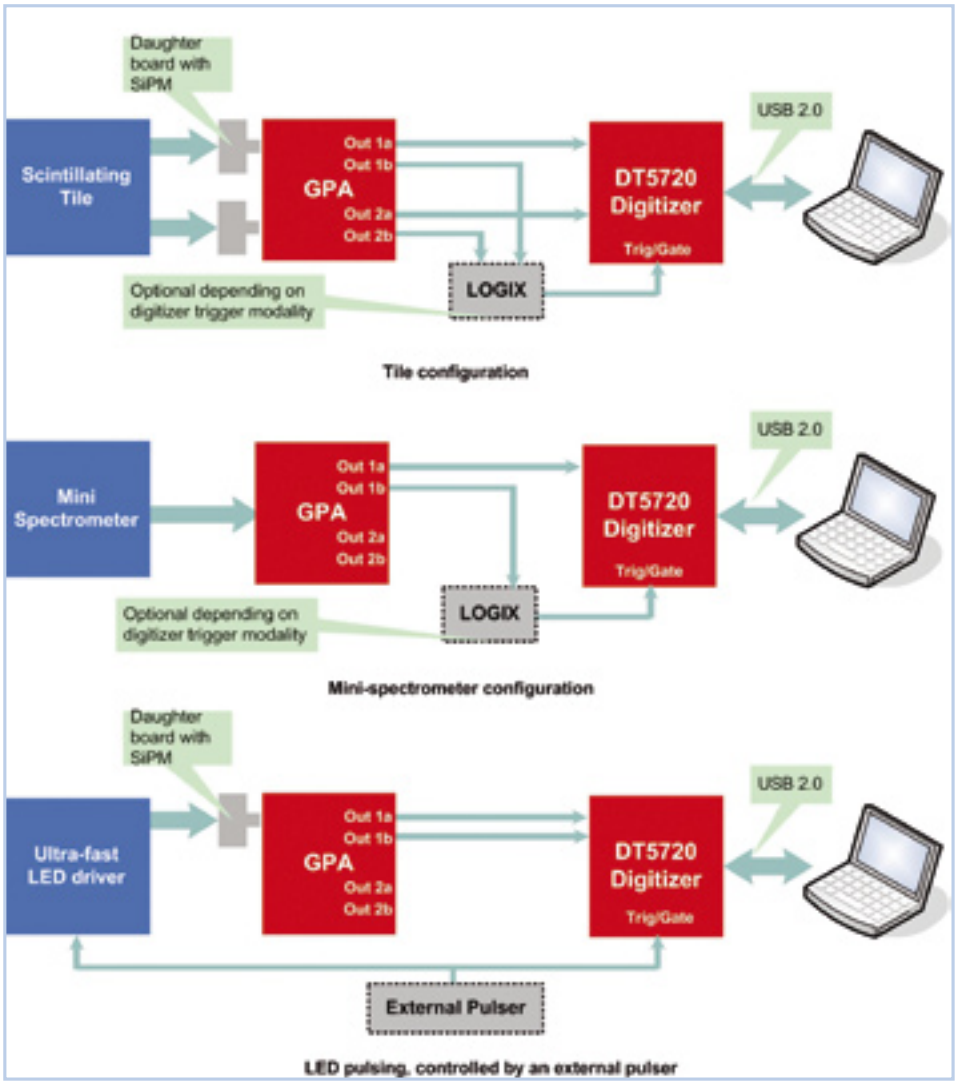
Silicon PhotoMultiplier Development Kit

COMING SOON

CAEN is happy to announce a modular development kit dedicated to Silicon Photomultipliers, representing the state-of-the-art in low light field detection with photon number resolving capabilities.

The kit comprises:

- A General Purpose Amplification box (GPA hereafter), integrating the SiPM in a mother & daughter architecture allowing easy mounting and replacement of the sensor. The basic configuration features two channels, with customization options.
- A CAEN Desktop Waveform digitizer (Mod. DT5720), housing 4 channel 12 bit 250 MS/s ADC with dedicated integration modalities.
- A LOGIc Box (LOGIX hereafter), implementing a two-channel amplitude discrimination and a coincidence logic, for single channel counting and dark count rate reduction.
- An ultra-fast LED with pulse width at ns level, tunable intensity and width, to provide a low-cost tool for the detector characterization.
- A plastic scintillating tile, with light collected by a fiber, FC terminated and ready-to-mount on the two sensor GPA & LOGIX. The tile, with a sensitive volume of 100 x 100 x 10 mm^3, is the ideal tool for tests with beta emitting isotopes and cosmic rays.
- A mini-spectrometer for gamma ray detection, built around the daughter board of the GPA in an easy handling set-up.
- A Power Supply box that provides all of the power necessary for the Kit devices (GPA, DT5720, LOGIX, LED driver) and the bias for SiPM. This module implements an active control of the SiPM gain by varying the bias as a function of the temperature.



The different building blocks can be assembled in a customized configuration, according to the specific application and the user's requirements. Upon request, sensors from the main producers can be provided, fully integrated in the front-end.

