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Overview of the NSTX Control System

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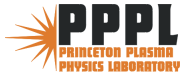
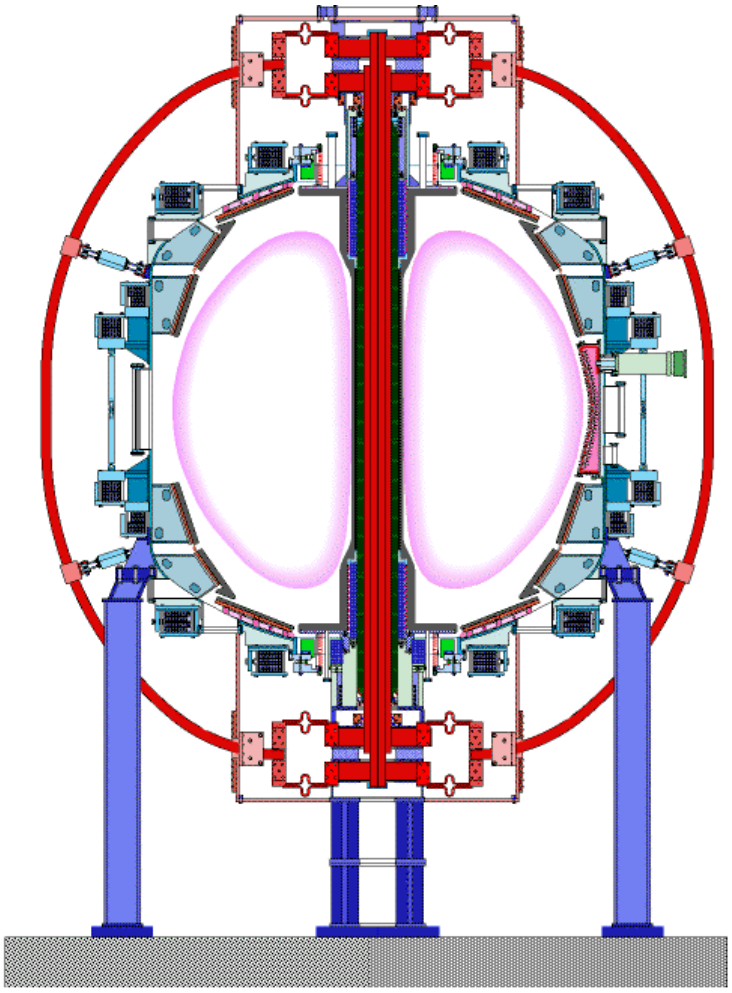


