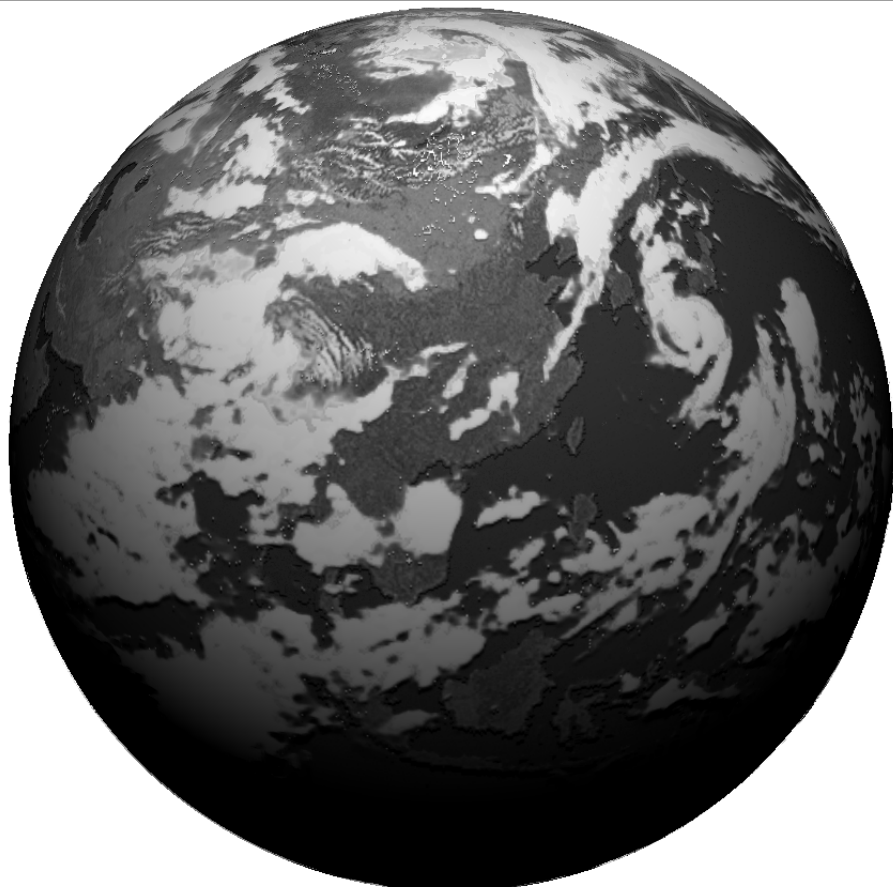
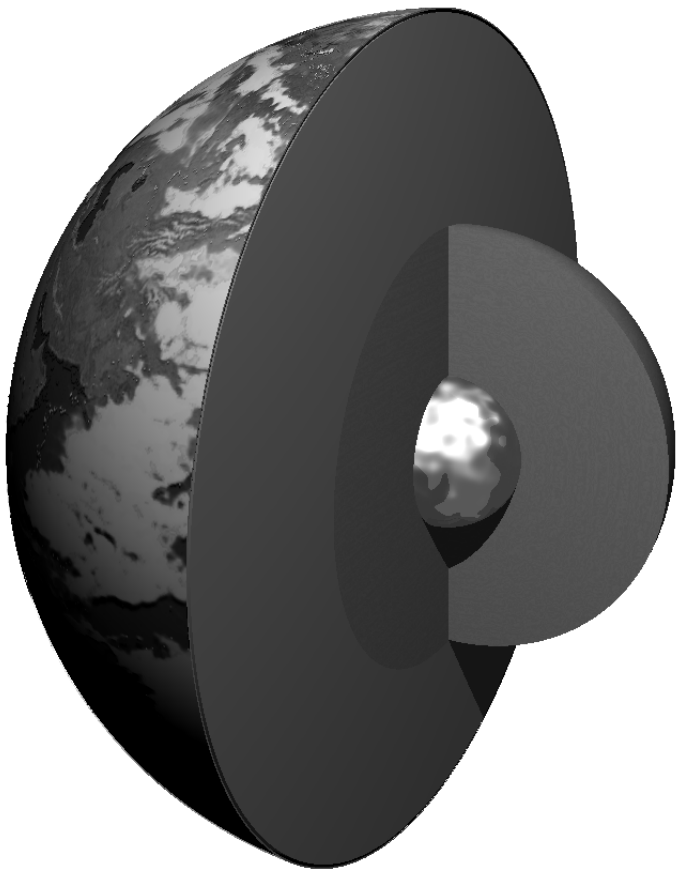


Wyznaczenie okresu swobodnej nutacji jądra na podstawie pomiarów grawimetrycznych w Józefosławiu

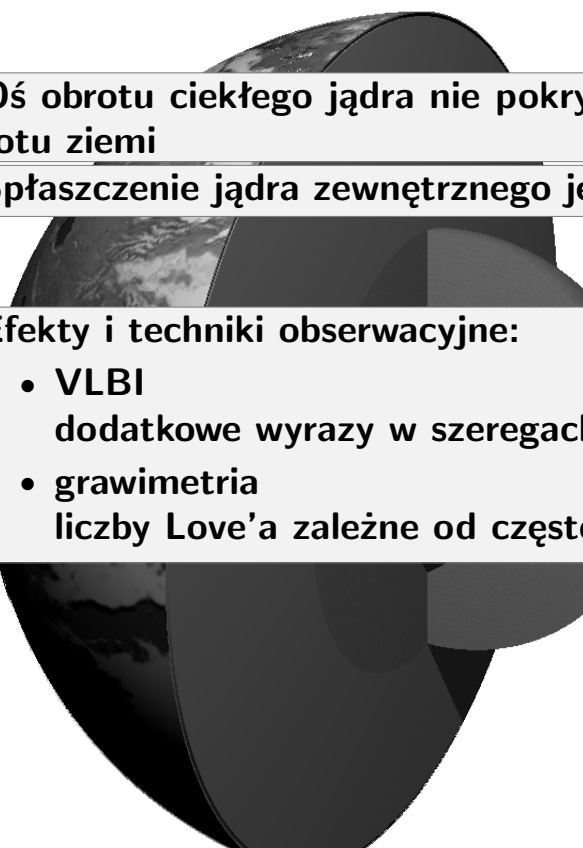




Oś obrotu ciekłego jądra nie pokrywa się z osią obrotu ziemi

Spłaszczenie jądra zewnętrznego jest inne niż Ziemi





Oś obrotu ciekłego jądra nie pokrywa się z osią obrotu ziemi

Spłaszczenie jądra zewnętrznego jest inne niż Ziemi

Efekty i techniki obserwacyjne:

- **VLBI**
dodatkowe wyrazy w szeregach nutacyjnych
- **grawimetria**
liczby Love'a zależne od częstotliwości



Oś obrotu ciekłego jądra nie pokrywa się z osią obrotu ziemi

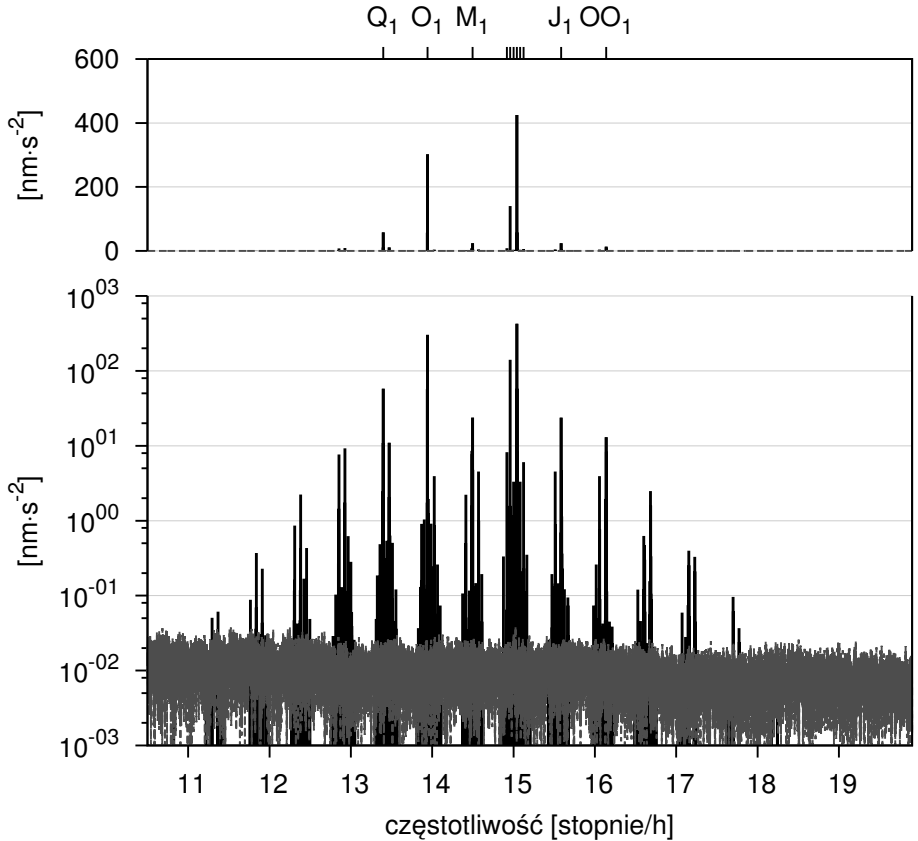
Spłaszczenie jądra zewnętrznego jest inne niż Ziemi

