Supported by

NSTX Facility Plan

Masayuki Ono
For the NSTX Team

NSTX Research Forum
Nov. 28-29

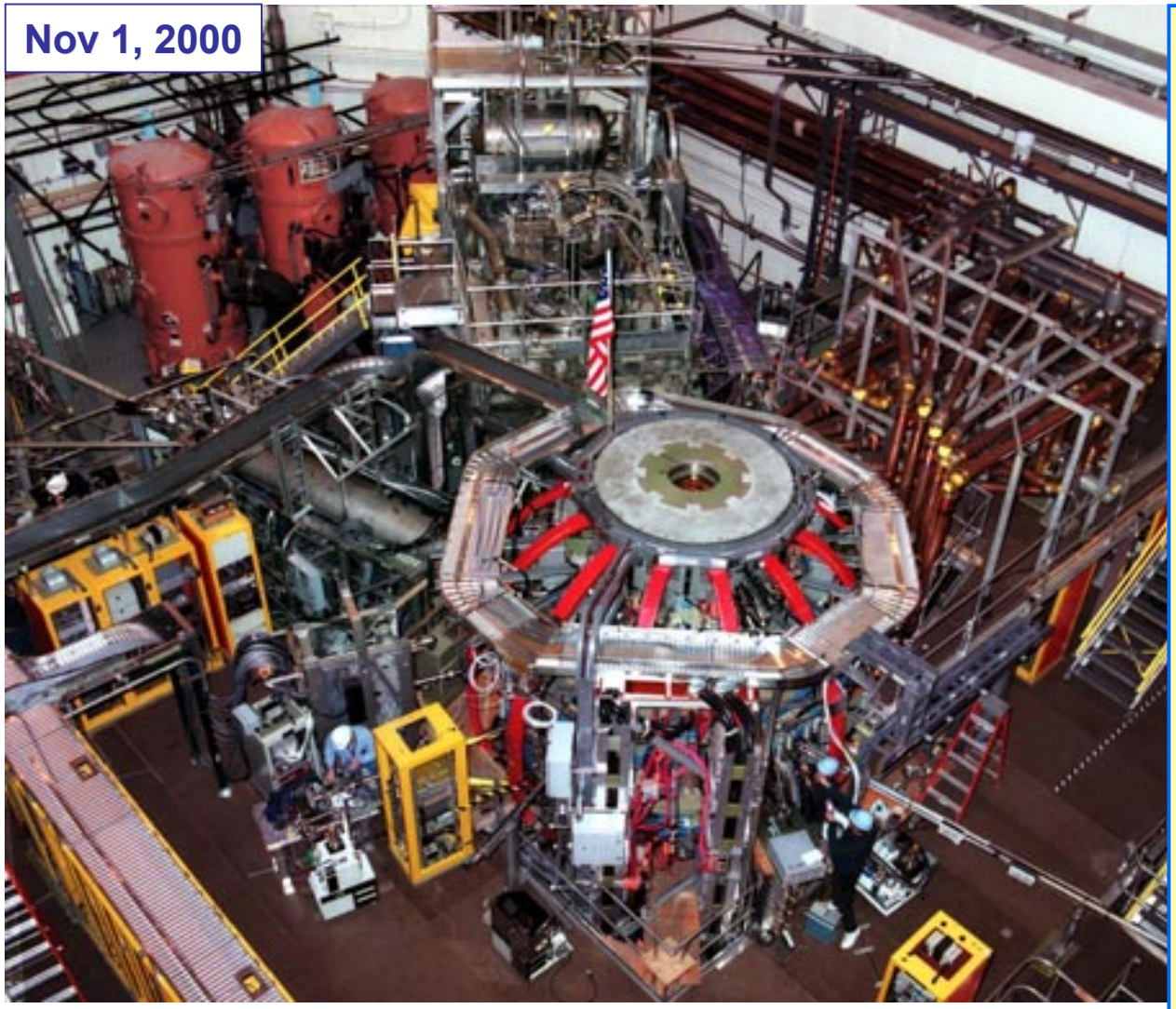
Facility Plan Outline

- Facility Overview (Diagnostics covered by Bob Kaita)

