Test of Bootstrap Current Models Using High $\beta_P$
EAST-Demonstration Plasmas on DIII-D*

Q. Ren¹, L.L. Lao², A.M. Garofalo², C.T. Holcomb³, W.M. Solomon⁴, E.A. Belli², S.P. Smith², O. Meneghini², J. Qian¹, G. Li¹, B. Wan¹, X. Gong¹, and G. Xu¹

¹Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, China
²General Atomics, PO Box 85608, San Diego, CA 92186-5608, USA
³Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA 94550, USA
⁴Princeton Plasma Physics Laboratory, PO Box 451, Princeton, NJ 08540-0451, USA

DIII-D high $\beta_P$ EAST-demonstration experiments aim at developing a high bootstrap current scenario to be extended on EAST for a demonstration of steady-state for long pulse lengths at EAST parameter for plasma shape, plasma current, toroidal magnetic field, total heating power and current ramp-up rate. The scenario provides a good opportunity to test different bootstrap current models. Magnetic measurements together with kinetic profile and motional Stark effect (MSE) measurements are used in full kinetic equilibrium reconstructions to test the Sauter and NEO bootstrap current models. It is found that the large edge bootstrap current in these high-$\beta_P$ plasmas allows the use of magnetic measurements to clearly distinguish the two bootstrap current models; magnetic measurements are very sensitive to large edge bootstrap currents in high-$\beta_P$ plasmas while much less sensitive in low-$\beta_P$ plasmas. In high-$\beta_P$ plasmas, Sauter model overpredicts the peak of the edge current density by about 30% while the first-principle kinetic NEO model is in close agreement with the edge current density of the reconstructed equilibrium. The bootstrap current density predicted by the NEO model is similar to the bootstrap current density predicted by the Sauter model ($c_{boot}=1.0$) scaled down by 70% ($c_{boot}=0.7$) in the edge region. There is a sharp drop of $\chi^2_{Sauter}$ (fitting quality factor for magnetic measurements) when scaling down the bootstrap current density predicted by the Sauter model from 100% ($c_{boot}=1.0$) to 70% ($c_{boot}=0.7$), and $\chi^2_{NEO}$ is close to $\chi^2_{Sauter}$ with the scaling parameter $c_{boot}=0.7$ as shown in Fig. 1.


*This work was supported in part by the US Department of Energy under DE-FC02-04ER54698, DE-AC52-07NA27344 and DE-AC02-09CH11466 and the National Magnetic Confinement Fusion Program of China under No. 2015GB110000 and No. 2015GB110001.