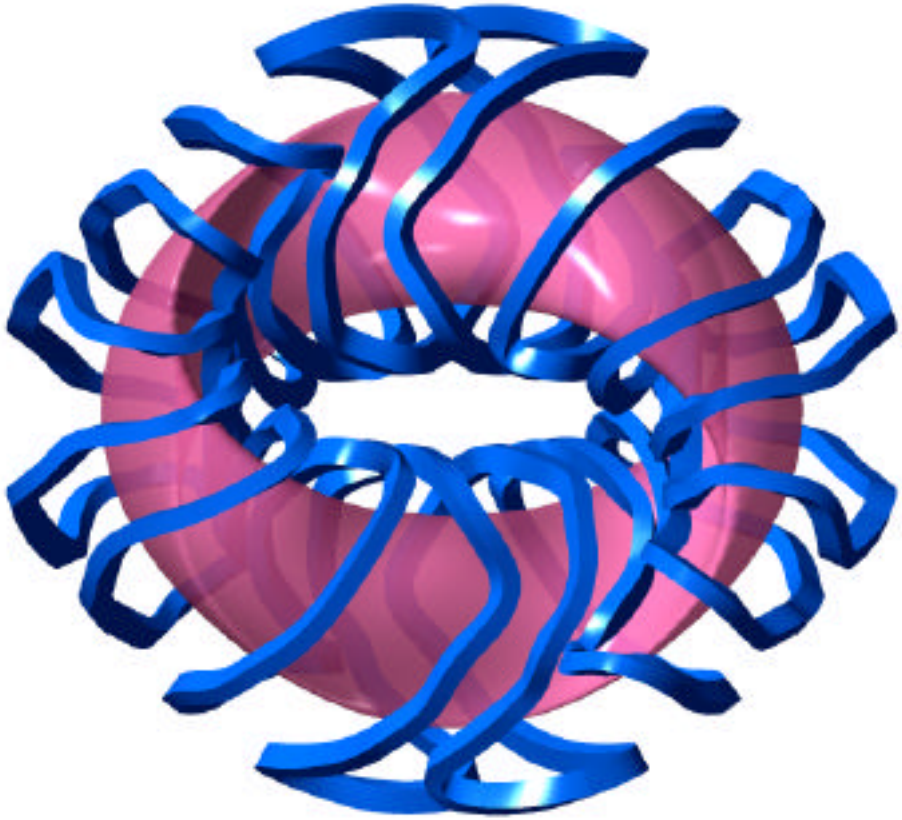
Experimental Program



J.F. Lyon

QOS Project Meeting **Feb. 28, 2001**

TOPICS

- Plasma Equilibrium and Stability
- Transport and Turbulence
- Wave-Particle Interaction
- Plasma-Wall Interaction
- Plasma Parameters Required
- Plasma Access Required
- Configuration Flexibility Required

Plasma Equilibrium and Stability

- ***What are the fundamental causes and nonlinear consequences of plasma pressure limits in magnetically confined plasma systems?***
  - **Study equilibrium quality (islands, ergodic regions) and its repair at *R/a* ~ 2.6; vary aspect ratio using islands to bound the plasma**
  - **Study configuration robustness with β for different configurations**
  - **Study dependence of the bootstrap current on configuration properties at low *R/a***
  - **Reduce magnetic island widths and control neoclassical tearing modes at low *R/a* through changes in the rotational transform, magnetic shear, and plasma current**
  - **Understand β limits and instabilities for quasi-poloidally symmetric configurations at very low *R/a***

- **Need to vary the quasi-poloidally symmetric components of the magnetic field with different modular coil currents, VF, TF, & I_{plasma}**

Transport and Turbulence

- ***What are the fundamental causes of heat loss in magnetically confined plasmas, and how can heat losses be controlled?***
  - **Study reduction of neoclassical transport through improved alignment of *B* and B; spoil improvement through modifying configuration properties**
  - **Extend study of anomalous transport, internal transport barriers, and flow shear to low-*R/a* configurations with quasi-poloidal symmetry**
  - **Study possible impact of poloidal flows on enhanced confinement**

Secondary Issues

Wave-Particle Interaction

- ***What are the fundamental causes and nonlinear consequences of wave interactions with thermal and non-thermal particles?***
  - **EBW and ICRF at higher n_e and β**
  - **OH assist to obtain higher n_e**

Plasma-Wall Interaction

- ***What are the fundamental processes occurring near the boundary of a confined plasma and how can the interaction between the plasma and material surfaces be controlled ?***
  - **Since there is no interior vacuum vessel and a large distance between plasma and coils, QOS can operate with *or* without divertor plates**
  - **Can use magnetic islands to bound the plasma or an open divertor**

