New Controls Tutorial

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Outline

- <u>Today</u>
- Overview (J. Patrick)
  - What we are doing and why
- Getting Started, Basic Guidelines (C. Schumann)
  - PC configuration, programming basics

- <u>Next Week</u>
- Data Acquisition (K. Cahill)
- Application Framework (A. Petrov)
  - How to write a standard application

Goals

- Provide overview of what we are doing and why
- Give a flavor of how to get started
- Provide pointers on where to obtain more information
- Not a language tutorial
- Not a “hands on” tutorial
- We don’t expect you to remember every detail, but at least learn how to get started

What Are We Doing?

- Migrating control system functionality away from VAX/VMS
  - Gradually…
- New software is based on the Java language/platform
  - Operating system agnostic
- Began over 5 years ago! (K. Cahill)
- Started with infrastructure, central services (no user interface)
- Starter applications were Notify, SDA suite
- Other applications have been done as well
  - But a small fraction of the total number in the control system

Why?

- Not because the current system is bad
- VAX/VMS is obsolete
  - VAX hardware unchanged in ~10 years
  - VAXes not manufactured for several years
  - ~12-30 MIP machines; < few % of typical desktop PC
  - Younger people have never used it
  - Little support for newer tools, languages
  - Non-standard user interface and other programming
- Maybe some of the developments in computing in the last 10 years might prove useful…
  - Newer technology is used in many areas outside the core controls software…

From Recent CDF Shift Training…

- Runs on VAXes (!) and can create a virtual console on machines running X-Windows.
- If interface seems unusual, it might have to do with the fact that ACNET is about the same age as younger ACEs.
- There is an ACNET console in first floor counting room if you want to practice. Do NOT experiment outside of CDF procedures. It is possible to turn off the TEV from ACNET.
- ACNET consoles are physically connected to a Beams Division network.

Constraints

- No long shutdowns to replace large blocks of functionality
  - Precludes fundamental redesign of the system
  - Parts of new system must be plug-compatible/communicate with old
  - Must be able to easily switch new things in and back out and/or run them in parallel
  - “Scorched-earth” is much harder anyway…
- No big pile of money to replace everything
  - Base on inexpensive commodity computing equipment
  - Many small PCs/unix boxes rather than few large systems
- No big influx of new people for a parallel effort
  - Work must be done by existing personnel.
- No long break to learn a new system
  - New languages, tools etc. should have modest learning curve
  - A lot of code written by non-Computing Professionals
- New system needs to be viable through 2010? 2012?

Why Java?

- Modern, Object-Oriented Language
- Very much easier to learn, program and maintain than C++
  - Focus on learning object-oriented programming
- Very popular and well supported
  - Modern programming tools (Integrated Developer Environments)
- Basically platform independent
  - Same **object** code runs on Windows, unix, Mac
- Web integration
  - Launch programs from web browsers
- Excellent bundled libraries
  - Graphical User Interface
  - Threads
  - Networking
  - I/O
  - Database access

Java Overview

- General purpose object oriented programming language
  - Potentially better code organization
  - Potentially better code reuse
- Borrows basic syntax from C/C++
  - But leaves out a lot, no obligation to compatibility
- Source code compiled to processor independent “byte code” (psuedo-assembler code)
- No link/load step, linking is done at run time
- Java run-time interprets and runs byte code
  - Locates and loads code as needed
  - Gradually compiles to optimized processor specific machine code
  - Still slower than C/C++ code for various reasons

