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High Bandwidth Readout Electronics for TCT in Thin Detectors

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The transient current technique (TCT) has been a workhorse of detector characterization, allowing for the extraction of drift velocities, electric fields, space charge densities, and more. However, for very thin detectors ($\leq$ 50 µm), the currently available readout electronics start to run into bandwidth limitations, as the charge carrier drift time becomes of the same order of magnitude as the rise time of the readout electronics. This poses a challenge for wide bandgap materials such as silicon carbide, as the detector thickness that can be depleted is typically limited to 100 µm or less. However, at the same time, there is a high demand in TCT studies as several material properties, such as the mobility, are not as precisely known as they are for silicon.

We present ongoing work by HEPHY and SCIPP on readout electronics with very high bandwidths exceeding 5 GHz. Different approaches and the impact of the detector capacitance, bond wires, and other parasitics are discussed.
At HEPHY, a readout based on a commercial low-noise amplifier has reached rise times as low as 58 ps. With this readout setup, we conducted measurements on SiC diodes using alpha particles, a UV laser, and proton beams, for which we analyzed the resulting transient current signals to extract information about the charge carrier drift velocity. Comparisons with SPICE simulations highlight the impact of parasitics, particularly bond wire inductance. Finally, we outline upcoming studies, including TPA-TCT, where SCIPP is aiming to characterize SiC PIN sensors.

Type of presentation (in-person/online)

in-person presentation

Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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