

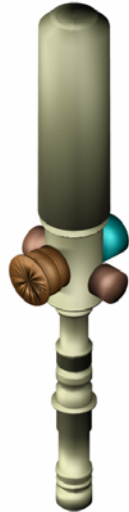
Status of the ECH System on DIII-D

Y. A. Gorelov, J. Lohr, D. Ponce, R.W. Callis,
K. Kajiwaraa,

General Atomics, P.O. Box 85608, San Diego,
California 92186-5608, USA

aORISE, Oak Ridge, Tennessee, USA

DIII-D Gyrotrons.



**GYCOM, Russia,
110 GHz, 890 kW max,
3 units were installed**

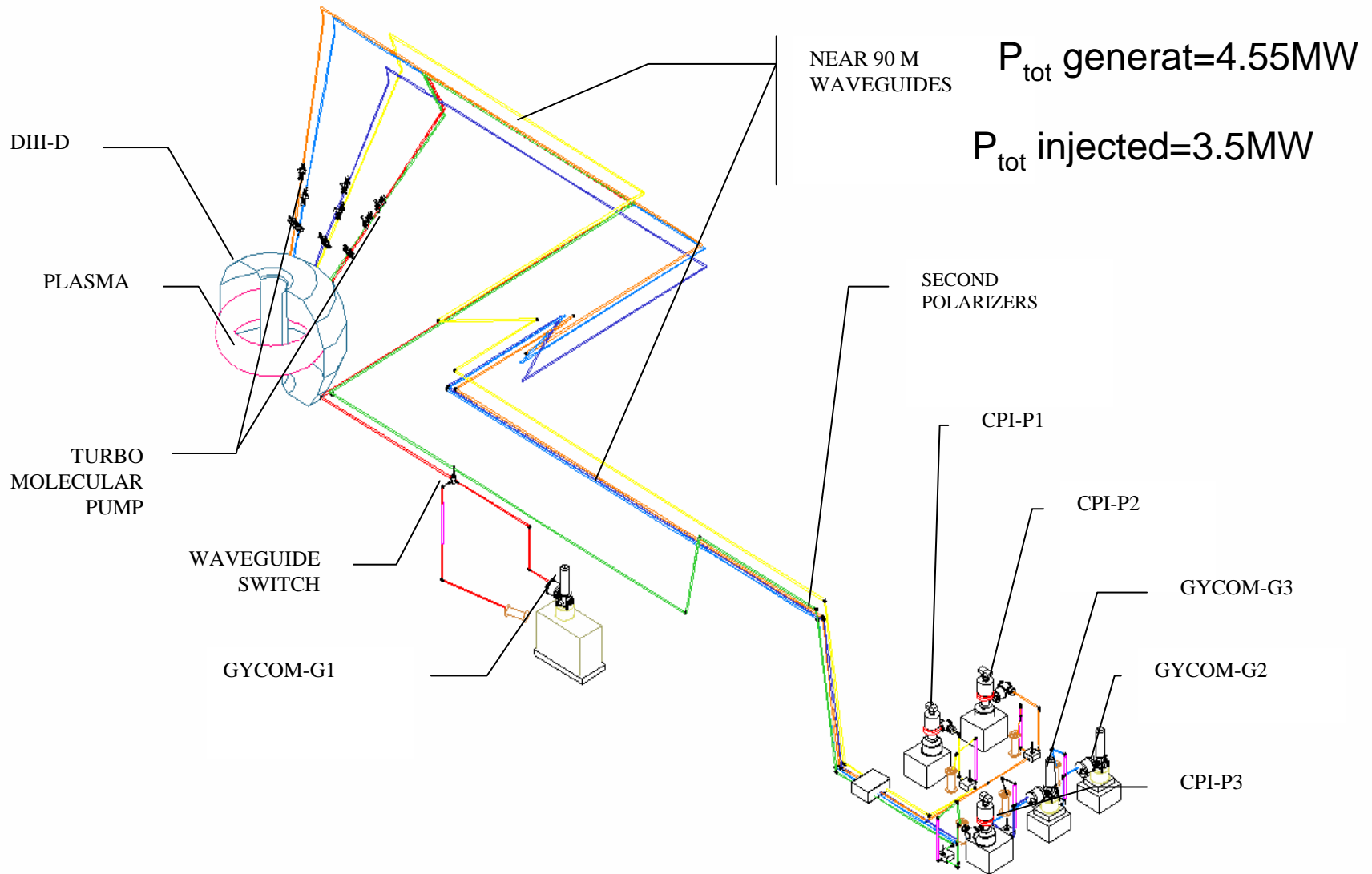


**CPI, USA,
110 GHz, 1000 kW max,
4 units were installed**

GA Gyrotron Parameters

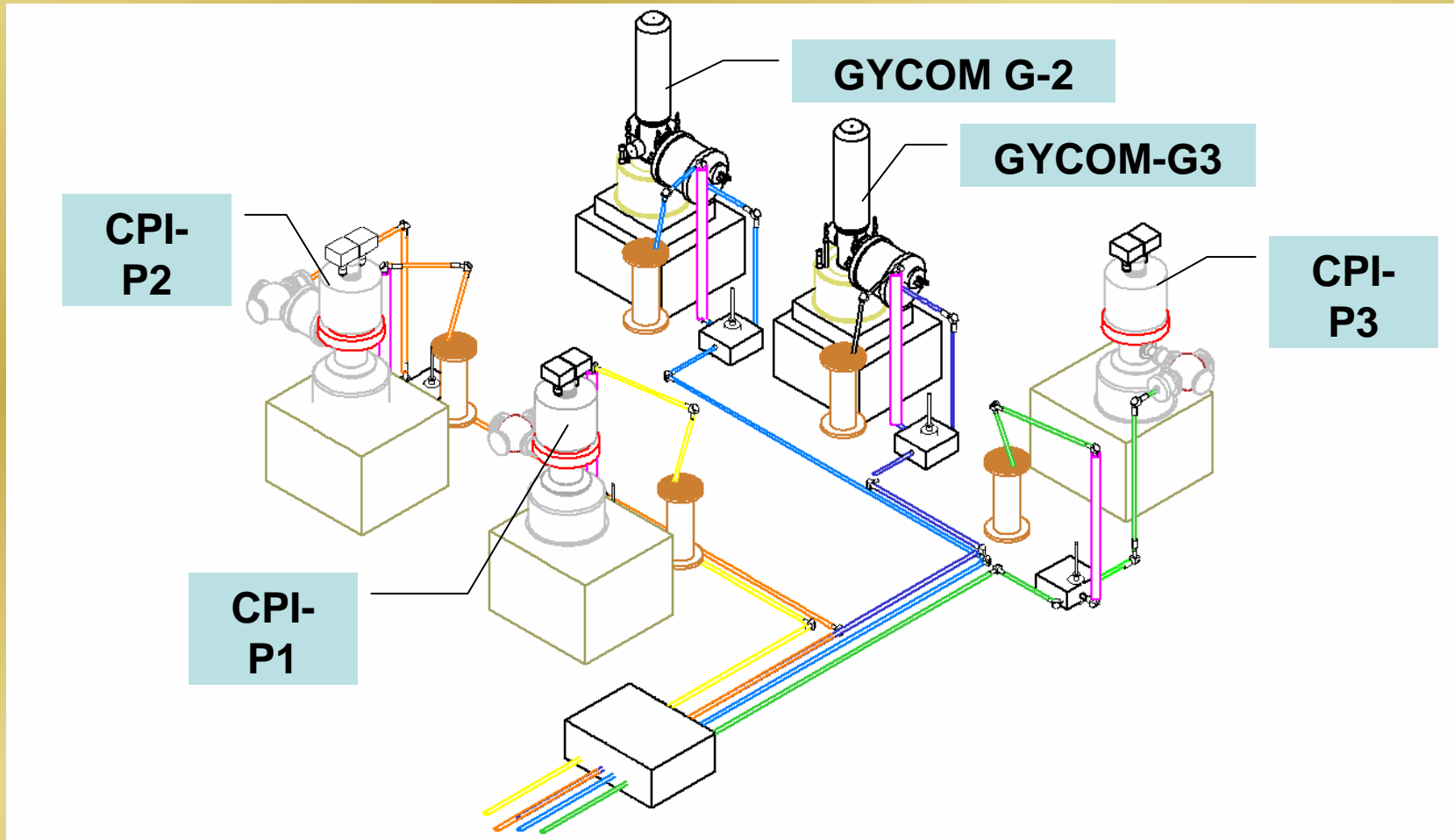
Gyrotron name	Pulse length (sec)	Vbeam (kV)	Ibeam (A)	Effeciency (%)	Pwin (kW), %	Since In GA	Pgen (KW)
Gycom-G1 (Katya)	2.1	72	31	31	33 (3.7%)	1995	700
Gycom-G2 (Boris)	2.1	69	30	30	30 (3.9%)	2000	775
Gycom-G3 (Natasha)	2.1	69	30	30	25 (4.1%)	2000-2003	610
CPI-P1 (Sacrecrow)	5	80	40	31	1.6 (0.35%)	2002	980
CPI-P2 (TinMan)	5	78	40	30	2.1 (0.22%)	2000	950
CPI-P3 (Lion)	5	80	40	31	2.8 (0.28%)	2002	980