Efekty i techniki obserwacyjne:

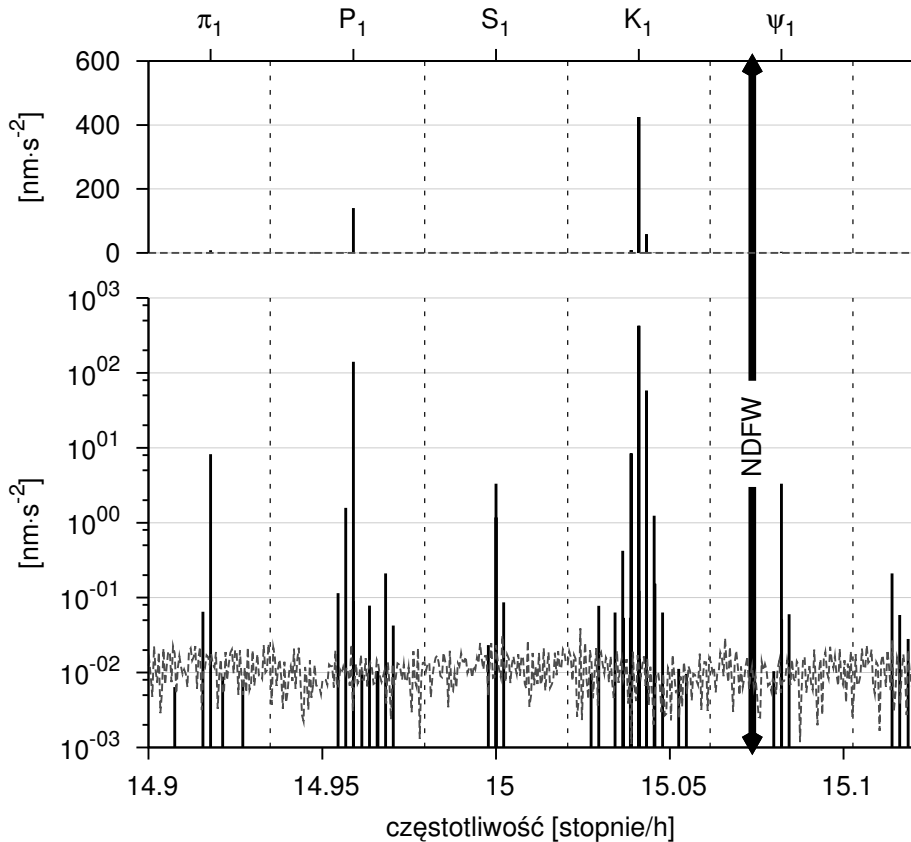
- VLBI
 dodatkowe wyrazy w szeregach nutacyjnych
- grawimetria
 liczby Love'a zależne od częstotliwości

Zagadnienie, w którym metody geodezyjne konkurują z technikami sejsmicznymi

Fale pływowe



Fale pływowe



Korekcje grawimetryczne

Poprawka atmosferyczna (PC)

$$\Delta g = -3.45 \left[\frac{nm}{s^2 \cdot hPa} \right] \cdot \Delta p$$

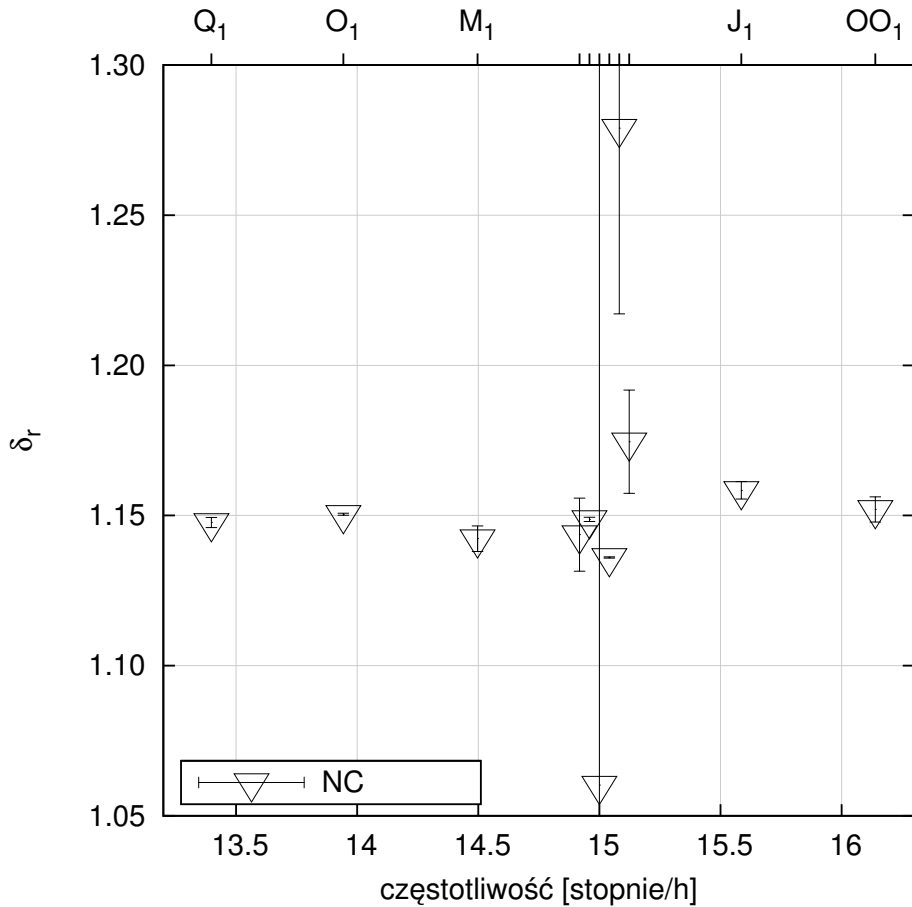
Pośredni efekt pływów oceanicznych (OTLC)

- modele pływów oceanicznych Q_1 , O_1 , P_1 , K_1
- interpolacja na inne częstotliwości

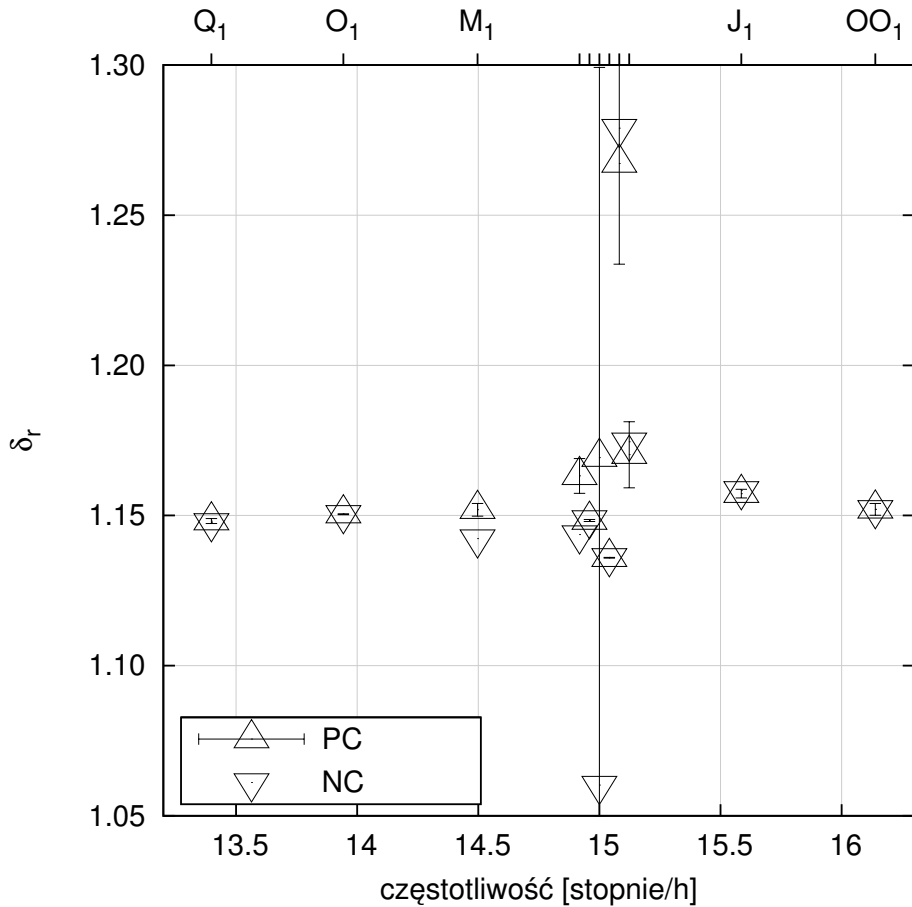
$$\frac{L_i \cos(\lambda_i)}{A_{thj}} = a_{r1} + a_{r2} \cdot \sigma_j + a_{r3} \cdot \sigma_j^2,$$

$$\frac{L_i \sin(\lambda_i)}{A_{thj}} = a_{i1} + a_{i2} \cdot \sigma_j + a_{i3} \cdot \sigma_j^2,$$

