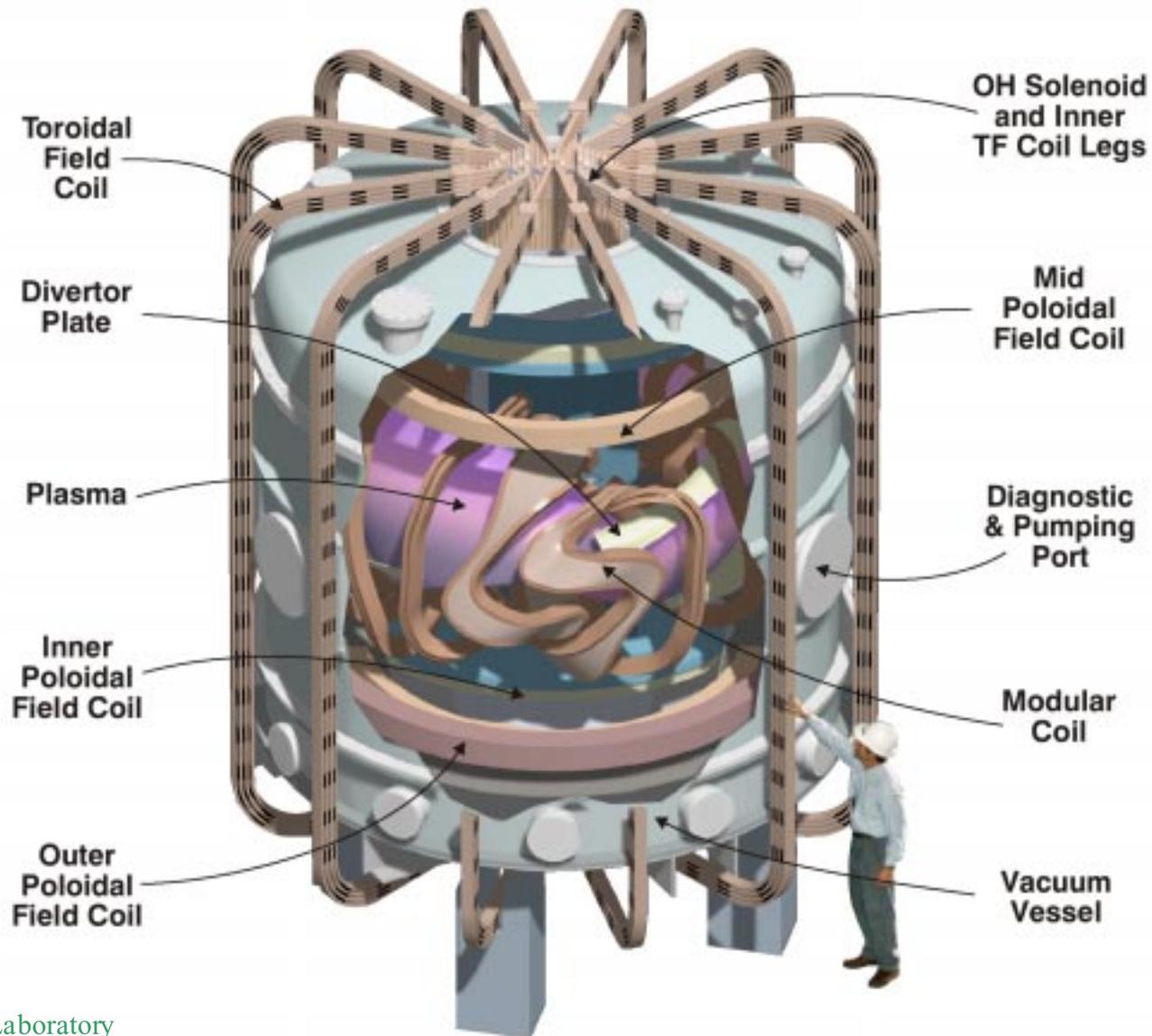




# QPS

## A Compact Quasi-Poloidal Stellarator Experiment





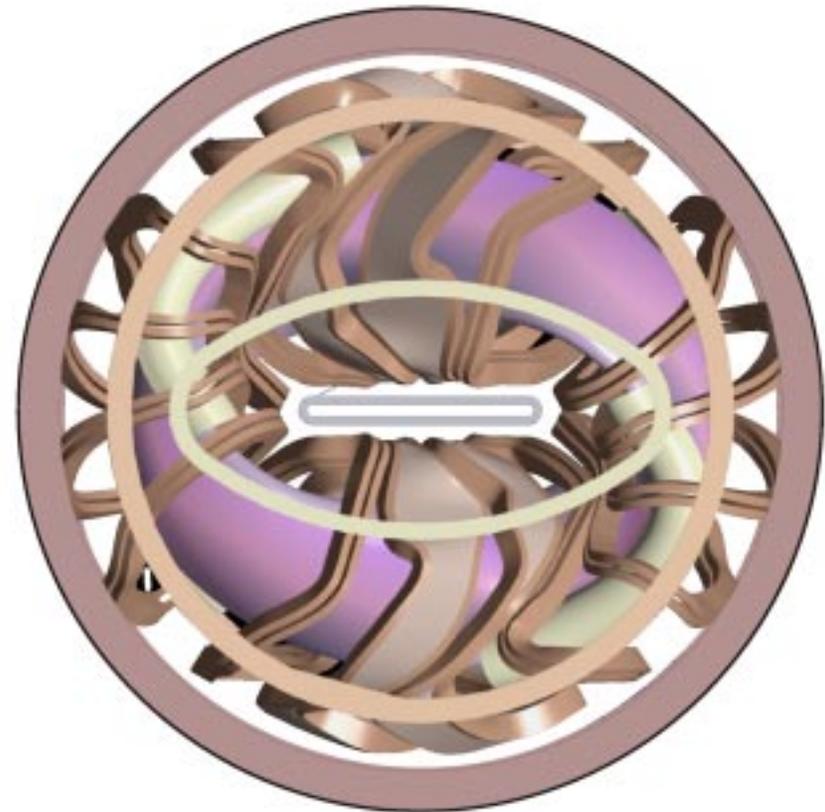
# Features & Improvements

<b>Feature</b>	<b>APS 2000</b>	<b>Recent Improvements</b>
<b>Base Magnetic Configuration</b>	<ul style="list-style-type: none"> <li>- Quasi-poloidal features</li> <li>- Reduced neoclassical transport</li> <li>- <math>R / a = 2.5</math>, <math>a = 36</math> cm</li> <li>- Inadequate space in center for TF coil legs &amp; ohmic current solenoid</li> </ul>	<ul style="list-style-type: none"> <li>- Higher degree of quasi-poloidal symmetry</li> <li>- Improved neoclassical confinement</li> <li>- <math>R / a = 2.7</math>, <math>a = 33</math> cm</li> <li>- Adequate space in center for coils</li> </ul>
<b>Modular Coils</b>	<ul style="list-style-type: none"> <li>- 22 coils, 6 coil types</li> <li>- Coil overlap problems</li> </ul>	<ul style="list-style-type: none"> <li>- 16 coils, 4 coil types</li> <li>- Adequate coil spacing</li> </ul>
