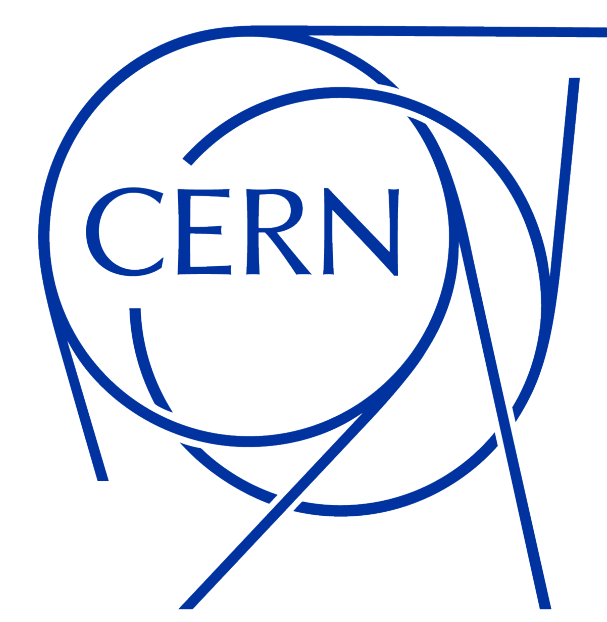
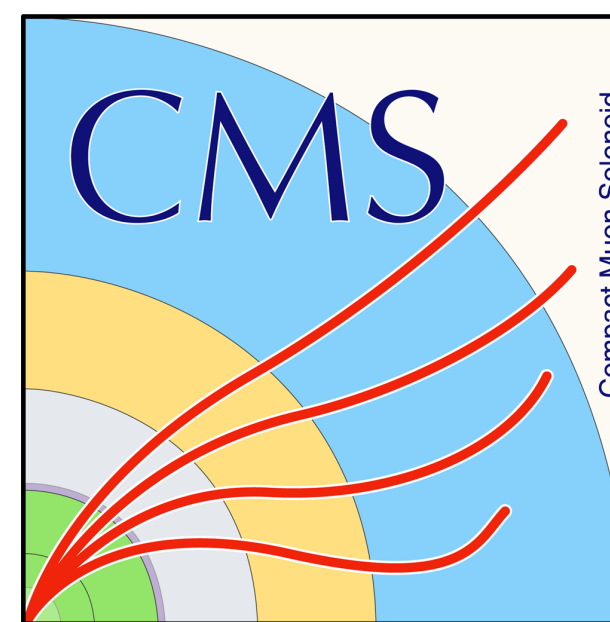


Advancing the CMS Level-1 Trigger: Jet Tagging with DeepSets at the HL-LHC

Duc Hoang, Chris Brown, Stella Schaefer, Sebastian Wuchterl, Sioni Summers, Philip Harris.



