Multi-Anode Readout Chip for MaPMTs

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LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

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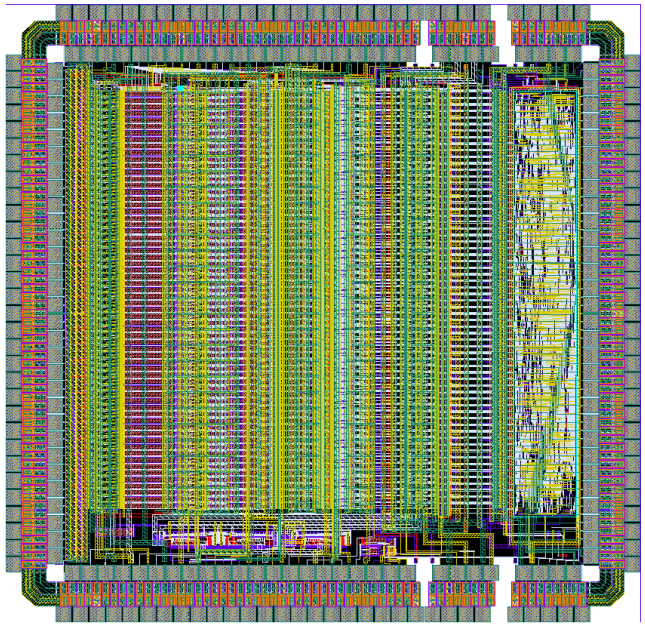
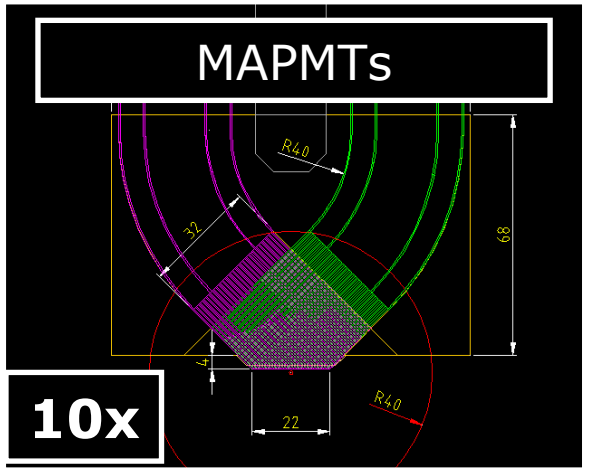
Omega

- Applications
- Description
- Requirements
- Performances
- Future



Experiments and applications

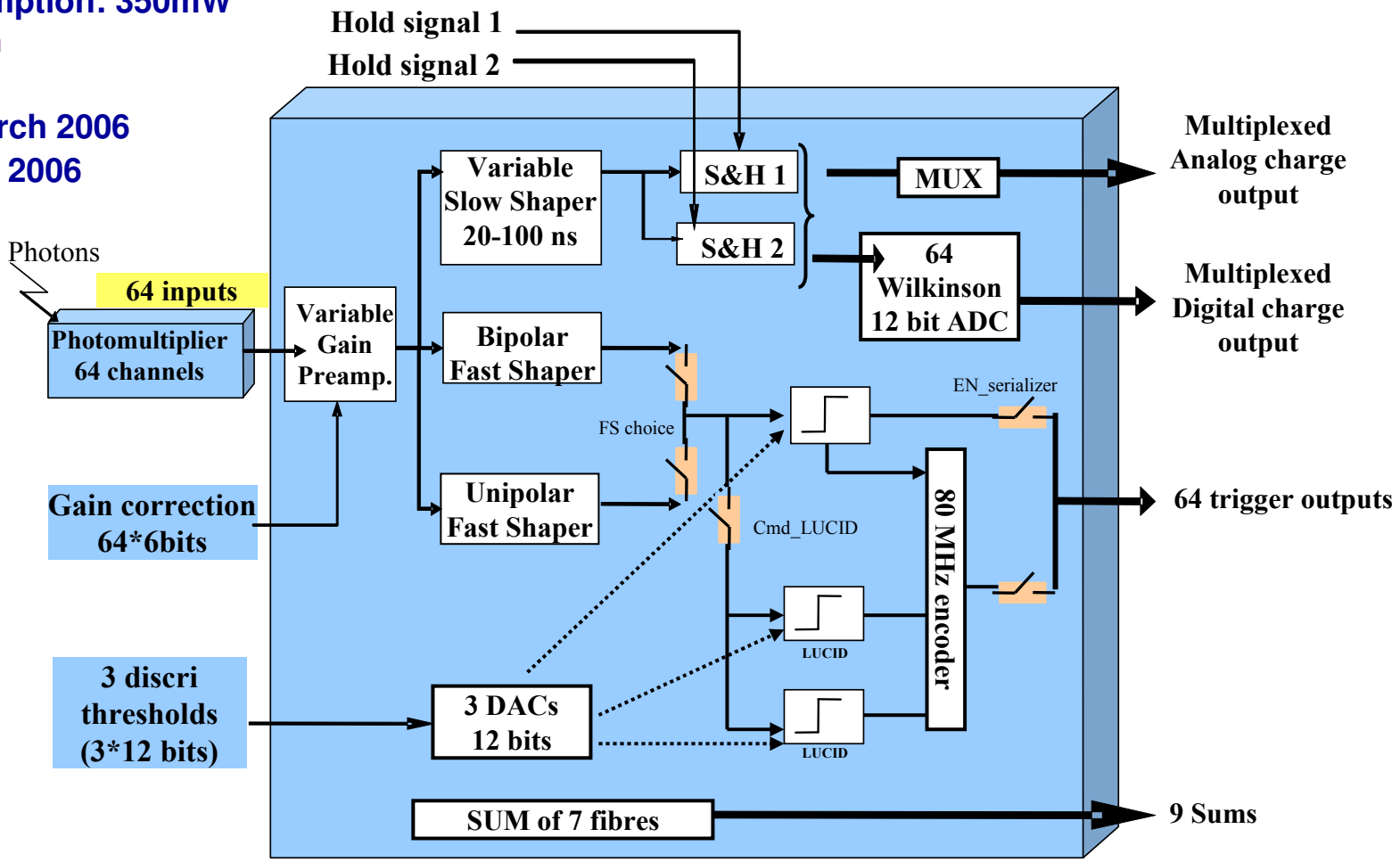
- Main one : **ATLAS Luminometer** (absolute measurement of the luminosity)
- Roman Pots:
  - ✓ 0.5mm^2 scintillating fibers
  - ✓ 1 RP = 10*64 fibers in U + 10*64 fibers in V
- Multi Anode PM Tubes
  - ✓ 64ch Hamamatsu H7546
  - ✓ HV = 800-950 V
  - ✓ Gain 3.10^5-10^6
  - ✓ Maximal signal: 4-6 photoelectrons
  - ✓ 1-3 non uniformity
- 200 readout chips needed (to be produced in 2008)
- **Other applications** : medical imaging (project with ISS Roma), neutrino experiments, etc.



