New physics searches with the ILD detector at the ILC

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BSM at ILC: not only SUSY.

- Dark matter in $\chi^1_m + \chi^2_m$ (SIM/MDM) + SUSY: More photon searches, shown to the right. Searches done either with an EF1 approach with heavy iteration (full simulation) or by approximate methods (fast estimation).
- Searches for a new invisible Higgs (125) shown below, produced in $h\rightarrow b\bar{b}$ with unknown decays. Search for a new invisible neutral Higgs. The mass of the system can be measured in the way shown in the lower right. The couplings shown to the left show how the SM Higgs equivalent can be included.
- Dark-physics $\gamma+\gamma$, $\gamma+\bar{\nu}$, $\gamma+\nu$ in the logarithmic scale, not shown here, and also enough to make decay searches. One can search for a $p_\gamma^m$ resonance about background in $\chi^1_m \rightarrow \gamma\gamma+$ $\chi^2_m \rightarrow \gamma\nu\nu$ in both cases.

Indirect BSM: discovery and model separation

- SM effective field theory study using ILC results on Higgs properties and $M_{H\eta}$.
- Exotic models that are not discoverable at HL-LHC:
  - At ILC both separate at $5\sigma$ from the SM, but do not have each other.

Hints of the GUT scale

In the context of SUSY analyses, thanks to the combination of the measured masses, $BR$s and Higgs properties, at IR-scale scale parameters get constrained for all three branch modes. In particular, the Higgs and non-SUSY breaking masses, $M_1$ and $M_2$, can be determined at present level.

The fitted mass scale parameters can be related to the appropriate RGs to higher scales. This allows to verify or discard the idea of GUT scale evolution of $M_1$ and $M_2$.

Take-home message

- Sometimes the capability for the direct discovery of new particles at the ILC exceed those of the LHC, since ILC provides:
  - Well-defined initial state
  - Clear measurement without QCD backgrounds
  - Extensibility in energy and polarized beams
- Detection of $\chi^1_m \rightarrow \gamma\gamma$, $\chi^2_m \rightarrow \gamma\nu\nu$, and $\chi^1_m \rightarrow \gamma\bar{\nu}\bar{\nu}$ is sensitive and achievable for triggering.

More info: