EndoTOFPET-US: a novel multimodal tool for endoscopy and positron emission tomograhy

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The endoTOFPET-US project aims to jointly exploit Time-Of-Flight Positron Emission Tomography (TOFPET) and ultrasound endoscopy with a multi-modal instrument for diagnostic and therapeutic oncology. This will require the development of two novel detectors, a PET head extension for a commercial ultrasound endoscope (depicted in Fig.1) and an outer PET plate, shown in Fig.2, is to be placed outside the body in coincidence with the PET head.

The paper will outline the functionality of the proposed instrument and the challenges for its realization. The high level of miniaturization and integration poses strong demands to the fields of scintillating crystallography, ultra-fast photodetection, highly integrated electronics, and system integration. Possible solutions derive from techniques and instrumentation prominent in high energy physics like fast scintillators coupled to diffractive optics to increase light output, and fast and compact photodetectors such as silicon photomultipliers (SiPMs) with the option of single SPAD readout. For the project both conventional SiPM (for the outer detector plate) and custom developed digital-SPAD arrays (for the endoscopic detector head) are employed.

A coincidence time of flight resolution (CTR) of 200ps FWHM is mandatory to suppress the background from organs surrounding the area of interest. First results using LSO crystals with specific doping, together with commercial SiPMs (Hamamatsu), produced a CTR of 180ps FWHM[1].

The simulated energy resolution for the head and plate detectors are presented. A dedicated GATE simulation is used to optimize the overall detector geometry [2].

The first design and integration considerations will be given together with an outlook of the future R&D until the completion of the project.

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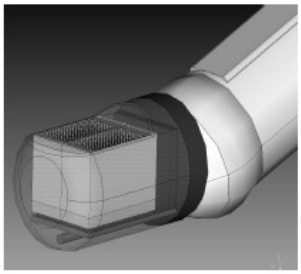

Figure 1: 3D rendering of the inner probe extension as mounted on the transrectal ultrasound probe. The picture shows the cristal matrix with integrated electronics beneath and the EM sensor for position tracking.

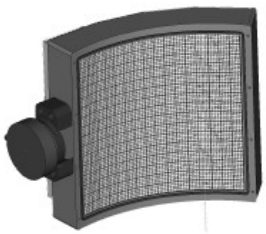

Figure 2: 3D rendering of the outer PET plate. In the picture are shown: the crystal matrix in a pointing geometry, the aluminium casing and the attachment for a robotic arm.

References

[1] E. Auffray et al., A Comprehensive & Systematic Study of Coincidence Time Resolution and Light Yield Using Scintillators of Different Size, Wrapping and Doping, IEEE NSS-MIC 2011

[2] E. Garutti, A. Silenzi, et al., Single Channel Optimization for an Endoscopic Time-of-Flight Positron Emission Tomography Detector, IEEE NSS-MIC 2011