

WG1-SRCH working meeting on
Heavy Neutral Lepton search potential of future HET factories

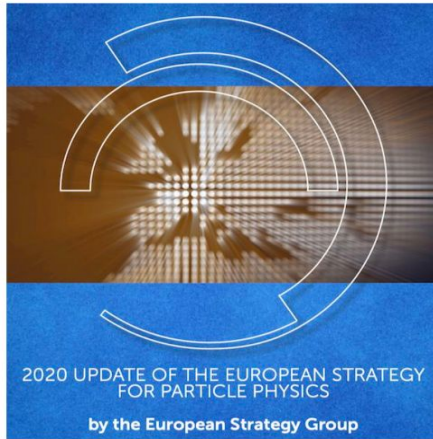
Goals and challenges - introduction to the discussion

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◆ ECFA study is a key input for the next European Strategy Update

→ should be coherent with the European Strategy timeline



◆ For the 2020 Update:

- project inputs: December 2018
- open community meeting: Granada, May 2019
- drafting session: Bad Honnef, January 2020
- strategy presented later in 2020

◆ The next European Strategy Update is provisionally expected in **2026–27**

→ provisionally expect strategy inputs to be due in late 2025

◆ ECFA study should coordinate with project inputs and timelines, e.g. FCC Feasibility Study report is scheduled for end 2025, writing from 2025Q2

◆ ECFA report should be available as reference for projects' individual ESPP inputs

→ target spring 2025 for ECFA study final report

Scenarios for the final ECFA Higgs factory report

For the WG1-SRCH part, we identified possible “areas of interest”, which could be covered in the final ECFA study report:

- **Heavy Neutral Leptons**
- **Scenarios with light scalars**
- **Exotic Higgs Boson decays**
- **Light SUSY scenarios**
- **Axion-Like Particles, dark photons, other light mediator scenarios**
- ... (new ideas still welcome)

We do want to cover as wide scope as possible in the final report...

Topical meetings

We would like to organize focused working meetings for each of the “areas of interest” which we consider relevant for the final workshop report in 2024.

Today we have our first meeting on **Heavy Neutral Leptons**

Next meeting is planned in two months:

- **Standard and exotic Scalars at future HET factories**,
April 14, starting 9:00 AM on zoom.
 - <https://indico.cern.ch/event/1253605/>

Please let us know, if you would like to contribute...

Our goals

The report should summarize what Higgs Factory can add (in terms of the direct BSM search potential) beyond the state-of-the-art at the end of HL-LHC.

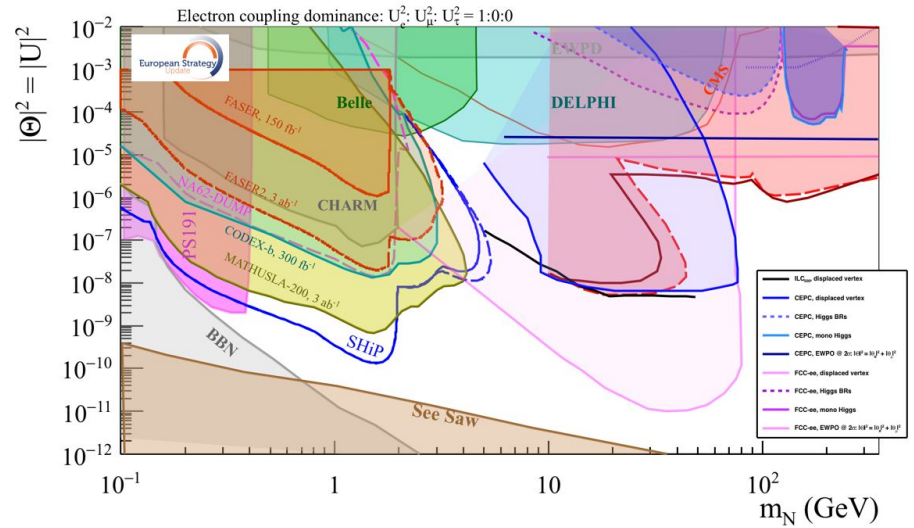
While a lot of results are already available, we should focus on what can be added in the next ~ year:

- Try to combine existing studies into one coherent picture, demonstrate complementarity of different approaches.
- Try to identify scenarios which have not been covered yet, or where more work is still needed

The goal of the ECFA study is not to build new research groups, but rather to build new collaborations between the existing ones, encourage members of the community to contribute and collaborate, newcomers are welcome...

Our goals

Heavy Neutral Lepton search potential as summarised in the Physics Briefing Book for ESPP Update 2020.



We can try to prepare similar plot(s), including results of recent studies.

However, this is only possible if we agree on some common framework...

Challenges

Theoretical framework / model

We need to define the framework, in which the search potential can be presented.

This includes HNL nature, as well as coupling and flavour structure of the model.

Parameter space is multi-dimensional. We need to define the “hyper-surface” we consider for the presentation.

On the other hand, we could also include the guidelines for extrapolating presented results to other scenarios, with different assumptions (eg. flavour structure, but also concerning integrated luminosity, beam polarisation etc.).

How can one “translate” limits from the considered model to another one?

Challenges

Precision measurements

Scenarios with HNL are likely to affect different precision measurements at HET factories as well.

What processes are most sensitive to HNL contributions?

eg. contribution to $e^+e^- \rightarrow W^+W^-$ or $e^+e^- \rightarrow W^+W^-H$

Are the expected limits from precision observables relevant?

Challenges

Limit definition

When comparing limits, we should also make sure that we they can be directly compared, i.e. that they are defined in the same way.

Otherwise we need to make sure we understand differences and can scale the results to the same limit definition.

Do we include systematic uncertainties in the limit calculation?

If so, which uncertainties are included and how do we take them into account?

Challenges

Monte Carlo samples / resources

Precision of the results should not be limited by the MC statistics.

We need to make sure that enough statistics, of the background samples in particular, is produced. Do we have resources? What is enough?

Are all relevant backgrounds included?

Is the simulation level is adequate to the process/signature considered?