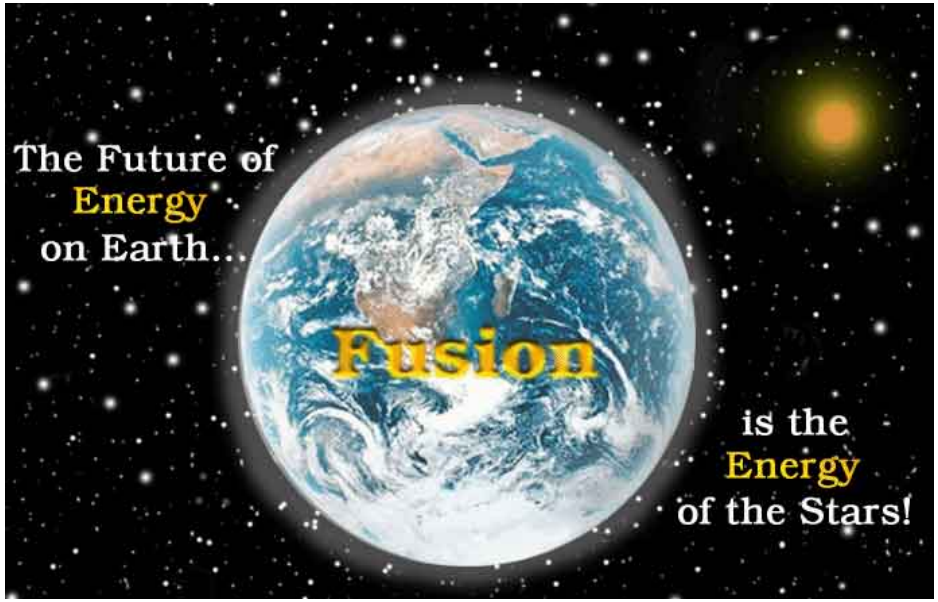
National Spherical Torus eXperiment

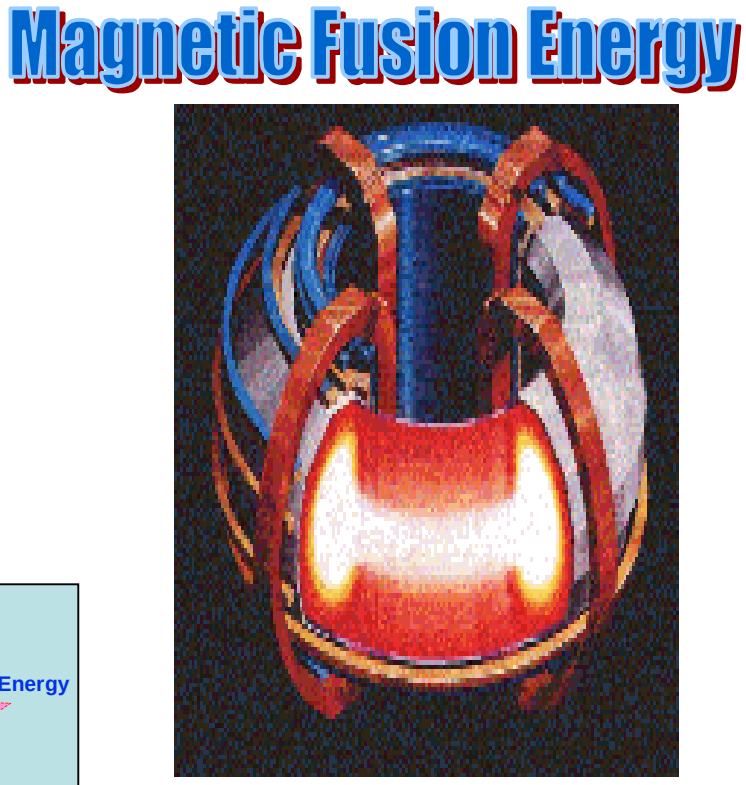
NSTX

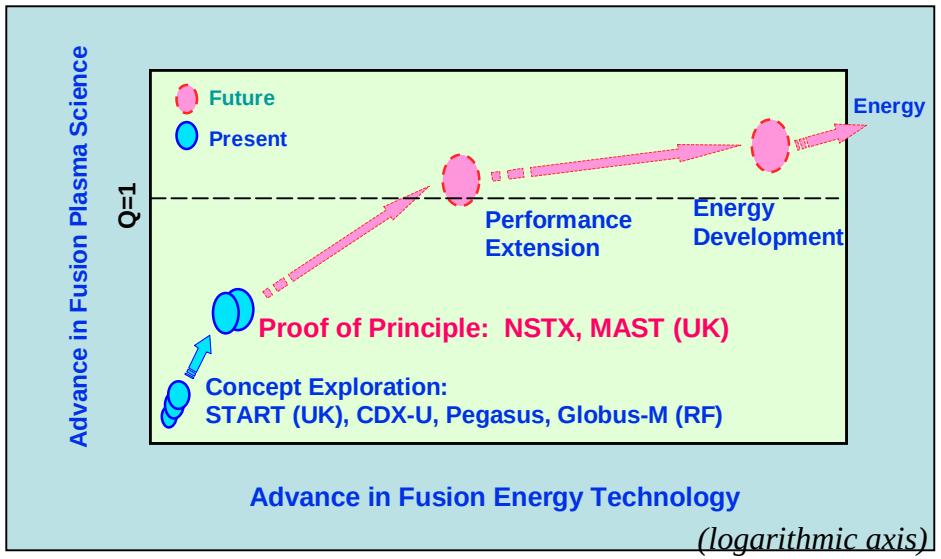
- Fusion Energy Research
