

VieRDS: Informal Documentation

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Abstract

A informal documentation of VieRDS is presented. This documentation describes download and installation, how to run the software, and several examples with results are presented. The results are presented by fourfit plots obtain from DiFX correlation. All examples can be reproduced by using the corresponding input_val.yaml files which are shown next to the fourfit plots. More information of the algorithms are shown in the corresponding PASP article.

VLBI, raw telescope data, simulations

1 Download and Installation

Download or clone the repository to your directory (e.g. /home/jakob/software/BasebandSim). The folder contains a CODE/ folder, a DIFX/ folder, and an EXAMPLES/ folder. In the CODE/ folder the Matlab library of VieRDS is stored. In the DIFX/ folder auxiliary scripts are stored to run DiFX and fourfit. In the EXAMPLES/ folder examples of VieRDS simulations are stored.

The main function of VieRDS is vierds.m. This function needs to be executed to run VieRDS. The function vierds.m requires one argument: the input_val.yaml file. In the next section 2 an example of how to execute VieRDS is presented. In section 5 several examples are presented to realize simulations with VieRDS.

2 Run

2.1 With Matlab Installation from Linux Command Line

VieRDS is configured by one input text file. It is called input_val.yaml. Several examples of the input_val.yaml file can be found in section 5.

To run VieRDS under Linux execute

```
/usr/local/MATLAB/R2020a/bin/matlab -c ~/.matlab/R2020a/licenses/license_jgruber1_338656  
-r 'vierds input_val.yaml; exit;'
```

Description of command:

```

/usr/local/MATLAB/R2020a/bin/matlab ... Matlab installation directory
-c ~/.matlab/R2020a/licenses/license_jgruber1_338656_R2020a.lic ... path to license
-nodisplay -nosplash -nodesktop ... run it without the GUI
-r 'vierds_input_val.yaml;_exit;' ...
... run vierds.m script with argument input_val.yaml

```

2.2 Without Matlab Installation from Linux Command Line

3 Software Output

When you run vierds.m a output folder according to the processing time tag will be created. The output folder will stored in OUT/.

4 DiFX Correlation and Fourfit Fringe-Fitting

To process the simulated basebanddata go to the output folder described in section 3 and execute:

```
DIFX/easy_corr.sh
```

Make sure to edit the lines in the machines file name according to your machine name.

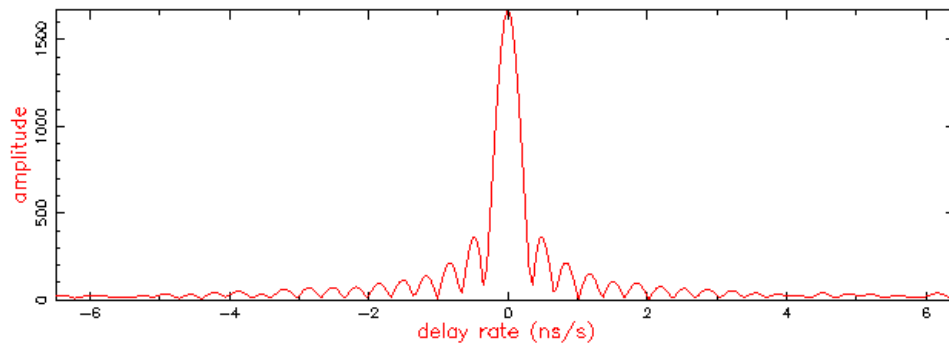
5 Simulation Examples

In this section, several examples for simulations with VierDS are presented. The input_val.yaml file is shown and the corresponding fourfit fringe-plots are shown. To reproduce the results, copy the presented input_val.yaml file to the head of the VierDS folder and execute the command shown in section 2.

5.1 Zero Baseline Simulation

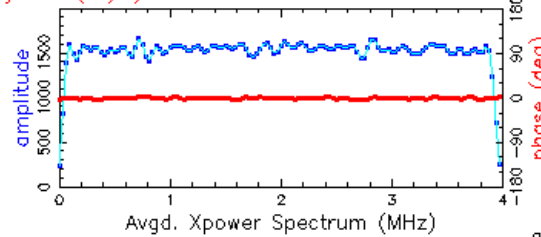
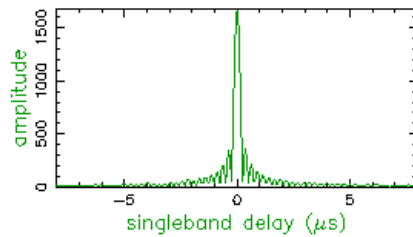
5.1.1 Very Basic

```
setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: WETTZELL
  station_name_trf_coord: Wz
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 10
  fluxdensity_system: 50
  f0: 3016.30
  number_of_bits: 1
  source_name: 0026+892
  bandpass_filter_name: default
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: YEBES12M
  station_name_trf_coord: Ys
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 10
  fluxdensity_system: 50
  f0: 3016.30
  number_of_bits: 1
  source_name: 0026+892
  bandpass_filter_name: default
```



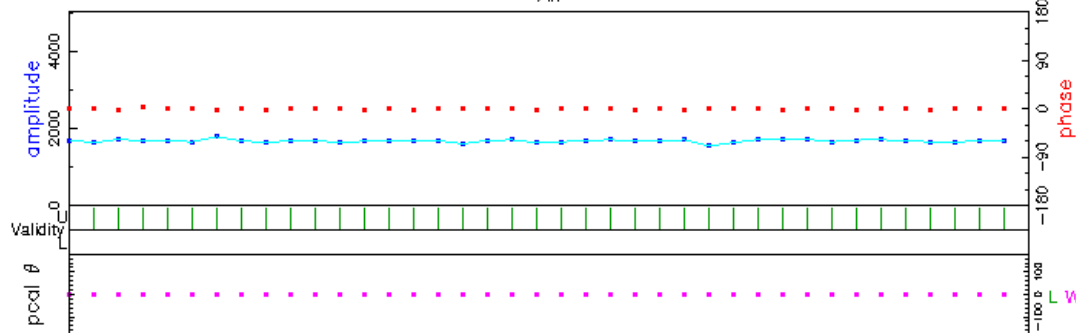
Fringe quality 9

SNR 290.4
Int time 0.984
Amp 1674.906
Phase -0.3
PFD 0.0e+00
Delays (us)
SBD -0.000192
MBD -0.000200
Fringe rate (Hz)
0.000820
Ion TEC 0.000
Ref freq (MHz)
3014.3000
AP (sec) 0.026



Exp. sim
Exper # 16383
Yr:day 2020:028
Start 173000.00
Stop 173001.00
FRT 173000.00
Corr/FF/build
2020:321:1 65412
2020:321:1 85025
2020:111:1 81228
RA & Dec (J2000)
03h49m10.987080s
+00°00'00.000000"

Amp. and Phase vs. time for each freq., 39 segs, 1 APs / seg (0.03 sec / seg.), time ticks 1 sec
All



3014.30
-0.3
1674.9
129.0
U/L 3300
L 0
W 0
L:W 0.0
L:W 0.0
L 1000
W 1000
L X000UR
W X000UR

Chan ds
Chan ds

Group delay (usec)(mode)	-1.99976113857E-04	Apr or delay (usec)	0.0000000000E+00	Res d mbdelay (usec)	-1.99976E-04	+/- 4.7E-04
Sband delay (usec)	-1.32000000000E-04	Apr or c ock (usec)	0.0000000000E+00	Res d sbdelay (usec)	-1.32000E-04	+/- 4.7E-04
Phase delay (usec)	-2.69238773877E-07	Apr or c ockrate (us/s)	0.0000000000E+00	Res d phdelay (usec)	-2.69239E-07	+/- 3.6E-07
Delay rate (us/s)	2.72140304788E-07	Apr or rate (us/s)	0.0000000000E+00	Res d rate (us/s)	2.72140E-07	+/- 6.3E-07
Total phase (deg)	-0.3	Apr or accoe (us/s/s)	0.0000000000E+00	Res d phase (deg)	-0.3	+/- 0.4

RMS Theor. Amp tude 1674.906 +/- 5.768
ph/seg (deg) 1.2 1.2 Search (128X8) 1674.903
amp/seg (%) 2.3 2.2 Interp. 0.000
prv/fq (deg) 0.0 0.2 Inc. seg. avg. 1674.896
amp/fq (%) 0.0 0.3 Inc. frq. avg. 1674.895

