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NSTX Computing and Controls

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Princeton University

EPICS Collaboration Meeting
June 2-4, 2010
Aix-en-Provence, France

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Columbia U
Comp-X
General Atomics
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LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
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PSI
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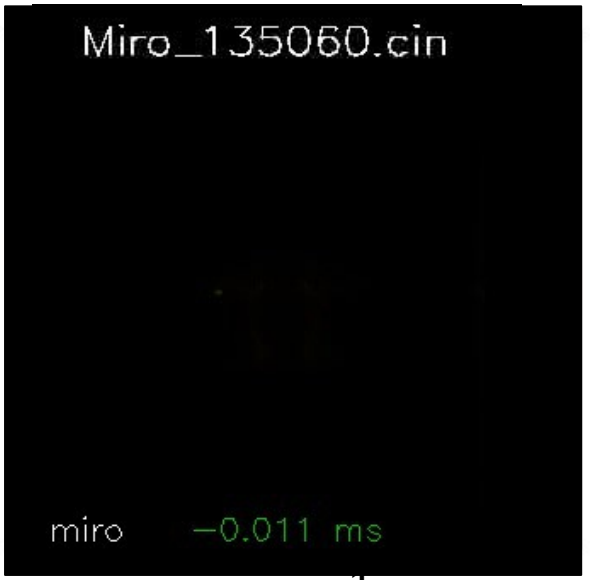
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Maryland
U Rochester
U Washington
U Wisconsin



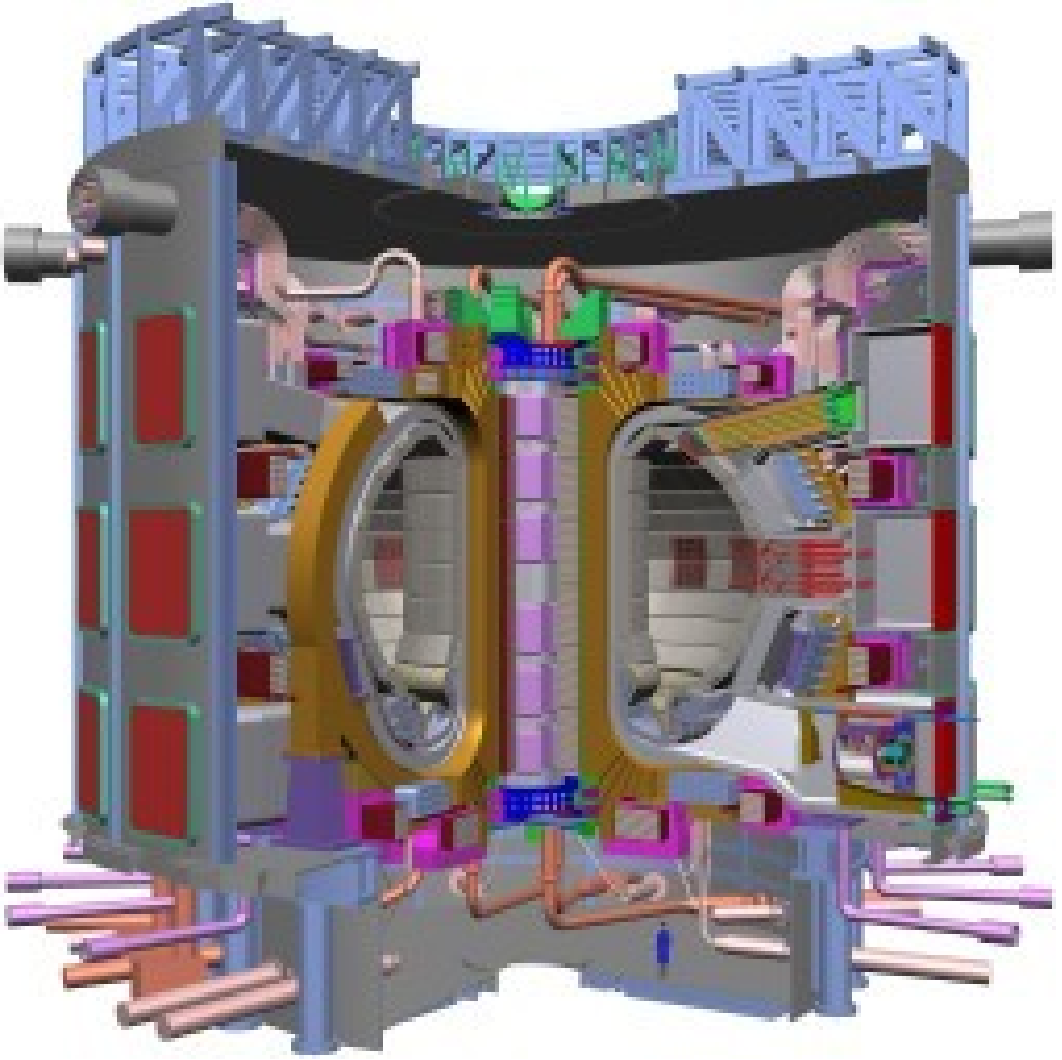
Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAERI
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

