Two-color laser ranging with the MLRO system

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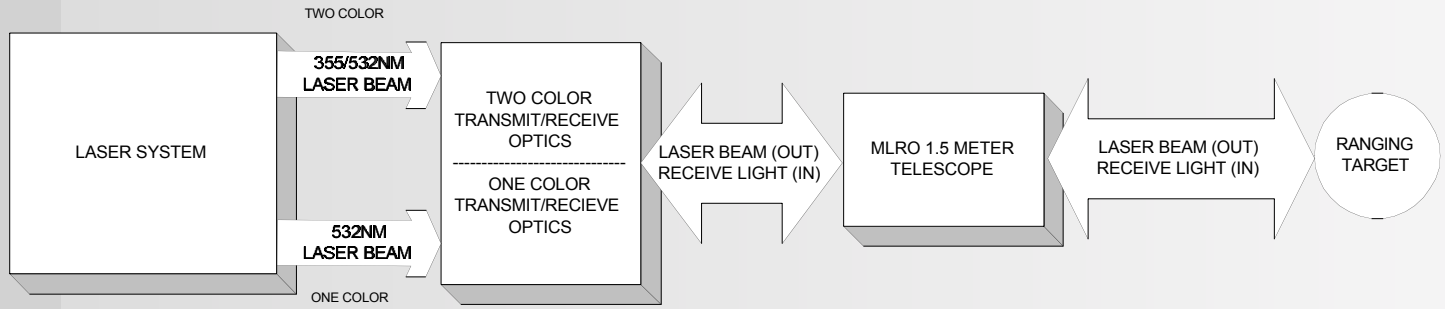
MLRO specifications

- Astronomical quality telescope, 1” pointing accuracy, 1.5 m aperture
- Day & night, 1- and 2-color ranging capability to satellites from 400 km orbit to the Moon
- Single-shot RMS jitter
  - **≤ 5 mm on LAGEOS (≤ 1 mm NP)**
  - **≤ 5 mm on Starlette, ERS (≤ 1 mm NP)**
  - **≤ 15 mm on Etalon, Glonass (≤ 3 mm NP)**
  - **≤ 15 mm on Moon (≤ 10 mm NP)**

MLRO status report

- System is producing good quality data
- 2-color PMT configuration operational
- 2-color streak camera configuration operational (several passes tracked)
- LLR configuration operational (Moon tracked)
- System currently undergoing final acceptance tests

MLRO 2-color concept



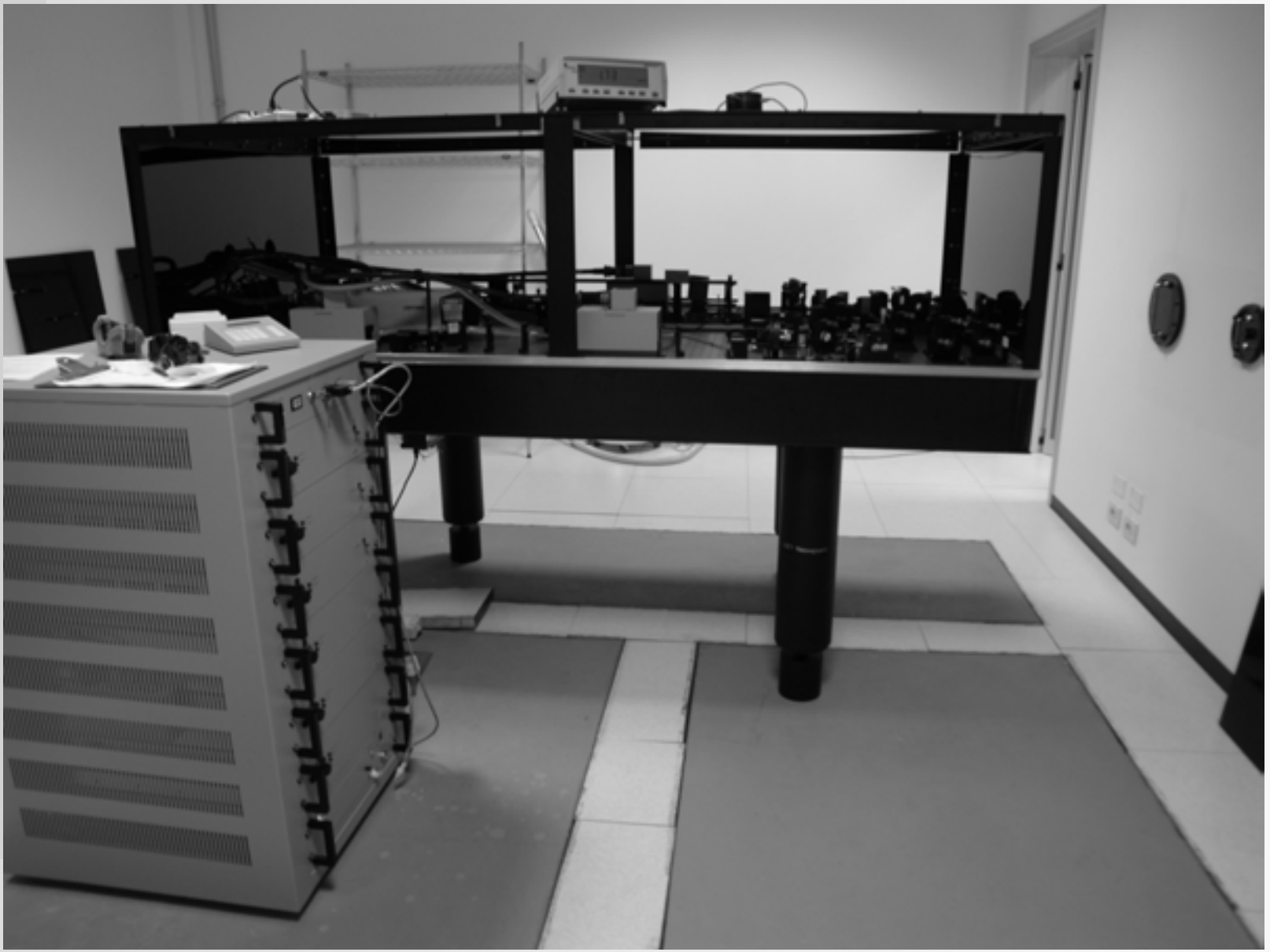
WAVELENGTH.....355NM/532NM
ENERGY.....10MJ/10MJ
PULSEWIDTH.....50PSEC
BEAM SIZE.....12MM
FULL ANGLE DIVERGENCE.....600URAD
REPETITION RATE.....10HZ

FULL FIELD OF VIEW (FWHM).....60.9 ARCSEC
ANGULAR MAGNIFICATION.....26
WAVEFRONT ERROR @ 0°..... λ/7 RMS
POINTING ACCURACY.....1 ARCSEC
LIGHT BUNDLE DIAMETER.....56MM
THROUGHPUT.....75%

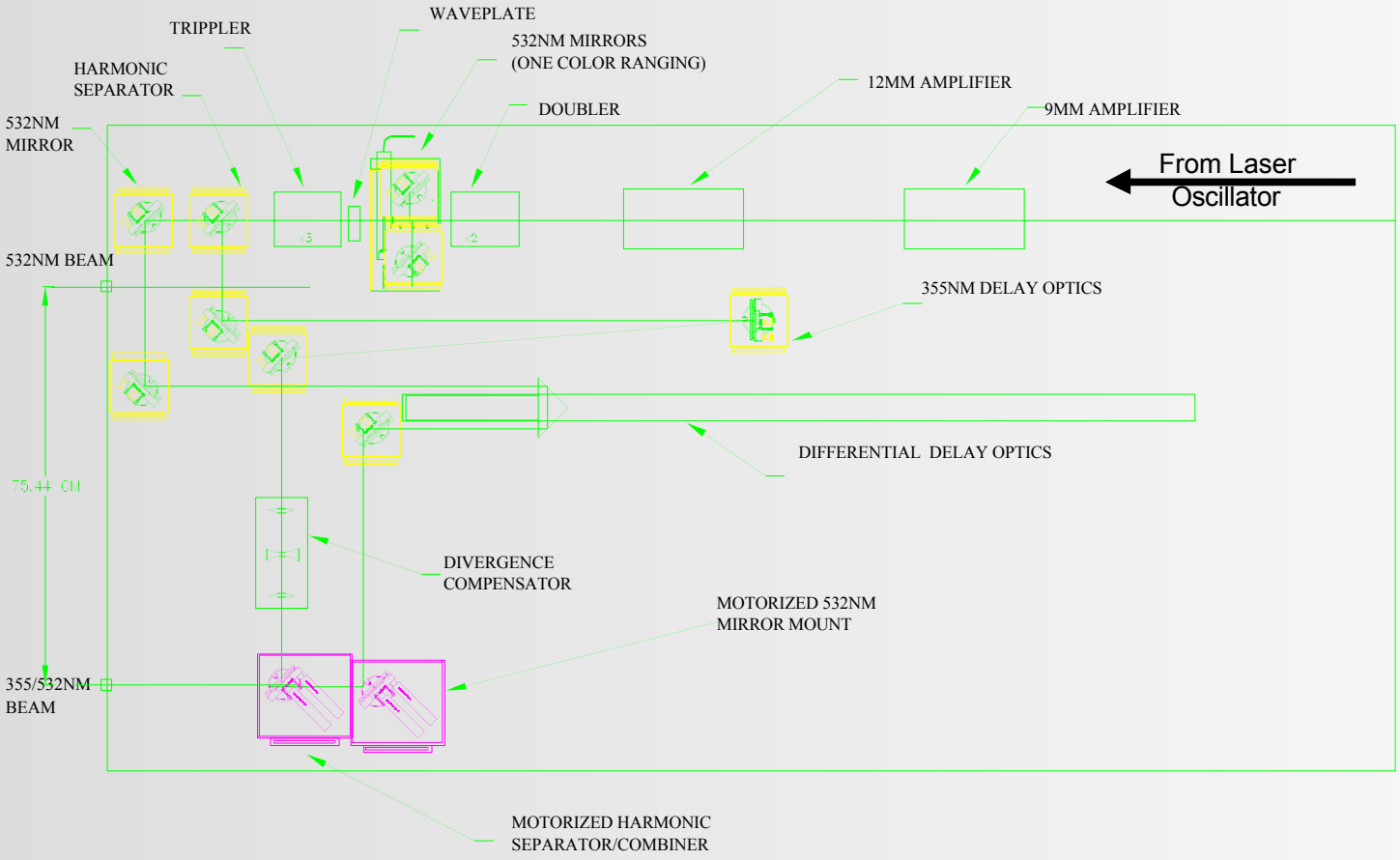
FIELD OF VIEW AT STREAK CAMERA.....10 ARCSEC
ADJUSTABLE BEAM DIVERGENCE.....20 TO 60 ARC SEC
THROUGHPUT TO STREAK CAMERA.....50%

