Precyzyjna astrometria i geodezja

Prezentacja na seminarium
Fale Grawitacyjne
Warszawa, 18 XII 2009

Kazimierz M. Borkowski
(prac. nauk.-techn. Centrum Astronomii UMK, Toruń)

Techniki i dokładności pomiarów

Układy odniesienia na niebie

- ICRF(1) i jego rozszerzenia
- ICRF2 – katalog radioźródeł (2010)

Przykłady pomiarów baz VLBI

Ziemski układ odniesienia (ITRF)

- Ruchy stacji pomiarowych
- Ruchy względem płyt tektonicznych (świat, Europa, Włochy)

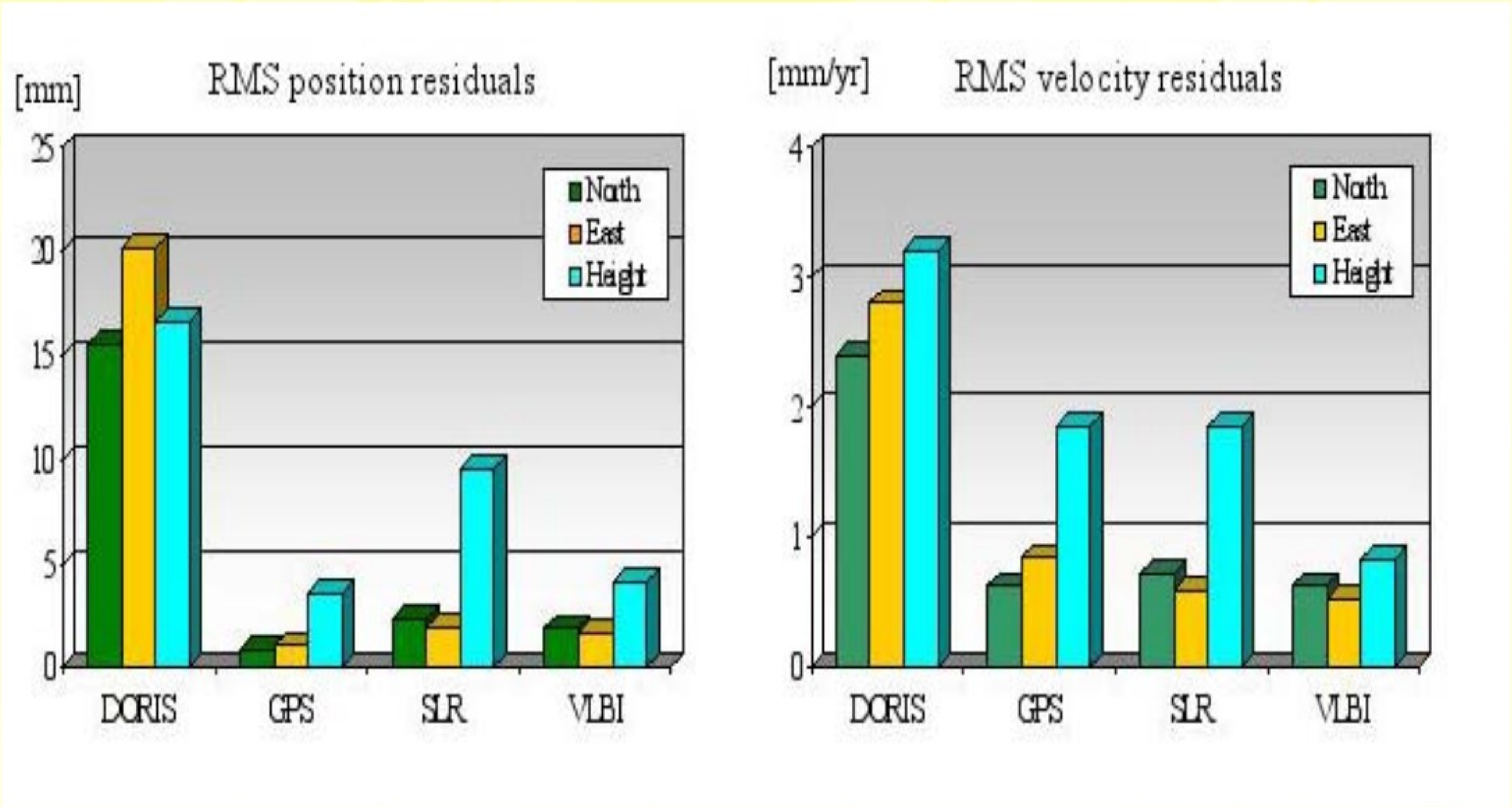
Produkty IVS/IERS

- Nutacja
- Ruchy bieguna Ziemi
- UT1 – UTC
- Sekunda przestępna

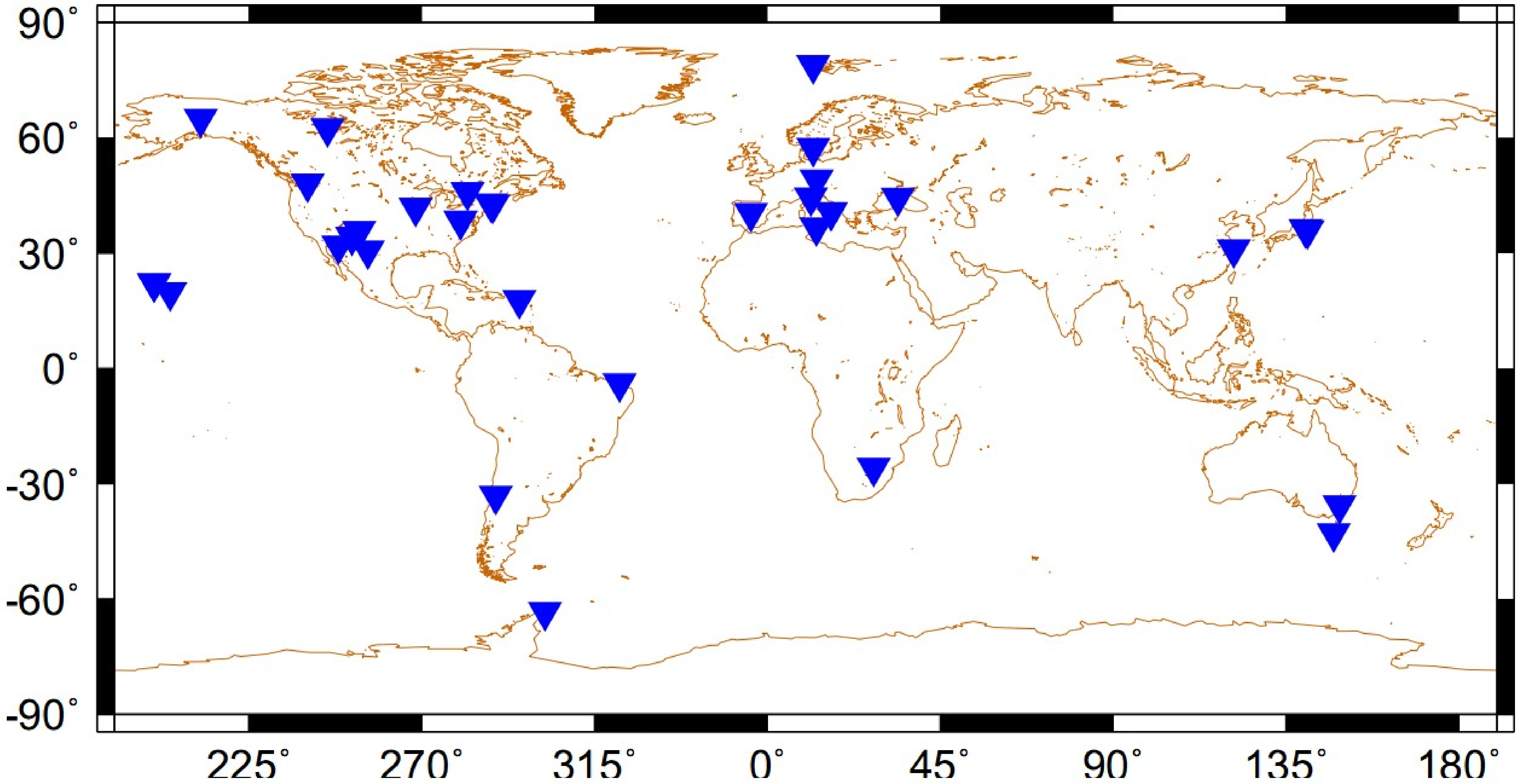
O toruńskim Centrum Astronomii

- RT32
- OCRA
- PIAST
- RT100

RMS of Space Geodetic Techniques



(From a global TRF solution derived by DGFI, Munich)



Geodetic VLBI Network

IERS TN 34

IVS products for the CRF

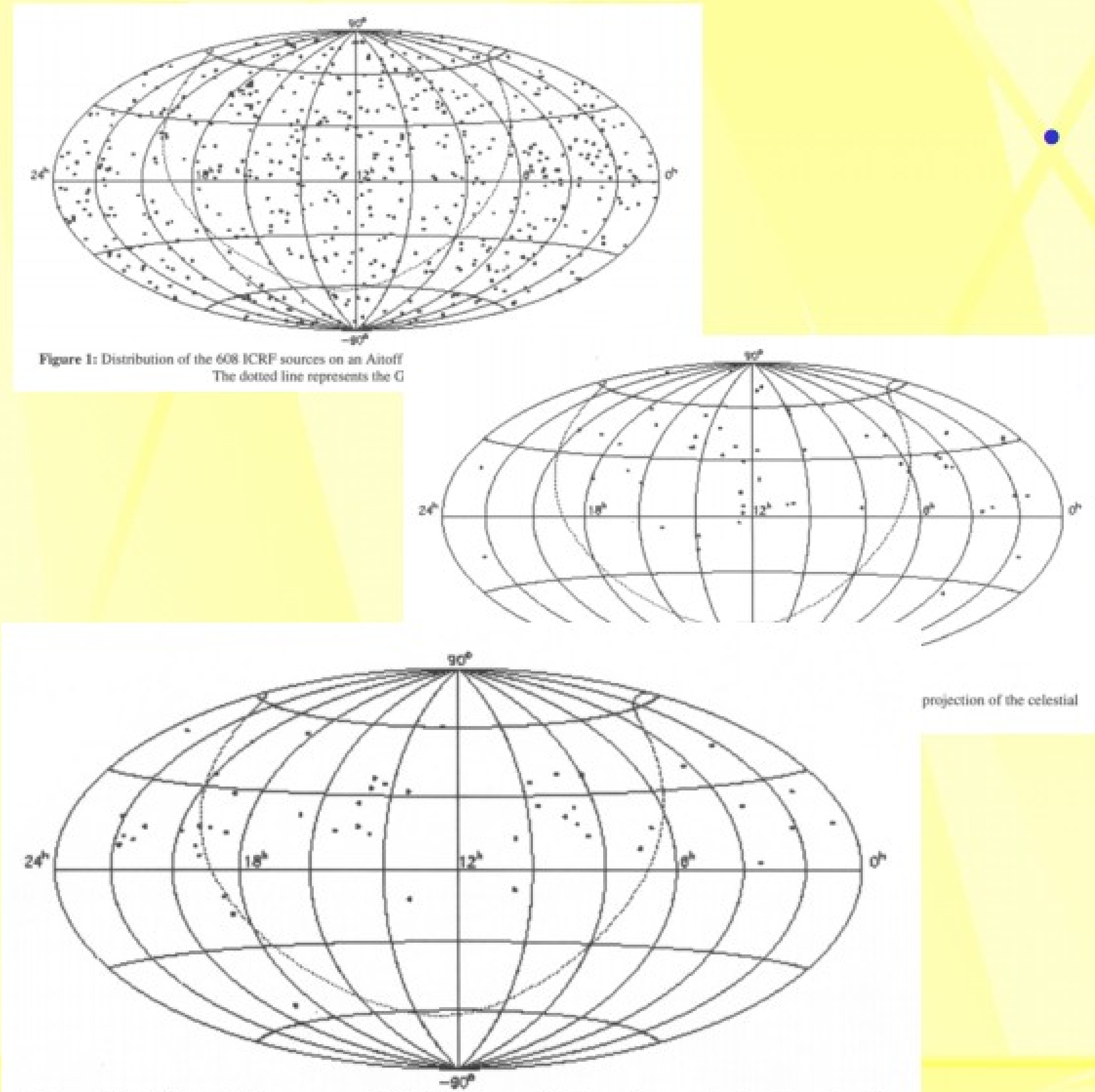


Figure 4: Distribution of 50 new sources in ICRF-Ext.2 on an Aitoff equal-area projection of the celestial sphere. The dotted line represents the Galactic equator.

- ICRF
  - CRF (Ma, et al., 1998)
    - 212 defining sources
    - 294 candidate sources
    - 102 other sources
  - ICRF-Extension 1 (IERS, 1999)
    - completed 1999
    - adding 59 sources
  - ICRF-Extension 2 (Fey et al., 2004)
    - completed 2002
    - adding 50 sources

ICRF2

VLBI Catalogue of Compact Radio Sources

The Second Realization of ICRS

- ICRF is currently **defined** by radio positions of 295 extragalactic objects.

- The ICRF2 catalogue is the most complete. It includes 3414 (295+922+2197) sources sufficiently observed with astrometric and geodetic VLBI from August 1979 to March 2009.

- On 13 August 2009 it has been adopted by the IAU as the fundamental realization of the ICRS effective 1 January 2010.

IERS Technical Note No. **35** (2009), 1-204

http://www.iers.org/MainDisp.csl?pid=46-1100252

Notes:

(1) ICRF Designations, constructed from J2000.0 coordinates with the format
ICRF JHHMMSS.s+DDMMSS or ICRF JHHMMSS.s-DDMMSS
They follow the recommendations of the IAU Task Group on Designations.

(2) IERS Designations, previously constructed from B1950 coordinates.
The complete format, including acronym and epoch in addition to the coordinates, is
IERS BHHMM+DDd or IERS BHHMM-DDd

(3) D means defining sources, i.e. define the ICRF2 frame axes.

