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Electron Temperature Measurement And observation Of Sawtooth Behavior In IR-T1 Tokamak By E.C.E Diagnostic

*R.Shariatzadeh *,**M.Ghoranneviss,**P. Khorshid, **R. Avin
* Faculty of science, Islamic Azad University,Kashan, p.o.box:87135-433, Iran
**Plasma Physics Research Center,Science and Research Campus, Islamic Azad University,Tehran, p.o.box:14665-678,Iran
(*r_shariatzadeh@yahoo.com)

Abstract

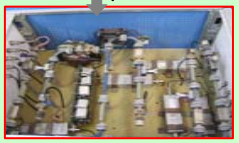
A suitable instrument for electron temperature measurement in tokamak is electron cyclotron emission (E.C.E) diagnostic. We used a heterodyne radiometer in IR-T1 tokamak to measure this parameter. This 5 channel system works in K_α-band and has a very fast response time and good resolution frequency for IR-T1 tokamak with R=45cm, a=12.5cm, B_t=0.6-0.8T and I_p=20-40KA.

This receiver was used outside the tokamak in horizontal direction to B_t, and with second harmonic Of X-mode, and electron temperature was measured.

sawtooth behavior in diagrams was observed, when plasma current reaches to the certain value, and their characteristics according to E.C.E channel region with respect to the plasma center and the plasma edge were studied.

Finally effects of B_t, RHF and gas pressure on electron temperature and sawtooth behavior was studied.

heterodyne radiometer



$$\theta = 0 \qquad r = \left(\frac{56B_0}{f} - 1\right)R_0$$

B_0 is in Tesla and f is in GHz

The operational parameters of IR-T1 tokamak were:

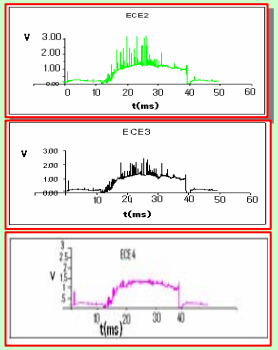
- B_t =0.7 T
- P = 3.0 * 10^{-5} Torr
- I_p=20-40KA
- Loop voltage (peak) =2-20 V
- $\overline{n_e}$= 0.4 ~ 2 × 10^{13} cm^{-3}

Channel 2: r=2.6cm with f=38.65GHz

Channel 3: r=3.25cm with f=38.12GHz

Channel 4: r=3.7cm with f=36.25GHz

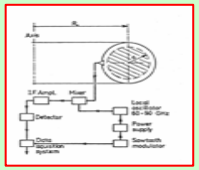
ECE signal for 3 channels



T_e versus time for channel 2

Different diagnostics are used in IR-T1 to study the plasma behavior:

- •Soft X-Ray
- •Mirnov coils
- •Rogowsky coils
- •Langmuir Probe
- •E.C.E
- •…



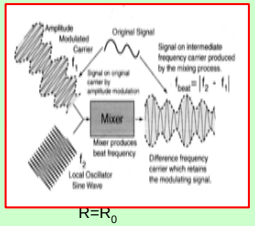
Due to the electron gyration around magnetic field lines, electromagnetic radiation is emitted. This radiation occurs at discrete angular frequencies w=nw$_c$.

$$I(\omega)=I_B(\omega)[1-e^{-\tau(\omega)}] \qquad \tau=-\int_L^0 \alpha(\omega)ds$$

When $\tau >> 1$ I=I_B

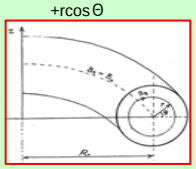
Rayleigh-jeans law

$$I_B(\omega)=\frac{\omega^2}{4\pi^2c^3}KT_e \qquad \omega=\frac{neB_tR_0}{m_eR}$$

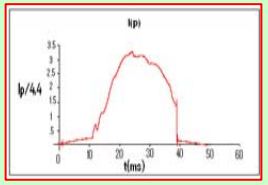


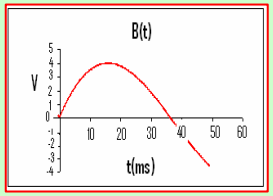
R=R_0

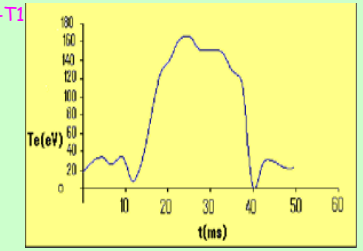
+rcosΘ



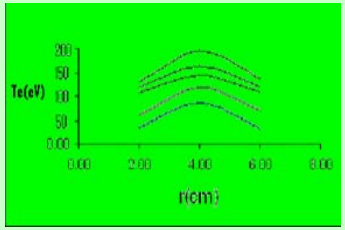
I_p and toroidal magnetic field for a typical IR-T1 discharge







radial profile of T_e



ECE receivers

- Michelson Interferometer
- •Grating Polychromator
- Fabry-Perot Interferometer
- •Heterodyne Radiometer

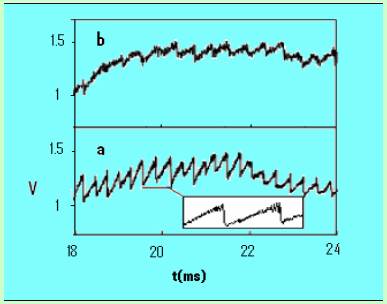
frequency resolution $\left(\frac{\Delta f}{f} \le 10^{-3}\right)$

Time resolution (less than 1mS)

we don't have a maximum value of temperature at the center of the torus, because of the high rate of recombination in the center.

- sawtooth behavior that initially occurs at the channels closer to the center.

Sawtooth behavior



When we use RHF, we see that radiation intensity increases, and so does the temperature. sawtooth behavior is related to the energy confinement and profiles of plasma parameters, so we can use RHF to improve internal stability property of tokamak plasma.

Influence of RHF on E.C.E signal