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Results obtained using VieVS: Love numbers and FCN period

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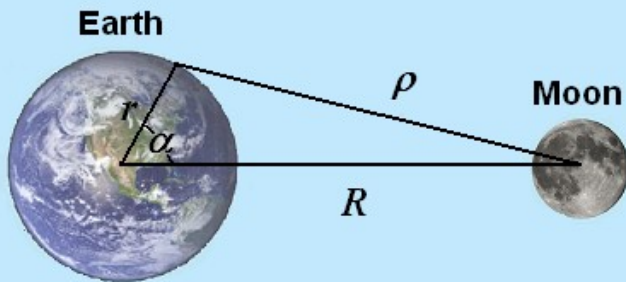


-  **Solid Earth tidal deformation** arises from the variations in the Earth's gravitational field caused by the **Moon/Sun** relative to its strength at the geocentre

$$V_{Grav} = \frac{GM_M}{R} \sum_{n=0}^{\infty} \left(\frac{r}{R} \right)^n P_n(\cos \alpha) = V_0 + V_1 + V_2 + \dots$$

 tidal potential V^{tid}

-  **Love and Shida numbers** h, l are dimensionless **parameters**, which characterize how strong is the **effect** of the potential component **on the displacement**



tidal displacement in REN system

basic Earth model:

spherical, non-rotating,
elastic, isotropic

h and l depend only on
the **degree** of the tidal
potential

$$u_R = \sum_{n=2}^{\infty} h_n \cdot \frac{1}{g} \cdot V_n^{tid}$$

$$u_N = \sum_{n=2}^{\infty} l_n \cdot \frac{1}{g} \cdot \frac{\partial V_n^{tid}}{\partial \phi}$$

$$u_E = \sum_{n=2}^{\infty} l_n \cdot \frac{1}{g \cdot \cos \phi} \cdot \frac{\partial V_n^{tid}}{\partial \lambda}$$

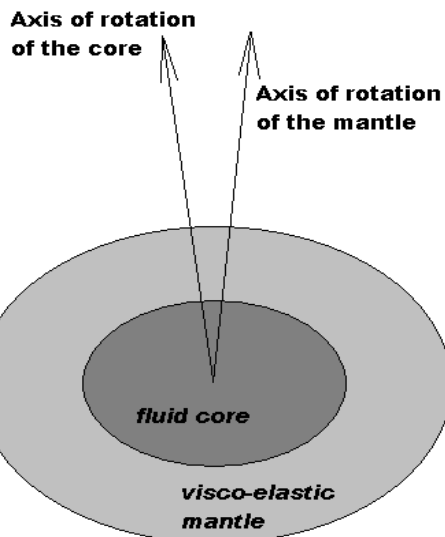
More precise Earth model with fluid core and elastic mantle

- the tidal response of the Earth becomes frequency dependent in the diurnal band

$$\delta u_{R(f)}^{(21)} = -\frac{3}{2} \sqrt{\frac{5}{24\pi}} H_f \delta h_{21(f)} \sin(2\varphi) \sin(\theta_f + \lambda)$$

the corrections to radial displacement coming from the harmonic terms of the second degree tidal potential in the diurnal band

