The LCROSS Impact Location

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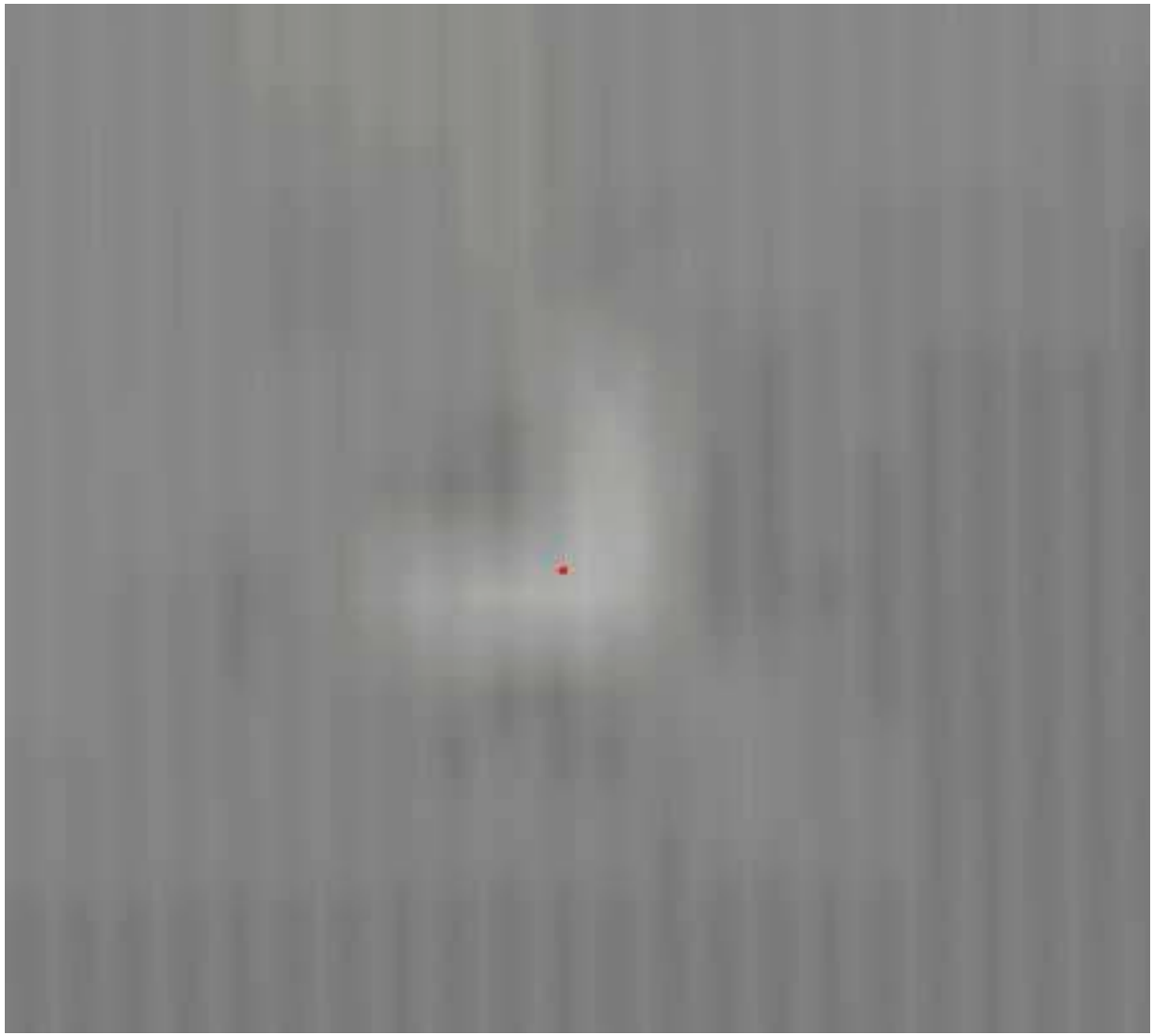
Overview

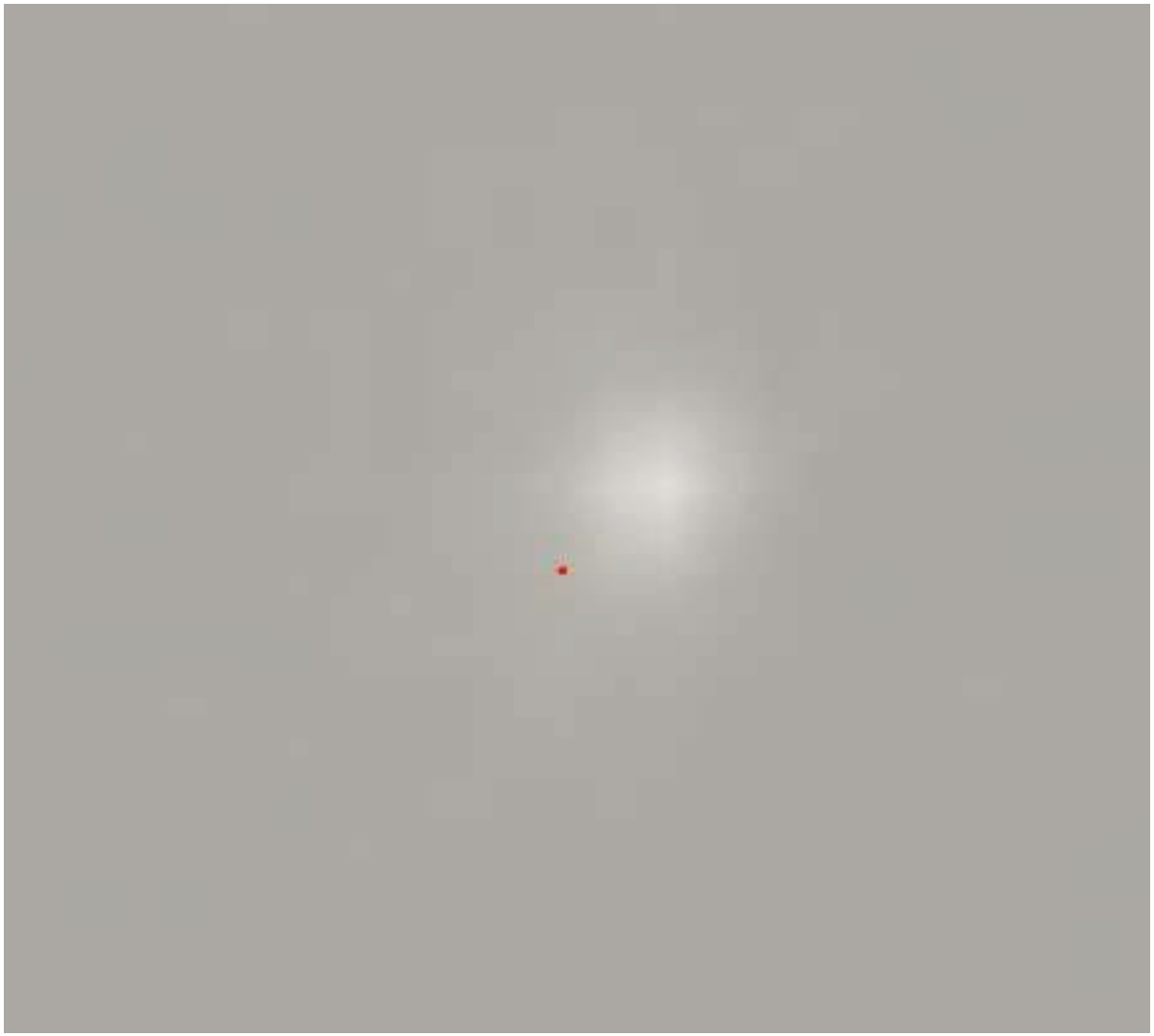
1. Registration of Imagery of the LCROSS Impact Site
   - Identification of impact
   - Registration of LCROSS-MIR, -NIR, Goldstone to LRO-LOLA
2. Impact Location Determination
3. Instrument Pointing
4. Summary

