3° SuperB Collaboration Meeting
Frascati, 21 March 2012

Test of CLARO chip readout

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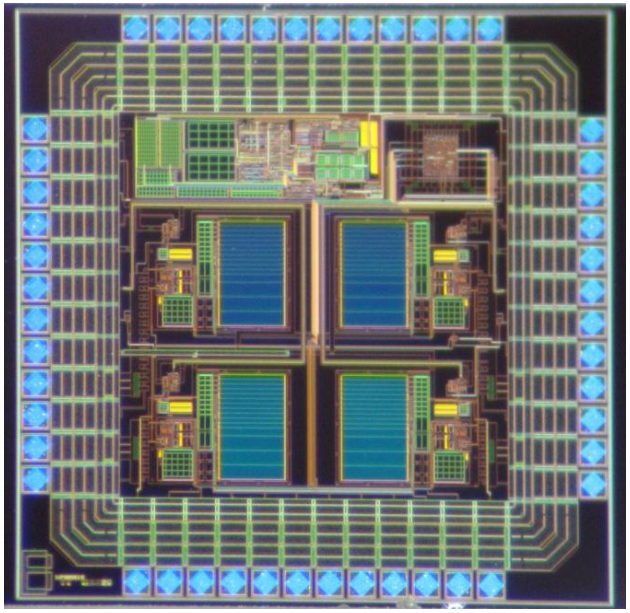
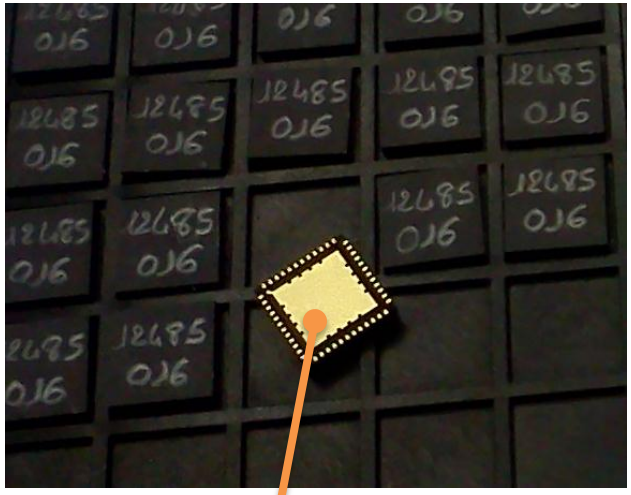
The CLARO-CMOS

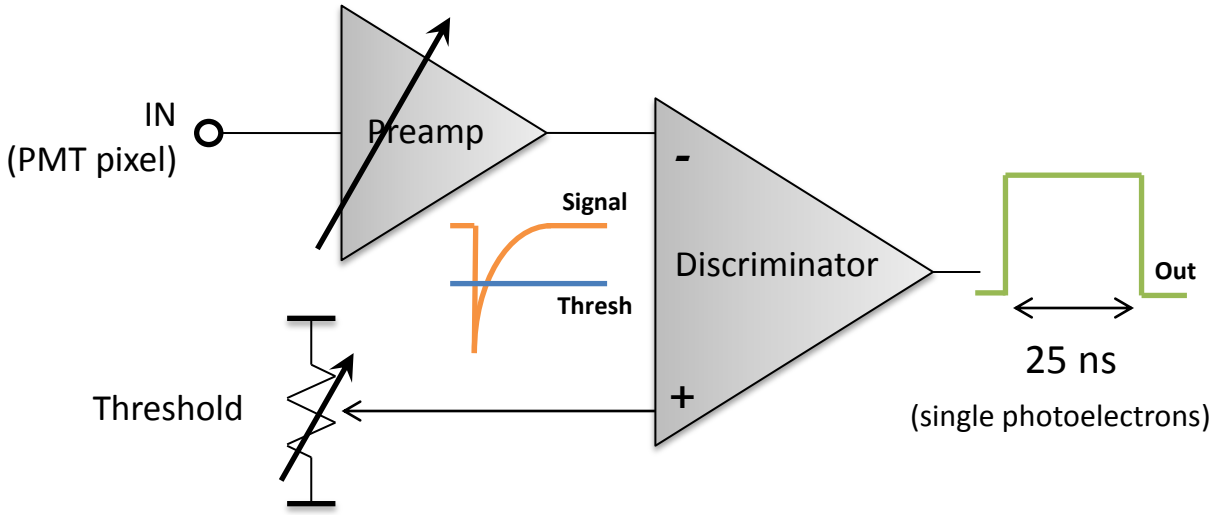
The CLARO-CMOS is the first prototype of an ASIC for single photon counting with photomultipliers, designed to readout multi-anode PMTs (Hamamatsu R11265) in the upgraded LHCb RICH.

