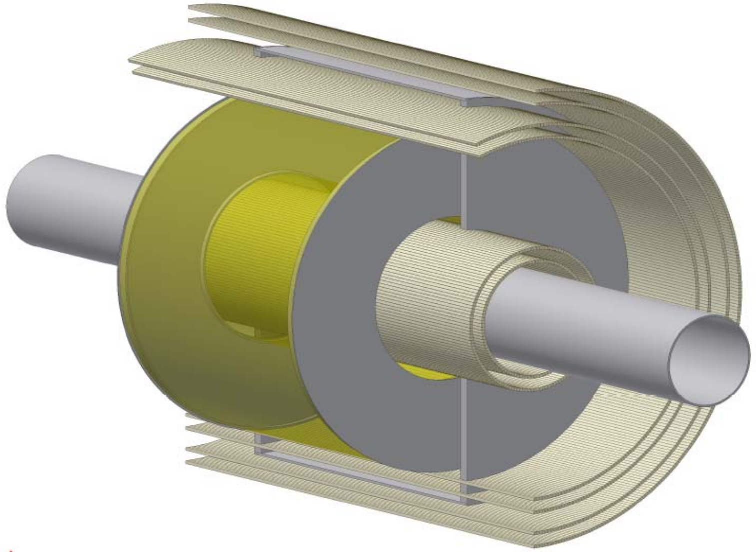
Experimental test for a trigger prototype for the AMADEUS experiment



Ing. Massimiliano Bazzi

LNF – INFN

Silicon Multiplier Workshop - GSI 6th - 7th October 2011

AMADEUS

Antikaon Matter At DAΦNE: Experiments with Unraveling Spectroscopy

AMADEUS collaboration
116 scientists from 14 Countries and 34 Institutes

lnf.infn.it/esperimenti/siddharta
and
LNF-07/24(IR) Report on lnf.infn.it web-page (Library)

EU Fundings FP7 – I3HP2:
WP24 (SiPM JRA)

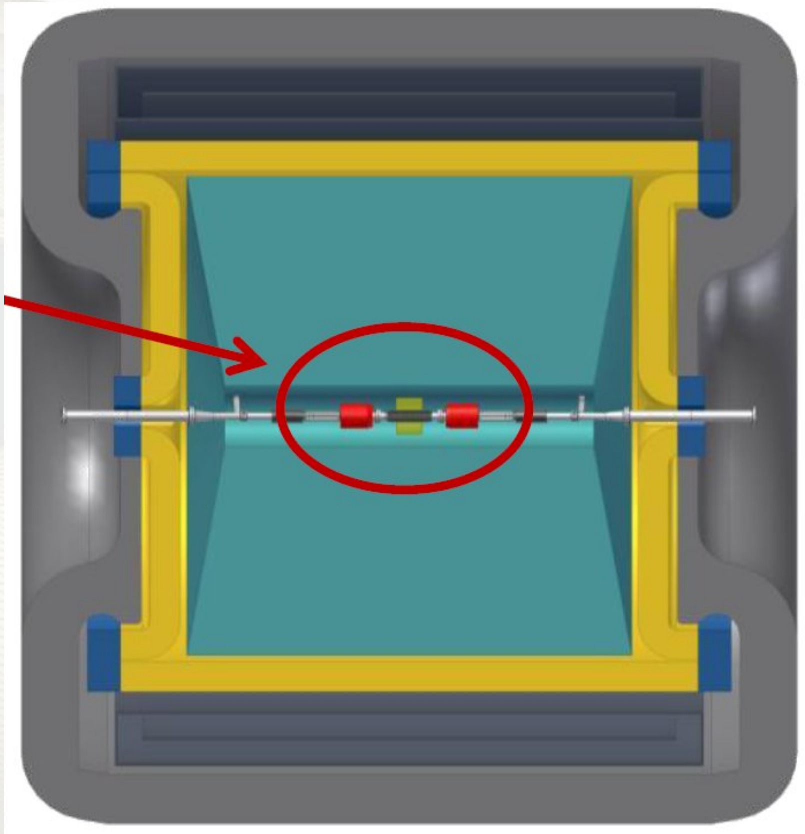
HadronPhysics2
Study of Strongly Interacting Matter

Summary

- Amadeus Experiment
- Experimental set-up
- Detector characteristics
- DAQ chain
- Preamplifier Board
- Constant Fraction Discriminator
- Test @ PSI

The experimental setup of AMADEUS

- Full acceptance and high precision measurements by implementing the KLOE detector with an inner AMADEUS setup.
- AMADEUS setup placed in the 50cm gap in KLOE DC around interaction point.
- Cylindrical layer of scintillating fibers surrounding the beam pipe to trigger K+/K- emitted back to back from $\phi(1022)$ decay

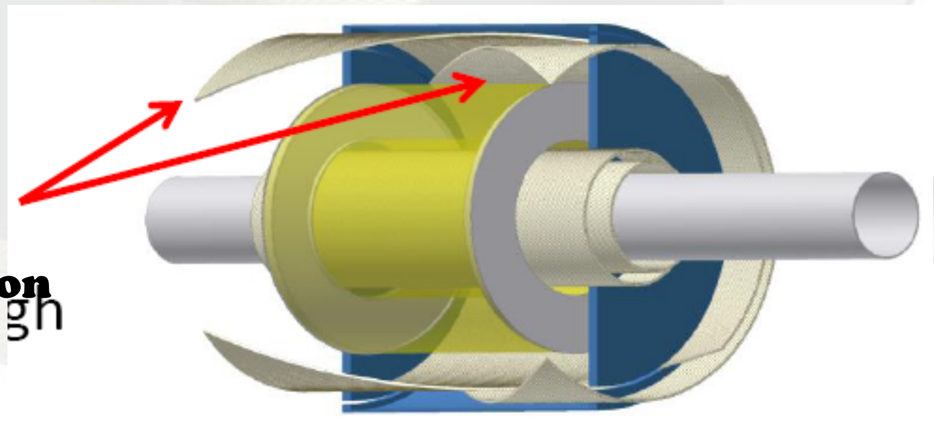


Target:

A gaseous He target for the first phase of study

Inner tracker:

eventually, a first tracking stage before the DC



Trigger:

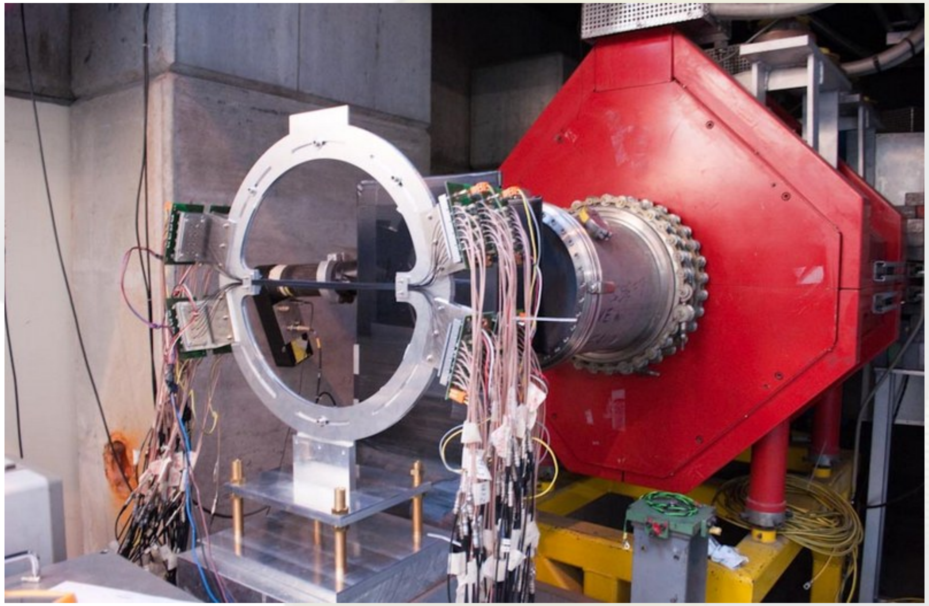
1-2 layers of ScFi surrounding the interaction point

