C211D Correlation Report

General Information

- Session info: http://www3.mpifr-bonn.mpg.de/div/vlbi/globalmm/
- Station feedback: http://www3.mpifr-bonn.mpg.de/div/vlbi/globalmm/sessions/apr21/feedback_apr21.asc
- Observations were (1) 86 GHz continuum with Aa Ef Mh Br Fd, (2) 86 GHz line with Aa Ef Mh VLBA, (3) 88 GHz continuum with Aa VLBA.
- Performance: Pv and Ys and Gl scheduled but could not observe. Mh had bad weather and no fringes. NL, MK no fringes.

C211D is a spectral line test observation used for commisioning spectral line VLBI capabilities at ALMA. The experiment contains scans observed at 86 and 88 GHz (see sections below).

Revisions

88G v1	mixed-pol	08/2021	First continuum and line correlation with CALC9 model, DiFX 2.6.2 + difx2difx.py
88G v2	mixed-pol	03/2022 Bonn, 06/2022 to PI	Recorrelation with CALC11 model as used by ALMA. DiFX 2.7.1 with 128 MHz wide IFs. PolConvert attempts at Bonn failed after lack of any functional C211D APP QA2 package. Eventually the dataset was provided to PI at MIT Haystack 06/2022 for further PolConvert attempts there.
88G v2_fakePols	"linear"	08/2022 to PI	Binary data of 88G v2 with ALMA relabeled as circular, to generate FITS-IDI. Shared with PI.
86G v1	mixed-pol	08/2021	First continuum and line correlation with CALC9 model, DiFX 2.6.2. A subset of stations only. No polconversion since no APP QA2.
86G v2	mixed-pol	10/2022	Recorrelation with CALC11 model. All stations. Continuum scans 64 MHz wide IFs, 256 ch, 0.512 s. Line scans single 32 MHz wide IF centered on line, 1024 ch, 1.024 s. No polconversion since no APP QA2.

86 GHz correlation

Initial Continuum Correlation

This correlation run includes only a subset of stations, Aa, Ef, Pv and two of VLBA: Br and Fd. For technical reasons the correlation performed for all antennas only in two 58MHz bands: starting at 86209.703125 MHz and at 86268.296875 MHz (where Aa, Ef and VLBA bands overlap). For VLBA and ALMA only two additional 58MHz bands are added below and above (they don't work for Ef with its 64Mhz x 8 configurations).

At the moment we are not concerned with the linear polarization of ALMA, its "R" and "L" are arbitrarily reassigned X and Y, and the strength of its parralel and cross-hands fringes is roughly the same, as it should be.

Fringes detected from all stations (except Pico, its data for this experiment is useless, it was recording while stowed) only to ALMA and only for calibrators: 1055+018, OJ287, 4C39.25. There is a significant non-linear behavior in fringe rate: being fully compensated in scan 1 it increases to a significant value in scan 22 (130+ mHz or in d-rate units 1600 fs/s). It is not a real cause for concern (if we compensate it in the middle of the experiment, it won't lead to large single-band delays because this is a short experiment), but should be noted.

Map of the currently detected ALMA fringes in the context of the whole experiment:

c211d_FRINGE_RfAnt_Aa_LLRR_AllSrc.pdf

Full fringe plot sets (to ALMA only) for a few scans with the brightest fringes (including autocorrelations and antennas with no fringes):

No0001_A.pdf (1055+018)

No0003_A.pdf (OJ287)

No0014_A.pdf (4C39.25)

No0017_A.pdf (1055+018)

No0022_A.pdf (OJ287)

Station	Code	Fringes	Plots	Comments
Aa (ALMA)	A	yes	see below... For ALMA "L" = X and "R" = Y	
Ef	B	yes	c211d_No0001_1055+018_AB_LL.pdf, c211d_No0001_1055+018_AB_LR.pdf, c211d_No0001_1055+018_AB_RL.pdf, c211d_No0001_1055+018_AB_RR.pdf c211d_No0003_OJ287_AB_LL.pdf, c211d_No0003_OJ287_AB_LR.pdf, c211d_No0003_OJ287_AB_RL.pdf, c211d_No0003_OJ287_AB_RR.pdf c211d_No0014_4C39.25_AB_LL.pdf, c211d_No0014_4C39.25_AB_LR.pdf, c211d_No0014_4C39.25_AB_RL.pdf, c211d_No0014_4C39.25_AB_RR.pdf	
Pv	P	no	----------	down due to bad weather
Br	b	yes	c211d_No0017_1055+018_Ab_LR.pdf, c211d_No0017_1055+018_Ab_RL.pdf c211d_No0022_OJ287_Ab_LL.pdf, c211d_No0022_OJ287_Ab_LR.pdf, c211d_No0022_OJ287_Ab_RL.pdf, c211d_No0022_OJ287_Ab_RR.pdf	
Fd	f	yes	c211d_No0014_4C39.25_Af_LL.pdf, c211d_No0014_4C39.25_Af_LR.pdf, c211d_No0014_4C39.25_Af_RL.pdf, c211d_No0014_4C39.25_Af_RR.pdf	

