

REVISED EPHEMERIS FOR THE ECLIPSING  
BINARY PP LAC

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ABSTRACT : PP Lac is a variable discovered by W.J. Miller; it was at first classified as "EW or RR ?", but later Figer and Rolland, by visual observations made by GEOS, found it to be an EW-type eclipsing binary and gave the first ephemeris. In this paper, 128 minima observed visually by GEOS members from 1976 to 1988, plus 18 minima observed by BBSAG, are analysed. On the basis of these data, a more precise ephemeris can be computed :

$$\text{Min I (or II)} = \text{JD Hel } 2442903,235 + 0,401\,161\,50 \cdot E \quad (1)$$

$$\qquad \qquad \qquad \pm 2 \qquad \qquad \qquad \pm 48$$

It has been impossible to discriminate the primary minimum from the secondary one.

RESUME : PP Lac est une étoile variable découverte par W.J. Miller et d'abord classifiée comme "EW ou RR ?". En 1977, des observations visuelles effectuées par le GEOS, permirent à A. Figer et R. Rolland de conclure qu'il s'agissait d'une binaire à éclipses du type EW et de donner une première éphéméride.

Dans cet article, on analyse 128 minimums observés visuellement par le GEOS de 1976 à 1988 et 18 minimums observés par le BBSAG. Ces observations permettent de calculer une éphéméride plus précise :

$$\text{Min I (ou II)} = \text{JJ Hel } 2\,442\,903,235 + 0,401\,161\,50 \cdot E$$

$$\qquad \qquad \qquad \pm 2 \qquad \qquad \qquad \pm 48$$

Il n'a pas été possible de différencier le minimum principal du minimum secondaire.

RIASSUNTO : La variabile PP Lac fu scoperta da W.J. Miller, ed inizialmente classificata come "EW o RR ?". Successivamente, Figer e Rolland, tramite osservazioni GEOS, stabilirono trattarsi di una binaria ad eclisse di tipo EW e ne fornirono la prima effemeride. In questo articolo sono analizzati 128 minimi osservati visualmente da membri del GEOS tra il 1976 ed il 1988, unitamente a 18 minimi pubblicati dalla BBSAG. Sulla base di questi dati e' stato possibile calcolare la seguente effemeride :

$$\text{Min I (o II)} = \text{JD Hel } 2\,442\,903,235 + 0,401\,161\,50 \cdot E$$

$$\qquad \qquad \qquad + 2 \qquad \qquad \qquad + 48$$

Non e' risultato possibile distinguere il minimo principale da quello secondario.

RESUMEN : PP Lac es una estrella variable descubierta por W.J. Miller y clasificada en principio como "EW o RR ?". En 1977, las observaciones visuales efectuadas por el GEOS, permitieron a A. Figer y R. Rolland concluir que se trataba de una binaria a eclipses del tipo EW y dar una primera efemeride. En este artículo, se analizan 128 mínimos observados visualmente por los miembros del GEOS de 1976 a 1988 y 18 mínimos observados por el BBSAG. Estas observaciones permiten calcular una efemeride más precisa :

$$\text{Min I ( o II )} = \text{DJ Hel } 2\,442\,903,235 + 0,401\,161\,50 \cdot E$$

$$\qquad \qquad \qquad \pm 2 \qquad \qquad \qquad \pm 48$$

No ha sido posible distinguir el mínimo principal del mínimo secundario.

## Revised ephemeris for the eclipsing binary PP Lac

### Introduction

PP Lac was discovered by W. J. Miller on photographic plates taken at Castel Gandolfo during 1948 - 1955 in the Cygnus star cloud.

Miller and Wachmann [1] found a range from 11.1 to 12.0 p and a period of about 0.5<sup>d</sup>; the classification proposed was EW or RR.

The star was added to GEOS observing programme in 1976. Figer and Rolland [2],[3] classified the star as EW, finding a period of 0.4011<sup>d</sup>. The classification was made on the basis of the shape of light curve, but it was impossible to discriminate between the primary and the secondary minima. Thus, an uncertainty still remains about the classification of the star.

The most recent edition of GCVS [4] gives the following elements:

EW/KW. 11.1 - 12.0 p; min II 12.0  
 Min I = JD<sub>Hel</sub> 2445595.438 + 0.401163 · E

In this paper, all visual observations made by GEOS will be analyzed (including those which led to the papers of Figer and Rolland [2],[3]), in order to obtain a more precise ephemeris, assuming that the star is an EW-type variable.

