Optical tomography of the plasma on the PROTO-SPHERA experiment

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A system of six fast visible light cameras has been implemented around the PROTO SPHERA experiment thanks to the new vacuum vessel in polymethylmethacrylate (PMMA), transparent to visible light. The cameras have been placed outside the vessel, thus leaving the existing ports available for other possible diagnostics. The aim was to detect the axial symmetric brightness profile and to recognize the toroidal structures around the plasma central column via developing an optical tomography. To do so, the six acA640-750um Basler ace USB 3.0 cameras have been placed on the equatorial plane of the vacuum vessel, separated by 60 degrees around its circular circumference and covering the whole volume of the central plasma. The cameras have been managed by two PCs, while a NANO Arduino has been exploited to trigger synchronous frames acquisition and to control the exposition time. The acquisition system has been implemented using the MARTe2 software framework. A proper calibration/reconstruction of each line of view for all the cameras has been implemented, so as to compute a 3D representation of the vessel. This has been instrumental in performing a tomography inversion of the plasma column under the consideration that the value of each pixel represents the integrated brightness along its line of sight. A 2D tomography has been performed on the equatorial plane of PROTO SPHERA exploiting an analysis based on the Zernike polynomials. The latter are a complete set of polynomial functions, continuous and orthogonal over a unit circle and are a good basis for comparing the point quantities defined on a unitary circle with their line integrals. Since the camera acquisition system allows stereo setup of lines of sight, a 3D tomography is also under study using a different algorithmic approach.

The camera acquisition system, the experimental setup and the obtained results will be presented.