Using WaveCatcher for Quality Control

A. Casajus, O. de la Torre, D. Gascon, R. Graciani, S. Gomez, R. Manera, J. Mauricio, E. Picatoste, A. Sanuy, D. Sanchez, A. Sanmukh

ICCUB//SiUB, University of Barcelona

WaveCatcher and SAMPIC International Workshop 2018

SiUB

UNIVERSITAT DE BARCELONA

ICCUB Institute of Cosmos Sciences

EXCELENCIA MARÍA DE MAEZTU

Outline

I. **Introduction**
II. Motivation / Objectives
III. Custom software for automated tests
IV. Conclusions

I - Technological Unit of the Institute of Cosmos Science of the Universitat of Barcelona (ICCUB)

- The **Technological Unit** of the Institute of Cosmos Science of the Universitat of Barcelona was created in 2017.

- The members of this unit has a long history in electronic development, based on a strong collaboration with the electronics department among others.

- This unit has an strong expertise on developing ASICs for:
  - Design and test of Front End Electronics for Readout of PMT's and SiPMs.
  - Semiconductor sensor and photo-sensor modeling and characterization.
  - Design and test of radiation tolerant systems for scientific/space applications.

Outline

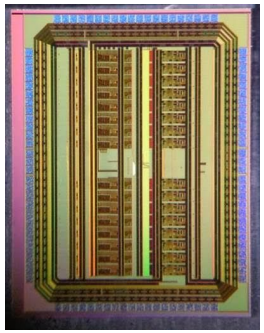
I. Introduction
II. Motivation / Objectives
III. Custom software for automated tests
IV. Conclusions

II - Motivations

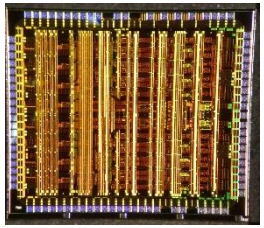
- We test a large variety of ASICs (different prototypes for different projects).

- Large productions must undergo a systematic Quality Assurance and Quality Control for the final version before mounting them.

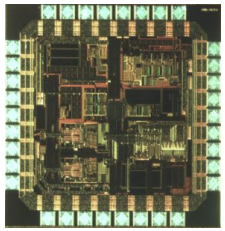
- Quality Control testbench requires:
  - Large number of input analog channels.
  - High resolution both in time and amplitude.
  - Reliable communication channel.
  - Compatibility with Linux.
  - Open top socket.



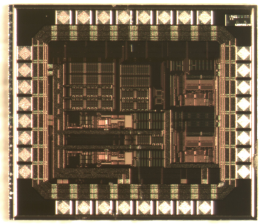
HRFlexToT



MUSIC



PACTA



ICECAL

II - WaveCatcher features

- Large number of input analog channels.
  - We have both 8-channels and 16-channels.
- High resolution both in time and amplitude.
  - Sampling time precision is less than 5 ps rms at 3.2GS/s.
  - 12bits +/-1.5V dynamic range.
- Reliable communication channel.
- Compatibility with Linux.

Outline

I. Introduction
II. Motivation / Objectives
III. Custom software for automated tests
IV. Conclusions

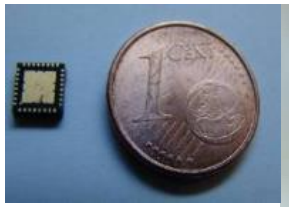
III - Functional requirements

- Automated tests require full control of the laboratory instruments:
  - Automatically configure lab equipment at run-time.
  - Need to be able to power-down equipment to swap chips and then power up for the next test .

- Would like to avoid using a 30k€ oscilloscope for a two months run.
  - Wavecatcher is a great fit.
    - Small form-factor.
    - Cheap(er).

