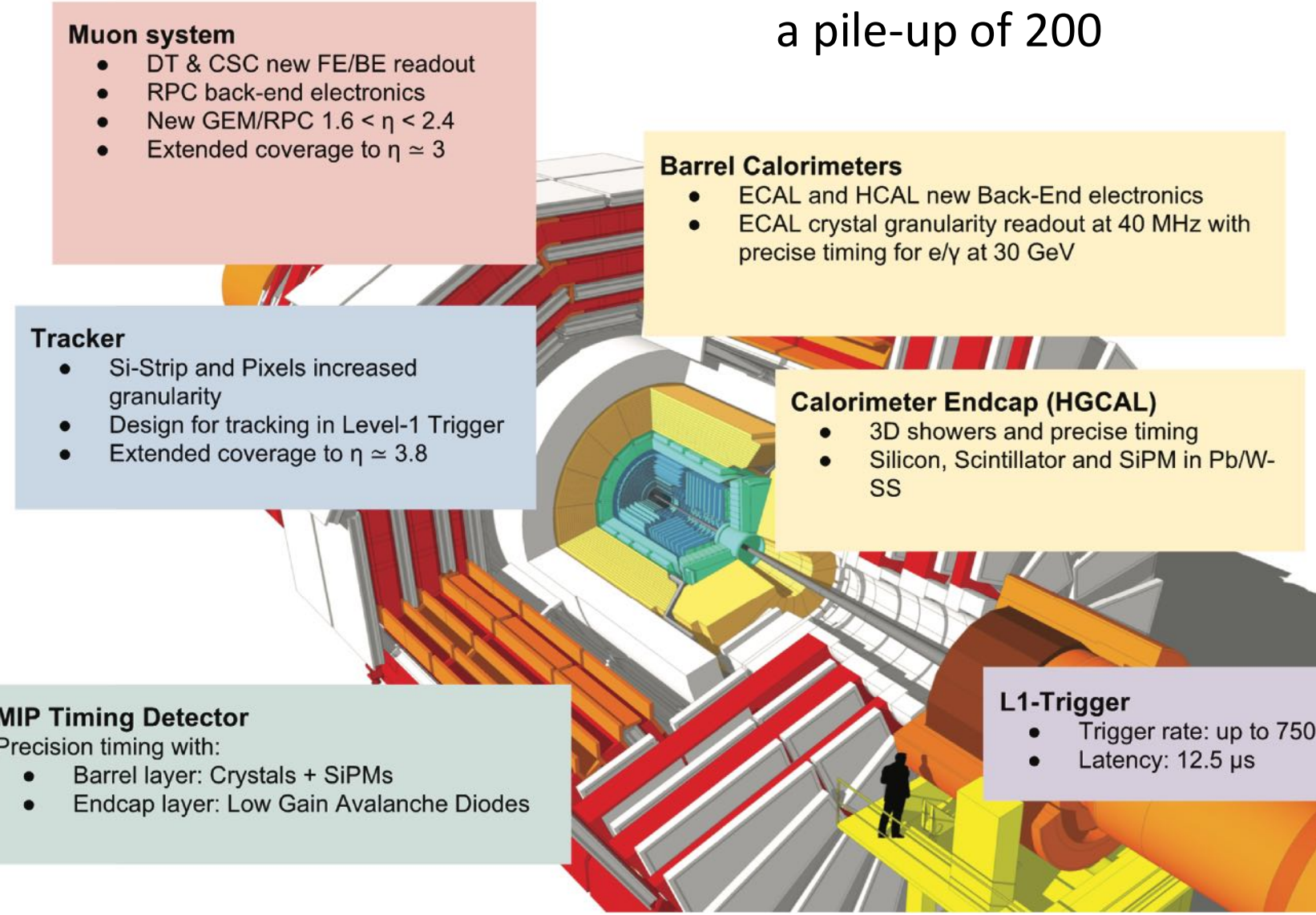


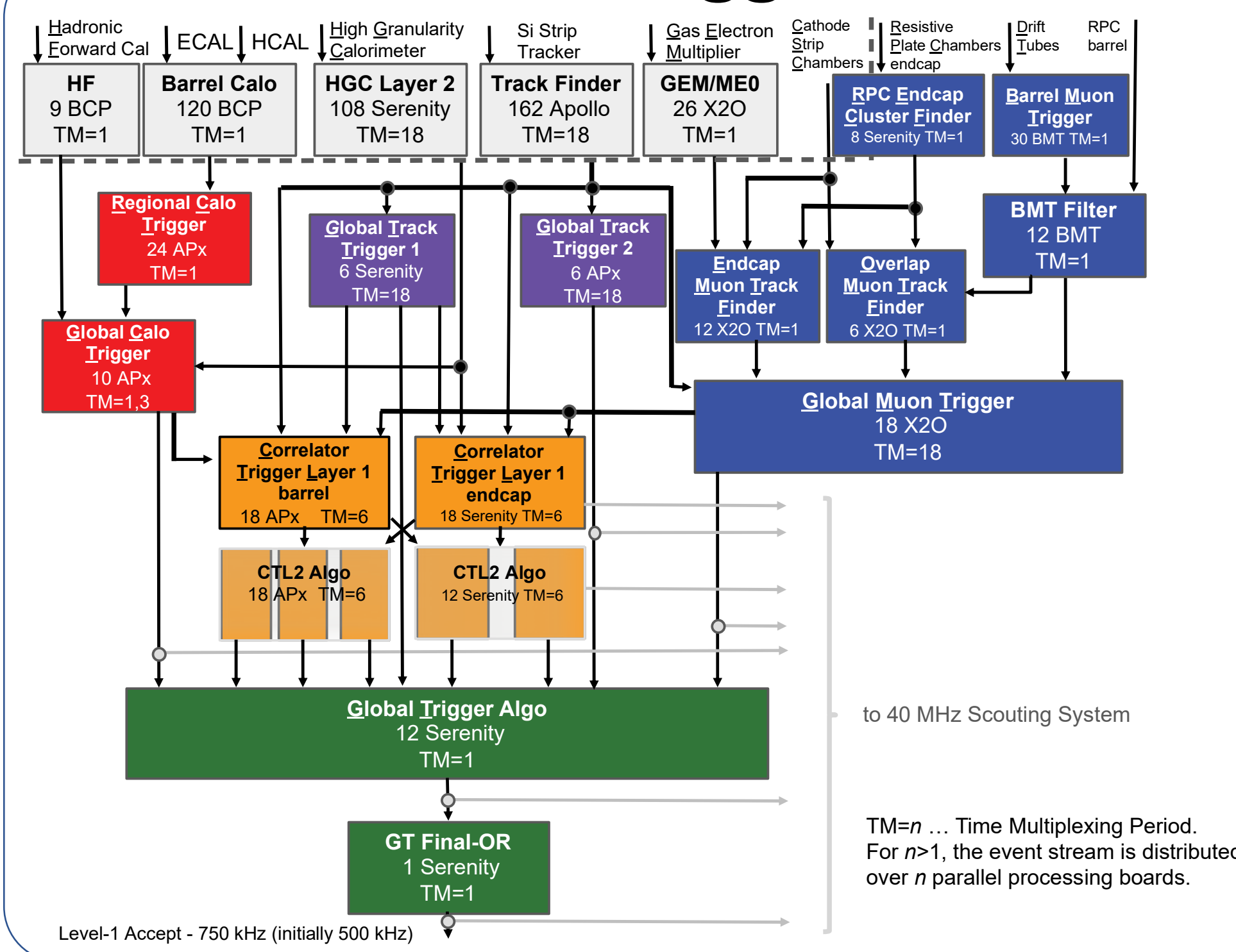
CMS Phase-2 Upgrades

Phase-2 = High Luminosity LHC, starting 2029+

CMS is upgraded to cope with a pile-up of 200

