



Centre hospitalier
universitaire vaudois

FLASH RT setups at CHUV & CLEAR, CERN

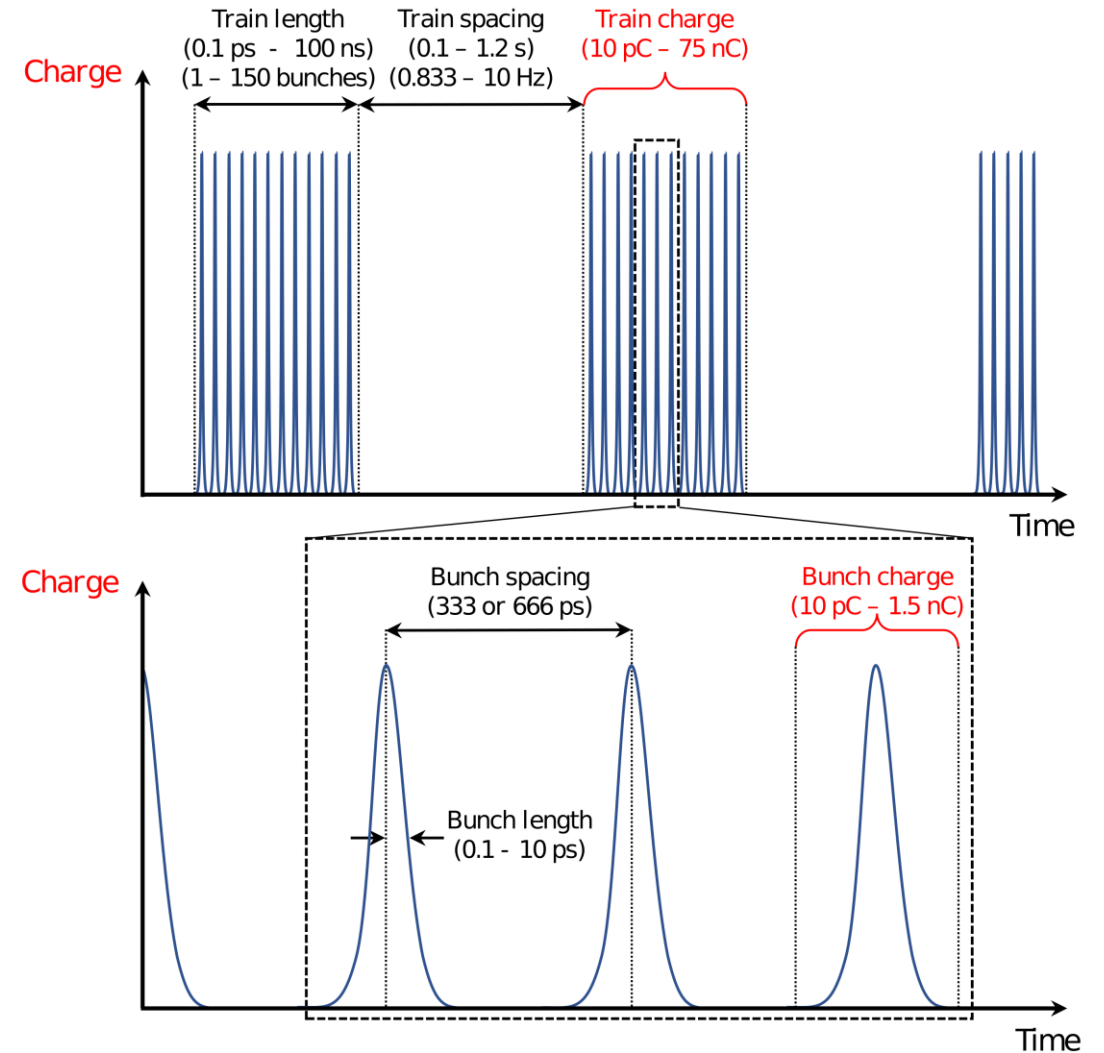
Anna Grebinyk for the PPS, June 1st, 2023

clear



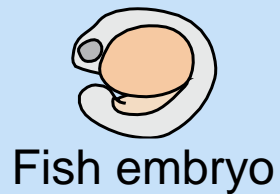
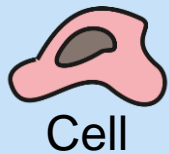
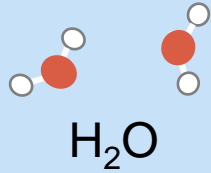
CERN Linear Electron Accelerator for Research – *clear*

- built on the basis of CALIFES, previously used at CTF3 as Probe Beam injector for testing the CLIC Two Beam Acceleration concept
- 20-metre-long linear accelerator
- photocathode coated with cesium telluride (Cs_2Te)
- 60-220 MeV
- 0.8 - 10 Hz



CERN Linear Electron Accelerator for Research – clear*

Models:



Read-outs:

- H₂O₂ generation at hypoxic conditions with Amplex Red assay
- Cancer U87 and normal HaCaT cells survival with clonogenic assay
- Fish embryo morphological changes

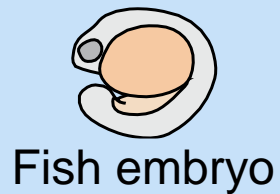
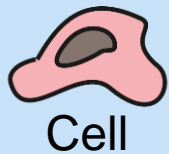
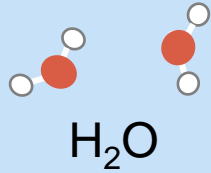
Infrastructure:

- CHUV to clear is 65 km – 1-2 h by car or train
- One-two times per day
- Water is transported in **gas-not permeable container**
- Cells & embryos are transported in **car-incubator**
- Embryoes are selected before the irradiation on site
- Hydrogen peroxide done immediately after irradiation on site
- Cells & embryos transported back to CHUV



CERN Linear Electron Accelerator for Research – clear*

Models:



Read-outs:

- H₂O₂ generation at hypoxic conditions with Amplex Red assay
- Cancer U87 and normal HaCaT cells survival with clonogenic assay
- Fish embryo morphological changes

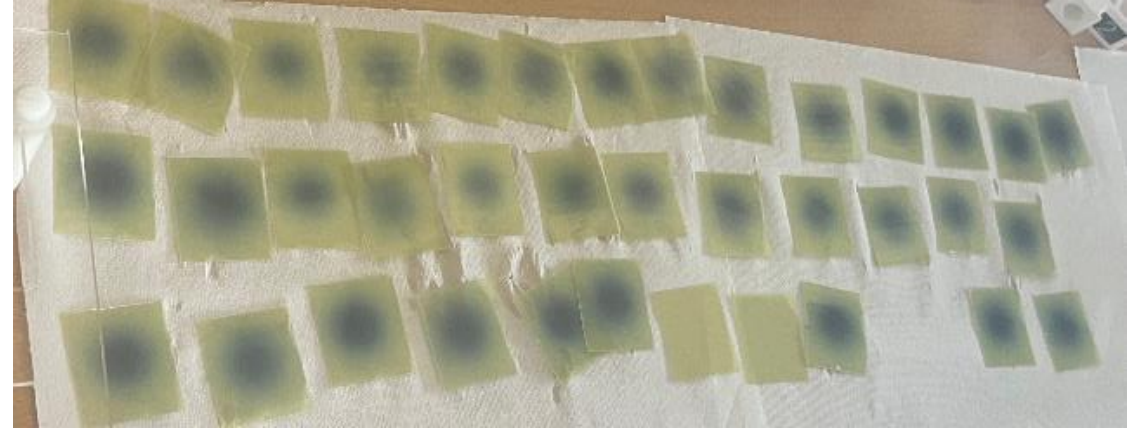
Methodology:



