

KPS 2006'

The Result of Gyrotron Power Supply of 84-GHz ECH System*

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Abstract

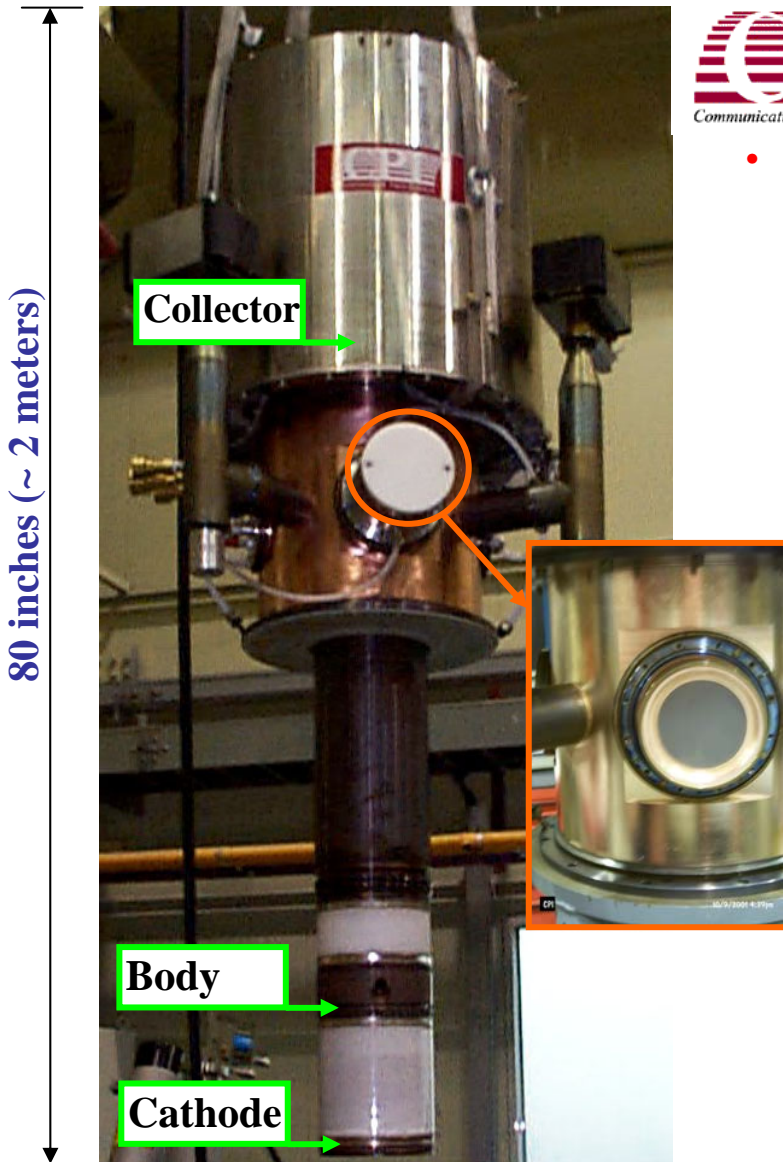
- The KSTAR ECH system is installed and the test of 2-MW power supply system is carried out using dummy resistors before the connection to the 84 GHz CPD (collector potential depression) gyrotron.
- The power supply system is divided into two power supplies, the acceleration power supply (APS) and the cathode-current power supply (CPS). The APS provides the stable acceleration field between cathode and body to CPD gyrotron. On the other hand, the CPS provides beam current and power for CPD gyrotron.
- The KSTAR 84 GHz CPD gyrotron requires about 80 kV with +/- 0.1 % stability at the APS output voltage while the CPS provides about -56 kV with the current of 25 A.
- The dummy resistor test shows that the CPS supplies 25 A with 60 kV for 2-s long pulse, and the APS supplies the stable acceleration voltage with respect to CPS voltage.
- The modulation test of the APS is also performed in open circuit. In the event of arcing in the CPD gyrotron, the high voltage has to be removed within 10 us and the permitted maximum arc energy inside the CPD gyrotron is 6 Joules.
- The short circuit test of the CPS is carried out with series IGBT switches and redundant crowbar switch system in the case of IGBT switch failure. The arc energy less than 6 Joules was measured in the short circuit test.

