ILRS Products, Standards, Modeling

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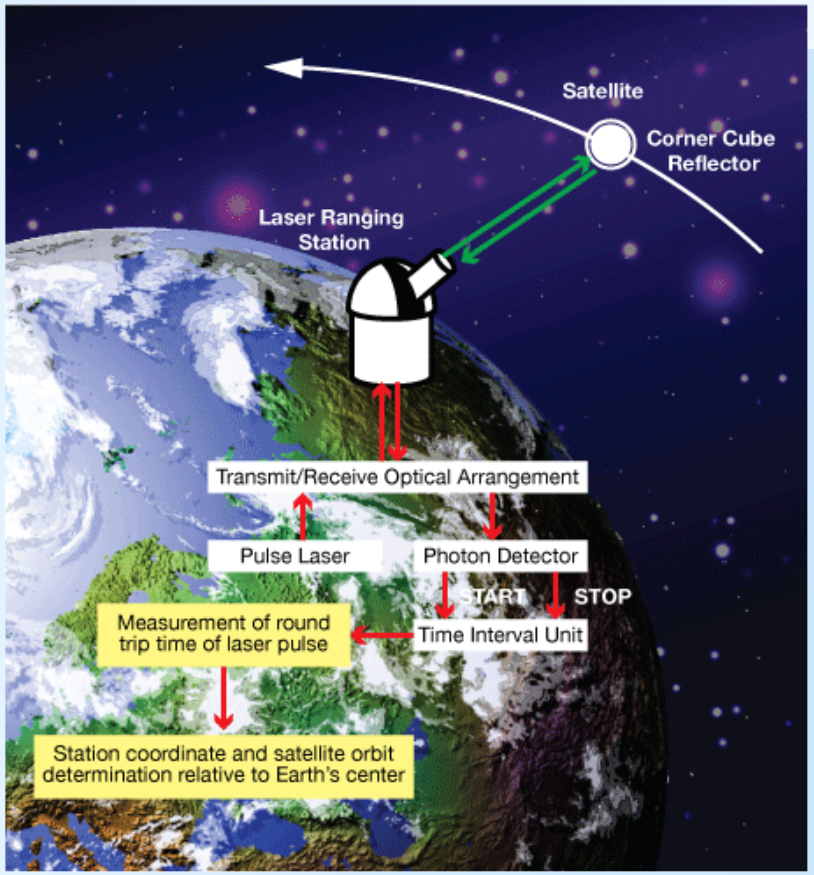
Satellite Laser Ranging - the Technique

Precise range measurement between an SLR station and a satellite using ultra-short laser pulses.

- Simple range measurement
- Space segment is passive
- Simple refraction model
- Night / Day Operation
- Near real-time global data availability
- Satellite altitudes from <300 km to geosynchronous satellites, and the Moon (Mars also with transponders)
- *cm* satellite Orbit Accuracy
- High accuracy and resolution long time series, EOP, $C/S_{n,m}$



