Appendix A - Table I. NSTX Measurement Capabilities – January 2015

(black – available for experiments, blue – under active development)

Physics Measurement	Typical range and coverage	Spatial; Temporal Resolution	Typical Precision	Available Diagnostic Techniques	Comment	Contact
Coil currents	0-130 kA	follow pulse shape.	1.0%	Rogowski coil on buswork; Hall effect transducers at power supplies	For EFIT/LRDFIT equilibrium reconstruction	S. Gerhardt – PPPL
Plasma current, I$_p$,	0-2 MA	2-5 kHz sampling rate	1.0%	2 Rogowski coils around plasma outside vacuum vessel	For EFIT/LRDFIT reconstruction	S. Gerhardt – PPPL
Equilibrium Poloidal Field and Flux		Variable spatial resolution 2-5 kHz sampling rate	1-3%	2D and 3D solenoids (Mirnov coils) inside vv, flux loops inside and outside vv	For EFIT/LRDFIT reconstruction	S. P. Gerhardt-PPPL
Plasma Equilibrium Reconstruction		10 mm absolute 1 ms		Solutions of the Grad-Shafranov Equation Constrained by Measurements	Between shot analysis with the EFIT code; post-experiment analysis with EFIT and LRDFIT	S. Sabbagh – CU, J. Menard-PPPL
Plasma kinetic energy	> 10 kJ	1 ms	1 kJ	Diamagnetic loop	EFIT/LRDFIT constraint, uses TF coil	S. Gerhardt - PPPL
Electron density line integral	>2x10^{11} cm^{-2}	4 MHz	2x10^{11} cm^{-2}	Tangential interferometry, polarimetry (FIReTIP)	FIR laser with retro-reflector in 1 tangential chord	C. Domier – UC Davis, Y. Ren - PPPL
Electron density profile	5x10^{11} - 5x10^{14} cm^{-3}	3.0 cm core, 0.9 cm edge, 2 30 Hz lasers	>3%	Thomson scattering	60 Hz Nd:YAG, laser nearly radial on horizontal midplane, 42 of 48 channels implemented	B. LeBlanc, A. Diallo, M. Coury – PPPL
	0.02-1.6x10^{13} cm^{-3}	1 kHz		Reflectometry (SOL)	6 - 36 Ghz swept system, 1 kHz sweep rate	C. Lau - ORNL
Real time density for density feedback control	>2x10^{11} cm^{-2}	5kHz	2x10^{11} cm^{-2}	Tangential interferometry, polarimetry (FIReTIP)	FIR laser with retro-reflector in 1 tangential chord	C. Domier – UC Davis, Y. Ren - PPPL
Electron temperature profile	0.003 – 5 keV	3.0 cm core, 0.9 cm edge, 2 30 Hz lasers	>3%	Thomson Scattering	2 - 30 Hz Nd:YAG lasers nearly radial on horizontal midplane, 42 of 48 possible spatial channels implemented	B. LeBlanc, A. Diallo, M. Coury – PPPL
	0.1-5 keV	1 cm, < 10 kHz	5% (rel)	Edge (r/a: 0.6-1.1) tangential multi-color SXR arrays	5 color/ 20 spatial channels, AXUV diode arrays	K. Tritz, J. M. Burgos– JHU
	0.1-5 keV	3 cm, < 10 kHz	5% (rel)	Core (r/a: 0-1.1) tangential multi-color SXR arrays	5 color/ 20 spatial channels, AXUV diode arrays	K. Tritz, J. M. Burgos– JHU
Ion temperature profile	0.02 – 5.0 keV	3.0 cm core, 0.5 cm edge, 10 ms	≥ 2%	Toroidal CHERS	51 channels system using C VI with heating beam, dedicated background view	R. Bell, M.Podestà – PPPL
		3.0 cm edge	≥ 2%	Edge Doppler spectroscopy	7 channels from tangential view	R. Bell, M.Podestà