(4) For the 39 special handling sources the correlation RA-DC is not available and set to 0.000

Coordinates of 1217 non VCS sources in ICRF2

ICRF Designation (1)	IERS Des. (2)	Inf. (3)	Right Ascension J2000.0 h m s	Declination J2000.0 o ' "	Uncertainty R.A. s	Uncertainty Dec. "	Corr. RA-Dc (4)	Mean MJD	First MJD	Last MJD	Nb sess.	Nb del.
ICRF J000108.6+191433	2358+189		00 01 08.62156690	19 14 33.8017390	0.00000490	0.0000984	0.080	53306.0	50085.5	54907.7	21	716
ICRF J000211.9-215309	2359-221		00 02 11.98262436	-21 53 09.8359742	0.00115400	0.0386714	0.971	54818.7	54818.7	54818.7	1	3
ICRF J000435.6-473619	0002-478	D	00 04 35.65550384	-47 36 19.6037899	0.00001359	0.0002139	0.383	52501.0	49330.5	54670.7	28	129
ICRF J000435.7+201942	0002+200		00 04 35.75829931	20 19 42.3174919	0.00001434	0.0002426	0.079	52600.4	52409.7	52983.7	3	102
ICRF J000557.1+382015	0003+380		00 05 57.17539168	38 20 15.1489409	0.00000488	0.0000621	-0.083	52010.2	48720.9	54718.7	26	1518
ICRF J000613.8-062335	0003-066		00 06 13.89288849	-06 23 35.3353162	0.00000277	0.0000437	-0.035	52342.2	47176.5	54889.8	1254	26713
ICRF J000800.3-233918	0005-239		00 08 00.36965673	-23 39 18.1511374	0.00002400	0.0007055	-0.650	50918.1	50632.3	54643.7	3	95
ICRF J001031.0+105829	0007+106	D	00 10 31.00590186	10 58 29.5043827	0.00000491	0.0000930	-0.187	53063.9	47288.7	54803.7	29	559
ICRF J001033.9+172418	0007+171		00 10 33.99063132	17 24 18.7613217	0.00000486	0.0000824	-0.098	51780.9	47931.6	54844.7	40	1242
ICRF J001052.5-415310	0008-421		00 10 52.51790008	-41 53 10.7781702	0.00019412	0.0043581	-0.068	50998.2	48162.4	52409.7	5	22
ICRF J001101.2-261233	0008-264	D	00 11 01.24673846	-26 12 33.3770171	0.00000660	0.0000936	-0.183	52407.5	47686.1	54768.6	45	592
ICRF J001135.2+082355	0009+081		00 11 35.26963063	08 23 55.5862723	0.00001305	0.0004120	-0.455	52574.8	49914.7	53609.2	2	100
ICRF J001331.1+405137	0010+405	D	00 13 31.13020334	40 51 37.1441040	0.00000482	0.0000683	-0.139	51619.2	48434.7	54713.7	22	1083
ICRF J001611.0-001512	0013-005	D	00 16 11.08855479	-00 15 12.4453413	0.00000435	0.0001005	-0.235	50403.0	47394.1	51492.8	67	716
ICRF J001708.4+813508	0014+813		00 17 08.47492105	81 35 08.1365288	0.00008598	0.0002624	0.000	50567.9	47023.3	54112.5	1185	61191
ICRF J001937.8+202145	0017+200		00 19 37.85450158	20 21 45.6446718	0.00000655	0.0001138	-0.040	51210.3	50085.5	53609.2	5	356
ICRF J001945.7+732730	0016+731	D	00 19 45.78641940	73 27 30.0174396	0.00000989	0.0000424	-0.050	49249.8	44343.6	54865.7	458	25038
ICRF J002232.4+060804	0019+058	D	00 22 32.44120914	06 08 04.2690807	0.00000439	0.0000956	-0.237	52705.8	47394.1	54880.7	42	800
ICRF J002427.3+243926	0021+243		00 24 27.33054544	24 39 26.2295755	0.00001415	0.0002517	-0.039	52670.8	52409.7	53307.8	11	115
ICRF J002442.9-420203	0022-423		00 24 42.98977943	-42 02 03.9479276	0.00006971	0.0013214	-0.582	51518.2	48162.4	53131.8	8	37
ICRF J002715.3+224158	0024+224		00 27 15.37153913	22 41 58.0688698	0.00004355	0.0006729	-0.137	50621.1	50085.5	54664.7	3	120
ICRF J002829.8+200026	0025+197		00 28 29.81848608	20 00 26.7443060	0.00001399	0.0003630	-0.143	50454.5	50085.5	54837.7	5	209
ICRF J002914.2+345632	0026+346		00 29 14.24246572	34 56 32.2471186	0.00003535	0.0004340	0.457	49505.8	47011.4	51386.3	14	234
ICRF J002945.8+055440	0027+056		00 29 45.89631066	05 54 40.7124201	0.00001584	0.0003807	-0.175	50645.2	49914.7	54643.7	2	123
ICRF J003525.3+613030	0032+612		00 35 25.31063011	61 30 30.7613057	0.00006099	0.0004981	0.307	53460.9	52620.7	53552.8	2	71
ICRF J003758.2+240711	0035+238		00 37 58.29982404	24 07 11.8699687	0.00016333	0.0046830	-0.479	54292.7	54292.7	54292.7	1	12
ICRF J003814.7-245902	0035-252		00 38 14.73550693	-24 59 02.2351862	0.00000815	0.0001397	-0.095	52498.1	50632.3	54907.7	7	301
ICRF J003820.5-020740	0035-024		00 38 20.52934827	-02 07 40.5476126	0.00001584	0.0004962	-0.410	54125.8	54125.8	54125.8	1	82
ICRF J003824.8+413706	0035+413	D	00 38 24.84359231	41 37 06.0003032	0.00000499	0.0000613	-0.035	52262.4	49422.9	54887.7	18	1024
ICRF J003939.6+141157	0037+139		00 39 39.61959335	14 11 57.5567419	0.00001465	0.0003107	-0.249	50925.2	50085.5	53193.7	6	195
ICRF J004007.8-590352	0037-593		00 40 07.84908888	-59 03 52.7640423	0.00006916	0.0007714	0.327	53594.7	52887.6	54457.4	5	30
ICRF J004204.5+232001	0039+230		00 42 04.54517179	23 20 01.0620234	0.00000425	0.0000798	-0.119	52211.0	48919.9	54795.7	21	1079
ICRF J004219.4+570836	0039+568		00 42 19.45169063	57 08 36.5860772	0.00002746	0.0002988	0.207	51249.7	49577.0	54664.7	2	146
ICRF J004847.1+315725	0046+316		00 48 47.14148006	31 57 25.0848725	0.00000468	0.0000875	-0.137	53102.3	50219.8	54739.7	23	813
ICRF J004943.2+023703	0047+023		00 49 43.23594851	02 37 03.7783255	0.00001326	0.0003898	-0.169	51750.4	49914.7	54872.7	5	185
ICRF J004959.4-573827	0047-579		00 49 59.47306878	-57 38 27.3399688	0.00001384	0.0001470	0.245	52043.3	47626.5	54706.7	39	189
ICRF J005041.3-092905	0048-097	D	00 50 41.31738756	-09 29 05.2102688	0.00000278	0.0000428	-0.030	51323.1	44773.8	54816.7	1802	41482
ICRF J005109.5-422633	0048-427	D	00 51 09.50182012	-42 26 33.2932480	0.00000932	0.0001177	0.013	53857.8	52306.7	54907.7	31	315
ICRF J005655.2+162513	0054+161		00 56 55.29432846	16 25 13.3409281	0.00000984	0.0001923	0.212	53385.7	50156.3	54852.7	6	130
ICRF J005748.8+302108	0055+300		00 57 48.88334932	30 21 08.8119505	0.00000590	0.0000921	-0.356	51950.0	50219.8	53178.7	22	869
ICRF J005805.0-053952	0055-059		00 58 05.06630952	-05 39 52.2778596	0.00000507	0.0001022	-0.066	53919.4	50576.2	54852.7	7	346
ICRF J005846.5-565911	0056-572		00 58 46.58117584	-56 59 11.4706965	0.00003993	0.0005795	0.358	50239.8	47626.5	52941.7	8	36

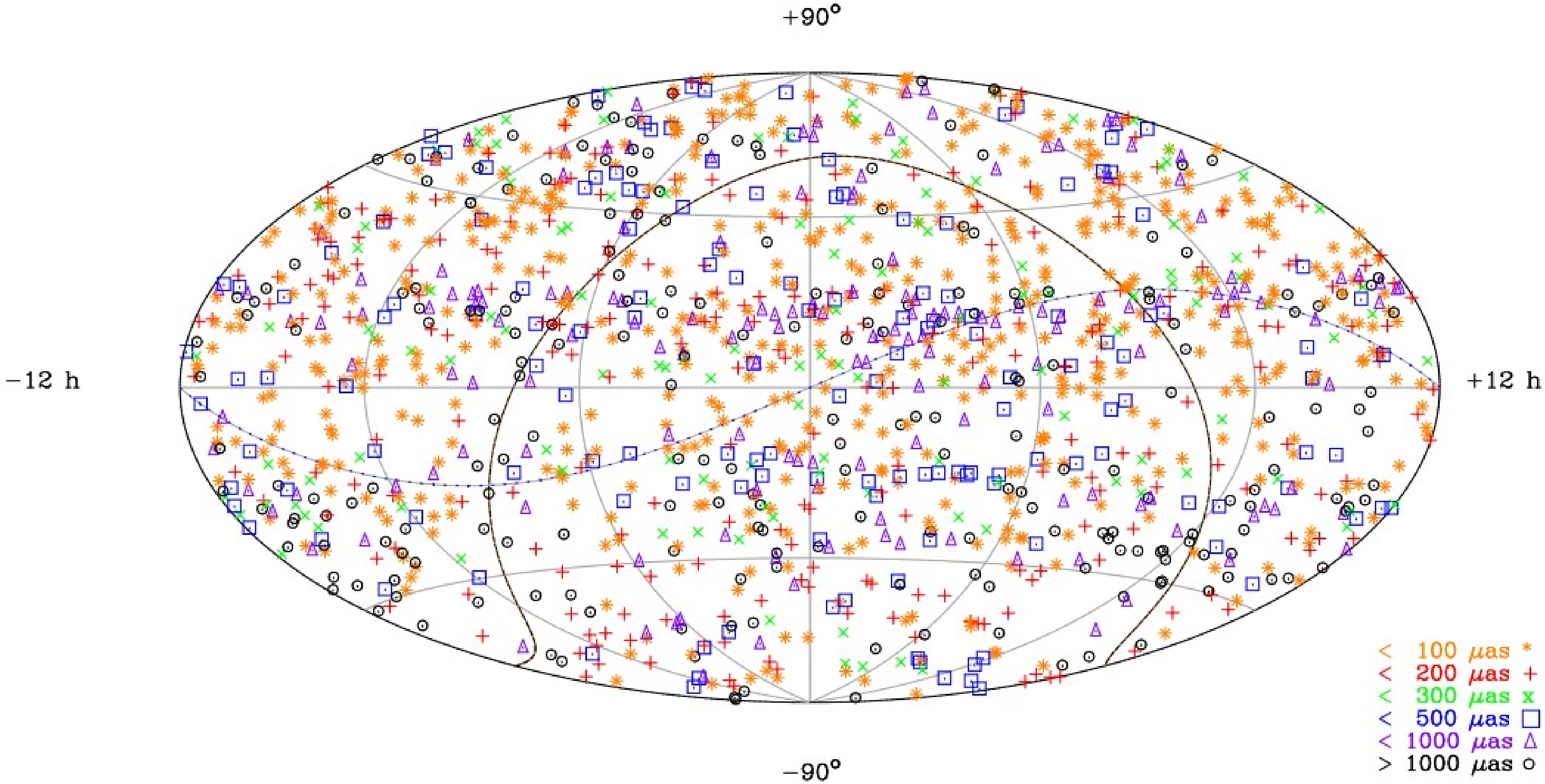
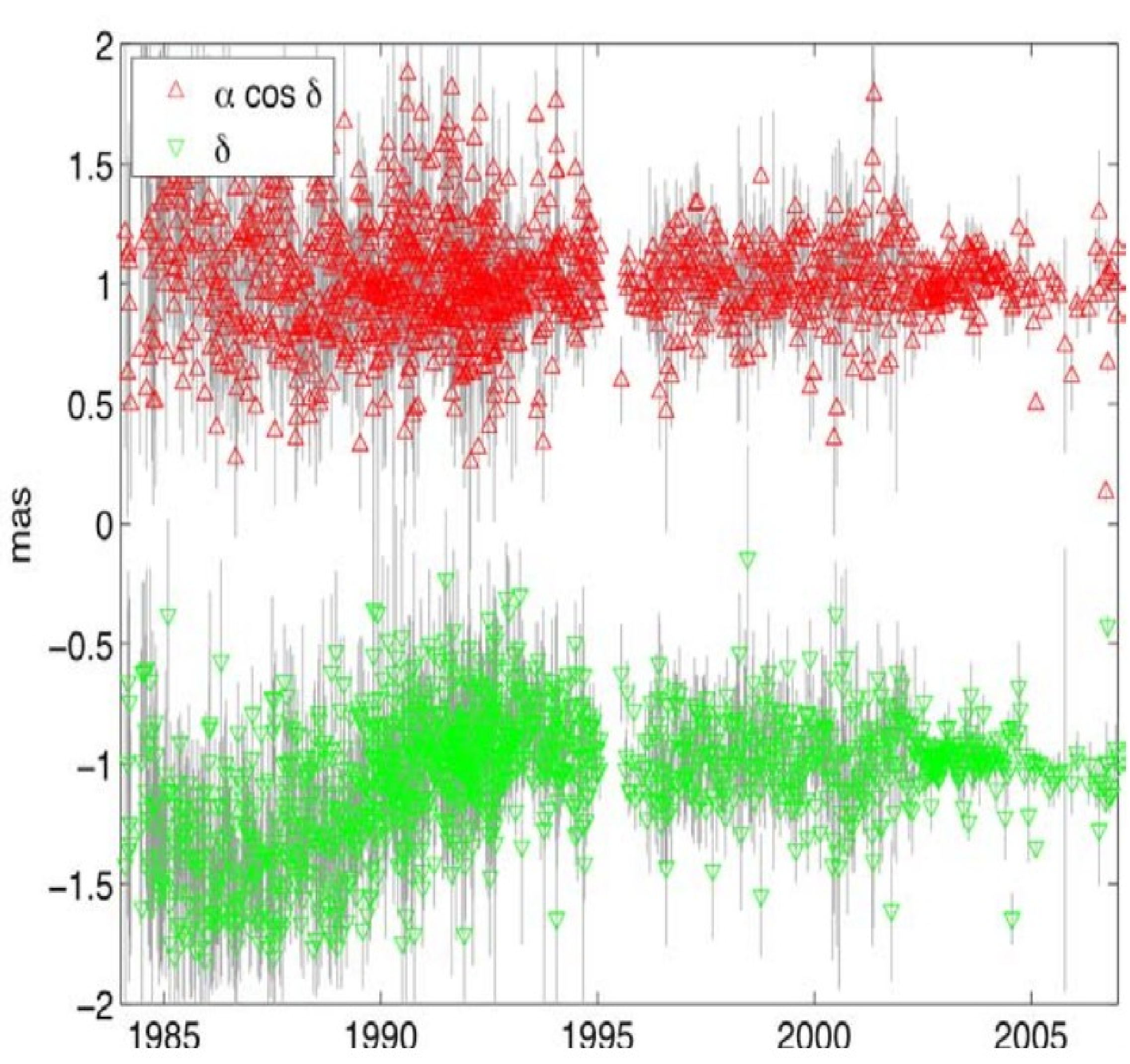
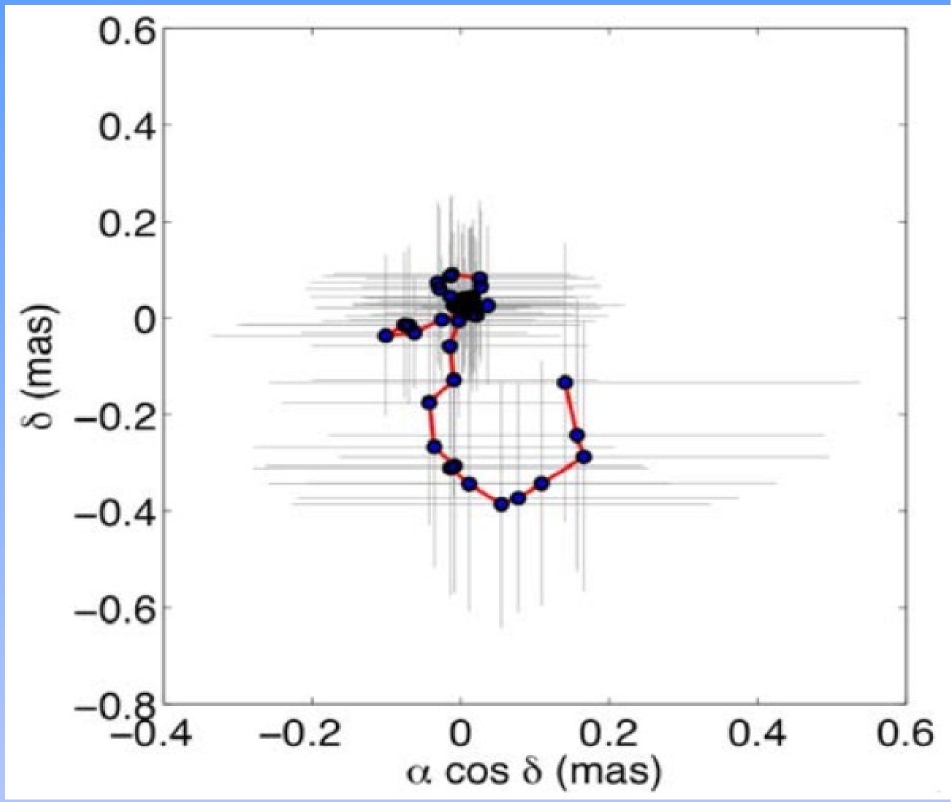


Figure 42: gsf008a distribution of 1448 multi-session sources (at least 2 observing sessions). The un-inflated 1-σ formal declination errors are color coded according to the legend in the figure. The median $\sigma_\delta = 175$ μas. The center is $(\alpha, \delta) = (0, 0)$. The Galactic plane is the roughly Ω-shaped line surrounding the center. The ecliptic plane is the dashed line. The single-session survey sources used to densify are shown in the next figure, Figure 43.