MINIMUM TARGET DISTANCE.....10M
MAXIMUM TARGET DISTANCE.....LOW EARTH ORBIT

MLRO laser room

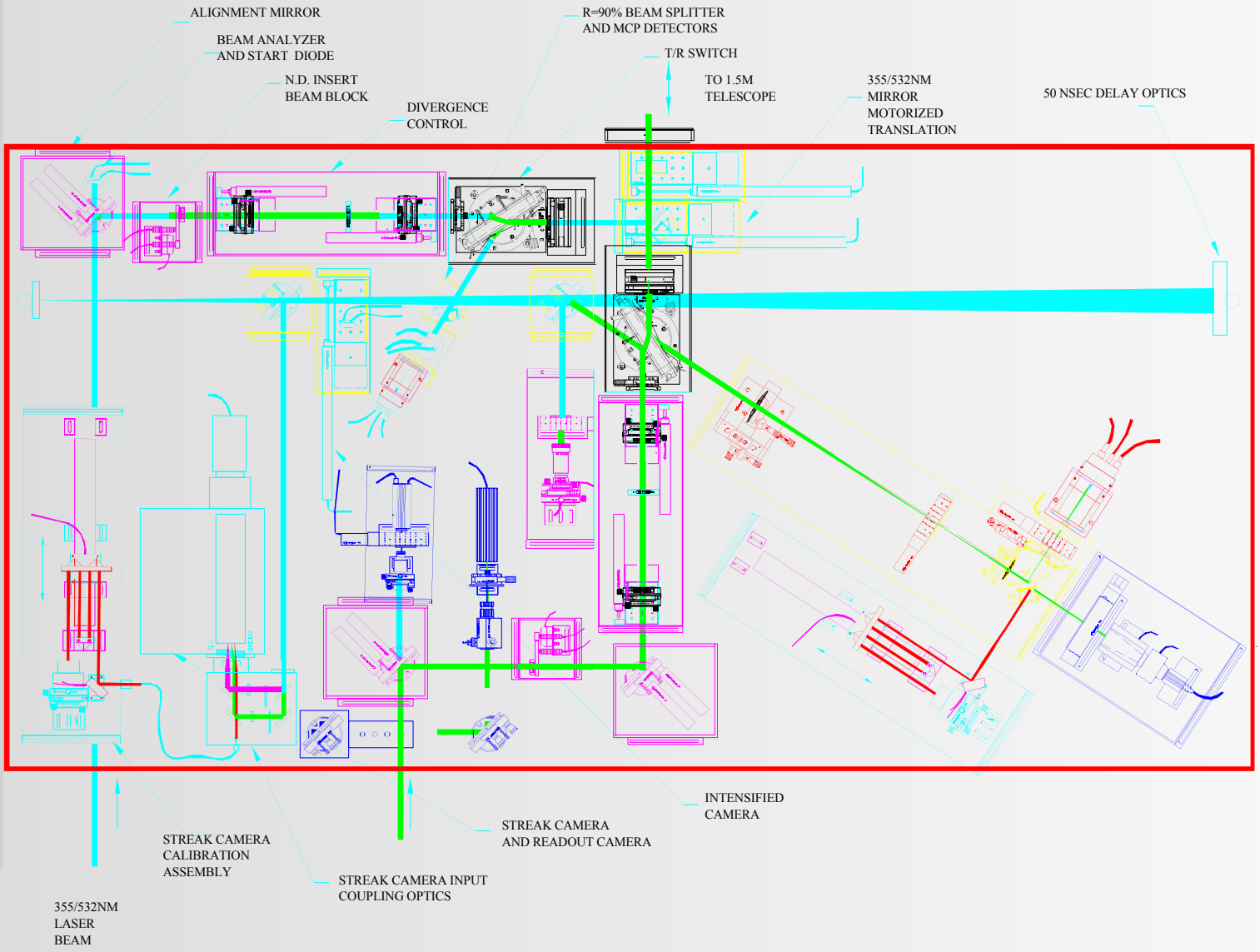


MLRO laser

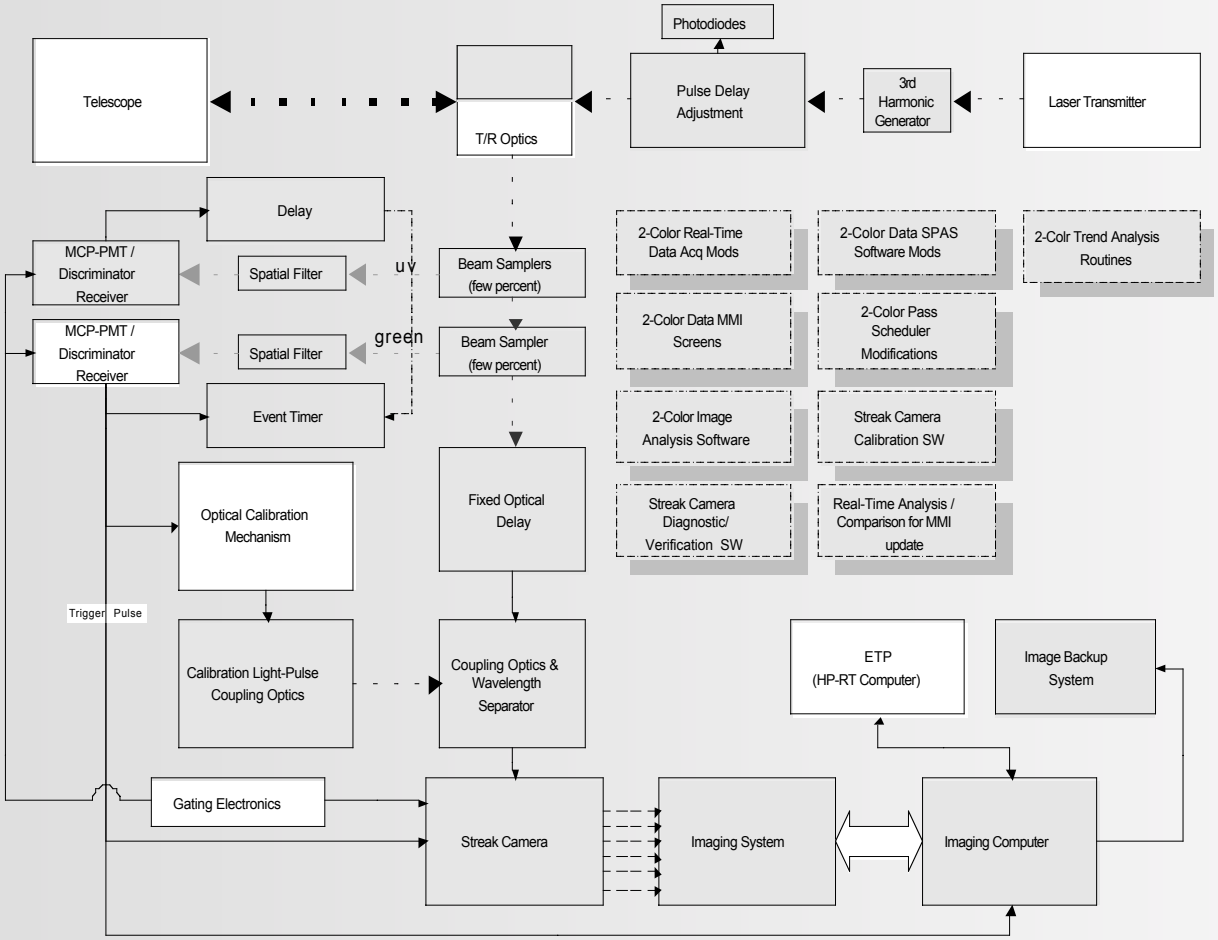

TRIPPLER
WAVEPLATE
532NM MIRRORS
(ONE COLOR RANGING)
HARMONIC
SEPARATOR
12MM AMPLIFIER
DOUBLER
9MM AMPLIFIER
532NM
MIRROR
From Laser
Oscillator
532NM BEAM
355NM DELAY OPTICS
DIFFERENTIAL DELAY OPTICS
75.44 CM
DIVERGENCE
COMPENSATOR
MOTORIZED 532NM
MIRROR MOUNT
355/532NM
BEAM
MOTORIZED HARMONIC
SEPARATOR/COMBINER

