Non-inductive start-up on Pegasus: Temperatures and heating
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Local helicity injection (LHI) for non-inductive start up on the Pegasus ST

- Localized helicity injection possible via DC washer-gun plasma sources mounted through diagnostic ports
- 4 injectors each
  \[ I_{inj} = 2 \text{kA}, V_{inj} = 2.5 \text{kV} \]
- Recent shots in divertor configuration

Visible light images from Pegasus during LHI shot [3]

Outboard gun configuration on Pegasus.

Divertor gun configuration on Pegasus [2].
John’s NIMROD models of LHI show flux rope evolution and formation of current rings

▶ Two-fluid and MHD simulations produce qualitatively similar results
▶ One injector modeled with localized current and ion heating source
▶ Poloidal flux builds up and relaxation proceeds through a series of flux-rope mergers and ring-formation events

After several mergers a magnetic null forms and the current winds back down the central column
Toroidally averaged poloidal flux profiles show transient spikes during ring formation.
Poloidal flux builds up over time, tokamak-like profile seen prior to injector shut off.
Closed flux surfaces form after injector shut off, decay with no additional heating

DB: dump_923932_b.vtk
Cycle: 923932  Time:0.00799999
Toroidally averaged pressure profiles also show spike at current ring, not as nice as averaged poloidal fluc profiles.
New diagnostics on divertor LHI experiments see anomalous impurity ion temperatures reaching 50-250 eV

Several possible factors, including:
- Viscous heating
- Poloidal flux swing
- Number of injectors

Running two new two-fluid simulations using a simplified viscous heating model and full Braginskii model.
Temperature discrepancy shows slight improvement with addition of viscous heating

- Initial results show definite increase in $T_i$
- Still order of magnitude off experimental values
Conclusions and future work

Conclusions

▶ Toroidally averaged profiles show accumulation of flux profiles required for plasma start up and transition to other heating methods
▶ Ion temperature values helped by addition of viscous heating, but more work to be done to accurately model LHI experiments

Future work

▶ Multiple injectors in various locations
▶ Addition of poloidal flux swing
▶ Further comparisons of simulations to growing collection of experimental data
References


