SiPM properties study
by
INFN Roma-1
and
University “la Sapienza” of Rome
- first results

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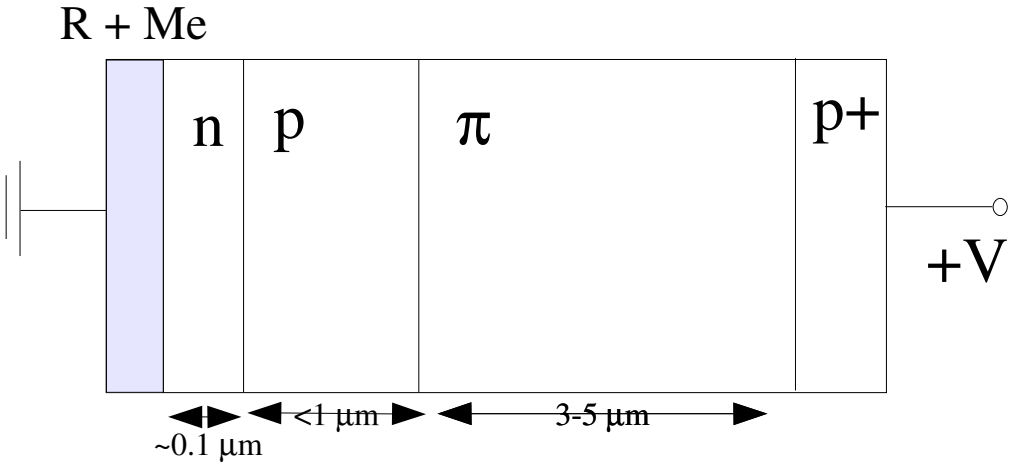
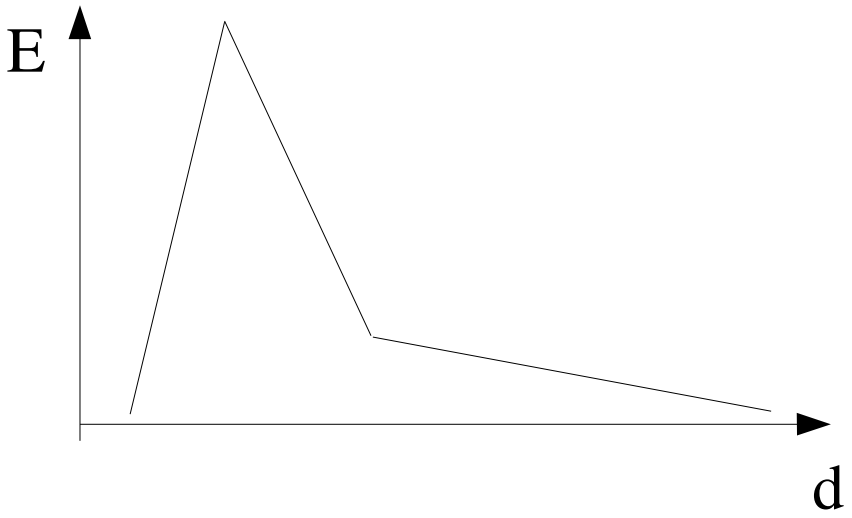
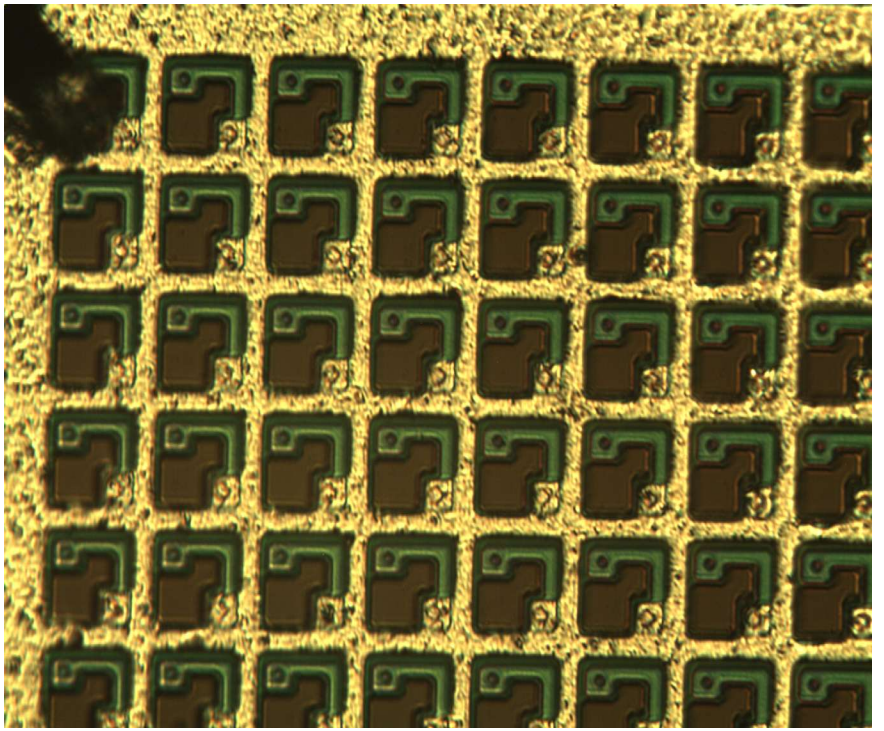
SILICON PHOTOMULTIPLIERS

Golovin and Sadygov, mid of 90s

CELLS -> MATRIX





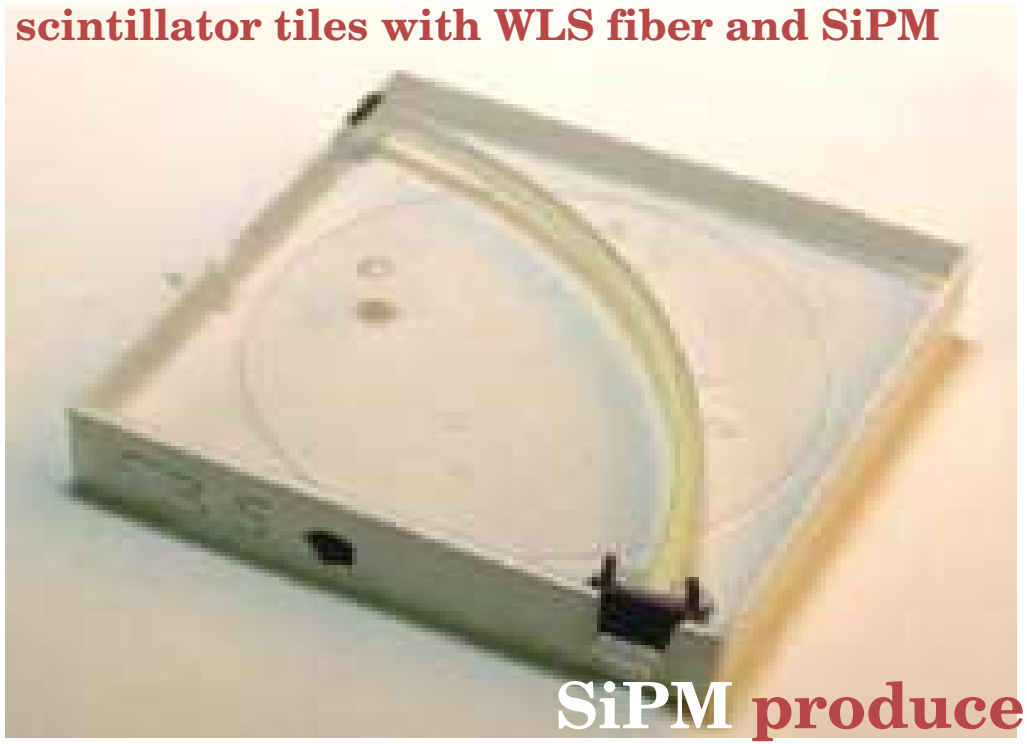


- insensitive to magnetic field
- fast (≤100 ps) response
- small size
- nowadays - reasonable price

SIPM CUSTOMERS AND PRODUCERS

AHCAL for the ILC detector

scintillator tiles with WLS fiber and SiPM



HEP, astrophysics,
medical applications, ...