84-GHz, 500-kW Gyrotron

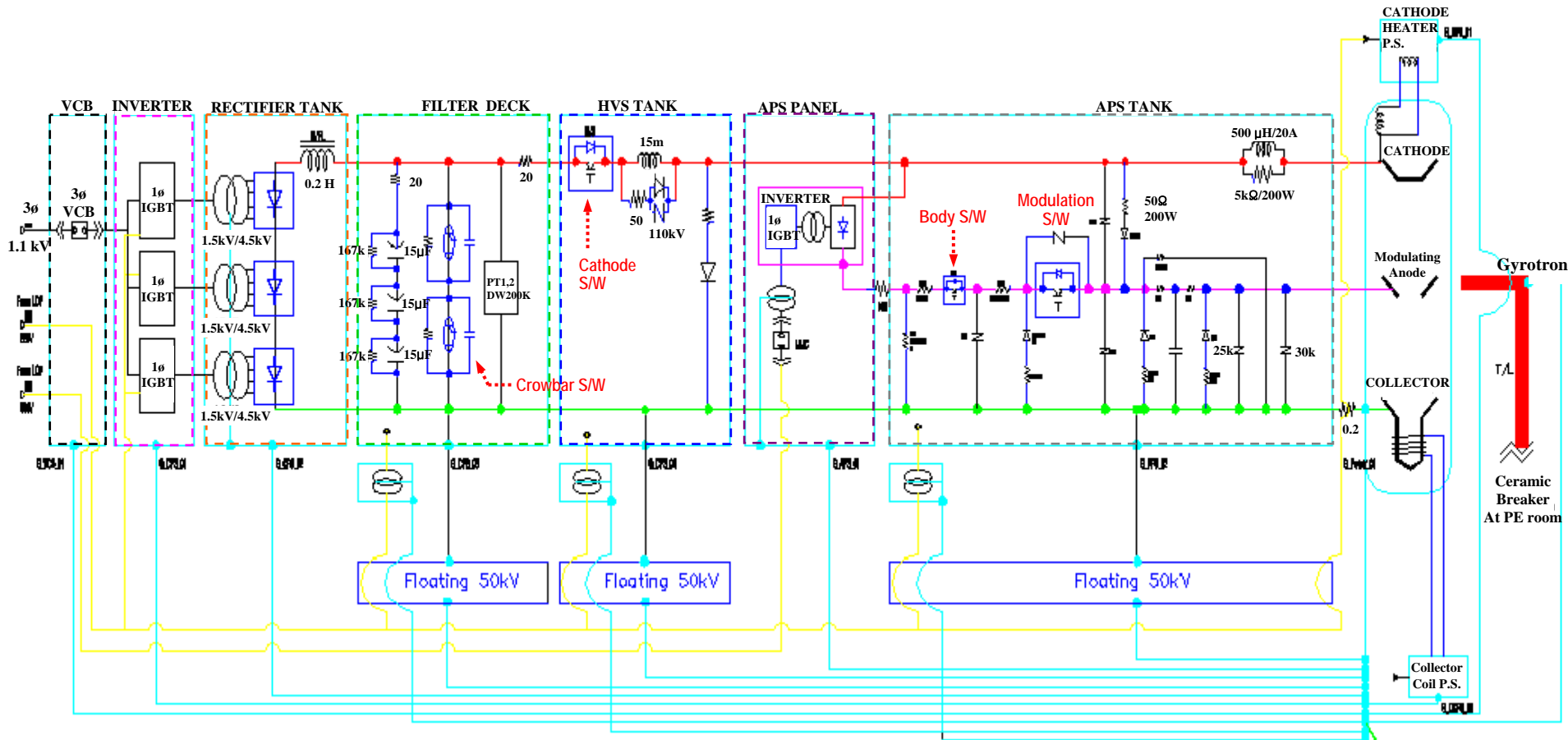


- **Specifications of Gyrotron (CPI VGB8084)**

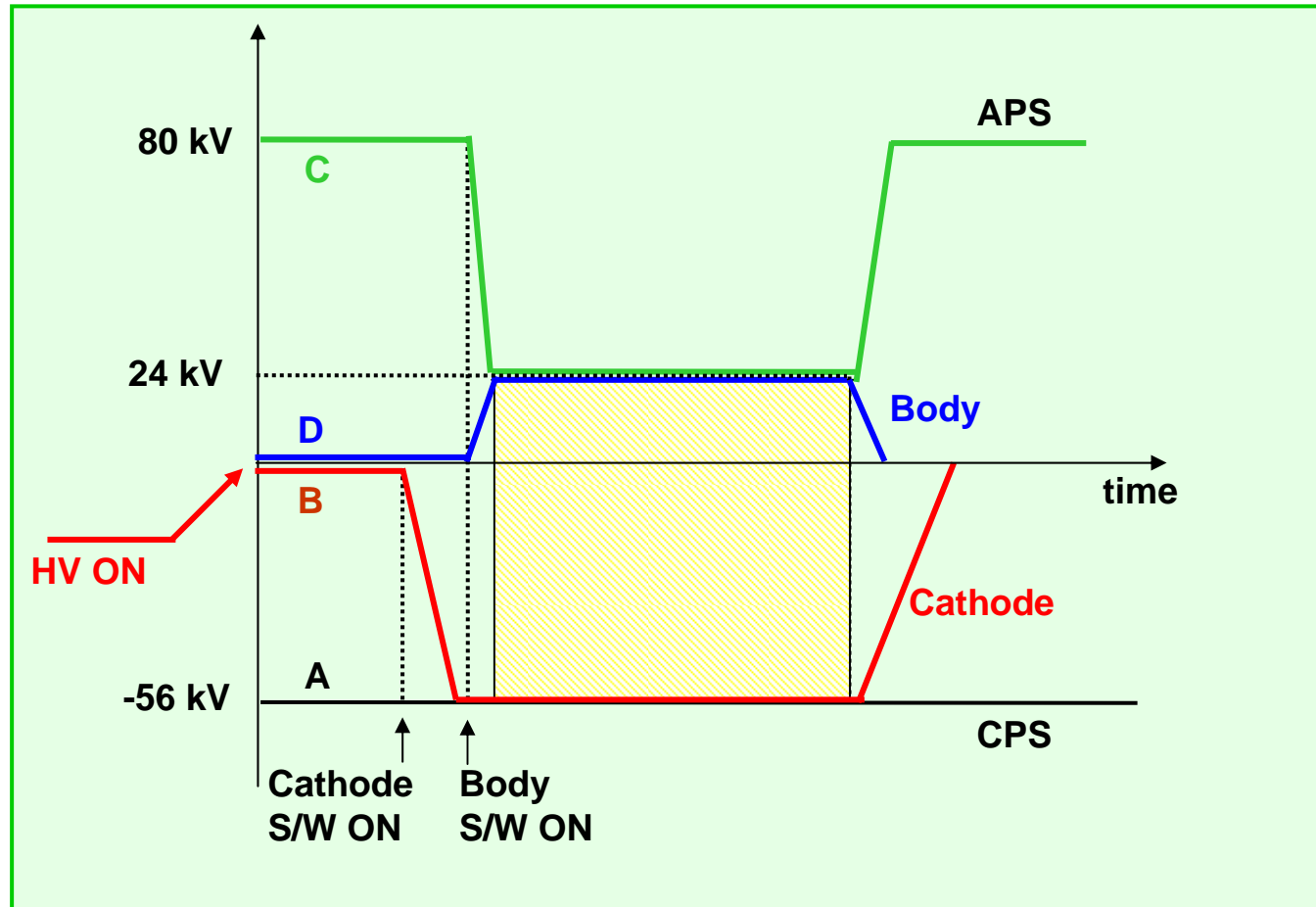
- Frequency: 84 GHz with 0.1 GHz bandwidth
- Power: 500 kW with duration of 2 sec pulse
- Gun Type: Diode-gun with cathode of 40.6 mm-radius
- Cavity mode: TE_{15,4,1} (31-kG focusing field)
- $\alpha = 1.4$ (80 kV and 25 A)
- Collector Potential Depression
 - Cathode-Collector Voltage: -56 kV
 - Cathode-Body Voltage: -80 kV
 - Beam Current: 25 A
- Heater voltage: 28 V, Heater current: 9 A
- Efficiency: 40 %
- RF output mode: TEM₀₀ Gaussian mode with linear polarization
- Diamond window: edge-cooled single-disk with 2.0-inch (50.8 mm) aperture and 0.059-inch (1.5 mm) thickness



