

Weakly Interacting Particles one-pager

Definition of cluster

The Weakly Interacting Particles (WIP) cluster covers future weakly and feebly interacting particle research at Nikhef. It is about studying neutrino properties: oscillation, mass and mass ordering, leptonic CP violation / leptogenesis and (forward) cross-sections, as well as searches for Dark Matter (DM), Axion-like particles (ALP) and sterile neutrinos/long-lived particles (LLP) beyond primary collider physics experiments. As such, it covers our involvement in a potential successor/upgrade of *KM3NeT*, long-baseline neutrino experiments like *DUNE*, our future involvement in XENONnT successor (*XLZD*), as well as the continuation of forward facilities (e.g. *SND@LHC*, *FASER*, *FPF*) or beam-dump facilities (*SHiP*).

There is potential synergy with astrophysical neutrino research and multi-messenger astronomy in the “Cosmic messengers” cluster (and perhaps also with collider physics, or even an in-house experiment). It complements the energy frontier with a broad programme of precision, rare processes and ultra-low backgrounds.

Strategic questions

- What should Nikhef’s WIP/neutrino identity be around 2040?
 - What is the landscape and timeline of future experiments?
 - Should we invest in neutrino telescopes and/or expand our involvement in long-baseline experiments?
 - Should we invest more into low-energy (scattering) avenues (*KATRIN++/Project8/Ptolemy*, *CEnuNS*, ...), axion searches like *ADMX*, or others?
- How do we stay relevant in future neutrino telescopes?
 - How will we participate in *KM3NeT* extensions beyond *ORCA/ARCA*?
 - Can we scale up detector volume with different technologies?
 - Should we further contribute to a ‘global neutrino network’ (connects to multi-messenger aspects of Cosmic Messengers cluster)?
- What should be our involvement in long-baseline experiments in the (post-)*DUNE* / Hyper-K era, and do we lead or participate?
 - Do we extend our participation in long-baseline setups, e.g. by getting involved in neutrino tagging?
 - What technology do we need to invest in now to make an impact?
 - How do we synergise with the CERN neutrino platform?
- What is Nikhef’s role in beam-dump/LLP programmes around 2040?
 - Does Nikhef have an ambition to realise a forward-physics facility at the *FCC-ee*? (connects to Collider physics cluster)
- What is the continuation of our direct DM detection programme?
 - Is there a role for new technologies such as quantum sensing? (connects to In-House cluster)
 - What is Nikhef’s ambition once the neutrino floor has been reached?

Which experts should be part of the cluster

- KM3NeT (potentially shared person with cosmic messengers cluster)
- DUNE
- FASER
- DM
- Theorist

Outcome

- A desired Nikhef portfolio on WIPs in 2040: neutrino programme, direct DM and beyond.
- Concrete scenarios on how to get there.