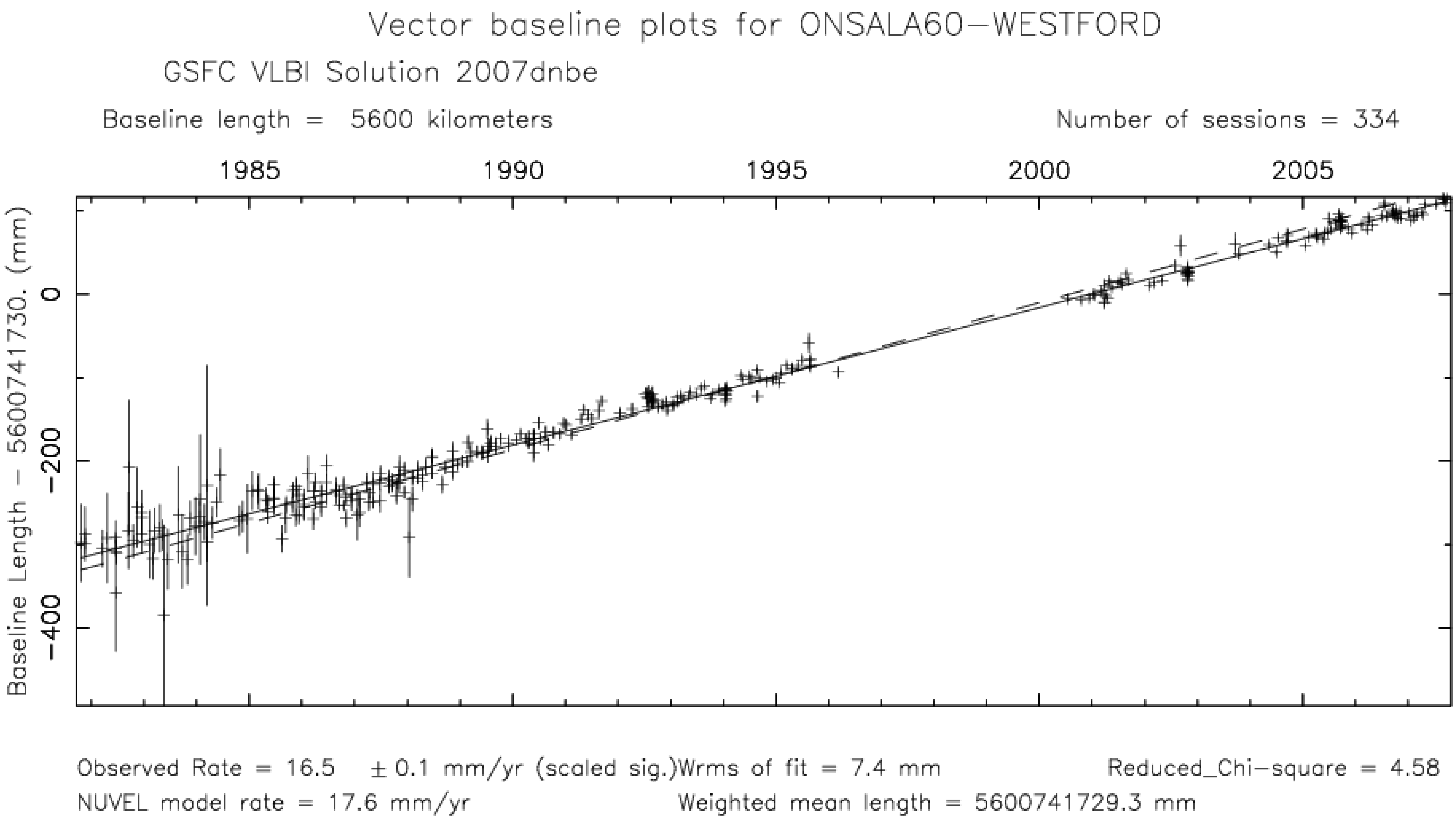
Radio source 1803+784

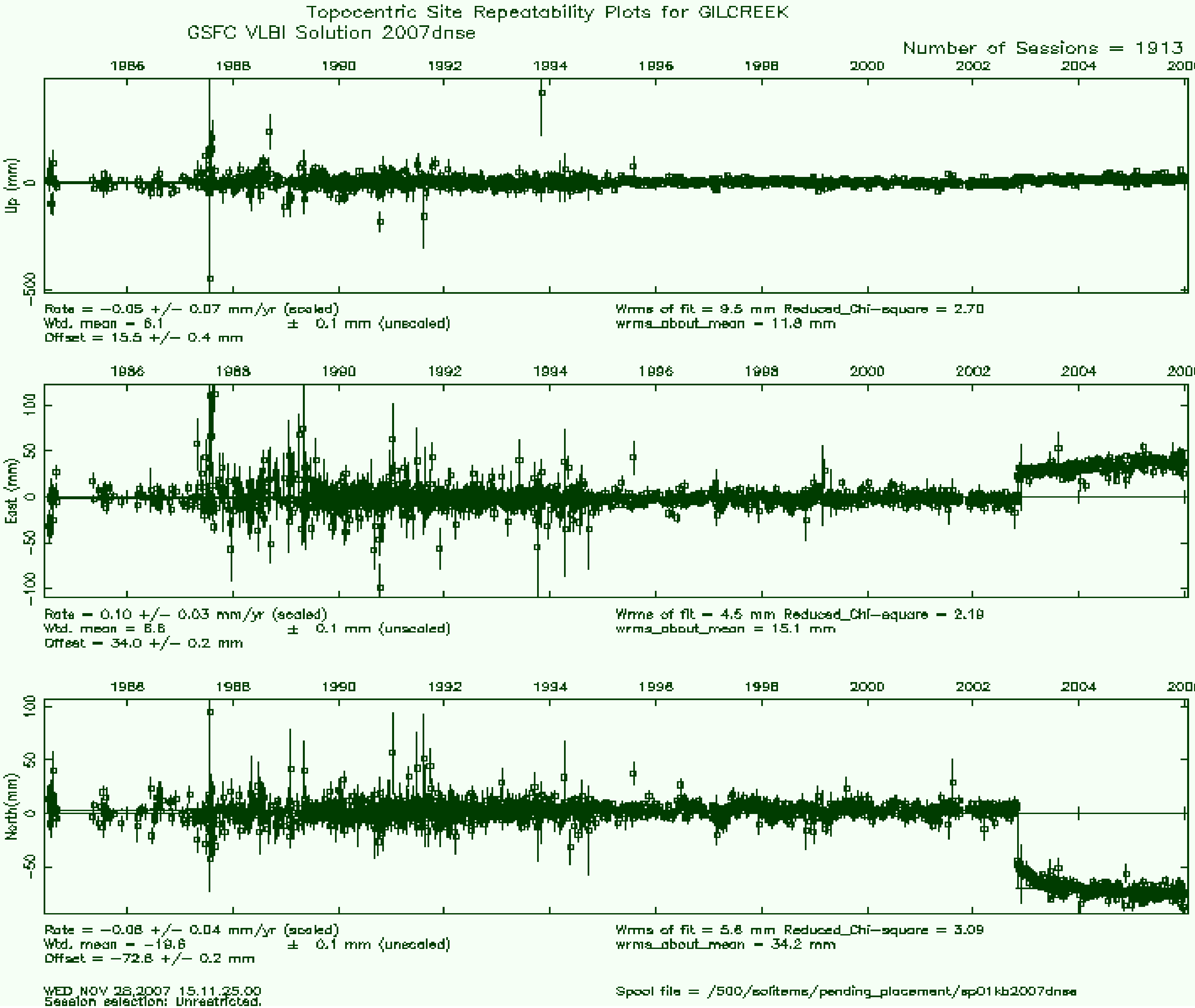
Positions by sessions

Semi-annual positions

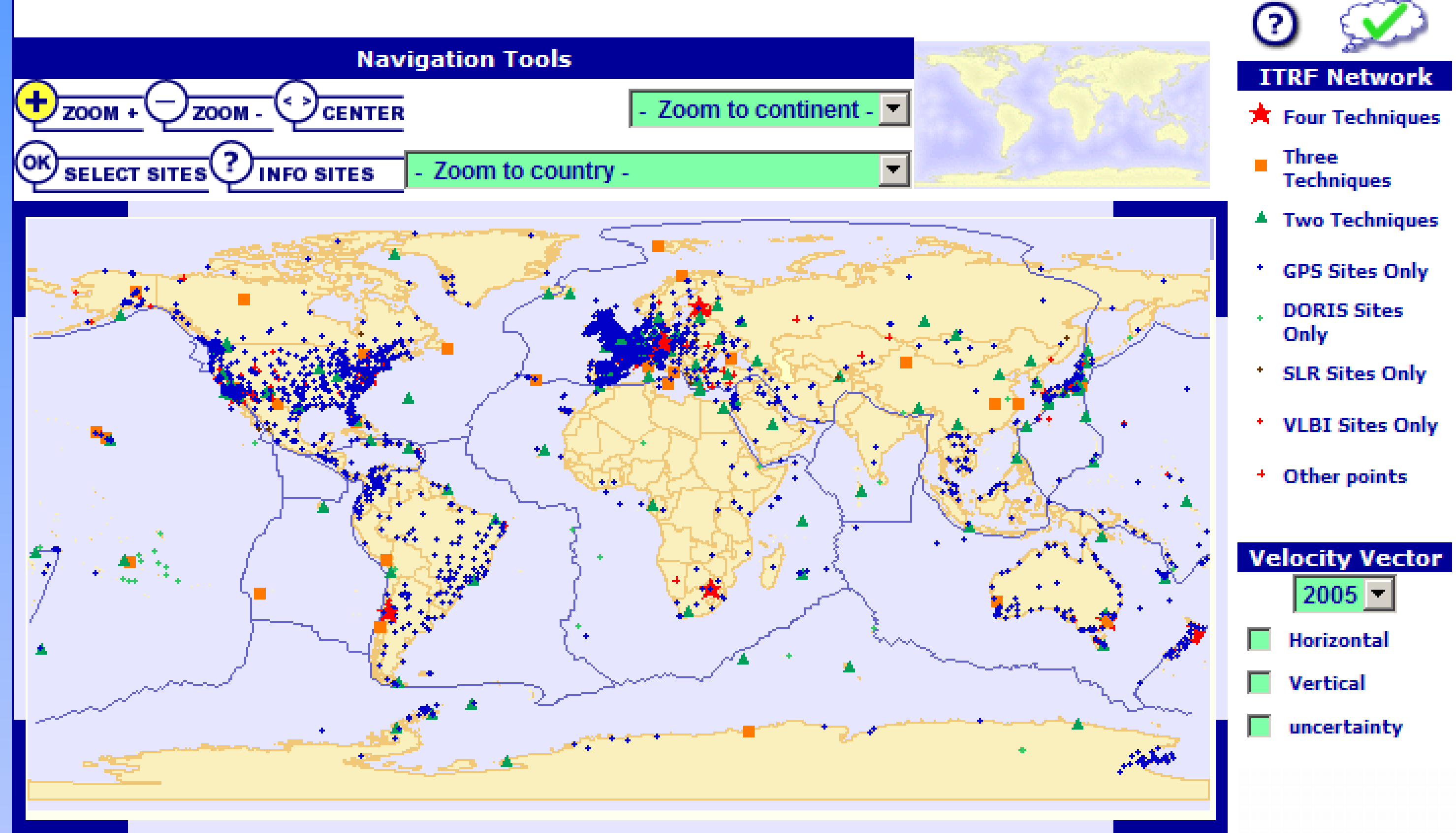
IERS Annual Report 2006

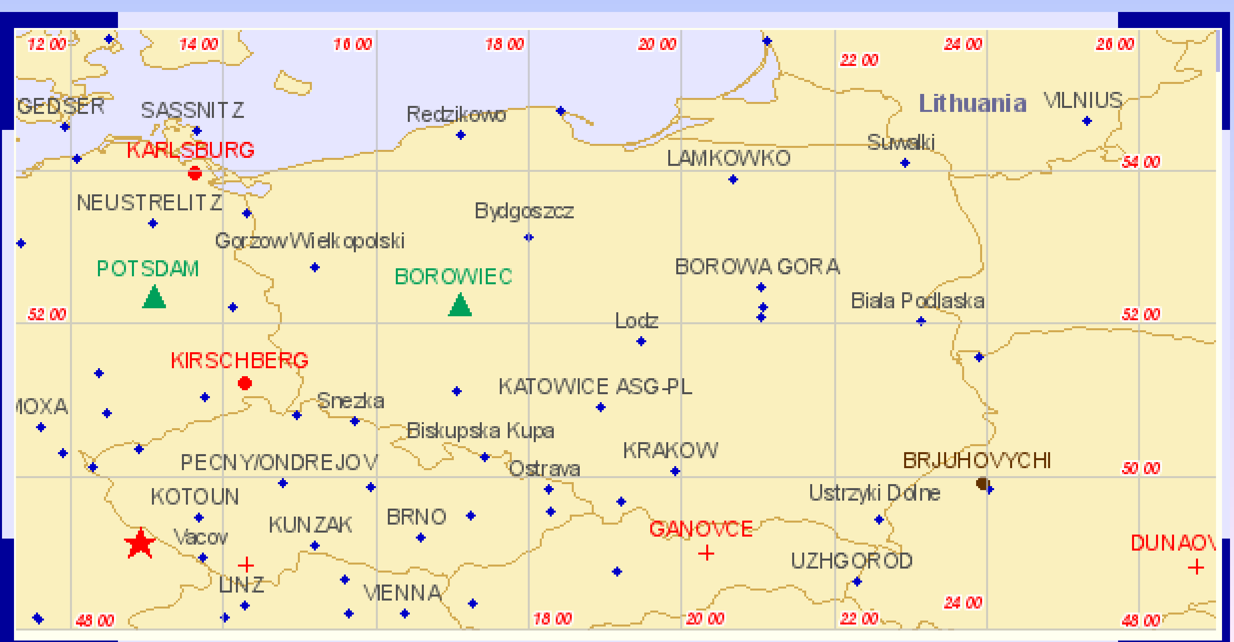
http://www.iers.org/MainDisp.csl?pid=47-1100232


Vector baseline plots for ONSALA60–WESTFORD
GSFC VLBI Solution 2007dnbe
Baseline length = 5600 kilometers
Number of sessions = 334
1985
1990
1995
2000
2005
Baseline Length – 5600741730. (mm)
0
–200
–400
Observed Rate = 16.5 ± 0.1 mm/yr (scaled sig.)
Wrms of fit = 7.4 mm
Reduced_Chi–square = 4.58
NUVEL model rate = 17.6 mm/yr
Weighted mean length = 5600741729.3 mm