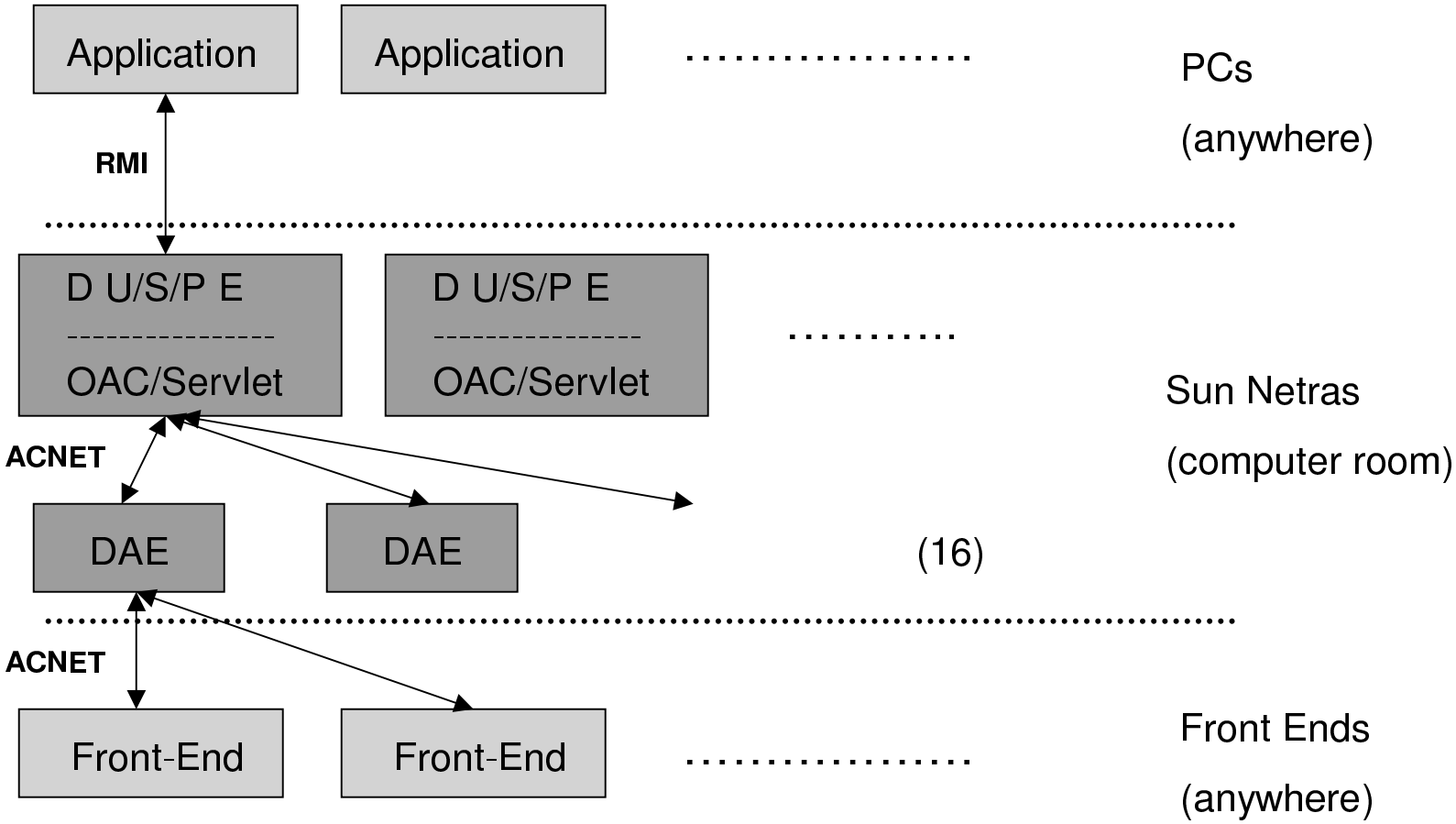
Java Advantages

- Much simpler language than C++ (or even C)
- Transparent memory management
  - Automatic garbage collection
  - no malloc/free
  - no memory leaks (almost)
- No pointers (no `int *(*i[10])(int **p)`)
- Memory overwrites/array overruns are **impossible**
- No global variables
- No preprocessor macros
- No templates
- No operator overloading
  - String manipulation cheats

Java Disadvantages

- Resource intensive
  - Memory, CPU
- Performance is < C/C++
  - Greatly improved since initial releases
  - Adequate for control system type applications
  - Performance limitations due to front-ends, networks, database access as well as CPU power
  - Most things are still going to be much faster than on a VAX!
- It is harder to write FORTRAN in Java than in C (or C++)
  - Which is claimed to not be a disadvantage…
  - Forces at least some attention to object oriented design

Control System Overview



Control System Overview

- Applications generally run on PCs (or nova etc.)
- Data Server Engines (dse, due, dpe)
  - Run on Sun Netra systems in the computer room
  - Bridge application communication protocol (RMI) to ACNET
  - Insulate misbehaving applications from daes
  - Some application logic can be performed here
  - Boxes also run Open Access Clients (psuedo front-ends), servlets
- Data Acquisition Engines
  - Consolidate requests across entire control system
  - Each of 16 dae's is assigned a set of front-ends
  - Provide missing front-end functionality:
    - Make all devices look equivalently supported to high level code
    - Collection on clock event, event + delay
    - Collection on state transition, transition + delay
    - FTP/Snap if not supported by front-end (15 Hz limit)
- Front Ends
  - Work with new system without changes

What Infrastructure Exists

- Application framework
  - Provides common infrastructure for applications
  - Capture, mail, etc. utilities like VAX program tools
  - Message capture, application monitoring
  - Management of dXe connection
- Open Access Client (OAC) framework
  - Makes it rather easy to write an OAC
- Control system access (readings/settings)
- Database access
- Plotting
- Synoptic display infrastructure/builder

- NOT a straight port of CLIB/User Libraries
- Likely there are missing pieces in the above

Data Acquisition API

- ACNET API (dio_, datalogger_, etc.) reorganized
- DaqJob (what, from, to, when, who, control)
  - **what**: device(s)
  - **from**: Accelerator, DataLogger, SaveFile, SDA, Mirror, Model, …
  - **to**: your code, Accelerator, Mirror, Model, DataLogger, SaveFile…
  - **when**: now, later, clock event (+delay), state transition (+delay), …
  - **who**: who is making the request and from where (privileges)

What Infrastructure Doesn't Exist

- Functionality of most machine specific VAX User Libraries
  - Though functional equivalents exist in some cases
- Numerical/linear algebra use not extensive so far
  - Usage in autotune, some other places
  - Third party packages exist that should satisfy requirements
- Full support for GPIB/specific scope models
  - Lowest level infrastructure exists, needs to be built up

Routine Operation

- Big Saves
- All Data Loggers
- 43 Open Access Clients (OACs)
  - Some are general purpose, CACHE, MACALC, BATCH, TIMEAV
- All SDA tools
  - Configuration, acquisition, viewers
- MiniBoone autotune