- Sub-Systems
  - Magnets
  - NBI
  - RF (HHFW/EBW)
  - CHI
  - Error Fields
  - Impurity Control
  - Particle Fueling
  - Plasma Control System (Dave Gates)
  - I&C Infrastructure

- Summary

NSTX Facility Has Continued Rapid Progress in Operational and Experimental Capabilities



Baseline Parameters
(Achieved)

Major Radius 0.85 m

Minor Radius 0.68 m

Elongation = 2.2 (2.5)

Triangularity = 0.6 (0.7)

Plasma Current
1 MA (1.4 MA)

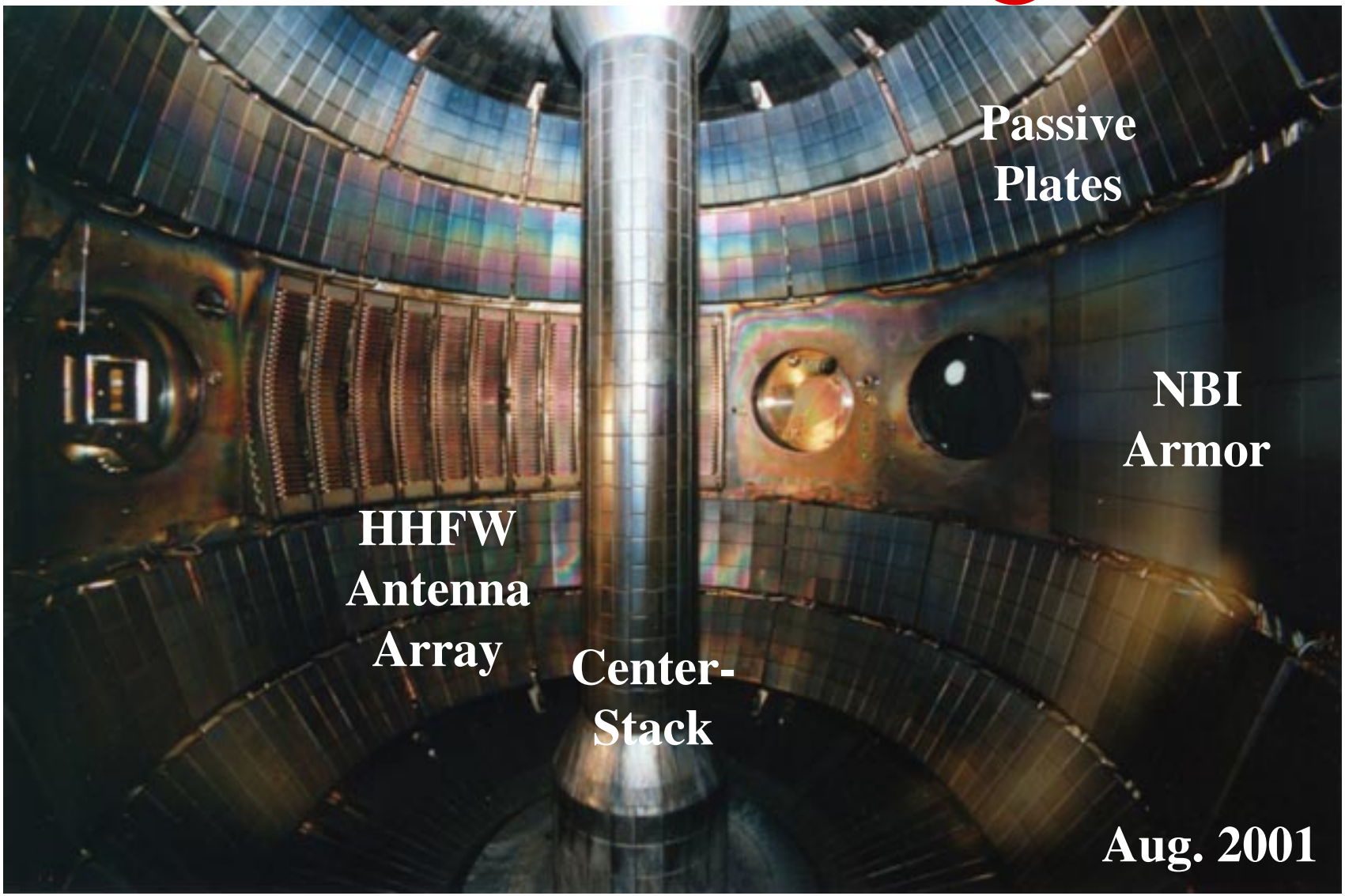
Toroidal Field
0.3 to 0.6 T (≤0.45 T)

