NA ALMA Antenna Review

Introduction

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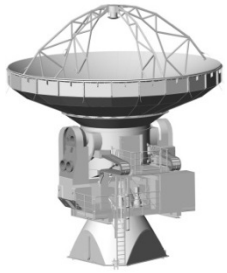
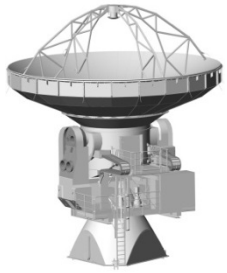
Atacama Large Millimeter/submillimeter Array
Karl G. Jansky Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

Presentation Outline



- **Background Information**
  - problem statement
  - non-conformance description
  - primary objectives
  - Panel charges
  - review protocol
- **Investigation Chronology**
  - methodology
  - timeline
  - progress to date
- **Science Goals**
  - support requirements
  - implications and consequences

Background Information



- **Problem statement**

  The antenna surface does not respond to bulk temperature changes as predicted by the Finite Element Model (thermo).

- **Non-conformance description**

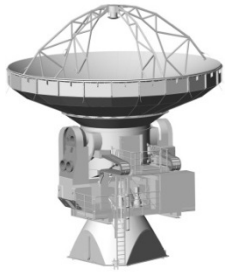
  A substantial number of NA antennas do not meet the design specification of 25μm rms, total surface accuracy, over the specified ambient temperature range of ± 20°C.

- **Primary objectives**

  1) identify the root cause, or causes, of the non-conformance;
  2) verify the root cause(s) by analysis and test (if possible);
  3) develop a corrective action;
  4) verify efficacy, by test, of the corrective action; and
  5) implement corrective action.

The root cause of the non-conformance is unidentified.

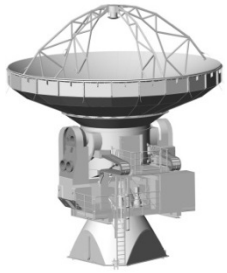
Background Information (cont.)



- **Panel charges**
  - evaluate accuracy (veracity) of the antenna surface measurements;
  - evaluate antenna performance as a function of bulk temperature changes;
  - provide recommendations to assist the investigation or improve antenna performance; and
  - provide written feedback to the NRAO Director no later than 28 November
- **Review protocol**
  - management of proprietary information
  - schedule discipline
  - Observer participation

Stay focused on objective #1 – identification of root cause.

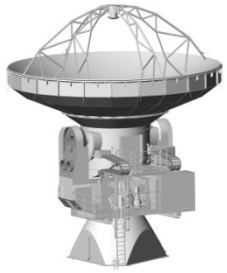
Investigation Chronology



- **Methodology**
  - Fault Tree Analysis (FTA) … a logical, systematic and comprehensive approach to definition of root cause(s)
- **Timeline**
  - May 2010 — preliminary astro-holography revealed displacements of entire panels at random locations
  - Nov 2011 — surface problem with "persistent" thermal astigmatic influence identified during subsequent surface adjuster inspections of antennas starting with DV08
  - Jul 2012 — Vertex formally notified of surface performance issue
  - Jun 2013 — on-going astro-holography campaign and investigation
- **Progress to date**
  - investigation converging on cabin wall temperature control

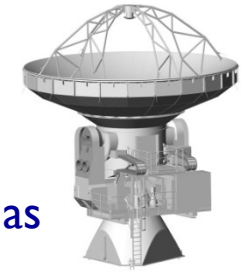
This is an on-going investigation; several possible causes dismissed.

Investigation Chronology (cont.)



DATE	ITEM DESCRIPTION	REFERENCE
May 2010	Preliminary Astro-Holography revealed problems with displacements of entire panels at random locations	CAR-88
Jan 2011	Systematic Program for Surface Adjuster inspections and replacement on all Antennas up to DV12	CAR-88
Nov 2011	**Surface problem with "persistent" thermal astigmatic influence was identified during subsequent surface adjuster inspections of Antennas starting with DV08**	CAR-222
Nov 2010 - Present	CSV & NRAO continue surface studies based on OSF Tower & AOS Astro-holography efforts {specific efforts indicated below as bullet-items}	
Nov 2010 - Present	• Thermal structure change studies on DV08 at AOS	CSV-570
Apr 2012	• Interim Astigmatism Summary Report (DV01-DV11): "Summary of the Astigmatism with Tower Holography after AOS Operations" (S. Asayama; Sr. RF Engineer; Array System Group)	CAR-222
Apr 2012	Interim MRB to discuss status of DV Antenna Surface Investigations conducted by AIV/CSV & NRAO	CAR-222
Jul 2012	**Vertex formalyy notified of the identified surface performance issue (involving the apparent thermally-induced astigmatism)**	
Aug 2012	On the basis of CSV Surface Measurement Studies (& Report which was sent to Vertex in July {see above}), a new CAR initiated: Vertex Antennas at the AOS show changes in surface errors which appear to be correlated with the ambient temperature	CAR-234
Dec 2012	Face-to-Face Meeting with Vertex to discuss status of surface performance issue (19 Vertex & NRAO Action Items assigned)	CAR-222 CAR-234
Jan 2013 - Present	Ongoing efforts by Vertex & NRAO to resolved the 19 Action Items established at the 2012 Face-to-Face	
Jun 2013 - Present	• Astroholography Campaign for all antennas B3,6,7,9	CSV-2826
Nov 2013	Interim MRB to discuss status of DV Antenna Surface Investigations conducted by AIV/CSV & NRAO {2013.11.07}	CAR-222

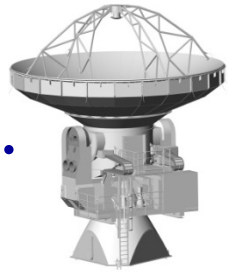
Science Goals



- **Support requirements**
  - Cycle 3 Science proposal acceptance reviews begin Q2 CY2015
  - ALMA Operations assumes uniformity (interchangeability) of antennas
  - Band 9 (f_{max} = 720 GHz; λ_{min} = 420μm)
  - Band 10 (f_{max} = 950 GHz; λ_{min} = 320μm)
- **Implications and consequences**
  - "grace period" expires in approximately six months
  - low aperture efficiency will require increased integration time (schedule risk)
  - non-uniformity (non-interchangeability) of antennas will complicate planning and logistics to an unacceptable degree
  - non-uniformity (non-interchangeability) of antennas will strain partnership relations with the ESO-SRON and the NAOJ (Bands 9 and 10, respectively)

Verified corrective action is required within six months.

Summary



- **Root cause of the surface accuracy non-conformance (as a function of bulk temperature change) is unidentified.**
- **Stay focused on objective #1- identification of root cause.**
- **This is an ongoing investigation – not a "green field"; several possible causes have already been evaluated and dismissed.**
- **Verified corrective action for the surface accuracy non-conformance is required within six months.**

Thank you for your support.

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