Identification: MIR

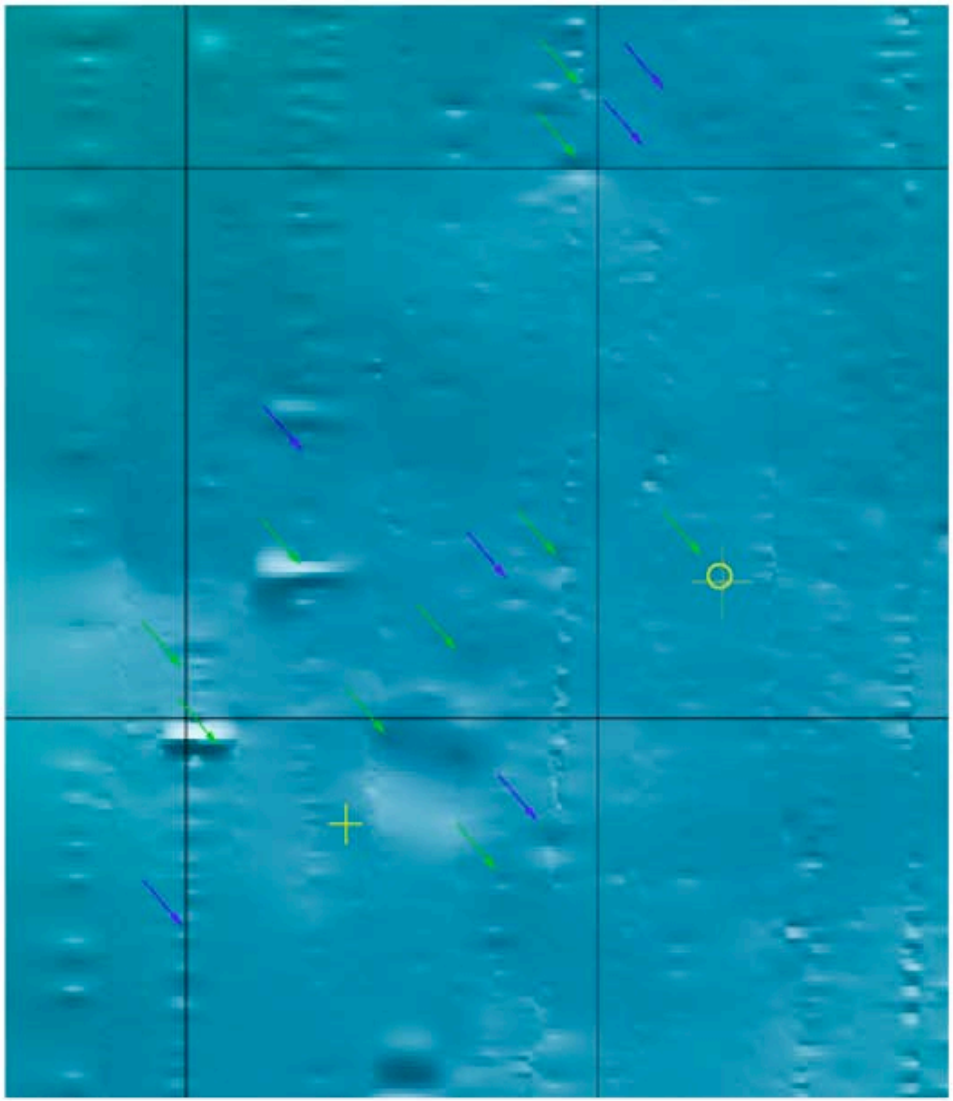
Identification: NIR

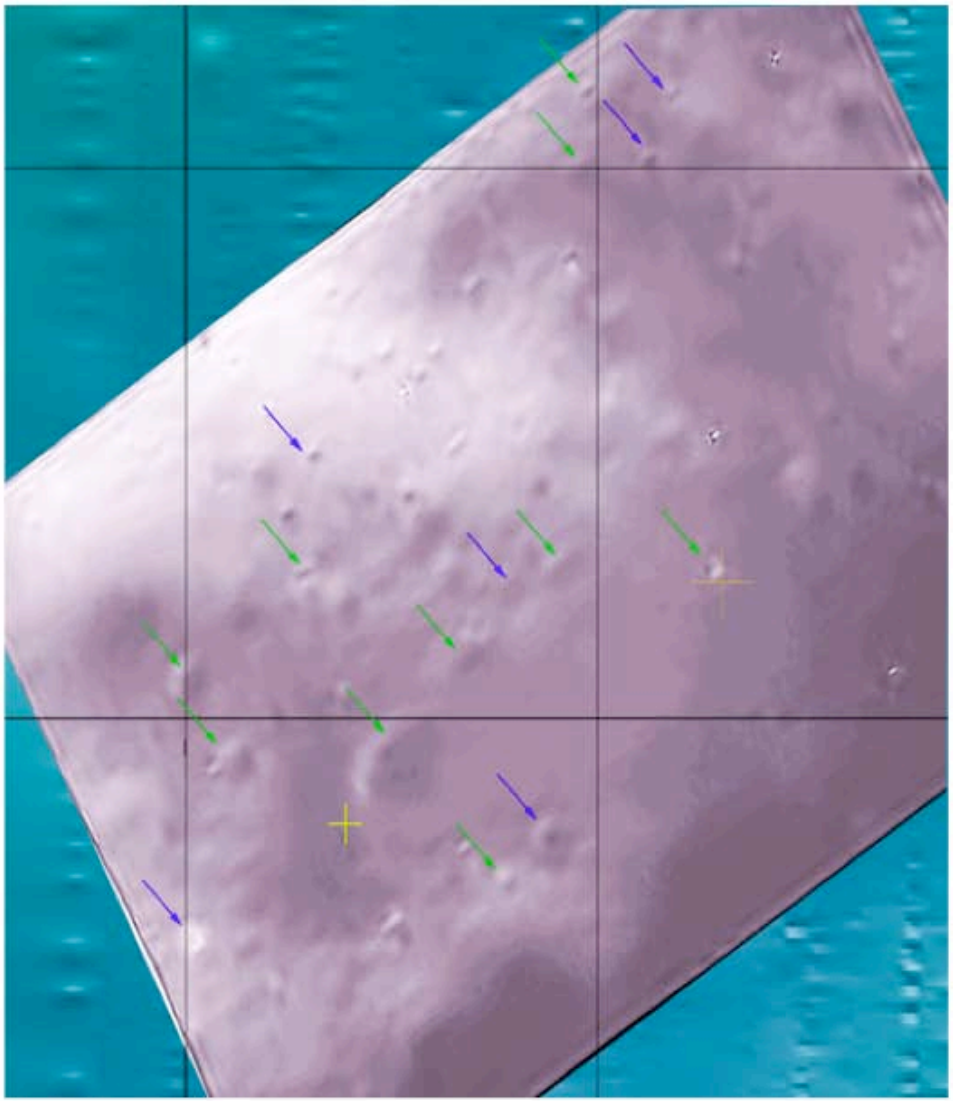


Identification: MIR



Registration: NIR onto LOLA

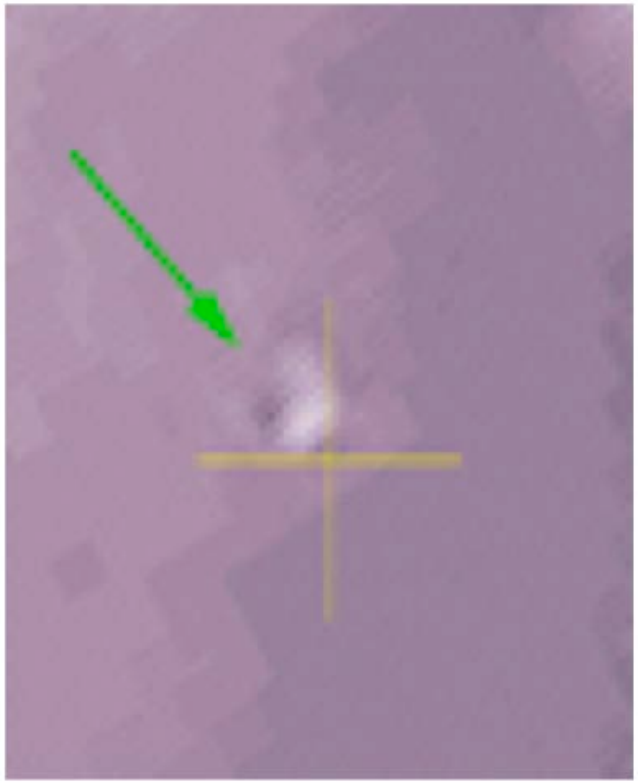


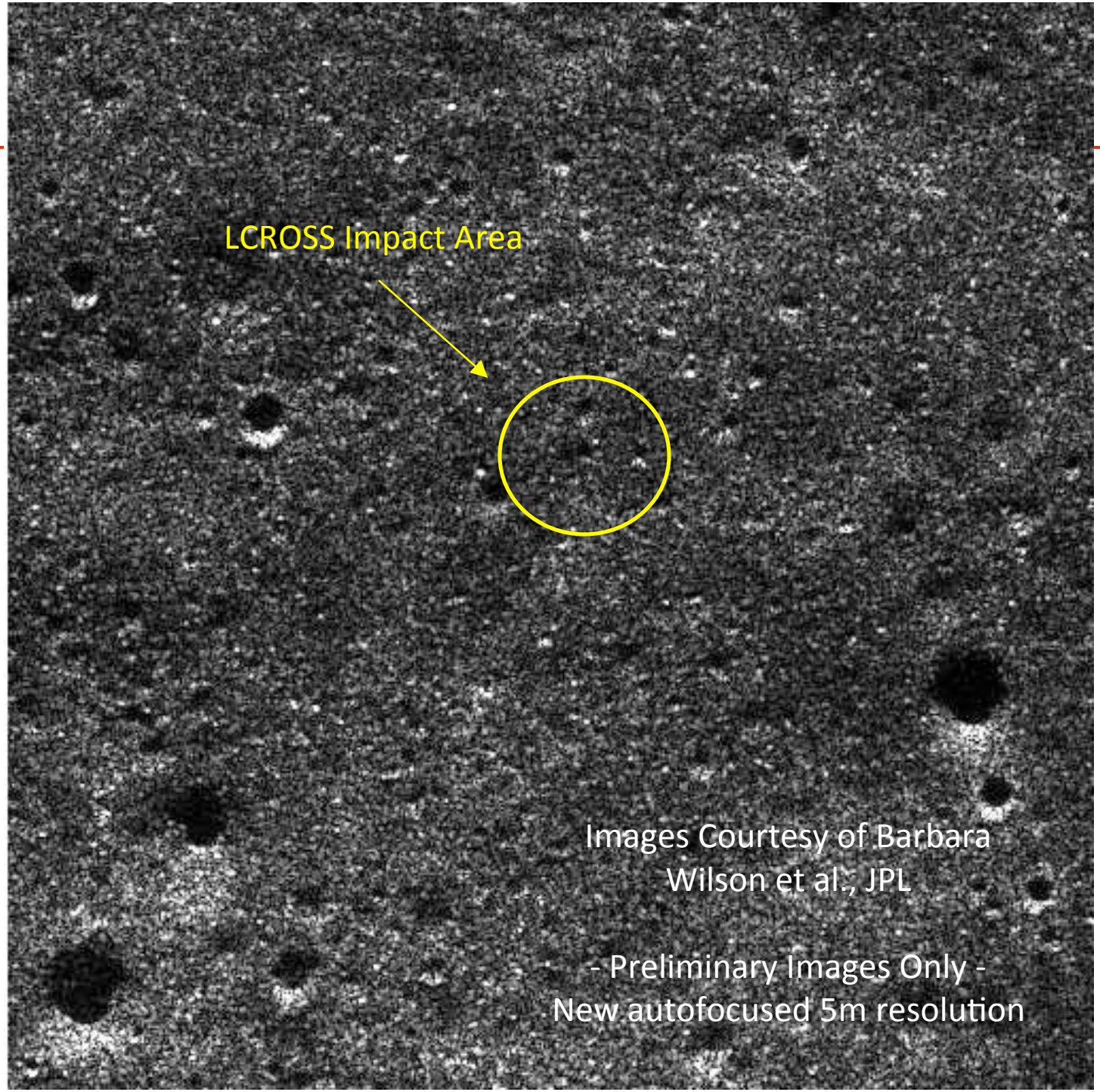


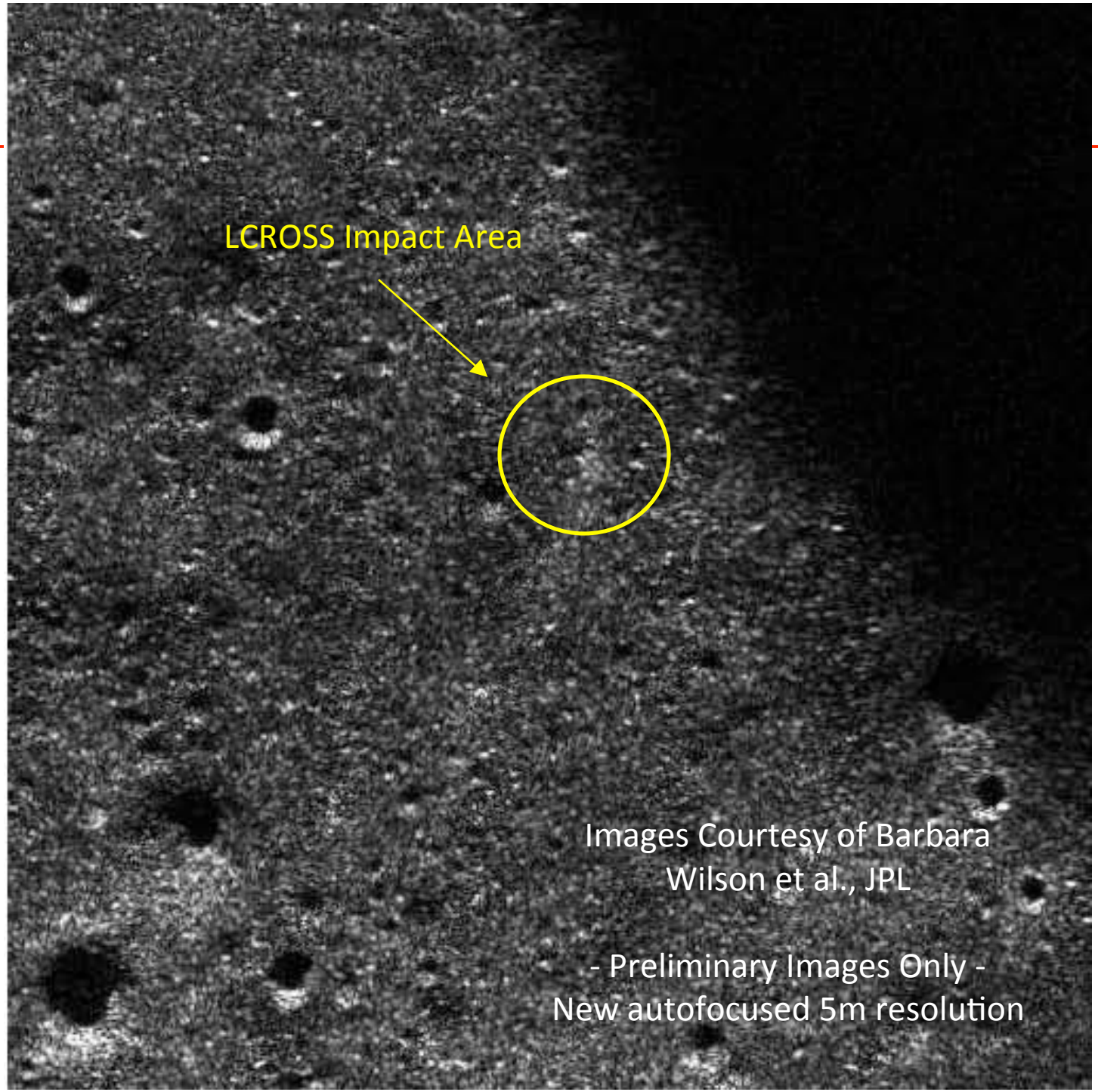
Impact Site: NIR2 Camera

