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# EURO-LABS

EUROpean Laboratories for Accelerator Based Sciences  
HORIZON-INFRA-2021-SERV-01-07 Project EURO-LABS

## MILESTONE REPORT

# EURO-LABS-RELATED WORKSHOPS CARRIED OUT AT ECT\*

## MILESTONE: MS9

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<b>Lead beneficiary:</b>	FBK-ECT*
<b>Document status:</b>	FINAL

### Abstract:

The report describes the activities carried out at the European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT\*) in connection with EURO-LABS funds for TA activities. It summarizes the objectives, participation, and outcomes for each of the 21 projects that took place in the period 2022-2025.

EURO-LABS Consortium, 2025

For more information on EURO-LABS, its partners and contributors please see <https://web.infn.it/EURO-LABS/>

The EUROpean Laboratories for Accelerator Based Sciences (EURO-LABS) project has received funding from the Horizon Europe programme dedicated to Research Infrastructure (RI) services advancing frontier knowledge under Grant Agreement no. 101057511. EURO-LABS began in September 2022 and will run for 4 years.

### Delivery Slip

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## Executive summary

*The European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT\*) has provided transnational access through EURO-LABS in the period 2022-2026. Twenty-one projects were carried out on topics related to other EURO-LABS activities, with an emphasis on theoretical aspects of nuclear experimental programs and techniques. The activities brought together users from a wide range of subfields, countries, and career stages to discuss current ideas and next steps in subatomic research.*

## 1. INTRODUCTION

The European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT\*) is a unique European infrastructure where researchers in nuclear physics and related areas, such as particle physics, congregate to critically evaluate new ideas and chart future research directions. Its main mission is to organize and host workshops, schools, and collaboration meetings that provide a forum for the frank exchange of ideas in these fields. An emphasis is the training of early career researchers, supported by a local group of permanent researchers in nuclear and computational physics.

Each year ECT\*, a centre of the Fondazione Bruno Kessler (FBK) in Trento (Italy), receives about 800 visitors per year. While the majority are researchers based in Europe, ECT\*'s worldwide reach is evident in a significant in-person participation of scientists from North America and Asia, and to a smaller extent Central and South America, Oceania, and Africa. With funding from agencies and institutions across Europe and FBK, ECT\* provides partial financial support for the participants in its activities.

From September 1, 2022 for a duration of four years, ECT\* receives support from EC's HORIZON program as a transnational access facility through the EURO-LABS project (Grant Agreement No. 101057511). Access includes local logistical, technical and scientific support, as well as specific training which is provided to external researchers using the infrastructure. EURO-LABS enables research in nuclear and particle physics -- core areas at ECT\*. TA at ECT\* is Task 2.4 (Theoretical Support) of WP2 (Research Structures for Nuclear Physics), which fosters a stronger synergy between theory and experiments by opening up virtual access to established computing codes and theoretical tools for planning and analyzing experiments performed at TA RIs and for the wider community.

EC funding allows a wide participation at a broad spectrum of ECT\* activities ("projects") for theorists and experimentalists ("users") based in Europe, particularly those at career stages and institutions with limited funding. Milestone MS-9 (*EURO-LABS-related workshops carried out at ECT\**) consists of the activities supported under the EURO-LABS project in the period 2022-2025. Following a brief summary of the activity selection process, a detailed description of each activity is provided.

## 2. EURO-LABS-RELATED WORKSHOPS AT ECT\*

Projects carried out at ECT\* can be dedicated workshops and associated collaboration meetings. The role of the projects is to enhance cooperation and discussions among smaller groups of workshop participants in order to stimulate new scientific endeavors and joint research activities. ECT\* activities are open to all qualifying users. Participation is, however, limited by the capacity of the centre and goes through a selection procedure.

For over 30 years now, each year ECT\* issues two calls for workshop proposals to take place in the following year. The call is announced at the center's webpage and through an email list of about 1100 ECT\* Associates all over the world. Project proposals can be submitted following a template accessible from the website. Typically the number of competitive proposals exceeds capacity by about 50%. Proposals are evaluated and selected by ECT\*'s Scientific Board, which is made up of nine distinguished scientists (typically eight from across Europe and one from overseas) who serve staggered three-year terms.

The Scientific Board acts as the selection panel for EURO-LABS activities, with relevance for other project activities as a guiding principle. Once selected, scientific projects are carried out under the supervision of the ECT\* Director ("Activity Leader"). Each project has a group of users that receive support through EURO-LABS. Each group is managed by a user appointed as "Group Leader", who oversees the distribution of funds and the outcomes, and provides a report at the end of the project. Details of the selection procedure can be found in the MS-8 report (*Calls for proposals to be hosted at ECT\**), accessible at [web.infn.it/EURO-LABS/results-milestones/](http://web.infn.it/EURO-LABS/results-milestones/).

In the next subsection, a summary table of supported activities in the period 2022-2025 is given. Further EURO-LABS-related activities take place in 2026 until the end of EURO-LABS's four-year span. In the following subsection, activity reports are provided for each project.

### 2.1 LIST OF SUPPORTED ACTIVITIES 2022 - 2025

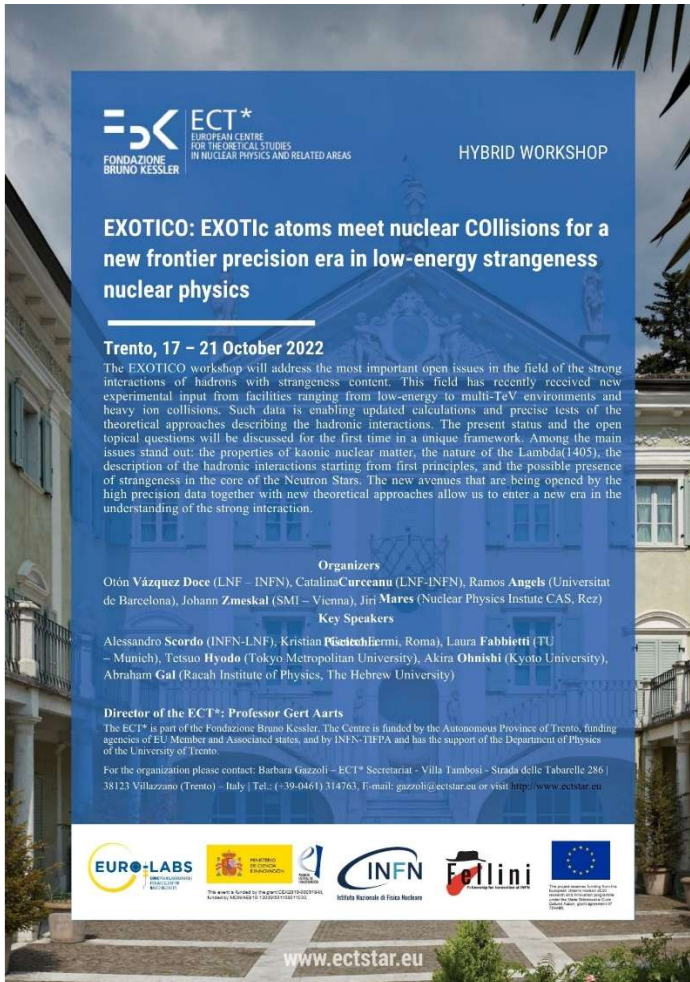
Project Acronym	Project Title	Group Leader	Date
19Vazquez-Doce22	<a href="#">EXOTICO: EXOTic atoms meet nuclear COLLisions for a new frontier precision era in low-energy strangeness nuclear physics</a>	Àngels Ramos	12-21 October 2022
13Slifer23	<a href="#">Tensor Spin Observables</a>	Karl Slifer	10-14 July 2023
DTP-2023	<a href="#">Ab Initio Methods and Emerging Technologies for Nuclear Structure</a>	Carlo Barbieri	10-28 July 2023
21Scordo23	<a href="#">ROCKSTAR: Towards a ROadmap of the Crucial</a>	Àngels Ramos	9-13 October 2023

	<a href="#">measurements of Key observables in Strangeness reactions for neutron sTARs equation of state</a>		
23Napolitano23	<a href="#">ALPACA: modern ALgorithms in machine learning and data analysis: from medical Physics to research with ACcelerAtors and in underground laboratories</a>	Magdalena Skurzok	20-24 November 2023
04Degenkolb24	<a href="#">EDMs: complementary experiments and theory connections</a>	Skyler Degenkolb	4-8 March 2024
13Barbieri24	<a href="#">Towards a consistent approach for nuclear structure and reactions: microscopic optical potentials</a>	Alexandre Obertelli	17-21 June 2024
14Yang24	<a href="#">New opportunities and challenges in nuclear physics with high power lasers</a>	Chieh-Jen Yang	1-5 July 2024
DTP/TALENT2024	<a href="#">Nuclear Theory for Astrophysics</a>	Almudena Arcones	15 July – 2 August 2024
16Boer24	<a href="#">Towards improved hadron tomography with hard exclusive reactions</a>	Jakub Wagner	5-9 August 2024
18Ding24	<a href="#">New developments in studies of the QCD diagram</a>	Frithjof Karsch	9-13 September 2024
19Beccattini24	<a href="#">Spin and quantum features of QCD plasma</a>	Dirk Rischke	16-20 September 2024
21Dolan24	<a href="#">Measuring neutrino interactions for next-generation oscillation experiments</a>	Stephen Dolan	21-25 October 2024
01Tumino25	<a href="#">Key Reactions in Nuclear Astrophysics</a>	Livius Trache	17-21 February 2025
05Bennaceur25	<a href="#">Lepton flavor change in nuclei</a>	Karim Bennaceur	14-17 April 2025
10Colò25	<a href="#">Theory Service for the Low Energy Nuclear Physics Community: a Hands-on Workshop</a>	Armand Bahini	7-9 July 2025
11Barbieri25	<a href="#">Next generation ab initio nuclear theory</a>	Carlo Barbieri	14-18 July 2025
13Hagelsteing25	<a href="#">New perspectives in the charge radii determination for light nuclei</a>	Franziska Hagelstein	28 July – 1 August 2025

19Hupin25	<a href="#"><u>Pan-American Few-Body Physics Boot Camp: Fostering Collaboration</u></a>	Guillaume Hupin	13-24 October 2025
20Spyrou25	<a href="#"><u>Neutron-capture reactions for astrophysical processes</u></a>	Artemis Spyrou	3-7 November 2025
21Ekstrom25	<a href="#"><u>ISNET-11: Information and Statistics in Nuclear Experiment and Theory</u></a>	Andreas Ekström	17-21 November 2025

*Table 1. List of the activities carried out by ECT\* and supported through EURO-LABS*

## 2.1 SCIENTIFIC REPORTS OF THE ACTIVITIES



**ECT\***  
EUROPEAN CENTRE  
FOR THEORETICAL STUDIES  
IN NUCLEAR PHYSICS AND RELATED AREAS  
FONDAZIONE  
BRUNO KESSLER  
HYBRID WORKSHOP

**EXOTICO: EXOTIC atoms meet nuclear COLLISIONS for a new frontier precision era in low-energy strangeness nuclear physics**

**Trento, 17 - 21 October 2022**





The EXOTICO workshop will address the most important open issues in the field of the strong interactions of hadrons with strangeness content. This field has recently received new experimental input from facilities ranging from low-energy to multi-TeV environments and heavy ion collisions. Such data is enabling updated calculations and precise tests of the theoretical approaches describing the hadronic interactions. The present status and the open topical questions will be discussed for the first time in a unique framework. Among the main issues stand out: the properties of kaonic nuclear matter, the nature of the  $\Lambda(1405)$ , the description of the hadronic interactions starting from first principles, and the possible presence of strangeness in the core of the Neutron Stars. The new avenues that are being opened by the high precision data together with new theoretical approaches allow us to enter a new era in the understanding of the strong interaction.

