ITER-FEAT and its diagnostics programme

Tony Donné

FOM-Instituut voor Plasmafysica 'Rijnhuizen', Associatie EURATOM-FOM,
Partner in the Trilateral Euregio Cluster, P.O. Box 1207, 3430 BE Nieuwegein, The Netherlands,
E-mail: donne@rijnh.nl

ITER-FEAT is expected to be the next step device in the worldwide fusion endeavour. It is anticipated that ITER-FEAT can reach extended burn in an inductively driven plasma at Q > 10. Furthermore, it aims at demonstrating steady-state operation through non-inductive current drive at Q > 5. Controlled ignition at a slightly higher value of the plasma current is not precluded. Apart from reaching the above physics goals, ITER-FEAT should demonstrate the availability and integration of essential fusion technologies. Furthermore, it should test components for the future reactor including tritium-breeding blankets with an average neutron flux exceeding 0.5 $MW.m^{-2}$ and an average neutron fluence exceeding 0.3 $MW.a.m^{-2}$. The main parameters of ITER-FEAT are given in the table below:

R (m)	6.2	L_{wall} (MWm^{-2})	0.57
a (m)	2.0	t_{burn} (s)	≤ 400
R/a	3.1	$\langle n\rangle/n_{GW}$	0.8
B (T)	5.3	$\langle n\rangle$ (10^{20} m^{-3})	0.97
I_p (MA)	15.1	$\langle T\rangle$ (keV)	9.0
κ_{95}/κ_x	1.70/1.85	Z_{eff}	1.8
δ_{95}/δ_x	0.35/0.48	n_{He} (axis)/n_e (%)	4.8
P_{fus} (MW)	400	β_N	1.6
Q	10	β (%)	2.3

ITER-FEAT will have four distinct operational phases. After a H-phase of about two years, which is mainly planned for full commissioning in a non-nuclear environment without the need for remote handling, a one year D-phase with limited T follows for exploration of the H-mode. From the fourth year onwards ITER-FEAT will operate with a D/T mixture. First in an inductive ELMy H-mode and later with non-inductive current drive, eventually leading to steady state operation with 1000 s long pulses. Especially, the last phase is very demanding for the diagnostics since it requires the active feedback control of (the profiles of) many different plasma parameters. Apart from the physics requirements that are already challenging in present-day non-nuclear devices, the diagnostics at ITER-FEAT have to work in a very vulnerable environment with high neutron and gamma loads, huge thermal stresses, limited access, etc.

After a short introduction of ITER-FEAT, highlighting its aims, its different operating scenarios and its overall design, an overview will be given of the detailed measurement requirements that strongly depend on the operating scenarios. Specific examples of some diagnostic designs for ITER-FEAT will be shown. The examples will be chosen such that they give a reasonable illustration of the difficulties that one encounters when implementing diagnostics in the various type of ports (upper plug, equatorial plug and divertor).

In the last part of the talk an overview will be given of the outstanding high priority, intermediate term and long term diagnostic issues.