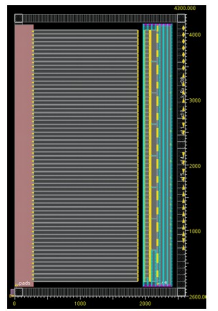


Proposal for a readout system for TORA

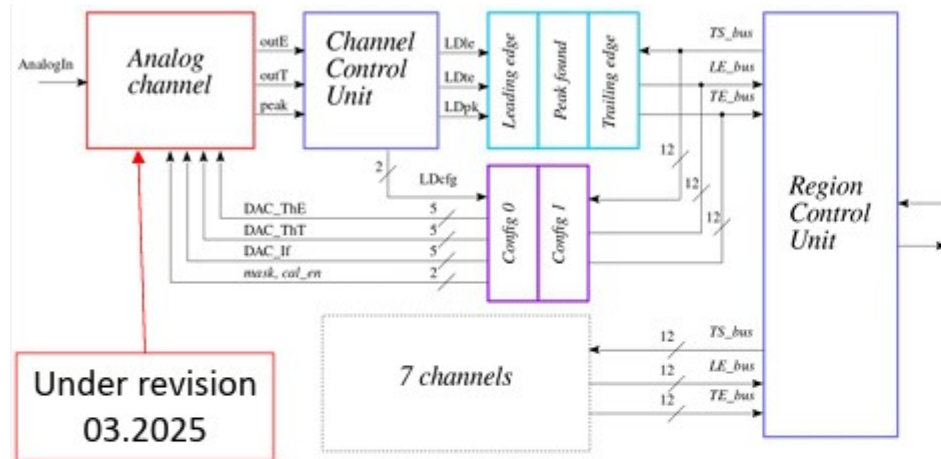
Davide Falchieri
INFN Bologna

uRWELL activities in IDEA
15 Sept 2025

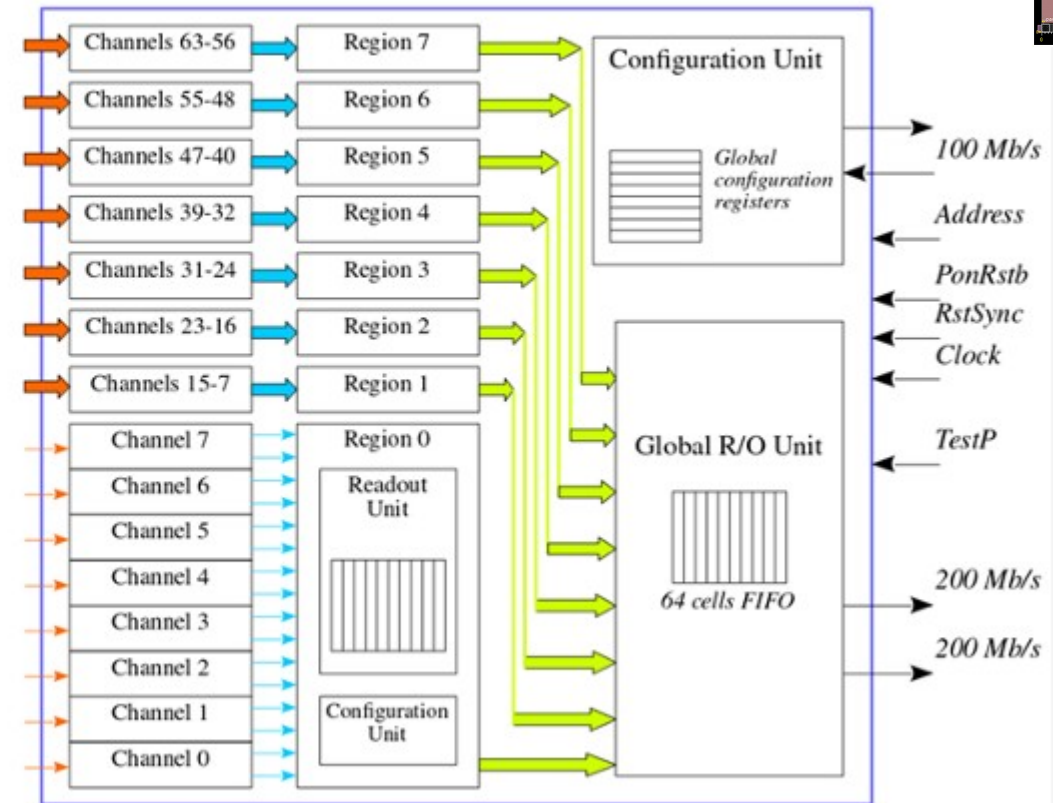
TORA ASIC: TOrino Readout for Amber



charge sensitive amplifier shaper discriminator

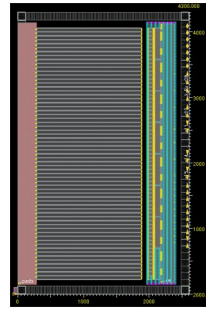


- Common time stamp distributed to all channels
- 3 data register for time acquisition
- 2 configuration registers
- Threshold and discharge current fine tuning



From: https://indico.global/event/8670/contributions/82750/attachments/37921/70725/AMBER_MM_Alexeev_09_01_25.pdf

DAQ proposal



TORA

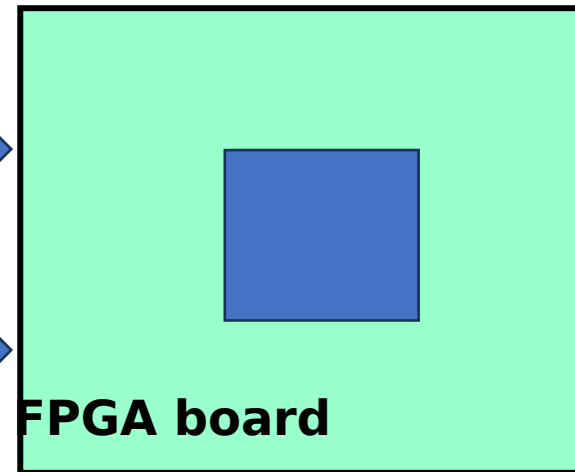
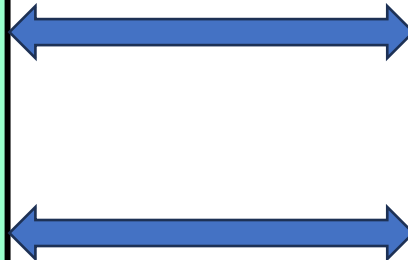
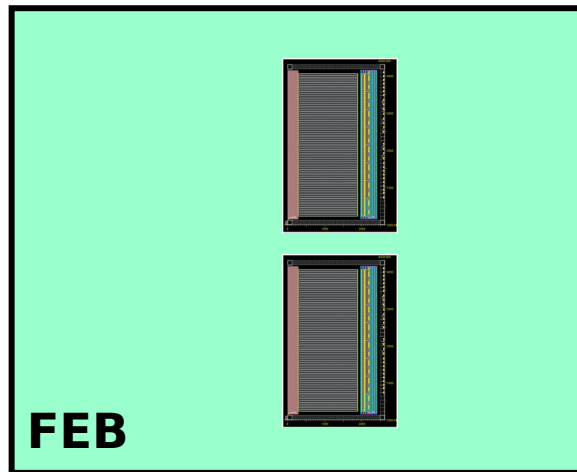


