



U.S. DEPARTMENT OF  
**ENERGY**



# JLab Hall B Controls: Infrastructure and IT Integration

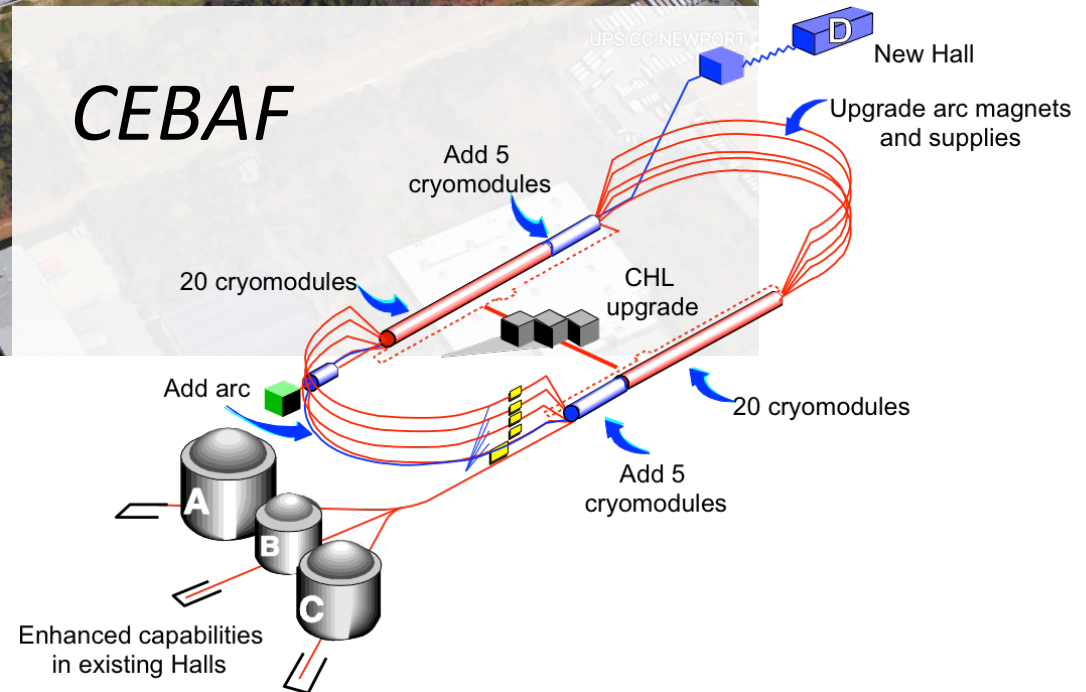
Wesley Moore  
JLab CNI

# Overview

- Hall B at JLab
- Migration to modern software
  - EPICS, GUIs, etc
- Useful utility scripts
- How we leveraged IT and security expertise
  - Host Management
  - Monitoring
  - Remote Access
- Future plans