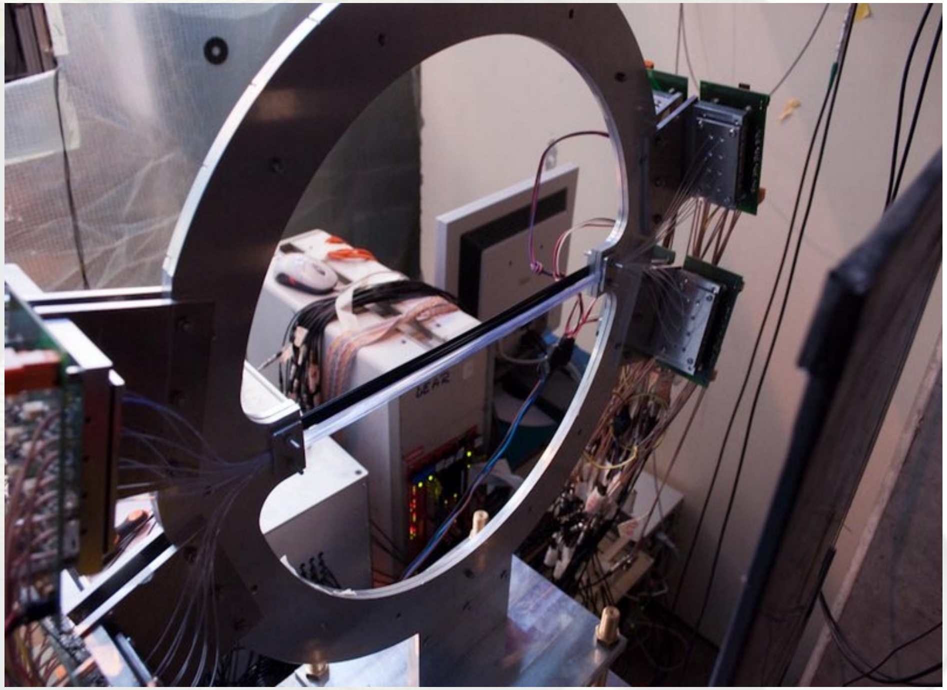
Read-out:

SiPMs HAMAMATSU S10362-11-050U

AMADEUS preliminary Test Setup

A small prototype was developed in order to test the effective functioning of the trigger system.





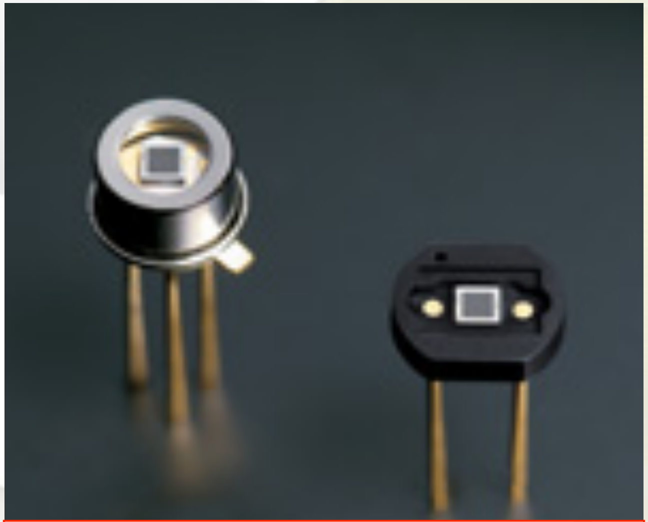
- 2 double layer of fibers (32 fibers)
- White and painted fibers for optical cross-talk study
- Variable cross angle between the two layers
- Each fiber read both sides by independent SiPMs
- Dedicated preamplifiers
- Constant fraction discriminators
- Dedicated mechanical support

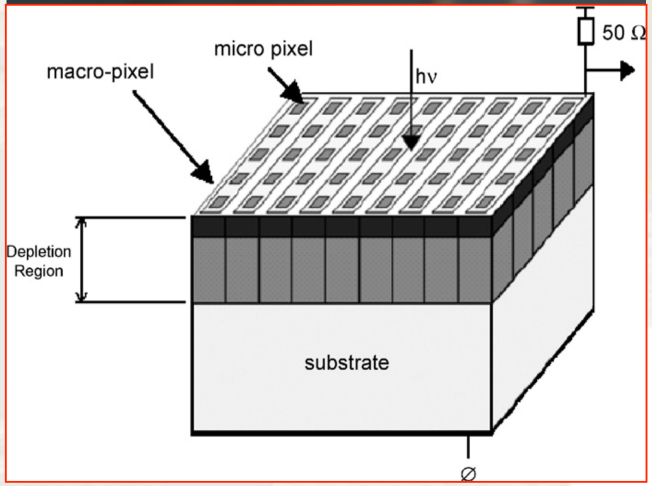
Detector characteristics

SiPM: MPPC HAMAMATSU S10362-11-050U

Supply voltage ≈70V

Gain: 10^5-10^6 (heavily depending on power supply)





They consist of a P-N junction array working in Geiger mode (micropixel)

e-h pairs generated by ionizing radiation, drift in the junction

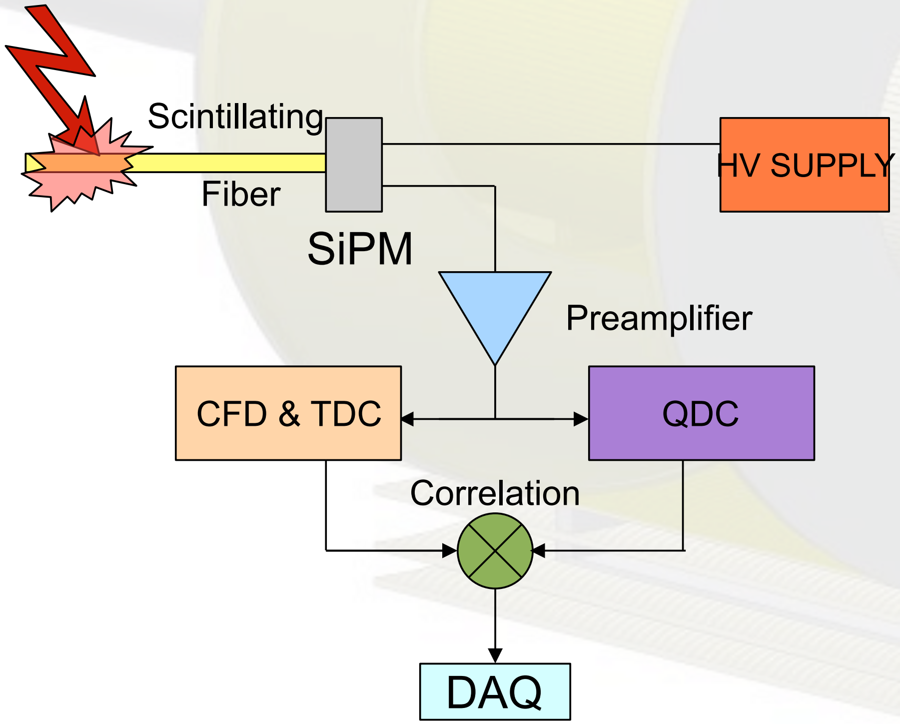
Each micropixel gives a high gain signal which is independent of the number of incident photons and has a fixed amplitude (binary mode).