Layout of DIII-D ECH system in 2003.

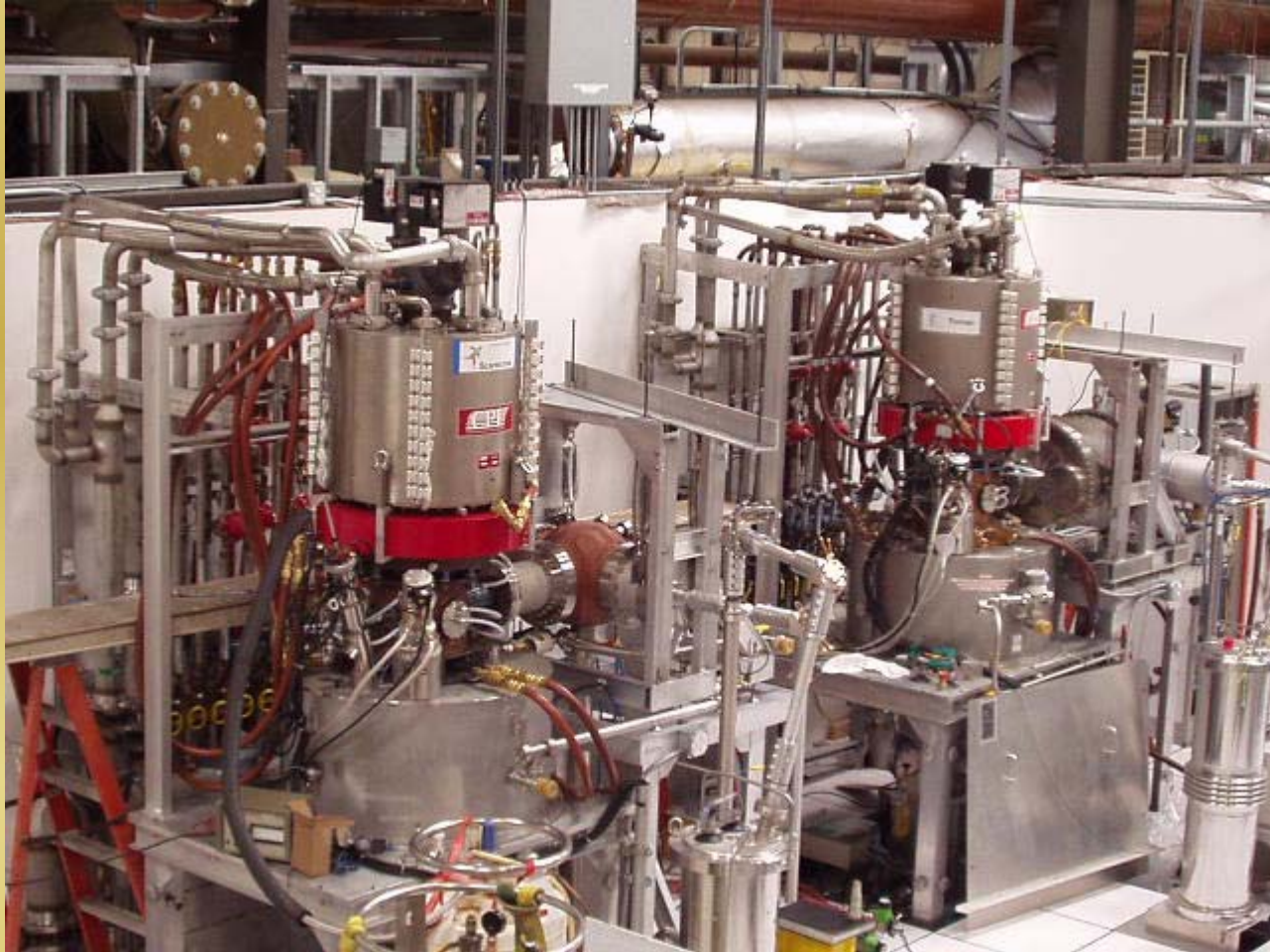


May, 2004

ECH new hall, 2003

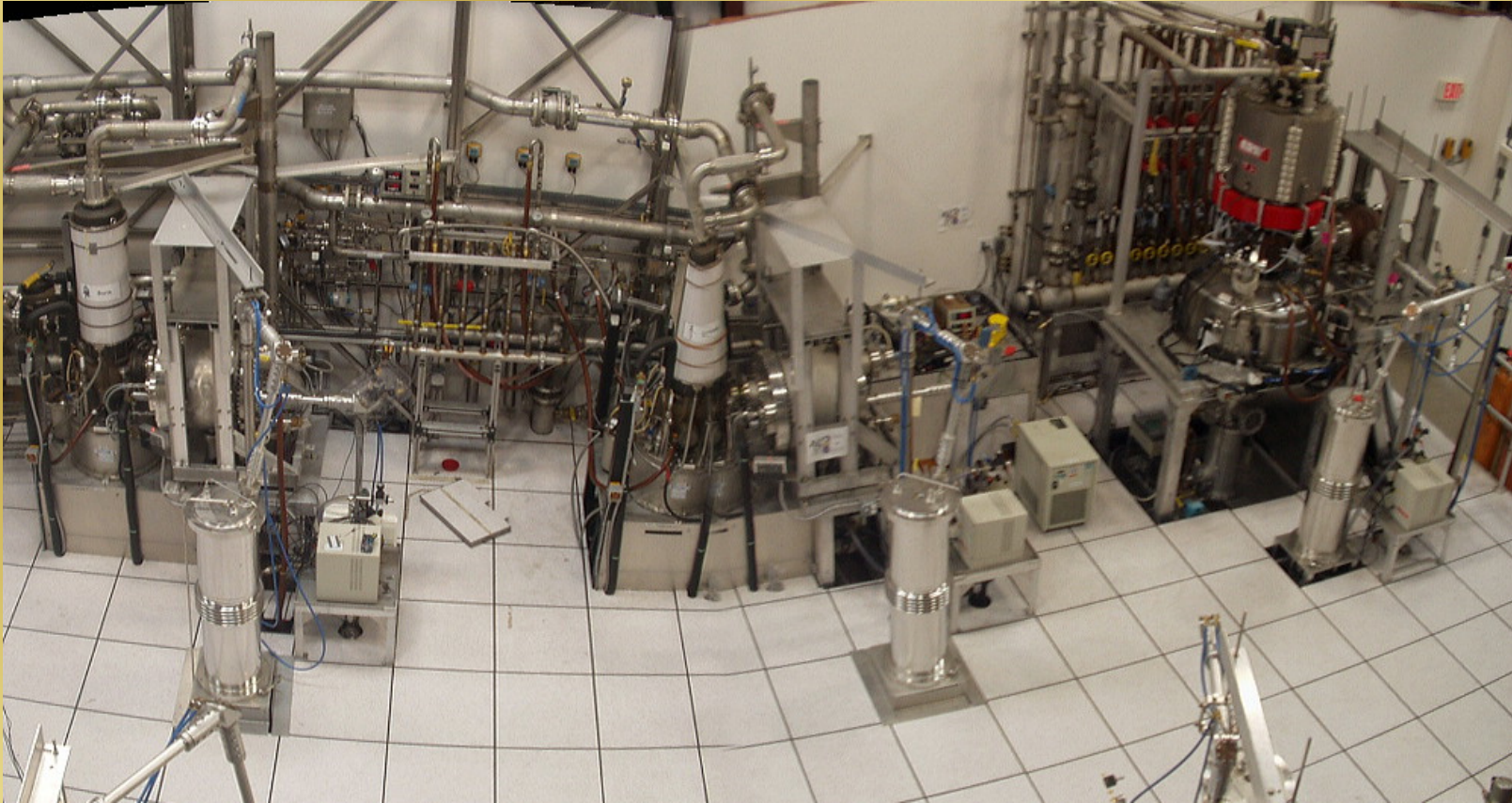


CPI-P1, CPI-P2



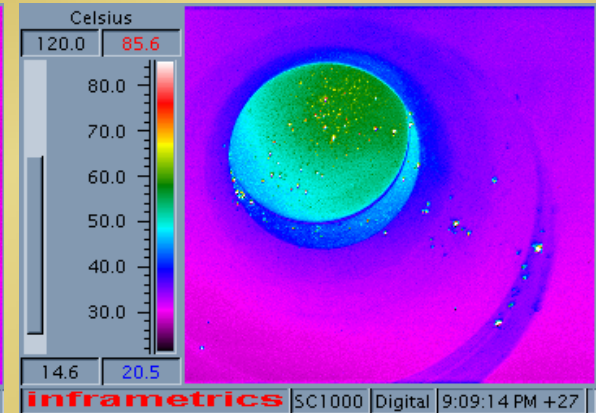
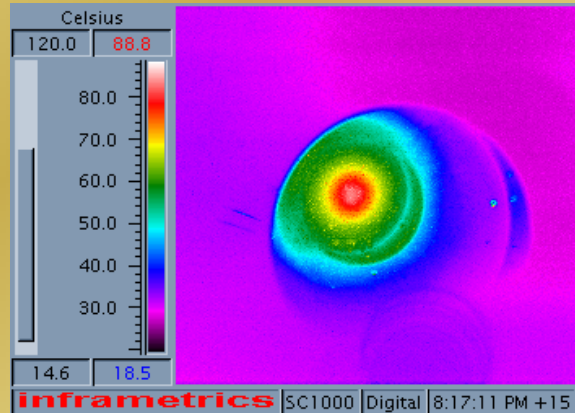
