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Digital system for signal processing from a position-sensitive detector based on a digitizer with Open FPGA

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Digitizer in the data acquisition system

Digitizer – is an electronic device that continuously acquires analog pulses, passing through an analog input stage of signal conditioning, an **analog-to-digital conversion** by fast ADCs, and **storage** of the digitized samples as event data into digital memories, where they can be **read out** by a host computer through fast communication interfaces (USB, VMEbus, Optical Link, Ethernet).

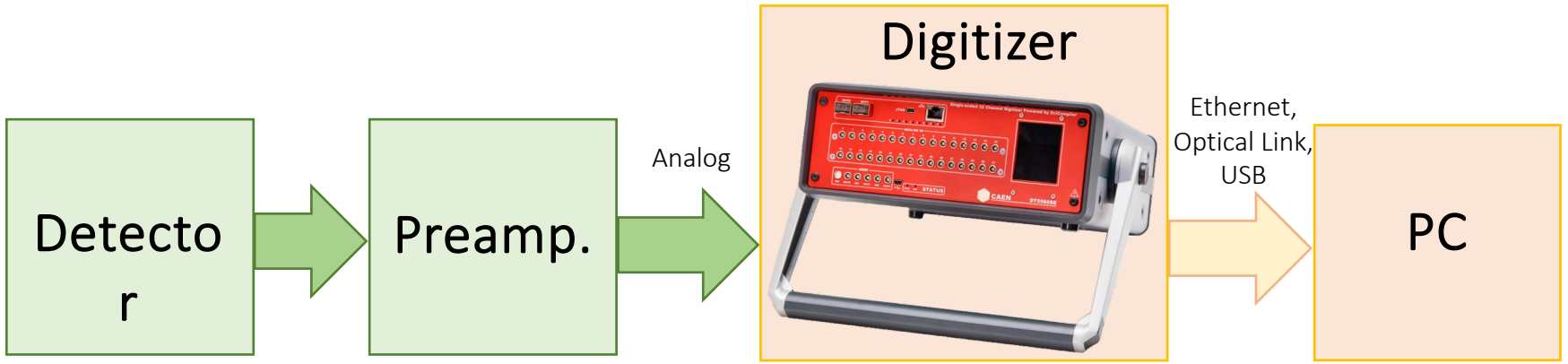


Figure 1. Structure of a digitizer-based data acquisition system

Digitizer DT5560SE:

- 32 channel, **14-bit @125 MS/s** Digitizer,
- **Programmable analog frontend**,
- Xilinx Zynq-7000 SoC with **open FPGA**,
- Supported software tool by **SCI-Compiler**,
- Board-to-board **synchronization,** etc.

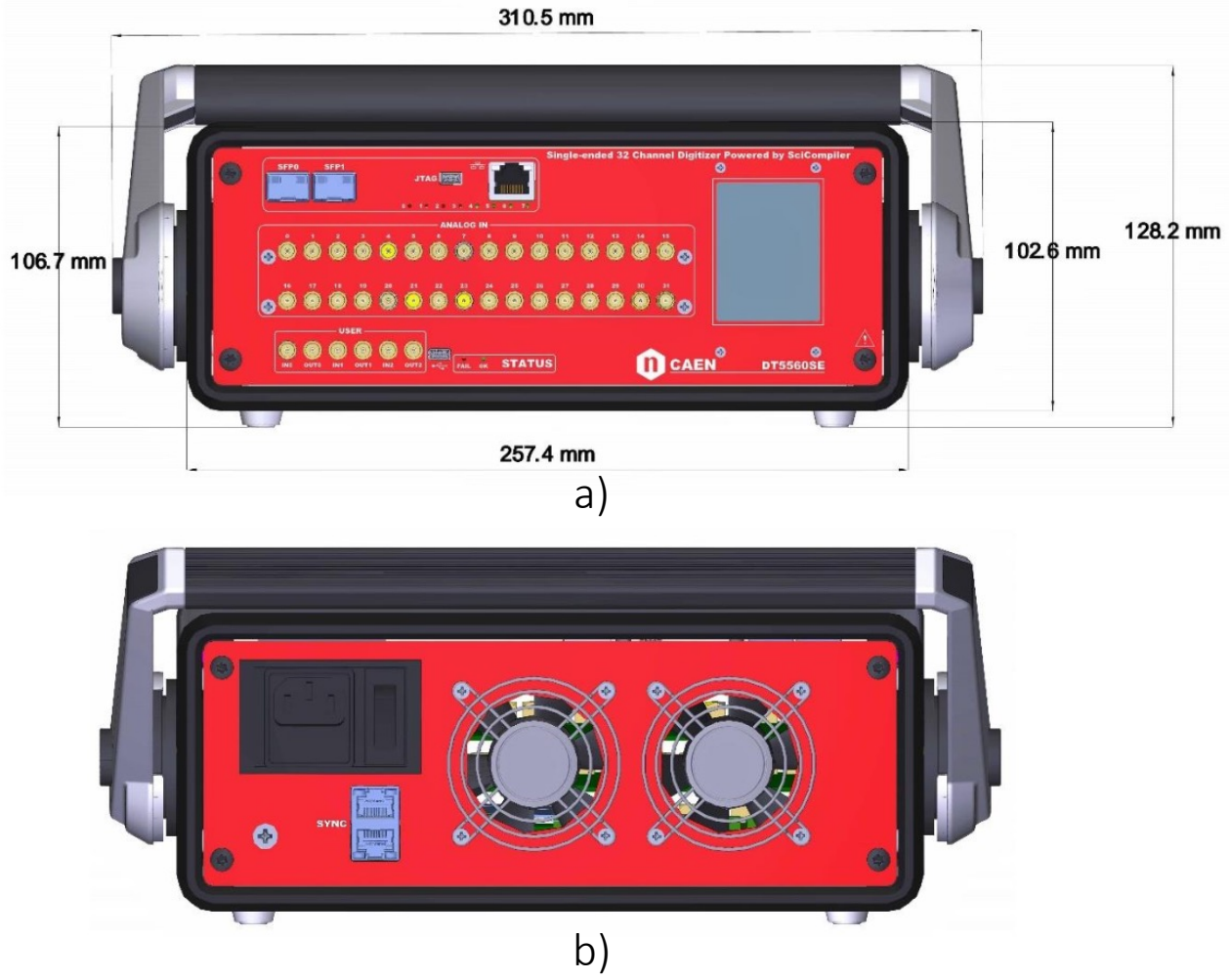


Figure 2. Panels description a) front panel view, b) rear panel view.

