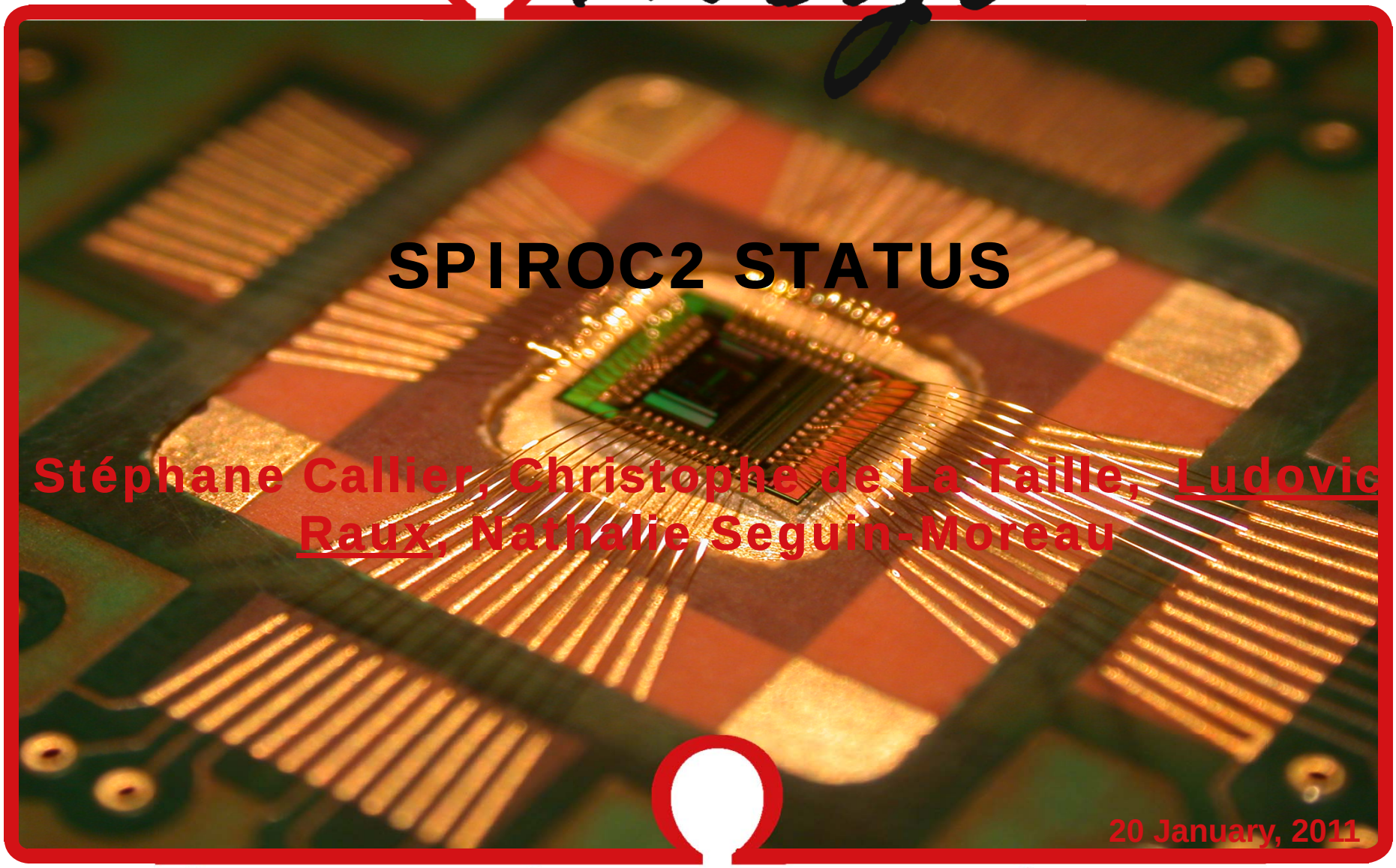
IN2P3 CSNSM Omega LAL LPN rsay



SPIROC2 STATUS

Stéphane Callier, Christophe de La Taille, Ludovic Raux, Nathalie Seguin-Moreau

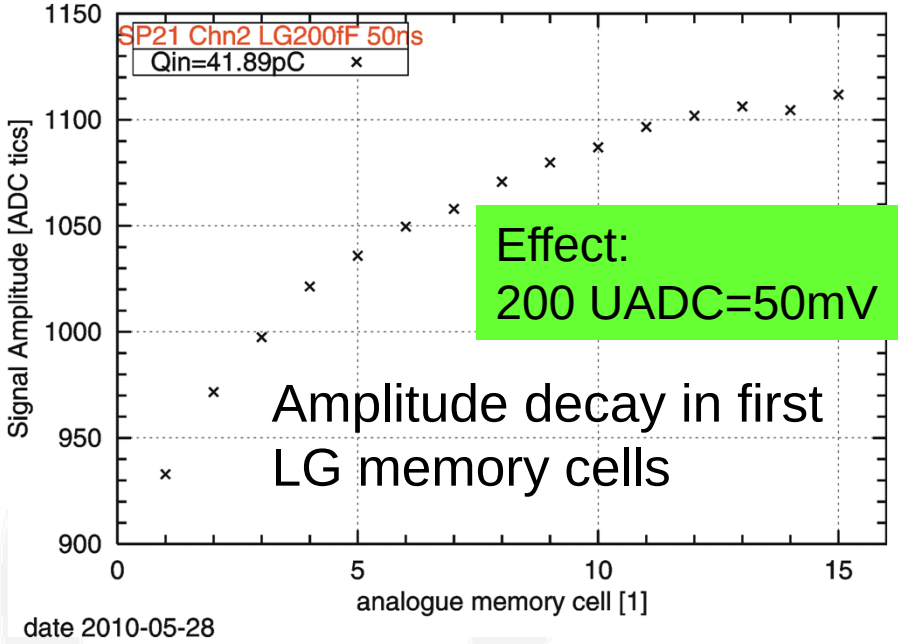
20 January, 2011

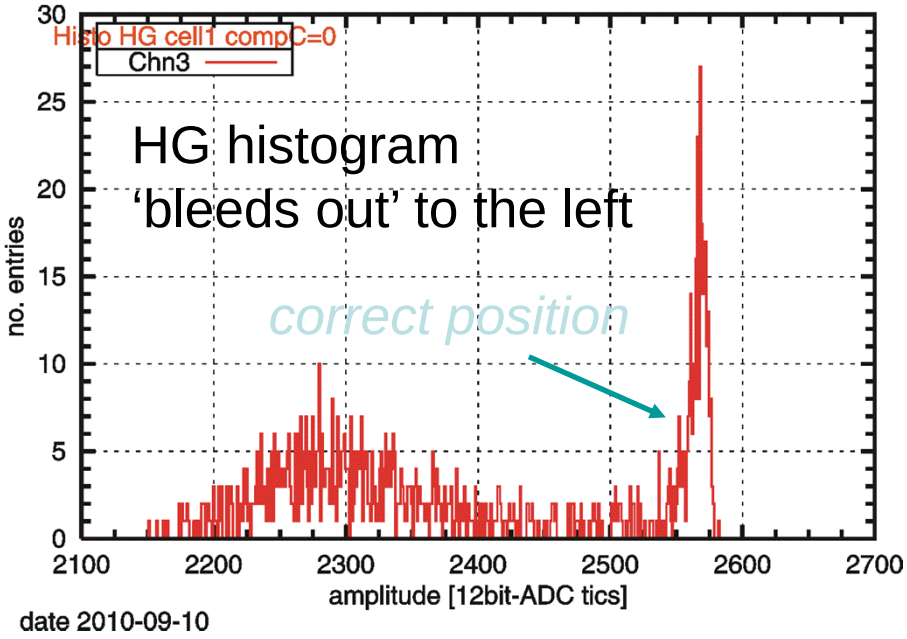
Orsay MicroElectronics Group Associated

Study of the Gain variation vs cell

- DESY measurements: (Report December 2010)
  - Effect = f(amplitude, input signal shape, PA comp. caps)
  - Effect != f(trigger rate, block-caps@100µF)

