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Straightness evaluation for the KEK electron/positron linac using a level

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We adopted straightness measurement using a level for evaluating vertical aligning straightness of the 600-m-long KEK electron/positron linac. It measures tangential angles of the straightness and obtains the straightness by integrating the measured angles without affected by any substantial straightness references.

Here, straight bars with length of from 1640 mm to 2306 mm were put on between each center of the neighboring base plates for the linac and slope angles of the bars were measured sequentially by a precise electronic level system (Talyvel 4). The bars were for ensuring continuity of the aligning straightness between the discretely-aligned plates. Pairs of contact feet were adopted under both ends of the bars. They were for preventing plate distortions from affecting the straightness and for avoiding obstacles in measurements. Systematic error caused by offset of the level, distortions of the bars and height differences between the pairs of feet were eliminated by reversal measurement.

As a result, straightness with the average reproducibility of 26 micro-m (sigma) for the 71-m-long part of the linac could be obtained. It can be hardly achieved by any conventional methods. The results were compared with the measurements by a telescope-based alignment technique and our laser-based alignment technique. They agreed well with each other.

Error estimation based on our error propagating model shows that straightness evaluation with reproducibility of 0.6 mm (2 sigma) for a 500-m-long measurement, sufficient for upgrading the KEK electron/positron linac, and that of better than 1 mm (2 sigma) for a 10-km-long measurement, expected for the ILC project can be achieved.

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