Inter-shot calibration of the MSE diagnostic on Alcator C-Mod*

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### Summary:

MSE calibrations must accurately capture the polarization response of the diagnostic, which can change from one tokamak discharge to another due to thermal, magnetic, and optical variations. A new calibration technique has been developed to diagnose and implement to properly account for the changes in polarization response.

A system to quickly input polarized light into the diagnostic independent of vacuum, fields, plasma or even the diagnostic itself, is used to observe and calibrate. This system is used to sequentially perform plasmas to accurately calibrate the diagnostic response.

Future devices may require similar techniques in MSE systems become more complex, calibrations become less frequent, environments become harder and calibrations become administratively limited.

### Harsh environments cause MSE polarization response to drift shot to shot

- Effects from finite view volume, often changes between plasma discharges
- Primary remaining cause of changes inferred from the intra-shot calibration technique
- Heating the vacuum window with a blower increased the birefringence significantly (left)
- The rotation is from both the toroidal field (red,green) and the poloidal field (yellow,blue)
- One of 4 WGPs are spring aligned into calibrator, precisely aligned in their frames
- Position uncertainty < 2mm
- The polarization response of the diagnostic changes on the minute time scale, faster than the shot repetition rate. ISC system can be used to calibrate these effects out.
- If left unaccounted for, these effects cause systematic error in the MSE measurement
- \[ V_{\text{field}} = \frac{\text{force on feedthru}}{\text{change in feedthru position}} \]

### Vacuum window identified as primary remaining cause of changes in the polarization response

By calcination the vacuum window is slowly changing in the ambient environment, and the force from this window with a tenfold increased force is significantly different from the calculated force.

Future upgrades of ISC to decrease stress birefringence is planned and incorporate into automated analysis routines.

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

- Determine input polarization angle from the polarization response of the diagnostic
- Provides measurement of polarization changes, drift in the PEM retardances or Faraday rotation can be quantified.
- If left unaccounted for, these effects cause systematic error in the MSE measurement.