Problem: Cell dependent amplitude @DESY

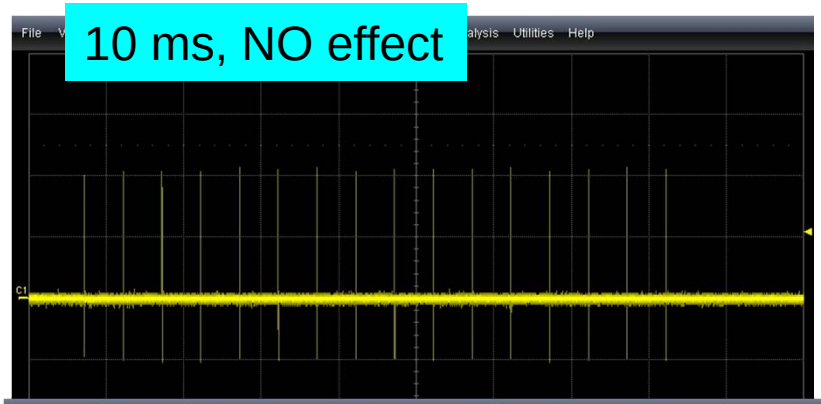


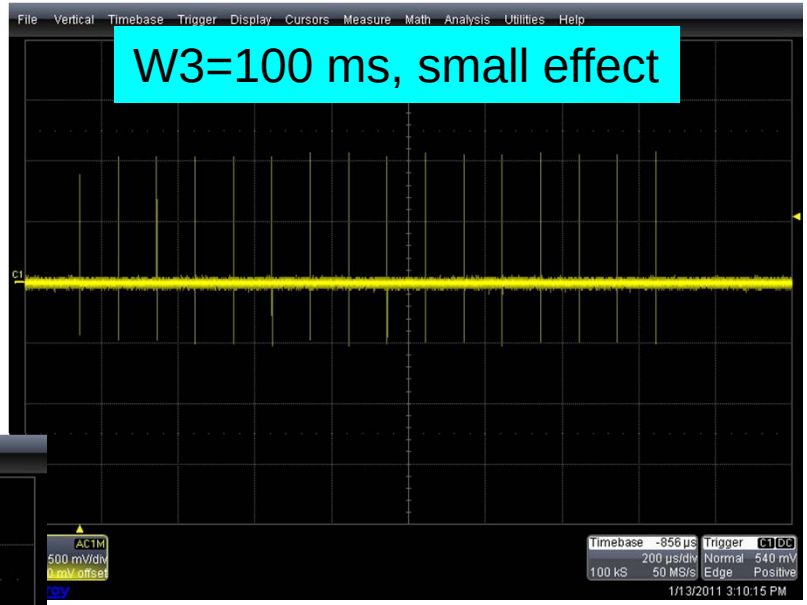


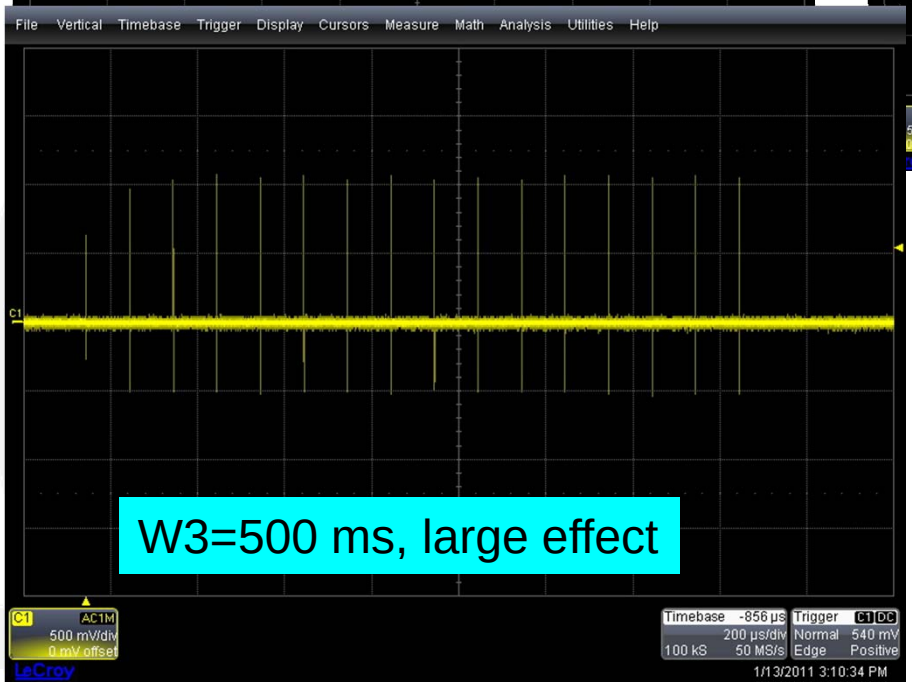
- ORSAY: test bench measurements and simulations to reproduce/understand this effect

TEST BENCH MEASUREMENT (1)

- **With current injection, Rinj=1K, pulse width w1=10ns, rate between pulse 100 µs (10 Khz), Interburst time 10 ms, 100ms or 500 ms**



