# QuickBird and OrbView-3 Geopositional Accuracy Assessment

**Dennis Helder**
Department of Electrical Engineering & Computer Science
Room 201, Harding Hall - Box 2220
South Dakota State University
Brookings, SD 57007-0199
phone: 605-688-4526
e-mail: Dennis_Helder@sdstate.edu

**Kenton Ross**
Science Systems and Applications, Inc.
Stennis Space Center, MS 39529
phone: 228-688-1869
e-mail: Kenton.Ross@ssc.nasa.gov

High Spatial Resolution Commercial Imagery Workshop
Reston, Virginia, USA
November 8, 2004

# Contributors



**NASA, Stennis Space Center**
Tom Stanley  Vicki Zanoni

**Science Systems and Applications, Inc., Stennis Space Center**
Mary Pagnutti  Steve Tate  Brennan Grant

**Computer Sciences Corporation, Stennis Space Center**
Debbie Fendley

**Lockheed Martin**
Charles Smith  Richard Sellers

**South Dakota State University**
Dennis Helder  Ravi Darbha

This work was directed by the NASA Applied Sciences Directorate (formerly the Earth Science Applications Directorate) at the John C. Stennis Space Center, Mississippi. Participation in this work by Lockheed Martin Space Operations – Stennis Programs was supported under contract number NAS 13-650. Participation in this work by Computer Sciences Corporation and by Science Systems and Applications, Inc., was supported under NASA Task Order NNS04AB54T.

# Outline



- Ground Reference Sites
  - Brookings, SD
  - Stennis Space Center, MS
- Methods
- OrbView-3 Assessment
  - Data Collections
  - Results
- QuickBird Assessment
  - Data Collections
  - Results

# Assessment Overview



- Objective
  - Compare vendor-provided image coordinates with known references visible in the imagery
- Approach
  - Use multiple, well-characterized sites with >40 ground control points (GCPs); sites that are
    - Well distributed
    - Accurately surveyed
    - Easily found in imagery
  - Perform independent assessments with independent teams. Each team has slightly different measurement techniques and data processing methods.
    - NASA Stennis Space Center
    - South Dakota State University

# Data Providers



- DigitalGlobe, Inc.
  - Imagery acquired by the QuickBird sensor
  - Data purchased by NASA through the Scientific Data Purchase project
  - Assesement is a continuation from the previous year

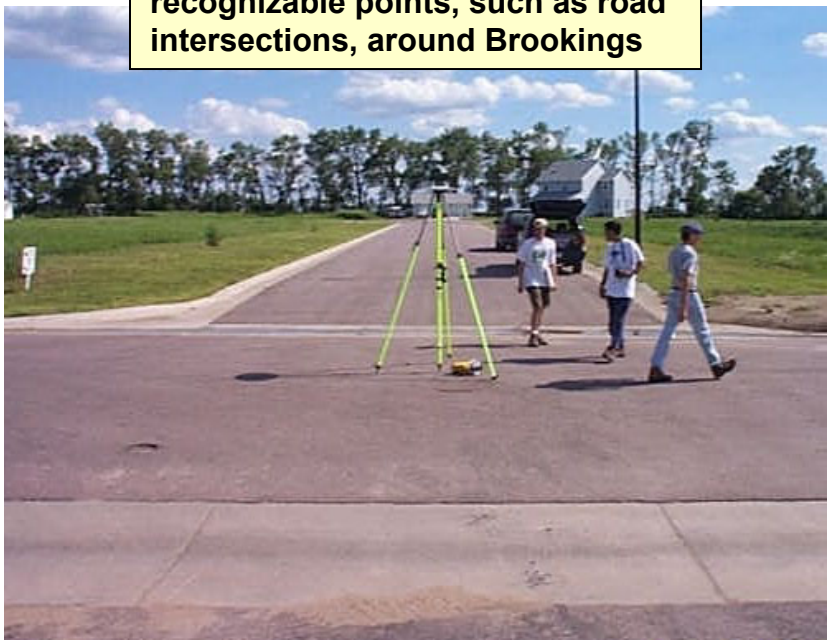
- OSC/ORBIMAGE, Inc.
  - Imagery acquired by the OrbView-3 sensor
  - Data received through a Space Act Agreement among NASA, Orbital Sciences Corporation, and ORBIMAGE, Inc.
  - Independent assessment performed on pre-initial on-orbit checkout (pre-IOC) data

# Sites

# Brookings and Stennis Ground Control



**SDSU uses a distribution of 96 recognizable points, such as road intersections, around Brookings**



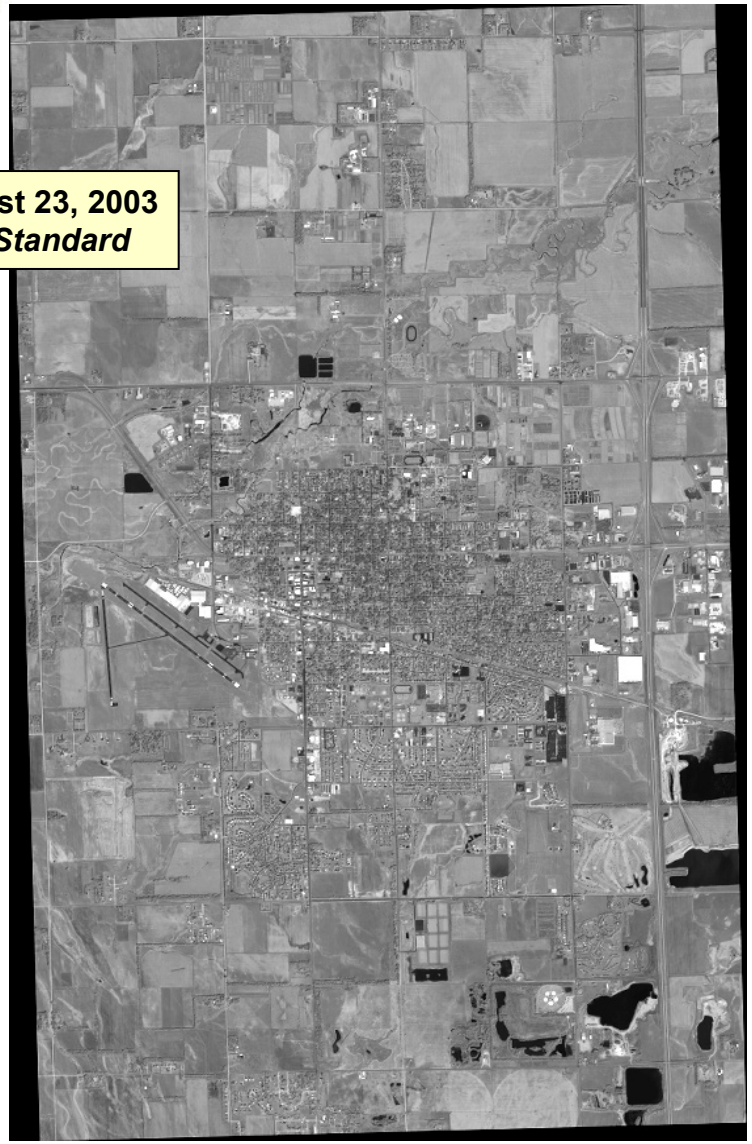
**SSC uses 45 circular targets, 2.44 m in diameter, distributed across the Fee Area**

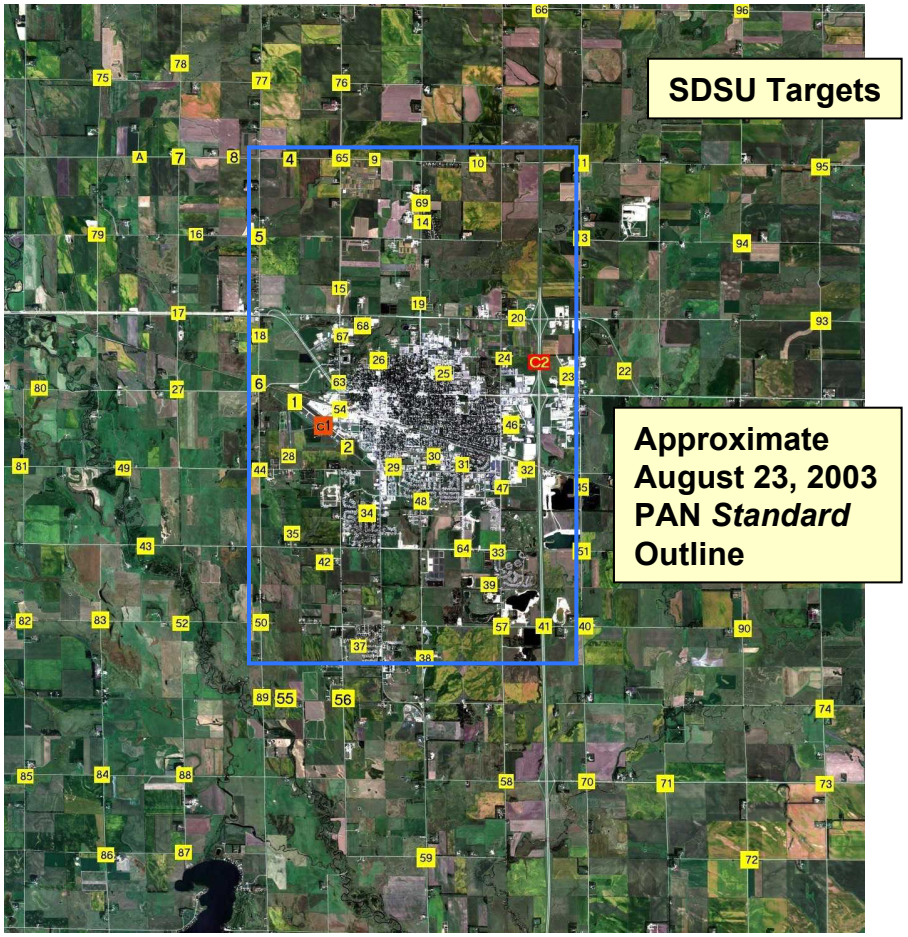
Both sets of GCPs were RTK GPS located by the SSC survey team to absolute horizontal accuracies in the 3-6 cm range