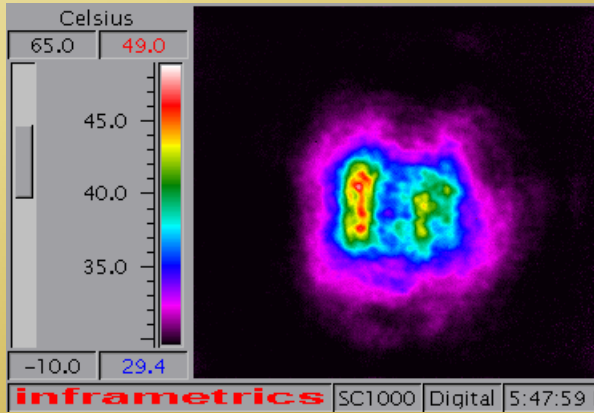
EC-13, Nizhny Novgorod, 17-20
May, 2004

Gycom-G2, Gycom-G3, CPI-P3



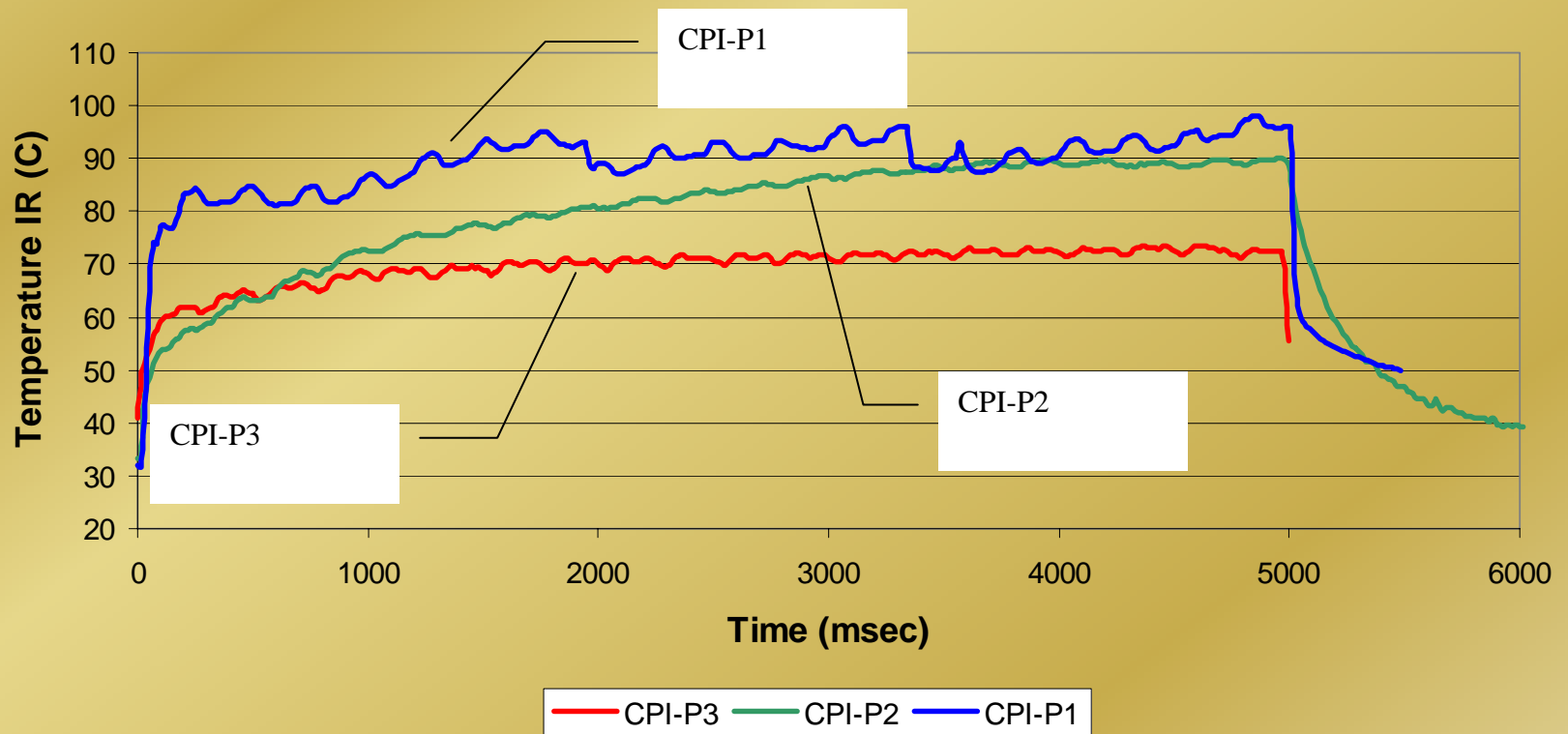
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May, 2004