Pca mode: MANUAL, MANUAL PC period (APs) 5, 5
Pca rate: 0.000E+00, 0.000E+00 (us/s) sb w ndow (us) -8.000 8.000
B ts/sample: 1x1 SampCntNorm: dsab ed mb w ndow (us) -0.000 0.000
Sample rate(MSamp/s): 8 drw ndow (ns/s) -6.480 6.480
Data rate(Mb/s): 8 nags: 128 t_coherence n f n te on w ndow (TEC) 0.00 0.00

L: az 160.8 e 39.3 pa -12.4 W: az 160.8 e 39.3 pa -12.4 u,v (fr/sec) 0.000 0.000 s mutaneous nterpol
Contro 1 e: default Input 1 e: /home/jakob/software/BasebandS m/KUT/zerobase ne_001_very_bas c/1234/SIM001/LW_1F4TV8 Output 1 e: Suppressed by test mode

5.1.2 Arbitrary Magnitude Filter: Station Frequency Response

```
setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: KOKEE12M
  station_name_trf_coord: K2
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 64
  scan_length: 1
  fluxdensity_targetsource: 50
  fluxdensity_system: 50
  f0: 3016.30
  number_of_bits: 2
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892
  bandpass_filter_name: default
  arb_mag_file_1: K2.txt
  arb_mag_filter_signal_type_1: super
  arb_mag_interpolation_res_1: 1e3
  arb_mag_filter_order: 300
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: YEBES12M
  station_name_trf_coord: Ys
  sampling_frequency: 64
  scan_length: 1
  fluxdensity_targetsource: 10
  fluxdensity_system: 50
  f0: 3016.30
  number_of_bits: 2
  source_name: 0026+892
  bandpass_filter_name: default
```

F (GHz)	Mag	F (GHz)	Mag
3.000400	0.044193	3.016650	2.710862
3.000650	0.062204	3.016900	2.707471
3.000900	0.103179	3.017150	2.706091
3.001150	0.183057	3.017400	2.703437
3.001400	0.261378	3.017650	2.703482
3.001650	0.393336	3.017900	2.703735
3.001900	0.543534	3.018150	2.704476
3.002150	0.700005	3.018400	2.706426
3.002400	0.876209	3.018650	2.709184
3.002650	1.053162	3.018900	2.712081
3.002900	1.232959	3.019150	2.723395
3.003150	1.412478	3.019400	2.731020
3.003400	1.590275	3.019650	2.733028
3.003650	1.754650	3.019900	2.737126
3.003900	1.915873	3.020150	2.732720
3.004150	2.075617	3.020400	2.717076
3.004400	2.227008	3.020650	2.702468
3.004650	2.362459	3.020900	2.690739
3.004900	2.479694	3.021150	2.674824
3.005150	2.578114	3.021400	2.663886
3.005400	2.654331	3.021650	2.654963
3.005650	2.711728	3.021900	2.648248
3.005900	2.757487	3.022150	2.641970
3.006150	2.802019	3.022400	2.637719
3.006400	2.841063	3.022650	2.633201
3.006650	2.871627	3.022900	2.631797
3.006900	2.898534	3.023150	2.627386
3.007150	2.921241	3.023400	2.624240
3.007400	2.937567	3.023650	2.620748
3.007650	2.951368	3.023900	2.620170
3.007900	2.966399	3.024150	2.625760
3.008150	2.972899	3.024400	2.628006
3.008400	2.977383	3.024650	2.621404
3.008650	2.978795	3.024900	2.618467
3.008900	2.978899	3.025150	2.602479
3.009150	2.980630	3.025400	2.572535
3.009400	2.983068	3.025650	2.541222
3.009650	2.979730	3.025900	2.510501
3.009900	2.980404	3.026150	2.466307
3.010150	2.973435	3.026400	2.420613
3.010400	2.957100	3.026650	2.368399
3.010650	2.942613	3.026900	2.308377
3.010900	2.929595	3.027150	2.239787
3.011150	2.914425	3.027400	2.162666
3.011400	2.901956	3.027650	2.077228
3.011650	2.891284	3.027900	1.982237
3.011900	2.882199	3.028150	1.877392
3.012150	2.875131	3.028400	1.761273
3.012400	2.869162	3.028650	1.634952
3.012650	2.866354	3.028900	1.499963
3.012900	2.864326	3.029150	1.359951
3.013150	2.861510	3.029400	1.196208
3.013400	2.859163	3.029650	1.020491
3.013650	2.854946	3.029900	0.865441
3.013900	2.849708	3.030150	0.709193
3.014150	2.849802	3.030400	0.552803
3.014400	2.844400	3.030650	0.420985
3.014650	2.832448	3.030900	0.310697
3.014900	2.823164	3.031150	0.195493
3.015150	2.806697	3.031400	0.149515
3.015400	2.781994	3.031650	0.097383
3.015650	2.760481	3.031900	0.079180
3.015900	2.744270	3.032150	0.079675
3.016150	2.726962		
3.016400	2.717698		

Figure 1: Frequency-Magnitude table for the simulation of an arbitrary magnitude filter. Copy the values without the header to a text file called K2.txt as specified by the parameter "arb_mag_file_1" to run the simulation.

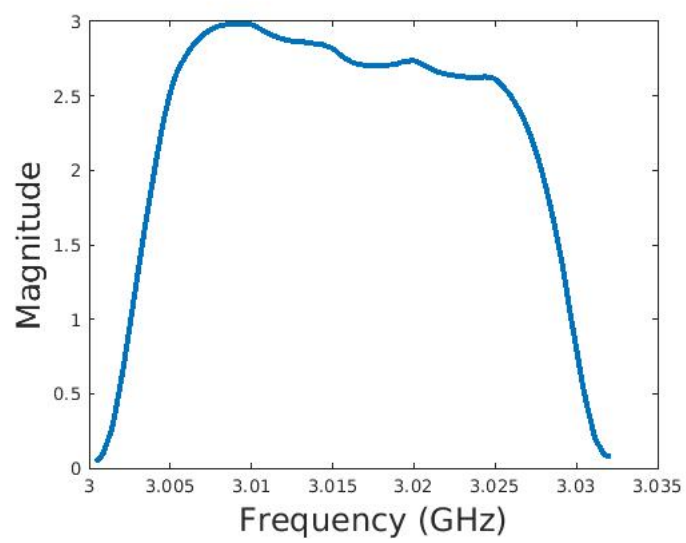
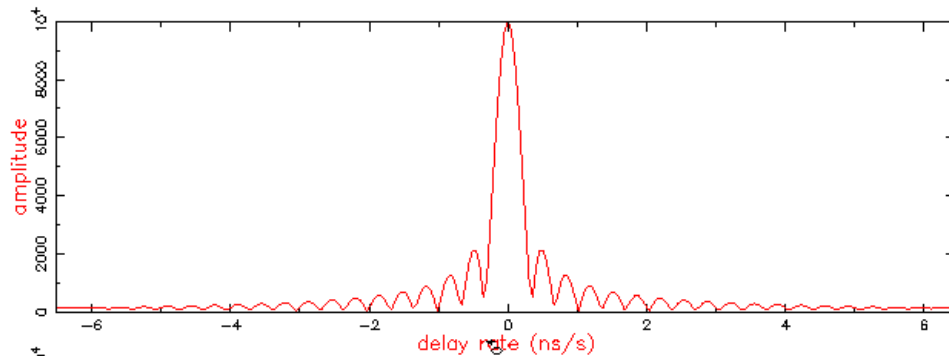
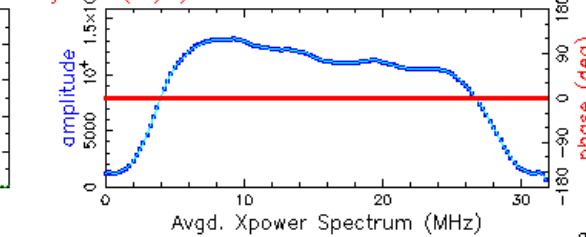
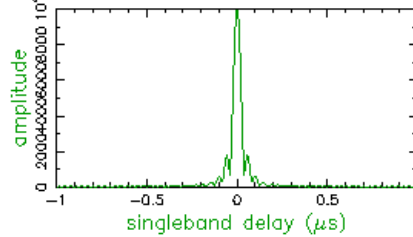