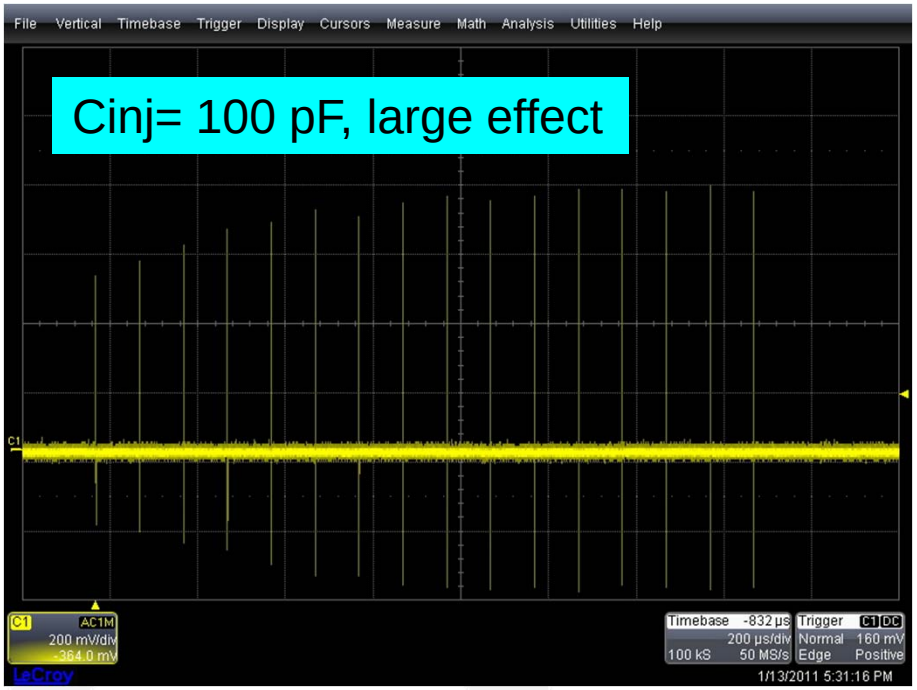


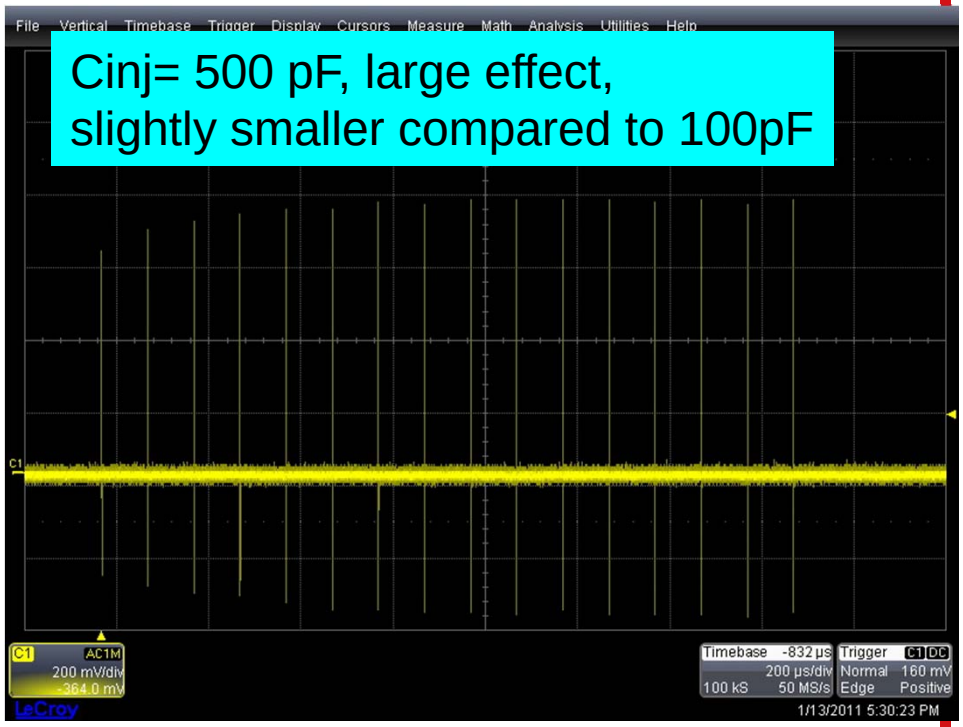


= CONCLUSION
Interburst rate dependent
Effect for rate > 50ms

TEST BENCH MEASUREMENT (2)

- **With Charge injection, using Cinj=100pF or 500pF, Interburst 500 ms, rate 10KHz**



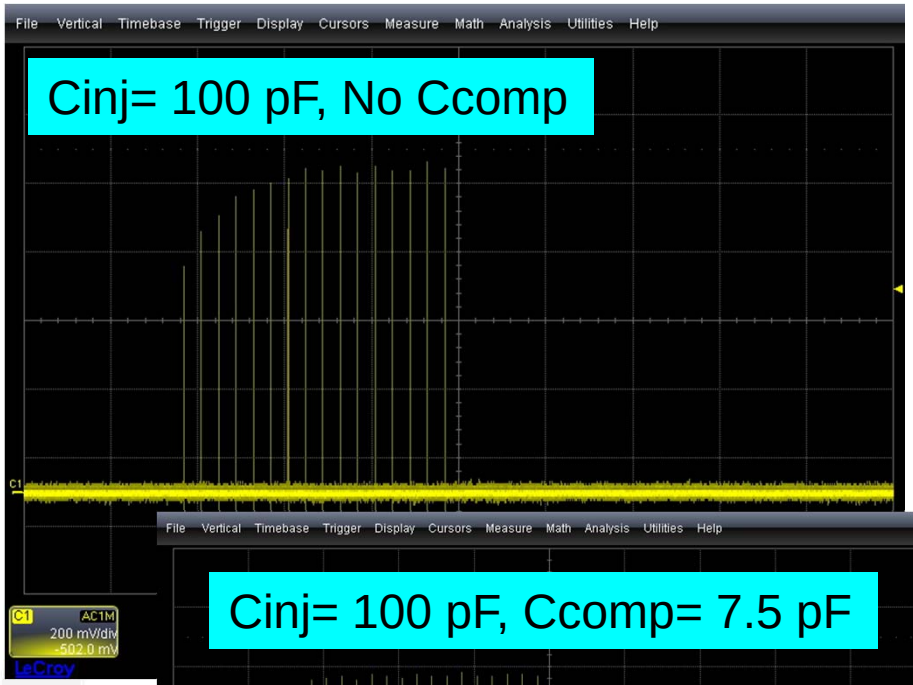


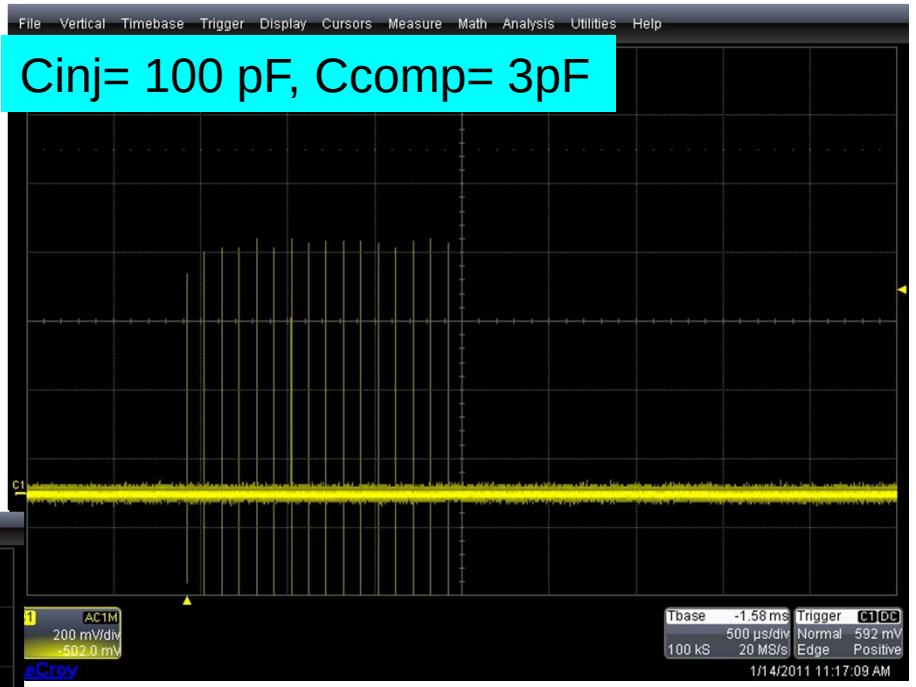
CONCLUSION:

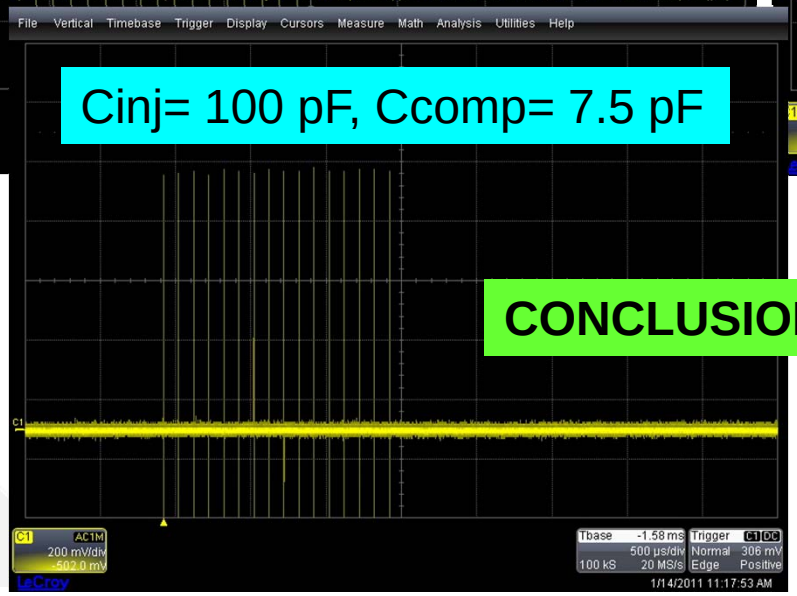
- **Signal waveforms dependency: when the charge is more « spread », the effect less pronounced.**