**Organizers**  
Oti3n V3zquez Doce (LNF - INFN), Catalina Curceanu (LNF-INFN), Ramos Angels (Universitat de Barcelona), Johann Zmeskal (SMI - Vienna), Jiri Mares (Nuclear Physics Institute CAS, Rez)

**Key Speakers**  
Alessandro Scordo (INFN-LNF), Kristian P3seltchiermi, Roma), Laura Fabbietti (TU - Munich), Tetsuo Hyodo (Tokyo Metropolitan University), Akira Ohnishi (Kyoto University), Abraham Gal (Racah Institute of Physics, The Hebrew University)

**Director of the ECT\*:** Professor Gert Aarts  
The ECT\* is part of the Fondazione Bruno Kessler. The Centre is funded by the Autonomous Province of Trento, funding agencies of EU Member and Associated states, and by INFN-TIFPA and has the support of the Department of Physics of the University of Trento.

For the organization please contact: Barbara Gazzoli - ECT\* Secretariat - Villa Tambosi - Strada delle Tabarelle 286 | 38123 Villazano (Trento) - Italy | Tel.: (+39-0461) 314763, E-mail: [gazzoli@ectstar.eu](mailto:gazzoli@ectstar.eu) or visit: <http://www.ectstar.eu>

**EURO-LABS**    

[www.ectstar.eu](http://www.ectstar.eu)

19Vasquez-Doce22

**EXOTICO: EXOTIC atoms meet nuclear COLLISIONS for a new frontier precision era in low-energy strangeness nuclear physics**

17-21 October 2022

Total participants: 49

EURO-LABS Users: 8

### Objectives

The main objective was to find a common ground for the current approaches to study one of the most fundamental problems in nuclear physics, namely the measurement and quantitative understanding of the strong interaction between hadrons with strangeness content. The theoretical approaches in this sector are not only tested but anchored to the experimental results and the feedback between theoreticians and experimentalists is of particular importance in a moment of important experimental developments.

### Achievements

The most recent results and future plans from facilities at different energy regimes have shown a new avenue being opened with the possibility of measuring the strong interaction of any hadron pair even in the charm sector. Currently also the three-body interactions are being addressed experimentally and theoreticians quickly delivering predictions of new observables such as correlation functions. We have seen how such studies are crucial to describe the properties of matter under extreme conditions, as a complementary approach to famous recent astrophysical observations.



**ECT\***  
EUROPEAN CENTRE  
FOR THEORETICAL STUDIES  
IN NUCLEAR PHYSICS AND RELATED AREAS

**WORKSHOP**  
Trento, 10–14 Jul 2023

## TENSOR SPIN OBSERVABLES

**ORGANIZERS**  
Karl Sliifer (University of New Hampshire, US)  
Elena Long (University of New Hampshire, US)  
Douglas Higinbotham (Jefferson Lab, US)  
Dustin Keller (University of Virginia, US)

**MAIN TOPICS**  
Tensor Polarization in DIS  
Tensor Structure Functions  
Hidden Color at Large X  
Tensor Observables at X>1  
Solid Tensor-Polarized Target Development  
Elastic Deuteron Form Factors  
Tensor Polarization at the EIC  
Analyzing Powers in Scattering from Tensor Polarized Targets

**KEY SPEAKERS**  
James Maxwell, JLab - Douglas Higinbotham, JLab -  
Simon Sirca, U. Ljubljana - Misak Sargsian, FIU -  
Sabine Jeschonnek, OSU - Shunzo Kumano, KEK -  
Simonetta Liuti, UVA - Vladimir Pascalutsa, Johannes Gutenberg  
U. Mainz - Wim Cosyn, FIU - Yubing Dong, Institute of High Energy  
Physics, Beijing China - Mark Strikman, PSU -  
Christian Weiss, JLab - Alessandro Bacchetta, U. Pavia -  
Mikhail Gorshteyn, Johannes Gutenberg U. Mainz -  
Elena Long, UNH - Karl Sliifer, UNH - Devin Seay, Uva -  
Dustin Keller, UVA - Thorsten Maly, Bridge12 - Carlos Yero, ODU -  
Ishara Fernando, UVA - David Mack, JLab - Jennifer West, LBNL -  
Michael McClellan, UNH - Nathaly Santiesteban, UNH -  
Anchit Arora, UNH - Allison Zec, UNH

**Director of ECT\*:** Professor Gert Aarts  
The ECT\* is part of the Fondazione Bruno Kessler. The Centre is funded by the Autonomous Province of Trento, funding agencies of EU Member and Associated states, and by INFN-TIPPA and has the support of the Department of Physics of the University of Trento. For the organization please contact: ECT\* Secretariat - Villa Tambosi - Strada delle Tabarelle 286 | 38123 Villazano (Trento) - Italy | Tel: (+39-0461) 314723. E-mail: staff@ectstar.eu or visit <http://www.ectstar.eu>

### 13Slifer23

### Tensor Spin Observables

10-14 July 2023

Total participants: 24

EURO-LABS Users: 4

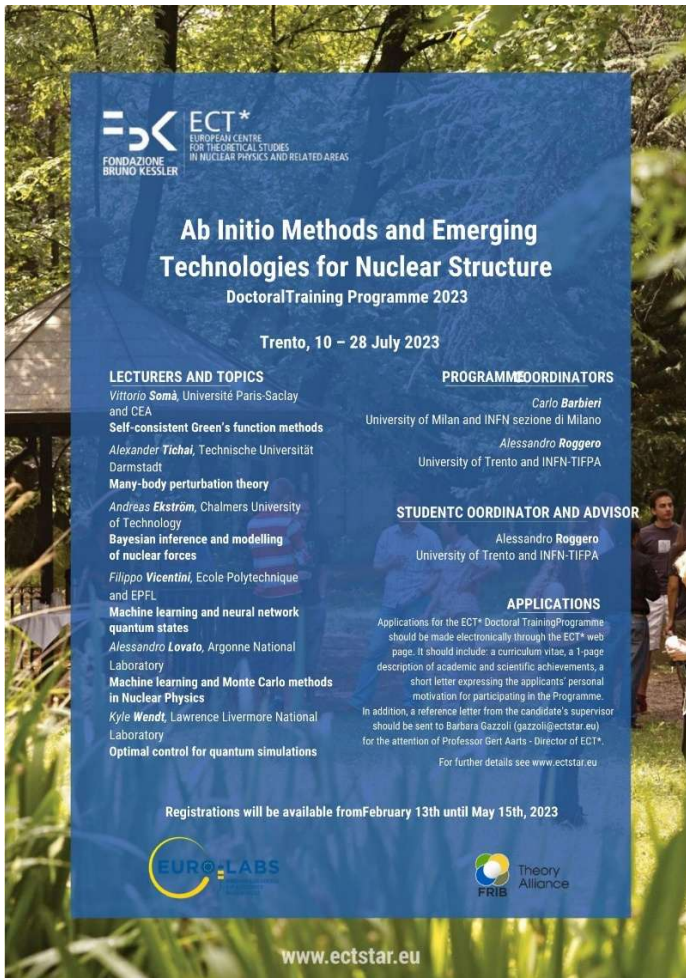
### Objectives

This workshop focused on a discussion of several experiments planned at Jefferson Lab and other facilities which will utilize a solid tensor-polarized deuteron target. Many of the experimental and theoretical techniques relevant to this program have already been developed, but the progress on both these fronts in the past decade sparked a renewed interest in vector and tensor observables accessible by using the deuteron target.

### Achievements

The tensor-deuteron program at Jefferson Lab will help to clarify how the properties of the nucleus arise from the underlying

partons, and provide novel information about gluon contributions, quark angular momentum, and the polarization of the quark sea that is not accessible in spin-1/2 targets. This workshop brought together the foremost experts in the field who have managed to devise a clear strategy for moving forward on both the theoretical and the experimental front, thereby ensuring the success of the planned experiments and a tremendous increase of our knowledge of the deuteron.



**ECT\***  
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IN NUCLEAR PHYSICS AND RELATED AREAS  
FONDAZIONE  
BRUNO KESSLER

**Ab Initio Methods and Emerging  
Technologies for Nuclear Structure**  
Doctoral Training Programme 2023

Trento, 10 – 28 July 2023

**LECTURERS AND TOPICS**

Vittorio Somà, Université Paris-Saclay  
and CEA  
Self-consistent Green's function methods

Alexander Tichai, Technische Universität  
Darmstadt  
Many-body perturbation theory

Andreas Ekström, Chalmers University  
of Technology  
Bayesian inference and modelling  
of nuclear forces

Filippo Vicentini, Ecole Polytechnique  
and EPFL  
Machine learning and neural network  
quantum states

Alessandro Lovato, Argonne National  
Laboratory  
Machine learning and Monte Carlo methods  
in Nuclear Physics

Kyle Wendt, Lawrence Livermore National  
Laboratory  
Optimal control for quantum simulations

**PROGRAMME COORDINATORS**

Carlo Barbieri  
University of Milan and INFN sezione di Milano

Alessandro Roggero  
University of Trento and INFN-TIFPA

**STUDENT COORDINATOR AND ADVISOR**

Alessandro Roggero  
University of Trento and INFN-TIFPA

**APPLICATIONS**

Applications for the ECT\* Doctoral Training Programme  
should be made electronically through the ECT\* web  
page. It should include: a curriculum vitae, a 1-page  
description of academic and scientific achievements, a  
short letter expressing the applicants' personal  
motivation for participating in the Programme.  
In addition, a reference letter from the candidate's supervisor  
should be sent to Barbara Gazzoli (gazzoli@ectstar.eu)  
for the attention of Professor Gert Aarts - Director of ECT\*.  
For further details see [www.ectstar.eu](http://www.ectstar.eu)

Registrations will be available from February 13th until May 15th, 2023

**EURO-LABS**

**FRIB** Theory Alliance

[www.ectstar.eu](http://www.ectstar.eu)

## DTP-2023

### Ab initio methods and emerging technologies for nuclear structure

10-28 July 2023

Total participants: 33

EURO-LABS Users: 15

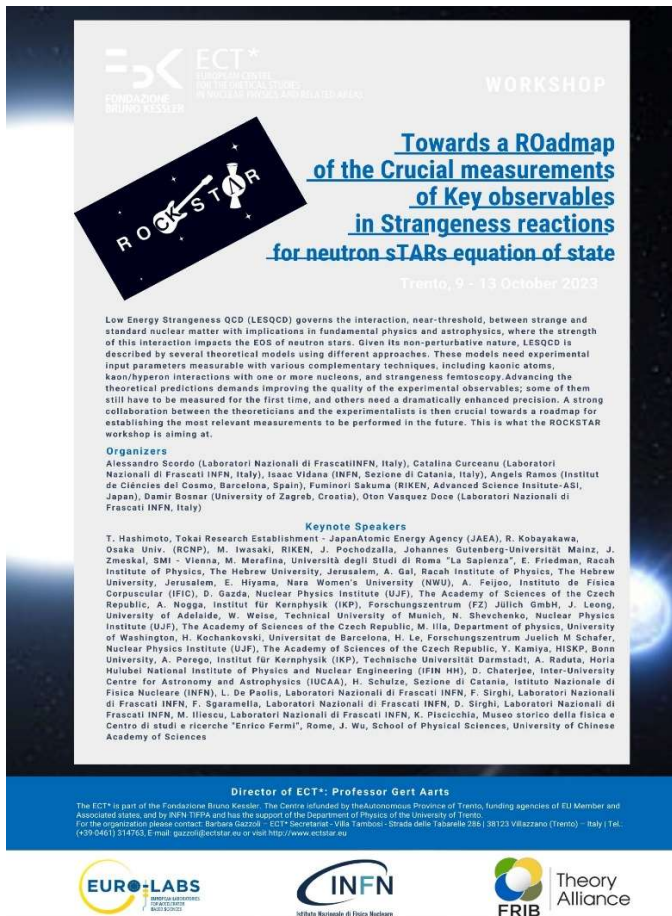
### Objectives

This Doctoral Training Programme (DTP) focused on modern developments in ab initio nuclear theory. The field of ab initio (microscopic) nuclear structure is evolving toward the exploitation of novel technologies based on artificial intelligence and quantum computing. These topics not only hold the promise to impact nuclear theory but will likely attract bright researchers to our field. The topics detailed below offered the opportunity to attract young talented researchers to the field of nuclear structure and reactions, while preparing them for

embracing new technologies in their future work.