Gyrotron windows

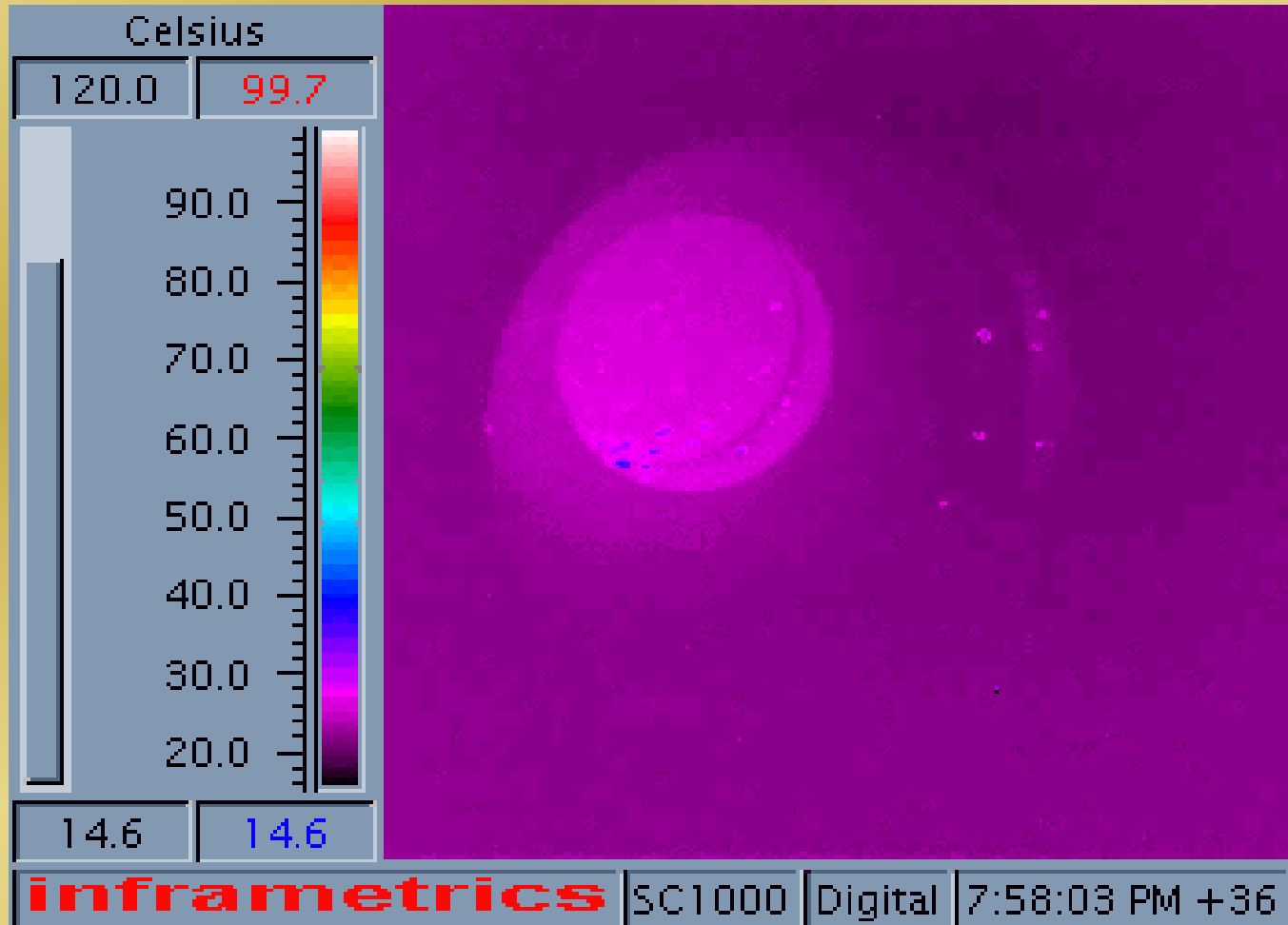


GYCOM-G1	CPI-P2	CPI-P3
boron nitride	Diamond, D=57mm, Thickness=1.14mm	Diamond ,D=73.5mm, Thickness=1.71mm
IR image of Paper target	IR image of diamond disk	IR image of diamond disk
RF beam is broadened to a non-Gaussian profile	Gaussian RF beam, graphite film contamination on the surface.	Gaussian RF beam, Isolated hot spots.

Diamond window temperature during 5 sec pulse, output power more than 900 kW.

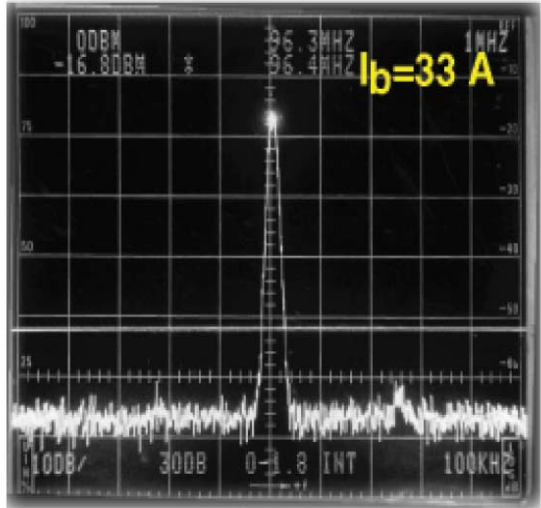


IR image of CPI-P2 5 sec, 900 kW

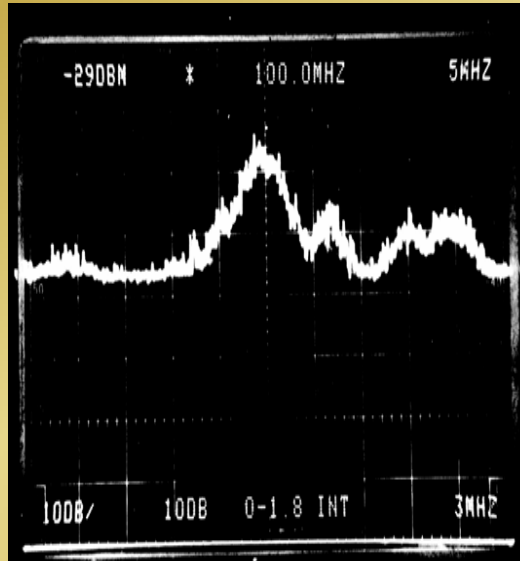


Parasitic emission near 100 MHz.