# Brookings: QuickBird Image and Targets

*Stennis Space Center*

**August 23, 2003**
**PAN *Standard***






**GCP Locations** **Base Stations**

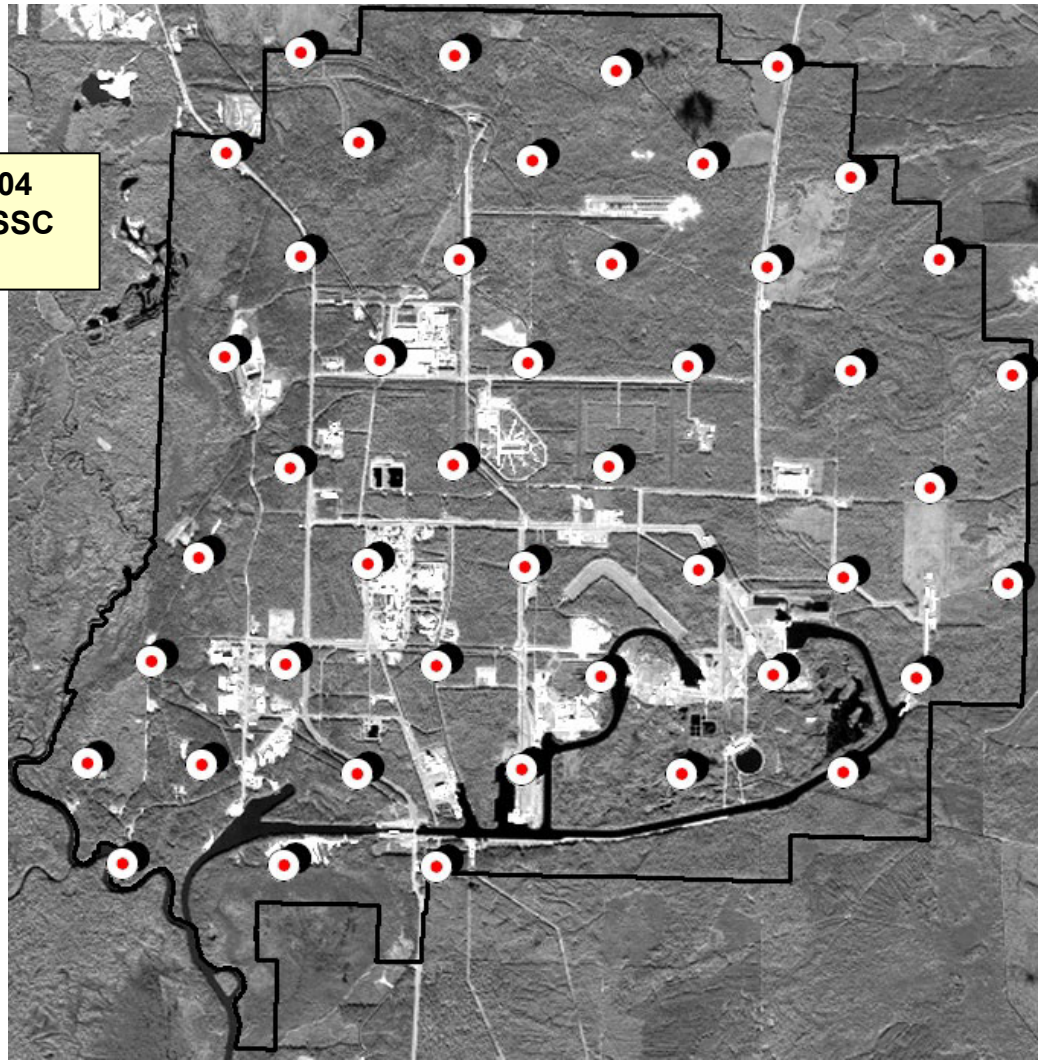
Includes material © Space Imaging, LLC

Includes material © DigitalGlobe™

# SSC: OrbView-3 Image and Targets



**December 15, 2004**
**PAN *Basic* with SSC Targets Overlaid**



Copyright 2004 ORBIMAGE Inc.
All Right Reserved

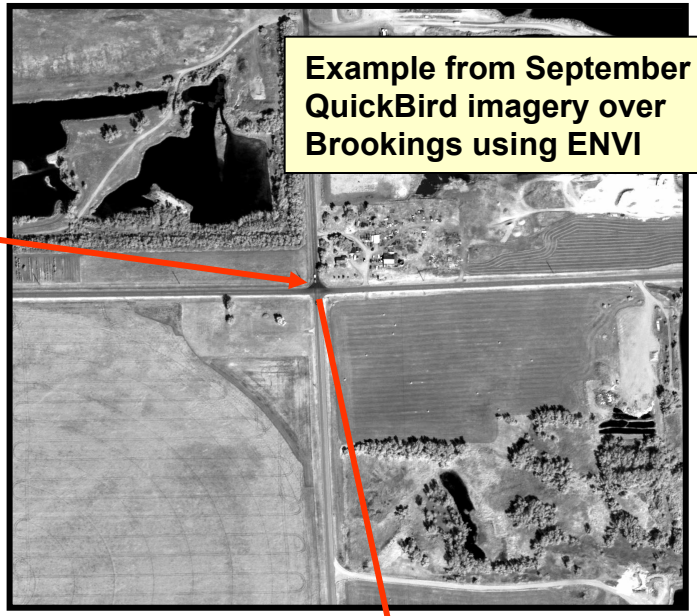
# Methods

# Finding Image Coordinates over Brookings



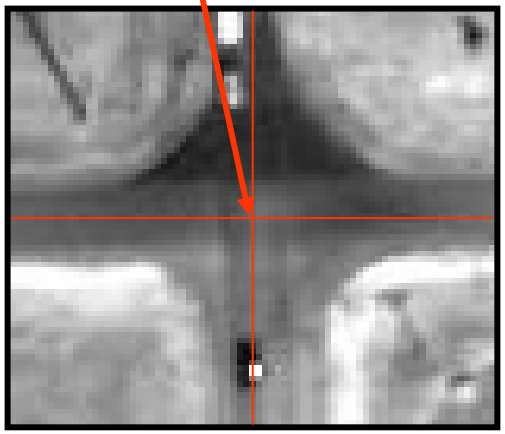
Includes material © Space Imaging, LLC

Step 1



**Example from September 7, 2002 QuickBird imagery over Brookings using ENVI**

Step 2



Step 3

**Disp #1 (8749.250,16600.250) Scrn: R:110 G:110 B:110**

**Projection: UTM Zone #14 North**

**Map: 678122.55E, 4904054.85N Meters**

**LL: 44°16'4.58"N, 96°46'5.70"W**

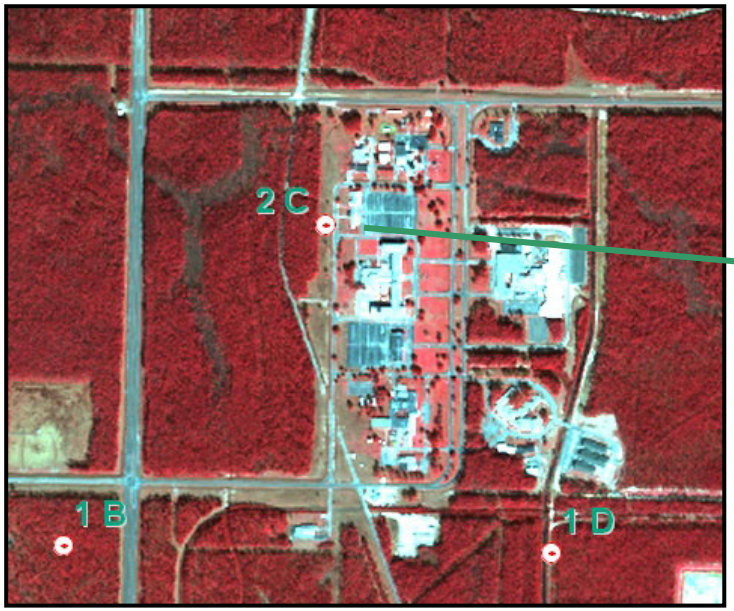
**Data: 249**

***Cursor Location/Value of Point 33***

Includes material © DigitalGlobe™

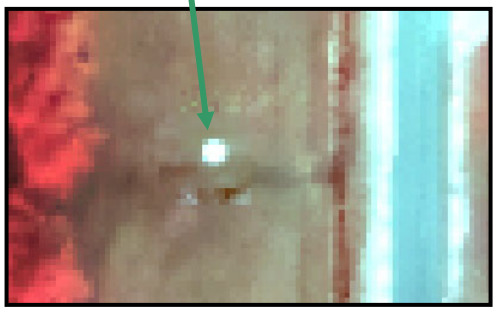
# Finding Image Coordinates over SSC






Step 1

Step 2



Step 3

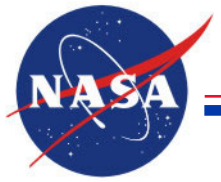
**Example from February 17, 2002 QuickBird pan-merged imagery over SSC**

Includes material © DigitalGlobe™

# Additional Notes on Methods



- At South Dakota State, images were analyzed by three individuals using ENVI software
  - Visible points are determined for the group
  - Each individual finds points independently
  - If individual mistakes are found, individual is asked to re-select the point in question
  - Final image points are averaged before comparison with reference coordinates and generation of results
- SSC images were analyzed by a single individual using ERDAS IMAGINE software to select image coordinates and MATLAB® to generate results
  - Results are reviewed for indications of mistakes





