We developed a trigger signal converting circuit, a trigger and isolated high-voltage generators for PAD modules. The first beam test of the FoCal-E, namely a combination of digital thermo-sensors, independent regulated power circuits and isolated high-voltage generators for PAD modules, was carried out at CERN PS and SPS beam lines in 2014.

We developed a trigger signal converting circuit, a trigger signal processor, a temperature monitor using precision digital thermo-sensors, independent regulated power circuits and isolated high-voltage generators for PAD modules.

Fig. 1 FoCal-E PAD modules at CERN PS beam line.

Fig. 2 The beam test setup and developed circuits.

Fig. 3 A new temperature monitor.

Fig. 4 The exterior of the temperature monitor.

Fig. 5 High-precision digital thermo-sensors.

Fig. 6 A new trigger signal processor.

Fig. 7 The PAD signal

Fig. 8 The pedestal distribution

Fig. 9 α of the pedestal distribution

Summary
We have developed the trigger signal converting circuit, the new trigger signal processor, the new temperature monitor using precision digital thermo-sensors, the new independent regulated power circuits and isolated high-voltage generators for PAD modules. The new temperature monitor has got the important data because they were working on different DAQs as shown in Fig. 2. The circuit receives the 10-bit parallel trigger data from a trigger counter through optocouplers and sends a serial trigger data with the timing and channel information to DAQ for PAD. The circuit and DAQ for PAD can be connected with each other through an ordinary HDMI cable.

And then, we developed a new trigger signal processor with the FPGA to merge the PAD data with the MAPS data because they were working on different DAQs as shown in Fig. 2. The circuit receives the 10-bit parallel trigger data from a trigger counter through optocouplers and sends a serial trigger data with the timing and channel information to DAQ for PAD. The circuit and DAQ for PAD can be connected with each other through an ordinary HDMI cable.

The new trigger signal processor can read out the discriminated signals of three scintillation counters directly and make a higher-precision serial trigger data for PAD. It is easy to modify the trigger configuration through the USB interface. The circuit also has three output ports for 8-digit 7-segment LEDs. The new trigger signal processor is going to be used at the next beam test.

A new trigger signal processor
First, we developed a trigger signal converting circuit with the CPLD to merge the PAD data with the MAPS data because they were working on different DAQs as shown in Fig. 2. The circuit receives the 10-bit parallel trigger data from a trigger counter through optocouplers and sends a serial trigger data with the timing and channel information to DAQ for PAD. The circuit and DAQ for PAD can be connected with each other through an ordinary HDMI cable. And then, we developed a new trigger signal processor with the FPGA as shown in Fig. 6. The new circuit can read out the discriminated signals of three scintillation counters directly and make a higher-precision serial trigger data for PAD. It is easy to modify the trigger configuration through the USB interface. The circuit also has three output ports for 8-digit 7-segment LEDs. The new trigger signal processor is going to be used at the next beam test.

A new temperature monitor
Fig. 3 shows a temperature monitor with high-precision digital thermo-sensors to manage the temperature-sensitive photodiodes. The thermo-sensors are controlled through the 1-wired serial interface, and it is easy to increase the number of sensors up to 160. In the remote control mode, it sends the temperature data to a personal computer through the USB interface. Figs. 4 and 5 show the exterior of the temperature monitor and thermo-sensors, respectively.