AMBER

RD_FCC

A common DAQ system can be developed for both applications

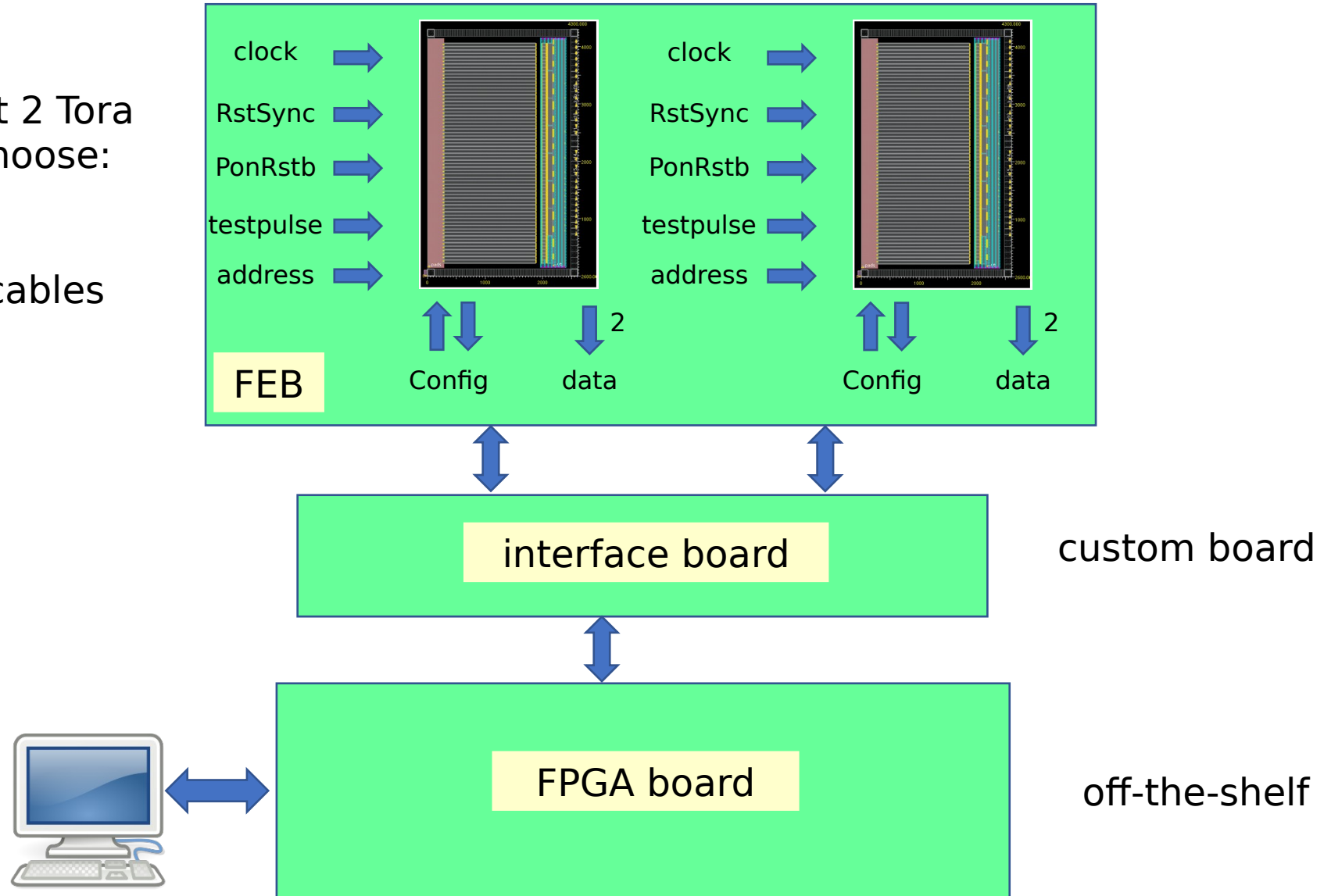
128 channels



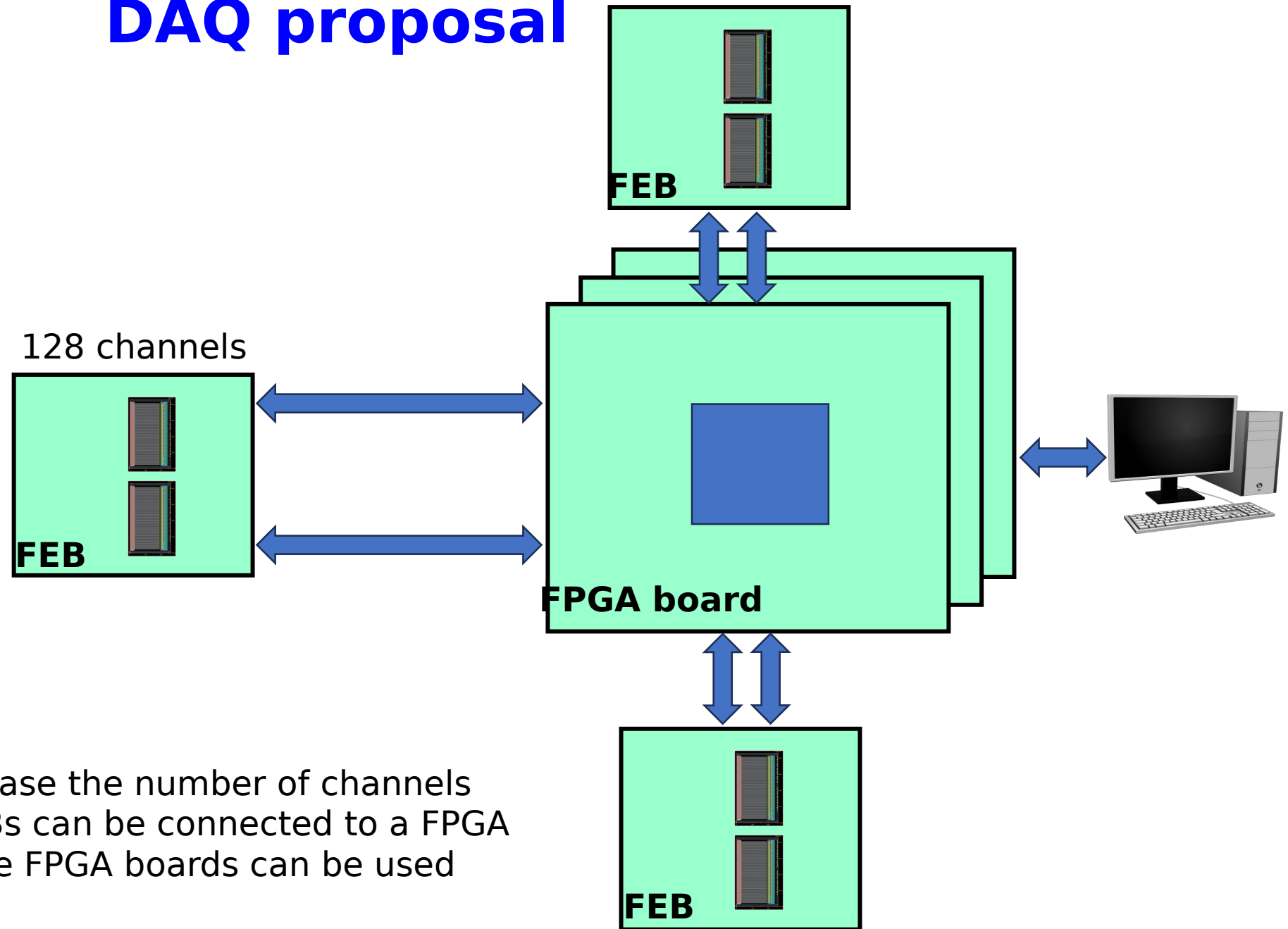
DAQ hardware

We start reading out 2 Tora chips, we need to choose:

- FPGA board
- interface board
- interconnection cables



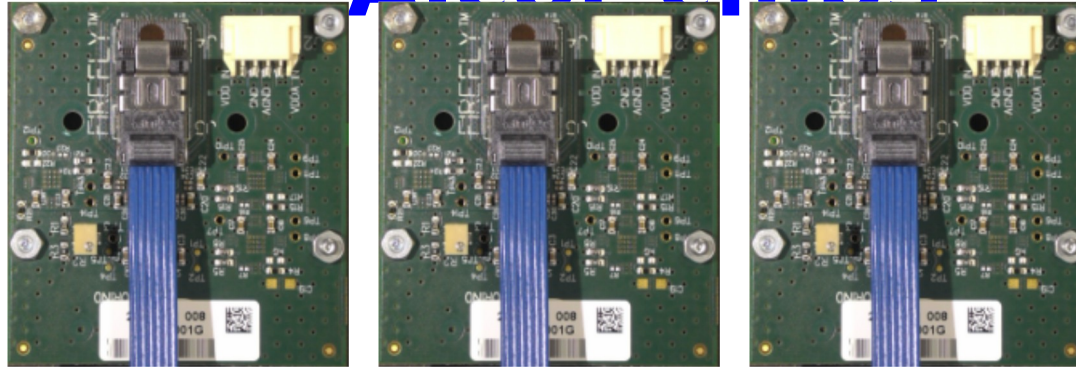
DAQ proposal



In order to increase the number of channels readout, more FEBs can be connected to a FPGA board and more FPGA boards can be used

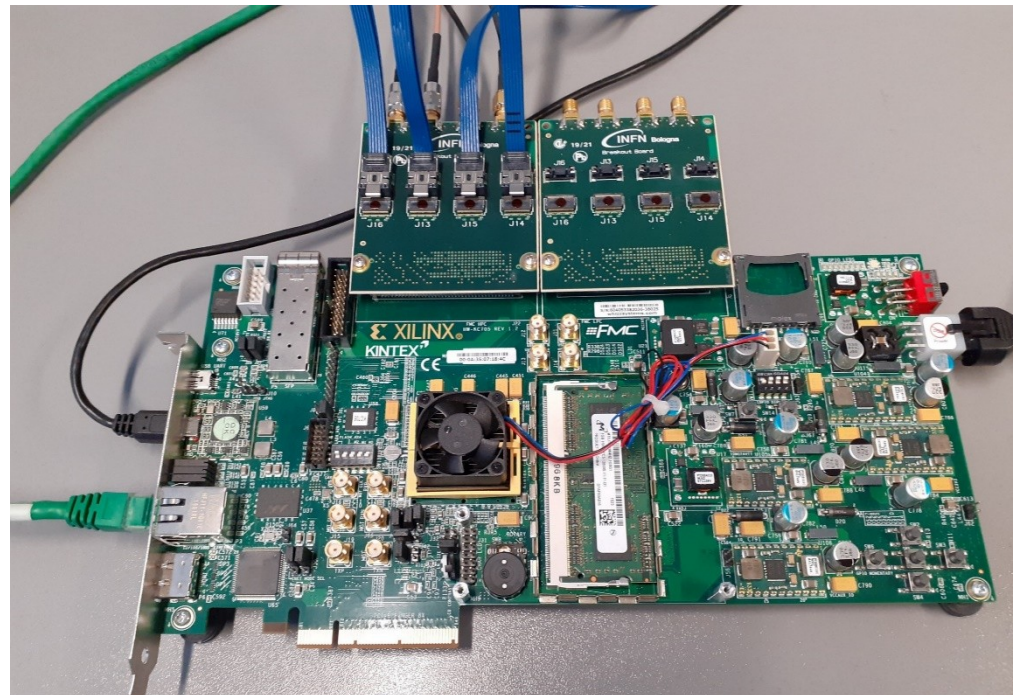
Previous experiences: reading 6

Alcor chips



Alcor front end boards

Samtec Firefly cables



custom FMC breakout board

FPGA board KC705

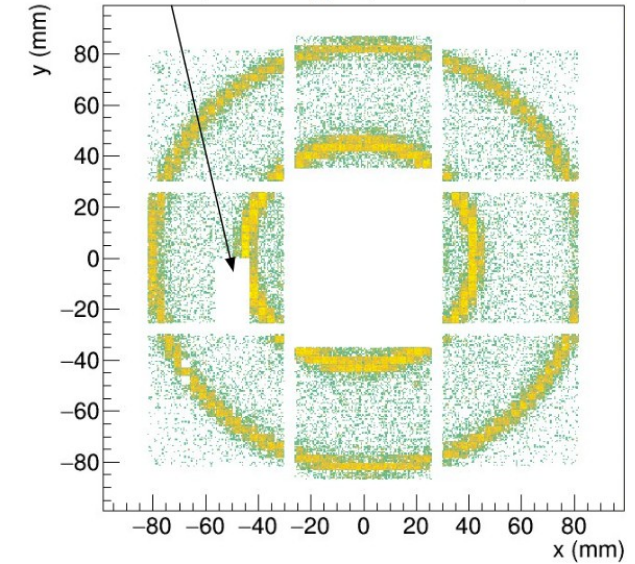
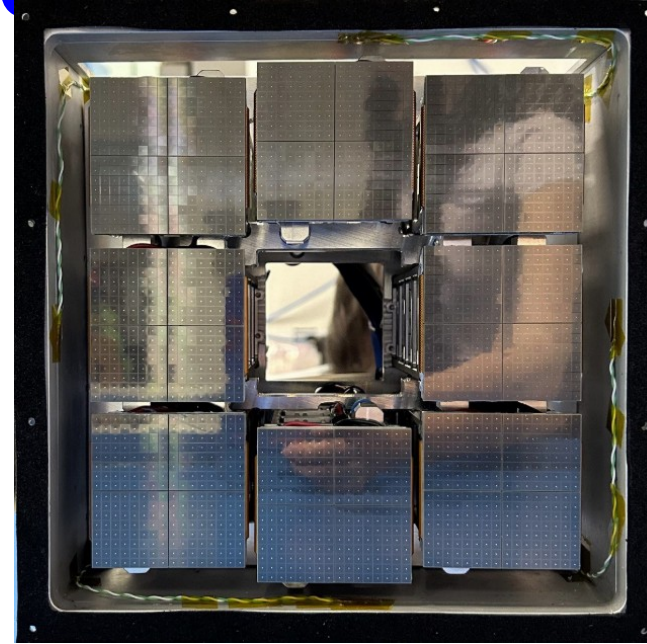