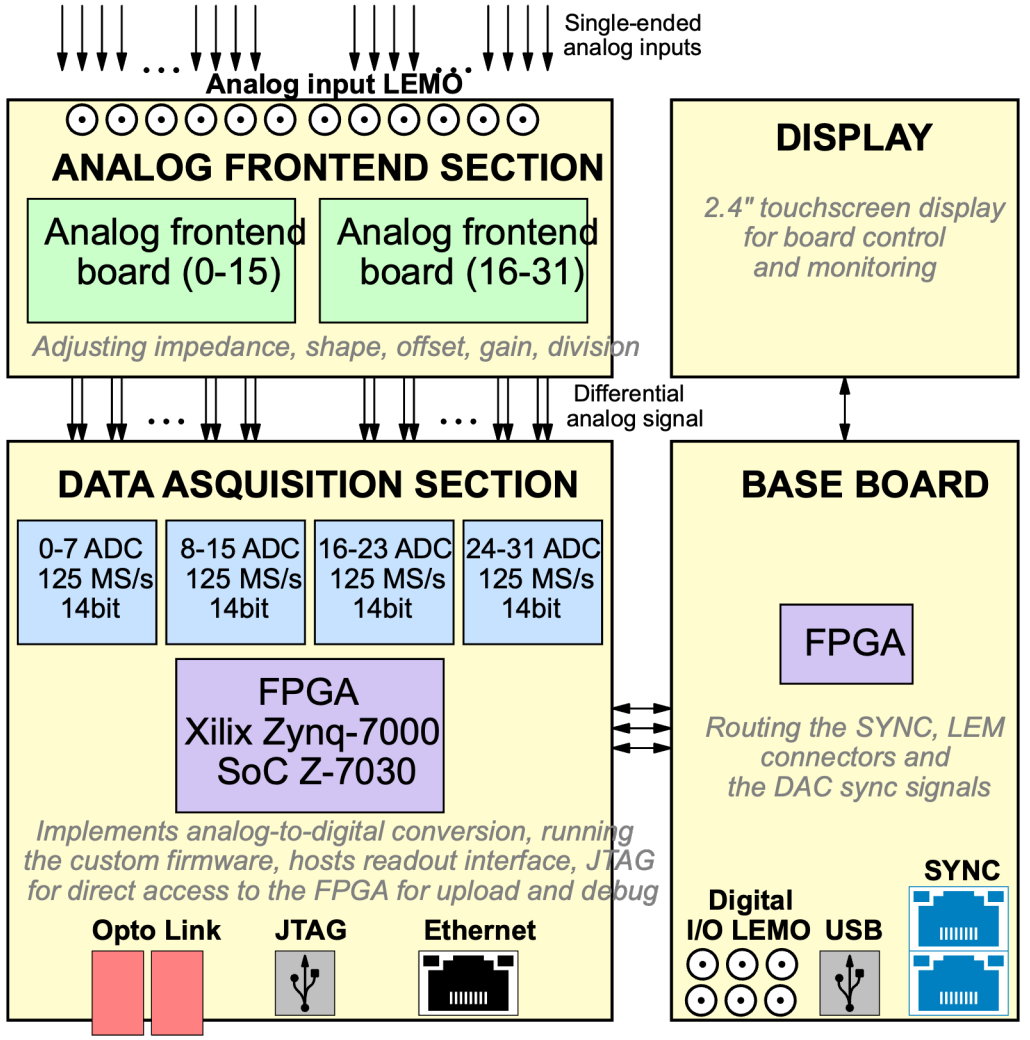


Figure 3. Block diagram of DT5560SE digitizer device

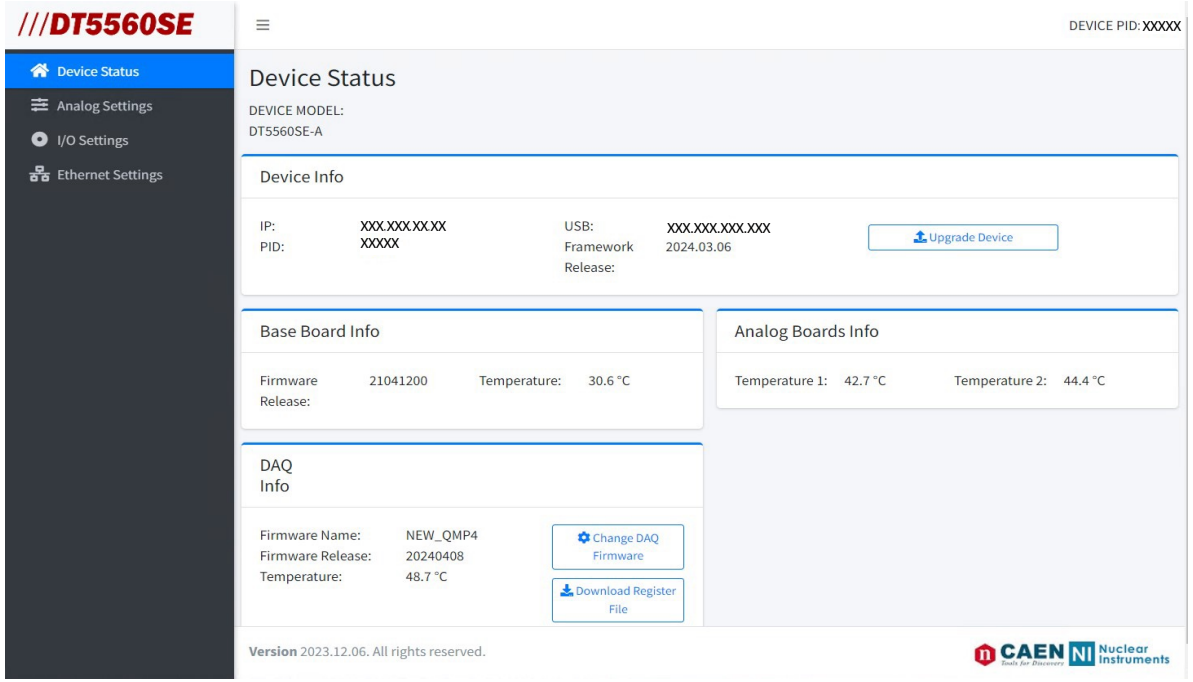


Figure 4. Embedded Web interface home page.

