

COTS Technology for High Energy Physics Instrumentation
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National Instruments (NI) uses Commercial Off-The-Shelf (COTS) semiconductor and computing technology and applies it to measurement, diagnostics and instrumentation needs. NI leverages the rapid technological advancement of the semiconductor and computer industry, while retaining the flexibility and ensuring interoperability between HW & SW. Until recently, most measurement, diagnostic and instrumentation applications in accelerator physics required custom development efforts. Most COTS products did not meet the needs of the community due to high-end specifications, redundancy, availability and safety requirements, long term serviceability aspects, closed driver stacks, limited operating system support etc. In recent years NI has led efforts to address these issues by developing state-of-the-art products that meet demanding specifications, making great progress towards reliable and redundant systems, providing long-term replacement and calibration services, support for Linux, providing register maps for open driver development and collaborating on EPICS, Tango and other middleware support. In addition, using COTS products minimizes development costs, reduces unit costs thus focusing limited resources on scientific endeavors.

A variety of measurement and diagnostic instrumentation have been developed at synchrotron facilities using NI COTS platforms. At the Shanghai Synchrotron Radiation Facility¹ (SSRF), engineers have leveraged PXI platform to develop an EPICS-based system for profile monitor, slit, scraper, parametric current transformer data acquisition and beam feedback system control. Scientists at the Siam Photon Source² have built a pattern memory system using PXI modules to ramp the booster synchrotron magnet and RF power supplies. NI digital waveform generators (9) are used to output signals to the RF power supply and the strobe signals and input the main trigger signal from the timing system. Investigators report orders of magnitude improvement in memory capacity and data transfer rates. New pattern memory system cost a factor of 25 less than the previous proprietary system. A Fast Orbit Feedback³ (FOFB) system has been evaluated by a prominent synchrotron facility recently. The FOFB is a distributed cRIO and PXI based system using EtherCAT interface. Initial testing has been successful with control loop rate of the order of several KHz. The evaluators have concluded that the NI system is comparable in performance with other state of the art systems around the world with distinct advantages of COTS platform such as reliability, scalability and cost savings. Other synchrotron applications include a Multi-Pixel Photon Counter testing at KEK and POLCA beamline experiment at the ESRF.

The technical presentation will discuss NI PXI, CompactRIO and LabVIEW instrumentation platforms for applications in High Energy Physics. Along with complex measurement, control and diagnostic systems, data must be processed real-time to make intelligent decisions about measurement and control parameters. For mathematical computations and simulations, National Instruments LabVIEW offers scientists and engineers a unique graphical programming environment that combines control and measurement system development along with real-time high performance computing including multicore processors and FPGAs. National Instruments ensures customer success by offering services such as technical consulting, training, calibration and replacement parts worldwide.

1. Y.B.Leng, W.M.Zhou, Y.Z.Chen, etc., "SSRF Beam Instrumentation System", ICALECS'07, Knoxville, US, Oct. 2007, p. 205 (2007)
2. G.G. Hoyes, APAC 2007, Indore, India, p. 461
3. Private communication, work under progress