Prototype used in test beam

MAROC – Main Features

- **Technology: AMS SiGe 0.35 µm**
- **Package: CQFP240**
- **Power consumption: 350mW**
  - ⇒ 5 mW/ch
- **Area: 16 mm²**
- **Submitted March 2006**
- **Received July 2006**



MAROC – One channel schematic

→ **Variable gain preamplifier (6 bits)**

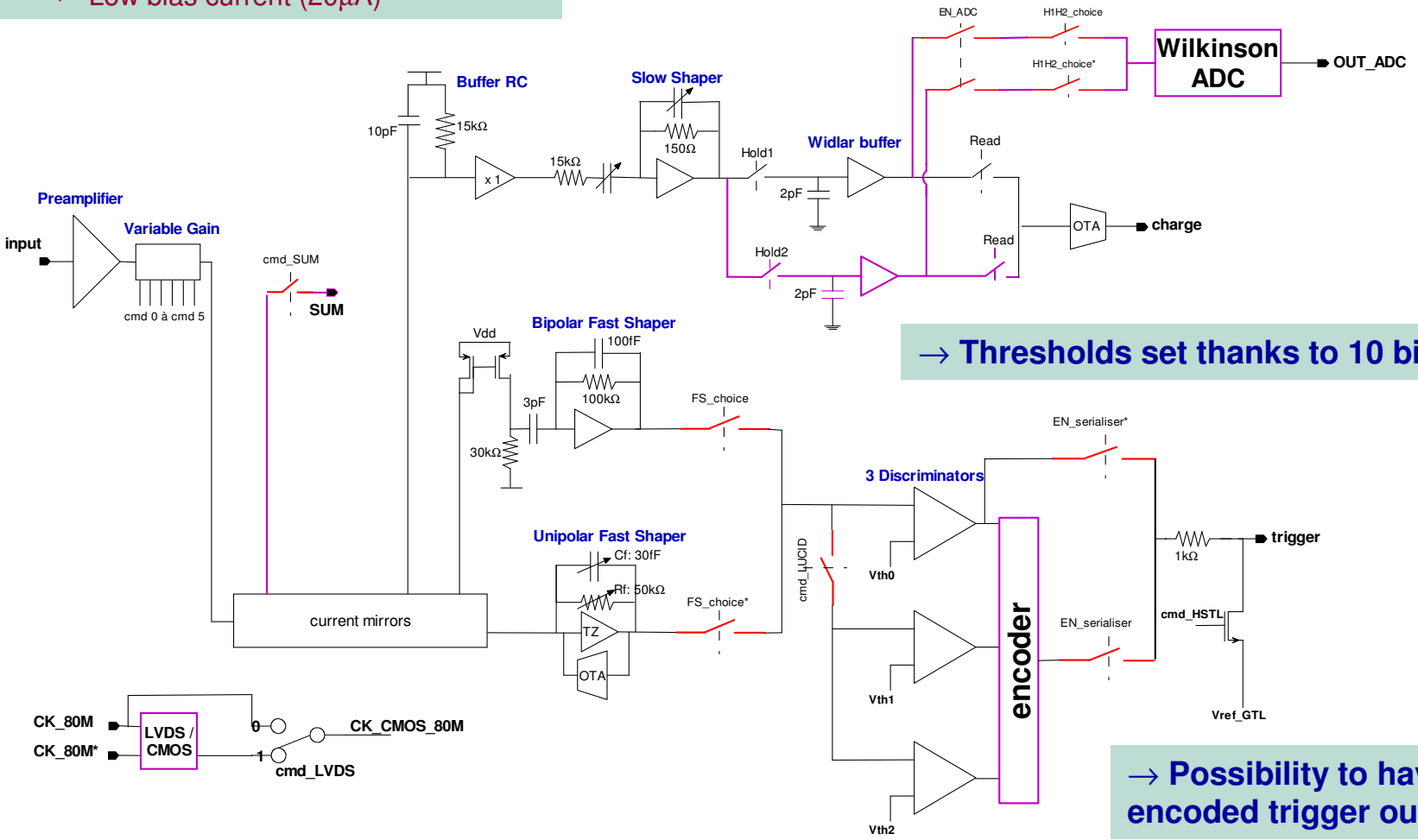
→ **Super common base inputs:**

- ✓ Low impedance (50-100 Ω) tunable
- ✓ Low bias current (20µA)