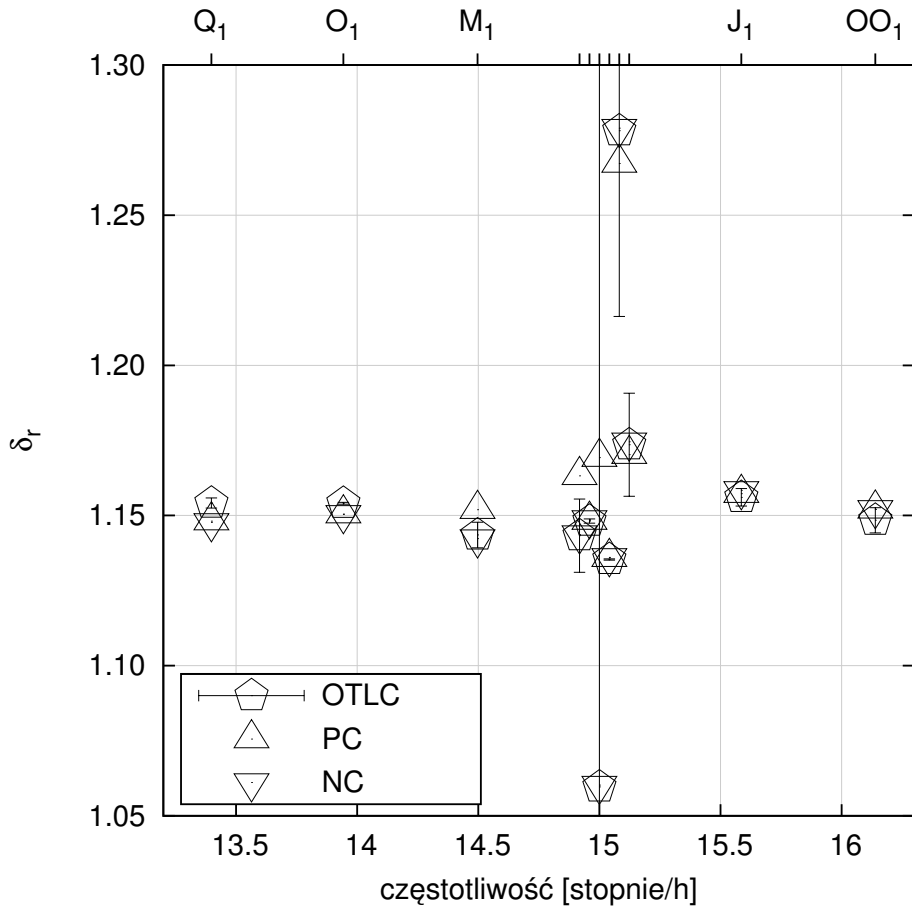
Współczynniki grawimetryczne



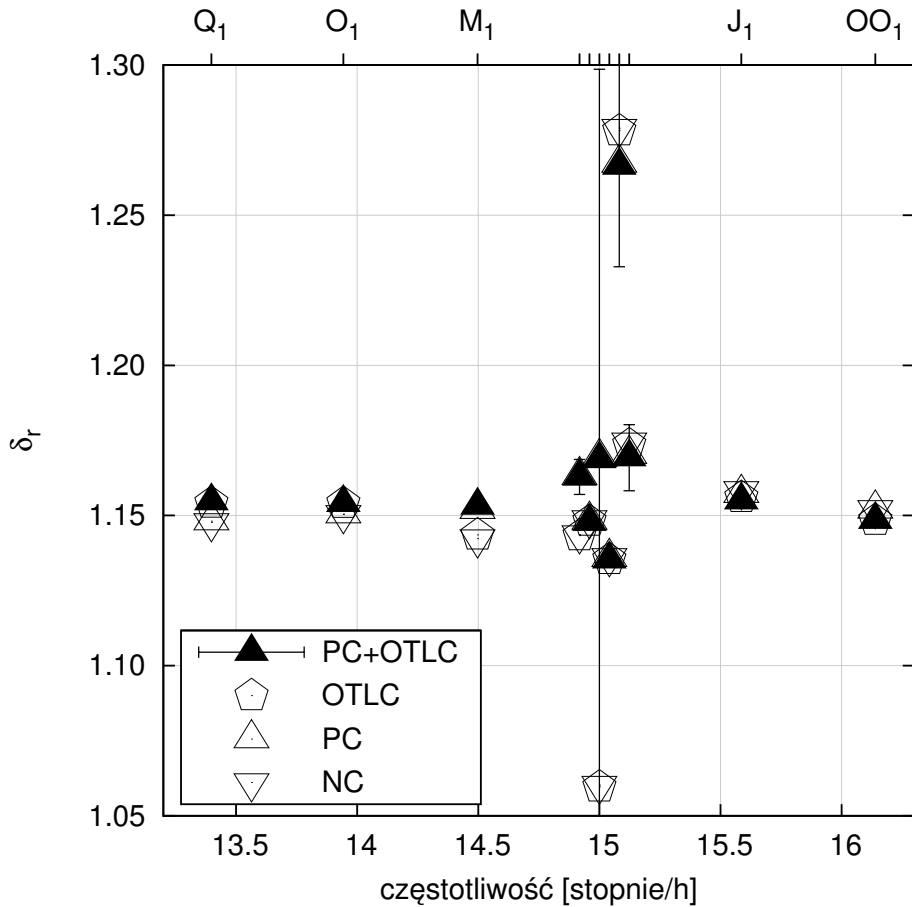
Współczynniki grawimetryczne



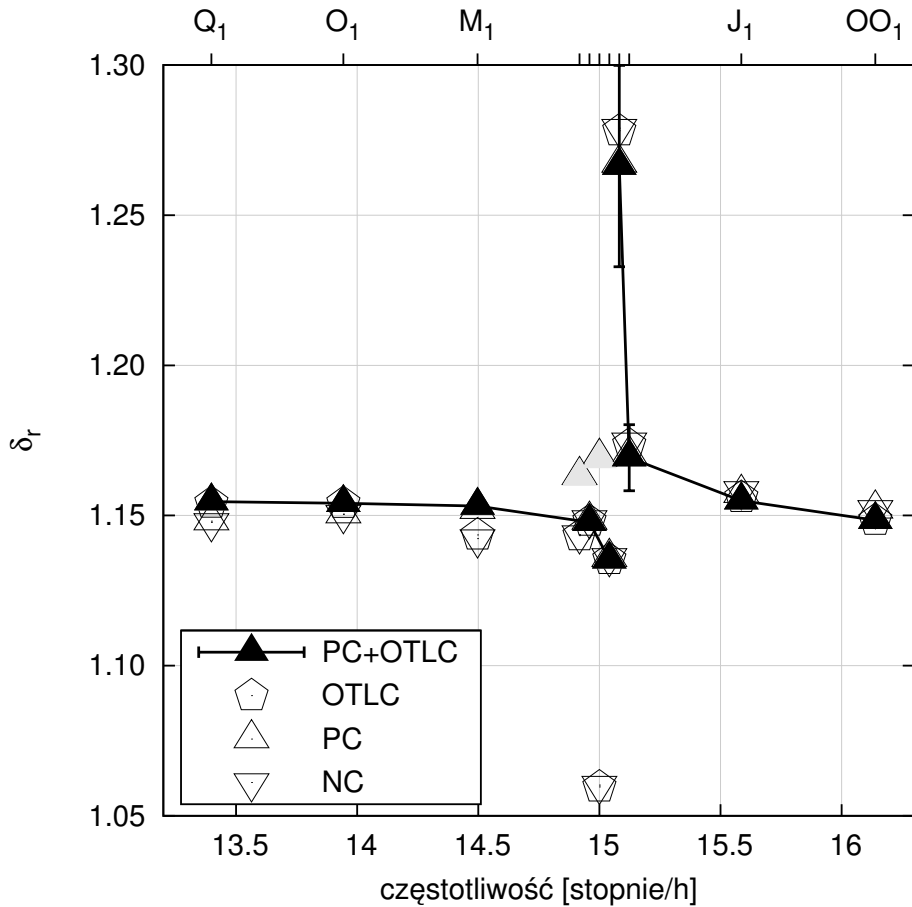
Współczynniki grawimetryczne



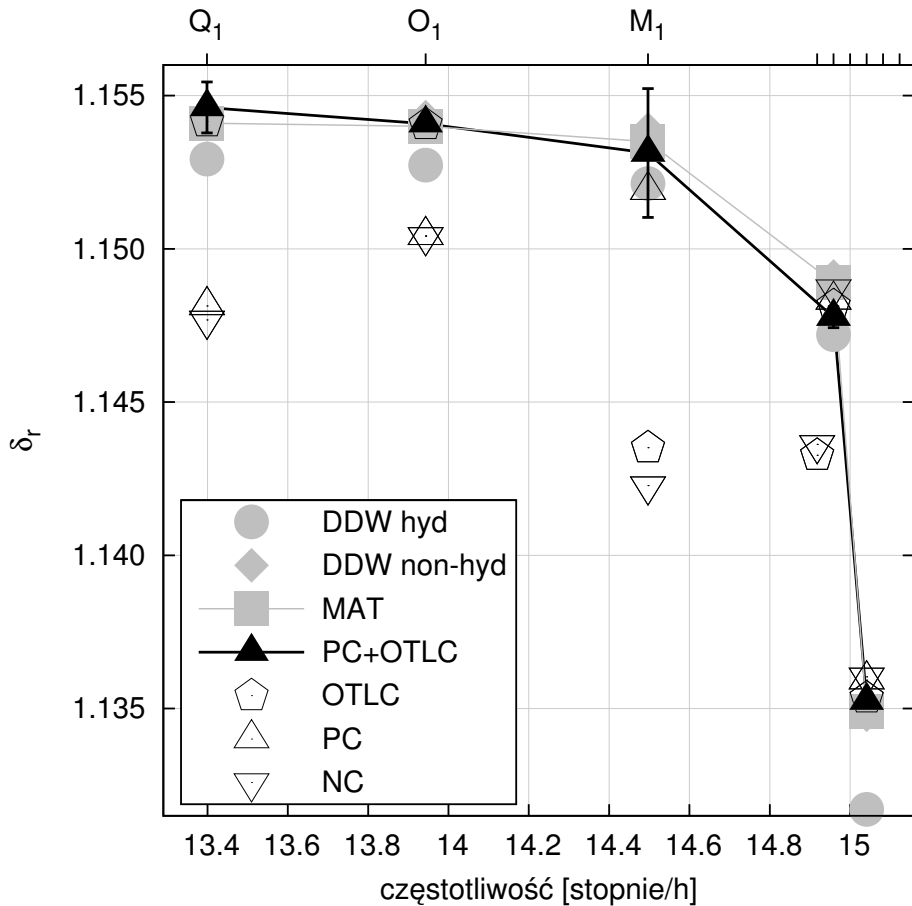
Współczynniki grawimetryczne



Współczynniki grawimetryczne



Współczynniki grawimetryczne



„Prosta metoda”

