MLAB
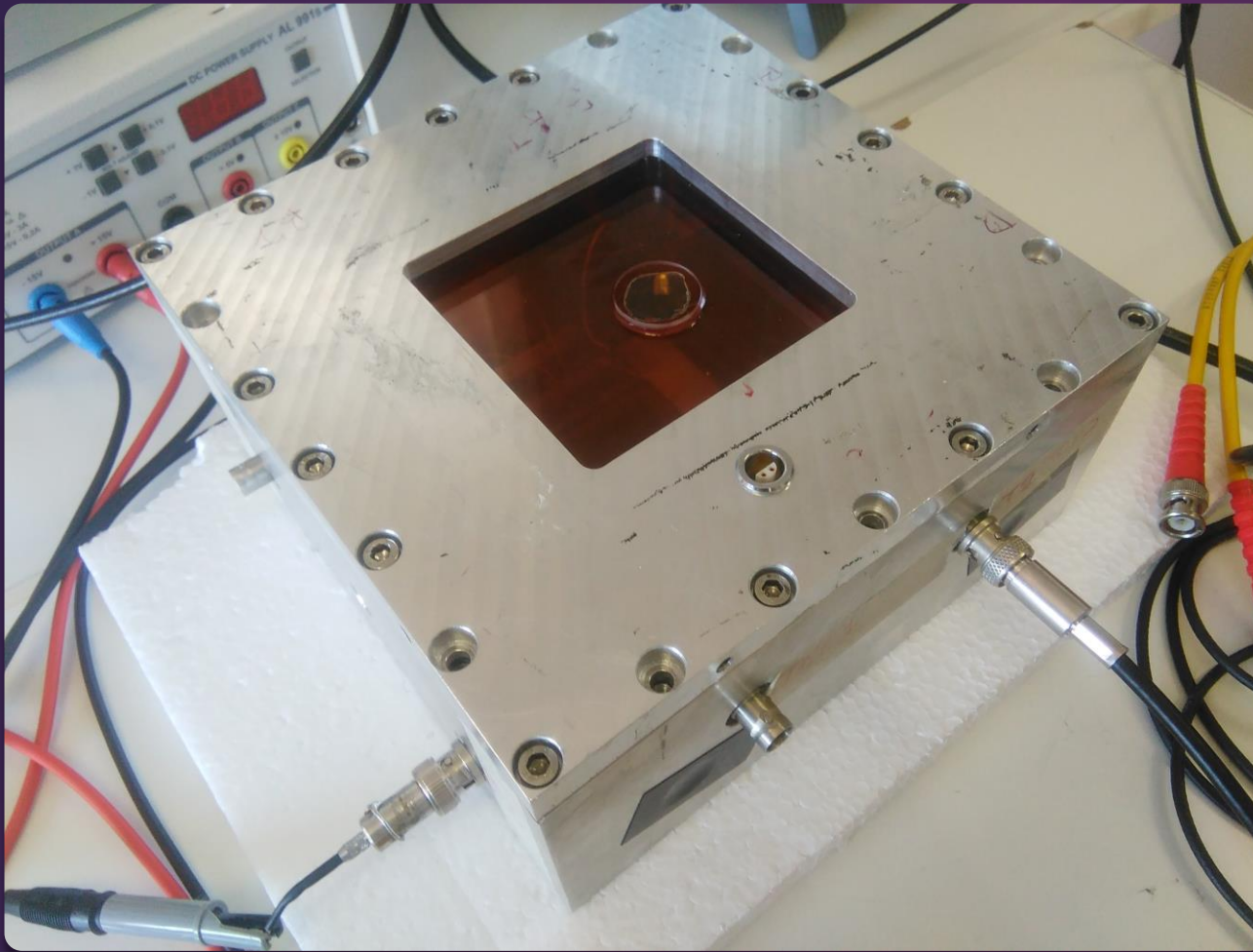
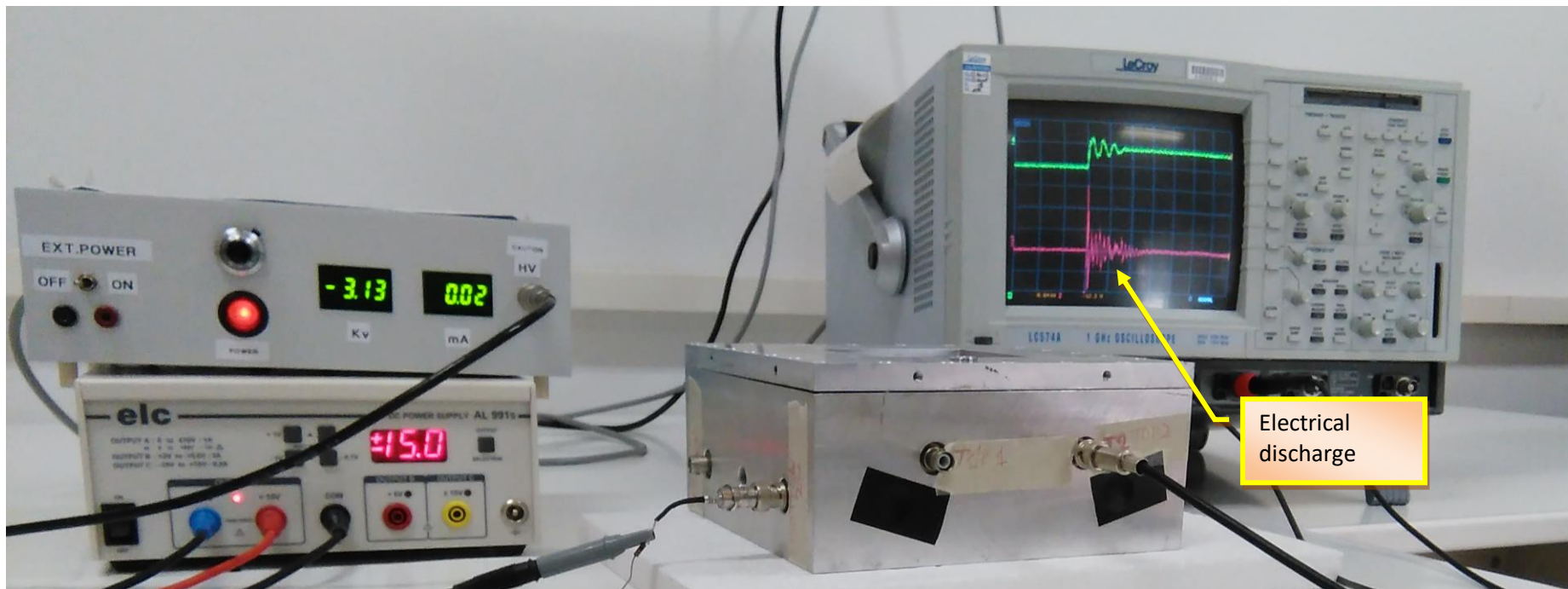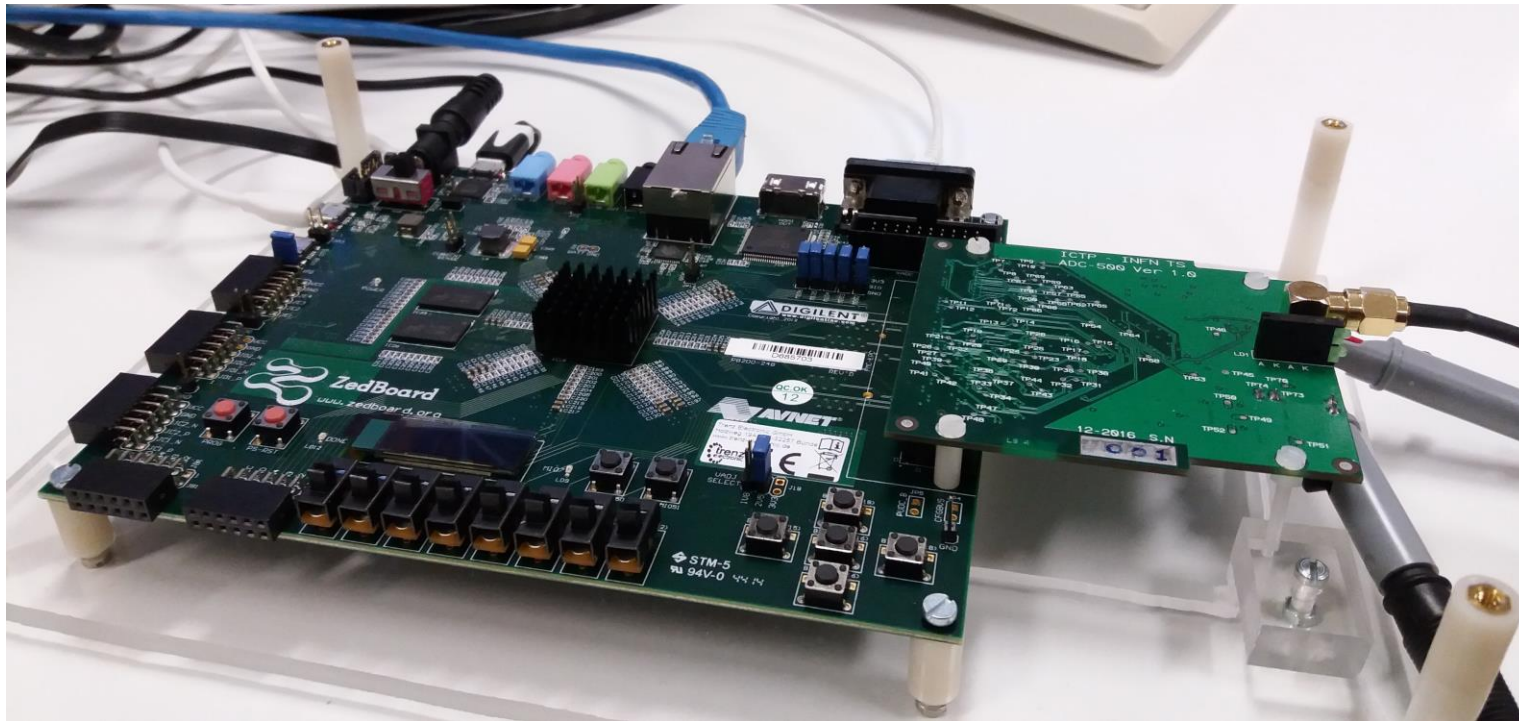# *SoC opportunities for IoT*