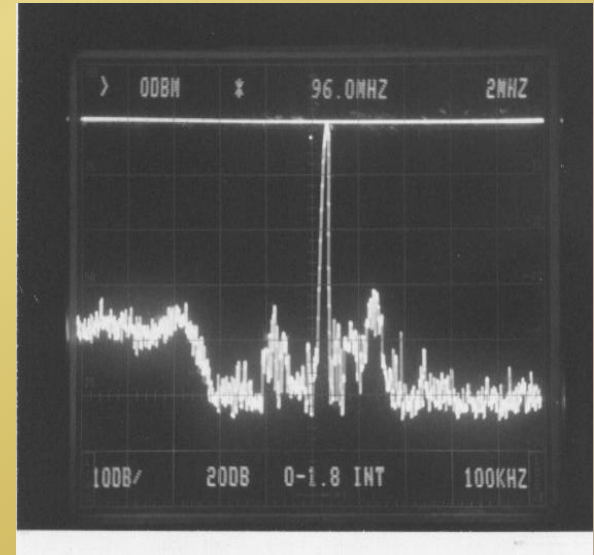
10 dB/div



1 MHz/div



5 MHz/div

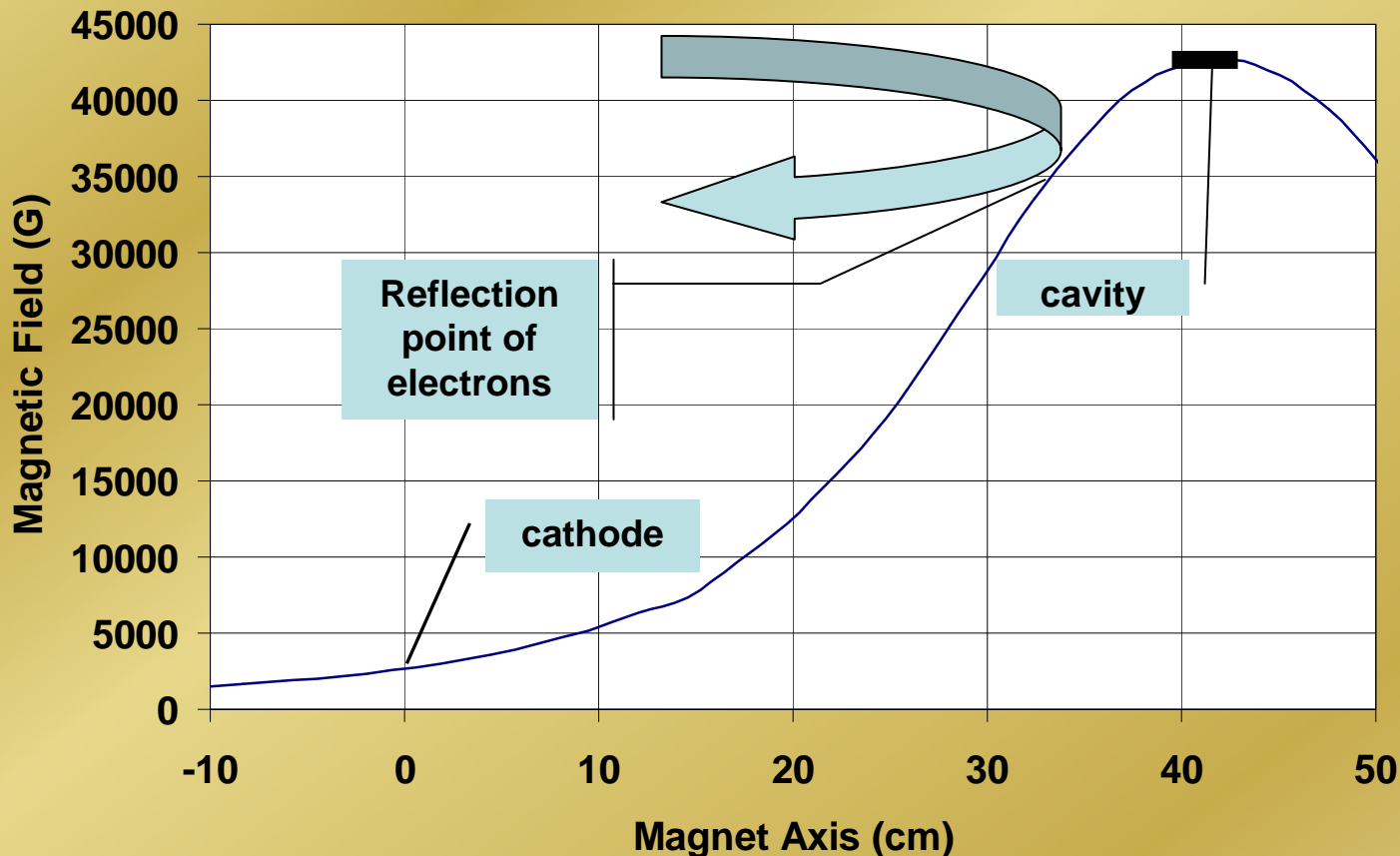


2 MHz/div

Gycom-G1	CPI Prototype 2	CPI-P2
Gun: diode, since 1996	Gun: triode, since 1999	Gun: diode, since 2004