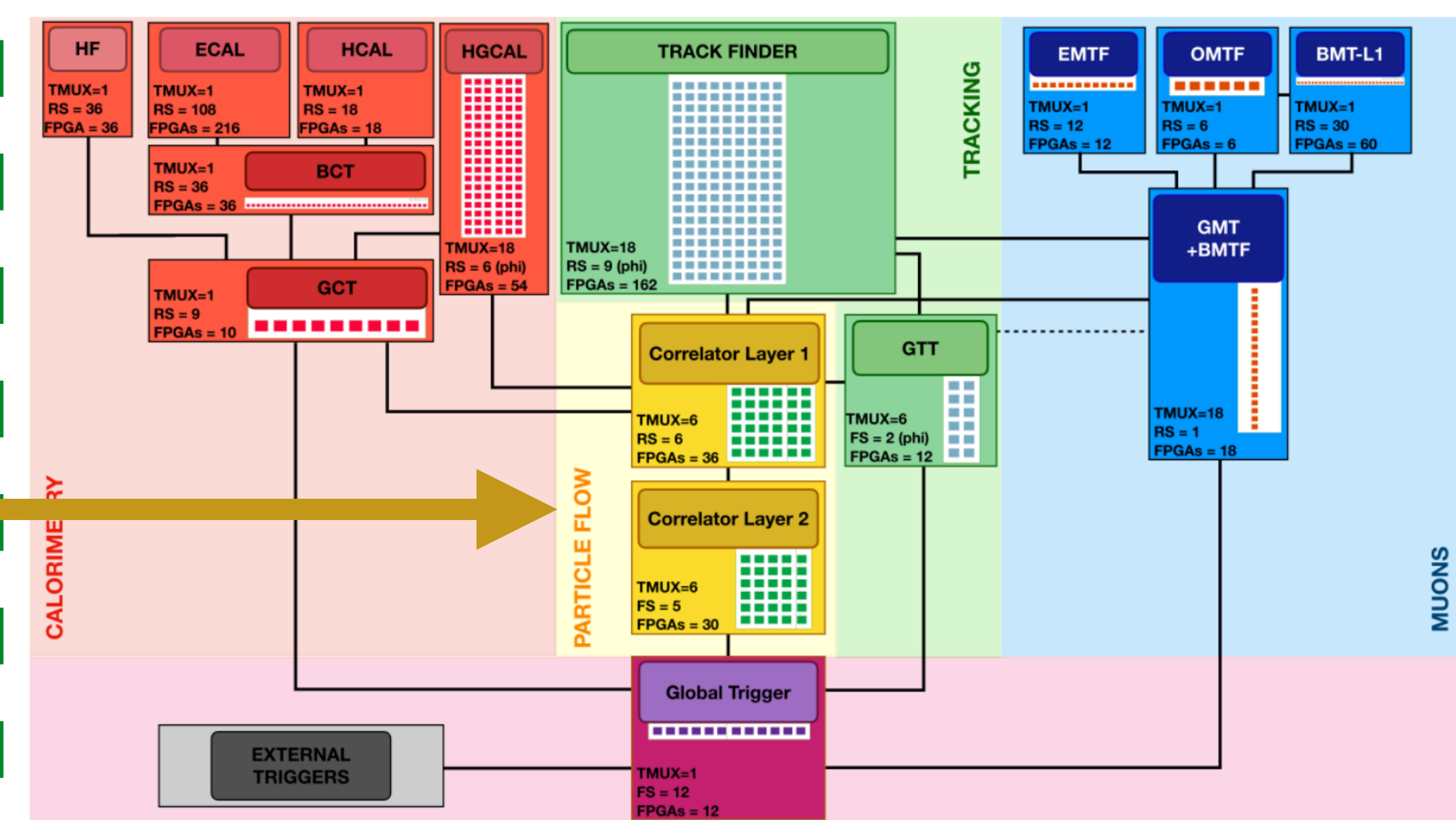
At the **Large Hadron Collider (LHC)**, galaxies of protons collide **40 millions times per second**.

Identifying jets in real time at data rates of roughly **Petabit/s** is a crucial task at the LHC.

Successful jet identification allows scientists to **reconstruct collisions** and probe the **fundamental physics** behind them.

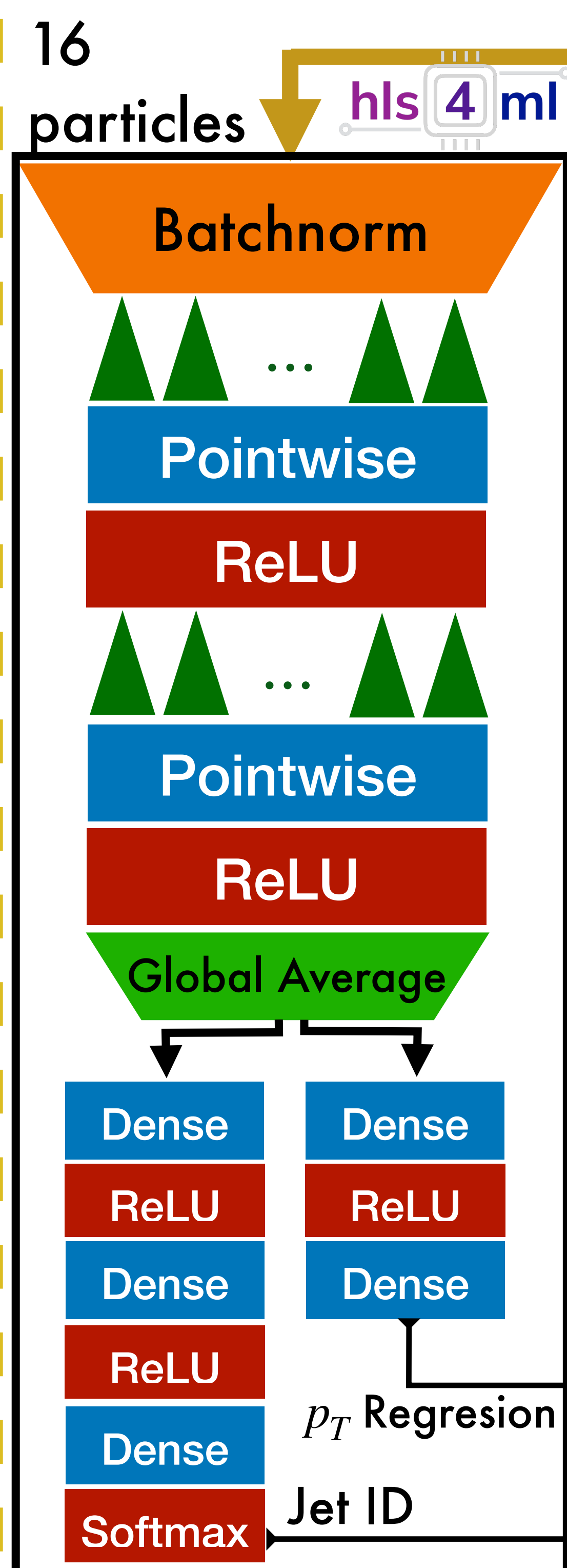
CMS Detector
O(Pb/s) data rate
Level 1 trigger