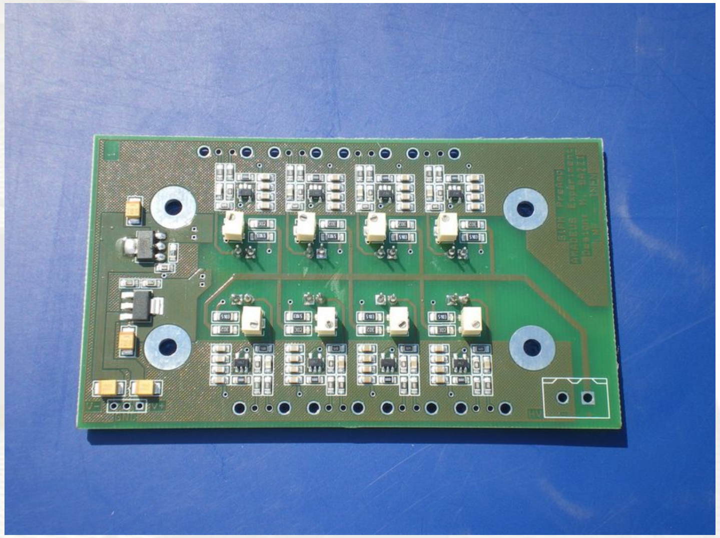
The output signal is the superposition of the photocurrents of all fired pixels.

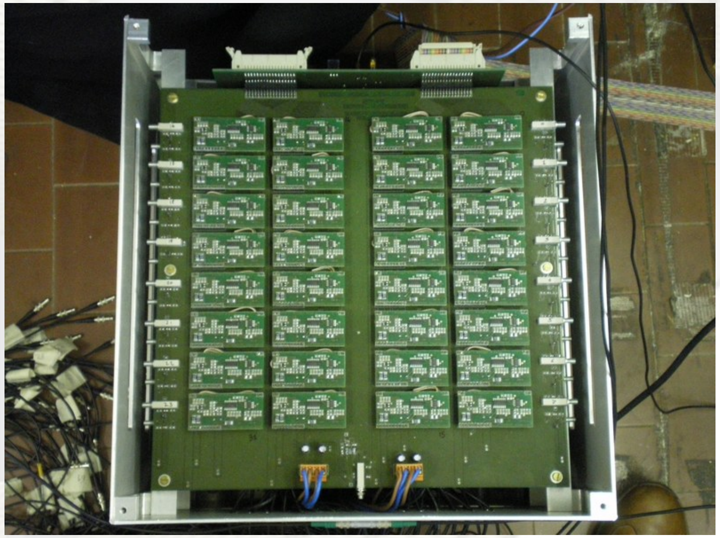
$$Q_{out} = C \times (V_{bias} - V_{bd}) \times N_{fired}$$

Electronics and DAQ chain

- Dedicated electronics for read-out and time discrimination designed and developed @ LNF.
- TDC & QDC both VME modules (CAEN).
- Acquisition chain able to read single channel time and charge information, and to correlate data.





