Status and future plans for European VLBI correlators

Kaj Wiik, JAXA

with information from

Walter Alef, MPIfR,
Bob Campbell, JIVE
and
Jouko Ritakari, Metsähovi Radio Observatory

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Outline

European VLBI Correlators

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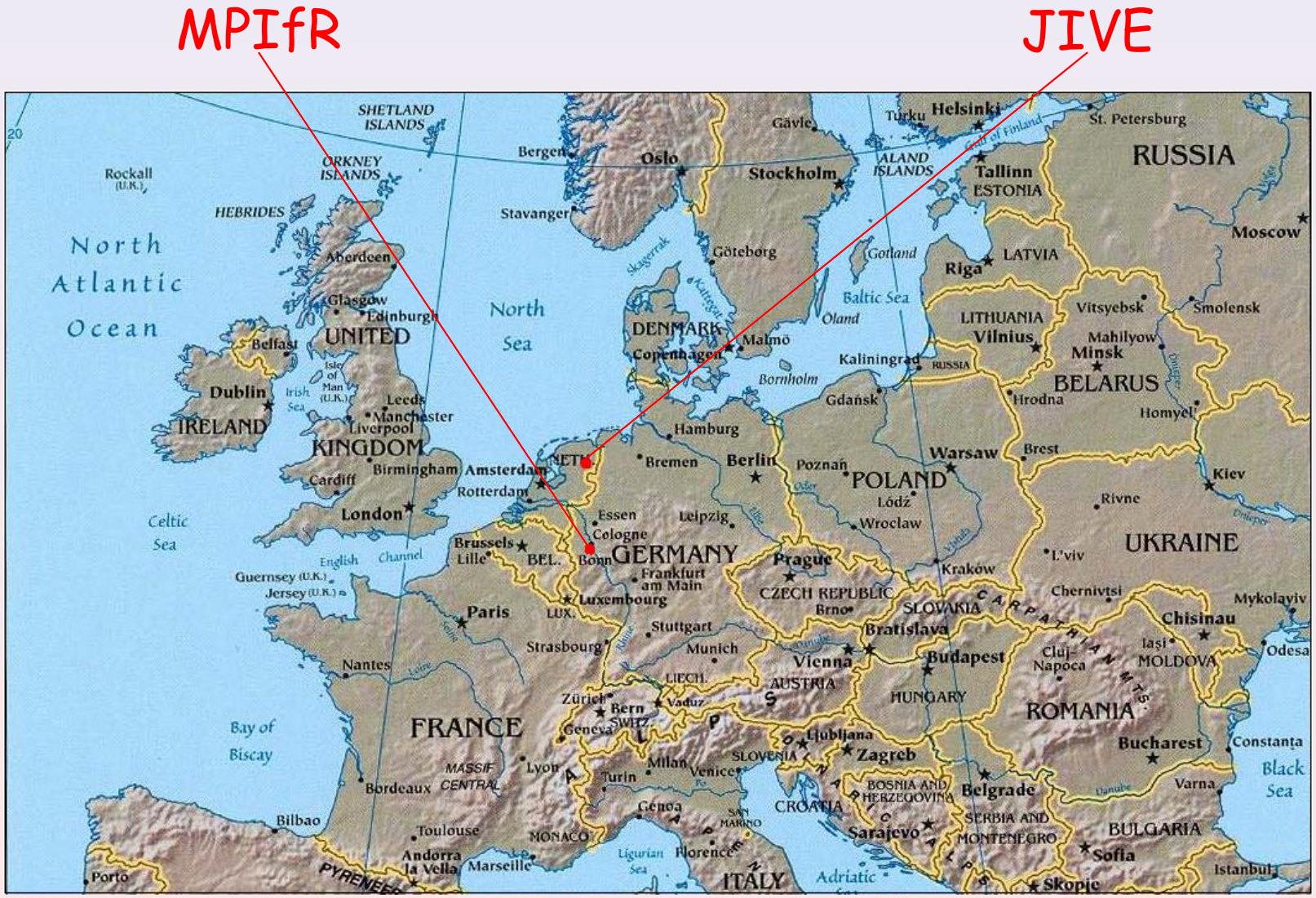