<b>VF Coils</b>	2 pairs	3 pairs
<b>Vacuum Vessel</b>	Bell jar with aluminum spool pieces	Bell jar with stainless steel spool pieces
<b>Diagnostic Ports</b>	4 (56 cm), 18 (20 cm dia.)	12 (61 cm diameter)
<b>Vacuum Approach</b>	<ul style="list-style-type: none"> <li>- Differentially pumped Viton o-rings</li> <li>- Rectangular access door with Viton Seals</li> </ul>	<ul style="list-style-type: none"> <li>- Metal seals</li> <li>- Personnel access through one of the twelve diagnostic ports</li> </ul>



# Machine Parameters

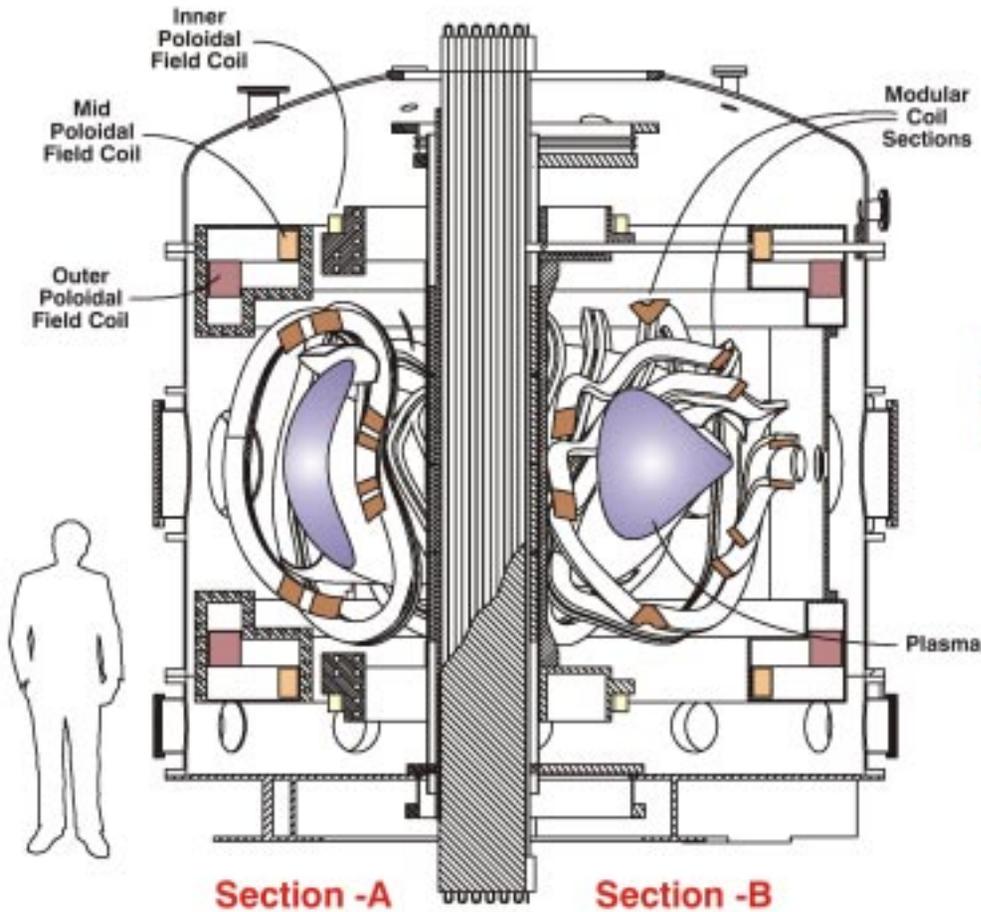
<b>Major Radius</b>	<b>0.9 m</b>
<b>Minor Radius</b>	<b>0.33 m</b>
<b>Aspect Ratio</b>	<b>2.7</b>
<b>Toroidal Field on Axis</b>	<b>1 T</b>
<b>Number of Modular Coils</b>	<b>16</b>
<b>Plasma Current</b>	<b>&lt;150 kA</b>
<b>Pulse Length</b>	<b>~1 s</b>
<b>Plasma Heating Power</b>	<b>1- 3 MW</b>



