FINUDA TRIGGER: an introduction

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FINUDA trigger is based on TOF signals. We named TOFino the internal time of flight system, and TOFone the external one.
All the trigger logics uses the Mean Timer (MT) signals of the TOF slabs. These have been aligned, within 2 ns, by means of laser light pulses. Besides, the trigger timing has also been done using the DAFNE beam due to the different lengths of the optical fibers used for Tofino and Tofone.
The alignment is performed making the TOF MTs signals pass through a CAMAC programmable delay (C211) before entering the trigger specific electronics. The minimum step for delay modules is 100 ps. For the TOFino slabs there are two MT signals: *Low Threshold* MTs, to select m.i.p., and *High Threshold* MTs, to select kaons and highly ionizing particles.
After the alignment 7 basic triggers are constructed:

1. the logic OR of the low threshold TOFino MTs: ORtofino_MinimumBias (OR-MB);
2. the logic OR of the high threshold TOFino MTs: ORtofino_EnergyLoss (OR-EL);
3. the logic OR of TOFone MTs: ORtofone;
4. the Back-to-Back (BTB) of TOFino MTs with low thresholds: BTB-MB. This is an exclusive BTB that imply multiplicity 2 on TOFino and a correlation 1 to 3 (i.e a fired slab must be in coincidence only with its opposite or the two nearest neighbours of its opposite)
5. the Back-to-Back (BTB) of TOFino MTs with high thresholds: BTB-EL. Here the multiplicity on TOFino can be greater than 2. The correlation is again 1 to 3.
6. the Back-to-Back (BTB) of TOFino MTs with low thresholds: BTB-1-1. This is an exclusive BTB that imply multiplicity 2 on TOFino and a correlation 1 to 1 of fired slabs;
7. the multiplicity selection of TOFone MTs: Multfone.

A simplified scheme of the Back-To-Back selection section is shown in figure 1.
Both BTB-MB and BTB-EL are constructed by a custom VME module (LE297), while BTB-1-1 is obtained using a MLU (LeCroy 2373) that in principle could be programmed to select other event topologies on TOFino. The TOFino OR signals (OR-MB, OR-EL) are also produced by LE297 module.

