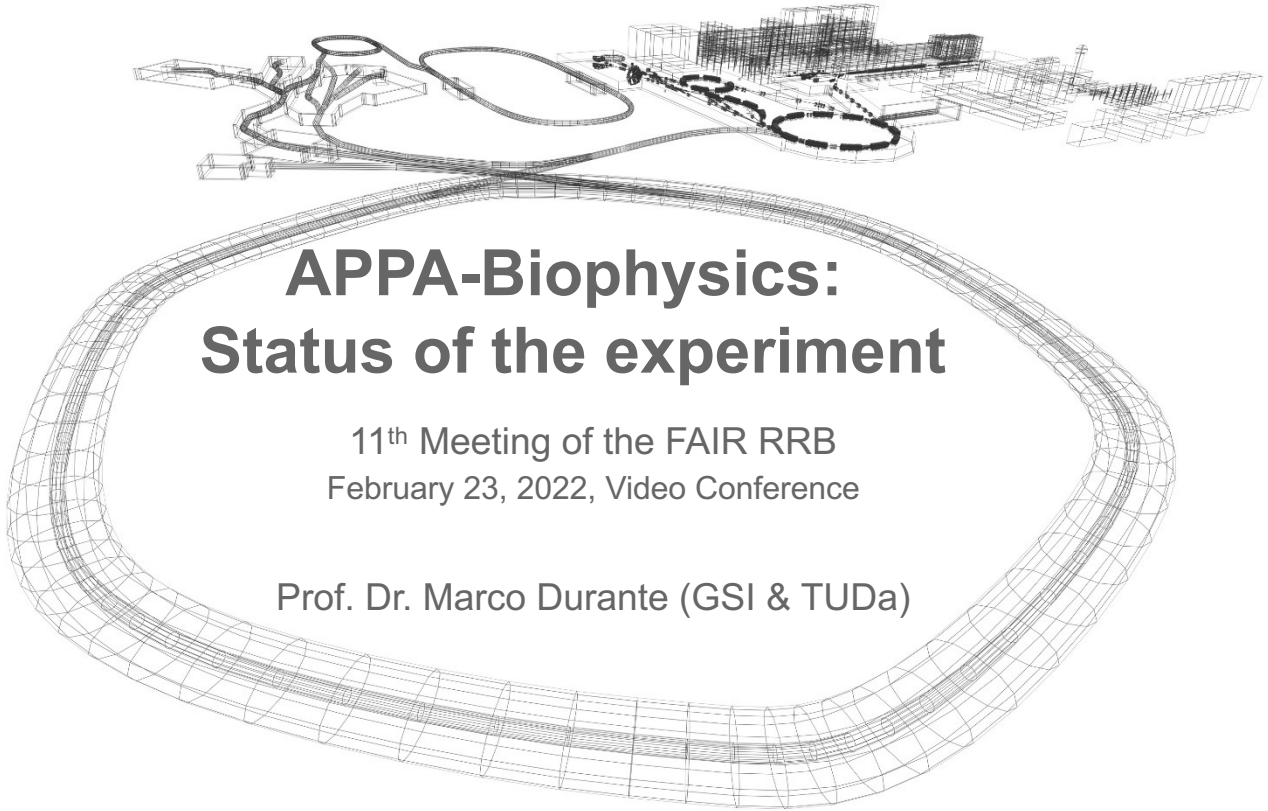


APPA-Biophysics: Status of the experiment

11th Meeting of the FAIR RRB

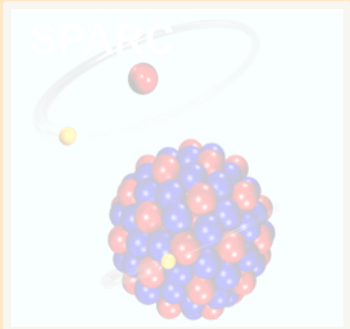
February 23, 2022, Video Conference

Prof. Dr. Marco Durante (GSI & TUDa)

Atomic Physics, Plasma Physics, and Applied Sciences from fundamental to applied research

