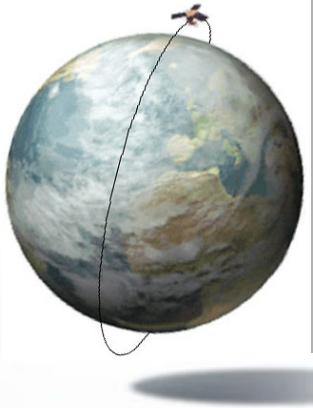
IKONOS Geometric Characterization

Gene Dial

Jacek Grodecki

Topics



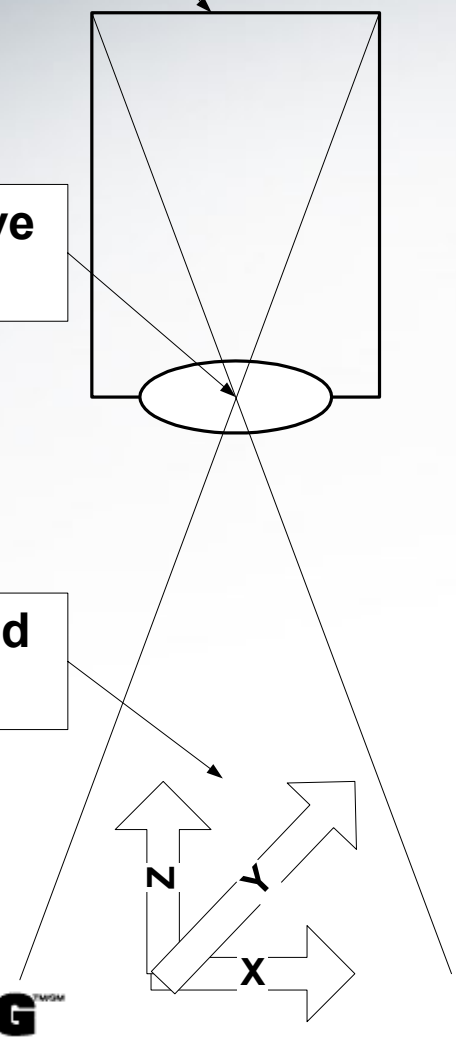
- Exterior orientation
  - Stable interlock angles
  - Minor update improves accuracy
- Interior orientation
  - Stable Field Angle Map (FAM)
  - Minor update improves multi-image block adjust accuracy
- Case studies
  - RPC Block Adjust
  - Digital Elevation Model (DEM)

Interior & Exterior Orientation

2-D Image Space

Perspective Center

3-D Ground Space



Interior Orientation
- Optics
- Mechanical alignments
- Relates field angles to image detectors

Exterior Orientation
- Position (Ephemeris)
- Attitude (Angles)
- Relates 3-D ground positions to field angles

RPC
Complete 3-D Object to 2-D Image Relation-ship

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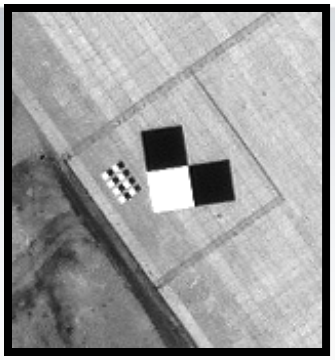
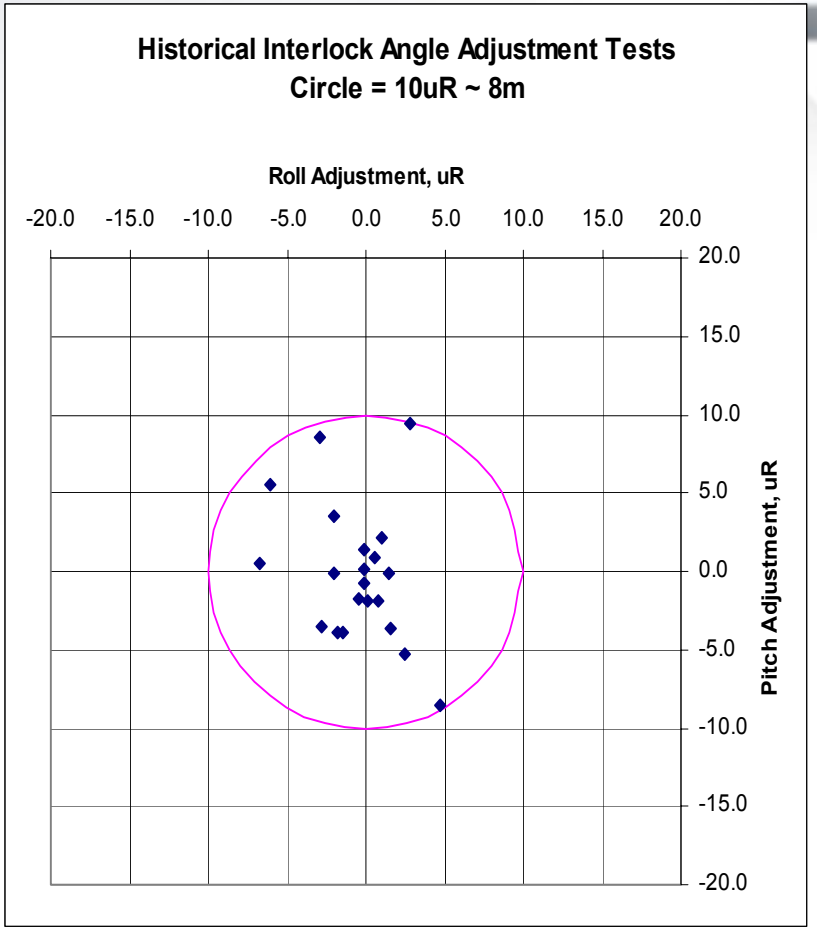
Visual Information. Visible Results.

