# Advances in Plasma Diagnostics: 20 Years of the Ball-Pen Probe in Fusion and Non-Fusion Research

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The ball-pen probe, introduced in 2004 [1] by Jiří Adámek from the Institute of Plasma Physics, Czech Academy of Sciences, has marked a significant advancement in plasma diagnostics, particularly for the direct measurement of plasma potential in magnetized plasmas. Over the past two decades, this diagnostic technique has been extensively utilized in a variety of fusion and non-fusion plasma devices, including major tokamaks (ASDEX Upgrade [2], COMPASS [2, 3], MAST [4], ISTTOK [5], CASTOR [1]), stellarator (W7-X [6], TJ-K [7]), and non-fusion devices (DC magnetrons in Prague [8], Mirabelle in Nancy [9] etc). The ball-pen probe's innovative design, which balances electron and ion currents, enables precise measurements of plasma potential without the need for complex corrections. In addition, recent developments have expanded its diagnostic capabilities to measure electron and ion temperatures, as well as heat flux, with high temporal resolution (~1 micros), making it an essential tool for probing fast plasma dynamics. Its widespread application across numerous devices has contributed to significant advancements in understanding plasma behavior, enhancing both fusion-oriented research and fundamental plasma studies. This talk will review the design, operational principles, and the impact of the ball-pen probe on plasma diagnostics over the last 20 years.

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