		only, 10 ms			and 6 channels from vertical view of outer midplane edge. Uses intrinsic C III and He II.	– PPPL
Plasma rotation profile	-100 km/s to +300 km/s	3.0 cm core, 0.5 cm edge, 10 ms	≥ 2%	Toroidal CHERS	See above	R. Bell, M.Podestà – PPPL
		~ 3.0 cm edge only, 10 ms	≥ 2%	Edge Doppler spectroscopy	See above	R. Bell, M.Podestà – PPPL
		1.6 cm core, 0.6 cm edge, 10 ms		Poloidal CHERS	Up and down views of heating beam and dedicated background views, 75 active channels using C VI with heating beam.	R. Bell, M.Podestà – PPPL
		~ 3.0 cm, 10 ms		Edge Doppler spectroscopy	See above	R. Bell, M.Podestà – PPPL
	-100 km/s to +300 km/s	4 radial channels; up to 5kHz sampling rate		Real-time toroidal CHERS	4 channels measuring C VI, active and passive (background) views, fast acquisition and analysis for real-time velocity data	M.Podestà, R. Bell – PPPL
	ExB flow Core plasma	5MHz BW Δr ~ 1cm		Quadrature Doppler Backscattering (DBS)	1 Channel, 96 GHz (2015) 4 Channels (2016)	S. Kubota - UCLA
B field pitch (for determination of q(R) using LRDFIT or EFIT)		3 cm core, 2 cm edge, 10 ms (target 5 ms)	≥ 0.2°	Motional Stark effect based on collisionally-induced-fluorescence (MSE/CIF)	18 channels, presently applies correction for toroidal rotation, requires heating beam source A.	H. Yuh, F. Levinton – Nova Photonics
		target - 3 cm core, 2 cm edge, 10 ms	target ≥ 0.2°	Motional Stark effect based on laser-induced-fluorescence (MSE/LIF) using DNB	10 channels, Requires compact, radial DNB	Y. Sechrest, F. Levinton – Nova Photonics
		TBD (probably ~2 MHz)		1 mm radial polarimeter	Provides line integral constraint, in conjunction with electron density profile input	S. Kubota - UCLA
	Compact array of microwave receiving antennas. Two antennas can be configured to launch microwaves for imaging reflectometry.	Measures plasma emission up to 40 GHz with sub-millisecond time resolution.		Synthetic Aperture Microwave Imaging (SAMI)	Measures EBW emission as a function of poloidal and toroidal angle, allowing high radial resolution measurements of edge magnetic field pitch. Also can be configured for imaging relectometry to measure edge plasma flows.	G. Taylor – PPPL R. Vann – University of York, UK
Magnetic field pitch angle fluctuations		3 cm core, 2 cm edge, 5 ms	>0.2°	Motional Stark effect based on collisionally-induced-fluorescence (MSE/CIF)	18 channels implemented, presently applies correction for toroidal rotation, requires heating beam source A.	Y. Sechrest, F. Levinton – Nova Photonics
B field magnitude, P(R)		5 cm core, 2 cm edge, 10 ms	>5 Gauss	Motional Stark effect based on laser-induced-fluorescence (MSE/LIF) using DNB	10 channels, Requires compact, radial DNB	Y. Sechrest, F. Levinton – Nova Photonics

