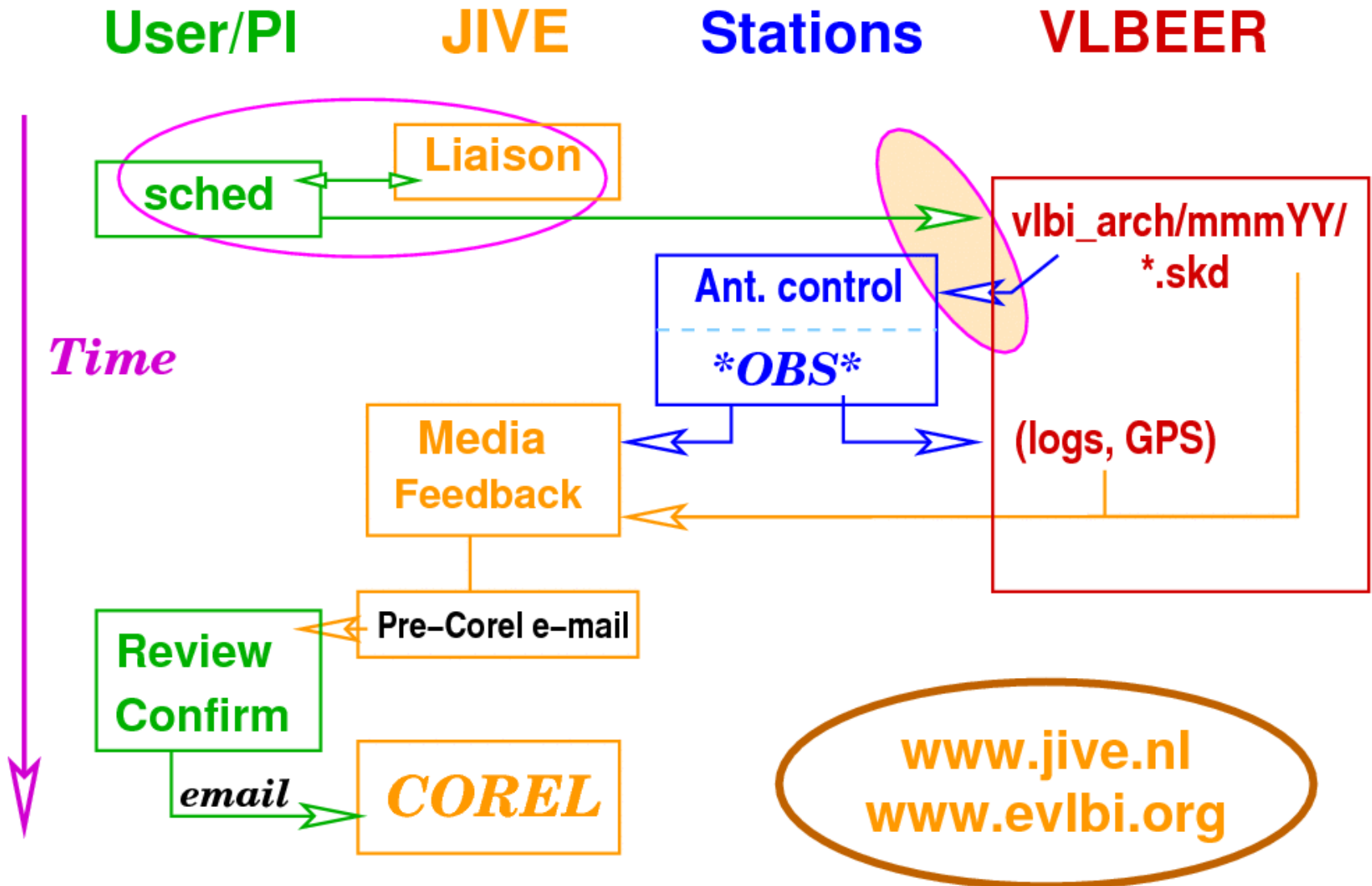


e-EVN & other Developments at the EVN MkIV Data Processor at JIVE

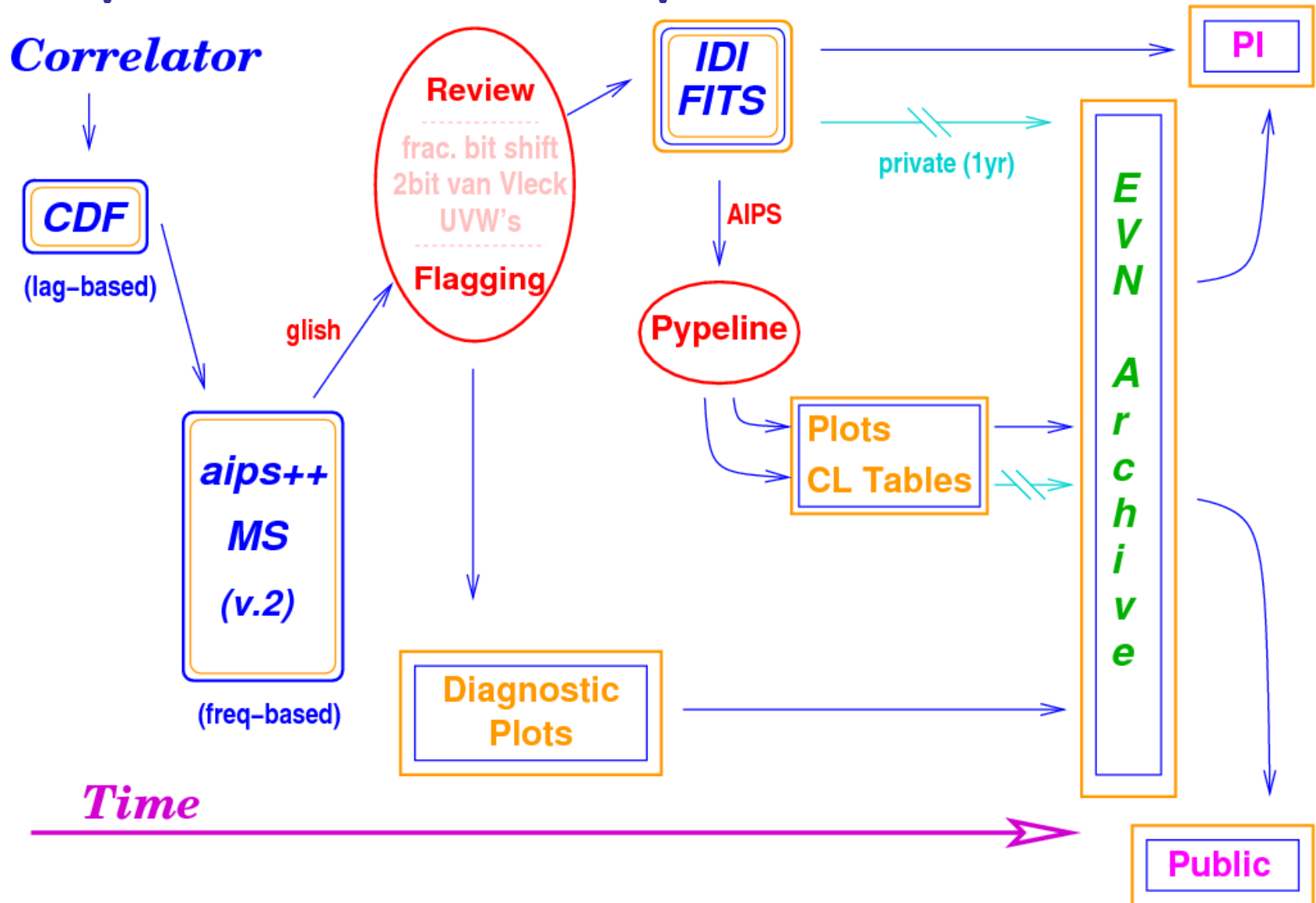
Bob Campbell, JIVE

- Operations and PI Interaction
- Correlator (MkIV) Capacities
- Real-time e-EVN Astronomy
- Software Correlation at JIVE
- EVN Trans-National Access

Ops Flowchart (≤ Correlation)



Ops Flowchart (post-Correlation)



Specific Correlator Capabilities

- Total observed rates up to 1 Gbps (max. sampling = 32Mb/s)
- 1-, 2-bit sampling (e.g., include VLBA's at 512 Mbps in Gbps obs)
- Full-Stokes polarization output
- Up to 2048 frequency points per SB/polarization
- Full-correlator $t_{\text{int}} \geq \frac{1}{4}$ sec (half-corr $t_{\text{int}} \geq 1/8$ sec)
- Oversampling (2, 4x Nyquist $\rightarrow$ 500kHz filters)
- >16 stations through multiple passes
- Improved UVWs; 2-bit van Vleck, frac. bit shift comp.
- Multiple MERLIN out-stations as separate EVN ants.
- Recirculation (time-sharing correlator in low-BW obs)
- Real-time e-VLBI operation

Correlator Capacity (Spectral Resolution)

$$N_{sta}^2 \cdot N_{sb} \cdot N_{pol} \cdot N_{frq} \leq 131072 \cdot \mathcal{R}$$

$$N_{sta} = (4, 8, 12, 16); \quad N_{pol} = (1, 2, 4); \quad N_{chan} \leq 16; \quad N_{frqmax} = 2048$$

Recirculation: $\mathcal{R} \leq 16 \text{ MHz} / \text{BW}_{sb}$; N_{frqmax} still 2048

Examples:

	5–8 Sta	1 SB	1 Pol	2048 Frq		