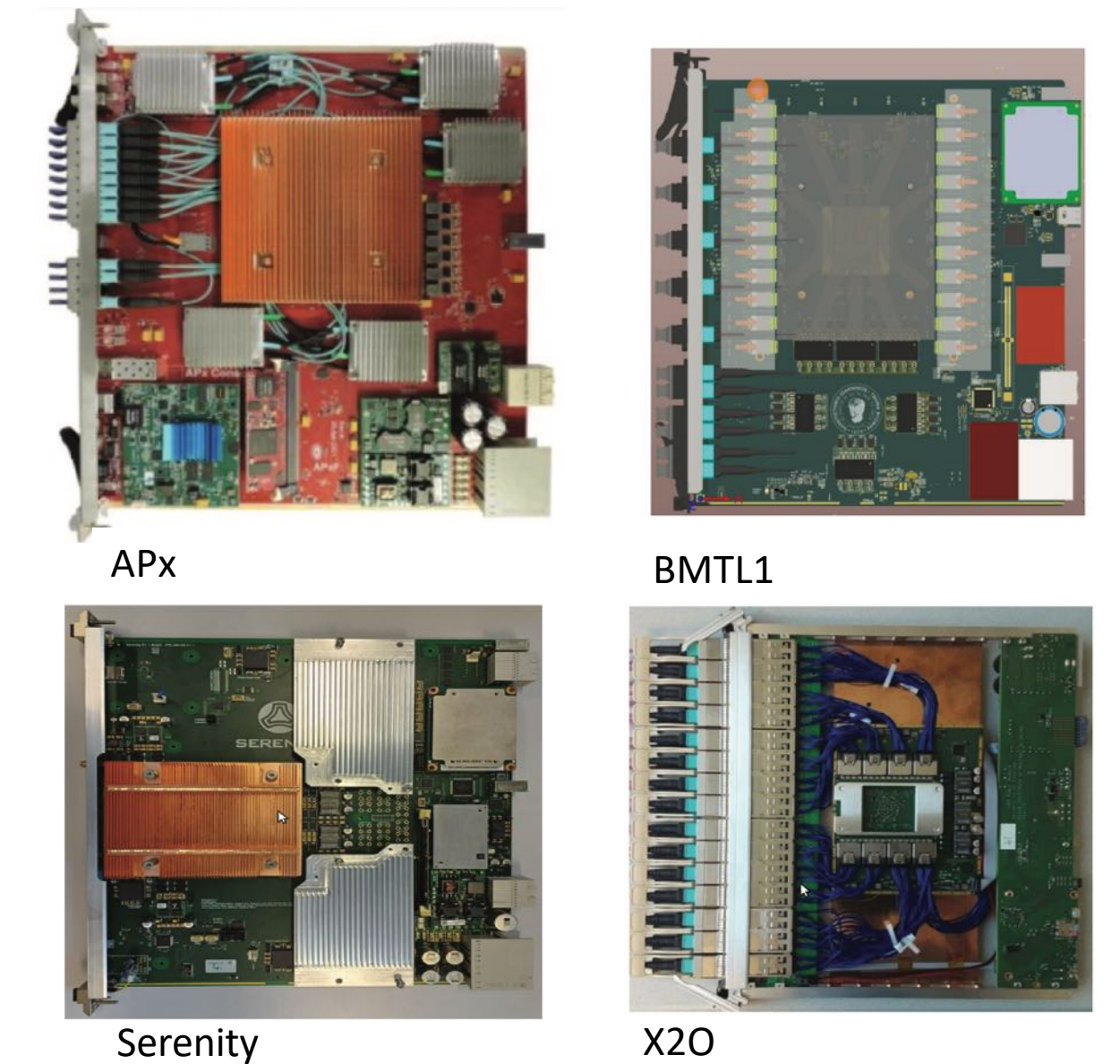


A new Level-1 Trigger for Phase-2



New features at Level-1

- Silicon Tracker Tracks
- Vertex finding
- High granularity calorimetry
- Particle flow objects
- Pile-Up Per Particle Identification (PUPPI)
- Extensive use of machine learning conditions/algorithms
- 40 MHz Data Scouting System