MLRO TX/RX optics room

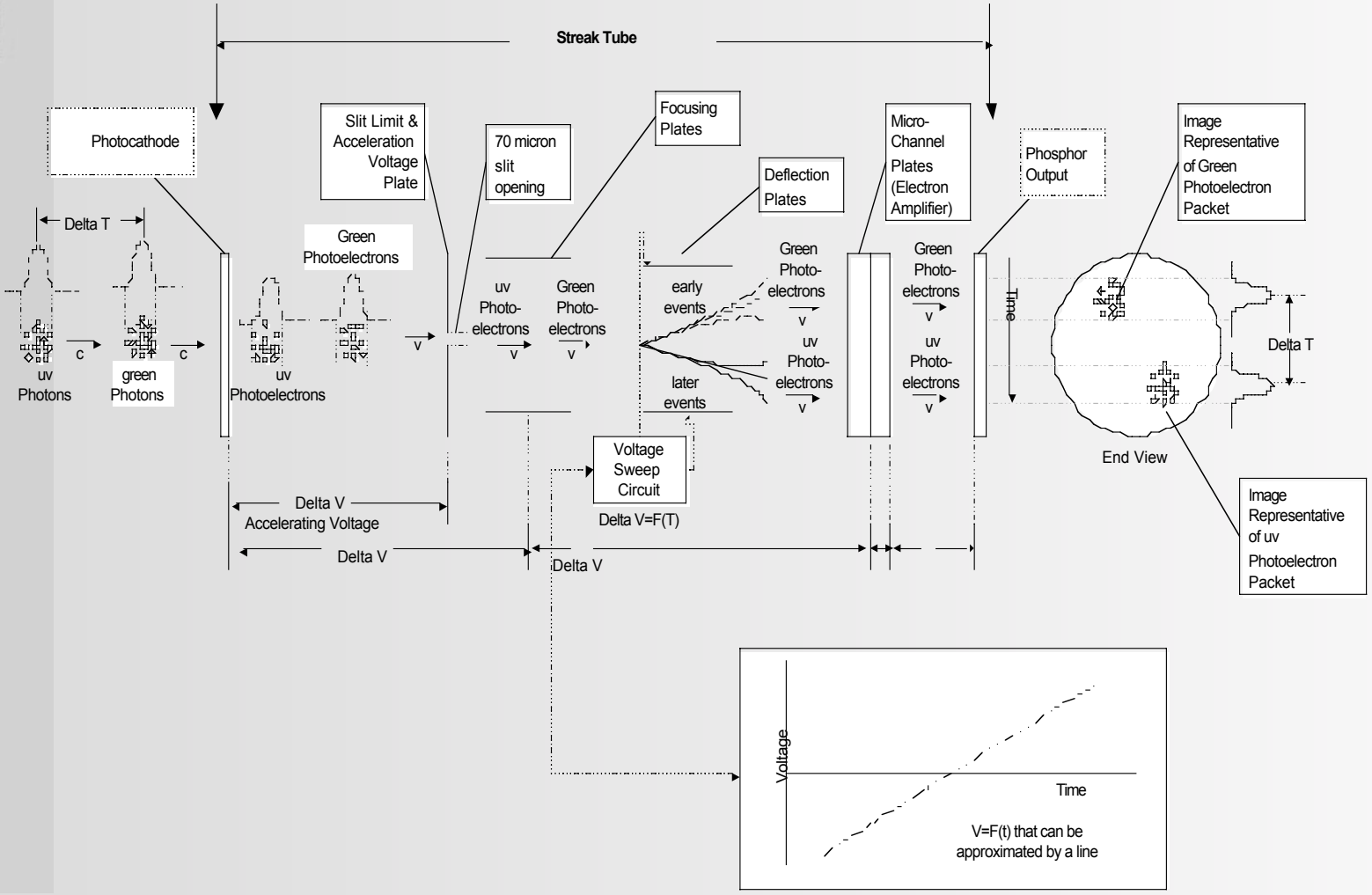
MLRO TX/RX optics



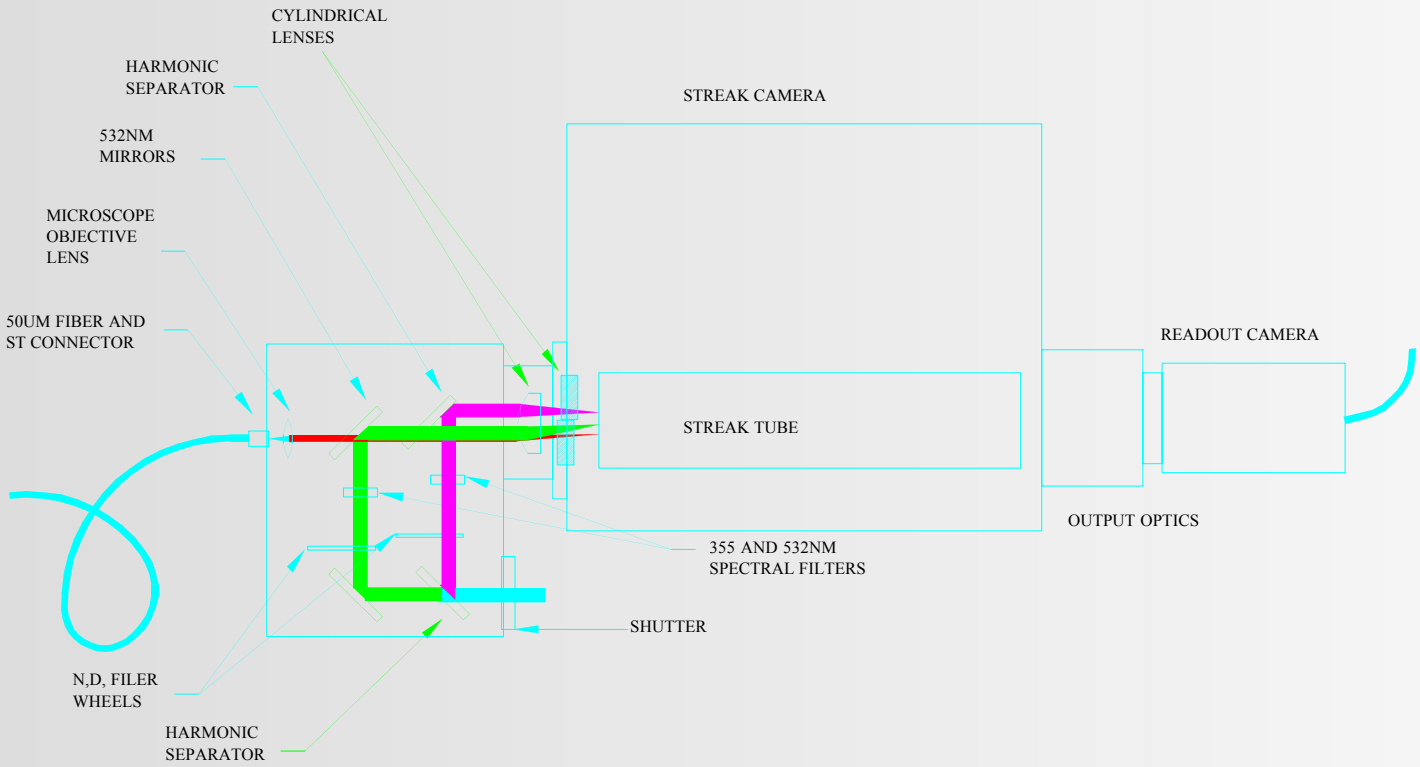
MLRO 2-color block diagram



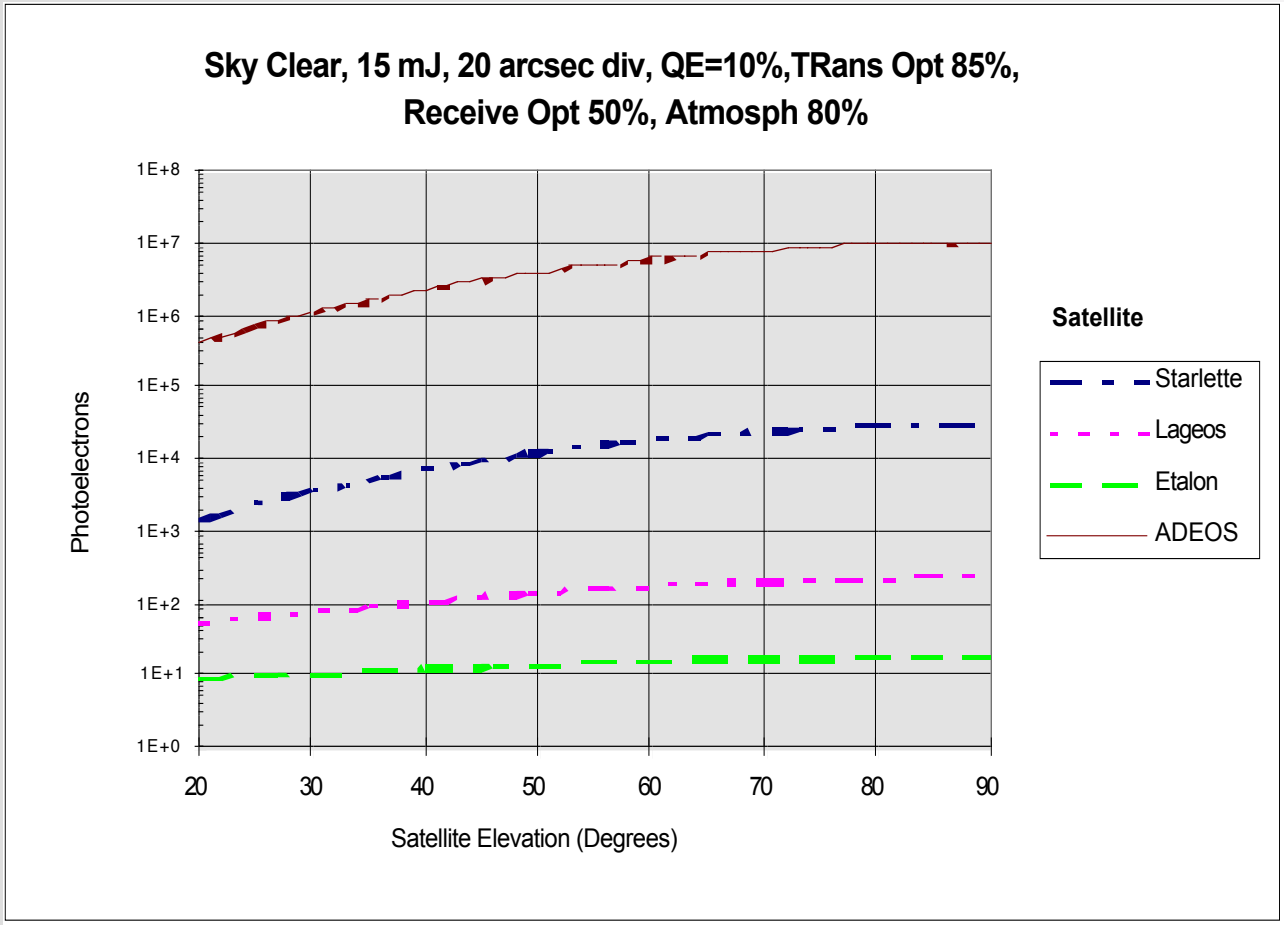
MLRO streak camera