→ **Slow shaper**

→ **2 Track & Hold (baseline and max)**

→ **Analog and digital multiplexed charge output**

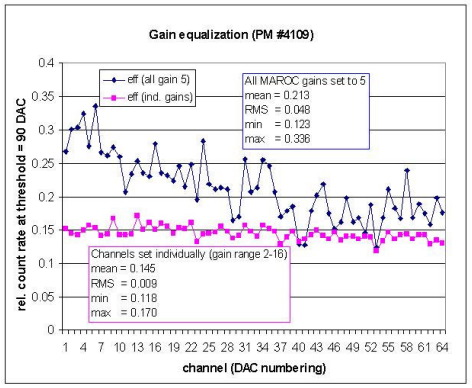


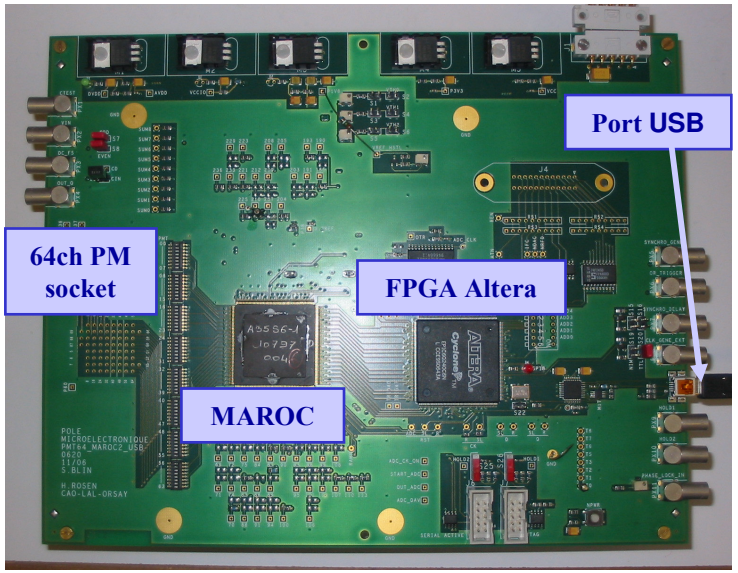
→ **Thresholds set thanks to 10 bits DACs**

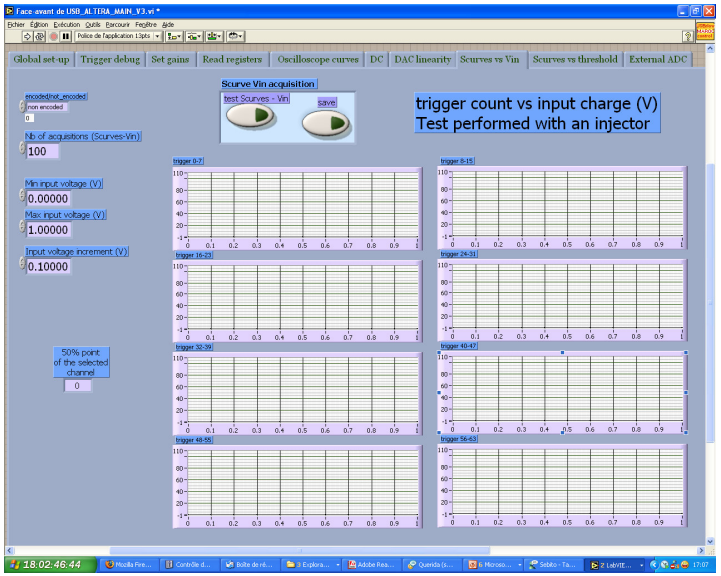
→ **Possibility to have 3 encoded trigger outputs**

MAROC - Specifications

- Variable gain preamplifier 0-4 to correct PM non uniformity
- 100% trigger efficiency at 1/3 p.e (= 50fC)
- Qmax = 5pC (=30 p.e)
- Noise = 2fC
- Linearity ~ 2%
- Cross talk : 1%







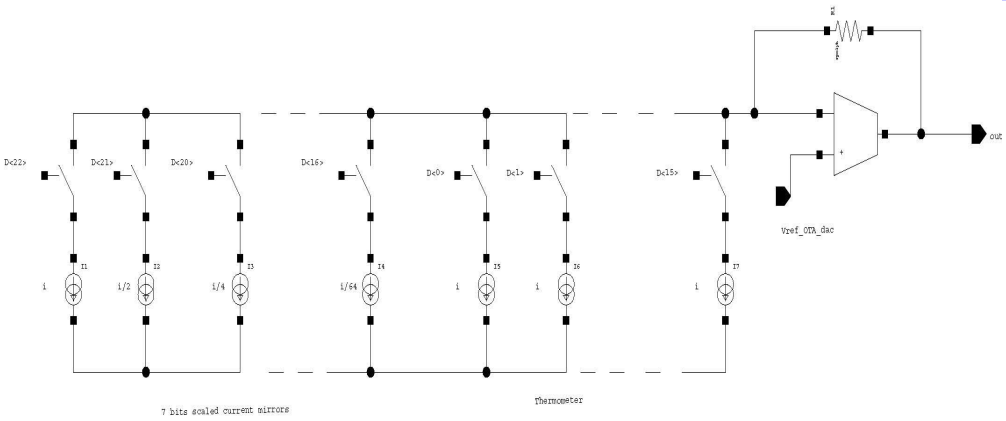
⇒ Characterisation tests performed in lab

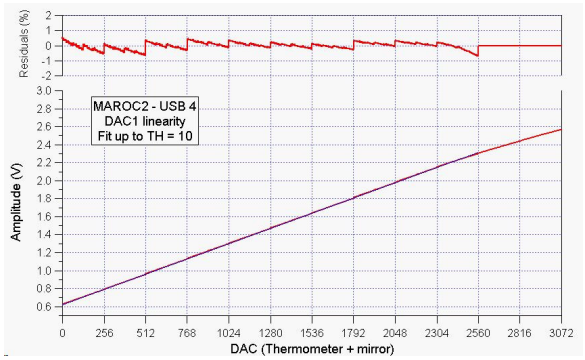
⇒ Dedicated test board driven by a PC through a USB connection

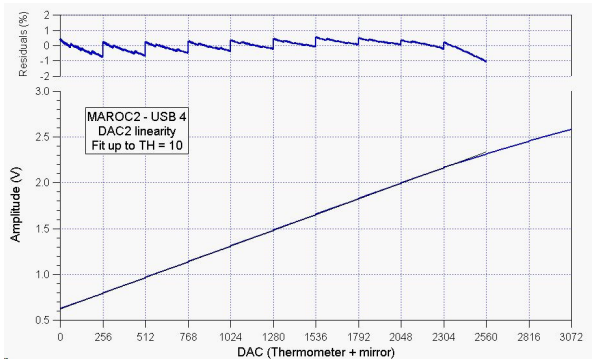
⇒ Labview software

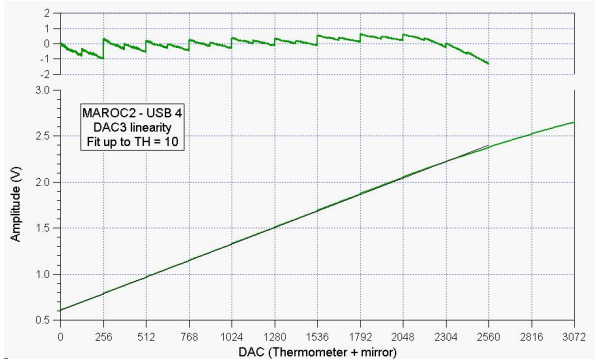
Threshold - DAC Linearity

- Three DACs made of two parts
- Thermometer:
  - ✓ 4 bits DAC
  - ✓ coarse tuning
  - ✓ ~ 200 mV/bit
- Mirror:
  - ✓ 6 bits DAC
  - ✓ fine tuning
  - ✓ ~ 3 mV/bit
- Linearity: +/- 1%