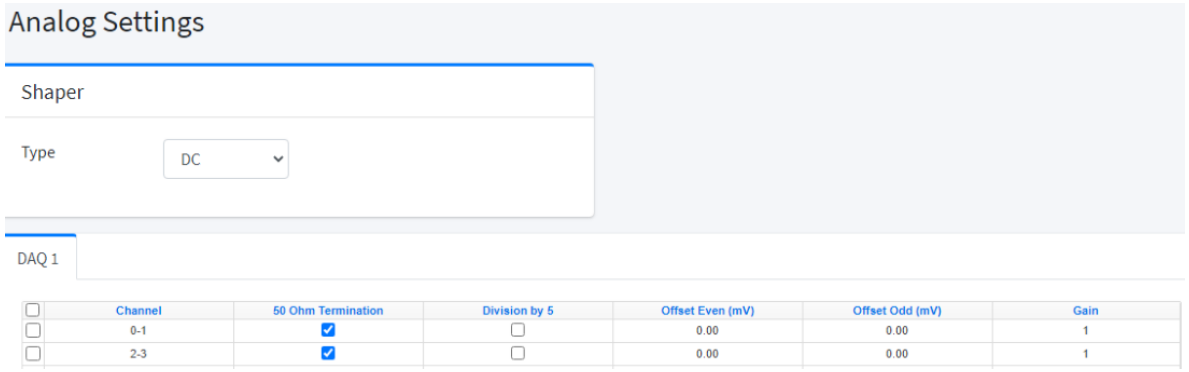


Figure 5. The Analog Settings page on Web interface.

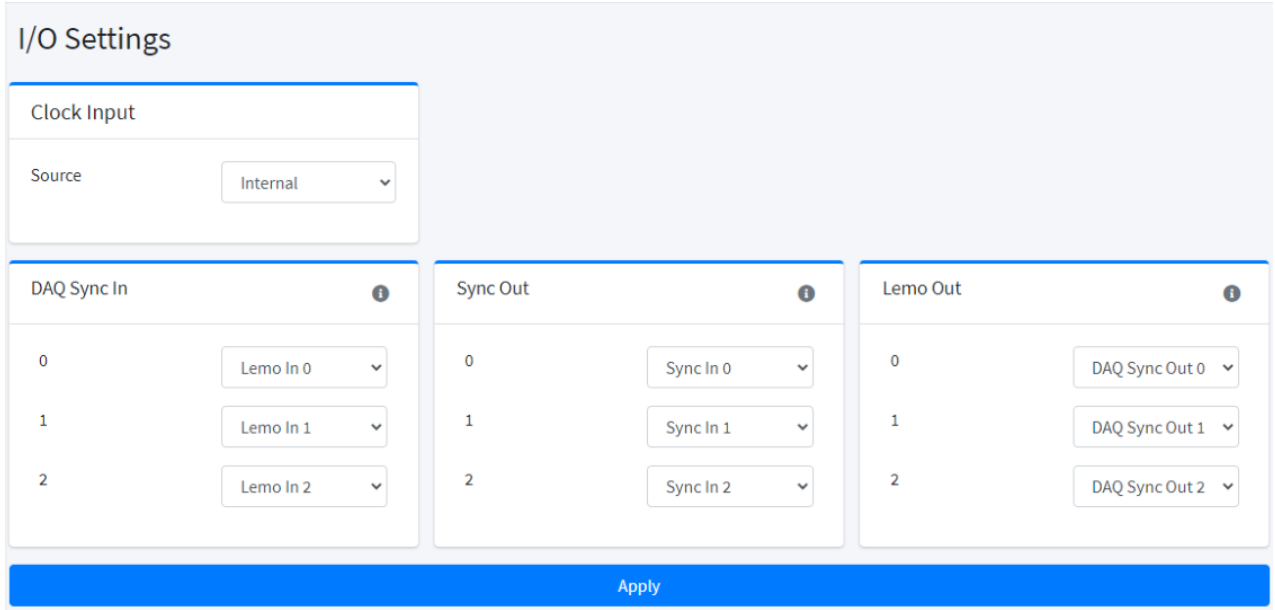


Figure 6. I/O Settings page.

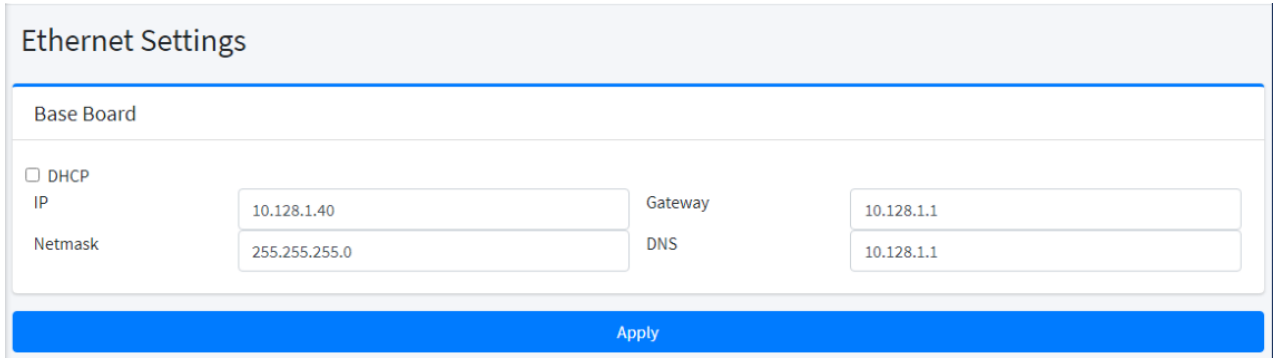


Figure 7. Ethernet Settings page.

Graphical Programming Language for CAEN Open FPGA boards

SCI-COMPILER Open FPGA

- Block Building Interface
- Automatic Firmware Code Simulation
- Debug with Resource Explorer

Sci-Compiler uses a set of high level functionalities (**IP blocks**) to mask the real firmware coding, which improves and speeds-up the R&D phase. Placing and interconnecting the available blocks on a diagram, it is able to automatically generate a **VHDL code** that implements the required function and deploy it to the **FPGA**.

