The Development of the VLBI2010 Global Observing System (VGOS)

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Solar System Exploration Seminar
for the Director of
Science and Exploration
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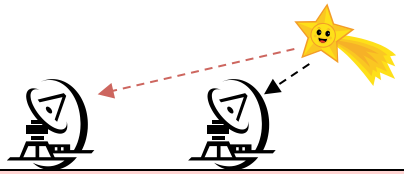
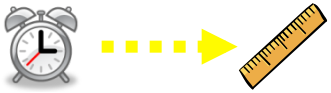
Geodetic VLBI: How does it work?



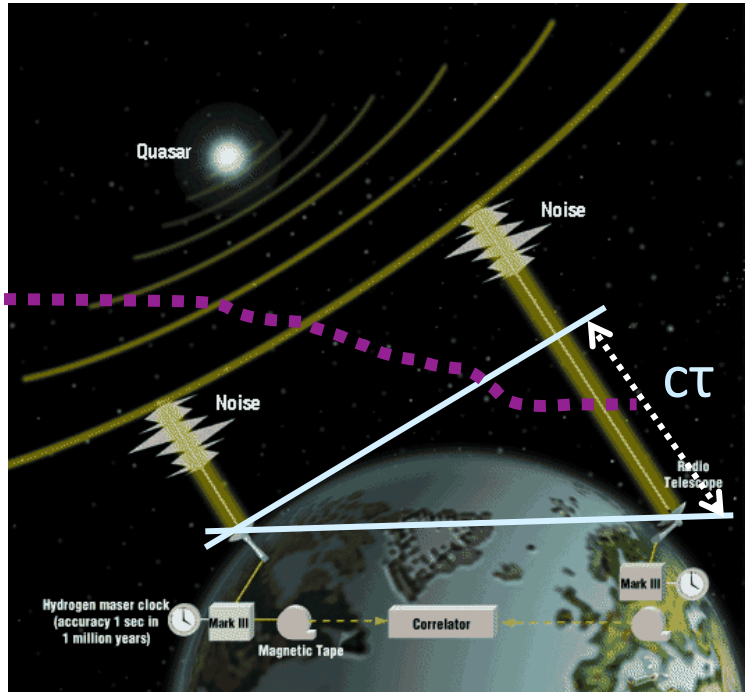
A network of antennas observes a Quasar

The delay between times of arrival of a signal is measured



Using the speed of light, the delay is interpreted as a distance

The distance is the component of the baseline toward the source



By observing many sources, all components of the baseline can be determined.

Launch of VGOS in March 2012

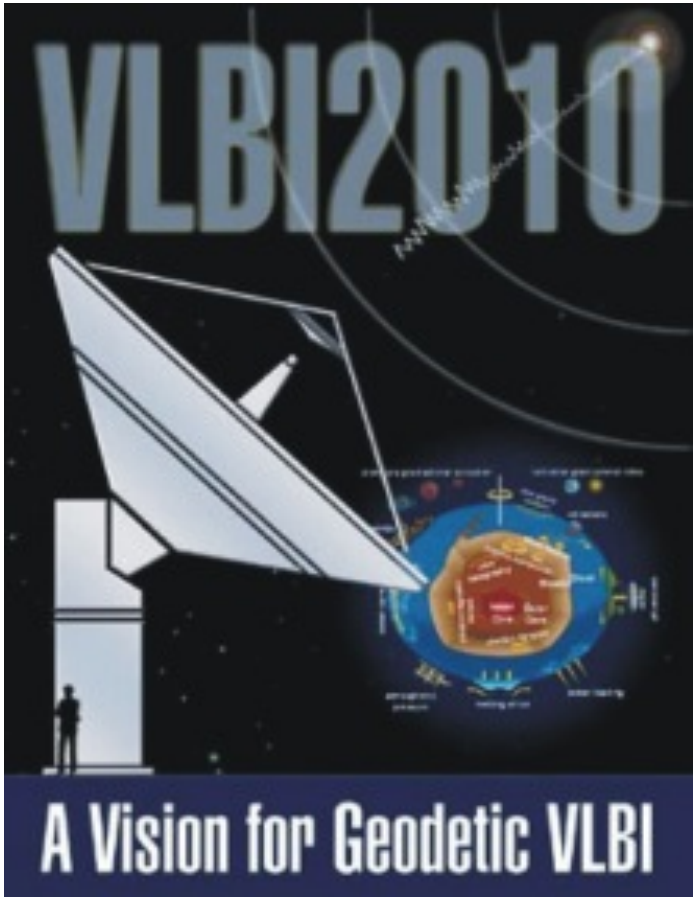
VLBI2010: Why do we need it?