- Unambiguous ~ cm accurate orbits
- Long-term stable time series

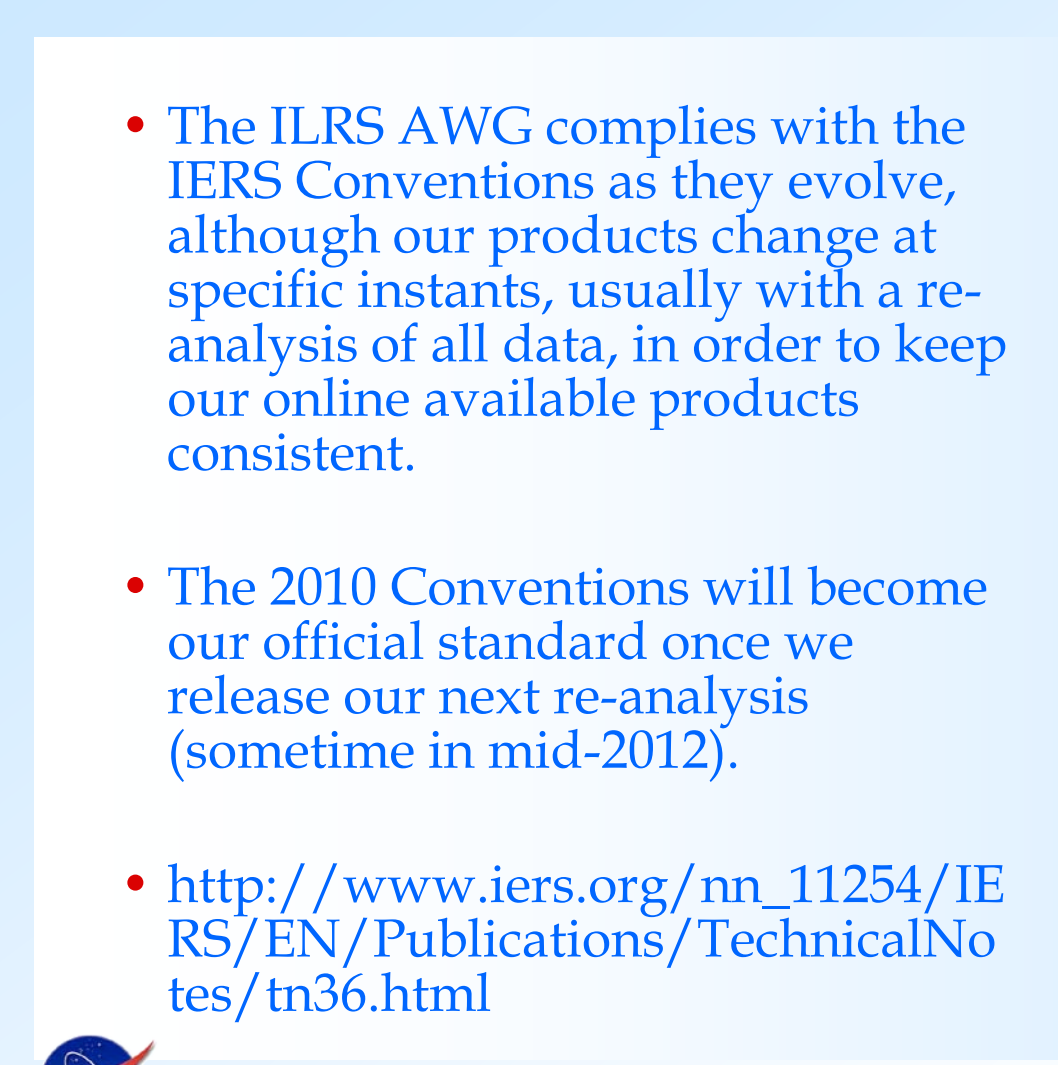
ILRS Analysis Products and Services

- Nine ACs and two ***CCs:***
  - ***ASI***, BKG, DGFI, ESA, GA, GFZ, GRGS, ***JCET***, and NSGF

- AWG Products and Services:
  - Operational **weekly** & **daily** products routinely delivered
  - ITRF2008-based TRF used internally (SLRF2008)
  - Orbit products (SP3C files) in testing Pilot Project
  - Testing the application of atmospheric effects in ILRS products
  - Generation of a "low degree harmonics" series (for CPP/GGOS)
  - New/returning station validation
  - Validation of submitted data in the new data format (CRD)

IERS Conventions 2010

- The ILRS AWG complies with the IERS Conventions as they evolve, although our products change at specific instants, usually with a re-analysis of all data, in order to keep our online available products consistent.
- The 2010 Conventions will become our official standard once we release our next re-analysis (sometime in mid-2012).
- http://www.iers.org/nn_11254/IERS/EN/Publications/TechnicalNotes/tn36.html



International Earth Rotation and Reference Systems Service (IERS)
Service International de la Rotation Terrestre et des Systèmes de Référence

IERS Technical Note No. 36

IERS Conventions (2010)

Gérard Petit[1] and Brian Luzum[2] (eds.)

