Correlation Report for e18pXX e18sXX

General information

- Technical VLBI sessions with ALMA VLBI carried out mid-October 2018 at 345 GHz and 230 GHz on the days of 17 Oct 2018 UTC (e18p17, e18s17), 19 Oct 2018 UTC (e18p19), and 21 Oct 2018 UTC (e18s21). The roughly 2 hour long schedules started with 345 GHz and ended with a few scans at 230 GHz.
- Details: https://eht-wiki.haystack.mit.edu/Event_Horizon_Telescope_Home/Observing/2018_Oct_345_GHz_test/
- Driven by ALMA Phasing Project need to
  - a) testing of "230 GHz passive phasing" for sources below the ALMA VLBI flux density cut-off of 500 mJy
  - b) attempt 345 GHz fringes on VLBI baselines to support future commissioning of 345 GHz for ALMA VLBI
- IRAM Plateau de Bure joined in ad-hoc with a single dish; NOEMA phasing & VLBI interface still under construction
- APEX did on-sky DBBC3 testing by recording from R2DBE (EHT-official) and DBBC3 (new) backends in parallel
- APEX observed at 345 GHz only because switching between 345G/230G would have needed recabling
- Correlation was carried out at MIT Haystack (primary) and at MPIfR Bonn (APEX and European stations).
- The Haystack correlator report is at https://eht-wiki.haystack.mit.edu/Event_Horizon_Telescope_Home/Observing/2018_Oct_345_GHz_test/Correlation

Status

what	date
Finished observations. Copy of APEX data hand-carried to ALMA OSF and Bonn MPIfR.	21.10.2018
MIT Haystack first-pass at ALMA + APEX correlation. Weak fringes in s18s21; APEX 345G rx coherence poor	24.10.2018
Copy of Pico Mk6 scans by FTP arrived in Bonn	08.11.2018
Copy of PdB Mk6 module data arrived in Bonn, copied out, looks complete now	14.11.2018
Fringe searches Pico x PdB single-dish	14.11.2018+
Two ALMA scans downloaded Hays->Bonn. Repeated fringe search Pico x PdB (x ALMA). No fringes. Haystack had no luck either. Abandoned.	03.12.2018
Recorrelation e18p19 ALMA--APEX for DBBC3 on-sky fringe comparison to R2DBE	07.12.2018

Fringes

Station	Code	Fringes	Plots 345G	Comments
ALMA	Aa	Yes	291-2352-adhoc (MIT)	correlated at Haystack, and MPIfR

Station	Code	Fringes	Plots 345G	Comments
APEX	Ax	Yes	292-0007 (MPIfR)	correlated at Haystack, and MPIfR; poor low-SNR fringes
SMA (Hawaii)	Sw	Yes	294-0938_adhoc (MIT)	correlated at Haystack; acceptable fringe SNR
Pico Veleta	Pv	No		correlated at MPIfR, and Haystack
PdB Antenna 6	Na	No		correlated at MPIfR, and Haystack
JCMT	Jc	?		correlated at Haystack
GLT	Gl	(waiting)		GLT modules to be shipped after Jan19 DR Data on modules at GLT is corrupted, recovery...? To be correlated at Haystack

Notes

Details of the station setups during Oct 2018 are on the EHTC wiki (ALMA, APEX, SMA_Oct_2018, Pico 30m, PdB antenna 6, GLT). Scans and their data at Bonn are:

- 289-xxxx : 345 GHz : APEX, PdB
- 290-xxxx : 345 GHz : APEX, PdB
- 291-2344 : 345 GHz : APEX, PdB
- 291-2352 : 345 GHz : ALMA, APEX, Pico, PdB
- 292-0007 : 345 GHz : ALMA, APEX, Pico, PdB
- 292-0103 : 230 GHz : Pico, PdB
- 292-0109 : 230 GHz : PdB only

Fringe search results

ALMA

Haystack's priority was the correlation of ALMA, SMA, APEX. At MPIfR we received a copy of ALMA scans early 12/2018 mainly in orer to facilitate APEX DBBC3/R2DBE verification. But also to help with a secont attempt at a Pico, PdB fringe search.

