Preliminary Results of ICESat GSFC Overpasses on 11/3/2006

GLAS Science Team Meeting

Rev. 1

Austin, TX

2/22/2007

Xiaoli Sun/Code 694

Bill Hasselbrack/Sigma/Code 694

Jeff Guerber/SGT/Code 614

Peggy Jester/Code 614

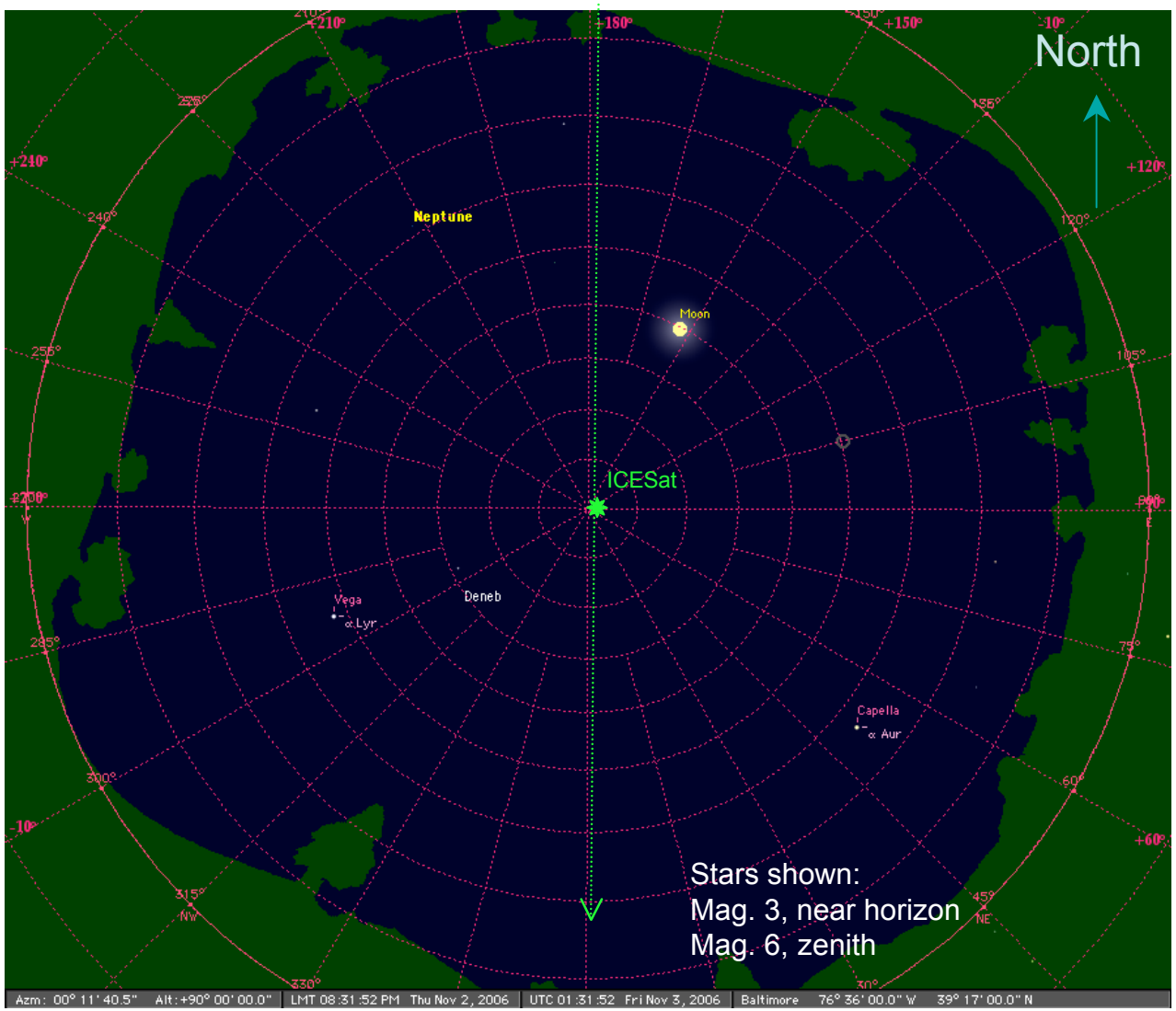
And many help from:

John DiMarzio, David Hancock, Tim Urban, Scott Luthcke, Jeff Lee, Jack Saba, Claudia Carabajal, Pete Liiva, Steve Palm Tim Berkoff, Sebastian Stewart, Jim Spinhirne, Tom Feild, and Jim Abshire, Pam Millar, Brya Blair, Jay Zwally, Bob Schutz

Outline

- ICESat GSFC overpass on Nov. 3, 2006 and the test setup at GSFC Building 33 rooftop
- Laser pulses observed on Building 33 rooftop
- GLAS product data during the overpass
- Comparison between GLAS product data and independent measurements at GSFC
- Conclusions

