

DBBC Setup and Operation



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IVS TOW, MIT-Haystack Observatory, May 2015

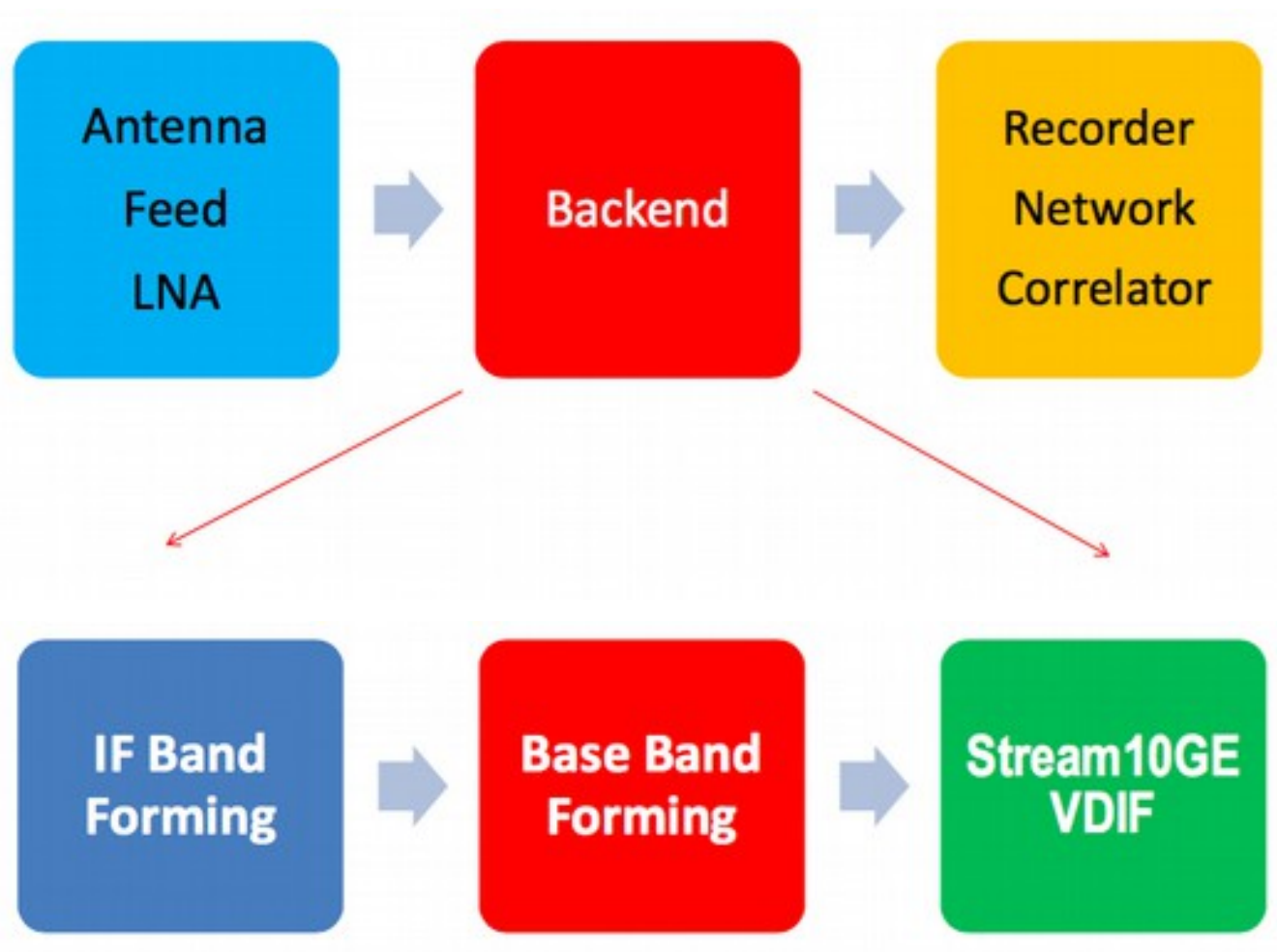


Content

- DBBC hardware characteristics
 - What is it good for
 - A tour around the DBBC
 - Component description
- Installation of a DBBC
- DBBC software
 - Poly-phase Filter Bank (PFB)
 - Digital Down Conversion (DDC)
- Basic testing
- Field System integration
- VLBI operation



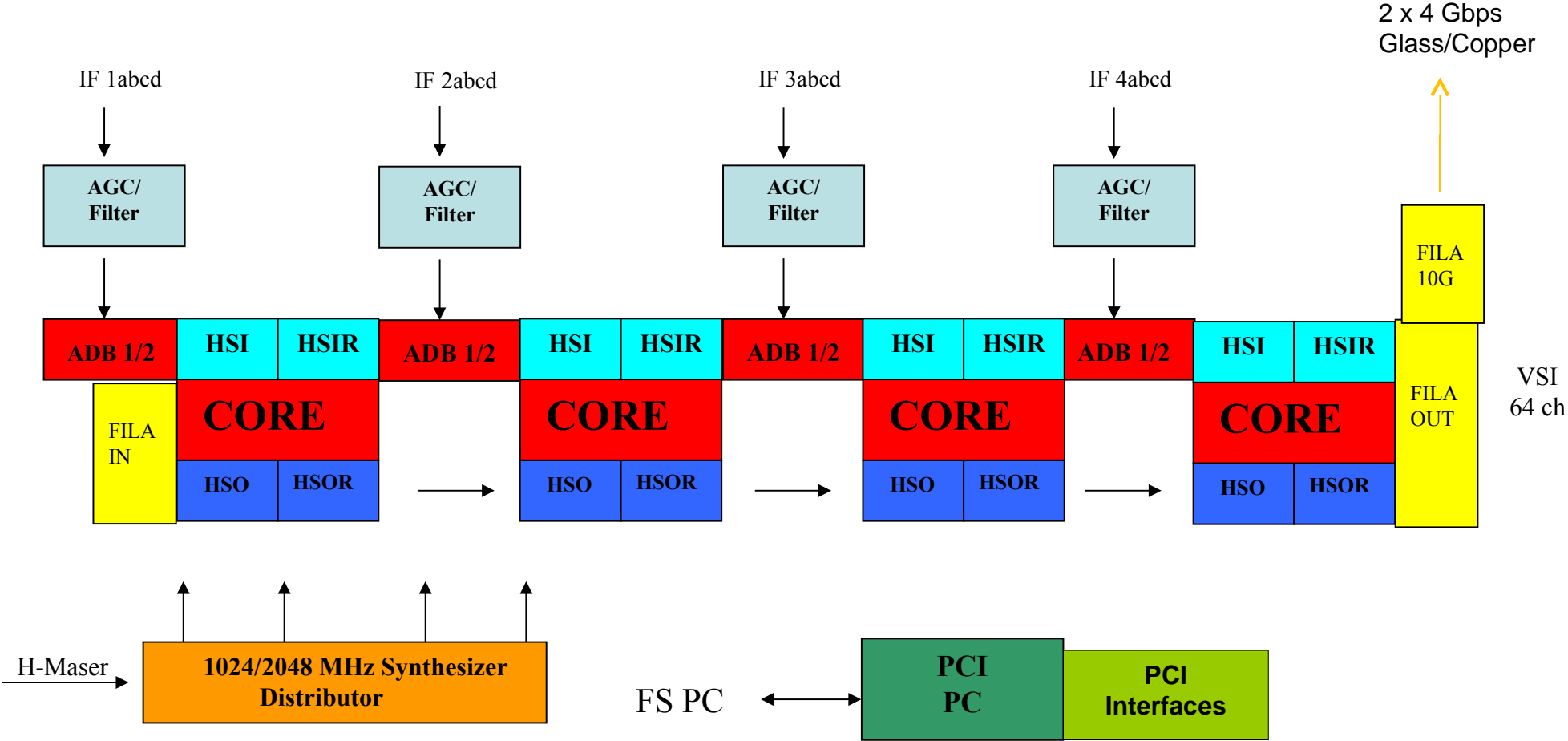
The VLBI backend





The DBBC Architecture

IF_n (MHz)
1~512, 512~1024, 1024~1536, 1536~2048
or
1~1024, 1024~2048 MHz

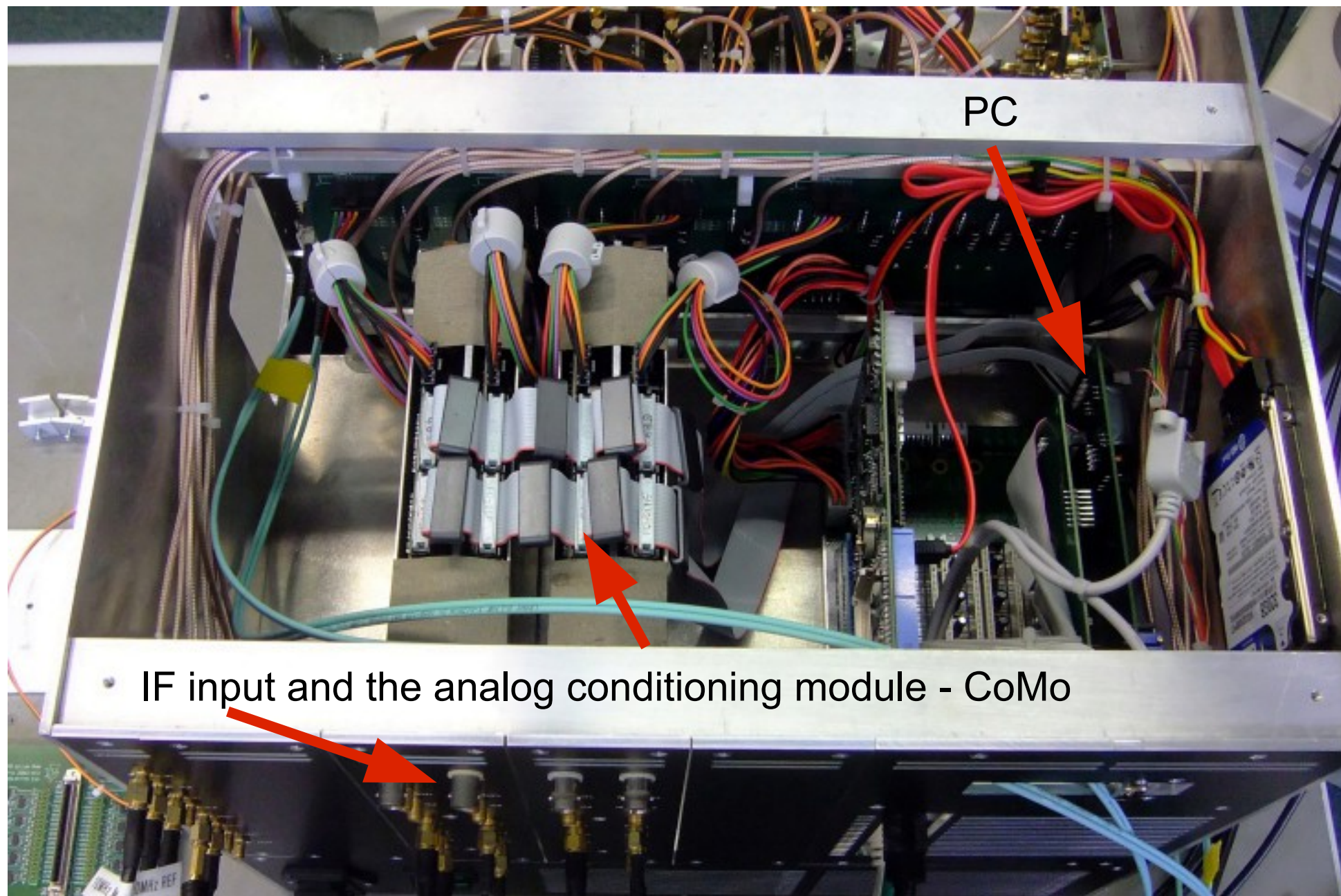


DBBC Outside (front view)

