EPICS Migration for the Fermilab Accelerators

**PIP-II and Modernization**

EPICS Collaboration Fall Meeting 2020

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Controls at Fermilab

Not historically an EPICS lab for the accelerators
EPICS in use for experiments slow-controls (Nova, ICARUS)
PIP-II

250 meter 800 MeV Superconducting RF Linac
Feed into existing Booster and rest of accelerator chain and beam lines
Enable intense high-energy neutrino beam for LBNF/DUNE
International Collaboration
The PIP-II linac is technically complex, state of the art superconducting RF accelerator. PIP-II is the world’s highest energy CW proton linac, and the first U.S. accelerator project to be built with major international contributions.
**PIP-II Controls**

All New Linear Accelerator
   - BPMs, BLMs, Motion Ctrl, Images, Vacuum, MPS,…
New Cryo Plant
New Accelerator Clock Timing System
Integration Into Existing Accelerators
EPICS Selected for Control System
   - EPICS Is a Toolkit
   - Different Implementation Choices
   - We’re trying to select the best subsystems/apps/clients that fit our needs
PIP-II Feeds Into Existing Accelerator Chain
Accelerator Controls Modernization

Fermilab recently awarded DOE CD-0 for Controls Modernization
Expected to be about a 7 year project
Focus on replacing obsolete hardware and software
Opportunities for upgrades abound
Not in the budget to replace *everything*
Accelerator Controls Modernization

- Replace obsolete hardware and software, reducing some serious failure risks
- Allow us to take advantage of modern hardware and software technologies
- Position ourselves to exploit future emerging technologies.
- Attract talented engineers
Accelerator Controls – Timeline of Accelerator Controls

- 1980: C1981-83 Fermilab ACNET
- 1983: SLAC SLC
- 1989: C1989 LANL EPICS
- 1993: Argonne APS(EPICS)
- 1995: Brookhaven RHIC
- 2000: C2002 ESRF et al TANGO
- 2002: ESRF et al TANGO
- 2007: C2007 CERN LHC
- 2009-2017 SLAC LCLS
- 2018-2019 APS Rejuvenation
Fermilab Accelerator Control System

- One common control system used for all the core accelerators
- Support operator consoles used in control rooms and offices throughout lab.
- Accelerators provide beams for Fermilab experiments: Nova, MiniBoone, ICARUS, SBND, g-2, mu2e, Test Beam Facility,…
Accelerator Controls Modernization Focus

Replacement of CAMAC Fieldbus hardware
   275 crates, 200 Multiplexing ADCs, many custom cards
Replacement of 68040-based data acquisition systems
Get rid of PSOS Operating System
Modernize user interface
   Move off of X-windows
   Adapt to more modern screens
Opportunities for upgrades abound (e.g. VXI-based LLRF)
Not in the budget to replace *everything*
Accelerator Controls Modernization

Leaning towards EPICS as the #1 alternative for modernization
(CD-1 funding requires that we consider alternatives)

Software for Control System Includes:

- Data Acquisition Framework and Device-Specific Software,
- Console and Application Software Framework and Applications
- Central Services Replacements (Alarms, Archiving, Save/Restore,…)
Accelerator Controls Modernization Focus

Why EPICS?

Proven solution at many labs
Easier opportunity for collaboration
Has many existing solutions (clients, drivers) that will fit our needs
PIP-II Integration
EPICS — What Is There to Like?

Large existing variety of device drivers (OPC/UA, …)
Archiving Clients/applications
Kafka-based Alarm Applications
User Interface Choices
  Phoebus/CSS
Community of Knowledge to Draw Upon.
Accelerator Controls Modernization EPICS and PIP-II

EPICS and Current System (ACNET) will have to co-exist for some time

Bridging tools already in use
  These are good for protocol translation
  Harder problems come with data management (archives, etc.)

Larger issues with integration and management of databases
  ACNET relies on one central database of devices
  EPICS IOCs are more decentralized but there are tools like Channel Finder

We’re building infrastructure for both
Migrating to EPICS Is a Management Problem/Opportunity

• We’re confident in the technical capabilities of EPICS
• Specifications for Collaborators
  • We can’t just say “Make it EPICS” and expect it will inter-operate
• Database Integrations
• Choice of Central Applications (Alarms, Modern, supportable technologies)
• Authentication Issues and Policies
• Settings logging consistency
• Common precision timing system
• Sustainable Control System for future experiments.
Migrating to EPICS Is a Management Opportunity — People!

- Collaborators!
- New Hires (there’s a lot of work!)
  - (But Covid-19 — remote interview, remote on-boarding:-(. )
- Training
- Modernization can attract talented engineers
- Deal with staff turnover
- Position ourselves to exploit future emerging technologies.
• Despite Heinz’ presentation Monday, I’m pretty sure it’s going to take us longer than 45 minutes.