- Aging systems
- New technology
- New requirements
- phenomena to be observed have magnitudes of a few millimeters → mm accuracy!
- **VLBI2010:** response of the IVS to significantly improve geodetic VLBI and reach this high level of accuracy
- 2003-2005:

  IVS Working Group 3 „VLBI2010“

  - goals and requirements
  - strategies and recommendations

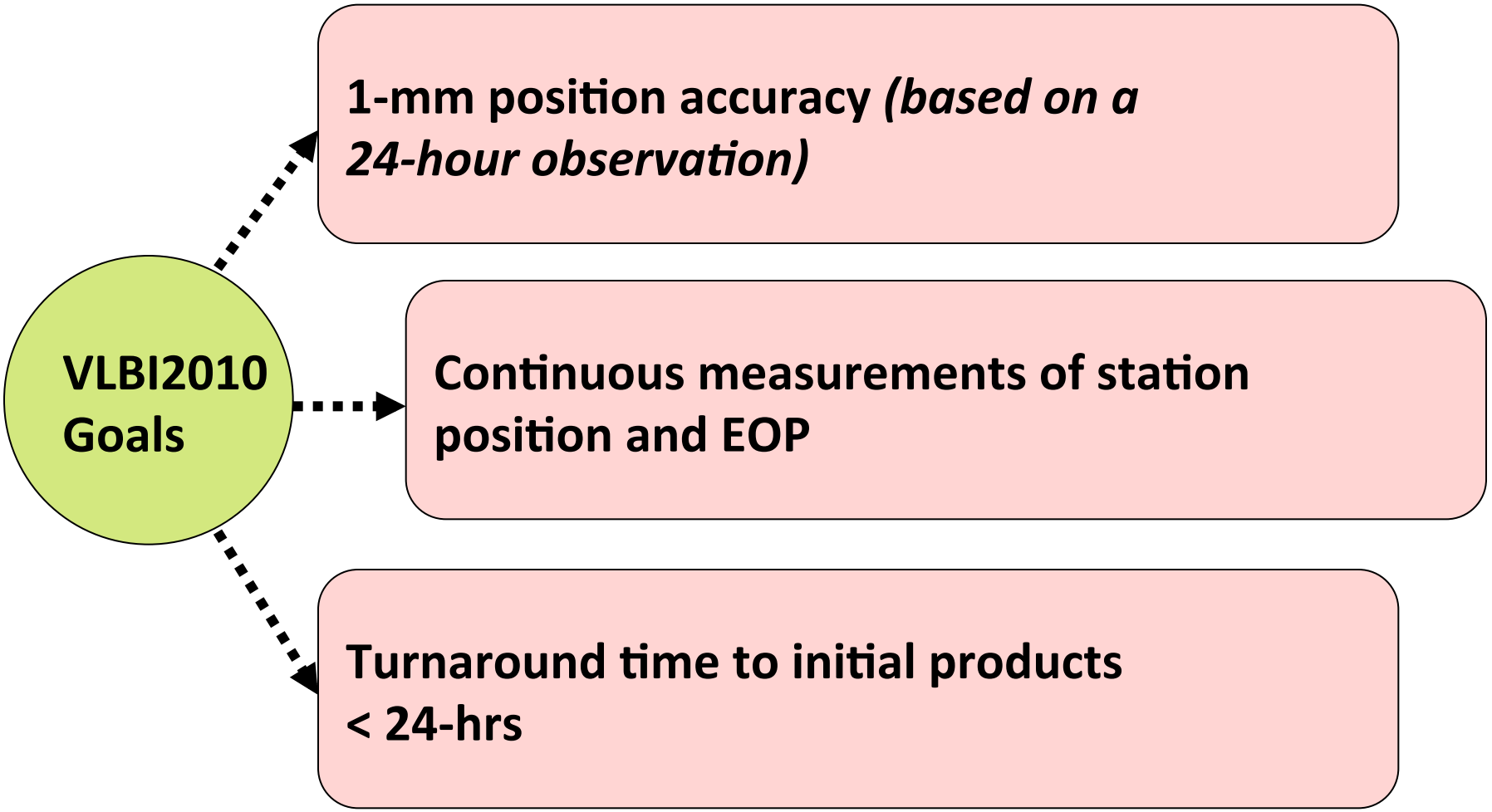
IVS WG 3 Final Report



- Vision paper
- Published Sept 2005

http://ivscc.gsfc.nasa.gov/about/wg/wg3/IVS_WG3_report_050916.pdf