Accuracy Test without GCP

- MTF target is check point.
- Interlock angles
  - Camera to body angles
  - Adjusted 1/31/02
    - +4.5 uR Pitch
    - -2.5 uR Roll
    - (1 uR ~ 0.8 m)
  - After adjustment
    - 10 uR CE90 ~ 8m CE90
  - Older orders meet specs.
  - Newer orders are better.





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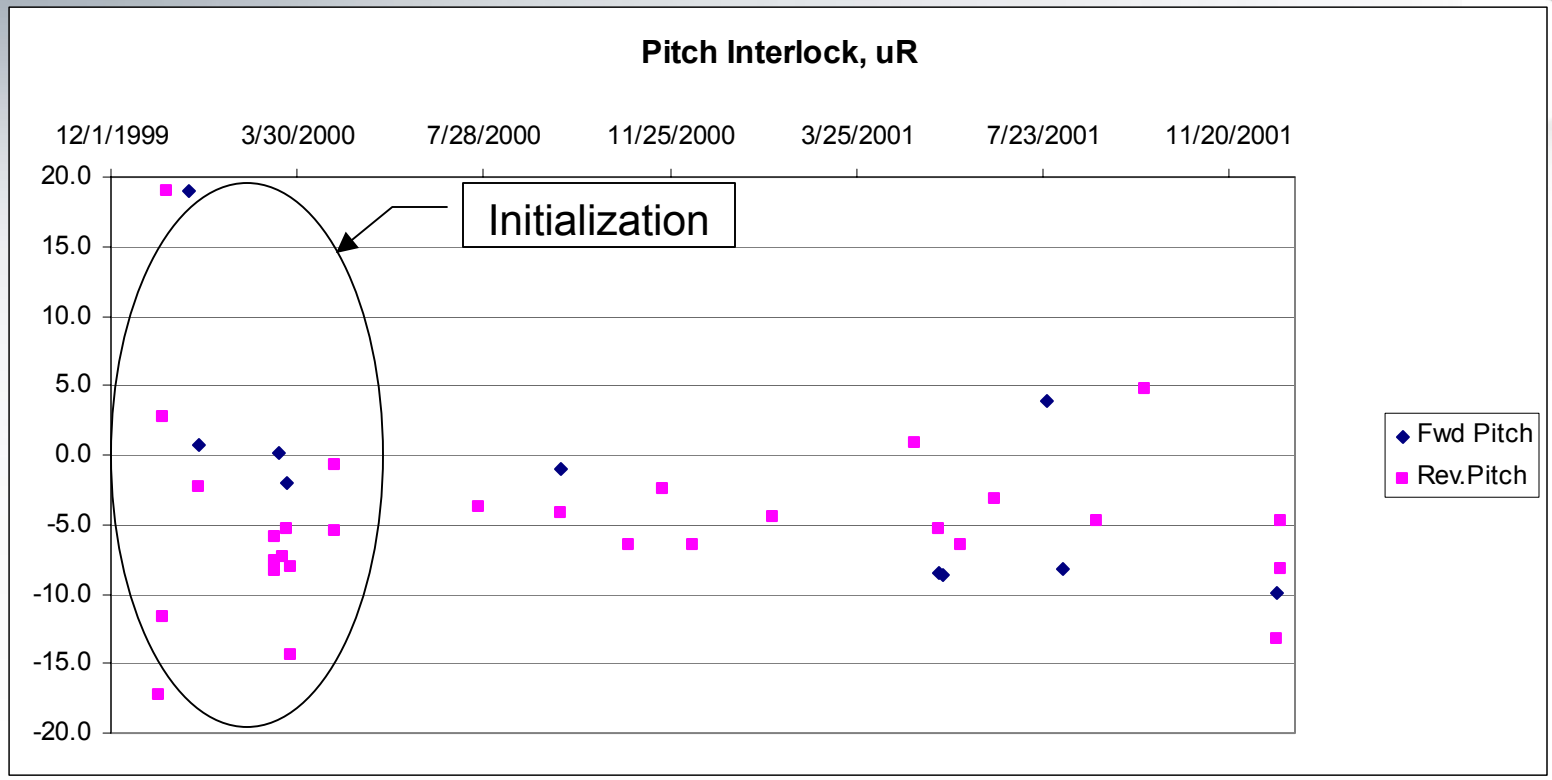
History of pitch angle tests



