DUNE Timing System

How much space do we need underground?
**(All graphics and info from https://edms.cern.ch/project/CERN-000210277)**

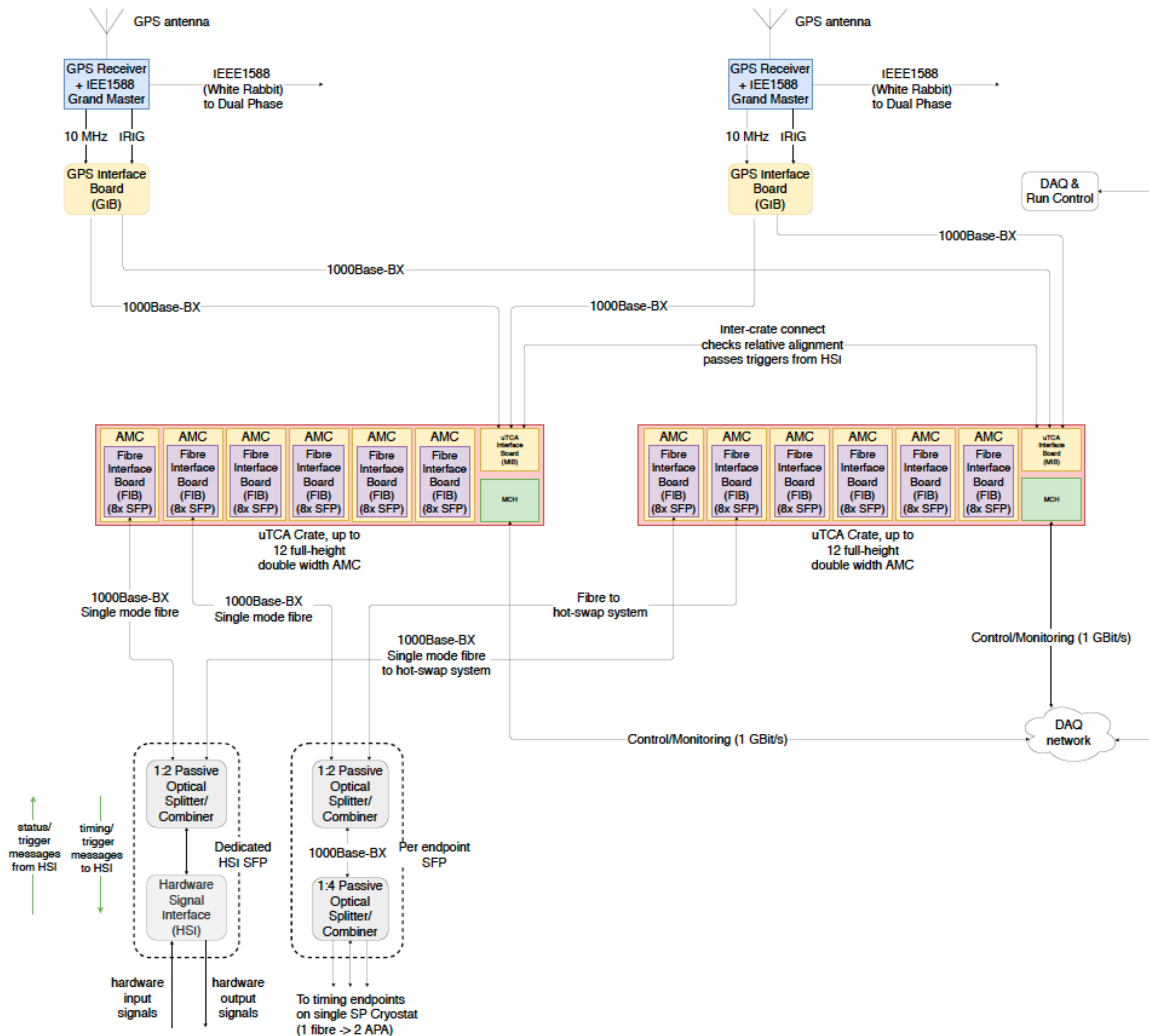**Linda Cremonesi - 9th October 2020**

DUNE FD Timing System

- GPS Interface Board (GIB) receives a high-quality 10MHz clock, and a serial Inter-Range Instrumentation Group (IRIG) signal (UTC encoded within it)

- The GIB generates the timestamp and encodes it into periodic synchronisation messages. These messages are transmitted to each sub detector over a single mode optical fibre, using the DTS-SP protocol.

