**PSTF EQUIPMENT FOR PPPL & PRINCETON UNIVERSITY**

**1. PPPL Equipment:**

**Lasers:**

1. Nd:YAG pulsed laser ,PowerLite 8020, pulse energy 1200/550/300 mJ for wavelengths 355/532/400 nm, 5-7 nsec, rep. rate 20 Hz.
2. Horizon OPO , tuning range 190-2750 nm, pulse width 3-7 ns, linewidth 3-10 cm-1, pulse energy 3-150 mJ (pumped with PowerLite 8020).
3. Nd:YAG pulsed laser ,Continuum Surelite III, pulse energy 120/250/400 mJ for wavelengths 355/532/400 nm, 5-7 nsec, rep. rate 10 Hz.
4. Nd:YAG pulsed laser, Quantel Ultra 100, pulse energy 100 mJ at 1064 nm, 8 ns , rep.rate 20 Hz.
5. DYE laser, Sirah Cobra, range 370-920 nm, linewidth 0.08 cm-1.
6. CW laser, Quantronix Corp 118F-M, 325 W.
7. CRBS system based on Nd:YVO4 laser, 150 ns , 100 mJ at 1060 nm , intracavity LiTaO3 electro-optic modulator (EOM)
8. TLB-6917 series New Focus tunable diode laser, 834.95 nm , 30 mW
9. Toptica DLC DL PRO 670 tunable diode laser , 670 nm, tunability from 660-673 nm, coarse range, 50GHz mode-hope free fine-tuning, 25 mW , linewidth 600 kHz.

**Cameras:**

1. iCCD: 4Picos, min. exposure 200 ps, 1360 x 1024 px
2. iCCD: Andor iStar 734 , min. exposure 2 ns, 1024x1024 px.
3. iCCD: PI Max 3, min exposure 3 ns, 1024x1024 px.
4. fast-framing Phantom V7.3 , up to 500000 frames per second, 1 µs exposure.
5. 2xGreyPoint BlackFly USB Cameras: 84 fps 648x488 , 50 fps 808x608.

**Spectrometers:**

1. HRS Spectra Pro 750, 0.75 mm, 2400/1200/150 gr/mm gratings, resolution(CCD) <0.3 A
2. iHoriba 550 , 0.5 m ,2400/1200/150 gr/mm gratings, resolution(CCD) <0.4 A.
3. Chromex 250is, 0.25 m. 1200/2400 gr/mm, gratings, resolution(CCD) <0.8 A.
4. Ocean Optics, USB4000 , 200-500 nm , resolution < 2 A
5. Ocean Optics, USB4000 ,500-823 nm , resolution < 2 A
6. Ocean Optics, HR200+ , 370-810 nm, resolution < 2 A

**Photomultipliers:**

1. Hamamatsu 1P28 :185-650 nm, 2.2 ns, gain: 1e7
2. Hamamatsu H10720 :210-720 nm, 0.57 ns, gain: 3e6
3. Hamamatsu R1463 :185-850 nm, 2.5 ns, gain 1e6

**Fourier transform infrared spectrometer:**

JASCO-FTIR 660+ with an external MCT detector, range: 25000-5 cm-1, resolution: 0.4 cm-1.

**Residual gas analyzer:**

SRS RGA-300

**Power supplies:**

1. 2xSorensen 10 kW DC power supply
2. AC power supply: 1-10 kV peak-to-peak, frequency 20-60 kHz
3. Several DC power supplies 500-1000 V , I-limited by ext. shunt 105 
4. HV pulsed power supply 3-30 kV, 1 µs, 1-500 Hz.

**Vacuum facilities:**

**Vacuum chambers:**

2x 10 inch 6-way cross chamber, 12 inch 6-way cross chamber, 8 inch 6-way cross chamber

**Vacuum chambers:**

A large collection of mechanical vacuum pumps, blowers, turbo-molecular and cryogenic pumps with the pumping speed up to 90,000 L/s for xenon.

**Hall thrusters**

1. 2.6 cm diameter CHT with electromagnets - Power: 100-200 W, Electromagnet coils power: 50-100 W, Overall dimensions: 7.8 cm Diameter × 7 cm Length, Mass: ~ 700 g)
2. 2.6 cm diameter CHT with Samarium-Cobalt permanent magnets (Power: 100-200 W, Overall dimensions: 5.5 cm Diameter × 3.5 cm Length , Mass: 350 g)
3. The Large Hall Thruster Facility (LHTF) : 28 m3 stainless steel vacuum vessel, with two CVI cryogenic pumps TMP 1000 and one CVI cryogenic pump TM 1200i (total measured pumping speed is ≈90,000 l/s with xenon flow). The base tank pressure is 2-3.10-8 Torr. At xenon flow rates below 20 sccm, the background pressure is lower than 2 µtorr.
4. The Small Hall Thruster Facility (SHTF) : 0.7 m diameter, 1.1 m long stainless steel tank, , magnetically levitated Osaka turbo-molecular pump, backed by a blower and a roughing pump. The measured pumping speed reached ~2000 liters/s for xenon. The working background pressure of Xe was about 7×10-5 Torr for the total propellant mass flow rate of 6 sccm.

