The AliVATA DAQ system

The Alibava DAQ system for spectroscopy

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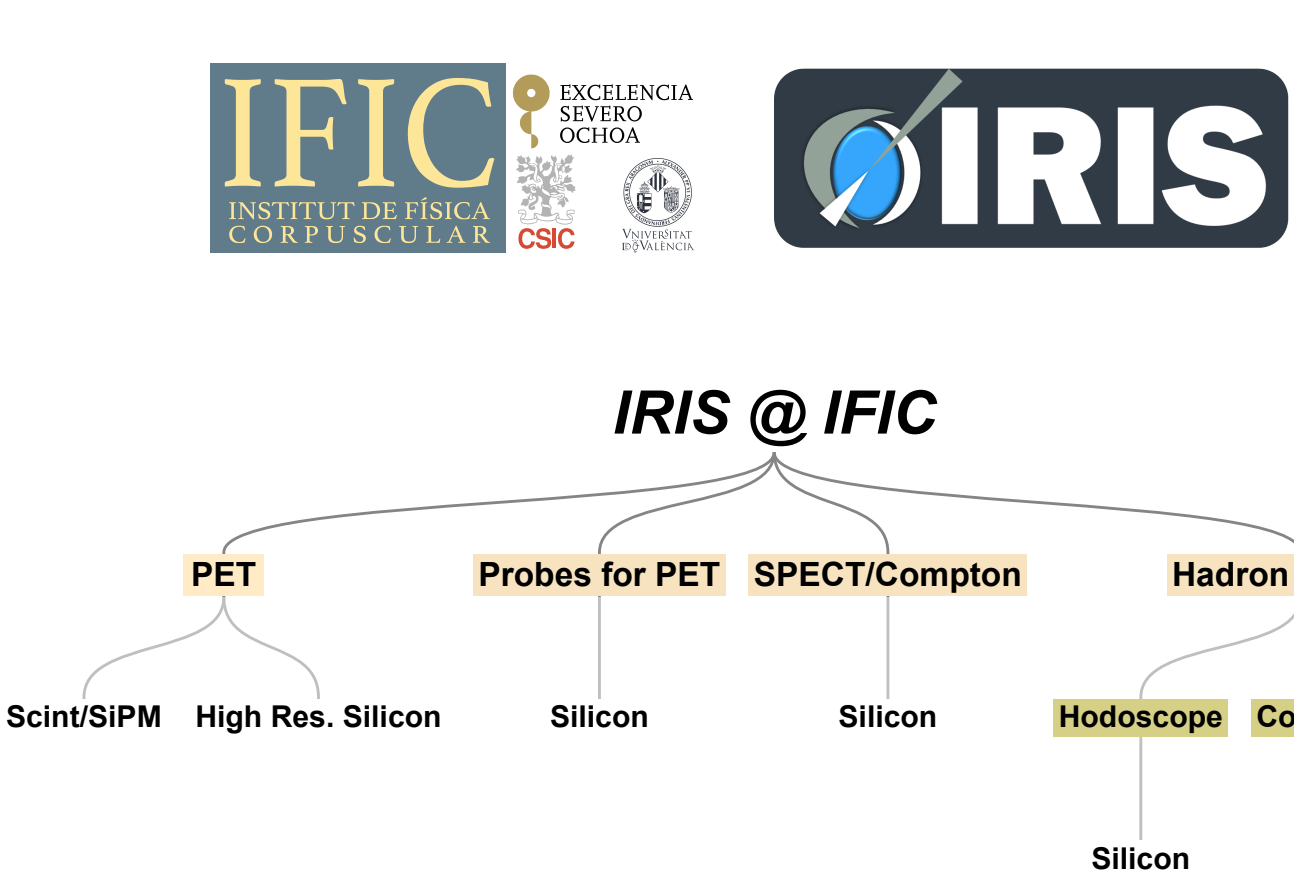
31st RD50 Workshop, November 2017

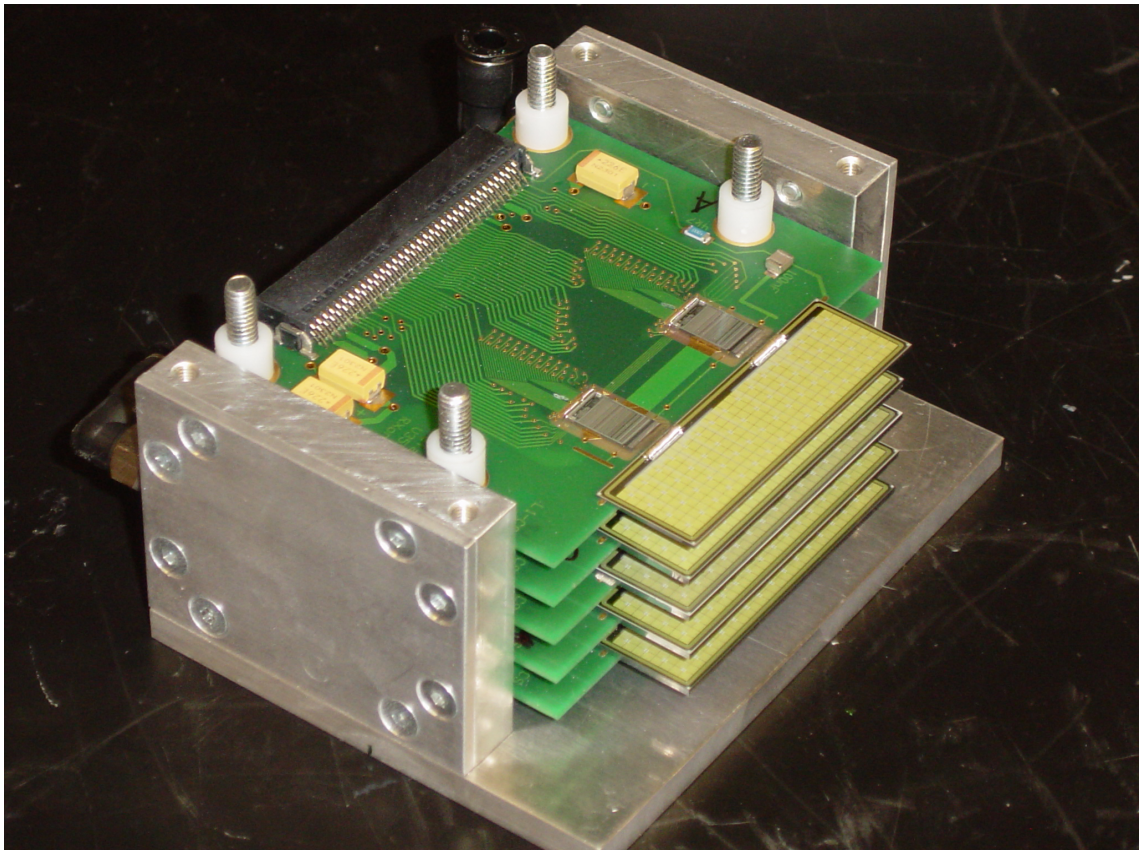
The AliVATA system



A DAQ system that could handle all of their different setups and sensor types was needed

