International VLBI Service for Geodesy and Astrometry: Evolution of Observing Programs

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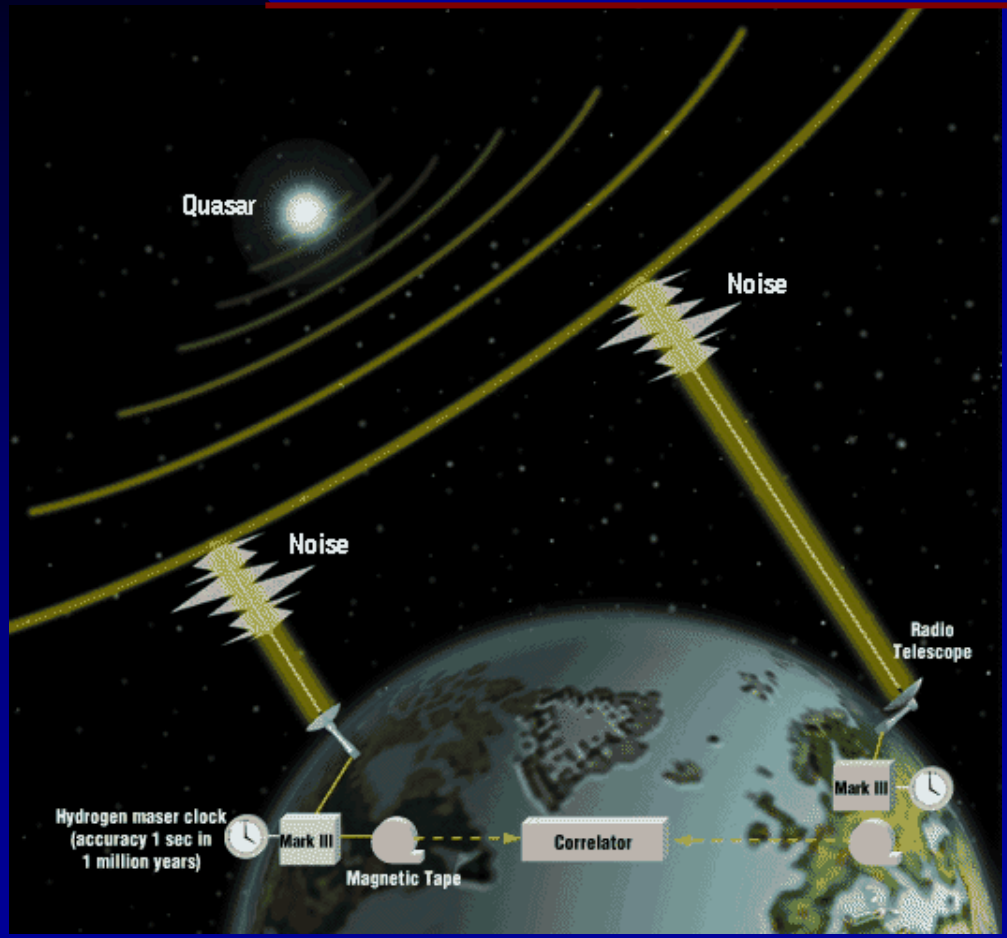
http://ivscc.gsfc.nasa.gov

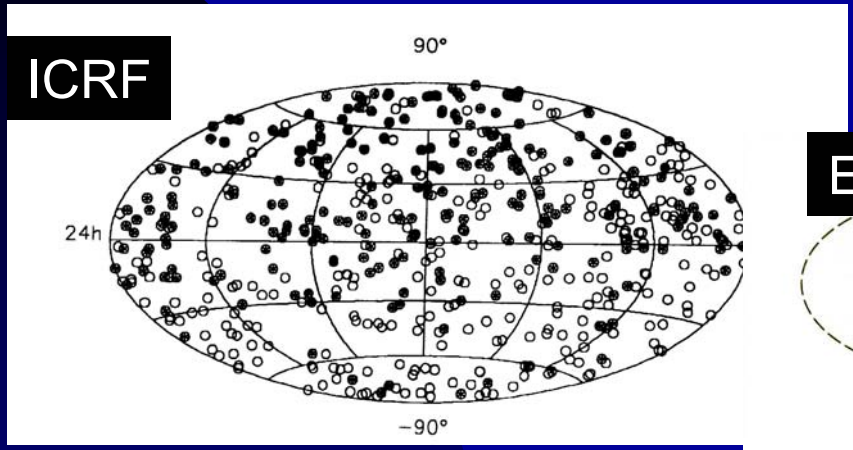
Very Long Baseline Interferometry
- fundamental role -



