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To: Mark 5 Development Group

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Subject: Mark 5B File Utility Programs

We have some handy utility programs that read `.m5b` files written by the `dimino` `disk2file` command. These programs can be downloaded from
< ftp://web.haystack.mit.edu/pub/mark5/B/util/>.
A summary of the function of these programs is

`bstate` – Analyze state counts in each channel in the file
`bpcal` – Calculate amplitude and phase of a phase cal tone in each channel in the file
`time_check` – Read start and stop times in the file, requires `header_reader`
`time_check.py` – A faster python version of `time_check`
`vlbi2` – Calculate cross- or autocorrelation spectra

With no arguments, each of these programs returns its usage syntax.

The `bstate` program is used to analyze the state counts in a Mark 5B data file. The `bstate` program accepts a Mark 5B file name and the number of Mark 5B disk frames to analyze. The `bstate` program can analyze only 2-bit Mark 5B data recorded with a bitmask of 0xFFFFFFFF. For more information on Mark 5B bitmasks and recording modes see the *Mark 5B Command Set* documentation at <www.haystack.edu/tech/vlbi/mark5/software.html>. The `bstate` program reports the number of samples and the percentage of time each channel is in each state. It also reports a correction factor to apply to the channel gain to produce ideal state counts. The usage of `bstate` is

```
bstate <input m5b file name> <number of disk frames>
```

The `bpcal` program is used to analyze the phase cal tones in a Mark 5B data file. The `bpcal` program accepts a Mark 5B file name, the tone frequency, and optionally the number of Mark 5B disk frames to analyze. The `bpcal` program can analyze only 2-bit Mark 5B data recorded with a bitmask of 0xFFFFFFFF. The `bpcal` program reports the amplitude and phase of the specified phase cal tone in each channel in the file. The usage of `bpcal` is

```
bpcal <input m5b fname> <tone freq (KHz)> [<# frames>]
```

Where `[<# frames>]` is optional and defaults to 200.

The time_check programs are used to check the start and end times in a Mark 5B file. The time_check programs accept a Mark 5B file name. The time_check programs report the time code in the first and last Mark 5B headers found in the file. The usage of time_check is

```
time_check < input m5b file name>
```

To use the time_check.py python version of the program, you must have python installed on your system. To install python on a Debian (or Ubuntu) system, enter, as root

```
aptitude install python
```

The vlbi2 program is used to correlate two Mark 5B files with the same starting record time and record mode. A postscript file dd1.pos is produced showing the correlation amplitude and phase as a function of frequency in all channels in the two files with all channels plotted on the same axes. Correlation coefficients (fringe amplitudes, which will be 1.00 for an autocorrelation) are indicated below each channel. The vlbi2 program accepts two files, each 10 MB in size, and two flags. The usage is:

```
vlbi2 <file1> <file2> [-2bit <2bit_arg>] [-rev <rev_arg>]
```

Where the items in **[]** are optional. The -2bit flag indicates whether the files are 2 bits/sample recordings (2bit_arg is 1) or 1 bit/sample (2bit**_arg** is 0) [default]. The files must be the same number of bits per sample. The **-rev** flag determines whether the channels in **dd1.pos** are plotted in reverse order (rev_arg is 1) or normal order (rev_arg is 0) [default]. It is important to note that with the -rev flag, though the channels can be plotted in the reverse order, they are not flipped in frequency. If file1 and file2 are the same, an autocorrelation is produced; if they are different a cross correlation is produced.

To display the results of the correlation, enter

```
gs dd1.pos
```

or

```
gv dd1.pos
```

in an X terminal window.

If Ctrl-Alt-F7 doesn't give you an X terminal window, try startx &. If gs is not installed on your system, and you have a Debian (or Ubuntu) operating system, you can enter, as root

```
aptitude install gs
```

to install gs. If you are unable to view the dd1.pos output file on your system, you can copy it to another system that has linux ghostscript or Windows gsview installed. If you copy it to a Windows system, I suggest changing the name to dd1.ps.

