

# EPICS

## Spring Meeting 2016

### Overview

Adam Stephen, UKAEA

# Spring Meeting at ESS 2016

- 53 talks in 3 days
- Free lunch and Dinner. Thanks to Timo and team.
- Training sessions.

# ESS News

## My challenge today

- Go through 37 slides in 25 minutes

**milliLampson** /mil<sup>l</sup>\*-lamp<sup>ˈ</sup>sn/ n.

A unit of talking speed, abbreviated **mL**. Most people run about 200 milliLampsons.  
The eponymous Butler Lampson (a CS theorist and systems implementor highly regarded among hackers) goes at 1000. A few people speak faster. This unit is sometimes used to compare the (sometimes widely disparate) rates at which people can generate ideas and actually emit them in speech. For example, noted computer architect C. Gordon Bell (designer of the

For some awe, to think at about 1200 mL but only talk at

### Timeline for the ESS facility



## ESS is a pulsed neutron source



# Project Status News

## – Large in-kind collaborations

- Proscriptive model : ITER, CCS, SDD, XML
- Collaborative model : ESS Env, “a control system that will be loved”
  - But getting in-kind aligned is a challenge
- Keep an eye on tech-talk for job opportunities.
- ESS will be hiring, and it ~~never, rarely, sometimes, always rains~~ didn't rain for most of the duration of the collaboration meeting in Southern Sweden.

## – Funding/governance/decision making

- Plea for more assistance to the core team
- Some interesting models where insightful managers get resources invested
- CSS open governance model reiterated
- V4 charters and progress have been very successful

# Technical Highlights

- CSS BOB – lots of promise
- High Level Applications and Services in V4
- V3/V4 Integration demonstrations with atomic record groups
- LUA record from Jeff Hill
- Embedded Matlab in IOCs
- Microservices/RAD in Python
- Deployment/Monitoring
  - Mechanisms for controlling top down
  - Mechanisms for monitoring bottom up
  - Highly scalable and performant central services
- Trends
  - Discussion of unit testing, version control, continuous integration.
  - Machine Protection a common requirement lacking a common solution.
  - Lots of discussion of hardware, lots of interesting stuff on FPGA

# Collaboration Highlights

- Quo Vadis EPICS ? Elke Zimoch
  - A challenge to set out a roadmap and improved collaboration model for the next decade.
- $3+4 = 7$  ?
  - V4 and V3 very much coming together.
  - Releases of 3.x + 4 being integrated.
  - Demonstration of V3 records as a group over pvAccess (Michael Davidsaver)
  - Much discussion and debate.
  - Marty K is working on a V4 database.
  - General trend is V3 control system + V4 high level services layer.
- HMI options
  - CSS has a revised display manager and is getting better all the time.
  - Some interest in caQt
  - Web front ends increasingly common : talks on microservices from Matt Gibbs and Murali Shankar
- Workshops on hardware, timing, motion control
- A number of general approaches to interfacing new hardware, especially FPGA (RegDev, ITER RIO)