ICESat GSFC Overpass on Nov. 3, 2006

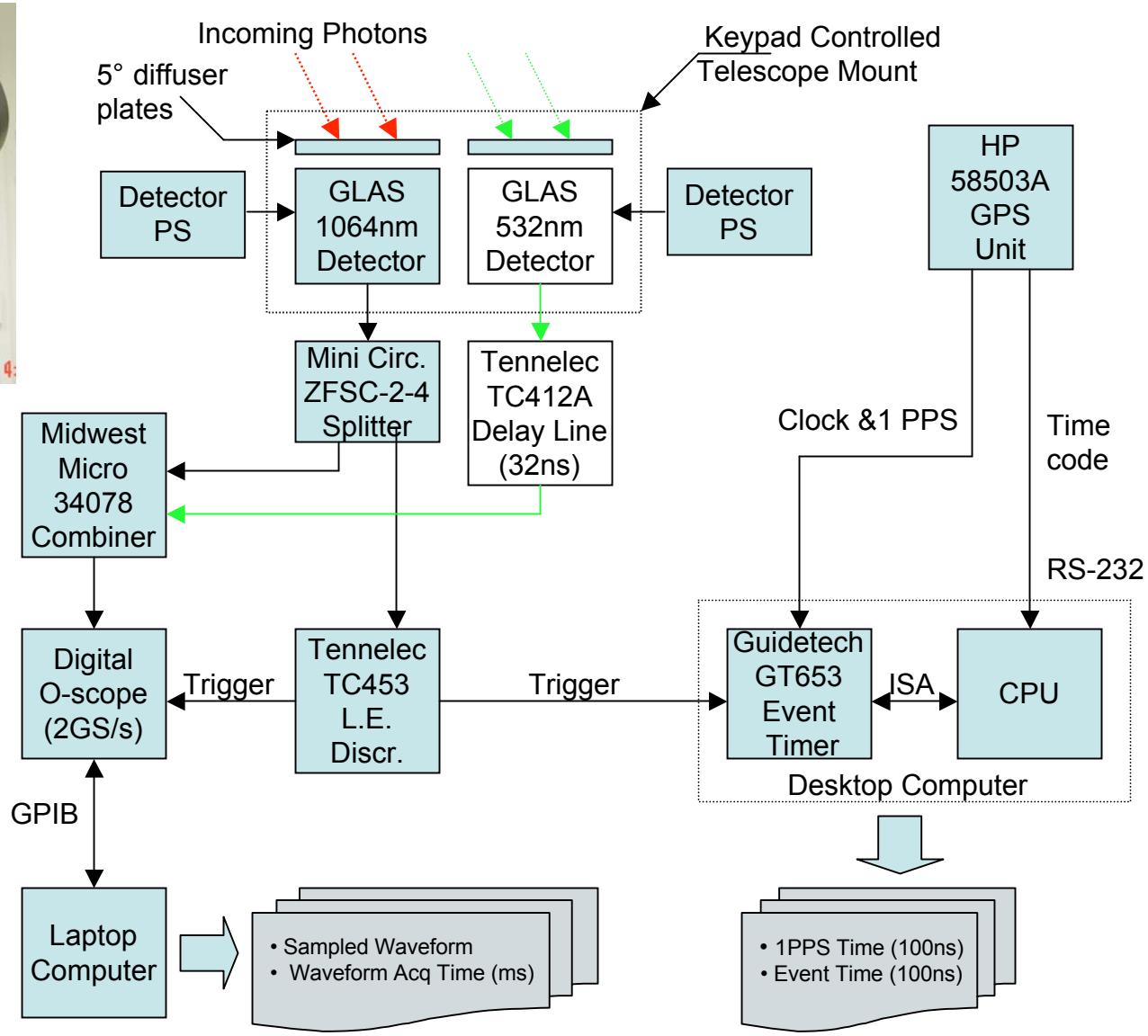


- Predicted Time of overpass:
  Nov. 3, 2006,
  1:39:34.718 (UTC)
- ICESat ~2º to the west, traveling north to south
- GLAS laser energy:
  29.4mJ/pulse@1064nm
  1.55mJ/pulse@532nm
- GSFC local conditions:
  very clear sky
  near full moon
  temperature ~50ºF

GSFC B33 Rooftop Test Setup

(Third attempt since Feb. 2006)

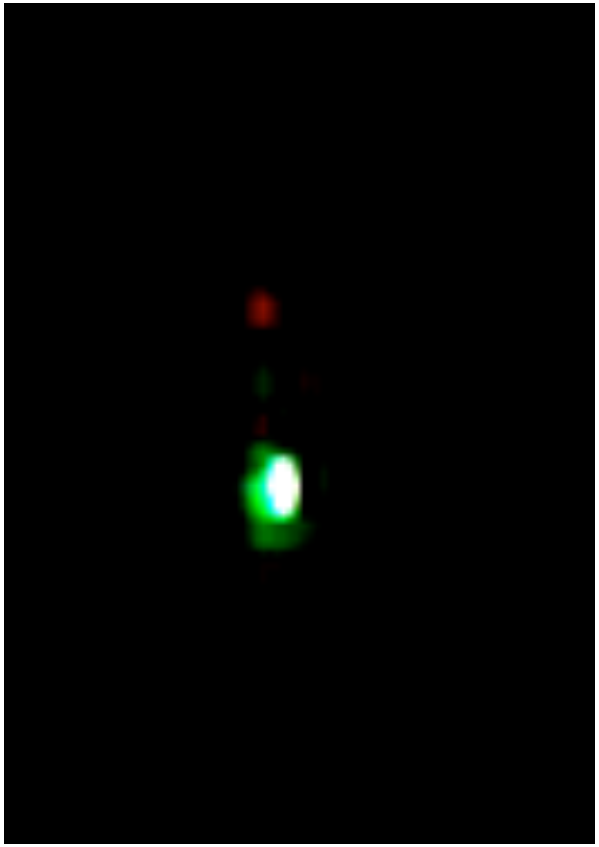
The GLAS EM detector and aft optics piggy backed on a Meade 10" telescope. A diffuser was placed in front of the detector to attenuate the signal by ~1000 and widen the field of view to +/-3° FWHM.



