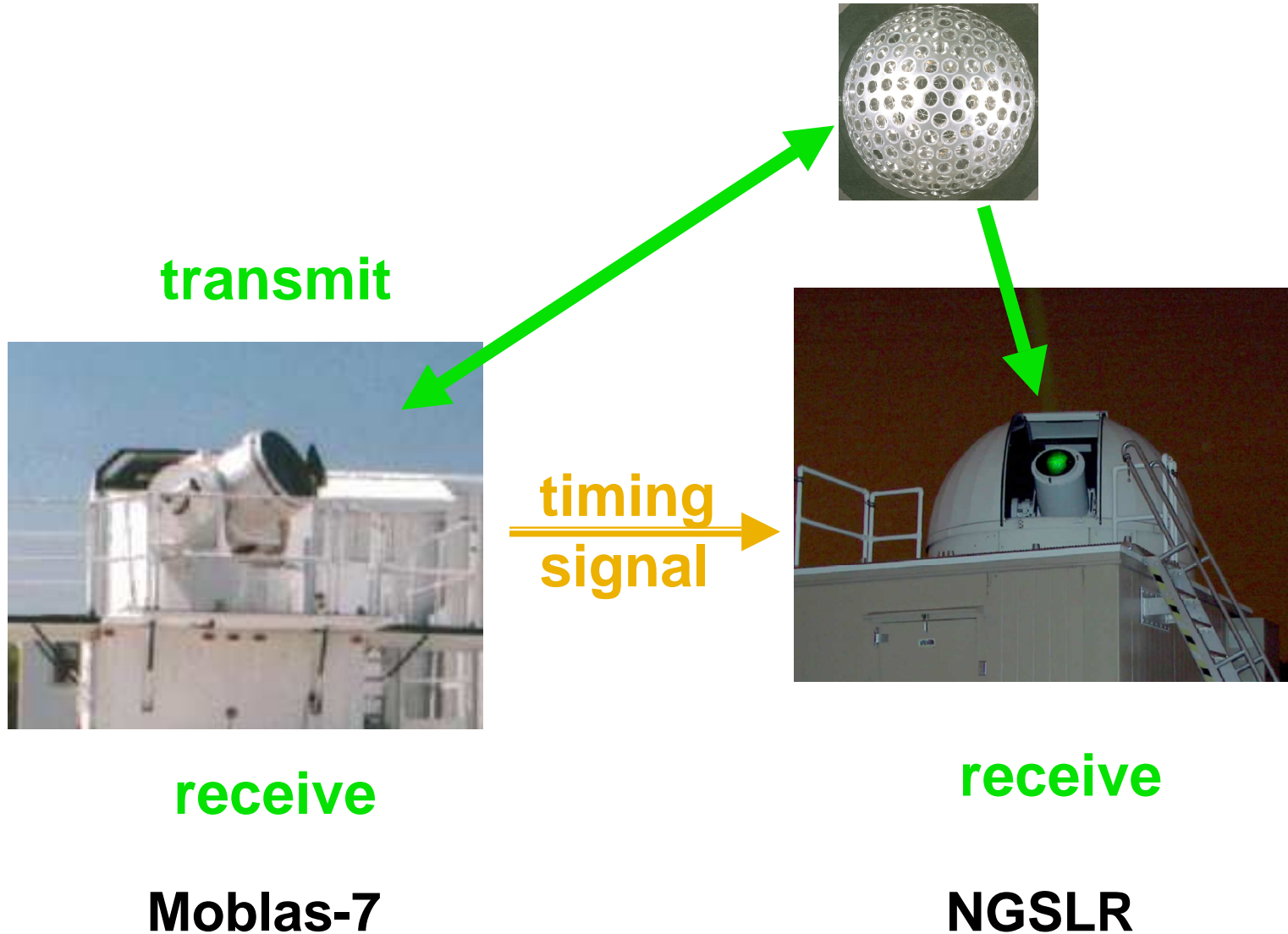


CHARACTERISTICS OF AN EYE-SAFE KILOHERTZ INSTRUMENT

Peter Dunn, Raytheon Intelligence and Information Systems, Maryland, USA
Christopher Clarke, Honeywell Technology Solutions Inc., Maryland, USA