Examples

```
time_check 1bit.m5b
Please be patient, I'm working on it.
Start: 623.19:12:52.0000
  End: 623.19:12:52.6237

time_check.py 2bit.m5b
Start Time: 566.12:10:10.0000
 Stop Time: 566.12:10:10.1559
```

The "date code" in the above examples is the 3 least-significant digits of the Modified Julian Date (MJD). The MJD is defined in Section B of the "Astronomical Almanac" and in 2008 is given by: 54465 + day of year (DOY). Therefore, in 2008 the Mark 5B "date code" is 465 + DOY. In 2009 the Mark 5B "date code" is 831 + DOY before June 18, and DOY – 169 after June 17.

```
bstate 2bit.m5b 100
```

ch	--	-	+	++	--	-	+	++	gfact
0	41711	84031	82960	41298	16.7	33.2	33.6	16.5	1.07
1	48485	76818	76640	48057	19.4	30.7	30.7	19.2	0.95
2	50976	74837	72690	51497	20.4	29.1	29.9	20.6	0.91
3	50186	74926	74590	50298	20.1	29.8	30.0	20.1	0.92
4	47720	78170	77152	46958	19.1	30.9	31.3	18.8	0.97
5	48753	77121	76023	48103	19.5	30.4	30.8	19.2	0.95
6	46371	78573	78224	46832	18.5	31.3	31.4	18.7	0.98
7	44481	81065	79702	44752	17.8	31.9	32.4	17.9	1.01
8	48164	77136	76669	48031	19.3	30.7	30.9	19.2	0.95
9	47718	77739	76876	47667	19.1	30.8	31.1	19.1	0.96
10	43296	82539	81352	42813	17.3	32.5	33.0	17.1	1.04
11	46701	79146	78697	45456	18.7	31.5	31.7	18.2	0.99
12	43526	82236	79995	44243	17.4	32.0	32.9	17.7	1.02
13	51520	73822	72917	51741	20.6	29.2	29.5	20.7	0.90
14	45475	80074	79228	45223	18.2	31.7	32.0	18.1	1.00
15	44273	80917	80483	44327	17.7	32.2	32.4	17.7	1.02

```
vlbi2 1bit.m5b 1bit.m5b ; mv dd1.pos 1bit.ps
```

produces the autocorrelation spectra shown in the PostScript file `1bit.ps`.

```
vlbi2 2bit.m5b 2bit.m5b -2bit 1 ; mv dd1.pos 2bit.ps
```

produces the autocorrelation spectra shown in the PostScript file `2bit.ps`.

Channel 13 has a strong harmonic of the 5-MHz reference at 4.010 MHz, which corresponds to a sky frequency that is a multiple of 5 MHz.

You can see this harmonic in the phase cal with

```
bpcal 2bit.m5b 4010

integration time  0.062 sec

ch  amp   phase(dg)
 0     46    -44.5      USB1
 1     44    -55.4      USB2
 2     41     64.6      USB3
 3     44    -76.7      USB4
 4     43     49.9      USB5
 5     44     61.8      USB6
 6     45     64.4      USB7
 7     44    140.6      USB8
 8      0   -151.1      LSB1
 9      2    101.5      LSB8
10     38     72.9      USB9
11     40    -69.8      USB10
12     42     47.0      USB11
13    358    147.9      USB12
14     32   -154.6      USB13
15     38   -139.0      USB14
```

Compare the above with normal phase cal at 3.01 MHz:

```
bpcal 2bit.m5b 3010

integration time  0.062 sec

ch  amp   phase(dg)
 0     44   -175.5
 1     43    173.4
 2     42    -70.6
 3     43    146.2
 4     42    -78.4
 5     44    -69.0
 6     45    -67.5
 7     43      9.9
 8      2    -58.1
 9      2     -2.3
10     36    -58.6
11     40    152.1
12     41    -82.7
13     37   -157.9
14     33     73.6
15     37     92.3
```

Channels 8 and 9 are lower side-band, with phase cal at n MHz – 10 KHz:

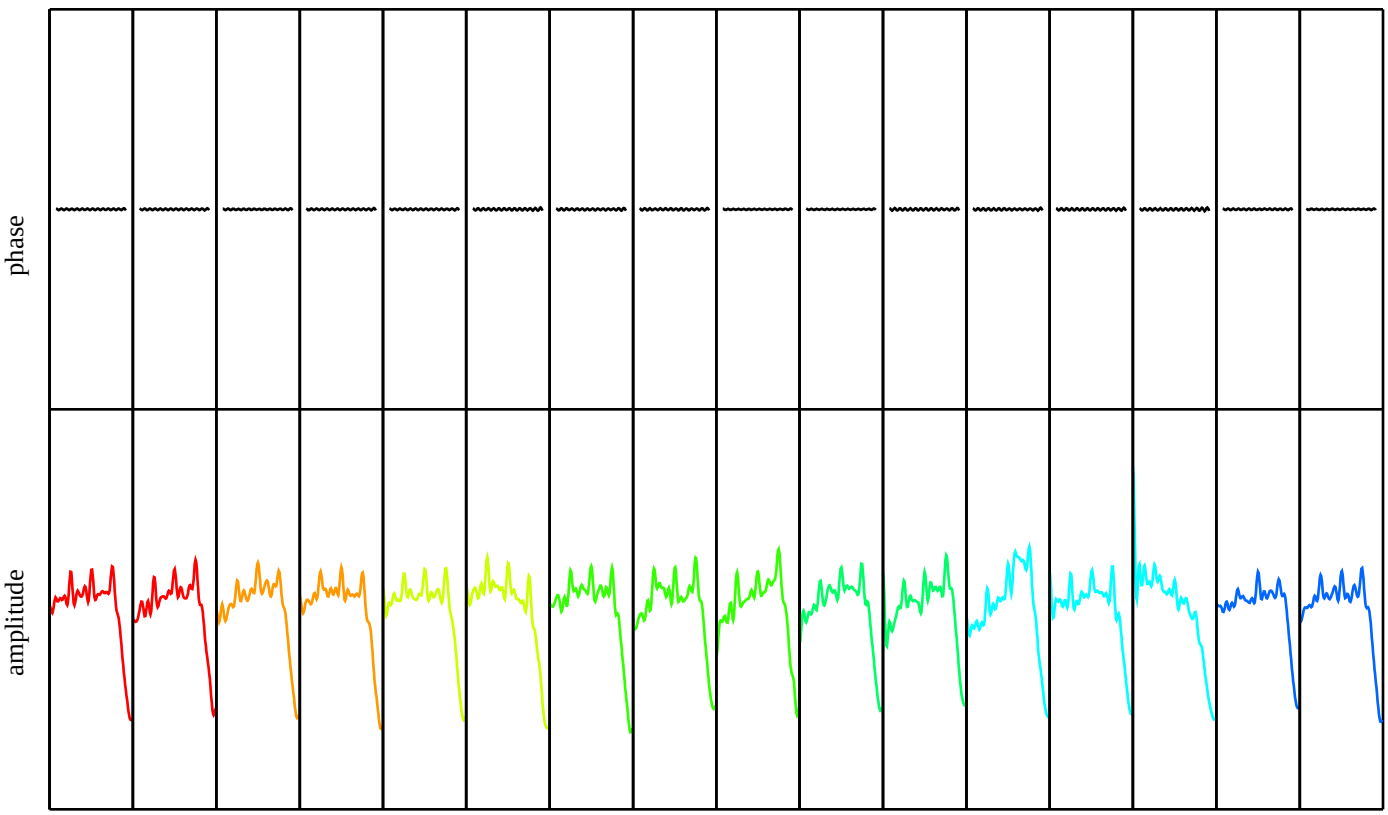
```
bpcal 2bit.m5b 2990

integration time  0.062 sec

ch  amp   phase(dg)
 0      1    145.1
 1      2     83.6
 2      1    -32.0
 3      3     50.1
 4      0   -166.6
 5      2     83.0
 6      3    147.1
 7      3    131.5
 8     44   -104.1
 9     43     62.1
10      2   -108.0
11      2     67.9
12      3    -99.0
13      2    -80.1
14      4    133.6
15      3    141.1
```

