National Radio Astronomy Observatory

VLBA Antenna Memo Series – No. 114

Steve Taylor

Trip Report-
Visit to Kitt Peak VLBA with Keyence CMM 20th August 2026

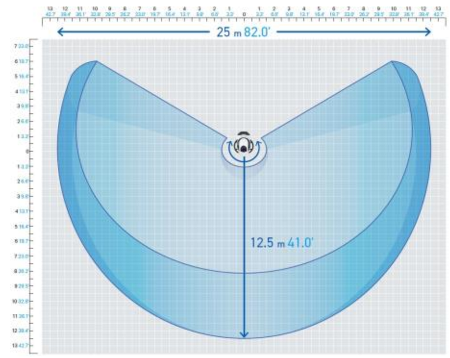
Attending	Steve Taylor	VLBA
	Dave Alderman	VLBA
	Riley Schaefer	Keyence Inc.
	Cam Pereira	Keyence Inc

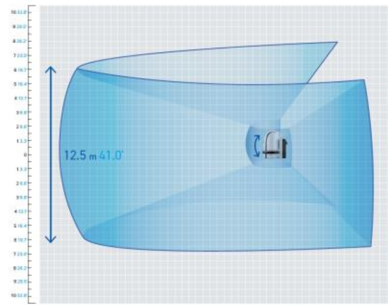
Purpose of visit

Field evaluation of performance, access and use of Keyence wide area CMM (coordinate measurement machine) system model WM 6000. Our particular interest was to confirm the device could operate happily in a full-sun environment. Co-incidentally, we obtained basic data at modest resolution of the surface of a quadrant of the dish, contained between two quadlegs, and data of the flatness of the best fit plane drawn across the Azimuth rails, as well as its oblateness.

Explanatory

Keyence manufacture a wide area CMM which can measure the position of a point in space within the volume defined by a 12.5 metre radius, 270 degree encompassing circle, and +/- 6.25 metres from a horizontal plane defined by the centre of the reference platform. Positional accuracy in space is defined by the equation +/- (50 + 5L/1000) um for the laser scanner and +/- (28 +5L/1000) um for the point probe, where L is the radial distance from the reference head to the probe.





First task: Evaluation of scanning process for the dish profile

Equipment, showing reference head, associated control laptop and the scan head – in operator's hand.

The scanning process began. There is a display on the scan head for the operator to evaluate the scan coverage and to be informed of issues with the scan. None were found.

The scan head has to be within 350mm of the surface being scanned.

Total time to complete a scan of a quadrant of the dish (evaluation stopped 2 panels below the edge) was approximately 1.5 hours from arriving on site.

Second task: Evaluation of Azimuth rail planarity

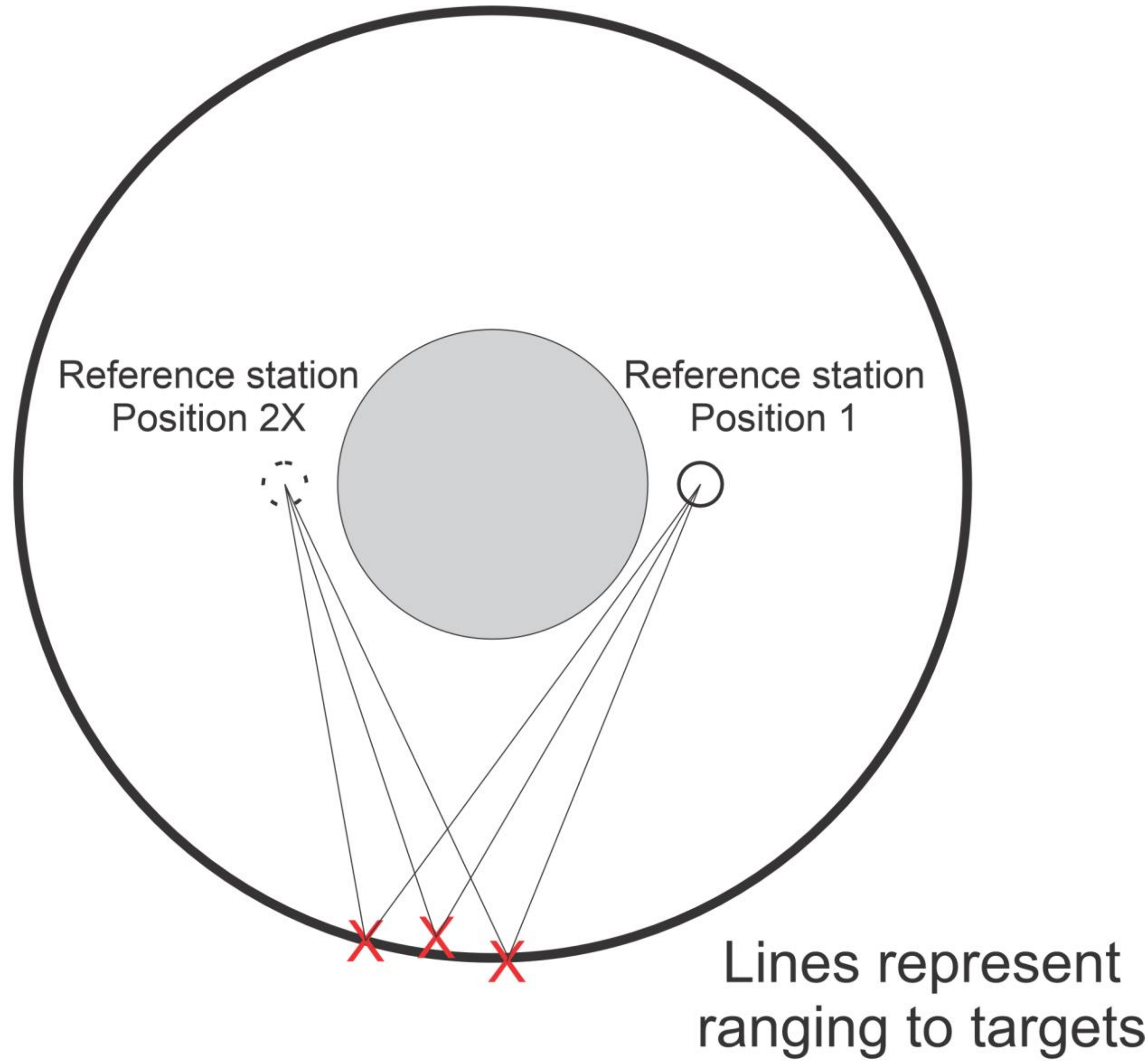
We have major problems as a team with evaluating the planarity and oblateness of the azimuth rail. Planarity testing using conventional survey instruments can take in excess of four hours per iteration, and multiple iterations are often required in on-site conditions.

