EPICS at NLCTA

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SLAC

FNAL 12 April 2006

Outline

- Lay of NLCTA-Land
  - Definitions
  - Floor plan
  - Sketch of network of EPICS supporting HW
- What's where: HW/SW
  - IOCs, GTWs
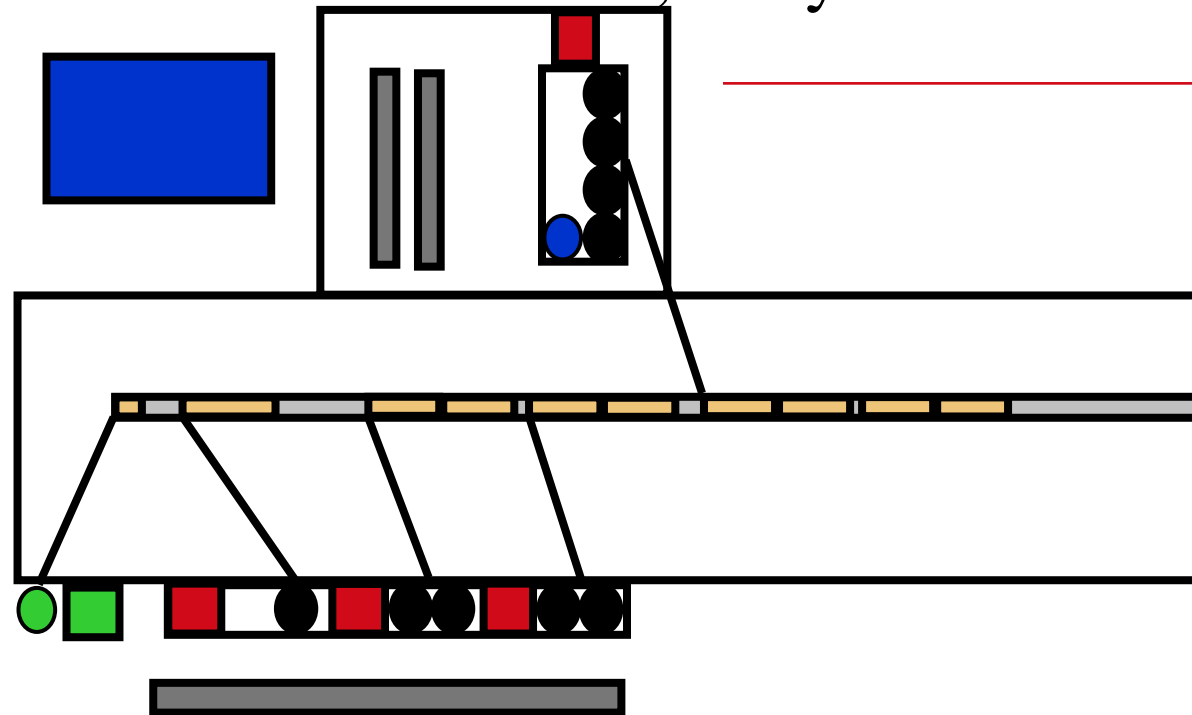- Main Tools/Interfaces

Lingo

Definitions:

- **EPICS = Experimental Physics and Industrial Control System**

- **IOC = I/O Controller (VxWorks VME Crate Controller)**

- **GTW = Gateway Machine – Main CA server**

- **PV = Process Variable – database element**

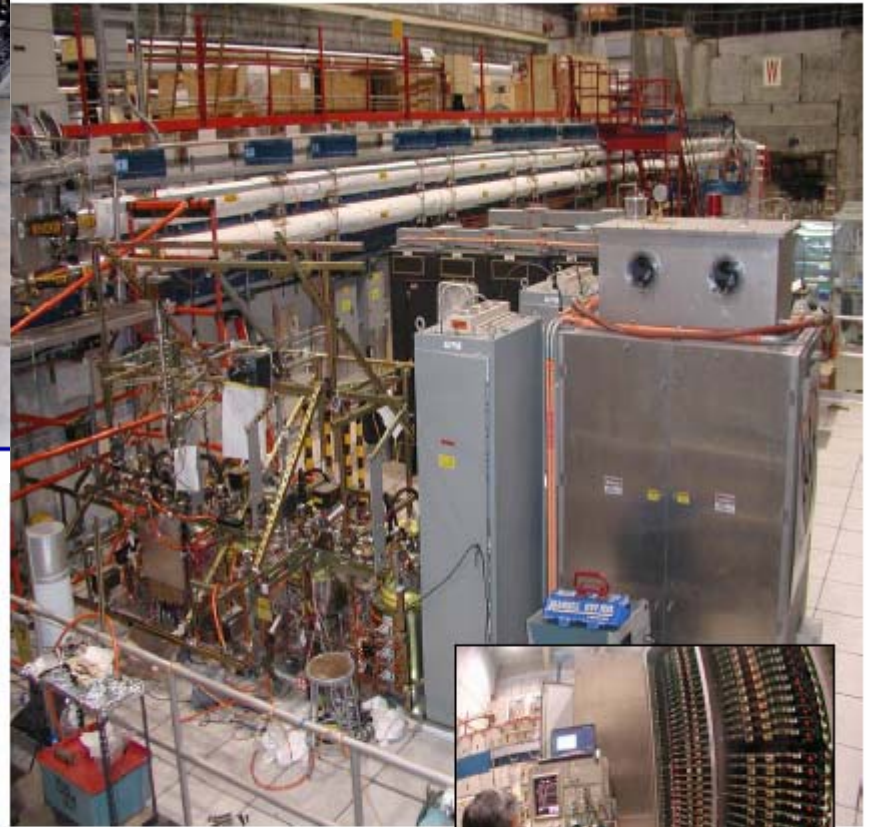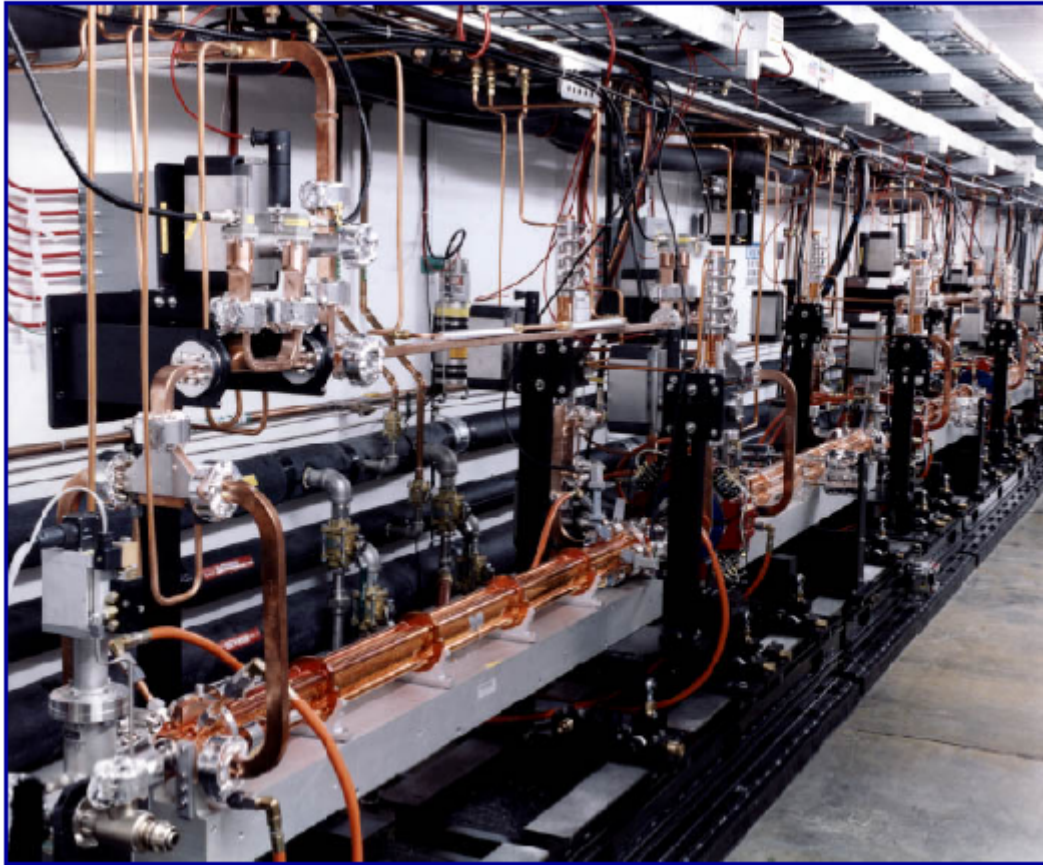- **PLC = Programmable Logic Control – Allan-Bradley hardware**

EPICS at NLCTA

- Until late '98
  - Used labview to drive an accelerating structure (AS) processing loop but
    - it was insufficiently powerful, too slow, not designed with growth in mind
- EPICS
  - AS processing loop (similar to coupler & cavity)
    - auto recovery from arcs, breakdowns, vacuum, klystron REs
    - track statistics
    - Plus EPICS extensions: archiving, striptool, etc.
  - Readout of PS/Mod/Klys PLC variables
- NLCTA code developed organically
  - 8-Pack a hurried copy of NLCTA code (~20 person-months)

