



Work Status Report

Hall C Controls and Monitoring Systems (CMS)

Detector Support Group

Peter Bonneau

Contents

- I. Upgrade of HMS/SHMS PLCs
- II. Development of EPICS CMS
 - Why DSG recommends EPICS-CSS
 - Advantages of EPICS CMS over PLC CMS
 - EPICS-CSS Toolkit used to develop
 - i. User interface screens
 - ii. Remote monitoring
 - iii. Alarm handler
 - iv. Archiving
 - EPICS for PLC systems
 - i. Development SoftIOCs for PLC to EPICS communications
 - ii. Implementation of CSS CMS
 - HV Systems
 - i. Transitioning from Tcl/Tk to CSS for controls and monitoring
- I. Status
- II. Conclusion

Upgrade Work Done for the PLC Systems

Item	Description	Status	Comments
1	HMS and SHMS dipole field regulation routine	Completed	Completed on 09/13/2018
2	New NMR communication through PLC to PSU	Does not work as expected	Issues to lock PT2026 when field > 1.4 T
3	Test Ethernet vs Controlnet interface	Completed	Completed on 06/13/ 2018
4	Swapping of Controlnet by Ethernet modules in SHMS	Completed	Completed on 7/13/2018
5	Add spectrometer rotation electric break control	Completed	Completed on 08/03/2018
6	Add HMS Spectrometer vacuum to controls	Completed	Completed on 07/23/2018
7	Data logging upgrade, install, and make operational	EPICS task	Will be completed in EPICS MYA Archiver
8	Develop "on loop" current regulation routine for quads PSU	Completed	Completed on 08/06/2018
9	Wire UPS status to controls	Completed	Completed on 09/13/2018
10	Modify SHMS shutter not in place status	Completed	Completed on 08/03/2018
11	Add HMS shutter controls and status	Completed	Completed on 08/03/2018
12	Alarm notification to on-call staff	EPICS task	Will be completed in EPICS
13	Add HMS quadrupoles hall probe readouts to PLC	Completed	Completed on 08/29/ 2018
14	End of life for Windows 7 upgrade to Windows 10	Completed	Completed on 10/02/2018
15	Upgrade SHMS PLC from version 16 to version 20	Completed	Completed on 7/13/2018
16	Upgrade HMS PLC from version 16 to version 20	Completed	Completed on 01/18/2019

PLC Upgrade

Regarding highlighted tasks in previous slide

Task #2 New NMR communication through PLC to power supply

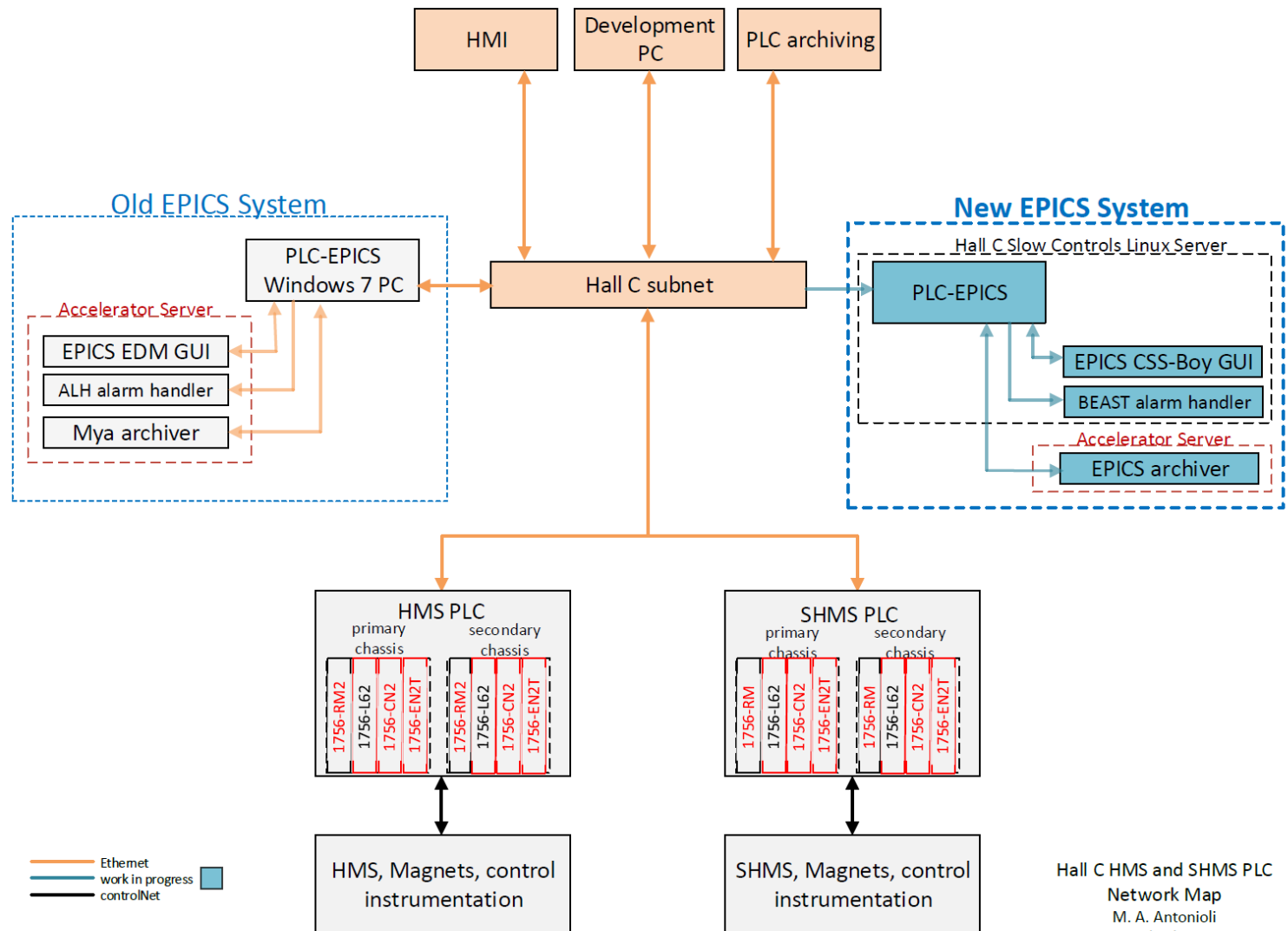
- New GMW PT2026 NMR purchased by Hall C to increase data acquisition rate over the installed PT2025 NMR
- Issues
 - PT2026 loses lock on field soon after dipole current is changed
- Old PT2025 NMR still in use