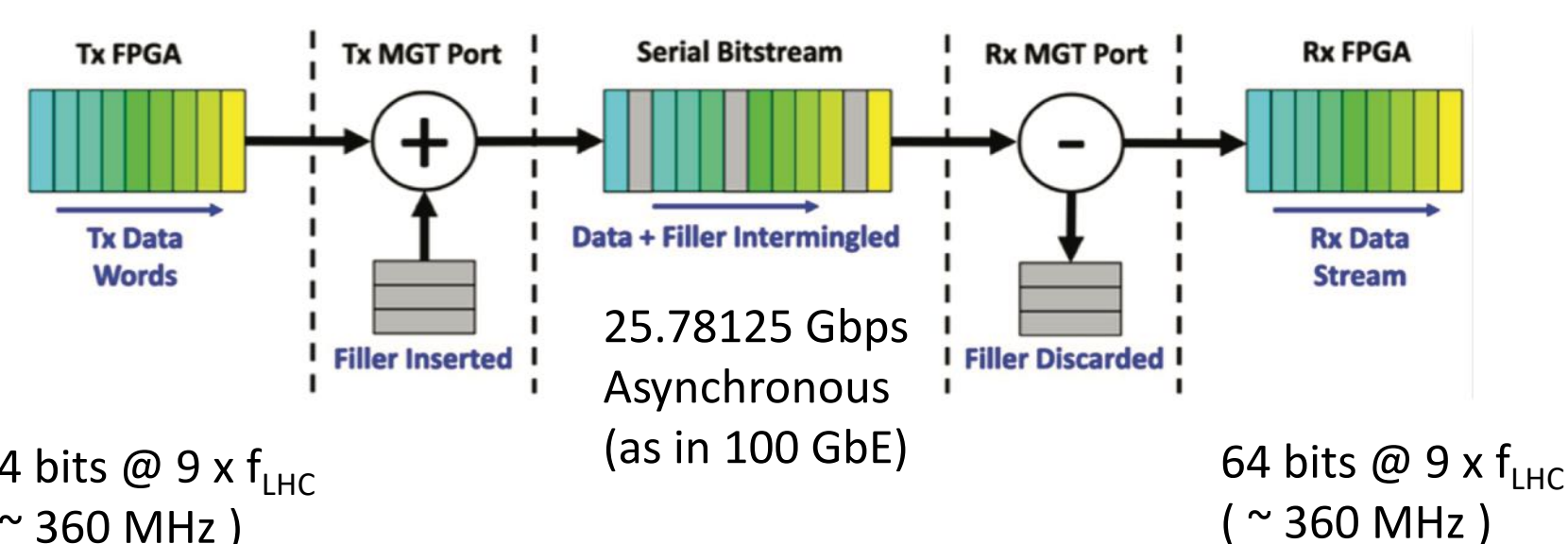


Four types of custom ATCA processing boards