- NLCTA =
  - NLCTA – 2 X-band RF Stns: 2 modulators, 4 klystrons, 2 pair of sled-lines, 4 accel. structures
  - 8-Pack – 1 X-band Stn: 1 modulator, 4 klystrons, a pair of high-power sled-lines, 4 accel. structures
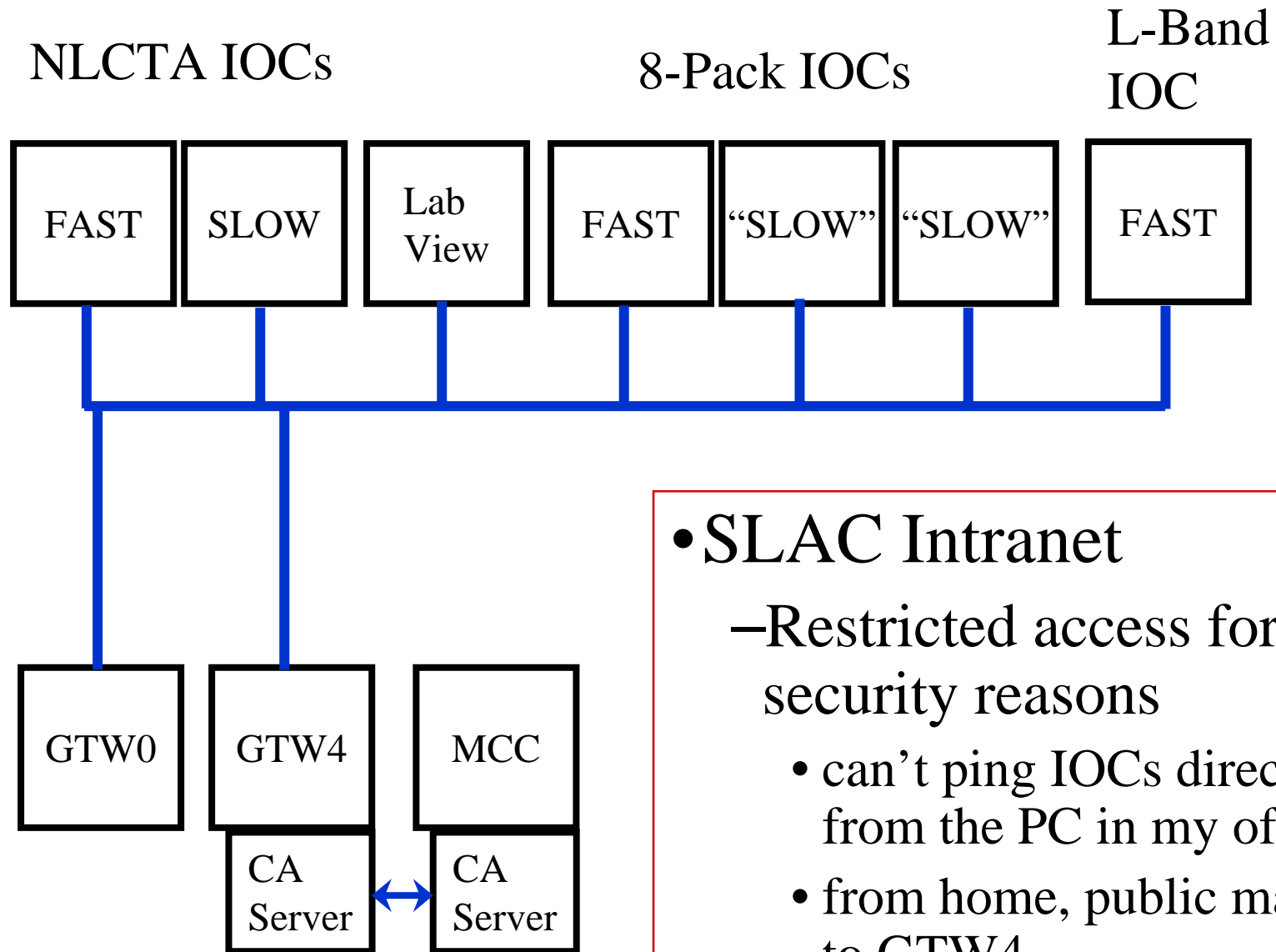 - 1 L-Band stn: 1modulator, 1 klystron

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NLCTA IOCs

| FAST | SLOW | Lab View | FAST | "SLOW" | "SLOW" |

8-Pack IOCs

L-Band IOC

| FAST |

GTW0   GTW4   MCC

CA Server ↔ CA Server
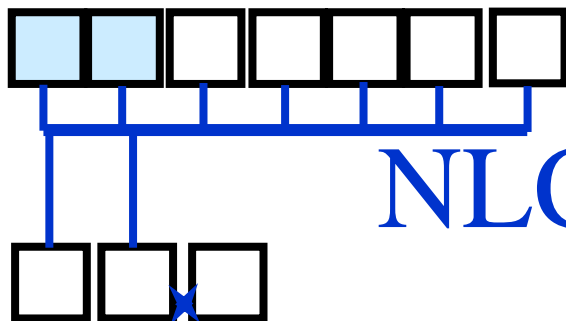
- SLAC Intranet
  - Restricted access for security reasons
    - can't ping IOCs directly from the PC in my office
    - from home, public machine to GTW4

