

DBBC4

A NEXT GENERATION VLBI BACKEND

Helge Rottmann on behalf of the DBBC4 team



DBBC4 OVERVIEW & SPECS



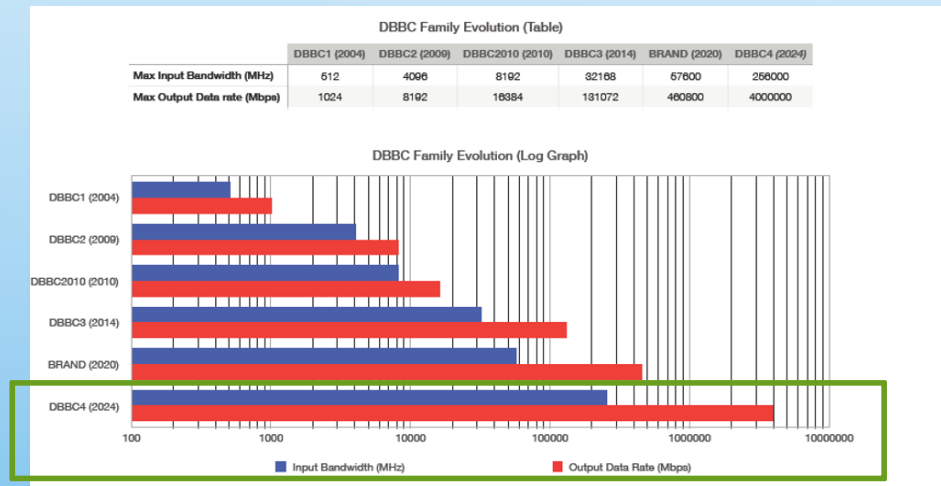
The DBBC4 is the latest of the DBBC family of backends (DBBC, DBBC2, DBBC3)

Technical specs:

- Maximum input bandwidth: $8 \times 28\text{GHz} + 8 \times 4\text{GHz} = \mathbf{256\text{ GHz}}$
- Maximum output data rate: **1 Tbps** @ 2bit sampling

Novel capabilities:

- AI methodology:
 - Real-time interference mitigation
 - Transient search
- Output stream buffering, duplication and modification
 - Burst mode operations (match output data rate to recording rate)
 - Signal streaming to correlators for real-time fringe verification



DBBC4 DESIGN GOALS



Future proof approach

- Wide band RX / frequency agility
- Interference mitigation
- Matching of high output data rate to lower recording rates (burst mode)
- Support analogue or digital input signals

Scalability

- scalable design of 1 - 4 dual-polarization signal chains (max. 8 IFs)