### Achievements

The program ran for three weeks. Each day, from Monday to Friday, 1.5-hour lectures in the morning covered the theoretical aspects of the program. The morning program consisted of about 30 lectures (for a total of 45 hours) organized in five modules. Each module had dedicated afternoon sessions for solving practical problems and for gaining hands-on computational work and putting in practice the techniques learned. Three modules focused on state-of-the-art many-body methods, while the remaining two were dedicated to novel technologies. Specific ab initio methods have been selected, based on the availability of professional public computer codes and because of their impact on our understanding of the nuclear force (Chiral EFT and Bayesian analysis), on fundamental nuclear structure (many-body perturbation theory), and on studies of particle-transfer spectroscopy and nuclear reactions (Self-Consistent Green's Function theory, SCGF). Quantum Monte Carlo techniques have also been covered through neural-network quantum states and the quantum computing modules.



**Towards a Roadmap of the Crucial measurements of Key observables in Strangeness reactions for neutron sTARs equation of state**

Trento, 9 - 13 October 2023

Low Energy Strangeness QCD (LESQCD) governs the interaction, near-threshold, between strange and standard nuclear matter with implications in fundamental physics and astrophysics, where the strength of this interaction impacts the EOS of neutron stars. Given its non-perturbative nature, LESQCD is described by several theoretical models using different approaches. These models need experimental input parameters measurable with various complementary techniques, including kaonic atoms, kaon/hyperon interactions with one or more nucleons, and strangeness femtoscopy. Advancing the theoretical predictions demands improving the quality of the experimental observables; some of them still have to be measured for the first time, and others need a dramatically enhanced precision. A strong collaboration between the theoreticians and the experimentalists is then crucial towards a roadmap for establishing the most relevant measurements to be performed in the future. This is what the ROCKSTAR workshop is aiming at.

**Organizers:**  
Alessandro Scordo (Laboratori Nazionali di Frascati INFN, Italy), Catalina Cuceanu (Laboratori Nazionali di Frascati INFN, Italy), Isaac Vidana (INFN, Sezione di Catania, Italy), Angela Ramos (Institut de Ciències del Cosmos, Barcelona, Spain), Fuminori Sakuma (RIKEN, Advanced Science Institute-ASI, Japan), Damir Bossan (University of Zagreb, Croatia), Oton Vasquez Dece (Laboratori Nazionali di Frascati INFN, Italy)

**Keynote Speakers**  
T. Hashimoto, Tokai Research Establishment - Japan Atomic Energy Agency (JAEA), R. Kobayakawa, Osaka Univ. (RCNP), M. Iwasaki, RIKEN, J. Pochodzalla, Johannes Gutenberg-Universität Mainz, J. Zmeskal, SMI - Vienna, M. Moratfin, Università degli Studi di Roma "La Sapienza", F. Friedman, Racah Institute of Physics, The Hebrew University, Jerusalem, A. Gal, Racah Institute of Physics, The Hebrew University, Jerusalem, E. Hiyama, Nara Women's University (NWU), A. Fejoo, Instituto de Física Corpuscular (IFIC), D. Gazda, Nuclear Physics Institute (UJF), The Academy of Sciences of the Czech Republic, A. Nogga, Institut für Kernphysik (IKP), Forschungszentrum (FZ) Jülich GmbH, J. Leong, University of Adelaide, W. Weise, Technical University of Munich, N. Shevchenko, Nuclear Physics Institute (UJF), The Academy of Sciences of the Czech Republic, M. Vila, Department of physics, University of Washington, H. Kochanowski, Universität de Barcelona, H. Le, Forschungszentrum Juelich M. Schafer, Nuclear Physics Institute (UJF), The Academy of Sciences of the Czech Republic, Y. Kamiya, HISKP, Bonn University, A. Parago, Institut für Kernphysik (IKP), Technische Universität Darmstadt, A. Raduta, Horia Hulubei National Institute of Physics and Nuclear Engineering (IFN MM), D. Chatterjee, Inter-University Centre for Astronomy and Astrophysics (IUCAA), H. Schulze, Sezione di Catania, Istituto Nazionale di Fisica Nucleare (INFN), L. De Paolis, Laboratori Nazionali di Frascati (INFN), F. Sighi, Laboratori Nazionali di Frascati (INFN), F. Sganrella, Laboratori Nazionali di Frascati (INFN), K. Piseicchia, Museo storico della fisica e Centro di studi e ricerche "Enrico Fermi", Rome, J. Wu, School of Physical Sciences, University of Chinese Academy of Sciences

Director of ECT\*: Professor Gert Aarts

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EURO-LABS | INFN | Theory Alliance | FRIB

21Scordo23

**ROCKSTAR: Towards a Roadmap of the Crucial measurements of Key observables in Strangeness reactions for neutron sTARs equation of state**

9-13 October 2023

Total participants: 41

EURO-LABS Users: 17

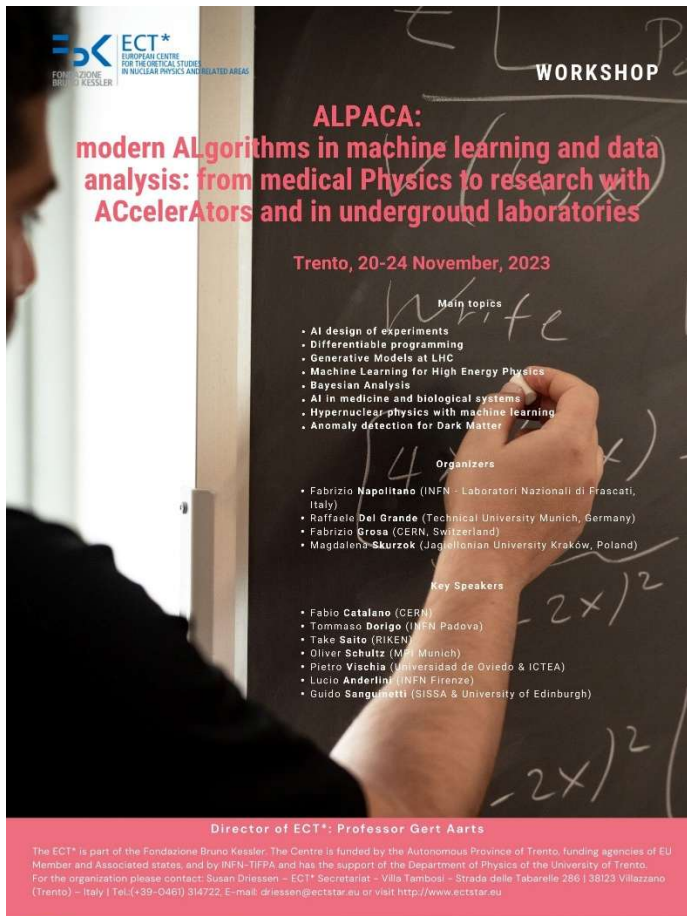
**Objectives**

The scope of the workshop was to draw the near/mid-term road-map towards a better understanding of the physics laws regulating the interaction between strange and standard matter at very low energies, which has important implications in fundamental physics and astrophysical problems. Given its nonperturbative nature, low-energy strange QCD is described by several theoretical models based on different approaches, which need to be constrained by experimental

observations, measurable with various techniques, such as kaonic atoms, kaon scattering, kaon absorption or kaon-nucleon femtoscopy. Fruitful discussions were expected about the latest results obtained from the experiments and the already planned future measurements, as well as about the most recent tests of the existing theoretical models and the possible development of new ones. The ROCKSTAR workshop also aimed at connecting communities, such as those working on low- and high-energy hadron physics and astrophysics, which have the role of strangeness as a common interest.

**Achievements**

The workshop offered the opportunity to discuss the most recent achievements in strangeness nuclear physics and to identify where to focus future efforts for an efficient development of the field. Theoretical advances in the study of Lambda hypernuclei and how they help constrain two- and three-body hyperon nucleon forces, which have a tremendous influence on the possible existence of hyperons in neutron stars were presented. In synergy with the astrophysical community, the extent the analyses of gravitational waves emitted in binary neutron-star mergers could provide a smoking gun to elucidate the presence of hyperons in dense and hot matter was discussed. There has also been a lot of progress on antikaon nuclear interactions. The upcoming measurement of kaonic deuterium by SIDDHARTA-2@DAΦNE (and later by E57@JPARC) will set a very valuable direct constraint on the much-needed K-n interaction. The JPARC results on K-NN and K-NNN bound states are also providing important information on antikaon absorption processes in nuclei, complementary to that obtained by AMADEUS from absorption on heavier nuclei or from the very precise kaonic atoms experiments being performed and planned at DAPHNE.



## 23Napolitano23

**ALPACA: modern algorithms in machine learning and data analysis: from medical physics to research with accelerators and in underground laboratories**

20-24 November 2023

Total participants: 37

EURO-LABS Users: 13

### Objectives

The general theme of the workshop was the use of state-of-the-art techniques of modern algorithms in machine learning and data analysis, in particle, nuclear and medical physics, above and below ground. In a field where progress is being driven at an increasingly fast pace, it is important to bring together researchers of various fields, stimulating cross fertilization of ideas. The workshop addressed the central question in experimental and computational physics: maximizing information extraction from data. In the past two decades, the remarkable

advancements in artificial intelligence and machine learning algorithms have revolutionized experimental physics, providing unprecedented opportunities for smaller groups and individuals to engage in complex experiments.

### Achievements

The workshop was a very useful opportunity to share challenges and solutions among diverse fields in particle nuclear and medical physics. Since the advent of machine learning and artificial intelligence technologies, pioneered in various contexts decades ago in physics, their use has showcased incredible gains in the scientific reach. Still, the consensus among the participants was that even greater gains are yet to be uncovered, as new techniques and paradigms emerge from research in hard sciences and industry. In particular, the workshop yielded insights in various fields. As an example, advancements in quantitative biology were presented, emphasizing the coupling of components in a physics-informed machine learning framework for more accurate measurements. In the field of quantum computing, the potential in high-energy physics was explored, raising questions about effective algorithm training and leveraging physics laws. The MODE collaboration's innovative approach to optimizing experimental design showcased the high gains achievable in terms of physics reach and project's costs. Talks on data preparation highlighted its critical role in various contexts, from geomagnetic storm prediction to exploring the thermodynamic characterization of learning problems. Simplifying complex systems for better understanding was a recurring theme, with information-theoretic approaches providing insights into high-dimensional simulation datasets of biological systems. Generative models at the LHC were identified as a promising strategy to reduce

computing time, though challenges in deployment were acknowledged. The intersection of computational imaging and AI in medicine demonstrated the broad impact of machine learning in medical applications. Additionally, the potential of silicon microring resonators in photonic spiking neural networks underscored the versatility of integrated photonics in neural network development. Overall, the workshop showcased the diverse and impactful applications of machine learning across various domains, emphasizing collaboration between disciplines and the need for innovative approaches to address challenges in experimental design, data preparation, and model deployment.

The hands-on sessions at the workshop offered tangible experiences and practical applications of machine learning concepts. The scientific high-performance programming session in Julia equipped participants with valuable skills in implementing Bayesian analysis and machine-learning algorithms. This not only enhanced their technical capabilities but also underscored the practical relevance of efficient programming in the context of scientific research. The second hands-on session, in collaboration with the MODE initiative, demonstrated the power of differentiable optimization in the context of detector geometries. Participants actively contributed to the optimization of the SWGO telescope array, gaining first-hand experience in addressing real-world challenges in particle physics experiments. The collaborative nature of the MODE initiative highlighted the importance of interdisciplinary collaboration in achieving optimal experimental designs. Overall, the hands-on sessions complemented the theoretical discussions, providing participants with an holistic learning experience. The practical application of scientific high-performance programming and differentiable optimization showcased the real-world impact of machine-learning methodologies in advancing research in particle nuclear and medical physics. The workshop, enriched by these interactive sessions, emphasized the importance of both theoretical understanding and practical implementation. The opportunity of a working set-up was particularly useful for students.



