A VIRTUALIZED BEAMLINE CONTROL AND DAQ ENVIRONMENT AT PAL

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I. Abstract

At least three different computers are used in the beamlines of PAL, first for EPICS IOC, second for device control and data acquisition(DAQ), and third for analyzing data for users. In the meantime, stable beamline control was possible by maintaining the policy of separating applications listed above from the hardware layer. As data volumes grow and the resulting data throughput increases, demands for replacement of highly efficient computers has increased. Advances in virtualization technology and robust computer performance have enabled a policy shift from hardware-level isolation to software-level isolation without replacing all the computers. DAQ and analysis software using the Bluesky Data Collection Framework [1–5] have been implemented on this virtualized OS. In this presentation, we introduce the DAQ system implemented by this virtualization method.

II. Virtualization

● Virtualization Solutions

Virtualization solutions can be classified into three major types depending on the hypervisors: KVM, Xen, and ESXi

Solutions	Hypervisor	Pricing
Linux/kvm	KVM	Free
PROXMOX	KVM, LXC	Free
Linux/Xen	Xen	Free
XCP-ng	Xen	Free
Citrix XenServer	Xen	$763.00 / CPU
VMware	ESXi	Free (w/ limit)

Table 1: Virtualization Solutions for GPU Passthrough

The hypervisors listed above enable operating system virtualization and passthrough for free. Based on these hypervisors, there are commercial solutions that provide virtual machine (VM), network and storage management tools, and commercial support. Some examples are VMware vSphere (ESXi), Citrix XenServer (Xen), XCP-ng (Xen), and PROXMOX (KVM).

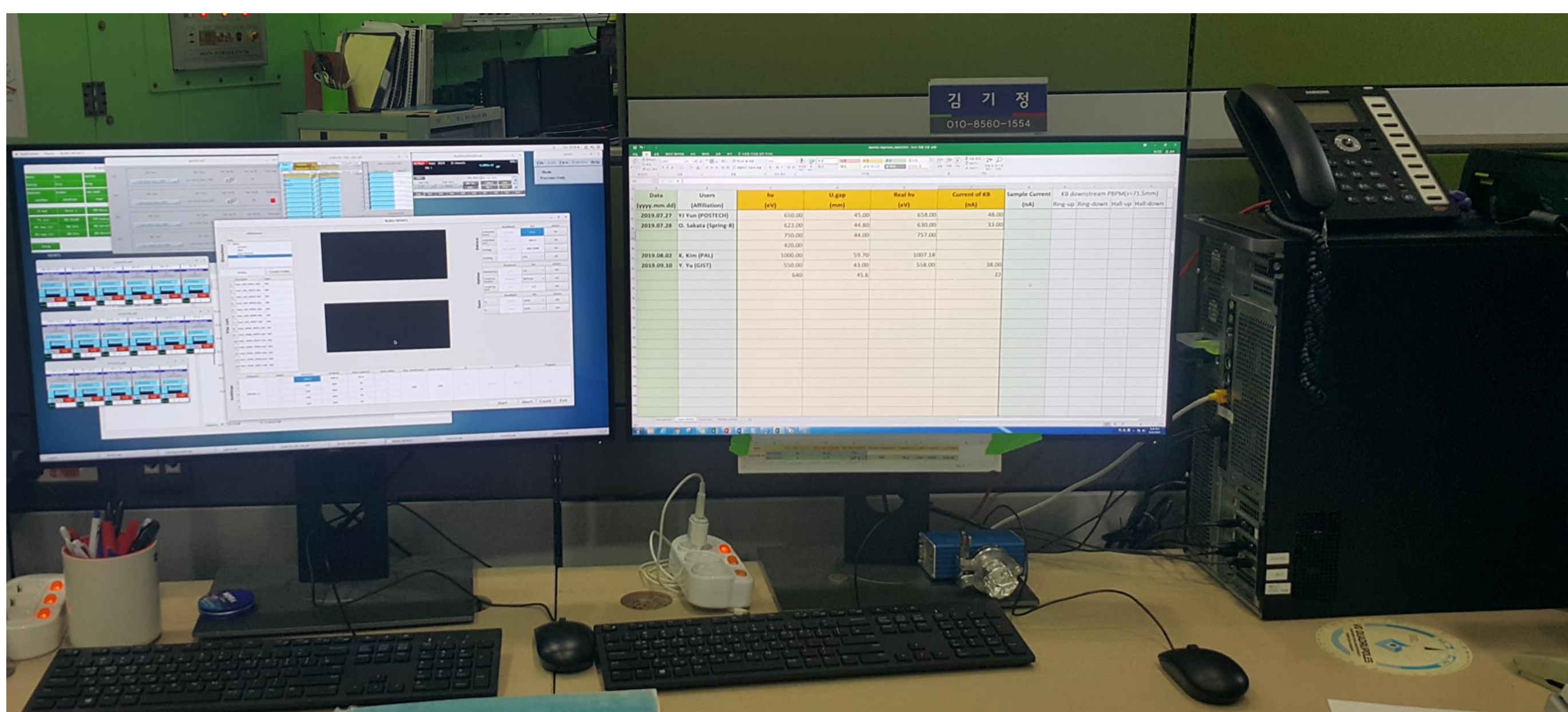### ● Virtualization Host using CentOS 7 / KVM as a Hypervisor