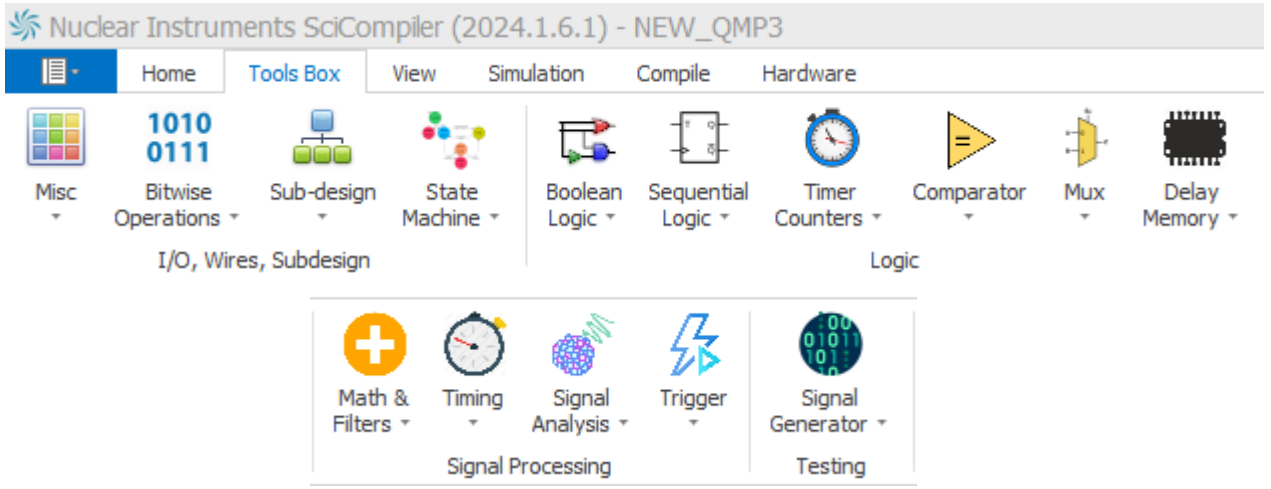


Figure 8. Tools Box with 100+ virtual blocks that works exactly as real laboratory instrumentation

Measurement setup for testing digital processing system

Helium-3-filled linear position-sensitive detectors (LPSDs) are based on the position-sensitive proportional counters design and have been widely applied to neutron scattering instruments owing to the high detection efficiency, the excellent neutron/gamma discrimination, and the ability to construct the detector with large area coverage.

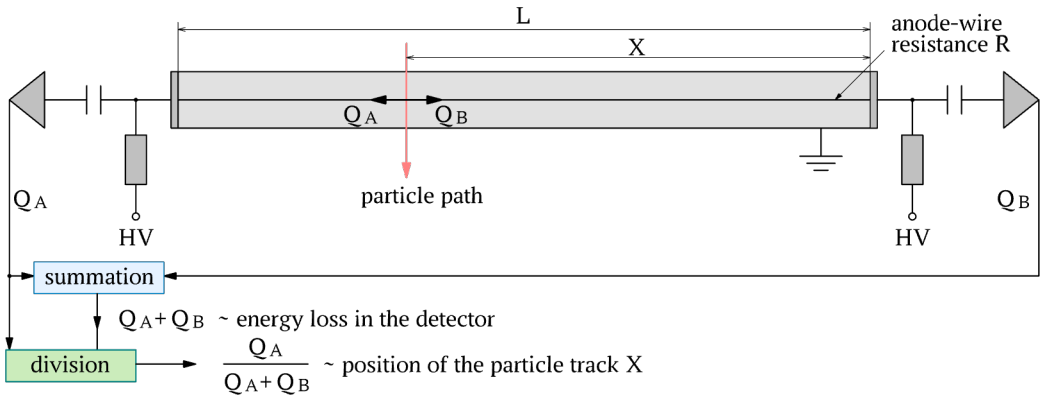


Figure 9. Schematic diagram of position determination in a Helium-3 filled position sensitive proportional counters

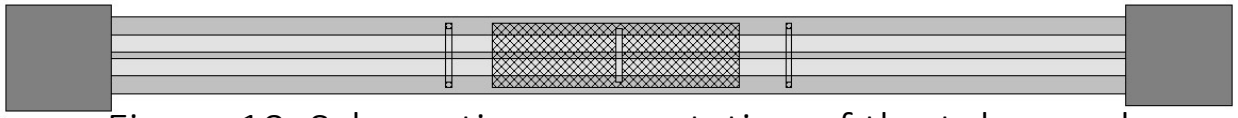


Figure 10. Schematic representation of the tubes and placement of a cadmium mask with a slide.