Task #7 Data logging upgrade, install, and make operational

Task #12 Alarm notification to on-call staff

- These two tasks can be implemented in EPICS-CSS

Upgraded PLC Systems



Hall C HMS and SHMS PLC
Network Map
M. A. Antonioli
4/12/19

Why DSG recommends EPICS-CSS

Advantages of EPICS CMS over PLC -CMS

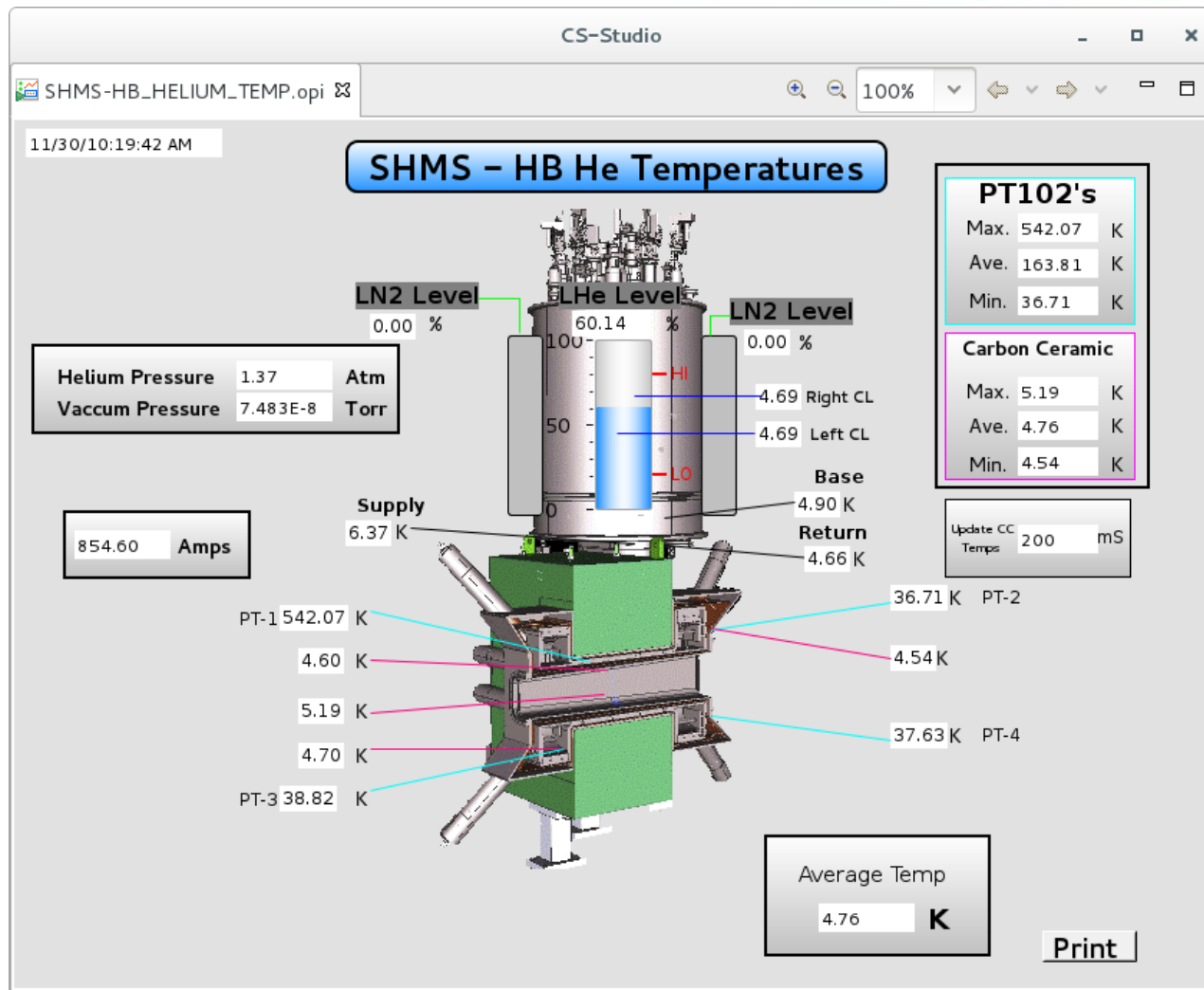
Feature	PLC	EPICS - CSS
Make control system changes without need to reboot	X	
Does not require installation of software on user or development system		X
Remote web monitoring capabilities		X
Does not require a license for each control or HMI session		X
Free open-source control software (PLC cost per control development license: \$6,530)		X
Free open-source GUI software (PLC cost for GUI license: \$16,700)		X
Runs on more reliable Linux systems		X
Runs on all hardware platforms (VME, cRIO, PLC, HV crates, LV crates, GPIB, etc. PLC software can <i>only</i> run on PLCs; EPICS/CSS can run on <i>any</i> hardware platform		X
Unified user experience – operator interface identical independent of hardware platform		X
Can run multiple novice or expert GUI sessions		X
Uses open-source programming languages (C, C++, Python, etc.)		X
Integrated development environment (control and GUI) for all applications		X
Extensive support for multiple vendors' hardware and software		X
Distributed control functions to reduce load on central controller (examples: PID loop control, pulse generation, latching, events and alarms)		X

- EPICS Toolkit CSS selected by DSG
 - Consistency within Physics Division
 - DSG expertise for maintenance and support
- CSS components used for this project
 - BOY - User interface screen
 - WebOPI - Remote monitoring
 - BEAST - Alarm handler system
- CSS components under investigation
 - Data browser
 - Logbook
 - Diagnostic tools

Development of CSS-BOY User Interfaces

- Exported signal names from PLC HMI screens
 - 63 HMS HMI screens
 - 210 SHMS HMI screens
- Added diagrams and background images
- Added indicators and controls
- Assigned EPICS PVs to indicators and controls
- Added rules to indicators for alarm notifications
- Integrated CSS-BOY screens into slow controls server

CSS-BOY User Interface Screen

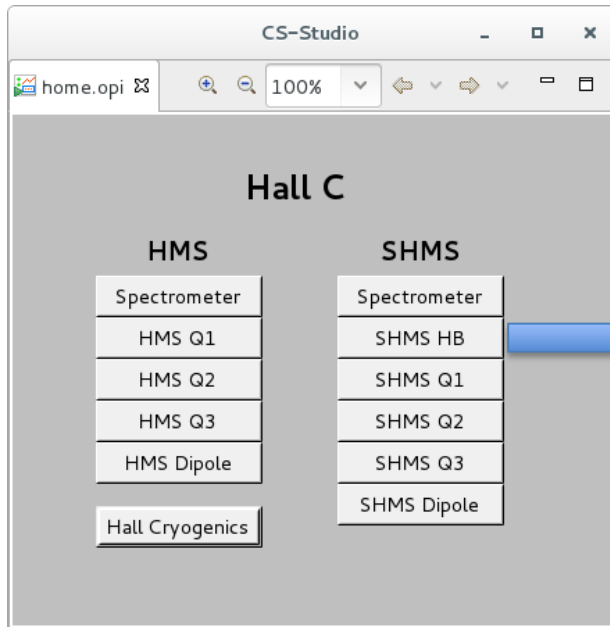


Working CSS-BOY OPI for SHMS Horizontal Bender magnet developed by DSG
Screen is replicated from current PLC HMI screen

