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GammaMRI: towards high-resolution single photon imaging using highly-polarized gamma-emitting nuclei

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A new hybrid medical imaging modality with promising benefits for in vivo studies has been under development since 2017 by the CERN-UCM-UNIGE and HEdS-Geneva collaboration. With this technique, called gammaMRI, we are aiming to combine the high spatial resolution of MRI (~1 mm) while increasing the sensitivity of the technique using radioactive tracers as contrast agents, as performed in PET and SPECT [1,2]. In addition, we can possibly profit from the clinical benefits of xenon isotopes [3].

The gammaMRI setup has been assembled and tested over the timespan of the last two years. This technique is based on the detection of asymmetric γ-ray emission of long-lived polarized nuclear states in the presence of low magnetic fields (4.5 mT) [2]. The nuclei used in our proof- of- principle experiments are the long-lived isomers of Xe isotopes: 129mXe (T1/2 = 8.9 d),131mXe (T1/2 = 11.8 d) and 133mXe (T1/2 = 2.18 d) produced at the ILL high flux reactor in Grenoble and at the ISOLDE facility at CERN [4].

The two established methods of Xe production required different extraction techniques of these isotopes. Due to the gaseous state of the radioactivity used, special handling and radiation protection procedures were followed. The production of 133mXe was tested at GLM (General Low Mass) end station at ISOLDE. Satisfying yields of 133mXe (80 – 270 MBq) were obtained from thorium carbide (ThC) and uranium carbide (UCx) targets. During LS2 129mXe (300 MBq) and 131mXe (100 MBq) isotopes were produced at ILL by irradiating stable Xe atoms with thermal neutrons. During the experimental period of 2019, the finalised polarisation setup was tested under working conditions. Different parameters contributing to polarisation efficiency of xenon were tested: partial pressure of Xe and N2, gas mixture temperatures, Rb vapor saturation, glass cell shapes and the internal wall coating for nuclear spin relaxation etc. This contribution will present the principle of gammaMRI and the results of the tests performed this summer.

References:
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