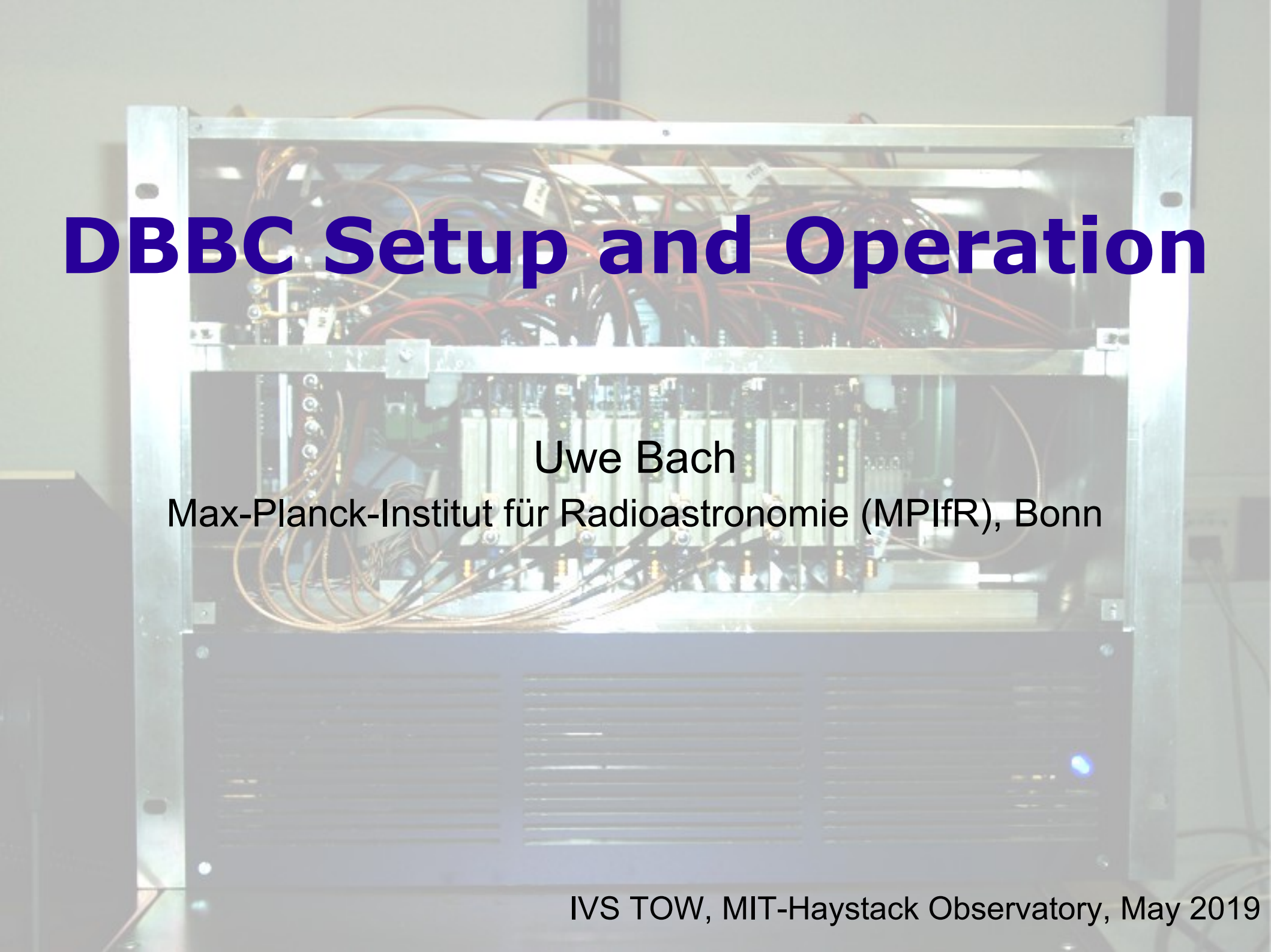


# DBBC Setup and Operation

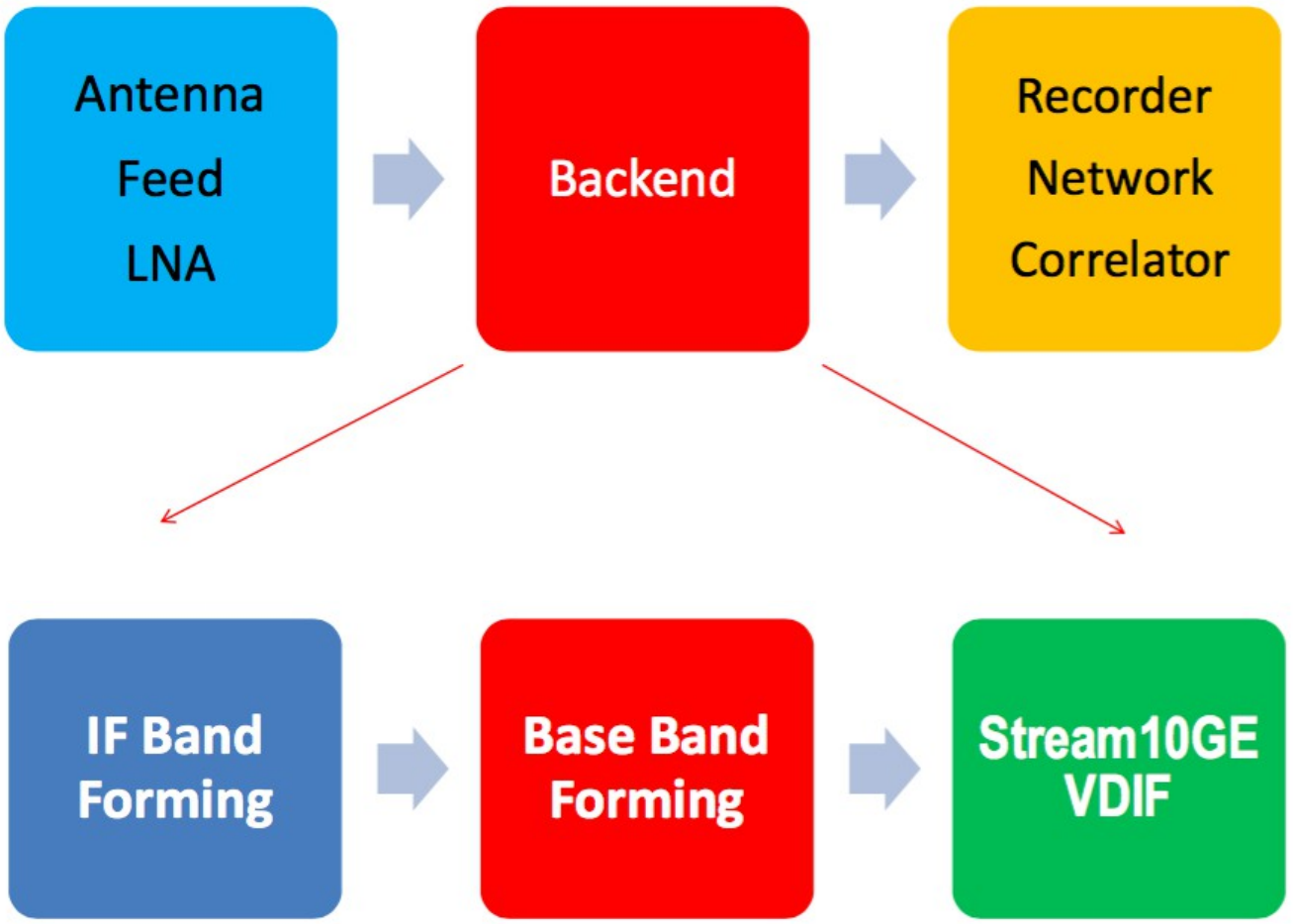
Uwe Bach
Max-Planck-Institut für Radioastronomie (MPIfR), Bonn

IVS TOW, MIT-Haystack Observatory, May 2019

# Content

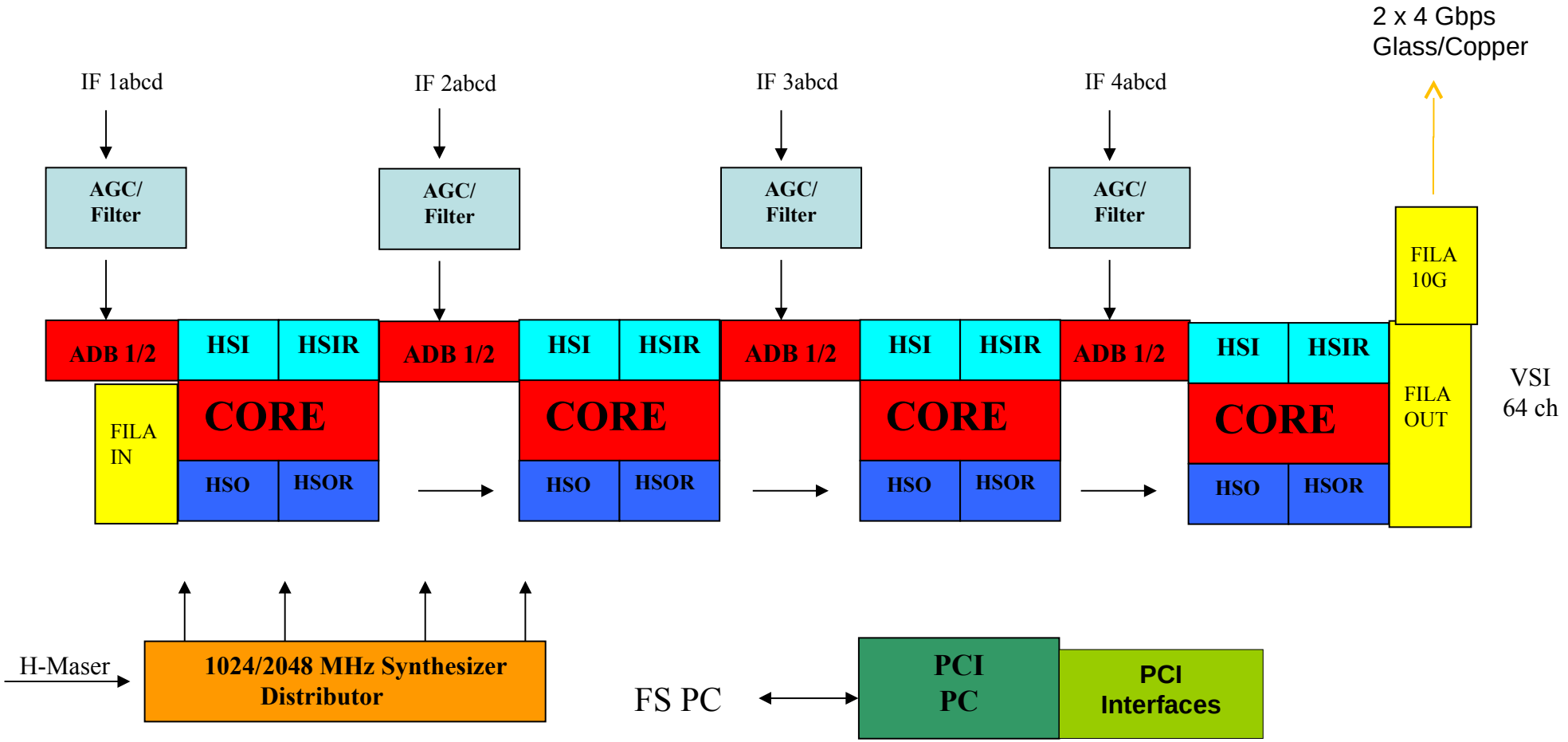
- DBBC hardware characteristics
  - What is it good for
  - A tour around the DBBC
  - Component description
- Installation of a DBBC
- DBBC software
  - Poly-phase Filter Bank (PFB)
  - Digital Down Conversion (DDC)
- Basic testing
- Field System integration
- VLBI operation