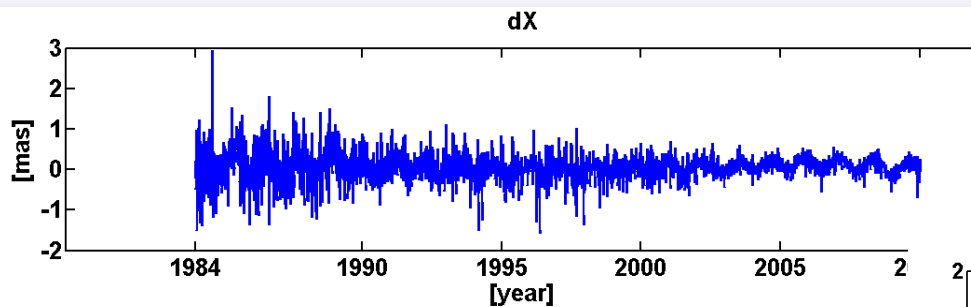
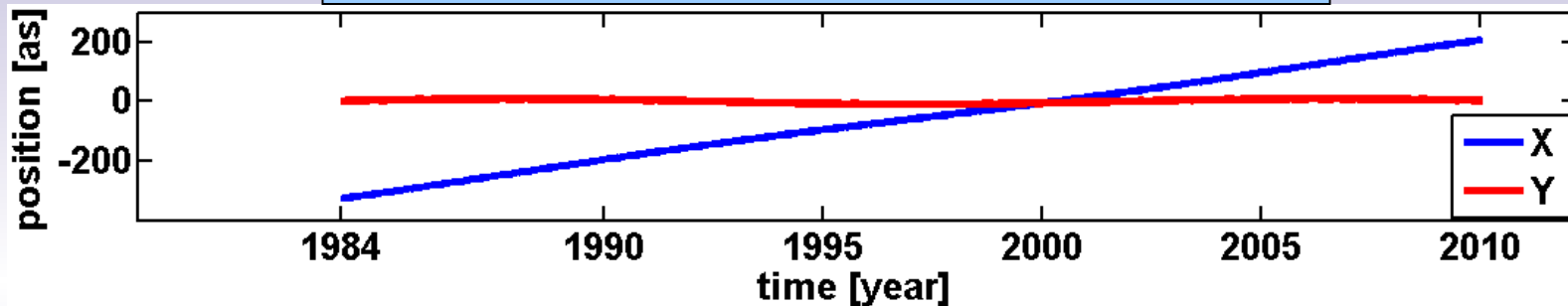
H_f	Cartwright-Taylor amplitude of the tidal term
$\delta h_{21(f)}$	difference of $h_{21}(f)$ from the nominal value h_2
θ_f	tidal harmonic argument



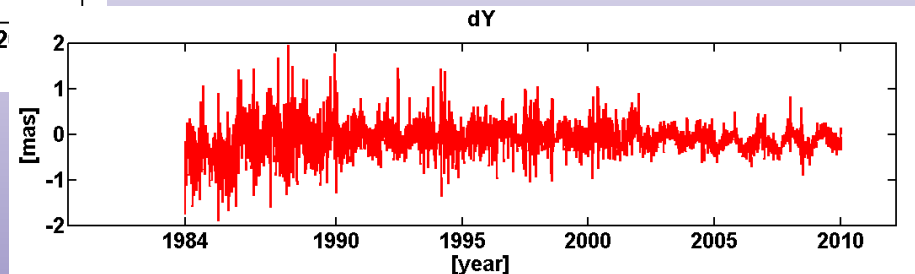
- Resonance** of the tidal force with the forces at the elliptical core-mantle boundary at the Free Core Nutation period
- FCN**: the fluid core rotates around an axis which is slightly inclined w.r.t. the axis of rotation of the mantle → **small periodic motion of the Earth's axis of rotation** (Wahr, 1981)

Motion of the Earth's rotational axis in the celestial system

Position of the **Celestial Intermediate Pole** in the **Geocentric Celestial Reference System**