- The 62.5MHz clock is embedded within the data stream.
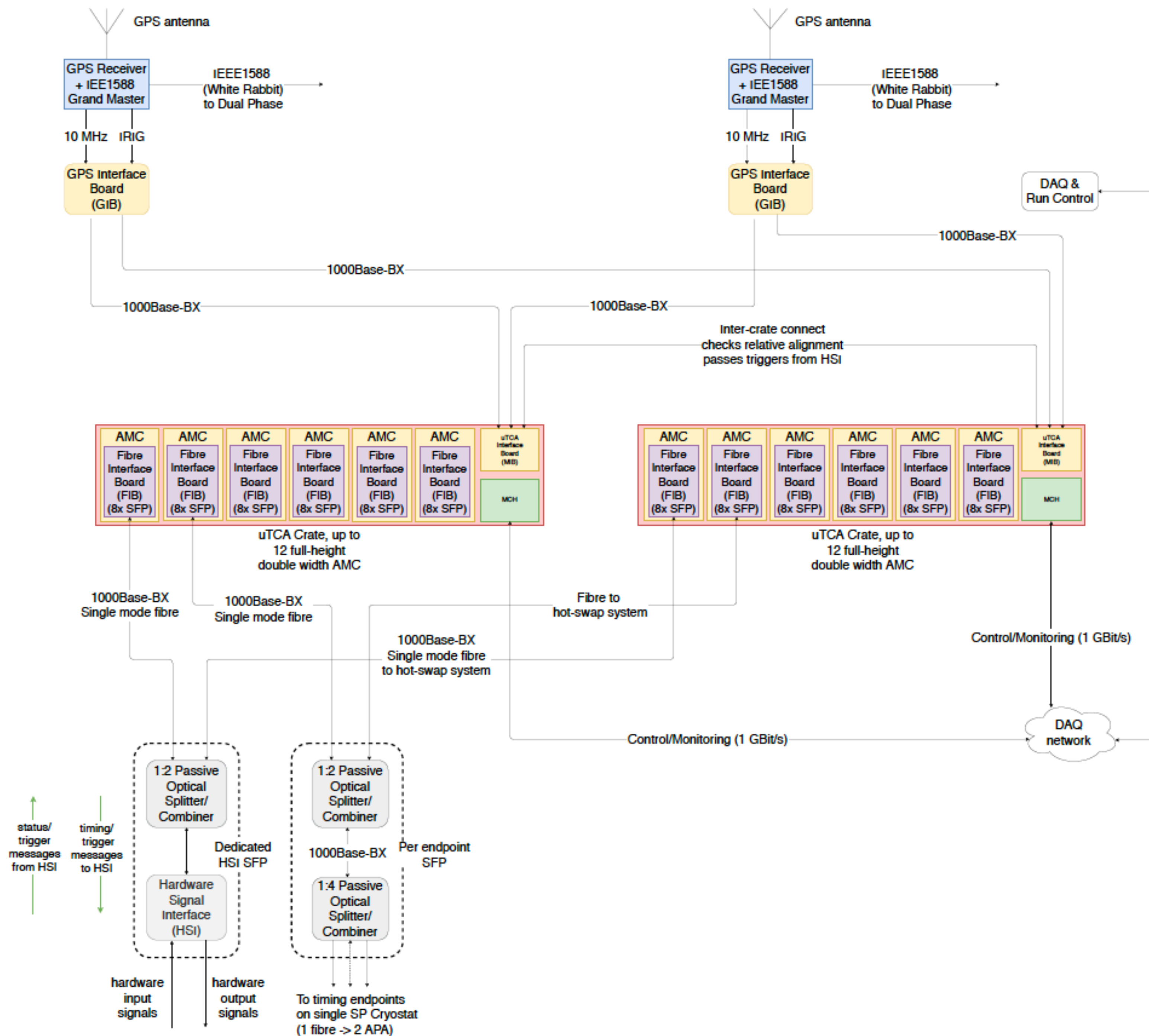
DUNE FD Timing System
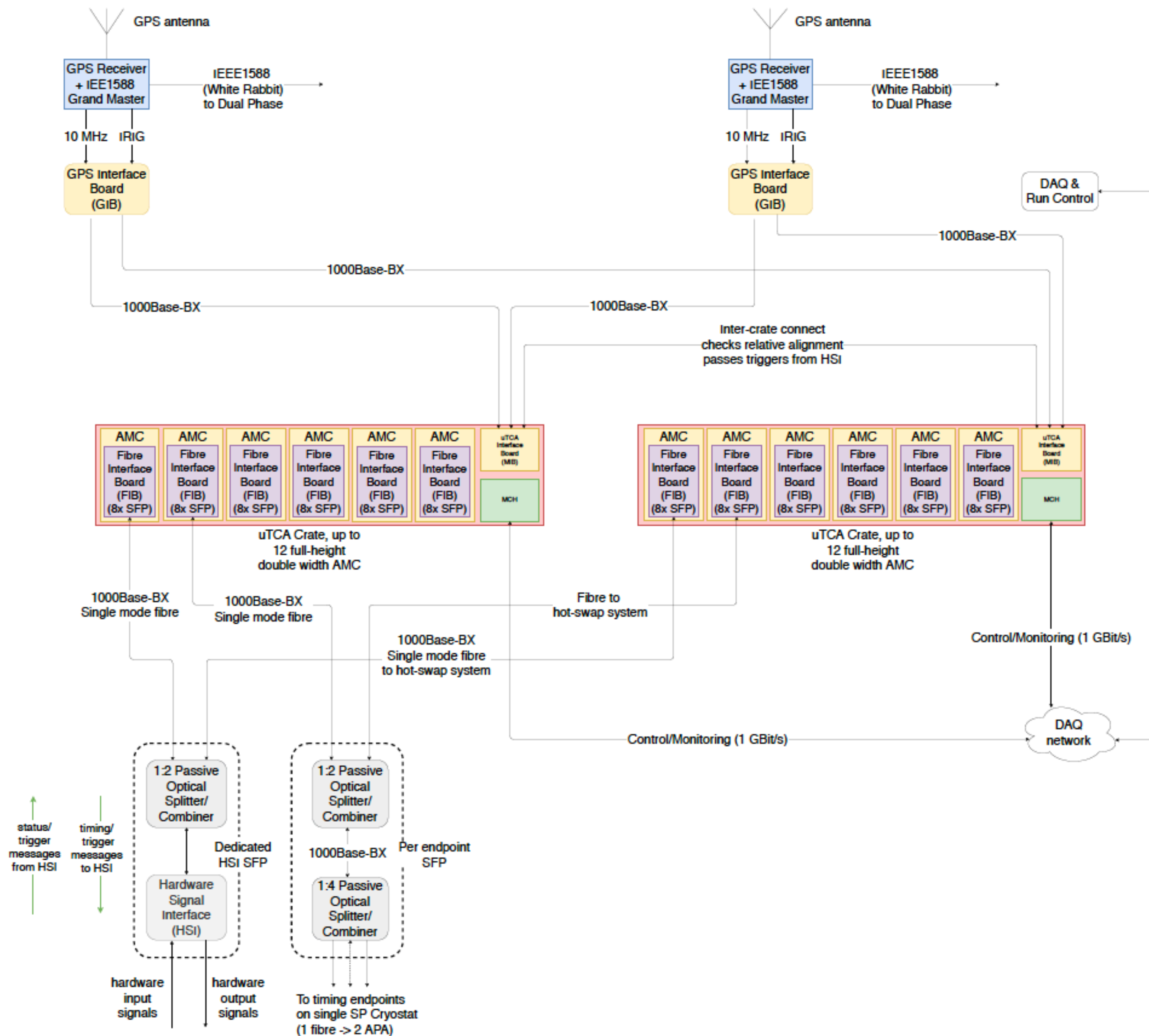
- The data stream at each SP module is received, and decoded into separate clock and data signals by a uTCA Interface Board (MIB).