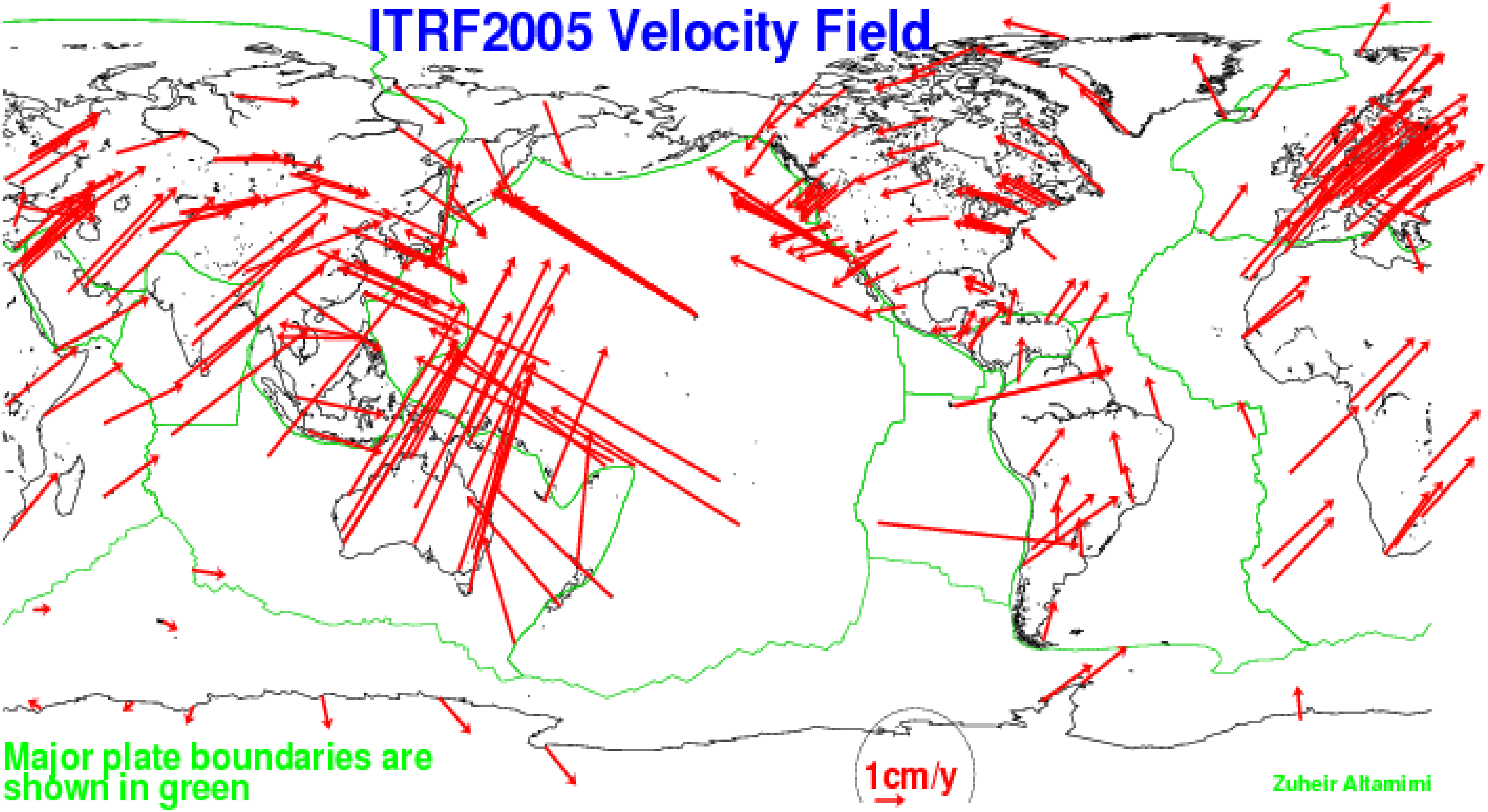


Topocentric Site Repeatability Plots for GILCREEK
GSFC VLBI Solution 2007dnse
Number of Sessions = 1913
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Up (mm)
0
-500
Rate = -0.05 +/- 0.07 mm/yr (scaled)
Wtd. mean = 6.1 ± 0.1 mm (unscaled)
Offset = 15.5 +/- 0.4 mm
Wrms of fit = 9.5 mm Reduced_Chi-square = 2.70
wrms_about_mean = 11.8 mm
East (mm)
100
50
0
-50
-100
Rate = 0.10 +/- 0.03 mm/yr (scaled)
Wtd. mean = 6.6 ± 0.1 mm (unscaled)
Offset = 34.0 +/- 0.2 mm
Wrms of fit = 4.5 mm Reduced_Chi-square = 2.19
wrms_about_mean = 15.1 mm
North(mm)
100
50
0
-50
Rate = -0.08 +/- 0.04 mm/yr (scaled)
Wtd. mean = -19.6 ± 0.1 mm (unscaled)
Offset = -72.8 +/- 0.2 mm
Wrms of fit = 5.8 mm Reduced_Chi-square = 3.09
wrms_about_mean = 34.2 mm
WED NOV 28,2007 15.11.25.00
Session selection: Unrestricted.
Spool file = /500/solitems/pending_placement/sp01kb2007dnse



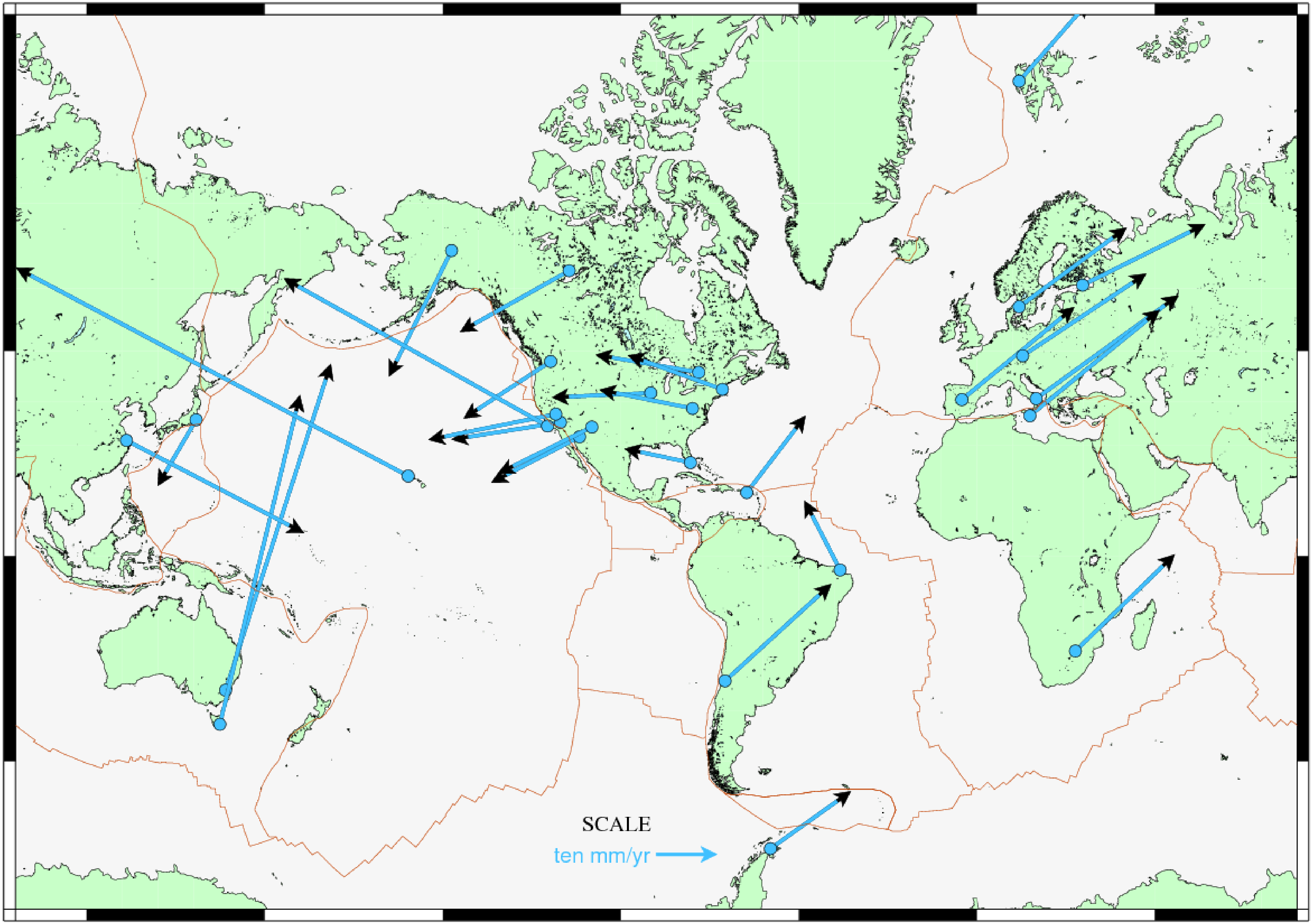


http://itrf.ensg.ign.fr/GIS/index.php



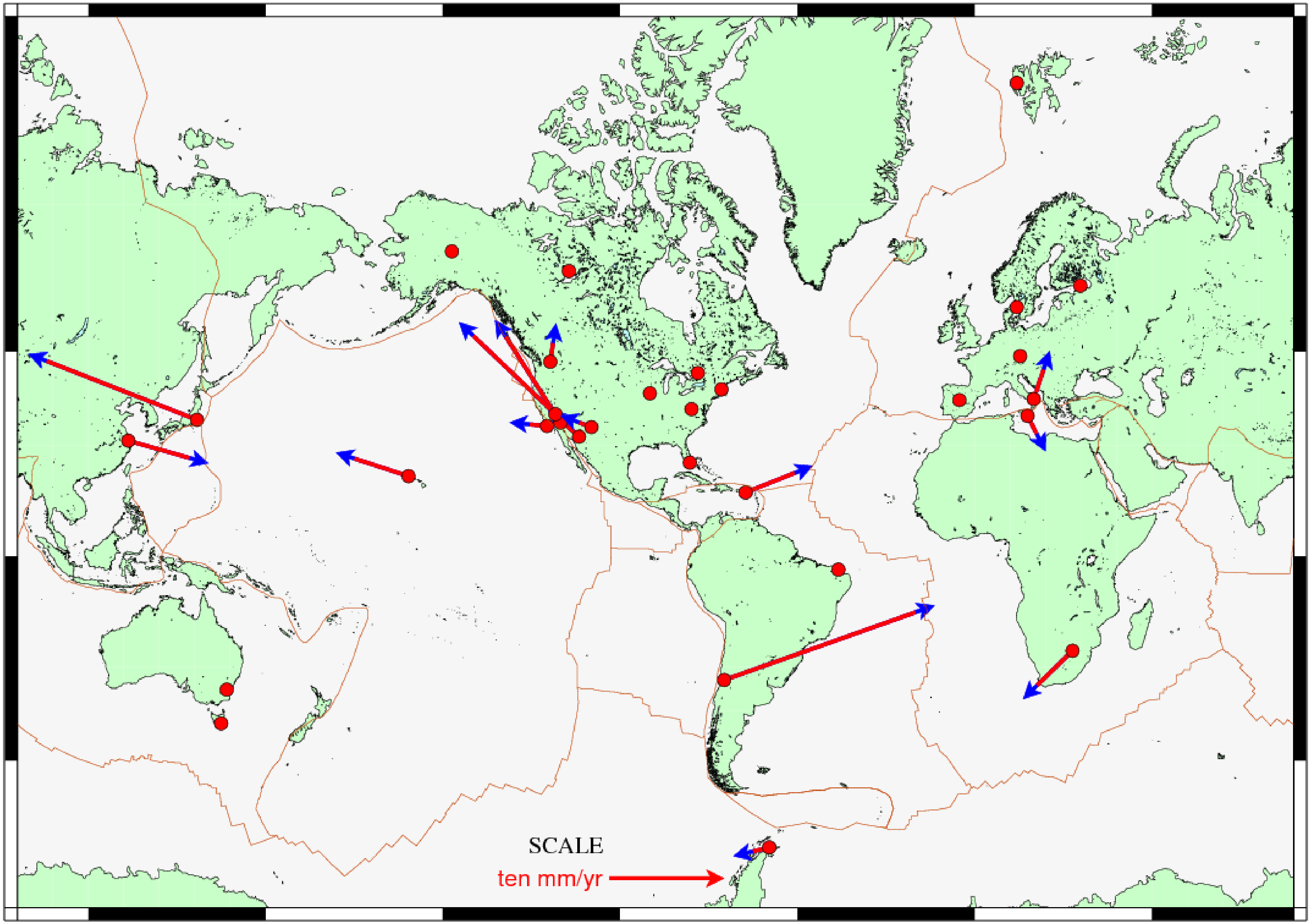
http://itrf.ensg.ign.fr/ITRF_solutions/2005/ITRF2005.php

Selected VLBI Velocities



Goddard Space Flight Center VLBI solution KB 2007dn version 01
NUVEL1A-NNR reference frame.

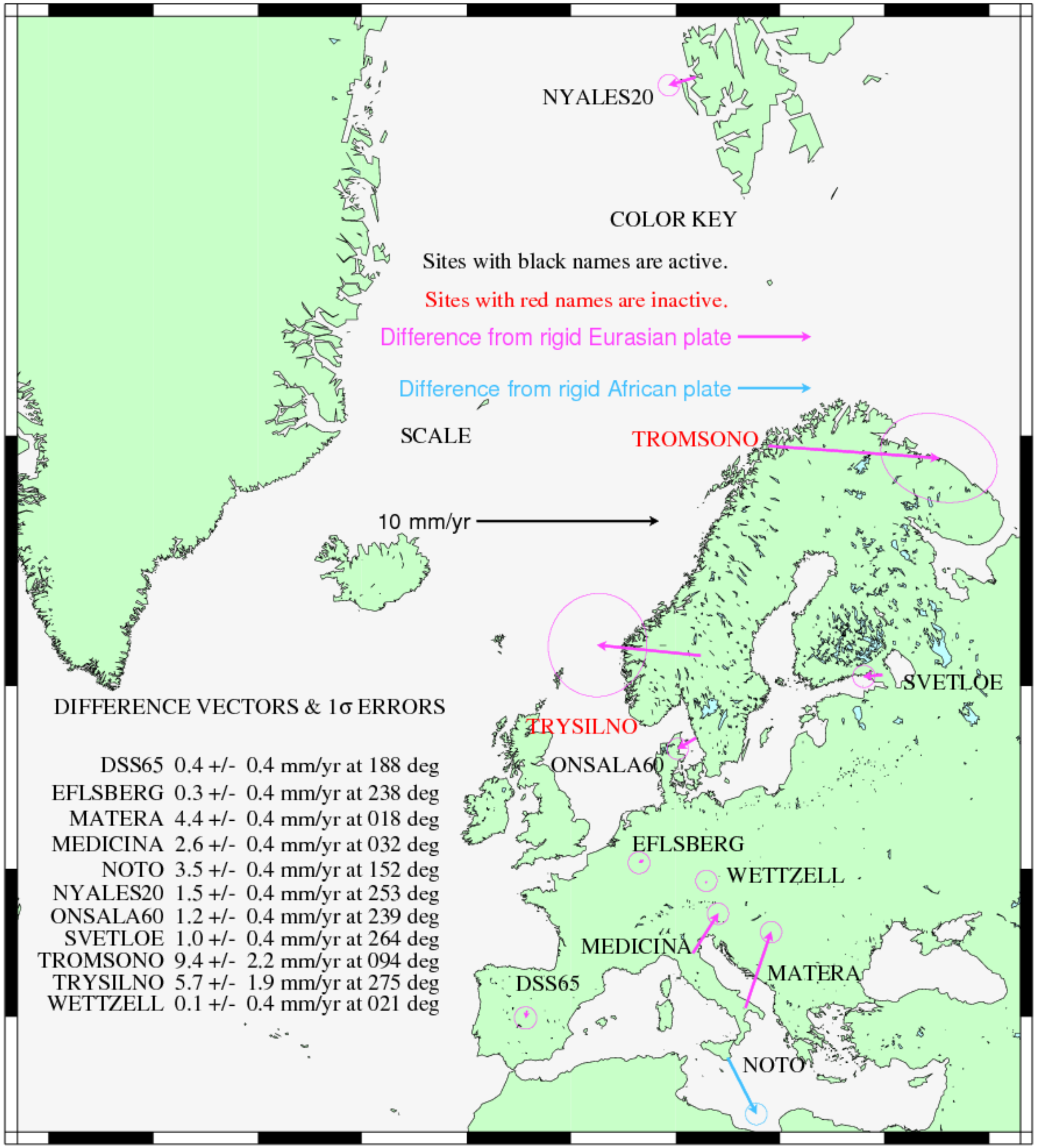
Differences between VLBI Velocities and Plate Model



Goddard Space Flight Center VLBI solution KB 2007dn version 01
Velocity residuals < 2 mm/yr are not displayed. NUVEL1A-NNR reference frame.

