White Light Depth Gage for Defects in Glass Surfaces

NNWG Project Status

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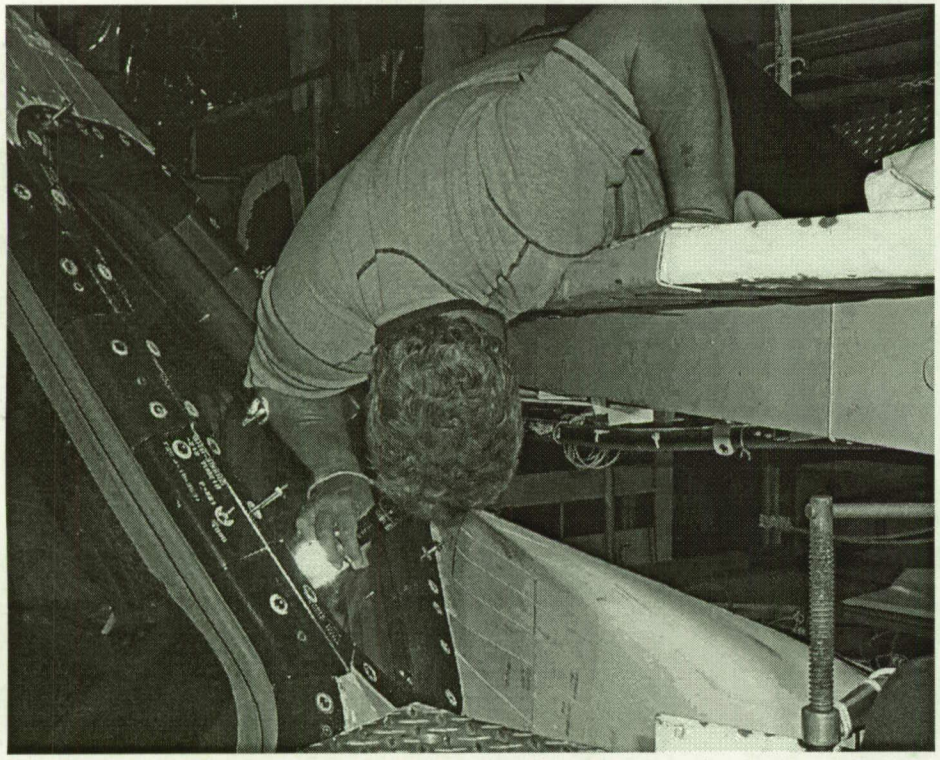
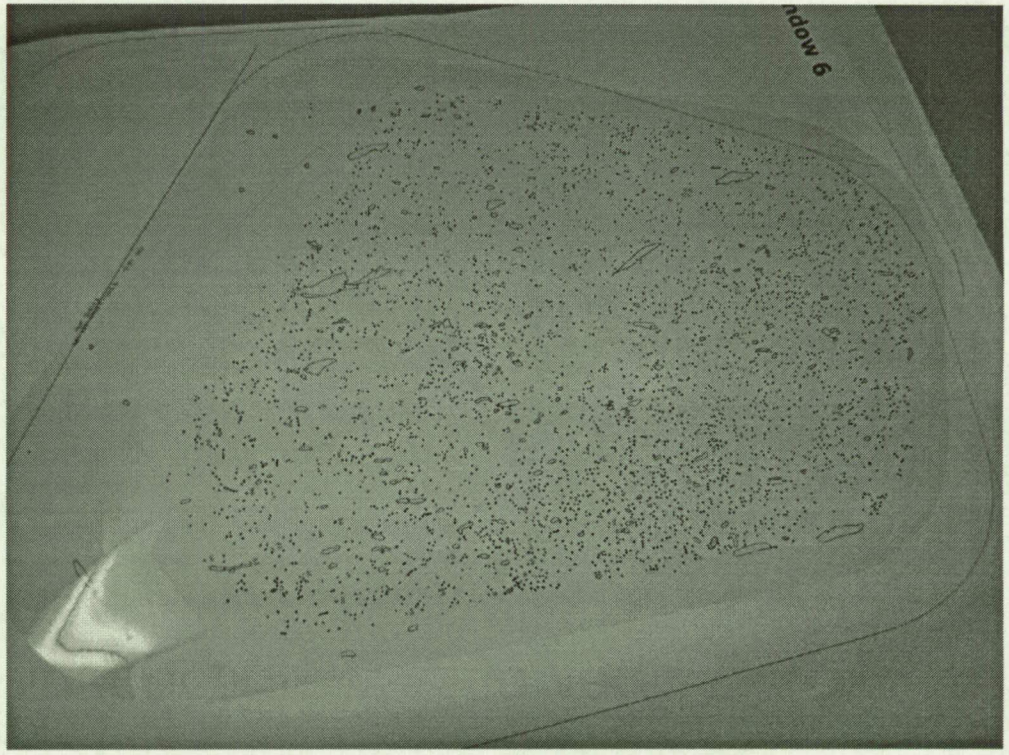
Bob Youngquist, Stan Starr
Applied Physics Lab, KT-D
Kennedy Space Center

Need for this sensor

Previous method of on-vehicle inspection was flawed:





Inspectors arduously search for and document the location of defects on Mylar sheets. There might be hundreds of suspect defects on a single window and more appear after each mission.