III - Automated test example: PACTA

- PACTA is an ASIC for the CTA project.
  - Preamplifier with:
    - High dynamic range (16bits).
    - High bandwidth (500Mhz)
    - Low noise (10pA/Hz$^{1/2}$).
    - Low power consumption (130mW).
  - Developed for large and mid size telescopes
  - More than 10k units to be tested



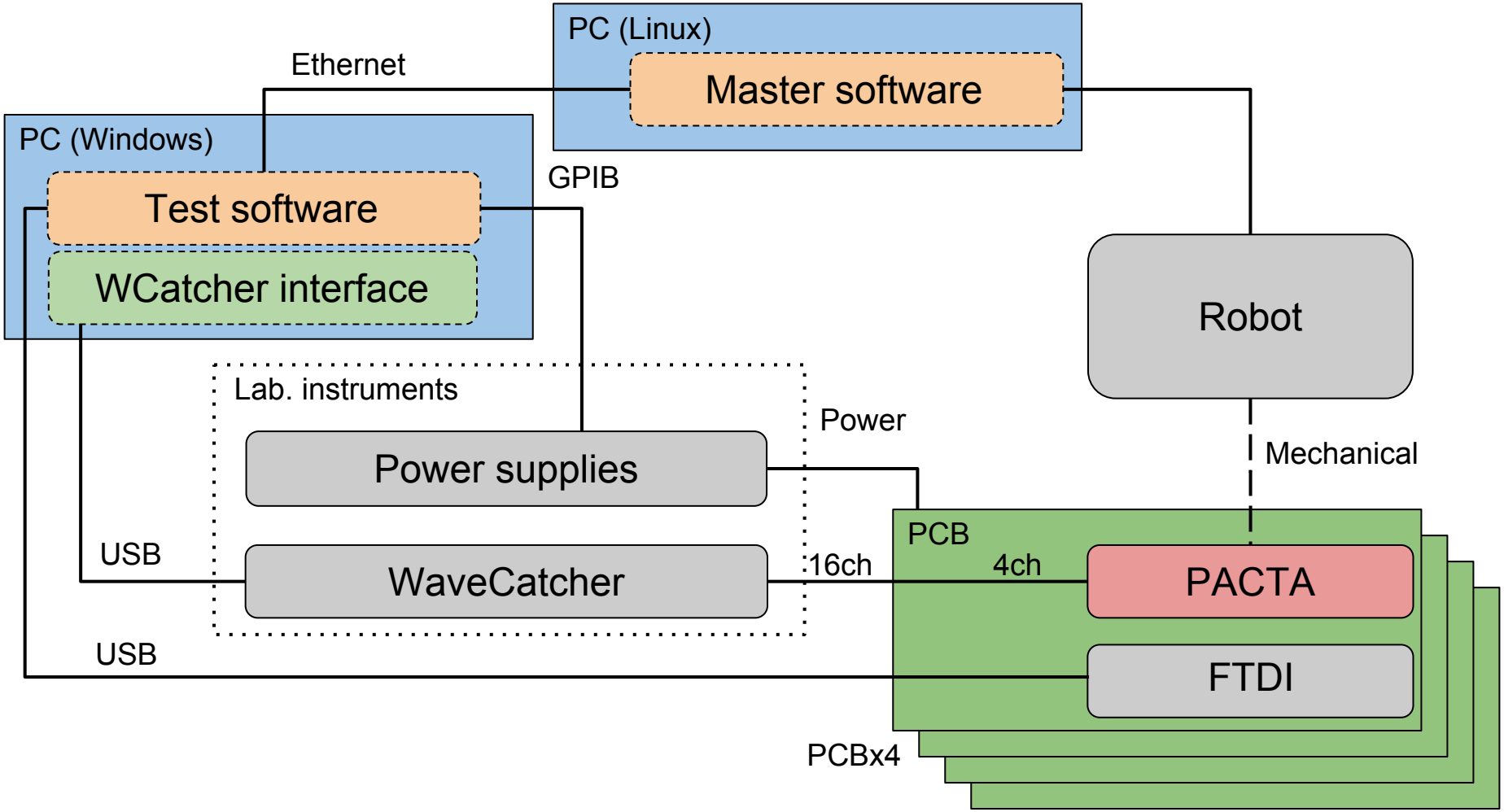
PACTA (2mm^2)