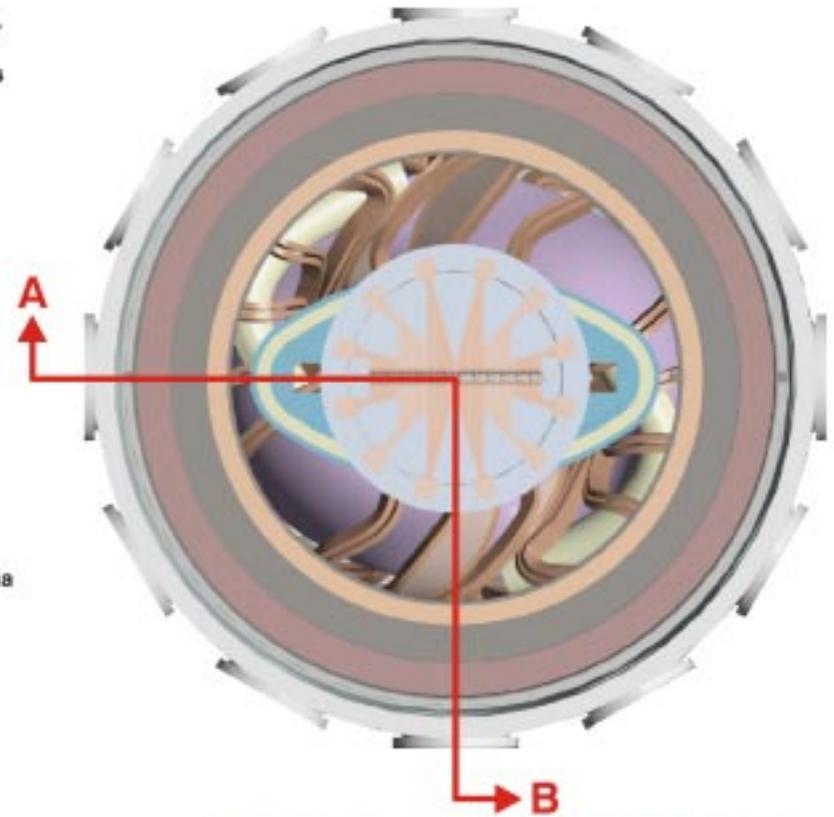
Top View of Coils and Plasma



# Machine Elevation & Plan Views



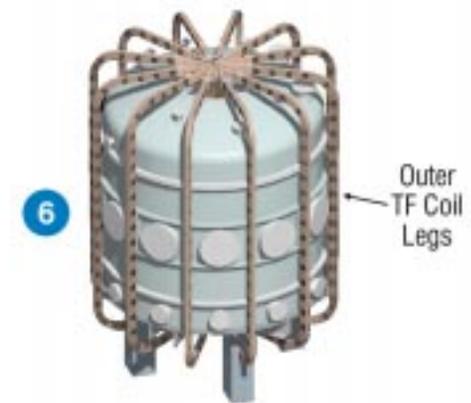
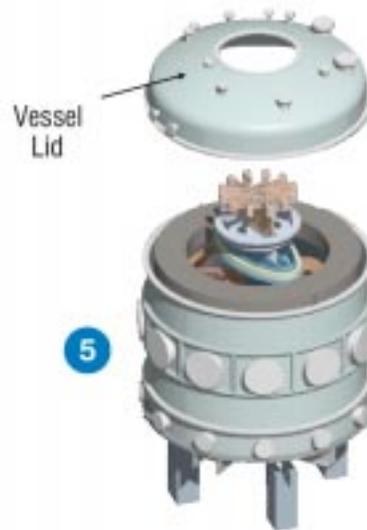
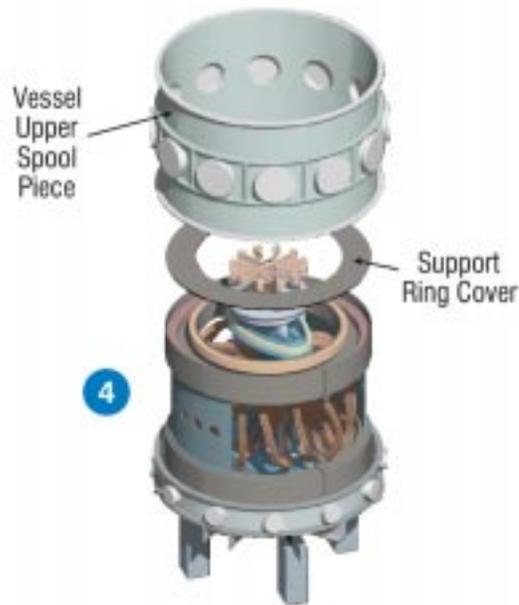
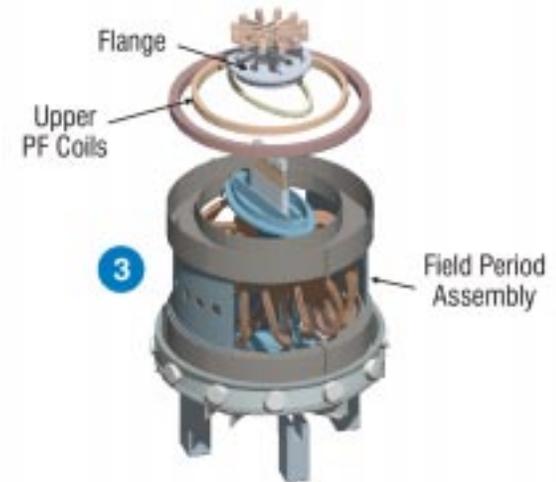
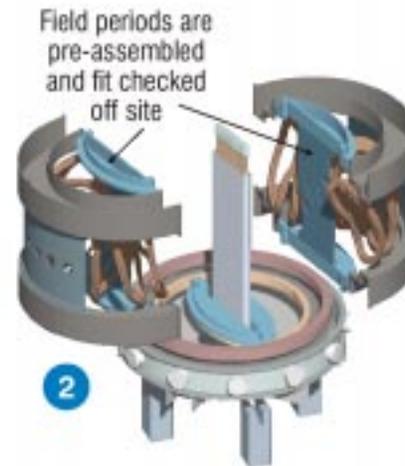
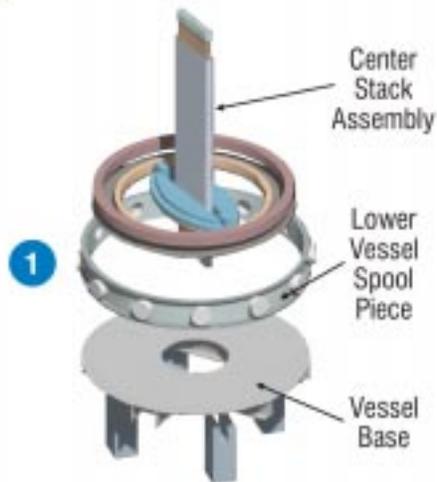
Split elevation views of the machine cross sections