# The VLBI backend



# The DBBC Achitecture

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



# DBBC Outside (front view)

# DBBC Outside (rear view)

# DBBC Inside

PC

- IF input and the analog conditioning module - CoMo

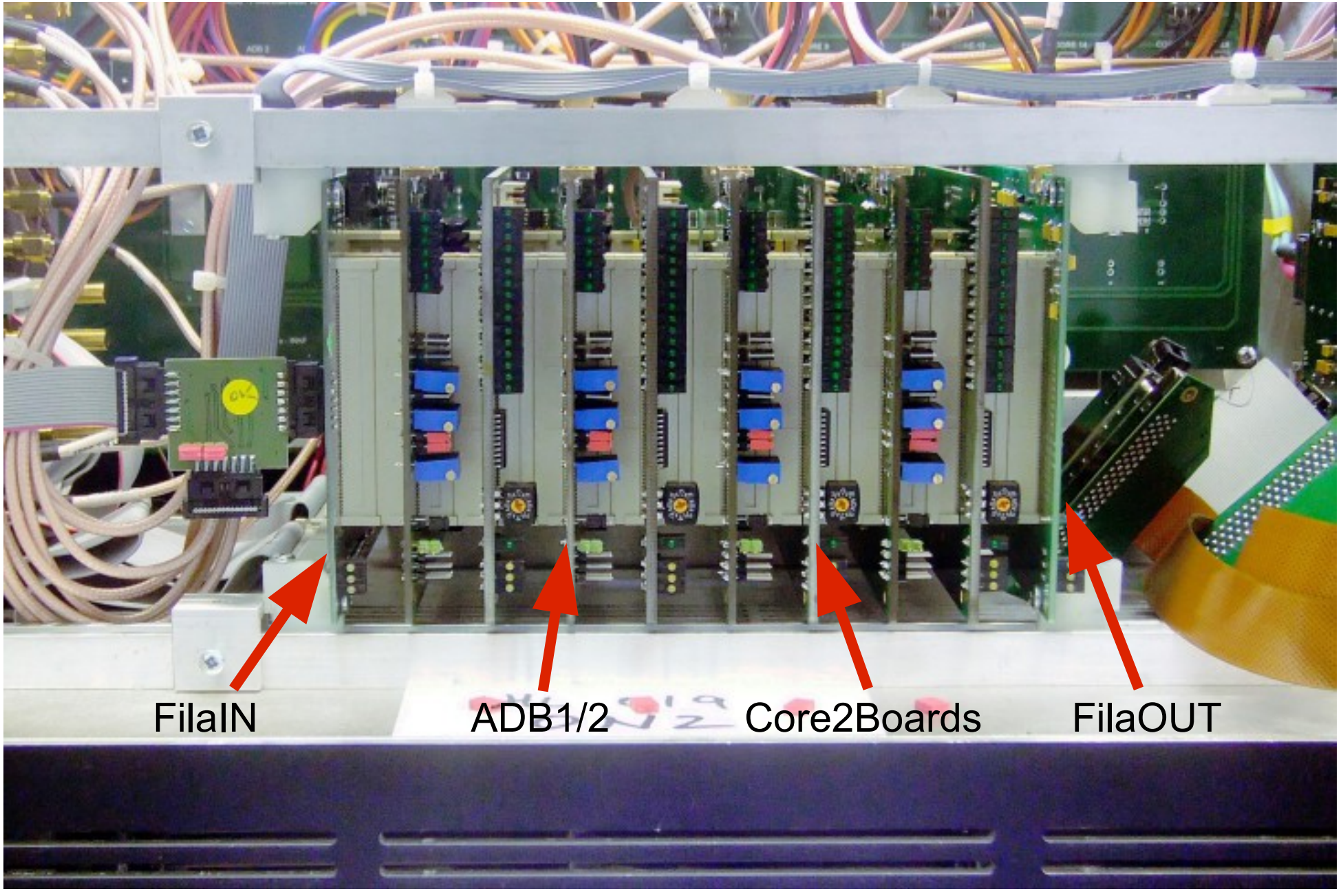
# DBBC Inside

Timing and clock board - CaT2

Stack with FilaIN, ADB1/2, Core2Boards, and FilaOUT

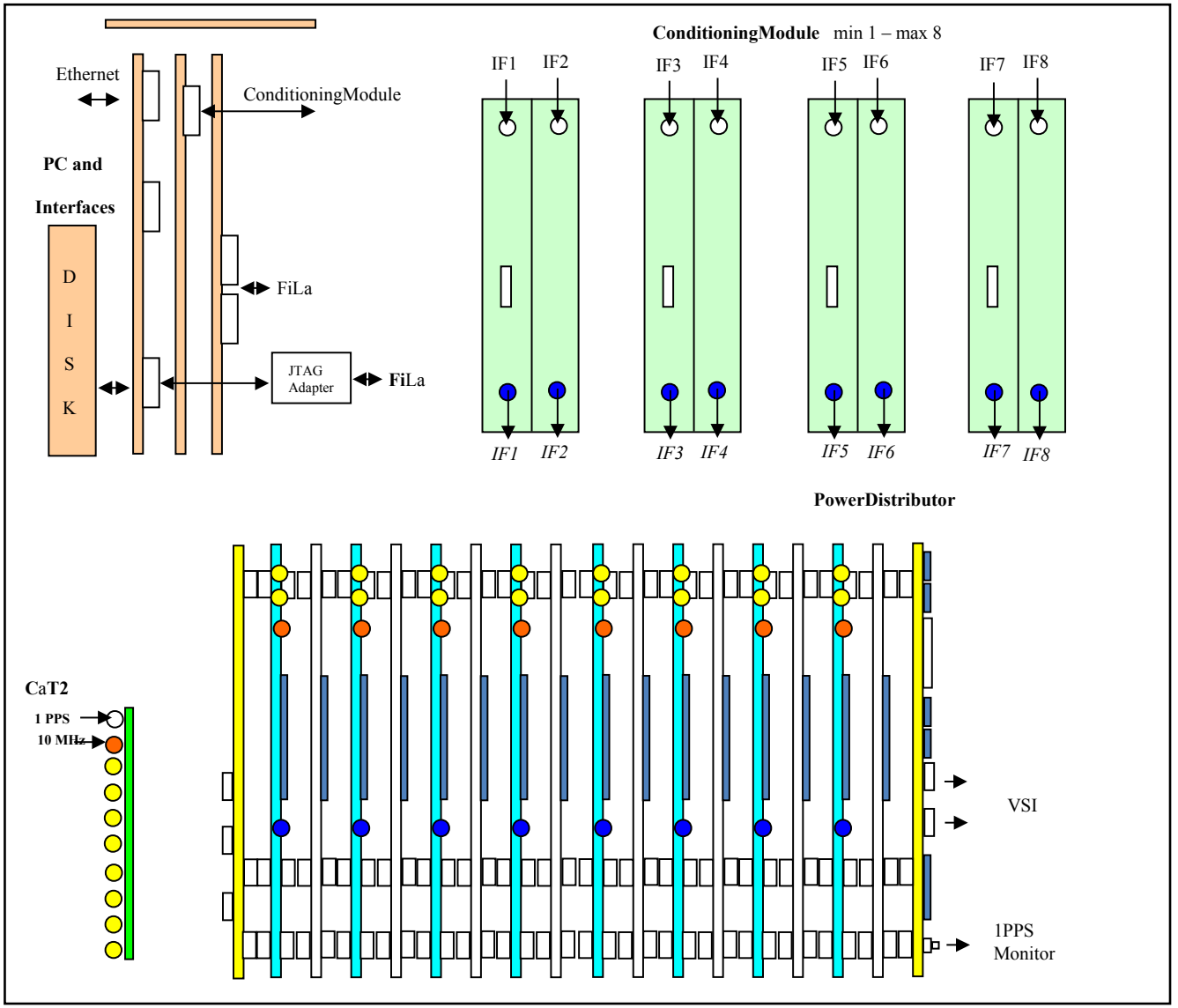
# DBBC Inside

# DBBC Inside

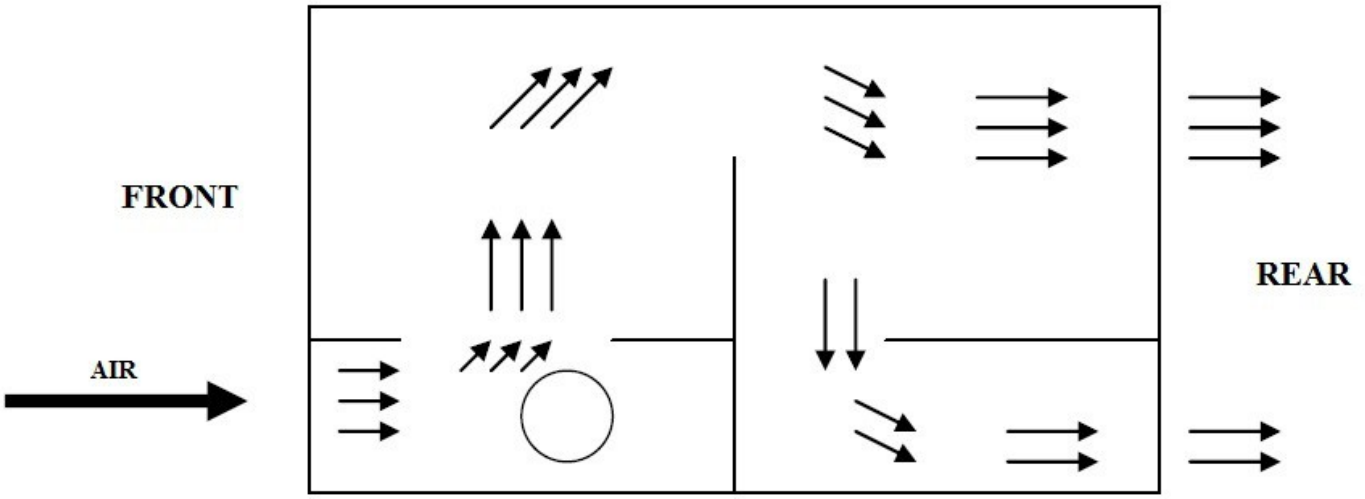


# The DBBC Achitecture

## DBBC2 / DCCB2010 Schematic Top View



# The DBBC Achitecture




The air cooling flow from a side view

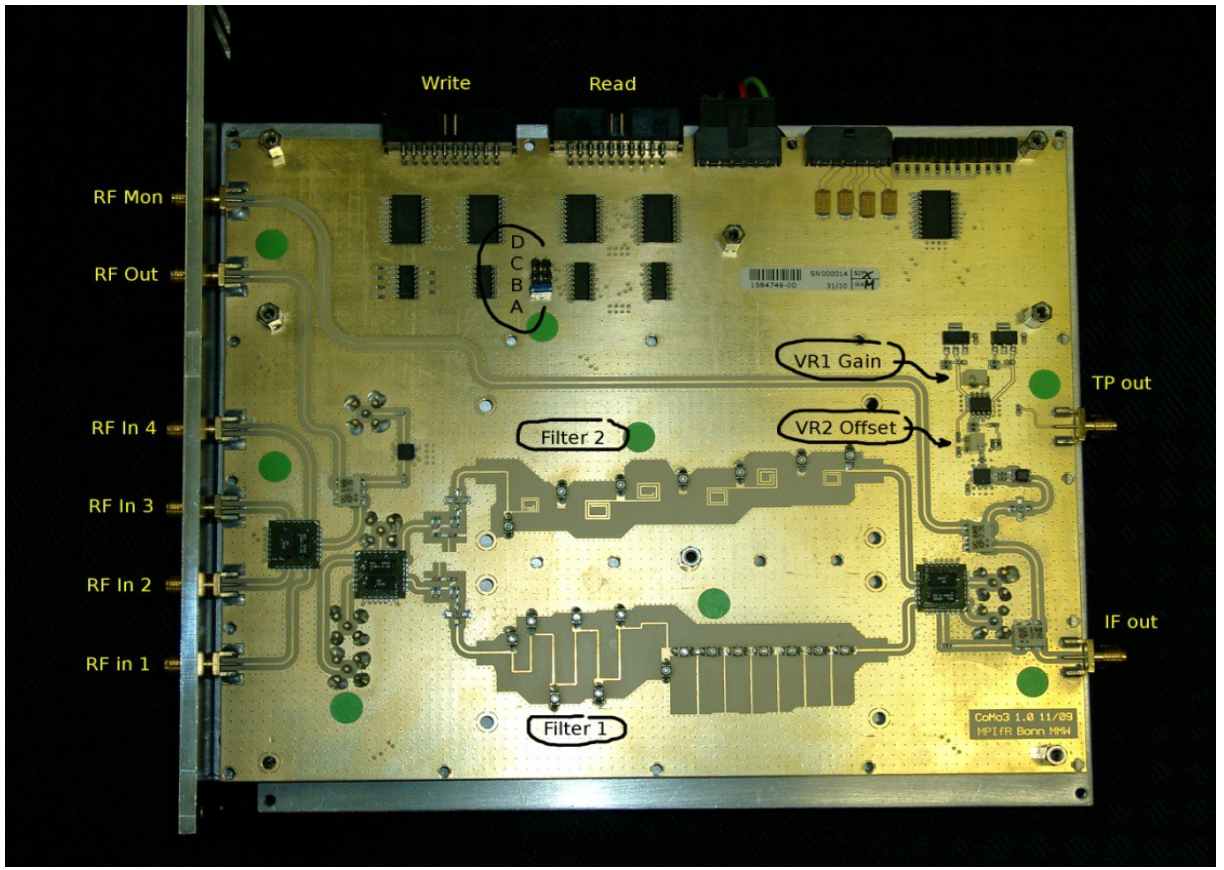
# General Features

- 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
- Several 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

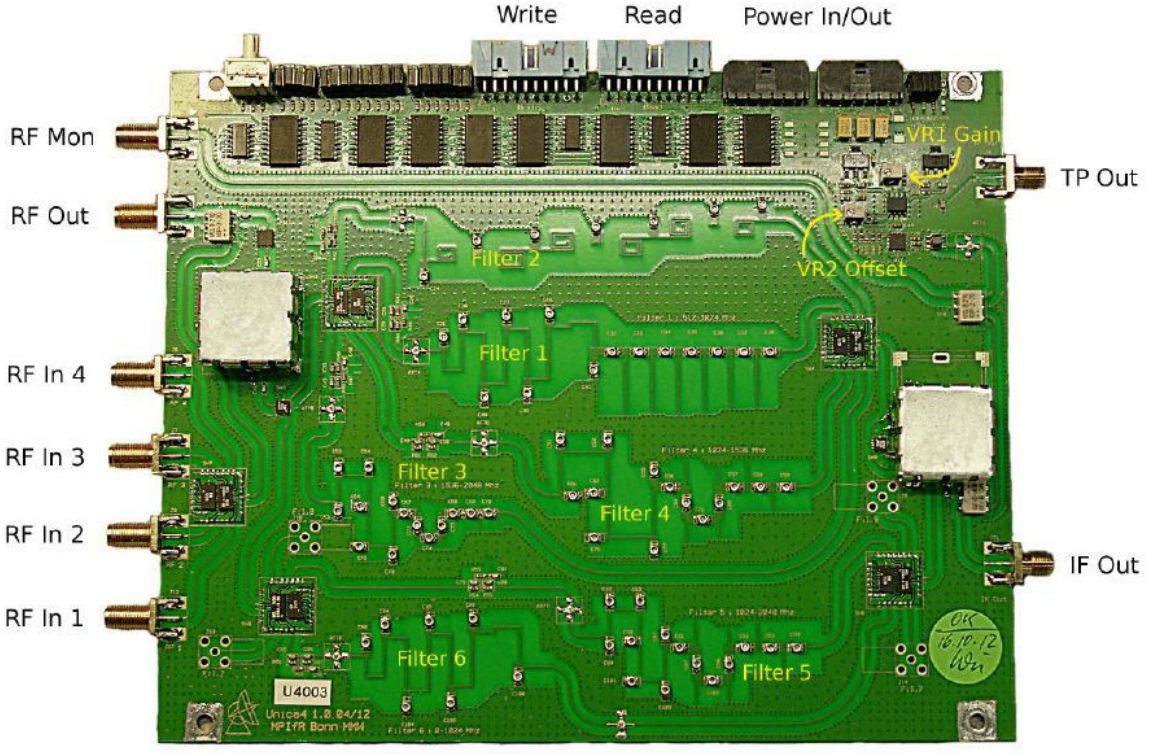
1. Analog Conditioning Module – CoMo
2. Analog-Digital Converter (ADB1 / ADB2)
3. Data Processing (Core2)
4. Connection and Service
   (FiLaIN/OUT – FiLa10G FILA10G-4)
5. Timing and Clock (CaT2 – Clock and Timing)
6. Computer Control (PCSet)

# 1. Conditioning Module (Unica3)



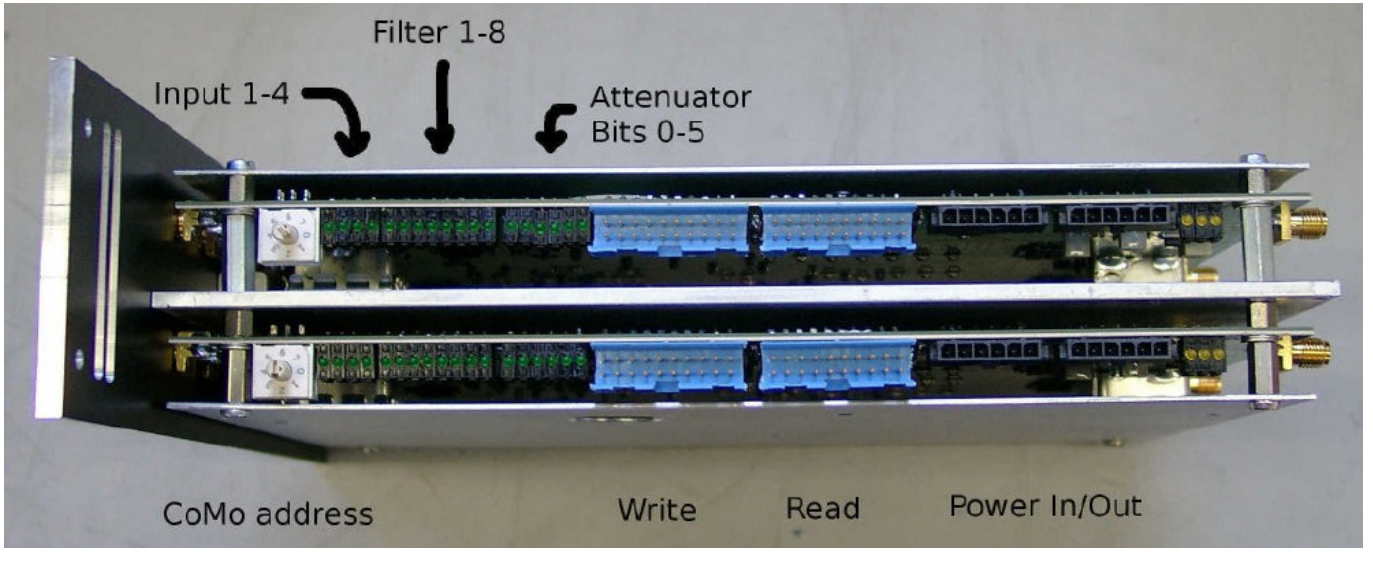

- 4 selectable RF inputs
- 4 selectable Nyquist f lters
- 31.5 dB programmable attenuation
- Total power full band
- Manual or automatic gain control