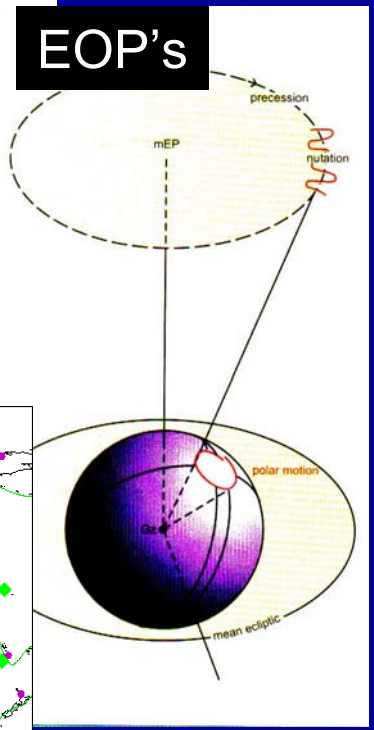
- Unique Technique for
  - CRF
  - Celestial Pole
  - UT1-UTC
- Primary Technique for
  - EOP's (complete set of parameters)
  - TRF (most precise technique for long baselines)

Global Reference Frames and Related Products

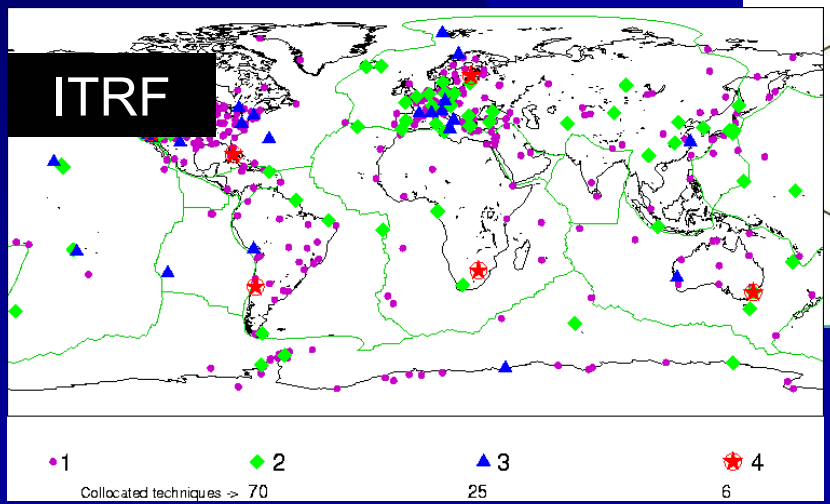
ICRF



EOP's



ITRF



- **ICRF:**
  - Radio Source Positions
- **ITRF:**
  - Station Positions
  - Velocities
- **EOP's:**
  - Celestial Pole ($d\varepsilon$, $d\psi$)
  - Polar Motion (x_P, y_P)
  - UT1-UTC (DUT1)
- Importance documented: coming up IAG Project **IGGOS** with demand for
  - mm-accuracy
  - consistent for decades
  - …..

I V S - International VLBI Service for Geodesy and Astrometry

IVS is a service of

- **IAG** - International Association of Geodesy
- **IAU** - International Astronomical Union
- **FAGS** - Federation of Astronomical and Geophysical Data Analysis Services

IVS goals:

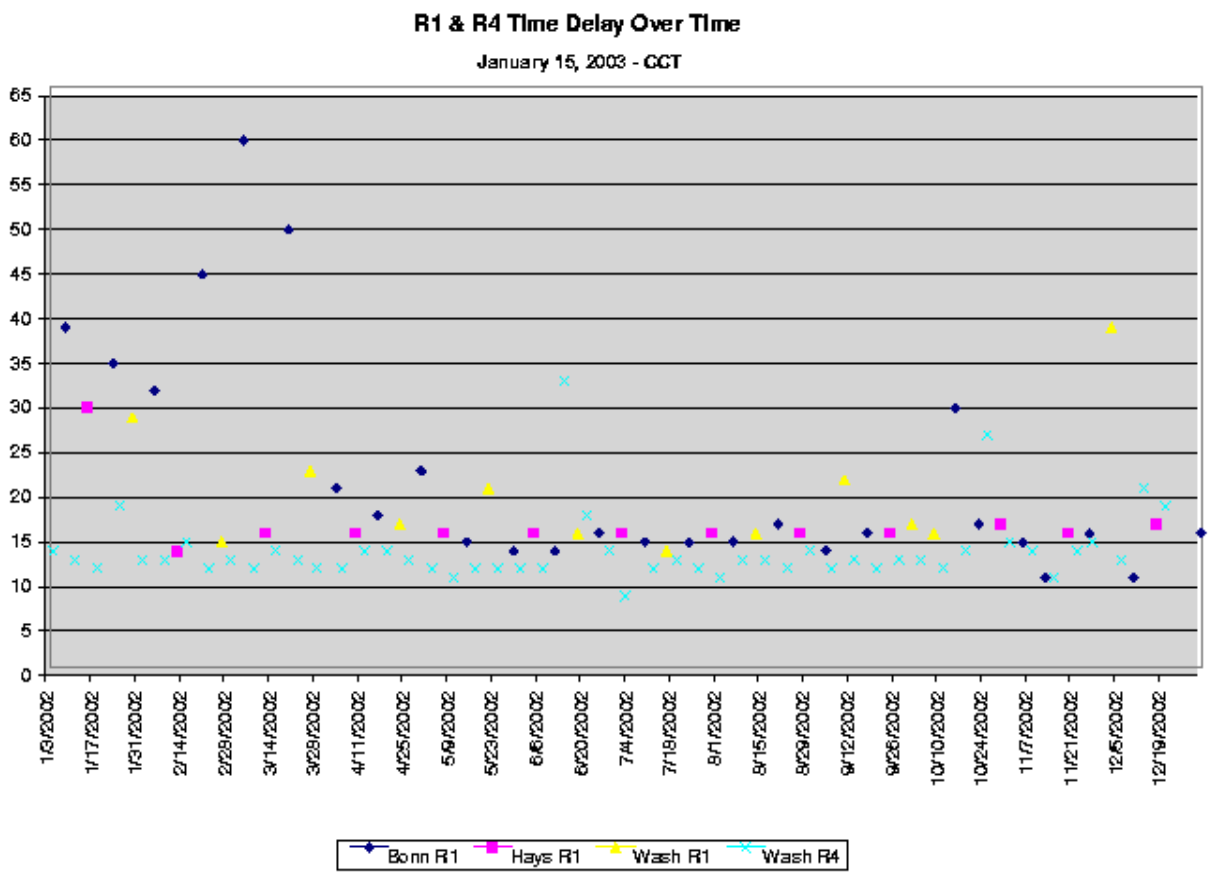
- To provide a service to support geodetic, geophysical and astrometric research and operational activities
- To promote research and development in the VLBI technique
- To interact with the community of users of VLBI products and to integrate VLBI into a global Earth observing system

Main tasks of the IVS are: coordinate VLBI components, guarantee provision of products for CRF, TRF and the set of EOP's

- IVS inauguration was on March 1st, 1999
- 75 Permanent Components supported by 37 institutions in 16 countries


Ny Ålesund
Gilmore Creek
Yellowknife
Onsala
FFI
Svetloe
IAA
JIVE
AIStPbU
GIUB
BKG
FGS(BKG,GIUB)
Wettzell
MAO
Algonquin
Canadian VLBI
Paris
DGFI
Haystack
Bordeaux
Medicina
Simeiz
Westford
CNR
GGAO
IEEC
Yebes
Matera
Nanshan
Mizusawa
Tsukuba
Kashima34
GSFC
Noto
CRL
Green Bank
JPL
USNO
Seshan
Shanghai
Kashima 11
NEOS
Miura
Koganei
Kokee Park
Tateyama
Fortaleza
Hartebeesthoek
Conception
Hobart
Network Station
Operation Center
Correlator
Data Center
Analysis Center
Technology Development Center
Coordinating Center
O'Higgins
Syowa