DEMO 1

HVPS CONTROL AND MONITORING SYSTEM FOR THICK-GEM DETECTORS.
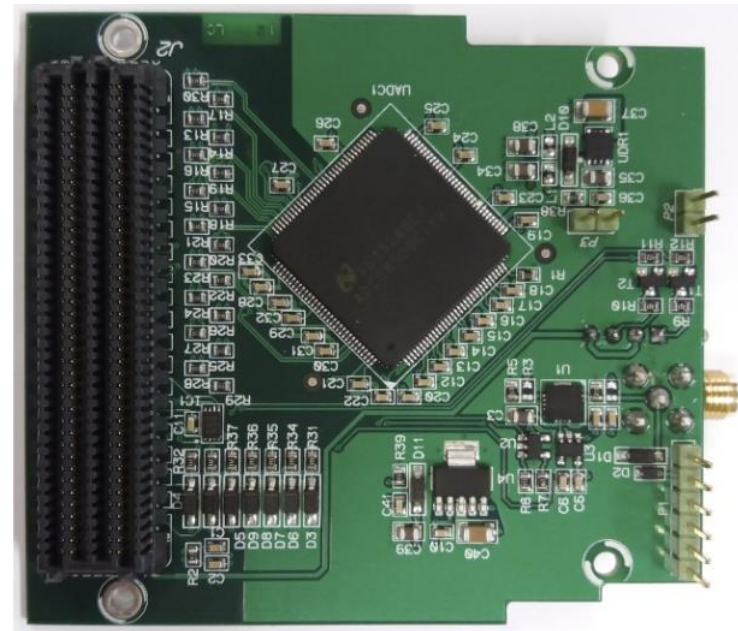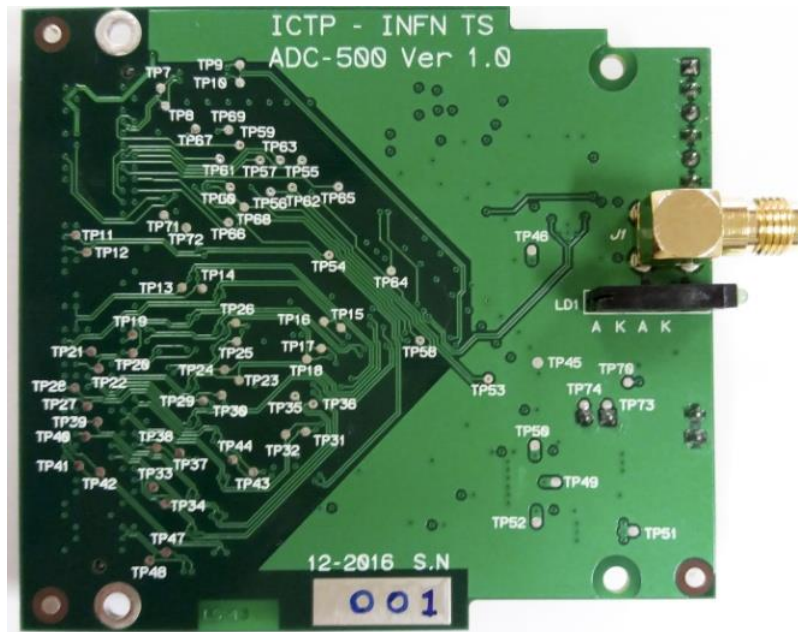
Demo HVPS control and monitoring system for Thick-GEM Detectors
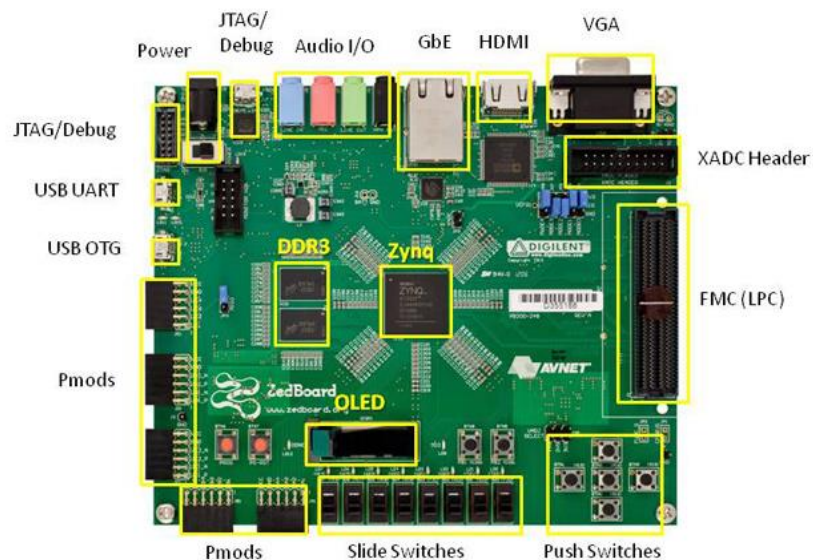