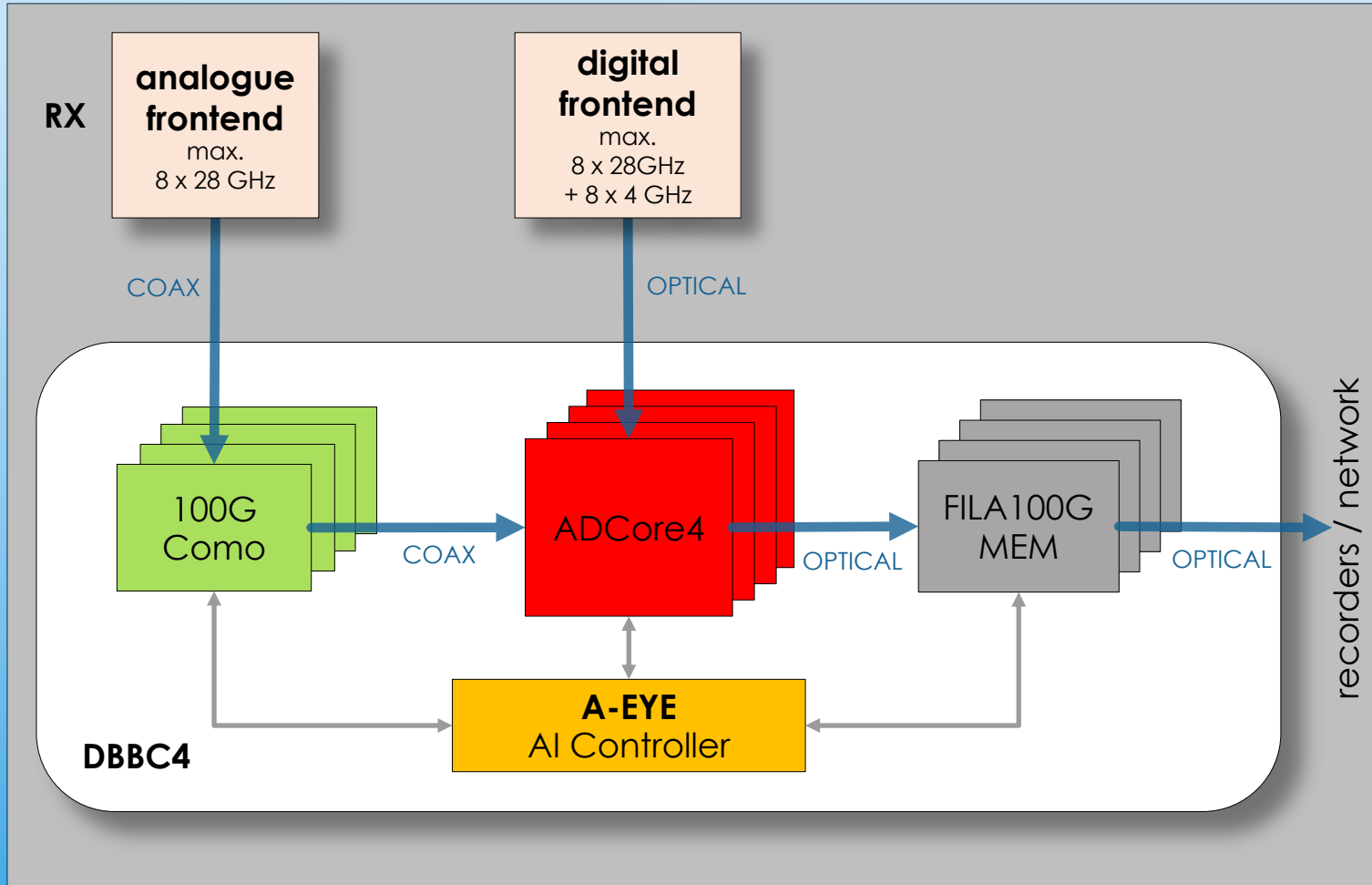
Versatility

- Support EHT, GMVA, EVN, legacy geodesy, VGOS, etc. observing modes

Compatibility

- Downwards compatible with DBBC3

SYSTEM SCHEMATICS



Modular design:

1 – 4 signal chains

Two operational scenarios*:

1) Analogue-in

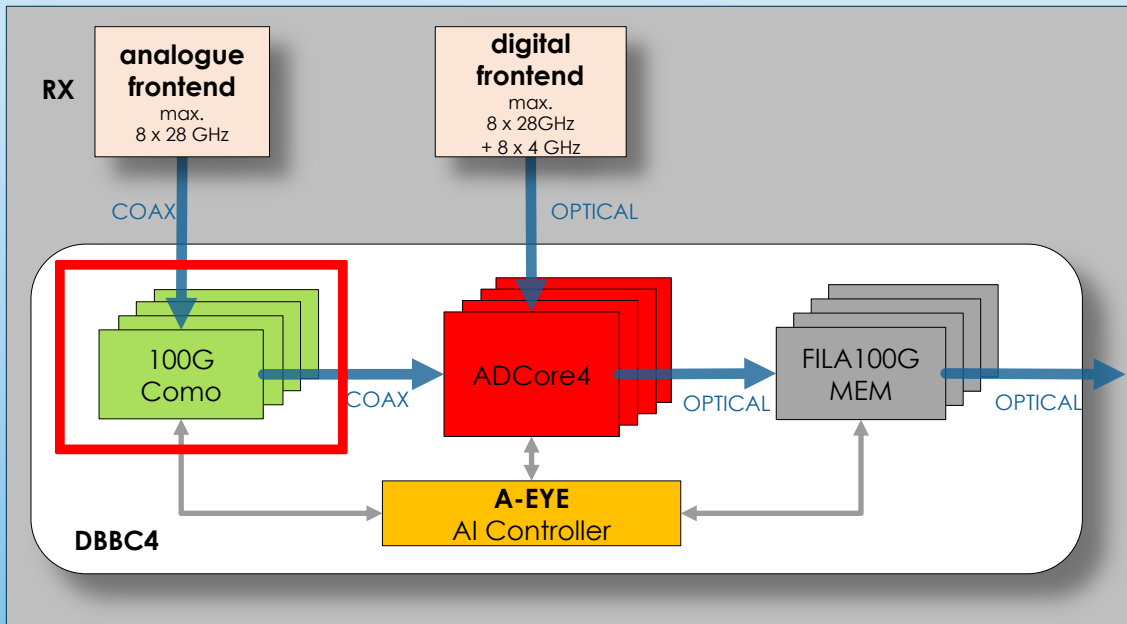
- Sampling of 2 x 28 GHz
- Analogue conditioning

