SNS Control System

EPICS Collaboration Meeting

May, 2001

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SNS –The Spallation Neutron Source

The Next Large EPICS Project

A Partnership between Six National Laboratories:

Argonne National Lab

Brookhaven National Lab

Lawrence Berkeley National Lab

Los Alamos National Lab

Oak Ridge National Lab

Thomas Jefferson National Lab

The Spallation Neutron Source

- Largest civil science construction project – $1.4B
- Forefront Facility for future high beam power facilities
- First superconducting pulsed proton linac
- Key Parameters
  - » Beam Energy: 1 GeV
  - » Beam Power: 1.4 MW (can reach 2)
  - » Linac tunnel length: 320 m
  - » Repetition rate: 60 Hz
  - » Avg Macropulse Current: 26 ma
  - » Pulse length on Target: 695 ns
  - » Duty Cycle: 6 %
- Projected Finish date is December, 2005

Spallation Neutron Source Aerial/Site Plan

Project Status

- Funding of $1.4B approved (incl $60M for Controls)
- FY01 Funding of $278M approved (and half spent!)
  - » (including $9.5M for Controls)
- FY02 Funding of $291M in the President's budget
  - » (including ~$12.5M for Controls)
- 1.4 million cu. yards of dirt moved; first concrete poured

Over 168,000 Construction Hours Worked Safely

• Completed two major access roads on plan

• Completed installation of three temporary electrical distribution centers

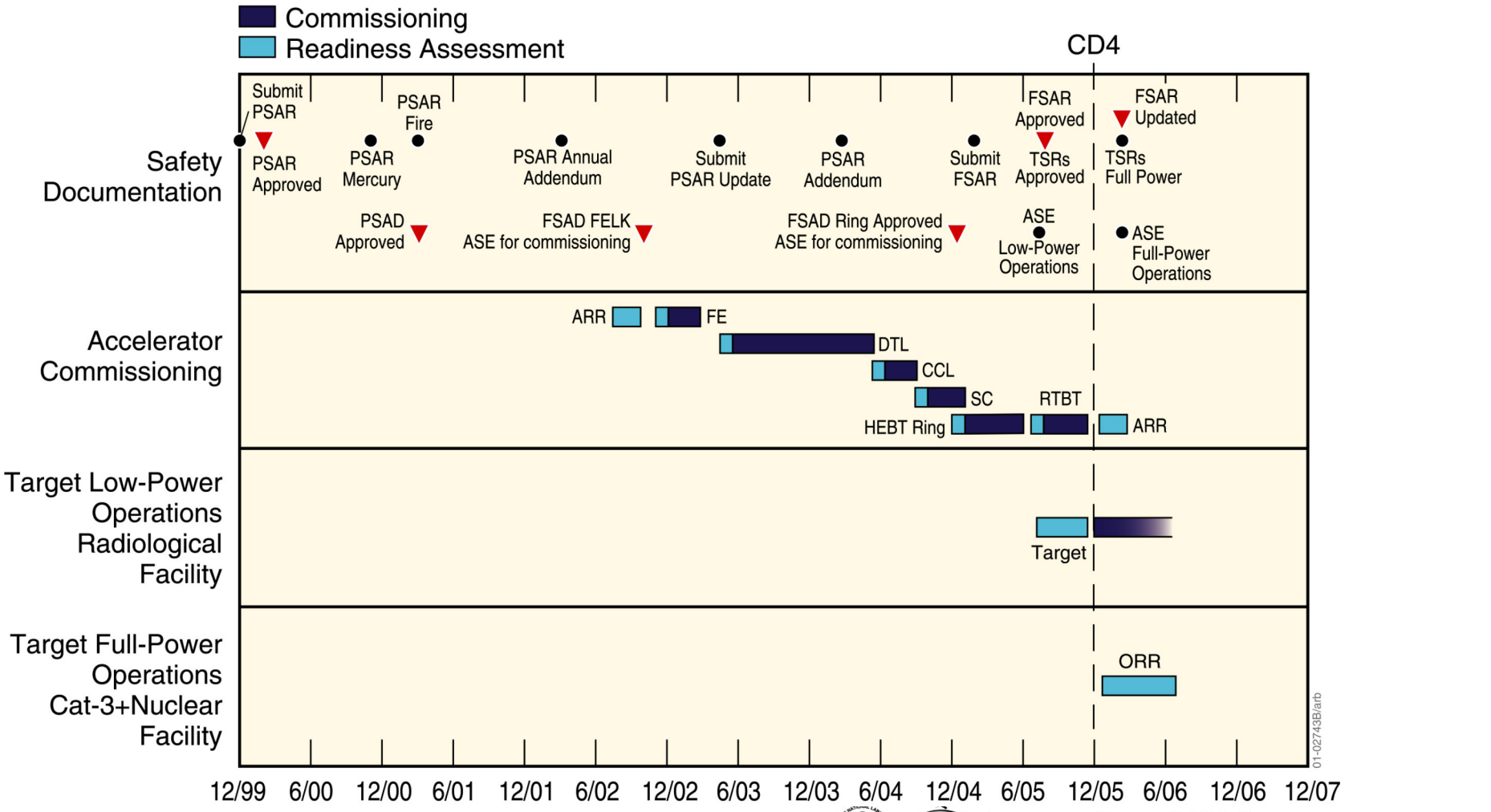
• Completed Target Building deep foundation installation on schedule

• Moved over 1.3 million cubic yards of dirt

• Linac tunnel excavation in process

• Completed retention pond on plan

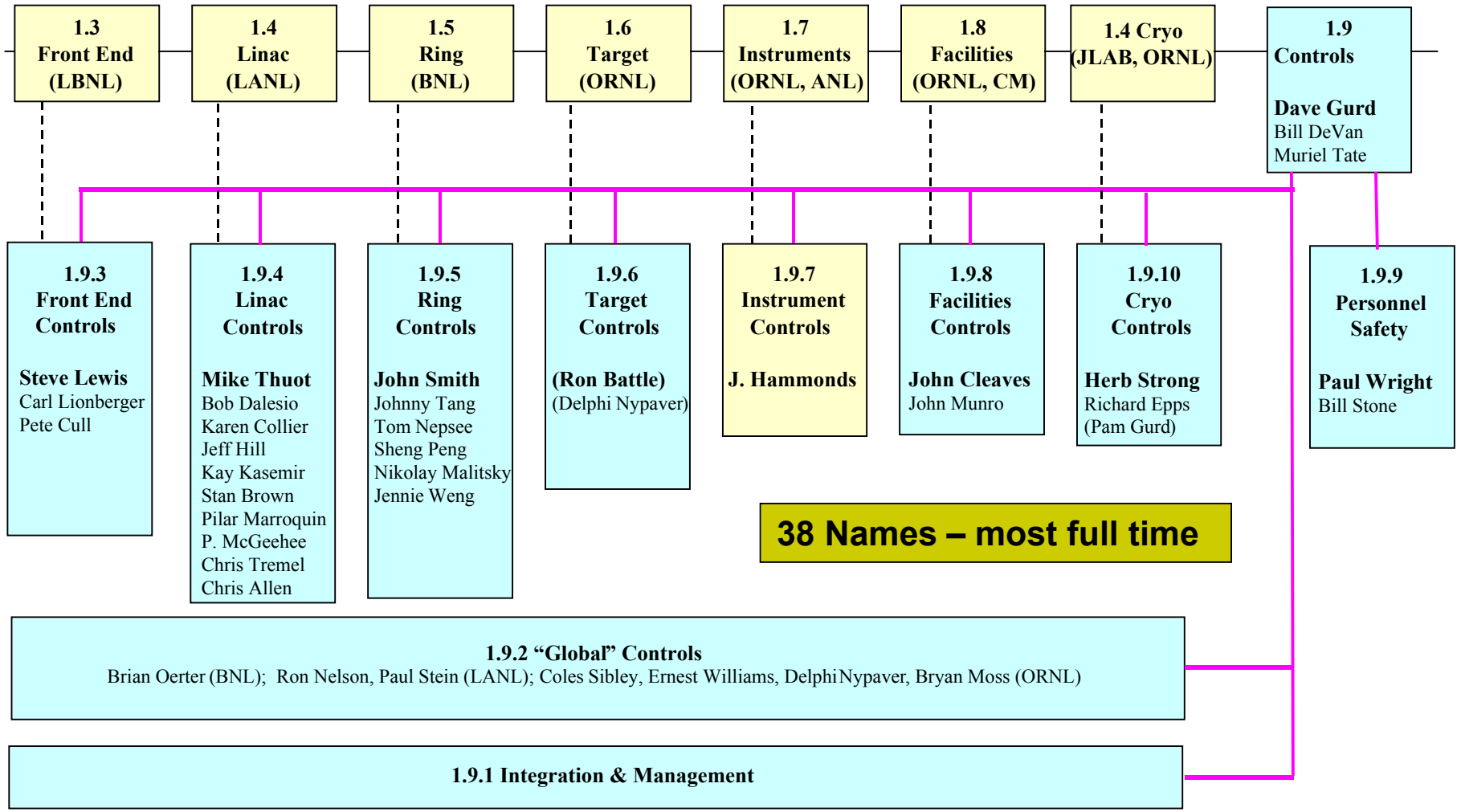
SNS Project Commissioning



We plan a system fully integrated under EPICS, including…

- Accelerator Systems
  - » Front End, Linac, Compressor Ring, Beamlines
  - » ~ 50,000 channels, 160 IOCs
  - » Front End already running under EPICS (at Berkeley)
- Target System
  - » Large and complex liquid Mercury Target
  - » 1000 channels, 6 PLCs
  - » Test facility already running prototypical EPICS system
- Conventional Facilities
  - » 2500 channels, 10 PLCs, 150 screens
  - » To be done in EPICS by Sverdrup in Tullahoma
  - » Training in June

