National Laser-Initiated Transmutation Laboratory
University of Szeged

NATIONAL LASER-INITIATED TRANSMUTATION LABORATORY

DEVELOPMENT OF A LASER NEUTRON SOURCE FOR THE TRANSMUTATION TREATMENT OF NUCLEAR WASTE

The first objective of the Laboratory is to develop source of fast neutrons based on the use of few-cycle, high average power lasers in ELI-ALPS. Once the neutron source is operational with a neutron flux of 10^8 n/cm^2/s, it will be used for material science, radiobiological, and nuclear photonics researches, partially within the ELI-ERIC user program.

Learning from the experience of the developed laser-based neutron source, we will develop designs to increase the neutron yield by several orders of magnitude. This will provide the milestones for the realisation of a sub-critical nuclear reactor powered by a laser neutron source, in line with the long-term (15-year) objective of the project. Such a sub-critical reactor will transmutate spent nuclear fuel actinides, providing a realistic alternative to close the nuclear fuel cycle.

MAIN RESEARCH AREAS

- Laser ion acceleration
- Plasma physics
- Transmutation
- Radiobiology
- Imaging

IMPLEMENTER:
University of Szeged

FUNDING PERIOD: 01.07.2020 - 28.02.2025

OVERALL BUDGET: 3.485.000.000 HUF

HUNGARIAN NATIONAL LABORATORY

BENEFITS TO BE EXPECTED FROM LABORATORY RESEARCH

- Laser-based neutron source development and neutron diagnostics
- The production of medical isotopes to replace the cyclotrons needed for PET, which would allow a much wider dissemination of the technique
- Supplementing the control units used in road and rail freight transport to monitor licensed nuclear materials

THE PROFESSIONAL TEAM

15-21 people have been working on the technical implementation since the project started. 14 university students are taking part in the work in addition to five senior colleagues and one postdoctoral fellow this year.
An experienced project management team supports the project leader, including two part-time project manager, a full-time financial officer and a part-time strategic liaison officer.

Project leader: Osvay Károly
Károly Osvay was awarded the degree Candidate of Sciences of the Hungarian National Academy of Sciences in Physics for his research results in laser physics in 1995. He habilitated at the University of Szeged (SZTE) in 2011. Founder (1998) and head of the first terawatt laser laboratory in Hungary (SZTE TeWaTi). He spent a total of 8 years in leading international research institutes (RAL UK; Lund University, Sweden; MBI, Berlin). He was the scientific project manager of the ELI-Preparatory Phase between 2008-2011, head of the ELI-ALPS scientific working group from 2011, and research technology director from 2013-2019. His main research interests include ultrafast laser pulse generation and applications, laser-matter interaction, nonlinear optics, and laser particle acceleration. He has (co)authored 103 internationally peer-reviewed papers, having total independent citations of 2119 and h-index of 28.

Leading scientist: Sargis Ter-Avetysian (2020-23)
Sargis Ter-Avetisyan PhD (Candidate) in Physics (Optics) from the Institute for Physical Research of the National Academy of Sciences of Armenia in 1991 (USSR). He worked last two decades in USA, Germany, UK, Czech Republic, and South Korea in a field of relativistic, ultra-high intensity laser plasma interactions: in particular x-ray generation, ion and electron acceleration and their applications; high energy density physics and laboratory astrophysics. As a head of High Density Plasma Physics Laboratory at the Centre of Relativistic Laser Science, Institute of Basic Science (IBS), Gwangju, South Korea, and a Professor in the Department of Physics and Photon Science, Gwangju Institute of Science and Technology, South Korea, he carried out extensive research program on “Ultra-high Intensity Laser Plasma Interactions”, supervise 3 MSc and 2 PhD students. He had research grants from LaserLab Europe (3 topical research grants), International Science Foundation (2 topical research grants) and Copeland fellow in Physics Department of Amherst College, Amherst, MA, USA. He has (co)authored more than 110 papers in peer reviewed scientific journals, received 1500 independent citations, h=23, and holds 1 international patent. He joined the Hungarian, National Laser-Initiated Transmutation Laboratory, University of Szeged, project in 2019 as a Senior Research Fellow.

