INTRODUCTION

- Fluorescent Nuclear Track Detectors (FNTDs) (Fig. 1) are based on biocompatible single aluminium oxide crystals doped with carbon and magnesium (Al$_2$O$_3$:C, Mg).
- Their superior spatial resolution allows for monitoring single particle tracks with a detection efficiency close to 100% for ions with LET greater than approximately 0.2 keV/μm [1].
- Implanted detectors or detectors in body cavities can help accessing direct information on a radiation treatment such as ion fluences, energies or ranges.
- We therefore measured ion ranges for particle beams of low and clinical fluence in order to investigate the feasibility of future in-vivo FNTD applications.

FNTDs

- Because FNTDs are grown in a highly reduced atmosphere, they contain high concentration of clustered oxygen vacancy defects charge compensated by magnesium ions substituting aluminium ions in the crystal lattice (Fig. 2).
- A high quantum yield of secondary electrons under ionising irradiation (middle); radiochromic transformation (right)

EXPERIMENT 1: Range measurements

FNTDs were irradiated with mono-energetic ions using a broad range of particle types (hydrogen to xenon), kinetic energies, and particle fluences $\Phi$ (from $4.5 \times 10^3$ up to $1.0 \times 10^7$ cm$^{-2}$) (Fig. 5).

EXPERIMENT 2: Absorbed dose measurements

FNTDs were homogeneously irradiated with 50 MeV/u to establish a dose-fluorescence relation for this treatment modality (Fig. 7, Fig. 8).

EXPERIMENT 3: Treatment plan verification

FNTDs were placed in a PMMA cylinder as a phantom undergoing clinical workflow. Based on computed tomography (CT) scans, a treatment plan (applying 1 Gy protons at the detector edge) was created at HIT (Fig. 9). The planned depth-dose curve at 80% was compared to the detected intensity profile.

REFERENCES


Acknowledgements:

We would like to thank Felix Besterer (DKFZ LIC) for his support concerning detector readout, as well as Dr. Roland Repnow, Manfred Klink (both MPI/K) and our colleagues at HIT for the possibility of and the help with irradiation.