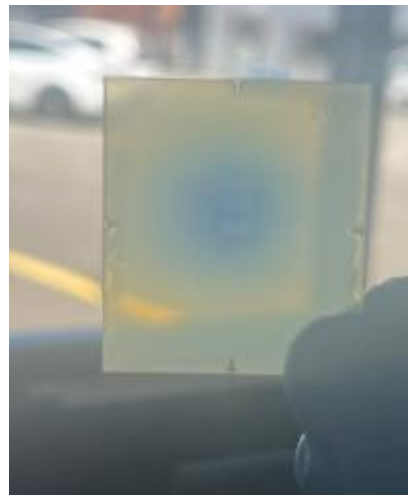
- Microscope for fish embryos: Leica KL 300 LED binocular & Leica M60

CERN Linear Electron Accelerator for Research – *clear*

- 100 μL of sample in 250 μL tube upside-down



- Lead inserts for sample position monitoring post-irradiation

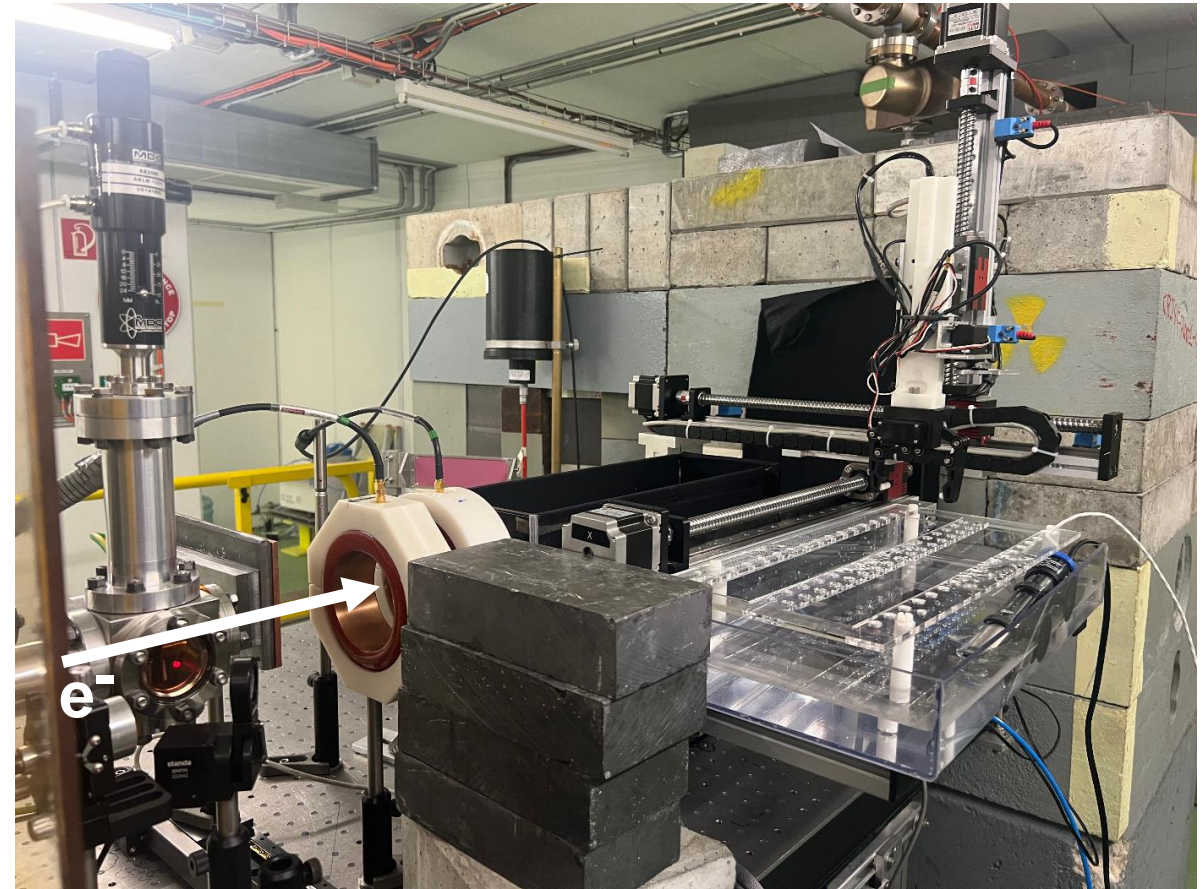
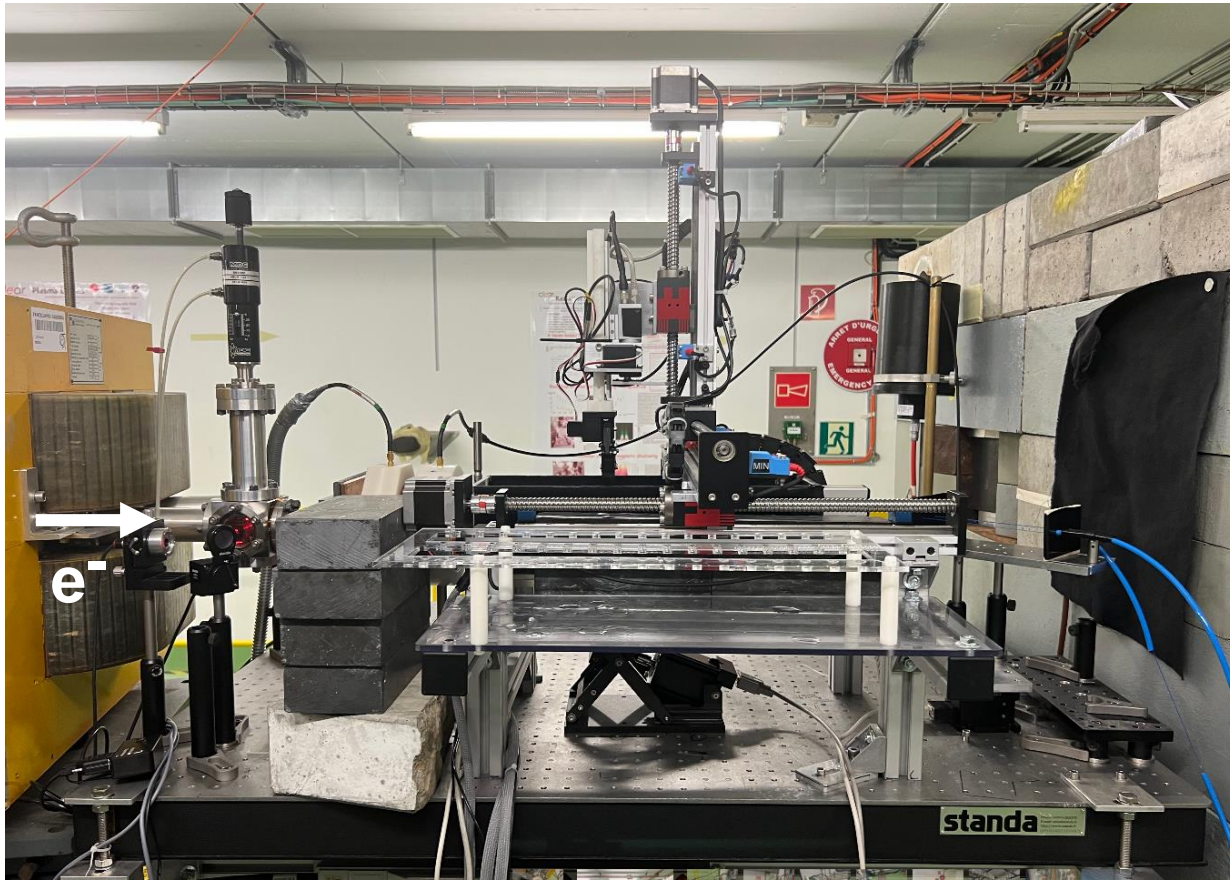