	9–16 Sta	1 SB	1 Pol	512 Frq	($\mathcal{R} = 1$)	
{	(if 8 MHz SB)	9–16 Sta	1 SB	2 Pol	512 Frq	($\mathcal{R} = 2$)
	(if 2 MHz SB)	9–16 Sta	1 SB	2 Pol	2048 Frq	($\mathcal{R} = 8$)
	9–16 Sta	8 SB	4 Pol	16 Frq		

Maximal Spectral Resolution ($N_{frq} = 2048$, Δv in [m/s])

BW _{sb} [MHz]	Δv [Hz]	Δv_{1420}	Δv_{1665}	Δv_{6668}	Δv_{22235}
16	7813	1651	1408	351	105
2	977	206	176	44	13
0.5	244	52	44	11	3.3

But no Recirc.

Correlator Output Capacity

Raw output (local validity):

- lag-space correlation functions (32 kB/brd) + headers (16 kB/brd)
- Full-correlator min. $t_{\text{int}} = 1/4$ sec (half-corr. min. $t_{\text{int}} = 1/8$ sec)
 - Max. operational output rate = 6 MB/s

Approximate FITS-file growth rate:

- $1.75 \kappa f / t_{\text{int}}$ GB per hour of observation
 - $\kappa \approx 1-1.7$ (fudge-factor for "efficiency" of FITS storage)
 - f = fraction of correlator used
- Record for an experiment: 1028.7 GB (still)

Recirculation: $\text{min. } t_{\text{int}} \rightarrow (\text{min. } t_{\text{int}}) \cdot \mathcal{R}$

- $\{2\text{MHz SBs} \ \&\& \ t_{\text{int}} < 2\text{s}\}$ may well imply no recirculation

New Stations (KVAZAR)



Svetloe



Zelenchukskaya



Badary

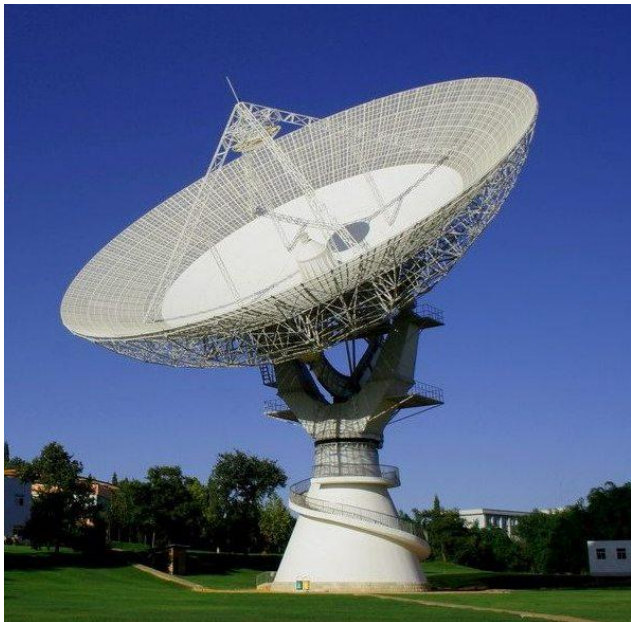
movie: www.ipa.nw.ru/PAGE/ENG/film/film.htm

- ❑ 1st EVN experiments = EK028A-C (Oct'08)
- ❑ Officially joined EVN in Nov'09
- ❑ Regular user experiments since Mar'10 session

New Stations (Miyun, Kunming)