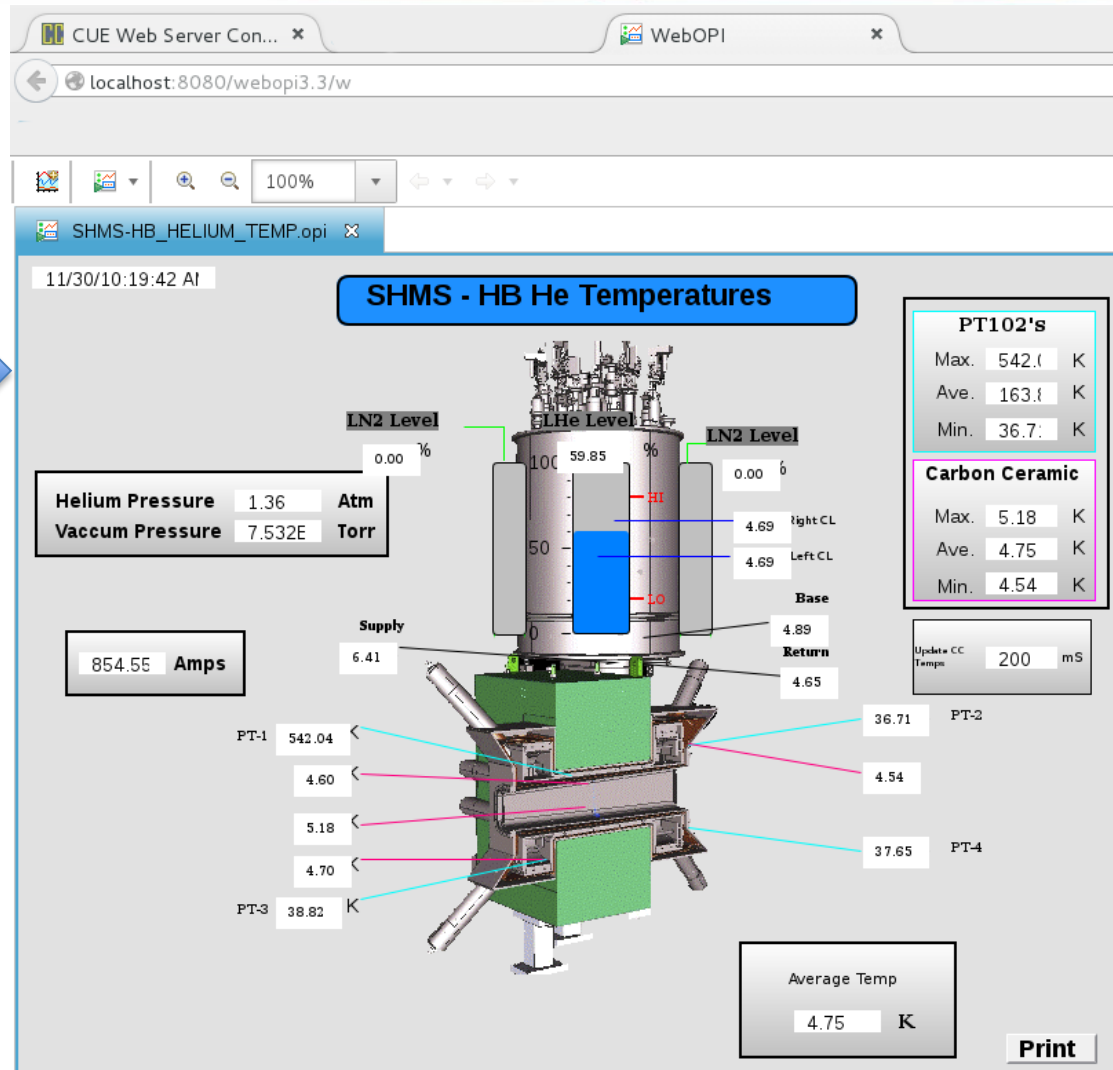
Development of WebOPI Remote Monitoring

- Develop CSS screens
 - Status: **In progress**
- Verified screen layouts on WebOPI
 - Status: **In progress**
- Set up server in computer center
 - Status: **Not allowed to run a server**
 - Tomcat installed on DSG PC for initial development
- Configure and run servlet with WebOPI
 - Status: **Not allowed to run a server**
 - Completed on DSG development PC

Operational WebOPI Screens



Hall C WebOPI Main Menu



WebOPI screen for SHMS HB magnet (with live data)

WEDM Remote Monitoring System

WEDM an alternate to WebOPI

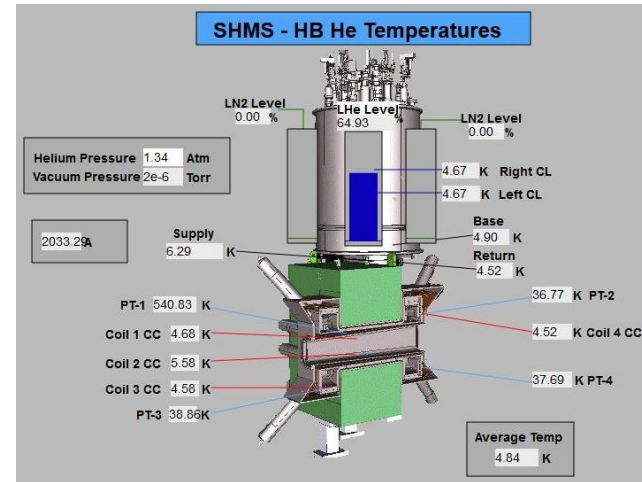
- WEDM = Web Extensible Display Manager
- Runs on an accelerator server
- Screens can display alarms for PVs
- Screens monitor only - no control
- Two WEDM screen types under development:
 - List view for overview (top image)
 - Graphical view (bottom image)
- Python script developed to convert CSS-BOY screens to EDM screens



PLC system menu on Accelerator's *epicsweb* menu

Cryogenics Overview		
4K Return valve	106.20	%
4K Flow limit	27.00	g/s
Hall C 4K Supply Flow	22.42	g/s
Hall A 4K Supply Flow	26.39	g/s
Hall B 4K Supply Flow	6.52	g/s
4K Supply Pressure ESR	3.39	Torr
Hall C 4K Supply Pressure	2.67	Torr
Hall C 4K Return Pressure	1.20	Torr
Hall C Quench Line Pressure	1.79	Torr
Hall C Quench Line Pressure	1.21	Torr
Quench line flow	22.69	g/s
Lead line flow	0.82	g/s
Lead line pressure	1.10	Torr
Hall C LN2 Flow	1.02	g/s
Hall C LN2 Supply pressure	3.96	g/s

Hall C Cryogenics overview WEDM screen



WEDM conversion of CSS-BOY user interface

<https://epicsweb.jlab.org/wmenu/#HallCMenu-page>

Click on: *Hall C PLC System*

Development of CSS BEAST Alarm Handler

Work Completed:

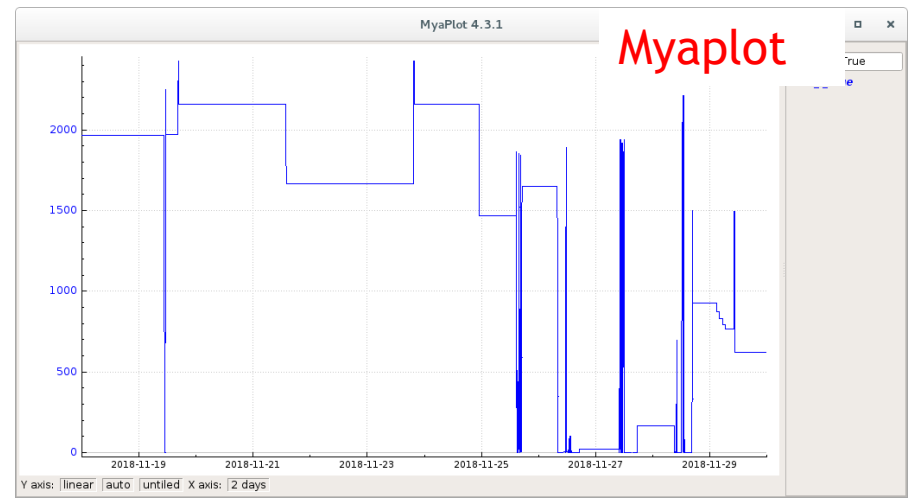
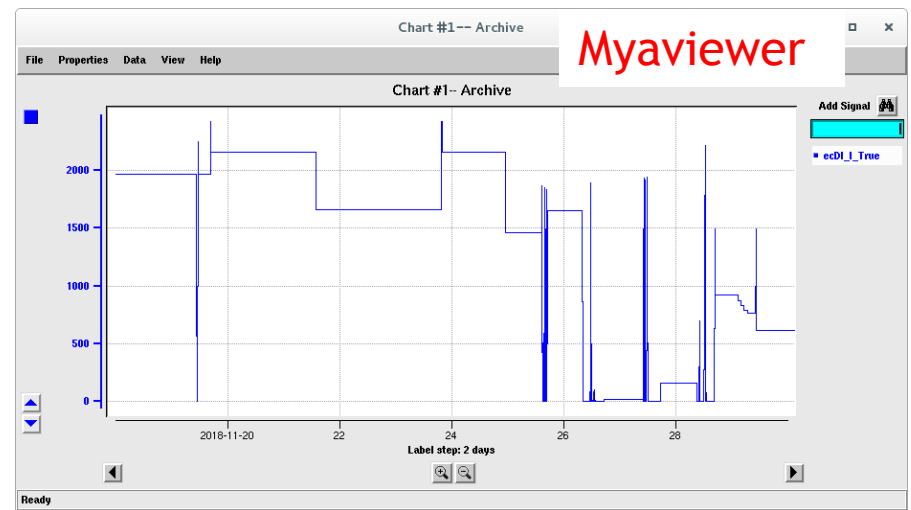
- Generated CSV data files of EPICS signals
- Developed Python script to convert CSV data to alarm configuration file

Work to be Done:

- Develop message logging
- Write annunciator routine
- Configure “Alarm configuration and state” to generate web reports
- Create operator interfaces

Mya for Data Archiving

- Hardware
 - Accelerator's servers
 - Maintained by Accelerator
- Software
 - JLab's Mya Archiver
 - PVs archived with “dead-bands”



Need to Buy Server for EPICS

- Cost ~\$4800
- Will run EPICS software base and support services
- Operating system and monitoring software
 - RedHat Enterprise Linux (RHEL7)
 - Monitored by [Nagios](#) with regular automatic checks



Development of EPICS SoftIOCs

- SoftIOCs convert PLC tags into EPICS PVs
- SoftIOCs run on the EPICS Server
 - Uses *ether-ip* device as EPICS support driver
 - Supports module that interfaces ControlLogix PLCs with EPICS via Ethernet
 - Used by Hall B and Hall D
 - Created from PLC tags and configuration parameters

Development of EPICS SoftIOCs

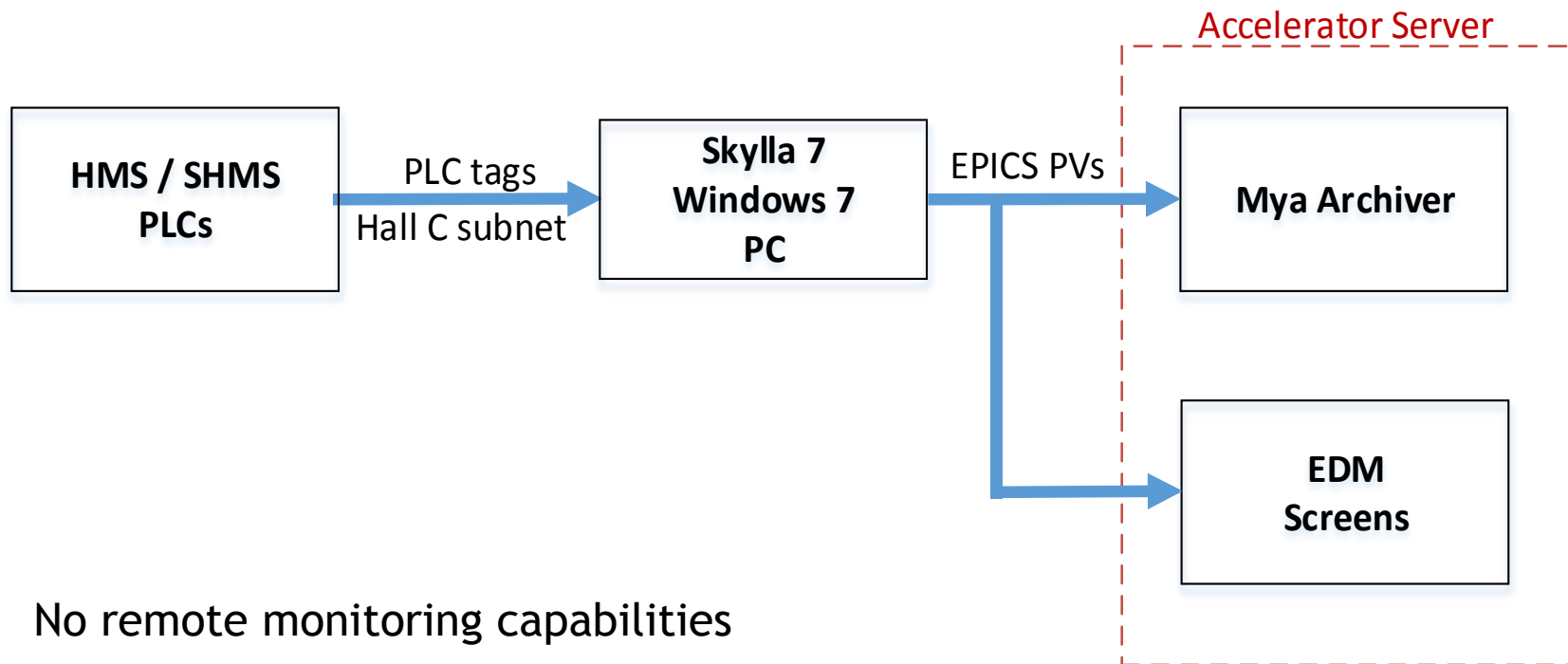
Work Completed:

- Generated merged data list from PLC tags of HMS and SHMS
- Determined optimized number of SoftIOCs for Hall C PLCs
- Developed Python scripts for generation of:
 - EPICS databases
 - Alarm handler configuration
- Created and tested PLC-EPICS databases

Work to be Done:

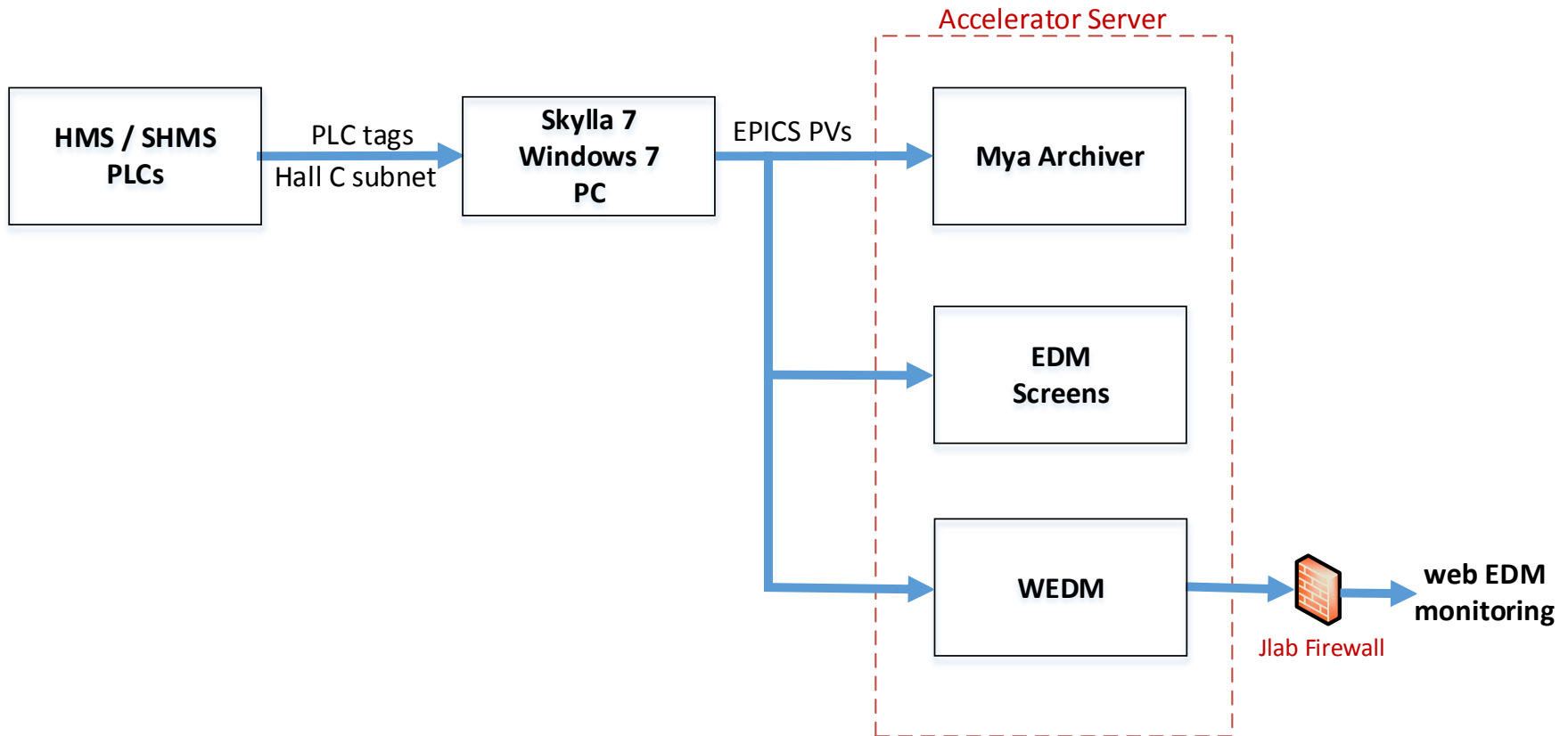
- Develop Python scripts to convert tag data list into EPICS databases
- Determine EPICS process variable aliases for PLC tags
- Use Python scripts to convert tag data list into EPICS databases
- Develop initialization scripts
- Install and configure PLC to EPICS SoftIOCs on slow controls server

Old System - PLC to EPICS



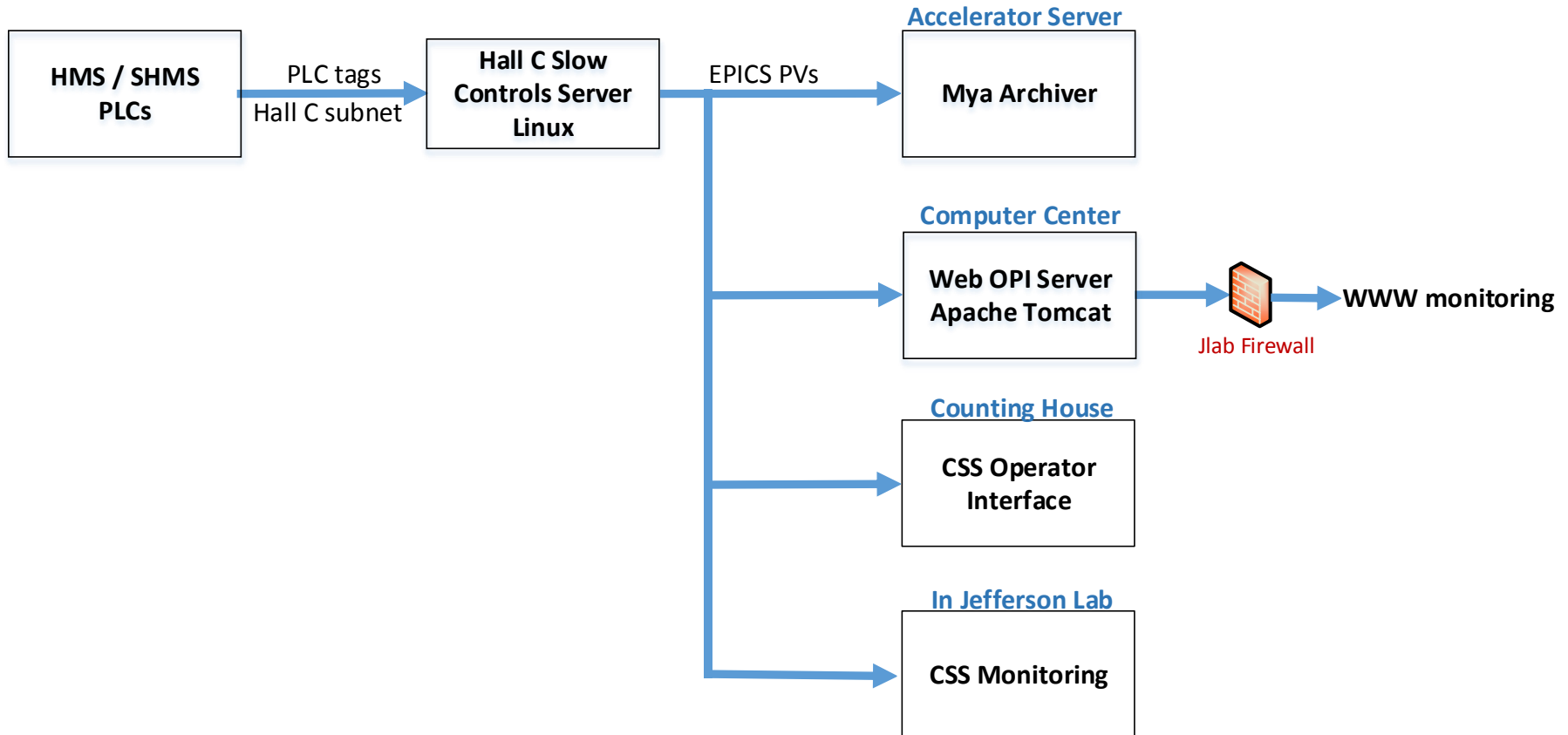
- No remote monitoring capabilities
- Windows 7 PC converts PLC tags to EPICS PVs