- Beam profile



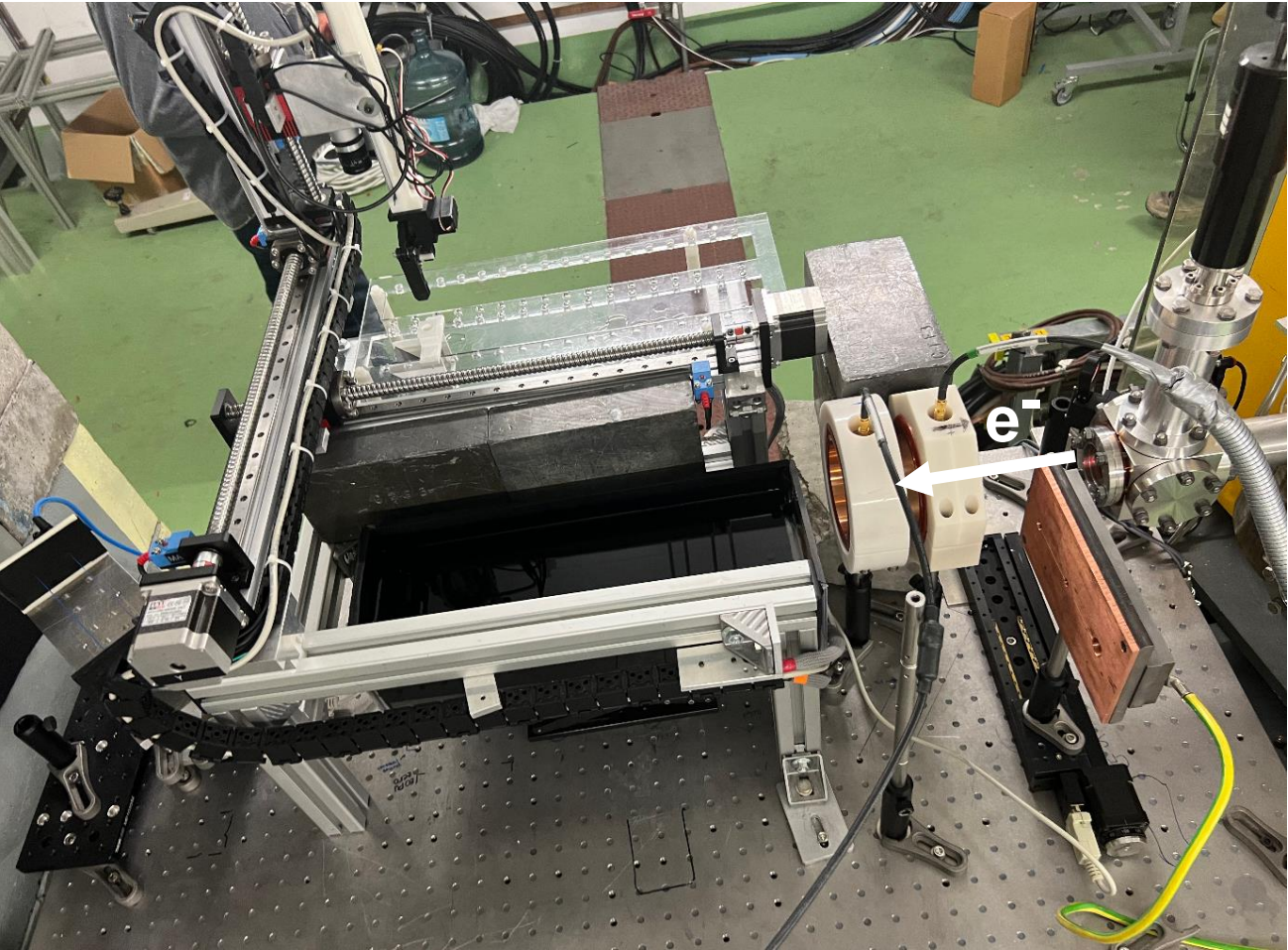
CERN Linear Electron Accelerator for Research – *clear*

Experimental setup – overview



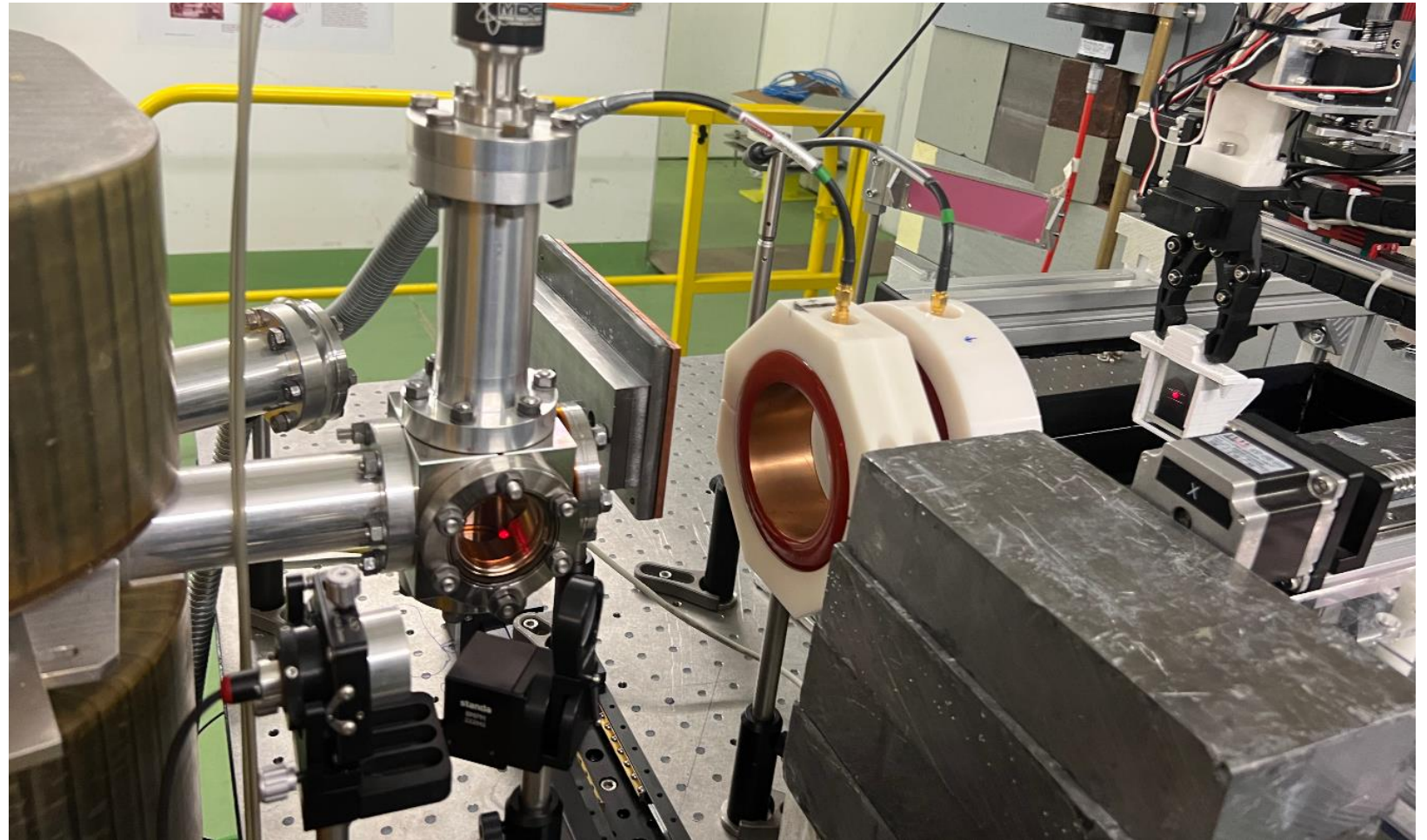
CERN Linear Electron Accelerator for Research – *clear*