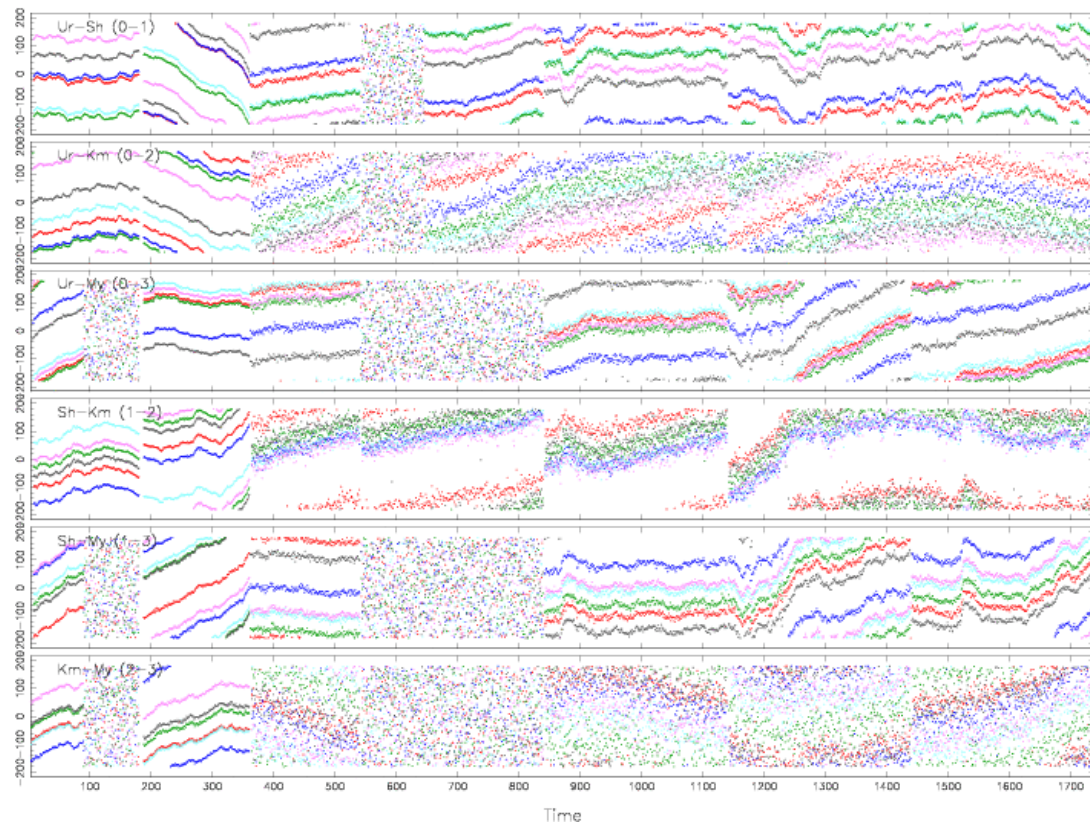
My



Km

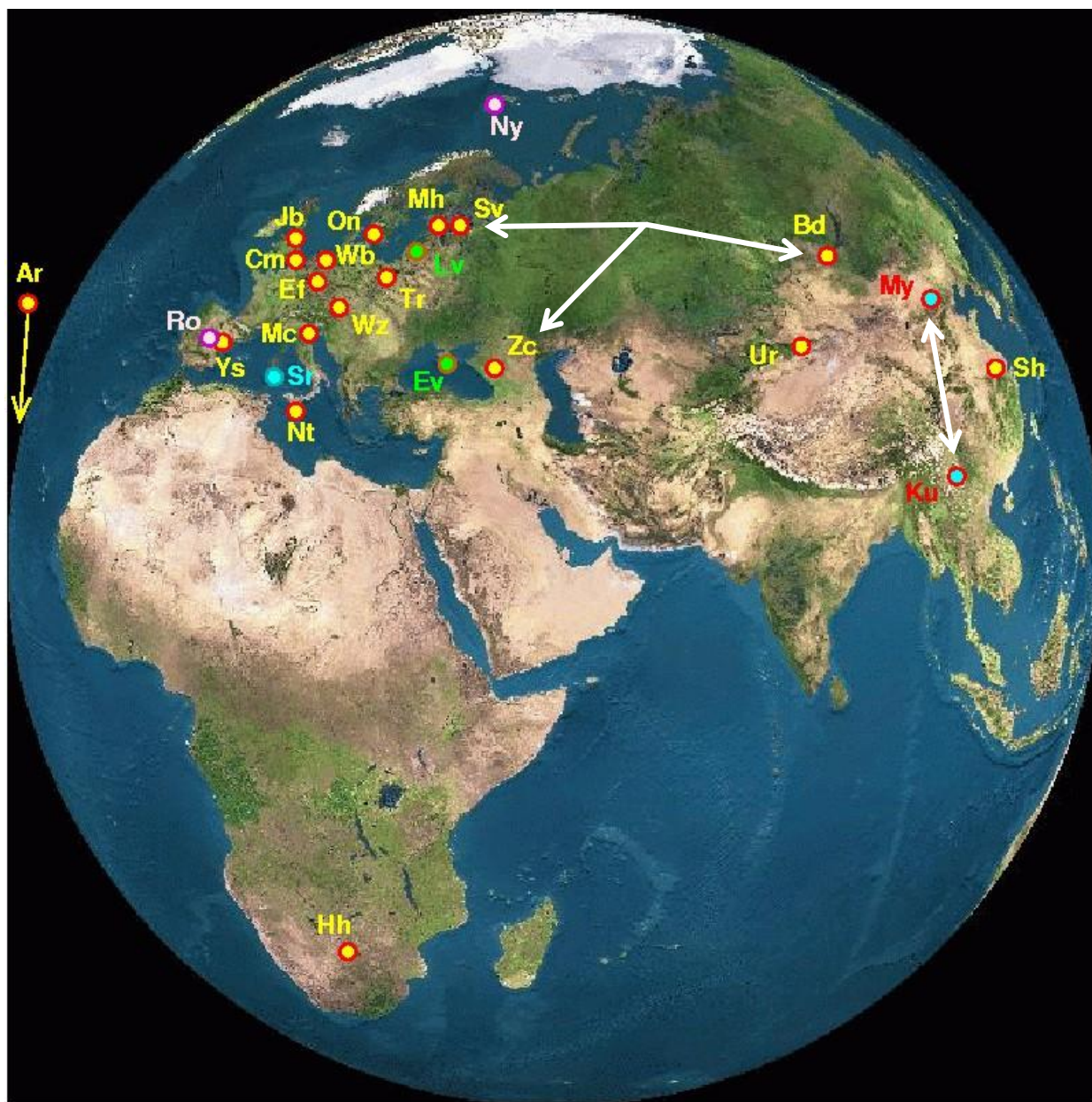
phs(t) for F.F.'s in EY008A
(X-band): Ur-Sh-Km-My

Phase for ey008a.ms



(fringe-finder scans juxtaposed)

T h e E V N



Real-time e-EVN Science (I)

- Proposal-driven e-VLBI science observations
 - 1st observation = 16 Mar 2006 (6 stations at 128 Mb/s)
 - 88 observations from 60 proposals (717.5 hours)
 - 30 different PIs
- Topics (rapid turn-around; urgency; denser time-sampling):
 - X-ray binaries in flaring states
 - Just-exploded GRBs, SNe, Novae
 - Binary stars at specific orbital phases
 - Monitoring SNe population/birth in starburst galaxies
 - AGN γ -ray outbursts — locus of VHE emission
 - Gravitational lenses // AGN in a sub-mm galaxies
 - High-z sources: UL galaxies, core-dominated triples
 - Seeking IMBH via compact radio emission in ULXs
 - Pre-proposal detection exp. // reference-source search

Real-time e-EVN Science (II)