Goals of the next generation system



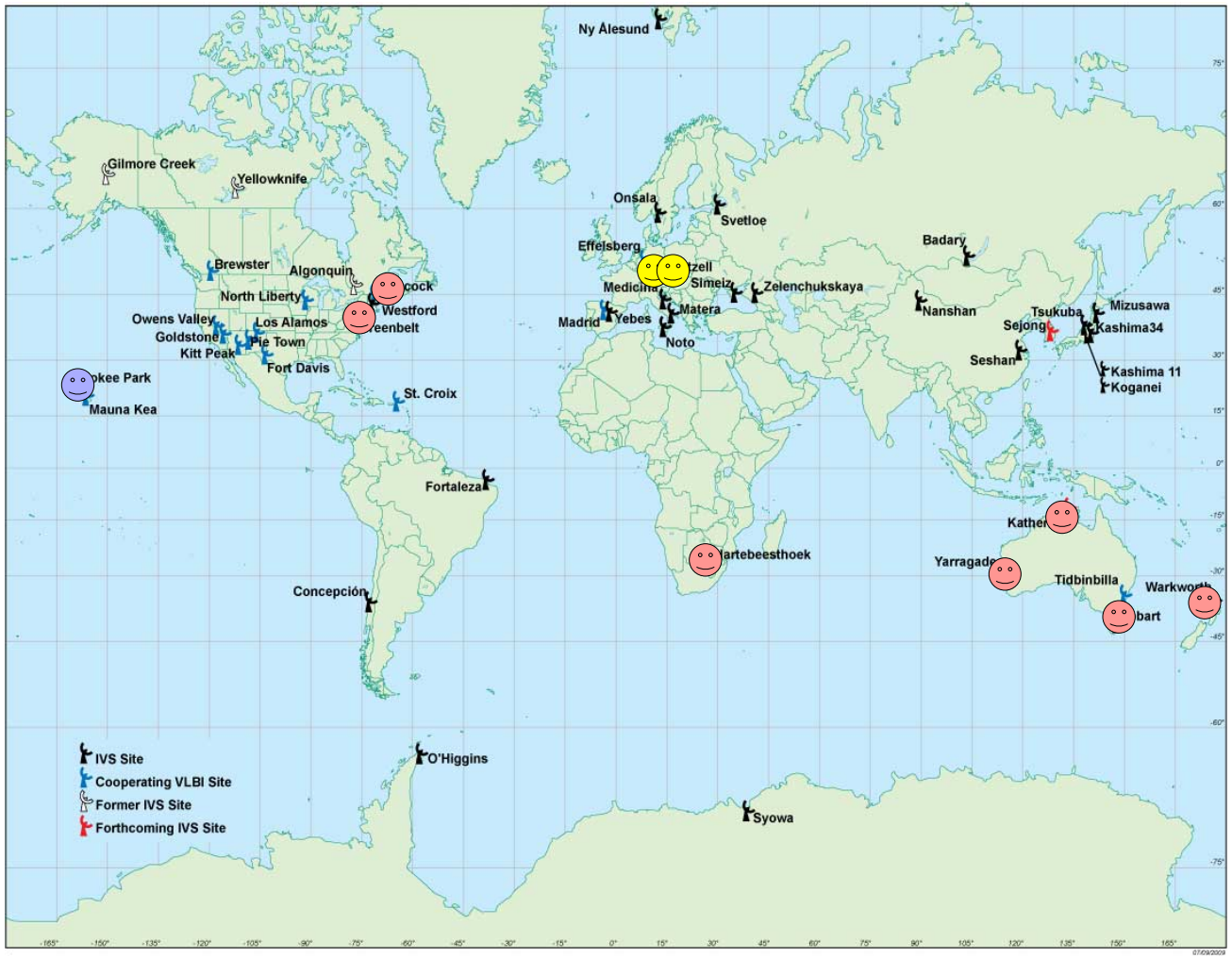
VLBI2010 – V2C Progress Report

- "Design Aspects of the VLBI2010 System"

	Current	VLBI2010
antenna size	5–100 m dish	~ 12 m dish
slew speed	~20–200 deg/min	≥ 720 deg/min
sensitivity	200–15,000 SEFD	≤ 2,500 SEFD
frequency range	S/X band	~2–14 (18) GHz
recording rate	128, 256 Mbps	8–16 Gbps
data transfer	usually ship disks, some e-transfer	e-transfer, e-VLBI, ship disks when required

