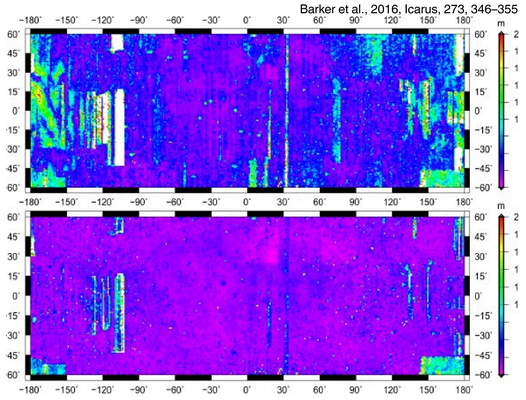
Gaussian Splat CISLUNE Lunar Worksite Mapping

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Background

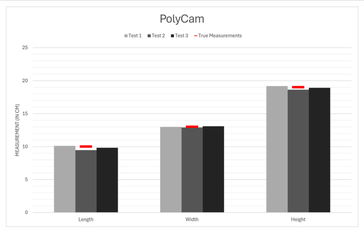
- **Orbital lunar maps** were designed for **landing-site and regional planning**, not for verifying a construction worksite. This project tests whether an inexpensive, phone-based photogrammetry workflow can fill that gap by **measuring elevation change and rut depth** before and after a wheel pass.

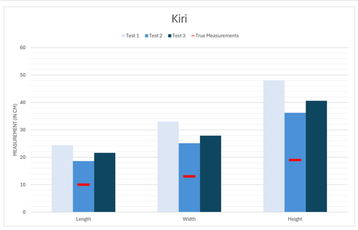


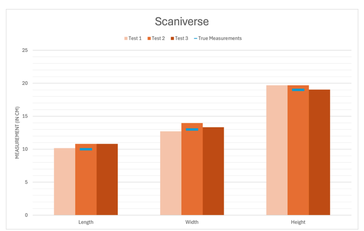
Even after correction, **global lunar elevation maps carry meter-scale errors (2 to 20 m)**, far larger than a wheel rut.

How reliably can a phone-based scanning setup measure a small terrain change?

Choosing a Scanning Software







To choose a software, we measured an object three times in three different applications to see how accurate measurements were incomparison to real life: **PolyCam, Kiri, and Scaniverse.**

PolyCam % Difference Mean	1%
Kiri % Difference Mean	74%
Scaniverse % Difference Mean	3%

Photograph of PolyCam scan

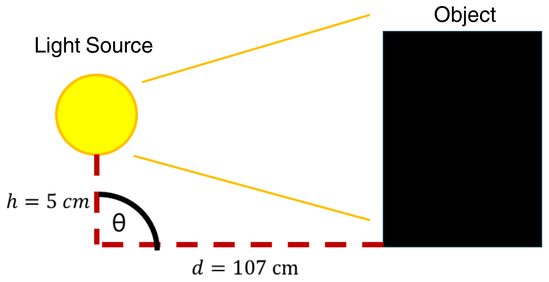


Polycam had the lowest percent difference (1%) using raw, unscaled measurements and supports photo upload. Because a rover cannot rescale scans by hand, we moved forward with **Polycam for future testing**

Experimental Methods: Scanning in Harsh Lighting

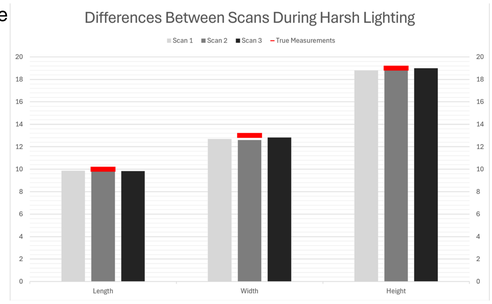
Photograph of PolyCam scan





$$\theta = \arctan\frac{h}{d} = arctan\frac{5}{107} \approx 2.7°$$

- A single desk lamp, with its bulb about 5 cm above the floor and **3 to 4 ft (about 1 m)** away, lit the scene at a grazing angle of about **2.7°** from the lower left of the top-down scan view. The room was otherwise dark.
- **Small edge and texture distortions of a few millimeters** appeared in some scans, which limit how precisely edge-to-edge dimensions can be measured on small objects. Even so, mean error stayed **around 1.4%**, so the workflow is accurate to roughly the millimeter scale.



