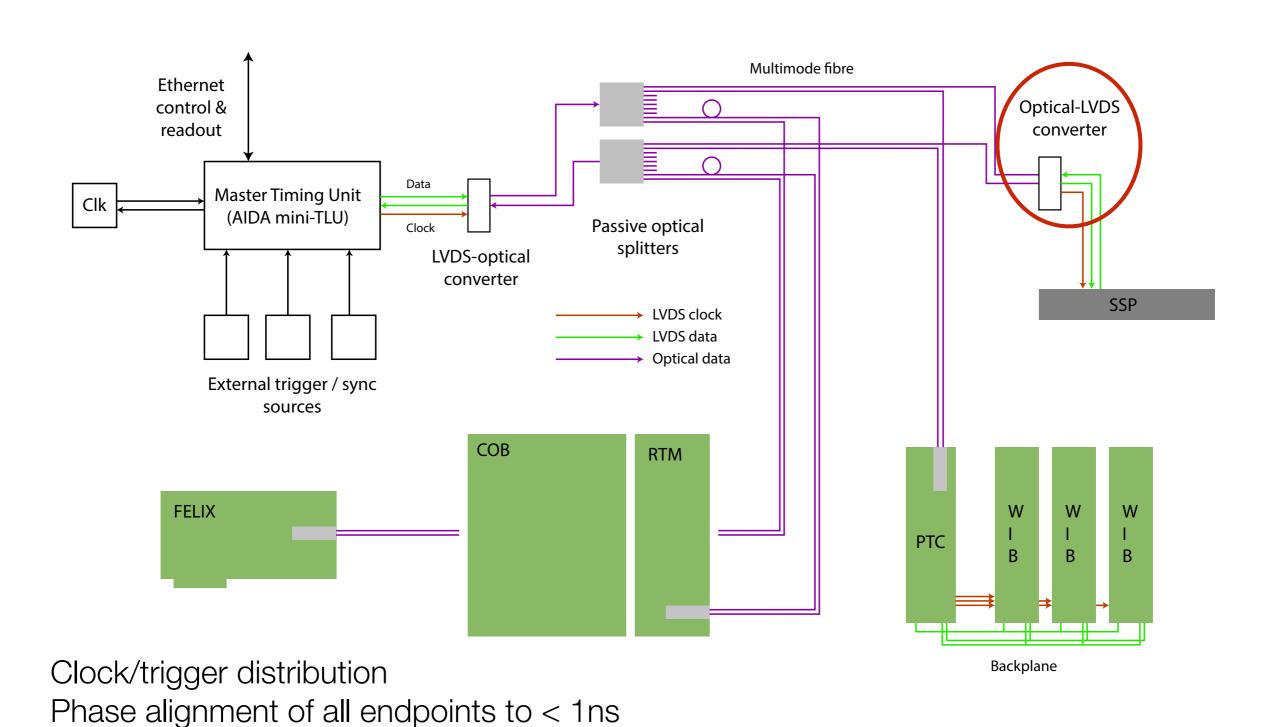# Integration with LHC/CMS

J. Brooke, J. Goldstein

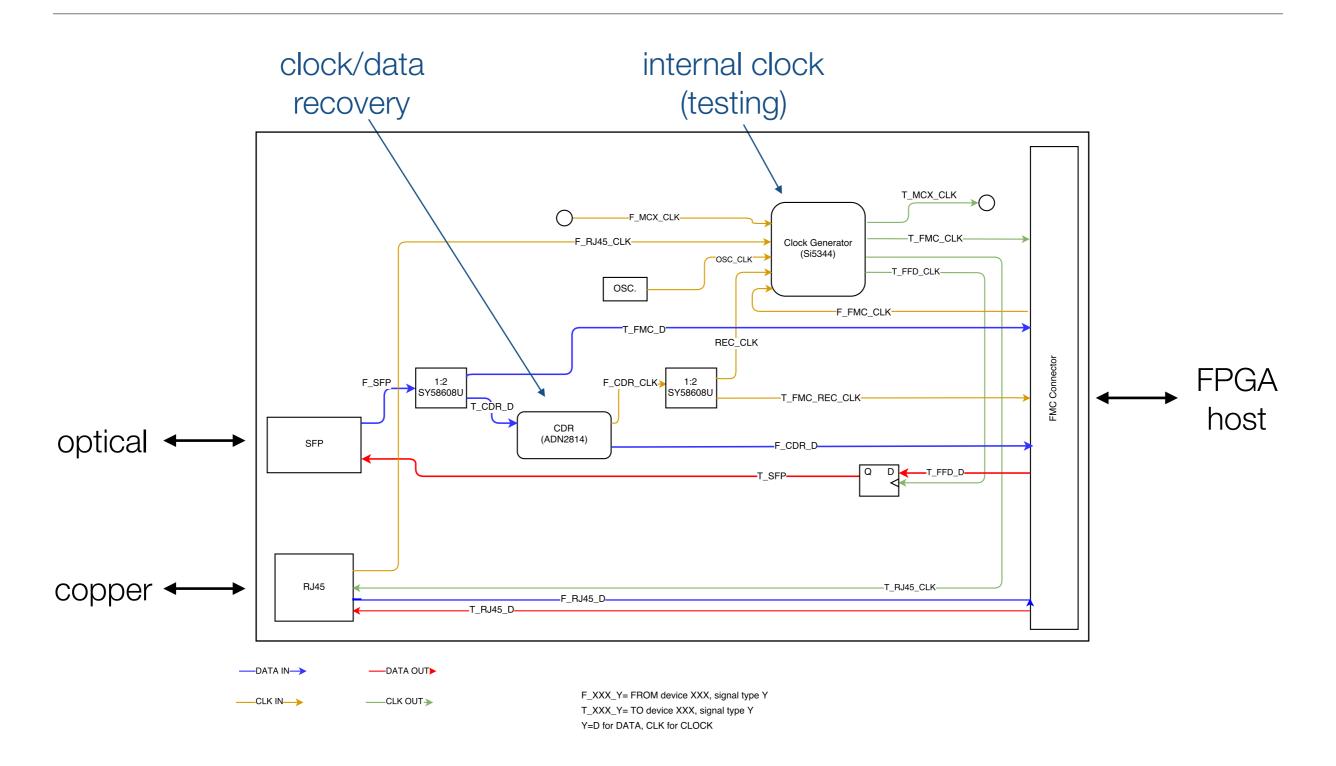2nd MilliQan Collaboration meeting - 12-13 Dec 2016, NYU

Integration with LHC

- Coincidence with LHC clock provides additional background rejection

    - 5 ns resolution would give factor ~5 reduction of any constant-in-time backgrounds

- 40 MHz LHC clock signal distributed by CMS on "TCDS fibre"

    - Which also encodes various timing signals (orbit, run start/stop, etc.)

- We need to :