The Keyence unit can use two readheads, one with the laser scanner, and one with a point probe, as used by a conventional fixed CMM. For this second task we chose to use the point probe. Measurements of position of the top of the rail were taken and then another sequence of the outer edge of the rail obtained. This made it easier to present the final data. In addition, we obtained some information across the splice bars.

Further testing of the planarity at the wheels as a function of rotation of the antenna is also feasible.

Since it is impossible to scan the full 360 degrees of the azimuth rail with a single station measurement, the reference head has to be moved from one side to the other of the pintle bearing. Three kinematic refence pads were attached to the rail in such a way that the reference scanner could measure the position of the targets in both station positions. The keyence software would then be able to reconnect the scans in 3d space.

Measurements of the rail were obtained in 360 degrees, in a time of only around 25 minutes.



Setup(s) used for rail measurements.

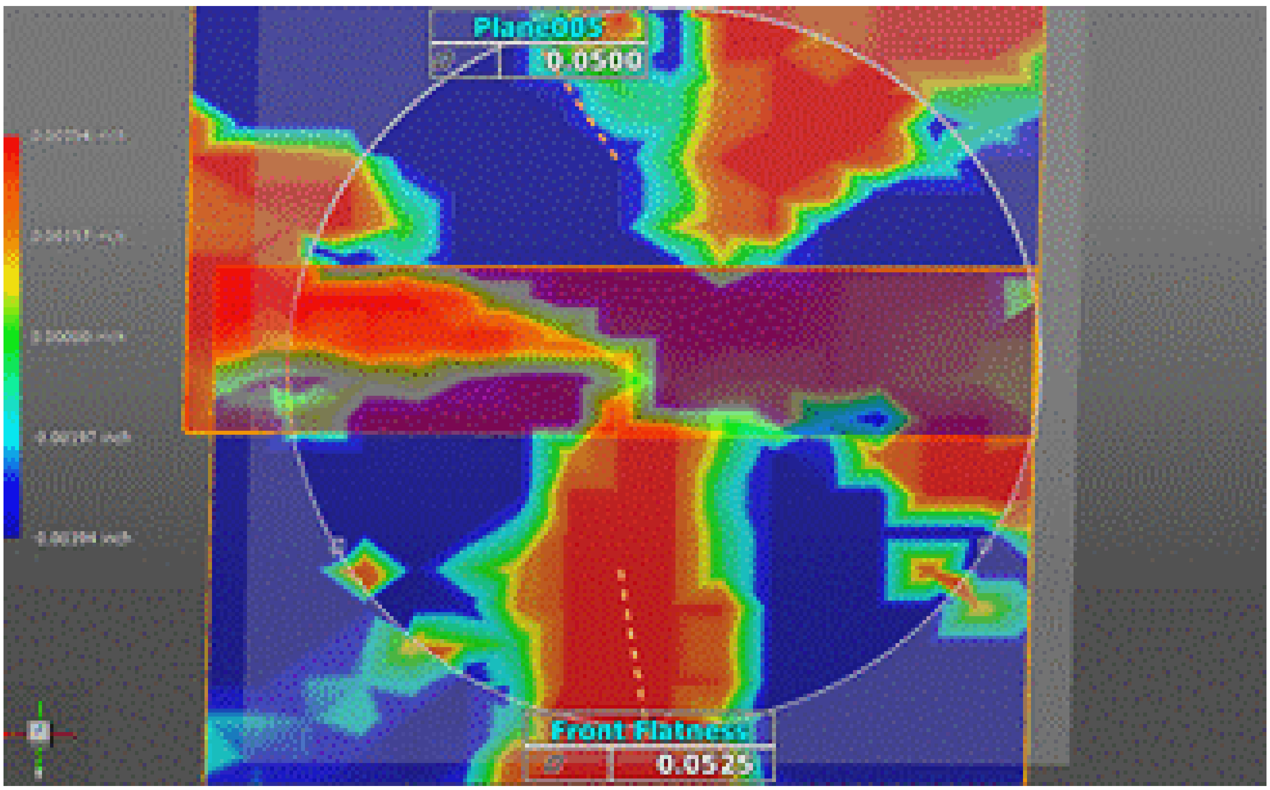
Results.