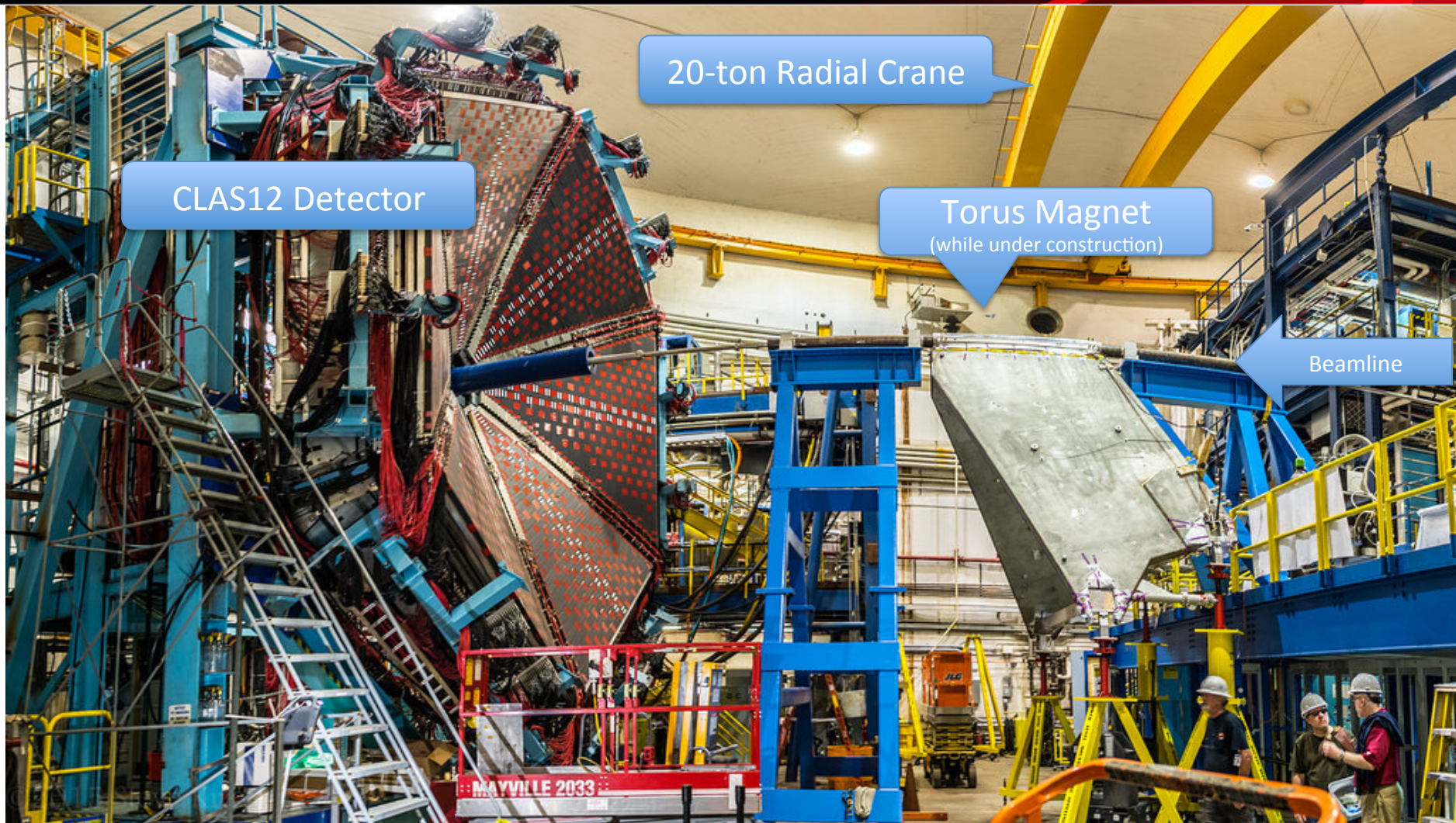
# Hall B at JLab



Google Maps: taken 09/08/2016

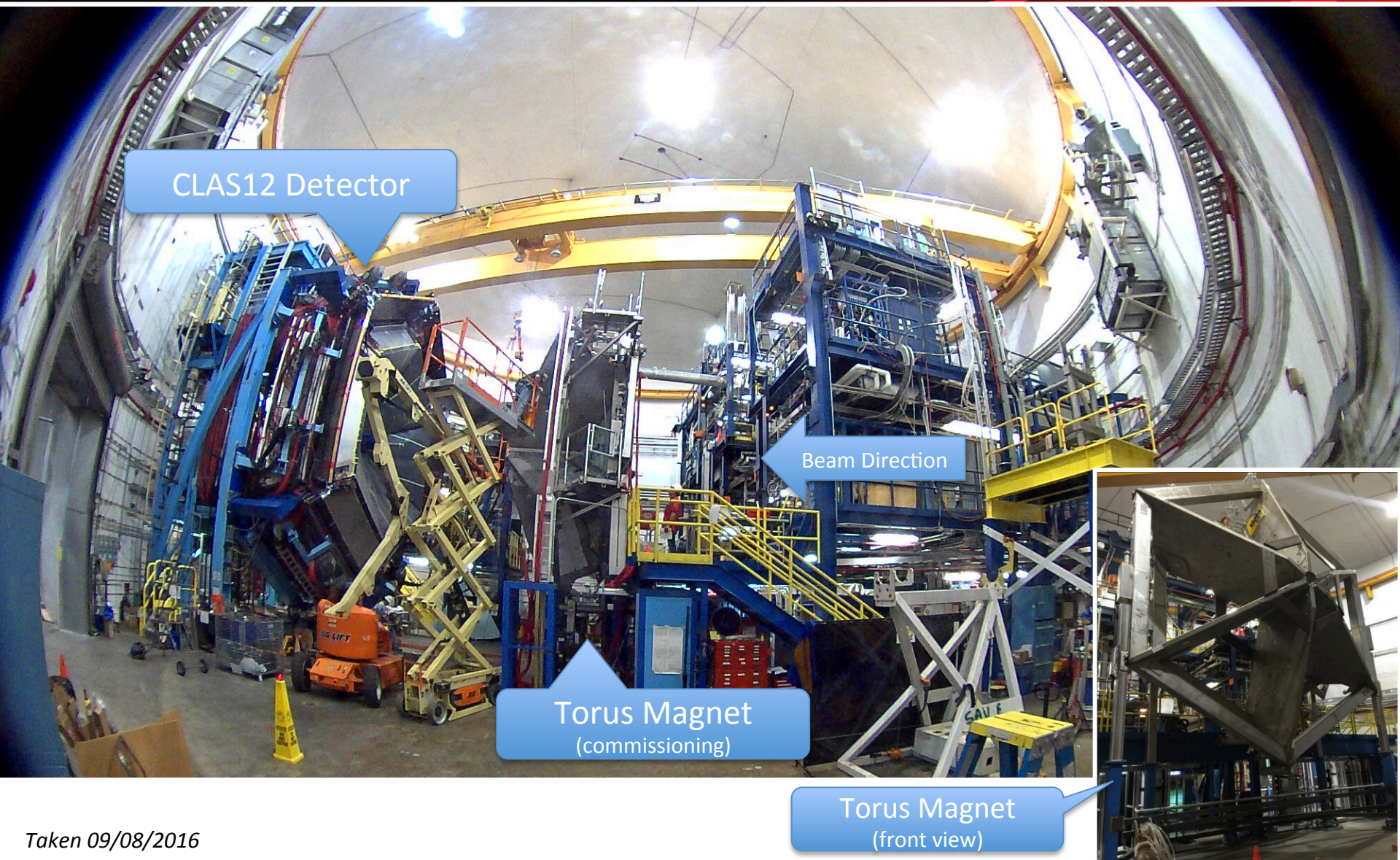


# Hall B at JLab





# Hall B at JLab





# Hall B at JLab

Slow controls supports beamline, detectors, and experiments

>50 apps/drivers, >65 IOCs

Diverse subsystem support:

- Cryogenics (mostly PLC-based)
- Detectors, targets
- Magnets
- Vacuum
- Motors (collimators, harps, targets)
- Scalers
- Gas (He, N, etc)
- High/Low voltage
- Chillers

