ILRS Tracking Activities on GNSS

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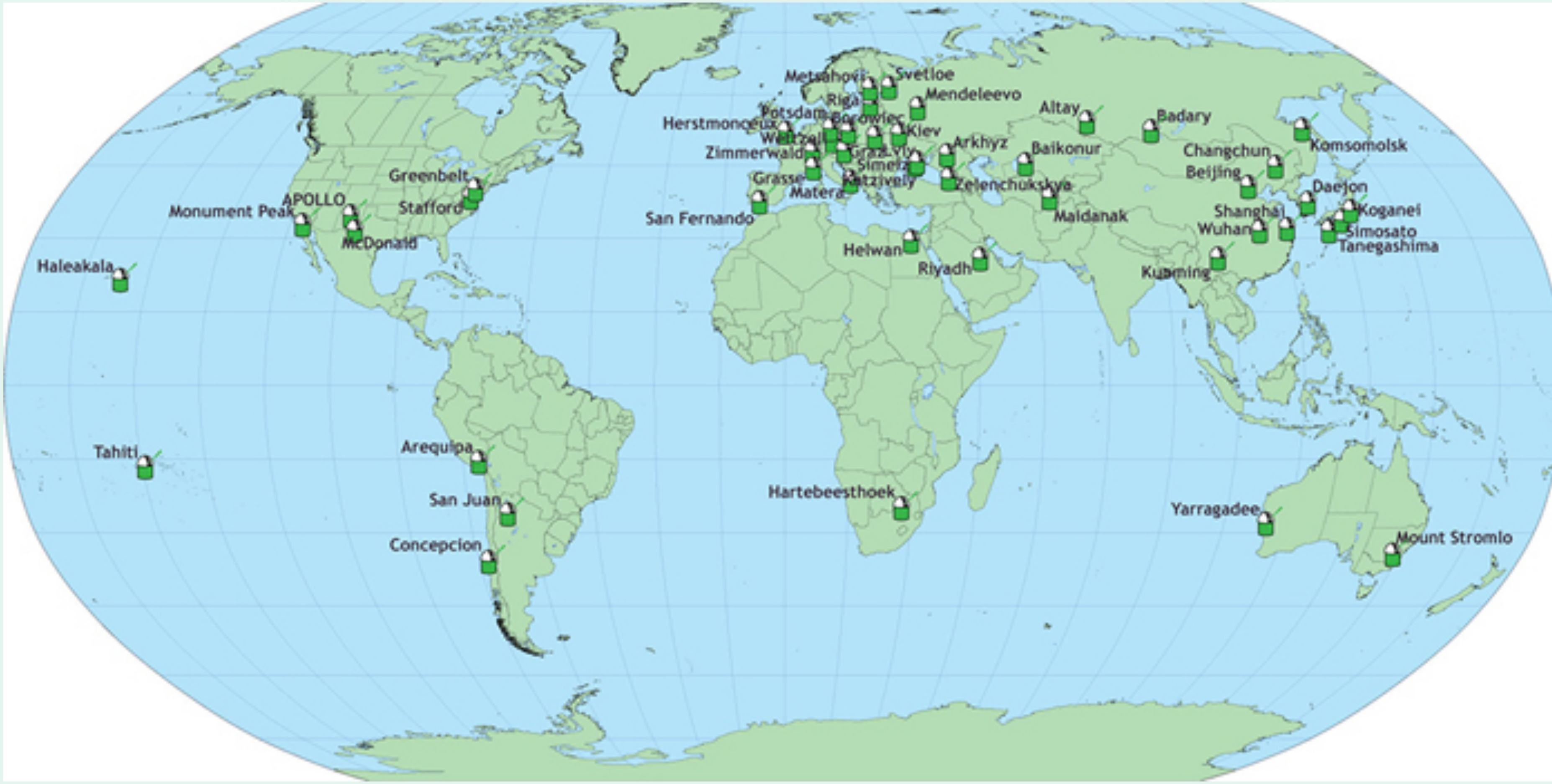
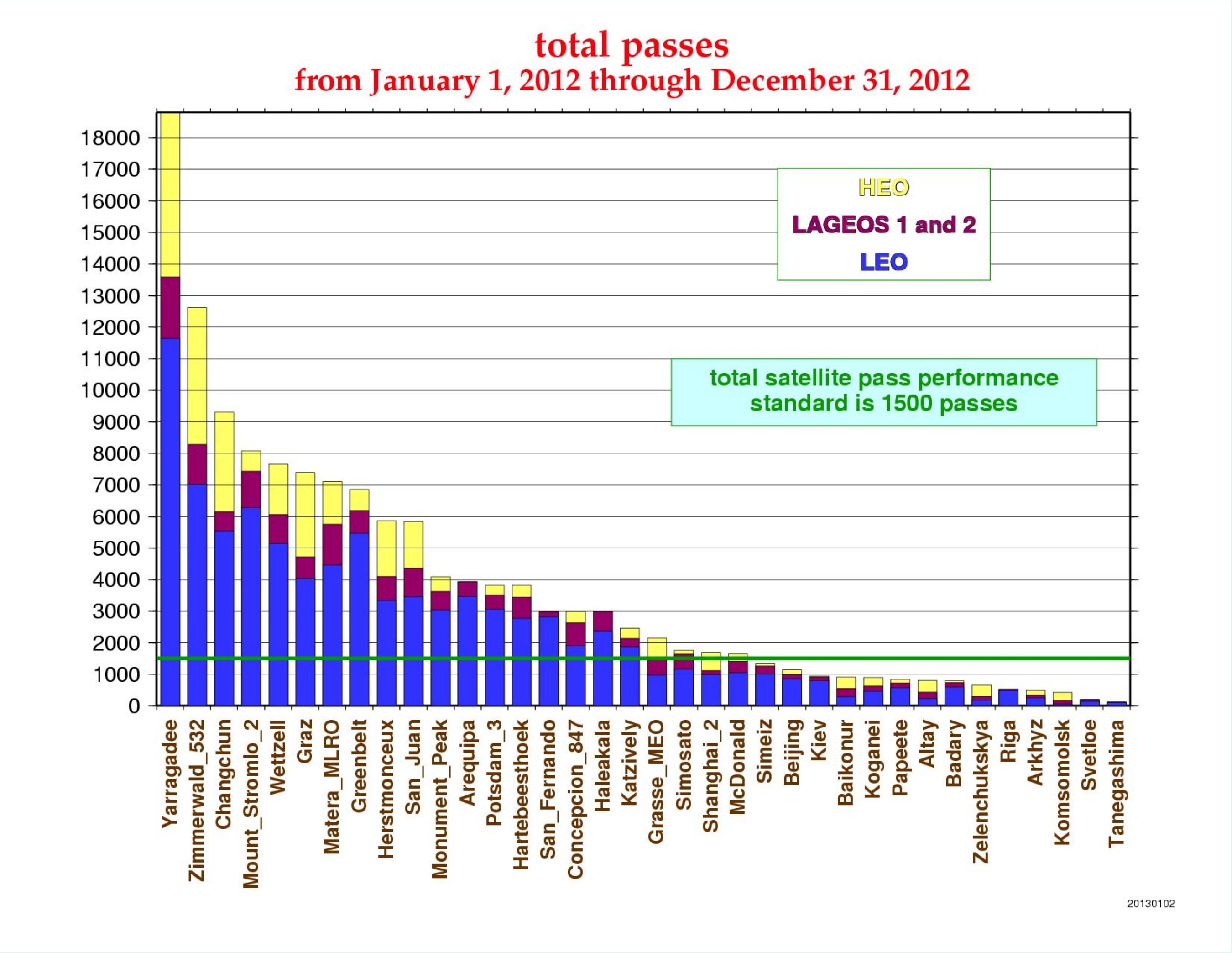
Outline

