



# National Geodetic Survey Absolute Antenna Calibrations

CORS User Forum

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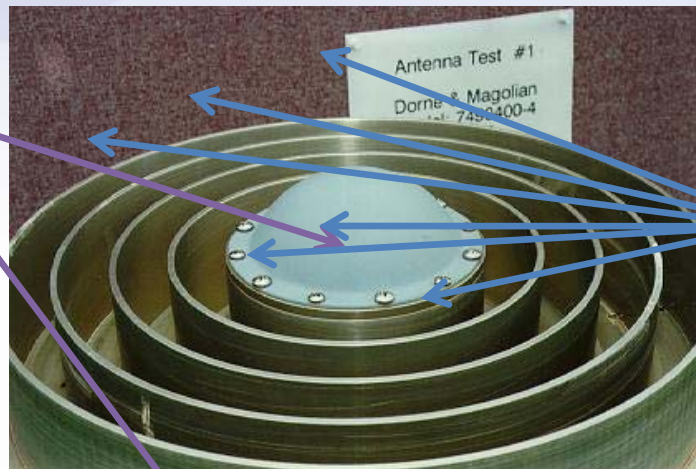
NGS Geosciences Research Division

# Outline

- Absolute calibrations
  - What are they?
  - How are they different from relative calibrations?
  - What does this mean to me?
- Calibration examples
- NGS Calibration Services

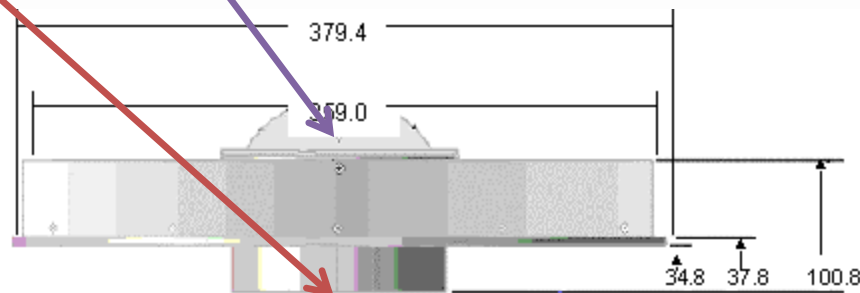
# Where do I receive the signal?

Antenna element



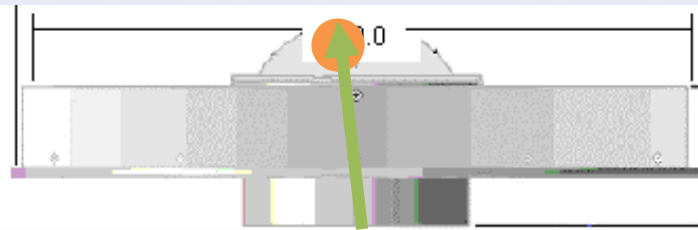
Intangible point floating in space

Antenna reference point (ARP)



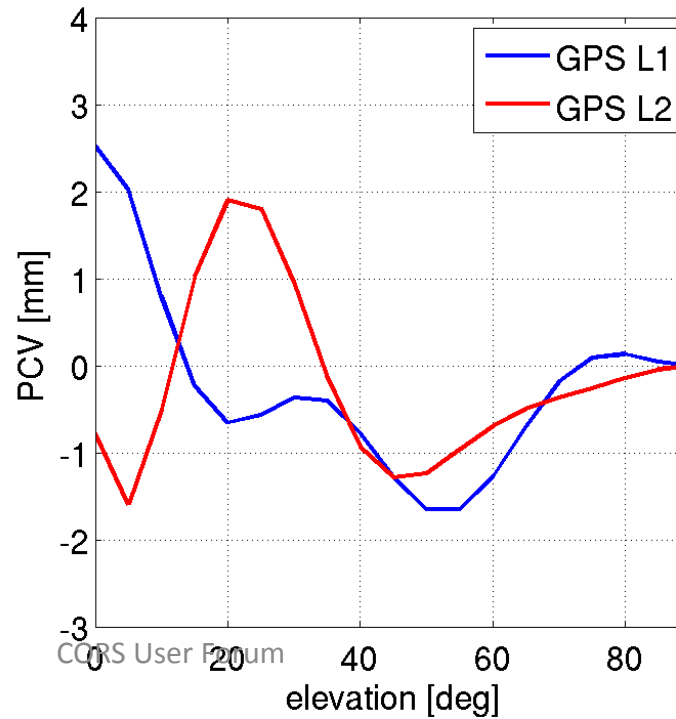
# Calibration: Map of Phase Delay/Advance