Europe

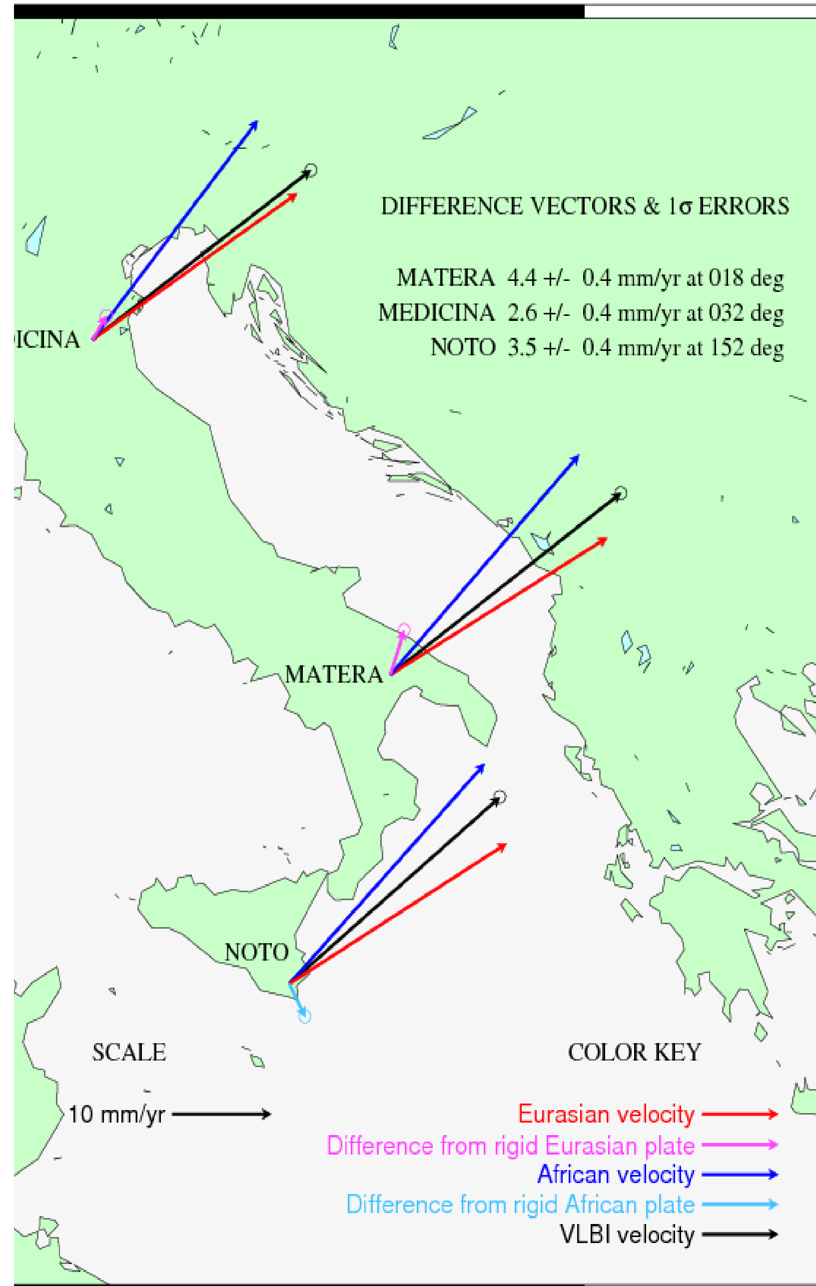
(Differences are from the rigid plate model)



Goddard Space Flight Center VLBI solution KB 2007dn version 01
NUVEL1A-NNR reference frame. 1σ (realistic) error ellipses.

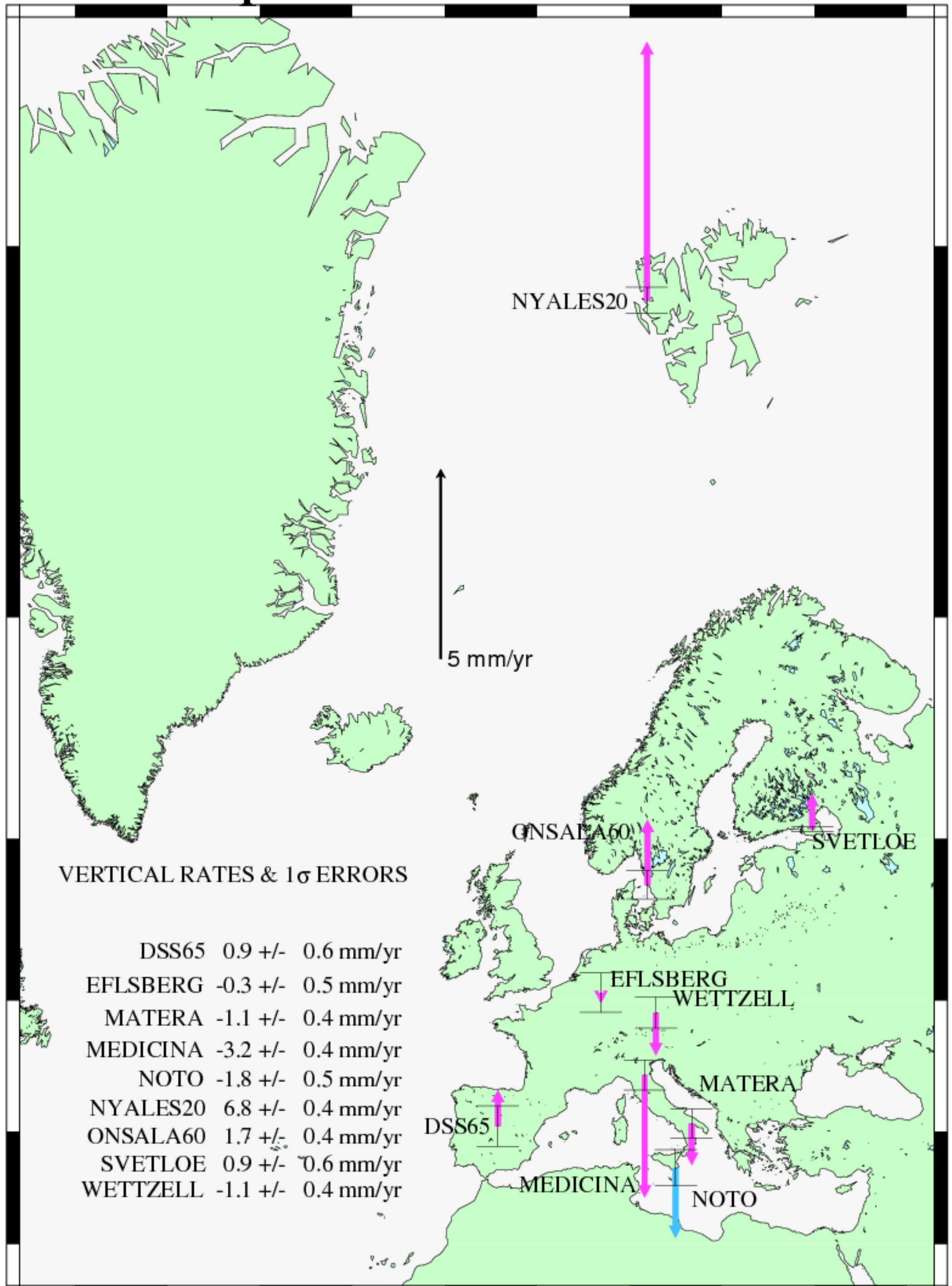
Italy

ing plates (Eurasian, African)



ght Center VLBI solution KB 2007dn version 01
R reference frame. 1σ (realistic) error ellipses.

European Vertical Motions

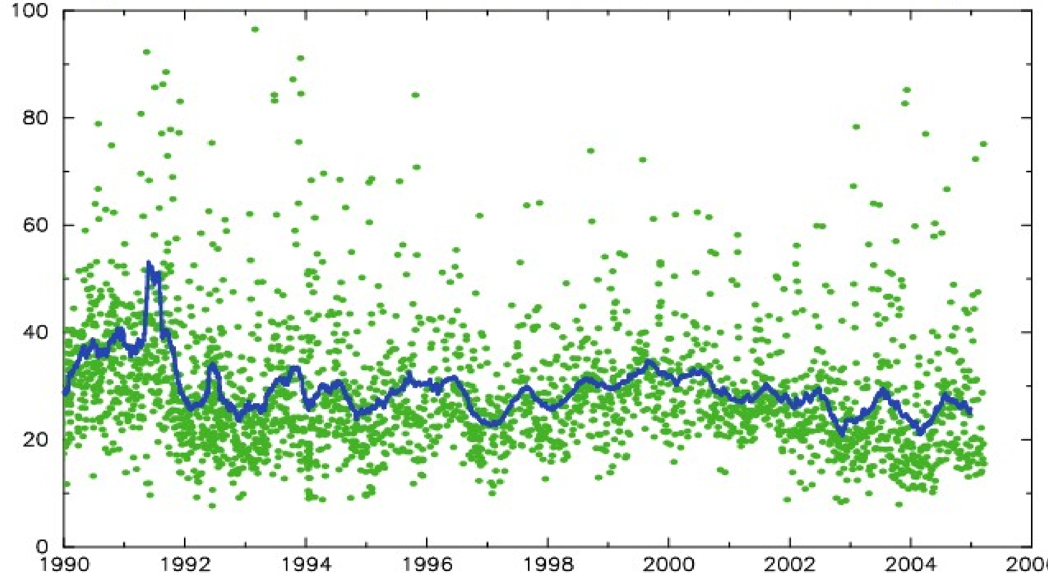


Goddard Space Flight Center VLBI solution KB 2007dn version 01
1σ (realistic) error bars.

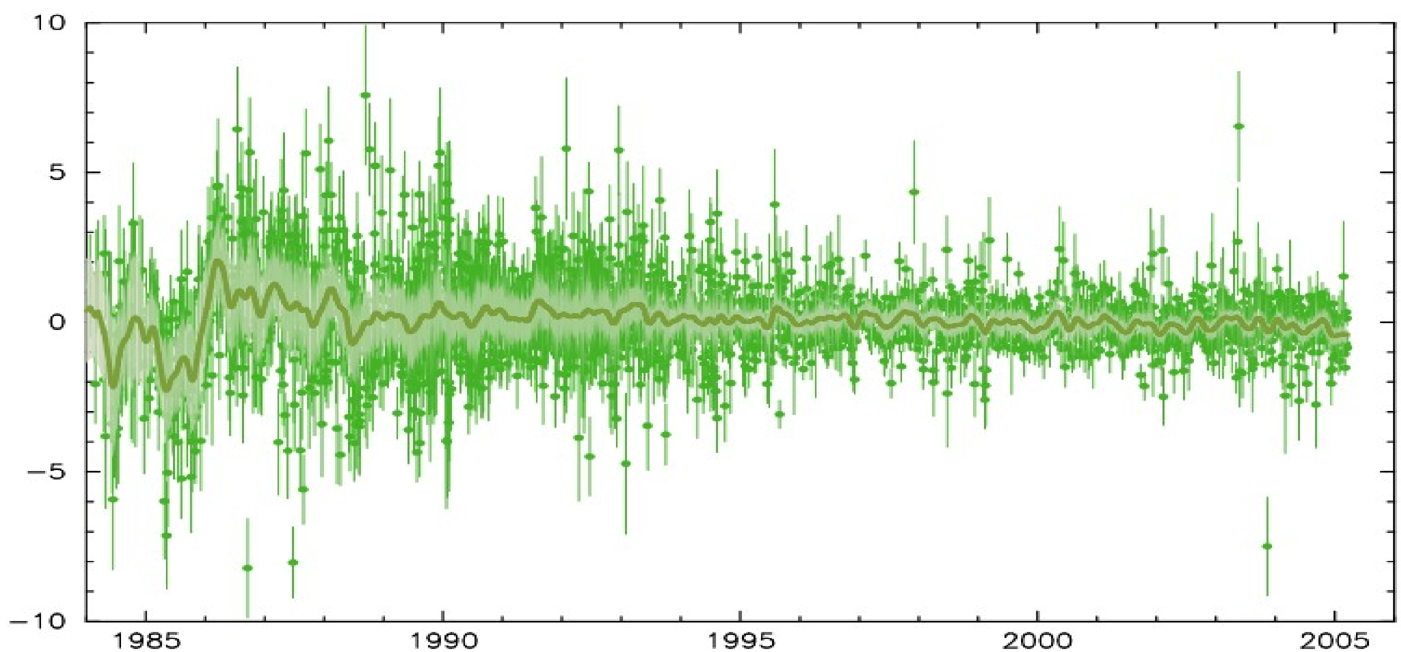
Were VLBI results improved in last 10 years?