Transition System PLC to EPICS



- Remote monitoring via WEDM hosted by Accelerator server

Planned New System - PLC to EPICS



- Hall C Linux slow controls server converts PLC tags to EPICS PVs
- Remote web monitoring via WebOPI on Computer Center server

HV System Software Development

- Replacing old Tcl/Tk software
- Replacing and rebuilding software components
 - CSS control screens for HMS/SHMS
 - Channel grouping scripts
 - PV save/restore scripts
 - Alarm configuration file
- All software will run on EPICS Linux slow controls server

EPICS Project Status

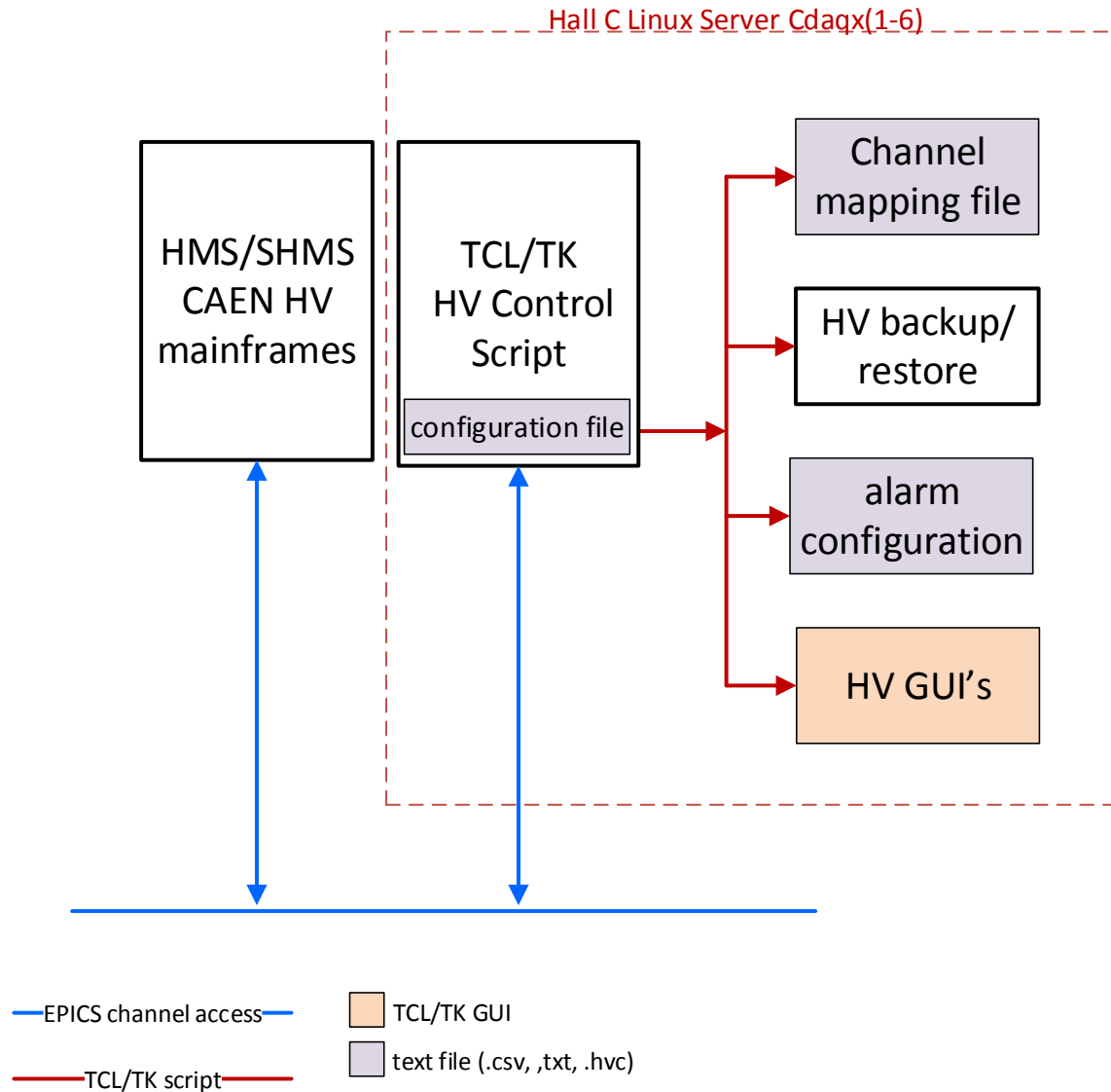
- Work completed

- Web WEDM PLC remote monitoring system
- PLC monitoring screens developed and tested for HMS and SHMS
- Alarms implemented on remote monitoring system

