WP 7.1: Data Density and Power Efficiency

More channels and more bits per sample require higher data rates inside and out of the front-end ASICs. Novel link technologies must be developed to cope with higher data rates, to connect neighbouring detector layers for advanced data reduction techniques, and to do so with reduced mass and power. Critical technologies include radiation-hard optical links, wireline, wireless, and free-space optics; Low-power design techniques are needed at the front-end, including novel architectures. Efficient power distribution, power converter and regulator devices, and protection circuits are required to minimise detector mass and heating. Efficient readout controllers must work in concert with DAQ to optimally aggregate, buffer and transmit data to maximise the utilisation factor of very high bandwidth off-detector links.

7.1.a Silicon Photonics Transceiver Development

Develop high-speed optical transceivers based on Silicon Photonics technology for use in a wide range of future particle physics applications from low-temperature neutrino detectors to high-radiation environment HL-HLC pixel detectors.

- 100 Gb/s per fibre optical readout with 2.5 Gb/s control optical link
- Radiation tolerance up to 1×10^{16} particles/cm^2 and 10 MGy
- Power consumption of 250 mW
- Cryogenic temperature operation for some lower-speed variants

Sherbrooke
CERN
DESY, KIT, Wuppertal
IGFAE
Birmingham, Imperial
INFN Milano, INFN Pisa, Sant’Anna, Uni. Trento
Argonne, Fermilab

7.1.b Powering Next Generation Detector Systems

Develop power distribution schemes and their voltage/current regulators and converters for use in a wide range of future particle physics applications, from low-temperature neutrino detectors to high-radiation environment HL-HLC pixel detectors and beyond.

- High-efficiency (at least 90% at high load) converters for serial and parallel powering schemes for high voltage conversion and around 75% for fully integrated DCDC in 28nm technology
- Radiation tolerance up to 1×10^{16} particles/cm^2 and 10 MGy

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FH Dortmund, RWTH Aachen University
Tallinn University of Technology (TalTech)
ITAINNOVA
INFN Milan, University of Udine (UNIUD), University of Milan (UNIMI)

7.1.c WADAPT

Develop wireless technology based on a millimeter wave (mmw) transceiver IC as well as on Free Space Optics to connect neighboring detector layers, providing increased data rates, high power efficiency and high density of data links, with the aim of reducing mass and power consumption.

- Data from detector front-end modules can be serialized as channels up to 10 Gb/s and be aggregated across detector layers (25 to 100 Gb/s)
- Radiation tolerance up to 2×10^{16} particles/cm2 (HL-LHC) and at FCC-hh is 6×10^{17} particles/cm2 (FCC-hh)

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