ftp://ivscc.gsfc.nasa.gov/pub/misc/V2C/TM-2009-214180.pdf

VGOS Network in 2012



VLBI2010 very fast

radio telescope

twin radio telescope

VLBI2010 fast

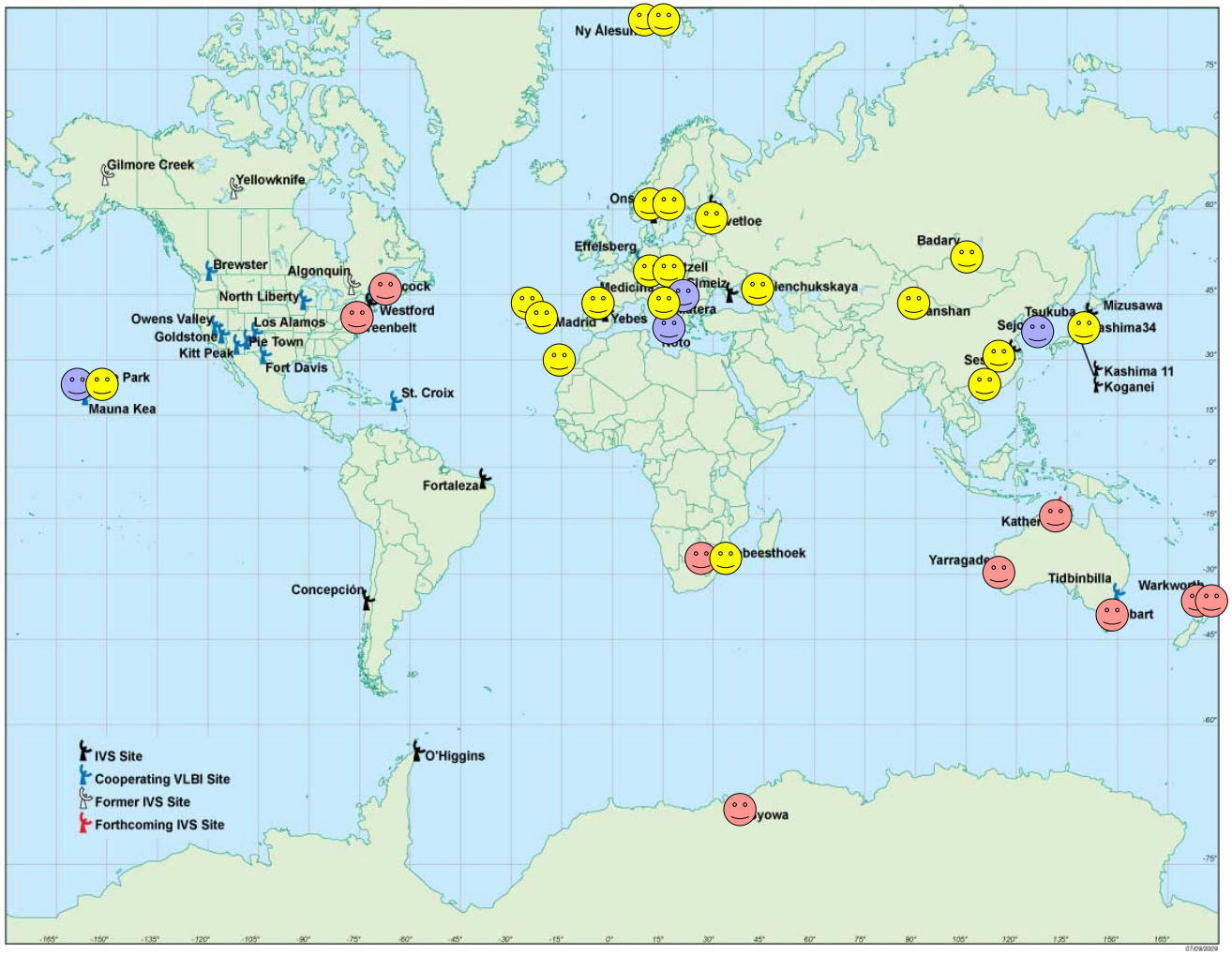
radio telescope

upgrade legacy

radio telescope

[Hase et al., 2011]

