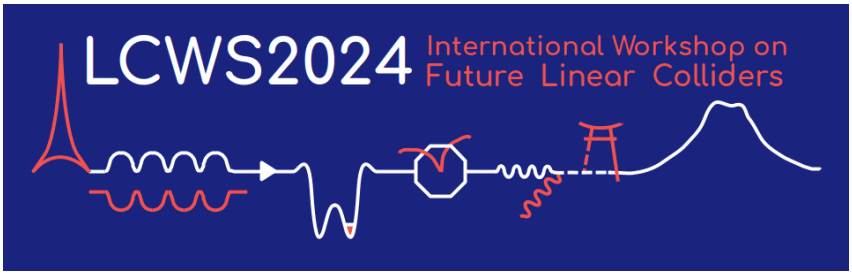

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Cavity Beam Position Monitor Development for the ILC Main Linac

For future particle colliders, cavity Beam Position Monitors (cBPMs) have emerged as the optimal solution for precisely measuring the beam position, crucial for guiding and stabilizing high-energy beams with nanometer precision, thus enhancing luminosity at the interaction point. Resonant BPMs operate under the principle of detection of specific field configurations (resonant modes) induced by an off-centered beam within a cavity.

Development is underway for a cryostat accommodating a reentrant cBPM and a superconducting (SC) quadrupole for the ILC Main Linac. Initially, the cBPM and its associated electronics readout system will undergo testing at ATF under ambient conditions and subsequently at STF for cryogenic temperature tests. Alignment of the SC quadrupole and cBPM centers within the cryostat is crucial for precise beam position determination. Moreover, the BPM prototype must be capable of measuring the beam position on a bunch-by-bunch basis with temporal and spatial resolutions of less than 6 ns (for STF) and 1 µm, respectively.

Currently, electromagnetic simulations are being conducted using the commercial software CST Studio Suite to evaluate BPM performance and converge towards a system that meets the aforementioned requirements. Additionally, a numerical method called BI-RME 3D is being employed to simulate the effect of a well-defined beam on the cBPM, providing estimates of voltages and waveforms observed at the output ports.
The selection of the read-out electronic system is critical to effectively down-convert the frequency of the rapidly decaying signal (less than 6 ns) while preserving a spatial resolution of under 1 µm.
Looking ahead, initial tests are aimed to be conducted at ATF using an existing prototype developed by CEA-Saclay (France), along with the corresponding readout system, by the end of 2024.

The presentation aims to provide an overview of the cBPM working principle and the progress made towards the new model.

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