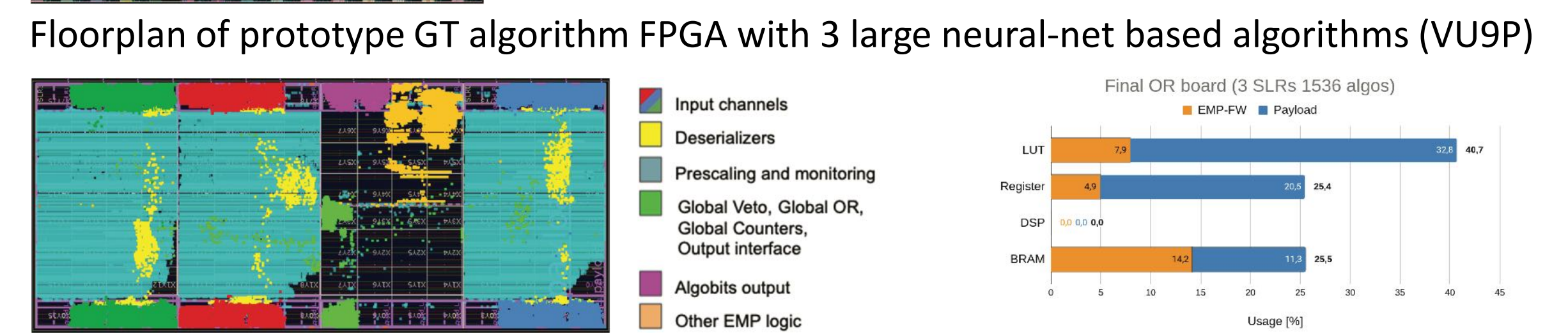
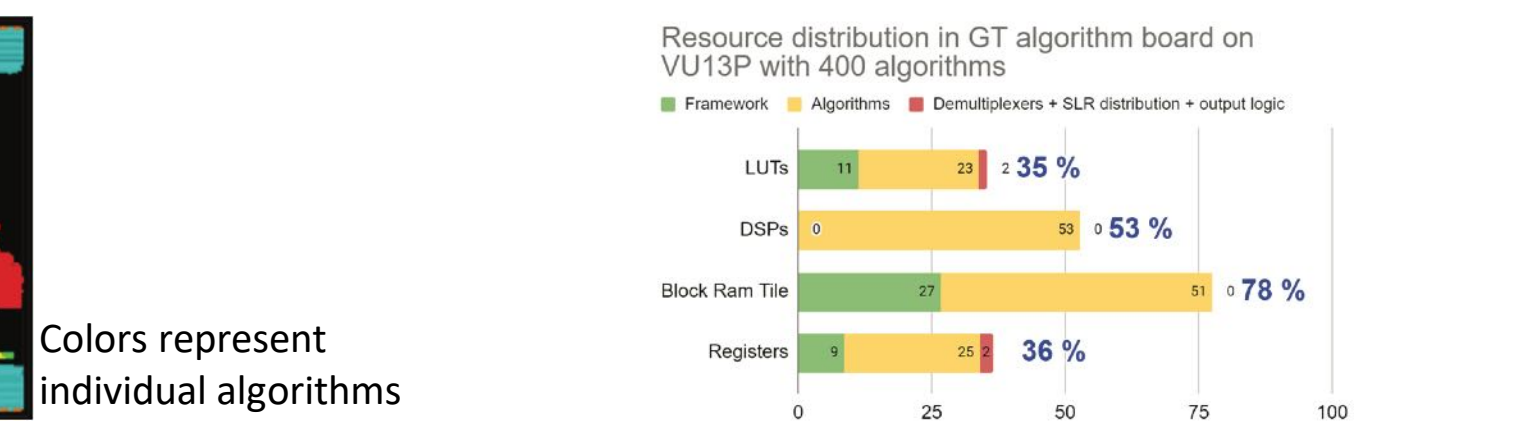