TEST BENCH MEASUREMENT (3)

- **With Charge injection**, Cinj=500pF, Interburst **500 ms**, rate 10KHz, various Compensation capacitors

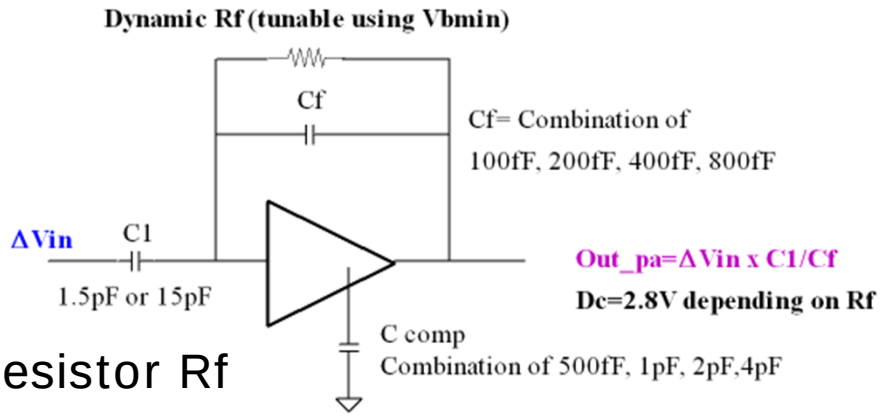




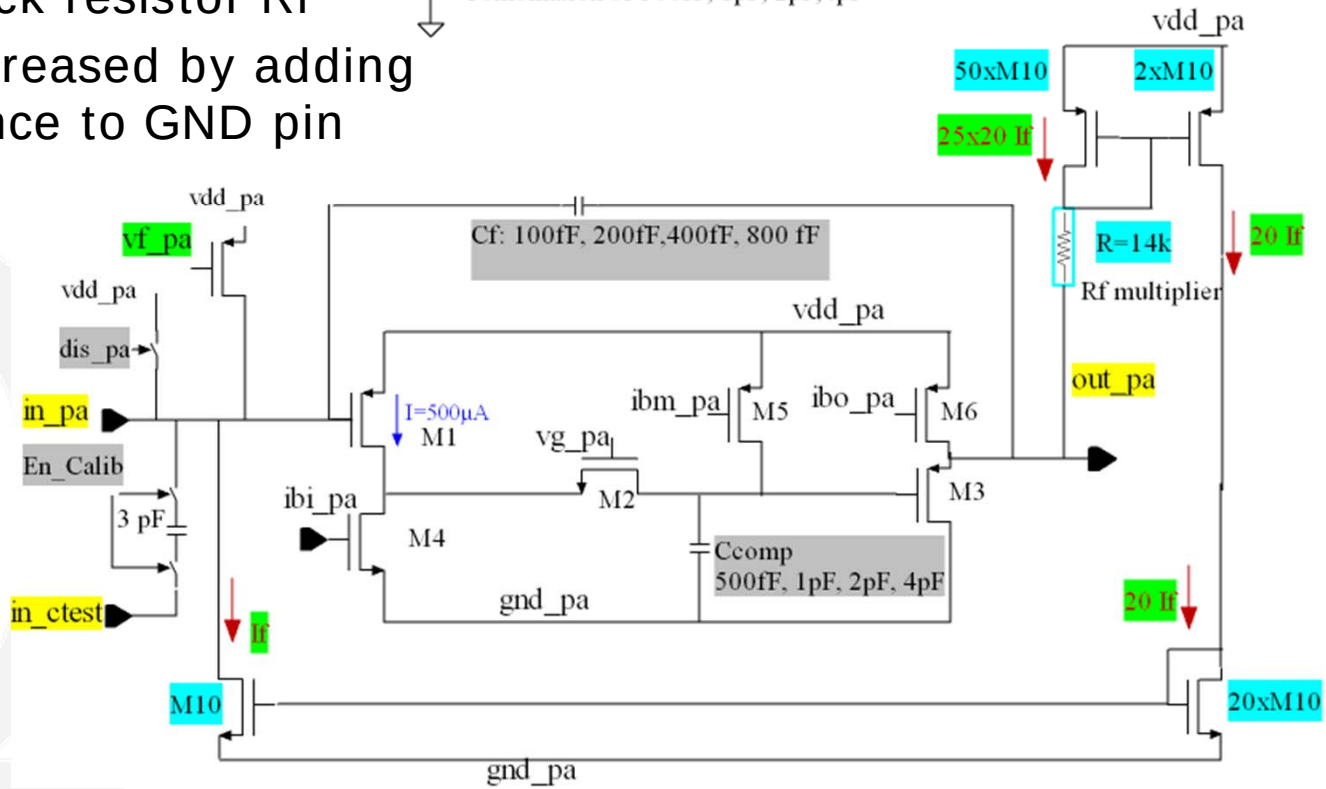


CONCLUSION: No more effect with Ccomp=7.5 pF

VOLTAGE PREAMPLIFIER



- Dynamic feedback resistor Rf
- Value can be increased by adding external resistance to GND pin
  201=Ibmin_pa