### Observations

Visual observations were carried on by GEOS members until 1988. Most of observations were made using Argelander's method.

Fig. 1 shows the field of the variable and the comparison stars used. The magnitudes of the comparison stars had been roughly estimated by Figer and Rolland [3]. As the aim of this paper is to find a new ephemeris, and not to analyze the range of variation, the lack of precision in the values of magnitude of comparison stars does not represent a problem.

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The light curves obtained by each observer during each night of monitoring were examined in order to find times of minimum of the variable. Some of these light curves are shown in figg. 2+5. Minima were determined by the tracing-paper method.

A total of 128 minima, from 17 observers, was collected. Table 1 shows all observers (identified by a three-letter abbreviation) and the number of observed minima.

Table 1

Observer	Site	abbr.	n. of minima
A. Figer	Paris	FGR	68
A. Maraziti	Catanzaro	MRZ	20
Ph. Ralincourt	Nantes	RAL	12
P. Wils	Niel	WLS	11
R. Boninsegna	Dourbes	BNN	2
M. Penna	Asti	MPN	2
C. Romoli	Altopascio	RML	2
P. Baruffetti	Massa	BFF	1
G. Boistel	Nantes	BTL	1
J.F. Le Borgne	Toulouse	FLB	1
S. Ferrand	Bougival	FND	1
A. Grycan	Toulouse	GRY	1
P. Guiraudou	Montpellier	GUI	1
E. Le Saout		LSA	1
L. Maurin	Paris	MRN	1
C. Pampaloni	Firenze	PMP	1
L. Rivas	Valencia	RVS	1

In addition to these minima, 18 more minima published by BBSAG [5] have been analyzed. A linear regression on these 146 minima leads to the following ephemeris:

$$\text{Min I (or II)} = \text{JD}_{\text{Hel}} 2442903.235 + 0.40116150 \cdot E \quad (1)$$

$\pm 2$ 
 $\pm 48$

(95% level of confidence for error bars)

The ephemeris refers to primary or secondary minimum because, once more, it was impossible to discriminate between them (as we will see later).

Table 2 lists all minima, showing the O-Cs with respect to

this ephemeris. Residuals are comparable with intrinsic accuracy of visual observations; it results  $\sigma_{o-c} = 0.010^d$ , which is a typical value for a short period variable observed visually. Only one minimum lies beyond  $\pm 3\sigma$ , which is a further confirm of reliability of visual observations.

In order to check the ephemeris (1), the composite light curves obtained by the two more productive observers are shown in figg. 6.7. Each dot represents the moving average over an interval of 0.04 period; each interval is shifted by 0.02 period with respect to the previous one. The reason of using moving averages is to filter observing errors without affecting the general shape of the curve.

The shape of these curves is consistent with the hypothesis of an EW-type variable. Both curves show a difference between the two minima, but these differences are too small to be considered significant. The phases of minima are very close to 0.00 and 0.05, which confirms the validity of ephemeris (1).

### Conclusion

A revised ephemeris for PP Lac has been calculated, assuming the EW classification for the star. This conjecture will be checked in a following paper, by means of photoelectric observations planned by GEOS members at Jungfraujoeh Observatory.

Antonio Maraziti

### Bibliography

- [1] Miller, W.J., Wachmann, A.A., 1971, Ricerche Astronomiche, vol.8, n.12.
- [2] Figer, A., Rolland, R., 1977, I.B.V.S. no. 1231.
- [3] Figer, A., Rolland, R., 1976, GEOS NC 142.
- [4] Kholopov, P.N. et alii, 1985, Genetal Catalogue of Variable Stars.
- [5] Locher, K., 1977, 1978, 1979, BBSAG Bulletin no. 32, 33, 35, 38, 40, 42, 44, 45.