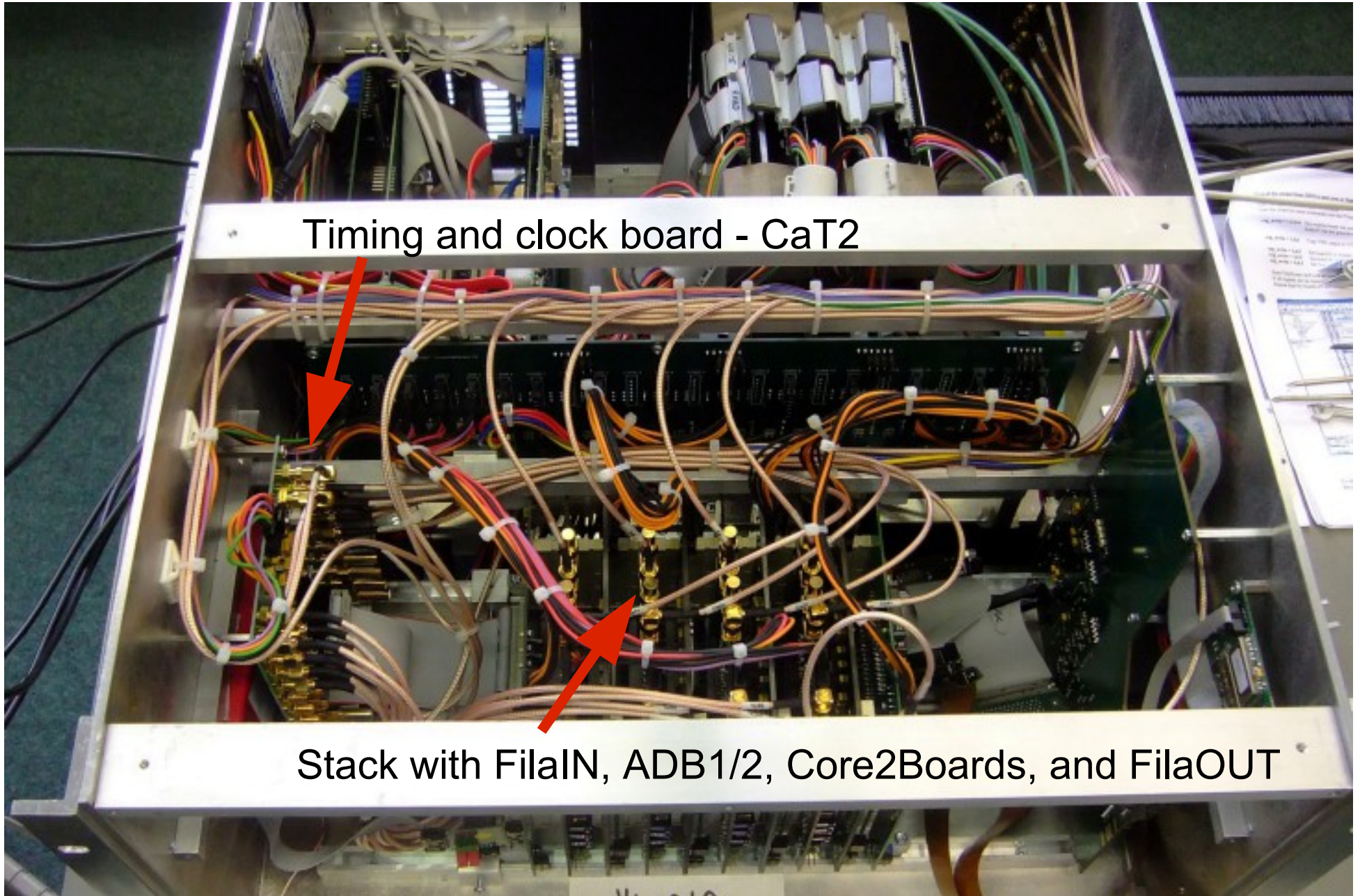




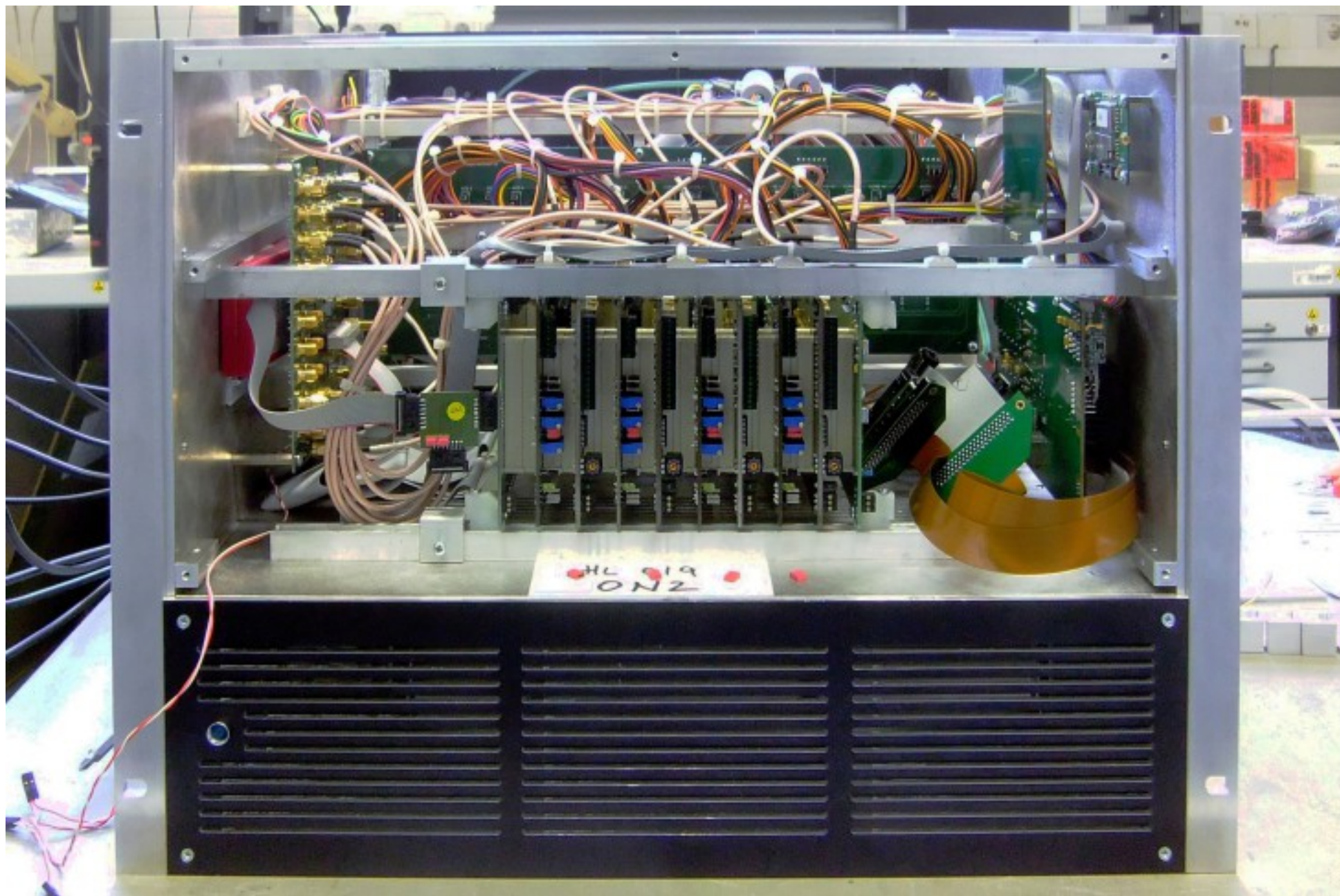
DBBC Inside



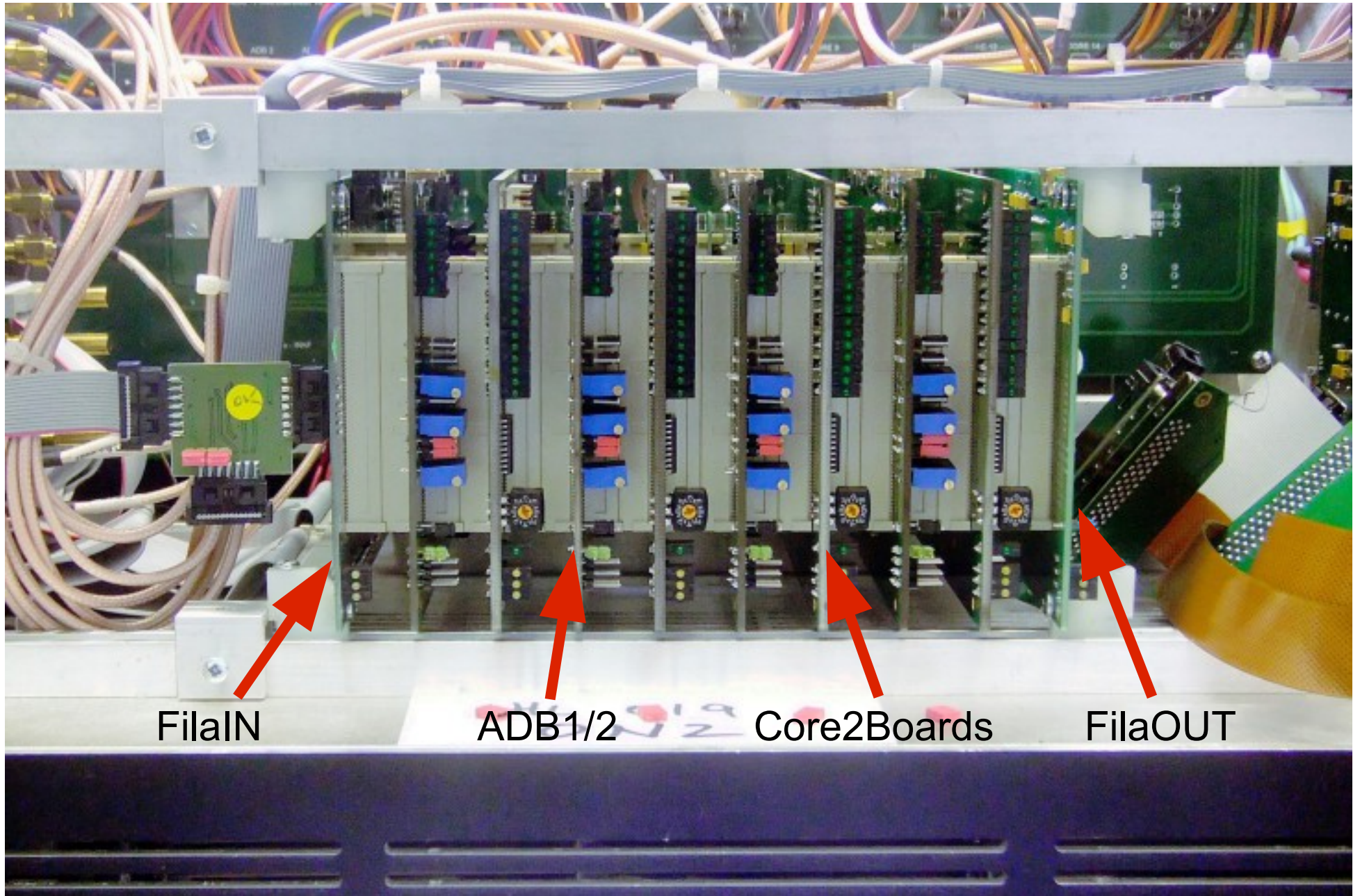
DBBC Inside



DBBC Inside



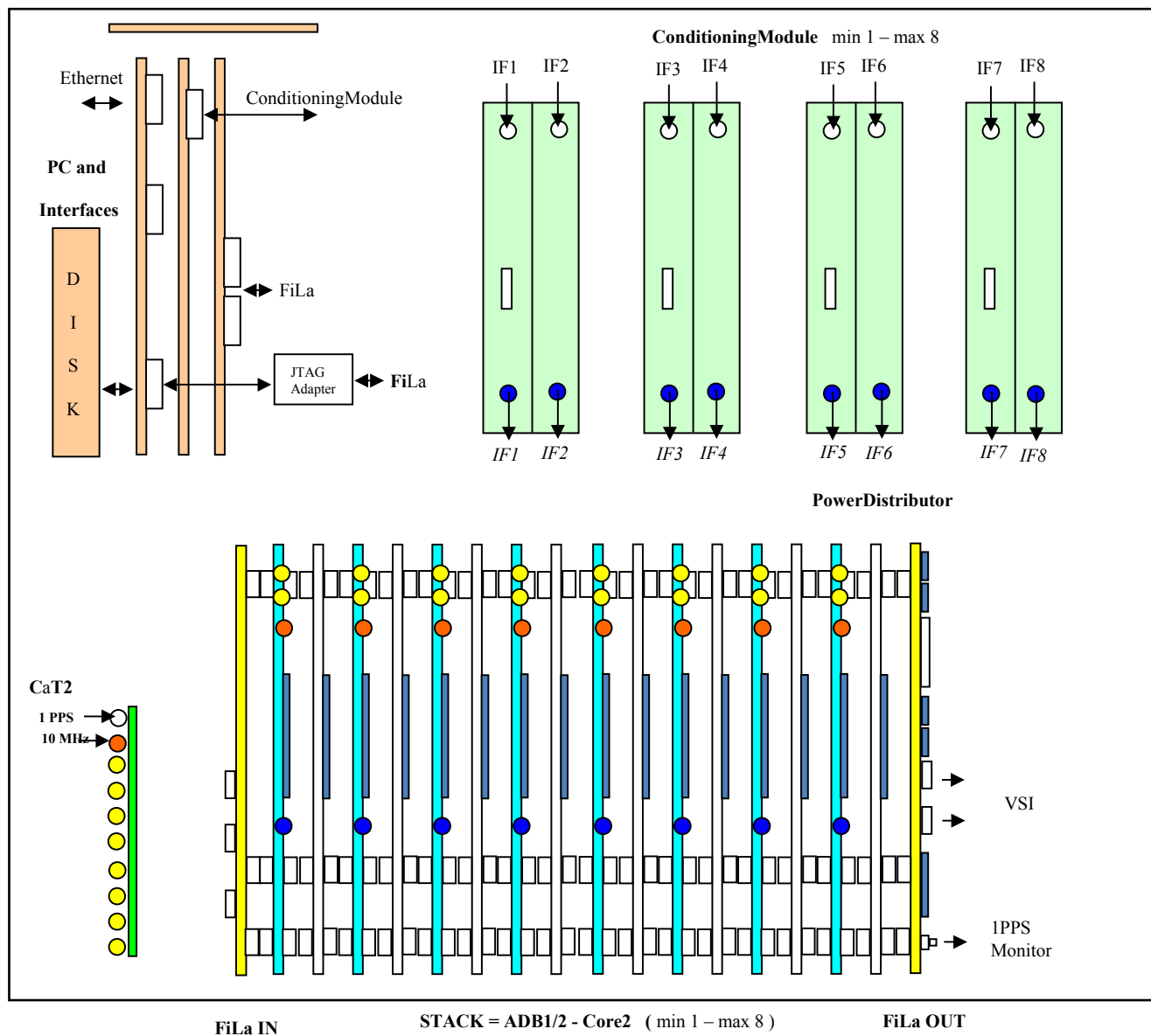
DBBC Inside





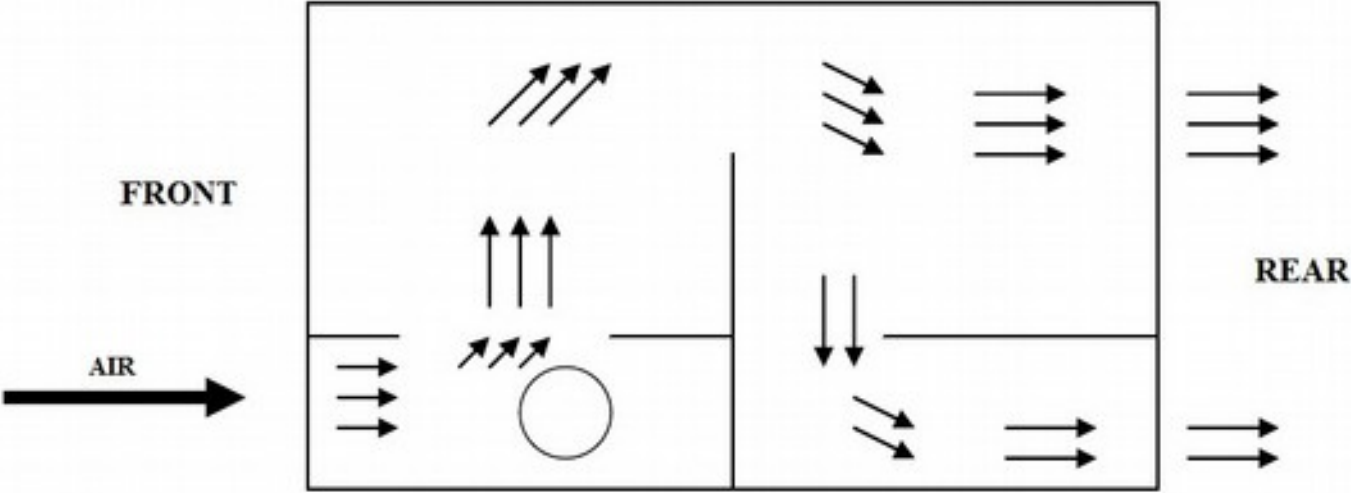
The DBBC Architecture

DBBC2 / DCCB2010 Schematic Top View





The DBBC Achitecture



The air cooling flow from a side view



General Features

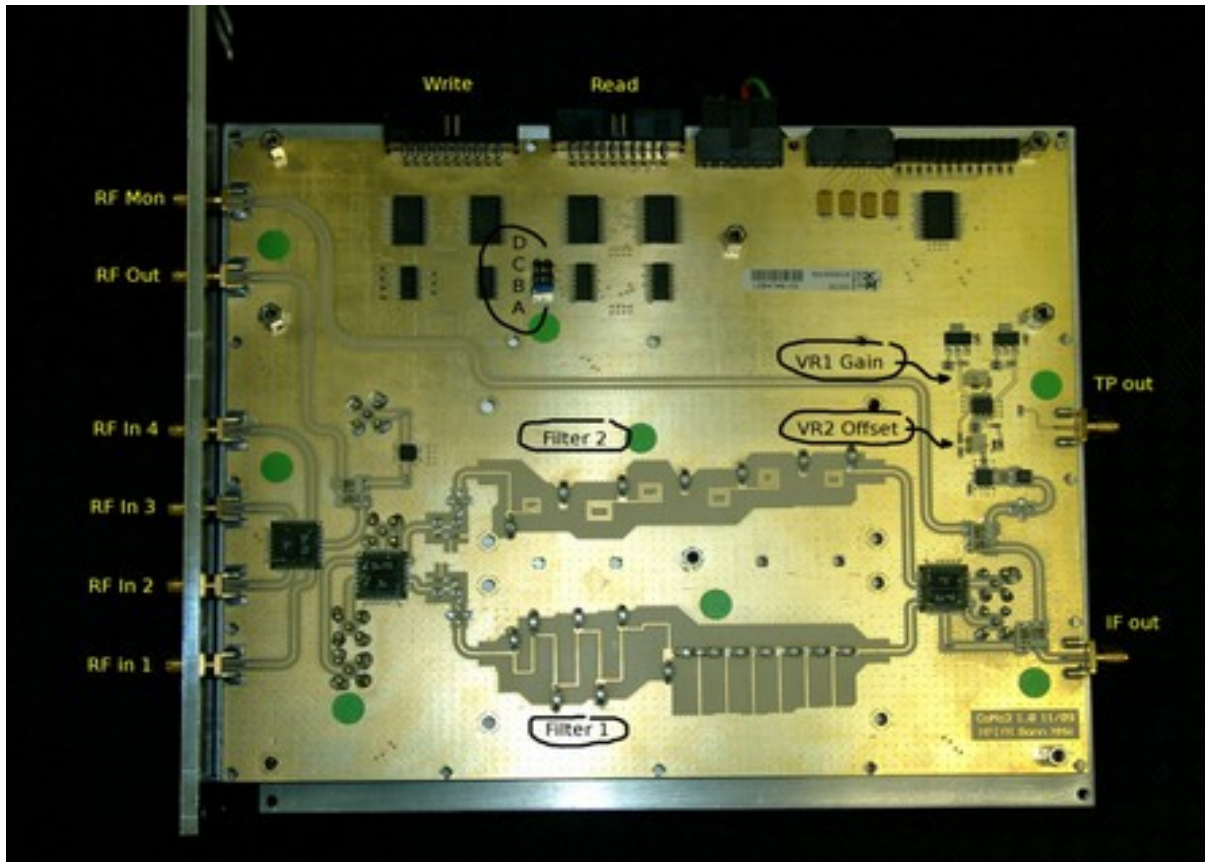
- 4/8 RF/IF Input out of 16 (4x4) in a range up to 2.2 (3.5) GHz
- 1024/2048 MHz sampling clock frequency
- More personalities for different observing modes
- Input 4/8 polarizations / bands
- Output 4/8 groups of 32 data channel
- Output as VSI interfaces or as 10G Ethernet streams
- Control under Field System or other client console



Component description

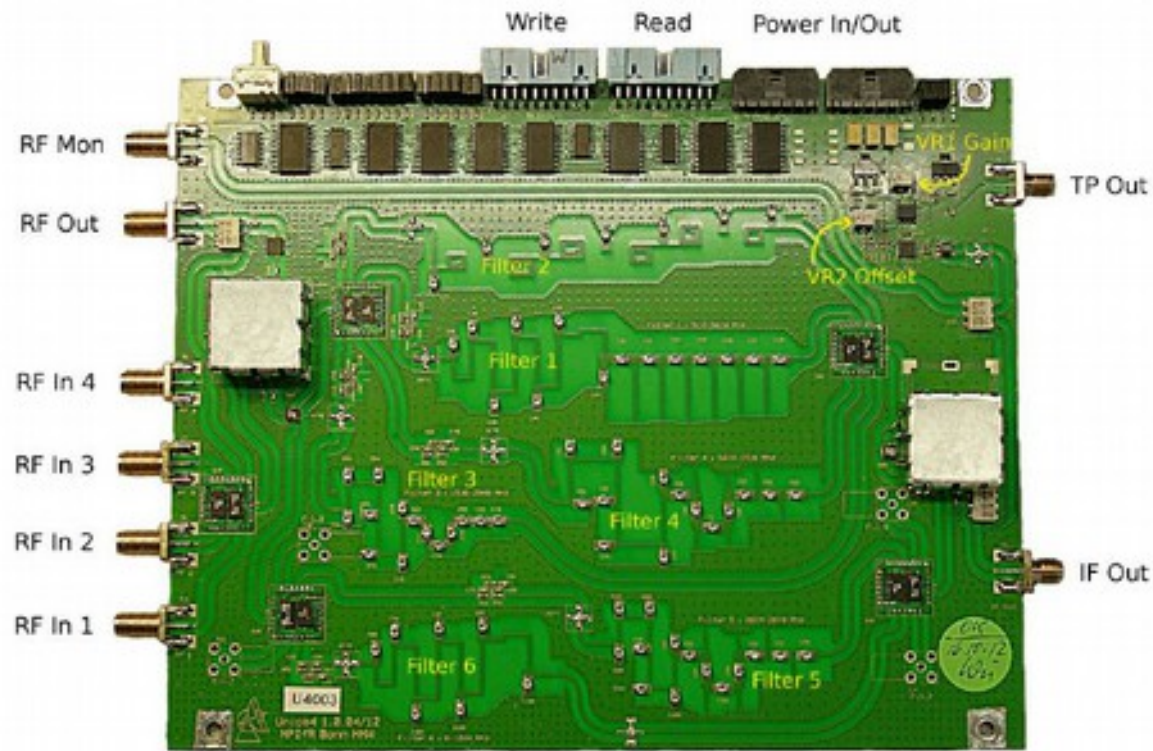
1. Analog Conditioning Module – CoMo
2. Analog-Digital Converter (ADB1 / ADB2)
3. Data Processing (Core2)
4. Connection and Service
(FiLaIN/OUT – FiLa10G FILA10G-4)
5. Timing and Clock (CaT2 – Clock and Timing)
6. Computer Control (PCSet)

