

MEETING ABSTRACT

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Analog electro-optical readout of SiPMs for compact, low power ToF PET/MRI

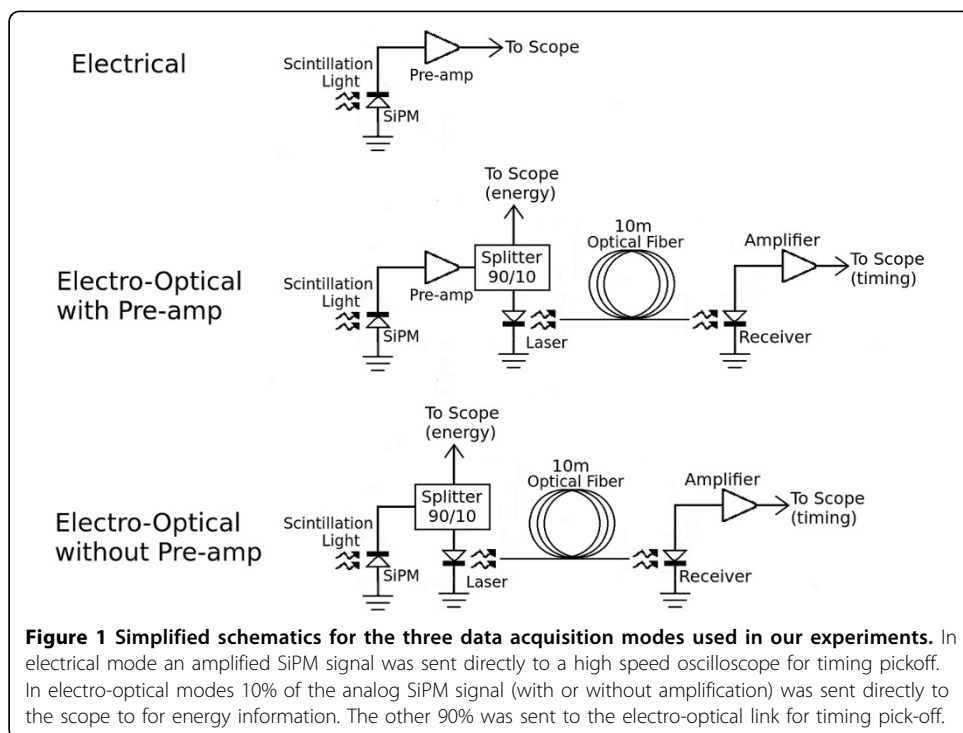
Matthew F Bieniosek^{1,2,4*}, Craig S Levin^{1,2,3,4,5}