Delay from observation to product availability



Two time series per wee

- IVS R1
- IVS R4

Results available

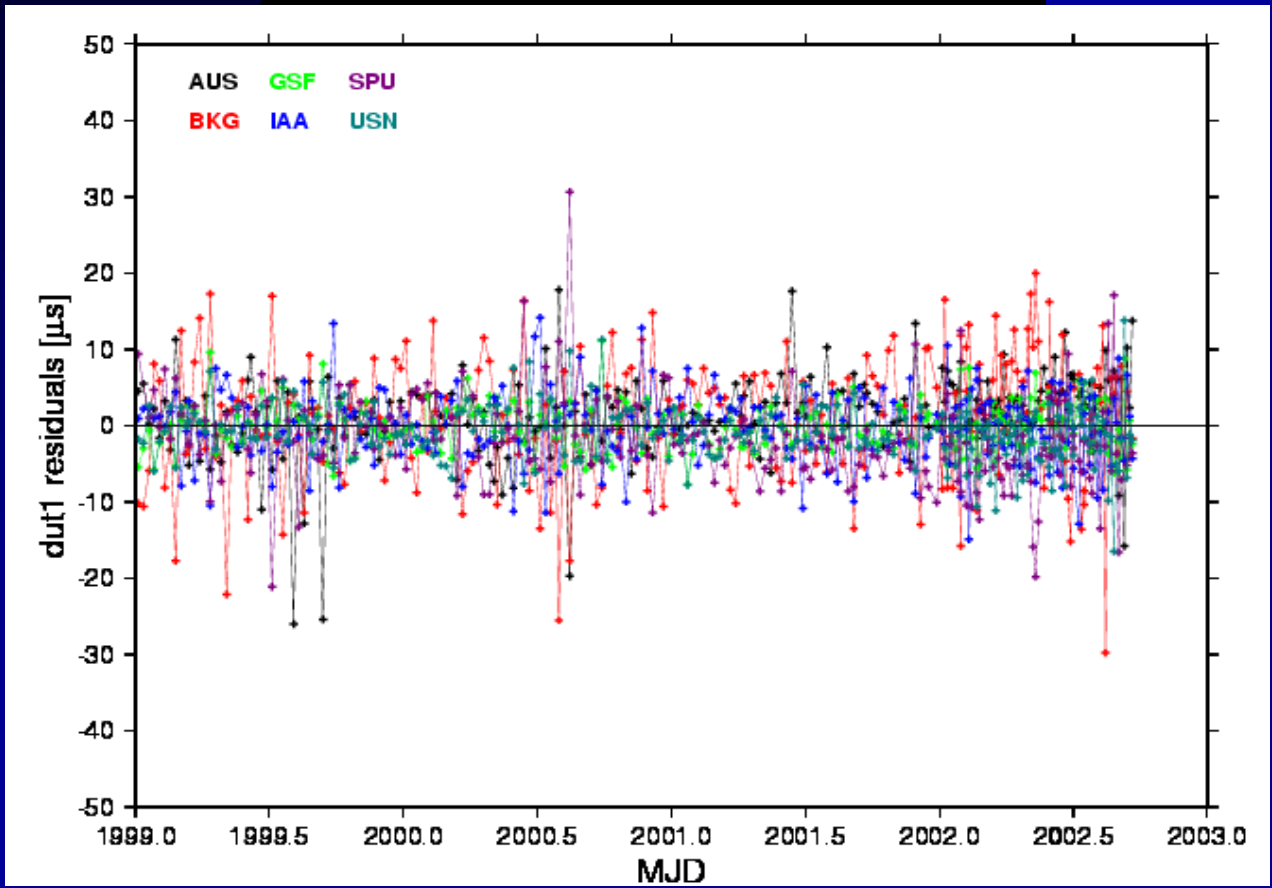
- After approximately two weeks

Potential for Improve-ments

- Faster shipping
- e-VLBI
- Improved correlator processing factor

Combined EOP's are regular IVS Products

