On-shot dosimetry setup for radiobiology studies on volumetric *in-vivo* samples with laser accelerated proton beams

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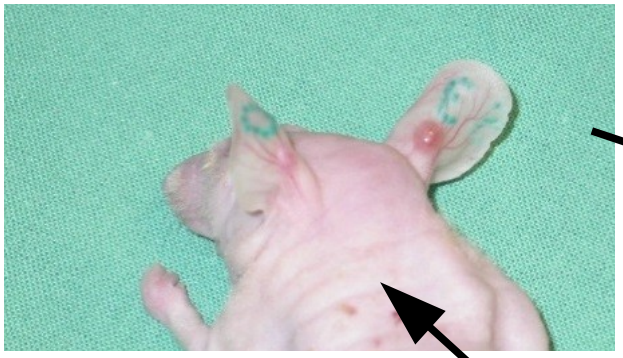
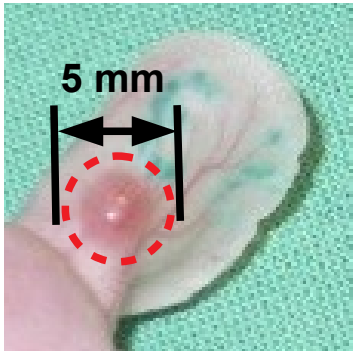
2 TU Dresden, Dresden, Germany
3 OncoRay - National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Dresden, Germany
4 Attosecond Light Pulse Source, ELI-HU Nonprofit Ltd., Szeged, Hungary

Motivation: Mouse model

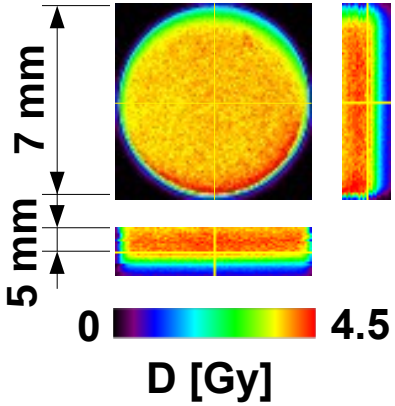
Mouse



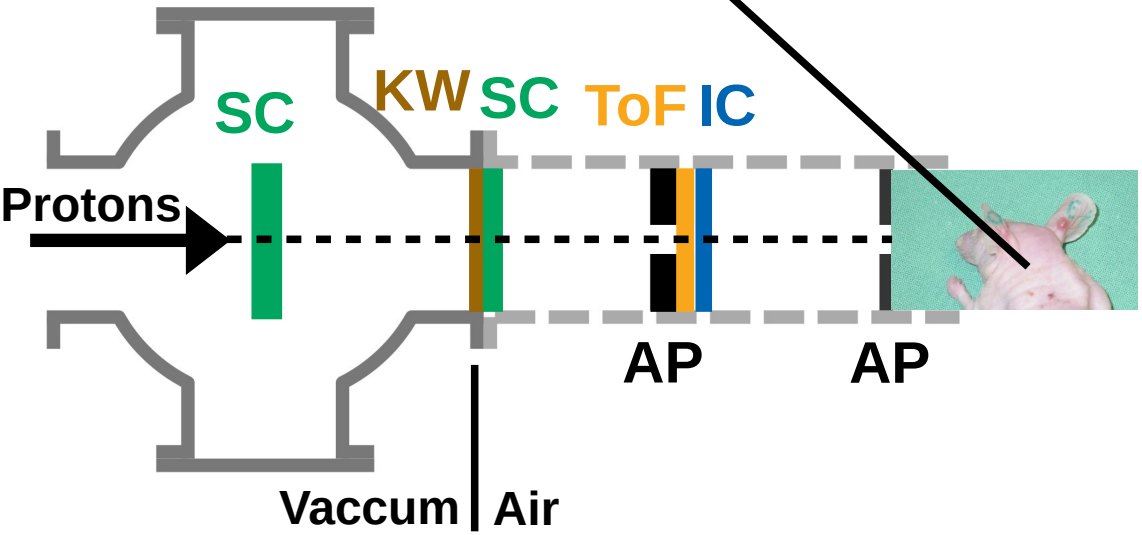
Mouse ear tumor



Dose distribution



Beam-line



Requirements:

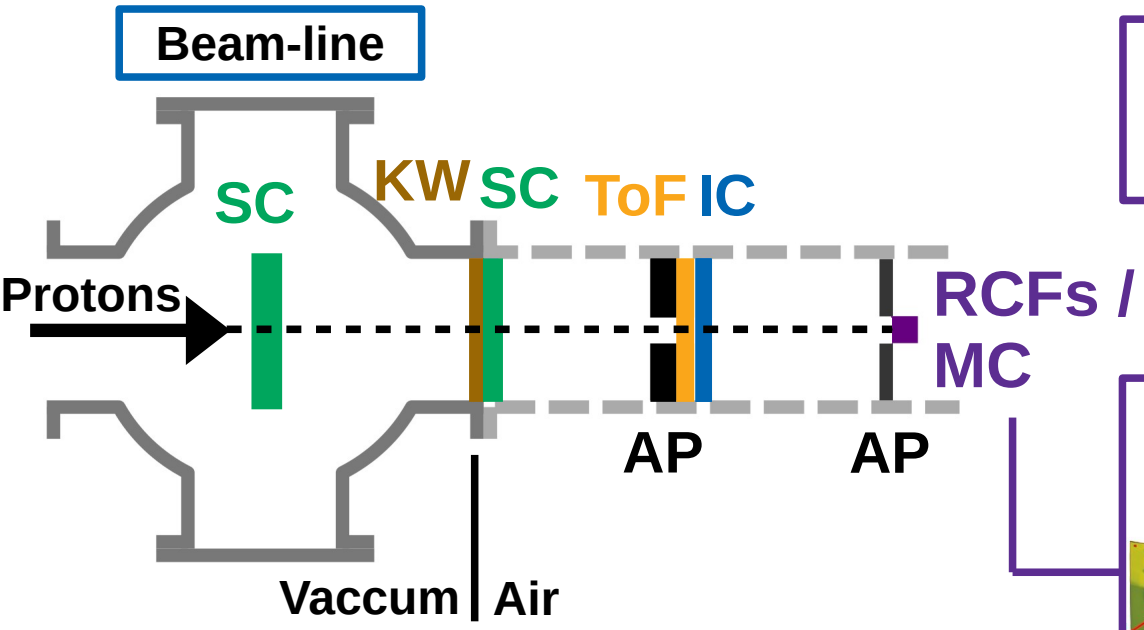
- Irrad. vol.: 5 x 5 x 5 mm³
- Dose: 4 Gy
- Doserate: 1 Gy/min
- Pulse dose: 600 mGy/shot
- Homogeneity: +/- 5 %

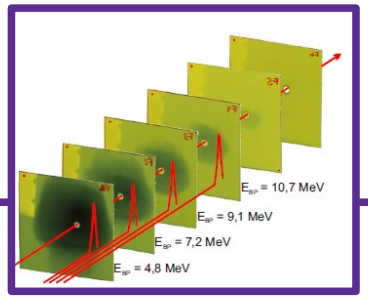
SC: Scatter foil KW: Kapton Window RCFs: Radiochromic Films AP: Aperture
ToF: Time of Flight IC: Ionization Chamber MC: Markus Chamber

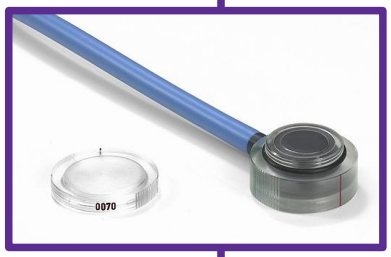
Dosimetry: Mouse model

Dose at irradiation site

Absolute dosimeter:
→ 3D dose distribution (RCFs)
→ Absolute dose value (MC)







SC: Scatter foil KW: Kapton Window RCFs: Radiochromic Films AP: Aperture
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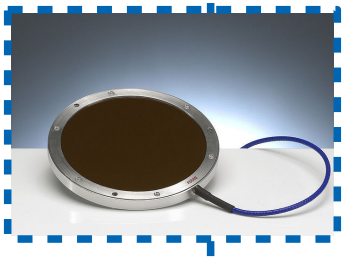
Dosimetry: Mouse model

Dose at irradiation site

Reference dosimeter:
→ Reference dose value



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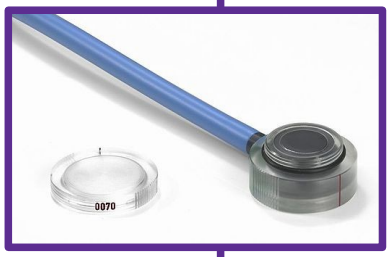
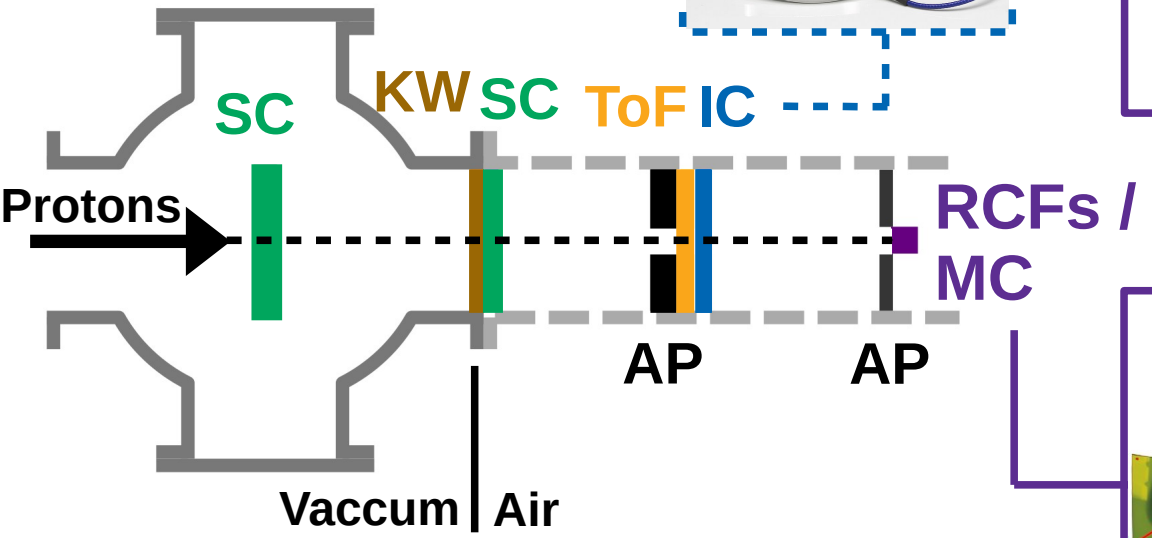
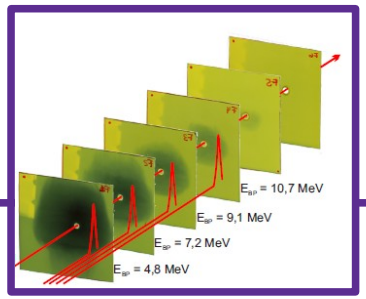