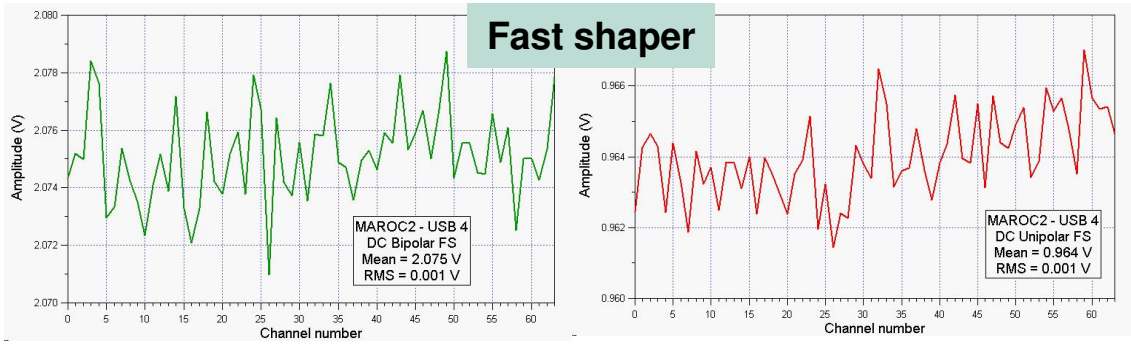
Pedestals

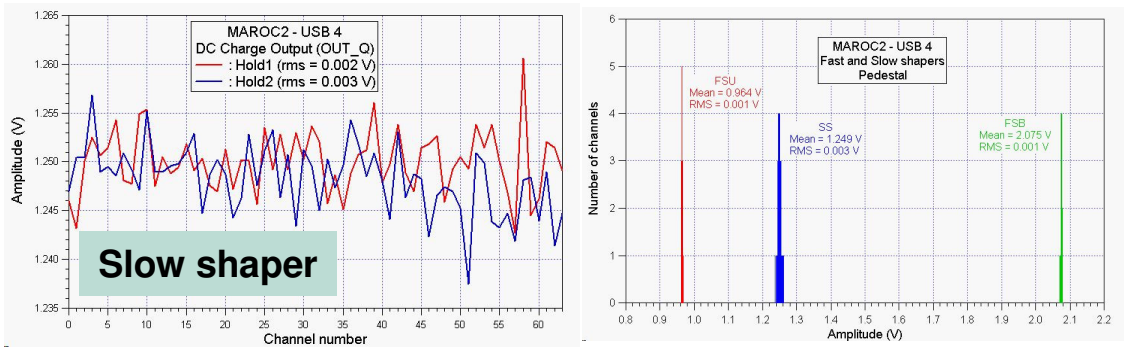
- Uniform slow and fast shaper pedestal

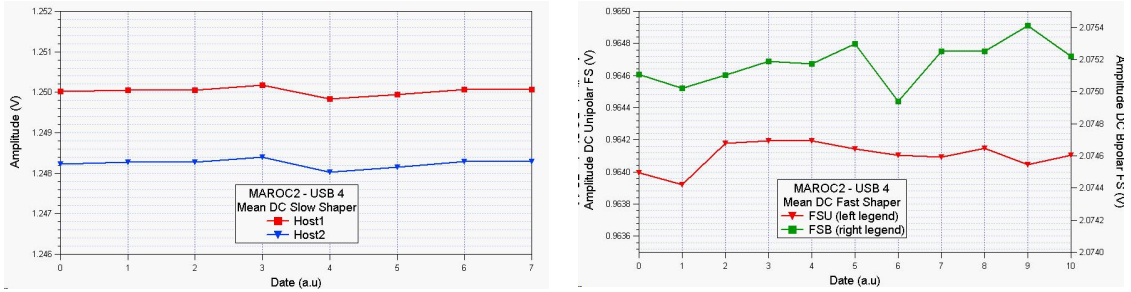
  ⇨ Dispersion < 1 ‰

- Very nice stability

  ⇨ Variation < 1 ‰

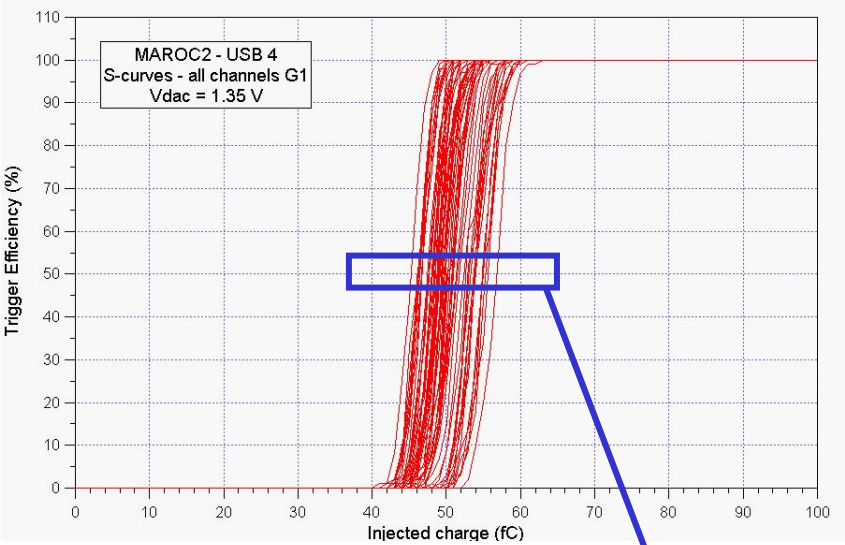


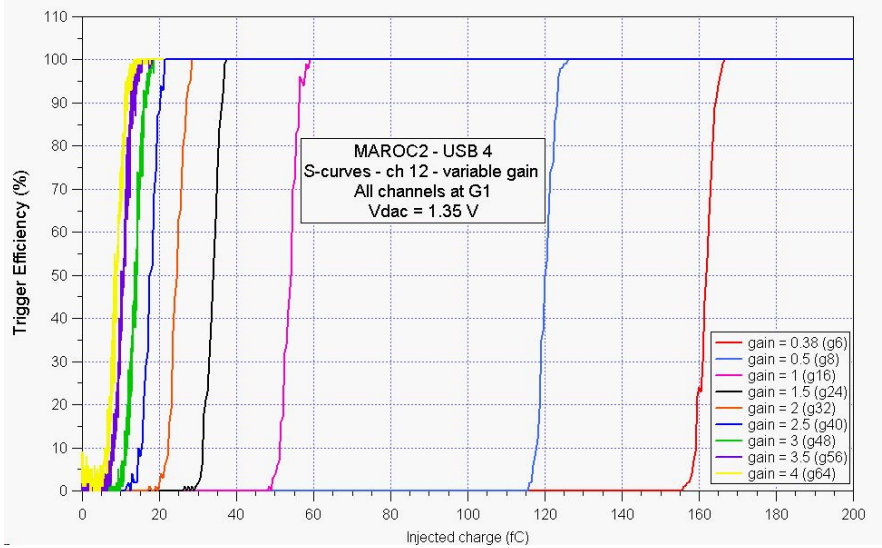