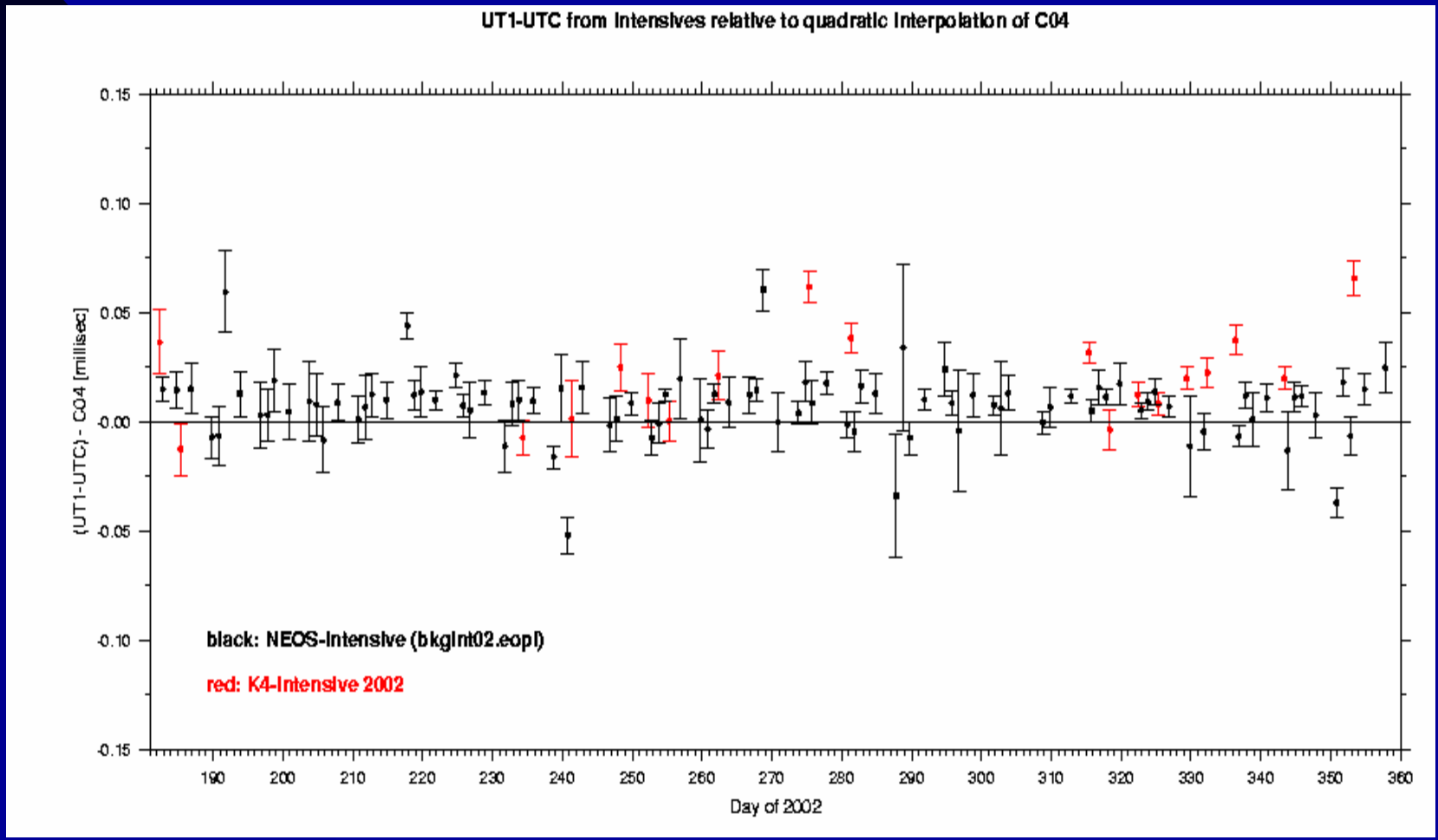
Example: DUT1 from R1 and R4



- Complete set of EOP's
- Combined Solution from 6 Analysis Centers
- 20-30% improved
  - accuracy
  - robustness
- R1 & R4 since 2002

UT1-UTC from INTENSIVES with reference to CO4

MK4: Wettzell - Kokee Park (black) and K4: Wettzell – Tsukuba (red)