1. Conditioning Module (Unica3)



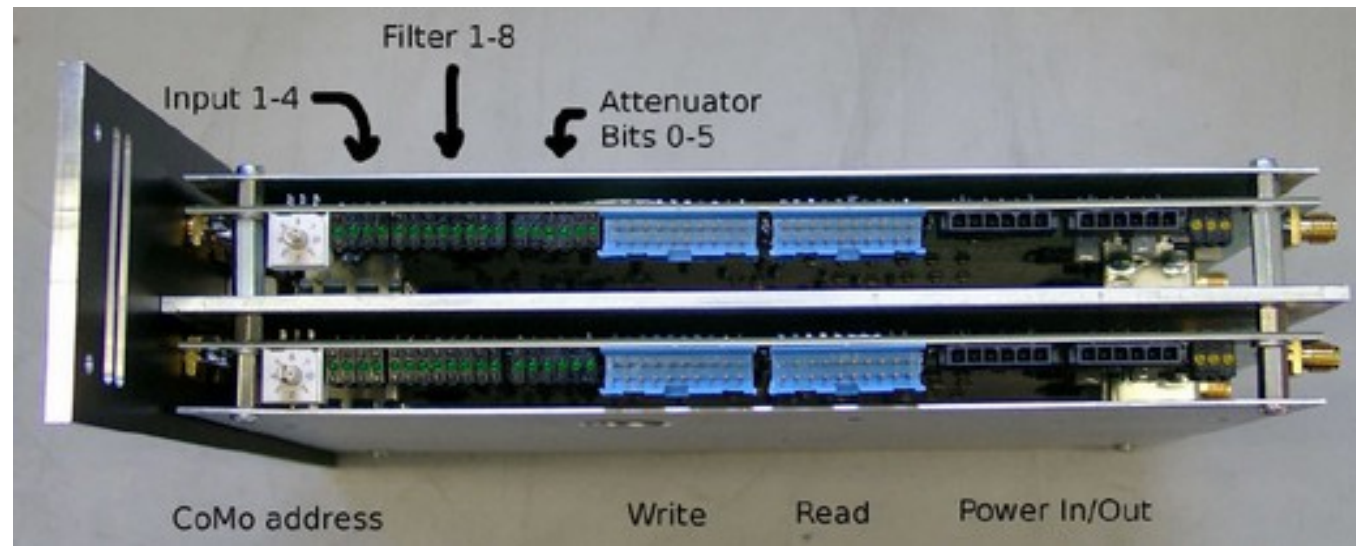
- 4 selectable RF inputs
- 4 selectable Nyquist filters
- 31.5 dB programmable attenuation
- Total power full band
- Manual or automatic gain control

1. Conditioning Module (Unica4)

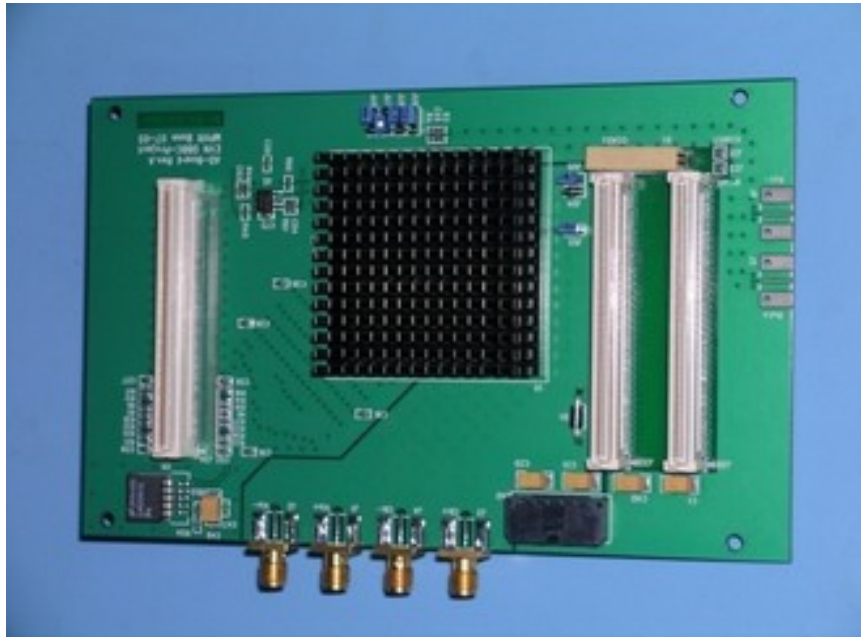


- Now with:
8 selectable Nyquist filters

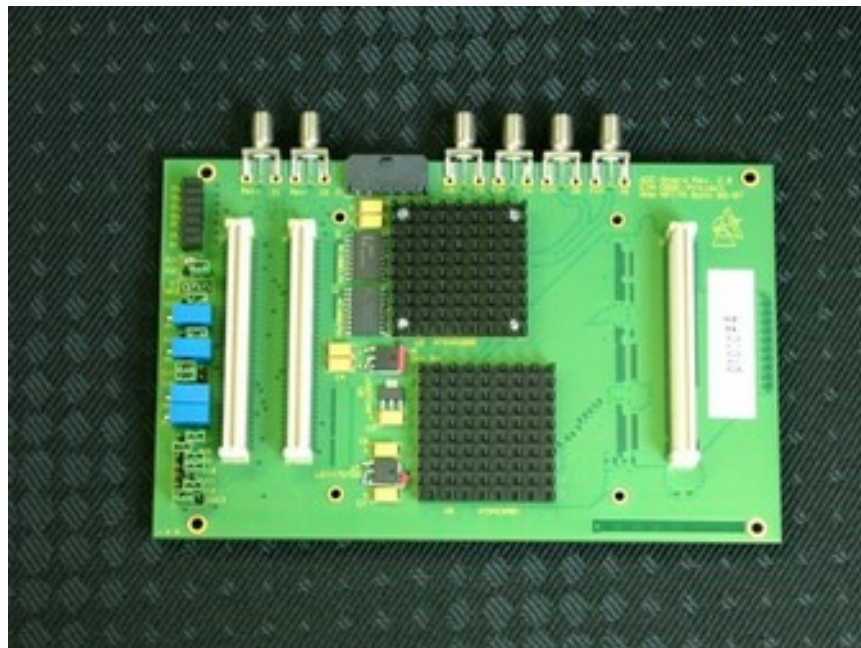
- 2 Unica boards build 1 CoMo



2. Analog to digital converter ADB1/2



- Analog input: 0 - 2.2 GHz
- Max Sampling clock 1.5 GHz
- Max Instantaneous bandwidth 750 MHz (real) / 1.5 GHz (complex)
- Output data 2 x 8-bit @ 1/4 Sclk DDR



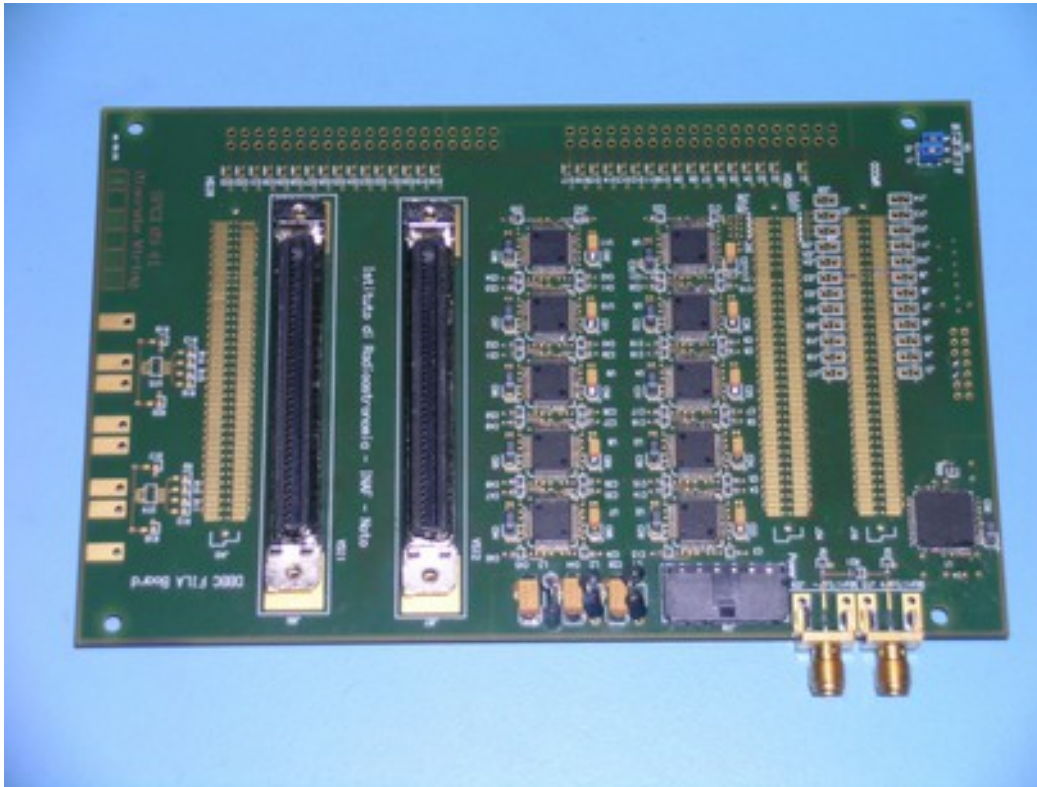
- Analog input: 0 – 3.5 GHz
- Max sampling clock 2.2 GHz
- Max instantaneous bandwidth 1.1 GHz (real) / 2.2 GHz (complex)
- Output data 2 x 8-bit @ 1/4 Sclk DDR
4 x 8-bit @ 1/8 Sclk DDR
- Piggy pack module support for 10-bit output and connection to Fila10G

3. Basic processing unit - Core2

- Input rate:
 - (4 IF x 2 bus x 8-bit x SClk/4 DDR) b/s
 - (2 IF x 4 bus x 8-bit x SClk/8 DDR) b/s
 -
- Typical output rate:
 - (64 ch x 32-64-128) Mb/s
- Programmable architecture
 - Digital down conversion (DDC)
 - 1 Core2 = 4 BBCs
 - Poly-phase Filter Bank (PFB)
 - 1 Core2 = 16 Poly-phase filters
- 1 VSI 32 channel output



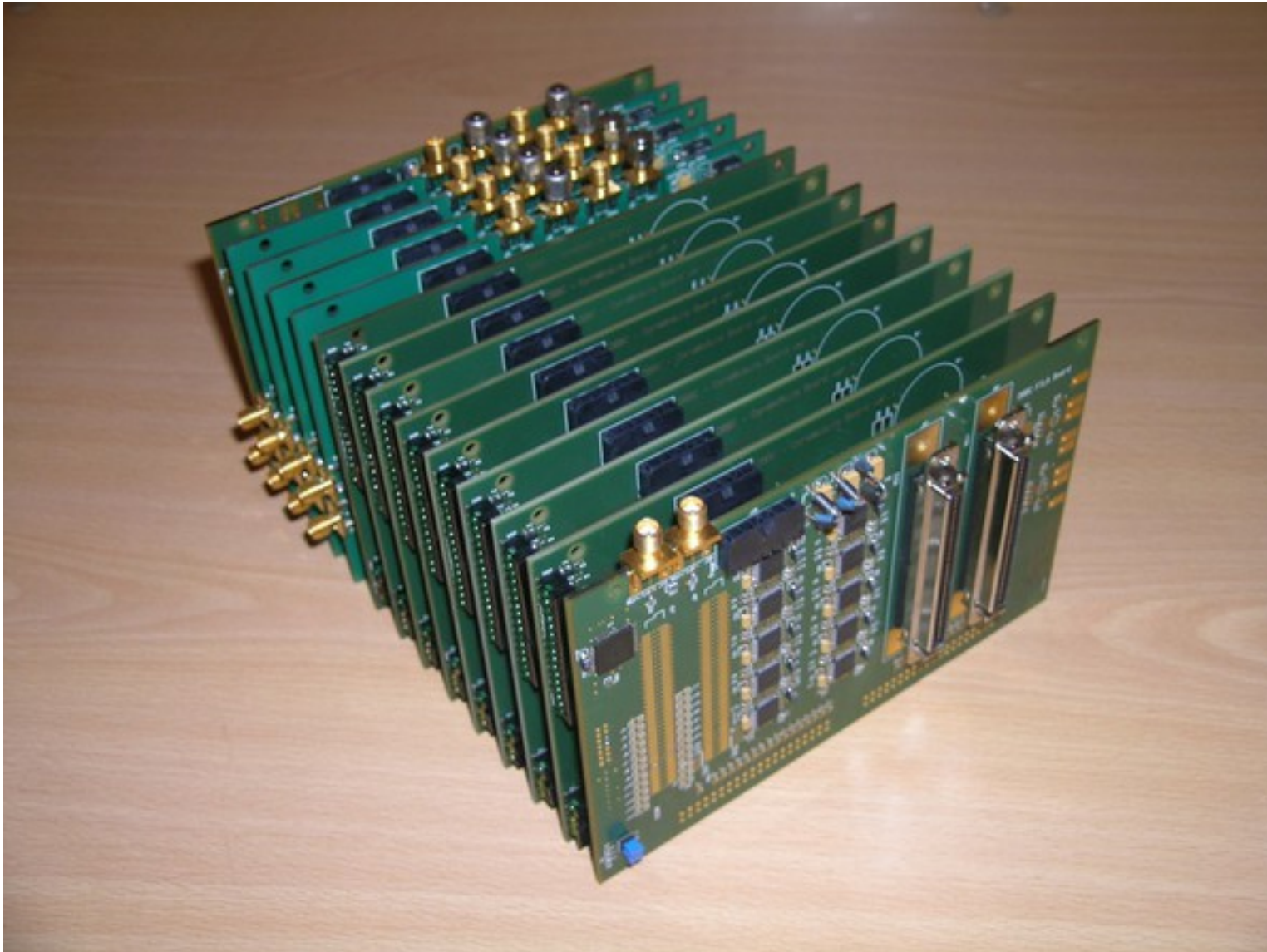
4. Connection and service - FiLaBoard



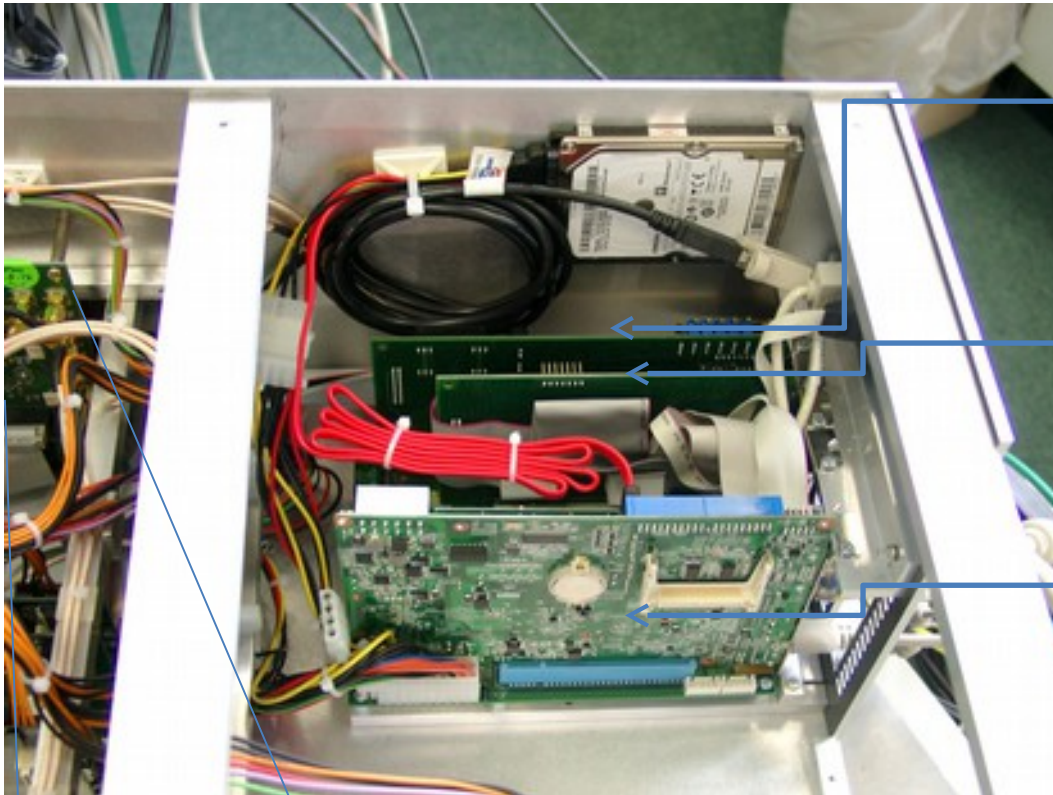
First and Last board in the stack

- First: IN
 - Communication interface
 - JTAG programming channel
 - 1pps in
- Last: OUT
 - 2 VSI interfaces
 - 1pps monitor out
 - 80 Hz continues calibration out

Complete Module Stack



6. PC Set – Control computer



ADLink PCI9111HR:
Communication with Conditioning Modules for IF total power measure, automatic gain control, registers control, etc.