SiPM produced by :

- ***MEPhI / PULSAR (Russia)***
- ***Obninsk Uni / CPTA (Russia)***
- ***HAMAMATSU (Japan)***
- ***IRST (Italy)***
- ***SensL (Ireland)***
- ***...***

SIPM STUDIES at ROMA

First steps :

- ***Development of the test setup and measurement procedure***
- ***General measurements of the SiPM response to LED light (single photoelectron spectra)***
- ***Comparison of SiPM produced by different manufacturers***

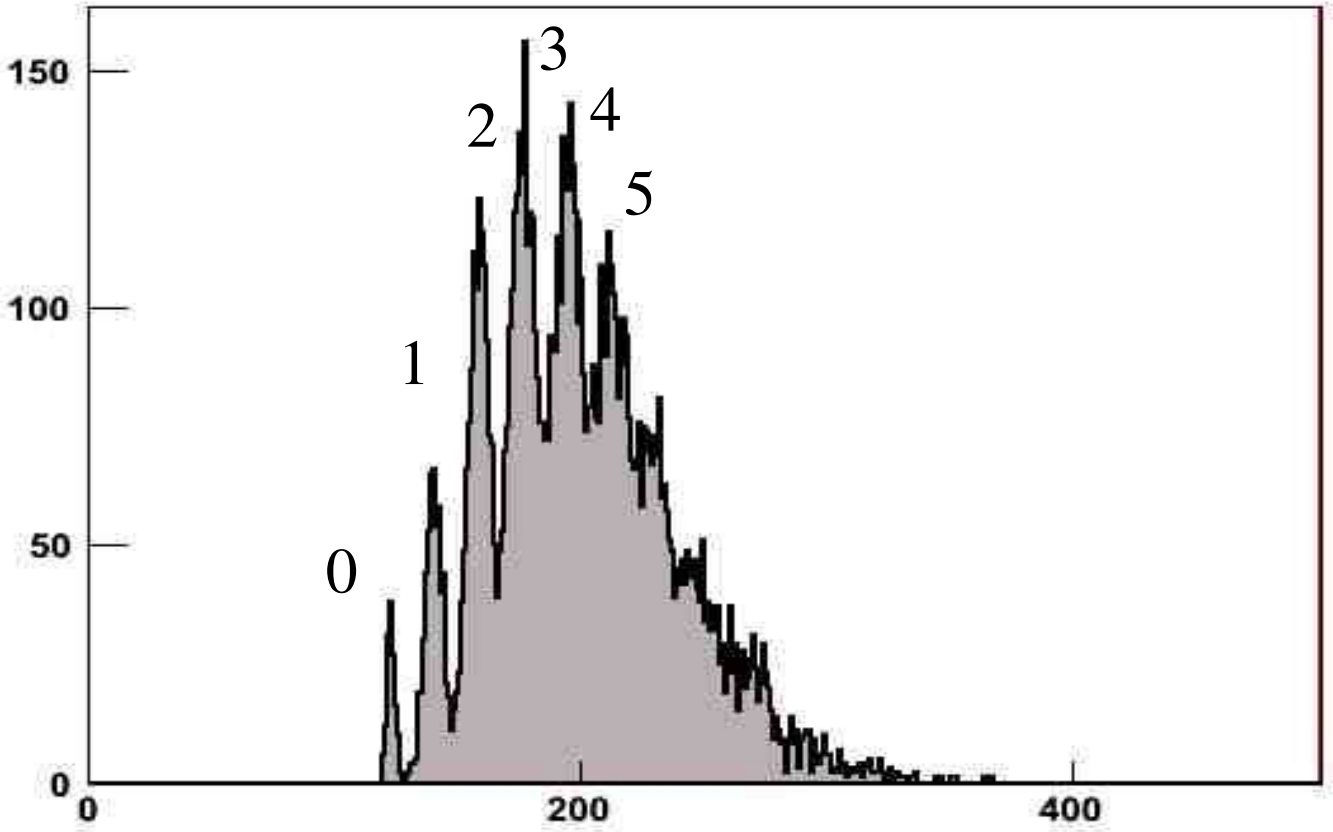
SiPM samples :

- Obninsk Uni / CPTA	~ 1x1 mm, ~500 cells
- HAMAMATSU	1x1 mm, 1600 cells
- FORIMTECH / CPTA	~ 1x1 mm, ~500 cells
- IRST	1x1 mm, 625 cells
- SensL	1x1 mm, 620 cells

Measurements :

- ***Current-Voltage characteristics***
- ***Response to low-intensity light (UV LED)***

SINGLE PHOTOELECTRON SPECTRUM



Parameters :

- ***Gain***
- ***Width of the pedestal and single pe peak***
- ***Efficiency of light registration***
- ***Crosstalk between pixels***

LED DRIVE

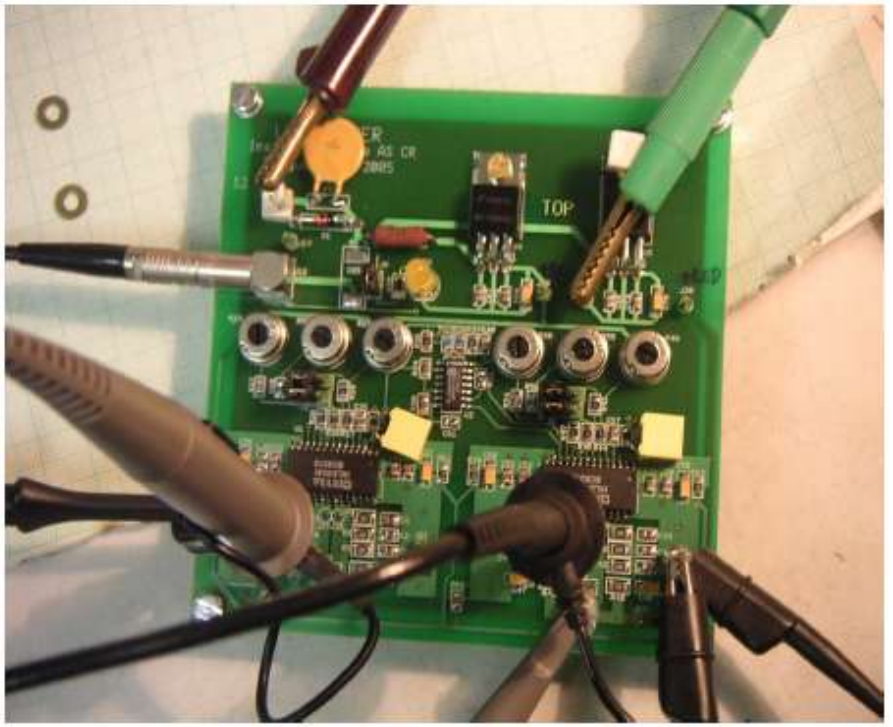
Low intensity fast light pulses :