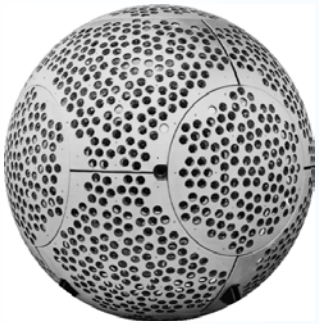
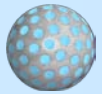
IERS Conventions Centre

[1] Bureau International des Poids et Mesures (BIPM)
[2] US Naval Observatory (USNO)

Verlag des Bundesamts für Kartographie und Geodäsie
Frankfurt am Main 2010

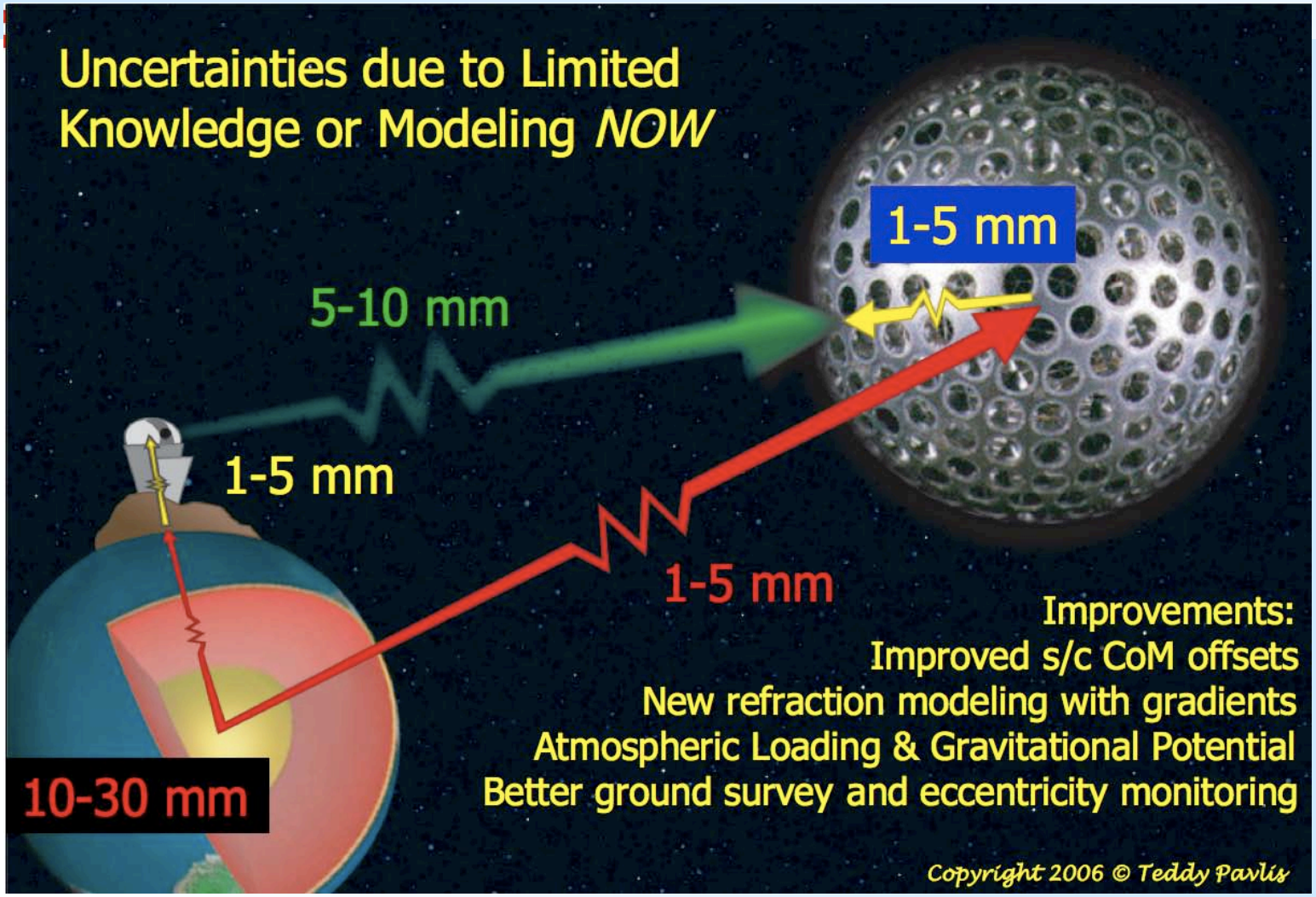
SLR Geodetic Satellite Constellation

International Laser Ranging Service

	Etalon-I & -II	LAGEOS-1	LAGEOS-2	Ajisai	Starlette	Stella	LARES
							
Inclination	64.8°	109.8°	52.6°	50°	50°	98.6°	~70°
Perigee ht. (km)	19,120	5,860	5,620	1,490	810	800	~1500
Diameter (cm)	129.4	60	60	215	24	24	36
Mass (kg)	1415	407	405.4	685	47.3	47.3	~400

LARES $_{A/m}$ = 0.36 x LAGEOS

Current SLR Model Status



Target signature (CoM)