Figure 1: Multiple operating systems are running on one workstation. Headless: IOC VM (CentOS 6), Left: DAQ VM (CentOS 7), Middle: Analysis VM (Windows 7), Right: Workstation.

The procedures of setting up CentOS 7 as a hypervisor and GPU passthrough are summarized separately [8]

Hardware resources

- 32 Logical Cores
- 32 GB Memory
- 250 GB SSD
- Nvidia Quadro P400
- Radeon Pro Wx2100
- PCIe to USB Bridge
- 2x Keyboard
- 2x Mouse

IOC (VM)
- 8 Logical Cores
- 8 GB memory
- 50 GB Storage

DAQ (VM)
- 8 Logical Cores
- 8 GB Memory
- 50 GB Storage
- Quadro P400
- Keyboard
- Mouse

ANALYSIS (VM)
- 8 Logical Cores
- 8 GB Memory
- 100 GB Storage
- Radeon Wx2100
- PCIe to USB Bridge
- Keyboard
- Mouse

Figure 2: The workstation's resources have been allocated to the virtual machines

III . Control & DAQ Environment with the Bluesky

● Data Acquisition Framework

The EXAFS measurement software, previously developed in Labview, was rewritten with utilizing the Bluesky data collection framework to unify the fragmented development environment..
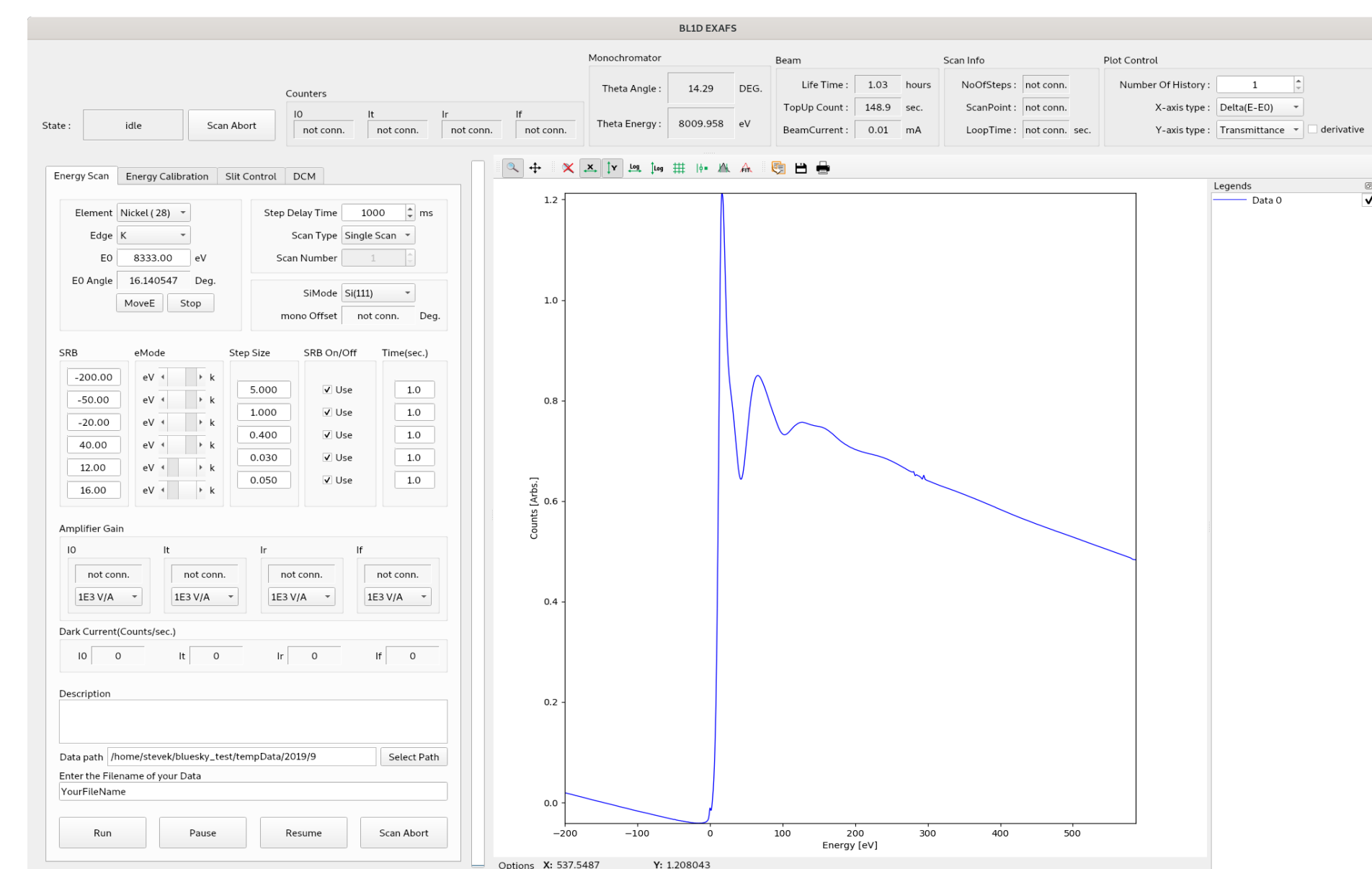

Figure 3: EXAFS data-acquisition software built with the Bluesky Framework [1–5] and the silx plotting library [7].