Florsch i in., 1994

$$\tilde{\sigma}_{NDFW} = f(\sigma_1, \sigma_2, \sigma_3, \tilde{\delta}_1, \tilde{\delta}_2, \tilde{\delta}_3)$$

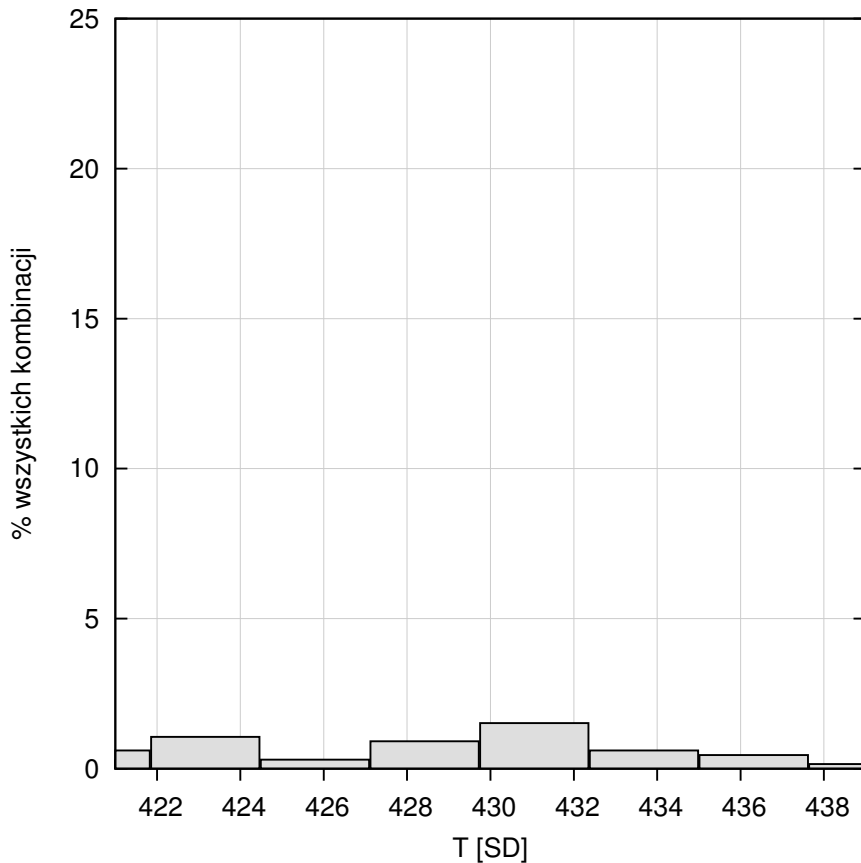
$$\tilde{\sigma}_{NDFW} = \frac{\sigma_1 \tilde{\delta}_1 (\sigma_2 - \sigma_3) + \sigma_2 \tilde{\delta}_2 (\sigma_3 - \sigma_1) + \sigma_3 \tilde{\delta}_3 (\sigma_1 - \sigma_2)}{\sigma_1 (\tilde{\delta}_3 - \tilde{\delta}_2) + \sigma_2 (\tilde{\delta}_1 - \tilde{\delta}_3) + \sigma_3 (\tilde{\delta}_2 - \tilde{\delta}_1)},$$