- Each channel has a preamplifier (with settable gain) and a discriminator (with settable threshold)
- This prototype has 4 channels
- No dead time at 40 MHz hit rate (for single photoelectrons)
- Power consumption below 1 mW/channel

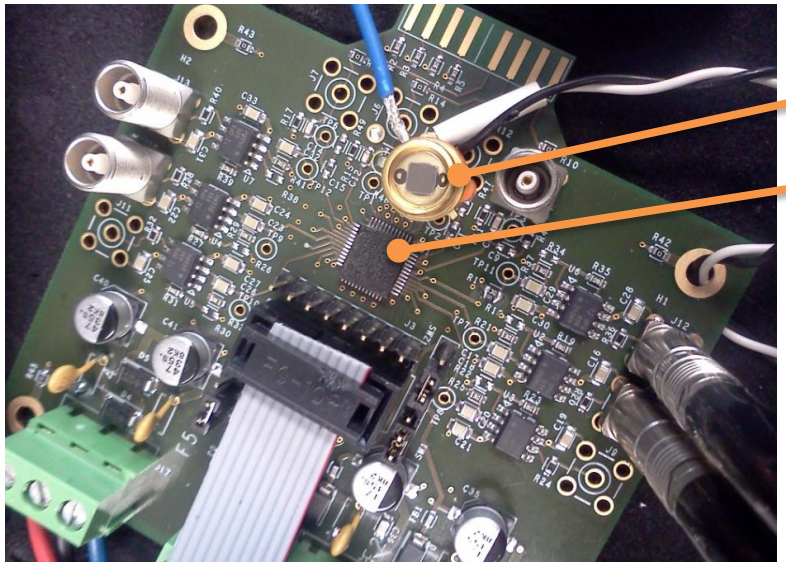




QFN48 package