- Overview of ILRS support for reference frame realisation and POD
  - Primary constellation of geodetic satellites
- Current ranging activities on GNSS satellites
- Estimated network capacity
  - Station example
- Need for a clear direction re GNSS tracking

Global Network of SLR stations

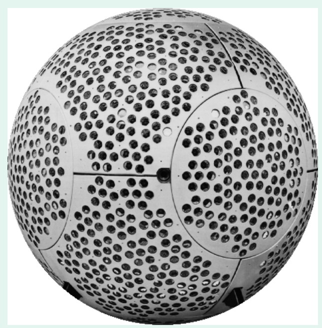
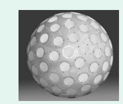


ILRS is a major contributor to precise tracking of EO (altimetry, SAR) missions as well as dedicated geodetic spheres

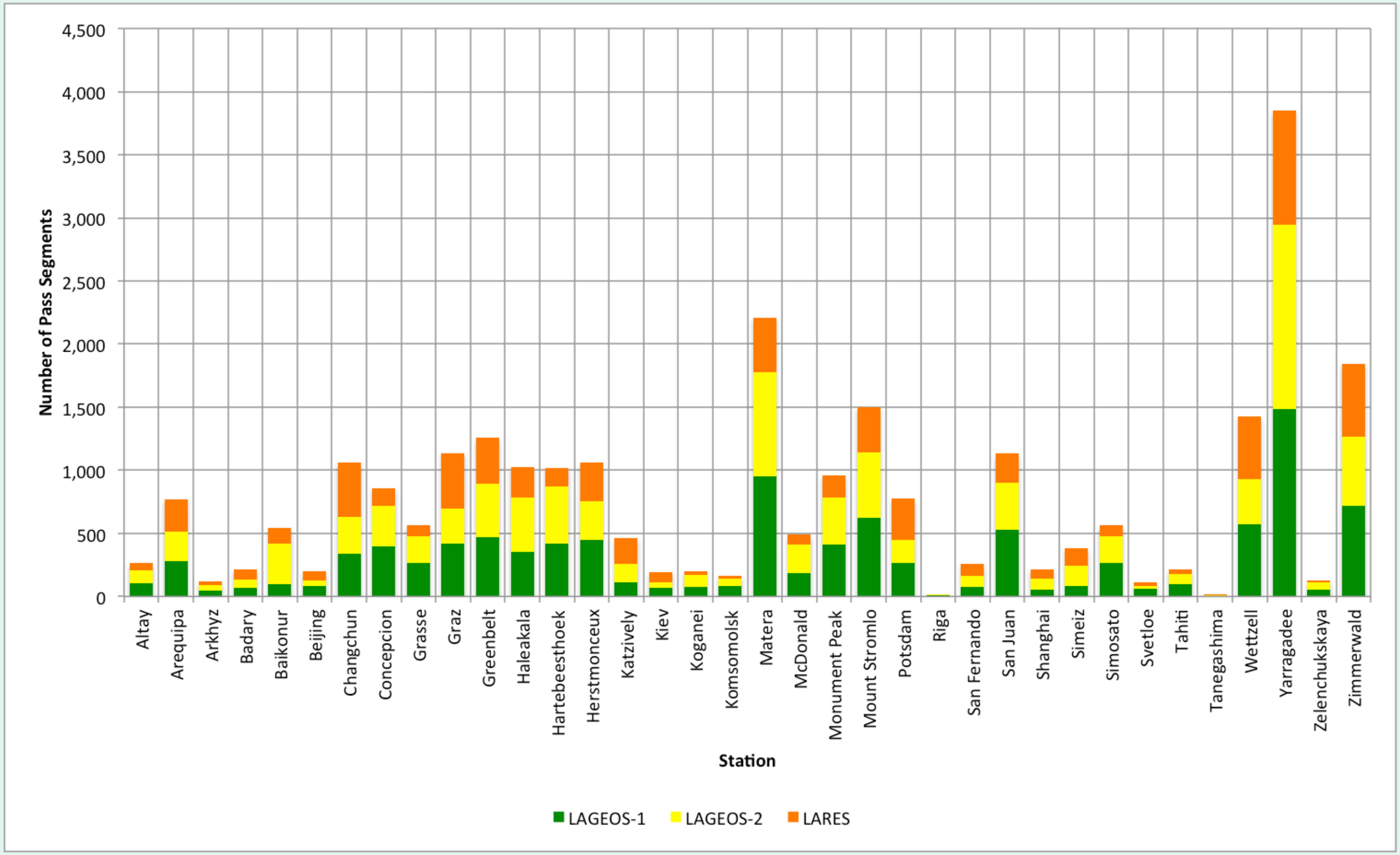


Sample of SLR Satellite Constellation

(primary reference-frame geodetic satellites)

	Etalon-I & -II	LAGEOS-1	LAGEOS-2	LARES
				
Inclination	64.8°	109.8°	52.6°	69.5°
Perigee ht. (km)	19,120	5,860	5,620	1,450
Diameter (cm)	129.4	60	60	36.4
Mass (kg)	1415	407	405.4	386.8

Large variation in volume of contribution to geodetic satellites from the Network