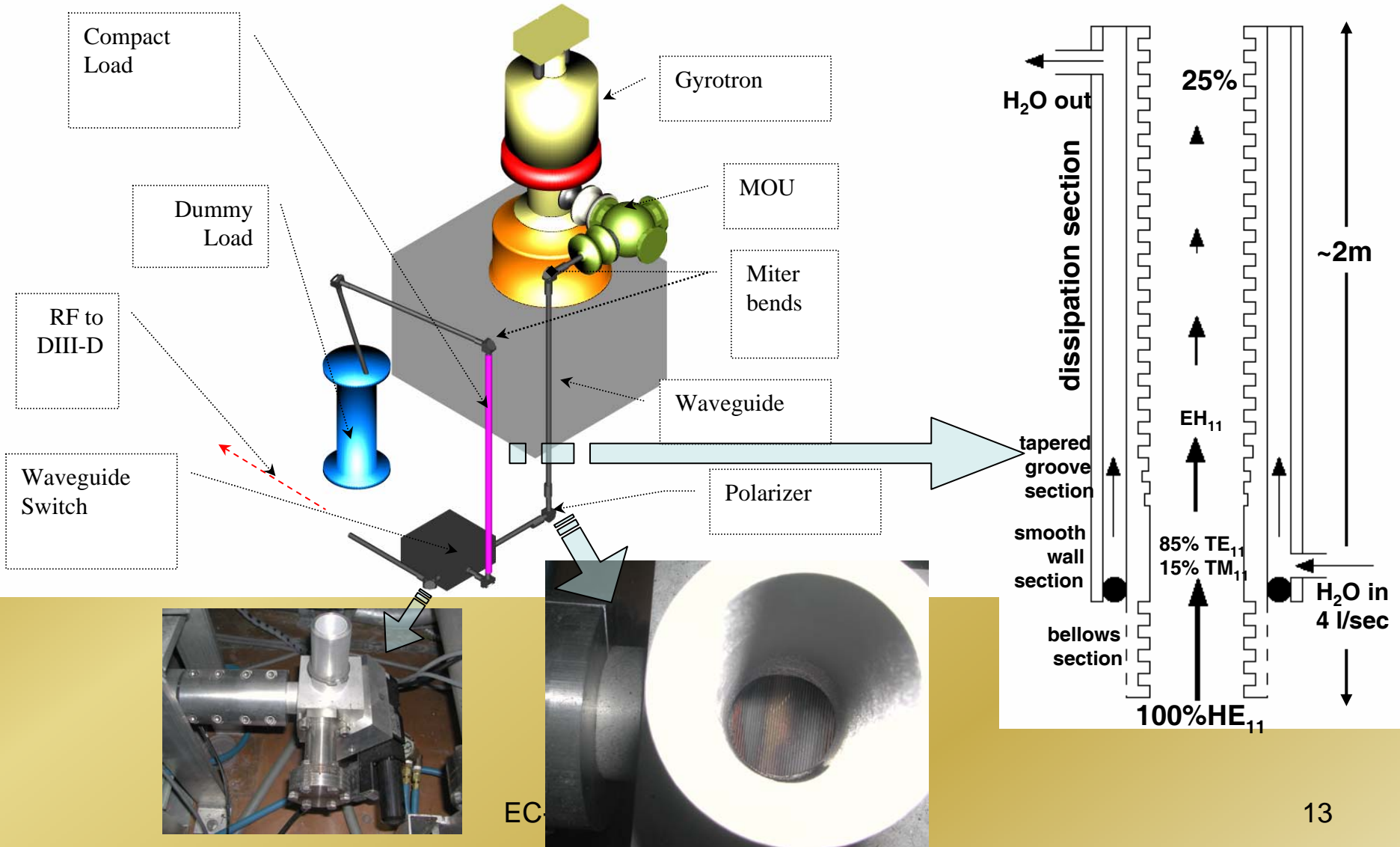
Mechanism of parasitic emission.

Magnetic field axial distribution

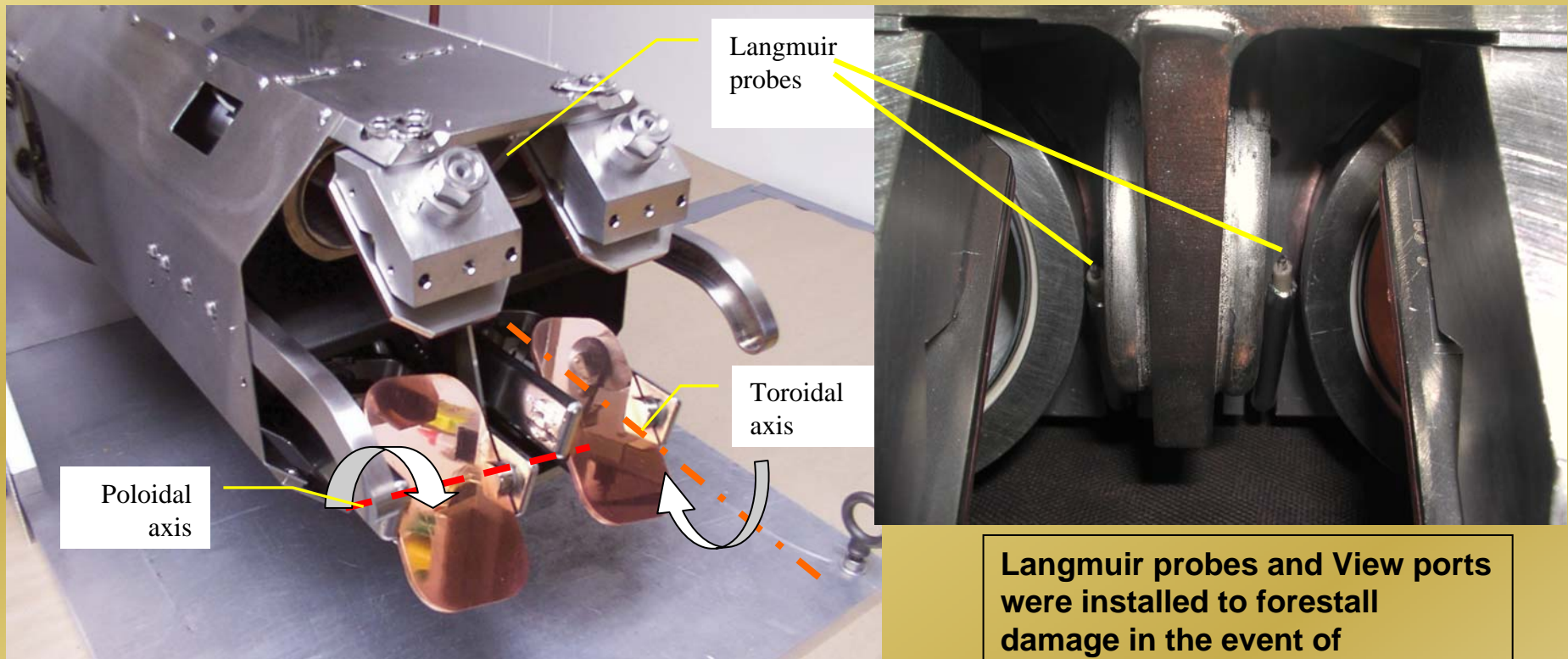


The frequency is consistent with the transit time for electrons reflected from the magnetic mirror field at the cavity and trapped between the cavity and the gun.

Transmission line.



PPPL fully articulating dual launchers.