Figure 2: Plot of the values listed in the Figure 1



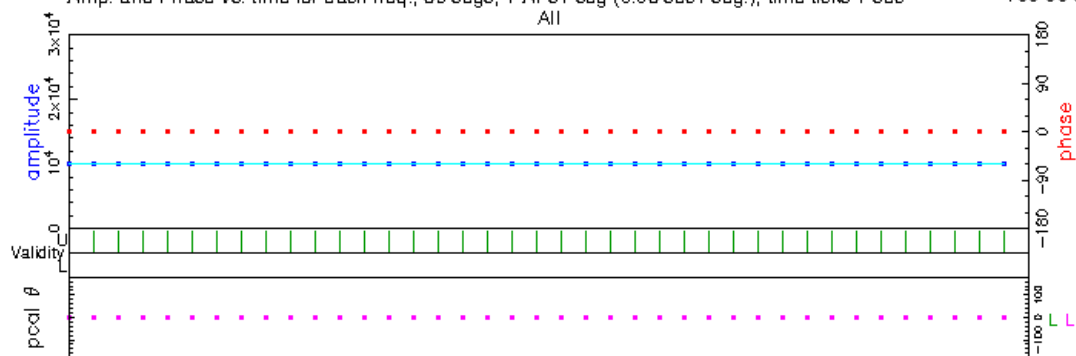
Fringe quality 9

SNR 6784.7
Int time 0.985
Amp 10000.000
Phase -0.0
PFD 0.0e+00
Delays (us)
SBD 0.000000
MBD -0.000196
Fringe rate (Hz)
0.000000
Ion TEC 0.000
Ref freq (MHz)
3000.3000
AP (sec) 0.026



Exp. sim
Exper # 16383
Yr:day 2020:028
Start 173000.00
Stop 173001.00
FRT 173000.00
Corr/FF/build
2020:321:1 74004
2020:321:1 74025
2020:111:1 81228
RA & Dec (J2000)
03h49m10.987080s
+00°00'00.000000"

Amp. and Phase vs. time for each freq., 39 segs, 1 APs / seg (0.03 sec / seg.), time ticks 1 sec
All



Validity

pcal θ

3000.30
-0.0
10000.0
129.0
U/L 330
L 0
L 0
L:L 0.0
L:L 0.0
L 1000
L 1000
L X000UR
L X000UR

Freq (MHz)
Phase
Amp.
Sbd box
APs used
PC freqs
PC freqs
PC phase
Man PC
PC amp

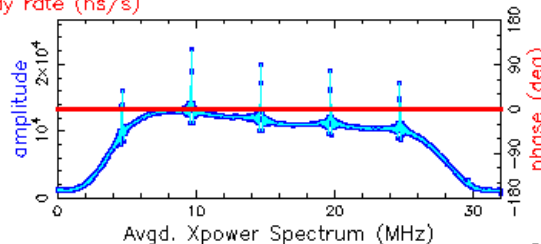
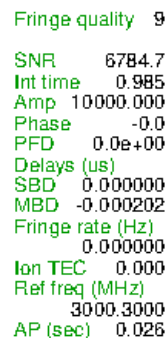
Chan ds
Chan ds

Group delay (usec)(mode)	-1.35380401960E-04	Apr or delay (usec)	0.000000000E+00	Res d mbdelay (usec)	-1.35380E-04	+/- 2.5E-06
Sband delay (usec)	0.000000000E+00	Apr or c lock (usec)	0.0000000E+00	Res d sbdelay (usec)	0.00000E+00	+/- 2.5E-06
Phase delay (usec)	-2.62053767756E-16	Apr or c lockrate (us/s)	0.0000000E+00	Res d phdelay (usec)	-2.62054E-16	+/- 1.6E-08
Delay rate (us/s)	0.000000000E+00	Apr or rate (us/s)	0.0000000E+00	Res d rate (us/s)	0.00000E+00	+/- 2.7E-08
Total phase (deg)	-0.0	Apr or accse (us/s/s)	0.0000000E+00	Res d phase (deg)	-0.0	+/- 0.0
RMS	Theor.	Amp tude	10000.000 +/- 1.474	Pca mode: MANUAL, MANUAL	PC period (APs) 5, 5	
ph/seg (deg)	0.0	Search (128X8)	10000.000	Pca rate: 0.000E+00, 0.000E+00 (us/s)	sb window (us)	-1.000 1.000
amp/seg (%)	0.0	Interp.	0.000	B ts/sample: 2x2	mb window (us)	-0.000 0.000
ph/freq (deg)	0.0	Inc. seg. avg.	9999.996	Sample rate (MSamp/s): 64	drw window (ns/s)	-6.510 6.510
amp/freq (%)	0.0	Inc. frq. avg.	10000.000	Data rate (Mb/s): 128	nags: 128 t_coherence nfn te	on window (TEC) 0.00 0.00
L: az 160.8 e 39.3 pa -12.4 L: az 160.8 e 39.3 pa -12.4 u.v (fr/sec) 0.000 0.000 simultaneous interp at						

Contro 1 e: default Input 1 e: /home/jakob/software/BasebandS m/OUT/2020_321_18_37_44/1234/SIM001/LL.1 F4VZO Output 1 e: Suppressed by test mode

5.1.3 Phase Calibration Signal

```
setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: KOKEE12M
  station_name_trf_coord: K2
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 64
  scan_length: 1
  fluxdensity_targetsource: 50
  fluxdensity_system: 50
  f0: 3016.30
  number_of_bits: 2
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892
  bandpass_filter_name: default
  arb_mag_file_1: K2.txt
  arb_mag_filter_signal_type_1: super
  arb_mag_interpolation_res_1: 1e3
  arb_mag_filter_order: 300
  phase_cal_tone_power_perc: 0.9
  phase_cal_repetition_rate: 5.0
  phase_cal_phase_offset: 0
  phase_cal_frequency_offset: -310000
  phase_cal_delay: 0.0
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: YEBES12M
  station_name_trf_coord: Ys
  sampling_frequency: 64
  scan_length: 1
  fluxdensity_targetsource: 10
  fluxdensity_system: 50
  f0: 3016.30
  number_of_bits: 2
  source_name: 0026+892
  bandpass_filter_name: default
```



```

Exp.          sim
Exper #      16383
Yr:day       2020:028
Start        173000.00
Stop         173001.00
FRT          173000.00
Corr/FF/build
2020:321:1 74934
2020:321:1 74939
2020:111:1 81228
RA & Dec (J2000)
3h49m10.987080s
+00°00'00.000000"

```

Amp. and Phase vs. time for each freq., 39 segs, 1 APs / seg (0.03 sec / seg.), time ticks 1 sec



Group delay [usec] (mode)	-2.01511848819E-04	Apr or delay [usec]	0.0000000000E+00	Res d mbde ay [usec]	-2.01512E-04	+/-	2.5E-06
Sband delay [usec]	0.0000000000E+00	Apr or cck rate [usec]	0.00000000E+00	Res d sbde ay [usec]	0.00000E+00	+/-	2.5E-06
Phase delay [usec]	-2.73246973906E-16	Apr or cckrate [us/s]	0.00000000E+00	Res d phde ay [usec]	-2.73247E-16	+/-	1.6E-08
De lay rate [us/s]	0.0000000000E+00	Apr or rate [us/s]	0.0000000000E+00	Res d rate [us/s]	0.00000E+00	+/-	2.7E-08
Total phase [deg]	-0.0	Apr or acce [us/s/s]	0.0000000000E+00	Res d phase [deg]	-0.0	+/-	0.0

	RMS	Theor.	Amp tude	10000.000 +/- 1.474	Pca mode: MANUAL	MANUAL	PC period [AP's] 5, 5		
phfseq [deg]	0.0	0.1	Interp.	10000.000	Pca rate: 0.000E+00,	0.000E+00 [us/s]	sb w ndow [us]	-8.000	8.000
ampfseq [%]	0.0	0.1	Interp.	0.000	B ts/sample: 2x2	SampCntrNorm: d sabed	mb w ndow [us]	-0.000	0.000
phfrq [deg]	0.0	0.0	Inc. seq. avg.	9999.996	Sample rate[MSample]: 64		drr w ndow [ns/s]	-6.510	6.510
amprfq [%]	0.0	0.0	Inc. frq. avg.	10000.000	Data rate[Mb/s]: 128	nags: 1024 t_cohere nfinite	on w ndow [TEC]	0.00	0.00

L: az 160.8 e 39.3 pa -12.4 L: az 160.8 e 39.3 pa -12.4 u/v f[r/sec] 0.000 0.000 s mutaneous interp at