Beam-line





SC: Scatter foil KW: Kapton Window RCFs: Radiochromic Films AP: Aperture
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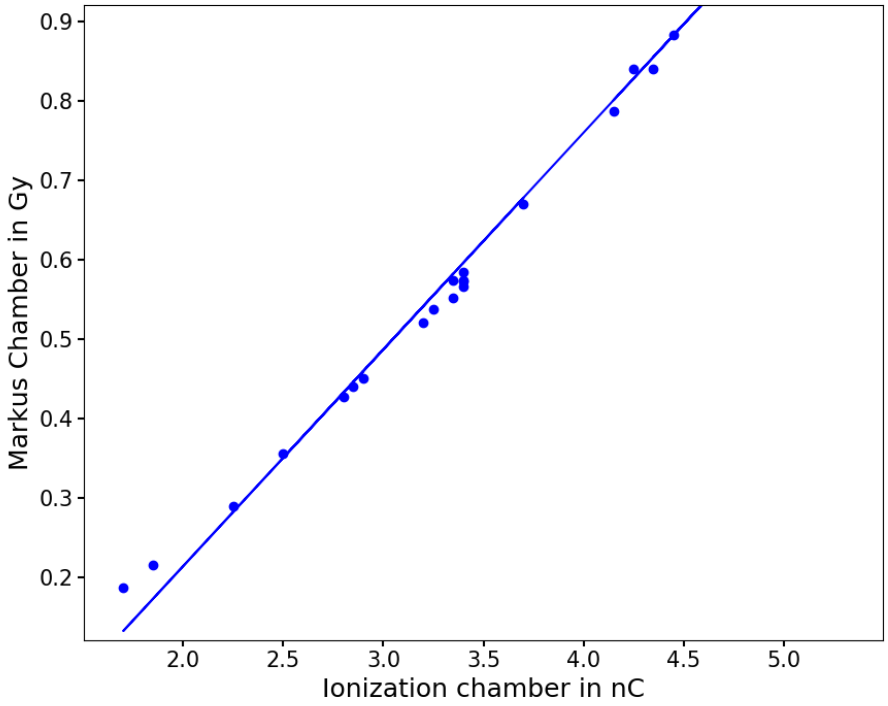
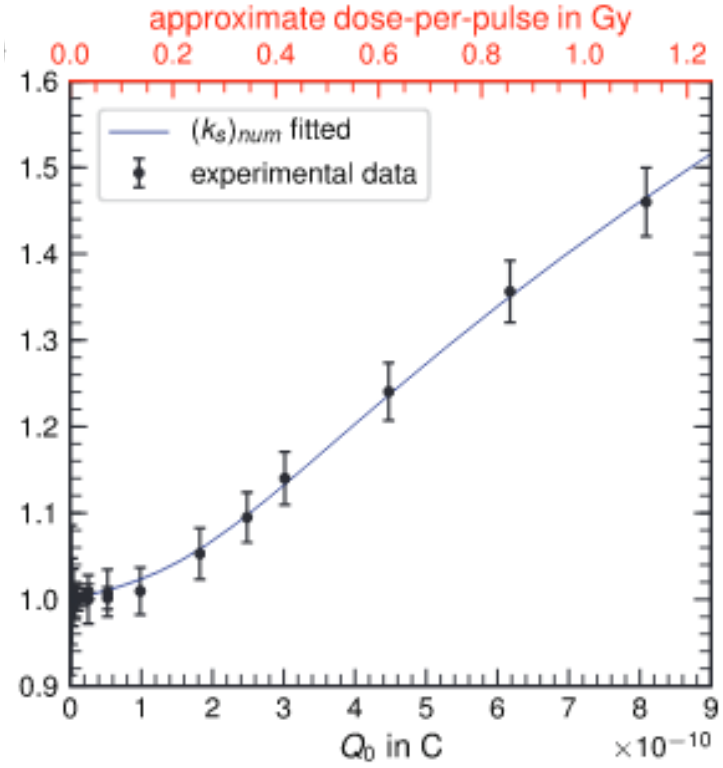
Dosimetry: Markus chamber

Correlation of MC & IC



Fit parameters:
Slope: 0.27 Gy/nC Offset: -0.33 Gy

Saturation of Markus chamber

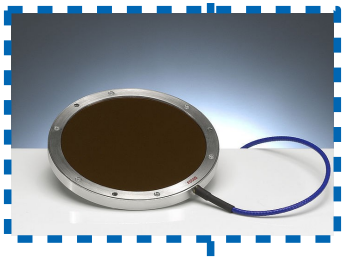


(Gotz, et al., 2017, PMB)

Dosimetry: Mouse model

Dose at irradiation site

Reference dosimeter:
→ Reference dose value



Absolute dosimeter:
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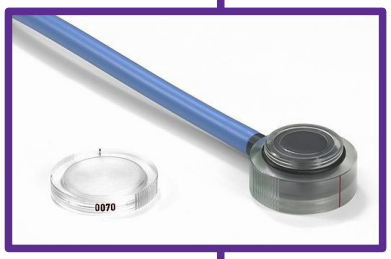
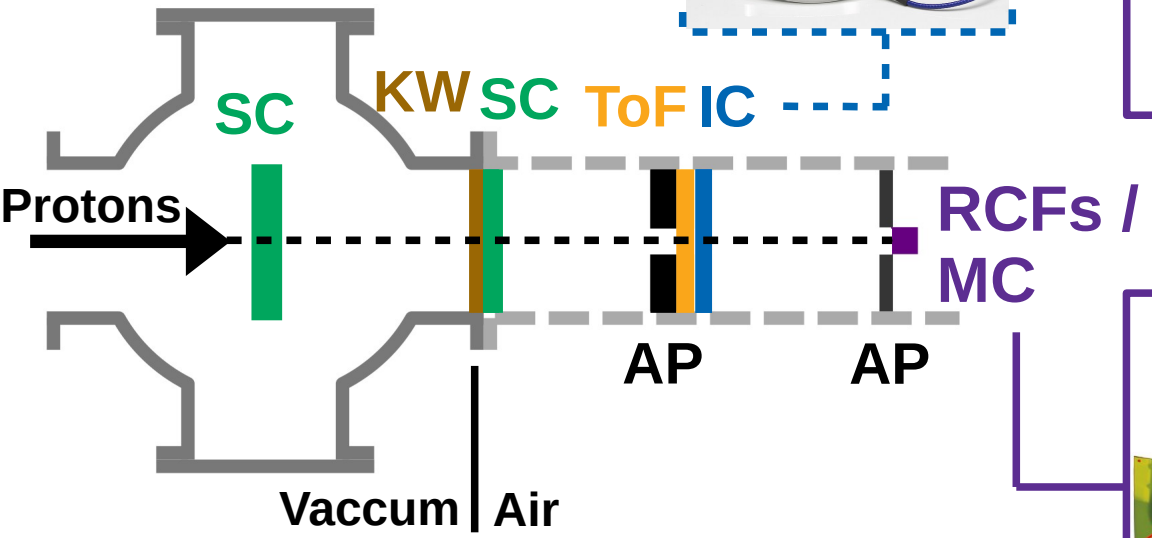
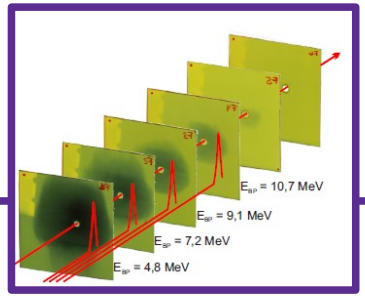


Beam-line





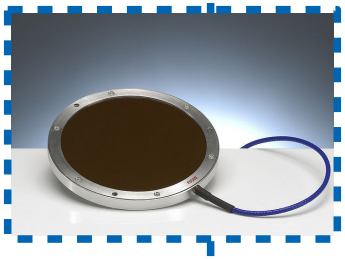
SC: Scatter foil KW: Kapton Window RCFs: Radiochromic Films AP: Aperture
ToF: Time of Flight IC: Ionization Chamber MC: Markus Chamber

Dosimetry: Mouse model

Spectrometer:
→ Depth dose distribution
Reference dosimeter:
→ Reference dose value