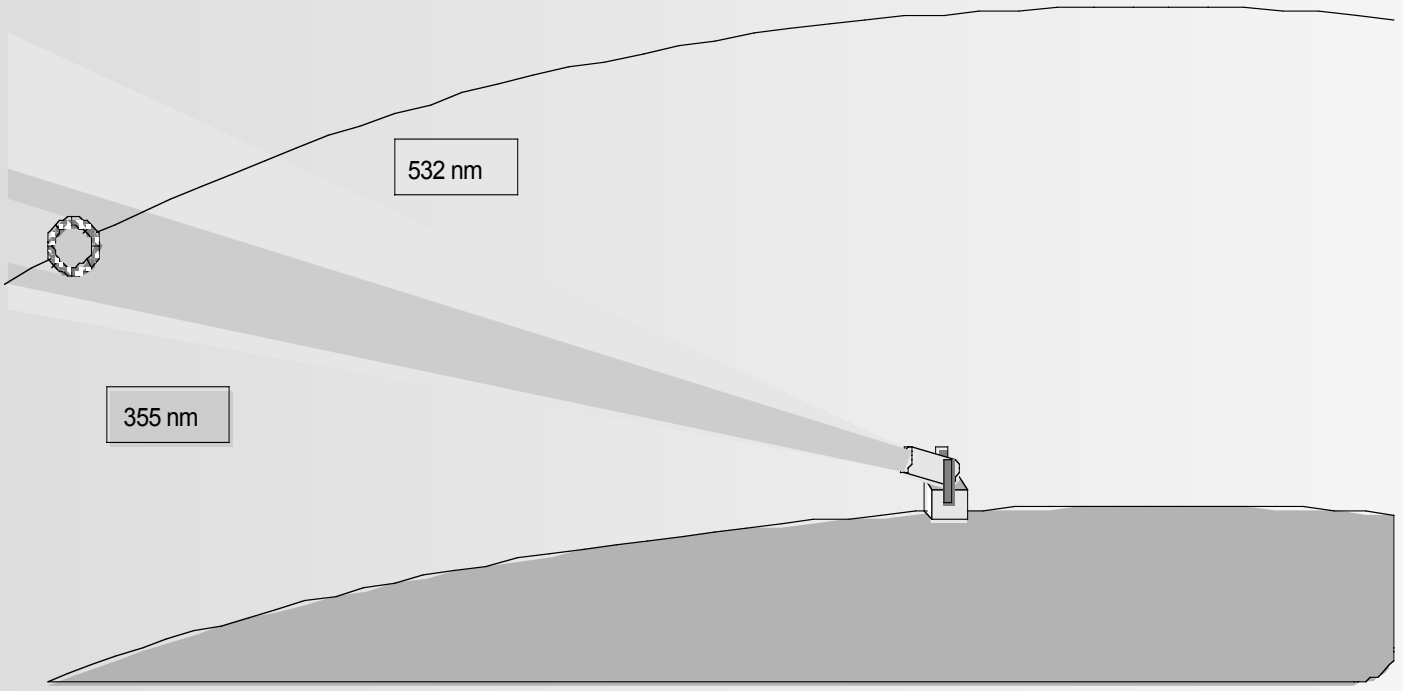
MLRO streak camera



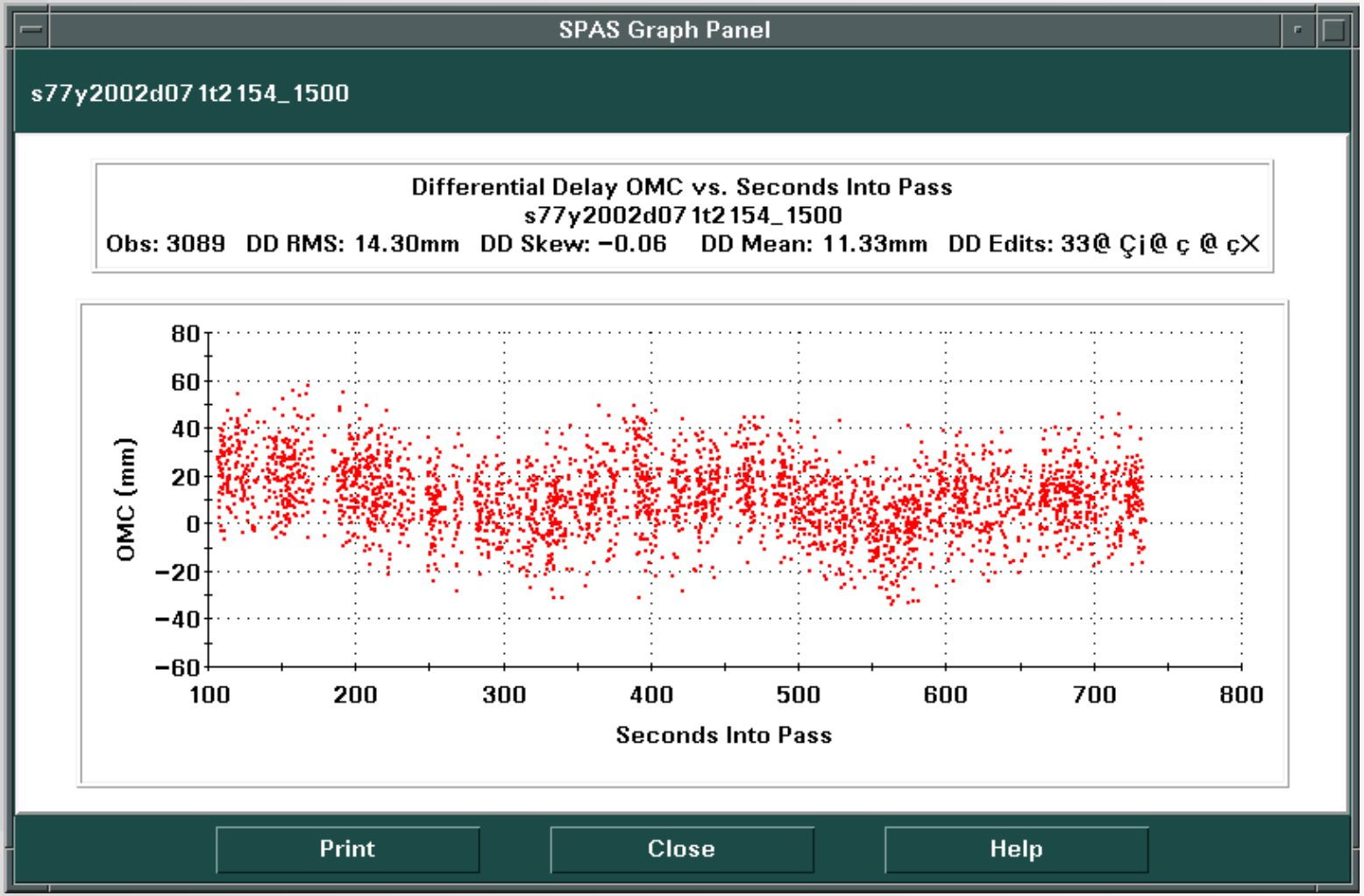
MLRO link budget



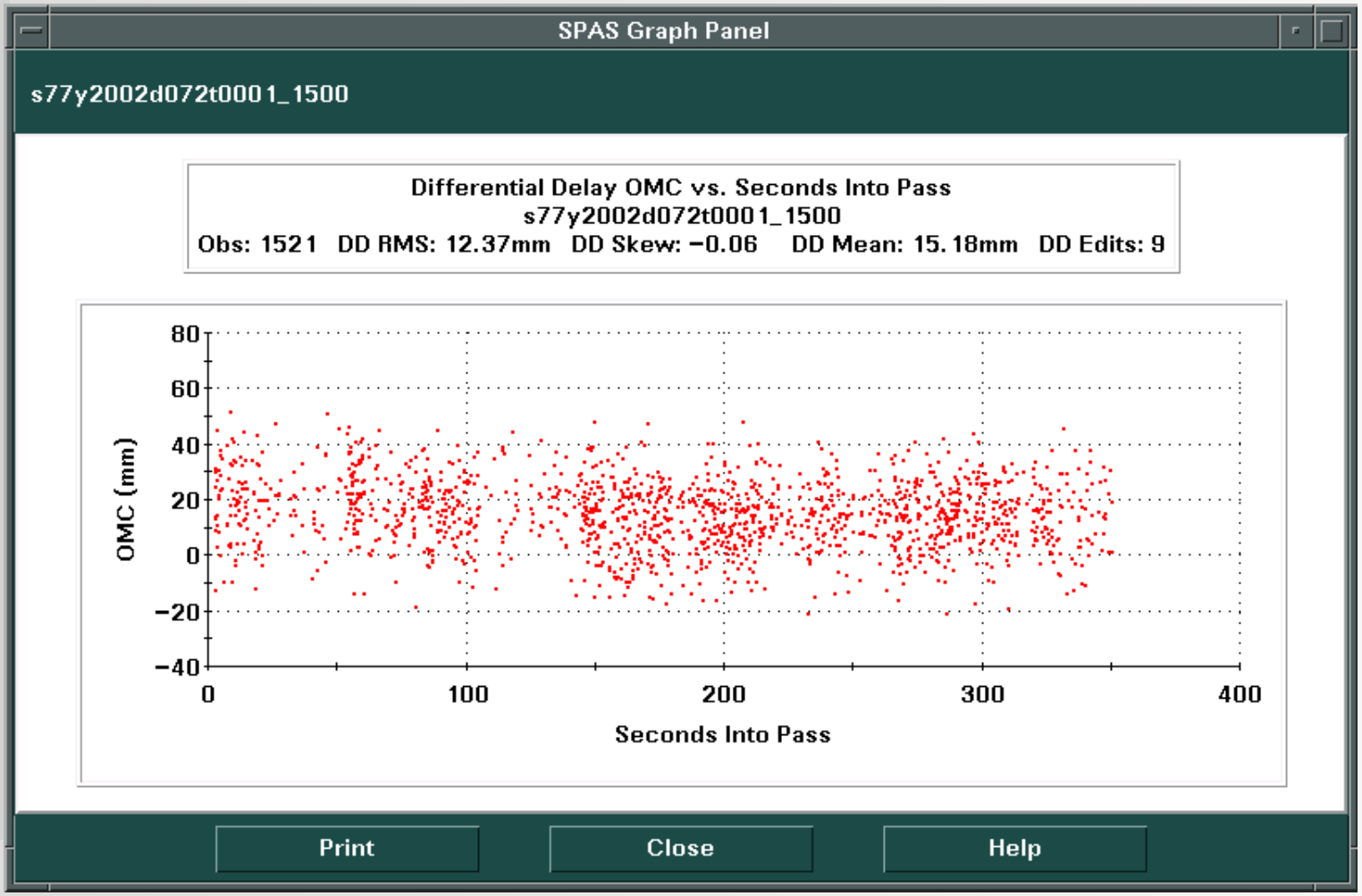
Differential refraction



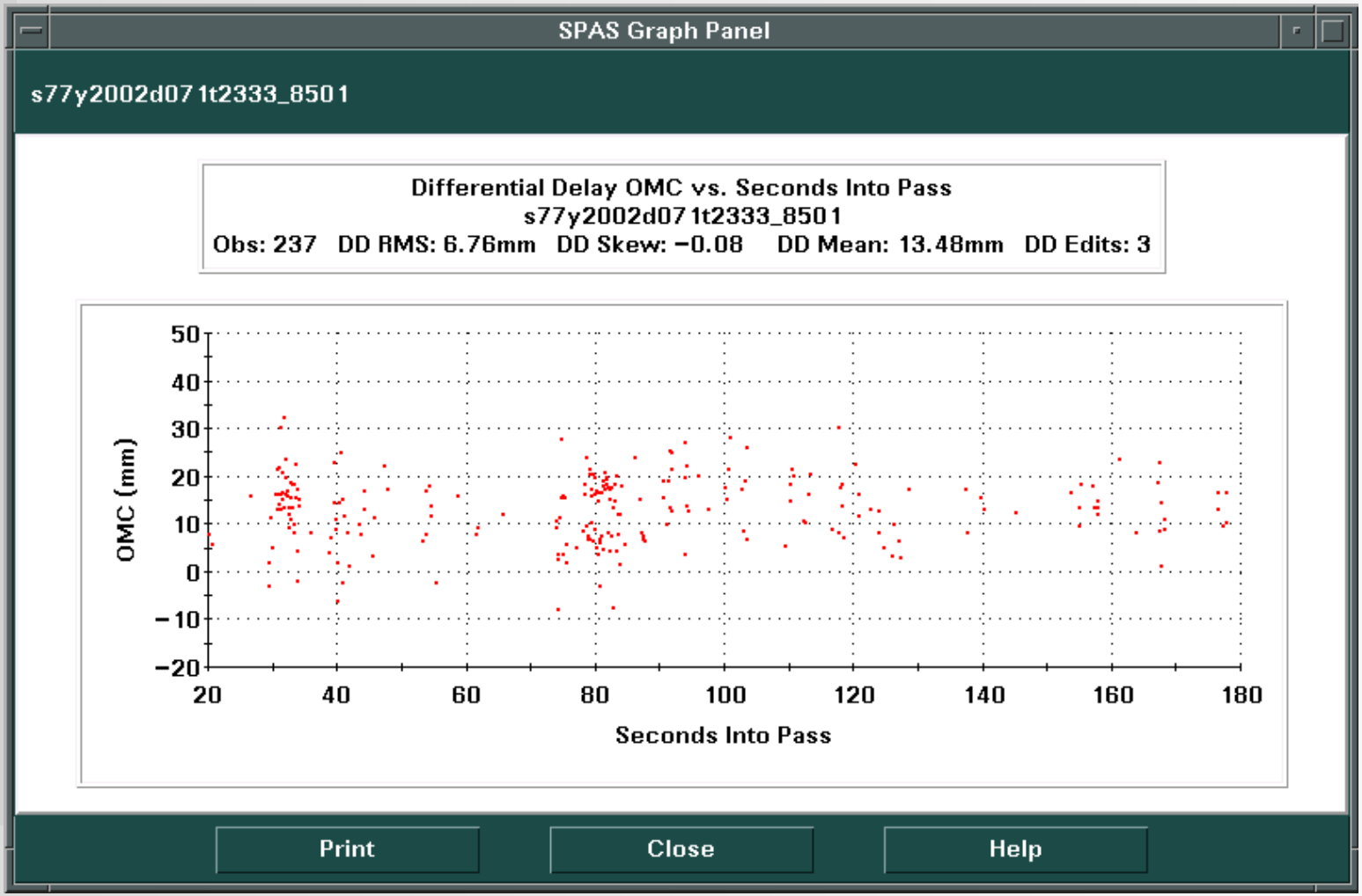