Note small variation and lack of historical trends.

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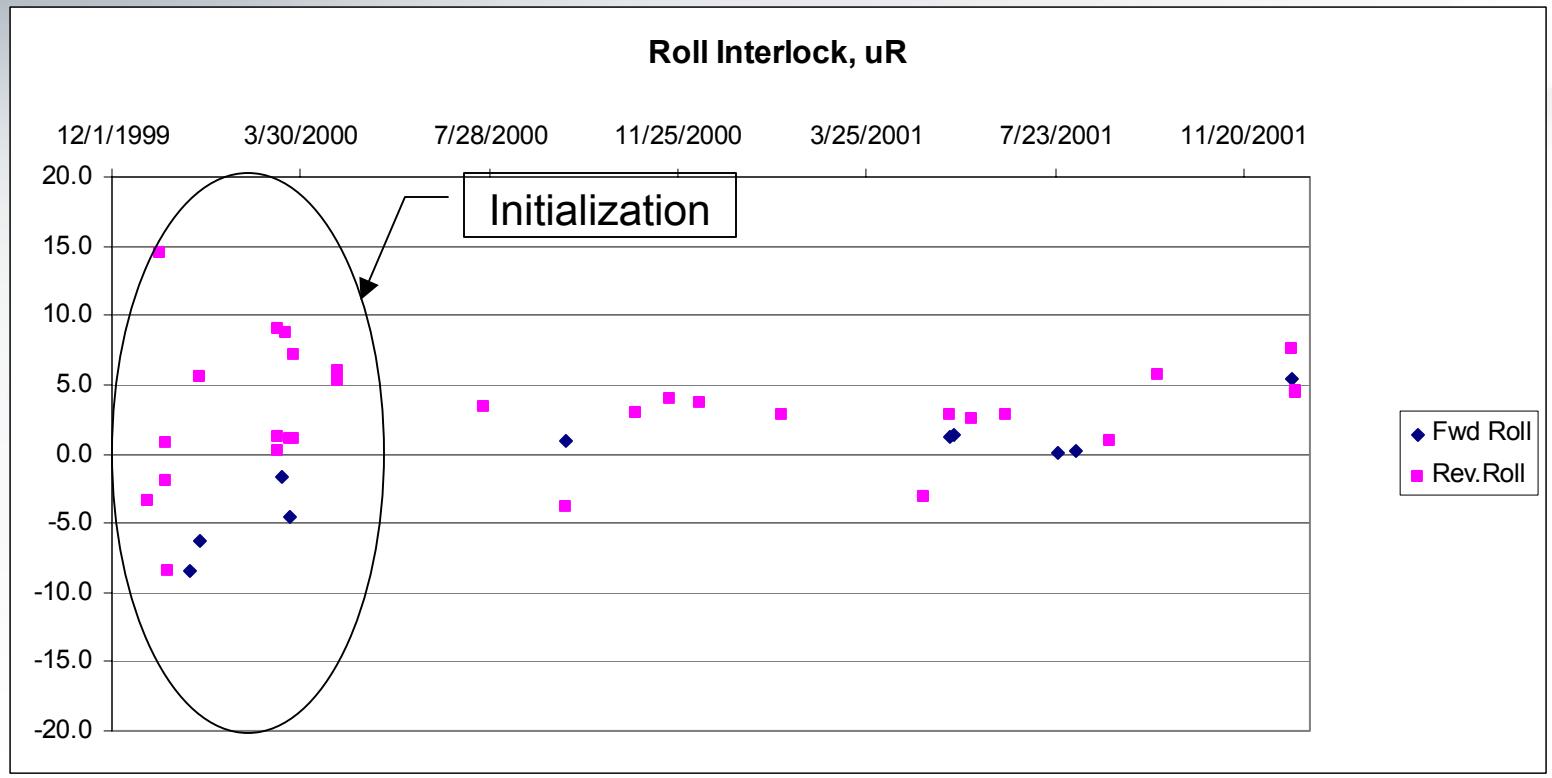
History of roll angle tests



