Current status of EOP combination at the Institute of Applied Astronomy

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IERS Workshop on Combination, Potsdam, Germany, October 10-11, 2005

Goals of IAA EOP combination

- **Main goal:**
  Independent EOP series with better uncertainty and systematic stability than individual ones.
- **Special goals:**
  - Dense UT1 series for alignment of satellite free-running (LOD→UT) series.
  - CIO offset series (using VLBI data from other ACs) for investigation of FCN.

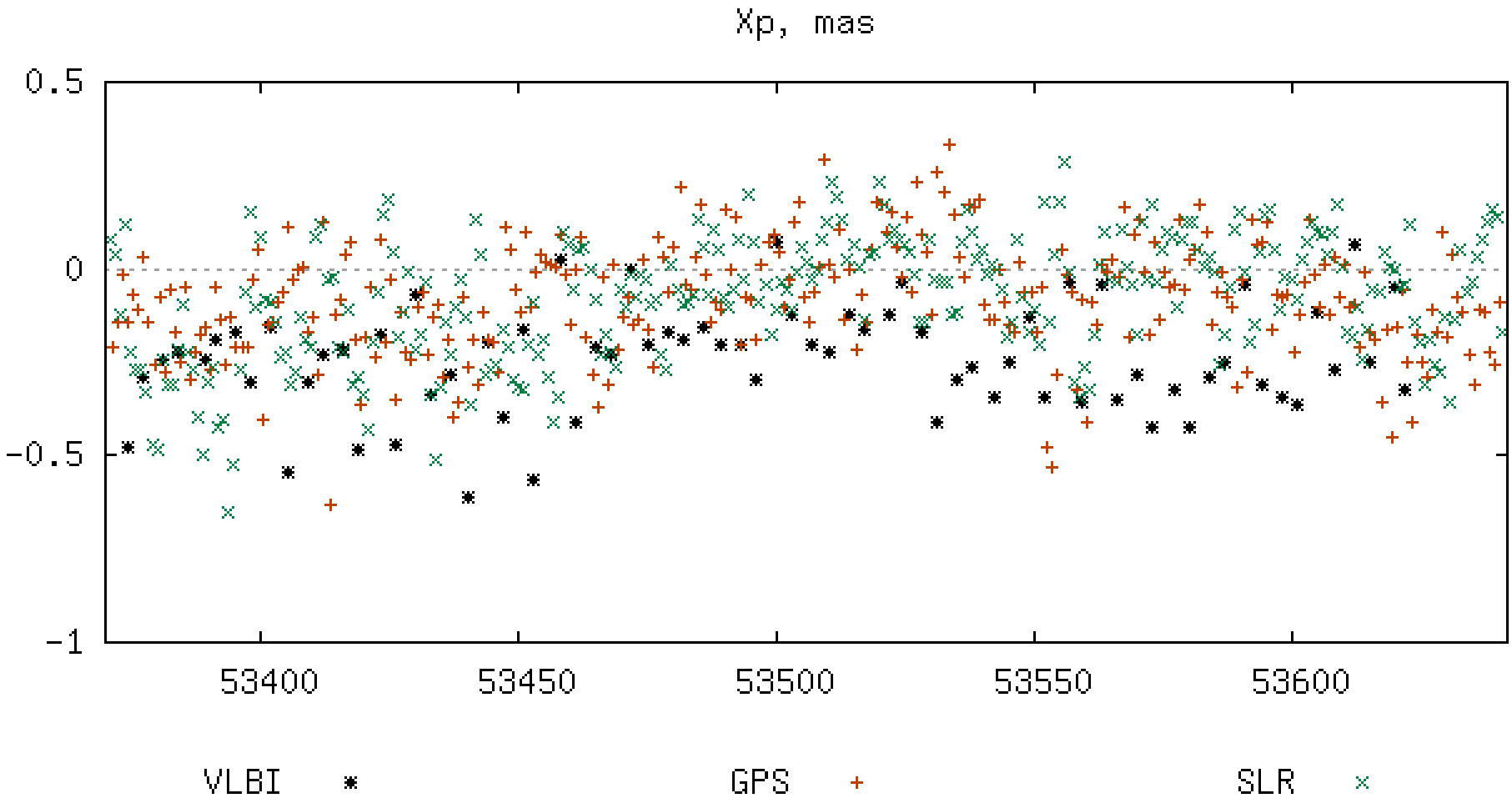
EOP series computed at IAA on regular basis