		c211d_No0017_1055+018_Af_LL.pdf, c211d_No0017_1055+018_Af_LR.pdf, c211d_No0017_1055+018_Af_RL.pdf, c211d_No0017_1055+018_Af_RR.pdf c211d_No0022_OJ287_Af_LL.pdf, c211d_No0022_OJ287_Af_LR.pdf, c211d_No0022_OJ287_Af_RL.pdf, c211d_No0022_OJ287_Af_RR.pdf	

Full Continuum Correlation (86G v2)

Full correlation run under DiFX-2.7.1 with all stations, using the outputbands feature in DiFX with 64 MHz wide bands.

Station	Code	Fringes	Plots	Comments
Aa (ALMA)	A	**yes**	No0006	
Ef	B	**yes**	No0006	
Mh	Z	**yes**	No0006	poor weather
Pv	P	**no obs.**		did not observe, bad weather
Ys	Y	**no obs.**		did not observe, bad weather
GLT	G	no obs.		scheduled but not observed
Br	b	**yes**	No0022	
Fd	f	**yes**	No0022	
Kp	k	**yes**	No0022	poor weather?
La	l	**yes**	No0022	
Mk	m	**yes**	No0022	
Nl	n	**yes**	No0022	
Ov	o	**yes**	No0022	
Pt	p	**yes**	No0022	

Initial Line Correlation 1

All 4 line sources were correlated in all scans, that is scans No0002, No0004, No0005, No0008, No0010, No0011, No0012, No0013, No0015, No0016, No0018, No0019, No0020, No0021.

This correlation included ALMA, Ef, Pv (as control, knowing that it has no real signal), and 6 VLBA stations: Br, Fd, Mk, Nl, Ov, Pt.

The correlation frequency window was 86231 - 86236 MHz, fringe search window 86232.5 - 86234 MHz.

The following are some fringe plot examples:

RLEO: No0002_all.pdf, No0021_all.pdf

RLMI: No0013_all.pdf, No0015_all.pdf, No0016_all.pdf (including all stations)

VYCMA: No0019_all.pdf

RCNC: No0020_all.pdf

Unfortunatly, the problem with difx2mark4 / fourfit persists and so not all autocorrelations and baselines are available in these plots.

In general it seems, that ALMA successfully detects the spectral line in some cases, as seen in autocorrelation plots for RLEO and RLMI, however the crosscorrelation "fringes" with other stations are just artefacts created by fourfit, as confirmed by low SNR, random values of single-band delay (reliable clocks have already been established in continuum correlation), the shape of the "line" in cross-corr plots (basically just amplified noise spikes) and the fact that they are detected even for Pv, which must have no meaningful signal.

Initial Line Correlation 2

The correlation included the same stations with exception of Pv. A continuum correlation was performed for Mh, but no fringes were found, so it was not included in the line correlation.

To fix the problem with the difx2mark4 / fourfit, 8 zoom bands were created to cover all 64 MHz bands of the EVN configuration (and. of course, also 128 MHz bands of the VLBA) and overlap well with ALMA 62.5 MHz bands. Only the 4th one (band d in fourfit designations) is of interest, approximately centered at the line.

```
ZOOM narrow {
    addZoomFreq = freq@86045.000000/bw@12.0/noparent@true
    addZoomFreq = freq@86105.000000/bw@12.0/noparent@true
    addZoomFreq = freq@86165.000000/bw@12.0/noparent@true
    addZoomFreq = freq@86227.000000/bw@12.0/noparent@true # this one real
    addZoomFreq = freq@86295.000000/bw@12.0/noparent@true
    addZoomFreq = freq@86355.000000/bw@12.0/noparent@true
    addZoomFreq = freq@86415.000000/bw@12.0/noparent@true
    addZoomFreq = freq@86465.000000/bw@12.0/noparent@true
}
```

This time all autoccorelations and cross-correlations for all baselines, including VLBA stations with each other, were processed by fourfit with no problem. The full sets of fourfit plots are below, fringe search was performed in the passband of 86231.5 - 86235 MHz.

RLEO: No0002_all.pdf, No0004_all.pdf, No0005_all.pdf, No0010_all.pdf, No0021_all.pdf

RLMI: No0008_all.pdf, No0011_all.pdf, No0012_all.pdf

No0013_all.pdf, No0015_all.pdf, No0016_all.pdf (including all stations)

RCNC: No0020_all.pdf

No clear fringes were found yet, however in the autocorrelations of scans No0002 and No0004 the line is clearly visible in acutocorrs for Aa and Ef, and in scan No0021 — for Fd and Ov. And several cross-correlation plots show what seems to be a line profile, but with wrong delays.

