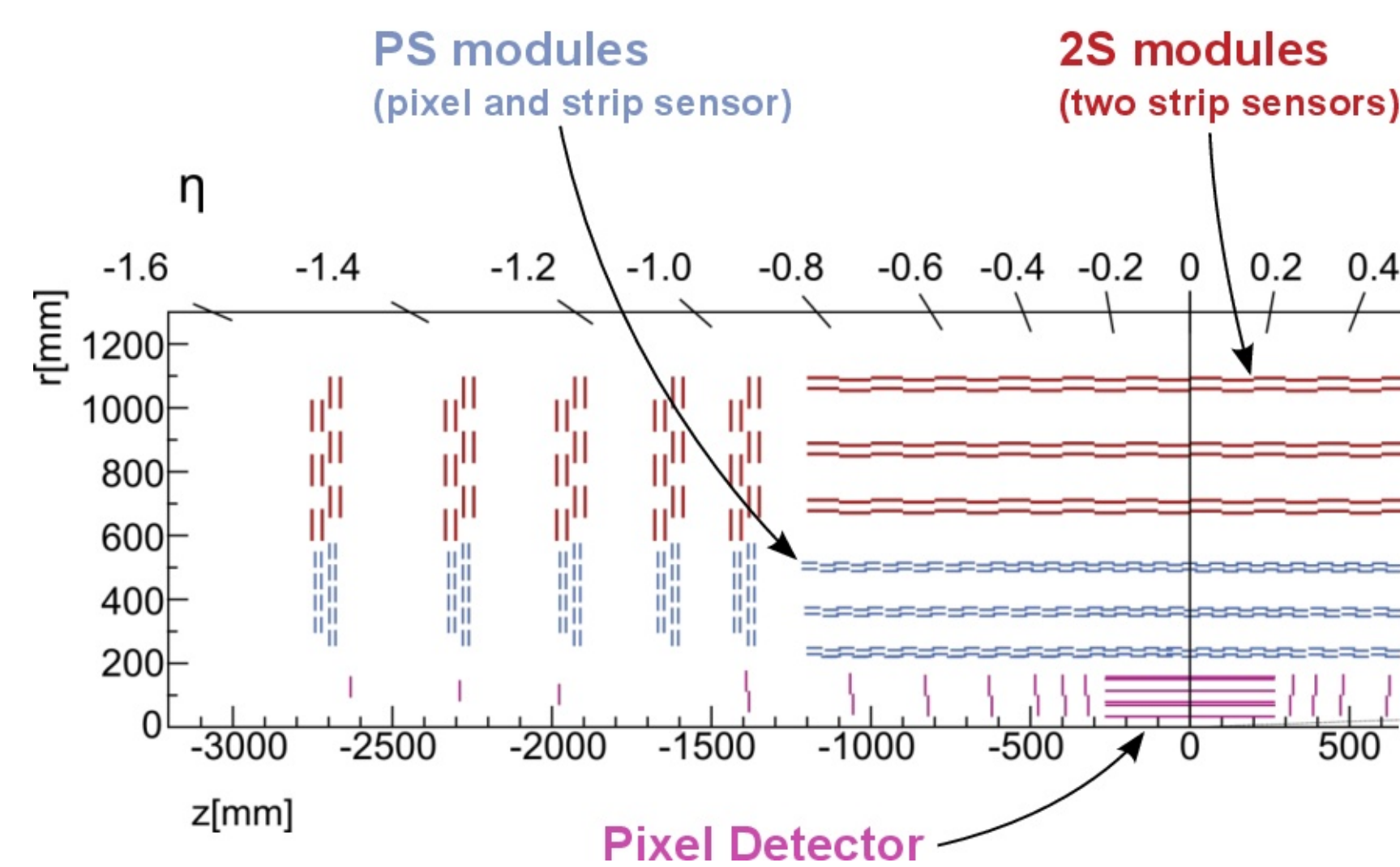


Specifications of the Track Trigger

After the high luminosity upgrade at the Large Hadron Collider (LHC), a Track Trigger processor at the CMS experiment will be needed. It must fulfill following properties:

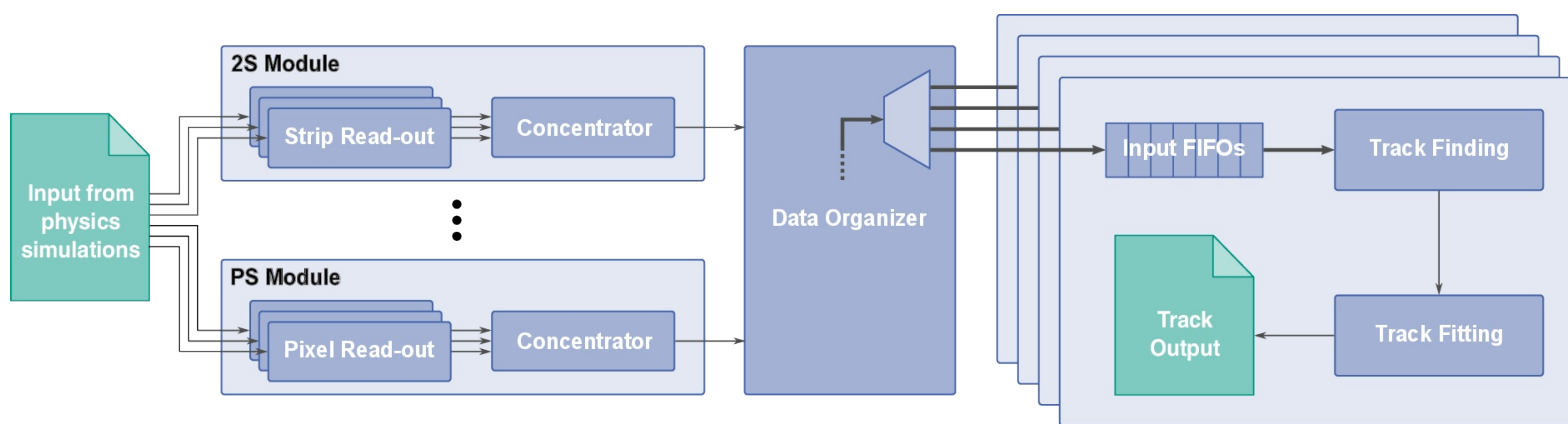
- Input bandwidth in the order of 100 Tbit/s
- Latency below 10 μ s
- Output event rate below 1 MHz



Targets of the Framework

- Evaluation of system architectures
- Evaluation of algorithms
- Evaluation of figures of merit, e.g. latency, buffer sizes
- HDL validation through co-simulation of SystemC and HDLs

Structure of the Framework



2S Module and PS Module: Represents the 2 types of sensor modules foreseen within silicon tracker.

Read-out: Represents the front-end electronics of the silicon detectors. In the model they read the input data from a text file.

Concentrator: Collects the data from all the read-out chips of one module, and transmits up to 12 hits to the back-end within a 8 clock cycle window.

Data Organizer: Collects data from the different layers of one slice and the adjacent modules of the

