The Use of V-STARS for Antenna Manufacturing

Overview of Photogrammetry Features:

What makes Photogrammetry ideal for Antenna Manufacturing Applications?

Fast
Results in minutes with our single-camera system (V-STARS/S) and real-time results with our multiple-camera system (V-STARS/M). No warm-up time is required by either system. Also, production downtime is minimal because many production operations can take place during much of the measurement.

Portable
One "size-wise" carry-on case and a laptop computer is all the equipment needed for most measurements.

1. INCA3
2. Spare Strobe Head
3. Viewfinder
4. PC Disk
5. Wireless Card
6. Camera Batteries
7. Network Power
8. AutoBar
9. Camera Strap
10. Battery Network Power
11. Lens Cloth

Non-Contact
Non-contact measurements are possible with our PRO-SPOT target projector. PRO-SPOT is well-suited for measuring delicate items that deform when touched. If physical targets are needed, they are very small and lightweight so deflection of the surface is not a concern. After targeting, no further touching of the surface is necessary.

High Accuracy
Less than 0.025mm on a 4m object. (5µm + 5µm/meter). Accuracy can be increased by taking more pictures and this has little effect on overall measurement time.

Works Where Other Can't
V-STARS works in unstable environments, where movement, vibration, and/or extreme temperatures often pose problems for other measurement systems.

Repeatability Measurements
The system's use of inexpensive stick-on targets and its automated operation make repeatability measurements fast and easy.

V-STARS Antenna and Satellite Manufacturing Customers.

V-STARS systems are used by some of the world's leading antenna and satellite manufacturers. Customers include,

Portable
The entire system is battery operated and hence is highly portable. The system can be taken to even the remotest places. One "size-wise" carry on case and a laptop computer is all the equipment needed to complete a measurement. This makes it ideal to complete measurements at the supplier or customer site.

Minimal temperature effect.
As the photography is completed in less than 10-15 minutes the effect of temperature differential between the start and end of measurement is greatly minimized. Systems that require longer measurement times have the added uncertainty of temperature and wind effects.

Thermal vacuum chamber operation
The V-STARS system has an optional canister that adapts the INCA for use in the hostile environment of a Thermal Vacuum Chamber. The canister is rated for use in temperature ranging from –200°C to +100°C.

Target projector operation
GSI has developed a target projection system that can be used to measure thousands of points on a surface without applying a single target. The system is suited to rapid surface measurement for inspection or adjustment purposes.

Self-calibration
The V-STARS system is self-calibrating. This means that the user doesn't have to worry about the validity of calibration when moving from one environment to another.

Proven track record
GSI has established itself as the premier manufacturer of measurement systems for antenna manufacturing. Our customer list boasts the most prestigious manufacturers from around the world.

Feature Comparison for Antenna Measurement: V-STARS versus Laser Tracker

Feature	V-STARS	Laser Tracker
High accuracy	Yes	Yes
Non-contact	**Yes** –No contact during measurement. Physical surface can be measured with PRO-SPOT if necessary. No panel deformation due to operators walking on them during measurement.	**Generally No** – In most cases the tracker ball has to touch the surface. Some laser scanning options allow non-contact measurement, but these are somewhat limited.
Fast results	**Yes** –Results are typically available within minutes of completing the object photography with single camera (V-STARS/S). In the two camera on-line system (V-STARS/M) results are available instantly.	**Yes** – points collected as ball is moved around
High data rates	**Yes** – The system lends itself well to high point data requirements. It is capable of measuring thousands of points in the same amount of time it would take to measure a few. Once the antenna has been targeted, there is no requirement to re-visit points for each subsequent measurement. This means the system is ideally suited to repeatability and deformation measurements.	**Yes** – tracker ball has to be moved all over surface.
Versatile in confined spaces.	**Yes** – measurement still possible even in restricted spaces	**Limited** – measurement in confined spaces severely limited.
Immune to vibration	**Yes** – V-STARS works in unstable environments. This includes vibrating or unstable floors, man lifts, cranes and ladders. Additionally the object itself can be vibrating or moving during the measurement without affecting the results. Finally, in outdoor measurements, systems that require stability have to contend with the effects of wind and sun on the instrument. V-STARS doesn't suffer from this limitation.	**No** – stability required
Flexibility	**Yes** – System is capable of measuring objects of varying size. System is also readily adaptable to measurements with severe restrictions. The same system that is used to measure the 2m panel is used to inspect the completed 32m antenna.	**Yes** – Trackers are also flexible, but are unable to work in situations were stability is an issue
Portable	**Yes** – The entire system can be carried on a plane as hand luggage. Rough treatment during transportation not normally a	**Limited** – The tracker can be moved from site to site, but rough handling may lead to calibration