- Mean point being positioned: **PCO** (phase center offset)
- Spatial variations about the mean: **PCV** (phase center variations)
- After applying PCO & PCV, all signals converge to a single point (ARP)



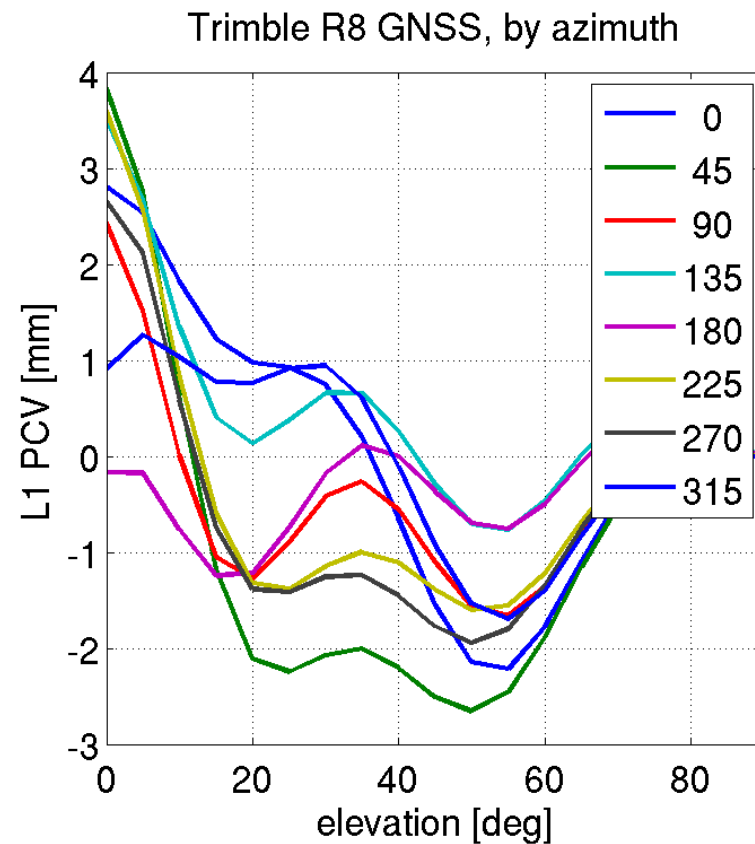
**PCO**  
*[ENU]*

Trimble R8 GNSS



**PCV**  
*(elev)*

# PCV Azimuthal Dependence



# Why Do I Need Calibrations?

- Antenna introduces elevation (and azimuth) dependent phase variation to the observed phase data -> range errors
- Input to most GNSS data processing software
- Omitting calibrations leads to estimation errors:
  - Long baselines
  - Combining multiple antenna models
  - Height errors

# Relative vs. Absolute

	Relative	Absolute
Calibration values	Relative to a reference antenna (JPL chokering D/M_I)	Independent of reference antenna
Method	Stationary antennas	Test antenna moves
Advantages	Straightforward math	Sample full hemisphere and low elevation angles; independent of source
Limitations	Cannot sample full pattern; source-dependent	Requires robot and rigorous accounting of angles & rotations

Do not combine relative and absolute calibrations!