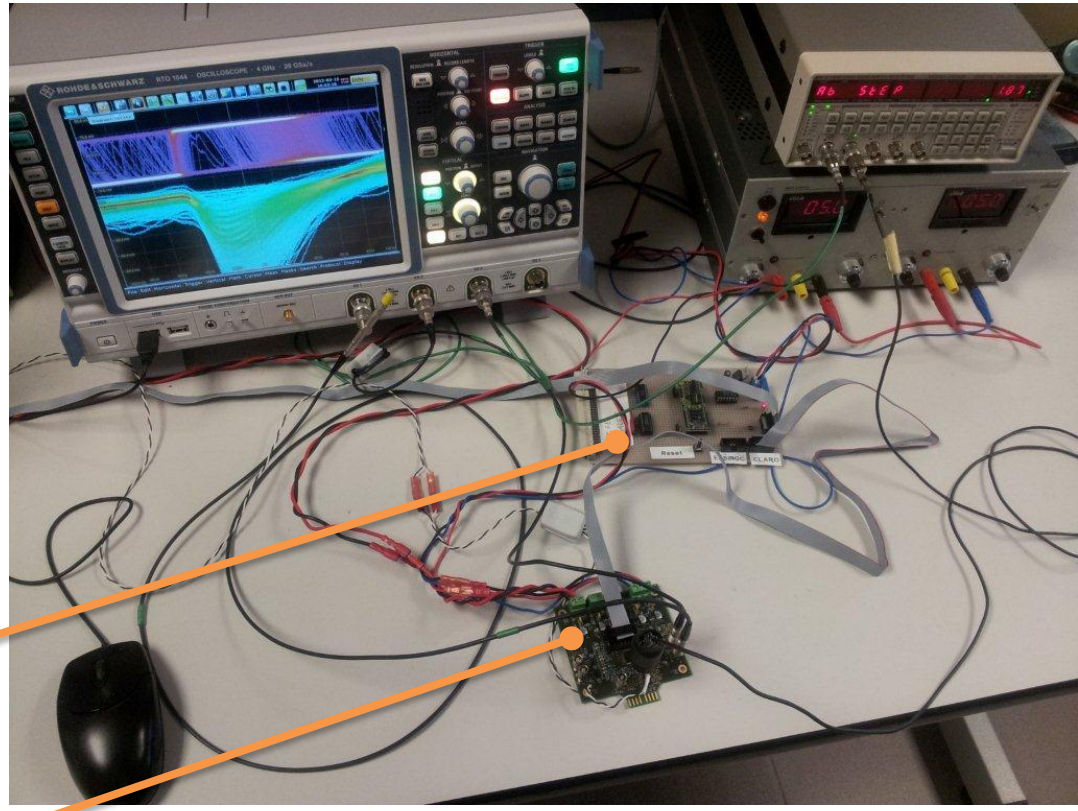


Test Setup in Ferrara



SiPM

CLARO-CMOS



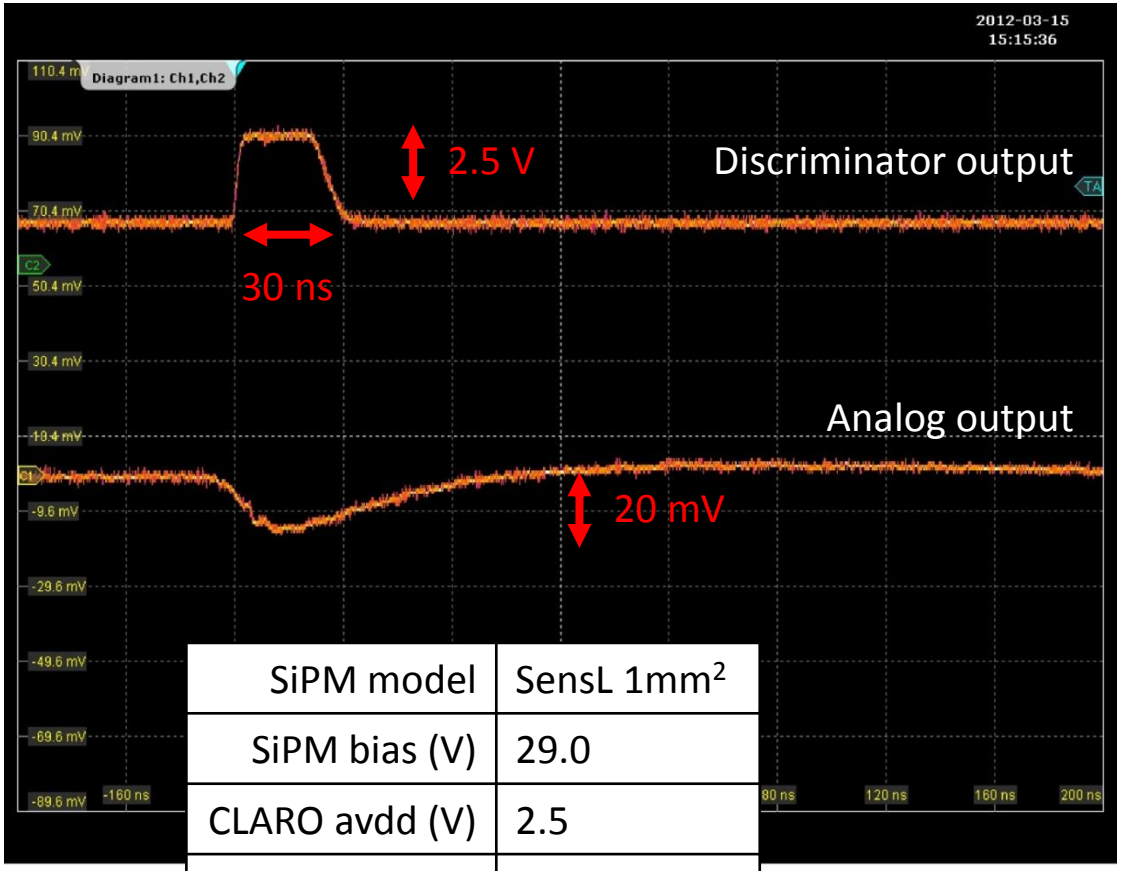
Pulsed blue LED on the SiPM

Microcontroller
(to program the CLARO)

CLARO test board

SiPM+CLARO results (1)

Output of the CLARO to a dark signal from a SensL 1mm^2 SiPM (MicroSL-10050-X18):