NLCTA IOCs – 2 Crates

- FAST processor (Motorola MVME2700-3431, 366MHz)
  - Hardware
    - 2 8-channel GADC Caen V265
    - Lecroy 1176 TDC
    - 16-channel, 12–bit DAC VMIC VME 4100
    - Digital I/O VMIC VME 2534
  - Software – kept to a minimum
    - 1672 PVs
    - 2 AS processing loops "sequencers" – Stn 1 & 2, 60 Hz
    - detection & recovery from breakdowns, soft vacuum faults, klystron REs, et. al. and maintain statistics
    - ramps power and pulse width based on rate of breakdowns and other user-enterable parameters

- SLOW processor (Motorola MVME177-55SE, 50 MHz)
  - Hardware
    - AB link module – VME6008-SVR2
    - 2-channel ADC BiRa VSAM
    - 5 Joerger VTR812/10 – 8-channel 10 MHz 12-bit analog digitizer
  - Software – everything else
    - 1322 PVs for PLC, 1153 for everything else
    - readout of digitizers on fault, DB for PLC variables, slow diurnal power feedback, vacuum
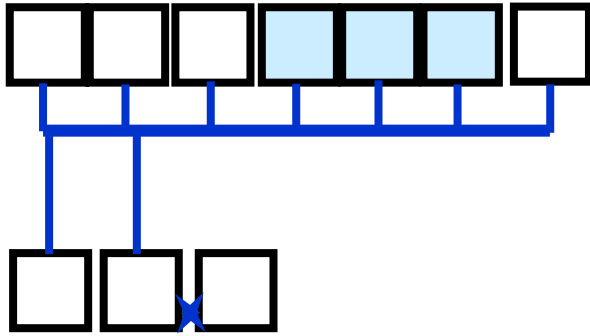
8-Pack IOCs

- Cut & Paste of NLCTA with minor device support developed
- 3 crates
  - 1 fast processor (Motorola MVME2700-3441, 366 MHz)
    - Hardware
      - DIO VMIC VME 2534 32-bit
      - 2 64-channel 16-bit ADCs VMIC VME 3122
      - 8 32-channel 12-bit ADCs VMIC VME 4132
    - Software
      - 2640 PVs
      - Like NLCTA fast crate–proc loop, but never quite got to 60Hz
  - 2 slow processors (same as above)
    - Hardware
      - 8 8-channel 100 MHz 12-bit digitizers (Struck SIS)
    - Software
      - 1005 PVs for PLC, 1539 for rest
   - Like NLCTA
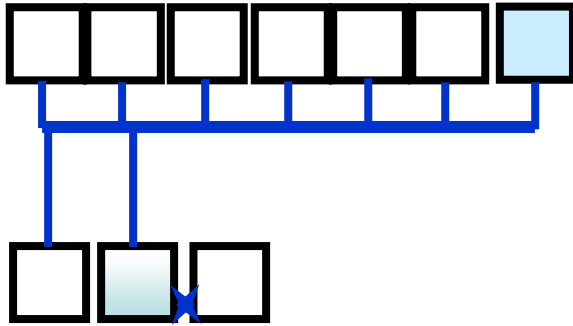
L-Band IOCs

- 1 Fast crate (Motorla MVME2700-3441 366 MHz)
  - Hardware
    - Same module types as NLCTA/8-pack: ADC, DAC, DIO, 4 SISes
  - Software
    - 590 PVs
    - Just slow LLRF support. Proc loop in the future.
- 2 Soft IOCs
  - Modulator PLC (EtherIP) - 253 PVs
    - from SNS: worked first time we compiled
    - Only minor mods - naming scheme (to play well with others)
  - GPIB (Asyn) – 163 PVs
   - 2 AFGs for LLRF, Peak Power Meter
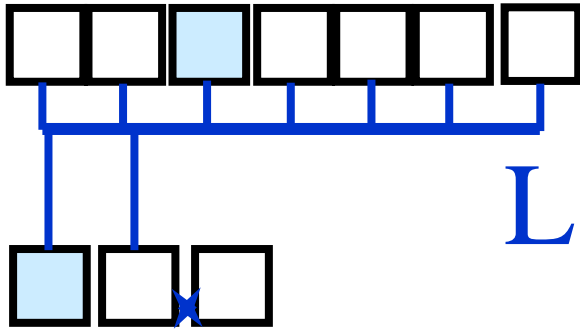
Labview & GTW 0