2) Digital-in

- 2 x 28 GHz
- 2 x 4 GHz bw (in range 0-36 GHz)

* Input bandwidth per signal chain. Max 8x28GHz.

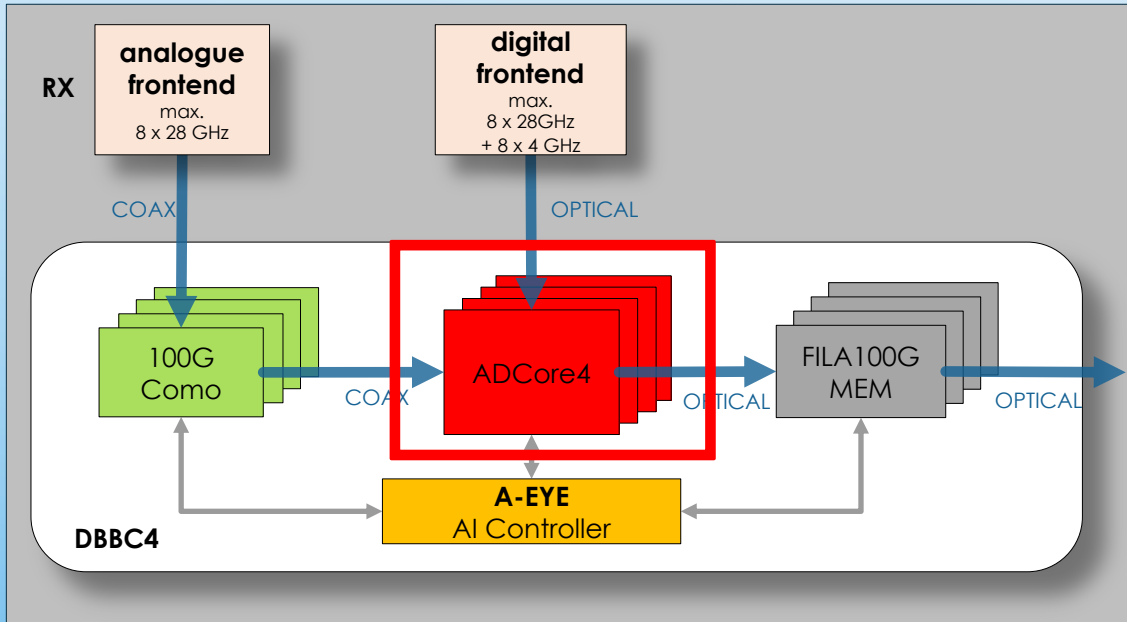
100G COMO



- Analogue conditioning module
- Adapt the analogue input signal for the digital conversion steps in the ADCore4 board.
- Automatic gain control (AGC) for optimal 2bit sampling
- Measures total power e.g. for Tsys calibration
- Supports 80Hz noise diode switching for Tsys calibration

