Contribution ID: **644** Type: **Poster**

Achievement of Field-Reversed Configuration Plasma Sustainment via 10 MW Neutral-Beam Injection on the C-2U Device

Wednesday, 19 October 2016 08:30 (4 hours)

The world's largest compact-toroid device, C-2, has been upgraded to C-2U at Tri Alpha Energy to achieve sustainment of field-reversed configuration (FRC) plasmas by neutral-beam (NB) injection (NBI) and edge biasing [1,2], and the C-2U experiment is characterized by the following key system upgrades: increased total NB input power from ˜4 MW (20 keV hydrogen) to 10+ MW (15 keV hydrogen) with tilted injection angle; enhanced edge-biasing capability inside of each end-divertor for boundary/stability control. C-2U experiments with those upgraded systems have successfully demonstrated dramatic improvements in FRC performance. As anticipated, there are strong effects of the upgraded NB injectors on FRC performance such as: (i) rapid and strong accumulation of fast ions (about a half of initial thermal pressure replaced by fast-ion pressure); (ii) fast-ion footprint largely determines FRC dimensions; (iii) double-humped electron density and temperature profiles; (iv) FRC lifetime and global plasma stability scale strongly with NBI power; and (v) plasma performance correlates with NB pulse duration in which diamagnetism persists several milliseconds after NB termination due to accumulated fast ions. The key accomplishment on C-2U is sustainment of advanced beam-driven FRCs with a macroscopically stable and hot plasma state for up to 5+ ms, limited only by hardware and stored energy constraints such as the NBs'pulse duration (flat-top ˜8 ms) and current sourcing capability of end-on plasma guns. Furthermore, plasma diamagnetism in the best discharges has reached record lifetimes of over 11 ms, timescales twice as long as C-2. In this regime fast ions are well trapped and nearly classically confined, suppressing broadband magnetic turbulence as well as enhancing fusion reactivity via beam driven collective effects. Density fluctuations near the separatrix and in the scrape-off layer have also been dramatically suppressed by a combination of NBI and E×B shearing via plasma-gun edge biasing, thereby improving confinement properties. The demonstrated sustainment of beam-driven FRCs in C-2U is an extraordinary achievement for the FRC and innovative confinement concepts communities, and may lead to intriguing possibilities for fusion reactors.

[1] M. Tuszewski et al., Phys. Rev. Lett. 108, 255008 (2012).
[2] M.W. Binderbauer et al., Phys. Plasmas 22, 056110 (2015).

Paper Number

EX/P3-41

Country or International Organization

USA

Primary author: Dr GOTA, Hiroshi (Tri Alpha Energy, Inc.)

Co-authors: Dr IVANOV, Alexander A. (Budker Institute of Nuclear Physics); Dr SMIRNOV, Artem (Tri Alpha Energy, Inc.); Dr BARNES, Dan (Tri Alpha Energy, Inc.); Dr GARATE, Eusebio (Tri Alpha Energy, Inc.); Dr SCHMITZ, Lothar (University of California, Los Angeles); Dr THOMPSON, Matthew C. (Tri Alpha Energy, Inc.); Dr

TUSZEWSKI, Michel (Tri Alpha Energy, Inc.); Dr BINDERBAUER, Michl (Tri Alpha Energy, Inc.); Dr DETTRICK, Sean (Tri Alpha Energy, Inc.); Dr PUTVINSKI, Sergei (Tri Alpha Energy, Inc.); Dr KOREPANOV, Sergey (Tri Alpha Energy, Inc.); Prof. ASAI, Tomohiko (Nihon University); Dr TAJIMA, Toshiki (Tri Alpha Energy, Inc.); Dr YANG, Xiaokang (Tri Alpha Energy, Inc.); Prof. LIN, Zhihong (University of California, Irvine)

Presenter: Dr GOTA, Hiroshi (Tri Alpha Energy, Inc.)

Session Classification: Poster 3

Track Classification: EXS - Magnetic Confinement Experiments: Stability