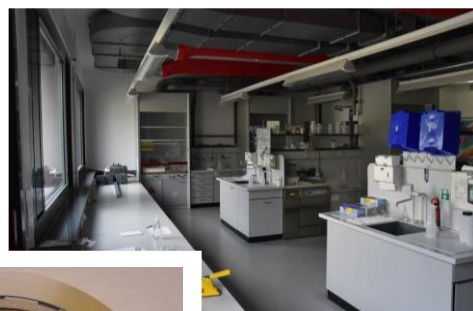


INTDS

Newsletter

International Nuclear Targets Development Society



Actinide target laboratory, Johannes Gutenberg University, Mainz, Germany

November 2024
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Number 2

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Editorial

Dear INTDS Members,

As we wrap up a productive year, we are happy to share highlights from recent events and updates from the INTDS community.

The 31st INTDS Conference, held in Knoxville, US, brought together new and old target developers from across the globe for impactful discussions on advancements in our field and for intense networking. We hope that this conference helped in creating new international collaborations and strengthening the current ones. We would like to congratulate the newly elected board members and wish them fruitful and constructive discussions.



The newly elected board (and John).

In this edition, we are pleased to feature Johannes Gutenberg University Mainz as our “Target Laboratories of the World.” Known for their actinide target production, JGU Mainz presents their current target fabrication and characterization methods, as well as a guide on how they develop new techniques.

During the Nuclear Target Development Summer School 2024, our colleague Maxim visited Argonne National Laboratory, gaining insights into advanced target production techniques and connecting with fellow target makers. His visit is presented in this newsletter’s edition.

Lastly, we are happy to announce the Target Fabrication Workshop 9, to be held in Oxford, UK, at the beginning of April. This event will offer hands-on training, technical discussions, and networking opportunities for target developers at all stages.

We would love your help in making our newsletter as engaging and informative as possible! Please share your contributions, ideas, ads, or anything you'd like to discuss with fellow target makers by emailing INTDS-Newsletter@gsi.de.

We wish you all happy holidays.

Best wishes,

Birgit Kindler and Noemi Cerboni

Target Laboratories of the World

Actinide target laboratory

Johannes Gutenberg University, Mainz, Germany

Dennis Renisch

Exotic radioisotopes, like those of the actinide elements, are essential for various applications in the nuclear sciences. The most prominent use within the research group of Prof. Dr. Christoph Düllmann is that as target isotopes for the production of superheavy elements (SHE) in heavy ion induced fusion reactions. Due to our expertise in purifying actinides, producing tailor-made samples and their characterization, we provide a multitude of samples to various international collaborations. The studying topics range from targets for laser and mass spectroscopic investigations, over myon-based experiments for the determination of nuclear charge radii to recoil sources, where the daughter nuclides are to be used for atomic and nuclear physics or for chemical experiments. Our targets are also involved in a bunch of experiments related to the exotic low-energy isomer Th-299m, which has the capability to be used in the future in the construction of a “nuclear clock”. While the actual physics and chemistry experiments typically are carried out at the experimental sites of our collaboration partners all over the world, the target production itself takes place in the laboratories of the former institute for nuclear chemistry of the Johannes Gutenberg University in Mainz. The laboratory building of the nuclear chemistry was constructed in the 1960s and a modern extension was added in 2008. A completely new building is currently under construction, in which research can be continued in state-of-the-art laboratories from 2025.

Production methods for actinide targets

Depending on the specific experiment, the desired targets must meet certain requirements regarding thickness, homogeneity, (radio-)chemical purity and mechanical stability. To fulfill these requirements, and to offer a broad range of possible target specifications, various target production techniques have been studied over the past decades.

The method used for the longest time is an electrochemical deposition technique called molecular plating (MP). The desired actinide compound is dissolved in an alcoholic solution and deposited on a backing connected to the cathode of the electrochemical cell. Different kinds of geometries are possible by designing suitable cells, whereby in most cases circular depositions from the so-called “chimney” cells or banana-shaped depositions for SHE experiments are required (see Figure 1).