$$\frac{1}{T_{FCN}} = \frac{1}{T_{NDFW}} - 1.$$

$$Q = \frac{\sigma_{NDFW}^r}{2\sigma_{NDFW}^i}$$

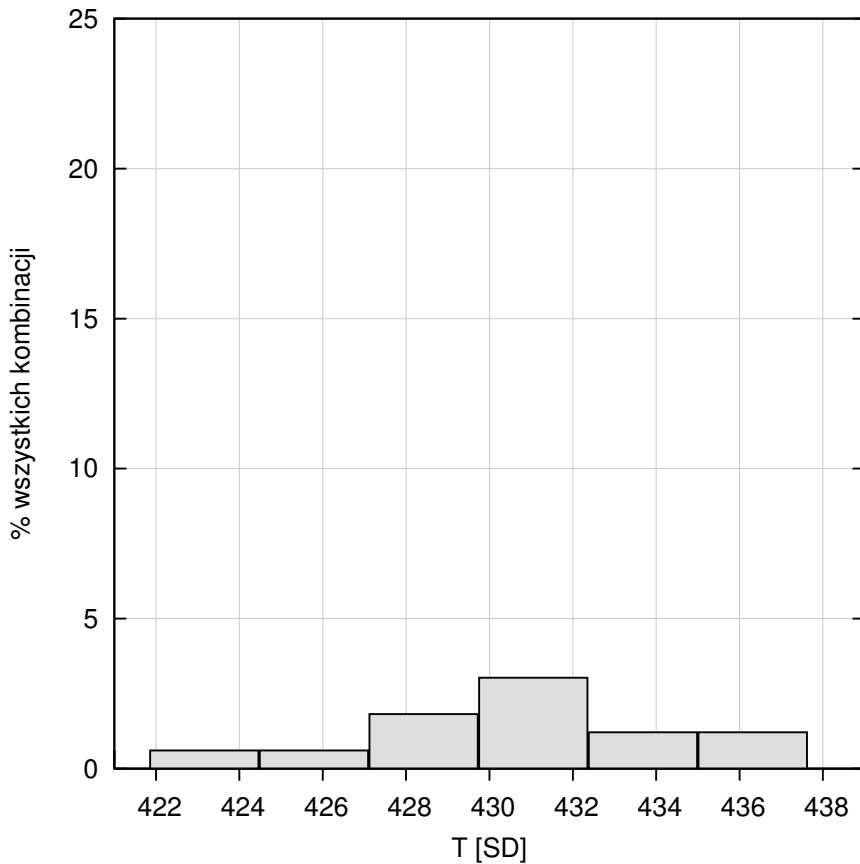
Okres nutacji

NC, PC, OTLC, PC+OTLC, Q_1 , O_1 , M_1 , π_1 , P_1 , S_1 , K_1 , ψ_1 , φ_1 , J_1 , OO_1



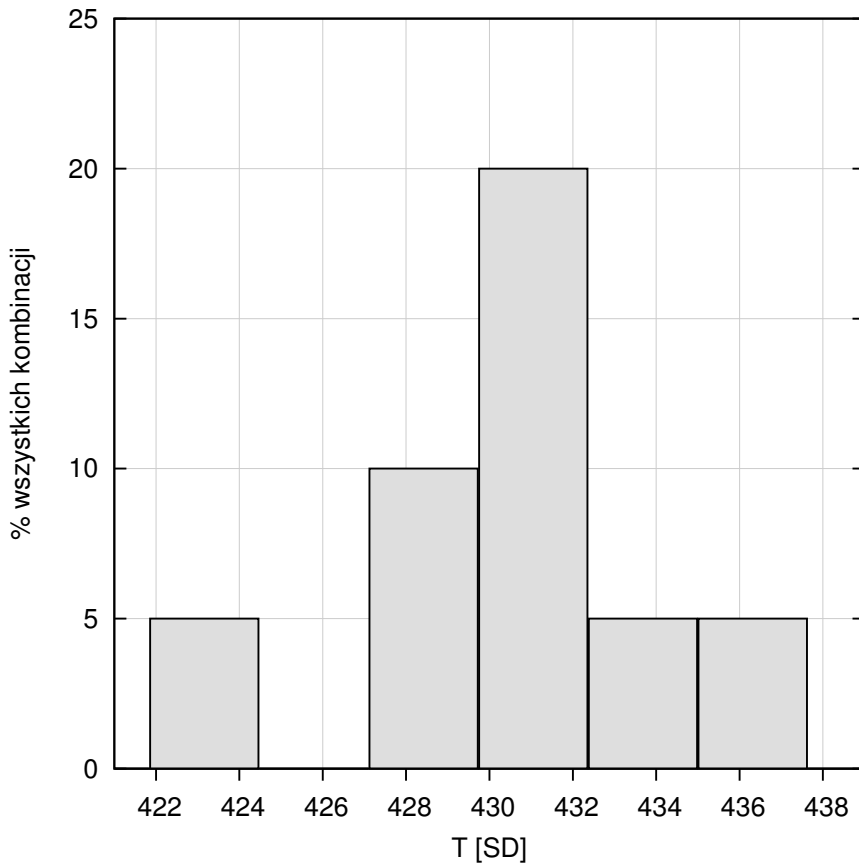
Okres nutacji

$PC+OTLC, Q_1, O_1, M_1, \pi_1, P_1, S_1, K_1, \psi_1, \varphi_1, J_1, OO_1$



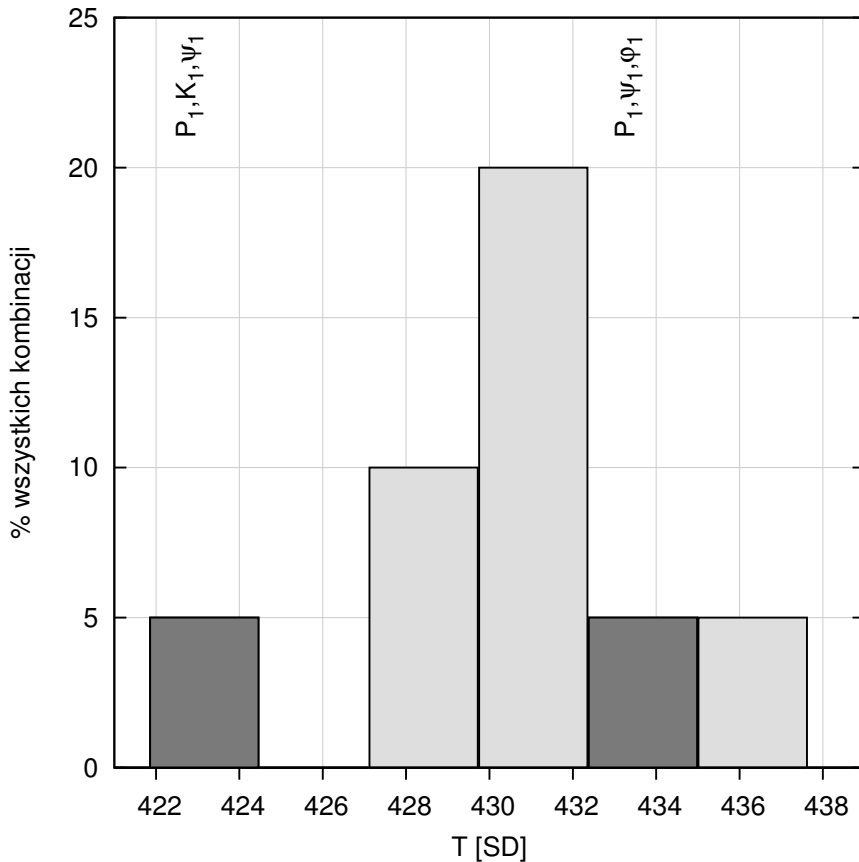
Okres nutacji

$PC+OTLC, Q_1, O_1, P_1, K_1, \psi_1, \varphi_1$



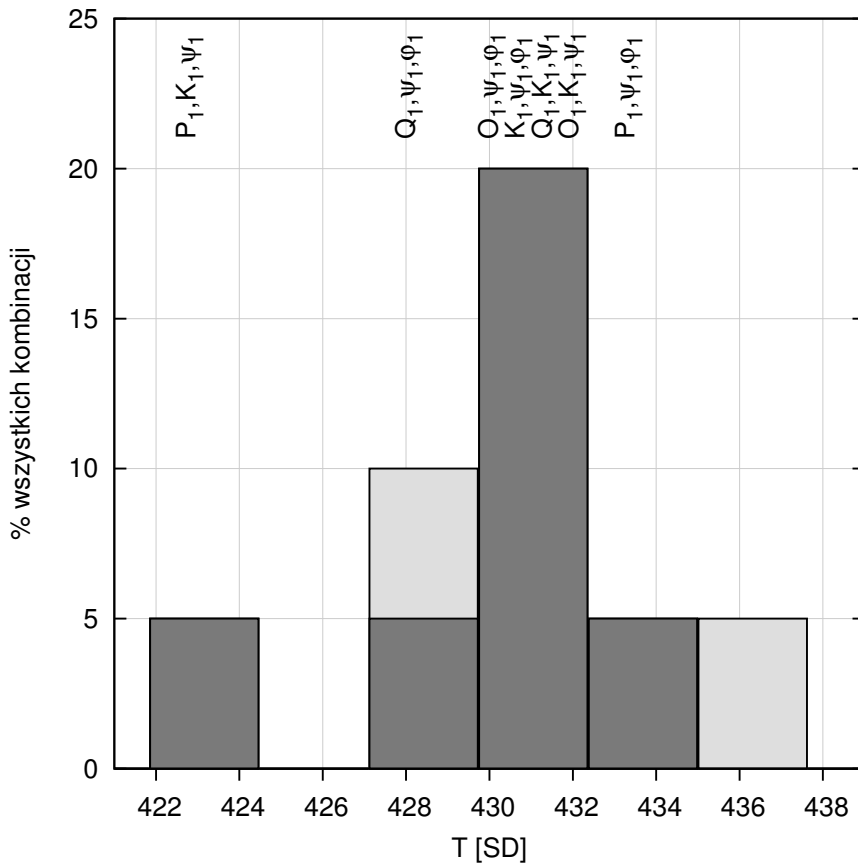
Okres nutacji

$P_1 - PC+OTLC, Q_1, O_1, P_1, K_1, \psi_1, \varphi_1$



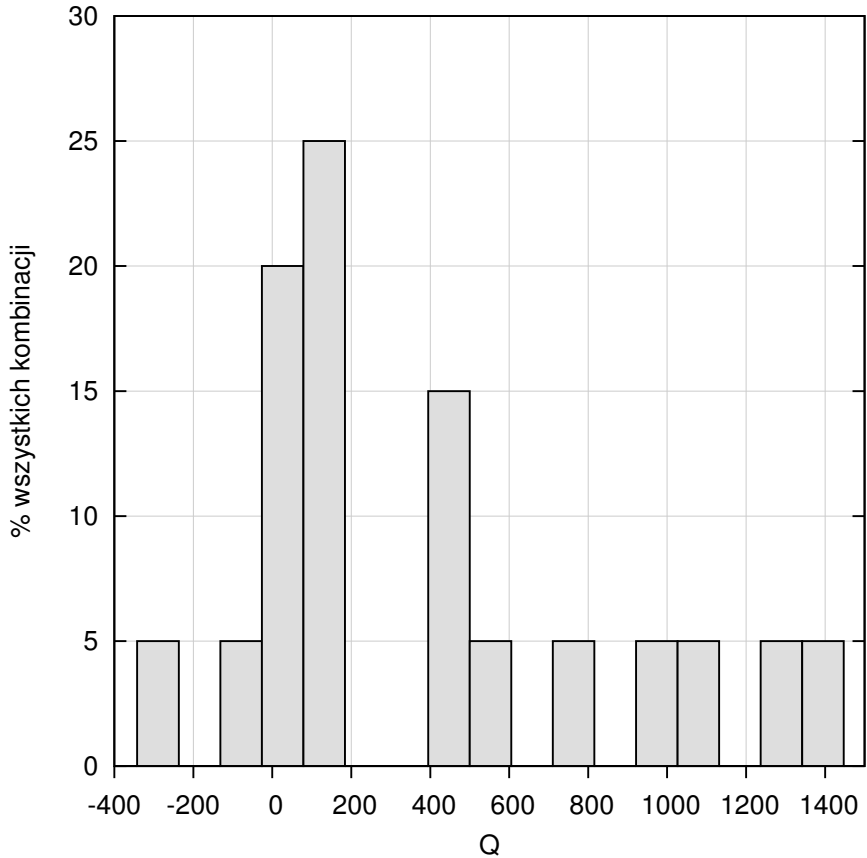
Okres nutacji

$\psi_1 - PC+OTLC, Q_1, O_1, P_1, K_1, \psi_1, \varphi_1$



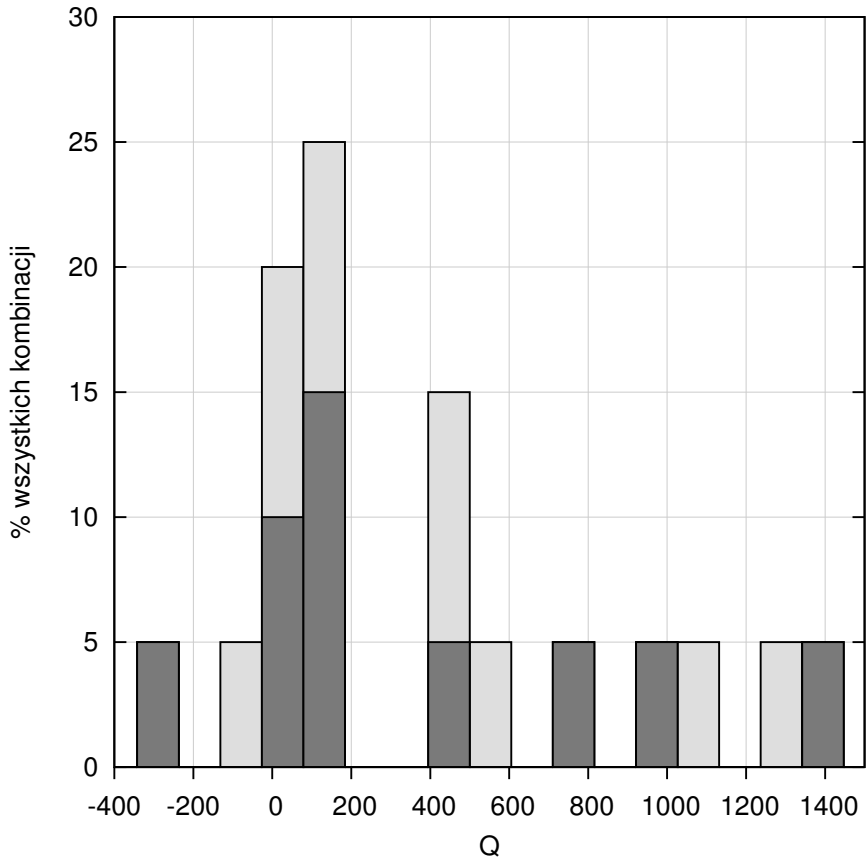
Parametr Q