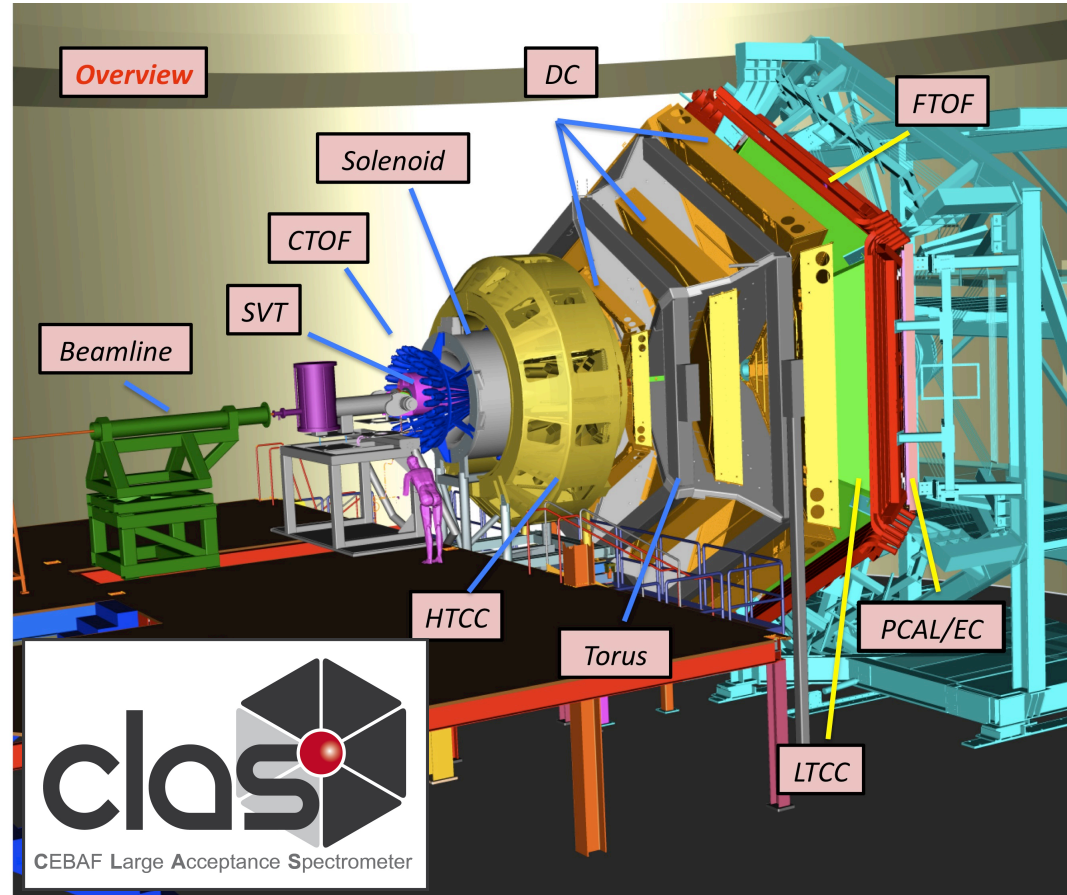
Slow Controls Team:

Wesley Moore, Nathan Baltzell (JLab)

Ken Livingston, Bryan McKinnon (Glasgow)

PLC Programming:

Nicholas Sandoval, Pablo Campero (JLab)



PRoton  
Radius



## Before...

### EPICS R3.13.4

- VME-centric (VxWorks)

### MEDM 3.1.9

### ALH

### No web interfaces

### CVS for ***most*** code

- Some with no version control

*<2yr migration*

## After...

### EPICS R3.14.12.5

- softIOc-centric (RHEL7 64-bit)

### CS-Studio 4.1.1

- Wrapper script generates tmp workspace
- Open MEDM-style Menu or Alarm Perspective

### BEAST/Notifier

- Some script generated configs

### WebOPI

- Read-only gateway access
- Used for Management Staff and basic monitoring

### Git for ***all*** code

- Branching (master, develop, hotfix)

Archiving done with JLab's Mya Archiver/Viewer

## CSS launcher scripts

1. clascss , opens CSS with MEDM-style.
2. clascss-alarm, opens CSS in alarm perspective with menu to the left.

Both generate temporary Workspaces, provides consistent behavior and user experience.

The screenshot displays the CS-Studio Alarm perspective. On the left, there is a sidebar with a 'clas' logo and two main sections: 'Detectors' and 'Subsystems'. The 'Detectors' section lists CTOf, DC, ECAL, FT, FTOF, HTCC, LTCC, RICH, and SVT. The 'Subsystems' section lists Asym, Devices, Gas System, HV, IOCs, Moeller, Motors, Scalers, Torus, and Wiener Crates. Below these is a 'Tools' section with 'Strip Charts'. The main area is divided into three panels. The top-left panel, 'Alarm Area Panel', shows a grid of colored buttons for different systems: PLC Comms (green), Cryo (red), Vacuum (yellow), HTCC (green), Cooldown (red), Forces (green), cRIO Comms (green), and SVT (red). The top-right panel, 'Alarm Table [HallB]', displays a table of current alarms. The bottom panel, 'Alarm Tree', shows a hierarchical view of the alarm system, including 'Area: Torus (MAJOR/HIHI\_ALARM)' and 'Area: Gas Systems (MAJOR/LOLO\_ALARM)'. The 'Alarm Table' contains two tables: 'Current Alarms (7)' and 'Acknowledged Alarms (8)'. Both tables have columns for PV, Description, Alarm Time, Current Seve, Current Statu, Alarm Severit, Alarm Status, and Alarm Value.

