

FRIDA

**FLASH Radiotherapy with high Dose rate
particle beams**

E. Ciarrocchi

Preventivi 2024 INFN Pisa

6/7/2023



Call CSN5 2021

Research area

Radiation biophysics / Radio Therapy /
Particle Therapy / Medical Applications /
Accelerator science

Sezioni partecipanti

7 (24 FTE + 10 annualita' Ass Ric)
CT , LNS , MI , PI , Roma1, TIFPA , TO
Budget: 996 kEU

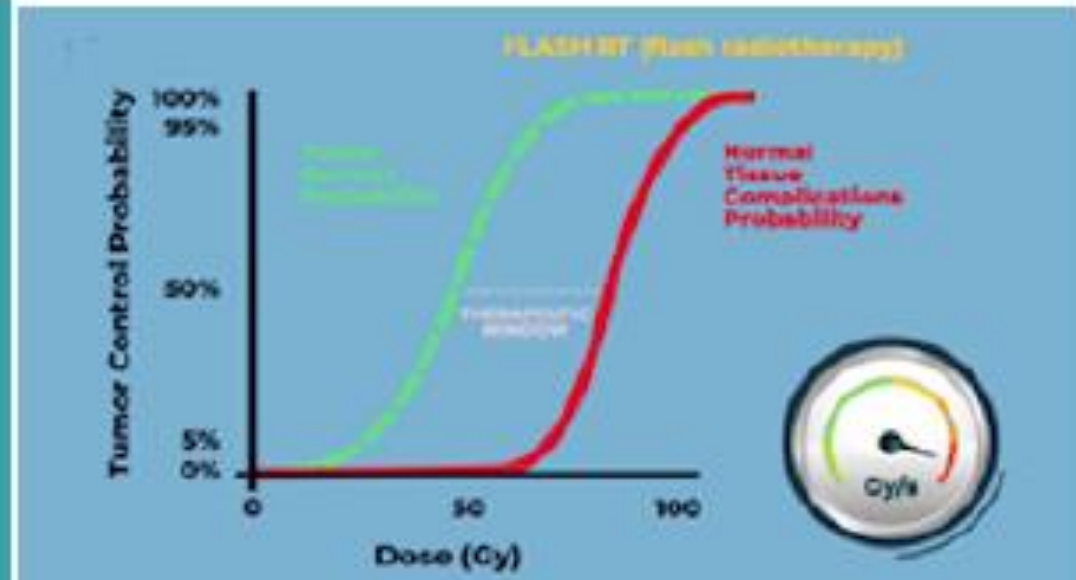
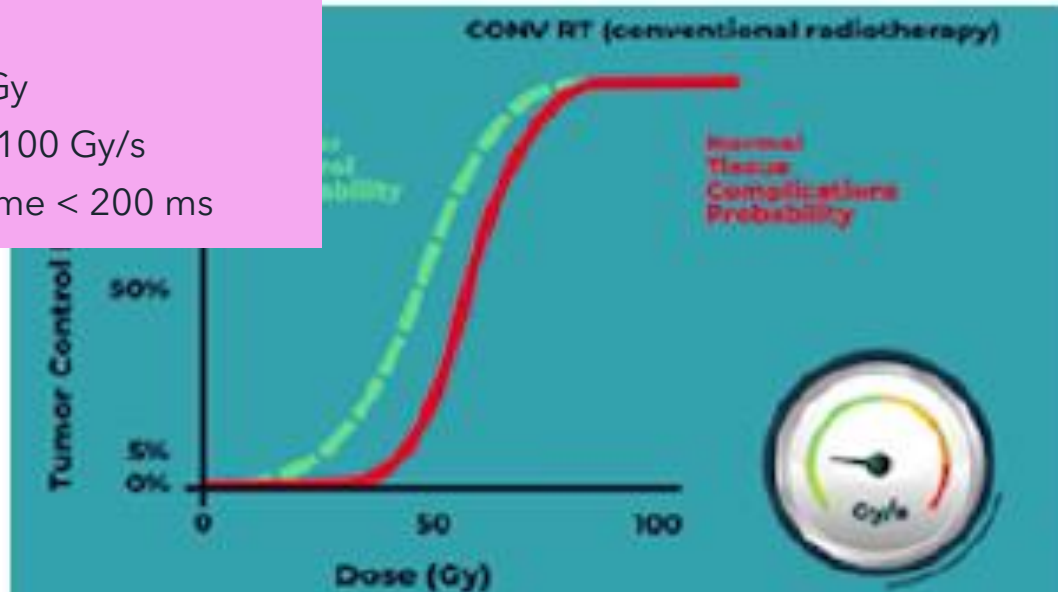
Responsabile Nazionale