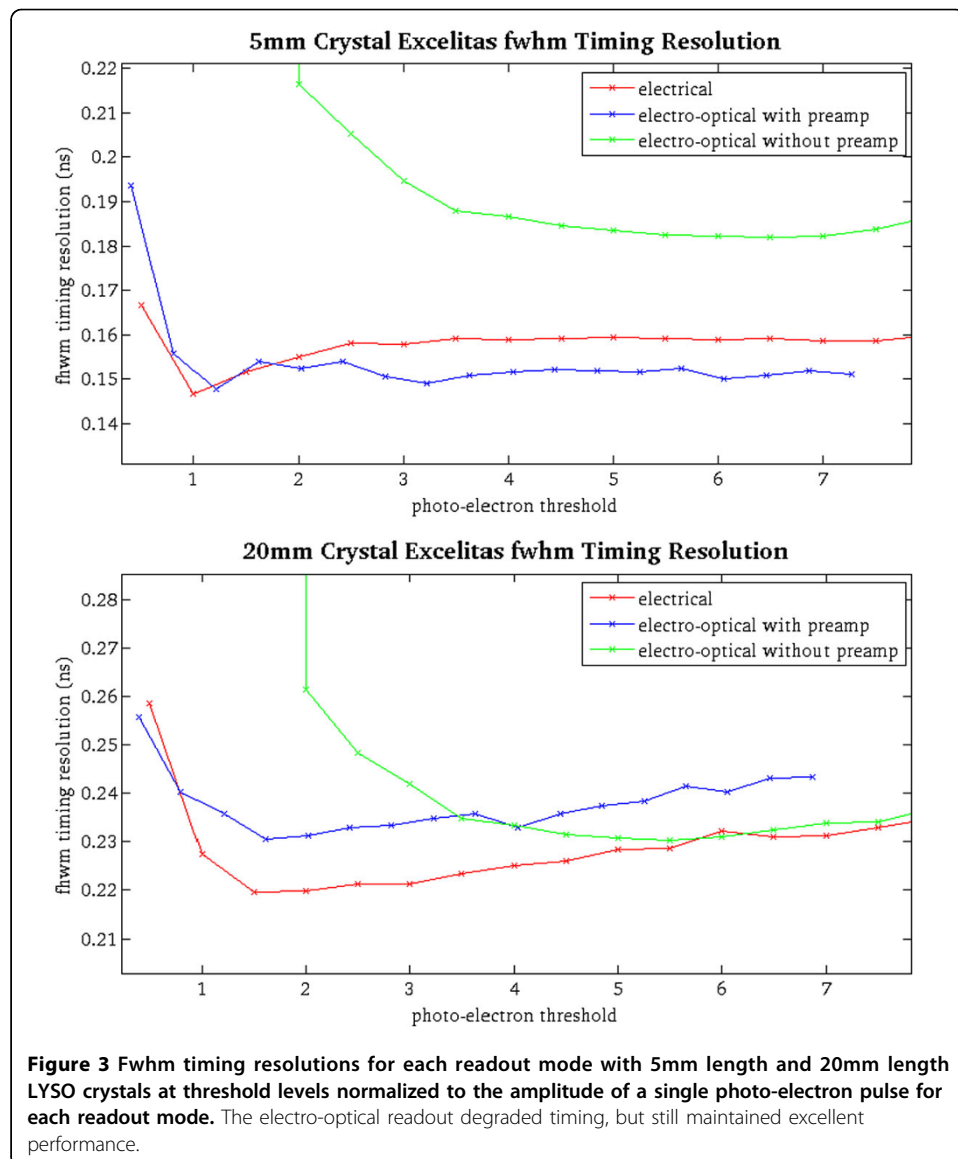
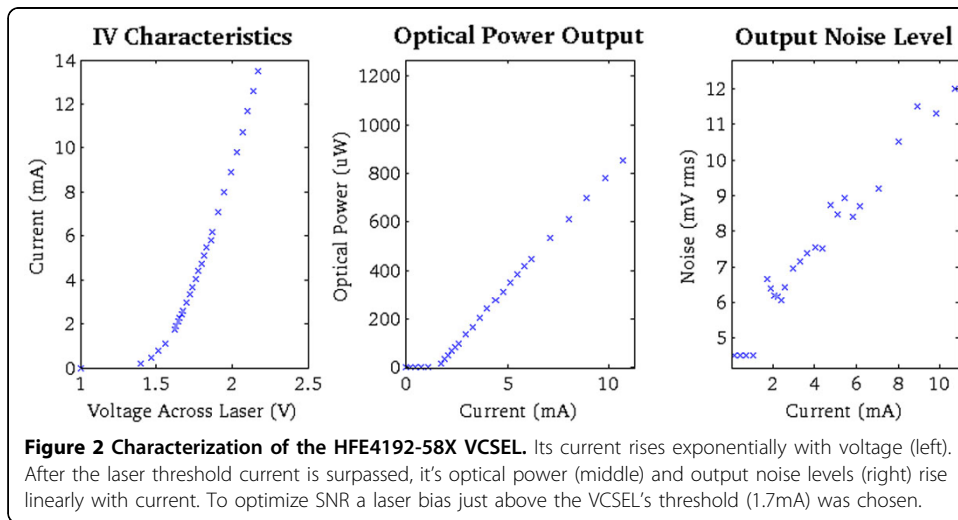
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¹Department of Radiology,
Stanford University, Stanford, CA
94305, USA

The aim of this work is to demonstrate time of flight (ToF) performance from analog electro-optical transmission of SiPM-based PET detector signals. In electro-optical readout schemes, scintillation signals are converted to near-infrared light by a laser diode and transmitted out of the MRI bore with fiber-optics [1], greatly reducing the PET system's footprint, power consumption, and mutual interference with the MRI.

Our approach uses vertical-cavity surface-emitting lasers (VCSEL) and fiber-optics borrowed from telecommunication systems to directly transmit analog signals from an SiPM (see Figure 1). Our experiments used 3mm x 3mm x 5 mm teflon wrapped, and 3mm x 3mm x 20mm ESR wrapped LYSO scintillation crystals, 3mm x 3mm C30742- 33-50-C SiPMs (Excelitas, Waltham, USA), ZX60-4016E+ preamplifiers (Minicircuits, Brooklyn,





USA), HFE4192-58X VCSELs (Finisar, Sunnyvale, USA), and 10m multi-mode optical patch cables. The VCSEL was characterized as seen in Figure 2. To get the best analog performance a bias current just above the laser threshold (1.7 mA) was chosen to minimize noise, and power dissipation (2.8 mW).

The results of the timing experiments are seen in Figure 3. The best timing resolution achieved with 5mm length crystals was 147ps +/- 1ps in electrical mode, 148ps +/- 2ps in electro-optical with preamp mode, and 182 +/- 2ps in electro-optical without preamp mode. With 20mm length crystals the best timing achieved was 220 +/- 3ps in electrical mode, 230 +/- 2ps in electro-optical with preamp mode, and 230 +/- 2ps in electro-optical without preamp mode.

This work shows that SiPM ToF information can be preserved after analog electro-optical transmission. In the future this readout strategy could drastically simplify the design of high performance PET/MRI systems by reducing the in-bore electronics to two active components (SiPMs and VCSELs).

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Authors' details

¹Department of Radiology, Stanford University, Stanford, CA 94305, USA. ²Molecular Imaging Program at Stanford (MIPS), Stanford, CA 94305, USA. ³Department of Physics, Stanford University, Stanford, CA 94305, USA. ⁴Department of Electrical Engineering, Stanford University, Stanford, CA 94305, USA. ⁵Department of Bioengineering, Stanford University, Stanford, CA 94305, USA.

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Reference

1. Olcott PD, et al: Novel Electro-Optically Coupled MR-Compatible PET Detectors. *IEEE NSS Conference Record* 2008, 4640-4645.

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