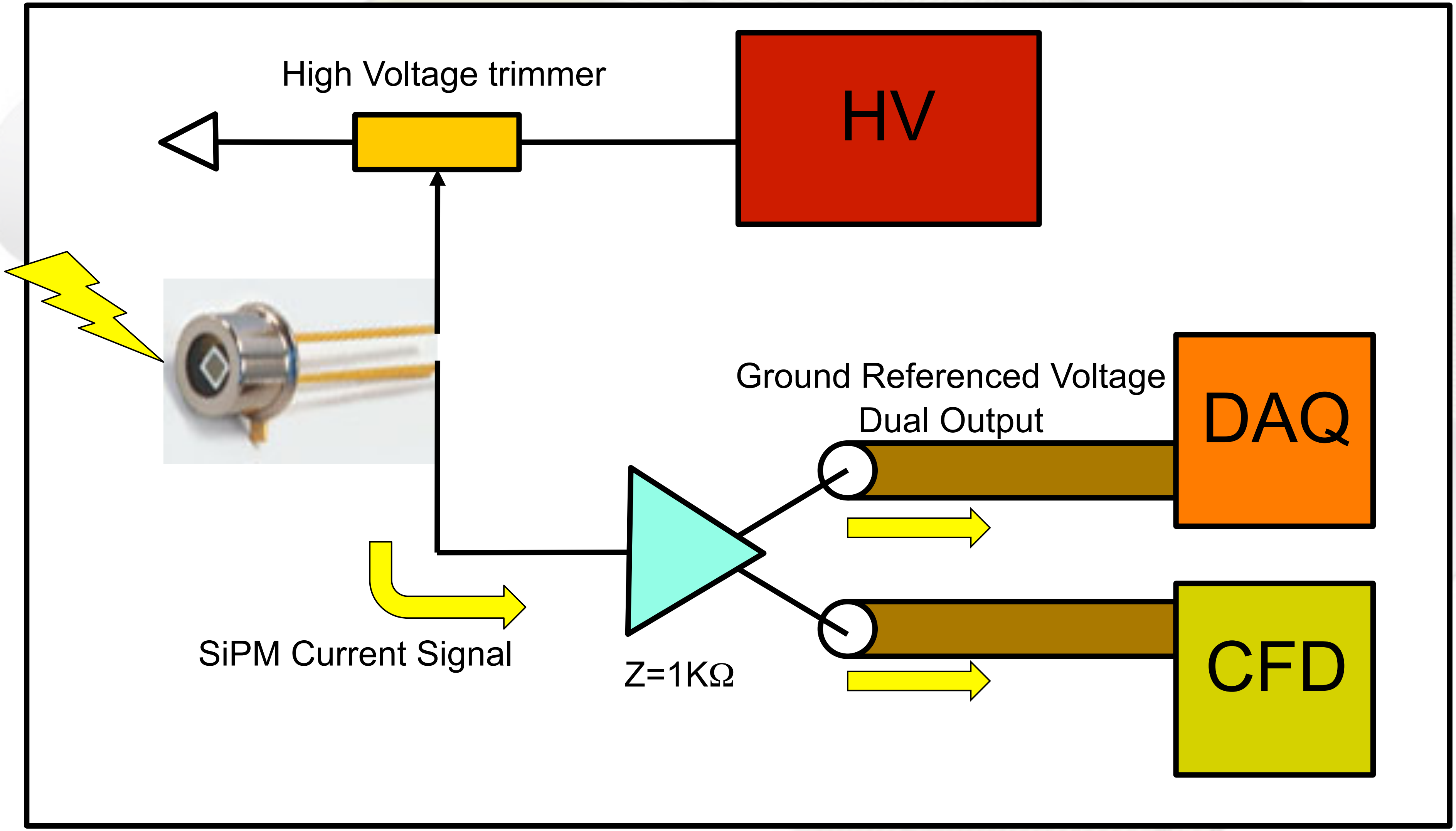


Preamplifier Board

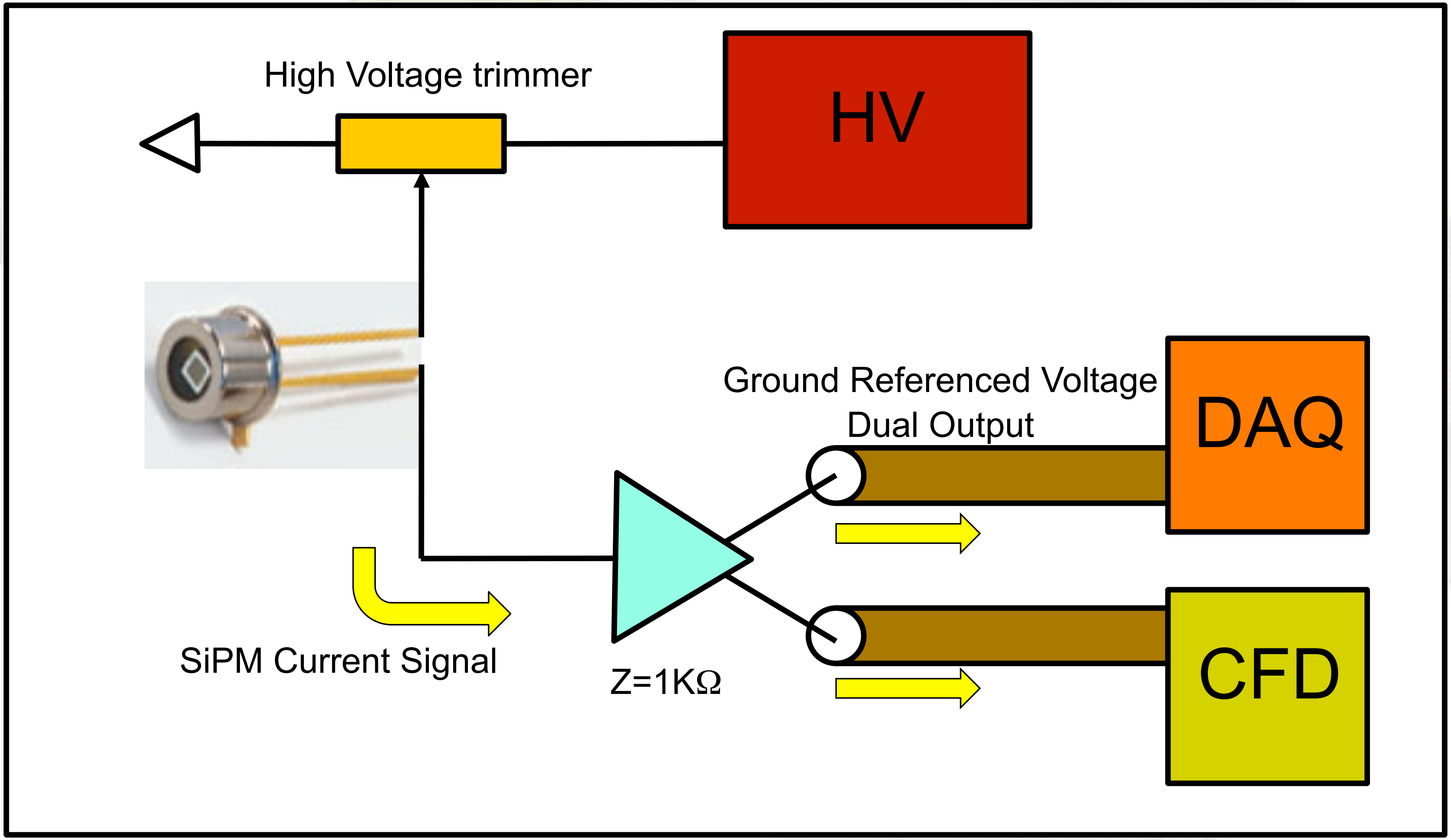
A dedicated preamplifier board has been developed for the experimental set-up. Main Characteristics are:

- 8 SiPM channels
- Independent and 10% tunable HV supply for each channel
- LV stability below 0.1%
- Ultra fast amplifiers
- Dual output signal per channel
- Transipedance amplifier (Gain = 1KOhm)

