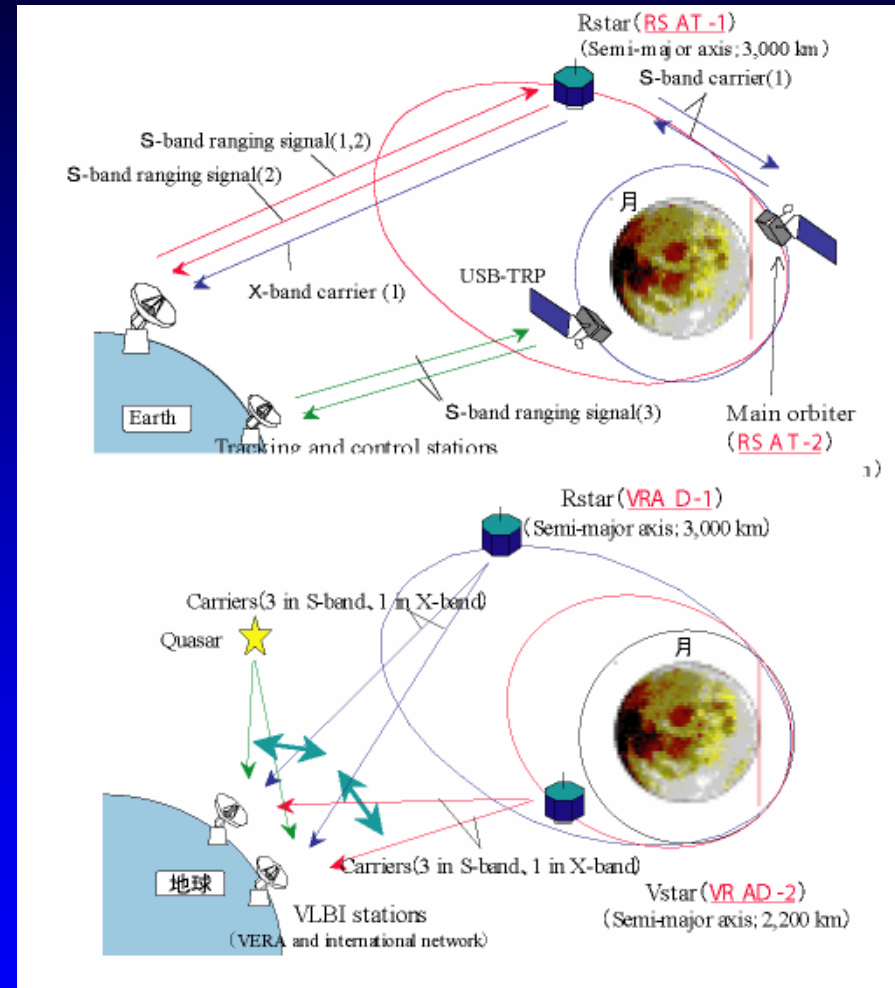
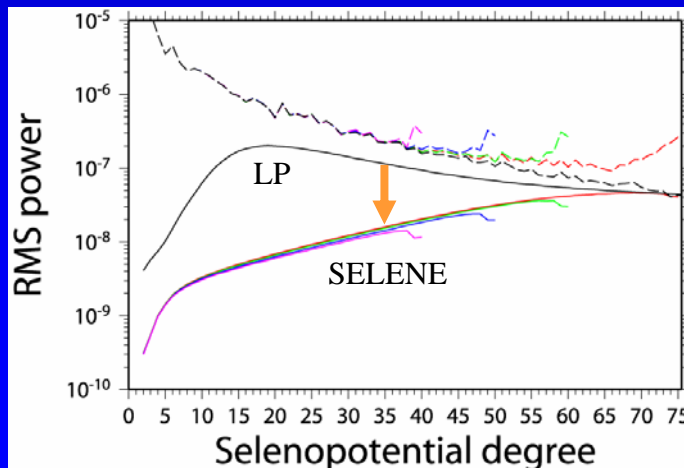