Evolution of WRMS of post-fit residuals of individual experiments (on psec)

All data:



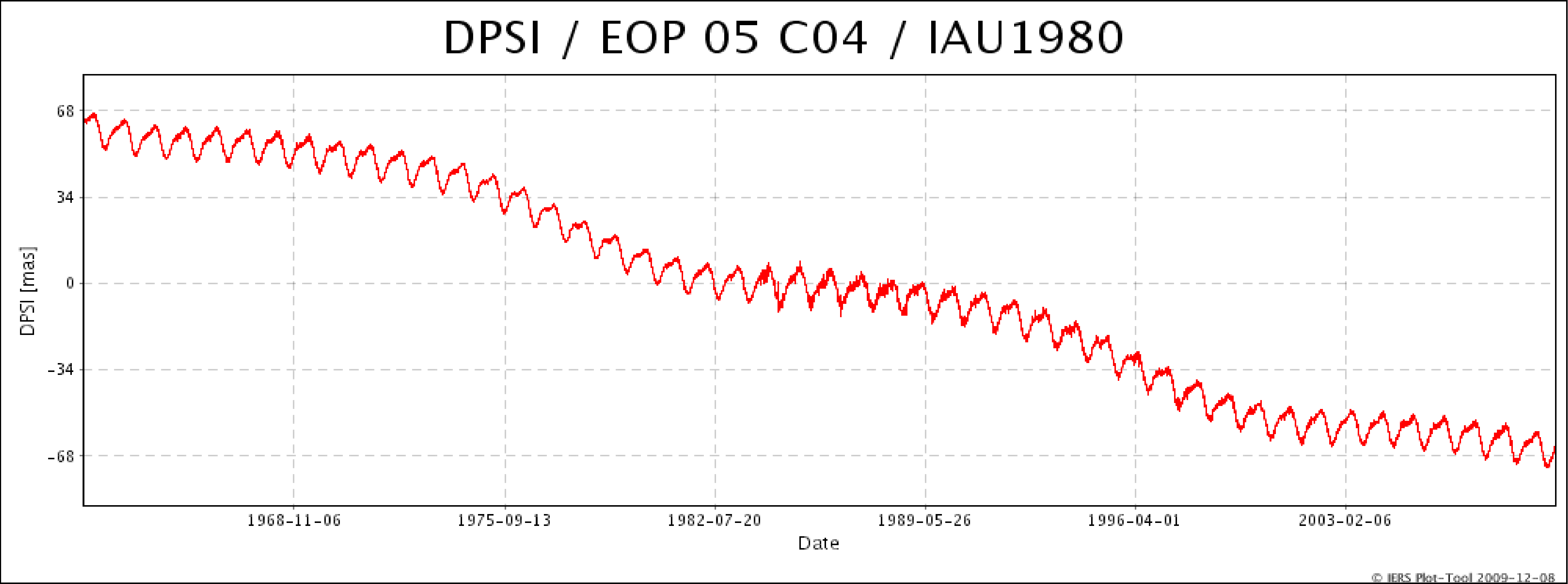
Differences: daily estimates of $\Delta\epsilon$ versus heo_05c (in nrad)

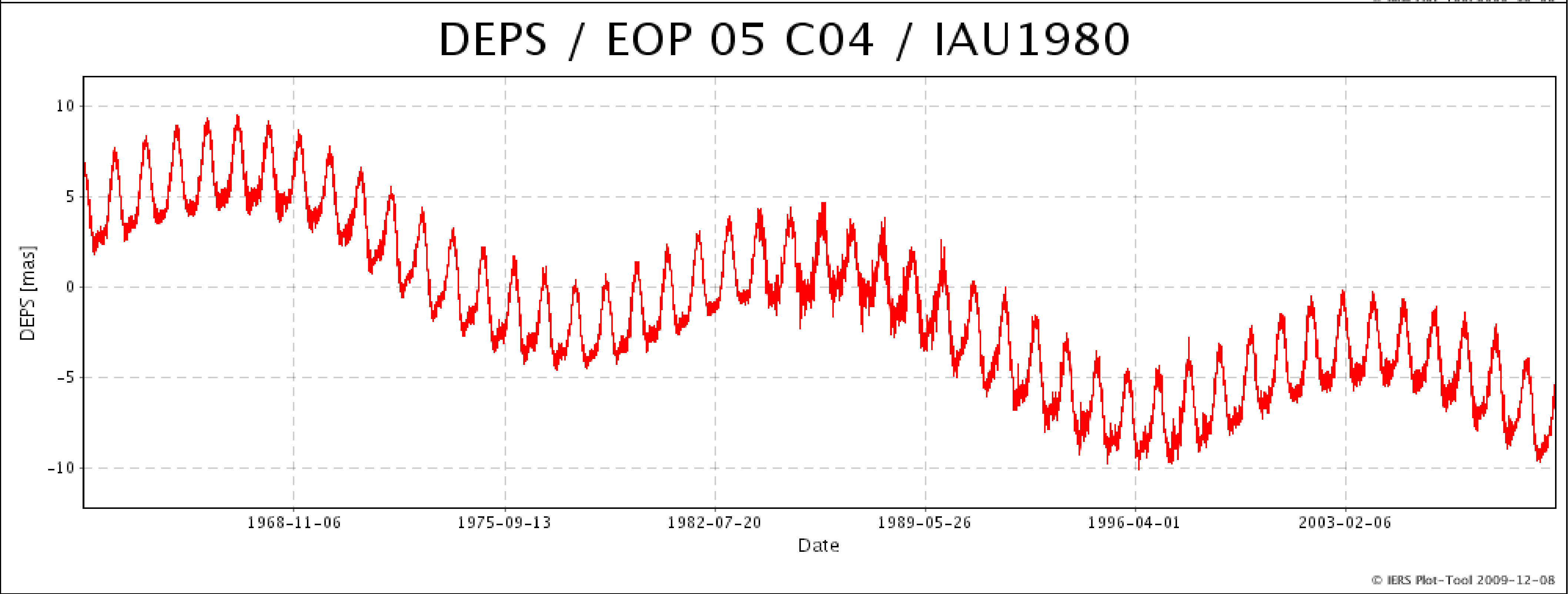


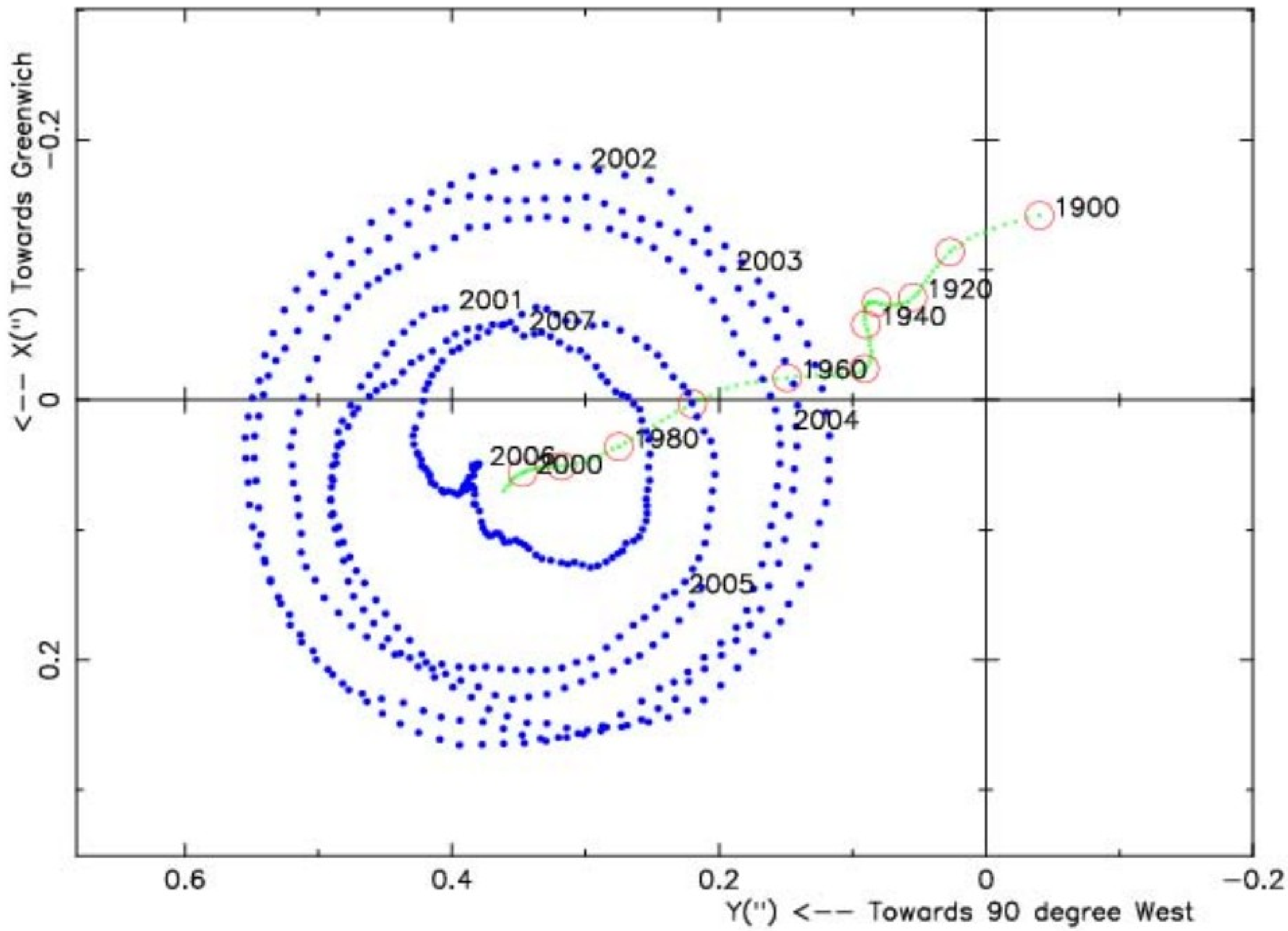
Leonid Petrov
GSFC (2007)

Summary of current IVS main products status and goals (WG2)

Products	Specification	Status 2002	Status 2006	Goals (2010)
Polar Motion (x_p, y_p)	accuracy product delivery resolution frequency of solution	x_p ~ 100, y_p ~ 200 µas 1 – 4 weeks – 4 months 1 day 3 days/week	x_p , y_p: 50 – 80 µas 8 – 12 days 1 day	25 µas 1 day 10 min – 1 h 7 days/week
UT1-UTC (DUT1)	accuracy product delivery resolution	5 – 20 µs 1 week 1 day	3 µs 3 – 4 days 1 day	2 µs 1 day 10 min
Celestial Pole ($d\varepsilon$; $d\psi$)	accuracy product delivery resolution frequency of solution	100 – 400 µas 1 – 4 weeks – 4 months 1 day ~ 3 days/week	50 µas 3 – 4 days 1 day	25 µas 1 day 7 days/week
TRF (x, y, z)	accuracy	5 – 20 mm	5 mm	2 mm
CRF (α; δ)	accuracy frequency of solution product delivery	0.25 – 3 mas 1 year 3 – 6 months	0.25mas (improv. distribution) 1 year 3 months	0.25 mas improve. for more freq. Bands 1 month


DPSI / EOP 05 C04 / IAU1980
68
34
0
-34
-68
DPSI [mas]
1968-11-06
1975-09-13
1982-07-20
1989-05-26
1996-04-01
2003-02-06
Date
© IERS Plot-Tool 2009-12-08

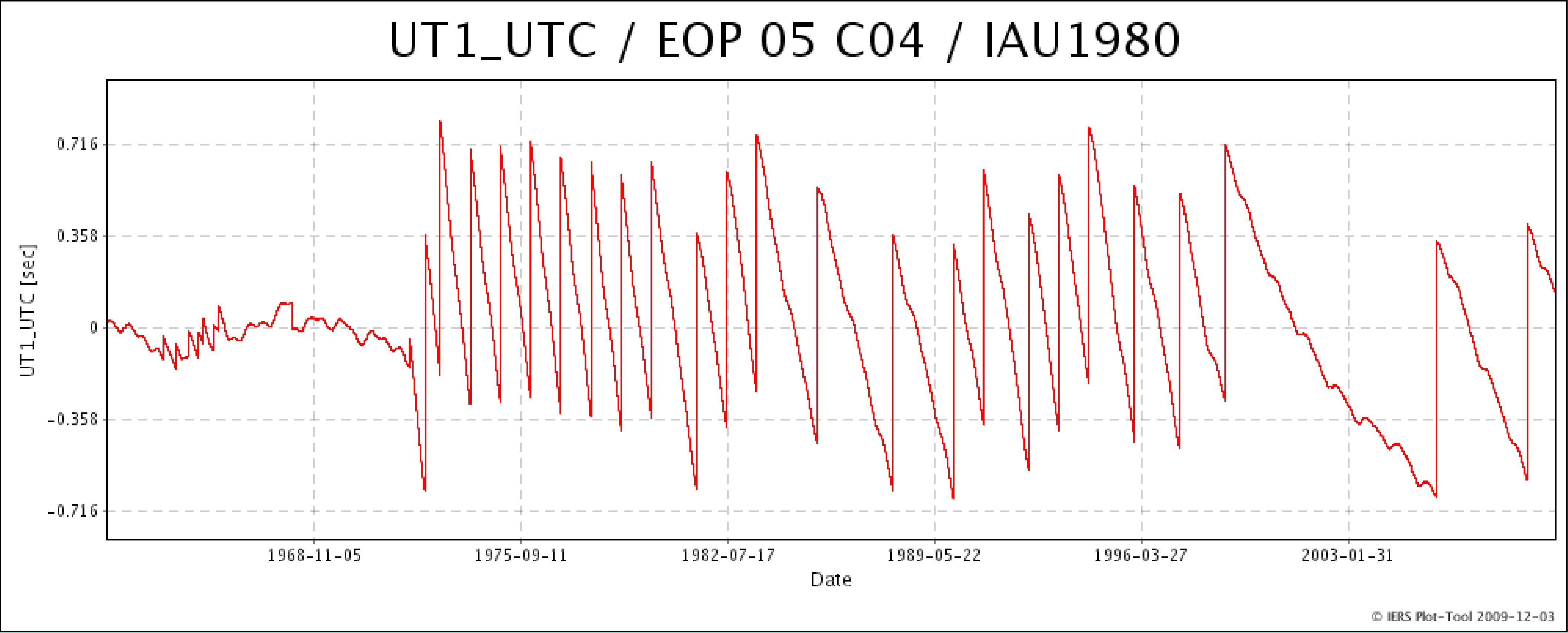

DEPS / EOP 05 C04 / IAU1980
10
5
0
-5
-10
DEPS [mas]
1968-11-06
1975-09-13
1982-07-20
1989-05-26
1996-04-01
2003-02-06
Date
© IERS Plot-Tool 2009-12-08



Mean polar motion (1900–2010) and IERS C04 polhody over 2001–2007

0.1” = 3.1 m

www.iers.org/MainDisp.csl?pid=47-1100232



http://www.iers.org/plots/EOPC04_05_62-NOW_IAU1980-UT1-UTC.png

INTERNATIONAL EARTH ROTATION AND REFERENCE SYSTEMS SERVICE (IERS)
SERVICE INTERNATIONAL DE LA ROTATION TERRESTRE ET DES SYSTEMES DE REFERENCE

SERVICE DE LA ROTATION TERRESTRE OBSERVATOIRE DE PARIS
61, Av. de l'Observatoire 75014 PARIS (France)
Tel. : 33 (0) 1 40 51 22 26
FAX : 33 (0) 1 40 51 22 91
Internet : services.iers@obspm.fr

Paris, 4 July 2009

Bulletin C 38

To authorities responsible
for the measurement and
distribution of time

INFORMATION ON UTC - TAI

NO positive leap second will be introduced at the end of December 2009.
The difference between Coordinated Universal Time UTC and
the International Atomic Time TAI is :

from 2009 January 1, 0h UTC, until further notice : UTC-TAI = -34 s

Leap seconds can be introduced in UTC at the end of the months of December or June, depending on the evolution of UT1-TAI. Bulletin C is mailed every six months, either to announce a time step in UTC, or to confirm that there will be no time step at the next possible date.