- The NSTX Facility
- The Control System
- Timing & Synchronization
- Summary



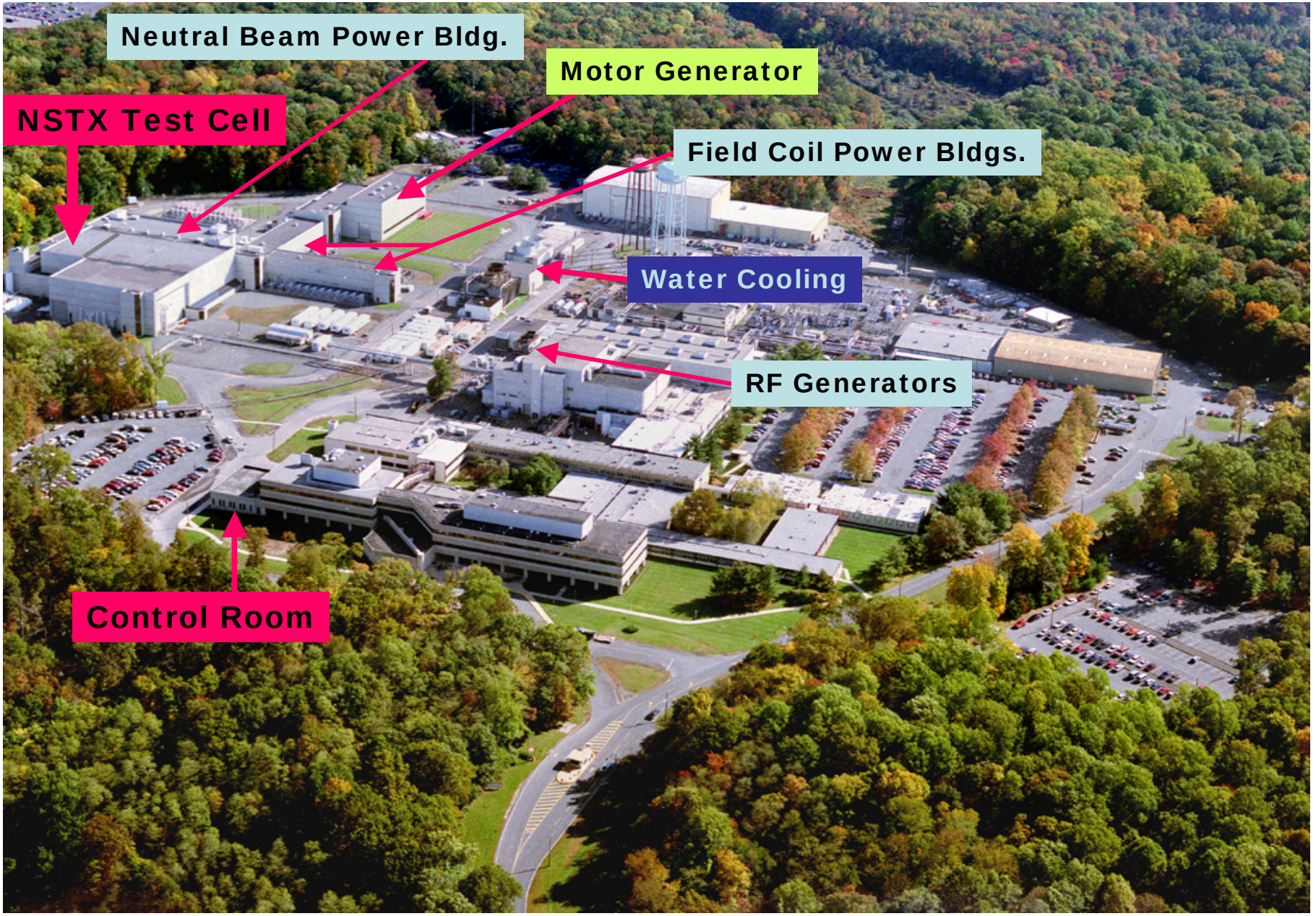
ST Development May Be An Attractive Element Of The World Program





