

# First dosimetry tests at PITZ

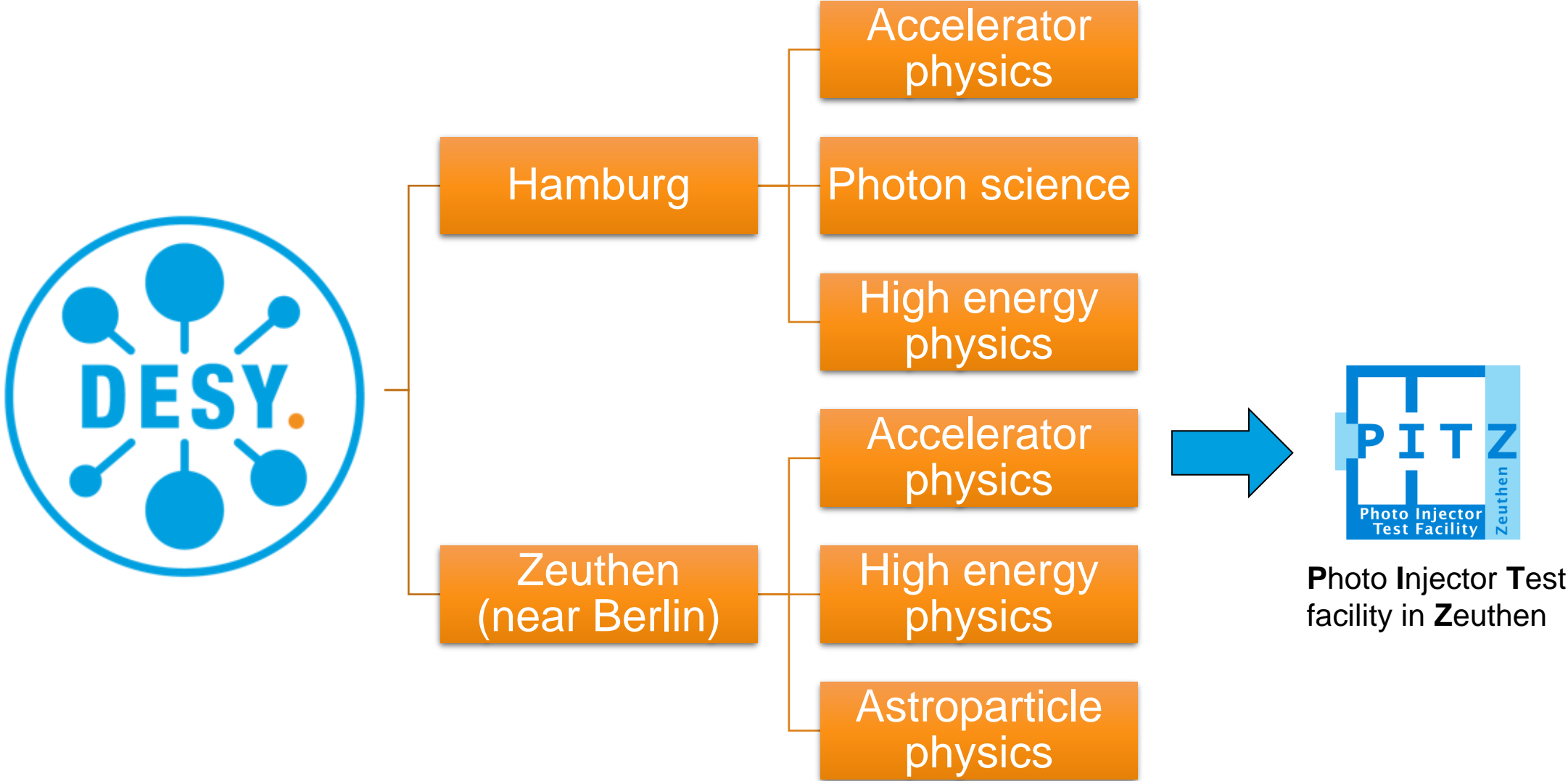
UHDpulse 2<sup>nd</sup> Stakeholder Meeting  
Prague, January 26 – 27

