

18th International Workshop on Laser Ranging

FujiYoshida
10-15 November 2013

Lunar Laser Ranging: Recent activities of POLAC

Sébastien Bouquillon et al.

*Service Polac / SYRTE / Observatoire de Paris
In collaboration with the INPOP Group and the MéO laser Station
(IMCCE Observatoire de Paris /GeoAzur, Observatoire de la Côte d'Azur)*

Lunar Laser Ranging: Recent activities of POLAC

Contents

Overview of POLAC history and activities.

POLAC recent activities:

- Support for LLR observers:
 - Improvements of “Prediction and Validation” tools
 - Validation of LLR Observations by e-mail
- Support for LLR DATA users:
 - Critical analyse of an extended LLR data gathering.

POLAC projects.

Overview of POLAC history activities.

Paris Observatory Lunar Analysis Center (*since 1996*)

In SyRTE division of Paris Observatory

- Current members: *S. Bouquillon & C. Le Poncin-Lafitte*
- Founding members: *J. Chapront, M. Chapront-Touzé & G. Francou*
- Main collaborators: *H. Manche(IMCCE), J-M Torre(OCA), D. Feraudy(OCA)
C. Lhotka(Roma University)*

Specificities of this service:

- LLR data reduction based on two semi-analytical Lunar theories:
 - ★ ELP(Ephéméride Lunaire Parisienne) *J.Chapront & M.Chapront-Touzé*
 - ★ The Lunar Libration Theory *developed by M.Moons*
- Implications with EOP-PC and ICRS-PC (products centers of IERS)
- Close Cooperation with the Grasse Station(Me0).
- Collaboration (since 2006) with the group in charge of the development of INPOP (Intégration Numérique Planétaire de l'Observatoire de Paris)
- Recent interactions with the Team "Theory & Metrology" of SyRTE division of Paris Observatory

POLAC recent activities:
Support for LLR observers.

Improvement of “Prediction & Validation” Tools

<http://polac.obspm.fr/PaV/>

Improvement of “Prediction & Validation” Tools





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  **Lunar Laser Ranging Service**  

Paris Observatory Lunar Analysis Center

Version 1.1 : 10th September 2013

Prediction for future LLR Observations Validation of past LLR Observations

HELP HOME

Developed by : C. Barache, S. Bouquillon, T. Carlucci, F. Deleflie, D. Feraudy, G. Francou, H. Manche, E. Samain, J-M. Torre & W. Zerhouni
Acknowledgments to Randall Ricklefs & to Pierre Tessandier for their helps.

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Pointing towards the Moon.





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Paris Observatory Lunar Analysis Center

Prediction for future LLR Observations :

Ephemerides : ELP96 ELPMPPO2

Sites :

Targets :

Year :

Month :

Day :

Hour :

Minute :

Second :

Step :

Number of Points :

Temperature (°C) :

Pressure (hPa) :

Humidity (%) :

Wavelength (nm) :

Current Predictions Repositories :

Critics and suggestions are welcome (polac.contact at obspm.fr)

LLR SERVICE / PREDICTION - Ref : ELP96 #1101.00 FIT IERS02CEP

Site : GRASSE
Target : APOLLO 15
Pressure : 852.5 milliBar
Temperature : 7.1 degrees Celsius
Humidity : 32.0 %
Wavelength : 0.532 micrometers

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[Download Prediction with cpf format \(right click and save as ...\)](#)

[Download Prediction with tpf format \(right click and save as ...\)](#)

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Pointing towards the Moon.

The screenshot shows the Lunar Laser Ranging Service website interface. The main heading is "Lunar Laser Ranging Service" with logos for Observatoire de Paris, SYRTE, and AZUR. Below it is "Paris Observatory Lunar Analysis Center". The section is titled "Prediction for future LLR Observations :".

Submission area (highlighted in red):

- Ephemerides :** ELP96 ELPMPPO2
- Sites :** GRASSE
- Targets :** APOLLO 15
- Year :** 2011
- Month :** 2
- Day :** 14
- Hour :** 19
- Minute :** 0
- Second :** 0
- Step :** 30 (min)
- Number of Points :** 20
- Temperature (°C) :** Default (7.1)
- Pressure (hPa) :** Default (852.5)
- Humidity (%) :** Default (32)
- Wavelength (nm) :** Default (532)
- GO** button
- Default Values** button

Results (highlighted in red):

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HELP HOME

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Submission area

Pointing towards the Moon.





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Submission area

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GO

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LLR Stations

01.00 FIT IERS02CEP

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Pointing towards the Moon.

- sites currently available in the web interface

MeO, Caussols, France



Wettzell, Germany



Koganei, Japan

Mc Donald, Texas, USA



Apollo, New Mexico, USA



Matera, Italy

Pointing towards the Moon.

- sites currently available in the web interface



- **New site added last year : Shanghai SLR station (07821)**

Pointing towards the Moon.

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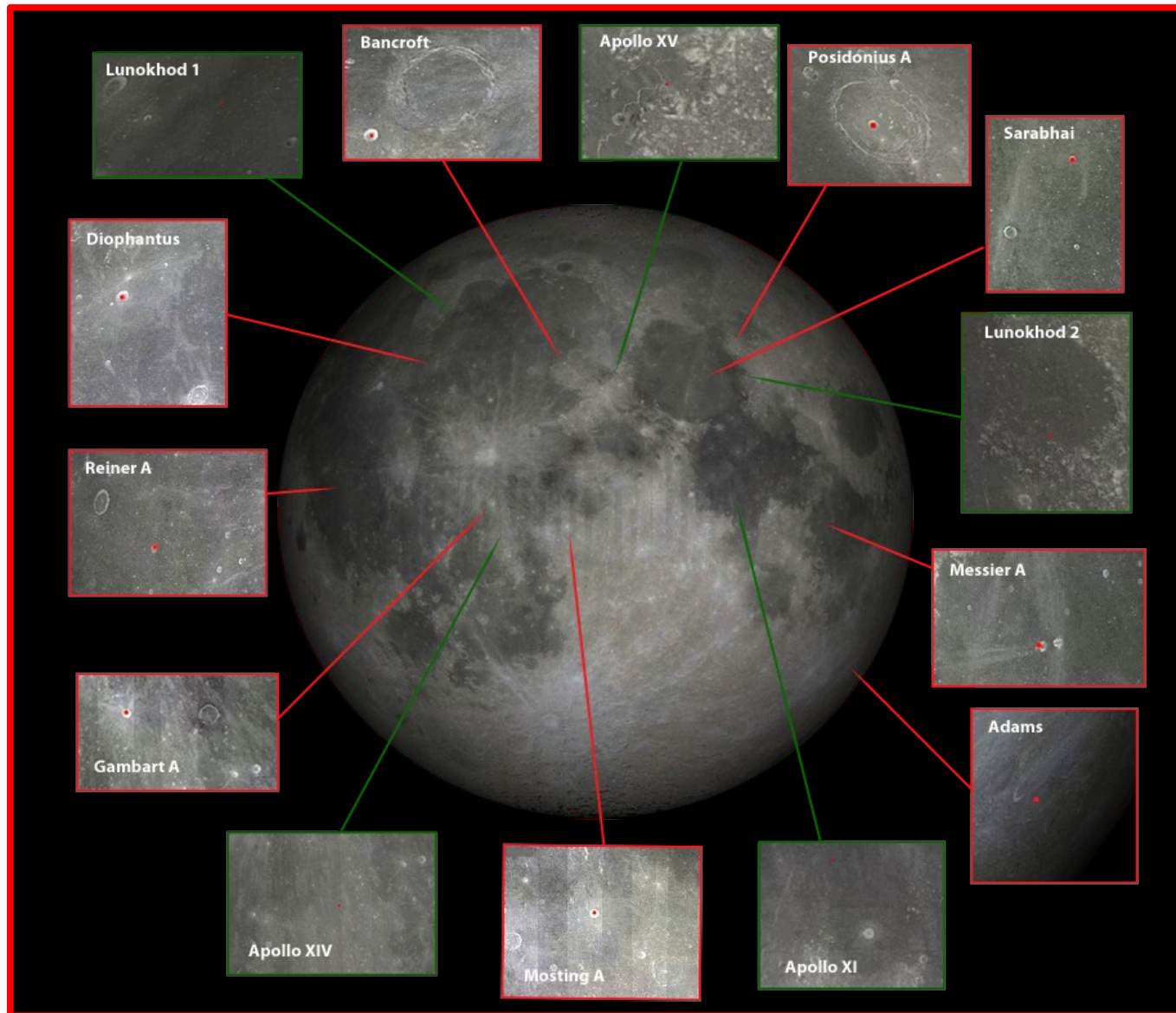
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- Reflectors and Craters currently available in the web interface



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Fichier Edition Affichage Historique Marque-pages Outils Aide

http://polac.obspm.fr/PaV/IndexPred.html la mediterranee paris

Courriel Meteo Dico Astro Reservations PagesJaunes Cinema Cartes Les Roches - La Ma... MissionCNRS Transport Nara

http://polac...ndexPred.html W faciliter - Dictionnaire Fran... http://polac...ndexPred.html

Lunar Laser Ranging Service

Paris Observatory Lunar Analysis Center

Prediction for future LLR Observations :

Ephemerides : ELP96 ELPMPPO2

Sites : GRASSE

Targets : APOLLO 15

Year : 2011

Month : 2

Day : 14

Hour : 19

Minute : 0

Second : 0

Step : 30 (min)

Number of Points : 20

Temperature (°C) : Default (7.1)

Pressure (hPa) : Default (852.5)

Humidity (%) : Default (32)

Wavelength (nm) : Default (532)

GO

Download Prediction with cpf format (right click and save as ...)

Download Prediction with tpf format (right click and save as ...)

Current Predictions Repositories : CPF TPF

Critics and suggestions are welcome (polac.contact at obspm.fr)

Ephemeris & prediction model

Site : GRASSE
Target : APOLLO 15
Pressure : 852.5 milliBar
Temperature : 7.1 degrees Celsius
Humidity : 32.0 %
Wavelength : 0.532 micrometers

RESULTS TPF (TOPOCENTRIC PREDICTION FORMAT) :

/ Number / Date / Time (UTC) / Modified Julian Date at 0h / Seconds of Day (UT
/ Rectangular coordinates X, Y, Z in the Equatorial Frame J2000 (meter) /
/ Right Ascension (degree) / Declination (degree) / Azimuth (degree) /
/ Zenith Distance (degree) / Refraction (degree) /
/ Light Time for the reflectors (second) /

| | | | | | | | |
|-------|------------|----------|-------|---------|---------------|---------------|--------|
| 00001 | 2011/02/14 | 19:00:00 | 55606 | 68400.0 | -48399786.632 | 336508507.319 | 140355 |
| 00002 | 2011/02/14 | 19:30:00 | 55606 | 70200.0 | -49638668.317 | 336128805.761 | 140054 |
| 00003 | 2011/02/14 | 20:00:00 | 55606 | 72000.0 | -50867763.560 | 335819574.259 | 139751 |
| 00004 | 2011/02/14 | 20:30:00 | 55606 | 73800.0 | -52097430.508 | 335581263.446 | 139443 |
| 00005 | 2011/02/14 | 21:00:00 | 55606 | 75600.0 | -53337996.916 | 335412958.492 | 139132 |
| 00006 | 2011/02/14 | 21:30:00 | 55606 | 77400.0 | -54599581.666 | 335312394.819 | 138818 |
| 00007 | 2011/02/14 | 22:00:00 | 55606 | 79200.0 | -55891919.877 | 335275997.045 | 138500 |
| 00008 | 2011/02/14 | 22:30:00 | 55606 | 81000.0 | -57224194.616 | 335298940.477 | 138179 |
| 00009 | 2011/02/14 | 23:00:00 | 55606 | 82800.0 | -58604878.105 | 335375234.105 | 137854 |
| 00010 | 2011/02/14 | 23:30:00 | 55606 | 84600.0 | -60041585.158 | 335497823.668 | 137525 |
| 00011 | 2011/02/15 | 00:00:00 | 55607 | 0.0 | -61540941.365 | 335658713.010 | 137194 |

Terminé

[bouquillon@pcbou... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Naviga... [*]lr_residuals_1990... Residuals.png-4.0 (R...

Pointing towards the Moon.

- Lunar solutions & reduction models available to compute predictions:

ELP96: It is an improved version of the analytical solution of the Moon ELP2000-82B (Chapront-Touzé M. & Chapront J., 1988, 1997). The numerical ephemeris DE245 (JPL) is used for the motion of the Earth-Moon barycenter and for numerical complements to the lunar librations and orbital motion. Initially, the lunar coordinates given by this solution are referred to the dynamical mean ecliptic of the date. The change to the equatorial frame of the Celestial Ephemeris Pole (J2000) is carried out by analytical expressions of the precession-nutation. This solution is fitted to the Lunar Laser Ranging observations made from 1972 until 2010 (Chapront J. & Francou G., 2002)

ELPMPP02: The main differences from the previous solution 'ELP96' is the use of the new planetary perturbations MPP01 (Bidart, 2001). The numerical ephemeris DE405 is used for the motion of the Earth-Moon barycenter and for numerical complements to the lunar librations and orbital motion. This solution is fitted to the Lunar Laser Ranging observations made from 20/08/1969 until 30/05/2013. The initial positions of station are given in ITRF 2008 and the transformation between terrestrial reference frame and celestial reference frame is done with the help of SOFA routines (consistent with IERS Conventions 2003)

New Ephemeris and New Reduction Model

Bidart, P., 2001, A&A, 366, 351B.

Chapront-Touzé, M., Chapront, J., 1988, A&A, 190, 342.

Chapront-Touzé, M., Chapront, J., 1996, Celest.Mech., 66, 31.

Chapront-Touzé, M., Chapront, J., Francou, G., 1997, Celest.Mech., 66, 31.

Chapront, J., Chapront-Tousé, M., Francou G., 2002, A&A, 387, 700.

Pointing towards the Moon.





Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:31

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  **Lunar Laser Ranging Service**  

Paris Observatory Lunar Analysis Center

Prediction for future LLR Observations :

Ephemerides : ELP96 ELPMPPO2

Sites : GRASSE

Targets : APOLLO 15

Year : 2011

Month : 2

Day : 14

Hour : 19

Minute : 0

Second : 0

Step : 30 (min)

Number of Points : 20

Temperature (°C) : Default (7.1)

Pressure (hPa) : Default (852.5)

Humidity (%) : Default (32)

Wavelength (nm) : Default (532)

Default Values

HELP HOME

GO

LLR SERVICE / PREDICTION - Ref : ELP96 #1101.00 FIT IERS02CEP

Site : GRASSE
Target : APOLLO 15
Pressure : 852.5 milliBar
Temperature : 7.1 degrees Celsius
Humidity : 32.0 %
Wavelength : 0.532 micrometers

RESULTS TPF (TOPOCENTRIC PREDICTION FORMAT) :
/ Number / Date / Time (UTC) / Modified Julian Date at 0h / Seconds of Day (UT
/ Rectangular coordinates X, Y, Z in the Equatorial Frame J2000 (meter) /
/ Right Ascension (degree) / Declination (degree) / Azimuth (degree) /
/ Zenith Distance (degree) / Refraction (degree) /
/ Light Time for the reflectors (second) /

| | | | | | | | |
|-------|------------|----------|-------|---------|---------------|---------------|--------|
| 00001 | 2011/02/14 | 19:00:00 | 55606 | 68400.0 | -48399786.632 | 336508507.319 | 140355 |
| 00002 | 2011/02/14 | 19:30:00 | 55606 | 70200.0 | -49638668.317 | 336128805.761 | 140054 |
| 00003 | 2011/02/14 | 20:00:00 | 55606 | 72000.0 | -50867763.560 | 335819574.259 | 139751 |
| 00004 | 2011/02/14 | 20:30:00 | 55606 | 73800.0 | -52097430.508 | 335581263.446 | 139443 |
| 00005 | 2011/02/14 | 21:00:00 | 55606 | 75600.0 | -53337996.916 | 335412958.492 | 139132 |
| 00006 | 2011/02/14 | 21:30:00 | 55606 | 77400.0 | -54599581.666 | 335312394.819 | 138818 |
| 00007 | 2011/02/14 | 22:00:00 | 55606 | 79200.0 | -55891919.877 | 335275997.045 | 138500 |
| 00008 | 2011/02/14 | 22:30:00 | 55606 | 81000.0 | -57224194.616 | 335298940.477 | 138179 |
| 00009 | 2011/02/14 | 23:00:00 | 55606 | 82800.0 | -58604878.105 | 335375234.105 | 137854 |
| 00010 | 2011/02/14 | 23:30:00 | 55606 | 84600.0 | -60041585.158 | 335497823.668 | 137525 |
| 00011 | 2011/02/15 | 00:00:00 | 55607 | 0.0 | -61540941.365 | 335658713.010 | 137194 |

[Download Prediction with cpf format \(right click and save as ...\)](#)

[Download Prediction with tpf format \(right click and save as ...\)](#)

Current Predictions Repositories : CPF TPF

Critics and suggestions are welcome (polac.contact at obspm.fr)

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Results area

Pointing towards the Moon.

