Observers Guide for the Blazar monitoring at Medicina

Initial Setup

If not already running, but also necessary after a reboot, start the windows-PC and the Field-System PC and login as "oper". Start the programs "sub-reflector" and "ACU" on the windows-PC and after that the Field-System with the command "fs" on the pcfs. Useful tools on pcfs. Useful programs are also "Antm5", "Monit: tsys" and "Monit: status" which can be found by pressing the middle mouse button. To unlock the telescope and enable tracking:

fs > antenna=setup

fs > antenna=track

Since the current position of the sources is calculated from the PC time the time must be be correct. To adjust the PC time with the formater time type

fs > sy=run setcl adapt

It can happen that one losts the connection to the ACU (I guess Antenna Control Unit), or to the antenna itself. One can enable the connection again by

fs > antenna=connect

fs > vertex=connect

fs > scu=connect

Everything else should be specified in the start5ghz and start8ghz scripts in our procedure file (blazar_m.prc).

Most important before starting the schedule is to control the right order of the IFs at the video-converters (VC) at the backside of the backend rack. To avoid RFI we measure only single VCs at 5 GHz and the correct order is therefore important. All odd VCs should be connected to IF1 (LL) and all even VCs to IF2 (RR), so that we can combine them to Stokes I at the end. Copies of all our procedures and schedules are stored in /usr2/oper/uwelars.

The procedure file

The procedure file, blazar_m.prc (located in /usr2/proc/), contains all source positions and the scripts or commands which are called by our schedule. It

should loaded to the fs by
fs > proc=blazar_m
A description of the file can be found in Appendix A.

The schedule

The actual schedule is called bm_[month+version].ctl (see also Appendix B) and starts to observe at our sources at one or several frequencies. The schedule should be started with
fs > acquire=bm_all.ctl

Sometimes, specially if one had to kill a previous running schedule before, the fs hangs directly after the start of a new schedule. This can be often solved by typing another
fs > sy=go aquir &
on the fs-command line.

Manual observations

After loading the procedure file one can also use the defined commands to observe manually. E.g., to observe at 5 GHz:
fs > log=ul_5ghz
sets the log file to ul_5ghz.log in /usr2/log. One should always separate the frequencies in two different log files, because it causes a lot of work to do it afterwards before the data reduction.
fs > setupccc
initialises the 5 GHz receiver (setupxxp does the same at 8 GHz)
fs > setvc5
procedure to set all VCs to values based on our experience (setvc8 at 8 GHz)
fs > valarm
fs > pcaloff
fs > check=*,-ifd
to avoid to many error messages because we are not doing VLBI.

For a source change one just has to type the source name e.g.,
fs > 0836+710
If the source is not predefined than one has to give the full RA and DEC of the new source
fs > source=0836+710,084124.37,705342.17,2000.0
with source=name,RA,DEC,epoch

To start an ONOFF measurement

fs > onoff

to view the settings of the ONOFF

fs > onoff=?

which shows something like:

```
2004.345.12:18:35.41/onoff/12,5,75.0,5.0,450,
2004.345.12:18:35.41/onoff/v1,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v2,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v3,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v4,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v5,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v6,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v7,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v8,,,,,,,,,,,
2004.345.12:18:35.41/onoff/v9,,,,,,,,,,,
2004.345.12:18:35.41/onoff/va,,,,,,,,,,,
2004.345.12:18:35.41/onoff/vb,,,,,,,,,,,
2004.345.12:18:35.41/onoff/vc,,,,,,,,,,,
2004.345.12:18:35.41/onoff/vd,,,,,,,,,,,
2004.345.12:18:35.41/onoff/ve,,,,,,,,,,,
2004.345.12:18:35.41/onoff/i1,,,,,,,,,,,
2004.345.12:18:35.41/onoff/i2,,,,,,,,,,,
```

which means that we will make 12 onoffs (max. is 99) with 5 sec integration (1–10 sec are possible). Above 75° elevation the onoff will change from AZI switching to ONOFFs in elevation, since it will take less time and the differences in the atmosphere are not too large anymore. The off position is 5 beams, and the time to wait for the correct pointing is 450 sec. The following lines list all used channels. Here all VCs and both IFs. New values can be set by e.g.,

onoff=8,5,75,5,450,allvc,i1,i2

More options are also listed in the field system manual `http://192.167.189.40/manuals.html`.