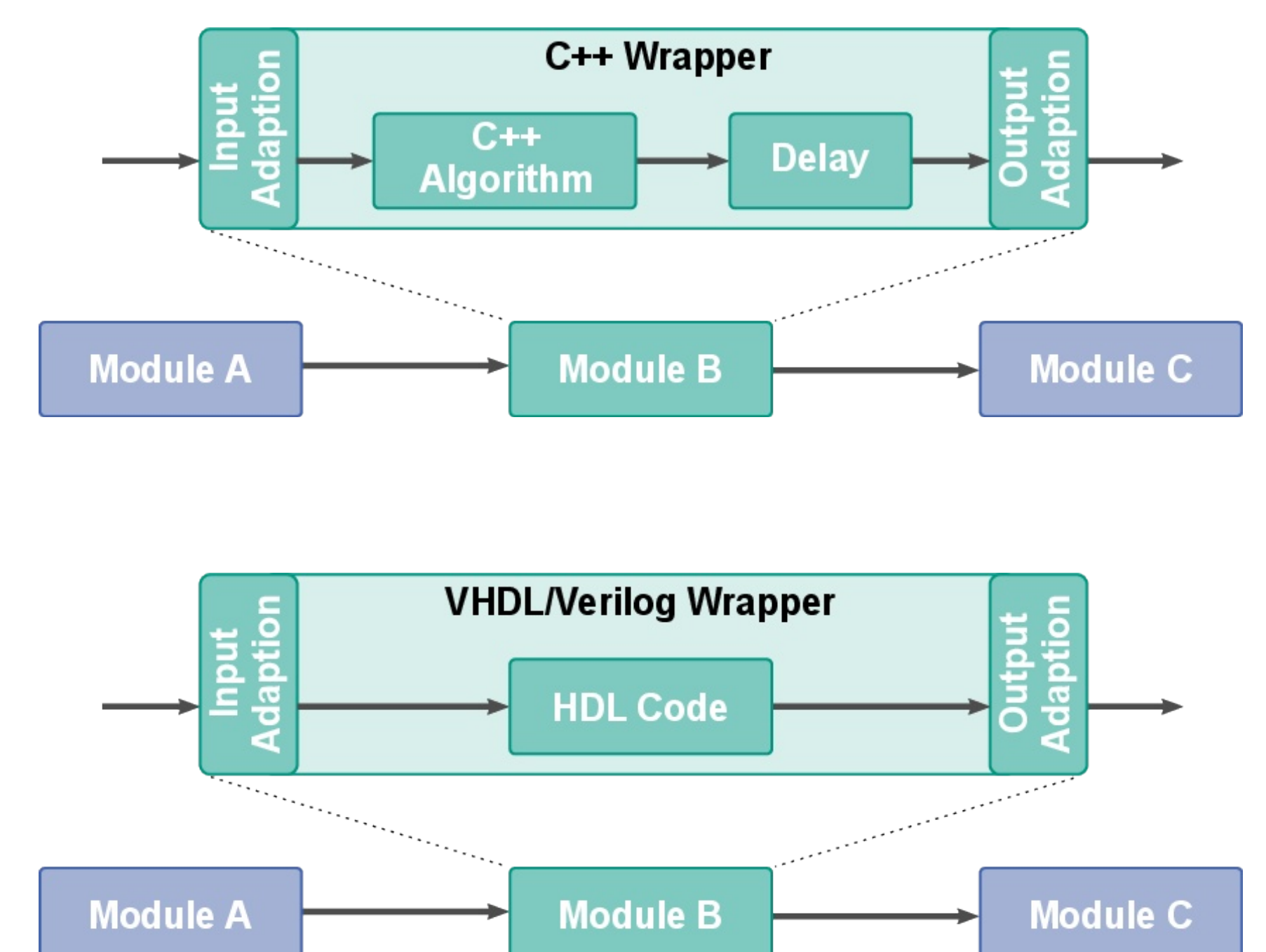
neighbouring slices and distributes them to the processing units.

Track Finding: Compares the hits with the tracks stored in associative memories. Hits that build to a stored track are forwarded to the Track Fitting. Four Track Finding units handle hit data from one data organizer. They are time-multiplexed to fit the expected data rate.