Profile of the radial Electric field		5 cm core, 2 cm edge, 10 ms		MSE/CIF and MSE/LIF	See above; requires heating source A and DNB	F. Levinton, H. Yuh, Y. Sechrest - Nova Photonics
		3.0 cm core, 0.5 cm edge, 10 ms		Toroidal and poloidal CHERS	See above; requires heating beam	R. Bell, M.Podestà – PPPL
		3.0 cm, 10 ms		Edge Doppler spectroscopy	May need helium	R. Bell, M.Podestà – PPPL
Radiation profile		8 cm, 0.2 ms		Toroidal bolometer array	Tangential view, 16 channel AXUV diode array	L. Delgado-Aparicio - PPPL
	Lower divertor area	1-2 cm, 10-20 kHz		Divertor radiometer (bolometer) array, can be used with Ly-alpha filter	Vertical view, 20 channel AXUV diode array	V. Soukhanovskii - LLNL
Z_{eff}		line integral	10% abs.	Visible continuum sensor	Single filterscope chord, R_{TAN}~60 cm, λ=	C. Skinner - PPPL
		3.0 cm core, 0.5 cm edge, 10 ms	≥ 5% in (Z_{eff}-1)	Toroidal CHERS	See above, assumes C only impurity	R. Bell, M.Podestà – PPPL
Impurity concentrations	C^{+5} conc.	3.0 cm core, 1.0 cm edge, 10 ms	20% abs.	Toroidal CHERS	See above	R. Bell, M.Podestà – PPPL
	H/D ratio, survey, impurity studies	Integral; 10 ms	5% (rel)	Ultraviolet-visible survey spectrometer VIPS-2	**3 (10)** sightlines coupled via fiber to 0.5 M Czerny-Turner; 350-1100 nm, CCD detector.	V. Soukhanovskii - LLNL
	Z≥3 ions (Li, B, C, O, Cu, Ne, Ar, Fe, Kr, Mo)	5 cm; 5 ms for impurities	15% abs	Filtered poloidal soft x-ray arrays	2 arrays (32 ch); discrete AXUV diode arrays	K. Tritz, J. M. Burgos– JHU
		1 cm, < 10 kHz	5% (rel)	Tangential multi-color SXR arrays	5 color/ 20 spatial channels, AXUV diode arrays	K. Tritz, J. M. Burgos – JHU
		r/a~0.08, 10 ms	15% abs	TGI spectrometer	12 chord transmission grating imaging spectrometer; 10Å – 300Å CCD camera	K. Tritz, J. M. Burgos – JHU
		Integral; 12 ms	5% (rel)	EUV spectrometer (XEUS)	Flat field grazing incidence spectrometer covering 5-60 Å	P. Beiersdorfer-LLNL
		Integral; 12 ms	5% (rel)	EUV spectrometer (LoWEUS)	Flat field grazing incidence spectrometer covering 220-400 Å	P. Beiersdorfer-LLNL
		Integral; 12 ms	5% (rel)	EUV spectrometer (MonaLisa)	Flat field grazing incidence spectrometer covering 60-220 Å	P. Beiersdorfer-LLNL
Low (m,n) MHD modes, sawteeth, locked modes, and disruption precursors	$\Delta B/B = 10^{-4} – 10^{-1}$, (0,0)<(m,n) < (5,10)	2 MHz		Mirnov coils outside plasma, known as the “high-n” array	12 toroidal	E. Fredrickson, S. P. Gerhardt - PPPL
		n=1,2&3 RWM Detection		Toroidal arrays of B_P and B_R sensors inside the vessel.	Used for both n=1 RWM feedback and Dynamic Error Field Correction, and offline analysis	C. Myers-PPPL
		5 cm; < 300kHz bw		Filtered poloidal SXR arrays	2 arrays (32 ch); discrete AXUV diode arrays	J. M. Burgos, D. Clayton – JHU
		1 cm, < 10 kHz	5% (rel)	Tangential multi-color SXR arrays	5 color/ 20 spatial channels, AXUV diode arrays	J. M. Burgos, D. Clayton – JHU

	$>2\text{x}10^{11}$ cm^{-2}	4MHz	$2\text{x}10^{11}$ cm^{-2}	Tangential interferometry, polarimetry (FIReTIP)	FIR laser with retroreflector in 1 tangential chord	C. Domier – UC Davis, Y. Ren - PPPL
	Cut-off 1.1-7.0 $\text{x}10^{13}$cm^{-3}	2.5 MHz BW $\Delta r \sim$ 1cm		Quadrature reflectometer (MHD density fluctuation)	30-75 GHz, 16 channels	S. Kubota - UCLA
		250 kHz		Neutron scintillator array	Plastic scintillators with PM tubes 1- ZnS; 3 BC400	D. Darrow - PPPL
High frequency instabilities (MHD, fast ion modes)	$\Delta B/B \geq 10^{-3}$ to 10^{-7}, $n = 0 - 30$	5 MHz	Toroidal and poloidal	Mirnov coils outside plasma, known as the “high-f” array	3-B_T in toroidal array, and 8-B_P in Toroidal array, 4-B_P in poloidal array	E. Fredrickson – PPPL
		5 cm; < 300kHz BW		Filtered poloidal SXR arrays	2 horizontal arrays (32 ch); discrete AXUV diode arrays	K. Tritz, J. M. Burgos – JHU
	1.1-7.0 $\text{x}10^{13}$cm^{-3}	2.5 MHz BW		Quadrature reflectometer	30-75 GHz, 16 channels	S. Kubota - UCLA
	$>2\text{x}10^{11}$ cm^{-2}	500 kHz	$2\text{x}10^{11}$ cm^{-2}	Tangential interferometry, polarimetry (FIReTIP)	FIR laser with retroreflector in 1 tangential chord	C. Domier – UC Davis, Y. Ren - PPPL
Disruption Halo Currents	0-1000 A	~10x~20cm tiles, 0.1 msec resolution		Shunt Tile Arrays	10 tiles in outboard divertor and 18 on center column	S.P. Gerhardt, PPPL
Turbulence	$k_\perp\rho_I<1$	2 MHz sampling rate; ΔR ~2 cm; spatial coverage: r/a~0.4 to SOL	$\Delta n/n > 0.1\%$	Beam Emission Spectroscopy	2-D (radial and poloidal) array of 48 detector channels viewing heating beams	D. Smith, G. McKee - UW
	$k_\perp\rho_I \sim 0.5\text{-}10$ Density turbulence	5MHz BW $\Delta r \sim$ 1cm		Quadrature Doppler Backscattering (DBS)	1 Channel, 96 GHz (2015) 4 Channels (2016)	S. Kubota - UCLA
	Cut-off 1-7 $\text{x}10^{13}$cm^{-3} $k_\perp\rho_I<1$	2.5 MHz BW $\Delta r \sim$ 1cm		Quadrature reflectometer	30-75 GHz, 16 channels	S. Kubota - UCLA
	$T_e < 200$ eV	~ 1 cm for r/a> 0.8, <400 kHz	12 bit	gas puff imaging (GPI)	Supported by gas puff manifold. (Phantom 710 camera)	S. Zweben – PPPL
	Compact array of microwave receiving antennas. Two antennas can be configured to launch microwaves for imaging reflectometry.	Measures plasma emission up to 40 GHz with sub-millisecond time resolution.		Synthetic Aperture Microwave Imaging (SAMI)	Measures EBW emission as a function of poloidal and toroidal angle, allowing high radial resolution measurements of edge magnetic field pitch. Also can be configured for imaging relectometry to measure edge plasma flows.	G. Taylor – PPPL R. Vann – University of York, UK
Edge recycling and impurity		2 kHz	5% (rel)	EIES (filterscopes)	5 upper divertor, 5 lower divertor, 5 midplane inner wall. Filters	V. Soukhanovskii – LLNL

