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Straightness evaluation for the 206-m-long part of the KEK electron/positron linac using inclinometers

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We have studied to adopt a precise inclinometer for evaluating alignment of large particle accelerators. We had already evaluated the straightness of the approximately 70-m-long part of the KEK electron/positron linac, which corresponds to the single accelerator sector of the linac. The results had good reproducibility with the standard deviations of less than 49 micro meters and agreed with those by an alignment telescope, our laser-based alignment system, and a laser tracker within sub mm range; however, the measurement distance was limited by obstacles in measurement which block the measurement path.
Here, two straight beams named offset bars are adopted for avoiding the obstacles. Their axes are directed perpendicular to the measurement path with their one ends on the measurement path. The obstacles can be avoided by measuring slope angles between the far ends of the bars. Error arises from the newly adopted bars, such as shape error, distortions, and tilts can be eliminated by reversal measurement, which considers slope angles of the offset bars detected by extra inclinometers. The reversal measurement can also eliminate offset error of the inclinometers.
As a result, straightness for the approximately 206-m-long part of the linac, which corresponds to three accelerator sectors of the linac, could be evaluated. The result agreed fairly well (partially within sub mm range) with those by the alignment telescope and our laser-based alignment system. It indicates that they are fairly reliable with each other. On the other hand, the reproducibility expressed by the standard deviation of the detected slope angles for the four-times of repeat measurements was 15 micro rad, while that for the former measurements was 10 micro rad for their averaged value. It indicates that the shape derived from the newly devised reversal measurement can be expected to have similar reproducibility as the former in spite the measurement system becomes complicated.
It follows that the newly devised method can also be applicable for evaluating alignment of large particle accelerators.

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