Note small variation and lack of historical trends.

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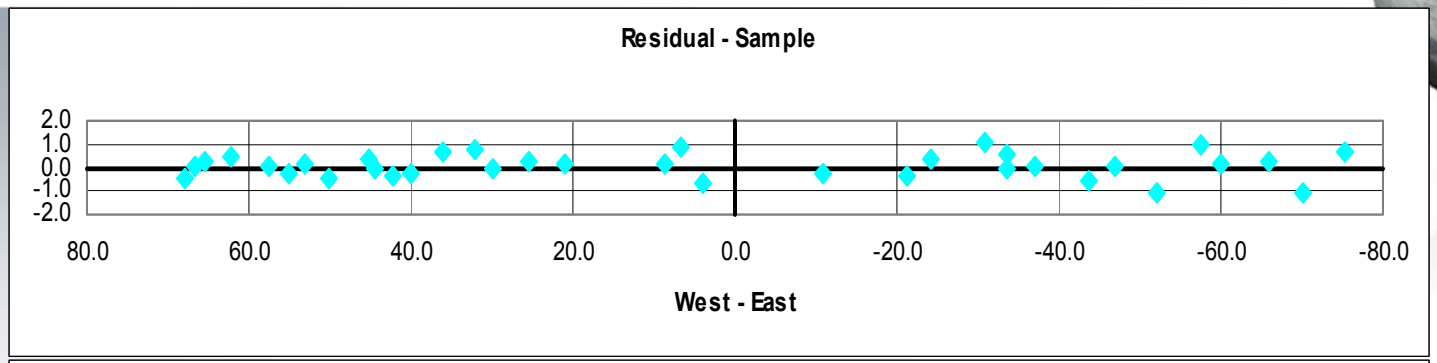
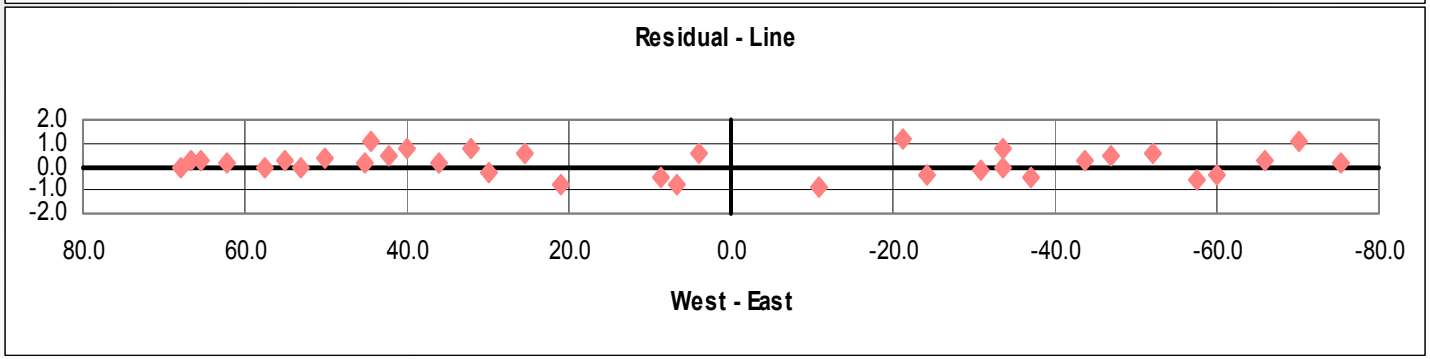
Calibration of Interior Orientation





