Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: Te Comparison

XP-206	**Revision: 1**	Effective Date: *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Author: M. Bitter	Date 12/19/01
ATI - Task Force Leader: D. Darrow	Date
RLM - Run Coordinator: R. Maingi	Date

Responsible Division: Experimental Research Operations

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

Comparison of Te measurements at NSTX

1. Overview of planned experiment

The goal of this XP is to document the Te measurements from different diagnostics and to resolve the existing discrepancies. The Te results from the Multi-Point Thomson Scattering system (MPTS) and Ultra Soft X-ray (USXR) array seem to be in agreement but are systematically lower than those from the X-ray Pulse Height Analysis (PHA) and the X-ray crystal Spectrometer (XCS). The difference can be as much as 40%, *see* Figs 1 and 2. An increase of the electron temperature by this amount would significantly change the NSTX power balance.

The discrepancies of the Te-measurements may be caused by (1) a non-Maxwelllian electron energy distribution or (2) neutral charge exchange recombination of hydrogen-like argon, ArXVIII, to helium-like argon to ArXVII, which would enhance the intensity of the ArXVII resonance line. Both effects would result in an overestimate of the electron temperatures from the XCS. A non-Maxwellian electron distribution could also lead to an overestimate of the electron temperature from the PHA.

In order to investigate the above-mentioned effects and to document the results from the different Te diagnostics, it is planned to perform experiments in plasmas with pure ohmic heating and plasmas with additional RF and neutral-beam heating at different plasma currents and plasma densities..