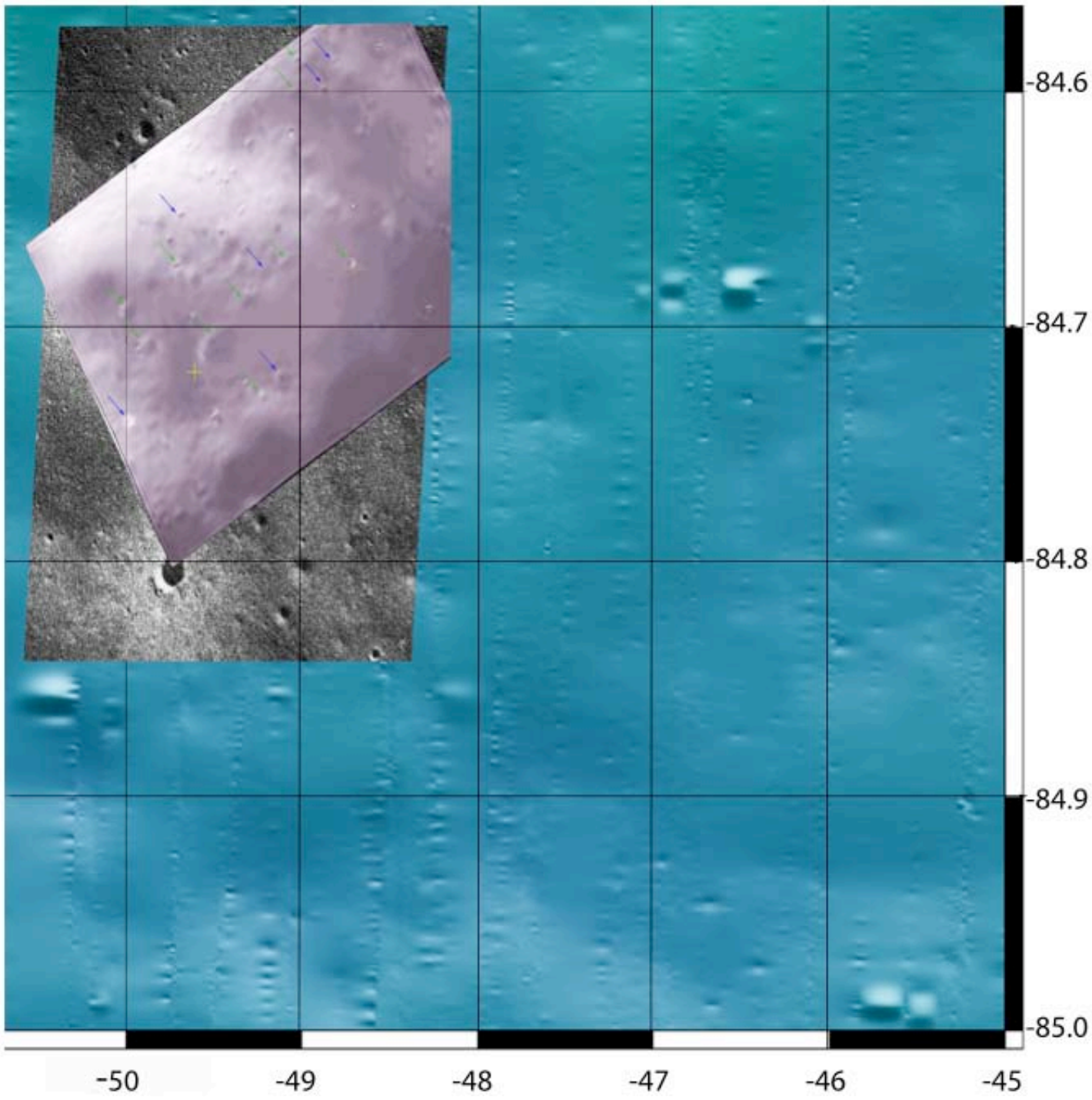
Dark Region Diameter: 62+-20m
Light Ring Diameter: 158+-40m

Ejecta blanket dominant to East




LCROSS Impact Area
Images Courtesy of Barbara Wilson et al., JPL
- Preliminary Images Only -
New autofocused 5m resolution


LCROSS Impact Area
Images Courtesy of Barbara Wilson et al., JPL
- Preliminary Images Only -
New autofocused 5m resolution


-84.6
-84.7
-84.8
-84.9
-85.0
-50
-49
-48
-47
-46
-45

Location Determination

Method	Data
Centaur:	
1. Registered Images (NIR & GSR to LOLA)	Imagery Only
2. Trajectory Data	Tracking Only
3. Hybrid Forward Projection	Both
4. Hybrid Bundle Adjustment[1]	Both
SSC:	
1. Registered Images (GSR to LOLA)	Imagery Only
2. Trajectory Data	Tracking Only

[1] See Moratto et al, Poster 220

Location Determination: Trajectory

Centaur Trajectory:

Inputs:

1. Centaur state pre-separation
2. SSC State post Separation
3. Relative masses of Centaur and SSC

→ Centaur state post separation

Propagate to ground

→ <u>Location</u>

SSC Trajectory

Inputs:

1. SSC Trajectory post-separation

Propagate to ground

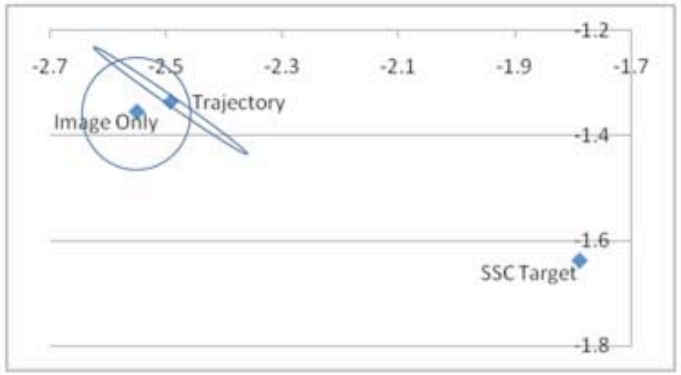
→ <u>Location</u>

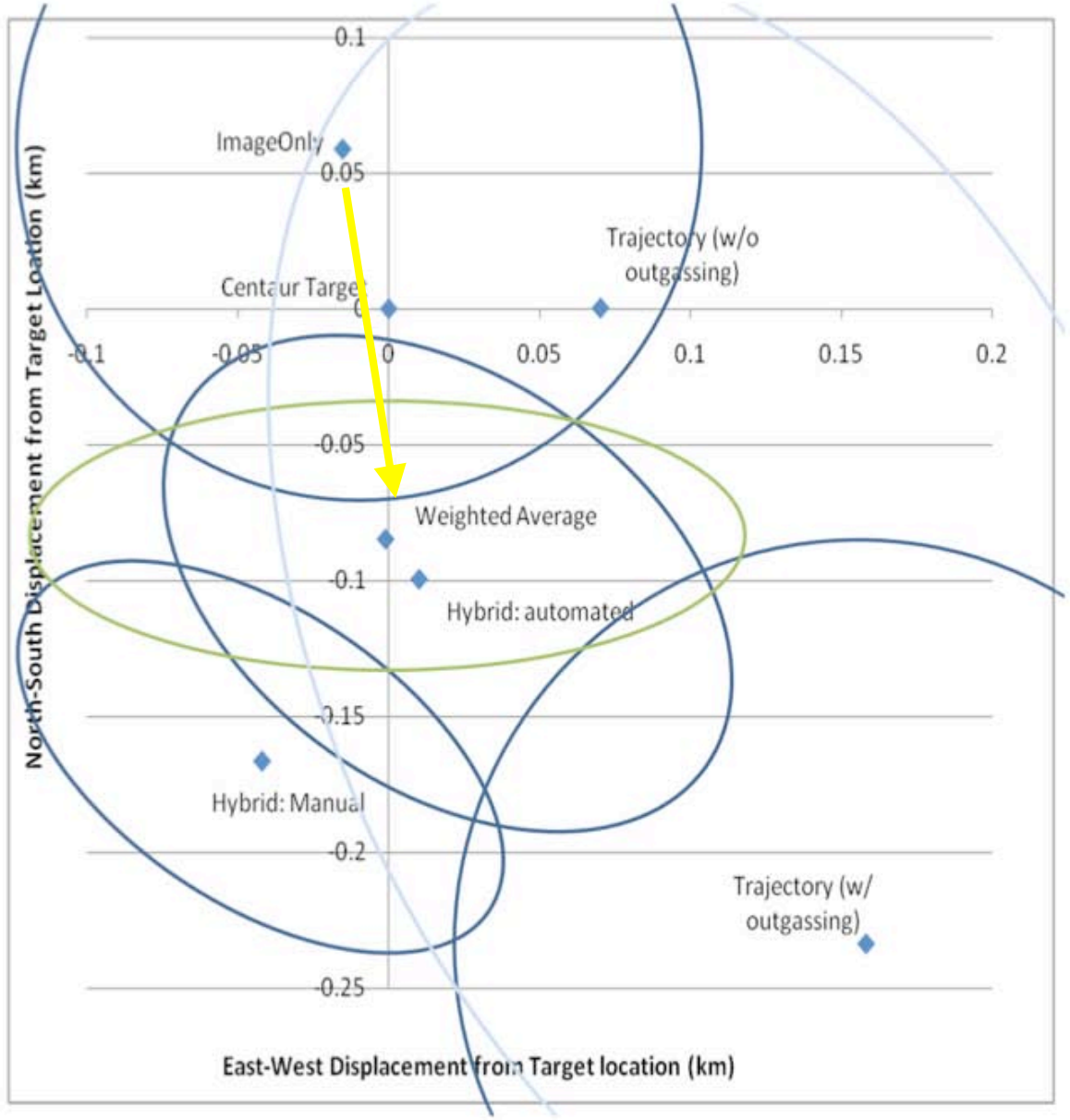
Location Summary Schematic

All agree within 150 m.

All consistent at 3-sigma level

Possible Map-Tie Issue?