- VLBI 24h series (1979-2005, 3148 epochs)
  (Xp, Yp, UT1, Xc, Yc) => IERS, IVS
- VLBI Int series (1979-2005, 5072 epochs)
  (UT1) => IERS, IVS
- SLR series (1992-2005, 4729 epochs)
  (Xp, Yp, UT1*, LOD) => IERS
  (Xp, Yp, Xp_rate, Yp_rate, UT1*, LOD)

EOP accuracy and delay
(wrms w.r.t. IERS C04, 2005, bias removed)

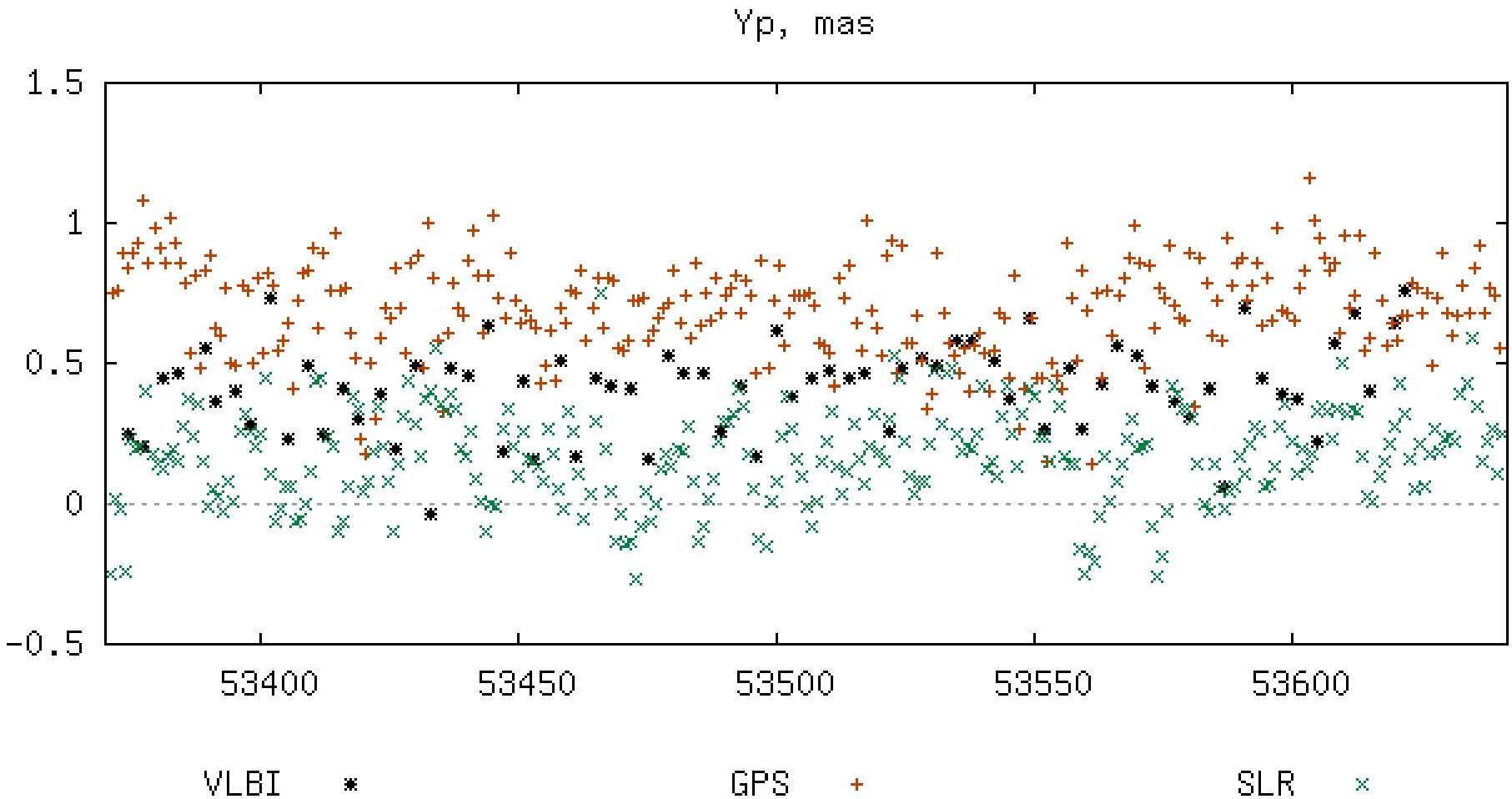
Series	XYp, µas	UT1, µs	LOD, µs	XYc, µas	Delay d
VLBI 24h	128	5.7	—	114	8-18
VLBI Int	—	14	—	—	2-8
SLR	158	30	15	—	2-2,5
SLR w/PM_rate	180	34	17	—	1-1.5
GPS	154	—	46	—	1.5-2*
Combination (goal)	**<150**	**<15**			**1**

