**Diagnostics for, and of, the open large volume TCV divertor transiting from attached to detached regimes**

B.P.Duval1, C.Theiler1, O.Fevrier1, H.Reimerdes1, A.Perek1, B.Linehan2, L.Martinelli1, D.Mykytchuk1, Y.Andrebe1, S.Gorno1, C.Colandrea1, C.Wuethrich1, N.Offeddu1, D. S.Oliveira1, K.Lee1, W.Han2, T.Golfinopoulos2, E.Huett1, L.Simons1, G.Sun1, C.Tsui3, Y.Wang1, M.Zurita1, M.Baquero1, U.Sheikh1 and the TCV Team

*1 Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland*

*2 PSFC, Massachusetts Institute of Technology, 77 Massachusetts Avenue, NW17 Cambridge, MA 02139, U.S.A*

*3 UCSD, Center for Energy Research (CER), La Jolla, CA 92093, United States of America*

TCV has an up/down symmetric open vacuum chamber where diverted configuration’s legs may be placed near anywhere within the capabilities of its 16-element, independently powered, poloidal coil array. Diagnosing such a range of poloidal magnetic configurations originally relied upon a generous array of tile-embedded Langmuir probes, floor and high-field-side IR cameras and surveillance imaging. In recent years, diagnostic needs have extended to partially and deeply detached configurations with and without in-vessel neutral gas baffles and this for the widest range of divertor configurations that include a range of two, four (and more) strike points, ranges of divertor leg flux expansion and, in TCV tradition and a wide range of core shapes that include high negative triangularity.

Furthermore, to make physics progress, results from all these configurations are to be compared with edge plasma physics modelling. Two more factors are required: systems that can simultaneously diagnose a large part of the diverted plasma *and* surrounding, and some direct experimental data validation. This paper describes a wide slew of novel diagnostics that include inversions of images from arrays of spectrally filtered cameras (MANTIS), reciprocating Langmuir Probe arrays (RDPA and fastRP), neutral pressure valves (Baratrons and AUG-in-field types), a highly complete visible spectroscopy array (DSS: survey to high resolution), edge turbulence characterisation (though edge GPI), edge radiation intensities (AXUV and blackened Bolometer Arrays) and Thomson Scattering spectrometers able to measure temperatures to below 1eV. To understand the results of extensive SOLPS simulations, TCV’s magnetic control system was programmed to scan the divertor leg positions across the diagnostics’ positions permitting 2D divertor comparisons/validations both in space and time with model-everything codes (SOLPS-ITER) for detachment relevant conditions. Although each of these diagnostic systems is the subject of both diagnostic and physics publications, their combined, validated, usage provides the basis for a leap forward in diagnostic/modelling comparisons. Finding the physical processes, missing in such models, that are required to generate better experimental agreement will greatly improve extrapolation to upcoming fusion-grade devices.