1 Gb ETH



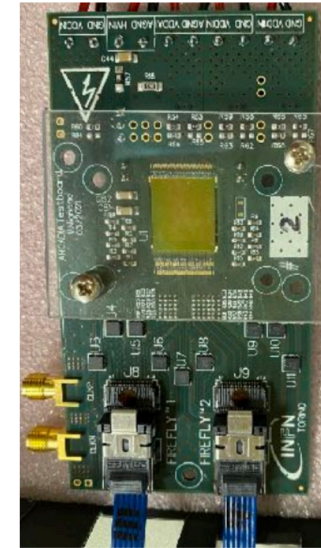
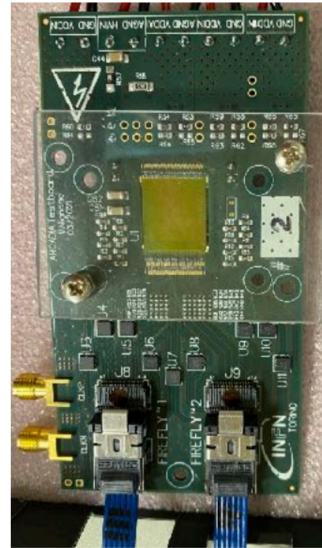
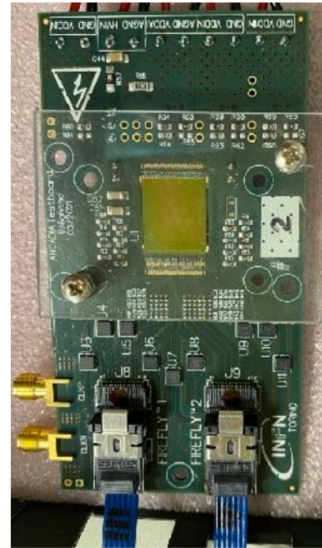
CERN IPbus

Previous experiences: reading up to 64 Alcor chips



11 KC705 FPGA boards in parallel □ 64 Alcor chips □ 2048 SiPMs

Previous
experiences:
Arcadia MD3
DAQ hardware

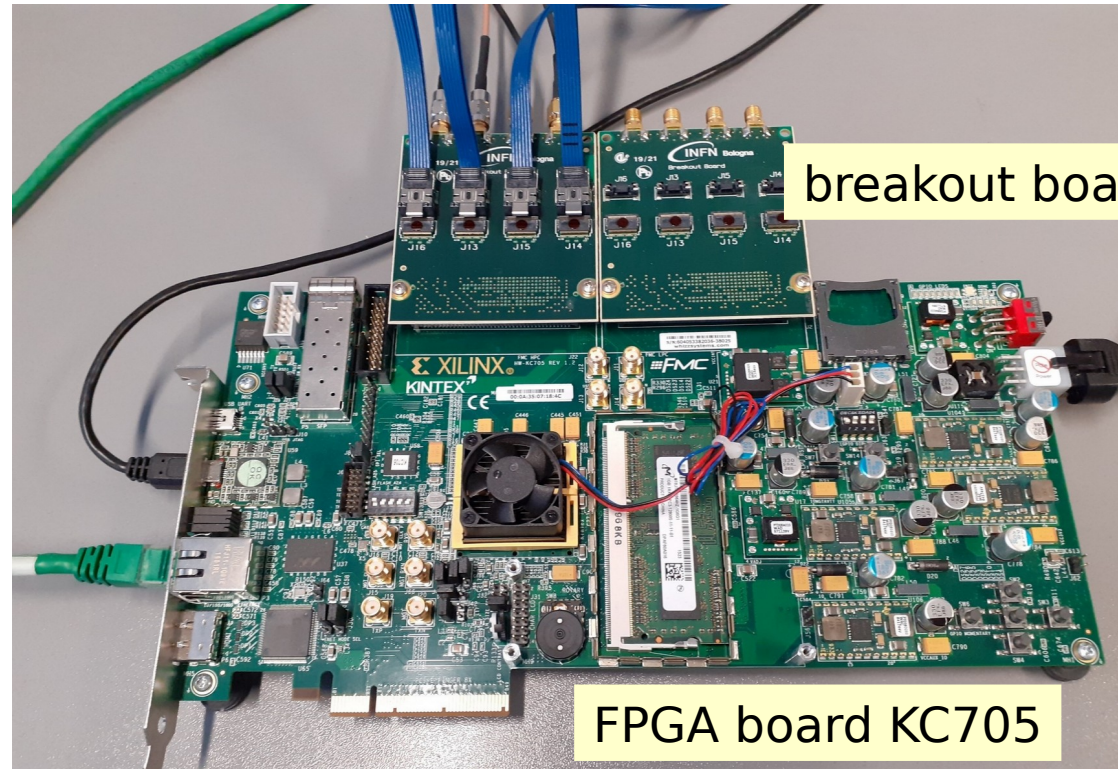


FEB cards

Samtec Firefly cables
(20 cm - 50 cm - 100 cm -
200 cm)