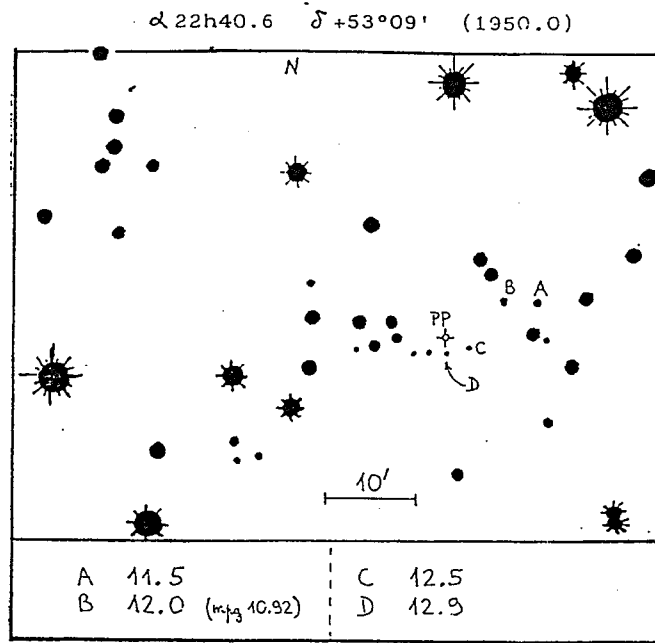
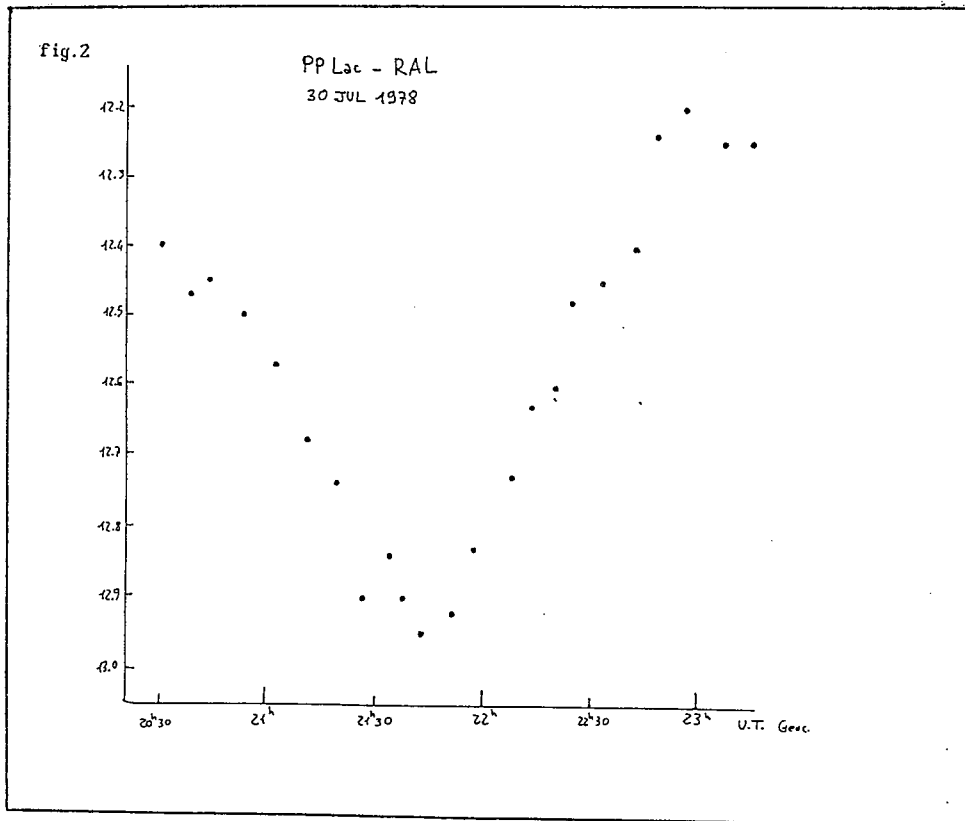