Daniel GAMBIS
Director Earth Orientation Center of IERS

Observatoire de Paris, France

Plik **eopc04.09**

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            INTERNATIONAL EARTH ROTATION AND REFERENCE SYSTEMS SERVICE
                           EARTH ORIENTATION PARAMETERS
                             EOP (IERS) 05 C04


                FORMAT(2X,A4,I3,2X,I5,2F9.6,F10.7,2X,F10.7,2X,2F9.5)
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    Date     MJD       x         y        UT1-UTC        LOD         dPsi  dEpsilon
                       "         "          s             s            "         "
     (0h UTC)


  YEAR ==> 2009

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  JAN  11  54842-0.053086 0.162767 0.3974553   0.0008102   -0.06232 -0.00439
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  JAN  13  54844-0.059603 0.166143 0.3952847   0.0013483   -0.06187 -0.00428
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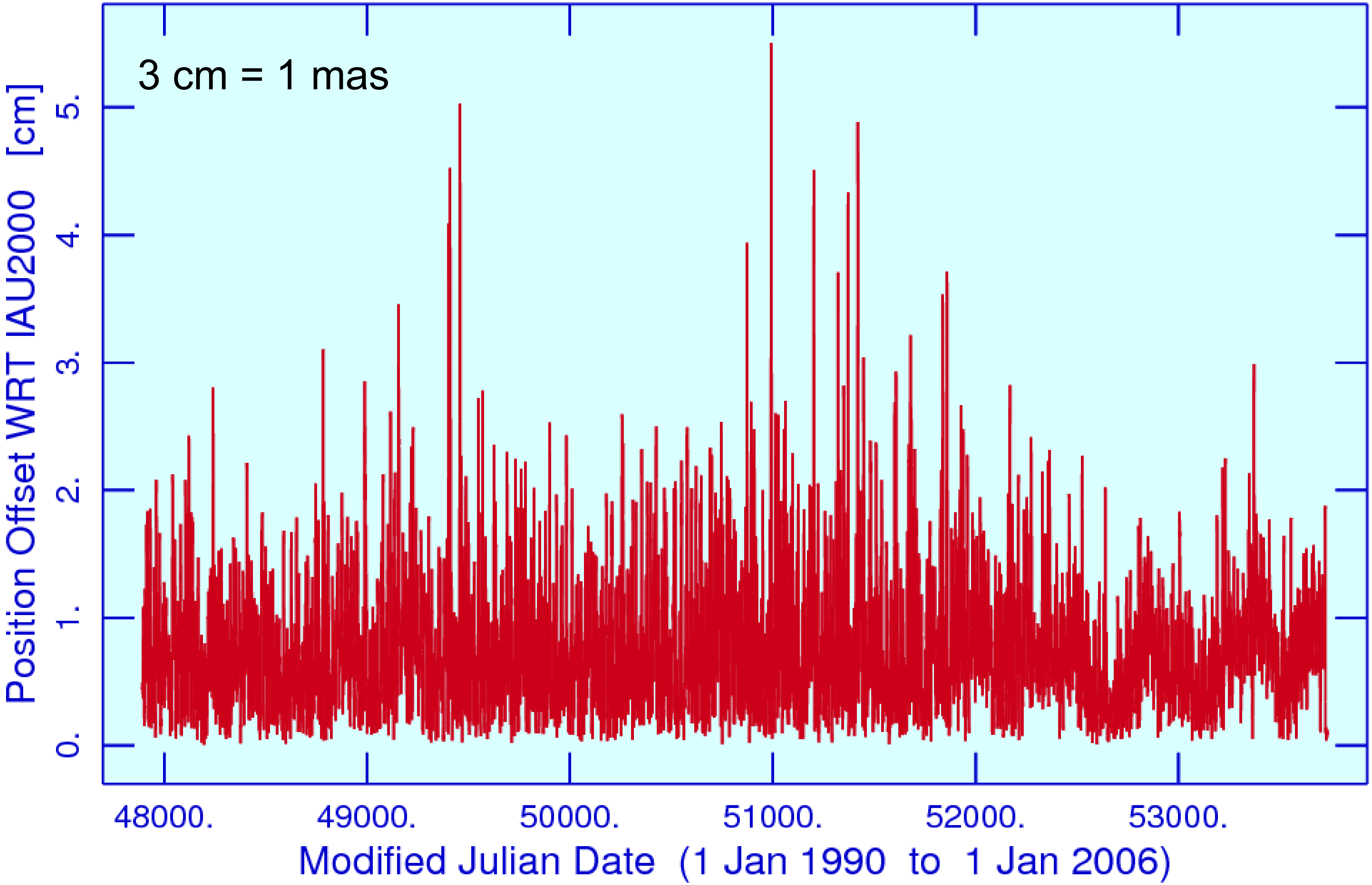


Absolute difference between the Explorer location referred to the geocentric ICRF computed with two packages: the `Top2Bary` and `T2C2kA`, the latter incorporating full precision software based on the 1997–2000 IAU astronomical reference systems, time scales, and Earth rotation models.

Hipparcos Celestial Reference Frame

Launched in August 1989 Hipparcos successfully observed the celestial sphere for 3.5 years before operations ceased in March 1993.

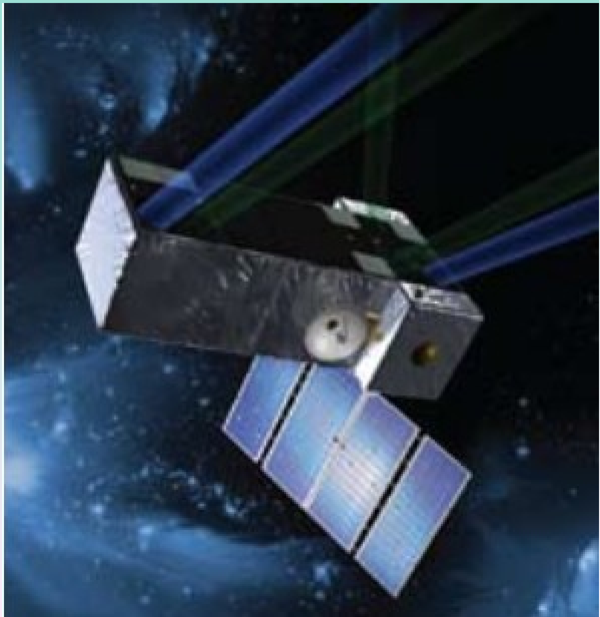
The Hipparcos catalogue contains 118,218 stars. The positional accuracies of 1 to 3 mas at epoch 1991.25 are unsurpassed in the optical. Proper motion accuracies, of around 1 to 2 mas/yr, remain state of the art. **Thus typical positional errors at a 2005 epoch are around 15 mas.**

The **Tycho 2 Catalogue**, completed in 2000, contains 2,539,913 stars. Positional accuracies range from about 10 to 100 mas, depending on magnitude. Proper motion accuracies are from 1 to 3 mas.

Over 10 years after the successful Hipparcos mission a first attempt was made to improve upon the original link between the HCRF and the extragalactic ICRF (Bobylev et al., 2004). The **possible error** in the alignment between the 2 systems increases with time, approaching about **3 mas** estimated standard error per axis at the 2005 epoch.

SIM-Planet Quest

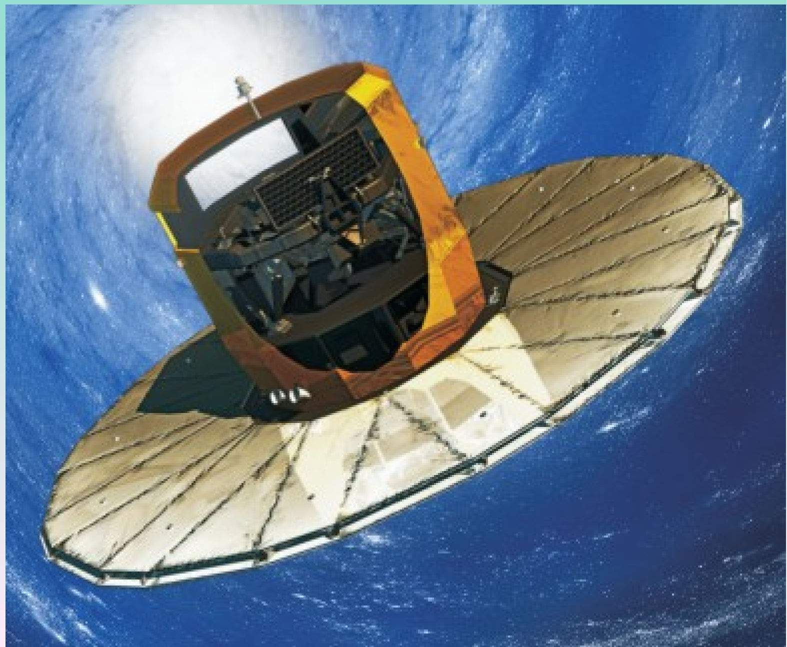
• **Synopsis:** SIM Planet Quest is a space-based optical interferometer operating in a near Earth-trailing orbit
• **Acronym:** Space Interferometer Mission
• **Funding Agency:** NASA
• **Launch:** 2010 (plan). Five year baseline mission, potential ten year extended mission
• **ConOps:** SIM Planet Quest is a pointed mission with predefined targets
• **Number of Objects:** about 10,000 stars (1,300 grid stars)
• **Magnitude Range:** brighter than (a limiting magnitude of) about 20th
• **Astrometric Accuracy:** 4 microarcseconds wide angle, 1 microarcsec. narrow angle
• **Reference Frame:** Should SIM achieve 4 microarcseconds wide angle astrometric accuracy, the resultant grid will form the basis of the most accurate reference frame ever produced, easily exceeding the accuracy of the current radio-based ICRF. SIM will also be capable of observing a fair number of extragalactic sources. Detailed plans are currently being developed with regard to SIM observations of the extragalactic frame sources.
• **Additional Information:** SIM Planet quest is currently in mission development Phase B (Preliminary Design phase).



http://planetquest.jpl.nasa.gov/SIM

Gaia

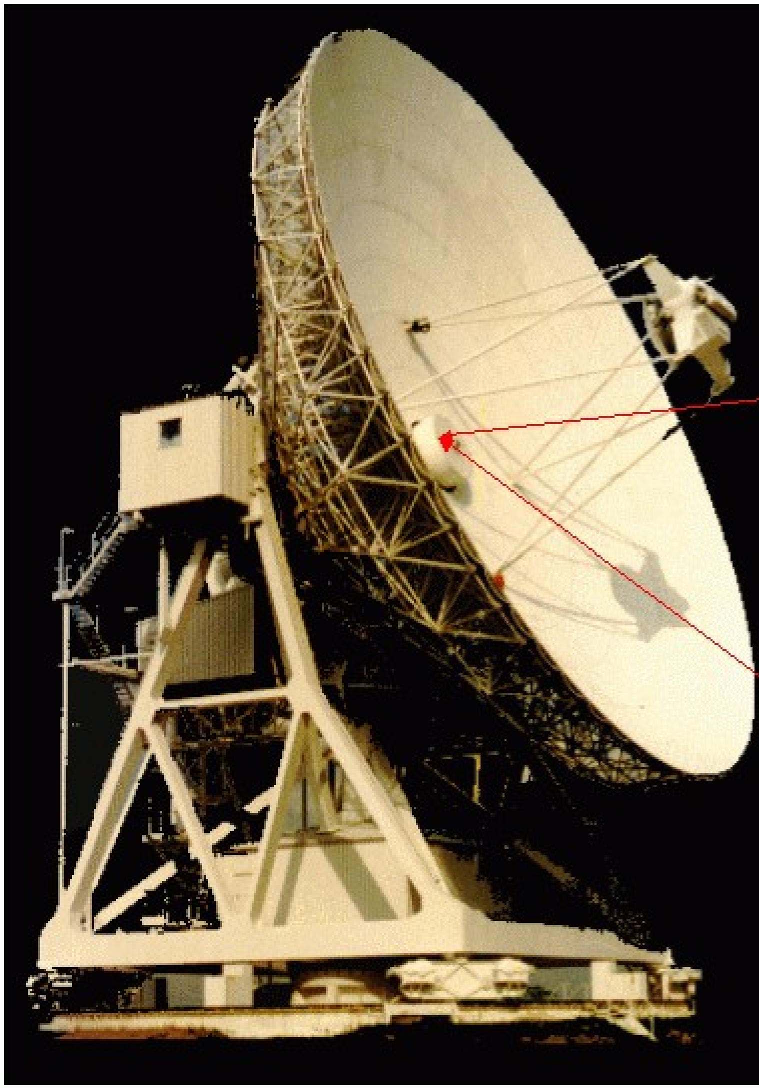
- **Synopsis:** Gaia is a funded space astrometry mission intended to launch in 2010-2012 Operating at L2, Gaia consists of three instruments which provide astrometric, photometric, and spectroscopic data
- **Funding Agency:** ESA
- **Launch:** before 2012 (planned). Five year operation phase
- **ConOps:** Continuous scanning. Two optically combined fields of view
- **Number of Objects:** 10^9
- **Magnitude Range:** 7-20^th magnitude
- **Astrometric Accuracy:** 15-20 microarcseconds @ 15^th m_v
- **Reference Frame:** The stated accuracy goal of Gaia is somewhat less than that of SIM-PlanetQuest. What Gaia loses in accuracy, however, is easily overcompensated in the number of mission objects, of order 10^5 more than SIM-PlanetQuest. Gaia will also detect and measure the positions of about 400,000 QSOs, enabling an extremely rigid attachment of the impressively dense Gaia stellar frame to the extragalactic frame
- **Additional Information:** In addition to astrometry, Gaia will provide 12 band millimagnitude photometry, radial velocity data for brighter stars to an accuracy of a few km/s and spectrophotometry in the visible and near-IR to mv 17.5



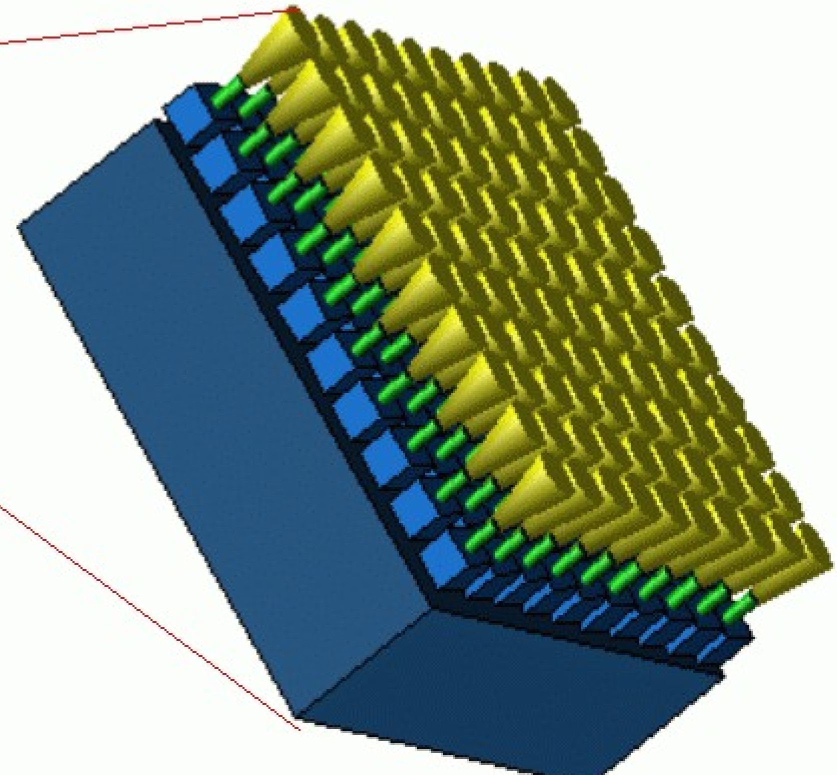
http://www.rssd.esa.int/gaia/

Radioteleskop 32- i 15-metrowy w Piwnicach k. Torunia

Oświetlacze w ognisku wtórnym RT32



OCRA One Centimetre Receiver Array



OCRA (One Centimetre Receiver Array), scientific papers

- "**OCRA: a One-Centimetre Receiver Array**", Proc. SPIE, 4015
- "**30 GHz flux density measurements of the Caltech-Jodrell flat-spectrum sources with OCRA-p**", A&A, 474, 1093L
- "**Preliminary Sunyaev Zel'dovich Observations of Galaxy Clusters with OCRA-p**", MNRAS, 378, pp 673-680
- "**Survey of Planetary Nebulae at 30 GHz with OCRA-p**", A&A, 498, 463
- "**30 GHz observations of sources in the VSA fields**", MNRAS (Submitted)

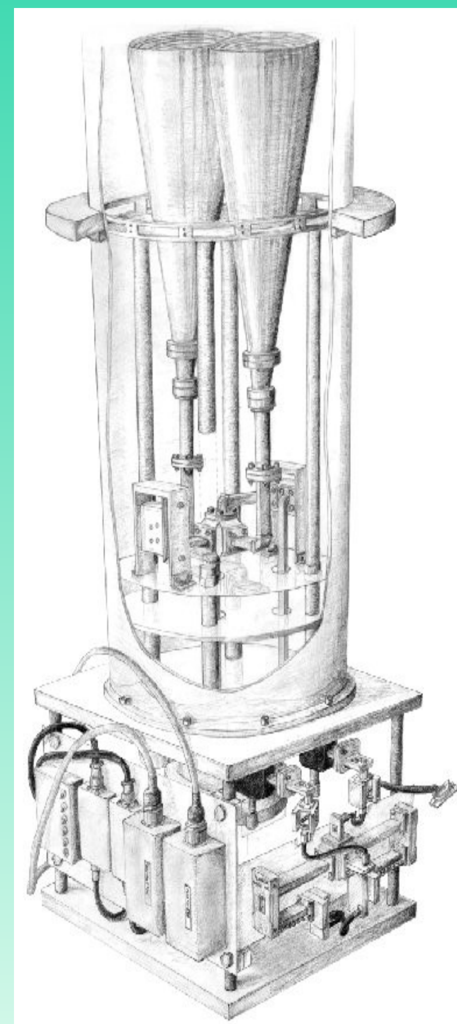
MANCHESTER
1824

The OCRA project aims to construct a one hundred beam receiver system, operating in a frequency band centred on 30 GHz