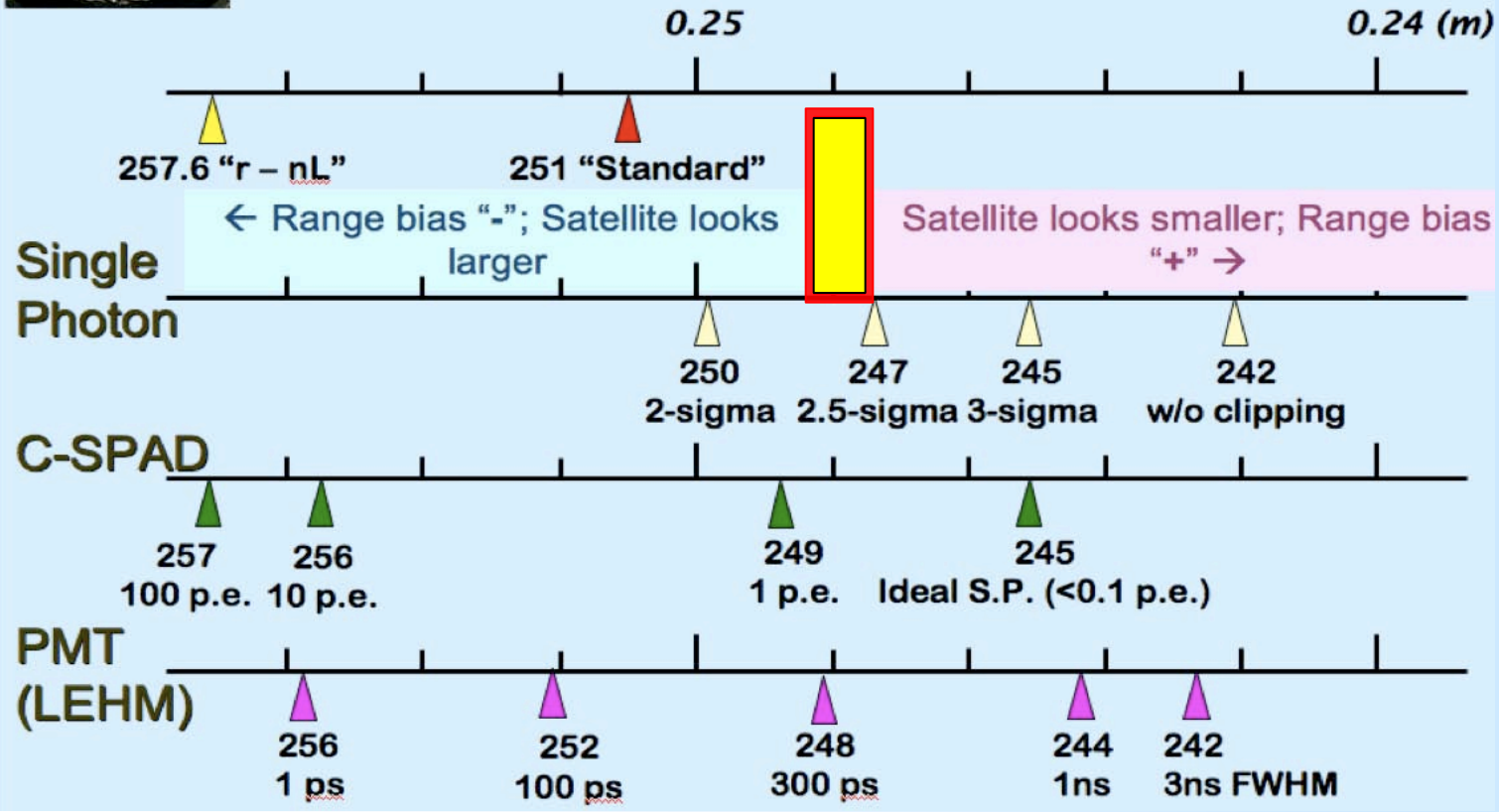
Graham Appleby & Toshi Otsubo

LAGEOS

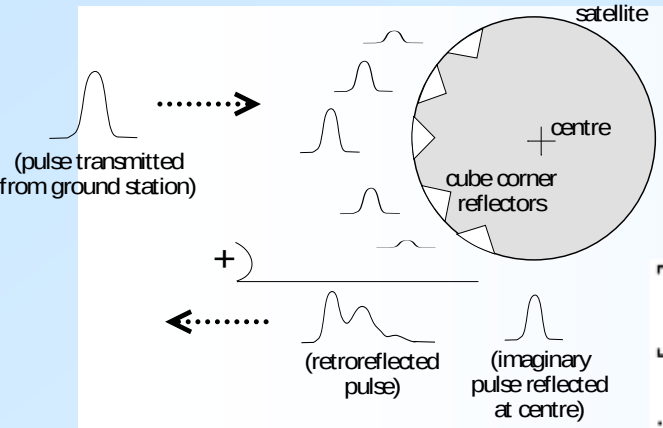
Diameter 600 mm

Centre-of-mass correction

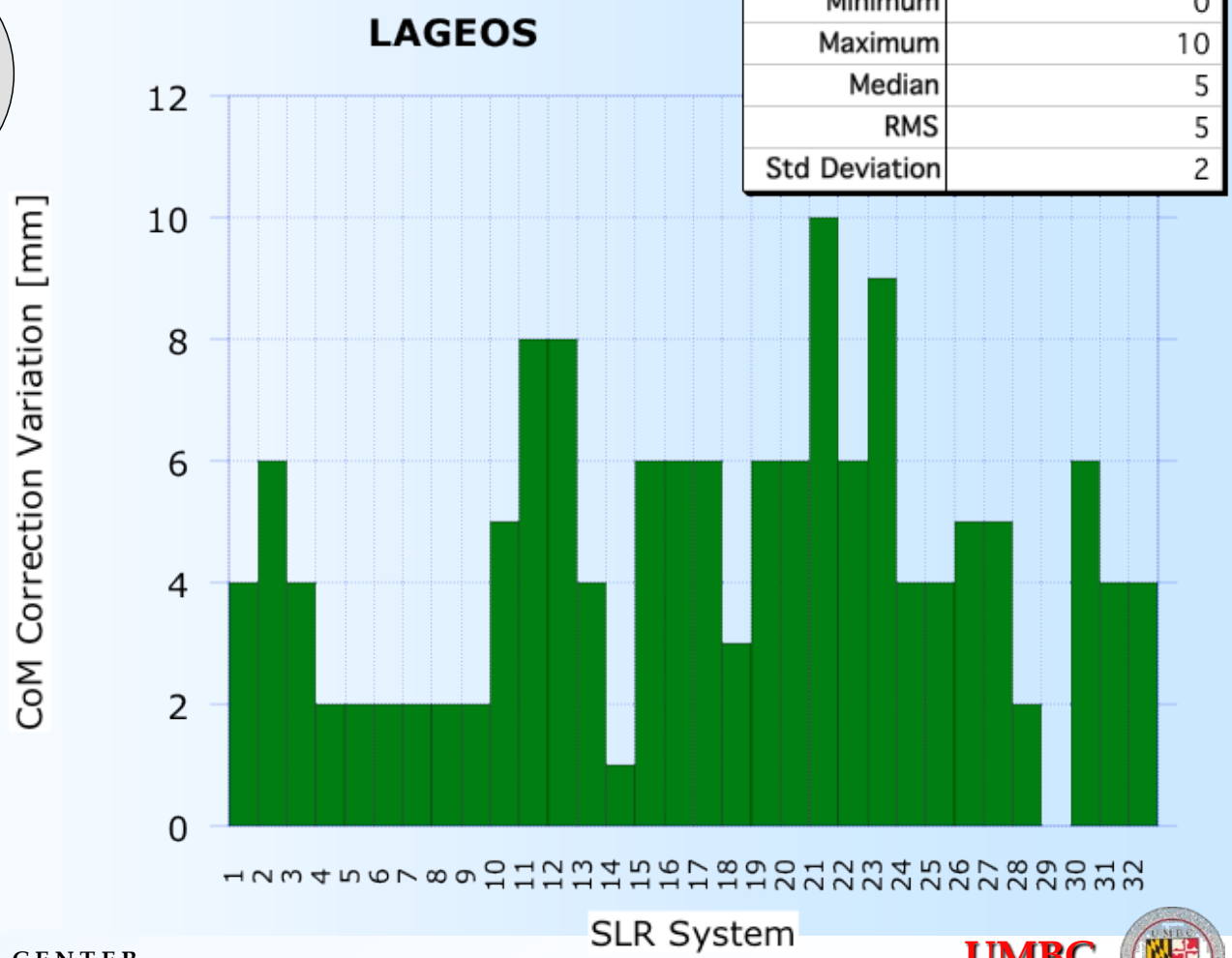
Otsubo & Appleby, JGR, 2003



Target Signature (CoM)



LAGEOS	ΔCoM Range [mm]
Minimum	0
Maximum	10
Median	5
RMS	5
Std Deviation	2

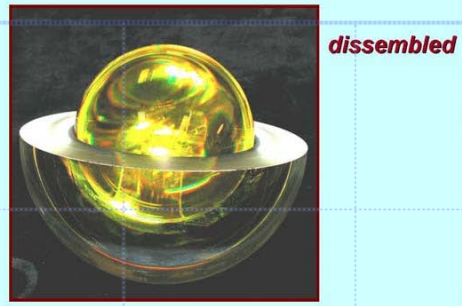


Target signature (CoM)

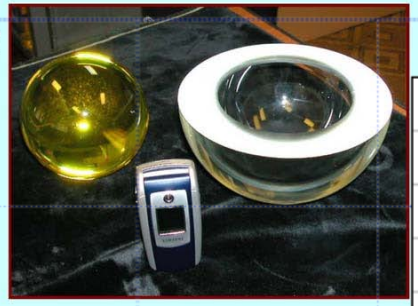
Stn pad ID	Name	Pulse length (ps)	Detector	Regime (single, few, multi)	Editing Level (×σ)	Calib. St. error (mm)	LAGEOS St. error (mm)	LAGEOS CoM range (mm)	LAGEOS CoM ADOPTED (mm)
1873	Simeiz	350	PMT	No CNTL	2.0	60	70	248-244	246
1884	Riga	130	PMT	CNTLD s->m	2.0	10	15	252-248	250
