List of anticipated research topics for the different phases of NCSX operation v0.2 17-Dec-01

NCSX Mission & Goals

Demonstrate:

Conditions for high-beta, disruption-free operation.

Understand:

Beta limits and limiting mechanisms.
Reduction of neoclassical transport by QA design.
Confinement scaling; reduction of anomalous transport by flow shear control.
Equilibrium islands and neoclassical tearing-mode stabilization by choice of magnetic shear.

Compatibility between power and particle exhaust methods and good core performance.

Facility Upgrade Possibilities		WBS	Cost (r.o.m.)
	Heating; up to 3MW more NBI	25	
	Heating; up to 6MW of RF	24	
	Heating; pulse length up to 1-1.5 s.	24, 25	
	Fueling: pellet injector	212	
	Control: outboard trim coils	18, 4	
	Control: 2T upgrade	4	
	Control: system (e.g., more signals or computations)	55	
	Control: magnet power supplies (faster ramps)	4	
	P&PH: First wall #1 (e.g., add a slot, pump, and plenum baffles)	11	
	P&PH: First wall #2 (e.g., optimized divertor)	11	
	P&PH: Electrically biased first wall elements	11	

	P&PH: Wall conditioning upgrades (e.g. Lithiumization)	233			

Phase	Topic	Aux Power	**Facility upgrades**	**Facility upgrade comments**	Measurement Requirements
1. Initial Operation					
	initiate plasma				plasma current
	control plasma evolution				conductivity
					plasma position
					plasma/wall imaging
					total stored energy
					line integrated density
					total radiated power
					central electron temperature
					impurity species Z<30
2. Field Line Mapping					
	map flux surfaces				vacuum flux surfaces
	verify iota and QA				
3. Initial Ohmic					
	Improved plasma control, plasma evolution control		pellet injector	for density limit and profile studies.	electron temperature profiles
	global confinement & scaling, effect of 3D shaping				electron density profiles
	density limit & mechanisms **with pellets?**				radiated power profiles
	study of Te and ne profiles.				low (m,n) MHD (<50kHz)
	vertical stability				flux surface topology
	current-driven kink stability				Zeff
	effect of low-order rational surfaces on flux-surface topology				hydrogen recycling
	initial study of effect of trim coils, both signs				
	effect of contact location on plasma edge & recycling				
	initial attempts to control plasma contact location				

Phase	Topic	Aux Power	Facility upgrades	Facility upgrade comments	Measurement Requirements
Progress toward NCSX goals	Test predictions about kink & vertical stablity (limiting mechanisms) Initial global scalaing data base. *…. Needs more work.*				
4. Initial Aux. Heating					
	Plasma control with NB heating and CD	3MW NBI	Control system	to cope with aux. Heating &optimize based on phase 3 results.	ion temperature profile
	confinement scaling w/ iota, B, …		Outboard trim coils	to cope with wider range of profiles & optimize based on phase 3 results.	toroidal rotation profile
	local transport measurements				poloidal rotation profile
	test of quasi-symmetry on confinement and transport				iota profile
	perturbative transport measurements				fast ion loss
	density limits with heating				ion energy distribution
	density control with aux. Heating				neutron flux
	test of kink & balooning stability at moderate beta				IR imaging
	effect of shaping on MHD stability				high frequency MHD(<5Mhz)
	pressure effects on surface quality				
	controlled study of neoclassical tearing using trim coils				
	use of trim coils to minimize rotation damping				
	initial study of Alfvenic modes w/ NB ions				
	blip measurements of fast ion confinement and slowing down				
	wall coatings with aux. Heating				
	effect of contact location on plasma edge & recycling				

Phase	Topic	Aux Power	Facility upgrades	Facility upgrade comments	Measurement Requirements
	initial attempts to control plasma contact location				
	initial attempts to obtain enhance confinement regimes				
	wall biasing effects on confinement				
5. Confinement & beta push					
	Stability tests at beta >~ 4%	3MW NBI + 6MW (NBI or RF)	P&PH #1 (divertor)	Locate slot based on Phase 4 results.	
	detailed study of beta limit scaling		6 MW of NB or RF	decide which based on Phase 4 results	
	detailed studies of beta limiting mechanisms		Control system	to cope with divertor & optimize based on phase 4 results.	
	disruption-free operating region at high beta		Lithiumization		
	Enh. Conf.: Hmode		Power supplies	faster ramp rates	
	Enhanced confinement, rotation effects		Biased first wall	confinement enhancement	
	Enh. Conf.: hot ion regimes		2T	low vu-star	
	Enh. Conf.: RI mode				
	Enh. Conf.: pellets				
	Scaling of local transport and confinement				
	turbulence studies				
	scaling of power or other thresholds for enhanced confinement				
	ICRF wave propagation and damping (possible)				
	ICRF heating of ions and electrons (possible)				

Phase	Topic	Aux Power	Facility upgrades	Facility upgrade comments	Measurement Requirements
	perturbative RF measurements of transport (possible)				
	active mapping of Alfvenic mode stability (with antenna)				
	edge studies (2nd generation wall, e.g. divertor)				
	trace helium exhaust and confinement				
	scaling of power to divertor				
	evolution control of high beta plasmas				
6. Long Pulse					
	long pulse plasma evolution control	12 MW	3 MW of NB or RF	decide which based on Phase 5 results and depending on availability of long-pulse beams	
	equilibration of current profile	Long pulse	long-pulse heating		
	beta limits with ~ equilibrated profiles		P&PH #2	Re-contour based on Phase 5 results.	
	edge studies (3nd generation wall)		Control system	to cope with longer pulses and more power.	
	long-pulse power and particle exhaust handling				
	compatibility of high confinement, high beta, and divertor operation				