Electrical discharge

ZEDBOARD Dev-Board

ICTP-INFN high-speed data acquisition FMC mezzanine board, 500 MSPS, 8 Bits
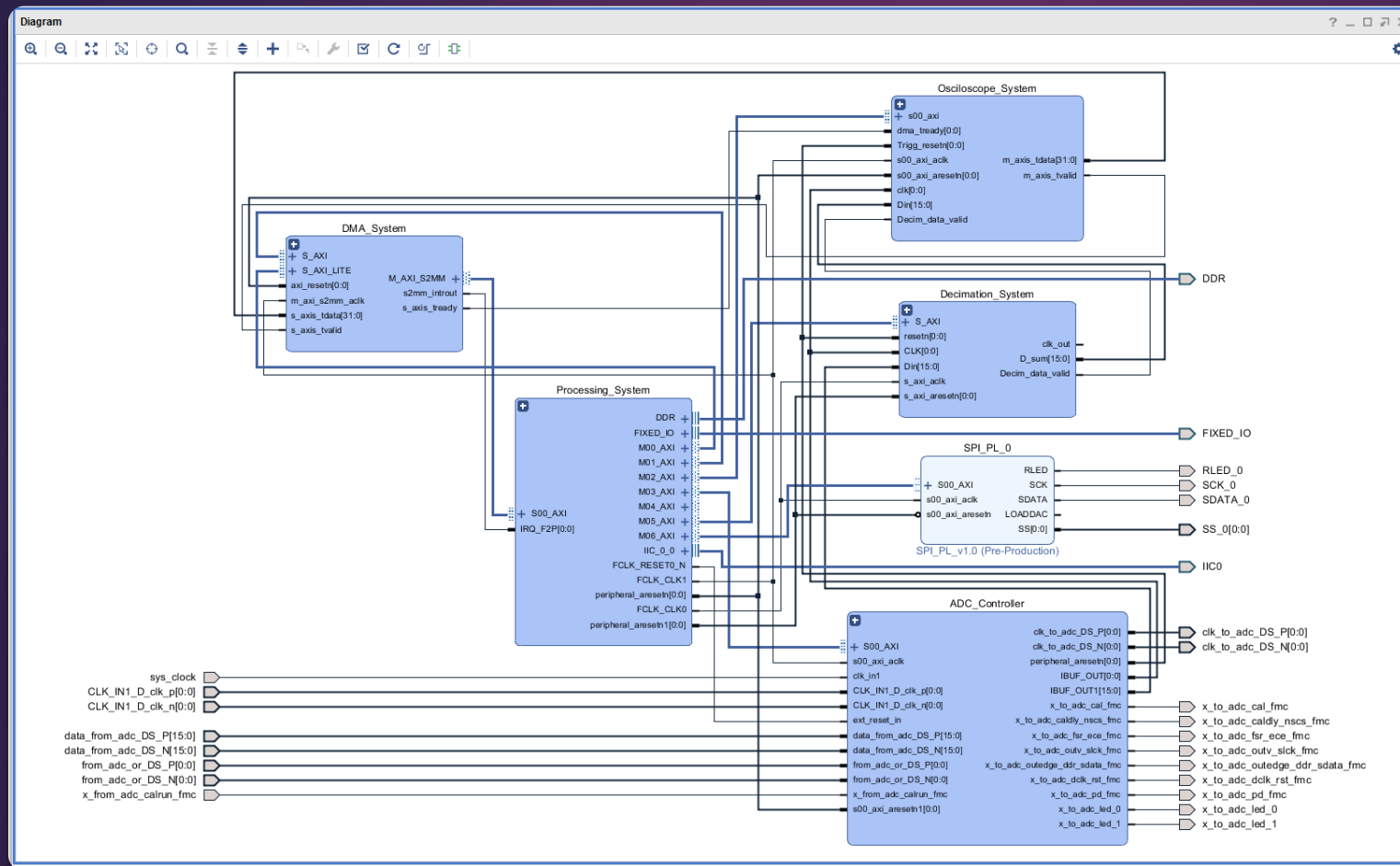
ZEDBOARD Dev-Board
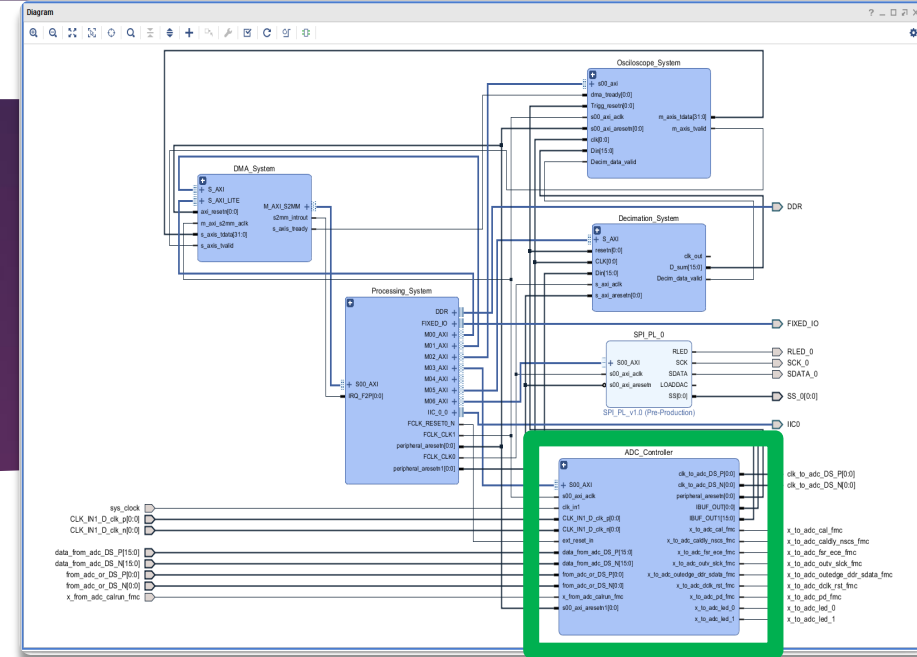