# 1. Conditioning Module (Unica4)

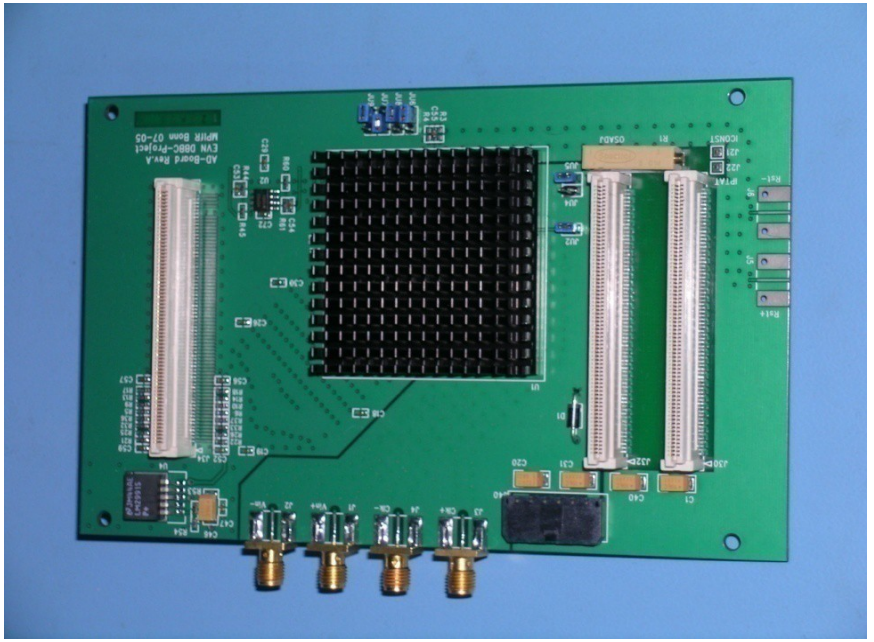



- Now with:
  8 selectable Nyquist f lters

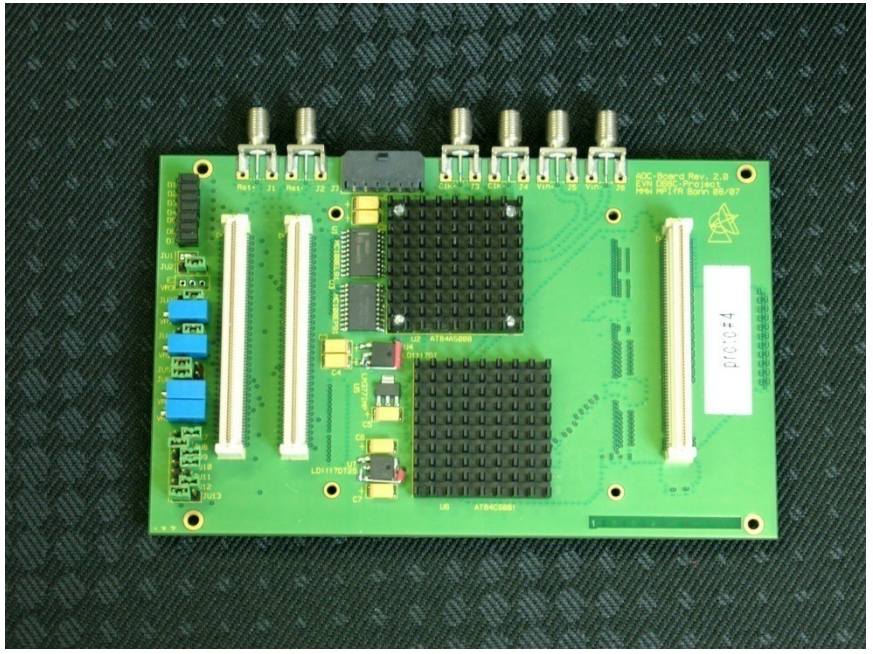
- 2 Unica boards build 1 CoMo



# 2. Analog to digital converter ADB1/2

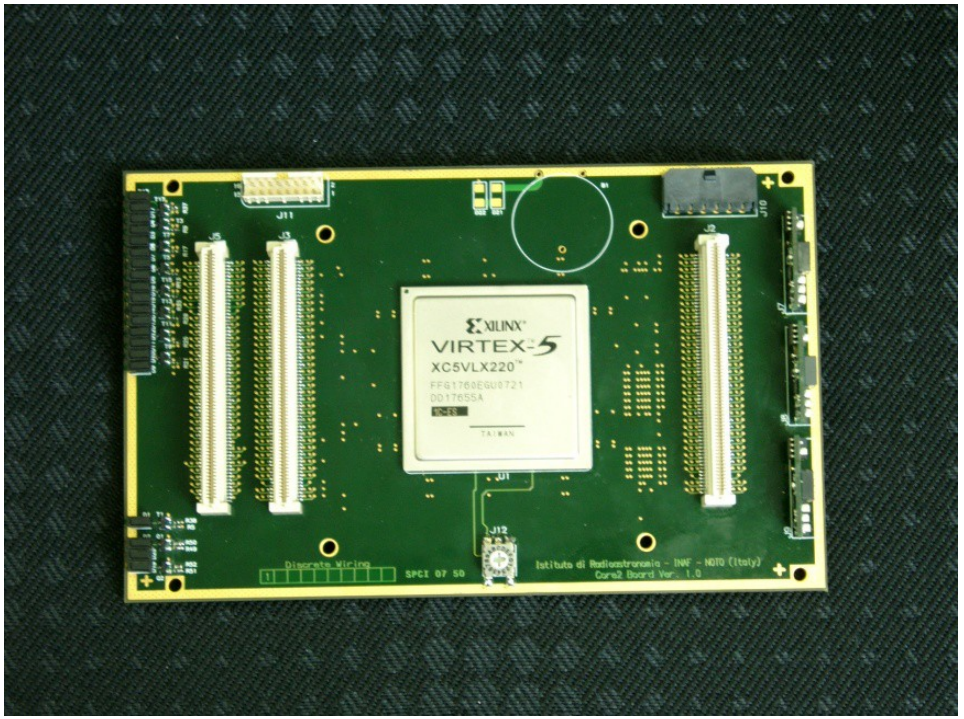


- Analog input: 0 - 2.2 GHz
- Max Sampling clock 1.5 GHz
- Max Instantaneous bandwidth
  750 MHz (real) / 1.5 GHz (complex)
- Output data 2 x 8-bit @1/4 Sclk DDR



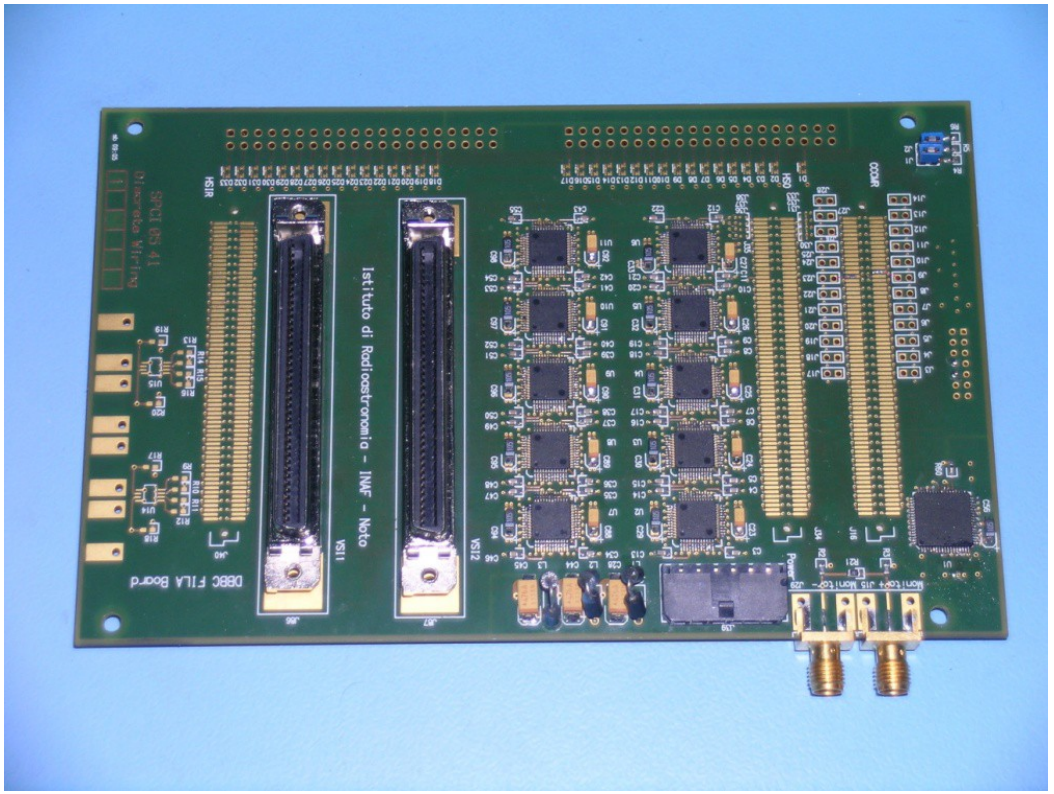
- Analog input: 0 – 3.5 GHz
- Max sampling clock 2.2 GHz
- Max instantaneous bandwidth
  1.1 GHz (real) / 2.2 GHz (complex)
- Output data 2 x 8-bit @1/4 Sclk DDR
  4 x 8-bit @1/8 Sclk DDR
- Piggy pack module support for 10-bit output and connection to Fila10G