Systematic differences: Xp



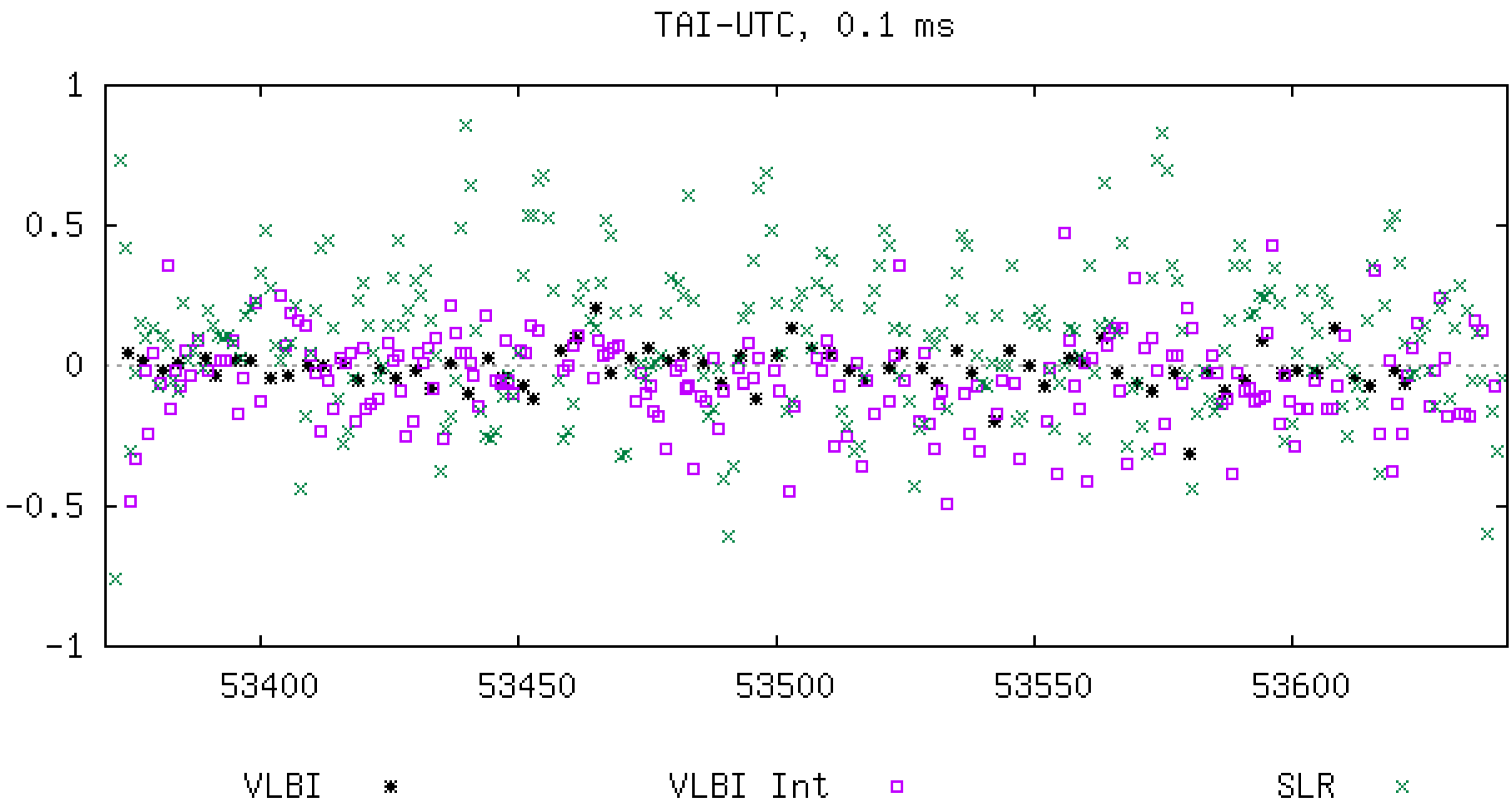
Bias	-0.229	-0.082	-0.053

Systematic differences: Yp



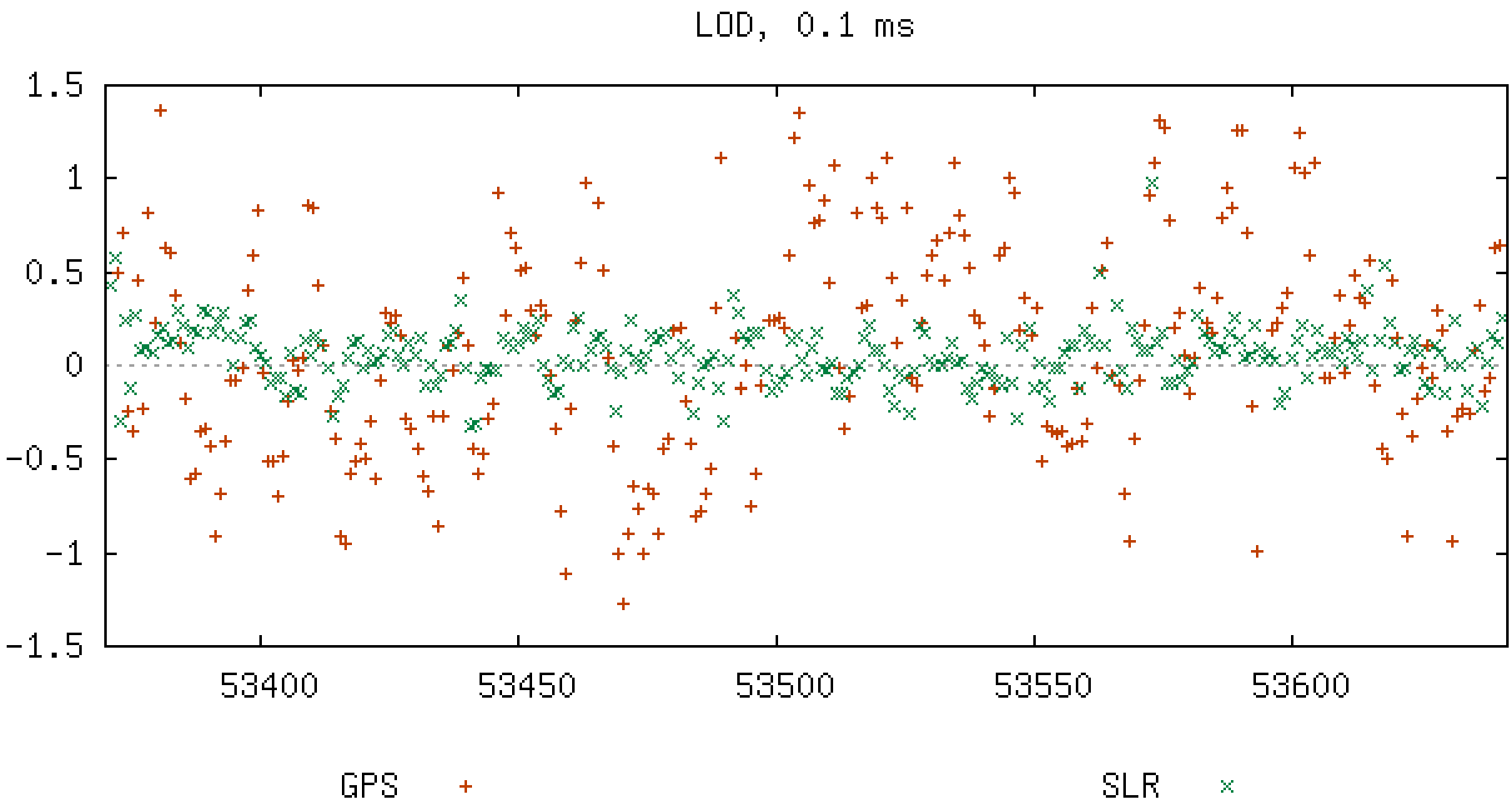
	VLBI	GPS	SLR
Bias	0.440	0.691	0.176

Systematic differences: UT1



Bias	-0.005	-0.051	0.074

Systematic differences: LOD



Bias	-0.482	0.049

Long-term stability

- **Computation of initial systematic corrections w.r.t. IERS C04; estimate long-term stability.**
- **Computation of the reference EOP series EOP0 as the mean of corrected series with weights depending on long-time stability.**
- **Routine combination using systematic corrections for individual series EOP0-EOPi.**
- **When an input EOP series is updated, use supplement systematic correction EOPi(new)-EOPi(old).**