LST PMT unit

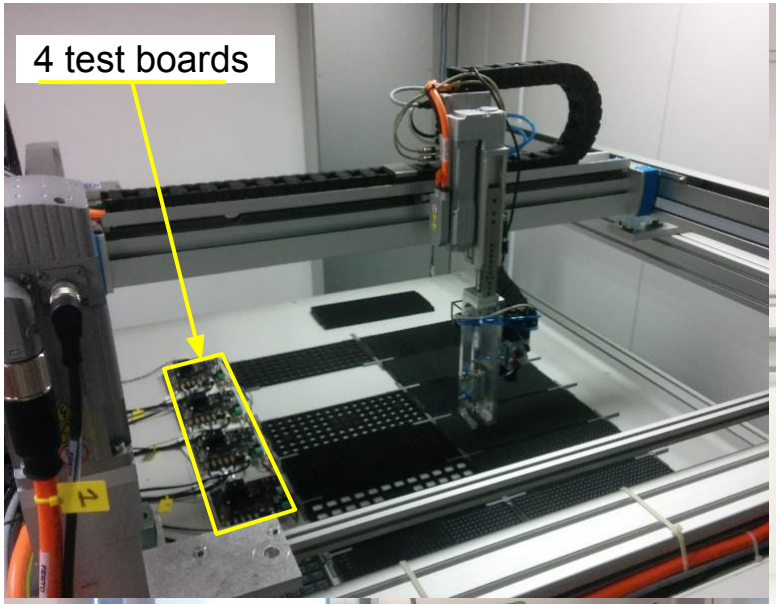
Cherenkov Telescope Array rendering.

