Princeton Plasma Physics Laboratory

NSTX Machine Proposal

Title: Bring HHFW online and raise power to 6MW

OP-XMP-026	Revision**:** **1**	Effective Date: 2-20-06 *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

Procedure Approvals

Responsible author: J.C. Hosea	Date
ATI (NSTX Physics Ops):	Date
RLM (NSTX Experimental Research Ops):	Date

Responsible Division: **Experimental Research Operations**

Procedure Requirements
designated by RLM

	NSTX Work Permit (TBD)		Lockout/Tagout (OP-AD-61)
	TFTR Work Permit (OP-AD-09)		Door Permit (OP-G-93)
	Tritium Work Permit (OP-AD-49)		T-MOD (OP-AD-03)
	RWP (HP-OP-20)		Lift Procedure (ENG-021)
	Confined Space Permit		DCA/DCN (OP-AD-104)
	Pre-job brief (OP-AD-79)		ATI Walkdown
	USQD (OP-AD-63)		Independent Review
	Master Equip. List Mod (OP-AD-112)		ES&H Review (NEPA, IH, etc)

MINOR MODIFICATIONS

REVIEWERS (designated by RLM)
ATI
Test Director
Independent Reviewer
D-Site Shift Supervisor
NSTX
TFTR Caretaking
Vacuum
Computer
Tritium
QA/QC
AC Power
FED
ECS/MG
FED
ERWM
Water
NB
RF
Diagnostics

TRAINING (designated by RLM)

Training required: No ■ Yes ☐ Instructor _____

Personnel (group, job title or individual name)	Read Only	Instruction	Hands-On

Training Rep. _____

RLM _____

NSTX MACHINE PROPOSAL

TITLE: Bring HHFW System online and rasie power to 6MW No.**OP-XMP-026**

AUTHORS: J.C. Hosea DATE: 1-06-03

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1. Overview of experiment:

Operate HHFW into plasma to check out system performance, condition antenna to maximum voltage and evaluate performance in standard discharges. Power will be applied starting at a low level (~0.6 MW). Phase and amplitude control will be verified. Arc control and plasma current inhibit will be verified. Power will be raised until either a hard voltage limit or 6 MW level is reached. Some arcing during the conditioning process is expected. Evaluate plasma heating utilizing magnetics and Thomson scattering. Compare voltage limits and performance in multiple plasma configurations

2. Justification:

After a major vacuum opening the HHFW system needs to be re-conditioned up to maximum power into plasma. Any significant changes in the systems behavior either due to changes in HHFW system itself or in the machine need to be documented. In addition the performance of the system in terms of plasma heating needs to be verified in standard discharge conditions. The many scans allow the antenna to be power conditioned in a variety of discharge conditions, promoting reliability in future experimental operations.

3. Plan:

Establish standard HHFW plasma like shot 107965. Plasma may be either D or He4 (use D for prefill in either case). Inject HHFW power from 0.2- 0.4 s beginning at 100 kW per transmitter. Look for arcing, density rise, D_{alpha} signal and electron temperature response. Verify phase and amplitude control at this power level. Increase power on succeeding shots by increments of ~100 kW per transmitter while observing plasma behavior, repeat shots at a given power if arcing occurs or a large increase in density or D_{alpha} is observed. Continue until an arcing limit is found. Vary outer gap and plasma density to see if limit is a true voltage limit or a power limit. Vary plasma current to observe dependence of voltage limit. Vary antenna phasing to observe voltage dependence Repeat power scan in double null configuration.

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Test Director

4. Required machine, beam, ICRF and diagnostic capabilities:

I. HHFW system

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Verification, if appropriate

5. Sign-off and Documentation

5.1 Permission to Proceed:

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Head, Experimental Research Operations Division

5.2 Documentation of results:

Documentation of the results completed, attached to proposal and sent to Ops. Center with copies to Cognizant Physicist and Head of Boundary Physics.

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Test Director

PHYSICS OPERATIONS REQUEST

Title Bring HHFW system online and raise power to 6MW **OP-XMP-026**

Machine conditions

I_{TF} (kA): 0.35 – 0.5 T Flattop start/stop (s):

I_P (MA): 0.5-1.0 MA Flattop start/stop (s):

Configuration: LSN and DN Z (m):

Gas Species: D or 4He

NBI: no

ICRF: full system

CHI: no

Previous shot numbers for setup: 112699 or equivalent

If shots are new and unique, sketch the desired time profiles and shapes. Accurately label the sketch so there is no confusion about times or values.