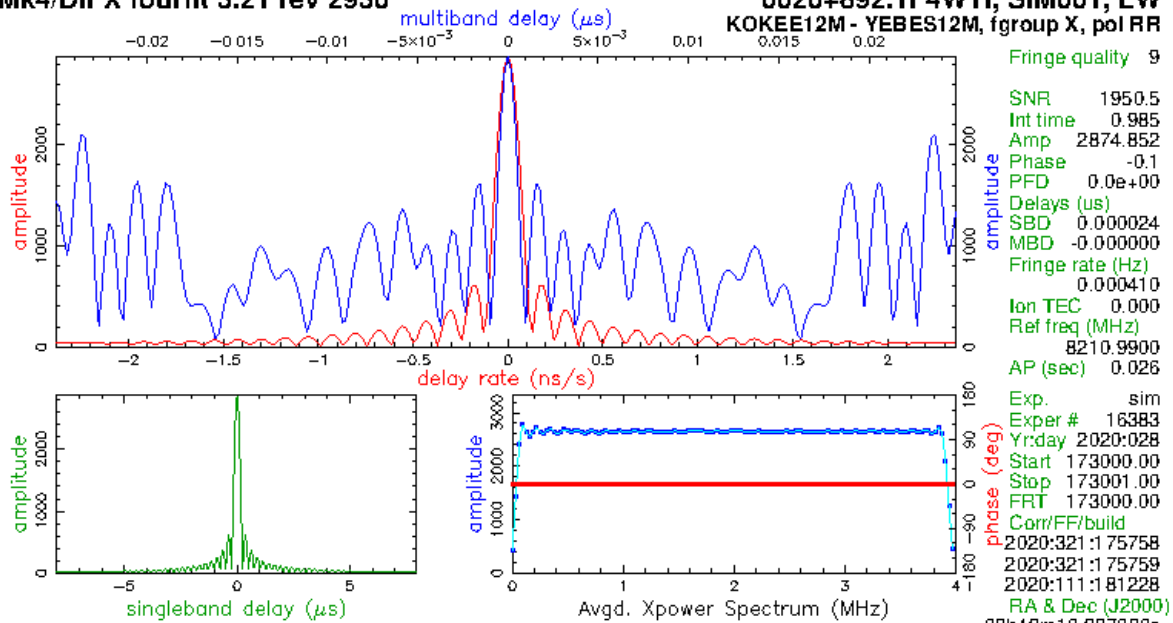
Contro l: default Input file: /home/jakob/software/BasebandS m/OUT/2020_321_18_44_57N234/SIM001/L.L.1.F4WRF Output file: Suppressed by test mode

5.1.4 8 Channel X-band

```
setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: KOKEE12M
  station_name_trf_coord: K2
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 50
  fluxdensity_system: 50
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892
  bandpass_filter_name: default
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: YEBES12M
  station_name_trf_coord: Ys
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 10
  fluxdensity_system: 50
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  source_name: 0026+892
  bandpass_filter_name: default
```

Mk4/DiFX fourfit 3.21 rev 2936

0026+892.1F4WTI, SIM001, LW
KOE12M - YEBES12M, fgroup X, pol RR

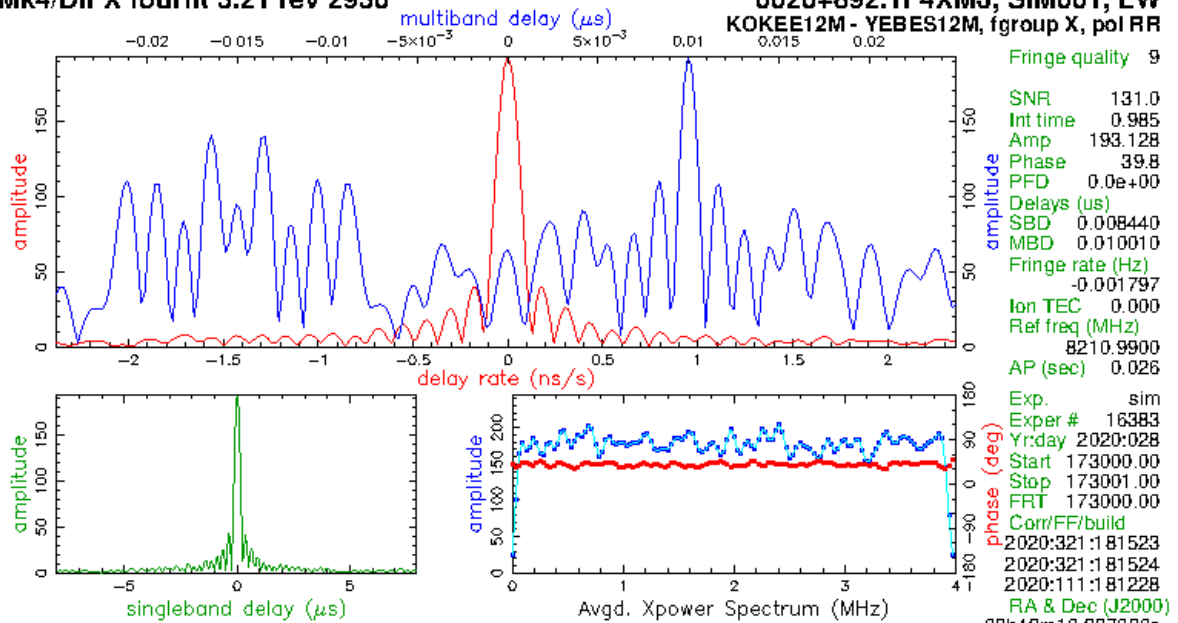


5.1.5 8 Channel X-band plus 10 ns Multiband Delay

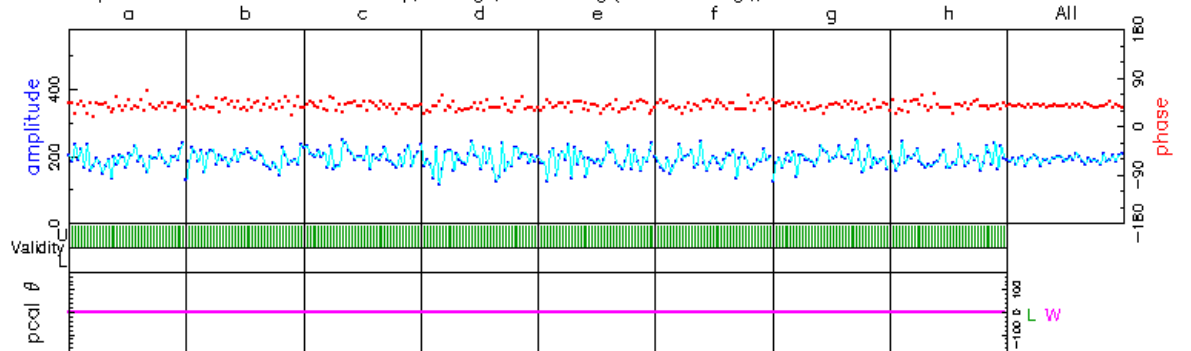
```
setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: KOKEE12M
  station_name_trf_coord: K2
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 1
  fluxdensity_system: 50
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892
  bandpass_filter_name: default
  delay_source: 10
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: YEBES12M
  station_name_trf_coord: Ys
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 1
  fluxdensity_system: 50
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  source_name: 0026+892
  bandpass_filter_name: default
```

Mk4/DiFX fourfit 3.21 rev 2936

0026+892.1F4XMJ, SIM001, LW
KOKEE12M - YEBES12M, fgroup X, pol RR



Amp. and Phase vs. time for each freq., 39 segs, 1 APs / seg (0.03 sec / seg.), time ticks 1 sec



