

# An artificial retina processor for track reconstruction at the full LHC crossing rate

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The goal of the “INFN-RETINA” R&D project is to develop and implement a parallel computational methodology that allows to reconstruct events with an extremely high number (>100) of charged-particle tracks in pixel and silicon strip detectors at 40 MHz, thus matching the requirements for processing LHC events at the full crossing frequency.

Our approach relies on a massively parallel pattern-recognition algorithm, dubbed “artificial retina”, inspired by studies of the processing of visual images by the brain as it happens in nature.

Preliminary studies on simulation already showed that high-quality tracking in large detectors is possible with sub-microsecond latencies when this algorithm is implemented in modern, high-speed, high-bandwidth FPGA devices, opening a possibility of making track reconstruction happen transparently as part of the detector readout.

In order to demonstrate that a track-processing system based on the retina algorithm is feasible, we built a sizable prototype of a tracking processor with 3,000 patterns, based on already existing readout boards equipped with Altera Stratix III FPGAs. The detailed geometry and charged-particle activity of a large tracking detector currently in operation are used to assess its performances.

All the processing steps, like dispatching hit data and finding local maxima in the track parameters space, have been successfully implemented in the board at the nominal clock frequency (160 MHz). We test the whole processing chain providing hit sequences as input, and correct parameters for reconstructed tracks were received on the output. Hits are processed at a 1.8-MHz event rate, using boards that had originally been designed for a 1-MHz readout-only functionality.

We report on the test results with such a prototype, and on the scalability prospects to larger detector systems and to higher event rates.

## Tertiary Keyword (Optional)

Parallelization

## Secondary Keyword (Optional)

Reconstruction

## Primary Keyword (Mandatory)

Trigger

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