The AliVata system was born from a collaboration with ALIBAVA & IRIS @ IFIC

Needs: SPECT/Compton camera



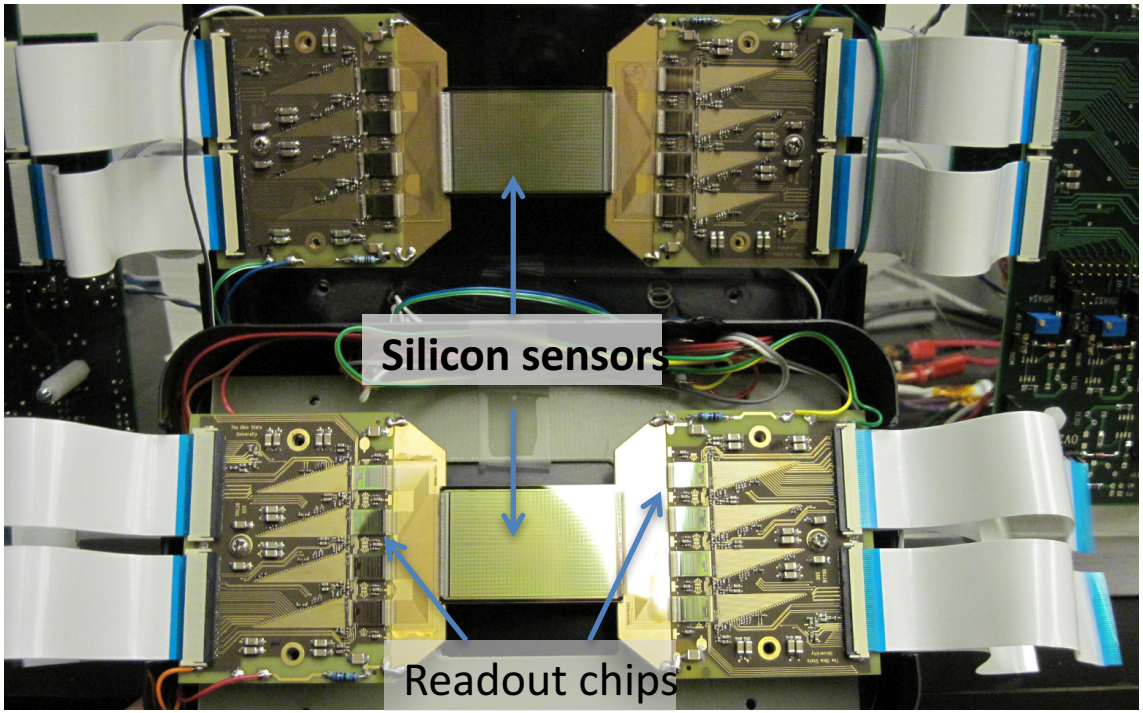
Stack of silicon pad detectors for a SPECT/Compton camera.

2 ASICS per plane
1 Trigger per plane
1 data stream per plane

Need to

1. *timestamp* for event building,
2. Handle multiple data streams.

Needs: PET probe & Small Animal PET



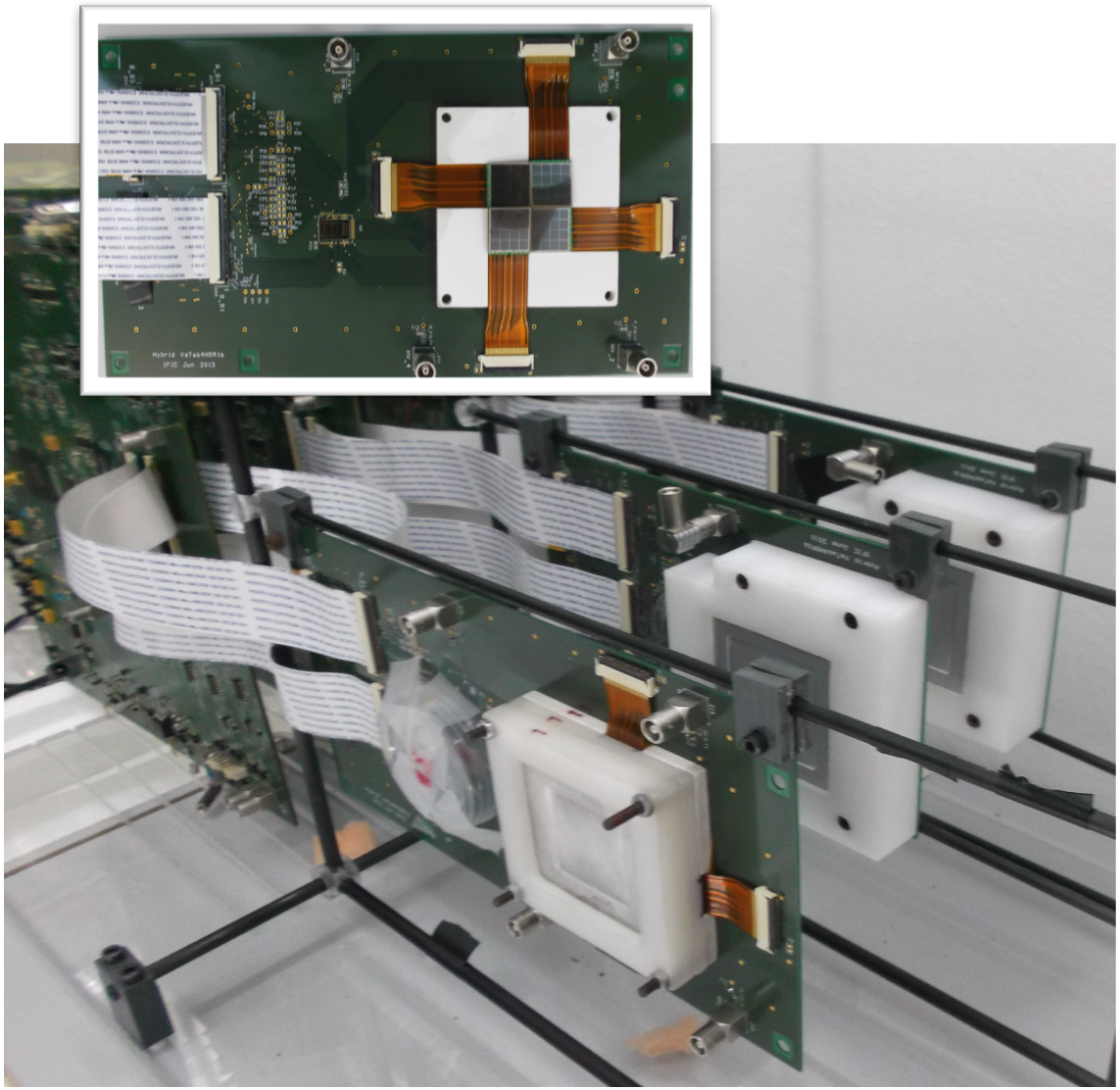
Yet another **stack of silicon pad detectors** for a PET probe

8 ASICS per plane
1 Trigger per plane
1 data stream per plane.

Need to

1. *timestamp* for event building,
2. Handle a large number of chips per data stream
3. Handle multiple data streams.

Needs: Hadron therapy monitoring



A **stack of Scintillarors+SiPM** for a Compton Telescope to monitor hadron therapy.

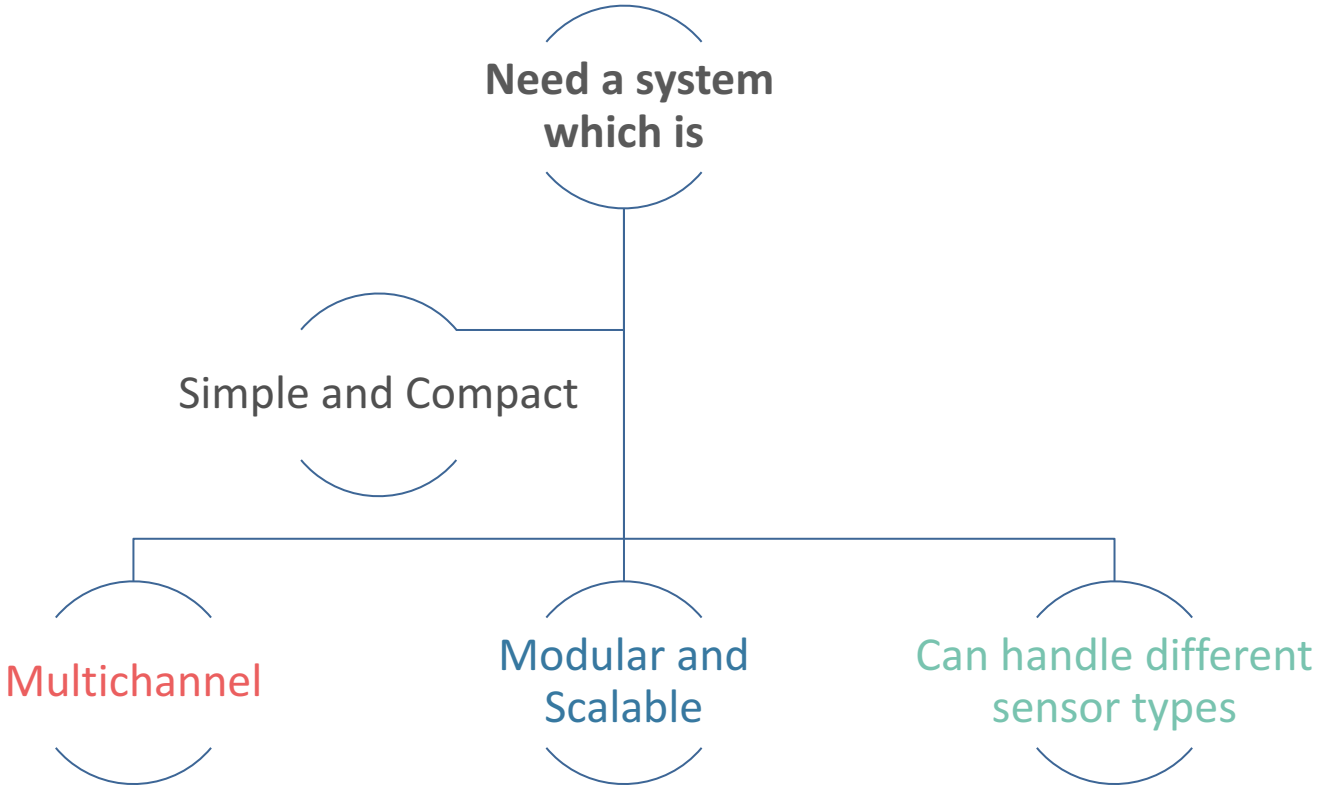
1 ASIC per plane
1 Trigger per plane
2 data stream per plane