influx		2 kHz	5% (rel)	EIES (filterscopes)	include D-alpha, CII, CIII, He I, HeII, LiI, LiII, BII, OII	V. Soukhanovskii – LLNL
		36 kHz	5% (rel)	Filtered 1D CCD arrays	3 lower divertor, 2 inner wall, 2 upper divertor. Filters include D-alpha, D-beta, D-gamma, CII, CIII, CIV, LiI, LiII, HeI, HeII	V. Soukhanovskii – LLNL
		1 kHz or lower	5% (rel)	Divertor Imaging Spectrometer - DIMS	19 sightlines coupled via fiber to 0.61m Czerny-Turner; 350-1100 nm, CCD detector. Divertor ion temperature measurements (via Doppler broadening) under development.	V. Soukhanovskii - LLNL
		2 kHz or lower	5% (rel)	Divertor vacuum ultraviolet spectrometer SPRED	1 sightline; two gratings: 102-310 Å and 165-1650 Å , CCD detector. Real-time divertor feedback control signal under development.	V. Soukhanovskii - LLNL
		1 kHz or lower	5% (rel)	Divertor Control Spectrometer - DICS	26 sightlines coupled via fiber to 0.3m Czerny-Turner-Schmitt; 300-1100 nm, CCD detector. Real-time divertor feedback control signal under development.	V. Soukhanovskii - LLNL
		0.1 kHz	5% (rel)	Near-infrared spectrometer - NIRS	1 sightline via fiber, 3 NIR-optimized gratings, 0.5 m Czerny-Turner, InGaAs LN-cooled detector, 800-2400 nm. Presently at DIII-D.	V. Soukhanovskii - LLNL
		500 kHz or lower	12 bit	Divertor Control Camera	Horizontal divertor view with Phantom V1211. Real-time divertor feedback control signal under development.	V. Soukhanovskii, F. Scotti - LLNL
		Up to 100 kHz at 256x208 resolution	12 bit, 14 bit	Downward facing wide angle divertor fast cameras	View of lower divertor from Bay E-top (Phantom 710) and Bay J-top (Phantom 7.3).	F. Scotti – LLNL
		Up to 8 kHz at 256x256 resolution	12 bit	Upward facing wide angle divertor fast camera	View of upper divertor from Bay H-bottom (Miro 4).	F. Scotti – LLNL
		30 Hz, VGA resolution	8 bit	Two-color radiation-hardened intensified CIDTEC camera	View of lower divertor from Bay I-top	F. Scotti – LLNL
		30 Hz, VGA resolution	8 bit	Radiation-hardened intensified CIDTEC camera	Midplane view	F. Scotti – LLNL
		6 ms, 128x128	12 bit	Edge Neutral Density Diagnostic (ENDD)	Tangential view of outer midplane edge – Bay G CII filter	F. Scotti – LLNL
		190 kHz at 32x32	14 bit	Lower divertor tangential camera	Tangential image of lower divertor from Bay F (Phantom 7.3)	R. Maqueda – X Science
	350-900 nm range 0.08nm/pixel	5ms		Imaging Spectrometer at bay G bottom viewing upper Divertor (R=0.3-	Monitor upper divertor and center stack with 16 sightlines separately (not simultaneously for both views)	K.F. Gan-UTK, T.K. Gray-ORNL