Dose at irradiation site

Reference dosimeter:
→ Reference dose value



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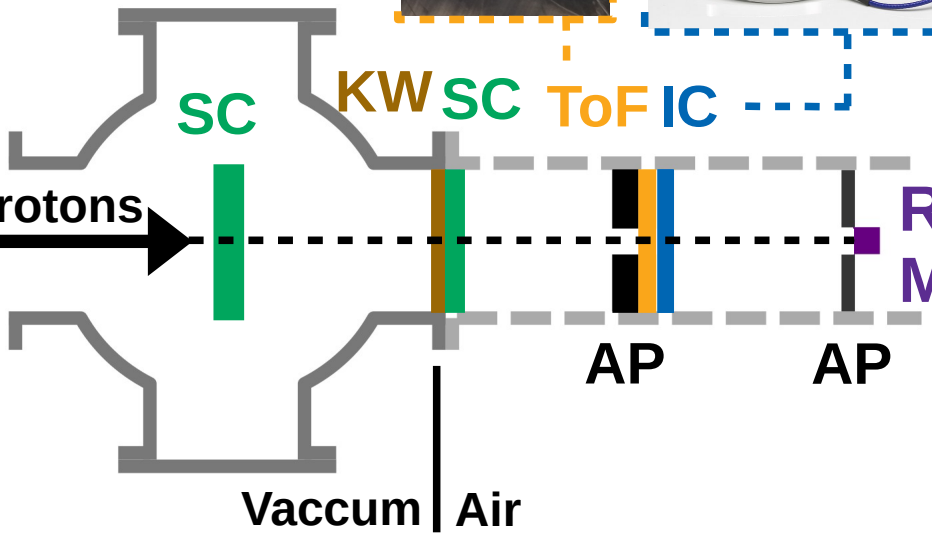
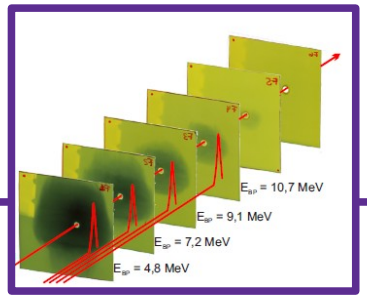
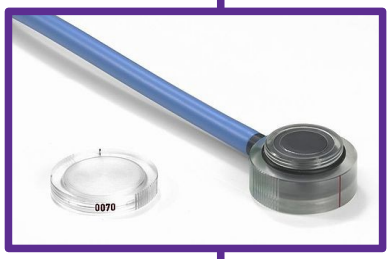
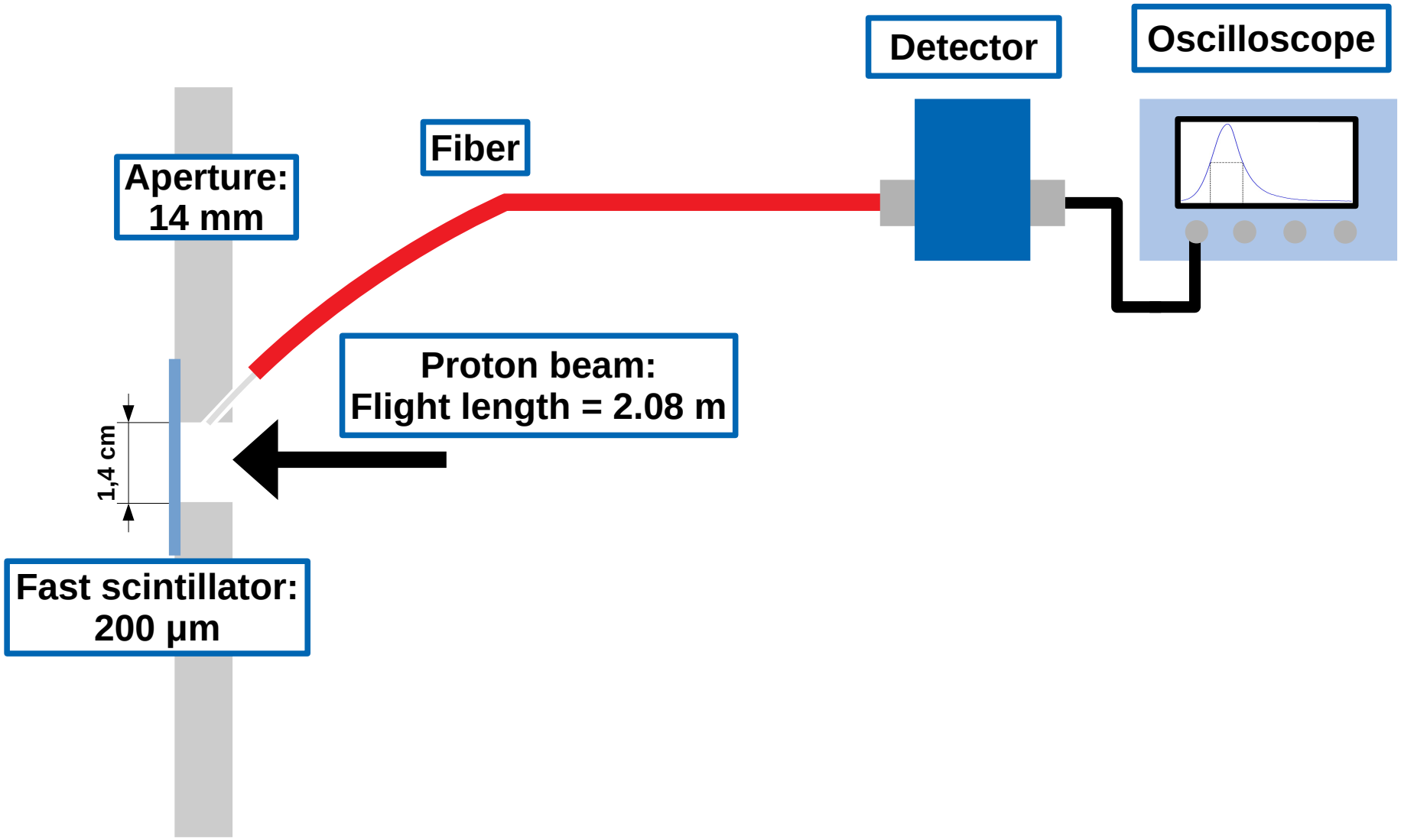




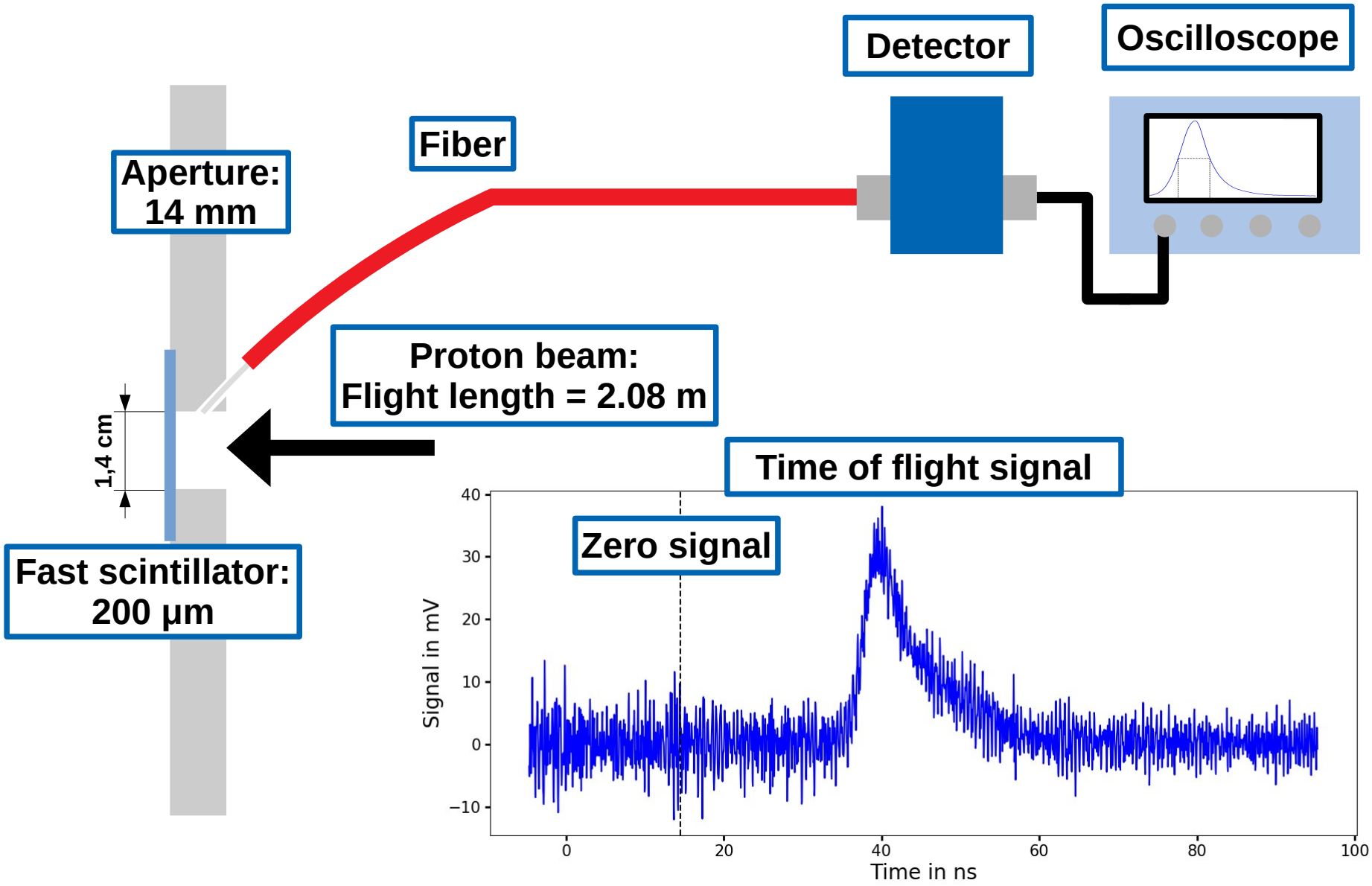


SC: Scatter foil KW: Kapton Window RCFs: Radiochromic Films AP: Aperture
ToF: Time of Flight IC: Ionization Chamber MC: Markus Chamber