1 Gb ETH

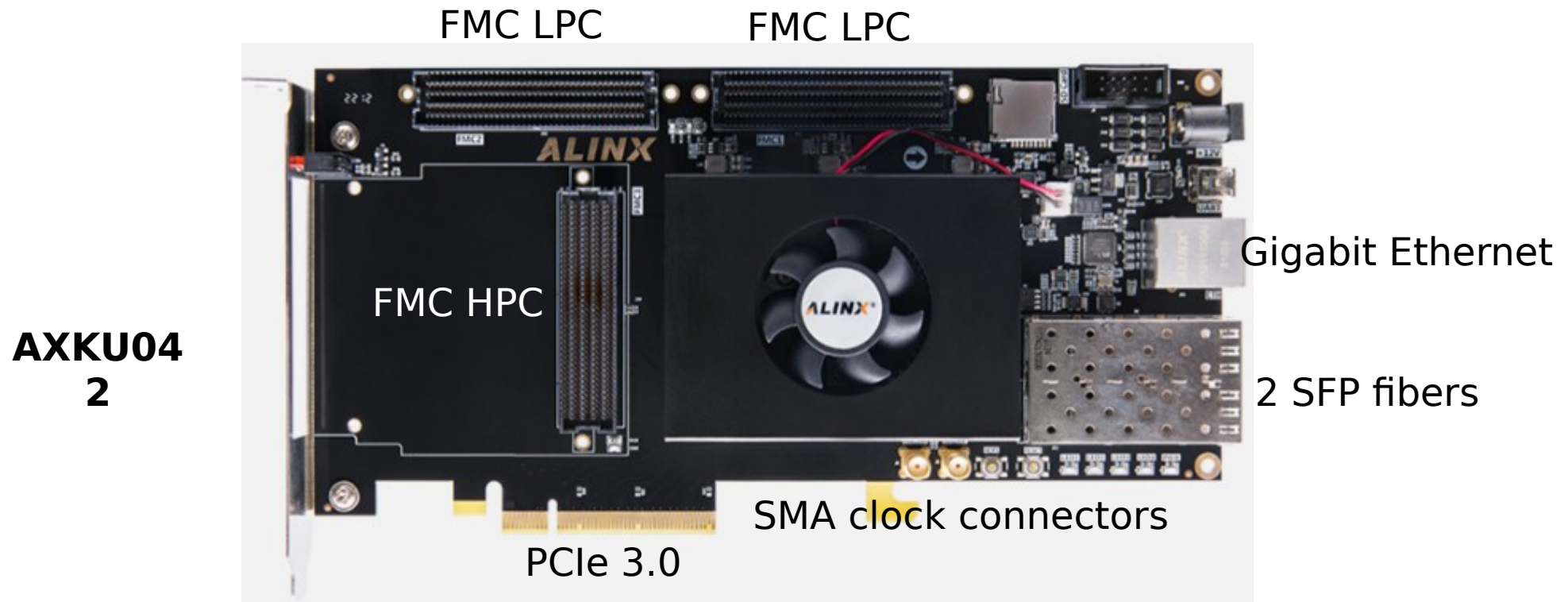


breakout boards

FPGA board KC705

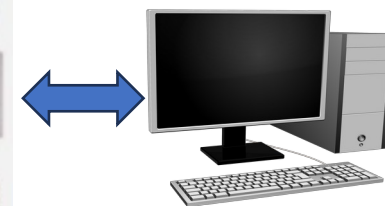
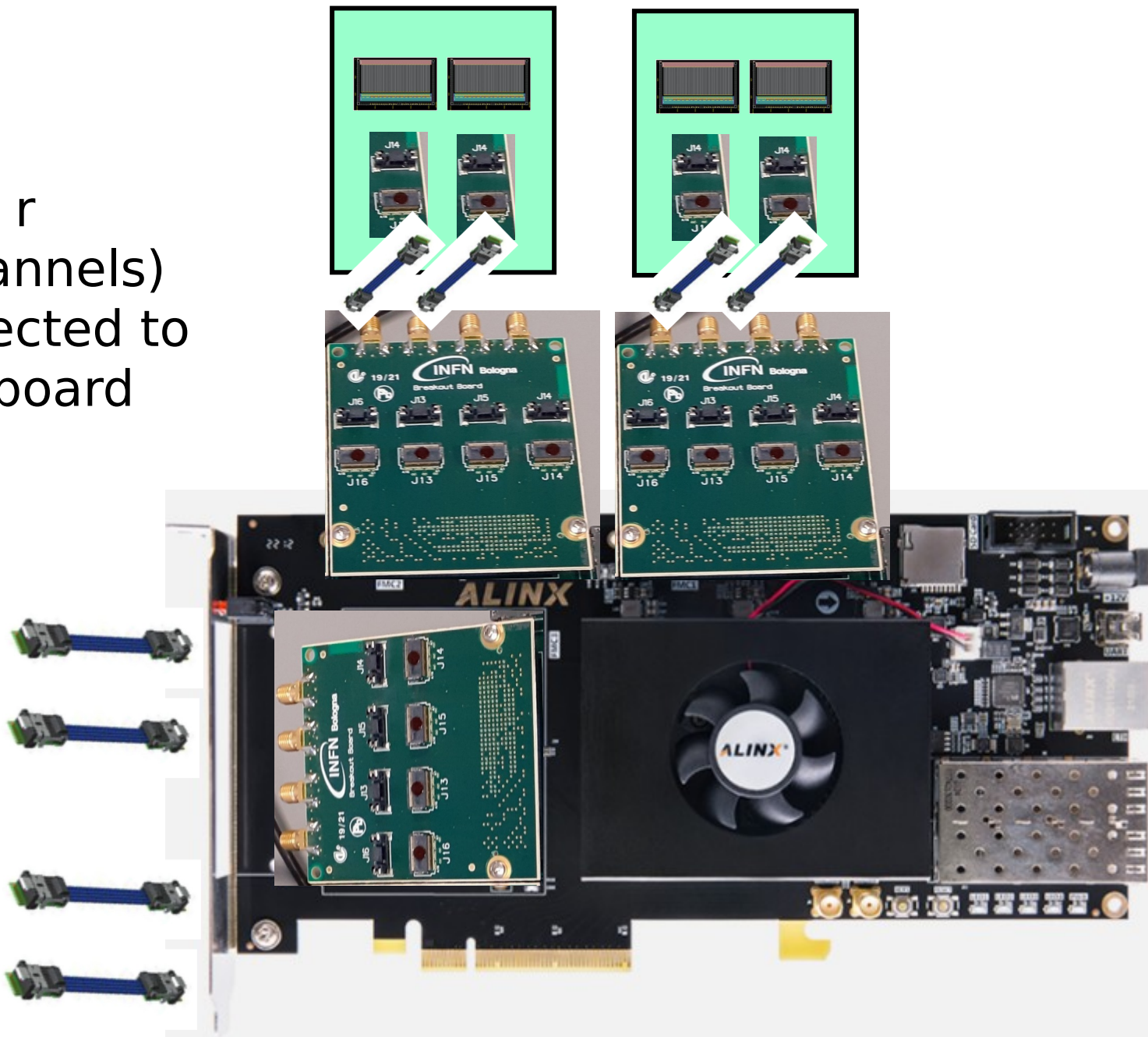
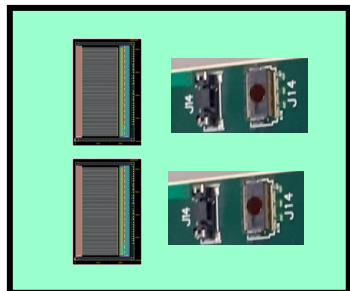
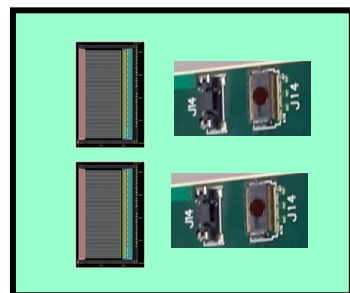
FPGA board proposal

As the KC705 is no longer available, we propose a different FPGA board



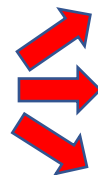
<https://www.en.alinx.com/Product/FPGA-Development-Boards/Kintex-UltraScale/AXKU042.html>

Up to 8 r
(= 1024 channels)
can be connected to
one FPGA board



Telescope/test beam

clock →



← start, reset, trigger

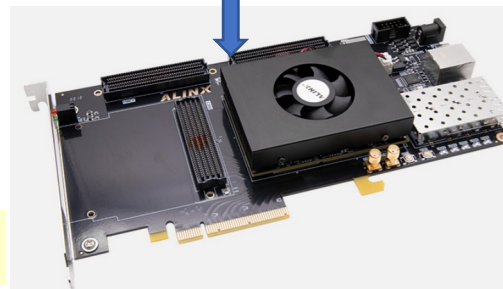


ETH1 ETH2 ETH3

start, reset, trigger



ETH1



start, reset, trigger



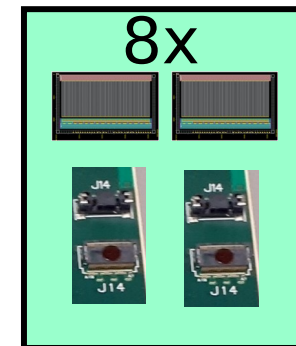
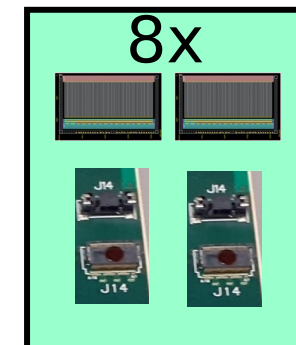
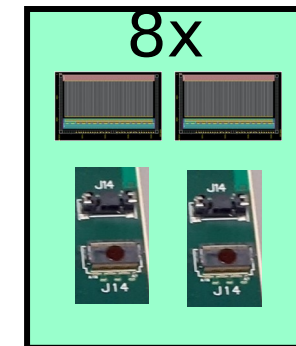
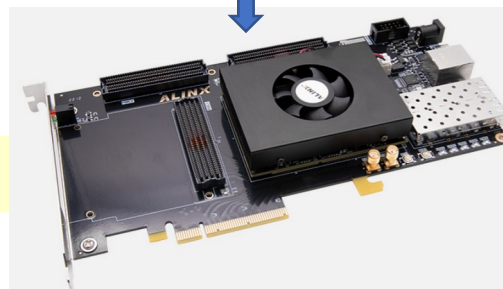
ETH2



start, reset, trigger



ETH3



Telescope/test beam

The readout system

1 FPGA -> 3 Break Board -> 8 Fire-Fly cable -> 8 FEB -> 16 TORA = 16x64 channels = 4 XY detectors

4 FPGA -> 16 XY detectors

-

The setup needs:

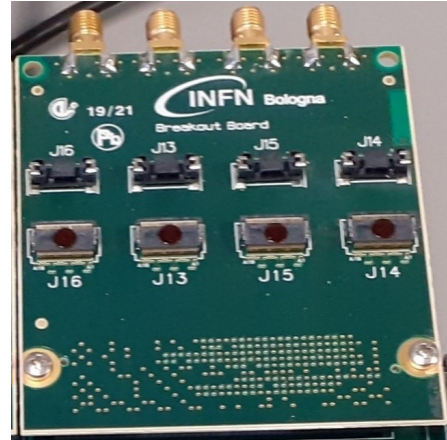
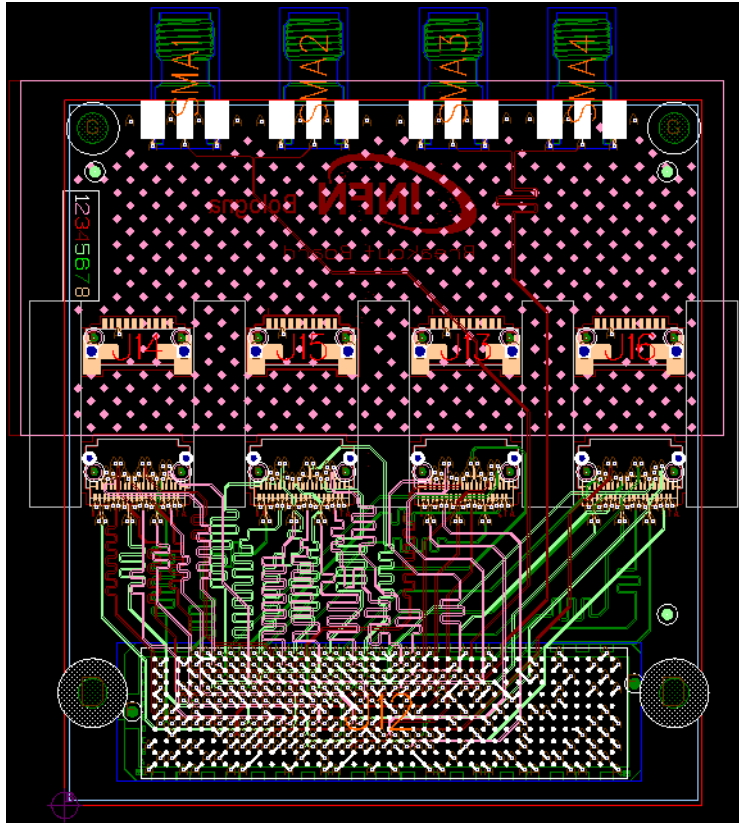
4 tracking detectors + 4 test chambers = 8 detectors

1 readout system = 4 FPGA + 3x4 (12) break-board + 8x4 (32) Fire-Fly cable + 4x4 (16) FEB

1 clock distribution system

Backup

Breakout board proposal



Samtec Firefly cables
(12 differential lines each)

a passive board routing some FMC signals into Firefly connectors (12 LVDS pair each), plus 4 SMA connectors

LOW-PROFILE MICRO FLYOVER™ ASSEMBLY

SPECIFICATIONS

For complete specifications see www.samtec.com?ECUE

Cable:
Eye Speed® 34 AWG twinax,
Eye Speed® 34 AWG
ultra low skew twinax
or Eye Speed® 36 AWG twinax
Signal Routing:
100 Ω Differential
Bend Radius:
(3.18 mm) .125"
RoHS Compliant:
Yes

RECOGNITIONS

For complete scope
of recognitions see
www.samtec.com/quality



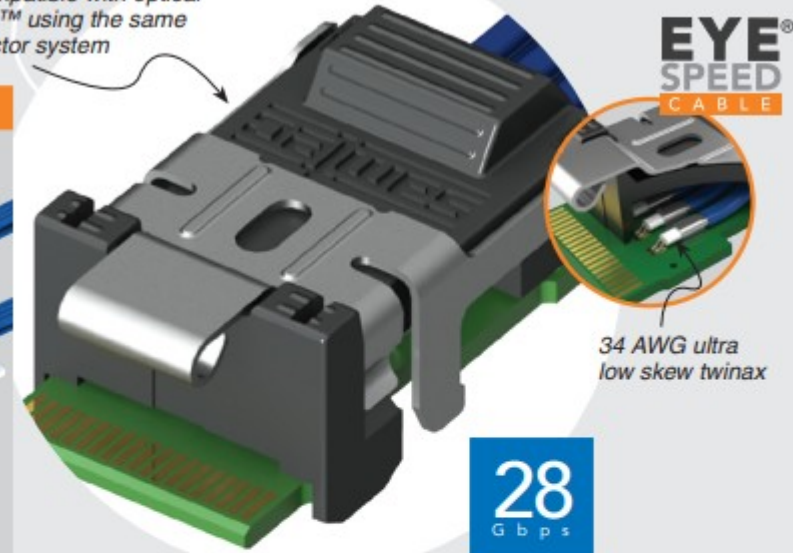
Mates with:
UEC5, UCC8

Pin compatible with optical
FireFly™ using the same
connector system

APPLICATION



The UEC5 and UCC8 connectors were designed to work specifically with the FireFly™ flyover™ system. They were not designed for use with mating cards other than those used with FireFly™. For other edge card options, please see samtec.com/edgecard or contact CustomerEngineeringSupport@samtec.com.

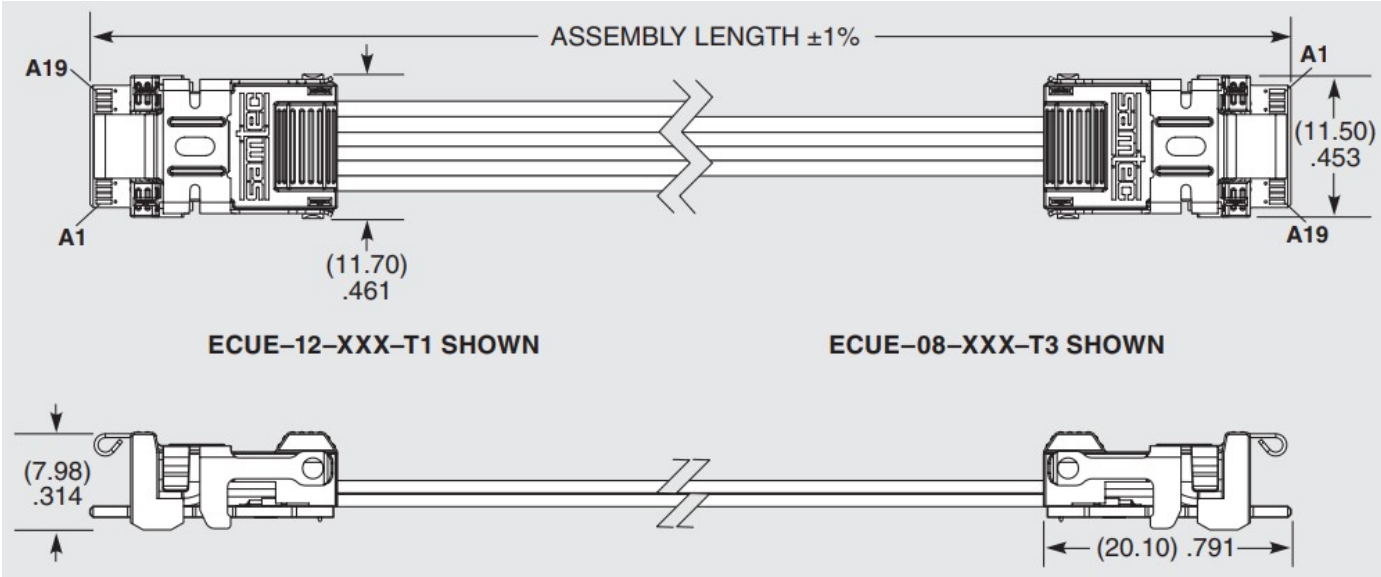
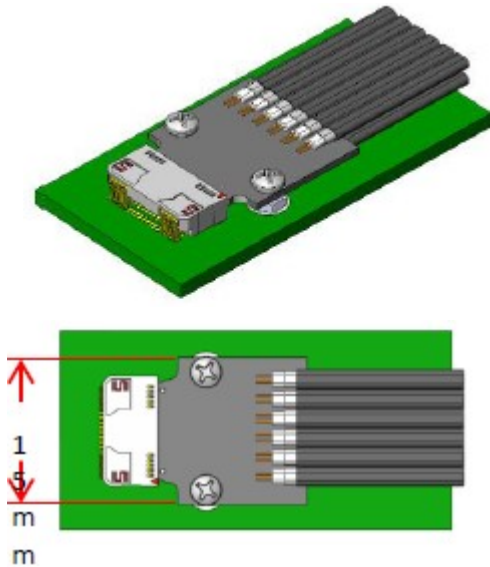