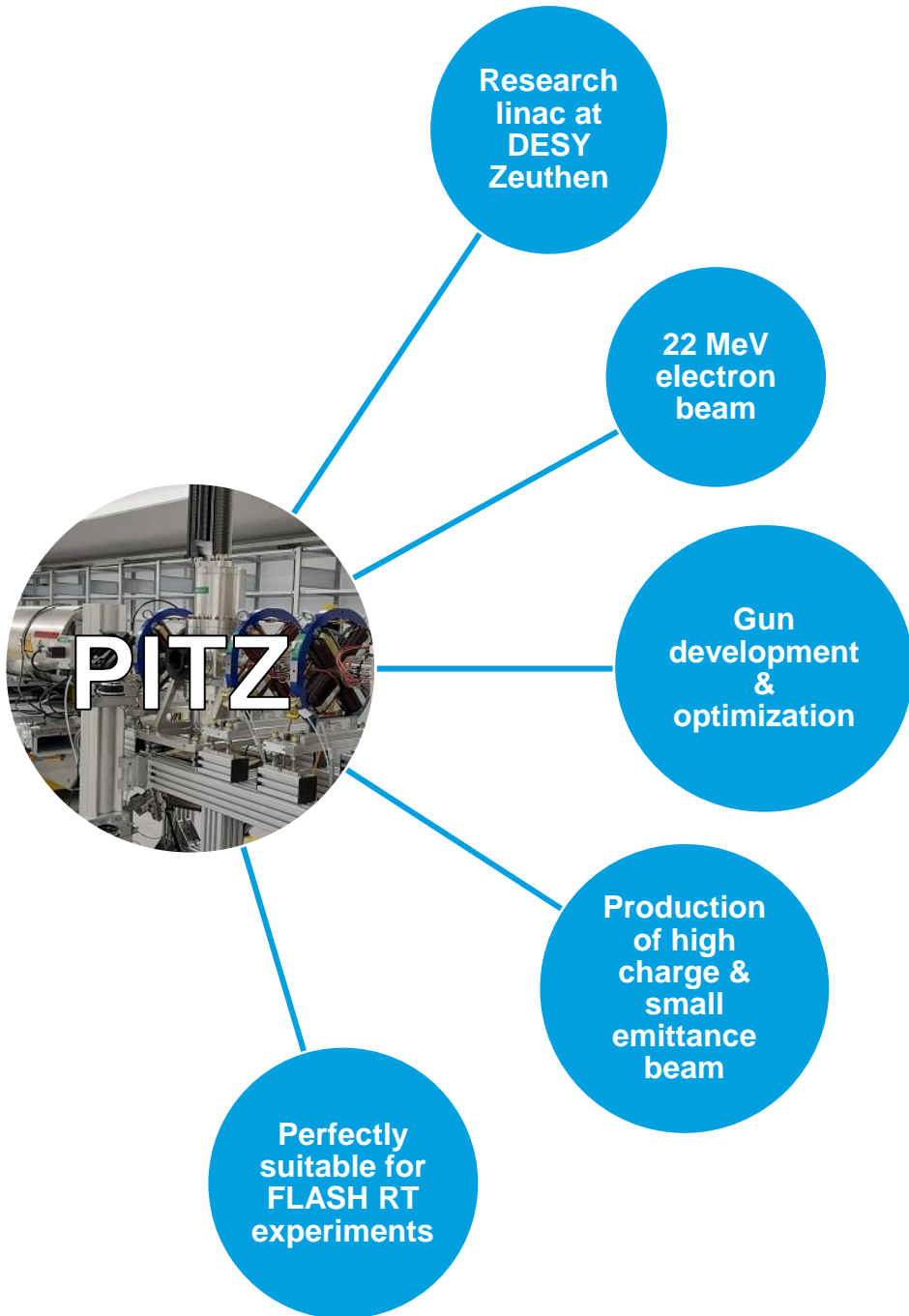
**Felix Riemer**

PhD student

In behalf of the PITZ team

# R&D at DESY (national research centre in Germany)

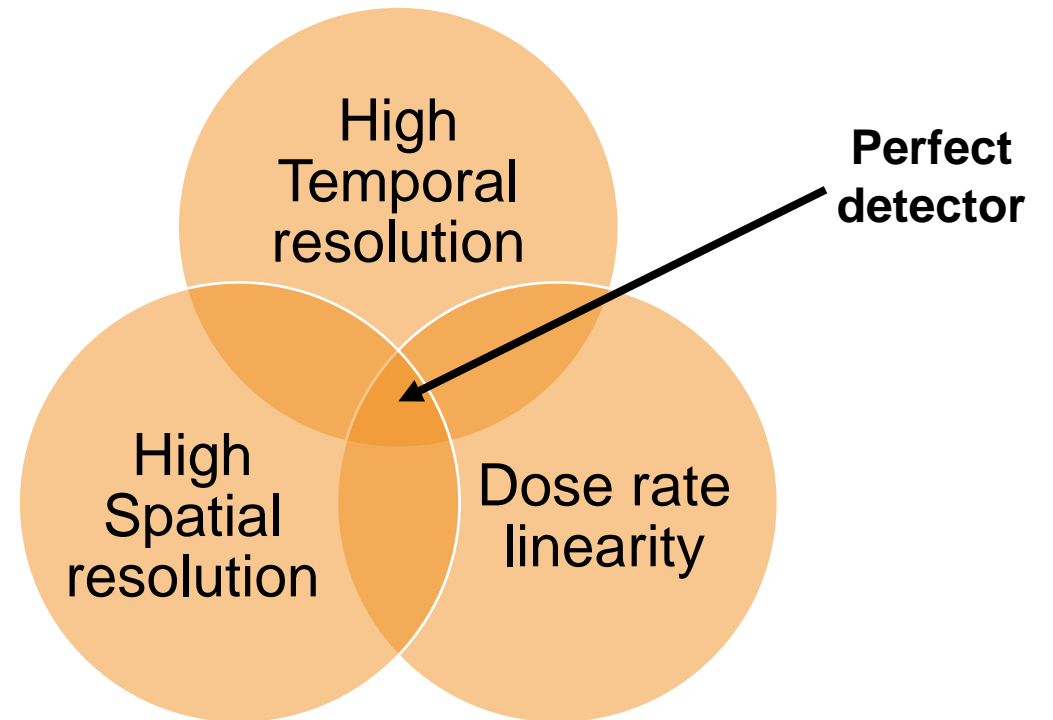




# New challenge: Dosimetry

Detection of a huge amount of particles in a very short amount of time

**PITZ:**  
Up to  $5.5 \times 10^{10}$  particles within 30 ps  
(1cm<sup>2</sup> sensitive area)



# Beam parameters available at PITZ

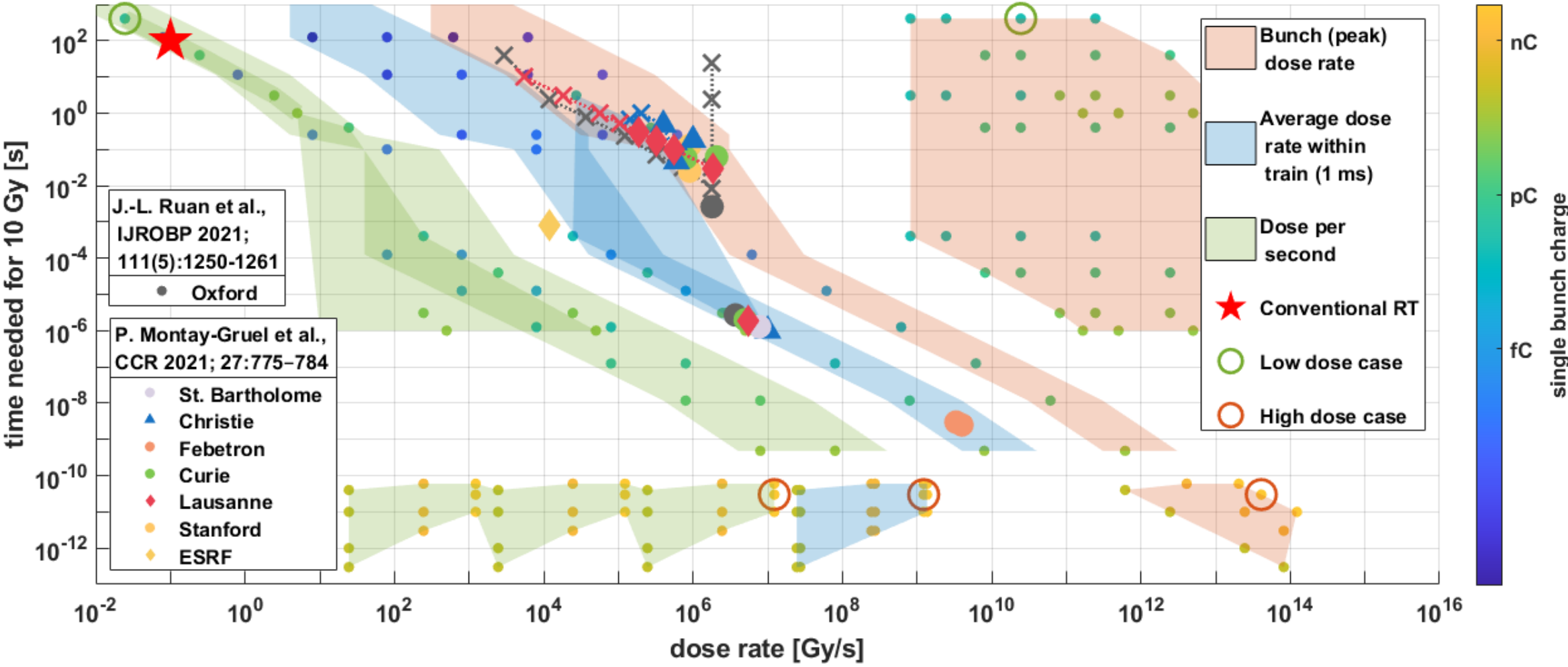
Options @PITZ:	low dose case	high dose case
Bunch charge	<b>0.1 pC</b>	<b>5 000 pC</b>
Single bunch OR train	single bunch	1ms train (1MHz)
RF pulse rep. rate	1 Hz	10 Hz
Bunch length	<1 ps	~30 ps
Dose per bunch	0.02 Gy	1000 Gy
Dose rate per bunch	$2 \times 10^{10}$ Gy/s	$4 \times 10^{13}$ Gy/s
Dose per train(ms)	<b>0.02 Gy</b>	<b><math>1 \times 10^6</math> Gy</b>
Dose rate per train(ms)	20 Gy/s	$1 \times 10^9$ Gy/s
Dose per second	<b>0.02 Gy/s</b>	<b><math>1 \times 10^7</math> Gy/s</b>