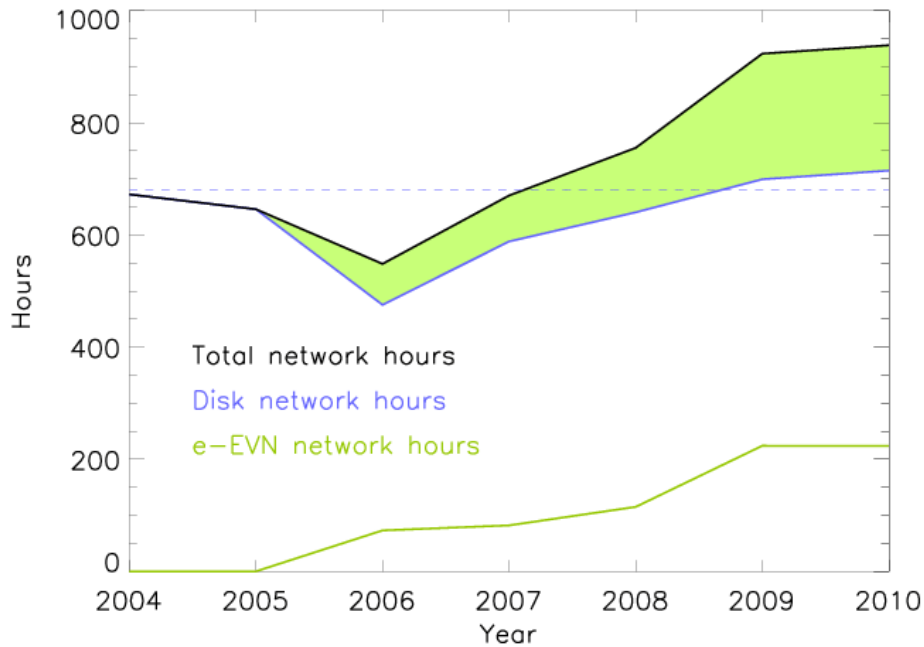
- Evolution of e-EVN procedures
 - 24-hour periods run on fixed dates (fit to station commitments)
 - Proposals now within standard proposal-submission cycles
 - Proposal Class for “**triggered**” observations (5 since 2008)
 - Proposal Class for “**short**” observations
 - Target of Opportunity Observations (e-EVN + **disk**)

	N_{proj}	N_{obs}	N_{hour}
2007	1	1	12
2008	2	4	38
2009	3 + 1	6	68
2010	8 + 2	11 + 5	109 + 43

- Growth rate in each e-EVN ToO stat. $\geq$ Fibonacci
- Some e-EVN ToOs have included Australian stations

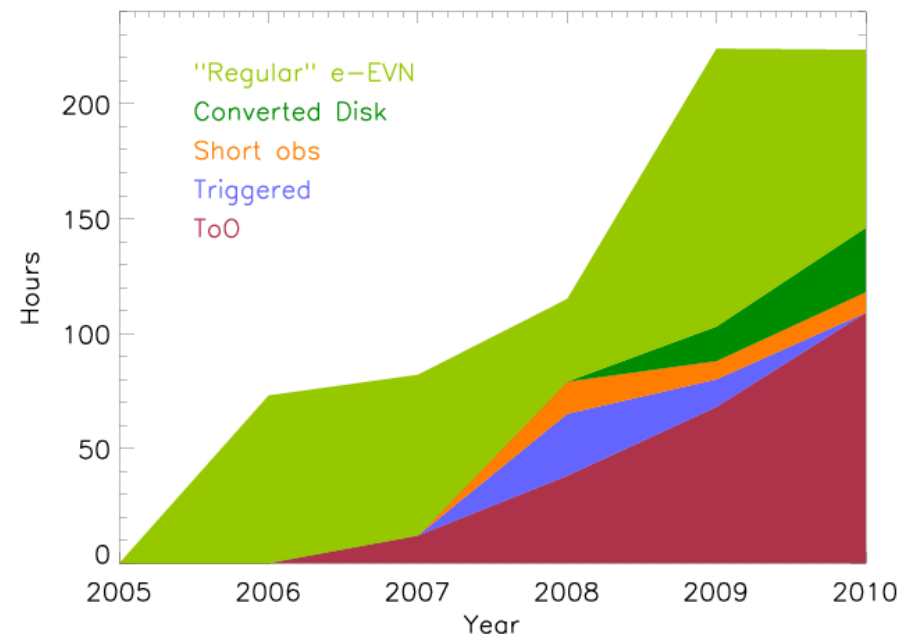
e-EVN: Growth / Composition

EVN network hours



- Disk-based network hours roughly constant
- 2010 e-EVN network hours now at 223.5 (& counting)

e-EVN network hours



ToOs: almost half the total of e-EVN observing time in 2010 so far (48.8%)

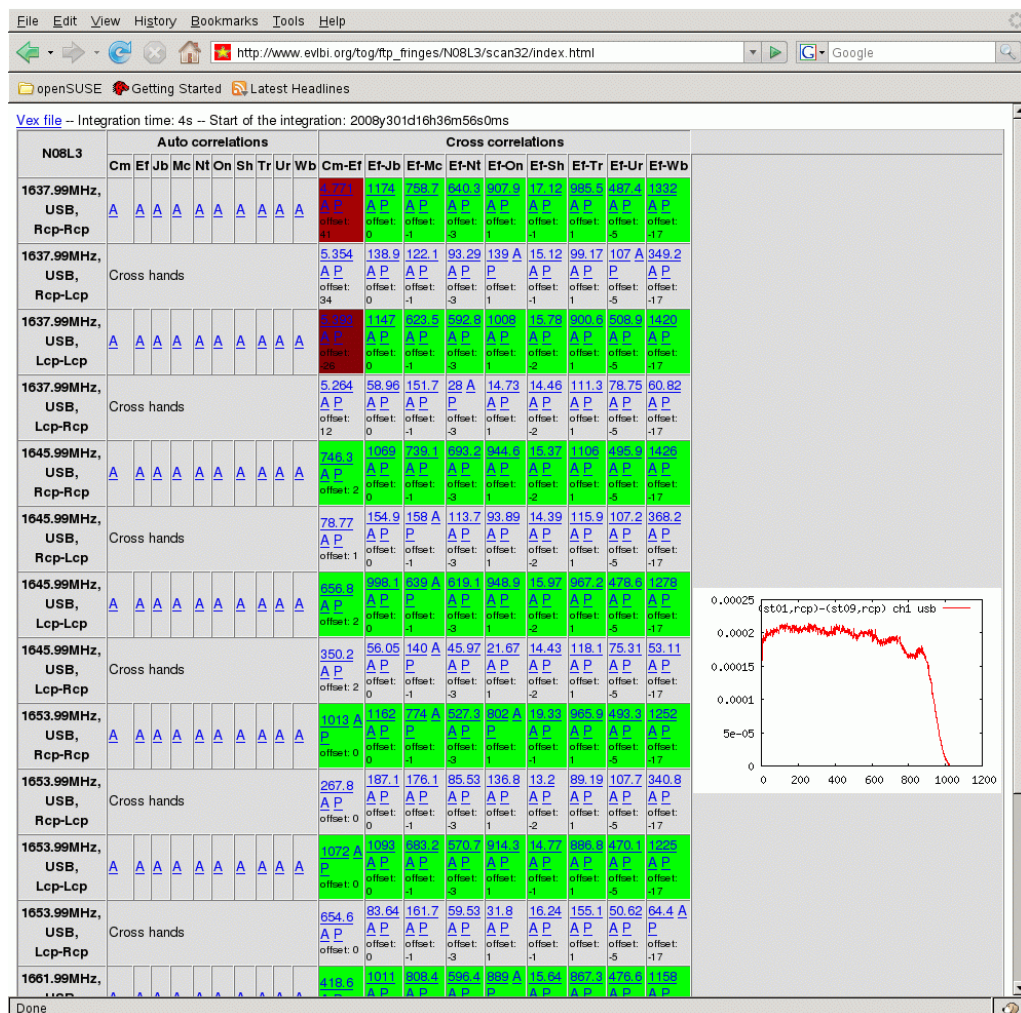
Software Correlation at JIVE (I)

