Science with Ultracold Neutrons at the MLZ

Report of Contributions

https://indico.frm2.tum.de/e/ucnsource

Contribution ID: **1** Type: **Talk**

First ultracold neutrons from the new TUCAN source at TRIUMF

Wednesday 8 October 2025 11:15 (30 minutes)

The TUCAN collaboration is developing a next-generation spallation-based ultracold neutron (UCN) source at TRIUMF to supply high-density UCNs for fundamental physics experiments. The source's design leverages protons from TRIUMF's 500-MeV cyclotron and a large flux of cold neutrons created by a room-temperature heavy water moderator and a liquid deuterium shell, which then feed a superfluid liquid helium-4 volume at ~1 K. The unique properties of the superfluid allow for the efficient production and extraction of UCNs with a long storage lifetime.

Construction of the source was completed in 2025, and it is currently undergoing commissioning with beam. Following successful cryogenic commissioning, the first ultracold neutrons were produced from the spallation target's irradiation. Initial tests, conducted without the liquid deuterium moderator, demonstrated a significant UCN yield, with approximately 900,000 UCNs detected after a 60-second irradiation. We anticipate that the liquid deuterium moderator will increase this yield by an order of magnitude, up to a factor of 50.

This presentation will detail the source's innovative design, highlight the key milestones of its construction and commissioning, and discuss these exciting initial results.

Author: PICKER, Ruediger (TRIUMF)

Co-author: FOR THE TUCAN COLLABORATION

Presenter: PICKER, Ruediger (TRIUMF)

Session Classification: UCN Sources

Contribution ID: **2** Type: **Talk**

TUCAN EDM and PENeLOPE

Thursday 9 October 2025 11:20 (30 minutes)

Ultracold neutrons are indispensable probes for precision experiments in fundamental physics, providing unique opportunities to search for new physics beyond the Standard Model. This presentation will cover the principles and current status of two key experiments poised to utilize high-yield UCN sources: the TUCAN EDM experiment and the PENeLOPE neutron lifetime experiment.

The TUCAN EDM experiment aims to measure the electric dipole moment of the neutron, a quantity directly linked to the universe's matter-antimatter asymmetry. Using a state-of-the-art magnetically shielded room, a double-cell arrangement at room temperature and the TUCAN high-yield UCN source, the experiment is projected to achieve a statistical sensitivity of 10–27 ecm (1-sigma) within 400 days of beam time.

The PENeLOPE experiment addresses the long-standing 4-sigma discrepancy between beam and trap measurements of the neutron lifetime, a crucial parameter for Big Bang nucleosynthesis and the CKM quark mixing matrix. Over the last decade, we have designed and constructed a superconducting magnetic trap with a large storage volume of ~800 liters. This system, commissioned in 2020 at the Technical University of Munich, was transferred to TRIUMF in 2024 to begin its first series of measurements at the new TUCAN UCN source. The design allows for both traditional counting of remaining neutrons and real-time detection of decay protons, enabling a precise measurement with a focus on minimizing systematic uncertainties.

This talk will provide a detailed overview of both experiments, highlighting their potential to contribute to the future scientific program with a high-yield UCN source like the one at the MLZ.

Author: PICKER, Ruediger (TRIUMF)

Co-author: FOR THE TUCAN AND PENELOPE COLLABORATIONS

Presenter: PICKER, Ruediger (TRIUMF)

Session Classification: Science with UCN

Contribution ID: **3** Type: **Talk**

PULSTAR UCN source and SFnEDM test bed

Wednesday 8 October 2025 10:30 (30 minutes)

First part of my talk will be an update on status of the PULSTAR UCN source commissioning at NC State University. Last year we verified expected thermal neutron flux with a real source assembly and tested gamma shielding. This year we are assembling source for the final installation in the thermal column enclosure. A first test of UCN production has been approved by the reactor and university safety administration and installation is planned for October, 2025. The second part of the talk will discuss testbed for the new generation of nEDM as a possible experiment for FRM-II UCN source.

Author: KOROBKINA, Ekaterina (NC State University)

Presenter: KOROBKINA, Ekaterina (NC State University)

Session Classification: UCN Sources

Contribution ID: **4** Type: **Talk**

UCNA+: an upgraded experiment to measure the beta-asymmetry with polarized ultracold neutrons

Thursday 9 October 2025 13:30 (30 minutes)