Heating and CD
5 MW NBI (5 MW)
6 MW HHFW (6 MW)
0.5 MA CHI (0.39 MA)

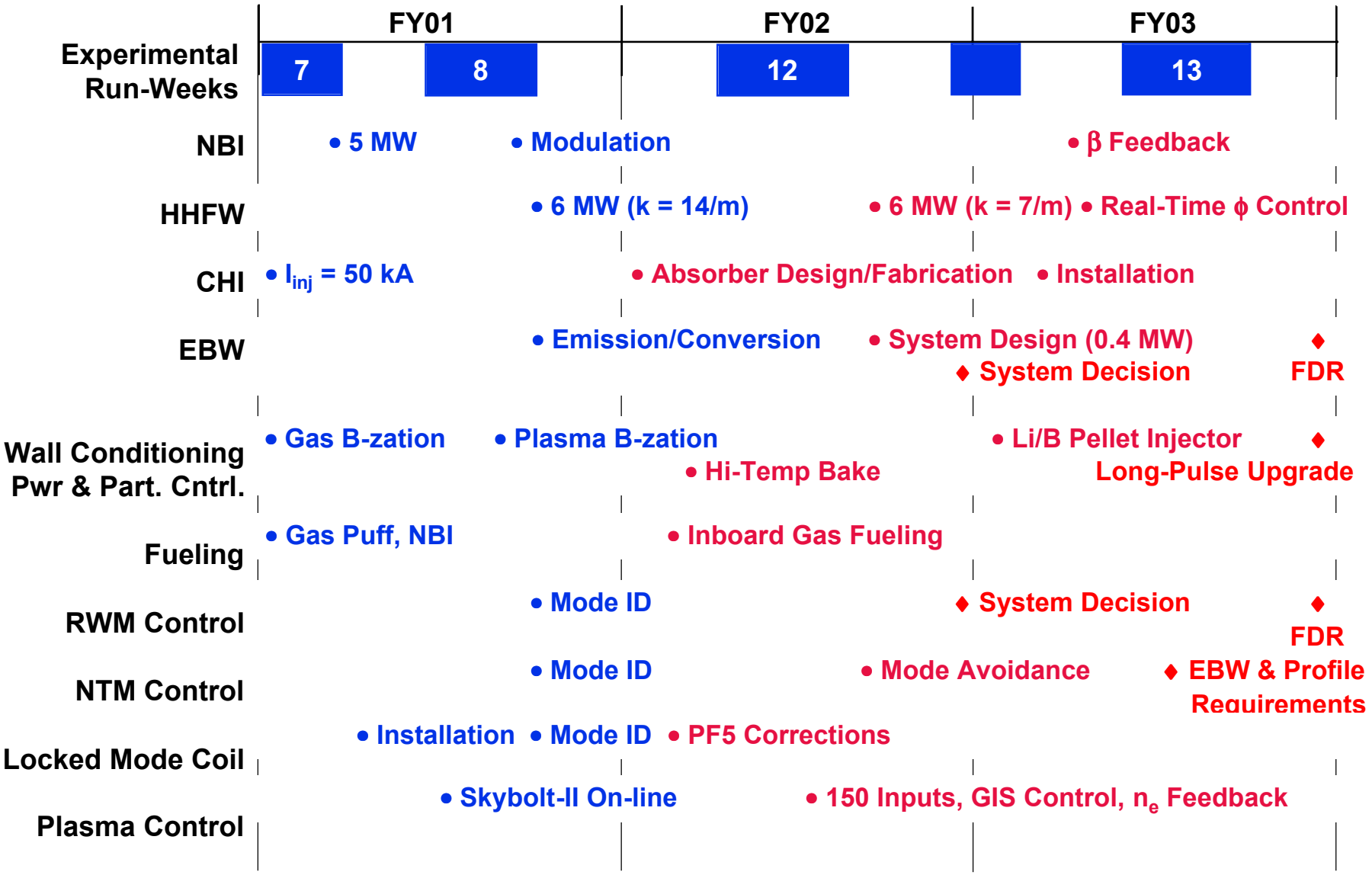
Pulse Length
= 5 sec (0.5 sec)