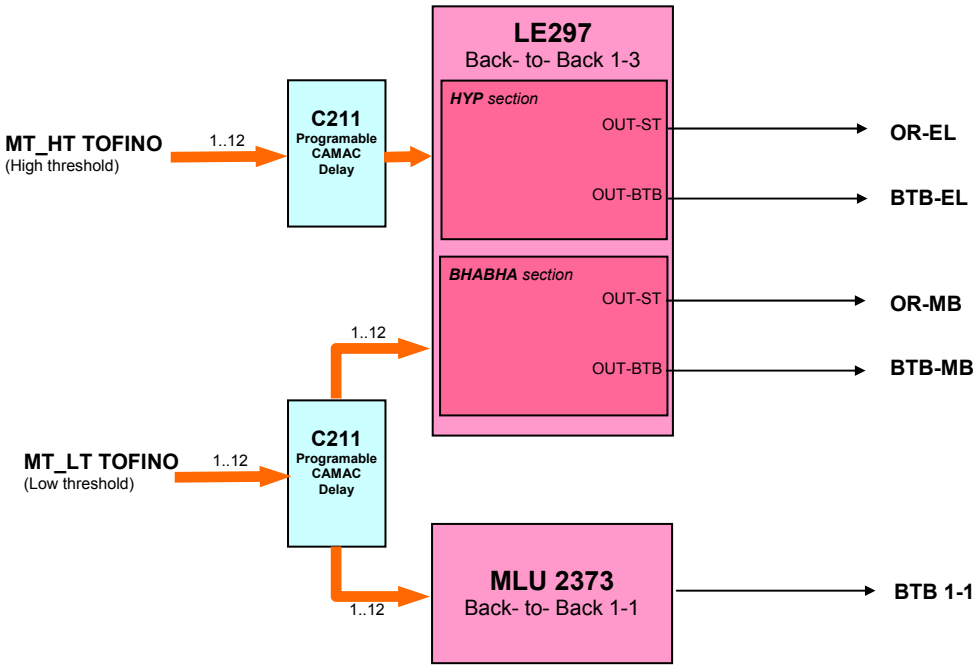


Fig. 1 Simplified layout of the Back-to-back selection scheme on TOFino

To construct Multfone trigger, a signal (AMIO) whose amplitude is proportional to the number of hits on Tofone is used. See Figure 2. It is provided by three "MALU" modules LeCroy 4532 and fed to the custom "Multiplicity Selector" module LE308. The Multiplicity Selector works like a "strobed window discriminator": it provides an output signal whenever the input multiplicity falls within a user-programmed window, and a STROBE pulse occurs.
A very accurate STROBE timing is required to perform efficient multiplicity selections. At first, it is done using laser pulses, and then it is adjusted and checked with real signals given by the beam.
The Multiplicity Selector has two independent strobe inputs (G1, G2) to allow different multiplicity selections: G1 is generated by the OR-EL signal and G2 by the OR-MB signal. Therefore, two basic multiplicity triggers are available: Multfone_bha (based on OR-MB) and Multfone_hyp (based on OR-EL).

To perform straw tube calibrations, another multiplicity trigger on TOFone is provided. The multiplicity signal AMIO is fed to a discriminator which responds when input multiplicity exceeds a user-programmed value.
The multiplicity selection for this trigger is normally set >=2.
The OR-tofone trigger is based on the OR TOFONE signal, produced by the custom module LE301.

