Enhancement of Fusion Rate by Superthermal Tritium Ions

CARMINE CASTALDO, ENEA Frascati Italy, ALESSANDRO CARDINALI, ENEA, MASSIMO MARINUCCI, ENEA Frascati Italy — We propose a new concept of a nuclear fusion reactor. It is based on the enhancement of the DT fusion rate in tokamak plasmas by a superthermal population of Tritium ions heated by ICRH. It was already shown that break-even conditions might be reached [C. Castaldo and A. Cardinali, Phys. Plasmas 17, 072513 (2010)]. Here we show that $Q \approx 20$, suitable for nuclear fusion power station, can be achieved in a compact tokamak configuration (major radius $R=160\text{cm}$, minor radius $a=55\text{cm}$, elongation $k=1.9$, triangularity $\delta=0.4$, $q_{95}=3.5$), operating with $I_p=8\text{MA}$ plasma current, $B_T=11.3\text{T}$ toroidal field, line averaged plasma density $n=5\times10^{20}\text{m}^{-3}$, and 40% D, 35% H, 25% T concentrations of the Hydrogen isotopes. The burning plasma is obtained by the injection of 15 MW ICRF power, coupled by six antennas, with radiating areas of $0.25\text{m}^2$, at the operating frequency $f=125\text{MHz}$ and toroidal wave number $n_A=4$. The heating scenario has been analyzed by the code TORIC, and approximated analytical equilibria are considered. As a result the total fusion power expected for the proposed scenario is about 350MW, with $Q \approx 20$, assuming that at least 70% of the fusion power carried by the $\alpha$ particles is absorbed by the electrons in the plasma core so that the expected central plasma temperature is about 10keV.