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Development of Fast HV Electronics for a Spark Chamber

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The effectiveness of a spark chamber in detecting charged particles is contingent upon the timely recombination of ions after a Townsend avalanche, typically occurring over several microseconds. To achieve optimal spark efficiency, the system necessitates fast electronics capable of operating within a delay time of less than 500 ns. The spark chamber's electronic system is composed of three primary components: the discriminator, the logic module, and the high-voltage generator. As charged particles pass through the scintillators, photons are emitted and subsequently converted into current pulses by Photomultiplier Tubes (PMTs). Three discriminators are employed to process the signals from the PMTs, transforming them into digital signals. These signals are then fed into a 3-input AND gate, functioning as a coincidence module, with the output pulse width fine-tuned by a monostable multivibrator. The generated coincidence signal activates an Insulated-Gate Bipolar Transistor (IGBT), which is positioned between the capacitors and ground. This action causes the capacitors to discharge, resulting in a high-voltage pulse that induces a breakdown and subsequent sparking between the gaps of the spark chamber. The total delay time of the electronics, from the PMT output to the capacitor discharge, is approximately 350 ns. This rapid response is critical for the chamber's ability to reliably detect the presence of charged particles via the spark formation process.

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