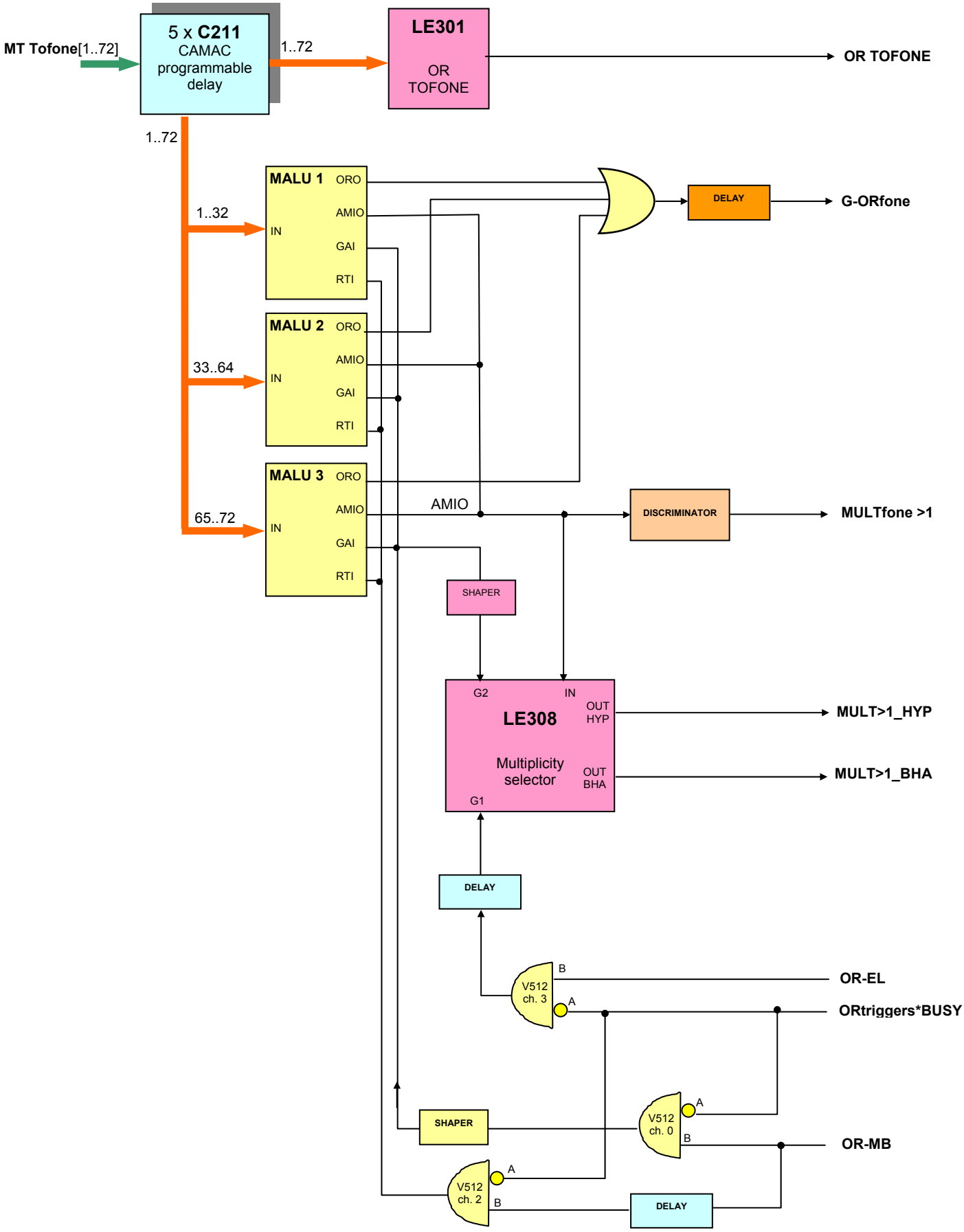


Fig. 2 Simplified layout of the multiplicity selection scheme on TOFone

There are also 3 more basic triggers that are used for tests and calibration procedures:

1. Laser photodiode;
2. Pulser;
3. Time Calibrator.

All the basic triggers are built in parallel and then used to realize more complex selections. This is done by sending them into programmable Logic Units (PLU LeCroy V495) where they are properly combined. Therefore, the triggers that can be selected from the FINUDA Run Control (Frc) program are:

- HYP;
- BHABHA;
- Back-to-back tofino;
- ORtofino;
- Back-to-back K^+K^-
- ORtofino*ORtofone
- LASER;
- PULSER;
- Time calibrator;
- ORtofone;
- Multfone >1

All of them can also be downscaled, except HYP, LASER and Time calibrator.

