

Performance of MT-I Spherical Tokamak with Upgraded Power Supply System

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ABSTRACT

- Upgrade of MT-I spherical tokamak (aspect ratio 1.67) with three independent capacitor-bank-based power supplies.
- Double capacitor bank scheme for CS improved startup.
- MATLAB simulations validated design.
- Experimental verification using Rogowski coils, loop voltage probe, photodiode, and high-speed camera.
- Improved plasma pulse length and intensity observed.

BACKGROUND

- Tokamak research crucial for nuclear fusion development.
- MT-I is a small spherical tokamak ($R=0.15$ m, $a=0.09$ m).
- Vessel of stainless steel with multiple diagnostic ports.
- Uses ECRH pre-ionization (2.45 GHz, 3 kW).
- Capacitor-bank power supplies are economical for small devices.

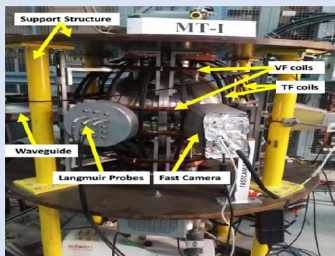


Fig.1: MT-I tokamak with coil systems and support structure

CHALLENGES / METHODS / IMPLEMENTATION

- TF Supply: Fast-slow capacitor bank design, flat top ~ 10 ms, $B\phi \sim 0.1$ T.
- VF Supply: Series coil arrangement with RC snubber to prevent false triggering.
- Simulation + experimental validation.
- CS Supply: Double capacitor bank ($C1=17$ mF, 3kV; $C2=5.5$ mF, 2.7kV) higher loop voltage, longer plasma duration.

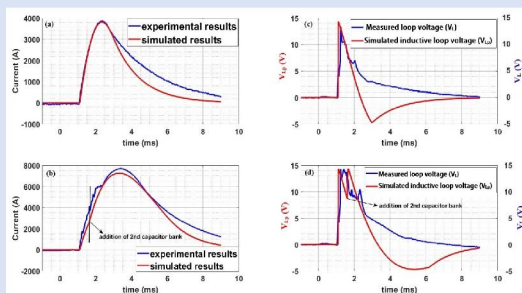


Fig.2: CS current & loop voltage (single vs. double bank)

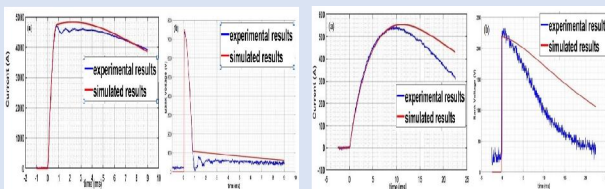


Fig. 4: (i) TF waveforms (fast & slow banks), (ii) VF current & voltage

OUTCOME

- Plasma current and pulse length improved from 12 kA / 0.5 ms (single bank) to 15 kA / 1.2 ms (double bank).
- Loop voltage maintained above critical value for longer time.
- Optical emission stronger; plasma images brighter with improved confinement.
- TF supply provided steady resonance conditions for microwave absorption.
- VF supply stabilized plasma position

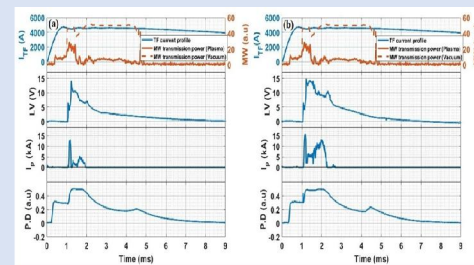


Fig.4: TF current & diagnostics: single vs. double bank

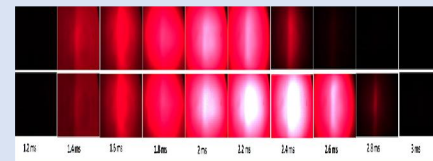


Fig. 5: Plasma images: single vs. double CS bank

CONCLUSION

- Upgraded capacitor-bank power supplies significantly improved MT-I spherical tokamak startup and performance.
- Double CS bank boosted plasma current and also extended pulse length.
- TF supply gave flat-top current for efficient microwave absorption.
- VF supply & RC snubber circuit stopped false triggers and stabilized the plasma discharge.
- Brighter plasma images confirm better confinement, validating MT-I for future small-tokamak studies.

ACKNOWLEDGEMENTS

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