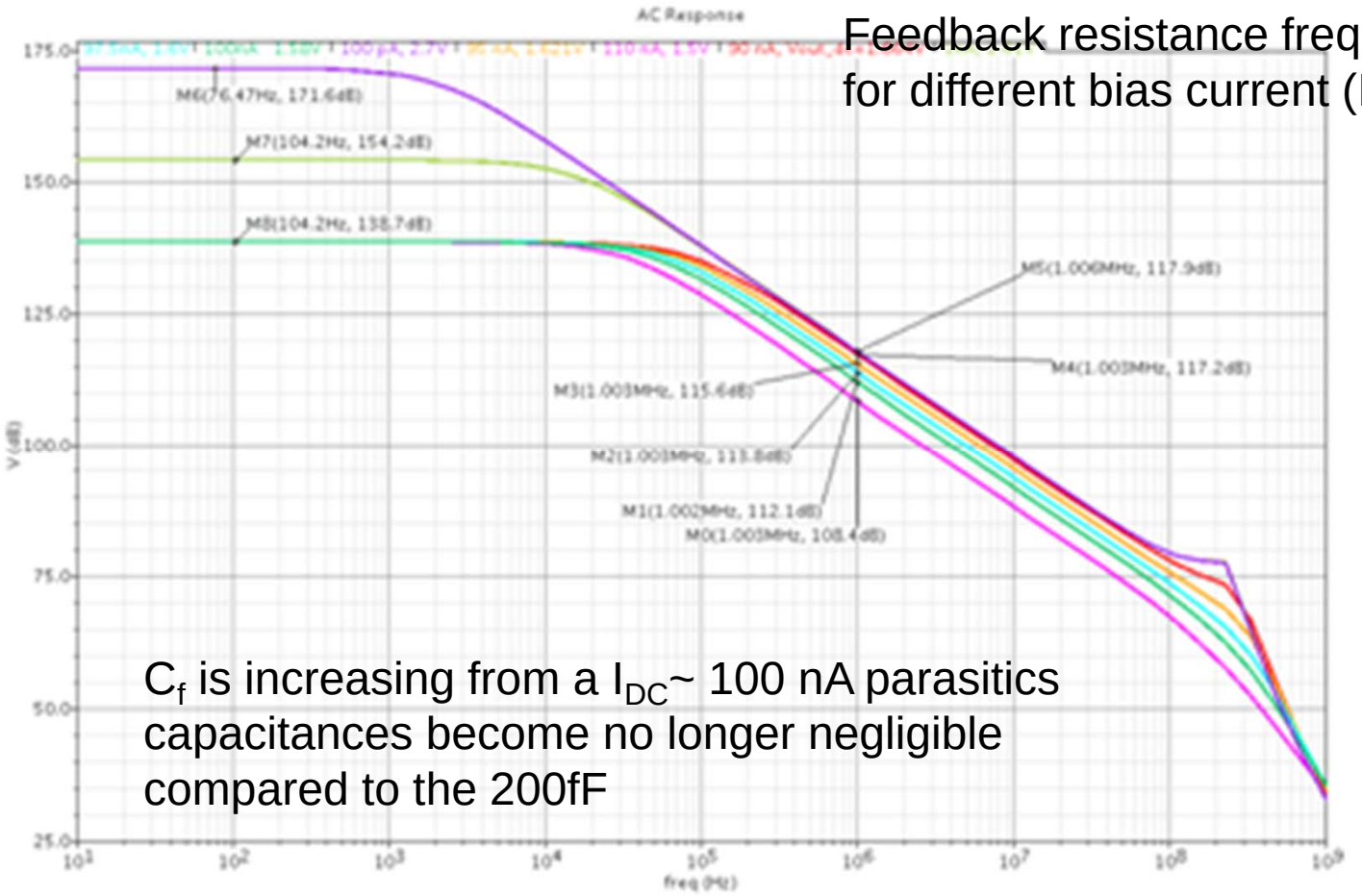
Dynamic resistor:

Rf=20/1 x 50/2 x (14K + 1/gm) = 500 x (14k +1/gm)

Simulations

Rf // Cf ⇒ $Z_f = \frac{R_f}{1 + j\omega . R_f C_f}$

Rf = 20/1x50/2x(14K + 1/gm)
= 500 (14k + 1/gm)



Feedback resistance frequency response for different bias current (I_{DC})

C_f is increasing from a I_{DC}~ 100 nA parasitics capacitances become no longer negligible compared to the 200fF

Explanation

- With such low currents (pA range), 1/gm >> 14k.

The equivalent capacitor in parallel of the dynamic resistor is given by the parasitic capacitors of the current mirrors and is very small (few fF).

- With large preamp output signals, the current flowing in the mirror in series with the 14K is then large (50 µA) and then 1/gm << 14K

The mirrors exhibit higher parasitic capacitors which are no longer negligible compared to the feedback capacitor Cf=200fF.

- Maybe dark current of the SiPM ~160 fC @1 MHz (or 100kHz) =>160 nA (16 or nA) might help to cure this problem for low rate applications by providing enough current to bias the feedback resistance

Gain variation effect: conclusion

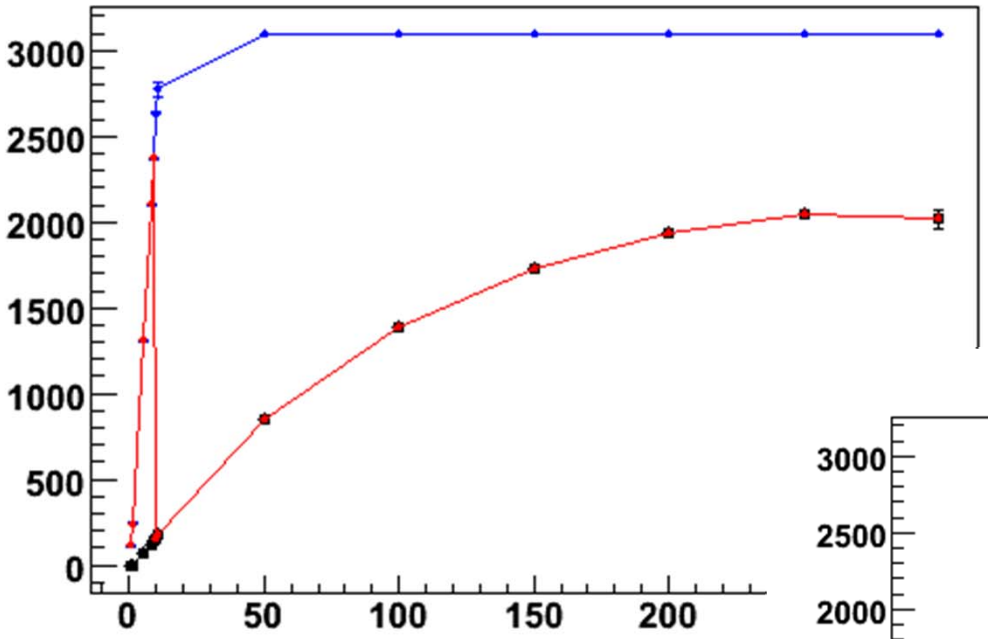
- Gain variation effects seen by simulation, and cured only in simulation by adding 10K to gnd on ib_min (pin 201)
- Gain variation effects seen on test bench and strongly depend on the rate.
- Same behaviour and dependency as already shown by DESY
- Effects corrected with C_{comp}=7.5pF because charge more “spread” and the amplitude are smaller but not a satisfying solution (linearity problem, worse SNR, etc.)
- Check if the problem occurs with a SiPM and if the dark noise cures the problem
- The investigations and measurements are still on going