Time of Flight: Set-up



Time of Flight: Set-up



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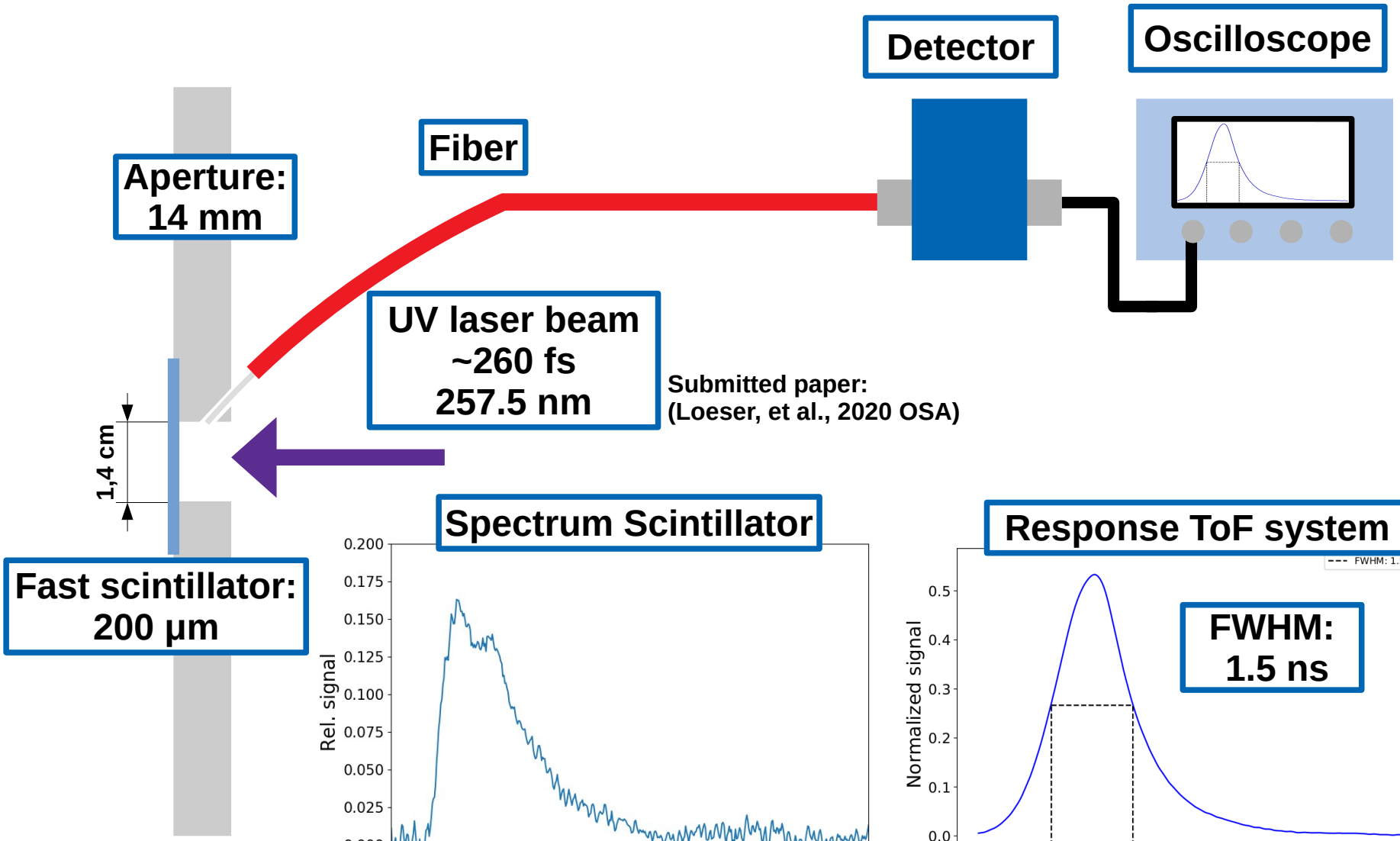
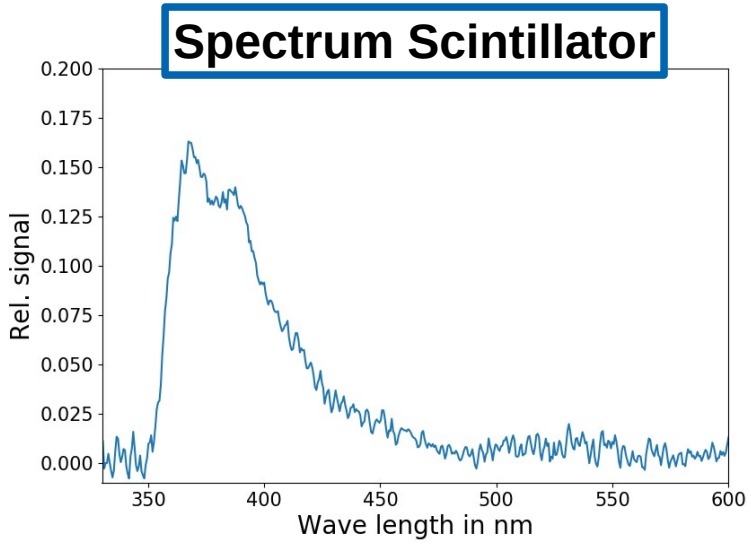
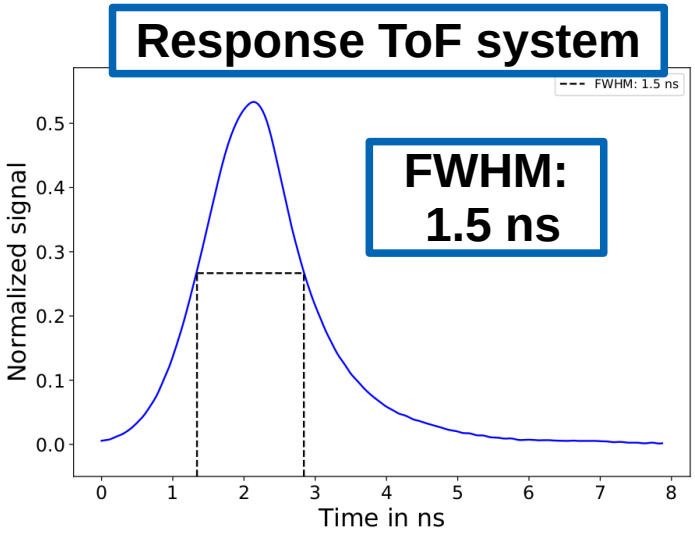
Time of Flight: Response

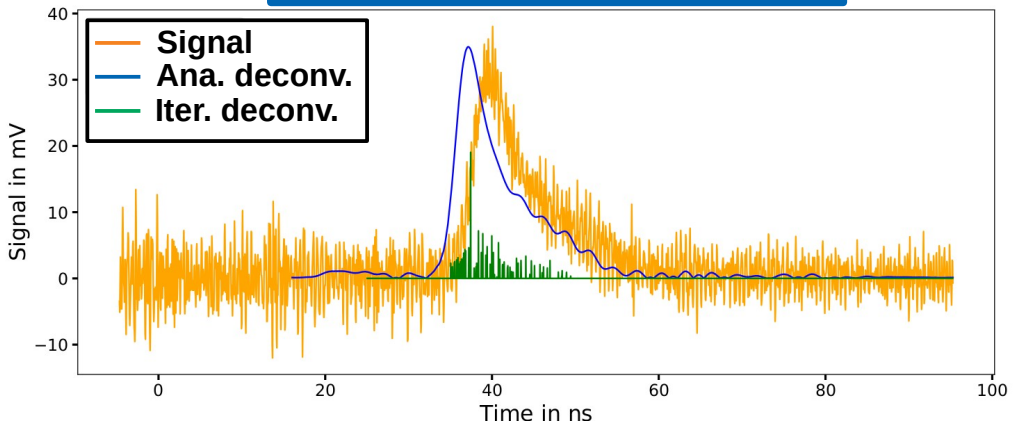






Time of Flight: Mouse model

Signal deconvolution



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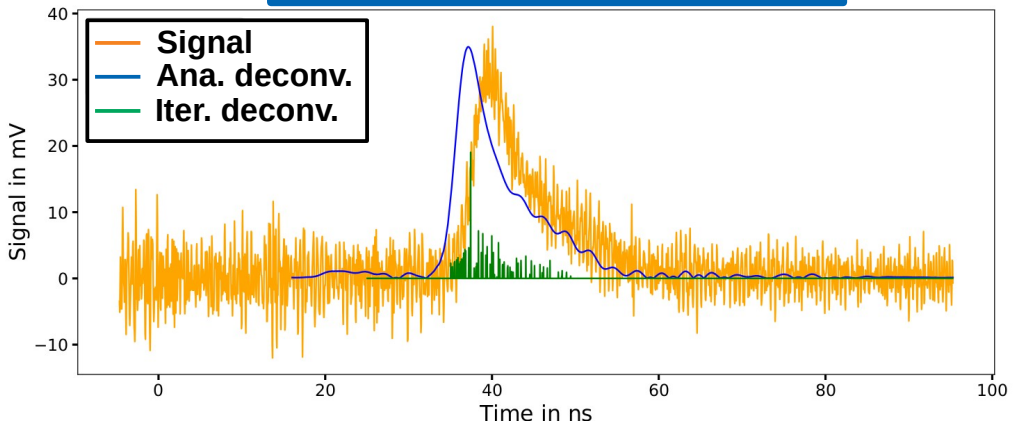
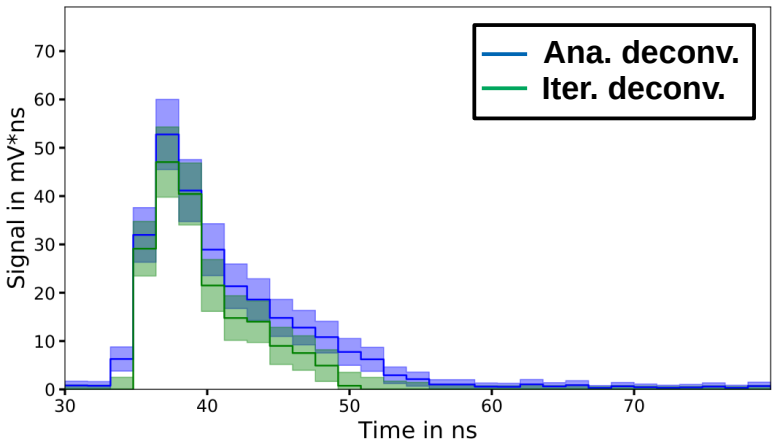
Time of Flight: Mouse model

Signal deconvolution



Time binning



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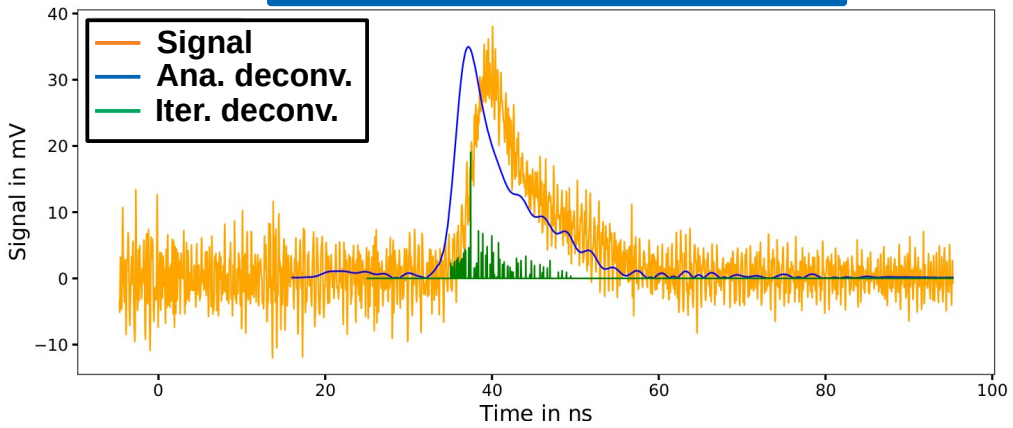
Time of Flight: Mouse model