ALSO AVAILABLE (MOV Required)

- A selection of connectors for end 2 option

TYPE	NO. OF PAIRS	ASSEMBLY LENGTH	CABLE TYPE	END 2 OPTION	WIRING OPTION	DATA RATE	OPTION
ECUE = Rugged FireFly™ Cable Assembly	-08 = Eight Pair (-T2 & -T3 cable only)	-“XXX” = Assembly Length in Centimeters (007 cm to 999 cm)	-T1 = 36 AWG twinax (-12 pairs only)	-FF = FireFly™ (Mates with UEC5/UCC8)	-01 = Pin A1 to Pin A19	-1 = 14 Gbps (-T1 or -T2 only)	Leave blank for standard FireFly™
	-12 = Twelve Pair (-T1 cable only)		-T2 = 34 AWG twinax (-08 pairs only)		-02 = Pin A1 to Pin B1	-2 = 28 Gbps (-T3 only)	-D1 = Decoupling Capacitors (only available with -02 & -B4 wire options)
			-T3 = 34 AWG ultra low skew twinax (-08 pairs only)		-B4 = Pin A1 to Pin B19 (-08 pair only)		

<https://www.samtec.com/products/ecue>



Products	Pitch	Cable Length	7 dB Insertion Loss Point
Differential Pair - High Speed Twinax			
ECUE	0.80 mm	500 mm	13.50 GHz
ECUE	0.80 mm	300 mm	15.00 GHz
ECUE	0.80 mm	1000 mm	5.50 GHz

cable length up to 10 m

Assembly			-7 dB Frequency	Speed Rating
ECUE-12-050-T1-FF-01-1	Differential	Short Path	13.5 GHz	27 Gbps
		Long Path	7.0 GHz	14 Gbps

<https://datasheet.octopart.com/ECUE-12-100-T1-FF-01-1-Samtec-datasheet-129008604.pdf>
http://suddenoceans.samtec.com/testreports/hsc-report-sma_ecue-12-xxx-t1-ff-01-1_web.pdf