# 4-way Doppler and VLBI

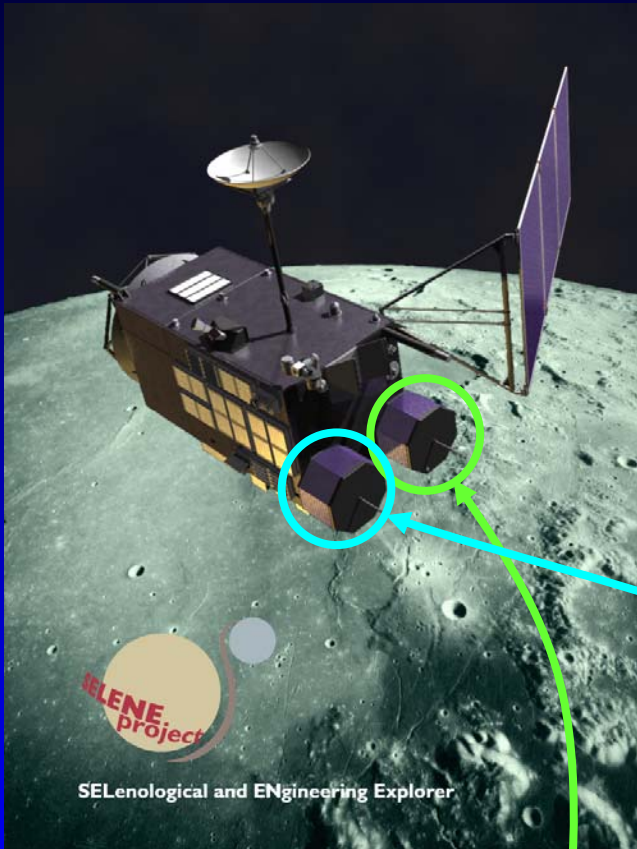
RSAT relays ranging signals between main orbiter and ground antenna.

VRADs allow differential VLBI experiments.



Combination of high, middle and low altitude satellites enables gravity field retrieval through wide-range of wavelength.

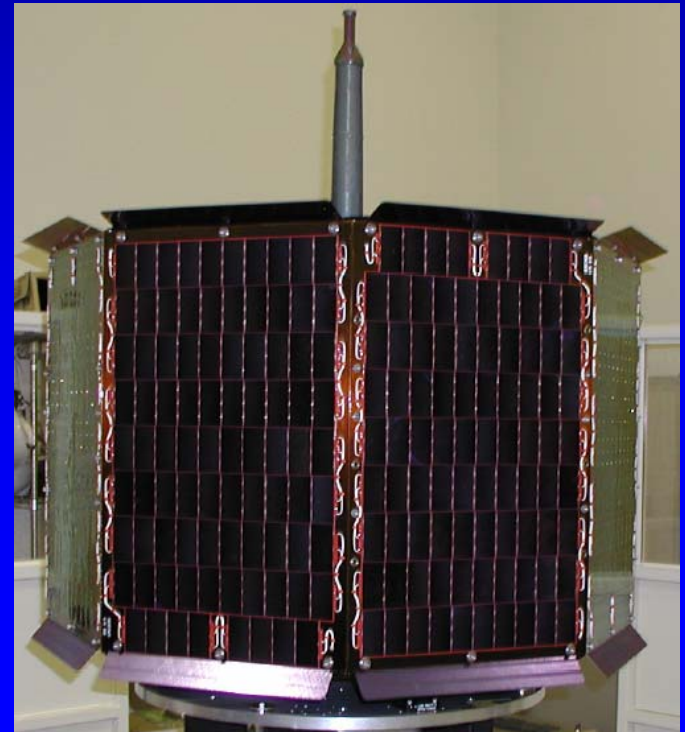
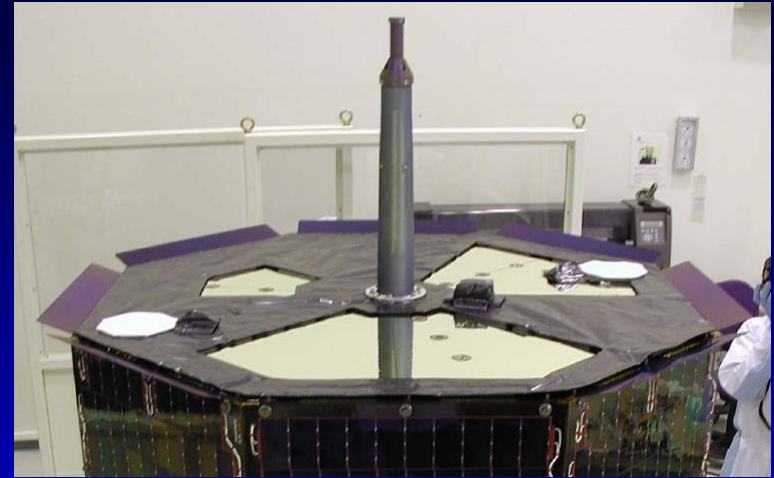
# Sub-satellites



