Imaging System Integration at the SNS

Tom Shea, Willem Blokland, Tom Pelaia (ORNL)
Callie Goetz (Middlebury College)

Systems developed by instrumentation and controls staff at BNL, LANL, and ORNL
Ring Injection Foil

- Foil positioning and beam imaging at high radiation ring injection point
- 2 Rad-hard all-tube (yes, tubes) cameras
- NI framegrabber - Labview - shared memory - IOC - EDM

The BNL/Diamond/ORNL EDM widget
Laserwire Stabilization

- Analog CID cameras in linac radiation environment
- Interactive user interface to allow selection of desired laser beam position
- Feedback algorithm maintains desired position by actuating upstream mirror
Temporary Target Viewscreen

- Dose on fiber tip: ~ 1 GigaRad
- Imaging fiber allowed use of rad-soft Firewire camera

Over one megawatt goes here
On-line Analysis

- Non-linear geometric mapping to correct for optical distortion, screen angle, screen offset
- Normalization using real-time data stream from Beam Current Monitor
- Calculate projections, centroids, RMS widths
- Calculation and strip chart display of horizontal and vertical centroid and RMS width of beam distribution
- Labview, datasockets, global timestamps, live webpage - but no EPICS integration for this temporary system
Future Target Viewscreen

- Transition radiation or Helium scintillation may demand specialized low light cameras
- Use imaging fiber and reflective optics to allow rad-soft camera
- Integrate with EPICS
Neutron Beam Imaging

- Low photon intensity from scintillator (similar to future target viewscreen options)
- Cooled astronomical camera, proprietary USB interface
## Interfaces

- Prefer GigE, but all are supported at SNS via Labview
- Most are interfaced to EPICS via shared memory

<table>
<thead>
<tr>
<th>System</th>
<th>Interface</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>RS-170</td>
<td>low radiation, intensity trigger</td>
</tr>
<tr>
<td>Laser</td>
<td>RS-170</td>
<td>radiation, in feedback system</td>
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<tr>
<td>Injection</td>
<td>RS-170</td>
<td>high radiation</td>
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<tr>
<td>Linac Dump</td>
<td>GigE</td>
<td>remote camera via fiber</td>
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<tr>
<td>Electron scanner</td>
<td>GigE</td>
<td>future system</td>
</tr>
<tr>
<td>Target</td>
<td>Firewire/USB</td>
<td>remote camera via fiber, future low light option</td>
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<tr>
<td>Neutron</td>
<td>Firewire/USB</td>
<td>low light, MCP, EMCCD</td>
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</tbody>
</table>
Multicast Demo

- **Broadcaster**: PV arrays to MPEG4 (CPU: 20% for 10 Hz frame rate)
- **Streaming Server**: RTSP multicast (CPU: <1%, network: <100kb/s)
# Video on the Network

<table>
<thead>
<tr>
<th>Technique</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>EPICS Channel Access over TCP</td>
<td>Integration with: archiver, EDM, etc; easy correlation via EPICS timestamp; lossless</td>
<td>high network utilization; does not scale to many clients; no industry standard tools/clients</td>
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<tr>
<td>with frame as Array PV</td>
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<tr>
<td>MPEG-4 over RTSP</td>
<td>Low network utilization; scaleable; industry standard; many standard clients</td>
<td>time correlation still not implemented; challenging integration with EPICS tools; lossy</td>
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</tbody>
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Summary

- Radiation environment leads to nifty 1950s technology and complex optics
- Performance requirements lead to unique camera interfaces
- Commercial software used to handle variety of interfaces and image processing requirements
- Via shared memory DLL, imaging subsystems successfully integrated with EPICS toolkit
- Multicast streaming technologies are being assessed