    - Receive TCDS fibre from CMS

    - Recover clock and send into spare input on CAEN V1743

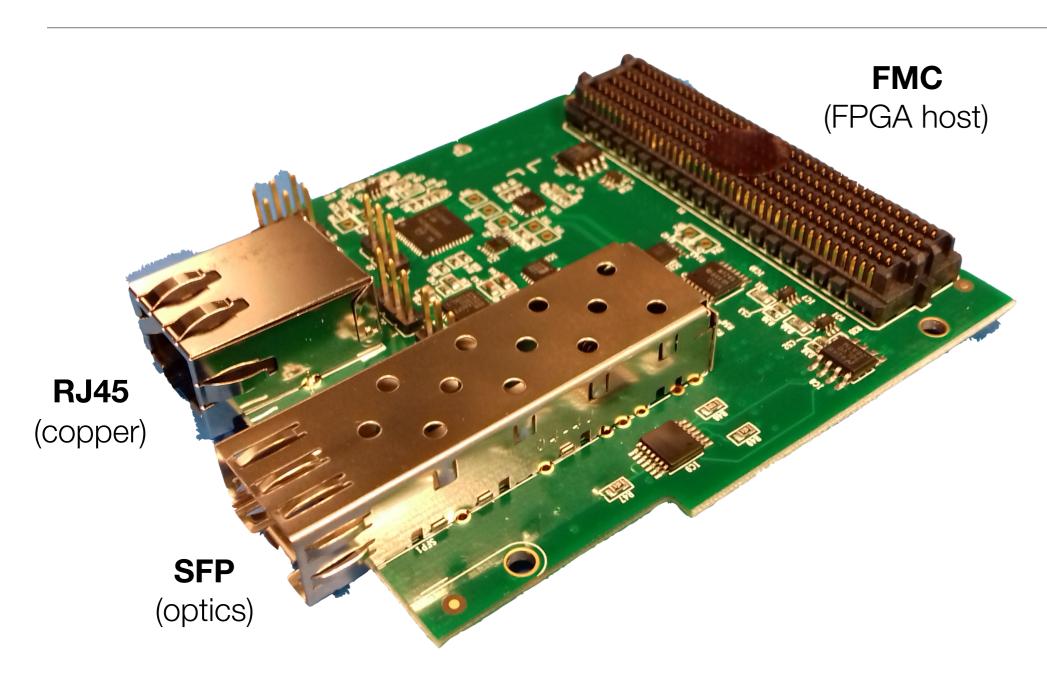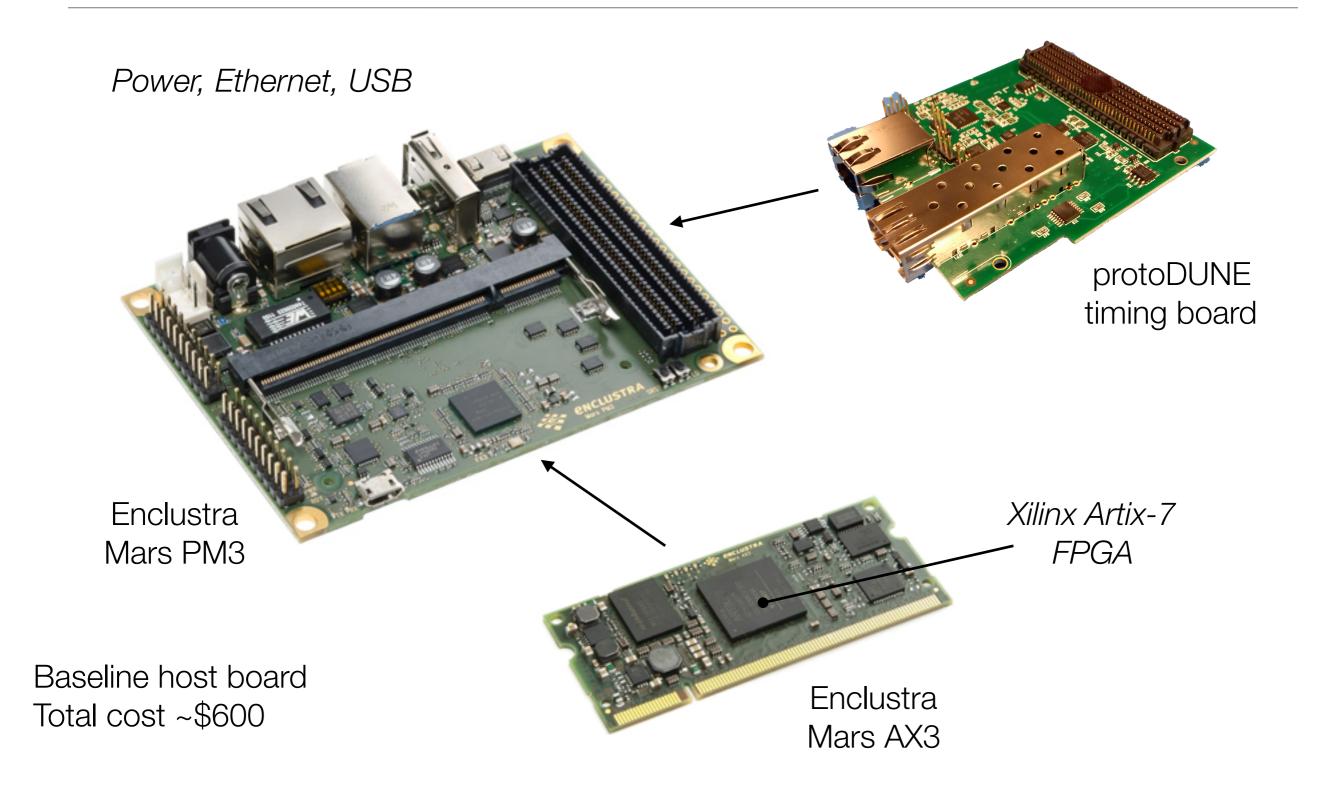   - Potentially decode & store timing signals

protoDUNE Timing System

Clock/trigger distribution
Phase alignment of all endpoints to < 1ns

protoDUNE Timing Board

protoDUNE Timing Board

FMC
(FPGA host)