IVS Observing Program 2003-4

Type and purpose	Planned sessions				Resources used		
	# sess	# stn	bw	corr	stn days	media	corr days
R1 - rapid turnaround EOP	52	7	256	all	364	96	130
T2 - TRF monitoring	12	8	56	Bonn, Wash	96	40	36
E3 - EOP using S2	12	5	128	Pent	60	40	36
R4 - rapid turnaround EOP	52	7	56	Wash	364	96	130
Regional - Europe, Pacific, Antarctic	12	8	56	Bonn, Mitaka	96	48	36
CRF - monitor, extend	12	3	56	Wash	36	12	36
R&D - technique improvement	10	8	256	Hays	80	42	30
RDV - 20-station with VLBA	6	10	128	VLBA	60		
Total sessions	168	(average ~3 per week)					
Resource usage					1156	374	434
Maximum available					1509	450	390

IVS Products

Products		Status	Goals(2002-2005)
polar motion	accuracy	x_p ~100 μas, y_p ~200 μas	x_p, y_p: 50 ... 25 μas
	latency	1-4 weeks... 4 months	4 - 3 days...1day
	resolution	1 day	1 day...1h... 10min
	freq. of sessions	~3 d/week	.....7d/week
UT1	accuracy	5... 20 μs	3..... 2 μs
	latency	1 week	4 - 3 days 1day
	resolution	1 day	1 day 10min
Δε, Δψ (nutation)	accuracy	100... 400 μas	50...25 μas
	latency	1-4 weeks... 4 months	4 - 3days... 1 day
	resolution	1 day	1 day
	freq. of sessions	~3 d/week	..... 7 d/week
TRF (x,x,z)	accuracy	5-20 mm	5 ..... 2 mm
CRF	accuracy	0.25-3 mas	0.25 mas (improved distribution)
	freq. of solution	1 y	1 y
	latency	3-6 months	3 ..... 1 month(s)

Future Challenges

- **Increase temporal coverage**
  - remove weekend gaps
  - automation for unattended observing
  - need more observing time
- **Reduce time delay and reduce expenses**
  - deploy modern disc based recording system **(Mk5)**
  - development of electronic data transfer **(e-VLBI)**
- **Improve global network configuration**
  - especially in the southern hemisphere
  - encourage additional institutions and include the **S2 and K4** technologies
- **Improve product robustness**
  - more analysis centers
  - use of different software
  - combination with other techniques

Further improvements required

- **weekend gaps,** automation for unattended observing needed
- **reduce time delay and reduce expenses**
  - employment of a modern disc based recording system **(Mk5)**
  - development of data transfer via the Internet **(e-VLBI)**
- **global network configuration** has to be improved
  - especially in the southern hemisphere
  - encourage additional institutions and include the **S2 and K4** technologies
  - more observing time will required overall
- **timeliness, shorten turn-around time** at the correlators
  - better logistical organization of tape/disc transport or e-VLBI,
  - improving the correlation factor (MK5)
- **robustness** of the products, **more analysis centers with different software**

MK5 deployment plans

- Replacement of MKIII/MKIV by MK5:
  - Vandenberg/Whitney memo and Mark 5 upgrade chart distributed in January
  - Contacted all stations to request information on their upgrade plans
  - Priority to upgrade correlators first, stations second, disk purchase third
- Transition from MKIII/IV to MK5 in the year 2003

IVS Mk5 Usage Plan

	Sep-03	Oct-03	Nov-03	Dec-03
Correlator				
Bonn	8	8	8	8
Haystack	4	4	4	8
Washington	4	6	6	8
	Sep-03	**Oct-03**	**Nov-03**	**Dec-03**
Station				
Algonquin				
Effelsberg				
Fortaleza				
Gilmore Creek				
GGAO				
HartRAO				
Hobart				
Kashima34				
Kokee Park				
Matera				
Medicina				
Noto				
Ny Alesund				
O'Higgins				
Onsala				
Seshan				
Simeiz				
Svetloe				
TIGO				
Tsukuba				
Urumqi				
Westford				
Wettzell				
Yebes				
Yellowknife				

Mk5-only

Mk5 partial

thin tape

Vision Paper 2010

- **Working Group WG 3 :** on the way to be established
- Needs for a vision paper:
  - Increasing requirements from IGGOS/IAG
  - RFI, frequency bands?
  - Aging antennas
- Goals:
  - Unattended observing, more regular
  - Improved global coverage
  - Electronic data transfer
  - Near real time correlation and product provision
- Close collaboration with radio astronomers (SKA)