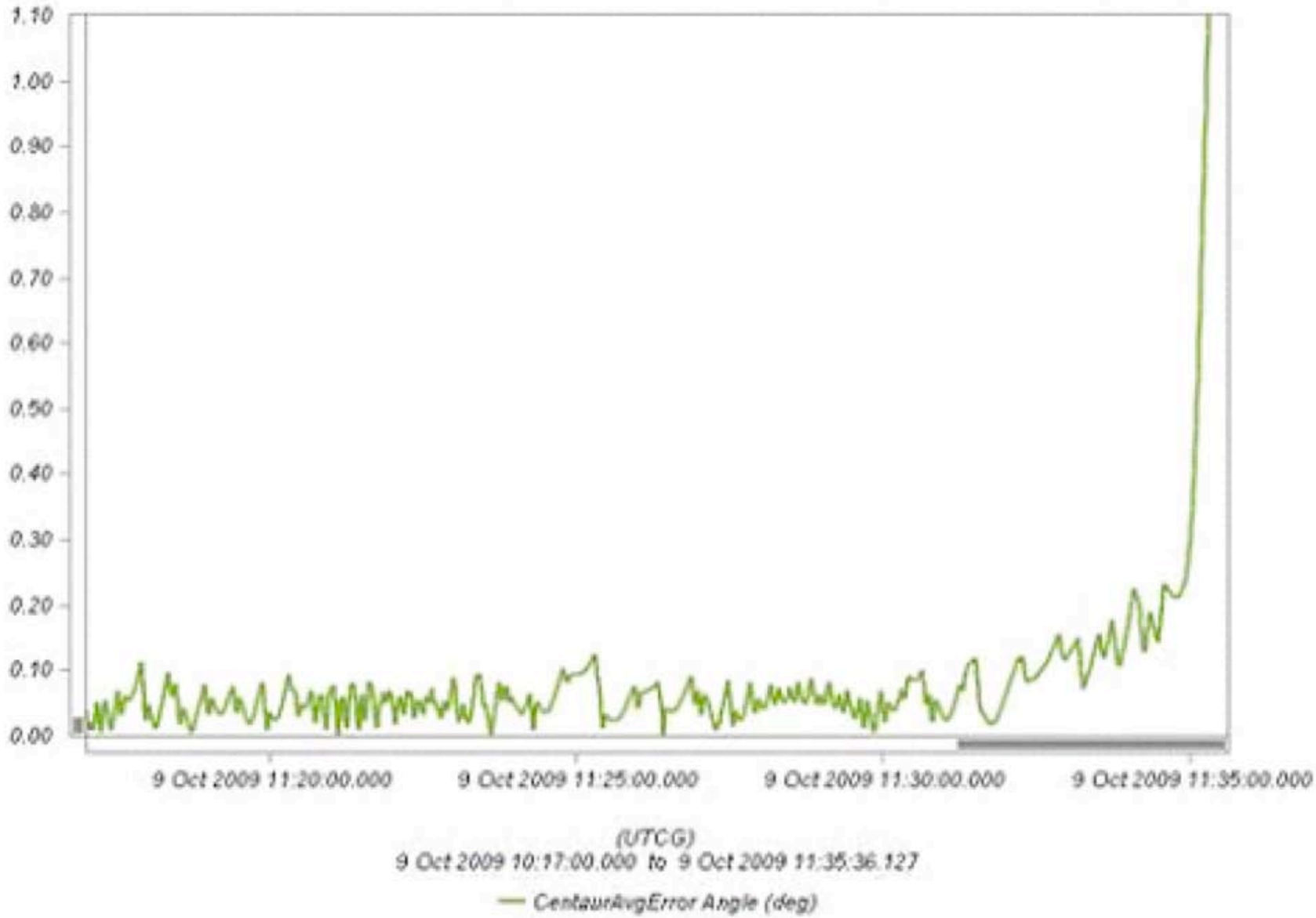


Summary of Location

	Centaur	SSC
Time (UTC)	11:31:19.506	11:35:36.116
Latitude (deg)	-84.6778 +- 0.004	–84.7193 +- 0.016
Longitude (deg)	-48.7254 +- 0.001	–49.6203 +- 0.014
Altitude (m):	-3,825	-3,809
Error (1-sigma) (m):	119x46	31x39
Dist to target (m):	85	800
Impact Angle (deg):	3.7 +- 2.3	
Instrument Pointing:		<0.1 deg[1]

[1] From 5 mins prior to 3 mins after Centaur Impact

SSC Instrument Pointing



Assessment of 6 Mission Requirements

Req. No.	Requirement Text	Result
LPRP4.4	The LCROSS impactor shall impact the target location at an angle greater than 60 degrees to the plane of the lunar surface.	Impact angle $86.3 \pm 2.3^\circ$ w.r.t. local slope.
PRJ4.2.3	The LCROSS shall be able to target a 10 km radius impact area (3-sigma).	Distance to target: 85m, Max mean plus 3σ range < 450m
PRJ6.4.8	LCROSS shall be capable of observing impact target location and the sunlit ejecta cloud with at least 0.1 Hz frequency from EDUS impact minus 5 minutes until EDUS impact minus 3 minutes	Sample rates varied by instrument at time, but all were $<$ 0.1 Hz over this period and were observing the target location and ejecta cloud.
PRJ6.4.14	The FS shall maintain payload pointing to the Centaur impact site at the time of Centaur impact with an accuracy of +/- 0.5 degrees	Pointing error $< 0.1^\circ$ at impact
PRJ6.4.15	The FS shall maintain payload pointing to the Centaur impact site at Centaur impact plus 60 seconds with an accuracy of +/- 0.64 degrees.	Payload pointing to impact location $< 0.1^\circ$ at impact plus 60s
PRJ6.4.16	The FS shall point the nadir viewing NIR Spectrometer to the Centaur impact site at a time of 60 seconds prior to S-SC impact to an accuracy of +/- 5 degrees.	Payload pointing to impact location $< 0.2^\circ$ at SSC impact -60 s

Questions?

