Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Beta Scaling of Confinement in Weakly Shaped Plasmas**		
OP-XP-910	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: S. Kaye	Date 4/7/09
ATI – ET Group Leader: K. Tritz	Date
RLM - Run Coordinator: R. Raman	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: **Beta Scaling of Confinement in Weakly Shaped Plasmas** No. **OP-XP-910**

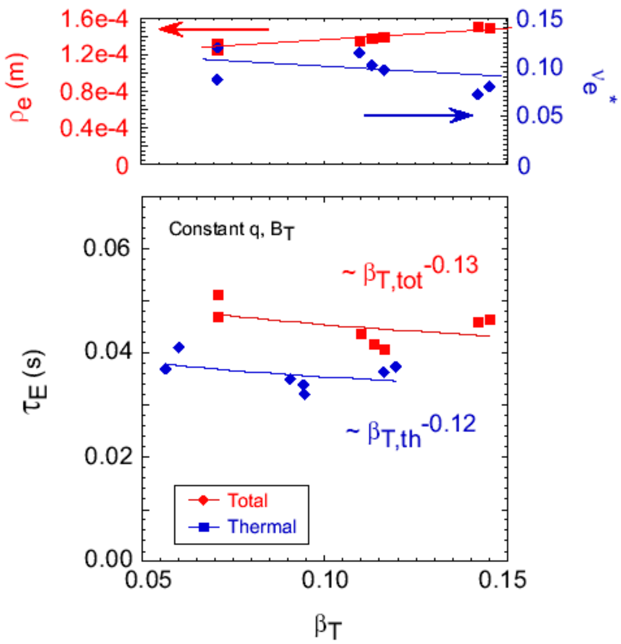
AUTHORS: **S. Kaye** DATE: **4/7/09**

1. Overview of planned experiment

This XP follows up on last year's confinement scaling XP in which the degradation of energy confinement with beta was found to be negligible. That scan was done in a strongly shaped plasma (κ~2.1, δ~0.8). This result supported results found in other strongly shaped tokamak devices, while experiments in more weakly shaped plasmas indicated a strong degradation of confinement with beta. This XP will address the shape issue by redoing the power scan but in an ITER-shaped plasma, **and using Li to suppress ELMs**.

2. Theoretical/ empirical justification

The results from last year's XP showed very little degradation of confinement with beta. This conclusion was obtained from a scan in which B_T, I_p and line-averaged density were the same, and in which the beam power was varied from one to three sources. Over this beam power range, the



effective collisionality and electron gyroradius were constant to within 20%, while beta varied by a factor of 2.5 to 3. The results are shown below.

These results supported the lack of beta scaling on other devices (DIII-D and JET) with strongly shaped plasmas, but differed from those on AUG and JT60-U, which showed a strong degradation of confinement with beta. In these latter two experiments, the plasma shaping was weaker. It has been hypothesized that the difference in the beta degradation results is due to the differences in plasma shaping. NSTX will test this hypothesis by redoing the beta scan in an ITER-shaped plasma with κ~1.7 and δ~0.4

3. Experimental run plan

Redo beta scan with κ~1.7 and δ~0.45. **Shot 127301, developed for the small ELM experiment, but with B_T increased to 5.5 T will be used as a baseline. In addition, 15-20 mg/min of Li injection will be used to suppress large ELMs.** This is a ½ day experiment, and the shot list is given below.

Case	Power
Low-β	Source A
Med-β	Source A,B
High-β	All sources

If there is time, the medium β case will be rerun with sources A&C. Two shots per condition will be taken, with 2 to 3 setup shots anticipated.

If the high-β case disrupts with all three sources, the voltage on source C will be lowered. Start off with full energy on each beam, but then might have to lower voltage to get wide enough range in beta without hitting beta limit. Will also consider modulating beam instead of, or in addition to, lowering voltage.

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

Optimum EF, low-n mode stabilization feedback on.

5. Planned analysis

EFIT, TRANSP, etc.

6. Planned publication of results

APS, journal article, ITPA

PHYSICS OPERATIONS REQUEST

TITLE: **Beta Scaling of Confinement in Weakly Shaped Plasmas** No. **OP-XP-910**

AUTHORS: **S. Kaye** DATE: **4/7/09**

Describe briefly the most important plasma conditions required for the XP:

Quiescent, ELM-free discharges that are capable of attaining high-betan at the highest beam power.

List any pre-existing shots: 127301

Equilibrium Control: Gap Control / rtEFIT(isoflux control):

Machine conditions *(specify ranges as appropriate, use more than one sheet if necessary)*

I_{TF} (kA): **66 kA (0.55 T)** Flattop start/stop (s):

I_P (MA): **0.8 MA** Flattop start/stop (s):

Configuration: **LSN**

Outer gap (m): Inner gap (m): Z position (m):

Elongation κ: **1.7** Upper/lower triangularity δ: **0.45 (lower)**

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

NBI Species: **D** Voltages (kV or off) **A: max** **B: max** **C:** max Duration (s): ~1 s

ICRF Power (MW): 0 Phasing: Duration (s):

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

LITERs: On Total deposition rate (mg/min): **~15**

EFC coils: On Configuration: **Other** (optimal EF correction with low-n feedback)

DIAGNOSTIC CHECKLIST

TITLE: **Beta Scaling of Confinement in Weakly Shaped Plasmas** No. **OP-XP-910**

AUTHORS: **S. Kaye** DATE: 4/7/09

Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
Bolometer – tangential array	√	
Bolometer – divertor		
CHERS – toroidal	√	
CHERS – poloidal		√
Divertor fast camera		
Dust detector		
EBW radiometers		
Edge deposition monitors		
Edge neutral density diag.		
Edge pressure gauges		
Edge rotation diagnostic		
Fast ion D_alpha - FIDA		√
Fast lost ion probes - IFLIP		
Fast lost ion probes - SFLIP		
Filterscopes	√	
FIReTIP		
Gas puff imaging		
Hα camera - 1D		
High-k scattering		√
Infrared cameras		
Interferometer - 1 mm		
Langmuir probes – divertor		
Langmuir probes – BEaP		
Langmuir probes – RF ant.		
Magnetics – Diamagnetism	√	
Magnetics – Flux loops	√	
Magnetics – Locked modes	√	
Magnetics – Pickup coils	√	
Magnetics – Rogowski coils	√	
Magnetics – Halo currents		
Magnetics – RWM sensors	√	
Mirnov coils – high f.		
Mirnov coils – poloidal array		
Mirnov coils – toroidal array		
Mirnov coils – 3-axis proto.		

Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
MSE	√	
NPA – ExB scanning		
NPA – solid state		
Neutron measurements	√	
Plasma TV		√
Reciprocating probe		
Reflectometer – 65GHz		
Reflectometer – correlation		
Reflectometer – FM/CW		
Reflectometer – fixed f		
Reflectometer – SOL		
RF edge probes		
Spectrometer – SPRED		√
Spectrometer – VIPS		
SWIFT – 2D flow		
Thomson scattering	√	
Ultrasoft X-ray arrays		√
Ultrasoft X-rays – bicolor		
Ultrasoft X-rays – TG spectr.		
Visible bremsstrahlung det.		
X-ray crystal spectrom. - H		
X-ray crystal spectrom. - V		
X-ray fast pinhole camera		
X-ray spectrometer - XEUS		