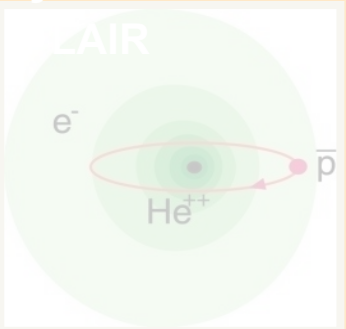
FACILITY CAPABILITY		SCIENTIFIC CAPABILITY
Highest Charge States		*Extreme Static Fields*
Relativistic Energies		*Extreme Dynamical Fields and Ultrashort Pulses*
High Intensities	⇔	*Very High Energy Densities and Pressures*
High Charge at Low Velocity		*Large Energy Deposition*
Low-Energy Anti-Protons		*Antimatter Research*

Atomic Physics



strong field research
... probing fundamental laws of physics

Atomic Physics



antimatter
... matter / anti-matter symmetry

Plasma

extreme states of matter
... common in astrophysical objects

Materials

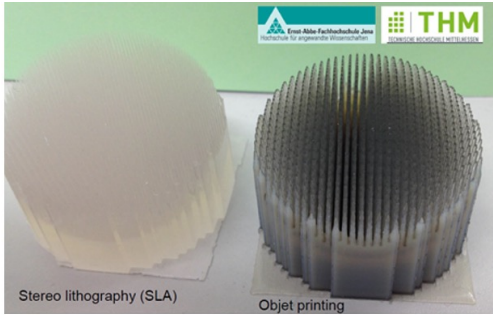
radiation effects
... materials degradation and nanostructuring

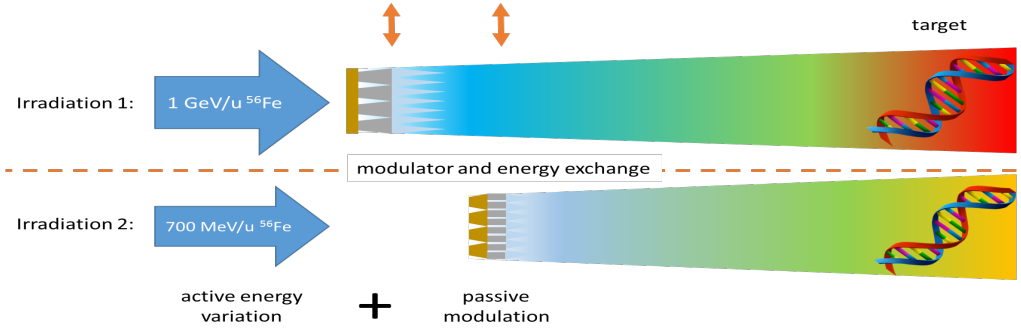
Bio

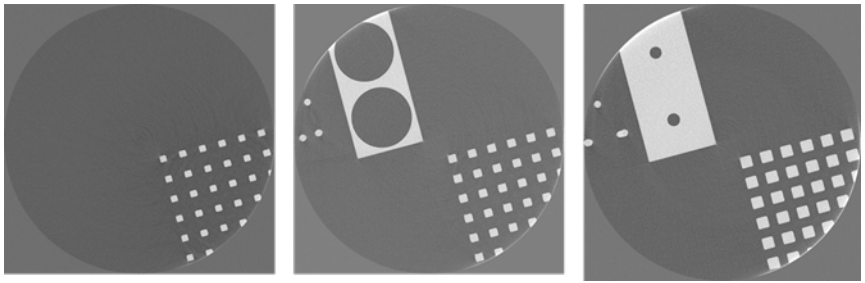
space travel & therapy
... cosmic radiation risk and theranostics

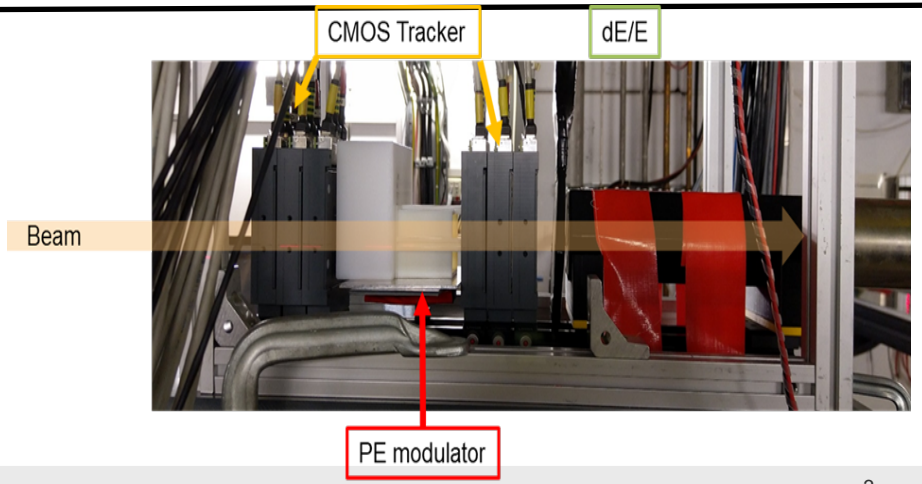
New infrastructures for FAIR tested in FAIR-phase-0 (March-June 2021)