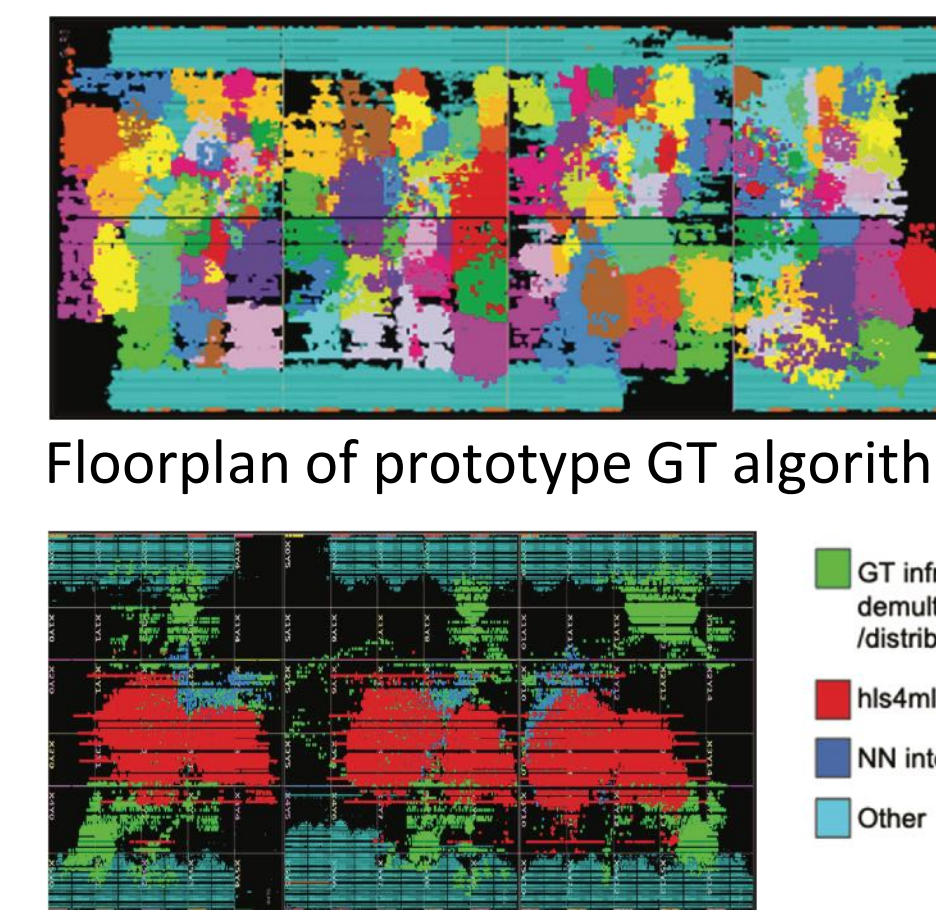
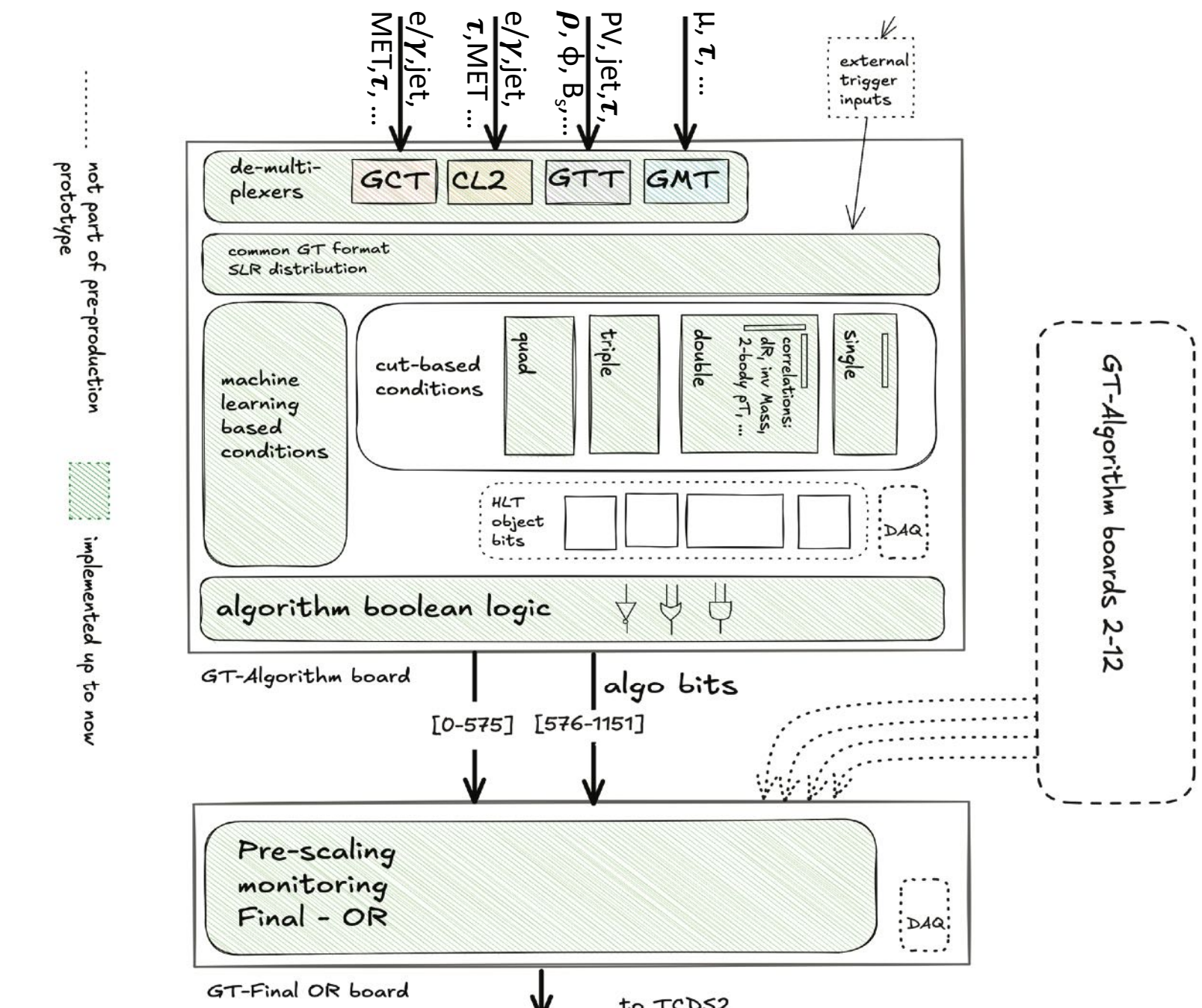
- Hosting 1 or 2 AMD Ultrascale+ FPGAs
- Interconnected with 25 Gb/s optical links

