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# Chemical radiation dosimetry in magnetic fields: Characterization of a Fricke-type chemical detector in 6 MV photon beams and magnetic fields up to 1.42 T

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**Introduction**
The ideal detector for MR guided radiotherapy (MRgRT) applications is not influenced by the presence of a magnetic field during the irradiation. The Fricke-type detector is a chemical dosimetry method in which ferrous iron ($Fe^{2+}$) is oxidized to ferric iron ($Fe^{3+}$) upon irradiation. The increase of the $Fe^{3+}$ concentration is proportional to the absorbed dose and it is not expected that the chemical reactions are greatly influenced by the magnetic field.

**Materials and Methods**
The Fricke detector consists of a perfluoroakoxy alkane (PFA) sample cup filled to the top with an acidic ferrous iron solution. The detector readout was performed with a UV spectrophotometer (Varian Cary 6000i) by measuring the absorbance change of the solution upon irradiation and calculating the change of the $Fe^{3+}$ concentration ($\Delta c$) using the Lambert-Beer law. The irradiations were performed in a 6 MV photon beam of a linear accelerator (Elekta Precise Treatment System) using a dose rate of 2 –3 Gy/min and a pulse repetition frequency of 400 Hz. A magnetic field was generated in between the pole shoes of a constant-current driven electromagnet (Bruker ER0173W), which was homogeneous within 1 μT over 1 $cm^3$ region up to 1.42 T.

**Results**
The linearity of the Fricke response curves between 6 Gy and 100 Gy is not influenced by the applied magnetic fields (0 T –1.42 T) during the irradiation with a 6 MV photon beam. The magnetic field correction factors k_B for the Fricke detector for magnetic field strengths of 0.35 T and 1.42 T are 0.995±0.005 and 0.998±0.005, respectively.

**Conclusion**
The response of the Fricke detector is not significantly influenced by the presence of a magnetic field during the irradiation and the correction for the applied magnetic field is <0.5%. This correction is rather small in comparison to ionization chamber type detectors, which have corrections up to several percent dependent on the mutual orientation of the detector and the magnetic field.

**Primary authors:** TRACHSEL, Maria (Federal Office of Metrology METAS); POJTINGER, Stefan (Physikalisch-Technische Bundesanstalt); MEIER, Markus (Physikalisch-Technische Bundesanstalt); SCHRADER, Markus (Physikalisch-Technische Bundesanstalt); KAPSCH, Ralf-Peter (Physikalisch-Technische Bundesanstalt); KOTTLER, Christian (Federal Office of Metrology METAS)

**Presenter:** TRACHSEL, Maria (Federal Office of Metrology METAS)

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