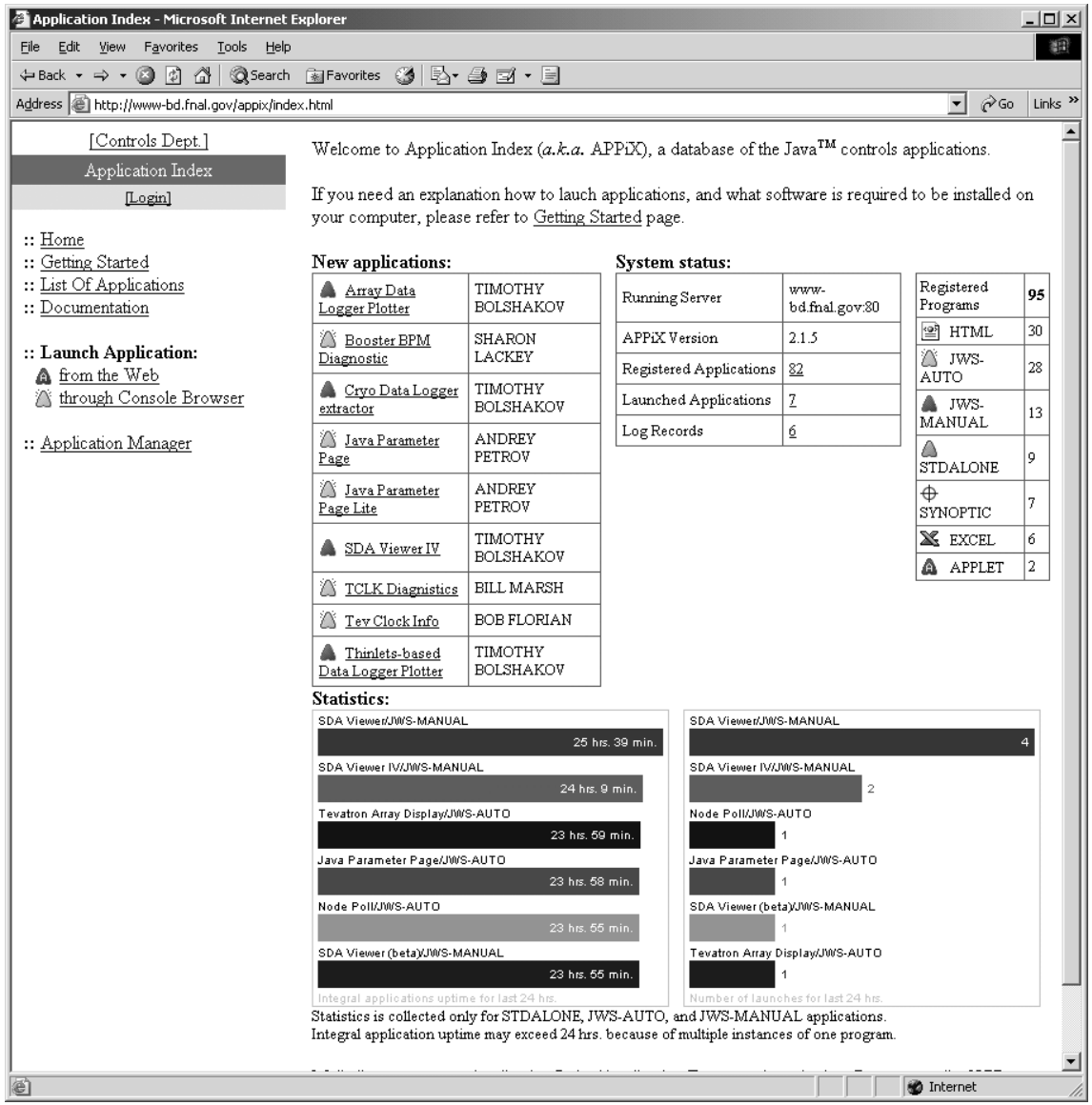
Security

- Must be on Beams network for
  - Direct access to control system devices
  - Direct access to the database
  - And therefore to run most applications
- However:
  - Versions of primary infrastructure applications have been written that can be run from outside the beams network
    - Parameter page
    - Data logger plotter (D44)
    - Device Database (D80)
    - Others
  - Some of these use the web browser as the client and “servlets” as the server part inside the firewall, proxied through www-bd.fnal.gov
  - Xml-rpc can be used to perform readings, set cache type devices
    - Lower rate capability, less flexibility
    - Can be used by non-Java programs to access control system data

Application Startup

- Application Index
  - Catalog of applications
  - Web page (http://www-bd.fnal.gov/appix)
  - Standalone program (like Windows Explorer)
  - Click to start programs
    - Can start both normal and browser based applications
- Java Web Start
  - Most efficient startup method
  - Only Java need be installed on your PC
  - All required code is automatically copied to your PC
  - Program starts and runs on your PC
- Possible to start some programs manually from P:\AppsRunFiles
  - Most sensible for standalone Application Index
  - Not always well maintained for other programs

Application Home Page



Application Index

Application Index

File Edit View Tools Process Help

Address: /Application Index/D * Diagnostic & Utility

- Application Index
  - B * Booster
  - C * Collider
    - SDA
  - D * Diagnostic & Utility
  - F * Refrigerator
  - H * Hardware Diagnostics
  - I * Main Injector
    - SDA
  - P * P-Bar
    - SDA
  - R * Recycler
    - SDA
  - T * Tevatron
    - SDA
  - W * Work In Progress
  - Z * Test Applications
  - L * Linac

Application	Help URL	Keeper	Ext.
Application Utilities			
Device Utilities			
FSM			
Notification			
Parameter Pages			
SDA			
Synoptic Display			
Accelerator Studies	http://www-bd.fnal.gov/co...	LUCIANO PICCOLI	6593
Array Data Logger Plotter		TIMOTHY BOLSHAKOV	8034
Data Logger Plotter		TIMOTHY BOLSHAKOV	8034
Settings Log		ZONGWEI YUAN	6878
Thinlets-based Data Logger Plotter		TIMOTHY BOLSHAKOV	8034

This Console application browser shows all applications, currently registered in APPiX database. Under Windows y
all types of programs: standalone, web-startable, html pages, and synoptic display projects. Under SunOS, only sta
is supported.