Main Orbiter

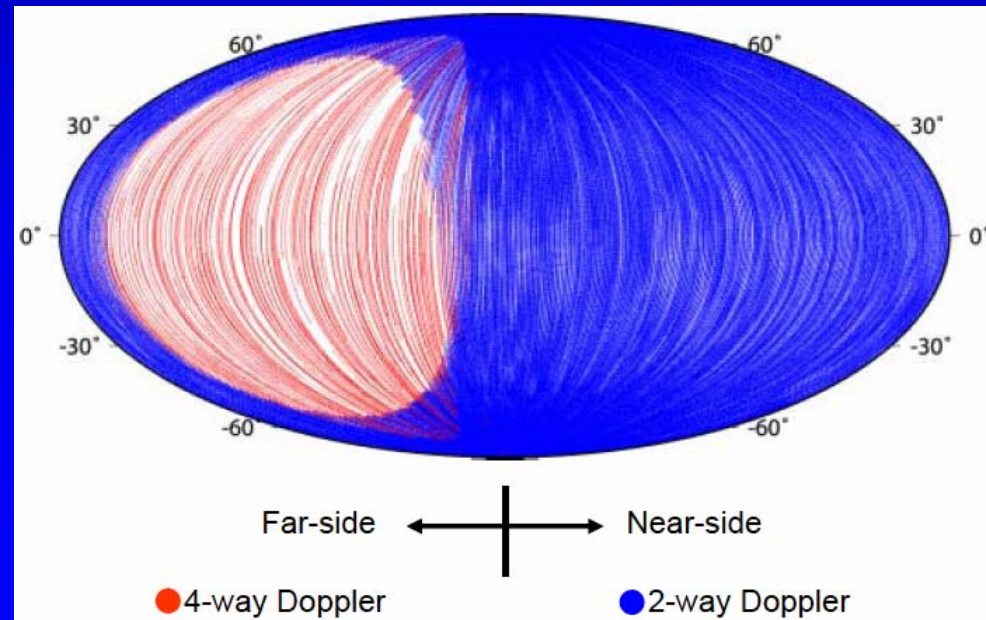
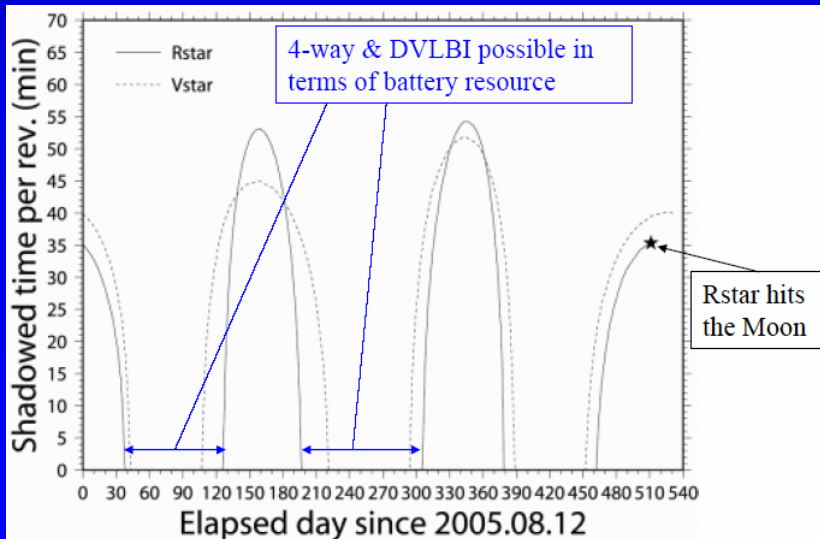
Relay sub-satellite (Rstar)