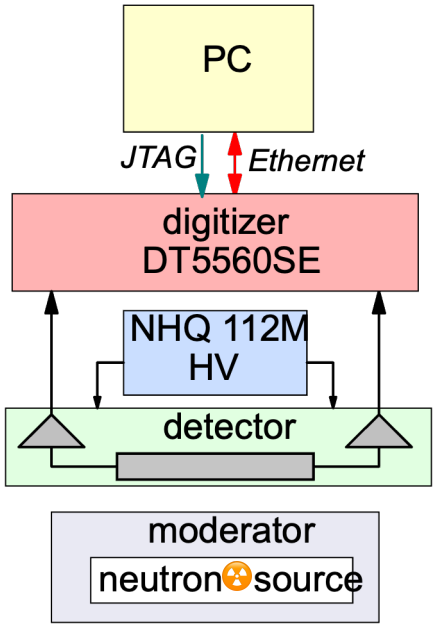


Figure 11. Block diagram connecting of installation

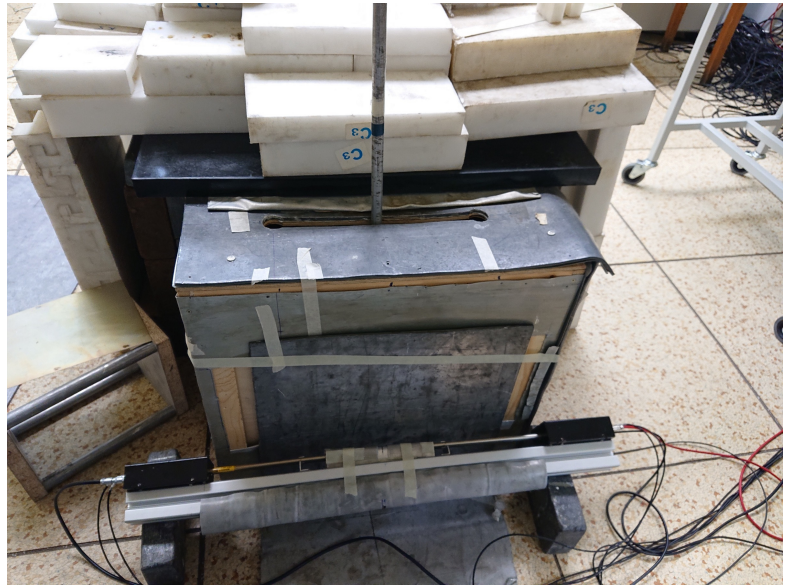
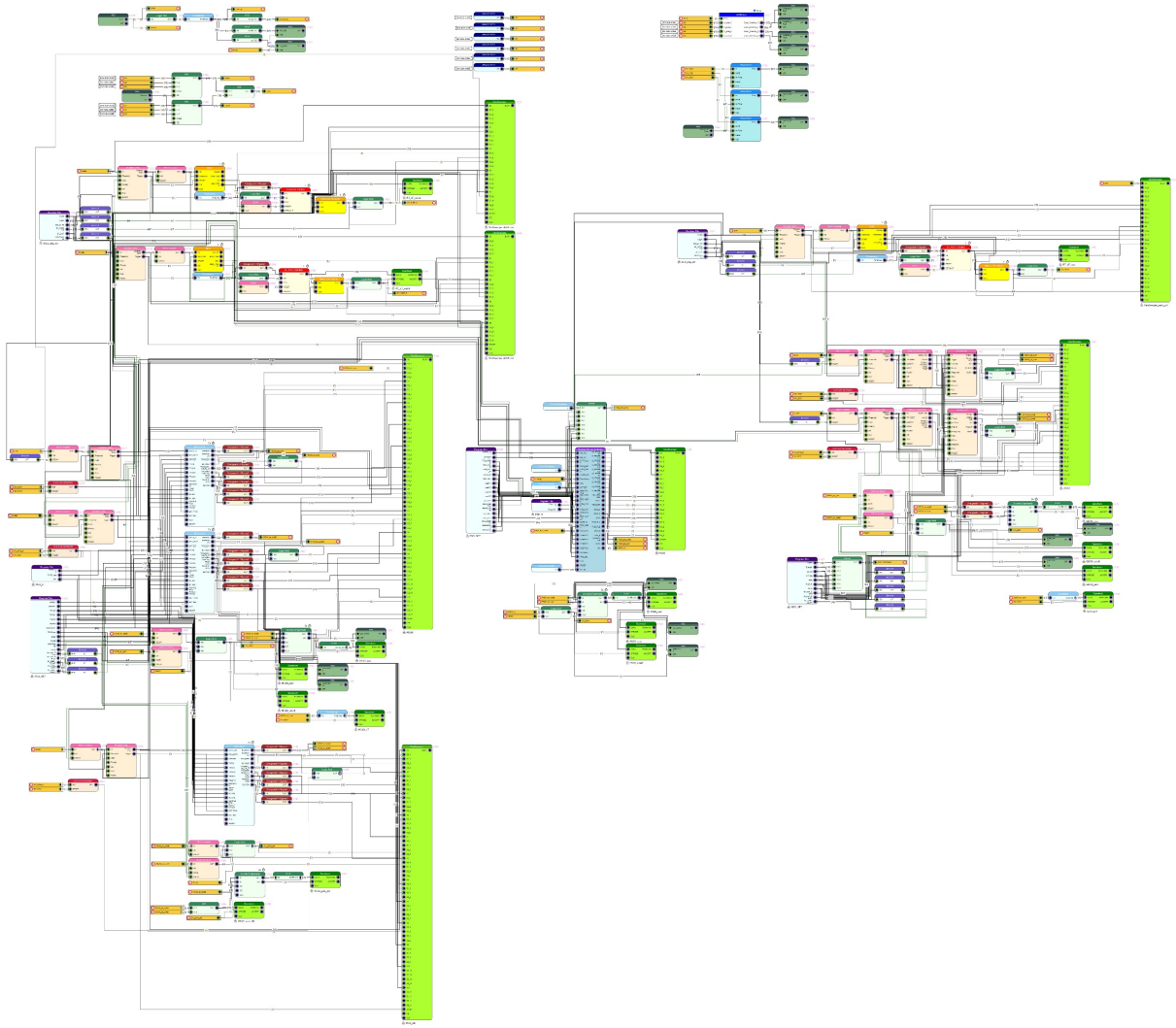


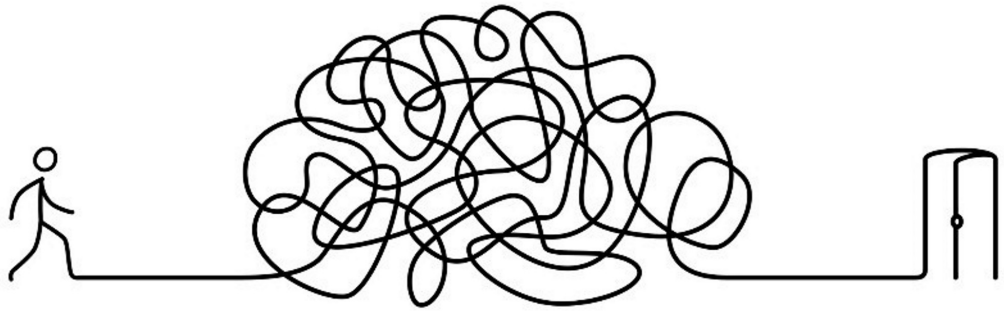
Figure 12. Part of a test setup with source, moderator and detector