- Labview
  - GPIB interface to Peak Power Meters
  - Measure waveforms, calculate peak power, pulse width, &c
  - ActiveX CA serve these to intranet
- GTW0
  - Sun solaris workstation
  - Main CA server for PEP
  - IOC boot scripts
  - Alarm Handler (extension)
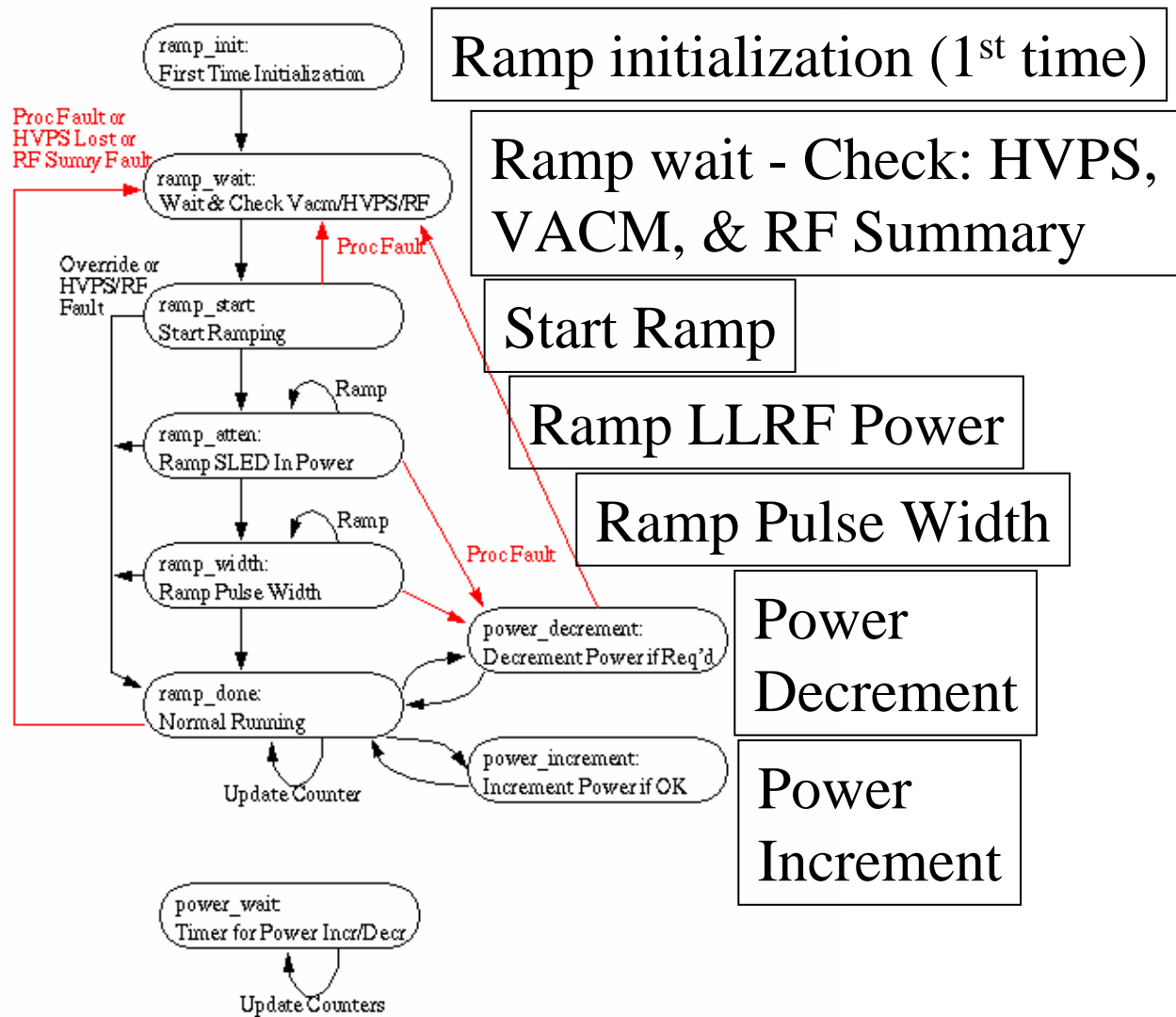   - Network/Gateway status
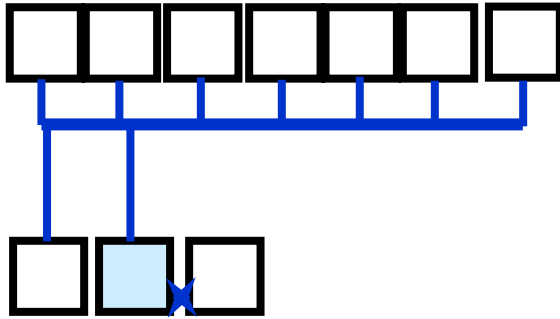
GTW 4

- GTW4 – Solaris Workstation
  - CA Server for NLCTA – main EPICS interface (R3.13.2)
  - NFS/AFS storage – save/restore (Channel Watcher)
  - Displays
  - Archiver
  - Striptool
  - CMLog
  - Matlab interface
  - Soft IOCs for new projects (R3.14.6)
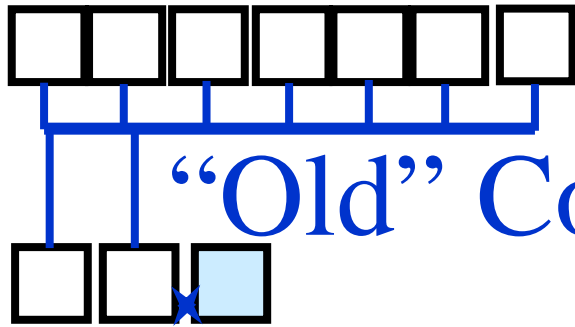
"Old" Control System Mainframe