## Software team scope description

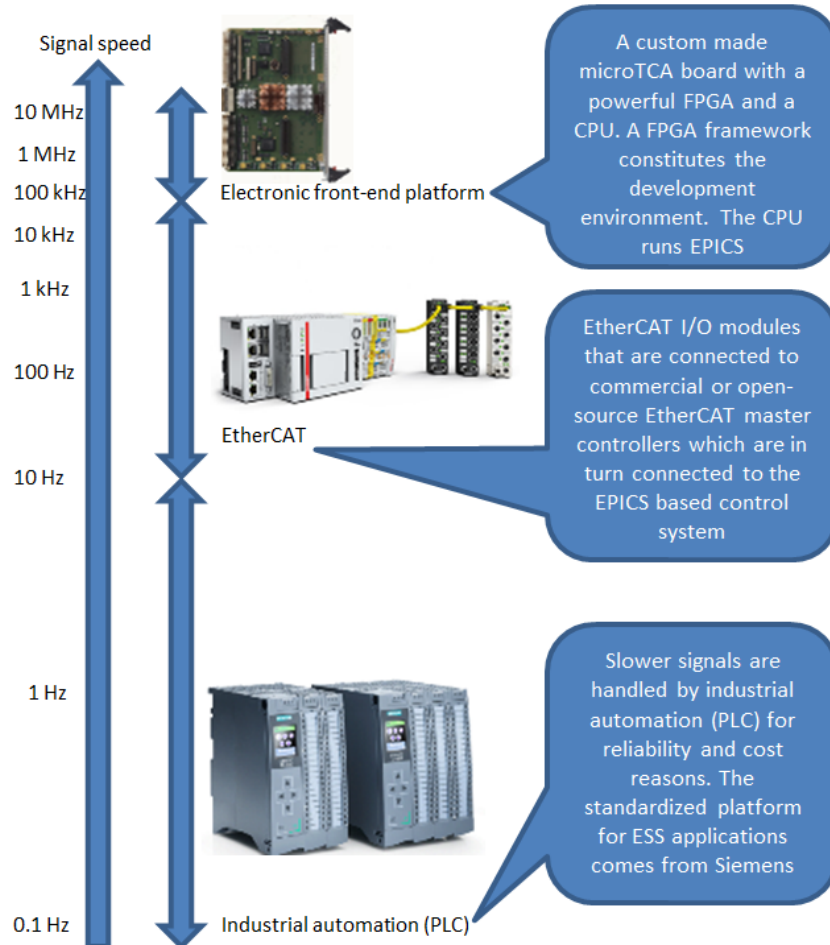
- **Controls configuration tools**
  - Controls Configuration Database (CCDB)
  - Naming Server for naming convention
  - Cable Database (CDB)
  - IOC Factory
  - CS Entry
  - Role Based Access Control (RBAC)
- **Clients**
  - Alarm Handling
  - E-logbook
  - Archiving System
  - Save, Compare & Restore
  - Scenario management
  - GUI/HMI (Control System Studio)
- **Core controls software**
  - Development/contributions to core EPICS
  - Timing applications
  - Post-mortem diagnostics
- **Physics modelling**
  - Open XAL
  - ESS [Linac Simulator](#)
  - Beam Physics Applications
- **Operation tools – Scripting frameworks**
  - [iPython](#)
  - Scripting Execution Environment
  - [Macroserver](#)
- **Software development environment**
  - Vagrant for virtualization
  - [Ansible](#) for automation of deployment and configuration of our software infrastructure
  - Jenkins for continuous integration support



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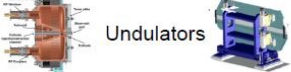


# Three layer strategy - control systems at ESS



- **ICS has adopted a three layer strategy for implementing the control system based on signal speed**
  - A custom made platform based on microTCA for applications with data acquisition exceeding 100 kHz
  - The CPU will run EPICS and the FPGA will have a complete application development environment
  - For slower signals, EtherCAT will be used as a real-time fieldbus with good price/performance ratio
  - Synchronization and event information are key for applications where a full custom platform solution would be too costly
  - Low speed signals are handled with commercially available PLC systems from Siemens
  - This is a cost-effective solution that addresses ESS reliability and maintainability requirements
  - The PLC:s will be connected to EPICS for further integration into the control system



# LCLS\_II Update

<b>Fermilab</b>	½ of cryomodules: 1.3 GHz	
<b>Jefferson Lab</b> <small>EXPLORING THE NATURE OF MATTER</small>	½ of cryomodules: 1.3 GHz	
	e <sup>-</sup> gun & associated injector systems	
<b>Argonne</b> <small>NATIONAL LABORATORY</small>	Undulator Vacuum Chamber	Undulator R&D: vertical polarization
	R&D planning, prototype support e <sup>-</sup> gun option	

## LCLS-II Parameters

SLAC

Parameter	LCLS	LCLS-II
Accelerator Type	Normal conducting Cu	Superconducting
Final Electron Energy Range	2.5 - 15 GeV	2.0 - 4.5 GeV
Typical Electron Bunch Charge Range	20 - 300 pC	10 - 300 pC
Max Repetition Rate	120 Hz	929 kHz
Max Electron Beam Power	540 W	1.2 MW

LCLS-II's high repetition rate and beam power present new challenges for the control system.

## Mature Subsystems - New Software

SLAC

- New EPICS v4 services for high level apps (Directory, Name, Model Manager, Archive Appliance, ...) will make it easier to build new applications.  
*See Murali Shankar's talk on Friday for more info.*
- New Model Manager based on MATLAB and MAD
- Evaluating EDM alternatives for GUIs

## New High Performance Subsystems

SLAC

- New timing system, diagnostics (BPMs, Bunch Length Monitors, etc), and beam-based feedbacks needed for 1 MHz repetition rate
- New machine protection system, enhanced beam containment system needed to handle 1 MW beam power
- Brand New Subsystems
  - Superconducting RF, ODH, Cryo
  - Partner Labs involved