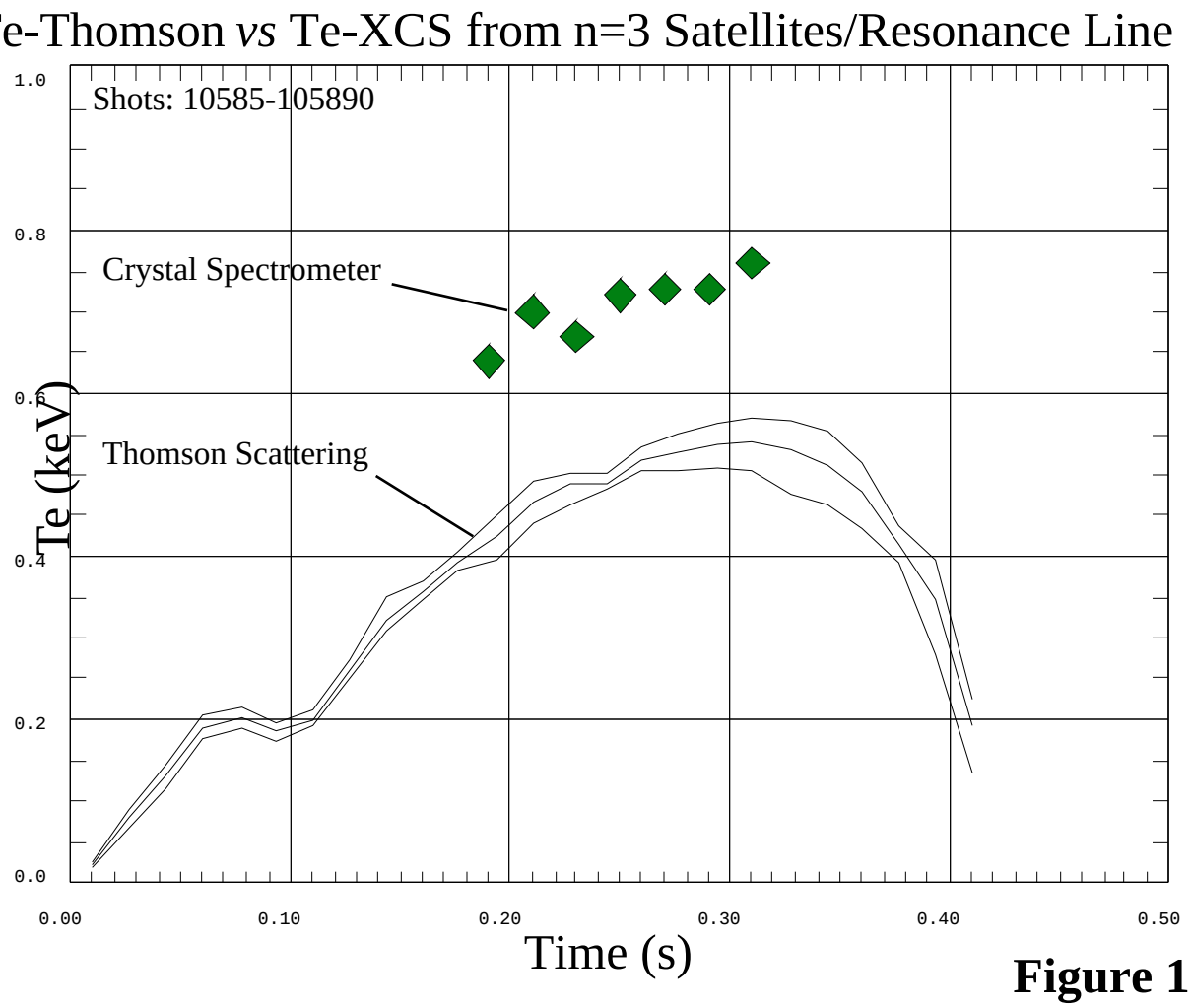

Figure 1

Figure 1: Time histories of $Te^{Thomson}$ and Te^{XCS} from shots 105885 – 105890. These discharges were nearly identical, since they were used for antenna loading experiments. Te^{XCS} was derived from the accumulated spectra from these shots.

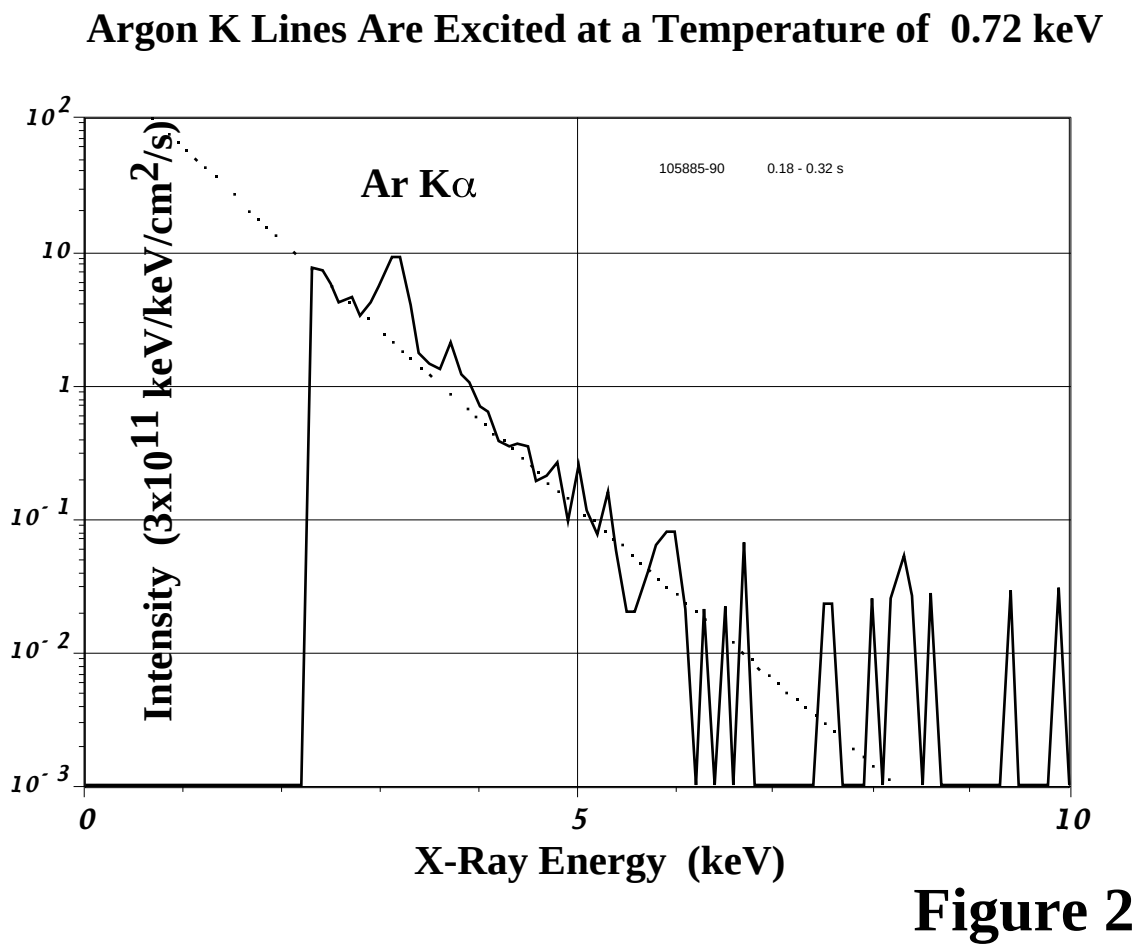

Figure 2: Te^{PHA} = 720 eV from the accumulated PHA spectra from shots 105885 – 105890, time averaged from 0.19 – 0.32 s

