HST Pointing Improvements
Some recent Statistics

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HST Pointing Improvements

Why Improve HST Pointing & Astrometry?

1. Absolute astrometry increasingly important:
   - multi-mission archives, multi-wavelength campaigns, coordinated observations
   - “Fundamentally important property of HST data” – STUC, 2002

2. Improved pointing supports the most efficient COS acquisition scenarios.

3. Well-calibrated FOV entering SM4 simplifies SMOV calibrations & operations.

What Comprised the Initiative?

1. Use of GSC2 in operations since mid-2006 (Cycle 15)
   - Reduces catalog error to 0.25” (1σ absolute) and 0.18” (1σ relative across FOV)

2. Retroactive improvements in HLA astrometry
   - Updated astrometry keywords by identifying GSC2 objects in images. Other methods for archive astrometry improvements being assessed.

3. SI & FGS alignment calibrations (“focal plane alignment”)
Focal Plane Alignment

Basic Process

1. update FGS magnifications (this linear distortion term continues to trend significantly for many years on-orbit)
2. with ~20mas astrometry stars, use guidestars and astrometer FGS to obtain zero point and rotation of the three FGSs
3. with the resulting current FGS calibrations, determine accurate relative locations of SIs
4. make operational updates to SIAF, FGS matrices, FGS magnifications and related products.

CAL-OTA 11021 and the routine FGS calibration program obtained such data.

**New FGS calibrations were made operational on 2008.014 (matrices & magnifications)**

**SI updates were not made due to the loss of ACS, and small deltas for WFPC2 & NICMOS**
Assessing the Improvement

Guidestar Separations

Compare guidestar pairs’ angular separation based on their GSC coordinates against their separation based on their FGS-observed locations and operational transformation to V2V3.

Pro: large number statistics

Con: doesn’t tell you what’s happening at the SI

Target coordinates obtained from science data

For centroidable astrometric targets, determine from the science data headers the RA & Dec and compare against their astrometric coordinates

Pro: measures exactly what you want to check

Con: more labor intensive and not possible/feasible in most cases
**Guidestar Separations**

Guide Star Pair Fit Error during 2005 GSC1 Ops

- Number of GS pairs: 32177
- Mean Separation Error: +0.14 arcseconds
- 1 sigma scatter: 0.73 arcseconds
Guidestar Separations

Guide Star Pair Fit Error during 2007 GSC2 Ops

Number of GS pairs: 23749
Mean Separation Error: +0.22 arcseconds
1 sigma scatter: 0.49 arcseconds
Guidestar Separations

Guide Star Pair Fit Error since 2008.014 realignment

Number of GS pairs 9688
Mean Separation Error +0.04 arcseconds
1 sigma scatter 0.26 arcseconds
Guidestar Separations

GSC1- 2005

arcseconds
Guidestar Separations

GSC2 Operations - 2007

The histogram shows the distribution of Guidestar separations for the year 2007, with the x-axis representing the separation values and the y-axis representing the frequency of separations. The graph indicates a peak around the zero separation value, with a significant number of separations occurring within a small range of values, suggesting a normal distribution with a slight skew toward positive separations.
Guidestar Separations

GSC2 & New Calibrations, 2008 days 14 - present

Histogram of Guidestar Separations
Observations of Upgren 69 with WFPC2/PC:
RA & Dec for centroided pixel position using DS9
compared against Tycho position with proper motions
applied.
Maintain pointing and astrometry close to the GSC2-catalog limited value of \( \sim 0.2 \) arcseconds

Align new SIs & FGSs

Newly flown instruments trend the most. Keep new FGS from acting as dominant guider during Cycle 17.

Only use dedicated HST time when necessary

- Track COS & STIS missed distances. From the stored slew amount to center a target with the on-board acq, we will obtain a large number of "missed distances" indicating pointing performance. These data were amassed with STIS for a number of years in early 2000 and facilitated FGS alignment in 2002.

- Guidestar pair statistics, sorted by FGS, gives information to facilitate alignment.

- All-sky UCAC3 (early 2009) can allow accurate SI alignment to be accomplished without dedicated observations.