Agenda

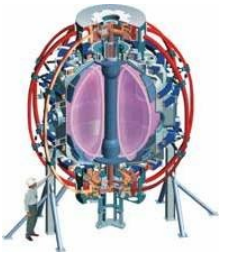
- PPPL - NSTX
- Computing and Controls
- 10+ years of Operations:

  The Good, the Bad, and the Ugly

ITER



NSTX



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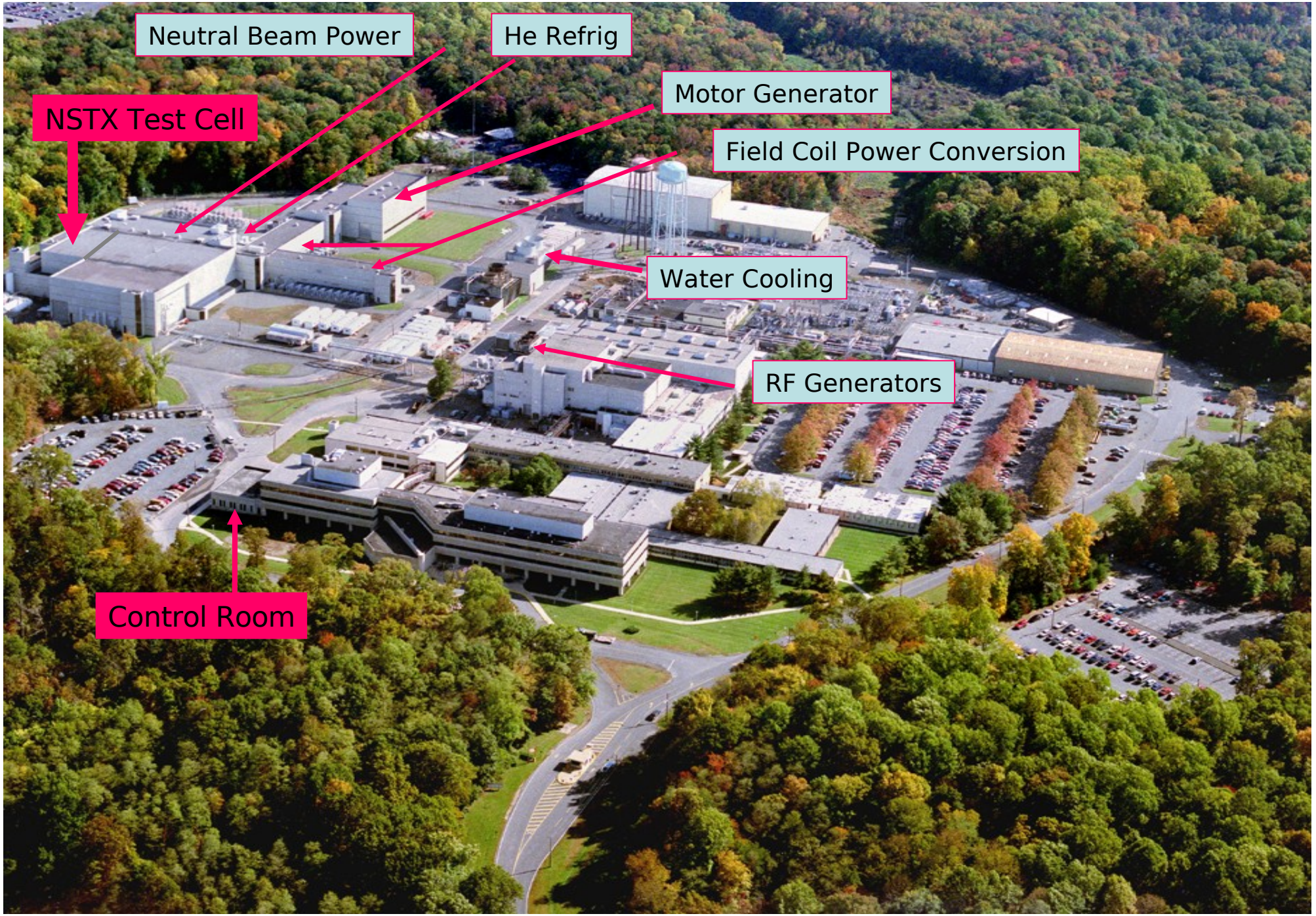
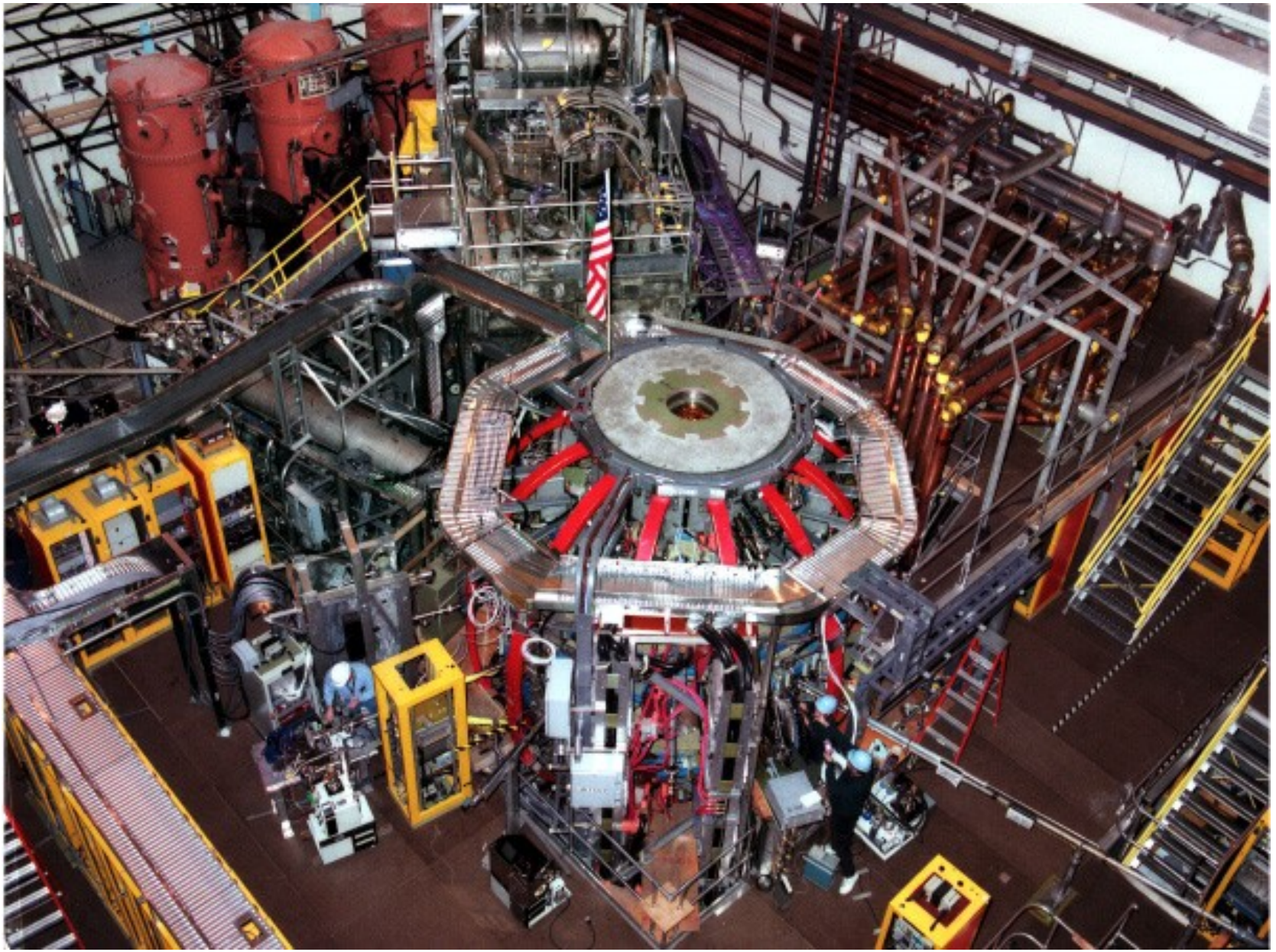
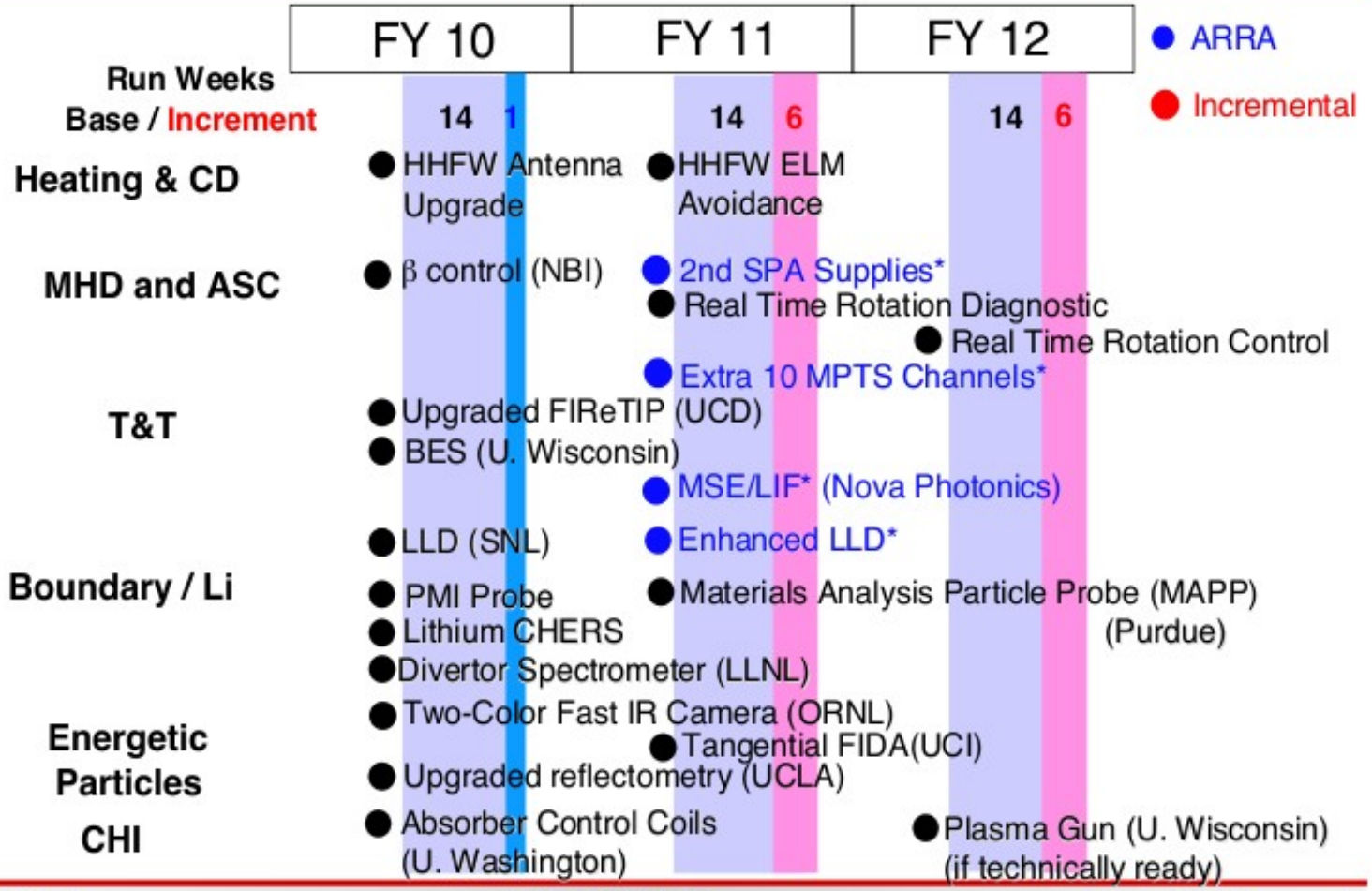