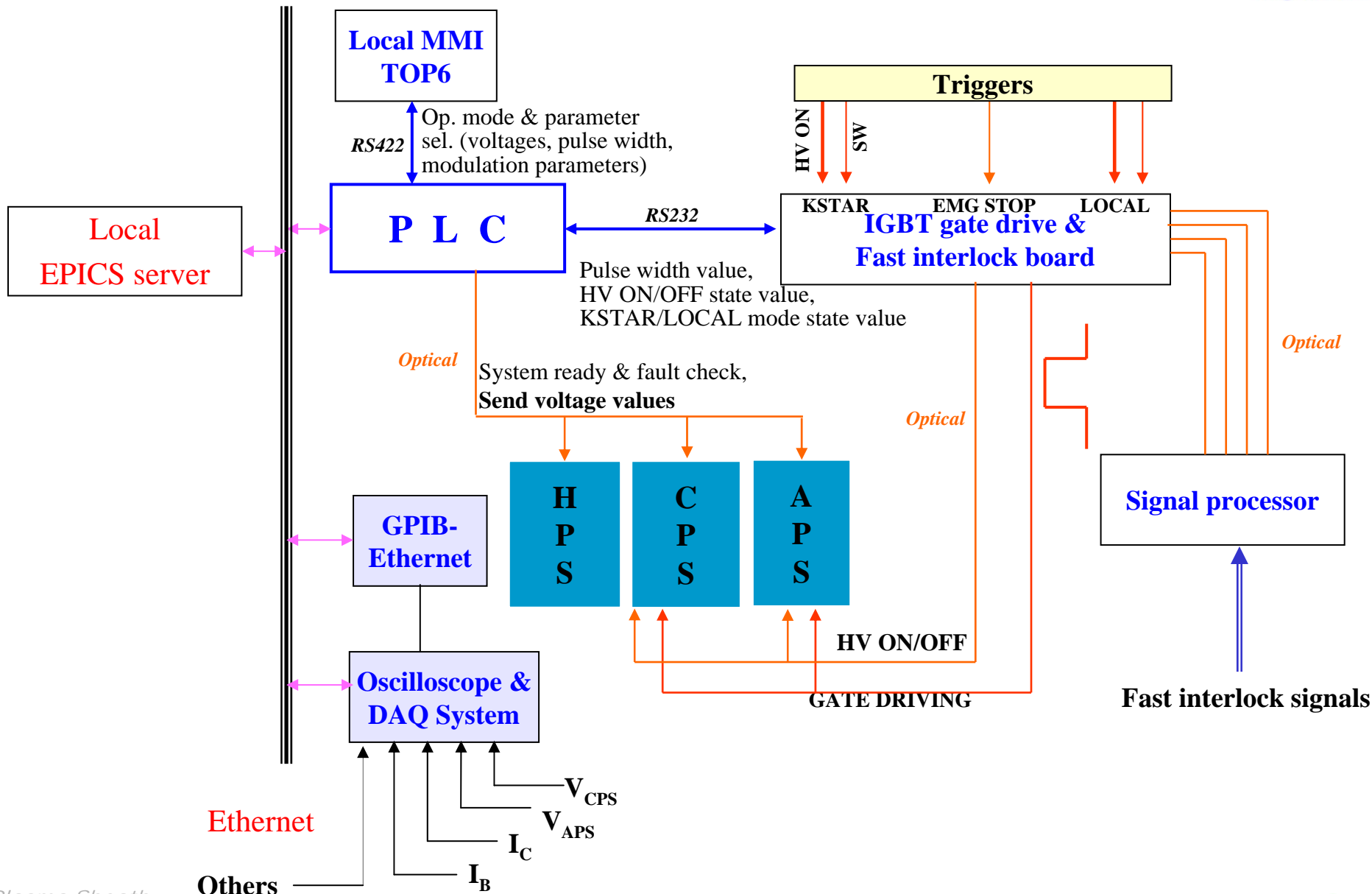
Gyrotron Power Supply System