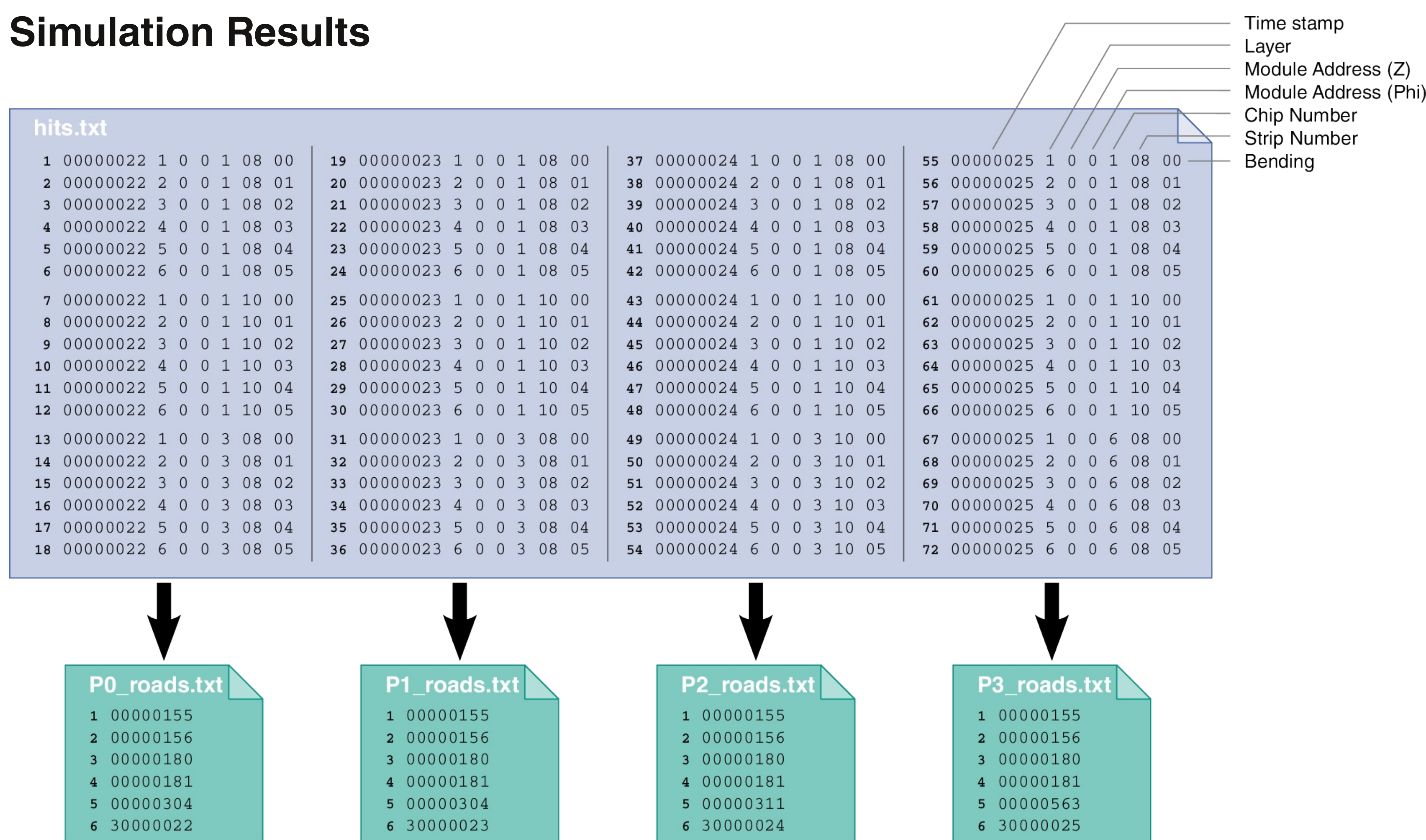
Track Fitting: Processes the hits of the selected tracks again to achieve better filtering and higher resolution tracks.

Co-Simulation

The Simulation Framework is developed in SystemC, a C++ library that extends the programming language's features with the possibility to simulate hardware. The higher abstraction level of SystemC allows faster modelling on the one hand and faster simulation on the other hand. Within Modelsim, co-simulation with VHDL and Verilog modules is possible.