VLBI radio satellite (Vstar)

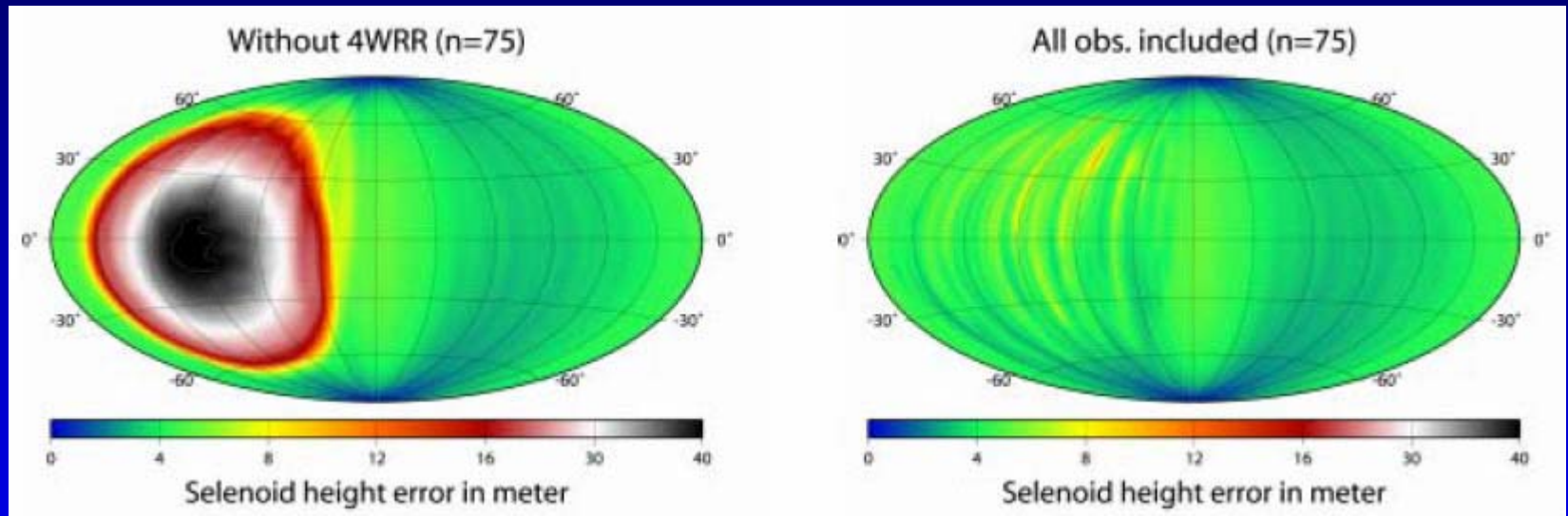


# Limitations on 4-way Doppler OBS

1. Nominal mission period: 11 months
2. Constellation of two satellites
3. Assignment of ground station  
(UDSC 6 h/day, VERA 8 h/day & 3 days/week, international collaboration 1 month x 2)
4. Rstar to be fully sunlit