# OrbView-3 Geopositional Assessment (pre-IOC)

# OrbView-3 Geopositional Assessment Notes



- The OrbView-3 images were not delivered as geocorrected products as has been the case with JACIE geopositional assessments to date
- OrbView-3 images were delivered as the OrbView-3 *Basic* product, which is not geocorrected but is delivered with rational functions for customers to apply
- The OrbView-3 rational functions were applied for this assessment using a local photogrammetrically generated DEM for the SSC Fee Area
- DEM metadata
  - Elevations referenced to ellipsoid
  - Estimated accuracy: 30 cm, LE90
  - Rasterized to 3 m grid

# Data Acquisitions



- All acquisitions were OrbView-3 *Basic Enhanced*, panchromatic
  - 25 meters $CE_{90}$ product specification
- All over Stennis Space Center, MS
  - September 17, 2003
  - December 12, 2003
  - December 15, 2003
  - December 26, 2003
  - January 12, 2004

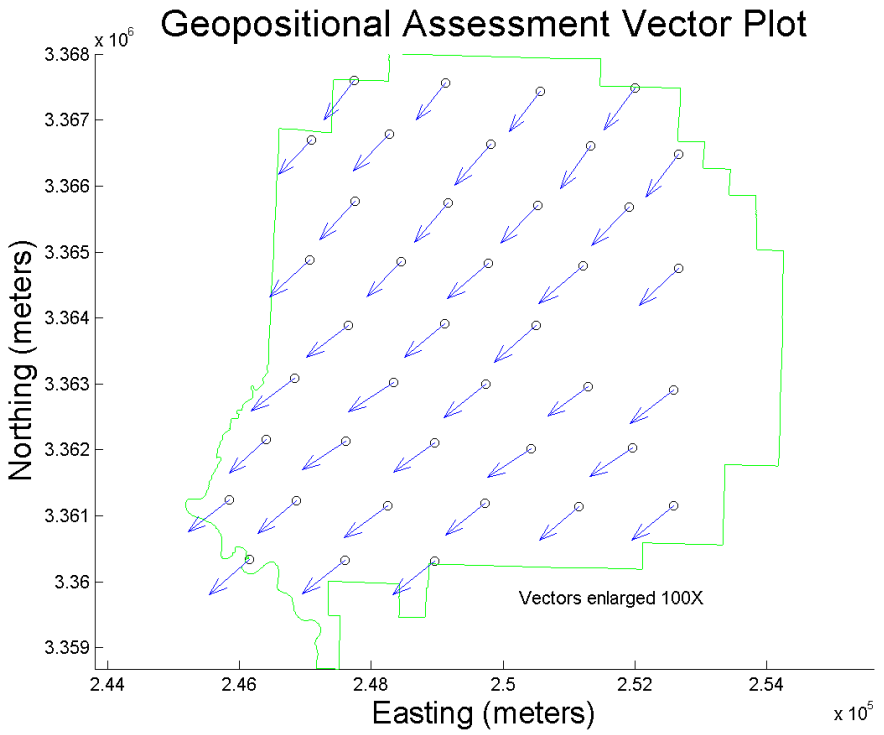
**OrbView-3 Basic Enhanced:**

- *Includes satellite telemetry data, rational functions, post processed GPS data and sufficient metadata to allow rigorous photogrammetric triangulation.* (from product catalog)

# SSC, Sep 17, 2003 – PAN *Basic*



| OrbView-3 | | | |
|---|---|---|---|
| ***Acquisition Date*** | 9/17/2003 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 40 | $\mu_H$ ***(Bias)*** | 7.92 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 0.64 m |
| ***St. Dev. Min Max Ratio*** | 0.84 | $\mu_H/\sigma_C$ | 12.40 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 8.32 m | ***Empirical CE 95*** | 8.44 m |

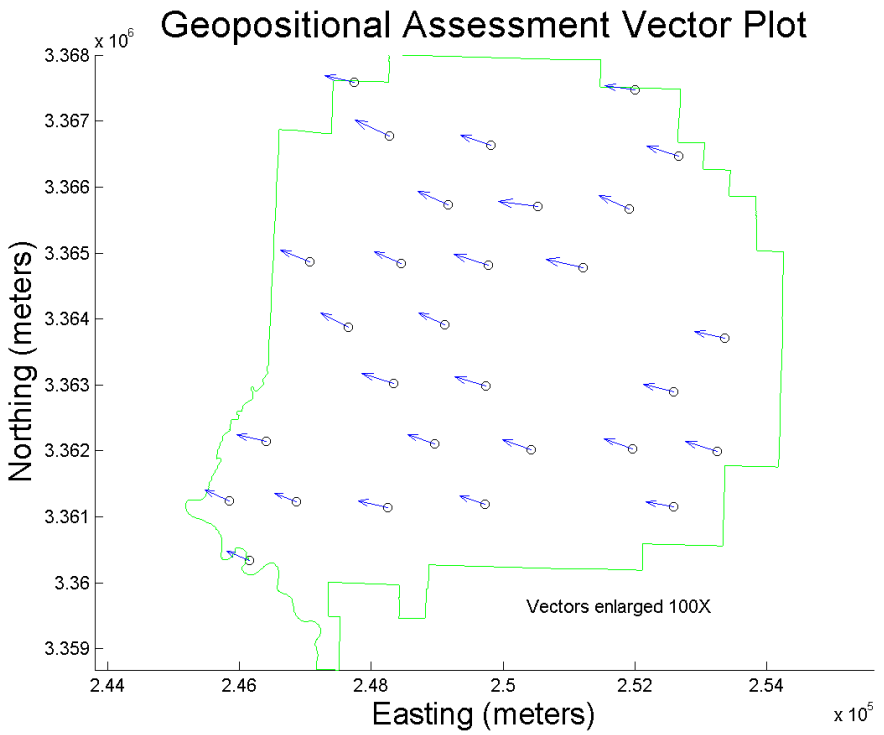



**$CE_{90}$ 8.32 m**

# SSC, Dec 12, 2003 – PAN *Basic*



| OrbView-3 | | | |
|---|---|---|---|
| ***Acquisition Date*** | 12/12/2003 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 29 | $\mu_H$ ***(Bias)*** | 4.69 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 0.50 m |
| ***St. Dev. Min Max Ratio*** | 0.74 | $\mu_H/\sigma_C$ | 9.43 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 5.57 m | ***Empirical CE 95*** | 5.68 m |

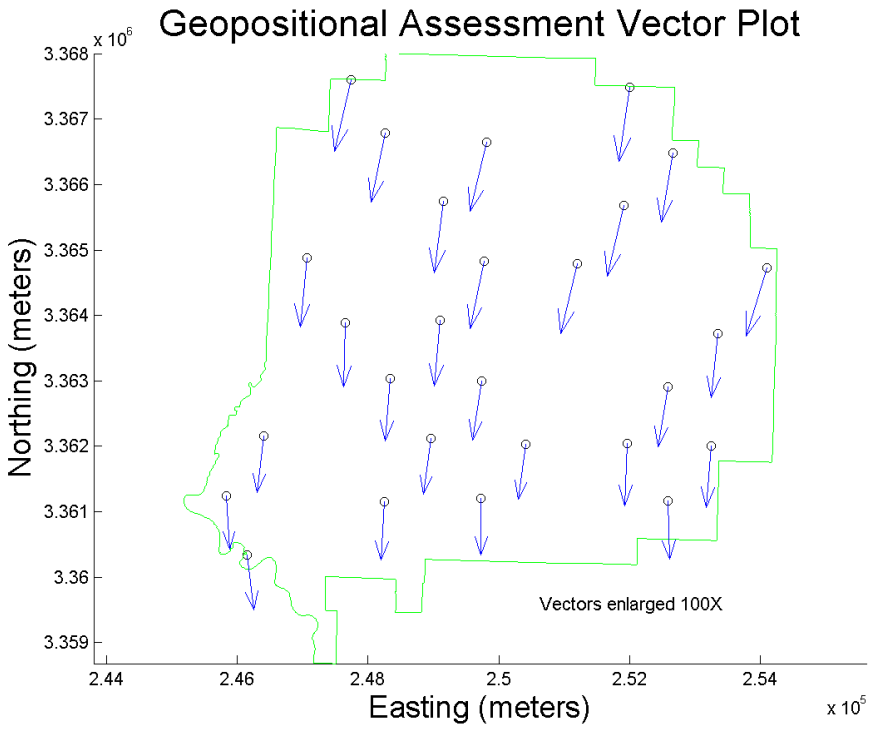



**$CE_{90}$ 5.57 m**

# SSC, Dec 15, 2003 – PAN *Basic*



| OrbView-3 | | | |
|---|---|---|---|
| ***Acquisition Date*** | 12/15/2003 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 27 | $\mu_H$ ***(Bias)*** | 9.80 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 1.00 m |
| ***St. Dev. Min Max Ratio*** | 0.91 | $\mu_H/\sigma_C$ | 9.83 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 11.11 m | ***Empirical CE 95*** | 11.25 m |