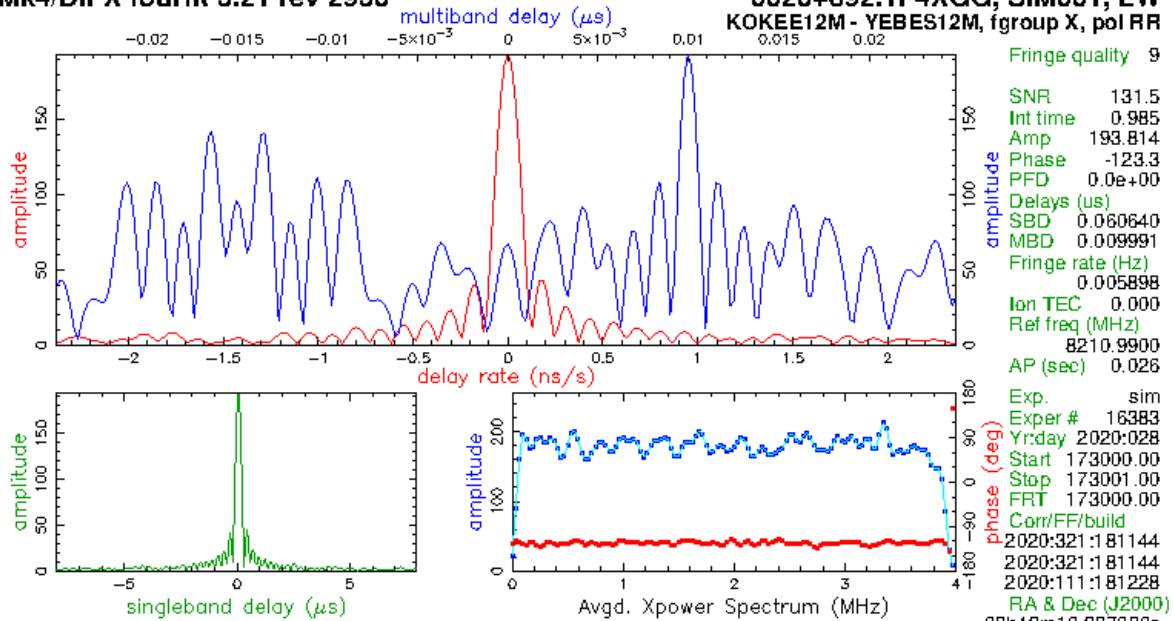
	8210.99	8250.99	8350.99	8510.99	8730.99	8850.99	8890.99	8930.99	Freq (MHz)	A
	39.4	41.3	39.9	38.0	39.3	40.9	39.9	40.0	Phase	39.8
	191.7	193.8	200.2	190.0	192.2	188.4	194.4	191.9	Amp.	192.8
	129.1	129.2	129.1	129.1	129.1	129.1	129.1	129.1	Sbd box	129.1
U/L	39/0	39/0	39/0	39/0	39/0	39/0	39/0	39/0	APs used	
L	0	0	0	0	0	0	0	0	PC freqs	
W	0	0	0	0	0	0	0	0	PC freqs	
L:W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	PC phase	
L:W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Man PC	
L	1000	1000	1000	1000	1000	1000	1000	1000	PC amp	
W	1000	1000	1000	1000	1000	1000	1000	1000		
L	X00UR	X01UR	X02UR	X03UR	X04UR	X05UR	X06UR	X07UR	Chan ds	
W	X00UR	X01UR	X02UR	X03UR	X04UR	X05UR	X06UR	X07UR	Tracks	
									Chan ds	
									Tracks	
Group de ay (usec)(mode)	1.00100000000E-02		Apr or de ay (usec)		0.0000000000E+00		Res d mbde ay (usec)	1.001000E-02	+/-	4.4E-06
Sband de ay (usec)	8.44000000000E-03		Apr or c ock (usec)		0.0000000000E+00		Res d sbde ay (usec)	8.440000E-03	+/-	1.1E-03
Phase de ay (usec)	1.34780923960E-05		Apr or c ockrate (us/s)		0.0000000000E+00		Res d phde ay (usec)	1.34781E-05	+/-	3.0E-07
De ay rate (us/s)	-2.18837807060E-07		Apr or rate (us/s)		0.0000000000E+00		Res d rate (us/s)	-2.18838E-07	+/-	5.1E-07
Total phase (deg)		39.8	Apr or acce (us/s/s)		0.0000000000E+00		Res d phase (deg)	39.8	+/-	0.9
RMS		Theor.	Amp tude	193.128 +/- 1.474	Pca mode: MANUAL, MANUAL	PC perod (APs) 5, 5				
ph/seg (deg)	2.6	2.7	Search (128X256)	192.077	Pca rate: 0.000E+00, 0.000E+00 (us/s)	sb w ndow (us)	-8.000	8.000		
amp/seg (%)	4.9	4.8	Interp.	0.000	B ts/sample: 2x2	SampCntNorm: dsab ed	mb w ndow (us)	-0.025	0.025	
ph/frq (deg)	1.1	1.2	Inc. seg. avg.	192.764	Sampe rate(MSamp/s): 8		drw ndow (ns/s)	-2.379	2.379	
amp/frq (%)	1.7	2.2	Inc. frq. avg.	192.764	Data rate(Mb/s): 128	nags: 128	t_coheie nfn te	on w ndow (TEC)	0.00	0.00
L: az 160.8 e 39.3 pa -12.4 W: az 160.8 e 39.3 pa -12.4 u,v (fr/sec) 0.000 0.000 s mutaneous interpo at										
Contro t e: defaut Input f e: /home/jakob/software/BasebandS mKOUT/2020_321_19_13_34/0026+892.1F4XMJ Output f e: Suppressed by test mode										

5.1.6 8 Channel X-band plus 60 ns Multiband Delay

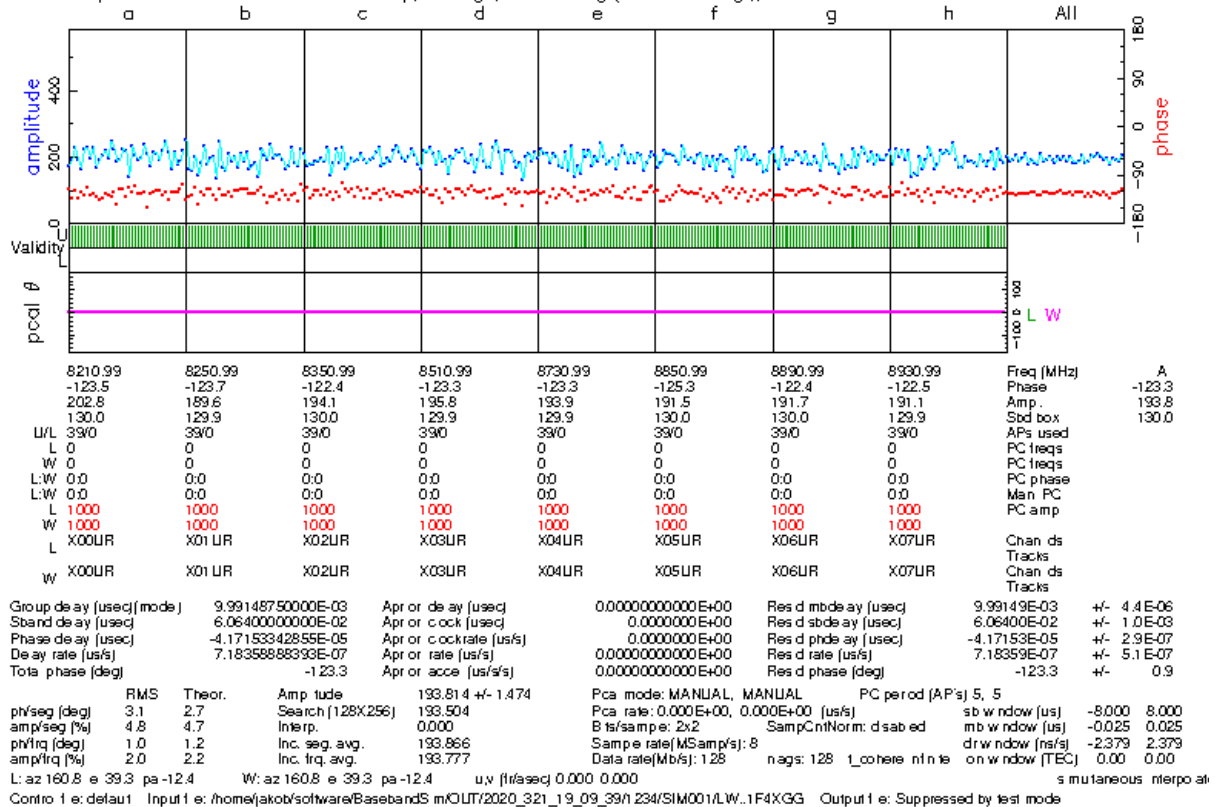
```
setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: KOKEE12M
  station_name_trf_coord: K2
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 1
  fluxdensity_system: 50
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892
  bandpass_filter_name: default
  delay_source: 60
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: YEBES12M
  station_name_trf_coord: Ys
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: 1
  fluxdensity_system: 50
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  source_name: 0026+892
  bandpass_filter_name: default
```

Mk4/DiFX fourfit 3.21 rev 2936

0026+892.1F4XGG, SIM001, LW
KOE12M - YEBES12M, fgroup X, pol RR



Amp. and Phase vs. time for each freq., 39 segs, 1 APs / seg (0.03 sec / seg.), time ticks 1 sec