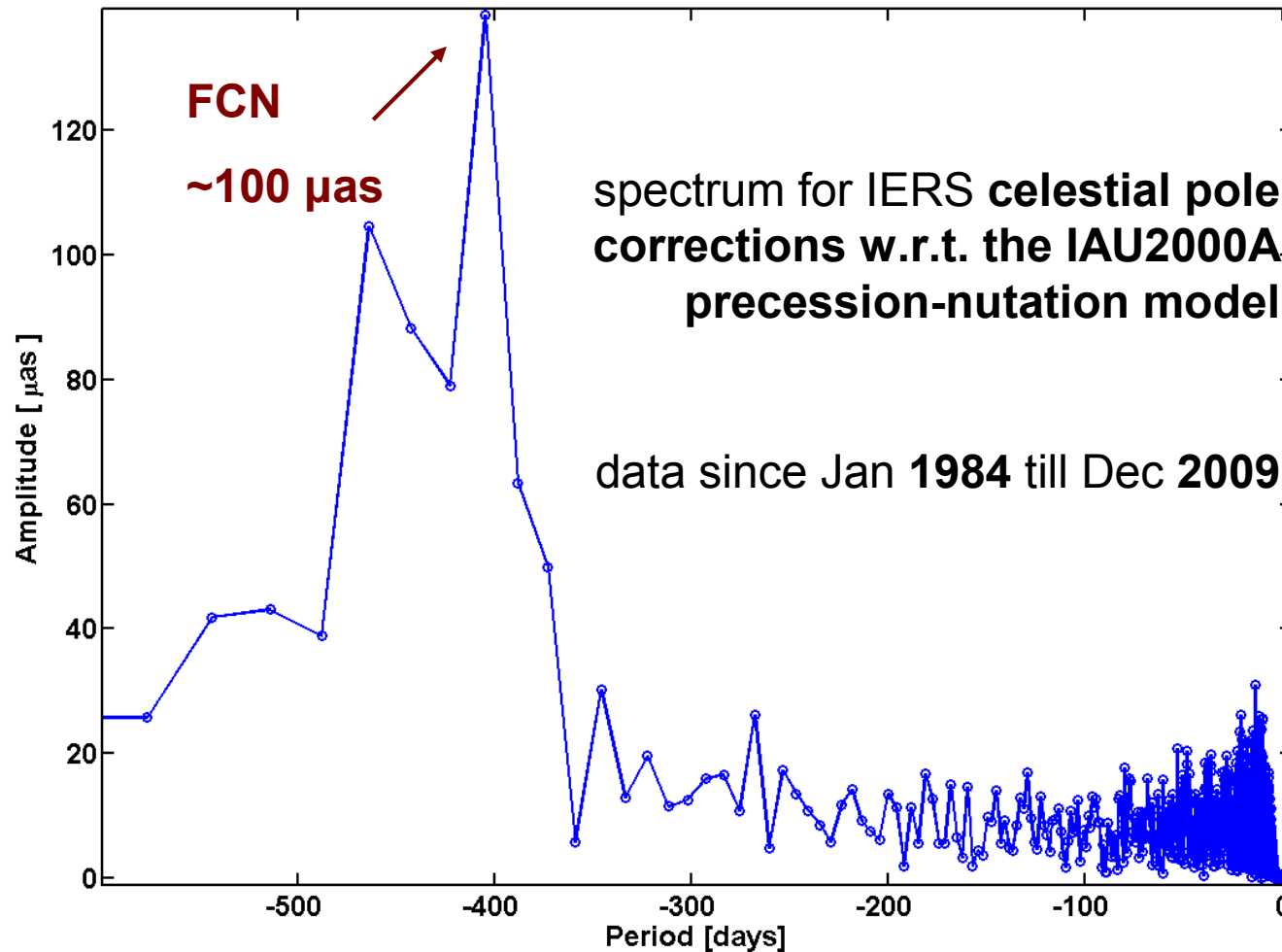


Celestial pole offsets w.r.t. the IAU 2000A precession-nutation model



FCN is a rotational free mode of the Earth, which **cannot be predicted** rigorously. It is not considered as a part of the a-priori precession-nutation model