# 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 f lters
- 1 VSI 32 channel output

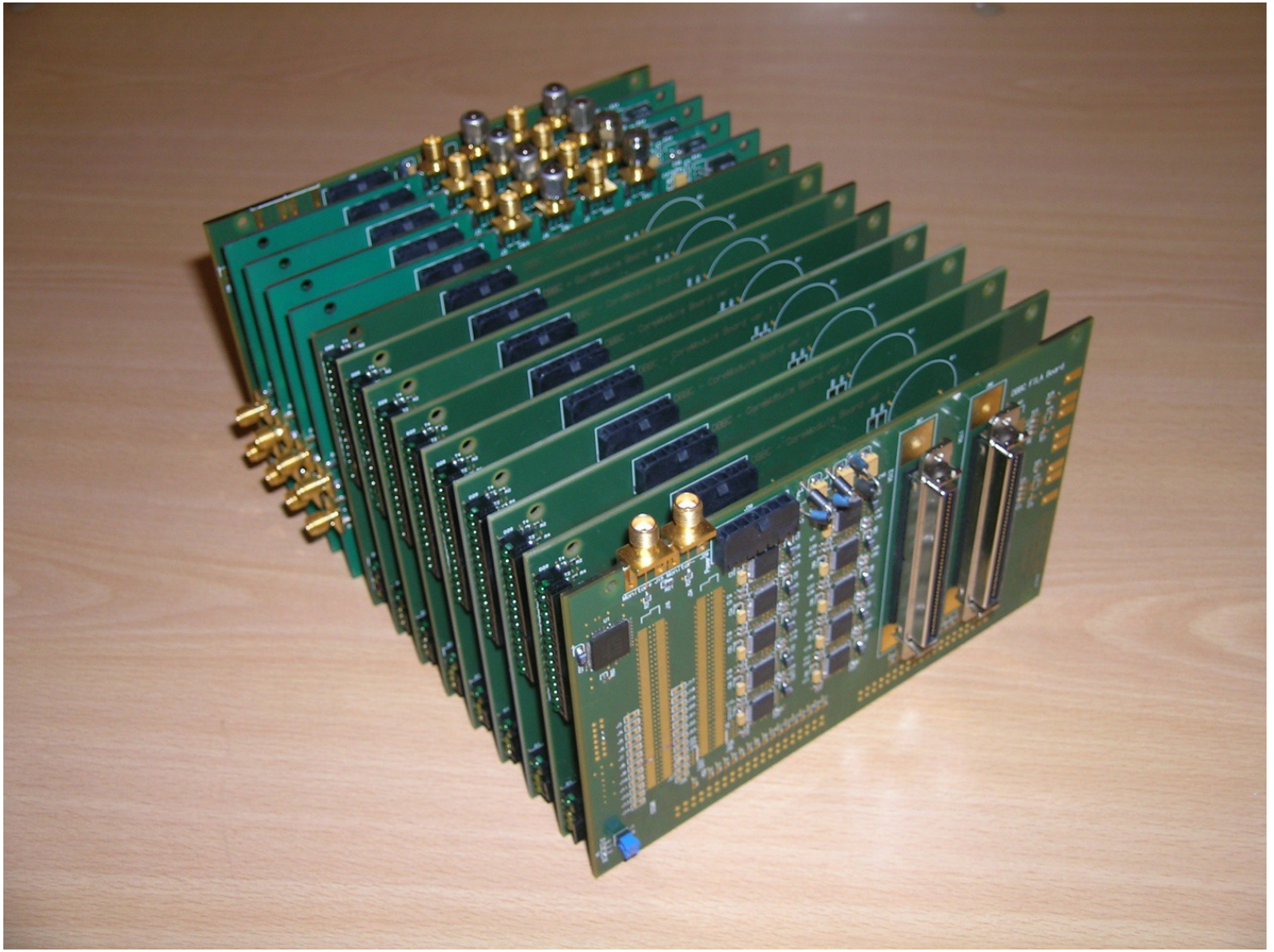
# 4. Connection and service - FiLaBoard



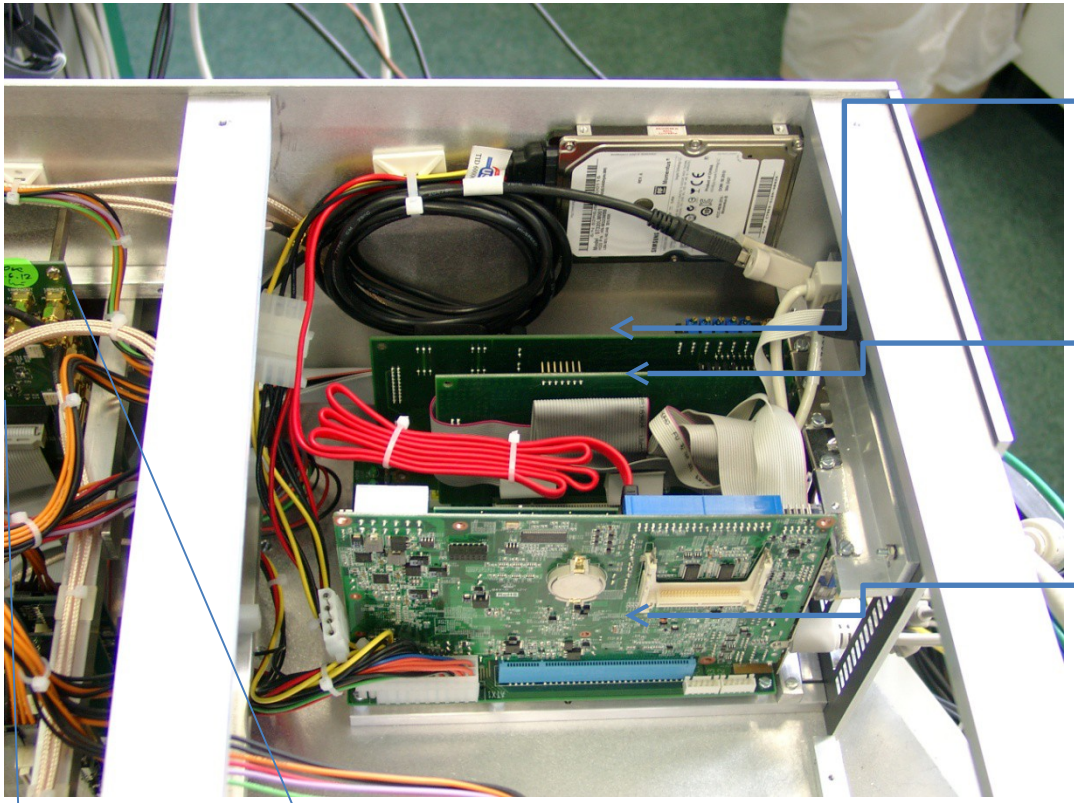

First and Last board in the stack

- 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,**

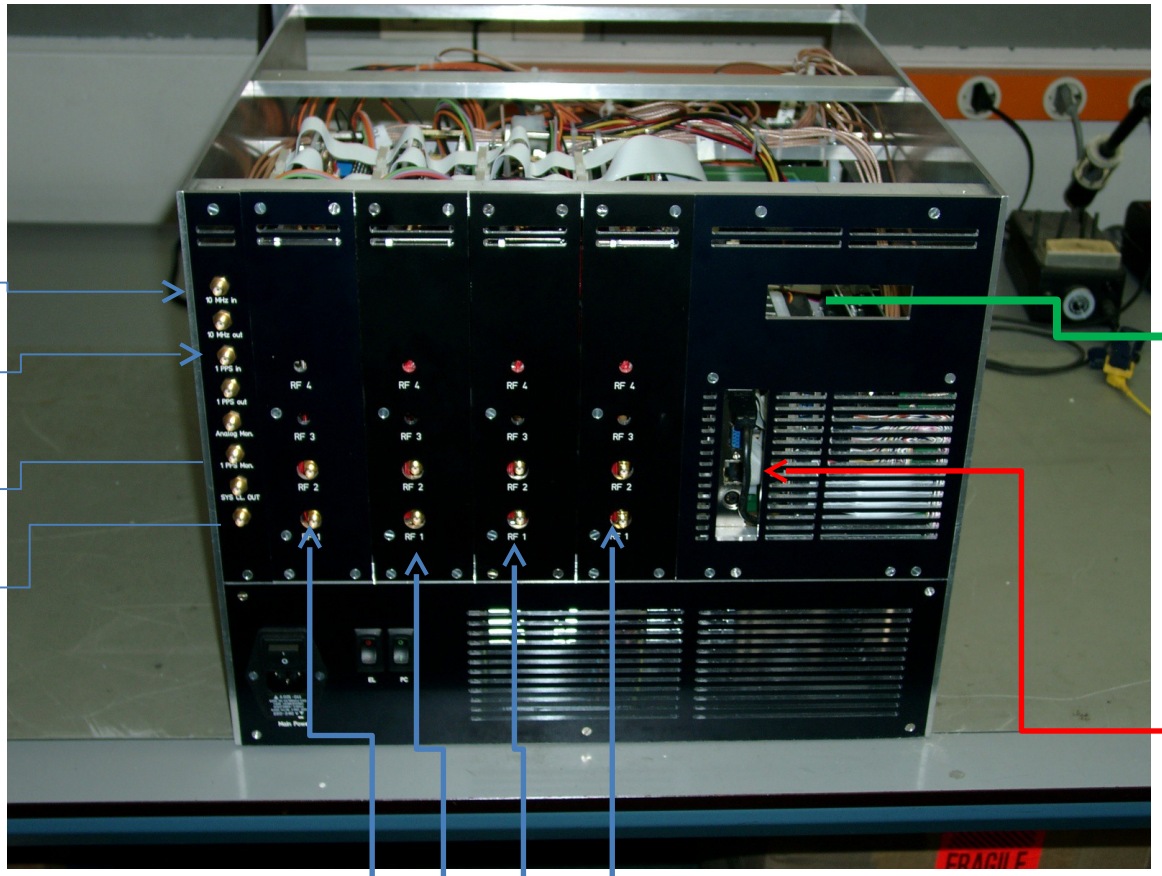
**state statistics, etc.**

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

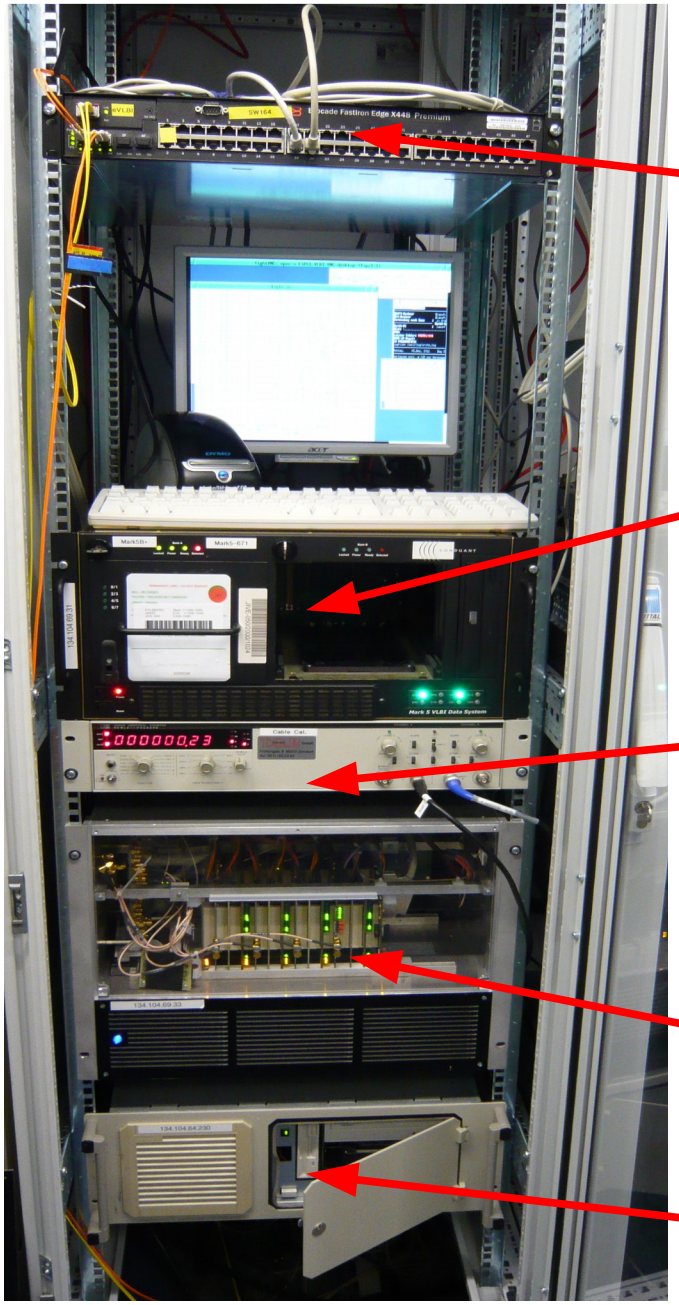
**Xilinx programmer:**
**FPGA device configuration through USB – JTAG interface**

# Installation of a DBBC

## How to connect the DBBC



# Installation of a DBBC



e-VLBI 10 GE switch

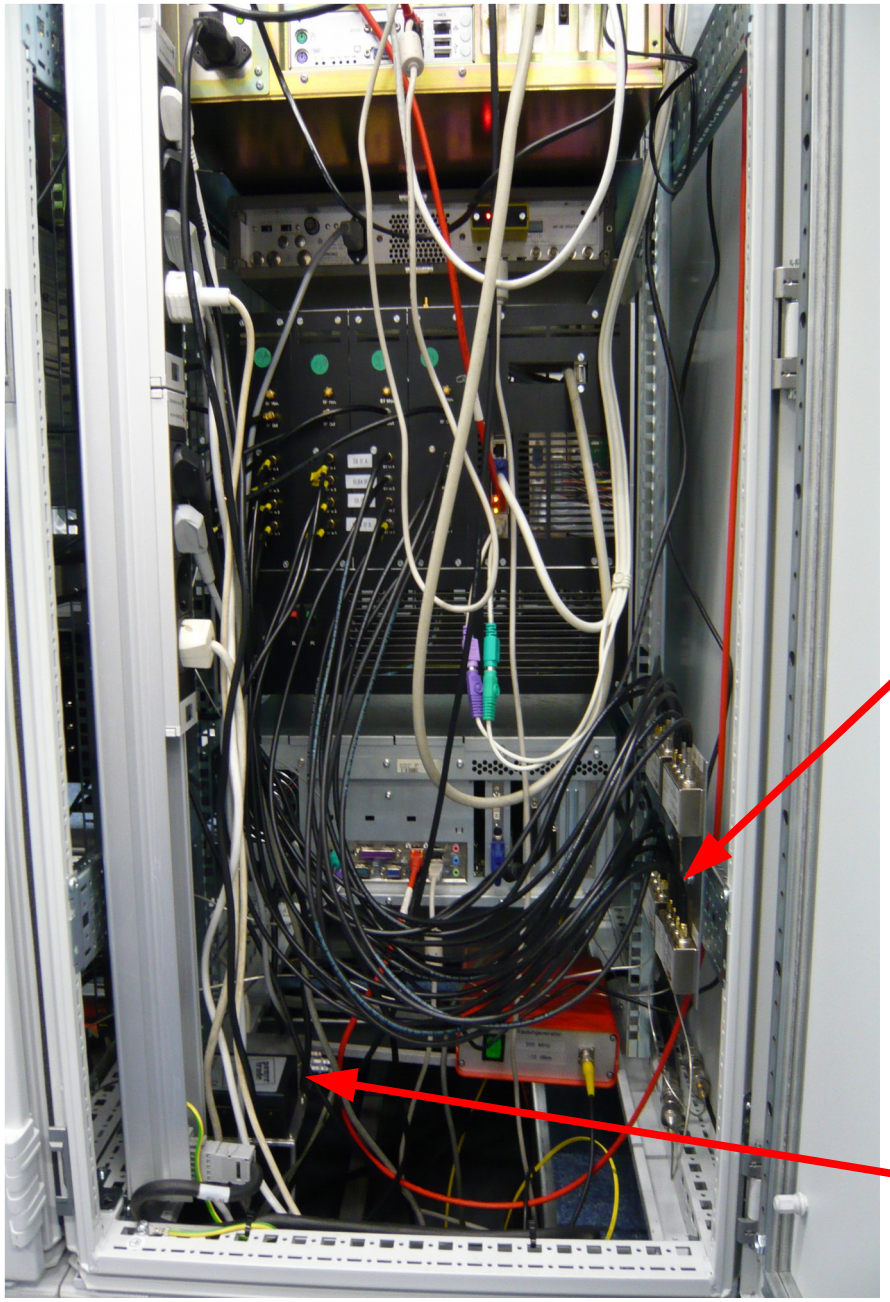
Mark5B+ disk recorder

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

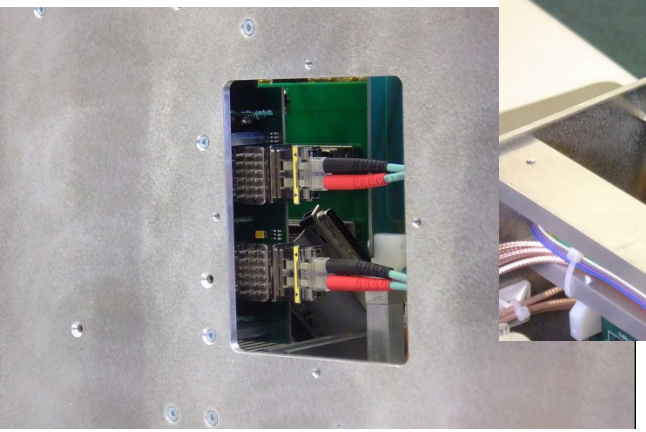
IF2: a. 500-1000 IF RCP
b. 0-500 IF RCP
c. 500-1000 IF LCP
d. 0-500 IF LCP

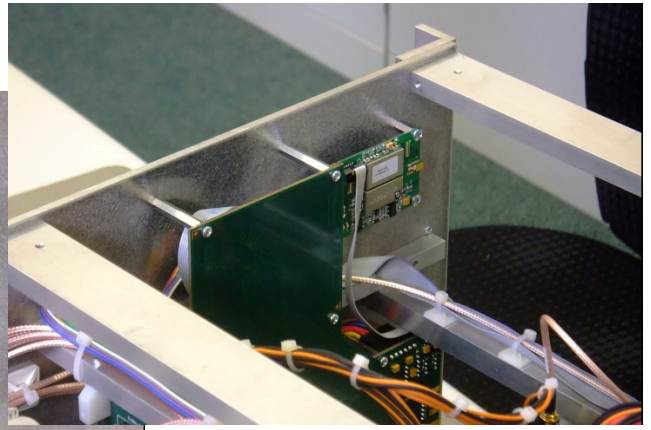
IF3: a. 500-1000 IF RCP
b. 0-500 IF RCP
c. 500-1000 IF LCP
d. 0-500 IF LCP

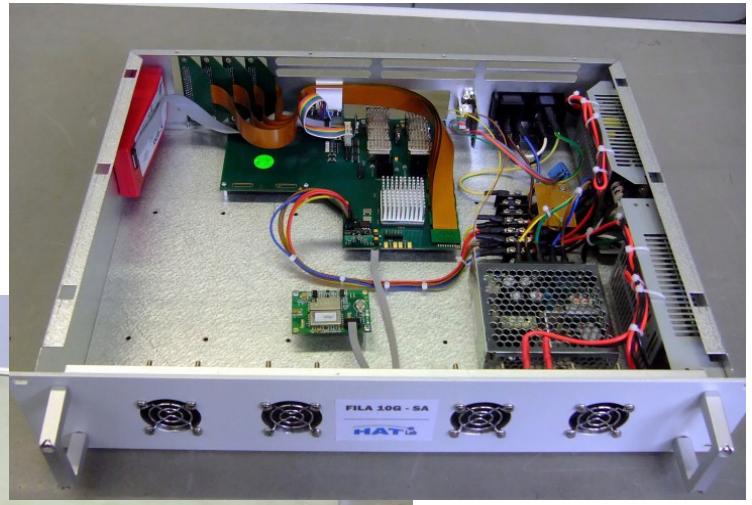
IF4: a. 500-1000 IF RCP
b. 0-500 IF RCP
c. 500-1000 IF LCP
d. 0-500 IF LCP