Growing Need for SLR measurements on the GNSS Constellations

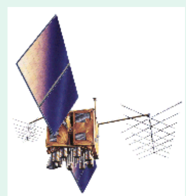
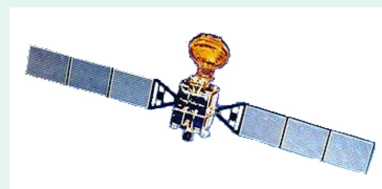
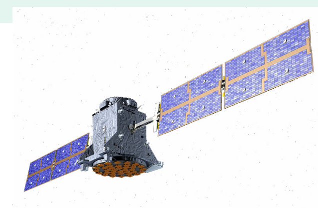
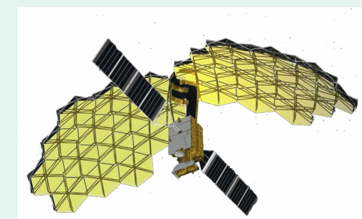
- **Geoscience**
  - Improve the Terrestrial Reference Frame (colocation in space)

  - Improve LEO POD via GNSS tracking of SLR-calibrated GNSS orbits
    - Altimeter satellites

- **GNSS World**
  - Provide independent Quality Assurance: - The GNSS orbit accuracy cannot be directly validated from the GNSS data itself;
  - Assure interoperability amongst GPS, GLONASS, Galileo, COMPASS
  - Insure realization of WGS84 reference frame is consistent with ITRF
  - SLR is NOT required for use in routine / operational RF-derived orbit and clock products
- **GNSS Support** is set to become more demanding, with GALILEO, GPS...

Sample of SLR Satellite Constellation

(Global Navigational Satellite System support via SLR)

	GLONASS	GPS	COMPASS	GIOVE/GALILEO	ETS-8
					
Inclination	64°	55°	55.5°	56°	0°
Perigee ht. (km)	19,140	20,100	21,500	23,920	36,000
Mass (kg)	1,400	930	1,000	600	2800