* SD card cage and QSPI Flash reside on backside of board

- ▶ Zynq®-7000 All Programmable SoC XC7Z020-CLG484-1
- ▶ Memory
  - ▶ 512 MB DDR3
  - ▶ 256 Mb Quad-SPI Flash
  - ▶ 4 GB SD card
- ▶ Onboard USB-JTAG Programming
- ▶ 10/100/1000 Ethernet
- ▶ USB OTG 2.0 and USB-UART
- ▶ (FMC, Pmod™ Compatible, XADC)
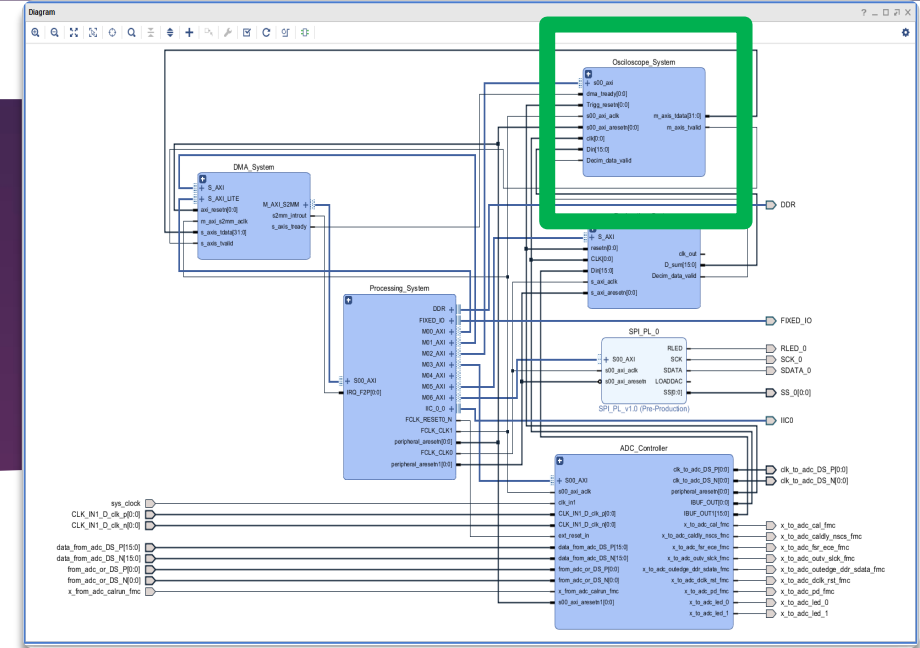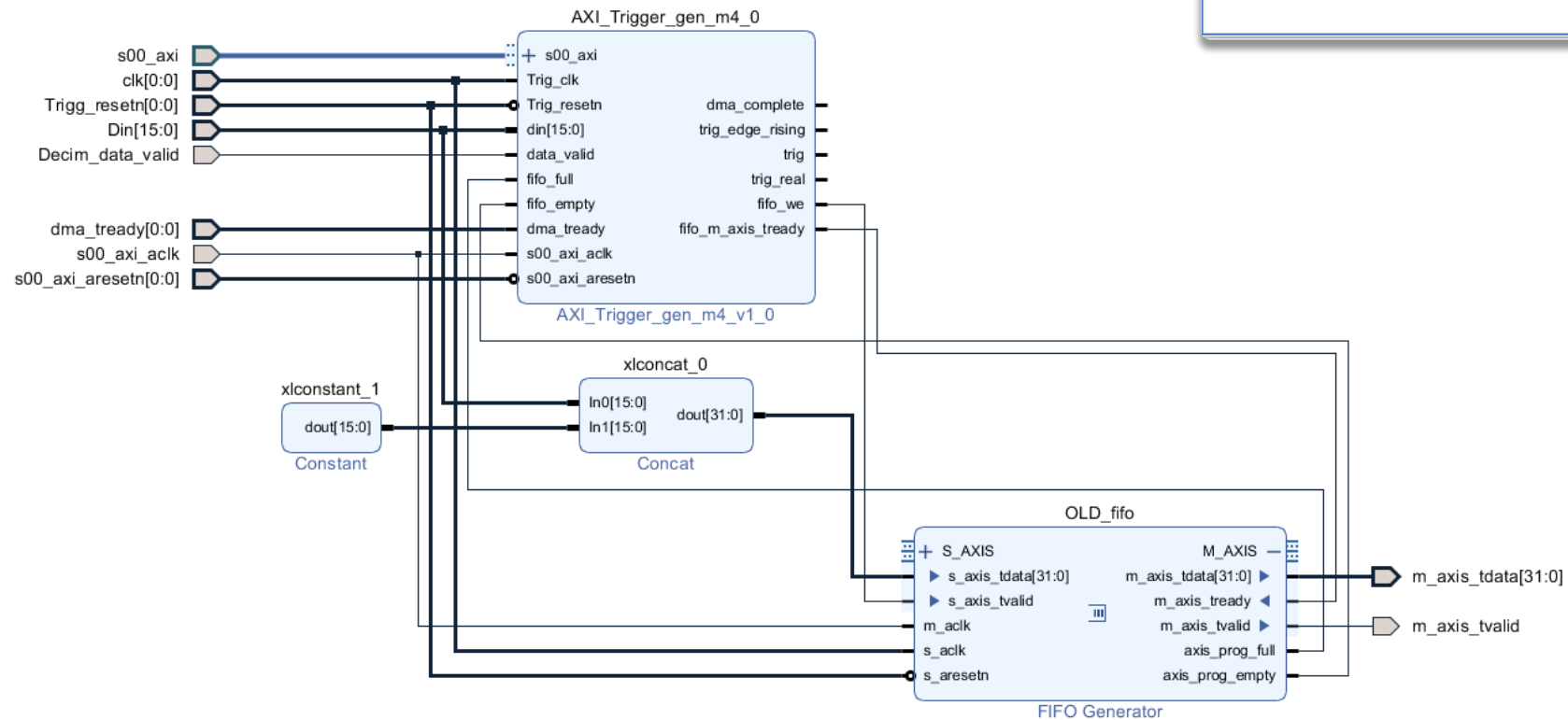- ▶ Multiple displays (1080p HDMI, 8-bit VGA, 128 x 32 OLED)