- The MIB also receives external signals from the calibration system, and beam spill information.

- The MIB multiplexes synchronization and other timing messages, along with user-defined message sequences generated by software, into a single data stream.
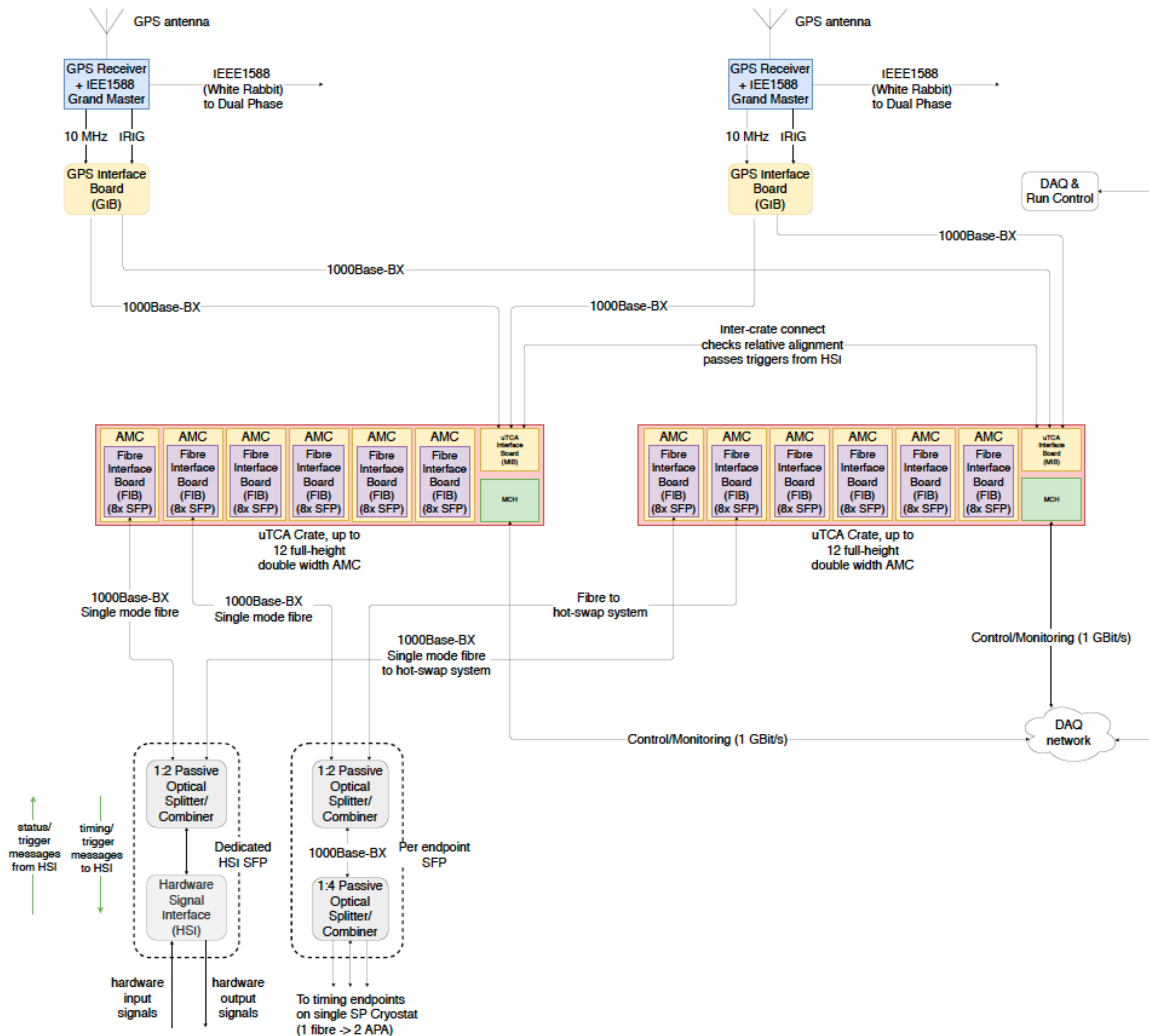
DUNE FD Timing System

