Discussion Material
EF09 - BSM

More general explorations

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https://snowmass21.org/energy/bsm_general

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Reminder: EF09 Focus Questions

representative,
not comprehensive.
more input welcome!

- Are there new interactions or new particles around or above the electroweak scale? To what extent can future experiments and colliders probe this ?
- Long-lived and feebly-interacting particles represent an alternative paradigm with respect to traditional BSM searches. To what extent can future detectors and accelerators probe such particles ?
- How do we conduct searches in a more model-independent way ?
- How do we compare the results of different experiments in a more model-independent way to ensure complementarity and avoid gap in coverage?
- Is lepton flavor universality violated ? What do we learn from high energy/p_T searches ?

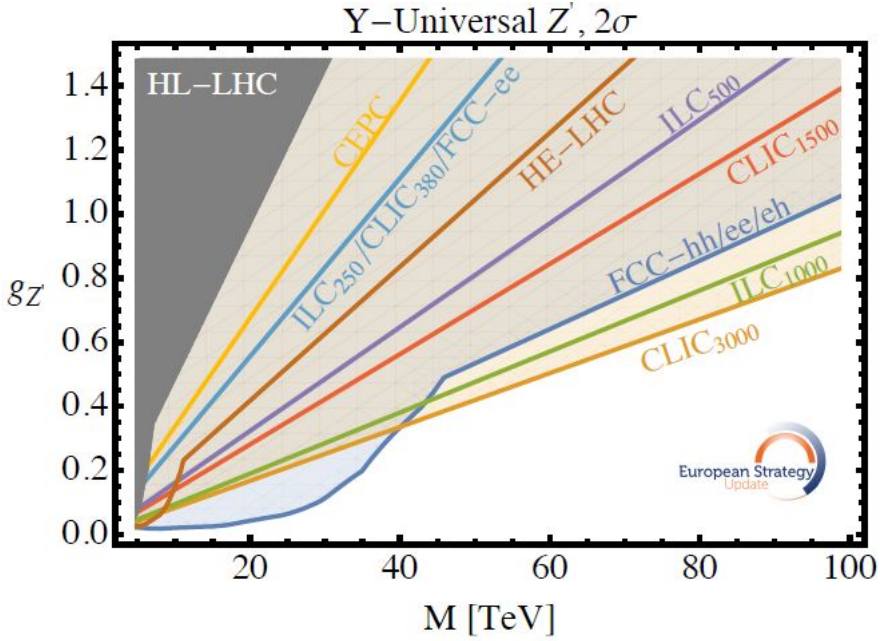
New Resonances:

- Simplified modes:
  - Dilepton
  - Dijets
  - Diboson (VV, Vh, etc)
  - Heavy Neutrino

We hope to layout the basic reach of future collider programs **comprehensively** in these simplified modes.

Resonance search and EFT searches are both needed.

Also explore more complicated modes (triboson, boosted topologies, modes w/ taus etc.)



Add updates since European Strategy (e.g. muon collider results, new HL-LHC results etc.)

New fermions:

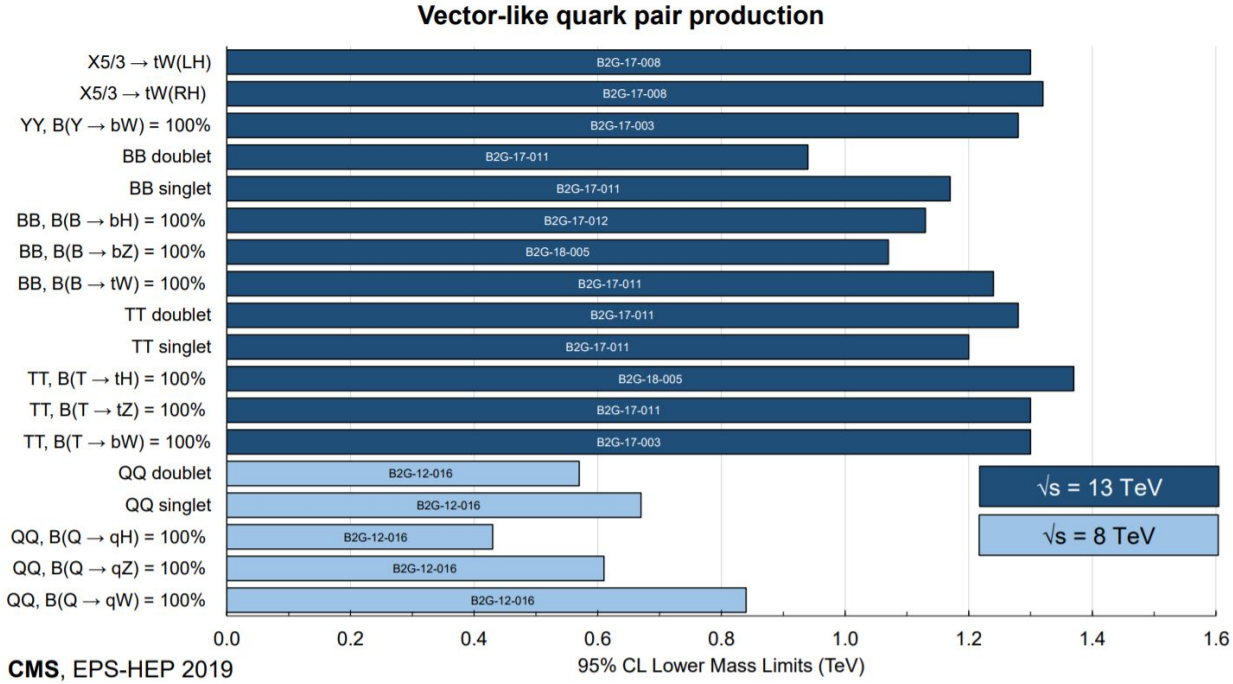
Simplified Modes:

Heavy Neutral Leptons

Vector-like Quarks

- T, B, X5/3

*Leptoquarks, Top squark are covered through (EF08)



VLQ topologies not much studied for the European Strategy.
Opportunity to add new results, updates (including muon collider results), summary plot (if possible)

Long-lived particles:

- LLP searches have strong interplay with detector design!
  - Of the uncovered (or less well-covered) signatures, which ones are most demanding in terms of new technologies or experiments needed?
  - how can we take advantage and/or shape future development in detector technology?
  - how to reasonably approach projection for detectors at early stage of design?
- How do we compare future collider options ?
  - What are “must-have” LLP signatures (e.g.. HSCP, disappearing tracks, displaced vertices…) ?
  - Can we compile a short list of benchmark models ?
  - And then test sensitivity to LLP signatures ? For varying assumptions of detector performance ?
- How do we achieve comprehensive coverage with existing accelerator facilities ?
  - Build on and extend the LLP white paper: arXiv 1903.04497
  - Better exploit upgraded HL-LHC detectors, advanced techniques, new trigger strategies...
  - Exploit the full potential of auxiliary experiments (FASER, milliQan, MATHUSLA, MOEDAL,...)
  - Explore novel forward facilities/detectors with unique physics cases for LLPs...

Synergy with Instrumentation Frontier, Accelerator Frontier, Cosmic Frontier & Rare Processes Frontier

LLP: modes under consideration

- Colored LLP
  - (gluino, mini-split SUSY)
  - (LSP mass 0 GeV and 100 GeV mass gap)
  - (mass v.s. ctau)
- Non-colored LLP
  - (Higgsino, GMSB)
  - (decay via Higgs and Z, getting reach from both leptonic and hadronic decays)
  - (mass v.s. ctau)
- Higgs portal
  - (Higgs to LLPs, neutral naturalness)
  - (LLP mass 50 GeV, 10 GeV, 1 GeV)
  - (Br v.s. ctau)
- Disappearing Track
  - (Higgsino reach and Wino reach)
  - (mass reach at different colliders)
- Other more complicated scenarios:
  - Dark showers w/ EF10
  - Light LLP benchmarks w/ RF6

Add updates since European Strategy, new results (incl. muon collider results), updated and/or new summary plots (e.g. in SUSY and Higgs decay scenarios…)

Additional Questions:

Are there broad classes of signatures and/or models that are not covered ?

How do we compare the results of different experiments in a more model-independent way to ensure complementarity and avoid gap in coverage?

How do we compare different collider options in a comprehensive way (different options have varying levels of maturity, coverage…) ?