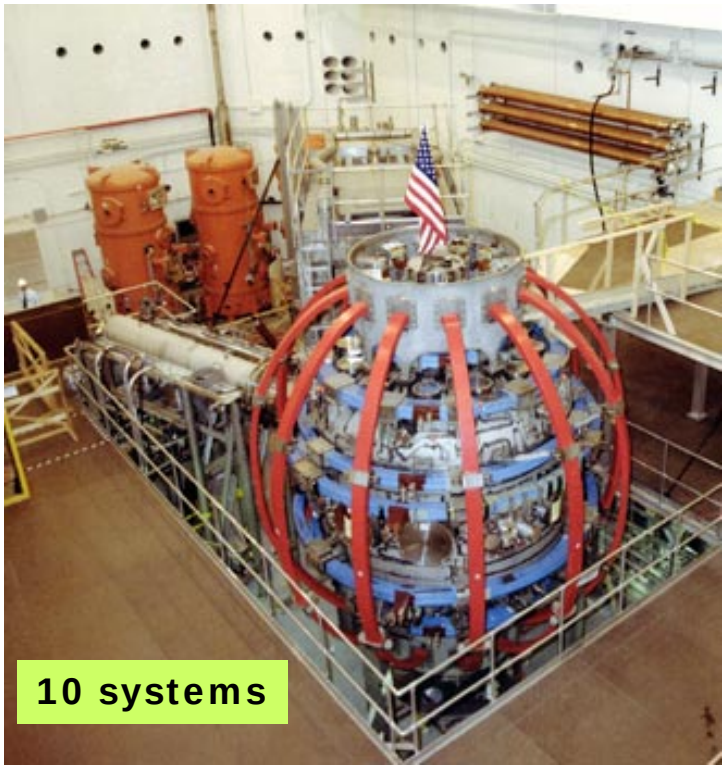


Princeton Plasma Physics Laboratory



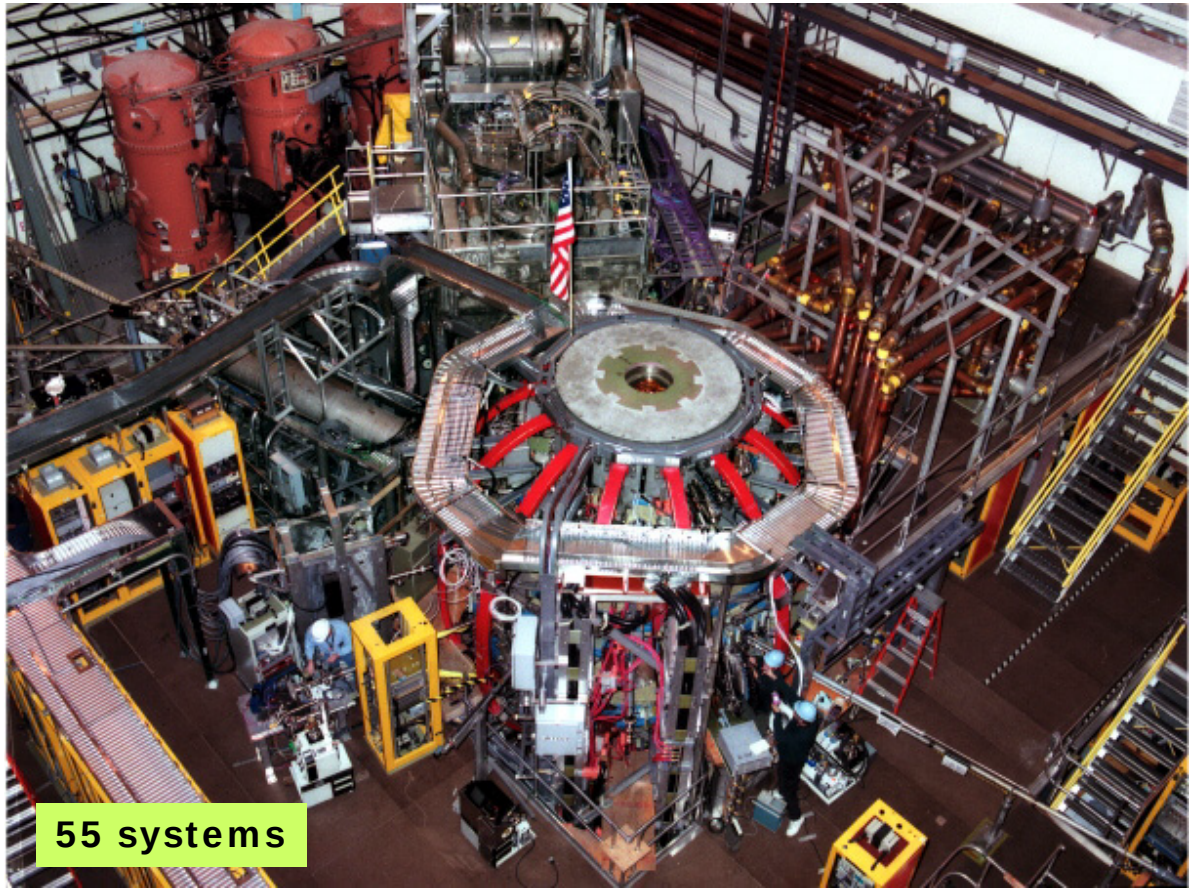
Operational and Experimental Capabilities have Progressed Rapidly since *First Plasma* in 1999