The kit was developed within the EC-FP6 project RAPSODI (contract no. 32993), licensed to CAEN by the Research & Technology Development parties and finalized in a joint project. The scintillator tile is produced by ITEP-Moscow for CAEN.

General Purpose Amplifier (GPA)

COMING SOON

The General Purpose Amplifier is a SiPM dedicated module designed to feature:

- Variable amplification gain (6x up to 80x);
- Low noise, not to spoil the sensor performance for small signals;
- Wideband, to comply with the fast sensor response.

The module offers an extreme flexibility and is easy to handle. It implements a mother&daughter architecture, where the daughter board is hosting the SiPM.

The board is based on a high-bandwidth inverting pulse amplifier in a two-stage scheme, with a passive divider between the first and the second stage to comply different illumination levels in the amplifier dynamic range. The signal is output after each stage, to allow the implementation of a triggering scheme together with proper signal digitization. The GPA naturally couples to the digitizer and the LOGIX box.
The daughter board allows a local fine tuning of the sensor supply voltage with a further RC-CR filtering stage. The SiPM sensor is mounted on the daughter board in a custom-made FC receptacle, for proper interconnection with a WLS or scintillating fibre. Use of index matching grease is recommended.

The basic configuration of the GPA features two channels; however, the board design allows an easy customization.

Tentative Data

- **Number of Channels = 2 (customizable)**
- **Mother & Daughter system**
- **Device Operating Voltage = 10 V ÷ 17V**
- **Gain = 6x up to 80x**
- **Noise Figure = 3.5dB (@50MHz)**
- **Recommended Operating Voltage = 12V**
- **Device Operating Current = 0.15A (@12V)**
- **Output connectors = SMA**
- **Output signals: after the first & second stage amplification**

LOGIc Box (LOGIX)

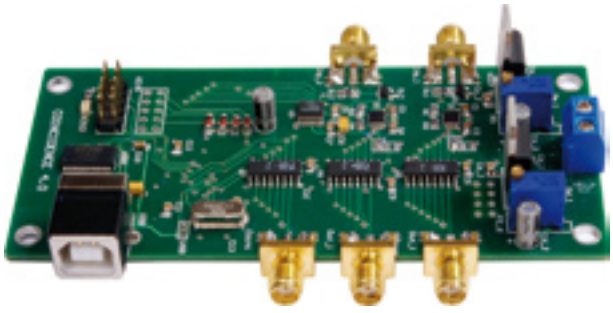
COMING SOON

The LOGIX is a stand-alone module performing pulse height discrimination of two analog positive signals and time coincidence.

The input signal is amplified and shaped with asymmetric triangular edges (fast leading edge and slow trailing edge). The signal feeds a comparator with tunable threshold via a Digital-to-Analog Converter with 12 bit resolution, ~1mV/bit, on a 0-2.5 V range and 3-wire serial interface to a micro controller. As long as the input signal exceeds the threshold, a TTL pulse with tuneable width (within the 10-520 ns range, at 1 ns step) is generated and routed to the coincidence block.

The LOGIX provides three outputs related to the comparator state for each channel and the output of the coincidence module.

Because of the high frequency Poissonian regime of the Dark Counts, a veto system has been implemented to avoid random concurrencies within the pulse width to latch-up the system. The architecture has been qualified up to input pulse frequencies in excess of 20 MHz.



Tentative Data

- **Operating Bias voltage: 15 V**
- **Operating current: 100 mA**
- **Signal comparator = Analog Device ADCMP602**
- **Threshold controller = MAX5230, 12 bit resolution on a 0 ÷ 2.5 V range**
- **Comparator noise = 0.5 mV**
- **Discriminated signal delay = 3.5 ns**
- **Pulse Generator = 3D7608**
- **Pulse Length = 10 ÷ 520 ns, 1 ns step**
- **Minimum coincidence window = 1ns**
- **Coincidence Output delay = 9ns**
- **Input signals range = 3 mV ÷ 2.5 V**
- **Output signals = TTL**
- **Input/Output connectors = SMA**

Ultra-fast LED driver

COMING SOON

A fast LED source represents the ideal tool for SiPM tests and characterization, through a triggered light burst of a intensity down to a few photons and up to a number saturating the sensors currently available.

The proposed device features tuneable intensity, repetition rate and pulse duration. Green and blue LED's can be integrated. The key feature of the proposed LED driver is pulse duration, not exceeding 3 ns and well below the typical time development of the SiPM signals.

The optical signal is routed to the sensor through a fibre, FC interfaced.

