PXIE Control System Status

Jim Patrick
07 April 2015
Control System Scope

• High level subsystem control and monitoring:
  – Power Supplies
  – LCW
  – Cryogenics
  – Instrumentation
  – RF
  – Motion Control
  – Machine Protection

• Beam control & monitoring applications

• Timing system
General Plan

• Based on ACNET
  – It is what we know and use in the main complex
  – Operators are familiar with it
  – Goal is to provide an integrated interface to everything

• Similar to NML

• Try to be forward looking:
  – No CAMAC, CIA vacuum, IRMs, C190/290 MADCs, …
  – Instead have VME, PLCs, HRMs
  – Limited console style applications, more extensive use of synoptic displays, Java applications, …
  – Environment for trying out new things for PIP-II

• Assume most development by FNAL
Hardware Infrastructure

- **Hotlink Rack Monitor (HRM)**
  - General purpose digitizer/controller
  - 64 16 bit ADCs, 10 KHz sampling rate
  - 8 16 bit DACs
  - 64 digital I/O bits
  - Chassis connects to VME based front-end

- **V474 Non-ramping 4 channel power supply controller**
  - Greater density than HRMs

- **Various PLCs**
Timing System

• Similar to TCLK system in main complex
• Based on 9.028 MHz reference provided by LLRF system
• Rep rate generator generates fixed rate events:
  – 60Hz, 10Hz, 5Hz, 2Hz, 1Hz, 0.5Hz, 0.1Hz
• Extraction electrode modulator provides “beam” trigger event
• Timer module available to provide delayed events
• Core events from main system available – 00, 02, 0f, 8f
Hardware

• Vacuum, LCW
  – Hardware interfaced via PLCs to ACNET front-ends
  – Controllers moved to racks outside the cave
  – Allison scanner vacuum monitored via HRM front-ends

• Power Supplies
  – HRMs used for many things
  – V474 used for trim magnets
  – Custom front-end for extraction electrode and chopper modulator

• Motion Control
  – Our standard system
  – LEBT and prototype MEBT scrapers operational
Hardware

• RFQ power amplifier
  – HRM for drive, forward & reflected power
  – PLC for temperature, flow (Labview)
PXIE Applications

• Console generic core applications
  – Parameter Page
  – Fast Time Plot
  – Data Logging
  – Alarms
  – Save/Restore
  – Sequencer

• Synoptic Displays
  – Drag and Drop Builder

• Finite State Machines

• Java Applications
Synoptic Display

- Simple way to make nice graphical applications
- Drag and drop builder, no code writing required
- Launch via console index page, or Java web start
- Web display available, no extra work required
  - Viewable on phones, no settings
- Supports plots, fetching data logger data
- Basic functional expressions available with no code writing
- Possible to have Finite State Machine back end
- Possible to attach ACL scripts for more complex things
  - Discouraged for very complicated things
- Heavily used at NML
PXIE Applications

• A couple of synoptic displays have been developed
• An automated scan application using our Java application framework is also available
• Finite State Machines for stabilizing arc current, rudimentary machine protection system pending hardware system.
• These frameworks together with the core console applications should be able to meet most needs
PXIE Overview Synoptic

<table>
<thead>
<tr>
<th>6.40E-05</th>
<th>3.65E-06</th>
<th>9.88E-12</th>
<th>Vacuum (Torr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Current (ma)</td>
<td>ID 1</td>
<td>DCCT</td>
<td>ID 2</td>
</tr>
<tr>
<td>-8.257</td>
<td>-0.029</td>
<td>-8.059</td>
<td>-5.567</td>
</tr>
<tr>
<td>Pulsed Current (ma)</td>
<td>-8.488</td>
<td>-5.690</td>
<td>-8.580</td>
</tr>
</tbody>
</table>

Ion Source

- Water Status: 
- Ready Status: 
- N2 Flow: 14.286 sccm
- N2 Flow Control: 14.994 sccm
- Bias Voltage: 29.810 KV
- Extractor: 2.580 KV
PXIE RFQ RF Distribution
PXIE Scraper Scan Result

![Graph Image]

This page contains a graph titled "PXIE Scraper Scan Result." The graph appears to show data with peaks and troughs along the x-axis labeled 'PL130Z' and the y-axis labeled with various numerical values. The graph includes multiple curves that intersect and vary in amplitude, indicating some form of signal or measurement data. The context provided suggests it is related to PXIE Controls, and the page is part of the Fermilab documentation, with a date of 4/7/2015.
Application Issues

• Long term future application framework is uncertain
• Technology and people’s tastes evolve
• Many other technologies are in use elsewhere
  – Traditional console applications, C++/ROOT, Matlab, python, Labview, ACL scripts
  – Not all are available from index pages
  – Sometimes no or limited code management
  – Expertise is diffuse among various technologies
• Knowing what applications are required would be helpful in developing future plans
• As the facility is built out, it will become much more complex
• We can help!
Some Random Issues/Thoughts

• Data acquisition in CW mode
• Prototype PIP-II timing system?
• Instrumentation front-end/applications
  – Scanner Labview not currently integrated into control system
• RFQ resonance control architecture
• Beam steering applications
• HWR cryomodule from Argonne
Summary

- PXIE control system is based on ACNET
  - Trying to be forward looking
- Existing hardware has been (mostly) integrated
- System has supported studies to date
  - Short periods of operation by operators
- There are things to think about for the future