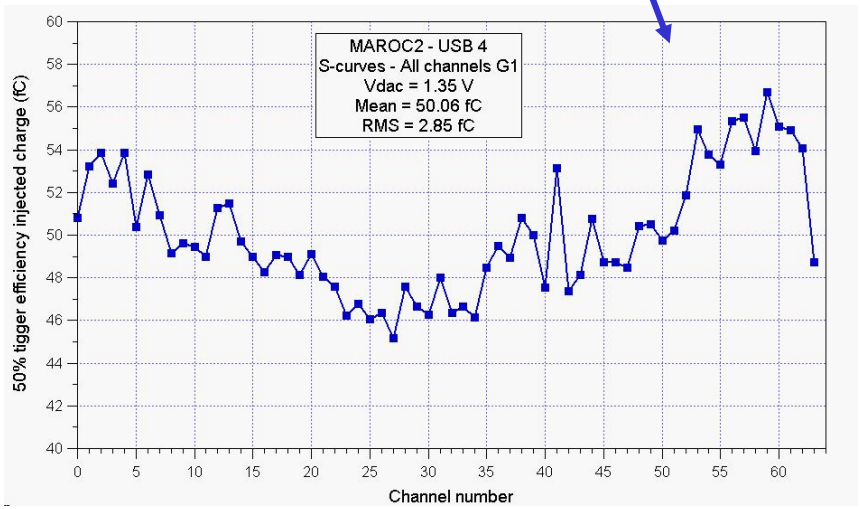


S-curves vs injected charge

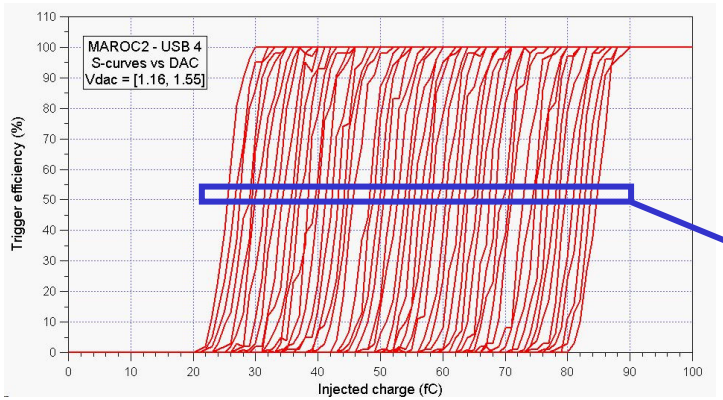
- Input charge (Qinj) scan with fixed threshold
- Trigger efficiency 100% around 50fC as requested
- Nice spread of 50% trigger efficiency point: 2.85fC rms
- Can go down to 10 fC