ADLink PCI7200:
Communication with 32-bit bus for Core2 register setting, total power measurement, state statistics, etc.

Adventech PCI-7030:
Half Size PCI Motherboard (Intel Atom) on PCI backplane

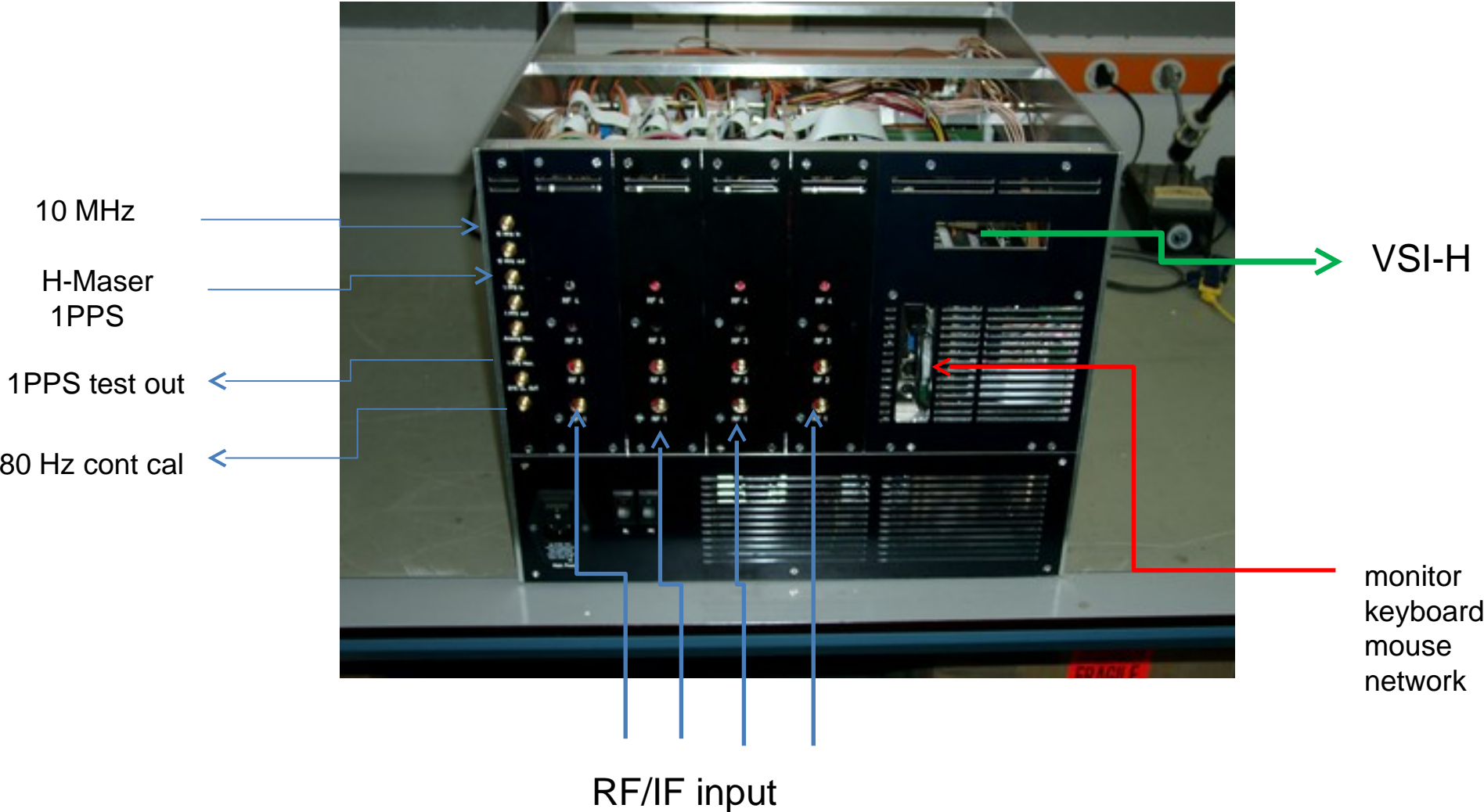
Xilinx programmer:
FPGA device configuration through USB – JTAG interface



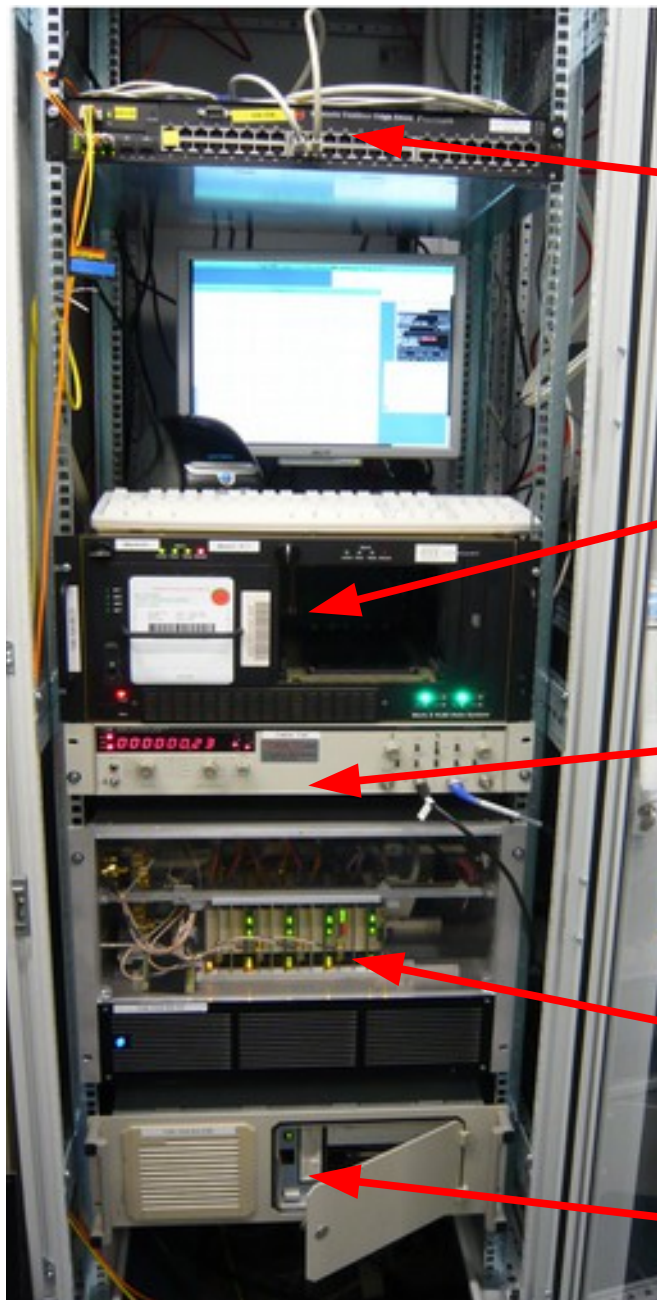


Installation of a DBBC

How to connect the DBBC



Installation of a DBBC



e-VLBI 10 GE switch

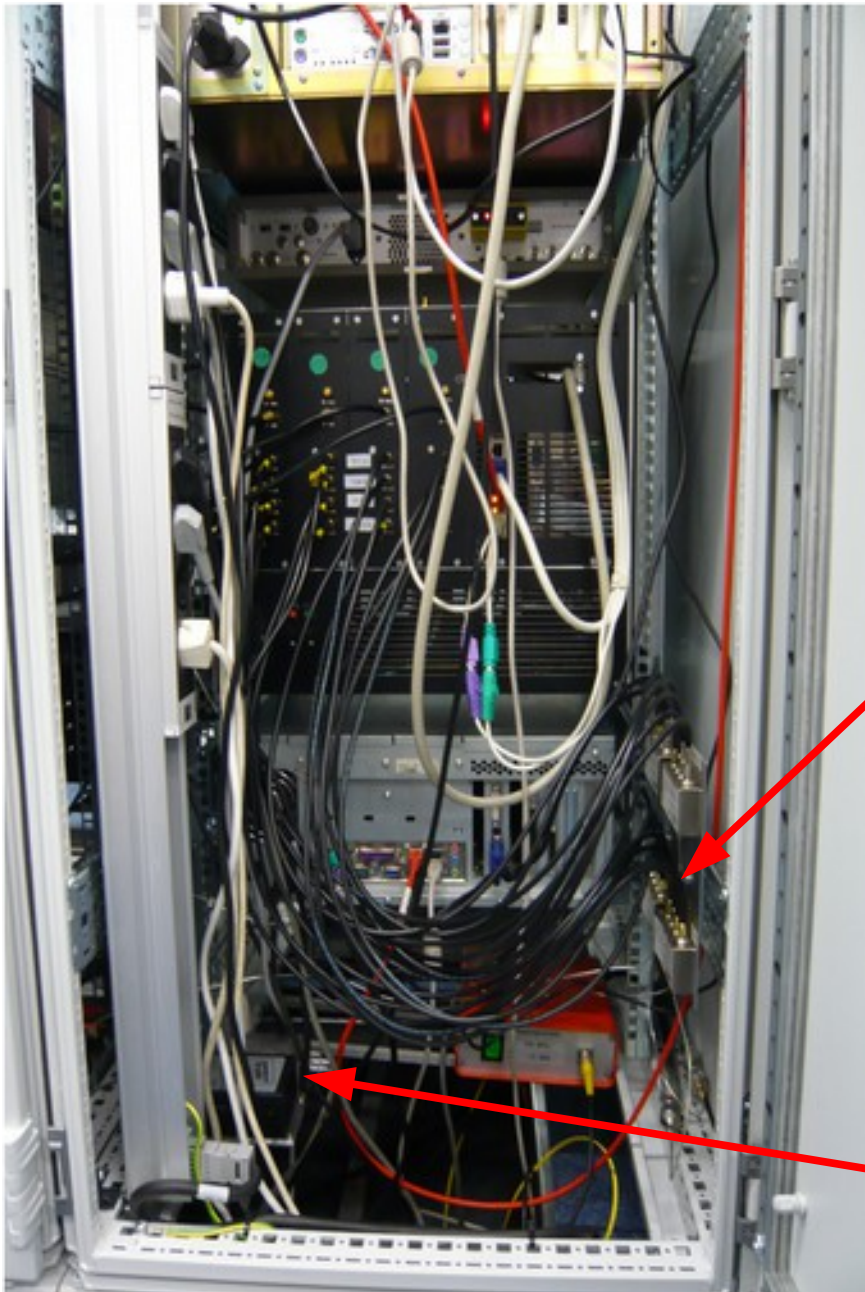
Mark5B+ disk recorder

Counter to monitor
gps – 1pps out (MK5B)

DBBC

Field System PC

Installation of a DBBC

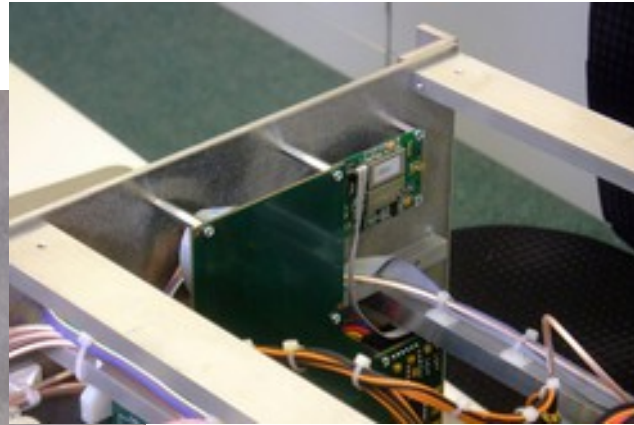
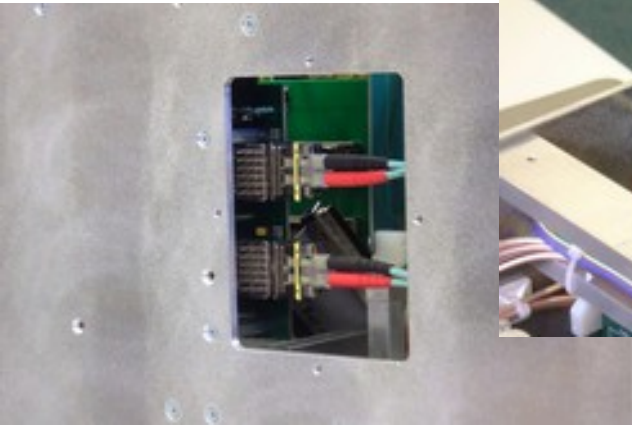


4x4 IF-Splitter to provide all possible IFs at the DBBC Inputs:

- IF1: a. 500-1000 IF RCP
b. 0-500 IF RCP
c. 500-1000 IF LCP
d. 0-500 IF LCP
- IF2: a. 500-1000 IF RCP
b. 0-500 IF RCP
c. 500-1000 IF LCP
d. 0-500 IF LCP
- IF3: a. 500-1000 IF RCP
b. 0-500 IF RCP
c. 500-1000 IF LCP
d. 0-500 IF LCP
- IF4: a. 500-1000 IF RCP
b. 0-500 IF RCP
c. 500-1000 IF LCP
d. 0-500 IF LCP

blank – sync generation from 80 Hz

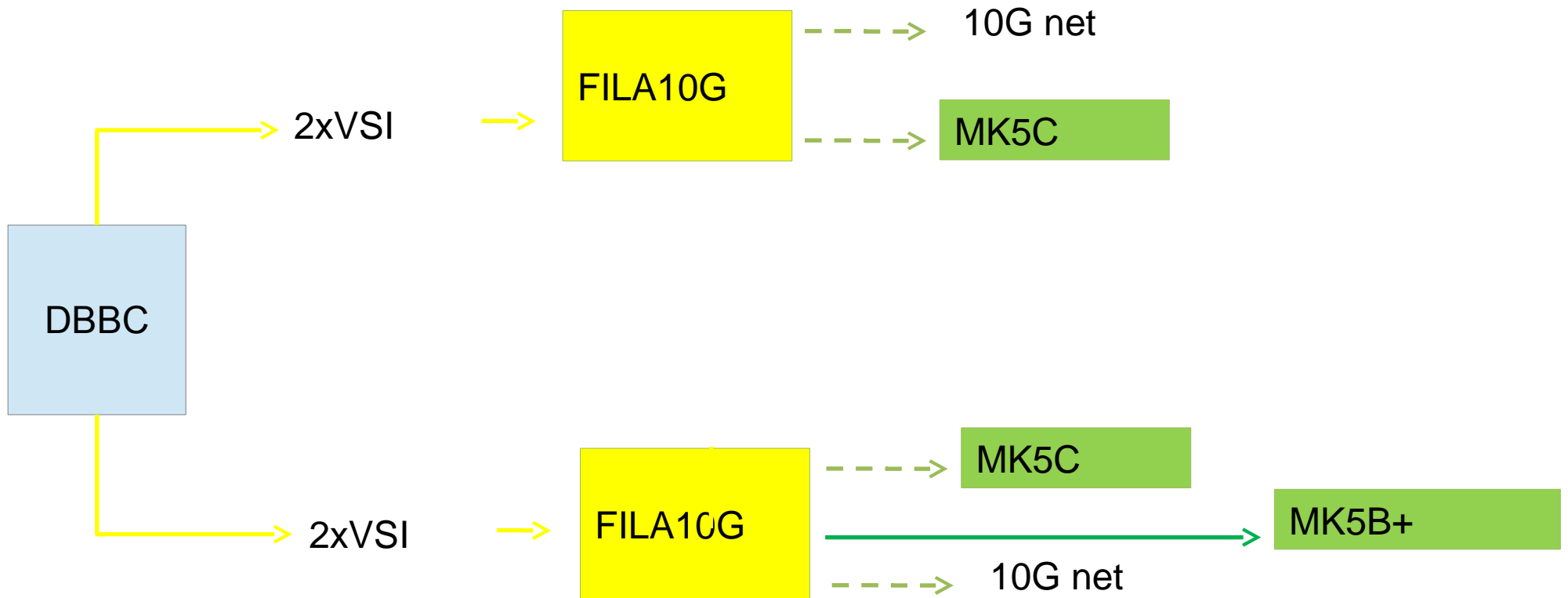
FiLa10G (SA)



- Two independent 10G Ethernet UDP port
- Physical interface optical XFP
- 10G port fully bidirectional
- Installed inside the DBBC box or as stand-alone
- Data rate: 1 – 2 – 4 Gbps each 10G port
- Format mode: RAW, MK5B or VDIF



Connection examples





FiLa10G Software

- **FILA10G Files:**

- c:\DBBC\bin\timesyncFILA10G.exe (MK5B time set)
 - c:\DBBC\bin\vdif_timesyncFILA10G.exe (VDIF time set)
 - c:\DBBC\bin\sendstr.exe (serial communication)
 - c:\DBBC_conf\FilesDBBC\fila10g_v3.3.1.bit
 - c:\DBBC\doc\DBBC2 FILA10G Command set v3.3.1.pdf

Note: a program to sync with a NTP server is required (eg. NetTimeSetup-314.exe) or new FiLa10G modules have a GPS module build in that can be used to get the GPS time.