P/N C0405 IAU2000A



Three options for determining the FCN-period

1. analysis of **celestial pole offsets**

- e.g. Herring et al., 1986; Vondrak and Ron, 2006

2. analysis of tidal **gravity data**

- e.g. Defraigne, 1994; Florsch and Hinderer, 2000; Ducarme et al., 2007

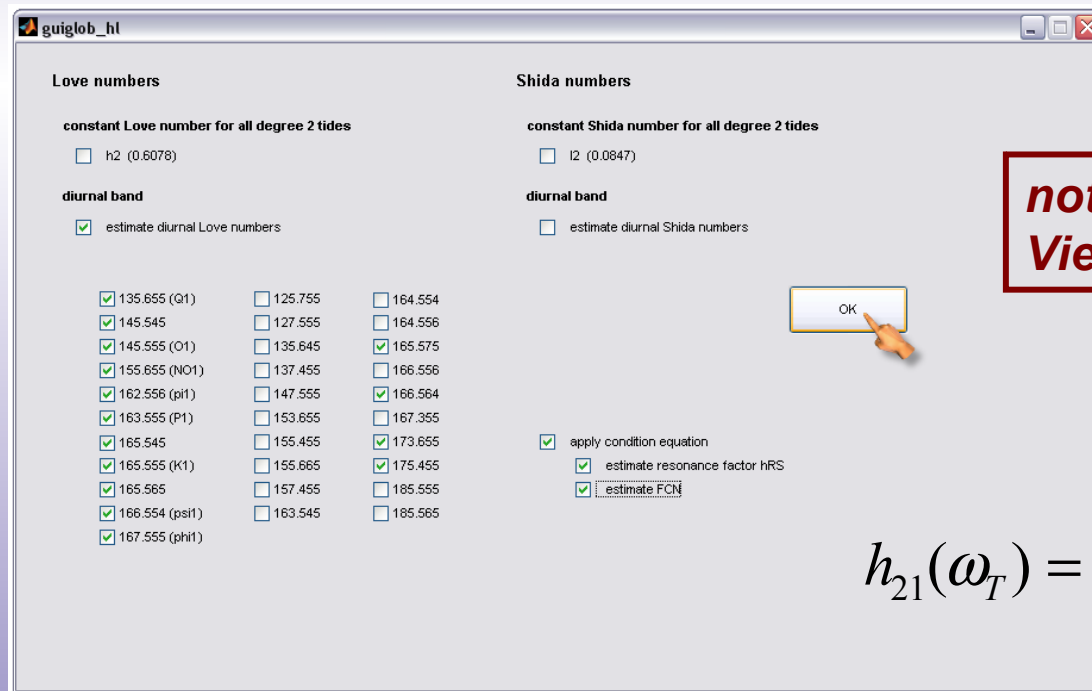
3. analysis of observed solid Earth **tidal displacements**, e.g., of the VLBI antennas

- Haas and Schuh, 1996 – 10 years data
(Determination of frequency dependent Love and Shida numbers from VLBI data. Geophysical Research Letters. Vol. 23 No. 12/1996. p.1509-1512)

motivation for our work

Estimation of Love numbers in VieVS

- ▶ degree 2 Love & Shida numbers: h_2, l_2
- ▶ **frequency dependent** Love & Shida numbers in the diurnal band
 - ▶ 31 diurnal tidal waves (also in dehanttideinel.f (=subroutine provided by V.Dehant))
 - ▶ estimate Love & Shida numbers separately or
 - ▶ apply condition equation with **FCN-period** and **resonance strength** factor