7080	McDonald	200	MCP	CNTLD s->m	3.0	8.5	13	250-248	249
7090	Yaragadee	200	MCP	CNTLD f->m	3.0	4.5	10	250-248	249
7105	Greenbelt	200	MCP	CNTLD f->m	3.0	5	10	250-248	249
7110	Mon. Peak	200	MCP	CNTLD f->m	3.0	5	10	250-248	249
7124	Tahiti	200	MCP	CNTLD f->m	3.0	6	10	250-248	249
7237	Changchung	200	CSPAD	CNTLD s->m	2.5	10	15	250-245	248
7249	Beijing	200	CSPAD	No CNTL, m	2.5	8	15	255-247	251
7355	Urumqui	30	CSPAD	No CNTL	2.5	15	30	255-247	251
7405	Conception	200	CSPAD	CNTLD s	2.5	15	20	246-245	246
7501	Harteb.	200	PMT	CNTLD f->m	3.0	5	10	250-244	247
7806	Metsahovi	50	PMT	?	2.5	15	17	254-248	251
7810	Zimmerwald	300	CSPAD	CNTLD s->f	2.5	20	23	246-244	245
7811	Borowiec	40	PMT	No CNTL f	2.5	16	23	256-250	253
7824	San Fernando	100	CSPAD	No CNTL s->m	2.5	30	25	252-246	249
7825	Stromlo	10	CSPAD	CNTLD s->m	2.5	4	10	257-247	252
7832	Riyadh	100	CSPAD	CNTLD s->m	2.5	10	15	252-246	249
7835	Grasse	50	CSPAD	CNTLD s->m	2.5	6	15	255-246	250
7836	Potsdam	35	PMT	CNTLD s->m	2.5	10	20	256-252	254
7838	Simosato	100	MCP	CNTLD s->m	3.0	20	40	252-248	250
7839	Graz	35	CSPAD	No CNTL m	2.2	3	9	255-250	252
7839	Graz kHz	10	CSPAD	No CNTL s->f	2.2	3	9	255-250?	252
7840	Herstmonceux	100	CSPAD	CNTLD s	3.0	6	15	246-244	245
7840	Hx kHz	10	CSPAD	CNTLD s	-1.5,+2.5	3	9	245	245
7841	Potsdam 3	50	PMT	CNTLD s->f	2.5	10	18	254-248	251
7941	Matera	40	MCP	CNTLD m	3.0	1	5	252-248	250
8834	Wettzell	80	MCP	No CNTL f->m	2.5	10	20	252-248	250