Lunar Laser Ranging Service
Paris Observatory Lunar Analysis Center

Prediction for future LLR Observations :

Preview area:
In this area, a preview of the prediction requested by the user of this web interface is displayed. The format of this prediction is a format we developed recently and that we named **TPF** (for **T**opocentric **P**rediction **F**ormat.)

GO

```
LLR SERVICE / PREDICTION - Ref : ELP96 #1101.00 FIT IERS02CEP

Site      : GRASSE
Target   : APOLLO 15
Pressure  : 852.5 milliBar
Temperature : 7.1 degrees Celsius
Humidity  : 32.0 %
Wavelength : 0.532 micrometers

RESULTS TPF (TOPOCENTRIC PREDICTION FORMAT) :
/ Number / Date / Time (UTC) / Modified Julian Date at 0h / Seconds of Day (UT
/ Rectangular coordinates X, Y, Z in the Equatorial Frame J2000 (meter) /
/ Right Ascension (degree) / Declination (degree) / Azimuth (degree) /
/ Zenith Distance (degree) / Refraction (degree) /
/ Light Time for the reflectors (second) /

00001 2011/02/14 19:00:00 55606 68400.0 -48399786.632 336508507.319 140355
00002 2011/02/14 19:30:00 55606 70200.0 -49638668.317 336128805.761 140054
00003 2011/02/14 20:00:00 55606 72000.0 -50867763.560 335819574.259 139751
00004 2011/02/14 20:30:00 55606 73800.0 -52097430.508 335581263.446 139443
00005 2011/02/14 21:00:00 55606 75600.0 -53337996.916 335412958.492 139132
00006 2011/02/14 21:30:00 55606 77400.0 -54599581.666 335312394.492 138818
00007 2011/02/14 22:00:00 55606 79200.0 -55891919.877 335275997.045 138500
00008 2011/02/14 22:30:00 55606 81000.0 -57224194.616 335298940.477 138179
00009 2011/02/14 23:00:00 55606 82800.0 -58604878.105 335375234.105 137854
00010 2011/02/14 23:30:00 55606 84600.0 -60041585.158 335497823.668 137525
00011 2011/02/15 00:00:00 55607 0.0 -61540941.365 335658713.010 137194
```

[Download Prediction with cpf format \(right click and save as ...\)](#)
[Download Prediction with tpf format \(right click and save as ...\)](#)

Current Predictions Repositories : **CPF** **TPF**

Critics and suggestions are welcome (polac.contact at obspm.fr)

Pointing towards the Moon.

The screenshot shows the Lunar Laser Ranging Service website interface. The main heading is "Lunar Laser Ranging Service" with logos for Observatoire de Paris, SYRTE, and AZUR. Below it is "Paris Observatory Lunar Analysis Center". The section is titled "Prediction for future LLR Observations :".

On the left, there are input fields for "Ephemerides" (ELP96 selected), "Sites" (GRASSE), "Targets" (APOLLO 15), "Year" (2011), "Month" (2), "Day" (14), "Hour" (19), "Minute" (0), and "Second" (0). A "GO" button is next to these fields.

On the right, a text box displays the prediction data:

```
LLR SERVICE / PREDICTION - Ref : ELP96 #1101.00 FIT IERS02CEP
Site : GRASSE
Target : APOLLO 15
Pressure : 852.5 milliBar
Temperature : 7.1 degrees Celsius
Humidity : 32.0 %
Wavelength : 0.532 micrometers

RESULTS TPF (TOPOCENTRIC PREDICTION FORMAT) :
/ Number / Date / Time (UTC) / Modified Julian Date at 0h / Seconds of Day (UT
/ Rectangular coordinates X, Y, Z in the Equatorial Frame J2000 (meter) /
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/ Light Time for the reflectors (second) /

00001 2011/02/14 19:00:00 55606 68400.0 -48399786.632 336508507.319 140355
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00007 2011/02/14 22:00:00 55606 79200.0 -55891919.877 335275997.045 138500
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00010 2011/02/14 23:30:00 55606 84600.0 -60041585.158 335497823.668 137525
00011 2011/02/15 00:00:00 55607 0.0 -61540941.365 335658713.010 137194
```

Below the data table, there are two links: "Download Prediction with cpf format (right click and save as ...)" and "Download Prediction with tpf format (right click and save as ...)".

At the bottom, there are "HELP" and "HOME" buttons, and a note: "Current Predictions Repositories : CPF TPF".

At the very bottom, there is a footer: "Critics and suggestions are welcome (polac.contact at obspm.fr)".

Area for downloading prediction:

In this area, the prediction requested can be downloaded under **TPF** or **CPF** format.

[Download Prediction with cpf format \(right click and save as ...\)](#)

[Download Prediction with tpf format \(right click and save as ...\)](#)

Pointing towards the Moon.

Lunar Laser Ranging Service
Paris Observatory Lunar Analysis Center

Prediction for future LLR Observations :

Ephemerides : ELP96 ELPMPPO2

Sites : GRASSE

Targets : APOLLO 15

Year : 2011

Month : 2

Day : 14

Hour : 19

Minute : 0

Second : 0

Step : 30 (min)

Number of Points : 20

Temperature (°C) : Default (7.1)

GO

LLR SERVICE / PREDICTION - Ref : ELP96 #1101.00 FIT IERS02CEP

Site : GRASSE
Target : APOLLO 15
Pressure : 852.5 milliBar
Temperature : 7.1 degrees Celsius
Humidity : 32.0 %
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RESULTS TPF (TOPOCENTRIC PREDICTION FORMAT) :

/ Number / Date / Time (UTC) / Modified Julian Date at 0h / Seconds of Day (UT
/ Rectangular coordinates X, Y, Z in the Equatorial Frame J2000 (meter) /
/ Right Ascension (degree) / Declination (degree) / Azimuth (degree) /
/ Zenith Distance (degree) / Refraction (degree) /
/ Light Time for the reflectors (second) /

| | | | | | | | |
|-------|------------|----------|-------|---------|---------------|---------------|--------|
| 00001 | 2011/02/14 | 19:00:00 | 55606 | 68400.0 | -48399786.632 | 336508507.319 | 140355 |
| 00002 | 2011/02/14 | 19:30:00 | 55606 | 70200.0 | -49638668.317 | 336128805.761 | 140054 |
| 00003 | 2011/02/14 | 20:00:00 | 55606 | 72000.0 | -50867763.560 | 335819574.259 | 139751 |
| 00004 | 2011/02/14 | 20:30:00 | 55606 | 73800.0 | -52097430.508 | 335581263.446 | 139443 |
| 00005 | 2011/02/14 | 21:00:00 | 55606 | 75600.0 | -53337996.916 | 335412958.492 | 139132 |
| 00006 | 2011/02/14 | 21:30:00 | 55606 | 77400.0 | -54599581.666 | 335312394.819 | 138818 |
| 00007 | 2011/02/14 | 22:00:00 | 55606 | 79200.0 | -55891919.877 | 335275997.045 | 138500 |
| 00008 | 2011/02/14 | 22:30:00 | 55606 | 81000.0 | -57224194.616 | 335298940.477 | 138179 |
| 00009 | 2011/02/14 | 23:00:00 | 55606 | 82800.0 | -58604878.105 | 335375234.105 | 137854 |
| 00010 | 2011/02/14 | 23:30:00 | 55606 | 84600.0 | -60041585.158 | 335497823.668 | 137525 |
| 00011 | 2011/02/15 | 00:00:00 | 55607 | 0.0 | -61540941.365 | 335658713.010 | 137194 |

[Download Prediction with cpf format \(right click and save as ...\)](#)

[Download Prediction with tpf format \(right click and save as ...\)](#)

Current Predictions Repositories :

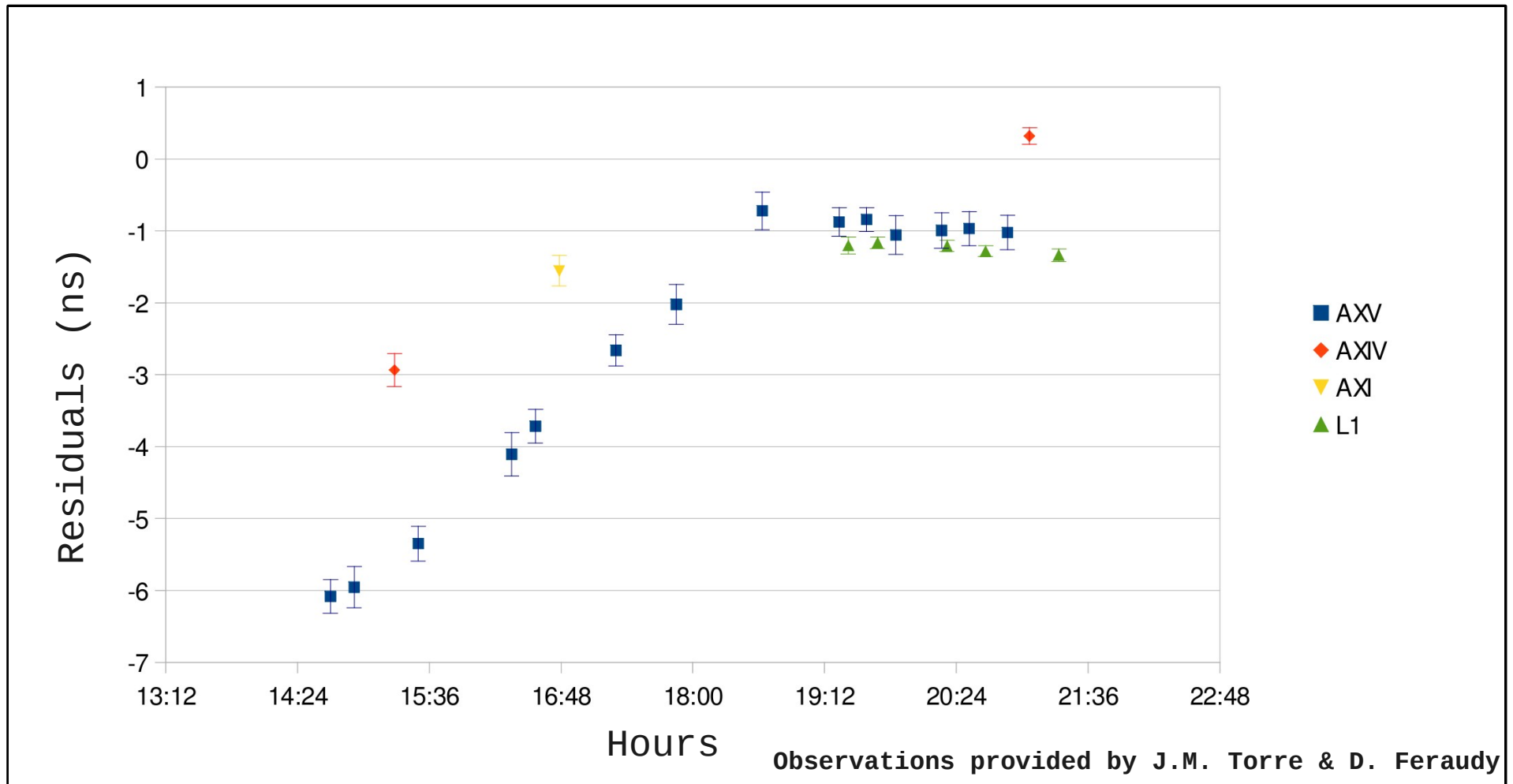
Current predictions repositories:

In this area, daily predictions are available under CPF or TPF format for all the lunar targets. They are computed for 3 days since the current date with a step of 30 min and they are updated each day at 10:30am (Paris Local time) just after the **EOP** daily solution produced by IERS EOP product center.

Current Predictions Repositories :

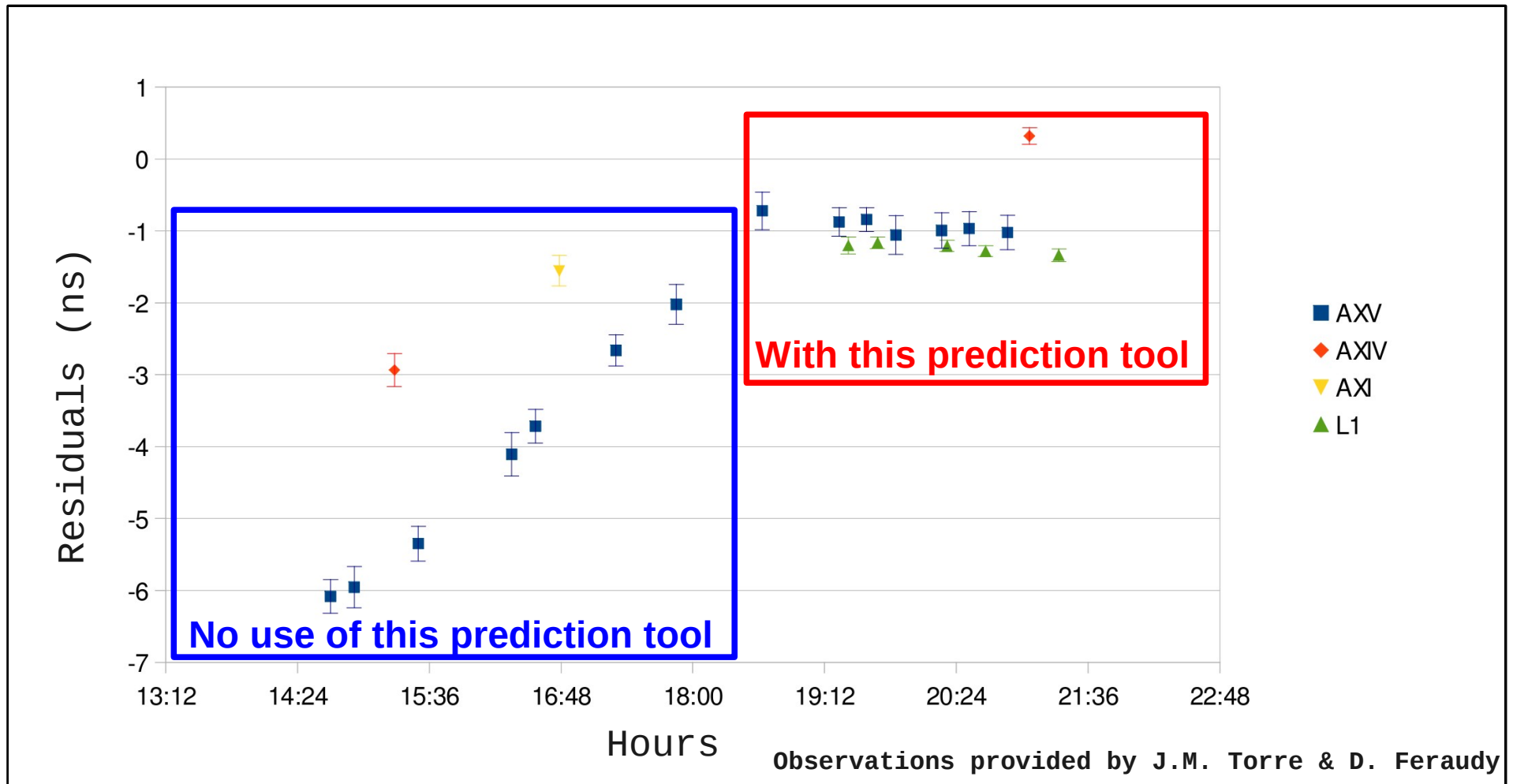
Example of Prediction done with this tool: First Detection of Lunokhod 1 with Me0 *Night 19th/20th of March 2013*

- LLR NP Residuals obtained during the night



Example of Prediction done with this tool: First Detection of Lunokhod 1 with Me0 *Night 19th/20th of March 2013*

- LLR NP Residuals obtained during the night







Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:41

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http://polac.obspm.fr/PaV/ apercu - Dictionnaire Fran... http://polac.o...dexValid.html



Lunar Laser Ranging Service

Paris Observatory Lunar Analysis Center

Version 1.1 : 11th September 2013

[Prediction for future LLR Observations](#) [Validation of past LLR Observations](#)

[HELP](#) [HOME](#)

Developed by : C. Barache, S. Bouquillon, T. Carlucci, F. Deleflie, D. Feraudy, G. Francou, H. Manche, E. Samain, J-M. Torre & W. Zerhouni
Acknowledgments to Randall Ricklefs & to Pierre Tessandier for their helps.