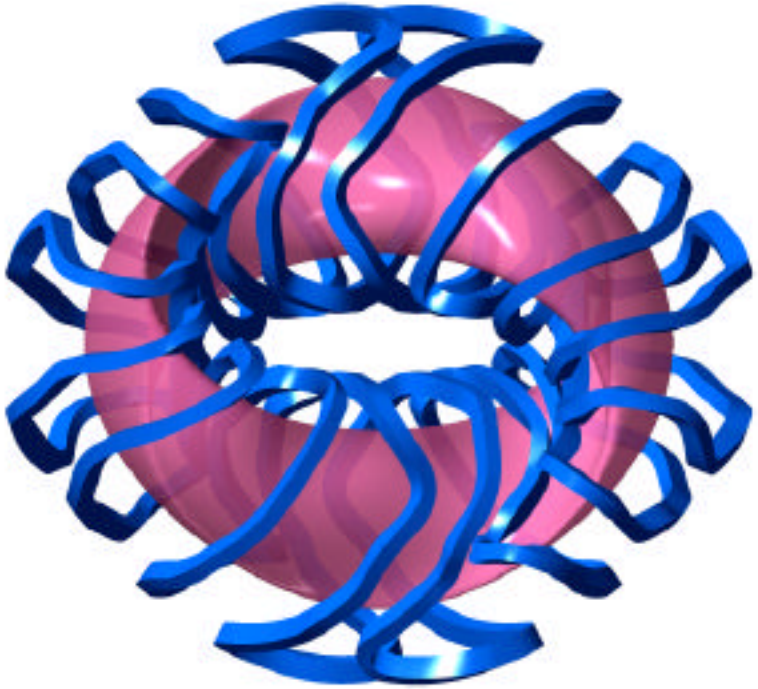
Available Heating Power Allows Parameters Needed for Physics Objectives

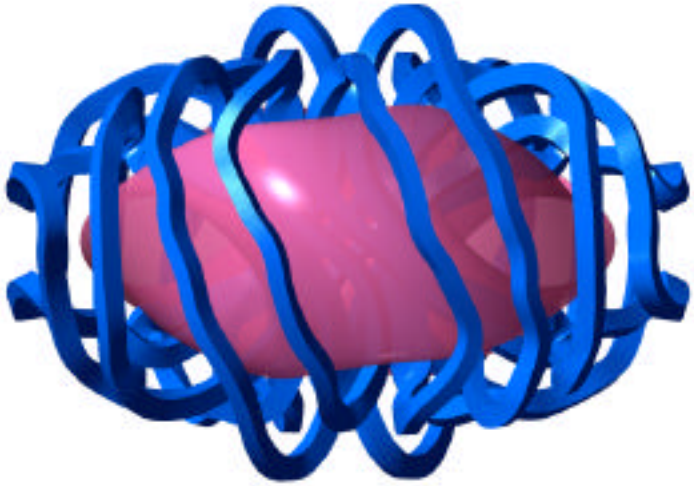
B (T)	P (MW)	RF	n_e (10^{19} m^{-3})	T_e (keV)	T_i (keV)	τ_E (ms)	$\langle\beta\rangle$ (%)
0.5	1	28 GHz ECH	0.48	2.1	0.2	3.3	0.44
1	1.5	28 + 53 ECH	1.9	2.1	0.4	9.4	0.94
0.5	1	28 GHz EBW	7.5	0.3	0.3	13.4	1.8
1	1	28 + 53 EBW/ICH	10.5	0.45	0.45	28.5	1.9
1	2	28 + 53 EBW/ICH	14.9	0.50	0.50	22.6	3.0
1	3	28 + 53 EBW/ICH	18.2	0.54	0.54	19.7	4.0

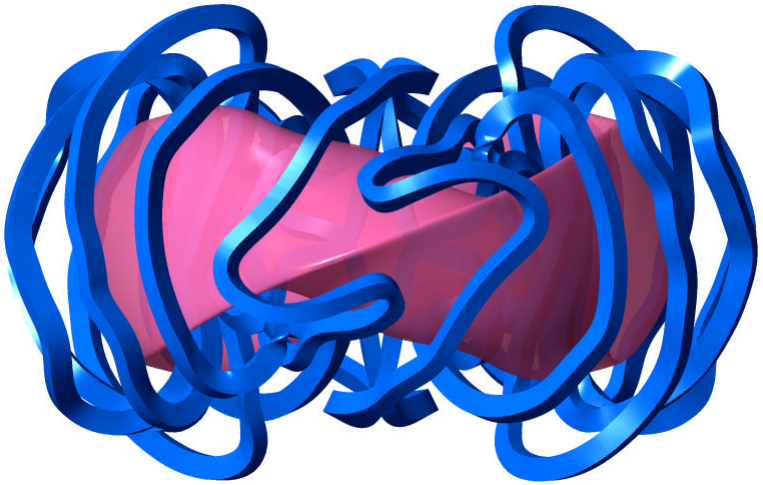
Assumed H = 1.5 x ISS-95, 1.5 x n_{Sudo}; τ_E, T and $\beta \propto$ H

