PRELIMINARY ANALYSIS OF IGS REPROCESSED ORBIT & POLAR MOTION ESTIMATES

- IGS is reprocessing old GPS data consistently
  - will cover ~1994-present (finish by end of 2009)
  - results for 2000-2008 submitted for ITRF2008
- Examine spectra for polar motion & polar motion discontinuities
- Examine spectra for AC orbit discontinuities

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EGU 2009 General Assembly, Vienna, 20 April 2009 – paper EGU2009-5037

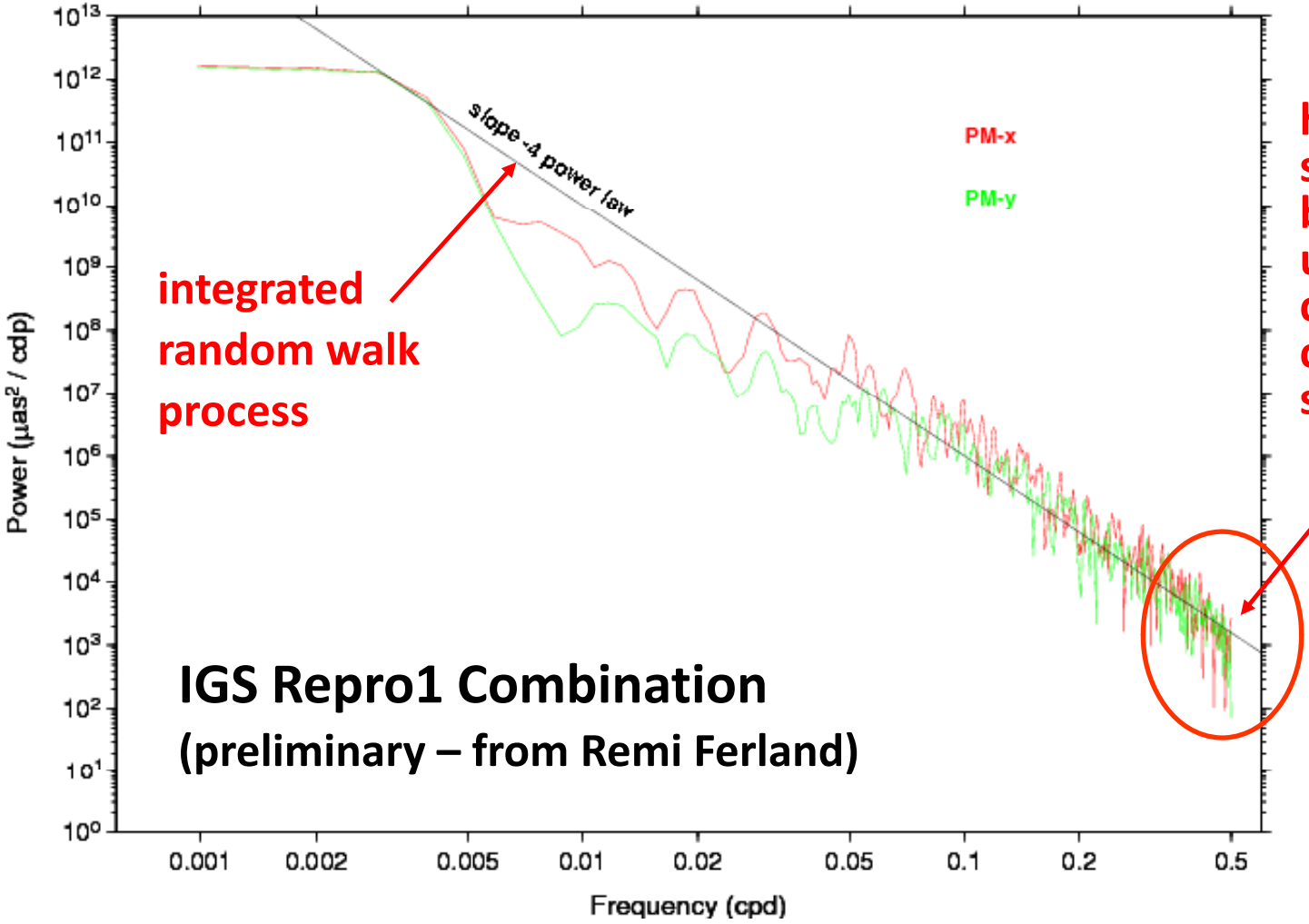
IGS 1st Reprocessing Campaign

- **Full reprocessing of GPS data using modern, consistent methods**
  - first results from 2000 thru 2008 submitted for ITRF2008
  - all data since ~1994 to be finished by end of 2009
  - for details, see: **http://acc.igs.org/reprocess.html**