VGOS Network in 2017



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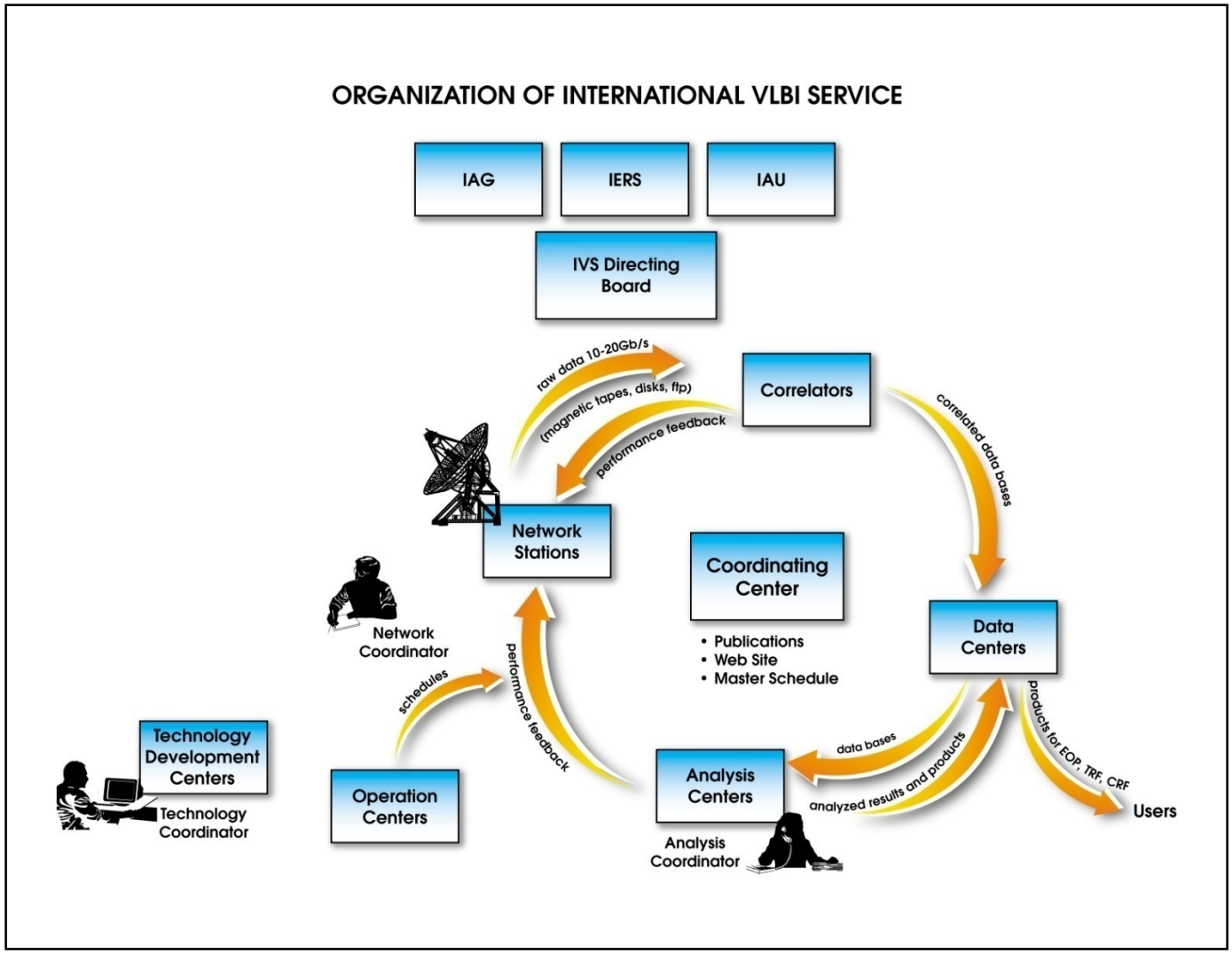
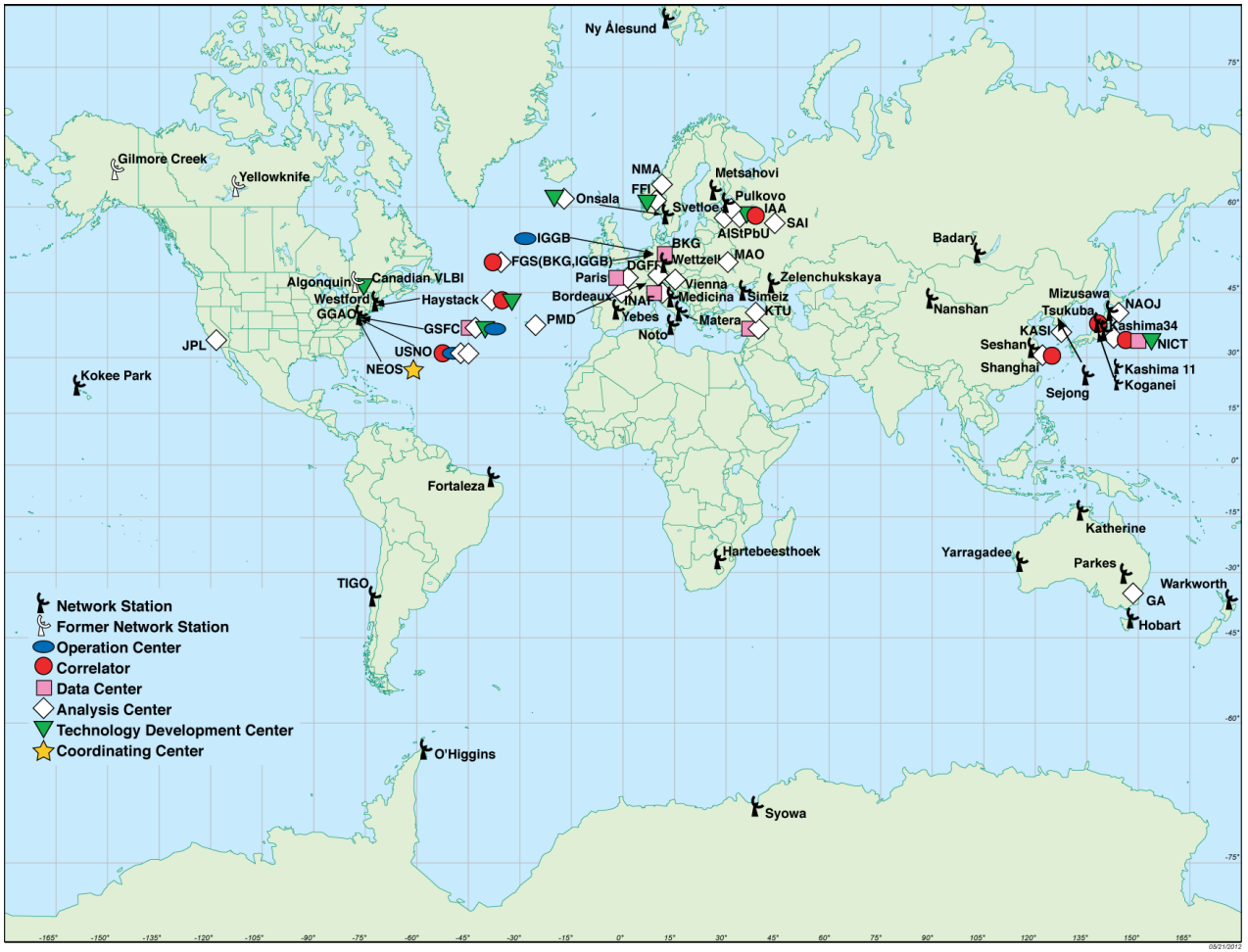
[Hase et al., 2011]