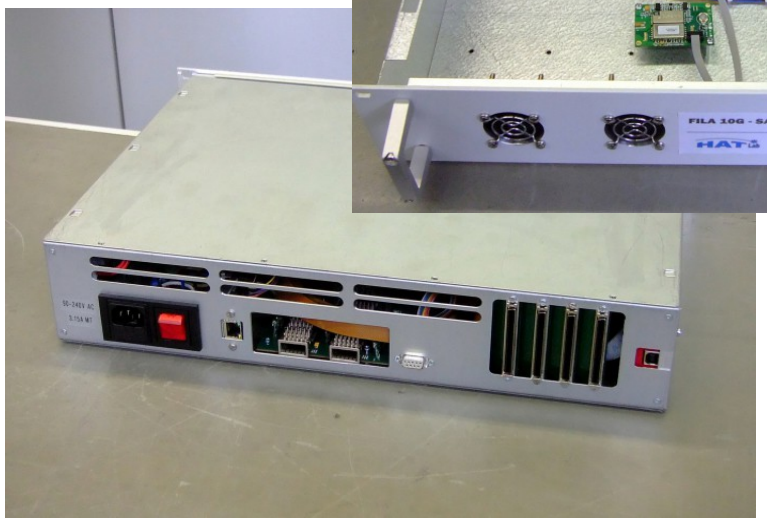
blank – sync generation from 80 Hz

# FiLa10G (SA)



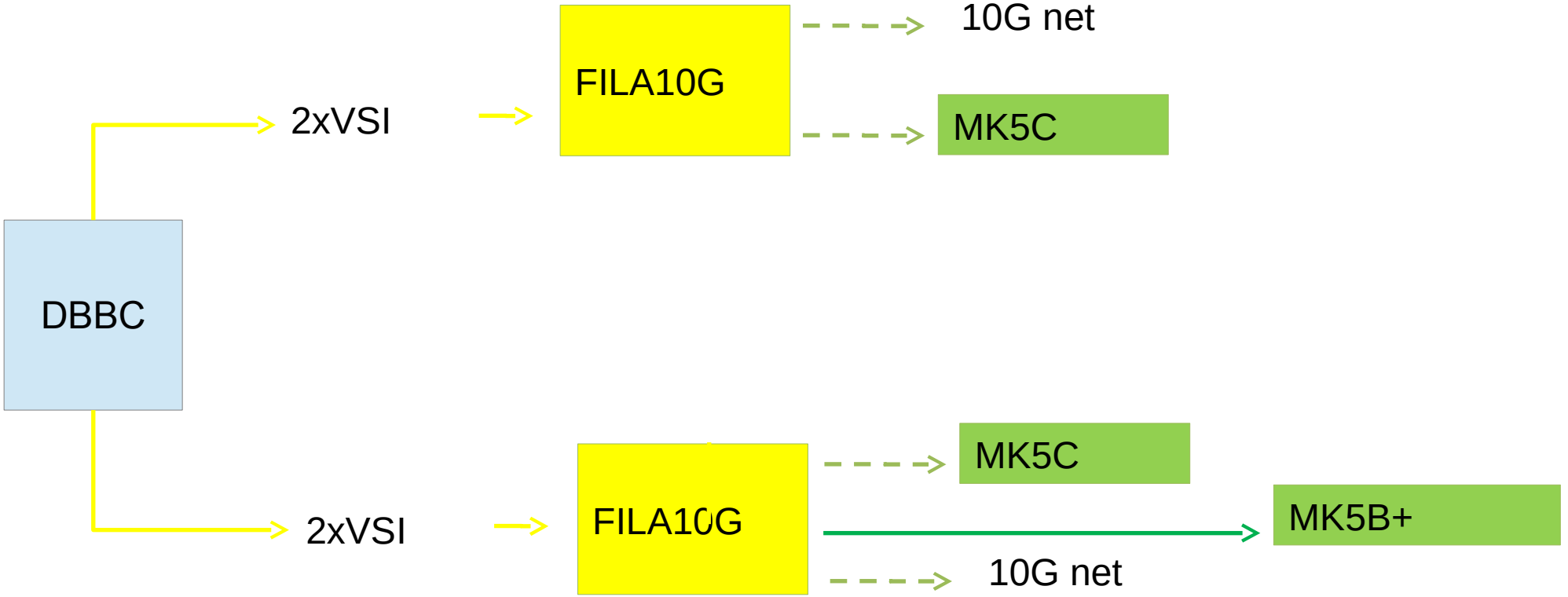




- Two independent 10G Ethernet UDP port
- Physical interface optical XFP
- 10G port fully bidirectional
- Installed inside the DBBC box or as stand-alone
- Data rate: 1 – 2 – 4 Gbps each 10G port
- Format mode: RAW, MK5B or VDIF

# 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

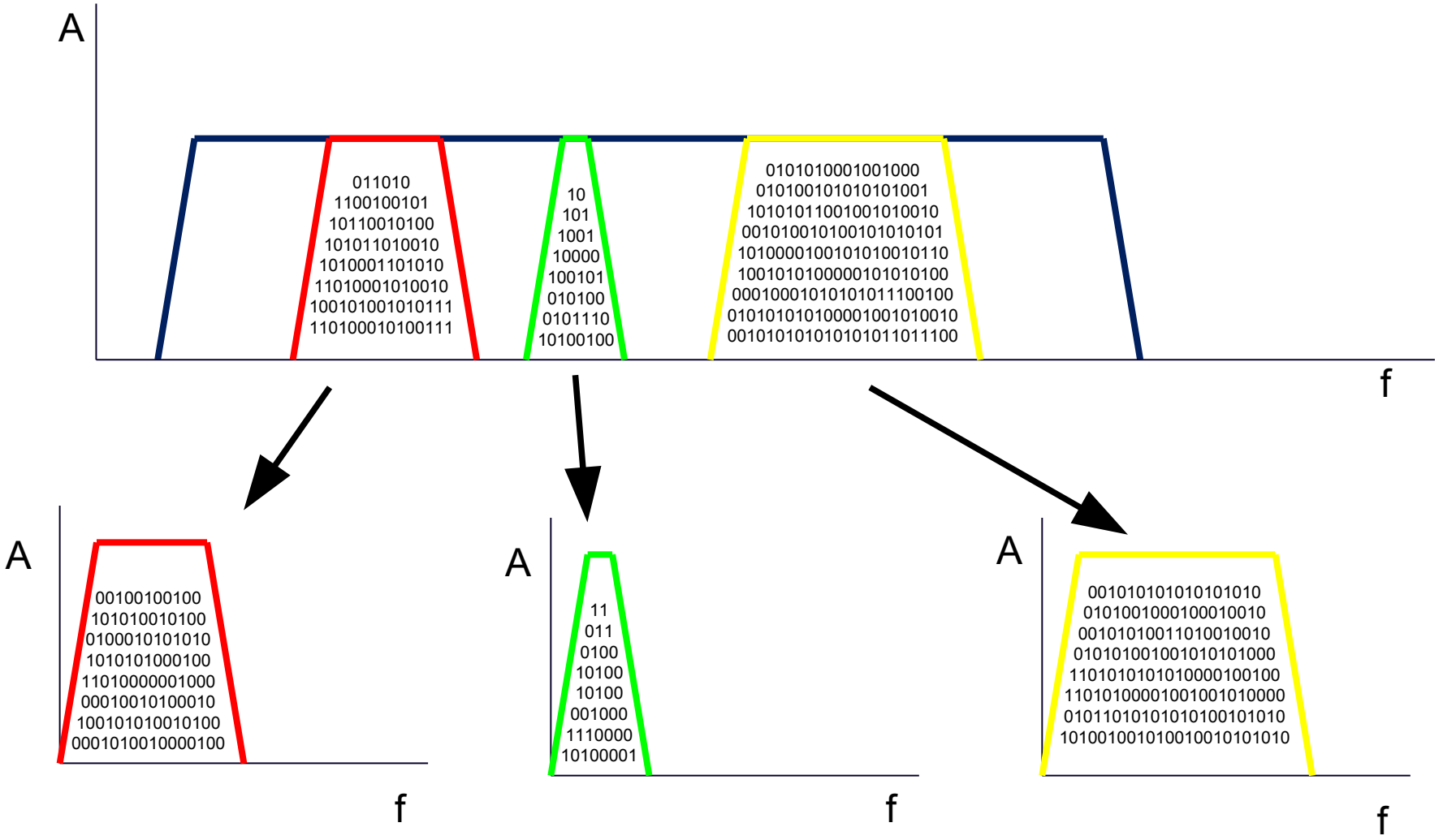
- Upload of the f rmware is
  - automatically made by the DDC/PFB control software (internal FiLa10G)
  - done with an additional Xilinx JTAG programmer using a script for IMAPCT (external FiLa10G-SA)
- Communication is through serial port or Ethernet in the stand-alone version
- Commands available 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

# Observing modes

- DDC: tunable, channel bandwidth between 1 MHz and 64 MHz, U&L, Continuous cal with 80 Hz synchronization, modes: geo, astro, astro2, w-astro, lba, test
- 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

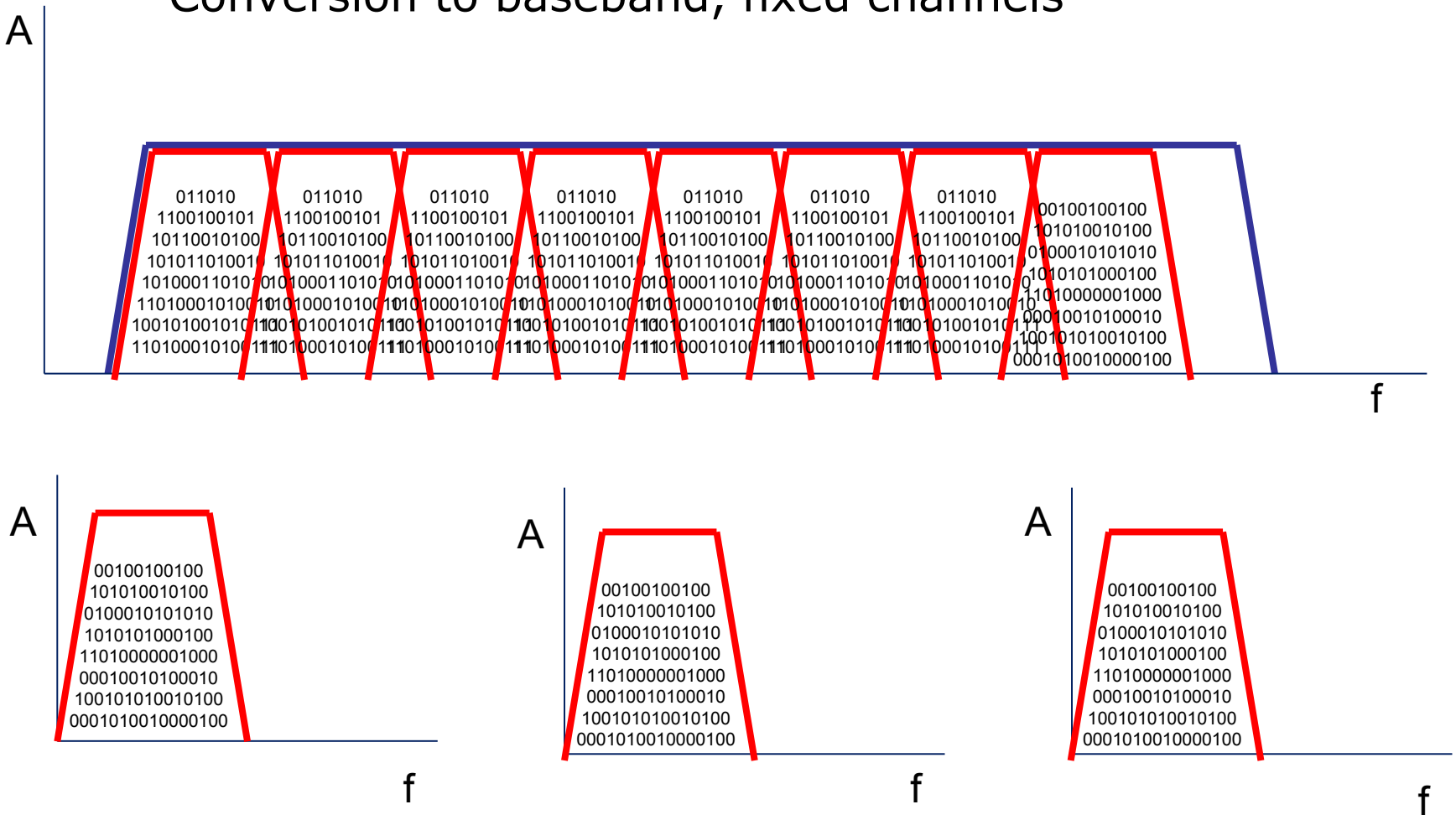
# DDC – digital down conversion

Conversion to baseband, tunable channels of variable bandwidht

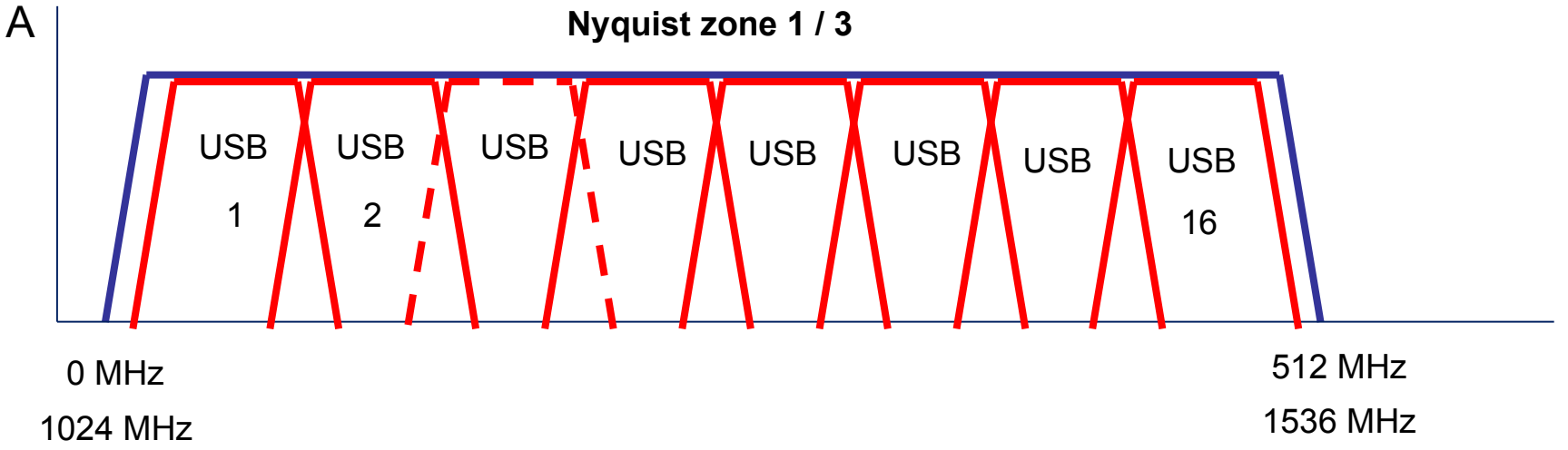


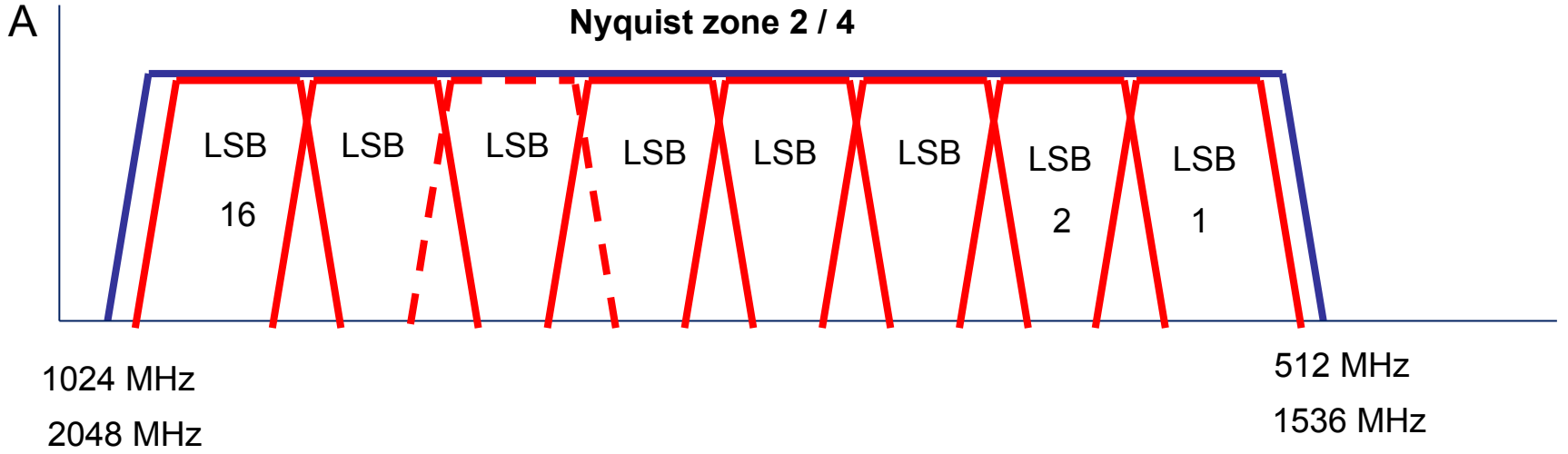
# PFB – poly-phase filter bank

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)