- Each 100GComo module processes an input IF band width of 2 x 28 GHz
- A DBBC4 can have up to 4 x 100GComo modules

ADCORE4

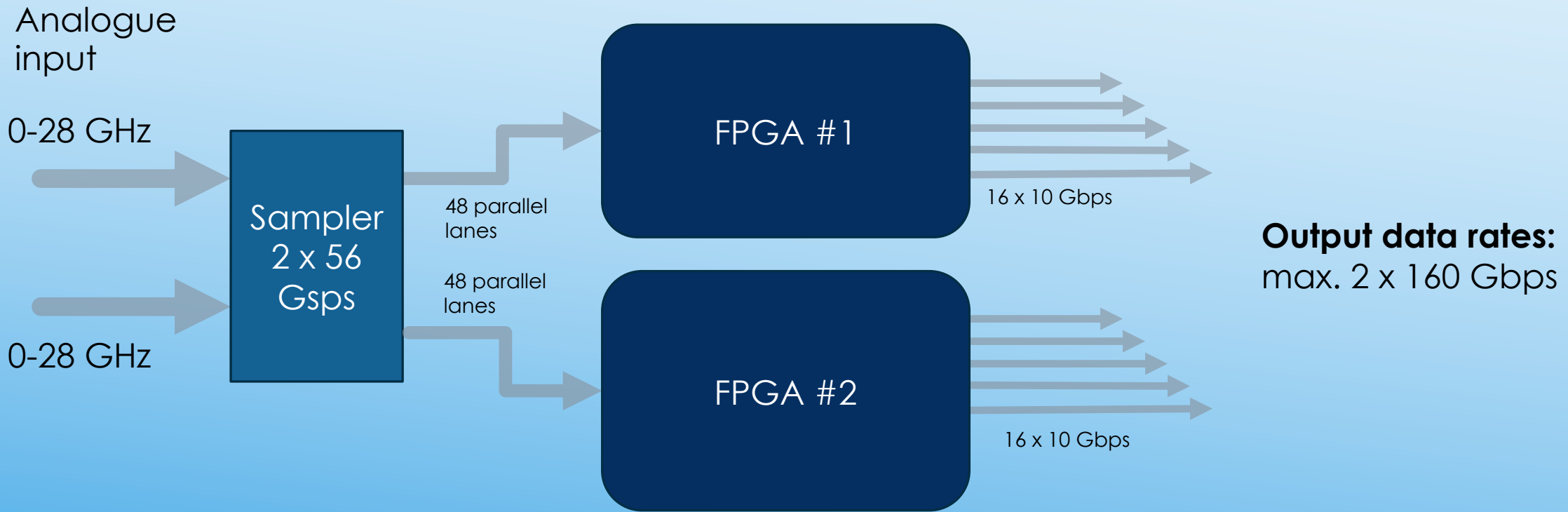


- A/D conversion with **2x56 Gsps @8bit**
- band processing in various modes
- VDIF formatting

Processing modes

- **DSC**
full 28GHz, direct sampling
- **OCT**
full 28 GHz divided into sub-bands
4 filters of sizes:
225, 450, 900, 1800, 3600, 7200, 14400 MHz
- **DDC**
tunable with sub-bands of various band widths:
3.5, 7, 14, 28.1, 56.25, 112.5 MHz