Less than 1 pixel residual error across entire width of focal plane

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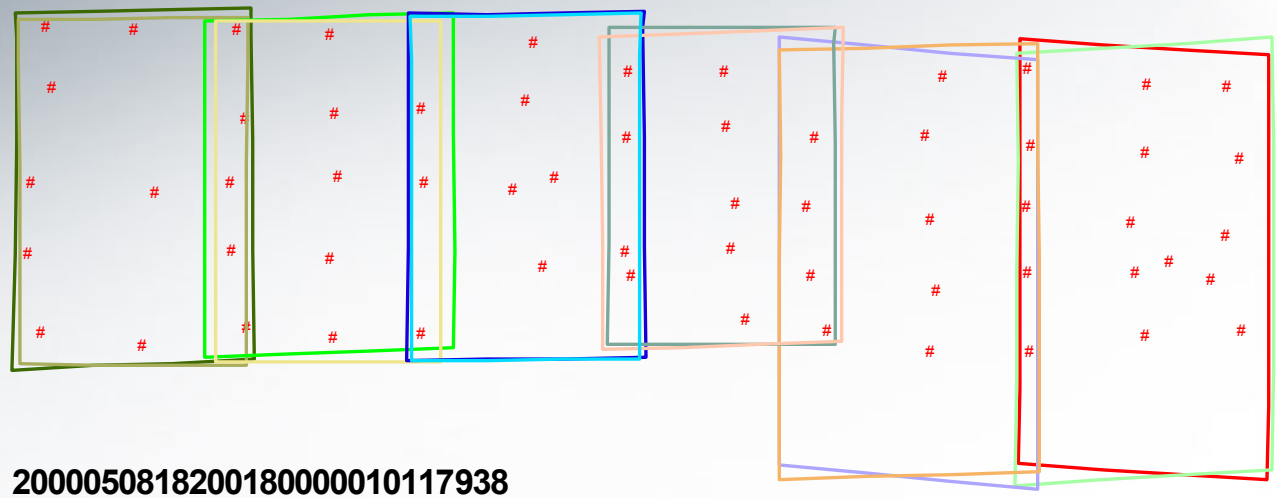
Calibration Updates

- Interior Orientation (Field Angle Map)
  - Nov 19, 2001
  - Improved accuracy ~ 2 meters/strip.
- Exterior Orientation (Interlock Angles)
  - Jan 31, 2002
  - Improved accuracy w/o GCP by ~ 4 meters.
- Modulation Transfer Function Compensation
  - Jan 18, 2002
  - Corrected transpose of kernel coefficients (imperceptible)
- Calibration Updates
  - Updates apply to all image collection dates.
  - Effectivity determined by creation date.
  - Older products meet all specification requirements.
  - Newer products will be slightly better.

Case Study: 6 Stereo Pair, 60 GCP



2000050818200180000010117938
2000050818210350000010117940
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2000062118260060000011612352
2001031418272660000010128951
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2001031418281680000010128952
2001031418282990000010128950
2001032518284320000010105273
2001032518290160000010105275
2001032518293190000010105274
2001032518295100000010105276

- Processed with one GCP.
- Remaining GCP test accuracy.

5 0 5 10 Miles

N W E S

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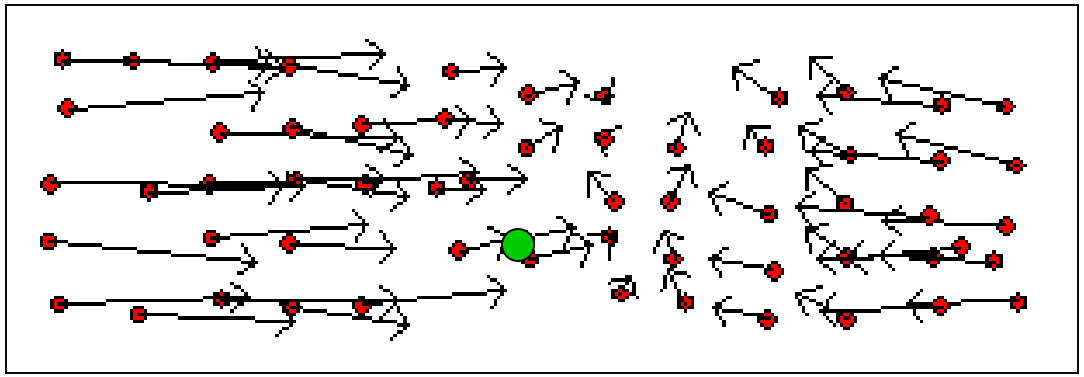
Old FAM, 1 GCP