Terminé

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Validation of LLR normal Points.



Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:32

Fichier Edition Affichage Historique Marque-pages Outils Aide

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http://polac...ndexPred.html W. faciliter - Dictionnaire Fran... http://polac.o...dexValid.html

 **Lunar Laser Ranging Service** 

Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

| | | | | | | |
|---|----|----------|-------|-------|-------|-------|
| 5119871012233117486916126297157660987401910 | 6 | 05201105 | 85300 | 50 | 0 | 5320a |
| 5119871012235004873258726280567766329401910 | 4 | 07608 | 35 | 85300 | 5072 | 5320a |
| 5119871013011307053117126217469840300401910 | 9 | 05709 | 67 | 85300 | 5255 | 5320a |
| 5119871013014819685043226197305667975401910 | 9 | 05409 | 60 | 85300 | 5255 | 5320a |
| 5119871013021559908215326184811743533401910 | 12 | 05805100 | 85300 | 5055 | 5320a | |
| 5119871013023252626434326178753673865401910 | 5 | 07100 | 18 | 85300 | 5055 | 5320a |
| 5119871013032007786105626168512771693401910 | 7 | 06006 | 36 | 85300 | 5055 | 5320a |
| 5119871013034055826281126167279062366401910 | 6 | 06401 | 21 | 85300 | 5055 | 5320a |
| 5119871013235221763810426539151442103401910 | 6 | 5300 | 42 | 85700 | 10053 | 5320a |
| 5119871014041711895746926365591980764401910 | 3 | 6100450 | 85700 | 9658 | 5320a | |
| 5119871014044734172282426363465928185401910 | 19 | 5100120 | 85700 | 7975 | 5320a | |

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

Generate an exemple of LLR Normal Points file with format CRD

HELP HOME

Critics and suggestions are welcome (polac.contact at obsprm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

LLR SERVICE / RESIDUALS - Ref : ELP96 #1101.00 FIT IERS02CEP

| | | | | | | |
|-------|------------|--------------------|------------|--------|----------|-----------|
| 00001 | 1987/10/12 | 23h 31m 17s4869161 | Lunakhod 2 | Grasse | -0.043 m | -0.284 ns |
| 00002 | 1987/10/12 | 23h 50m 04s8732587 | Lunakhod 2 | Grasse | 0.043 m | 0.290 ns |
| 00003 | 1987/10/13 | 01h 13m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00004 | 1987/10/13 | 01h 48m 19s6850432 | Lunakhod 2 | Grasse | -0.007 m | -0.049 ns |
| 00005 | 1987/10/13 | 02h 15m 59s9082153 | Lunakhod 2 | Grasse | -0.081 m | -0.538 ns |
| 00006 | 1987/10/13 | 02h 32m 52s6264343 | Lunakhod 2 | Grasse | -0.044 m | -0.294 ns |
| 00007 | 1987/10/13 | 03h 20m 07s7861056 | Lunakhod 2 | Grasse | -0.133 m | -0.886 ns |
| 00008 | 1987/10/13 | 03h 40m 55s8262811 | Lunakhod 2 | Grasse | -0.170 m | -1.133 ns |
| 00009 | 1987/10/13 | 23h 52m 21s7638104 | Lunakhod 2 | Grasse | 0.026 m | 0.175 ns |
| 00010 | 1987/10/14 | 04h 17m 11s8957469 | Lunakhod 2 | Grasse | -0.080 m | -0.535 ns |
| 00011 | 1987/10/14 | 04h 47m 34s1722824 | Lunakhod 2 | Grasse | -0.134 m | -0.894 ns |
| 00012 | 1987/10/17 | 04h 09m 01s1112443 | Apollo 15 | Grasse | 0.095 m | 0.637 ns |
| 00013 | 1987/10/17 | 04h 30m 47s4253015 | Apollo 15 | Grasse | 0.128 m | 0.856 ns |
| 00014 | 1987/10/17 | 05h 02m 29s3328607 | Apollo 15 | Grasse | 0.099 m | 0.662 ns |
| 00015 | 1987/10/17 | 05h 34m 50s0082027 | Apollo 15 | Grasse | 0.085 m | 0.570 ns |
| 00016 | 1987/10/18 | 03h 12m 14s4013468 | Apollo 15 | Grasse | -0.042 m | -0.283 ns |
| 00017 | 1987/10/18 | 03h 34m 46s1977089 | Apollo 15 | Grasse | 0.110 m | 0.733 ns |
| 00018 | 1987/10/18 | 03h 47m 29s1821324 | Apollo 15 | Grasse | 0.090 m | 0.604 ns |
| 00019 | 1987/10/18 | 03h 59m 54s8907994 | Lunakhod 2 | Grasse | 0.072 m | 0.479 ns |
| 00020 | 1987/10/18 | 04h 21m 50s2436903 | Apollo 15 | Grasse | 0.075 m | 0.498 ns |

Normal Points : 00020
Valid : 00020
Wrong (***) : 00000 Limit: 1.000 m

[\(O-C\) graphics interface](#)

Terminé

[bouquillon@pcbou... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Navigate... [*]lr_residuals_1990... Residuals.png-4.0 (R...

Validation of LLR normal Points.



Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:32

Fichier Edition Affichage Historique Marque-pages Outils Aide

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http://polac...ndexPred.html W. faciliter - Dictionnaire Fran... http://polac.o...dexValid.html

 **Lunar Laser Ranging Service** 

Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

| | | | | | | |
|---|----|----------|-------|-------|-------|-------|
| 5119871012233117486916126297157660987401910 | 6 | 05201105 | 85300 | 50 | 0 | 5320a |
| 5119871012235004873258726280567766329401910 | 4 | 07608 | 35 | 85300 | 5072 | 5320a |
| 5119871013011307053117126217469840300401910 | 9 | 05709 | 67 | 85300 | 5255 | 5320a |
| 5119871013014819685043226197305667975401910 | 9 | 05409 | 60 | 85300 | 5255 | 5320a |
| 5119871013021559908215326184811743533401910 | 12 | 05805100 | 85300 | 5055 | 5320a | |
| 5119871013023252626434326178753673865401910 | 5 | 07100 | 18 | 85300 | 5055 | 5320a |
| 5119871013032007786105626168512771693401910 | 7 | 06006 | 36 | 85300 | 5055 | 5320a |
| 5119871013034055826281126167279062366401910 | 6 | 06401 | 21 | 85300 | 5055 | 5320a |
| 5119871013235221763810426539151442103401910 | 6 | 5300 | 42 | 85700 | 10053 | 5320a |
| 5119871014041711895746926365591980764401910 | 3 | 6100450 | 85700 | 9658 | 5320a | |
| 5119871014044734172282426363465928185401910 | 19 | 5100120 | 85700 | 7975 | 5320a | |

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

Generate an exemple of LLR Normal Points file with format CRD

LLR SERVICE / RESIDUALS - Ref : ELP96 #1101.00 FIT IERS02CEP

| | | | | | | | |
|-------|------------|-------------|---------|------------|--------|----------|-----------|
| 00001 | 1987/10/12 | 23h 31m 17s | 4869161 | Lunakhod 2 | Grasse | -0.043 m | -0.284 ns |
| 00002 | 1987/10/12 | 23h 50m 04s | 8732587 | Lunakhod 2 | Grasse | 0.043 m | 0.290 ns |
| 00003 | 1987/10/13 | 01h 13m 07s | 0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00004 | 1987/10/13 | 01h 48m 19s | 6850432 | Lunakhod 2 | Grasse | -0.007 m | -0.049 ns |
| 00005 | 1987/10/13 | 02h 15m 59s | 9082153 | Lunakhod 2 | Grasse | -0.081 m | -0.538 ns |
| 00006 | 1987/10/13 | 02h 32m 52s | 6264343 | Lunakhod 2 | Grasse | -0.044 m | -0.294 ns |
| 00007 | 1987/10/13 | 03h 20m 07s | 7861056 | Lunakhod 2 | Grasse | -0.133 m | -0.886 ns |
| 00008 | 1987/10/13 | 03h 40m 55s | 8262811 | Lunakhod 2 | Grasse | -0.170 m | -1.133 ns |
| 00009 | 1987/10/13 | 23h 52m 21s | 7638104 | Lunakhod 2 | Grasse | 0.026 m | 0.175 ns |
| 00010 | 1987/10/14 | 04h 17m 11s | 8957469 | Lunakhod 2 | Grasse | -0.080 m | -0.535 ns |
| 00011 | 1987/10/14 | 04h 47m 34s | 1722824 | Lunakhod 2 | Grasse | -0.134 m | -0.894 ns |
| 00012 | 1987/10/17 | 04h 09m 01s | 112443 | Apollo 15 | Grasse | 0.095 m | 0.637 ns |
| 00013 | 1987/10/17 | 04h 30m 47s | 4253015 | Apollo 15 | Grasse | 0.128 m | 0.856 ns |
| 00014 | 1987/10/17 | 05h 02m 29s | 3328607 | Apollo 15 | Grasse | 0.099 m | 0.662 ns |
| 00015 | 1987/10/17 | 05h 34m 50s | 0082027 | Apollo 15 | Grasse | 0.085 m | 0.570 ns |
| 00016 | 1987/10/18 | 03h 12m 14s | 4013468 | Apollo 15 | Grasse | -0.042 m | -0.283 ns |
| 00017 | 1987/10/18 | 03h 34m 46s | 1977089 | Apollo 15 | Grasse | 0.110 m | 0.733 ns |
| 00018 | 1987/10/18 | 03h 47m 29s | 1821324 | Apollo 15 | Grasse | 0.090 m | 0.604 ns |
| 00019 | 1987/10/18 | 03h 59m 54s | 8907994 | Lunakhod 2 | Grasse | 0.072 m | 0.479 ns |
| 00020 | 1987/10/18 | 04h 21m 50s | 2436903 | Apollo 15 | Grasse | 0.075 m | 0.498 ns |

Normal Points : 00020
Valid : 00020
Wrong (***) : 00000 Limit: 1.000 m

[\(O-C\) graphics interface](#)

HELP HOME

Critics and suggestions are welcome (polac.contact at obsprm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

Submission area

Terminé

[bouquillon@pcbouq... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Navigate... [*llr_residuals_1990... Residuals.png-4.0 (R...

Validation of LLR normal Points.



Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:32

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http://polac.obsprm.fr/PaV/IndexValid.html la mediterranee paris

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http://polac...ndexPred.html W. faciliter - Dictionnaire Fran... http://polac.o...dexValid.html

 **Lunar Laser Ranging Service** 

Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

| | | | | | | |
|---|----|----------|-------|-------|-------|-------|
| 5119871012233117486916126297157660987401910 | 6 | 05201105 | 85300 | 50 | 0 | 5320a |
| 5119871012235004873258726280567766329401910 | 4 | 07608 | 35 | 85300 | 5072 | 5320a |
| 5119871013011307053117126217469840300401910 | 9 | 05709 | 67 | 85300 | 5255 | 5320a |
| 5119871013014819685043226197305667975401910 | 9 | 05409 | 60 | 85300 | 5255 | 5320a |
| 5119871013021559908215326184811743533401910 | 12 | 05805100 | 85300 | 5055 | 5320a | |
| 5119871013023252626434326178753673865401910 | 5 | 07100 | 18 | 85300 | 5055 | 5320a |
| 5119871013032007786105626168512771693401910 | 7 | 06006 | 36 | 85300 | 5055 | 5320a |
| 5119871013034055826281126167279062366401910 | 6 | 06401 | 21 | 85300 | 5055 | 5320a |
| 5119871013235221763810426539151442103401910 | 6 | 5300 | 42 | 85700 | 10053 | 5320a |
| 5119871014041711895746926365591980764401910 | 3 | 6100450 | 85700 | 9658 | 5320a | |
| 5119871014044734172282426363465928185401910 | 19 | 5100120 | 85700 | 7975 | 5320a | |

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

Generate an exemple of LLR Normal Points file with format CRD

HELP HOME

Critics and suggestions are welcome (polac.contact at obsprm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

LLR SERVICE / RESIDUALS - Ref : ELP96 #1101.00 FIT IERS02CEP

| | | | | | | | | |
|-------|------------|-----|-----|------------|------------|--------|----------|-----------|
| 00001 | 1987/10/12 | 23h | 31m | 17s4869161 | Lunakhod 2 | Grasse | -0.043 m | -0.284 ns |
| 00002 | 1987/10/12 | 23h | 50m | 04s8732587 | Lunakhod 2 | Grasse | 0.043 m | 0.290 ns |
| 00003 | 1987/10/13 | 01h | 13m | 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00004 | 1987/10/13 | 01h | 48m | 19s6850432 | Lunakhod 2 | Grasse | -0.007 m | -0.049 ns |
| 00005 | 1987/10/13 | 02h | 15m | 59s9082153 | Lunakhod 2 | Grasse | -0.081 m | -0.538 ns |
| 00006 | 1987/10/13 | 02h | 32m | 52s6264343 | Lunakhod 2 | Grasse | -0.044 m | -0.294 ns |
| 00007 | 1987/10/13 | 03h | 20m | 07s7861056 | Lunakhod 2 | Grasse | -0.133 m | -0.886 ns |
| 00008 | 1987/10/13 | 03h | 40m | 55s8262811 | Lunakhod 2 | Grasse | -0.170 m | -1.133 ns |
| 00009 | 1987/10/13 | 23h | 52m | 21s7638104 | Lunakhod 2 | Grasse | 0.026 m | 0.175 ns |
| 00010 | 1987/10/14 | 04h | 17m | 11s8957469 | Lunakhod 2 | Grasse | -0.080 m | -0.535 ns |
| 00011 | 1987/10/14 | 04h | 47m | 34s1722824 | Lunakhod 2 | Grasse | -0.134 m | -0.894 ns |
| 00012 | 1987/10/17 | 04h | 09m | 01s1112443 | Apollo 15 | Grasse | 0.095 m | 0.637 ns |
| 00013 | 1987/10/17 | 04h | 30m | 47s4253015 | Apollo 15 | Grasse | 0.128 m | 0.856 ns |
| 00014 | 1987/10/17 | 05h | 02m | 29s3328607 | Apollo 15 | Grasse | 0.099 m | 0.662 ns |
| 00015 | 1987/10/17 | 05h | 34m | 50s0082027 | Apollo 15 | Grasse | 0.085 m | 0.570 ns |
| 00016 | 1987/10/18 | 03h | 12m | 14s4013468 | Apollo 15 | Grasse | -0.042 m | -0.283 ns |
| 00017 | 1987/10/18 | 03h | 34m | 46s1977089 | Apollo 15 | Grasse | 0.110 m | 0.733 ns |
| 00018 | 1987/10/18 | 03h | 47m | 29s1821324 | Apollo 15 | Grasse | 0.090 m | 0.604 ns |
| 00019 | 1987/10/18 | 03h | 59m | 54s8907994 | Lunakhod 2 | Grasse | 0.072 m | 0.479 ns |
| 00020 | 1987/10/18 | 04h | 21m | 50s2436903 | Apollo 15 | Grasse | 0.075 m | 0.498 ns |

Normal Points : 00020
Valid : 00020
Wrong (***) : 00000 Limit: 1.000 m

[\(O-C\) graphics interface](#)

Results area

Terminé

[bouquillon@pcbou... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Navigat... [*llr_resid

Validation of LLR normal Points.

Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:32

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http://polac...ndexPred.html W. faciliter - Dictionnaire Fran... http://polac.o...dexValid.html

Lunar Laser Ranging Service
Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

| | | | | | | |
|---|----|----------|-------|-------|-------|-------|
| 5119871012233117486916126297157660987401910 | 6 | 05201105 | 85300 | 50 | 0 | 5320a |
| 5119871012235004873258726280567766329401910 | 4 | 07608 | 35 | 85300 | 5072 | 5320a |
| 5119871013011307053117126217469840300401910 | 9 | 05709 | 67 | 85300 | 5255 | 5320a |
| 5119871013014819685043226197305667975401910 | 9 | 05409 | 60 | 85300 | 5255 | 5320a |
| 5119871013021559908215326184811743533401910 | 12 | 05805100 | 85300 | 5055 | 5320a | |
| 5119871013023252626434326178753673865401910 | 5 | 07100 | 18 | 85300 | 5055 | 5320a |
| 5119871013032007786105626168512771693401910 | 7 | 06006 | 36 | 85300 | 5055 | 5320a |
| 5119871013034055826281126167279062366401910 | 6 | 06401 | 21 | 85300 | 5055 | 5320a |
| 5119871013235221763810426539151442103401910 | 6 | 5300 | 42 | 85700 | 10053 | 5320a |
| 5119871014041711895746926365591980764401910 | 3 | 6100450 | 85700 | 9658 | 5320a | |
| 5119871014044734172282426363465928185401910 | 19 | 5100120 | 85700 | 7975 | 5320a | |

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

Generate an exemple of LLR Normal Points file with format CRD

HELP HOME

Critics and suggestions are welcome (polac.contact at obsprm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

Submission area

LLR SERVICE / RESIDUALS - Ref : ELP96 #1101.00 FIT IERS02CEP

| | | | | | | | | |
|-------|------------|-----|-----|------------|------------|--------|----------|-----------|
| 00001 | 1987/10/12 | 23h | 31m | 17s4869161 | Lunakhod 2 | Grasse | -0.043 m | -0.284 ns |
| 00002 | 1987/10/12 | 23h | 50m | 04s8732587 | Lunakhod 2 | Grasse | 0.043 m | 0.290 ns |
| 00003 | 1987/10/13 | 01h | 13m | 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00004 | 1987/10/13 | 01h | 48m | 19s6850432 | Lunakhod 2 | Grasse | -0.007 m | -0.049 ns |
| 00005 | 1987/10/13 | 02h | 15m | 59s9082153 | Lunakhod 2 | Grasse | -0.081 m | -0.538 ns |
| 00006 | 1987/10/13 | 02h | 32m | 52s6264343 | Lunakhod 2 | Grasse | -0.044 m | -0.294 ns |
| 00007 | 1987/10/13 | 03h | 20m | 07s7861056 | Lunakhod 2 | Grasse | -0.133 m | -0.886 ns |
| 00008 | 1987/10/13 | 03h | 40m | 55s8262811 | Lunakhod 2 | Grasse | -0.170 m | -1.133 ns |
| 00009 | 1987/10/13 | 23h | 52m | 21s7638104 | Lunakhod 2 | Grasse | 0.026 m | 0.175 ns |
| 00010 | 1987/10/14 | 04h | 17m | 11s8957469 | Lunakhod 2 | Grasse | -0.080 m | -0.535 ns |
| 00011 | 1987/10/14 | 04h | 47m | 34s1722824 | Lunakhod 2 | Grasse | -0.134 m | -0.894 ns |
| 00012 | 1987/10/17 | 04h | 09m | 01s1112443 | Apollo 15 | Grasse | 0.095 m | 0.637 ns |
| 00013 | 1987/10/17 | 04h | 30m | 47s4253015 | Apollo 15 | Grasse | 0.128 m | 0.856 ns |
| 00014 | 1987/10/17 | 05h | 02m | 29s3328607 | Apollo 15 | Grasse | 0.099 m | 0.662 ns |
| 00015 | 1987/10/17 | 05h | 34m | 50s0082027 | Apollo 15 | Grasse | 0.085 m | 0.570 ns |
| 00016 | 1987/10/18 | 03h | 12m | 14s4013468 | Apollo 15 | Grasse | -0.042 m | -0.283 ns |
| 00017 | 1987/10/18 | 03h | 34m | 46s1977089 | Apollo 15 | Grasse | 0.110 m | 0.733 ns |
| 00018 | 1987/10/18 | 03h | 47m | 29s1821324 | Apollo 15 | Grasse | 0.090 m | 0.604 ns |
| 00019 | 1987/10/18 | 03h | 59m | 54s8907994 | Lunakhod 2 | Grasse | 0.072 m | 0.479 ns |
| 00020 | 1987/10/18 | 04h | 21m | 50s2436903 | Apollo 15 | Grasse | 0.075 m | 0.498 ns |

Normal Points : 00020
Valid : 00020
Wrong (***) : 00000 Limit: 1.000 m

[\(O-C\) graphics interface](#)

Terminé

[bouquillon@pcbouq... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Navigat... [*llr_residuals_1990... Residuals.png-4.0 (R...

Validation of LLR normal Points.



Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:32

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http://polac...ndexPred.html W. faciliter - Dictionnaire Fran... http://polac.o...dexValid.html

 **Lunar Laser Ranging Service** 

Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

| | | | | | | |
|---|----|----------|-------|-------|-------|-------|
| 5119871012233117486916126297157660987401910 | 6 | 05201105 | 85300 | 50 | 0 | 5320a |
| 5119871012235004873258726280567766329401910 | 4 | 07608 | 35 | 85300 | 5072 | 5320a |
| 5119871013011307053117126217469840300401910 | 9 | 05709 | 67 | 85300 | 5255 | 5320a |
| 5119871013014819685043226197305667975401910 | 9 | 05409 | 60 | 85300 | 5255 | 5320a |
| 5119871013021559908215326184811743533401910 | 12 | 05805100 | 85300 | 5055 | 5320a | |
| 5119871013023252626434326178753673865401910 | 5 | 07100 | 18 | 85300 | 5055 | 5320a |
| 5119871013022007786105626168512771693401910 | 7 | 06006 | 36 | 85300 | 5055 | 5320a |
| 5119871013034055826281126167279062366401910 | 6 | 06401 | 21 | 85300 | 5055 | 5320a |
| 5119871013235221763810426539151442103401910 | 6 | 5300 | 42 | 85700 | 10053 | 5320a |
| 5119871014041711895746926365591980764401910 | 3 | 6100450 | 85700 | 9658 | 5320a | |
| 5119871014044734172282426363465928185401910 | 19 | 5100120 | 85700 | 7975 | 5320a | |

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

Generate an exemple of LLR Normal Points file with format CRD

HELP HOME

Critics and suggestions are welcome (polac.contact at obsprm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

LLR SERVICE / RESIDUALS - Ref : ELP96 #1101.00 FIT IERS02CEP

| | | | | | | |
|-------|------------|--------------------|------------|--------|----------|-----------|
| 00001 | 1987/10/12 | 23h 31m 17s4869161 | Lunakhod 2 | Grasse | -0.043 m | -0.284 ns |
| 00002 | 1987/10/12 | 23h 50m 04s8732587 | Lunakhod 2 | Grasse | 0.043 m | 0.290 ns |
| 00003 | 1987/10/13 | 01h 13m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00004 | 1987/10/13 | 01h 48m 19s6850432 | Lunakhod 2 | Grasse | -0.007 m | -0.049 ns |
| 00005 | 1987/10/13 | 02h 35m 49s0931373 | Lunakhod 2 | Grasse | 0.001 m | 0.030 ns |
| 00006 | 1987/10/13 | 03h 07m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00007 | 1987/10/13 | 03h 42m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00008 | 1987/10/13 | 04h 17m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00009 | 1987/10/13 | 04h 52m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00010 | 1987/10/13 | 05h 27m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00011 | 1987/10/13 | 06h 02m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00012 | 1987/10/13 | 06h 37m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00013 | 1987/10/13 | 07h 12m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00014 | 1987/10/13 | 07h 47m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00015 | 1987/10/13 | 08h 22m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00016 | 1987/10/13 | 08h 57m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00017 | 1987/10/13 | 09h 32m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00018 | 1987/10/13 | 10h 07m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00019 | 1987/10/13 | 10h 42m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00020 | 1987/10/13 | 11h 17m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |

Normal Points :
Valid :
Wrong (***) : 00000 Limit: 1.000 m

User's data capture area :

The user makes a copy of his own file of LLR observations and then pastes it into this area for submission and validation.

(O-C) graphics interface

Terminé

[bouquillon@pcbouq... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Navigate... [*llr_residuals_1990... Residuals.png-4.0 (R...

Validation of LLR normal Points.



Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:32

Fichier Edition Affichage Historique Marque-pages Outils Aide

http://polac.obsprm.fr/PaV/indexValid.html la mediterranee paris

Courriel Meteo Dico Astro Reservations PagesJaunes Cinema Cartes Les Roches - La Ma... MissionCNRS Transport Nara

http://polac...ndexPred.html W facilitier - Dictionnaire Fran... http://polac.o...dexValid.html

 **Lunar Laser Ranging Service** 

Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

| | | | | | | |
|---|----|----------|-------|-------|-------|-------|
| 5119871012233117486916126297157660987401910 | 6 | 05201105 | 85300 | 50 | 0 | 5320a |
| 5119871012235004873258726280567766329401910 | 4 | 07608 | 35 | 85300 | 5072 | 5320a |
| 5119871013011307053117126217469840300401910 | 9 | 05709 | 67 | 85300 | 5255 | 5320a |
| 5119871013014819685043226197305667975401910 | 9 | 05409 | 60 | 85300 | 5255 | 5320a |
| 5119871013021559908215326184811743533401910 | 12 | 05805100 | 85300 | 5055 | 5320a | |
| 5119871013023252626434326178753673865401910 | 5 | 07100 | 18 | 85300 | 5055 | 5320a |
| 5119871013032007786105626168512771693401910 | 7 | 06006 | 36 | 85300 | 5055 | 5320a |
| 5119871013034055826281126167279062366401910 | 6 | 06401 | 21 | 85300 | 5055 | 5320a |
| 5119871013235221763810426539151442103401910 | 6 | 5300 | 42 | 85700 | 10053 | 5320a |
| 5119871014041711895746926365591980764401910 | 3 | 6100450 | 85700 | 9658 | 5320a | |
| 5119871014044734172282426363465928185401910 | 19 | 5100120 | 85700 | 7975 | 5320a | |

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

Generate an exemple of LLR Normal Points file with format CRD

HELP HOME

Critics and suggestions are welcome (polac.contact at obsprm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

LLR SERVICE / RESIDUALS - Ref : ELP96 #1101.00 FIT IERS02CEP

| | | | | | | | | |
|-------|------------|-----|-----|------------|------------|--------|----------|-----------|
| 00001 | 1987/10/12 | 23h | 31m | 17s4869161 | Lunakhod 2 | Grasse | -0.043 m | -0.284 ns |
| 00002 | 1987/10/12 | 23h | 50m | 04s8732587 | Lunakhod 2 | Grasse | 0.043 m | 0.290 ns |
| 00003 | 1987/10/13 | 01h | 13m | 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00004 | 1987/10/13 | 01h | 48m | 19s6850432 | Lunakhod 2 | Grasse | -0.007 m | -0.049 ns |
| 00005 | 1987/10/13 | 02h | 15m | 59s9082153 | Lunakhod 2 | Grasse | -0.081 m | -0.538 ns |
| 00006 | 1987/10/13 | 02h | 32m | 52s6264343 | Lunakhod 2 | Grasse | -0.044 m | -0.294 ns |
| 00007 | 1987/10/13 | 03h | 20m | 07s7861056 | Lunakhod 2 | Grasse | -0.133 m | -0.886 ns |
| 00008 | 1987/10/13 | 03h | 40m | 55s8262811 | Lunakhod 2 | Grasse | -0.170 m | -1.133 ns |
| 00009 | 1987/10/13 | 23h | 52m | 21s7638104 | Lunakhod 2 | Grasse | 0.026 m | 0.175 ns |
| 00010 | 1987/10/14 | 04h | 17m | 11s8957469 | Lunakhod 2 | Grasse | -0.080 m | -0.535 ns |
| 00011 | 1987/10/14 | 04h | 47m | 34s1722824 | Lunakhod 2 | Grasse | -0.134 m | -0.894 ns |
| 00012 | 1987/10/17 | 04h | 09m | 01s1112443 | Apollo 15 | Grasse | 0.095 m | 0.637 ns |
| 00013 | 1987/10/17 | 04h | 30m | 47s4253015 | Apollo 15 | Grasse | 0.128 m | 0.856 ns |
| 00014 | 1987/10/17 | 05h | 02m | 29s3328607 | Apollo 15 | Grasse | 0.099 m | 0.662 ns |
| 00015 | 1987/10/17 | 05h | 34m | 50s0082027 | Apollo 15 | Grasse | 0.085 m | 0.570 ns |
| 00016 | 1987/10/18 | 03h | 12m | 14s4013468 | Apollo 15 | Grasse | -0.042 m | -0.283 ns |
| 00017 | 1987/10/18 | 03h | 34m | 46s1977089 | Apollo 15 | Grasse | 0.110 m | 0.733 ns |
| 00018 | 1987/10/18 | 03h | 47m | 29s1821324 | Apollo 15 | Grasse | 0.090 m | 0.604 ns |
| 00019 | 1987/10/18 | 03h | 59m | 54s8907994 | Lunakhod 2 | Grasse | 0.072 m | 0.479 ns |
| 00020 | 1987/10/18 | 04h | 21m | 50s2436903 | Apollo 15 | Grasse | 0.075 m | 0.498 ns |

Normal Points : 00020
Valid : 00020
Wrong (***) : 00000 Limit: 1.000 m

[\(O-C\) graphics interface](#)

Sample of Data Submission with MINI, CSTG or CRD format.

Terminé

[bouquillon@pcbou... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Navigate... [*llr_residuals_1990... Residuals.png-4.0 (R...

Validation of LLR normal Points.



Applications Raccourcis Système Mozilla Firefox lun. 7 févr., 19:32

Fichier Edition Affichage Historique Marque-pages Outils Aide

http://polac.obsprm.fr/PaV/IndexValid.html la mediterranee paris

Courriel Meteo Dico Astro Reservations PagesJaunes Cinema Cartes Les Roches - La Ma... MissionCNRS Transport Nara

http://polac...ndexPred.html W facilitier - Dictionnaire Fran... http://polac.o...dexValid.html

**Lunar Laser Ranging Service**
Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Available Lunar solutions

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

| | | | | | | |
|---|----|----------|-------|-------|-------|-------|
| 5119871012233117486916126297157660987401910 | 6 | 05201105 | 85300 | 50 | 0 | 5320a |
| 5119871012235004873258726280567766329401910 | 4 | 07608 | 35 | 85300 | 5072 | 5320a |
| 5119871013011307053117126217469840300401910 | 9 | 05709 | 67 | 85300 | 5255 | 5320a |
| 5119871013014819685043226197305667975401910 | 9 | 05409 | 60 | 85300 | 5255 | 5320a |
| 5119871013021559908215326184811743533401910 | 12 | 05805100 | 85300 | 5055 | 5320a | |
| 5119871013023252626434326178753673865401910 | 5 | 07100 | 18 | 85300 | 5055 | 5320a |
| 5119871013032007786105626168512771693401910 | 7 | 06006 | 36 | 85300 | 5055 | 5320a |
| 5119871013034055826281126167279062366401910 | 6 | 06401 | 21 | 85300 | 5055 | 5320a |
| 5119871013235221763810426539151442103401910 | 6 | 5300 | 42 | 85700 | 10053 | 5320a |
| 5119871014041711895746926365591980764401910 | 3 | 6100450 | 85700 | 9658 | 5320a | |
| 5119871014044734172282426363465928185401910 | 19 | 5100120 | 85700 | 7975 | 5320a | |

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

Generate an exemple of LLR Normal Points file with format CRD

HELP HOME

Critics and suggestions are welcome (polac.contact at obsprm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

LLR SERVICE / RESIDUALS - Ref : ELP96 #1101.00 F11 IERS02CEP

| | | | | | | |
|-------|------------|--------------------|------------|--------|----------|-----------|
| 00001 | 1987/10/12 | 23h 31m 17s4869161 | Lunakhod 2 | Grasse | -0.043 m | -0.284 ns |
| 00002 | 1987/10/12 | 23h 50m 04s8732587 | Lunakhod 2 | Grasse | 0.043 m | 0.290 ns |
| 00003 | 1987/10/13 | 01h 13m 07s0531171 | Lunakhod 2 | Grasse | -0.017 m | -0.115 ns |
| 00004 | 1987/10/13 | 01h 48m 19s6850432 | Lunakhod 2 | Grasse | -0.007 m | -0.049 ns |
| 00005 | 1987/10/13 | 02h 15m 59s9082153 | Lunakhod 2 | Grasse | -0.081 m | -0.538 ns |
| 00006 | 1987/10/13 | 02h 32m 52s6264343 | Lunakhod 2 | Grasse | -0.044 m | -0.294 ns |
| 00007 | 1987/10/13 | 03h 20m 07s7861056 | Lunakhod 2 | Grasse | -0.133 m | -0.886 ns |
| 00008 | 1987/10/13 | 03h 40m 55s8262811 | Lunakhod 2 | Grasse | -0.170 m | -1.133 ns |
| 00009 | 1987/10/13 | 23h 52m 21s7638104 | Lunakhod 2 | Grasse | 0.026 m | 0.175 ns |
| 00010 | 1987/10/14 | 04h 17m 11s8957469 | Lunakhod 2 | Grasse | -0.080 m | -0.535 ns |
| 00011 | 1987/10/14 | 04h 47m 34s1722824 | Lunakhod 2 | Grasse | -0.134 m | -0.894 ns |
| 00012 | 1987/10/17 | 04h 09m 01s1112443 | Apollo 15 | Grasse | 0.095 m | 0.637 ns |
| 00013 | 1987/10/17 | 04h 30m 47s4253015 | Apollo 15 | Grasse | 0.128 m | 0.856 ns |
| 00014 | 1987/10/17 | 05h 02m 29s3328607 | Apollo 15 | Grasse | 0.099 m | 0.662 ns |
| 00015 | 1987/10/17 | 05h 34m 50s0082027 | Apollo 15 | Grasse | 0.085 m | 0.570 ns |
| 00016 | 1987/10/18 | 03h 12m 14s4013468 | Apollo 15 | Grasse | -0.042 m | -0.283 ns |
| 00017 | 1987/10/18 | 03h 34m 46s1977089 | Apollo 15 | Grasse | 0.110 m | 0.733 ns |
| 00018 | 1987/10/18 | 03h 47m 29s1821324 | Apollo 15 | Grasse | 0.090 m | 0.604 ns |
| 00019 | 1987/10/18 | 03h 59m 54s8907994 | Lunakhod 2 | Grasse | 0.072 m | 0.479 ns |
| 00020 | 1987/10/18 | 04h 21m 50s2436903 | Apollo 15 | Grasse | 0.075 m | 0.498 ns |

Normal Points : 00020
Valid : 00020
Wrong (***) : 00000 Limit: 1.000 m

[\(O-C\) graphics interface](#)

Terminé

[bouquillon@pcbou... [BERN2011 - Naviga... [ISSI_2011.odp - Op... [Courrier entrant - M... Mozilla Firefox [JSR2010 - Navigat... [*llr_residuals_1990... Residuals.png-4.0 (R...