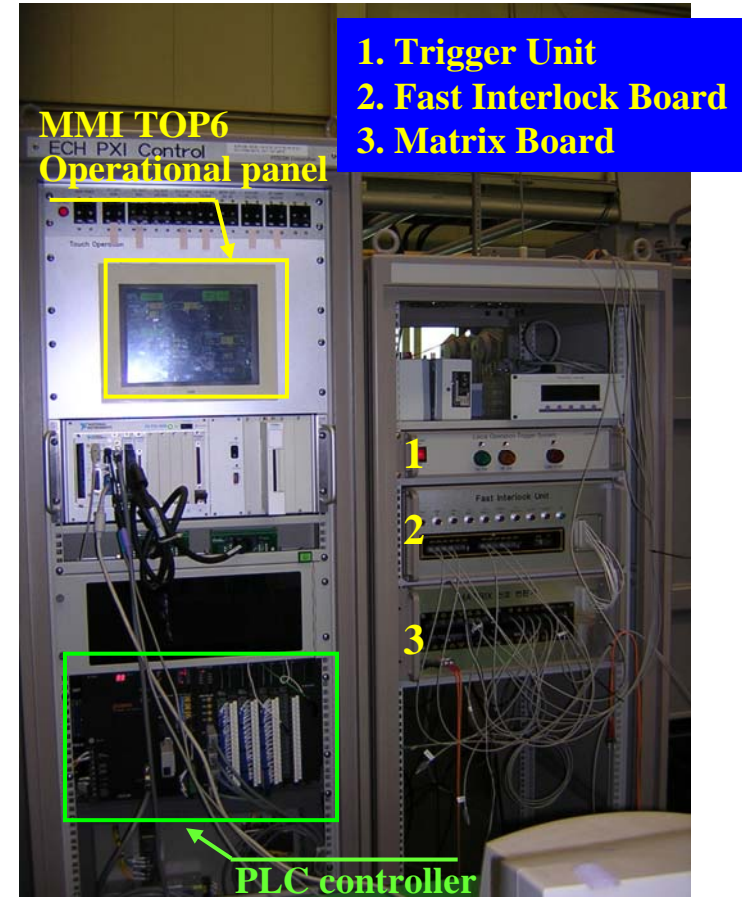
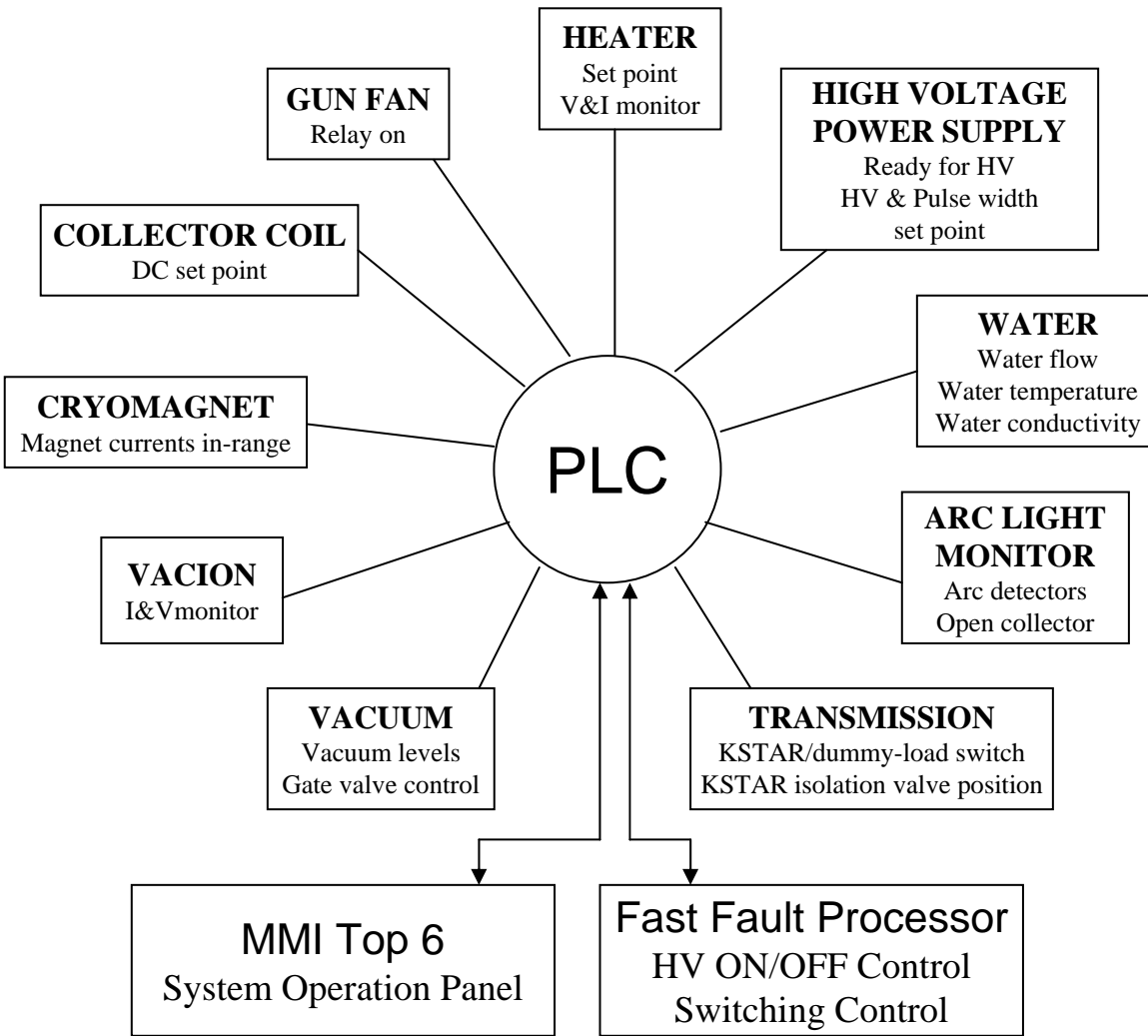
Timing of ECH operation