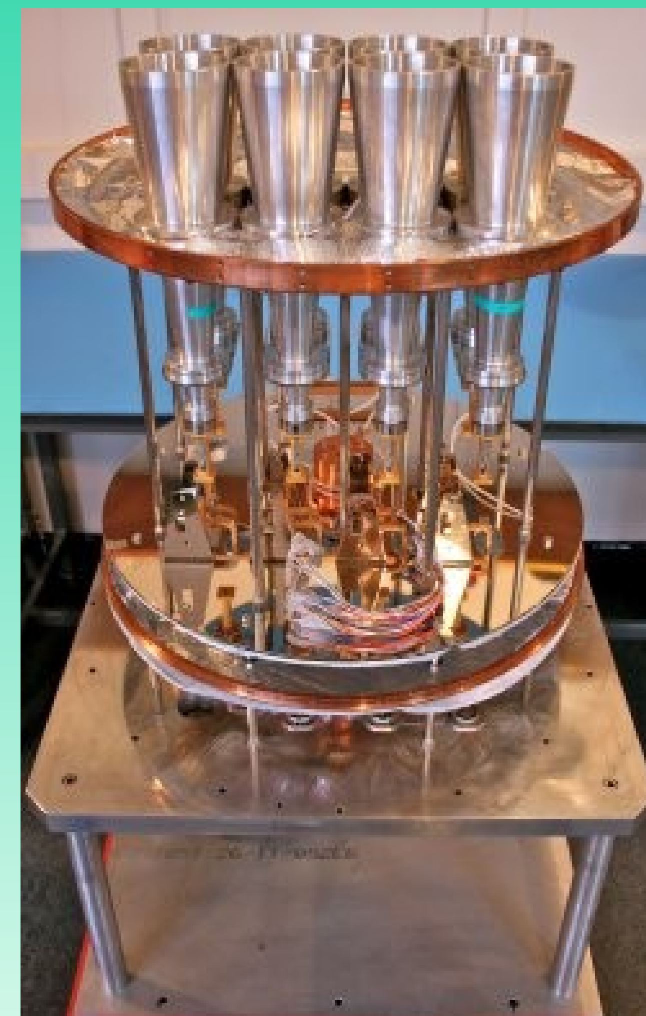
OCRA-F is currently being assembled and is expected to begin observing at the start of 2010, with an upgrade to 16 beams around 2012. OCRA-F will be used to do small scale blind surveys for point sources and the Sunyaev-Zel'dovich effect, and will also be able to create maps of extended emission.

http://www.jb.man.ac.uk/research/ocra/

OCRA-p



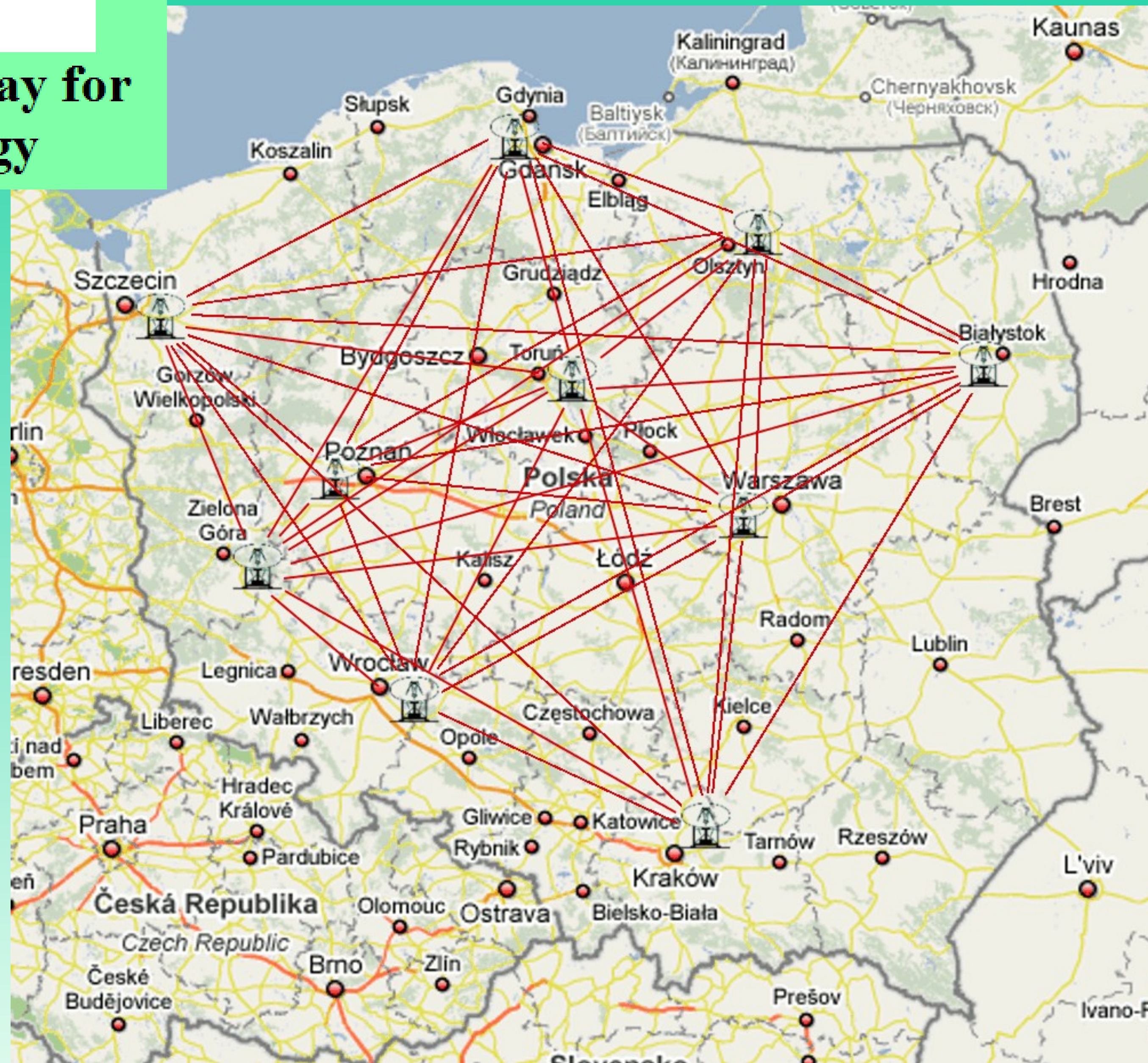
OCRA-F



http://www.astro.uni.torun.pl/piast/index.php

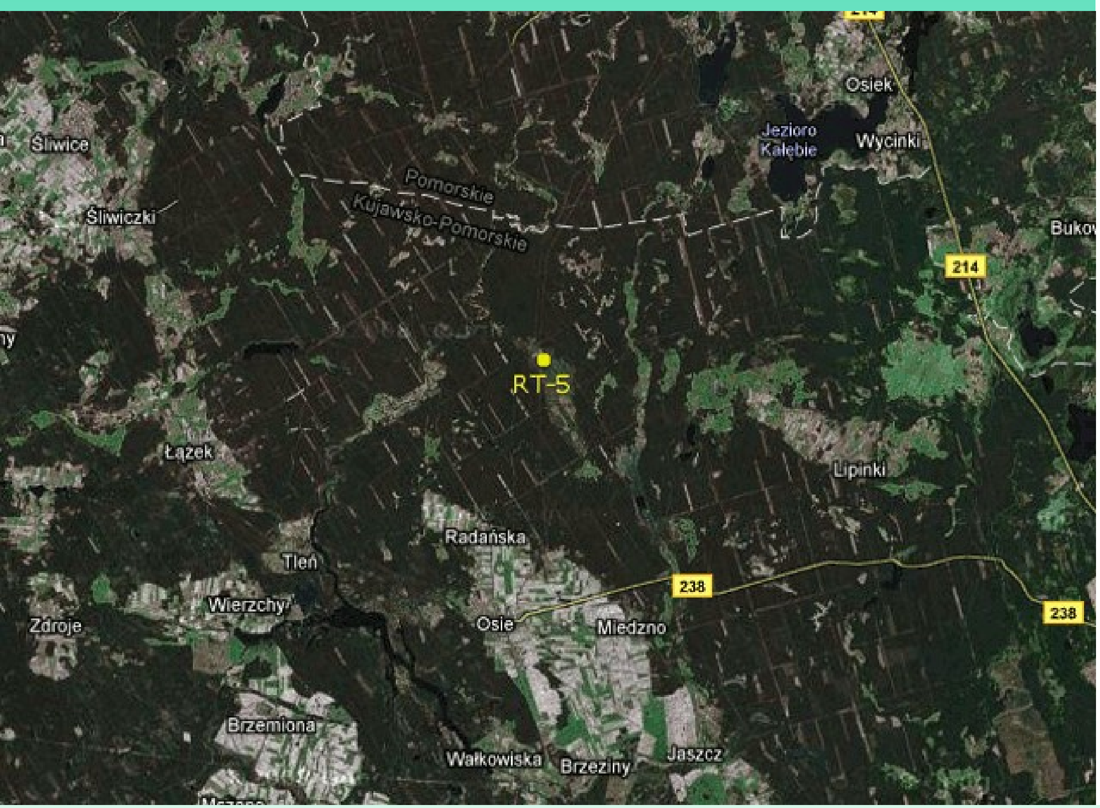
PIAST

Polish Interferometer Array for Science and Technology



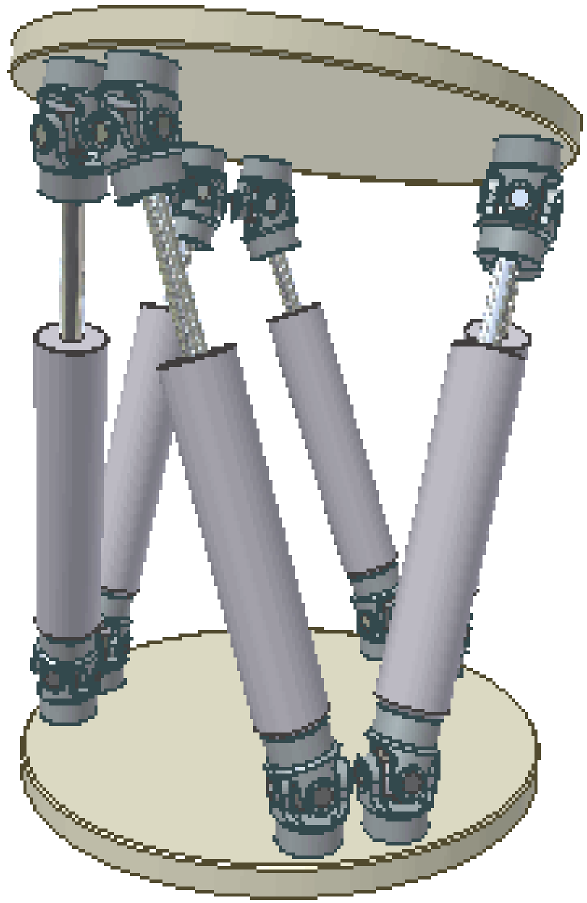
Nowy toruński radioteleskop (90-100 m)

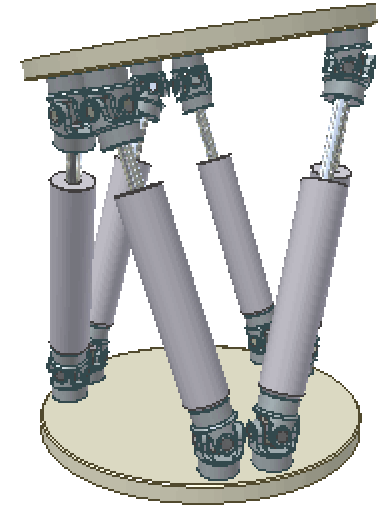
http://www.astro.uni.torun.pl/rt5.php

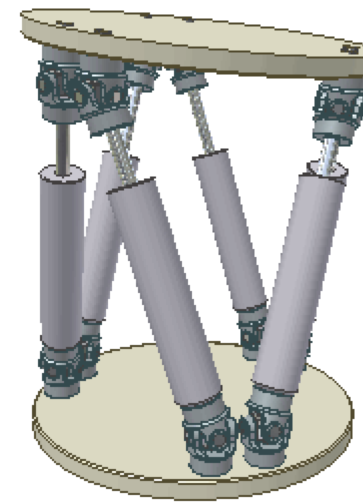


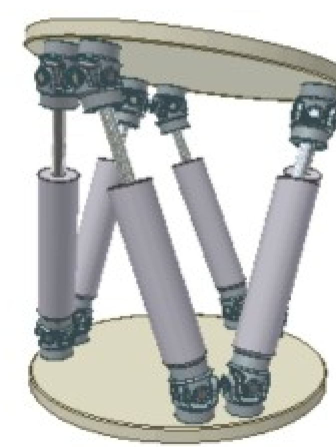
Podstawowe parametry techniczne i eksploatacyjne proponowanego 90m radioteleskopu

Parametry	Wielkość/typ	Uwagi
System optyczny	Cassegrain	
Średnica czaszy reflektora D	90 m	Paraboloida obrotowa
Ogniskowa głównego reflektora f	31,5m	
Światłosiła f/D	0,35	
Lustro wtórne średnica d	9 m	Hiperboloida obrotowa
Efektywna ogniskowa F	273 m	
Położenie ognika wtórnego	3 m	Powyżej powierzchni czaszy
Precyzja wykonania powierzchni	0,5 mm	RMS
Zakres ruchów anteny (w wysokości)	25 – 90 stopni	Pochylanie w każdym kierunku
Precyzja sterowania	0.002 stopnia	Pozycjonowanie i śledzenie
Maksymalna prędkość ruchu	30 deg/min	Ruch tylko w wysokość
Całkowita waga	~1000 ton	
Pole widzenia (straty < 5%)	1-2 stopni	Zależnie od wielkości kamery
Zakres częstotliwości pracy	1-22 GHz	W ognisku wtórnym
Rozdzielczość kątowa	2,7 -0,5 arcmin	W zakresie 5 – 22 GHz
Czułość radioteleskopu przy 1 sek integracji	1,2 mJy	Dla kontinuum, 5 x RMS
Czułość radioteleskopu dla 1 godz. integracji	20 mikroJy	j.w
Temperatura szumowa systemu odbiorczego	25-35 K	W zakresie 5 -22 GHz
Konfuzja (ograniczenie rozdzielczości kątowej)	0,3 – 0,1 mJy	Dla 5 - 22 GHz
Liczba niezależnych odbiorników w matrycy odb.	49 (100)	I etap (docelowo)
Liczba niezależnych torów odbiorczych	784 (1600)	
Rozdzielczość spektralna	1 kHz	
Rozdzielczość czasowa	0,1 msec	
Rodzaj cyfrowych „backendów"	FPGA	Projekt FP7 UNIBOARD
Lokalizacja	Dębowiec	53°39'31,4"N 18°21'43,8"E
Transmisja danych do obserwatora	>10 Gb/s	Dedykowana sieć światłowodowa









Koncepcja sterowania czaszą nowego 90-metrowego radioteleskopu