- **All IGS Final-product ACs are participating (not all in ITRF2008):**
  - CODE/AIUB – Switzerland
  - EMR/NRCan – Canada
  - ESA/ESOC – Germany
  - GFZ – Germany
  - JPL – USA
  - MIT – USA
  - NGS/NOAA – USA
  - SIO/SOPAC – USA

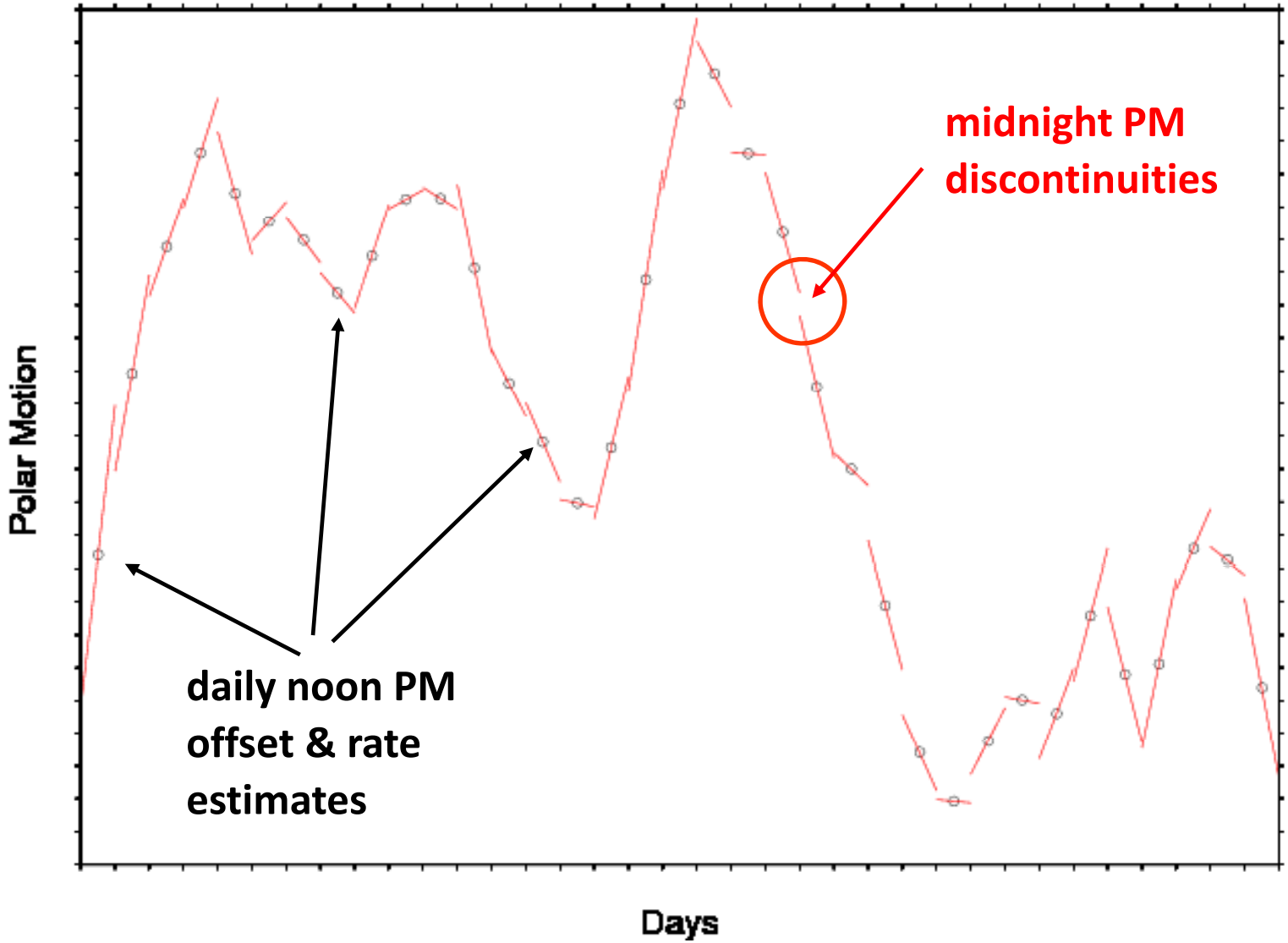
- **Plus 3 reprocessing groups:**
  - PDR – Potsdam/Dresden Reprocessing, Germany
  - GTZ – GFZ TIGA (tide gauges), Germany
  - ULR – University of La Rochelle TIGA (tide gauges), France