- Work in progress

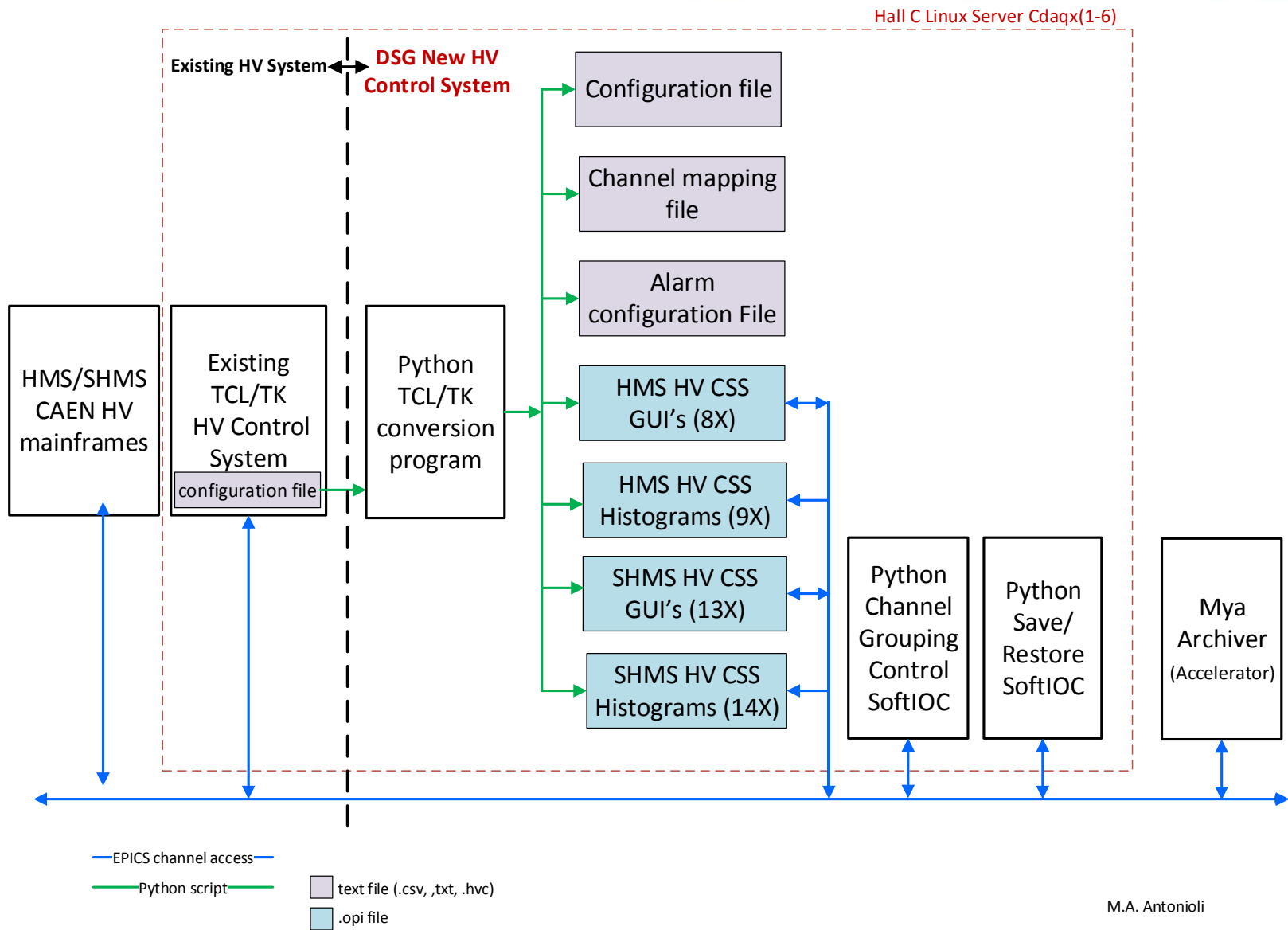
- Development of CSS HV system for HMS and SHMS
- Integration, debugging, and testing of HV control and monitoring system
- CAEN-EPICS HV test station development

