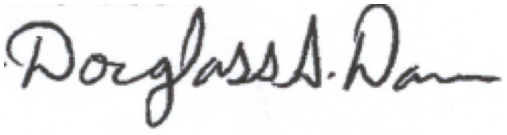
Princeton Plasma Physics Laboratory

NSTX-U Machine Proposal

Title: **Neutron calibration transfer through low power NBI plasmas**

OP-XMP-107	Revision**: 0**	Effective Date: **July 7, 2015** Expiration Date: **July 7, 2017** *(2 yrs. unless otherwise stipulated)*

Proposal Approvals

Responsible author: **D. S. Darrow** 	Date **July 7, 2015**
ATI (NSTX-U Physics Ops): Dennis Mueller	Date July 8, 2015
RLM (NSTX-U Expt. Research Ops): Stefan Gerhardt Digitally signed by Stefan Gerhardt DN: cn=Stefan Gerhardt, o=Physics, ou=PPPL, email=sgerhard@pppl.gov, c=US Date: 2015.07.08 16:06:21 -04'00'	Date

Responsible Division: **Experimental Research Operations**

Procedure Requirements

designated by RLM

	NSTX Work Permit		T-MOD (OP-AD-03)
	Independent Review		ES&H Review

RESTRICTIONS AND MINOR MODIFICATIONS

Approved by RLM

REVIEWERS (designated by RLM)		
Organization/Position	Name	Signature
ATI	D. Mueller	Dennis Mueller
Test Director		
Independent Reviewer		
NB system		
RF systems		
FCPC systems		
Diagnostics		

TRAINING (designated by RLM)

Training required: No ■ Yes ☐ Instructor _____

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

RLM _____

NSTX-U MACHINE PROPOSAL

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AUTHORS: **D. S. Darrow** DATE: **July 7, 2015**

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1. Overview:

NSTX-U utilizes several fission chambers as the primary calibrated neutron detectors, with scintillator detectors as a secondary set of measurements. The fission chamber absolute calibration is performed with a solid neutron source of known intensity that is run around the vessel interior on a circular model train track to simulate the emitting volume of a toroidal plasma. This calibration is done in count mode, where the detectors register individual neutrons as discrete pulses. At high neutron emission, such as in a normal NSTX-U plasma conditions, the rate of events in the fission chambers are so high that individual pulses are no longer evident, and the detector registers only a total current versus time. That current varies linearly with the neutron rate of the plasma. To assign a calibration factor for the current outputs of the fission chambers on NSTX-U, it is necessary to run plasmas whose neutron output causes the less sensitive fission chambers to remain in count mode with no pulse pile up while the most sensitive chamber has transitioned to current mode. Because this neutron rate is well below that for normal NSTX-U research plasmas, dedicated shots at much de-rated plasma parameters are needed. In addition to obtaining the current mode calibration factor, a secondary goal of this XMP is to obtain as much count rate data as possible on all operating fission chambers in order to better quantify the ratios of their absolute detection efficiencies.

2. Justification:

An absolutely calibrated neutron rate is required to assure that NSTX-U operates within safe and administratively allowed levels of neutron production. The rate measurements are also needed for many scientific experiments to benchmark TRANSP and other modeling code results. In addition, absolutely calibrated neutron rates are needed for comparison of NSTX-U plasma performance to that of other machines.

3. Plan:

The goal is to obtain 0.5-1.0 sec of accumulated operation over several shots with count rates in fission chamber 2 well above zero but ≤150 counts/ms. The latter count rate limit avoids the possibility of pulse pile up in the detection electronics. It is preferred that this count rate be attained in reasonably steady conditions, with a minimum of MHD activity. To achieve this, take the following steps:

- Condition one or two beam sources to operate at 45 kV.
- Run plasmas at 700 kA, 0.65 T and inject a single source at a time.
- If the desired neutron performance cannot be obtained, then reduce plasma current and toroidal field to 500 kA, 0.45 T
- Alternatively, or in addition, change gas feed to be predominantly helium with a minority of deuterium and adjust fractional abundance of deuterium feed to achieve desired neutron rate.

- If necessary, further adjust plasma current and toroidal field.

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

Condition at least one neutral beam source to operate at 45 kV. Have available the ability to fuel the discharge with both deuterium and helium.

5. Sign off at run time:

5.1 Permission to Proceed: _____

Physics Operations Head

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 Physics Operations.

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Cognizant Physicist/Test Director