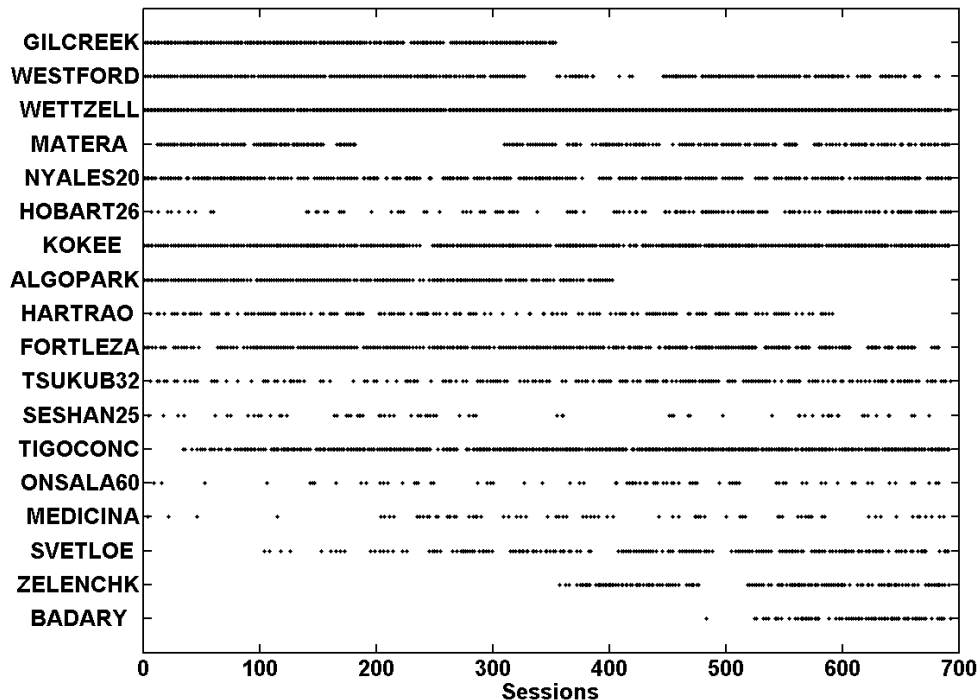
**not available in
VieVS Version 1c**

$$h_{21}(\omega_T) = h_{21}(\omega_{O1}) + h_{RS} \frac{\omega_T - \omega_{O1}}{\omega_{FCN} - \omega_T}$$

- ▶ R1 and R4 IVS sessions
 - ▶ 24-hour sessions
 - ▶ since Jan 2002 – Nov 2009 (7 years)

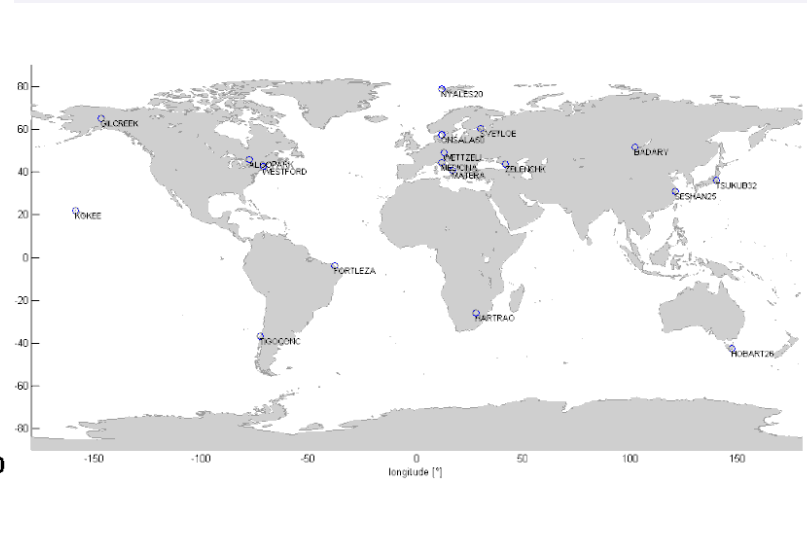
- ▶ outliers in observations removed
- ▶ only sessions with a posteriori variance of unit weight < 1.5