Alessio Sarti, INFN Roma1



FRIDA Brief Description and Objectives

- FLASH dosimetric parameters:
 - Dose ~ 10 Gy
 - Dose rate > 100 Gy/s
 - Irradiation time < 200 ms

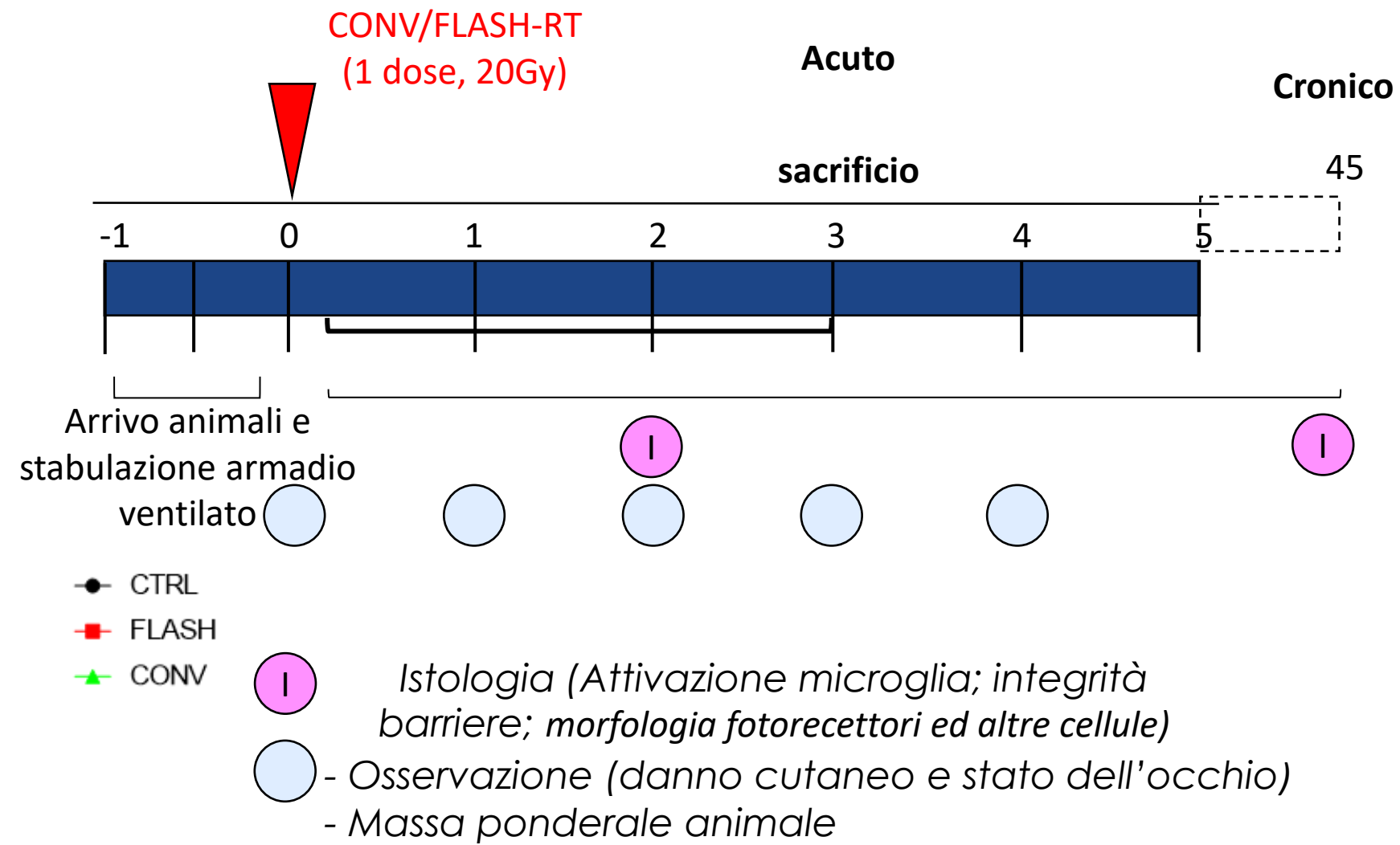
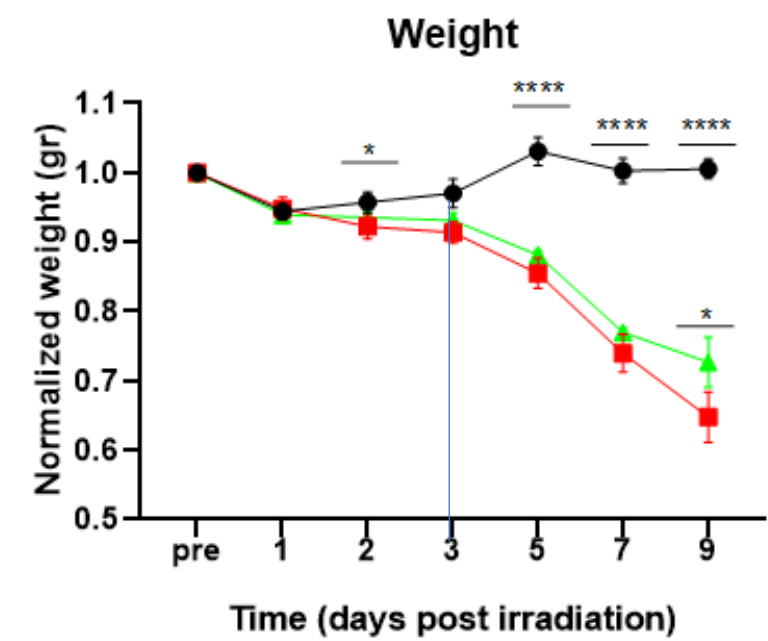