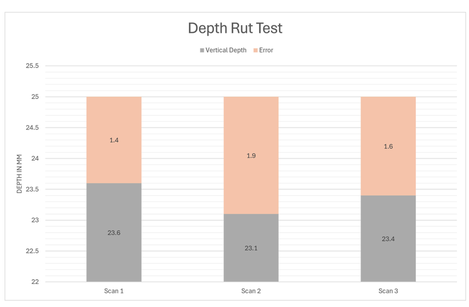
Experimental Methods: Terrain ①



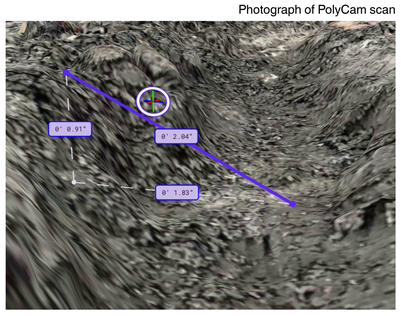




- Wet (left) and dry (right) **sand scanned together in one tray.** Rut walls appear **sharper on wet sand**; dry sand shows **softer ruts and smeared texture.**

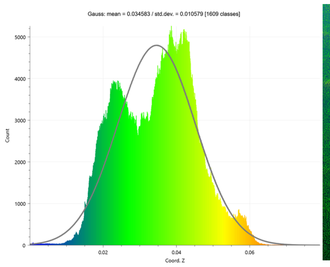


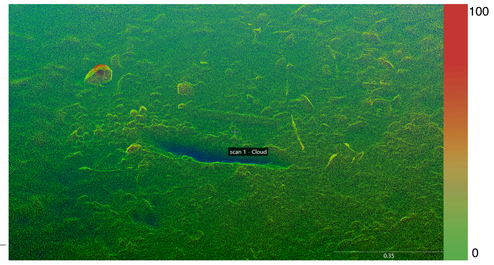
Photograph of PolyCam scan



- Three scans of a **25.0 mm** trench gave depths of **23.4 ± 0.3 mm**, a consistent underestimate of about **1.6 mm (6.5%)**.

Experimental Methods: Terrain ②





- Height map of a trench dug to **25.0 mm (scan 2)**, built from phone photos in Polycam and viewed in CloudCompare. Blue is low and yellow is high. Measured depth: **23.1 mm (–1.9 mm, –7.5%).**

Results and Discussion

- *App selection.* On a known object, Polycam had the lowest raw (unscaled) percent difference from **measured values (1%**), compared with **Scaniverse (3%) and Kiri (74%)**. Polycam was chosen for its accuracy and photo-upload feature. The 1% vs. 3% gap is small, and the Kiri result may reflect a scale problem.
- *Box scans (known dimensions).* **Three scans of a 10 × 13 × 19 cm box** averaged about **1.4% error**, with every dimension within about **4 mm** and repeat scans varying by about **1 mm**. Width was read short in all three scans. Small edge and texture distortions of a **few millimeters** appeared in some scans.
- *Trench depth (known depth).* Three measurements of a **trench dug to 25.0 mm gave 23.6, 23.1, and 23.4 mm (mean 23.4 ± 0.3 mm)**. That is a consistent underestimate of about **1.6 mm (6.5%),** so precision was better than accuracy. A **10 mm** span on a ruler in the scene measured **9.9 mm (about –1%)**, which suggests the depth bias isn't a general scale error.
- *Harsh Lighting.* Harsh lighting introduced minor scanning distortions, particularly around object edges, but **measurements remained reasonably consistent.**

Conclusion and Future Works

- *Measure scan noise on unchanged, leveled ground, and compare it with the trench depth to set a detection limit.*
- *Scan the same object under diffuse light as a baseline for the harsh-light comparison.*
- *Record tape-measured depths for the sand tray ruts to validate them.*
- *Repeat the trench at additional depths to see whether the depth bias is constant or proportional.*
- *Compare separate captures against repeat measurements of one scan.*
- *Test rover-mounted capture and additional sensors.*

References and Acknowledgements

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