Need for this sensor

After finding a defect, it's depth must be determined.

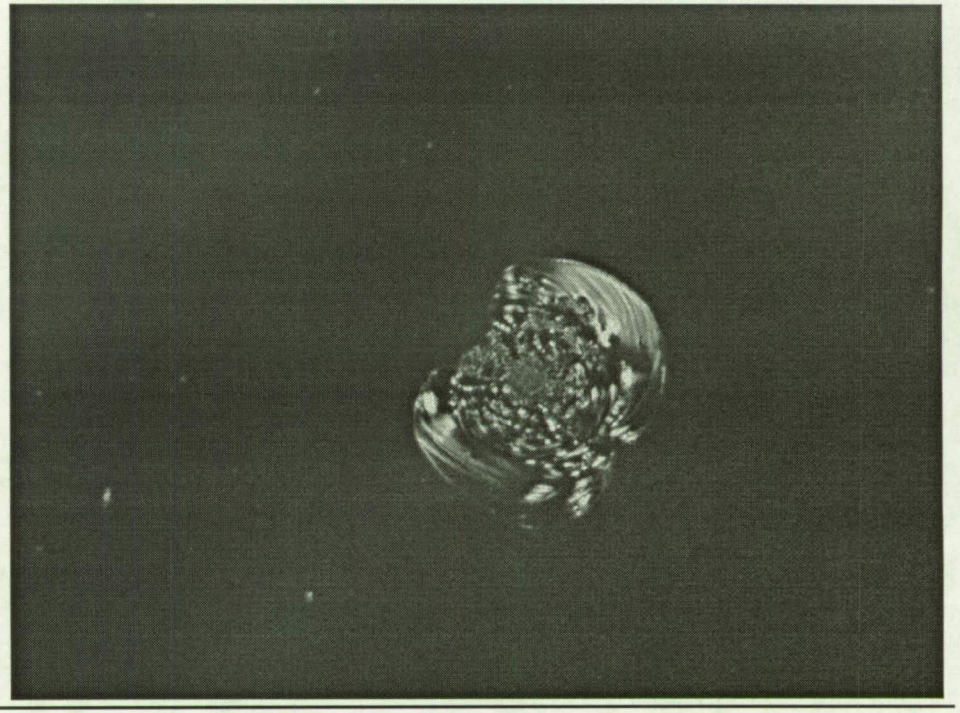
Previously this measurement was performed using a refocus microscope:

However, a Boeing 6 Sigma initiative showed that the refocus test was highly flawed.

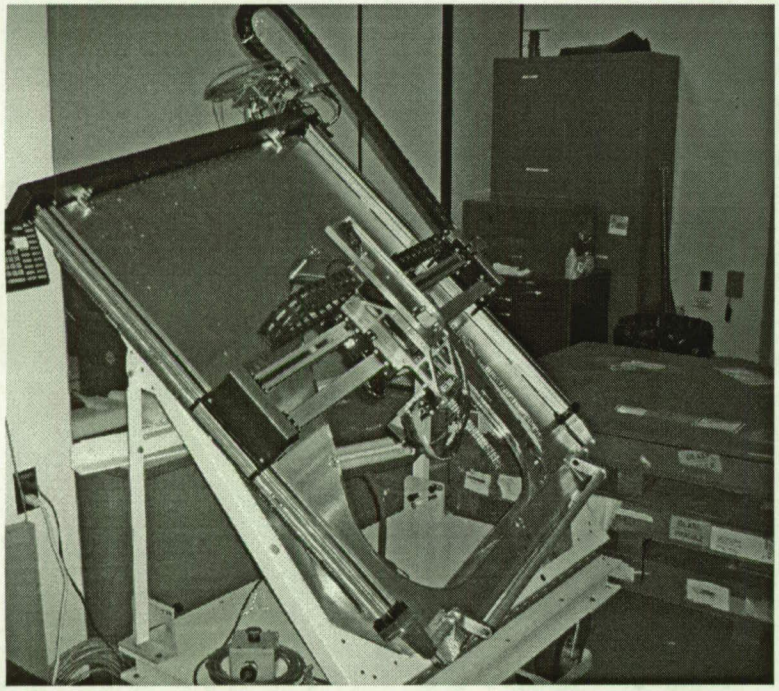
Now the windows are removed and inspected at NSLD. Mold impressions are made of all suspect defects and then measured off-line.