- MIB distributes recovered clock and data stream to the Advanced Mezzanine Cards (AMCs)

- The clock and timing data are fanned out to the AMCs over the uTCA backplane.

- The AMCs are the carriers of the Fibre Interface Boards (FIBs), which are FPGA Mezzanine Cards (FMCs).

- The FIBs are used to broadcast the timing data stream to each timing endpoint, using single mode optical fibres.
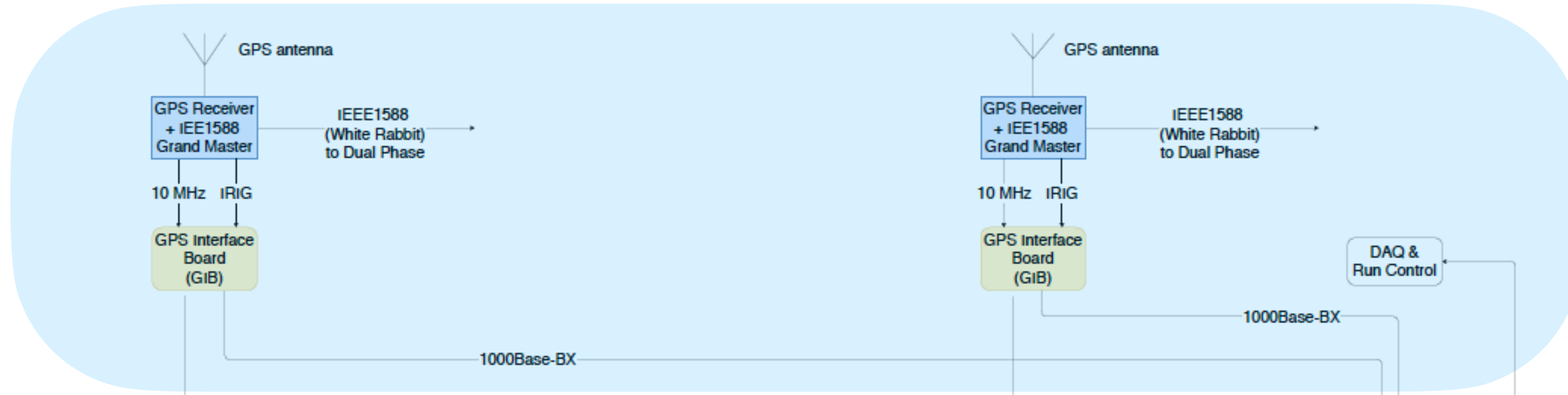
DUNE FD Timing System

- Each FIB has eight Small Form-Factor Pluggable (SFP) transceiver modules. A uTCA crate can host up to 12 AMCs for a total of 96 SFP interfaces.

- These Hardware Signal Interface (HSI) units contain a timing endpoint, which receives clock and synchronization signals from the timing system and acts as a source of DTS-SP messages.