If application icon has a small yellow triangle, you can select which type of program you whant to launch (through

To set you home directory, use Ctrl+H. That directory will be open every time your start Browser.

To hide this information window press F12.

Application Index - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: http://www-bd.fnal.gov/appix/index.html

Accelerator Con Instant Message Internet Lookup New&Cool

[Controls Dept.]

Application Index

[Login]

:: Home
:: Getting Started
:: List Of Applications
:: Documentation

:: **Launch Application:**
from the Web
through Console Browser

:: Application Manager

File

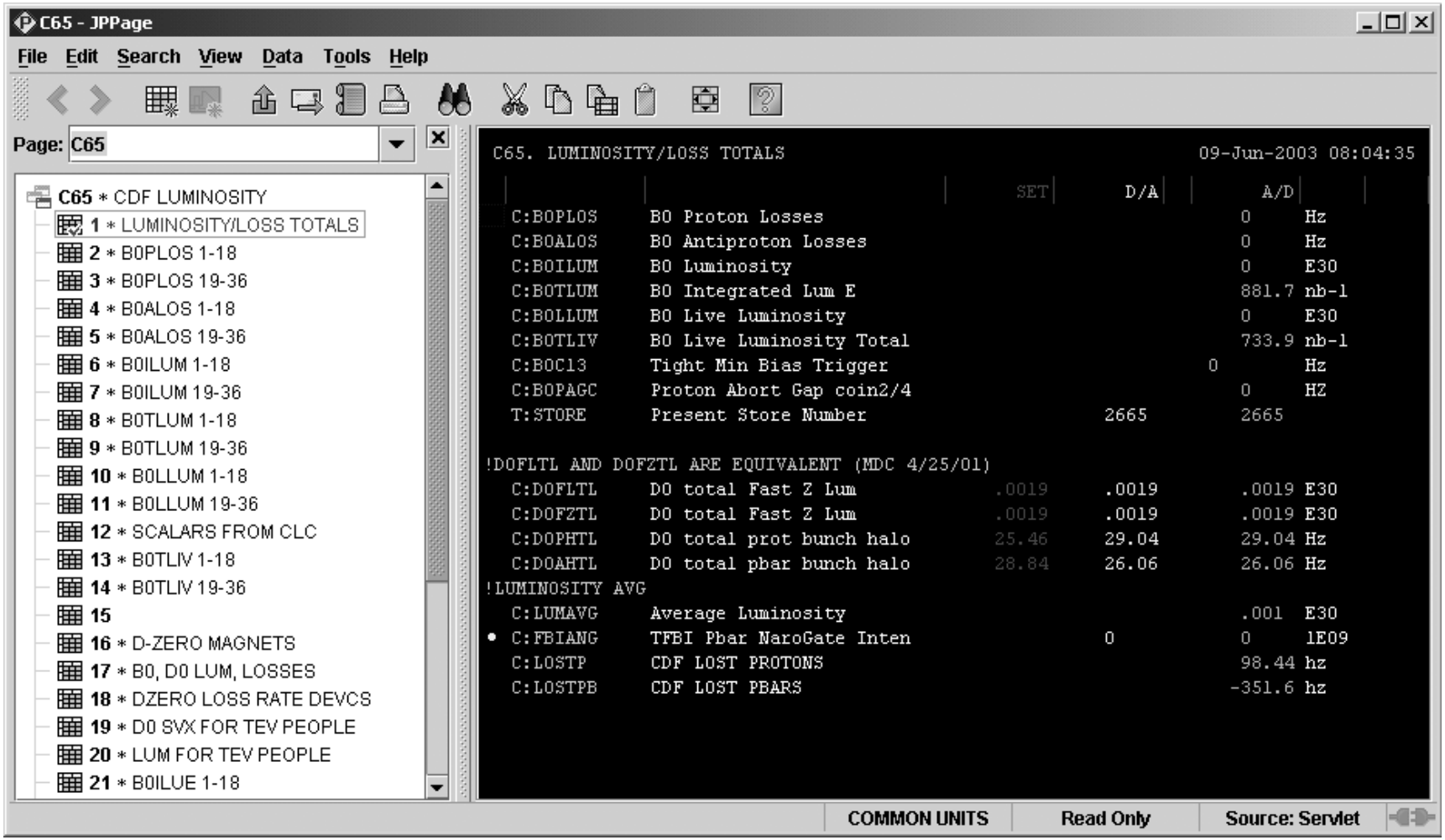
- Appix
  - B * Booster
    - Booster BPM Diagnostic
    - Booster Magnet Move
    - Booster Monitor
  - C * Collider
    - SDA
    - Lowbeta Qpm
  - D * Diagnostic & Utility
  - F * Refrigerator
  - H * Hardware Diagnostics
  - I * Main Injector
  - L * Linac
    - Chopper Timing
    - Linac Modulator Trans. Rec.
    - Linac Toroids
  - P * P-Bar
    - SDA
    - Pbar Vacuum Plotting
  - R * Recycler
  - T * Tevatron
    - SDA
    - Tevatron Array Display
  - W * Work In Progress
    - Composite Devices Editor
    - Electrom Cooling Autotune
    - Fast Time Plot (Florian)
    - Lookup Vac
    - MiniBooNE Autotune
    - Parameter Page (Florian)
    - SDA Plot Viewer beta
    - SDA Viewer (beta)
    - Simple Optics
    - Tev Clock Info
  - Z * Test Applications

Document: Done

Infrastructure Applications

- Notify
- Data Logger Plotter (D44)
- Database Examine (D80)
- Parameter Page
- Synoptic Display/Builder
- Last 4 have versions that run outside beams network
  - No settings in that case.