# LCLS-II (2)

## HPS Common Platform Hardware

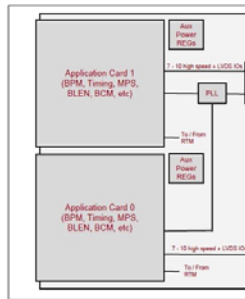
SLAC

- The high performance systems are built on a common ADC + FPGA platform.
- ATCA based
- Carrier board hosts up to two application specific daughter boards
- Each application card can associate with an IOC running on a Linux host



## Summary

SLAC



- LCLS-II is a significant advancement over LCLS
- Where possible, we plan re-using our existing EPICS software from LCLS in LCLS-II
- Some new systems are required due to LCLS-II's high repetition rate and beam power
- Adding new EPICS v4 infrastructure
- Development is progressing on the common platform for high performance systems
- Final Design Reviews for all controls subsystems will be complete by the end of 2016

SLAC

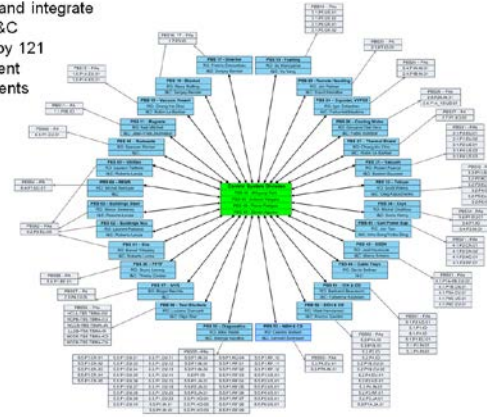
NATIONAL  
ACCELERATOR  
LABORATORY



# ITER News



- Interface and integrate 28 PBS I&C
- supplied by 121 procurement arrangements



## CODAC Core System: Based on Open Source

- OS: **Red Hat Enterprise Linux** (RHEL x86\_64) with **MRG-R** real-time extensions on fast controllers
- Infrastructure: **EPICS**, used in hundreds of projects world-wide: light sources, high energy physics, fusion (KSTAR, NSTX), telescopes
- CODAC services layer: **Control System Studio** used at many EPICS and other sites and including HMI, alarming, archiving etc.
- ITER **specific software** such as configuration (system description), state handling, drivers, networking, etc.  
→ Talk by Denis Stepanov
- Fixed **release cycle** (minor release every year), extensive testing procedures



- Division formed “Integration Team” to better support the upcoming integration phase
- CODAC Core System release: 5.3 (2016B)
  - RHEL 6.5
  - EPICS Base 3.15.4
  - EPICS V4 (evaluation)
- New S7 communication driver  
→ Talk by Jignesh Patel
- EPICS Support for NI RIO (ASYN and NDS)  
→ Talk by Mariano Ruiz (UPM)

# V4 News

## User Feedback – what's good:

- Performance is excellent
- Reliability needs have been met or exceeded
- Easy programming and scripting, once you've got started
- Complex data and RPC enables one, simple, high performance, infrastructure across the whole controls and online scientific system. Utility of this effect previously overlooked, but in practice seen to be key
- Normative Types enable systems of narrowly defined services to be applied generally to many experiment user problems
- Streaming supports big online data processing. Beats tested alternatives in ease of use and performance.

## User Feedback – what's bad

It's difficult to get started!

<http://epics-pvdata.sourceforge.net/informative/developerGuide/developerGuide.html>

New Developer's Guide:

We've started training.

Documentation reorganized for clarity.

## User Feedback – what's bad

We want one  
EPICS!

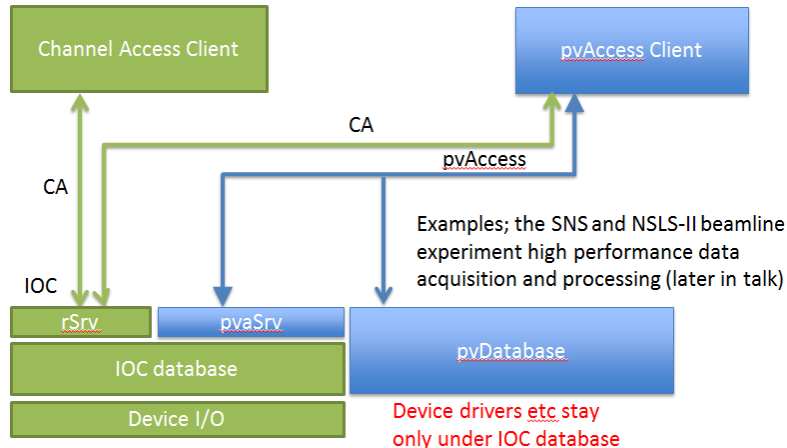
Not so easy. Different sites use different versions of base.