# Why Go to Absolute?

- Better/fuller description of phase behavior
  - Includes 0-10° elevation coverage
  - Captures azimuthal variations
  - Multipath removed/negated
- The way of the future
  - International GNSS Service (IGS) standard
  - Used in OPUS
  - Used in CORS multiyear [IGS08 epoch 2005.0 and NAD 83(2011) epoch 2010.0]

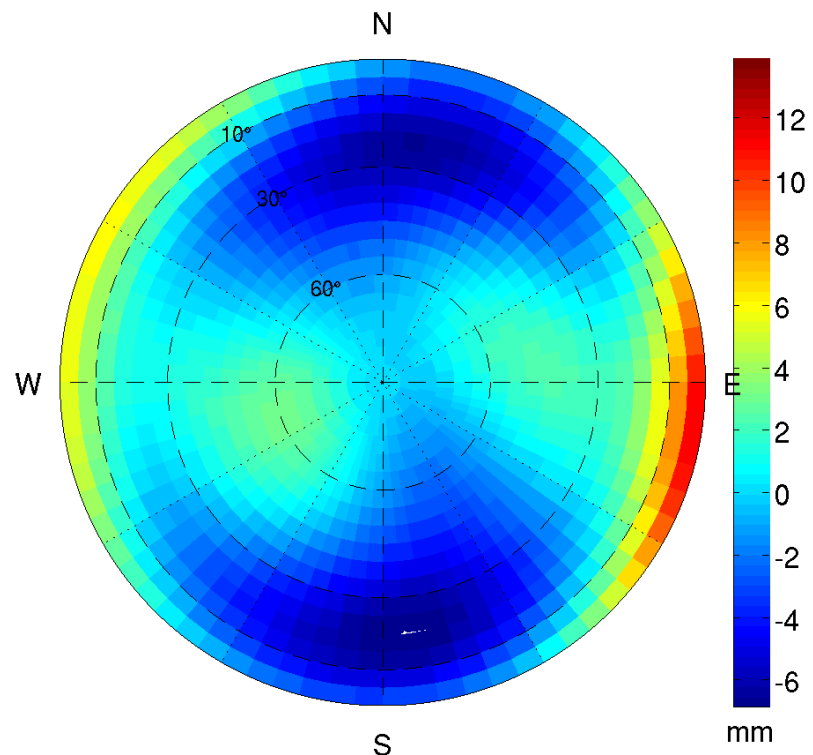


# NGS Absolute Calibration Motivations and Goals

## **Serve high precision needs of U.S. surveying and geodesy communities**

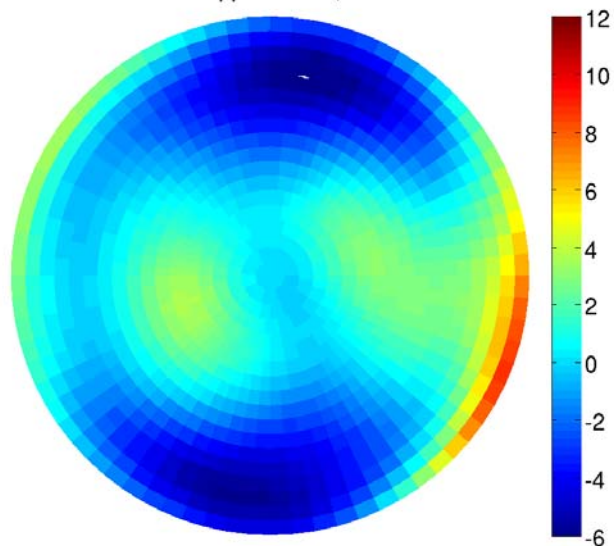
- Multi-frequency, multi-GNSS calibrations
- 2-D (elevation, azimuth) phase center patterns
- Free calibration service w/ quick turn-around
- Calibration values publicly distributed via Internet
- Compatibility with IGS ANTEX values