Need to:

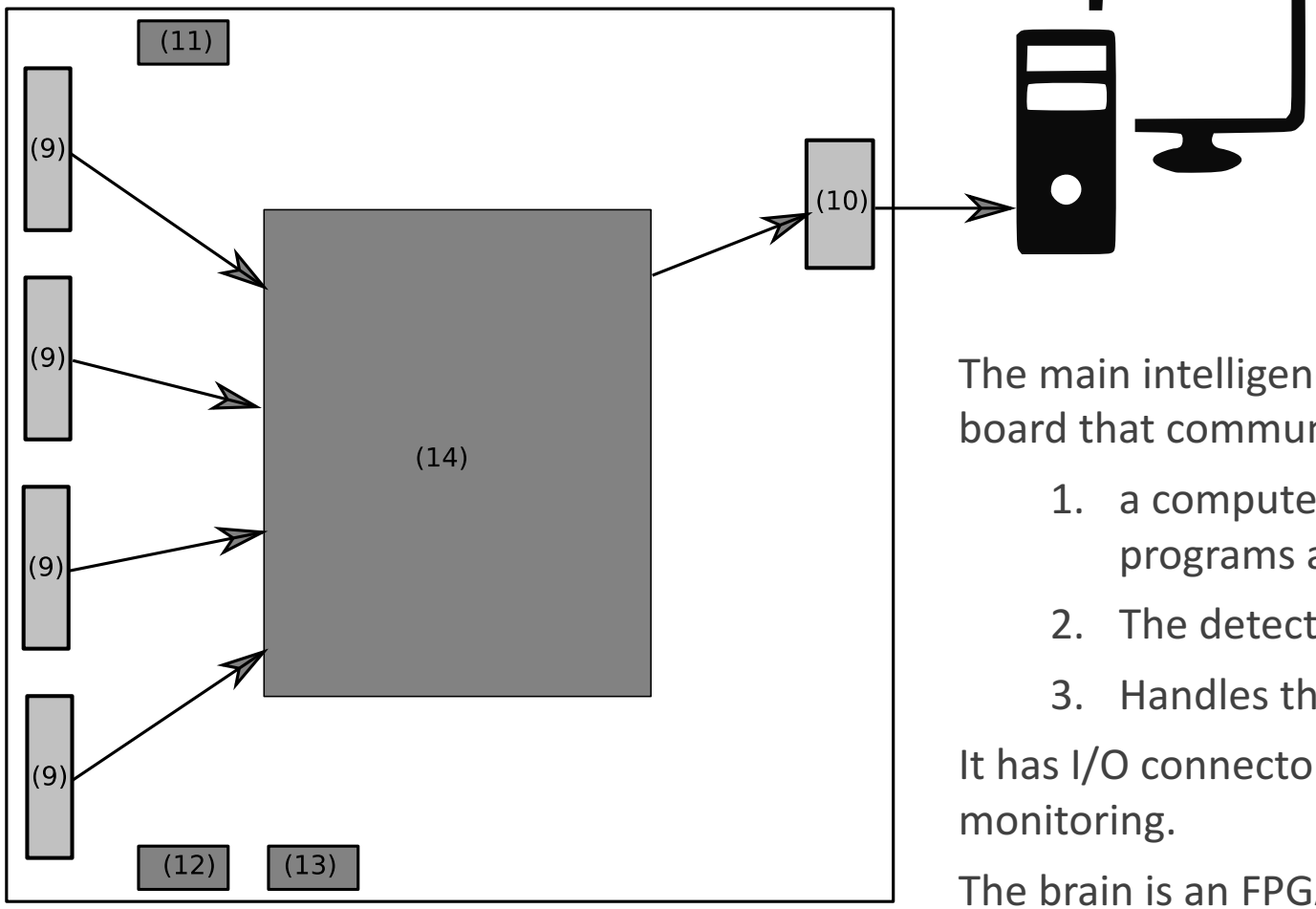
1. Timestamping for coincidence building

Different Sensor, different range

The idea behind



The system mother board



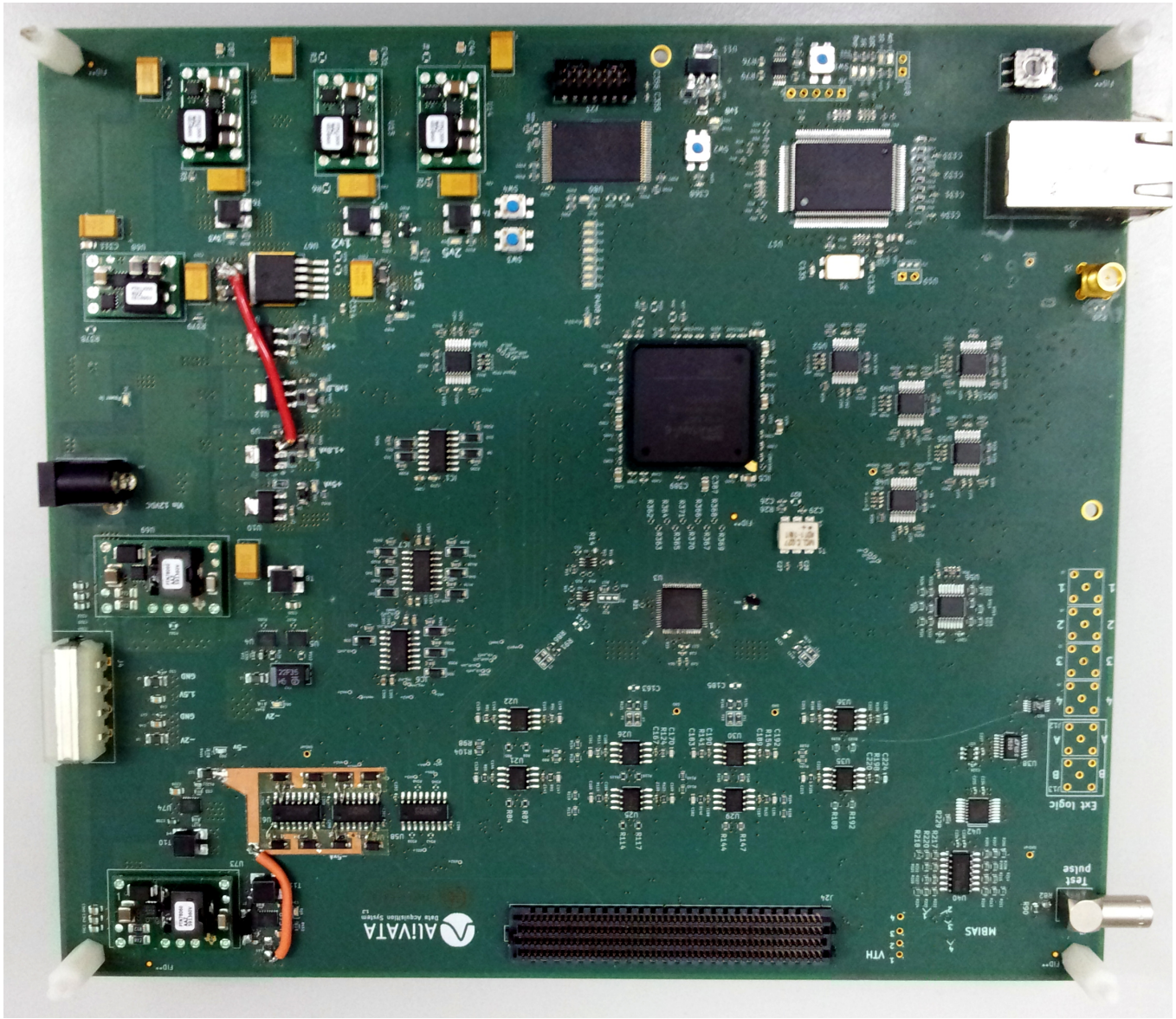
The main intelligence is in a mother board that communicates to