fig. 1



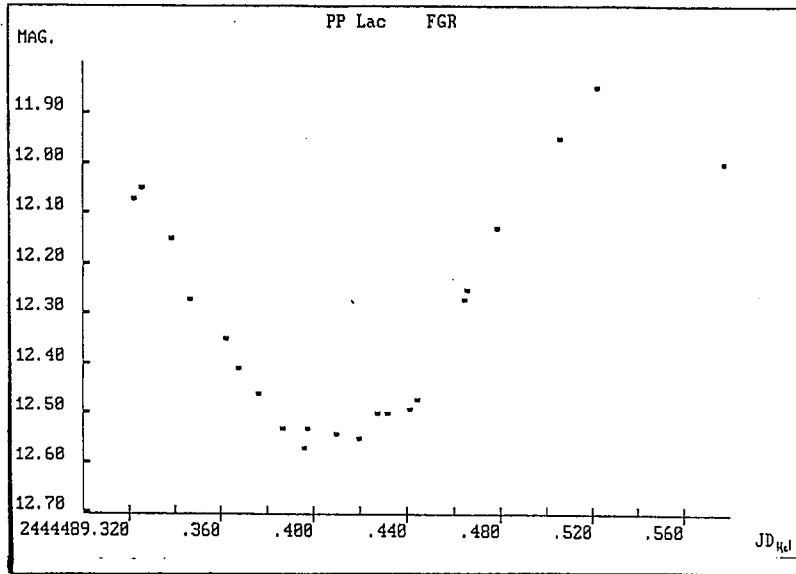


fig.3

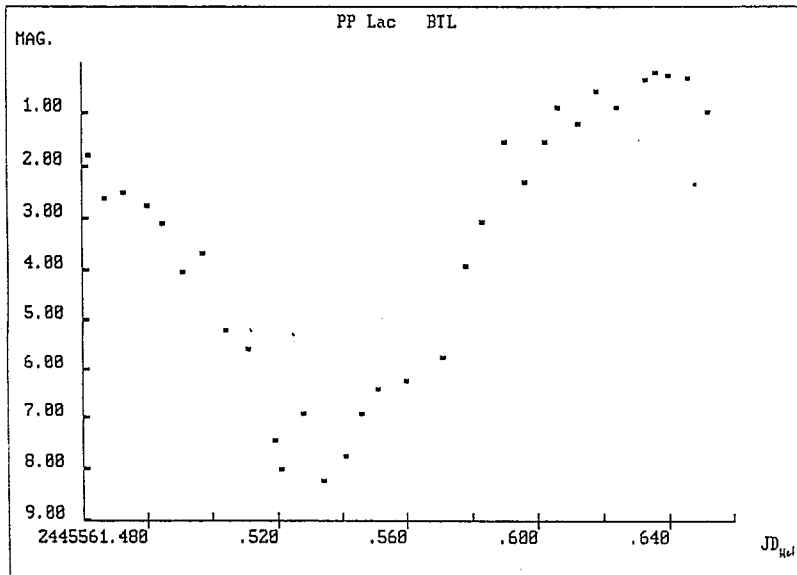


fig.4

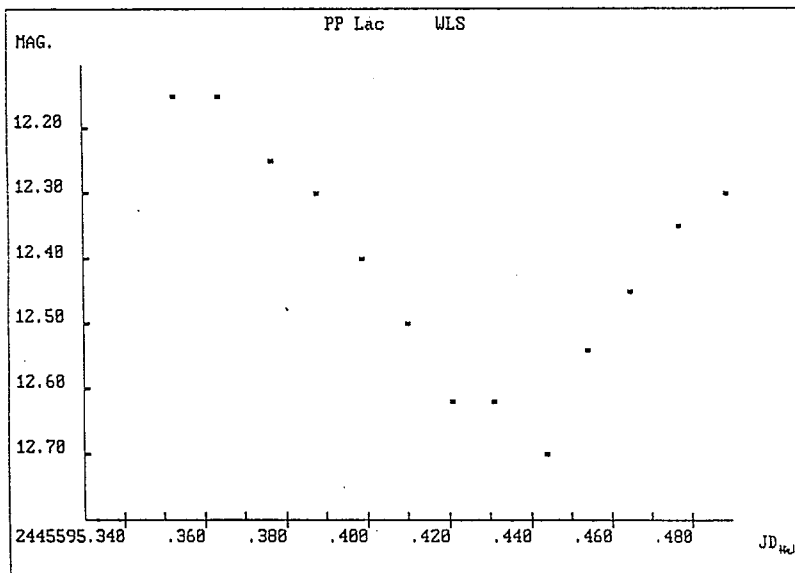


fig.5

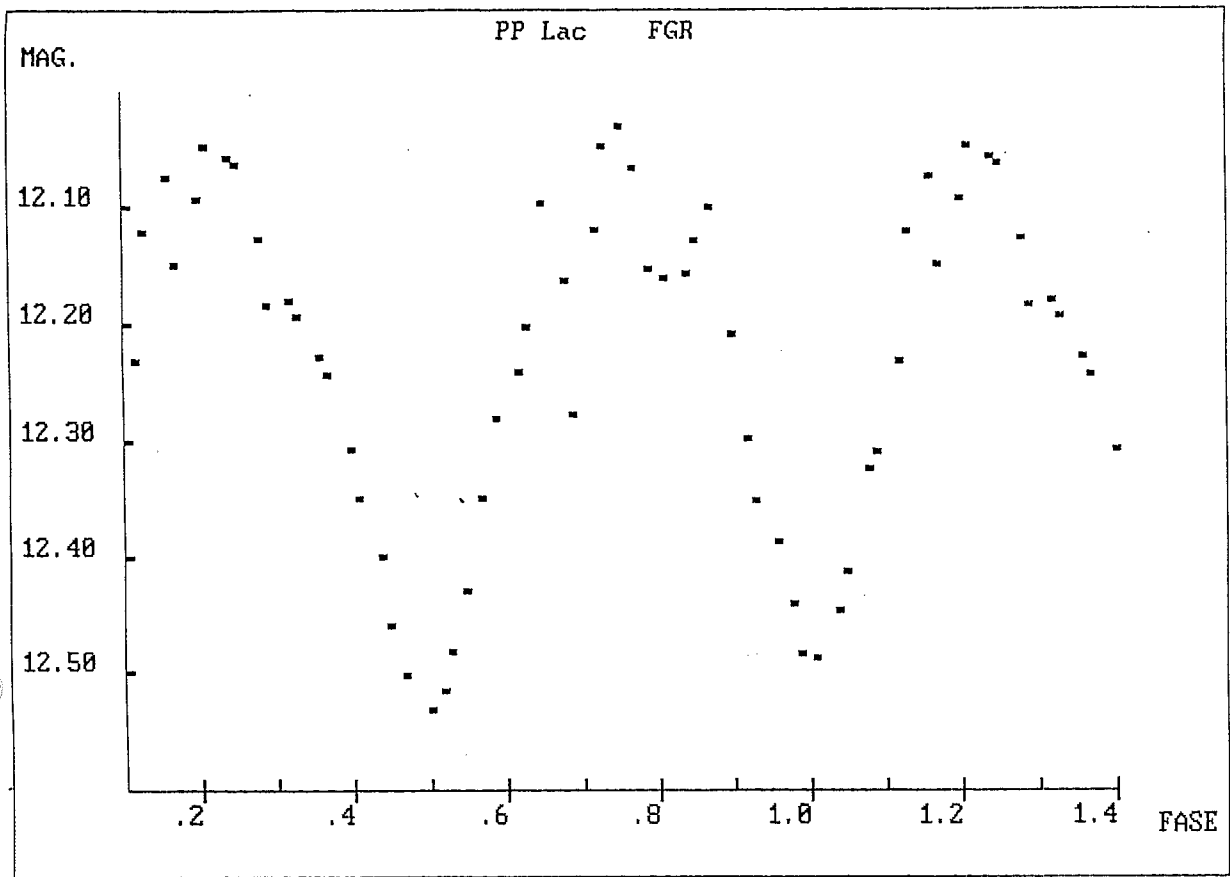


fig.6

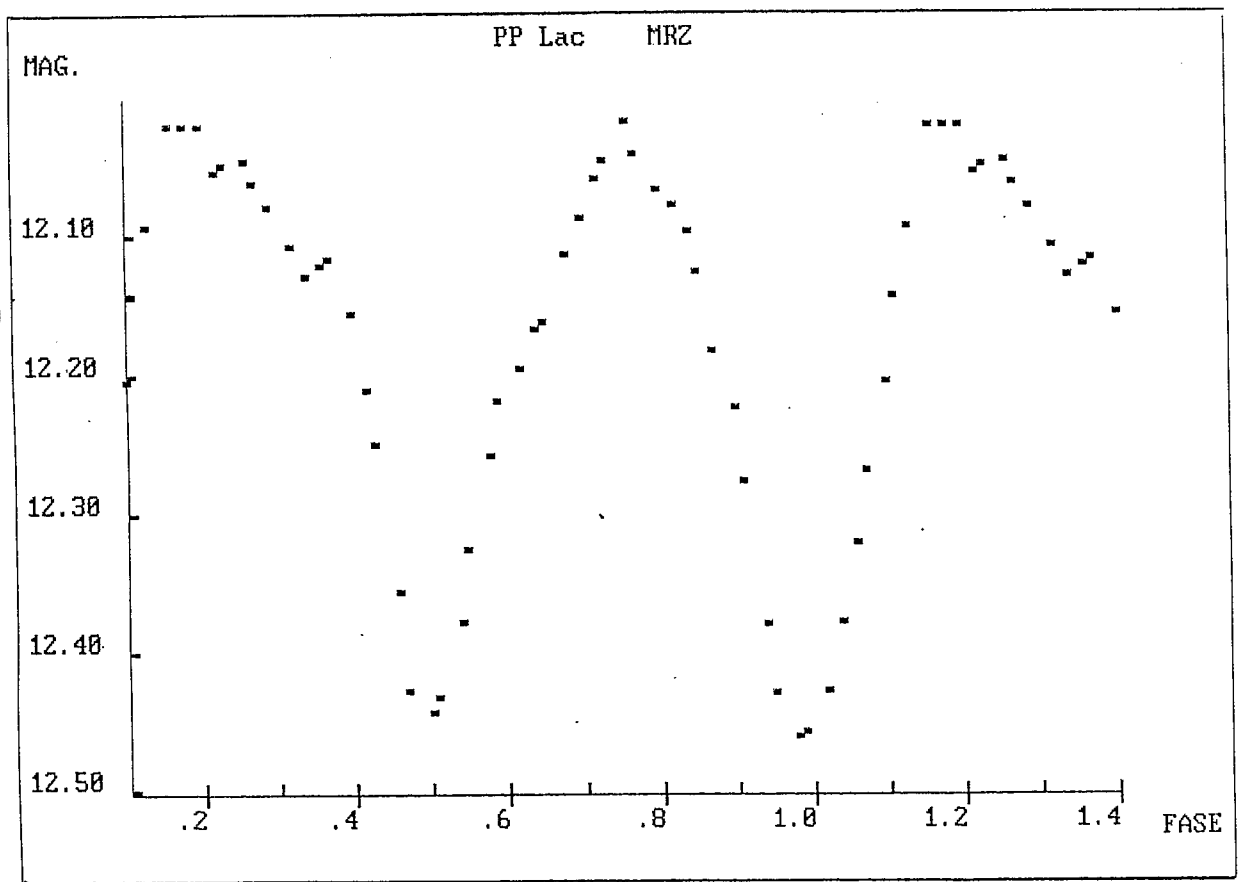


fig.7

Minimi PP Lac  
effemeride: 2442903.235 + 0.4011615 \* E

n obs	min. id hel. 2440000+...	E	O-C
99	FGR	4810.555	-0.002
100	RAL	4812.561	-0.002
101	FGR	4812.562	-0.001
102	FGR	4814.564	-0.005
103	FGR	4816.566	-0.009
104	FGR	4839.000	-0.003