Experimental setup – moving waterbath



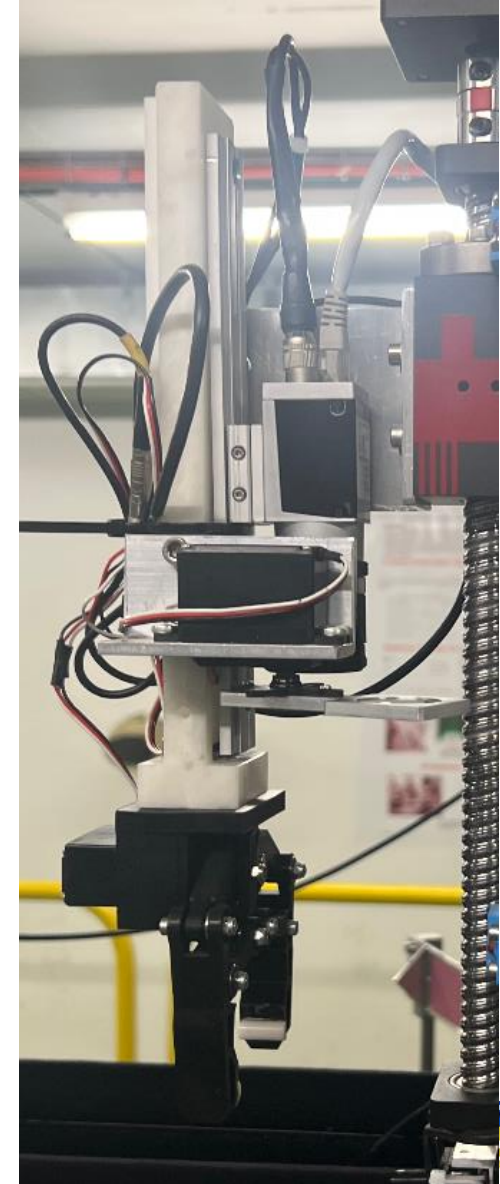
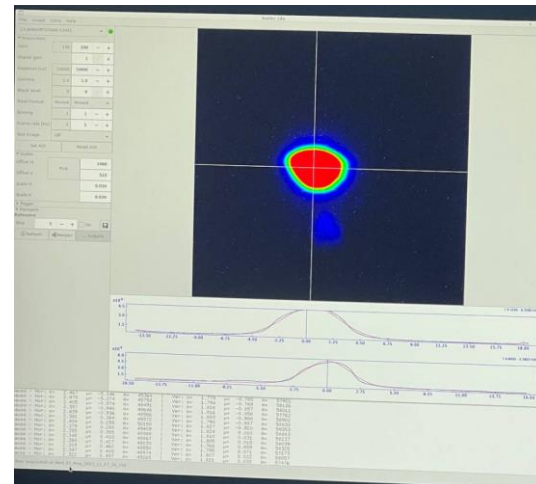
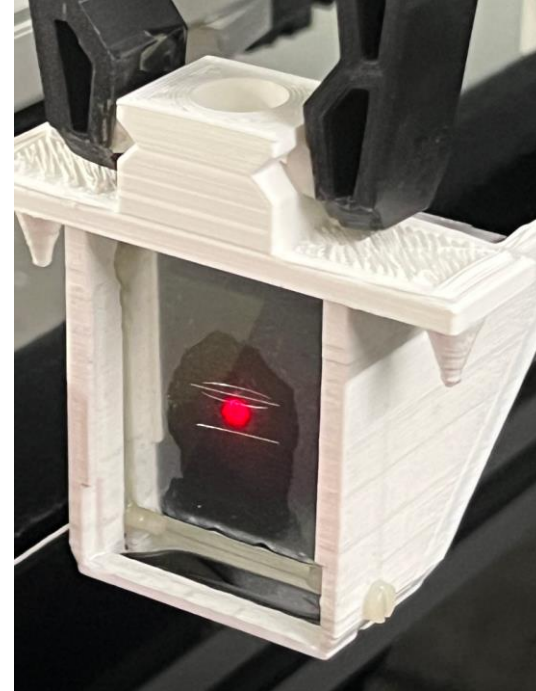
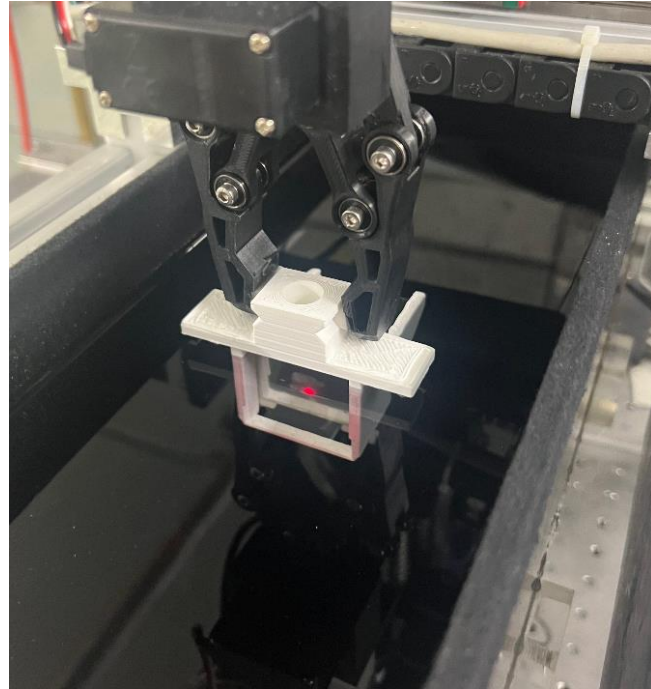
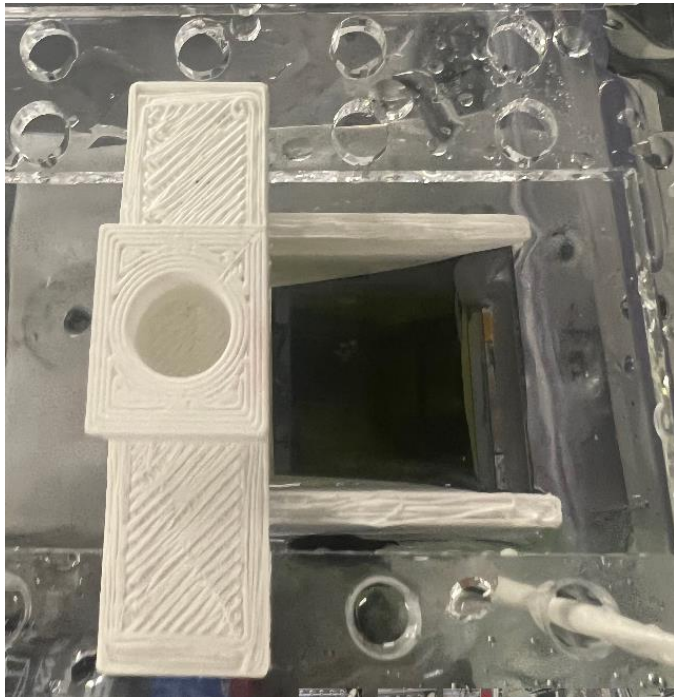
CERN Linear Electron Accelerator for Research – clear*