Power Spectra of IGS Polar Motion Estimates



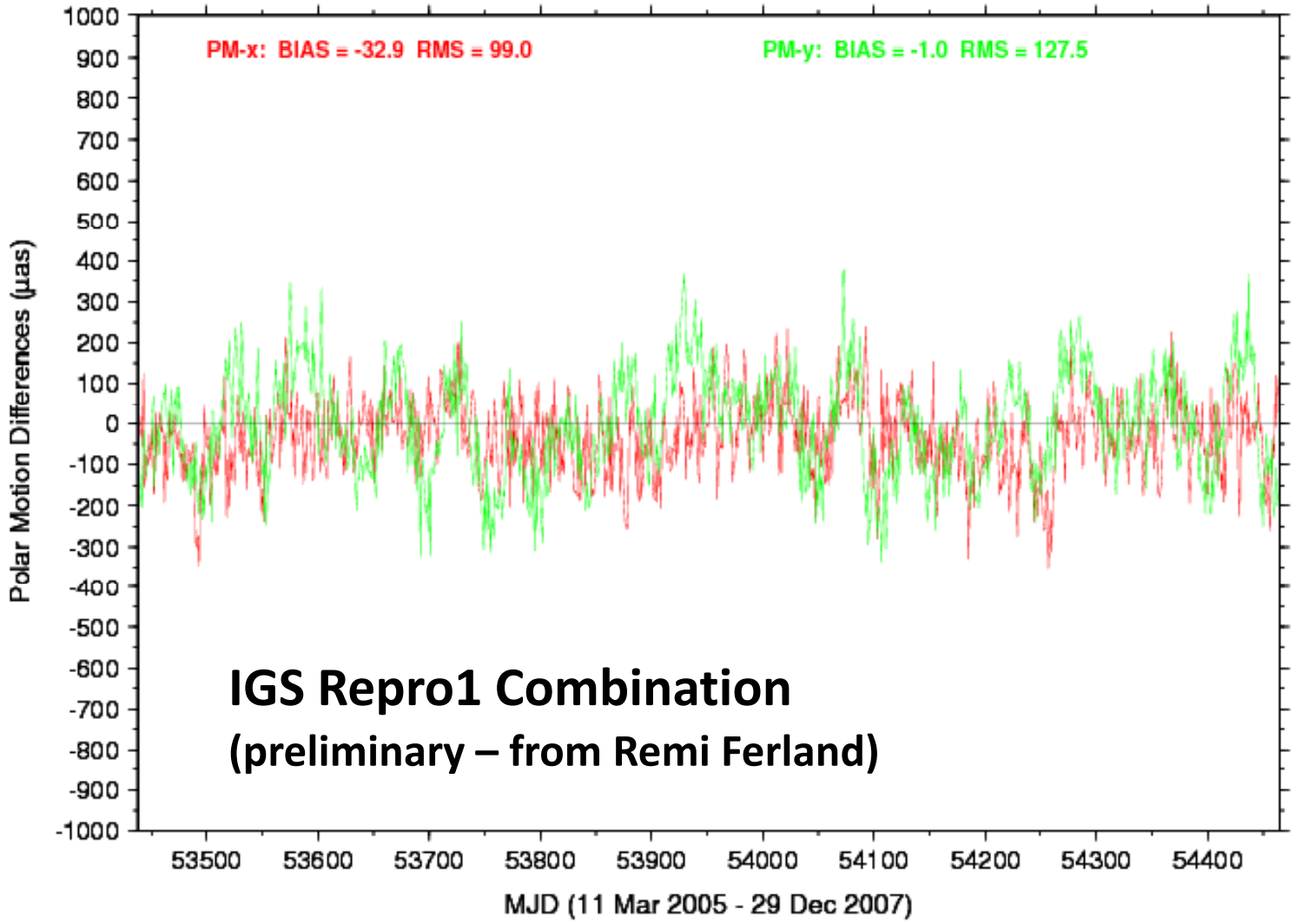
- Use 1024 d from 11 Mar 2005 thru 29 Dec 2007
  - extract PM values from .erp files (any SINEX constraints ignored here)
  - sliding boxcar filter used to smooth across each 3 adjacent frequencies

Compute Polar Motion Discontinuities



- Examine PM day-boundary discontinuities for IGS & all ACs
  - should be non-zero due to PM excitation & measurement errors

