

CORRELATOR REPORT, EVN Correlator at JIVE  
EVN TOG MEETING, November 2020, virtual

4 November 2020 (statistics cover 27 April - 25 October 2020)  
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(essentially a shortened copy of the CBD report)

SCIENCE OPERATIONS

The table below summarizes projects correlated, distributed, and released from 27 April to 25 October 2020. The table lists the number of experiments as well as the network hours and correlator hours for both user and test/NME experiments. The definitions of network and correlator hours remain the same as in previous reports. Multiple correlator passes for SFXC typically occur only for phase-referenced spectral-line experiments (separate "continuum" and "line" passes) and for pulsar observations wanting multiple gating/binning configurations. The actual time to correlate a specific observation can of course deviate significantly from the number of "correlator hours", depending on a variety of factors (e.g., bit-rate, mixed-BW modes, multiple phase-centers, pulsar gating/binning, etc.)

	User Experiments			Test & Network Monitoring		
	N	Ntwk_hr	Corr_hr	N	Ntwk_hr	Corr_hr
Correlated	60	475	567	6	15	15
Distributed	66	579	695	6	15	15
Released	69	604.5	678.5	18	49	49

Covid-19 impacts:

Correlation has continued primarily remotely since 16 March. The first shift of e-EVN days has been manned in Dwingeloo. When anti-covid measures in the Netherlands, and then also for local building access, were relaxed from June, we were able to have an operator in Dwingeloo three days per week, which provided more responsiveness to logistical issues (pack sending/receiving/mounting, handling back-up LTOs, etc.). In mid-October, national and local anti-covid measures were tightened up, but so far the three-day-per-week operator presence has been maintained.

Operations are somewhat less efficient in the current environment, but so far this has not led to falling behind in the regular sessions. This of course has been "helped" by session 2/2020 being smaller than normal, as some PIs decided to defer their observations owing to the anticipated unavailability a number of stations. In the end, Mc,Nt,Sr,Tr missed the entire session, and T6,Ys, and the e-MERLIN out-stations missed various portions. With session 3/2020, a full array and observing load has returned.

Some landmarks since the previous CBD report:

Session 1/2020:

A special version of sfxc was made to "build in" the >200us offset between channels containing each of the two different polarizations for Arecibo, and the affected observation (ER047D) was correlated. Arecibo had repaired this condition by session 2/2020. The first trigger from correlator-only FRB burst found via the CHIME-shadowing MOU-driven observations was called and correlated (specific observation from between sessions 1-2/2020).

Session 2/2020:

Three ToO's observed during the session, including one a last-minute addition. Topics include methanol maser bursts in a high-mass YSO, the second epoch on a potential Galactic FRB (see e-EVN below), and observations of a FAST-detected FRB (plus two epochs just following the session -- no burst was seen in any of these three epochs).

Session 3/2020:

One late-addition ToO observed during the session, and an even later one to follow a couple days after it ends. Topics include a new

Galactic XRB and a new short GRB.

Schedule deposition was quite a protracted process: the first schedules were ready on 29 Sep, the last on 2 Nov. It's not clear how much of this can be attributed to remote working -- but that has not facilitated things...

Two observations will require reconstructing the vex-file for correlation, as it was easier for the PIs to schedule separate sub-arrays for observing that are intended to be correlated together.

e-EVN:

A normal-strength e-EVN array was back in place for the September and October runs. First time to use the new higher-capacity connection (replacing the separate 10G segments, as discussed in the previous report) at 2Gbps (Sep). No network-related issues.

Each of the previous four e-EVN days has featured a full 24 hours of science time (i.e., no unused inter-observation gaps).

One target-of-opportunity observation and one triggered observation ran in this period. Topics included Type Ia supernova progenitors and a potential Galactic FRB (from a magnetar).

ET036A-C: These were geodetic-style observations wanting totals in mark4 format. Their status had been awaiting distribution, while we gathered experience from Jumping JIVE/WP6 efforts that the path to mark4 harbored no lurking issues (e.g., analysis of R1872 and EC065). The ET036 team is unrelated to any of the JJ/WP6 participants. The mark4 data for all three epochs were distributed in early September. These are the first "external" users to have received mark4 data from sfxc. They have provided positive (unsolicited) feedback: "All three sessions show good results. Positions of the high-z objects consistent with positions obtained from other networks. So, I could say that the new geodetic feature of your EVN correlator [sic] works pretty well." (O. Titov)

RadioAstron: Three 18cm observations have been correlated and distributed over the summer/autumn; RadioAstron fringes were seen in most scans, with weakening detections as the (non-projected) baseline-length increased towards/above 8 earth diameters (similar to the behavior seen in the previous 18cm observation with fringes). These observations brought in Australian and Japanese stations, whose data-stream/vex-channel mapping had to be worked out. Another observation was prepared and clock-searched, but with no RadioAstron fringes seen in any scan.

