

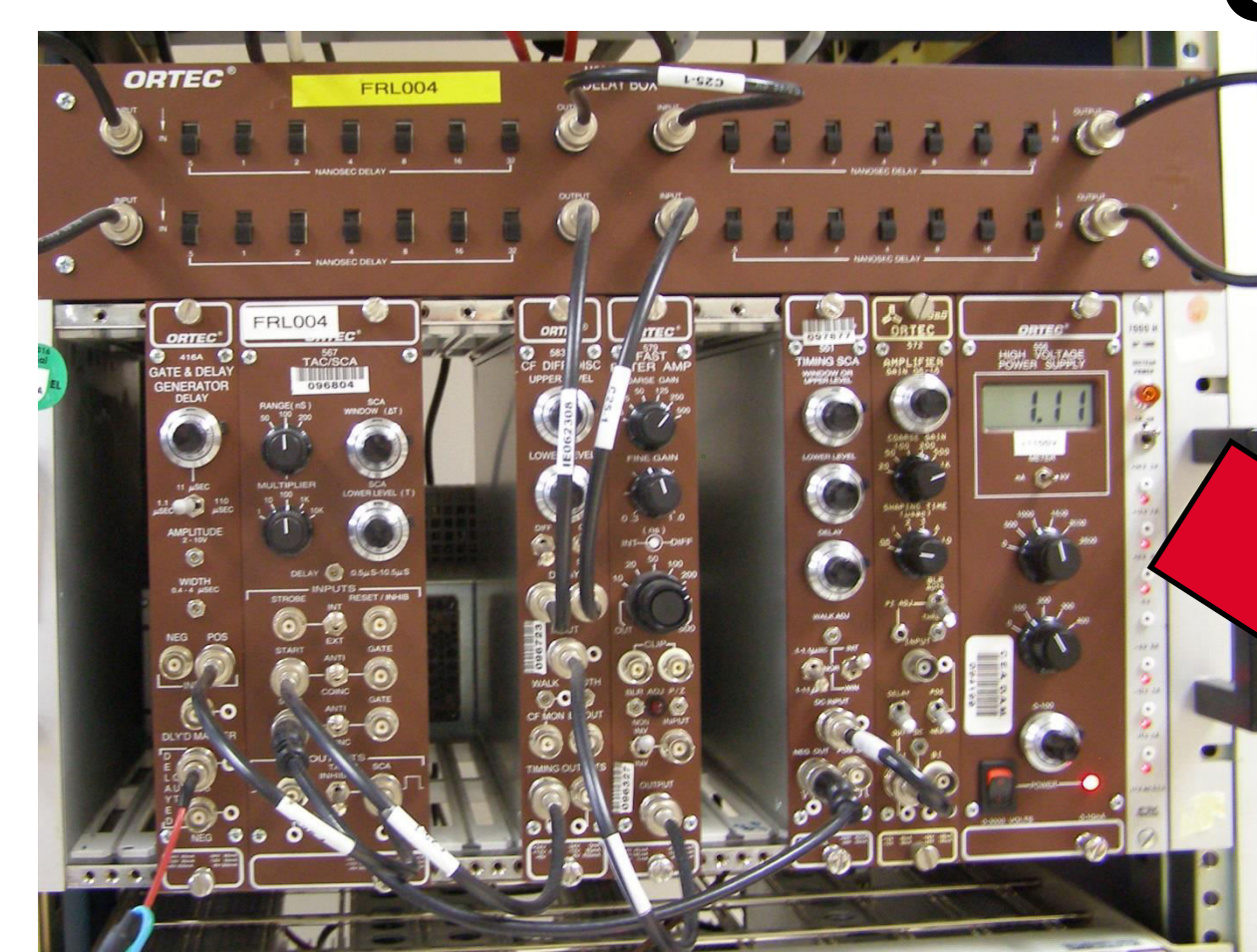
DIGITAL REVOLUTION IN GAMMA ACQUISITION SYSTEMS: COSTS AND BENEFITS

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Context

Digital electronics have been developed since the 1990s. Since then, it replaces progressively the analogue acquisition systems in the laboratories. This new digital acquisition system offers plenty of advantages but also presents several issues that do not exist with the well-established analogue electronics. In the following years, laboratories will finally shift to this new electronics. Digital electronics relies mainly on software while analogue electronics is mainly hardware. With digital electronics, **hardware issues are replaced by software problems**.

