Brainstorming for a future FCC-hh detector

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LLP9

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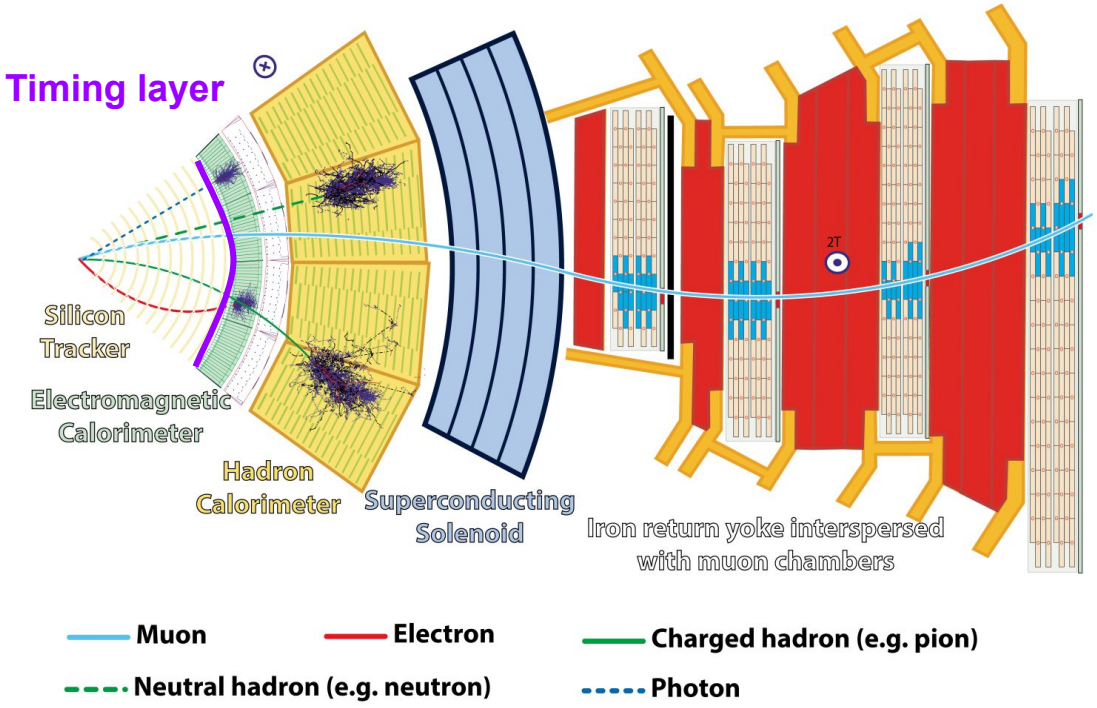
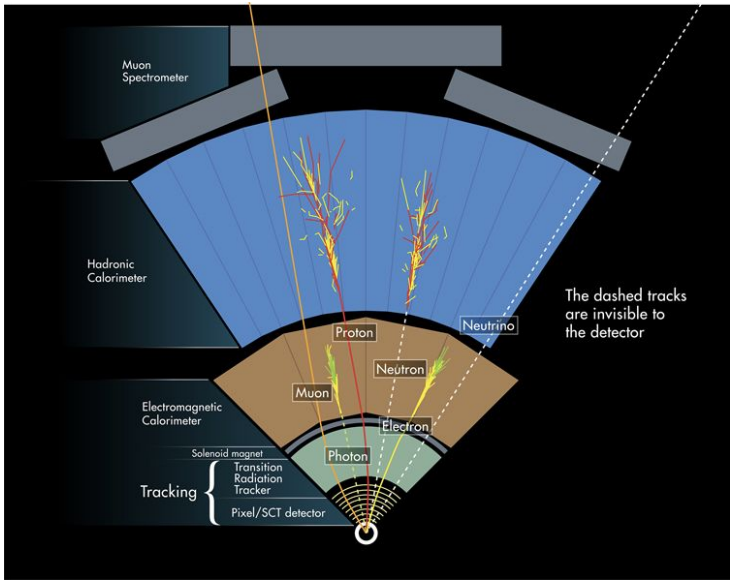
Detector overview





General topics

- Triggering: should *effectively* use full event information (tracking, timing, etc.)?
  - what area is most important? ID vertices? calo objects? other?
- Precision timing is a potential game changer for LLP
  - where is it most important? ID? muon system?
- Trackers will be more capable?
  - short tracks? triggering on IP displacement? other?
- Calorimeters will be (much?) more granular
  - how is this useful for LLP? background rejection?
- Muon systems will be ~the same?
  - But what would we like in terms of new capabilities? Background suppression?
- Forward regions / other caverns can be *designed* instead of parasitically used
  - what would be ideal for these?
- Other ideas …
  - Subdetector ideas that can help help BIB, cosmics, ?