Controls Effort is Distributed across the Partner Laboratories



Control System Systems and Functions

- Data Acquisition and Control
  - » 160 distributed Input Output Controllers with 50,000 signals
- Timing and Synchronization
  - » Synchronizes choppers, kickers, rf systems and beam diagnostics
  - » Time stamps all acquired data to microsecond accuracy
- Machine Protection
  - » Turns off beam in <20usecs for beam loss) or equipment failure
- Control System Network
  - » Isolated Control system network includes >20 switches
- System and Application Software
  - » Communications, databases, EPICS core software, “engineering applications” and the human interface
- Control Room
  - » Operator Consoles, Personnel Access control, network hub, computer servers, timing distribution etc

Where we are now

- Controls Group Staff of 10 at Oak Ridge
  - » (…and still hiring… hint… hint…)
- EPICS Systems running Target Test Facility in Oak Ridge and Front End Systems at Berkeley
- Application Development Environment runs at ORNL
  - » Distributed CVS – accessible by all the partners
- Prototypical Environment running
  - » MVME 2100 PPC, EPICS 3.13.3, Tornado II, EDM
  - » ControlLogix PLC
  - » ControlNet over EtherNet Driver

Some things we have agreed upon…

- Site-wide Device and Signal Naming Convention
- ControlLogix PLCs (Allen-Bradley)
  - » ControlNet over EtherNet Driver
- Standard Cabinets
- PowerPC IOCs (MVME 2100)
- VME64x (Contract awarded)
  - » Including Utility Board
- Linux Environment where appropriate
- Oracle

Some EPICS Developments are needed

- Large Array Support
  - » Needed for Diagnostics
- Long PV Names
  - » We could bump up against the current limit
- Variable String Size
- Multipriority Channel Access
  - » Needed for Diagnostics and Machine Protect

- SNS will fund some of these Core developments, but we will need help from the community…

Network

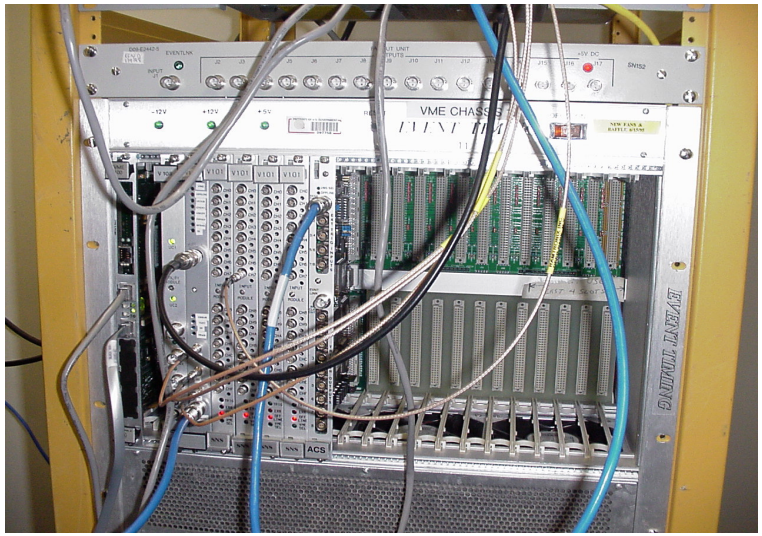
- Controls Network based upon Gigabit Ethernet backbone. High speed brought close to front ends (IOCs) using new Cisco switch technology.
- Private IP address space set up and tested in lab. This allows nearly unlimited IOCs and PLCs and can be used to model planned subnets. Cisco switch installed – this will be the core switch for the control system network. (Currently on loan.)
- Redesign for network hub and temporary control room in the Front End Building. FDR coming up.
- "PV Gateway" at LBNL allows remote access to FE control system (from ORNL), demonstrating EPICS security. Will demo during DOE semi-annual review.

Prototype Control System network core switch.

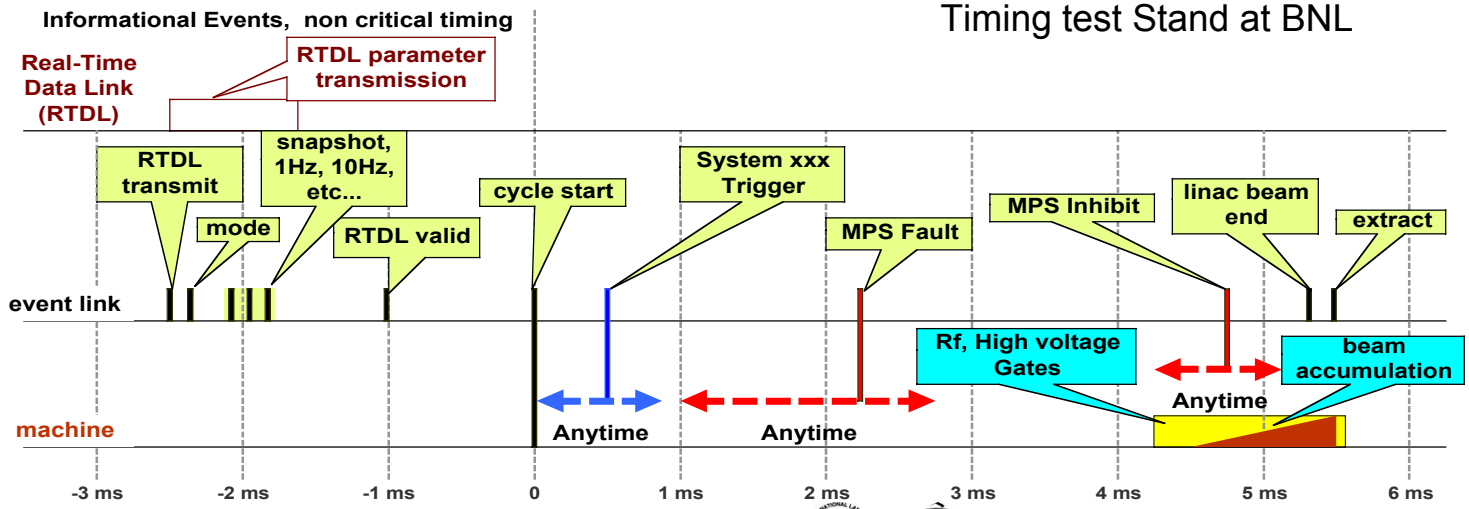
Low cost terminal server and remote reboot device.