Cheaper and more compact



Analogue electronics used to record HPGe energy in anticoincidence with a cosmic veto

Digital electronics used to record HPGe energy in anticoincidence with a cosmic veto



Analogue electronics:

- Amplification modules
- Coincidence modules
- Timing modules
- Discrimination modules
- Analogue-to-Digital Converter

Digital electronics: **only one module** between a pre-amplifier and a computer is needed

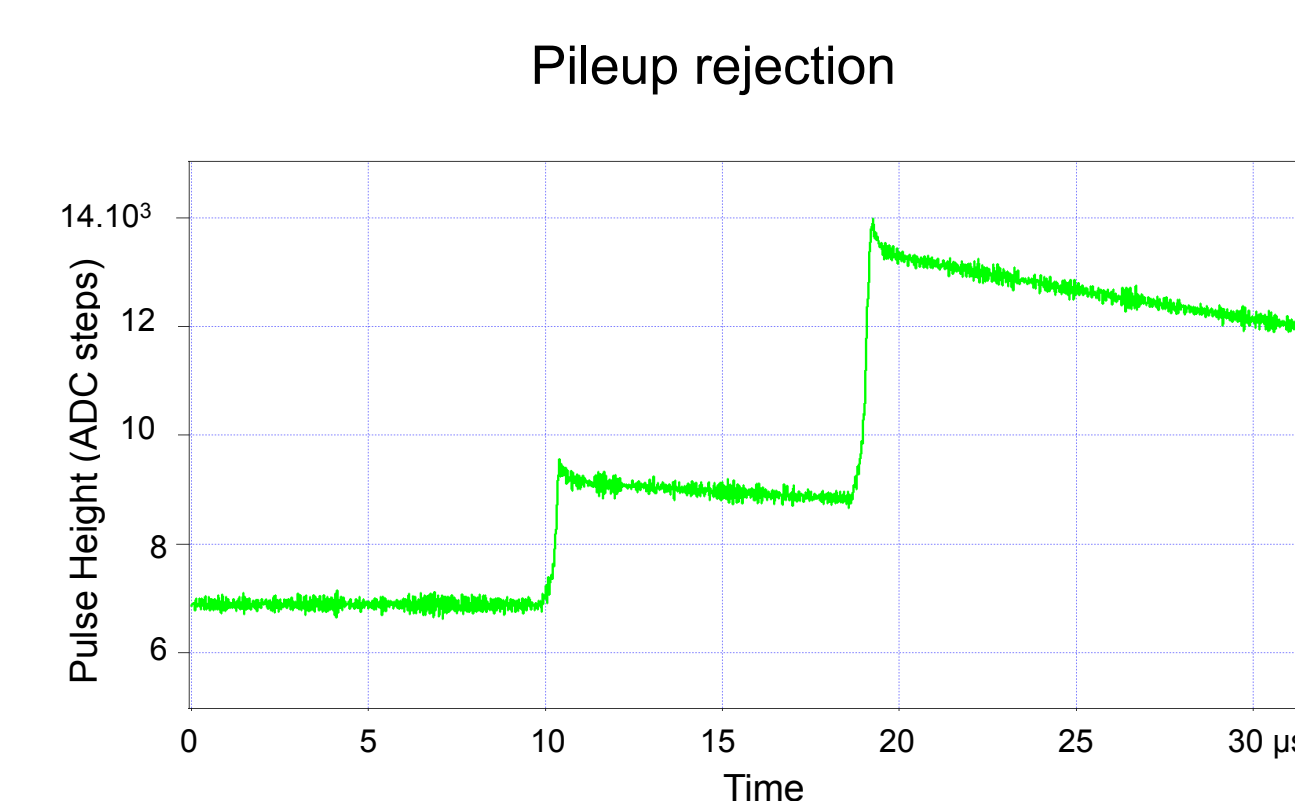
→ **Save money (~50%) and place**

More powerful

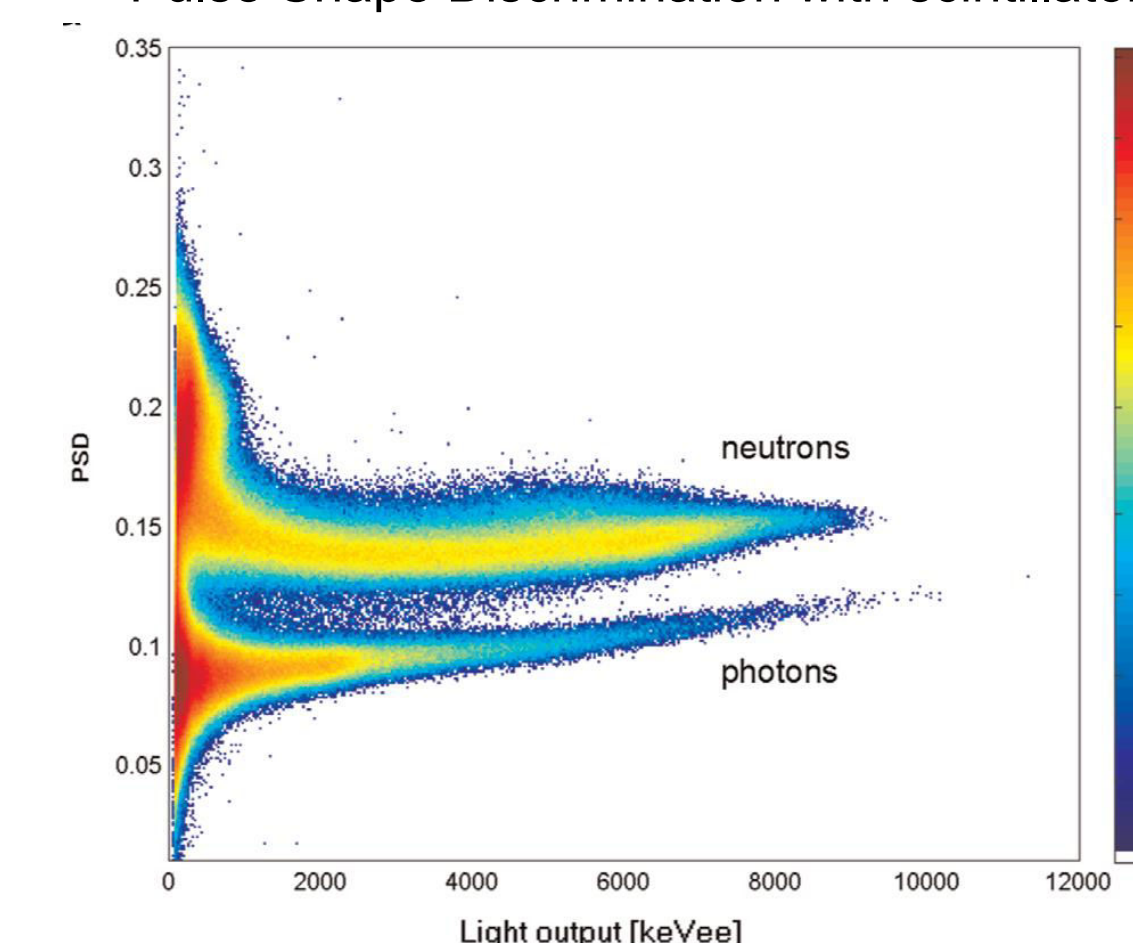
A new type of signal property can be recorded by digital electronics: the **pulse shapes**;