PC+OTLC, $Q_1, O_1, P_1, K_1, \psi_1, \varphi_1$



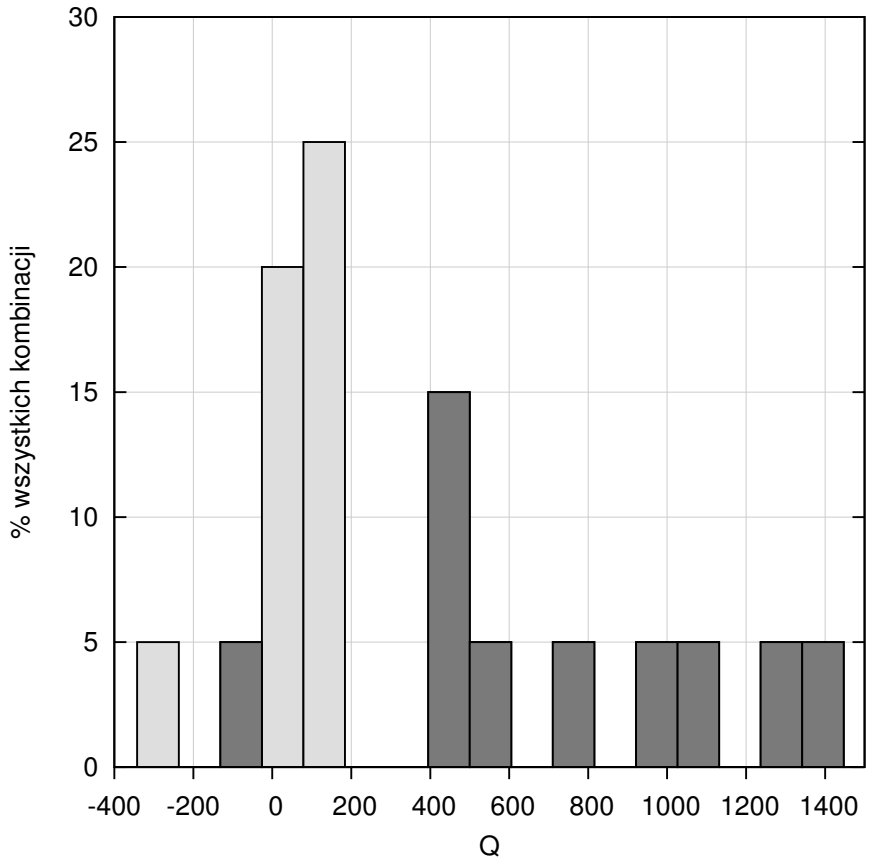
Parametr Q

$P_1 - PC+OTLC, Q_1, O_1, P_1, K_1, \psi_1, \varphi_1$



Parametr Q

$\psi_1 - \text{PC+OTLC}, Q_1, O_1, P_1, K_1, \psi_1, \varphi_1$



Model rezonansowy

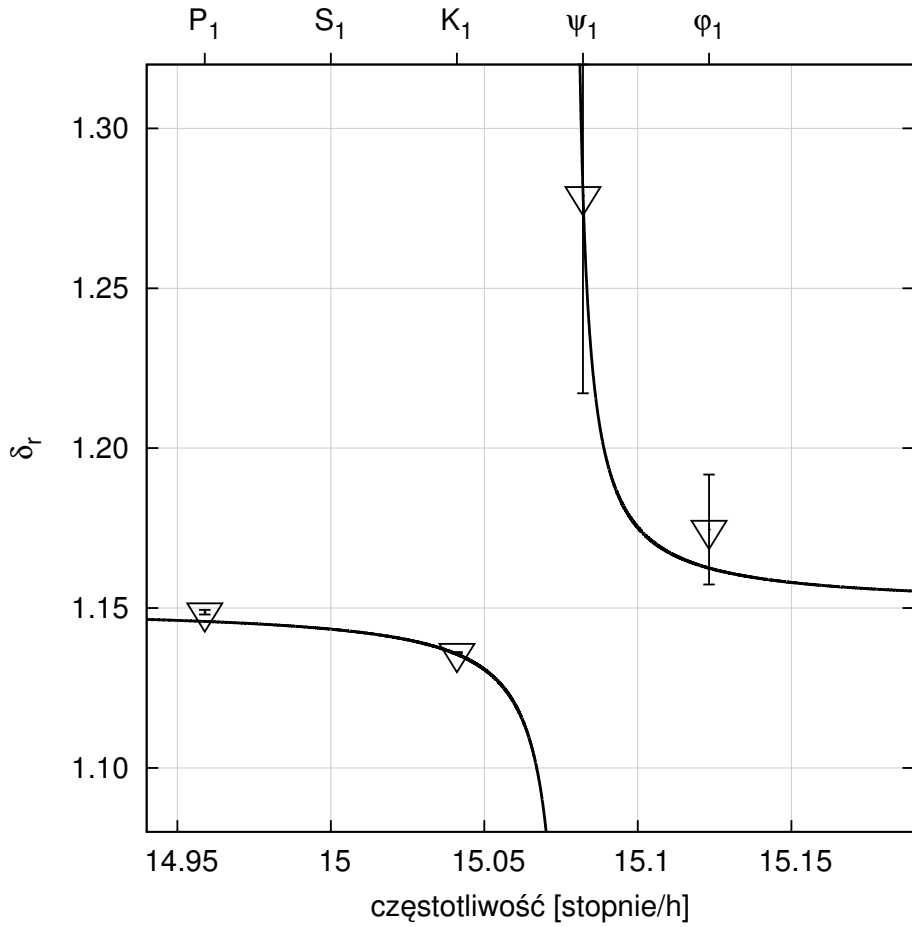
$$\tilde{\delta}(\sigma) = \delta_0 + \frac{\tilde{A}}{\sigma - \tilde{\sigma}_{NDFW}},$$

$$\tilde{\delta}(\sigma) - \tilde{\delta}(\sigma_{O_1}) = \frac{\tilde{A}}{\sigma - \tilde{\sigma}_{NDFW}} + \frac{\tilde{A}}{\sigma_{O_1} - \tilde{\sigma}_{NDFW}},$$

$$\sum_{j=1}^n p_j \left[\tilde{\delta}(\sigma_j) - \tilde{\delta}(\sigma_{O_1}) - \frac{\tilde{A}}{\sigma_j - \tilde{\sigma}_{NDFW}} + \frac{\tilde{A}}{\sigma_{O_1} - \tilde{\sigma}_{NDFW}} \right]^2.$$