Parameter Page



Device Database (D80)

D80:Device Diagnostic - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: http://www-bd.fnal.gov/webD80/Summary.jsp

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File Tool Help Site

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Device Diagnosis

Summary

Quick Navigation

1. READING PROPERTY
2. SETTING PROPERTY
3. ANALOG ALARM
4. DIGITAL ALARM
5. BASIC CONTROL
6. BASIC STATUS
7. FAMILY PROPERTY
8. SAVING PROPERTY
9. DEVICE DUMP
10. DEVICE SUMMARY

General Info: FB1 proton narrow gate intensity device

Device Name C:FBIPNG | Device Index 149526

Descriptive Text TFBI PROT NAROGATE INTEN | Node TFBI 18 10

SUBMIT VALUE | Start DAQ

Analog Alarm Information: No such property exists.

Alarm Bypass | Tolerance 1 | Alarm Present

Beam Abort | Tolerance 2

Abort Inhibit | Tolerance Type

Reading Information:

Reading 21.3262 1E09

Setting Information

Setting Value 0.0 Dely

Basic Status Information: No such property exists.

On | Ready | Remote | Positive | Ramp

Sibling Information

Next null | Previous null

Protection Mask | Audit Information | SSDR Data | Virtual Mac

Is Broken No

Error Message: Total = 0

Contact : Zongwei Yuan

Examine Device Database

File Edit Program Tools Search Tools Tasks Tools Help

Analog | Digital | Reading | Setting | Summary | Start Daq

Dump | Control | Status | Save/Restore | Family | Stop Daq

General: Device type description not yet available .

Device Name: G:CDFDN | Device Index: 109624

Descriptive Text: CDF (0=UP,1=PEND,2=DOWN) | Node: DUE28 153 11

Reading Block

SSDN 0044/0000/0000/0000

Default Data Size 4 | Maximum Array Size 4 | Atomic Size 4

Frequency Time Descriptor(FTD) 1 Hz | Address Mode 0

Raw Reading

Reading-Engineering Units

Reading PRT Block

Primary Units MODE | Transform Index 16 | Display long

Common Units MODE | Transform Index 4 | Notation decimal

Input Length 4 | Motor Controller D/A | Snap Shot

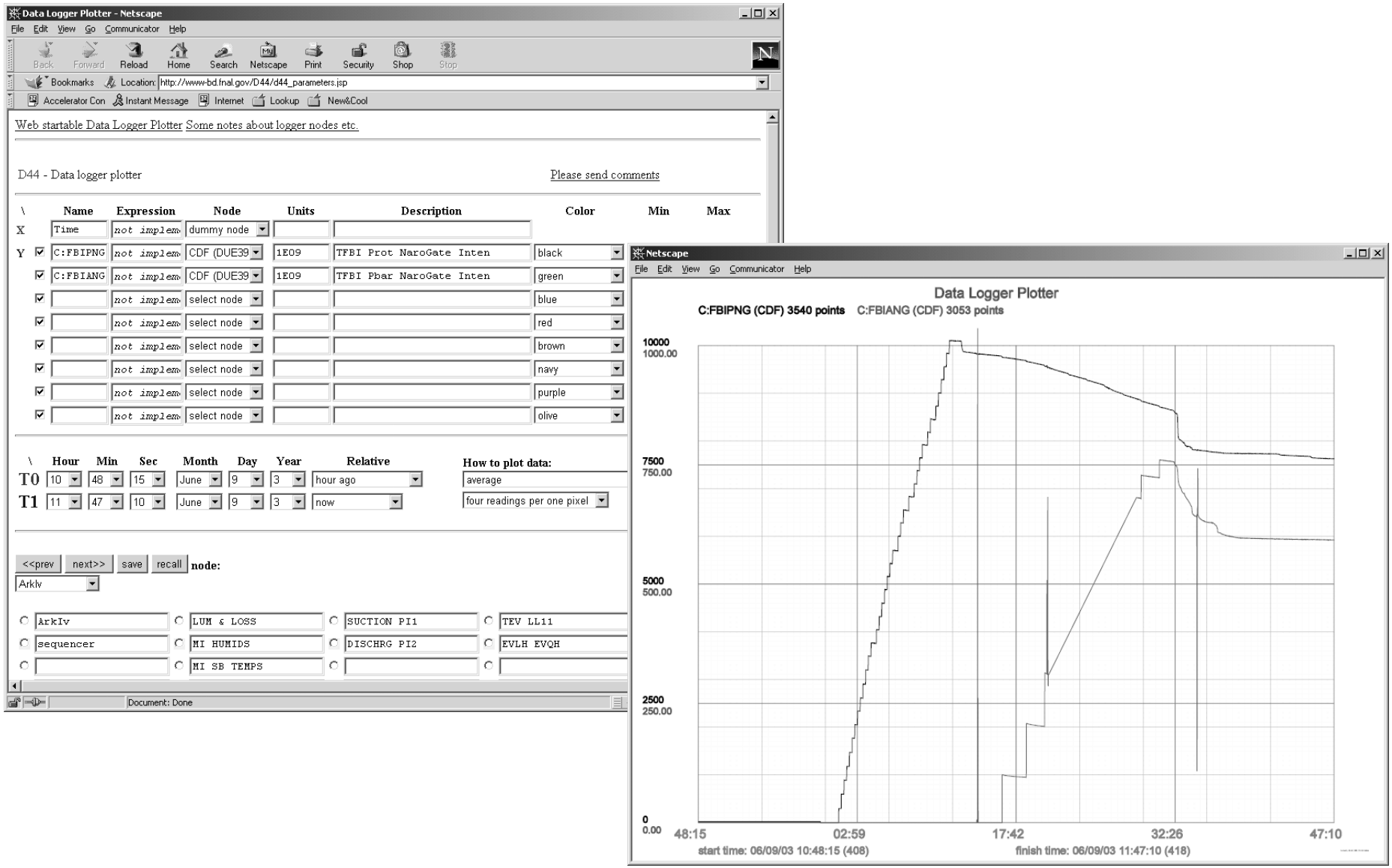
Primary Transform X = IEEE-DEC floating format (standard) | Test Scaling