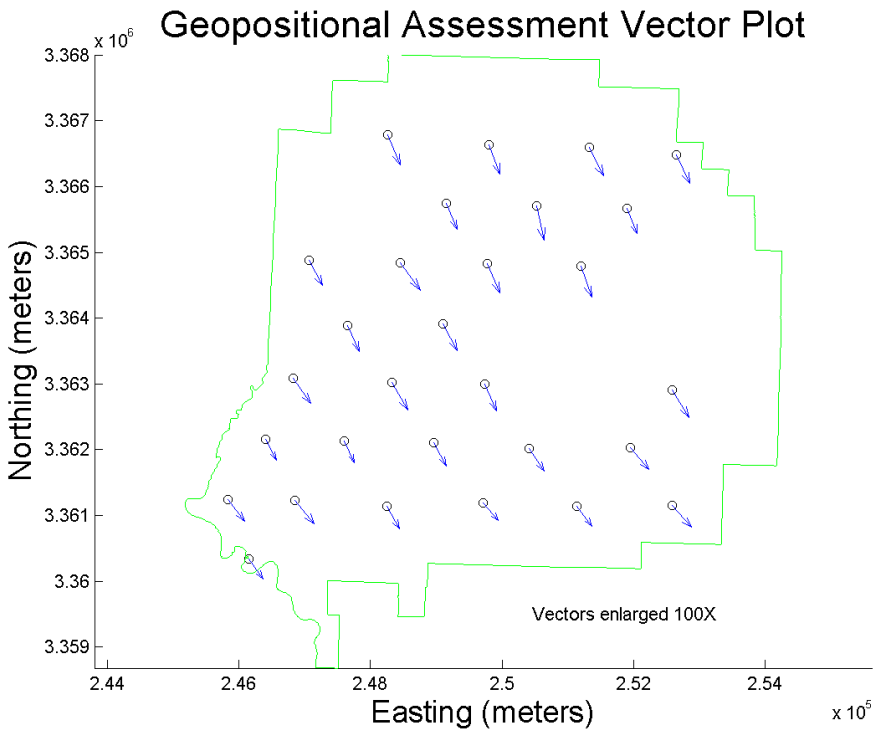



**$CE_{90}$ 11.11 m**

# SSC, Dec 26, 2003 – PAN *Basic*



| OrbView-3 | | | |
|---|---|---|---|
| ***Acquisition Date*** | 12/26/2003 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 29 | $\mu_H$ ***(Bias)*** | 4.38 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 0.53 m |
| ***St. Dev. Min Max Ratio*** | 0.80 | $\mu_H/\sigma_C$ | 8.28 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 4.98 m | ***Empirical CE 95*** | 5.24 m |

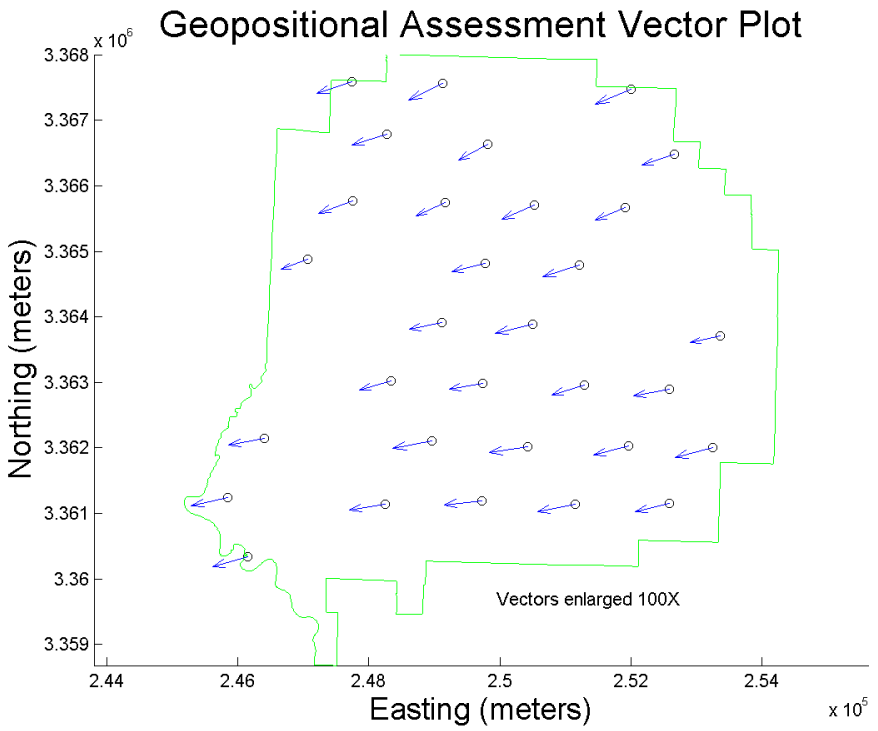



**$CE_{90}$ 4.98 m**

# SSC, Jan 12, 2004 – PAN *Basic*



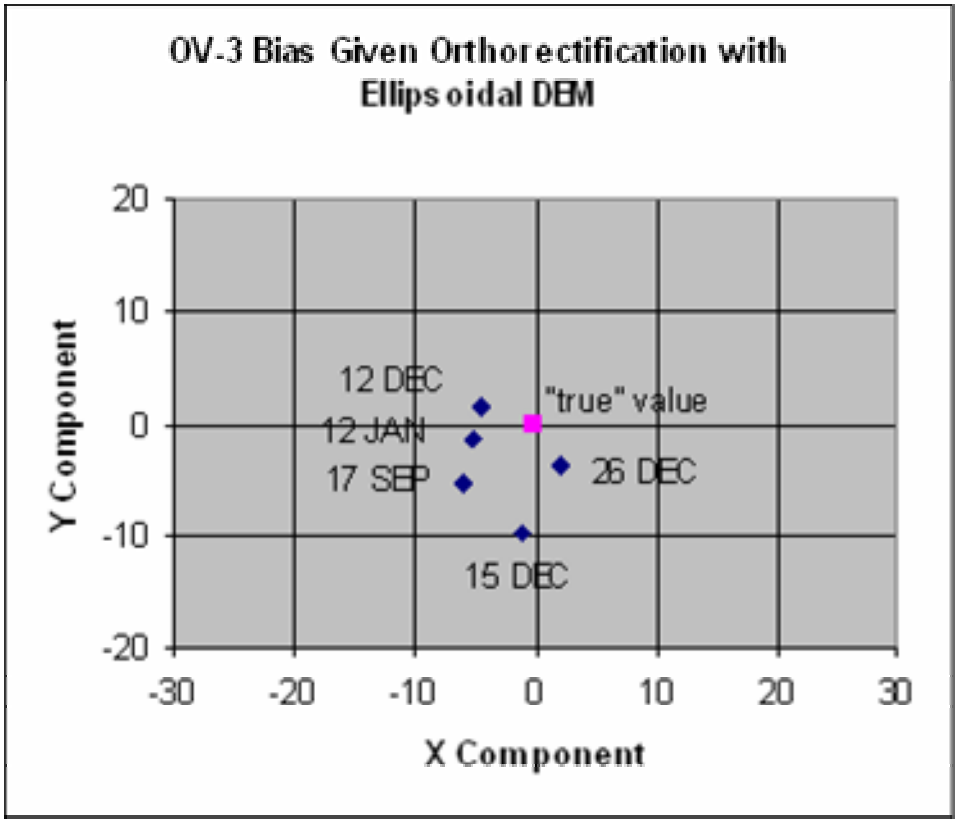
| OrbView-3 | | | |
|---|---|---|---|
| ***Acquisition Date*** | 1/12/2004 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 31 | $\mu_H$ ***(Bias)*** | 5.42 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 0.48 m |
| ***St. Dev. Min Max Ratio*** | 0.99 | $\mu_H/\sigma_C$ | 11.37 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 5.93 m | ***Empirical CE 95*** | 5.96 m |




