

A Comparative Study on Various Capacitance Compensation Technique for SiPM based TOF-PET detector

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Purpose-SiPM is a highly used photosensor in PET systems, however, its detector capacitance needs to be compensated for fast timing. Two capacitance compensation technique has been proposed, active compensation using an op-amp, and passive compensation using a balun transformer. In this study, we evaluated the performance of two compensation technique by measuring the CTR with the same reference detector.

Methods-We used R9800 PMT coupled with $4 \times 4 \times 10$ mm³ LYSO as a reference detector. The single timing resolution of the reference detector was 233.3 ps. For the active compensation, we used 4×4 mm² SiPM coupled with $3 \times 3 \times 20$ mm³ LGSO wrapped with ESR. and for the passive, we used 3×3 mm² SiPM coupled with the same crystal. We also compared the CTR using the raw signal and the high pass filtered signal from the SiPM anode. The time constant of the high pass filter used was 0.5 ns (10 pF & 50Ω).

Results-The CTR of the raw and the filtered signal of SiPM anode were 541.6 ps and 400 ps respectively. The CTR of the active compensation technique was 397.1 ps, 26.7 % improvement from that of the raw signal, and that of the passive compensation technique was 272.4 ps, 49.8 % improvement from that of the raw signal. The calculated CTR of the active compensated pair was 454.6 ps and that of passive compensated pair was 192.1 ps. Optimal CTR obtained with the high pass filter had an equivalent performance with that obtained with the active compensation technique.

Conclusion-In this study, we built the first experimental basis that the passive capacitance compensation technique on SiPM based PET detector can improve the timing resolution better than the active capacitance compensation technique. Although, the set-up is not optimized for measuring CTR, the comparisons were made under the same conditions as possible. For the future work, we are planning to evaluate two different compensation technique with optimal timing measurement set-up to achieve sub 100 ps CTR.

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