Equipment setup as used on 11/3/2006

GLAS Laser Light Observed at GSFC on 11/3/2006

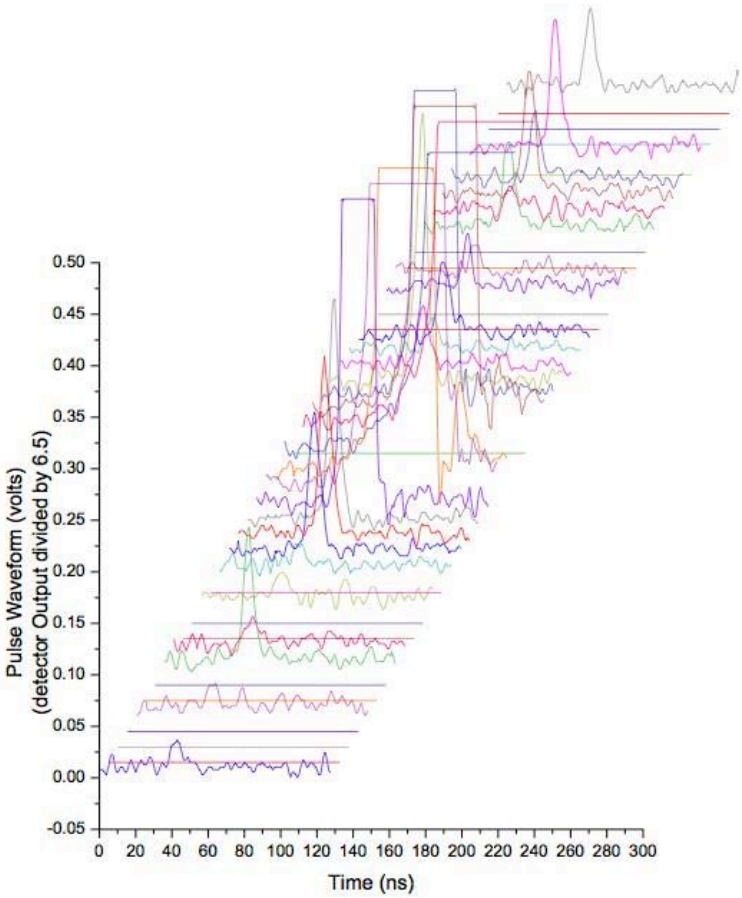
- A single green spot near zenith was observed within the second of the predicted time by a number of witness (Xiaoli Sun, Bill Hasselbrack, Jeff Guerber, Tom Field, Jay Zwally, Greg Neumann, Claudia Carabajal, Sebastian Stewart, and Jim Spinhirne)
- The green spot was much brighter than the stars visible at the time, e.g., Vega (Mag. 0)
- A green spot was captured by a video camera.
- The green laser pulse was also captured by a digital camera but the lens assembly was partially broken and not in focus.

