Non-inductive confinement techniques are critically important for ITER.

Anomalous bootstrap current discovered through simulations may radically impact our understanding of tokamak physics, including:

- Overall plasma confinement
- Key magnetohydrodynamic (MHD) instabilities such as neoclassical tearing mode (NTM) and edge localized mode (ELM).

**Objectives**

- Study self-generated, non-inductive currents in the presence of drift wave turbulence in fusion plasmas
- Use the global, Gyrokinetic Tokamak Simulation code “GTS” to carry out this work
- Challenges of this study:
  - Requires the self-consistent implementation of neoclassical physics and turbulence in gyrokinetic codes

**Impact**

- Non-inductive confinement techniques are critically important for ITER.
- Anomalous bootstrap current discovered through simulations may radically impact our understanding of tokamak physics, including:
  - Overall plasma confinement
  - Key magnetohydrodynamic (MHD) instabilities such as neoclassical tearing mode (NTM) and edge localized mode (ELM).

**Accomplishments**

- Successful implementation of self-consistent neoclassical physics in GTS gyrokinetic PIC code.
- Recent GTS simulations, which include both turbulent and neoclassical physics self-consistently and simultaneously, show that bootstrap current generation is significantly enhanced in the presence of trapped electron mode (TEM) induced fluctuations.
- Simulations reveal important plasma parameter dependence of turbulence-driven currents, which can be tested experimentally.
- The simulations also show that the TEM-driven current is essentially carried by trapped electrons, unlike the neoclassical bootstrap current, which is mainly carried by passing particles.
- The simulations were carried out at NERSC on the new Edison Cray XC30 computer.