Validation of LLR normal Points.

- Lunar solutions & reduction models available to compute Validation :

ELP96 & ELPMP02: Same Ephemeris and Reduction Model than the ones used in the prediction tool.

INPOP10e: It is the latest version of the planetary and lunar ephemeris INPOP, developed at the Observatory of Paris (IMCCE). This numerical solution is fitted on both planetary and LLR observations. It is available at <http://www.imcce.fr/inpop>, and is used to estimate new initial conditions and librations parameters as well as tests for inner Moon (Fienga et al., 2008, 2009, 2011). The LLR observations are reduced with a model consistent with IERS Conventions 2003, including tectonic plate motion, solid tides effects, ocean and atmospheric loading, polar tide, relativistic light deviation and tropospheric time delay.

Fienga, A., et al., 2008, A&A, 477, 315.

Fienga, A., et al., 2009, A&A, 507, 1675.

Fienga, A., et al., 2011, Celest.Mech., 111, 363.

New Ephemeris and New Reduction Model

Validation of LLR normal Points.

Mozilla Firefox

http://polac.obspm.fr/PaV/IndexValid.html

LUNAR LASER RANGING SERVICE

Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e

Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

```
99999
0000103000137845780153200016425400003001942764103991391
731186731431513503242764000039908732271005500260223000
99999
000010300014708024195320-000174700000002202463104725071
066240862323490806689182000047308099279804500050260394
99999
0000103000157845780153200016429900003002242764103901351
751151309259436075570206000039008768274406300740221500
99999
0000103000157845780153200016433300003002272764103621261
```

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

HELP HOME

Critics and suggestions are welcome (polac.contact at obspm.fr)

""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

```
00006 1910 3 20000116 184600.3949065 2.4017942374030s 0.0049m 0.0325ns
00007 1910 2 20000116 185710.3422887 2.4010547531250s 0.0233m 0.1557ns
00008 1910 3 20000116 190851.0404788 2.4009653197260s 0.0183m 0.1223ns
00009 1910 3 20000116 192754.9054263 2.4004875736110s 0.0102m 0.0681ns
00010 1910 2 20000116 193906.0778061 2.3999873773040s 0.0176m 0.1174ns
00011 1910 2 20000116 200235.6093546 2.3998015859340s 0.0370m 0.2465ns
00012 1910 3 20000116 201306.5335845 2.4001330005080s 0.0080m 0.0536ns
00013 1910 3 20000116 203823.8612687 2.4004048179700s 0.0177m 0.1181ns
00014 1910 2 20000116 205105.0878678 2.4003363724220s 0.0079m 0.0526ns
00015 1910 3 20000116 210122.1450114 2.4009348195420s 0.0025m 0.0167ns
00016 1910 3 20000116 221121.6229576 2.4040937863280s -0.0090m -0.0602ns
00017 71112 3 20000117 072108.2244945 2.4012100681630s 0.3111m 2.0757ns
00018 1910 3 20000117 182653.4376673 2.3781317753930s -0.0052m -0.0347ns
00019 1910 3 20000117 185124.3903713 2.3764394383790s 0.0046m 0.0309ns
00020 1910 2 20000117 190642.4202007 2.3752609587180s 0.0072m 0.0478ns
```

Normal Points : 20 obs.
Valid : 19 obs.
Wrong (***) : 1 obs. Limit: 0.750 m

Reflector 2 : 5 obs. Bias: 0.019 m St.dev.: 0.011 m
0.124 ns 0.073 ns

Reflector 3 : 14 obs. Bias: 0.032 m St.dev.: 0.079 m
0.211 ns 0.529 ns

Global : 19 obs. Bias: 0.028 m St.dev.: 0.069 m
0.188 ns 0.457 ns

(O-C) graphics interface

Results area

Terminé

Validation of LLR normal Points.

LUNAR LASER RANGING SERVICE
Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e
Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

99999
0000103000137845780153200016425400003001942764103991391
731186731431513503242764000039908732271005500260223000
99999
000010300014708024195320-00017470000002202463104725071
066240862323490806689182000047308099279804500050260394
99999
0000103000157845780153200016429900003002242764103901351
751151309259436075570206000039008768274406300740221500
99999

| | | | | | | | |
|-------|-------|---|----------|----------------|------------------|----------|-----------|
| 00006 | 1910 | 3 | 20000116 | 184600.3949065 | 2.4017942374030s | 0.0049m | 0.0325ns |
| 00007 | 1910 | 2 | 20000116 | 185710.3422887 | 2.4010547531250s | 0.0233m | 0.1557ns |
| 00008 | 1910 | 3 | 20000116 | 190851.0404788 | 2.4009653197260s | 0.0183m | 0.1223ns |
| 00009 | 1910 | 3 | 20000116 | 192754.9054263 | 2.4004875736110s | 0.0102m | 0.0681ns |
| 00010 | 1910 | 2 | 20000116 | 193906.0778061 | 2.3999873773040s | 0.0176m | 0.1174ns |
| 00011 | 1910 | 2 | 20000116 | 200235.6093546 | 2.3998015859340s | 0.0370m | 0.2465ns |
| 00012 | 1910 | 3 | 20000116 | 201306.5335845 | 2.4001330005080s | 0.0080m | 0.0536ns |
| 00013 | 1910 | 3 | 20000116 | 203823.8612687 | 2.4004048179700s | 0.0177m | 0.1181ns |
| 00014 | 1910 | 2 | 20000116 | 205105.0878678 | 2.4003363724220s | 0.0079m | 0.0526ns |
| 00015 | 1910 | 3 | 20000116 | 210122.1450114 | 2.4009348195420s | 0.0025m | 0.0167ns |
| 00016 | 1910 | 3 | 20000116 | 221121.6229576 | 2.4040937863280s | -0.0090m | -0.0602ns |
| 00017 | 71112 | 3 | 20000117 | 072108.2244945 | 2.4012100681630s | 0.3111m | 2.0757ns |
| 00018 | 1910 | 3 | 20000117 | 182653.4376673 | 2.3781317753930s | -0.0052m | -0.0347ns |
| 00019 | 1910 | 3 | 20000117 | 185124.3903713 | 2.3764394383790s | 0.0046m | 0.0309ns |
| 00020 | 1910 | 2 | 20000117 | 190642.4202007 | 2.3752609587180s | 0.0072m | 0.0478ns |

Normal Points : 20 obs.
: 19 obs.
) : 1 obs. Limit: 0.750 m
2 : 5 obs. Bias: 0.019 m St.dev.: 0.011 m
: 0.124 ns 0.073 ns
3 : 14 obs. Bias: 0.032 m St.dev.: 0.079 m
: 0.211 ns 0.529 ns
: 19 obs. Bias: 0.028 m St.dev.: 0.069 m
: 0.188 ns 0.457 ns

[Physics interface](#)

Results of validation process:

The lines in this area are the results of validation process for each submitted LLR observation.

Each line contains :

- Number of processed observation according to submission order,
- Station ID,
- Reflector Number,
- Date,
- Time,
- Observed round-trip light time in second,
- (Observed light time - Computed light time) in meter,
- (Observed light time - Computed light time) in nanosecond.

Validation of LLR normal Points.

Mozilla Firefox
http://gbotfov/llrObs/IndexValid.html 7837 SHANGHAI LLR

LUNAR LASER RANGING SERVICE

Paris Observatory Lunar Analysis Center

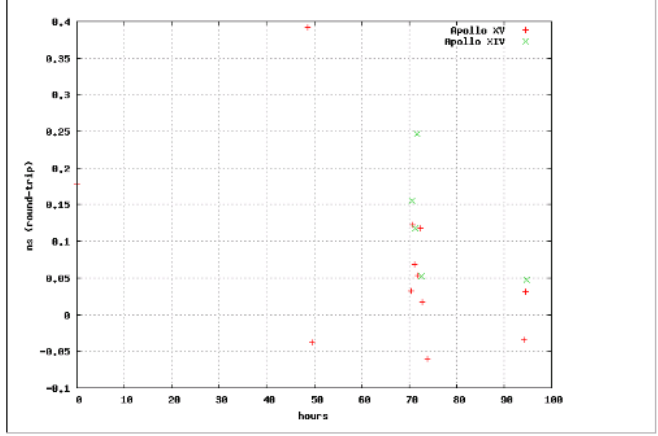
Validation of past LLR Observations :

Ephemerides : ELP96 ELPMP02 INPOP10e
Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

```
99999
0000103000137845780153200016425400003001942764103991391
731186731431513503242764000039908732271005500260223000
99999
000010300014708024195320-000174700000002202463104725071
066240862323490806689182000047308099279804500050260394
99999
0000103000157845780153200016429900003002242764103901351
751151309259436075570206000039008768274406300740221500
99999
0000103000157845780153200016433300003002272764103621261
```

GO



The plot shows residuals (NS in round-trip) on the Y-axis (ranging from -0.1 to 0.4) against time in hours on the X-axis (ranging from 0 to 100). Data points are color-coded: red '+' for Apollo XV and green 'x' for Apollo XIV. A legend in the top right corner identifies the series. The residuals fluctuate around zero, with some larger deviations for Apollo XV.

Sites : GRASSE
Reflectors : ALL REFLECTORS
X-axis unit : HOURS
Y-axis unit : NS (round-trip)

Date of First Observations : 2000/01/13_20:18
[\(O-C\) numerical results](#)

Critics and suggestions are welcome (polac.contact at obspm.fr)

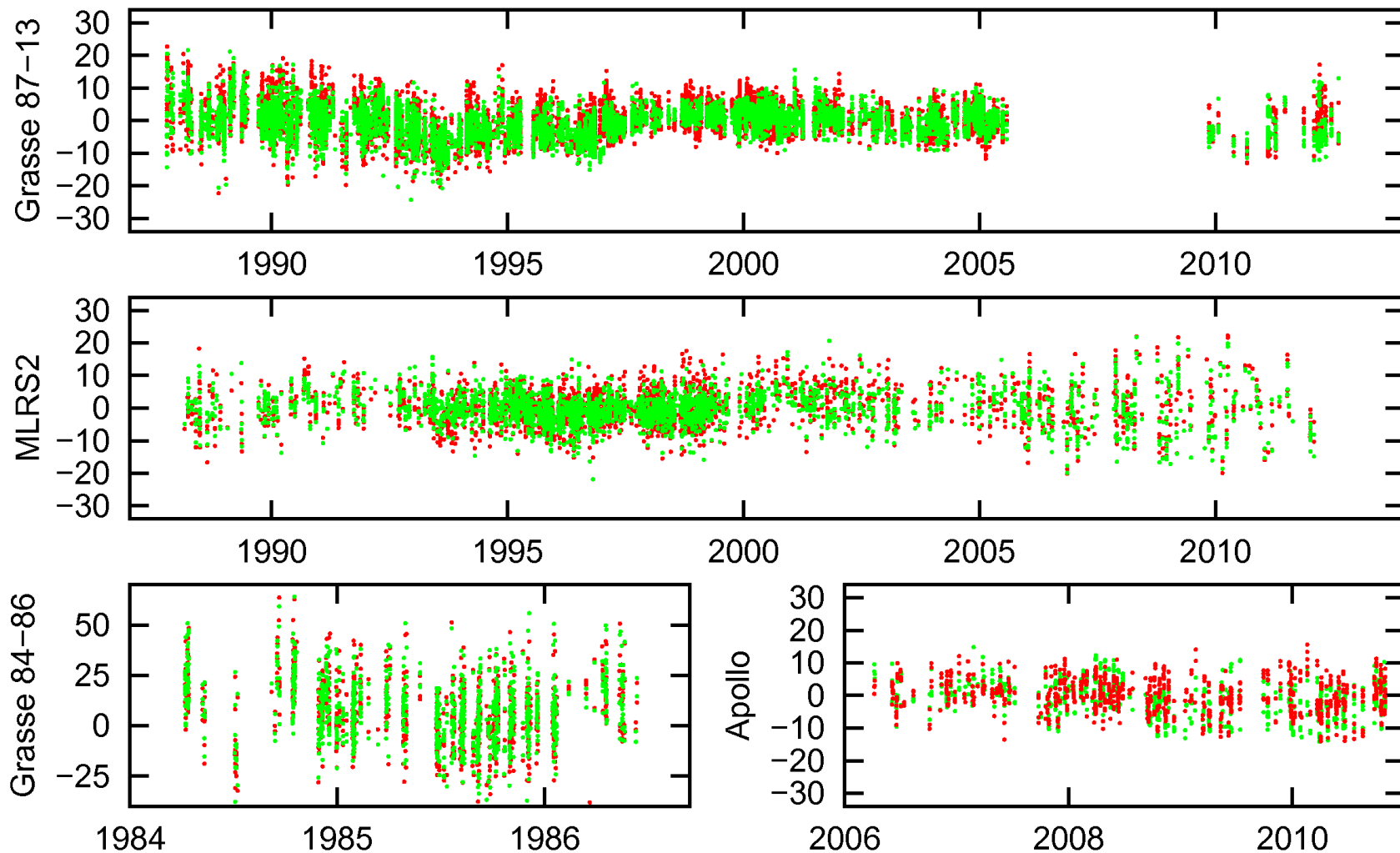
Graphs of residuals:

Residuals are displayed according to the sites, the reflectors, the time and residuals units.

Reduction of All LLR normal Points since 1984
carry out with this interface:

*O-C plots for two different models: **INPOP10e** and **ELPMPP02***

INPOP10e and ELPMPP02: residuals in cm



Reduction of All LLR normal Points since 1984
carry out with this interface:

*0-C Statistics for **INPOP10e** & **ELPMPP02** models*

INPOP10e and **ELPMPP02**: RMS of residuals in cm

| Stations (<i>periods</i>) | INPOP10e | ELPMPP02 |
|------------------------------------|-----------------|-----------------|
| GRASSE (1984-1986) | 15,89 | 15,41 |
| GRASSE (1987-1995) | 6,35 | 5,48 |
| GRASSE (1995-2012) | 4,01 | 3,82 |
| MLRS2 (1985-1996) | 4,71 | 4,29 |
| MLRS2 (1996-2012) | 5,59 | 5,08 |
| Apollo (2006-2012) | 5,22 | 5,34 |

POLAC recent activities:
Support for LLR observers.