LED drive from Institute of Physics ASCR Prague

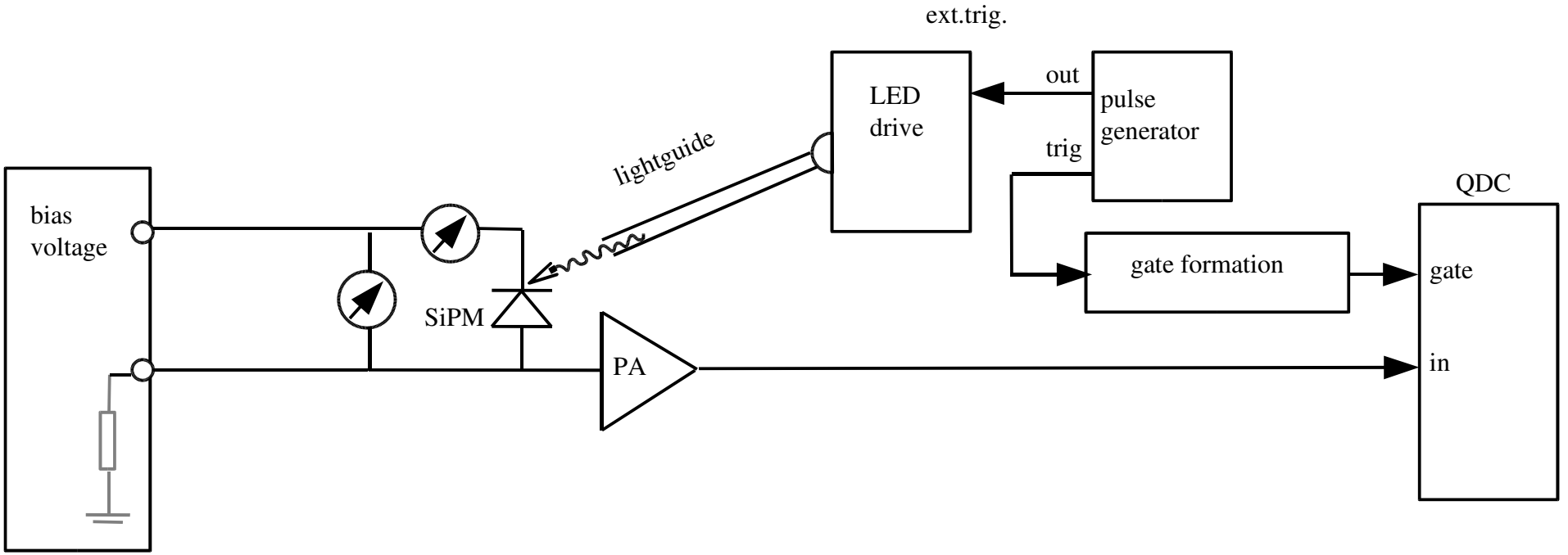
- ***developed for Calibration and Monitoring Board***
- ***external trigger***
- ***variable current pulse width***
- ***variable current pulse amplitude***

- Common input for signal LED-trigger, lemo, 50Ω
- One 12V (60mA) supply, protection
- Rise time 2ns,