Tentative Data

- **Operating Voltage = +/- 5V**
- **LED operating current = 20 ÷ 100 mA**
- **LED colors (to be specified while ordering):**
  - **yellow (590 nm)**
  - **blue (430 nm)**
- **LED output power:**
  - **yellow: 1300 mcd**
  - **blue: 21000 mcd**
- **Rise time of pulse = 1.3 ÷ 1.5 ns**
- **Width of pulse = 3 ÷ 60 ns**
- **External generator pulse = NIM standard**
- **Optical Output connector = FC**

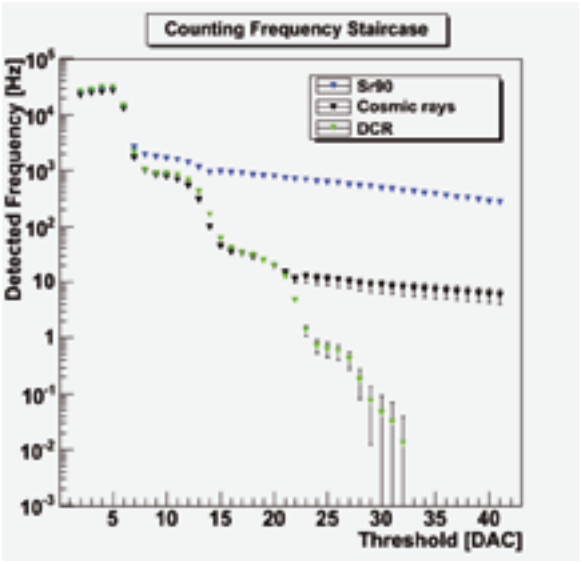
Scintillating tile & the mini-Spectrometer

COMING SOON

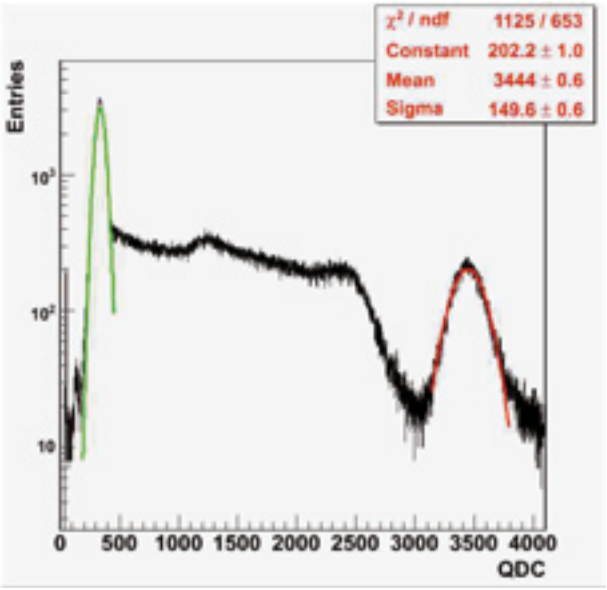
The SiPM develoment kit offers as well two tailored and complementary scintillation systems:

- A polystyrene plastic scintillator tile with a sensitive volume of 100 x 100 x 10 mm^3, embedding a WaveLength Shifting fiber for light collection and delivery. The two tips of the fiber are FC mounted for an easy interface to a pair of SiPM. The system naturally couples to SiPM's mounted on the GPA, offering the possibility to reduce the dark count rate by amplitude discrimination and a coincidence scheme. The tile offers an ideal and low cost radiation detector with a full range of applications. The one-plot demonstration of its potential is shown below, featuring the coincidence rate vs discrimination threshold in the LOGIX for signals from the fibre tips in coincidence. The curves refer to the pure random coincidence, the event rate with a ^{90}Sr source and from cosmic rays.
- A mini-spectrometer, crystal based, with fairly good minimum detectable energy and resolution. The mechanical structure, designed to be interfaced to the GPA, is shown in the annexed picture. Different crystals can be mounted in the spectrometer; the ^{137}Cs spectrum obtained with a LYSO crystal is also shown. The 30 keV peak is clearly visible and the resolution on the 662 keV peak corresponds to a FWHM/peak = 13%.

The plastic scintillator tile.



Coincidence frequency vs discriminator threshold for random coincidences, cosmic rays detected through the tile and signals from a ^{90}Sr source. The results were obtained using two SiPM mounted on the GPA and implementing a coincidence scheme through the LOGIX. SiPM's were gain equalized.



A ^{137}Cs spectrum obtained with the mini-spectrometer and a LYSO crystal. The resolution on the 662 keV peak corresponds to a FWHM ~ 13% of the peak.

A sketch of the mini-spectrometer, uncapped.

SiPM Kit Power Supply Box

COMING SOON

The SiPM Power Supply is implemented in a stand alone desktop module. The unit is remotely controlled via USB interface. Maximum output voltage is 100 V, settable with 10 mV resolution. Maximum ripple is guaranteed within 1 mVpp.
To stabilize the SpIM gain, the Module implements an active control of the gain by varying the SiPM bias as a function of the temperature.

Tentative Data

- **Stand-alone unit**
- **Provide Low voltage power for SiPM Kit devices**
- **Provide bias for SiPM:**
  - **0 ÷ 100 V output range**
  - **10 mV Vset resolution**
- **5 mV Vmon resolution**
- **1 mVpp ripple**
- **Active control of the SiPM gain via temperature feedback on bias voltage.**
- **20 mA**
- **USB 2.0 interface**