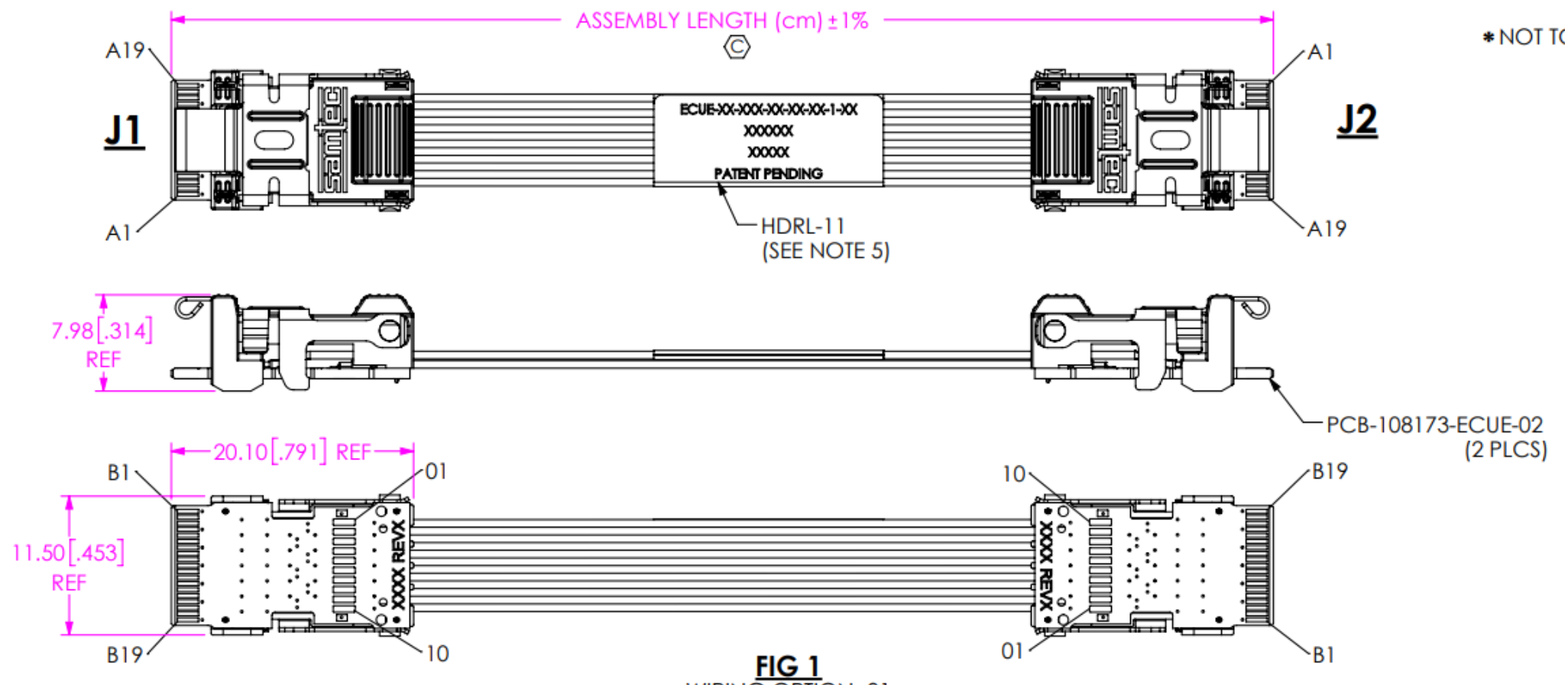
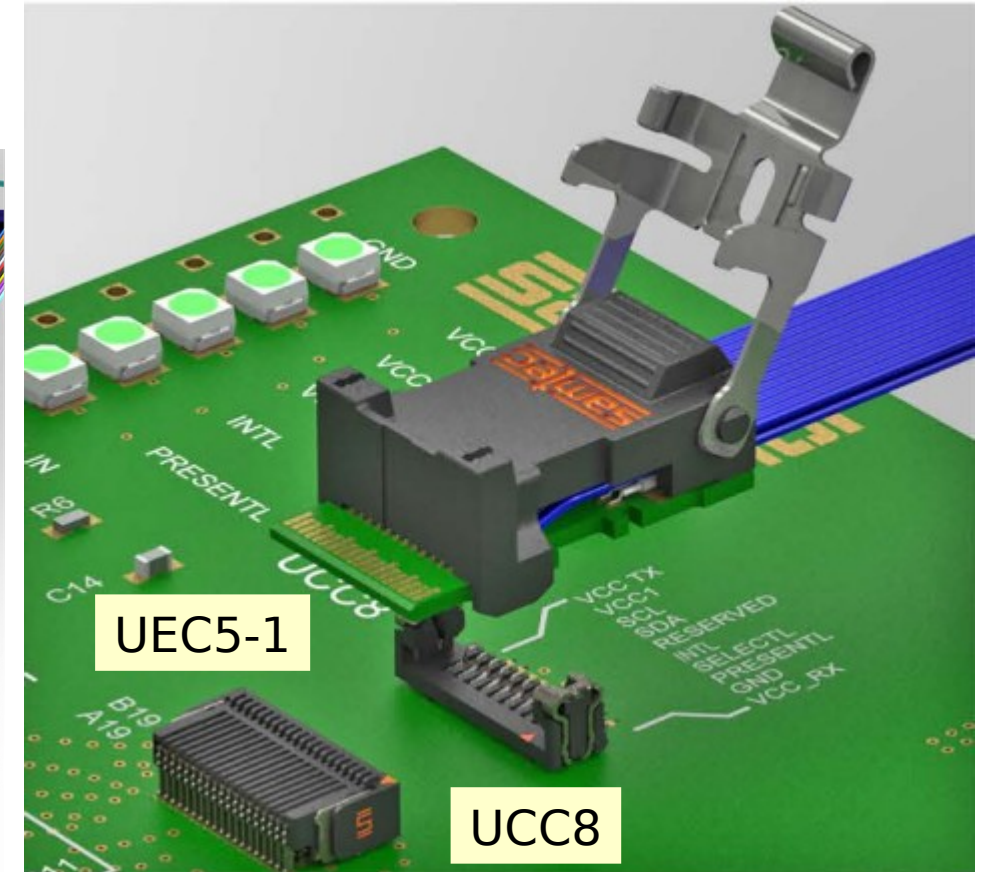
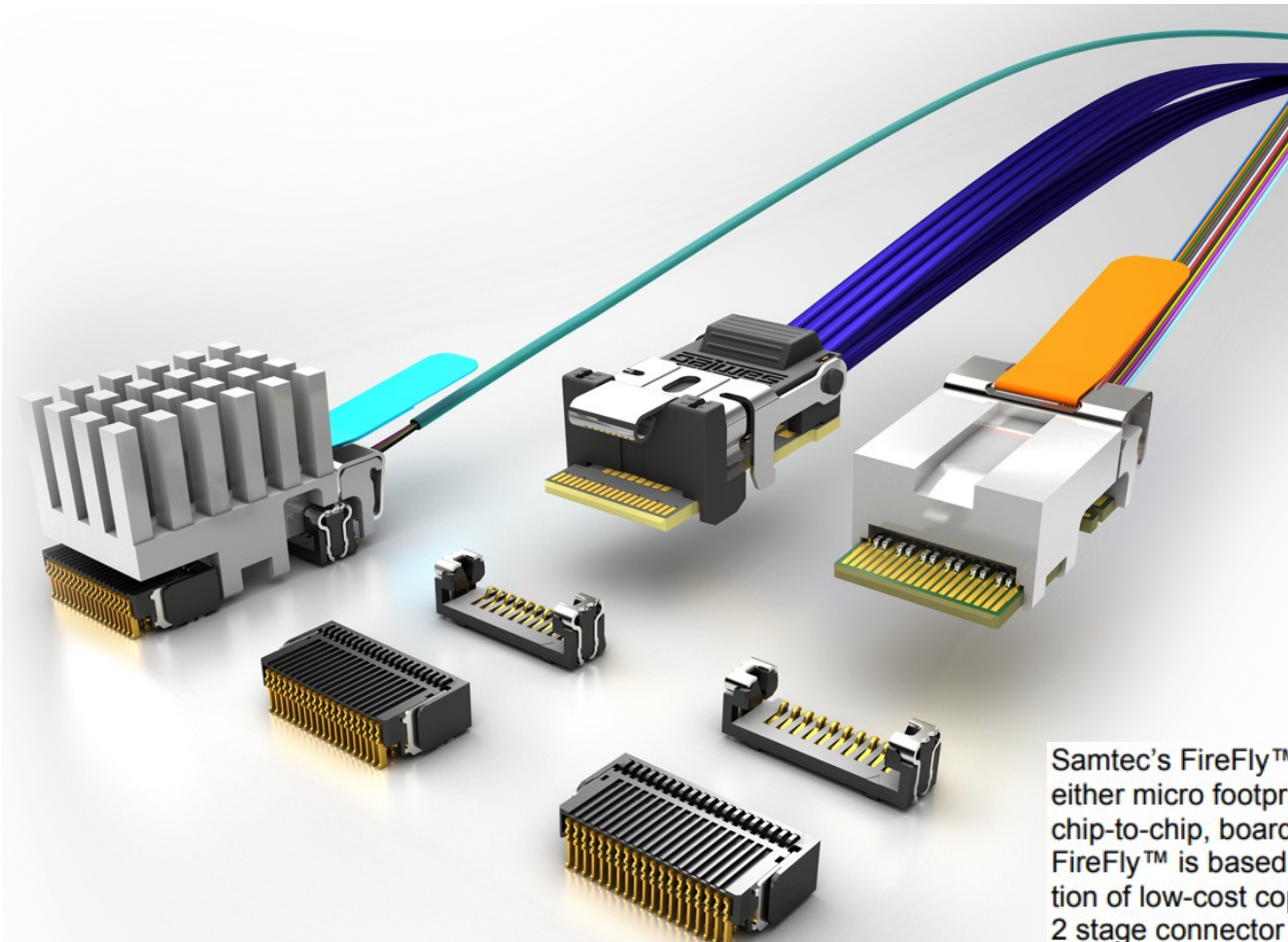


TABLE 2
ECUE-12-XXX-X1-FF-01-1 SIGNAL MAPPING
(12 PAIRS, -01 WIRING OPTION)

J1	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19
NAME	G	S	S	G	S	S	G	S	S	G	S	S	G	S	S	G	S	S	G	G	S	S	G	S	S	G	S	S	G	S	S	G	S	S	G	S	S	G
J2	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	B19	B18	B17	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Available with both Copper and Optical Modules

Both modules fit in the same connector system



Samtec's FireFly™ Micro Flyover System is a complete interconnect system that uses either micro footprint optical or copper interconnects. The FireFly™ system enables chip-to-chip, board-to-board, and system-to-system connectivity at rates up to 28Gbps. FireFly™ is based on a high performance interconnect system which allows the utilization of low-cost copper cables or high performance active optical engines. Firefly uses a 2 stage connector system. The UEC5 carries the high speed digital signals while the UCC8 carries the DC/low frequency status line.