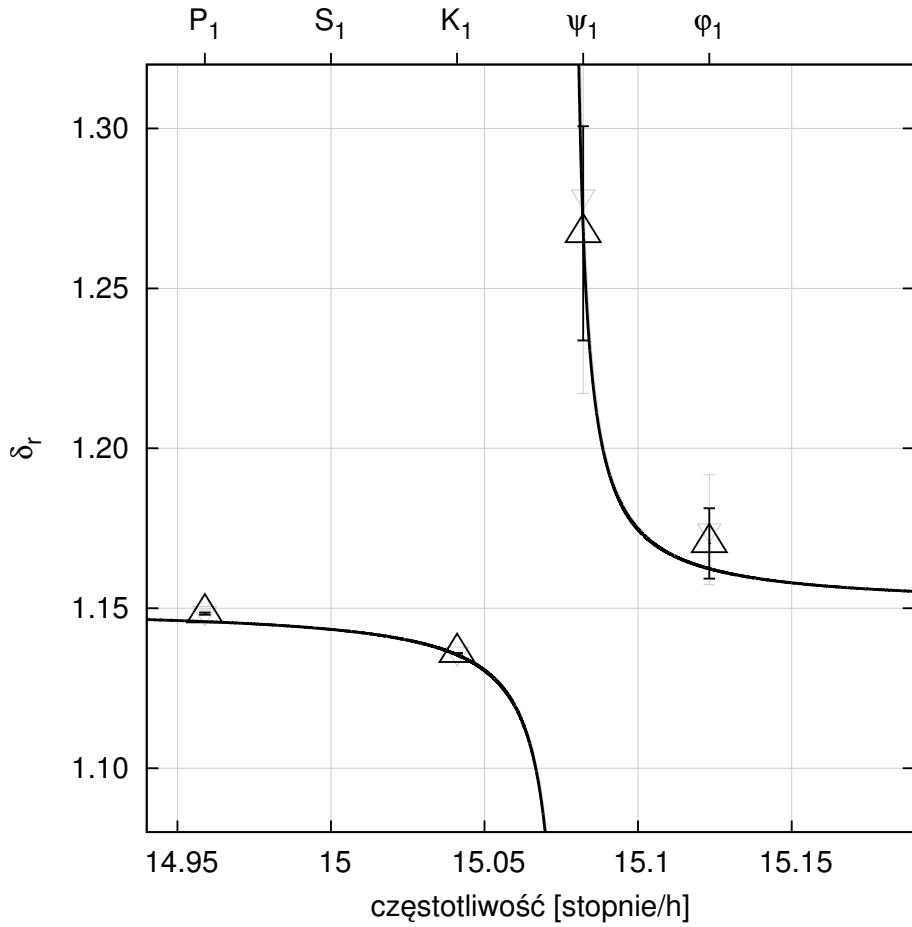
NC

$T_{FCN} = 408.3$



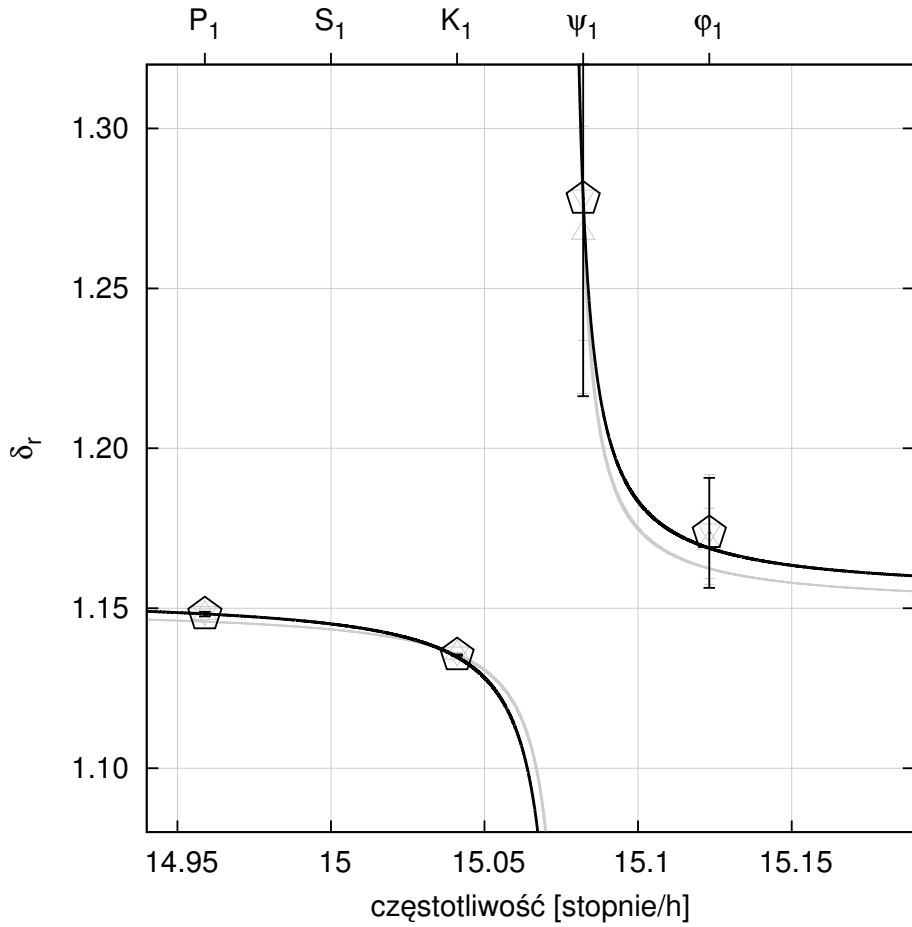
PC

$T_{FCN} = 413.1$



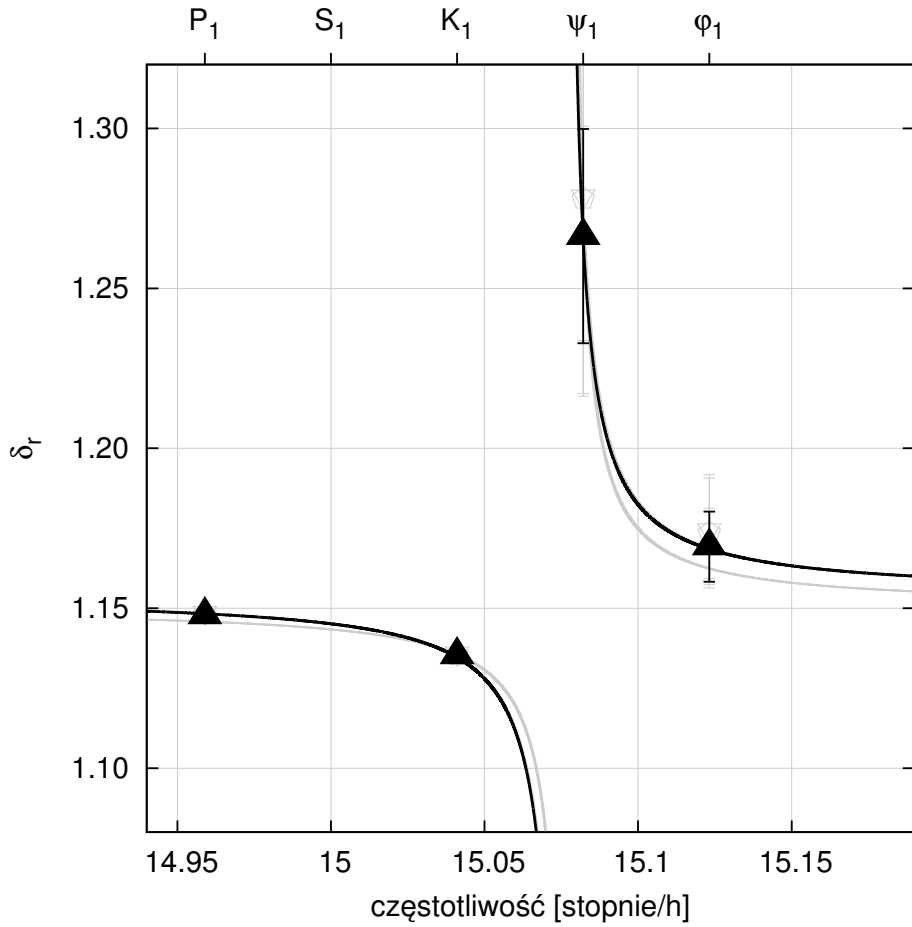
OTLC

$T_{FCN} = 423.2$

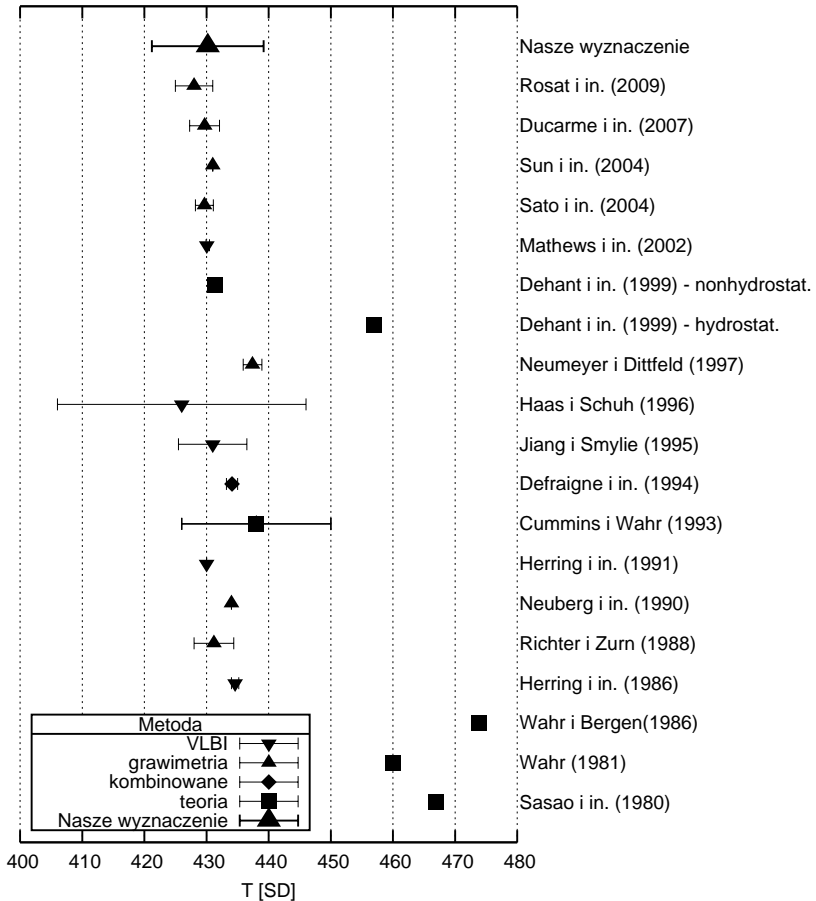


PC+OTLC

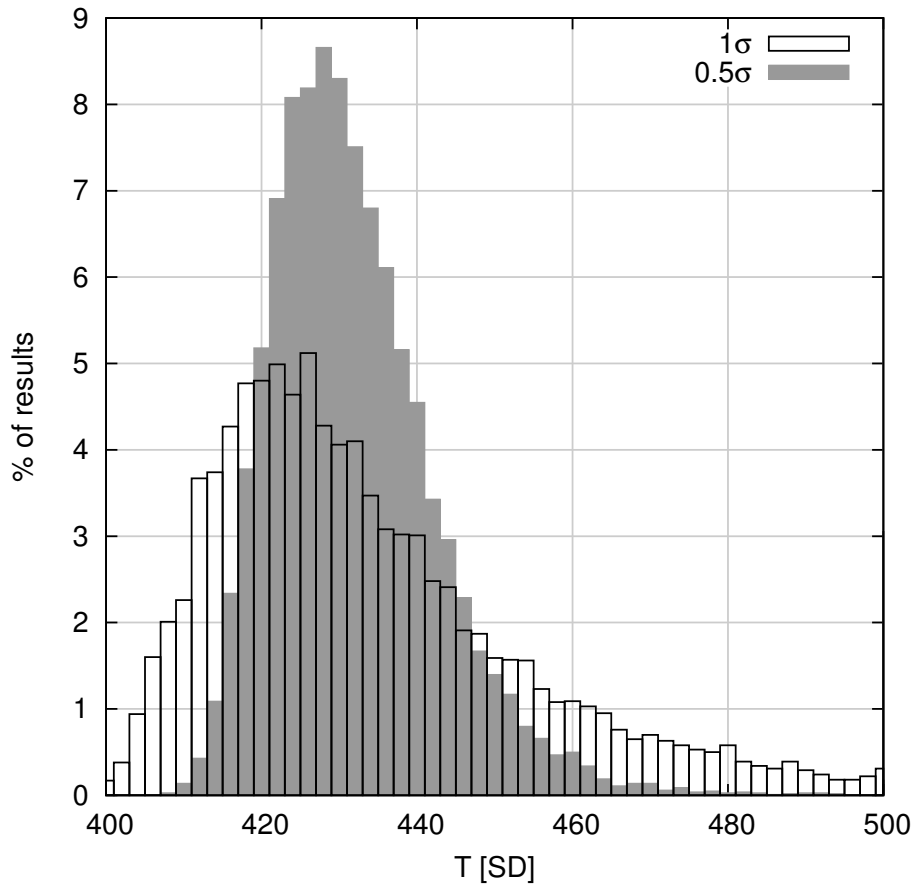
$T_{FCN} = 430.2$



Inne wyznaczenia



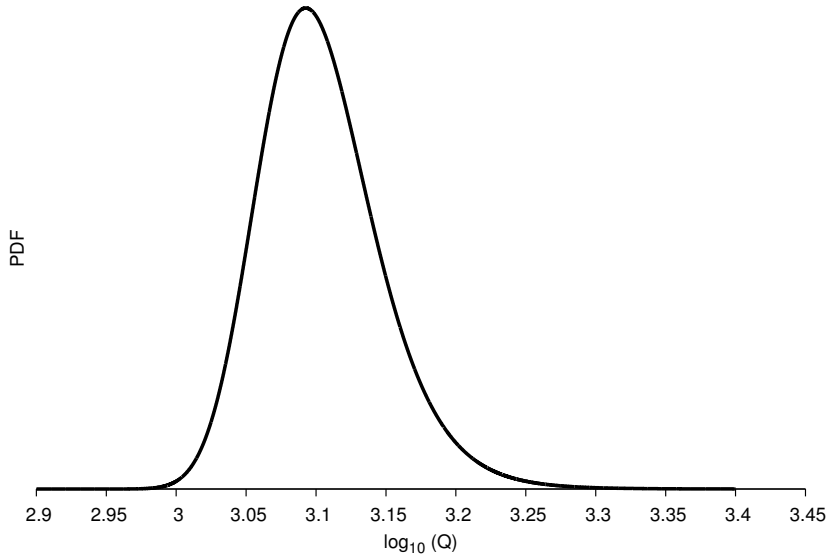
Dokładność?



Parametr dobroci - met. Bayesa

Florsch i Hinderer, 2000

$$Q = \frac{\sigma_{NDFW}^r}{2\sigma_{NDFW}^i} = 10^x$$



Dziękuję za uwagę



Slajdy dodatkowe

	NC						PC				PC+OTLC	
	$f [^\circ/h]$	$A_{th} [\frac{mm}{s^2}]$	δ	m_δ	$\varphi [^\circ]$	$m_\varphi [^\circ]$	δ	m_δ	$\varphi [^\circ]$	$m_\varphi [^\circ]$	δ	φ
Q_1	13.399	57.7	1.1477	0.0017	-0.0870	0.0840	1.1481	0.0008	-0.0660	0.0410	1.1546	0.0085
O_1	13.943	301.3	1.1504	0.0003	0.0720	0.0160	1.1504	0.0002	0.0930	0.0080	1.1541	-0.0498
M_1	14.497	23.7	1.1423	0.0042	0.1280	0.2120	1.1519	0.0021	0.1120	0.1040	1.1531	-0.0803
π_1	14.918	8.2	1.1436	0.0116	0.3290	0.5800	1.1632	0.0058	-0.0420	0.2860	1.1628	-0.1637
P_1	14.959	140.2	1.1487	0.0007	0.2350	0.0340	1.1483	0.0003	0.1100	0.0170	1.1478	0.0068
S_1	15.000	3.3	1.0835	0.0364	-11.8850	1.9270	1.1767	0.0201	-6.4250	0.9750	1.1763	-6.5248
K_1	15.041	423.6	1.1360	0.0002	0.1330	0.0100	1.1359	0.0001	0.0950	0.0050	1.1352	-0.0001
ψ_1	15.082	3.3	1.2799	0.0258	2.1780	1.1550	1.2682	0.0134	2.2900	0.6060	1.2673	2.2255
φ_1	15.123	6.0	1.1746	0.0159	-0.4040	0.7780	1.1704	0.0080	-0.9310	0.3940	1.1694	-0.9899
J_1	15.585	23.7	1.1584	0.0029	0.0040	0.1450	1.1573	0.0014	0.0330	0.0720	1.1550	0.2339
OO_1	16.139	13.0	1.1521	0.0039	-0.3670	0.1960	1.1520	0.0020	0.0110	0.0980	1.1485	0.6568