Program for measurement and testing digital processing system



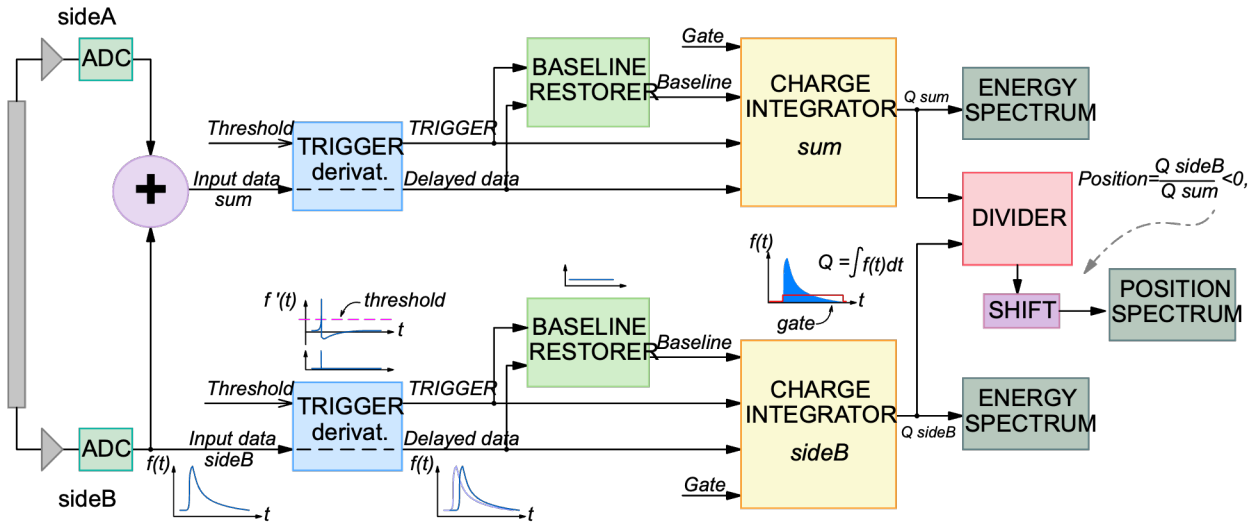
The first inconvenience is that debugging the programme looks something like this...

... but we don't take the easy way out!



Data processing methods

QDC (Charge-to-Digital Converter)



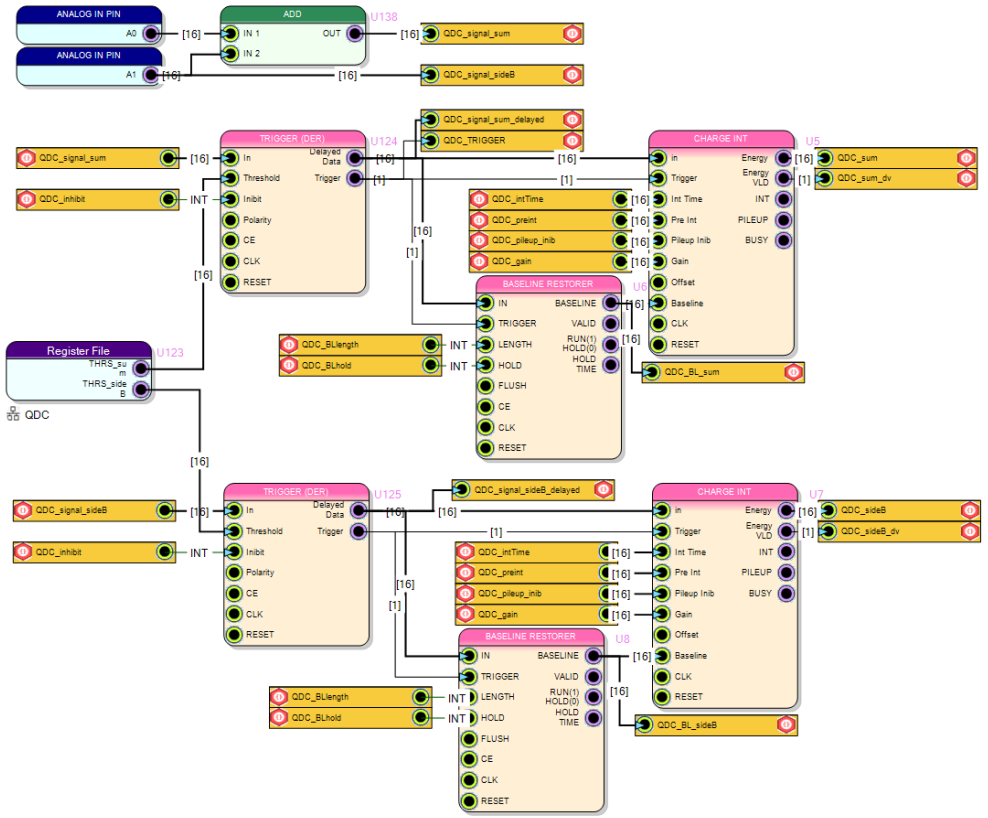
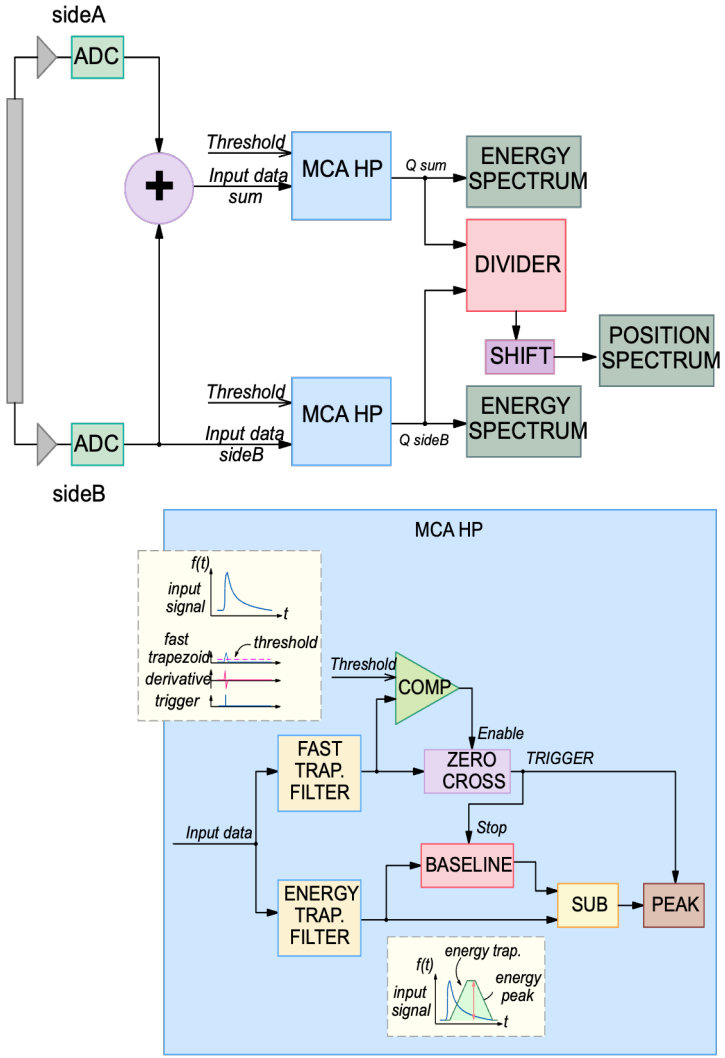


