDR particle beams.

The specific aims of the project are:

- Development of primary and secondary absorbed dose standards and reference dosimetry methods
- Characterization of state-of-the-art detector systems in UHPDR beams
- Development of methods for relative dosimetry and for the characterization of of stray radiation
- Provide input data for future CoP in UHPDR beam dose measurement

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UHDpulse Project Consortium

5 National Metrology Institutes
leading in the field of dosimetry

2 academic hospitals
pioneers in FLASH-RT

3 universities
experts in detector development
pioneer in laser-driven beams

3 national research institutes
pioneer in detector development
pioneer in laser-driven beams
dosimetry expert

1 European research institute
laser-driven beam research

2 companies
expert in detector development

NMI's

- PTB – Physikalisch-Technische Bundesanstalt Braunschweig und Berlin
- NPL – National Physical Laboratory
- METAS
- CMI – Czech Metrology Institute
- Central Office of Measures

Irradiation facility provider

- CHUV – Centre hospitalier universitaire vaudois
- institut Curie
- eli beamlines
- Nuclear Physics Institute of the CAS – public research institution
- Queen's University Belfast
- HZDR – Helmholtz Zentrum Dresden Rossendorf

Radiation detector developer

- ADVACAM – Imaging the Unseen
- CSIC – Consejo Superior de Investigaciones Científicas; CNM – Centre Nacional de Microelectrònica IMB
- USC – Universidade de Santiago de Compostela
- Politecnico Milano 1863
- PTW – The Dosimetry Company

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UHDpulse - Work Package Structure

WP1: Primary standards

- Definition of reference conditions
- Reference radiation fields
- Adapting primary standards (water calorimeter, Fricke dosimeter)
- Prototype graphite calorimeters for laser-driven beams

WP2: Secondary standards, relative dosimetry

- Transfer from primary standards
- Characterizing established detector systems
- Formalism for reference dosimetry for future Code of Practice

WP4: Detectors and methods outside primary beam

- Active detection techniques for pulsed mixed radiation fields of stray radiation
- Methods with passive detectors

WP3: Detectors for primary beam

- Novel and custom-built active dosimetric systems
- Beam monitoring systems

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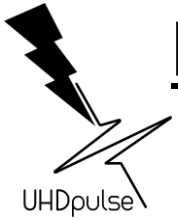

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This project has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme.

Thank you very much for your attention