Feature	V-STARS	Laser Tracker
	problem	problems. Generally can't be checked as luggage.
Minimal temperature effect.	**Yes** – quick photography reduce influence of temperature and environmental effects.	**Limited** – Data collection time will depend on the antenna size
Target projector operation	**Yes** – regular grid of targets created on surface using PRO-SPOT	**No**
Self-calibration	**Yes** – each time a network is processed the calibration parameters are optimized to suit the prevailing conditions	**No**

Feature	V-STARS	Laser Tracker
Proven track record.	**Yes** – V-STARS has a long association with Antenna measurement	Yes
Thermal vacuum chamber	**Yes** – via optional INCA canister	**No**
Hand held probes	Yes	Yes
Targeting	**Yes** - Cheap and disposable	**No** – expensive reflectors
System warm up	**No** – no warm up required	**Yes** – varies according to system.
Re-creating Measurement	**Yes** – images can be re-processed at any stage	**No** – data can only be collected while the tracker is set up
Antenna measurement at different look angles	**Yes** – with portable lifts and ladders the antenna can easily be re-measured at different angles.	**No** – measurement limited to the antenna facing up. At other angles tracker can't be easily used.

Antenna Application Guide (V-STARS versus Laser Trackers

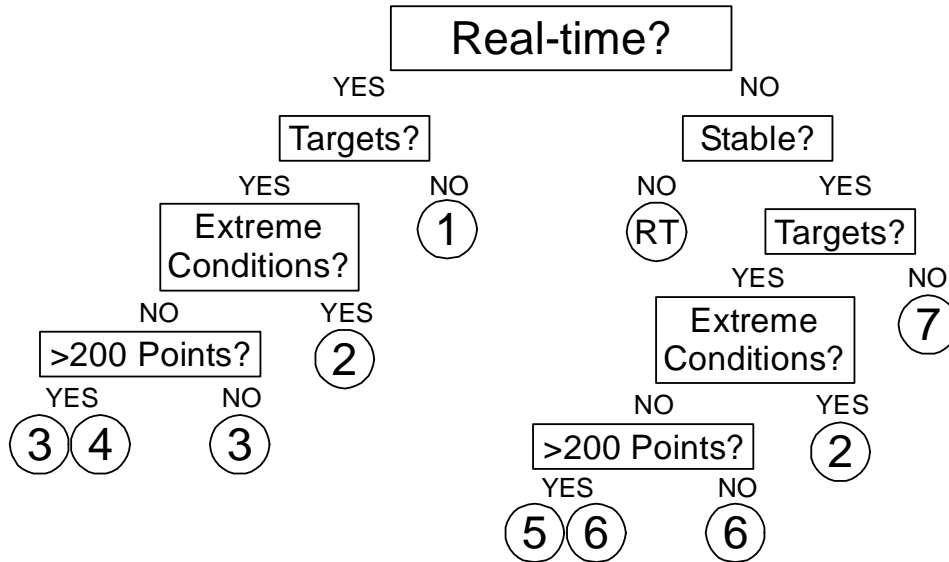| Application	V-STARS	Laser Tracker
Panel Measurement – Solid surface	Measurement via target projection, stick on targets or surface probing	Measurement by dragging reflector over surface
Panel Measurement – mesh, fragile or unstable surface	Measurement via target projection or stick on targets	Not possible due to surface deformation due to ball touching
Antenna assembly	Targets placed in key positions and measured. No contact with panels during measurement	Tracker set up in the middle and ball moved to each location. Potential movement of individual panels as operator moves around
Structure Build	Targets can be placed on the structure to determine geometric information	Tracker ball moved from point to point
Feed alignment	Feed can be targeted and measured at the same time as the main surface	Depends on the antenna size and access to the feed from the ground.
Antenna Shape Measurement	Measurement via stick on targets. Probes and target projection also possible for smaller (<4m diameter) antennas	Antenna must be orientated so tracker can sit in middle. Chance of panel movement during measurement.
Antenna Deformation Study	Measurement of same stick on targets at different look angles or conditions	In order to compare different networks it is necessary to attach tracker bushes or reflectors to the surface. Due to the cost the number of points is limited. Access also restricted when the antenna is moved to different look angles
Transportation check	The antenna can be measured before and after transportation. Moving camera from place to place is very easy.	Permenant tracker targets need to be installed on the antenna. Tracker also has to be moved from factory to site which can be difficult.