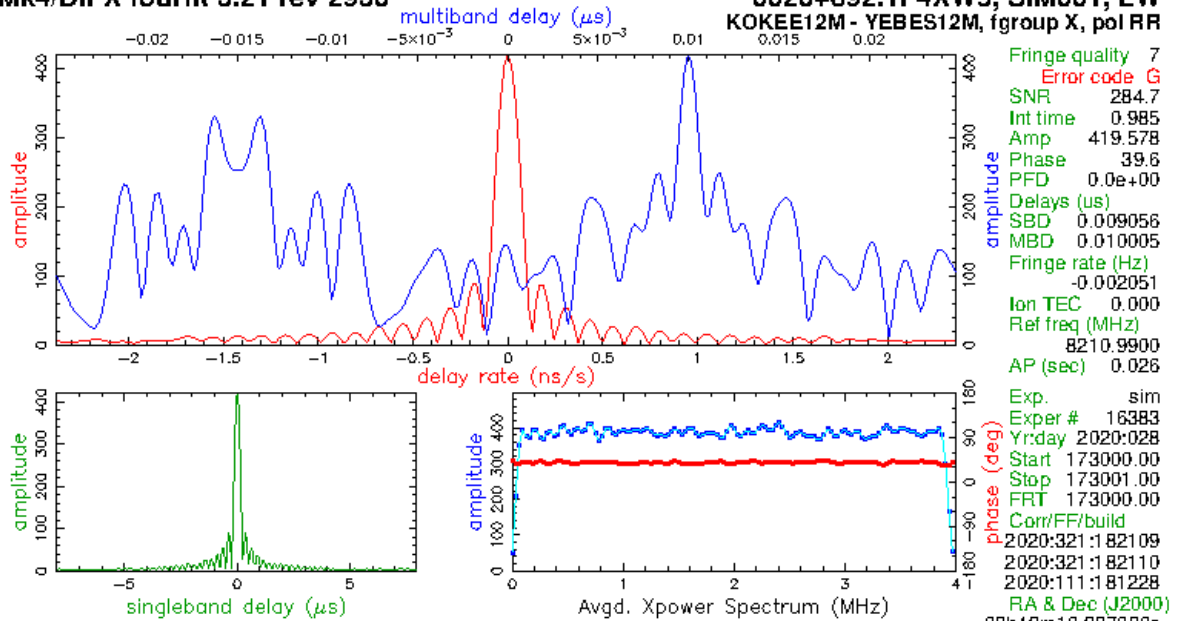


5.1.7 8 Channel X-band with Increasing Source Flux

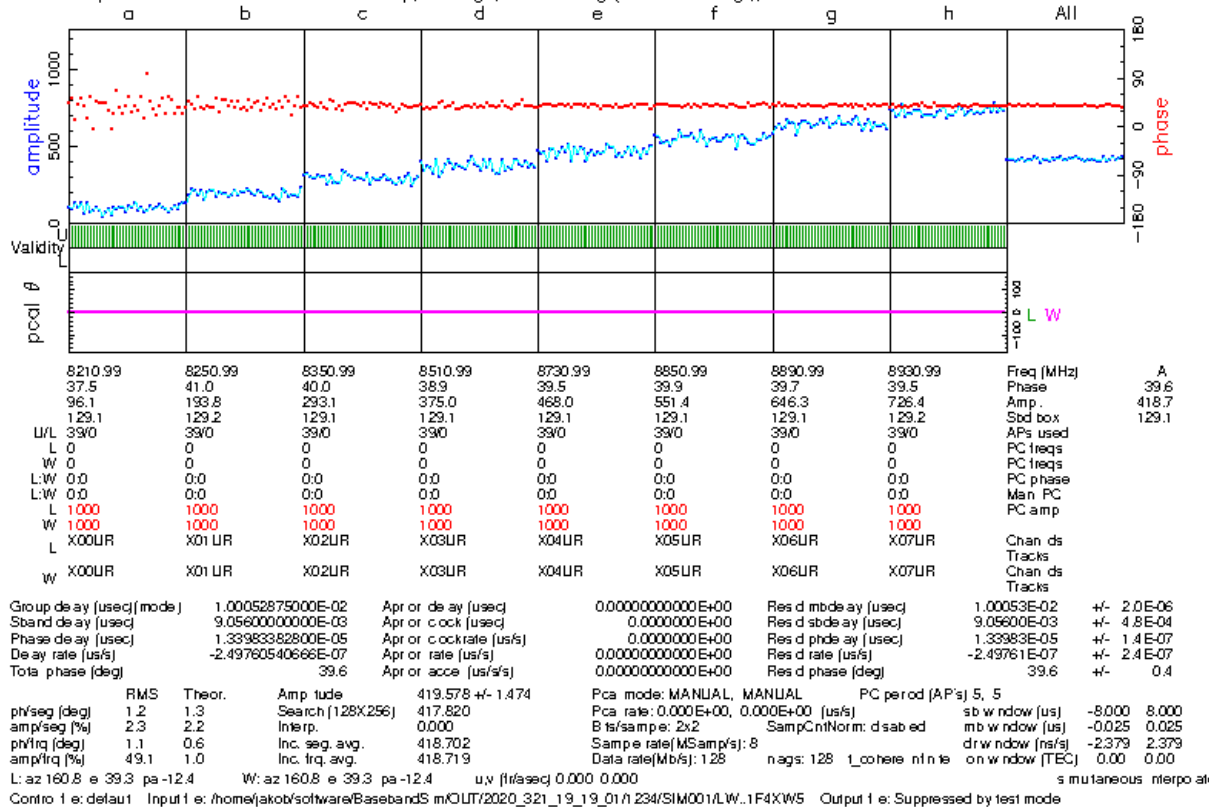
```
setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: KOKEE12M
  station_name_trf_coord: K2
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: [1,2,3,4,5,6,7,8]
  fluxdensity_system: 100
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892
  bandpass_filter_name: default
  delay_source: 10
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: YEBES12M
  station_name_trf_coord: Ys
  sampling_frequency: 8
  scan_length: 1
  fluxdensity_targetsource: [1,2,3,4,5,6,7,8]
  fluxdensity_system: 100
  f0: [8212.99, 8252.99, 8352.99, 8512.99, 8732.99, 8852.99, 8892.99, 8932.99]
  number_of_bits: 2
  source_name: 0026+892
  bandpass_filter_name: default
```

Mk4/DiFX fourfit 3.21 rev 2936

0026+892.1F4XW5, SIM001, LW
KOEK12M - YEBES12M, fgroup X, pol RR



Amp. and Phase vs. time for each freq., 39 segs, 1 APs / seg (0.03 sec / seg.), time ticks 1 sec



5.1.8 VGOS 32 Channel Setup with Dispersive Group Delay due Ionosphere 8 TEC (sampling frequency 1 MHz, can be simulated on private machine)