IGS Polar Motion Discontinuities



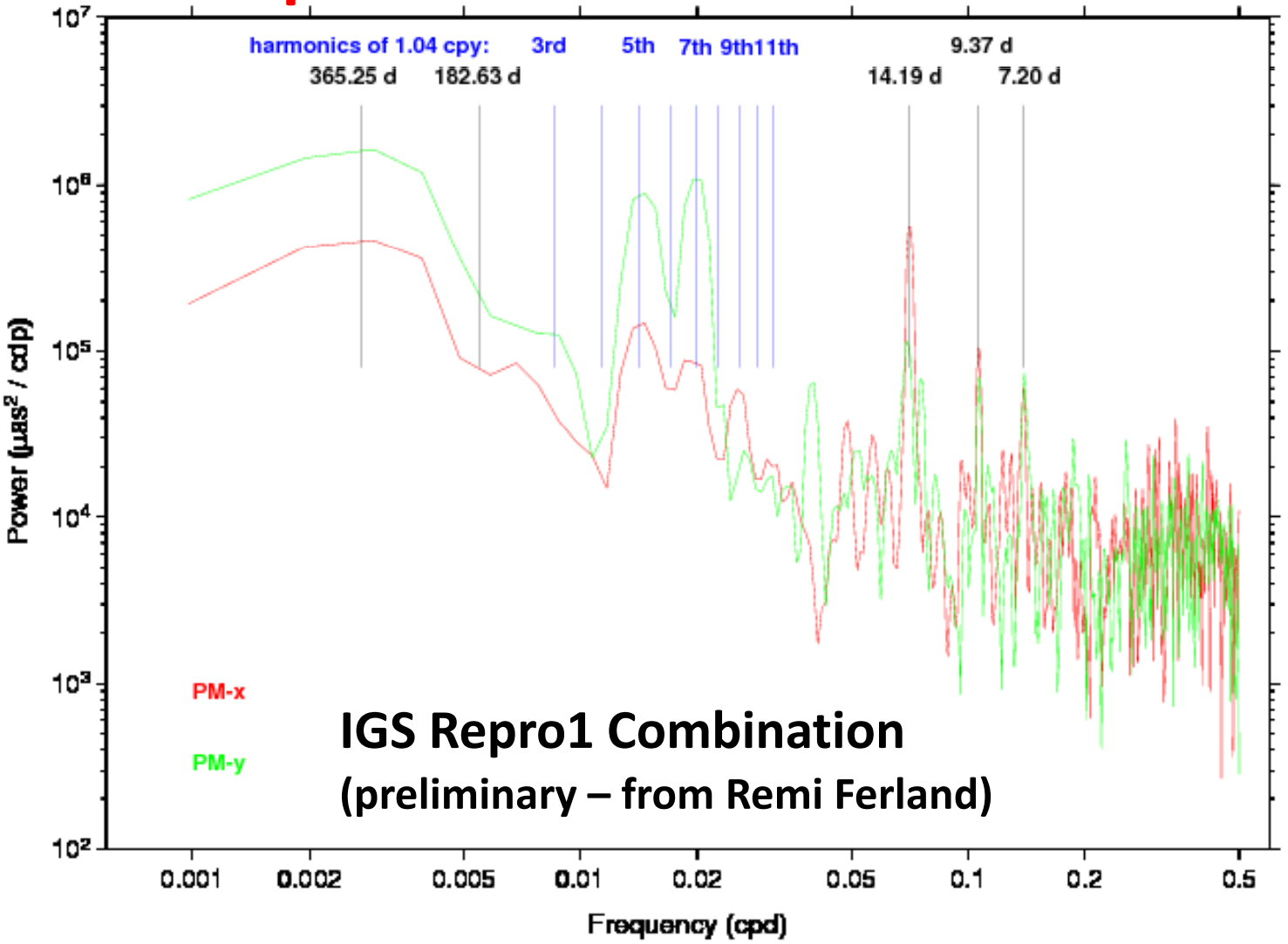
- **Clear systematic patterns found for IGS combination & all ACs**
  - **behaviors vary greatly among ACs**

Statistics of Day-boundary Polar Motion Discontinuities

AC	PM-x (µas)		PM-y (µas)		Remarks
	bias	RMS	bias	RMS	
IGS	-32.9	99.0	-1.0	127.5	multi-AC combination
EMR	-2.3	277.7	76.2	266.2	no continuity condition
ESA	50.3	149.3	-75.4	222.8	no continuity condition
GFZ	-28.6	78.0	2.2	66.0	*weak (?) continuity imposed*
GTZ	-63.1	132.1	8.5	117.8	*weak (?) continuity imposed*
JPL	31.8	154.9	49.0	164.2	no continuity condition
MIT	-114.6	204.1	-51.0	236.6	no continuity condition
NGS	-16.7	137.3	-6.9	194.5	no continuity condition
PDR	0.1	18.6	1.1	20.1	*continuity constraints not removed*
SIO	-40.0	280.2	-105.5	279.5	no continuity condition

