

# GYROTRON BASED ELECTRON CYCLOTRON START UP SYSTEM FOR ITER

ITER-INDIA, INSTITUTE FOR PLASMA RESEARCH, BHAT, GANDHINAGAR

## INTRODUCTION

Electron Cyclotron Heating & Current Drive System (ECH & CD) on ITER

### EC H&CD SYSTEM

- Plasma heating
- On axis and off-axis CD
- Discharge cleaning

Plasma Start Up

Heating & Current Drive  
24 MW at 170 GHz  
24 Gyrotrons/1MW/CW

Plasma Start-Up  
3 MW at 127 GHz  
3 Gyrotrons/1MW/10s

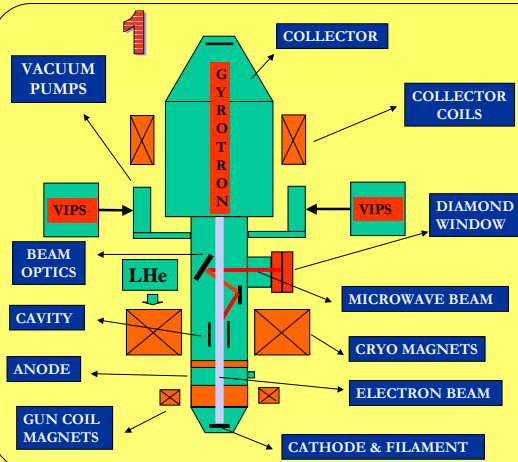
### ECH Start Up Package

#### Objective

RF/Microwave Power at ECR (Electron Cyclotron Resonance) frequency helps produce reliable gas breakdown or plasma formation at very nominal breakdown voltage

## SCOPE OF THE PACKAGE

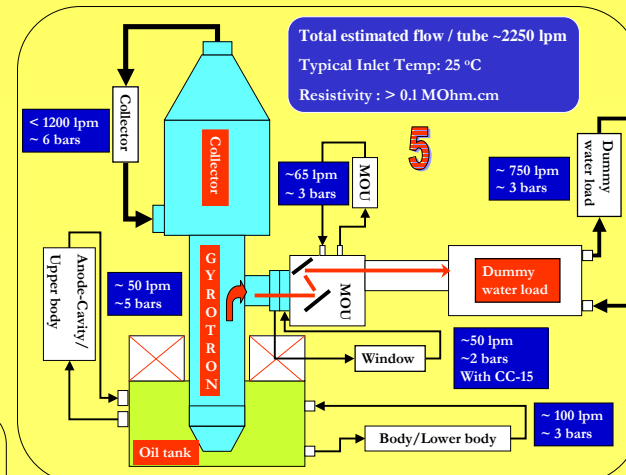
1. High power Gyrotron tubes	3 SETS
2. Auxiliary Power Supplies for the gyrotron tubes	3 SETS
3. Gyrotron Oil Tank with HV circuitry	3 SETS
4. Data acquisition, Control with a common controller	1 SETS
5. Cooling connections & Instrumentation	3 SETS
6. Other accessories	
7. Testing and commissioning at ITER site	



## GYROTRON TUBE

### TYPICAL SPECS

- Frequency : ~127 GHz
- Power : 1 MW
- Pulse : 10 sec or more
- Type : Depressed Collector type
- Efficiency : 50 %
- Output mode : Gaussian TEM<sub>00</sub>
- Mode Purity : 95 %
- Cathode Voltage : ~ 65 kV
- Beam current : ~ 40 A



## TYPICAL GYROTRON COOLING SYSTEM

(Actual values may vary with the Gyrotron make)

### COOLING INSTRUMENTATION & COMPONENTS

Flow control valves ; Pressure sensors ; Flow meters ; PRVs, Conductivity monitors, Connecting pipes ; Other accessories

