Caribou DAQ

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Caribou DAQ System

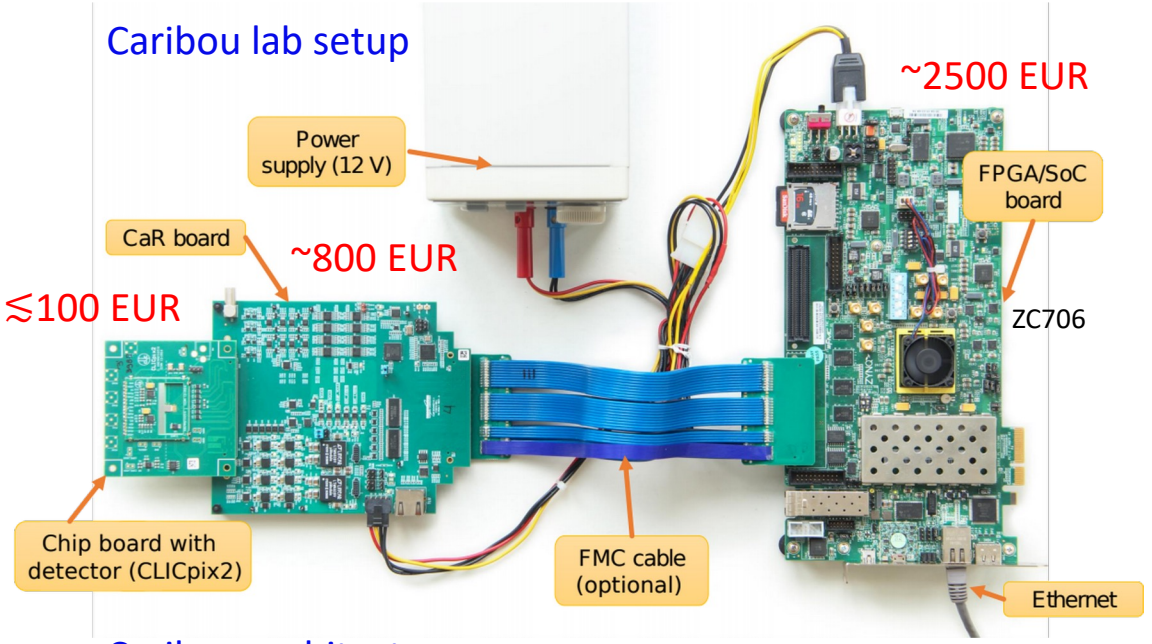
Caribou versatile open-source DAQ system

- Re-usable hardware, firmware and software
  - System-on-Chip (SoC) board
    - Embedded CPU for Linux operating system, DAQ software (Peary), user interface
    - FPGA for detector control and data processing, TDC
  - Common Carboard interface board
    - Physical interface from SoC board to detector
    - Provides resources (voltage regulators, ADCs, pulse/clock generator)
  - Application-specific chip carrier boards
    - Detector and passive components

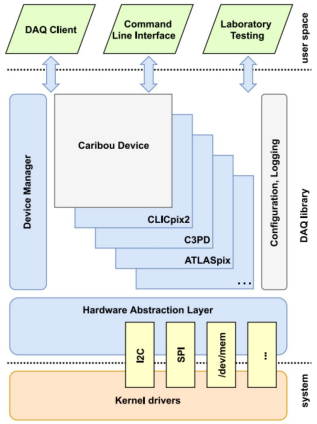
Target applications:

- Lab and beam tests of silicon-detectors
- Optimised for R&D support, easy integration of new prototypes
- Not targeting project-specific DAQ in large experiments

Caribou lab setup



Caribou architecture



https://gitlab.cern.ch/Caribou/

http://dx.doi.org/10.1088/1748-0221/12/01/P01008

http://dx.doi.org/10.22323/1.370.0100

https://doi.org/10.1088/1748-0221/18/02/C02005

Application examples

Caribou integration of many detectors

- Profit from re-usable firmware and software
  → largely reduced integration time for new devices

Support for various readout schemes:

- digital interface via GTx or LVDS
- analogue waveforms (sampling ADCs or external oscilloscope)
- TDC in FPGA (<10ps resolution)