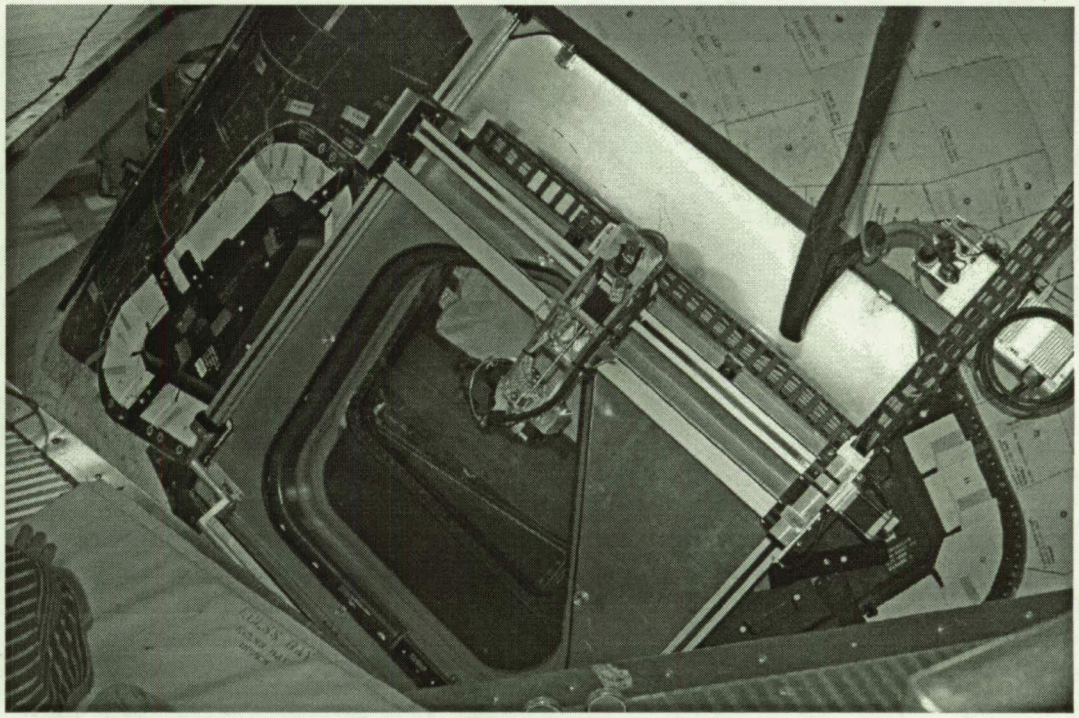
The Refocus Microscope

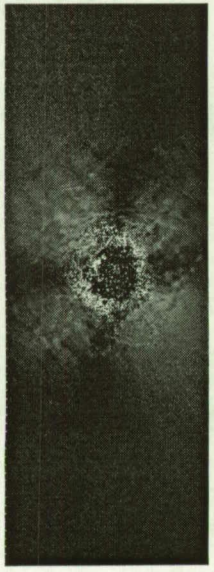
An Orbiter Window Defect



Other Window Tools In Development





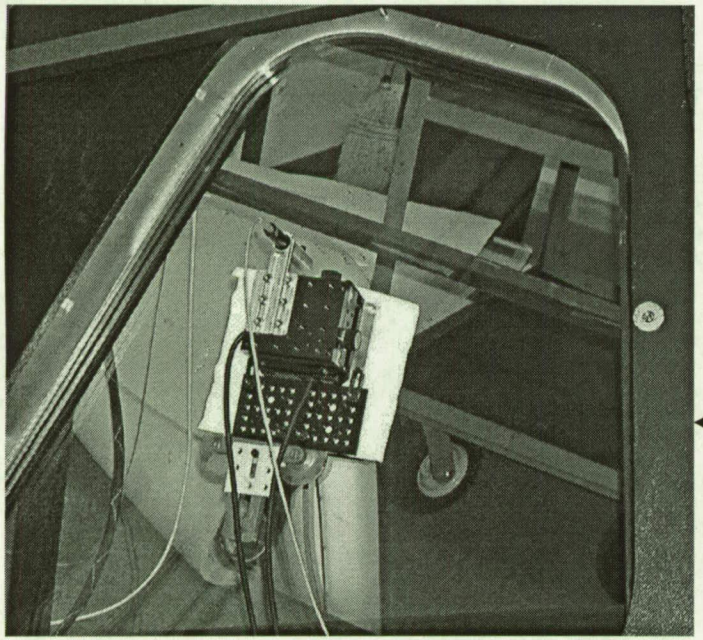


Stress fields associated with a defect

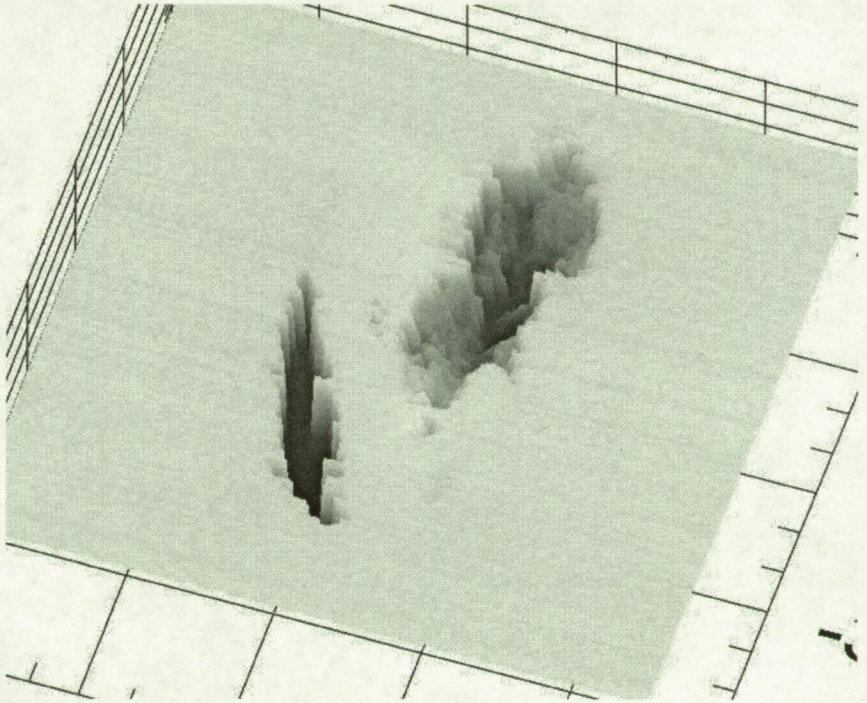