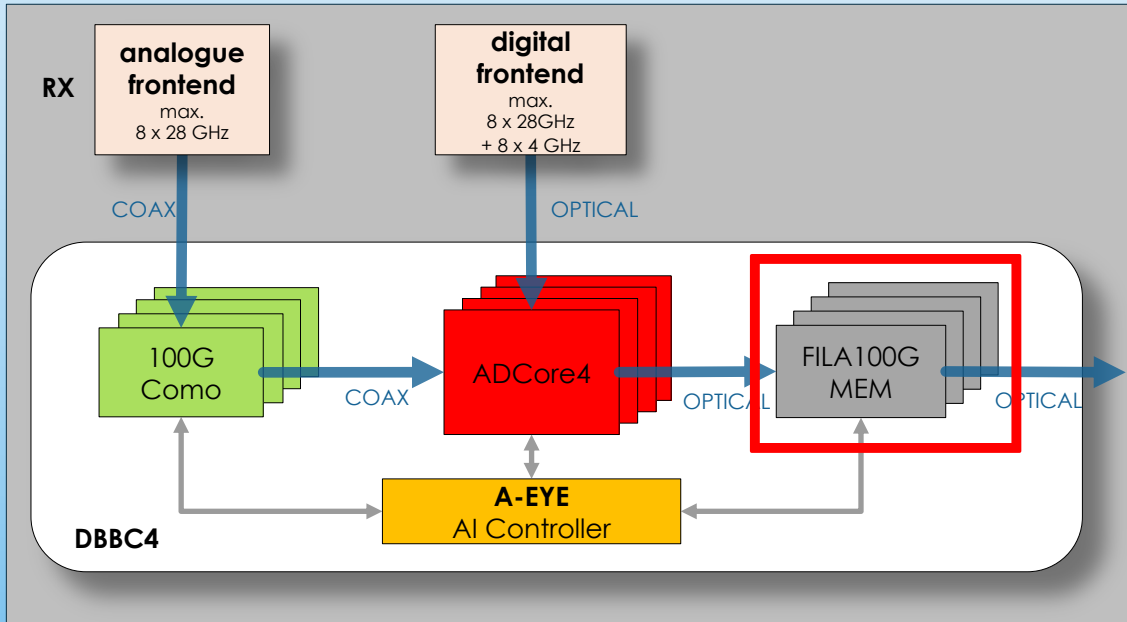
CORE4 “ANALOGUE-IN” MODE



CORE4 “DIGITAL-IN” MODE



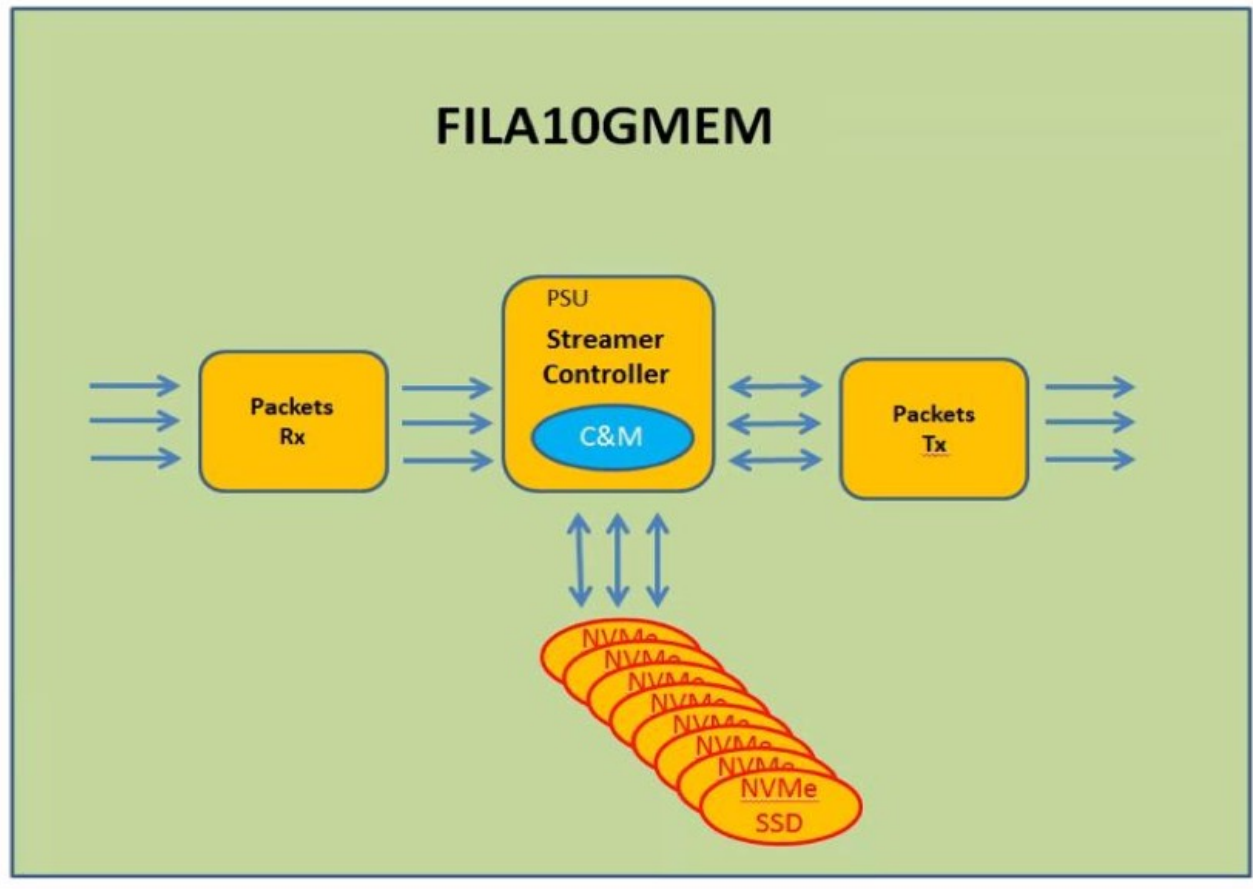
FILA 100G MEM



- Fast buffered memory for storage of output streams
- Fast recording onto NVMe/SSD
- Time delayed off-loading of broadband data to recorders (burst-mode recording)