Common Transform X' = (X-C1)/C2

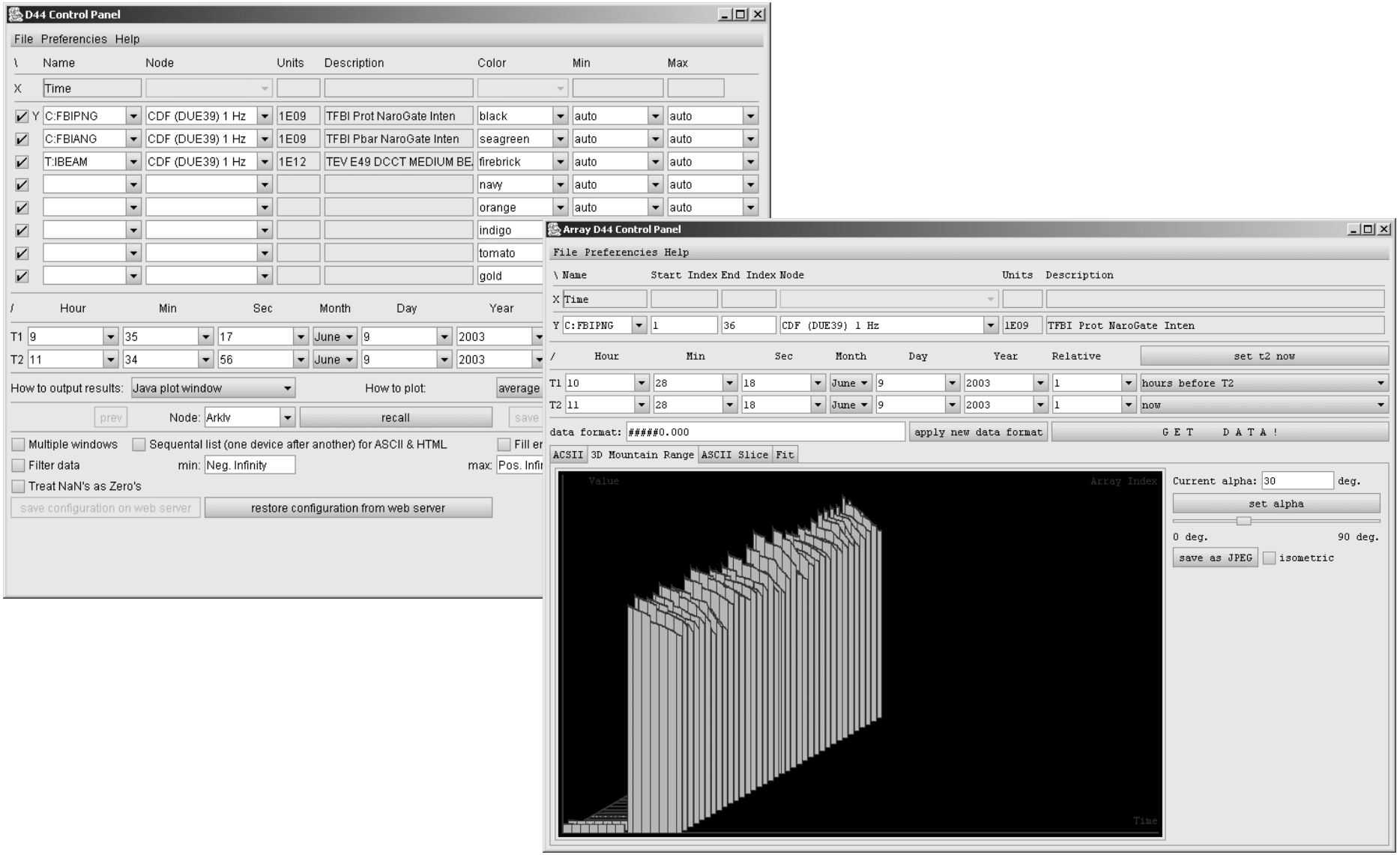
C1 0.0 | C2 1.0 | C3 0.0