## 04Degenkolb24

### EDMs: complementary experiments and theory connections

4-8 March 2024

Total participants: 42

EURO-LABS Users: 10

### Objectives

Research on permanent electric dipole moments (EDMs) is an active and highly diverse field that is driven, for both theory and experiment, by relatively small and disjoint groups. This workshop was intended as a first step in building awareness and strengthening connections among European researchers studying EDMs, in relation to three broad challenges.

(1) Individual groups, though well-connected within a topical area (e.g., atomic physics/particle physics/neutron physics), are typically missing strong connections to other EDM research outside that area. The

goal in this context was to establish connections across these topical areas, highlight opportunities for borrowing/modifying experimental and theoretical methods, and begin building a strong network to broadly improve recruitment and transfer of students and early-career researchers across these boundaries. (2) The relatively small size of the groups means that any one institution typically has too few students working on EDMs to firmly establish the relevant experimental and theoretical foundations as a stable component of their educational curricula. Our goal was to begin building a critical mass, partly through this workshop, to help organize training activities and transfer structures that can operate on a European level. (3) There exists a great deal of conflicting notation and conventions, which makes it challenging even for experts to extract reliable information from literature (and especially across topical boundaries). Without attempting to fully “resolve” this issue, we aimed to improve the situation by explicit discussion and establishment of standard approaches to perform reliable transfer and conversions.

### Achievements

Twenty-five scientific presentations were given on a range of topics representing almost all active research directions in both theory and experiment for EDMs, and including those not yet actively pursued in Europe. Unfortunately, there was finally no presentation on lattice QCD (cancelled due to illness of the invited speaker), and none on the proton EDM (we were unable to arrange a speaker despite multiple invitations). Moderated discussions addressed community-level concerns in a systematic way (either proposing solutions or clarifying the challenges with clear points for follow-

up) and identified novel opportunities such as a radioactive isotopes/molecules program that could be envisioned at PSI. Recent research work was actively discussed within and beyond the workshop sessions, and at least one publication preprint acknowledged the workshop. There was strong participation of young researchers at the student and postdoc level (10 talks and 7 posters), and a clear path was established toward organizing future training events such as topical summer schools. Most importantly, the community interest and initiative to pursue joint funding, and thus secure a collective future for networks and early-career training in these topical areas, was strongly confirmed. Detailed text-based survey responses were overwhelmingly positive.



**ECT\***  
EUROPEAN CENTRE  
FOR THEORETICAL STUDIES  
IN NUCLEAR PHYSICS AND RELATED AREAS

**WORKSHOP**  
Trento, June 17-21, 2024

**Towards a consistent approach for nuclear structure and reactions: microscopic optical potentials**

Direct nuclear reactions, processes such as nucleon transfer, knockout, anti-nucleon capture have been extensively exploited by experiments to learn about the structure of exotic isotopes far away from stability, to infer properties of the nuclear forces, to describe nucleosynthesis and to learn about the nuclear equation of state. In this respect, nucleon-nucleus optical potentials are of great importance since they are the fundamental building blocks needed to predict reaction observables to address such a wide range of nuclear physics facets. Traditional phenomenological optical potentials are constructed empirically reliable only in a narrow range of energies and masses, and the stable nuclei. As a consequence, to. On the contrary, microscopic optical potentials can be systematically extended to isotopes far from stability that are the focus of modern experimental searches. This workshop will address the state-of-the-art of nuclear optical potentials to foster advances in their accuracy and handling of uncertainty propagation.

**Organizers**  
C.Barbieri (Uni Milano), A.Obertelli (TU Darmstadt), C.Elster (Ohio Uni), C.Hebborn (FRIB)

**Key-note speakers**  
M.Atkinson (Lawrence Livermore National Laboratory), G.Blanchon (CEA, DAM, DIF), A.Bonaccorso (INFN, Pavia), S.Brolli (Uni Milano and INFN), P.Capel (Johannes Gutenberg Universität Mainz), W.Dickhoff (Dept of Physics, Washington University in St. Louis), P.-Y. Duerinck (Université Libre De Bruxelles), P.Finelli (Uni of Bologna and INFN), A.Flores (Washington University In St. Louis), J. Gomez Camacho (CNA - Uni of Sevilla), A.Gottardo (INFN LNL), A.Kedia (North Carolina State University), J.B. Linares Fernandez (Louisiana State University), G.Lotay (University of Surrey), F.Núñez (Michigan State University), A.Obertelli (TU Darmstadt), F.Pederiva (University of Trento and INFN-TIFPA), S.S.Perrotta (Lawrence Livermore National Laboratory), G.Potel Aguilar (Lawrence Livermore National Laboratory), G.Sargsyan (Facility For Rare Isotope Beams, Michigan State University), E.Vigezzi (INFN Milano), M.Vorabbi (University of Surrey), S.Wang (Southwest University), G.Yang (Chongqing University), K.Yoshida (Japan Atomic Energy Agency)

Director of ECT\*: Eng. Andrea Simoni

The ECT\* is part of the Fondazione Bruno Kessler. The Centre is funded by the Autonomous Province of Trento, funding agencies of EU Member and Associated states, and by INFN-TIFPA and has the support of the Department of Physics of the University of Trento.  
For the organization please contact: Ives Campo - ECT\* Secretariat - Villa Tambosi - Strada delle Tabarelle 256 | 38123 Villazano (Trento) - Italy | Tel. (+39-0461) 314721, E-mail: [incaamp@kessler.it](mailto:incaamp@kessler.it) or visit <http://www.ectstar.eu>

## 13Barbieri24

### Towards a consistent approach for nuclear structure and reactions: microscopic optical potentials

17-21 June 2024

Total participants: 30  
EURO-LABS Users: 9

#### Objectives

Nucleon-nucleus optical potentials are of great importance in nuclear physics when reactions are involved. Phenomenological optical potentials have very limited predictive power and prevent the derivation of reliable uncertainties. Microscopically derived potentials can be systematically extended to isotopes far from stability that are the focus of modern experimental searches. The workshop addressed the state-of-the-art of nuclear optical potentials to foster advances in their accuracy and handling of uncertainty propagation.

#### Achievements

The workshop brought together experimentalists focused on reactions and theorists from different subfields of nuclear reactions. The most recent and promising methods towards microscopic optical potentials, covering a broad range of energies and applications, were presented and discussed. An overview of today's use of optical potentials could be obtained from their applications to stable nuclei and radioactive isotopes for nuclear structure and astrophysics. Modern methods in deriving optical potentials and the role of specific observables to constrain the optical potentials were reviewed. Methods to derive uncertainties in cross section predictions were also discussed. The workshop was the occasion to define directions for an ab initio development of optical potentials, in particular the Dispersive Optical Model and methods applied to Green's Function Theory. Finally, optical potentials for exotic processes such as antiproton-nucleus elastic scattering and annihilations were discussed.



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**ECT\***  
EUROPEAN CENTRE FOR THE OPTICAL STUDIES IN NUCLEAR PHYSICS AND RELATED AREAS

**WORKSHOP**  
Trento, 01-05 July - 2024

**NEW OPPORTUNITIES AND CHALLENGES IN NUCLEAR PHYSICS WITH HIGH POWER LASERS**

**GOALS OF THE WORKSHOP**

1. Promote communications and establish collaborations between researchers in laser-plasma and nuclear physics.
2. Improve the current status of PIC simulations to be connected to nuclear codes.
3. Explore applications in nuclear physics. Laser-plasma acceleration can produce dense proton beams that undergo a spallation process, creating a high-flux neutron source.
4. Investigate possible new phenomena in nuclear physics. With the Laser Plasma based beams, many interesting physics could occur.

**ORGANIZERS**

- Chieh-Jen YANG (ELI-NP) (ELI-NP) (ELI-NP) (Kansai)
- Klaus SPOHR Photon Science Institute, QST) (ELI-NP)
- Paolo TOMASSINI NP (Istituto Nazionale di Ottica (INO))
- Yuji FUKUDA (ELI-NP)
- Mojtech HORNY
- Leonida GIZZI
- Domenico DORIA

**KEYNOTE SPEAKERS**

C. Bertulani (Texas A&M University-Commerce), A. Di Piazza (University of Rochester), C. Forrest (University of Rochester), Julien Fuchs (Ecole Polytechnique), S. Glenzer (SLAC National Accelerator Laboratory), H. Grieshammer (George Washington University), T. Hayakawa (QST), V. Horny (ELI-NP), Y. Kuramitsu (Osaka University), Z. Lan (Osaka University), E. Liang (Rice University), M. Lipoglavsek (Jozef Stefan Institute), P. McKenna (University of Strathclyde), B. Meyer (Clemson University), B. Mishra (INFN - LNS), K. Ostvay (University of Szeged), A. Palfy (University of Wurzburg), S. Pisano (INFN - INFN & Centro Fermi), J. Pomerantz (University Tel Aviv), P. Thirion (LMU Munich), Y. Fukuda (KPSI, QST), U. van Kolck (ECT\*), J. Vieira (Instituto Superior Técnico Lisboa), Phillip Walker (Univ. of Surrey), Y. Wu (Nankai University), C. Yang (ELI-NP), A. Yogo (Osaka University)

**Incoming Director of ECT\*: Professor Ubrajara van Kolck**

The ECT\* is part of the Fondazione Bruno-Kepler - The Center is funded by the Autonomous Province of Trento building agencies of EU Member and Associated states and by INFN INFN and has the support of the Department of Physics of the University of Trento.  
For the organization please contact: Susan Dawson - ECT\* Secretariat - Via Zanussi - Strada 6/6 - Taberna 286 - 38122 Villaverze (Trento) - Italy | Tel: (+39-0461) 334220 | Email: dawsone@provincia.tn.it | <http://www.ectstar.eu>

**EURO-LABS**  
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**Theory Alliance**  
FACILITY FOR RARE ISOTOPE BEAMS

**日本学術振興会**  
JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE

**陸江建設**

## 14Yang24

### New opportunities and challenges in nuclear physics with high power lasers

1-5 July 2024

Total participants: 22

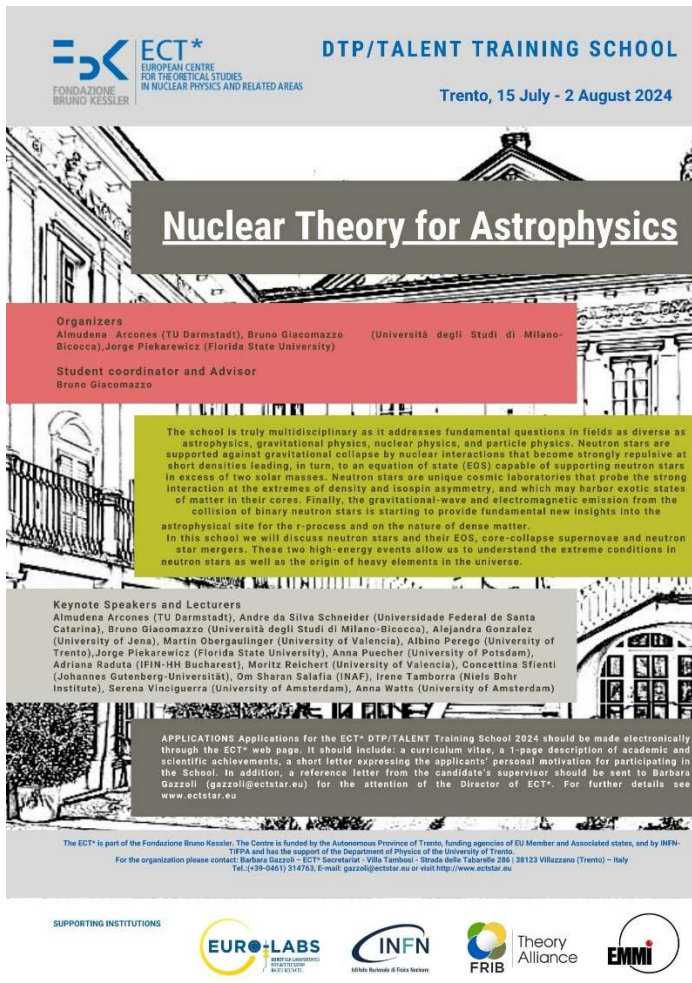
EURO-LABS Users: 8

### Objectives

Laser-driven ion and electron accelerations open a unique opportunity to probe/trigger new phenomena in nuclear physics. The intense beams produced by high-power lasers can generate neutrons/gamma rays that are orders of magnitude denser both in time and space than classical accelerators. With laser-plasma-based beams, interesting physics could occur. The goal of this workshop was to gather world experts from the nuclear and laser-plasma communities (both experimentalists and theorists) to discuss various new opportunities as well as existing challenges.