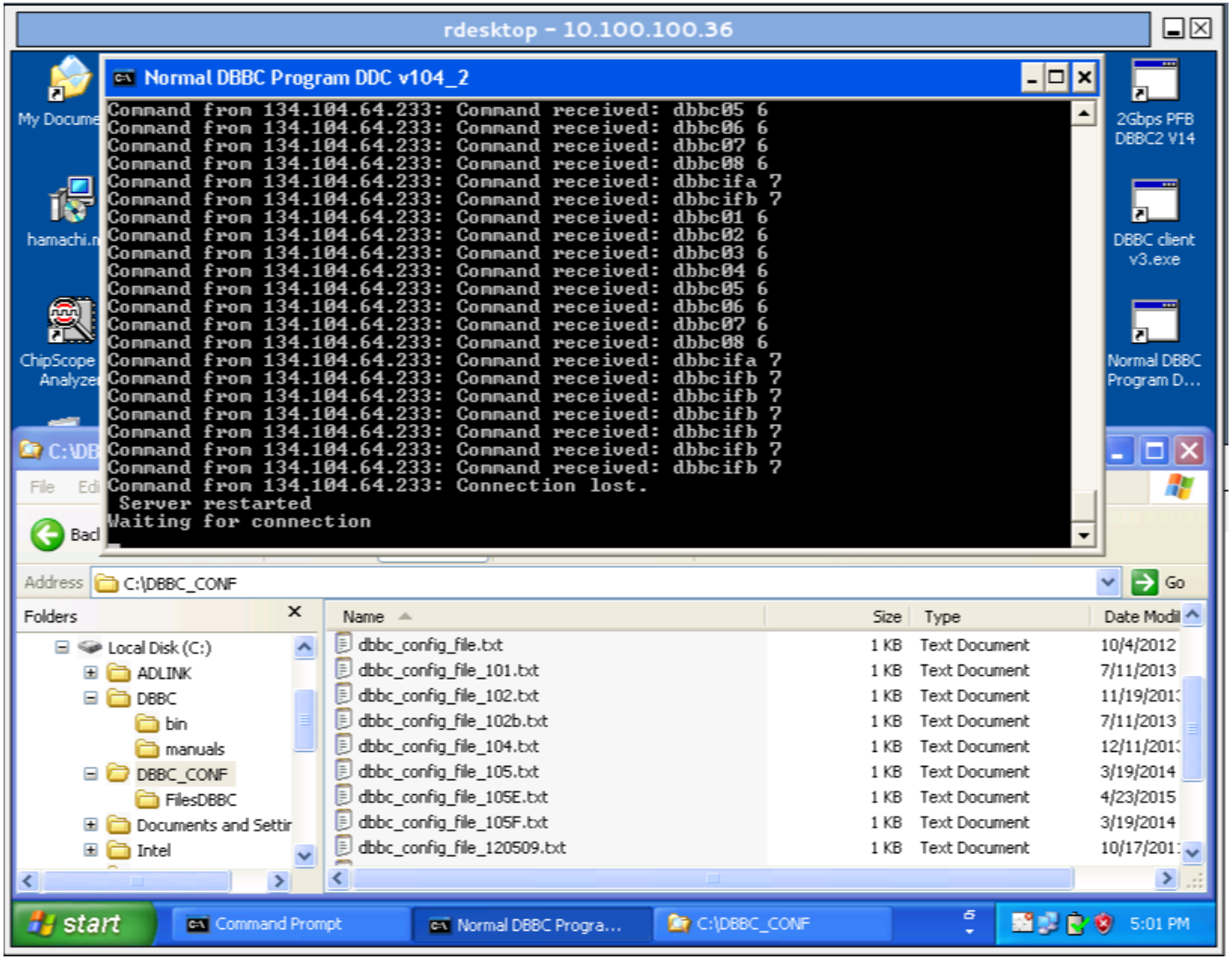
## Files Structure:

C:\DBBC\bin
→ control software

C:\DBBC\doc
→ manuals

C:\DBBC_CONF\
→ conf guration text f les

C:\DBBC_CONF\FilesDBBC
→ f rmware



# https://www.hat-lab.cloud

https://www.hat-lab.cloud/downloads-dbbc2-ddc/

Suchen

Hat Lab

Hi, Uwe Bach

HAT Lab

HOME | COMPANY PROFILE | DBBC BACK-ENDS EVOLUTION | ACTIVITY AND PLANS | PRODUCTS | FUNK HAUS | DOWNLOAD | LOGIN | CONTACTS

There are **5 files**, weighing **36.9 MiB** with **59 hits** in **DBBC2-DDC**.

Displaying **1** to **5** of **5** files.

## DBBC2-DDC

**DBBC2 DDC v105**
**» 3.1 MiB - 6 hits - 20 April 2018**
DBBC2 DDC v105

**DBBC2_DDC_v106_261118.rar**
**» 9.9 MiB - 5 hits - 26 November 2018**
DBBC2_DDC_v106_261118.rar

**DBBC2_DDC_v107_beta1.zip**
**» 6.8 MiB - 16 hits - 20 November 2018**
DBBC2_DDC_v107_beta1.zip

**DBBC2_DDC_v107_beta2.rar**
**» 8.4 MiB - 9 hits - 11 January 2019**
DBBC2_DDC_v107_beta2.rar

**DBBC2_DDC_v107_beta3.rar**
**» 8.7 MiB - 23 hits - 30 January 2019**
DBBC2_DDC_v107_beta3.rar

# Software

- DDC:

  c:\DBBC\bin\DBBC2 Control DDC v107.exe  (server)
  c:\DBBC_conf\dbbc_config_file_107.txt
  c:\DBBC_conf\FilesDBBC\dbbc2_ddc_v107.bit
  c:\DBBC\doc\DBBC2 DDC command set v107.pdf

- PFB:

  c:\DBBC\bin\DBBC2 Control PFB v16_2.exe (server)
  c:\DBBC_conf\dbbc_poly_config_file_16.txt
  c:\DBBC_conf\FilesDBBC\ dbbc2_pfb_v16.bit
  c:\DBBC\doc\DBBC2 PFB command set v16.pdf

# DDC configuration file

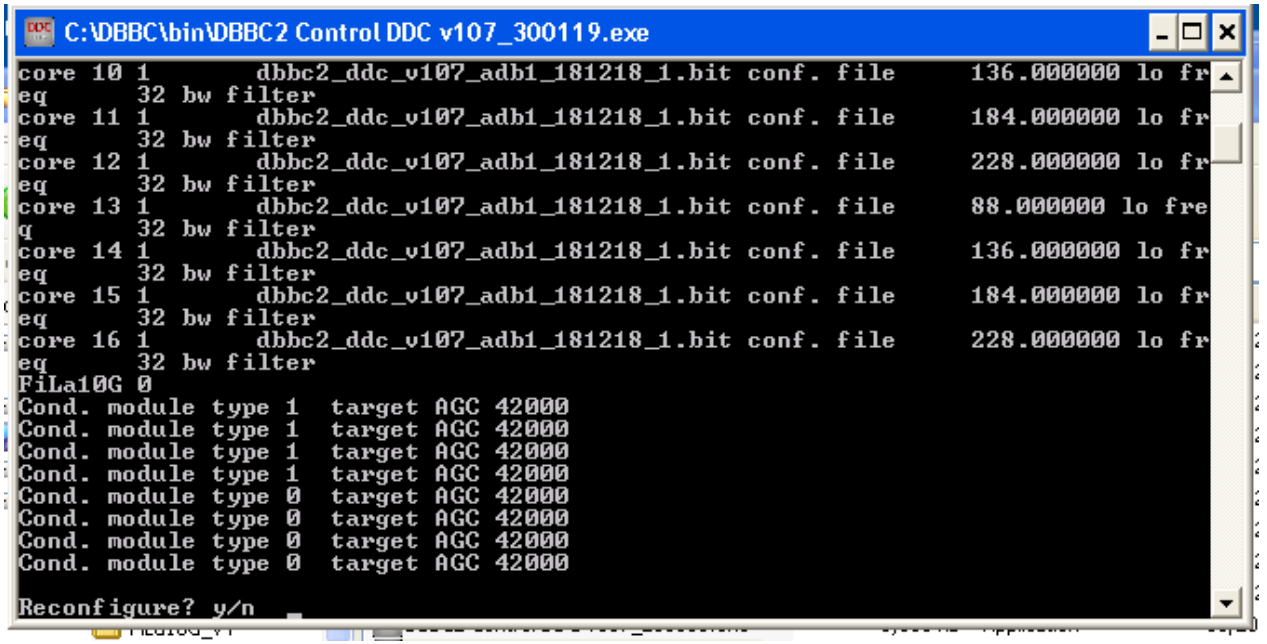
## c:\DBBC_conf\dbbc_config_file_v107.txt

Example:

```
1  dbbc2_ddc_v107.bit    597.00   8   ←the first number is indication of ADB1|2, in this case ADB1 is on
1  dbbc2_ddc_v107.bit    682.00   8     IFA  and ADB2 on IFB, ADB1 in IFC, no Core2 for IFD
1  dbbc2_ddc_v107.bit    853.00   8     If no Core2 is inserted in the first and second column put 0.
1  dbbc2_ddc_v107.bit    938.00   8     The second parameter is the firmware file name to be used.
2  dbbc2_ddc_v107.bit    597.00   8    The third and fourth parameters are frequency and bandwidth respectively.
2  dbbc2_ddc_v107.bit    682.00   8
2  dbbc2_ddc_v107.bit    853.00   8
2  dbbc2_ddc_v107.bit    938.00   8
1  dbbc2_ddc_v107.bit    597.00   8
1  dbbc2_ddc_v107.bit    682.00   8
1  dbbc2_ddc_v107.bit    853.00   8
1  dbbc2_ddc_v107.bit    938.00   8
0  dbbc2_ddc_v107.bit    597.00   8     Each Core2 board supports 4 bbcs so if not present 0 has to be inserted in
0  dbbc2_ddc_v107.bit    682.00   8    four lines
0  dbbc2_ddc_v107.bit    853.00   8
0  dbbc2_ddc_v107.bit    938.00   8
1   fila10g_v2_1.bit COM2   ← if installed set 1st version 1 (with ACE), 2nd version (without ACE 2), otherwise 0, ser. port
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
PROG 0 3                       ← jtag programmer: 0=xilinx, 1=digilent; prog freq. 3/6 MHz
```

# Starting the software

DDC: running **DBBC2 Control DDC v107.exe**




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.hat-lab.cloud
    currently v105/v106 or v107 beta3 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)
```

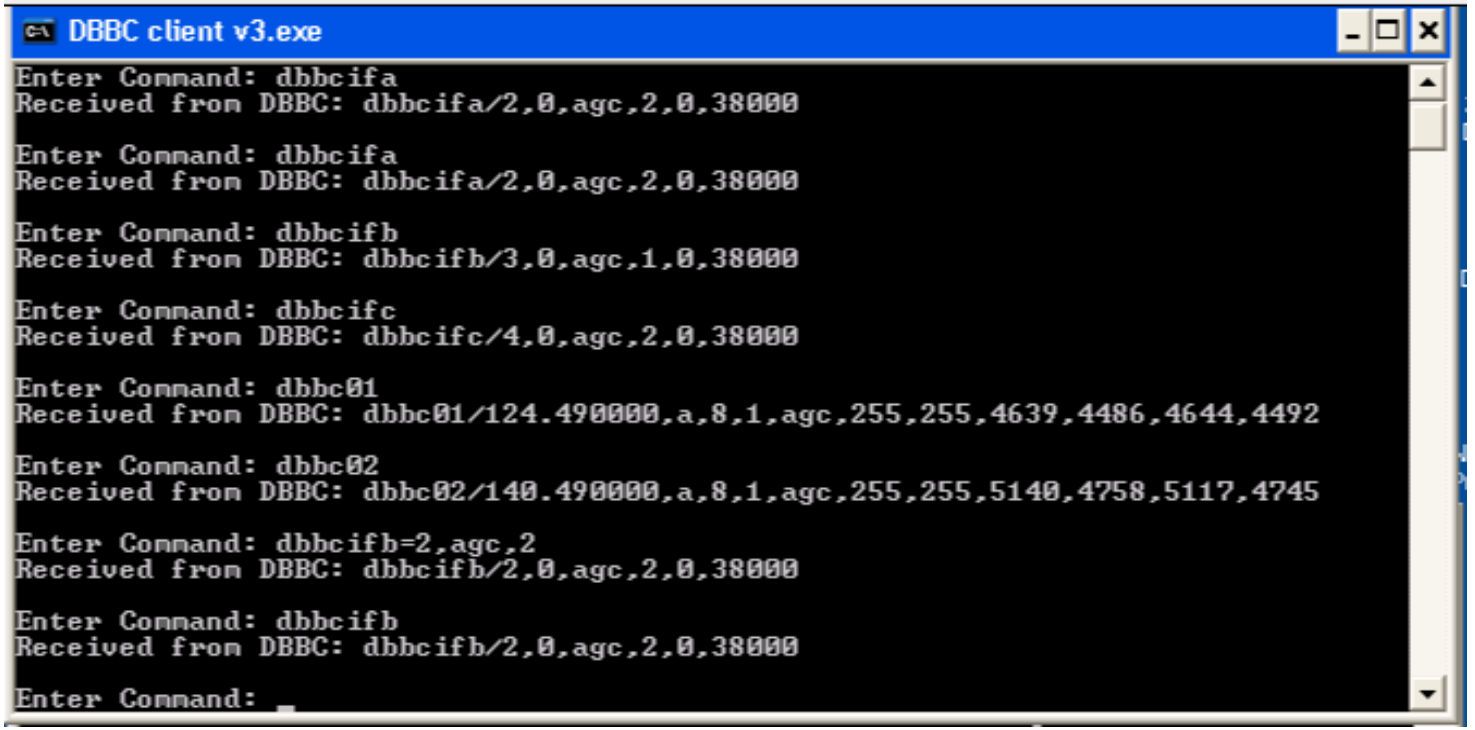
read out BBCs set different frequencies, ...