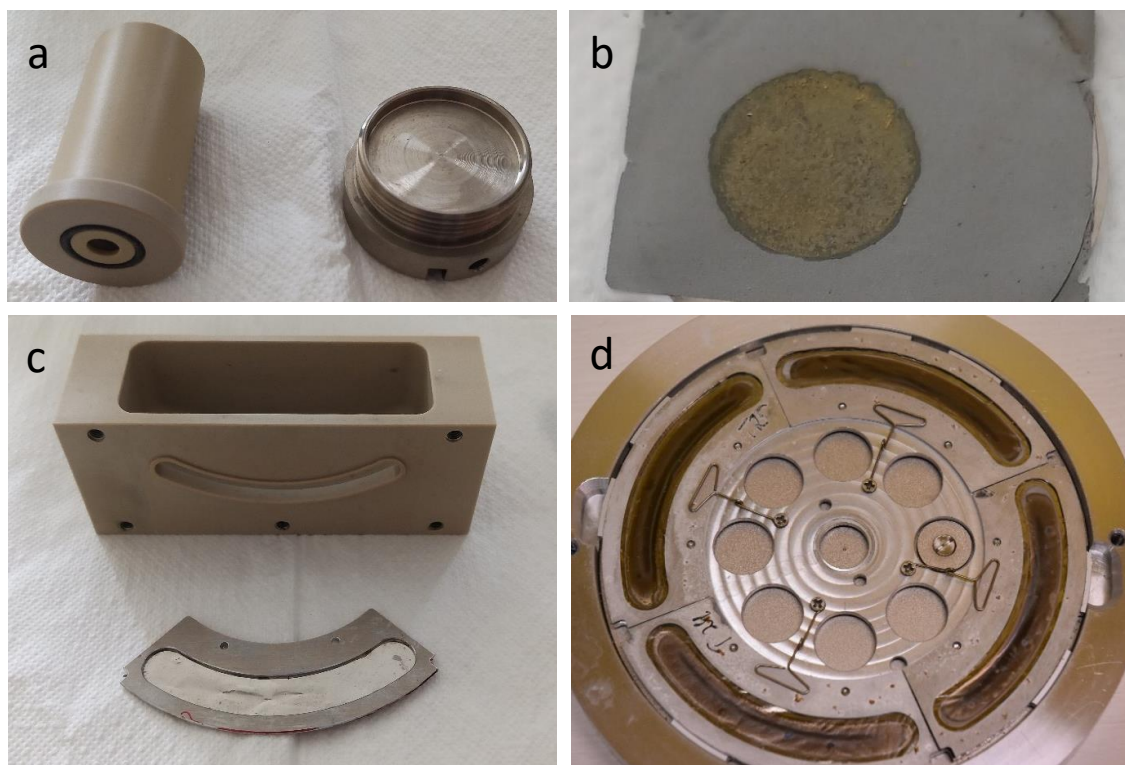


Figure 1: (a) Electro-deposition setup for circular targets, with the “chimney” cell made of PEEK and the stainless steel socket that serves as cathode. (b) Exemplary circular deposition of U-238 on a carbon foil. (c) Electro-deposition setup for banana-shaped targets, as they are used in the TASCA separator at GSI. The PEEK part is the actual cell. The metallic frame, where the Ti backing is glued on, is mounted onto the cell and serves as cathode. (d) A fully mounted TASCA target wheel with four electrodeposited Am-243 targets.

Beside the classical MP, we started to investigate other electrochemical approaches known from lanthanide chemistry. The aim is to adopt these approaches to actinides, namely the use of anhydrous organic f-metal compounds like tosylates or triflates in water-free solvents like dimethylformamide (DMF). First experiments show the potential of these methods to form homogeneous layers with areal densities of more than 1 mg/cm², the typical limit for MP targets, and a good stability under heavy ion beam irradiation.

Another important target production that became more and more versatile during the last few years is the so-called Drop-on-Demand (DoD) system, also called target printer. The DoD system combines a commercial nanoliter dispenser (Biofluidix PipeJet) with a x-y-translation stage (see Figure 2), enabling to print aqueous as well as organic solutions on any kind of substrate, e.g., metal, polymer or carbon foils. The wetting of the substrates surface by the droplets is affected by surface parameters, like roughness or passivation, as well as by solvent properties, like polarity, viscosity and pH value. The wetting behavior is directly related to the size and homogeneity of the remaining deposition after evaporation of the droplets. DoD printing is a good complement to electrochemical methods and is particularly useful

when radioactive material has to be applied to very small areas or onto fragile or non-conductive substrates.