NSTX Near Term Upgrade Plan

ARRA Funding Significantly Enhances Research Capability



FY12-13-14 NSTX-Upgrade Project *

Pulse Length: 1.8 → 6.5 sec

Ip: 1 → 2 MA

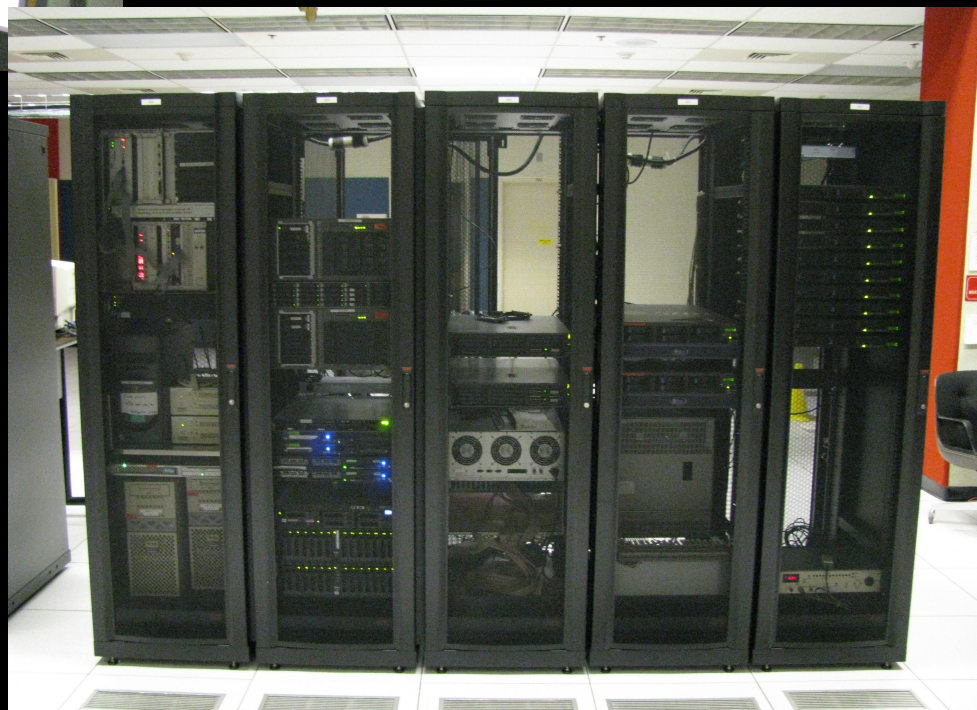
2nd NBI : 6 → 12 MW

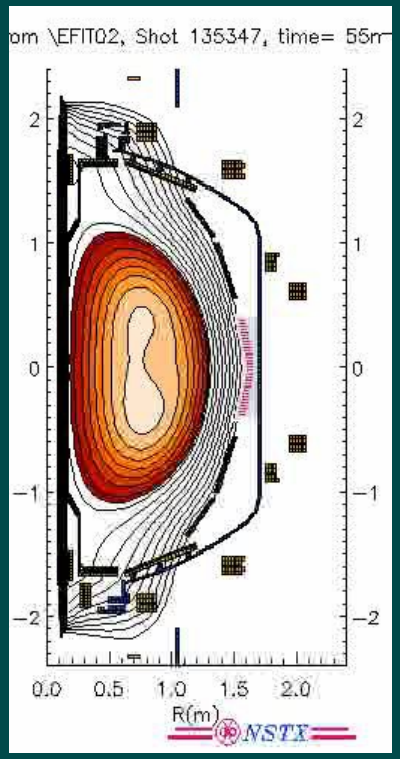