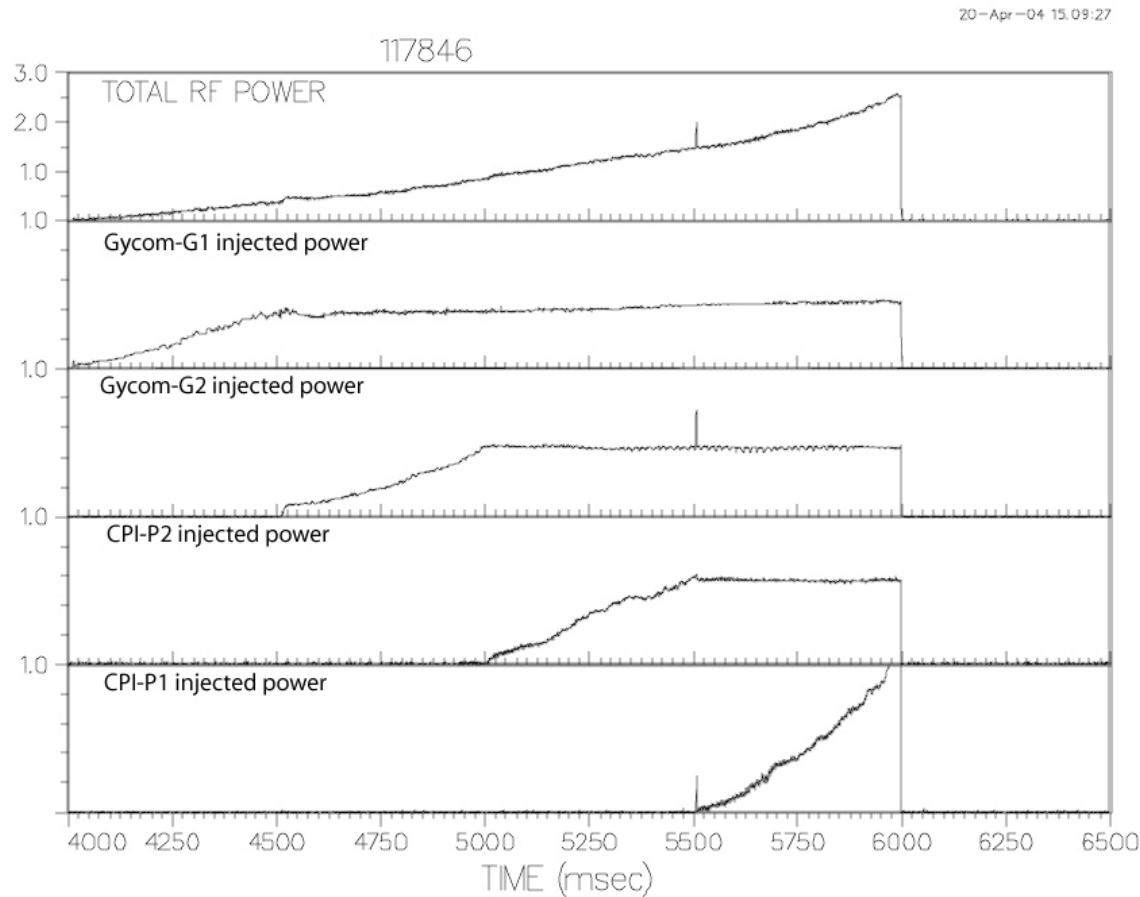
All 3 launchers can steer the RF beams poloidally and toroidally through $\pm 20^\circ$ in each direction, two of them are capable of high speed, 100° /s, spatial scanning.

Launcher damage.



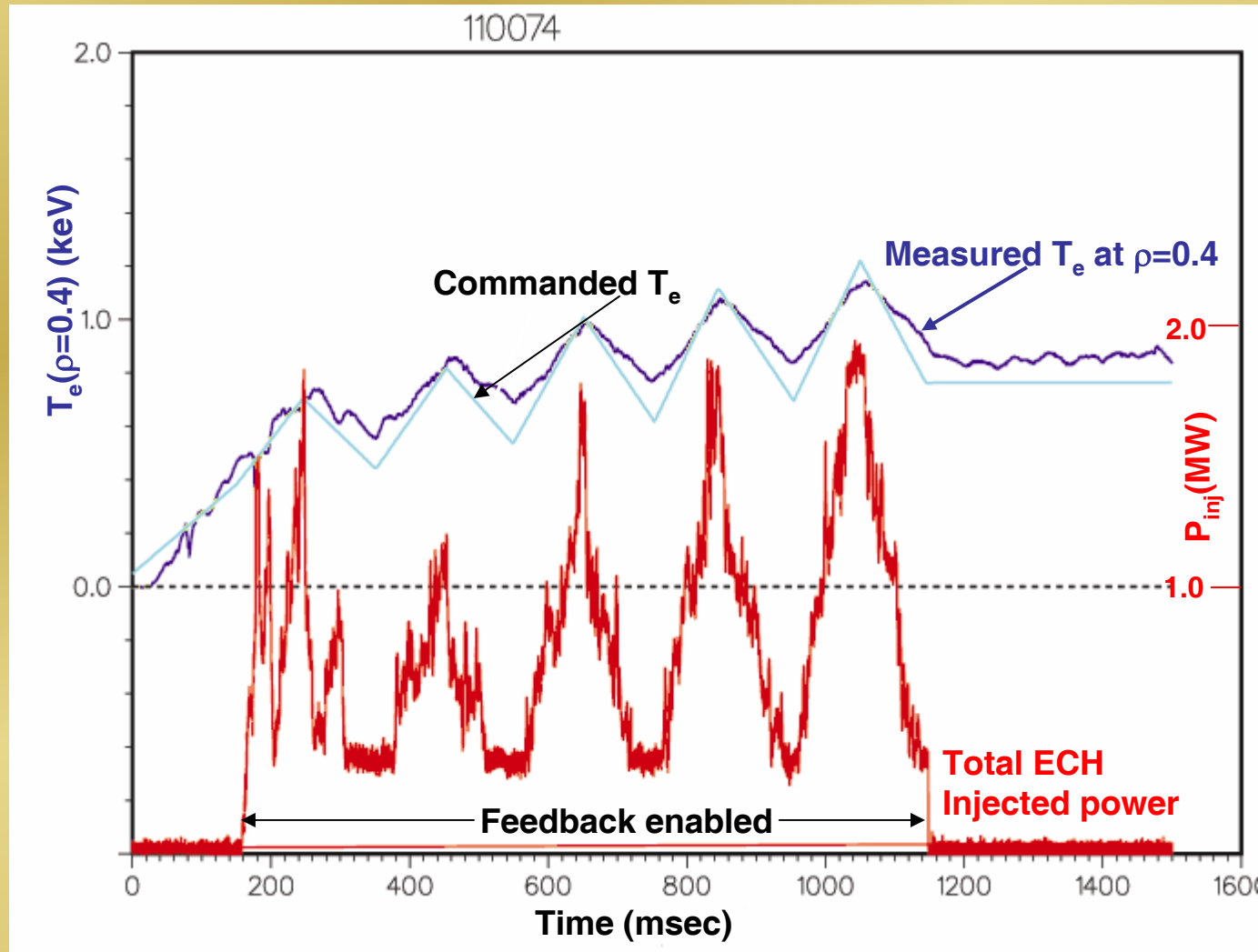
The shutter actuator arm length changed and the shutter failed fully to open. An rf driven arc ate the launcher waveguides.

Plasma Control System.



