TECHNISCHE UNIVERSITÄT DRESDEN
INSTITUT FÜR KERN- UND TEILCHENPHYSIK
OncoRay National Center for Radiation Research in Oncology Dresden
DRESDEN concept
PARTREC Particle Therapy Research Center

Institute of Nuclear and Particle Physics, Working Group Radiation Physics

Dosimetric Measurements using Radioluminescence of Beryllium oxide

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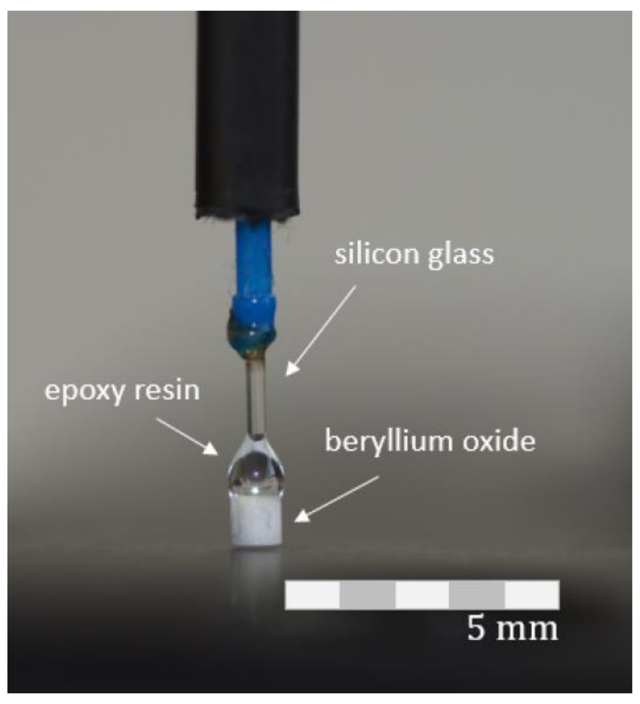
- **Solid state detector for quality assurance in proton fields**
- **High spatial resolution, high time resolution and resistance against magnetic fields and temperature changes**
- **Correction function is needed to compensate saturation effects in fields of high LET**
- **BeO determines time constant of the system → good dynamic behavior in FLASH conditions**

Measuring system

Fiber optic BeO probe

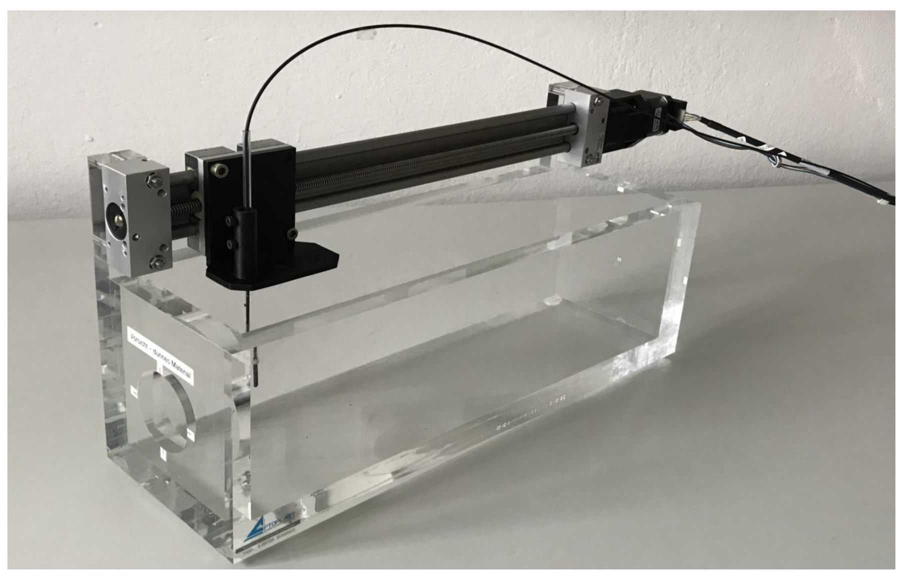


- ionizing radiation causes radioluminescence in the BeO probe, that means photons are emitted
- light guide transports photons to sensor

Uncoated BeO probe, which is glued to the light guide [1].