Global Timing and Synchronization

- **Timing System** based upon RHIC. “Event” link for synchronization operates at 16X Ring Frequency. “Real-time Data Link” distributes, time, modes, other data.
- System Components in design at BNL and LANL. Test stand set up at BNL. First articles required in May at LANL and LBNL (tight)

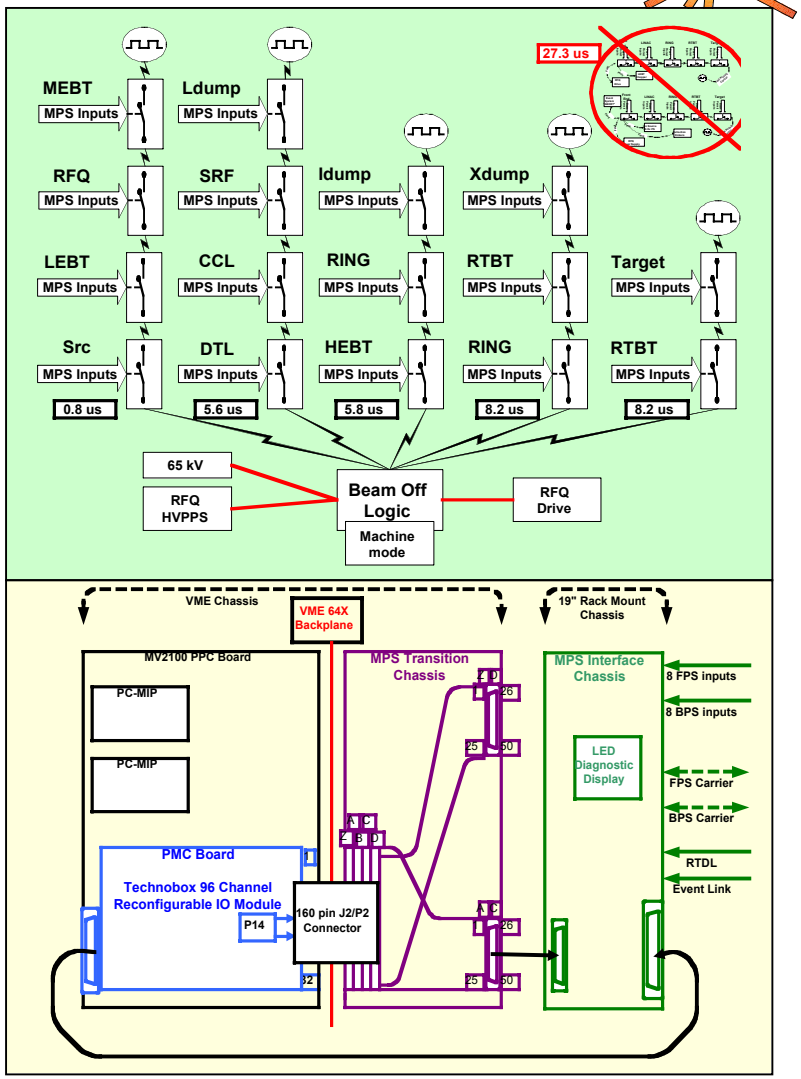


Timing test Stand at BNL



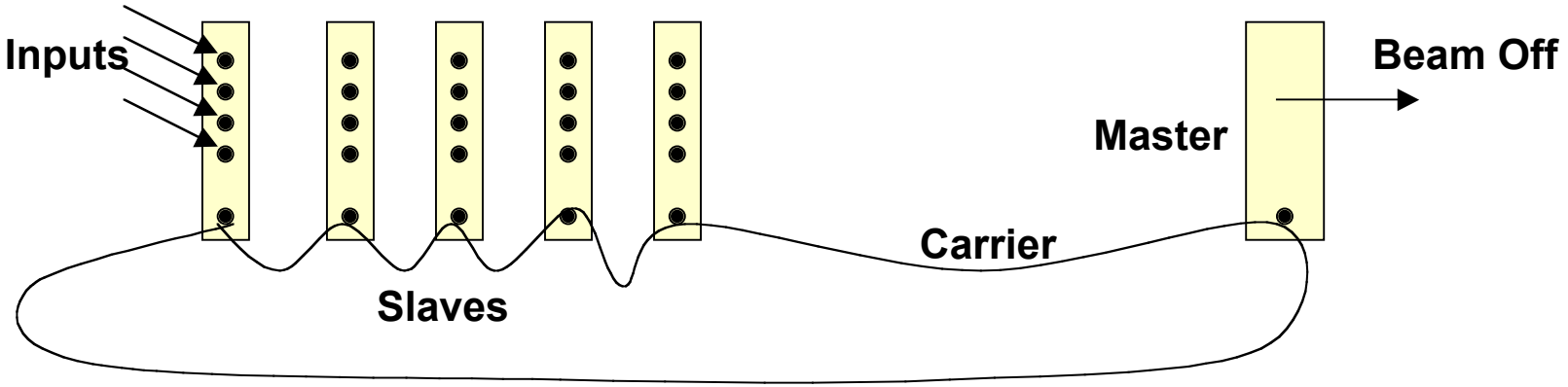
Machine Protection System (MPS)

- Star Configuration
  - » Easier for phased commissioning
  - » Shorter Propagation Delays
- Prototype system using PCI Mezzanine Card (PMC)
  - » Technobox 96 channel reconfigurable IO
  - » VME P2 transition module – Layout in progress at LANL
  - » MPS I/O Chassis – Prototype design near completion, PCB layout in progress at Los Alamos



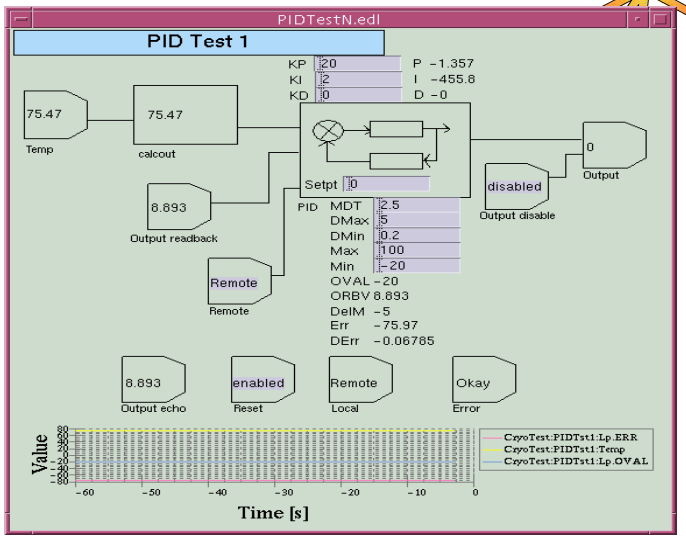
MPS based upon BNL Beam Permit System

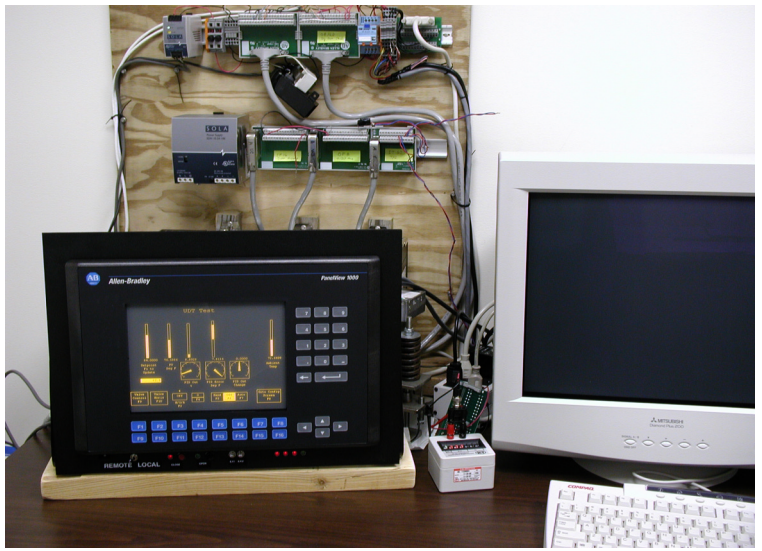
- Carrier loop (the “permit link”)
- 16 inputs (8 latched) + 4 outputs/board
  (8 inputs + 5 outputs/board)
- Interfaces with event system
- Time stamping of trips
- VME/PCI - based hardware (VME)
- Uses programmable logic devices
- Just one chassis to fab



Cryogenic Controls

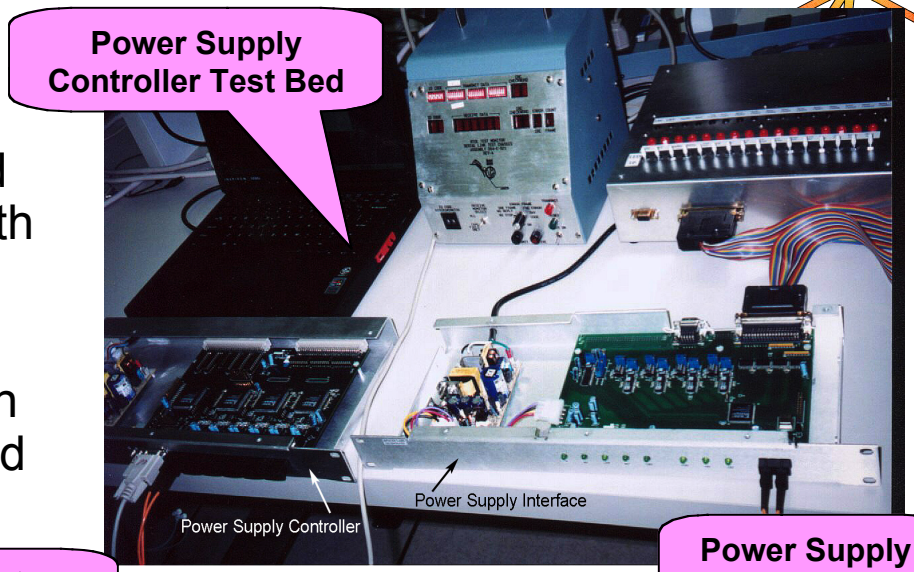
- Cryo control system for cryo plant and cryo modules being designed at Oak Ridge in collaboration with JLab..
- Design is based upon Jlab Design, with PLCs replacing hard-wiring, and VME replacing CAMAC.
- Operator screens are based upon Jlab screens converted to EDM
- A prototypical Cryo control system is operating in lab (ORNL)