GCR simulator

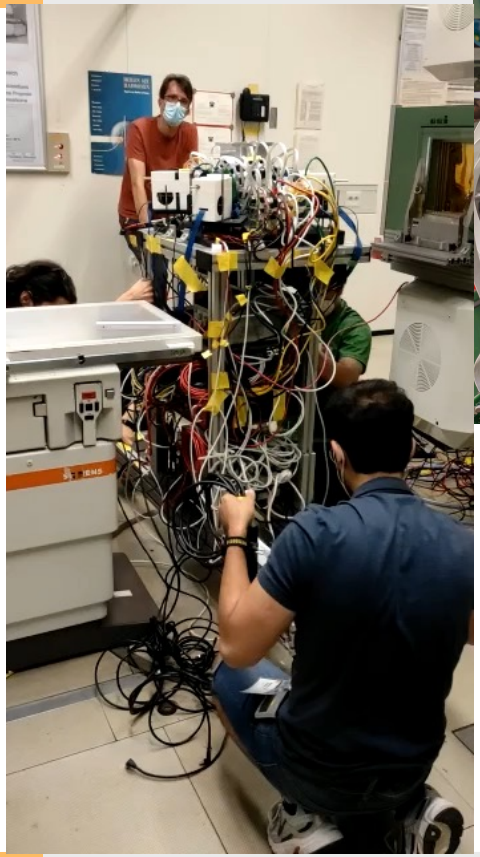


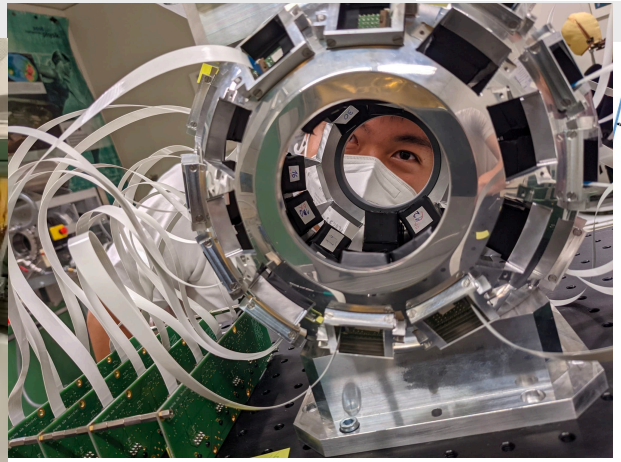


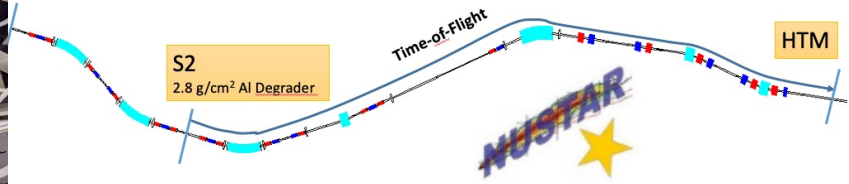




Schuy *et al., Front. Phys.* 2020

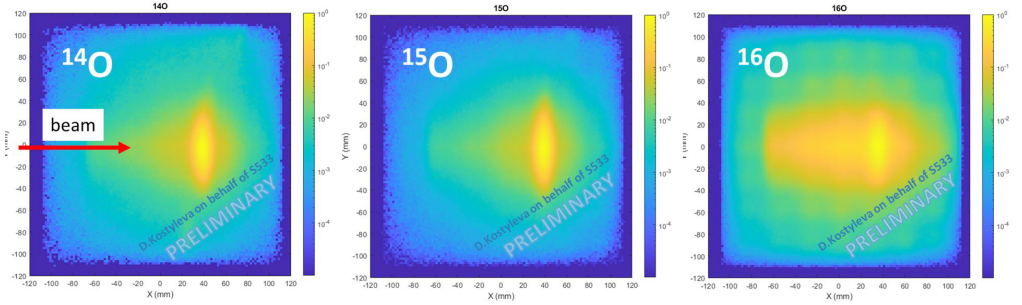






Boscolo *et al., Front. Oncol*. 2021

www.gsi.de/BARB

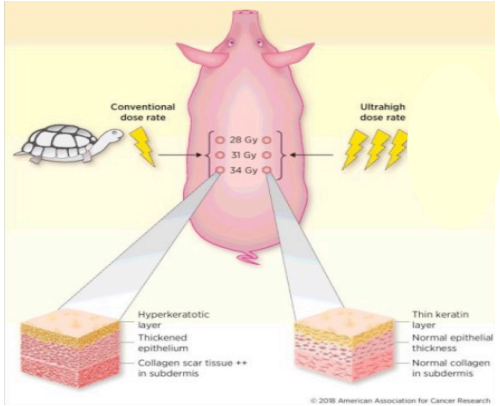


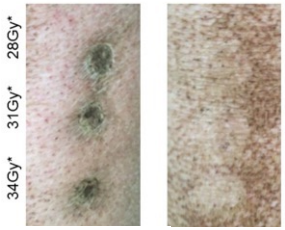
PET image

umcg

FLASH effect and new beamline instrumentation for FAIR

Decreasing of the normal tissue response

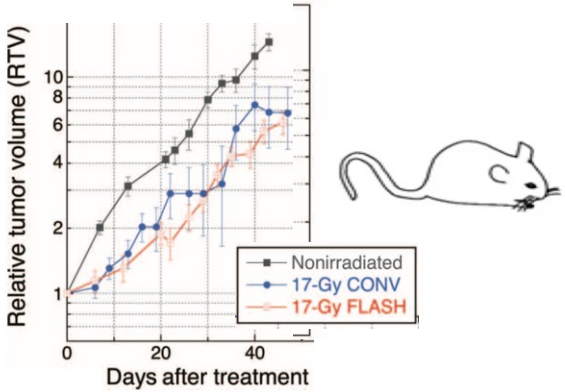




CONV FLASH

Vozenin et al. 2019, Clin. Canc. Res.