So, we now have V4 unbundled with base. Plus v4 bundled with base 3.15 and 3.16.

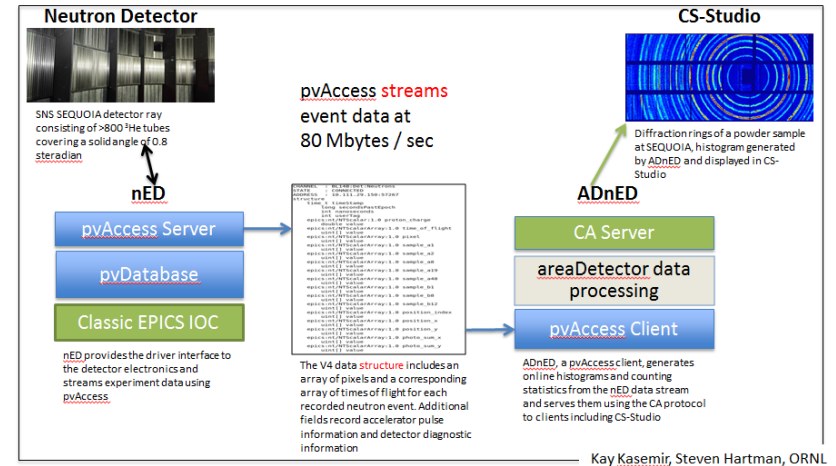
Andrew is planning when there will be one EPICS. Possibly about 3.16.3 -> 4.

# V4 Exploitation Model

A new smart database, “pvDatabase” can be used for data assembly and processing



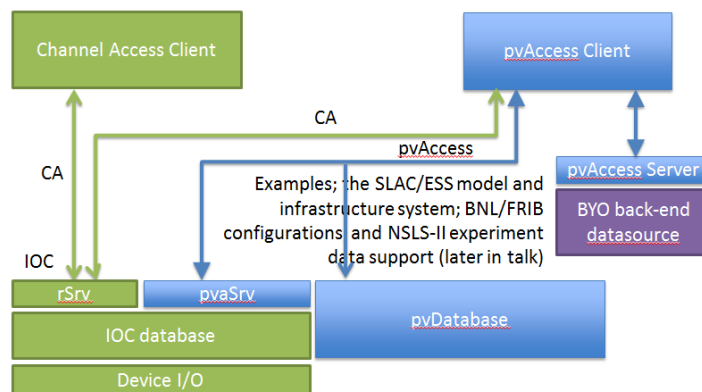
SNS uses EPICS V4 for high throughput event readout, of structured PV data.



- Kay Kasemir, Steven Hartman, ORNL

## EPICS Version 4 middleware support

## RPC and Service Oriented Architecture (SOA)



### Deployments of EPICS Version 4: BNL's CA PV Configurations save/restore system

## MASAR Architecture

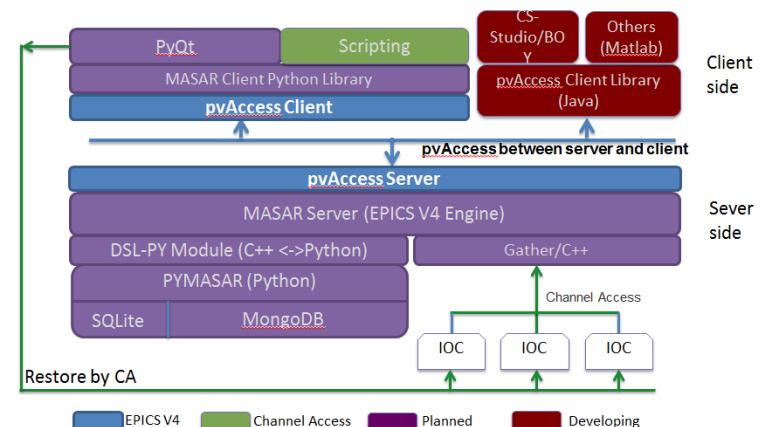


Figure : MASAR server side delivers CA PV configurations using EPICS V4, to various client types.

Guobao Shen, FRIB



# Archiver Appliance Update

## Deployment Survey

- SLAC (total 25GB/day)
- BNL 66k PVs, 95GB/day
- NSCL 93k PV 2GB/day
- HZB 118 PV 66GB/day
- DLS evaluation...

## Issues

- Broadcast storm (under investigation)
- TSE=-2 can be bad.
- #invalid PVs can now be limited
- Running out of space may lose data – check your logs

## New Features

- HTML5 viewer with JSON nice web client
- DBE\_PROPERTIES supported from 3.15+
- Full V4 types support
- eget support for complex types
- Now on JDK1.8 sources on github
- Docker deployment coming soon.