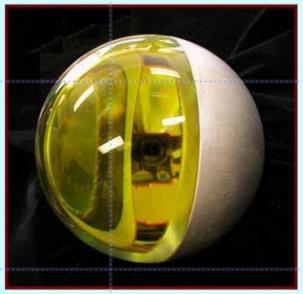
BLITS – Ball Lens In The Space Satellite

International Laser Ranging Service

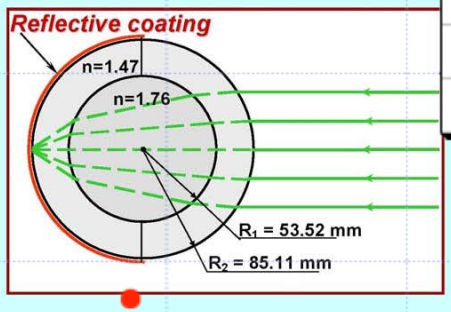


dissembled





Ready for testing



BLITS	RMS
Minimum	4.7
Maximum	18.0
Points	48
Mean	10.8
Std Deviation	3.1
Std Error	0.4

Atmospheric Loading (ECMWF)

Difference in the RMS of fit of weekly arcs of LAGEOS SLR for 2001 & 2006 and four Atmospheric loading treatments (one being NO loading)

Variable	Points	Mean	Median	RMS	Std Deviatio
ΔRMS v0-NO	52	3.4	2.7	4.45	2.87
ΔRMS v1-NO	104	2.9	2.1	4.31	3.16
ΔRMS v2-NO	52	2.7	1.7	4.09	3.08
ΔRMS v1-v0	52	0.4	0.0	0.92	0.82
ΔRMS v2-v1	52	1.7	1.4	2.58	1.96

"v0": 1970/01 - 2002/08: ECMWF Reanalysis (ERA40), with a spatial resolution of 1.125 degrees

"v1": 2000/12 - 2006/12: ECMWF Operational, with a spatial resolution of about 0.350 degrees

"v2": 2005/10 - now: ECMWF Operational, with a spatial resolution of about 0.250 degrees

Summary

- ILRS delivers to IERS a weekly POS+EOP product and a daily one, primarily for the EOP Rapid Service (NEOS)
  - *the later will transition from a PP to operational soon*
- AWG Products Plan for next twelve months:
  - **Daily Product** to become the **Operational Product (Nov. '11)**
  - **Weekly Product** will be enhanced with forward modeling of atmospheric modeling (at least) and estimation of low degree harmonics (2x2), and it will be available with a slightly longer delay, as the **"Definitive" Product (Feb. '12)**
  - Orbit products (SP3C files) when they transition from the PP they will be available at the same time with the WEEKLY Product and referenced to current ITRF (SLRF2008) **(Feb. '12)**
- Next AWG re-analysis around spring of 2012