Old HV System



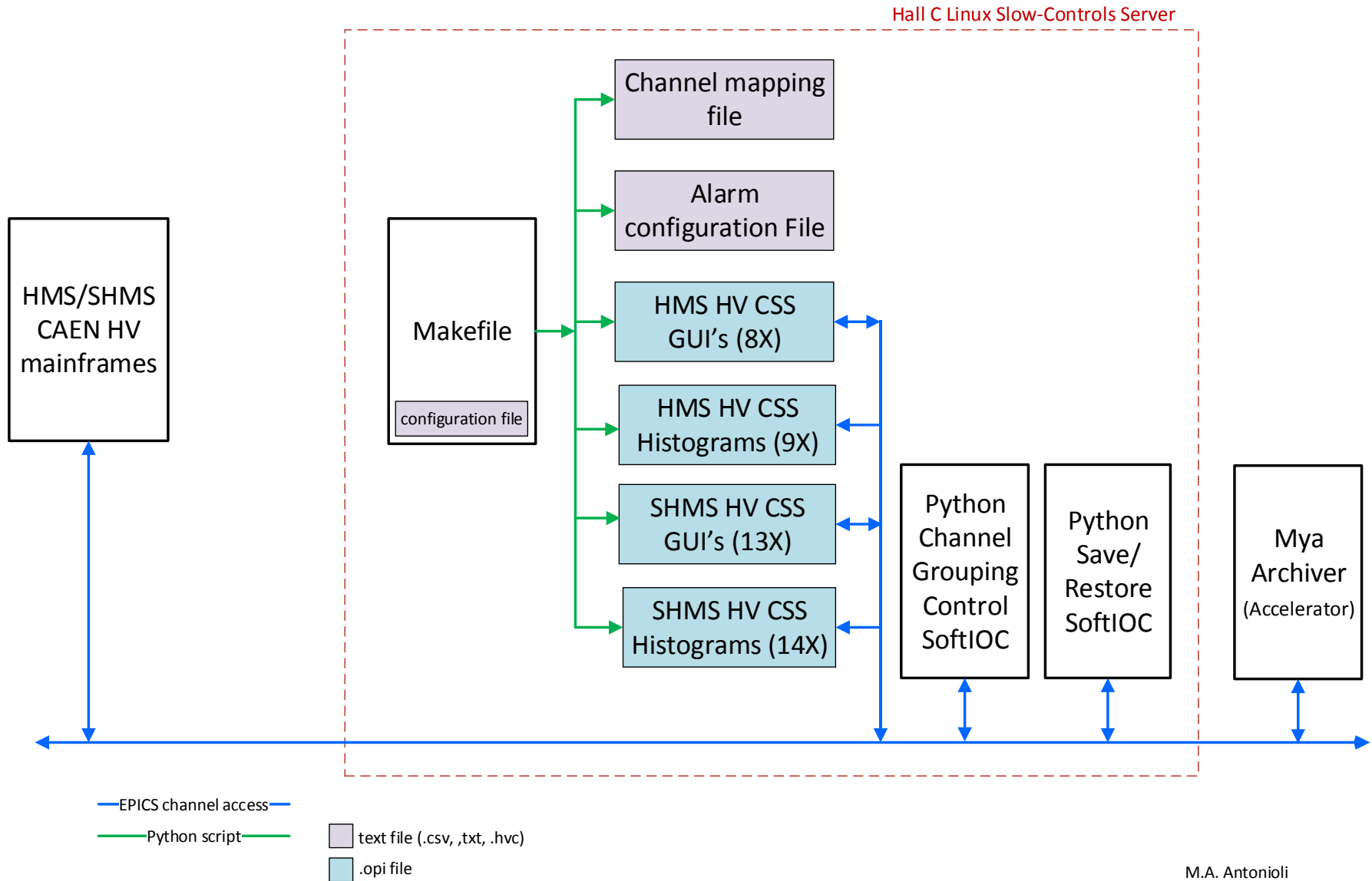
M.A. Antonioli

Transition HV System



M.A. Antonioli

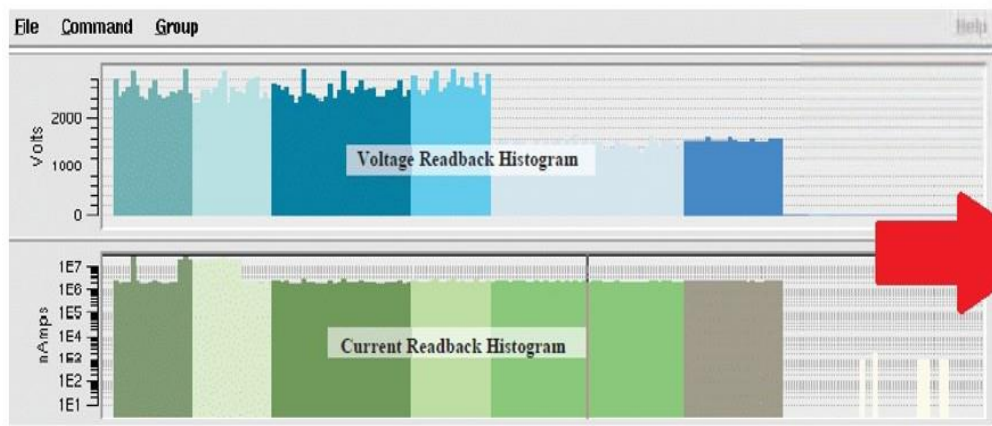
Planned New HV System



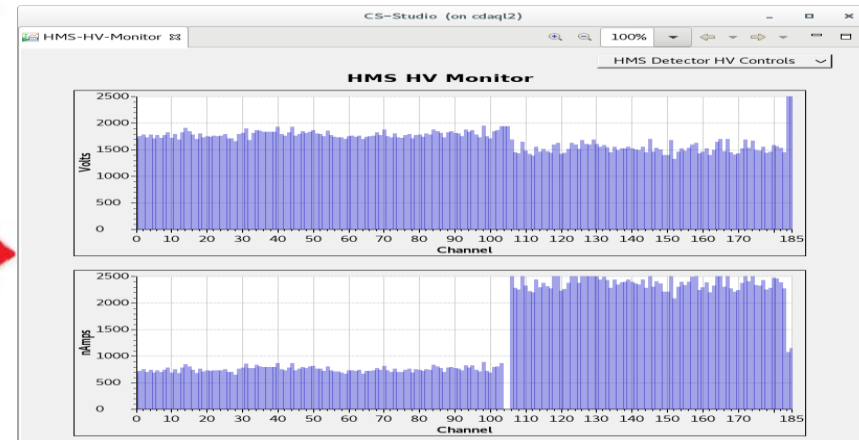
M.A. Antonioli

HV System Development

- Tcl/Tk to CSS
 - List view and histogram screens created for HMS and SHMS monitoring and controls
 - Python script used to convert screens from Tcl/Tk to CSS



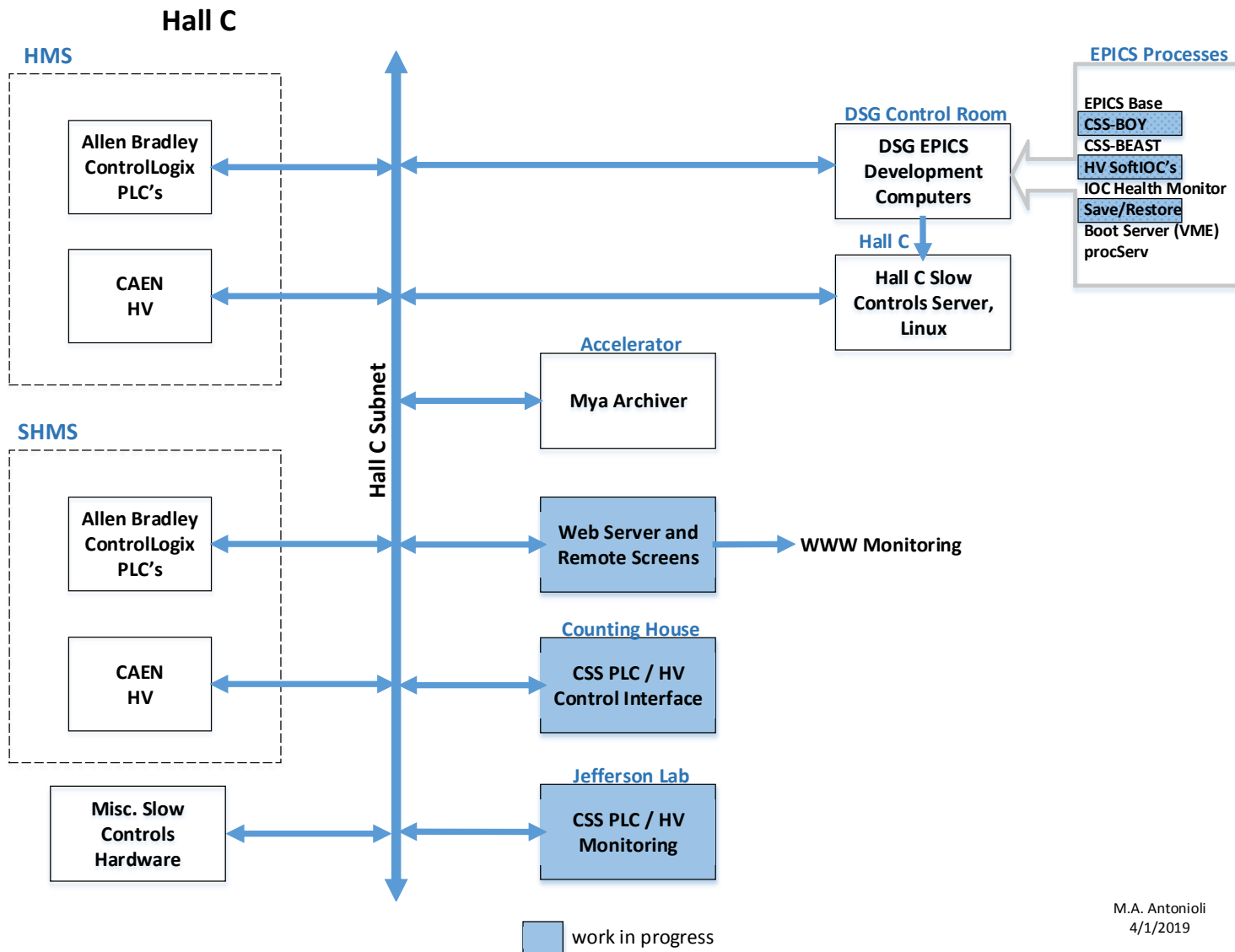
Tcl/Tk



CSS

Histogram screens monitor detector HV and current

Planned New System's Overview



M.A. Antonioli
4/1/2019

Conclusion

- Completed upgrade of PLC CMS
- Developing EPICS-CSS CMS for HMS/SHMS
- Advantages of EPICS-CSS CMS
 - Runs on all hardware platforms, not just PLC
 - Free, open-source software
 - Doesn't require license or software installation for each session
 - Runs on more reliable Linux systems
 - Consistency and experience within Physics Division

Thank You

DSG staff involved in this project

Mary Ann Antonioli, **Peter Bonneau (Lead)**,
Pablo Campero, Brian Eng, Amanda Hoebel,
and Tyler Lemon