B_{TF}: 1 → 2 Tesla

* Project is in the design stages

NSTX Control Room

NSTX Computer Center

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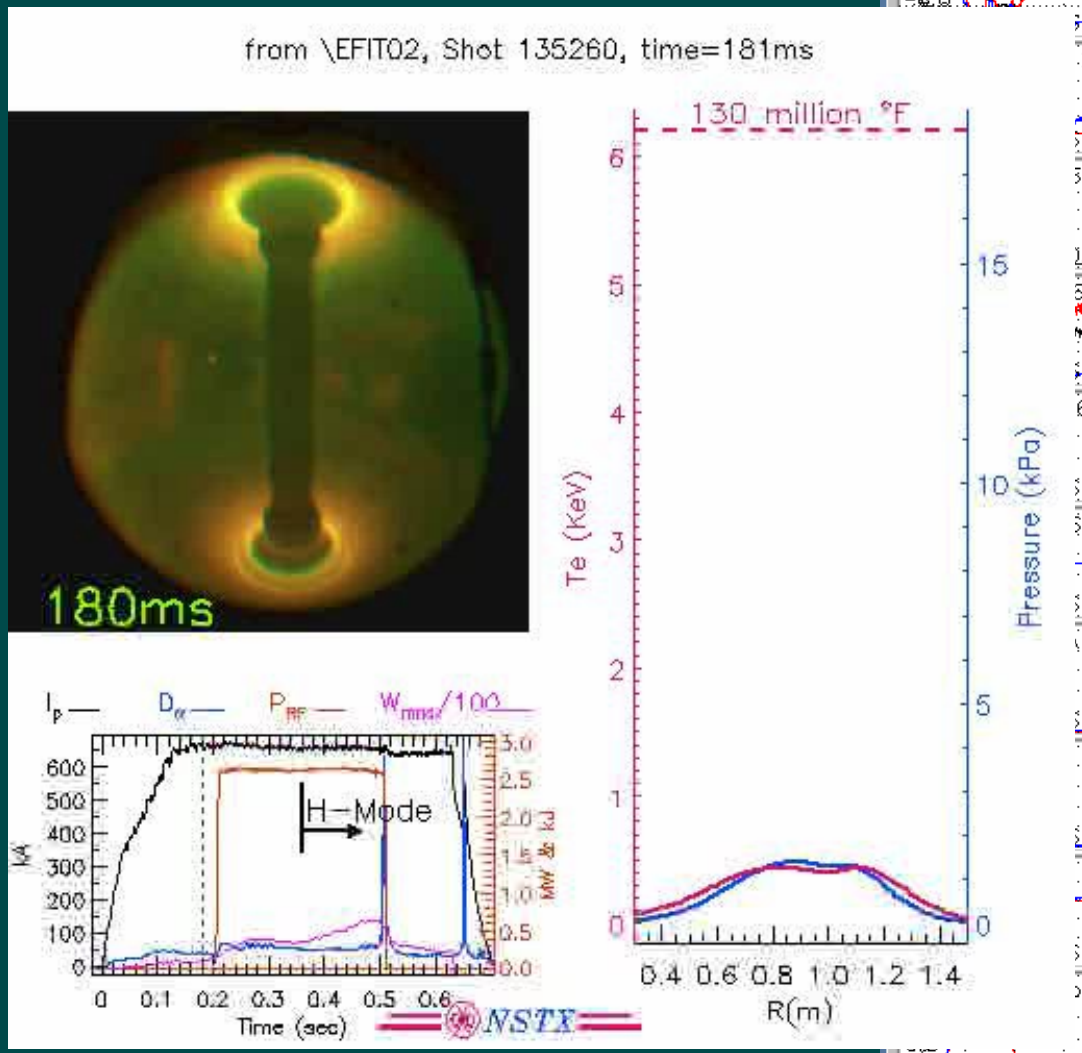
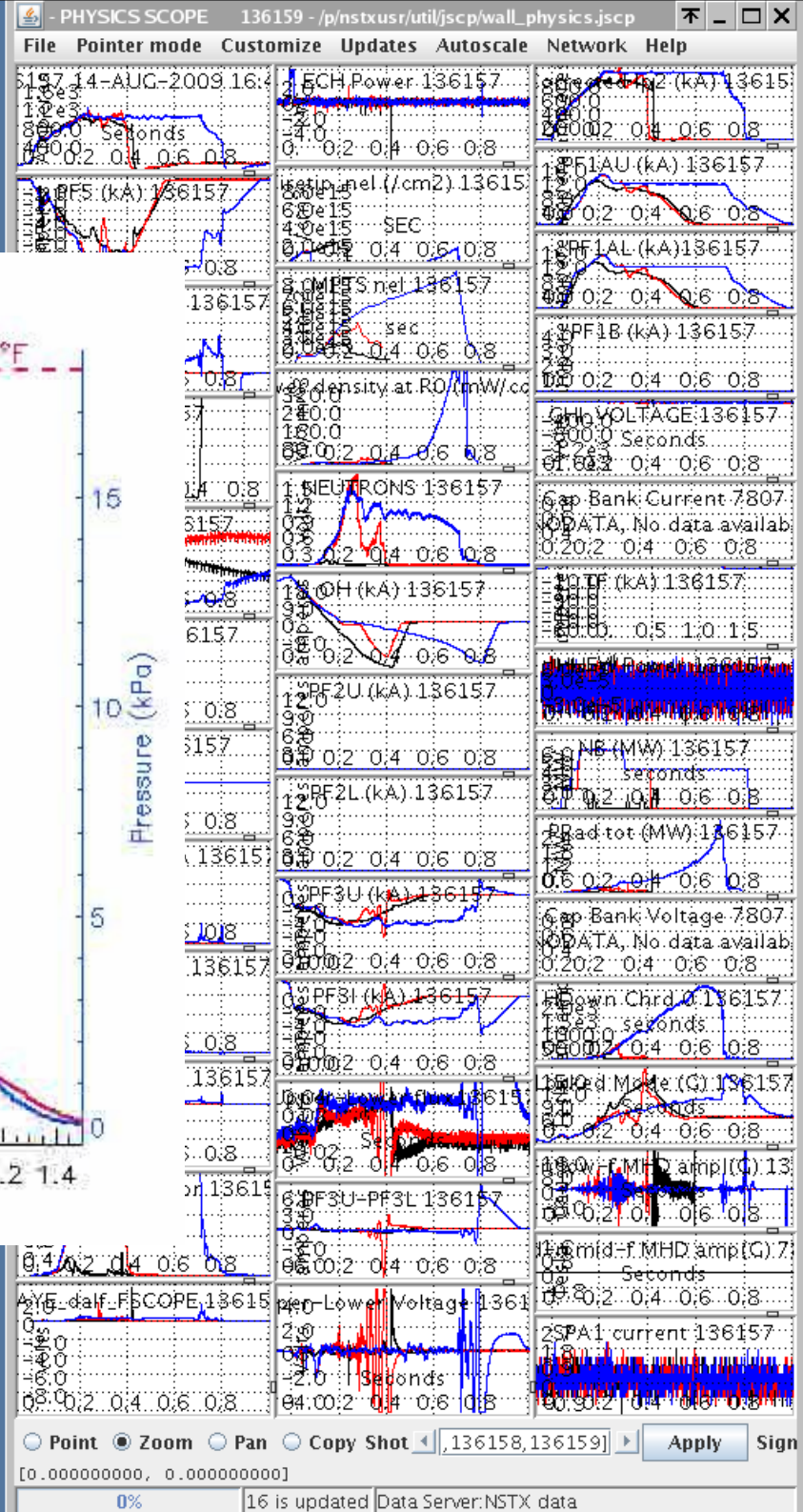
R(m)
NSTX