One reasonable candidate for a cross-correlation fringe is the following:

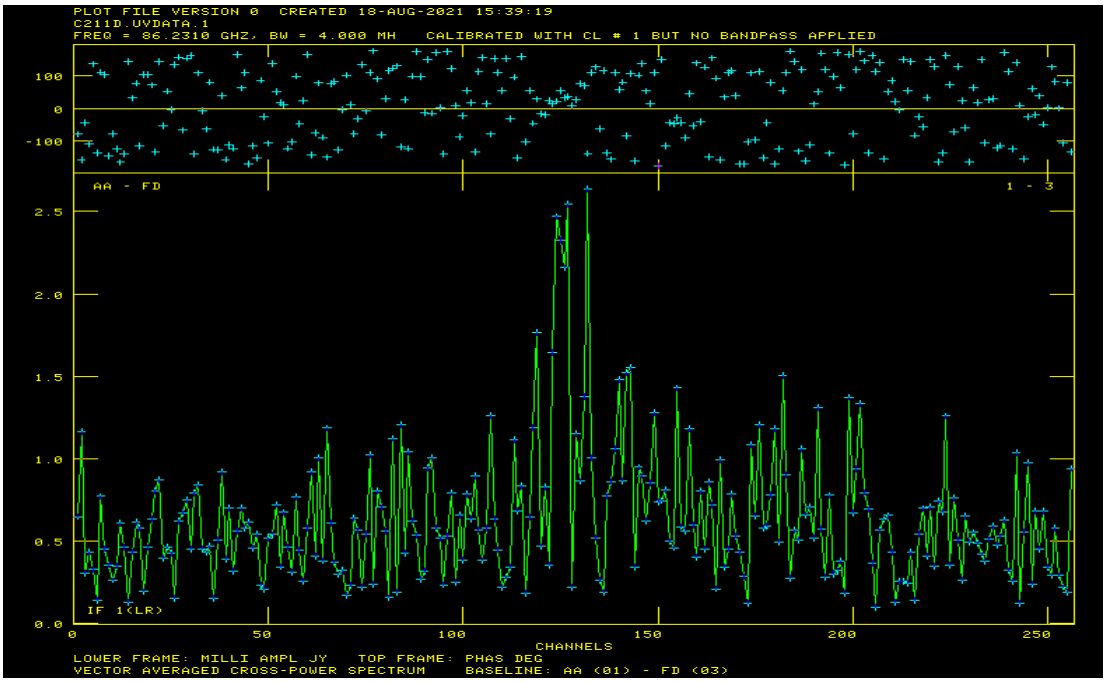
c211d_No0013_RLMI_Ao_XL.pdf

c211d_No0013_RLMI_Ao_XR.pdf

c211d_No0013_RLMI_Ao_YL.pdf

c211d_No0013_RLMI_Ao_YR.pdf

Looking at the same data with AIPS (it is a later correlation with slightly different parameters) provides the last bit of confirmation, that line shapes in some cross-correlation spectral analysis represent true if weak fringes: not only there is a peak at the right frequency, the phase also stabilizes for a few channels. Here's a good example of this:



Full Line Correlation (86G v2)

Carried out under DiFX 2.7.1 using outputbands.

Single 32 MHz wide IF of higher spectral resolution, centered on each source specific line velocity.

88 GHz correlation

continuum correlation

Scans No0023 and No0025 were observed on 3C273. In order to verify fringe detections to all stations a continuum correlation was done on these scans. In a first attempt a VLBA-only correlation was done without using any zoom/output bands. Fringes were detected for these stations: Br, FD, KP, LA, OV, PT. No fringes found for MK and NL despite using clock values that led to fringes in parts c211a, c211b c211c. NL generally had weak fringes in all other parts and MK dropped out of the observations regularly for the USNO time which possibly was the case here also. GL did not participate in c211d. The correlation was carried out using 128 MHz wide output bands.

Station	Code	Fringes	Plots	Comments
Aa (ALMA)	L	**yes**		
Br	b	**yes**		
Fd	f	**yes**		
Kp	k	yes		
La	l	yes		
Ov	o	yes		
Pt	p	yes		
Mk	m	no		
Nl	n	no		
Gl	-			did not participate

Notes

Unlike the c211a, c211b, and c211c parts of the session c211d was not affected by the 3MHz LO-offset at ALMA. Fringes were found with the band center frequency set to 86268.0 and 88268.0 for the 86GHz and 88GHz scans.

Usable ALMA APP QA2 solutions not available to Bonn. Instead, PolConvert will be done at MIT Haystack, starting from an initial APP QA2 produced by Ivan M Vidal.

Post-Correlation checks

Residuals

FITS completeness (pclist)