1. a computer (ethernet) that programs and receives data
2. The detectors
3. Handles the trigger

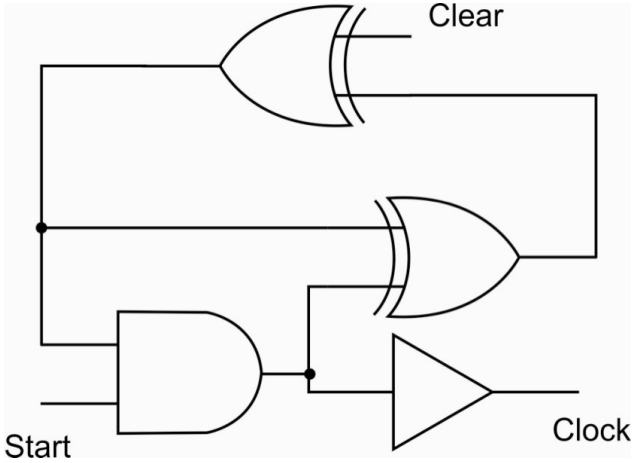
It has I/O connectors for trigger and monitoring.

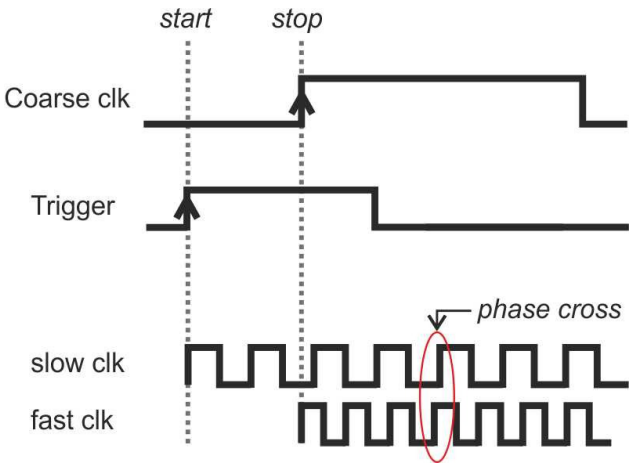
The brain is an FPGA (Spartan 6).

The mother board



The Embedded TDC





A Vernier TDC embedded in the FPGA

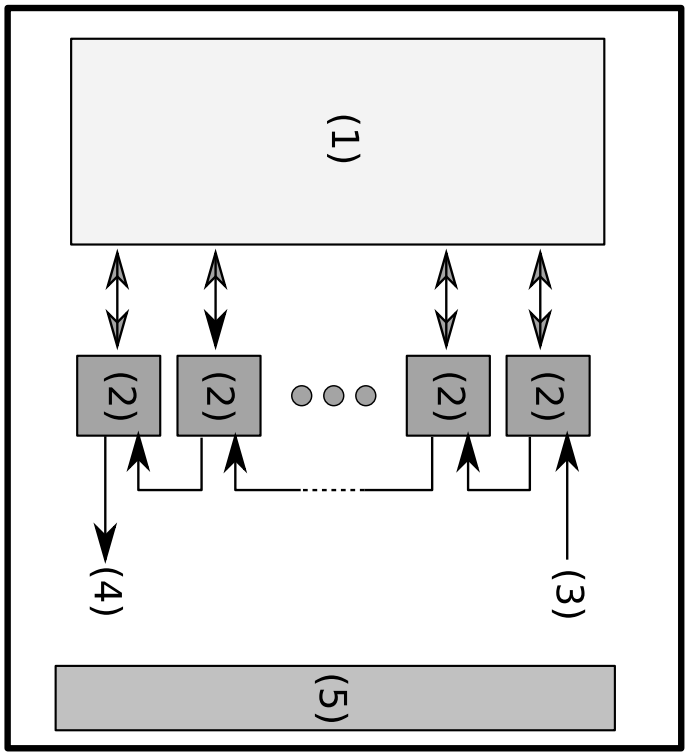
Implemented with 2 fast clocks with very similar frequency. The difference between periods gives the resolution.

Requires manual (and smart) routing in the FPGA.

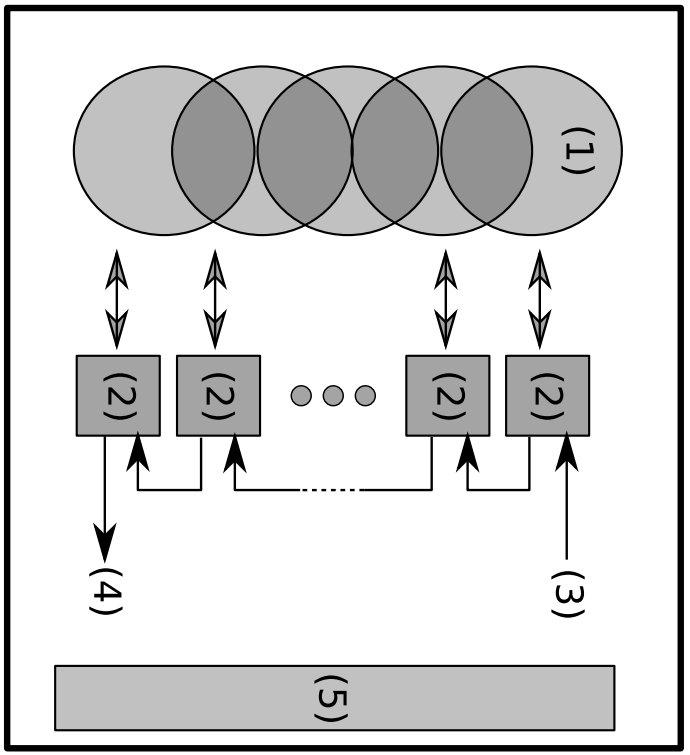
Same concept on a Spartan 3 gave 250ps resolution. Not yet tested on the Spartan 6 firmware but expect much better timing resolution.

The system: the daughter board

The sensor (1) is connected to the read out ASICs (2)



Sensors and readout ASICS can be different.

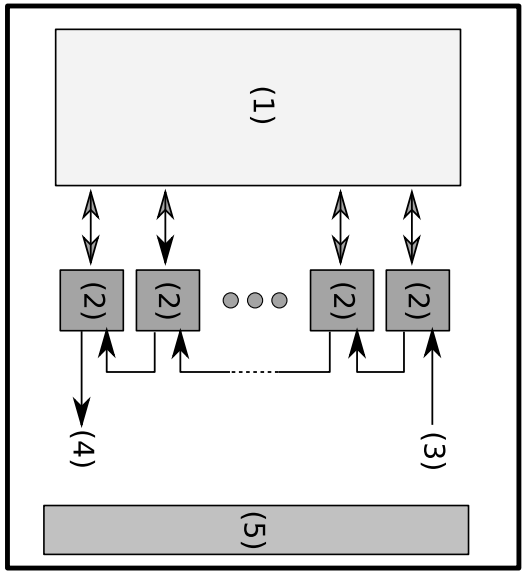


The input/output plus voltages go through connector (5)

The system: the read out ASICs

The system works with the assumption that the ASICs

1. Produce a multiplexed output (rather than parallel)
2. Chip I/O can be daisy-chained (3/4)



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The IDEAS VATA family work like this and have been used in first prototypes