NASA's Next Generation SLR system has conducted satellite measurements in two tracking modes. Two-way, single station returns have been received from satellites up to LAGEOS altitude with a conventional SLR configuration using the 2 kHz laser transmitter. These measurements show the characteristics of the target satellite in the single photon regime, and RMS noise levels are limited to a minimum of about 30 mm by the convolution of the transmitter pulse width and the receiver impulse response. The instrument has also taken measurements as the receiver in a two station (3-way) configuration with a nearby high energy system. This configuration can be used for receiver testing and the higher power of the 4 or 5 Hz transmitting laser allows easier detection of returns from satellites at GPS and ETALON altitudes. The tighter transmitted pulse yields measurements with an RMS noise level closer to 20 mm. When the receiver stop time of the transmitter is considered as well as the transmit time, the 10 mm RMS noise level of the high energy transmitter can be matched, demonstrating the integrity of the eye-safe system's event timer and processor. The increased number of returns per second from the NGSLR system produces normal points comparable in precision to the higher energy transmitter system and allows the station to autonomously close the tracking loop. Data taken at kilohertz resolution can also be used improve the definition of signals in the returns from satellites which have a strong satellite signature.

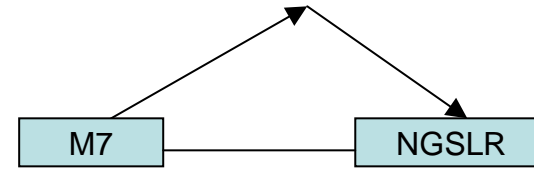
MOBLAS-7 GIVING...MOBLAS_7 and NGSLR RECEIVING



In 3-way configuration:

MOBLAS-7 fires – NGSLR receives only

Cables run from MOB-7 to NGSLR Event Timer for Start and Stop
NGSLR quadrant detector also receiving

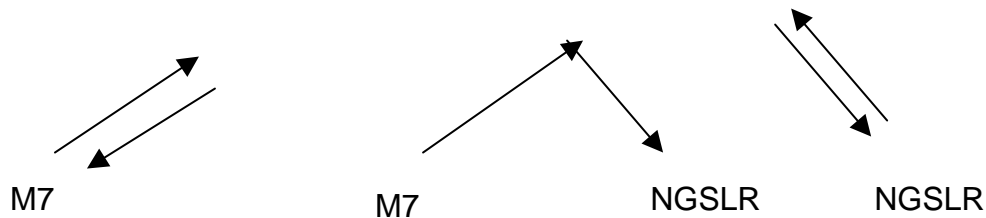


NGSLR uses threshold discriminator: higher detection noise level

MOBLAS transmits short pulses but multi-photon

In 2-way configuration:

NGSLR transmits longer, single photon pulses



RMS NOISE OF NGSLR RECEIVING MOBLAS_7 TRANSMIT PULSE

SATELLITE	RMS in mm	SKEW	KURT	
LAGEOS2	22	10	2	60810
LAGEOS2	21	8	2	60817
ERS2	21	3	0	60817
ENVISAT	20	3	0	60818
STARLETTE	26	4	0	60818
STARLETTE	26	4	5	60818
ETALON1	47	6	-1	60818
GFO1	25	3	0	60822
LAGEOS2	28	15	4	60822
STARLETTE	28	8	4	60822
GLONASS87	40	7	0	60822
LAGEOS2	30	14	6	60824
LAGEOS2	30	8	4	60918
BEC	31	13	4	60918
GFO1	27	2	1	60918
JASON1	25	4	4	60918
ENVISAT	23	6	5	60922
LAGEOS2	28	12	6	60922
JASON1	26	7	4	60922
BEC	32	11	4	60922
BEC	28	6	1	60922
AJISAI	31	13	9	60922