Fisheye View of NSTX Vacuum Vessel Interior

NSTX



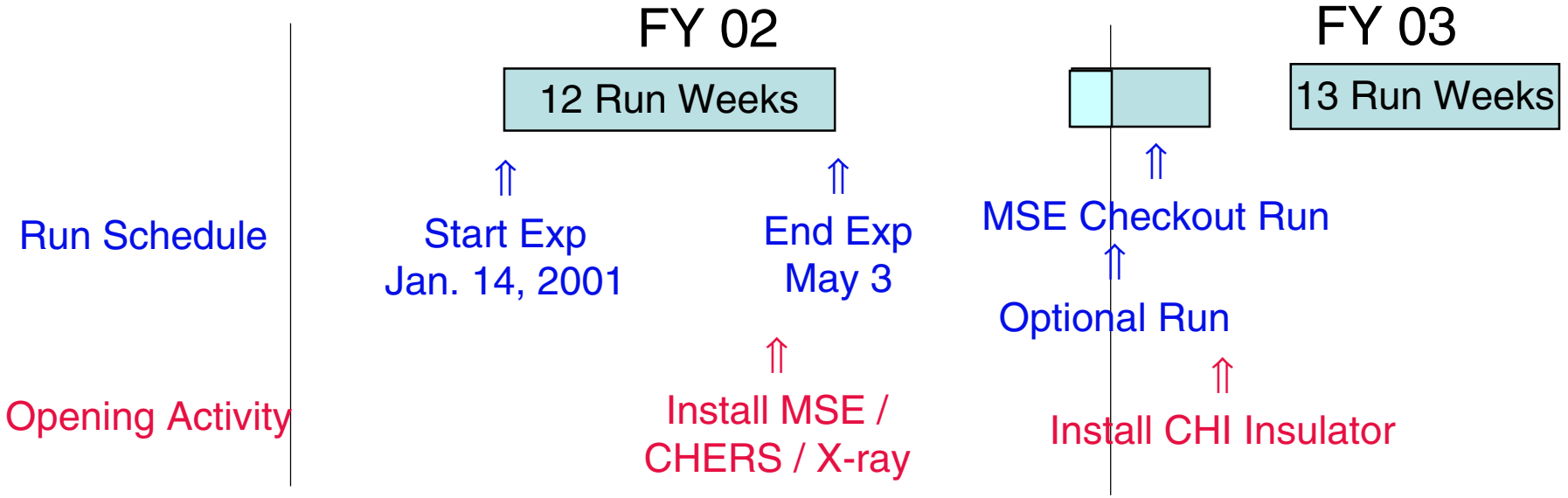
NSTX Facility status (•) and Plans (•)



Facility plan developed to maximize the FY02 research output within the budget constraints.

- Achieve twelve run weeks between Jan. 14 and May 3. "Three-run-weeks followed by one-maintenance-week" is a very aggressive schedule leaves little schedule contingency.

- Minimize technical and engineering activities (and expense) in July and Aug. Potential skill-mix problem.



Status of Magnet Systems

Existing Capability:

- PFs (1B, 2, 3,and 5) and OH running routinely at full rating.
- TF ran routinely at 4.5 kG but limited to $t_{pulse} \leq 0.5$ sec due to an uncooled turn. The water leak repaired.
- PF 1A coil bi-polar power supply commissioned available.

New Capability: (Next Run)

- A flourinert cooling system prepared for this run.
- Pulse length to be determined by the TF temperature rise (50 °C) allowable recommended by engineering for time being. The run will start with ≤ 4.5 kG and move up in the field as needed.
  - $B_T = 4.5$ kG , $t_{pulse} \leq 1$ sec
  - $B_T = 5$ kG , $t_{pulse} \leq 0.71$ sec
  - $B_T = 5.5$ kG , $t_{pulse} \leq 0.48$ sec
  - $B_T = 6$ kG , $t_{pulse} \leq 0.24$ sec

NBI (Neutral Beam Injection) System Routinely Operation at 80 keV

Existing Capability:

- Three ion sources (A,B, & C) operated routinely at 80 kV
- Total injection power of up to 5 MW
- Some modulation capability introduced
- One source went up to 90 kV.