from \EFIT02, Shot 135260, time=181ms
180ms
130 million °F
Te (KeV)
Pressure (kPa)
R(m)
H-Mode
Time (sec)
NSTX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File Pointer mode Customize Updates Autoscale Network Help
ECH Power 136157
PF5 (kA) 136157
PF1AU (kA) 136157
PF1AL (kA)136157
PF1B (kA) 136157
OH VOLTAGE 136157
Cap Bank Current 7807
NEUTRONS 136157
OH (kA) 136157
PF2U (kA) 136157
PF2L (kA) 136157
PF3U (kA) 136157
PF3L (kA) 136157
Cap Bank Voltage 7807
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Data Server:NSTX data


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137930 - 2:20

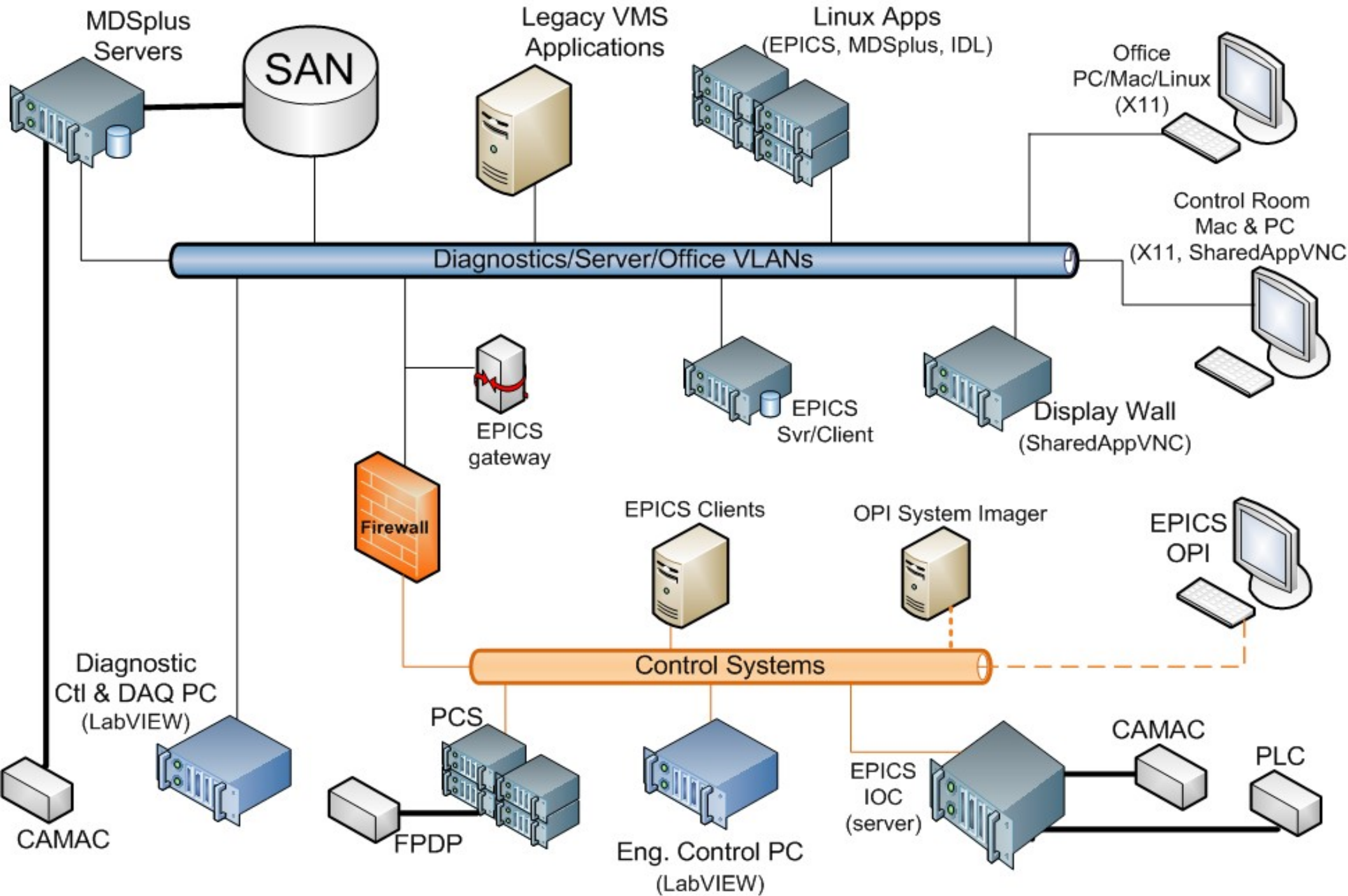
NSTX uses open-source and collaborative software

- EPICS
- MDSplus
- Plasma Control Software from *General Atomics*
- SharedAppVNC
- System Imager

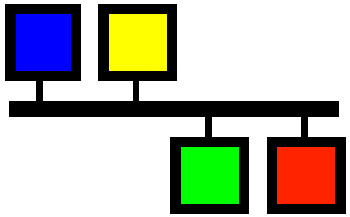
Commercial software:

- Red Hat Enterprise Linux; Windows; vxWorks
- LabVIEW
- Visualization:
  - IDL – lots of inertia
  - Matlab use growing