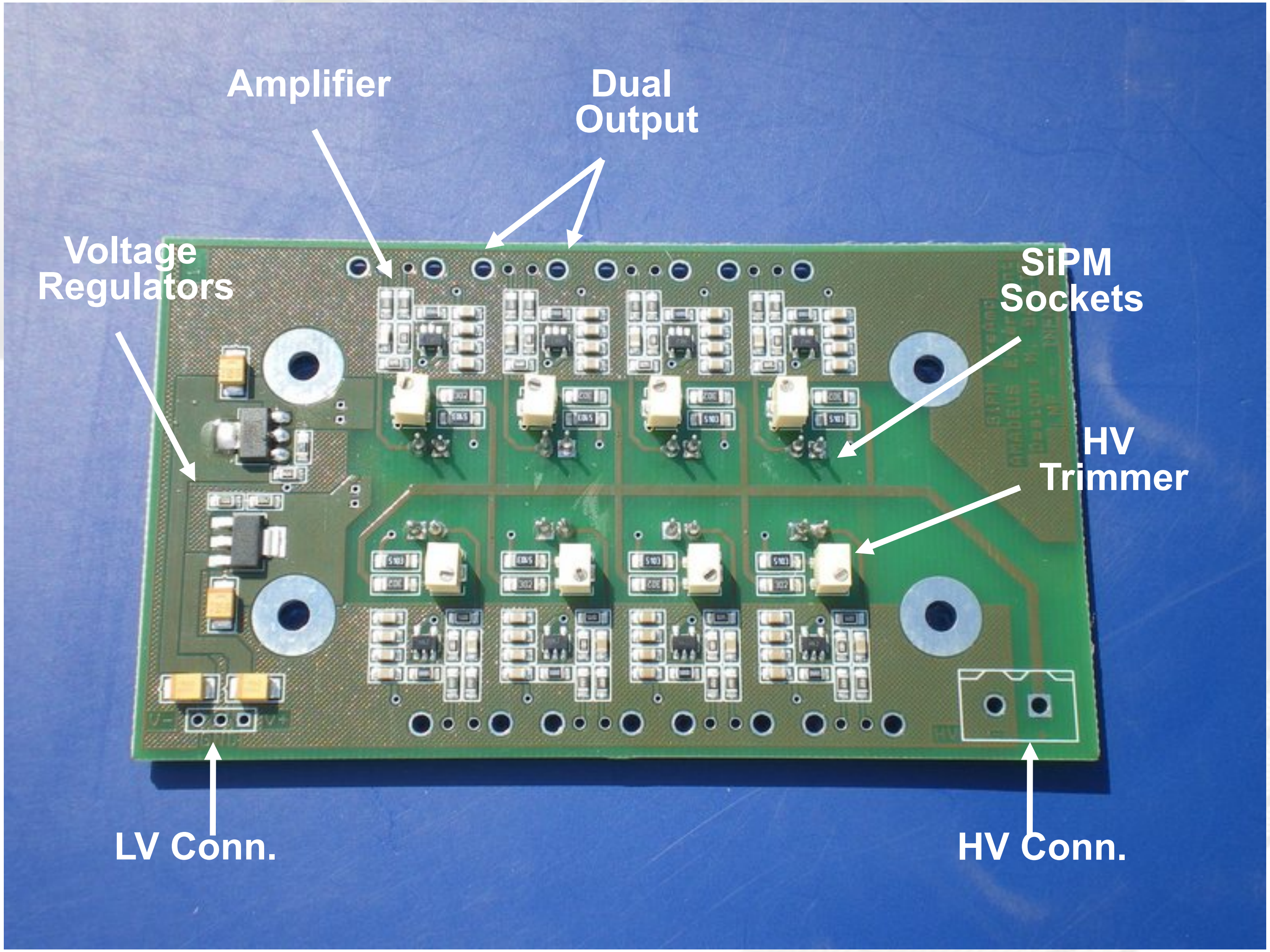
Preamplifier Board



Preamplifier Board

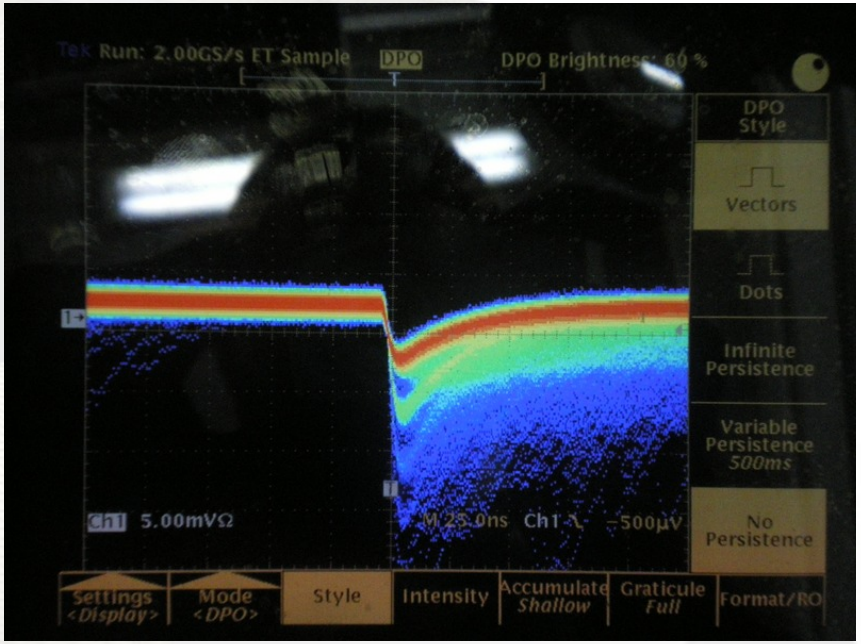


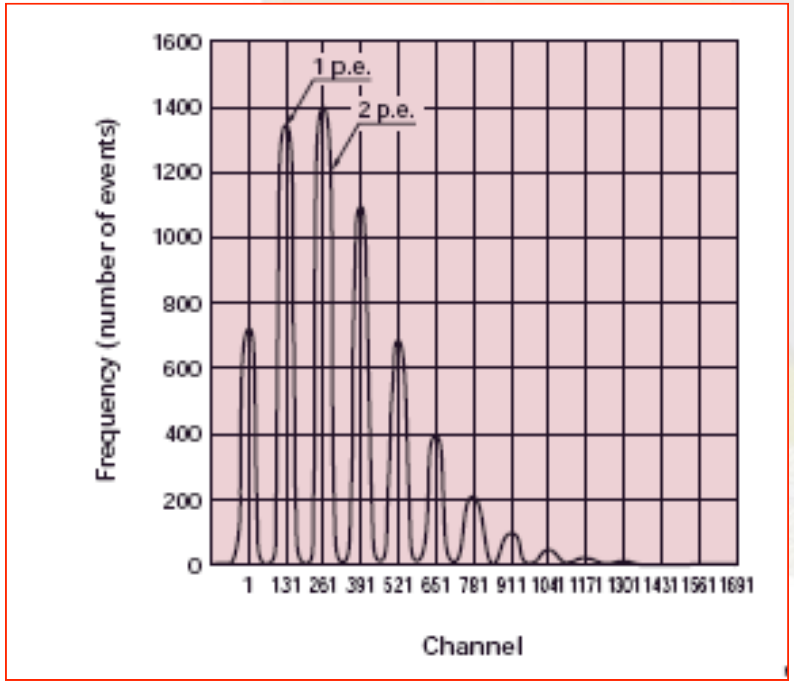
Preamplifier Board



Preamplifier Board

- Fast response, 5ns rise time
- 5-10mV per fired pixel
- Quenching time 60ns
- 100uA of photocurrent corresponds to 100mV output (Gain 1KOhm)
- QDC correct lecture tested





QDC spectra consist in a set of peaks whose x-axis position corresponds to the number of fired pixels

Preamplifier Board

Advantages

- Ultra fast, high bandwidth
- Dual independent output
- Compact architecture on dual layer PCB
- Quick & Cheap

Limits

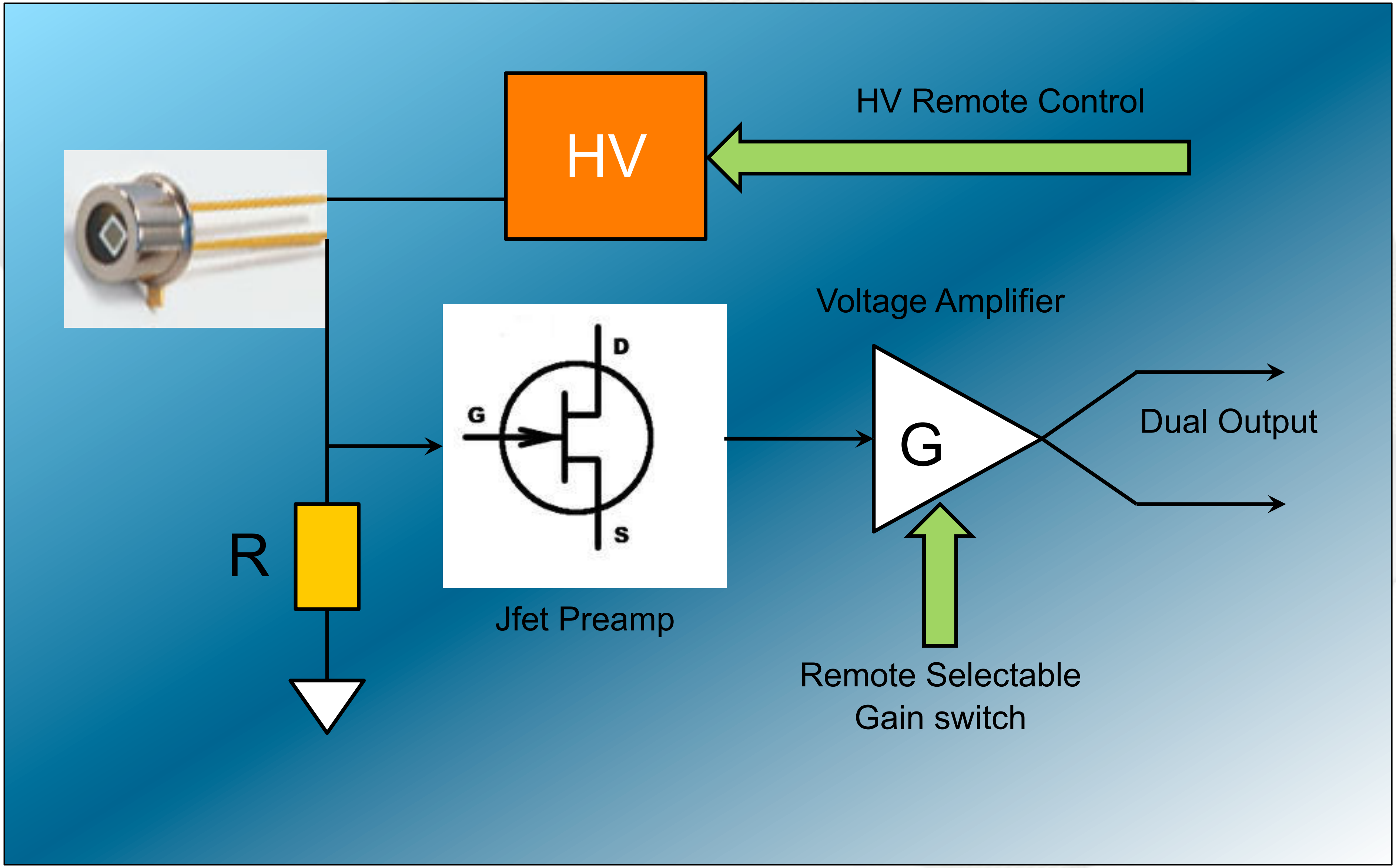
- Low flexibility
- Fixed transimpedance gain
- Manual HV regulation on board