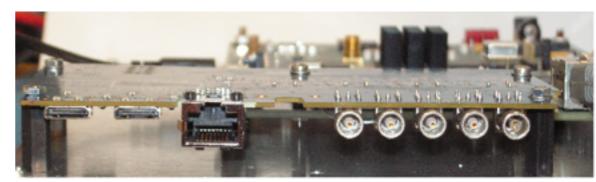**RJ45**
(copper)

SFP
(optics)

- First protoDUNE board currently under test
- Place production order right after Xmas break
- *Including one for MilliQan*

protoDUNE Timing Board

Power, Ethernet, USB

protoDUNE
timing board

Enclustra
Mars PM3

*Xilinx Artix-7
FPGA*

Baseline host board
Total cost ~$600

Enclustra
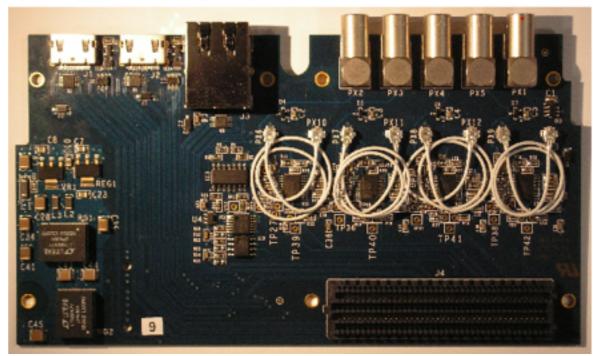Mars AX3

Possible extension

- It may be desirable to receive additional signals

  - eg. beam timing position monitors (BPTX), trigger from V1743

- Could be handled using AIDI mini-TLU

  - Bristol FMC card with variety of inputs, including LEMO

- Would require different FPGA host card with two FMC connectors

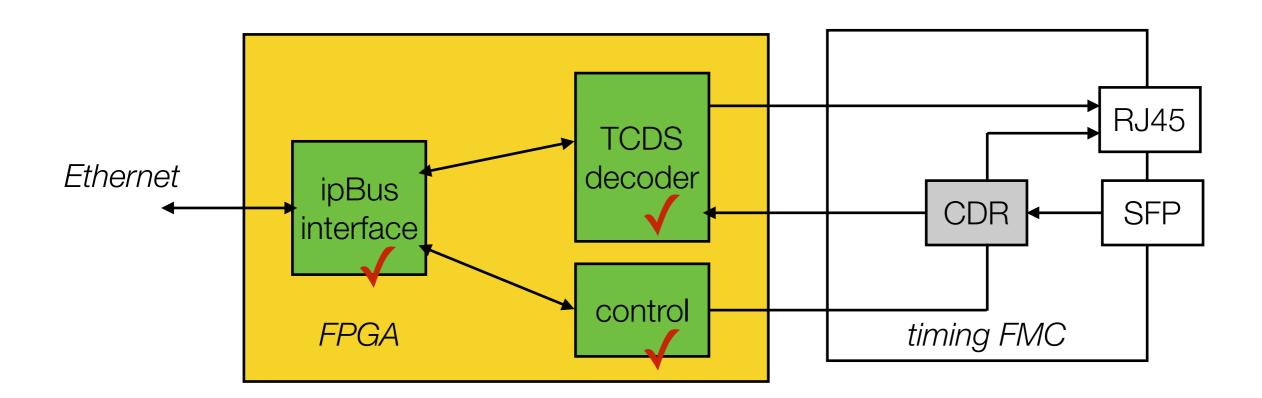
DUT0 (HDMI) DUT1 (HDMI) DUT2 (RJ45)   Trigger Inputs   Clock I/O

Firmware

- Firmware blocks already written for :

  - ipBus control (used in many HEP projects)

  - Control of clock/data recovery chip (used in protoDUNE)

  - Decoding TCDS signals (used in CMS)

Next Steps

- Choose FPGA host board - single or double FMC ?

- Glue firmware blocks together

- Power supply & packaging for P5 - 1U 19" rack case

- Aim to have system at P5 for testing with TCDS fibre by ~April

    - Ideally with CAEN V1743 + PMT + scintillator

- Hope to purchase V1743 test setup at Bristol

    - Investigating options

Outstanding Issues

- Need to request TCDS fibres if we are going to do tests in 2017
    - Useful to know location of test stands - USC55? PX56?

- How to use/store CMS timing signals
    - Maintain counters of orbit, run, etc. and save these with every trigger ?
    - Will need to send trigger from V1743 system to the timing board…

- Accessing luminosity information