  tested with P5050 scope probe (8pF, 500MHz)
  C=8pF, L=30nH
  f_{res}=290MHz

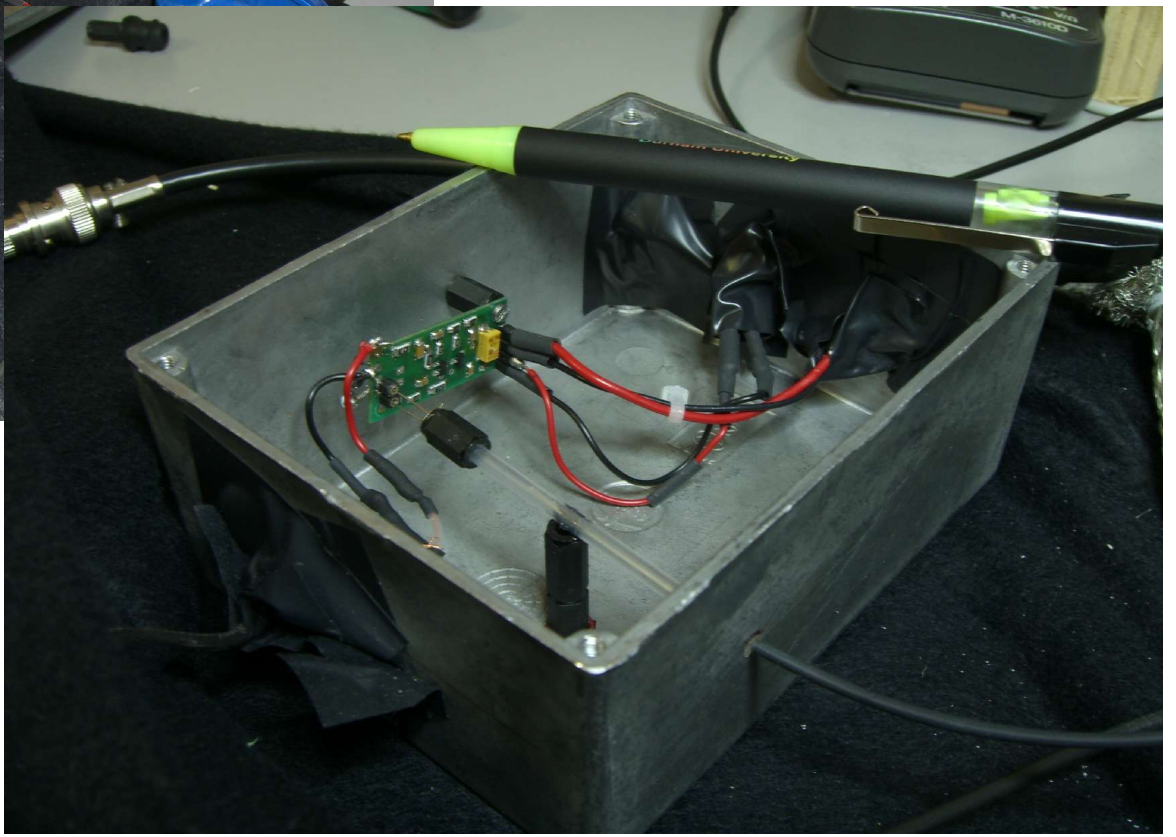


SETUP @ ROMA1

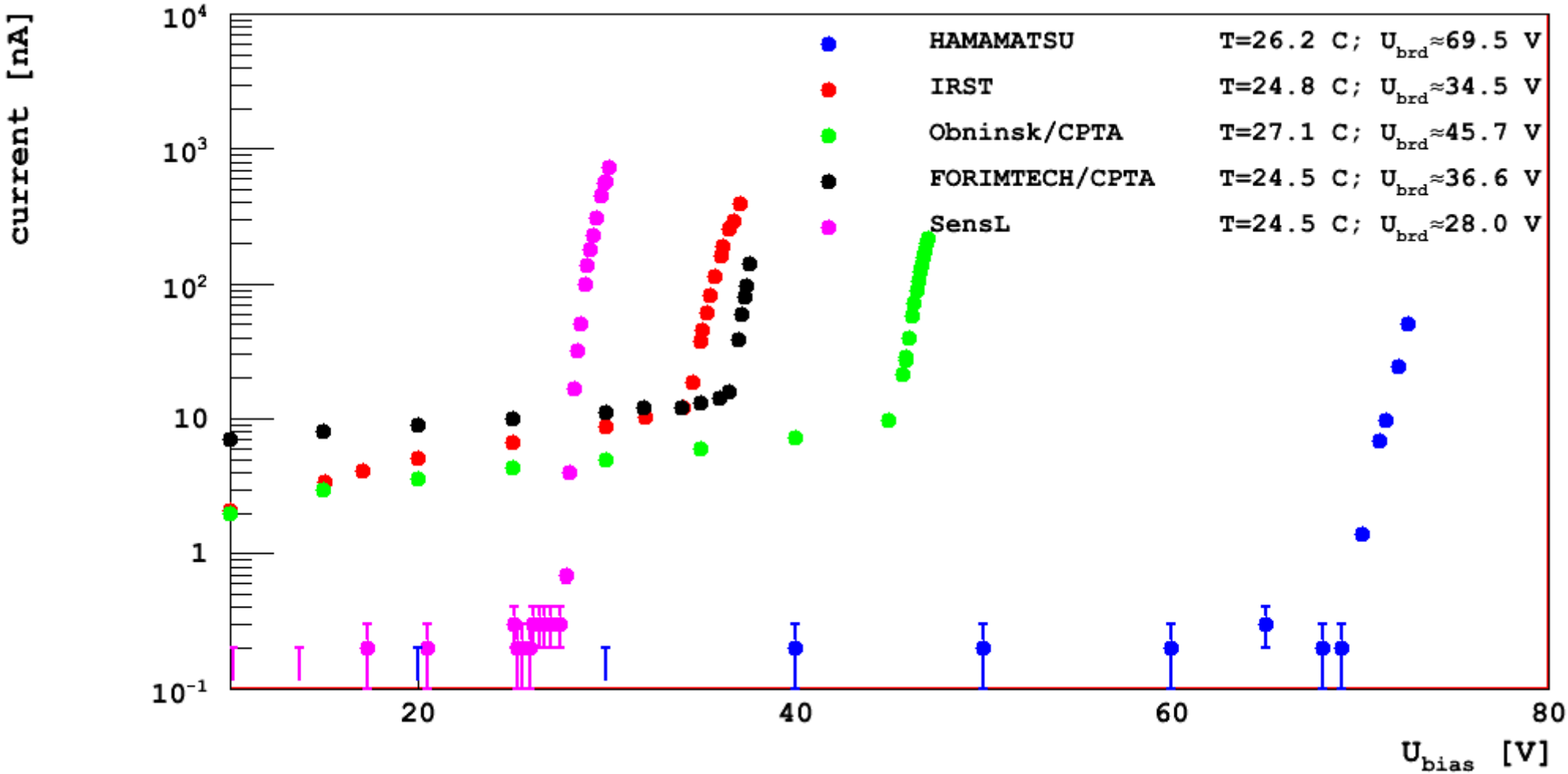

ext.trig.
LED
drive
out
pulse
generator
trig
lightguide
QDC
bias
voltage
gate formation
gate
SiPM
PA
in

SETUP @ ROMA1

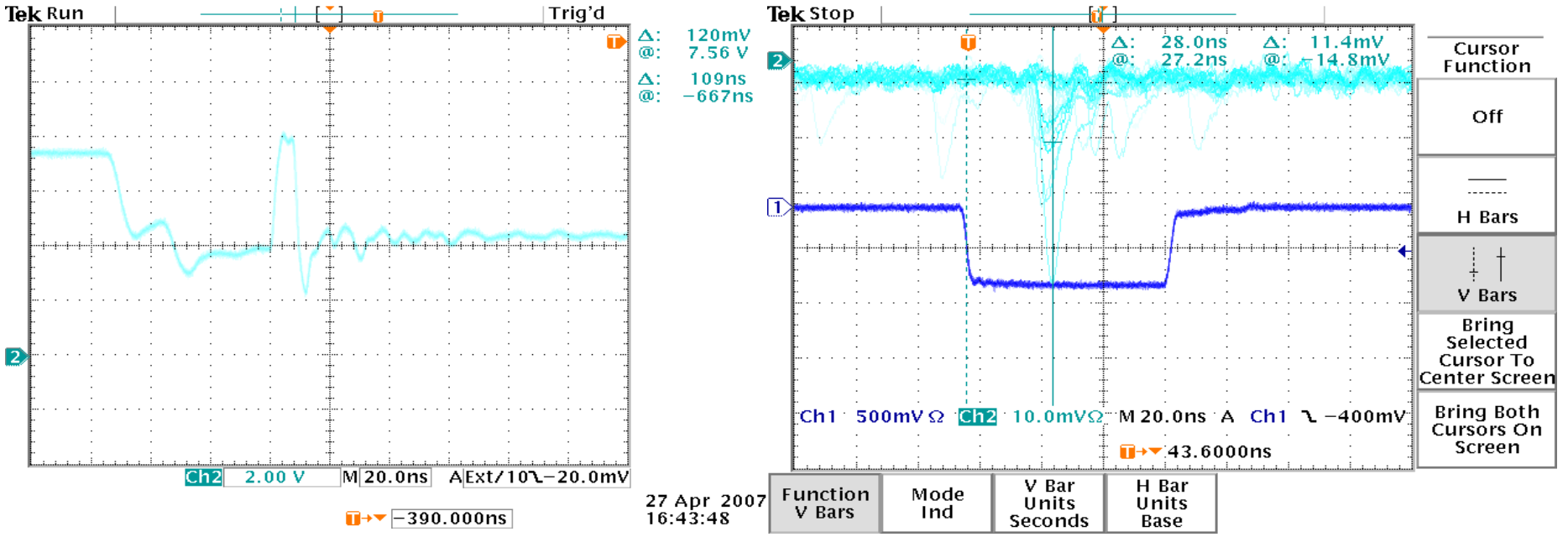
KEITHLEY 486 AUTORANGING PICOAMMETER
VOLT - AMPERE
197 AUTORANGING MICROVOLT DMM
EUTRON

