In addition to recent improvement where both magnetic pitch angle and magnitude are fully resolved from MSE spectra [1], initialization and constraints of fit parameters have been added based on the MSE model in the Atomic Data and Analysis Structure (ADAS). A collisional-radiative (CR) model with level populations nlm-resolved up to n = 4 and a simple Born approximation for ion-impact cross sections is used. Measurement uncertainty is quantified by making MSE measurements with multiple views of a single spatial location. A multi-view fit method improves the goodness of fit of MSE spectral features and background. A substantial portion of the background arises from overlap of MSE spectra on the detector.

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### Improved spectral analysis for the motional Stark effect diagnostic

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**Low-field MSE spectra at MST is complex**

Unlike tokamaks, |B| on axis is unknown since the toroidal field in this region is largely generated by poloidal current flowing in the edge, not by external TF coils.

Both |B| and its direction are unknown at the mid-minor radius (or off-axis) view.

Multiple views at each spatial location result in multiple groups of Stark multiplets within a CCD frame.

Each view has a narrow bandpass filter, occupying only a small portion of the CCD array.

One view at each spatial location does not have such a filter acting as a 'reference' view (black in the figure).

Polarizers are installed to suppress one polarization component in the spectrum.

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**Results**

Fitting the whole spectrum deals with the background between two adjacent peaks.

The asymmetry between +/- pi components is strong at high fields.

Clear dependence on the plasma current (200, 400, 500 kA).

Off-axis spectra strongly dependent of beam current, but less noisy than on-axis spectra.

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**Stokes formulism for Stark multiplets relates geometric information with the intensities**

Plasma (ne, Te etc)  ADAS V3.1 (305)*

Fitting was typically performed for individual peaks.

When all the shutters are open at the same time, it provides experimental uncertainty in the measurements. Very slight reduction in the uncertainty is observed with the multi-peak-fit scheme.

Upper bounds of the statistical uncertainties: 5 ~ 15 % for 0.6 ~ 0.2 T (roughly 600 kA ~ 200 kA).

Individual fit scheme  Multi-peak fit scheme

*ADAS V3.1 (305)*

This propagates < 10 % in J||() and < 5 % in q() in the magnetic equilibrium reconstruction [1]