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A scintillator tile hadron calorimeter prototype with novel SiPM readout for the ILC

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The CALICE collaboration is presently constructing a test hadron calorimeter (HCAL) with 8000 scintillator tiles read out by novel Geiger mode semiconductor photo detectors - Silicon Photomultipliers (SiPMs). This prototype is the first device which uses SiPMs on a large scale. We present the design of the HCAL including scintillator tile - WLS fiber - SiPM systems, mechanics, electronics and calibration systems. We report on measured properties of more than 10 thousand SiPMs and more than 6.5 thousand tile-SiPM systems. We present a detailed discussion of the SiPM efficiency, gain, cross-talk, and noise rate dependence on bias voltage and temperature including the spread in these parameters. We analyze the reasons for SiPM rejection and present the results of the long term stability studies of more than 5000 SiPMs. The first measurements of the SiPM radiation hardness are presented. We compare properties of SiPM with the properties of similar devices MRS APD and MPPC and discuss their advantages for the more than a million channel ILC calorimeter. Preliminary results of the Calorimeter beam tests at CERN are presented which represent the first operational experience with a large system based on such novel photo-detectors.

A scintillator strip with SiPM readout TCMT prototype is also being constructed within the CALICE collaboration to complement the combined ECAL and HCAL test beam program. The properties of this device are presented. A possibility to make the tiles thinner or to read them without WLS fiber has been studied, and the time resolution of scintillator counters with WLS fiber and SiPM readout has been measured.

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