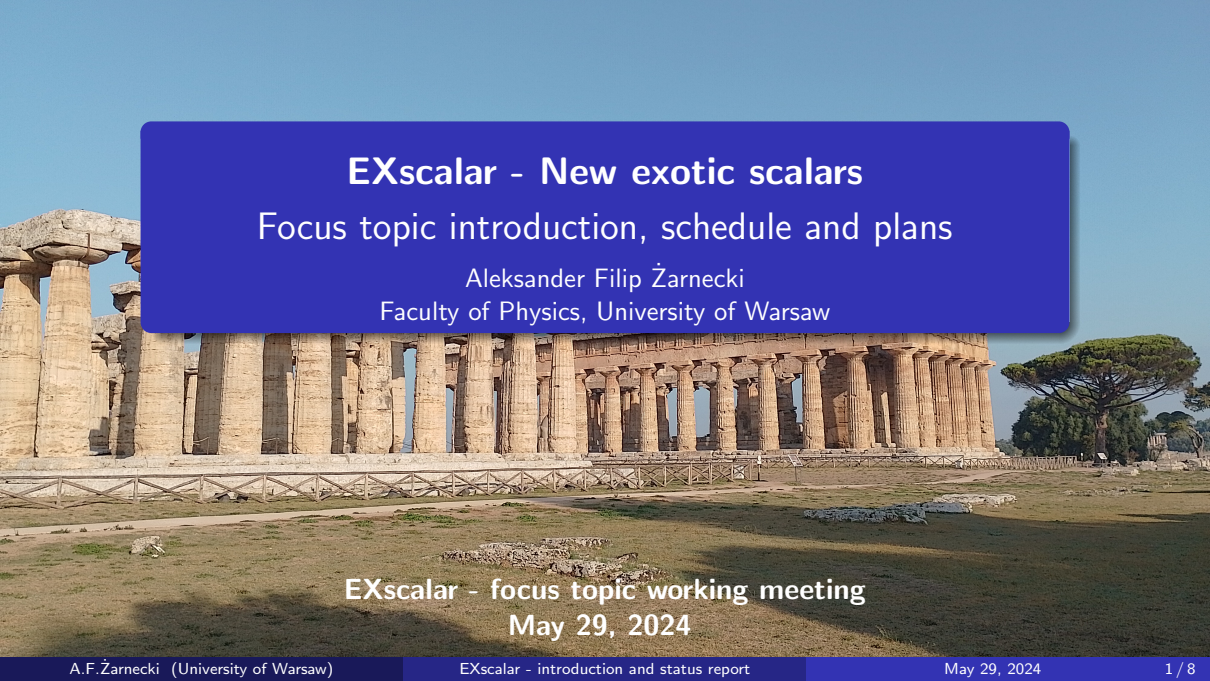
EXscalar - New exotic scalars

Focus topic introduction, schedule and plans

Aleksander Filip Żarnecki
Faculty of Physics, University of Warsaw



EXscalar - focus topic working meeting
May 29, 2024

Final report timeline after ESU schedule announced in April

- June 2024: list of topics expected to be included in the final report
  focus topics are clearly there, but there are more relevant topics worth presenting
- October 2024: deadline for new results
  should be presented, together with draft write-ups at the Paris workshop
  one of the reasons for the meeting today: to review what results can be expected
- December 2024: finalized text of the report
  released for the comments from the community
- March 2025: submission as input to the European Strategy Update

4. Searches for New Particles

current draft of the WG1-SRCH chapter, still being discussed, structure still not fixed!

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- general motivation for BSM (maybe out of scope for us)
- possible scenarios with focus on direct signatures (overview of possibilities and highlights)
- possible search strategies (general description/classification)

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4.13 Detector and running option considerations

as defined in the focus topic report arXiv:2401.07564

Theoretical and phenomenological targets (1)

Higgs factories are best suited to search for light exotic scalars in the process:

$$e^+e^- \to Z\,\phi$$

Production of new scalars can be tagged, independent of their decay, based on the recoil mass.

We should look for different scalar decay channels e.g. $b\bar{b}$, $W^{+(*)}W^{-(*)}$, $\tau^+\tau^-$ or invisible
Non-standard decays channels of the new scalar should also be looked for.

For maximum sensitivity, feasibility of including hadronic Z decays should be explored.

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Theoretical and phenomenological targets (2)

As as second benchmark scenario for the EXscalar focus topic,
light scalar pair-production in 125 GeV Higgs boson decays is proposed:

$$e^+e^- \to Z\,H \to Z\,\phi\,\phi$$

Here again, different decay channels should be considered, both SM-like and exotic.

While new scalar states could in general be long-lived, only scenarios with prompt decays are included in this focus topic (while a dedicated topic focuses on LLPs, see next presentation).

Possible scope of EXscalar section

- Scalar search in $e^+e^- \to S\,Z$:
  - decay independent (based on recoil mass): ILD full sim. arXiv:2005.06265; to be reexamined
  - $S \to \tau\tau$: ongoing fast sim. study, first result at EPS'2023, see proceedings
  - $S \to b\bar{b}$: ongoing fast sim. study; old LEP recast arXiv:1801.09662
  - $S \to inv$: old CLIC results at 380 GeV: arXiv:2002.06034, arXiv:2107.13903
- Scalar production in (exotic) Higgs decays
  invisible decays at ILD: arXiv:2002.12048
- Scalar production in (exotic) Z decays (?)

This is what we should review/discuss today...
Should be presented at the WG1 conveners meeting at CERN in June

Also to be discussed

We should have one page summary for each result, with 1-2 figures, for the October workshop. These could then be merged into the report section.

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Do we want to continue our activities beyond December 2024/March 2025?
We could clearly do more, improve our understanding of the subject, if we have more time...

Other relevant issues (considered previously)

When collecting results for the final report we also planned to address the following:

- what are the main experimental challenges
- what is the impact of the key detector performance parameters
- role of polarisation
- systematic uncertainties from SM/BSM theory predictions (SM parameters)
- systematic uncertainties from experiment

It will be much more difficult in the reduced time scale, but we should still try...
Easier, if we decide to continue...


Let us discuss...