# Calibration Examples: Ashtech Whopper (ASH700718B NONE)

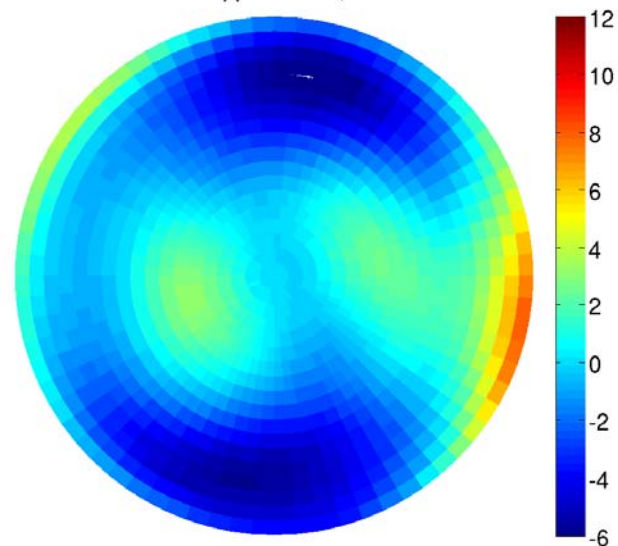


# Consistency within model group: Ashtech Whopper (ASH700718B NONE)

Ashtech Whopper: ant#1, scenario B



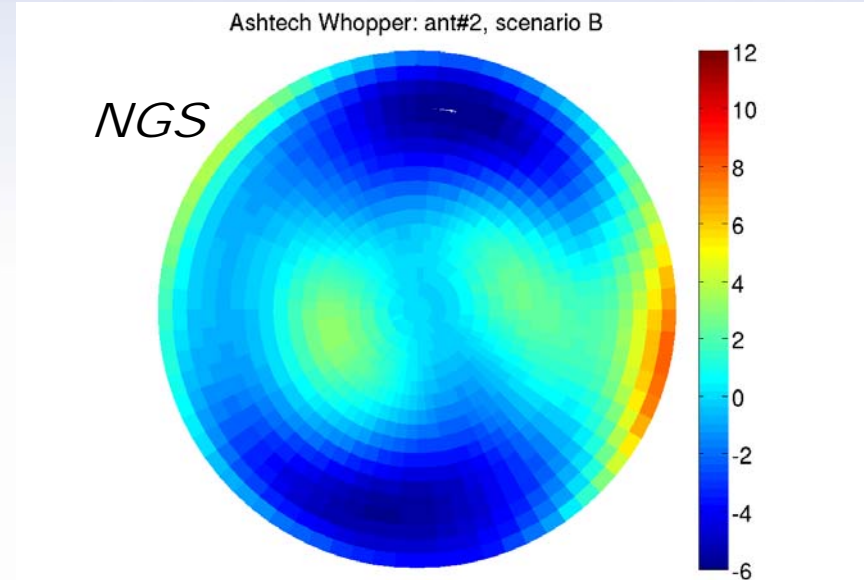
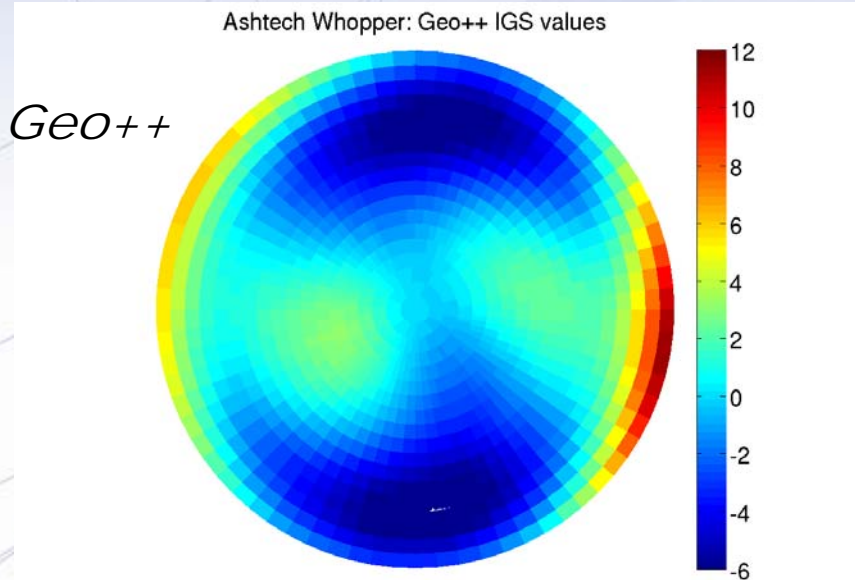
Ashtech Whopper: ant#2, scenario B