GP7:
128 ch.
500 ns peak time
Range: ± 30fC

GP8:
128 ch.
500 ns peak time
Range: 1 – 125 fC

HDR16: (SiPM)
64 ch.
100 ns peak time
Range: ~ 20 pC

The system: the read out ASICs

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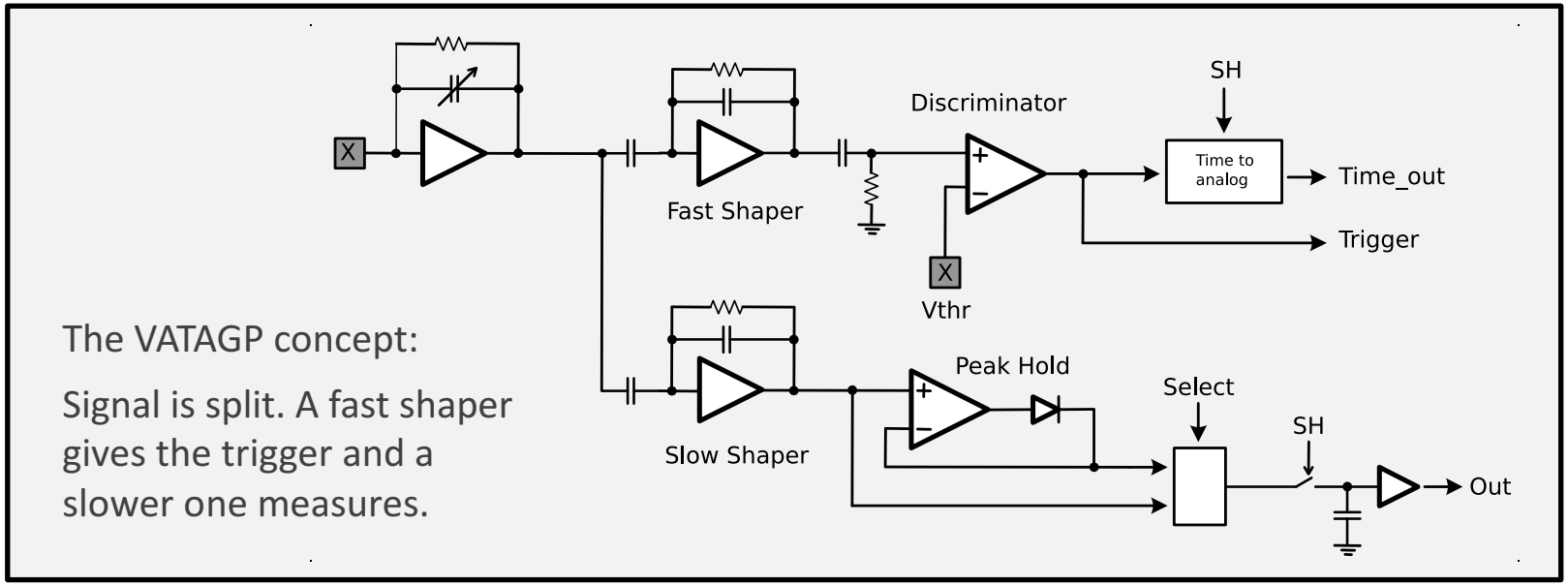


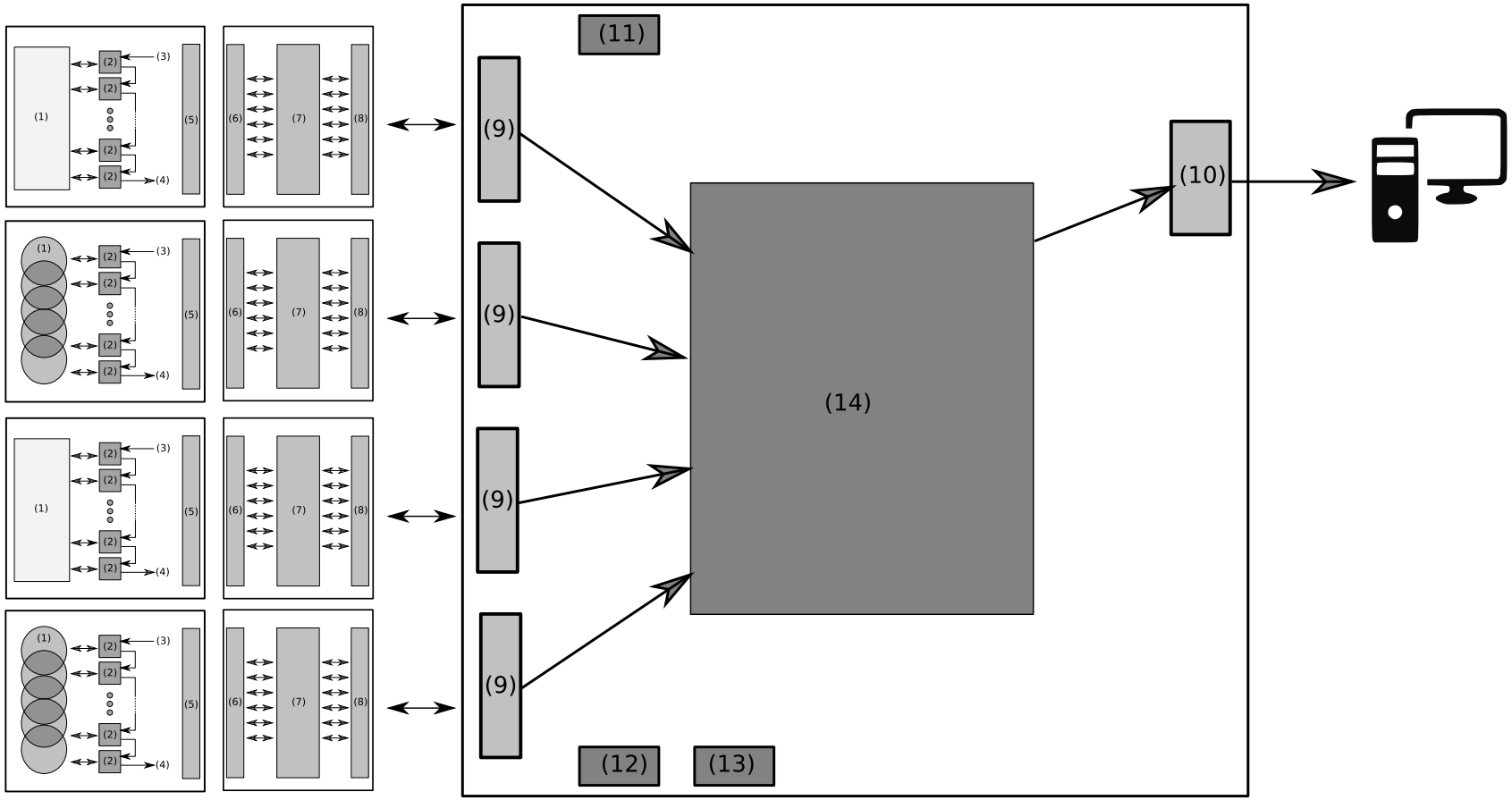
The VATAGP concept:

Signal is split. A fast shaper gives the trigger and a slower one measures.

The system

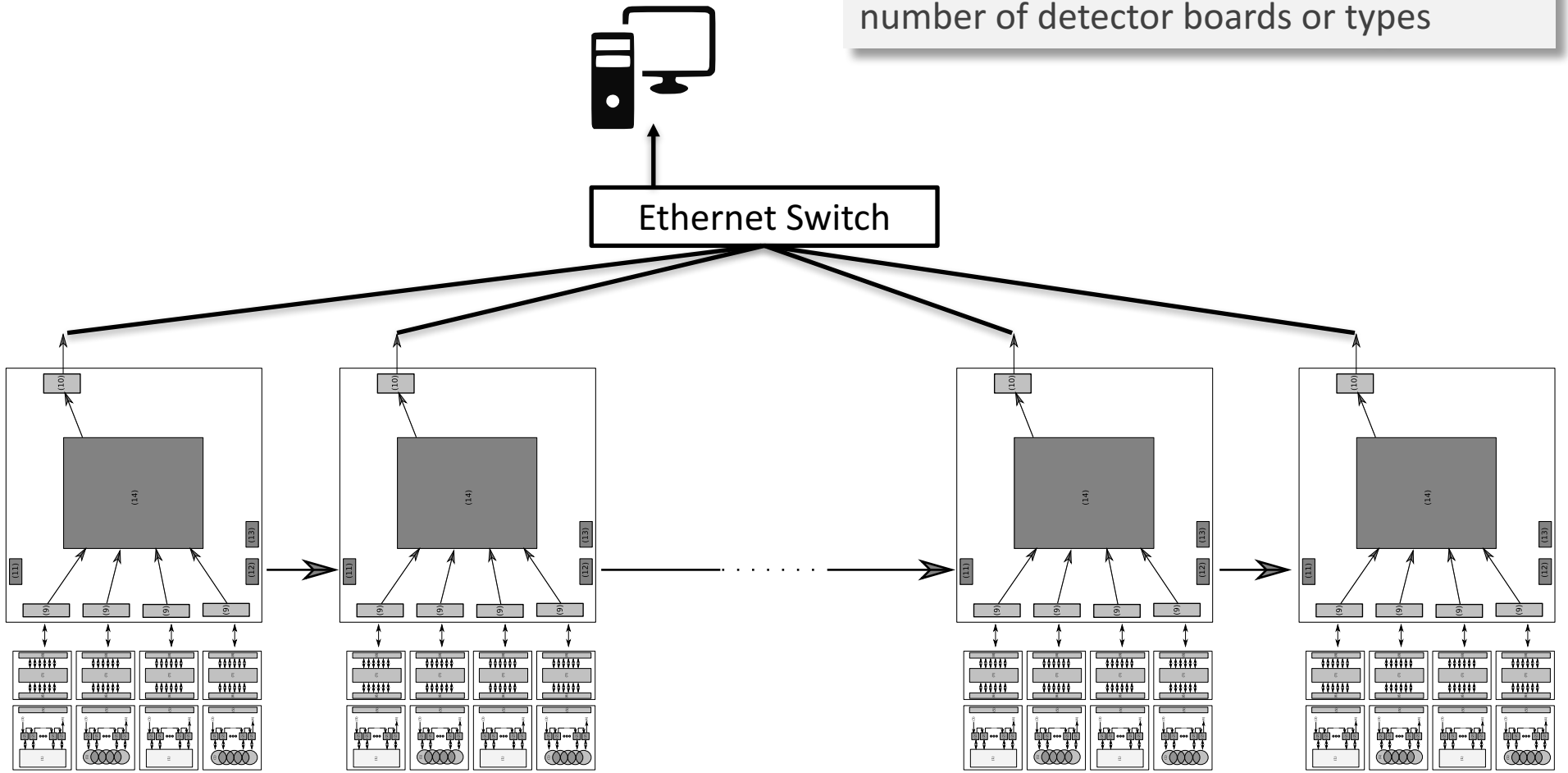
The system allows for 4 data streams per MB and up to 16 chips per data stream.