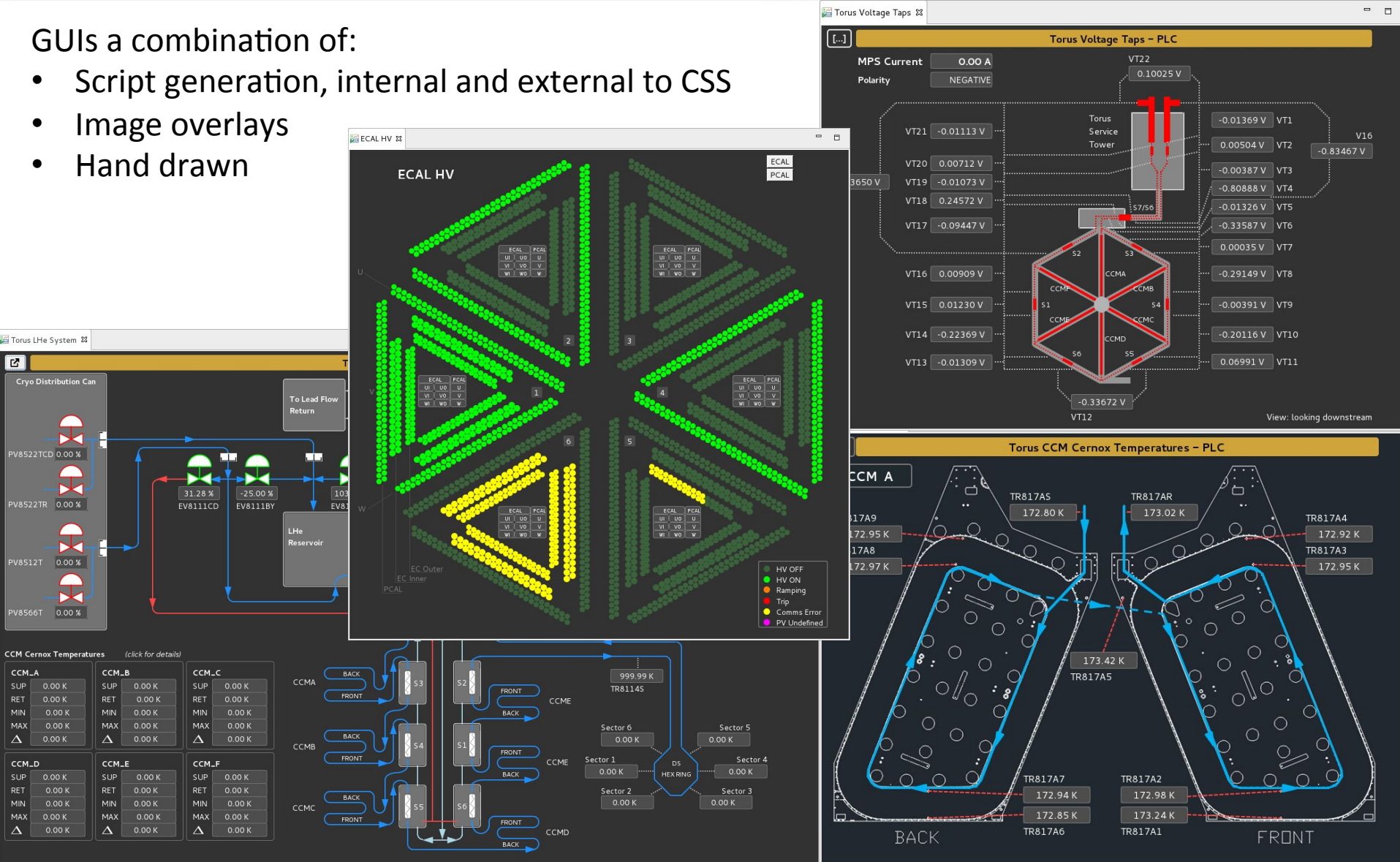
PV	Description	Alarm Time	Current Seve	Current Statu	Alarm Severit	Alarm Status	Alarm Value
B_TORUS:LN2:SHLD	MAJOR alarm: 600min avg, SHLD.T_AVG	2016/09/08 00:30:53.302	MINOR	HIGH_ALAF	MAJOR	HIHI_ALAR	8.85009794
B_TORUS:LN2:SHLD	MAJOR alarm: 120min avg, SHLD.T_AVG	2016/09/07 16:30:50.302	MINOR	HIGH_ALAF	MAJOR	HIHI_ALAR	2.74658202
B_TORUS:LHe:META	MAJOR alarm: Max of CCM_DT_MAX, CCM_DT	2016/09/07 17:30:43.300	OK	NO_ALARM	MAJOR	HIHI_ALAR	152.246000
B_TORUS:LHe:CCM	MAJOR alarm: Max CCM Diff. Temp	2016/09/07 17:30:43.299	OK	NO_ALARM	MAJOR	HIHI_ALAR	152.246000
B_TORUS:LHe:CCM	MAJOR alarm: 600min avg, CCM_DT_AVG	2016/09/07 17:31:51.299	MINOR	HIGH_ALAF	MAJOR	HIHI_ALAR	0.35448151
B_TORUS:LHe:CCM	MAJOR alarm: 30min avg, CCM_DT_AVG	2016/09/07 17:30:51.299	MINOR	HIGH_ALAF	MAJOR	HIHI_ALAR	0.23492431
B_DET_SVT_N2SupF	MAJOR alarm: SVT N2 Supply Flow	2016/09/08 14:37:59.090	OK	NO_ALARM	MAJOR	LOLO_ALAF	0.19790231

PV	Description	Alarm Time	Current Seve	Current Statu	Alarm Severit	Alarm Status	Alarm Value
B_TORUS:VAC:CG81	minor-ack'ed alarm: Torus upper vacuum	2016/09/01 15:12:51.000	MINOR	HIGH_ALAF	minor-ack'e	HIGH_ALAF	0.0
B_TORUS:LN2:TC85	major-ack'ed alarm: Nitrogen	2016/09/02 11:12:07.000	MAJOR	HIGH_ALAF	major-ack'e	HIGH_ALAF	166.448695
B_TORUS:LN2:SHLD	major-ack'ed alarm: 30min avg, SHLD.T_AVG	2016/09/07 15:40:50.302	MINOR	HIGH_ALAF	major-ack'e	HIHI_ALAR	3.96728511
B_TORUS:LN2:EV85	major-ack'ed alarm: Nitrogen		MAJOR	STATE_ALA	major-ack'e	STATE_ALA	MANUAL
B_TORUS:LN2:EV85	major-ack'ed alarm: Nitrogen		MAJOR	STATE_ALA	major-ack'e	STATE_ALA	MANUAL
B_TORUS:LHe:HE_M	minor-ack'ed alarm: TD8513T - METAL4K_T_M		MINOR	LOW_ALAR	minor-ack'e	LOW_ALAR	0.0
B_TORUS:LHe:HE_M	minor-ack'ed alarm: TD8111 - METAL4K_T_M		MINOR	LOW_ALAR	minor-ack'e	LOW_ALAR	0.0
B_TORUS:LHe:CCM	minor-ack'ed alarm: 120min avg, CCM_DT_AVG		MINOR	HIGH_ALAF	minor-ack'e	HIGH_ALAF	0.0



GUIs a combination of:

- Script generation, internal and external to CSS
- Image overlays
- Hand drawn



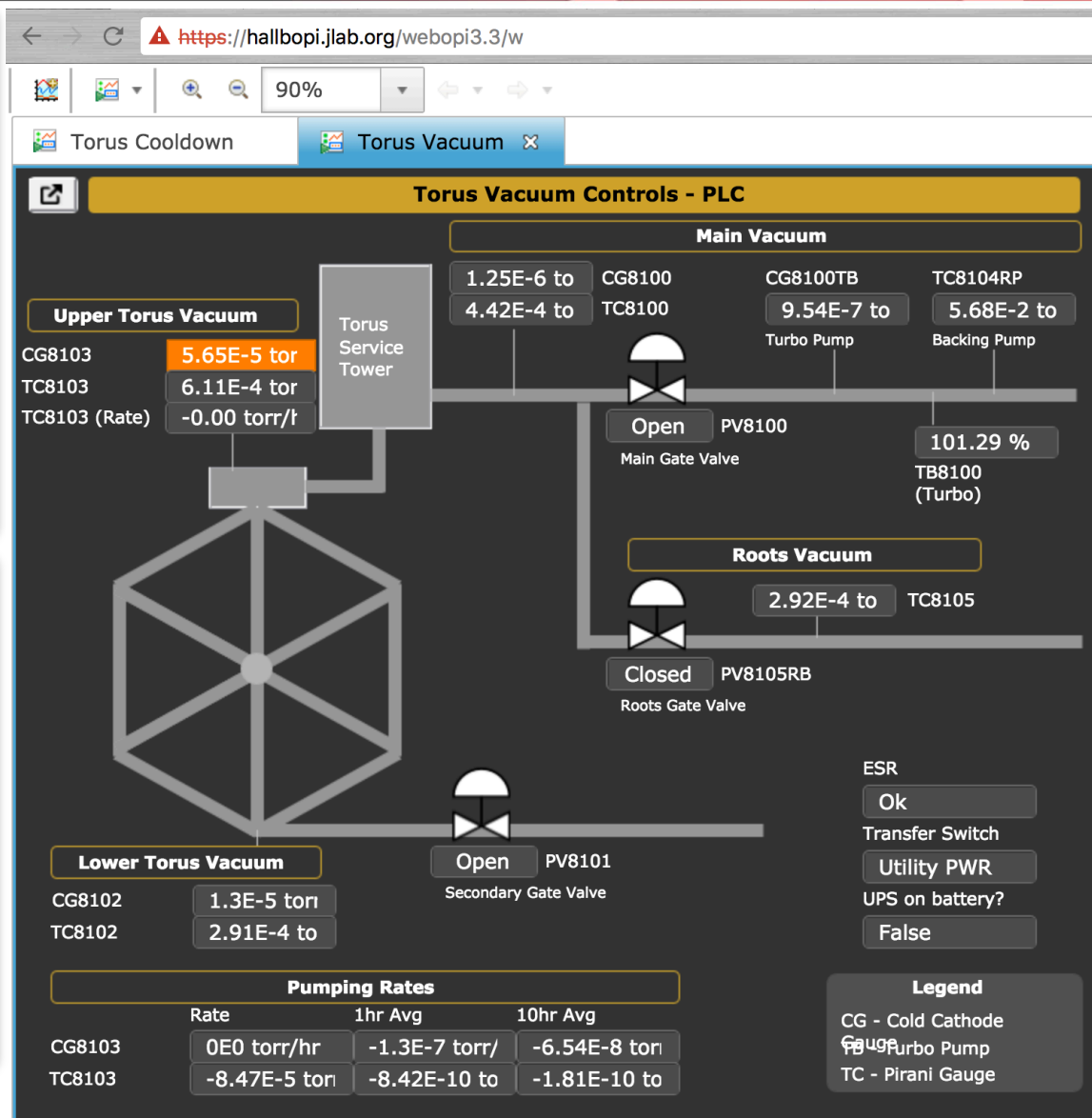
## Configuration

- RHEL7 VM, 8-Core, 8GB
- Tomcat reverse proxied behind Apache for access control.
- Firewall rules allow access to Read-only CA Gateway.
- Available off-site.

## Findings

- Images with PVs didn't display.
- Have seen linked OPIs not resolve.
- Macro inheritance issues.
- Had to use relative paths, we copied our full CSS Share to webserver.
- font.def still needs tuning.

Apache/Tomcat: Marty Wise (JLab)





# BEAST XML Generator

A	B	C	D	E	F
HallB	Torus	Vacuum			
pv	description	latching	annunciating	display title	display details
B_TORUS:VAC:CG8103	Torus upper vacuum	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:CG8103_RATE	CG8103 Rate	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:CG8103_AVG1HR	CG8103 1hr Avg	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:CG8103_AVG10HR	CG8103 10hr Avg	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:TC8103	Torus upper vacuum	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:TC8103_RATE	Torus upper vacuum pumping rate	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:TC8103_AVG1HR	TC8103 1hr Avg	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:TC8103_AVG10HR	TC8103 10hr Avg	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:CG8102	Torus lower vacuum	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:TC8102	Torus lower vacuum	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:PV8101	Torus secondary gate valve	true	true	Open Vacuum GUI	/CLAS12_Share/apps/plcApp/torus_vacuum.opi
B_TORUS:VAC:CG8100	Torus main vacuum				
B_TORUS:VAC:TC8100	Torus main vacuum				
B_TORUS:VAC:CG8100TB	Torus main vacuum				
B_TORUS:VAC:TC8104RP	Torus main vacuum				
B_TORUS:VAC:TB8100	Torus main vacuum				
B_TORUS:VAC:PV8100	Torus main gate valve				
B_TORUS:VAC:TC8105	Torus roots vacuum				
B_TORUS:VAC:PV8105RB	Torus roots gate valve				

## csv2beast.py

- Import/export spreadsheet as CSV for convenience.
- CSV converted to BEAST XML.
- Sub-elements found by column headers.