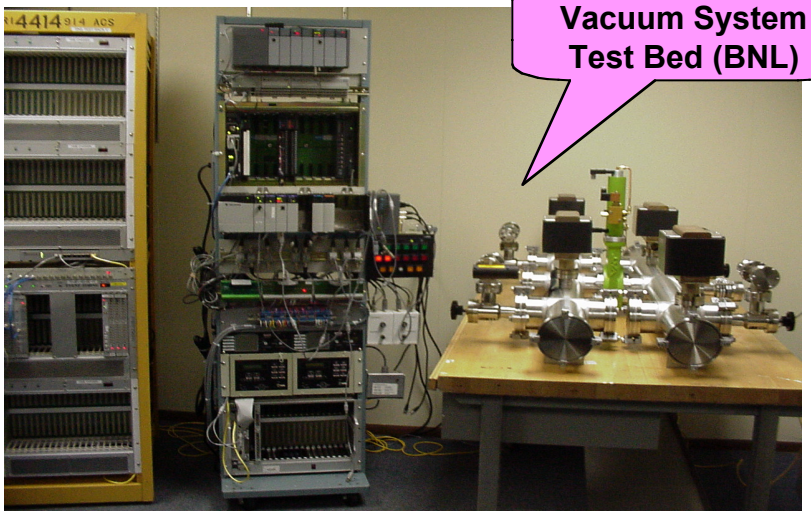


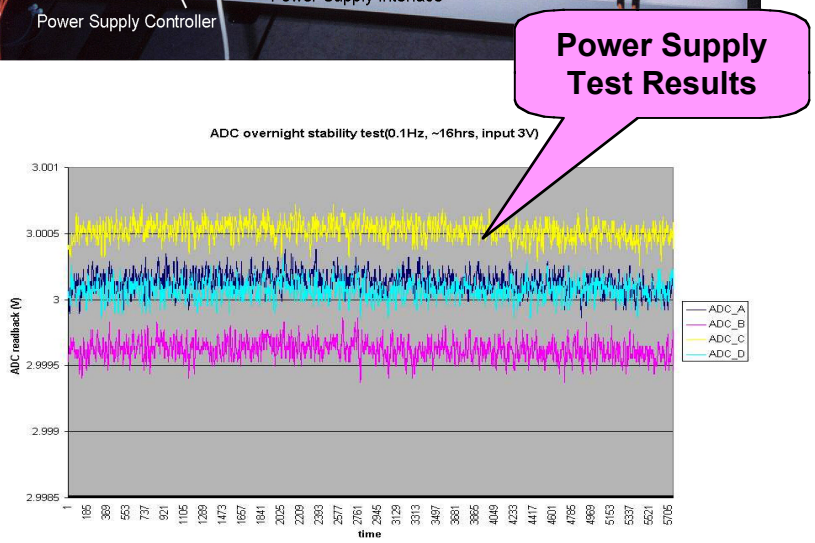


Testing of Power Supply Controllers and Standard Vacuum System Interfaces

- Power Supply Controller (PSC) and Interface (PSI) under test. Controller is VME module linked to 6 Power Supply interfaces with fiber. Supplies come integrated with interface.
- Vacuum controls Lab set up with prototype architecture to be used by all collaborators