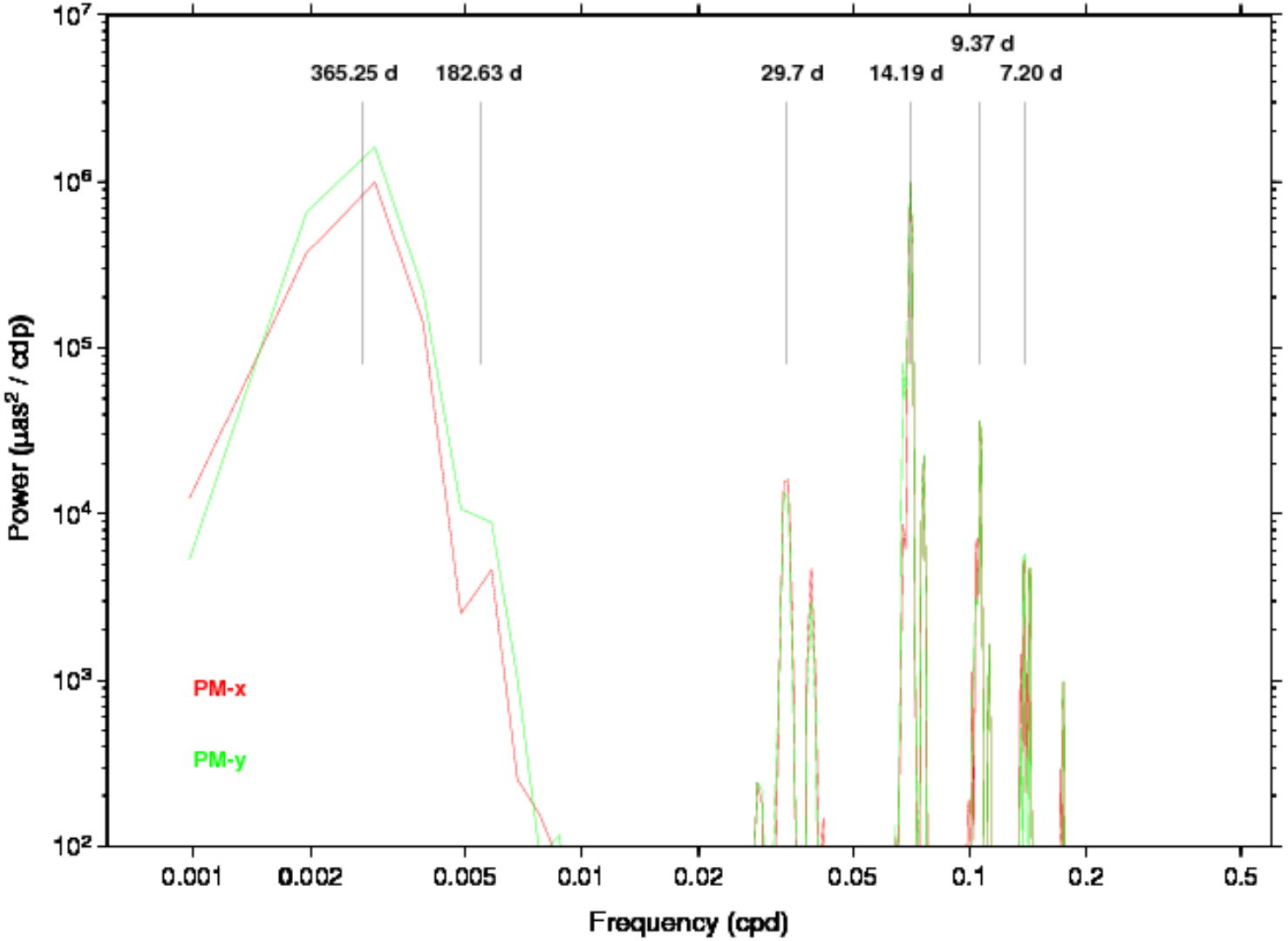
- **Significant long-term biases seen for some Acs (not all in ITRF2008)**
- **Effects of continuity constraints apparent for some other ACs**
- **Implied PM-rate errors: 136 µas for x; 179 µas for y**
- **PM-yrate scatter ~33% larger than for PM-xrate**