Angular correlation measurements can provide high precision values for the axial coupling constant in neutron decay, a fundamental input in the determination of the beta decay rate predicted by the Standard Model of particle physics. Completed in 2018, the UCNA experiment was designed to utilize polarized ultracold neutrons to perform a high precision measurement of the beta asymmetry – the angular correlation between the polarization vector of the neutron and the momentum of the emitted electron. The achieved precision for the axial coupling constant of 0.16% ultimately was limited by a combination of statistics and uncertainties in the detector response. An effort is underway at the Area B UCN Source in the Los Alamos Neutron Science Center to upgrade the UCNA experiment. This upgrade, called UCNA+, is based on exploiting the improved UCN densities available at Los Alamos after the source upgrade in 2016 and a scintillator detector system (developed by R. Pattie at Eastern Tennessee State University) with improved light-collection and lower thresholds for detection of decay electrons. When combined with improved source scanning systems, thinner end-cap foils, and dedicated scattering measurements to accurately benchmark Monte Carlo calculations of scattering, roughly a factor of 3 or more improvement appears feasible over the previous results of UCNA. At this precision level, UCNA+ would make a significant contribution to the global uncertainties for the axial coupling constant, contributing to a value for the CKM unitarity constant Vud potentially competitive with the precision established by the superallowed nuclear decays.

Author: YOUNG, Albert (North Carolina State University/Triangle Universities Nuclear Laboratory)

Presenter: YOUNG, Albert (North Carolina State University/Triangle Universities Nuclear Laboratory)

Session Classification: Science with UCN

Contribution ID: **5** Type: **Talk**

UCN intensity at the PSI UCN source

Wednesday 8 October 2025 10:00 (30 minutes)

I will report on different measurements which were conducted over many years to understand operation and UCN output of the PSI UCN source.
This was done also with simulation analysis of neutron production and UCN transport.

Author: LAUSS, Bernhard (Paul Scherrer Institut)

Presenter: LAUSS, Bernhard (Paul Scherrer Institut)

Session Classification: UCN Sources

Contribution ID: **10** Type: **not specified**

SuperSUN

Wednesday 8 October 2025 11:45 (30 minutes)

Presenter: DEGENKOLB, Skyler (Universität Heidelberg)

Session Classification: UCN Sources

Contribution ID: **11** Type: **not specified**

EDM landscape

Thursday 9 October 2025 09:30 (30 minutes)

Presenter: DEGENKOLB, Skyler (Universität Heidelberg)

Session Classification: Science with UCN

Contribution ID: **13** Type: **not specified**

Future EDM

Thursday 9 October 2025 10:00 (30 minutes)

Presenter: FIERLINGER, Peter (TUM)

Session Classification: Science with UCN

Contribution ID: **14** Type: **Talk**

LANL UCN Source

Presenter: ITO, Takeyasu (Los Alamos National Laboratory)

Session Classification: UCN Sources

Contribution ID: **16** Type: **not specified**

tauSpect Neutron Lifetime

Thursday 9 October 2025 13:00 (30 minutes)

Presenter: FERTL, Martin (Johannes Gutenberg Universität Mainz)

Session Classification: Science with UCN

Contribution ID: **20** Type: **Talk**

The n2EDM experiment at PSI

Thursday 9 October 2025 09:00 (30 minutes)

The n2EDM experiment, which is currently being commissioned by the international nEDM collaboration at the Paul Scherrer Institute, aims to search for a non-vanishing electric dipole moment of the neutron with a sensitivity of 1x10^-27 e cm in the baseline setup. An overview of the experimental setup and the current status of the experiment will be presented.

Author: RIES, Dieter (Paul Scherrer Institute)

Presenter: RIES, Dieter (Paul Scherrer Institute)

Session Classification: Science with UCN

Contribution ID: **21** Type: **Talk**

The Munich UCN source

Wednesday 8 October 2025 09:15 (45 minutes)

In this talk the current status of the UCN source project at the FRM II will be presented. Expected values for UCN density and UCN flux will be discussed. Further steps to install the source and take it into operation will be shown.

Author: Dr FREI, Andreas (FRM II - TUM)

Presenter: Dr FREI, Andreas (FRM II - TUM)

Session Classification: UCN Sources

Contribution ID: **22** Type: **Talk**

Gravity Resonance Spectroscopy: UCNs bound at ILL

Thursday 9 October 2025 10:50 (30 minutes)

Gravity Resonance Spectroscopy (GRS) investigates the energy states of Ultra-Cold Neutrons using an equivalent of Ramsey's method of separated oscillating fields. The manipulation of states is realized using mechanical oscillations instead of EM fields. This allows direct investigation of some "beyond-Riemann" gravity models as well as specific DM and DE candidates. An overview of current status and results from the ILL is given. Experimental challenges for a successful measurement campaign are discussed.

Author: MICKO, Jakob (Universitaet Bern)

Co-author: ABELE, Hartmut (Vienna University of Technology)

Presenter: MICKO, Jakob (Universitaet Bern)

Session Classification: Science with UCN

Contribution ID: **23** Type: **not specified**

Welcome

Wednesday 8 October 2025 09:00 (15 minutes)

Presenters: Dr FREI, Andreas (FRM II - TUM); MÄRKISCH, Bastian (Physik-Department, TUM); FIERLINGER, Peter (TUM)

Session Classification: Welcome