Preamplifier Board: Future Plans

After the success of measurements performed so far a new setup is in way of definition with the following specifics:

- JFet source follower at first Stage
- Flexible Gain needed for different kind of measurements (x1, x2, x10,…)
- HV Remote control
- Temperature sensor

Preamplifier Board: Future Plans



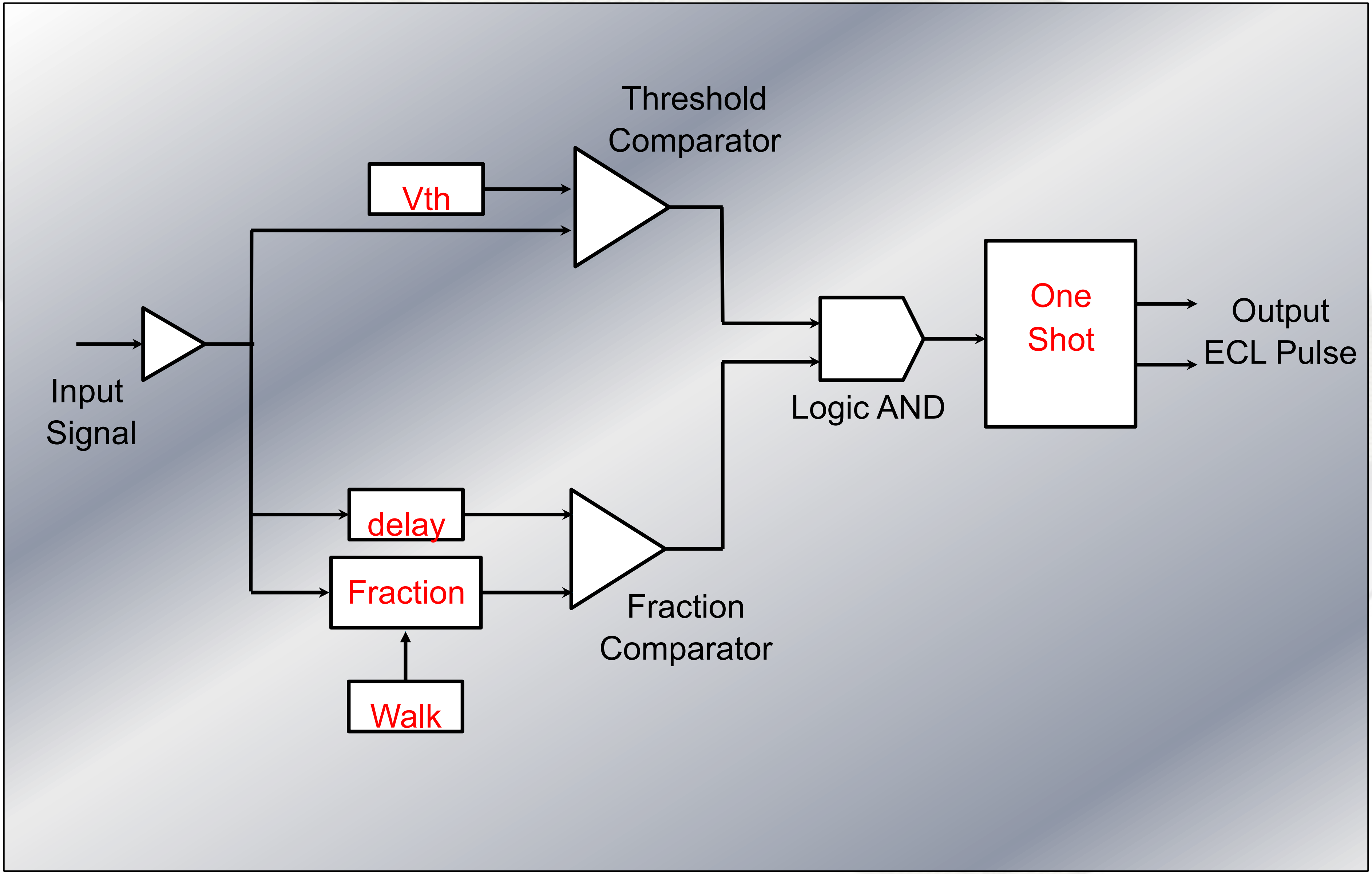
Constant Fraction Discriminator

A constant fraction discriminator has been developed for a large number of channels and to dispose of the correct output data format for TDC.

Main characteristic are:

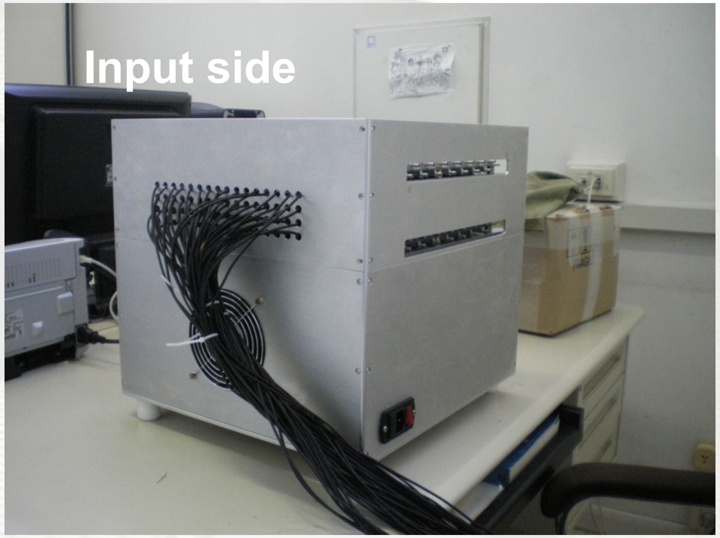
- **64 input channels (50Ohm terminated)**
- **Negative input**
- **Selectable threshold 10-1000mV**
- **Differential ECL output**
- **Minimum input amplitude signal 10mV**
- **Minimum input pulse width 10ns**
- **Jitter skew below 20ps**
- **230VAC power supply**