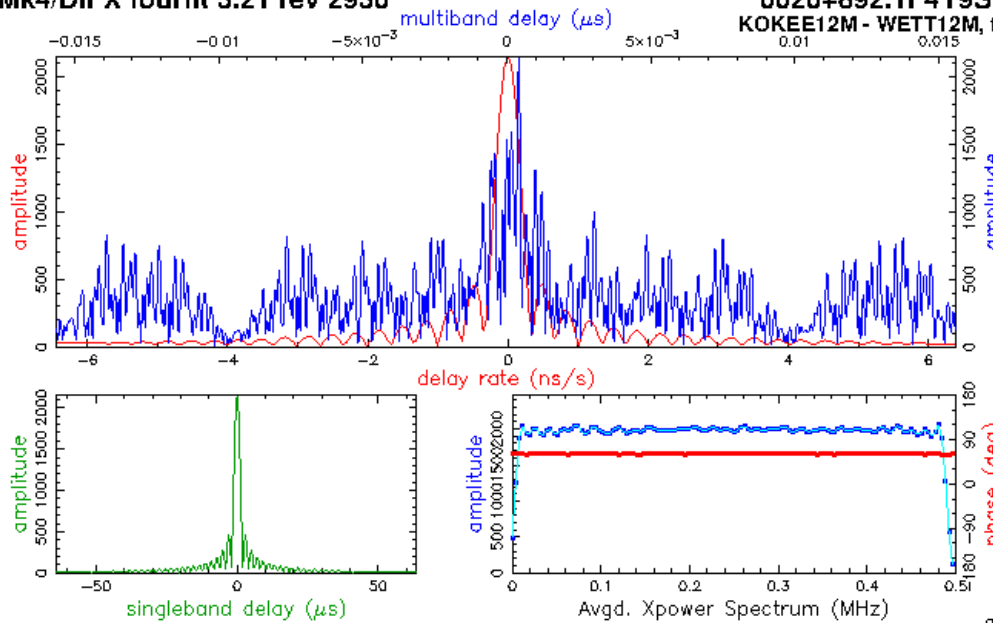
```

setup:
  zero_bl: 1
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: KOKEE12M
  station_name_trf_coord: K2
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 1
  scan_length: 1
  fluxdensity_targetsource: 20
  fluxdensity_system: 60
  f0:
    [3032.40,3064.40,3096.40,3224.40,3320.40,3384.40,3448.40,3480.40,5272.40,5304.40
    ,5336.40,5464.40,5560.40,5624.40,5688.40,5720.40, 6392.40, 6424.40, 6456.40,
    6584.40, 6680.40, 6744.40, 6808.40, 6840.40,10232.40, 10264.40, 10296.40,
    10424.40, 10520.40, 10584.40, 10648.40, 10680.40]
  number_of_bits: 1
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892
  delay_source: [-0.569826, -0.545521, -0.521966, -0.434654, -0.375689,
    -0.339136, -0.304599, -0.288041, 0.213037, 0.217692, 0.222263, 0.239753,
    0.252085, 0.259957, 0.267566, 0.271275, 0.336757, 0.339373, 0.341950, 0.351885,
    0.358965, 0.363518, 0.367943, 0.370109, 0.497263, 0.497902, 0.498536, 0.501012,
    0.502811, 0.503982, 0.505133, 0.505701]
  phaseoff_source: [-44.577691, -44.112163, -43.656258, -41.923135, -40.710988,
    -39.941097, -39.199784, -38.839353, -25.638204, -25.483533, -25.330717,
    -24.737351, -24.310255, -24.033624, -23.763218, -23.630285, -21.146122,
    -21.040791, -20.936505, -20.529497, -20.234477, -20.042462, -19.854058,
    -19.761178, -13.210386, -13.169201, -13.128273, -12.967071, -12.848745,
    -12.771053, -12.694295, -12.656260]
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: WETT12M
  station_name_trf_coord: WS
  X_trf: [4.0755139837000000e+06,9.317353092000000e+05,4.801629401000000e+06]
  sampling_frequency: 1
  scan_length: 1
  fluxdensity_targetsource: 20
  fluxdensity_system: 60
  f0:
    [3032.40,3064.40,3096.40,3224.40,3320.40,3384.40,3448.40,3480.40,5272.40,5304.40
    ,5336.40,5464.40,5560.40,5624.40,5688.40,5720.40, 6392.40, 6424.40, 6456.40,
    6584.40, 6680.40, 6744.40, 6808.40, 6840.40,10232.40, 10264.40, 10296.40,
    10424.40, 10520.40, 10584.40, 10648.40, 10680.40]
  number_of_bits: 1
  signal_type_target_source: gaussian-white-noise
  source_name: 0026+892

```

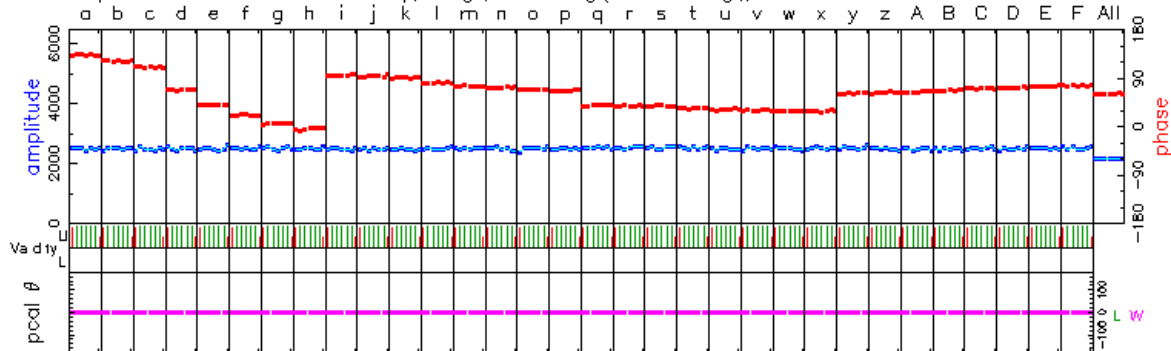
Mk4/DiFX fourfit 3.21 rev 2936

0026+892.1F4Y9S, SIM001, LW
KOKEE12M - WETT12M, fgroup X, pol RR



Fringe quality 7
SNR 746.2
Int time 0.985
Amp 2151.186
Phase 61.3
PFD 0.0e+00
Delays (us)
SBD -0.001440
MBD 0.000420
Fringe rate (Hz)
-0.002031
Ion TEC 0.000
Ref freq (MHz)
3032.1500
AP (sec) 0.026
Exp. sim
Exper # 16383
Yr:day 2020:028
Start 173000.00
Stop 173001.00
FRT 173000.00
Corr/FF/build
2020:321:1 82920
2020:321:1 82923
2020:111:1 81228
RA & Dec (J2000)
03h49m10.987080s
+00°00'00.000000"

Amp. and Phase vs. time for each freq., 7 segs, 6 APs / seg (0.15 sec / seg.), time ticks 1 sec

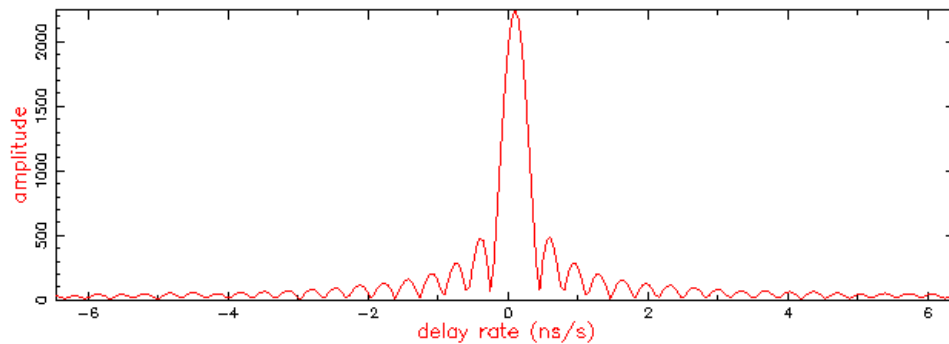


3032.153364		153364	153374	153384	153394	153404	153414	153424	153434	153444	153454	153464	153474	153484	153494	153504	153514	153524	153534	153544	153554	153564	153574	153584	153594	153604	153614	153624	153634	153644	153654	153664	153674	153684	153694	153704	153714	153724	153734	153744	153754	153764	153774	153784	153794	153804	153814	153824	153834	153844	153854	153864	153874	153884	153894	153904	153914	153924	153934	153944	153954	153964	153974	153984	153994	154004	154014	154024	154034	154044	154054	154064	154074	154084	154094	154104	154114	154124	154134	154144	154154	154164	154174	154184	154194	154204	154214	154224	154234	154244	154254	154264	154274	154284	154294	154304	154314	154324	154334	154344	154354	154364	154374	154384	154394	154404	154414	154424	154434	154444	154454	154464	154474	154484	154494	154504	154514	154524	154534	154544	154554	154564	154574	154584	154594	154604	154614	154624	154634	154644	154654	154664	154674	154684	154694	154704	154714	154724	154734	154744	154754	154764	154774	154784	154794	154804	154814	154824	154834	154844	154854	154864	154874	154884	154894	154904	154914	154924	154934	154944	154954	154964	154974	154984	154994	155004	155014	155024	155034	155044	155054	155064	155074	155084	155094	155104	155114	155124	155134	155144	155154	155164	155174	155184	155194	155204	155214	155224	155234	155244	155254	155264	155274	155284	155294	155304	155314	155324	155334	155344	155354	155364	155374	155384	155394	155404	155414	155424	155434	155444	155454	155464	155474	155484	155494	155504	155514	155524	155534	155544	155554	155564	155574	155584	155594	155604	155614	155624	155634	155644	155654	155664	155674	155684	155694	155704	155714	155724	155734	155744	155754	155764	155774	155784	155794	155804	155814	155824	155834	155844	155854	155864	155874	155884	155894	155904	155914	155924	155934	155944	155954	155964	155974	155984	155994	156004	156014	156024	156034	156044	156054	156064	156074	156084	156094	156104	156114	156124	156134	156144	156154	156164	156174	156184	156194	156204	156214	156224	156234	156244	156254	156264	156274	156284	156294	156304	156314	156324	156334	156344	156354	156364	156374	156384	156394	156404	156414	156424	156434	156444	156454	156464	156474	156484	156494	156504	156514	156524	156534	156544	156554	156564	156574	156584	156594	156604	156614	156624	156634	156644	156654	156664	156674	156684	156694	156704	156714	156724	156734	156744	156754	156764	156774	156784	156794	156804	156814	156824	156834	156844	156854	156864	156874	156884	156894	156904	156914	156924	156934	156944	156954	156964	156974	156984	156994	157004	157014	157024	157034	157044	157054	157064	157074	157084	157094	157104	157114	157124	157134	157144	157154	157164	157174	157184	157194	157204	157214	157224	157234	157244	157254	157264	157274	157284	157294	157304	157314	157324	157334	157344	157354	157364	157374	157384	157394	157404	157414	157424	157434	157444	157454	157464	157474	157484	157494	157504	157514	157524	157534	157544	157554	157564	157574	157584	157594	157604	157614	157624	157634	157644	157654	157664	157674	157684	157694	157704	157714	157724	157734	157744	157754	157764	157774	157784	157794	157804	157814	157824	157834	157844	157854	157864	157874	157884	157894	157904	157914	157924	157934	157944	157954	157964	157974	157984	157994	158004	158014	158024	158034	158044	158054	158064	158074	158084	158094	158104	158114	158124	158134	158144	158154	158164	158174	158184	158194	158204	158214	158224	158234	158244	158254	158264	158274	158284	158294	158304	158314	158324	158334	158344	158354	158364	158374	158384	158394	158404	158414	158424	158434	158444	158454	158464	158474	158484	158494	158504	158514	158524	158534	158544	158554	158564	158574	158584	158594	158604	158614	158624	158634	158644	158654	158664	158674	158684	158694	158704	158714	158724	158734	158744	158754	158764	158774	158784	158794	158804	158814	158824	158834	158844	158854	158864	158874	158884	158894	158904	158914	158924	158934	158944	158954	158964	158974	158984	158994	159004	159014	159024	159034	159044	159054	159064	159074	159084	159094	159104	159114	159124	159134	159144	159154	159164	159174	159184	159194	159204	159214	159224	159234	159244	159254	159264	159274	159284	159294	159304	159314	159324	159334	159344	159354	159364	159374	159384	159394	159404	159414	159424	159434	159444	159454	159464	159474	159484	159494	159504	159514	159524	159534	159544	159554	159564	159574	159584	159594	159604	159614	159624	159634	159644	159654	159664	159674	159684	159694	159704	159714	159724	159734	159744	159754	159764	159774	159784	159794	159804	159814	159824	159834	159844	159854	159864	159874	159884	159894	159904	159914	159924	159934	159944	159954	159964	159974	159984	159994	160004	160014	160024	160034	160044	160054	160064	160074	160084	160094	160104	160114	160124	160134	160144	160154	160164	160174	160184	160194	160204	160214	160224	160234	160244	160254	160264	160274	160284	160294	160304	160314	160324	160334	160344	160354	160364	160374	160384	160394	160404	160414	160424	160434	160444	160454	160464	160474	160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5.2 Non-Zero Baseline Simulation