Preparation began for two other observations, which are both dual 18/6cm in that the ground stations are split into two simultaneously-observing single-band sub-arrays, with RadioAstron at 18cm (thus with both polarizations). For these two observations, the L-band sub-arrays do not have the big antennas typically used for clock searching (viz., Ef,T6,Ti,At), rather comprising [VLBAs, Pa,Cd,Ho, Ks,Ud]. Usuda has one subband at 18cm and one at 6cm; it was scheduled as two different stations, but provided mark5B data as a single 2-subband station -- still cobbling together a workable correlation vex-file for the first of these to make Usuda appear as a single station (in order to find all the data on FlexBuff) but appearing in both the 6cm and 18cm scans at a given time.

ER047A-D: First four epochs of six, observing once per session; 760 output phase centers. First two epochs correlated and distributed, third and fourth correlated. Each epoch is 12hr, actual correlation time required for these first four epochs were 106.5, 102.5, 127.5, and 137 hours (the number of participating stations went up a couple after the second epoch). Cross polarizations required in the correlation to be able to transform the observed linear pols at Tianma (and sometimes Urumqi) into circulars before archiving the FITS files. This is done via polConvert, operating on the FITS files. Output FITS files for the first two epochs combined was about 19.5 TB; anticipated size of the next two epochs would be 13-14 TB apiece. The 100 TB increase in the size of the Archive disk-space over the summer was driven largely to enable archiving the remaining ER047 epochs. Post-correlation review of the third epoch is currently underway. The fifth epoch was deferred from session 2/2020 because of the absence of e-MERLIN out-stations.

## USER SUPPORT

Due to the travel restrictions worldwide, there were no data reduction visits at JIVE in this period, nor are any expected in the coming ~6 months. In cases when inexperienced users require, we provide support through Zoom and other remote collaboration tools. Sharing screens is an excellent way to monitor their progress, explain certain steps in detail, and easily spot errors. As from October the "usersupport@jive.eu" address is alive; communications related to EVN data reduction or other general user support issues are expected through this channel. This way the communication between support scientists and the users will be more transparent in the support group, and issues reported by the users will be easily monitored. The EVN web pages have been updated with this address, and it will be advertised more broadly in the next Call for Proposals.

The R&D and the support groups join efforts in developing software that aid production correlation, and user support. Current issues being discussed include reformatting ANTAB tables in the EVN Archive (these are readable by AIPS, but pose problems for CASA) and dealing with sparse calibration info within CASA to avoid data being unnecessarily flagged. Calibrating VLBI data within CASA will be demonstrated at the CASA VLBI workshop later this November.

Data calibration issues reported by users to JIVE are usually related to amplitude calibration, and phase-reference imaging. The former has been addressed earlier this year by implementing strict rules in spotting formal errors in ANTAB tables. The issue of poor initial gain values will have to be addressed at BOTH the stations and at JIVE. Wrong gain values are sometimes spotted in the pipeline but these are best spotted by hands-on imaging sessions of calibrators. Poor gains may be possible to correct to first order, and further training of support scientists will happen. But eventually it is unavoidable that stations dedicate more resources to this. The experience is that several PIs (especially with less experience) cannot deal with this issue well on their own, and this may degrade EVN data integrity.

There were two first-time EVN PIs in session 2/2020 (from Arecibo and Anhui Normal University, CN) and one in session 3/2020 (from U. Valencia). The new PI from Anhui Normal U. also has an observation from a different proposal as PI in session 3/2020.

JIVE continued to provide PIs with experiment-specific template "setini" blocks and station catalogs, and to follow the new procedure for depositing schedules in which PIs send their key files to JIVE rather than posting sched output directly to the VLBEER server themselves.

The size of FITS files from user experiments on the EVN Archive grew to 98.38 TB during this reporting period, gaining 23.28 TB since the previous CBD report. This is mostly in ER047A-B (19.47 TB).

The policy of mentioning the possibility of requesting a 3-month extension if they thought that such restrictions hampered their ability to analyze their data has remained in force. Text to this purpose has been added to the one-month warning prior to the public-release date for data from a project.

## NETWORK SUPPORT

There were further higher bit-rate tests including the 64MHz filters in the DBBC2 firmware v107, as a means to attain 4Gbps with tunable BBCs: in NMEs at 1.3cm and 5cm in session 2/2020 and at 6cm in session 3/2020. The 5cm test used 64MHz subbands, which continue to show sub-optimal band-pass shapes. Ef is currently constrained to only 2 IFs (16 channels) in the Nyquist zone used for 5cm with the 4-8 GHz receiver, but we'll move other stations to 32x 32MHz channels in the future (using the "wastro" configuration in the DBBC). The 1.3cm and 6cm tests used 32MHz channels. LO tunings that provide a common 512 MHz IF on the sky across the array have been found, but for various reasons, not all stations have been able

to participate in each test, so there are still some unknowns going forward. The first user experiment using 4Gbps will be a target-of-opportunity observation running just after session 3/2020 (9 Nov).

The Zolochiv antenna in the Ukraine co-observed with N20C3 (29 Oct), with 2 8MHz dual-pol subbands. We are waiting for transfer of the data. Discussions began with JPL/DSN about VLBI aspects of the development of their new DVP2 back-end (e.g., complex channels vs. real dual-sideband channels, VDIF parameterizations for translations from their native format, means of enabling e-shipping, etc.). We are expecting to receive some test data from them to investigate and begin iterating further.