Figure 13. QDC methods and program workspace Sci-Compiler

Data processing methods

MCA HP (Multi Channel Analyzer for high resolution detectors)



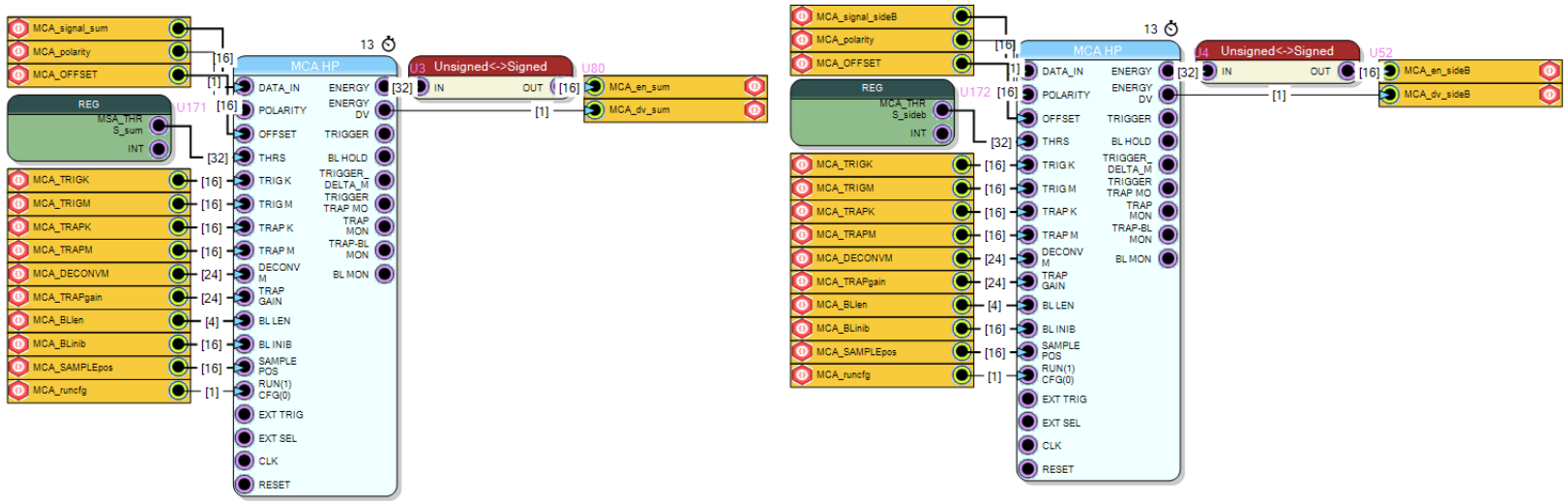
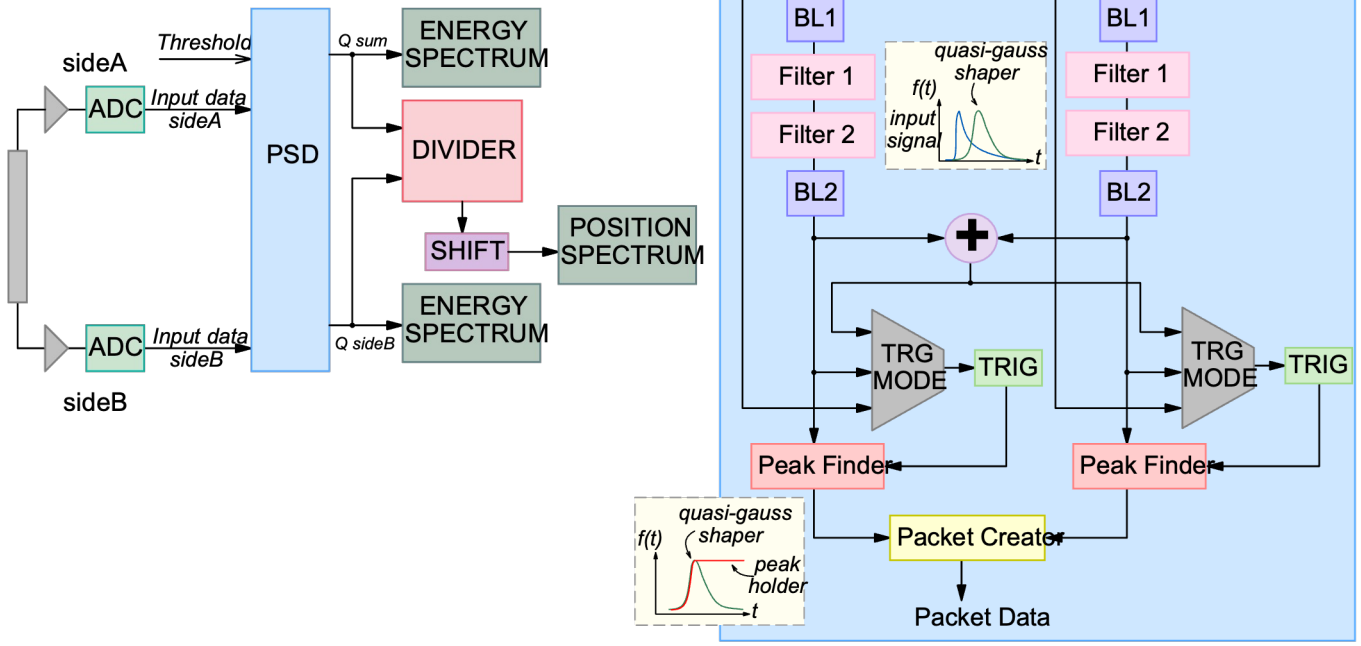


Figure 14. MCA methods and program workspace Sci-Compiler

Data processing methods

PSD (Position Sense detectors)