NSTX

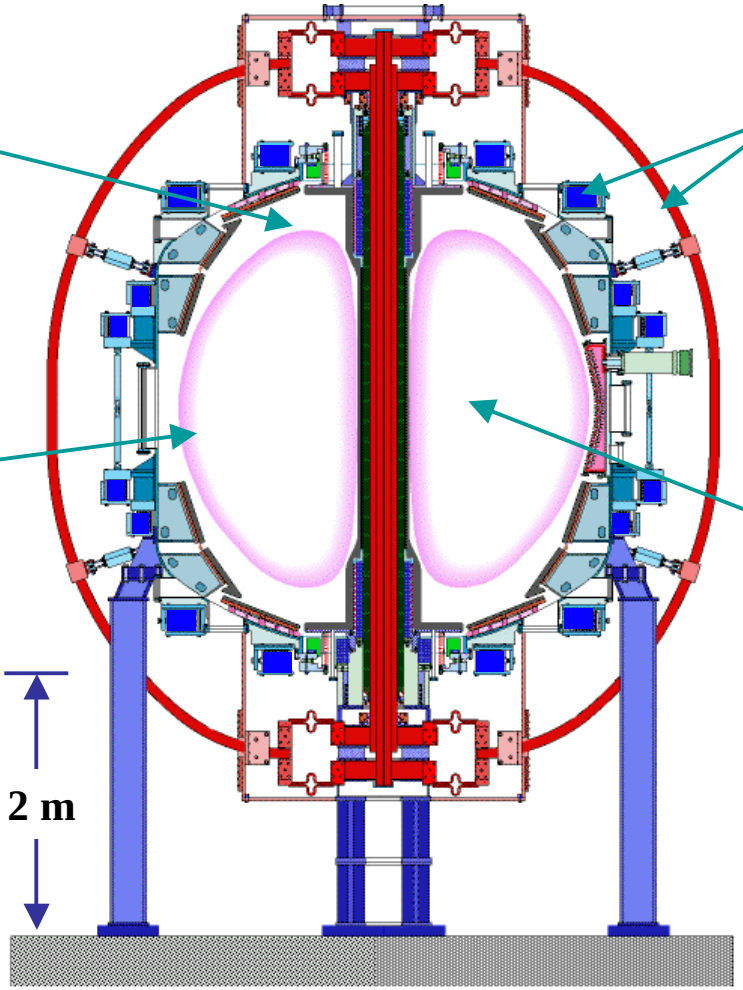


1999

2001



Achieved NSTX Machine Parameters



Vacuum System

10^{-8} Torr

Field Coil Power Supply Controls & Water Cooling

Toroidal Field
50 KA
0.45 T

Plasma Control System

Plasma Current
1.4 MA

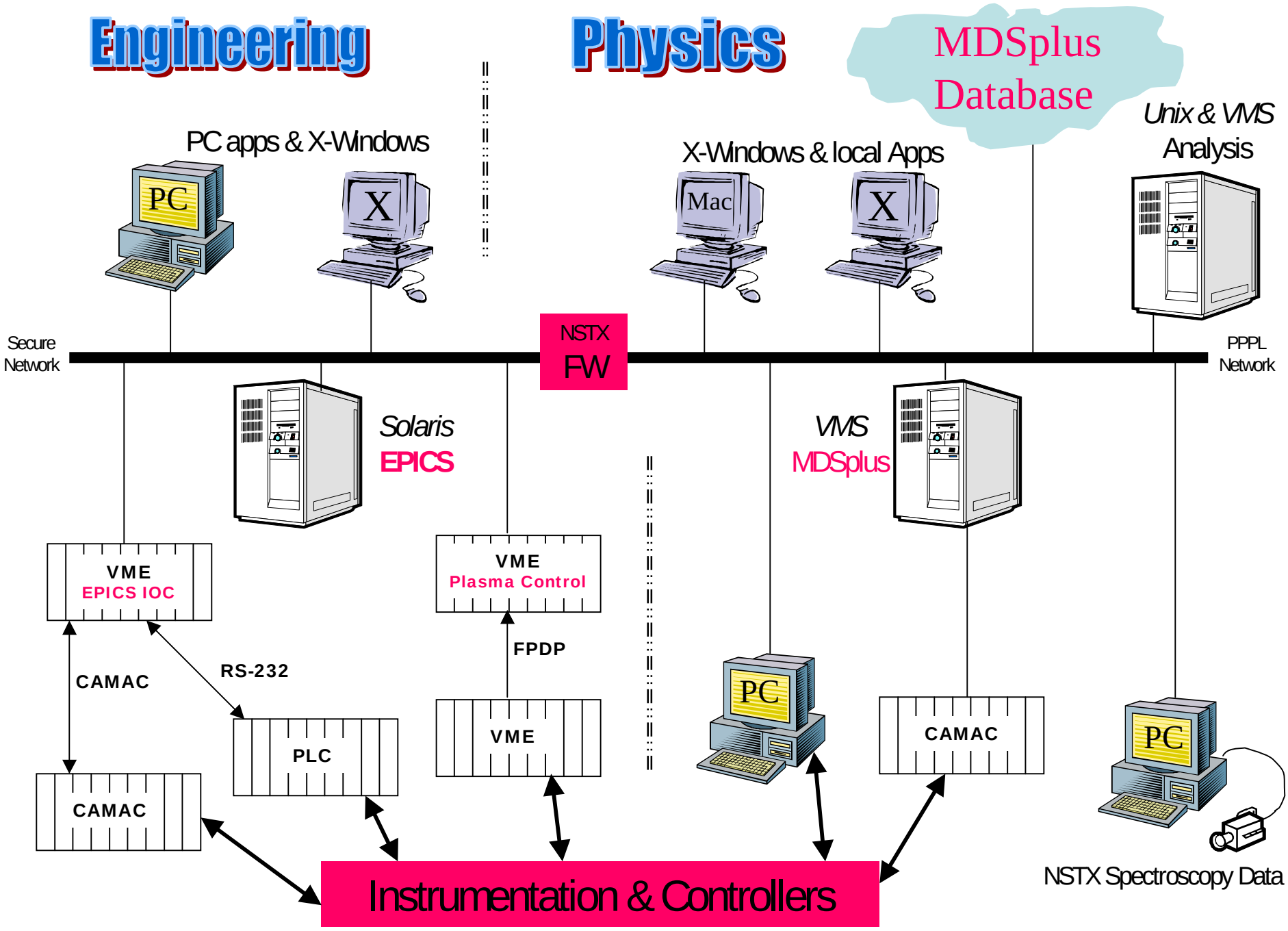
Plasma Temperature
38 MdegC

Pulse Length
= 0.5 sec

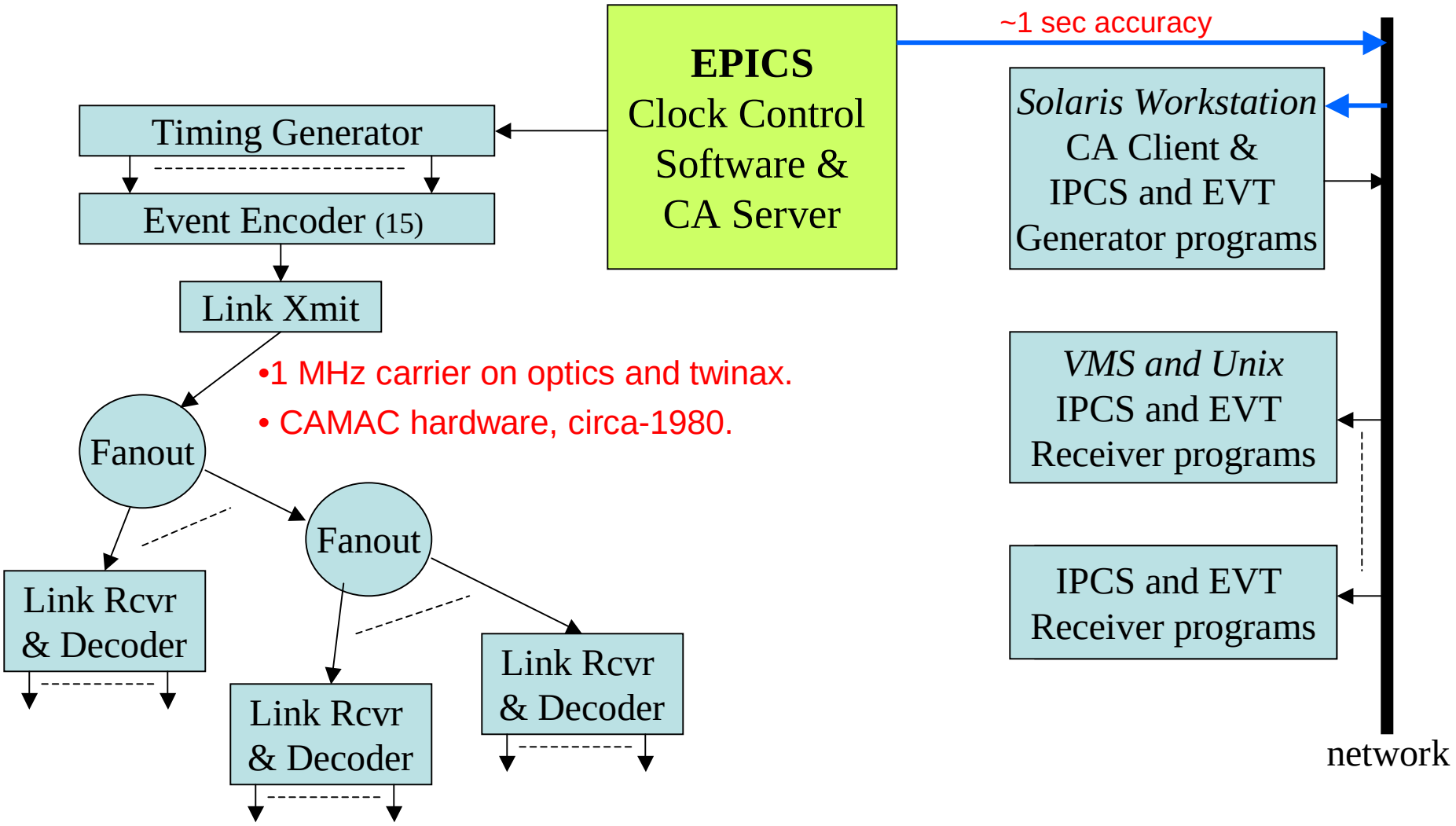
Plasma Fueling & Heating Systems

5 MW NBI
6 MW 'RF'
0.4 MA CHI

Topology of the NSTX Computing System



Topology of the Timing & Synchronization System



Common Computing Components and Collaborative-Software are used at NSTX

Computing Hardware

- *Solaris/SPARC* Workstations
- *VMS/Alpha* Server
- PC, MAC, and X-terminals

Networks

- 10/100 Mbps Switched
- Engineering systems behind firewall

Input/Output Technologies

- CAMAC – a maintainability problem.
- VME, CompactPCI
- PLC
- PC – applications growing.

Application Software

- X-Windows
- IDL
- **EPICS**
- **MDSplus**
- **PCS**
- IPCS
- CCL

Collaborative Software

EPICS provides integrated Control and Display services for Engineering Subsystems

- 10 of the 13 Engineering subsystems use EPICS.
- 1500 direct I/O points. Access to 2700 additional points via (6) PLCs.
- 7000 EPICS records on (3) VME Input Output Controllers.
- 135 EPICS displays, at 20 x-terminals.
- EPICS Applications: **medm**,**gdct**, alh, StripTool, ss_arch, chan_arch, SNL.
- 'C' programs written to interface EPICS with other NSTX software (IPCS/MDSplus/gnuPlot) and to support *pulsed* operations.

The “Model Data System” (MDSplus) is used for Storage of all Physics and Engineering NSTX Data

- *MDSplus* stores 100 MB raw and analyzed data for each NSTX ‘shot’. 5000 waveforms, 25,000 parameters.