To start a pointing scan (FIVEPT) use

fs > fivept

Again

fs > fivept=?

lists the current setting for FIVEPT e.g.,

`/fivept/azel,1,11,0.30,15,i1,120,8.7,0.0781,1.00,0.0000,1`

which means perform a FIVEPT in AZI and ELV (different choice could be hadc = Hour Angle/Declination), do this once (possible values are -10 to -1 and 1 to 10), but actually I don't know what negative repetitions could mean. Do a cross of 11 points on each axis, one should choose odd numbers to have one measurements in the centre. Do 0.3 beam steps between each measurement resulting in an maximum offset of 1.5 beam away from the centre. 15 sec integration time, and use IF1 (can be any other channel too, but only one not all as with ONOFFs). The rest is not important, but listed here `http://192.167.189.40/manuals.html` again.

   The system also knows a procedure to do skydips to measure the opacity
fs > skydip
but this procedure assumes that the telescope already points to the zenith, therefore it is necessary to point the telescope first with
fs > source=azel,*,90d
which points the telescope to a fixed position and where the * can be any AZI value in degrees (to avoid much driving one might choose a value close to the current position).
   If one wishes to continue with normal observations after the telescope was pointed to a fixed position one needs to enable the tracking again
fs > antenna=track

Data reduction

I wrote two Python programs which sort out the various information which is present in the log file to reduce the ONOFF measurements of our sample. They are called convert_log.py and corr_data.py. Execution without any options displays a little help like:

```
convert_log.py written by Uwe Bach 2004
Task to sort out various information from the log-files of the
MKIV Field System at the MEDICINA telescope

Usage:   convert_log.py parameter-file

The script produces the following files:
   logfile_fivpt.log; all fivept output
   logfile_onoff.log; all onoff output
   logfile_onoff_ll+rr.dat; onoff summary of the specified channel
```

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```
    logfile_skydip.dat; results from skydips
    logfile_tsys.dat; all tsys measurements

The parameter-file should have the following style:
    log-file:  'log'       # Name of the log file
    frequency: 'number'    # actually only 5 or 8 [GHz]
    channels:  'id1' 'id2' # LL and RR of the IFs or VCs which should
                           # be used.  i1 and i2 denote IF1 and IF2
                           # VCs are called:  1u,2u...,9u,au,bu...,eu
```

The two log files logfile_fivpt.log and logfile_onoff.log are just to make it easier to find a certain scan if one would like to review a whole ONOFF or FIVEPT scan after there appeared some problems during the data reduction. The program automatically calculates the opacity from the skydip and tsys measurements and produces a preliminary opacity calibrated output file of the ONOFF measurements. One can directly use this file to proceed if one can verify that the calculated zenith τ is correct.

A future version might also allow to make a time dependent opacity correction since we monitor the zenith τ value every few hours and actually we waste this information. If you are not satisfied with the automatic opacity correction one can use corr_data.py to perform a new one.

```
corr_data.py written by Uwe Bach 2005
Task to calibrate the MEDICINA onoff scans sorted out with convert_log.py
Usage:  corr_data.py [options] data-file(s)

Options:
-tau n:  opacity correction with a given tau 'n'.
-eff:  converts the data-file to a LIST.raw to be used with eff_flux.

-gain* file:  corrects data with the polynom given in the gain-curve-file
              gain-curve file should contain a single line specifying
              A0,A1,A2,A3 and A4 of the polynom A0+A1*x+A2*x²+A3*x³+A4*x⁴
              with x=ELV.
-flux* gain err:  gain correction from K to Jy!