A scanning window inspection system is in development which uses stress induced polarization changes in light to detect the stress field associated with a defect. It is undergoing final certification testing in the field, all windows now being scanned post-mission.

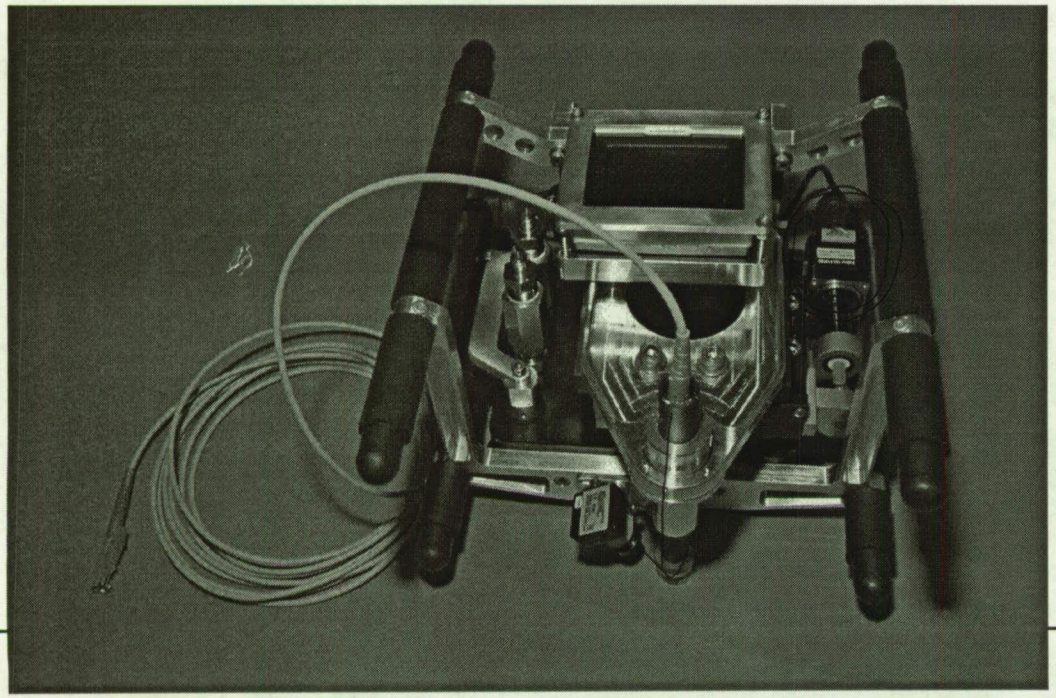
Funded initially by Orbiter and then by USA.