Vivado Block Diagram

ADC Controller
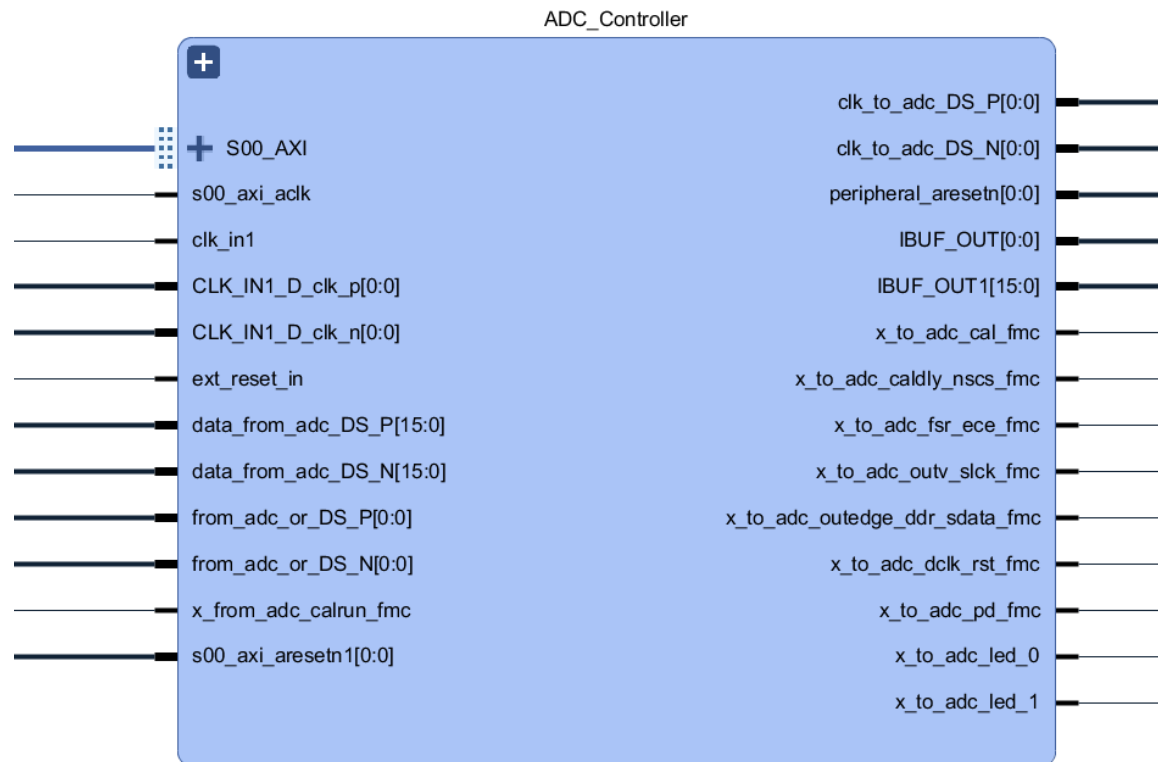
Oscilloscope System

DMA System
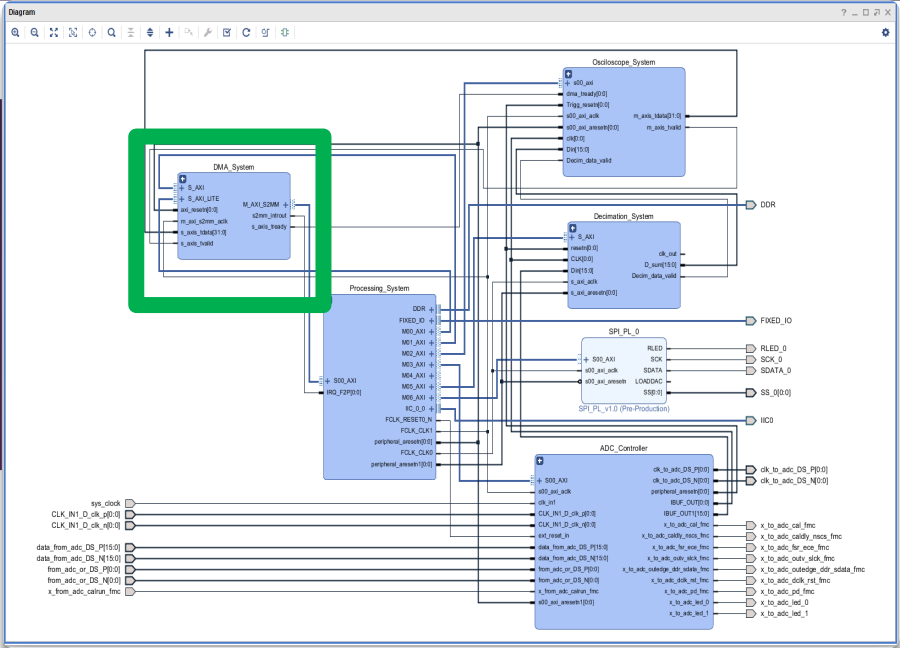
Processing system
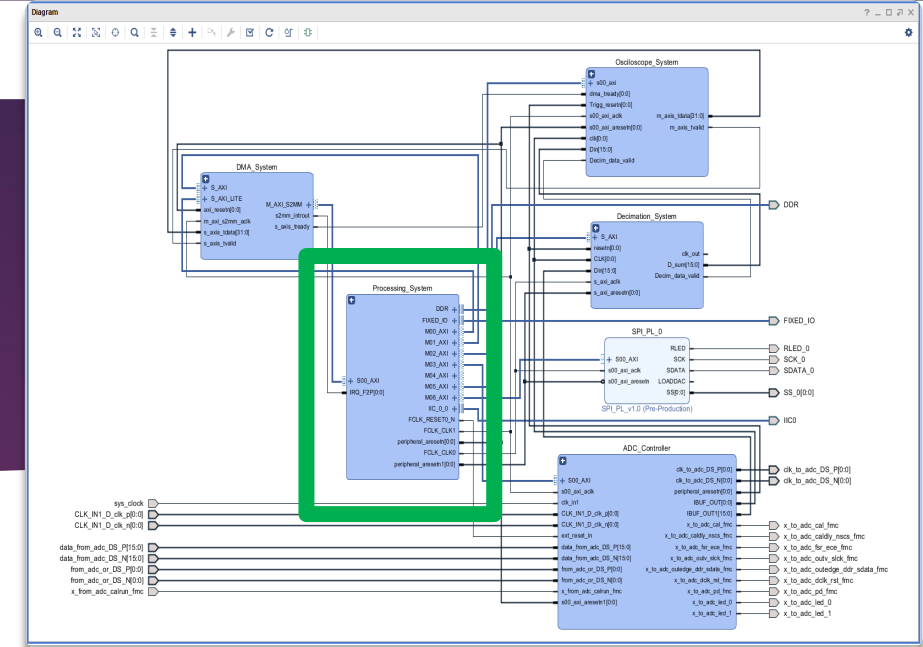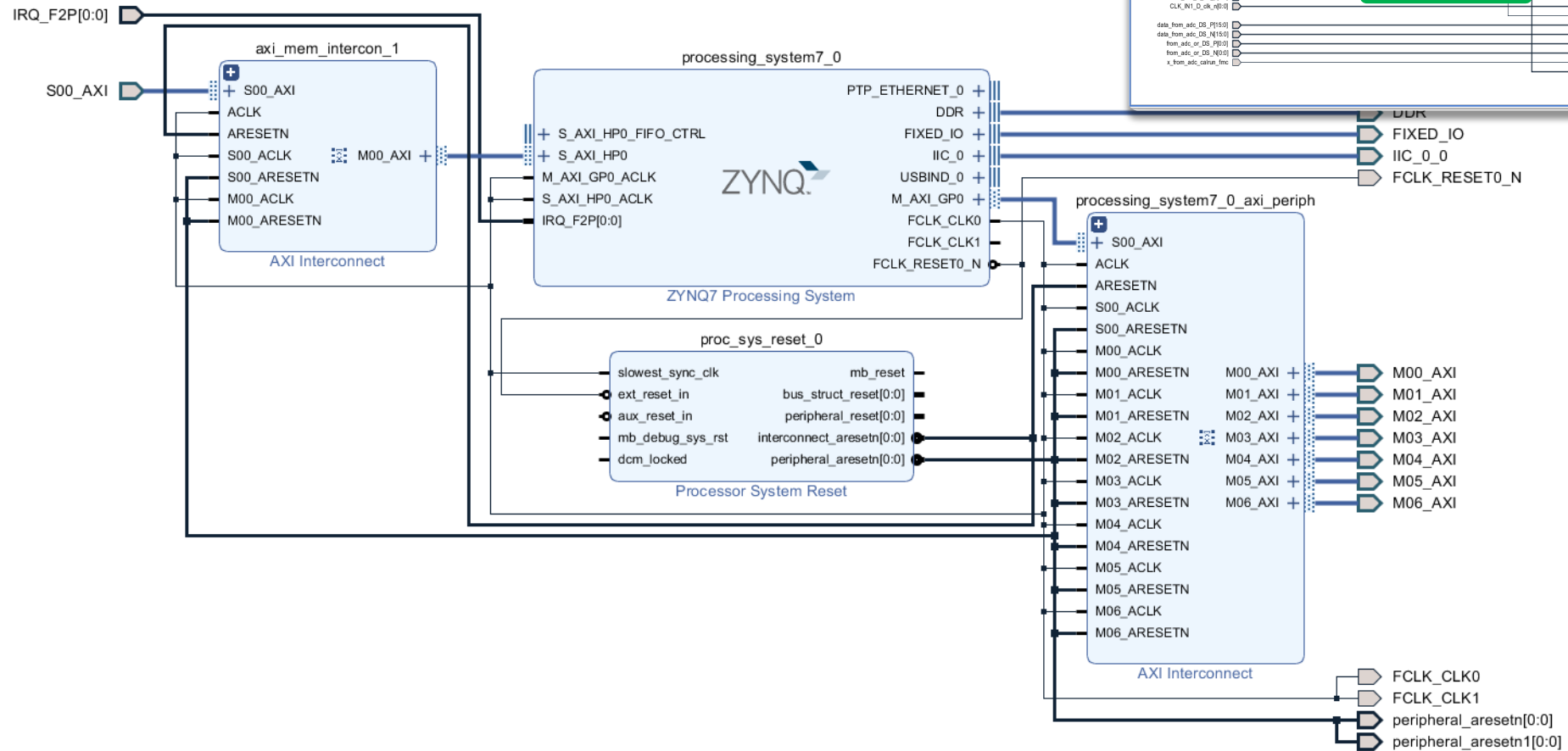
ARM Processor

- Dual ARM® Cortex™-A9 MPCore.

- 32-bit processor core.

- ARMv7-A architecture.

- ARM Advanced Microcontroller Bus Architecture (AMBA®) protocol: AXI.

- I/O peripheral interfaces such as SPI, I2C, CAN, UART, GPIO, SD, USN and Ethernet.

- Bare-Metal – Software system without an operating system.

- Open Source Linux.

- Open Source Android.

- Open Source FreeRTOS.

Demo HVPS control and monitoring system for Thick-GEM Detectors

▶ The main goal is avoid the electrical discharges in the Thick-GEM detectors that can ruin the data measurement.

▶ Controlling the HPVS is a suitable solution.

▶ The output voltage depends of temperature and pressure.

$$V = V_0(1 + 0.5(\frac{P}{P_0} * \frac{T_0}{T} - 1))$$

▶ The voltage adjustment of the HV DC-DC converter is set by 16-bit PMOD DAC Module.

Temperature and Pressure Sensors

▶ ADT7420 is a high accuracy digital I2C temperature sensor.

▶ −40°C to +150°C

▶ The MS5611 is an integrated digital pressure sensor with SPI and I2C bus interface. The pressure function is compensated by a digital temperature value.

▶ 10 to 1200 mbar and -40 to +85 °C

# Real Time Operating System

- Embedded Operating System for Embedded MicroController.

- Predictable response time.

- For timing sensitive applications.

- Multitasking Support.

- TCP/IP Stacks available.

freeRTOS

Direct Memory Access (DMA)

▶ DMA allows the system to temporarily take control (read/write) of the DDR memory.

▶ Therefore both the PS and PL can access the DDR memory allowing data transfer.

▶ Data transmission from PL (FIFO memory) through DMA configuration to the external DDR RAM memory.