105	FGR	4861.500	-0.001
106	FGR	5891.000	0.009
107	FGR	5267.272	-0.008
108	FGR	5294.363	0.005
109	RTL	5561.532	0.000
110	FND	5561.541	0.009
111	RYS	5561.554	0.022
112	RAL	5562.538	0.003
113	WLS	5577.373	-0.005
114	WLS	5578.383	-0.003
115	WLS	5593.390	-0.005
116	WLS	5595.437	0.007
117	WLS	5603.451	-0.002
118	WLS	5862.459	-0.002
119	WLS	5887.470	-0.005
120	WLS	5889.481	0.000
121	WLS	5904.523	-0.002
122	WLS	5906.525	-0.006
123	WLS	5910.547	0.005
124	RAL	6303.480	0.000
125	MRZ	6319.329	0.003
126	MRZ	6320.329	0.000
127	MRZ	6625.416	0.004
128	BFF	6651.487	0.005
129	MRZ	6652.494	0.004
130	MRZ	6676.358	-0.001
131	MRZ	6677.358	-0.004
132	MRZ	6678.375	0.010
133	MRZ	6680.377	0.006
134	MRZ	6682.380	0.003
135	MRZ	7024.364	-0.003
136	MRZ	7025.378	0.008
137	MRZ	7035.396	-0.003
138	MRZ	7037.394	-0.011
139	MRZ	7038.400	-0.008
140	MRZ	7115.430	-0.001
141	PMF	7353.515	-0.005
142	MRZ	7357.531	-0.001
143	MRZ	7376.383	-0.003
144	MRZ	7377.385	-0.004
145	MRZ	7379.388	-0.007
146	MRZ		