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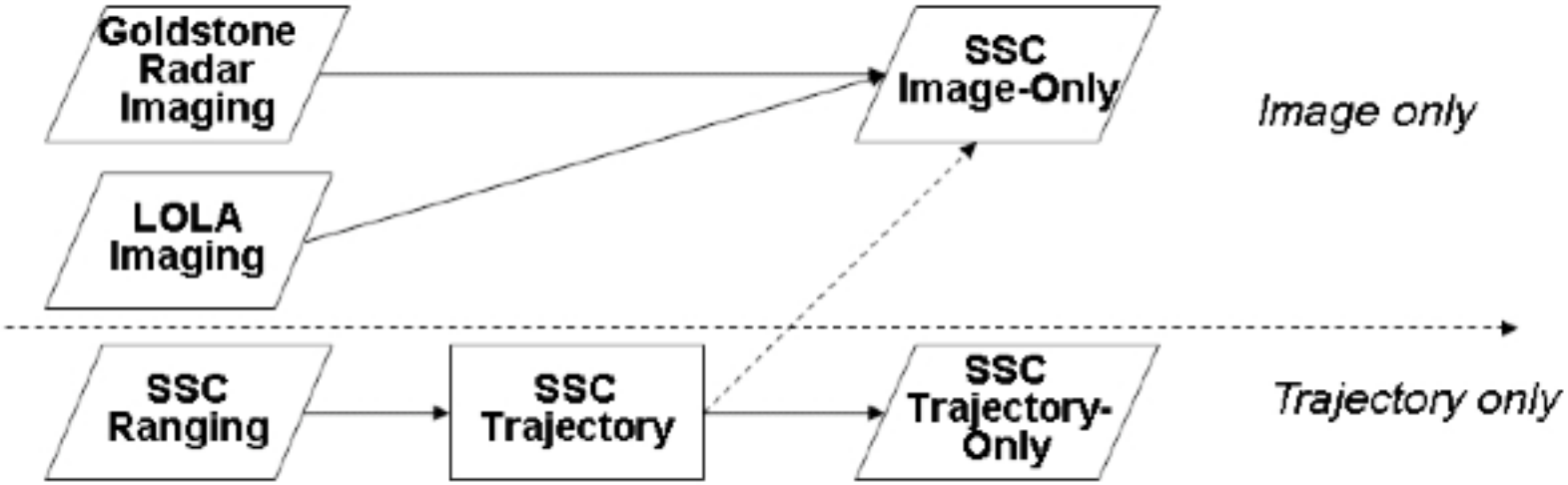
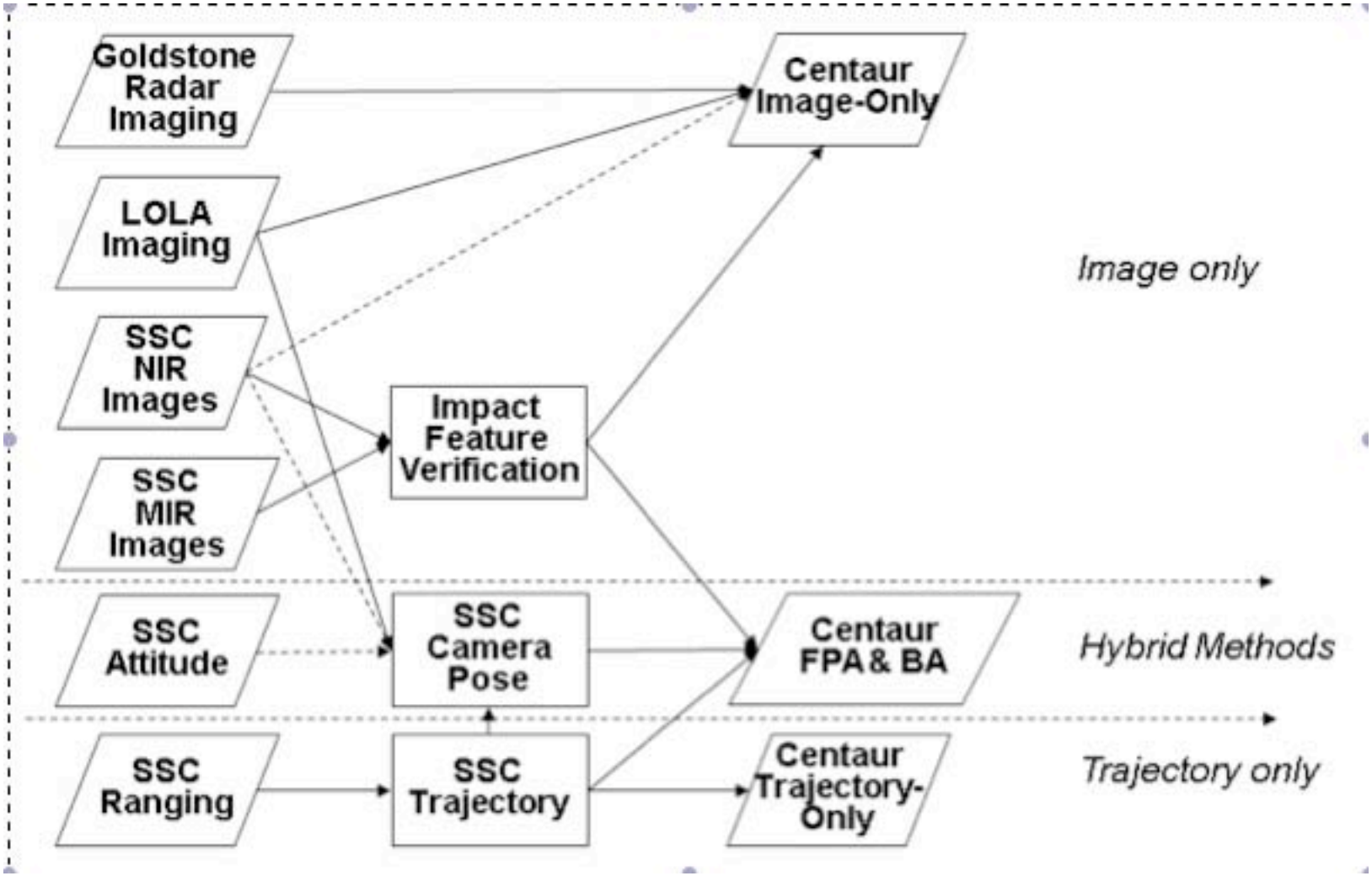
Location Determination: SSC



Location Determination: Centaur



Feature Characteristic	Centaur Impact	SSC Impact
Time (UTC)	11:31:19.506	11:35:36.116
Lattitude (°)	-84.6778 ± 0.004	-84.7193 ± 0.001
Longitude (°)	-48.7254 ± 0.016	-49.6203 ± 0.014
Altitude (m)	$-3,825 \pm 10$	$-3,809 \pm 10$
Error (m)	119×46	31×39
Dark Region Diameter (m)	62 ± 20	19 ± 10
Light Ring Diameter (m)	158 ± 40	-
Impact Angle (°)	3.67 ± 2.3	-
Distance to Target (m)	85	800

Method	Lat (°)	Long (°)	Alt. (km)	Error (m)
1. Image Only	-84.6731	-48.7304	n/a	130x130
2. Trajectory	-84.6750	-48.7001	-3.829	141×141
3. Hybrid: HFP	-84.6805	-48.7399	n/a	45×87
4. Hybrid: BA	-84.6782	-48.7214	-3.816	66×102?
Weighted Ave.	-84.6778 ± 0.004	-48.7254 ± 0.016	-3.825 ± 0.01	119×46
Target	-84.675	-48.725	-3.827	

Method	Lat (°)	Long (°)	Alt. (km)	Error (m)
1. Trajectory	-84.719	-49.61	n/a	3×75
2. Image Only	-84.7196	-49.6305	n/a	75×75
Weighted Ave.	-84.7193 ± 0.001	-49.6203 ± 0.014	n/s	31×39
Target	-84.729	-49.36	-3.8091	