- Output stream duplication e.g. for real-time fringe verification at correlators
- Stream manipulation: re-ordering and extraction of channels

Current recorder: 16 Gbps

FILA100GMEM SCHEMATICS



Stream controller

- channel manipulation / reordering

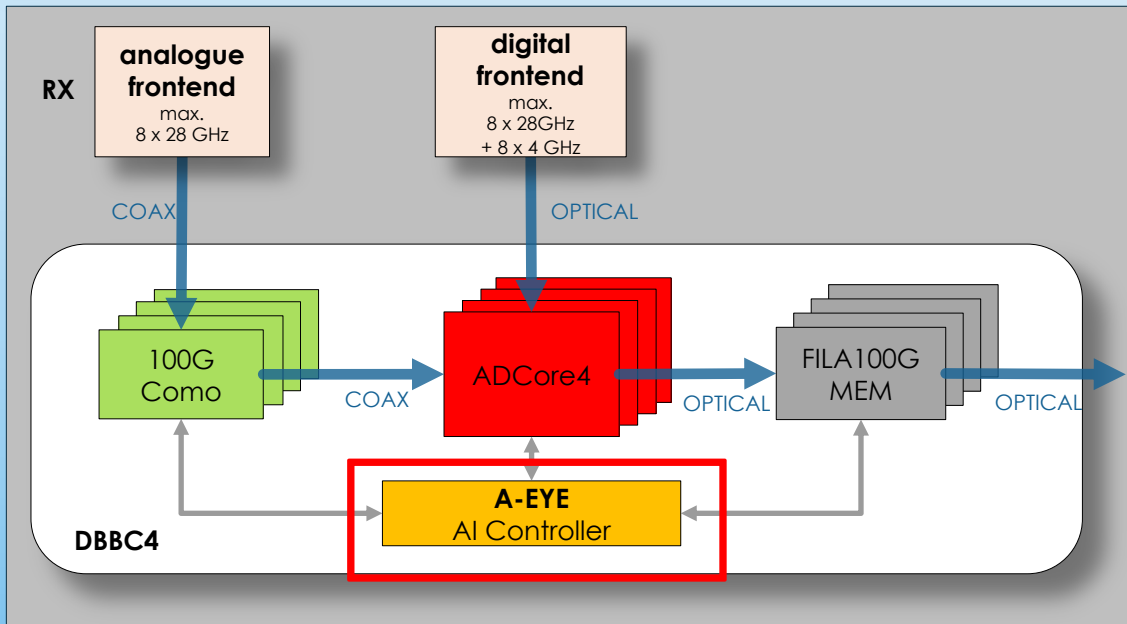
Module can accommodate a variable number of SSD/NVMe units

