1C14

Fusion Burning Physics Issues for the Ignitor Experiment*

A. Airoldi[+], G. Cenacchi[++], and B. Coppi[+++]
+Istituto di Fisica del Plasma, EIRATOM-ENEA-CNR Association, Milan, Italy
++CRE ENEA, Bologna, Italy
+++Massachusetts Institute of Technology, Cambridge, MA 02139

The Ignitor experiment is designed to reach ignition preserving its stability against the onset of macroscopic modes driven by the plasma pressure gradient. Given the high values of the poloidal field which can be produced [1], these values are also sufficient to generate sufficient ohmic heating of the plasma to enter the α-particle heating regime and attain ignition. The time interval over which ignited plasmas, or slightly subignited ones, can be studied is limited by the ohmic heating of the cryogenic magnets of Ignitor [2]. Therefore it is important to reduce the time needed to reach ignition and it is noted that the most effective process is to apply a modest level of Ion Cyclotron Heating power ($\lesssim$ 3 MW absorbed by the plasma) at the most critical phase of the approach to ignition. That corresponds roughly to the time when the ideal ignition condition is reached and the plasma peak temperatures is about 6 keV. In this phase the ohmic heating is weakened and the α–heating is beginning to be effective. A detailed numerical simulation of the relevant heating cycle has been carried out showing that ignition can be reached during the time over which the plasma current is ramped up to its final value of 11 MA. Thus the entire flattop of the current pulse (4 sec) is left to investigate methods to control the “thermonuclear instability” that follows ignition.

To keep the plasma temperature from “exploding” we consider the effects of small amplitude sawtooth oscillations that should take place when the magnetic parameter $q(\rho)$ drops below unity. The expectation that these amplitudes should be small is related to the fact that the parameter $\beta_p \equiv 8\pi\langle p\rangle / B_p^2$ remains small at ignition and is supported by an extensive series of experiments carried out by the Alcator CMod machine. A provision that is investigated in order to attain slightly subignited conditions is that of controlling independently the concentration of deuterium and tritium departing from the 50/50 local mixture that corresponds to the maximum reactivity.

The relevance of the latest series of experiments carried out by the FTU machine in ohmically heated plasmas with repeated pellet injection to the predicted transport properties of Ignitor is demonstrated.

*Sponsored in part by the U.S. Department of Energy and ENEA of Italy

[1] B. Coppi, A. Airoldi, F. Bombarda, et al., *Nucl. Fusion* **41**, 1253 (2001)
[2] B. Coppi and the Ignitor Project Team, Massachusetts Institute of Technology, R.L.E., Report PTP-02/05 (December 2002)