Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**			
Title: CHI into an ohmic discharge			
OP-XP-533	**Revision:**		Effective Date: *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*
PROPOSAL APPROVALS			
Author: D. Mueller		Date	
ATI – ET Group Leader: R. Raman		Date	
RLM - Run Coordinator: J. Menard, S. Sabbagh (Deputy)		Date	
Responsible Division: Experimental Research Operations			
Chit Review Board (designated by Run Coordinator)			
MINOR MODIFICATIONS (Approved by Experimental Research Operations)			

1. Overview of planned experiment

The aim of this experiment is to apply the CHI voltage after an ohmic discharge has been established and to observe changes in plasma parameters, especially the current, l_i or τ_E.

2. Theoretical/ empirical justification

Experiments on HIT-II have demonstrated that it is possible to increase the observed plasma current by adding CHI to an already established OH discharge and that this current persists after the CHI voltage is reduced to zero. It is expected that the CHI current is added as a surface current and that this may effect the energy confinement time as well as provide current drive. Of course, other effects may occur such as impurity generation or changes in the equilibrium that could affect plasma control.

A condition for driving current inside closed flux surfaces by CHI is that $\lambda_{inj} > \lambda_{tok}$, where

$$\lambda_{tok} = \mu_0 I_p / \Phi_T \text{ and } \lambda_{inj} = \mu_0 I_{inj} / \psi_{inj}$$

□□□ $\lambda = \mu_0 J/B$. Integrating **J** and **B** over a surface with current I and flux Φ gives $\lambda = \mu_0 I/\Phi$. For the injector, the flux is taken to be the flux penetrating the insulating gap.

□□□□□□□□

$\lambda_{tok} \sim 1$ for Ip = 500 kA and B_T = 4.5 kG

$\lambda_{inj} \sim 4$ for I_{inj} = 10 kA and $\psi_{inj} \sim 0.03$ Wb (from EFIT for shot 106447)

So this condition is easily satisfied.

3. Experimental run plan

Establish ohmic targets (3 each):

500 kA, LSN, TF = 4.5 kG

500 kA, CS, TF =4.5 kG

500 kA, DN, TF = 4.5 kG

with > 100 ms flattop and well-controlled shapes.

5 min. He GDC between shots.

Starting with the LSN plasma, apply the CHI voltage for 20 ms (time between application of cap bank voltage voltage and firing the crowbar) during the Ip flattop. Use a LDGIS branch 5 puff with fill of 1000 T with gas timed to arrive at the time CHI voltage is applied..

A) Begin with V_{CHI} = 400 V and increase V_{CHI} in ~200 V increments to 1500 V (or to machine inner-outer voltage and/or ignitron limits whichever is lowest). (8 shots)

B) Binary search from 0 to 2000 Torr for the "best" pressure for LDGIS branch 5 puff . (5 shots)

C) Try another gas puff location (outer midplane and/or top) if time permits (3 shots)

D) Use beam blips before and after CHI to compare current distributions. (4 shots)

E) Delay firing of crowbar as appropriate to allow longer current penetration time at best condition (3 shots)

"Best" is that which gives most Ip, low l_i or improved τ_E without a large impurity influx or density increase.

Repeat A-E with the DN plasma

Repeat A-E with the CS plasma

Repeat LSN plasma at end to document changing wall conditions

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

See above ohmic target requirements. CHI must be ready; use 8 capacitors in the CHI circuit (or choose number of capacitors consistent with CV and CV^2 limits of ingnitron at maximum voltage to be used) and use the crowbar to terminate injector current.

Required diagnostics:

Magnetics, EFIT (timed to get bins immediately before and after injector current pulse)

Filter scopes for C, Hα and O

Fast Camera with wide- angle view.

MPTS (at least some of the time)

Dynamo Probe (desired, but not essential for first go-round)

Divertor Langmuir probes (desired)

Possible MSE with beam blips before and after injector current pulse

5. Planned analysis

EFIT,

6. Planned publication of results

PPPL report, APS talk, and or journal publication, depending upon quality of results

Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **53.5** Flattop start/stop (s): **-.01/1.0**

I_P (MA): **0.5** Flattop start/stop (s): **~.15 / .5**

Configuration: **LSN**

Outer gap (m): **0.1**, Inner gap (m): **0.1**

Elongation κ: **2**, Triangularity δ: ~**0.4**

Z position (m): **0.00**

Gas Species: **D**, Injector: **Midplane / Inner wall / Lower Dome**

NBI - Species: **D**, Sources: **A**, Voltage (kV): **90**, Duration (s): **.01-.02**

ICRF – Power (MW): **____**, Phasing: **Heating / CD**, Duration (s): **_____**

CHI: **ON**

Either: List previous shot numbers for setup: **106447**

Or: Sketch the desired time profiles, including inner and outer gaps, κ, δ, heating, fuelling, etc. as appropriate. Accurately label the sketch with times and values.

DIAGNOSTIC CHECKLIST

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Diagnostic	Need	Desire	Instructions
Bolometer – tangential array			
Bolometer array - divertor			
CHERS		4	Beam Blips
Divertor fast camera		4	
Dust detector			
EBW radiometers			
Edge deposition monitor			
Edge pressure gauges			
Edge rotation spectroscopy		4	
Fast lost ion probes - IFLIP			
Fast lost ion probes - SFLIP			
Filtered 1D cameras			
Filterscopes			
FIReTIP			
Gas puff imaging			
Infrared cameras			
Interferometer - 1 mm			
Langmuir probe array		4	
Magnetics - Diamagnetism	4		
Magnetics - Flux loops	4		
Magnetics - Locked modes		4	
Magnetics - Pickup coils	4		
Magnetics - Rogowski coils	4		
Magnetics - RWM sensors			
Mirnov coils – high frequency			
Mirnov coils – poloidal array			
Mirnov coils – toroidal array			
MSE		4	Beam Blips
Neutral particle analyzer			
Neutron measurements			
Plasma TV	4		
Reciprocating probe		4	Dynamo Probe head
Reflectometer – core			
Reflectometer - SOL			
RF antenna camera			
RF antenna probe			
SPRED			
Thomson scattering			
Ultrasoft X-ray arrays			
Visible bremsstrahlung det.			
Visible spectrometers (VIPS)			
X-ray crystal spectrometer - H			
X-ray crystal spectrometer - V			
X-ray PIXCS (GEM) camera			
X-ray pinhole camera			
X-ray TG spectrometer			