Signal deconvolution



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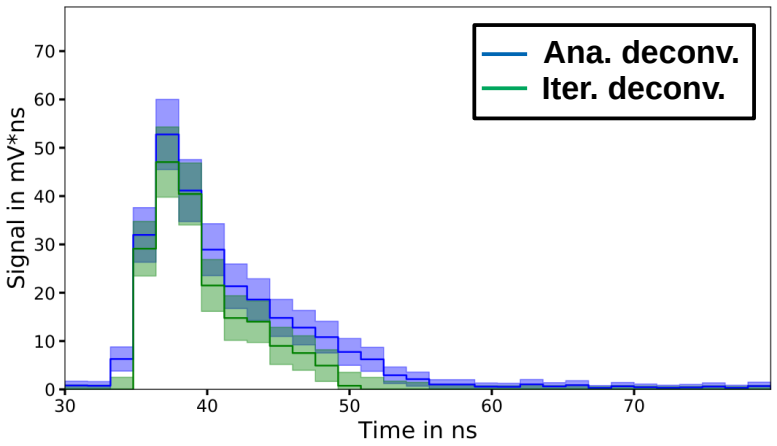
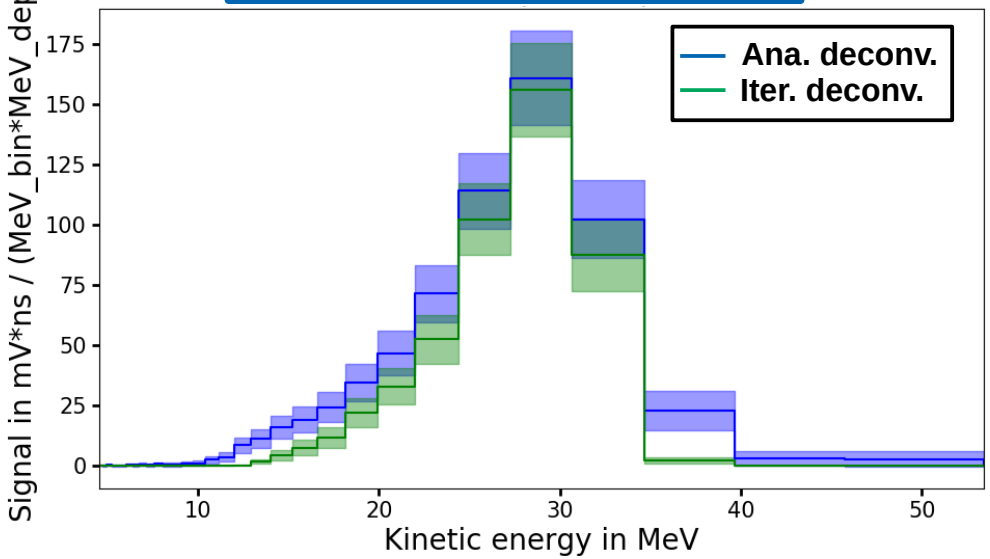
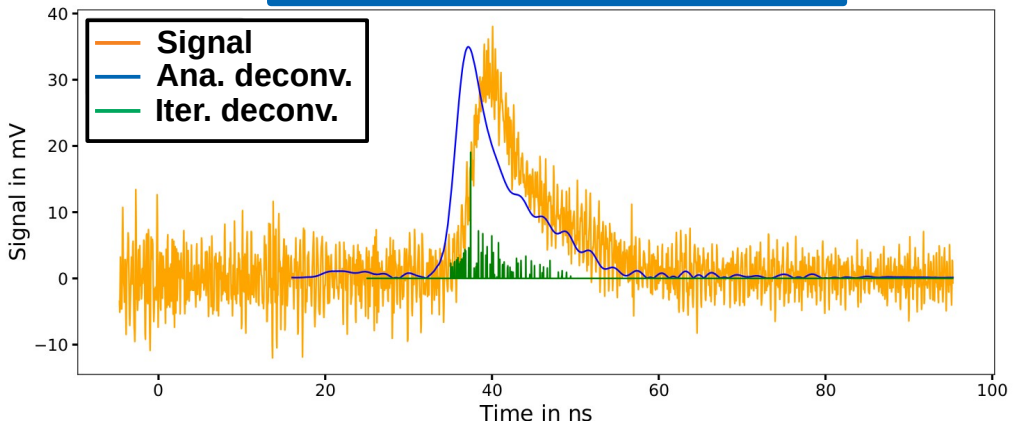


Proton energy spectrum



Time of Flight: Mouse model

Signal deconvolution



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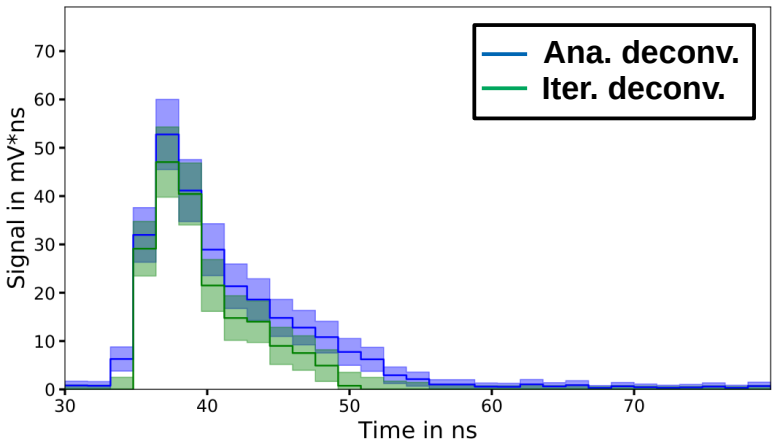

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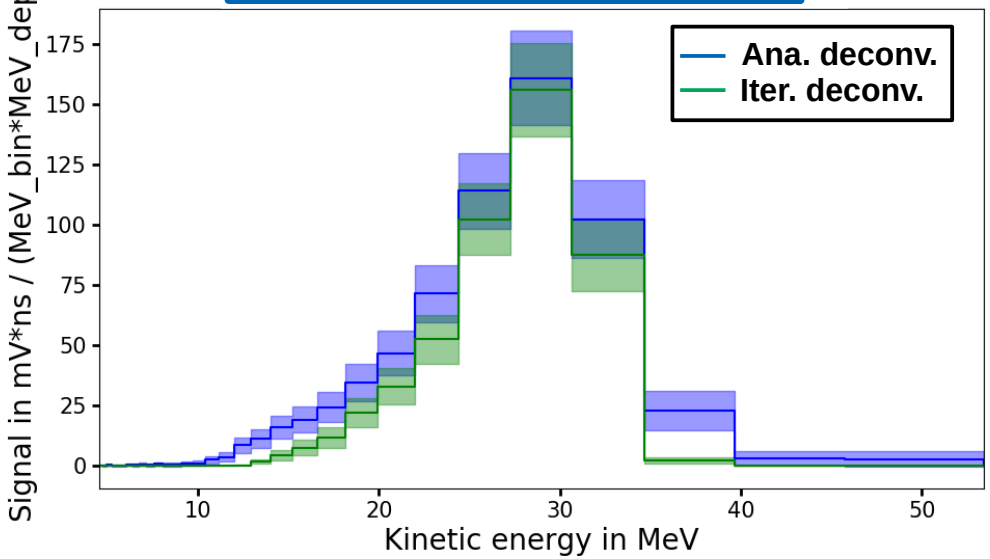
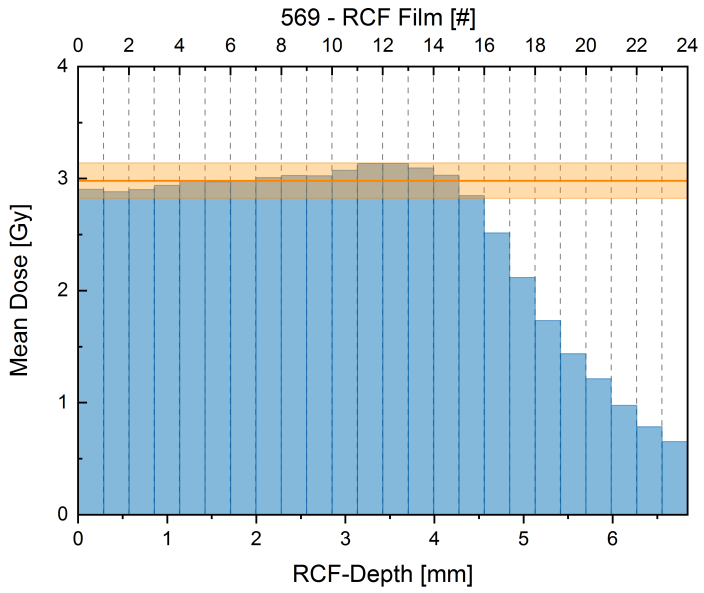
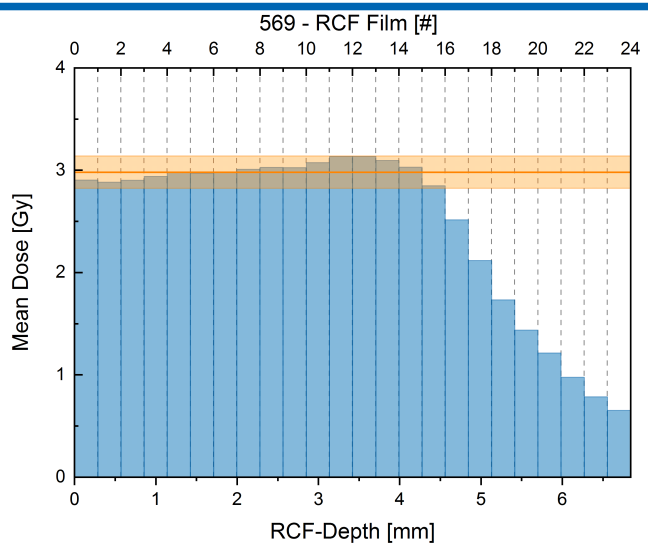