	Latitude (meters)	Longitude (meters)	Height (meters)	Str. Line (meters)
Mean	0.45	1.66	0.74	4.98
Std. Dev.(68)	0.79	5.51	1.65	2.95
Std. Dev.(90)	1.3	9.06	2.71	4.85
Maximum	1.98	11.86	4.57	11.86
Minimum	-1.33	-6.71	-2.47	0.2
Points: 60				

CE90 = 8.6 m

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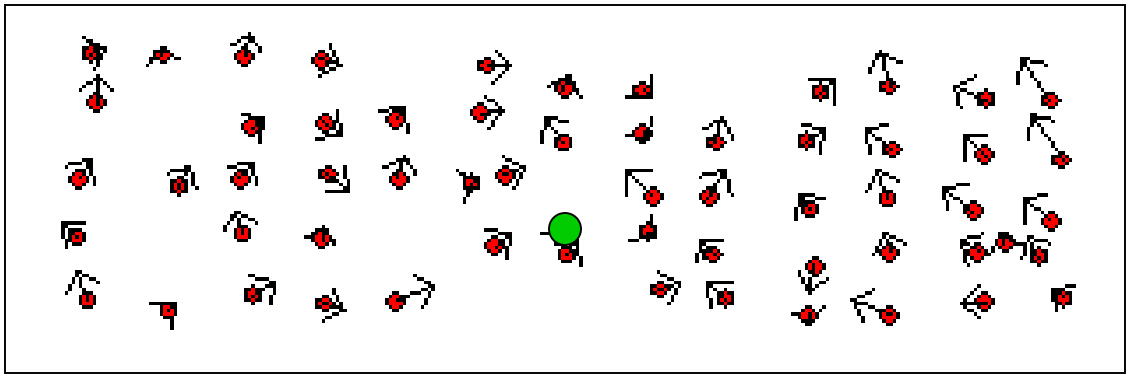
New FAM, 1 GCP



	Latitude (meters)	Longitude (meters)	Height (meters)	Str. Line (meters)
Mean	0.61	-0.02	-0.06	1.13
Std. Dev.(68)	0.67	0.86	1.62	0.51
Std. Dev.(90)	1.1	1.41	2.66	0.83
Maximum	2.24	1.92	3.38	2.72
Minimum	-1.29	-1.85	-3.78	0.23
Points: 60				

CE90 = 1.8 m

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RPC Image Adjustments

- Table shows RPC block adjustment offsets.
- Offsets
  - Small (< 8m)
  - ~Random
- Residual errors
  - Small (< 2m)
  - Random

Source ID	X	Y
20000508-17938	-2.6	-0.9
20000508-17940	-7.3	-5.4
20000621-12351	-5.8	-7.6
20000621-12352	1.5	-2.2
20010325-05276	-7.6	-2.3
20010325-05275	0.3	3.9
20010325-05273	6.0	5.9
20010325-05274	-1.4	2.7
20010314-28951	0.0	1.2
20010314-28952	1.2	1.5
20010314-28949	1.0	4.5
20010314-28950	-1.9	2.2
	AVG = -1.4 m	AVG = 0.3 m

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Case Study – Stereo Elevation

Images	Vertical Error	Status
2001112217124870000010202074 2001112217134000000010202075	-15.0 m	Clear, Old DEM
2001043017022950000011601246 2001043017031830000011601247	+2.0 m	Partly Cloudy
2001050816543660000011607780 2001050816552570000011607781	+8.5 m	Partly Cloudy
2001040817002200000011616122 2001040817011350000011616123	-4.5 m	Partly Cloudy
All of the above	-3.5 m	New DEM

Original DEM had 15 meter bias.
New DEM should have 3.5m bias.
Production procedures corrected.

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Summary

- Stable Interior & Exterior Orientation
- Calibration improvements
  - Small adjustments
  - Past products met specifications
  - Future products slightly better
- Process improvements
  - Space Imaging Proprietary
- RPC Block Adjustment
  - Replacement Camera Model
  - NIMA Block Adjust Study
  - Articles at ASPRS 2002 and in PERS

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