View looking down on top of the machine indicating the section views of drawing on left

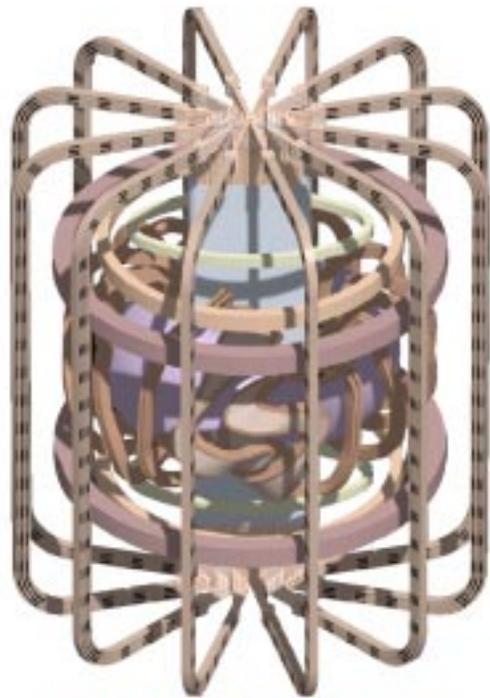


# Assembly Sequence

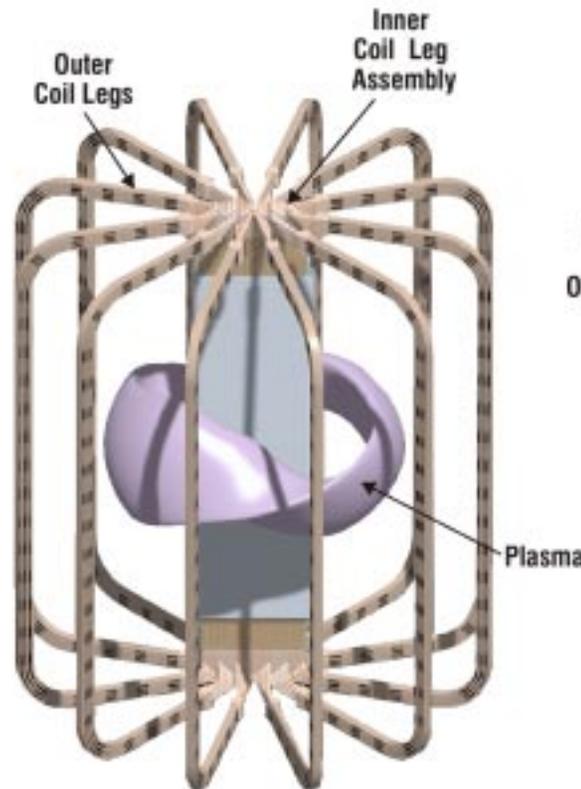




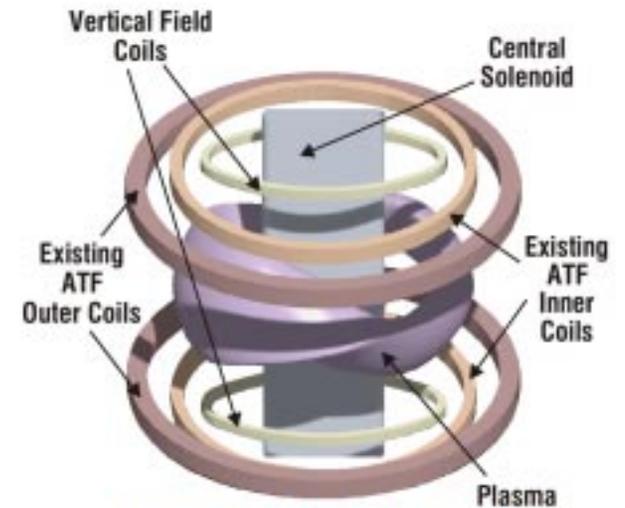
# Magnet Coil Sets



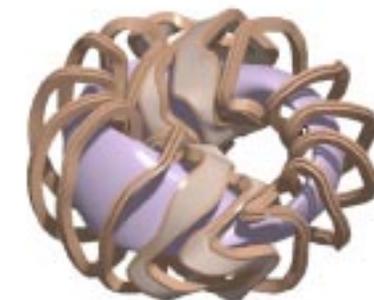