ECH local I&C



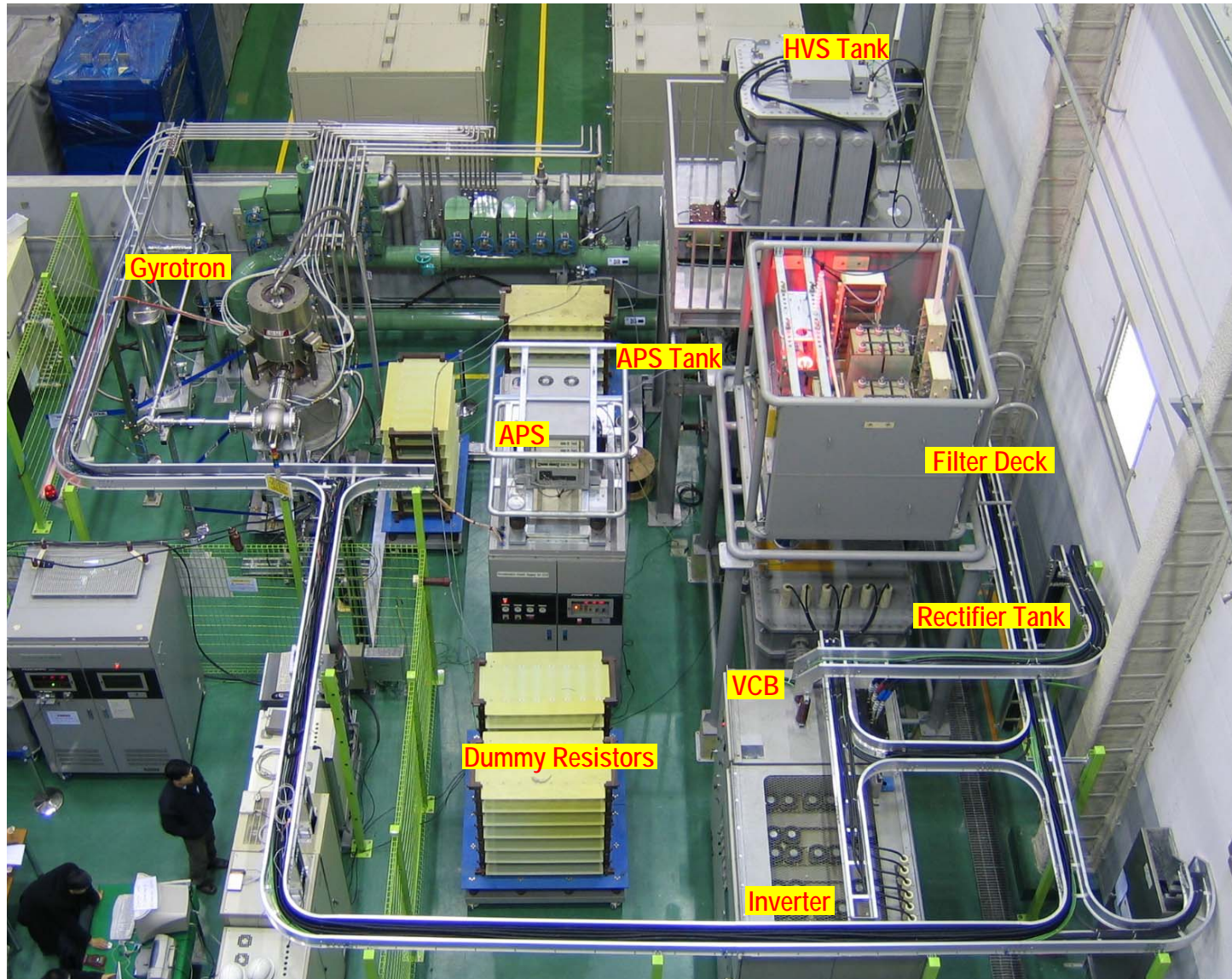
Programmable Logic Controller



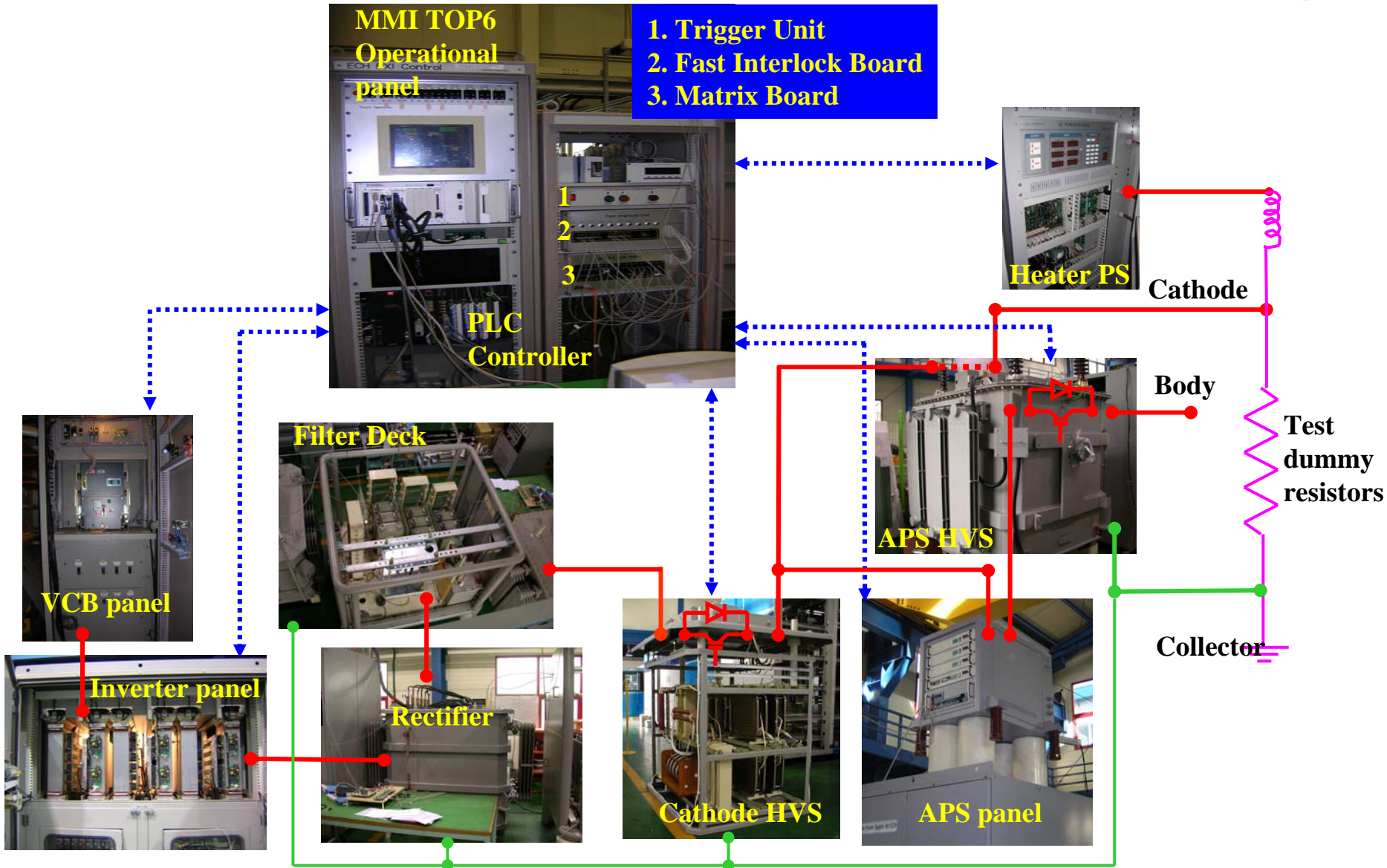
Test of 84 GHz Gyrotron Power Supply

POSTECH / KSTAR

1.5 MW: 60 kV, 25 A, 2 sec

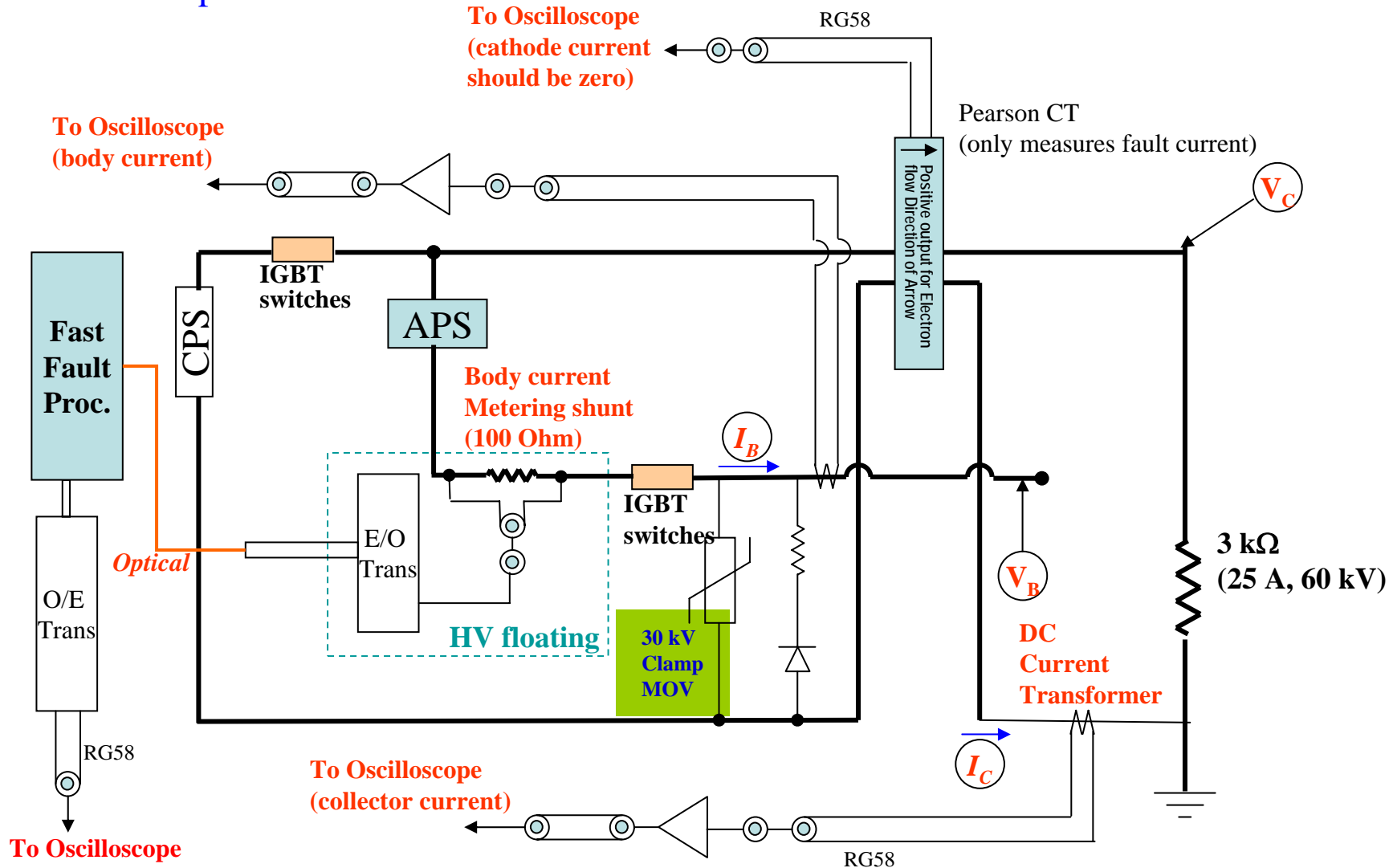