Setting up the FiLa10G

- Upload of the firmware is
 - automatically made by the DDC/PFB control software (internal FiLa10G)
 - done with an additional Xilinx JTAG programmer using a script for IMAPCT (external FiLa10G-SA)
- Communication is through serial port or Ethernet in the stand-alone version
- Commands available (see document)
- VDIF packet size setting (see document)
- Script files can be used for block of commands (see batch)



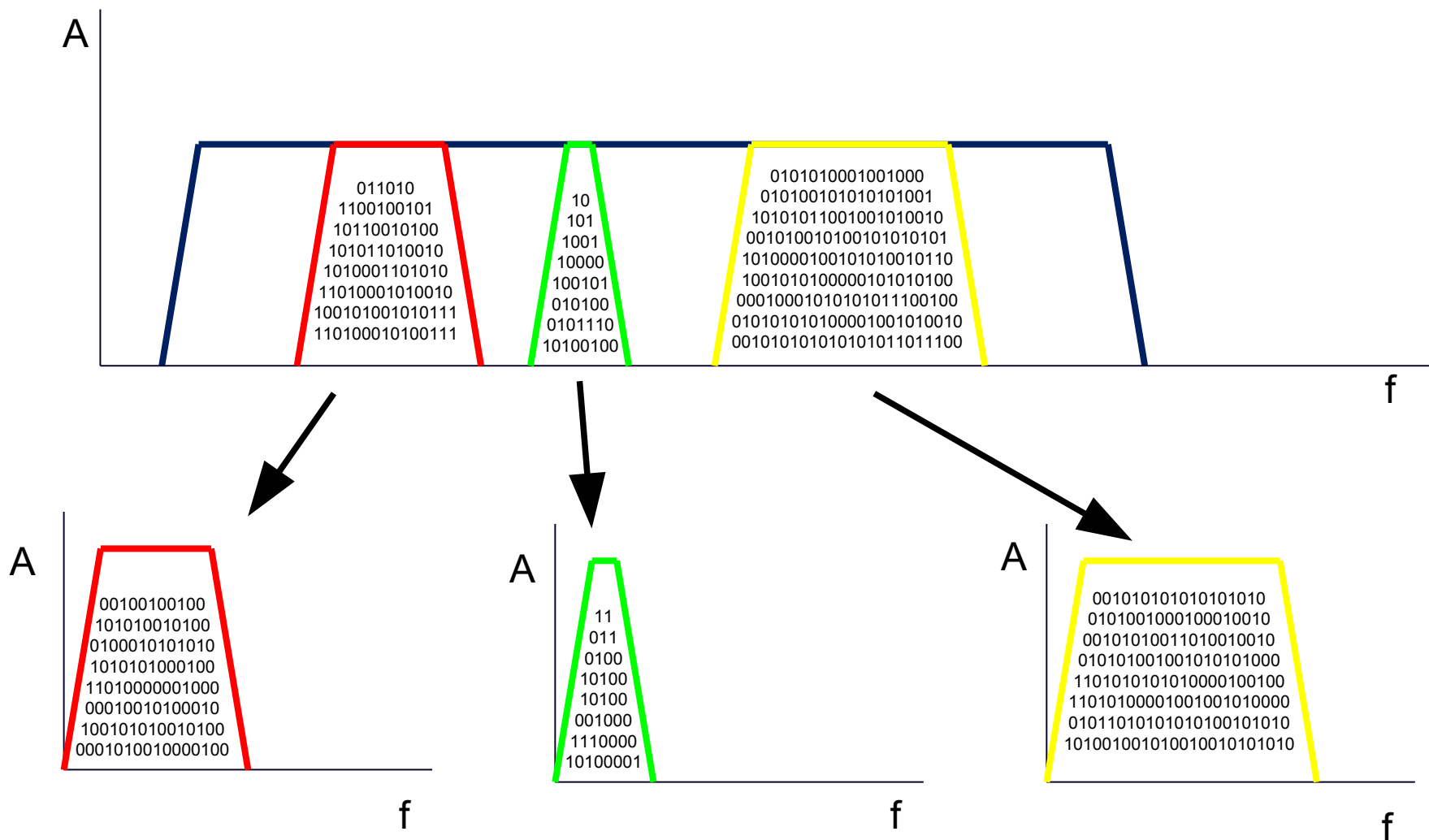
Observing modes

- DDC: tunable, channel bandwidth between 1 MHz and 16 MHz, U&L, Continuous cal with 80 Hz synchronization, modes: geo, astro, astro2, w-astro, lba, test
DDC-E: like DDC but bandwidth up to 32 MHz (astro3)
- PFB: fixed tuning, channel bandwidth 32/64 MHz, all U or L depending on the Nyquist zone
- DSC: full 4 x 512/1024 MHz, max 8 x 1024 MHz band direct sampling conversion, all U or L depending on the Nyquist zone
- SPECTRA: 4Kch/IF spectrometer, max 32K channels



DDC – digital down conversion

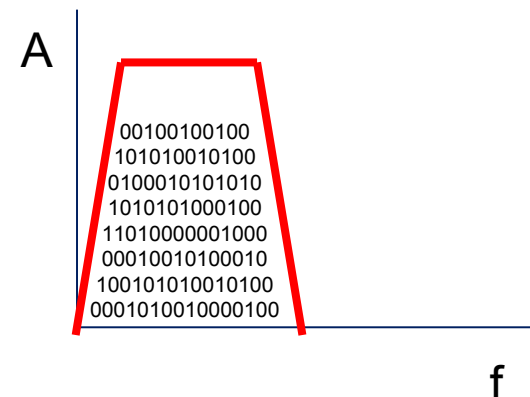
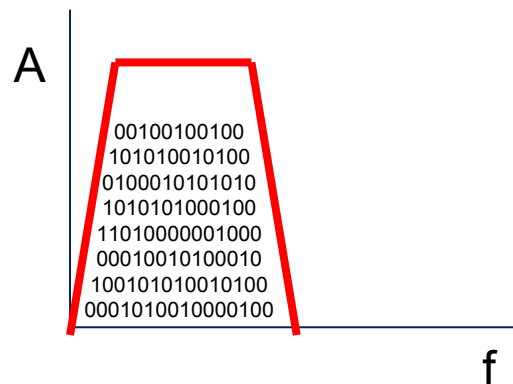
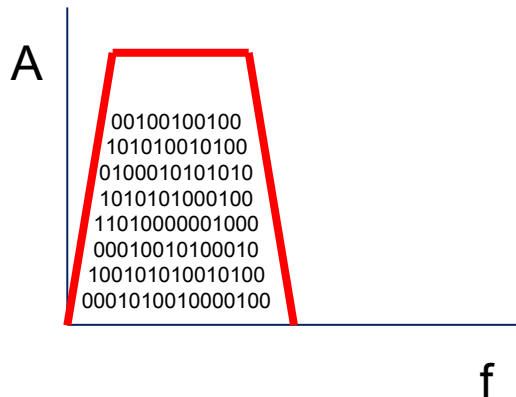
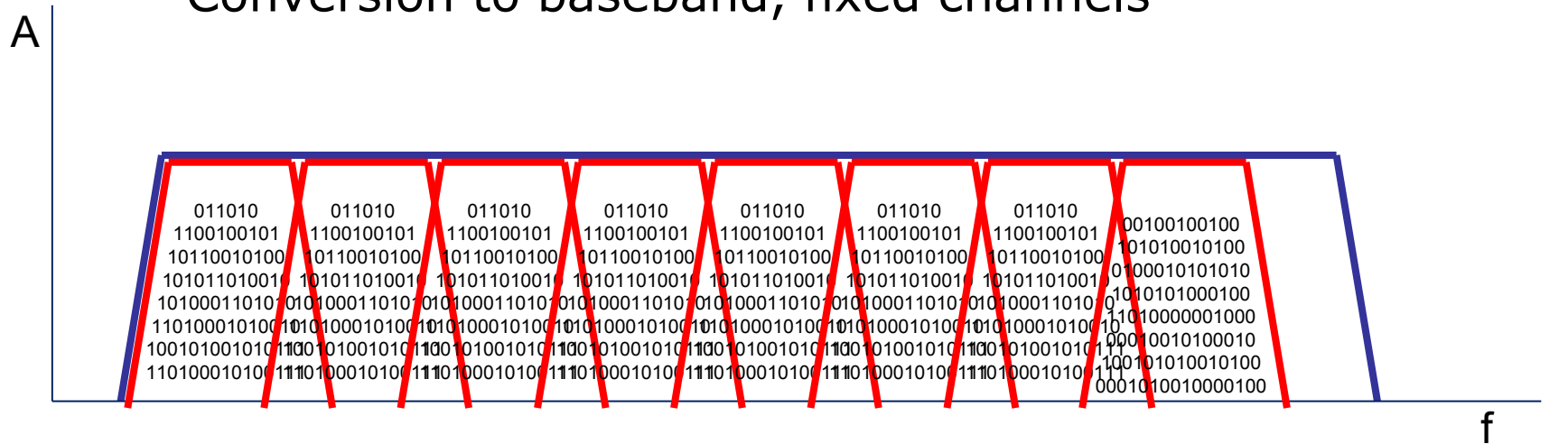
Conversion to baseband, tunable channels of variable bandwidth





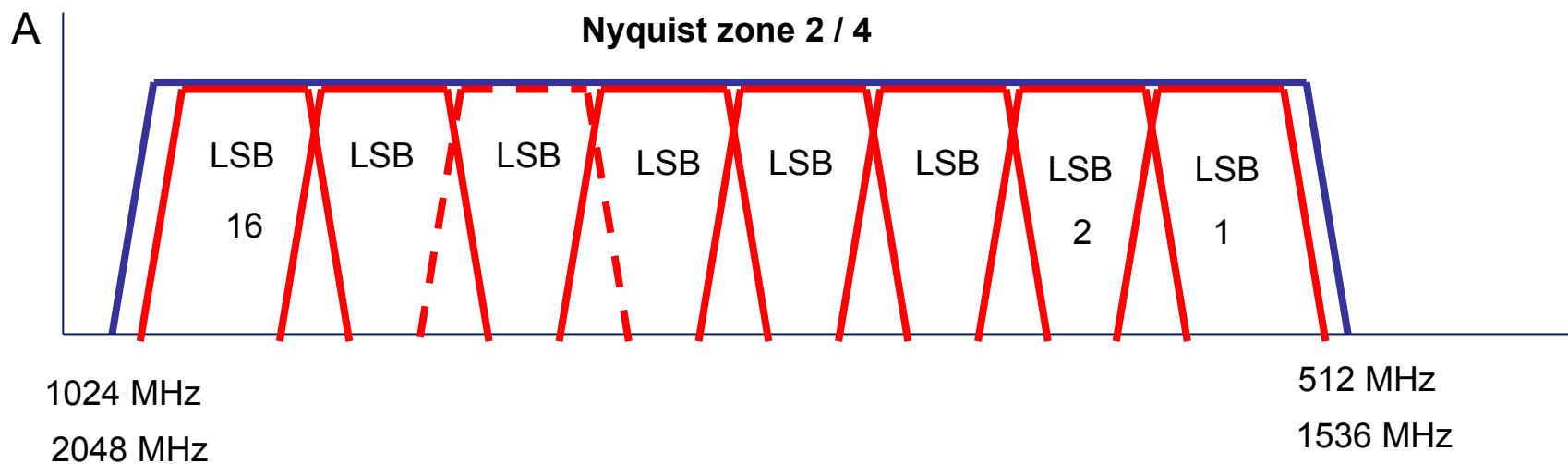
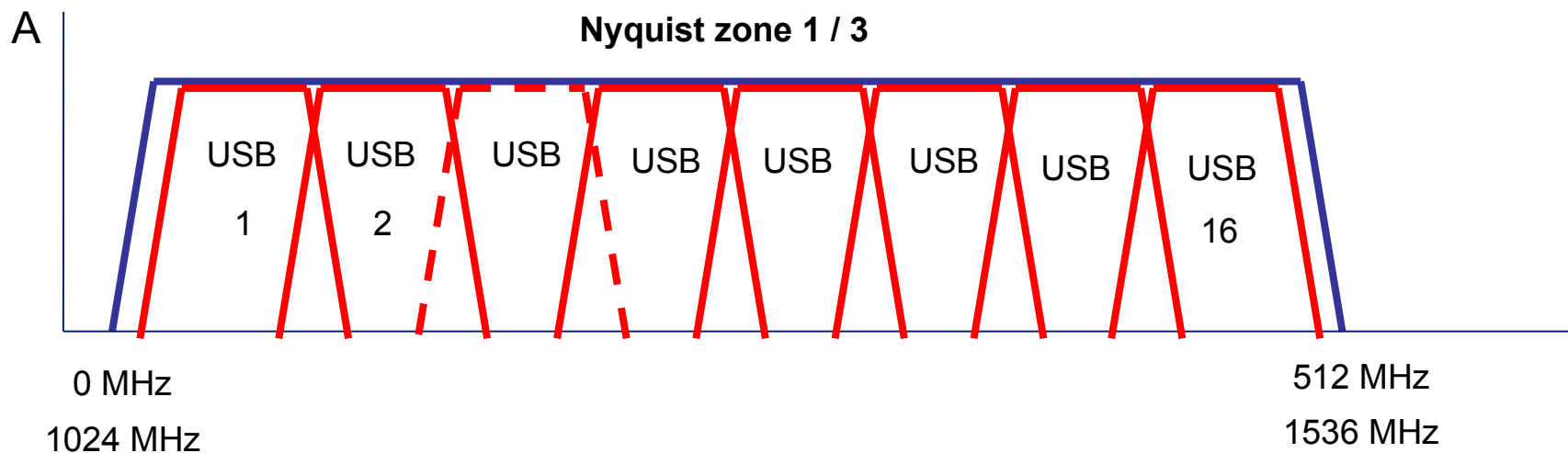
PFB – poly-phase filter bank

Conversion to baseband, fixed channels





PFB – poly-phase filter bank





Software

How the observing mode is selected

- Using a dedicated firmware
- Using a dedicated control software
- Using a dedicated configuration text file

Software (Windows XP)

Files Structure:

C:\DBBC\bin
→ control software

C:\DBBC\doc
→ manuals

C:\DBBC_CONF\
→ configuration text files

C:\DBBC_CONF\FilesDBBC
→ firmware

rdesktop - 10.100.100.36

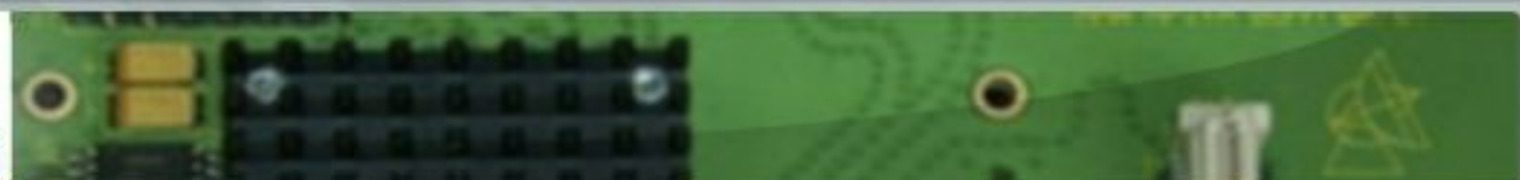
Normal DBBC Program DDC v104_2

```
Command from 134.184.64.233: Command received: dbbc05 6
Command from 134.184.64.233: Command received: dbbc06 6
Command from 134.184.64.233: Command received: dbbc07 6
Command from 134.184.64.233: Command received: dbbc08 6
Command from 134.184.64.233: Command received: dbbcifa 7
Command from 134.184.64.233: Command received: dbbcifb 7
Command from 134.184.64.233: Command received: dbbc01 6
Command from 134.184.64.233: Command received: dbbc02 6
Command from 134.184.64.233: Command received: dbbc03 6
Command from 134.184.64.233: Command received: dbbc04 6
Command from 134.184.64.233: Command received: dbbc05 6
Command from 134.184.64.233: Command received: dbbc06 6
Command from 134.184.64.233: Command received: dbbc07 6
Command from 134.184.64.233: Command received: dbbc08 6
Command from 134.184.64.233: Command received: dbbcifa 7
Command from 134.184.64.233: Command received: dbbcifb 7
Command from 134.184.64.233: Command received: dbbcifb 7
Command from 134.184.64.233: Command received: dbbcifb 7
Command from 134.184.64.233: Command received: dbbcifb 7
Command from 134.184.64.233: Command received: dbbcifb 7
Command from 134.184.64.233: Command received: dbbcifb 7
Command from 134.184.64.233: Connection lost.
Server restarted
Waiting for connection
```

C:\DBBC_CONF

Name	Size	Type	Date Modified
dbbc_config_file.txt	1 KB	Text Document	10/4/2012
dbbc_config_file_101.txt	1 KB	Text Document	7/11/2013
dbbc_config_file_102.txt	1 KB	Text Document	11/19/2013
dbbc_config_file_102b.txt	1 KB	Text Document	7/11/2013
dbbc_config_file_104.txt	1 KB	Text Document	12/11/2013
dbbc_config_file_105.txt	1 KB	Text Document	3/19/2014
dbbc_config_file_105E.txt	1 KB	Text Document	4/23/2015
dbbc_config_file_105F.txt	1 KB	Text Document	3/19/2014
dbbc_config_file_120509.txt	1 KB	Text Document	10/17/2013

start Command Prompt Normal DBBC Program... C:\DBBC_CONF 5:01 PM



Main Menu

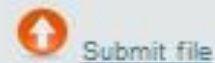
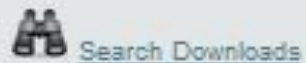
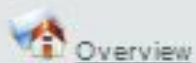
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Downloads



Overview

Page: 1 of 1

Number of Categories: 6



[DDC - Tunable 16 bbc](#)