*Anyone have similar tools?*

```

<?xml version="1.0" ?>
<config name="HallB">
  <!-- Generated by csv2beast.py -->
  <component name="Torus">
    <component name="Vacuum">
      <pv name="B_TORUS:VAC:CG8103">
        <description>Torus upper vacuum</description>
        <latching>true</latching>
        <annunciating>true</annunciating>
        <display>
          <title>Open Vacuum GUI</title>
          <details>/CLAS12_Share/apps/plcApp/torus_vacuum.opi</details>
        </display>
      </pv>
      <pv name="B_TORUS:VAC:CG8103_RATE">
        <description>CG8103 Rate</description>
        <latching>true</latching>
        <annunciating>true</annunciating>
        <display>
          <title>Open Vacuum GUI</title>
          <details>/CLAS12_Share/apps/plcApp/torus_vacuum.opi</details>
        </display>
      </pv>
      <pv name="B_TORUS:VAC:CG8103_AVG1HR">
        <description>CG8103 1hr Avg</description>
        <latching>true</latching>
        <annunciating>true</annunciating>
        <display>
          <title>Open Vacuum GUI</title>
          <details>/CLAS12_Share/apps/plcApp/torus_vacuum.opi</details>
        </display>
      </pv>
      <pv name="B_TORUS:VAC:CG8103_AVG10HR">

```

# softIOC Management

## procServMgr\*

- Launcher for procServ
- Uses a simple config file to manage:
  - Server hostname
  - telnet port number
  - IOC enable/disable
  - etc...
- Key actions:
  - start/stop/restart
  - check (start if not running)

## softioc\_console\*

- Uses procServ.conf as “lookup table”
- Issues ssh/telnet commands to softIOC host and port number

```
ssh -xt <hostname> telnet localhost <port>
```

## Puppet

- Installs cronjobs on softIOC servers, for polling procServMgr

## procServ.conf snippet

```
#----- :----- :----- :----- :----- :----- :-----
#iocname :hostname :port :status :stcmd :procServ options :startup options
#----- :----- :----- :----- :----- :----- :-----
#
# cloniocl
#
iocgasSystem :cloniocl :20000 :enabled :../st.cmd : :
iocftcChiller :cloniocl :20001 :enabled :../st.cmd : :
iocftcFlasher :cloniocl :20002 :disabled :../st.cmd : :
iocftcTemps :cloniocl :20003 :enabled :../st.cmd : :
iocprologix :cloniocl :20004 :disabled :../st.cmd : :
```

\*Written by: Anthony Cuffe (JLab)



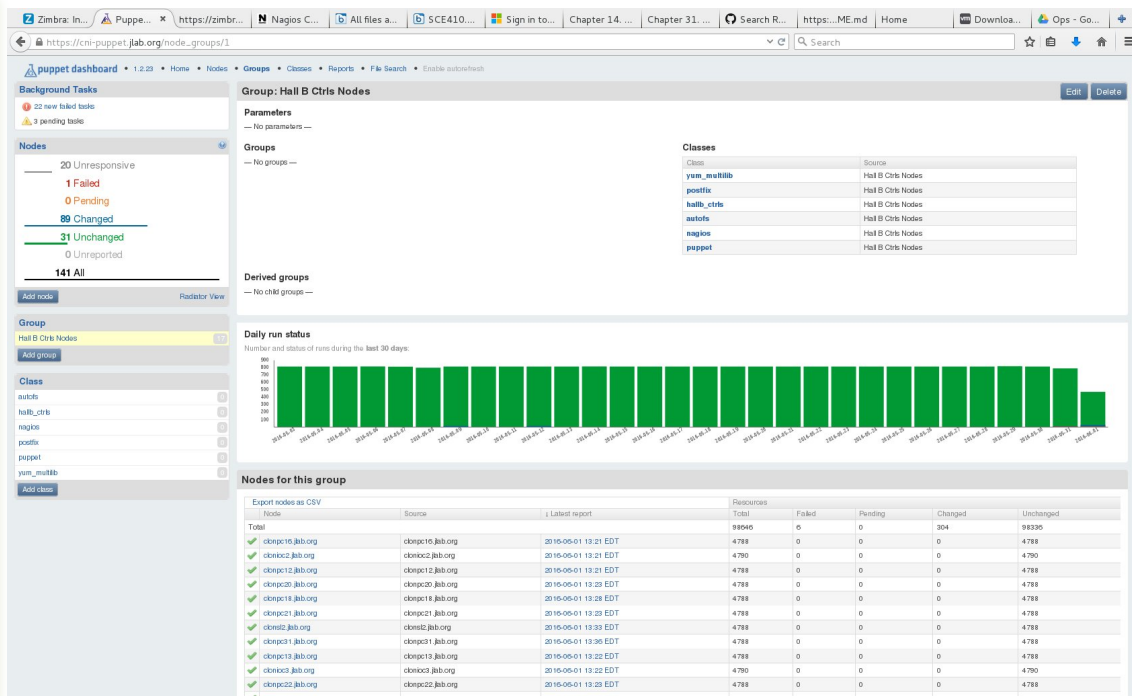
## Configuration

- RHEL6 VM
- Puppet
- Puppet Dashboard
- Facter (system profiling)
- All open source

## Notes

Host naming scheme makes Puppet config easier, allowing regex matching.

Not used for IOCs. Maybe in the future.



## Manages

- Installed packages, yum repos
- NFS mount points, autofs
- Group accounts/passwd
- cron jobs for IOC startups
- Ensures services running. Ex:
  - CA Gateways
  - iocLogServer
- Logrotate

*Puppet Server: Sherman White (JLab)*

## Configuration

- RHEL6 VM
- Nagios 4.0.6
- NRPE 2.15
- Apache
- All open source

## Notes

Sends Email and SMS alerts.