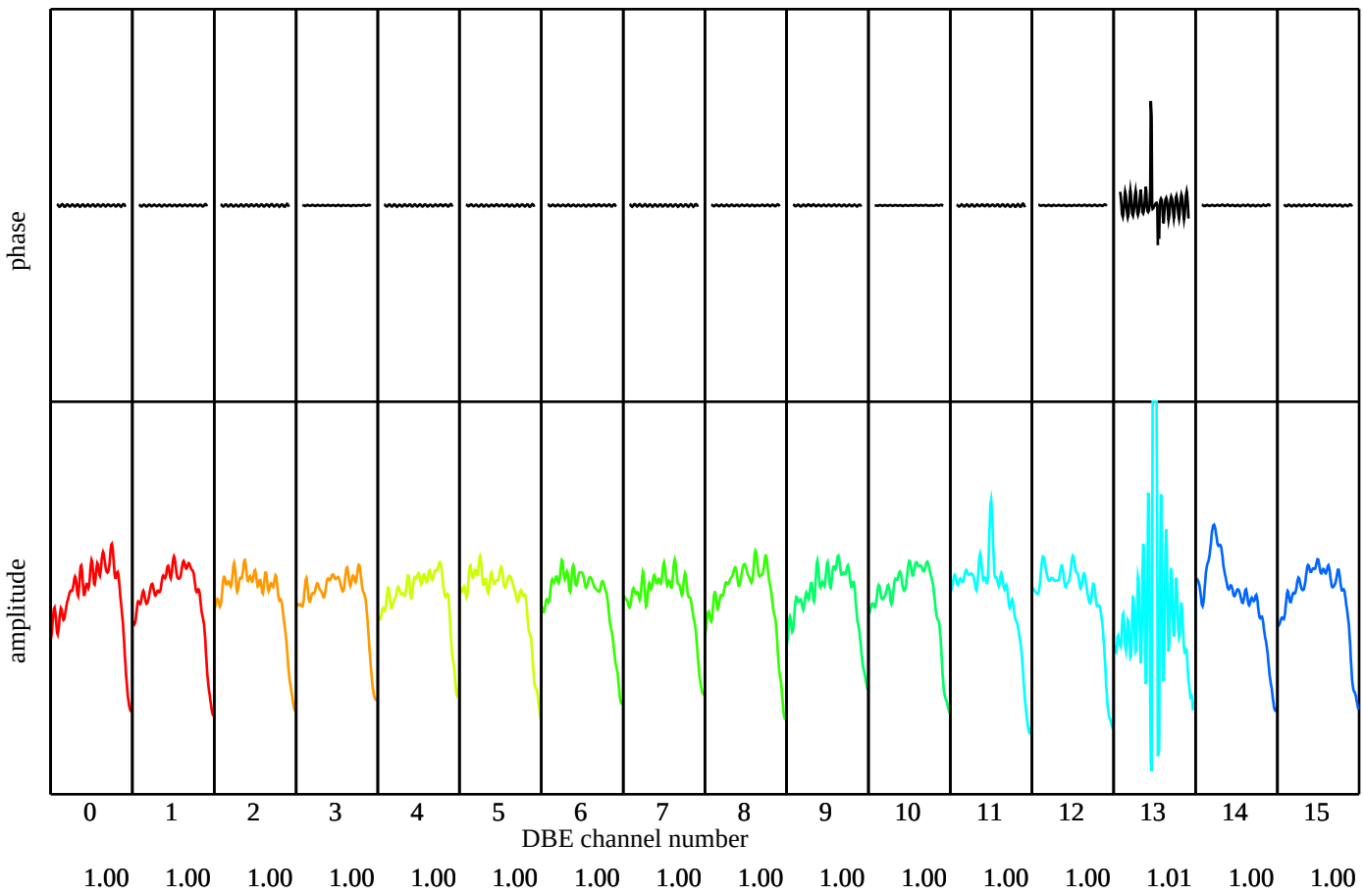
Acknowledgements:

`bstate` and `bpcal` were written by Roger Cappallo at Haystack.
`time_check` uses a `header_reader` perl script written by David Graham at MPI.
`time_check.py` was written by Pablo de Vicente at Yebes.
`vlbi2` was written by Alan Rogers at Haystack .



file1: test1.m5b file2: test1.m5b bits/sam 1

Sat Jun 14 09:33:47 2008



file1: rd0803_wf_101-1210.m5b file2: rd0803_wf_101-1210.m5b bits/sam 2

Tue Jun 17 14:01:32 2008