Streams can come from any detector type. Data is time stamped to allow for event building

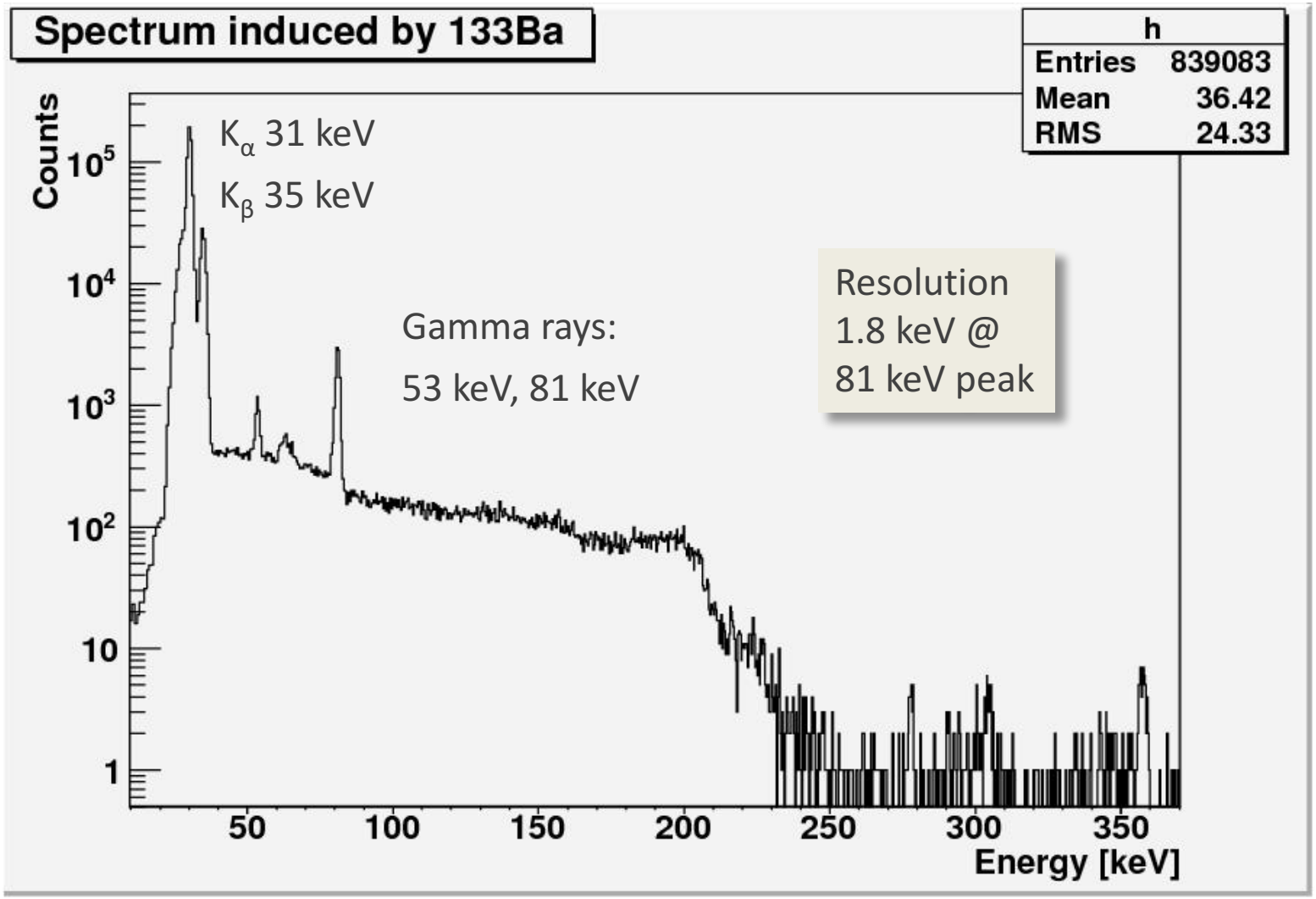


The whole System

The idea behind is a scalable system. With no limitations in channel number nor number of detector boards or types



Spectroscopy with silicon

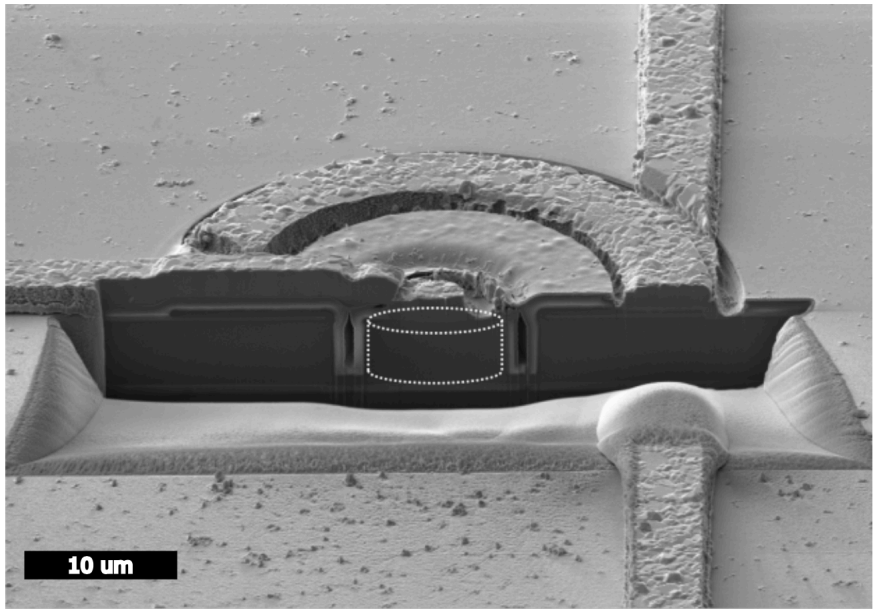


Newer applications: Microdosimetry

Centre Nacional de Microelectrònica IMB

Microdosimetry (cell volume) important to characterize hadron therapy for cancer.

The 3D microdosimeters designed at CNM-IMB are the first and only or their kind.