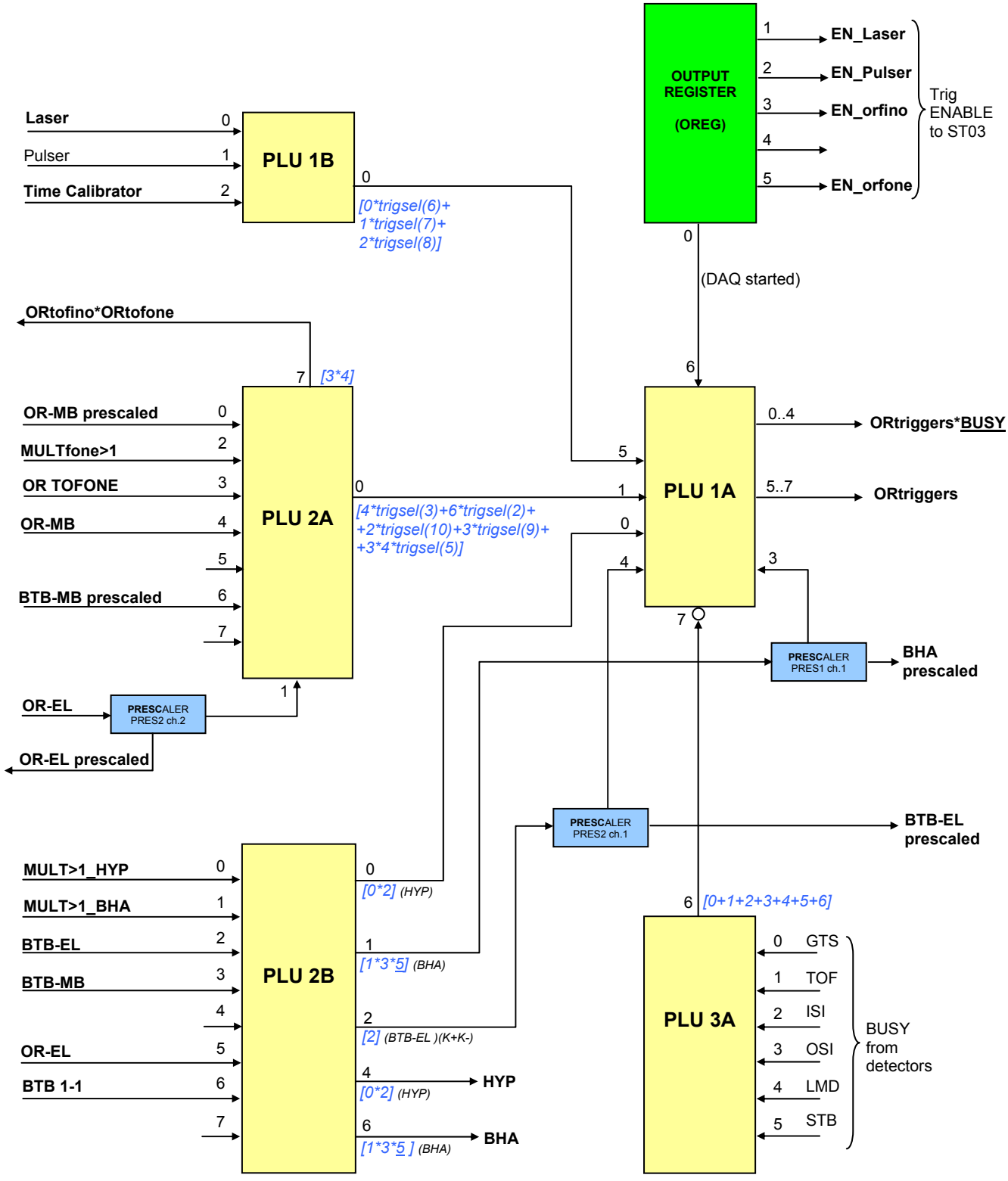


Fig. 3 Simplified layout of the Programmable Logic Unit section

ADC gate generation

Most ADCs require a logic signal (gate) to determine the time window in which the input signal has to be processed. The ADC integrates only the portion of input signal that occurs while the gate signal is active.

In the FINUDA experiment, the ADCs gates for LMD and TOF detectors are generated by the trigger itself. For each detector, a copy of the trigger signal is reshaped and delayed to generate a gate signal with proper time relationships with each ADC's input signal.

The diagram below shows in detail how the gate signals are generated. The trigger signal (ORtriggers*Busy) is fed to shapers T1 and T2, whose output gives the TOF ADC gate.

The signal from T1, fed to a fan-out module, is further delayed and then distributed as gate signal for LMD ADCs.