Trigger desires for LLPs

- Triggering should *effectively* use full event information (tracking, timing, etc.)
- Primarily computing problem, should be tractable by ~2040
- Default track reconstruction should consider vertices from anywhere
- Loose selections or good bandwidth reduction more important?
  - Scouting is also key and lives in between
  - How can we be confident enough in saving only reco quantities?
- Are DV's in the trackers still the main improvement possible?
  - How far in IP can we push the track trigger reco?
  - L1 reco of charm/b/tau decays / displaced photons
- Combinations of triggers from many detectors (at L1!)
  - e.g. calo jet + dv at L1

Timing desires for LLPs

- Each system should have some level of timing
  - Multiple layers for confirmation and tail removal
  - Separation of pi/K up to ~10 GeV?
  - Mass measurement of tracks
- Calo timing
  - Separation of jets from different interactions
  - Delayed jets? Dark shower decays?
  - How good timing do we want?
- *Example:* muon system has 0.5 ns resolution. Would it benefit from a dedicated O(30) ps timing layer?
  - Neutral decays in the MS?
  - Pileup rejection?
  - Reconstruction of complicated decays in the MS / EJs
- …

Tracker desires for LLPs

- Layers close to the beam? (for disappearing tracks)
- Pixels everywhere?
  - dE/dx (including triggering, and ability to combine with pT, other layers, etc. at L1)
- Ability to see fractional charged particles?
- ...

Calorimeter desires for LLPs

- More granular calorimeters (useful for emerging jets?)
- Can beam-induced backgrounds be vetoed?
- Non-pointing photons (including triggering)
-

Muon system desires for LLPs

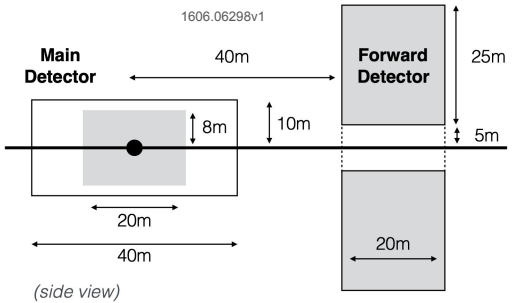
- *Idea:* wrap the muon system in a thin calorimeter?
- *Idea:* improve shielding from main collision? (may conflict with prompt muons)
- ...

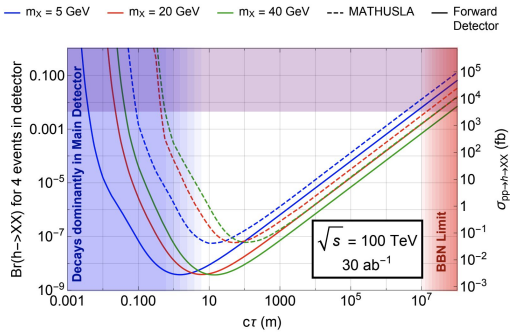
Forward region desires for LLPs

- FCC-hh version of FASER (minimal extra cost)?
- Best location? Closer with shielding?
- Proton tagging / exclusive production (Higgs?)
  - gamma-gamma collisions, other clean states
- ...

Idea: Separate shielded LLP detector subsystem

- If MS can't be arbitrarily shielded to *eliminate* QCD backgrounds, could have a dedicated LLP detector subsystem to avoid having to retrofit a MATHUSLA/CODEX.
- Could be some caverns in the forward region instrumented like MATHUSLA/CODEX (see 1606.06298), easy to put in when constructing tunnel.
- Fully integrated into main detector: reconstruction, triggering, etc.
- ...





Anything else (beyond the CMS/ATLAS paradigm)?

- ...