**$CE_{90}$ 5.93 m**

# No Clear Bias Trend

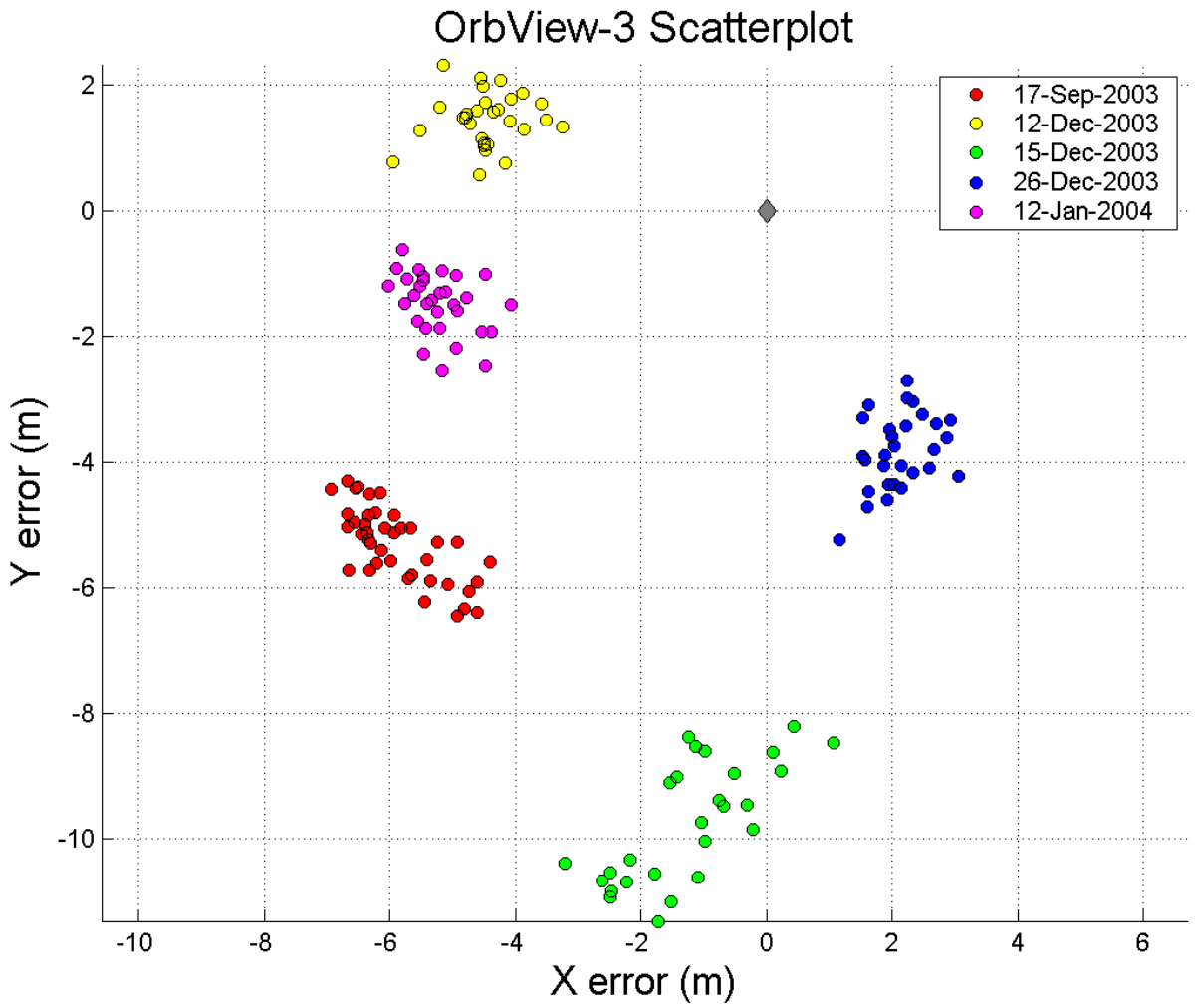





Direction of bias (with bias = image – reference) ranged from southeast to northwest

# OrbView-3 Error Scatterplot





# Summary



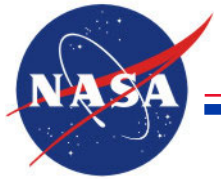
| OrbView-3 Product | Acquisition Date | Empirical $CE_{90}$ (m) | Empirical $CE_{95}$ (m) | Elevation Angle (deg) |
|---|---|---|---|---|
| Panchromatic *Basic* | 9/17/2003 | 8.29 | 8.37 | 79.3 |
| | 12/12/2003 | 5.49 | 5.66 | 65.8 |
| | 12/15/2003 | 11.11 | 11.19 | 52.7 |
| | 12/26/2003 | 4.98 | 5.13 | 80.2 |
| | 1/12/2004 | 5.92 | 5.96 | 61.6 |

- The mean $CE_{90}$ of OrbView-3 panchromatic *Basic* images characterized was 7.2 m
  - 95% confidence interval from 4.0 m to 10.3 m
- All OrbView-3 images characterized in this reporting period met ORBIMAGE's self-stated specifications for *Basic Enhanced* product configuration

# Extended OrbView-3 Summary



| OrbView-3 Product | Image Tracking ID | Acquisition Date | Bias X (m) | Bias Y (m) | $\mu_H$ - Bias (m) | $\sigma_C$ - Circular Standard Error (m) | Empirical $CE_{90}$ (m) | Empirical $CE_{95}$ (m) | Elevation Angle (deg) |
|---|---|---|---|---|---|---|---|---|---|
| **Panchromatic** ***Basic*** | 14442 | 9/17/2003 | -5.88 | -5.31 | 7.92 | 0.64 | 8.29 | 8.37 | 79.3 |
| | 24790 | 12/12/2003 | -4.46 | 1.45 | 4.69 | 0.50 | 5.49 | 5.66 | 65.8 |
| | 22760 | 12/15/2003 | -1.21 | -9.73 | 9.80 | 1.00 | 11.11 | 11.19 | 52.7 |
| | 23539 | 12/26/2003 | 2.11 | -3.84 | 4.38 | 0.53 | 4.98 | 5.13 | 80.2 |
| | 24515 | 1/12/2004 | -5.21 | -1.48 | 5.42 | 0.48 | 5.92 | 5.96 | 61.6 |





# QuickBird Geopositional Assessment

# Data Acquisitions

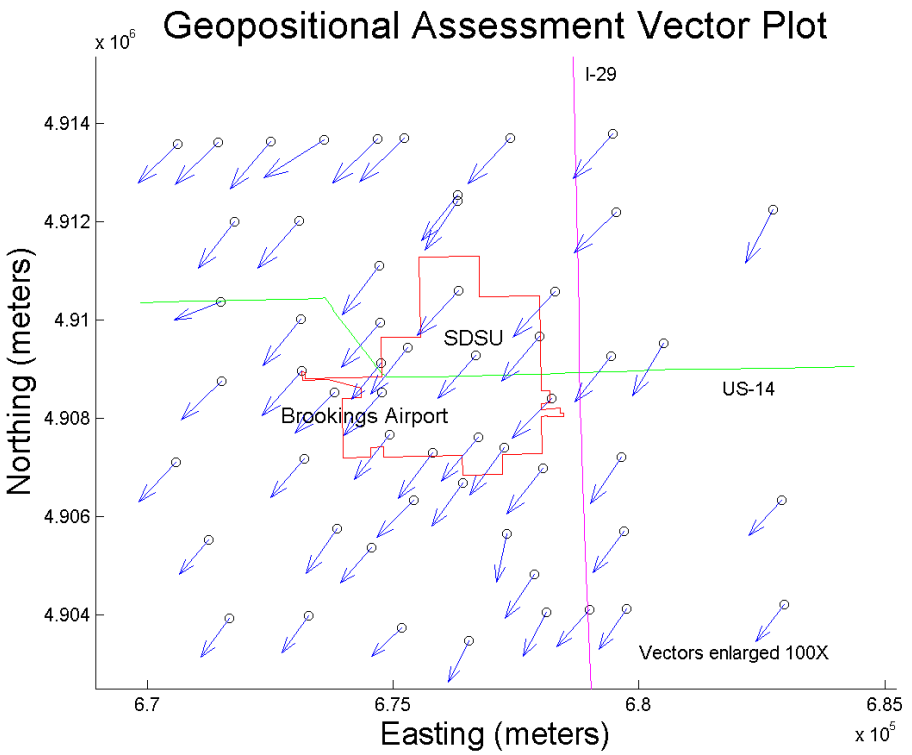


- Acquisitions Types
  - *Standard* (2A) – 23 meters $CE_{90}$
  - *Orthorectified* (3E – 1:10,000) – 8.3 meters $CE_{90}$
- Brookings, SD (both panchromatic & multispectral)
  - August 23, 2003 (both *Standard* & *Orthorectified*)
  - September 15, 2003 (*Standard*)
  - October 21, 2003 (*Standard*)
- Stennis Space Center, MS (panchromatic only)
  - January 10, 2004 (*Standard*)

# Brookings, Aug 23, 2003 – PAN *Standard*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 8/23/2003 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 56 | ***$\mu_H$ (Bias)*** | 11.24 m |
| **Test for Departure from Circular Distribution** | | ***$\sigma_C$ (Circular Standard Error)*** | 1.33 m |
| ***St. Dev. Min Max Ratio*** | 0.79 | ***$\mu_H/\sigma_C$*** | 8.45 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE $_{90}$*** | 12.67 m | ***Empirical CE $_{95}$*** | 12.76 m |

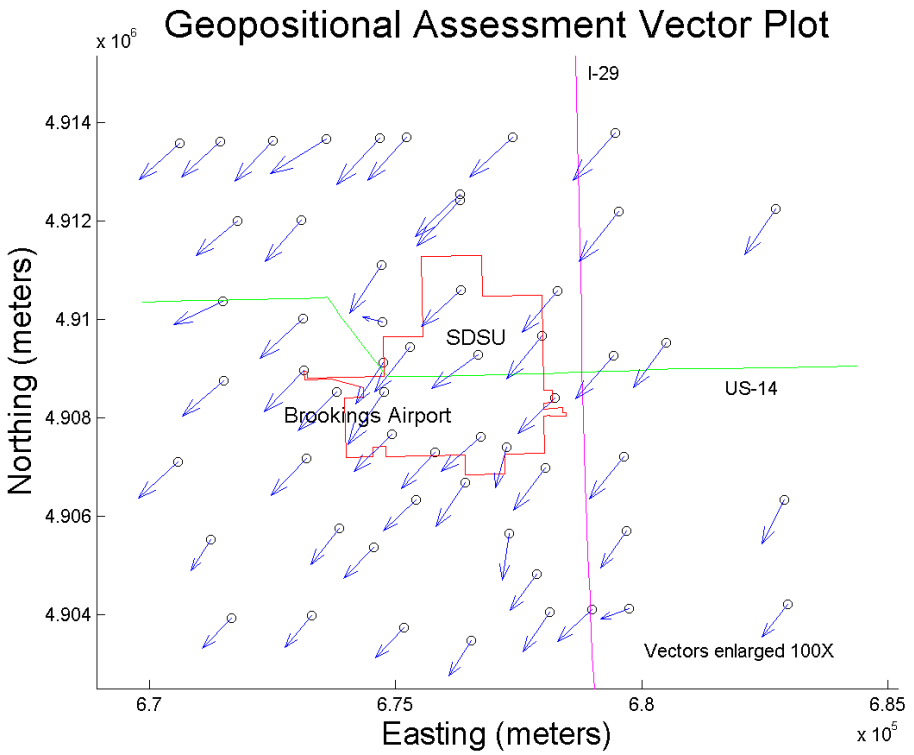



**$CE_{90}$ 12.67 m**

# Brookings, Aug 23, 2003 – MS *Standard*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 8/23/2003 | ***Imagery Band*** | MS |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 56 | $\mu_H$ ***(Bias)*** | 10.33 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 1.81 m |
| ***St. Dev. Min Max Ratio*** | 0.98 | $\mu_H/\sigma_C$ | 5.71 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 12.78 m | ***Empirical CE 95*** | 12.93 m |