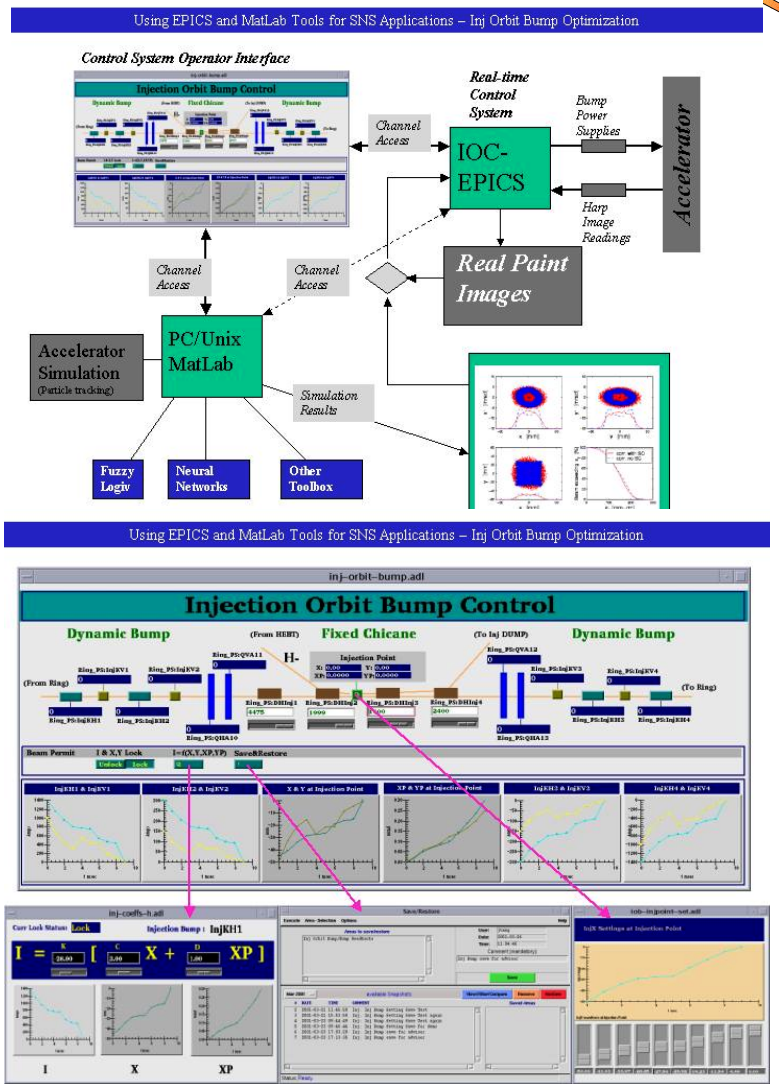


Application Development and Database

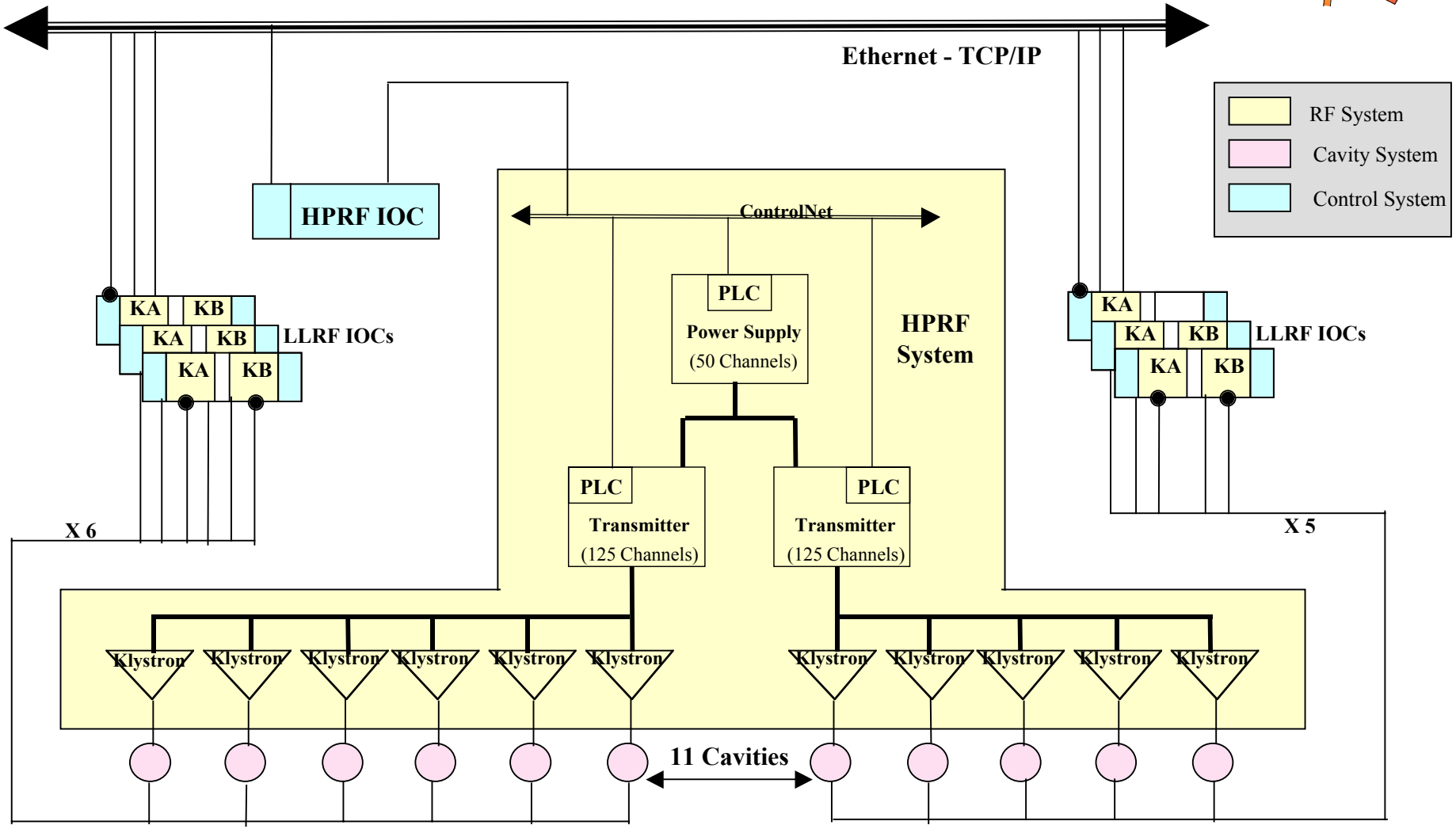
- A demonstration program has been set up at BNL to show the capability of the EPICS tools integrated with a commercial tool (Matlab) as a possible method for SNS control applications, such as the SNS Injection Orbit Bump Optimization shown here.

- Collaboration on new EPICS Display Manager (EDM) started with Holifield

- Technical database design ready for initial deployment. Derivation of EPICS distributed DB from Oracle demonstrated.



Superconducting RF Controls



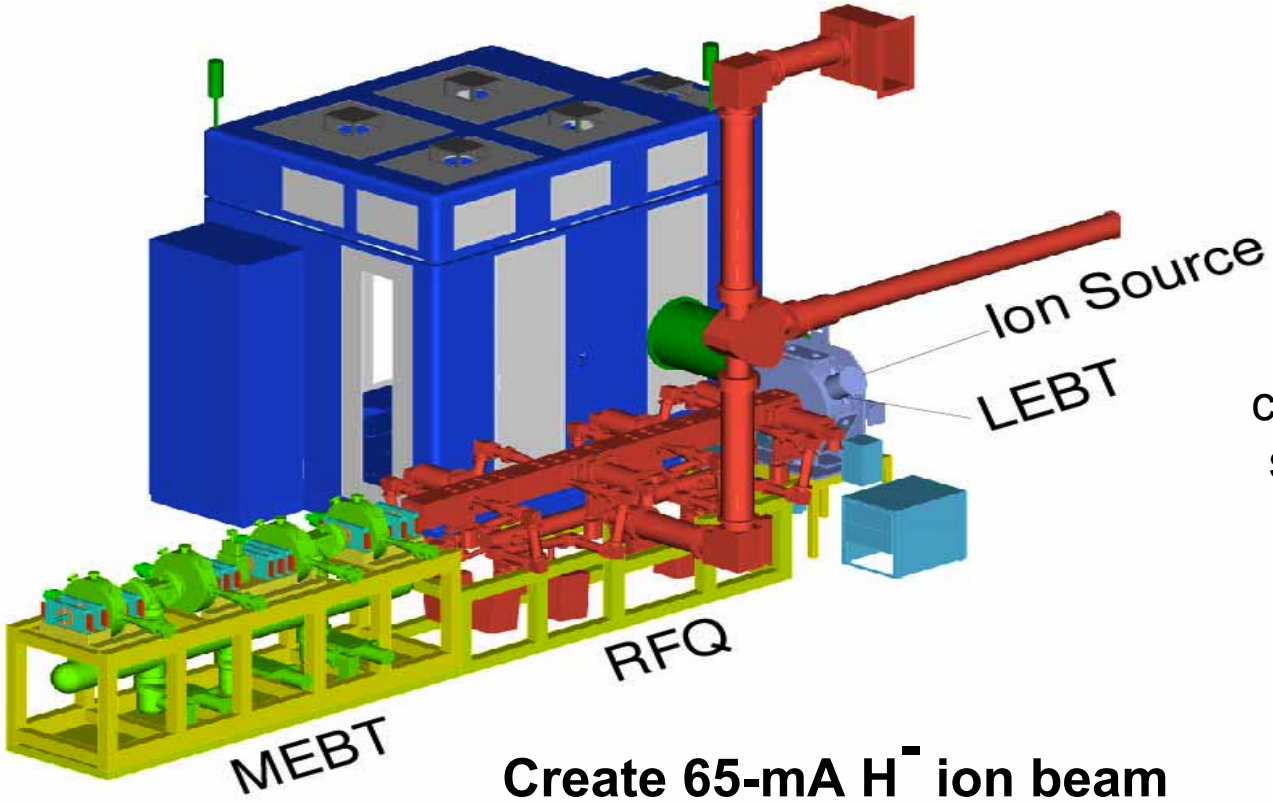
SNS Integrated Control System

Summary

- Lots going on
- Jobs available
- Many issues the EPICS Community can help us with.
- Jobs available
- SNS should become a major contributor to EPICS
- Jobs available
- We look for help and advice from this meeting
- Jobs available

SPARE SLIDES

Front End – A Highly Complex System with Several Major Subsystems and Critical Functions