- These messages are received by the FIB, transmitted to the MIB and then can be broadcast to the entire detector module.
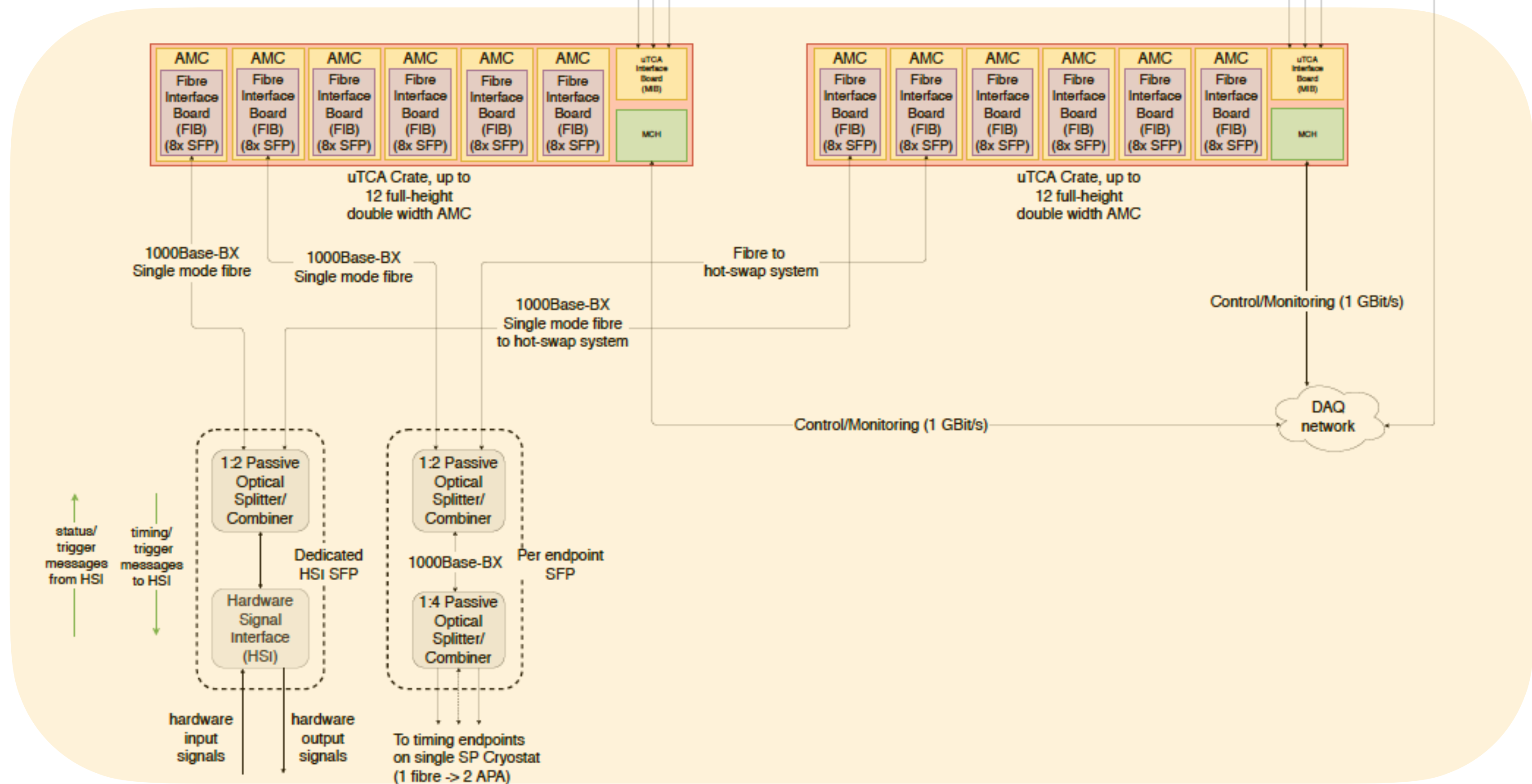
DUNE FD Timing System

- The serial timing data stream is decoded at each endpoint into separate clock and data signals.