	dispersion			0.9m) and at bay J middle viewing central stack (Z=0-1.5m)	16 sightlines via fiber to IsoPlane SCT 320 spectrometers and 512*512 detector CCD, monitor ratios of spectrally close C and Li lines	
First wall deposition		2 sec continuous	several Angstroms	Quartz microbalances	Four QMBs (Bay H top, Bay H bottom, Bay I midplane, Bay B midplane), 3 shuttered, Inficon XTM/2	C. Skinner - PPPL
Surface chemical state and composition	<1 micron	Outboard lower divertor. Single location intershot		Materials Analysis Particle Probe (MAPP) utilizes multiple surface-science measurement techniques to characterize a sample material exposed to NSTX conditions	Thermal Desorption Spectroscopy (TDS), X-ray Photoelectron Spectroscopy (XPS), Low energy Ion Secondary Scattering (LEISS), and Direct Recoil Spectroscopy (DRS)	J. P. Allain – U. Illinois Urbana-Champaign
Target Langmuir probes	1 – 40 eV $10^{17} – 10^{20}$ m^{-3}	~1mm electrode heads poloidally distributed along center stack and outboard divertors		Classical interpretation yields n_e, T_e, V. Non-local interpretation yields additional V_p and EEDF	Proud probes distributed poloidally throughout machine. Up-down symmetric on outboard divertor target, inboard divertor targets and center stack column. Operated as swept probes and in Isat mode.	M. Jaworski - PPPL
Fusion source profile				Si diode detectors	6-8 channels planned	W. Boeglin – Florida Int'l U
Neutron flux monitors		1 ms	5% rel. 20% abs.	Fission chambers	4 U^{235} detectors with x26 sensitivity ratio	D. Darrow - PPPL
		4 μs	<5% rel.	Scintillator detectors	Plastic scintillators with PM tubes 1- ZnS; 3 BC400	D. Darrow - PPPL
RF driven surface waves				High-frequency Langmuir probe	Located between antenna segments,	R. Perkins – PPPL, C. Lau - ORNL
Gas pressure at several locations				Penning gauges	1 in lower divertor, 1 in upper divertor, 1 in lower divertor with spectroscopy, 1 in inner lower divertor (organ pipe)	R. Raman – U. Washington, V. Soukhanovskii - LLNL
				Micro-ion gauges	Bays E and C-midplane, Bay L-pumping duct, Bay C-top	R. Raman – U. Wash
Gas composition in vacuum vessel	typ A = 1-50/100, ΔA=1	Approx. 1 min./1 sec. mass sweep	$10^{-11}/10^{-9}$ torr typical sens.	2 Residual gas analyzers (continuous monitoring/after discharge measurements)	In Bay L pumping duct, differentially pumped system	W. Blanchard - PPPL
Runaway electrons		10 ms	30%	Hard X-ray detector	At start-up and thermal quench	L. Delgado-Aparicio- PPPL
Plasma TV (discharge monitoring)	Fisheye-view of vessel interior,	~1cm spatial resolution		Qualitative discharge and operations monitoring via in-vessel imaging.	Plasma TV (Miro 2)	M. Jaworski, S. Zweben