**QPS Coil Assembly**



**Toroidal Field Coil Set**  
+/- 0.2 Tesla, 24 Turns - 89 x 19 mm



**Poloidal Field Coil Set**

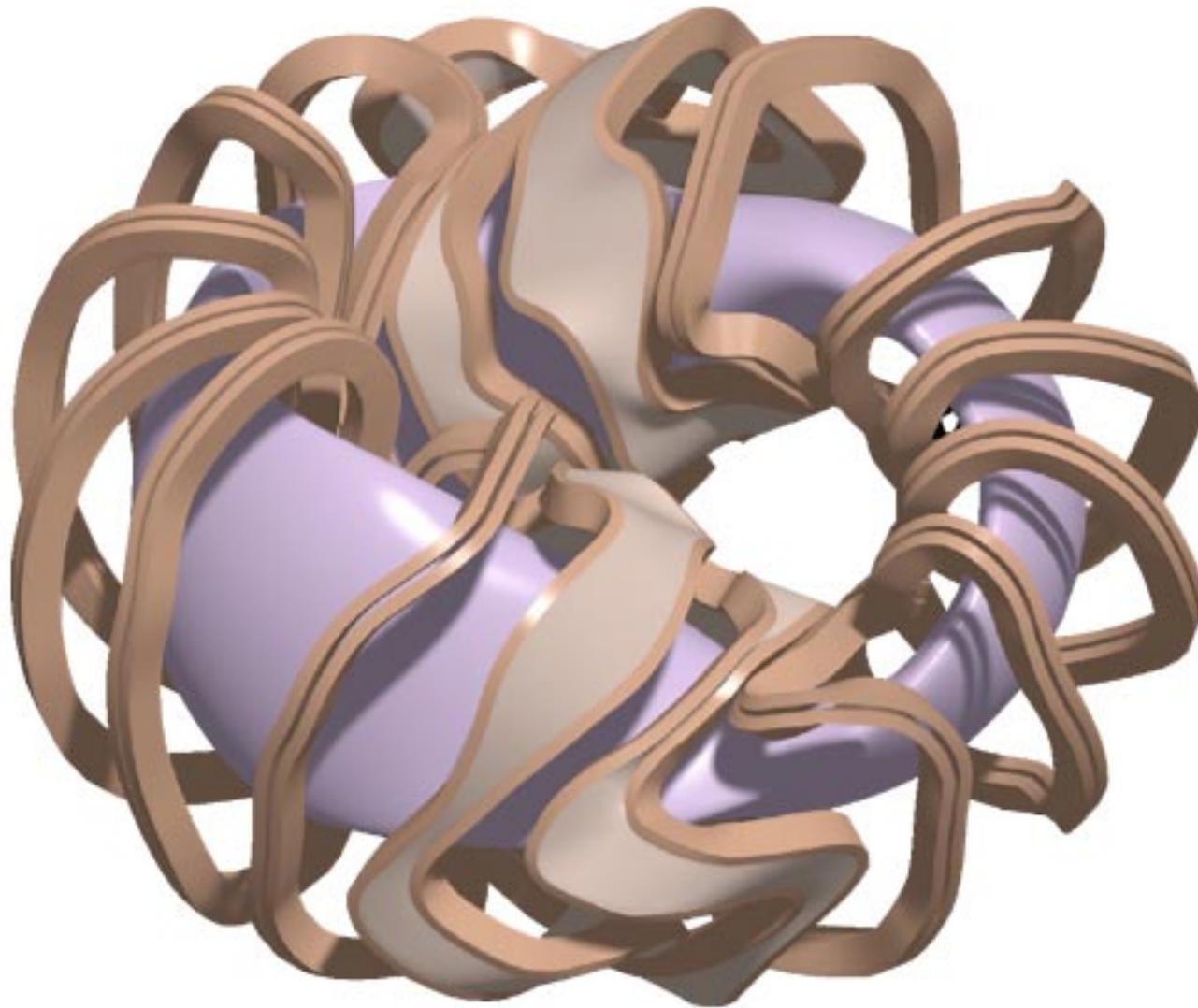


**Modular Coil Set**



# Modular Coil Configuration

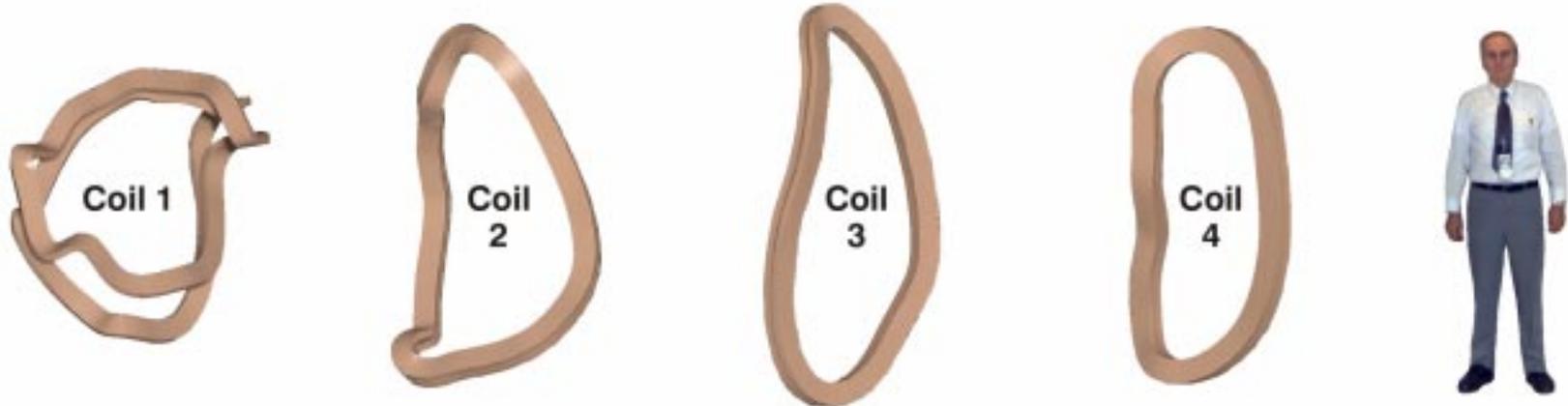
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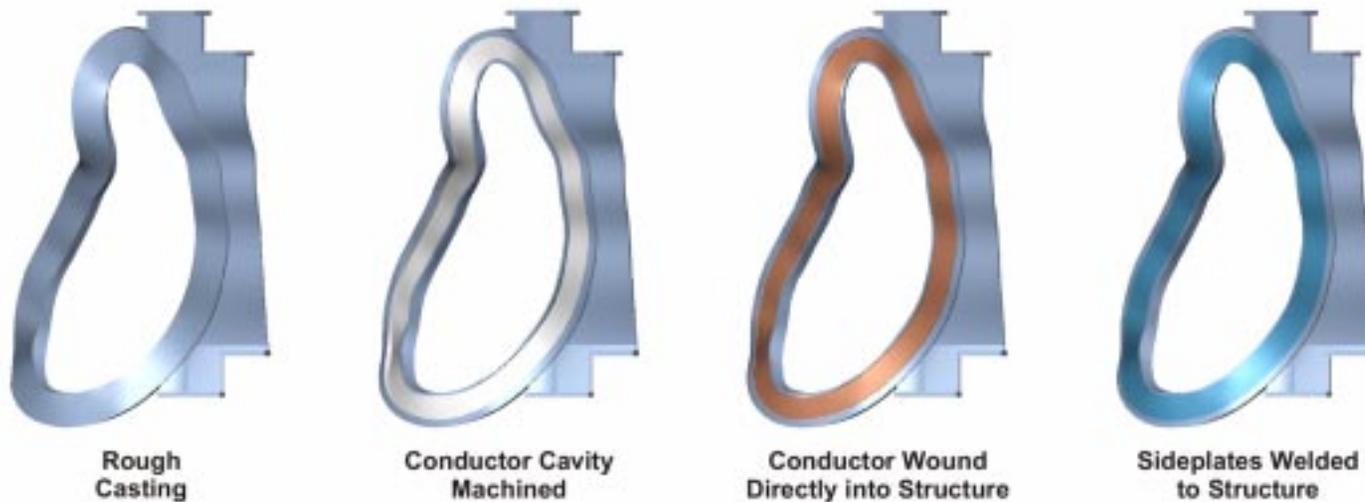