APEX

Coherence of the APEX 345 GHz receiver was known to be low. Coherence testing by sky frequency tone injection showed high rms phase noise. Fringes on 3C454.3 on the quite short APEX--ALMA were much weaker than anticipated, with a correlation coefficient of only ~0.005%. Efficiency across the two backends at APEX (R2DBE x DBBC3 zero baseline) was between 70% and 85%.

Scan 292-007 : 345 GHz : first 90 sec of data

- ALMA x APEX[R2DBE] : SNR~25, fraction of correlated flux dens. ~0.005%
- ALMA x APEX[DBBC3] : SNR~23, fraction of correlated flux dens. ~0.005%
- APEX[R2DBE] x APEX[DBBC3] : zero baseline between backends, efficiency ~74%

The APEX DBBC3 on-sky performance was acceptable. A known firmware issue, clock jumps by some nanoseconds roughly every minute, affected the observations somewhat. The firmware problem was fixed 12/2018 and should not affect future observations.

In any case, the APEX 345 GHz is scheduled for replacement in January 2019. Phase stability of the replacement receiver system must be evaluated during 2019/2020. The DBBC3 firmware and parts of hardware (esp. analog filters) will also undergo changes.

SMA, JCMT

After Haystack received SMA modules, Haystack found high-SNR fringes ALMA--SMA at 345 GHz.

No issues.

Pico Veleta

Both MIT Haystack and MPIfR correlators carried out extensive but unsuccessful fringe searches at 230 GHz and 345 GHz.

The reason for lack of fringes is not clear. Suspecting a 1PPS synchronization issue (not confirmed yet) due to suspicions VDIF header information with zero drift and clock offset of zero on some days vs. a quite large clock offset on other days. Apart of this, the data quality in VDIF files looks good.

Explored at MPIfR: Polarization swap, maser rate sign-swap, clock offsets to +-512 usec, +-1 second, sideband swap, unexpected LO offset.

Explored at Haystack: not known in detail, but the Haystack correlator tried out similar variants to Pico processing

PdB / "NOEMA" single-dish antenna 6 on pad W20

Both MIT Haystack and MPIfR correlators carried out extensive but unsuccessful fringe searches at 230 GHz and 345 GHz.

The reason for lack of fringes is not clear. Data quality in VDIF files looks good.

PdB had two conflicting VLBI positions, differing by about 6 meters, for Antenna 6 on pad W20. Neither position produced fringes.

If the VLBI position is too poor to start with, then at frequencies as high as 230G/345G due to already low coherence times and low expected fringe SNR it is not trivial to carry out a wide gridded position offset search to get a refined VLBI position. This should be done ideally with GPS measurements and geodetic-type 22/43/86 GHz VLBI on "short" intra-European baselines.

During PdB/NOEMA construction work 2017 there were no VLBI observations. The last GMVA 86 GHz session was 2016. It had low-SNR fringes (double-checked it) using one of the provided VLBI positions. Perhaps construction work affected some aspect of the PdB single-dish VLBI setup.

Another possibility is that PdB performed well, but there was an issue at Pico. Correlated flux densities on the long ALMA--PdB baseline at 230G/345G maybe have been too low for a detection.

Explored at MPIfR: Polarization swap, maser rate sign-swap, clock offsets to +-512 usec (Noema wiki says 0 usec), +-1 second, sideband swap, unexpected LO offset (Noema wiki gives different LO offsets for 230/345G), both VLBI positions.

Explored at Haystack: not known in detail, but the Haystack correlator tried out similar variants to PdB processing.

In any case, after NOEMA phasing and VLBI interface card completion, VLBI commissioning observations and position determination are needed.

GLT

GLT hand-carry files were denoted as "files on the GLT disk are corrupted and unreadable by DiFX" according to Haystack. Original Mark6 modules remain on site at GLT for the January 2019 Dress Rehersal, after which they will be sent to Haystack for correlation.