Experimental setup – laser beam for position alignment



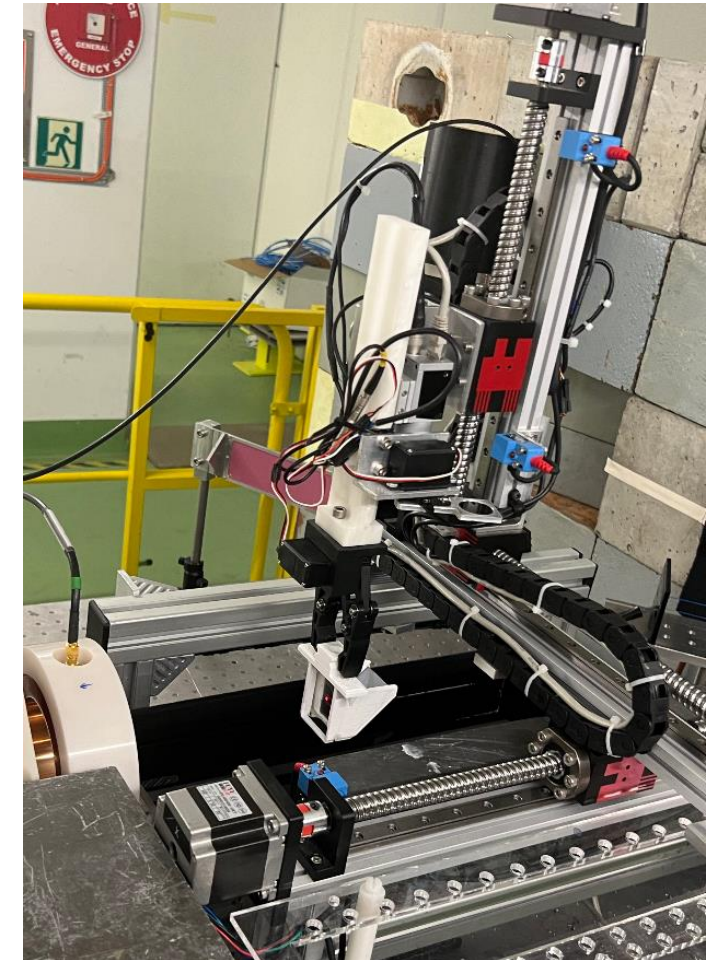
CERN Linear Electron Accelerator for Research – clear*

Experimental setup – beam online monitoring with screen at the sample position in air & water



CERN Linear Electron Accelerator for Research – clear*

Experimental setup – moving robot



- Multiple videos are available

CERN Linear Electron Accelerator for Research – *clear*

Experimental setup – online camera

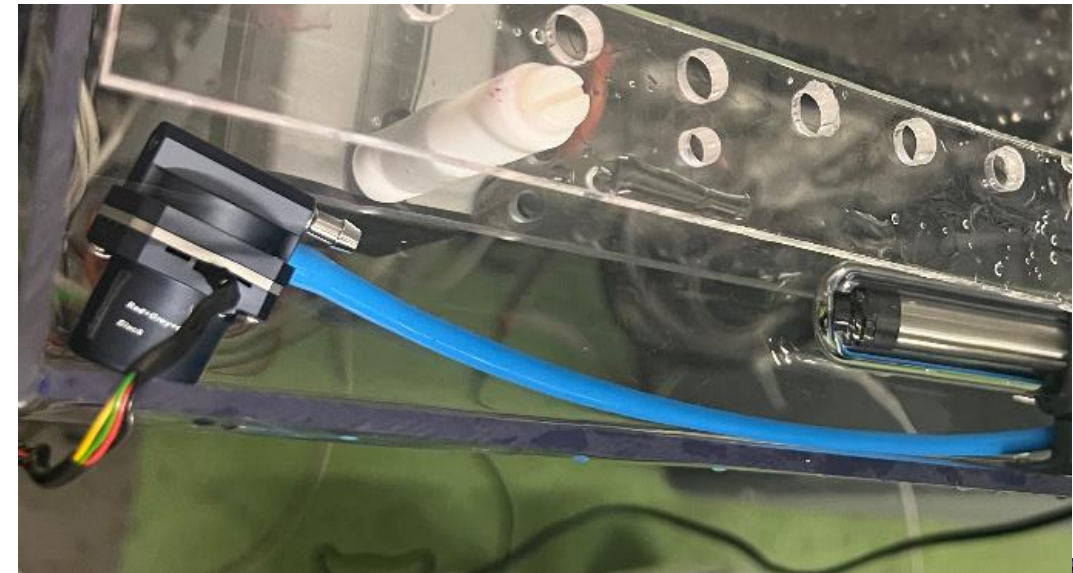
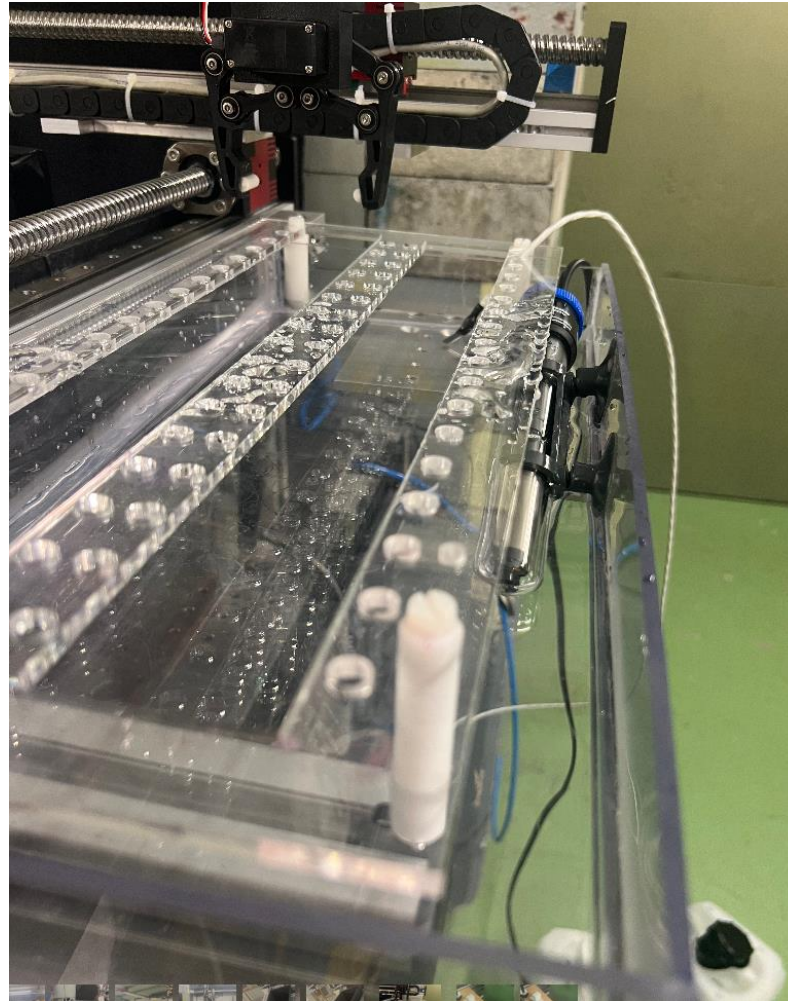