PCO =  
[-1.91 0.43 69.63] mm

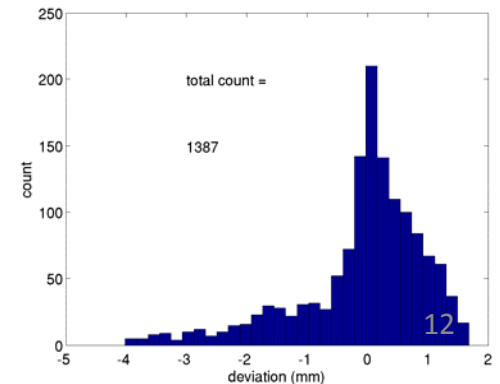
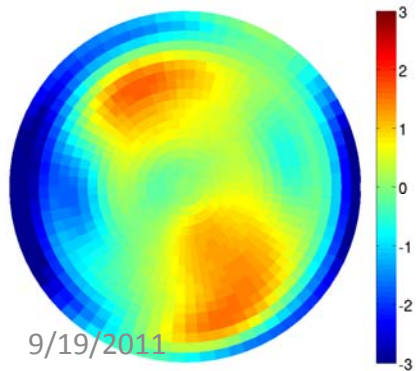
PCO =  
[-1.22 0.24 70.86] mm

# Comparison to IGS: Ashtech Whopper (ASH700718B NONE)



PCO =  
[-1.67 -0.47 69.48] mm  
NGS minus Geo++

PCO =  
[-1.22 0.24 70.86] mm



# Conclusions and Outlook

- Pending approval from IGS Antenna Working Group
- Soon to be “open for business”
- For more information
  - <http://www.ngs.noaa.gov/ANTCAL>
  - Email [andria.bilich@noaa.gov](mailto:andria.bilich@noaa.gov) or [NGS.AbsAntCal@noaa.gov](mailto:NGS.AbsAntCal@noaa.gov)

## GPS Antenna Calibration

## Calibrated Antennas:

- [Antcom Corporation \(ACC\)](#)
- [AeroAntenna \(AER\)](#)
- [Allen Osborne Associates \(AOA, NGS, JPL\)](#)
- [ALTUS Positioning Systems \(APS\)](#)
- [Ashtech \(ASH, THA\)](#)
- [DataGrid International \(DGR\)](#)
- [Gutec AB \(GUT\)](#)
- [Hemisphere GPS \(HEM\)](#)
- [Javad \(JAV, JNS, JPS\)](#)
- [Leica \(LEI\)](#)
- [Macrometer \(MAC\)](#)
- [Magellan Professional \(MAG\)](#)
- [Micro Pulse \(MPL\)](#)
- [NavCom \(NAV\)](#)
- [NovAtel \(NOV\)](#)
- [Sensor Systems \(SEN\)](#)
- [Septentrio Satellite Navigation \(SEP\)](#)
- [Sokkia \(SOK\)](#)
- [Spectra Precision \(SPP\)](#)
- [Thales Navigation \(ASH, THA\)](#)
- [Topcon \(TOP, TPS\)](#)
- [Trimble \(TRM\)](#)



Antenna testing facility

National Geodetic Survey

Antenna Calibrations

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**Links**

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[FAQ](#)

