

DBBC3 the new wide-band backend for VLBI



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DBBC3: Introduction

- **DBBC3** has been developed with support by RadioNet3 in the Joint Research Activity **VIVA** — partners: INAF, MPIfR, OSO
- **DBBC3** is a VLBI backend for **astronomy**: EVN wide-band, mm-VLBI, EHT... & **geodesy**: VGOS, legacy S/X
- **DBBC3** is the successor of the DBBC2, the most widely adapted digital VLBI backend.
- **DBBC3** is **backwards compatible with the DBBC2** — observing modes, control, and some of the hardware.
- **DBBC3** offers from **1 IFs to 8 IFs** on input with **16 Gbps to 128 Gbps** on output (2-bit samples; max 256 Gbps | 8-bit samples up to 512 Gbps)
- **Status: in production**
- **Commissioned modes:**
 - **DSC: 4 GHz wide** (no sub-bands)
 - **DDC: 8 BBCs/IF;** **DDC_Legacy = DBBC2** (in 4 GHz);
 - **OCT_S: 1 GHz selectable** in 4 GHz; **OCT_D: 2x 2GHz** in 4 GHz
- **AIM:** large effort in firmware to establish compatibility with all other existing VLBI backends (largely achieved already!)

Different modes available or under development (Firmware):

For each FPGA processing board (CORE3H; 2-8 per DBBC3):

- DSC: Whole 4 GHz band sampled w/o sub-bands
- DDC: Digital Down-Converter – digital filter and mixer 2 to 32 MHz sub-bands power of 2.
 - DDC-L: 16 BBC/CORE3 (U&L) 2-4-8-16 MHz tunable in 4GHz
 - DDC-V: 12 BBC (U&L) full 32MHz tunable in 4GHz
 - VGOS: 24 bands 32 MHz PFB block tunable in 4GHz
- OCT: wide-band band selection from 4 GHz
 - OCT1: 0-2, 2-4 GHz
 - 0-1, 1-2, 2-3, 3-4 GHz
 - 0.5-1.0, 1.0-1.5,, 3.5-4.0 GHz
 - OCT2: 2 filters as above per IF, output on different streams
 - 2x 2GHz for EHT 90% commissioned
- Automatic threshold calibration for 2-bit output during runtime
- Under development:
 - DDC: 16 bbc (U&L) tunable full 64-32-16-8-4 MHz in 4GHz
 - 32 bands tunable 64-32-16-8-4 MHz PFB block in 4GHz

DBBC3:

Front view.



DBBC3:

VGOS model: 8 IFs with 8 groups of ADB3 samplers and CORE3 processing boards. (see block diagram below)

The chassis is identical with the DBBC2 chassis.

This unit can deliver 128 Gbps @ 2-bit

(output limit is 512 Gbps)



DBBC3 components:

GCOMO: analogue conditioning module

- Has been replaced with GCoMo2 (second version with improved bandwidth response over 4 GHz)
- Match the receiver to the ADB3L, with a lot of flexibility, internal and external.
 - Measure and control the power before sending the signal to the sampler ADB3L
 - Takes pre-filtered signal up to 4 GHz in range 0 GHz – 4 GHz
 - If the signal is not in the first Nyquist zone (0 - 4 GHz) mix the receiver band down to the first Nyquist zone. This can be done with a piece of 4GHz taken in any position in the range 4-15 GHz.
 - Does gain, filtering, and impedance matching at 4-12 GHz before downconversion and 0-4 GHz after downconversion

ADB3L: Sampler module

- Performs interleaved sampling with 4 sampler chips per board
- Calibration of offset, gain and delay of the 4 sampler chips to prevent artefacts with calibration procedure
- Calibration with noise source or stable noise input from receiver
- Control software provides simple commands for each calibration step

CORE3H: FPGA processing board

- Processing board with single powerful FPGA, with output over 4x optical port @10 GE
- Firmware: Different modes (see text box above)
- Control via command set similar to DBBC2