Power Spectra of IGS PM Discontinuities



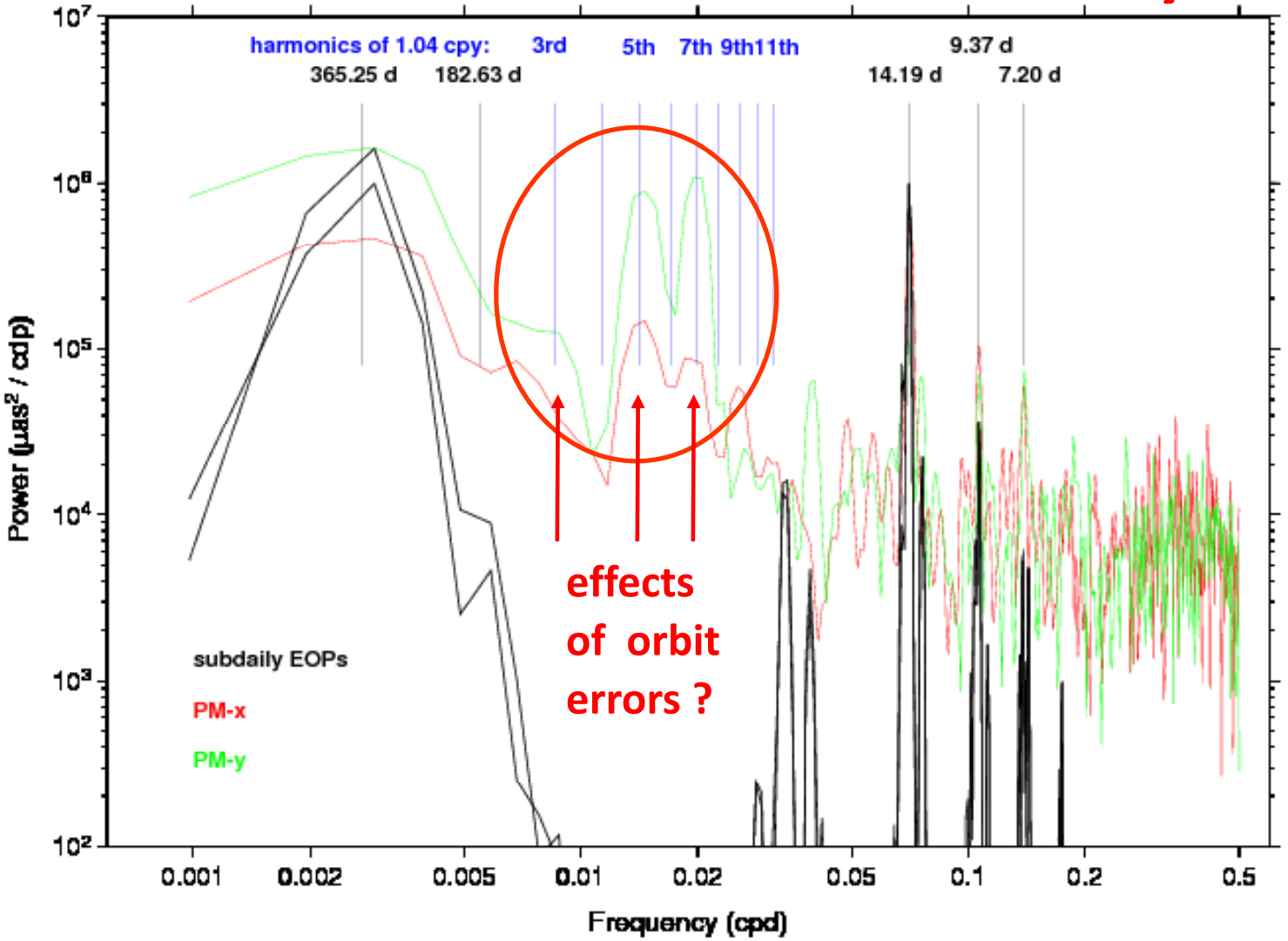
- **Common peaks seen in most spectra are:**
  - annual + 5th & 7th harmonics of GPS year (351 d or 1.040 cpy)
  - possibly aliased errors of subdaily EOP tide model (IERS2003)

Spectra of Subdaily EOP Tide Model Differences



- Compare TPXO7.1 & IERS2003 (used by IGS) EOP models
  - TPXO7.1 & GOT4.7 test models kindly provided by Richard Ray
  - assume subdaily EOP model differences expressed fully in IGS PM results

Spectra of PM Discontinuities & Subdaily EOPs

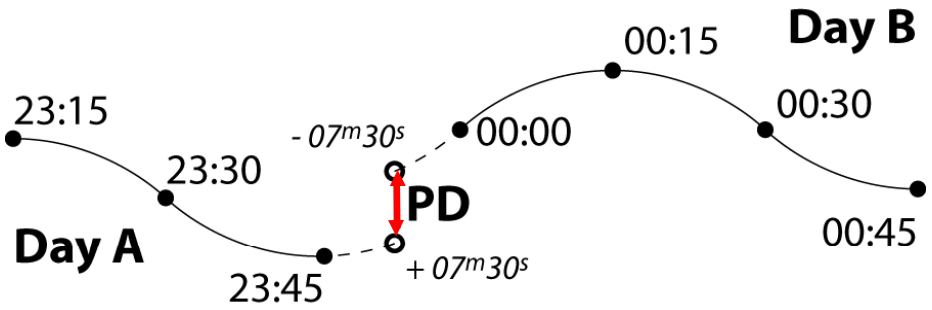


- Aliasing of subdaily EOP tide model errors probably explains:
  - annual (K1, P1, T2), 14.2 d (O1), 9.4 d (Q1, N2), & 7.2 d (σ1, 2Q1, 2N2, μ2)
- Orbit errors presumably responsible for odd 1.04 cpy harmonics

Compute Orbit Discontinuities

- **Fit orbits for each day with BERNE (6+9) orbit model**
  - fit 96 SP3 orbit positions for each SV as pseudo-observations for Day A
  - parameterize fit as $X, Y, Z, \dot{X}, \dot{Y}, \dot{Z}$ plus 3 SRPs per SV component
  - propagate fit forward to 23:52:30 for Day A
  - repeat for Day B & propagate backwards to 23:52:30 of day before