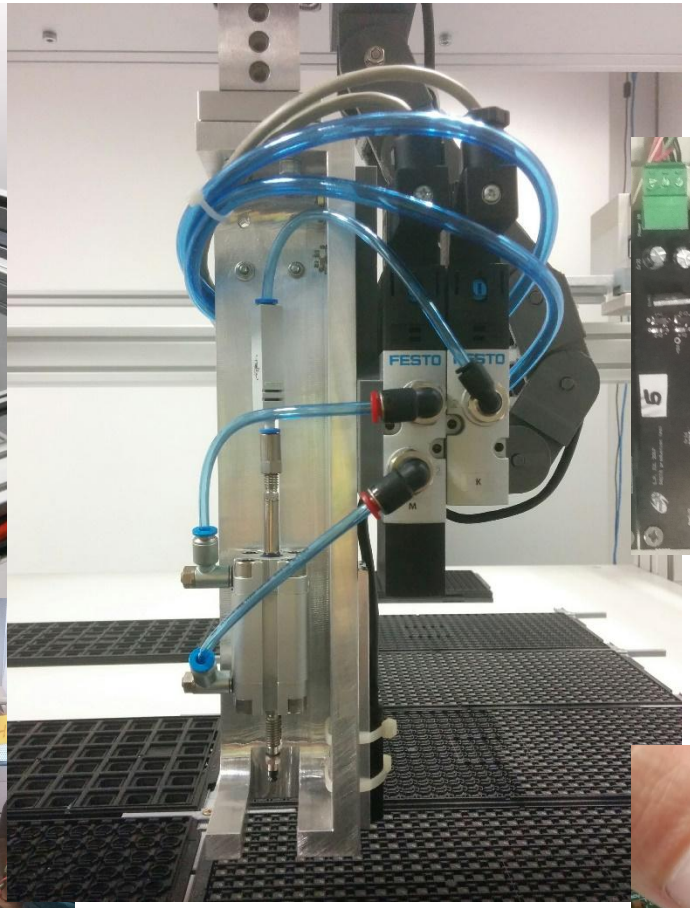
LST PMT cluster

III - PACTA automated test diagram



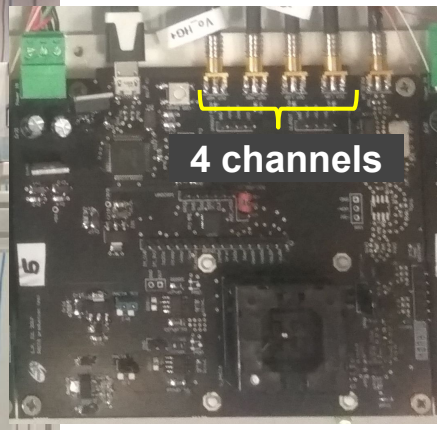
III - Quality Control Setup

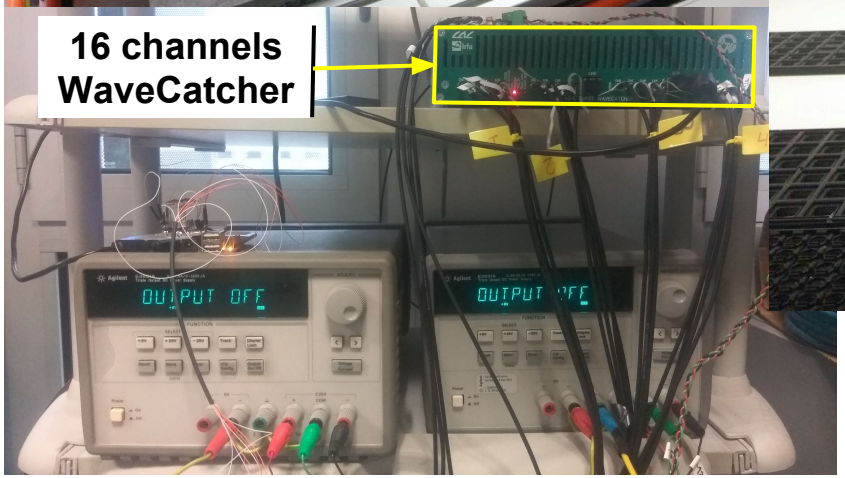




Robot arm

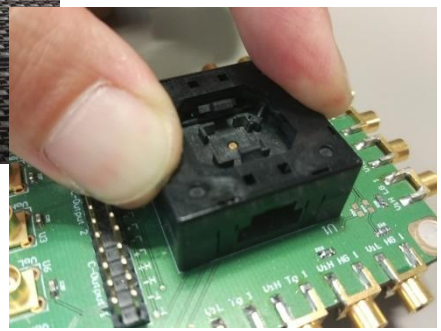
PACTA board



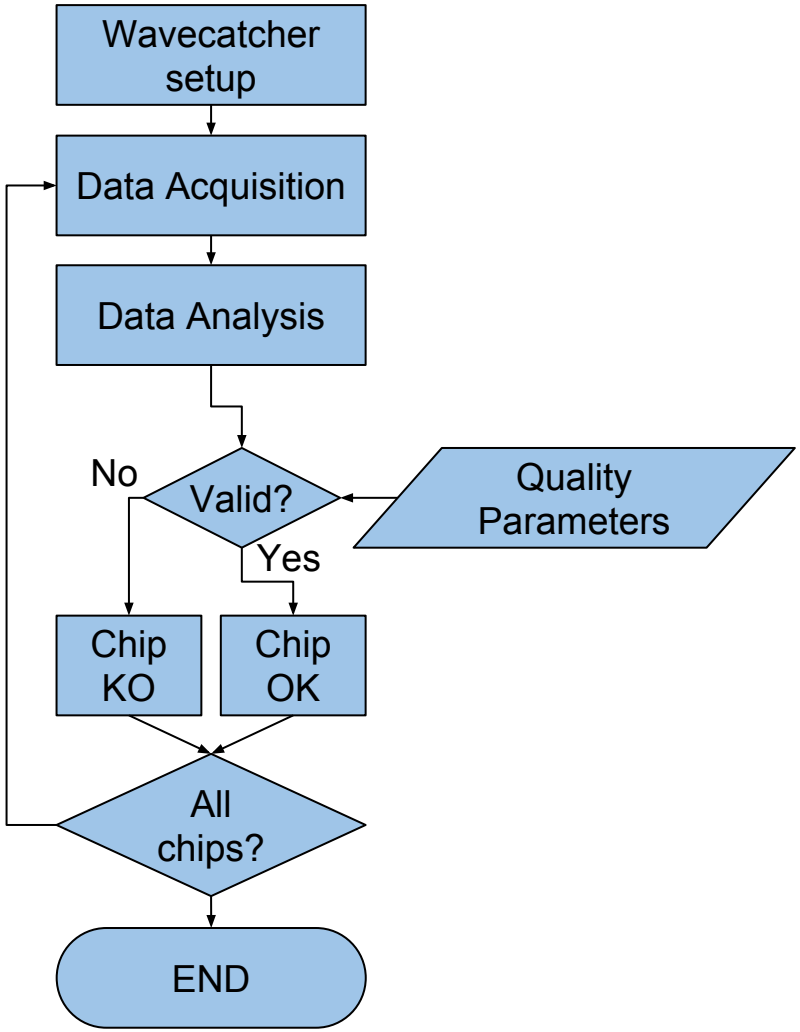


Instruments

PACTA socket



III - PACTA Quality Control flowchart