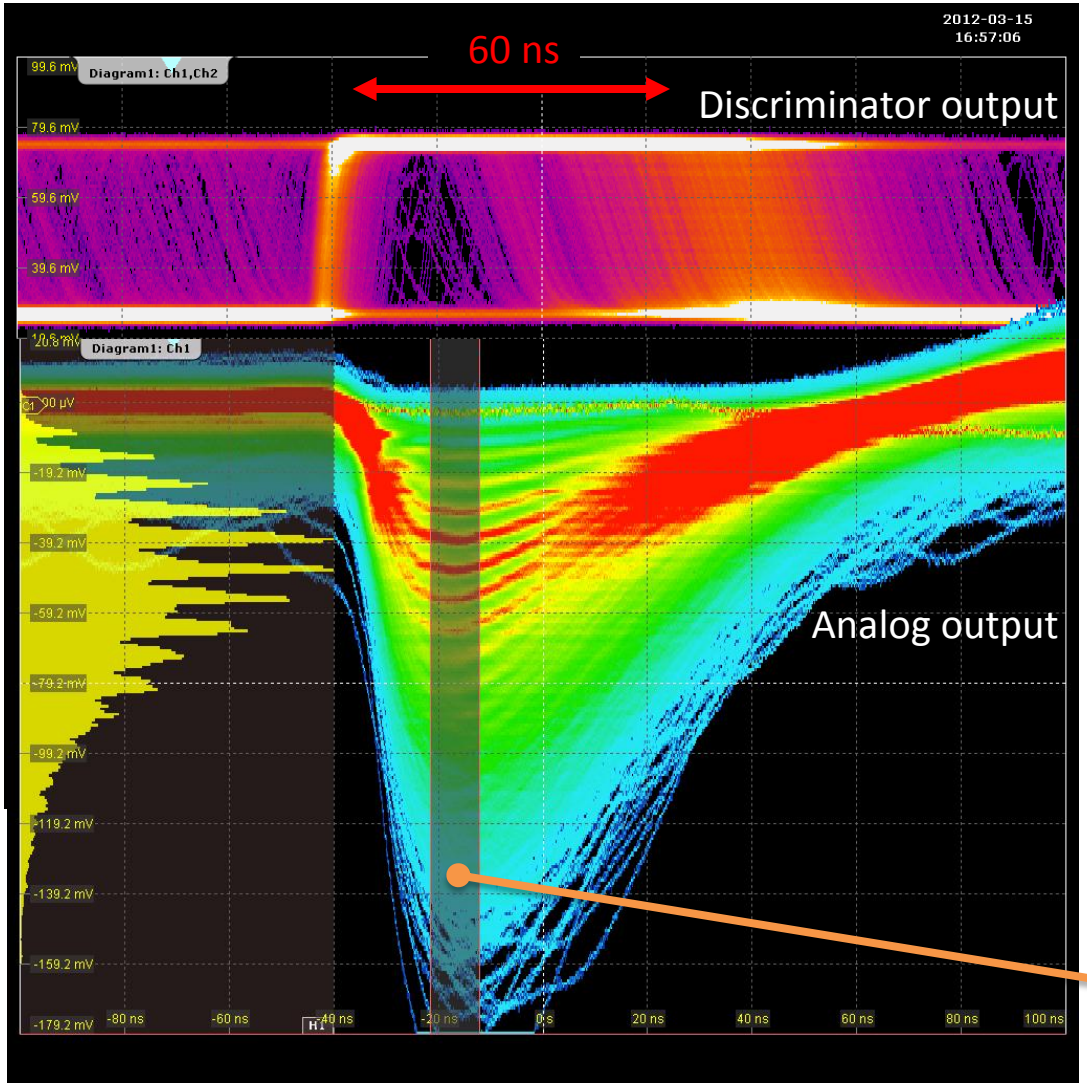


SiPM model	SensL 1mm^2
SiPM bias (V)	29.0
CLARO avdd (V)	2.5
CLARO settings	1616
CLARO channel	C

CLARO Baseline noise at the analog output: 2.5 mV pk-pk / 400 uV RMS (with the SiPM connected)

SiPM+CLARO results (2)

The amplitudes corresponding to a given number of photoelectrons are well resolved:



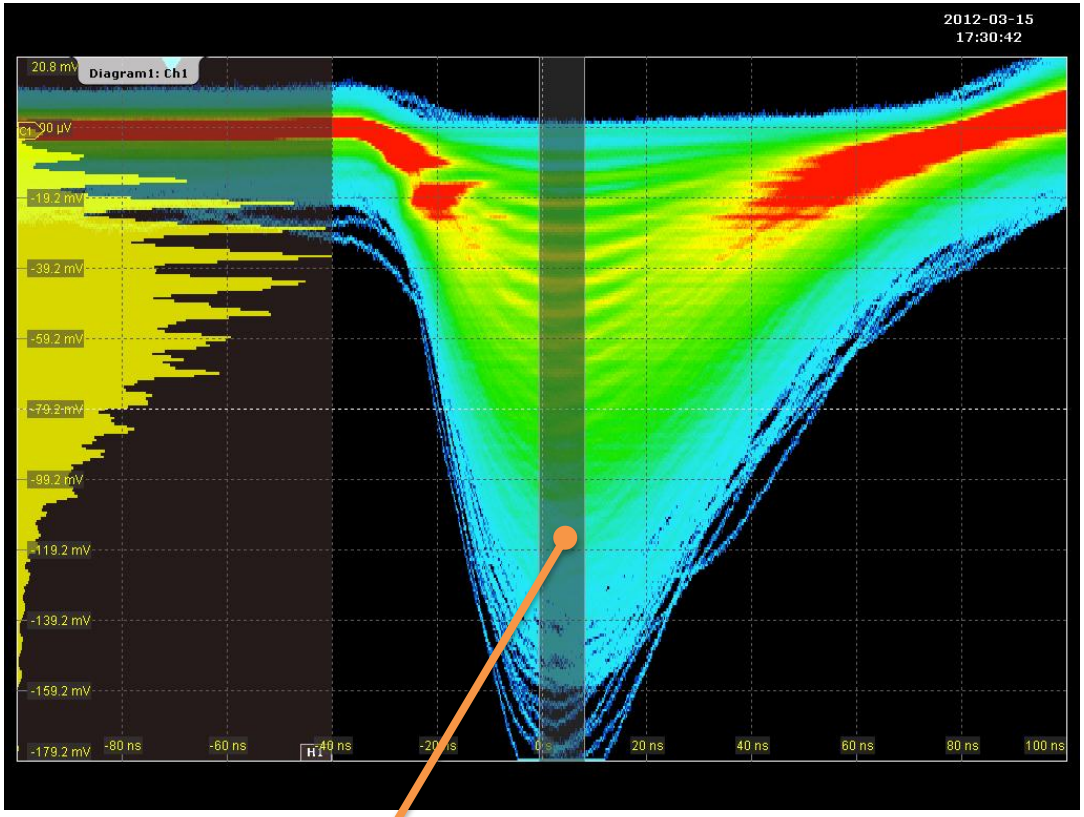
SiPM model	SensL 1mm^2
SiPM bias (V)	29.0
CLARO avdd (V)	2.5
CLARO settings	1616
CLARO channel	C

1 to 10 photoelectrons
from the pulsed LED

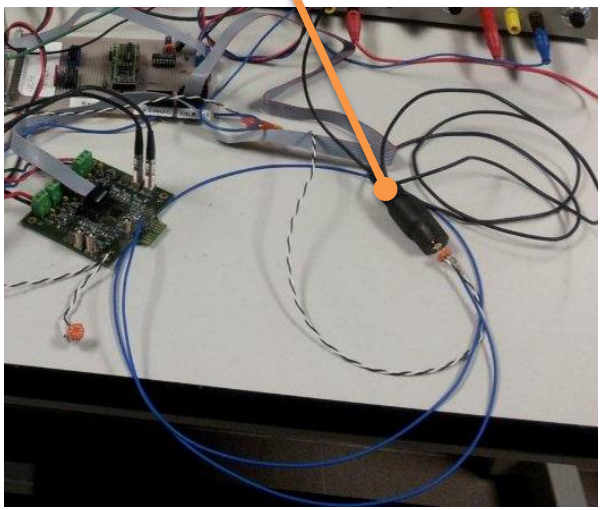
Analog peaking time: 10-15 ns
Limited by the analog output buffer
(the discriminator is faster)

SiPM+CLARO results (3)

Now the SiPM was moved far from the input, connected with a coax cable about 1 m long:



Analog peaking time: 30 ns



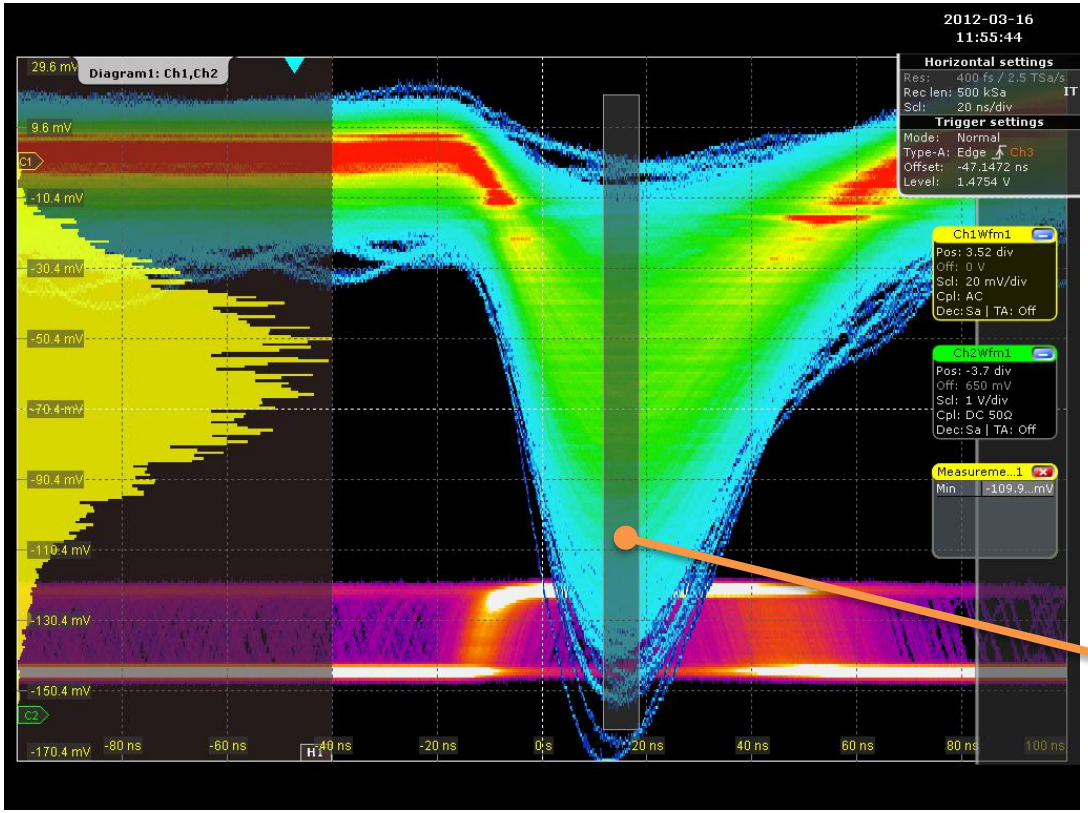
SiPM model	SensL 1mm^2
SiPM bias (V)	29.0
CLARO avdd (V)	2.5
CLARO settings	1616
CLARO channel	C

The pulses are slower, but the resolution is still good.

The noise increase due to the larger capacitance at the input is negligible.

SiPM+CLARO results (4)

Also a 3x3mm^2 SiPM with a larger capacitance was tested (the SiPM was placed close to the input):



SiPM model	SensL 9mm^2
SiPM bias (V)	29.0
CLARO avdd (V)	2.5
CLARO settings	1616
CLARO channel	C