**Nagios®**

**General**  
Home  
Documentation

**Current Status**  
Tactical Overview  
Map  
Hosts  
Services  
Host Groups  
Summary  
Grid  
Service Groups  
Summary  
Grid  
Problems  
Services  
(Unhandled)  
Hosts (Unhandled)  
Network Outages

Quick Search:

**Reports**  
Availability  
Trends

**Current Network Status**  
Last Updated: Fri Sep 9 21:01:09 EDT 2016  
Updated every 90 seconds  
Nagios® Core™ 4.0.6 - www.nagios.org  
Logged in as wmoore

**Host Status Totals**  
Up: 27, Down: 1, Unreachable: 0, Pending: 0  
All Problems: 1, All Types: 28

**Service Status Totals**  
Ok: 140, Warning: 0, Unknown: 0, Critical: 5, Pending: 0  
All Problems: 5, All Types: 145

**Service Status Details For Host Group 'hallb-slowctrls'**

Limit Results: 100

Host	Service	Status	Last Check	Duration	Attempt	Status Information
clondb3	Alarm Notifier - BEAST	OK	09-09-2016 20:52:32	114d 11h 25m 56s	1/3	PROCS OK: 1 process with command name 'alarm-notifier'
	Alarm Server - BEAST	OK	09-09-2016 20:55:05	30d 10h 1m 20s	1/3	PROCS OK: 1 process with command name 'AlarmServer'
	CA Gateway	OK	09-09-2016 20:52:32	15d 9h 48m 12s	1/3	PROCS OK: 1 process with command name 'gateway'
	CPU Load	OK	09-09-2016 20:51:32	52d 3h 48m 52s	1/3	OK - load average: 0.00, 0.00, 0.00
	Disk Usage	OK	09-09-2016 20:57:02	114d 11h 21m 11s	1/3	DISK OK - free space: / 105400 MB (82% inode=99%); /dev 15967 MB (100% inode=99%); /local 739626 MB (97% inode=99%); /boot 274 MB (55% inode=99%);
	Disk Usage /home	OK	09-09-2016 20:52:08	93d 20h 56m 47s	1/3	DISK OK - free space: /home 118838 MB (40% inode=84%);

## Monitors

Resources including:

- CPU load
- Disk space
- Process count

Services including:

- Alarm Server/Notifier
- CA Gateways
- Verify 2-factor logins



# Virtual Desktop Infrastructure

After installing client app:

1. Login to VDI connection server (password)
2. Select a VM-pool from list
3. Login to Linux VM (2-factor)

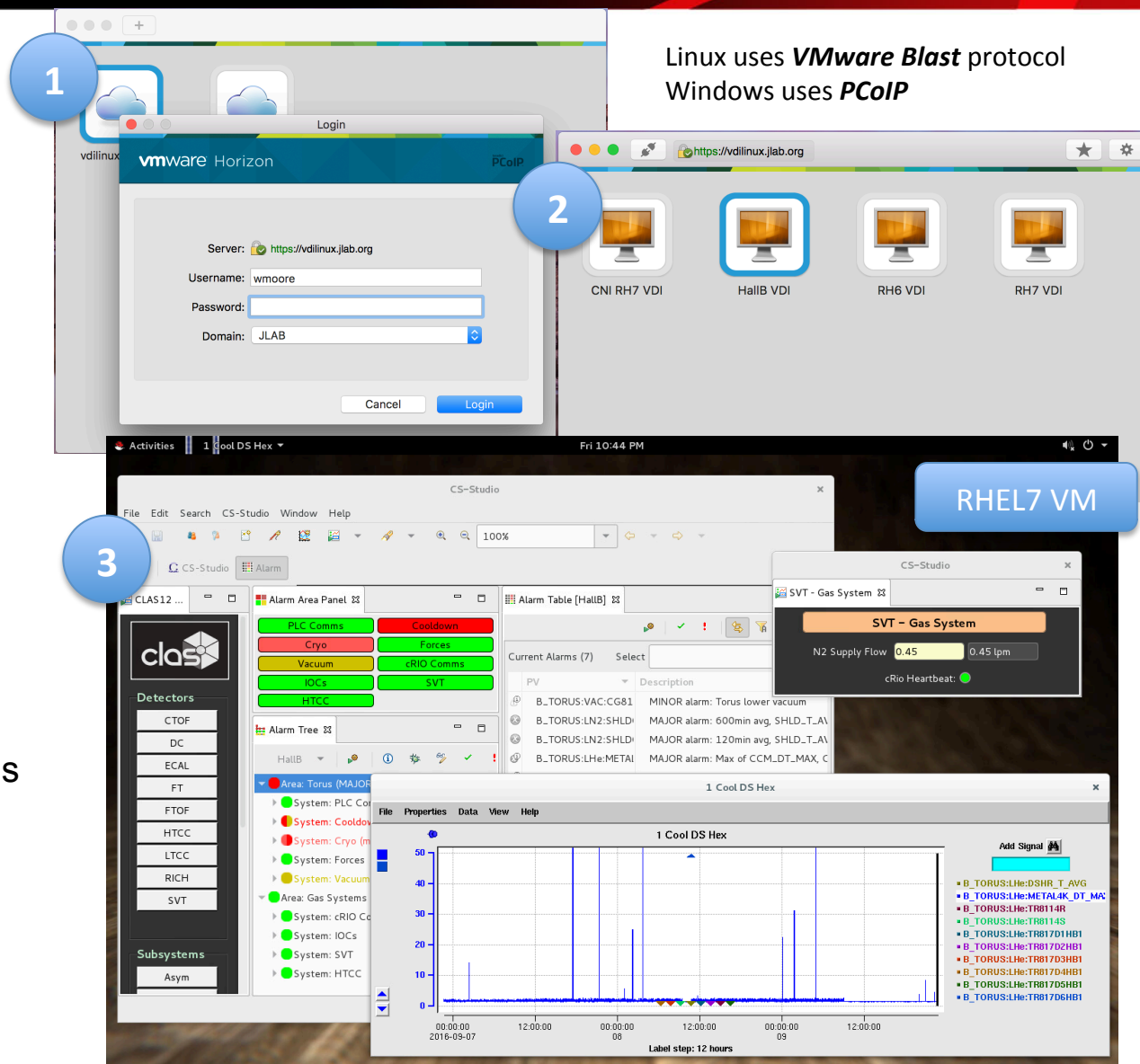
- Hosted on our existing VM infrastructure

- Cross-platform clients



- Reconnect to existing sessions
- Used for remote r/w access
- VMs managed by Puppet, monitored by Nagios

Infrastructure: Myung Bang (JLab)



Linux uses **VMware Blast** protocol  
Windows uses **PCoIP**

1. Login to VDI connection server (password)

2. Select a VM-pool from list

3. Login to Linux VM (2-factor)

RHEL7 VM

CS-Studio

Alarm Area Panel

Alarm Table [HallB]