Typical V-STARS Antenna Applications

Listed below are some typical V-STARS antenna applications and the equipment that could be used to complete the application.

Application	Description	Equipment
Panel measurement	• Individual panel measurement • Assembled panels	V-STARS/S PRO-SPOT
Surface Measurement	• Component verification • Lay up tools and die measurements • Real time inspection	V-STARS/S PRO-SPOT V-STARS/M
Deformation measurement	• Deformation due to changes in position or attitude • Deformation due to load • Dynamic measurement	V-STARS/S PRO-SPOT V-STARS/M
Temperature Deformation	• Deformation due to extreme temperatures	I-CAN
Node Adjustment	• Adjustment of node points on mesh antennas	V-STARS/S V-STARS/M
Deployment measurement	• Measurement to verify correct antenna shape after deployment	V-STARS/S
Repeatability check	• Repeatability of individual components. • Deployment repeatability study	V-STARS/S V-STARS/M
Jig Verification	• Periodic inspection of jigs	V-STARS/S
Component Alignment	• Alignment of components such as feeds and hinge lines	V-STARS/S V-STARS/M
Shape analysis	• Measurement of antenna to verify shape fit to parabola or surface model	V-STARS/S PRO-SPOT
Transportation check	• Check of built components after transportation to customer or from suppliers	V-STARS/S

Antenna Application Guide

The decision tree and table below can be used to determine the equipment configuration that best suits the application.

Real-time?
- YES
  - Targets?
    - YES
      - Extreme Conditions?
        - NO
          - >200 Points?
            - YES — 3 4
            - NO — 3
        - YES — 2
    - NO — 1
- NO
  - Stable?
    - NO — RT
    - YES
      - Targets?
        - YES
          - Extreme Conditions?
            - NO
              - >200 Points?
                - YES — 5 6
                - NO — 6
            - YES — 2
        - NO — 7

RT	If the targets are not stable this is a real-time application.
1	Use probes and/or special targets with V-STARS/M to measure these objects.
2	Use special V-STARS I-CAN canister.
3	Use V-STARS/M and stick-on retroreflective targets.
4	Use V-STARS/M and PRO-SPOT projector.
5	Use V-STARS/S and PRO-SPOT projector.
6	Use V-STARS/S and stick-on retroreflective targets.
7	Use V-STARS/S and special targets

For example, consider the case where the surface of an antenna needs to be measured in real-time. The decision process would proceed as follows:

Real-time	YES
Targets	YES
Extreme Conditions	NO
>200 Points	YES
RESULT	V-STARS/M with targets or PRO-SPOT