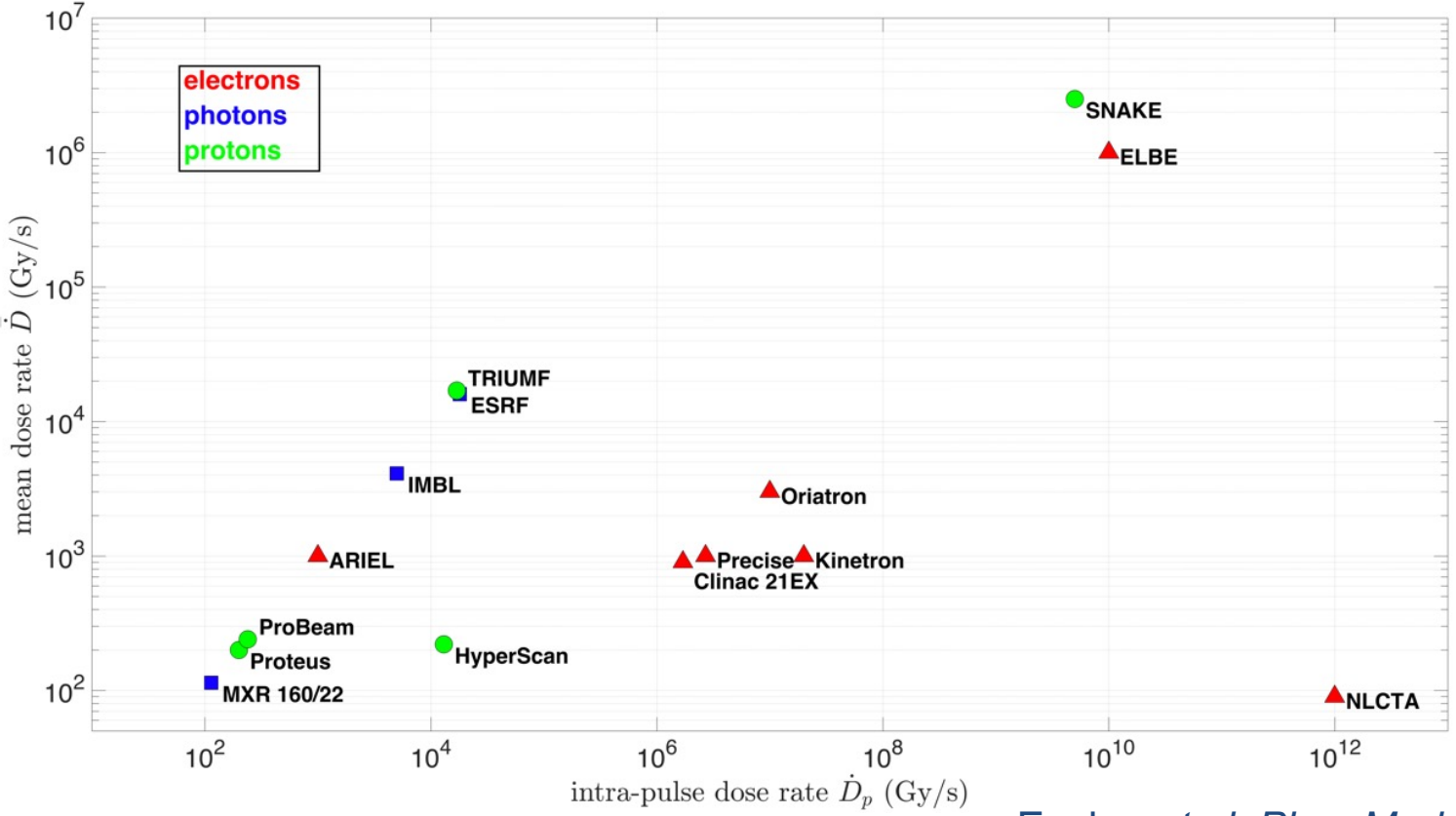
Preservation of the tumor responses



V. Favaudon et al. 2014, Sci. Transl. Med.

- Utra-high dose rate (>100 Gy/s) radiotherapy would make treatments faster and reduce the organ motion problem
- Recent results show that FLASH RT reduces normal tissue toxicity without affecting tumour control