Methods

- Depth dose curves in the water phantom, reference dose with ionization chamber and passive dosimeter
- Recording the amount of light for each position (photon counting or analogue integration)

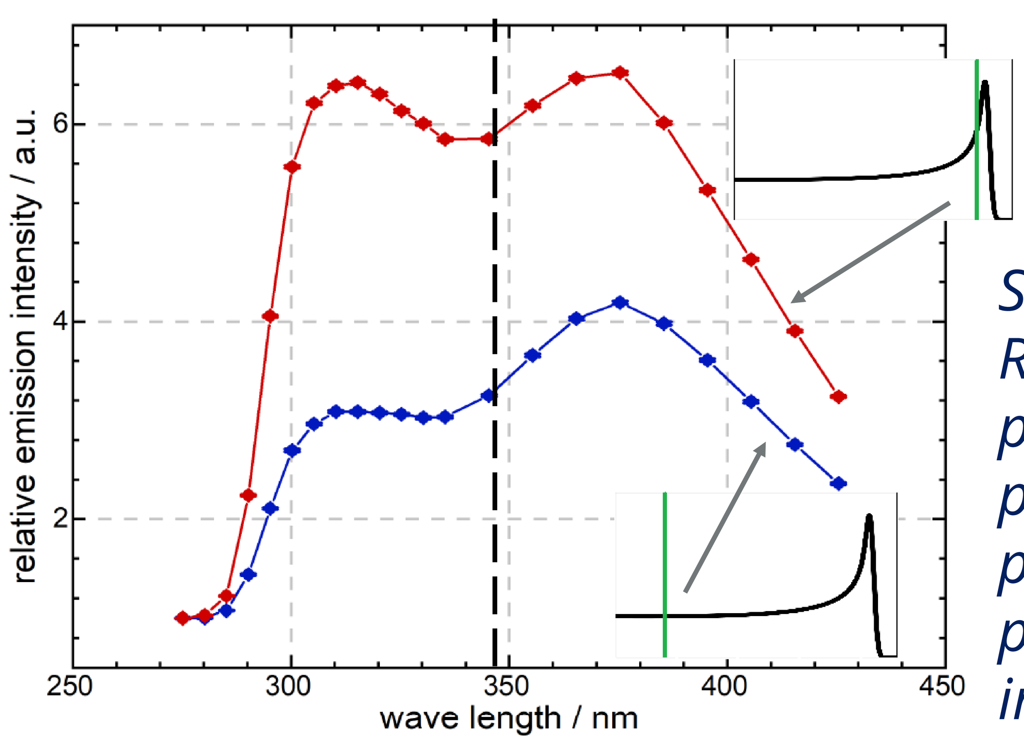


- different measurements with proton fields and X-ray pulses
- coming soon: FLASH proton fields

Water phantom with installed BeO probe.

Proton field measurements in a water phantom

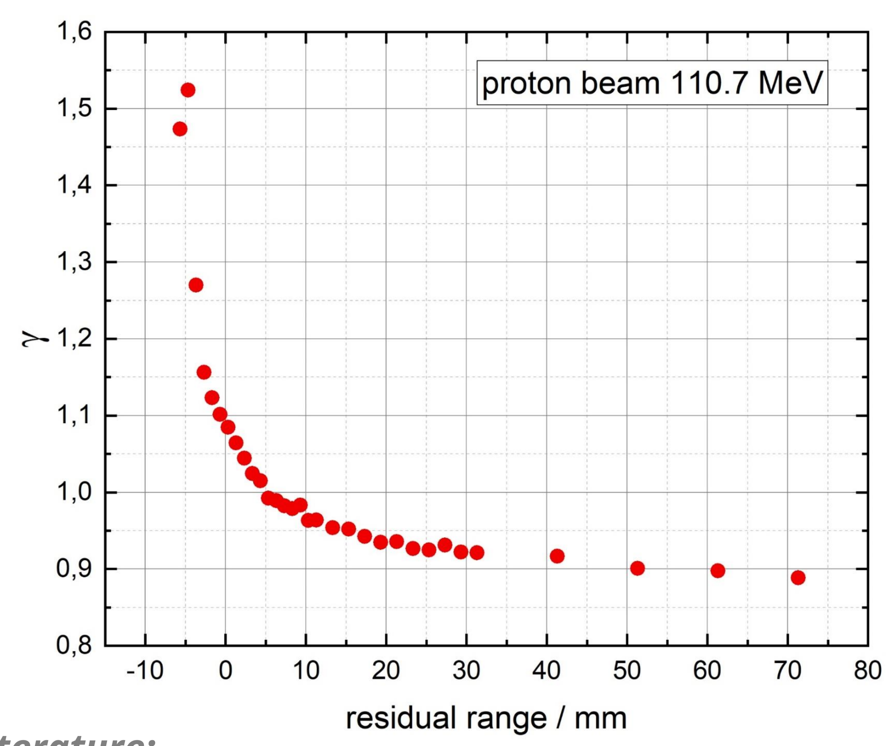
- a quasi mono-energetic proton beam of 110.7 MeV was focused on the BeO probe
- Gaining information about the LET from spectral changes, therefore the spectrum is divided at the minimum (347 nm) by a beam splitter
- $y = \frac{\text{number of photons with } \lambda < 347 \text{ nm}}{\text{number of photons with } \lambda > 347 \text{ nm}}$



