**Design of a wide-angle infrared visible viewing system using reflective optics on EXL-50 spherical torus**

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***Abstract.*** EXL-50 is a solenoid-free spherical torus with its major and minor radius 0.58 and 0.39 m. A high-resolution imaging system, consisting of mid-IR and visible cameras along the same line of sight, has been installed for the EXL-50[1-2]. This diagnostic system has a wide field of view with 70°×70°, which can provide imaging of the entire poloidal cross-section during a shot. The visible camera V1212 has a system capability of 5 mm spatial resolution at the ROI (region of interest) and a maximum 10kHz full resolution frame rate. The IR camera Telops M120 can operate between 3.5 and 5 μm waveband and up to sampling frequency of 210 Hz with a resolution of 640×480 pixels. In order to improve the resolution limit of the optics in the visible range, the Cassegrain telescope design is implemented like the design of JET and W7-X stellarator [3]. The reflecting mirrors are composed of a flat mirror with a 10 mm diameter aperture and an aspherical concave mirror. After a full-band ZnS sealed lens, the back-end transmitting lenses are adapted to the different detectors for mid-IR and visible observations, with their optical light paths separated by in-air dichroic beam splitters. By comparing the IR-measured temperature with those from the thermocouples which were installed beneath the surface of divertor target tiles during vacuum vessel baking, the key parameters of IR thermography have been calibrated. At the forefront of the optical path, a modified mechanical iris shutter with 18 blades is installed in the vacuum chamber. It not only has excellent space utilization but also can withstand up to 200℃ high temperature baking.

**Key words:** wide-angle, infrared visible, viewing system, iris shutter

**Reference:**

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