▶ *Pack data from DDR RAM and send it according to PC-Zynq TCP/IP communication protocol specifications.*
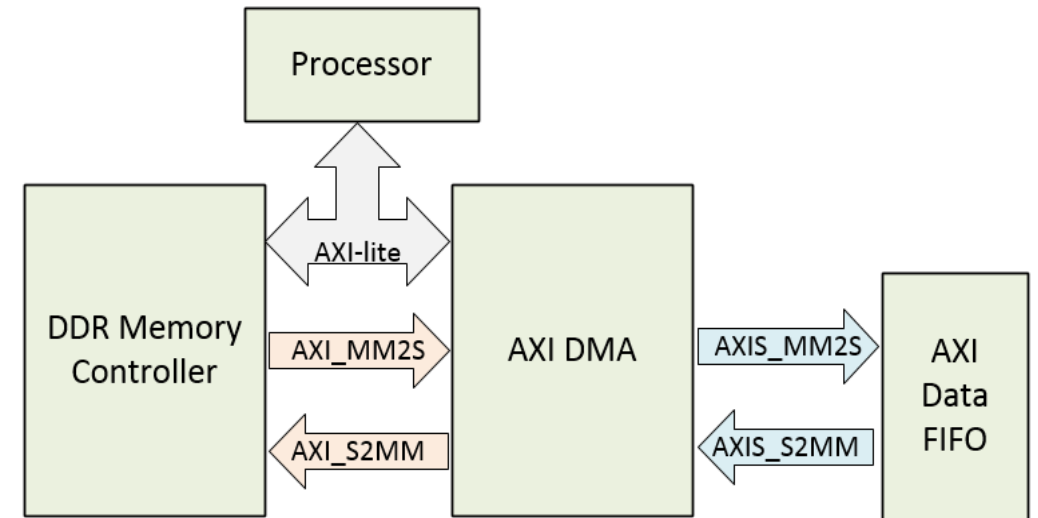
TCP/IP Communication

- High speed Ethernet connection (1Gbit/s) has been implemented using the lightweight TCP/IP stack (lwIP library) in the ARM processor.

- According with *TCP/IP communication protocol specifications between the PC and the PS, two* different packets of data are sent to the PC.

- The user also can send to the PS diverse acquisition parameters.

- IoT network technologies include cellular, Wifi, and Ethernet, as well as more specialized solutions. Not all IoT devices need to be wireless. For example the ones designed to be stationery or sensor units that are installed within a building automation system can use wired networking technologies like Ethernet.
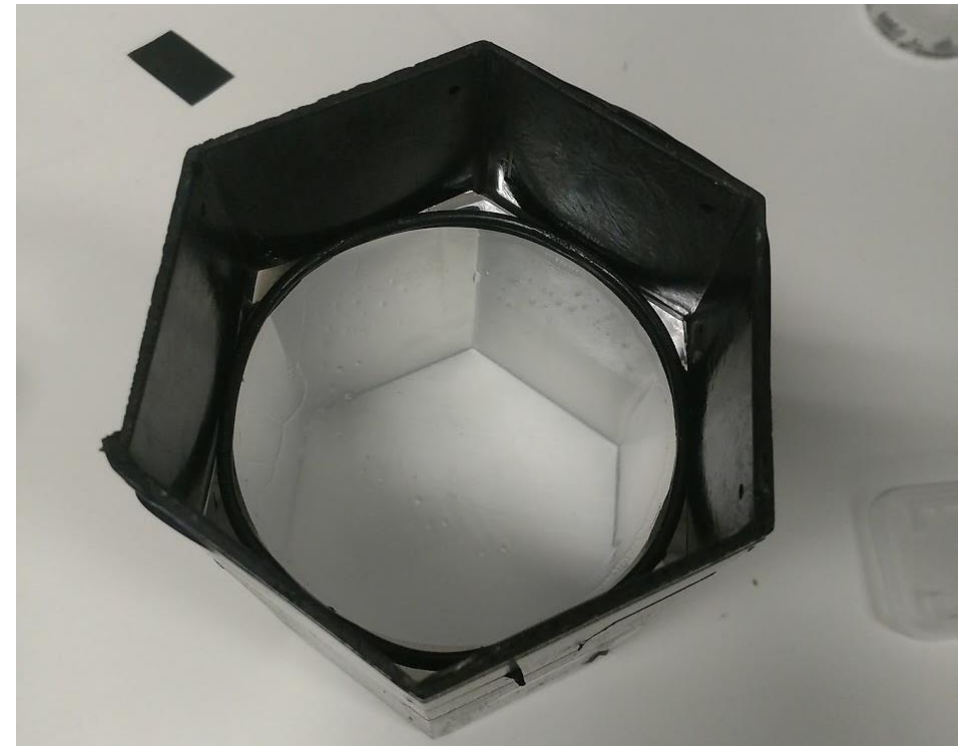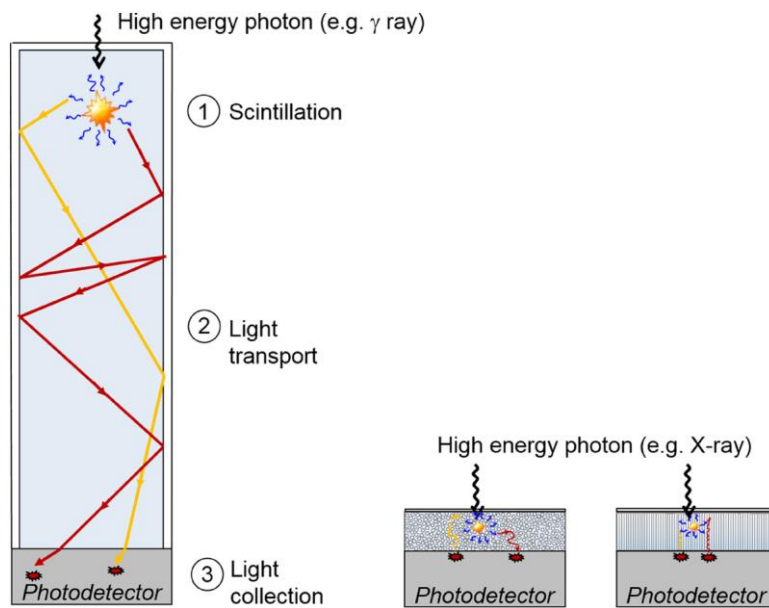
PC

Ethernet Cable (RJ45)
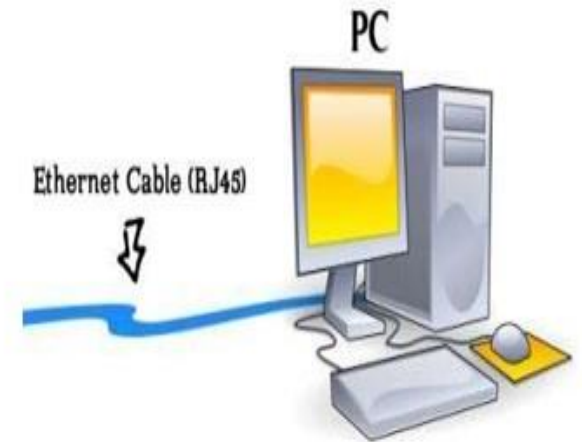
Communication with the PC: GUI

▶ PyQt5 (Python-Qt).

▶ Rich collection of GUI widgets.

▶ Multiplatform environment.