- Understanding the FLASH effect mechanism (WP1)
- Acceleration and beam delivery (WP2)
- Beam monitoring and dosimetry (WP3)
- Simulation and treatment optimization (WP4)

WP1 Evaluation of FLASH treatments on retina in vivo

EXP acuto N 3 animali per gruppo (età 4 settimane) ceppo C57Bl6

EXP cronico in progress N 3 animali per gruppo (età 4 settimane) ceppo C57Bl6



WP2 Laser-plasma acceleration for VHEE

Work based on existing laser-plasma accelerator at ILIRIA CNR

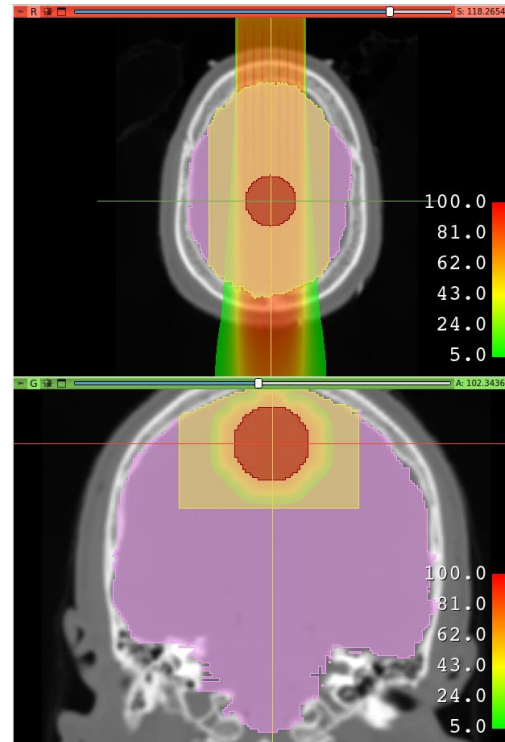
Currently available

- sub-Gy VHEE pencil beams with 10s of cGy/s dose rates
- investigating fundamental radiobiology vs dose-rate