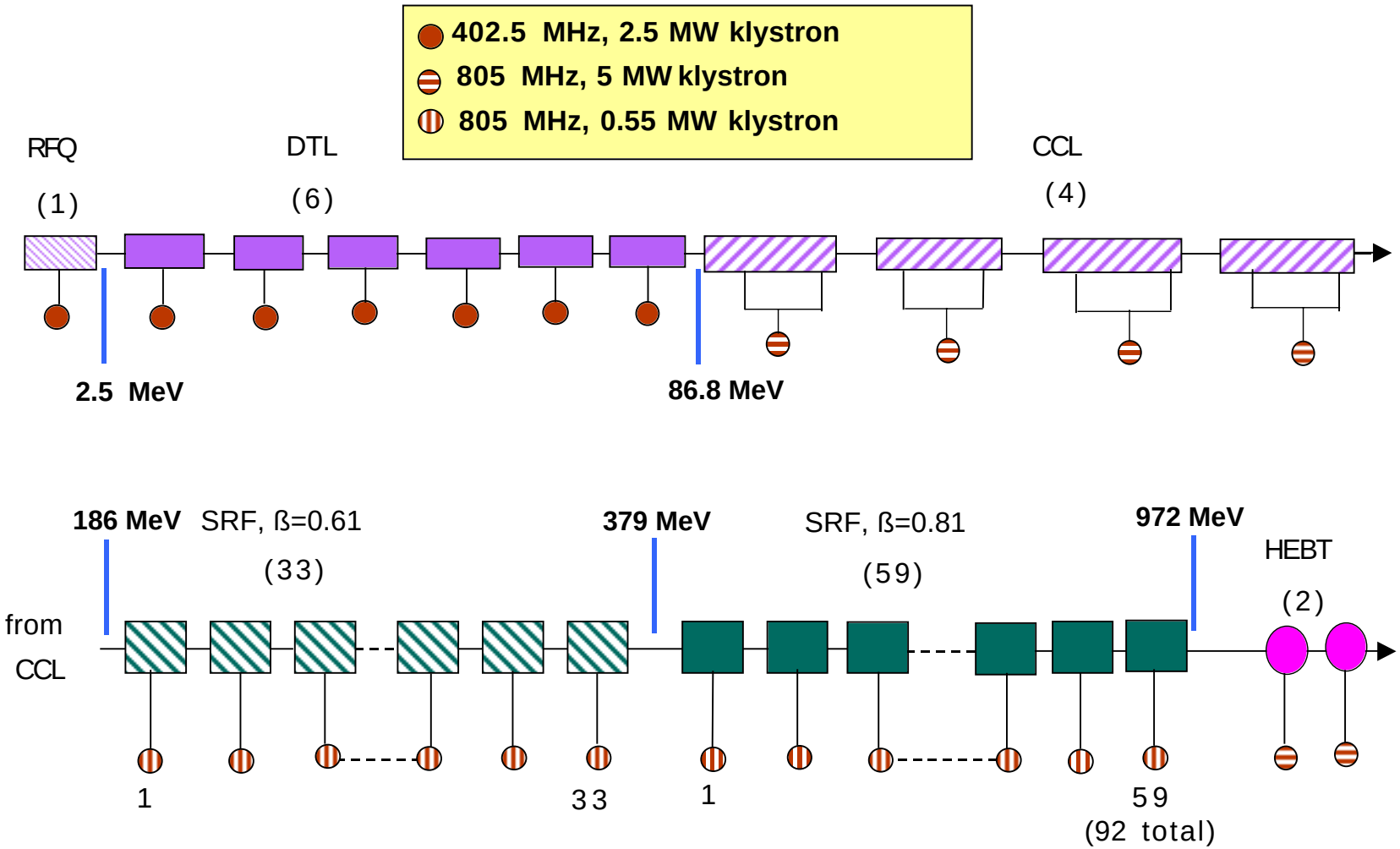


The Front End has relationships with all systems:

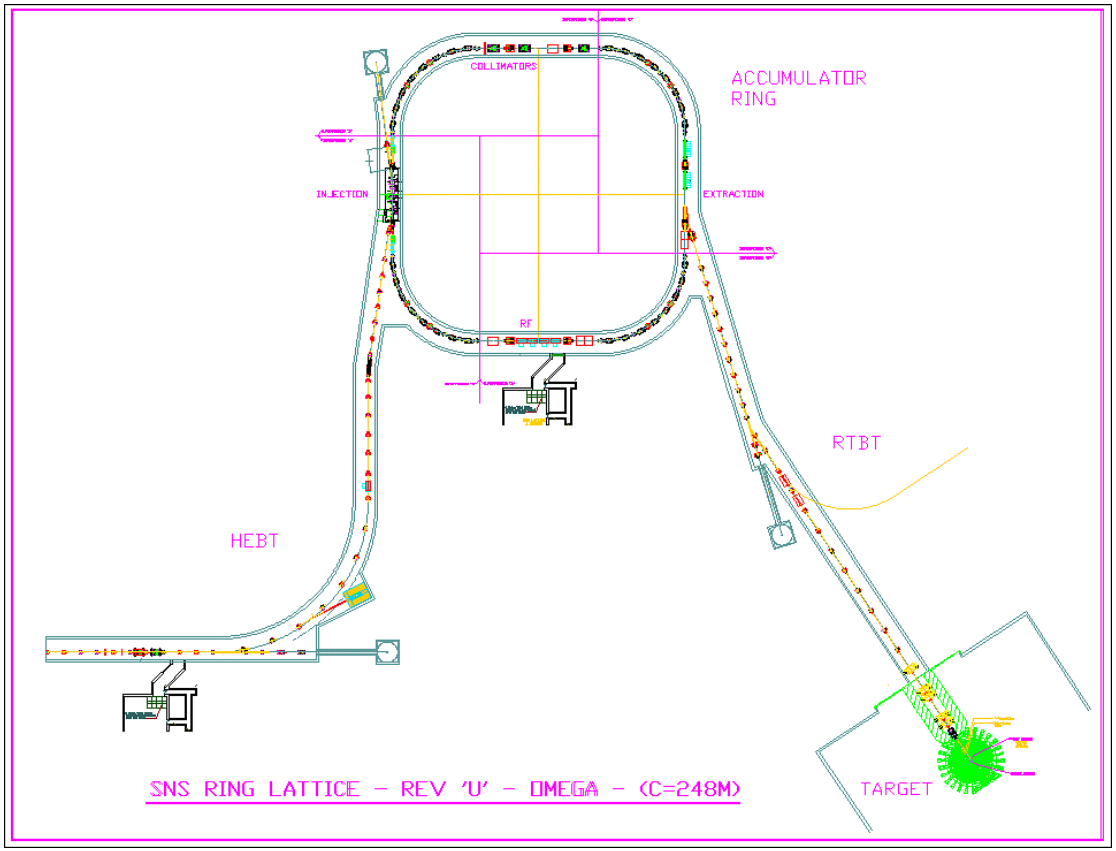
rf, high voltage, diagnostics, alignment, controls, magnets, power supplies, pulsed power, physics, vacuum, Cesium, radiation.

Create 65-mA H^- ion beam	**Ion Source/LEBT**
Accelerate beam to 2.5 MeV	**RFQ**
Chop beam into mini-pulses	**LEBT/MEBT**
Match 52-mA beam into DTL	**MEBT**

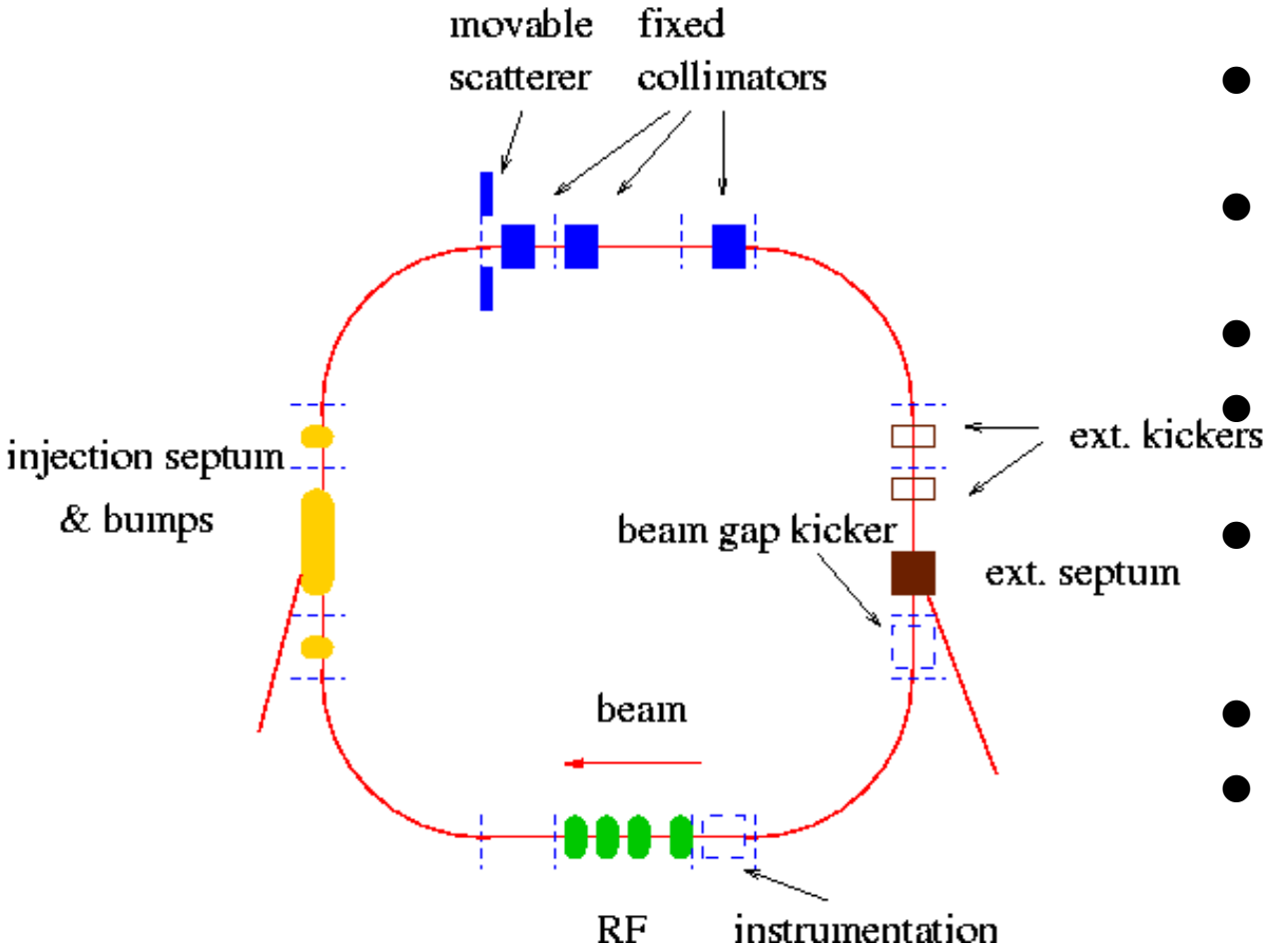
Layout of Linac RF with NC and SRF Modules