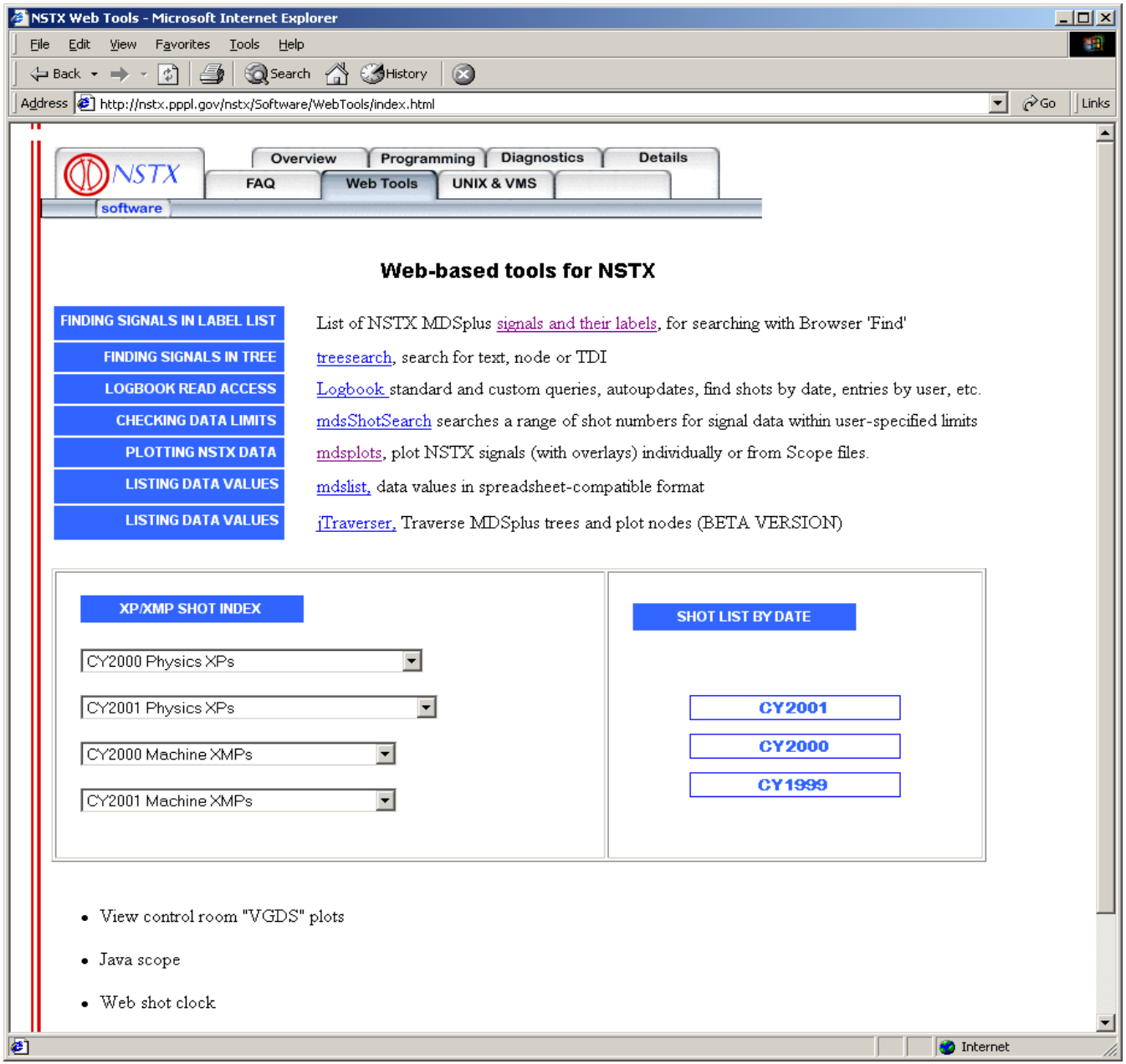
- *MDSplus* provides a set of tools for performing setup, data acquisition, and post-processing analyses for *pulsed experiments*.

- Access to all NSTX data with unified methods enables a broad range of scientific research.
  - *MDSplus* clients run on VMS/Unix/Windows.
  - API’s for FORTRAN, C, Java, IDL, and LabView.

- *MDSplus* is becoming the de facto standard in fusion science research.

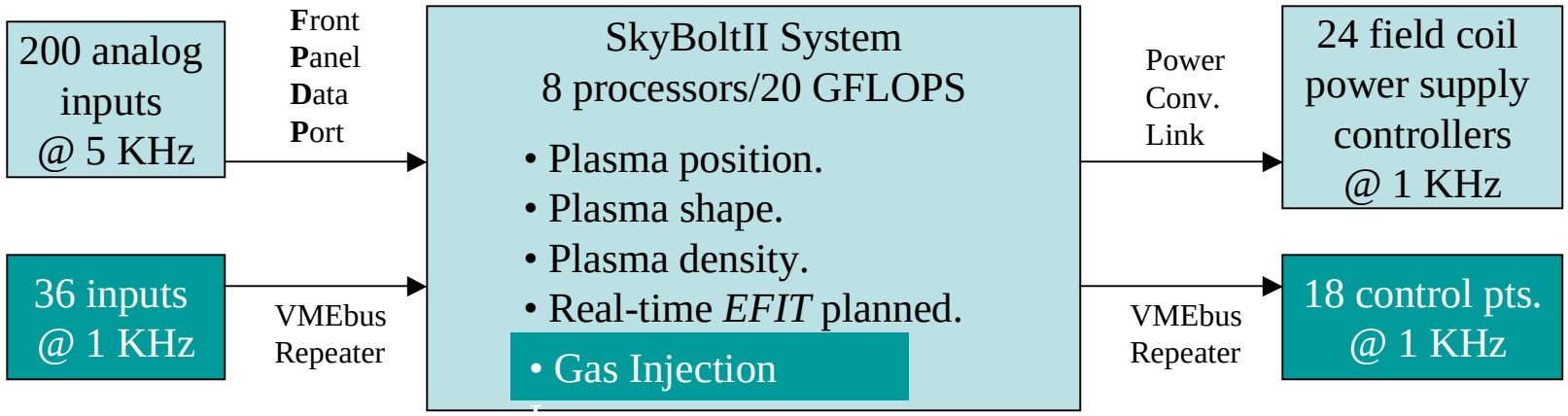
* Alcator C-Mod	* Pulse Test Facility
* LDX	* RFX
* TCV	* DIII-D
* **NSTX**	* H-1
* ZaP	