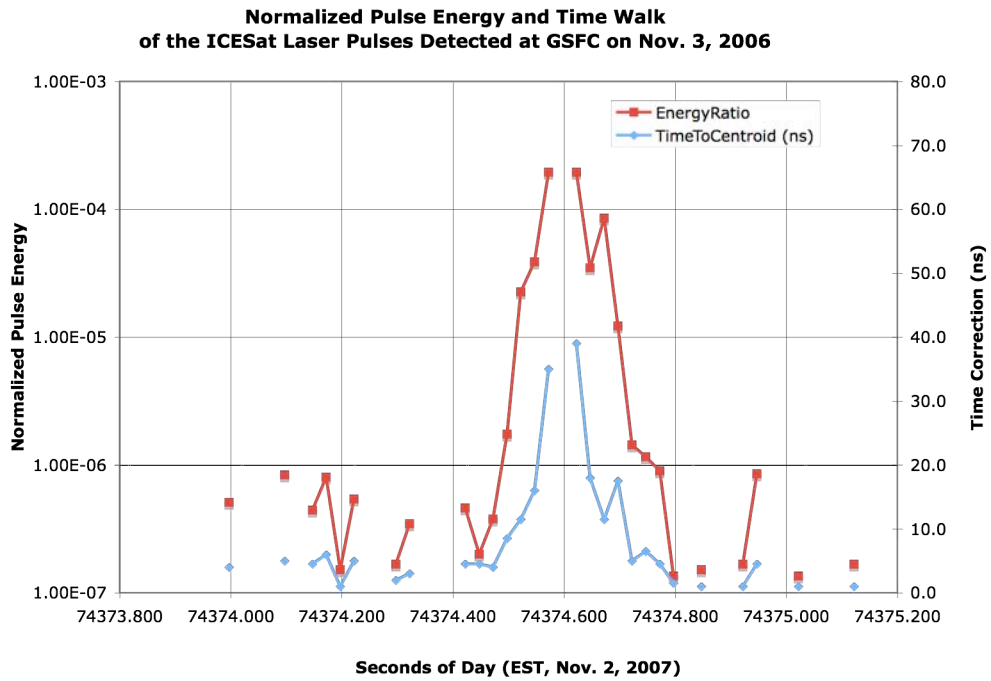


Video frame containing the laser spot

GLAS Laser Pulse Waveforms Observed at GSFC on 11/3/2006

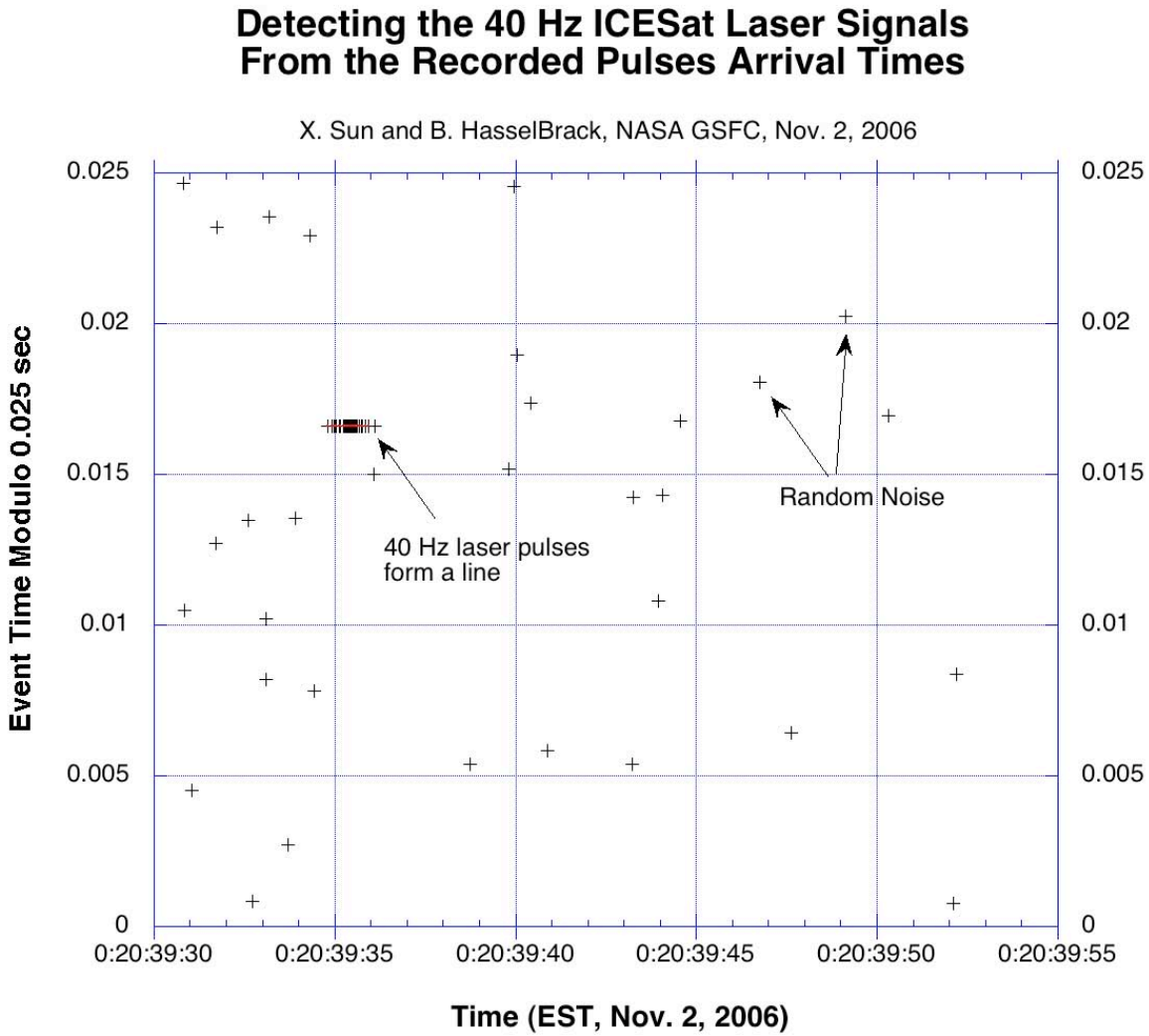
A total of 28 pulses were detected and recorded over an 1.1 second period.



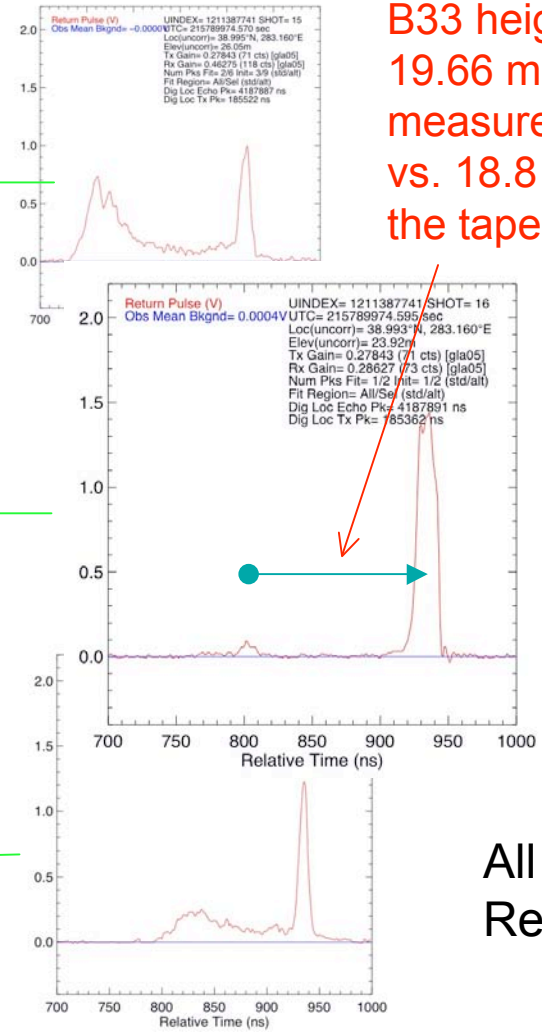


Actual detected energy divided by the peak energy that would have been detected directly under the beam.

