

OUTLINE

- **INTRODUCTION**
- **DAY ONE AND BASELINE DIAGNOSTICS**
- **IDEAS FOR ADDITIONAL DIAGNOSTICS**
- **SUMMARY**

Introduction

- Diagnostics will enable NSTX to achieve its goal:

Assess physics performance of the Spherical Tokamak.

- Mission elements supported by Day One and Baseline NSTX diagnostics:
 - 1) Confinement and Transport.
 - Electron and ion temperature, density, and impurity profile diagnostics.
 - 2) MHD Stability.
 - Magnetic and X-ray fluctuation diagnostics.
 - 3) Non-inductive Start-up, Current Drive, and Profile Control
 - Current profile measurements.
 - 4) Scrapeoff layer and divertor physics.
 - Spectroscopic and bolometric diagnostics and edge probes.

Day One and Baseline Diagnostics

- Day One Diagnostics: essential for machine operations.
- Baseline Diagnostics: to understand confinement and transport in 5 second, radio frequency-driven plasmas with neutral beam for diagnostics as well as heating.

| Day One* and Baseline Diagnostics Summary | |
|---|---------------------------------------|
| System | Function |
| Plasma current Rogowski coils* | Total plasma current |
| Eddy current Rogowski coils* | Halo current monitoring |
| Flux loops* | Poloidal flux for plasma control |
| B_θ , B_ρ coils* | Plasma control/magnetic fluctuations |
| Mirnov coils* | Magnetic fluctuations |
| Visible TV camera* | External shape for plasma control |
| IR camera* | Heat loads |
| “Slow” Diamagnetic Loop* (using toroidal field coil) | Stored energy |
| Multichannel TVTS ¹ (single pulse) | Electron temperature and density |
| CHERS ² (with heating beam) | Ion temperature & toroidal rotation |
| MSE ³ (with heating beam) | Plasma current density profile |
| Multichannel bolometer | Radiated power profile |
| Visible continuum array | $Z_{\text{eff}}(r)$ |
| 1 mm microwave interferometer* | Line-integrated plasma density |
| Survey spectrometer (SPRED)* | Plasma impurities |
| H_α detectors | Edge recycling |
| Langmuir probes | Edge parameters |
| Soft X-ray imaging system* | Plasma instabilities and fluctuations |

¹TVTS: Multichannel Thomson Scattering System

²CHERS: Charge-Exchange Recombination Spectroscopy

³MSE: Motional Stark Effect Polarimetry

Ideas for Additional Diagnostics

“DensPak” Mirnov coils

Fast diamagnetic loop

Beam emission spectroscopy

Multilayer mirror detectors

ECE with electron Bernstein waves

Soft X-ray pulse height analysis

X-ray crystal spectrometry

Heavy ion beam probes

Neutral particle analyzers

Fast and slow neutron counters

Poloidal CHERS

Fast ion losses detectors

Multipulse or CW TVTS

Multichannel IR interferometry

Fast X-ray camera

Ideas for Additional Diagnostics (continued)

Reflectometry

Edge and divertor diagnostics

- multichannel spectrometry
- full-coverage imaging systems (CCDs)
- bolometry to unfold 2-D radiation loss
- IRTV for divertor plate
- Langmuir probes for SOL
- edge Thompson scattering
- edge reflectometers
- neutral gas measurements
- poloidal rotation near separatrix
 - wall conditions (coatings, structure)

Questions to the Working Groups Concerning NSTX Diagnostic Requirements

- Identify measurements, particularly those not available from the baseline set of diagnostics, which are critical to the pursuit of the physics issues being addressed by your Working Group.
- At what stage in the NSTX program (e.g. 1 year after 5 MW NBI operation) are these critical measurements needed?
- What techniques should be considered for these measurements?
- Since the diagnostics budget is very constrained, would you recommend changes in the priorities for the diagnostics in the baseline vs. other diagnostic ideas.

NSTX Diagnostics Summary

- Purpose of plasma diagnostics:
 - provide information on discharge parameters to characterize NSTX plasmas and guide NSTX operations for optimized performance.
- Day One diagnostics:
 - essential for machine operations.
- Baseline diagnostics:
 - measurements to provide understanding of basic confinement and transport properties of 5 second, radio frequency-driven NSTX discharges with neutral beam heating.
- Ideas for additional diagnostics:
 - Working groups should consider the questions posed to them concerning diagnostics requirements.

*Responses to be summarized by D. Johnson on Friday,
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