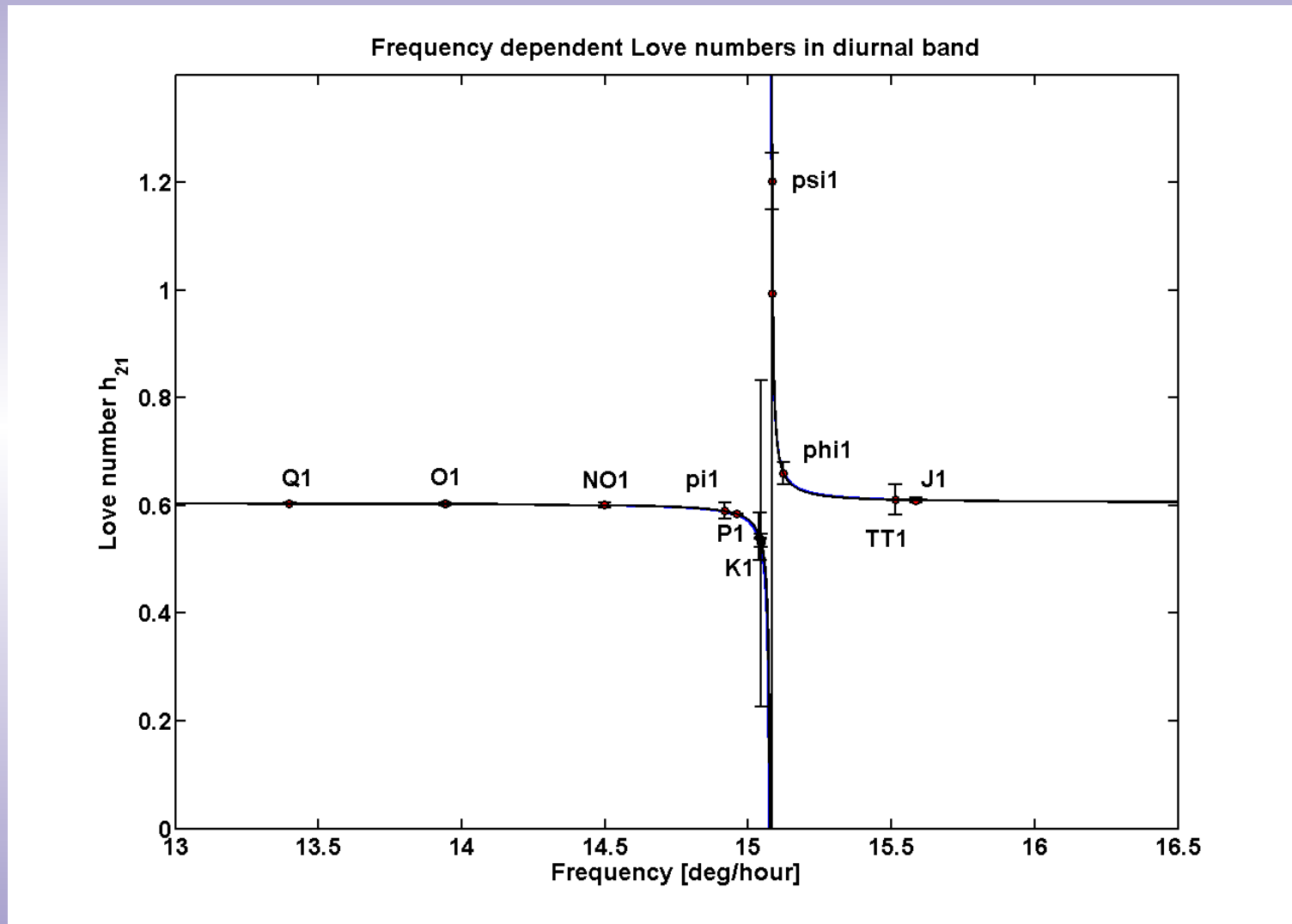
Activity of the antennas

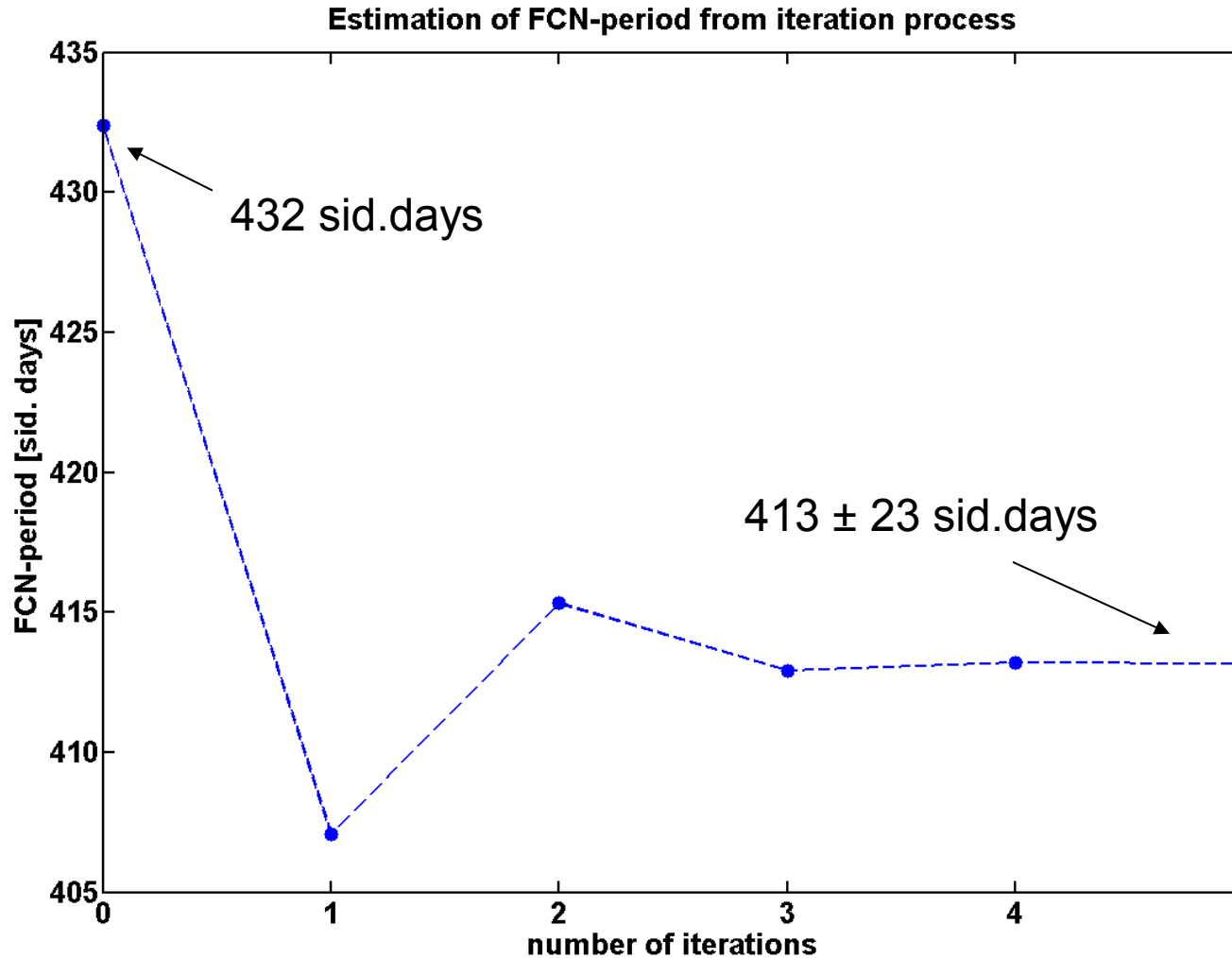


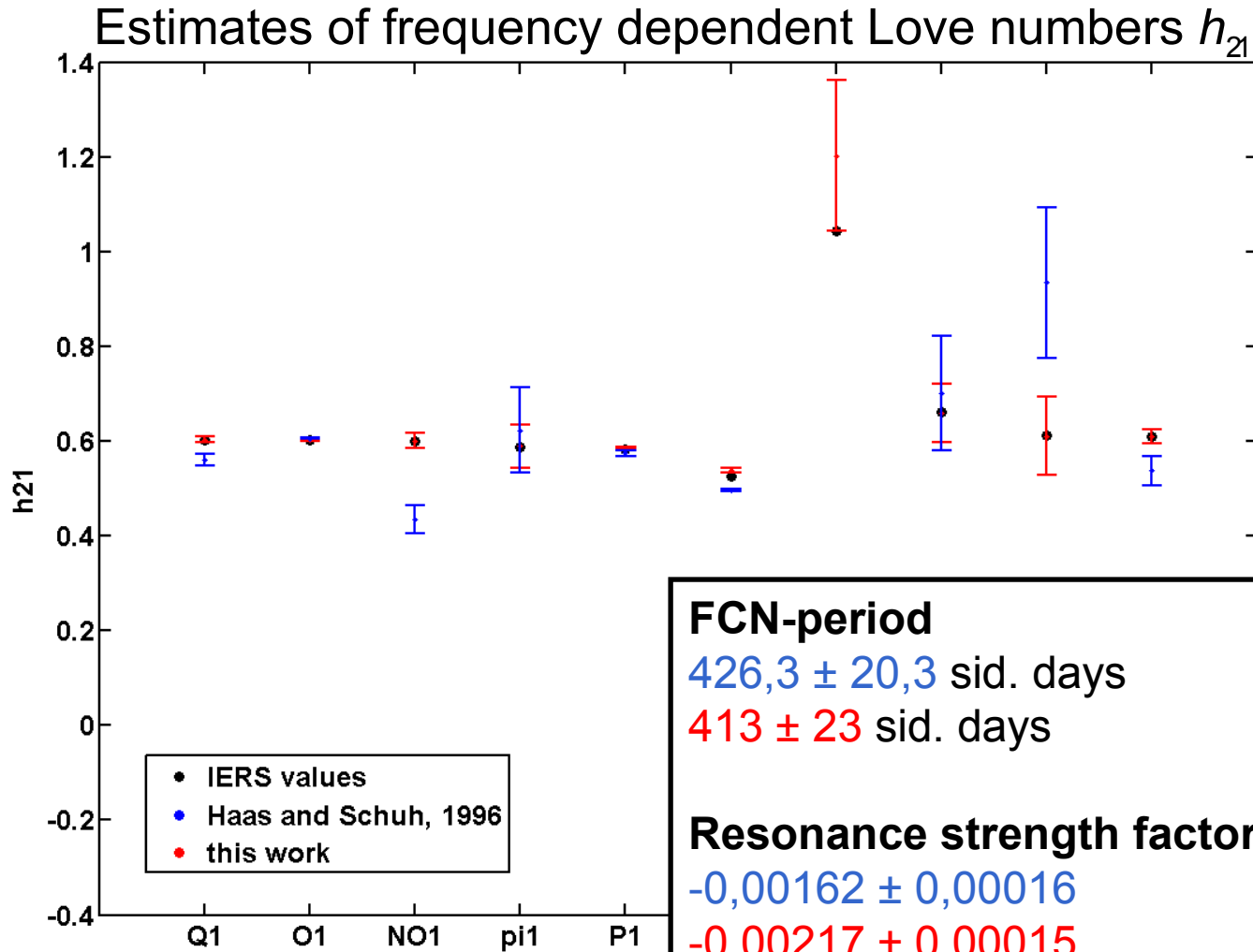
$$\sigma_0^2 = \frac{\mathbf{v}^T \mathbf{P} \mathbf{v}}{n_{obs} - u_{par}}$$

- ▶ 692 sessions at total









FCN-period
 426,3 ± 20,3 sid. days
 413 ± 23 sid. days

Resonance strength factor
 -0,00162 ± 0,00016
 -0,00217 ± 0,00015



Thank you for your attention!