HIGH POSITIVE SKEW : NOISE LONG

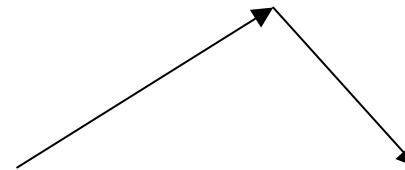
HIGH KURTOSIS: PEAKY SIGNAL

LEO NOISE LEVEL: 20-32 mm AJISAI: 31 mm

LAGEOS2 RMS: 21-30 mm

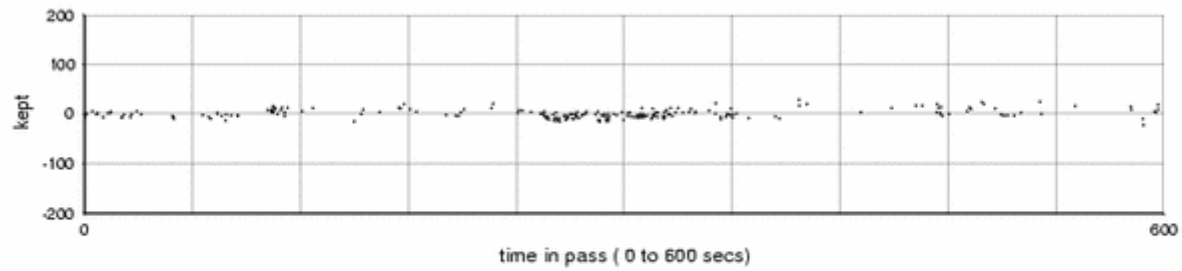
GLONASS87 RMS: 40 mm

ETALON1 RMS: 47 mm

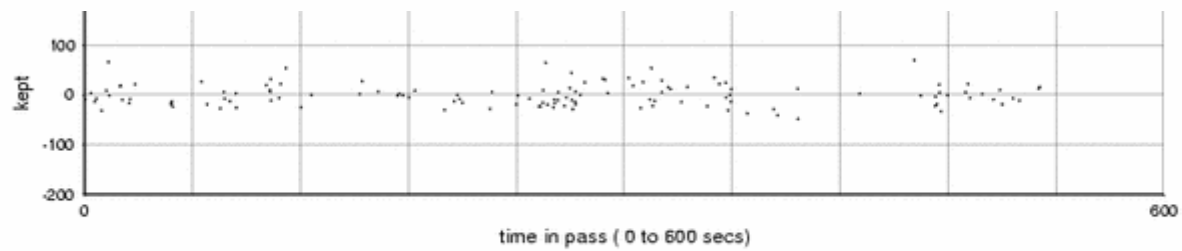


NGSLR RECEIVING FROM LAGEOS2 Aug 22

MOB7/MOB7 10mm

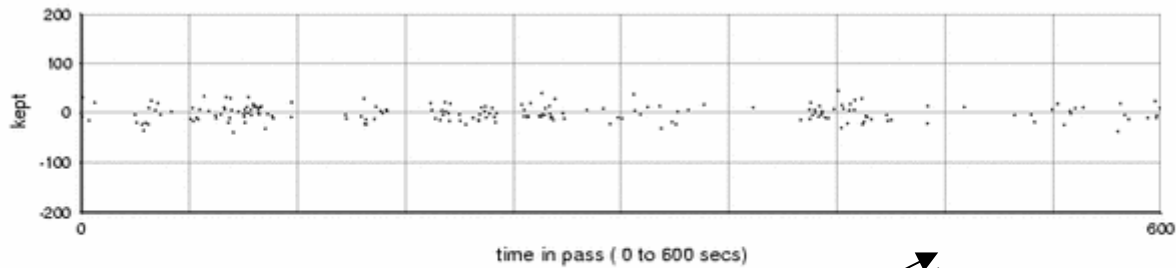


MOB7/NGSLR 28mm

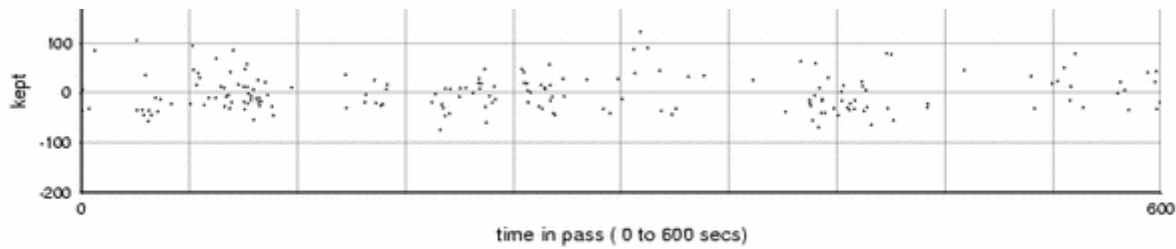


NGSLR RECEIVING FROM GLONASS87 Aug 22

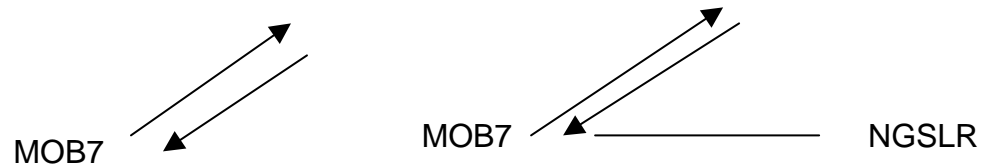
MOB7/MOB7 15mm



MOB7/NGSLR 35mm



NOISE LEVELS OF 2 WAY DATA



MOB7-MOB7

MOB7(NGSLR)