# *Selenoid height error estimated from covariance matrix*



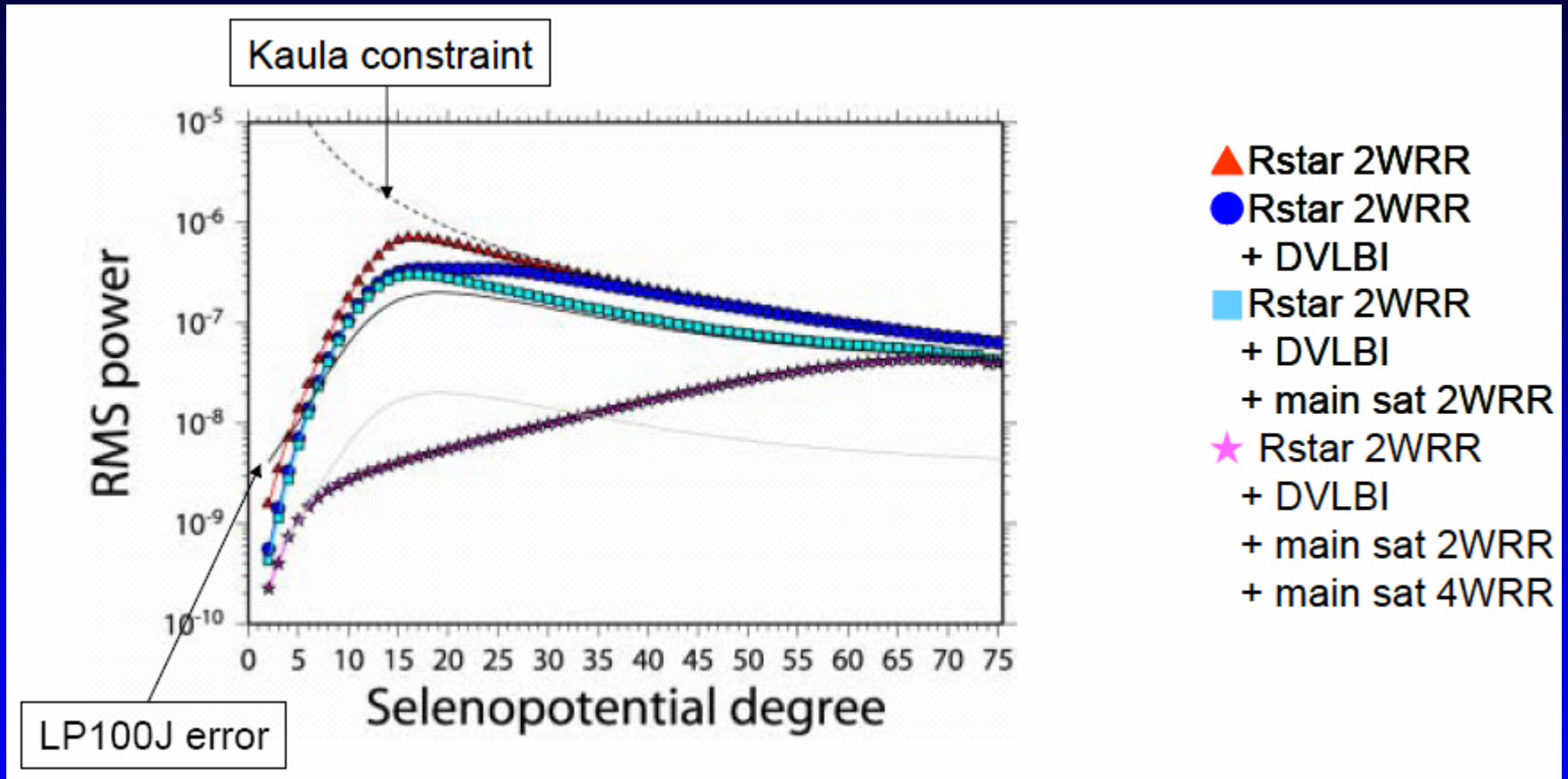
Without 4-way Doppler OBS

All OBS data (4-way  
Doppler, 2-way Doppler and  
range,  $\Delta$ VLBI) adopted