- Interlocks/Protections: Fast (~10µs) & Slow (>10 ms)
- Sequential start & shutdown
- Instrumentation /Sensors
- Signal Transfer Mechanism -FOC/Shielded twisted pair/Coaxial/Others
- Signal conditioning Hardware
- PLC based Controller System
- Acquisition & monitoring
- Controller Software & Application software for data visualization and archiving
- Interface module with ITER central DAC system (CODAC)

DAC

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## PS Specifications (Indicative Only)

(Actual Specifications depend on Gyrotron make)

### FPS : Filament Power Supply

AC / 25 V / 40 A / 1% V-stability

### CRMPs: Crvo Magnet PS

DC/50-100 A / Current-stability 0.05%

Typical Load Inductance : ~ 10 H

### VIPS: Vacuum Ion pump PS

Voltage (DC): 3-4 KV ; Current : ~ 1mA

### CCPS: Collector Coil PS

Current : ~ 60 A ; Pulse shape : triangular

Pulse duration : 100 ms ; Coil inductance : ~ 0.2 H

### AMPS: Anode Modulator PS

Three sets one for each gyrotron

30 to 35 KV / 40-100 mA typical

### RHVPS: Regulated High Voltage PS

One common PS for all the three gyrotrons

65 to 70 KV / 140 A typical

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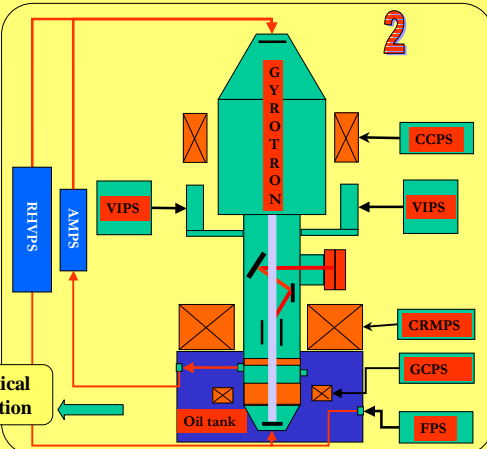
Mechanical Fabrication

### Gyrotron Tank

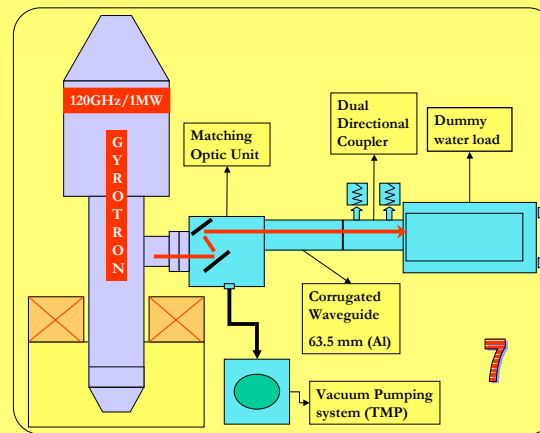
The oil tank would house the High voltage (~65kV) parts of the high power (1MW) gyrotron.

Oil provides the required HV insulation and cooling for the gyrotron electron gun

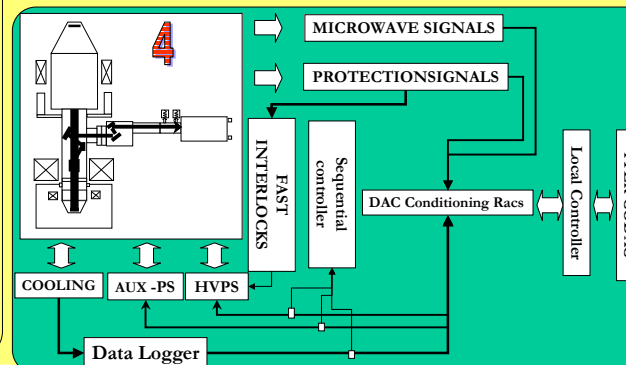
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## GYROTRON POWER SUPPLIES



## TYPICAL GYROTRON MICROWAVE TEST SET UP



## DATA ACQUISITION AND CONTROL SYSTEM