CERN Linear Electron Accelerator for Research – clear*

Experimental setup – water bath for “waiting” samples with heating&mixing



Fish embryo



Fish lab

Model:



Fish embryo

Infrastructure:

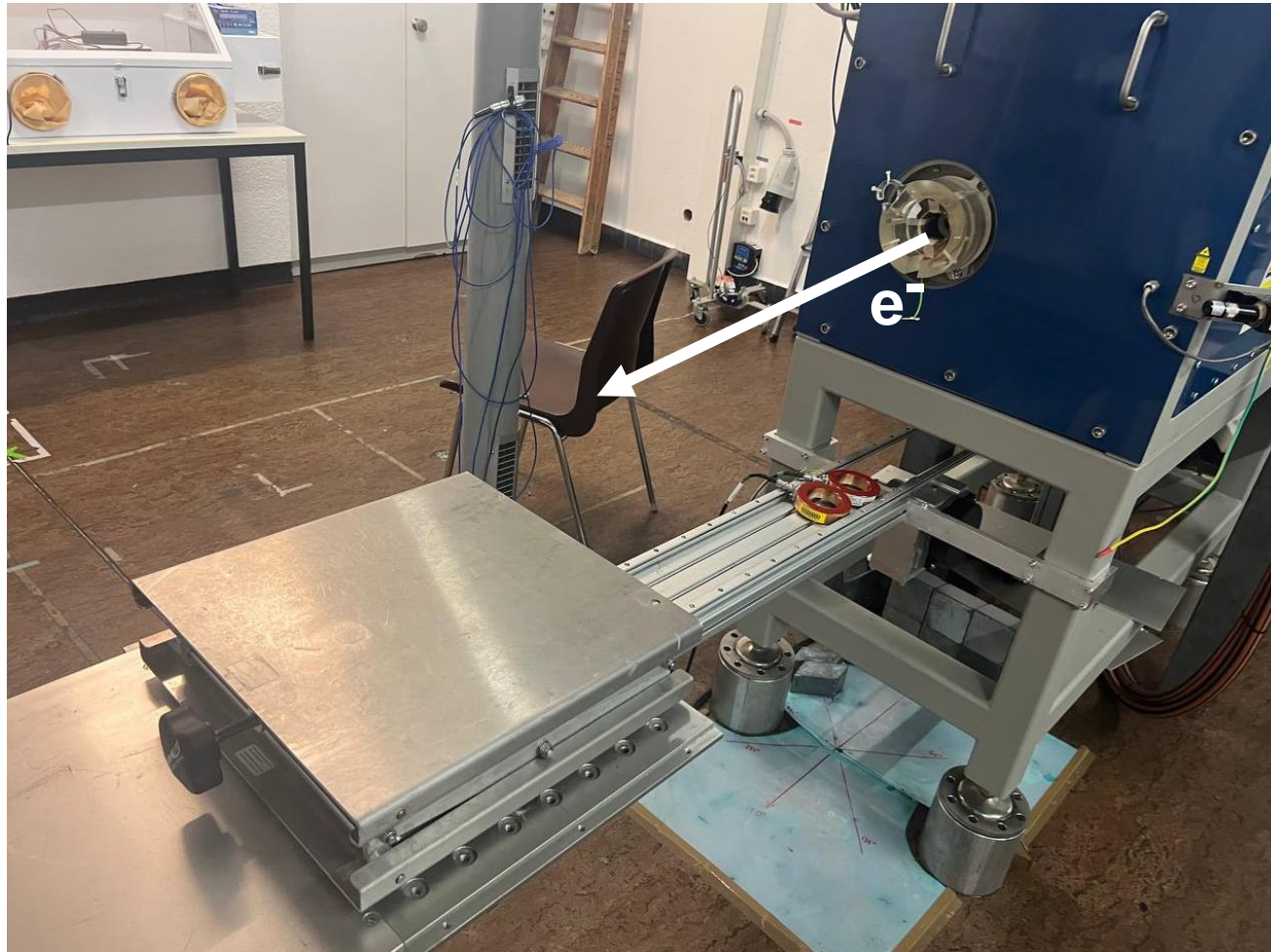
- Separated 3 rooms
- Tecniplast equipment x 3



