NCSX Physics Research and Diagnostics Plans

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NCSX Mission

Understand…

- Beta limits and limiting mechanisms in a low-A current carrying stellarator
- Effect of 3D fields on disruptions
- 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 in a compact stellarator.
- Explore Alfvenic-mode stability in reversed shear compact stellarator

Demonstrate…

- Conditions for high-beta, disruption-free operation

Acquire the physics data needed to assess the attractiveness of compact stellarators. (adopted as 10-year goal by FESAC-1999)

NCSX Reseach will Proceed in Phases

Currently envisioned as:

1. Initial operation - shake down systems
2. Field Line Mapping
3. Initial Ohmic
4. Initial Aux. Heating - (3MW NBI)
5. Confinement and Beta Push - (~6 MW)
6. Long Pulse

(included in project cost-TPC)

Initial Checkout Phases

	1. Initial Operation	Heating	Measurement Requirements
•	initiate plasma; exercise coil set & supplies	Ohmic	Plasma current
	control plasma evolution		Plasma position
	Initial wall conditioning		Conductivity
			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 surface topology
	verify iota and QA		

3. Initial Ohmic

	Topic	Heating	Measurement Requirements
•	Improved plasma control, plasma evolution control	Ohmic	Equilibrium flux surface topology
•	global confinement & scaling, effect of 3D shaping		Core ne & Te profiles
	density limit & mechanisms		Radiated power profile
	Characterize Te and ne profiles vs iota, current,		Low (m,n) MHD (< 50kHz)
•	vertical stability		Zeff
	current-driven kink stability		Hydrogen recycling
	effect of low-order rational surfaces on flux-surface topology		Impurity concentrations
•	initial study of effect of trim coils, both signs		PFC temperatures
•	effect of contact location on plasma plasma performance		SOL plasma characteristics
	control of plasma contact location		
	Plasma edge and exhaust characterization		

4. Initial Aux. Heating

	Topic	Heating	Measurement Requirements
•	Plasma and shape control with NB heating, CD	3MW NBI	Refinded magnetics diags.
•	test of kink & balooning stability at moderate beta		Iota profile
	effect of shaping on MHD stability		Core Ti profile
	initial study of Alfvenic modes w/ NB ions		Toroidal rotation profile
•	confinement scaling w/ iota, B, …		Fast ion losses
	local transport measurements, perturbative transport meas.		Ion energy distribution
•	test of quasi-symmetry on confinement and transport		Neutron flux
•	density limits and control with heating		High frequency MHD (<5MHz)
	use of trim coils to minimize rotation damping		Edge neutral pressure
	blip measurements of fast ion confinement and slowing down		Fast thermal imaging
	initial attempts to obtain enhanced confinement regimes		
•	pressure effects on surface quality		
	controlled study of neoclassical tearing using trim coils		
•	wall coatings with aux. Heating		
•	Plasma edge and exhaust characterization, w/ aux. heating		
•	Attempts to control wall neutral influx		
	wall biasing effects on edge and confinement		

5. Confinement and beta push

	Topic	Upgrades	Measurement Requirements
•	Stability tests at beta >~ 4%	6 MW total	Radial electric field
•	detailed study of beta limit scaling	2nd gen. PFCs	Edge/div Te & ne profiles
•	detailed studies of beta limiting mechanisms		Edge/div. Radiated power profile
	disruption-free operating region at high beta		Core helium density
	active mapping of Alfvenic mode stability (with antenna)		Target surface temperature
•	Enhanced Conf.: H-mode; Hot ion regimes; RI mode; pellets		Target Te, ne
•	Scaling of local transport and confinement		
	turbulence studies		
	scaling of power or other thresholds for enhanced confinement		
	ICRF wave propagation, damping, and heating (possible)		
	perturbative RF measurements of transport (possible)		
•	Divertor operation optimized for power handling and neutral control		
	trace helium exhaust and confinement		
	scaling of power to divertor		
•	control of high beta plasmas and their evolution		

6. Long Pulse

	Topic	Upgrades	Measurement Requirements
	long pulse plasma evolution control	Long pulse	
	equilibration of current profile	Divertor pumping	
	beta limits with ~ equilibrated profiles	12 MW?	
	edge studies with 3rd generation PFC design, pumping		
	long-pulse power and particle exhaust handling with divertor pumping		
	compatibility of high confinement, high beta, and divertor operation		