Minimi PP Lac  
effemeride: 2442903.235 + 0.4011615 \* E

n obs	min. id hel. 2440000+...	E	O-C
50	FGR	1319.000	0.002
51	FGR	1476.000	-0.003
52	FGR	1478.500	0.000
53	FGR	1962.500	-0.012
54	FGR	2000.000	0.003
55	FGR	2017.500	-0.004
56	KL	2024.500	0.001
57	KL	2029.500	0.009
58	RAL	2032.500	-0.023
59	FGR	2032.500	-0.021
60	KL	2034.500	0.000
61	RAL	2037.000	0.004
62	KL	2044.500	-0.005
63	KL	2049.500	-0.001
64	FGR	2059.500	-0.004
65	FGR	2087.000	-0.002
66	FGR	2089.500	0.000
67	FGR	2102.000	0.017
68	FGR	2104.500	0.008
69	FGR	2149.000	0.006
70	FGR	2154.000	0.003
71	FGR	2154.500	-0.007
72	FGR	2156.500	0.002
73	RAL	2161.500	0.000
74	FGR	2161.500	-0.009
75	FGR	2176.500	-0.008
76	FGR	2196.500	-0.001
77	FGR	2209.000	-0.019
78	FGR	2219.000	-0.030
79	KL	2293.500	-0.007
80	FGR	2298.500	-0.015
81	KL	2611.000	-0.006
82	KL	2611.000	0.001
83	KL	2914.500	0.008
84	KL	2927.000	0.007
85	KL	3039.000	0.028
86	FGR	3091.500	0.010
87	FGR	3114.000	0.013
88	KL	3178.500	-0.027
89	FGR	3183.500	-0.011
90	KL	3186.000	-0.001
91	FGR	3954.000	-0.019
92	FGR	3956.500	-0.010
93	MRN	3956.500	0.010
94	FGR	3976.500	-0.017
95	FGR	4498.437	0.011
96	FGR	4515.313	0.011
97	FGR	4599.357	0.011
98	FGR	4792.515	0.010
99	FGR	4804.539	-0.001

Minimi PP Lac  
effemeride: 2442903.235 + 0.4011615 \* E

n obs	min. id hel. 2440000+...	E	O-C
1	FGR	299.500	0.008
2	FGR	342.500	-0.008
3	FGR	344.500	-0.033
4	FGR	347.000	-0.027
5	FGR	367.000	-0.020
6	FGR	411.500	0.008
7	FGR	412.000	0.002
8	FGR	414.000	-0.004
9	RAL	481.500	0.002
10	LSA	3096.396	0.012
11	FGR	481.500	0.012
12	FGR	494.000	0.008
13	FGR	496.500	0.010
14	FGR	501.500	-0.005
15	KL	548.500	0.000
16	KL	711.500	0.005
17	KL	3188.666	0.004
18	KL	3189.668	0.001
19	FGR	3292.573	0.014
20	FGR	3292.576	0.014
21	RAL	3358.552	0.014
22	RML	3364.375	0.018
23	FGR	3361.379	-0.006
24	RAL	3361.562	0.000
25	RAL	3363.364	-0.003
26	GUI	3363.370	0.003
27	MPN	3364.371	0.016
28	RAL	3364.377	0.001
29	GUI	3364.372	0.002
30	FGR	3364.381	0.007
31	BNN	3364.558	-0.013
32	FGR	3364.570	-0.006
33	RAL	3364.565	-0.001
34	RML	3364.571	0.000
35	BNN	3364.582	0.011
36	MPN	3364.587	0.016
37	GRY	3364.588	0.017
38	FLB	3364.589	0.001
39	FGR	3370.589	-0.001
40	FGR	3386.433	-0.001
41	FGR	3388.447	0.007
42	FGR	3391.445	-0.004
43	FGR	3392.442	-0.009
44	FGR	3396.464	0.001
45	FGR	3397.457	-0.009
46	FGR	3398.456	-0.013
47	KL	3417.321	-0.002
48	FGR	3427.361	0.009
49	FGR	3428.362	0.007