- VMS Alpha – MCC
- SCP Con Sys – mature: wrinkly stability
  - Provides control for everything else (magnets, analogs, digital, BPMs, feedbacks, &c)
- CA Server – can see PVs for:
  - Histories, error logging, correlation plots, multi-device knobs, configurations
- EPICS can see all SCP db elements and control a few

Processing Loop

Ramp initialization (1st time)

Ramp wait - Check: HVPS, VACM, & RF Summary

Start Ramp

Ramp LLRF Power

Ramp Pulse Width

Power Decrement

Power Increment

State diagram labels:

- ramp_init: First Time Initialization
- ProcFault or HVPS Lost or RF Sumry Fault
- ramp_wait: Wait & Check Vacm/HVPS/RF
- ProcFault
- Override or HVPS/RF Fault
- ramp_start: Start Ramping
- Ramp
- ramp_atten: Ramp SLED In Power
- Ramp
- ramp_width: Ramp Pulse Width
- ProcFault
- power_decrement: Decrement Power if Req'd
- ramp_done: Normal Running
- Update Counter
- power_increment: Increment Power if OK
- power_wait: Timer for Power Incr/Decr
- Update Counters

- Sequencer
- Runs 24/7 unattended – after initial tests
- Both db logic and a sequence (SNL)
- 60 Hz - decides go/no go before next pulse

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Test Accelerator
RF Station 2 Acc Struct Processing

Print   Exit

Help

Energy Calib	Energy Limits	Time Limits	AS Prc Inputs	AS Fault List

	Smoothed Energy (J)	Check Limits	Error Limit	Warning Limit	Detail Plots	Latched Status	Fault Status	# Faults
Acc Struc 1:								
Input Refl	DB -19.0	NO	2500.0	3000.0	Diag	DISABLED	OK	2
Input Frwd	DB -4.8	NO	50.0	50.0	Diag	DISABLED	OK	0
Load Frwd	DB -4.0	NO	40.0	40.0	Diag	DISABLED	OK	0
Lost (Missing)	DB -0.8	YES	3.0	4.0	Diag	OK	OK	0
Acc Struc 2:								
Input Refl	DB -131.0	NO	-200.0	500.0	Diag	DISABLED	OK	106
Input Frwd	DB -2.5	NO	50.0	50.0	Diag	DISABLED	OK	0
Load Frwd	DB -1.9	NO	50.0	50.0	Diag	DISABLED	OK	0
Lost (Missing)	DB -0.6	YES	2.0	4.0	Diag	OK	OK	0

Get Snapshot   Last Snapshot: ____   Count Reset   Last Count Reset: ____   Total 109

DAC Control

		SLED In Power (MW)	Pulse Width (nsec)	Summary Status

Status   DB Running

Running Counter   58685

Post-Fault Wait Time (s)   5.00

Ramp   Autoramp

Target   50.00

Initial   1.00

Current   DB   0.99

Control   1.00   1.00   100.00

Control→Target

Target   250.0

Initial   10.0

DB   260.7

Control   0.0   250.0   250.0

Control→Target

Summary Status

Current   DB   OK

Latched   DB   OK

Last Fault: ____

Fault Reset

Displays

- We use multiple editors/display drivers:
  - dm/edd NLCTA & 8-Pack
  - dm2k graphics & large summary displays
  - edm is new within last year: LBand – Modulator (from SNS), GPIB, LLRF
    - Even newer: dm to edm conversion – pretty good

