# Hybrid Mueller matrix spectral and polarimetric imaging for high throughput plant phenotyping

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Many correlations exist between spectral reflectance or transmission with various phenotypic responses from plants. Of interest to us are metabolic characteristics; namely, how the various polarimetric components of plants may correlate to underlying environmental, metabolic, and genotypic differences among different varieties within a given species, as conducted during large field experimental trials. In this presentation, we overview a portable Mueller matrix imaging spectropolarimeter, optimized for field use, by combining a temporal and spatial modulation scheme. Key aspects of the design included minimizing the measurement time while maximizing signal-to-noise ratio by mitigating systematic error. This was achieved while maintaining an imaging capability across multiple measurement wavelengths, spanning the blue to near-infrared spectral region (405-730 nm). To this end, we summarize our optimization procedure, simulations, calibration methods, and polarimetric error. Validation results indicated that the polarimeter provides an average absolute error of $(5.3 \pm 2.2)\times10^{-3}$ or $(7.1 \pm 3.1)\times10^{-3}$, when using its slow or fast measurement modes, respectively. Finally, we provide preliminary field data (depolarization, retardance, and diattenuation) to establish baselines of barren and non-barren *Zea maize* hybrids (G90 variety), as captured from various leaf- and canopy-positions during our summer 2022 field experiments. Results indicated that subtle variations in retardance and diattenuation versus leaf canopy position may be present before they are clearly visible in the spectral transmission. We will also highlight some of our more recent work, from the summer of 2023, measuring the polarization properties of maize lesions and soybean leaves.