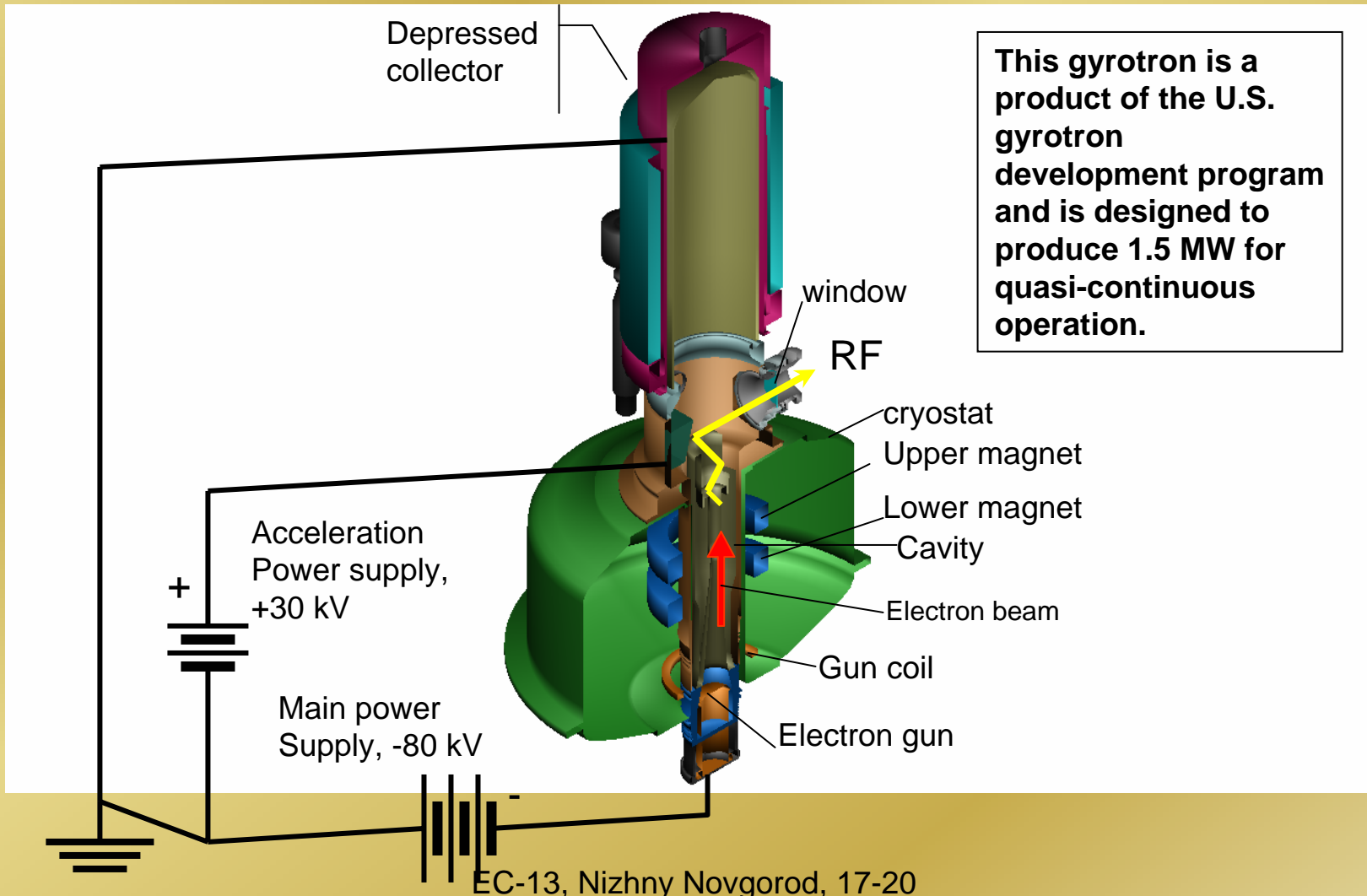
The DIII-D Plasma Control System (PCS) not only controls the plasma equilibrium and evolution during tokamak shots, but also can serve as a feedback system linking of variety of plasma parameters with the gyrotron output power.

Feedback Control of ECH Power



Future plans.

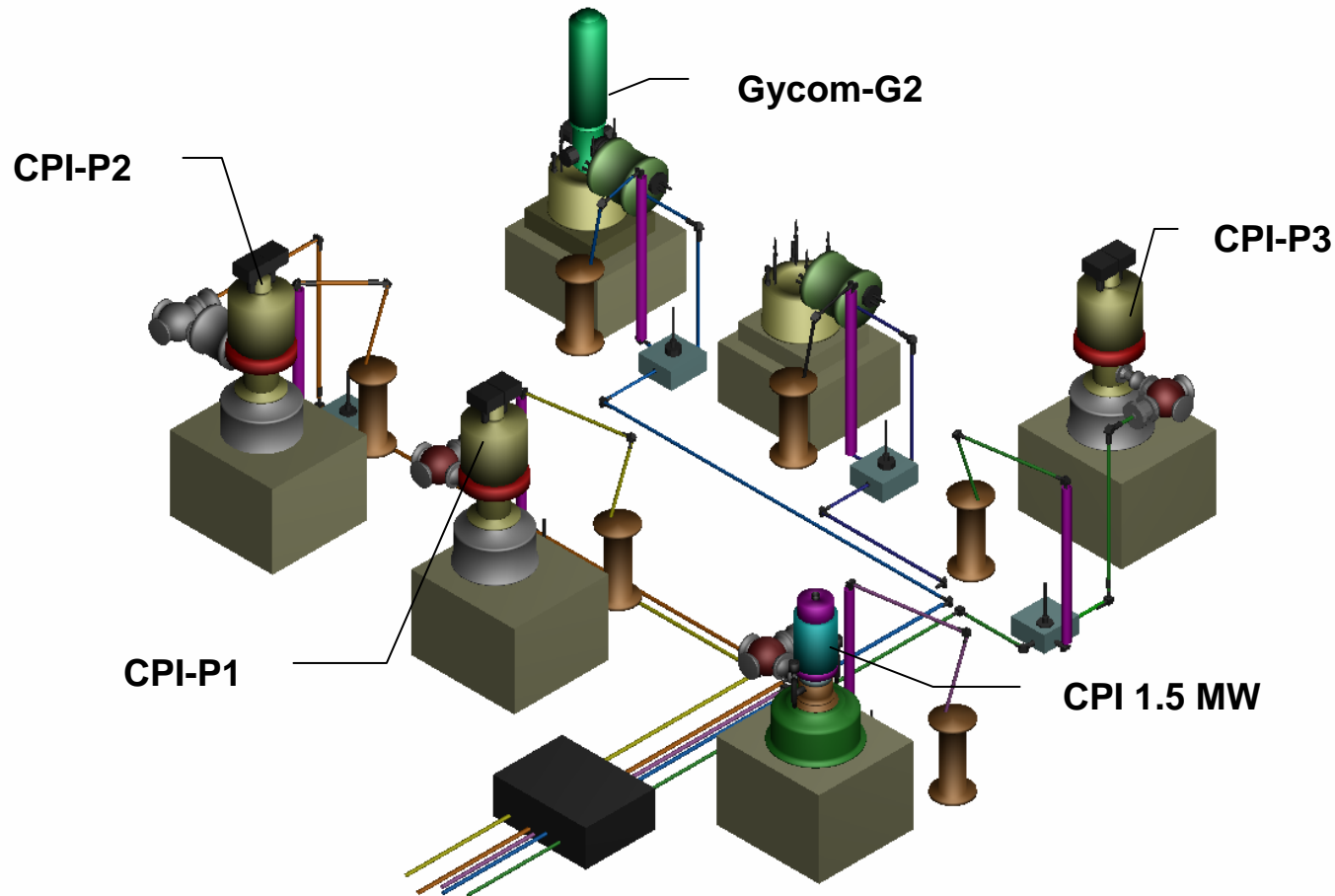
Installation and testing in GA 1.5 MW gyrotron with depressed collector.



This gyrotron is a product of the U.S. gyrotron development program and is designed to produce 1.5 MW for quasi-continuous operation.

Future plan (cont).

ECH new hall, 2004



EC-13, Nizhny Novgorod, 17-20
May, 2004

Summary

- ECH system on DIII-D presently consists of five 1 MW level gyrotrons
- Total injected into DIII-D RF power exceeded 3.5 MW, pulse duration 3.5 sec
- ECH system on DIII-D is a major tool for controlling current and pressure profile in plasma
- Plasma Control System (PCS) with the gyrotron beam voltage waveform generators permits real-time feedback control of plasma properties