Ongoing developments

- multi-Gy doses per shot and multi-shot per second
- relevance for FLASH-RT

Leo Gizzi ILIRIA CNR



MC simulations of deep tumor treatment with laser-driven VHEE pencil beams

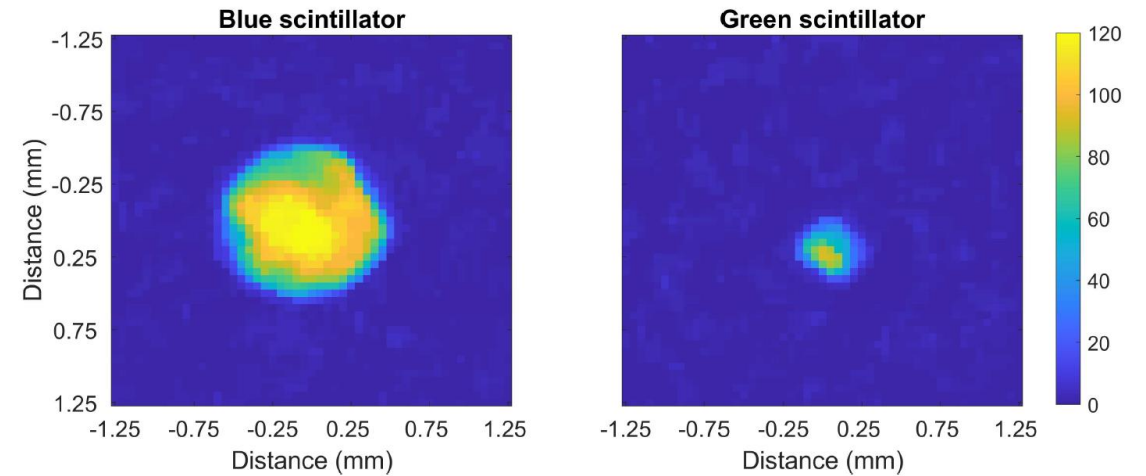
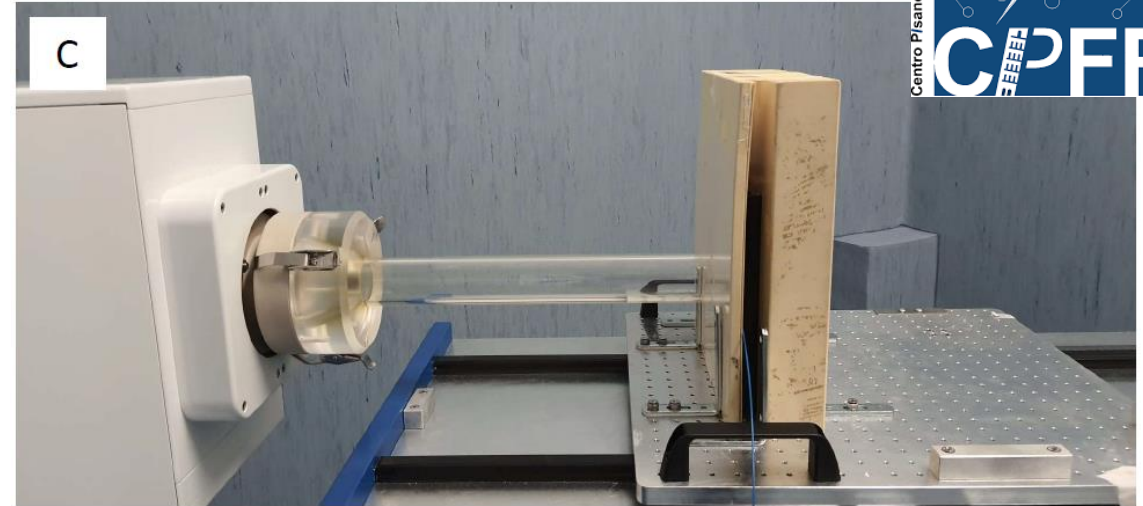
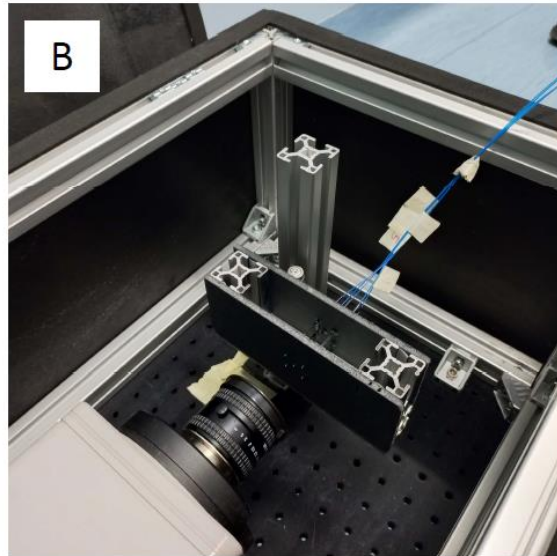
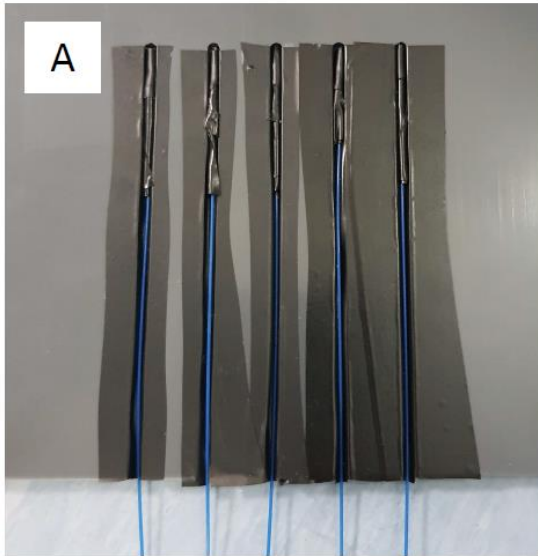
Investigation of LWFA regimes providing VHEE beams with low divergence/“high” charge using Particle-In-Cell (PIC) simulations