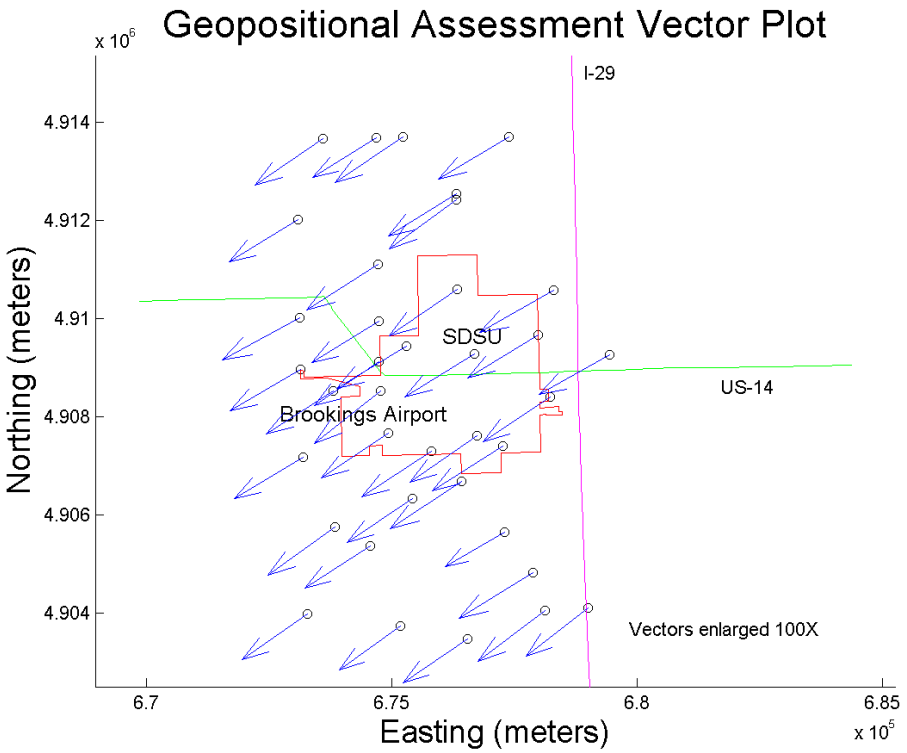



**$CE_{90}$ 12.78 m**

# Brookings, Sep 15, 2003 – PAN *Standard*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 9/15/2003 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 37 | $\mu_H$ ***(Bias)*** | 16.53 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 0.71 m |
| ***St. Dev. Min Max Ratio*** | 0.94 | $\mu_H/\sigma_C$ | 23.22 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 17.40 m | ***Empirical CE 95*** | 17.62 m |

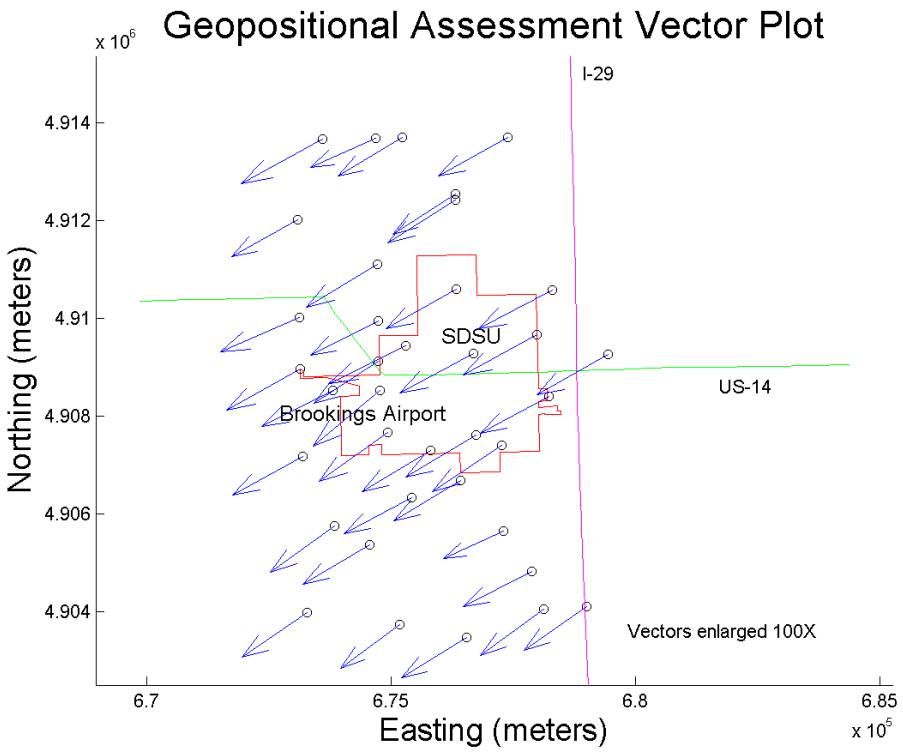



**$CE_{90}$ 17.40 m**

# Brookings, Sep 15, 2003 – MS *Standard*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 9/15/2003 | ***Imagery Band*** | MS |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 37 | $\mu_H$ ***(Bias)*** | 16.26 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 1.01 m |
| ***St. Dev. Min Max Ratio*** | 0.91 | $\mu_H/\sigma_C$ | 16.17 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 17.34 m | ***Empirical CE 95*** | 17.66 m |

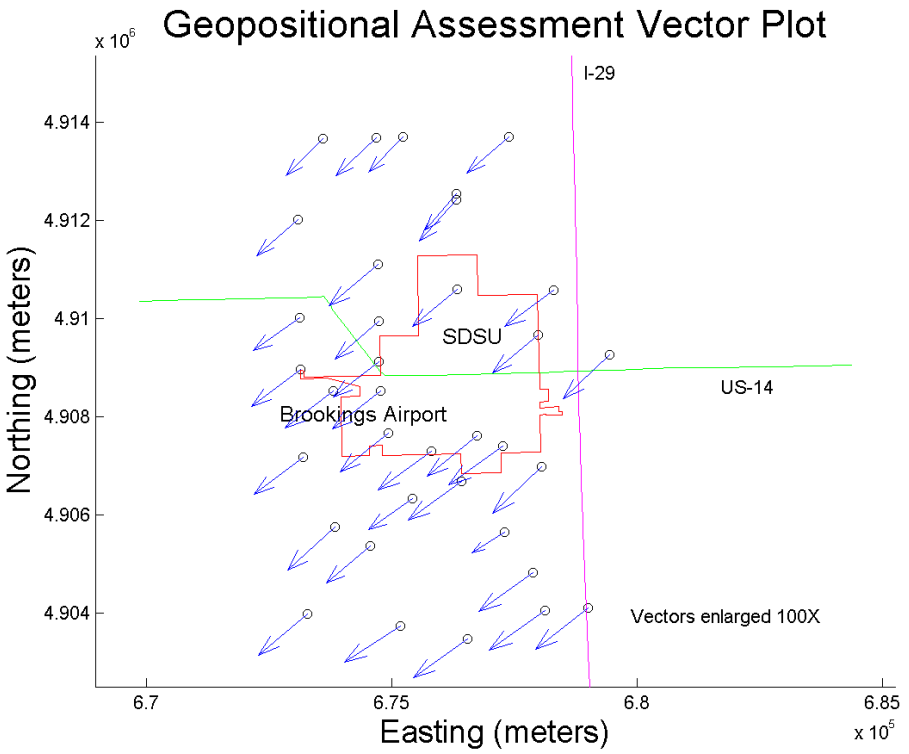



**$CE_{90}$ 17.34 m**

# Brookings, Oct 21, 2003 – PAN *Standard*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 10/21/2003 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 35 | $\mu_H$ ***(Bias)*** | 12.20 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 1.09 m |
| ***St. Dev. Min Max Ratio*** | 0.65 | $\mu_H/\sigma_C$ | 11.18 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 13.63 m | ***Empirical CE 95*** | 13.72 m |

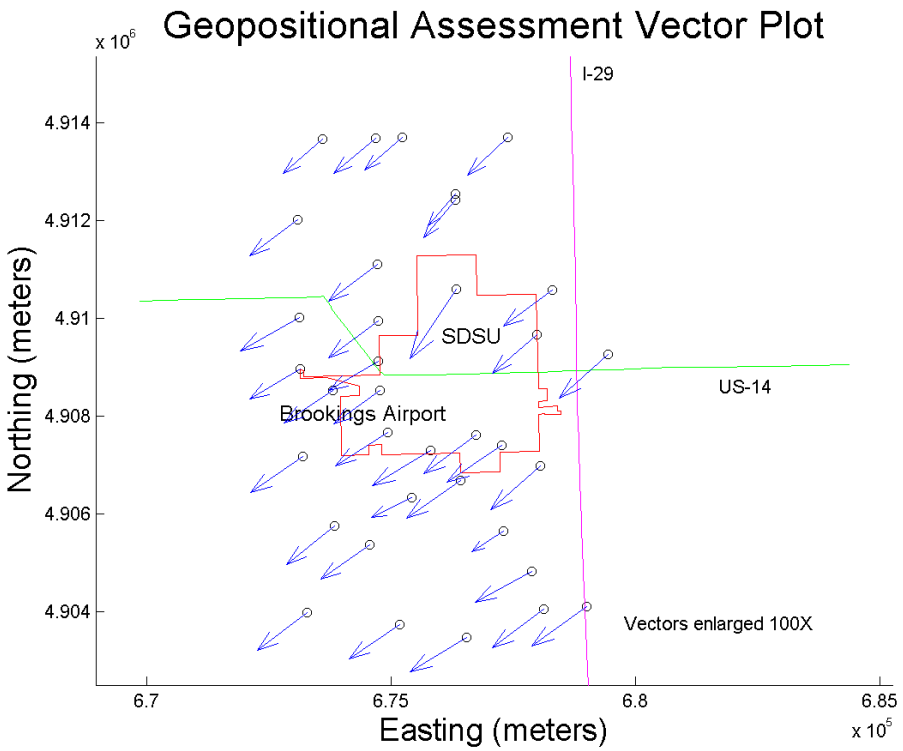



**$CE_{90}$ 13.63 m**

# Brookings, Oct 21, 2003 – MS *Standard*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 10/21/2003 | ***Imagery Band*** | MS |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 35 | $\mu_H$ ***(Bias)*** | 12.21 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 1.53 m |
| ***St. Dev. Min Max Ratio*** | 0.97 | $\mu_H/\sigma_C$ | 7.97 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 13.76 m | ***Empirical CE 95*** | 13.77 m * |