Depth dose distribution

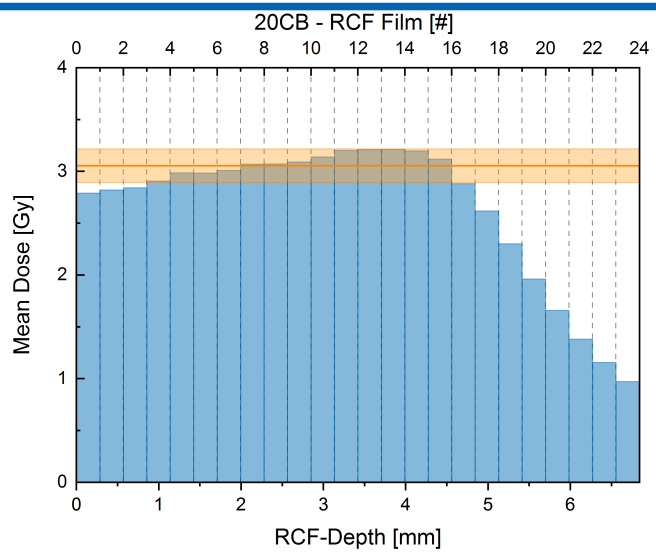


Time of Flight: Depth dose homogeneity

Depth dose distribution stack 1

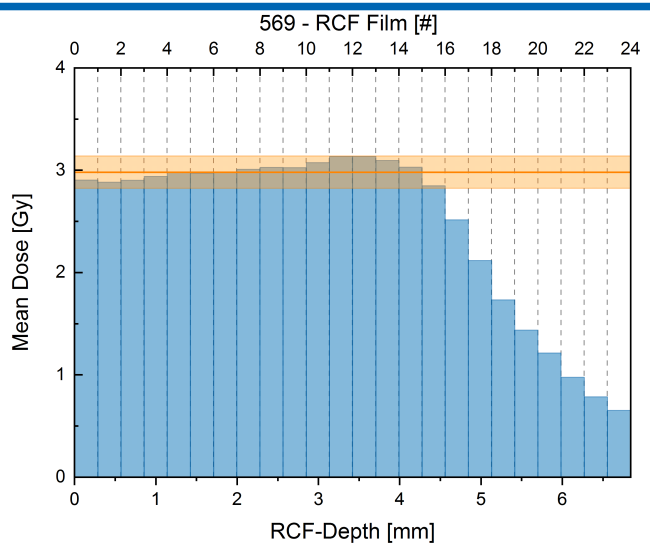


Depth dose distribution stack 2

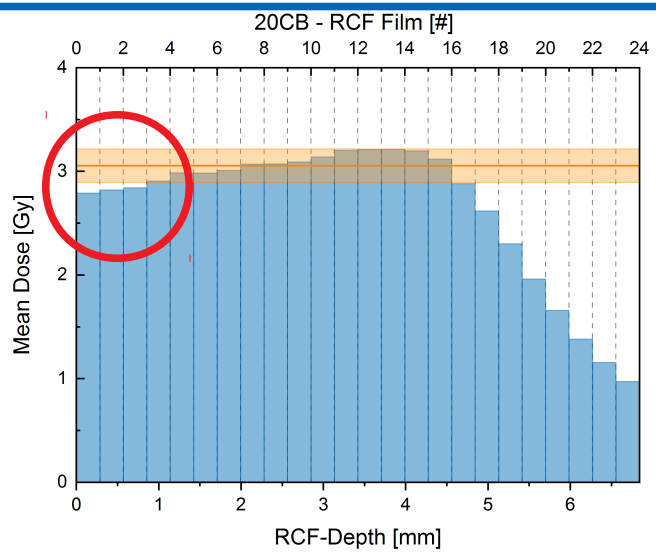


Time of Flight: Depth dose homogeneity

Depth dose distribution stack 1



Depth dose distribution stack 2



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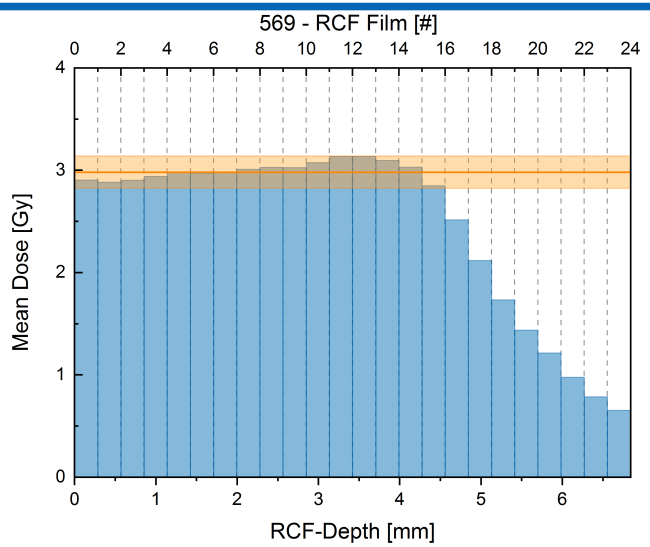
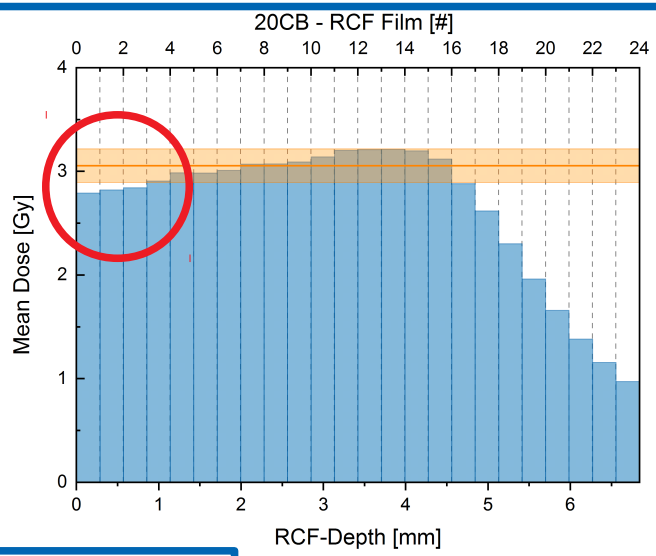
Time of Flight: Depth dose homogeneity

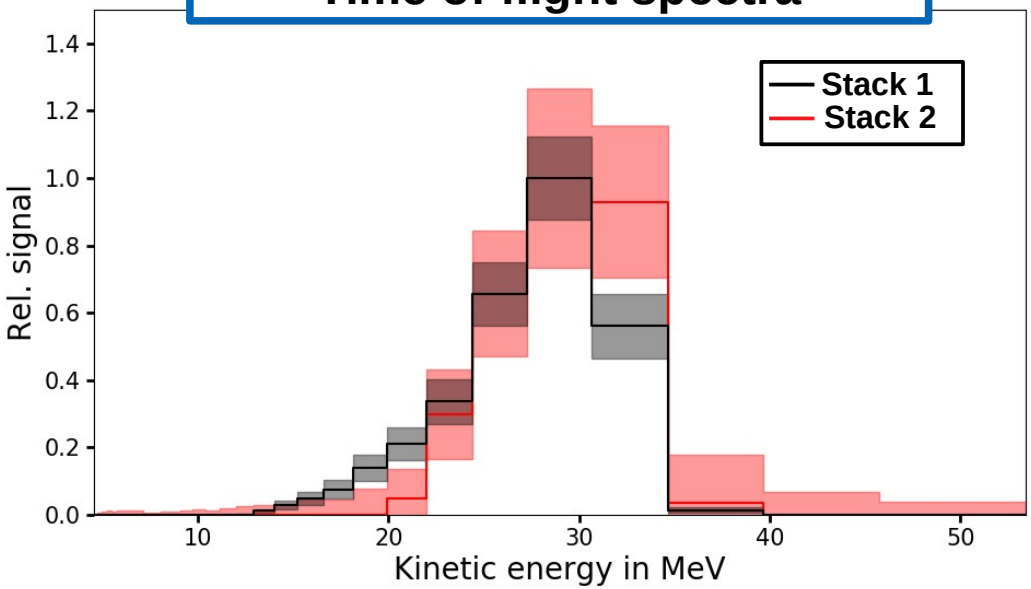
Depth dose distribution stack 1



Depth dose distribution stack 2



Time of flight spectra



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Summary

Absolute dosimetry (not possible during mouse irradiation):

- **RCF stacks are used to measure the 3D dose distribution at the mouse ear position**
  - **No online information & time consuming evaluation**
  - **Information about homogeneity and shape of the dose distribution**

- **Markus chamber is used to measure the dose at the mouse ear position**
  - **Online information**
  - **No information about homogeneity and shape of the dose distribution**

Summary

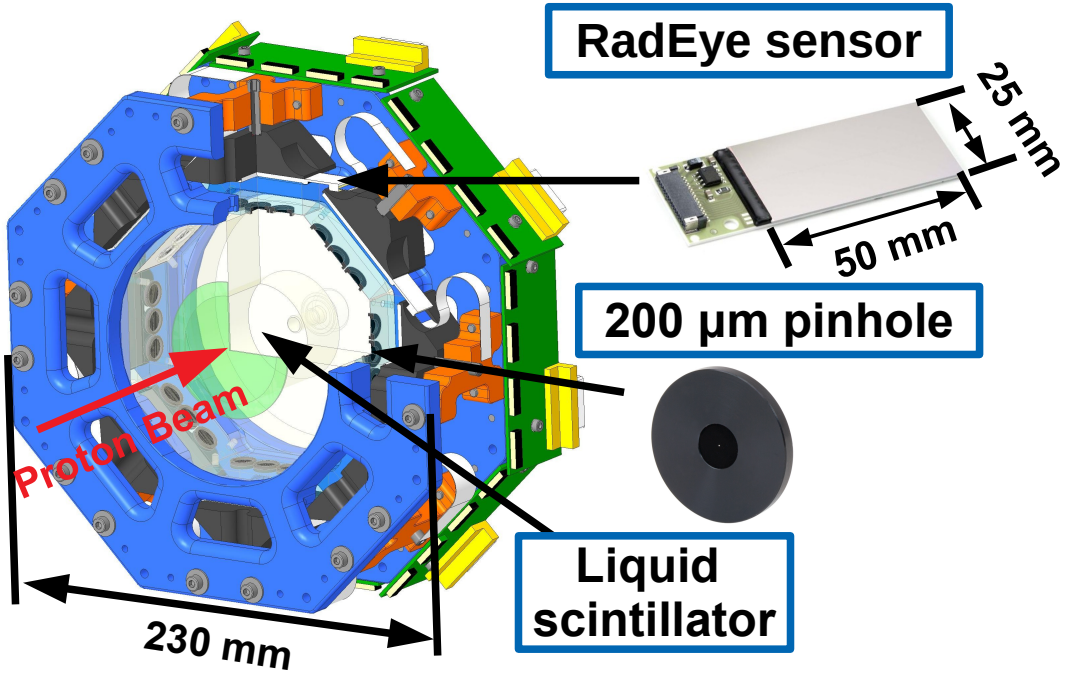
Absolute dosimetry (not possible during mouse irradiation):