**Bunch/micropulse charge is tunable from 0.1 pC up to 5 nC**

**# bunches/micropulses per pulse can be tuned from 1 up to 1000**

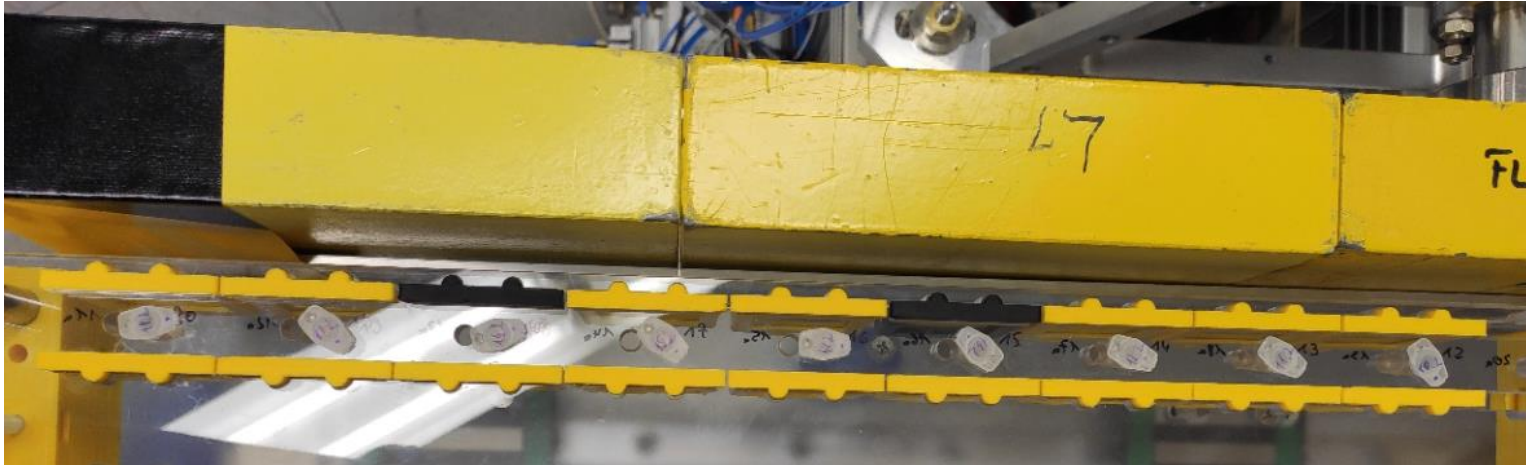
**Dose rate can be tuned from conv. DR up to UHDR**

# Time needed for 10 Gy vs. Dose rate at PITZ

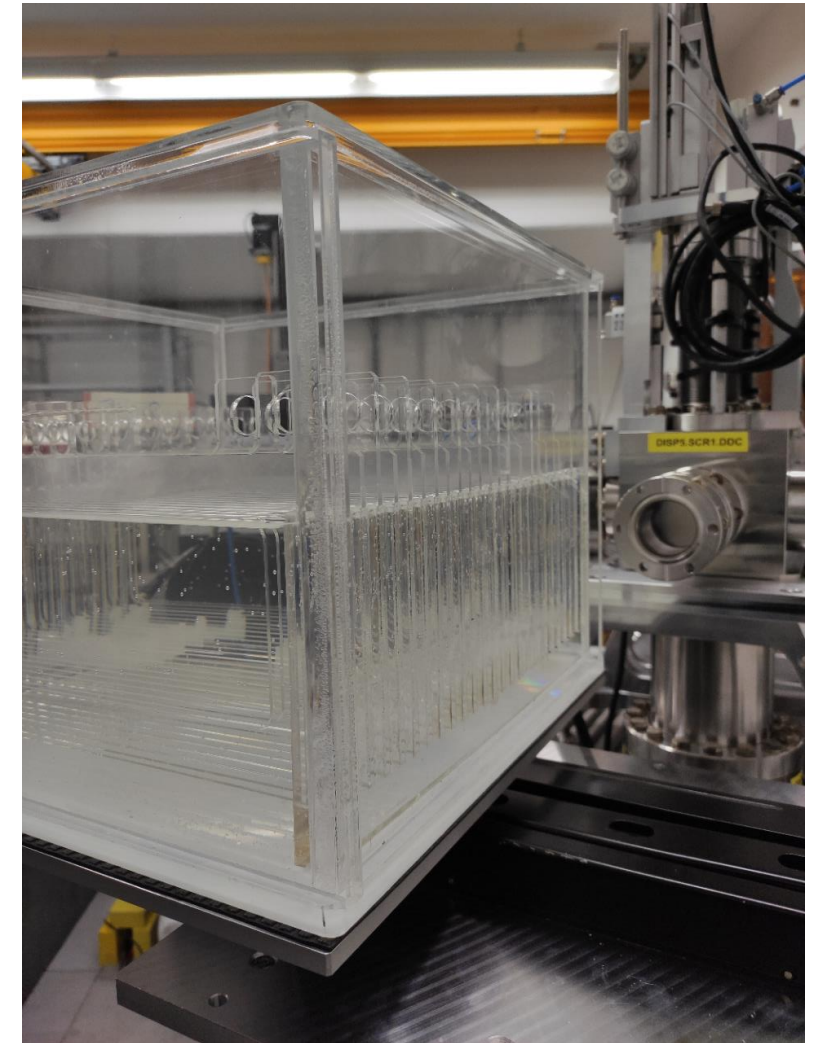
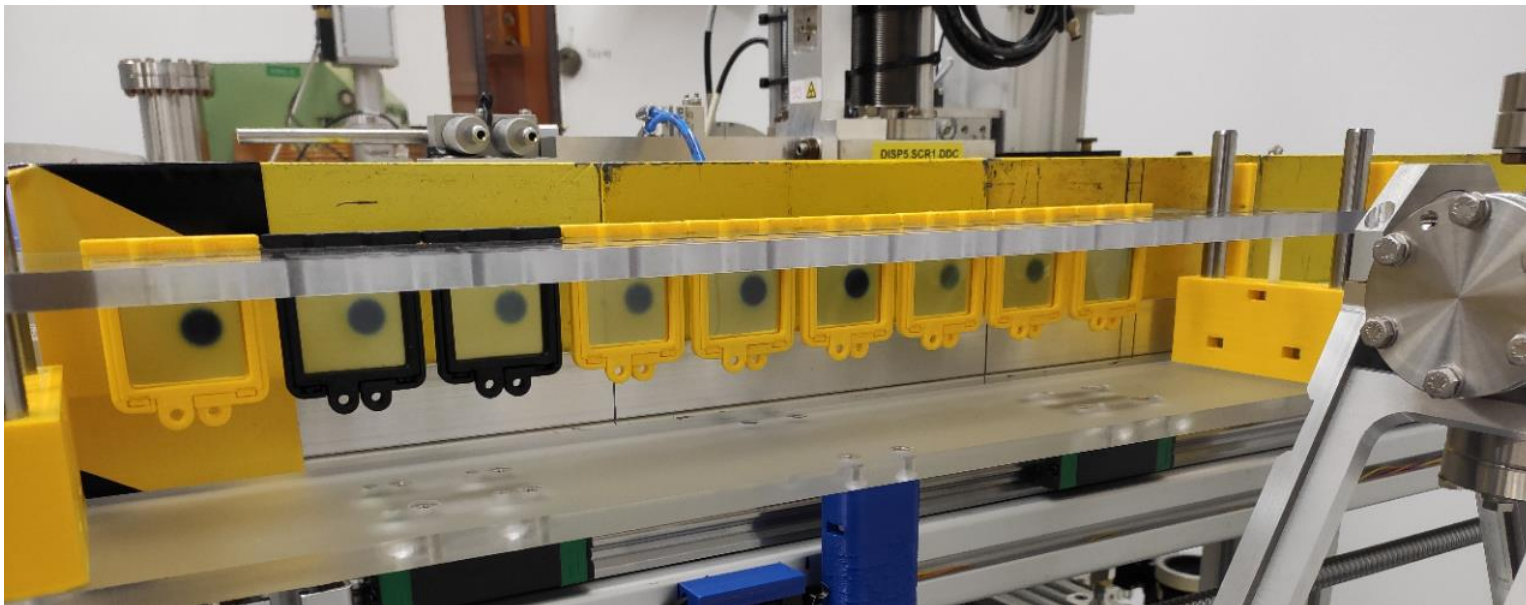