Note:  data-file(s) can be one file with all measurements or a list of
       single source files.
       The normalised antenna temperature (col 14 and 15) is useless if
       the data file contains measurements of more than one source
```

```
* currently not working!
```

Since there is an already existing program by Alex Kraus from Effelsberg to reduce flux density measurements we convert our data to his input format in a LIST.raw data file after the opacity correction. The LIST.raw is than read by eff_flux together with the eff_flux.par and does the further reduction including elevation dependent gain corrections, other time-dependent corrections and the conversion to Janskys.

Appendix A

Here some examples from our procedure file (blazar_m.prc) and there explanation. In general a procedure starts with
define [prc. name]   00000000000
...
and ends with
enddef

Every procedure file needs the acquire procedure to work
```
define  acquire      05084193347
sy=run aquir /usr2/control/$ &
log=acquire
enddef
```

To change the ONOFF and FIVEPT settings with regard to the brightness of the source
```
define  strong5      00000000000x
onoff=8,5,75,5,450,allvc,i1,i2
fivept=azel,1,11,0.30,5,vc7
!+1s
sy=go aquir &
enddef
```
for strong sources at 5GHz. Here we choose VC7 for the five points since it is less affected by RFI and for weak sources
```
define  weak5        00000000000x
onoff=12,5,75,5,450,allvc,i1,i2
fivept=azel,1,11,0.30,15,i2
!+1s
sy=go aquir &
enddef
```
Actually we don't do five points on weak sources. The `!+1s` was suggested as a solution to protect the schedule to hang and it seems to work.

The skydip procedure. "tau" was already defined in station.prc so I choose "tau-m".
```
define  tau-m        00000000000
skydip
!+1s
sy=go aquir &
```

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```
enddef
```

```
define  stopsched     00000000000
sy=brk aquir &
enddef
```
can be used as a post procedure in the schedule file (see Appendix B) to
finish a schedule at some point.

    Or as another example
```
define  rmoffset      00000000000
azeloff=0d,0d
!+1s
sy=go aquir &
enddef
```
which deletes the current entry of the pointing offset. This is implemented
in the schedule just before a five point on 3c123 (which is a very bright
source) to avoid that a schedule runs for hours with a wrong pointing offset
which might have been calculated from a failed FIVEPT on a weaker source
before.

Appendix B

The schedule file it self already contains a description of its structure and content, so I just display our current schedule here. Comment lines are marked with a *.

```
* bm_all.ctl control file for AQUIR for the blazar monitoring at
* Medicina at 5 and 8 GHz
* last edition:  Uwe 17 Arp 2005
*
*  This file is free format with blanks as delimiters.  Completely
*  blank lines and lines with a star '*' in column 1 are ignored.
*
*  Data formats:
*
*   Procedure names:  12 character Field System procedure or command
*                     name.
*
*   Waits:  minutes for corresponding procedure to complete
*           maximum of 32767
*           -2 => don't execute this procedure, its just a place holder
*           -1 => self suspend after entering command, expect a GO,AQUIR
*                 in order to continue
*
*           for FIVPT, ONOFF, and PEAKF waits:
*            0 -> don't execute this command
*           >0 -> wait that many minutes for FIVPT, ONOFF, or PEAKF program
*                 to complete, OF'ing them if they aren't done
*
*   Elevations:  degrees
*
*   Source Names:  10 characters
*
*   Right Ascension:  hhmmss.s
*
*   Declination:  ddmmss
*
*   Epoch:  yyyy.y
*
*  First data record:
*
```

```
*   Setup procedure, Setup wait, Terminate Procedure, Terminate wait,
*
*                    Upper elevation Limit, ONSOURCE Wait,
*
*                    Amount to lead source when calculating what's up
*
*         Sources outside elevation limits are considered 'down'
*
init5 -1 postp -2 85 500 600
```

init5 just sets the actual log file to ul_5ghz.log and specifies some preliminary values for ONOFF and FIVEPT. Postp −2 means do not execute a terminate procedure.

```
*
* Elevation mask for lower elvation limit:  AZ EL AZ EL ...  AZ
* may contain multiple lines, an incomplete line ends with an EL
*
0 20 360
```