Other Window Tools In Development



PHOWID
defect
scanner



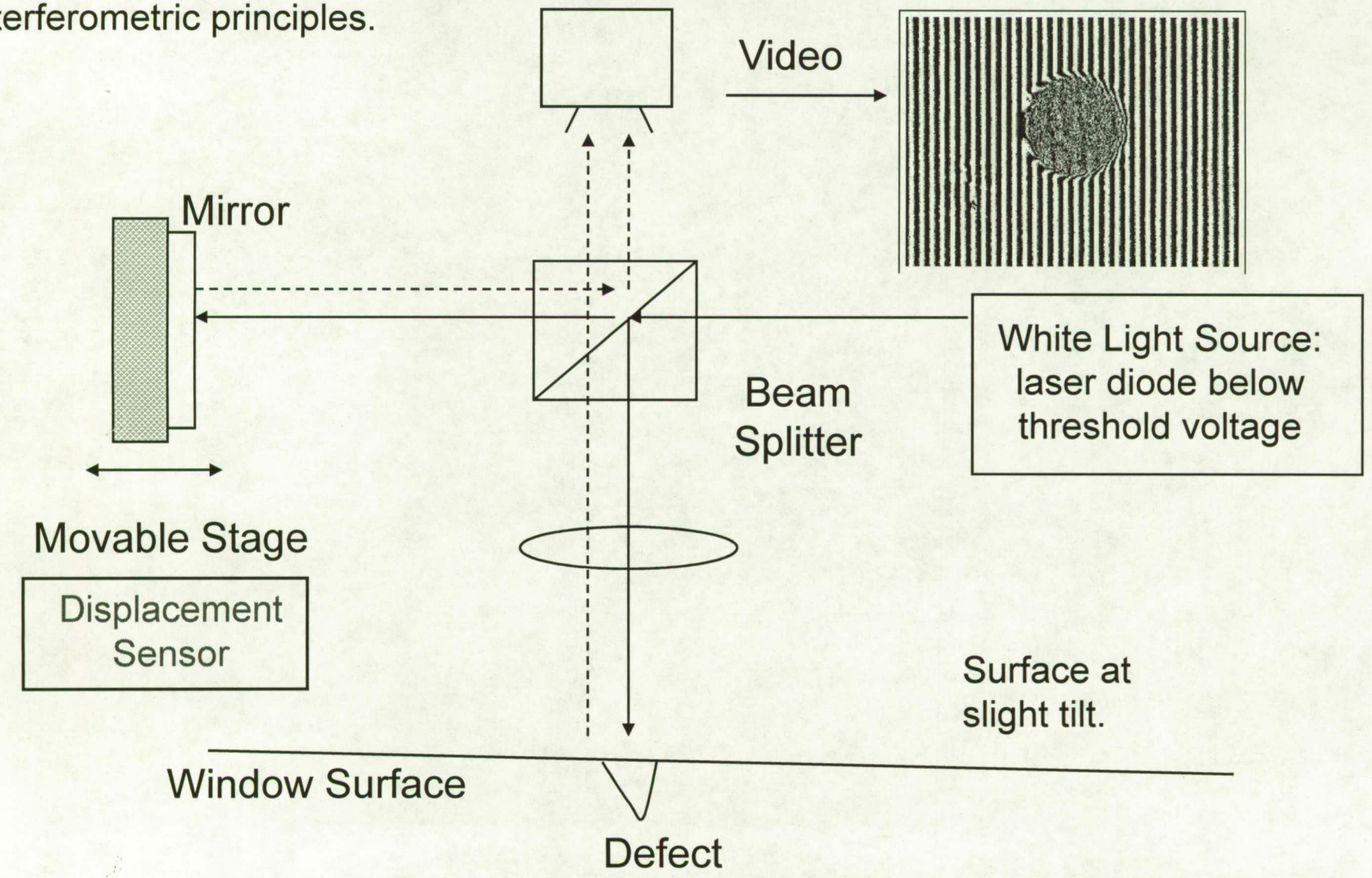


To replace the need for mold impressions a highly accurate surface topography scanning system is being developed. This device will be handheld and will be placed on a window where it will scan a defect and produce a 3-D contour map. Resolution about 20 micro-inches (50 microns).

Work funded by Shuttle-Orbiter.