Test Accelerator
HVPS 1 Modulator 1

Print   Exit

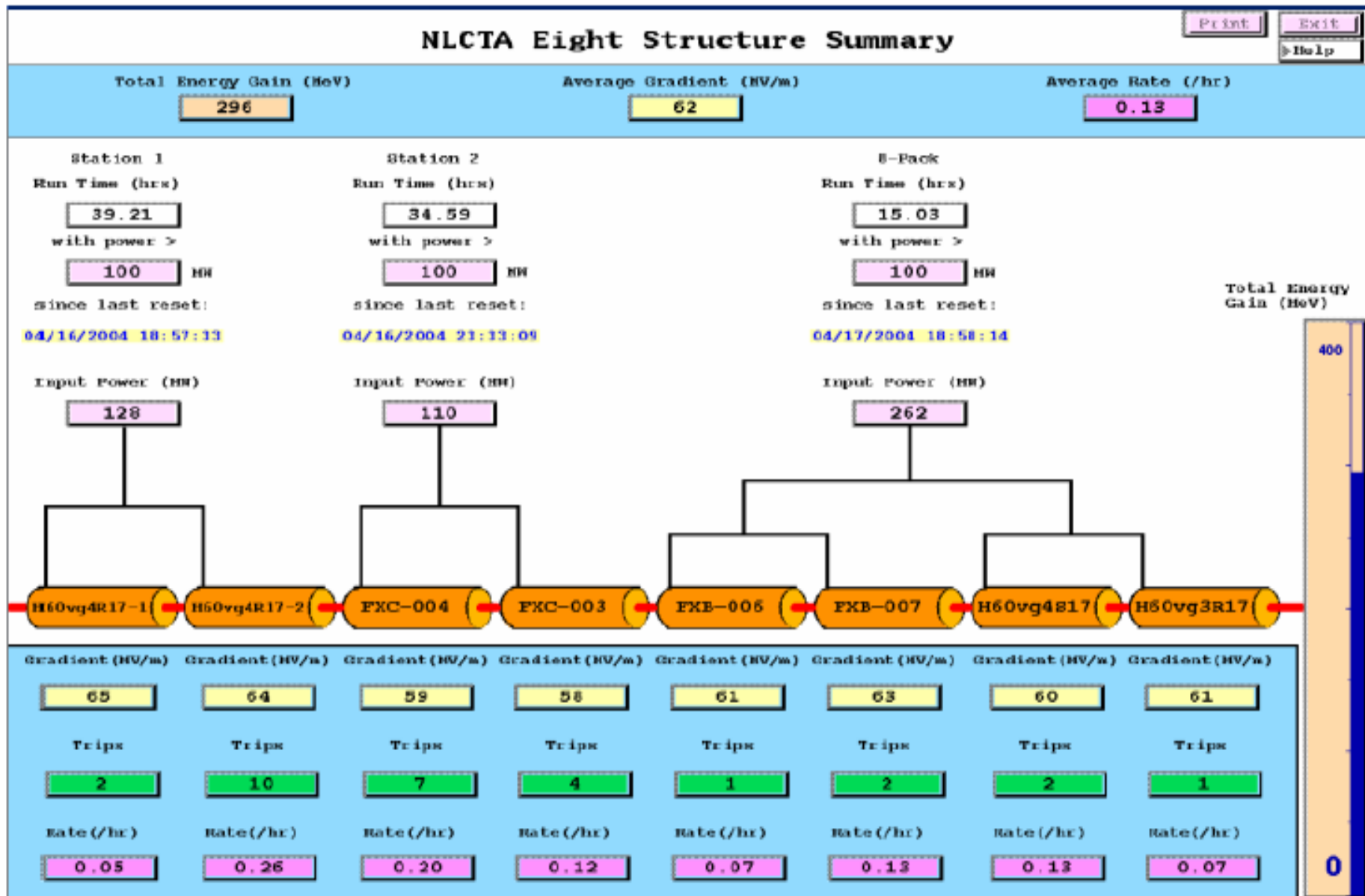Help

| Station | Klystron 1 | Klystron 2 | HVPS 1 | Mod Reset |

			Status	Latched	
Out of Range	DB OK	24V	DB FAULT	DB OK	DB BYPASS
Ready	DB READY	Beam Containment	DB OK	DB OK	DB NOBYPASS
Connection	DB CONNECT	RF	DB OK	DB OK	DB NOBYPASS
Time Delay	DB ON	Door	DB CLOSED	DB CLOSED	
Core Bias	DB ENABLE	Water Flow	DB OK	DB OK	
Kly Htr On-Off	DB ON	Air Flow	DB FAULT	DB OK	DB BYPASS
Kly/Thy On-Off	DB ON	Oil Flow	DB OK	DB OK	
HVPS System	DB OK	Oil Level	DB OK	DB OK	
Contactor	DB OFF	EOL Clipper Arc	DB OK	DB OK	
		Fire Alarm	DB OK	DB OK	

Klystrons

	Klystron 1		Klystron 2			Voltage (kV)
Htr Voltage (V)	DB 23.67	DB OK	DB 22.49	DB OK	Beam	DB -2.4
Htr Current (A)	DB 22.43	DB OK	DB 22.43	DB OK	Cathode	DB 0.2
Beam Current(A)	DB -1.4		DB 1.9		Output	DB 0.2
Latched Current Status		DB OK		DB OK		
Availability		DB ONLINE		DB ONLINE		

Thyratrons

	Thy 1 Reservoir		Thy 2 Reservoir		Thy Heater	
Voltage (V)	DB 5.59	DB OK	DB 5.39	DB OK	DB 7.30	DB OK
Current (A)	DB 17.30	DB OK	DB 16.75	DB OK	DB 119.3	DB OK
Availability		DB ONLINE		DB ONLINE		

CMLOG Browser

- GUI
- Update or Query mode
- NLCTA and global timing
But most folks still use
- Text driven program on Alpha
  - includes all devices in SCP
  - almost as flexible/powerful as
       CMLOG
  - very familiar to old-timers