- A uniform phase-aligned cycle counter, updating at the DTS-SP frequency of 62.5MHz, is maintained at all endpoints, allowing commands to take effect simultaneously at all endpoints regardless of cable lengths or other phase delays.
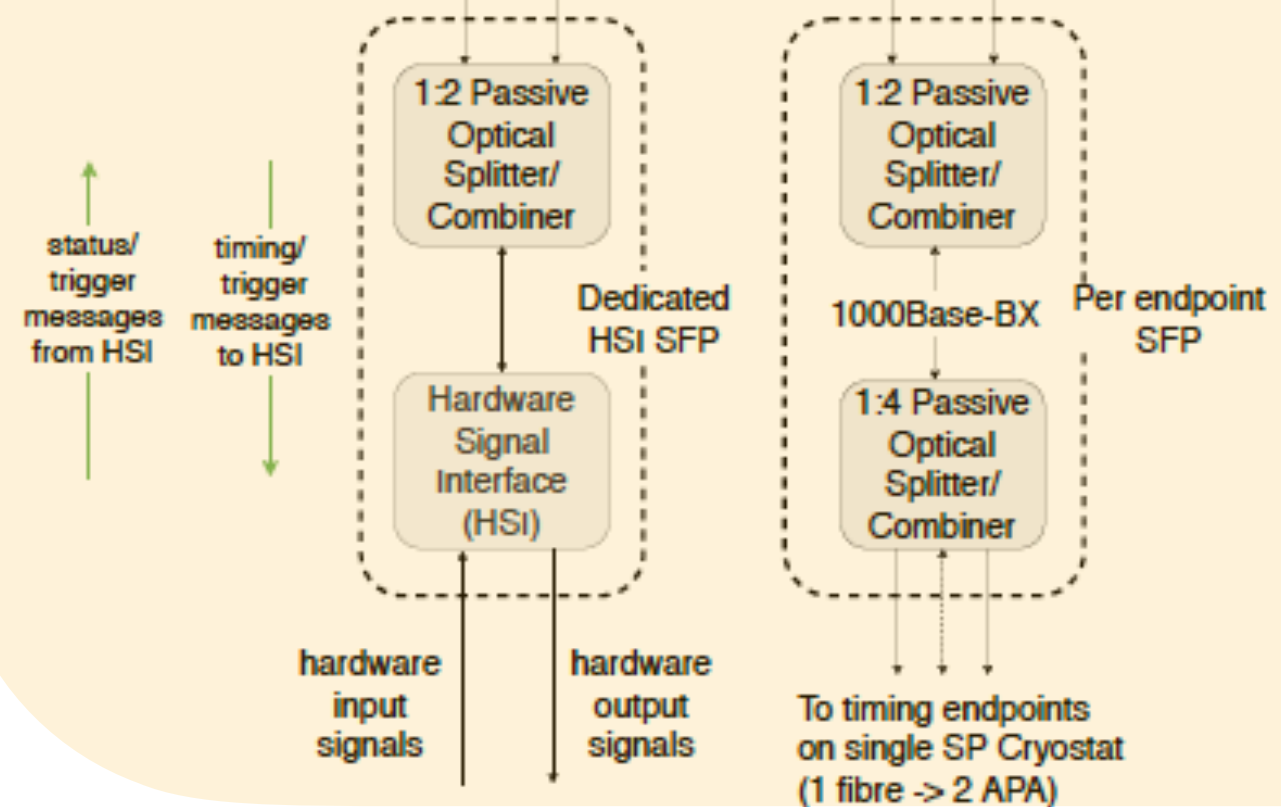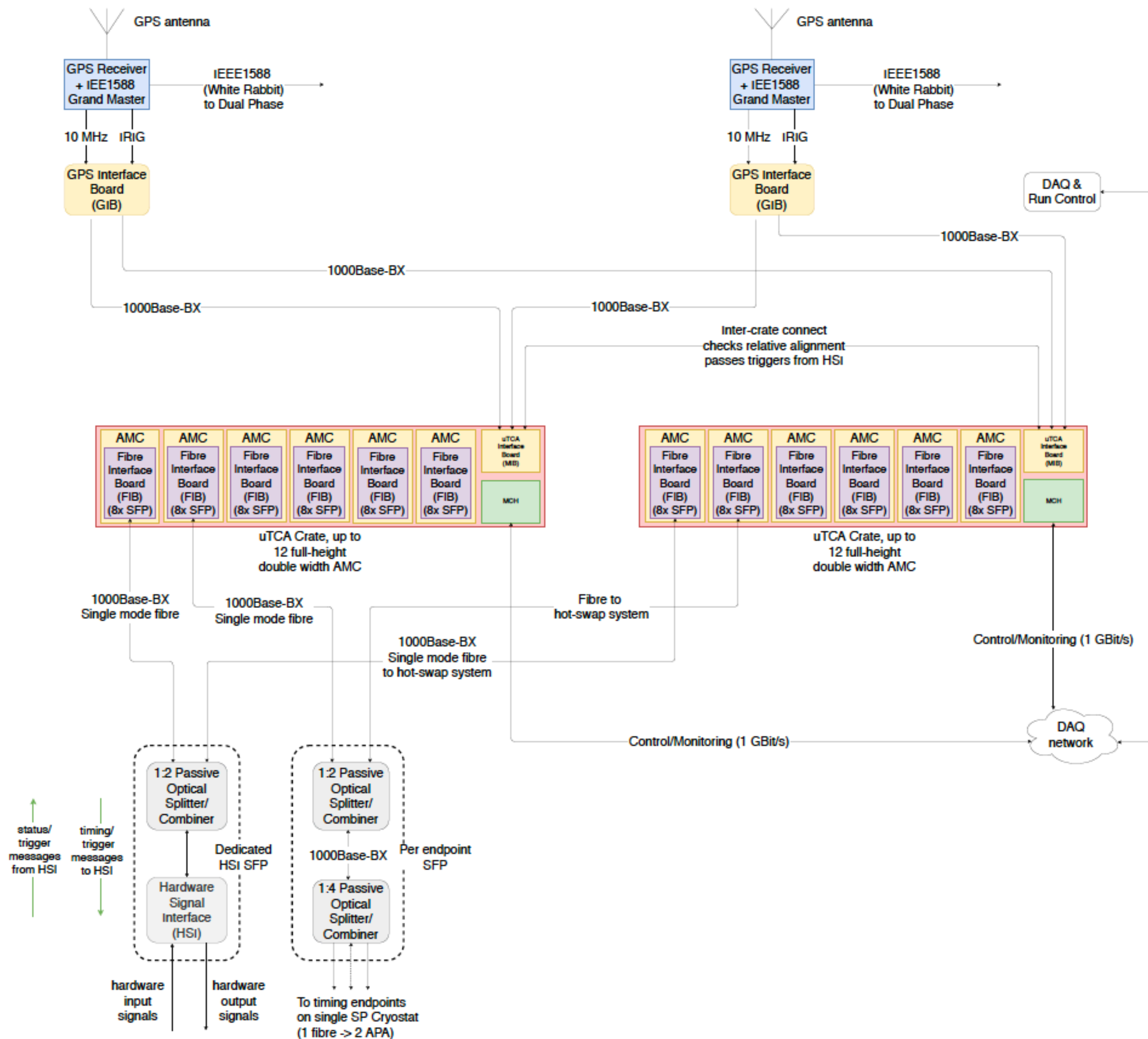
DUNE FD Timing System

DUNE FD Timing System

Redundancy

- Two independent GPS systems (from 2 shafts)

- Both feed 2 independent uTCA crates

- One unit can be left as hot spare for testing new firmware/software

- Coming from uptime requirement

How much space do we need?