- **Update of reference series EOP0 will be needed periodically, when IERS EOP system changed.**

Averaging of EOP series

1. Weighted LS averaging (modified algorithm)
   Malkin Z. On Computation of Combined IVS EOP Series. Proc. 15th Working Meeting on European VLBI for Geodesy and Astrometry, Barcelona, Spain, Sep 07-08, 2001, 55-62.
   Also available at
   http://www.ipa.nw.ru/PAGE/DEPFUND/GEO/zm/publ/zm02d.zip

2. LSC averaging
   Rusinov Yu. L.. Generalized mean of Earth orientation parameters individual series by least-squares collocation technique. Communications IAA RAS, No 167, 2004.
   Also available at
   ftp://quasar.ipa.nw.ru/incoming/RUSINOV/RUSINOV.PS

Computation of weighted mean (1)

Let we have ***n*** values x_i with associated errors s_i.
Then we have the known statistics:

$$p_i = \frac{1}{s_i^2}\ , \qquad p = \sum_{i=1}^{n} p_i\ , \qquad x = \frac{\sum_{i=1}^{n} p_i x_i}{p}\ ,$$

$$H = \sum_{i=1}^{n} p_i (x_i - x)^2 \ = \ \sum_{i=1}^{n} \left[\frac{(x_i - x)}{s_i}\right]^2\ , \quad \chi^2/dof = \frac{H}{n-1}$$

How to estimate the error in the mean value ***x*** ?

Computation of weighted mean (2)

Maximum Likelihood approah

$$\sigma_1 = \frac{1}{\sqrt{p}}$$

LS approach

$$\sigma_2 = \sigma_1 \sqrt{\frac{H}{n-1}}$$

"Statistical" approach

$$\sigma_3 = \begin{cases} \sigma_1, & \text{if } H \leq \chi^2(Q, n-1) \\ \sigma_2, & \text{if } H > \chi^2(Q, n-1) \end{cases},$$