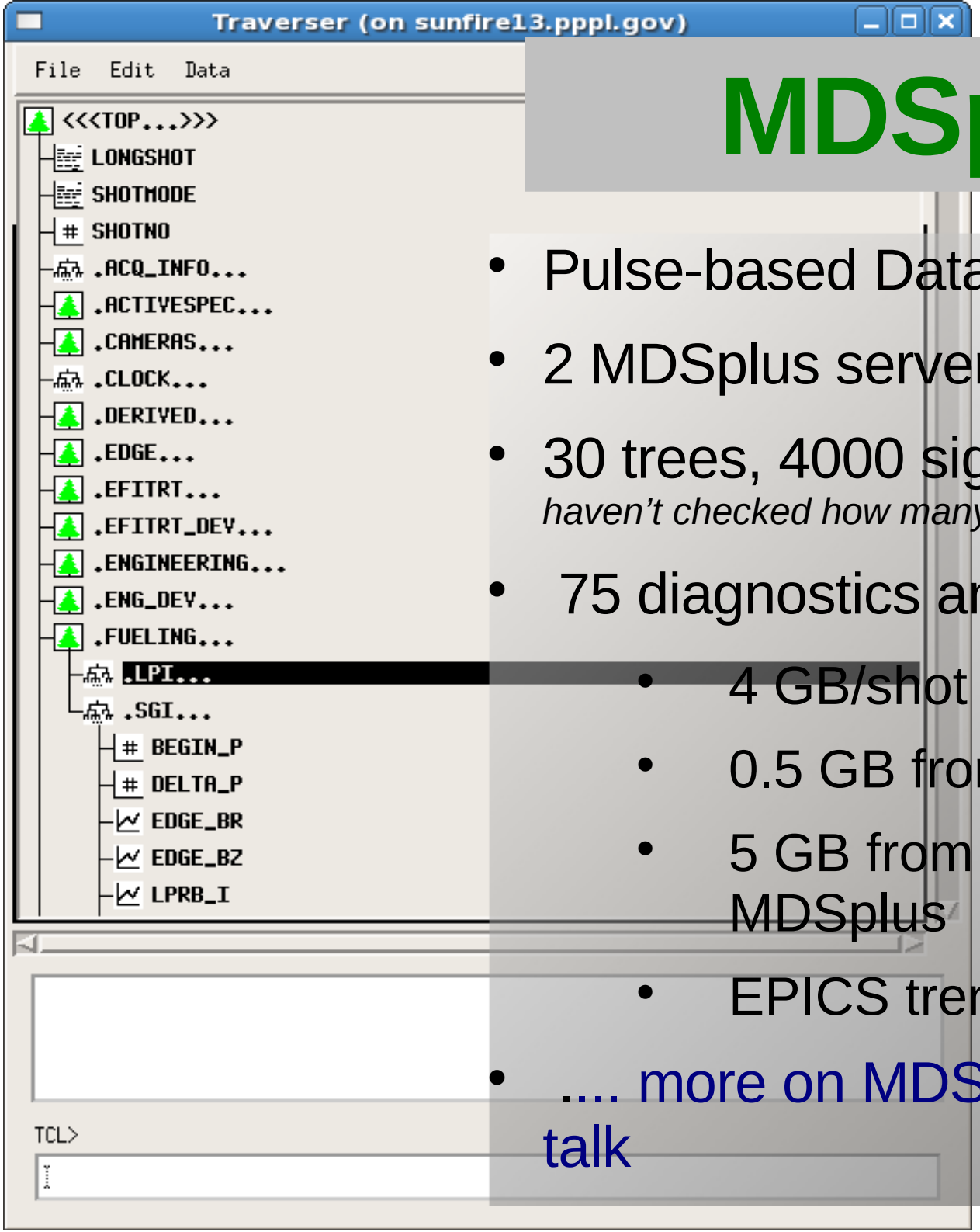
NSTX Computing & Controls



EPICS



- (6) IOC's
  - (4) vxWorks, (1) Linux, (1) Windows
- Device Support: CAMAC, OPC, MODBUS
  - 500 transient digitizer channels
  - 2000 discrete I/O points
- 11 EPICS Application Areas
  - 250 databases, 10,000 records
  - 400 MEDM displays
  - 15 Sequencer Programs
- 600 PV's to Channel Archiver/ArchiveViewer
- Gateway, StripTool, SaveSet & Restore



MDSplus

- Pulse-based Data Repository
- 2 MDSplus servers: 1 uses CAMAC
- 30 trees, 4000 signals, > 60000 nodes *(I haven't checked how many used)*
- 75 diagnostics and engineering systems
  - 4 GB/shot
  - 0.5 GB from EPICS
  - 5 GB from cameras - not kept in MDSplus
  - EPICS trend data (daily 'shot')
- .... more on MDSplus from Manduchi's talk

Real-time Plasma Control

- Controls plasma shape, position, and other properties via real-time control of magnet power supplies, gas injection, neutral beam injection
- 420 inputs @ 5 KHz, 50 outputs
- ~12 real-time control algorithms with a range of complexity, cycle time, and ‘phases’
- Real-time code runs on an 8-core Linux system
- I/O is hybrid of PPPL-designed and COTS
    - FPDP transport, FPGA, VME-format, CAMAC
- Software framework developed at General Atomics, used at numerous facilities.

The Good …

- Control systems supports the research - over 95% reliability for NSTX machine.
- EPICS : reliable and low maintenance
- MDSplus : generally good. NSTX experienced problems with CAMAC and with the event system.

… the Bad …

These aren't technical challenges - but are the realities of funding priorities

- Indirect IT support

reduces overall cost for PPPL

IT policies not optimized for the experiment

- Controls HW & SW are modernized only in 'crisis" mode
- No MDSplus connection management
- Hard to simulate 'real' operations environment - too many variables. So problems are discovered only during operations.

… and the Ugly

Cyber Security

- A top-level metric for PPPL's contract performance evaluation
- Current implementation affects RAM (Reliability-Availability-Maintainability):
  - configuration control -- simplicity -- operating envelope
- moving target - escalating cost

Test Cell computer hardware failures

- *Adnaco* PCI fiber optic extender
- all fiber network

Final Thoughts ...

- NSTX computing and controls have performed well
  - Open source software provides longevity and can be tailored for experimental needs
  - Active collaborations have provided excellent technical support
- EPICS gets an "A" grade for its primary role at NSTX – ***Integrated Control***
  - Staffing, and not the EPICS architecture or performance capabilities, have limited EPICS's wider role in NSTX control systems