New Capability: (Next Run)

- Source C developed water leak but was repaired.
- High voltage up to 100 kV can be made available as needed.
- NBI system will be available on Jan. 21,2001.

6MW 12-Antenna HHFW System is Ready

- Visual inspection of HHFW antennas after the last run showed no damages.
- Power level (up to 6 MW) and reliability has been steadily improving.
- All sources checked into dummy load after minor repair and maintenance
- Preparing for operation with full antenna phase feedback
- Remote control of sources and feedback controllers
  - Complete control of HHFW power, phase and timing from NSTX control room

Ready to begin current drive and pulse extension research starting January 14, 2002.

EBW / ECH
Viability of EBW for local CD in NSTX?

Existing Capability:

- ORNL ECH Preionization System (30 kW). Additional control and monitoring added to aid operation and troubleshooting
- EBW emission efficiency increased to 15 % from 5% during the L-H transition in NSTX.
- On CDX-U, near 100% EBW emission efficiency obtained with local limiter.

New Capability: (Next Run)

- New EBW emission detector near the HHFW antenna providing local limiter with a goal of getting high emission efficiency. Investigate a possible (low cost) local limiter option.
- Understand the EBW emission with edge measurements and theory modeling.
- Need more theory/modeling for EBW CD performance and benefits.

Impurity Control

Existing Capability:

- Graphite tiles covering plasma contacting surfaces
- HHFW antennas “boxed-in” with BN plates
- Resistive heater to bake center stack tiles to 300°
- Hot water heater to bake outer VV to 150°C
- TMB Gas Boronization
- Between-shots He Glow
- Plasma Boronization
- Wall coupons

New Capability: (Next Run)

- Compressed He Gas Bakeout system to bring graphite tiles to 350°C.
  - Thermocouples (53), IR Camera, metrology

Future Capability:

- Boron/Lithium Pellet Injector (CY 02)

Particle Fueling

Existing Capability:

- Out-board gas injectors (High throughput but not efficient for core fueling)
- Neutral Beam Injection (Efficient but $\leq 4 \times 10^{20}$/sec)

New Capability: (Next Run)

- In-board/mid-plane Gas Injection System
  - Essentially identical to the MAST system
  - Slow / uncontrolled injection due to low gas line conductance
- Real-time gas injection control system (Out-board injectors)

Central I&C

- NSTX diagnostic fiber infrastructure of 100 channels was completed in FY01.
- EPICS (Engineering Control System Software) upgraded to a current version. This also allowed migration to Solaris 8.
- A new disk storage cabinet with total of 144GB. This cabinet will provide two SCSI channels for improved MDSplus throughput.
- NSTX data serving and archival was enhanced for a total of 360GB. Future expansion possible for additional 1-2TB.
- Further acquisition time speed up being introduced.

Error Fields

Existing Capability:

- Locked-mode detector revealed PF 5 coil position error.
- The position error confirmed by direct measurements.

New Capability: (Next Run)

- New PF 5 Coil Alignment Clamps being installed.
- The alignment result to be checked with locked mode coils.

Future Capability: (Within one year)

- Finer field error corrections?
- Feedback coils?

Summary

- NSTX Facility has been rapidly ramping up. Many new capabilities implemented.
- The facility improvements to support FY 02 research goals.
  - Impurity reduction
  - Improved fueling
  - Error fields reduction
  - Longer TF pulse length
  - Higher TF capability
  - Improved plasma control, data acquisition systems
  - Improved heating and CD systems reliability
- Budge is very tight. Maintain the schedule is crucial.
  - Plasma Operations: Jan. 14 - May 3.
  - MSE/CHERS/X-ray Opening: May -June
  - Minimum activity months: July - Aug. to conserve fund.
  - Sept. as optional month for start of plasma operations for MSE.