Ajisai 2-color PMT



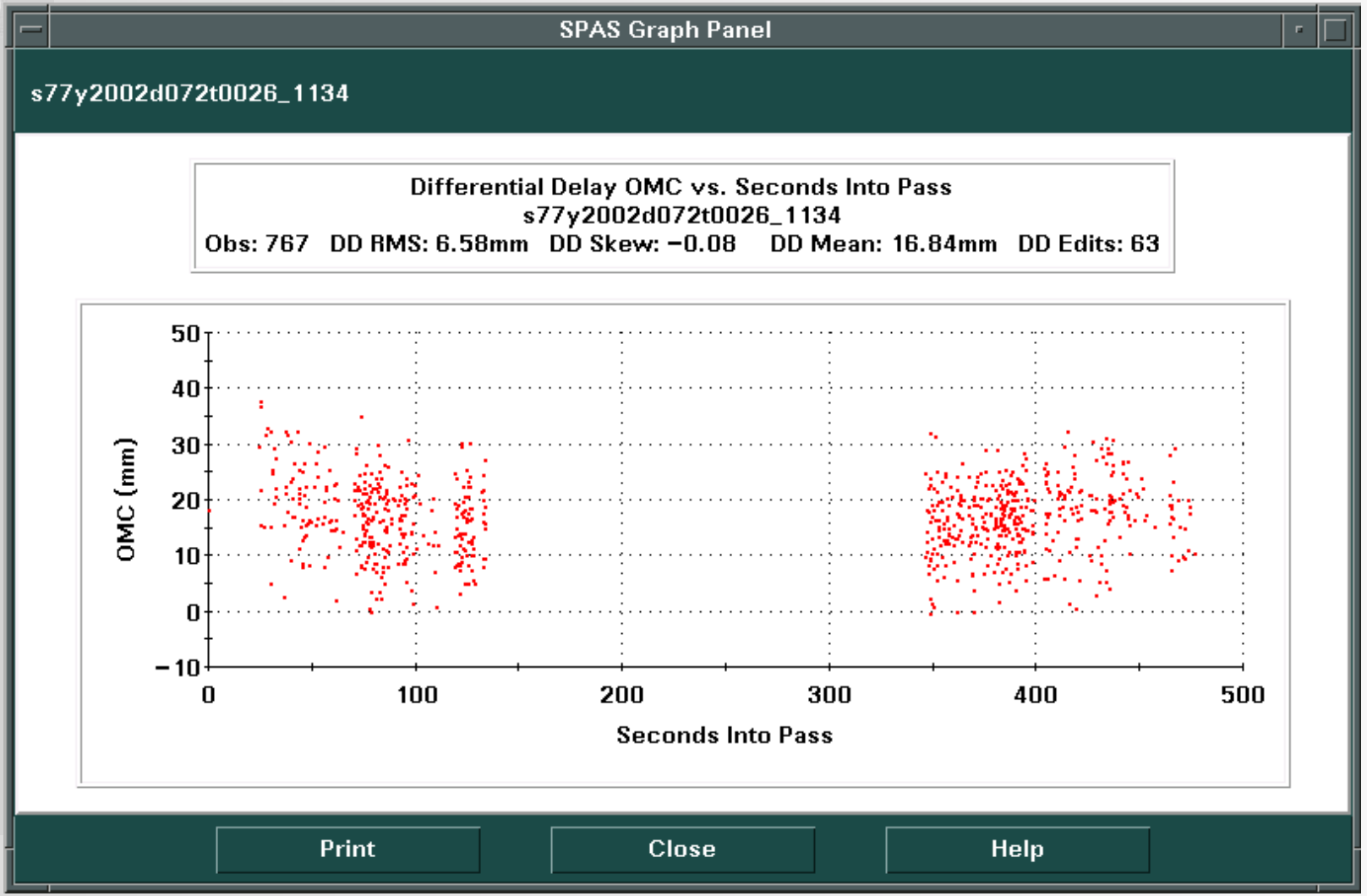
Ajisai 2-color PMT



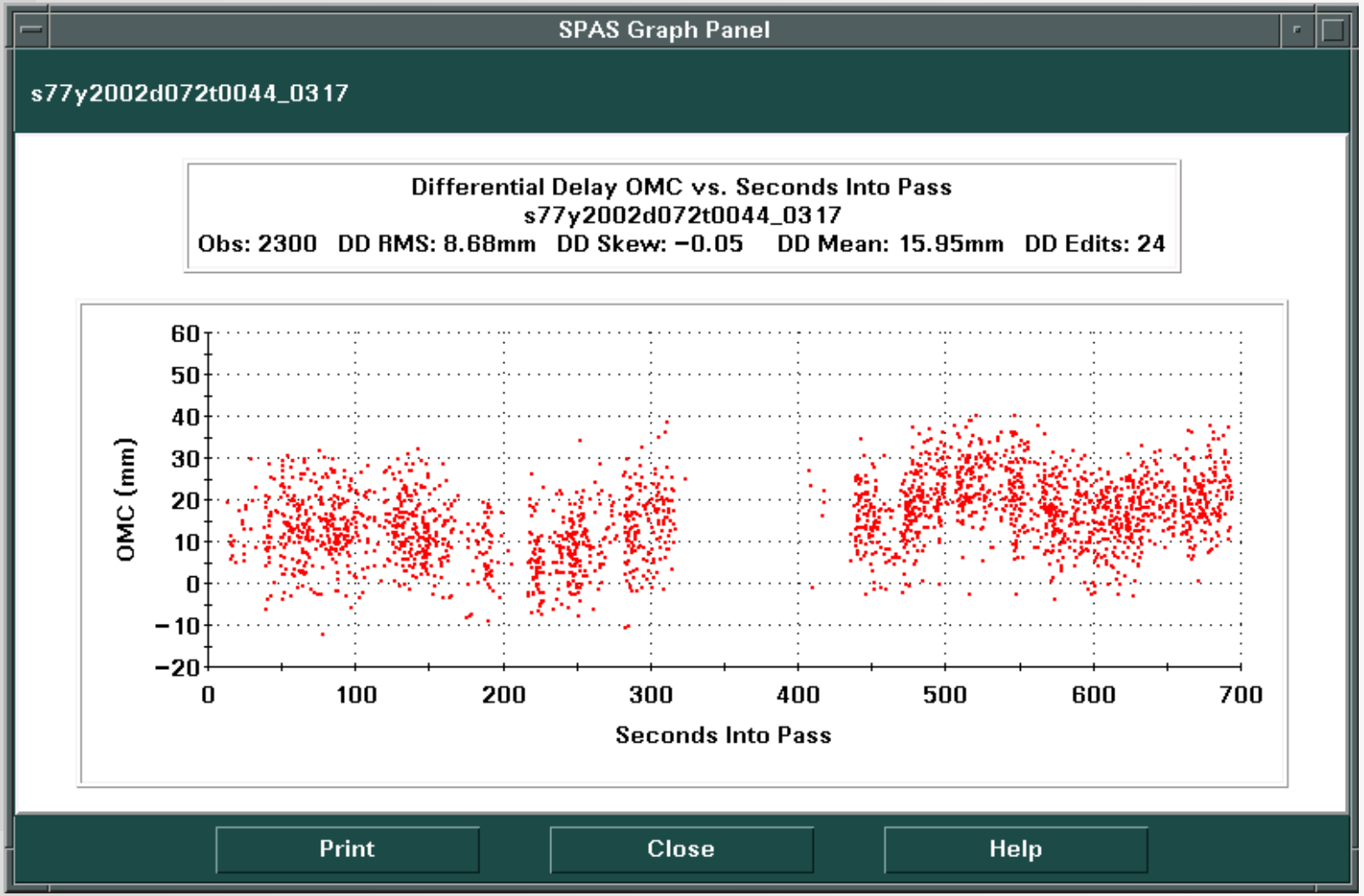
GFO-1 2-color PMT



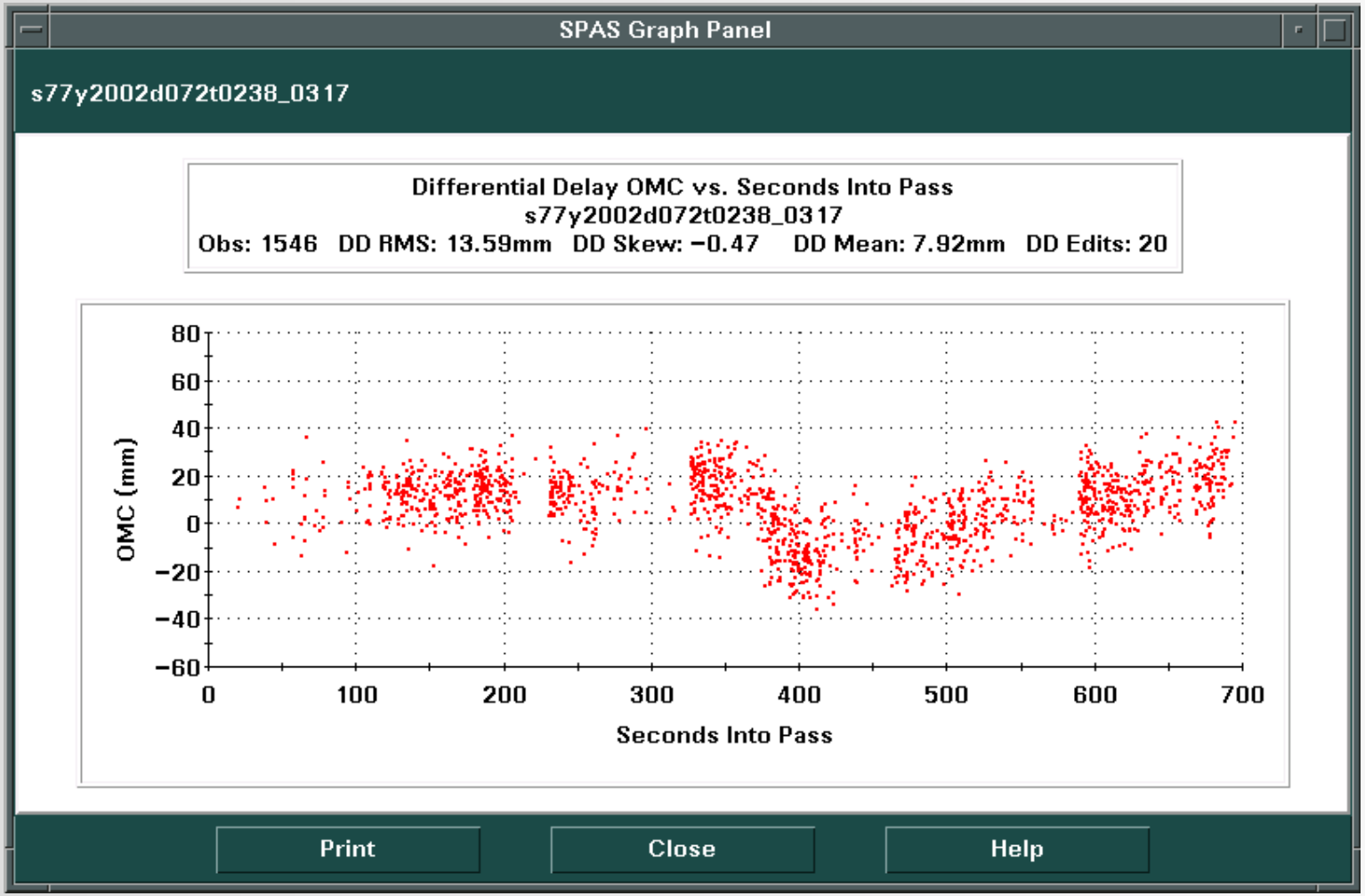
Starlette 2-color PMT