Example:

7 TByte = 8 min recoding @112Gbps

8 minute = typical calibration/pointing scan gap in VLBI

A-EYE CONTROLLER



implements artificial intelligence (AI) methodology for e.g.:

- RFI recognition and mitigation
- Extraction of non-statistical noise signals (transient search)
- multi-CPU FPGA device
- synthesizes pre-trained neural networks in a hardware DNN (deep neural network).
- interfaces to other DBBC4 components, e.g. for interference blanking

DIFREND28 / DIFREND4T



Digital frontend components to support “digital-in” mode

- Optional devices
- Required when analogue transport of broad band IFs is not possible /wanted

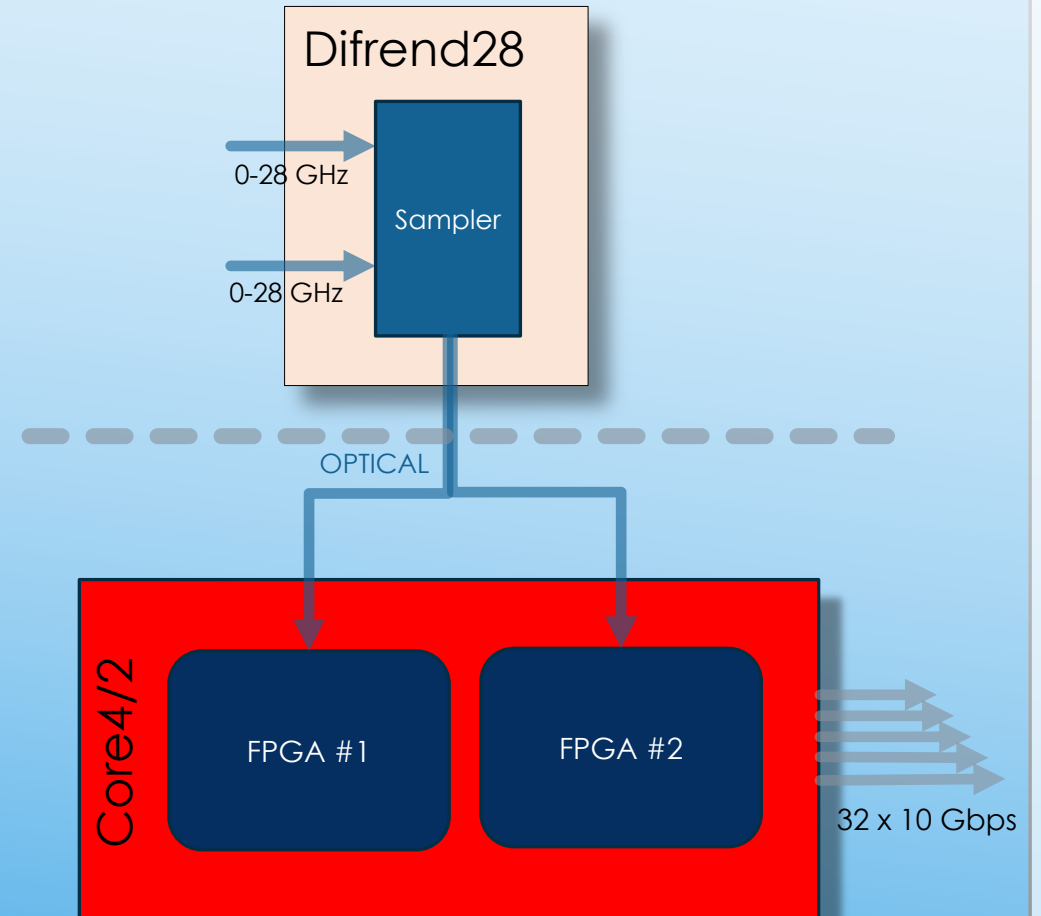
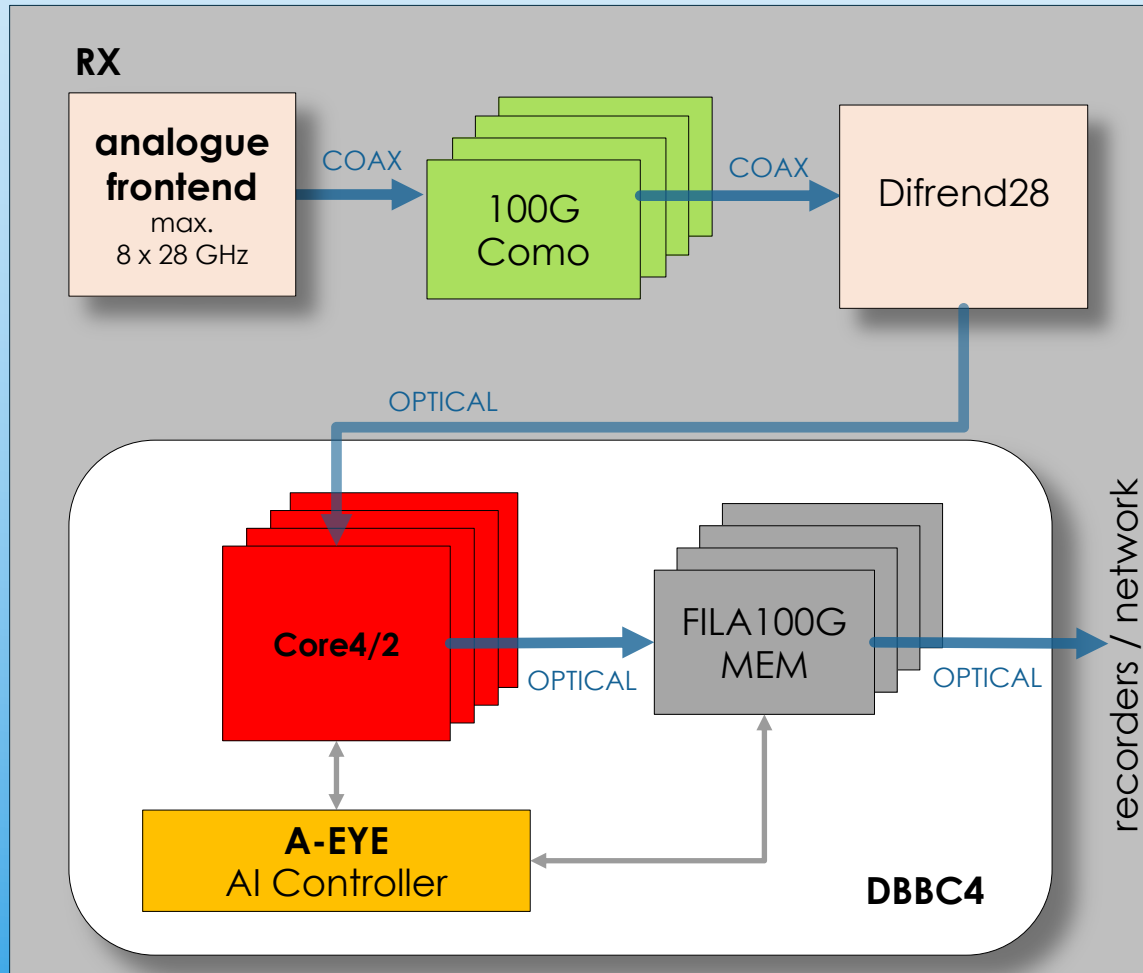
Difrend28

- Input bandwidth: 2 x 28 GHz
- Sampling at 2x56 Gsps @8bit
- Output data rate: 96 lanes@11.2Gbps = 1Tbps

Difrend4

- Input bandwidth: 2 x 4 GHz band width (in the range 0-36 GHz)
- Sampling rate 2 x 8 Gsps @ 12bit
- Output data rate: 64 Gbps
- VDIF formatting

DIFREND28 SETUP



RADIOBLOCKS PROJECT

A DBBC4 demonstrator will be realized within the RadioBlocks project

Deliverable:

D3.7 (month 48): DBBC4 design and implementation report