GLAS Laser Pulse Arrival Times Observed at GSFC on 11/3/2006



ICESat Data from the GSFC Overpass - Laser Footprint Locations



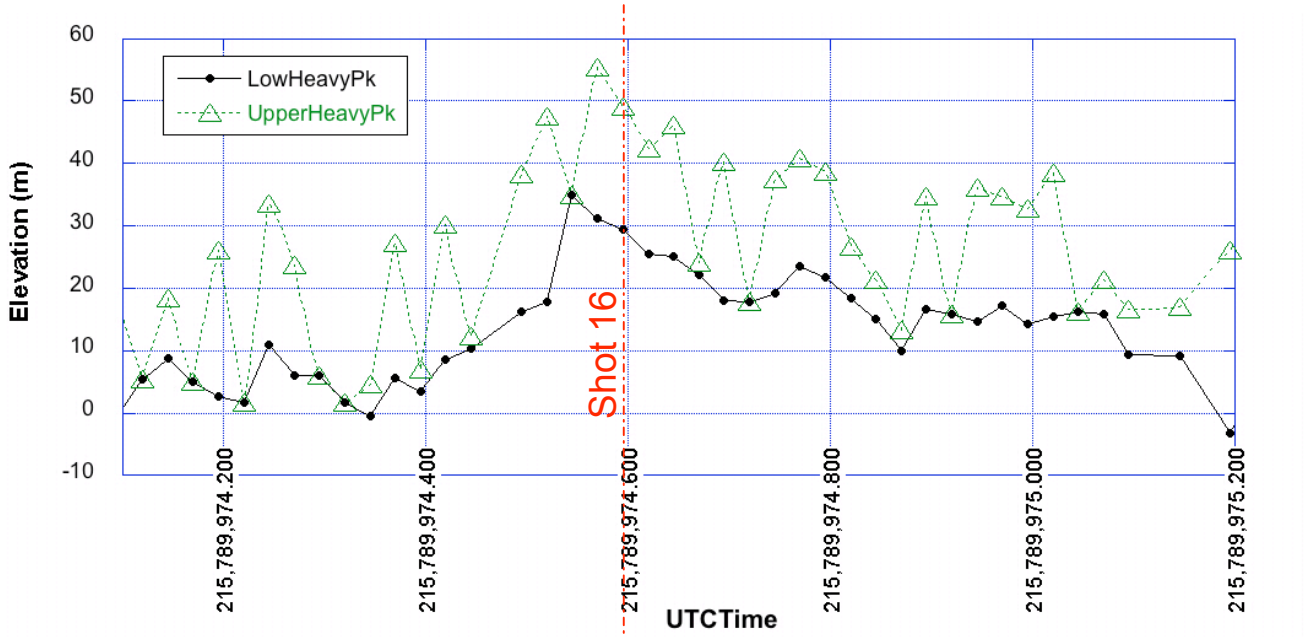
B33 height:
19.66 m from GLAS measurement
vs. 18.8 from via the tape measure

Difference maybe due to the surface slope in front of B33 and parapet on the roof

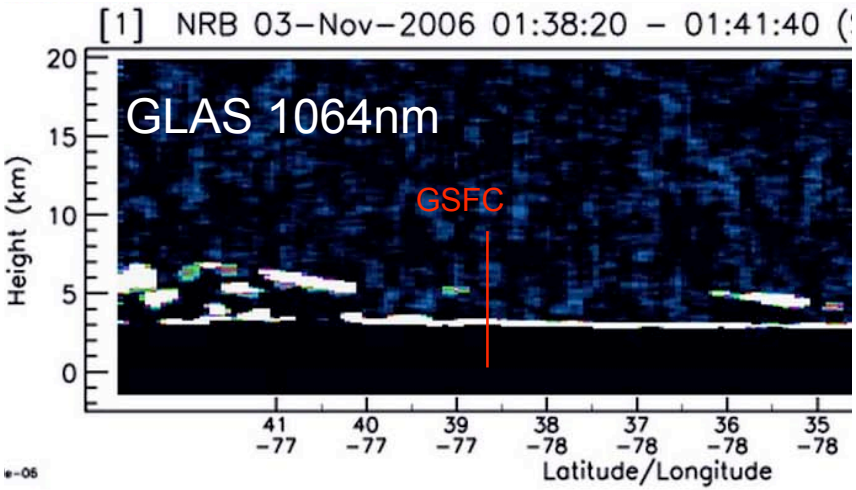
All data from Release 128

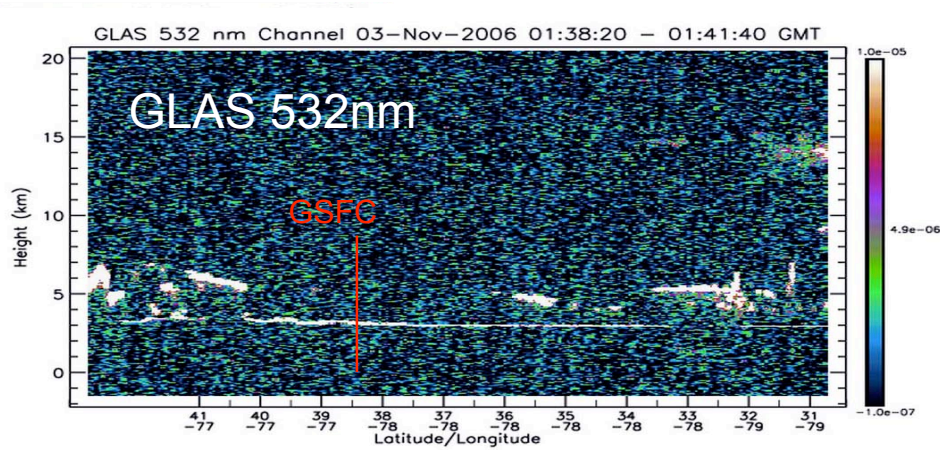
ICESat Data from the GSFC Overpass - Surface Elevation and Tree Canopy Height

Surface elevation and tree height determined from the two Gaussian fits of the most weights.