# Modular Coil Configuration

## Coil Winding Packs



## Coil Manufacturing Sequence

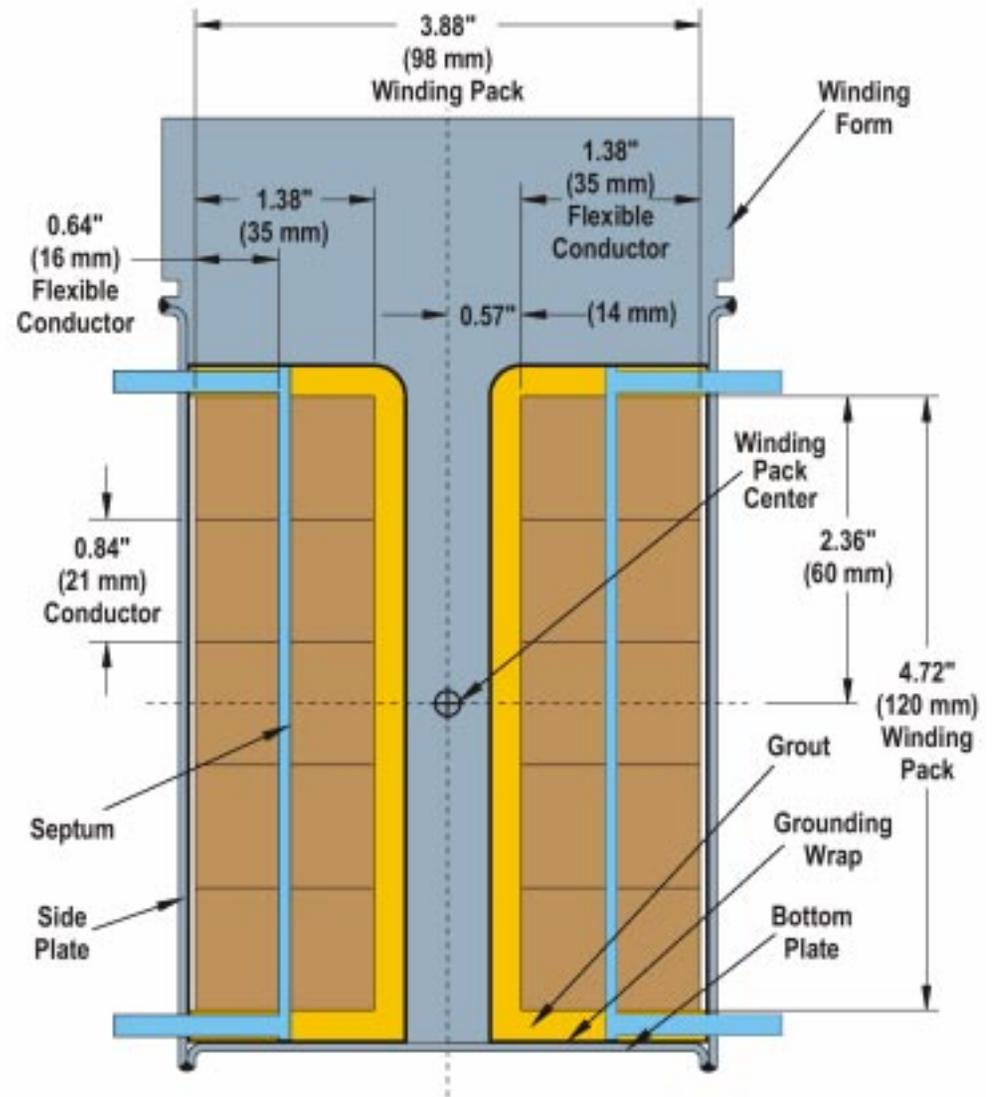




# Modular Coil Configuration

## Coil Parameters

Number of Field Periods .....	2
Number of Coils per Period .....	8
Number of Coil Types .....	4
Estimated Current per Coil, kA .....	231.9
Average Length per Coil, cm .....	417
Cross Section, WxH, cm .....	7.2 x 11.2
Current Density, Gross, kA/cm <sup>2</sup> .....	2.8