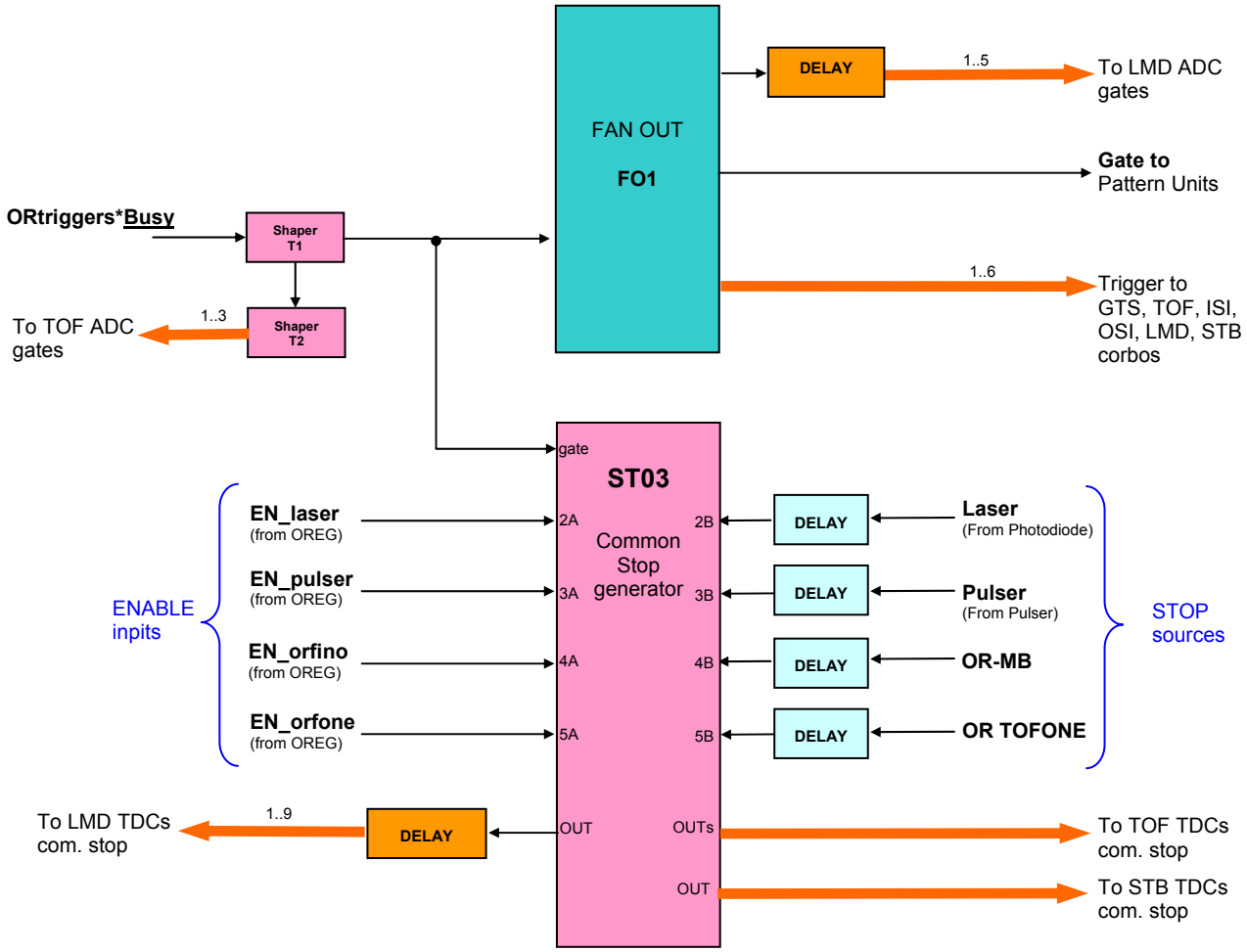
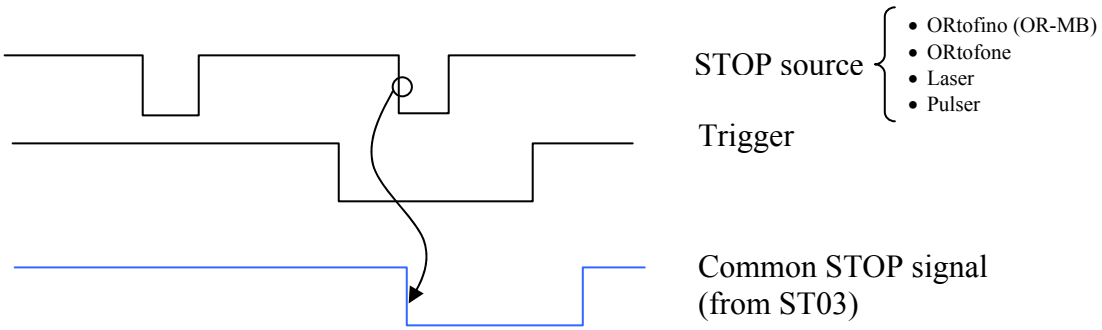


Fig. 4 Simplified layout of the "Gate and Common stop section"

TDC Common Stop generation

All TDCs of the FINUDA experiment operate in "common stop" mode: the TDC "start" command for each channel is provided by the input signal, while the stop signal is common to all channels.
Depending on the selected trigger type, the STOP source can be selected among ORtofino, ORtofone, Laser light detector (photodiode) or Pulser signal. The STOP source must be "in coincidence" with the trigger, as shown below.



The Common STOP signal is generated by ST03, a custom module shown in fig. 4. The trigger signal is applied on the "gate" input, while the stop signals are applied on inputs 2B to 5B.
ST03 selects the proper "stop source" by checking the state of the enable inputs 2A to 5A: the active enable input selects the corresponding stop source (es: 2A active → "stop" from 2B, etc...). The enable inputs are driven by an output-register board (OREG) which is controlled by the FINUDA Run Control program (Frc).
The Common Stop signal generated by ST03 is directly sent to TOF and STB TDCs by means of apposite signal distribution boards not shown in the simplified diagram of figure 4. The Common Stop signal for LMDs is further delayed to fit TDCs' time range.

Trigger documentation

The latest version of this document can be downloaded from the Finuda Trigger Home Page, reachable from the FINUDA private web page or directly at the following address:

www.lnf.infn.it/esperimenti/finuda/Trigger/Trigger_home_page.htm

The Finuda Trigger web pages contains also the following documents:

- Detailed Trigger diagram (hypertext and "pdf" file)
- FINUDA Trigger presentation (S.Marcello, Workshop on Hypernuclear Physics at DAFNE, Iseo, March 20-22 2002)
- FINUDA Trigger presentation (S.Marcello, FINUDA collaboration meeting, Trieste, may 6,7 2004)