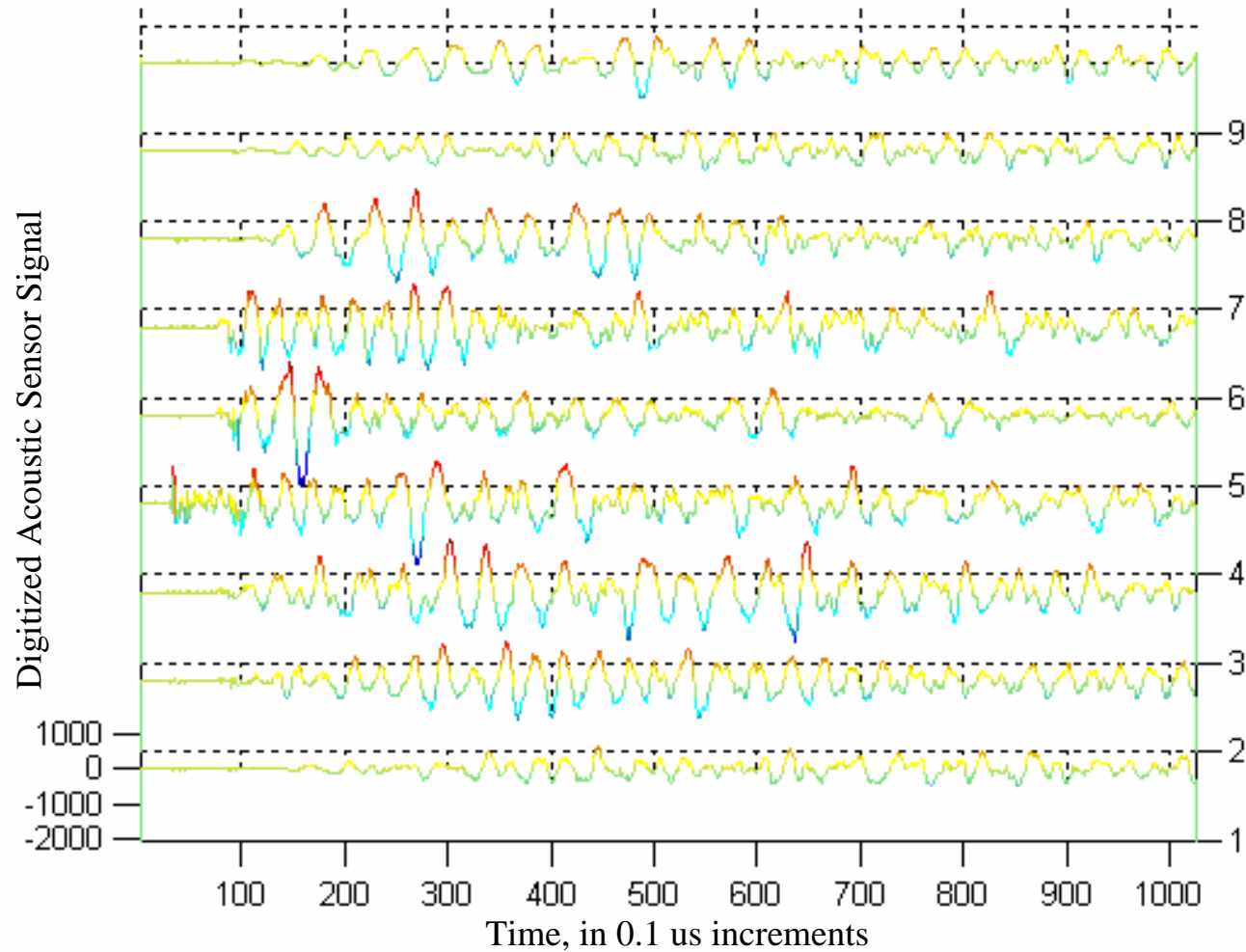12 April 2006   Janice Nelson, SLAC

Matlab Interface

- Access to CA server & archived data
  - Powerful enough to use as a processing loop
    - 8-pack: vacuum, pulse width then power, save waveforms for later analysis, make auto-elog entries
  - Used to test algorithms (SLED feedback) before EPICS-ification
    - Easy to convert to C or SNL (even by non-author)
  - Offline analysis

Digitization of AES on Fault

Acoustic Sensor Signals from an RF breakdown event in an X-band Accelerating Structure

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Present & Future

- Maintenance
  - 5-10% of my time
    - 90% of the time reboot fixes all
- Major Problems
  - Interface and coordinate with SW & HW folks

- SBand PLC Support (50 PVs)
- 2-pack
  - Use much of existing 8pack with resuscitation cost
  - PLC
- More Lband Stns
  - Probably Labview
  - EPICS a bit much

Biased Summary

- Pros
  - Very powerful
    - Enough rope to hang yourself with
  - Easy cut'n'paste-able items
  - Fancy GUIs
  - Extensions have caught up with SCP
  - Powerful collaboration
  - Improvements seen ~yearly scale

- Cons
  - Expert to set-up basic structure
    - Gotta get it right
  - Months to become capable of editing most files (good mentor needed)
    - Fewer people capable (or allowed or willing) to make small changes
  - Insufficient expert support