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Manufacturing, installation, commissioning and first results with LTCC-3D high-frequency magnetic sensors on TCV

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Innovative high-frequency magnetic sensors have been designed and manufactured in-house for installation on the Tokamak à Configuration Variable (TCV), and are currently routinely operational during the TCV experimental campaigns. These sensors combines the Low Temperature Co-fired Ceramic (LTCC) and the classical thick-film technologies, and are in various aspects similar to the large majority of the magnetic sensors currently foreseen for ITER (410 out of 454 are LTCC-1D).
The TCV LTCC-3D magnetic sensors provide measurements in the frequency range from 1kHz to 1MHz of the 3D perturbations to the parallel, namely quasi-toroidal (deltaBPAR), poloidal (deltaBPOL) and normal (to the flux surfaces, deltaBNOR) magnetic field components. The design principles were aimed at increasing the effective area and self-resonance frequency of the sensor in each measurement axis, while reducing the mutual and parasitic coupling between them. The physics requirements are set by the installation of two high-power / high-energy Neutral Beam Injection systems on TCV, namely studying fast ions physics, coherent instabilities and turbulence in the Alfvén frequency range.
We report on the manufacturing, installation and commissioning work for these high-frequency LTCC-3D magnetic sensors, and conclude with an overview of the first experimental results obtained with this system. We show that the LTCC-3D data for deltaBPOL are in agreement with those obtained with the standard Mirnov sensors installed on TCV in the frequency range where the respective data acquisition overlap, routinely up to 125kHz and up to 250kHz in some discharges. Moreover, the LTCC-3D data provide new insights on the deltaBPOL fluctuations in the higher frequency range from 125kHz/250kHz to 1MHz, on the deltaBPAR component, which is not available using the TCV Mirnov sensors, and on the deltaBNOR component, which is available using the TCV vessel-mounted saddle loops but only up to ~3kHz (due to the wall penetration time).

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