Integration in beam-telescope setups

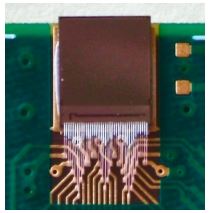
- FEI4, Timepix3, Mimosa, ALPIDE

Caribou chip-board examples

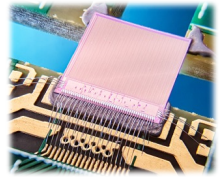
FEI4+H35Demo

ATLASpix

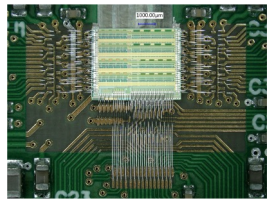
CLICpix2



CLICTD

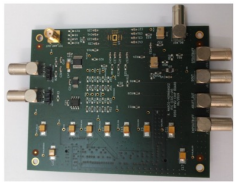


FASTPIX

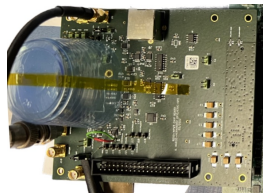


RD50-MPW1

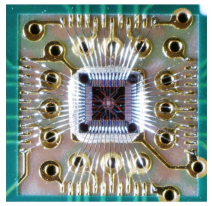
RD50-MPW2



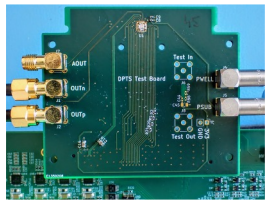
RD50-MPW3



APTS (65 nm)



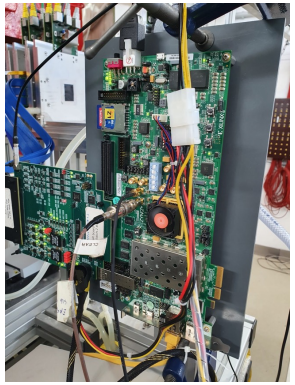
DPTS (65 nm)



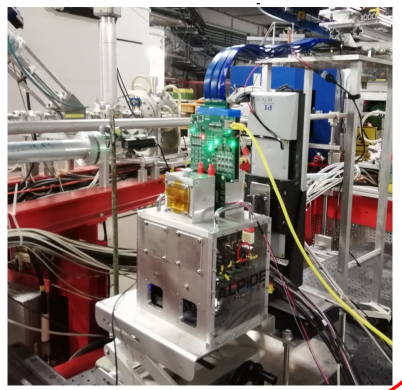
Telescope integration

CLICdp Timepix3 @ CERN

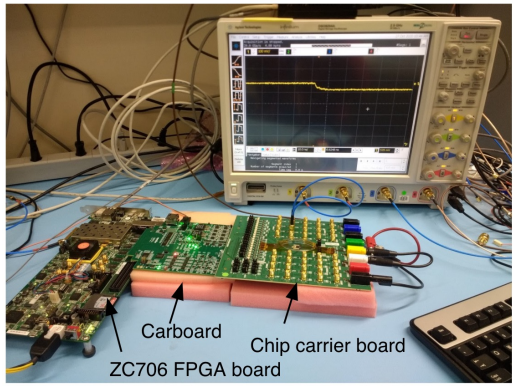
Mimosa @ DESY



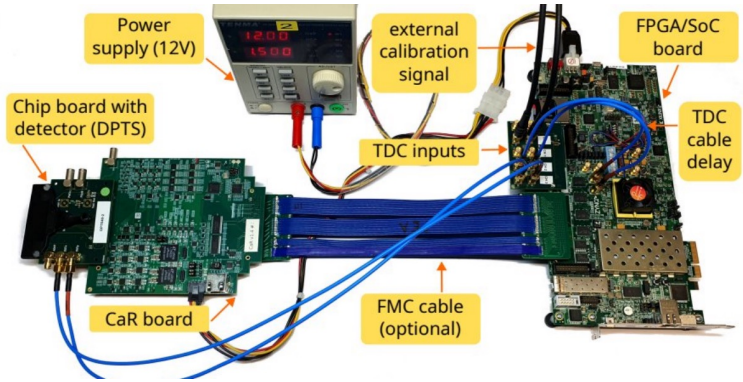
ALPIDE @ MAMI



FASTpix with oscilloscope r/o



DPTS with TDC in FPGA r/o



Development and support

BNL OMEGA group, Carleton University, ORNL

- Design of Common Hardware (Carboard)

