

## **HESSI Image Simulation GSE Requirements HSI\_IDPU\_019A**

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### **1. Introduction**

The Image Simulation GSE simulates the CSA signal outputs into the IDPU Analog Front End circuitry. All 18 detector segments are simulated simultaneously. The simulation is controlled by a 'event score' text file which tells the GSE the event timing and amplitude to simulate. With some modifications the simulator can also be used to provide test pulse inputs to the detectors via the test pulser input to the high voltage power supplies.

The GSE shall be based on a PC computer with a custom or commercial interface board and an external analog conditioning box. Software in the PC shall read an event score and pass it on to the interface card. The interface card shall time out the events based on timing information included with the events, and pass on the event amplitude to the appropriate segment analog conditioning electronics at the appropriate time (some of this work may be done in the analog conditioning box). The analog conditioning system shall contain 18 chains to convert the digital amplitude information into the analog CSA signal simulation signals. The simulated signals shall be routed to 18 coax connectors on the analog conditioning box. The analog signal ground must be isolated from all other grounds including the PC ground to avoid ground loops.

### **2. Digital Requirements**

The digital system shall include the PC interface board, and perhaps part of the analog conditioning box. The interface board might be custom or a commercial product if something suitable is available (a commercial product might have the advantage of already having a software driver written). The interface card might be an ISA or PCI card, and must be capable of the throughput requirements listed.

The digital system must process a stream of event data from the PC. Events shall include a time-tag, an amplitude signal, and a detector segment number. The digital system shall wait until an internal clock matches (greater than or equal to) the next event's time-tag before passing the event on to the selected detector segment's analog conditioning chain.

The system must have a peak throughput of 10,000,000 events/second and a sustained throughput of 1,000,000 events/second. Time tags must have 1 $\mu$ s resolution.

The 1MHz clock used to time the events shall be either internally generated or externally generated (switch or software selectable). The external clock shall be a 0-5V logic level signal, and should be opto-isolated.

An external 'enable' signal input shall also be provided. If the signal level is logic 0 (0V), the event stream shall be paused (the event clock shall be stopped). If the signal is logic 1 (5V), or no signals is connected, the event stream shall proceed. This signal should also be opto-isolated.

### **3. Analog Requirements**

The CSA signal to be simulated consists of a stair-case signal. Each event on a detector segment causes a step proportional to the indicated amplitude. The stair-step starts at -2V, and ramps up until an event causes the level to exceed +2V. At that time it discards further events while the system 'resets' back to -2V. The reset starts 1 $\mu$ s after the last event and lasts a few  $\mu$ s (TBR). The amplitude digital resolution shall be 16 $\mu$ V, and have a range of 65,000 (16 bits).

The stair-step can be implemented either by having the analog conditioning system sum up the events amplitude steps using some kind of integrator, or by summing the amplitudes digitally in the PC and putting out the stair-step amplitude signal digitally. The advantage of the second plan is that the reset system can be done by the PC rather than in the analog system. The problem is the huge dynamic range that must be covered 16 $\mu$ V resolution covering 4V range, or 250,000x (20 bits).

The step rise-time must be approximately 300ns.

The noise on the analog output signal shall be as low as possible, and cannot exceed 100 $\mu$ V.

The analog system ground shall be isolated from all other grounds except through the coax returns (a 1Mohm resistor may be used to connect the analog ground to PC signal ground to avoid static charge build-up). This can be accomplished with opto-isolators. Care should be taken to minimize the capacitance between analog ground and other grounds that will cause ground loops at high frequencies.