Performance Assessment of C-Mod MSE Upgrades*

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Summary

On a technical level, the new MSE Intershot Calibration system functioned reliably during the FY12 Alcator C-Mod run campaign.

- Measured Faraday rotation in MSE optics.
- Measured effect of heating of MSE objective lens.
- Lens or VW heating may become a problem during high-power, long-pulse operation in C-Mod, EAST, KSTAR, etc.
- Can compensate for drift of PEM retardance.
- Neither tokamak nor DNB operation affect MSE performance.
- MSE calibration remains constant over the time period of 10-20 seconds.
- It shows that the MSE calibration drifts slowly (vs time and vs channel) during routine C-Mod operation.
- To date, the ISC appears to compensate for only a fraction of the shot-to-shot drift that is experienced by MSE.
- In a series of quiescent, identical plasmas there remained ~2 degrees of spurious variability in the measured field-of-view pitch angle even after the MSE data were compensated by the ISC.
- The residual MSE variability exhibits relatively smooth behavior vs time and vs MSE channel number, similar to the drift that is measured by the ISC.
- Heating tests indicate that the ISC may capture only ~80% of the variability experienced by MSE, possibly due to the fact that the ISC illuminates only ~90% of the MSE plasma-facing lens. This could be an important issue for ITER-MSE.
- When used to calibrate MSE in plasma operation, the ISC appears to compensate for only about 20-25% of the total variability experienced by MSE.

Introduction

- An upgrade for the Motional Stark Effect (MSE) diagnostic on Alcator C-Mod was completed in late 2011 to compensate for drift of the system’s calibration over time.
- This Intershot Calibration System (ISC) provides an MSE calibration with linearly polarized light at four angles within 8 seconds of a C-Mod plasma shot.
- The ISC was routinely operated on C-Mod for the FY12 campaign, acquiring data on 650+ plasma shots.
- It is proven useful to assess a number of MSE issues including:
  - Faraday rotation in the MSE optical system
  - Effects of radiation heating of MSE plasma-facing lens
  - Drifts in the retardance imposed by MSE’s Photoelastic modulators (PEMs)
  - Effect of varying phase lag between PEM drive and actual retardance
  - Calibrating MSE on each C-Mod plasma shot using the ISC to compensate for the MSE calibration drift has reduced shot-to-shot variability – but only marginally
- Even after compensation by the ISC, the pitch angle measured by MSE still experience a shot-to-shot variability that is larger than typical statistical error bars.

ISC is useful to assess several MSE issues

- Evaluate accuracy of ISC's correction of MSE data in ensembles of reproducible Ohmic plasmas
- Calibrating MSE with the ISC reduces overall variability only marginally

Even after compensating for MSE's variability using the ISC, the measured pitch angle still 'drifts' over time.

Variability is not caused by movement of MSE's field-of-view

Evaluate accuracy of ISC's correction of MSE data in ensembles of reproducible Ohmic plasmas

Calibrating MSE with the ISC reduces overall variability only marginally

Effect of non-uniform ISC illumination when tracking absolute and relative changes to MSE

ISC provides accurate measurement of Faraday Rotation

In-situ inter-shot calibration (ISC) system design

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