### Individual Absolute Calibrations

- [3SNAVIGATION](#)
- [ALTUS Positioning Systems](#)
- [AeroAntenna](#)
- [Allen Osborne Associates](#)
- [Antcom Corporation](#)
- [Ashtech](#)
- [DataGrid International](#)
- [Gutec AB](#)
- [Hemisphere GPS](#)
- [Javad](#)
- [Leica](#)
- [Macrometer](#)
- [Magellan Professional](#)
- [Micro Pulse](#)
- [NavCom](#)
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- [NovAtel](#)
- [Sensor Systems](#)
- [Septentrio Satellite Navigation](#)
- [Sokkia](#)
- [Spectra Precision](#)
- [Stonex](#)
- [Topcon](#)
- [Trimble](#)

**Composite Absolute Calibrations**

- [ANTEX \(new IGS format\)](#)
- [ANTINFO \(old NGS format\)](#)

**Composite Relative Calibrations**

- [ANTINFO \(old NGS format\)](#)

**References**

- [ANTEX format information](#)
- [ANTINFO format information](#)

This page lists NGS's Antenna Calibrations.

Absolute Antenna Calibrations values are now the default values on this page and appear on all the antenna specific pages. These Absolute values should be used when processing data with CORS coordinates in IGS08 epoch 2005.00 and NAD 83(2011,MA11,PA11) epoch 2010.00 coordinates. These calibrations are different from earlier NGS calibrations that were relative antenna calibrations. For more information on the new CORS coordinates see: <http://geodesy.noaa.gov/CORS/coords.shtml>

If you are processing data with old CORS coordinates in ITRF00 epoch 1997.00 and NAD 83(CORS96, PACP00, MARP00) epoch 2002.00 you should use the Relative Antenna Calibrations available at the bottom of this page in table format only.

Please consult the FAQ on the left which contains additional information on the use of Absolute vs Relative Antenna Calibrations.

Do you have a suggestion/comment/question about this page please [email](#).

Website Owner: National Geodetic Survey / Last modified by Bruce Tran Sep 02 2011

# NGS Calibration Services

*Database, website, processes and policies*

# New Website

**Antenna Calibrations**

National Geodetic Survey

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**Trimble**

Antenna Model	Radome	Images	Calibrations	Description
TRM14177.00	NONE		<a href="#">ANTEX</a> <a href="#">ANTINFO</a>	4000ST L1 Geodetic, Model 14177.00
TRM14532.00	NONE	<a href="#">Side</a> <a href="#">Top</a>	<a href="#">ANTEX</a>	4000ST L1/L2 Geodetic, Model 14532.00
TRM14532.10	NONE	<a href="#">Side</a> <a href="#">Top</a>		
TRM22020.00+GP	NONE	<a href="#">Side</a> <a href="#">Top</a>		
TRM22020.00-GP	NONE	<a href="#">Side</a> <a href="#">Top</a>		
TRM22020.02	TCWD			
TRM23903.00	NONE	<a href="#">Side</a> <a href="#">Top</a>		
TRM27947.00+GP	NONE	<a href="#">Side</a> <a href="#">Top</a>		
TRM27947.00-GP	NONE	<a href="#">Side</a> <a href="#">Top</a>		
TRM29659.00	UNAV	<a href="#">Drawing</a> <a href="#">Side</a> <a href="#">Top</a>	<a href="#">ANTEX</a> <a href="#">ANTINFO</a>	Trimble L1/L2 Dorne Margolin element with chokeringsModel 29659.00
TRM29659.00	NONE	<a href="#">Side</a> <a href="#">Top</a>	<a href="#">ANTEX</a> <a href="#">ANTINFO</a>	Trimble L1/L2 Dorne Margolin element with chokeringsModel 29659.00
TRM29659.00	OLGA		<a href="#">ANTEX</a> <a href="#">ANTINFO</a>	Trimble L1/L2 Dorne Margolin element with chokeringsModel 29659.00
TRM29659.00	SNOW		<a href="#">ANTEX</a> <a href="#">ANTINFO</a>	Trimble L1/L2 Dorne Margolin element with chokeringsModel 29659.00
TRM29659.00	TCWD		<a href="#">ANTEX</a> <a href="#">ANTINFO</a>	Trimble L1/L2 Dorne Margolin element with chokeringsModel 29659.00
TRM29659.00	SCIT		<a href="#">ANTEX</a>	Trimble L1/L2 Dorne Margolin element with chokeringsModel 29659.00