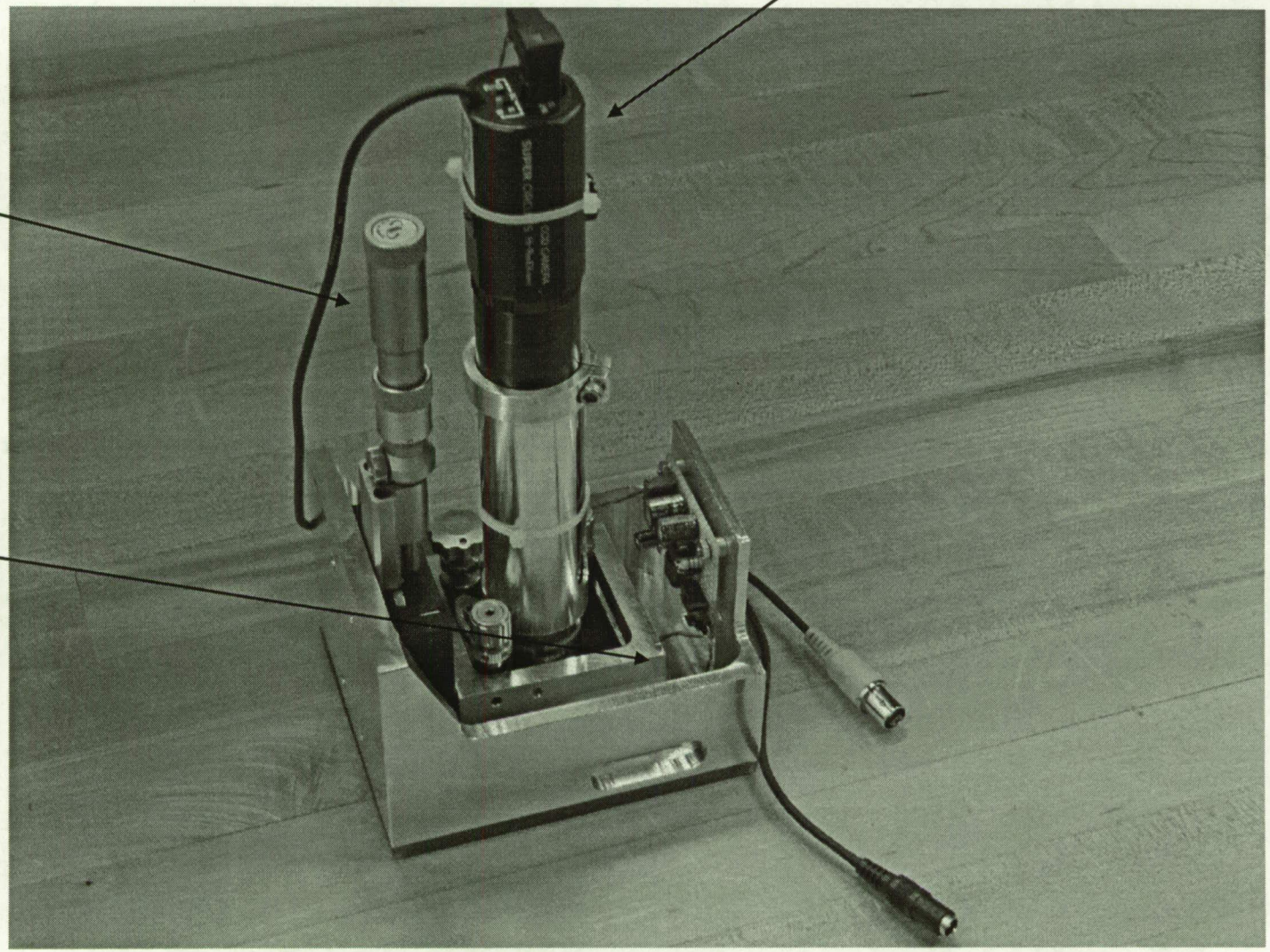
White Light Depth Gage Concept

But there is still a need for a rapid go-no go gage to replace the refocus microscope. We propose to develop a handheld tool that will accomplish this goal, based on white light interferometric principles.