Monte Carlo simulation of dose deposition pattern using a scanning pencil beam for a brain tumor

- Good beam to target conformation thanks to the pencil beam scanning
- Limited transverse spread of dose
- Dose deposition longitudinal profile better than photon beams at shallow depths provided that “low-energy” electrons are removed

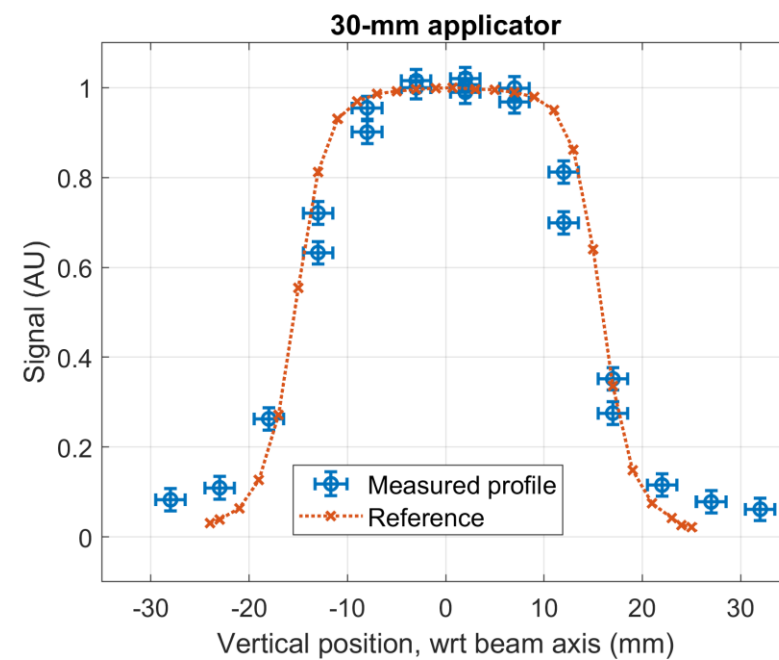
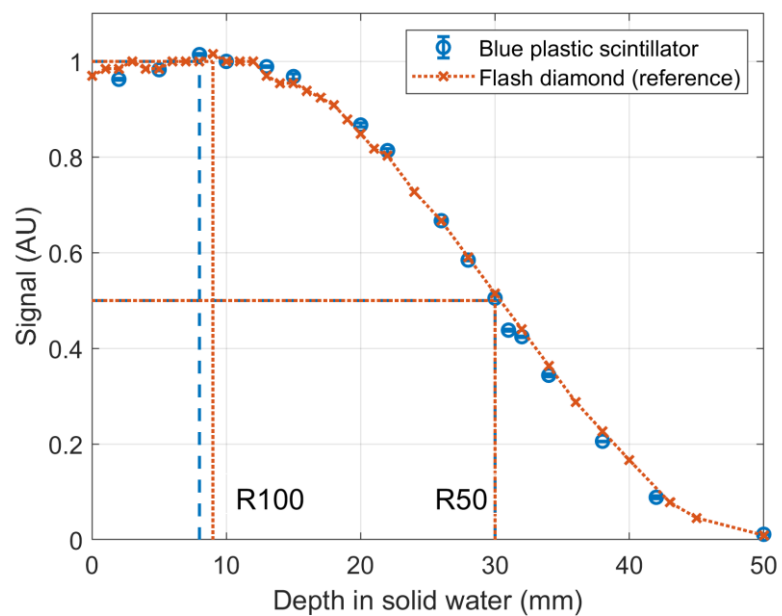
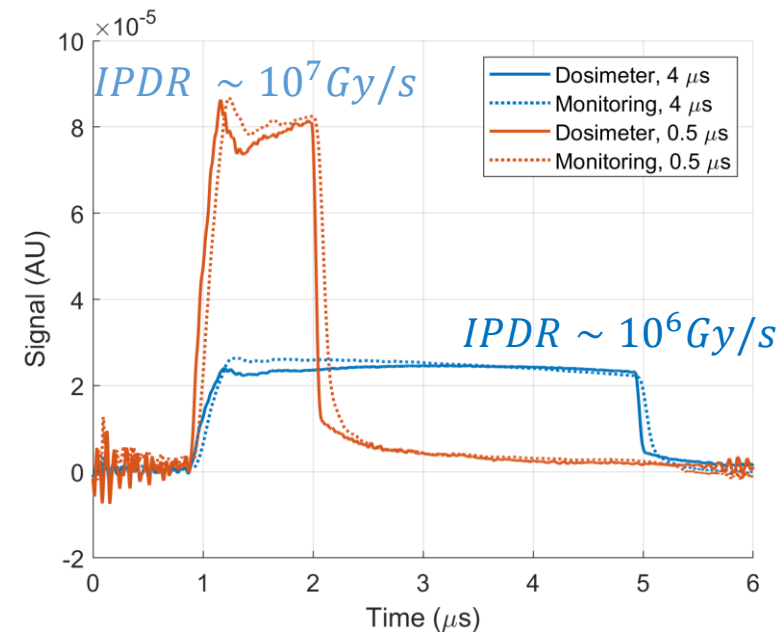
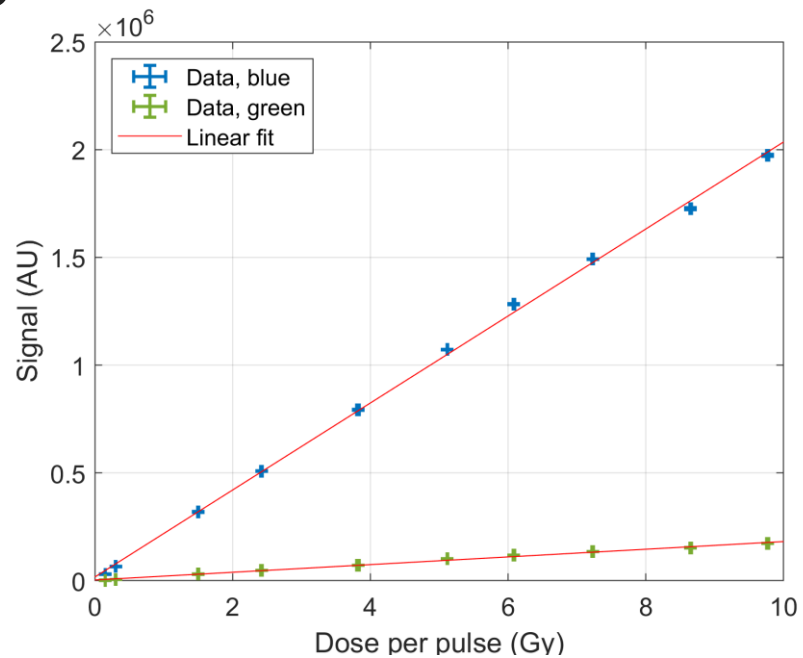
WP3 Dosimetry w scintillators