Developement of the Mark IV Correlator

- Conceived in 1993 to support large VLBI correlators at 1-Gbit/sec/station data rates, as well as specialized CEI requirements for SMA and Westerbork.
- A single basic correlator design serves as the basis for 6 large correlator processors:
  - Haystack VLBI correlator
  - USNO VLBI correlator (Washington, D.C.)
  - BKG/MPI (Bonn) VLBI correlator
  - JIVE VLBI correlator (Netherlands)
  - Westerbork CEI correlator (Niederlande)
  - Smithsonian Submillimeter Array CEI correlator (Mauna Kea, Hawaii)
- The correlator design was a joint effort of Haystack/JIVE/NFRA, funded by NASA/USNO/CfA/BKG/JIVE/NFRA
- Haystack design responsibility was in the correlator proper area.
- JIVE/NFRA design responsibility was in VLBI Station Unit area.
- The centerpiece of the design effort was the first full-custom ASIC VLBI correlator chip.
- The design effort, begun in 1993, reached fruition with the deployment to USNO and BKG/MPI in Dec 1999.

From http://www.mpifr-bonn.mpg.de/div/vlbicor/en/corel_e.htm

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Mark IV Correlator Features

- 1 Gbit/sec/station, expandable to 2 Gbits/sec/station
- Station-based XF architecture. Scalable architecture allows up to 32 stations, 16 channels/station
- Full compatibility with Mark IIIA, Mark IV, VLBA
- 4x playback speedup compared to Mark IIIA correlator
- Efficient processing of 'sub-netted' data
- Full multi-threaded task operation for multiple simultaneous correlation of different scans
- Full spectral-line capability to 4096 lags
- E-VLBI (electronic VLBI) ready
- Extensive use of 'VEX' files for correlator operation and configuration

From http://www.mpifr-bonn.mpg.de/div/vlbicor/en/corel_e.htm

Some facts...

- The full Mark IV correlator has a computing power equivalent to approximately 25 Tera-ips, more than 4000 times as powerful as the Mark IIIA correlator.
- The Mark IV VLBI correlator is a truly 'station based' XF correlator; data provided from each Station Unit goes directly into the correlator chips.
- Station-model information is spliced directly into the station data streams by the Station Unit; correlator-board DSP's use this station information to calculate baseline processing parameters on the fly.
- Once started, a VLBI correlation requires no activity from the control computer other than routine monitoring.
- All High-speed data between Station Units and the correlator proper are transmitted on high-speed serial links operating at $\sim$1 Gbit/sec on a single coax cable.

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EVN MKIV data processor (JIVE correlator)

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Correlator Capabilities

	JIVE	MPIfR
Total number of stations	16	9
MK5A playback units	6 (+3)	8
Correlator boards	32 with DSP	16, no DSP
Minimum integration time	0.125s (0.0625s)	0.5s
Phase cal extraction	Not yet available	1 tone
Post-correlation software	Based on AIPS++	HOPS
Main users	EVN + global up to 43 GHz	Geo + mm-VLBI

Both correlators support:

- MkIV, VLBA, MkIII and MkV recording modes (without barrel-roll)
- 1024 lags/channel (4096 max., not tested)
- Observing VEX file input, FS & VLBA logs
- 1 or 2-bit sampling
- 1:1 1:2 1:4 fan-out
- ....2, 4, 8, 16 MHz bandwidth/channel
- Upper/lower/dual sideband, single or dual polarization