Simulation Results



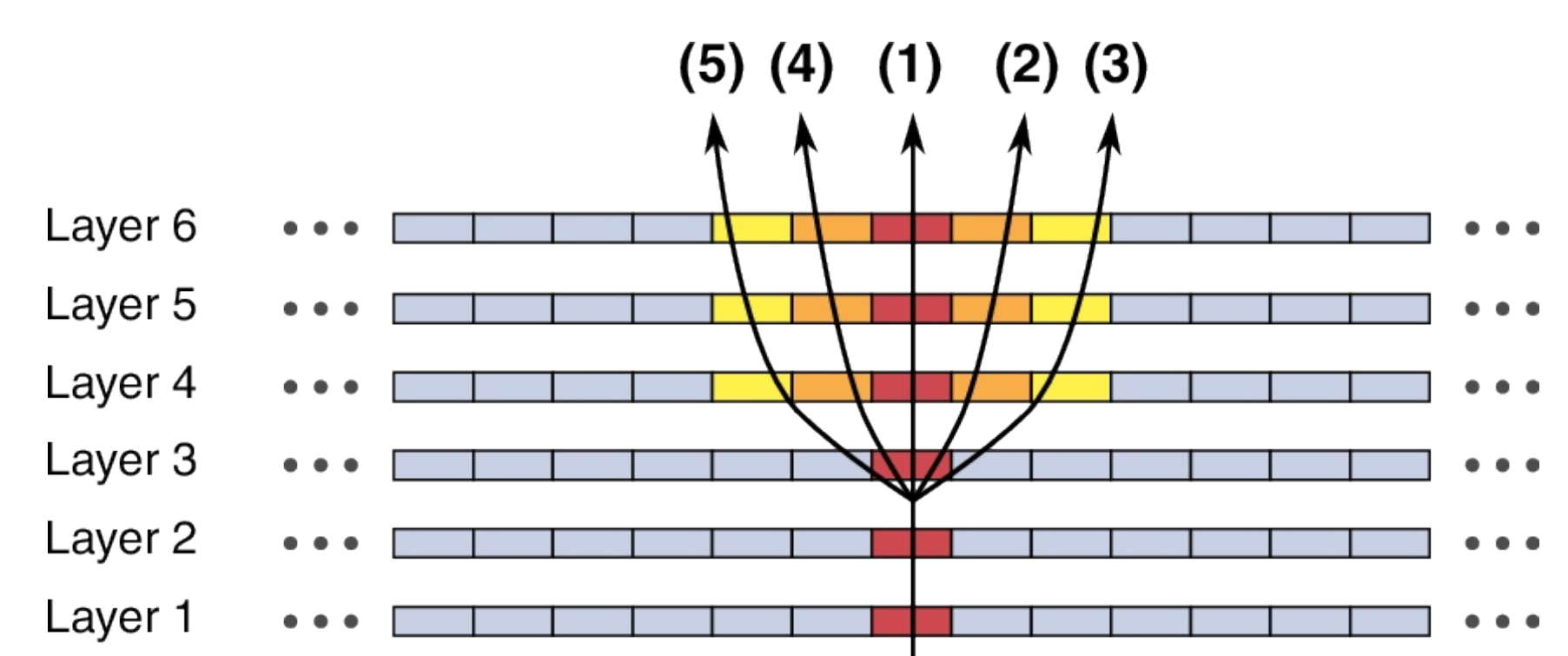
Input File

The hits, as picked up by the detector, are fed from the hits.txt file to the Simulation Framework. In this simplified example, there are events in four consecutive bunch crossings with 18 hits each.

Output Files

The tracks detected from the hits are written in one output file for each time-multiplexed track finding module. In the example, there are 5 detected hits which are written to the files with the according timestamp.

The following figure shows the tracks that are recognized by our test: Starting from each strip of the layer 1, there exist one straight track (1) and four tilted tracks (2-5).



Outlook

The SystemC and HDL models are fully validated within a simplified test bench. The framework will soon be available on GitHub to the community for testing of algorithms and HDL code.

- Using input data from physics simulations
- Evaluate figures of merit of the Track Trigger, e.g. latency, buffer sizes
- Simulate a complete slice of the detector
- Parallelize the Simulation Framework, run on computing grid