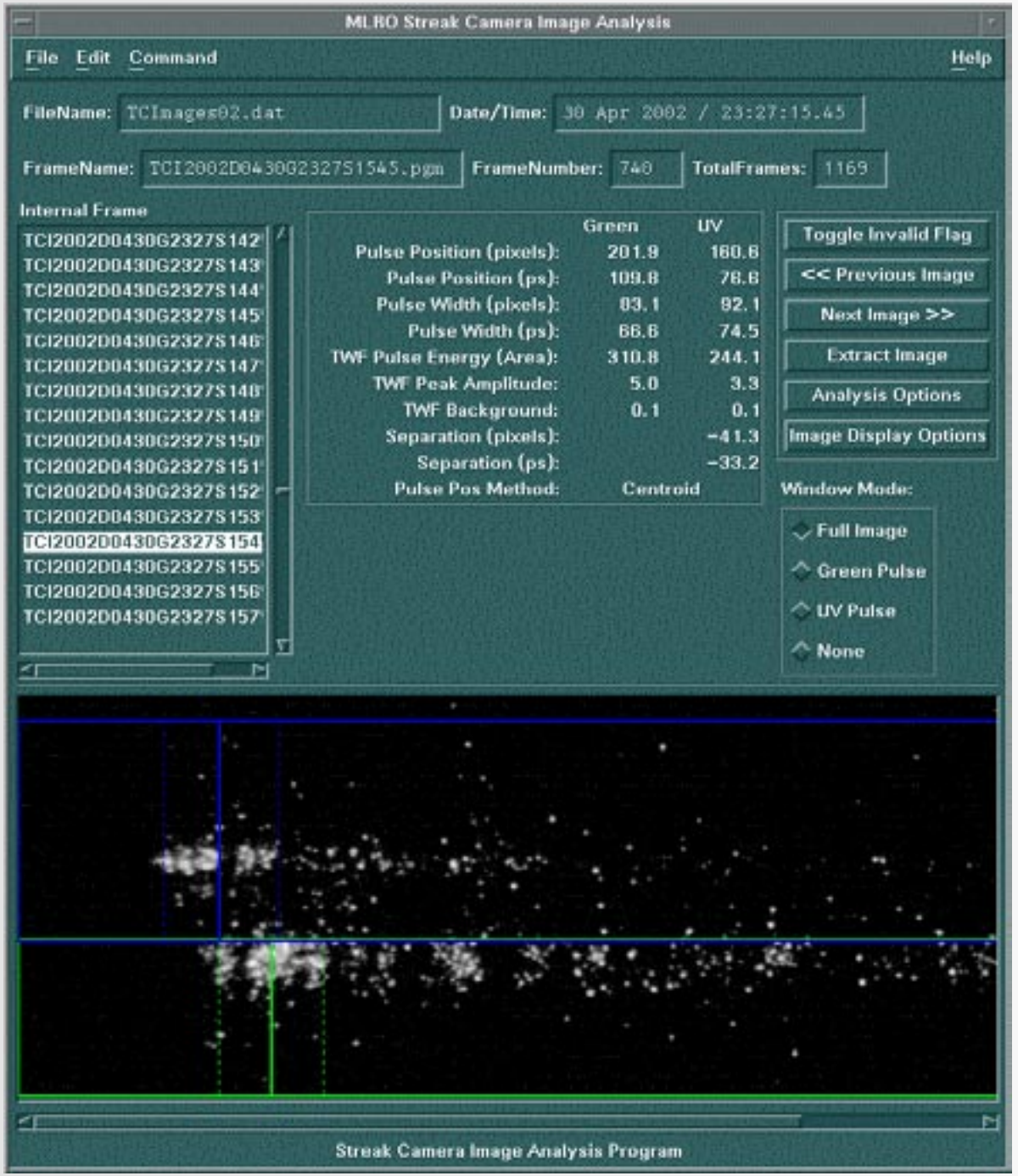
Beacon-C 2-color PMT



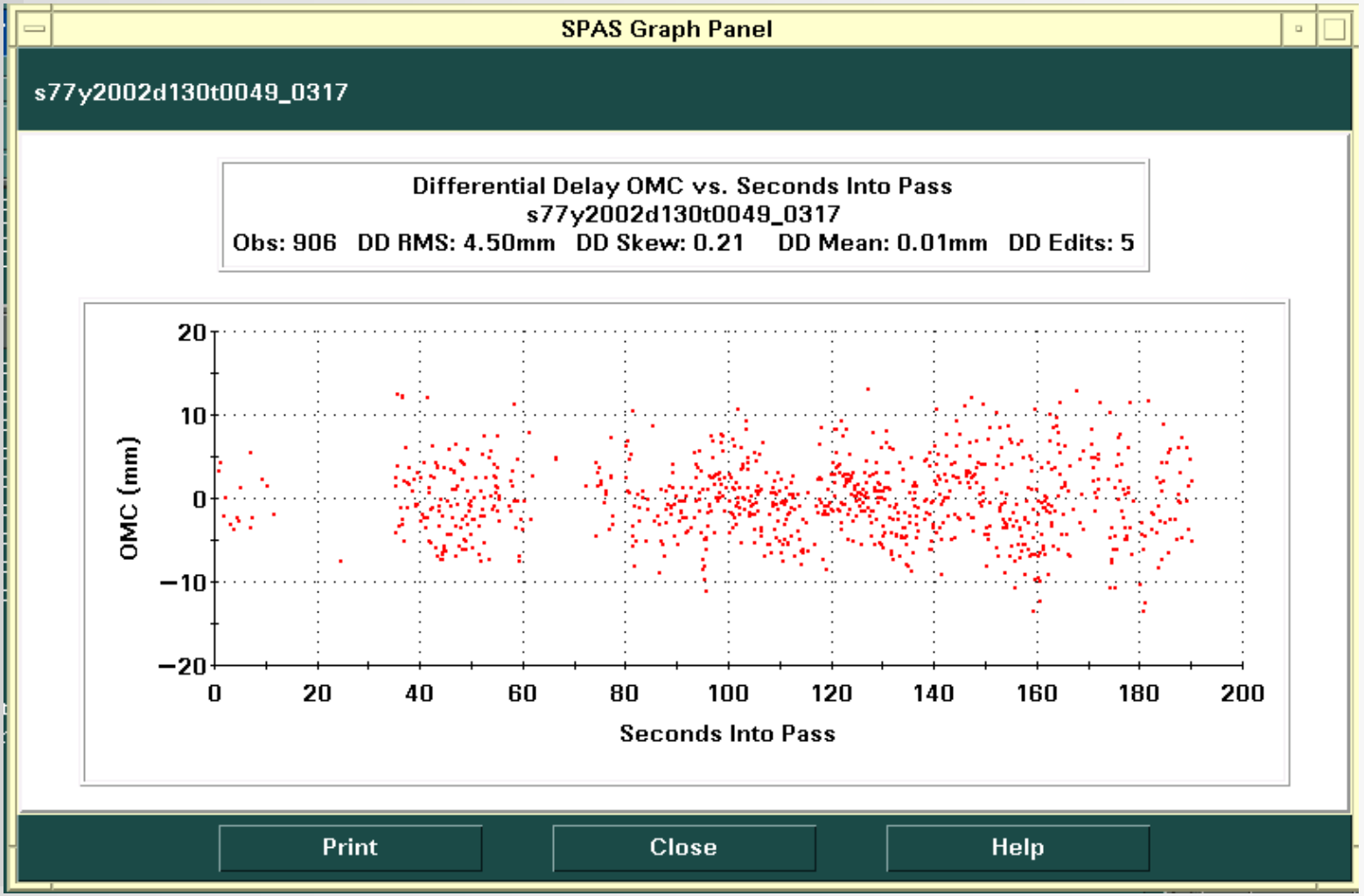
Beacon-C 2-color PMT



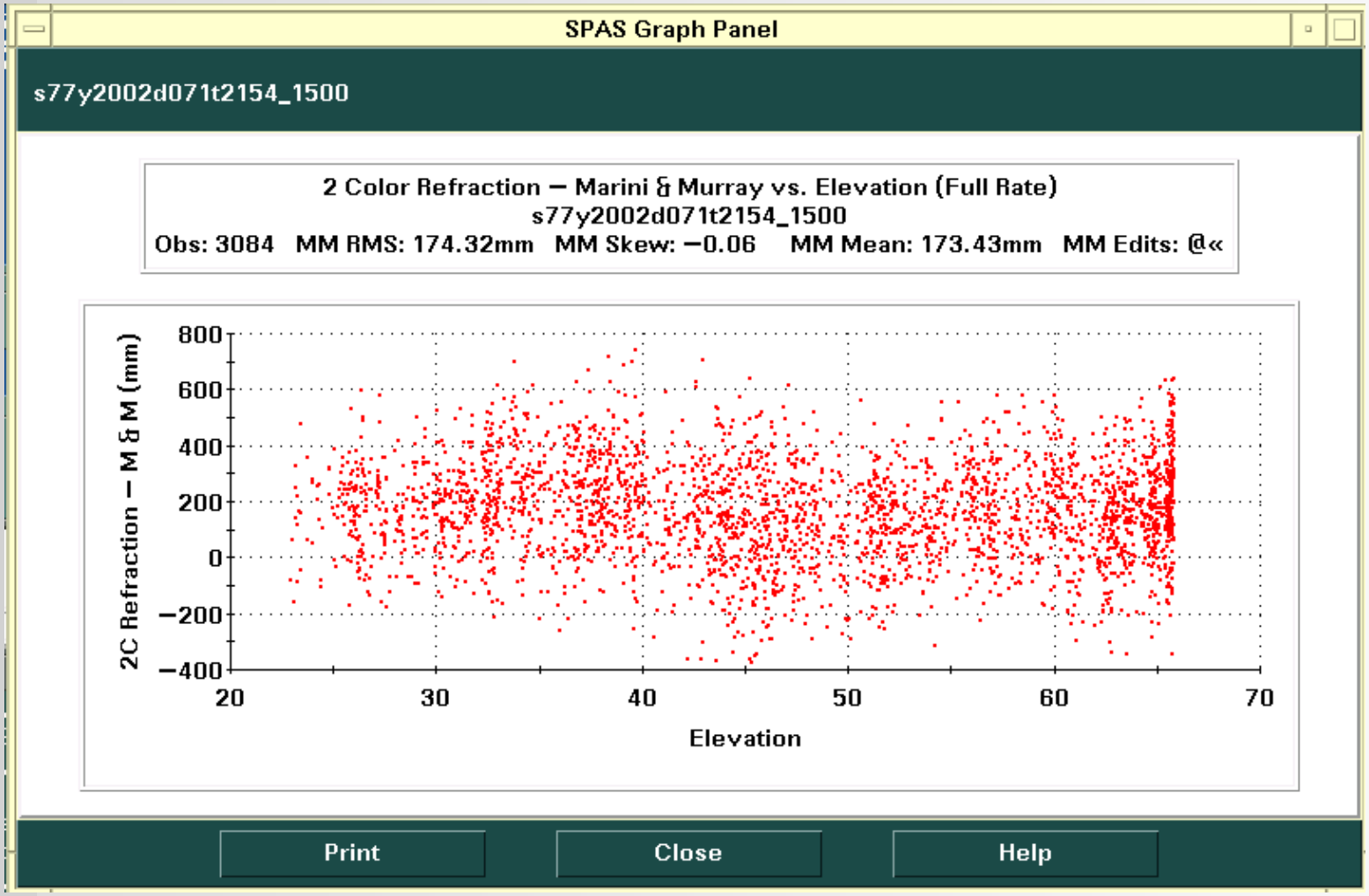
Streak camera dual pulse (green-UV) from TOPEX-Poseidon