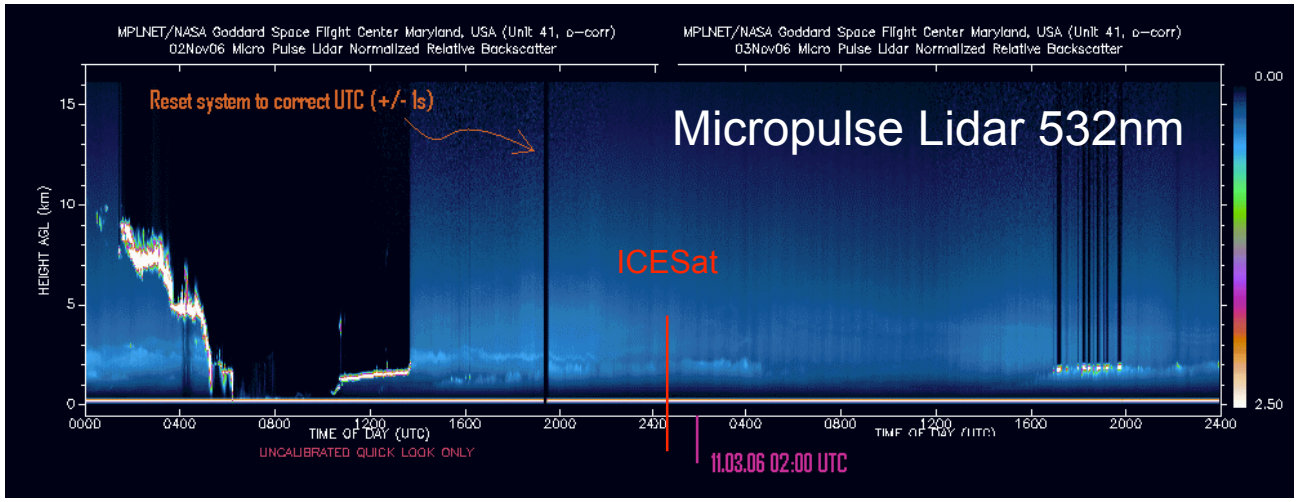


ICESat Data from the GSFC Overpass - Atmosphere Conditions





Clear sky condition during the overpass, atmosphere transmission >90%

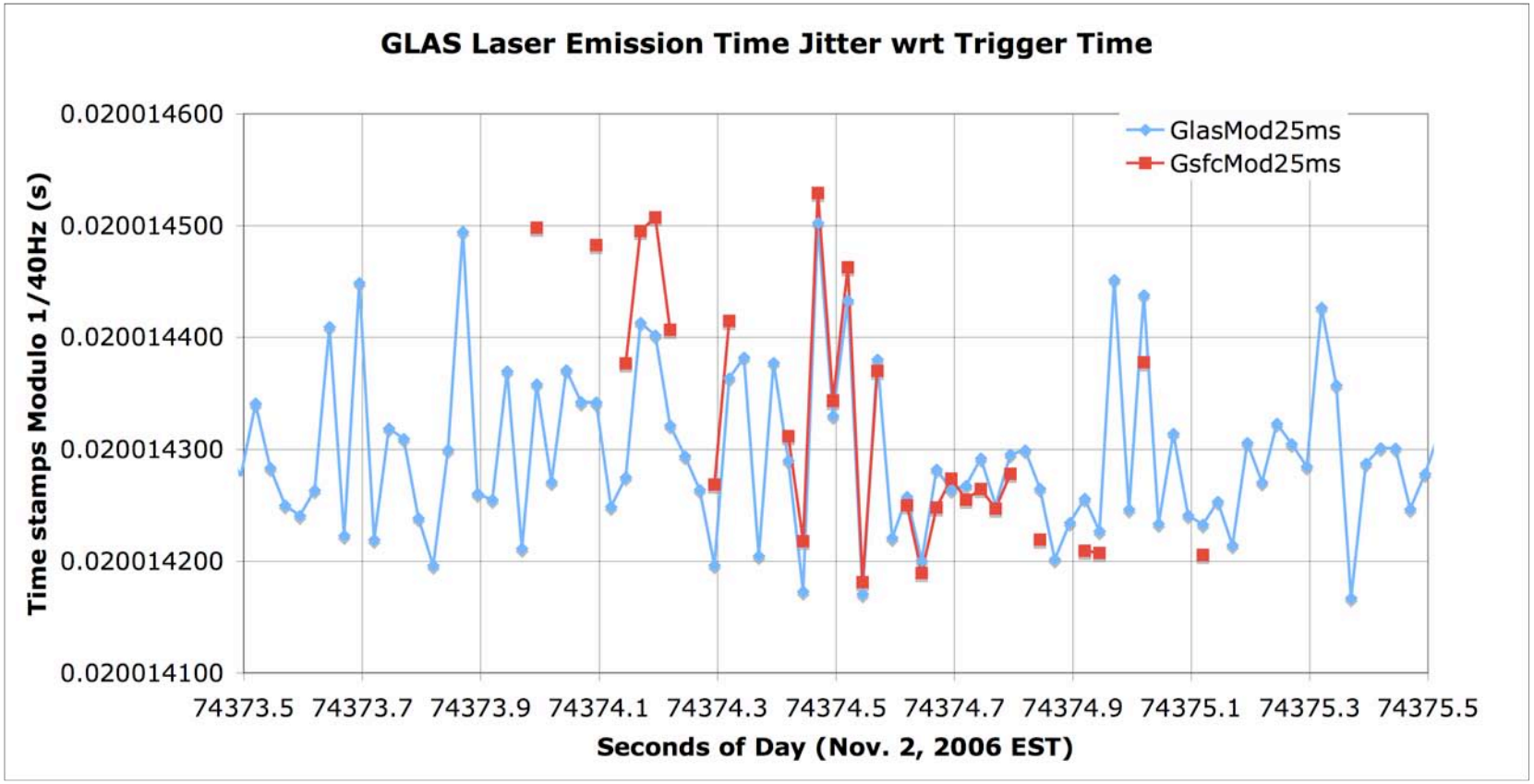


ICESat Data from the GSFC Overpass - Laser Pulse Arrival Times

GSFC measurements	*GLAS measurements*					
Laser Detection Time	**Shot #**	**Laser Emission Time**	**Laser Emission Time**	**GSFC-GLAS**	**Mean**	**Stdev**
Sec of Day (Nov. 2, EST)	0-39	(J2000)	Sec of Day (Nov. 2, EST)	(sec)	0.000000772	0.000000113
74373.997017948	32	215789973.997017	74373.997017	0.000000952		
	33					
	34					
	35					
74374.097017933	36	215789974.097017	74374.097017	0.000000942		
	37					
74374.147017826	38	215789974.147017	74374.147017	0.000000824		
74374.172017945	39	215789974.172017	74374.172017	0.000000937		
74374.197017957	0	215789974.197017	74374.197017	0.000000943		
74374.222017857	1	215789974.222017	74374.222017	0.000000866		
	2					
	3					
74374.297017719	4	215789974.297017	74374.297017	0.000000710		
74374.322017865	5	215789974.322017	74374.322017	0.000000850		
	6					
	7					
	8					
74374.422017762	9	215789974.422017	74374.422017	0.000000754		
74374.447017668	10	215789974.447017	74374.447017	0.000000654		
74374.472017979	11	215789974.472017	74374.472017	0.000000989		
74374.497017793	12	215789974.497017	74374.497017	0.000000797		
