

LLPs at the (HL-)LHC and external detectors

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SNOWMASS 2021 EF09 LLP Meeting
12 June 2020

EOIs:

David:

One possible worthwhile goal for the snowmass process would be for the **external LLP detector collaborations (MATHUSLA, FASER, CODEX) to work together (include SHIP) towards a somewhat harmonized discussion of their respective physics reach, signal, backgrounds, etc.** the extent to which this can be simply unified is limited, since the detectors are very different and operate in completely different environments. However, on the one year timescale is the snowmass process, the collaborations could advance their respective simulations and estimates to include the most important backgrounds and signal reconstruction issues. Bringing these studies under the snowmass umbrella would allow for an efficient exchange of expertise and timely progress on this goal.

Henry:

Searches for Long-lived particles in the LHC detectors and future searches In in proposed new detectors such as FASER, MATHUSLA, CODEX-b, SHiP... Suggest **focusing on a couple of baseline models such as Higgs/scalar portal and vector portal models to compare the physics reach of these detectors.** Also defining and implementing good studies of backgrounds, which by nature of the proposed new detectors and their location wrt to the IP detectors will be different for each detector.

Gordon:

I'm mostly interested in collider and MATHUSLA. Plans include understanding reach at HL-LHC and MATHUSLA (at HL-LHC). Very interested in capabilities of new detectors as well. Also interested in **understanding if there are new models or techniques that we could use to further our exploration of this field.**

Harmonizing External LLP Detector Projections

Problem: External LLP detector proposals like MATHUSLA, FASER, CODEX are very different in terms of scale/cost/design/environment/etc, and both their designs and their sensitivity projections appear to be at different stages of ‘finality’.

Proposal:

It is important to recognize that a 100% apples-to-apples comparison between all these experiments is not necessarily realistic. They are too different in environment/technology/scale. **However, within each collaboration, there are clear ‘major next steps’ that must be taken to bring the sophistication of sensitivity projections to the next level and allow a closer direct comparison to each other and to the main detectors.**

The Snowmass process would be a good umbrella venue for the external LLP detector collaborations to work together and harmonize their discussions of respective physics reach, signal efficiency, backgrounds, simulations. Due to the different nature of these detectors, and the unique challenges these studies face in each collaboration, this would be more of a ‘synchronization’ of effort to hold each other accountable to deadlines and exchange expertise regularly.

This would also involve coordinating with ATLAS/CMS/LHCb LLP sensitivity projections in agreeing on GeV-scale (c.f. PBC), weak- and TeV-scale (LLP white paper simplified models, higgs portal, etc) benchmark models/points to coordinate reach projections.

Benchmark Models

The external LLP detector collaborations should collaborate with ATLAS/CMS/LHCb in agreeing in LLP benchmark models to produce sensitivity projections for that can be compared (to the best extent possible).

These benchmarks should cover the whole range of LLP phenomena the LHC can probe: higgs portal, TeV-scale LLPs like Higgsinos, TeV-scale production modes, models inspired by supersymmetry, neutral naturalness, dark sectors, etc.

This should build on the simplified LLP model effort of the LHC LLP white paper (no need to reinvent the wheel!!!!!!).

It should also include low-mass LLP minimal models like the ones PBC studied, so the reach of the LHC can be compared to beam dump experiments etc.

See John Stupak et al slides!

New Things?

- Discussions/knowledge exchange between LLP collaborations on simulation/background/design issues could attract new members to collaborations.
- Are there new LLP models/phenomena the external detectors (or ATLAS/CMS/LHCb) can probe that have not been examined yet? (Dark showers? LLP connection to Cosmology? etc.)
- ???