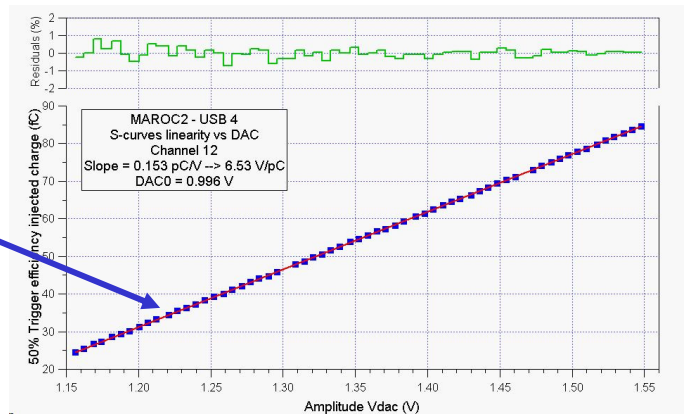


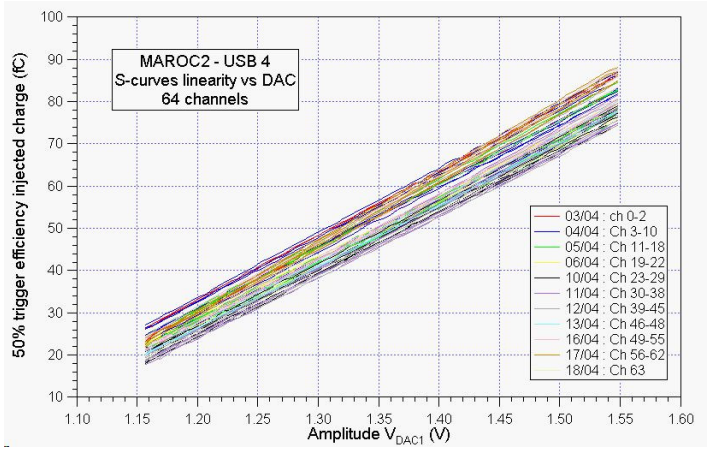


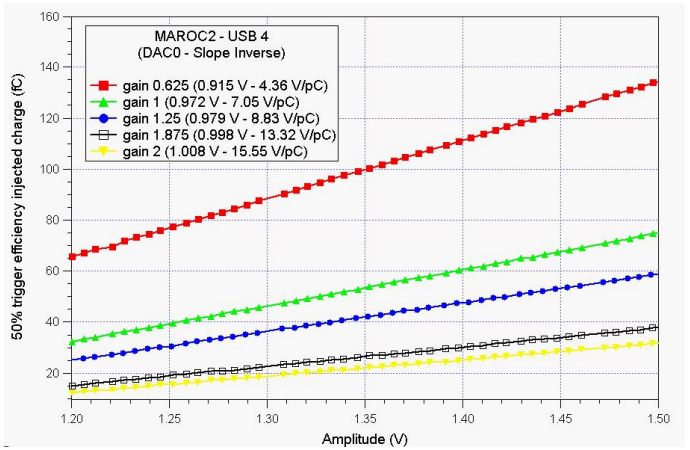


Scurves linearity vs threshold



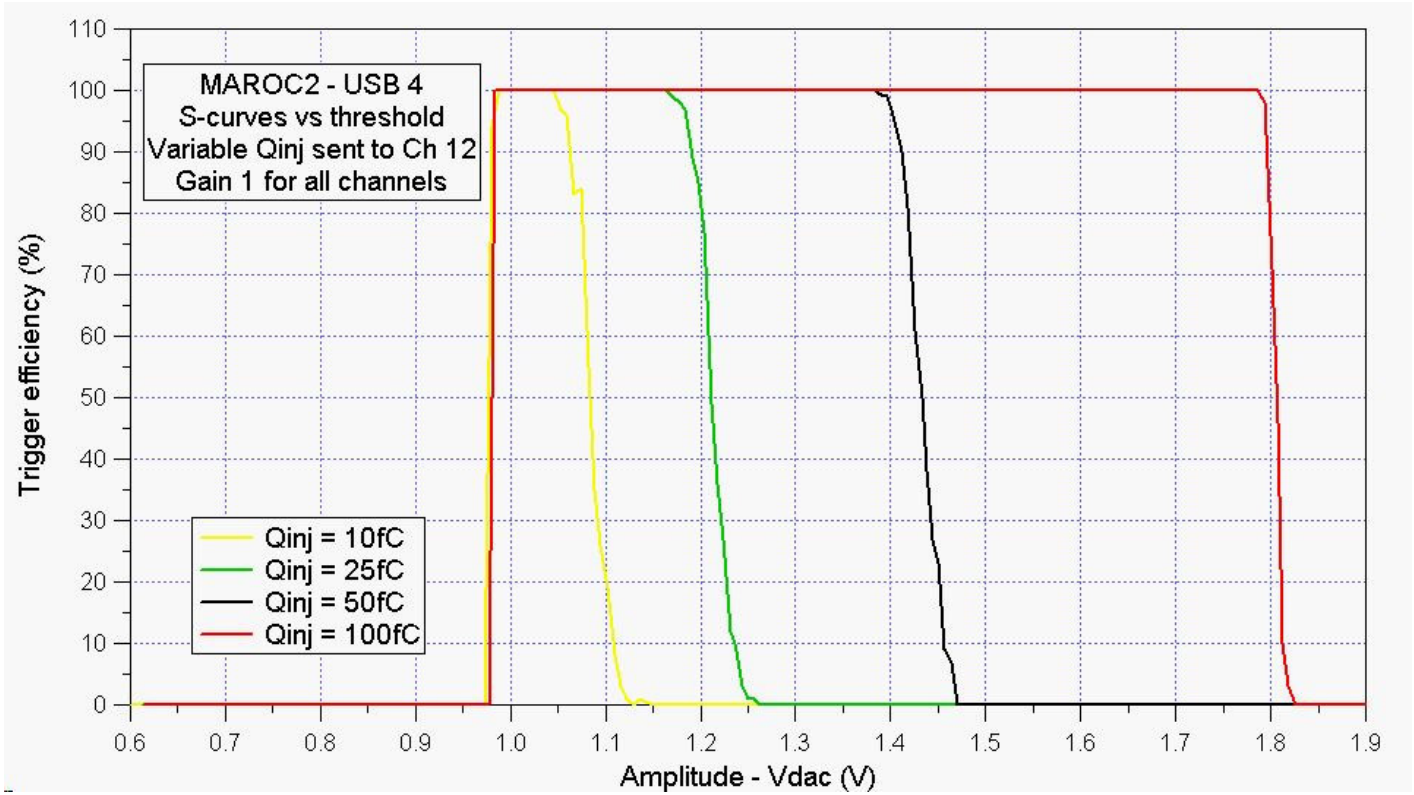






- Study of threshold effect on s-curves vs Qinj
- Linearity better than ±1%
- Linear for different gains

S-curves vs threshold

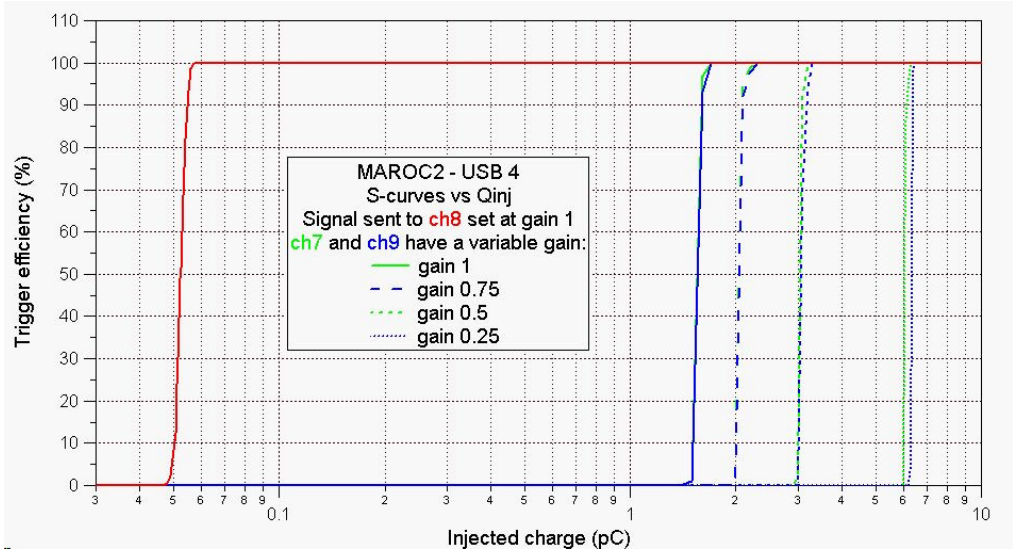


- Threshold scan with fixed injected charge
- Linearity vs injected charge is ~ 1%