Courtesy of James David Good,  
Marie-Catherine Vozenin, Jean-Francois Germond





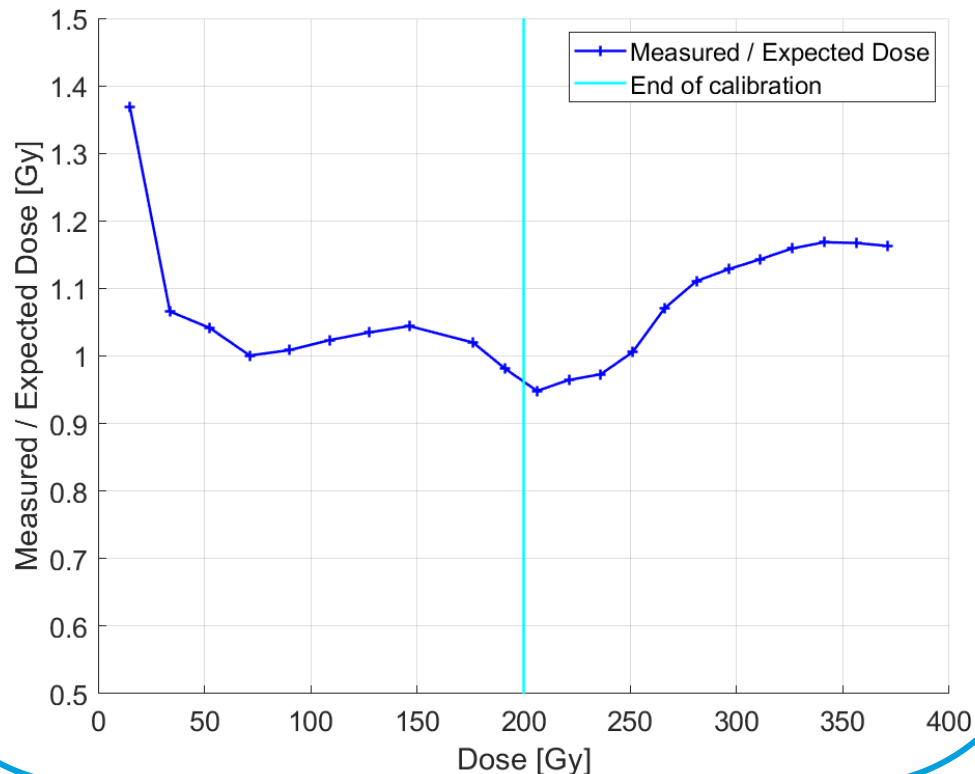
## Preliminary setup of Flashlab@PITZ



# EBT-XD Films: Limit test, Dose rate linearity & time dependence

## Limit test:

- Irradiation up to 370 Gy
- Still within 20% of expected dose
- But calibration was done only up to 200 Gy
- Next batch of films: Calibration up to 300 Gy  
-> Experiments ongoing.

