LET1+ timing discriminator

RoentDek Handels GmbH
Supersonic Gas Jets
Detection Techniques
Data Acquisition Systems
Multifragment Imaging Systems

The **RoentDek LET1+** is a single channel leading-edge discriminator with internal amplifying stage for simple and convenient read-out of signals from timing/counting devices like the **RoentDek DET** detectors and similar MCP-based detectors, or generally for any type of fast avalanche counter like channeltrons, photo-multipliers, -diodes or even gas-filled detectors. After adjusting a threshold level via a potentiometer for discriminating against electronic noise, the **LET1+** will produce a "logic" signal (usually of NIM-level) for every detected particle (or photon). The output signal width is fixed, but can be varied with a second potentiometer. This signal can be used as input for a counter or trigger device. Optionally the unit can be supplied with one TTL output (at position of OUT B in figure below) and/or one output of variable length, corresponding to the time over threshold (ToT, NIM only, at position of OUT A in figure below). Information on the arrival time is presumed with a precision on the order of signal rise time (typically 1 to 5 ns FWHM temporal resolution when used with a **RoentDek DET** detector). The ToT can give information about the input pulse height.

Figure: LET1 module. The LET1+version is similar but biased via an USB socket.

In standard confuguration a 50 Ohm impedance socket (Lemo00) requires positive input signals < 100 mV (with linear response up to 50 mV, AC-coupled, 30 dB internal amplification, bandwidth 350 MHz). This makes the **LET1+** especially suitable for direct read-out of MCP signals from a **RoentDek** detector (after AC-decoupling, e.g. with a **FT4TP**), without need of pre-amplification.

For negative input signals **RoentDek** can provide a passive inverter plug (**pInv**), likewise, a **pAtt** attenuator plug allows for operation with higher signal levels, i.e. signals from a photodiode or pre-amplified signals. Thus the **LET+** can also be used as **TTL-NIM** (or NIM-TTL) signal converter. Specifically configured factory settings can be chosen to allow for direct operation in different modes.

The unit has a power consumption of about 3 W (0.6 A at +5 V) via a USB socket as power input (no data connections). We strongly recommend using a standard external USB power supply (i.e. 5 V/1 A, not included) instead of connecting the **LET1+** to a PC.

Size (approx.): 110 mm x 65 mm x 40 mm, weight: 300 g (without power adapter).

Operation:

The **LET1+** requires input signals of positive polarity with pulse heights between 0 and 50 mV as typically obtained from an MCP detector contact after decoupling the high voltage. Higher signals (up to 200 mV) may be used, only the temporal resolution will then be compromised. Inadequate input signals in this respect can be matched to the **LET1+** input specifications by using inverters and attenuators (e.g. passive **pInv** and **pAtt** plugs as available from **RoentDek**).

Never exceed the input signal pulse height above 100 mV, positive or negative.*

Always make sure that input line from the detector/decoupler has **no DC load before connecting** it to the **LET1+** input socket (**RoentDek** can provide adequate signal decoupler circuits of type **FT4TP** for this purpose).

It is advisable to verify the input signals to the **LET1+** on an oscilloscope first. Here, the same safety rules as above apply before connecting the detector to the input. Furthermore, it is advisable to ensure that the detector operates safely and there is no risk for a discharge or any operational mishap. **RoentDek** can provide a passive safety circuit (**SP1**) which may increase operational safety for the equipment. The same circuit is an integral part of the **LET1+**, however, **there is no guarantee that the circuit will prevent damage in any event of malfunction**, e.g. discharge or high voltage break-down.

Once the input is connected to the **LET1+** use a voltage meter to verify the threshold level on the test pin (with reference to ground, i.e. the lemo sockets' shielding). The threshold value corresponds to about 30x the effective level acting on the input signals. Generally, the threshold level should be set as low as possible to detect also the smallest signals from the detector but must be higher than the electronic noise level on the input line when the detector is biased.

For setting the threshold properly first reduce the detector voltage down to a "quiet" level (no signals). At a threshold set value of about 100 mV (corresponding to about 3 mV on the input line) there should be no outputs from the **LET1+** then. Otherwise track down and eliminate noise sources in the lab before you continue. If it not possible to reduce the noise you may try operating at higher threshold and/or consider allowing spurious noise counts in the data.