```
> 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



# 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.

*For testing with a Flexbuff or Mark6 it is recommended to use the FS*

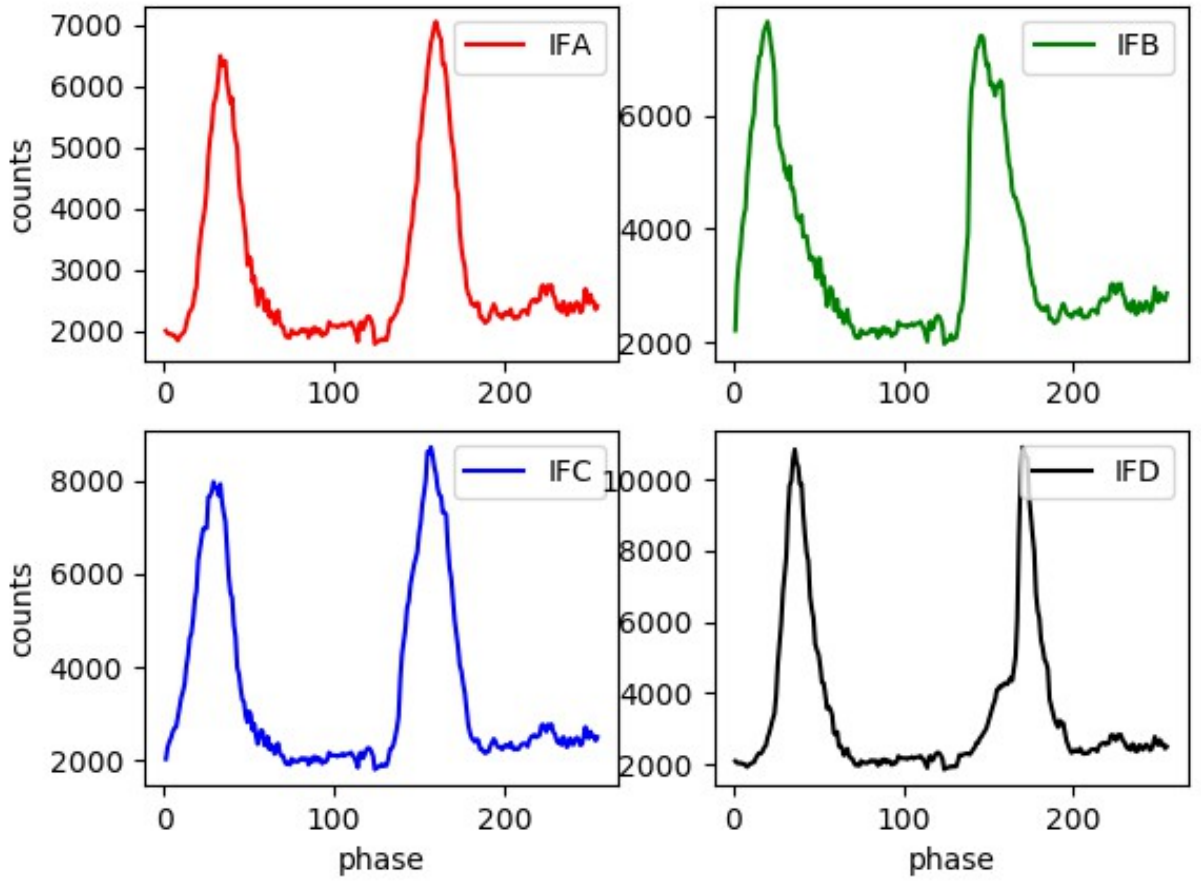
# Calibration of the DBBC

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 or a broad band IF signal (not too strong).
- Load the firmware to test.
- Point all dbbcifa,b,c,d to this input and set AGC to manual, e.g.
  - dbbcifa=1,40,1  # adjusted to about 10000 counts
  - In DDC mode: turn off AGC for BBCs: dbbcgain=all,20,20
- Run the DBBC command: calibration=all
- … wait

Description at:
https://deki.mpifr-bonn.mpg.de/GMVA/GMVA_HOWTO/DBBC2_calibration

# 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 **124**

….

| | | | | |
|---|---|---|---|---|
| 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_v107.txt

Example:

```
1  dbbc2_ddc_v107.bit    597.00   8   ←the first number is indication of ADB1|2, in this case ADB1 is on
1  dbbc2_ddc_v107.bit    682.00   8     IFA  and ADB2 on IFB, ADB1 in IFC, no Core2 for IFD
1  dbbc2_ddc_v107.bit    853.00   8     If no Core2 is inserted in the first and second column put 0.
1  dbbc2_ddc_v107.bit    938.00   8     The second parameter is the firmware file name to be used.
2  dbbc2_ddc_v107.bit    597.00   8    The third and fourth parameters are frequency and bandwidth respectively.
2  dbbc2_ddc_v107.bit    682.00   8
2  dbbc2_ddc_v107.bit    853.00   8
2  dbbc2_ddc_v107.bit    938.00   8
1  dbbc2_ddc_v107.bit    597.00   8
1  dbbc2_ddc_v107.bit    682.00   8
1  dbbc2_ddc_v107.bit    853.00   8
1  dbbc2_ddc_v107.bit    938.00   8
0  dbbc2_ddc_v107.bit    597.00   8     Each Core2 board supports 4 bbcs so if not present 0 has to be inserted in
0  dbbc2_ddc_v107.bit    682.00   8    four lines
0  dbbc2_ddc_v107.bit    853.00   8
0  dbbc2_ddc_v107.bit    938.00   8
1   fla10g_v2_1.bit COM2   ← if installed set 1st version 1 (with ACE), 2nd version (without ACE 2), otherwise 0, ser. port
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
100 100 100 100                       ←  phase calibration values
CAT2 1024                        ←  CAT1|2 and sampling frequency
PROG 0 3                         ← jtag programmer: 0=xilinx, 1=digilent; prog freq. 3/6 MHz
```

# 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)

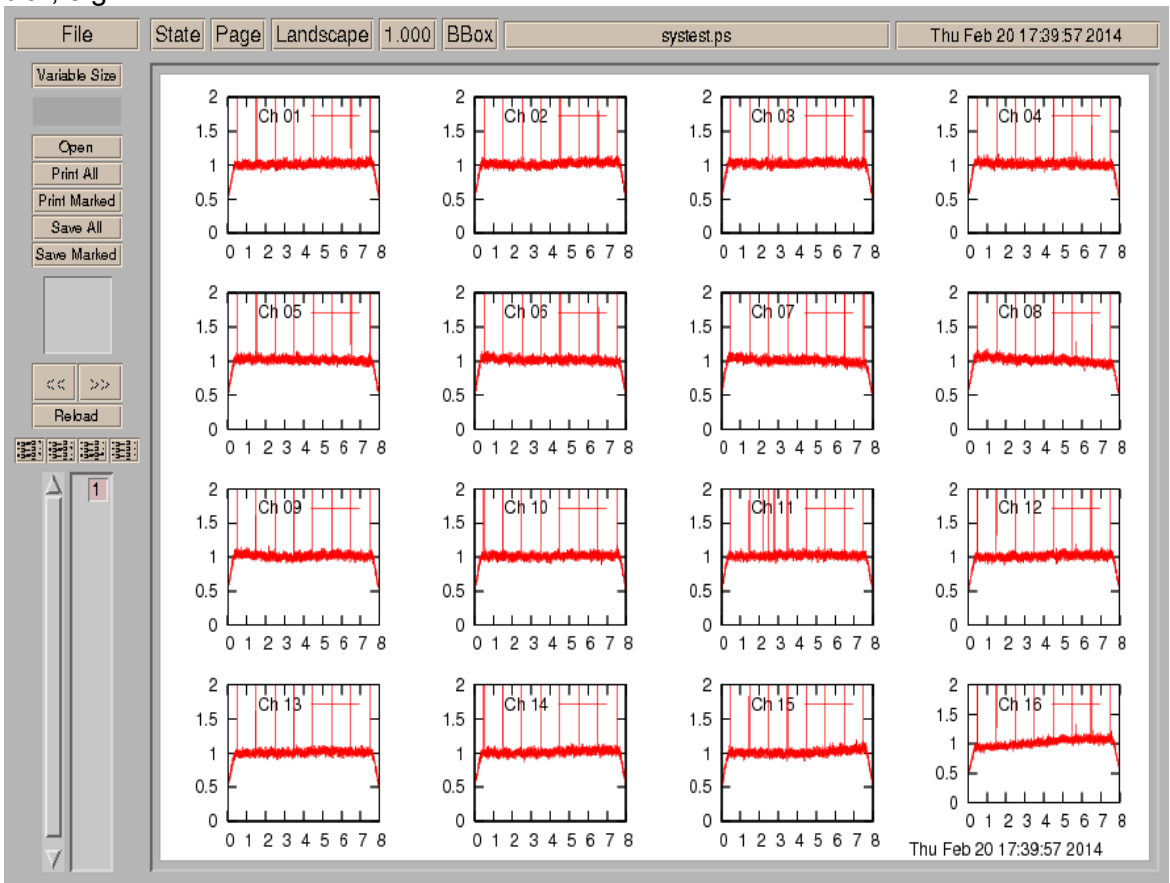
<nchan> is the number of channels to make per IF

<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

- *> vlbi2*

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

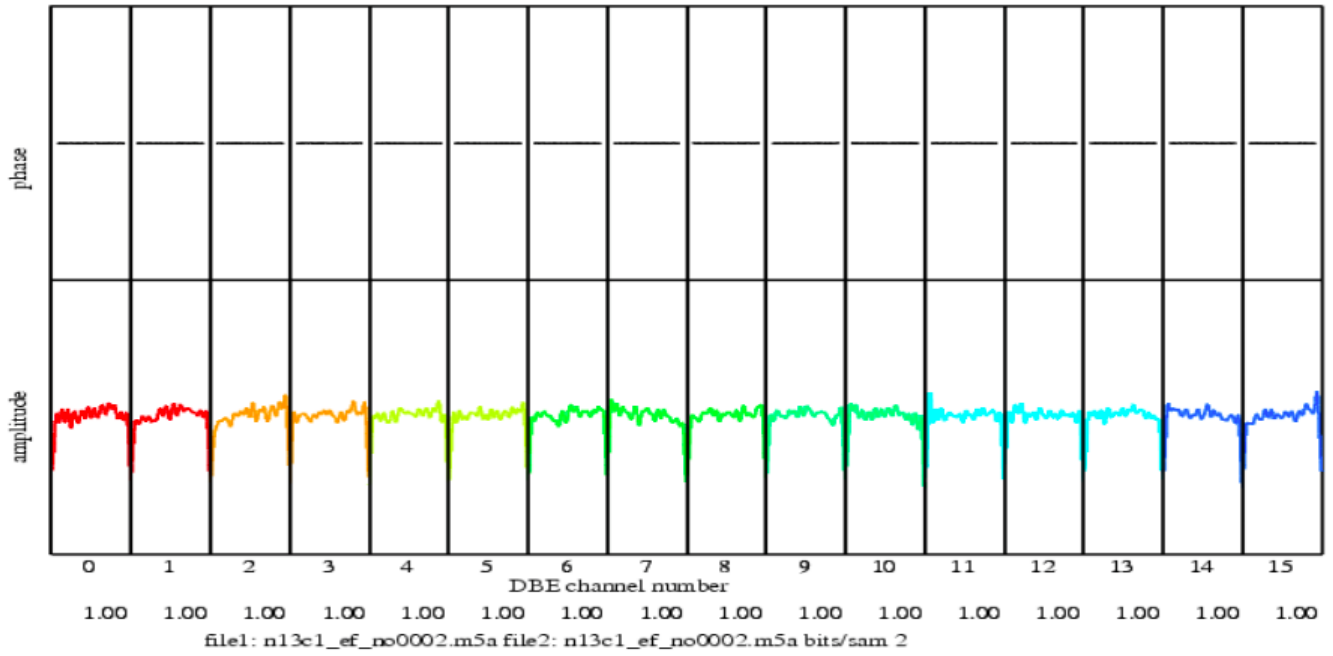
  *2bit: 1 to enable 2-bit input*

  *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* |

# 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

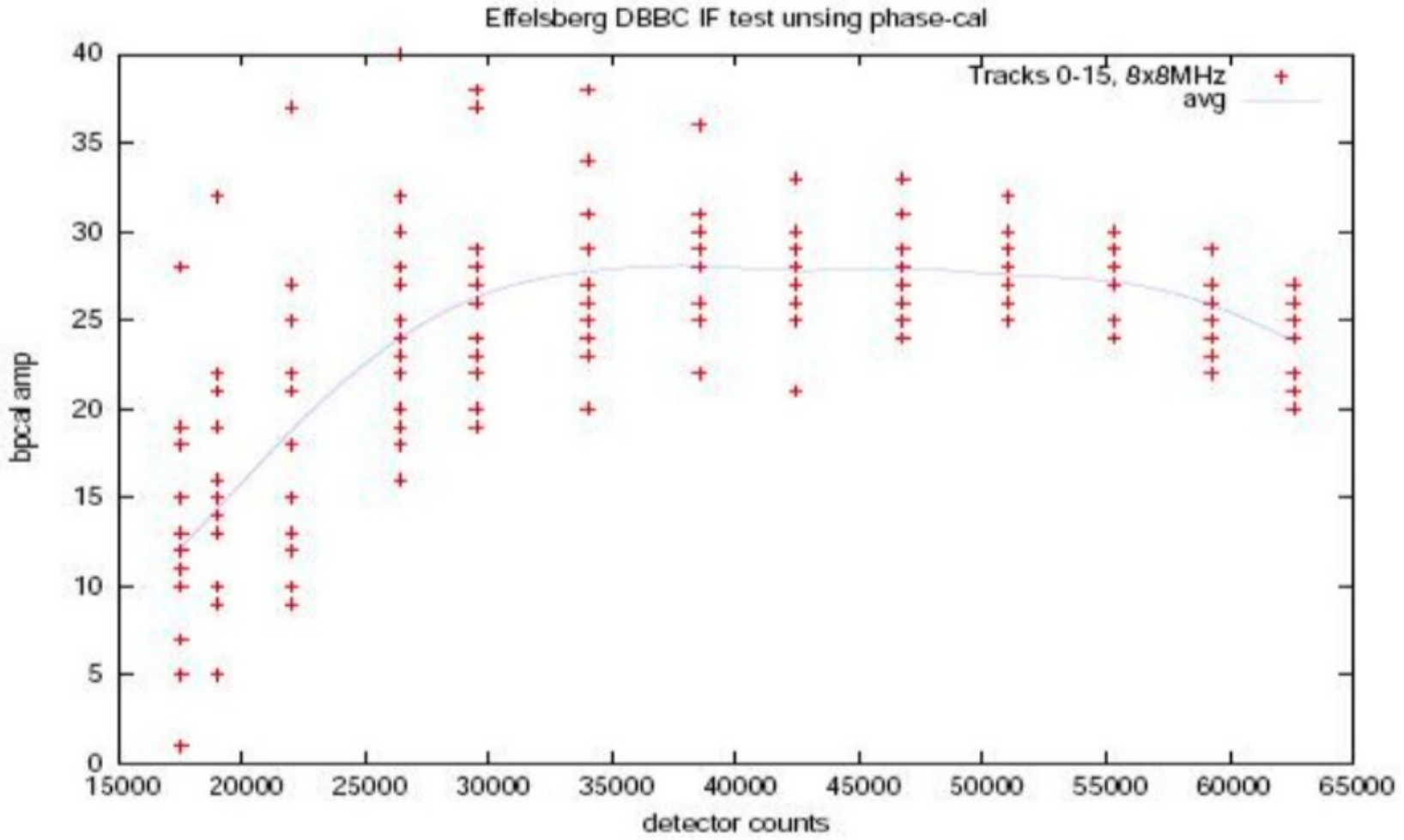



**Figure 2:** Phase-cal amplitude calulated by bpcal over 0.15 sec against detector counts.

# Field System integration

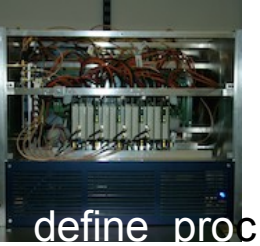
- The DBBC2 is fully integrated into the Field System:
  - It supports both PFB and DDC firmware.
  - Continues calibration in DDC mode.
  - With and without Fila10G.
  - Allows synchronization to internal GPS or NTP on FS-PC.

```
EFLSBERG equipment: Rack=DBBC_DDC/Fil   Recorder=FlexBuff
| Select rack           | Select Rec 1 | Select Rec 2 | Start|
|   1=none              |   1=none     | * 1=none     | * 1  |
|   2=Mark3A            |   2=unused   |   2=unused   |   2  |
|   3=VLBA              |   3=Mark3A   |   3=Mark3A   |      |
|   4=VLBAG             |   4=VLBA     |   4=VLBA     |      |
|   5=VLBA/8            |   5=VLBA4    |   5=VLBA4    |      |
|   6=VLBA4/8           |   6=Mark4    |   6=Mark4    |      |
|   7=Mark4             |   7=S2       |   7=S2       |      |
|   8=VLBA4             |   8=K4-1     |              |      |
|   9=K4-1              |   9=K4-2     |              |      |
|  10=K4-2              |  10=Mark5A   |              |      |
|  11=K4-1/K3           |  11=Mk5APigW |              |      |
|  12=K4-2/K3           |  12=Mark5P   |              |      |
|  13=K4-1/M4           |  13=K5       |              |      |
|  14=K4-2/M4           |  14=Mark5B   |              |      |
|  15=LBA               |  15=Mark5C   |              |      |
|  16=Mark5             | *16=FlexBuff |              |      |
|  17=VLBA5             |              |              |      |
|  18=DBBC_DDC          |              |              |      |
| *19=DBBC_DDC/Fila10g  |              |              |      |
|  20=DBBC_PFB          |              |              |      |
|  21=DBBC_PFB/Fila10g  |              |              |      |
|  22=VLBAC             |              |              |      |
|  23=CDAS              |              |              |      |
 Press <ret> or type 0 for no change.  Else <rack><rec1><rec2><start>
CAUTION! Be sure the schedule works with your choices!
```