8 mm

10

10

15

8 mm

10

10

15

ERS-2

STARLETTE

LAGEOS2

AJISAI

NGSLR Timing and Software checked

NOISE LEVELS OF 2 WAY AND 3-WAY DATA

MOB7
(NGSLR)

MOB7-
NGSLR

NGSLR-
NGSLR

8 mm

21 mm

30 mm

ERS-2

10

26

30 STARLETTE

10

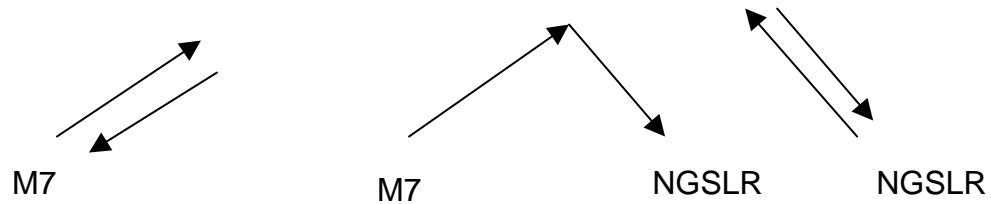
21

35 LAGEOS2

15

35

42 AJISAI



NOISE LEVELS OF NGSLR 2-WAY DATA

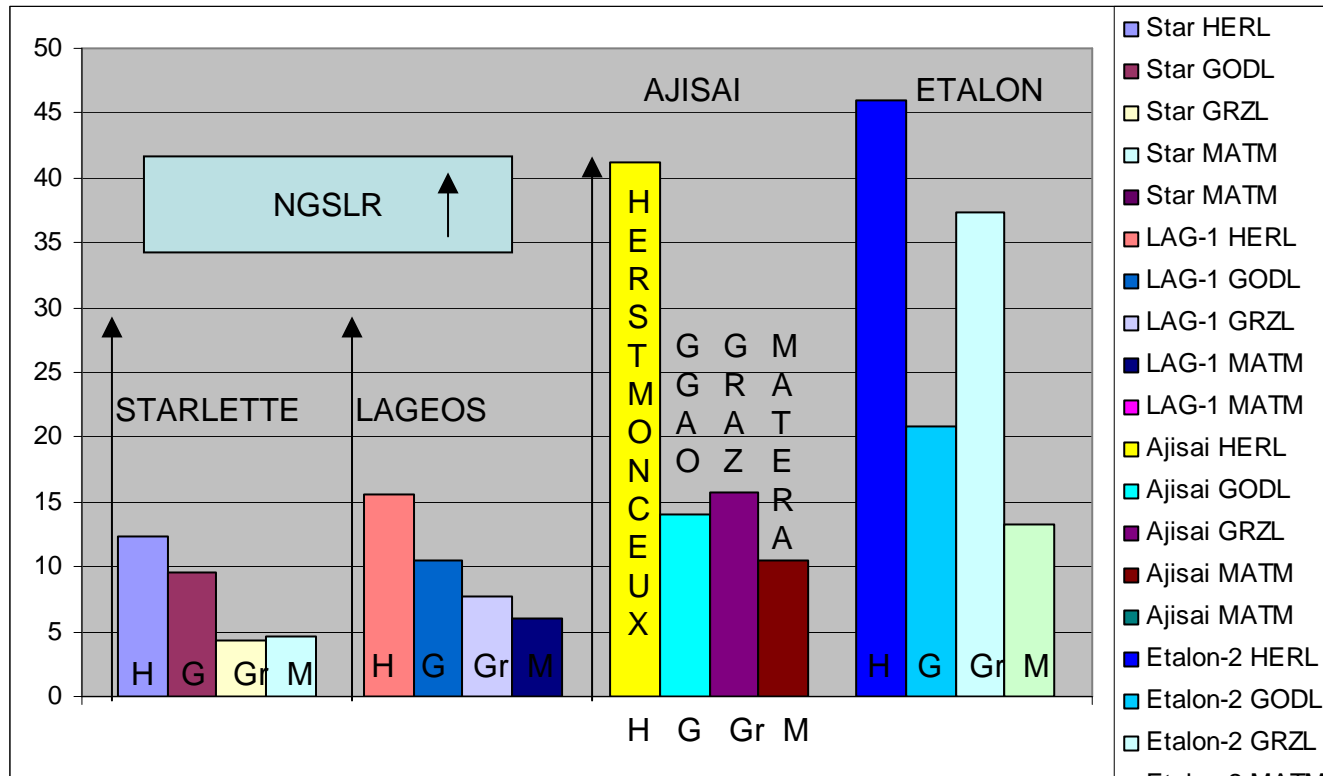