5.5 MeV Oriatron eRT6 (PMB Alcen)

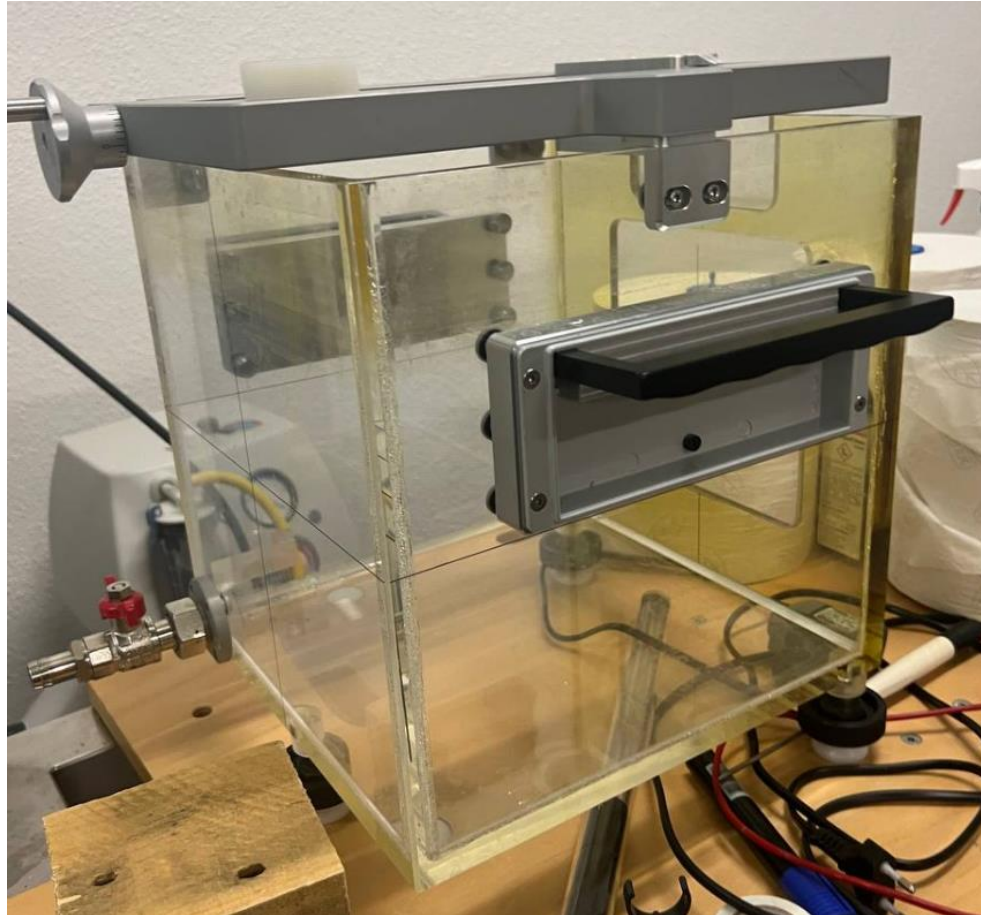
Experimental setup – overview

- was broken, no running experiments



5.5 MeV Oriatron eRT6 (PMB Alcen)

Experimental setup – water phantom



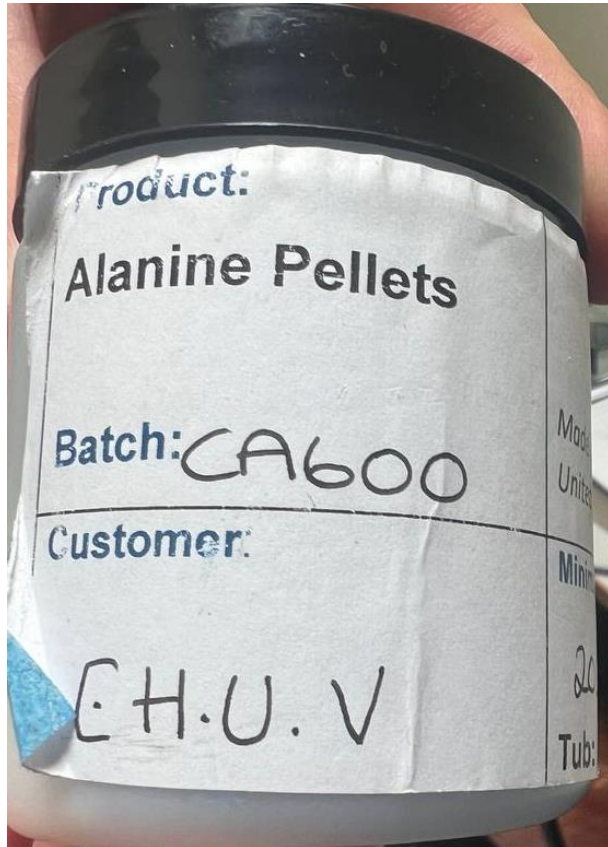
- Old, damaged



- Films are scanned in 3-10 days after irradiation

5.5 MeV Oriatron eRT6 (PMB Alcen)

Experimental setup – alanine



- To put pellet in water:



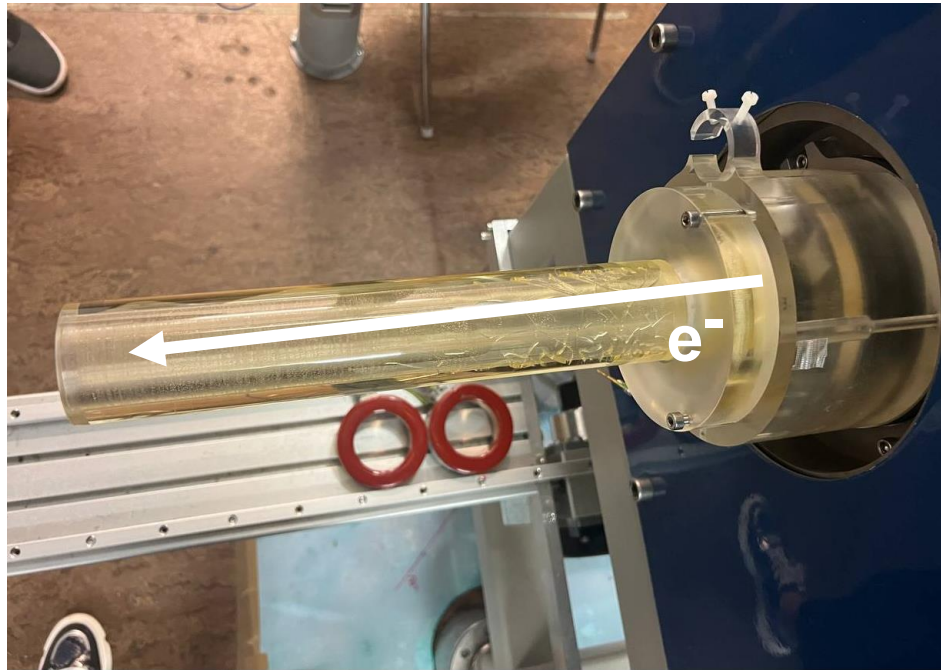
5.5 MeV Oriatron eRT6 (PMB Alcen)



Experimental setup – work with mice

- Animals w/o films, only coil
- Anesthesia: only air + isophuran?
O₂ supply atmospheric vs. common 95%
- Cross-border mice transport: irradiation at CHUV, analysis at Irvine

- 24 h earliest sample analysis post-irradiation (ROS, histology); weeks for long-term read-outs
- Prescribed dose is entrance dose

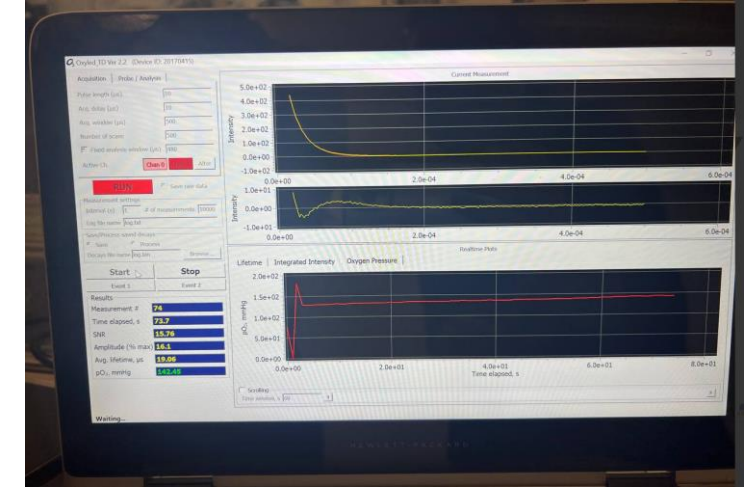


5.5 MeV Oriatron eRT6 (PMB Alcen)



Experimental setup – OxyPhor setup

- online O₂ level monitoring in
 - glass tube
 - 2 x optical fibers (excitation & emission) directly on sample
- + similar setup is needed for nanoparticle luminescence estimation for tumor tissue imaging development



