

Estimation of Earth rotation parameters from Lunar Laser Ranging data

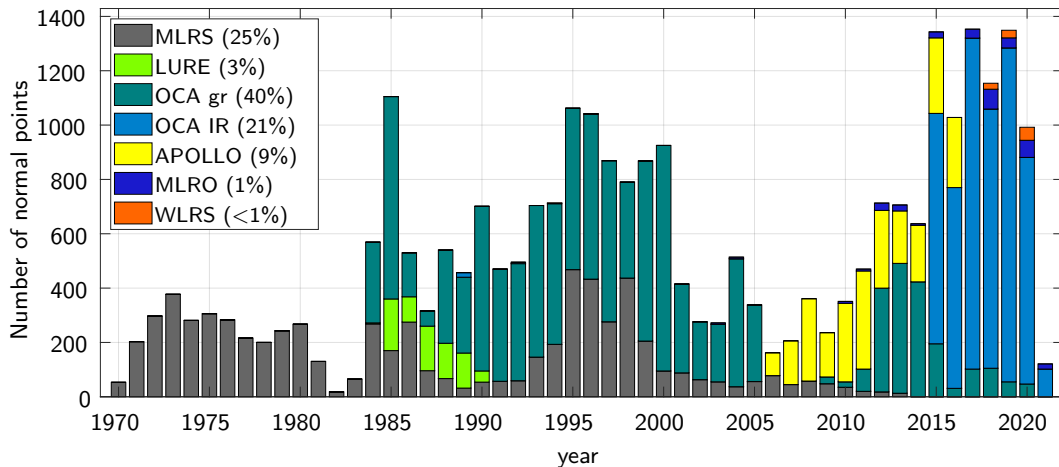
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28093 normal points over the time span April 1970 - April 2021.



- ▶ all LLR NP used to determine the parameters of Earth-Moon system
- ▶ pre-analysis to identify subsets of data with special conditions for ERP determination
- ▶ different constellations of stations and the number of NP per night tested
⇒ best results with LLR data from the Côte d'Azur Observatory, Grasse, France (OCA)
- ▶ simultaneous determination of either ΔUT1 , x_p or y_p , coordinates of all observatories and other parameters of the Earth-Moon system
- ▶ velocities of the observatories fixed to ITRF2014 values
- ▶ a-priori ERP from IERS C04 series, fixed for those nights that were not considered
- ▶ 15 NPs per night for time span 01.2000 - 12.2020 (234 nights)

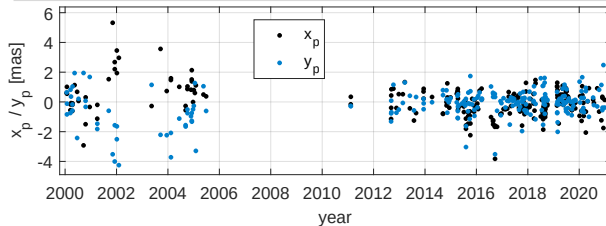


Figure: x_p, y_p differences to a-priori IERS C04 EOP series

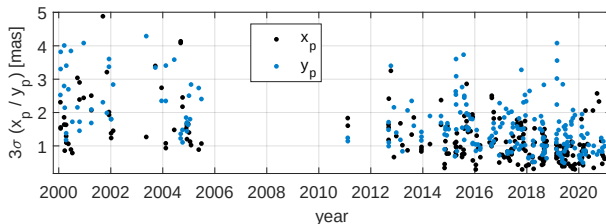


Figure: $3\sigma(x_p, y_p)$ uncertainties

- ▶ x_p values vary in the range of -3.8 mas to 5.3 mas with rms of the data of 1.0 mas
- ▶ y_p values vary in the range of -4.2 mas to 2.5 mas with rms of the data of 1.0 mas
- ▶ $3\sigma(x_p)$ values vary between 0.3 mas to 4.9 mas with rms of the uncertainty of 1.4 mas
- ▶ $3\sigma(y_p)$ values vary between 0.5 mas to 4.3 mas with rms of the uncertainty of 1.8 mas