Gyrotron Power Supply Connections

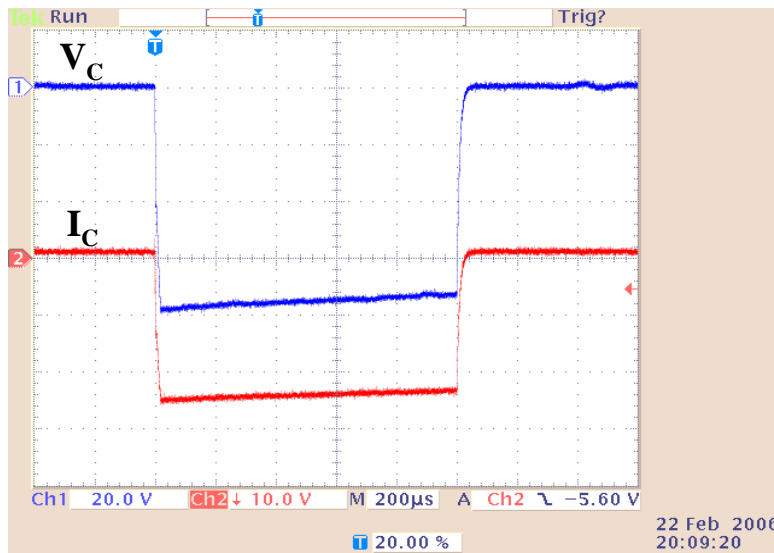


Test of Gyrotron Power Supply

The test of the CPS was performed using 3 kOhm resistors and the test of APS was performed with open circuit