- Clinical trials are already ongoing

FLASH facilites



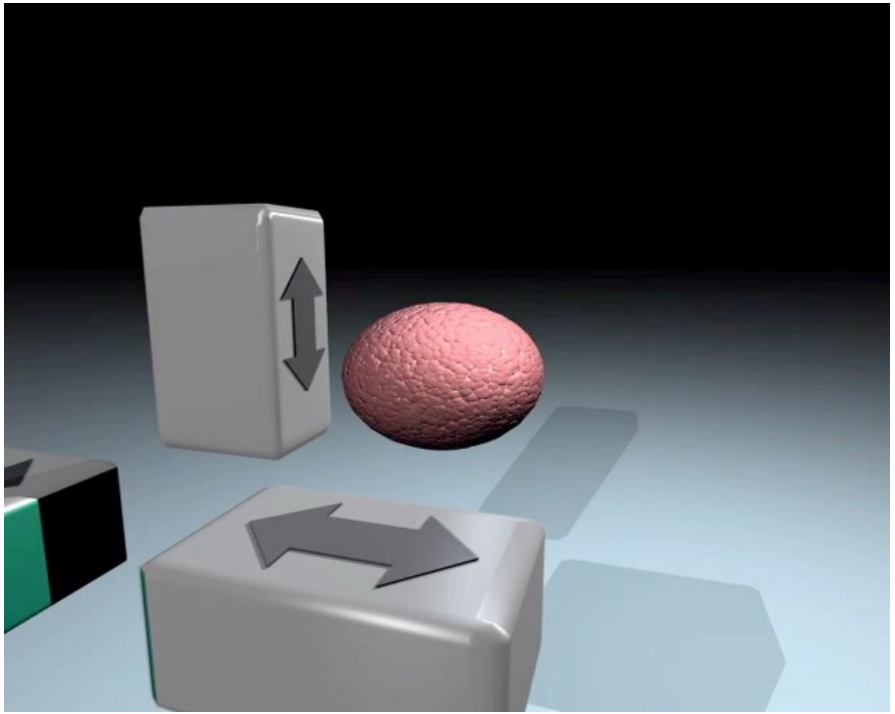
Esplen *et al. Phys.Med. Biol.* 2020

Multi-energy raster scanning lasts too long for FLASH

- Synchrotron Cycle > 1 sec , normally ~ 5-10 sec
- each energy step requires a new cycle