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Future plans, MPIfR

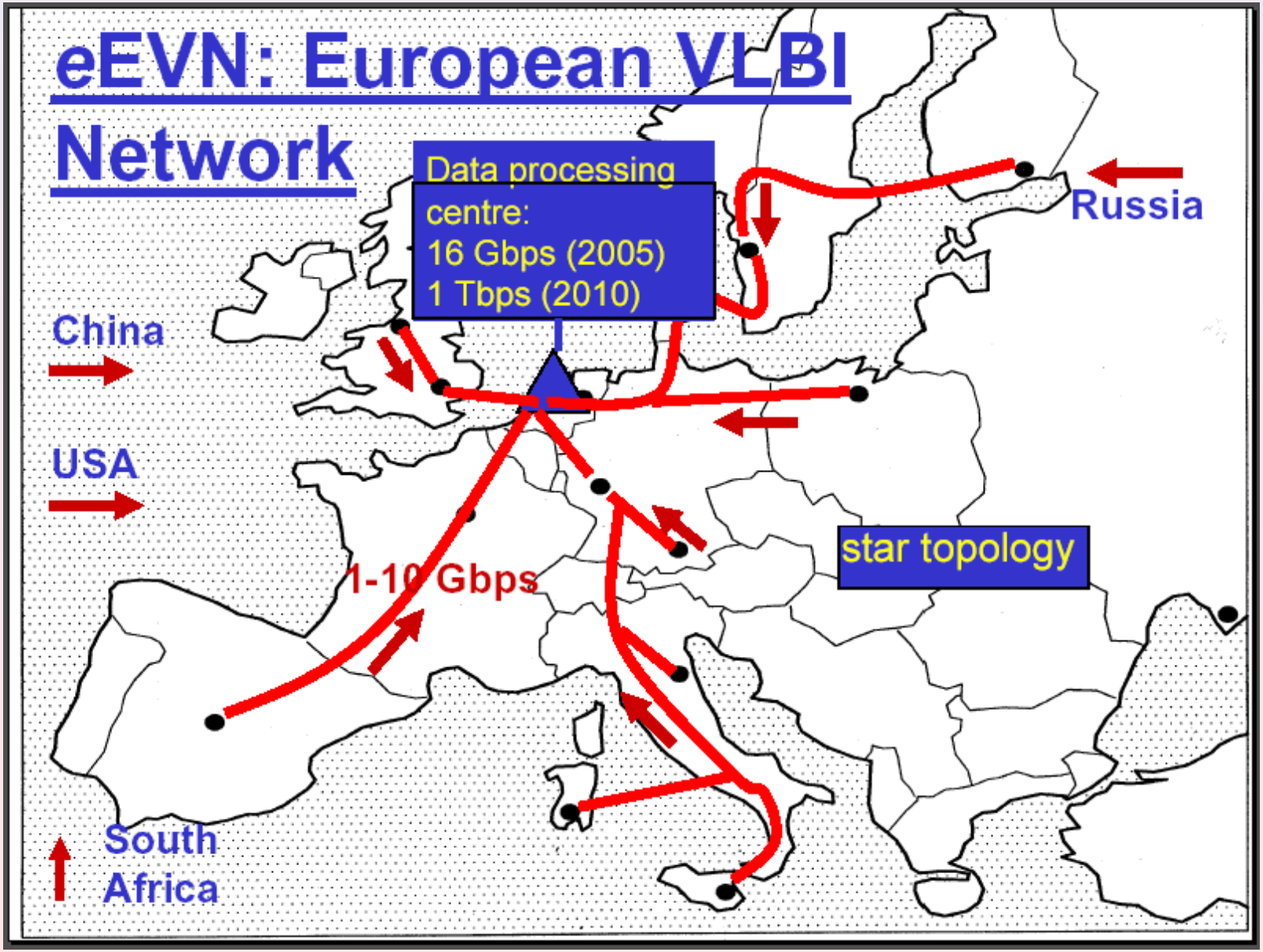
From Walter Alef (walefmpifr-bonn.mpg.de):

"At present we have 8 MK5As operating in parallel to 9 tape drives. Together with our geodetic partners we are planning to upgrade the correlator to 12 MK5B playback units in 2005. Eventually we might even go to 16 MK5B playback units. This will depend on our geodetic partners and IVS. In the upgrade process to MK5A the station units will be replaced with MK5B station units."