### Achievements

Several topics were discussed and at the end of the workshop participants agreed to share the group's viewpoints on the current and emerging areas in the field of high-power laser science and applications to nuclear physics. The main theme of all the discussion converged to the essential question: What can high-power laser systems do differently to forward the field of nuclear physics in a way that an existing accelerator system cannot provide? During the workshop, both theoretical and experimental efforts were presented, which resulted in a group consensus for the physics that can be achieved at ELI-NP or any other high-power laser facility.



**ECT\***  
EUROPEAN CENTRE FOR THEORETICAL STUDIES IN NUCLEAR PHYSICS AND RELATED AREAS

**DTP/TALENT TRAINING SCHOOL**  
Trento, 15 July - 2 August 2024

**Nuclear Theory for Astrophysics**

**Organizers**  
Almudena Arcones (TU Darmstadt), Bruno Giacomazzo (Università degli Studi di Milano-Bicocca), Jorge Piekarowicz (Florida State University)

**Student coordinator and Advisor**  
Bruno Giacomazzo

The school is truly multidisciplinary as it addresses fundamental questions in fields as diverse as astrophysics, gravitational physics, nuclear physics, and particle physics. Neutron stars are supported against gravitational collapse by nuclear interactions that become strongly repulsive at short densities leading, in turn, to an equation of state (EoS) capable of supporting neutron stars in excess of two solar masses. Neutron stars are unique cosmic laboratories that probe the strong interaction at the extremes of density and isospin asymmetry, and which may harbor exotic states of matter in their cores. Finally, the gravitational-wave and electromagnetic emission from the collision of binary neutron stars is starting to provide fundamental new insights into the astrophysical site for the r-process and on the nature of dense matter. In this school we will discuss neutron stars and their EOS, core-collapse supernovae and neutron star mergers. These two high-energy events allow us to understand the extreme conditions in neutron stars as well as the origin of heavy elements in the universe.

**Keynote Speakers and Lecturers**  
Almudena Arcones (TU Darmstadt), Andre da Silva Schneider (Universidade Federal de Santa Catarina), Bruno Giacomazzo (Università degli Studi di Milano-Bicocca), Alejandra Gonzalez (University of Jena), Martin Obergaulinger (University of Valencia), Albino Perego (University of Trento), Jorge Piekarowicz (Florida State University), Anna Puecher (University of Potsdam), Adriana Raduta (IFIN-HH Bucharest), Moritz Reichert (University of Valencia), Concettina Sfienti (Johannes Gutenberg-Universität), Om Sharon Salafia (INFN), Irene Tamborra (Niels Bohr Institute), Serena Vinciguerra (University of Amsterdam), Anna Watts (University of Amsterdam)

**APPLICATIONS** Applications for the ECT\* DTP/TALENT Training School 2024 should be made electronically through the ECT\* web page. It should include: a curriculum vitae, a 1-page description of academic and scientific achievements, a short letter expressing the applicants' personal motivation for participating in the school. In addition, a reference letter from the candidate's supervisor should be sent to Barbara Gazzoli (gazzoli@ectstar.eu) for the attention of the Director of ECT\*. For further details see [www.ectstar.eu](http://www.ectstar.eu)

The ECT\* is part of the Fondazione Bruno Kessler. The Centre is funded by the Autonomous Province of Trento, funding agencies of EU Member and Associated states, and by INFN-TIFPA and has the support of the Department of Physics of the University of Trento.  
For the organization please contact: Barbara Gazzoli - ECT\* Secretariat - Villa Tambori - Strada della Tabarella 286 - 38123 Villazano (Trento) - Italy  
Tel: (+39-0461) 314763, E-mail: [gazzoli@ectstar.eu](mailto:gazzoli@ectstar.eu) or visit <http://www.ectstar.eu>

**SUPPORTING INSTITUTIONS**  
EURO-LABS, INFN, FRIB, Theory Alliance, EMMI

## DTP/TALENT2024

### Nuclear Theory for Astrophysics

15 July – 2 August 2024

Total participants: 24  
EURO-LABS Users: 8

### Objectives

The 2024 DTP/TALENT school focused on neutron stars and the strong link between nuclear physics and astrophysics. This school had the objective of introducing students from different backgrounds in nuclear physics and in astrophysics to the current state of the art in the field of nuclear astrophysics. To reach this objective, the school was organized into three weeks of lectures and exercises on the following topics: 1) the equation of state of neutron-rich matter and new constraints inferred from nuclear theory, experiments, and observations, 2) core-collapse supernovae as the birthplace of neutron stars, and 3) neutron-star mergers and gravitational

waves to probe the neutron-star interior.

### Achievements

The students achieved a comprehensive understanding of neutron stars from the nuclear and astrophysics perspectives. An excellent and diverse group of lecturers made possible the following learning outcomes: understand the nuclear physics of neutron stars; learn how theory, experiment, and observations inform the equation of state; obtain a comprehensive understanding of core-collapse supernovae and how the equation of state impacts the dynamic, neutrino emission, and nucleosynthesis; and understand the evolution of neutron-star mergers and their gravitational, and electromagnetic signals. There were a total of 24 students (7 female, 17 male), all were early-career researchers (doctoral researchers or young postdocs). There were 14 lecturers (6 female, 8 male) including senior researchers and advanced postdocs. The support from ECT\*, and its year-long experiences with running Doctoral Training Programs and TALENT courses, was central to the success of the course. The organization, help, support and advice of Barbara Gazzoli was outstanding and critical for the success and smooth run of the school.



**ECT\***  
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IN NUCLEAR PHYSICS AND RELATED AREAS

**WORKSHOP**  
Trento, 05-09 August - 2024

**TOWARDS IMPROVED HADRON TOMOGRAPHY  
WITH HARD EXCLUSIVE REACTIONS**

**KEY TOPICS**

1. Lattice QCD
2. Computing methods
3. Hard exclusive meson production
4. Compton-like reactions, dilepton production
5. Theory / phenomenology
6. GPD models and beyond
7. Experimental facilities and programs

**ORGANIZERS**

- Marie Boer (Virginia Tech)
- Alexandre Camsonne (Jefferson Laboratory)
- Jakub Wagner (Narodowe Centrum Badań Jądrowych)
- Martha Constantinou (Temple University)
- Charlotte Van Hulse (University of Alcala)

**KEYNOTE SPEAKERS**

A. Alanneau (The George Washington University), J. S. Alvarado (JLab, Greyn), S. Bacchie (The Cyprus Institute), S. Bhattacharya (Los Alamos National Laboratory), D. Biswas (Virginia Tech), V. Braun (Regensburg University), A. Camsonne (JLab), K. Cichy (Adam Mickiewicz University), M. Constantinou (Temple University), W. Coresh (Florida International University), N. Crikorian (Rudjer Boskovic Institute), M. Cui (University of Virginia), M. Defurne (CEA Saclay), D. Djukanovic (Helmholtz Institute Mainz), E. Fuchey (William & Mary), G. Huber (University of Regina), A. Jentsch (BNL), B. Kriesten (ANL), S. Kay (University of York), M. Kazuk (Florida International University), K. Komarida (University of Zagreb), S. Liuti (University of Virginia), D. Melnick (JLab), V. Metzner (MCS), A. Messieris (JLab), M. Meledov (JLab, Greyn), K. Paschos (Rudjer Boskovic Institute, Zagreb), D. Richards (JLab), A. Rodriguez Castro (IRFU/CEA Saclay), P. Ross (Jefferson Lab/INFN-INFN), A. Sanchez (National Centre for Nuclear Research, Warsaw), K. Samsarov-Tyran-Chansky (INFN), S. Stepanian (Jefferson Lab), S. Szytan (Stony Brook University), P. Szondi (National Centre for Nuclear Research, Poland), A. Thomas (University of Adelaide), C. van Hulse (University of Alcala)

**Incoming Director of ECT\*: Professor Ujjayjara van Kolck**

The ECT\* is part of the European Strategy. The Centre is funded by the Autonomous Province of Trento, leading agencies of EU Member and Associated states, and by INFN/INFN and has the support of the Department of Physics of the University of Trento.  
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**EURO-LABS** **INFN** **JSA**

## 16Boer24

### Towards improved hadron tomography with hard exclusive reactions

5-9 August 2024

Total participants: 35

EURO-LABS Users: 7

### Objectives

The primary objective of the workshop was to advance the understanding of hadronic physics by focusing on hard exclusive reactions and the imaging of hadrons. The event aimed to gather theorists and experimentalists to discuss recent progress and identify new approaches for studying Generalized Parton Distributions (GPDs) and Generalized Transverse Momentum Distributions (GTMDs). Key goals included exploring theoretical advancements, such as lattice QCD (LQCD) calculations, and leveraging emerging computing techniques, such as machine learning. Another major objective

was to investigate novel reactions that could provide access to previously challenging quantities, thus broadening the scope of hadron tomography research

### Achievements

The workshop successfully met its objectives by presenting new approaches to study GPDs and GTMDs. Participants shared advanced theoretical developments and computational techniques, including the use of machine learning and LQCD. The discussions also highlighted experimental strategies for probing GPDs through novel exclusive processes, directly addressing the workshop's goal of enhancing methods for hadron tomography. The workshop directly addressed its goals by fostering discussions between theorists and experimentalists on improving methods for investigating the hadron structure.

18Ding24

## New developments in studies of the QCD diagram

9-13 September 2024

Total participants: 36  
EURO-LABS Users: 9

### Objectives

The main objective of the workshop was to highlight recent conceptual and technical advancements in understanding the QCD phase diagram and the nature of the chiral phase transition. Key topics included:

1) The nature of the chiral phase transition. The order and universality class of the chiral phase transition has not been determined yet. This is mainly hampered by the undetermined fate of the axial  $U(1)$  anomaly at the chiral phase transition temperature.

2) Critical behaviour at the QCD phase transition and its connection to the physical



**New developments in studies of the QCD phase diagram**

The workshop is in the field of nuclear physics, quantum chromodynamics and ultrarelativistic heavy-ion collisions. It aims at a thorough discussion of new conceptual and technical developments that arose in recent years in studies of the QCD phase diagram and its dependence on various external control parameters. We will discuss the still unresolved question concerning the impact of breaking or "effective" restoration of the axial anomaly on the QCD phase diagram. We will explore the influence of quark flavors and the presence of nonzero baryon number density on the QCD transition and, furthermore, will discuss very recent developments such as the usage of correlations among Dirac eigenvalue spectra, the resumed Taylor expansion method as well as Lee-Yang edge singularities in studying the QCD phase diagram.

