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Graphical and Numeric Measurement Station Uncertainty Characterization

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Understanding and communicating reliable measurement uncertainty is an important responsibility of advanced particle accelerator alignment. In many cases the measurement process uncertainty is difficult to control in accelerator alignment due to geometry constraints within the accelerator facility. Methods to characterize and communicate specific influences and dependences are key tools for the alignment teams.

While point uncertainties are the primary output of interest, understanding instrument/station uncertainty (Ux, Uy, Uz, URx, URy, URz, and TotalAngularU) is a key element to influence and control the alignment network uncertainty. Objectively characterizing and visualizing each instrument stations position and orientation uncertainty in context of the network is helpful. Understanding the influences and dependence that station position and its observation precision plays in network uncertainty enables alignment teams to make objective choices on how to effectively optimize station performance and position(s). The capability can both improve performance and reduce alignment uncertainty.

Several cases studies are presented showing how Ux, Uy, Uz, URx, URy, URz, and TotalAngularU station uncertainty plays a direct role in network uncertainty. Individual station uncertainty within the network results are presented both graphically and numerically. The evaluation and graphical results show the net differences in how the measurement network from a station influences component alignment characterization. The outcome demonstrates how choices in which sensors are used and how their position(s) within the network influence alignment fidelity.

Primary author: Mr SANDWITH, Scott (New River Kinematics)

Presenter: Mr SANDWITH, Scott (New River Kinematics)

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