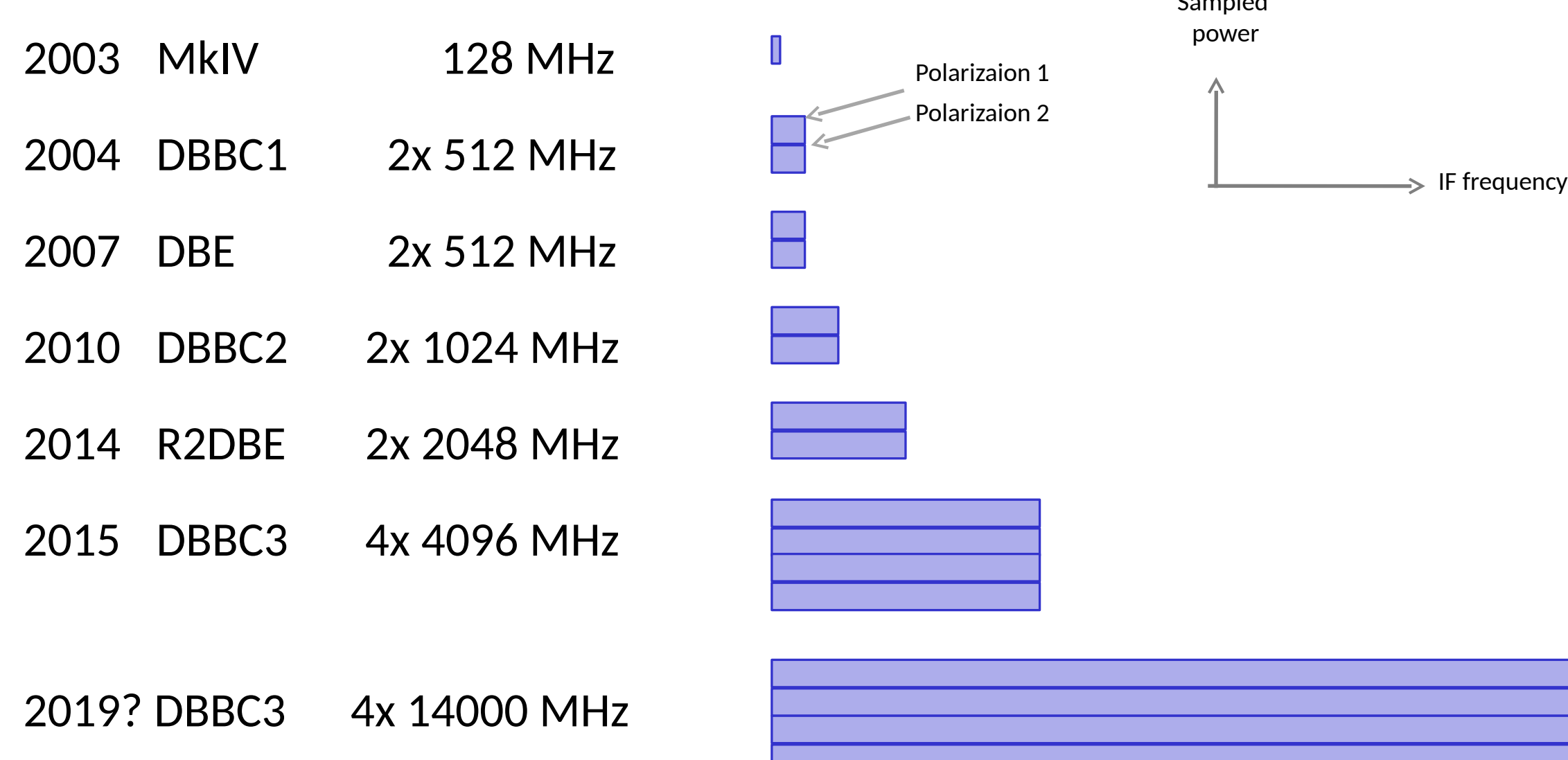
Production status:

- 14 DBBC3 operational: mostly for VGOS, 2x EHT, 3x EVN
- 2 systems under construction

Increase of sampling rates

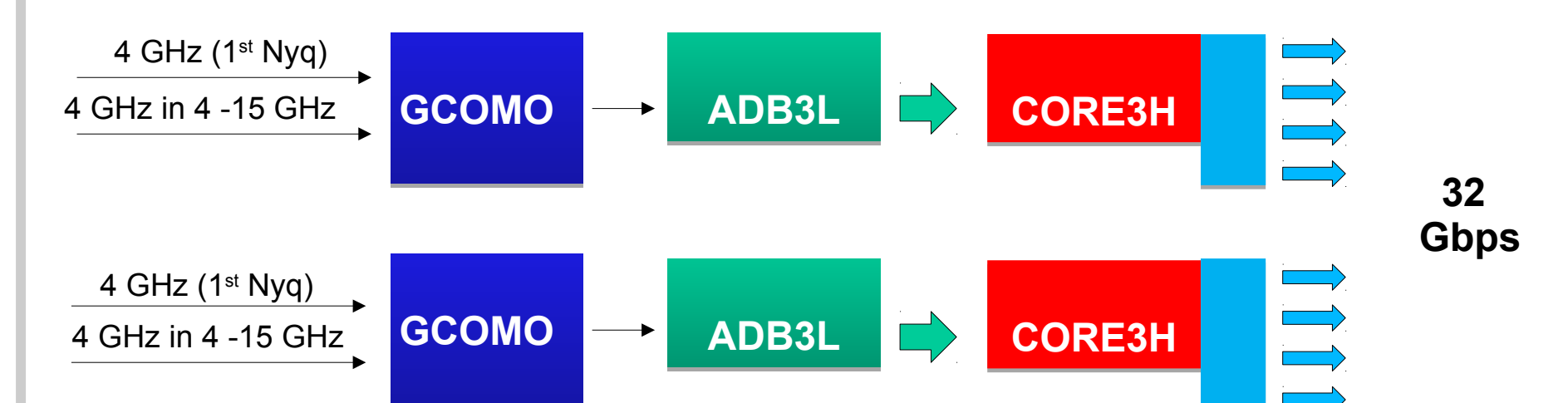
Since about 2003 the sampling rates in VLBI backends has doubled roughly every 1.6 y.

The DBBC3 backend for the BRAND receiver will be ready in 2019/2020 with 2x 14 GHz of bandwidth



EVN model:

- 2 IFs w. 4GHz
- Analogue conditioning module
- Sampler
- Processing
- 32 Gbps out
- 2x4x10 GbE



VGOS (full):

- 8 IFs w. 4GHz
- Analogue conditioning module
- Sampler
- Processing
- 128 Gbps out
- 8x4x10 GbE
- EHT model has only 4 IFs with 64 Gbps output