- RCF stacks are used to measure the 3D dose distribution at the mouse ear position
  - No online information & time consuming evaluation
  - Information about homogeneity and shape of the dose distribution
- Markus chamber is used to measure the dose at the mouse ear position
  - Online information
  - No information about homogeneity and shape of the dose distribution

Reference dosimetry (possible during mouse irradiation):

- Ionization chamber is used to measure a reference dose which correlates to the dose at the mouse ear position
  - Online information
  - No information about homogeneity and shape of the dose distribution
- Time of flight is used to measure a reference dose and proton energy spectrum which correlate to the dose and proton energy spectrum at the mouse ear position
  - Online information
  - Information about homogeneity and shape of the dose distribution

Outlook: OCTOPOD detector



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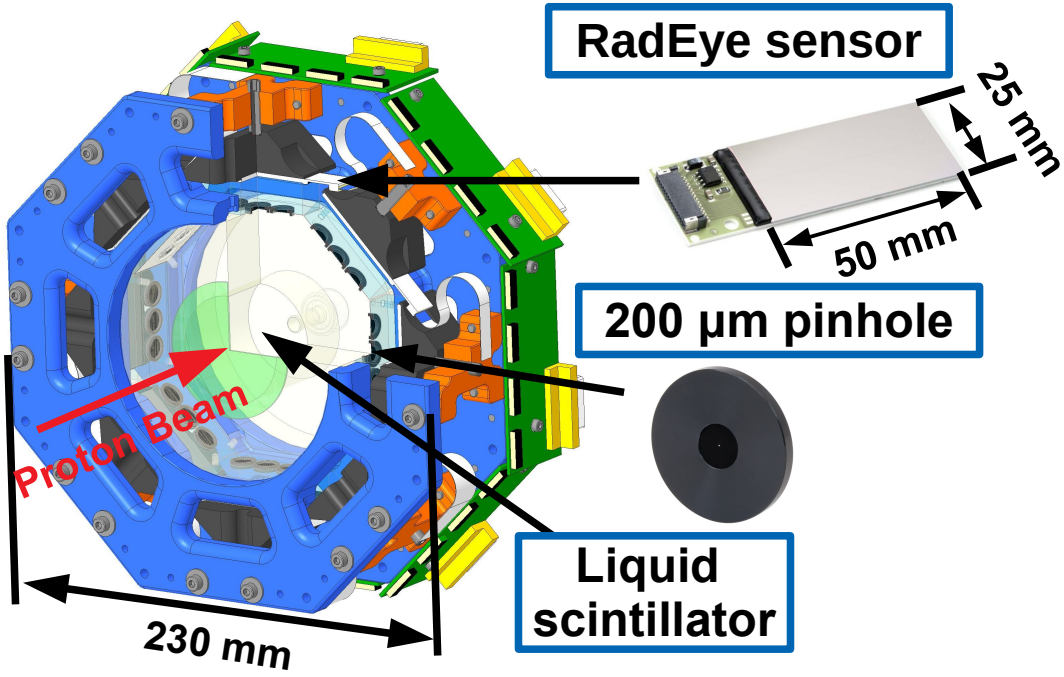

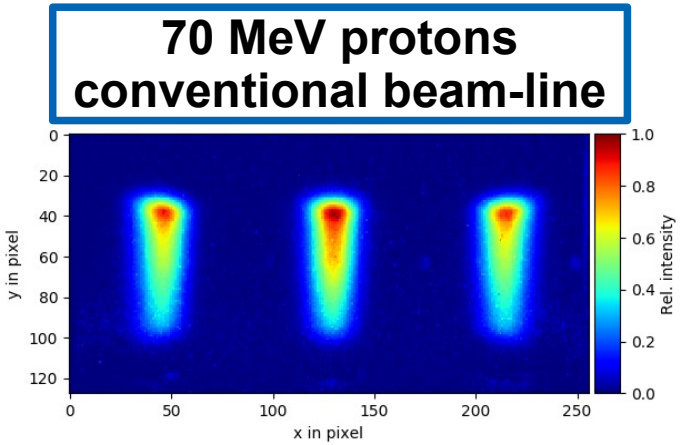

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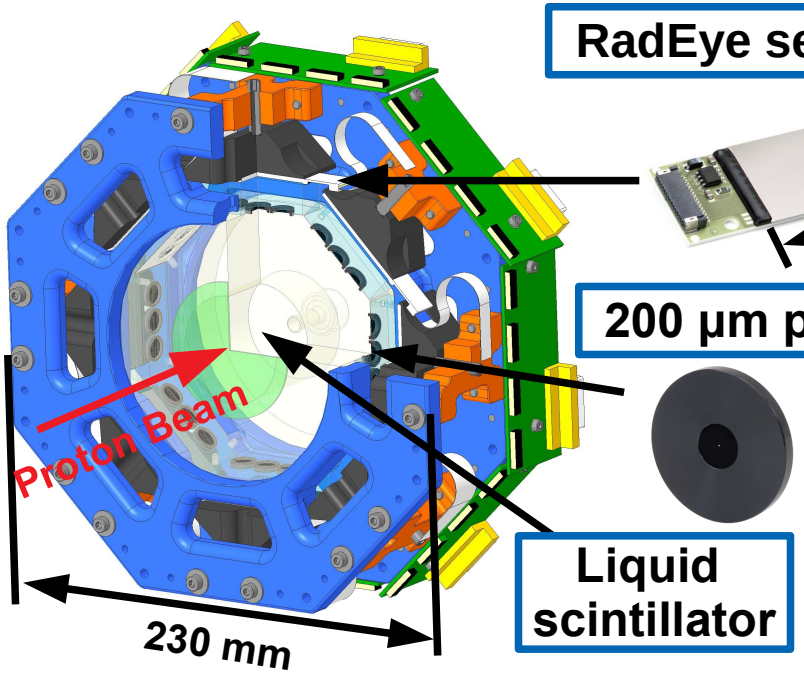
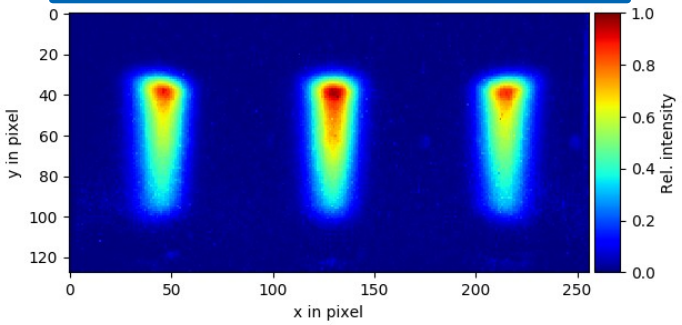
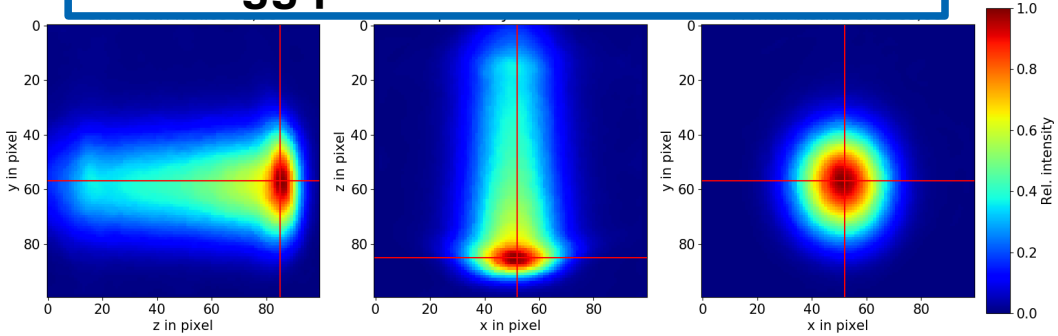
Outlook: OCTOPOD detector