Future plans, JIVE: MK5

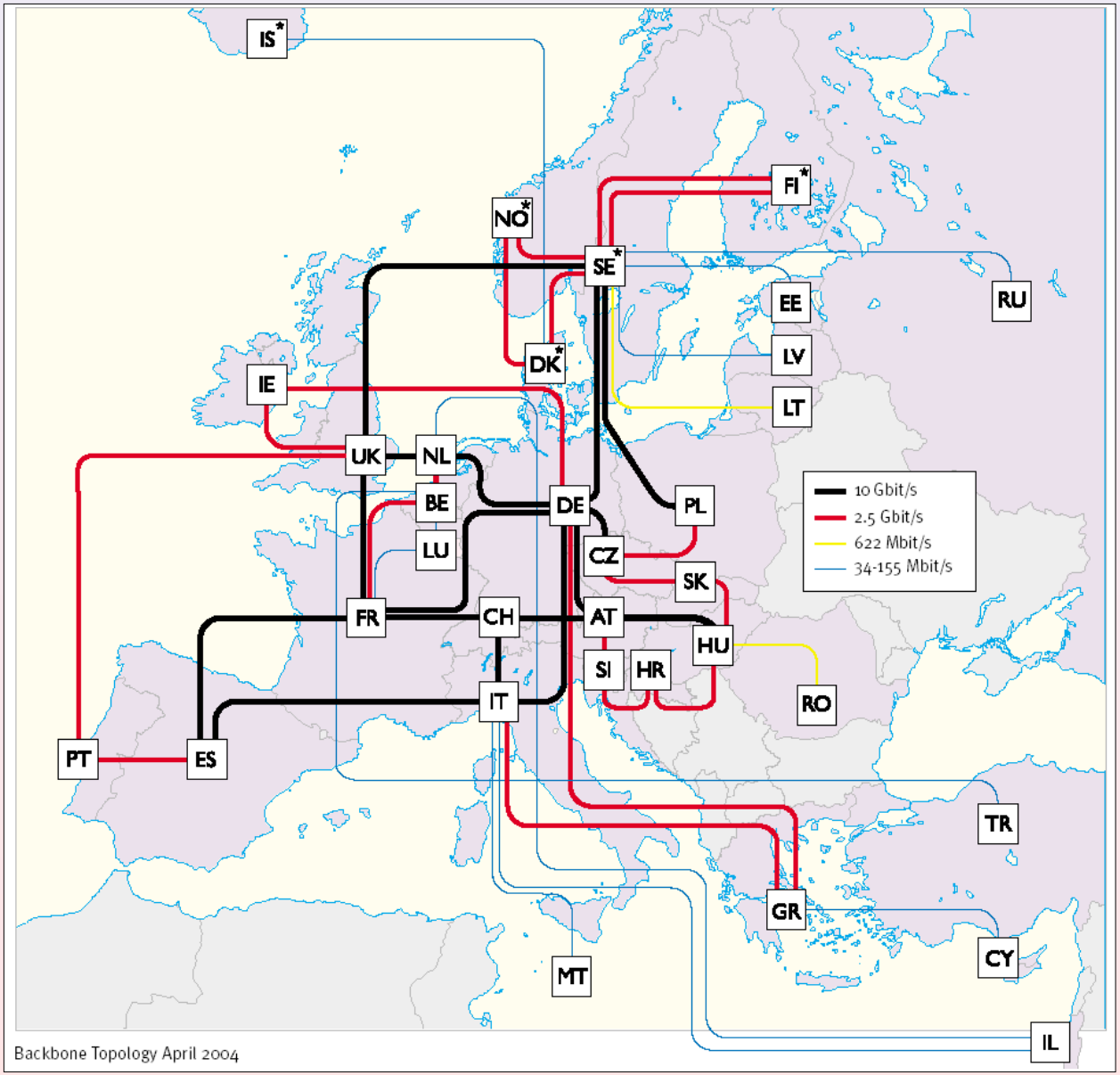
Station	MK5 status	1 Gbit/s @ 18/21 cm	1 Gbit/s @ 6 cm	1 Gbit/s @ 3.6 cm	1 Gbit/s @ 1.3 cm
Effelsberg	1024 Mbit/s tested	Only dual polarization	OK	OK	OK
Medicina	1024 Mbit/s tested	Only dual polarization	OK	OK	OK
Noto	1024 Mbit/s tested	Only dual polarization	OK	OK	OK
Onsala	1024 Mbit/s tested	Only dual polarization	OK	OK	OK
Westerbork	1024 Mbit/s tested	Only dual polarization	Only dual pol., (160 MHz)	?	---
Cambridge	1024 Mbit/s tested	Only **32** MHz available	Only **32** MHz	---	Only **32** MHz
Jodrell Bank	Available, will be tested in May	Only dual polarization	OK	---	?
Hartebeesthoek	Available, will be tested in May	Only dual polarization	OK	OK	---
Yebes	Available, will be tested soon	---	---	?	---
Urumqi	Available, will be tested in May	Only dual polarization	OK	OK	OK
Shanghai	Available, will be tested in May	Only LHC	OK	OK	OK
Torun	Has been ordered	Only dual polarization	OK	---	---
Metsähovi	Expected in 2004	---	---	?	?
Arecibo	Expected in 2004	Only dual polarization	?	?	---
Robledo	Expected at the end of 2004				