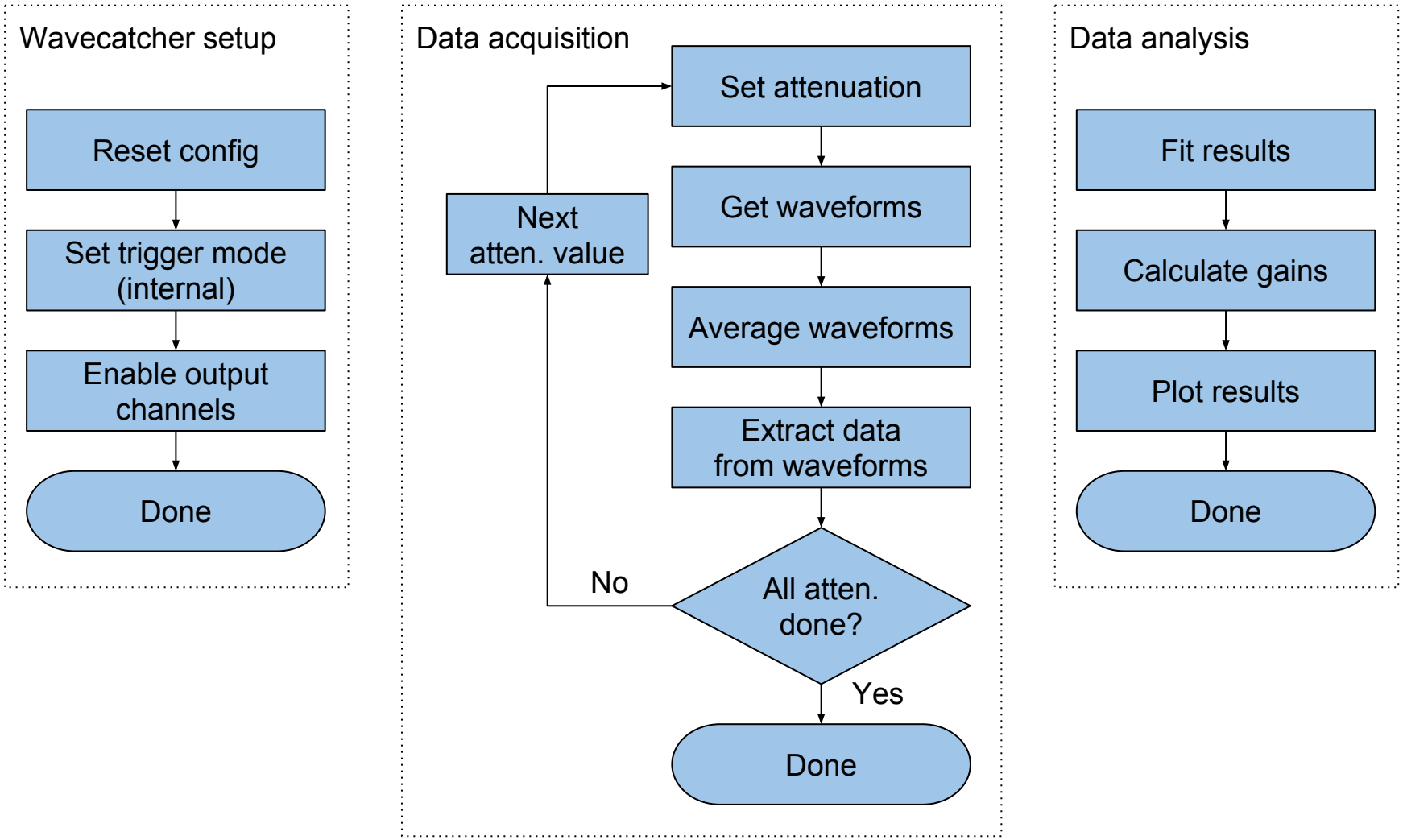


Data acquisition (for each ASIC's output):

- Read multiple raw waveforms.
- Average them to get one waveform.
  - Reduce noise
- Extract data from waveform.
  - Amplitude
  - Width
  - Charge
  - Time rising
  - Time falling

During the **data analysis** stage, the gain and its error are calculated by fitting the data.

