

# Neutrino working group report

**Roman Pasechnik and Chad Finley**

**On behalf of neutrino working group:**

Chad Finley, Olga Botner, Mattias Blennow, Joakim Cederkäll, Peter Christiansen,  
Allan Hallgren, Tord Ekelöf, Roman Pasechnik, Kjell Fransson, Carlos de los  
Heros, Else Lytken, Tommy Ohlsson, Stefan Prestel, Erin O'Sullivan, Klas Hultqvist

**European PP Strategy Day, Lund**

# Neutrino research in Sweden: Physics highlights

- ✓ Neutrino physics/astrophysics are **long traditions and top priorities** in Particle Physics in Sweden
- ✓ Discovery of oscillations proven that neutrinos have tiny masses, and the also mix: **a vast theo&exp window into Beyond-the-SM physics**
- ✓ Due to weak interactions, neutrinos propagate undisturbed and thus are **ideal as probe to cosmic processes** at cosmological scales

# IceCube experiment

*Flagship experiment for high-energy neutrino astronomy. Discovered the high-energy cosmic neutrino flux. Identified the first likely source of cosmic neutrinos. Competitive measurements of atmospheric neutrino oscillations with Swedish contribution DeepCore detector.*

**Main goals: characterisation of the cosmic neutrino flux, including up to UHE with radio, mapping of astrophysical neutrino sources, measurement of atmospheric tau-neutrino appearance (for e.g. testing unitarity of PMNS etc).**

Now undertaking a two-stage upgrade, initial funding has been raised (US, Germany, Japan). Sweden intends to contribute to the upgrade with hardware for two strings of optical modules, and has the ambition of contributing to a future radio array.

**Swedish participants** (PhD scientists and at least 50% research time): Olga Botner, Allan Hallgren, Carlos de los Heros, plus soon a new hire (all UU); Chad Finley, Klas Hultqvist, Erin O'Sullivan (all SU)

# ESS neutrino Super Beam ESSnuSB project

*Using the Lund ESS linac to produce a uniquely intense neutrino beam and sending it to a megaton Cherenkov detector in the Garpenberg mine, 540km from Lund, to measure of neutrino flavor oscillations at the second oscillation maximum with high precision.*

**Main goal: precision measurement of the CPV phase in the lepton sector in addition to measurements of neutrinos from supernovae, the Sun, the atmosphere as well as of the proton lifetime**

Now conducting in collaboration with 12 European groups a EU Design Study of ESSnuSB as a second generation neutrino Super Beam project

## **Swedish participants:**

Tommy Ohlsson (KTH), Mattias Blennow (KTH), Joakim Cederkäll (LLU), Peter Christiansen (LU), Kjell Fransson (UU), Tord Ekelöf (UU), Maja Olvegård (UU), Ye Zou (UU), Roger Ruber (UU), Colin Carlile (UU), Mamad Eshraqi (ESS), Björn Gålnander (ESS), David Saiang (LTU)

# Neutrino theory and phenomenology

*Main focus on the potential of future long-baseline neutrino oscillation experiments and signals from astrophysical neutrino sources, both in and beyond the Standard Model, with the interplay of collider signals.*

## Main goals:

**Building of models for neutrino mass and mixing based upon seesaw-like scenarios (including the SM extensions up to GUTs, also with multi-scale symmetry breaking, RG evolution and matching);**

**Thorough tests of these models against the existing data and predictions for new measurements (in connection to collider searches);**

**Accurate descriptions of neutrino-nucleon cross sections, nucleon-nucleon correlations, and subsequent evolution of scattering products in the nuclear medium in Monte-Carlo event generators.**

## **Swedish participants:**

Tommy Ohlsson (KTH), Mattias Blennow (KTH), Roman Pasechnik (LU), Stefan Prestel (LU)

# Swedish representation in other experiments

- ✓ **Hyper-Kamiokande** (Erin O'Sullivan [SU])

a water Cherenkov detector that will be constructed in Japan beginning in 2020, with data taking expected in 2027

**Main goals: first observation of CP violation, searches for proton decay as a test for the Grand Unified Theories, measurements of distant supernovae, detailed information about the direction and energy evolution of the neutrino signal, broad search for New Physics (e.g. DM decays).**

**Data taking expected in 2027.**

- ✓ **Ptolemy experiment** (Alfredo Ferella, Jan Conrad, Jon Gudmunsson (SU), Carlos de los Heros (UU))

**Main goal: Direct detection of the cosmic neutrino background by searching for the very rare electrons emitted in the inverse beta decay of Tritium nuclei, induced by the "wind" of relic neutrinos. Data-taking foreseen beginning 2025.**

Current activities in Sweden focus on characterizing the performance of the electromagnetic filter (MAC-E filter) of the experiment.