70 MeV protons conventional beam-line



3D Bragg peak reconstruction MLEM



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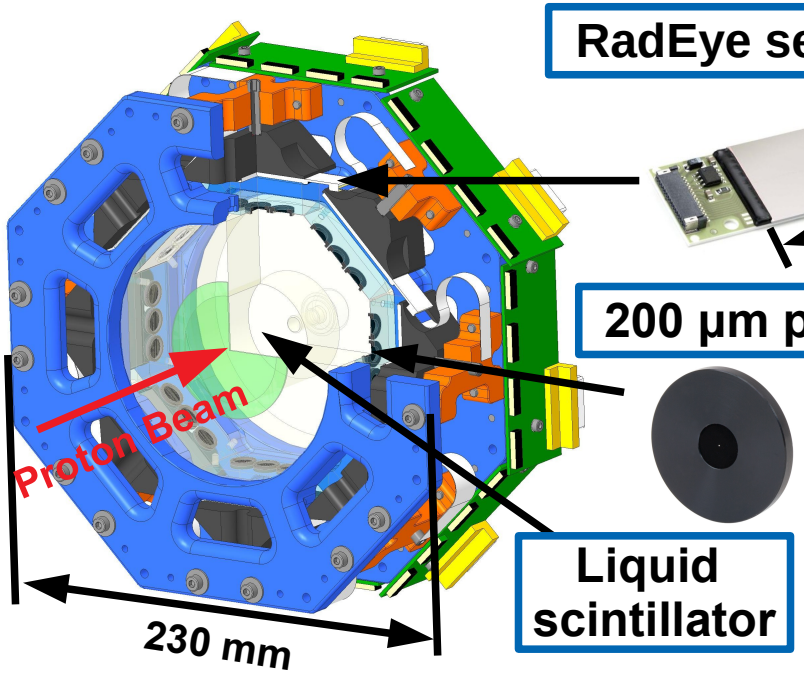
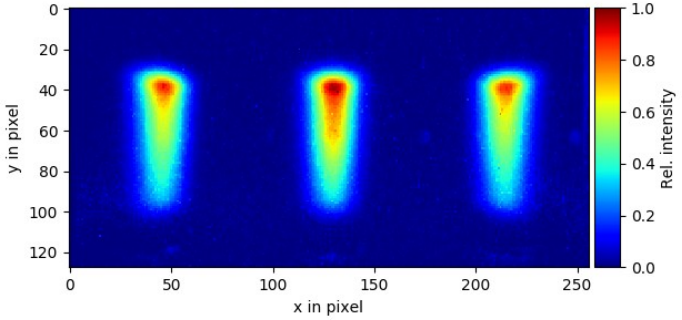
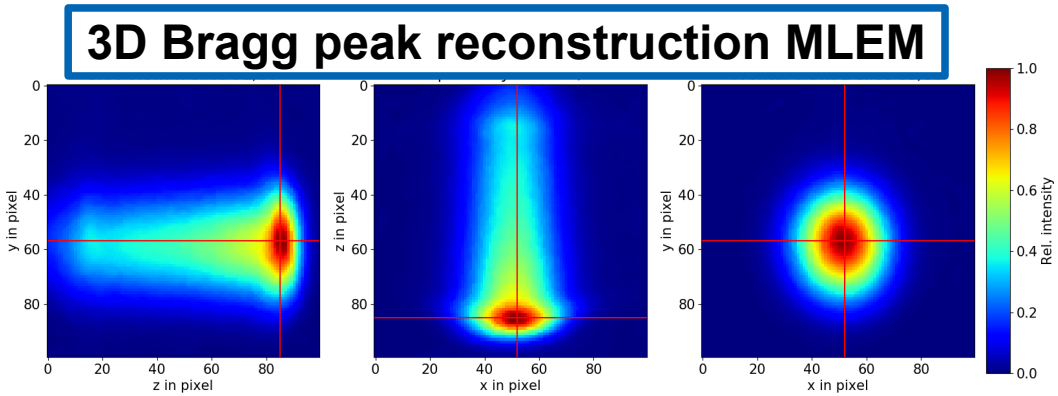
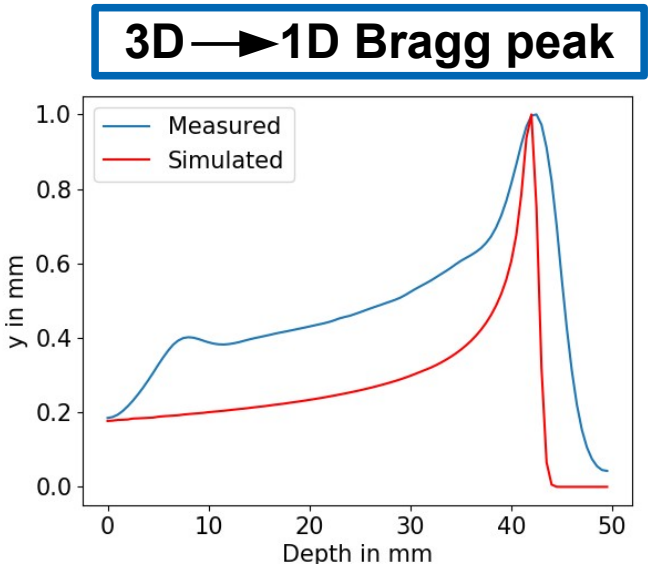
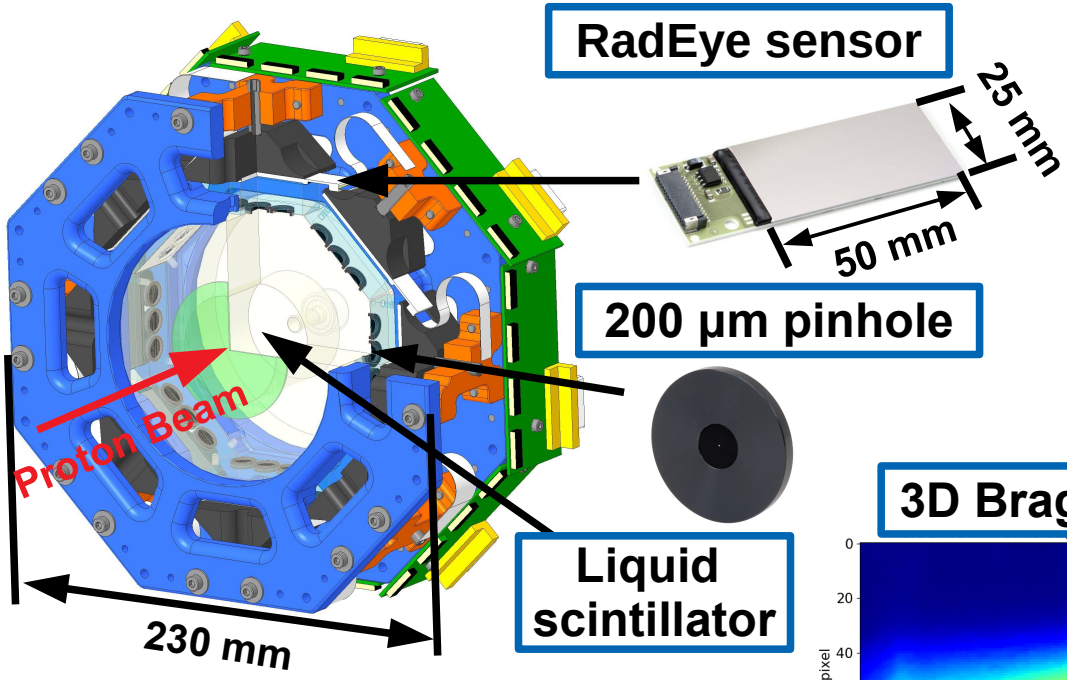


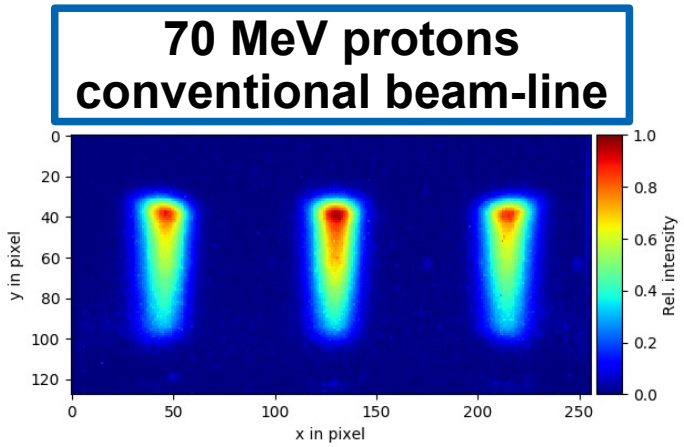


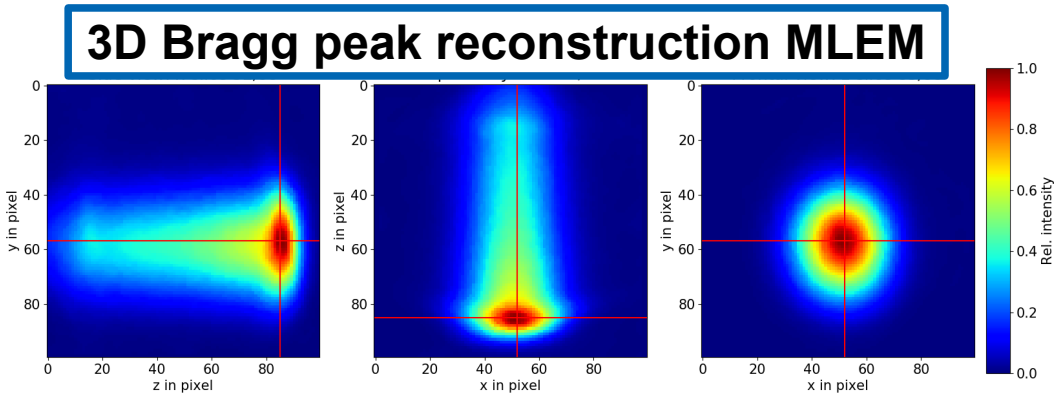


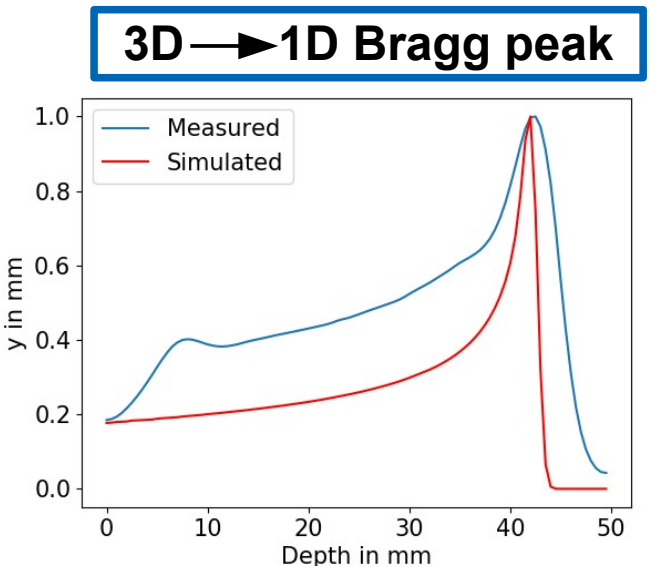


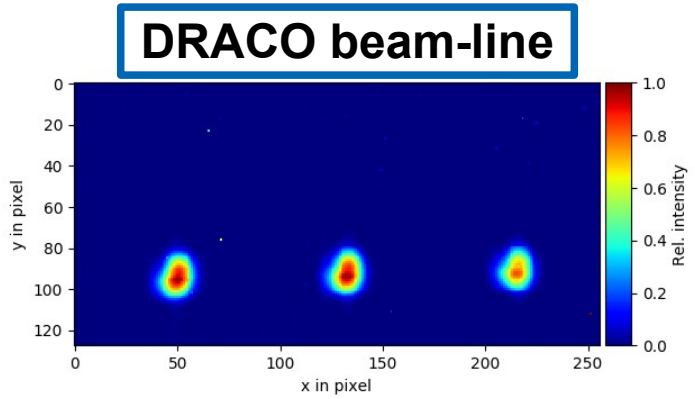
Outlook: OCTOPOD detector











Thank you for your attention!

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