- SFXC (based on correlator for tracking Huygens descent*)
 - VEX-driven + simple config. file with correlation parameters
 - Mark 5A, 5B, VLBA, and VDIIF support (thus 5C-ready)
 - Post-correlation processing → IDI-FITS as for Mk IV
 - Essentially unlimited $N_{\text{frq}} / t_{\text{int}}$ (wider-field mapping)
- Now running on a dedicated 16-node, 128-core cluster
 - “Real-time” processing currently = 9 stations at 512 Mb/s
 - Benchmarks summary on SFXC Poster
- Used for ftp fringe-tests in NMEs since 2007
- NEXPreS: integration of SFXC with e-EVN(+)
 - Globally distributed correlation (dynamic resource demand)

• www.jive.nl/jive-research-notes (R.N #4, 5, 11)

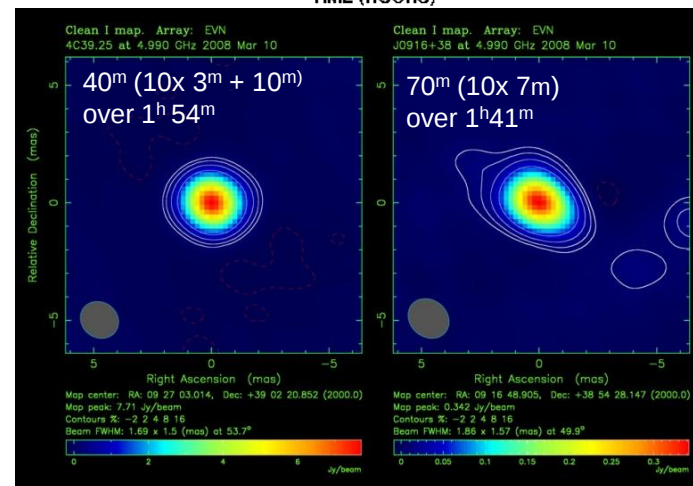
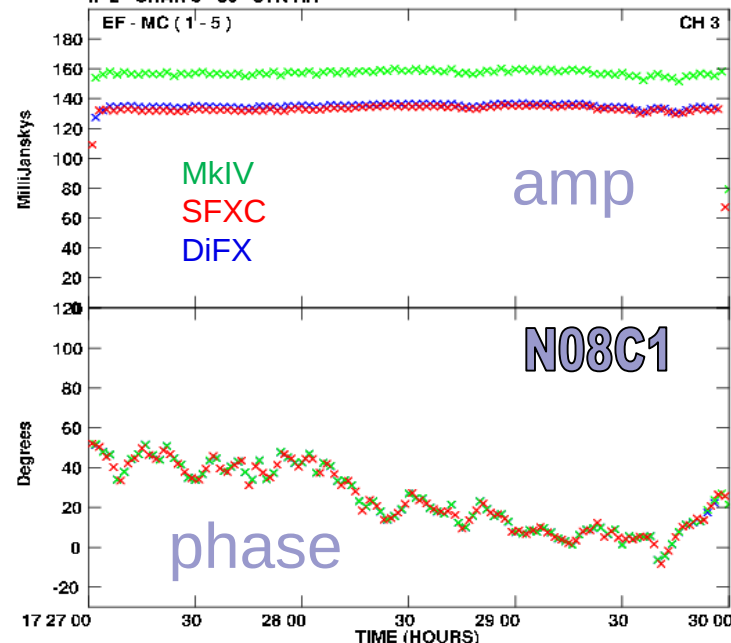
• www.mrc.uidaho.edu/entryws/full/programme_detailed.html (C-4.6)

Software Correlation at JIVE (II)



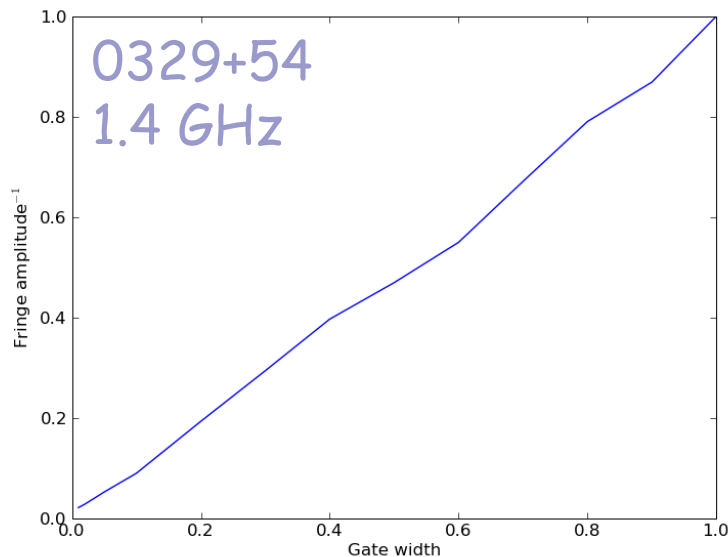
ftp fringe-test results web interface

Plot file version 1 created 13-MAY-2009 12:14:40
Amplitude and Phase vs Time for N08C1.SFXC.1 Vect aver.
IF 2 CHAN 3 - 30 STK RR

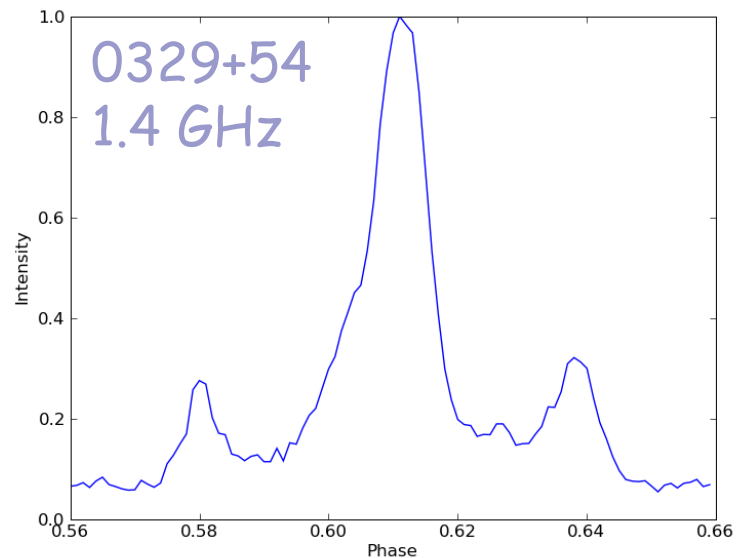


SFXC Pulsar Gating/Binning

- Gating = arbitrary interval within a PSR period
- Binning = arbitrary number of bins within the gate
 - Each bin $\rightarrow$ separate correlation / output IDI-FITS file