- 1 uTCA -> up to 12 Advanced Mezzanine Cards (AMCs)

- 1 AMC -> 1 Fibre Interface Board (FIB) -> 8 Small Form-Factor Pluggable (SFPs) transceiver modules

- 1 SFP can serve 1 fibre coming from hardware trigger, or 4 fibres coming from detectors (using 1:4 optical splitter/combiner)

- 1 uTCA -> 96-384 fibres (more than enough !)
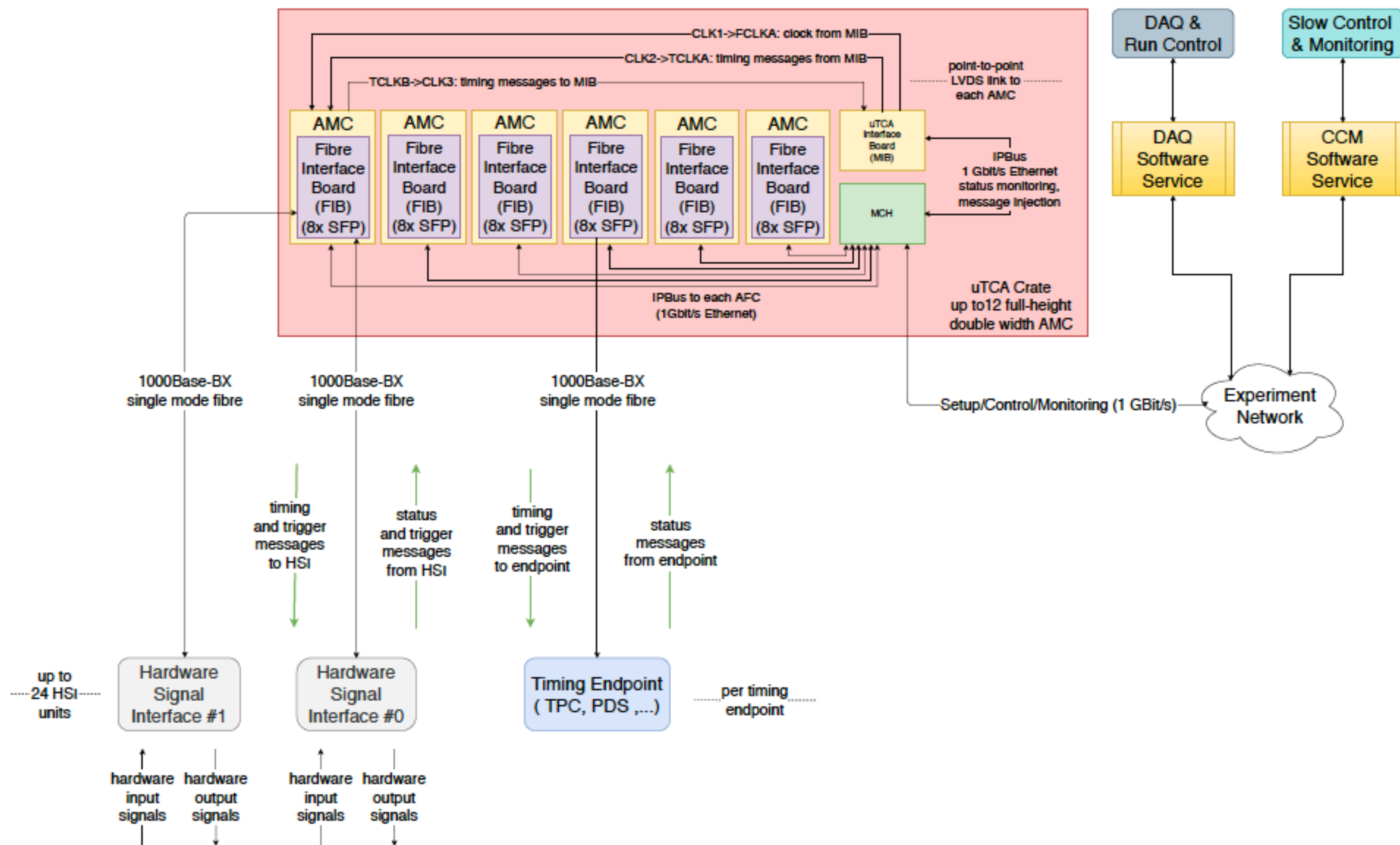
- If we want redundancy though we will need 2

