Plasma diagnostics by means of CVD diamond detector arrays

S. Cesaroni[1], F. Bombarda[2], M. Angelone[2], A. Belpane[3], A. Raso[2], C. Verona[2], G. Verona Rinati[2]

[1] ENEA CR Frascati, Nuclear Department, via Enrico Fermi 45, 00044 Frascati (RM), Italy
[2] Department of Industrial Engineering, University of Rome "Tor Vergata", via del Politecnico 1, 00133 Roma, Italy
[3] RFX Consortium, corso Stati Uniti 4, 35127 Padova, Italy

Thin, single crystal CVD diamond detectors are being developed at the Laboratory of Industrial Engineering, University of Rome "Tor Vergata", for some specific applications, including the diagnostic of fusion plasmas, both inertial and magnetically confined. From the first installation of two photodetectors on JET [1], and later on FTU [2], several potential areas of investigation have emerged, some of which will be further explored with the first Diamond Camera, planned for installation on TCV in 2026. Diamond photodetectors are primarily envisaged as replacements for other semiconductors, in particular Si diodes, in set-ups requiring close proximity to the plasma, thanks to their higher resilience to neutron damage and high temperatures, their high S/N ratios, and their extremely fast response. For these reasons, a diamond tomography system is currently under construction for the SPARC experiment [3] and is under design for the DTT facility [4]. The capability of CVD diamonds to detect various fast events, such as those associated with pellet ablation, MARFEs, ELMs, and Anomalous Doppler Instabilities, has also been demonstrated [5]. To a certain extent, they can complement traditional metal-foil bolometers for plasma radiated power estimates and for resolving internal mode numbers. A new area of investigation planned on TCV will be the detection of suprathermal and runaway electrons by measuring the asymmetries of the bremsstrahlung emission in the UV and keV energy ranges.

[1] M. Angelone, D. Lattanzi, M. Pillon, et al., Nuclear Instruments and Methods in Physics Research A **595** (2008) 616
[2] S. Cesaroni, M. Angelone, G. Apruzzese, et al., Fusion Engineering and Design **166** (2021) 112323
[3] S. Normile, D. Vezinet, C. Perks, et al., Rev. Sci. Instrum. **95** (2024) 093102
[4] A. Belpane, E. Peluso, S. Palomba et al., JINST **20** (2025) C04009
[5] F. Bombarda, M. Angelone, G. Apruzzese, et al., Nucl. Fusion **61** (2021) 116004