Int'l VLBI Service for Geodesy and Astrometry

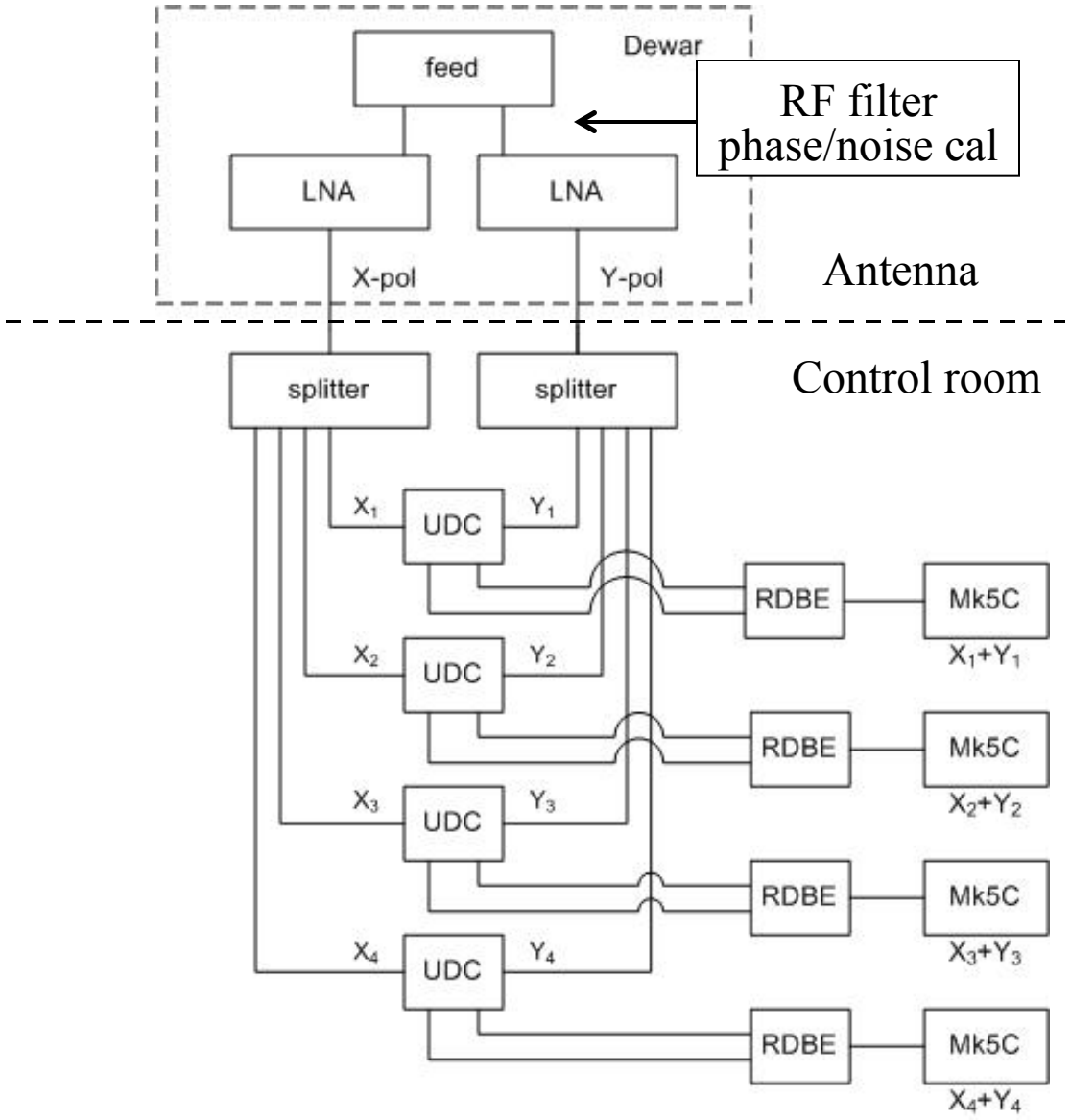


IVS Components (August 2012)



- The IVS currently has about ***80 permanent components*** supported by roughly ***40 institutions*** in ***20 countries***.

GGAO 12-m antenna



Feed and LNAs cooled to ~20K

Both senses of linear polarization used

Odd channels from each pol'n for one band output to each Mk5C.

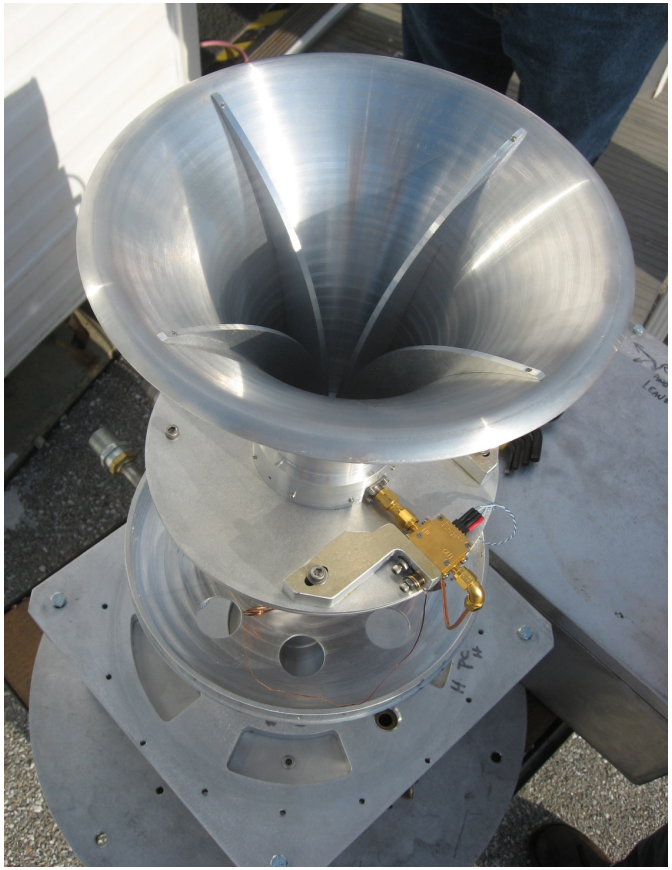
2 Gigabits/sec recorded on each Mk5C.

Total data rate: 8 Gbps

VLBI2010 signal chain

- Cooled broadband QRFH feed and LNAs (Caltech)
- UpDown Converters (4) (Haystack)
  - Select frequency bands in the range 2 to12 GHz
- RDBE digital back ends (4) (Digicom)
  - PFB to get 16 32-MHz channels (8 from each pol'n)
  - Noise diode control for power measurement for Tsys
  - In use by VLBA and NASA
- Mark5C recorder (4) (Conduant)
  - In use by VLBA and NASA

Quad-Ridge Flared Horn (Caltech)



Observations

- Antennas
  - GGAO12M
    - 12m VLBI2010 antenna
    - At Goddard Space Flight Center, Maryland, USA
    - Full VLBI2010 signal chain
  - Westford
    - 18m prime focus antenna
    - At Haystack Observatory, Massachusetts, USA
    - Full VLBI2010 signal chain
  - Baseline length approximately 600 km.