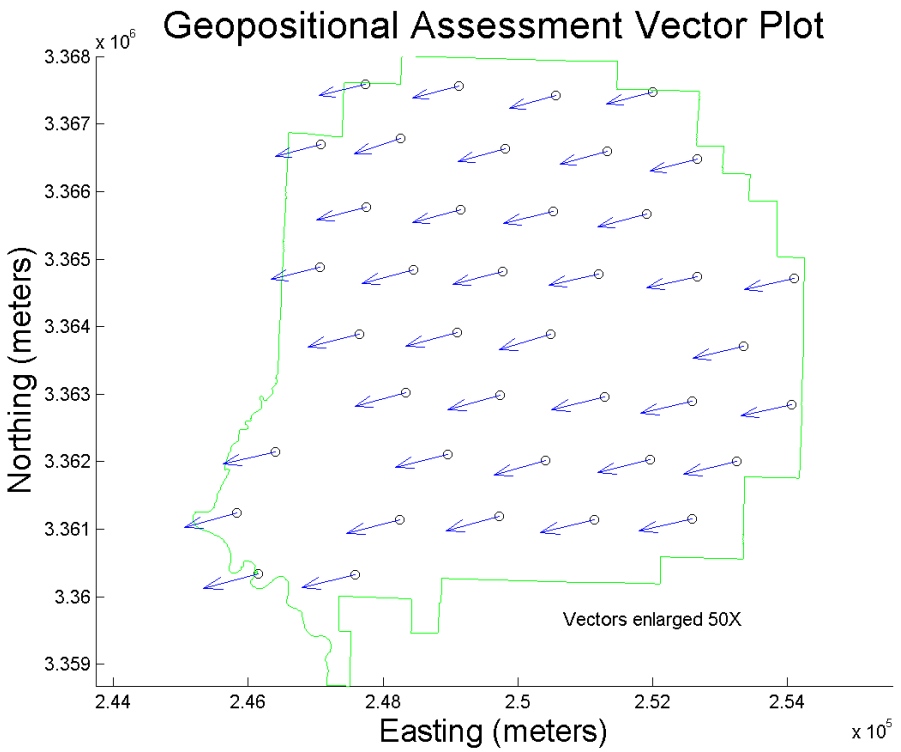

**$CE_{90}$ 13.76 m**

* Note that $CE_{90}$ and $CE_{95}$ determined empirically can be almost equal if the outermost errors happen to be close

# SSC, Jan 10, 2004 – PAN *Standard*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 1/10/2004 | ***Imagery Band*** | PAN |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 40 | $\mu_H$ ***(Bias)*** | 15.41 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 0.54 m |
| ***St. Dev. Min Max Ratio*** | 0.41 | $\mu_H/\sigma_C$ | 28.47 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 16.27 m | ***Empirical CE 95*** | 16.39 m |

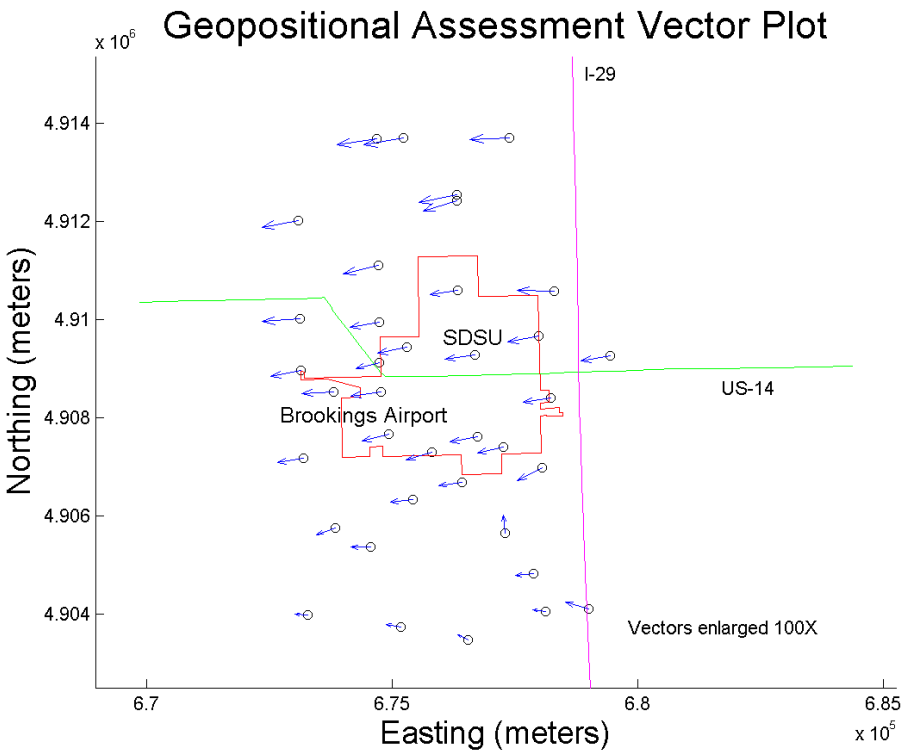



**$CE_{90}$ 16.27 m**

# Brookings, Aug 23, 2003 – PAN *Orthorectified*



| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 8/23/2003 | ***Imagery Band*** | PAN-ORTHO |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 37 | $\mu_H$ ***(Bias)*** | 5.52 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 1.45 m |
| ***St. Dev. Min Max Ratio*** | 0.63 | $\mu_H/\sigma_C$ | 3.81 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 7.93 m | ***Empirical CE 95*** | 8.11 m |