Spectrum of Radioluminescence photons caused by protons in the BeO probe at different penetration depths in water.

Results

- Using spectral information in proton fields for improved range determination

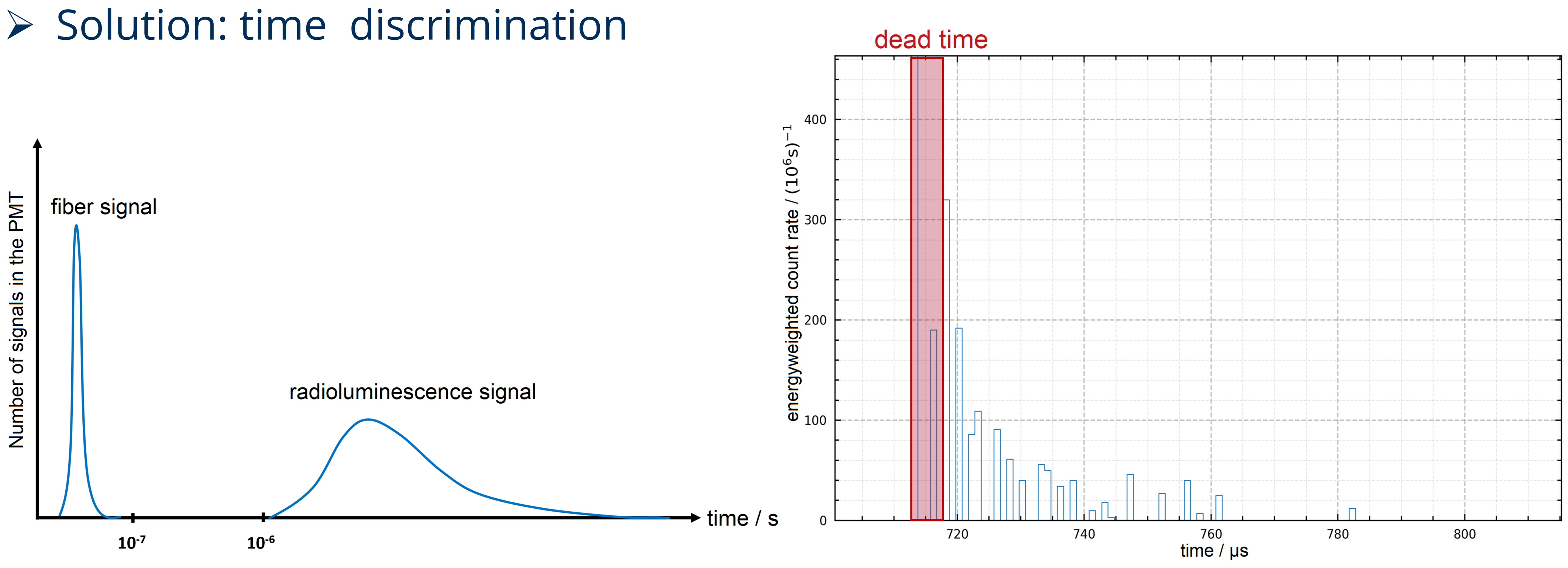


Spectral ratio γ of the BeO probe in dependence of the residual range of protons in water

