Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Reproduce medium triangularity EP H-mode**		
OP-XP-1114	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: R. Maingi	Date
ATI – ET Group Leader: V. Soukhanovskii	Date
RLM - Run Coordinator: S. Sabbagh	Date
Responsible Division: Experimental Research Operations	

RESTRICTIONS or MINOR MODIFICATIONS

(Approved by Experimental Research Operations)

1. Overview of planned experiment

The goal of this experiment is try to reproduce the medium triangularity discharge with the 300 msec long Enhanced Pedestal H-mode phase, and if successful, to try to extend it with β feedback. This is part of NSTX's contribution to the FY11 JRT on pedestal structure, in the area of scenarios with a separation of particle and thermal transport channels. An important component is to document the turbulence characteristics in the EP H-mode.

2. Theoretical/ empirical justification

The Enhanced Pedestal H-mode is a confinement regime with ~ 50% improvement in energy confinement, even relative to the good confinement obtained with lithium evaporation. It is characterized by a doubling of the T_e and T_i pedestals, without a corresponding increase in the n_e pedestal, and with H98y2 $\leq$ 1.7 [Maingi, PRL 2010]. It is also characterized by a minimum in the toroidal rotation, often at the q=3 surface but sometimes at the separatrix.

The longest duration EP H-mode (~3 τ_E) used SGI fueling, and was conducted in a medium δ configuration. Experiments to make long-pulse EP H-modes were tried at high δ in 2010 for scenario development; the longest achieved duration EP H-modes in those cases were typically < 1 τ_E. Here we propose to return to the medium δ configuration to see if that configuration facilitates EP H-mode access. Indeed that scenario seems to facilitate high confinement relative to the H97L scaling: Figure 1 compares the time evolution of 5 such discharges. Panel 1e shows that each of these discharges had enhanced H97L above the canonical multiplier of ~ 1.8-2.0 normally observed in NSTX H-mode discharges. Thus getting additional discharges in this scenario will help us quantify why the confinement continues to improve, even in the absence of EP H-modes. Piggyback data will be obtained with the divertor Langmuir probes.

3. Experimental run plan (1 day)

1. Restore 134991, including SGI fueling (3)
2. If not obtained easily, use several techniques to facilitate the EP H-mode transition (5-15)

   a) vary the amount of pre-discharge lithium 'dose' to obtain the proper nearly ELM-free regime, with a few naturally occurring ELMs

   b) If discharges are completely ELM-free, then trigger ELMs with short pulsed n=3 3-D field: 1.5-2 kA, 10 ms square wave on time, with a frequency ~ 5 Hz. Also try n=2, time permitting.

   c) vary the balance between SGI and HFS fueling

3. Decision point: if EP H-modes not observed, stop after ½ day and try again later in the run, otherwise apply β_N feedback to restrict below 6-6.5 to prevent RWM onset. Also change the OSP location ~ 70cm for better Langmuir probe piggyback data.
4. Perform an I_p scan in +/- 10% increments, followed by a B_t scan in +/- 10% increments; keep in mind that lower q95 may facilitate EP H-mode access
5. Document turbulence characteristics (FIReTIP, magnetics, high-k, BES)

4. Required machine, NBI, RF, CHI and diagnostic capabilities

Up to 4 MW NBI, no rf, no CHI. Nominally plan for 2-3 MW NBI.

5. Planned analysis

EFIT, TRANSP, and pedestal profile/stability analysis.

6. Planned publication of results

This will be published at the next APS meeting, and as part of the final FY2011 JRT report.