## Goals

- Scale to 1-2 millions PV's
- Fast data retrieval
- Users add PV's to archiver
- Zero oversight
- Flexible configurations on a per PV basis

# Area Detector Update

- Changes in the last year
  - ADCore R2-3, R2-4, R2-5 (coming soon)
  - HDF5 support for SWMR
  - NDPluginPva : interoperability of NDArrays with NTNDArrays
  - NDPluginTimeSeries – for other types of data
  - New FFT support
  - simDetector moved to ADExample, new sine sim mode.
  - NDPluginDriver can dynamically change queue size.
  - Core : file plugin simplified in R3-0 but will need to modify clients (hence major number)



# quadEM Talk

## Generic Data Acquisition support

- For quad channel electrometers measuring in pA to mA range
- One box to replace sets of amplifiers, ADCs, PSUs, controllers.
- Done in a very nice asyn style way exporting data as NDArrays
- Good use case for the TimeSeries plugin

## Conclusions

- Fast electrometers permit:
  - High-frequency diagnostics of beam motion
  - High-frequency feedback to compensate for beam motion (or deliberate steering)
  - Data acquisition with ion chambers or photodiode detectors
- EPICS quadEM software is part of synApps
  - Home page:  
<http://cars.uchicago.edu/software/epics/quadEM.html>
  - Documentation:  
<http://cars.uchicago.edu/software/epics/quadEMDoc.html>
  - github repository  
<https://github.com/epics-modules/quadEM>

**Thanks for your attention!**

# EPICS Roadmap Workshop

## Technical Demonstrations/Extensions

- Dirk Zimoch macros for in-line expressions
- IOCSH macro support
- Extensible link types (Andrew)
- Jeff Hill enhancements, especially LUA record
- Michael Davidsaver pvAccess group demo/gateway performance

## Core Team

- Plea for support from the community to help  
Andrew, Ralph, Michael
- Help with the wiki
- Help with testing on non-standard platforms
- Participation in code reviews
- Housekeeping/bug report triage
- Technical writers welcome

## Quo Vadis EPICS

- V3/V4/V7
- Branding and perception/Governance
- Time for a plan for EPICS 2025 ?

# Device Interfacing

RegDev – Dirk Zimoch

S7 Asyn Driver – Jignesh Patel

Device Support for VME Shared Memory – Hiroshi Kaji

Flex RIO Integration for ITER – Sergio Esquembri

# Frameworks for Project Control

ESS EPICS Environment – Timo Korhonen

ITER XML Framework & Packaging – Denis Stepanov

IRMIS at LANSCE Kanglin Xu

ESS EPICS at CEA Saclay – Nicolas Senaud

# IOC Monitoring

CLS PV Monitor – Gillian Black

EPICS Heartbeat Extension – Michael Bree

# Fast/Synchronous Control Systems

Fast Orbit Feedback System – Andrew Starritt

RF Control for SwissFEL

RF Test Stands at CEA Saclay

Panda/Zebra – Chris Turner (DLS)

Motion Control over Ethercat at ESS – Anders Sandstrom

CLF Laser Control – David Michel (best slides and cultural references)