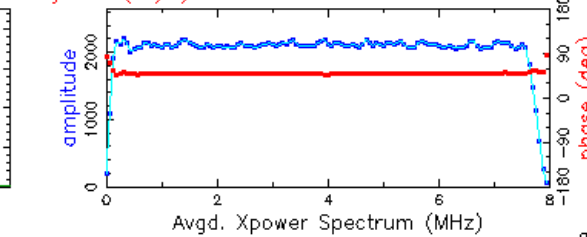
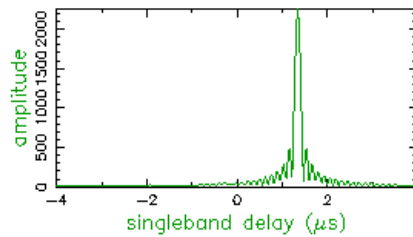
5.2.1 Very High delay rate, single channel

```
setup:
  zero_bl: 0
s1:
  date_vec: [2020,1,28,17,30,00]
  station_name: S1
  station_name_8character: HARTRA0
  station_name_trf_coord: Hh
  sampling_frequency: 16
  scan_length: 1
  fluxdensity_targetsource: 20
  fluxdensity_system: 60
  f0: [3032.40]
  number_of_bits: 1
  signal_type_target_source: gaussian-white-noise
  source_name: 2358+189
s2:
  date_vec: [2020,1,28,17,30,00]
  station_name: S2
  station_name_8character: WARK12M
  station_name_trf_coord: Ww
  sampling_frequency: 16
  scan_length: 1
  fluxdensity_targetsource: 20
  fluxdensity_system: 60
  f0: [3032.40]
  number_of_bits: 1
  signal_type_target_source: gaussian-white-noise
  source_name: 2358+189
```



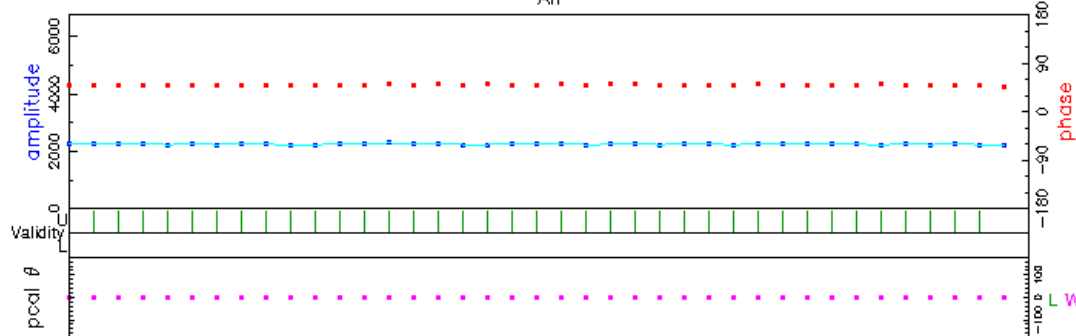
Fringe quality 9

SNR 546.6
Int time 0.967
Amp 2249.579
Phase 49.9
PFD 0.0e+00
Delays (us)
SBD 1.342534
MBD -0.000195
Fringe rate (Hz)
0.277832
Ion TEC 0.000
Ref freq (MHz)
3028.4000
AP (sec) 0.026



Exp. sim
Exper # 16383
Yr:day 2020:028
Start 173000.00
Stop 173001.00
FRT 173000.00
Corr/FF/build
2020:321:1 84253
2020:321:1 84253
2020:111:1 81228
RA & Dec (J2000)
00h01m08.621570s
+19°14'33.801743"

Amp. and Phase vs. time for each freq., 39 segs, 1 APs / seg (0.03 sec / seg.), time ticks 1 sec
All



3028.40
49.9
2249.3
172.0
U/L 3300
L 0
W 0
L:W 0.0
L:W 0.0
L 1.000
W 1.000
L X00UR
W X00UR

Chan ds
Chan ds

3028.40
49.9
2249.3
172.0
U/L 3300
L 0
W 0
L:W 0.0
L:W 0.0
L 1.000
W 1.000
L X00UR
W X00UR

Chan ds
Chan ds

Group delay (usec)(mode)	2.56839944588E+04	Apr or delay (usec)	2.56839946536E+04	Res d mbde ay (usec)	-1.94777E-04	+/- 1.3E-04
Sband delay (usec)	2.56853371876E+04	Apr or c ock (usec)	0.0000000E+00	Res d sbde ay (usec)	1.34253E+00	+/- 1.3E-04
Phase delay (usec)	2.56839946994E+04	Apr or c ockrate (us/s)	0.0000000E+00	Res d phde ay (usec)	4.57303E-05	+/- 1.9E-07
Delay rate (us/s)	-1.58745747983E+00	Apr or rate (us/s)	-1.58754922201E+00	Res d rate (us/s)	9.17422E-05	+/- 3.3E-07
Total phase (deg)	197.1	Apr or acce (us/s/s)	-1.30707031965E-04	Res d phase (deg)	49.9	+/- 0.2

ph/seg (deg) 0.7 0.7
amp/seg (%) 1.0 1.1
ph/frq (deg) 0.0 0.1
amp/frq (%) 0.0 0.2

RMS Theor. Amp tude 2249.579 +/- 4.116
Search (128X8) 2246.487
Interp. 0.000
Inc. seg. avg. 2249.287
Inc. frq. avg. 2249.255

Pca mode: MANUAL, MANUAL PC period (APs) 5, 5
Pca rate: 0.000E+00, 0.000E+00 (us/s)
B ts/sample: 1x1 SampCntNorm: dsab ed
Sample rate(MSamp/s): 16
Data rate(Mb/s): 16 nags: 128 t_cohere nfn te on window (TEC) 0.00 0.00

L: az 303.4 e 18.4 pa 127.2 W: az 122.5 e -62.9 pa -134.2 u,v (fr/sec) 338.831 -80.645
s mutaneous nterpol at

Contro 1 e: defaut Input 1 e: /home/jakob/software/BasebandS m/OUT/2020_321_19_38_12/234/SIM001/LW.1F4YWD Output 1 e: Suppressed by test mode