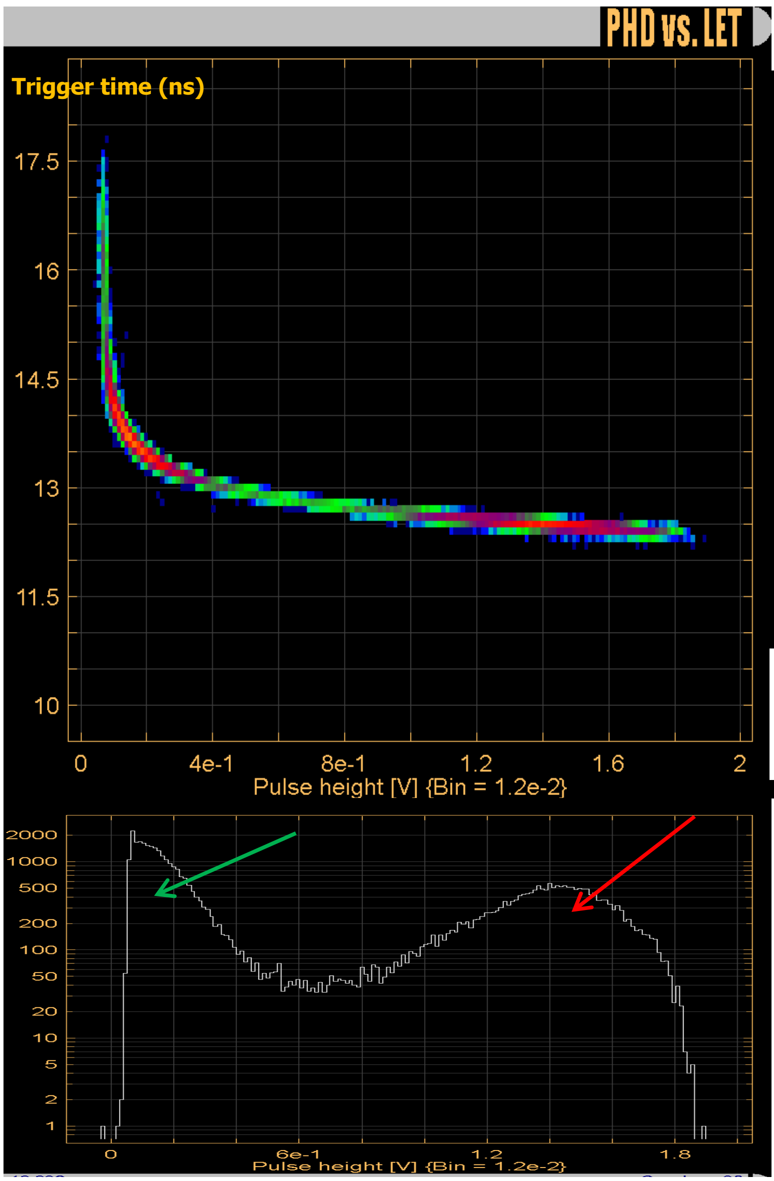
After ensuring the absence of noise counts bring the detector into operation (saturated "counting" mode). Detected particles/photons will now produce signals on the **LET1+** outputs. The threshold level may then be lowered to an optimal level. Occasional noise counts may be tolerated to maximize the efficiency for even the lowest "true" counts. In some case, high noise level will require operation at increased threshold level and not all particles/photons are registered. If possible, raise the voltage on the detector for improving signal-to-noise ratio.

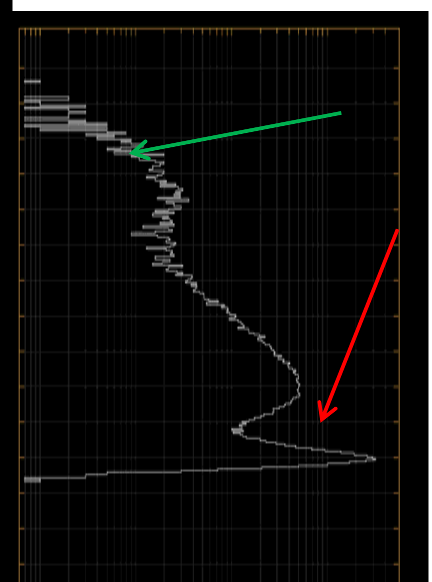
Note, that some high-voltage supplies have increased noise level as the bias is raised. **RoentDek** can provide adequate high-voltage supplies for operating avalanche detectors in counting mode. Note also that certain detector types (like MCP) produce some "dark" counts even in absence of particle/photon impact. These should not be mistaken for electronic noise.

The output signals can now be used with counting electronics like the **RoentDek RM6** or to trigger other logic or timing devices, also available from **RoentDek**.

* except if a unit is factory-set for operation with higher input levels.

The time of the output signal is correlated with the time when the input signal crosses the internal threshold level. Signals arriving at the same time will lead to an earlier output signal if they have a larger pulse height compared to those with low pulse height (see figure below). This results in a certain output timing jitter determined by the input signals' pulse rise time (which may be slightly increased due to the limited bandwidth of the input circuit). By measuring the width of the ToT output signal (optional circuit board assembly) the timing jitter can partially be compensated after calibration. If the jitter is not tolerable for a certain application **RoentDek** can alternatively provide constant-fraction discriminator circuits (e.g. the **CFD1**).





Input pulse-height to LET1+ output time correspondence:

Pulses fed into the **LET1+** have been attenuated in order to fit into the **LET1+**'s linear timing response range (< 50 mV positive). The y scale plots the output timing response ("trigger time") compared to the "true" signal time (measured in parallel by a **RoentDek CFD1x**, time offset is due do cable delays). The red/green arrows mark the MCP pulse height response to alpha particles and X-rays, respectively, resulting in a certain **LET1+** timing output response (above).

Those **LET1+** versions with an optional NIM level output label "***(var. width) NIM out***" (coding the time-over-threshold into NIM signal length on this output) can be used to distinguish higher signals from lower signals and possibly increase temporal resolution. For this an adequate timing digitizers such as a **RoentDek TDC8HP** is required.