Thoughts on Future Calorimetry

Issues are generally well known for increasing precision of calorimetry.

- **Cost/performance**
  - Reality looms over over most discussion for industrial scale instrumentation.
  - For R&D purposes, assume these issues get better with time.

- **Signal collection / active volume / granularity**
  - Speed/Efficiency of charge collection, light collection
    - Metalenses, designer optical impedance and filter technologies
    - Direct integration with (in)organic scintillator block fabrication?
  - (Effectively) Large area sensors
    - Integration of light concentrators/AR optics into sensors
    - How to go beyond silicon wafers? New printable electronics technologies? Much room for exploration for thin film tech, eg huge industrial base already existing forOLED displays.
Thoughts on Future Calorimetry

• **Signal Readout**
  • Dynamic range for ECAL
    • $10\text{MeV} - 100\text{GeV} \ @ \ higgs \ factor, \ O(13-14 \ bits)$
    • ~$50-100\text{MeV} - 10\text{TeV} \ @ \ super \ large \ hh \ machine, \ O(15-16 \ bits)$
  • Readout and sensor integration, ADC/TDC
  • Fight the tyranny of FPGA resource limits: fast, controlled-latency interfaces to CPU/GPU for L1 triggers
    • Move more towards computing HW model for R/O, reduce dependence on old tech due to long lead times

• **Calibration/operations**
  • Stability
    • Possible radiation resistance
  • Embedding calibration hardware at cell level
Thoughts on Future Calorimetry

- **Synergies**
  - PFA optimized, huge channel counts
  - High resolution / PFA balanced, more moderate channel counts / optimal E resolution
  - Exploit specific capabilities of calorimeters
    - Time spectrum of shower development
      - New paradigms for DAQ, eg continuous readout w/ RT analysis in larger time windows following L1 triggers
    - LLPs
      - (partial) collection of neutron afterglow to improve hadron resolution
  - Improvements on GEANT performance, materials and physics modeling