Trigger output crosstalk

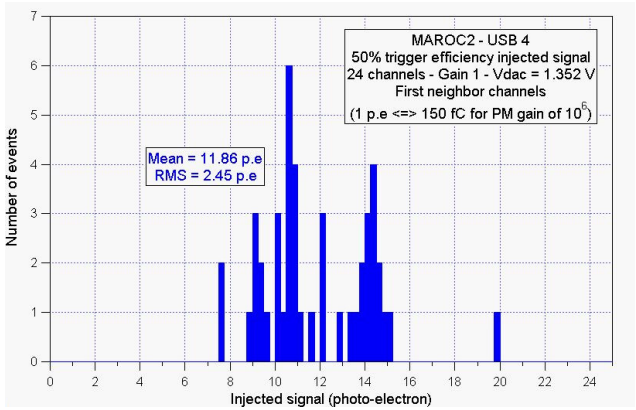
- Central channel fed with signal up to 10pC triggers at 50 fC
- Neighboring channels do not trigger before 1.5 – 2.5pC

⇒ Cross Talk ~ 2-3%



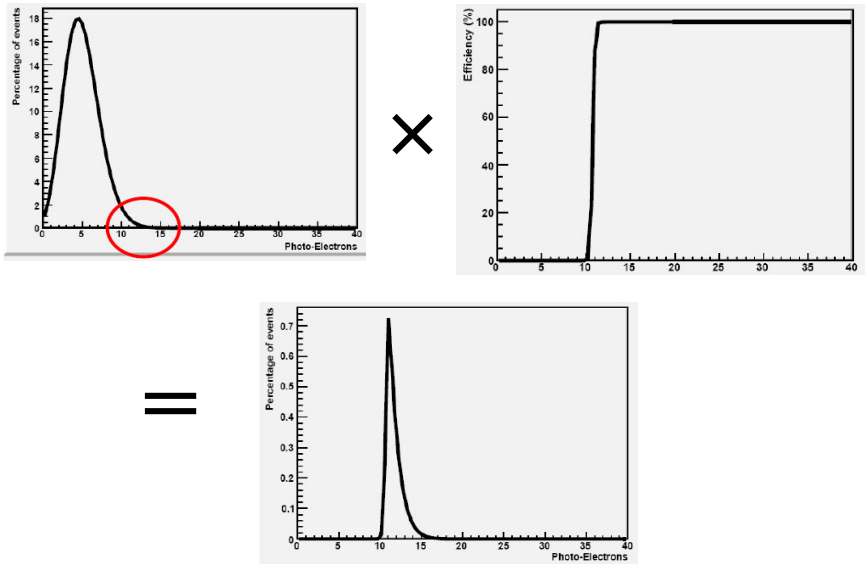
⇨ Cross-talk sensitive to the gain → it comes from the entry (preamplifier or test board)

Cross-talk signal appears for an input signal > 10 p.e for a threshold ~ 50 fC

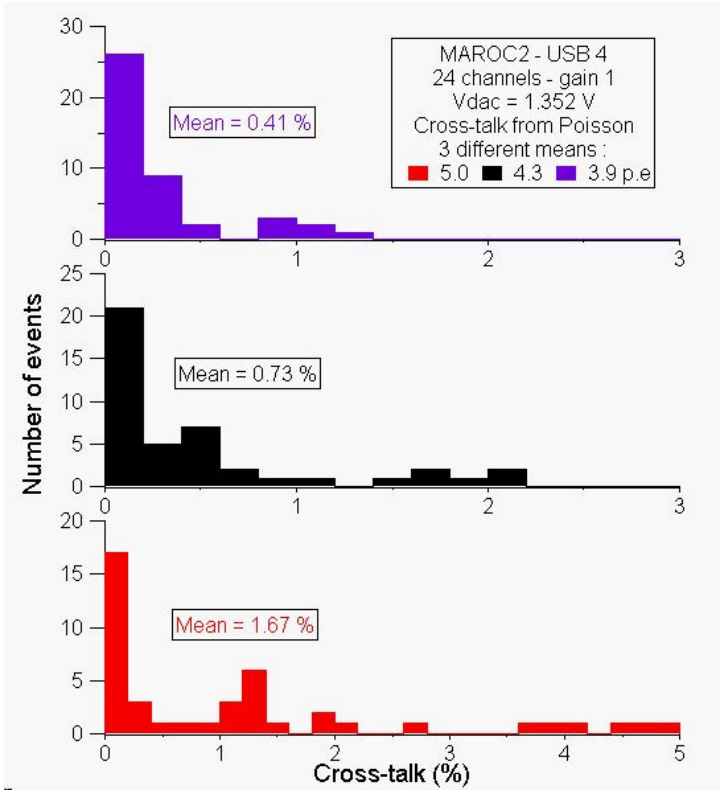


Trigger output crosstalk (physic approach)

- We expect a signal corresponding to a Poisson distribution with a mean of 3 to 5 photo-electrons depending on the type of scintillating fibers
- The idea is convolute this Poisson with the s-curves of the neighbors and look at the integral