	complementing views from bays B and I					
					RF antenna view (Phantom 4.1)	R. Perkins
First wall temperature	50-800°C	1.6 kHz 12° FOV 5 mm/pixel	5% typical	Fast, dual-band infrared camera at Bay G bot viewing upper divertor (R = 0.2 – 1.0 m). Calibrated to 4-6 µm (MWIR) / 7-10 µm (LWIR) intensity	SBFP ImagIR HgCdTe camera (128x128 pixels)	T.K. Gray, J.-W. Ahn - ORNL
	50-800°C	1.6 kHz 12° FOV 5 mm/pixel	5% typical	Fast, dual-band infrared camera at Bay H top viewing lower divertor (R = 0.2 – 1.0 m). Calibrated to 4-6 µm (MWIR) / 7-10 µm (LWIR) intensity	SBFP ImagIR HgCdTe camera (128x128 pixels)	T.K. Gray, J.-W. Ahn - ORNL
	20-800°C	30 Hz 40° FOV 4 mm/pixel >180° view of strike points	5% typical	Wide-angle, two-color infrared camera	FLIR Tau 640 µbolometer camera (640x480 pixels). Re-entrant view of lower divertor from Bay H top (R=0.2 to 1.2 m). Calibrated to 8-10 µm (LWIR) / 10.5-13 µm (LWIR) intensity ratio.	J-W. Ahn - ORNL
	20-1200°C	30 Hz 18° FOV 2 mm/pixel	5°C abs <1°C rel	Standard frame rate, single-band infrared camera	FLIR Tau 640 8-13 µm LWIR µbolometer camera (640x480 pixels). View from Bay B midplane of RF antenna straps at Bay D, E, and F.	R. Perkins – PPPL, T.K. Gray - ORNL
	0-2300°C	1 kHz 2 locations, 2 mm isolation	3% typical	Fast 'eroding' thermocouples	2 high speed, Type C eroding thermocouples at PFC surface. Located in the row 1 tile in the upper and lower inboard, horizontal divertor	T.K. Gray - ORNL
Vacuum Vessel Illumination				3 in-vessel tungsten filaments, ~ 25x5 mm helical	Provide lighting of the first-wall surfaces, Bays G and K near midplane, Bay K/L above midplane	W. Blanchard - PPPL
Fast Lost Ions				FLIP	Radial array of Faraday cups	D. Darrow - PPPL
		50 kHz	2° 3 cm	SFLIP	Scintillator probe with energy and pitch angle resolution	D. Darrow - PPPL
Fast ion dynamics and Fast ion distribution	$n < 5\text{x}10^{13}$ cm^{-3}	10ms, 5cm, 10keV		s-FIDA - Spectrometer/CCD (energy resolved signal)	Vertical views from Bay A/B. Tangential views from Bay L/F. Based on active charge-exchange spectroscopy: requires NB injection; MPTS and CHERS data needed for analysis	D. Liu, G.Z. Hao, W.W. Heidbrink – UCI
		20µs, R=100, 120,140cm		f-FIDA - Band-Pass Filter/PMT (energy-integrated signal)		D. Liu, G.Z. Hao, W.W. Heidbrink – UCI
		10µs in current mode, 5cm, three energy bands [>25, >45,		Solid state NPA system (t-SSNPA: subsystem at Bay I for active tangential views, r-SSNPA: subsystem at	15 tangential views with R_{maj} between 90-130 cm; 15 radial views with R_{maj} between 120-145 cm; 15 passive views; Si- diode arrays in current mode, 500kHz	D. Liu, G.Z. Hao, W.W. Heidbrink – UCI

		>65]keV		Bay L midplane for active radial views p-SSNPA: subsystem at Bay B for background passive signals)	sample rate, ~100kHz bandwidth ; requires NB injection; MPTS and CHERS data needed for analysis	

Appendix A - Table II. Systems Capable of Supporting Active Diagnostics – February 2015

(black – available for experiments, blue – under active development)

System	Purpose of system	Characteristics	Used in diagnostic:	Contact
Heating Neutral Beam	Provide neutral population to produce beam emission for various diagnostics	D, 90 - 100 keV, ~50cm V x 20cm H, ~ 150mA/cm^2 neutrals entering plasma	CHERS, MSE, MSE/LIF, BES (D)	T. Stevenson - PPPL
Diagnostic Neutral Beam	Provide excited neutral atoms for intensity and polarimetry measurement	H, 40 keV, 1 - 2 cm dia., 30 mA neutrals entering plasma	MSE/LIF	Y. Sechrest, F. Levinton – Nova Photonics
Supersonic Gas Injector	Provides low divergence, high pressure gas jet	Laval nozzle, on midplane probe	Thermal atomic beam spectroscopy	V. Soukhanovskii - LLNL
Laser Blow-Off Impurity Injector	Provides low divergence source (pulse) of atomic impurities for transport studies	Midplane location, multi-pulse, multi-slide, 1 J laser outside NTC	Impurity spectroscopy	P. Beiersdorfer, V. Soukhanovskii - LLNL
Gas Puff Manifold	Provides neutral atoms to highlight edge density turbulence	Linear manifold ⊥ to edge B field, multiple 1 mm dia holes, D, He or Ar.	gas puff imaging	S. Zweben - PPPL
TAE antenna	Excite stable Alvén waves to measure linear damping	5-turn radial loop antenna, ≤ 1 kW	Fast Mirnov Coil	E. Fredrickson - PPPL