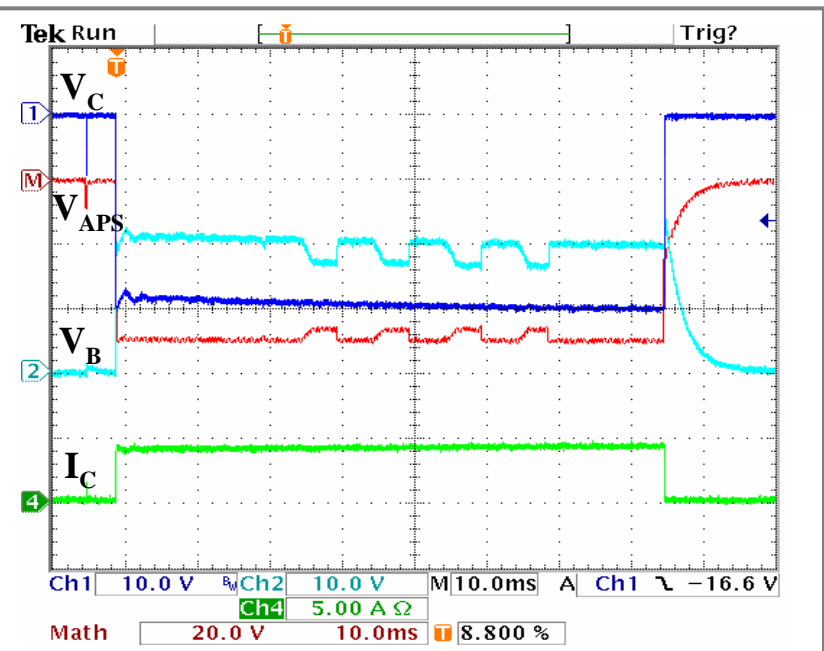


Test waveforms of Voltage and Current

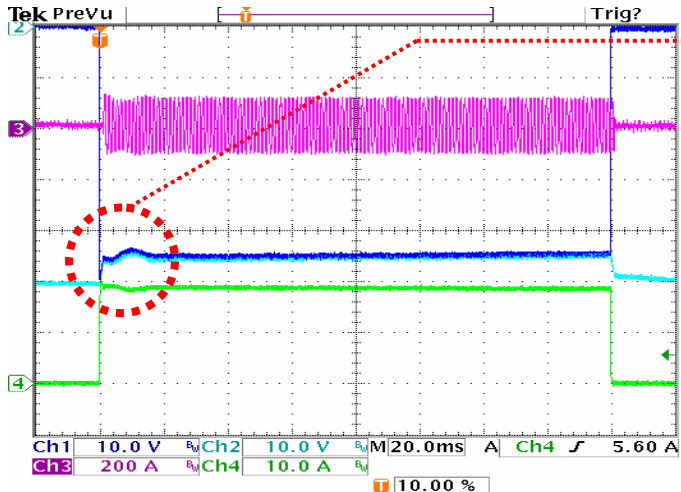


- V_C (Cathode-collector volt.) : 80 kV
- I_C (collector curr.) : 25 A
- Pulse width : 1 msec
- Load : 3k Ω