Expected inverse relation
between amp & gate-width
(y-axis = 1/amp)

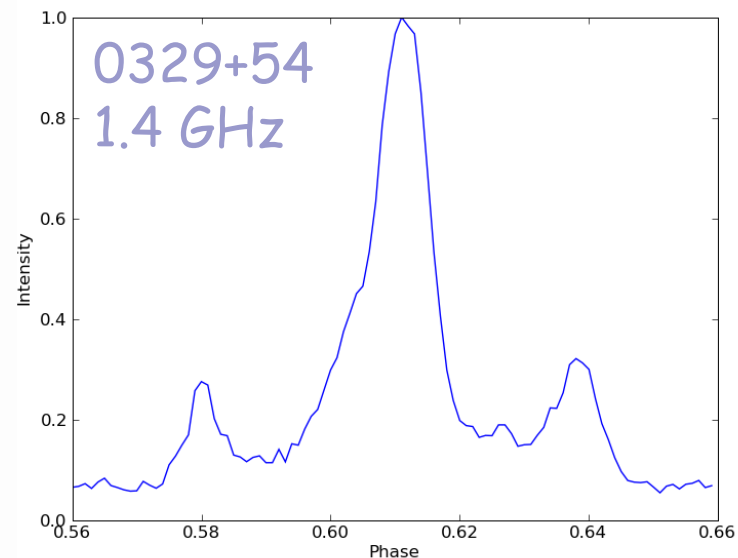
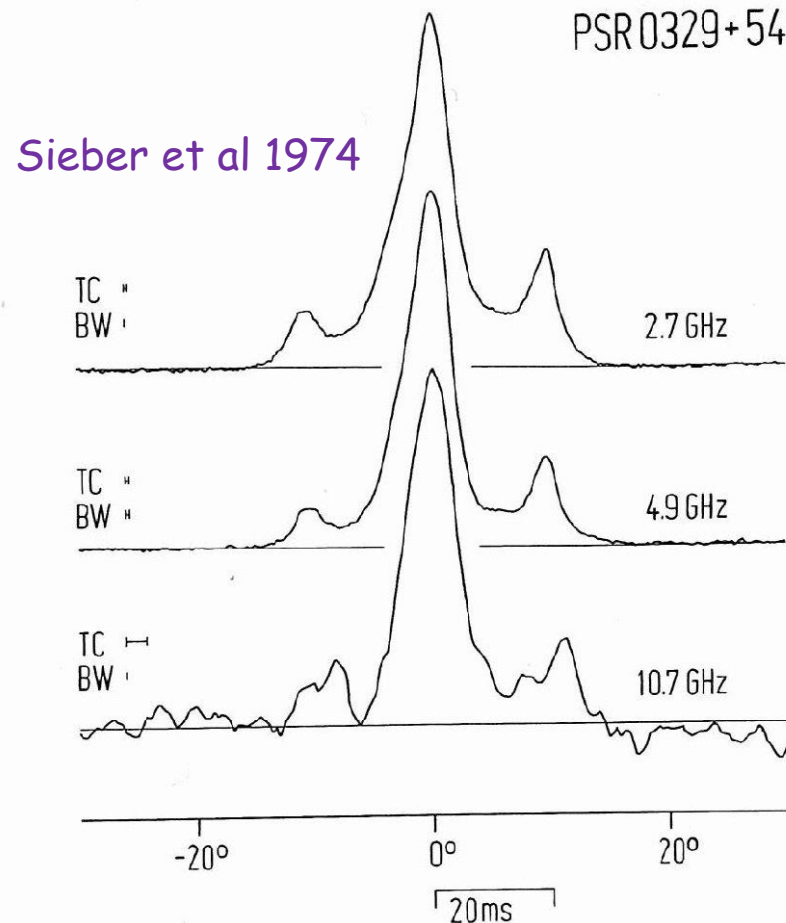


Pulse profile (1 gate, 100 bins)

SFXC Pulsar Gating/Binning

- Gating = arbitrary interval within a PSR period
- Binning = arbitrary number of bins within the gate

ation / output IDI-FITS file



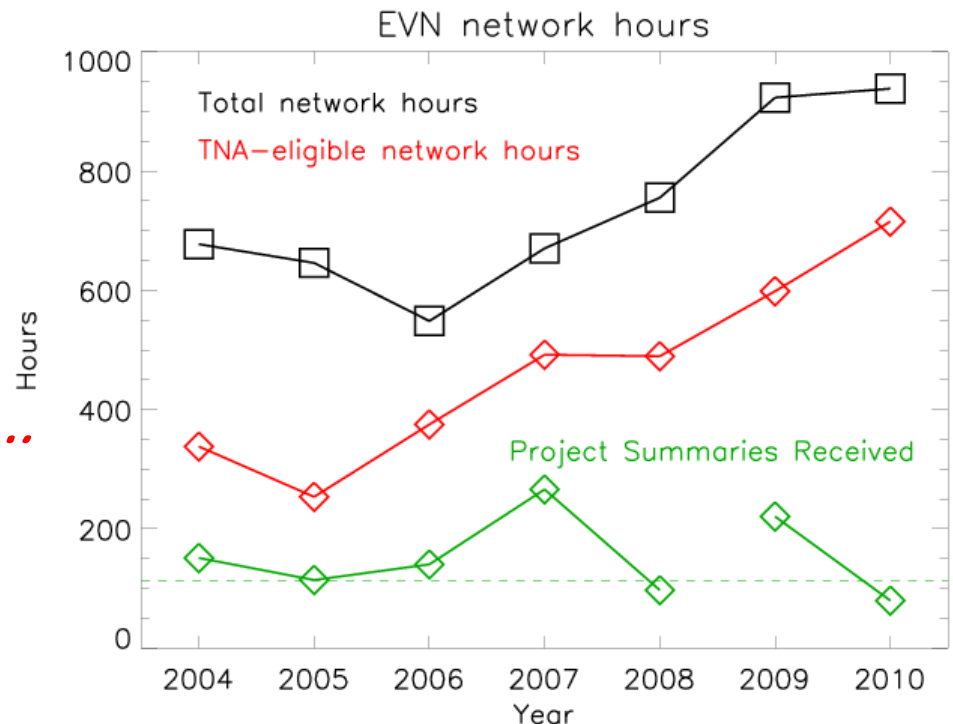
Pulse profile (1 gate, 100 bins)