Vacuum Control at SSC

Matlab Embedded in IOC – Mirosław Dach

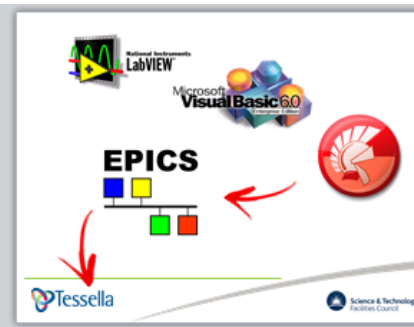
# Best Graphics – David Michel



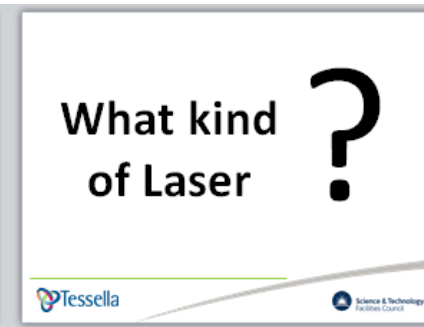
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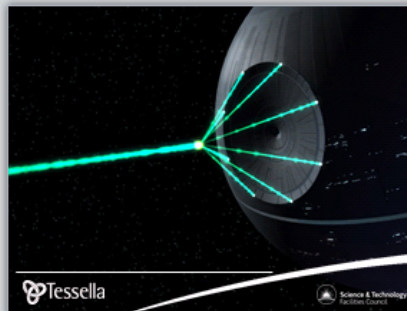
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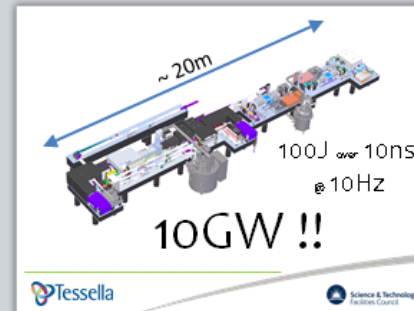
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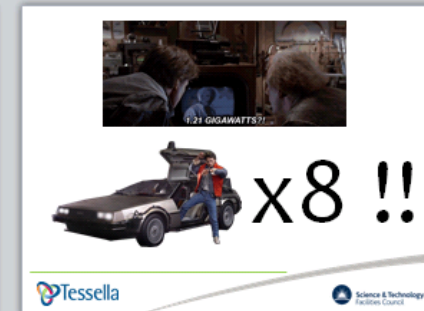
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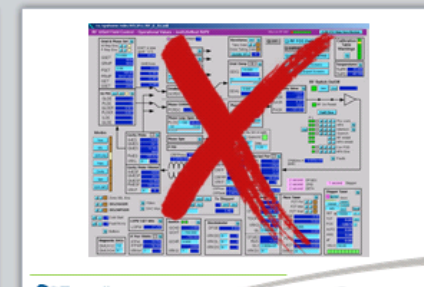
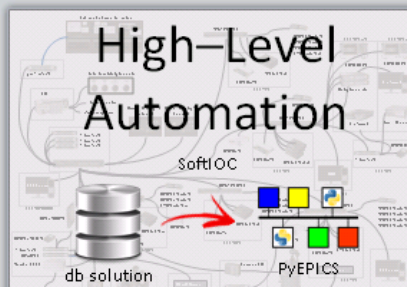
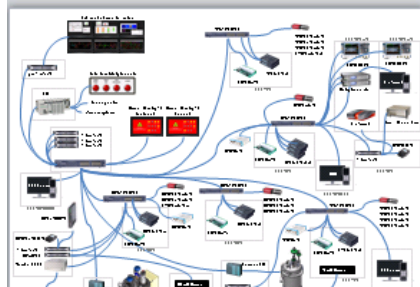
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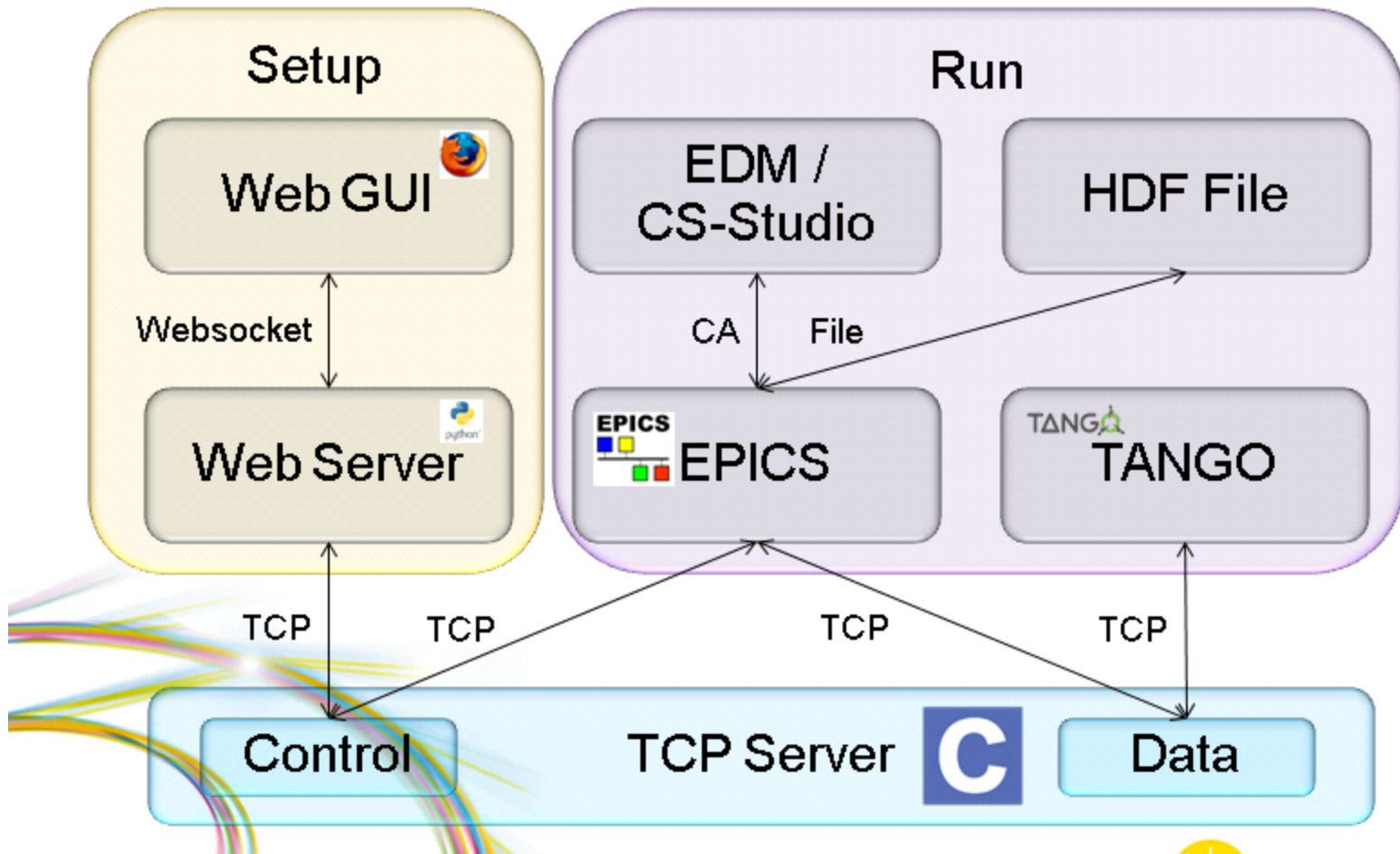