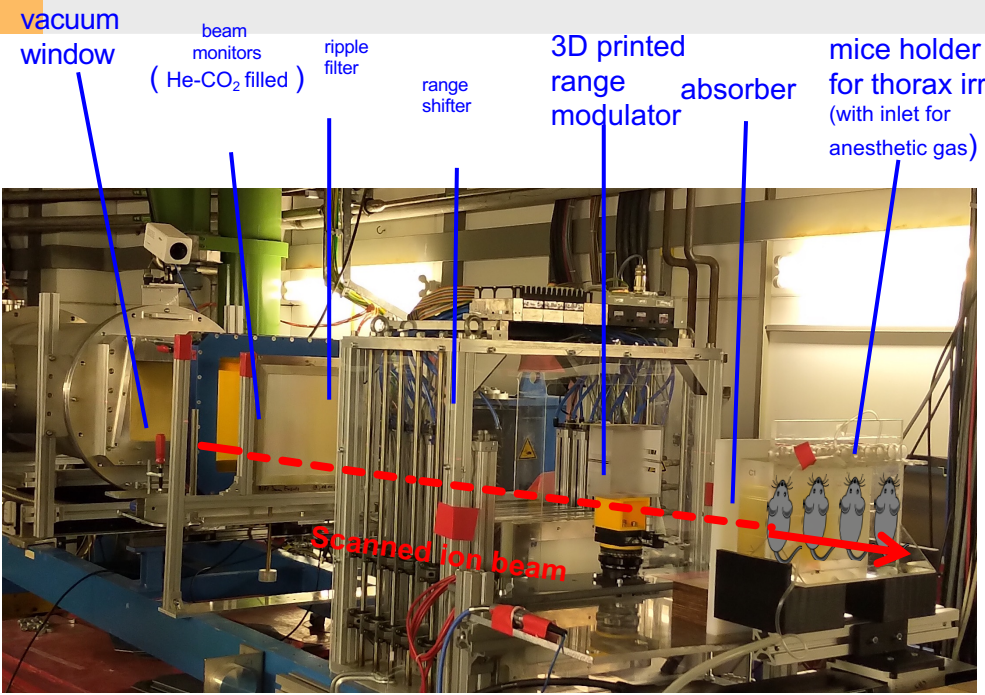
- However for FLASH
  8 Gy with 40 Gy/s
  should by appied in **t < 200 ms**

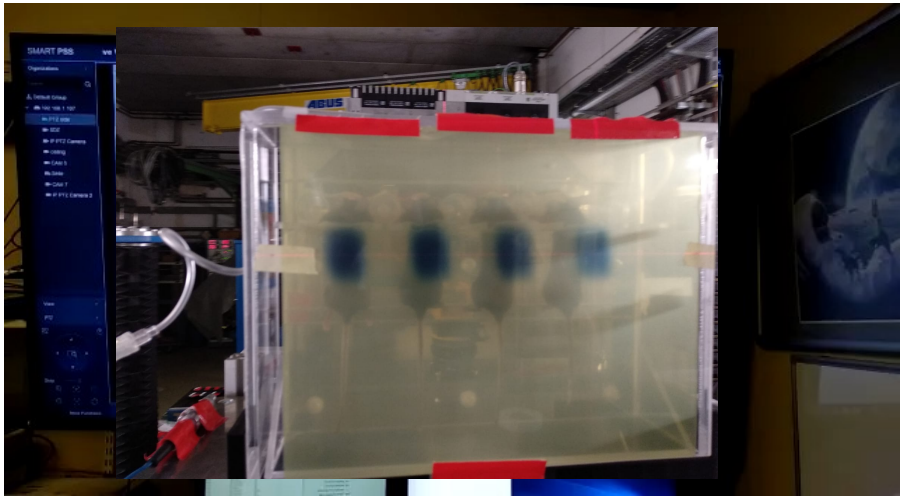
⇨ the normal multi-layer raster scanning
for 3D conformal irradiation
does not work
(neither for proton cyclotron, IBA, VARIAN …)
⇨big issue for FLASH in particle therapy