Current Density in Cu, kA/cm <sup>2</sup> .....	8.2



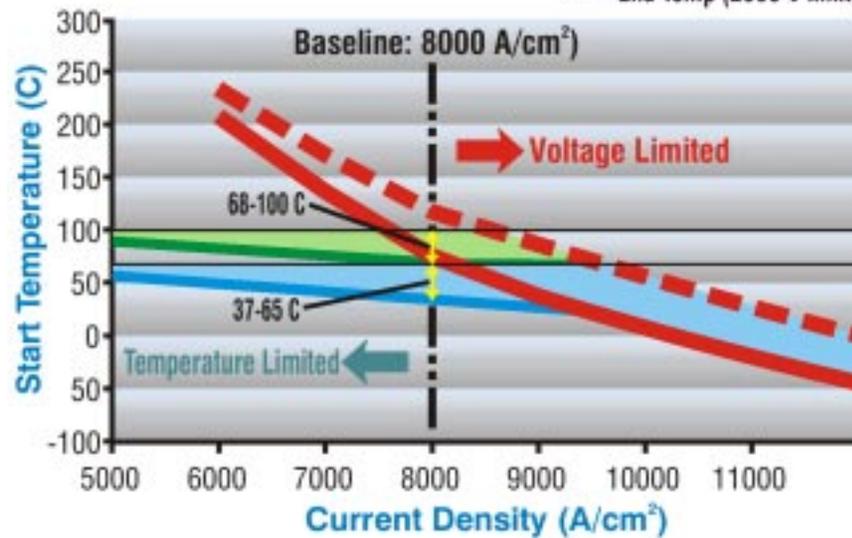


# Modular Coil Current

**QPS modular coil start temperature vs current density for 0.5 sec flat top**

16 coils in series, 16 turns per coil,  
2600 volts,  $\langle B \rangle = 1$  Tesla,  
variable cross section,  $R_0 = 0.9$  m

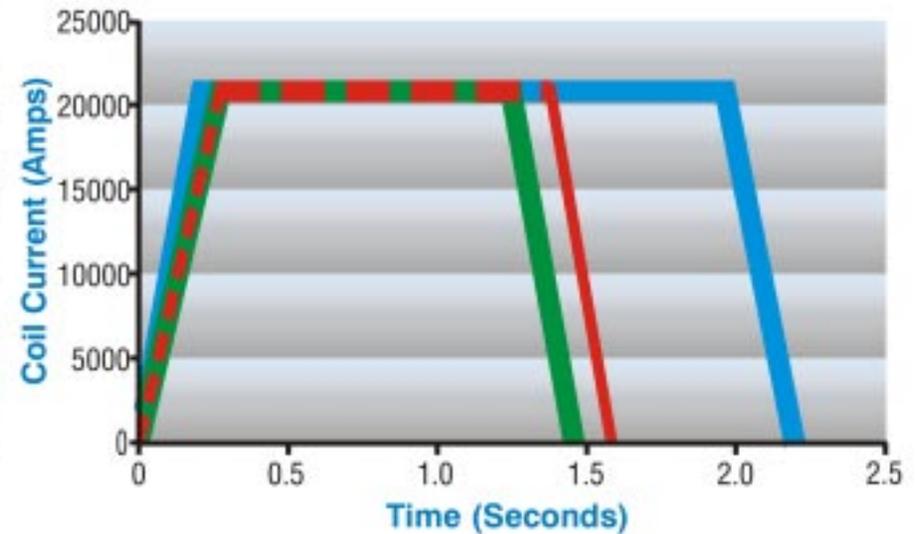
- Start Temp (2600 V limit)
- Start Temp (100 C peak)
- Start Temp (65 C peak)
- End Temp (2600 V limit)