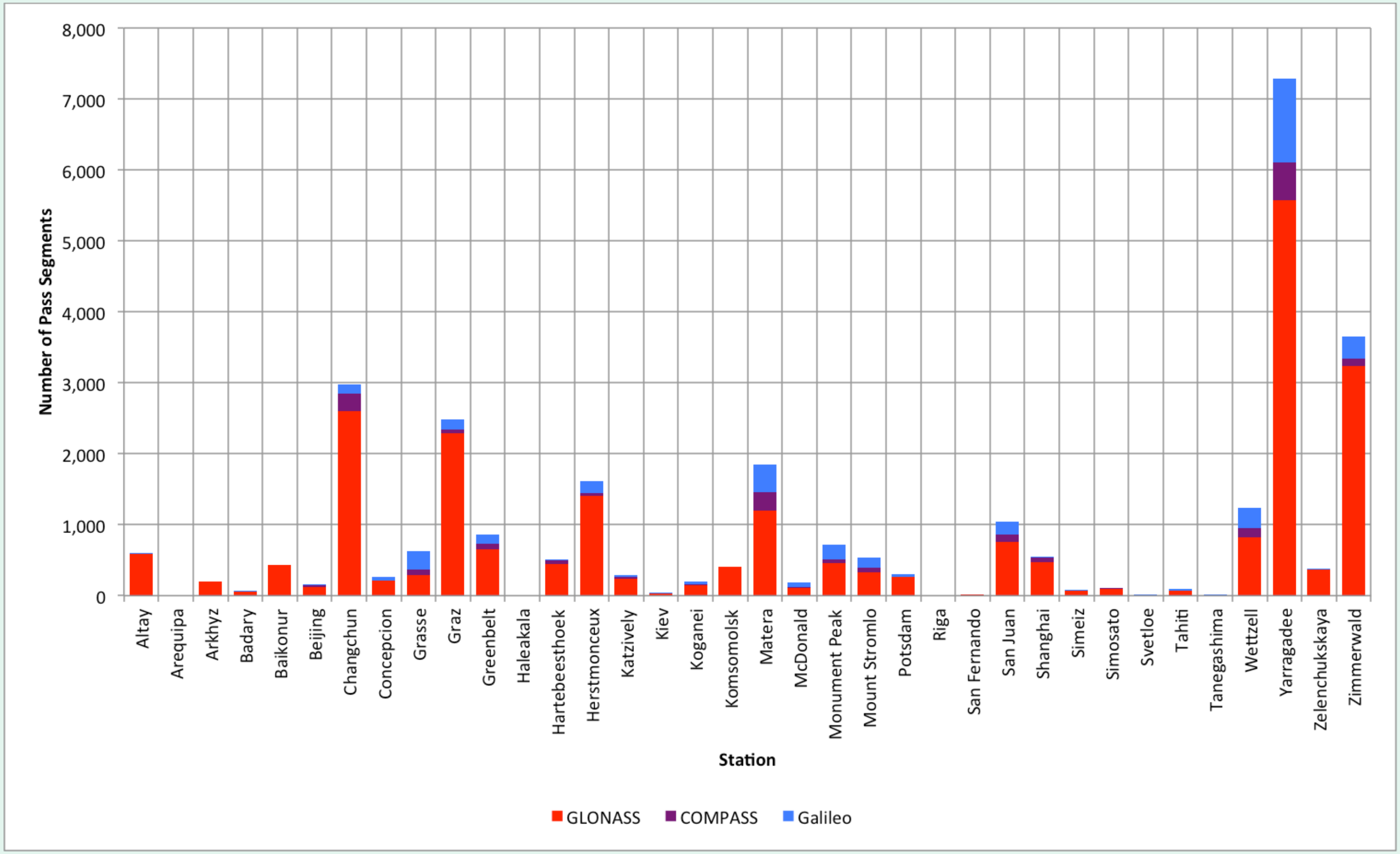
GNSS laser ranging

- Particularly challenging for stations because of distance:
  - Up to 24,000 km for GIOVE/ GALILEO
- Imperative that laser reflector arrays have sufficient radar cross-section to support day/ night ranging
- ILRS recommendation to LRA industry: $100 x 10^6$ m^2
- Collaboration with array Test Facility in Frascati
  - Potential for development of novel arrays