27-35 mm ERS2

26-36 mm STARLETTE

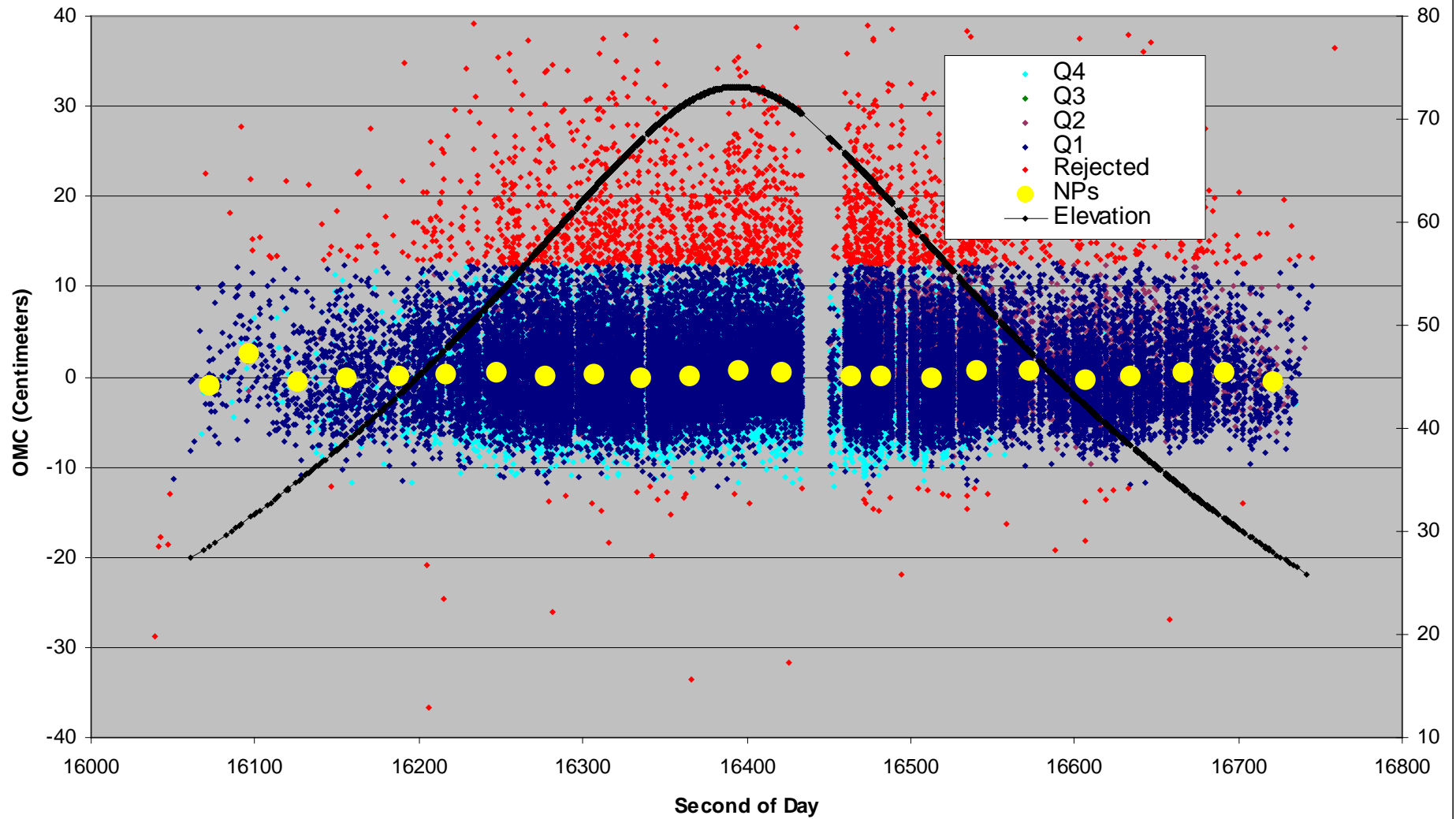
33-38 mm LAGEOS

38-49 mm AJISAI

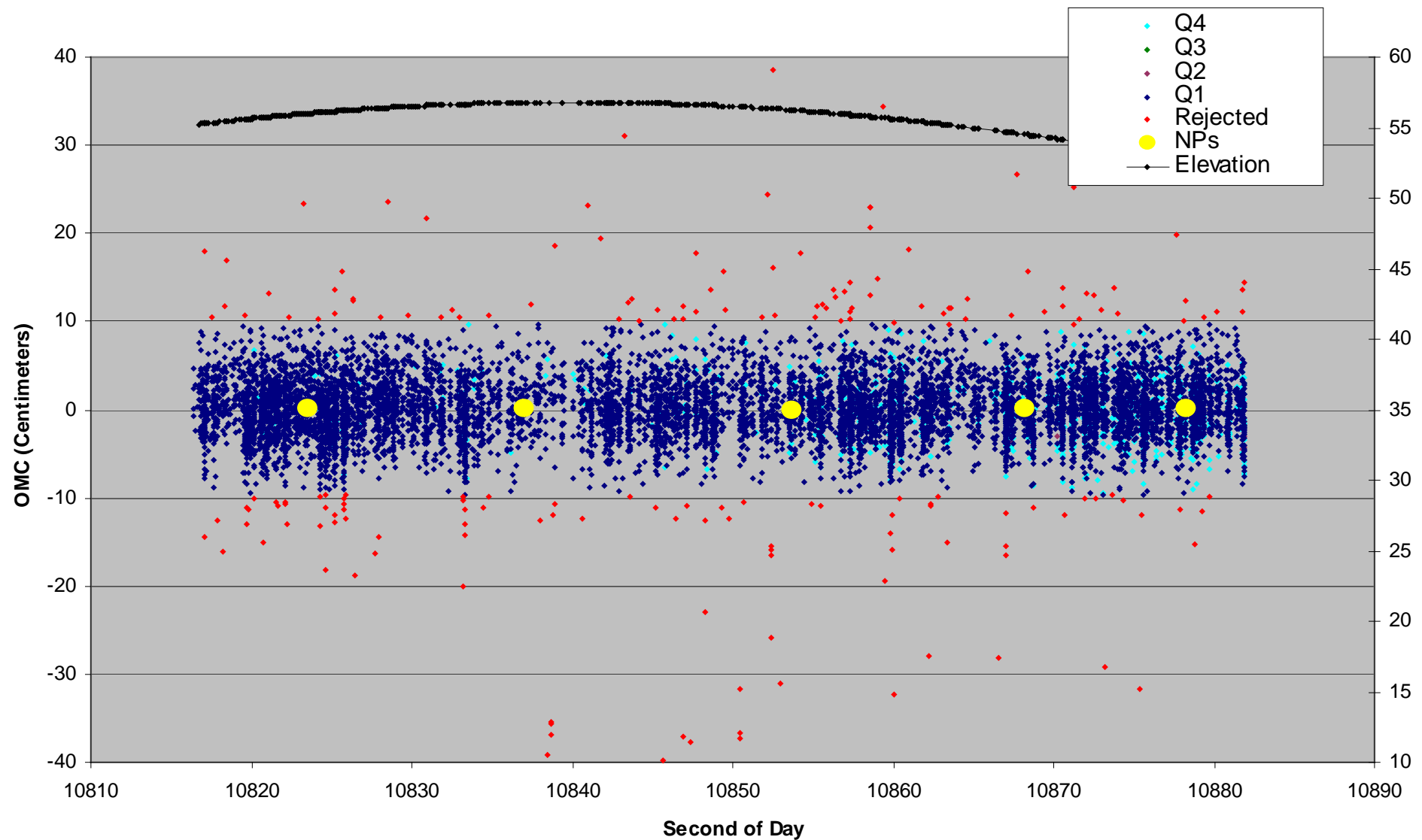
RMS in mm for four Stations from four Satellites