GPS Interface Board (GIB)
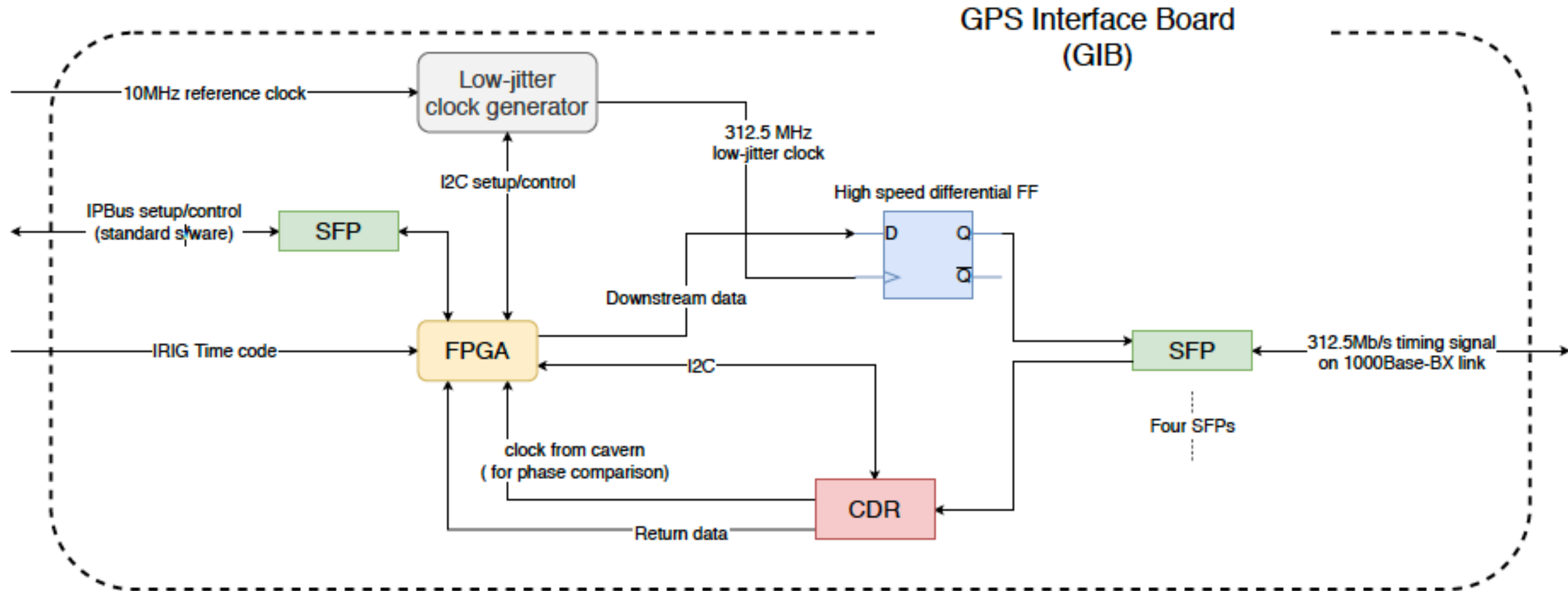
uTCA Interface Board (MIB)
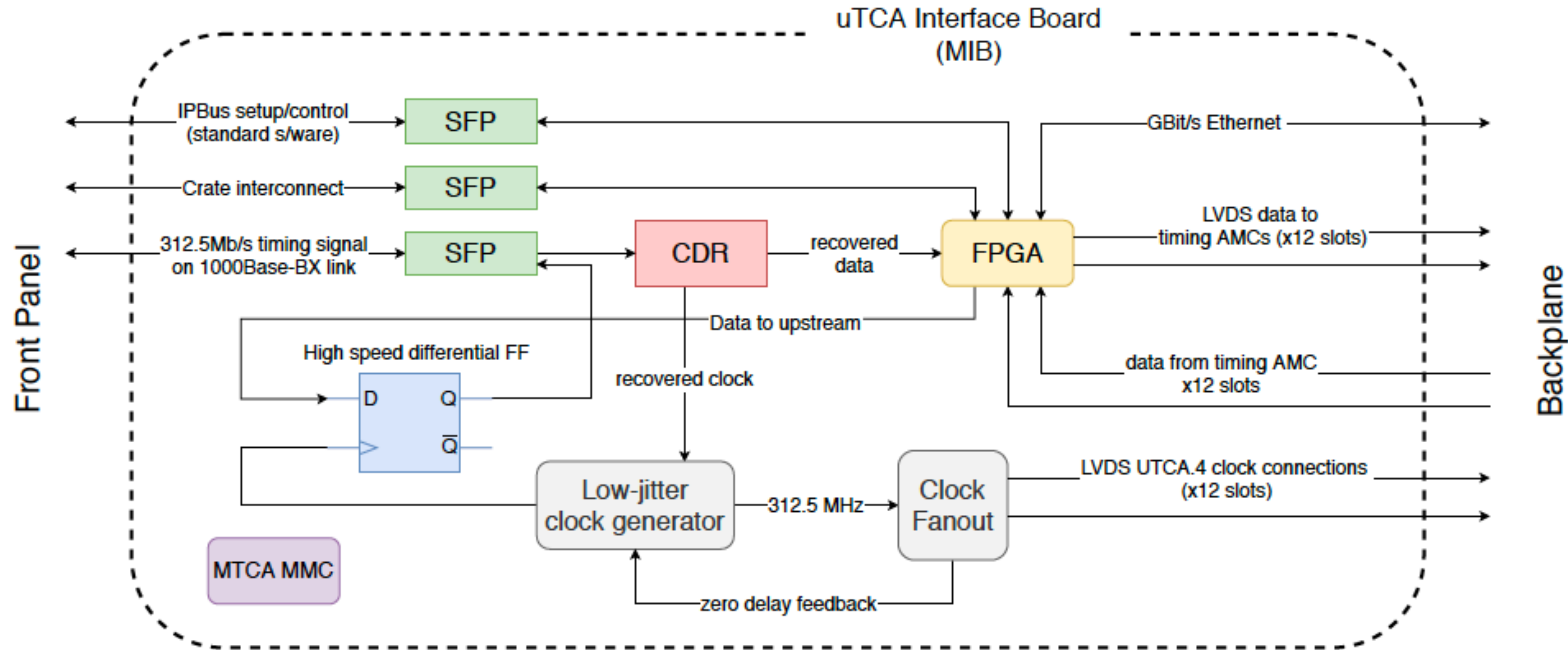
Connections between MIB and AMC in uTCA crate

FIB components