Antenna Test #25  
Trimble SST  
p/n:14532.00  
L1/L2  
CSPA  
20 Feb 96 to  
23 Feb 96  
Test Antenna

- Revamped along with database
- Photo & drawing mouseovers for easy ID
- ANTINFO and ANTEX formats

# PCO/PCV Distribution

- Distribution via website: <http://www.ngs.noaa.gov/ANTCAL>
- Data formats for different software:
  - NGS format (relative and absolute)
  - ANTEX (absolute)

<ant\_info.003>

<KKC-10/08/23=310>

ANTENNA ID	DESCRIPTION	DATA SOURCE	# OF TESTS	YR/MO/DY	AVE = # in average			END OF ANTENNA	START OF ANTENNA	TYPE / SERIAL NO	METH / BY / # / DATE	DAZI	ZEN1 / ZEN2 / DZEN	# OF FREQUENCIES	SINEX CODE	START OF FREQUENCY	NORTH / EAST / UP
[north] [ east] [ up ]	[75] [70]	ASH701945C_M	PFAN														
[90] [85] [80]	[40] [35] [30]	ROBOT	Geo++ GmbH	1	02-MAR-09												
[north] [ east] [ up ]	[75] [70]																
[90] [85] [80]	[40] [35] [30]																
		IGS05_1597															
		G01															
		0.25	-0.55	85.58													
		NOAZI	0.00	-0.23	-0.90	-1.90	-3.12	-4.44	-5.75	-6.94	-7.88	-8					
		0.0	0.00	-0.34	-1.10	-2.17	-3.41	-4.67	-5.88	-6.95	-7.79	-8					
		5.0	0.00	-0.34	-1.12	-2.19	-3.40	-4.65	-5.83	-6.89	-7.73	-8					
		10.0	0.00	-0.35	-1.13	-2.19	-3.39	-4.61	-5.77	-6.81	-7.66	-8					
		15.0	0.00	-0.36	-1.14	-2.19	-3.37	-4.56	-5.70	-6.74	-7.59	-8					
		20.0	0.00	-0.36	-1.14	-2.18	-3.34	-4.51	-5.63	-6.66	-7.52	-8					



# Formal Policy Document

- Purpose/Goal
    - Set clear expectations
    - Streamline process
  - Doc contents
    - Calibration process and stages
    - Eligibility for calibration
    - Rights and responsibilities (both NGS and antenna provider)
- Revisions expected*
- *with manufacturer input*
  - *after calibration tracking system comes online*


# Antenna Intake

- Request calibration via web form
- Tracking system
- Customer notification emails

Absolute Antenna Calibration - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Absolute Antenna Calibration

 Absolute Antenna Calibration National Geodetic S

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**NGS Absolute Antenna Calibrations Tracking System**

Antenna Calibration Request

**Returning Antenna Provider\* (mandatory)** [NGS privacy policy](#)

Email\*  [New Customer](#)

**New Customer? Please Register**

**Antenna Information (to be calibrated)**

Select Antenna Brand that exists in NGS Database. For non-existing, select 'Other' and type

Antenna Brand\*  Other

Select Antenna Type convention for Antenna Brand  For non-existing, suggest a name using NGS/IGS

Antenna Type

IGS Antenna Type Code

Model Name

Part #

Primary DOF (Directional Orientation Feature)

RF Connector Type

Click [here](#) to enable

**Calibration Information**

Note: Type Mean (3 - 5 antenna samples). \* (Special circumstances only)

Requested Calibration  [Explain if 'Relative'](#)

[User Forum](#)

Done

# Thank You

- Questions and Comments?