2. Experimental run plan

The XP consists of three parts: **(a)** ohmic discharges with different plasma currents and densities to vary peak electron temperatures and electron temperature profiles. With use of the PHA, it should be possible to document the effects of the electron density on the electron energy distribution; **(b)** plasmas with HHFW heating and an RF power scan for a fixed ohmic current and different densities. This will allow us to vary the electron temperature. We will also document whether a non-Mexwellian electron energy distribution is produced under any of these conditions. **(c**) plasmas with moderate NBI power – to avoid a perturbation of the PHA and XCS detectors by neutrons. In these experiments, we will find out whether the intensity of the ArXVII resonance line is enhanced by neutral charge exchange recombination of ArXVIII.

The number of shots needed for each part will depend on the statistics requirements for the diagnostics. The numbers given below are estimates.

(a) Ohmic Discharges

Sequence	Gas	I_p	B_T	n_e	Min. # Shots
1	He	0.5 MA	0.45	$2x10^{13}$ cm^{-3}	2
2	He	0.5	0.45	> 3.5 *	2
3	He	0.8	0.45	2	2
4	He	0.8	0.45	> 5.5 *	2
5	D_2	0.6	0.45	< 2 **	2
6	He	0.3	0.45 T	2	1

* avoid disruptions ** avoid MHD

(b) Plasmas with RF

Sequence	Gas	I_p	B_T	RF-Power	n_e	Min.#Shots
7	He	0.5 MA	0.45 T	1 MW	1.5	2
8	He	0.5	0.45	1	3	2
9	He	0.5	0.45	2	1.5	2
10	He	0.5	0.45	2	3	2
11	He	0.5	0.45	3	1.5	2
12	He	0.5	0.45	3	3	2

(c) Plasmas with NBI

Sequence	Gas	I_p	B_T	NB-Power	n_e	Min.#Shots
13	He	0.8 MA	0.45	1.5 MW	2	2
14	He	0.8	0.45	3	2	2

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

Ohmic plasmas as well as plasmas with RF and plasmas with NBI are required.

Required diagnostic capabilities

Main diagnostics:

• Multi-Point Thomson Scattering (MPTS)

• Ultra Soft X-ray Array (USXR)

• GRITTS

• X-ray Pulse Height Analysis System (PHA)

• X-ray Crystal Spectrometer (XCS)

Additional desirable diagnostics:

• Core Reflectometer (MMWR)
• Fast Lost Ion Probe (FLIP)
• Neutral Particle Analyzer (NPA)
• runaway electron detection 5.

5. Planned analysis

The electron temperature results obtained from the four diagnostics will be thoroughly discussed within the Transport Task Force in order to eliminate any systematic errors in the diagnostic systems or data analysis and hopefully resolve any discrepancies.

6. Planned publication of results

The purpose of this XP is to obtain reliable electron temperatures, which are needed for the NSTX power balance and many experiments. A special publication of the results from this XP is not planned.

PHYSICS OPERATIONS REQUEST

Title: Operational Limits **XP No.:**

Machine conditions (indicate range where appropriate):

TF: Flattop (kA) _≤ 53 Flattop start/stop (s) _____

I_p: Flattop (kA) _≤ 800 Flattop start/stop (s) 0.1/0.35

Position: R (m) __0.85 Z (m) __0.00 Inner wall / **Lower Single null** / Double null

Gas: Prefill __He^+____ Puff __ He^+__

NBI: Power (MW) __2____ Start / stop (s) _0.1/0.3_ Voltage (kV) _____

RF: Power (MW) __3____ Start / stop (s) _0.1/0.3_ Frequency (MHz) _____

CHI: **Off** / Start-up / Ramp-up / Sustainment

If this is a continuation of a previous run or if shots from a previous run are similar to those needed, provide shot numbers for setup

Desire generic OH flattop with elongation of 1.8.

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

DIAGNOSTIC CHECKLIST

Title: **XP No.:**

		Need	Desire	Special requirements
Magnetics	Flux loops, B-coils	x		
	Passive plate diag.			
n_e and T_e	Interferometer			Required for density scan
	Thomson Scattering	x		
T_i	CHERS			
	NPA			
Spectroscopy	$H\alpha$	x		
	SPRED (UV)/GRITS	x		
	VIPS (H/D ratio)		x	
	X-ray PHA	x		
	X-ray Crystal	x		
Particles	NPA			
Fluctuations	Mirnov Coils	x		
	X-ray Array	x		
	Reflectometer	x		
Edge	Bolometer	x		
	Plasma TV	x		
	IRTV		x	