

PETsys TOFPET ASIC evaluation kit

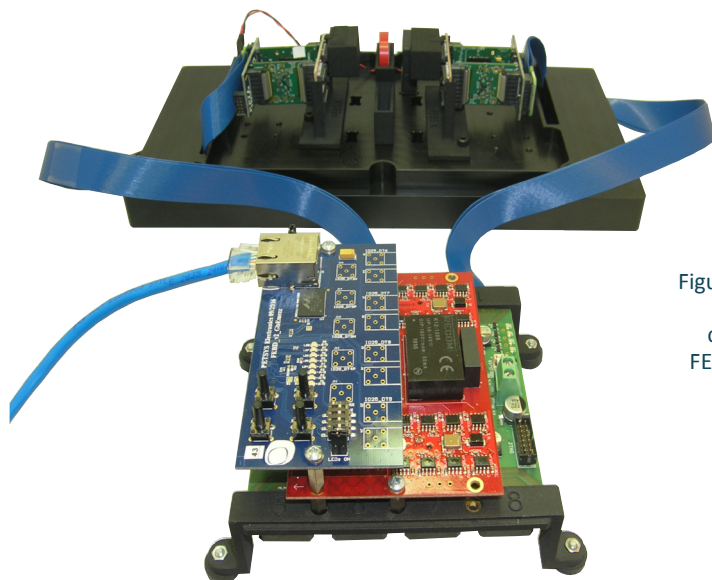


Figure 1: The PETsys TOFPET ASIC evaluation kit consists of a FEB/D board (boNom) with Ethernet link to the computer, and a mechanical assembly (top) with two FEM128 front end modules, two SiPM pixels, two LYSO crystals and a holder for placing a ^{22}Na source in between.

The PETsys TOFPET2 ASIC evaluation kit (Figure 1) is a complete readout system for up to 256 SiPM channels. It provides an easy-to-use and cost-effective platform for evaluating the features and performance of the PETsys TOFPET2 ASIC (Figure 2) [1]. For ASIC specifications, see the PETsys TOFPET2 ASIC flyer. The evaluation kit is also suitable for small detector prototypes and laboratory test setups.

The evaluation kit includes a FEB/D board with a Gigabit Ethernet connection to the host computer and two FEM128 front-end modules (Figure 3). Each FEM128 has two ASICs, each reading 64 channels. The FEM128 modules have connectors that directly accept the Hamamatsu S13361-3050AE-08, S13361-3075AE-08, and S14161-3050AS-08 MPPC arrays. With a suitable adapter board, the FEM128 can also be used with analog SiPM arrays from other vendors. Flexible cables connect the FEM128 boards to the FEB/D board, providing great flexibility in the experimental setup.

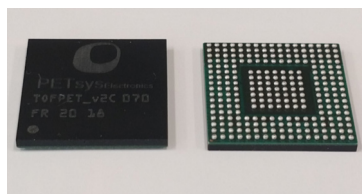


Figure 2: The PETsys TOFPET2 ASIC is a 64-channel L-me-of-flight PET readout ASIC available in a BGA package.

The evaluation kit is supplied with firmware and software. The data acquisition software runs under Linux and comes with an intuitive, easy-to-use graphical user interface (Figure 5). The software is written in Python and C++ and is supplied as source code under the MIT license, allowing advanced users to adapt and extend it as required.

To facilitate initial measurements, the evaluation kit includes two SiPM pixels mounted on adapter boards that plug directly into the FEM128, two $3 \times 3 \times 5 \text{ mm}^3$ LYSO crystals, and a holder for positioning a standard circular ^{22}Na source between the detectors. The cooling box is equipped with two Peltier elements and provides a stable temperature environment for the detector and front-end electronics.

The kit can be extended by adding more FEM128 units to read up to 1024 channels.

The evaluation kit includes one day of hands-on training for one or two users. The training covers operation of the evaluation kit, readout electronics, and software.

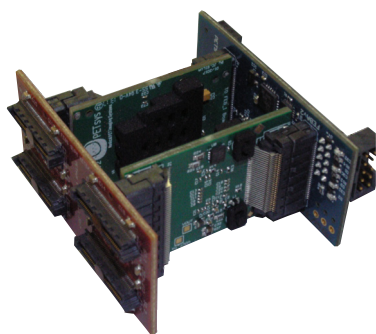


Figure 3: The FEM128 module incorporates two TOFPET2 ASICs and provides connectors for direct connection of Hamamatsu S13361-3050Ax-08 8x8 MPPC arrays.