QOS Coil Set Allows Good Access

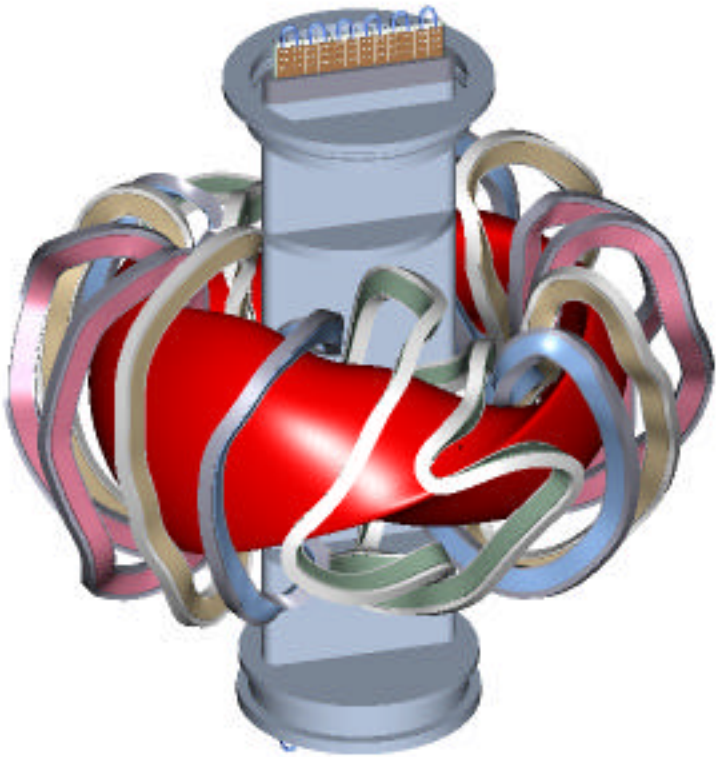
- **Good access between coils for heating and diagnostics**
  - **up to 40 cm at top & bottom**
  - **up to 60-140 cm from sides**
- **Room in center for TF coil legs and OH solenoid**
  - **$\Delta B_T = \pm 0.15$ T**
  - **±0.1 V-s flux swing**

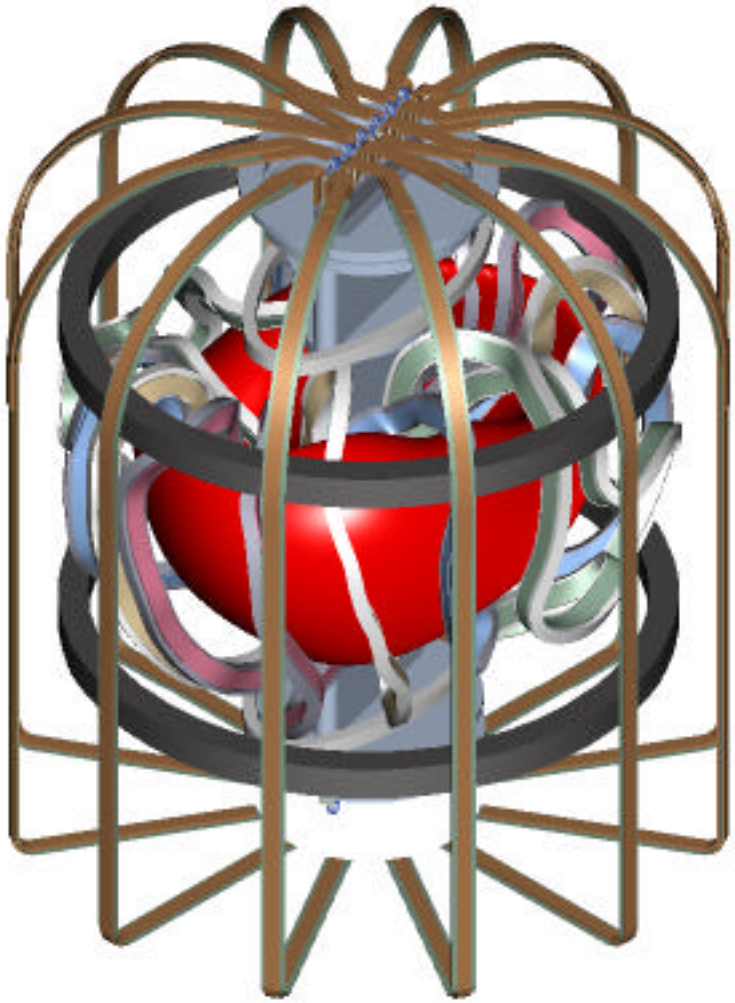






TF, VF and OH Coils Added for Flexibility





Centerstack assembly contains inner TF legs and OH current solenoid

TF, VF Coils and OH Solenoid Provide Flexibility

- **Need to modify B_{mn} spectrum to study effect on equilibrium quality, MHD stability, and neoclassical transport**
- **Different currents in the modular coils allow changing ι & shear, helical axis excursion, mirror field component, plasma shape, and *R/a***
- **VF coils can shift axis and shape the plasma surface**
- **TF coils (±0.15 T) can change ι and shear**
- **OH solenoid (±0.1 V-s) can drive plasma current and change/reverse shear**