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Versatile systems for characterization of large-area silicon pad sensors for highly-granular calorimetry

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High-granularity calorimeters utilizing silicon pad sensors as main active material are being designed for the CMS endcap calorimeter upgrade and have been proposed for the electromagnetic calorimeters at CLIC, ILC and FCC-ee. The silicon sensors in such experiments are foreseen to cover a very large area of O(1000m2). They are typically produced from 6- or 8-inch wafers and consist of a few hundred smaller cells, each with an area of O(0.1 to 1.1cm2). Currently the CMS endcap calorimeter upgrade is in a prototyping phase with the aim of choosing the final sensor design. Flexible systems are needed for quick sensor characterization as close as possible to operating conditions, for testing of prototypes and for quality control during mass production. The "ARRAY" system consists of an active switching matrix PCB with 512 input channels and a passive probe card specific for each sensor layout. The probe card makes contact with each individual pad through spring-loaded pins. ARRAY is designed to measure the leakage current and capacitance per-cell for different bias voltages, keeping the entire sensor area under bias. The "Hexaboard" probe card follows a similar principle: readout electronics foreseen to be used in the final CMS detector are mounted on a PCB that makes contact with the sensor through spring-loaded pins. Its main goal is to perform noise and charge collection efficiency measurements with irradiated sensors without the need for module assembly. We present the design of the ARRAY and Hexaboard systems as well as measurements performed on different CMS prototype silicon sensors. We also compare the results with alternative multi-needle setups.

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