CERN / EP R&D

- Coordination of common hardware production, firmware development, user support

DESY / Tangerine:

- Coordination of common Peary Software, test-beam integration

AIDAinnova, RD50

- Funding for development and hardware production

Caribou in RD50

- Caribou used in 10 RD50 member institutes, mostly for HV-CMOS DMAPS prototype development and related radiation-hardness studies
- RD50 common project since 2021
- Support from RD50 for production of batch of 20 Carboards v1.4
  - ~50% of the production cost from RD50 common fund (10k EUR)
  - Design, prototyping and validation of the new Carboard v1.4 provided by BNL, with support from CERN
  - Purchase order, testing, rework, shipment + invoicing provided by CERN
- Significant benefits with modest amount of funding:
  - Coordinated purchase reduced price and overhead for institutes
  - Project gained visibility and approval status
    → important to secure additional resources
  - Incentive for institutes to “get things started” and deliver testing results

RD50 Caribou participant	contact
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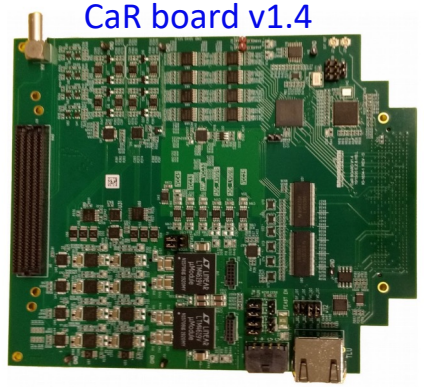
Uni. Sevilla	R. Palomo
NIKHEF	J. Sonneveld
Lancaster Univ.	D. Münstermann

CaR board v1.4



Ongoing developments and future plans

Caribou 2.0:

- Carboard 2.0 currently under development
  - System-on-Module (SoM) platform based on Zynq UltraScale+
  - Replace combination of Xilinx evaluation board + Carboard with a single custom carrier board housing the SoM

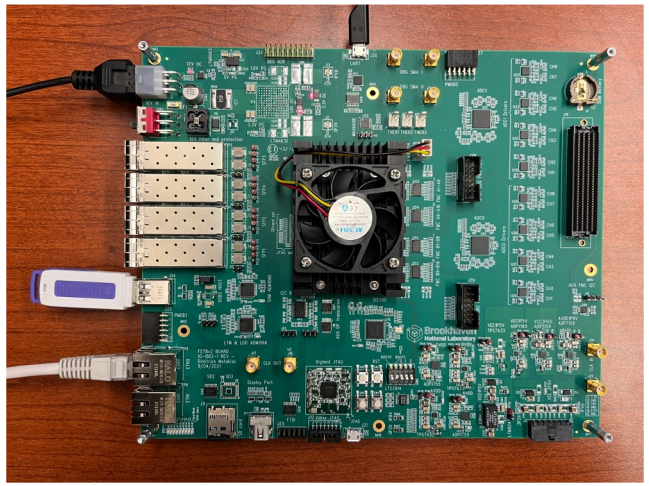
  → Reduced cost and improved performance
- Ongoing hardware design effort by Carleton University / BNL / ORNL
  - Pre-prototype carrier board tests at BNL using XU1 SoM validated the digital design successfully (M. Benoit and D. Matakias)
  - List of resources and design features iterated in Caribou user meetings
  - Carboard 2.0 design in progress (M. Pijacki)
  - Aim for first prototypes by mid 2023

Future Caribou extension:

- Caribou version geared towards operating several already characterized detector modules in parallel
  - e.g. as a flexible DAQ system for a future beam telescope

Enclustra Mercury+ XU1 SoM

Pre-prototype for Caribou 2.0 @ BNL



Caribou in DRD3

Caribou has proven beneficial for RD50 institutes

- Profit from existing re-usable hardware, firmware and software
- Community / best-effort support for integration of new detectors
- Financial support for hardware investments enables pooling of common DAQ infrastructure
- Visibility / approval status

We propose to include Caribou as common project in DRD3

- Open to new contributors and use cases
- Gives visibility to project and to groups active in DAQ for detector testing
- Facilitates securing external resources
- Common-fund support helps to accelerate common investments,
  e.g. participation in cost for Carboard 2.0 production, contribution to future multi-plane Caribou version