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## 8.12 Relative intensity calibration of KSTAR beam emission spectroscopy by using fast visible CMOS camera

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Relative intensity calibration for the KSTAR beam emission spectroscopy (BES) system is successfully achieved with a fast visible CMOS camera. The KSTAR BES system with 2D array ( $4 \times 16$ ) avalanche photodiode (APD) detectors is allowed to move its spatial position of measurements and rotate its orientation to study plasma turbulence at various spatial positions. A proper relative intensity calibration, thus, requires beam-into-gas shots for all possible measurement positions, which becomes not only laborious but also shortening the lifetime of the beam dump, since the optical alignments are altered as the position is changed. The KSTAR BES system is equipped with a fast visible CMOS camera sharing the most of the same optics system with the APD detectors, resulting in that some of the CMOS pixels have the same optical axes with the APD detectors. Based on this fact, we propose a relative intensity calibration technique for all possible positions of the APD detectors based on the CMOS camera signals with only few beam-into-gas-shots. Our proposed technique is examined against experimental data and found to be applicable at least for the KSTAR BES system.

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