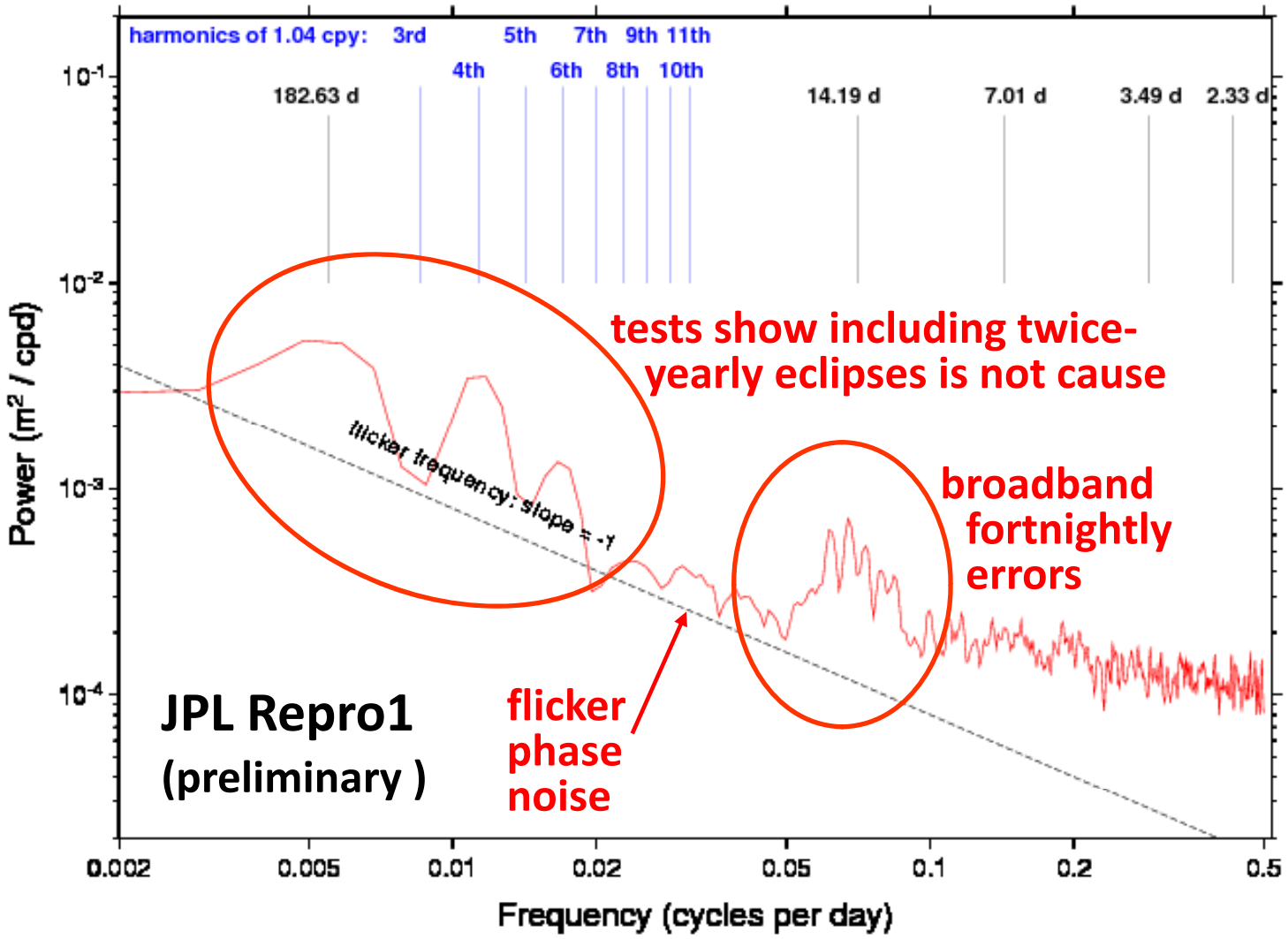
- **Compute magnitude of orbit 3D differences at 23:52:30**



- **Use 1025 d from 10 Mar 2005 thru 29 Dec 2007**
  - spectra for all SVs stacked for each AC; data gaps linearly interpolated
  - sliding boxcar filter used to smooth across each 3 adjacent frequencies