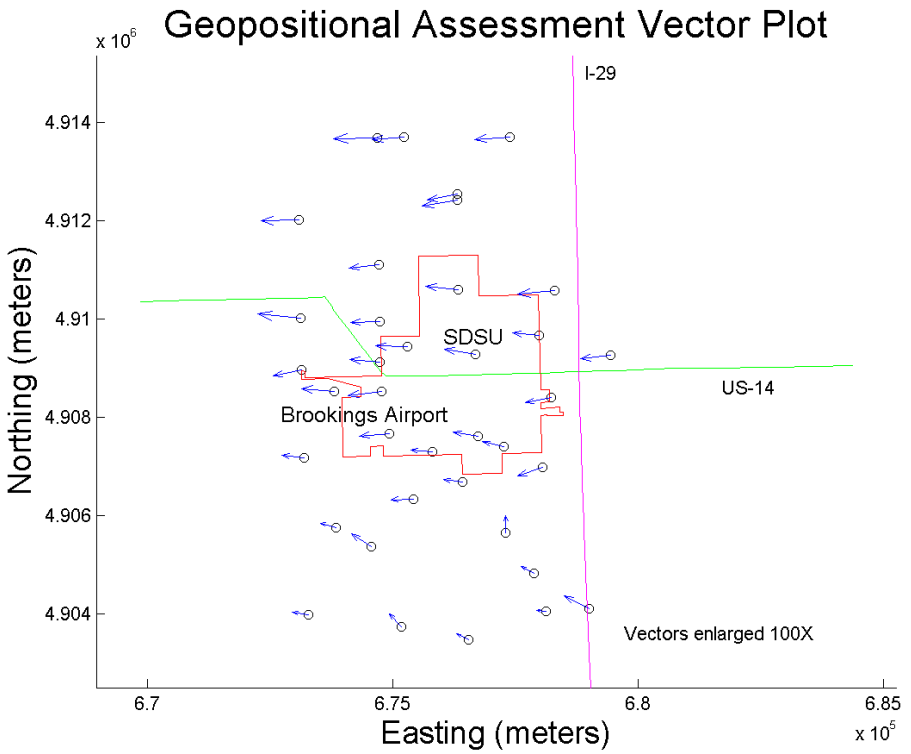



**$CE_{90}$ 7.93 m**

# Brookings, Aug 23, 2003 – MS *Orthorectified*



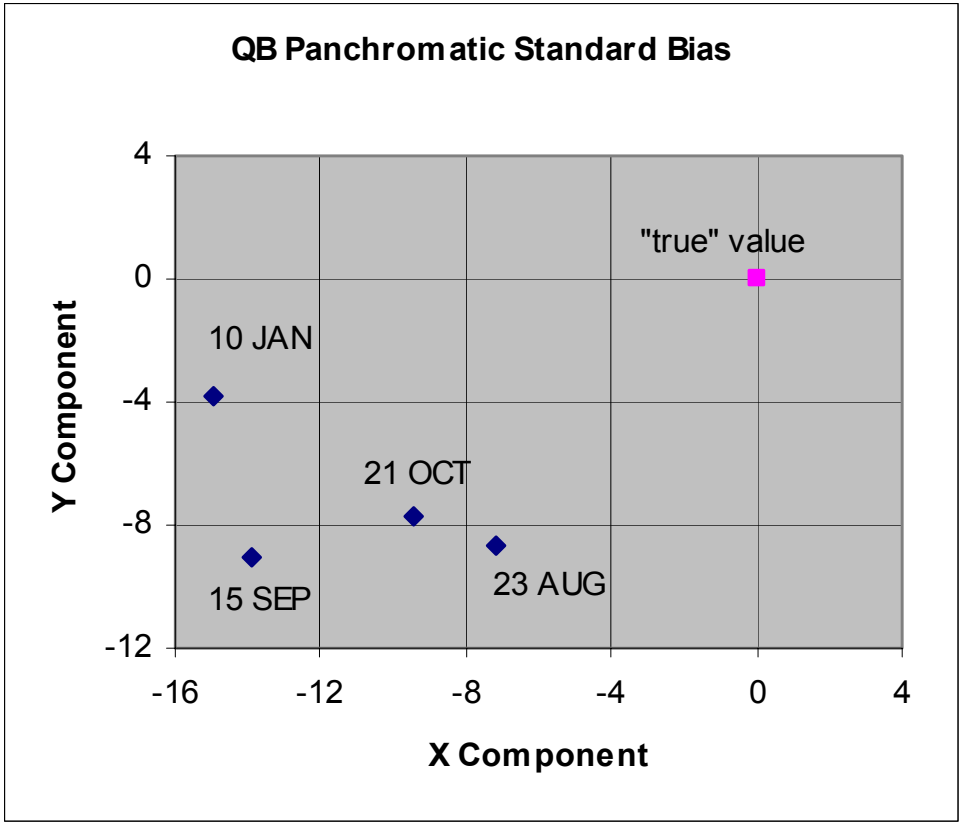
| QuickBird | | | |
|---|---|---|---|
| ***Acquisition Date*** | 8/23/2003 | ***Imagery Band*** | MS-ORTHO |
| | | | |
| **Number Targets Used** | | **Error Components** | |
| ***n*** | 37 | $\mu_H$ ***(Bias)*** | 5.34 m |
| **Test for Departure from Circular Distribution** | | $\sigma_C$ ***(Circular Standard Error)*** | 1.57 m |
| ***St. Dev. Min Max Ratio*** | 0.63 | $\mu_H/\sigma_C$ | 3.40 |
| St. Dev. Min Max Ratio should be at least 0.6 for Circular Error assumptions. | | If $\mu_H/\sigma_C$ is greater than 0.1, then error calculations should account for bias. | |
| | | | |
| **Circular Error** | | | |
| ***Empirical CE 90*** | 7.50 m | ***Empirical CE 95*** | 8.43 m |




**$CE_{90}$ 7.50 m**

# Bias Trend

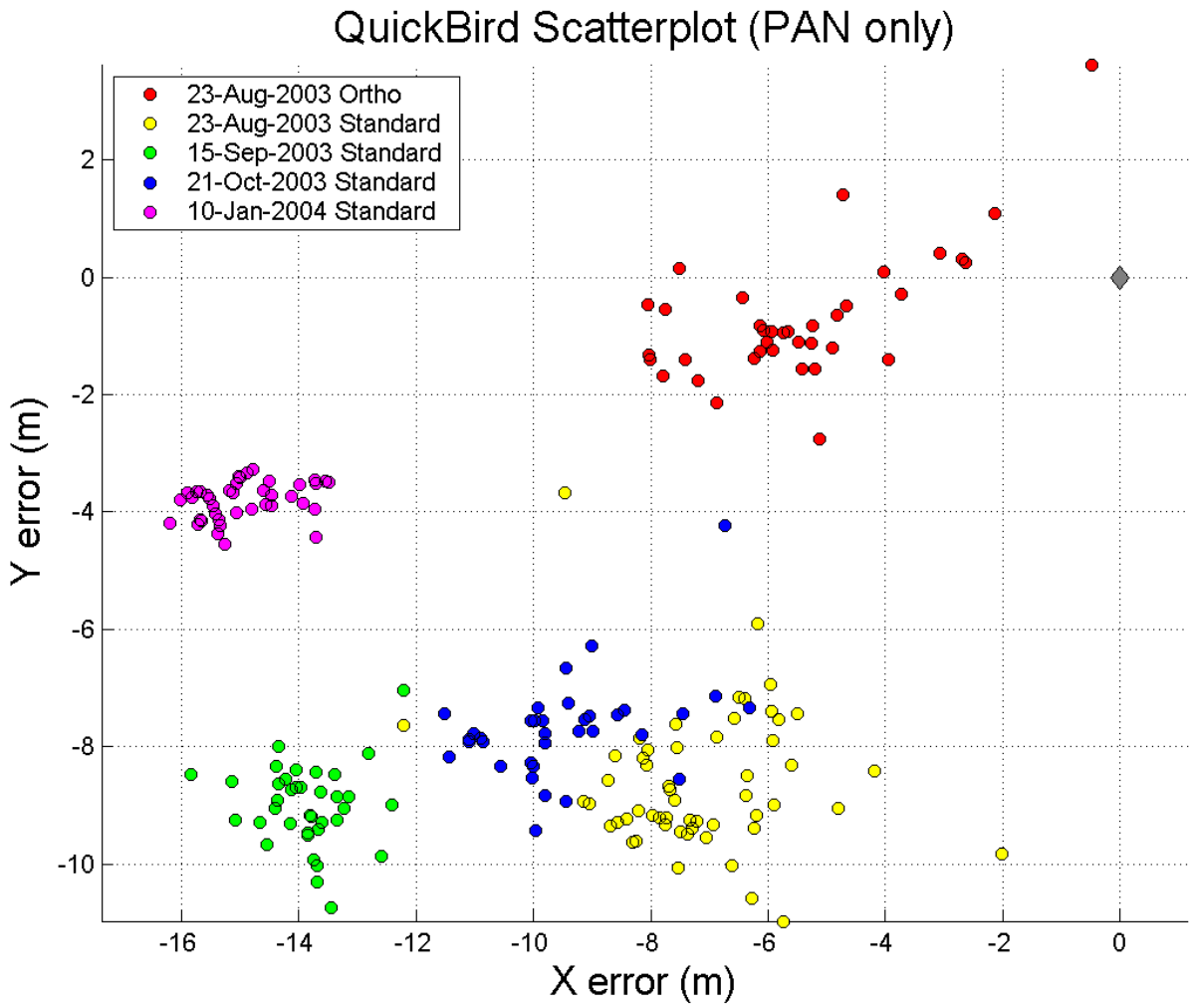





Bias trends to the southwest (with bias = image – reference) for all *Standard* images characterized

# QuickBird Error Scatterplot





# Summary



| QuickBird Product | Acquisition Date | Empirical $CE_{90}$ (m) | Empirical $CE_{95}$ (m) | Elevation Angle (deg) |
|---|---|---|---|---|
| Panchromatic *Standard* | 8/23/2003 | 12.67 | 12.76 | 76.8 |
| | 9/15/2003 | 17.40 | 17.62 | 83.3 |
| | 10/21/2003 | 13.63 | 13.72 | 81.3 |
| | 1/10/2004 | 16.27 | 16.39 | 89.2 |
| Panchromatic *Orthorectified* | 8/23/2003 | 7.93 | 8.11 | 76.8 |
| Multispectral *Standard* | 8/23/2003 | 12.78 | 12.93 | 76.8 |
| | 9/15/2003 | 17.34 | 17.66 | 83.3 |
| | 10/21/2003 | 13.76 | 13.77 | 81.3 |
| Multispectral *Orthorectified* | 8/23/2003 | 7.50 | 8.43 | 76.8 |

- The mean $CE_{90}$ of QuickBird panchromatic *Standard* images characterized was 15.0 m
  - 95% confidence interval from 11.5 m to 18.5 m
- The mean $CE_{90}$ of QuickBird multispectral *Standard* images characterized was 14.6 m
  - 95% confidence interval from 8.7 m to 20.6 m
- The single panchromatic *Orthorectified* image had $CE_{90}$ of 7.9 m, and the single multispectral *Orthorectified* image had $CE_{90}$ of 7.5 m
- All QuickBird images characterized in this reporting period met specifications
  - *Standard* 2A: $CE_{90}$ 23 m, *Orthorectified* 3E: $CE_{90}$ 8.3 m

# Extended QuickBird Summary



| QuickBird Product | Image Tracking ID | Acquisition Date | Bias X (m) | Bias Y (m) | $\mu_H$ - Bias (m) | $\sigma_C$ - Circular Standard Error (m) | Empirical $CE_{90}$ (m) | Empirical $CE_{95}$ (m) | Elevation Angle (deg) |
|---|---|---|---|---|---|---|---|---|---|
| Panchromatic *Standard* | 75234 | 8/23/2003 | -7.20 | -8.63 | 11.24 | 1.33 | 12.67 | 12.76 | 76.8 |
| | 76412 | 9/15/2003 | -13.86 | -9.01 | 16.53 | 0.71 | 17.40 | 17.62 | 83.3 |
| | 83586 | 10/21/2003 | -9.47 | -7.70 | 12.20 | 1.09 | 13.63 | 13.72 | 81.3 |
| | 98196 | 1/10/2004 | -14.93 | -3.80 | 15.41 | 0.54 | 16.27 | 16.39 | 89.2 |
| Panchromatic *Orthorectified* | 88508 | 8/23/2003 | -5.47 | -0.71 | 5.52 | 1.45 | 7.93 | 8.11 | 76.8 |
| Multispectral *Standard* | 75234 | 8/23/2003 | -6.94 | -7.66 | 10.33 | 1.81 | 12.78 | 12.93 | 76.8 |
| | 76412 | 9/15/2003 | -14.02 | -8.23 | 16.26 | 1.01 | 17.34 | 17.66 | 83.3 |
| | 83586 | 10/21/2003 | -9.76 | -7.33 | 12.21 | 1.53 | 13.76 | 13.77 | 81.3 |
| Multispectral *Orthorectified* | 88508 | 8/23/2003 | -5.33 | 0.31 | 5.34 | 1.57 | 7.50 | 8.43 | 76.8 |