Validation of LLR Observations by e-mail
`polac.processing at obspm.fr`

Validation of LLR Observations by e-mail

E-mail Format Example for the Submission of LLR Observations to Validate:

TO : **polac.processing at obspm.fr**
Subject : **##LLR-VALIDATION##**

DISPLAYOMC=1
DISPLAYOBS=1
DISPLAYPLOT=1
DISPLAYSTAT=1

EPHEM=1

FORMAT=1

IDOBS=MINI_01_17Nov1987

STARTOBS

| | | | | | | |
|---|----|---------|-------|-------|-------|-------|
| 5119871017053450008202726457869244256301910 | 9 | 6000 | 56 | 86100 | 10591 | 5320a |
| 5119871018031214401346826524391650493301910 | 18 | 4800160 | 87700 | 12020 | 5320a | |
| 5119871018033446197708926495002457698301910 | 7 | 6900140 | 86400 | 7684 | 5320a | |
| 5119871018034729182132426478835321705301910 | 18 | 4800121 | 86400 | 7684 | 5320a | |
| 5119871018035954890799426478807146132401910 | 15 | 5000171 | 86400 | 5794 | 5320a | |
| 5119871018042150243690326437079172454301910 | 51 | 3700320 | 86400 | 6970 | 5320a | |

ENDOBS

Mandatory keywords in red

Validation of LLR Observations by e-mail

Mozilla Firefox
http://polac.obspm.fr/PaV/IndexValid.html

LUNAR LASER RANGING SERVICE

Paris Observatory Lunar Analysis Center

Validation of past LLR Observations :

Ephemerides : ELP96 ELPMPPO2 INPOP10e
Format : MINI CSTG CRD

Please, enter your LLR normal points in the area below :

```
99999
0000103000137845780153200016425400003001942764103991391
731186731431513503242764000039908732271005500260223000
99999
000010300014708024195320-00017470000002202463104725071
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99999
0000103000157845780153200016429900003002242764103901351
751151309259436075570206000039008768274406300740221500
99999
0000103000157845780153200016433300003002272764103621261
```

GO

Clear

Generate an exemple of LLR Normal Points file with format MINI

Generate an exemple of LLR Normal Points file with format CSTG

HELP HOME

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""NEW"" [This LLR Data Validation Service is now available by e-MAIL.](#) ""NEW""

| | | | | | | | |
|-------|-------|---|----------|-----------------|------------------|----------|-----------|
| 00006 | 1910 | 3 | 20000116 | 184600.3949065 | 2.4017942374030s | 0.0049m | 0.0325ns |
| 00007 | 1910 | 2 | 20000116 | 185710.3422887 | 2.4010547531250s | 0.0233m | 0.1557ns |
| 00008 | 1910 | 3 | 20000116 | 190851.0404788 | 2.4009653197260s | 0.0183m | 0.1223ns |
| 00009 | 1910 | 3 | 20000116 | 192754.9054263 | 2.4004875736110s | 0.0102m | 0.0681ns |
| 00010 | 1910 | 2 | 20000116 | 193906.0778061 | 2.399873773040s | 0.0176m | 0.1174ns |
| 00011 | 1910 | 2 | 20000116 | 200235.6093546 | 2.3998015859340s | 0.0370m | 0.2465ns |
| 00012 | 1910 | 3 | 20000116 | 201306.5335845 | 2.4001330005080s | 0.0080m | 0.0536ns |
| 00013 | 1910 | 3 | 20000116 | 203823.8612687 | 2.4004048179700s | 0.0177m | 0.1181ns |
| 00014 | 1910 | 2 | 20000116 | 205105.0878678 | 2.4003363724220s | 0.0079m | 0.0526ns |
| 00015 | 1910 | 3 | 20000116 | 210122.1450114 | 2.4009348195420s | 0.0025m | 0.0167ns |
| 00016 | 1910 | 3 | 20000116 | 221121.16229576 | 2.4040937863280s | -0.0090m | -0.0602ns |
| 00017 | 71112 | 3 | 20000117 | 072108.2244945 | 2.4012100681630s | 0.3111m | 2.0757ns |
| 00018 | 1910 | 3 | 20000117 | 182653.4376673 | 2.3781317753930s | -0.0052m | -0.0347ns |
| 00019 | 1910 | 3 | 20000117 | 185124.3903713 | 2.3764394383790s | 0.0046m | 0.0309ns |
| 00020 | 1910 | 2 | 20000117 | 190642.4202007 | 2.3752609587180s | 0.0072m | 0.0478ns |

Normal Points : 20 obs.
Valid : 19 obs.
Wrong (***) : 1 obs. Limit: 0.750 m

Reflector 2 : 5 obs. Bias: 0.019 m St.dev.: 0.011 m
0.124 ns 0.073 ns

Reflector 3 : 14 obs. Bias: 0.032 m St.dev.: 0.079 m
0.211 ns 0.529 ns

Global : 19 obs. Bias: 0.028 m St.dev.: 0.069 m
0.188 ns 0.457 ns

[\(O-C\) graphics interface](#)

Terminé

Details about e-mail Submission process

POLAC recent activities:
Support for LLR data users.

critical analysis of an extended LLR data
gathering

ftp://polac.obspm.fr/pub/LLR_Observations/

critical analysis of an extended LLR data gathering

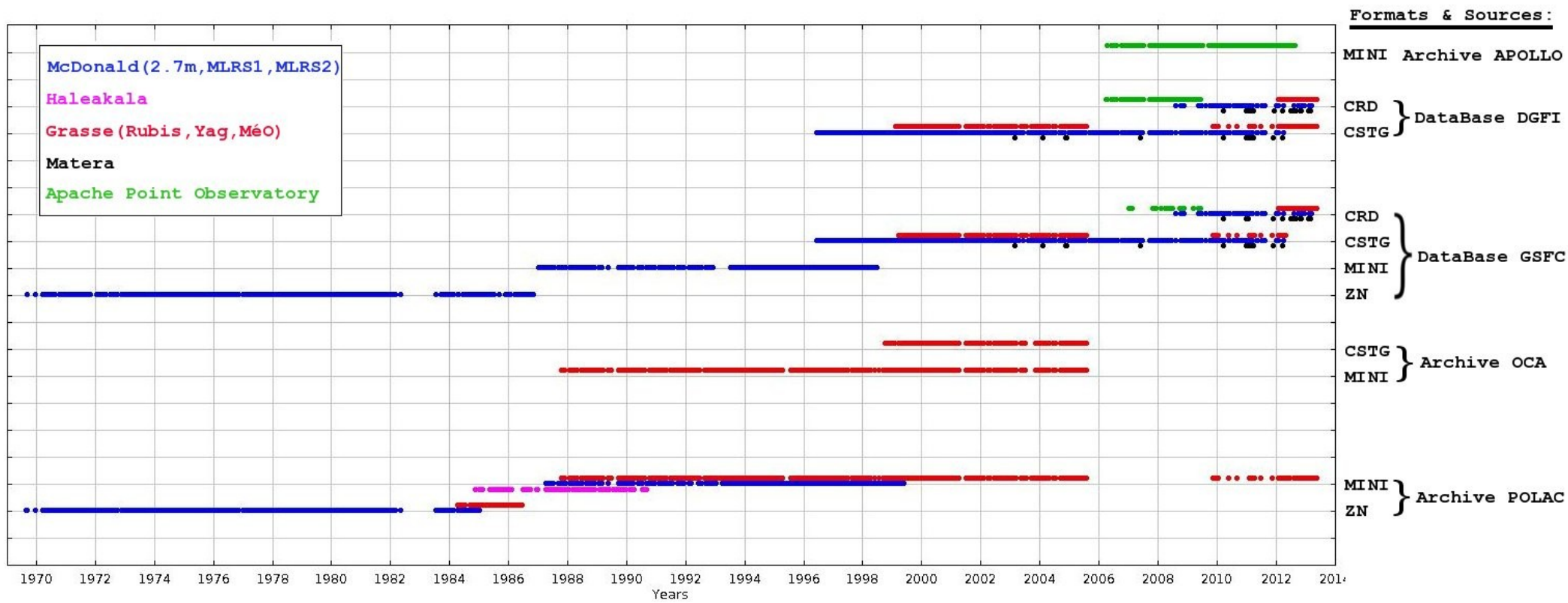
LLR Data Sources:

- Archive POLAC
- Archive of Grasse laser station (Observatoire de la Côte d'Azur, MÉO)
- Archive of APOLLO laser station (Apache Point Observatory Lunar Laser-ranging Operation)
- ILRS DataBase :
 - ◆ GSFC (Goddard Space Flight Center)
 - ◆ DGFI (Deutsches Geodätisches Forschung Institut)

LLR Data Formats:

- ZN Original Format, COSPAR Working Group 1, (Mulholland, 1971)
- MINI Mini Normal Point Record, NASA Management/Operations Working Group on LLR, (COSPAR Information Bulletin No. 108, April, 1987.)
- CSTG Coordination of Space Techniques for Geodesy and Geodynamics, ILRS Normal Point Format since March 1997
- CRD Consolidated Laser Ranging Data Format, ILRS Normal Point Format since 2009, (R.L. Ricklefs, C.J. Moore, October 2009).

critical analysis of an extended LLR data gathering



Distribution of All LLR Observations per Archive Center & per Format

critical analysis of an extended LLR data gathering

Main Steps of LLR Data gathering and Critical analysis Method:

First Step: DATA NORMALIZATION

FOR EACH DATABASE:

- Split LLR data by LLR station and by format
- Check the consistency of each data (values, format nomenclature, etc.)

Example:

Original data: 134677492928470346965323000010508792282625000560222200

Error for format of Humidity => correction 250 -> 025 :

Modified data: 134677492928470346965323000010508792282602500560222200

- Erase redundant data (only strictly identical Normal Points)
- Change the data format in the LLR standard Format "MINI"
- Check this new file consistency
- Sort Chronologically
- For each Normal Point keep a trace of Original Archive and Format

Example:

5 201305131633071529333266516406199301 1910 42 1949 16 87344 13556 5321 0673 | DGFI-CRD

Normal Point in "MINI" format

Archive and Format Name

critical analysis of an extended LLR data gathering

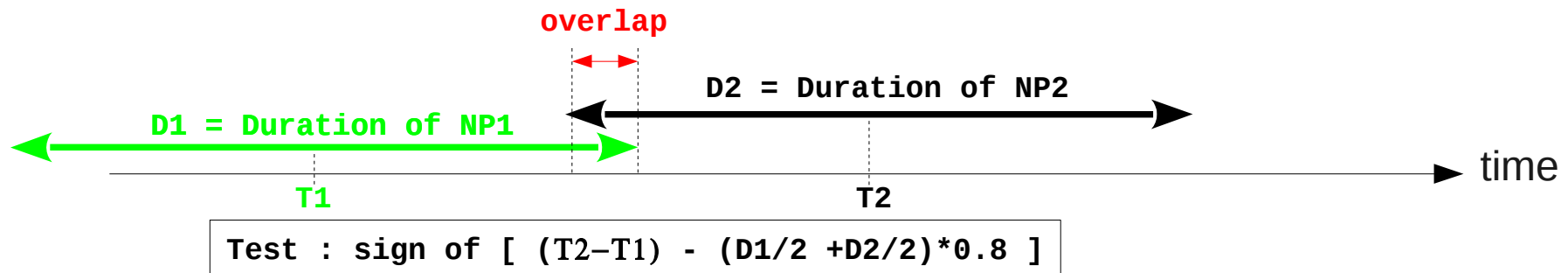
Main Steps of LLR Data gathering and Critical analysis Method:

Second Step: ERASE DATA WITH RESIDUALS LARGER THAN 100 METERS

Third Step: IDENTIFICATION OF DATA DUPLICATIONS AND SELECTION

METHOD FOR IDENTIFICATION OF DATA DUPLICATIONS:

- 2 Normal Points are considered as data duplications if there is a temporal overlap Larger than 20% of the sum of their half-duration.



- If LLR Normal point duration is not given, we fix it to 3 minutes.

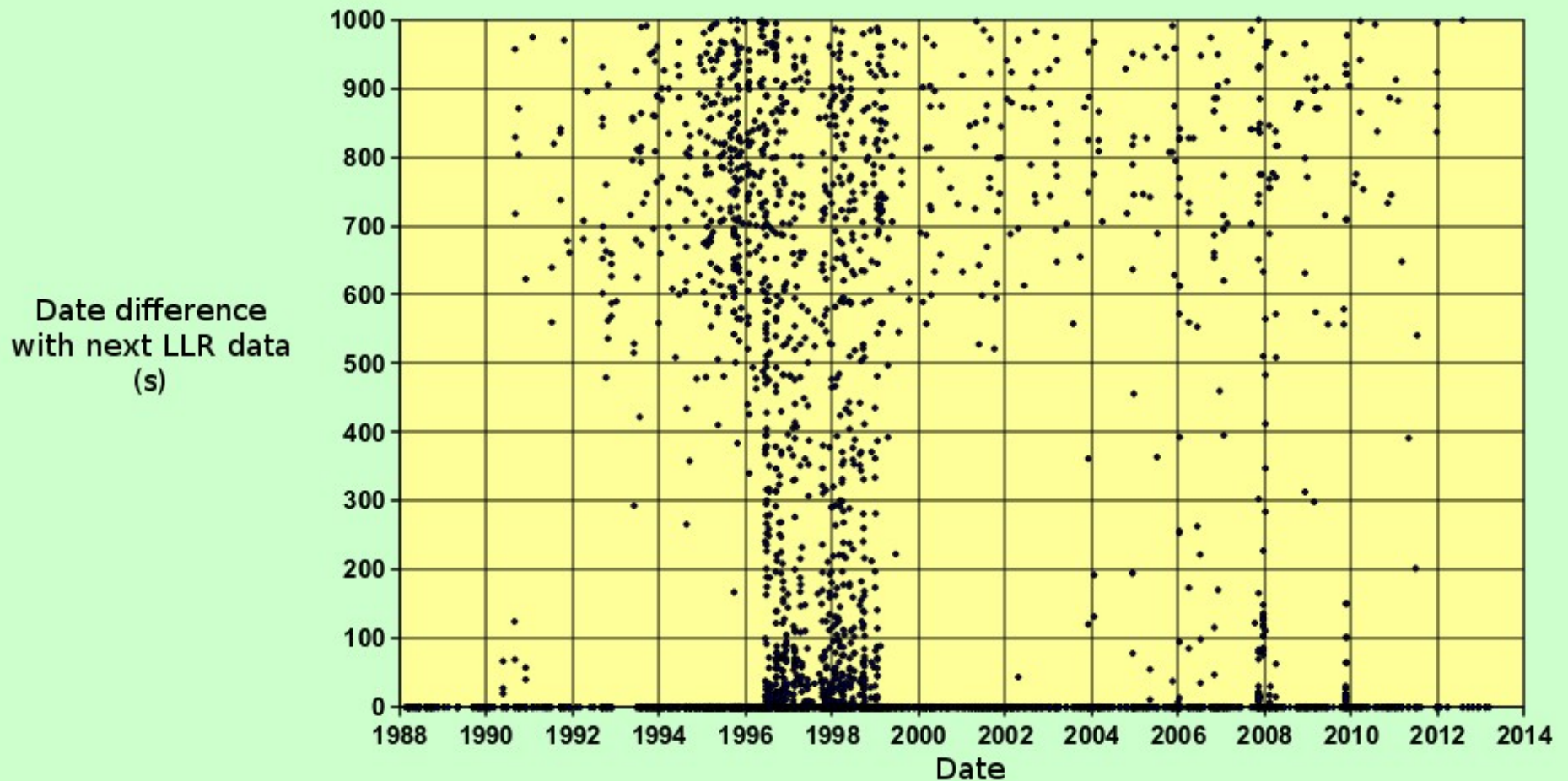
METHOD OF DATA SELECTION IN CASE OF DUPLICATION:

- The selection of one observation in case of duplication is based on the criteria listed below:
 - ♦ The Residual [O-C] (weight = 2)
 - ♦ The Echoes Number (weight = 1)
 - ♦ The Uncertainty (weight = 1)
 - ♦ The Signal to Noise Ratio (weight = 1)
 - ♦ The duration (weight = 1).