**QPS modular coil current vs time for various coolants**

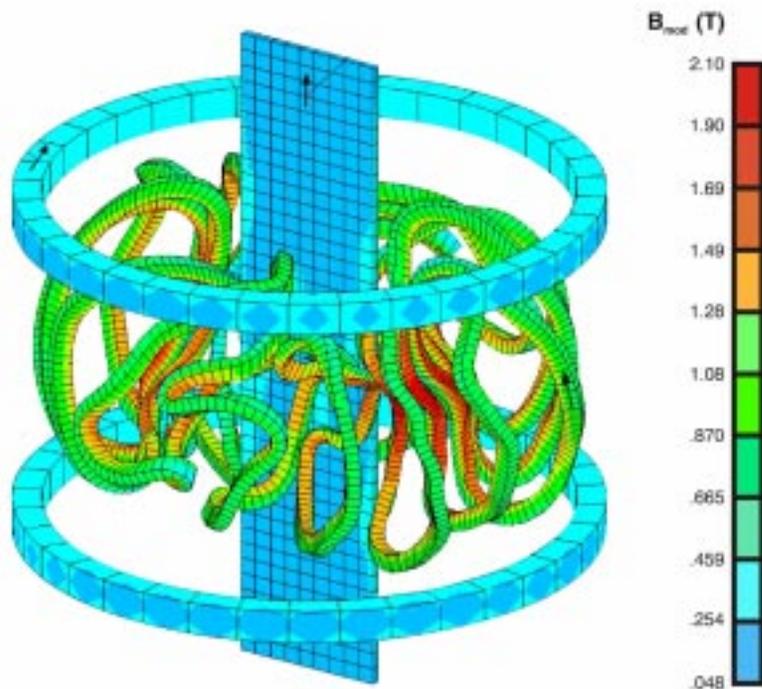
16 coils in series, 16 turns per coil,  
2600 volts, 8.2 x 12 cm cross section,  
0.43 copper fraction

- R.T.,  $T = 20-65$  C
- Refrig.,  $T = 0-65$  C
- Elev.,  $T = 45-100$  C

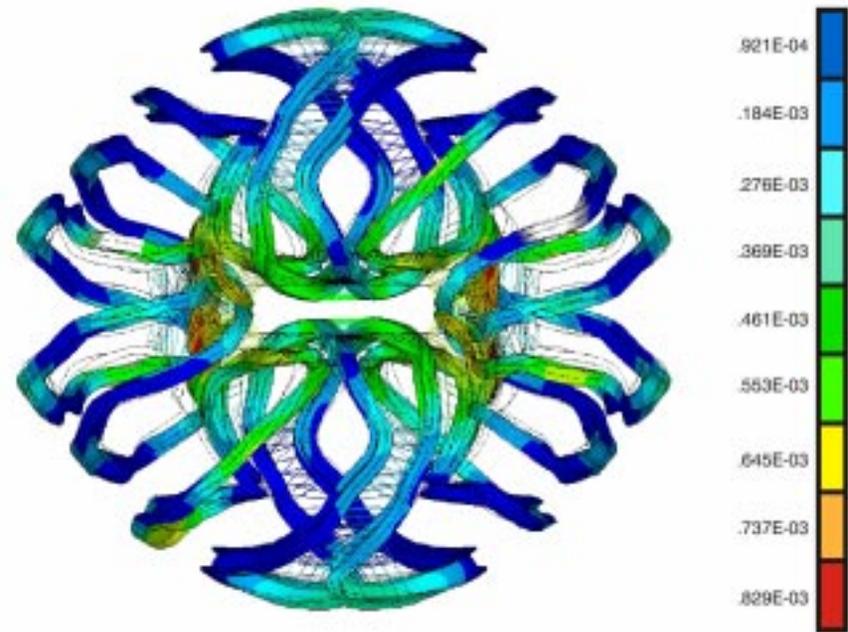




# Modular Coil Stress Analysis



Magnetic field distribution from all coils  
Maximum coil running load = 2,000 lb/in



Coil-to-coil structure shown is sufficient  
to limit maximum deflection to < 1 mm



## Status & Proposed Schedule

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- **QPS is now in the conceptual design phase after a successful Physics Validation Review in April, and a Project Validation Review in May**
- **Conceptual design, cost and schedule review planned for May 2002**
- **The design will continue to evolve through the Conceptual Design Review to account for improvements in the coil design and vendor input / participation**
- **4-year design and construction period required after that**
- **Open issues**
  - **Reducing construction cost for modular coils**
  - **Optimum design for coil support structure**
  - **Maximum baking temperature & divertor plate geometry**