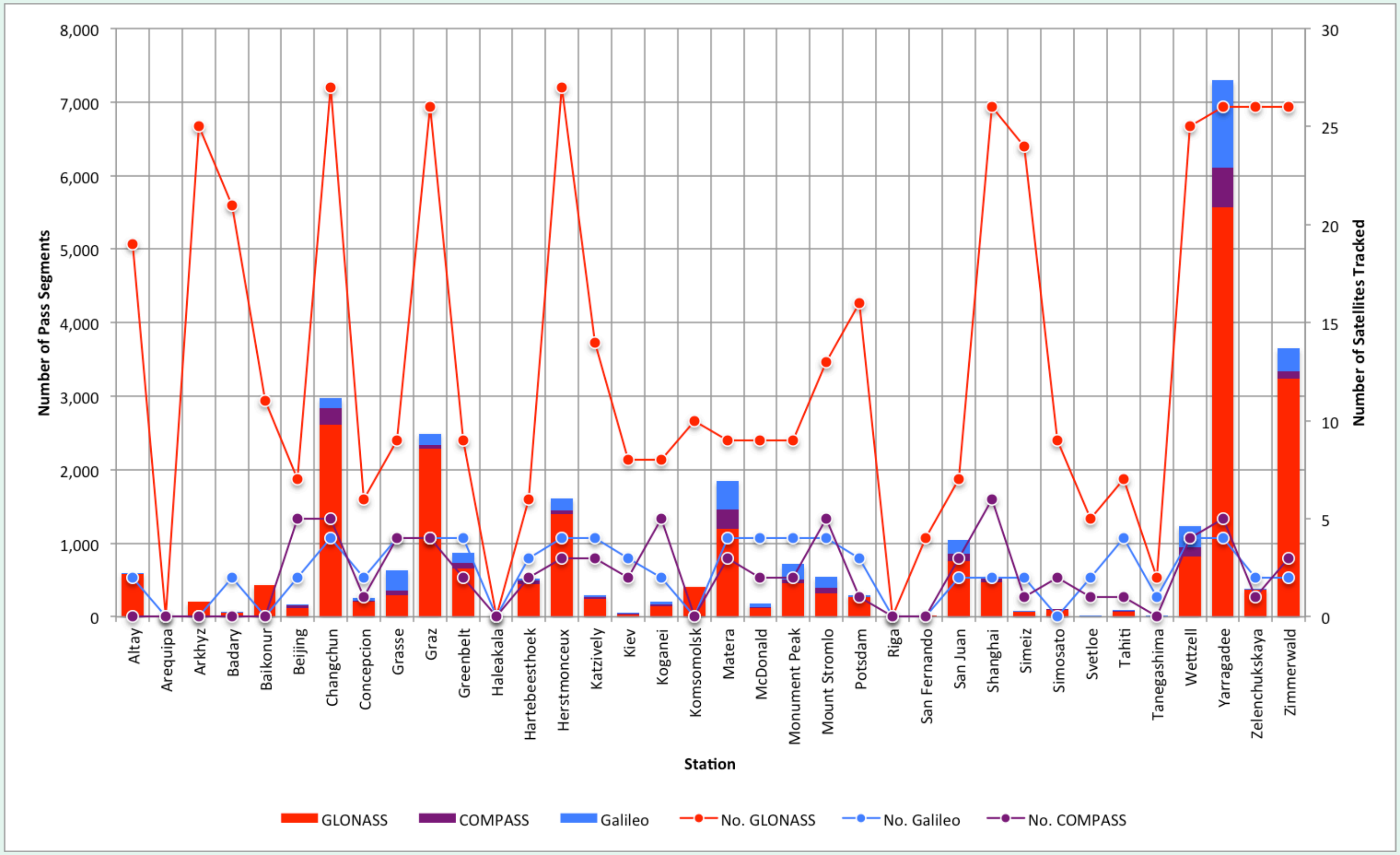
Current GLONASS tracking

- ILRS has official list of six GLONASS satellites;
- Constellation consists of 24 active satellites
- Some stations track **all** vehicles following informal request (at GNSS/SLR Meeting in Greece, 2009);
- This variation in station activities results in the following tracking records for 2012:

NETWORK performance 2012



NETWORK performance 2012 – with number of satellites tracked



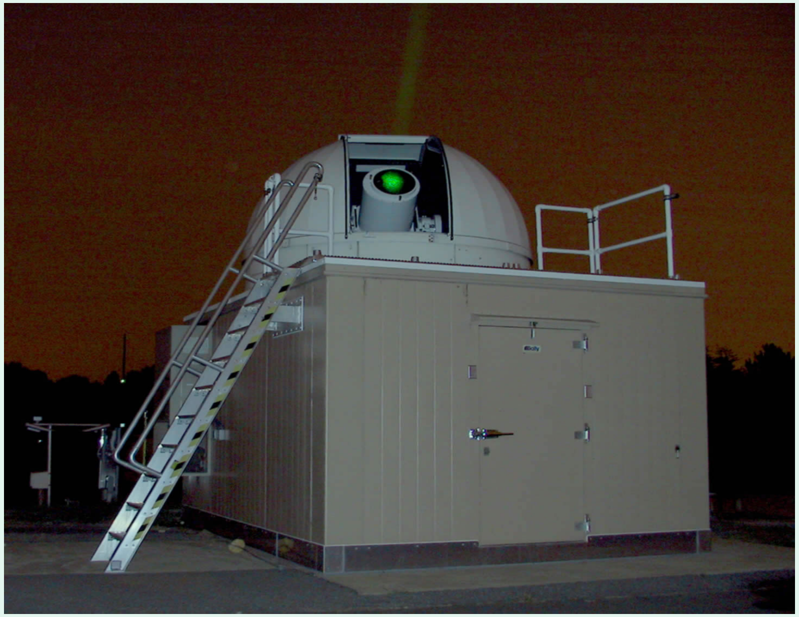
Some individual station's performances

What technology/modelling developments are on-going within the current ILRS Network

- To address this need for improvement and to expand the technique into new applications:

- 2 kHz operation:
  - to increase data yield and hence normal-point precision
  - improve efficiency of satellite interleaving
  - new science from attitude-monitoring
- Eye-safe operations and auto tracking
- Automation (unattended operation)
- Event timers with near-pico-sec resolution
- Evaluation of hardware-induced observational error
- Improved modelling of satellite mass-centre corrections
- **Some examples**:

High repetition-rate, automation



- Prototype Automated SLR System at NASA Goddard Space Flight Center;
- some other ILRS stations have upgraded to kHz repetition rates:
- Improved ranging precision through need to upgrade event timers
- Other benefits:

Experiment to obtain 1mm precision per NP