▶ Signal/slot mechanism for communicating between objects.
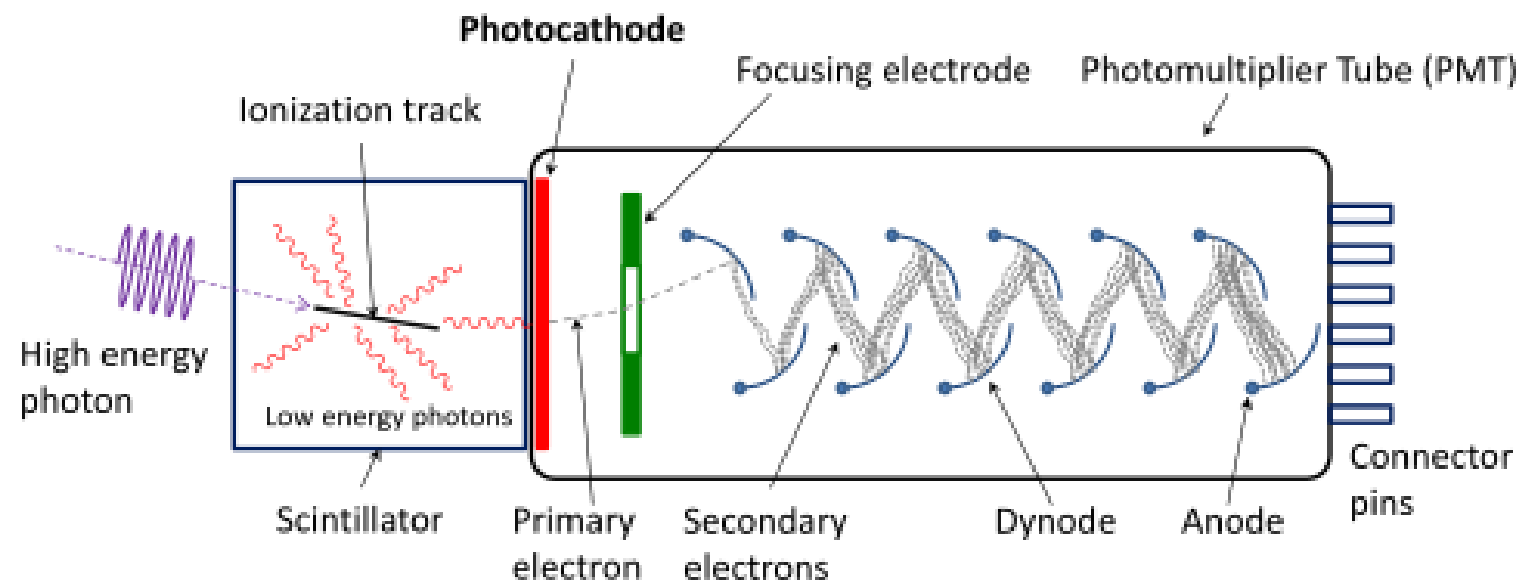
▶ Easy to create re-usable software components.

DEMO 2

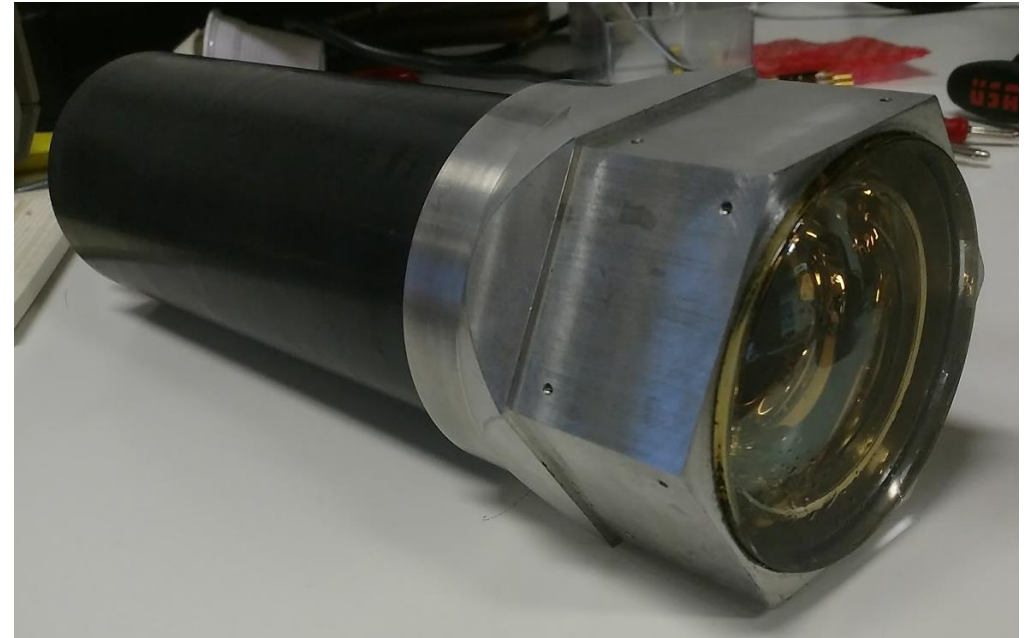PMT SIGNAL ACQUISITION FOR ENERGY SPECTRUM ANALISIS
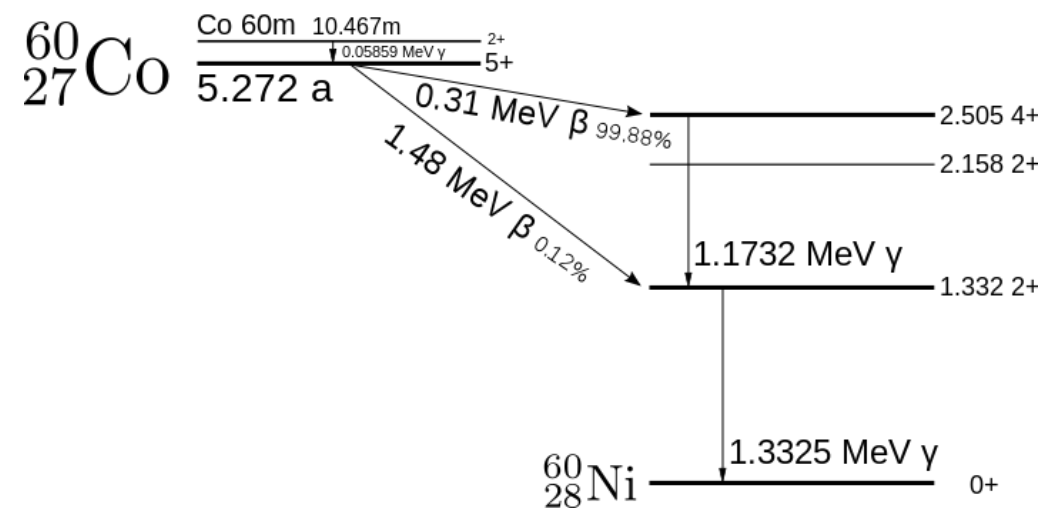
Scintillator Crystal