# Field System integration

- Notes on DBBC2 integration are available in /usr2/fs/misc/dbbc.txt
- 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
```

# Field System integration

Applications Places — Tue Apr 30, 9:03 AM — VLBI Operator

**Field System Log**

```
08:51:03&bread/if=bbc15,bbc15
08:51:03&bread/if=bbc16,bbc16
08:51:03&bread/if=pfb,if=core1\,pfb1
08:51:03&bread/if=pfb,if=core2\,pfb2
08:51:03&bread/if=pfb,if=core3\,pfb3
08:51:03&bread/if=pfb,if=core4\,pfb4
08:51:03/bbc01/ 866.490000,a, 8, 1,agc,136,133,11955,11963,11385,11393
08:51:03/bbc02/ 882.490000,a, 8, 1,agc,127,131,11812,11908,11241,11328
08:51:03/bbc03/ 898.490000,a, 8, 1,agc,127,124,11917,11830,11317,11256
08:51:03/bbc04/ 914.490000,a, 8, 1,agc,133,131,12130,12121,11525,11520
08:51:03/bbc09/ 866.490000,c, 8, 1,agc,219,219,10428,10938, 9932,10411
08:51:03/bbc10/ 882.490000,c, 8, 1,agc,219,219,11029,10552,10508,10059
08:51:03/bbc11/ 898.490000,c, 8, 1,agc,218,219,11835,10946,11274,10431
08:51:03/bbc12/ 914.490000,c, 8, 1,agc,219,217,10620,11806,10099,11233
08:51:15;caltsys
08:51:15&caltsys/onsource
08:51:15&caltsys/if=cont_cal,tpicd=tsys,caltsys_man
08:51:15&caltsys/if=cont_cal,,ifagc
08:51:15&caltsys/if=cont_cal,,if=ddc\,bbc_gain=all\\\,agc
08:51:15#antcn#Antenna TRACKING
08:51:15#antcn# RFcentre wanted:  4850 Antenna:  4850 synth1,2= 613.000000    0.000000
08:51:15/onsource/TRACKING
08:51:27/tpi/1l,11399.2,1u,11377.2,2l,11337.0,2u,11246.8,3l,11260.2,3u,11331.2,4l,11537.2
08:51:27/tpi/4u,11536.5,ia,1838.33
08:51:27/tpi/9l,11316.2,9u,11220.5,al,11290.0,au,11320.8,bl,11233.2,bu,11298.0,cl,11264.2
08:51:27/tpi/cu,11267.5,ic,1787.60
08:51:27/tpical/1l,11976.0,1u,11960.8,2l,11921.2,2u,11820.0,3l,11842.8,3u,11914.2,4l,12124.0
08:51:27/tpical/4u,12129.0
08:51:27/tpical/9l,11888.8,9u,11788.2,al,11855.5,au,11886.2,bl,11793.2,bu,11867.2,cl,11837.2
08:51:27/tpical/cu,11835.8
08:51:27/caltemp/1l,1.836,1u,1.840,2l,1.841,2u,1.837,3l,1.838,3u,1.846,4l,1.854,4u,1.890
08:51:27/caltemp/9l,1.817,9u,1.812,al,1.806,au,1.797,bl,1.793,bu,1.801,cl,1.817,cu,1.833
08:51:27/tsys/1l,36.3,1u,35.9,2l,35.7,2u,36.0,3l,35.5,3u,35.9,4l,36.4,4u,36.8
08:51:27/tsys/9l,35.9,9u,35.8,al,36.0,au,36.0,bl,36.0,bu,35.7,cl,35.7,cu,36.3
```

**I-Server (Wichtig nicht schliessen! r wiederholt den letzten Befehl)**

**Mark6-VLBI-Monitor**

```
r  V0.997
alized value $mk6state in string eq at /usr2/oper/bin/zl
 line 537.     :  laeuft                          |  OK
c zu 1pps      :                                  |  OK
t korrekt      :                                  |  OK
det Daten      :  e-VLBI stoppedessenen!          |  OK
---------------  Mark6-System  ---------------------------
               :  laeuft                          |  OK
.....................................................|  0 %
                                                   |  e-VLBI
ler:
el:                                                |  OK
IES:                                               ULO OK
sr2/log/em135bef.log
-------------------------------------------------------------
 30.Apr. 2019     Day 120                  09:03:40
-------------------------------------------------------------
it:  q (15 sec Verzoegerung)     Feb 2016  by AK/DG/UB
```

**System Temperatur**

| Tsys | 0.0 (IFA) | | (IFB) |
|---|---|---|---|
| | 0.0 (IFC) | | (IFD) |
| BBC | Freq | Ts-U | Ts-L |
| 01 | 866.49 | 35.9 | 36.3 |
| 02 | 882.49 | 36.0 | 35.7 |
| 03 | 898.49 | 35.9 | 35.5 |
| 04 | 914.49 | 36.8 | 36.4 |
| 05 | | | |
| 06 | | | |
| 07 | | | |
| 08 | | | |
| 09 | 866.49 | 35.8 | 35.9 |
| 10 | 882.49 | 36.0 | 36.0 |
| 11 | 898.49 | 35.7 | 36.0 |
| 12 | 914.49 | 36.3 | 35.7 |
| 13 | | | |
| 14 | | | |
| 15 | | | |
| 16 | | | |

**System Status**

```
EFLSBERG        2019.120.09:03:48  UT          TEMP     9.5C 3c48        TRACKING
MODE RATE             09:06:11  NEXT          HUMID  83.17% RA  01h37m41.3s
                   SCHED=none     LOG=station  PRES  984.8mb DEC 33d09m   (2000)
                      TSYS: IFA IFB IFC IFD  CABLE 0.000000s AZ  125.8  EL  65.5
                            0   0   0   0

NO CHECK: rx
```

**Operator Input**

```
>proc=n19c1ef
>setup01
>3c48
>iread
>bread
>caltsys
>
```

**ERRORS**

DBBC

# Field System integration

Applications Places — Tue Apr 30, 9:06 AM — VLBI Operator

Field System Log

gv: /tmp/systest.ps (on Mark6-4040)

File | State | Page | Landscape | 1.000 | BBox | /tmp/systest.ps | Tue Apr 30 09:06:40 2019

Variable Size | Open | Print All | Print Marked | Save All | Save Marked | Reload

RCP 1l | RCP 1u | RCP 2l | RCP 2u
LCP 5l | LCP 5u | LCP 6l | LCP 6u
RCP 3l | RCP 3u | RCP 4l | RCP 4u
LCP 7l | LCP 7u | LCP 8l | LCP 8u

Warning: Cannot convert string "-efont-biwidth-medium-r-normal--16-*-*-*-*-*-iso10646-1,-gnu-unifont-medium-r-normal--16-*-*-*-*-*-iso10646-1,-adobe-helvetica-medium-r-normal--14-*-*-*-*-*-*-*,-jis-fixed-medium-r-*--16-*-*-*-*-*-jisx0208.1983-0,-*-*-medium-r-*--16-*-*-*-*-*-*-*,*" to type FontSet

I-Server (Wichtig nicht schliessen! r wiederholt den letzten Befehl)

Mark6-VLBI-Monitor

```
r  V0.997
alized value $mk6state in string eq at /usr2/oper/bin/zl
 line 537.     :  laeuft                          |  OK
c zu 1pps      :                                  |  OK
t korrekt      :                                  |  OK
det Daten      :  e-VLBI stoppedessenen!          |  OK
---------------  Mark6-System  ---------------------
               :  laeuft                          |  OK
.....................................................|  0 %
                                                   |  e-VLBI
ler:
el:                                                |  OK
IES:                                               |  ULO OK
sr2/log/em135bef.log
-------------------------------------------------------------
 30.Apr. 2019      Day 120                  09:06:52
-------------------------------------------------------------
it:  q (15 sec Verzoegerung)      Feb 2016  by AK/DG/UB
```

System Temperatur

| Tsys | 0.0 (IFA) | | (IFB) |
|---|---|---|---|
| | 0.0 (IFC) | | (IFD) |
| BBC | Freq | Ts-U | Ts-L |
| 01 | 866.49 | 35.9 | 36.3 |
| 02 | 882.49 | 36.0 | 35.7 |
| 03 | 898.49 | 35.9 | 35.5 |
| 04 | 914.49 | 36.8 | 36.4 |
| 05 | | | |
| 06 | | | |
| 07 | | | |
| 08 | | | |
| 09 | 866.49 | 35.8 | 35.9 |
| 10 | 882.49 | 36.0 | 36.0 |
| 11 | 898.49 | 35.7 | 36.0 |
| 12 | 914.49 | 36.3 | 35.7 |
| 13 | | | |
| 14 | | | |
| 15 | | | |
| 16 | | | |

System Status

```
EFLSBERG        2019.120.09:06:54  UT          TEMP     9.5C  3c48          TRACKING
MODE  RATE            09:11:38  NEXT        HUMID   77.57%  RA   01h37m41.3s
            SCHED=none      LOG=station   PRES  984.7mb  DEC  33d09m    (2000)
                 TSYS:  IFA  IFB  IFC  IFD  CABLE 0.000000s  AZ   127.0  EL   65.9
                          0    0    0    0
NO CHECK: rx
```

ERRORS

Operator Input

```
>caltsys
>mk5=record=test_ef_no0430
>mk5=record=on:test_ef_no0430
>mk5=record?
>mk5=record?
>mk5=record=off
>checkmk5
>pcalon
>mk5=record=on:test_ef_no0431
>mk5=record=off
```

# Field System integration

Applications Places — Tue Apr 30, 9:05 AM — VLBI Operator

**Field System Log**

```
  sample rate = 16000000 Hz
  offset = 0
  framebytes = 8032 bytes
  datasize = 8000 bytes
  sample granularity = 1
  frame granularity = 1
  gframens = 125000
  payload offset = 32
  read position = 0
  data window size = 1048576 bytes

Ch    --      -     +     ++        --      -      +     ++     gfact
 0  138368  262632  262243  136757      17.3   32.8   32.8   17.1   1.04
 1  137356  263934  262360  136350      17.2   33.0   32.8   17.0   1.04
 2  140120  261046  260263  138571      17.5   32.6   32.5   17.3   1.03
 3  152449  249598  268300  129653      19.1   31.2   33.5   16.2   1.02
 4  138858  263584  261868  135690      17.4   32.9   32.7   17.0   1.04
 5  138883  263806  261438  135873      17.4   33.0   32.7   17.0   1.04
 6  138185  263866  261590  136359      17.3   33.0   32.7   17.0   1.04
 7  139228  263236  256358  141178      17.4   32.9   32.0   17.6   1.03
 8  135818  262091  263365  138726      17.0   32.8   32.9   17.3   1.04
 9  136270  261450  263638  138642      17.0   32.7   33.0   17.3   1.04
10  135398  262259  262153  140190      16.9   32.8   32.8   17.5   1.04
11  104176  293127  250359  152338      13.0   36.6   31.3   19.0   1.09
12  135139  261104  264012  139745      16.9   32.6   33.0   17.5   1.04
13  135031  261317  263550  140102      16.9   32.7   32.9   17.5   1.04
14  135647  260682  263579  140092      17.0   32.6   32.9   17.5   1.04
15  119476  277567  263587  139370      14.9   34.7   32.9   17.4   1.08
800000 / 800000 samples unpacked
8192000 / 8192000 samples unpacked
Warning: Missing charsets in String to FontSet conversion
Warning: Cannot convert string "-efont-biwidth-medium-r-normal--16-*-*-*-*-*-iso10646-1,-gnu-unifont
-medium-r-normal--16-*-*-*-*-*-iso10646-1,-adobe-helvetica-medium-r-normal--14-*-*-*-*-*-*-*,-jis-fi
xed-medium-r-*--16-*-*-*-*-*-jisx0208.1983-0,-*-*-medium-r-*--16-*-*-*-*-*-*-*,*" to type FontSet
```

**BI-Server (Wichtig nicht schliessen! r wiederholt den letzten Befehl)**

**Mark6-VLBI-Monitor**

```
r  V0.997
alized value $mk6state in string eq at /usr2/oper/bin/zl
 line 537.     :  laeuft                          |  OK
c zu 1pps      :                                  |  OK
t korrekt      :                                  |  OK
det Daten      :  e-VLBI stoppedessenen!          |  OK
--------------  Mark6-System  ----------------------
               :  laeuft                          |  OK
.....................................................  0 %
                                                  |  e-VLBI
ler:
el:                                               |  OK
IES:                                                 ULO OK
sr2/log/em135bef.log
-------------------------------------------------------
 30.Apr. 2019      Day 120                 09:05:54
-------------------------------------------------------
it:  q (15 sec Verzoegerung)      Feb 2016  by AK/DG/UB
```

**System Temperatur**

| Tsys | 0.0 (IFA) | | (IFB) |
|---|---|---|---|
| | 0.0 (IFC) | | (IFD) |
| BBC | Freq | Ts-U | Ts-L |
| 01 | 866.49 | 35.9 | 36.3 |
| 02 | 882.49 | 36.0 | 35.7 |
| 03 | 898.49 | 35.9 | 35.5 |
| 04 | 914.49 | 36.8 | 36.4 |
| 05 | | | |
| 06 | | | |
| 07 | | | |
| 08 | | | |
| 09 | 866.49 | 35.8 | 35.9 |
| 10 | 882.49 | 36.0 | 36.0 |
| 11 | 898.49 | 35.7 | 36.0 |
| 12 | 914.49 | 36.3 | 35.7 |
| 13 | | | |
| 14 | | | |
| 15 | | | |
| 16 | | | |

**System Status**

```
EFLSBERG        2019.120.09:05:59  UT          TEMP     9.6C 3c48        TRACKING
MODE RATE             09:10:30     NEXT        HUMID  80.15% RA  01h37m41.3s
                   SCHED=none      LOG=station PRES  984.7mb DEC 33d09m    (2000)
                      TSYS: IFA IFB IFC IFD  CABLE 0.000000s AZ  126.7  EL  65.8
                            0   0   0   0

NO CHECK: rx
```

**ERRORS**

**Operator Input**

```
>setup01
>3c48
>iread
>bread
>caltsys
>mk5=record=test_ef_no0430
>mk5=record=on:test_ef_no0430
>mk5=record?
>mk5=record?
>mk5=record=off
```

# DBBC2 resources

- DBBC2 software, firmware and documents:
  http://www.hat-lab.com (until 2018)
  https://www.hat-lab.cloud
- DBBC2 installation, testing, and operational notes:
  https://deki.mpifr-bonn.mpg.de/Working_Groups/EVN_TOG
  https://deki.mpifr-bonn.mpg.de/GMVA