CMS Standard Trigger Link Protocol (CSP)

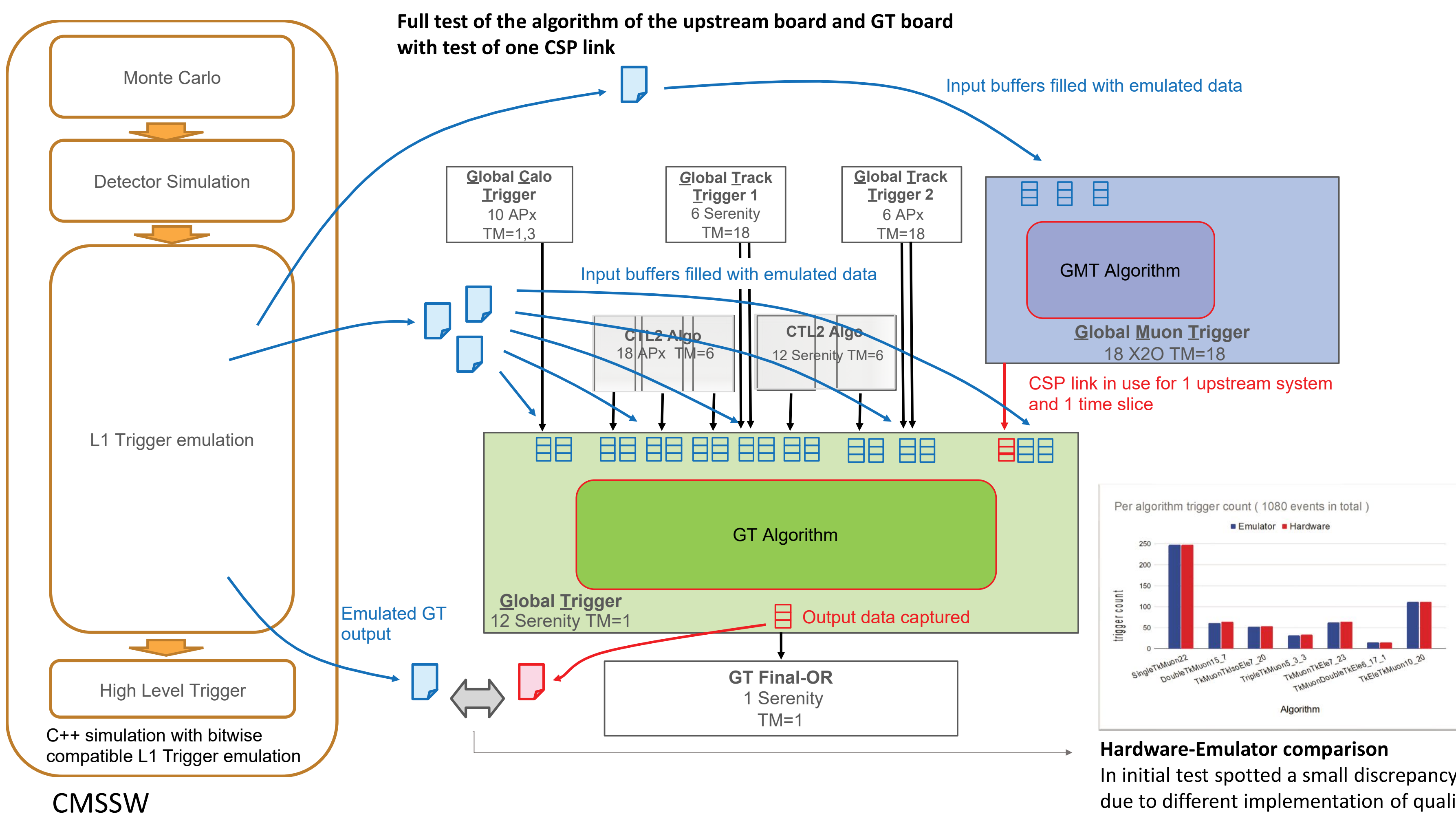
- Transfer LHC synchronous data with low latency
- No retransmit
- 67/65b encoding
 - Parity to correct bitflips in header
 - Scrambling to preserve DC line balance
- Control bytes are Hamming encoded
 - Correct single bitflip, detect double bitflip
- Filler bandwidth is used to mark orbit, protect data packets with CRC, send link ID



The Phase-2 Global Trigger



Integration tests



CLT2 jets (Serenity) → GT Algo (Serenity)	CLT2 e/γ (Serenity) → GT Algo (Serenity)	GMT (X2O) → GT Algo (Serenity)	GTT (APx) → GT Algo (Serenity)	Generic upstream (Serenity) → GT Algo (Serenity) → GT Final-OR (Serenity)	2x GT Algo (Serenity) → GT Final-OR (Serenity)
Tested jets, Missing ET	Tested electron / gamma	Tested standalone muons	Tested primary vertex and MET: 2 links from GTT synchronized at GT	3-board test including readout of monitoring counters in GT Final-OR board	3-board test including readout of monitoring counters in GT Final-OR board
With standalone GT emulator	With standalone GT emulator	With CMSSW emulator	With standalone GT emulator	With standalone GT emulator	
✓	✓	✓	✓	✓	✓

Successfully performed first tests with all types of upstream boards.

Slice Test connected to ongoing Run-3 (being commissioned)