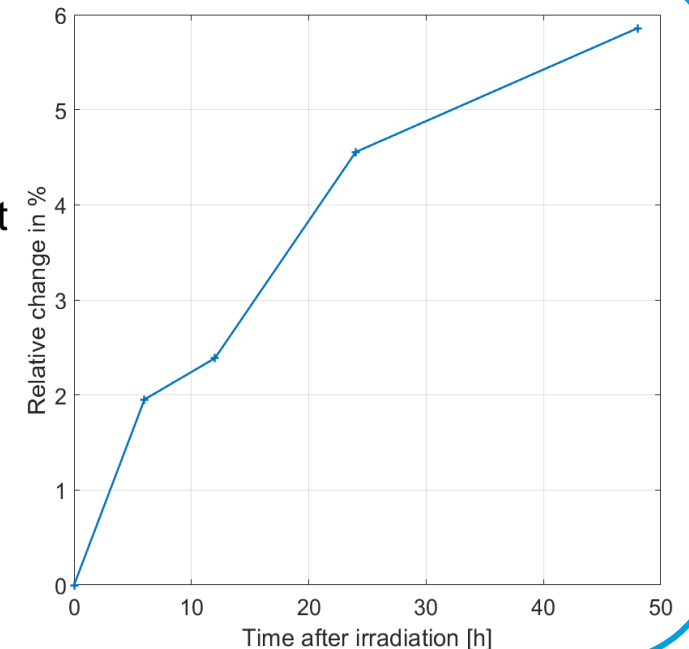


## Dose rate linearity

- Dose rate linearity was confirmed up to  $10^8$  Gy/s as in literature
- Irradiation to dose rates up to  $8 \times 10^{10}$  Gy/s were done
- High background due to dark current (Background 3 times higher than signal)
- Still within 20% of expected dose

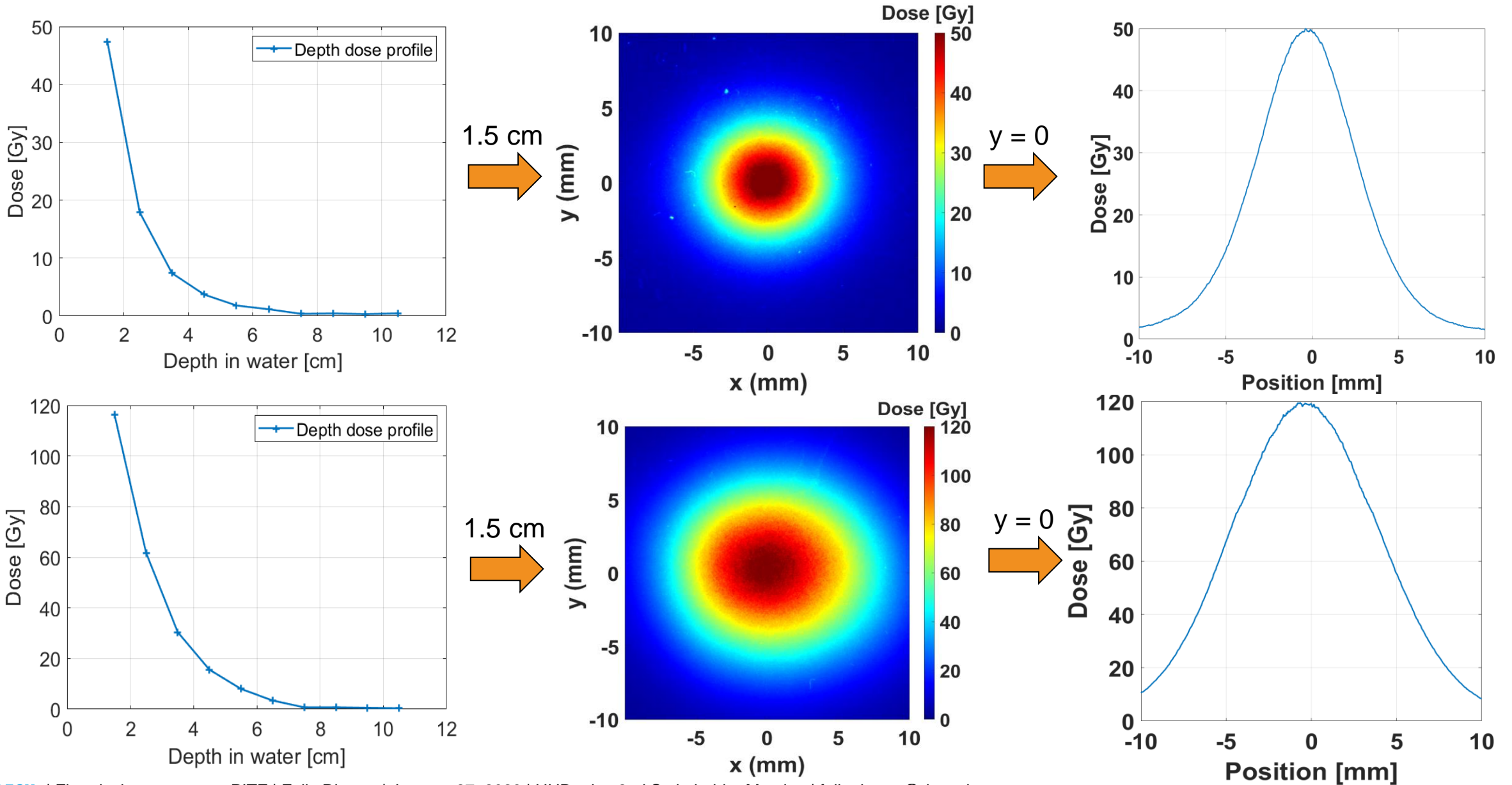
## Readout of films:

- Relative Change of about 5%, 24h after irradiation
- Standard readout after 24h was used for all experiments



# Water phantom: Depth dose curve & beam profile

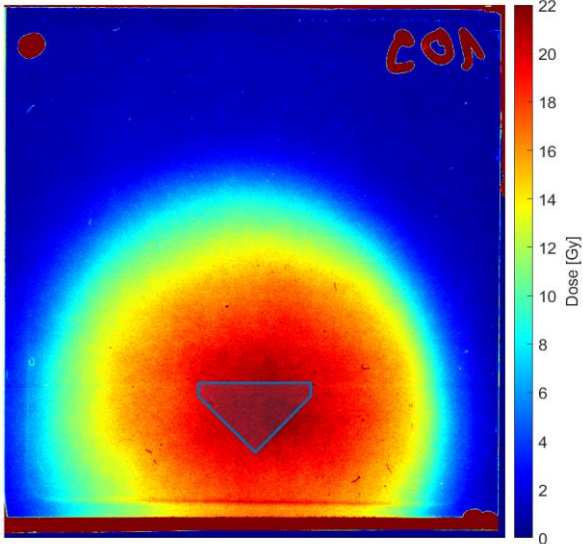
Beam Parameter ?



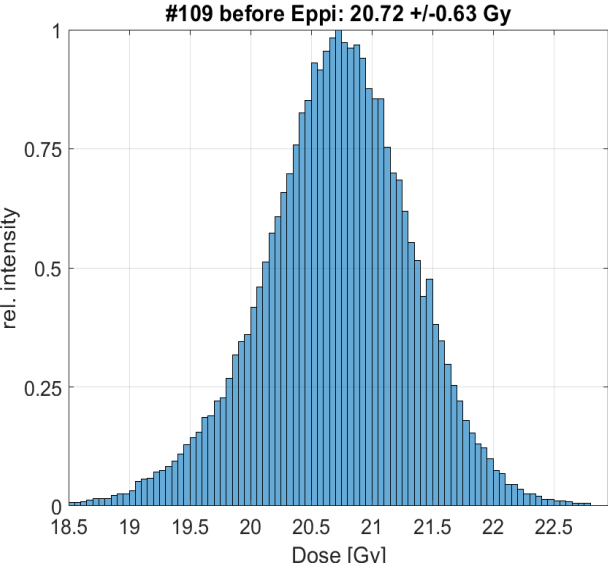
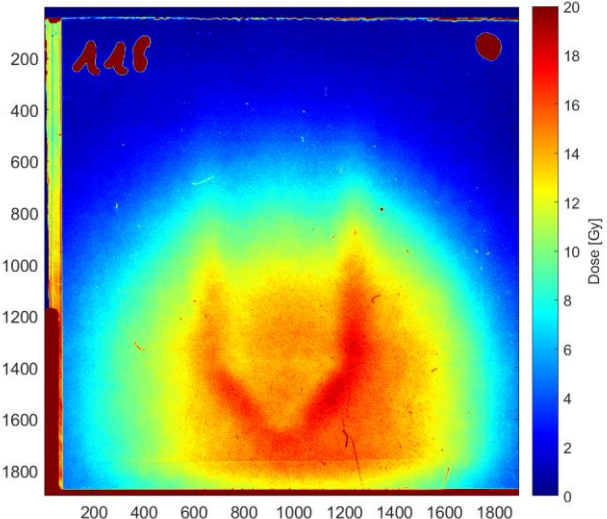