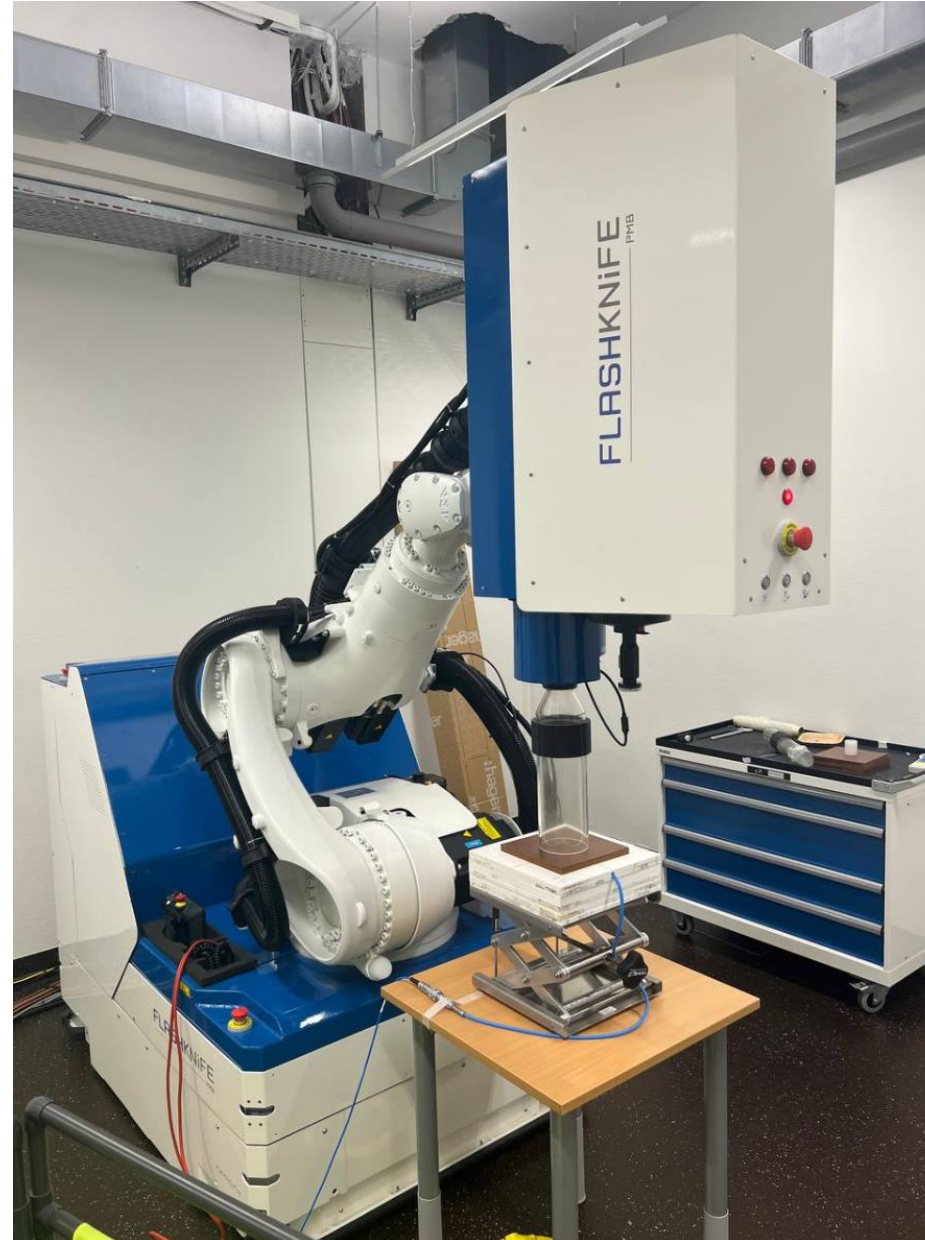
+



FLASH KNIFE (PMB Alcen)



- to help adapt this new technique to clinical practice



Lessons learnt

Set-up

- Coils for online monitoring of delivered dose (cross-calibrated at different doserates with ionising chamber that was cross-calibrated with films)
- Optic fibres to sample + camera/equipment around
- Water bath with heating&mixing „must have“
- Online beam monitoring?
- Online camera?

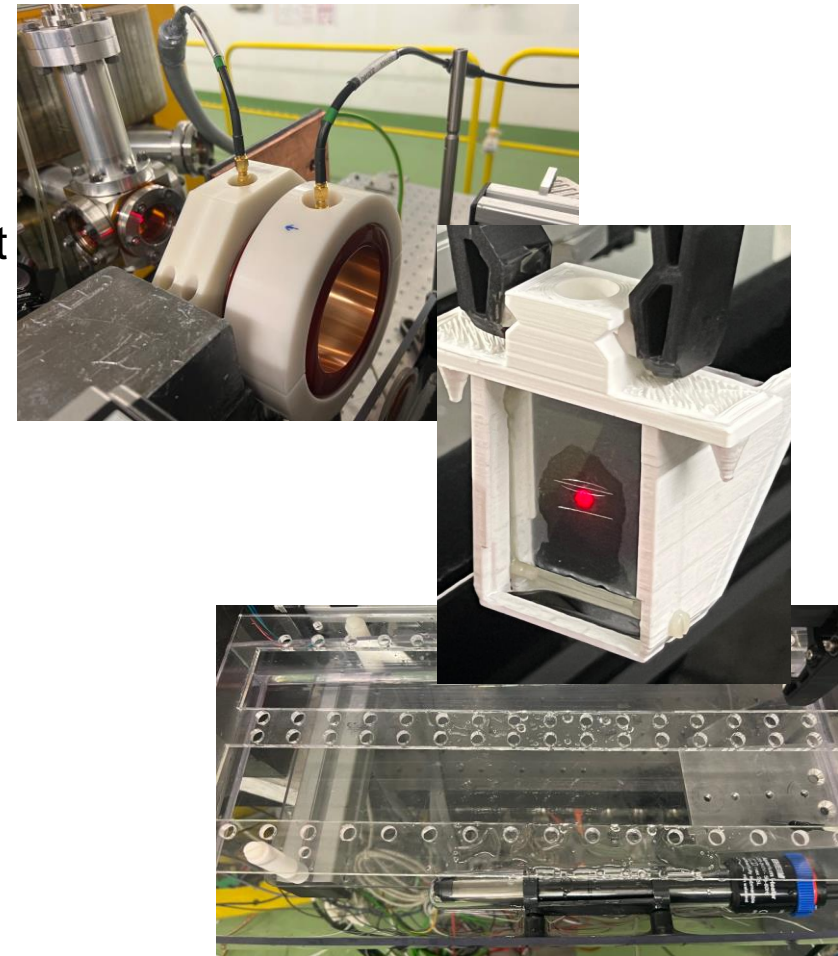
Bio

- Our optimized methods match well with Vozenin's group
- DNA plasmid effects <10 Gy → check 3.5k dialysis
- Hypoxia 1% O₂ is lowest stable, sealed with parafilm, transported in box
- Mice anesthesia – O₂ supply atmospheric vs. common 95%?
- Some equipment noted

Dosimetry

- Laser cutter for film cutting & numbering (laser cutter available at [ViNN:LaB, TH Wildau](#))
- Lead inserts for sample position monitoring post-irradiation

+ Switzerland has very tough control for incoming guests



ViNN:Lab

Makerspace der TH Wildau – offen für alle.

Thank you for the attention!