No limit in AZI, but sources below 20 ELV are discarded.

```
*
*  Source records:
*
*    Name, R.A., Dec., Epoch, Preob procedure, Preob wait,
*
*         FIVPT wait, ONOFF wait, PEAKF wait,
*
*         Postob procedure, Postob Wait
*
*  The nominal maximum number of sources is 200, but it may vary.
*  If there are too many in the file, the program will print a
*  message with the current number.
*
```

The schedule starts here and since we did not specify a terminate procedure (e.g., could be stopsched) at the beginning the system will perform this schedule for ever:

```
* 5 GHz
p-zenith   084124.37  705342.17 2000  start5ghz -1  0   0 0 postp    -1
p-zenith   084124.37  705342.17 2000  tau-m     -1  0  00 0 postp    -2
```

```
0836+710    084124.37   705342.17 2000   weak5     -1  0   20 0 postp    -2
3C48        013741.29   330935.13 2000   strong5   -1  0   20 0 postp    -2
0235+164    023838.93   163659.3  2000   weak5     -1  0   20 0 postp    -2
0235+164    023838.93   163659.3  2000   weak5     -1  0   20 0 postp    -2
3C66A       022239.61   430207.8  2000   weak5     -1  0   20 0 postp    -2
3C123       043704.38   294013.82 2000   strong5   -1  0    0 0 rmoffset -1
3C123       043704.38   294013.82 2000   strong5   -1 20   20 0 postp    -2
0414-189    041636.54  -185108.3  2000   weak5     -1  0   20 0 postp    -2
0420-014    042315.80  -012033.1  2000   weak5     -1  0   20 0 postp    -2
3C147       054236.14   495107.23 2000   strong5   -1  0   20 0 postp    -2
0735+178    073807.39  +174219.0  2000   weak5     -1  0   20 0 postp    -2
0829+046    083148.88  +042939.1  2000   weak5     -1  0   20 0 postp    -2
OJ287       085448.87   200630.6  2000   weak5     -1  0   20 0 postp    -2
3C286       133108.28   303032.9  2000   strong5   -1 20   20 0 postp    -2
1156+295    115931.83  +291443.8  2000   weak5     -1  0   20 0 postp    -2
3C273       122906.70   020308.6  2000   weak5     -1  0   20 0 postp    -2
3C279       125611.16  -054721.5  2000   weak5     -1  0   20 0 postp    -2
3C286       133108.28   303032.9  2000   strong5   -1  0   20 0 postp    -2
1510-089    151250.53  -090559.8  2000   weak5     -1  0   20 0 postp    -2
1611+343    161341.06   341247.9  2000   weak5     -1  0   20 0 postp    -2
1633+382    163515.49   380804.5  2000   weak5     -1  0   20 0 postp    -2
3C295       141120.65   521209.14 2000   strong5   -1  0   20 0 postp    -2
3C345       164258.81   394837.0  2000   weak5     -1  0   20 0 postp    -2
1819+384    181927.1    384508.0  2000   weak5     -1  0   20 0 postp    -2
NGC7027     210701.59   421410.19 2000   strong5   -1 20   20 0 postp    -2
BLLac       220243.29   421640.0  2000   weak5     -1  0   20 0 postp    -2
2230+114    223236.41  +114350.9  2000   weak5     -1  0   20 0 postp    -2
3C454.3     225357.75   160853.6  2000   weak5     -1  0   20 0 postp    -2
0836+710    084124.37   705342.17 2000   weak5     -1  0   20 0 postp    -2
0716+714    072153.45   712036.40 2000   weak5     -1  0   20 0 postp    -2
0917+624    092136.23   621552.18 2000   weak5     -1  0   20 0 postp    -2
0954+658    095847.24   653354.80 2000   weak5     -1  0   20 0 postp    -2
0414-189    041636.54  -185108.3  2000   weak5     -1  0   20 0 postp    -2
0420-014    042315.80  -012033.1  2000   weak5     -1  0   20 0 postp    -2
3C279       125611.16  -054721.5  2000   weak5     -1  0   20 0 postp    -2
1510-089    151250.53  -090559.8  2000   weak5     -1  0   20 0 postp    -2