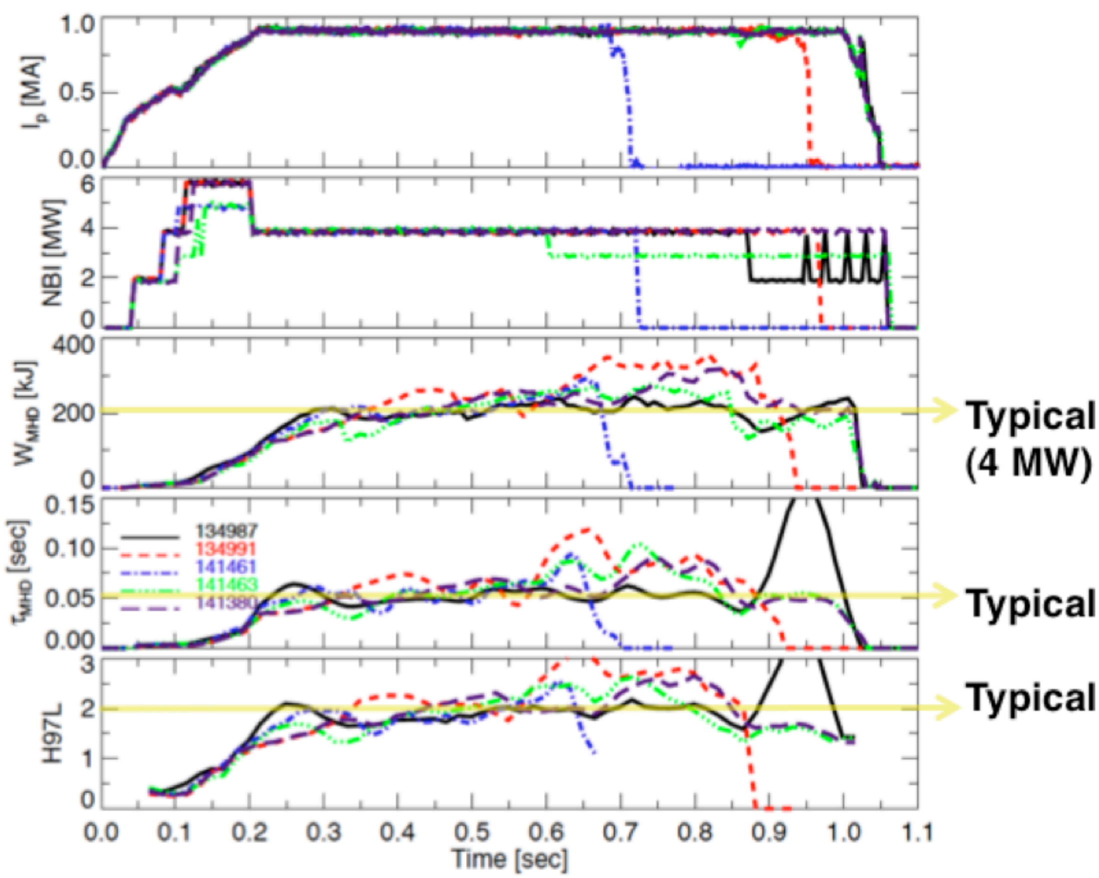

Figure 1: Evolution of plasma parameters for five medium δ discharges: (a) plasma current I_p, (b) Neutral beam power NBI, (c) Stored energy from EFIT02 reconstructions W_{MHD}, (d) energy confinement from EFIT02 reconstructions τ_{MHD}, and (e) confinement relative to ITRER-H97L scaling, H97L. Only 134987 and 134991 had EP H-mode phases.

PHYSICS OPERATIONS REQUEST

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Brief description of the most important operational plasma conditions required:

Medium delta discharge with SGI that produced longest pulse EP H-mode observed.

Previous shot(s) which can be repeated: 134991

Previous shot(s) which can be modified:

Machine conditions *(specify ranges as appropriate, strike out inapplicable cases)*

I_{TF} (kA): **4.8 kG** Flattop start/stop (s):

I_P (MA): **0.9 MA** Flattop start/stop (s):

Configuration: Limiter / DN / LSN / USN: **LSN drsep=-5mm**

Equilibrium Control: Outer gap / **Isoflux (rtEFIT)** / Strike-point control (rtEFIT)

Outer gap (m): **9-11 cm** Inner gap (m): **5-6 cm** Z position (m):

Elongation: **1.8-2** Triangularity (U/L): **0.6-0.65** OSP radius (m): **0.62-0.65**

Gas Species: **D** Injector(s):

NBI Species: **D** Voltage (kV) **A: 90** **B: 90** **C:** 70-90 Duration (s):

ICRF Power (MW): Phase between straps (°): Duration (s):

CHI: **Off / On** Bank capacitance (mF):

LITERs: Off / On Total deposition rate (mg/min):

LLD: Temperature (°C): **unheated**

EFC coils: Off/On Configuration: **Odd / Even / Other**

DIAGNOSTIC CHECKLIST

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Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
Beam Emission Spectroscopy		√
Bolometer – divertor		√
Bolometer – midplane array		√
CHERS – poloidal	√	
CHERS – toroidal	√	
Divertor L-alpha array		√
Divertor visible camera		√
Dust detector		
Edge deposition monitors		√
Edge neutral density diag.		
Edge pressure gauges		√
Edge rotation diagnostic		√
Fast cameras – divertor/LLD		√
Fast ion D_alpha - poloidal		√
Fast ion D_alpha - toroidal		√
Fast lost ion probes - IFLIP		
Fast lost ion probes - SFLIP		
Filterscopes	√	
FIReTIP	√	
Gas puff imaging – divertor		√
Gas puff imaging – midplane		√
Hα camera - 1D		√
High-k scattering		√
Infrared camera – standard		√
Infrared camera – 2-color		√
Infrared camera – wide-angle		√
Interferometer - 1 mm		
Langmuir probes – divertor		√
Langmuir probes – LLD	√	
Langmuir probes – bias tile		
Langmuir probes – RF ant.		
Magnetics – B coils	√	
Magnetics – Diamagnetism	√	
Magnetics – Flux loops	√	
Magnetics – Locked modes		√
Magnetics – Rogowski coils	√	
Magnetics – Halo currents		
Magnetics – RWM sensors		√

Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
MAPP		
Mirnov coils – high f.		√
Mirnov coils – poloidal array		√
Mirnov coils – toroidal array		√
Mirnov coils – 3-axis proto.		
MSE-CIF		√
MSE-LIF		
NPA – E‖B scanning		√
NPA – solid state		√
Neutron detectors		
Plasma TV		√
Reflectometer – 65GHz		√
Reflectometer – correlation		√
Reflectometer – FM/CW		
Reflectometer – fixed f		√
Reflectometer – SOL		
RF edge probes		
Spectrometer – divertor		
Spectrometer – SPRED		√
Spectrometer – VIPS		
Spectrometer – LOWEUS		√
Spectrometer – XEUS		
SWIFT – 2D flow		
TAE Antenna		
Thomson scattering	√	
USXR – pol. arrays		√
USXR – multi-energy		√
USXR – TG spectr.		
Visible bremsstrahlung det.		√
X-ray crystal spectrom. - H		
X-ray crystal spectrom. - V		
X-ray tang. pinhole camera		