# Irradiation of samples -> Homogeneity

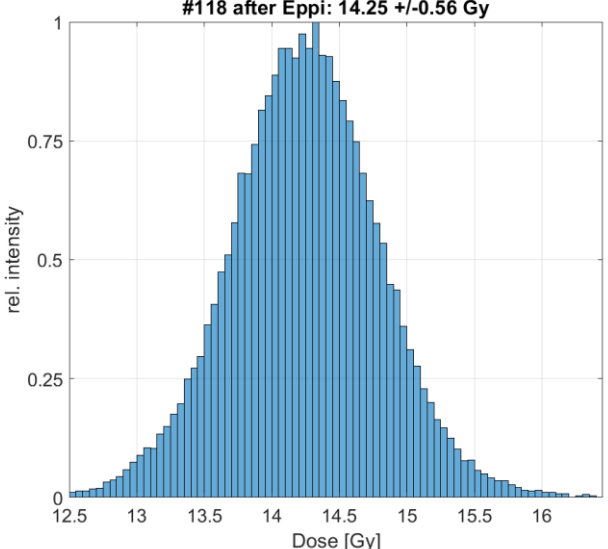
**1.4x10<sup>5</sup> Gy/s @ 700 pC**



Sample



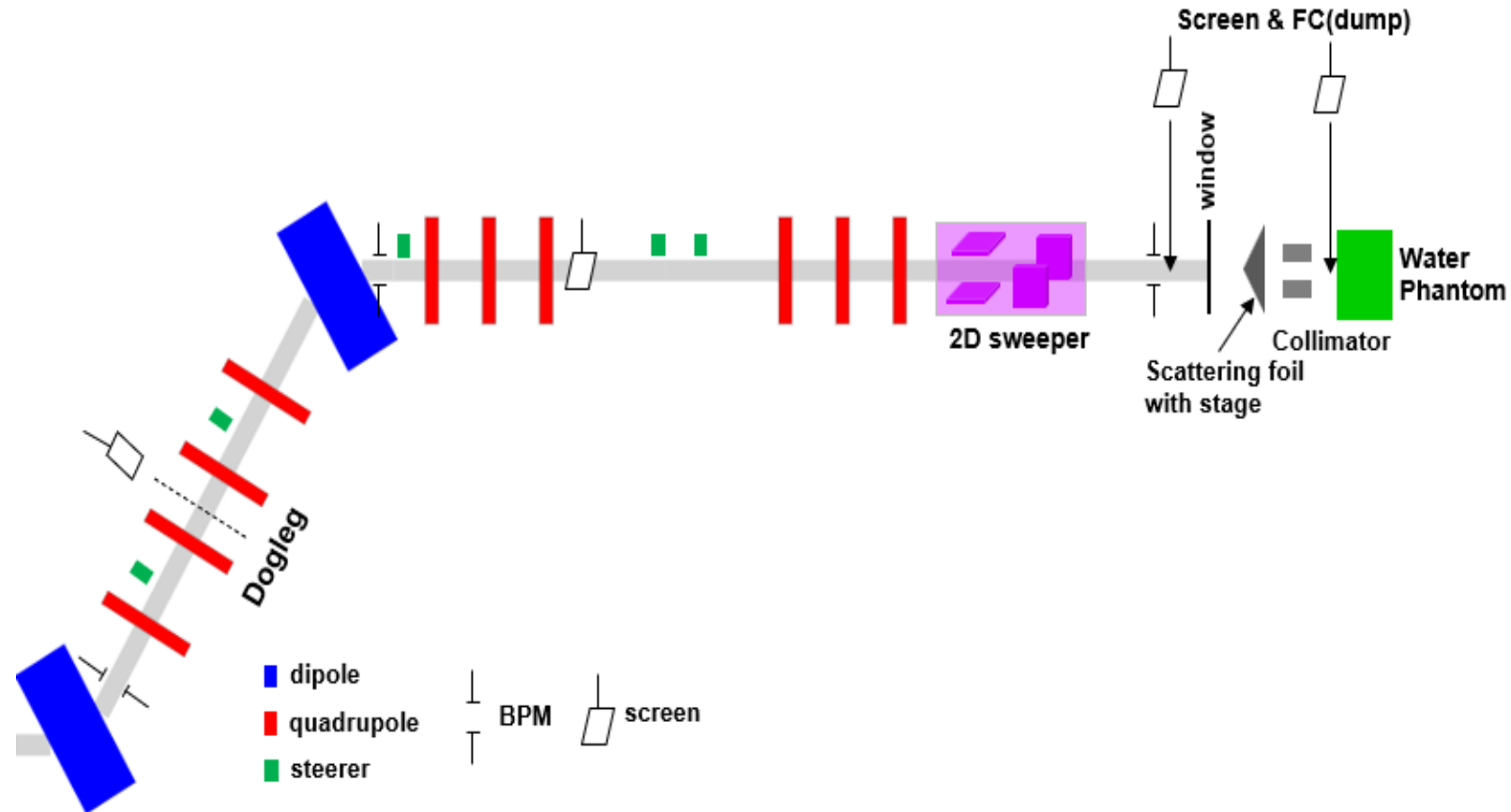
**Dose distribution of irradiated volume / surface**



**First irradiations of cancer cells were done last week**

# Upgrade plan for Flashlab@PITZ

- Upgrade of existing setup is planned to be finished 2023/24
- More than 10 magnets for beam focusing are planned
- Beam diagnostics (BPM, screen, Faraday cup)
- 2D sweeper to scan the beam over surface



# Summary

- The PITZ accelerator at DESY Zeuthen can provide conv. DR up to UHDR.
- Setups: Water phantom & movable stage for irradiation of samples in Eppendorf tubes
- Dosimetry: Gafchromic films
  - Limit test, dose rate linearity, time dependence
  - Water phantom: Depth dose profile, lateral profile
  - Homogeneity for irradiation of samples in Eppendorf tubes
- Upgrade plan for PITZ