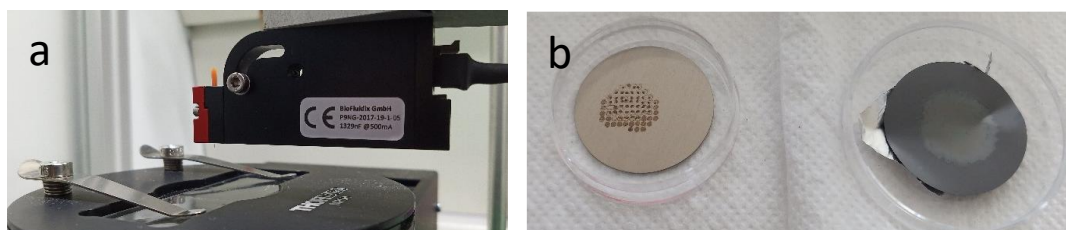


Figure 2: (a) Photo of the main part of the Drop-on-Demand system, a nanoliter dispenser PipeJet from BioFluidix. Blow the red part one can see the tiny tip of the capillary, from which droplets of a few nL can be released. The dispenser is mounted above a programmable x-y-translation stage, so that individual printing patterns can be realized. (b) Pictures of two different targets produced with the DoD system. The target on the left consists of Yb nitrate, printed from an alcoholic solution onto a Ti substrate. One can clearly see where the individual drops dried. The target on the right is a U-238 target produced by an aqueous solution mixed with tetraethylene glycol (TEG) onto a Ti backing. TEG helps to form a uniform layer, so that individual droplets are no longer recognizable.

Pre-treatment of solutions and substrates

Preparatory steps are often required before the actual target production. These include pre-treatment of the actinide solution used, for example to remove unwanted contaminants. For many experiments with radionuclides, it is important to remove any daughters that have grown into the solution, as their activity would interfere with the later measurements. Column chromatographic methods are used to separate the daughters or other contaminants from the nuclide of interest (see Figure 3a). The use of anhydrous solvents is also helpful for some applications. An argon glovebox is available for this purpose (see Figure 3b), in which dry solvents can be stored and where experiments can be carried out under controlled conditions.

In addition to the solutions, pre-treatment of the substrates on which the targets are to be deposited is often helpful. This can be, for example, simple etching of a metal foil or treatment with a sandblaster to increase the roughness of the surface. A plasma torch (see Figure 3c) is also available, which can be used to chemically activate surfaces and to increase hydrophilicity. A sputter coater (see Figure 3d) can be used to sputter thin metal layers, such as Au or Ti, of a few tens or hundreds of nanometers on any surface, and in rare cases also onto finished targets.



Figure 3: (a) Picture of a typical column used for chemical separation of unwanted contaminants or to separate daughter nuclides from the desired nuclide of interest. (b) An argon glove box used to store water-free solvents or to conduct experiments under controlled conditions. (c) A commercial sputter coater (Q150T from Quorum) to cover substrates or targets with thin metallic layers. (d) A commercial plasma torch (PlasmaBeam Mini from Diener Electronics), that can be used for cleaning of surfaces or to increase hydrophilicity of substrates.

Development of new methods

Before establishing new methods or optimizing parameters for inquiries with unusual requirements, it is advisable to first carry out inactive tests with lanthanides, which, as chemical homologues of the actinides, provide comparable results in many cases. A chemistry laboratory for inactive work is available at the Helmholtz Institute Mainz for such preliminary tests.

The second step, after the purely inactive work, is to use active lanthanides. For this purpose, lanthanides can be activated by neutron bombardment at the TRIGA Mainz research reactor so that radioactive tracers can be produced with which the preliminary experiments can be repeated. In this way, further analytical methods, such as yield determination via gamma spectroscopy or radiographic imaging, are available.

Analytical methods for target characterization

The characterization of the produced thin films often takes more time than the actual production. The aim is to answer questions that are relevant for the subsequent experiment, such as the absolute activity, the layer thickness or the chemical composition of the sample. A selection of analytical methods in the radioactive control area is available for this purpose, so that actinide targets can be examined. These methods include alpha- and gamma-spectroscopy, radiographic imaging, atomic force microscopy (AFM), scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDX). The latest method in our arsenal is a 3D laser scanning microscope Keyence VK-X3000, which provides detailed microscopy images with additional height information, allowing the layer thickness of a target to be obtained as a direct measurement. The device is currently still in the inactive area, but shall also be used to analyze actinide targets in the long term.