(75<sup>th</sup> degree and order)



# Error spectrum

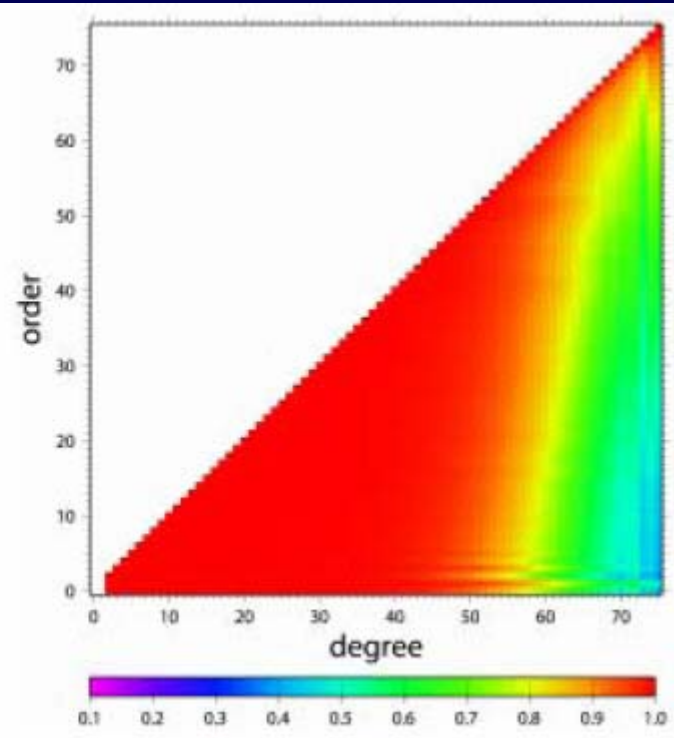
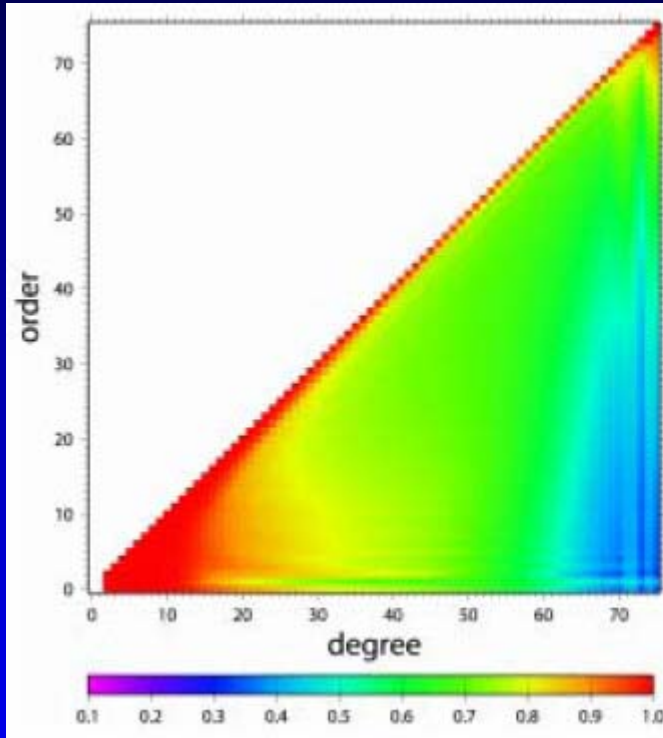


Given a priori constraint, lunar gravity field will be improved by orders of magnitude from present LP100J model.