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Main Steps of LLR Data gathering and Critical analysis Method:

Third Step : IDENTIFICATION OF DATA DUPLICATIONS AND SELECTION

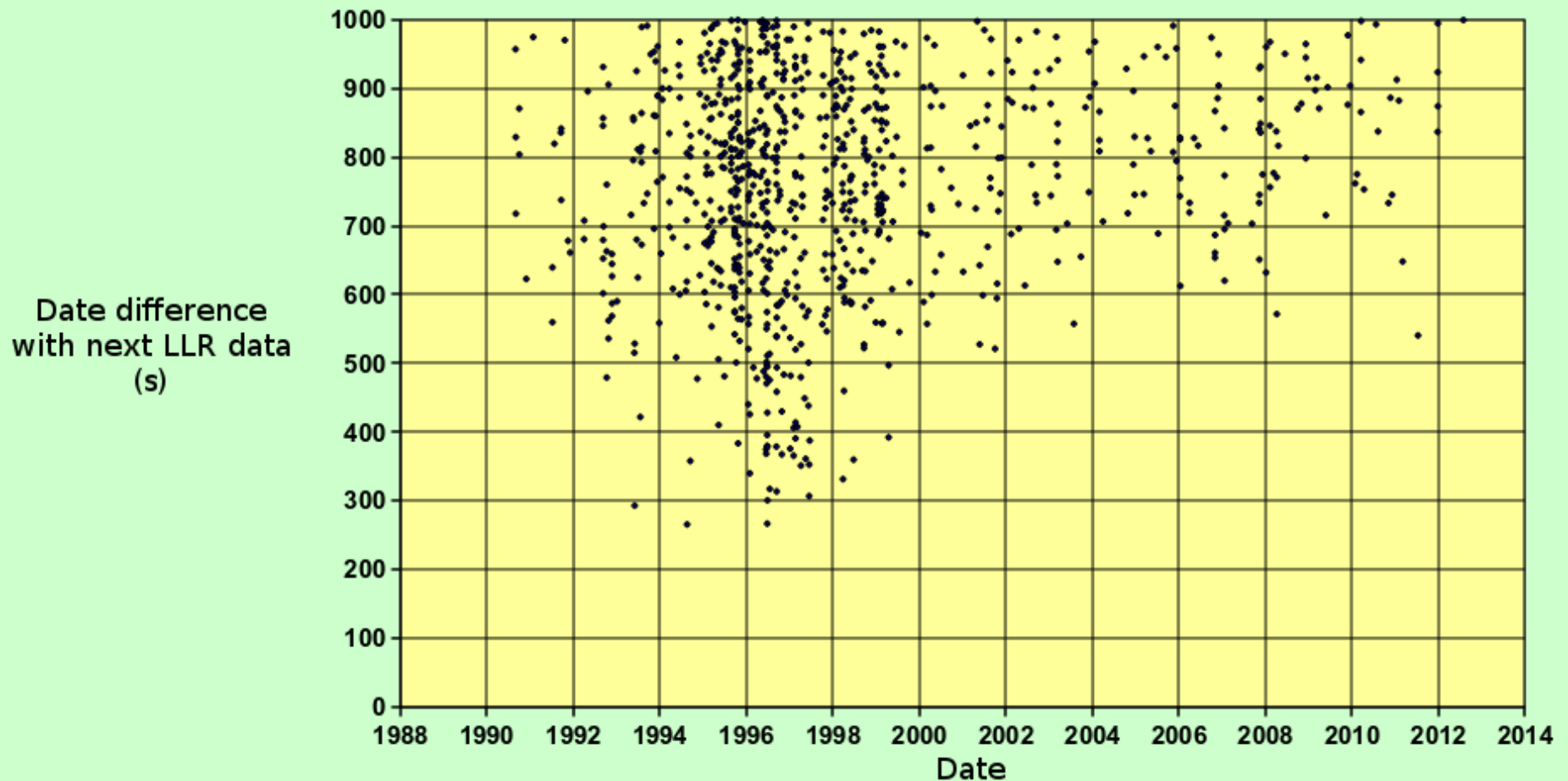


This plot shows for each LLR data gathering for the MLRS2 station, the observation date in X axis and the date difference with the next data in second in Y axis **with data duplications**.

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Main Steps of LLR Data gathering and Critical analysis Method:

Second Step : IDENTIFICATION OF DATA DUPLICATIONS AND SELECTION



This plot shows for each LLR data gathering for the MLRS2 station, the observation date in X axis and the date difference with the next data in second in Y axis **with no data duplications**.

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LLR Resulting Data Set:

ftp://polac.obspm.fr/pub/1_llr_analysis/2_llr_residuals/observationsUpdate/

• DATA SETS OF LLR OBSERVATIONS BY STATION AND PERIOD

- ◆ **OMCD6985.DAT** : 3604 Observations (20/08/1969 – 30/06/1985)
- ◆ **OMCD8388.DAT** : 631 observations (02/08/1983 – 27/01/1988)
- ◆ **OMCD8813.DAT** : 3653 observations (29/02/1988 – 20/03/2013)
- ◆ **OGRA8486.DAT** : 1188 observations (07/04/1984 – 12/06/1986)
- ◆ **OGRA8705.DAT** : 8324 observations (22/01/1987 – 30/07/2005)
- ◆ **OGRA0913.DAT** : 654 observations (11/11/2009 – 20/05/2013)
- ◆ **OHAL8490.DAT** : 770 observations (13/11/1984 – 30/08/1990)
- ◆ **OMAT0313.DAT** : 83 observations (22/02/2003 – 05/03/2013)
- ◆ **OAPO0612.DAT** : 1564 observations (07/04/2006 – 28/08/2012)

• DATA SETS FOR ALL THE LLR OBSERVATIONS FROM 1969 AUGUST 20 TO 2013 MAY 30

- ◆ **TOTALOBS6913.DAT** : Valid Observations (20471) (Format MINI)
- ◆ **TOTALOBS6913.xml** : Valid Observations (20471) (Format VOTABLE)
- ◆ **TOTALSUP6913.DAT** : Observations with residuals > 100m

| | |
|-----------|-----|
| Grasse | 103 |
| McDonald | 305 |
| Matera | 3 |
| Haleakala | 0 |
| Apollo | 0 |
| Total | 411 |

- ◆ **TOTALDBL6913.DAT** : DUPLICATED DATA (28615)

Planned improvements.

For Prediction Tool

- add some helpful information for reflectors (as their libration angle, their sun illumination, etc.)

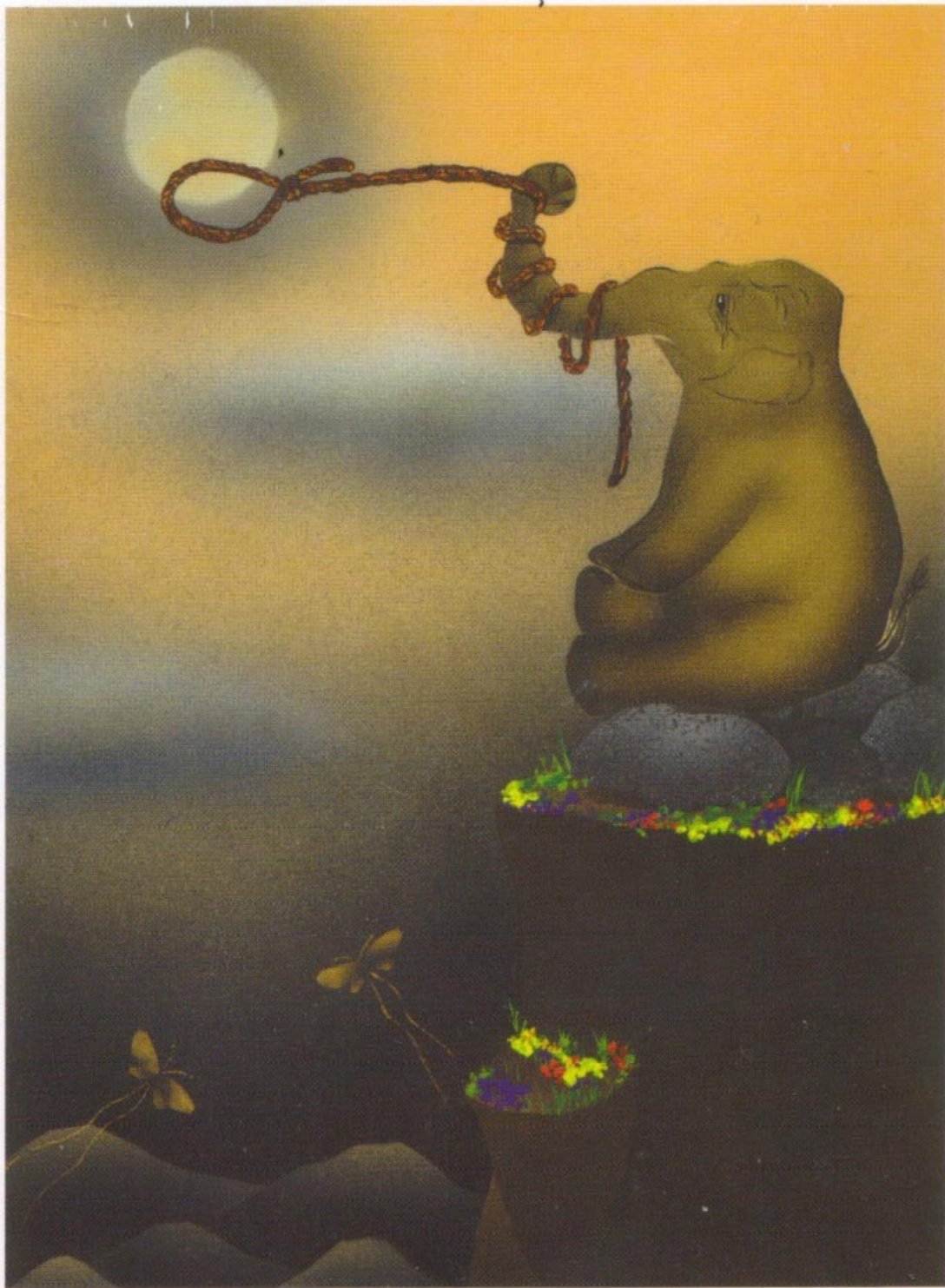
For Validation Tool

- Implementation of other lunar solutions or other reduction processes:
 - JPL lunar solution (DE421)
 - FESG/IFE Lunar solution
 - ?

=> Useful for unification of LLR observation reduction process
=> Useful for comparison of different lunar solutions
- Improvement of speed of PaV Tools when using ELP
(by using a tabulated version of ELP Ephemeris instead of Poissons Series) **DONE**
- Separate for the interface user the choice of Reduction Model to the choice of the Moon Ephemeris

For LLR Data Set

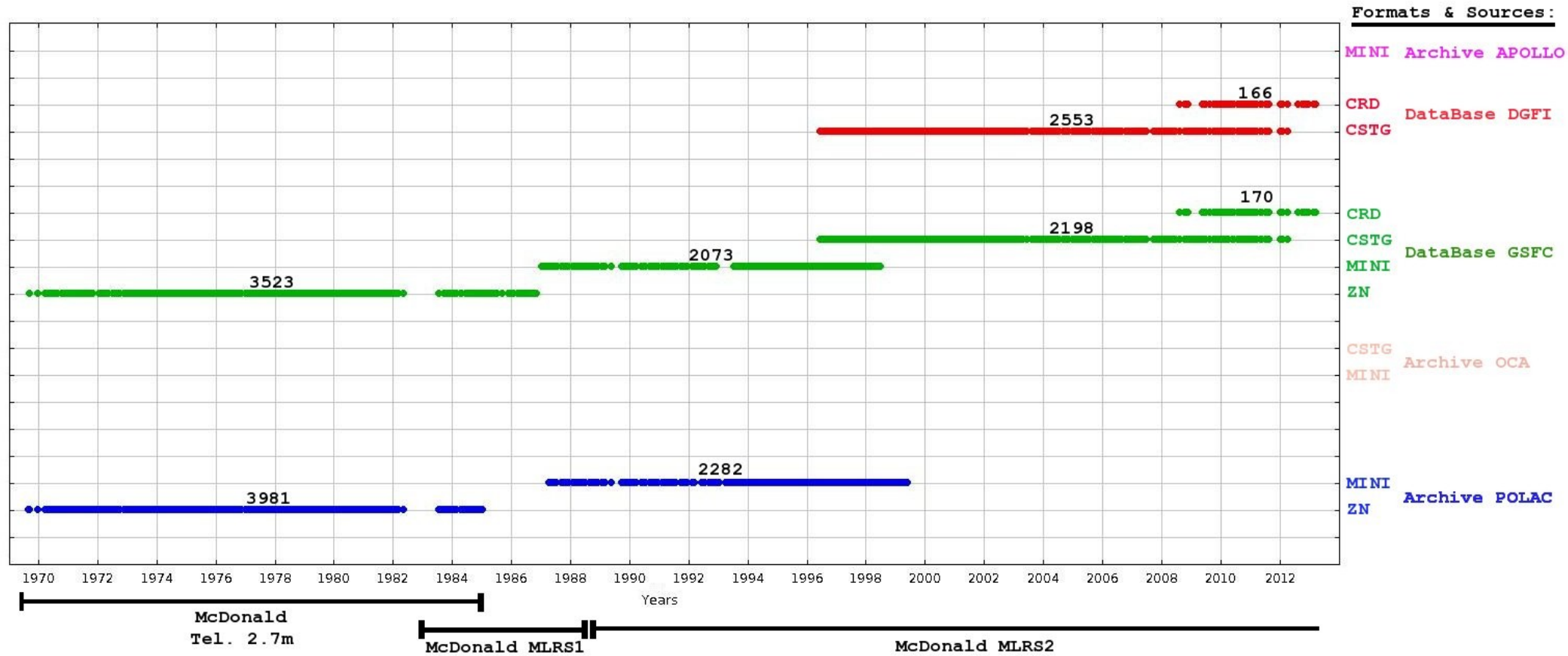
- Regularly update this data set
- Method Improvement for the Identification of LLR Data duplications



