# PLASMA FORMATION AND SUSTAINMENT BY A MULTIJUNCTION GRILL ON THE CASTOR TOKAMAK

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Radiofrequency power up to 40 kW injected into the vacuum chamber of the CASTOR tokamak by a multijunction grill was used for plasma formation during the ramp-up phase of the toroidal magnetic field. When electron cyclotron resonance (ECR) appears inside the tokamak chamber for a given pumping frequency ($f = 1{\cdot}25$ GHz) a plasma with a density greater than $2 \times 10^{18}$ m$^{-3}$ and temperature $T_e = 10 \div 40$ eV is produced. The plasma is sustained at some lower value of the density during the whole RF pulse. Simultaneously, a toroidal current up to $\simeq 0{\cdot}2$ kA is generated. The energy confinement time is estimated to be about 30 μs during the ECR breakdown.

## 1. INTRODUCTION

The noninductive current drive in tokamaks is a promising way to establish a steady-state operation in a future tokamak-reactor. Usually the target plasma for noninductive current drive is produced by an ohmic heating (OH) transformer. Then, lower hybrid waves (LHW) are injected into the plasma to maintain or to ramp up the toroidal current. Recently, experiments on current drive by LHW have been tried in a target plasma produced by a noninductive discharge. It offers the possibility of the complete omission of the OH transformer in future. In the WT-2 and JIPP T-IIU tokamaks an additional ECR source (gyrotron) has been used for the initiation of the discharge [1, 2]. The PLT group has been successful in the plasma start-up by the same power source, which was then used for noninductive current drive [3]. The LHW launcher was phased in this case first at 0° and after the plasma formation the phasing was changed to a value appropriate for effective current drive. Moreover, a careful programming of the vertical field $B_{vert}$ was highly necessary.

We report here preliminary results of a simple method of the noninductive plasma formation and sustainment in a tokamak by LHW, launched via a 4-waveguide multijunction grill with fixed phase shift ($\Delta\varphi = 120°$), used previously for LH current drive experiment in a target OH plasma [4].

## 2. EXPERIMENTAL ARRANGEMENT

An experiment was carried out on a CASTOR tokamak in IPP, Prague, ($R = 0{\cdot}4$ m, $a = 85$ mm, $r_0 = 100$ mm, $B_T \lesssim 2$ T, hydrogen working pressure $p_{H_2} \gtrsim 30$ mPa). The same preionization source (electron gun) was used as for standard inductive





breakdown. The RF power was launched into a vacuum chamber using a 4-waveguide multijunction grill with dimensions of waveguides 10 × 160 mm (see fig. 1). It should be noted that about 30% of the RF power is reflected when plasma has been created and that the RF power of the generator decreases approximately to 50% at the end of the pulse. The orientation of the grill is such that according to the numerical computation [4], about 50% of the incident power propagates in the

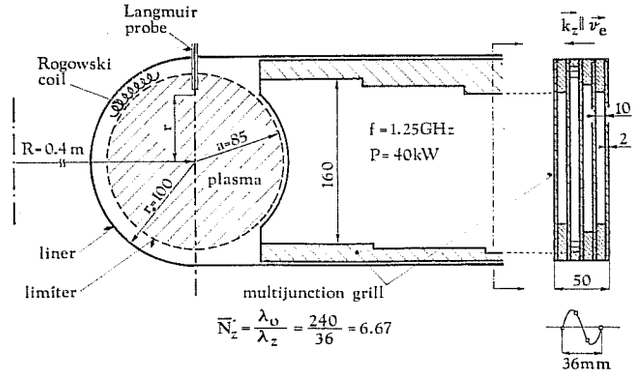


Fig. 1. Cross-sectional view of the tokamak plasma and 4-waveguide multijunction grill.

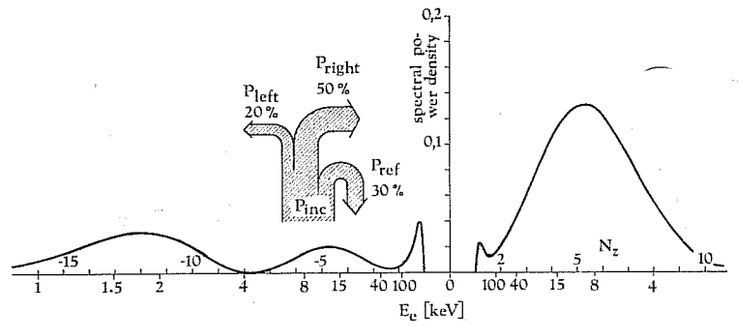


Fig. 2. Spectral power density of the 4-waveguide multijunction grill enumerated for a plasma density in the grill mouth $n_e = 3 \times 10^{18}$ m$^{-3}$ with radial gradient $\nabla n_e = 10^{20}$ m$^{-4}$.

direction of the electron drift velocity during the standard OH discharge in the CASTOR (antiparallel to the toroidal magnetic field $\boldsymbol{B}_T$, i.e. $\boldsymbol{k} \uparrow\downarrow \boldsymbol{B}_T$), see fig. 2. About 20% of the incident power propagates in the opposite direction ("parasitic" branch of the spectral density distribution, parallel to $\boldsymbol{B}_T$). While the calculated spectrum of the main branch has a peak at $N_\parallel = 5{\cdot}5$ (it corresponds to the electron energy about 9–10 keV), the "parasitic" spectrum is substantially extended to higher $N_\parallel$.

During the experiment the primary coil of the OH transformer was short-circuited. Moreover, we employed neither static (vertical and horizontal), nor dynamic magnetic compensating fields ($B_{vert}^{stat} = B_{hor}^{stat} = B_{vert}^{dyn} = 0$) in this experiment.