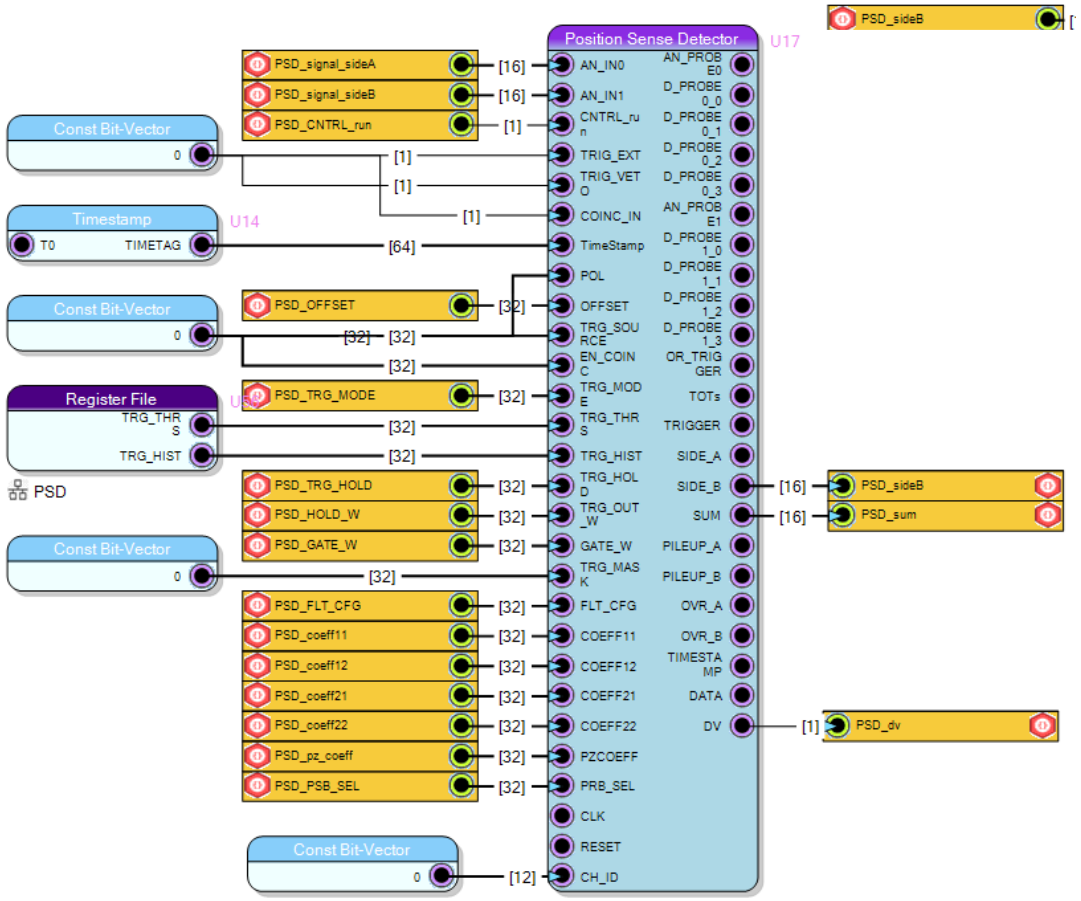


Figure 15. PSD methods and program workspace Sci-Compiler

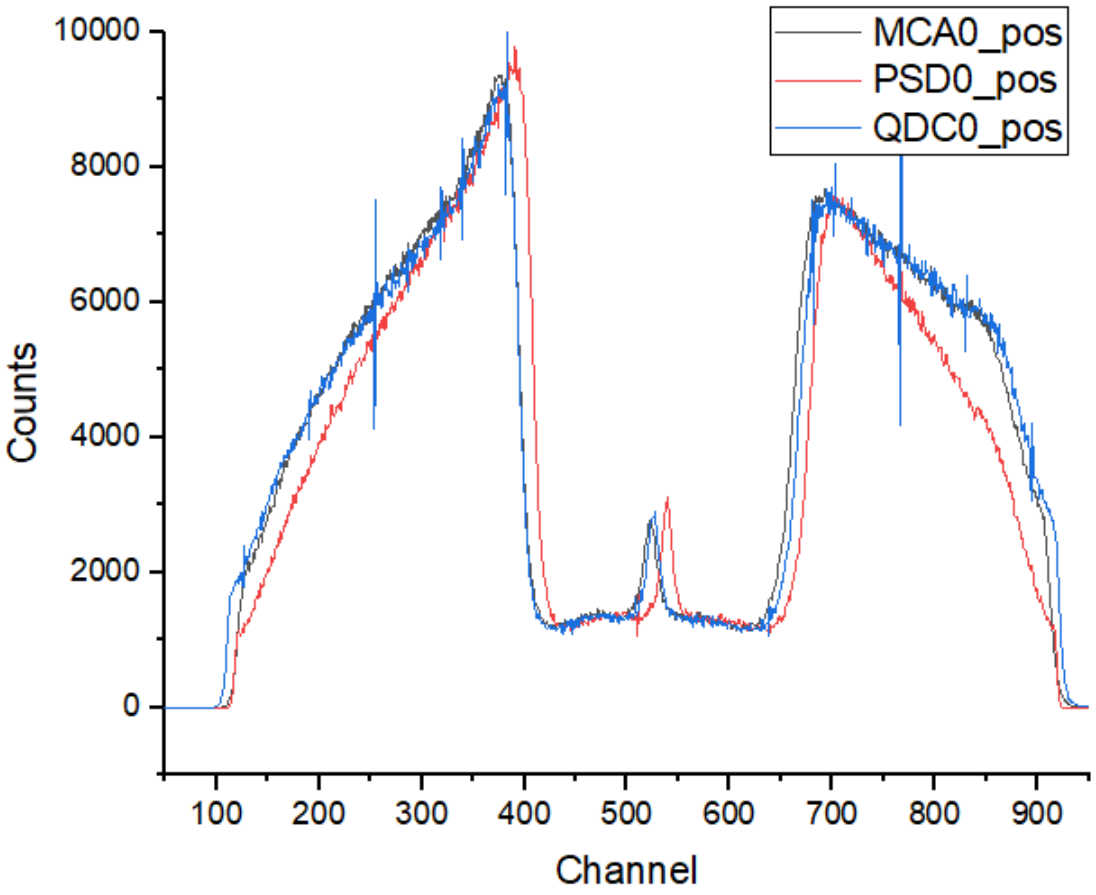


Figure 16. Full position spectrum

Table 1. Measurement results of the test system.

Method	Dead time methods, us	FWHM, channel	Position resolution, %
MCA HP	4,8	15,7	1,4
PSD	2	12,7	1
QDC	2	13,8	1,7

Conclusion

- Tube measurements require more extensive analysis and refinement.
- Digitizer and FPGA programming software Sci-Compiler cover almost all needs for setting up an experiment.

Thanks for your attention!

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