Ajisai y07 d178 t0425 400000 obs. 4.2 cm rms
(1 / 7 observations plotted)



Envisat y07 d227 t0256 10000 obs. 3.6 cm RMS

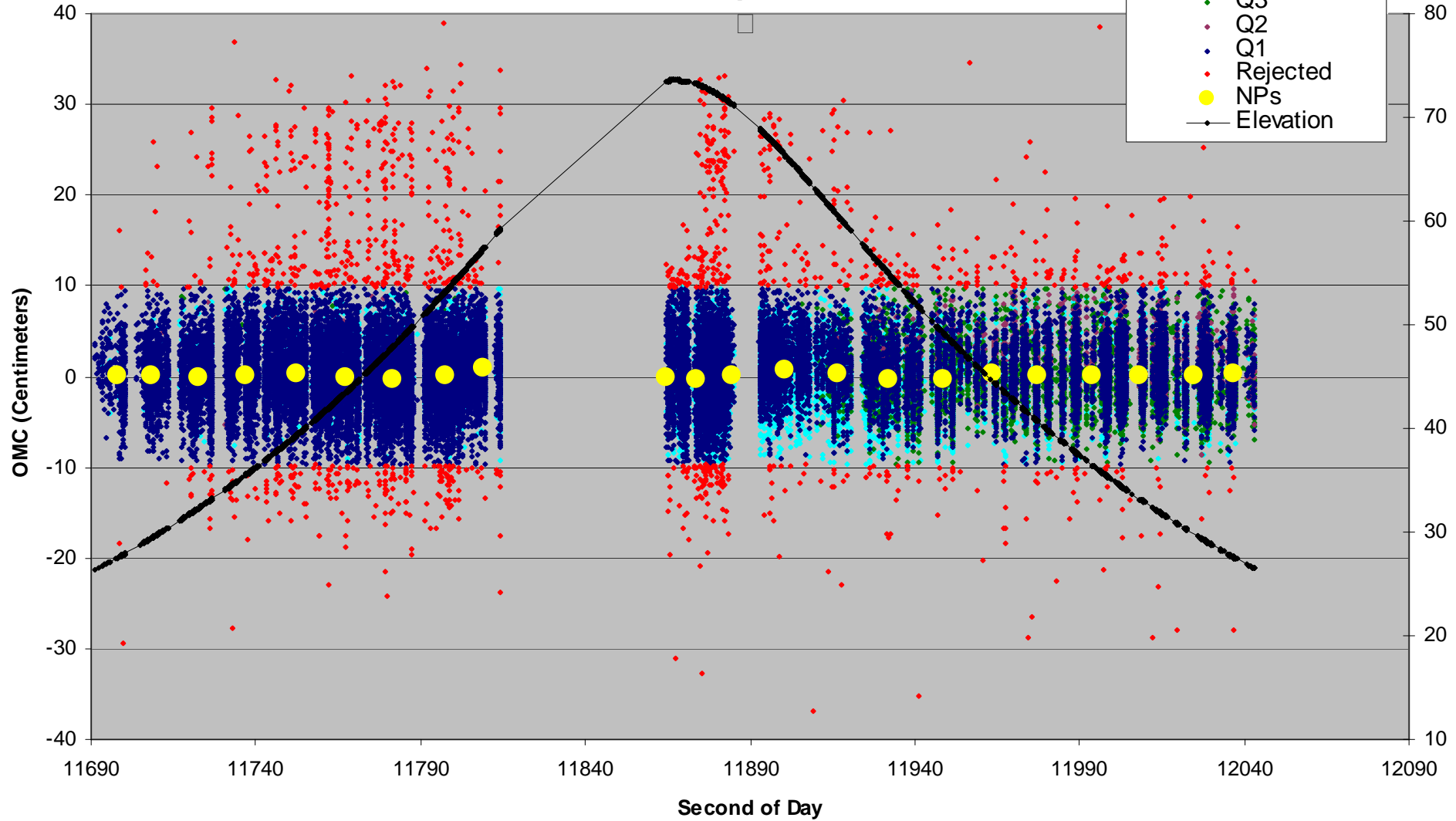


Conclusions

- NGSLR receiver performance has been calibrated using MOBILAS-7 transmissions
- NGSLR transmit/receive configuration shows noise characteristics expected from eye-safe operation
- Satellite signature will affect the accuracy of orbits determined with different systems

