## Theory of the oscillating-wire measurement method

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The single streched wire is moved along circular (and elliptic) trajectories at its stages, such that the wire traces out the generators of a cylinder. A sinusoidal current feeds the wire with a frequency sufficiently far from the resonances of the system. If the current amplitude is sufficiently low the wire will oscillate in a plane orthogonal to the direction of the magnetic flux density. Measuring the oscillation amplitudes at a position close to the stage yields the relative multipole coefficients of the integrated flux density.

We derive the solution of the wave equation in order to estimate the intrinsic error resulting from the fact that the longitudinal profiles of the field and the wire motion are not known. It is then an easy task to show that the intrinsic error vanishes for magnets which can be well approximated by a hard-edge field model. This was experimentally verified for the permament magnet quadrupoles for CERNs Linac4 project. We show in simulations how the end fields affect the intrinsic error and discuss strategies to estimate this error with metrological methods alone.