PMT Basics

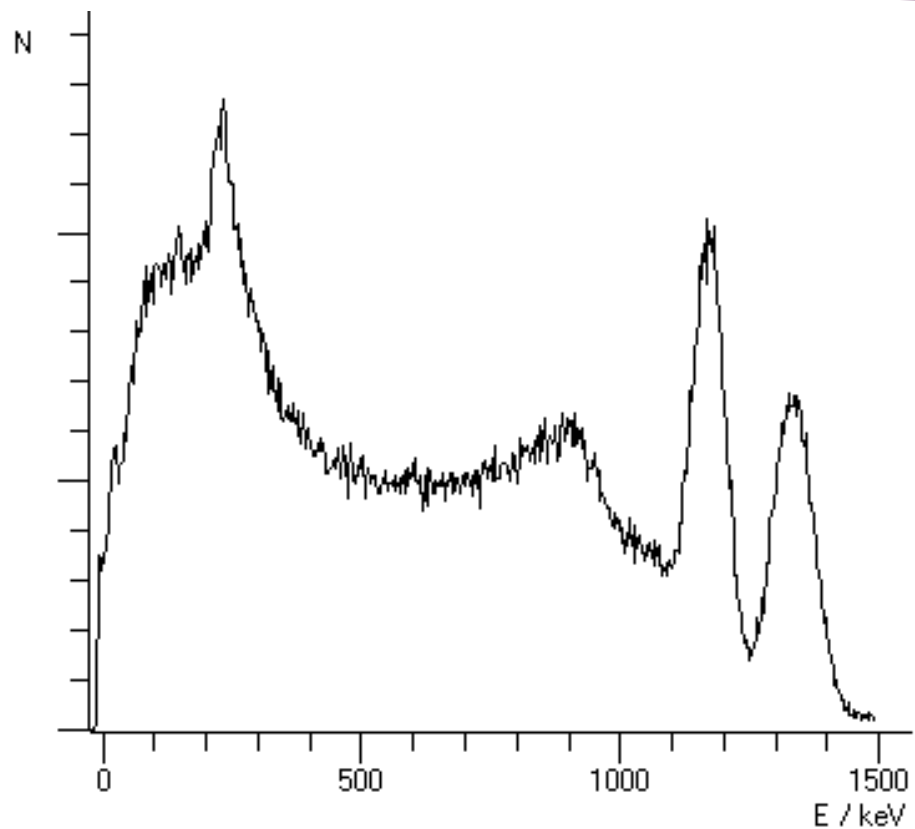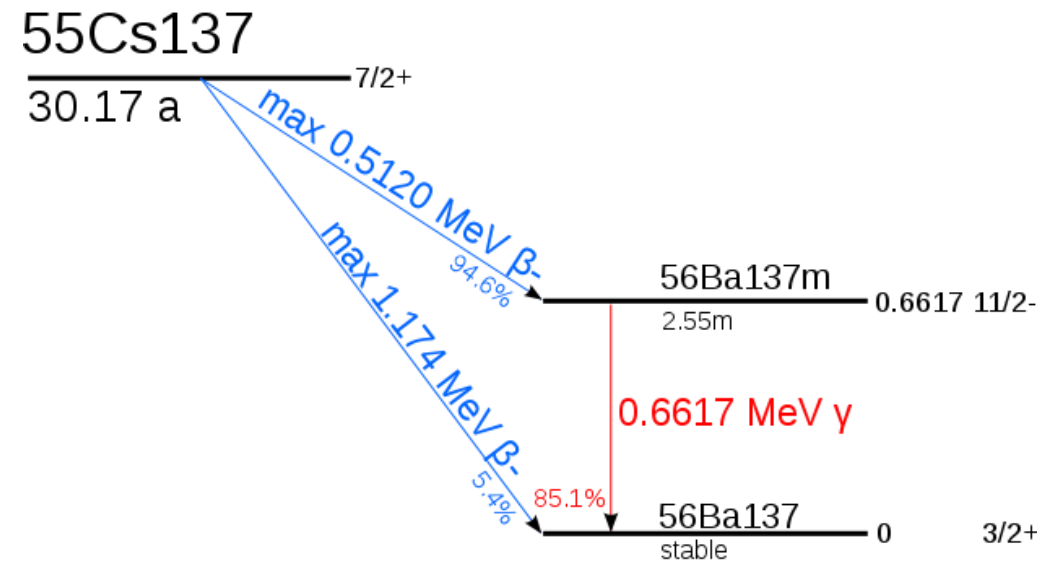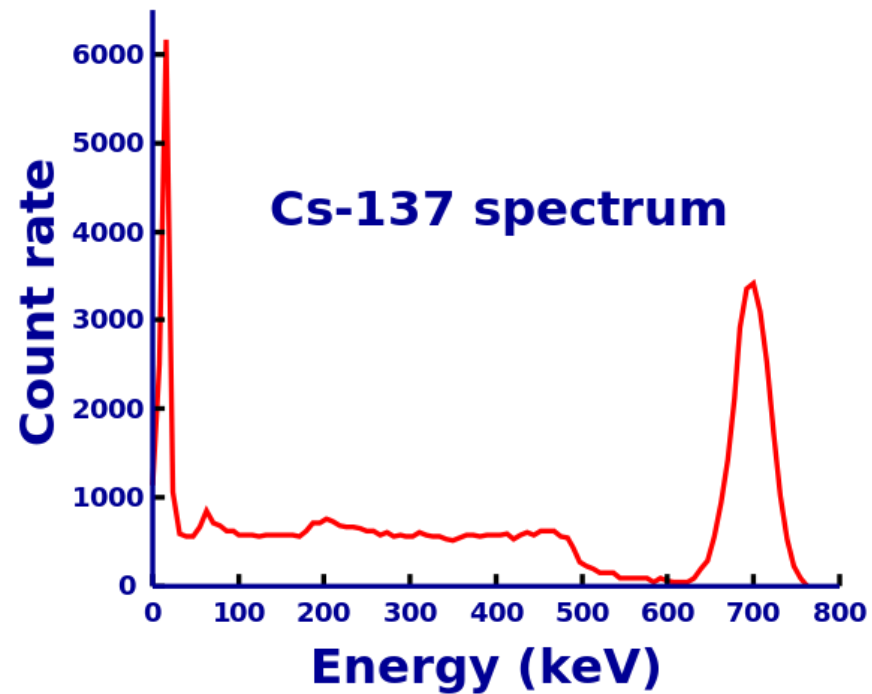# EMI 9821QB 75 mm PMT

- 75 mm diameter fast linear focused PMT
- 9 High gain BeCu dynodes for use in gamma cameras
- **Rise time response 2.1 ns**
- Gain (nom.) 6.7×10^6

Co 60

Cs137

Cs-137 spectrum

55Cs137
30.17 a — 7/2+

max 0.5120 MeV β⁻
94.6%

max 1.174 MeV β⁻
5.4%

56Ba137m
0.6617 11/2-
2.55m

0.6617 MeV γ
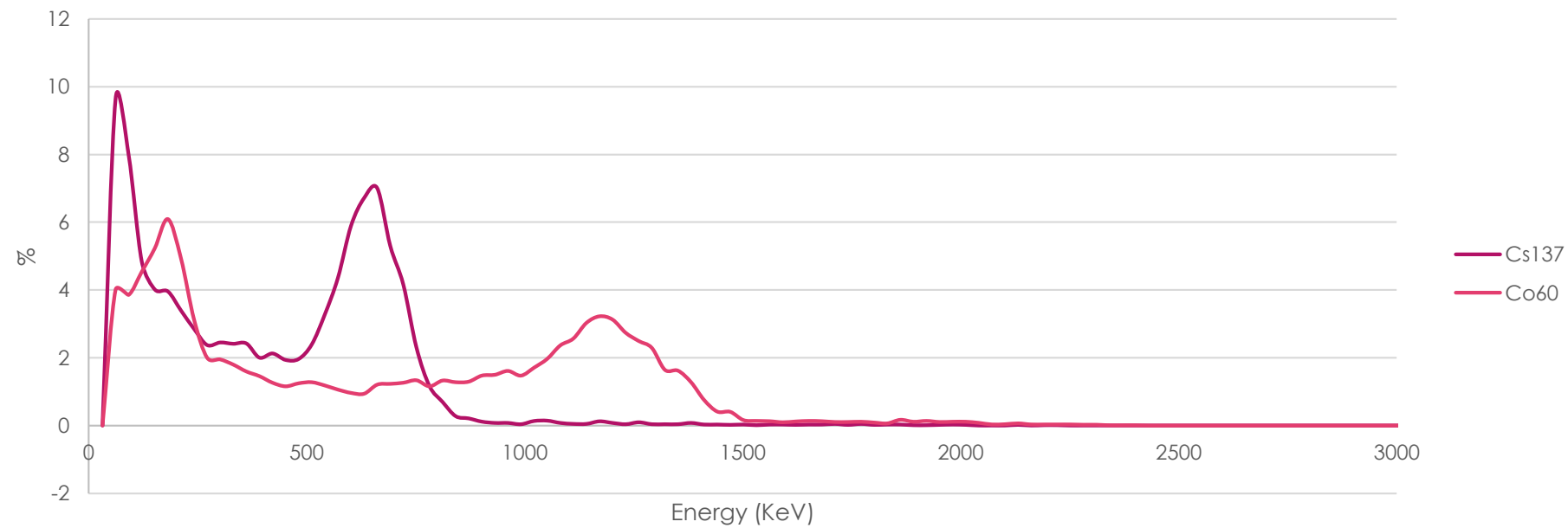
85.1%

56Ba137
stable — 0 — 3/2+

Spectrum acquisition

Energy Spectrum for Cs137 and Co60 captured with Zedboard at 500 Mhz

► Thank You!