- V_C (Cathode-collector volt.) : 30 kV
- V_B (Body-collector volt.) : 20 kV
- I_C (Collector curr.) : 5 A
- V_{APS} (Cathode-Body volt.) : 50 kV
- Pulse width : 80 msec
- Modulation frequency : 100 Hz
- Modulation Voltage : 5 kV
- Modulation pulse width : 40 msec
- Load : 2.41 k Ω



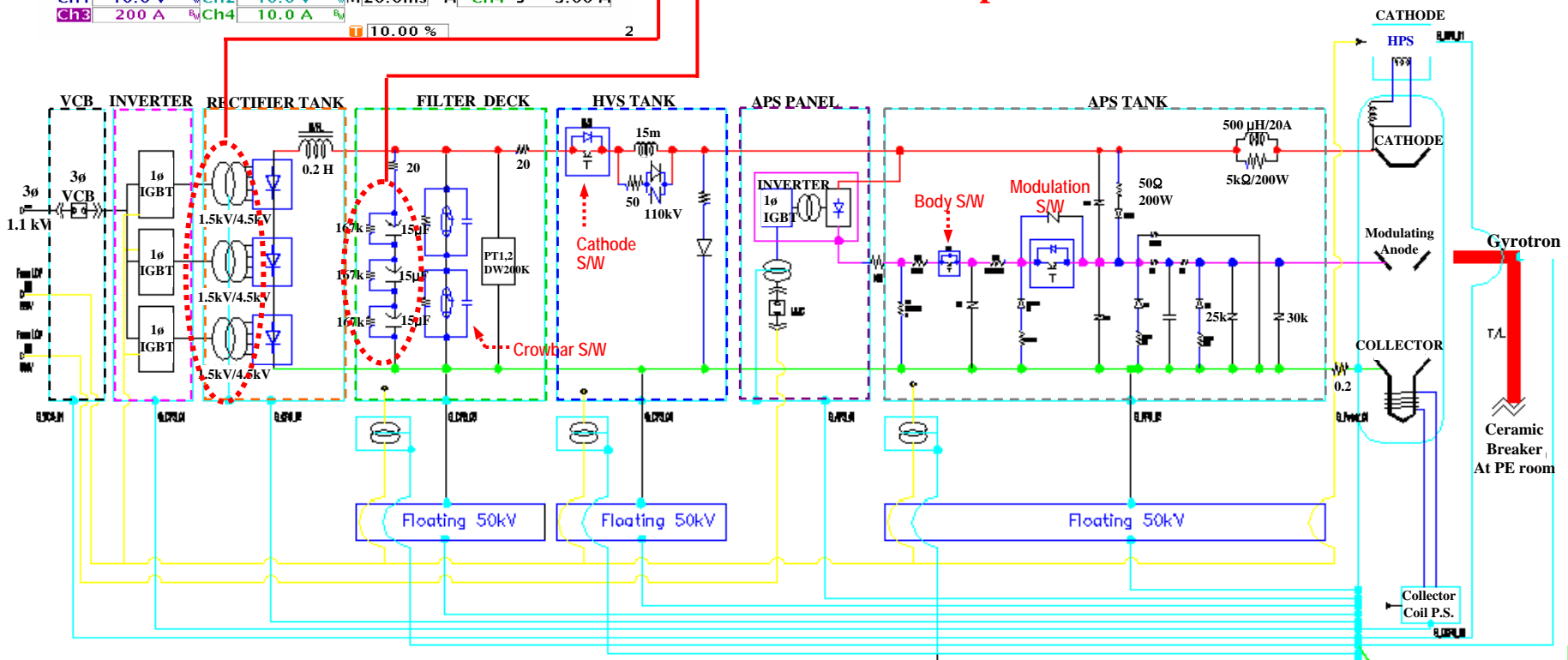
Problems and Improvements



Voltage drop and ripple of cathode affect beam current and power for Gyrotron. It must be reduced within 3 kV, 4 ms.

Replacement of transformer with new one for the impedance matching improvement.

Increase of capacitance.



Summary and Future Plan

- The KSTAR ECH system is installed and the test of 2-MW power supply system is carried out using dummy resistors.
- The dummy resistor test shows that the CPS supplies 25 A with 80 kV for 1 msec long pulse, and the APS supplies the stable acceleration voltage with respect to CPS voltage. And also, APS modulation test is performed with the conditions of modulation frequency 100 Hz, modulation voltage 5 kV in open circuit.
- As the results of the dummy resistor test, voltage drop and ripple of the CPS becomes an issue.
- How to achieve the solutions?
 - New design and replacement of transformer with new one for the impedance matching improvement.
 - Increase of capacitance with more capacitor.
- The full power test of the GPS will be on June with the conditions of 25 A, 80 kV, 2 sec.