Ring Lattice

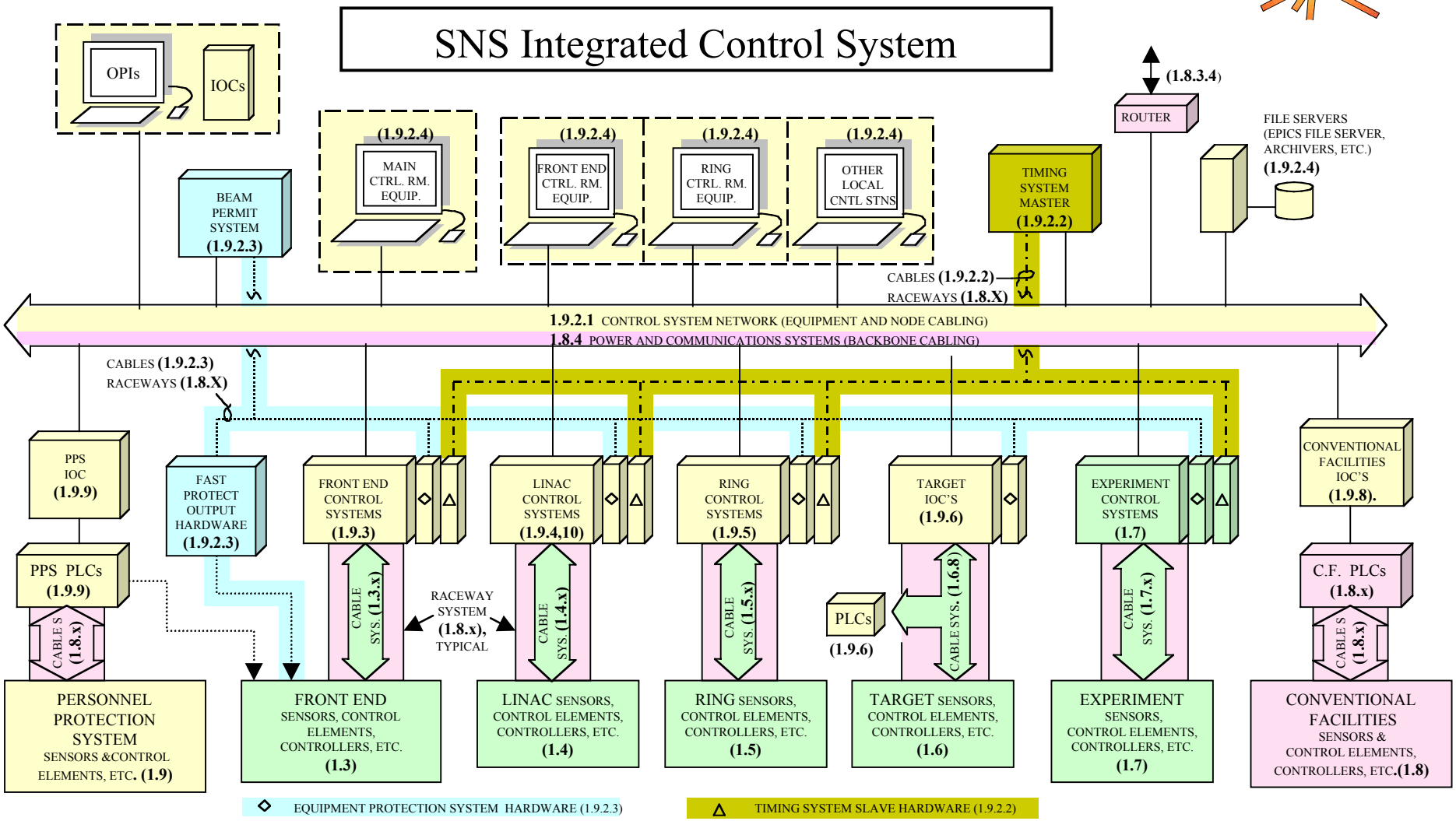


Ring Straight Section Functions

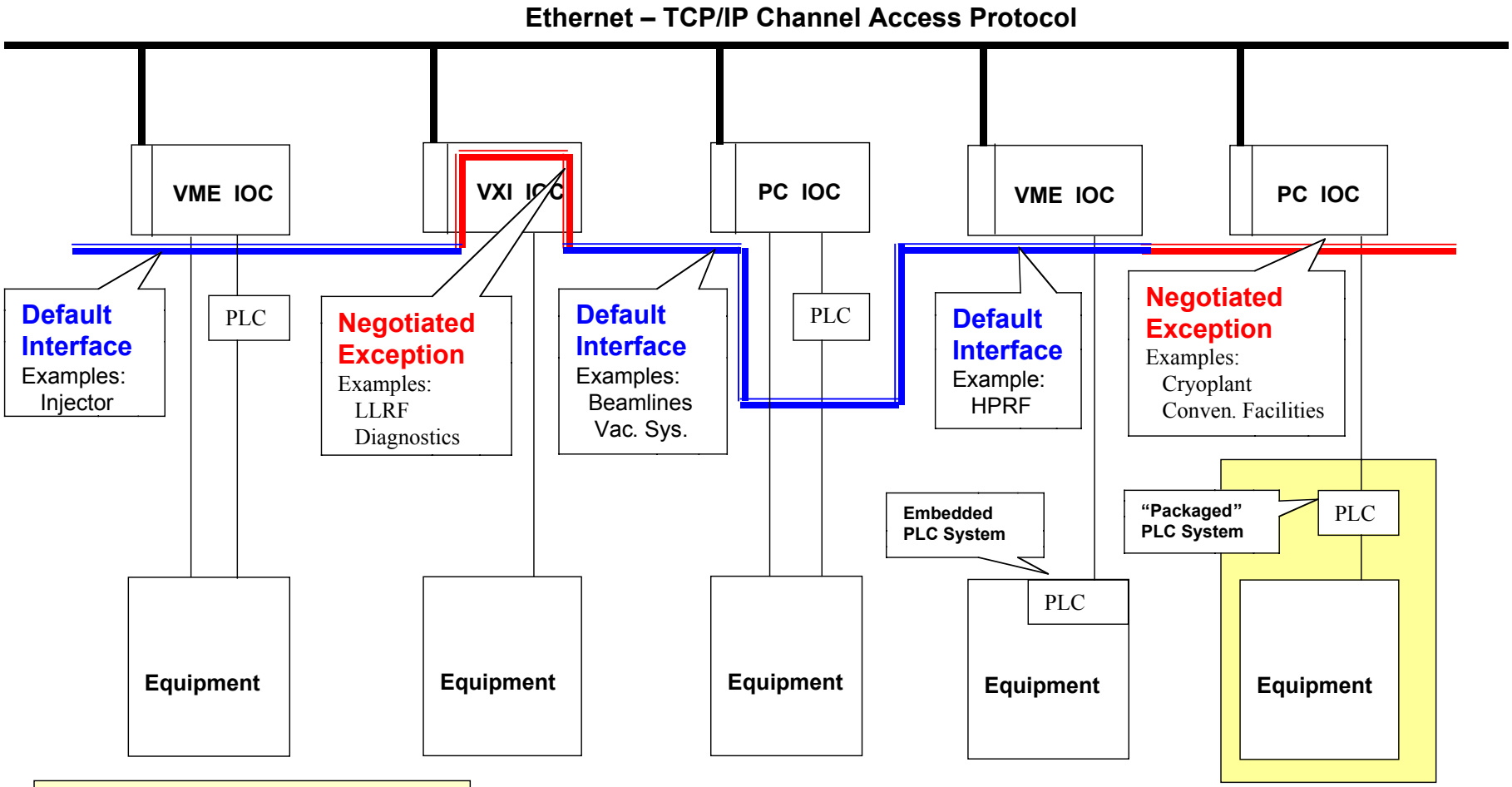


- Separate functions in each straight
- Four straights: 12.5 m; 2 x 6.85 m
- Injection modules
- Two-stage collimation
- 3 (h=1)+1 (h=2) interchangeable RF cavities
- Beam-in-gap kicker
- Empty section for future use