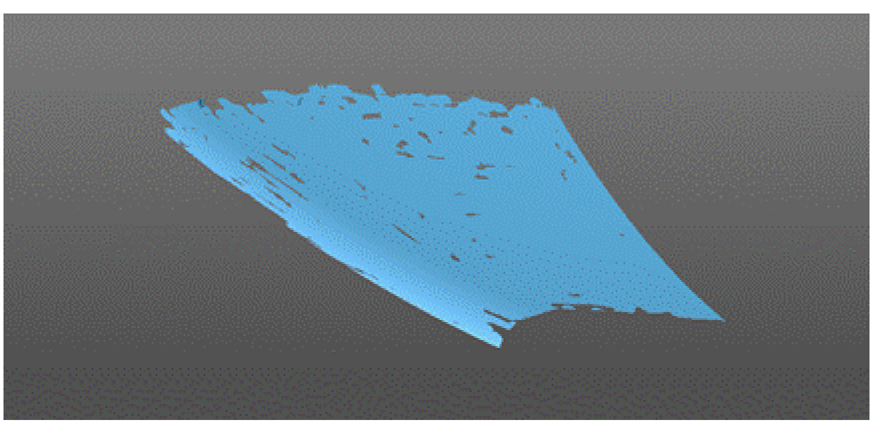
Data from the evaluation was sent by Keyence, both in graphical and digital form. A point cloud with an approximately 7mm grid was supplied as a 215 megabye XYZ file. An STL file to print a model of the surface was also supplied !

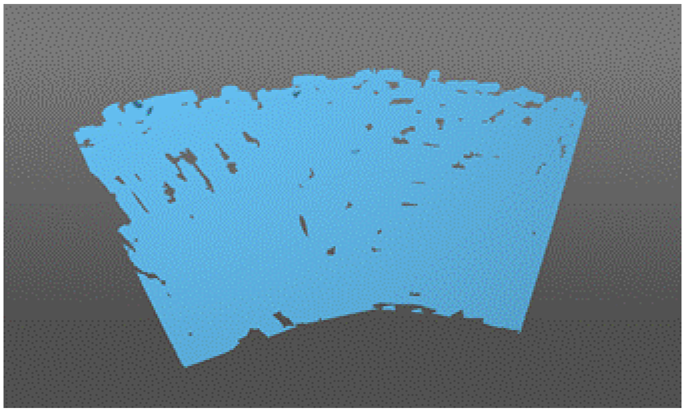
Sample reports were automatically generated and can be supplied on request.

Below, the rail showing a relief map blue were points close to the wheels of the antenna.

Oblateness was measured at 9mm.







Examination of the point cloud data will be more revealing. The Keyence software will automatically create a relief map of deviation from a model, if an accurate model of the dish can be supplied.

Conclusion

The device worked as advertised under full outdoor sun conditions and obtained interesting preliminary data. Further evaluation, and an attempt to get a best fit conic section over the quadrant of data mapped will be undertaken.

The improvement in testing time for rail measurements was somewhat eyeopening, since Steve Taylor had actually performed a field measurement with the optical system at Hancock, and his time of 4.5 hours was 12x slower than the Keyence instrument, and didn't measure the oblateness.

Dish scanning at VLBA antennas, using holographic methods as we do at the VLA is not possible at VLBA antennas because of the effects of baselines, but can be done readily with this equipment. It would be possible also to do tests at different dish tilt angles, if one created a suitable point to attach the reference station.

Riley Schaefer reported that the scan was somewhat back breaking, but Steve Taylor pointed out that a very simple robotic platform could be arranged to test the dish semi-autonomously.

We have many potential use cases for an instrument with the performance offered by the Keyence device. This set is not exhaustive.

- Dish profiling and adjustment (VLBA and VLA)
- in-situ subreflector profiling (VLBA)
- Rail measurements for VLBA
- El Axle alignments VLBA
- Az axle alignments. VLBA
- Az bearing pocket measurements VLBA
- FRM issue resolution.
- XKa band prototyping and reverse engineering VLBA
- Plate alignment and referencing VLA site
- GD+T compliance in machine shop and inward processing
- NgVLA surface measurement and alignment of optical axes.