A farm of **500 FPGAs** will receive data from the detector



The system have a **12.5 μ s** time window to process an event.

Real-time Machine Learning



Each event is assigned a **unique token** for tracking during parallel processing.

NN results and jet objects are saved in **64 bit words**

NN	%VU9P
LUT	35
FF	16
DSPs	15
BRAM	0
Latency	148ns (II=2.8ns)

Reconstruct particles constituents

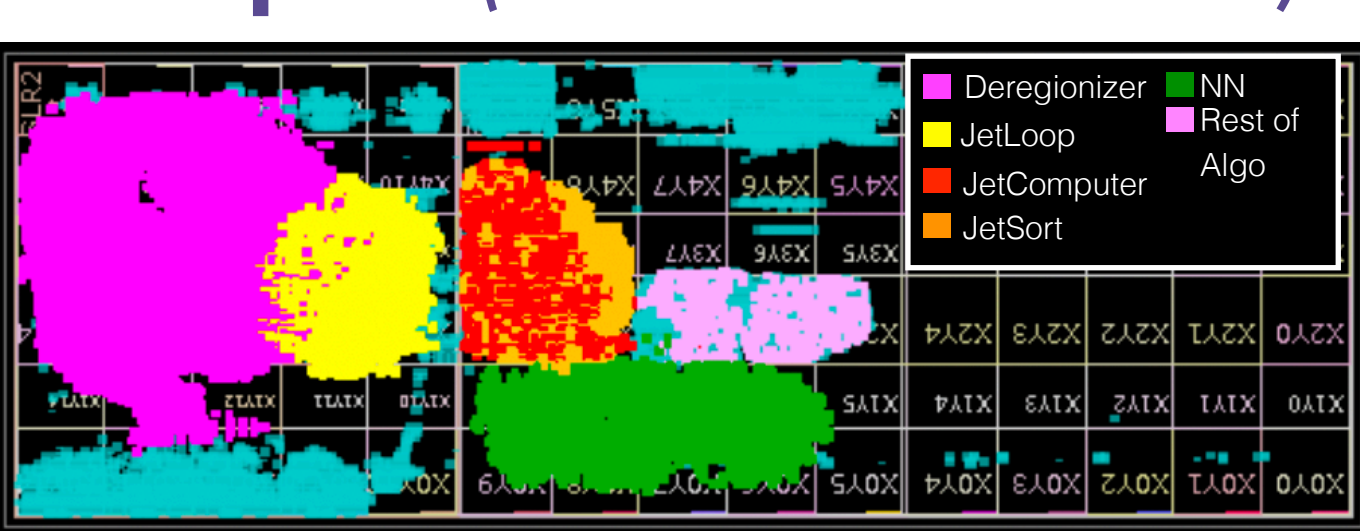
Sort particles by their momentum (p_T)

Standard jet reconstruction chain

Jet objects

Synchronizer
Final jet objects

Floorplan (Xilinx FPGA VU9P-2)



The **L1 trigger** decides if detector data is sent to next tier.

Yes/No?

Increased Physics Performance