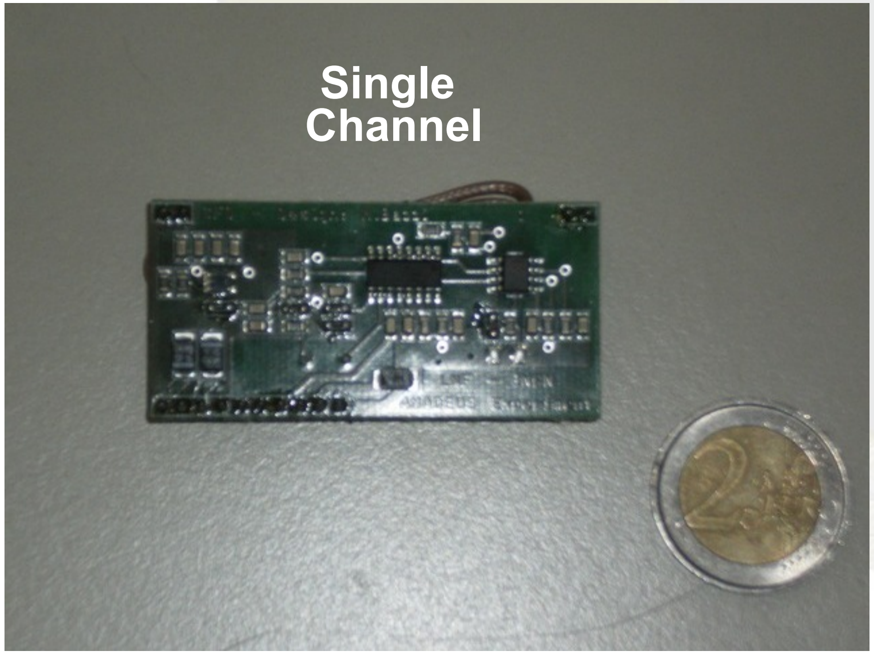
Constant Fraction Discriminator

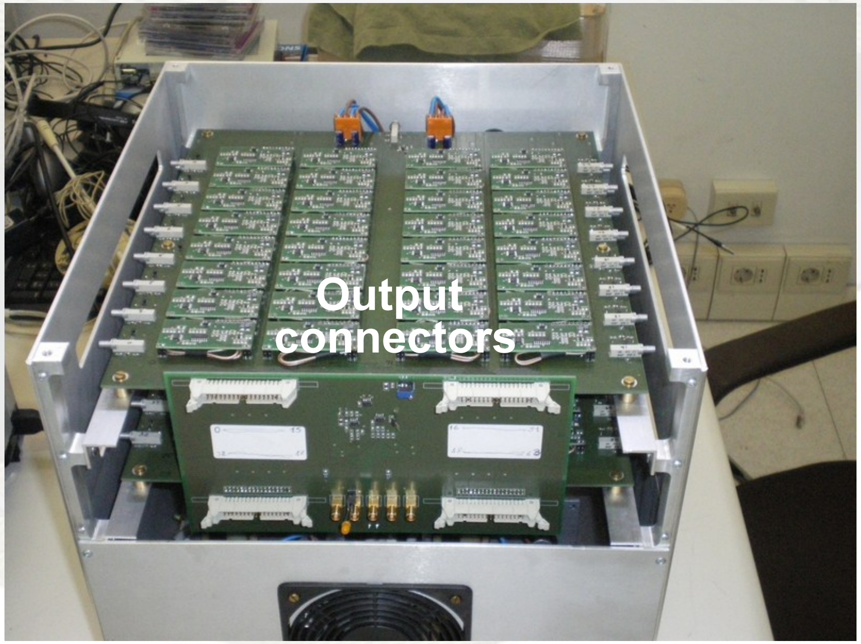


Constant Fraction Discriminator

- Piggyback board technique
- Flat twisted cable output connector
- Box provides NIM format GATE signal to TDC & QDC
- Performances compatible with CFDs available on market







Constant Fraction Discriminator

Advantages

- **Fast response, low jitter**
- **High integration (64 Channels)**
- **ECL Output**
- **OR Logic integrated**

Limits

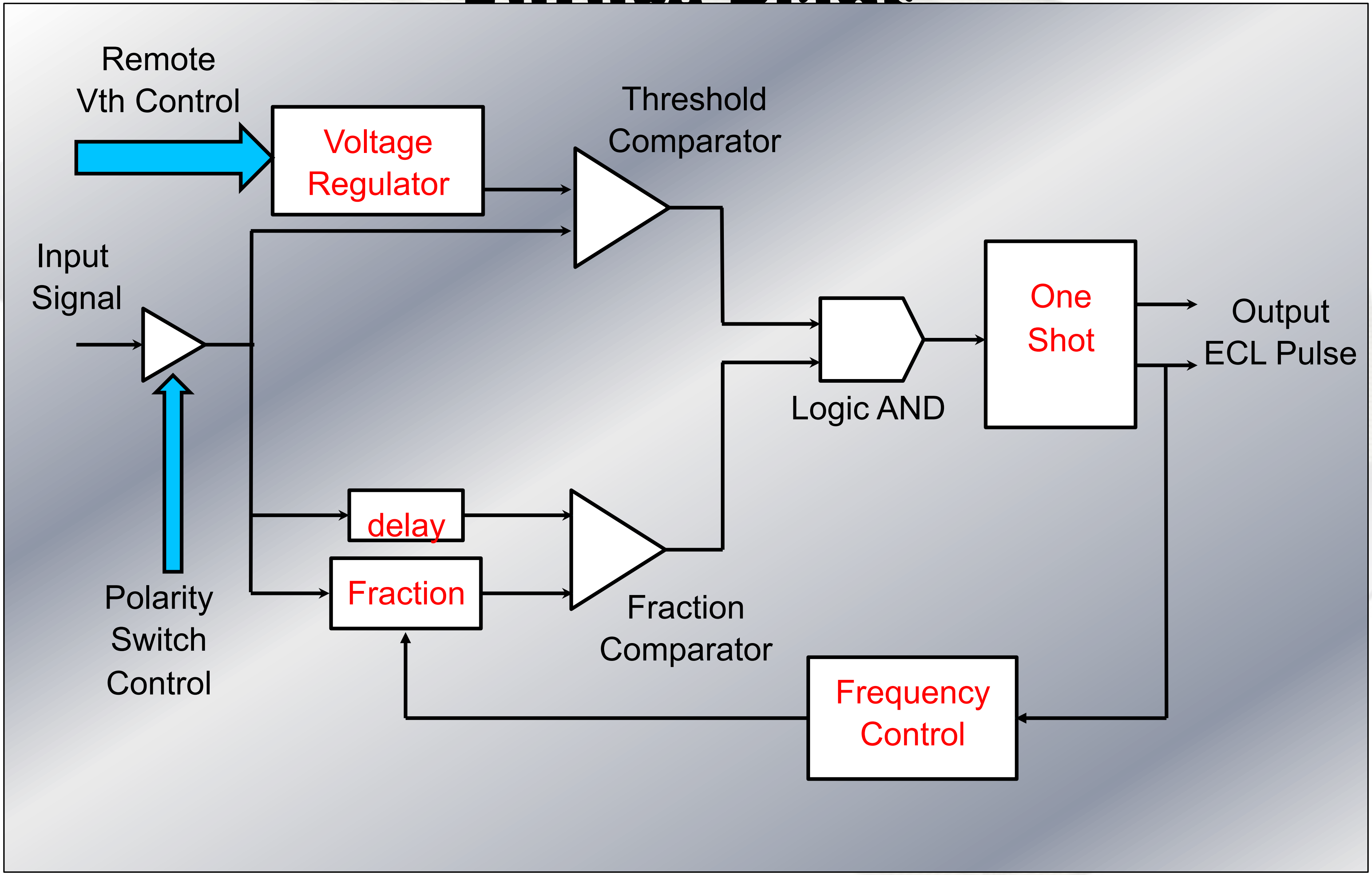
- **High power consumption due to ECL**
- **Constant Delay (Dimensioned for SiPMs)**
- **Manual Threshold Control**
- **Manual Zero-Crossing Control**
- **Only Negative Polarity**