Research Fellow: Prashant Kumar Singh (2020-22)
Prashant Singh received PhD in physics from the Tata Institute of Fundamental Research (TIFR), India in 2015. After this as a st Post-doctoral position he joined the Center for Relativistic Laser Science (CoReLS) in South Korea, where he carried out experimental work on particle acceleration and plasma dynamics using one of the most powerful short-pulse, 4 PW laser system. During the second post-doc he joined Los Alamos National Laboratory, USA to work on the laser driven electron fast ignition project. Until 2022, Prashant worked as a Research Fellow in National Laser-initiated Transmutation Laboratory (Uni. of Szeged), where the goal is to produce high flux of few-cycle laser driven neutron beam that can be used for transmutation of nuclear waste and for other fundamental/ applied science. Over the year, he has (co)authored 39 papers in peer reviewed scientific journals, having total citation of 535 and h-index of 14. He is also active reviewer of many Journals such as Physics of Plasmas, Journal of Optics, NIMA, PPCF, and JPhysD.

Research Fellow: Parvin Varmazyar (2019-)

Parvin Varmazyar completed her Ph.D. in the field of laser plasma interaction under the supervision of Professor Saeed Mirzanejhad at the University of Mazandaran, Babolsar, Iran, in 2019. During her doctoral research, her focus was on investigating particle acceleration via interaction of laser with solid and cluster targets. Additionally, during her Ph.D., she received a scholarship from the Iranian Ministry of Science and Technology (MSRT) to carry out part of her research at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) in Germany. Since 2019, she has been an active Research Fellow at the Hungarian National Laser-Initiated Transmutation Laboratory, University of Szeged. In this role, her primary objective is to generate a high flux of neutrons through few-cycle laser interaction with thin targets, with applications in nuclear waste transmutation and other fundamental/applied sciences. Over the years, she has contributed to the (co)authorship of 6 papers in peer-reviewed scientific journals, accumulating a total citation count of 17 and an h-index of 3.

Research fellow: Attila P. Kovács (2020-)

Attila P. Kovács received his Ph.D. degree in physics from the University of Szeged in 2001. His main research interests are femtosecond optics and spectral interferometry. He has co-authored 31 internationally peer reviewed papers, to which he has received 800 independent citations to date and has a Hirsch-index of 16. He teaches several theoretical and practical courses in optics and femtosecond optics at the University of Szeged.

POSSIBLE PARTNERSHIPS

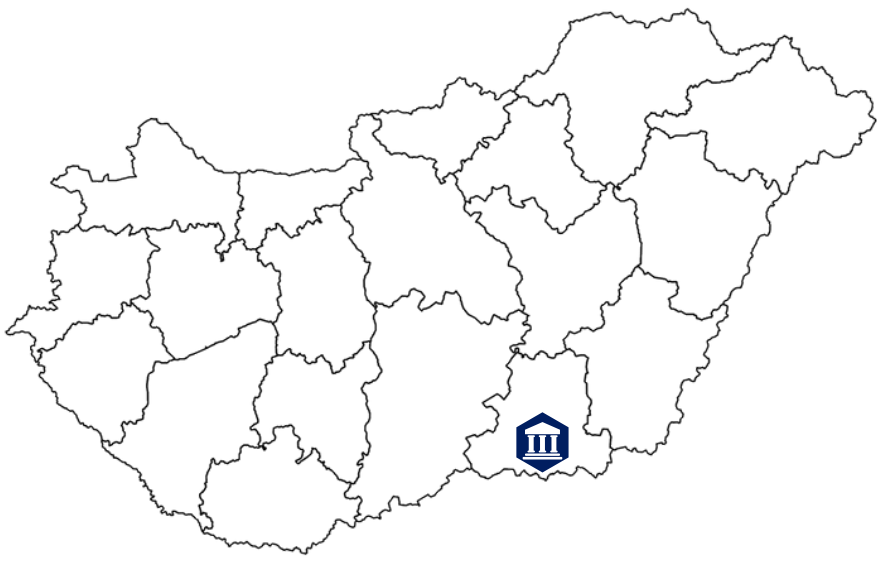
They seek partners for development of high repetition rate, ultrathin target systems, for characterisation of ultrafast neutron pulses, as well as for industrial applications of laser-generated neutrons.

TARGET GROUP

- (Next generation) particle accelerators and their users
- Nuclear power stations and spent fuel (re)processing
- Radiobiology
- CT Imaging
- Nuclear homeland security

PLACE OF IMPLEMENTATION:

- Szeged



PROFESSIONAL CONTACT

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