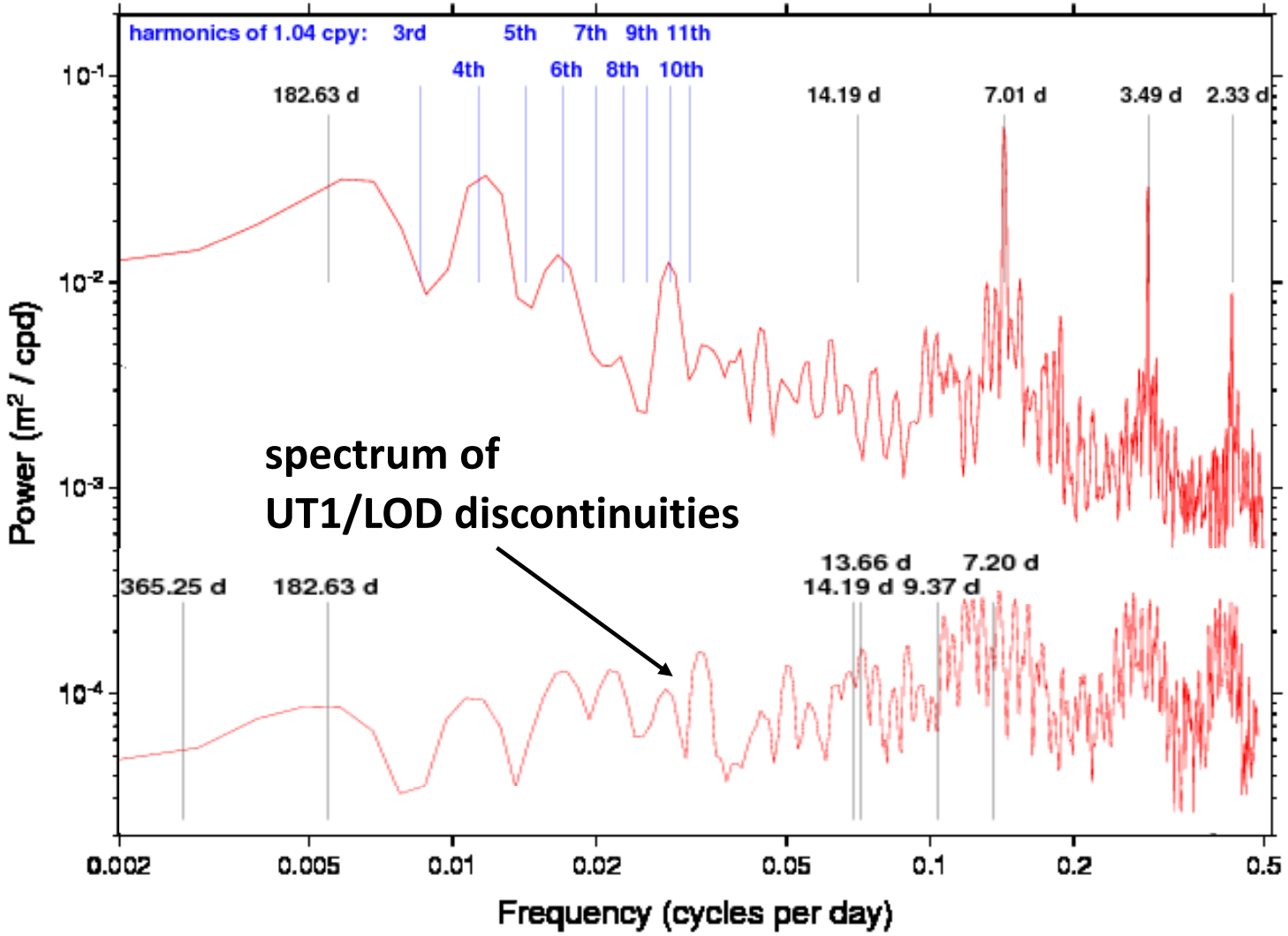
- **Tests indicate fit/extrapolation error ≤ ~4 mm RMS**

Power Spectrum of JPL Orbit Discontinuities



- Typical of performance for most AC orbits
  - even harmonics of 1.04 cpy & broad fortnightly peak common
  - flicker noise process with high-frequency white noise of ~14/√2 = 10 mm

Atypical Spectrum of Orbit Discontinuities



- An unusual case with strong harmonics of 1 week
  - spectrum of associated UT1/LOD discontinuities suggests possible link with handling of *a priori* UT1 or node constraints

Conclusions

- **Reprocessed AC polar motion & orbit results vary greatly**
  - unremovable *a priori* constraints may still be an issue
- **Polar motion rates very sensitive to subdaily EOP tide model**
  - imply IERS2003 errors for K1, O1, Q1/N2 & probably other lines
  - odd harmonics of 1.04 cpy may point to orbit errors
  - estimated PM-rate errors: 136 µas for x; 179 µas for y
- **Background spectrum of orbit errors follows flicker noise, similar to station position errors**
  - broad fortnightly peak also prominent – various possible sources
  - even harmonics of 1.04 cpy present for most AC orbits
  - high-frequency orbit errors approximately white with $\sigma \approx 10$ mm
- **Reprocessing results need careful study to prepare for future analysis improvements**
  - various new models under consideration too