# Sensitivity matrix

Without 4-way Doppler OBS

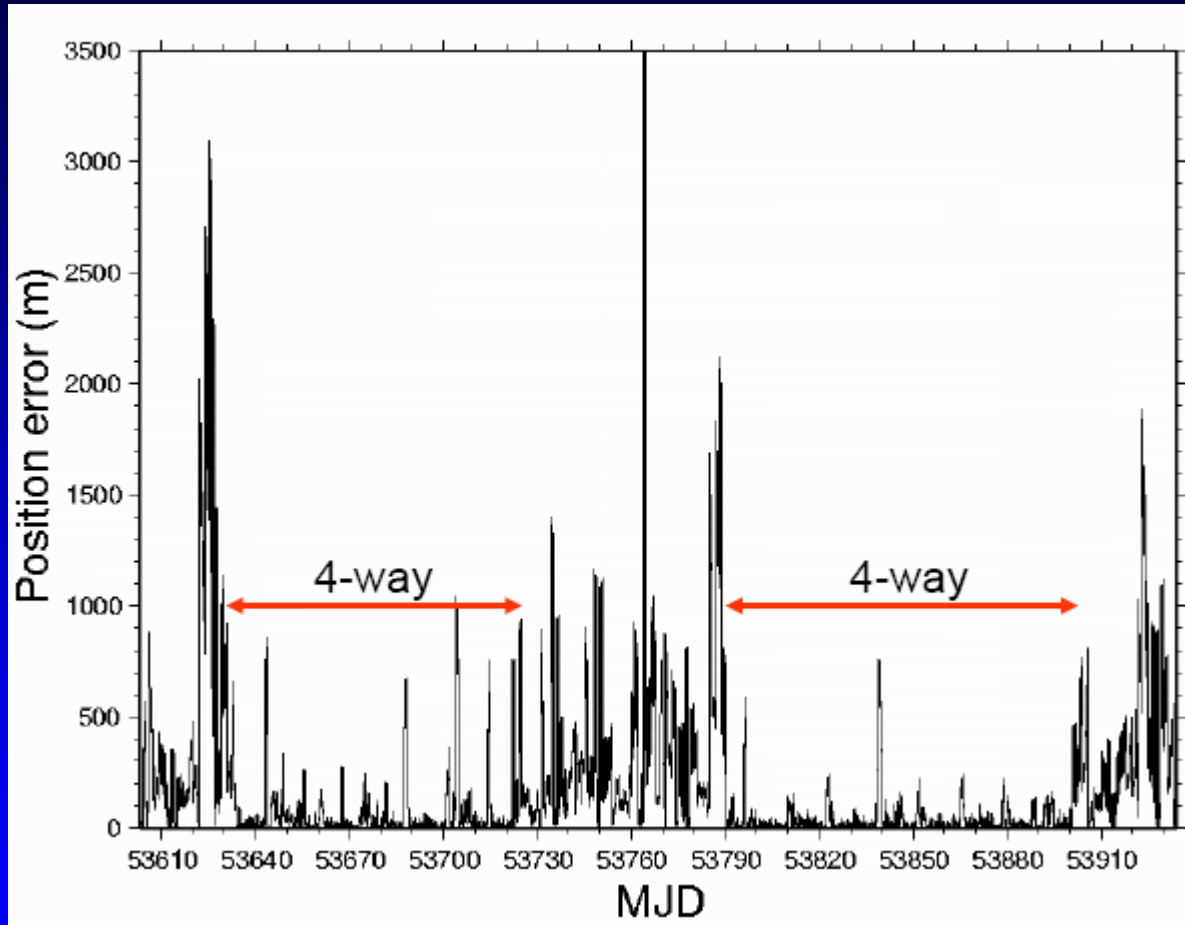
All OBS data adopted



Red: spherical harmonic coefficient is determined fully by *OBS data*.

Blue: spherical harmonic coefficient is determined mostly by *a priori constraint*.

# *Position error of main satellite*



4-way Doppler  
OBS data decrease  
in position error of  
SELENE main  
satellite.