Durante *et al., Nat. Rev. Phys*. 2021

FLASH in FAIR-phase-0– 2021
1st example of heavy ion FLASH @synchrotrons





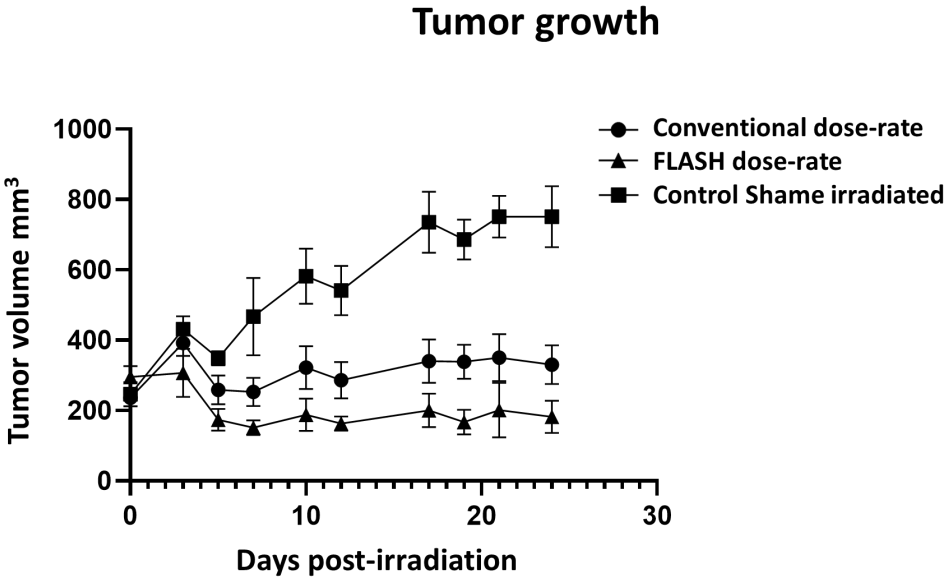
D= 18 Gy

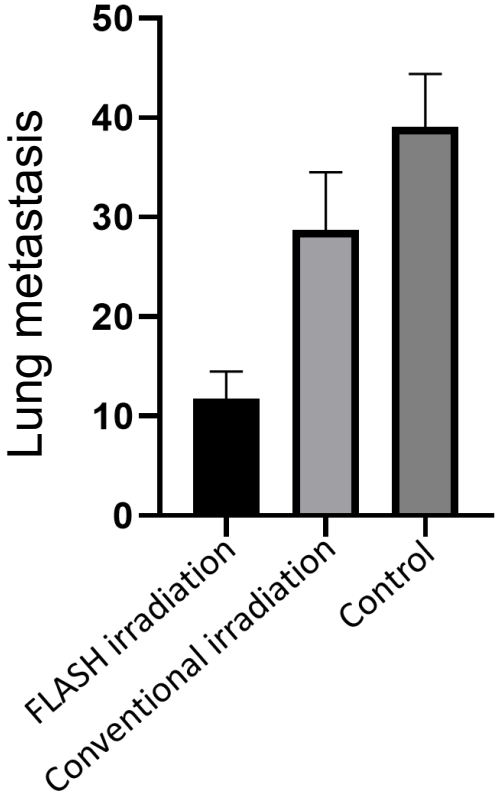
- HIT ≈ 5×10^8 ions per spill
  ⇨ 8 Gy | 50 Gy/s for 10 × 10 mm^2

- FAIR-phase-0 > 5×10^9 ions per spill (reliable)
  ⇨ 18 Gy | 100 Gy/s for 20 × 20 mm^2