There are new Web-browser Tools for Working with MDSplus Data

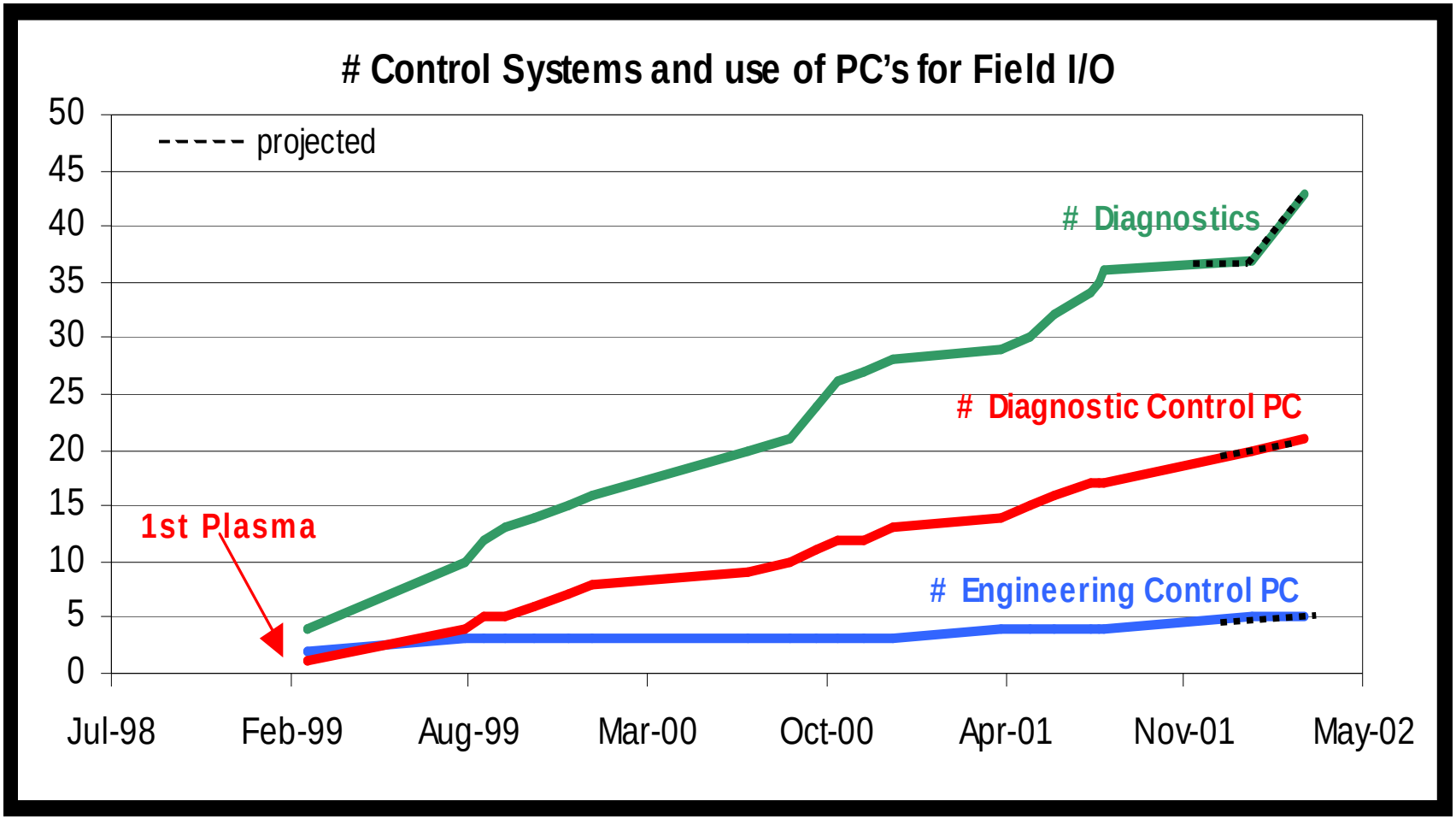


The Plasma Control System is a high-performance real-time control system

- VME-based Control System.
- The Plasma Control System software was developed by *General Atomics*, and is used on their DIII-D fusion experiment.
- May control auxiliary heating systems in the future.



PC's are the "Field I/O" platform of choice for many of NSTX's collaborator's Diagnostic Control Systems



Conclusion:
The Control Systems are Effectively Supporting NSTX

- NSTX is fostering world-class ‘ST’ physics research, with an ever-growing list of collaborating institutions.
- The NSTX machine has demonstrated high reliability (>90 % shot-success rate).
- Engineering and Physics computing have ‘very rarely’ caused a missed shot or schedule delay.
- Successfully used collaboration-supported software.
- Small engineering staff supports core computing (~10).

The Engineering Department is continuously striving to to improve the effectiveness and maintainability of the NSTX Control System

- Address the CAMAC obsolescence problem.
- Enhance use of web technologies.
- EPICS Development:
  - –Focus on hardware architectures and operating systems that have a large installed base, or promising future:
    * Well-known ‘features’. * Breadth and Longevity of support. * Cost effective.
- Clock System Enhancements:
  - – FPGA on Industry-Pack to permit clock receiver in a PC or VME system.
  - – Explore the Spallatial_Neutron_Source (10 MHz) timing system.