LINEARITY: test bench measurement

Injection through 100pF – Channel 14

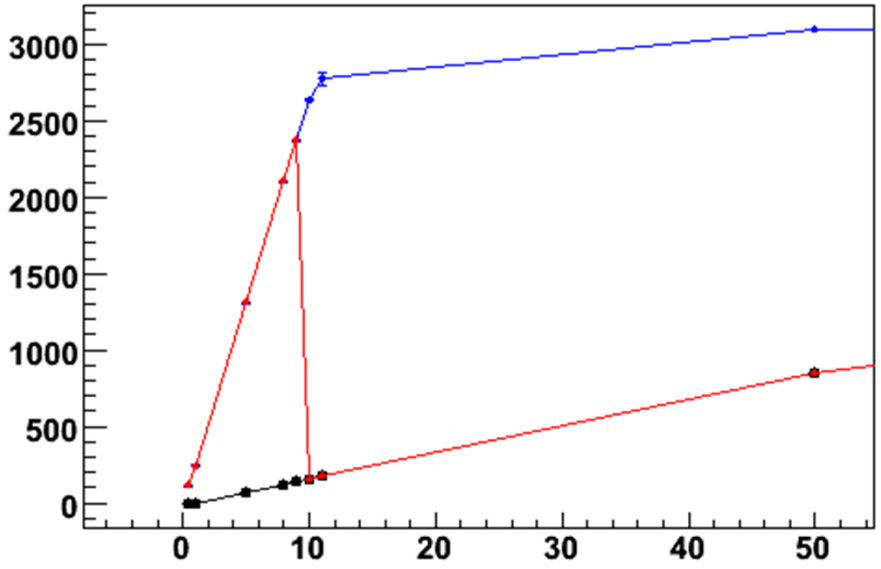
No Ccomp, 30K to gnd added pin 196

ADC



Auto-trigger mode
Auto-gain

with C_{comp}= 0 pF



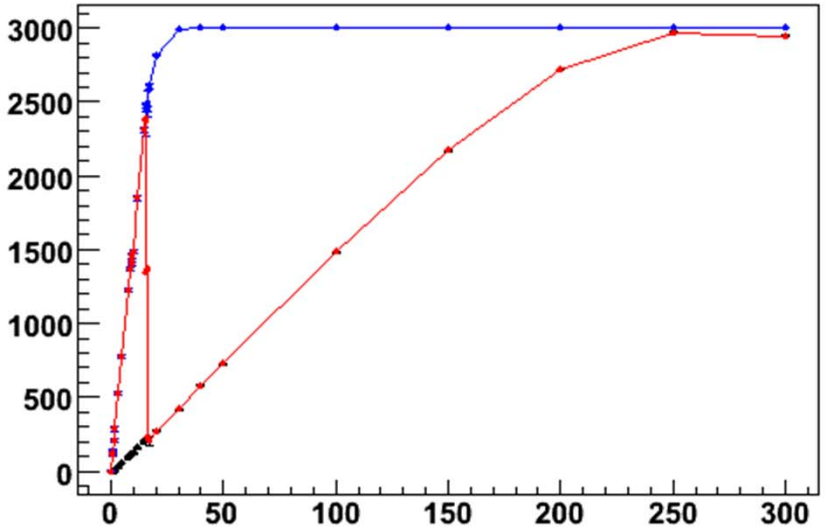
Plots performed by Thibault

Signal (entrée) en pC

LINEARITY: test bench measurement

Injection through 500pF – Channel 19

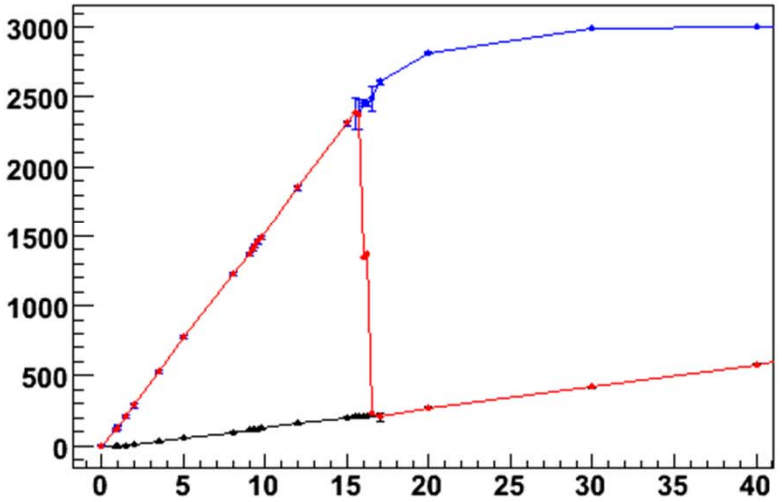
ADC



Plots performed by Thibault

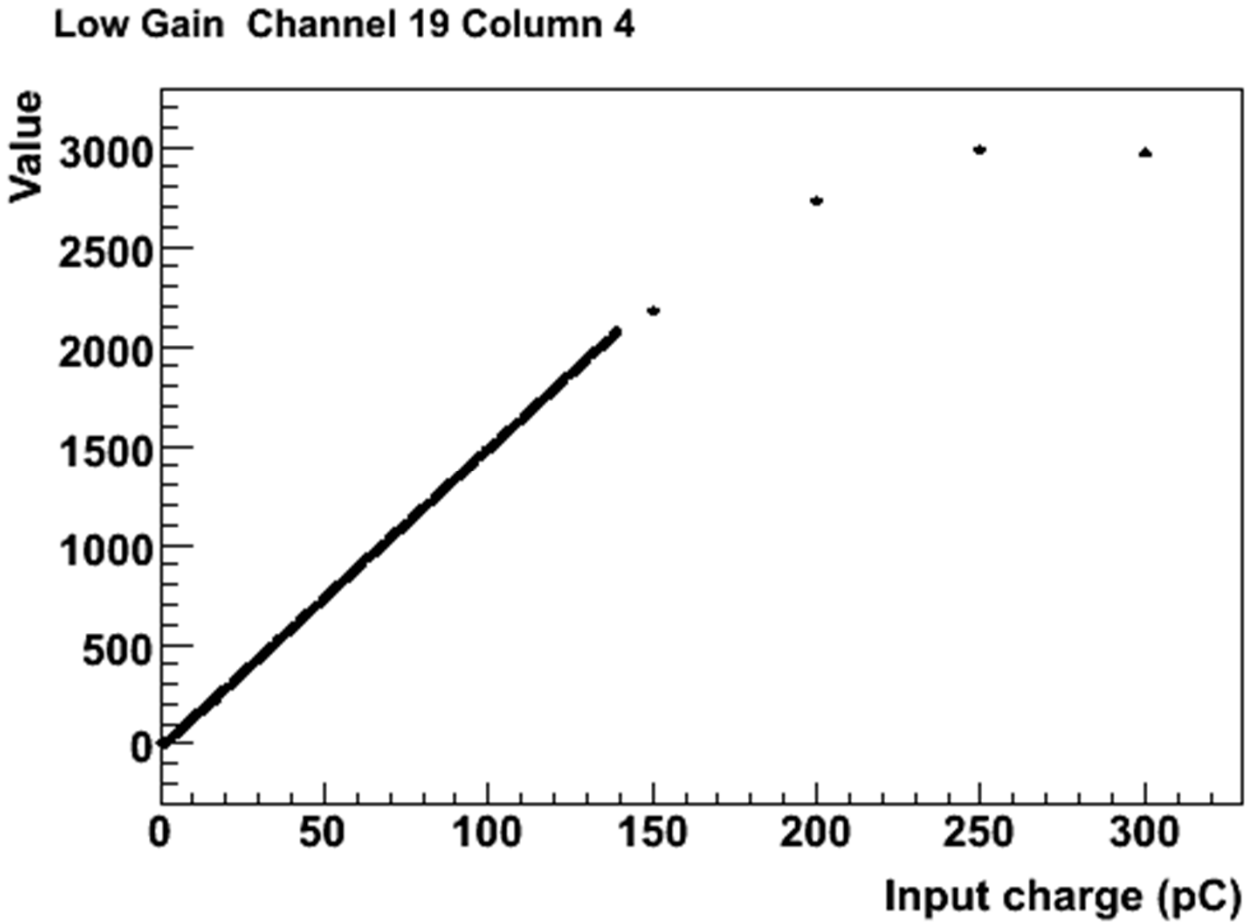
Auto-trigger mode
Auto-gain

with C_{comp}= 0 pF



Signal (entrée) en pC