# Best Looking Product ?



- All-in-one:
  - Digital signal level converter
  - Triggering
  - Position compare
  - Data acquisition
- Developed in 2013 and has been used on numerous beamlines.

# PandA/Zebra



# Display / HMI News

Qt versus CSS ; David vs Goliath ?

CaQtDM from PSI (Anton Mezger)

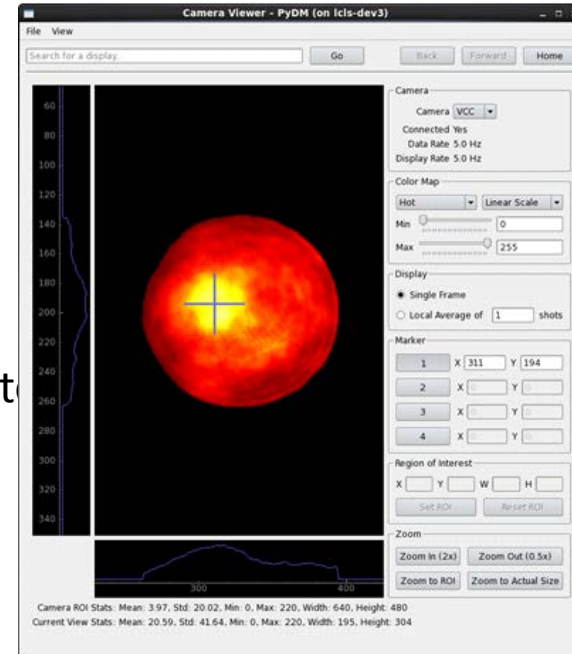
- Gaining some momentum (github, contributors)
- New feature to load .ui over http
- Refactored to allow other control system plugins
- Easier to develop new widgets
- But... total #downloads order 200

PyQt Framework from SLAC (Matt Gibbs)

- Need an MEDM replacement and physicists/operators write HLAs (high level apps) in matlab/python for one-off tasks
- Qt Designer + standard Display python classes.
- Data source can be other than CA scheme://
- CA done, PVA planned. Anticipate scaling to high loads.
- Aim to get EDM-like performance.
- Code on github.

Triumf QT Apps (Rolf Keitel)

- Moving on from trar+burt+StripTool+Alh



# CS-Studio News 1 (BOB)

DisplayBuilder : better than BOY ? Kay Kasemir

- Performance of CSS asserted better than QT (TUMIB10 ICALEPCS13)
- But issues with the UI thread causing freezes
- BOY architecture based on GEF problematic
- Display builder has a multithreaded approach.
- Looks similar, but better. Performs better.
- .opi syntax cleaned up and made much more implementation agnostic
- Better colormaps
- Caveat : minimal script compatibility
- Deployed/tested on 200 SNS screens
- First full release scheduled for end-2016.
- Candidate name ? BOY, only better. Hence BOB.