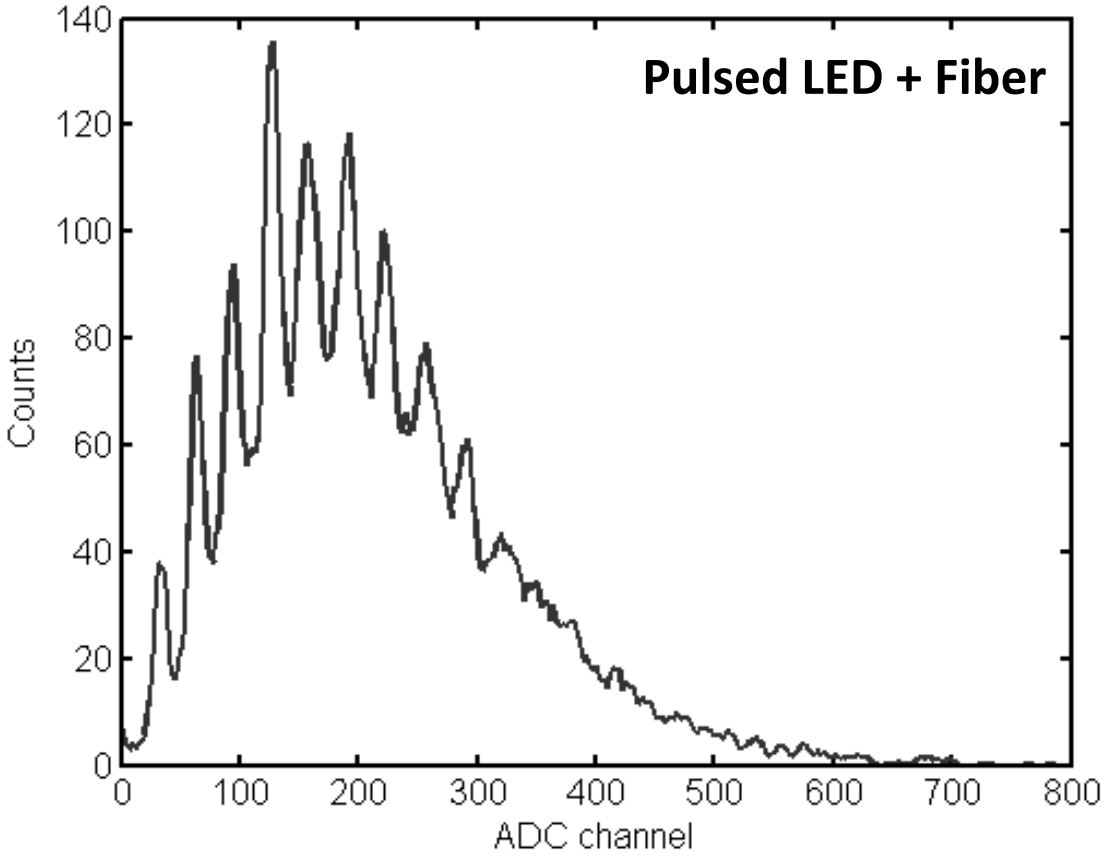
Analog peaking time: 25 ns

The pulses are slow, as in the previous case, due to the larger capacitance.

The «fingers» in the spectrum cannot be resolved, because of the large (10x) increase in the dark count rate.

SiPM+CLARO results (5)

Some integrated spectra were also acquired to test the CLARO with Gianluigi C.'s setup:



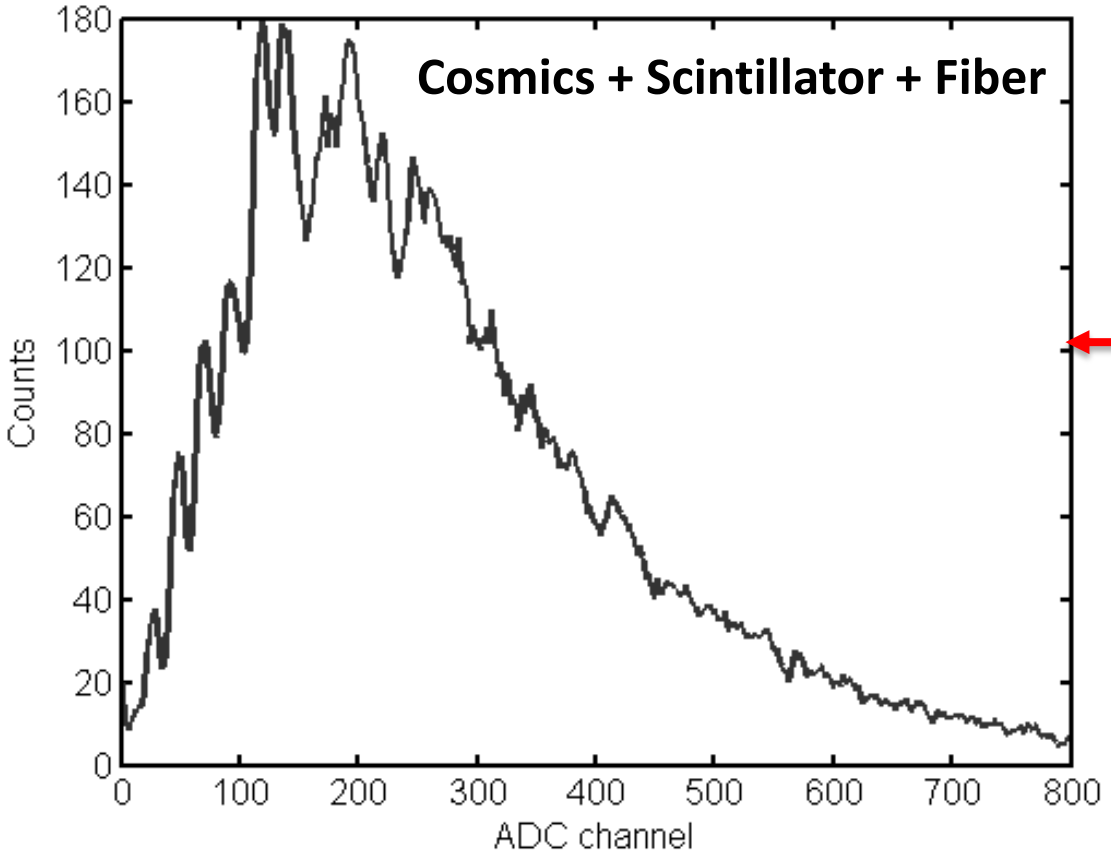
SiPM model	SensL 1mm^2
SiPM bias (V)	29.0
CLARO avdd (V)	2.5
CLARO settings	1616
CLARO channel	C

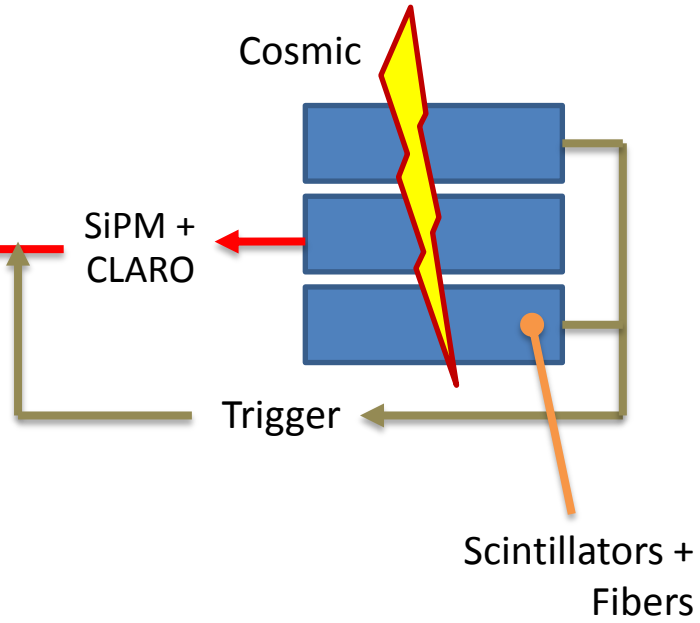
Light from the pulsed LED is centered on 5-6 photoelectrons.

The acquisition triggers on the LED pulse.

SiPM+CLARO results (6)

Some integrated spectra were also acquired to test the CLARO with Gianluigi C.'s setup:





The acquisition triggers on the coincidence of the other two scintillators.

The spectrum was acquired over the weekend.

(For this measurement, the coupling between the optical fiber and the SiPM was not optimal, giving less photons than expected.)

Open issues with the CLARO

The CLARO-CMOS chip behaves well with SiPMs.

Some improvements are possible:

- **Undershoot**

  With large signals, there is some undershoot due to an internal AC coupling.

  This is a known issue which we already planned to eliminate in a future version of the chip.

- **Speed**

  The analog output is slower than expected from simulations: this may be due to the capacitive load at the output.

  (This version of the chip is optimized for a fast pulse at the discriminator output.

  The analog pulse is fast (1 ns) at the discriminator input, but the analog output buffer was not optimized for speed.)

  An optimization will be tried in the next weeks, to see if it can be made faster.

  Also the effect of a cable at the input on the signal speed will be studied.

A deep characterization of the chip will be carried out in the next weeks, thanks to the new test board made by Roberto and Angelo.