- plastic scintillating fibers (Kuraray)
 - **'Blue'** : $d=1.0$ mm, $l=5-10$ mm
 - **'Green'** : $d=0.5$ mm, $l=2-5$ mm
 - single detectors and array
- Imaging with CCD camera + objective



Esther Ciarrocchi, Matteo Morrocchi, Eleonora Ravera, Andrea Cavalieri, Rebecca Anzalone

Results



Activities planned in 2024

WP1 Validation of the in vivo experiments

- On the basis of the findings obtained from the ongoing experiments, the animals will be sacrificed at the end of July, and the subsequent molecular and histopathological investigations will be performed up to the end of 2023
- in 2024 validation with another group of animals

WP2 Control, conditioning and steering of laser-driven VHEE

Experimental studies aimed at increasing dose rates toward FLASH

- Study of LWFA acceleration regimes with high-charge
- Monte Carlo assessment of dosimetric properties of “real” laser-driven VHEE pencil beams – “simple” account of FLASH sparing effect
- Study of beam “cleaning”/transport
- Research on laser operation/development aimed at producing high average rep-rate, FLASH-ready beams

WP3 Single Dosimeters Optimization and 2D/3D relative dosimetry

- **Spurious** luminescence contribution (Cerenkov and radioluminescence)
- Radiation **hardness** (aging and post-irradiation recovery)
- Development of **2D** and **3D** dosimetric systems to simultaneously measure, in real time, the relative dose distribution in the irradiated volume



Richieste Servizi Sezione

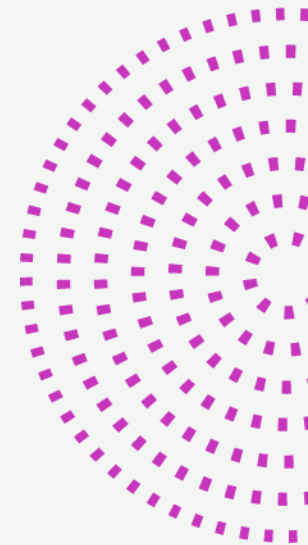
Progettazione meccanica (0.1 FTE) Officina
meccanica (0.1 FTE)

Alte Tecnologie (0.1 FTE)

costruzione dei dosimetri

progettazione

supporti meccanici



Anagrafica



Cognome Nome	Posizione/Ente	% FTE	WP
Avella Federico	PhD	0.5	2
Bisogni Maria Giuseppina	PA UNIFI	0.4	3
Ciarrocchi Esther	RTD UNIFI	0.2	3
Di Martino Fabio	Dir AOP	0.2	3
Gizzi Leonida	Dir CNR	0.2	2
Kraan Aafke	Ric INFN	0.1	4
Labate Luca	Ric CNR	0.2	2
Massa Maurizio	Tecn INFN	0.1	3
Moggi Andrea	Tecn INFN	0.1	3
Montefiori Marco	PhD UNIFI	1.0	3
Morrocchi Matteo	RTD UNIFI	0.2	3
Ravera Eleonora	PhD (PNRR?)	1.0	3
Rosso Valeria	PO UNIFI	0.15	4
Sportelli Giancarlo	PA UNIFI	0.1	3
Stretto Emilia	Ric CNR	0.1	1
Vannini Eleonora	Ric CNR	0.1	1

Totale 4.65 FTE

Richieste finanziarie INFN Pisa

Cost Category	Item	I anno	II anno	III anno	Totale	WP
Personnel	1 contratto per 2 anni (Pisa)	€ 28,400.00	€ 28,400.00		€ 56,800.00	3
Consumables	Animals		€ 4,000.00	€ 4,000.00	€ 8,000.00	1
	Scintillators and photodetectors	€ 4,000.00	€ 4,000.00	€ 1,000.00	€ 8,000.00	3
	Reagents	€ 3,000.00	€ 3,000.00	€ 2,000.00	€ 8,000.00	1
	Optics and electronics for Laser driven VHEE	€ 3,000.00	€ 3,000.00		€ 6,000.00	2
Instrumentation	DAQ for scintillators		€ 7,000.00		€ 7,000.00	3
	GPU board for PIC simulations	€ 14,000.00			€ 14,000.00	2
Travels	Travels (Pisa)	€ 2,000.00	€ 3,000.00	€ 3,000.00	€ 8,000.00	1-4
		€ 54,400.00	€ 52,400.00	€ 10,000.00		