First Operational results with SST-1 Superconducting Magnet System & Cryogenics System

Subrata Pradhan on behalf of SST-1 Team
Institute for Plasma Research

Thu-AF-OR 13, Jul 10, 1400 hrs
Steady State Superconducting Tokamak (SST-1) is a First Generation Experimental Tokamak indigenously developed and commissioned at Institute for Plasma Research
Cross sectional View showing SST-1 Magnet System (TF, PF, Central Solenoid & Compensating Magnets and Equilibrium Magnets)

SST-1 TF & PF magnets are superconducting (NbTi) whereas all other magnets are resistive (Cu)

SC TF magnets: 16
SC PF magnets: 09
Cu CS magnets: 07
Cu in-vessel Mag.: 04
Cu Equil. Mag.: 02
SST-1 Cryogenic System (1.3 KW)

Different Components of HRL
- Compressor Skids
- Oil Removal System
- Online Purifier
- Cold Box
- Main Control Dewar (MCD)
- Integrated Flow Distribution & Control System (IFDCS)
- Current Leads (CL)
- Current Feeders system (CFS)
Important sub-systems of SST-1 Cryogenics System

- Helium Screw Compressors Station
- Oil Removal System
- Main Purifier
- Helium cold-box and MCD (2500 L)
- LN2 Sub-cooler Dewar
- IFDC cold Helium distribution
Engineering validations: Magnets & Cryogenics sub-systems
Cryostat & Vacuum System of SST-1

SST-1 Vacuum parameters during plasma operation

- Cryostat Pressure
- Vessel Pressure
- LN2 Temp.

Graph showing vacuum parameters over time with dates from 20-05-13 to 01-07-13.
SST-1 TF 1.5 T operation
Significant First Time Achievements

- Long Pulse operation of TF magnets @ 1.5 T (at plasma centre) for 20000 s or more.
- TF magnets operation up to 2.0 T with Two Phase cooling
- Cold gas cooled Current Lead operations at 1.5 T instead of liquid helium.
Magnetic field profile with Long duration TF magnet current in Two Phase cooling charge
Temperature stability with Long TF magnet currents in Two Phase Cooling

![Graph showing temperature stability with Long TF magnet currents in Two Phase Cooling. The graph plots temperature (k) on the y-axis and time (s) on the x-axis. Two lines are shown: SST_PS_CURRENT in red and TF1_Outlet in green. The temperature remains stable with slight fluctuations.]
The SST-1 Helium system supporting the Two Phase Cooling

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**Actual Received Magnet Temp.**

<table>
<thead>
<tr>
<th>SST1 MAX</th>
<th>SST1 AVG</th>
<th>SST1 MIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>165.80 K</td>
<td>44.00 K</td>
<td>3.80 K</td>
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**SCMS**

- **TE891:** 146.4 K
- **TE892:** 123.5 K
- **TE893:** 83.0 K
- **TE894:** 89.7 K
- **TE895:** 142.1 K
- **TE896:** 109.7 K

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**Bus Duct**

- **TF Coils**
- **PF Coils**
- **SUPT. RING**

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**Cryostat Vacuum**

- **7.2E-6 mBar**

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**Bus Bars Current Lead Chamber**

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**Diagram Details**

- **PSV021**
- **NRV021**
- **PV021**
- **PV031**
- **PSV031**
- **NRV031**
- **TE090:** 113.9 K
- **PT0411:** 1.16 B
- **FT041:** 0.00 g/s
- **FCV041:** 7.80 K
- **TE0411:** 5.30 K
- **TE0311:** 259.20 K
- **PT0311:** 1.49 B
- **TE021:** 4.70 K
- **PT021:** 1.25 B
- **TE020:** 5.30 K
- **PT020:** 1.46 B
- **TE030:** 238.60 K
- **PT030:** 1.49 B
- **TE040:** 257.50 K
- **PT040:** 1.40 B

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**Temperature**

- **Tmax:** 165.80 K
- **Tmin:** 3.80 K
- **Tavg:** 44.00 K
- **Tcryo:** 0.00 K

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**Menus**

- **Menu**
Typical Long TF Flattop of 20,000 Seconds @ I = 4750 A / 1.5 T
2 T in TF with Two-phase helium

CURRENT & FIELD OF 2T SHOT (6.2KA)

- SST-PS-CURRENT (Amp)
- HP_TF3_OB (Gauss)

MAGNETIC FIELD (Gauss)

SST PS CURRENT (kA)

Time (s)
TF CL operating with gas cooled CLs @ 4.7kA
Reliable SC Magnet System and Cryogenic System of SST-1 has helped towards conducting reliable physics experiments in SST-1
Plasma Experiments at 0.75 T

SST-1 DATA FOR shot#5807
$\text{Imax(kA)} = 41.75$
$\text{V}_L (\text{V}) = 3.31$

Graphs showing various parameters over time, including:
- $I_p$ (mA)
- $V_L$ (V)
- $I_{Gf-Rso}$ and $I_{Vf-Rso}$
- $P_{ECDM}$ (kW)
- Bilhar
- $R_{profile}$
- Hoppy

Time (s) ranges from -0.1 to 0.526.
Plasma Experiments at 1.5 T
Acknowledging my SST-1 Team

Jai Hind