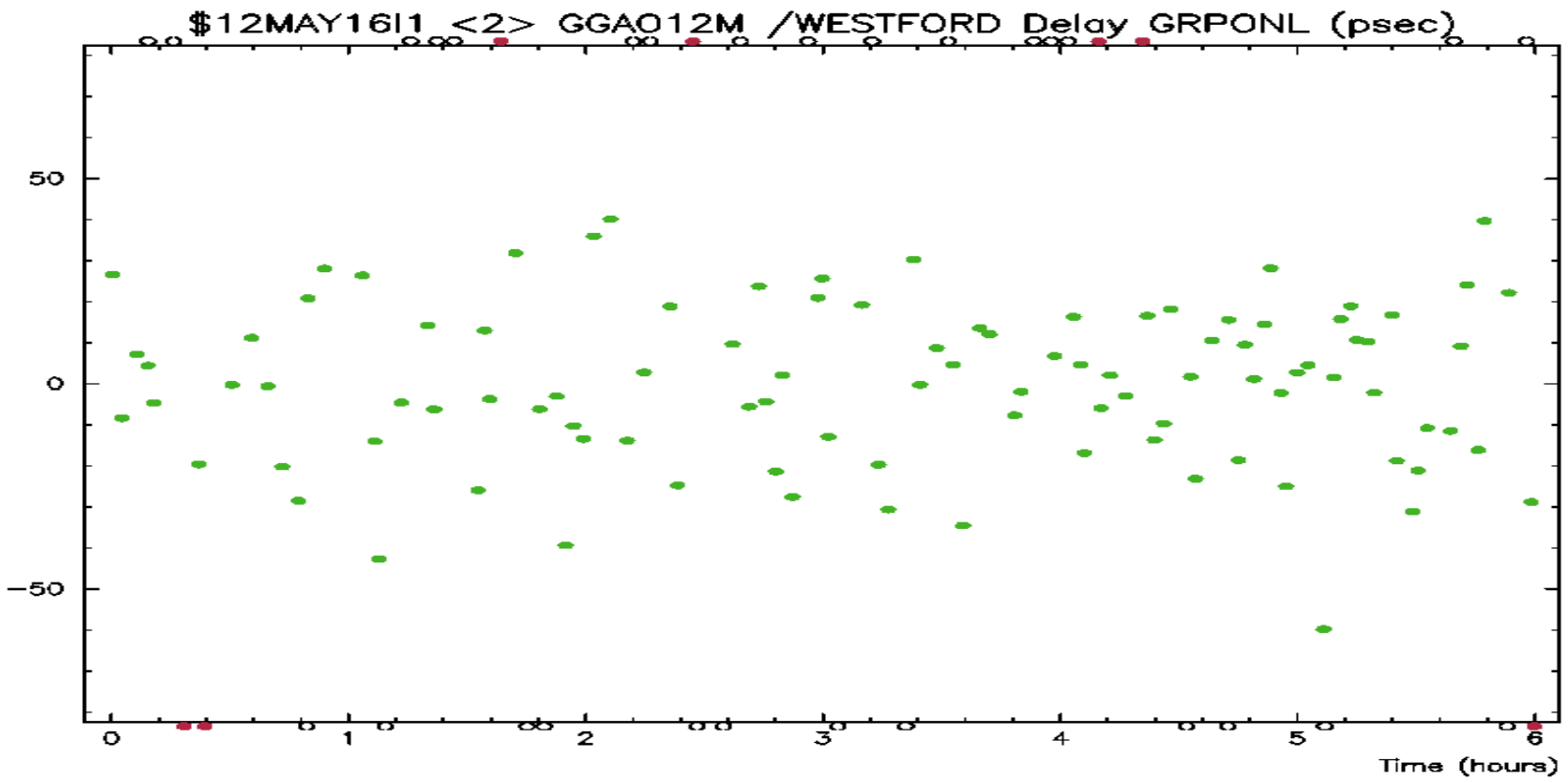
Observations – 2012 Jan 19

- Objectives
  - Several hours on one source to check system.
  - Observe a source with polarization rotation
- Scans
  - Five minute scans for high SNR
  - Source 3C345
  - Approximately four hours total
- Frequency bands
  - Contiguous bands spanning 2 GHz: 6.4 – 8.4 GHz

Observations – 2012 May 16

- Objectives
  - Geodetic schedule
  - Observe a number of sources over entire sky
- Scans
  - 30-second observations
  - 6 hours total
- Frequency bands
  - Four bands at 3.5, 5.5, 6.6 and 9.6 GHz

Fully coherent ionosphere-corrected full-polarization delays using all four RF bands (100 scans, 6 hr)
WRMS post-fit residuals: 20 ps
Position formal errors: 8 mm vertical, 2 mm horizontal



New VLBI2010 antennas: TTW

- Twin Telescope Wettzell (Germany), Vertex Antennas

Twin Telescope Wettzell, April 2012