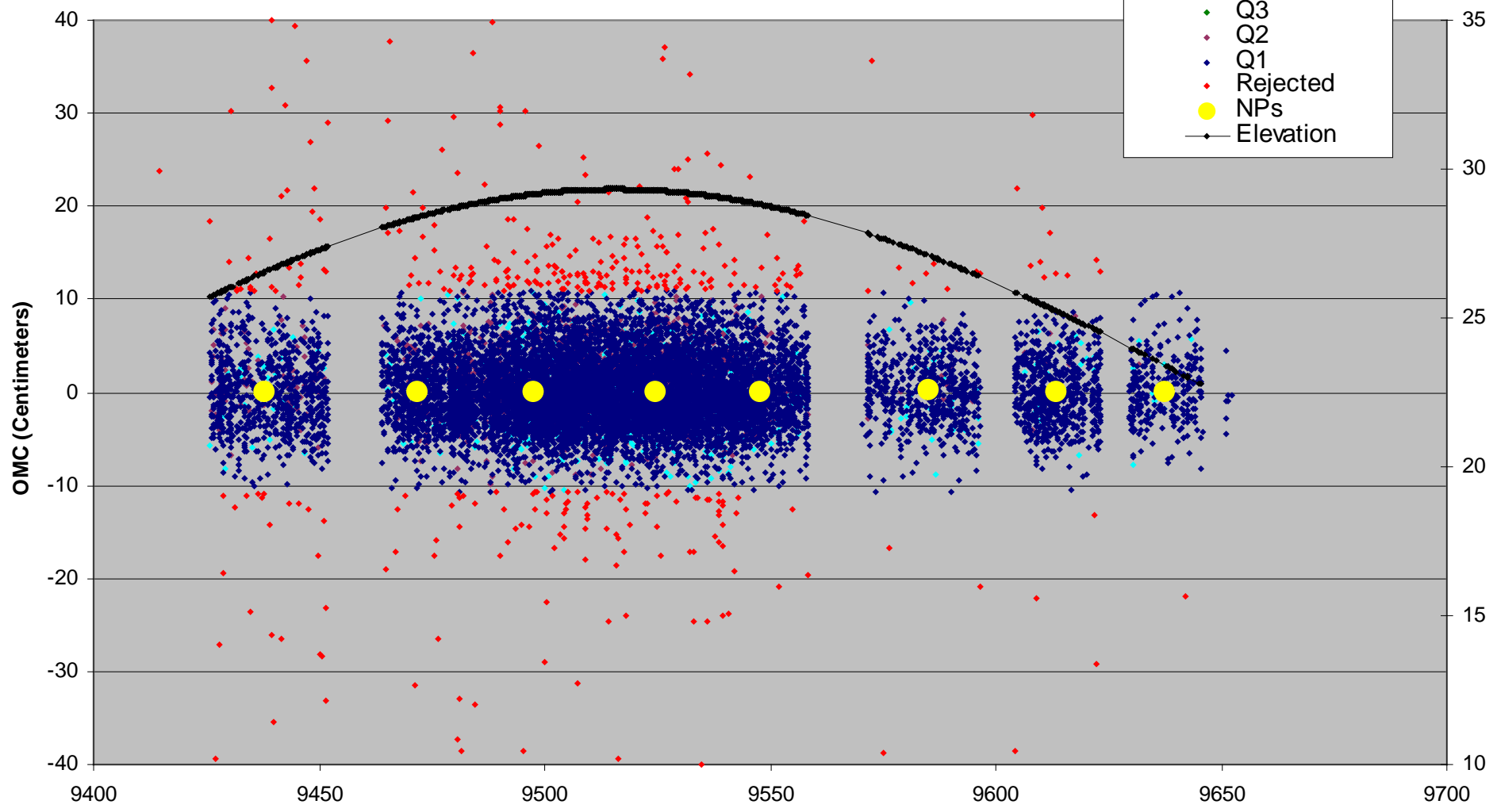
ERS2 y07 d151 t0312 150000 obs. 3.3 cm rms
1/3 obs plotted

- Q4
- Q3
- Q2
- Q1
- Rejected
- NPs
- Elevation



Starlette y07 d227 t0234 15000 obs. 3.6 cm RMS

- Q4
- Q3
- Q2
- Q1
- Rejected
- NPs
- Elevation



Second of Day