**Organizers**  
Heng-Tong Ding (Central China Normal University), Karach Frithjof (University of Bielefeld), Maria Paola Lombardo (INFN - Sezione di Firenze), Peter Petreczky (Brookhaven National Lab)

**Speakers**  
Yasumichi Aoki (RIKEN-Kobe), Francesco Di Renzo (University of Parma), Kenji Fukushima (University of Tokyo), Wei-Jie Fu (Dalian University of Technology), Tetyana Galatyuk (University of Darmstadt), Jana Guenther (University of Wuppertal), Prasad Hegde (Indian Institute of Science), Ivan Horvath (University of Kentucky), Andrey Yu. Kotov (Jülich supercomputing center), Tamas S. Kovacs (Eotvos Lorand University), Xiaofeng Luo (Central China Normal University), Enrico Meggiolaro (Pisa University), Jan Martin Pawłowski (University of Heidelberg), Owe Philipsen (Frankfurt University), Rob Pisarski (Brookhaven National Laboratory), Chihiro Sasaki (University of Wrocław), Christian Schmidt (University of Bielefeld), Sayantan Sharma (The Institute of Mathematical Sciences), Spaz Sharma (University of Bielefeld), Misha Stephanov (University of Chicago at Illinois), Massimo D'Elia (University of Pisa), Gergo Endrodi (University of Bielefeld)

The ECT\* is part of the Fondazione Bruno Kessler. The Centre is funded by the Autonomous Province of Trento, funding agencies of EU Member and Associated states, and by INFN, INFPA and has the support of the Department of Physics of the University of Trento.  
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Tel. (+39-0461) 314763, E-mail: gazzoli@ectstar.eu or visit <http://www.ectstar.eu>

**Supporting Institutions**  
INFN Istituto Nazionale di Fisica Nucleare  
EURO-LABS European Laboratories for Accelerator Based Science  
CRC-TR 211 Strong Interaction matter under extreme conditions  
ICTP International Centre for Theoretical Physics

world. True phase transitions of strong-interaction matter are only expected in the limits of massless and infinitely heavy quarks, or beyond a certain value of baryon number density and other external parameters. The development of QCD critical behaviour requires control over parameters that do break QCD symmetries explicitly, e.g. quark masses. Only then the influence of external parameters such as chemical potentials on the occurrence of phase or crossover transitions of strong-interaction matter in physical world can be analyzed reliably.

3) Manifestation of critical behaviour in heavy ion collision experiments. Searching for the QCD critical end point (CEP) has been one of the central goals in heavy-ion collision experiments. Systematic uncertainties are inherent in predictions for the location of the CEP obtained within different theoretical frameworks, using lattice QCD (LQCD) calculations, functional renormalization group (FRG) methods and others.

### Achievements

The workshop proved instrumental in addressing fundamental discrepancies within the QCD community, especially concerning the nature of the chiral phase transition as well as the possible signatures for the critical end point and axial  $U(1)$  anomaly. Notable outcomes included:

- Advances in lattice and continuum frameworks: Theoretical progress in lattice and continuum methods, including FRG, has enhanced our understanding of critical behaviour at high densities and temperatures. One novel approach in LQCD computations involved the use of Lee-Yang edge singularities to estimate the possible location of the CEP. Additionally, exploring QCD

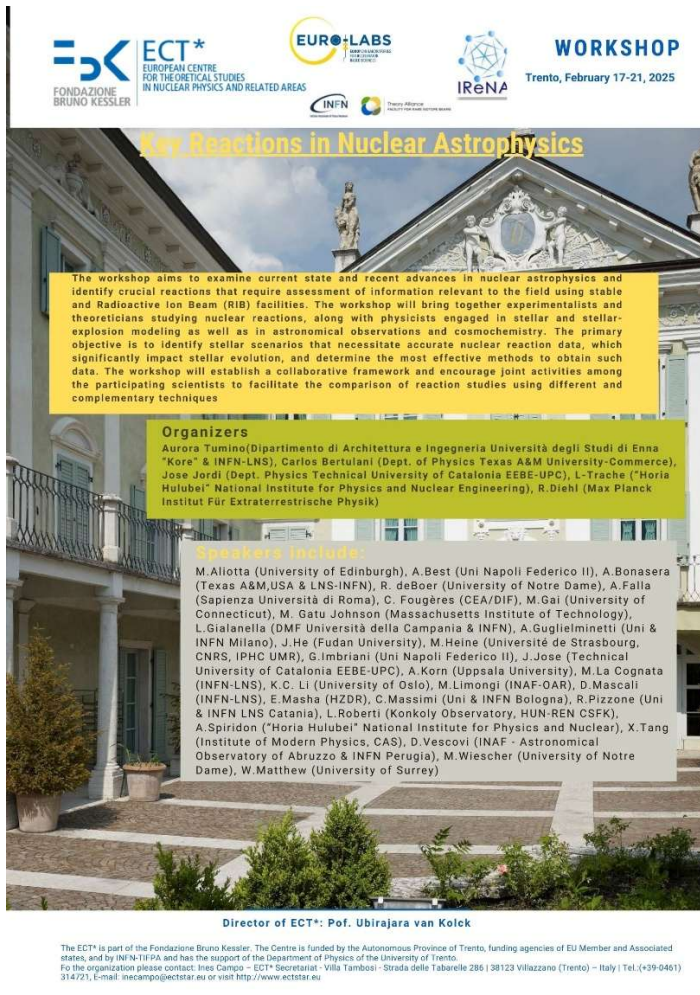
thermodynamics in small volumes at low temperatures was identified as a promising avenue for future studies.

- Insights into the Columbia Plot: LQCD computations with various discretization schemes suggest that the first-order chiral phase transition in the lower-left region of the Columbia plot (e.g., in three-flavour QCD) is likely absent. However, the underlying cause of this absence, such as the role of the axial U(1) anomaly, requires further investigation. Meanwhile, substantial evidence supports a second-order phase transition in the chiral limit of light quarks in (2+1)-flavour QCD.
- Progress in CEP Searches: Recent data from the Beam Energy Scan II (BES-II) program were presented and discussed, with consensus emerging from FRG and LQCD computations regarding the possible location of the CEP. However, further studies are needed to establish a consistent baseline for the BES-II data and to reduce uncertainties stemming from theoretical predictions and dynamic modelling in the evolution of heavy-ion collisions.



magnetohydrodynamics) up to first order in gradients was discussed, revealing intriguing collective modes. Furthermore, a calculable holographic framework for spin hydrodynamics was introduced and formulations of quantum kinetic theory in curved spacetime were discussed.





**Key Reactions in Nuclear Astrophysics**

The workshop aims to examine current state and recent advances in nuclear astrophysics and identify crucial reactions that require assessment of information relevant to the field using stable and Radioactive Ion Beam (RIB) facilities. The workshop will bring together experimentalists and theoreticians studying nuclear reactions, along with physicists engaged in stellar and stellar-explosion modeling as well as in astronomical observations and cosmochemistry. The primary objective is to identify stellar scenarios that necessitate accurate nuclear reaction data, which significantly impact stellar evolution, and determine the most effective methods to obtain such data. The workshop will establish a collaborative framework and encourage joint activities among the participating scientists to facilitate the comparison of reaction studies using different and complementary techniques.

**Organizers**  
Aurora Tumino (Dipartimento di Architettura e Ingegneria Università degli Studi di Enna "Kore" & INFN-LNS), Carlos Bertulani (Dept. of Physics Texas A&M University-Commerce), Jose Jordi (Dept. Physics Technical University of Catalonia EEBE-UPC), L-Trache ("Horia Hulubei" National Institute for Physics and Nuclear Engineering), R. Diehl (Max Planck Institut Für Extraterrestrische Physik)

**Speakers include:**  
M. Allotta (University of Edinburgh), A. Best (Uni Napoli Federico II), A. Bonasera (Texas A&M, USA & LNS-INFN), R. deBoer (University of Notre Dame), A. Falla (Sapienza Università di Roma), C. Fougères (CEA/DIF), M. Gai (University of Connecticut), M. Gatu Johnson (Massachusetts Institute of Technology), L. Gialanella (DMF Università della Campania & INFN), A. Guglielminetti (Uni & INFN Milano), J. He (Fudan University), M. Heine (Université de Strasbourg, CNRS, IPHC UMR), G. Imbriani (Uni Napoli Federico II), J. Jose (Technical University of Catalonia EEBE-UPC), A. Korn (Uppsala University), M. La Cognata (INFN-LNS), K.C. Li (University of Oslo), M. Limongi (INAF-OAR), D. Mascalci (INFN-LNS), E. Masha (HZDR), C. Massimi (Uni & INFN Bologna), R. Pizzone (Uni & INFN LNS Catania), L. Roberti (Konkoly Observatory, HUN-REN CSFK), A. Spiridon ("Horia Hulubei" National Institute for Physics and Nuclear), X. Tang (Institute of Modern Physics, CAS), D. Vescovi (INAF - Astronomical Observatory of Abruzzo & INFN Perugia), M. Wiescher (University of Notre Dame), W. Matthew (University of Surrey)

Director of ECT\*: Pof. Ubirajara van Kolek

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## 01Tumino25

### Key Reactions in Nuclear Astrophysics

17-21 February 2025

Total participants: 41  
EURO-LABS Users: 5

### Objectives

The scientific goals of this workshop were to summarize the current knowledge and remaining open questions on some of the recognized key reactions in nuclear astrophysics, like the  $^{12}\text{C}(\alpha, \gamma)$ ,  $^{12}\text{C}+^{12}\text{C}$  and  $^{22}\text{Ne}(\alpha, n)$  fusion reactions. We aimed at the reaching consensus on the reaction rates and their uncertainty, in order to propose new ideas for further work. In addition, other reactions, methods to establish their importance, and the experimental methods to be used were to be discussed. We intended to build bridges between theory and experiment and bridges to adjacent science branches that aim at understanding the origin of the elements and the star

evolution in the Universe.

### Achievements

The workshop was organized by scientists with direct involvement in the subject proposed. In morning and afternoon sessions during the week, summary reports and new ideas were presented. Most appreciation was given to the long overtime discussions following each presentation and at the end of each day. Experiments were presented which are carried out or proposed at such facilities as LUNA (Italy), JUNA and LEAF (China), CASPAR (USA), STELLA (France) and Felsenkeller (Germany), or with indirect methods at large RIB installations. Important were the presentations and the resulting discussions on stellar dynamics, sensitivity studies, and astrophysical observations, including the determination of elemental abundances in stars. The workshop was considered a success by all participants and periodic follow-ups were proposed.

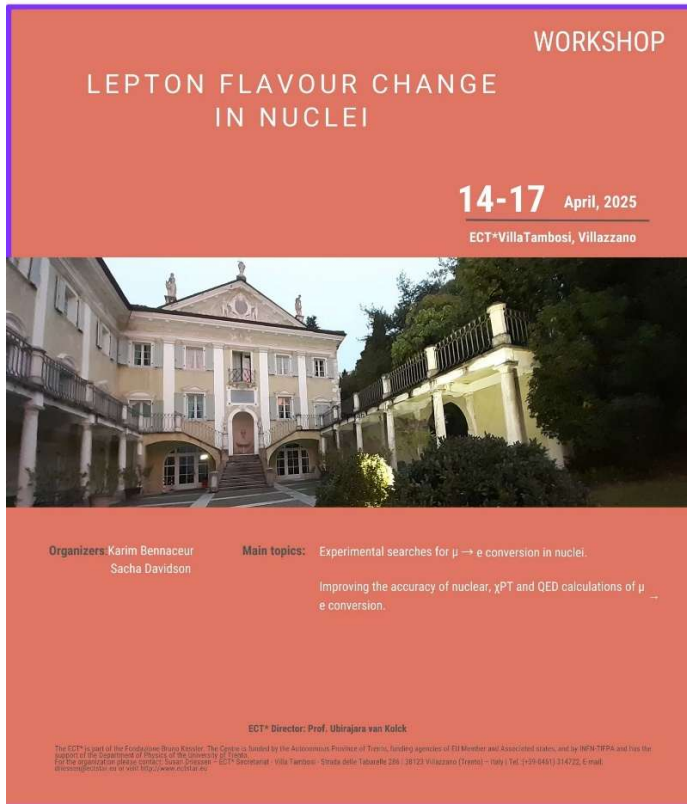
## 05Bennaceur25

### Lepton flavour change in nuclei

14-17 April 2025

Total participants: 17

EURO-LABS Users: 5



WORKSHOP

LEPTON FLAVOUR CHANGE  
IN NUCLEI

14-17 April, 2025

ECT\* Villa Tambosi, Villazzano

Organizers: Karim Bennaceur  
Sacha Davidson

Main topics: Experimental searches for  $\mu \rightarrow e$  conversion in nuclei.  
Improving the accuracy of nuclear,  $\chi$ PT and QED calculations of  $\mu \rightarrow e$  conversion.

