1st Asia-Pacific Conference on Plasma Physics, 18-22, 09.2017, Chengdu, China

Advances in diagnostic developments for steady-state tokamak operation on EAST and in support of future applications on CFETR

Haiqing Liu[1] on behalf of EAST diagnostic team and collaborators*

[1] Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, China

EAST facility has been developing capabilities to enable and advance research on (1) high performance steady-state operation; (2) suitable plasma exhaust for steady state; and (3) scientific understanding in support of in support of Chinese Fusion Engineering Test Reactor (CFETR), which is under conceptual design to bridge gaps between ITER and DEMO. EAST is equipped with flexible, long-pulse, high power Heating and Current Drive system (LHCD, ICRF, EC, NBI), and tungsten Divertor (ITER-like) which is actively cooled for steady-state single null and double null capability, and RMP 3D coil set; comprehensive set of fueling methods and comprehensive diagnostic set enables scientific understanding [1-4].

Tremendous progress of EAST diagnostics has been made for the new stage of the EAST project. Varieties of diagnostics have been employed to provide high quality experimental data for plasma control, operation of machine, and advanced physics research to accommodate requirements for the study on high performance steady-state operation in EAST and scientific understanding in support of CFETR. In this paper we present an overview of newly developed or upgraded diagnostics, in particular for current density and pressure profile measurements which serve a foundation of tokamak researches [5]. An 11 chord, double-pass, radially-viewing, far-infrared laser-based POlarimeter-INTerferometer (POINT) system has been routinely operated for fully diagnosing the plasma current and electron density profiles throughout the entire plasma discharge, over 100 seconds, with microsecond time response able to detect MHD events, for all heating schemes and all plasma conditions (including ITER relevant scenario development) since 2015. A 40-channel core (10 Hz) and a 10-channel edge (50Hz) Thomson scattering (TS) system for density and electron temperature is routinely operated. An X-ray crystal spectroscopy provides both ion and temperatures and plasma rotation velocity. A charge exchange recombination spectroscopy (CXRS) for the plasma ion temperature and toroidal rotation velocity for core and edge plasma with a high spatial resolution up to ~ 5-7 mm has been well developed.

An electron cyclotron emission (ECE) for electron temperature profile and profile reflectometry are utilized for long pulse plasma control. In addition, electron cyclotron emission imaging (ECEI) for turbulence and fluctuation research is also developed. Fast-Ion D-Alpha spectrum (FIDA) is developed for fast ion behavior and responsible for the possible damage of the first wall during NBI heated plasma. An extreme ultraviolet (EUV) spectrometers provides the measurement of tungsten spectra on EAST for ITER-like tungsten divertor physics study. Particular attention has also been devoted to the edge diagnostics (AC-BES; Li-BES; GPI; Reflectrometry) and diagnostics in measurement of fusion product (Gamma ray).

It is expected that all these diagnostics with cross-checks and data validations would play an important role in synthetic data analysis combined with integrated modeling. It has opened up a new stage of physics research on EAST.

The EAST diagnostic developments for steady-state tokamak operation are also considered in support of future application on the CFETR. The environment in CFETR will be even more challenging than ITER and other existing tokamaks nowadays, especially the high neutron fluence and limited space. Two diagnostic cases, ITER-like case and towards DEMO case, have been considered for CFETR phase I and phase II, respectively. Based on the experience obtained in the development of EAST diagnostics and combined with CFETR special requirements, some preliminary considerations and key diagnostic techniques for CFETR diagnostic system have been forward researched on EAST.

References

[1] B. N. Wan *et al.*, Nucl. Fusion **55**, 104015, 2015.
[2] B. N. Wan *et al.*, Plasma Physics and Controlled Fusion **58**, 014029, 2016.
[3] B. N. Wan *et al.*, IEEE Trans. Plasma Sci. **42**, 495, 2014.
[4] L. Q. Hu *et al.,* Plasma Science and Technology **13**, 125, 2011.
[5] J. Huang, J. *et al.*, 8th US-PRC Magnetic Fusion Collaboration Workshop, PPPL, June 28-30, 2016.

* Collaborators for the physics diagnostics on EAST :
Domestic: USTC, SWIP, HUST, PKU, THU, DHU, THU, DLUT, HFUT
USA: GA, JHU, MIT, ORNL, PPPL, UC Davis, UCLA, UCSD, UT Austin;
Japan: NIFS and JAEA;
Korea: NFRI and KAERI;
FRANCE: CEA;
Germany: IPP Garching and FZJ.