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Fast Electromagnetic Calorimeters for the New Muon g-2 Experiment

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The Intensity Frontier era brings a host of challenges for detector systems that must both accumulate data at very high rates while also maintaining an unusually high level of performance stability to suppress systematic uncertainties. The new muon g-2 experiment at Fermilab is typical of a group of next-generation measurements that also includes muon-to-electron conversion and rare kaon decay experiments. A common theme is detectors that must endure very high rates embedded in strong magnetic fields. I will focus on our design of the g-2 electromagnetic calorimeters, which must be compact, very fast, and be placed inside the highly uniform muon storage ring magnetic field. No magnetic materials can be used and stringent constraints exist on local current-generating electronics. We examined home-built W/SciFi detectors, PbF2 crystals and a custom undoped PbWO4 crystal using the Fermilab test beam facility. Very fast PMTs and on-board, large-area silicon photomultipliers (SiPMs) were used for readout options. The leading design is based on PbF2, which produces very short pure Cherenkov light pulses that must be optimally coupled to SiPMs directly placed on the downstream surface. Custom electronics for the candidate SiPM arrays has been designed to preserve the intrinsic fast pulse signal. I will report on our test beam and lab results and our iterations with SiPM devices and electronics.