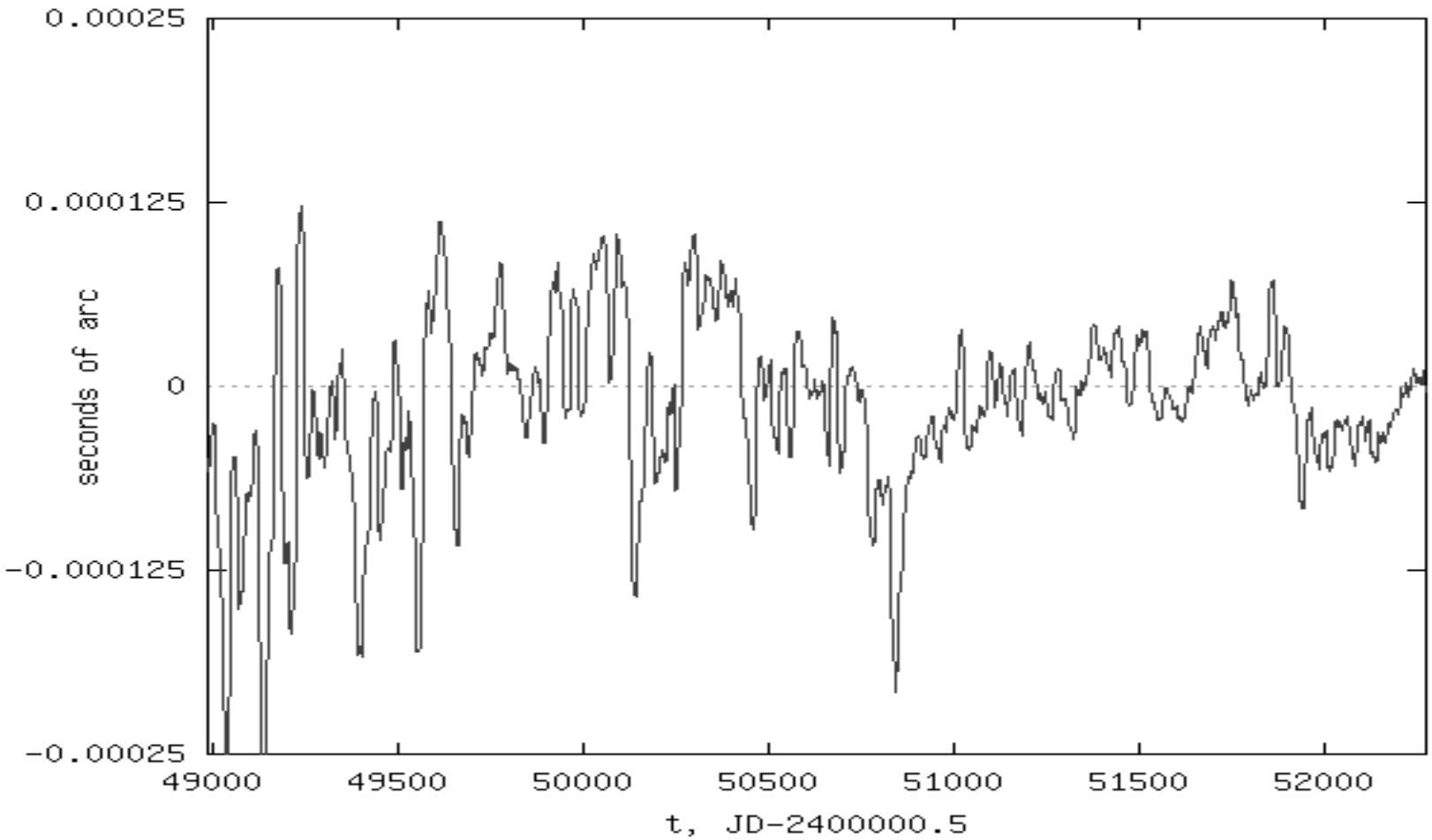
"Combined" approach

$$\sigma_4 = \sqrt{\sigma_1^2 + \sigma_2^2} = \sqrt{\frac{1}{p}\left(1 + \frac{H}{n-1}\right)}$$