● Fly Scan with FPGA based Scaler

A fly scan counter (see Fig. 4) with FPGAand ODROID was designed. The direction of the motor is confirmed by two encoder signals having a 90 degree phase difference, and the operation (Inc. / Dec.) of the position counter is managed. When the position counter reaches the preset value, the detector's counts is copied into the memory. At the end of the transfer, the measurement restarts and the data in memory is transferred to the EPICS IOC via serial communication. The data is stored in the waveform records allocated for each channel
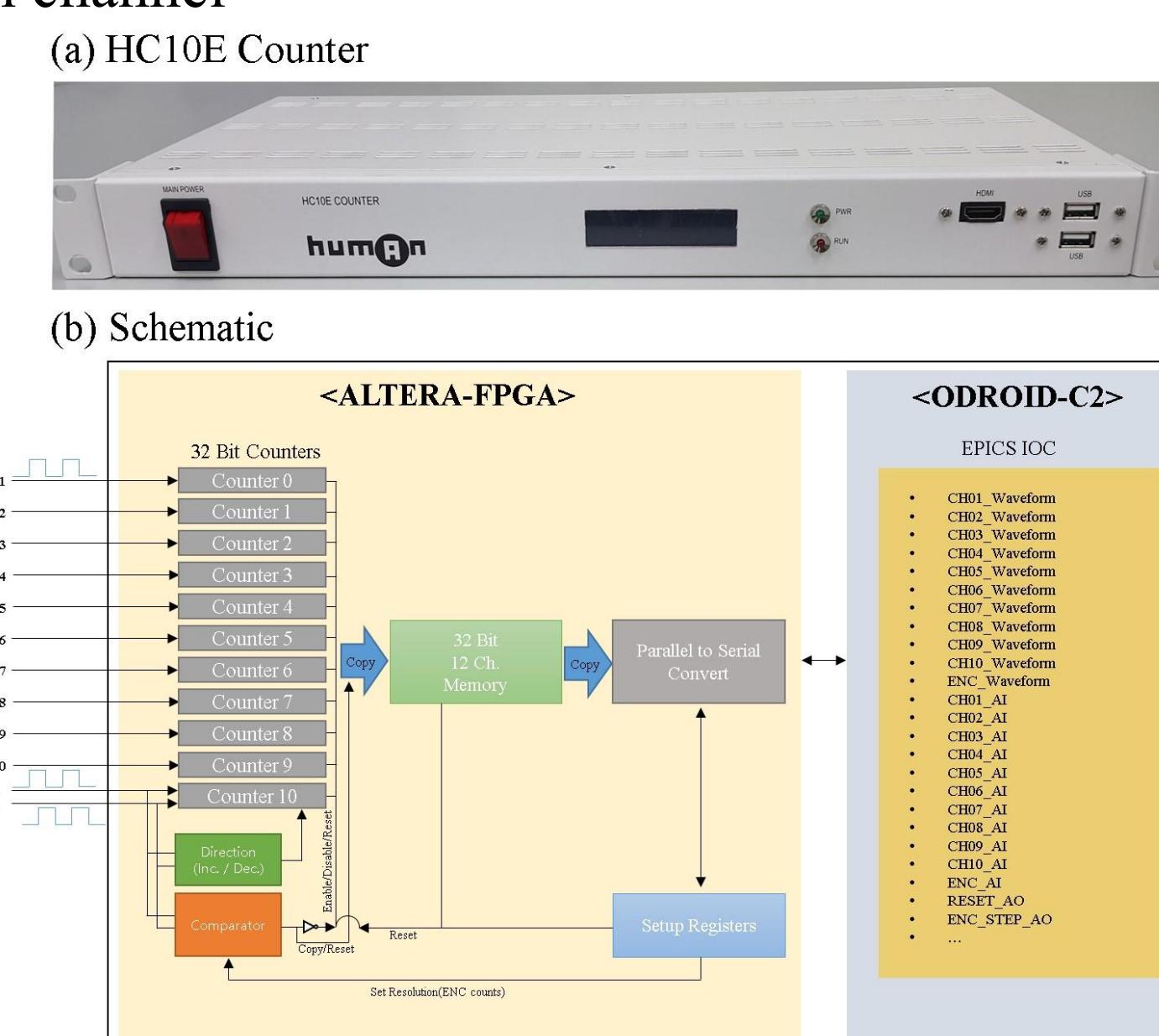

Figure 4: (a): Appearance of HC10E, (b): Internal design schematic.

IV. Conclusion

Virtualization is an interesting technology in terms of effectively utilizing the resources of multicore processor environment and facillating the construction and operation of a multi-OS in a single workstation. The types of hypervisors and virtualization solutions were discussed, and KVM was used to convert the linux kernel into a hypervisor to build various types of OS on it. EXAFS measurement software written in labview was rebuilt using the Bluesky data collection framework to unify the fragmented development environment. This confirmed the efficiency and versatility of the virtualization and the Bluesky framework. Therefore, these techniques will be applied to the multiple beamlines at PAL.

V. References

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[5] B. V. Luvizotto, K. Attenkofer, H. Bassan, and E. Stavitski, "XLive: Data Acquisition and Visualization at the NSLSII ISS Beamline", in *Proc. 16th Int. Conf. on Accelerator and Large Experimental Control Systems (ICALEPCS'17)*, Barcelona, Spain, Oct. 2017, pp. 62–965. doi:10.18429/JACoW-ICALEPCS2017-TUPHA211

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[8] GPU passthrough procedure with KVM on CentOS 7, https://bitbucket.org/physwkim/kvm_test/src/master/

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