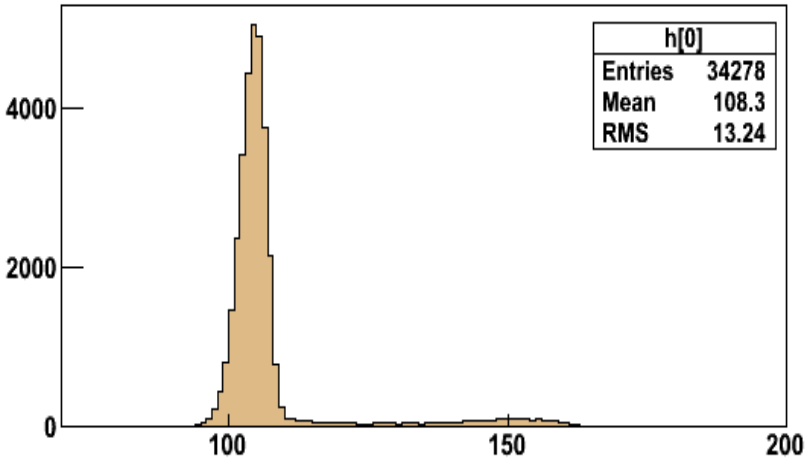


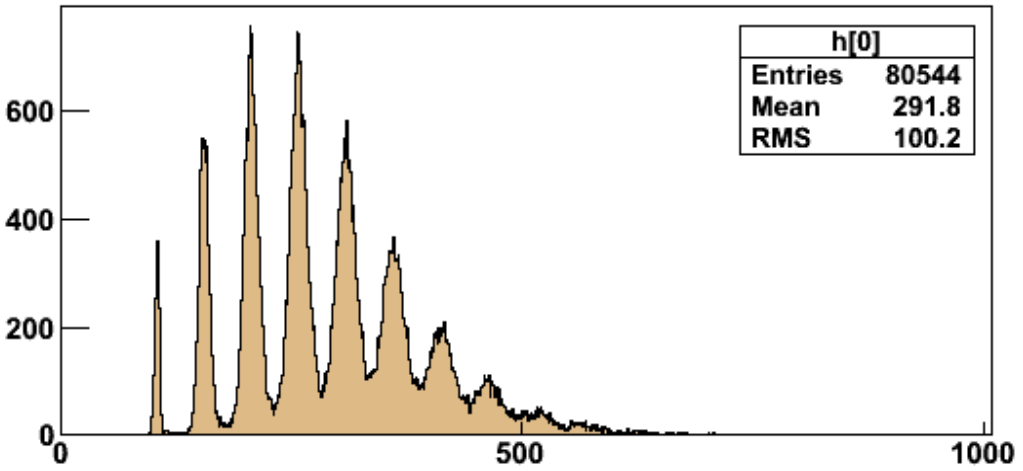
FIRST RESULTS - IV



FIRST RESULTS – light response





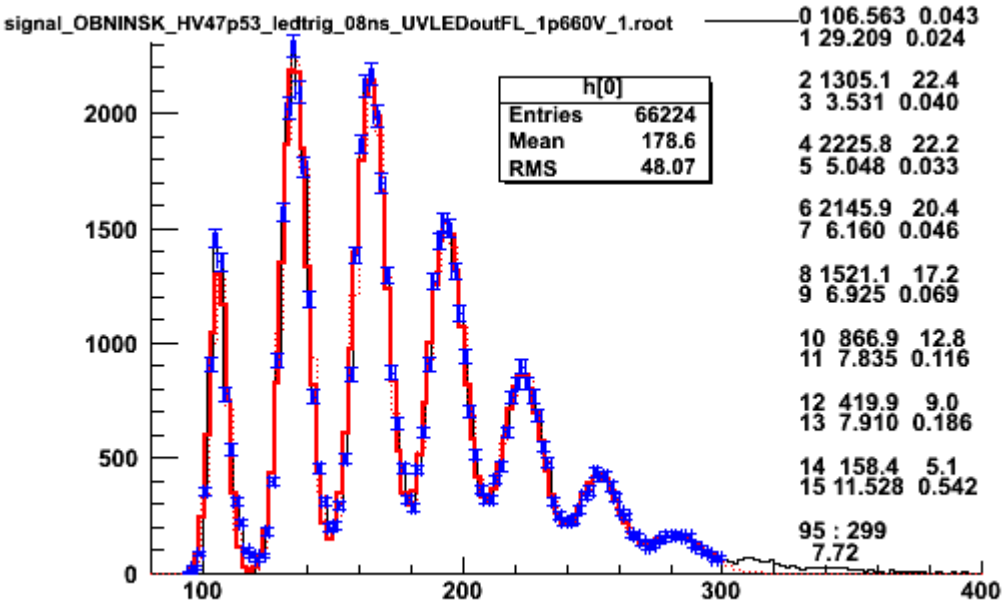


SPECTRA TREATMENT : INITIAL PROCEDURE

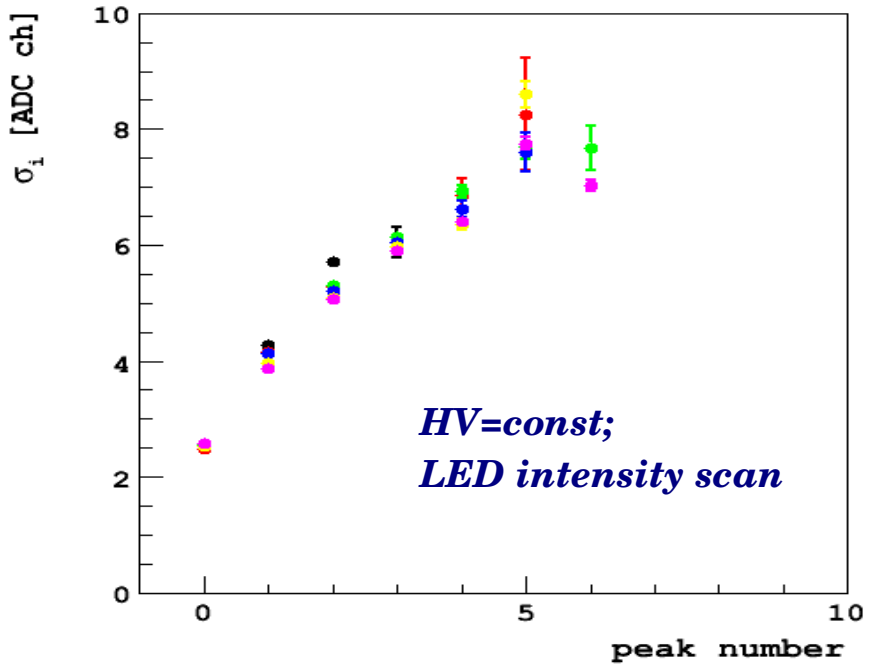
Fit parameters :

- *pedestal*
- *peak distance*
- *gauss N_i*
- *gauss σ_i*

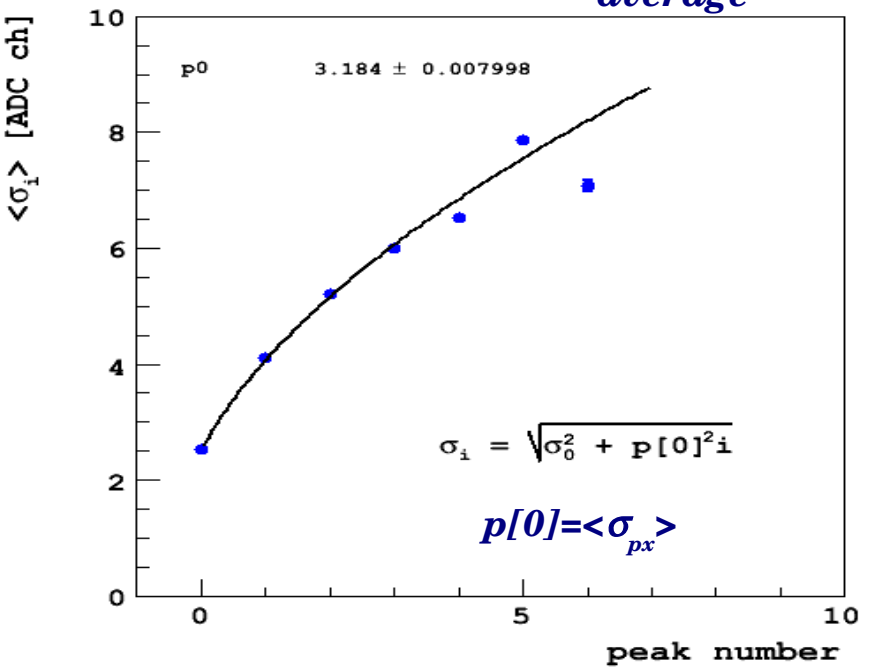
(no eff. nor x-talk consideration)