III - PACTA Quality Control flowchart detail

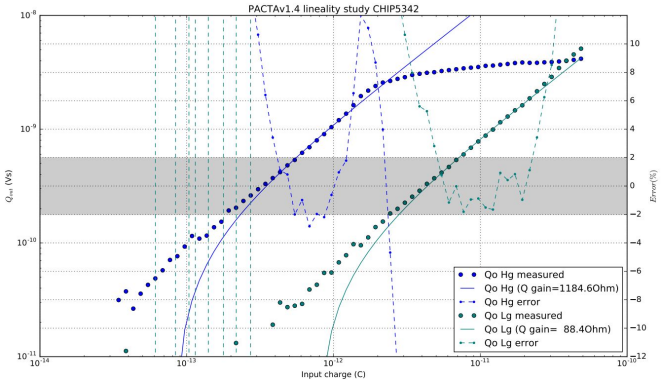


III - PACTA Quality Control summary

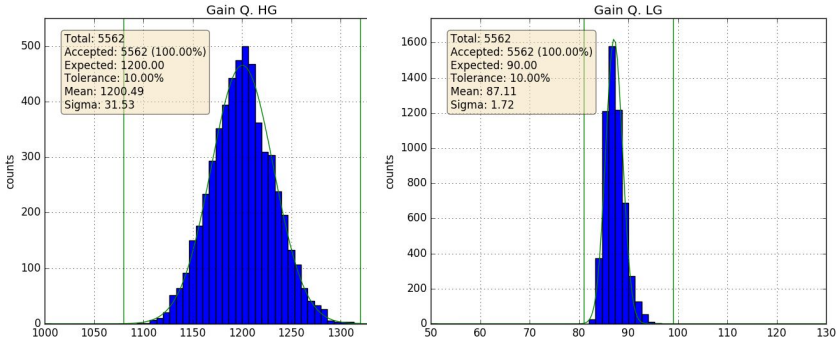
- Waveform data acquired for 63 attenuation values for the linearity test.

- 32 validation parameters:
  - 16 values from ADC chip reading current and voltage in different points.
  - Using WaveCatcher:
    - 8 parameters measured from the waveform.
    - 8 voltage and Charge gain and its error.

- 4 minutes per test → 1 chip validated per minute.



Charge gain calculated (1 ASIC)



Charge gain validation (5.5k ASIC)

III - WaveCatcher experience

- Development:
  - An extra PC had to be added with Windows for integrating USB communication with the WaveCatcher.
  - Easy to integrate in custom software.

- Data acquisition:
  - External and channel trigger mode introduced Jitter:
    - Made us difficult for averaging waveforms.
    - Solved using internal trigger instead.
  - Charge value on the event data differed from the calculated integrating the waveform.

III - WaveCatcher experience

- Usage:
  - Provided enough resolution for tests.
  - The MCX connectors are very handy since the connections are close to each other.
  - Compared to the 8-channels, the rear connections of the 16-channels+2 WaveCatcher are not so handy.

- Wishlist:
  - The acquisition window width is up to 2.5us. This is ok but a bit more range would be the better since it would allow for more applications.

III - WaveCatcher issues

- We have both 8-channels and 16-channels+2 but their trigger signal are slightly different (8-channel trigger signal is wider).

- Connection to the wavecatcher has to be open before any other USB device, otherwise the software does not recognize it.

- Although there's SW for Linux, it is unreliable over USB.
  - Haven't tried it over ethernet, but 16-channel+2 WaveCatcher doesn't have an ethernet interface…
  - 16-channel+2 has an optical fiber link that coupled with an optical transceiver may provide an ethernet connector.
    - This solution we haven't tried yet.

Outline

I. Introduction
II. Motivation / Objectives
III. Custom software for automated tests
IV. Conclusions

IV - Conclusions

- Important WaveCatcher features:
  - Can be integrated in custom software.
  - Excellent time resolution.
  - Enough voltage resolution for our use case.
  - Good price per channel and post-sale service.

- Wishlist:
  - More dynamic range (would like at least +/-3.3V).
  - Wider sampling window (would like at least 1ms).

- Issues:
  - USB usage under Linux.
  - Ethernet connection for the 16-channels+2.

IV - Conclusions

- Future needs:
  - Avoid jitter when using wavecatcher with external or normal trigger.
  - Radiation support specifications.

- Ideas to share:
  - Jitter between signals from two linked WaveCatchers?

Thanks a lot for your attention !!!

odelatorre@fqa.ub.edu

SI UB

UNIVERSITAT DE BARCELONA

ICCUB Institute of Cosmos Sciences

EXCELÈNCIA MARÍA DE MAEZTU