Fig. 1.2

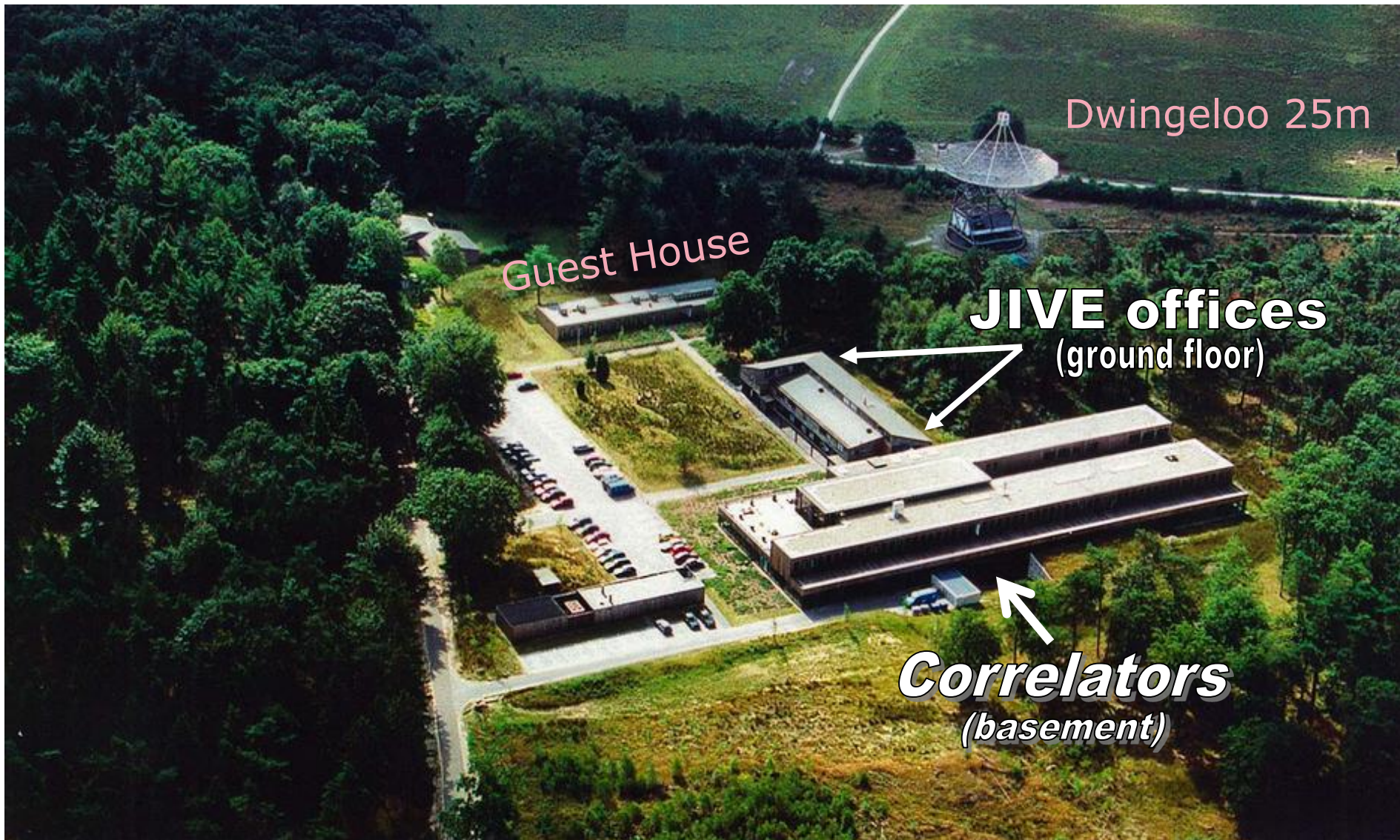
EVN Transnational Access (+)

- TNA eligibility rule:
 - {PI && $\geq \frac{1}{2}$ team members} from institutes in {EU && .not.NL}
- TNA "bennies": reimbursement of travel costs to JIVE or other EVN institute(s) for a member of the team

People seem to be learning the system.....



JIVE in Dwingeloo



EVN Transnational Access (-)

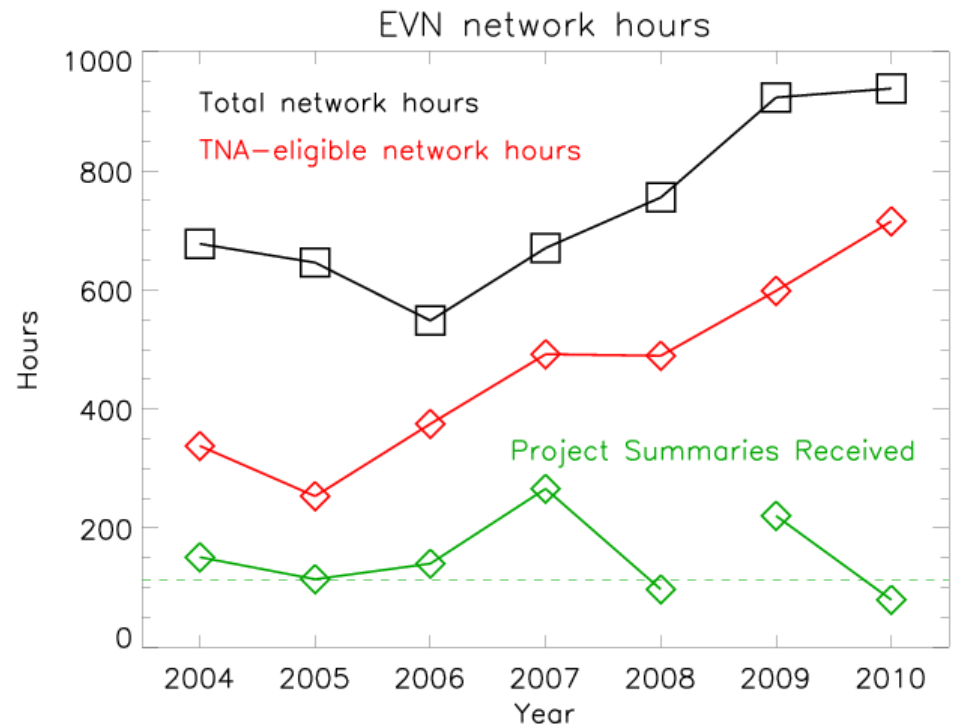
- TNA responsibilities:
 - Project Summary (prior to travel reimbursement)
 - Questionnaires (2 similar ones: RadioNet office, EC)