A special feature in Mainz is the direct access to the TRIGA Mainz research reactor as a strong neutron source, which can be used both for the production of radioactive tracers (see previous section) and for neutron activation analysis (NAA). NAA is a very sensitive method for determining the qualitative and quantitative elemental composition of a sample. In addition to determining any impurities in the solutions used, NAA can also be used to determine deposition yields. In electrochemical processes, for example, an aliquot of the solution used is taken before and after deposition and the residual content of dissolved target material is determined via NAA. The missing quantity can then be assumed to have been deposited on the target (indirect yield determination).

Special vacuum setups

For special applications, some individual vacuum setups are also available:

Offline Deposit Irradiation (ODIN): A setup equipped with an electron gun (E_{max} 1.5 keV) and an ion gun (E_{max} 5.0 keV). Finished targets can thus be exposed to particle beams with limited energy. Among other things, it is used to analyze the stability of targets in particle beams without the need for valuable beam time at an accelerator facility.

Detection of Internal Conversion Electrons (DICE): Setup equipped with an MCP detector, which is capable to detect low-energy conversion electrons. Currently used to determine and to optimize the recoil rate of U-235m from Pu-239 sources.

Laser ablation source: Many applications also require targets that are used in laser ablation ion sources. The question often arises as to what extent the chemical form of the target influences the distribution of the ionic species generated during laser ablation. This is currently being intensively investigated for thorium in particular, with the ionization behavior of metallic Th being compared with various Th salts by examining the ion species generated in a time-of-flight mass spectrometer.

News form the INTDS Board

Summary record of the pre INTDS Conference

Sunday, August 18th 2024, Knoxville, USA

- Status of the 2024 Conference => Task Matt
 - Cooperation between the local organizers and the Scientific Advisory Committee was not optimum
- Presidency of INTDS-Board
 - Handover of the presidency during Membership Meeting
 - Propositions for the position of the new Vice-President can be handed in. The Board of Directors will vote the Vice-President.
 - In future will the call for propositions for Vice-President send with the ballot for the Board election.
 - Potential candidates were discussed
- INTDS-Newsletter
 - Noemi Cerboni, PSI, worked as co-editor since 2022. The Board decided to nominate her as a regular officer as newsletter editor together with Birgit. Bettina will step back as editor.
- INTDS Financial and Membership Status report => Task Dannie
 - Membership holds for 2 years and members benefit once from a reduced conference fee.
 - Dannie will send out reminders to renew the INTDS membership well before the actual expiring date.
- INTDS reincorporation and by-laws => Task Matt
 - All formalities are handed in and the society will be reinstated in the state of Tennessee and will regain its nonprofit status.
 - Formal updates of the by-laws were discussed.
- Report of the Nomination Committee
 - The current voting is anonymous beside the nomination committee.
 - In future, the election will be performed online with full anonymity.
- Next conferences
 - Conference host guidelines will be updated. Matt will send a proposal from his actual experience from the organization.
 - Next conference host will be presented.

Summary record of the membership meeting

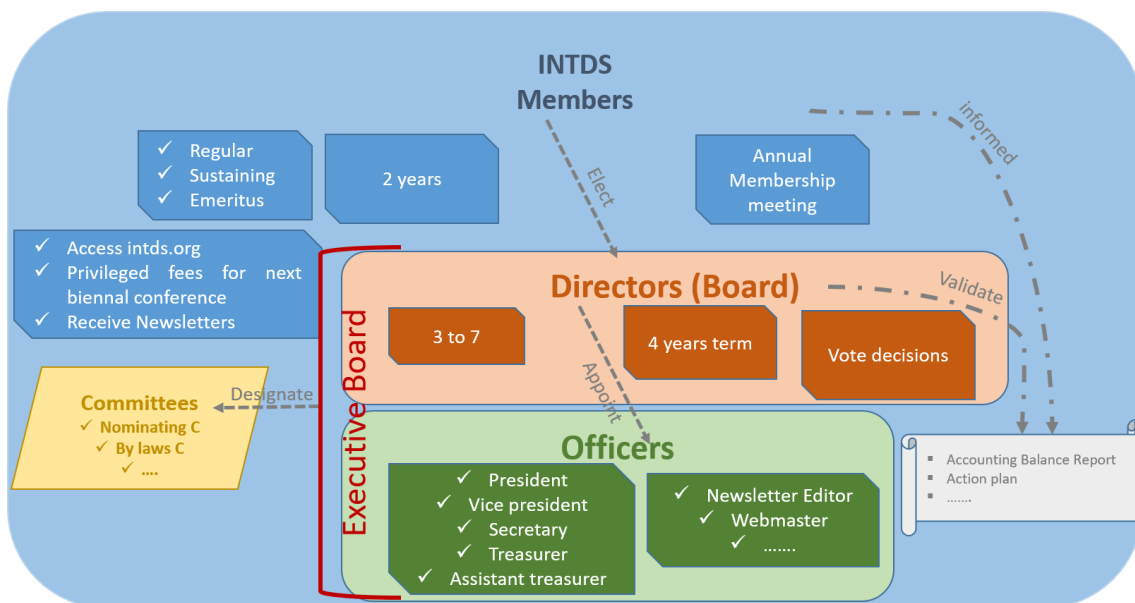
Thursday, August 22nd 2024, Knoxville, USA