74374.522017913	13	215789974.522017	74374.522017	0.000000910		
74374.547017631	14	215789974.547017	74374.547017	0.000000623		
74374.572017820	15	215789974.572017	74374.572017	0.000000806		
	16					
74374.622017700	17	215789974.622017	74374.622017	0.000000704		
74374.647017639	18	215789974.647017	74374.647017	0.000000637		
74374.672017698	19	215789974.672017	74374.672017	0.000000690		
74374.697017724	20	215789974.697017	74374.697017	0.000000710		
74374.722017705	21	215789974.722017	74374.722017	0.000000715		
74374.747017715	22	215789974.747017	74374.747017	0.000000719		
74374.772017697	23	215789974.772017	74374.772017	0.000000695		
74374.797017728	24	215789974.797017	74374.797017	0.000000720		
	25					
74374.847017669	26	215789974.847017	74374.847017	0.000000679		
	27					
	28					
74374.922017659	29	215789974.922017	74374.922017	0.000000651		
74374.947017657	30	215789974.947017	74374.947017	0.000000643		
	31					
	32					
74375.022017828	33	215789975.022017	74375.022017	0.000000825		
	34					
	35					
	36					
74375.122017656	37	215789975.122017	74375.122017	0.000000660		

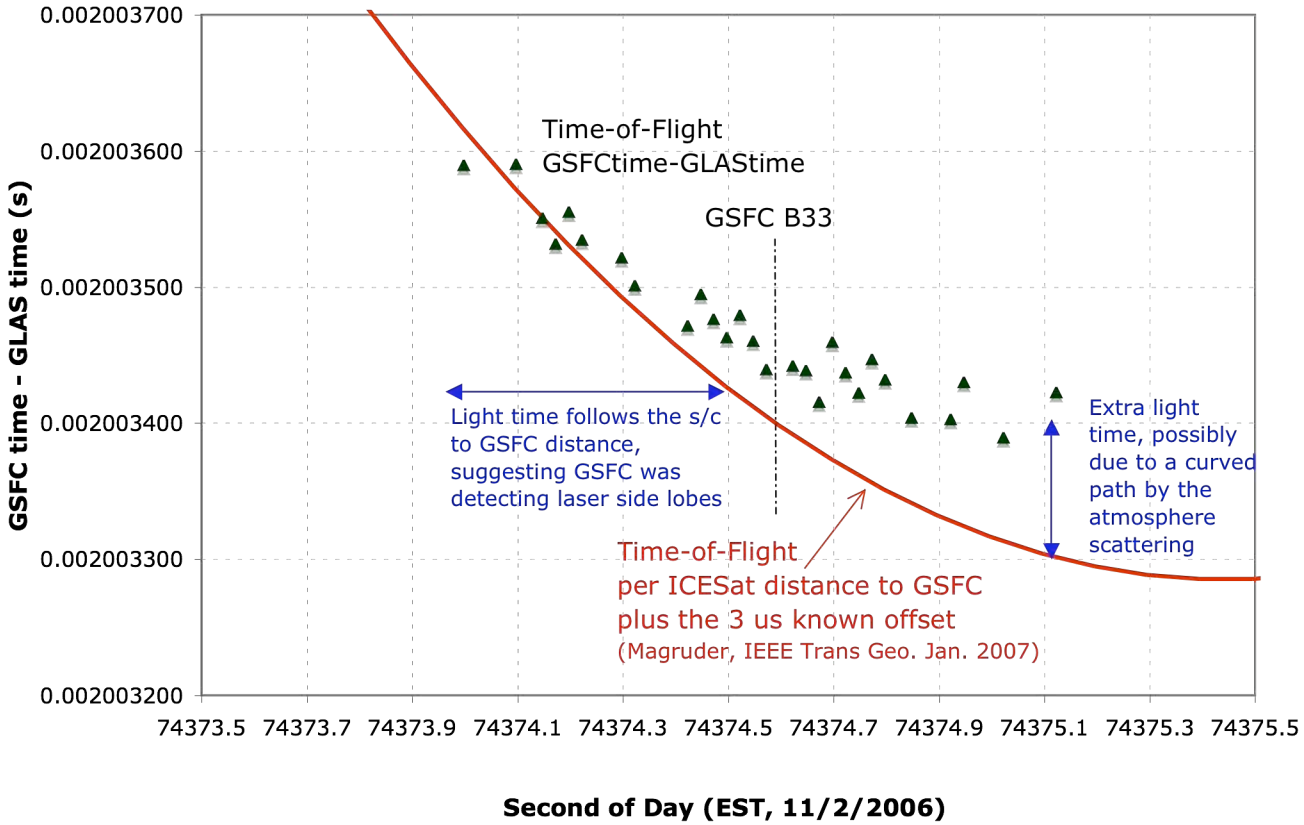
GLAS laser timestamps agreed with the GSFC GPS based event timer measurements to within 770 ns in average offset and 110 ns stdev (needs to be refined with Release 428 data.