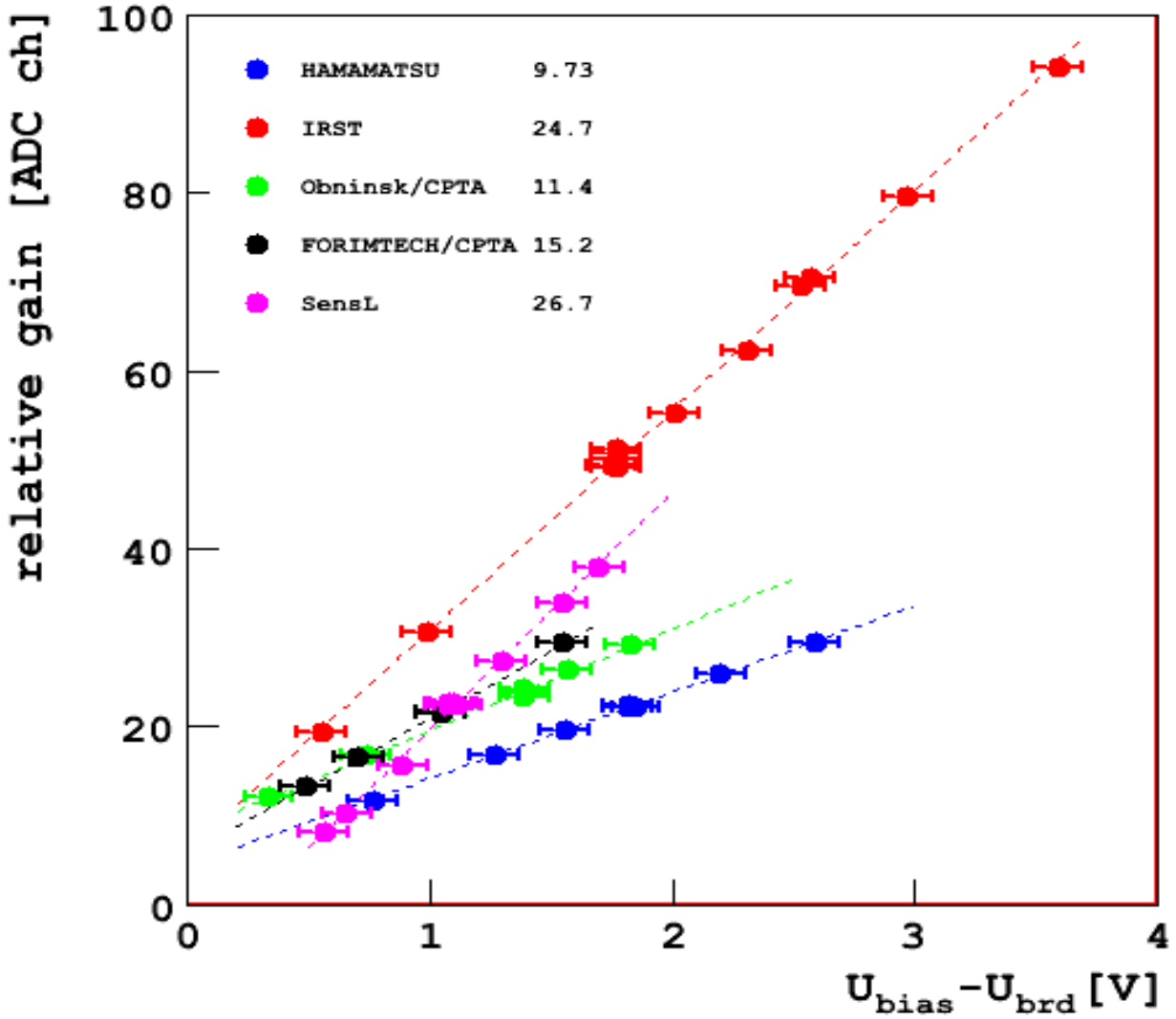
Intensity scan @ bias_U=const : x-check



average



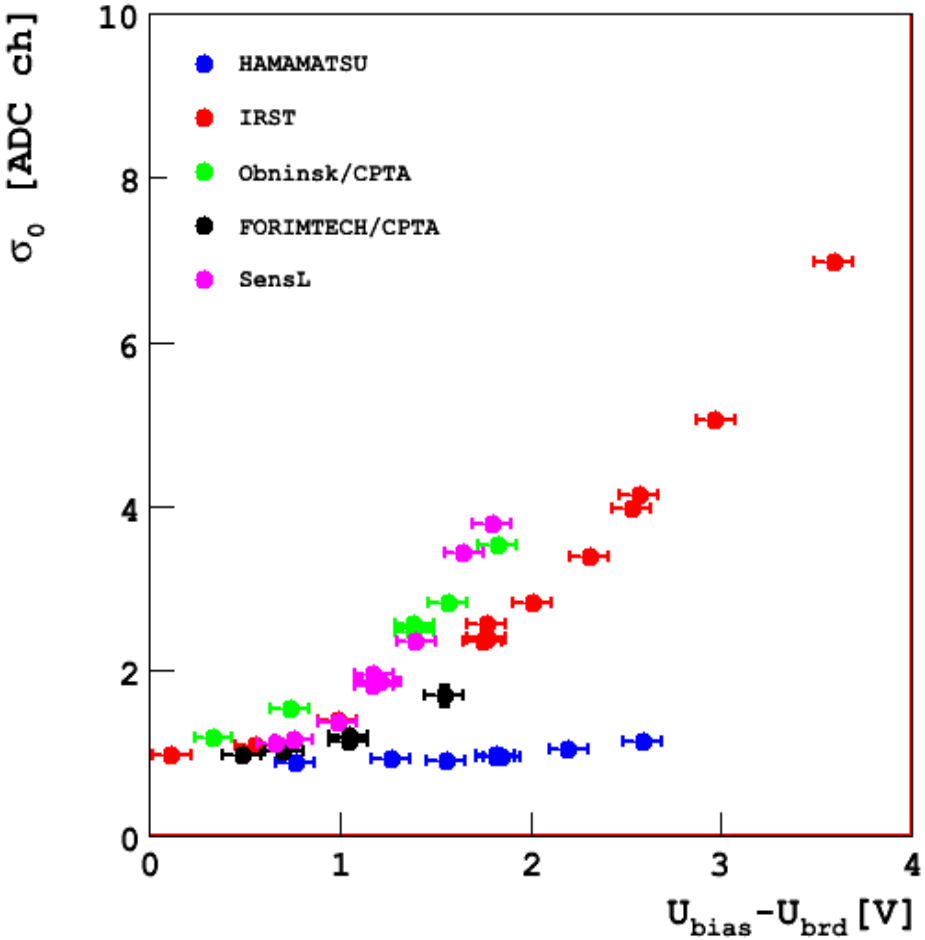
SPECTRA TREATMENT : PRELIMINARY RESULTS

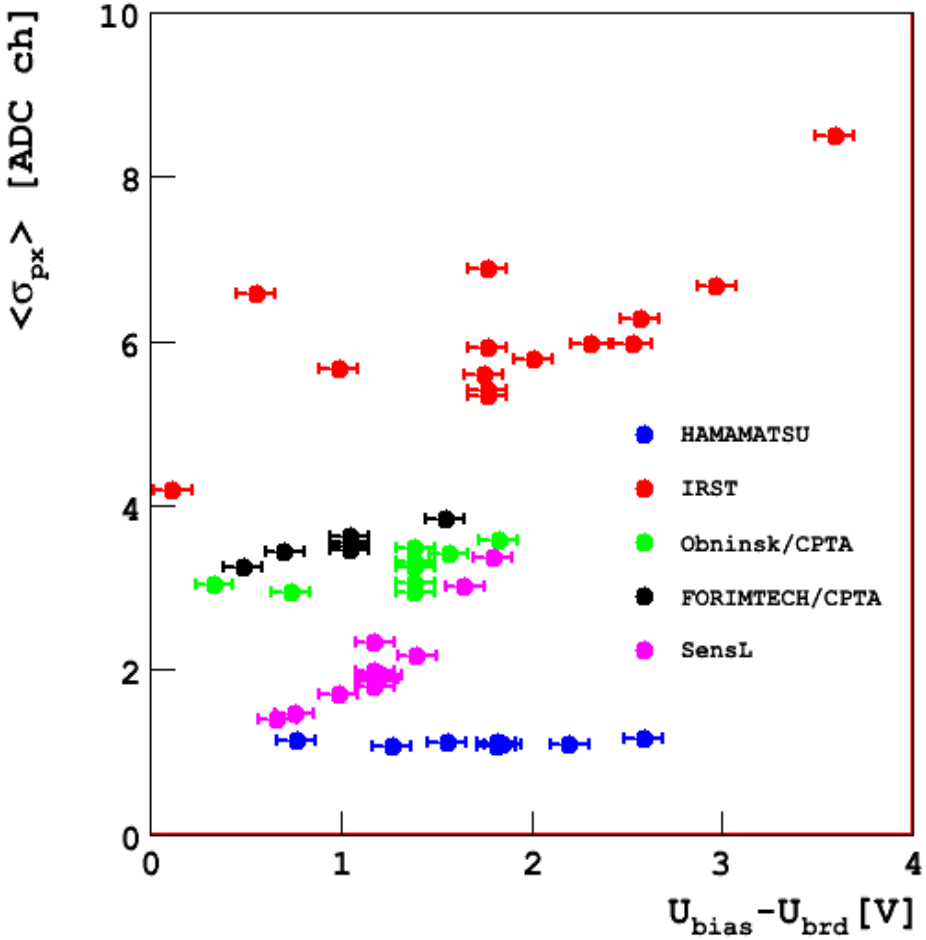


No temperature control yet :

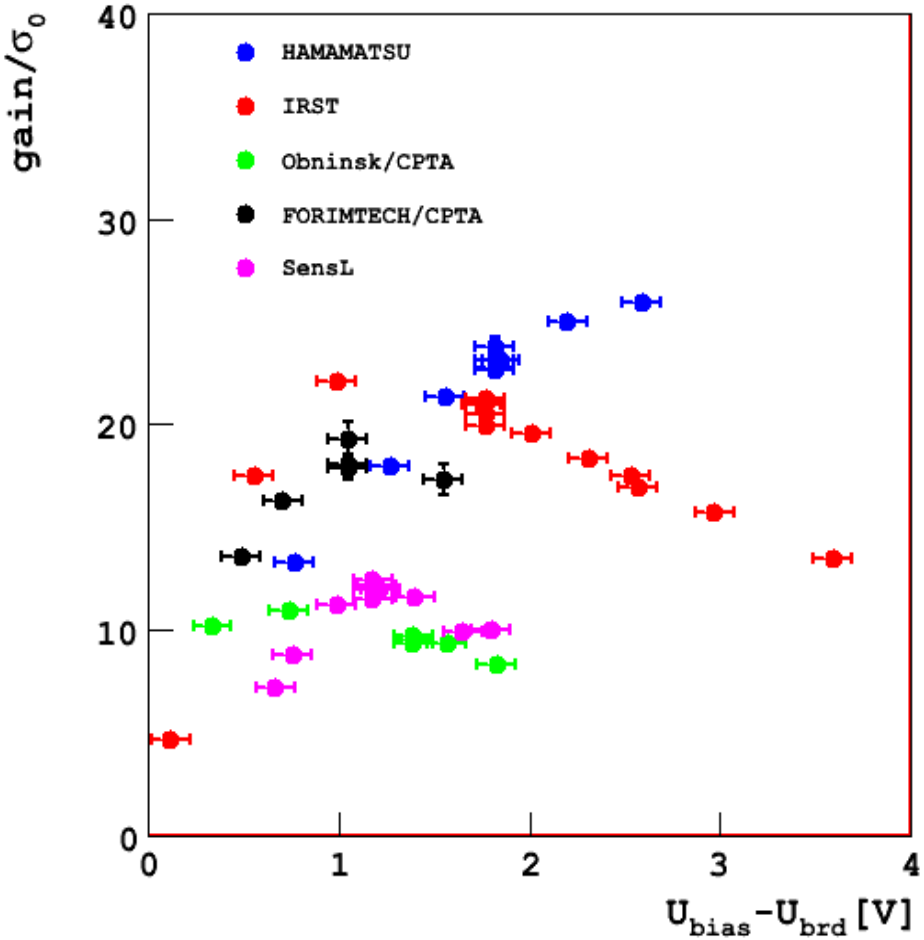
- *<T> ~ 24 C*
- *ΔT(one sample) ≈ 2 C*
- *ΔT(all) ≈ 4 C*

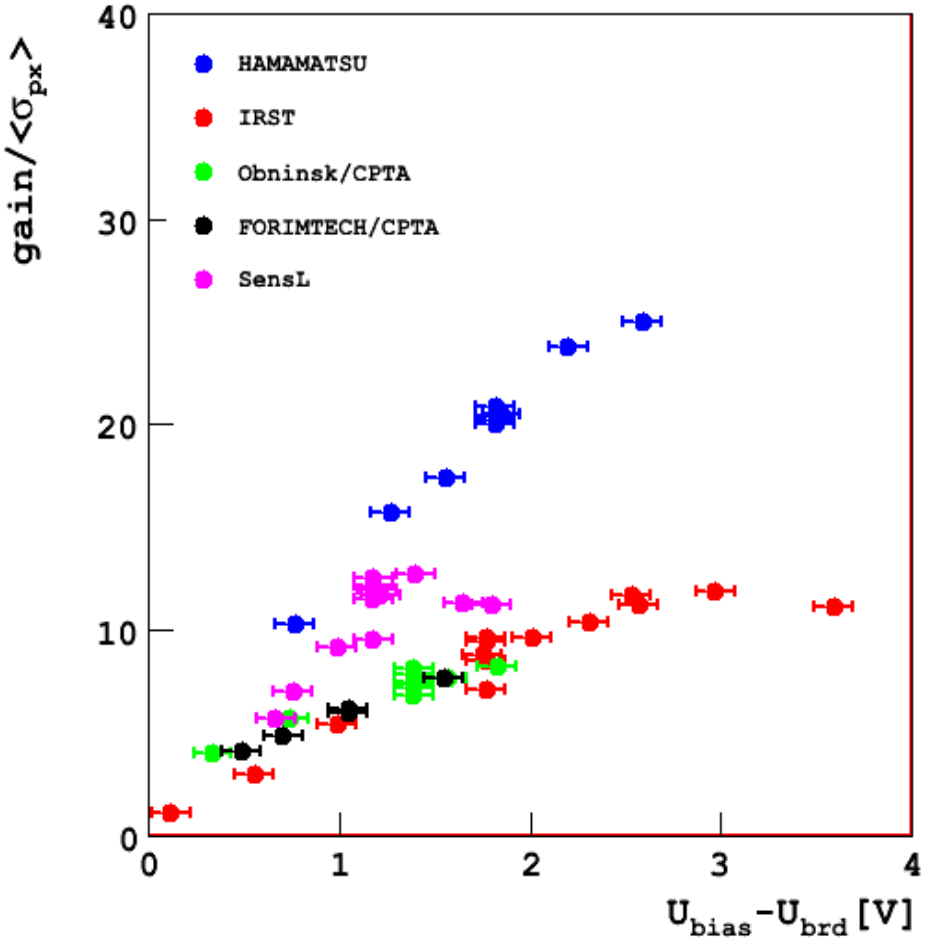
SPECTRA TREATMENT : PRELIMINARY RESULTS





SPECTRA TREATMENT : PRELIMINARY RESULTS





$gain \sim N$

$\sigma_{px} \sim \sqrt{N}$

$\langle\sigma_{px}\rangle \sim \sqrt{(N + \sigma^2_{nonun})}$

$gain/\langle\sigma_{px}\rangle \sim N, \quad N << \sigma^2_{nonun}$

$gain/\langle\sigma_{px}\rangle \sim \sqrt{N}, \quad N >> \sigma^2_{nonun}$

if $\sigma^2_{nonun} = const(N)$??