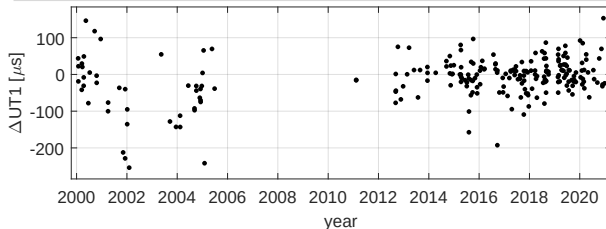


Figure: Δ UT1 differences to a-priori IERS C04 EOP series

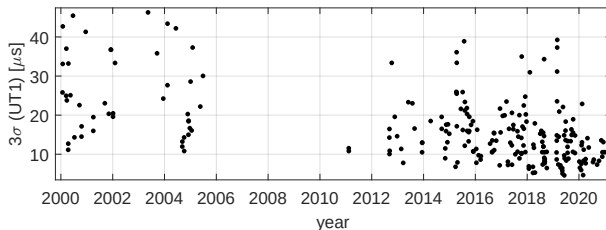


Figure: $3\sigma(\Delta$ UT1) uncertainties

- ▶ Δ UT1 values vary in the range of -253.8μ s to 153.1μ s with rms of the data of 58.5μ s
- ▶ $3\sigma(\Delta$ UT1) values vary between 4.6μ s to 46.3μ s with rms of the uncertainty of 18.6μ s
- ▶ ERP results published and under review: Singh et al, Advances in Space Research

periode	results 2018 [mas]	results 2022 [mas]
$A_{18.6y}$	1.42 ± 0.53	-0.24 ± 0.24
$B_{18.6y}$	-0.18 ± 0.19	0.04 ± 0.11
$A''_{18.6y}$	-0.68 ± 0.37	0.14 ± 0.19
$B''_{18.6y}$	-0.06 ± 0.21	0.06 ± 0.11
$A_{9.3y}$	-1.12 ± 0.34	-0.18 ± 0.20
$B_{9.3y}$	-0.27 ± 0.15	0.12 ± 0.08
$A''_{9.3y}$	-1.55 ± 0.34	-0.68 ± 0.19
$B''_{9.3y}$	0.17 ± 0.14	0.06 ± 0.08
$A_{365.3d}$	1.05 ± 0.19	-0.09 ± 0.11
$B_{365.3d}$	-0.51 ± 0.09	-0.09 ± 0.05
$A''_{365.3d}$	0.65 ± 0.15	0.00 ± 0.09
$B''_{365.3d}$	0.04 ± 0.06	-0.01 ± 0.04

periode	results 2018 [mas]	results 2022 [mas]
$A_{182.6d}$	0.51 ± 0.17	-0.14 ± 0.09
$B_{182.6d}$	-0.06 ± 0.07	0.02 ± 0.04
$A''_{182.6d}$	-0.57 ± 0.14	-0.32 ± 0.08
$B''_{182.6d}$	-0.07 ± 0.07	-0.12 ± 0.04
$A_{13.6d}$	1.49 ± 0.63	-0.50 ± 0.21
$B_{13.6d}$	-0.65 ± 0.26	0.13 ± 0.09
$A''_{13.6d}$	-1.42 ± 0.81	-0.09 ± 0.11
$B''_{13.6d}$	0.27 ± 0.32	-0.02 ± 0.05

- ▶ smaller differences to a-priori MHB2000 model
- ▶ uncertainties improved by factor 2
- ▶ biggest improvement for 13.6d period, benefit from IR OCA data

Hofmann et al, 2018,
DOI:10.1007/s00190-018-1109-3

- ▶ new results benefits from IR NP with higher accuracy and better distribution over synodic month
- ▶ best LLR result for x_p, y_p and ΔUT from the highly accurate OCA data with 15 NPs per night
- ▶ determination of Nutation coefficients with smaller differences to a-priori MHB2000 model and improved uncertainties
- ▶ next step: combination of VLBI and LLR for validation on both sides

- ▶ for any questions please contact:
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