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Detector Systems for the Muon g-2 Experiment (15' + 5')

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The Muon g-2 Experiment at Fermilab will collect more than 20 times the data obtained in the BNL E821 measurement of the muon's anomalous magnetic moment. Because $g \neq 2$, the spin of a muon confined in a magnetic storage ring precesses slightly faster than the cyclotron frequency; the difference between these frequencies is proportional to the magnetic moment anomaly. The signature of this difference is a modulation in the decay rate of muons to higher-energy positrons, which we measure using 24 electromagnetic calorimeters positioned uniformly around the inside of the ring. The larger data set compared to BNL will be obtained by employing a higher muon fill rate frequency, a longer running period, and higher muon storage intensity per fill. Each of these issues has implications in the instrumentation design, but none more challenging than handling the anticipated higher instantaneous rates and potential systematic uncertainties related to pileup and gain (energy) instability. We have developed an ultra-fast, segmented Cherenkov crystal calorimeter read out by silicon photomultipliers (SiPMs), which are insensitive to the magnetic field environment. The SiPM signals are continuously digitized at 800 MSPS at depth of 12 bits. The SiPM pulse widths are less than 8 ns, and two-pulse separation resolution has been demonstrated down to a few ns. Complementing this system is a series of in-vacuum straw chamber planes positioned in front of three calorimeters. The straw system allows both accurate determination of the important muon storage parameters that are critical for systematic error corrections {\e em and} sensitivity to a muon EDM signal that would manifest itself as an up/down modulation in the average slope of decay positrons at the $g-2$ precession frequency, but out of phase with it by $\pi/2$. This talk will emphasize the key developments in these systems and why they will lead to a robust measurement.

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