ECT\* Director: Prof. Ujjayanta van Kolck

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### Objectives

Lepton flavour change is observed in neutrino oscillations, but not yet in contact interactions among charged leptons – despite decades of active searching and a plethora of models. However, this could change soon, as a huge leap in experimental reach is promised by upcoming searches for  $\mu \rightarrow e$  conversion in nuclei. Since multiple scales are involved in this process, the workshop aimed to bring together lepton, hadron, and nuclear theorists to discuss the state-of-the-art calculations of the conversion rate, including the various nuclear models employed. With the participation of experimentalists, another

objective was a critical examination of the accuracy required of theoretical calculations by upcoming experiments, as well as the feasibility and complementarity of different nuclear targets to best identify the lepton-flavour-changing interactions.

### Achievements

The workshop brought together a small but active group of theorists and experimentalists. Presentations allowed specialists in a subfield to better understand the nature, techniques and approximations of calculations in other subfields. Topics included: muon conversion phenomenology and experiments; flavour physics models; hadronic/nuclear methods (chiral perturbation theory, nuclear effective field theories, ab initio methods, energy-density functionals, random-phase approximation); a calculation of the background from muon capture in nuclei; and leptonic wavefunctions and muonic orbitals. Discussion led to an improved understanding of the nature and precision of the quantities (overlap integrals) needed to evaluate the branching ratio of  $\mu \rightarrow e$  conversion -- in particular, the role of symmetry breaking and restoration in energy-density functionals, which are often overlooked but expected to play a significant role in modelling the charge densities needed for the calculations of overlap integrals.

Organizers received very positive comments from the participants about the workshop, which was seen as a great opportunity for physicists from high- and low-energy subatomic physics to interact, with significant time for questions and informal discussions. Great progress was made in understanding the various aspects of the theory, which may lead to further collaborations among

participants --- for instance regarding more realistic calculations of muonic orbitals by taking into account the deformation of nuclei. Participants also acknowledged the importance of estimating the uncertainties of theoretical calculations; although such estimates are difficult and frequently neglected, they are crucial for identifying what theoretical information can be extracted from data when  $\mu \rightarrow e$  conversion is observed.

## 10Colò25

### Theory Service for the Low Energy Nuclear Physics Community: A Hands-on Workshop

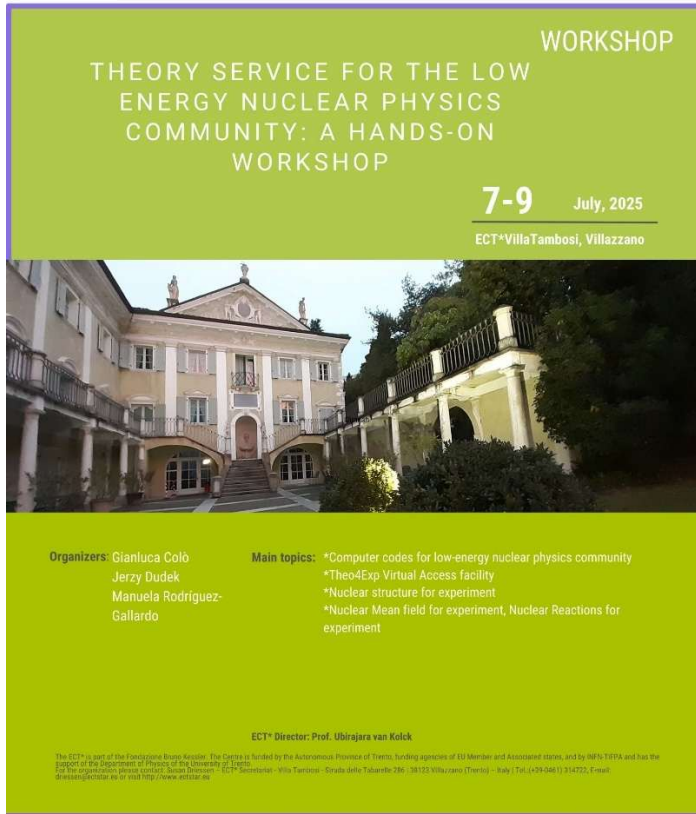
7-9 July 2025

Total participants: 40

EURO-LABS Users: 22

#### Objectives

The Theo4Exp workshop was designed to bring together experimental and theoretical nuclear physicists around a common goal: making theoretical tools more accessible and useful to the experimental community. A particular focus was placed on three virtual platforms, namely MeanFieldExp, Reaction4Exp, and Structure4Exp, developed to support experimental work by offering practical calculations and insights. The workshop aimed not only to introduce these tools, but also to encourage open discussion, gather feedback, and strengthen collaboration between the two communities.



**WORKSHOP**

THEORY SERVICE FOR THE LOW ENERGY NUCLEAR PHYSICS COMMUNITY: A HANDS-ON WORKSHOP

**7-9** July, 2025

ECT\* Villa Tambosi, Villazzano

**Organizers:** Gianluca Colo, Jerzy Dudek, Manuela Rodriguez-Gallardo

**Main topics:** \*Computer codes for low-energy nuclear physics community  
\*Theo4Exp Virtual Access facility  
\*Nuclear structure for experiment  
\*Nuclear Mean field for experiment, Nuclear Reactions for experiment

ECT\* Director: Prof. Ulf-Gregor Meißner

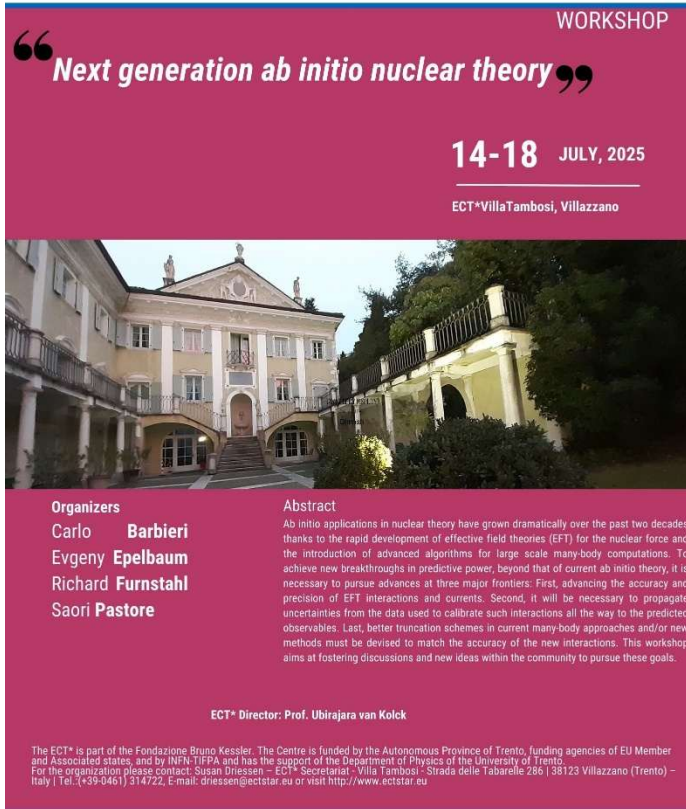
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#### Achievements

Over the course of the workshop, participants got a clear and hands-on introduction to each of the three platforms. The sessions helped understand the tools, showing how they can be used, from planning measurements to interpreting data. The open discussions were particularly interesting, allowing users to share suggestions and raise questions in a constructive manner. Beyond the technical content, the workshop created a friendly space for discussions between theorists and experimentalists, highlighting just how much both sides can benefit from closer collaboration. The positive engagement suggests real potential for these tools to be integrated into day-to-day research and even into teaching at the Master's level.



**WORKSHOP**

“Next generation ab initio nuclear theory”

**14-18 JULY, 2025**

ECT\* Villa Tambosi, Villazzano

**Organizers**  
Carlo Barbieri  
Evgeny Epelbaum  
Richard Furnstahl  
Saori Pastore

**Abstract**  
Ab initio applications in nuclear theory have grown dramatically over the past two decades thanks to the rapid development of effective field theories (EFT) for the nuclear force and the introduction of advanced algorithms for large scale many-body computations. To achieve new breakthroughs in predictive power beyond that of current ab initio theory, it is necessary to pursue advances at three major frontiers: First, advancing the accuracy and precision of EFT interactions and currents. Second, it will be necessary to propagate uncertainties from the data used to calibrate such interactions all the way to the predicted observables. Last, better truncation schemes in current many-body approaches and/or new methods must be devised to match the accuracy of the new interactions. This workshop aims at fostering discussions and new ideas within the community to pursue these goals.

ECT\* Director: Prof. Udirajara van Kolck

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## 11Barbieri25

### Next generation ab initio nuclear theory

14-18 July 2025

Total participants: 40

EURO-LABS Users: 5

### Objectives

The main objective of the workshop was to provide a forum and facilitate discussions of new ideas among the major players in the ab initio nuclear physics community in order to foster future progress and breakthroughs in three fields of research, namely (i) the next generation of many-nucleon interactions and electroweak currents, (ii) propagation of uncertainties and (iii) novel many-body methods for nuclear theory.

### Achievements

The workshop featured 36 scientific presentations including 4 talks focused on experimental topics and many talks given by

young participants. These covered recent highlights and ongoing developments in the application of chiral and pionless effective field theories to nuclear interactions and dynamics, exploration of new ideas and expansion schemes (e.g., expansion around the unitary limit), uncertainty quantification methods, development of efficient emulators to facilitate many-body applications (eigenvector continuation, parametric matrix models, greedy algorithms, etc), usage of neural networks in many-body calculations, novel and emerging technologies for ab-initio calculations (tensor factorization, diagrammatic Monte Carlo, etc.) and studies of nuclear structure, reactions and electroweak physics. To facilitate scientific exchange between participants, dedicated discussion sessions were held at the end of each workshop day (except the last day). The main outcome of the workshop was the efficient knowledge exchange as well as critical review and coordination of activities between experts and practitioners from different fields (model developers, many-body theorists, experimentalists), which make an important contribution to advancing the frontier of ab-initio calculations in nuclear physics.

## 13Hagelstein25

### New perspectives in the charge radii determination for light nuclei

28 July – 1 August 2025

Total participants: 27

EURO-LABS Users: 5

### Objectives

The workshop concerned the determination of the details of nuclear charge and magnetization distributions, such as charge and Zemach radii, from the spectroscopy of (exotic) atoms. The aim of the workshop was to discuss the innovative microcalorimeter detector technology for high-resolution X-ray spectroscopy, the interplay of various experiments, and the necessary improvements on the theoretical side, required to match the (anticipated) experimental accuracies. Of critical interest was a better understanding of nucleon and nuclear structure corrections, which notoriously constitute the main theoretical



**WORKSHOP**

**NEW PERSPECTIVES IN THE CHARGE RADII DETERMINATION FOR LIGHT NUCLEI**

28 July - 1 August 2025  
ECT\* Villa Tambosi, Villazzano

**Organizers:** Loredana Gastaldo  
Franziska Hagelstein  
Nancy Paul  
Randolph Pohl

**Main topics:**

- High-resolution X-ray and laser spectroscopy
- Microcalorimeter X-ray detector technology
- Experimental progress: target preparation, background suppression, calibration Theory of muonic atoms Nuclear and nucleon structure effects Searches for physics beyond the Standard model (BSM)

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limitations in predicting the spectra of muonic atoms. In addition, prospects for testing physics beyond the Standard Model (BSM) were presented. While fostering an exchange of expertise among experimentalists was important, a primary goal of the workshop was to further strengthen the crucial collaboration between experiment and theory.

### Achievements

The one-week workshop was attended by a near-even split of experimental and theoretical physicists representing various subdisciplines. One third of the participants were early career researchers, out of which 4 could join thanks to the support of EURO-LABS.