The following items are included in the evaluation kit:

1. Two FEM128 modules (Figure 3), and two cables for connecting the modules to the FEB/D board.
2. One FEB/D board that acquires the data and transfers it to the DAQ computer via a Gigabit Ethernet link. The FEB/D also supplies regulated voltages and clock and reset signals to the ASICs, and bias voltages to the SiPMs.
3. Two SiPM pixels (3x3mm) mounted on boards that plug into the FEM128 modules, two LYSO crystals and a radioactive source (^{22}Na) holder.
4. A cooling box with two Peltier elements providing protection against ambient light and allowing stable and reproducible temperature conditions (Figure 4).
5. Firmware for the FEB/D board, providing ASIC configuration and data acquisition via Gigabit Ethernet. The board is supplied with the firmware pre-installed.
6. JTAG interface cable for programming the firmware in the Xilinx FPGA of the FEB/D board. This cable allows firmware updates to be uploaded to the FEB/D board.
7. Source code of the application software for receiving the data in a PC under the MIT license.
8. One day of hands-on training for one or two users.
9. Documentation.

Not part of the standard evaluation kit package but needed:

- Power supply: 12 Vdc, 4 A.
- Host computer running Alma Linux 8 or later, Red Hat Enterprise Linux 8.5 or later, or Ubuntu 20.04 or later.
- A ^{22}Na radioactive source if the user wants to measure the coincidence time resolution with 511 keV gamma rays.

Possible options:

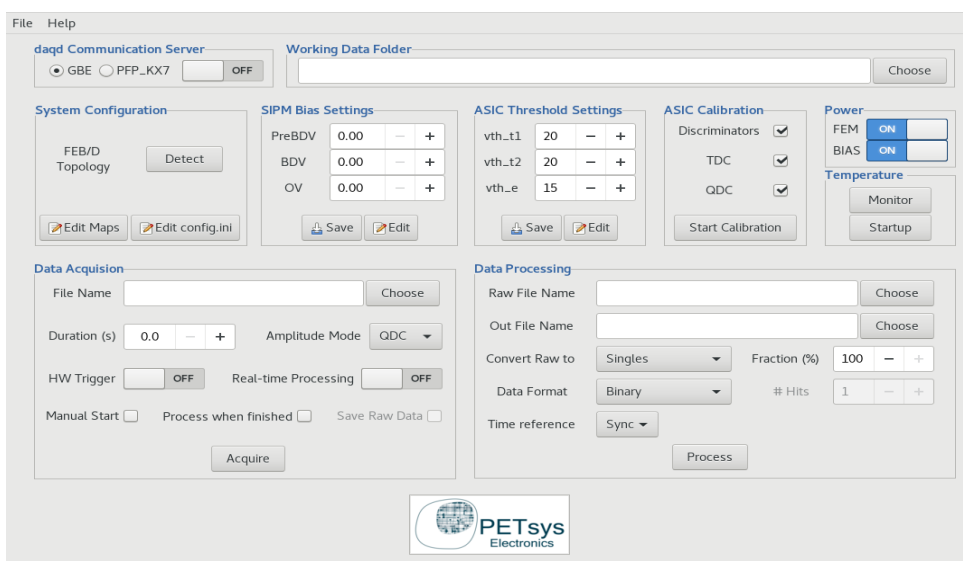
- We can supply LYSO crystal arrays, BGO crystal arrays and SiPM arrays.
- We can supply the DAQ computer with all application software installed.
- We can supply the FEM128 modules with a FEB/s taking the ONSem ARRAY-300XX-64P-PCB SiPM array instead of the Hamamatsu SiPM array.
- We can provide additional FEM128 modules. The e-kit can read up to 8 FEM128.

Systems with more than 1024 channels require a DAQ board and a Clock&Trigger module. See the PETsys SiPM Readout System flyer for additional information on larger system configurations.



Figure 4: A box with two Peltier cooling elements provides protection against ambient light and allows stable and reproducible temperature conditions.

Figure 5: The data acquisition is controlled by a graphical user interface.



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