Future plans, JIVE: eVLBI



From ftp://ftp.nfra.nl/jive/evlbi/e-EVN_roadmap.pdf

Future plans, JIVE: eVLBI



Summary

There are no plans to change the correlator core in the near future, development occurring mainly in

- Change from MKIV to disk-based recording
- Improving the production efficiency and data quality
- Real time pre-session fringe checks
- eVLBI
- Connected Element Interferometer correlators

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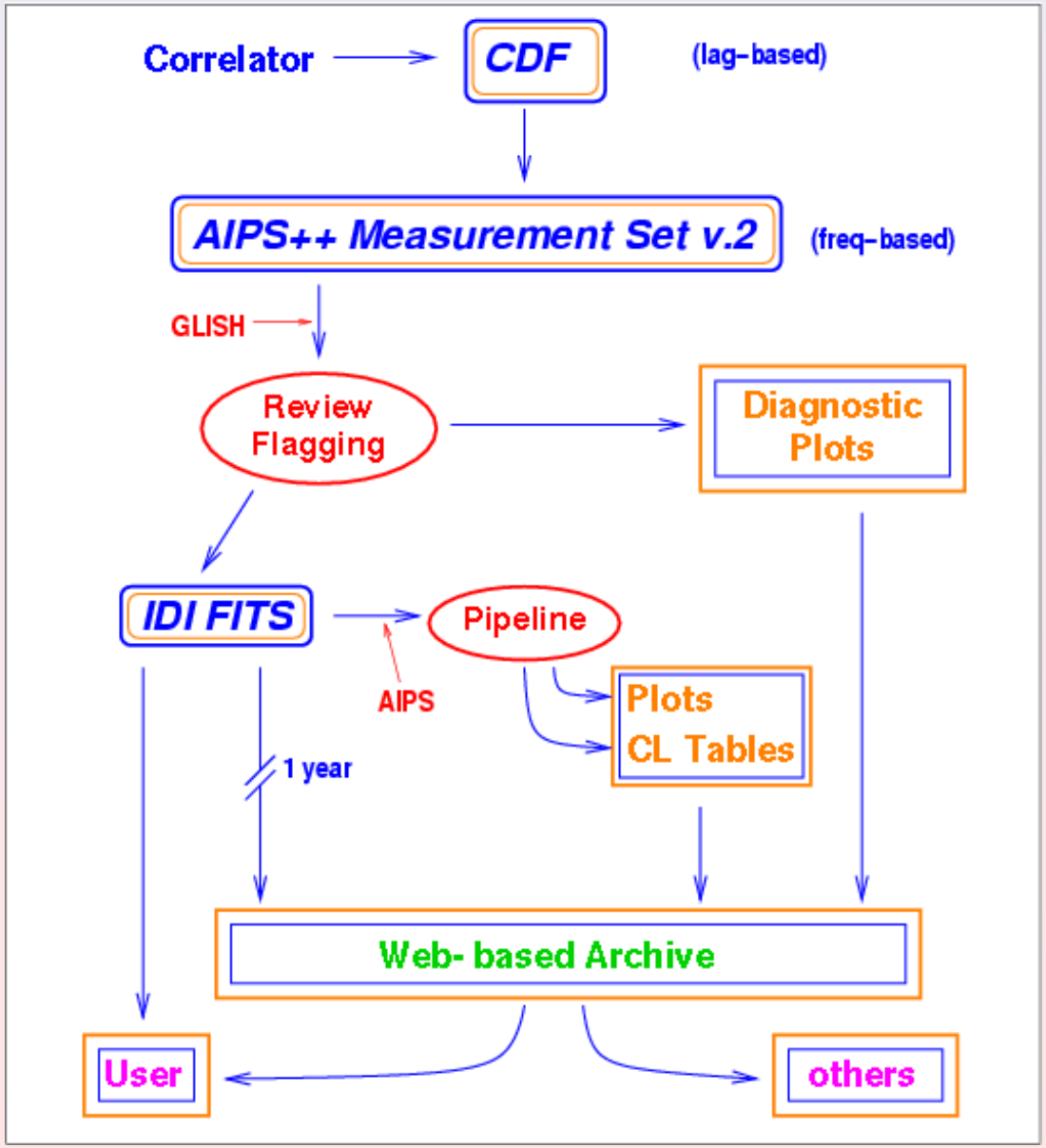
JIVE pipeline



MKIV correlator block diagram