**Plasma probes**

Large set of electrostatic probes and energy analyzers: for measurement of electron energy distribution functions (EEDF), including time-resolved EEDF, plasma potential, plasma density and electron temperature. A fast-sweeping probe system for low frequency (<10 kHz) oscillations( spoke or breathing instability), electrostatic probe with a low secondary electron emission shield. High frequency oscillations (1-100MHz) probe system (single Langmuir probe with special shielded probe connector-positioner, and an electronic impedance-matching circuit).

**Lock-in amplifiers:**

2x Stanford Research SR830.

**Oscilloscopes**

1. 2x Lecroy WaveSurfer 10, 1 GHz, 10 GS/s
2. 2xLecroy Waverunner LT264M, 350 MHz, 1GS/s.
3. 2xLecroy Waveace 2034, 300 MHz, 2 GS/s.
4. 2x Tektronix TDS 5054, 500 MHz, 5 GS/s.
5. Tektronix TDS 2014, 100 MHz, 1 GS/s.
6. Rigol DS6104, 1GHz 5 GS/s

**2. Princeton University Equipment**

Laboratory Facilities and Equipment: Optical laboratories with several optical setups including

* Femtosecond laser systems: Spectra-Physics Solstice ACE (1kHz, 100fs, 6mJ/pulse at 800nm), including harmonics and Topas Optical Parametric Amplifier; Coherent Legend amplified fs (tunable, 10Hz, 100fs, 2mJ/pulse); Light Conversion Carbide (60kHz, 4W, 300fs)
* Picosecond laser system: Coherent Legend (tunable, 10Hz, 30mJ/pulse@800nm, 100ps) with harmonics
* Nanosecond laser systems: 3x Continuum Nd:YAG’s (10Hz, 6ns)
* Tunable narrowband seeded Ti:Sapphire system (10Hz, 0.5J/pulse at 800nm, <100MHz linewidth) with harmonics
* CW laser: MSquared Solstis 2W, 100kHz linewidth, 750-900nm
* Spectrometers: Princeton Instruments 0.5m, 0.3m; several Ocean Optics spectrometers
* Cameras: PIMAX ICCD, PI Pixis, Hamamatsu EMCCD, PCO High Speed HD Dimax (2kHz) with SCO MHz intensifiers, LaVision HighSpeed IRO intensifier, Shimadzu HPV2 1MHz CCD camera
* Microwave systems: complete Radar systems at 12GHz, 33GHz, and 100GHz, microwave sources at 2.4-3GHz.
* Several digital storage oscilloscopes, up to 33Ghz.
* Pulse generators, power supplies, optical detection systems as fast as 12ps, data acquisition system.

Several high-voltage nanosecond pulsed generators with maximum pulse amplitude U = 20-160 kV, pulse width from 250 ps to 60 ns, frequency *f* = 10 kHz (continuous) – 1000 kHz (burst) will be used for proposed work. Picosecond pulse generator FPG 100-01 has an output voltage 200 kV, peak current 4 kA, pulse rise time 150 ps, pulse width 350 ps, pulse repetition frequency up to 100 Hz. Burst nanosecond pulse generator FPG 110-1000NM has an output voltage 110 kV, peak current 370 A, pulse rise time 1 ns, pulse width 12 ns, pulse repetition frequency up to 1 MHz/1000 pulses. Multi-channel pulse generator FPG 30-10MC4 has 4 independent channels with relative jitter less than 100 ps, an output voltage 30 kV, peak current 600 A/channel, pulse rise time 500 ps, pulse width 15 ns, pulse repetition frequency up to 10 kHz. High energy NS pulser FPG 140-01 has an output voltage 140 kV, peak current 3 kA, pulse rise time 5 ns, pulse width 65 ns, energy per pulse up to 6 J, and maximal repetition frequency up to 10 Hz. Smaller 20 kV/20 ns pulsers are also available for low-voltage, low-energy experiments.

Picosecond ICCD camera LaVision PicoStar 12 as a minimal gate 80 ps, S20 photocathode spectral response, photocathode diameter 12 mm, maximal frequency of intensifier 10 kHz (300 MHz for gate 300 ps and longer.

Powerlite DLS Plus Q-switched Nd:YAG laser has a pulse duration ~6 ns and energy up to 3J/pulse @1064 nm.