FP6: 2004–2008

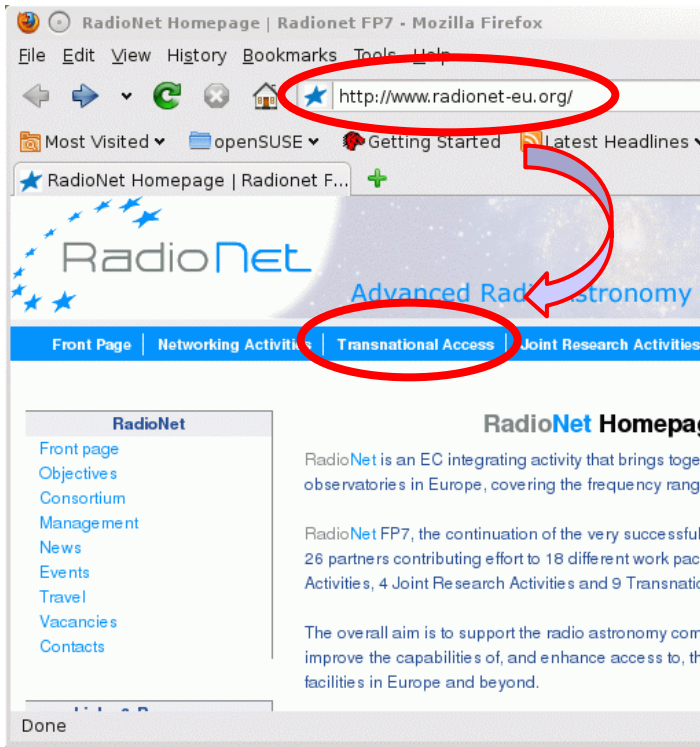
FP7_a: 2009–2011

Ideally, all eligible projects submit their reports —
Must have enough to account for contracted number of acces hours

-> KEEP BRUSSELS HAPPY!!



Where are these TNA Reports?



Transnational Access | Radionet FP7 - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.radionet-eu.org/transnational-access#questionnaire

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Transnational Access | Radionet ...

Proj. Summ.

Once the observing or data reduction run has been completed, the travel expense voucher and associated receipts must be sent by post to the TNA contact for the facility. The group leader is also required to complete the [Project Summary Report](#) (digital form: [Digital Summary Report](#)), and will also be invited to submit the [User Group Questionnaire](#). These questionnaires, treated in the strictest confidence by the RadioNet Project Manager and the EC, will help the whole RadioNet consortium to provide better scientific, technical and logistic support to visiting astronomers.

Once we have received your voucher and receipts and the required [Project Summary Report](#) (digital form: [Digital Summary Report](#)), the astronomer supported by the grant will be reimbursed for his/her expenses without delay.

Observer's Feedback

One of the aims of the European Community Research Infrastructures Action is to provide scientists from anywhere within the Community with easy access to Europe's major research infrastructures. The Action is implemented through contracts between the European Commission and major European research infrastructures. These contracts serve to support, among others, the mobility costs of visiting scientists and their costs of using the infrastructure.

To enable the Commission to evaluate the Research infrastructures Action, to monitor the individual contracts, and to improve the services provided to the scientific community, **each Group Leader of a user-project** supported under an EC Research infrastructure contract is requested to complete a **User Group Questionnaire**. In addition, in order for RadioNet to continually improve its TNA services to the astronomical community, user group leaders are also requested to complete a similar questionnaire which will be sent directly to RadioNet management. Each of the **two** questionnaires should be completed **once** by each user group as soon as the **experiments on the infrastructure come to an end**.

All replies will be treated in the strictest confidence. The information given will only be used for monitoring and assessment purposes.

EC Questionnaire	RNet Questionnaire
ONLINE Complete the EC questionnaire online.	PDF Complete the questionnaire and send electronic or paper copies to: Andre van Es RadioNet Project Manager ASTRON Oude Hoogeveensedijk 4 7991 PD Dwingeloo The Netherlands es@astron.nl Tel: +31 (0)521 595 248 Fax: +31 (0)521 595 101

Qstnr. (2)

Where are these TNA Reports?

ProjectSummaryReport extra question digital.pdf (application/pdf)

File Edit View History Bookmarks Tools Help

http://www.radionet-eu.org/sites/radi...

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Transnational Access | Radi... ProjectSummaryReport extra...

Please fill out the following form. You cannot save data typed into this form. Please print your completed form if you would like a copy for your records.

RadioNet: Project Summary Report

RadioNet Trans-national Access (TNA) users are required to complete the following Report. The report should be completed once by each User Group leader as soon as the infrastructure comes to an end or data reduction is completed. TNA travel will be reimbursed until the Project Summary Report has been submitted to the TNA Facility.

All reports will be treated in the strictest confidence. The information given will only be used for assessment purposes.

PROJECT SUMMARY REPORT

- RadioNet TNA Facility
- User Project Acronym
- User Project Title
- User Group Leader
- Address of Home Institution
- E-mail address
- Telephone/FAX numbers

Please give a brief description of the scientific objectives of your project.

8

RadioNet Project Summary Report

European Commission: CORDIS: FP7 - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://cordis.europa.eu/fp7/capacities/questionnaire_en.html

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Transnational Access | Radi... European Commission: COR...

USER GROUP QUESTIONNAIRE

- Number of the EC Grant Agreement that financed the user group's access to the research infrastructure
- User Project Acronym note 1
- Person filling in the questionnaire (normally the User Group Leader)
- Where did you first find out about the possibilities of access supported through the EC grant agreement?

☐ EC Research Infrastructures Action web-site
 ☐ CORDIS databases
 ☐ Grant Agreement web-site
 ☐ Infrastructure web-site

☐ Announcement in journal
 ☐ Announcement at conference
 ☐ Direct mailing from infrastructure
 ☐ Personal contact (please specify)
- Without the support of this EC grant agreement would you still have been able to carry out your work at this research infrastructure?

☐ Yes ☐ No

If no, please indicate the reason (you may indicate more than one choice)

☐ Not otherwise eligible to apply for access to the infrastructure(s)
 ☐ Too difficult to obtain access by applying directly
 ☐ Unable to pay the user fee
 ☐ Unable to pay travel & subsistence for one or more of the group members
 Other (please specify)
- assess the services provided by the grant agreement with respect to the following points rating them on a scale from 'very poor' to 'very good'.

(Please provide at least 4 ratings. Leave blank when the point is not applicable)

Publicity, made by the infrastructure, concerning the access financed by the EC	
Practical information provided on how to apply for access	
Advice to use the most appropriate installation or infrastructure note 2	
Information provided, once your project was accepted, on how to use the facility	
Scientific support to set up your experiments and interpret the results	
Technical support to make best use of the installation(s)	

Summary

- Pre-/Post-correlation PI Support
 - Help available — **not required to wait until last minute**
 - Archive: feedback, standard plots, FITS, pipeline
 - EVN Trans-national access
- MkIV Correlator Capabilities
 - ≤ 2048 freq.pts per SB/pol; $t_{\text{int}} \geq \frac{1}{4}\text{s}$ ($\frac{1}{8}\text{s}$, half-corr.)
 - **Recirculation: spectral resolution boost if $BW_{\text{SB}} < 16\text{MHz}$**
 - **e-EVN & new kinds of astronomy enabled**
- Software correlation at JIVE
 - **Applications beyond MkIV correlator**
 - Capacity to grow with increased hardware base