C M

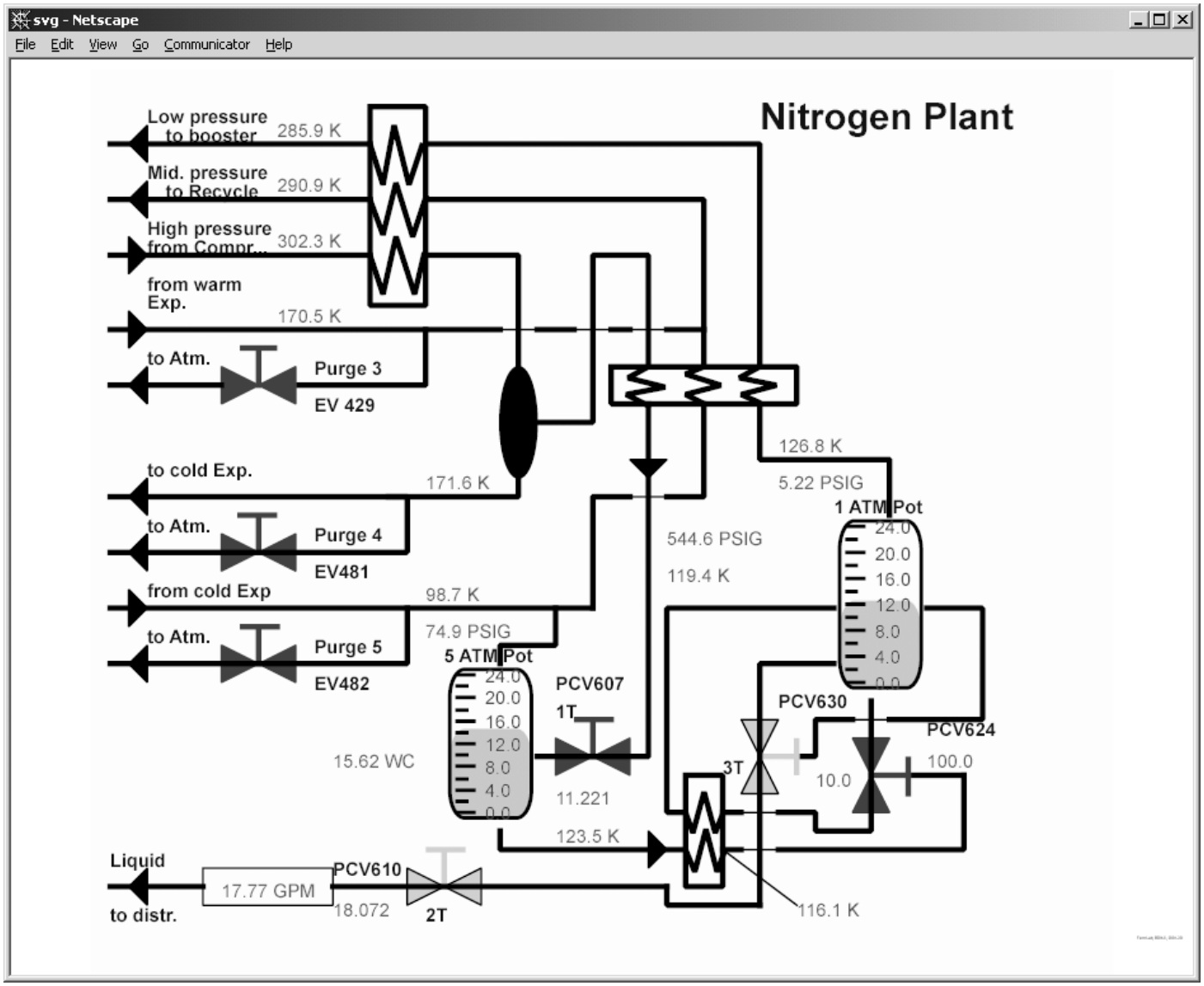
Data Logger Plotter (D44)