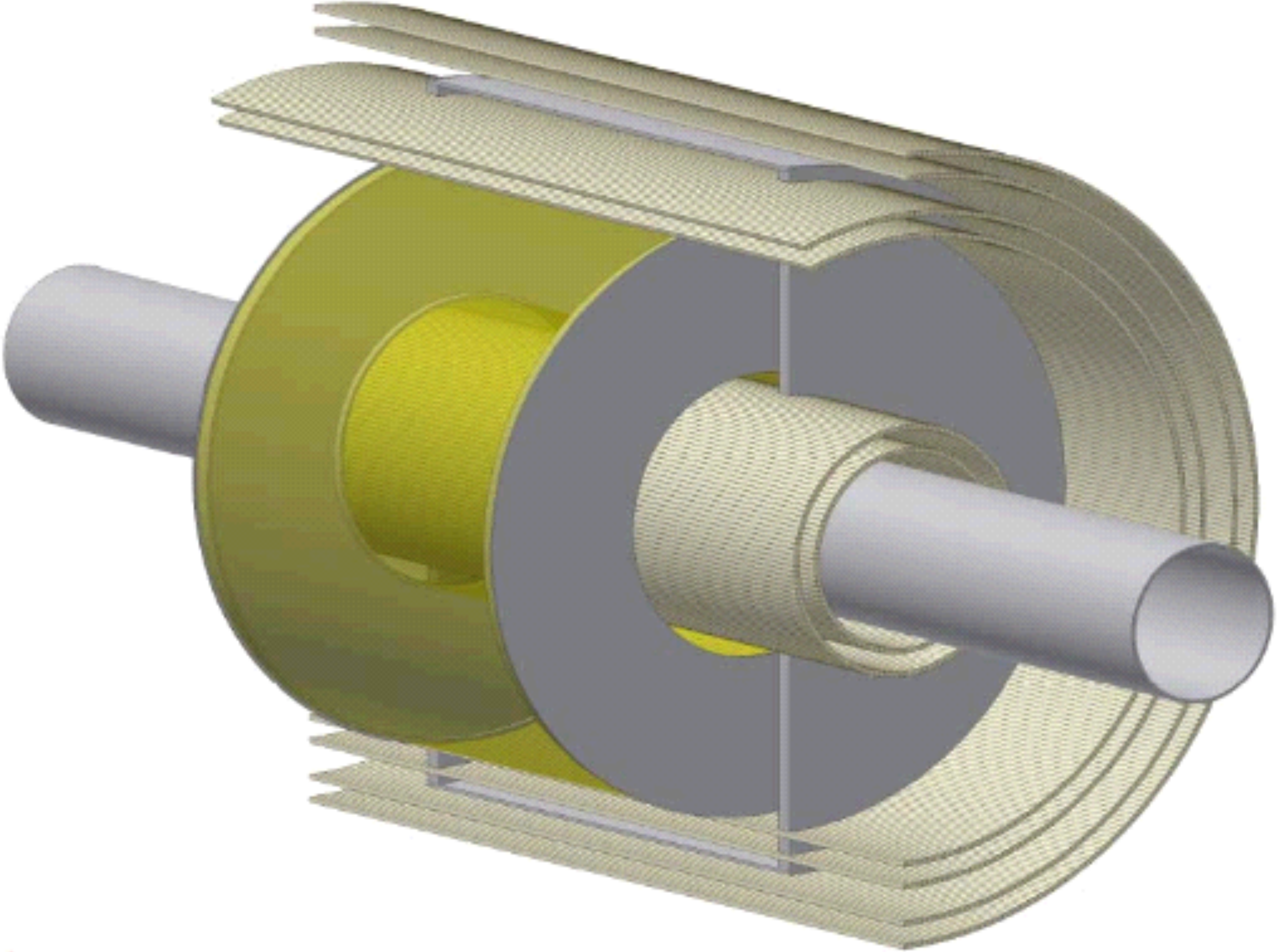
Constant Fraction Discriminator: Future Plans

For future applications CFD can be upgraded with extra features such as:

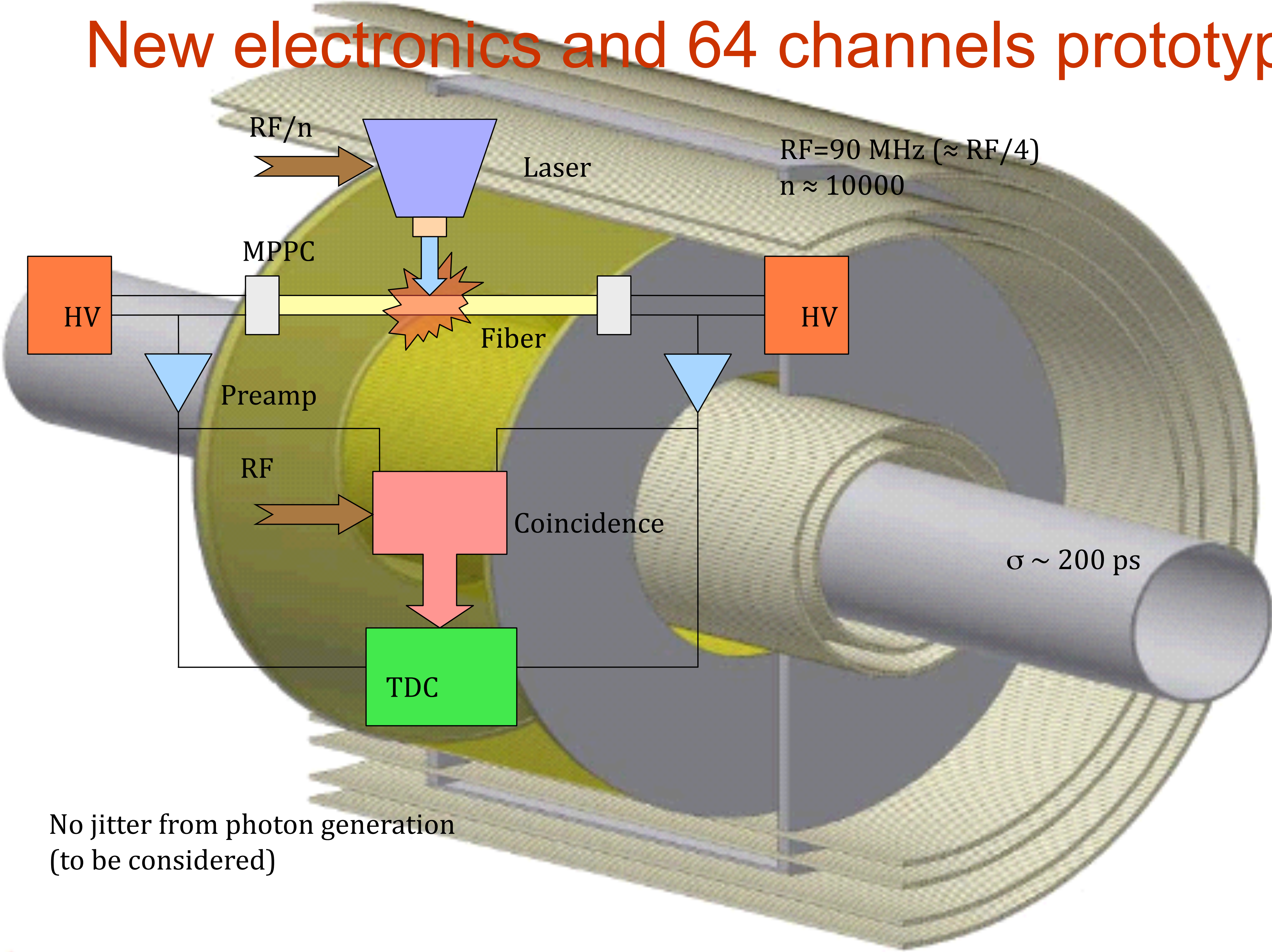
- Threshold Remote Control
- Input Polarity Switch
- Variable Delay
- ECL & NIM Output signals
- Auto Zero-Crossing Tuning
- μcontroller board for local control and remote communication

Constant Fraction Discriminator: Future Plans





New electronics and 64 channels prototype



No jitter from photon generation
(to be considered)

Test @ PSI