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# Pushing time resolution for ToF-PET molecular imaging employing the FastIC ASIC

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Time-of-flight Positron Emission Tomography (TOF-PET) scanning is a molecular imaging procedure for early diagnosis and even prevention in cancer disease. Standard PET scanners are mainly built by modules consisting of scintillation crystals optically coupled to photo-detectors with fast readout electronics. Pushing the limits of the readout system will improve tomographic image
reconstruction quality by reducing background correlations and thus improving signal-to-noise-ratio (SNR).

The 8-channel FastIC ASIC developed in CMOS 65 nm technology is capable of processing fast signals with a precise time stamp and a linear energy measurement of the detected events. Power consumption per channel is ≈ 12 mW. Readout channels can be processed individually or they can be summed in groups of 4 channels in view of exploiting sensor segmentation. Time information is extracted from the resulting reconstructed pulse and thus lowering the electronic jitter contribution.

This work provides an extensive analysis of the potential capabilities of the FastIC ASIC coupled to different scintillators and photo-detectors from different manufacturers. For 2 × 2 × 3 mm3 LSO:Ce:0.2%Ca crystals coupled to SiPMs from HPK (S13360-3050PE) or FBK (NUV-HD-LF, 3.2 × 3.12 mm2, pixel 40 µm), coincidence time resolution (CTR) values of 94 ± 2 and 76 ± 2 ps FWHM were obtained respectively upon 511-keV gamma excitation. When increasing the crystal length toward 20 mm and coupling to SiPMs from FBK, the CTR slightly deteriorates toward 126 ± 3 ps, in line with the best achieved CTR results (using the NINO ASIC) for PET-sized geometries and about twofold superior to the Siemens Biograph Vision. Beside measurements with standard scintillators, the applicability of the chip for prompt low light emitters (eg. using Cherenkov radiators such as BGO, TlCl and PbF2) was investigated. Further, we will discuss measurements on the summation feature of the ASIC.

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