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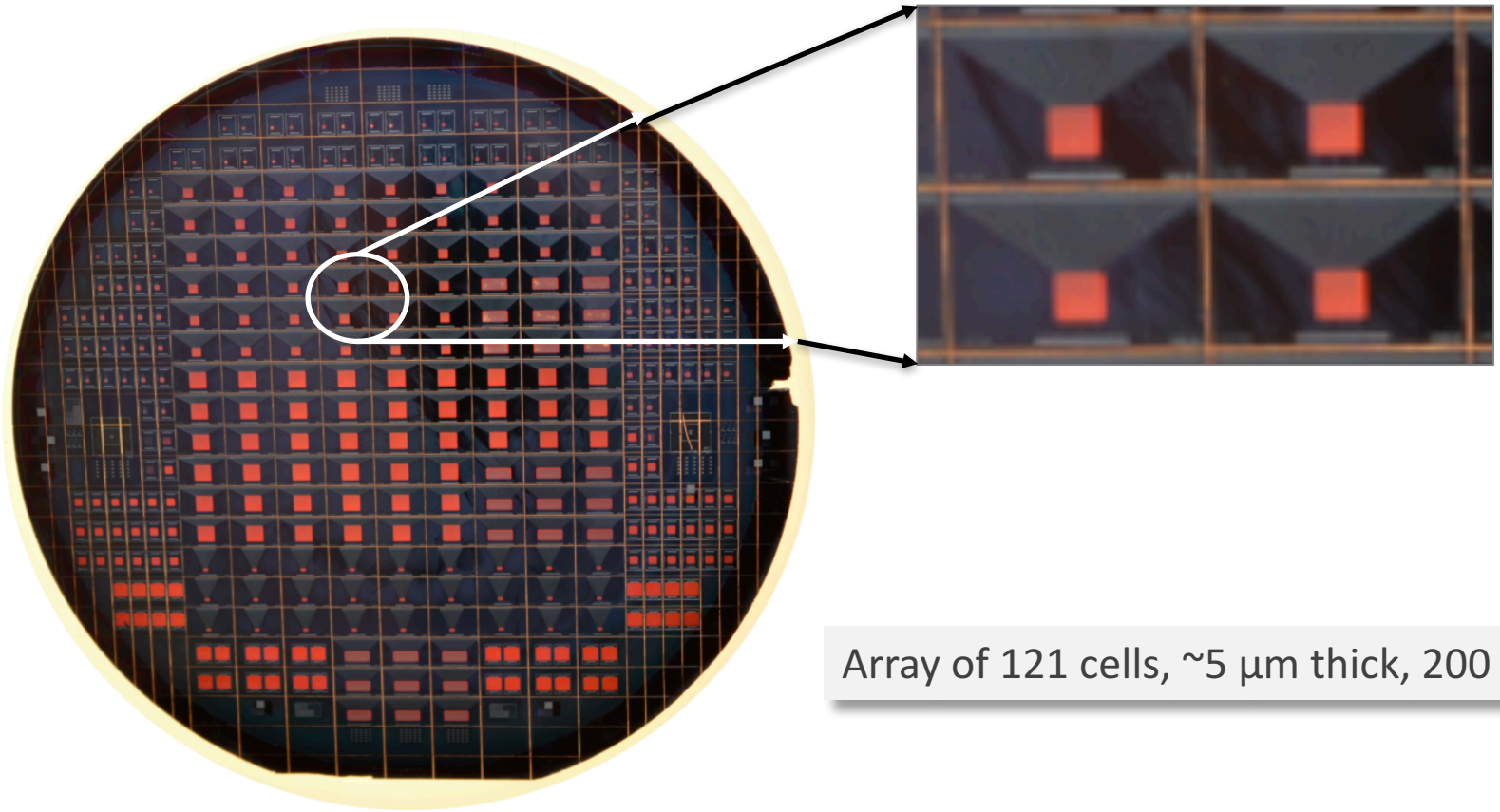
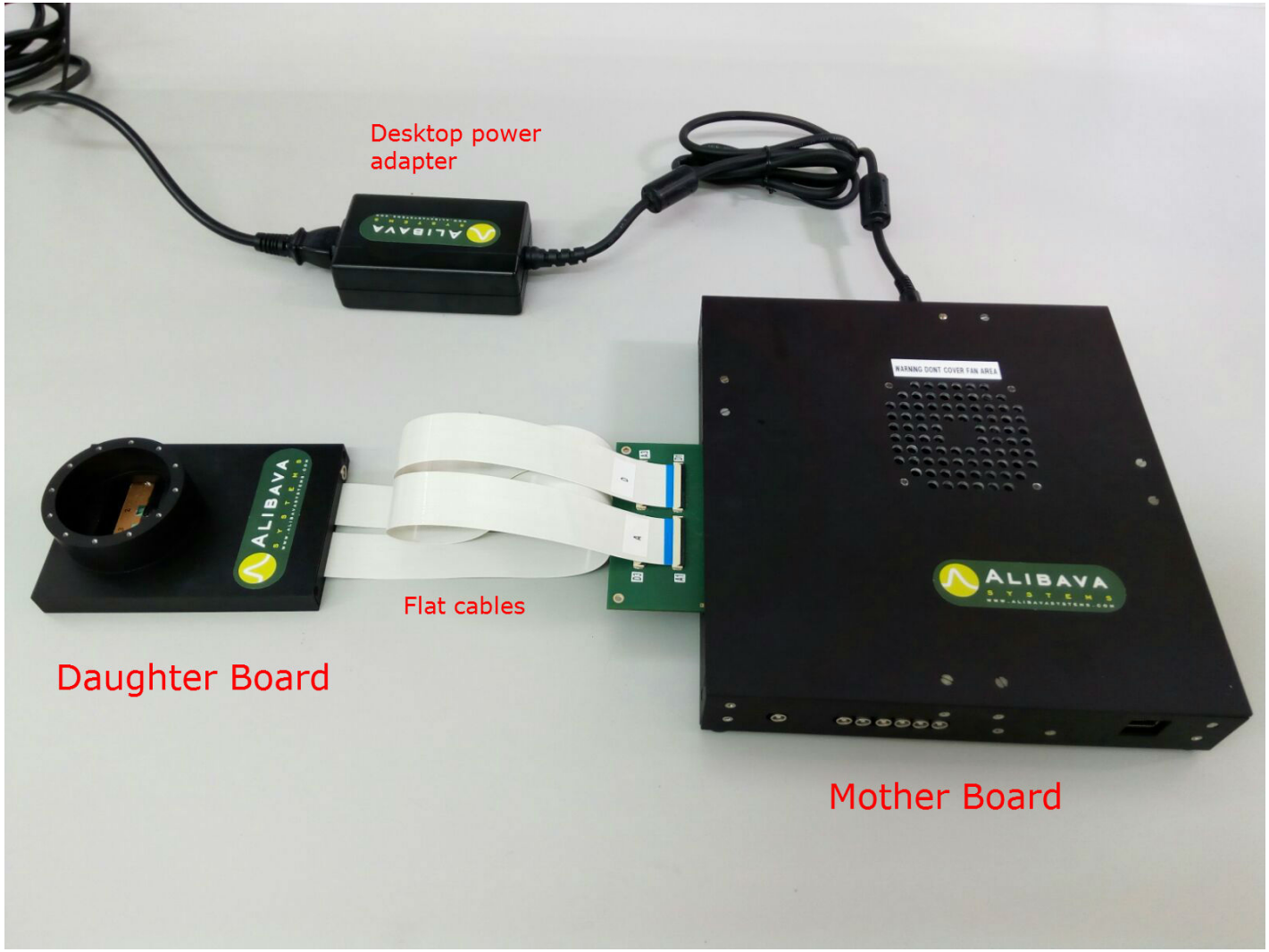