DIAGNOSTIC CHECKLIST

Title Bring HHFW online and raise power to 6 MW **OP-XMP-026**

Diagnostic	Need	Desire	Instructions
Bolometer – tangential array		x	
Bolometer array - divertor			
CHERS			
Diamagnetism	✔		
Divertor fast camera			
EBW radiometer			
Edge pressure gauges			
Edge rotation spectroscopy			
Fast lost ion probes			
Filterscopes		x	
FIReTIP			
Gas puff imaging			
H_α camera - 1D		x	
Infrared cameras			
Interferometer - 1 mm			
Langmuir probe array			
Magnetics - Flux loops	✔		
Magnetics - Locked modes			
Magnetics - pickup coils	✔		
Magnetics - Rogowski coils	✔		
Magnetics - RWM sensors			
Mirnov coils – high frequency			
MSE			
Neutral particle analyzer			
Neutron measurements			
Plasma TV	✔		
Reciprocating probe			
Reflectometer – core			
Reflectometer - SOL		x	
SPRED			
Thomson scattering	x		
Ultrasoft X-ray arrays			
Visible bremsstrahlung det.			
Visible spectrometer (VIPS)		x	
X-ray crystal spectrometer - H		x	
X-ray crystal spectrometer - V		x	
X-ray GEM camera			
X-ray pinhole camera			

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Discharge setup:

- LSN, 600kA discharge at B_T = 4.5T, L-mode discharge in helium as for shot 112699
- Requirements for triangularity and elongation similar to those for shot 112699.
- Outer gap to antenna ~ 4cm. HHFW power from 0.2-0.4sec beginning at 20kW per transmitter.
- Gas fuelling program - not critical for He but gas pulse should be terminated prior to RF turnon.

Plan:

- During this half day conditioning run we will start with $14m^{-1}$ phasing and after reaching sufficient power we will change to $7m^{-1}$ and then $3m^{-1}$ (if time permits)
- Checkout of HHFW system and pertinent diagnostics
- Measurement of gap RF signals - at 20 kW/source set signal attenuation for high power
- Push power up at 14 m^{-1}
- At elevated power vary phase to see effect on gap signals

Experiment duration:

- 1/2 day

XMP Shot Planning Form – XMP 026 – Rev 1
Date:

Author	J. Hosea
Title	Bring HHFW online and raise power to 6 MW
ET Group	Wave-Particle ET
Describe the shot(s) you require	Plasma current magnitude. L-mode or H-mode? With or without ELMs. DN, LSN or USN? Acceptable Elongation range if applicable Acceptable Triangularity range if applicable Does this shot use PF1B? LSN, 600kA discharge at B_T = 4.5T, L-mode discharge. Requirements for triangularity and elongation similar to those for shot 112699. He gas. Outer gap to antenna ~ 4cm. HHFW power from 0.2-0.4sec beginning at 20kW per transmitter. 112699 may have been nearer double null but LSN would be more interesting
Describe fuelling requirements	Center stack gas pressure and injection time. Out board gas injection requirements. Supersonic gas injection requirements. Similar to fueling for shot 112699. He flow is stopped prior to application of HHFW. Either inboard or out board gas injection OK for He discharges (in D neeed to puff more and usually we ask for the center stack injector)
Reference shot number	That has conditions similar to the one you require 112699
Glow discharge requirements	Is 5min HeGDC sufficient? Glow during this conditioning is not needed in He discharges. (In D discharges 5 min glow may be inadequate)
rtEFIT requirement	Do you require rtEFIT capability? If so do you have a target shot number to use? Are you willing to spend your XP time for rtEFIT development? Unless the pick-up problem has been solved, rtEFIT must be

	used. LSN shot may require some work.
Any other special requirements for this shot?	Should be programmed to be as stable as possible and as reproducible as possible. Start-up optimization to minimize MHD is probably key
Any other useful information?	During this half day conditioning run we will start with $14m^{-1}$ phasing and after reaching sufficient power we will change to $7m^{-1}$ and then $3m^{-1}$ (if time permits)