	GOT4.7		FES99		FES2004		CSR3.0		TPXO.7.2		SCHW		mean	
	L	λ	L	λ	L	λ	L	λ	L	λ	L	λ	\bar{L}	$\bar{\lambda}$
Q_1	0.4	-174	0.4	-160	0.4	-180	0.3	-169	0.4	-161	0.4	14	0.38	-167.0
O_1	1.4	139	1.5	143	1.4	146	1.3	136	1.4	139	1.4	14	1.40	141.8
M_1	0.1	104	0.1	109	0.1	106	0.1	111	0.1	104	0.1	14	0.10	107.7
π_1	0.0	79	0.0	86	0.0	56	0.0	103	0.0	84	0.0	14	0.02	81.8
P_1	0.3	76	0.4	81	0.3	41	0.3	101	0.3	78	0.2	14	0.30	75.2
S_1	0.0	72	0.0	78	0.0	42	0.0	102	0.0	77	0.0	14	0.01	72.7
K_1	1.0	68	1.0	74	0.9	41	0.7	104	0.8	75	0.7	14	0.85	70.0
ψ_1	0.0	61	0.0	66	0.0	27	0.0	102	0.0	63	0.0	14	0.01	59.3
φ_1	0.0	54	0.0	57	0.0	19	0.0	102	0.0	50	0.0	14	0.01	50.2
J_1	0.1	-58	0.1	-54	0.1	-32	0.1	-84	0.1	-73	0.1	14	0.11	-60.2
OO_1	0.1	-80	0.2	-71	0.1	-54	0.2	-87	0.2	-84	0.2	14	0.17	-74.4

		T [SD]		A_r [$\cdot 10^4 h \cdot deg^{-1}$]		T [SD]		A_r [$\cdot 10^4 h \cdot deg^{-1}$]	
Solution		$M_1, \pi_1, K_1, \psi_1, \varphi_1, J_1$				$M_1, \pi_1, P_1, K_1, \psi_1, \varphi_1, J_1$			
NC	408.3	(396.5 – 420.9)	5.47	(± 0.20)	412.0	(391.5 – 434.7)	5.40	(± 0.32)	
PC	413.2	(402.0 – 425.0)	5.45	(± 0.17)	418.0	(397.1 – 441.3)	5.37	(± 0.31)	
OTLC	423.2	(407.0 – 440.7)	6.87	(± 0.30)	421.4	(407.0 – 436.8)	6.90	(± 0.27)	
PC+OTLC	430.2	(421.4 – 439.5)	6.80	(± 0.15)	426.0	(414.1 – 438.6)	6.88	(± 0.21)	
Solution		K_1, ψ_1, φ_1				$P_1, K_1, \psi_1, \varphi_1$			
NC	408.5	(401.7 – 415.5)	5.47	(± 0.11)	412.3	(385.8 – 442.6)	5.39	(± 0.42)	
PC	413.2	(407.9 – 418.7)	5.45	(± 0.08)	418.1	(390.8 – 449.6)	5.37	(± 0.41)	
OTLC	423.4	(419.9 – 426.9)	6.86	(± 0.06)	421.5	(412.9 – 430.5)	6.90	(± 0.16)	
PC+OTLC	430.0	(429.8 – 430.2)	6.80	(± 0.00)	425.8	(410.6 – 442.2)	6.88	(± 0.27)	