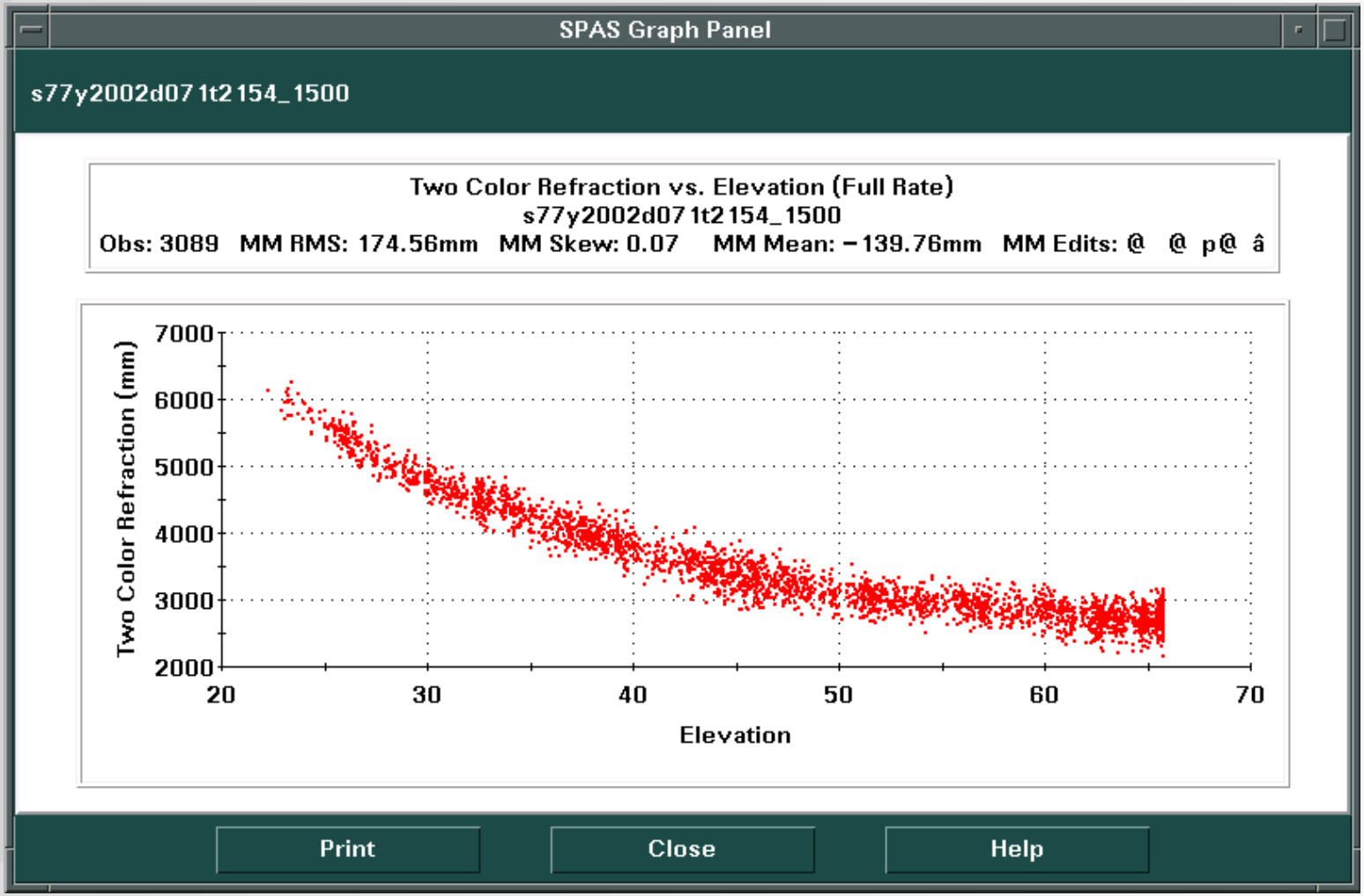
Beacon-C 2-color streak camera



Refraction O-C, green



Refraction vs. elevation, green



Conclusions

- Preliminary results!
- MLRO UV-green differential refraction appears larger (10-15 mm) than what predicted by Marini-Murray
- Bias vs. Marini-Murray does not show up on 2-color ranging to ground targets
- Bias is essentially satellite-independent
- Further work needed