Files: 4



[BASE - General](#)

Files: 4



[FILA10G - 10G Ethernet](#)

Files: 2



[PFB - Polyphase 16 bands](#)

Files: 3



[SPECTRA - Spectrometer](#)

Files: 1



[Technical Notes](#)

Files: 10



Software

- General:

BASE Package

c:\DBBC\bin\DBBC client v3.exe (general client)

c:\DBBC\bin\clock1024.exe (CAT2 1024)

c:\DBBC\bin\clock2048.exe (CAT2 2048)

c:\DBBC\bin\ad9858.exe (CAT1)

c:\DBBC\bin\power.exe (on-off hardware)

c:\DBBC\bin\agc_if.exe (CoMo Unica3 test)

c:\DBBC\bin\agc_if_unica4.exe (CoMo Unica4 test)



Software

- DDC:

- c:\DBBC\bin\DBBC2 Control DDC v104.exe (server)
 - c:\DBBC_conf\dbbc_config_file_104.txt
 - c:\DBBC_conf\FilesDBBC\dbbc2_ddc_v104.bit
 - c:\DBBC\doc\DBBC2 DDC command set v104.pdf

- PFB:

- c:\DBBC\bin\DBBC2 Control PFB v15.exe (server)
 - c:\DBBC_conf\dbbc_poly_config_file_15.txt
 - c:\DBBC_conf\FilesDBBC\ dbbc2_pfb_v15.bit
 - c:\DBBC\doc\DBBC2 PFB command set v15.pdf



DDC configuration file

c:\DBBC_conf\dbbc_config_file_104.txt

Example:

```
1 dbbc2_ddc_v104.bit 597.00 8 ←the first number is indication of ADB1|2, in this case ADB1 is on
1 dbbc2_ddc_v104.bit 682.00 8 IFA and ADB2 on IFB, ADB1 in IFC, no Core2 for IFD
1 dbbc2_ddc_v104.bit 853.00 8 If no Core2 is inserted in the first and second column put 0.
1 dbbc2_ddc_v104.bit 938.00 8 The second parameter is the firmware file name to be used.
2 dbbc2_ddc_v104.bit 597.00 8 The third and fourth parameters are frequency and bandwidth respectively.
2 dbbc2_ddc_v104.bit 682.00 8
2 dbbc2_ddc_v104.bit 853.00 8
2 dbbc2_ddc_v104.bit 938.00 8
1 dbbc2_ddc_v104.bit 597.00 8
1 dbbc2_ddc_v104.bit 682.00 8
1 dbbc2_ddc_v104.bit 853.00 8
1 dbbc2_ddc_v104.bit 938.00 8
0 dbbc2_ddc_v104.bit 597.00 8 Each Core2 board supports 4 bbcs so if not present 0 has to be inserted in
0 dbbc2_ddc_v104.bit 682.00 8 four lines
0 dbbc2_ddc_v104.bit 853.00 8
0 dbbc2_ddc_v104.bit 938.00 8
1 fila10g_v2_1.bit ← if a FILA10G is installed set 1st version 1 (with ACE), 2nd version (without ACE 2), otherwise 0
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFA
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFB
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFC
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFD
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFE
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFF
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFG
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFH
107 112 0 0 ← phase calibration values
CAT2 1024 ← CAT1|2 and sampling frequency
```



Starting the software

DDC: running **DBBC2 Control DDC v104.exe**

```
DBBC Control net_v101.exe
core 1 1 dbbc2_v101.bit conf. file 130.998000 lo freq 4 bw filter
core 2 1 dbbc2_v101.bit conf. file 140.998000 lo freq 4 bw filter
core 3 1 dbbc2_v101.bit conf. file 170.998000 lo freq 4 bw filter
core 4 1 dbbc2_v101.bit conf. file 230.998000 lo freq 4 bw filter
core 5 1 dbbc2_v101.bit conf. file 340.998000 lo freq 4 bw filter
core 6 1 dbbc2_v101.bit conf. file 420.998000 lo freq 4 bw filter
core 7 1 dbbc2_v101.bit conf. file 470.998000 lo freq 4 bw filter
core 8 1 dbbc2_v101.bit conf. file 490.998000 lo freq 4 bw filter
core 9 0 dbbc2_v101.bit conf. file 192.998000 lo freq 4 bw filter
core 10 0 dbbc2_v101.bit conf. file 207.998000 lo freq 4 bw filter
core 11 0 dbbc2_v101.bit conf. file 217.998000 lo freq 4 bw filter
core 12 0 dbbc2_v101.bit conf. file 247.998000 lo freq 4 bw filter
core 13 0 dbbc2_v101.bit conf. file 267.998000 lo freq 4 bw filter
core 14 0 dbbc2_v101.bit conf. file 272.998000 lo freq 4 bw filter
core 15 0 dbbc2_v101.bit conf. file 100.998000 lo freq 4 bw filter
core 16 0 dbbc2_v101.bit conf. file 200.998000 lo freq 4 bw filter
File10G 0
Reconfigure? y/n _
```

after the Core2 configuration is completed

then run a client ex. **DBBC Client v3.exe** or **Field System**

DDC Mode Commands and Form Table (see documents)



First tests with the DBBC

- Cabling the DBBC: IF, 1pps, 10 MHz, (80 Hz calibration?)
- Starting the DDC software (server) on the DBBC Windows PC
 - Newest version always available at <http://www.hatlab.com/hatlab/support> currently v104_2 or v105 for DDC
- Configuration file needs to be edit for your hardware installation.

First functionality can be tested with the DBBC_client or from the FS:

- select different IF inputs for the ADBs and let AGC adjustment work, e.g.

```
> dbbcifa # for query
```

```
> dbbcifa=2,agc,2 # to set RF input 2, agc on, IF filter 2 (0-500 MHz)
```

read out BBCs set different frequencies, ...

```
> dbbc01 # for query
```

```
> dbbc01=596.00,a,16.00 # to set BBC freq=596 MHz, IFA, BBC  
band width = 16 MHz
```


First tests with the DBBC

- > dbbcifa # for query
- > dbbcifa=2,agc,2 # to set RF input 2, agc on, IF filter 2 (0-500 MHz)

read out BBCs set different frequencies, ...

- > dbbc01 # for query
- > dbbc01=596.00,a,16.00 # to set BBC freq=596 MHz, IFA, BBC band width = 16 MHz

```
DBBC client v3.exe
Enter Command: dbbcifa
Received from DBBC: dbbcifa/2,0,agc,2,0,38000

Enter Command: dbbcifa
Received from DBBC: dbbcifa/2,0,agc,2,0,38000

Enter Command: dbbcifb
Received from DBBC: dbbcifb/3,0,agc,1,0,38000

Enter Command: dbbcifc
Received from DBBC: dbbcifc/4,0,agc,2,0,38000

Enter Command: dbbc01
Received from DBBC: dbbc01/124.490000,a,8,1,agc,255,255,4639,4486,4644,4492

Enter Command: dbbc02
Received from DBBC: dbbc02/140.490000,a,8,1,agc,255,255,5140,4758,5117,4745

Enter Command: dbbcifb=2,agc,2
Received from DBBC: dbbcifb/2,0,agc,2,0,38000

Enter Command: dbbcifb
Received from DBBC: dbbcifb/2,0,agc,2,0,38000

Enter Command: _
```



Connecting a Mark5B(+)

Connect the DBBC VSI1 port to the Mark5B using VSI cable.

Set Mark5B needs to be synced to the 1pps on the VSI cable.

```
tstDIM > clock_set=32:ext
```

```
tstDIM > 1pps_source=vsi
```

```
tstDIM > dot_set=:force
```

```
tstDIM > dot?           # query several times to see if it stays synced
```

Test the quality of the connection

```
DBBC > dbbcform=test,tvg           # starts TVG on the DBBC
```

```
tstDIM > tvr=0xffffffff           # TVR LED should be green.
```

If it is not green it might help to carefully disconnect and reconnect the VSI cable on both ends, sometimes cleaning the connectors with dry air is required.



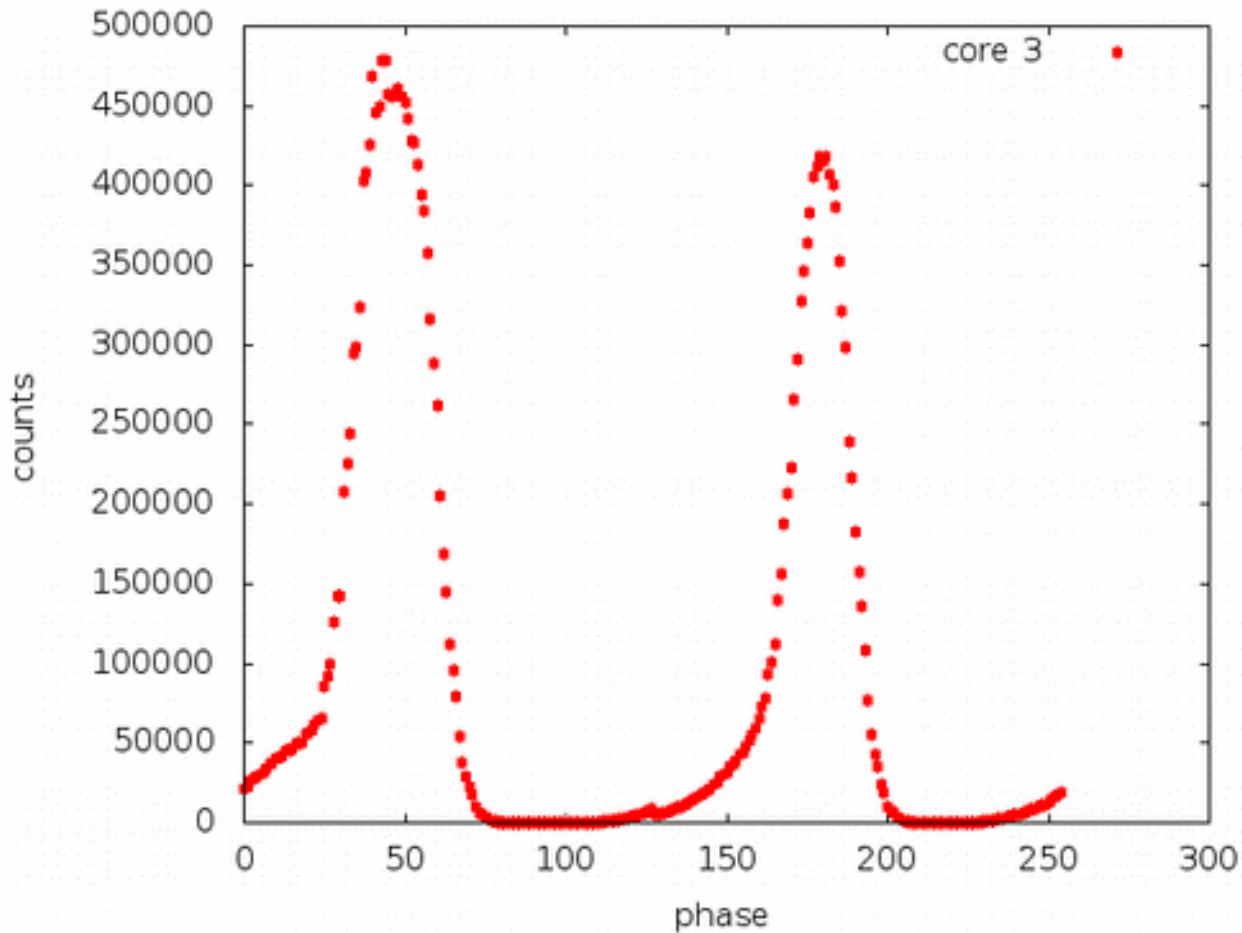
Calibration of the DBBC

Calibration or phase optimization is required at the system installation and has to be repeated after a hardware modification in the stack, transportation, or a new firmware. Periodically as a general check.

- Connect a synthesizer tuned to 764 MHz to all IFs.
- Load the firmware to test.
- Point all dbbcifa,b,c,d to this input
- Run the DBBC command: calibration=all
- ... wait



Calibration of the DBBC



```

...
252 106 3959 16276 10431
253 135 5588 17455 10729
254 161 5276 18712 11039
255

```

minM1 00050 ele1 **107** minM2 00050 ele2 **79** minM3 00049 ele3 **92** minM4 00051 ele4 **224**

```

....
60 270437 872 261803 16988
61 285347 653 205494 12851
62 289611 395 169170 10302
63 301585 352 144859 7090
64 309365 169 111552 3386
65 317749 102 95884 2313
66 322930 79 79745 1817
67 339064 67 54644 1305
68 332014 57 37490 881
69 338031 55 28940 526
70 324313 54 22799 296
71 320547 52 17611 223
72 310049 51 10504 187
73 276350 51 6440 148
74 260401 51 4751 106
75 251864 51 3334 84
76 204246 51 2061 76
77 169837 51 1407 60
78 149612 51 1155 56
79 97942 51 361 54
80 74886 51 228 53
81 55966 50 130 53
82 46097 51 113 53
83 28929 51 80 53
84 21030 53 69 52
85 7957 55 59 52
86 5530 55 51 52
87 2958 57 51 52
88 2078 61 50 52
89 1368 80 50 52
90 734 79 50 52
91 247 117 50 52

```

...



DDC configuration file

c:\DBBC_conf\dbbc_config_file_104.txt

Example:

```
1 dbbc2_ddc_v104.bit 597.00 8 ←the first number is indication of ADB1|2, in this case ADB1 is on
1 dbbc2_ddc_v104.bit 682.00 8 IFA and ADB2 on IFB, ADB1 in IFC, no Core2 for IFD
1 dbbc2_ddc_v104.bit 853.00 8 If no Core2 is inserted in the first and second column put 0.
1 dbbc2_ddc_v104.bit 938.00 8 The second parameter is the firmware file name to be used.
1 dbbc2_ddc_v104.bit 597.00 8 The third and fourth parameters are frequency and bandwidth respectively.
1 dbbc2_ddc_v104.bit 682.00 8
1 dbbc2_ddc_v104.bit 853.00 8
1 dbbc2_ddc_v104.bit 938.00 8
1 dbbc2_ddc_v104.bit 597.00 8
1 dbbc2_ddc_v104.bit 682.00 8
1 dbbc2_ddc_v104.bit 853.00 8
1 dbbc2_ddc_v104.bit 938.00 8
1 dbbc2_ddc_v104.bit 597.00 8 Each Core2 board supports 4 bbcs so if not present 0 has to be inserted in
1 dbbc2_ddc_v104.bit 682.00 8 four lines
1 dbbc2_ddc_v104.bit 853.00 8
1 dbbc2_ddc_v104.bit 938.00 8
0 fila10g_v2_1.bit ← if a FILA10G is installed set 1st version 1 (with ACE), 2nd version (without ACE 2), otherwise 0
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFA
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFB
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFC
1 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFD
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFE
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFF
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFG
0 38000 ← no unica=0 unica3=1, unica4=2, initial CoMos target values for IFH
107 79 92 224 ← phase calibration values
CAT2 1024 ← CAT1|2 and sampling frequency
```



Test recordings

- Test recordings are good to control the correct sampling (bit statistics), band pass shape, and pcal tones
- The Mark5B comes with a set of programs that allow to check the bit statistics (bstate), do auto- or cross correlations (vlbi2), and extract phase cal (bpcal).
- More power full are the mark5access programs: m5bstate, m5pcal, m5spec, m5timeseries, ...
Available from the EVN TOG wiki pages
https://deki.mpifr-bonn.mpg.de/Working_Groups/EVN_TOG/DBBC/DBBC_Test_Procedures
- jive5ab allows to stream data directly on a local disk, which avoids to record on diskpacks and use disk2file for small tests.



Test recordings

oper@eff-mark5c-1:~\$ m5spec

m5spec ver. 1.3.1 Walter Brisken, Chris Phillips 20120508

A Mark5 spectrometer. Can use VLBA, Mark3/4, and Mark5B formats using the mark5access library.