NEXT STEPS

Highest priority :

- *setup improvement (noise reduction, temperature control...)*
- *further development of the spectra treatment procedure (efficiency, x-talk)*
- *measurement program extension*
- *repeat the measurements for more samples*

After establishment of the full measurement procedure:

- *measurements of PDE as a function of light wavelength*

THANKS!

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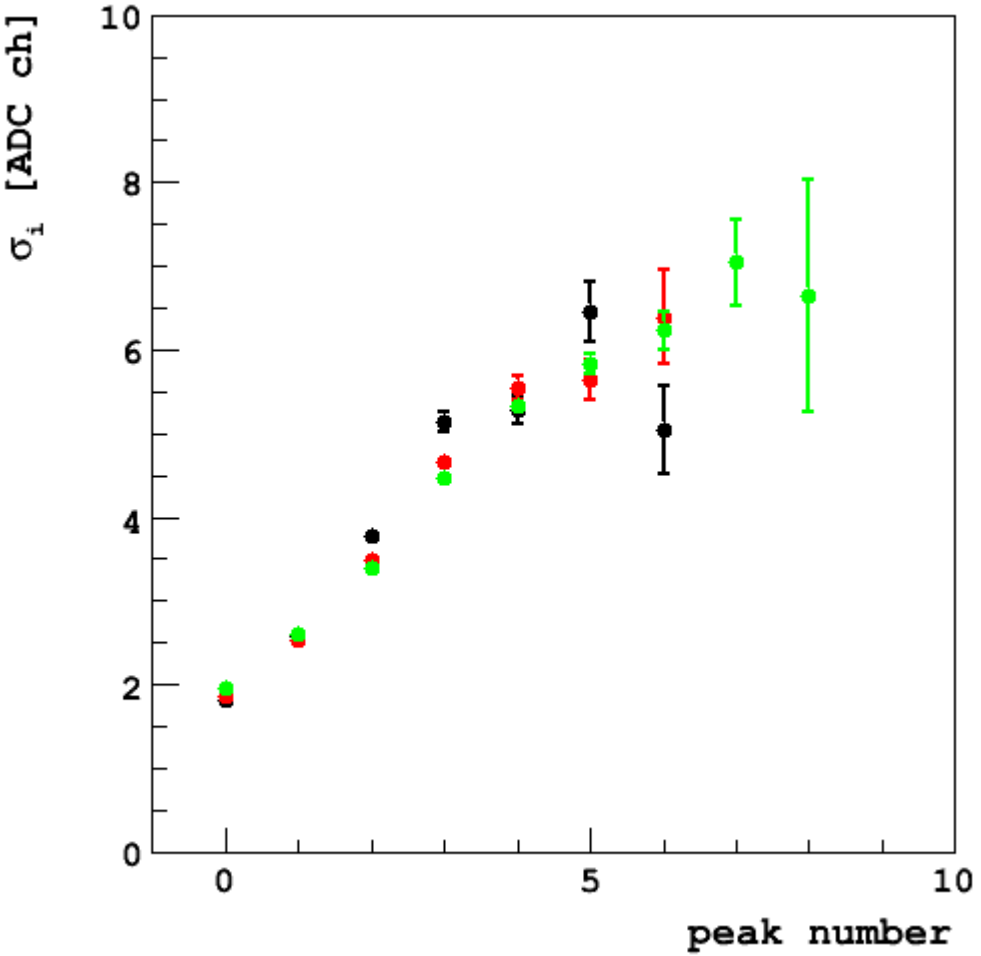
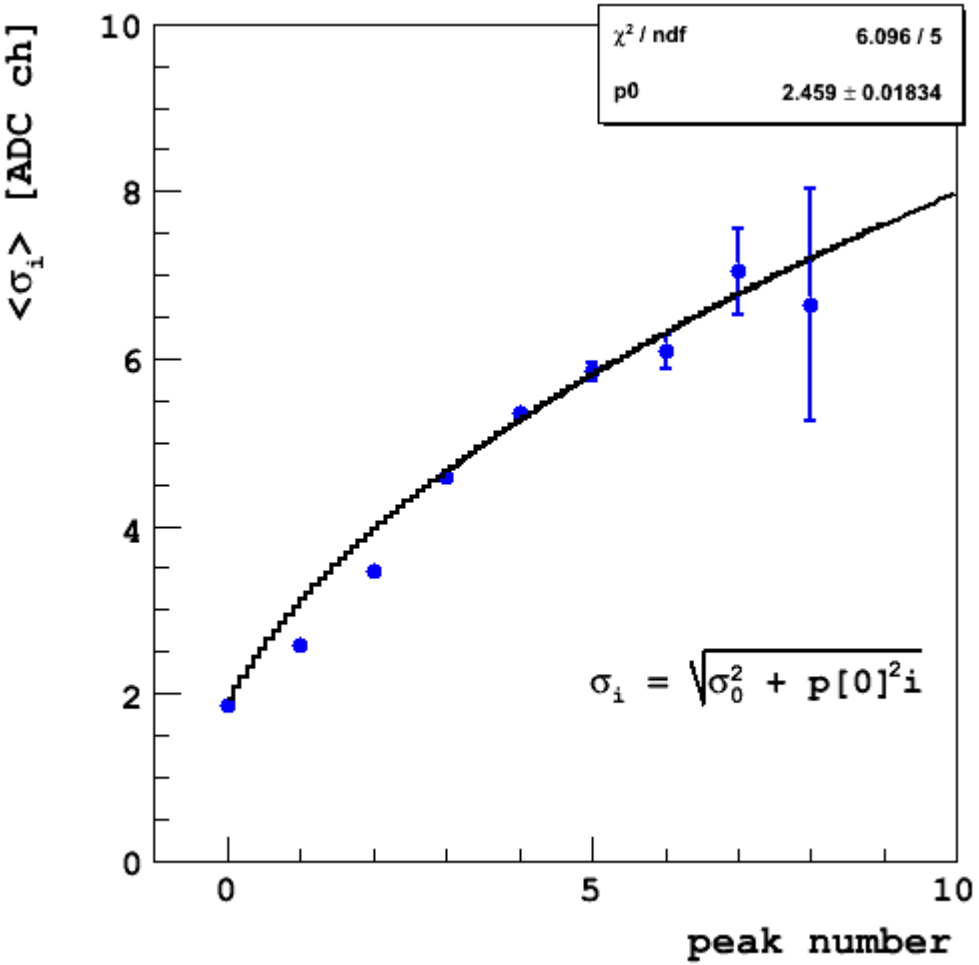
Ivo Polak, Nicola D'Ascenzo

BKUP


σ_i [ADC ch]
peak number
0
2
4
6
8
10
0
5
10


χ^2 / ndf 6.096 / 5
p0 2.459 ± 0.01834
$\sigma_i = \sqrt{\sigma_0^2 + p[0]^2 i}$
$<\sigma_i>$ [ADC ch]
peak number
0
2
4
6
8
10
0
5
10