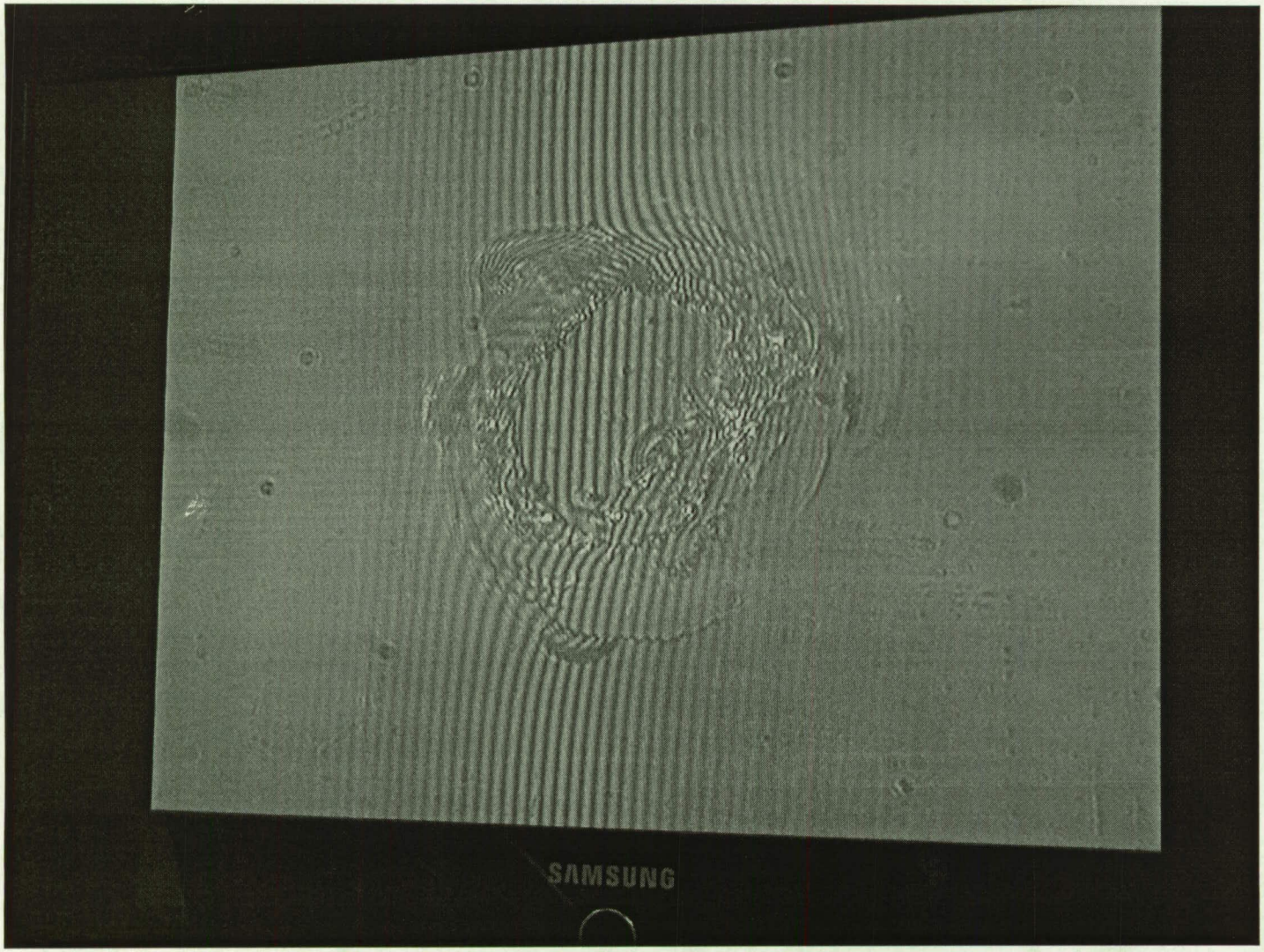
White Light Depth Gage Prototype

The field prototype White Light Depth Gage is shown here.



White Light Depth Gage Defect Image 1

Video image from the manual prototype showing the coherence function of the SLD (see the fringe visibility increase then decrease across the field of view). Also note the fringes are curved in regions where the slope of the surface changes near the defect.



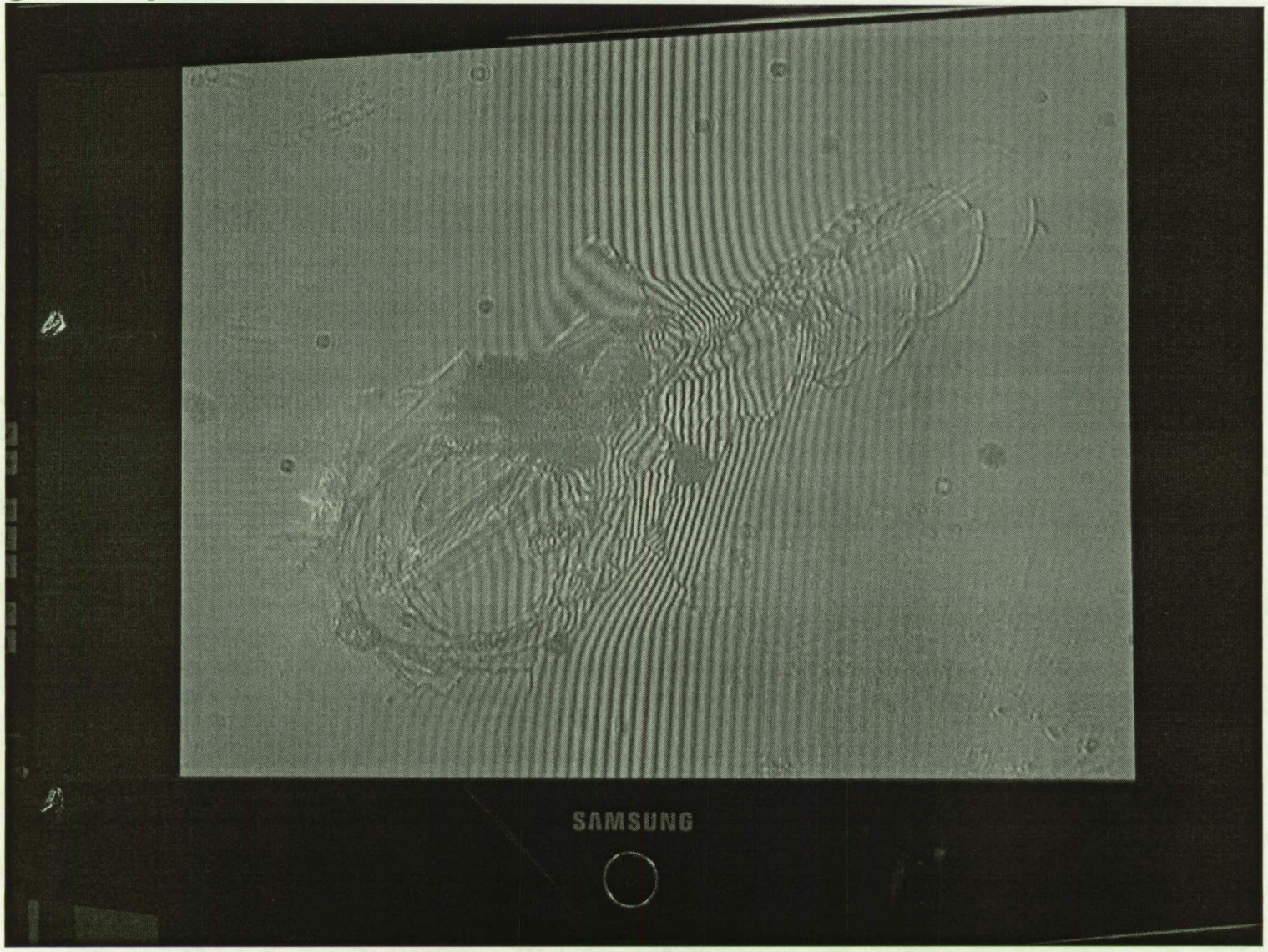
Spacing between fringes is about 400 nm, defect about 0.02 in. across (0.5 mm).