Usage : m5spec <infile> <dataformat> <nchan> <nint> <outfile> [<offset>]

<infile> is the name of the input file

<dataformat> should be of the form: <FORMAT>-<Mbps>-<nchan>-<nbit>, e.g.:

VLBA1_2-256-8-2

MKIV1_4-128-2-1

Mark5B-512-16-2

VDIF_1000-64-1-2 (here 1000 is payload size in bytes)

<nchan> is the number of channels to make per IF

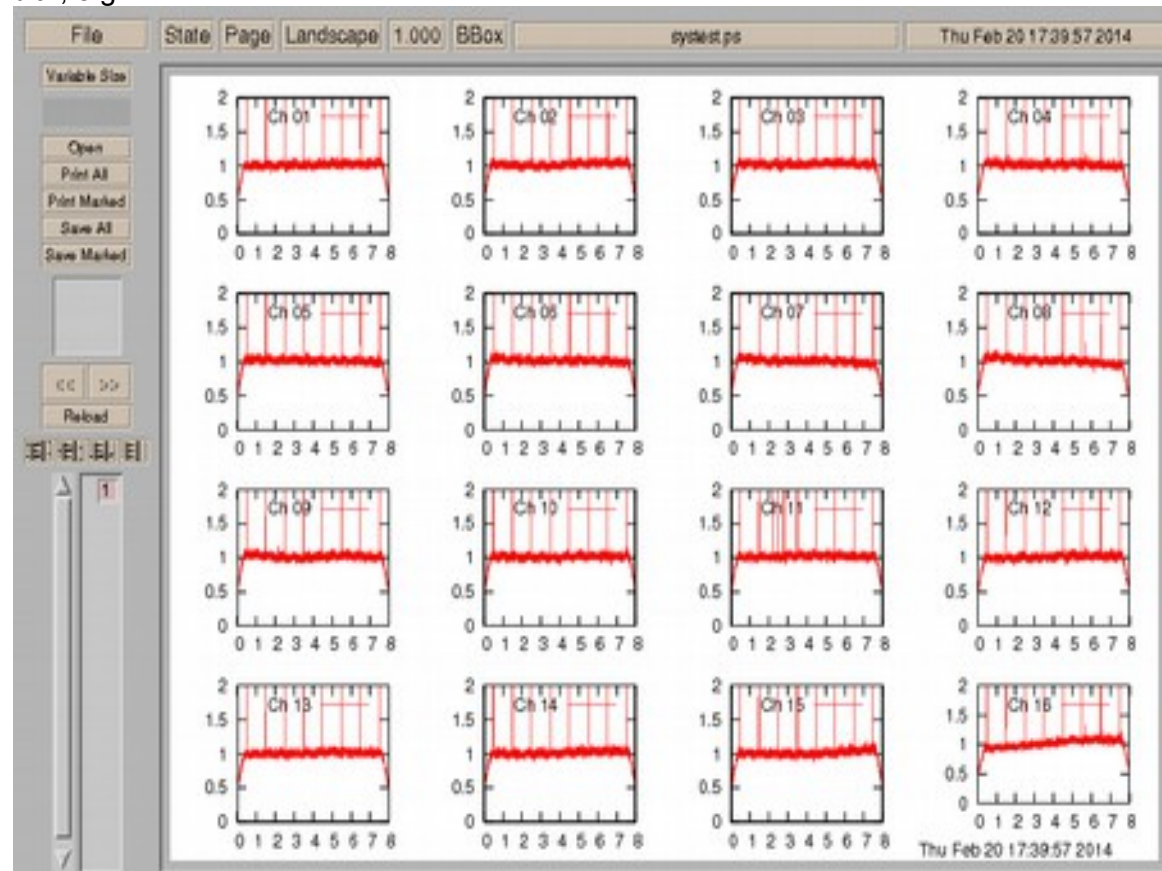
<nint> is the number of FFT frames to spectrometize

<outfile> is the name of the output file

<offset> is number of bytes into file to start decoding

The following options are supported

- dbbc Assume dBBC polarisation order (all Rcp then all Lcp)
- nopol Do not compute cross pol terms
- help This list



Test recordings

> bstate

Usage: bstate <input m5b fname> <# frames>

> bstate n13c1_ef_no0002.m5a 200

Ch	--	-	+	++	-	-	+	++	gfact
0	88032	157895	160426	93647	17.6	32.1	31.6	18.7	1.00
1	93899	151616	154405	100080	18.8	30.9	30.3	20.0	0.95
2	92338	153774	156561	97327	18.5	31.3	30.8	19.5	0.97
3	91497	154665	157139	96699	18.3	31.4	30.9	19.3	0.97
4	84797	161299	163577	90327	17.0	32.7	32.3	18.1	1.03
5	89860	155939	158073	96128	18.0	31.6	31.2	19.2	0.98
6	88426	157547	159995	94032	17.7	32.0	31.5	18.8	1.00
7	85429	160711	162749	91111	17.1	32.5	32.1	18.2	1.02
8	89485	153806	157650	99059	17.9	31.5	30.8	19.8	0.97
9	92445	150796	154915	101844	18.5	31.0	30.2	20.4	0.95
10	89559	153929	157131	99381	17.9	31.4	30.8	19.9	0.97
11	92958	151219	155066	100757	18.6	31.0	30.2	20.2	0.95
12	89607	153163	157750	99480	17.9	31.6	30.6	19.9	0.97
13	84856	158081	162791	94272	17.0	32.6	31.6	18.9	1.01
14	84164	159461	163177	93198	16.8	32.6	31.9	18.6	1.02
15	83381	159953	163898	92768	16.7	32.8	32.0	18.6	1.02



Test recordings

o > vlbi2

vlbi file1 file2 -proctime proctime [-rev <0|1>] [-2bit <0|1>] [-tforce <0|1>]

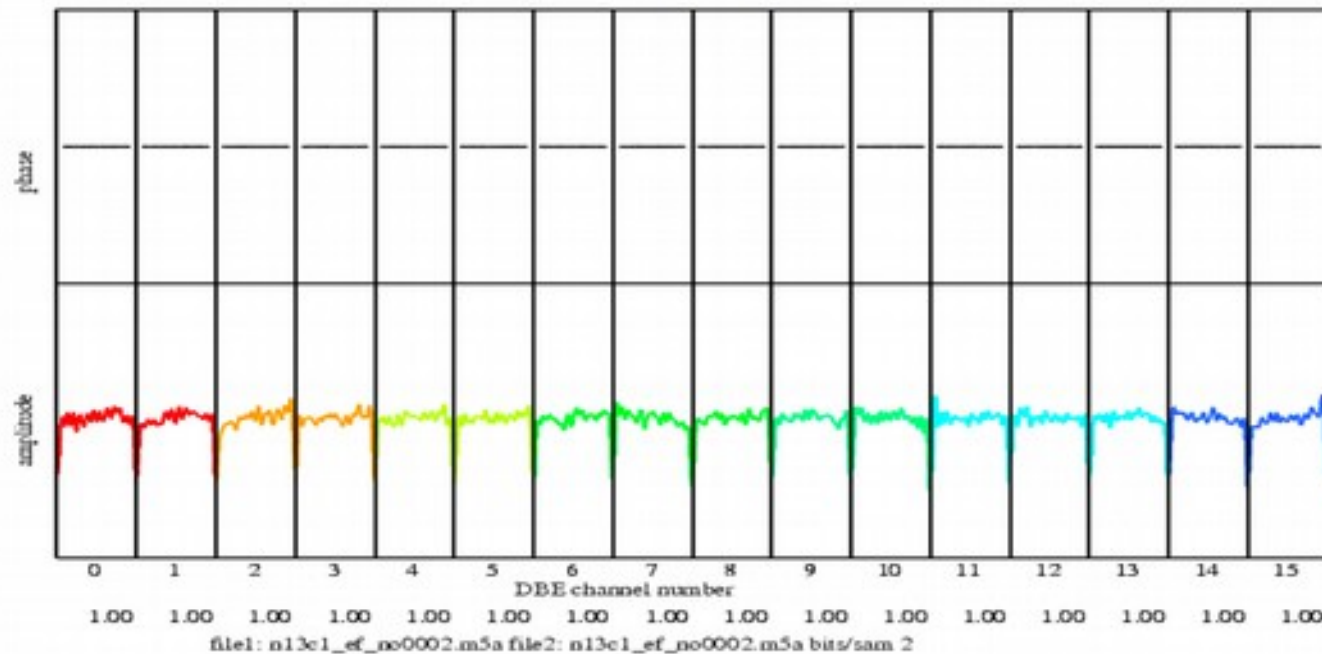
2bit: 1 to enable 2-bit input

rev: 1 to reverse channels in the plot

tforce: 1 to force correlation, ignoring timestamps

> vlbi2 n13c1_ef_no0002.m5a n13c1_ef_no0002.m5a -2bit 1 # for autocorrelation

> gv dd1.pos



Test recordings

- `> bpcal`
Usage: `bpcal <input m5b fname> <tone freq (KHz)> <# frames>`
`> bpcal n13c1_ef_no0002.m5a 2490 500`

integration time 0.078 sec

ch amp phase(dg)

0	1	153.7
1	0	-93.5
2	1	83.2
3	2	-20.0
4	1	-54.9
5	2	-111.1
6	0	-179.6
7	1	-152.4
8	12	-94.5
9	11	-82.5
10	11	-69.3
11	12	-47.9
12	12	24.3
13	12	-58.8
14	10	-154.2
15	9	134.2



Field System integration

- The DBBC is fully integrated into the Field System for DDC mode operation. See `/usr2/fs/misc/dbbc.txt` for all details.
- There are the typical control-files that need to be adapted for a new backend and one special for the DBBC IP address:
 - *dbbad.ctl* hold the DBBC IP address
 - *equip.ctl* for the FS
 - *skedf.ctl* for DRUDG
 - Some more in `point.prc`, `station.prc`, and `.Xresources`
- Once this is done the FS should be ready to DRUDG and observe DBBC schedules.



Field System integration

```
define proc_library 00000000000x
" EUR135 EFLSBERG Ef
" drudg version 2015Jan29 compiled under FS 9.11.07
"< DBBC rack >< Mark5B recorder 1>
enddef
define exper_initi 00000000000x
proc_library
sched_initi
logsw_jv
mk5=DTS_id?
mk5=OS_rev?
mk5=SS_rev?
mk5=status?
enddef
define setupsx 00000000000x
pcalon
tpicd=stop
mk5b_mode=ext,0x55555555,,8.000
mk5b_mode
form=geo
form
dbbcsx4
ifdsx
cont_cal=on,4
bbc_gain=all,agc,12000
tpicd=no,200
bank_check
tpicd
enddef
```

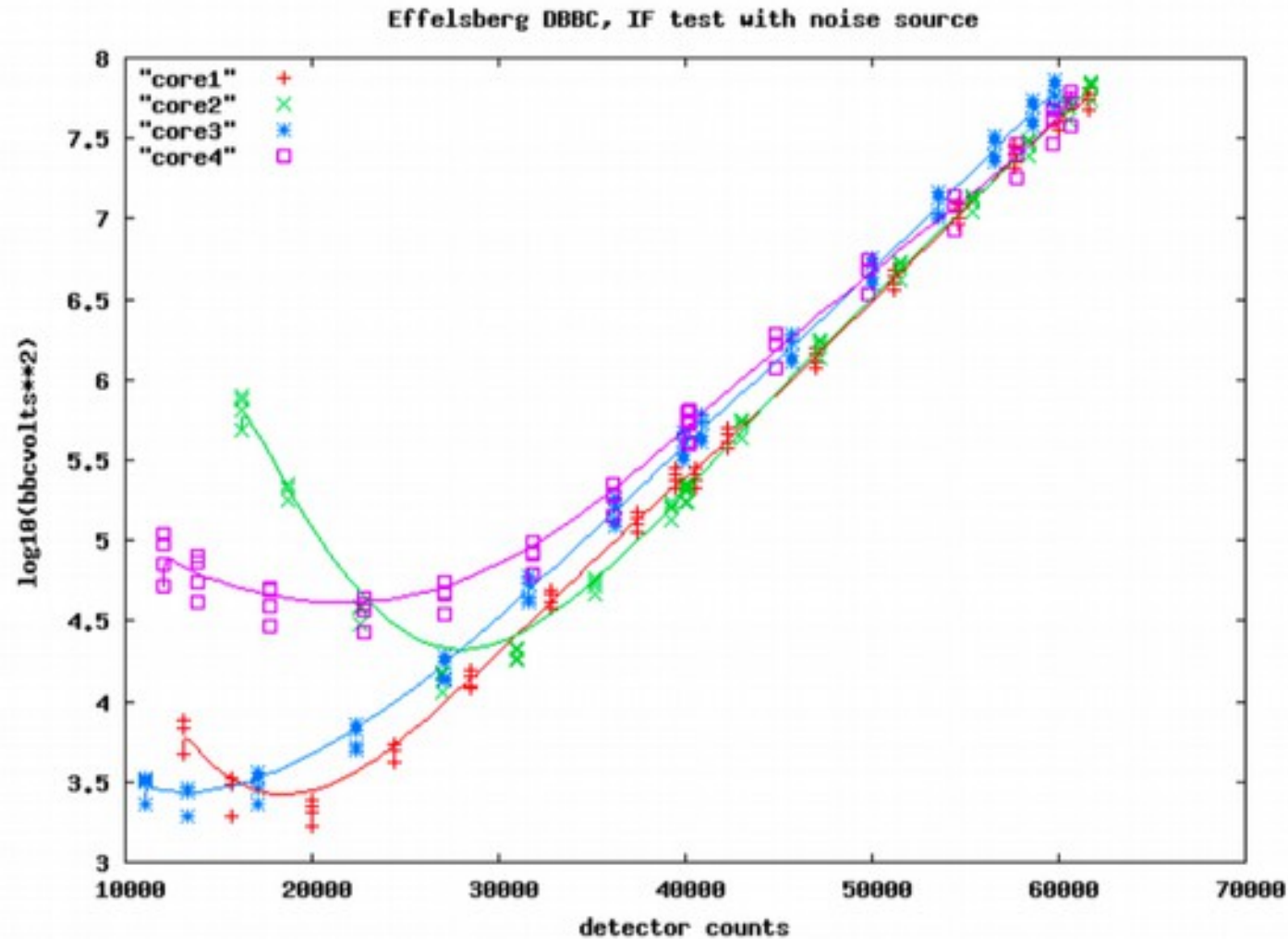
```
define dbbcsx4 00000000000x
bbc01=100.99,a,4.00
bbc02=110.99,a,4.00
bbc03=140.99,a,4.00
bbc04=200.99,a,4.00
bbc05=310.99,b,4.00
bbc06=390.99,b,4.00
bbc07=440.99,b,4.00
bbc08=460.99,b,4.00
bbc09=112.99,c,4.00
bbc10=127.99,c,4.00
bbc11=137.99,c,4.00
bbc12=167.99,c,4.00
bbc13=187.99,d,4.00
bbc14=192.99,d,4.00
enddef
define ifdsx 00000000000x
ifa=4,agc,2,38000
ifb=4,agc,2,38000
ifc=2,agc,2,38000
ifd=2,agc,2,38000
lo=loa,8110.00,usb,rcp,1
lo=lob,8110.00,usb,rcp,1
lo=loc,2100.00,usb,rcp,1
lo=lod,2100.00,usb,rcp,1
enddef
```



Estimate the best IF level

- IF commands (dbbcifa, or ifa (FS)) allow to specify values for the IF target counts where the AGC should adjusted to.
- With an increasing number of DBBCs the best target IF levels seem to cluster around 35000 to 45000 counts, but it might be worth to test those for your DBBC.
- Best to use with a true receiver with phase-cal on.
- Then change the attenuation in steps of 2.5 dB over the whole range, while checking detector counts, bbc counts and doing some short 10 sec recordings at the Mark5B
- Analyse the recordings using bpcal to measure the Pcal-tone amplitudes.

Estimate the best IF level



Estimate the best IF level

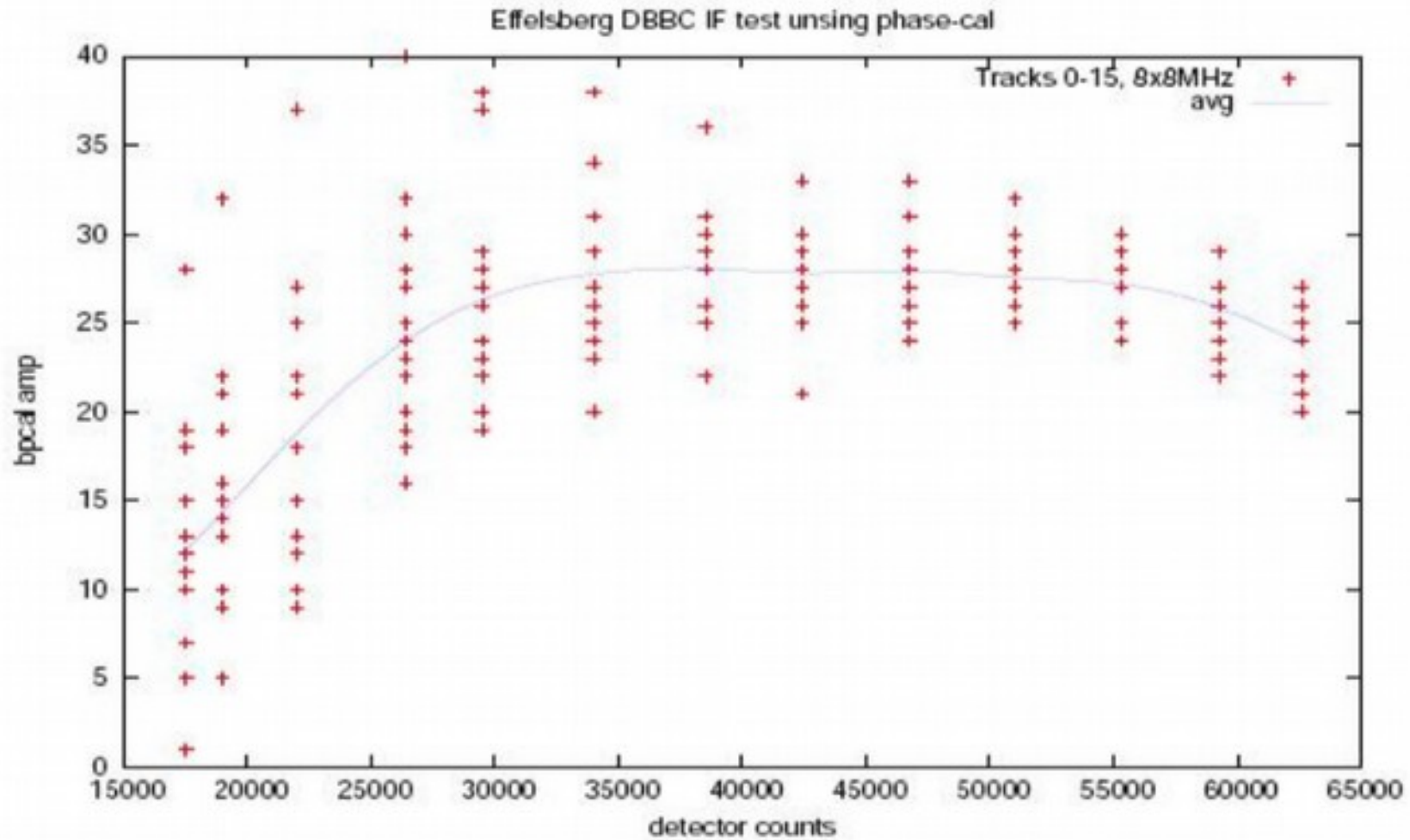


Figure 2: Phase-cal amplitude calculated by bpcal over 0.15 sec against detector counts.