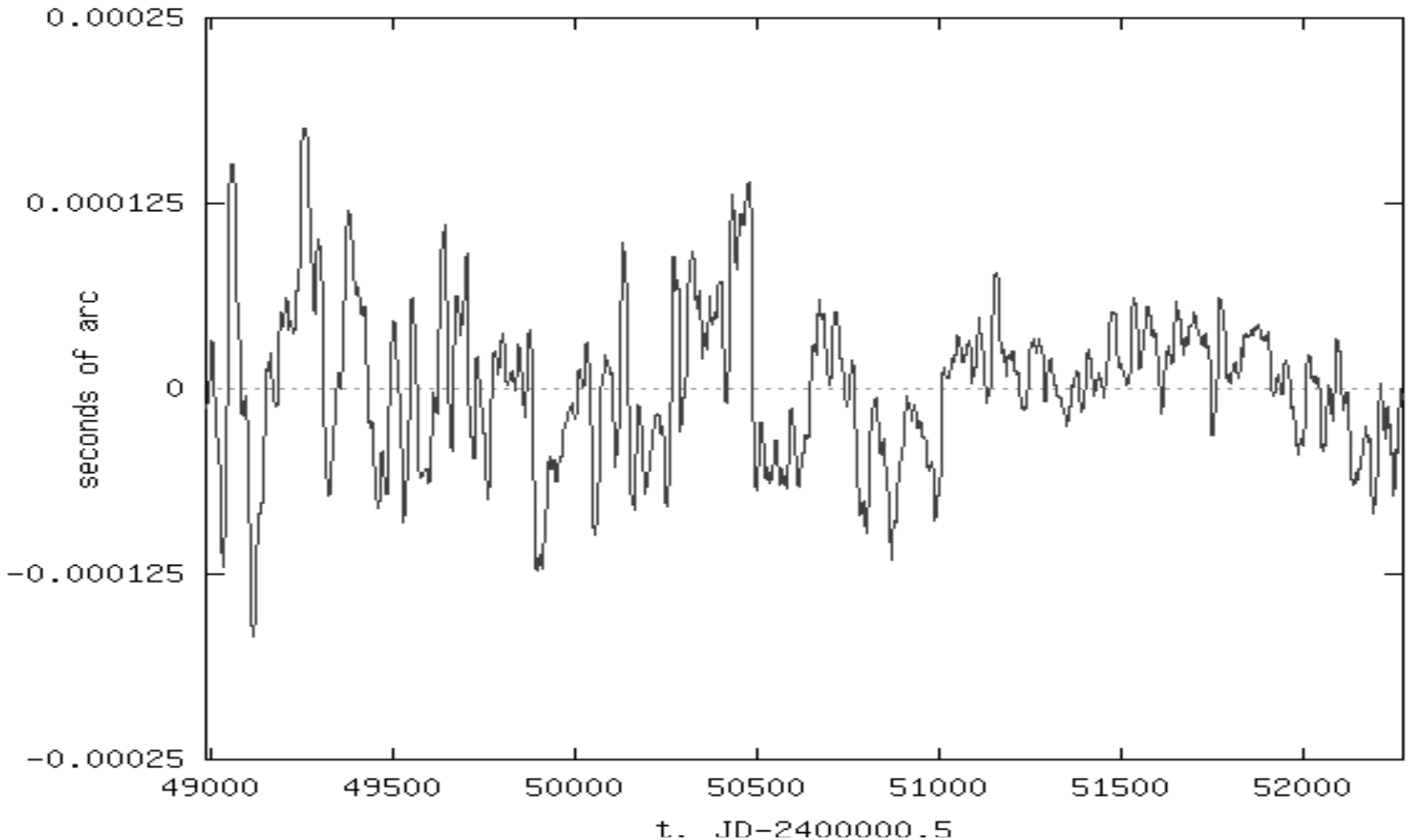
LSC averaging

1. Apply systematic corrections to input series.
2. Interpolate input series at equally spaced epochs, and filter noise using LSC technique.
3. Compute auto- and cross-correlation functions for interpolated and filtered series.
4. Apply LSC averaging.

LSC averaging
Difference with IERS C04: Xp



LSC averaging
Difference with IERS C04: Yp



LSC averaging
Difference with IERS C04: UT1