Advanced processing possible

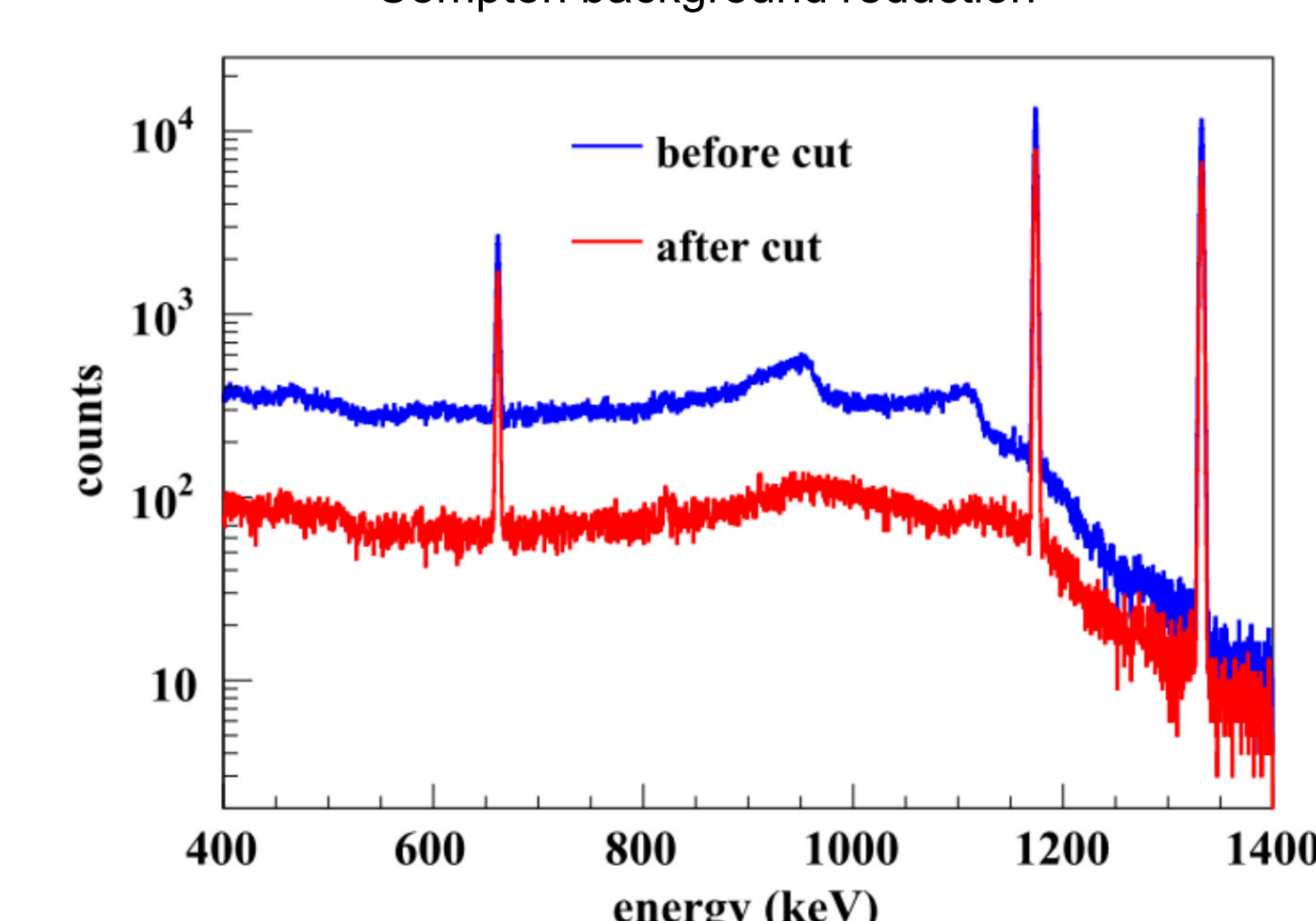
- Pileup rejection: reduction of sum peak, ...
- Pulse Shape Discrimination: criteria on rise time, fall time, ... allows to discriminate the type of particles (gamma, neutrons, ...)
- Compton background reduction: energy deposit that occurs on the edge of a HPGe crystal will take longer time to be collected (longer rise time) and have higher probability to escape from the crystal