# CS-Studio News 2 : Collaboration Update

## Collaboration Update

- Stats on issues/development (project remains very active)
- 4.3.x release end May adds a number of features, and is unit tested
  - Perspectives, Save/Restore, PVTable, Java8 Time,
  - BEAST datasource for Diirt, and prototype Display Builder.
- Code-at-thon April 16 at BNL
  - Quality improvements, unit tests, logging, feedback, java8
  - 600k loc *removed* !
- 4.4.x scheduled for December with full Display Builder, Cpython
- 10 registered sites (CSIRO, CSNS, DESY, DLS, FRIB, FANIL, ISIS, ITER, NSLSII, ORNL)
- Development+Governance processes outlined.
- More members welcome.
  
- Kay also pointed out that ORNL will host the next collaboration meeting in September 2016.

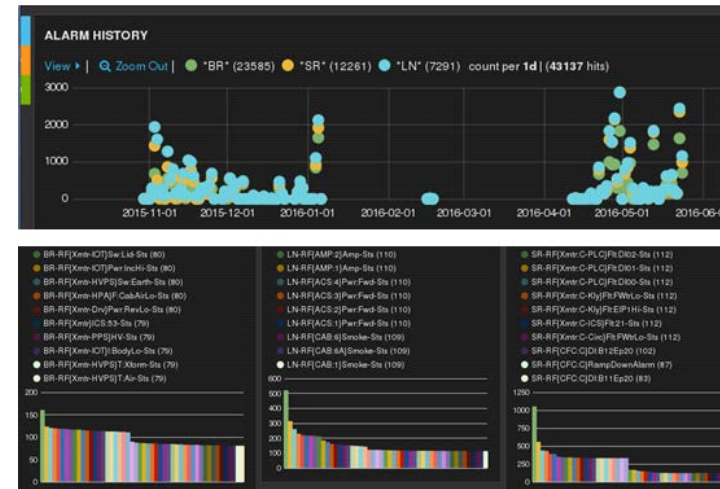
# Talks in Brief

JLAB/SLAC each presented machine save/restore systems.

- MASAR is the more advanced.

Kunal Shroff presented update on alarms in BEAST

- BEAST data now available as channel `beast://sub_info/`
- Channels can represent aggregate or single alarm data
- Alarm table attributes can be accessed over channel
- Channels can be read and written
- Alarm analysis (sequence of events probing)
  - Alarm history via jms messages dumped into Elastic
  - Kibana or CSS front end
  - Kibana good for visualisation



# More Talks in Brief

Websocket Microservices – neat stuff with minimal python (Matt Gibbs)

- looks useful and easy to get started with

EPICS Lua Record – Jeff Hill

- As if programming by side effect in EPICS databases wasn't already complicated enough for you ?

- But seriously, looks very powerful, and Jeff had a bunch of other powerful extensions in his toolbox nearly ready to share.

Unit Testing in EPICS (Juniper Willard, CLS). Good intent, but more of a work in progress.

Accelerator Physics/Software Eng Collaboration (John Bengtsson)

- Physics modelling/simulation for complicated beam optics
- Model based control versus Equipment control
- High Level Application Software Architectures
- Combining the RAD virtues of Python with fast numerical engines but with a rigorous software engineering approach supported by Michael Davidsaver and Bob.

ChannelFinder Service (Kunal Shroff)

- great talk, looks very useful, meta data/multiple views, highly performant, nice architecture.

V4 as Microservice Container (Murali Shankar)

- Similar, but even more general backend store of data with custom views.



# Base News from Ralph/Andrew

Nice talk by Ralph pointing out nice/lesser-known features in 3.15

- Assemblies : compose st.cmd from numbered snippets (like init.d files)
- Property events : monitor limit changes for GUIs
- Pointer swapping for arrays (saves data copy)
- IOC can be restricted to a particular network interface on multihomed hosts
- subArrayRecords can be pulled out on the fly caget wf.VAL[20:25]

Plans for Base 3.14,15,16 ... and Beyond (Andrew)

- -3.16.01 developer release : locks rewritten, epicsTime routines return status,
- Allocator APIs instrumented for valgrind, can disable readline for automation,
- New compress record features.
- 3.15.4 27 May 16 : NIF, IPv4 multicast for UDP, some other changes (see slides)
- 3.14.12.6 June/July 16 – mostly bug fixes, patches already published.
- V4 release 4.5.0.2 25 May 2016 for ESS training.
- Ongoing : iocsh changes, cleanup in C++ APIs, IOC support for 64-bit field types,
- Optimised loading of IOC dbs, new libCom API for monotonic high-res time source.
- Modular link support API
- Automated testing using qemu and wine (WINE)
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