# NON-DESTRUCTIVE METHODS FOR THE DEFECT DETECTION DURING THE MANUFATURING OF ITER HIGH HEAT FLUX COMPONENTS

S.Roccella[a], E.Cacciotti[a], A.Castillo[b,c], A.Mancini[a], A.Pizzuto[a], A.Tatì[b], E.Visca[a]

[a]*Associazione ENEA-Euratom sulla Fusione C.R.Frascati - 00044-Frascati, RM, Italy,*

[b]*Associazione Euratom-ENEA sulla Fusione, C.R.Casaccia, Via Anguillarese 301-00123 S.Maria di Galeria, RM, Italy*

[c]*Universidad Politécnica de Valencia, Spain*

The manufacturing of plasma facing components and in particular the divertor is one of the most challenging aspects for tokamak fusion machines like ITER. For this reason the manufacturing process has to include reliable quality controls on each phase and the non-destructive controls have the main role in this frame.

This paper discusses the application of non-destructive testing for the control of the joining interfaces present in the plasma facing units of the ITER divertor inner vertical target. The defect detection capability has to be demonstrated for both metal to metal and metal to carbon/carbon fibre composite (CFC) joints because these two types of joints have to be realized for the manufacturing of the high heat flux units. Copper has to be joined to other metals (i.e. the CuCrZr alloy tube, stainless steel, tungsten) and also to CFC.

ENEA has developed and widely tested a non-destructive testing method suitable for the control of all these joints with size and geometry according to the ITER specifications. The Ultrasonic Testing (UT) technique was chosen among others for its sharpness and capability to easily fit when the geometry of the components is changed.

The UT results coming from the investigation performed during the manufacturing but also after the thermal fatigue testing (up to 20 MW/m$^2$) of six mock-ups manufactured using the Hot Radial Pressure technology (HRP) in ENEA labs are presented and compared with the evidences from the final destructive examination. The activity, performed in the frame of the EFDA contract 05-1249, was aimed at investigating the feasibility of using an alternative W grade, manufactured in the Russian Federation, for the fabrication of the divertor target components.

Usually the ultrasonic tests are carried out from inside the tube while in this case, after the thermal fatigue, it was carried out also from the outside because of the poor state of the inner surface of the tube.

Regarding the Cu/CFC joint, the effectiveness of the ultrasonic test has been deeply studied due to the complete opacity of CFC to ultrasonic waves. To investigate the possibility to use the ultrasonic technique for this type of joint, an ‘ad hoc’ plane Cu/CFC joint sample, that reproduces faithfully the actual annular joint, has been manufactured. This plane sample has the advantage of being easily tested by a variety of probes. UT are compared with X-ray and eddy current testing of the same sample.