* 8 GHz
p-zenith    084124.37   705342.17 2000   start8ghz -1  0    0 0 postp    -1
p-zenith    084124.37   705342.17 2000   tau-m     -1  0   00 0 postp    -2
0836+710    084124.37   705342.17 2000   weak8     -1  0   20 0 postp    -2
```

```
3C48        013741.29   330935.13 2000   strong8   -1  0   20 0 postp      -2
0235+164    023838.93   163659.3  2000   weak8     -1  0   20 0 postp      -2
0235+164    023838.93   163659.3  2000   weak8     -1  0   20 0 postp      -2
3C66A       022239.61   430207.8  2000   weak8     -1  0   20 0 postp      -2
3C123       043704.38   294013.82 2000   strong8   -1  0    0 0 rmoffset   -1
3C123       043704.38   294013.82 2000   strong8   -1 20   20 0 postp      -2
0414-189    041636.54  -185108.3  2000   weak8     -1  0   20 0 postp      -2
0420-014    042315.80  -012033.1  2000   weak8     -1  0   20 0 postp      -2
3C147       054236.14   495107.23 2000   strong8   -1  0   20 0 postp      -2
0735+178    073807.39  +174219.0  2000   weak8     -1  0   20 0 postp      -2
0829+046    083148.88  +042939.1  2000   weak8     -1  0   20 0 postp      -2
OJ287       085448.87   200630.6  2000   weak8     -1  0   20 0 postp      -2
3C286       133108.28   303032.9  2000   strong8   -1 20   20 0 postp      -2
1156+295    115931.83  +291443.8  2000   weak8     -1  0   20 0 postp      -2
3C273       122906.70   020308.6  2000   weak8     -1  0   20 0 postp      -2
3C279       125611.16  -054721.5  2000   weak8     -1  0   20 0 postp      -2
3C286       133108.28   303032.9  2000   strong8   -1  0   20 0 postp      -2
1510-089    151250.53  -090559.8  2000   weak8     -1  0   20 0 postp      -2
1611+343    161341.06   341247.9  2000   weak8     -1  0   20 0 postp      -2
1633+382    163515.49   380804.5  2000   weak8     -1  0   20 0 postp      -2
3C295       141120.65   521209.14 2000   strong8   -1  0   20 0 postp      -2
3C345       164258.81   394837.0  2000   weak8     -1  0   20 0 postp      -2
1819+384    181927.1    384508.0  2000   weak8     -1  0   20 0 postp      -2
NGC7027     210701.59   421410.19 2000   strong8   -1 20   20 0 postp      -2
BLLac       220243.29   421640.0  2000   weak8     -1  0   20 0 postp      -2
2230+114    223236.41  +114350.9  2000   weak8     -1  0   20 0 postp      -2
3C454.3     225357.75   160853.6  2000   weak8     -1  0   20 0 postp      -2
0836+710    084124.37   705342.17 2000   weak8     -1  0   20 0 postp      -2
0716+714    072153.45   712036.40 2000   weak8     -1  0   20 0 postp      -2
0917+624    092136.23   621552.18 2000   weak8     -1  0   20 0 postp      -2
0954+658    095847.24   653354.80 2000   weak8     -1  0   20 0 postp      -2
0414-189    041636.54  -185108.3  2000   weak8     -1  0   20 0 postp      -2
0420-014    042315.80  -012033.1  2000   weak8     -1  0   20 0 postp      -2
3C279       125611.16  -054721.5  2000   weak8     -1  0   20 0 postp      -2
1510-089    151250.53  -090559.8  2000   weak8     -1  0   20 0 postp      -2
```

Any questions: bach@to.astro.it!

Appendix C

RemoteFS

"remotefs" can be used to monitor and control a running field system session. BE CAREFUL one can also terminate a session and it is NOT possible to restart it remotely!

    > remotefs

    starts the program and gives you a new prompt >. With
> all
one can redirect the outprint of the FS to your onw terminal window. Every field system command is working also in remotefs.

    > quit
quits the remotefs session!