Pulsed X-ray measurements in a water phantom

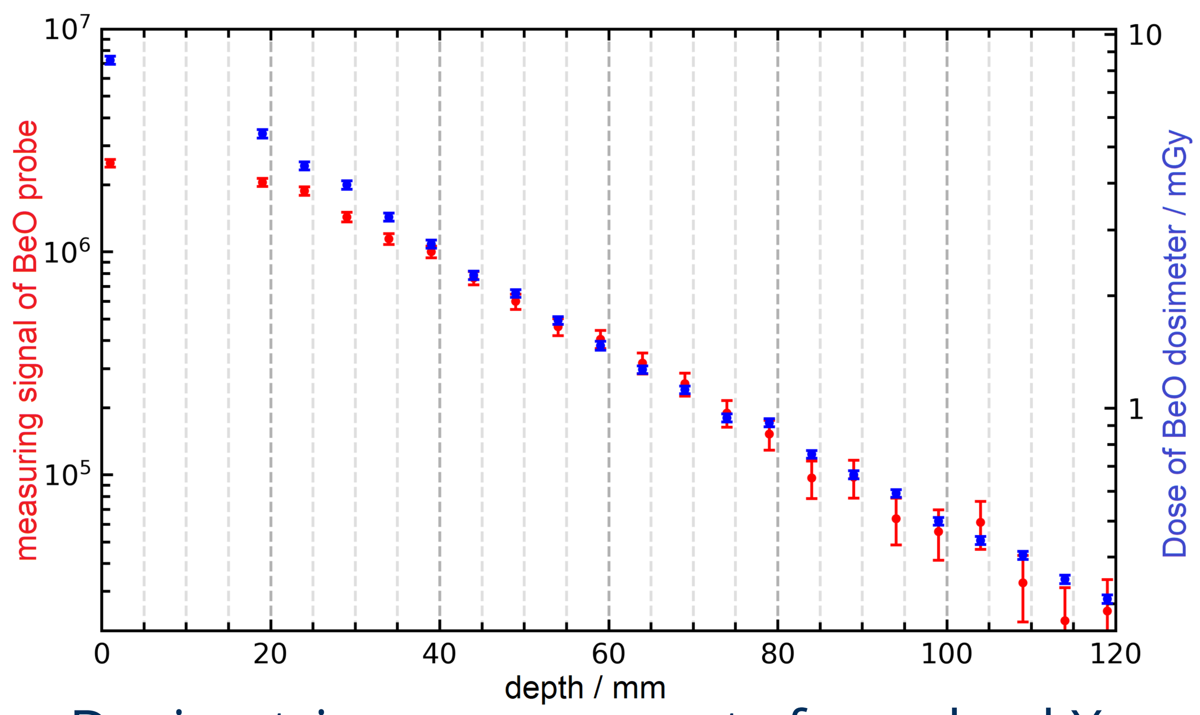
- Pulsed X-rays with 50 ns pulse width and 25 pulses per second were focused on the BeO probe in water which lead to 170 µGy - 6 µGy dose per pulse
- Necessary 1% uncertainty per pulse requires analogue integration instead of single-photon counting for high dose rates
- Problem: stem effect in the fiber generates an additional signal, which decays faster than the generated radioluminescence signal of BeO

➢ Solution: time discrimination



Time structure of fiber signal and radioluminescence signal

Results



Measurement signal of the BeO probe and the reference measurement with a BeO OSL-dosimeter for variied penetration depths in water.

- Dosimetric measurements for pulsed X-rays using radioluminescence of BeO are possible

Literature:

1 E. Metzner, "Optimization of Spectral Fiber Dosimetry", Master thesis, IKTP, TU Dresden, Dresden, Germany, 2021.

2 L. Grabs, "Korrektur des LET-abhängigen Ansprechvermögens von faseroptischen Dosimetrie-Sonden", Master thesis, IKTP, TU Dresden, Dresden, Germany, 2020

3 T. Teichmann, J. Sponner, J. Henniger, "Fiber optical dose rate measurement based on the luminescence of beryllium oxide", EPJ Web of Conferences, 2018.