Array of 121 cells, ~5 µm thick, 200 µm pitch

The sensor card

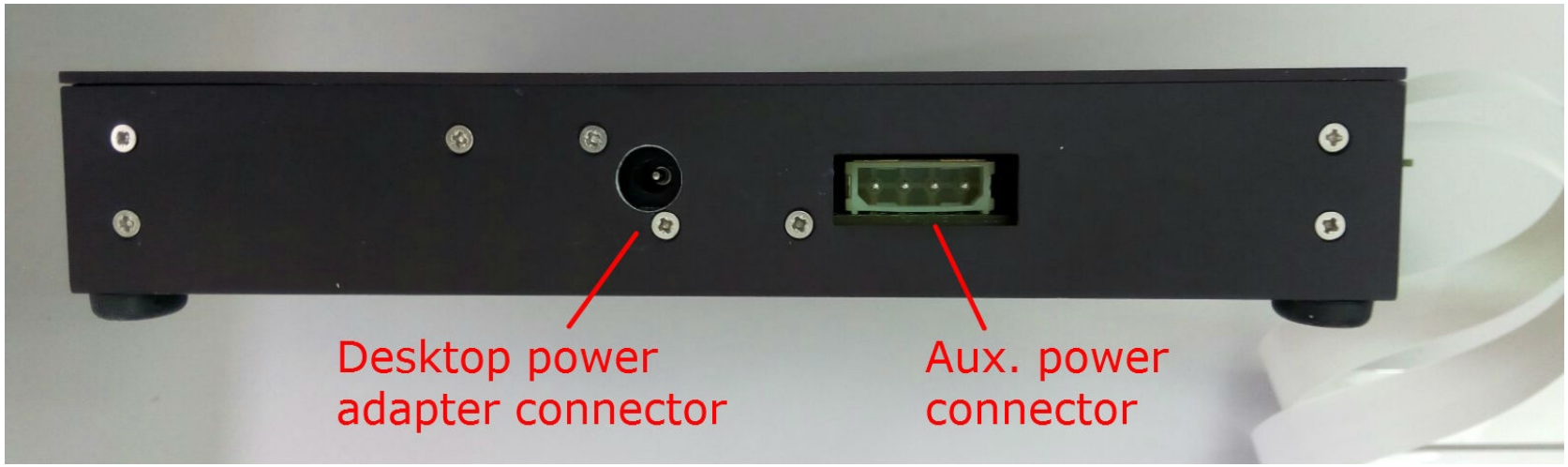
First AliVATA for Microdosimeters

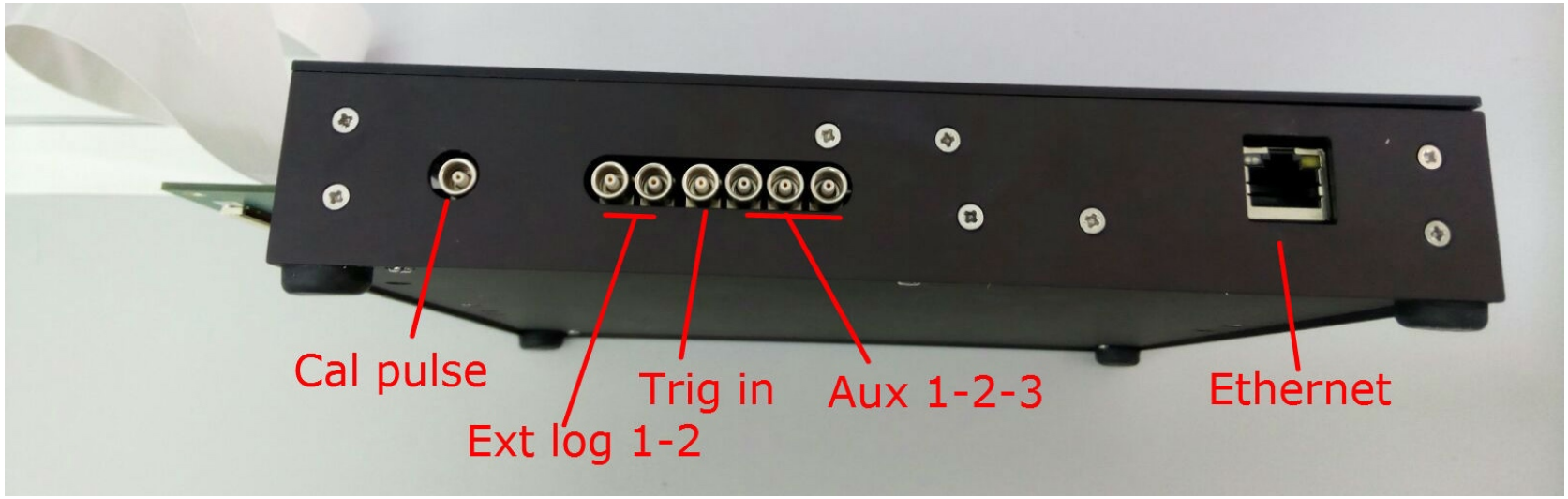


Summary

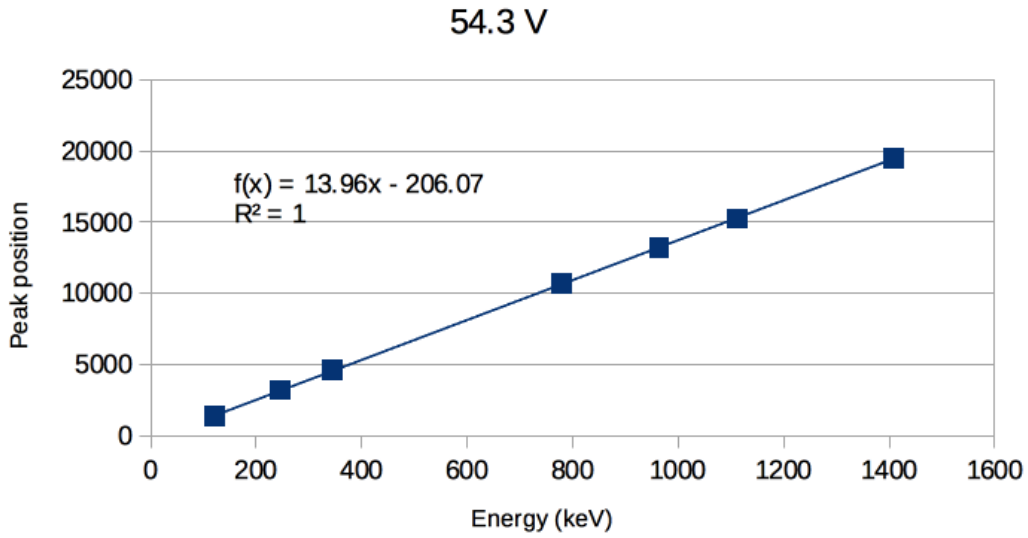
- ✔ ALIVATA readout system for spectroscopy
  - ➔ Several detector types (Silicon strips, pads or pixels, SiPM, etc.)
  - ➔ Self-trigger
  - ➔ Time stamping
  - ➔ Really scalable (with the IDEAS GP7 chip, up to 8192 channels per motherboard)

The mother board





Linearity



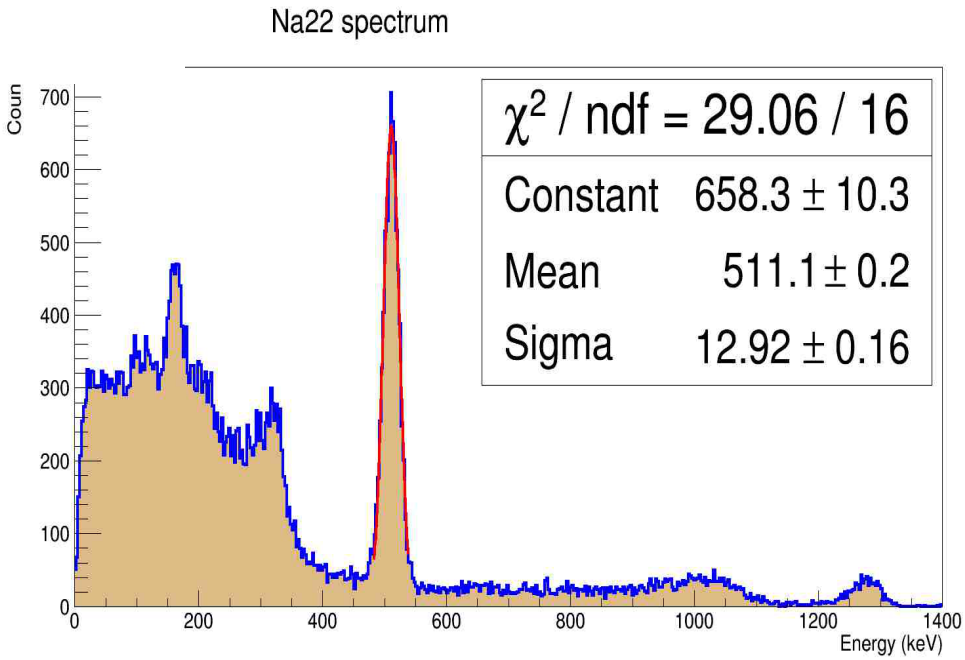
J. Barrio et al, to be published in NIMA.

Linearity tested with a ^{153}Eu point-like source.

Linear up to ~1500 keV.

ENERGY RESOLUTION

5.9% @ 511 keV



The intermediate board

This is an auxiliary board that might be needed to adapt the input/output of the detector and motherboard.

It can be just a passive board or an “intelligent” board, anything you need to connect the detector board to the mother board.