Tinganelli *et al., Int. J. Radiat. Oncol. Biol. Phys*. 2021

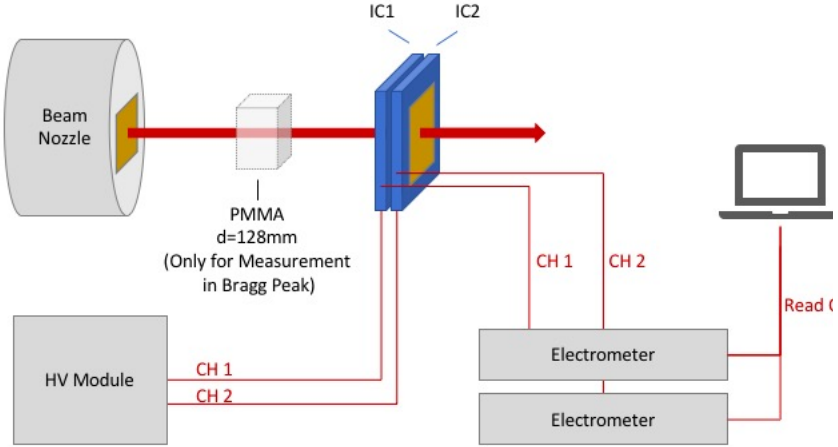
Impact on tumour control and metastasis

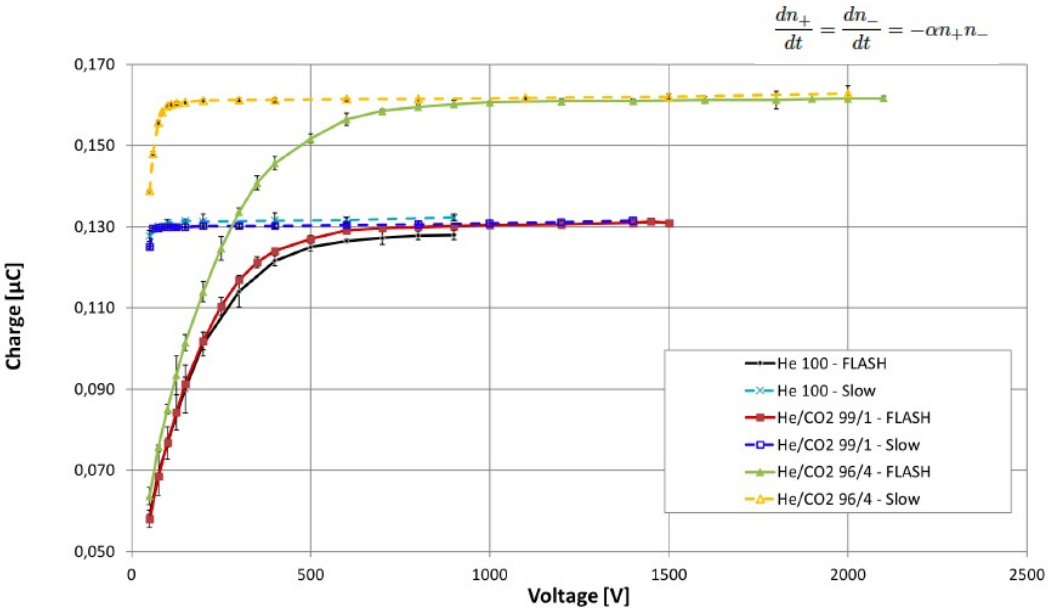




Durante *et al., Radiother. Oncol.* , submitted

New dosimetry for FLASH@FAIR



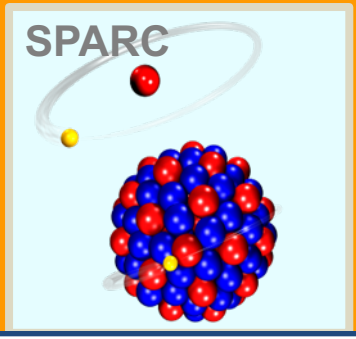


Weber *et al., Med. Phys*. 2021

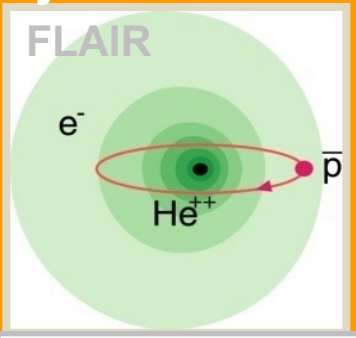
New He/CO_2 ionization chambers for FAIR under development with EU Horizon Europe contribution

Thank you very much!

Atomic Physics



strong field research
... probing fundamental laws of physics



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