Field System integration

VLBI - KONFIGURATION / CHECKLISTE

erstellt am: Dienstag, 28. April 2015 6:48 Uhr

Programm-Name: **rk08ww**

Art: DBBC

Beginn : SUN., MAY. 03, 2015 Tag: 123 Startzeit: 15:00:00 UTC
 Ende : SUN., MAY. 03, 2015 Tag: 123 Endzeit : 16:00:00 UTC

1. Quelle: 1123+264 Azimut: 80.8 Elevation: 26.9

	1. Freq	Kontrolle:
Empfänger:	860m	<input type="radio"/>
Version:	LINE_500MHz	<input type="radio"/>
Pruefen :	U101 - 746	MHz <input type="radio"/>
(Empfaengerraum)	U102 - 840	MHz <input type="radio"/>
	ESM1: 5	<input type="radio"/>
	RX: 2	<input type="radio"/>
SDR :	Sky_freq = 04850*LSB	<input type="radio"/>
Zusätzlich :	XFFTS: Auf 500 MHz oder 2 GHz Filter einstellen MultiFIRa Mode auf 161, Pegel am xfftsGUI okay?	<input type="radio"/>
	U10-Select Wahlschalter (S 315) nach unten; Phasen-Diskriminator (S 172-2) an!	<input type="radio"/>

Starten der Schedules mit **schedule = rk08wwel #1** (#1= to start at the first line)

Phasecal: on

Bei aktiver Schedule kann mit 'phasecal = on/off' die Phasecal geschaltet werden.
Zur Kontrolle sollte in den Bandpass des XFFTS gezoomt werden, dort kann man die Töne in einem Abstand von 1 MHz als Kamm sehen.

BBC-Pegel: Abfragen mit **bbcread** (zeigt auch die BBC-Frequenzen an)

Einstellung erfolgt automatisch, Pegel counts variable.
(benutze Videokonverter: siehe Rückseite)

PD-Einstellung:

Abfrage mit **ifread**

Einstellung erfolgt automatisch, Pegel sollte um 38000 liegen

Teys messung:

caltsys (Antenne und OBS/INP müssen im VLBI Modus sein)

(TeyS in benutzten BBCs okay; S7 lauft?)

TeyS= _____

(Typische Werte bei schwache Quellen: z.B. 18cm-35-40, 6cm-30-35, 5cm-30, 4cm-25-30, 1.3cm-90-100 (wetterabhaengig))

SCHEDULE lauft? keine **HALT** in 'System Status' fenster

Aufnahme auf: DiskPack (Rueckseite beachten!!!) Total: 83.654 GB

Korrelator: **** Moskau ****

SumLo = 4100.00

Bemerkungen:

Nach dem Experiment:

ggf. DiskPack entnommen

ggf. Phasecal abgeschaltet

ggf. U10-Select Wahlschalter (S 315) nach oben!

Angaben kontrolliert und Programm gestartet von:

Wetter: _____

Baender/DiskPacks:

01. _____

05. _____

02. _____

06. _____

03. _____

07. _____

04. _____

08. _____

Probleme, Ausfaelle:

*****Neu***:**

Die Schedules werden nicht mehr ausgedruckt, koennen aber bei Bedarf im FSPC1 VNC-Fenster mit:
 /home/oper-gv/usr2/sched/Listings/rk08wwsrp.ps
 /home/oper-lpr/usr2/sched/Listings/rk08wwsrp.ps
 angesehen bzw. ausgedruckt werden.

DBBC und IF Einstellung:

```

ek5b_moderekt, 0x3030303, 32, 000
formastro
ifan1, agc, 1, 38000
ifb3, agc, 1, 38000
    
```

Einstellung der Videokonverter:

```

Procedur dbbc01d :
bbc01=736.00,a,16.00
bbc05=736.00,b,16.00
    
```

Field System integration

Applications Places Sun May 3, 3:01 PM VLBI Operator

login sh

```

15:00:01&midob/" strongly recommended
15:00:01&midob/"add your station command to measure the gps to fa output clock offset
15:00:01&midob/"gps-fmout=c2
15:00:01&midob/disk_pos
15:00:01&midob/m5b_mode
15:00:01&midob/!+1s
15:00:01&midob/m5=dot?
15:00:01&midob/sy=run setcl adapt &
15:00:01&midob/getgps
15:00:01&midob/sy=exec /home/oper/bin/checkdisk.py 'logm' &
15:00:01#antcn#Antenna TRACKING
15:00:01#antcn# RFcentre wanted: 4850 Antenna: 4850 synth1,2= 746.000000 840.000000
15:00:01/onsource/TRACKING
15:00:01/wx/ 13.4, 966.6,100.1, 6.9, -89
15:00:01/ifc/4, agc, 2, 38000, 4, 38226
15:00:01/ifa/1, agc, 1, 38000, 35, 37502
15:00:01/bbc01/ 736.000000, a, 16, 1, agc, 50, 54, 12482, 12369, 12000, 11877
15:00:01/bbc05/ 736.000000, b, 16, 1, agc, 61, 60, 11988, 11787, 11502, 11316
15:00:01/bbc09/ 124.490000, c, 8, 1, agc, 199, 207, 11798, 11785, 10969, 10903
15:00:01/bbc13/ 597.000000, a, 16, 1, agc, 63, 101, 11913, 12081, 11917, 11533
15:00:01/disk_pos/2124641992704, 2086212608000, 2124641996800
15:00:01/m5b_mode/ext, 0x3030303, 1, (32, 000), 2
15:00:01;"MultFiBa mode: Ch08=161 Ch16=161, Attn08=21.5 dB Attn16=22.0 dB
15:00:02/m5/!dot? 0 : 2015y123d15h0m02.0840s : syncerr_eq_0 : FHG_on : 2015y123d15h0m02.0863s : -0.002322 ;
15:00:02/fmout-gps/ -2.846000e-05
15:00:02;!2015.123.15:14:30
15:00:02#setcl#time/528181968, 0, 2015, 123, 15, 00, 02, 08, -5.500, 0.393, 0
15:00:02#setcl#model/old, 1425383710, -32751, 528040589, -5.385, 15.541, rate, 0, unknown, 1, 1
    
```

nt schliessen! r wiederholt den letzten Befehl)

```

Ch08=161 Ch16=161
>SV NONE 1123+264 11:25:53.7 26:10:20 4100.00 0 1 20000N
command: >>SV NONE 1123+264 11h25m53.7s 26d10°20' 4100.0 0 1 20000N
DINTING 30 -4.0 2
EPEAT
53.7s 26d10°20' 4100.0 0 1 20000N to be4
    
```

VLBI-Monitor

```

VLBI-Monitor- V0.999
188C
DE4-Rechner : lauft | OK
BBC in sync zu IFA : | OK
Mark5 in sync zu BBC : | OK
Mark5-PC : lauft | OK
Disk: | OK
VME: SMO-037 | OK
Letzter Fehler: | OK
BBC-ZF-Pegel: | OK
LI FREQUENCIES: | OK
Logfile: /usr2/log/rk08wef.log
Sonntag, 03. Mai 2015 Day 123 15:01:352
Verlassen mit: a (15 sec Verzögerung) Oct 2012 bu 06/05/08
    
```

Operator Input

```

>schedule/rk08wef.#1
>bbread
>ifread
>caltys
>fspointing
>repeat
>
    
```

System Status

```

2015.123.15:01:36 UT TEMP 13.4C 1123+264 TRACKING
15:14:30 NEXT HUMID 100.03% RA 11h25m53.7s
SCHED=rk08wef LOG=rk08wef PRES 966.5mb DEC 26d10m (2000)
ISSUES 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
AZ 81.2 EL 27.2
    
```

ERRORS

```

    
```

System Temperatur

Case	Temp	IFB	IFC	IFD
01	736.00	40.3	40.3	
02	0.00	0.0	0.0	
03	0.00	0.0	0.0	
04	0.00	0.0	0.0	
05	736.00	39.6	40.2	
06	0.00	0.0	0.0	
07	0.00	0.0	0.0	
08	0.00	0.0	0.0	
09	0.00	0.0	0.0	
10	0.00	0.0	0.0	
11	0.00	0.0	0.0	
12	0.00	0.0	0.0	
13	0.00	0.0	0.0	
14	0.00	0.0	0.0	
15	0.00	0.0	0.0	
16	0.00	0.0	0.0	

mark5

Time	GB	X	Check	UT
570	18h52m	3894.130	97.3	14:36:26
057	3h46m	435.536	17.0	14:45:44

BBC

Field ... VLBI... [oper... xterm VLBI... Systeme... ERRO... Oper... Systeme... mark5 DBBC Mark5+ Field System Spare

Field System integration

```

01:d
01:m
01#antcn#antenna TRACKING
01#antcn# RFcentre wanted: 4850 Antenna: 4850 synth1,2= 746.000000 840.000000
15:15:01/onsource/TRACKING
15:15:01/wx/ 13.5, 966.5, 99.9, 3.5, -89
15:15:01/ifc/4, agc, 2, 38000, 4, 37932
15:15:01/ifa/1, agc, 1, 38000, 33, 38377
15:15:01/bbc01/ 736.000000, a, 16, 1, agc, 49, 53, 11963, 11894, 11467, 11389
15:15:01/bbc05/ 736.000000, b, 16, 1, agc, 62, 61, 12076, 11881, 11586, 11381
15:15:01/bbc09/ 124.490000, c, 8, 1, agc, 202, 211, 11244, 11272, 10319, 10293
15:15:01/bbc13/ 597.000000, a, 16, 1, agc, 63, 103, 11917, 11867, 11927, 11293
15:15:01/disk_pos/2152462417920, 2124641996800, 2124661996800
15:15:01/mk5b_mode/ext, 0x3030303, 1, (32.000), 2
15:15:01: *MultFiBa mode: Ch08=161 Ch16=161, Attn08=21.5 dB Attn16=22.0 dB
15:15:02/mk5/!dot? 0 : 2015y123d15h15m02.0478s : syncerr_eq_0 : FHG_on : 2015y123d15h15m02.0502s : -0.002376 ;
15:15:02/fmout-gps/ -2.845000e-05
15:15:02: !2015. 123. 15:29:30
15:15:02#setcl#time/528271971, 0, 2015, 123, 15, 15, 02, 06, -5.228, 0.643, 0
15:15:02#setcl#model/old, 1425383710, -32751, 528040589, -5.365, 15.541, rate, 0, unknown, 1, 1
15:15:02: * Disk 00 (1.81e-03, 0.00e+00) is OK!
15:15:02: * Disk 01 (1.75e-03, 0.00e+00) is OK!
15:15:02: * Disk 02 (1.41e-03, 0.00e+00) is OK!
15:15:02: * Disk 03 (2.04e-03, 0.00e+00) is OK!
15:15:02: * Disk 04 (1.83e-03, 0.00e+00) is OK!
15:15:02: * Disk 05 (1.98e-03, 0.00e+00) is OK!
15:15:02: * Disk 06 (2.19e-03, 0.00e+00) is OK!
15:15:02: * Disk 07 (2.00e-03, 0.00e+00) is OK!

```

```

>SV NONE 1123+264 11:25:53.7 26:10:20 4100.00 0 1 2000N0N
>SV NONE 1123+264 11:25:53.7 26:10:20 4100.00 0 1 2000N0N
>SV NONE 1123+264 11:25:53.7 26:10:20 4100.00 0 1 2000N0N
>SV NONE 1123+264 11:25:53.7 26:10:20 4100.00 0 1 2000N0N

```

VLBI-Monitor

VLBI-Monitor: W0.996 DEBC

```

DE4-Rechner      : laeuft      | OK
DEBC in sync zu fpps :      | OK
Mark5 in sync zu DEBC :      | OK

```

Mark5-System

```

Mark5-PC        : laeuft      | OK
Disk: (XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX) | 84.2
VSI: SH0-037
Letzter Fehler:
DEBC-Z-Pegel:   | OK
LO FREQUENCIES: | 1.0 OK
Logfiles /usr2/log/rk08wef.log

```

Sonntag, 03.Mai 2015 Day 123 15:16:31

Verlassen mit: 0 (15 sec Verzögerung) Oct 2012 by BK/DG/UB

Operator Input

```

>schedule=rk08wef.#1
>bbcread
>ifread
>caltsys
>fspointing
>repeat
>

```

System Status

```

2015.123.15:16:33 UT      TEMP 13.6C    1123+264    TRACKING
MODE RATE                HUMID 99.87%    RA 11h25m53.7s
                             PRES 966.6mb    DEC 26d10m (2000)
                             AZ 83.9    EL 29.6

```

ERRORS

```


```

System Temperatur

Temp	IFB	IFC	IFD
01	736.00	38.3	38.4
02	0.00	0.0	0.0
03	0.00	0.0	0.0
04	0.00	0.0	0.0
05	736.00	38.8	38.1
06	0.00	0.0	0.0
07	0.00	0.0	0.0
08	0.00	0.0	0.0
09	0.00	0.0	0.0
10	0.00	0.0	0.0
11	0.00	0.0	0.0
12	0.00	0.0	0.0
13	0.00	0.0	0.0
14	0.00	0.0	0.0
15	0.00	0.0	0.0
16	0.00	0.0	0.0

mark5

Time	GB	Z	Check	UT
370	18h52m	3894.130	97.3	14:36:26
037	3h32m	407.716	15.9	15:14:42

BBC

Field System integration

Applications Places Sun May 3, 3:15 PM VLBI Operator

login sh

gv: /tmp/systest.ps (on mark5-671)

File State Page Landscape 1,000 BBox /tmp/systest.ps Sun May 3 17:14:44 2015

Variable Size

Open
Print All
Print Marked
Save All
Save Marked

CC >>
Rebad

System Status

```

2015.123.15:15:17 UT      TEMP 13.5C 1123+264 TRACKING
15:29:30 NEXT           HUMID 99.89% RA 11h25m53.7s
SCHED=rk08wef LOG=rk08wef PRES 966.6mb DEC 26d10m (2000)
SYSZ: 1123 1123 1123 1123 1123 1123 0.000000s AZ 83.7 EL 29.4
    
```

ERRORS

System Temperatur

Tem	1123	1123	1123	1123	1123	1123	1123	1123	1123	1123	1123	1123	1123	1123	1123
01	796.00	80.9	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
03	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
04	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
05	796.00	80.1	80.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
06	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
07	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

mark5

Time	GB	Z	Check	UT
370	18h52m	394.130	97.3	14:36:26
037	3h32m	407.716	15.9	15:14:42

Operator Input

```

$sched|enrk08wef.#1
$bbread
$ifread
$caltsys
$fpointing
$repeat
>
    
```

VLBI-Monitor

```

VLBI-Monitor W0.999 188C
4-Redner : lauft | OK
BC in sync zu Ipps : | OK
rk5 in sync zu 188C : | OK
Mark5-System
rk5-PC : lauft | OK
sk1 : | OK
M: 940-037 | 94.2
Zuletzt Fehler: | OK
BC-Z-Pegel: | OK
FREQZENTIS: | 1.0.0.0
$files: /usr2/log/rk08wef.log
nntag: 03.Mai 2015 Day 123 15:15:10
$lassen mit: g (15 sec Verzögerung) Oct 2012 by WJ/SG/UB
    
```

mark5

370 18h52m 394.130 97.3 14:36:26

037 3h32m 407.716 15.9 15:14:42

Field System

Field System integration

The screenshot displays a complex control interface for a VLBI system. The main window, titled 'gv: systest.ps', contains a 4x4 grid of 16 subplots. Each subplot shows a red signal trace over a time axis from 0 to 16 seconds. The subplots are labeled as follows:

- Row 1: RCP 1u, RCP 2u, RCP 3u, RCP 4u
- Row 2: LCP 5u, LCP 6u, LCP 7u, LCP 8u
- Row 3: RCP 1l, RCP 2l, RCP 3l, RCP 4l
- Row 4: LCP 5l, LCP 6l, LCP 7l, LCP 8l

Each plot has a y-axis from 0 to 2 and an x-axis from 0 to 16. The signals show a characteristic rise and fall pattern.

Other interface elements include:

- Terminal (top left):** Displays configuration parameters for 'systest.ps', such as 'stream = File-1/1=systest.psb', 'format = Mark5B-1024-1', and 'sample rate = 32000000'.
- Terminal (top right):** Shows a 'new source' command: 'new source: send >>SV NONE J0619+0736 6h19m10.0s 7d36'41" 1510.0 0 0 2000NON to be4'.
- System Status (bottom left):** Shows real-time data: '2014.051.21:20:36 UT TEMP 7.3C', 'HUMID 95.40%', 'RA 06h32m59.3s', 'DEC 05d48m (2000)', and 'AZ 206.6 EL 42.4'.
- ERRORS (bottom middle):** Lists a series of warnings: '2014.051.19:49:56.01?ERROR go -301 WARNING: ONSOURCE status is SLEWING!'.
- System Temperatur (bottom right):** A table showing temperatures for various components.

Temp	IFB	IFB	IFB
01	100.49	19.3	26.3
02	132.49	22.6	22.4
03	164.49	21.6	22.2
04	196.49	22.4	24.7
05	100.49	22.1	25.1
06	132.49	21.6	22.1
07	164.49	21.3	21.6
08	196.49	21.8	23.4
09	0.00	0.0	0.0