Real Time Processing Challenges for Silicon Based Tracking Trigger at High Luminosity LHC

In order to fulfill the physics goals in the environment of very high pile-up envisioned for HL-LHC, CMS must preserve its ability to identify in real time signatures of events originating from interesting physics processes. Ability to use tracker information at Level 1 trigger provides a highly efficient handle for pile-up mitigation and will be one of the main goals of the CMS Phase 2 upgrades. However the higher occupancies anticipated at the HL-LHC and the low latency required at L1 (about several μs for the track finding stage) present us with a formidable set of challenges. The bandwidth required to bring all the useful data from the massive outer silicon tracker reaches to 100 Tbps, and for every 25 ns (beam crossing rate at 40MHz) the tracks from each beam crossing will need to be fully reconstructed out of an ocean of background hits. This is as high performance computing as it ever gets, and has to be done using a non-von Neumann approach. In other words, High Luminosity LHC requires the most advanced Real Time processing technology. In this talk, we will take a brief look at the past, present and what challenges lie ahead and ways to address them, with the view from the physics motivations, the technical challenges, and the interplay between particle physics and industry. Specific examples of recent and current technical developments will be presented, including generic use of the Advanced Telecommunication Computing Architecture, emerging 3D-IC technology and ultra-large high-performance pattern recognition associative memories.