- With this approach we obtain a cross-talk close to 1%

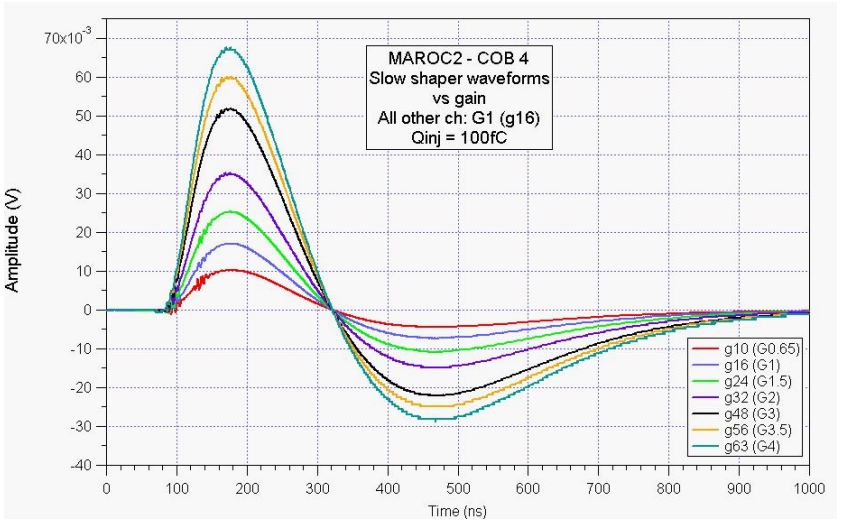


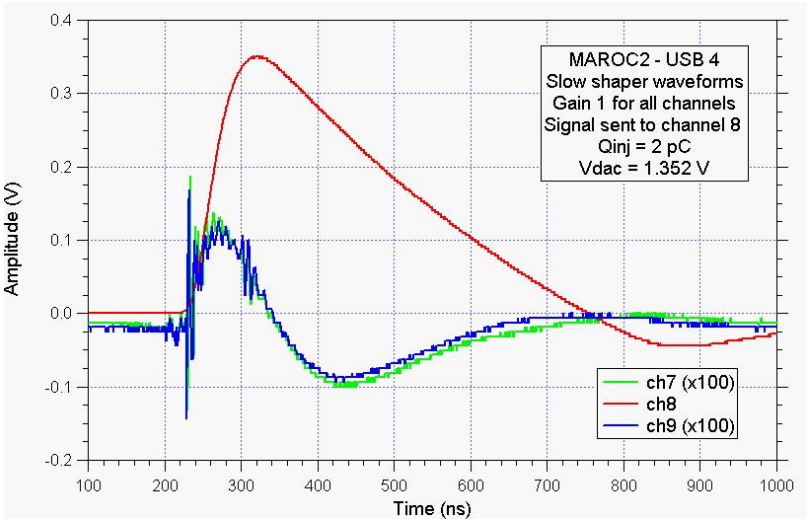
Slow Shaper – Charge Output

- Waveforms taken for different preamplifier gains with fixed input charge: Q_{inj} = 100 fC

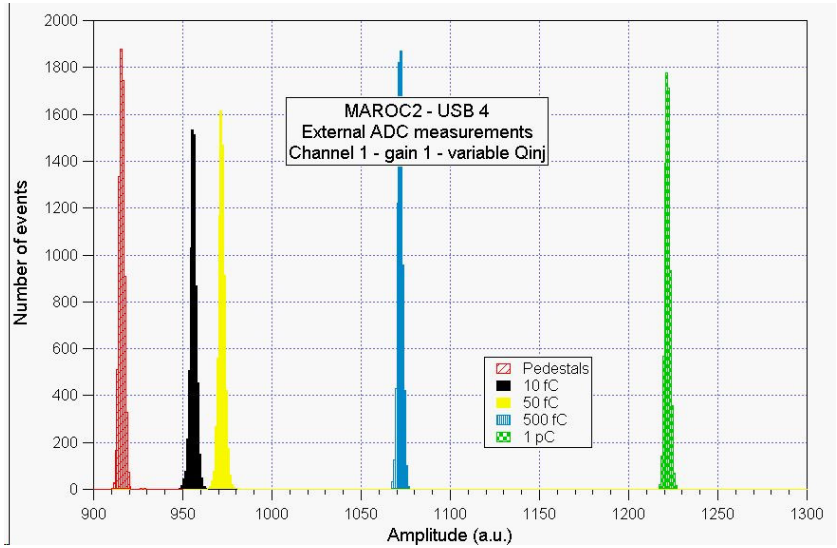
  ⇒ Linearity vs gain: ±1%

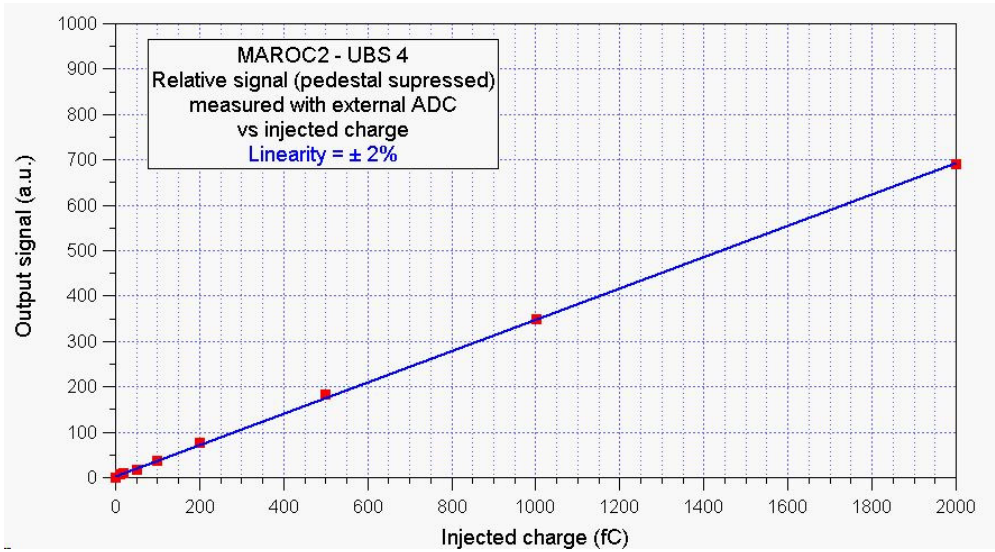
- Cross-talk on the slow shaper path is < 1%





Charge output linearity

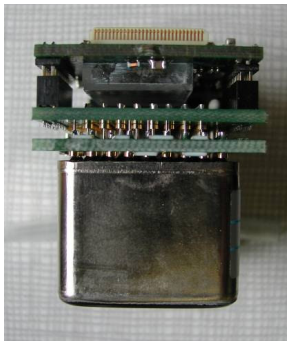




- Measurements performed with the external ADC of the test board
- The pedestal (measured with the first T&H) was suppressed
- Linearity of ± 2% approximately

Conclusions - what next ?

- Second version of MAROC has showed nice performances
- It will be used during beam tests this winter
  - ✓ Full Roman Pot prototype
  - ✓ New generation of the PMF (PhotoMultiplier Front-end)



BOTTOM side