Participants discussed recent results of the QUARTET and Reference Radii collaborations, with a special focus on the new MMC detector technology. Furthermore, the workshop covered a feasibility study for the Quartz collaboration, the status of the HyperMu experiment, and complementary experiments including spectroscopy of He-like ions, bound electron g-factors, King plots, electron-scattering experiments, and antiprotonic atom X-ray spectroscopy. The workshop highlighted the present limitations on muonic-atom theory and the need for refined calculations, most importantly, for the nuclear-structure corrections that are currently the limiting uncertainty in determining charge radii from muonic-atom spectroscopy. The atmosphere at the workshop fostered lively discussions and suggestions for future collaborations. A plan was developed to perform a first full comparison of nuclear-structure predictions for muonic helium and lithium across various approaches, including ab

initio nuclear theory with different potentials and  $\eta$ (-less) formalisms, data-driven estimates of nuclear-polarizability corrections, a novel method employing an artificial neural network, and precise computation of electromagnetic radii from variational Monte Carlo. In addition, several presentations discussed SM tests and BSM searches.

WORKSHOP

**“Pan-American Few-Body Physics Boot Camp: Fostering Collaboration”**

**13-24 OCTOBER, 2025**

ECT\* Villa Tambosi, Villazzano



**Organizers**

- Guillaume Hupin
- Tobias Frederico
- Sebastian König
- Alinka Lepine-Szily

**Abstract:** The study of short-lived states, whether at the edge of nuclear stability or just above a reaction threshold, represents a complex and multifaceted domain where few-body physics emerges from the interactions of many nucleons. Recent years have seen a surge in experimental observations that continue to challenge our current models of the nucleus. As instrumentation advances rapidly, a widening gap has emerged between nuclear modeling capabilities and the data being collected. To address this gap and stimulate new ideas and collaborations, this workshop proposes a fresh approach by reimagining the traditional format. We aim to shift the focus toward young scientists with an interest in nuclear physics and few-body systems. By empowering these emerging researchers to cross disciplinary boundaries, share techniques, and collaborate on unresolved problems – identified by senior theorists and experimentalists or newly raised during the workshop – we hope to break the current impasse in theoretical modeling and to connect different generations working in the rich and exciting field of nuclear few-body physics.

ECT\* Director: Prof. Ubirajara van Kolck

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## 19Hupin25

### Pan-American Few-Body Physics Boot Camp: Fostering Collaboration

13-24 October 2025

Total participants: 22

EURO-LABS Users: 4

#### Objectives

The primary goal of the workshop was to bring together theoreticians and experimentalists from both sides of the Atlantic working across a wide range of energy scales and topics, from low-energy nuclear structure to hadronic physics. By fostering collaboration among these communities, we aimed to narrow the gap between theoretical developments and experimentally accessible observables. A central objective was to reverse the traditional workshop format by placing junior researchers at the centre of the program.

#### Achievements

We created an environment where early-career scientists could present their work, exchange ideas, and build new collaborations. Through a combination of plenary sessions, focused discussions, and small-group breakout activities, participants were encouraged to explore methods in depth, learn from one another, and engage in genuine scientific training and dialogue. This was the first edition of such a program in Europe, and one of the main challenges was to attract enough young scientists willing to dedicate two weeks of their research time to topics that are not necessarily at the core of their PhD work. On this point, we believe we succeeded: all the long-talk slots reserved for junior researchers (two each morning) were fully filled. Another significant challenge was to animate the afternoons with meaningful discussions and collaborative work. Here again, we consider the outcome very positive.

Groups of collaborators often withdrew to work together, individual participants had time to advance their own research plans, and, when offered, lecture-style sessions on specific topics were well attended. Each afternoon ended with a collective discussion aimed at deepening and expanding the physics introduced in the morning talks.

## 20Spyrou25

### Neutron-capture reactions for astrophysical processes

3-7 November 2025

Total participants: 30

EURO-LABS Users: 5

### Objectives

The scope of the workshop was to bring together the different communities that measure, calculate or use neutron-capture cross sections for astrophysical applications and trigger discussions along the following questions:

- Which neutron-capture reactions are the most impactful for each relevant astrophysical process?
- Which neutron-capture reactions should be treated as statistical and which ones not?
- How can we extend direct measurements of neutron-capture reactions into unstable nuclei?
- What are the advantages and limitations

of existing indirect methods (Oslo, surrogate, shape, particle evaporation, Coulomb dissociation, etc.)?

- How can experiment and theory work more closely together to provide strong constraints for the various nuclear properties, and therefore neutron-capture cross sections?
- What are the uncertainties associated with adopted cross sections and how to properly propagate these uncertainties into nucleosynthesis observables?
- What are the neutron-capture rates and associated uncertainties to be recommended for astrophysical simulations?

### Achievements

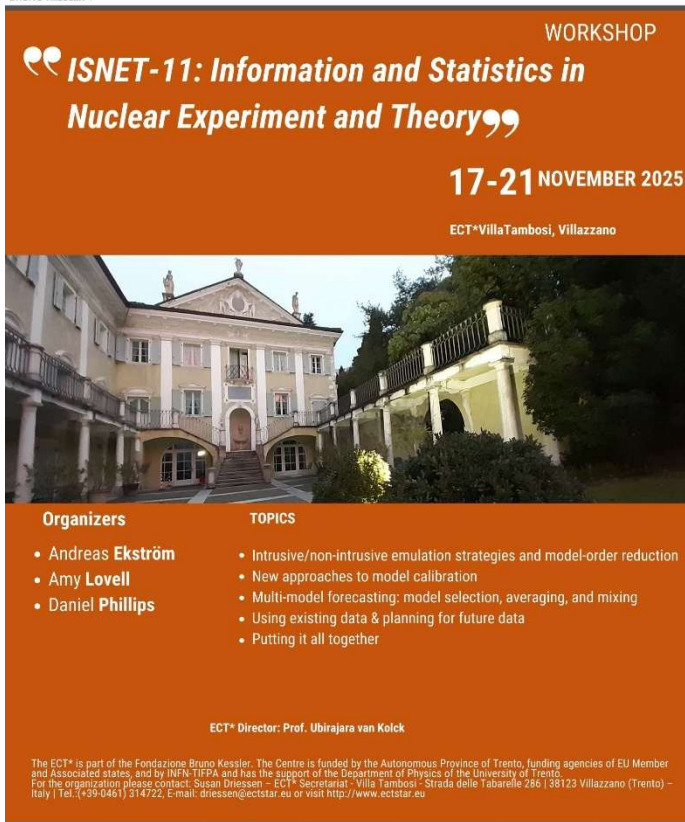
The participants of this workshop reviewed recent advances in predicting, constraining, and measuring neutron-induced cross sections, as well as their impact on astrophysical applications. Multiple theoretical and experimental developments were discussed, persistent challenges identified, and proposed ways forward suggested, such as:

- Continue to develop accurate and robust microscopic models relevant to reactions on unstable nuclei, along with quantified uncertainties.
- Pursue complementary indirect measurements and, where possible, direct measurements to constrain and determine neutron-induced reactions or properties relevant for determining cross sections for unstable nuclei, including radioactive beams in inverse-kinematics

experiments; storage rings that enable the storage, accumulation, and recycling of short-lived isotopes; indirect surrogate or Oslo-type measurements

- Perform astrophysical simulations on a representative sample of trajectories to propagate nuclear uncertainties including both model and parameter uncertainties constrained by experimental data.
- Explore possibilities for creating and maintaining a common database that includes cross sections from indirect measurements such as the surrogate method and Oslo methods.
- Continue to work on reaching a good understanding of how uncertainties should be treated and properly quantified for nucleosynthesis network simulations of the various astrophysical scenarios, such as the intermediate neutron-capture process and the rapid neutron-capture process.

## 21Ekstrom25



WORKSHOP  
**ISNET-11: Information and Statistics in Nuclear Experiment and Theory**  
17-21 NOVEMBER 2025  
ECT\*VillaTambosi, Villazzano

**Organizers**

- Andreas Ekström
- Amy Lovell
- Daniel Phillips

**TOPICS**

- Intrusive/non-intrusive emulation strategies and model-order reduction
- New approaches to model calibration
- Multi-model forecasting: model selection, averaging, and mixing
- Using existing data & planning for future data
- Putting it all together

ECT\* Director: Prof. Udirajara van Kolck

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### ISNET-11: Information and Statistics in Nuclear Experiment and Theory

17-21 November 2025

Total participants: 34

EURO-LABS Users: 3

### Objectives

ISNET-11 brought together researchers to explore how modern statistical methodology for uncertainty quantification, Bayesian inference, emulation, and multi-model forecasting can help accelerate scientific progress across nuclear theory and experiment. The program was organized around five core themes, each combining topical presentations with discussion-driven sessions at the end of each day to stimulate cross-disciplinary exchange. A central objective was to examine how statistical reasoning can be embedded into the nuclear scientific workflow: from model calibration

and parameter inference to predictive forecasting and experimental design. This format, coupling presentations and vigorous discussion sessions, ensured broad engagement across subfields and highlighted the increasing relevance of machine learning, reduced-order modelling, and principled likelihood construction for next-generation nuclear physics research.

### Achievements

The workshop demonstrated substantial advances in statistical emulation, correlated likelihood development, and data-driven forecasting. Participants reported remarkable gains in speed and scalability of many-body and transport calculations through reduced-basis strategies and Gaussian-process surrogates, while also identifying open challenges in extrapolation control, discrepancy representation, and interpretability.

Lively discussions emerged on the value and limitations of discrepancy models, the need for curated experimental data, and the potential of model-mixing for robust prediction. ISNET-11 thereby achieved its goal of fostering collaboration, clarifying research frontiers, and strengthening the bridge between nuclear physics and computational statistics, setting a strong foundation for future development in the ISNET series.

### 3. SUMMARY AND OUTLOOK

From its beginning in 2022 to the end of 2025, funding through EURO-LABS supported the participation of users in 21 projects carried out at ECT\*. These projects reflected the diversity of research areas covered by EURO-LABS. An emphasis was on topics for which nuclear experiment is ongoing or forthcoming, such as those dealing with spin probes of the QCD plasma, hadron tomography, tensor spin observables of the deuteron, and prospects with high-power lasers. In some workshops, the opportunity to interact with scientists in other communities, in particular atomic, particle, and/or astro physicists, was crucial for success, for example in workshops dealing with the determination of the charge radii of light nuclei, key nuclear reactions in astrophysics, the role of strangeness in nuclei, the detection of electric dipole moments, probes of lepton-flavour violation, and the next generation of neutrino experiments. There were also workshops that dealt with more theoretical aspects of nuclear physics, which incorporate recent experimental results and may pave the way for future experiments, such as the QCD phase diagram, few-body physics, ab initio many-body methods for structure and reactions, nuclear theory for astrophysics, machine learning, data analysis, and uncertainty quantification.

The highlight was *Theory Service for the Low Energy Nuclear Physics Community: a Hands-on Workshop*, which was organized by the task leaders of EURO-LABS's Theo4Exp initiative. As reported in EURO-LABS Milestone MS11, three virtual platforms (MeanFieldExp, Reaction4Exp, Structure4Exp) have been developed, where various theoretical tools are made accessible to users in support of on-going experimental work and of the design of future experiments. The workshop attracted a large number of young researchers, mostly experimentalists, who became familiar with the platform via lectures and hands-on activities. This stress-test of the platforms provided useful feedback to the platform designers, who could use results to improve an already very useful service for the community.

The long-lasting impact of ECT\* workshops relies on the participation of a diverse group of scientists who bring complementary viewpoints to a well-defined aspect of experiment or theory. Funding through EURO-LABS allowed the transnational access of a significantly larger number and variety of scientists than would otherwise be possible. In the reporting period, about one in four participants in eligible activities were EURO-LABS supported, in almost all cases the determining factor to reach the critical mass for workshop success. For example, in *Theory Service for the Low Energy Nuclear Physics Community: a Hands-on Workshop* more than 50% of the participants could attend thanks to EURO-LABS. EURO-LABS funding also enabled the access of Europe-based students and postdocs to two advanced schools (Doctoral Training Programs) in this period. ECT\*'s DTPs are known worldwide as *the* training ground for the next generation of nuclear physicists, the lifeline of a research field that is key to Europe's energy and security needs.

For 2026, several workshops and schools have been selected by the ECT\* Scientific Board as EURO-LABS eligible, and will take place before the end of the project. EURO-LABS support continues to be essential for the success of transnational access in its area of research.