# ILRS LARGE Meeting
IGS Requirements

- Requirements from IGS
- Combination of GNSS and SLR
- SLR tracking of GNSS

TU Vienna, 26-April-2014

IGS Requirements

- From GGOS-RAS/Roscosmos Meeting, April 8, 2013

- Tracking network

  - Extension of multi-GNSS network

  - Multi-GNSS (MGEX), real-time

- Precise GNSS orbit modeling

  - GPS orbits currently at a 1d RMS consistency of 2cm

  - draconitic periods in geodetic time series

  - issues with orbit modeling for new types of satellites

  - requirements for improved radiation pressure modeling

  - requirements for independent orbit validation

- Issues with Galileo IOV orbit modeling
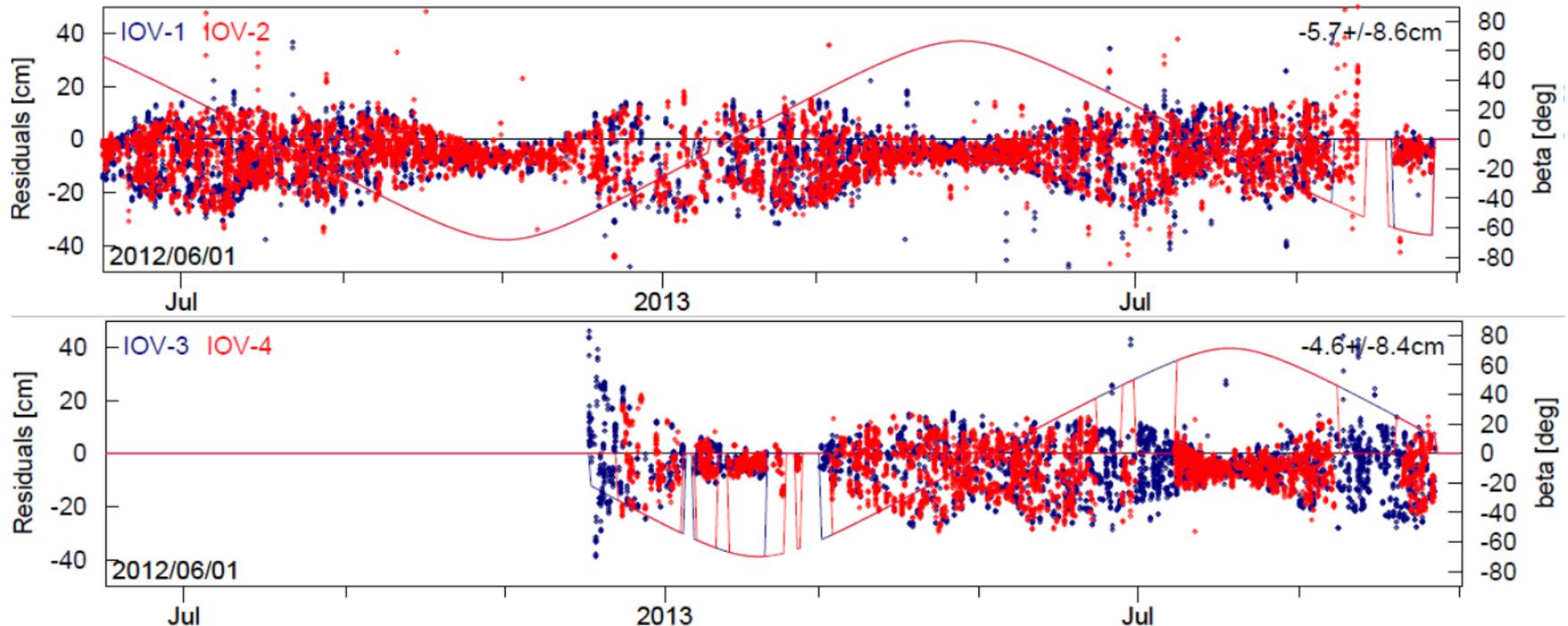
- Orbits determined within MGEX

- Dependency of SLR residuals on Sun beta angle

Required Satellite Information

- **Operations**
  - timely information on maneuvers, configuration changes etc.

- **Satellite reference frames**
  - satellite body reference frame, center of mass position, view cone angles

- **Satellite attitude**
  - attitude laws for satellite body and panels as function of beta angle
  - in particular for deep shadow maneuvers, midnight turn, noon turn
  - accuracy of attitude law
  - measured attitude

- **Navigation antenna**
  - mechanical antenna position
  - lab measured antenna phase centers and nadir-azimuth dependent phase pattern per frequency

Required Satellite Information

- Signal characteristics

  - group delay calibrations, stability, thermal sensitivity

  - clock information, stability, thermal sensitivity

- SLR retro reflector

  - mechanical position in satellite body frame, type etc.

- Satellite mechanical and optical informations

  - dimensions, shapes of surfaces

  - optical properties for visual and infrared frequencies

  - thermal model for thermal emission modeling

  - radio emission power

  - mass at launch and mass history, nominal accuracy

  - strategy for momentum dumping

Orbit Validation

- Issue mainly for new types of satellites

  - Development of new empirical, semi-empirical, or analytical radiation pressure models

  - More or different parameters

  - Impact on shape of orbit

- Independent orbit model validation required

  - Orbit comparisons, orbit overlaps, orbit prediction

  - Validation with SLR

- SLR strategy for validation ...

  ... dense observation

  ... of selected satellite types

- What means "dense"? Number of NPs per revolution?

GNSS and SLR Combination

- GNSS is a one-way measurement technique providing pseudoranges

- As all clock corrections need to be determined, GNSS technique provides precise angular measurements

- SLR provides ranges

- GNSS and SLR thus provide precise 3d information of satellite positions

- Conclusions: Combination GNSS & SLR ...

  ... reduces orbit-clock-correlations in GNSS

  ... allows to develop improved rpr models

  ... provides access of GNSS to the geocenter

  ... would support the realization of Epoch Reference Frames

SLR Observation Strategies of GNSS

- Full SLR tracking of GNSS vs economic arguments

- Full constellation vs. dense observation of selected satellites

    - one satellite per orbital plane, per satellite type?

    - continuously or every few days?

    - how many observations per pass, per revolution?

- Strategies

    - reasonable coverage of orbital arc, e.g. 6 NP per revolution, to measure the orbit eccentricity and short periodic orbit perturbations

    - selected block types and orbital planes for orbit model validation

    - full constellation for new, well centered products such as epoch reference frames

SLR Observation Strategies of GNSS

- Strategy: Full constellation, 6 NP per revolution per satellite
  - for orbit model validation and combination
  - coordination of observations between stations
  - coordination in real-time due to weather issues
  - issue of range biases?
- Novel Strategies
  - quasi simultaneous observations
  - to cross-calibrate station biases
  - formation of single differences and double differences, ...