Comparison of the ICESat Measurements and the GSFC Measurements - Laser Emission Time Jitter



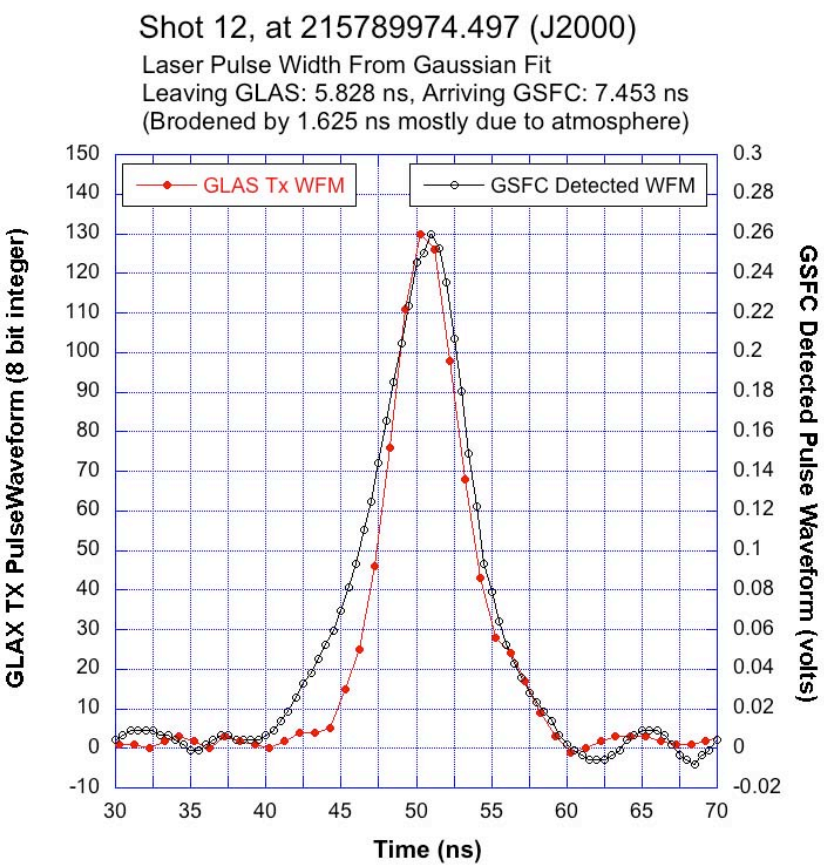
The GLAS random laser emission jitter pattern was used to unambiguously identify the GLAS laser emission timestamps to the GSFC event times.
(had to reconstruct the GLAS time form raw data to attain ns resolution)

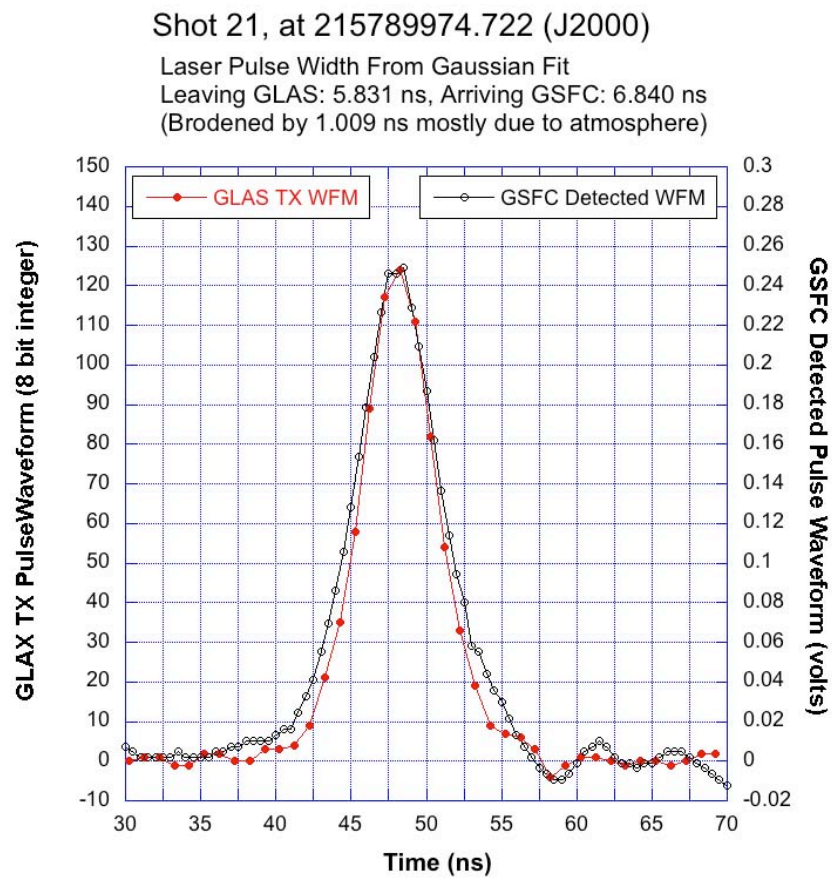
Comparison of the ICESat Measurements and the GSFC Measurements - One way laser time of flight



- Distance from GSFC B33 to ICESat decreased during the overpass due to the ICESat pitch forward pointing angle.
- Difference between GLAS and GSFC measurement can be <50 ns pk-pk after removing the spacecraft trajectory and atmosphere delays.

Comparison of the ICESat Measurements and the GSFC Measurements - Transmitted laser pulseshape





- a 1.0 to 1.5 ns pulse broadening was observed, possibly due to the atmosphere scattering effects.

Conclusions

- ICESat is the brightest star in the sky.
- One can detect a number of GLAS laser pulses without being directly under the laser beam and use the results to calibrate GLAS time base.
- GLAS laser time stamp accuracy was verified to be accurate to within 1 us, and possibly less than 50ns.
- GSFC Building 33 height by GLAS measurement agreed with the survey via tape measures.
- Atmosphere appeared to broaden the laser pulses by 1-1.5ns.

* Better results are expected with Release 428 data.