Abstract of an oral presentation at the Joint Conference of the ÖGMP, DGMP and SGSMP, Dreiländertagung der Medizinischen Physik, 19.-22. September 2021, Digital Conference. Published in: Dietmar Georg and Wolfgang Birkfellner (eds.), *Abstractband.* ISBN: 978-3-948023-16-4

Development of an Optical Micromegas Detector for Precision Particle Beam QA

J. Bortfeldt[1], O. Belker[1], A. Denker[2], A. Dittwald[2], A. Frenzel[1], K. Schnürle[1], M. Würl[1], K. Parodi[1]

[1] Ludwig-Maximilians-Universität München, Lehrstuhl für Medizinische Physik, München, Deutschland
[2] Protonentherapie, Helmholtz-Zentrum Berlin, Deutschland

Introduction
Small beam diameters of 1mm FWHM and below and low particle energies (20-50MeV), as needed for precision pre-clinical proton irradiation, challenge available quality assurance devices. Radiochromic films yield the desired spatial resolution, but their application is tedious and results are only offline available. We are developing a Micromegas detector with optical readout, able to resolve beam spots below 1mm in real-time and with minimum beam shape distortion.

Materials & Methods
Micromegas detect ionizing radiation through the ionization charge that is produced in a few mm wide, gas-filled region between a planar cathode and a micro mesh. Ionization electrons are amplified in avalanches in 40kV/cm electric fields between mesh and anode. The scintillation light emitted in the CF_4 gas mixture [1] during the amplification is observed through a transparent glass anode with a 1 MPixel EMCCD camera behind a mirror. Detection sensitivity can be tuned for single particle or for beam integrating operation. As the proton beam traverses only a 12µm thick aluminum window and a 2µm thick aluminized Mylar cathode before registration, beam distortion due to scattering is minimized.

Results
We have developed and successfully tested a prototype with radioactive sources and in 20MeV proton beams (see Fig. 1). It was possible to detect individual 5.9keV photons and to record the proton beam shape for various beam currents between 0.03 and 20pA. An improved version, used to characterize pre-clinical proton beams below 1mm FWHM will be presented.

Summary
Micromegas with optical readout were developed and tested. They are suitable for precise pre-clinical proton beam characterization.

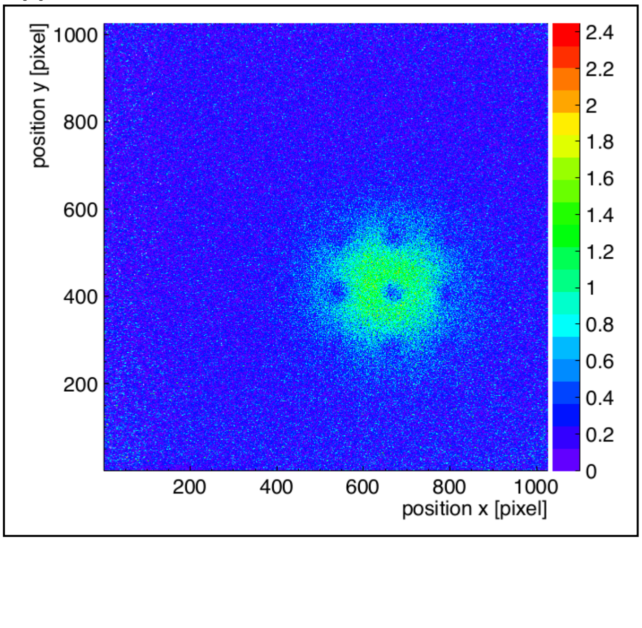
Appendix 1


Figure 1: Shape of a 20MeV, 4mm FWHM proton beam at I_{beam} = 12pA. The color bar describes intensity in arbitrary units.

References

[1] Brunbauer F, et al. Radiation imaging with glass Micromegas. *Nucl. Instrum. Meth. A.* 2020; 955:163320

Supported by ERC grant 725539 (SIRMIO).