ありがとうございます。

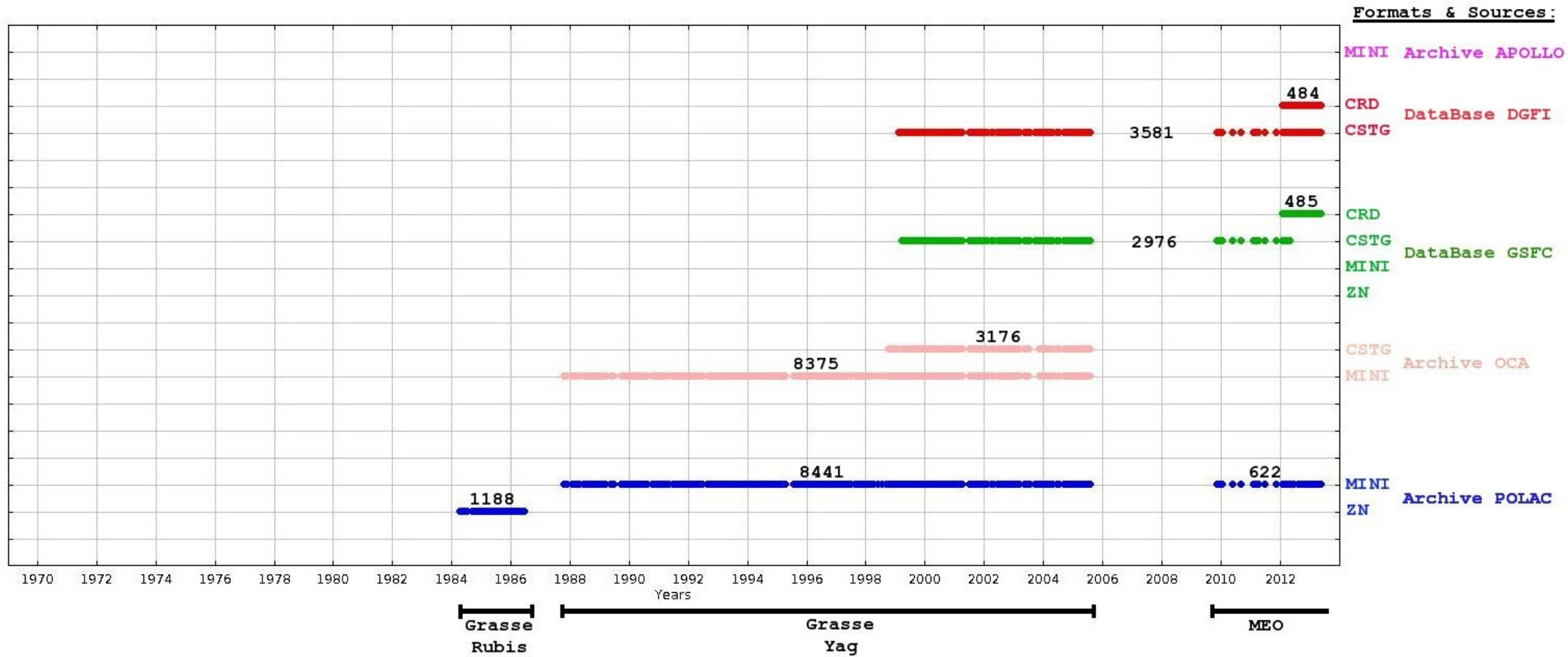
Extra slides

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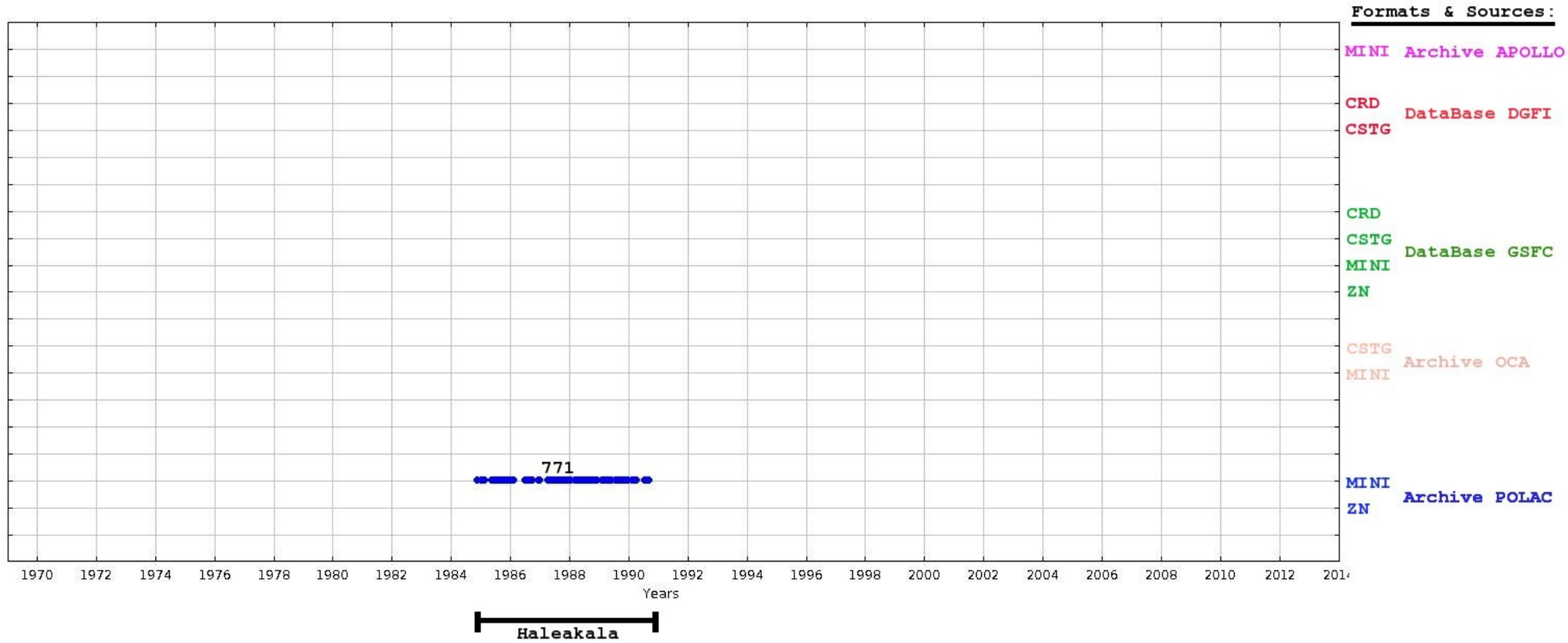
Distribution of **McDonald** LLR Observations per Archive Center & per Format

critical analysis of an extended LLR data gathering



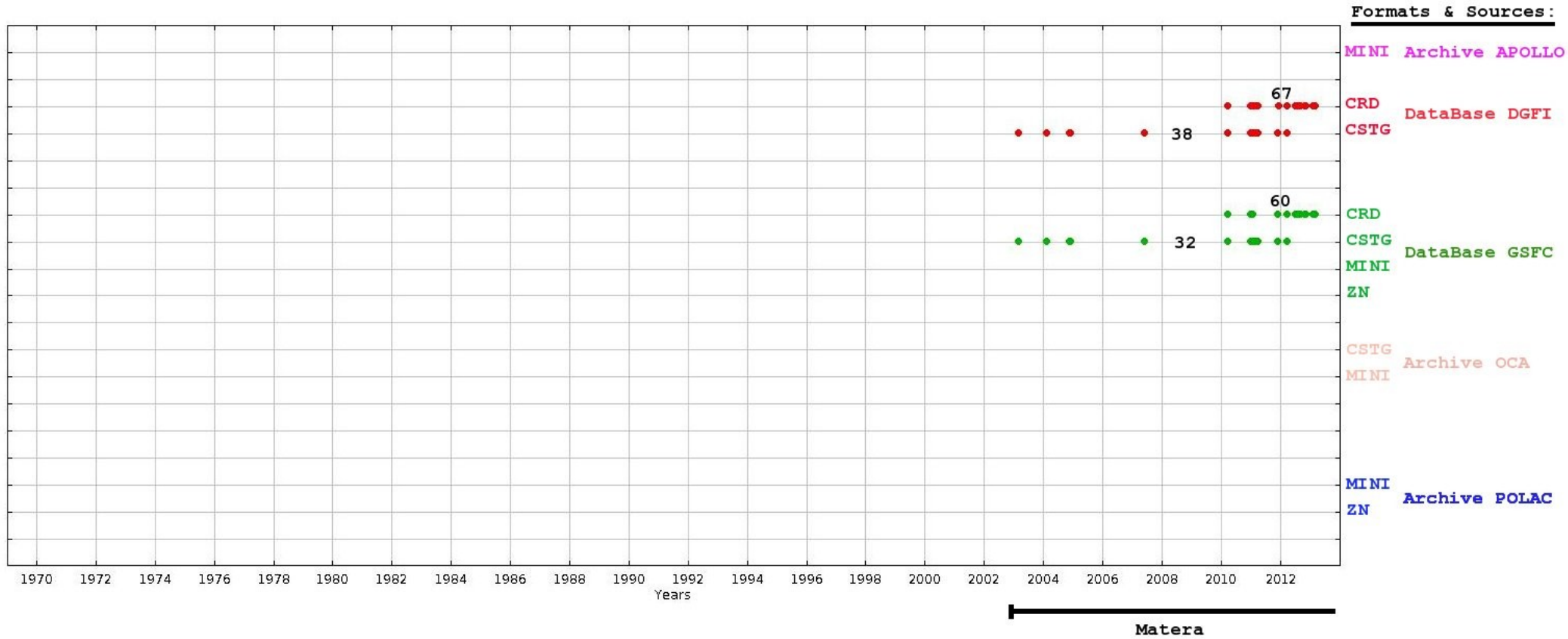
Distribution of Grasse LLR Observations per Archive Center & per Format

critical analysis of an extended LLR data gathering



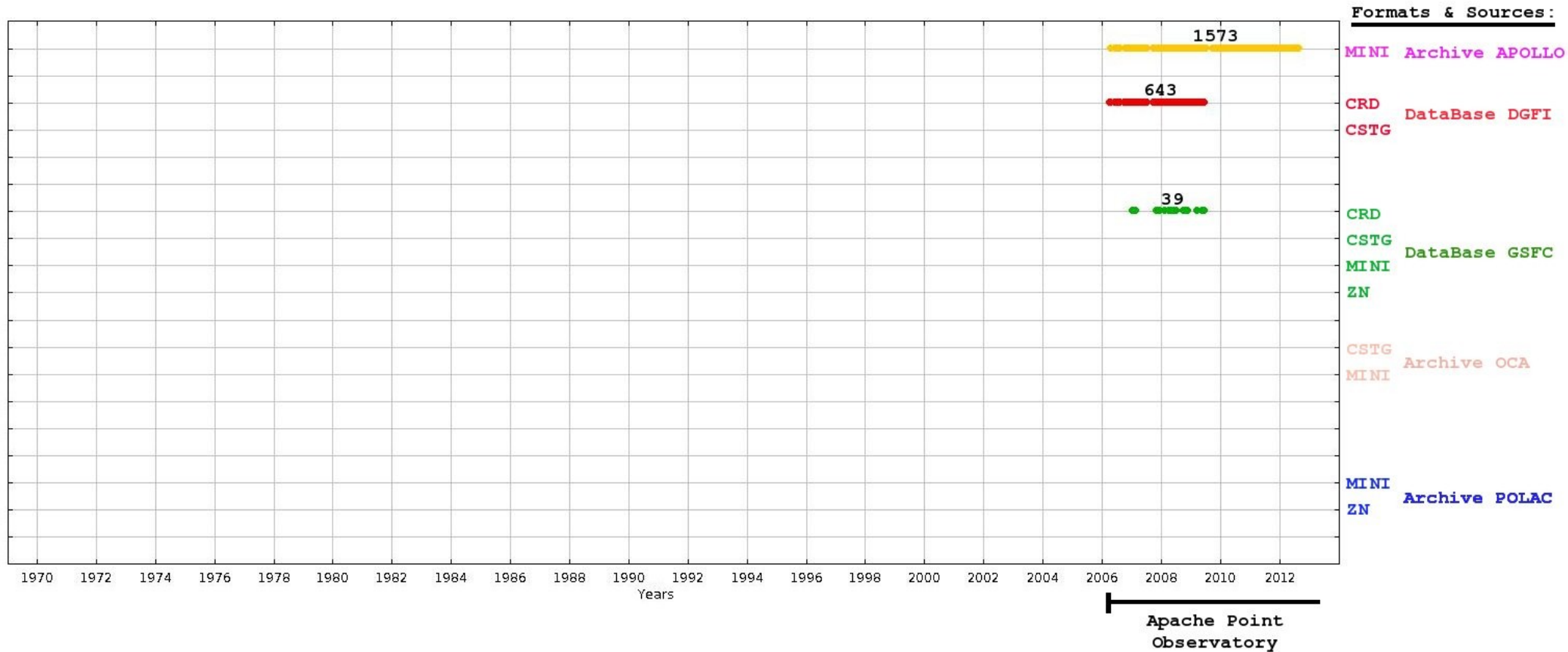
Distribution of **Haleakala** LLR Observations per Archive Center & per Format

critical analysis of an extended LLR data gathering



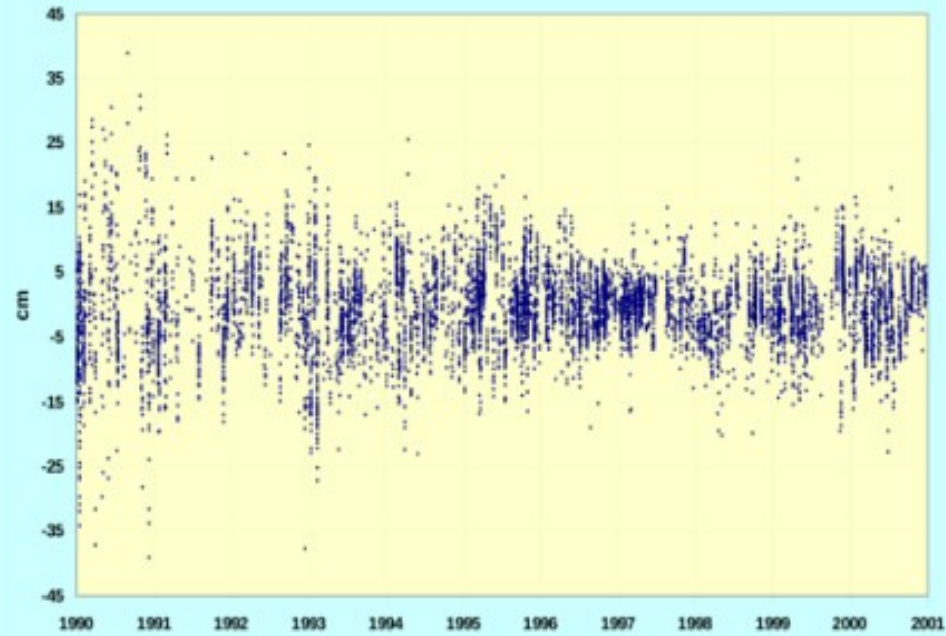
Distribution of **Matera** LLR Observations per Archive Center & per Format

critical analysis of an extended LLR data gathering

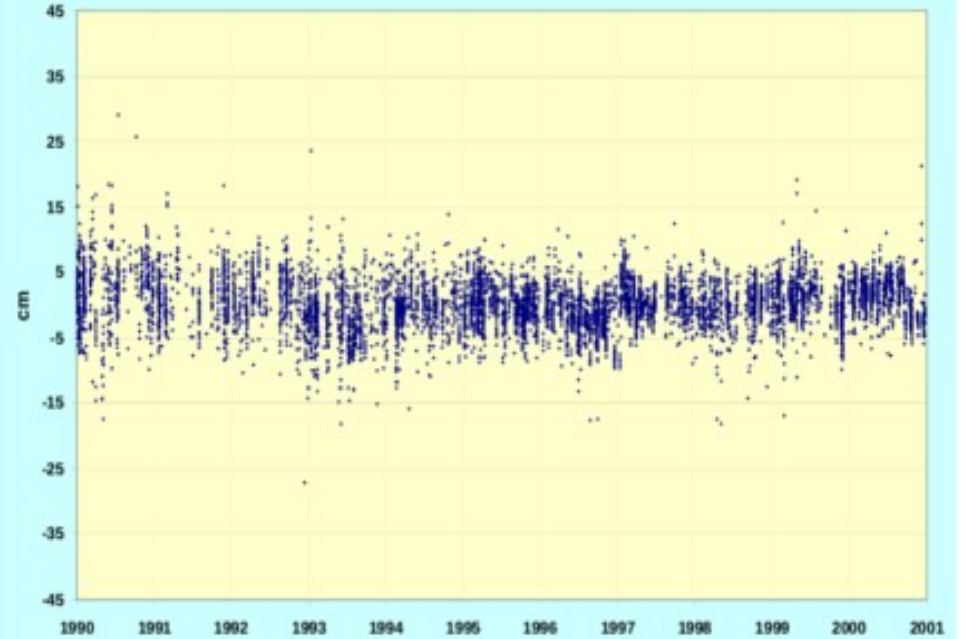


Distribution of **APOLLO** LLR Observations per Archive Center & per Format

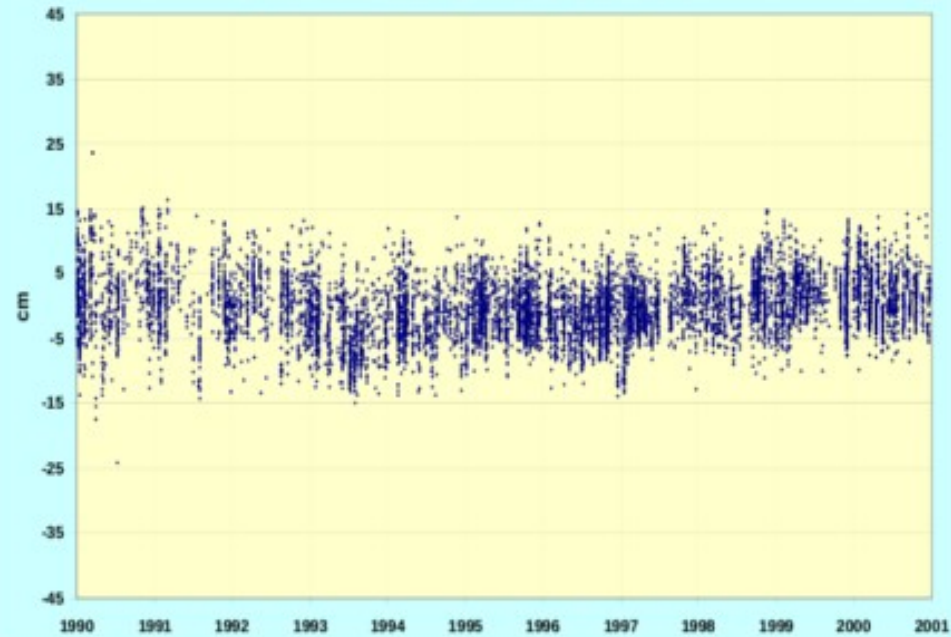
LLR RESIDUALS
FESG/IFE - Hannover (L. Biskupek)
8150 Normal Points - Mean : -0.17 cm - Std. Dev. : 6.47 cm



LLR RESIDUALS
SYRTE/POLAC - Paris (S. Bouillon)
8150 Normal Points - Mean : 0.14 cm - Std. Dev. : 3.84 cm



LLR RESIDUALS
IMCCE/ADS - Paris (H. Manche)
8478 Normal Points - Mean : -0.24 cm - Std. Dev. : 4.66 cm



LLR RESIDUALS
JPL - Pasadena (J. Williams)
8288 Normal Points - Mean : -0.14 cm - Std. Dev. : 2.88 cm