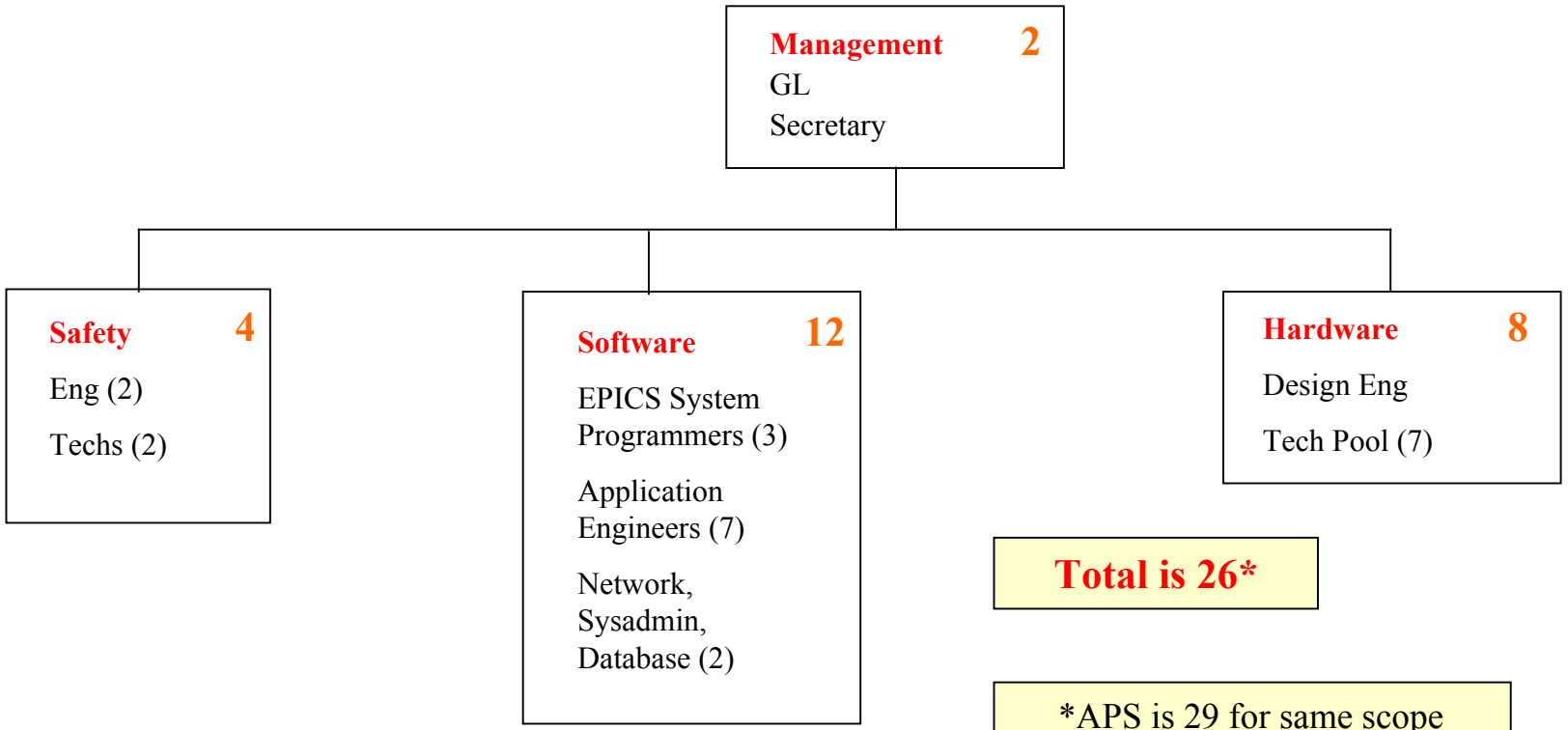
WBS 1.9 Scope includes control of all major subsystems as well as Personnel Safety and "Global Systems."



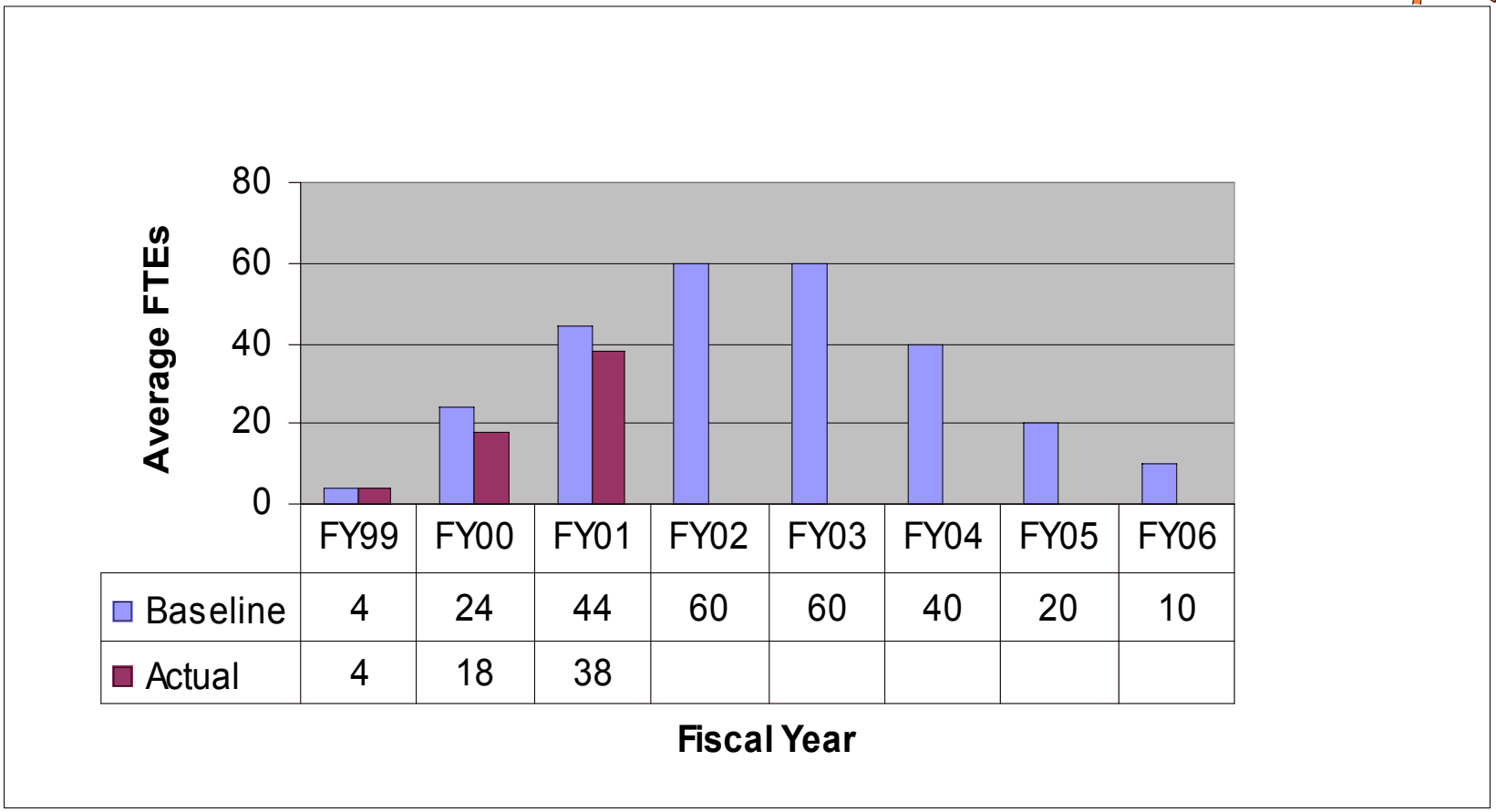
Subsystem interfaces are varied and complex



Proposed Baseline for full operations (26)



Staffing Plan for Controls



NOTE: FY01 Actual FTEs represent the average actual FTE from October 01 through March 01

Cost Summary for Controls

WBS	Description	Costs & Commitments thru 3/01	ETC	BAC
1.09.01	ICS Integration	1,294	3,674	4,968
1.09.02	Global Systems	1,342	8,740	10,082
1.09.03	Front End Systems	661	325	986
1.09.04	Linac Control Systems	1,257	16,709	17,966
1.09.05	Ring Controls	1,942	10,795	12,737
1.09.06	Target Global Controls	190	1,918	2,108
1.09.07	Control Systems (moved to 1.7)	20	(11)	9
1.09.08	Conventional Facilities ICS Interface	86	909	995
1.09.09	Personnel Protection	253	4,705	4,958
1.09.10	CHL & Cryomodule Supervisory Controls	188	2,371	2,559
	1.9 TOTAL	**7,232**	**50,136**	**57,368**
1.01.09	Global Controls R&D	1,700	16	1,716
	Burdened, Escalated Dollars **TOTAL**	**8,932**	**50,152**	**59,084**