LINEARITY: test bench measurement



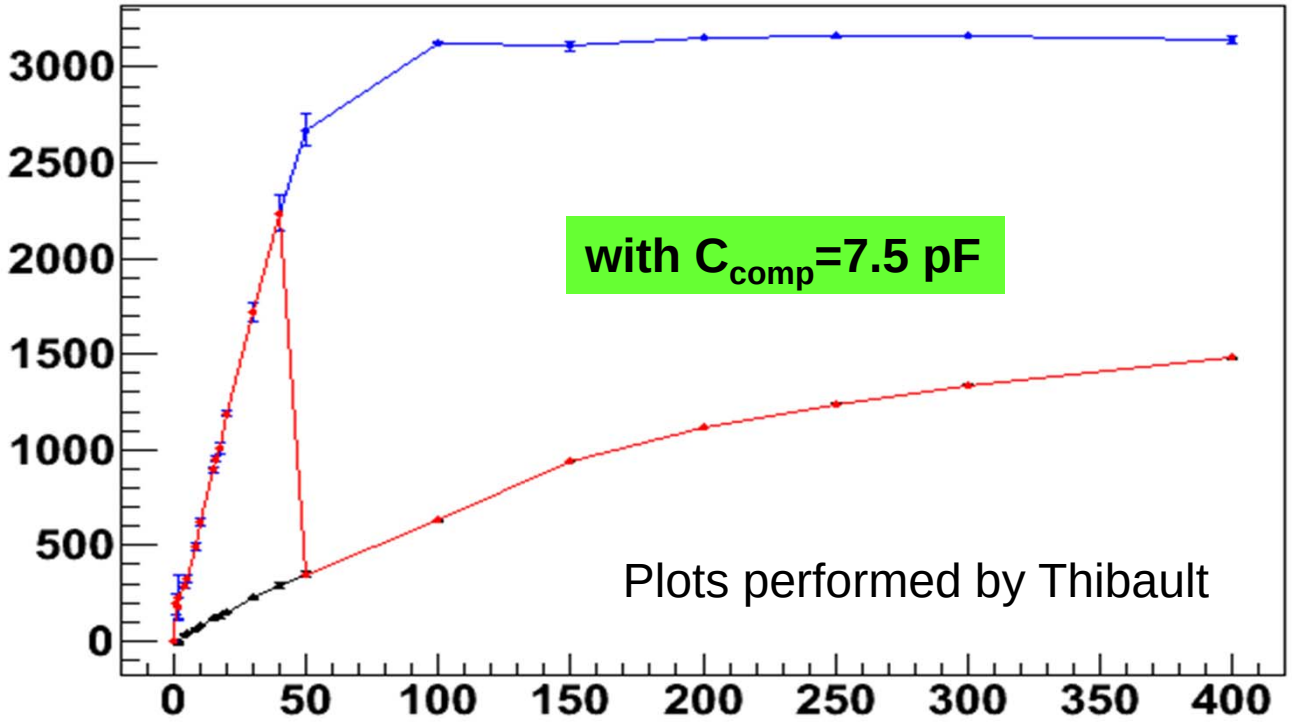
Plots performed by Thibault

LINEARITY: test bench measurement

ADC

Injection through 500pF – Channel 19

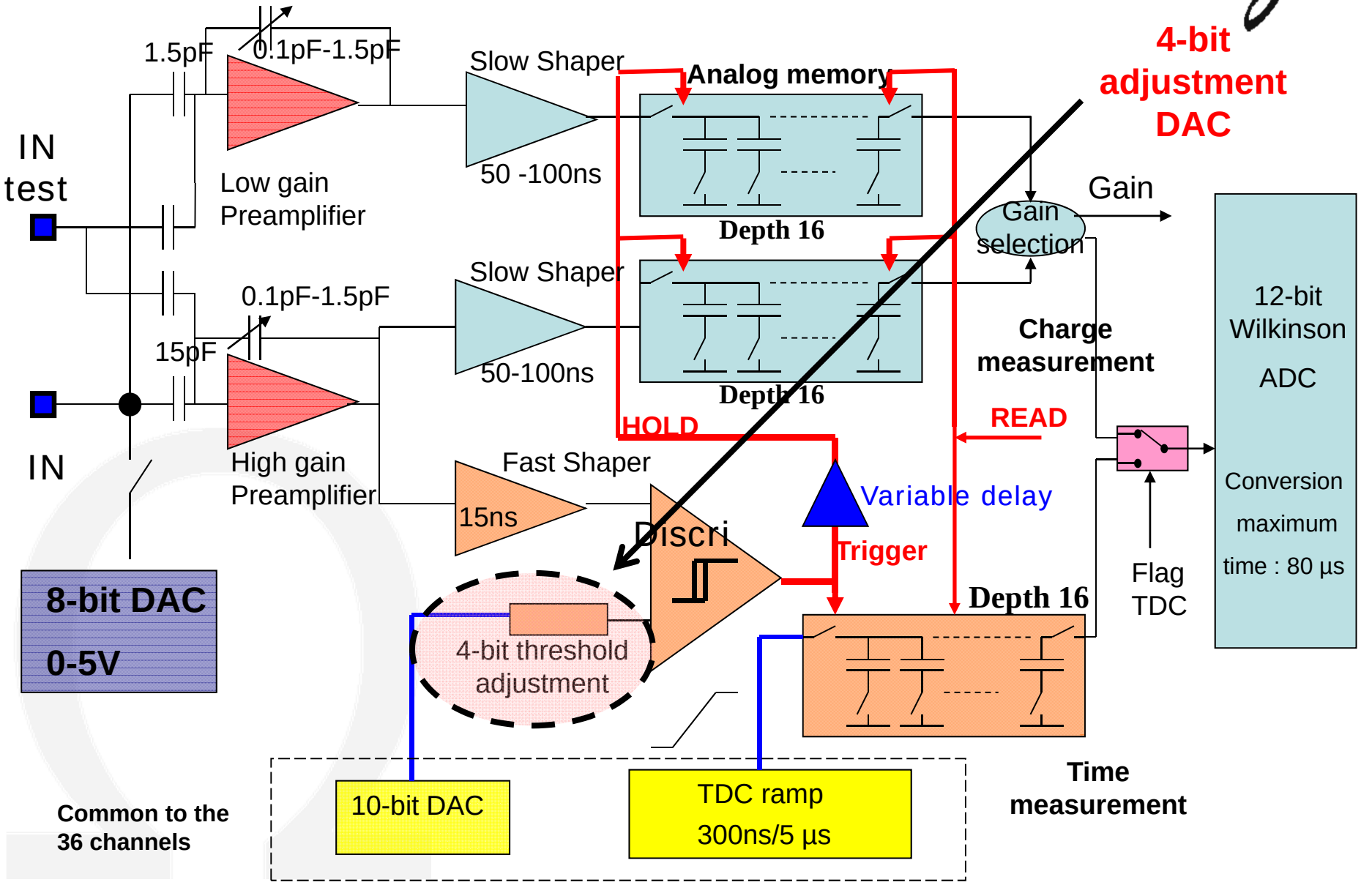
Auto-trigger mode
Auto gain selection



Bad Linearity

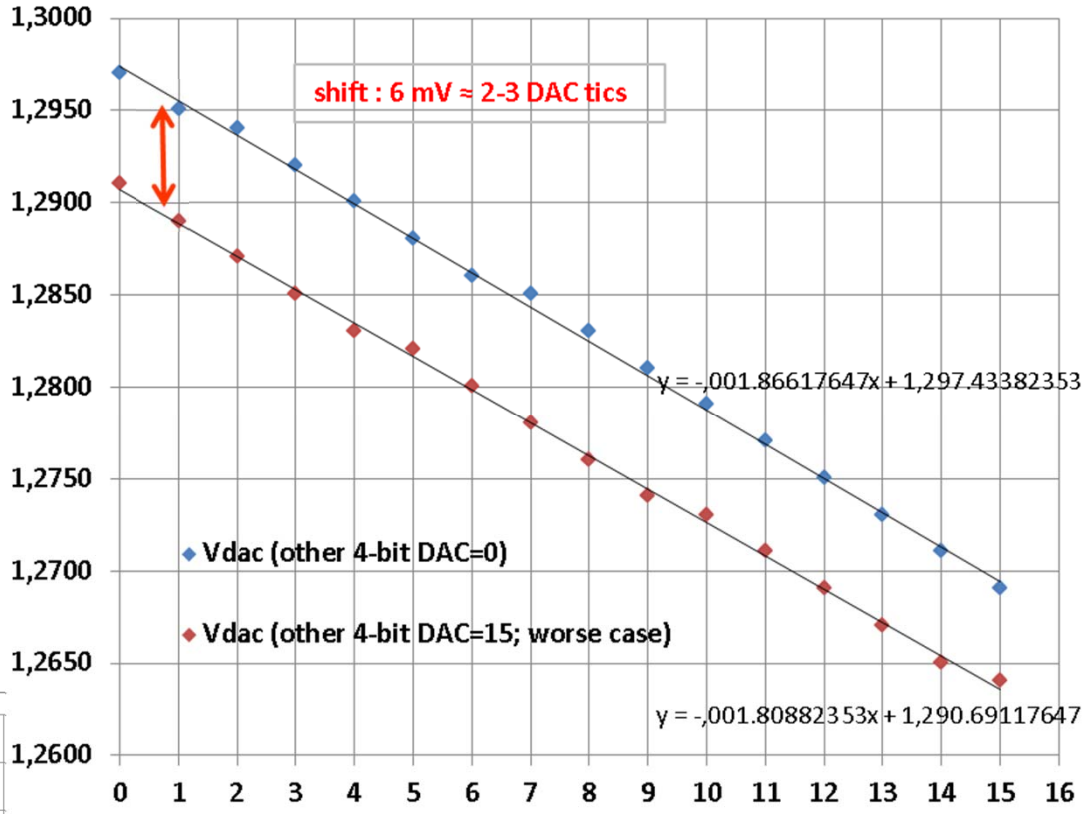
Signal (entrée) en pC

4-bit adjustment DAC measurement

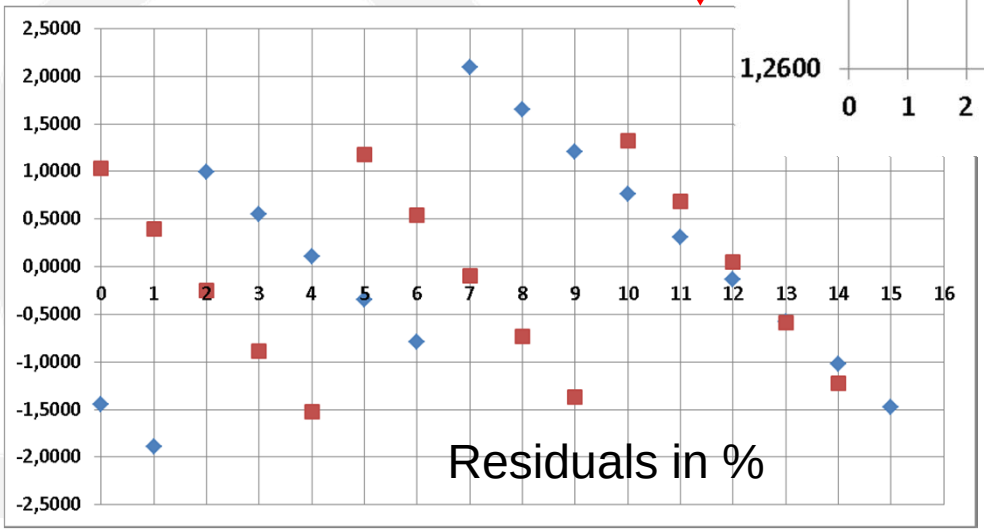


4-bit adjustment DAC measurement

Adjustement on 30mV ~ 5 DAC tics



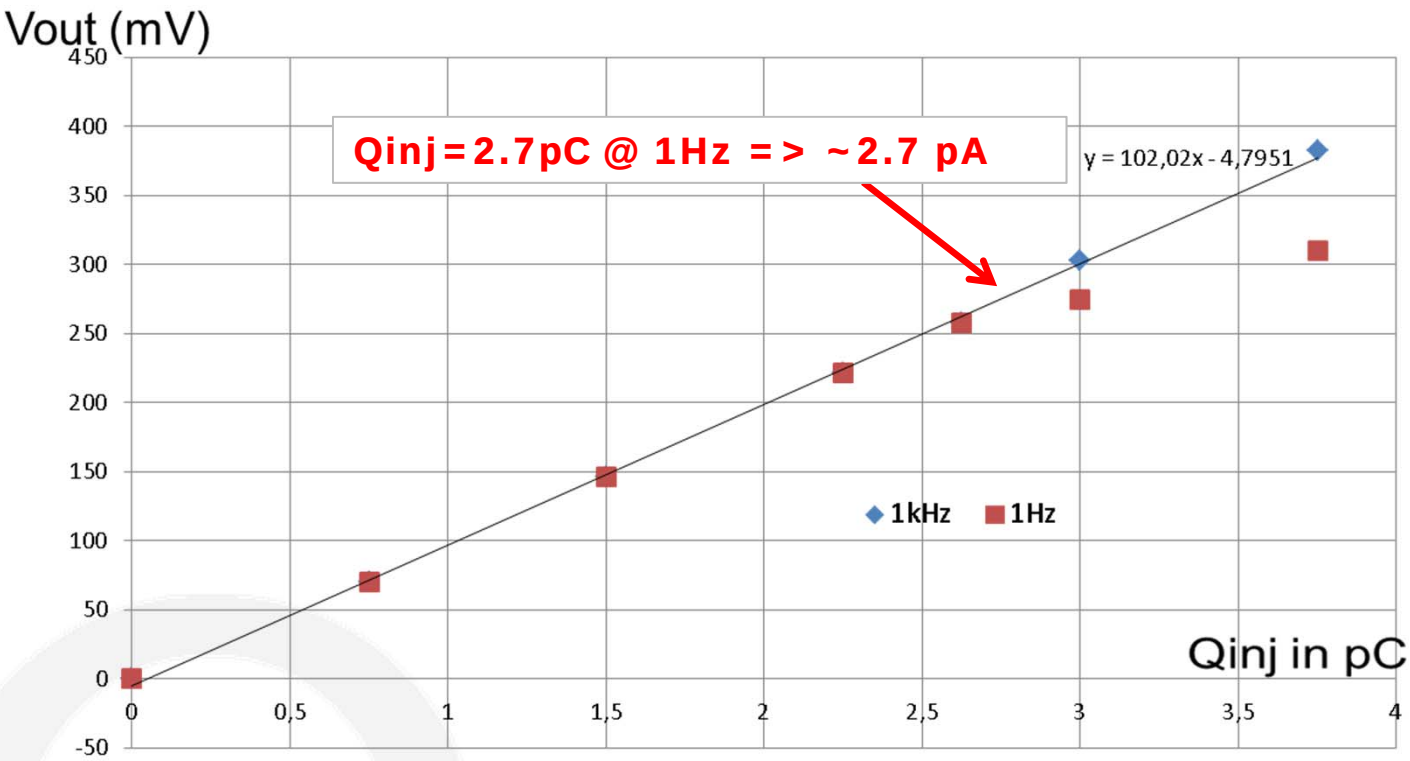
Linearity: +/-2%



The slope can be changed (extended or reduced) by adding an external resistance.

Conclusion

- The investigations on the SCA cell decay are still on going
- HG and LG linearities are correct
- Auto-Gain selection is working
- The threshold adjusment DAC is useable to have the ability to tune the threshold channel by channel and consequently improve the auto-trigger efficiency



- Maybe dark current of the SiPM (160 fC @1 MHz (or 100kHz) =>160 nA (16 or nA) **>> 2,7pA**) might help to cure this problem for low rate applications by providing enough current to bias the feedback resistance