Array Plotter



Synoptic Display



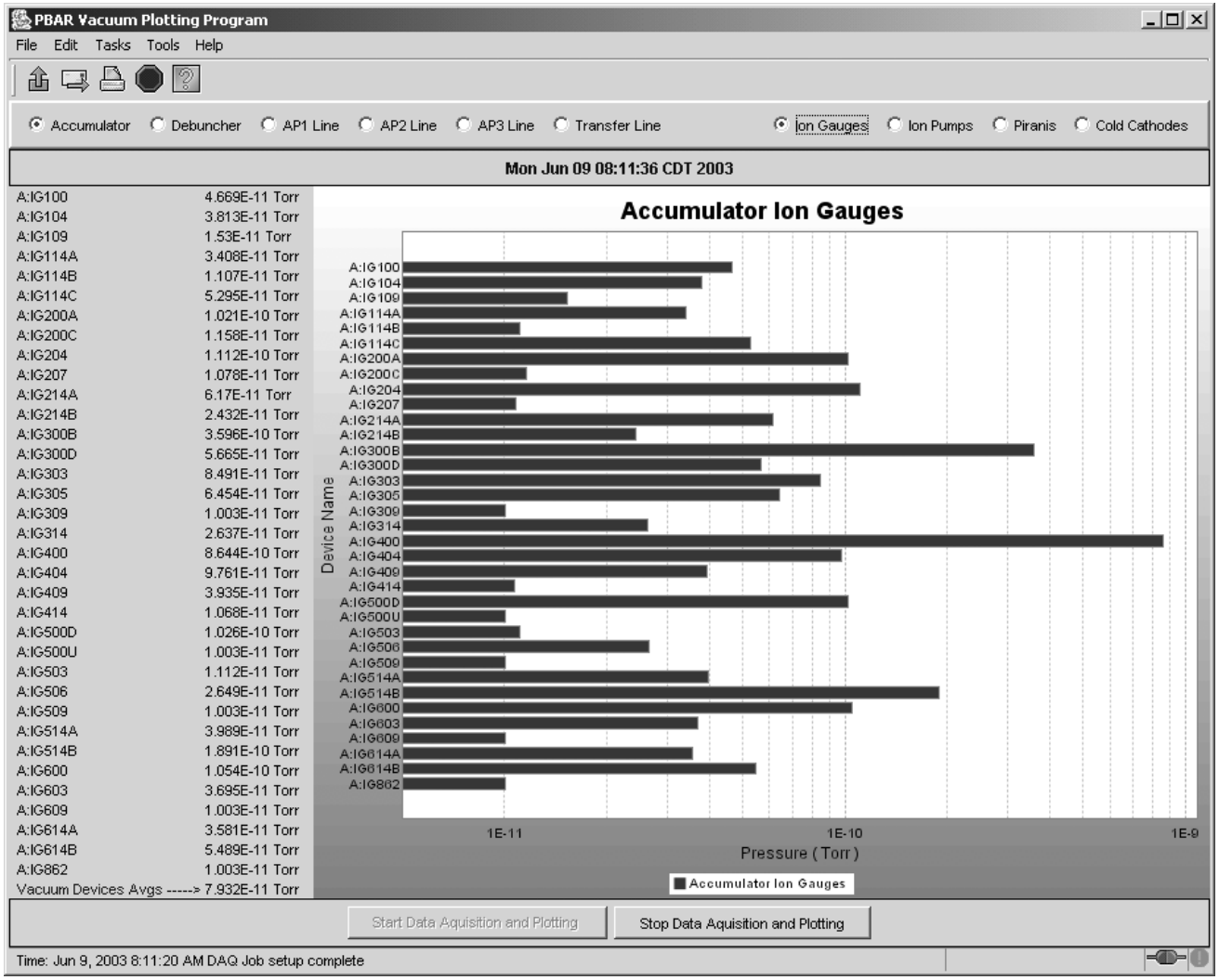
Controls Machine Applications

- SDA
  - Everything; configuration, data acquisition, analysis tools
- Low Beta QPM
  - Now default for operations
- Fixed target autotune
  - MiniBoone, SY120, electron cooling
- Booster BPM diagnostic
- Linac - various

External Machine Applications

- Tevatron:
  - Array Display (R. Moore)
  - Mountain Range Display (R. Moore)
- Pbar:
  - Vacuum display (J. Budlong)
- Booster:
  - General waveform monitor (G. Guglielmo)
  - Magnet Move (A. Waller)
- Linac:
  - TransRec display (B. Bolek)
- General:
  - “Studies” application (L. Piccoli)

Pbar Vacuum


PBAR Vacuum Plotting Program
File Edit Tasks Tools Help
Accumulator
Debuncher
AP1 Line
AP2 Line
AP3 Line
Transfer Line
Ion Gauges
Ion Pumps
Piranis
Cold Cathodes
Mon Jun 09 08:11:36 CDT 2003
A:IG100 4.669E-11 Torr
A:IG104 3.813E-11 Torr
A:IG109 1.53E-11 Torr
A:IG114A 3.408E-11 Torr
A:IG114B 1.107E-11 Torr
A:IG114C 5.295E-11 Torr
A:IG200A 1.021E-10 Torr
A:IG200C 1.158E-11 Torr
A:IG204 1.112E-10 Torr
A:IG207 1.078E-11 Torr
A:IG214A 6.17E-11 Torr
A:IG214B 2.432E-11 Torr
A:IG300B 3.596E-10 Torr
A:IG300D 5.665E-11 Torr
A:IG303 8.491E-11 Torr
A:IG305 6.454E-11 Torr
A:IG309 1.003E-11 Torr
A:IG314 2.637E-11 Torr
A:IG400 8.644E-10 Torr
A:IG404 9.761E-11 Torr
A:IG409 3.935E-11 Torr
A:IG414 1.068E-11 Torr
A:IG500D 1.026E-10 Torr
A:IG500U 1.003E-11 Torr
A:IG503 1.112E-11 Torr
A:IG506 2.649E-11 Torr
A:IG509 1.003E-11 Torr
A:IG514A 3.989E-11 Torr
A:IG514B 1.891E-10 Torr
A:IG600 1.054E-10 Torr
A:IG603 3.695E-11 Torr
A:IG609 1.003E-11 Torr
A:IG614A 3.581E-11 Torr
A:IG614B 5.489E-11 Torr
A:IG862 1.003E-11 Torr
Vacuum Devices Avgs -----> 7.932E-11 Torr
Accumulator Ion Gauges
Device Name
1E-11
1E-10
1E-9
Pressure (Torr)
Accumulator Ion Gauges
Start Data Aquisition and Plotting
Stop Data Aquisition and Plotting
Time: Jun 9, 2003 8:11:20 AM DAQ Job setup complete

Resources

- Books
- Web Sites
  - http://java.sun.com
- Controls documentation
  - http://www-bd.fnal.gov/controls
- Controls examples
  - P:\gov\fnal\controls\examples
- **Ask us!**

What Should You Do?

- Spend at least some time learning about this
- Use existing applications and provide feedback
- Try writing a simple application to gain experience
- Write or suggest an application that might be useful
  - New functionality
  - Address deficiencies in VAX version
  - Take advantage of functionality in Java API
  - Improve automation
  - If better performance useful
- Rather than blindly port VAX code, we would like to be driven by what would be useful for the accelerator
- We will provide whatever infrastructure is required
- We will provide whatever personal help people need
- We will write programs that people suggest