SVT - Gas System

N2 Supply Flow 0.45 0.45 lpm

cRio Heartbeat: ●

1 Cool DS Hex

Label step: 12 hours



Horizon Toolbar

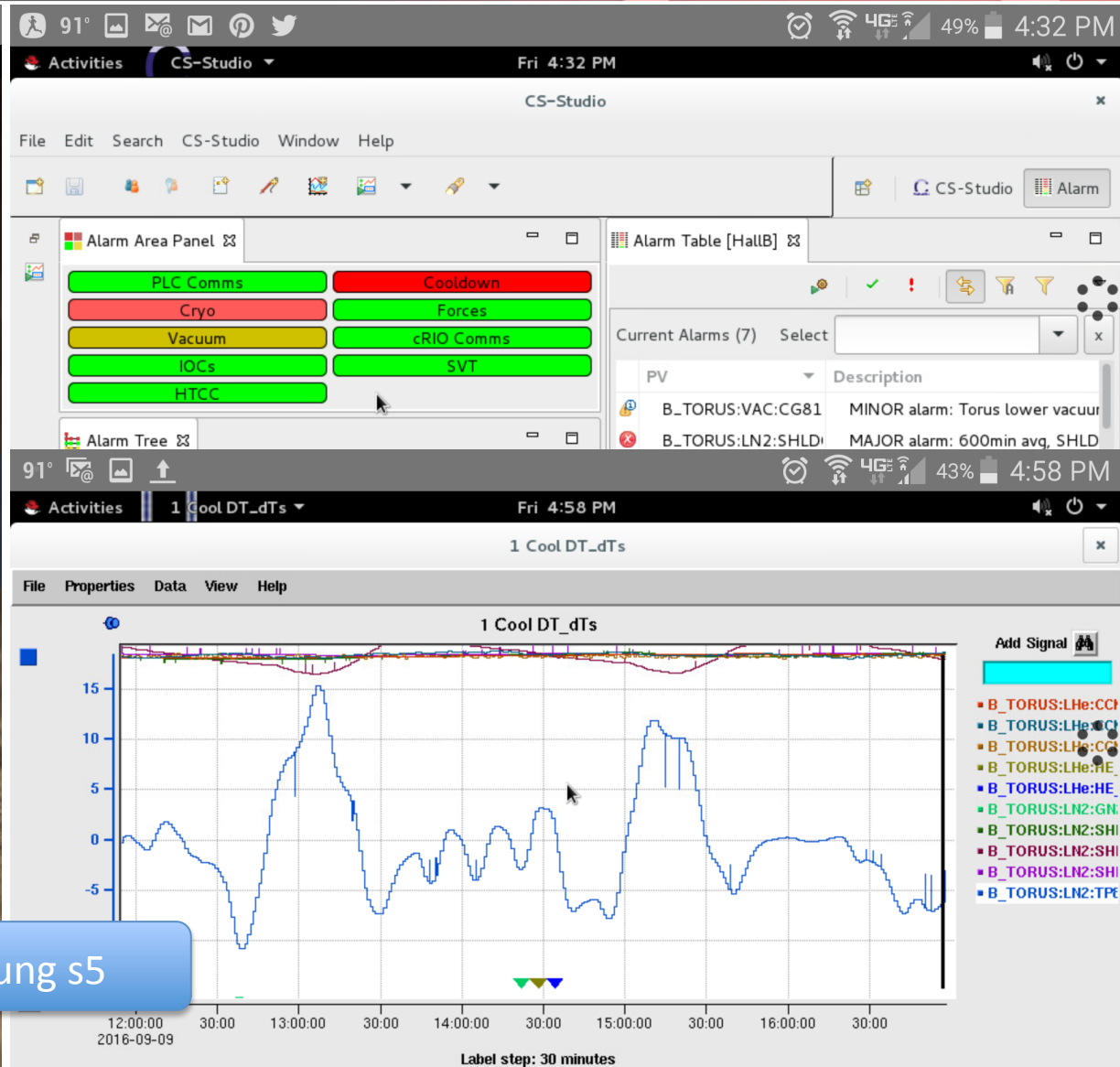
Detectors

- CTOF
- DC
- ECAL
- FT
- FTOF
- HTCC
- LTCC
- RICH
- SVT

Subsystems

- Asym
- Devices
- Gas System
- HV
- IOC Health
- HV IOC Health
- CA Gateway Stats
- JScalers IOC Health

vmware

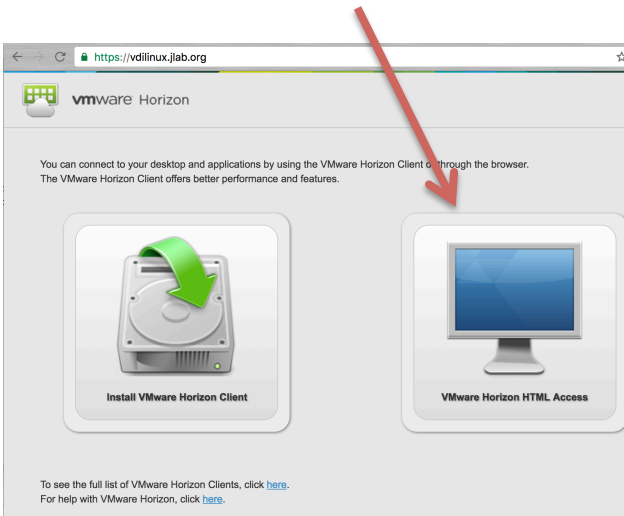




## HTML Access

- Connect to Virtual Desktop using only a browser
- No client install required

We haven't configured, but on the TODO list.



## Windows

- Better support than Linux (*No zero-clients yet*)
- Used for thin-clients and zero-clients at JLab



# *Future Plans*

- Integrate JLab tools with CS-Studio
  - Logbooks
  - Mya Archiver
- Split alarm configuration
  - Provide separate trees for main detectors
- Improve deployment of new releases
  - CS-Studio
  - BEAST
  - WebOPI and OPI tree to webserver
- Configure VDI HTML access



# Questions?

## Acknowledgements:

Nathan Baltzell (JLab, Hall B)

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