Pulse Shape Discrimination with scintillator



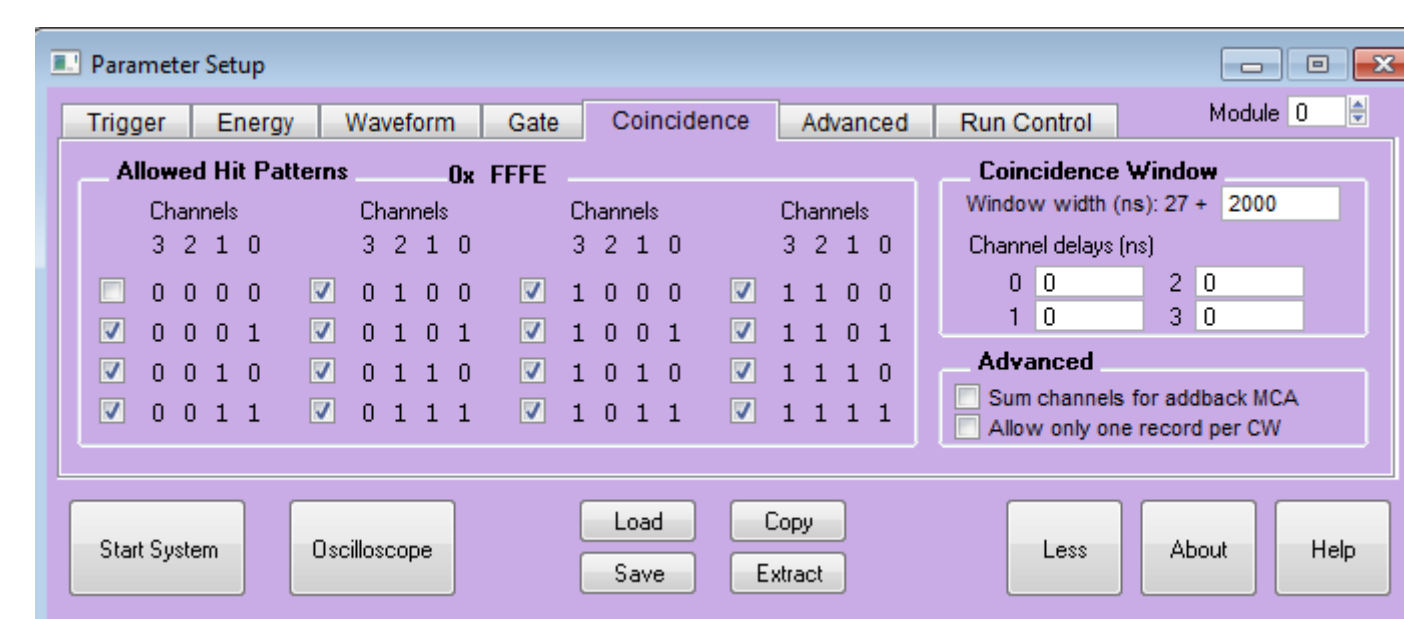
Compton background reduction



Coincidences:

- **Analogue electronics:** complex cabling, only few configurations are possible, decided *a priori*
- **Digital electronics:** limited cabling, all configurations can be selected and analysed *a posteriori*

Easier



Coincidence panel of PIXIE Viewer software used to select coincidence/anticoincidence

Timestamping:

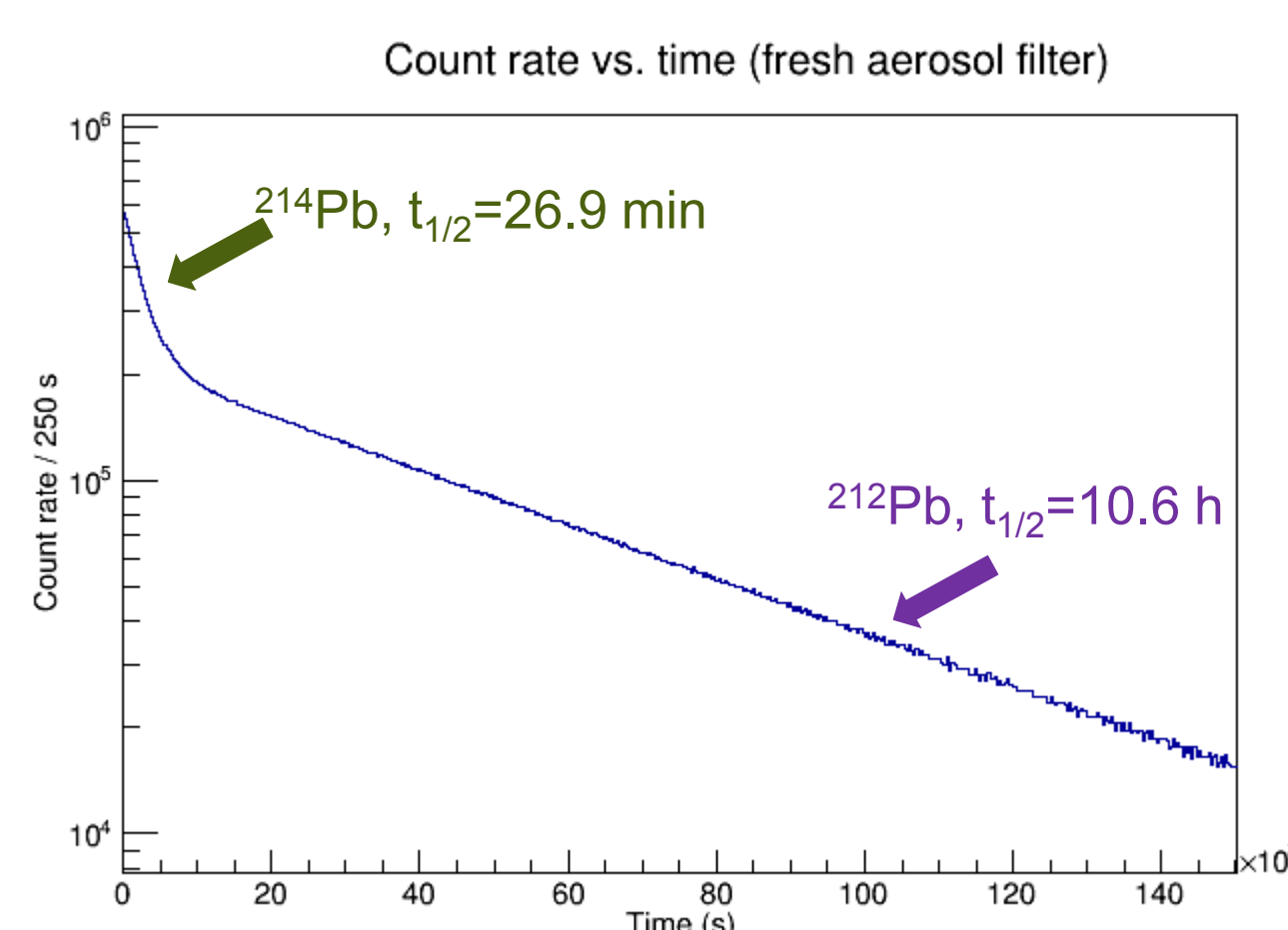
- **Analogue electronics:** complex implementation
- **Digital electronics:** timestamp is recorded for each event

Digital electronics allows:

the extraction of short half-life radionuclides from a long measurement to analyse or re-analyse a part of a long spectrum (effect of liquid nitrogen filling, ...)

Settings:

- **Analogue electronics:** precise settings on each module
- **Digital electronics:** few "hardware" settings



Evolution of the integral count rate as a function of the time for a fresh aerosol filter

But some drawbacks

- Rather new electronics with completely **different philosophy**: domestication is time consuming;
- Digital electronics manufacturers may **not understand analogue electronics**: difficulty to communicate problem solving can be cumbersome;
- Digital electronics is a **black box**: difficult to diagnose the issue part by part in case of problem;
- Digital electronics evolves faster than analogue electronics: module designed 10 years ago becomes **obsolete** today; (need to redevelop some codes)
- Saving pulse traces makes **files much bigger** than the ones created with analogue electronics
- Codes developed to analyse/display data become obsolete with the new modules (new data format)

Conclusion

- Digital electronics offers **plenty of advantages** compared to analogue electronics (management of coincidences, timestamping, waveform capture, ...);
- Philosophy is different between both types of electronics: **need time** to take the new electronics in hand and to debug software;
- **Different issues appear** depending on the manufacturer (CAEN, Mirion, XIA LLC, ...) but should be solved progressively;
- Transition to digital electronics will occur in the coming years; laboratories should **prepare the transition from now on**.