WLDG is tilted slightly so that fringe pattern crosses field of view.

Resolution is comparable to PHOWID.

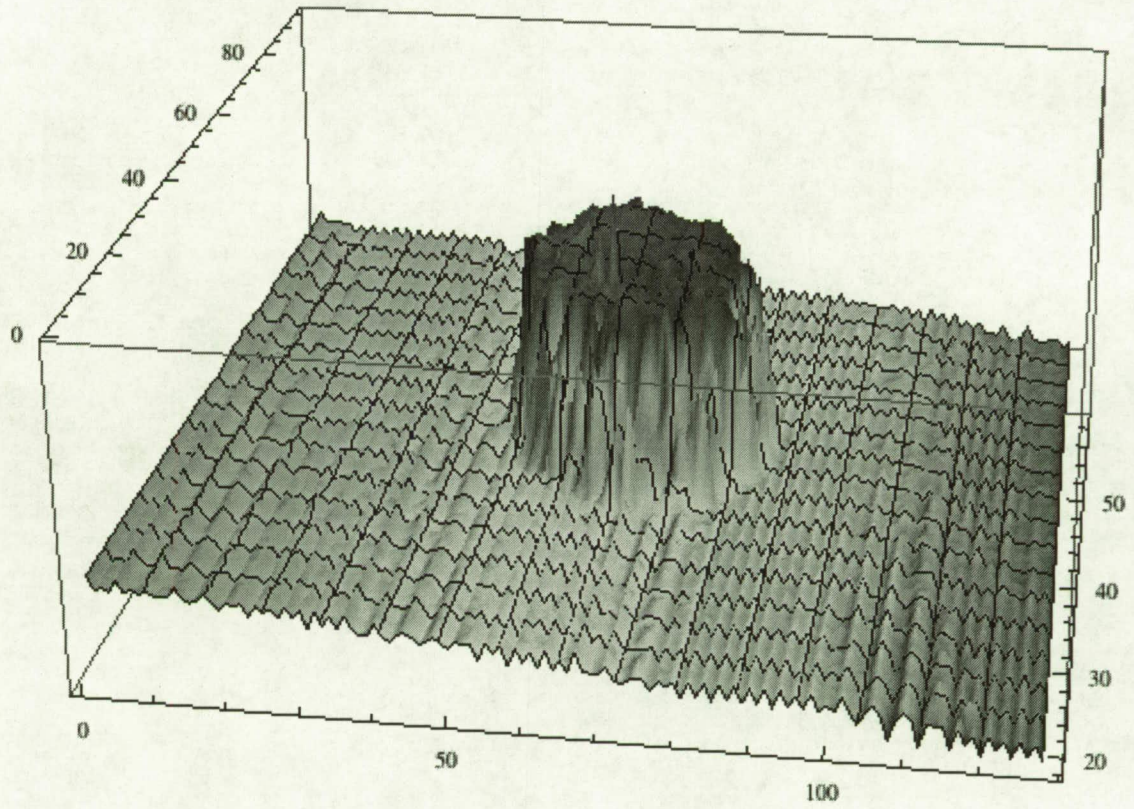
White Light Depth Gage Image 2

- Image from glancing blow showing "chatter check" features and low angle chip removal.



White Light Depth Gage Progress

This is a contour plot of a defect generated by tracking the interference fringes corresponding to a stream of stepped images.



Our current plans are to field test the prototype then rebuild the unit and add software for automated depth analysis and image processing.

Technical Plan and Status

Outline of Plan with Status: (original plan adjusted for late start)

FY07: 1. Develop a tabletop system and determine its performance characteristics. (Due October 07, Complete July 07.)

2. Test against known defects and modify the design to achieve best operation and to meet the needs of the operations community (for example, the size of monitored spot and the distance to the defect can be modified). (Due December 07, Complete)

FY08 3. Build a field version of the device using miniaturized optical components. (Due September 08, Complete) This task has been split into a purely mechanical version and an electronic version.

FY09 4. Monitor field testing and modify the instrument as needed for different applications. Test calibration methods for various surfaces of importance. (Due May 09)

5. Refine the instrument and begin the conversion to either a shop aid or full ground support equipment. (Due January 10)