1) Introduction of INTDS Society (Christelle Stodel)

a) Who we (INTDS) are? INTDS is a **non-profit, educational organization composed of members and an executive board** open to all interested in the science and technology of target fabrication.

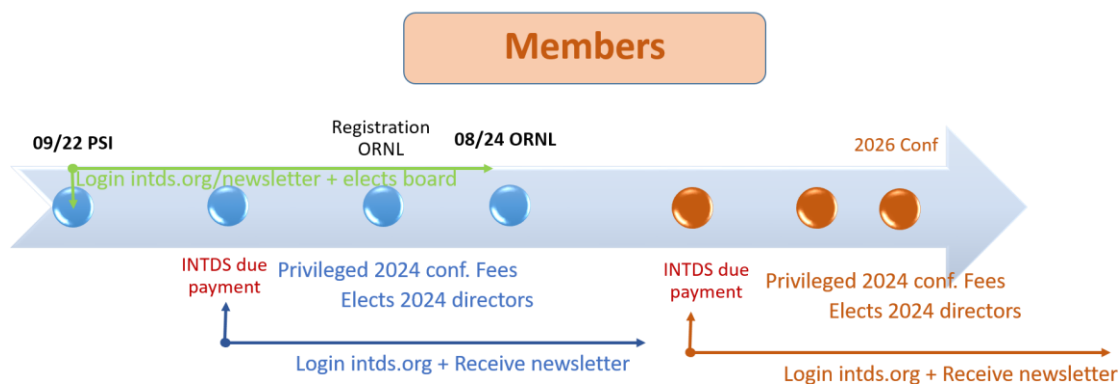
The INTDS is governed by:

- a Board of Directors, elected by Society members, (the Board of Directors shall consist of seven members representing different geographical locations).
- and Officers such as President, Vice-President, Corresponding Secretary/Treasurer and Recording Secretary and others as appointed by the Board of Directors. Officers may or may not be members of the Board of Directors.



a) How to become a member and what does it imply?

- To become INTDS member, one needs to pay a membership fee of \$100.
- These are the benefits of becoming a member of the society: A reduced INTDS conference fee every two years, access to the INTDS-newsletter, access to a wealth of INTDS bibliography, world target laboratory information and the easy access to target community.
- The society also has a Karasek fund which partially assists emerging target makers to obtain hands-on-training from the world target laboratories of their choice depending on the skill they want to acquire.



2) Board elections

Bettina Lommel as chair of the nomination and election committee (with Emilio Maugeri and Wim Weterings) reported on the nomination process and the candidates introduced themselves to the membership. Then the ballots were distributed and after the filling-in collected by the election committee that left for the counting.

3) Minutes of the virtual Board Meeting in 2023/2024 and of the pre-conference Board Meeting

at Knoxville, August 18th 2024 (Birgit Kindler)

The minutes of the Board Meetings were presented without comments.

4) Report on INTDS newsletters (Birgit Kindler)

Birgit presented the newsletter report and welcomed Noemi Cerboni officially as newly appointed officer as second Newsletter Editor. Bettina stepped back as Newsletter Editor.

5) Membership and financial status report (Dannie Steski)

- a) Dannie presented the membership and financial report without any comments. (Reports attached)
- b) Then he reported on the decisions of the Board regarding membership fees and status: The fee for normal members will be raised to 100 USD for 2 years; The Emeriti do not pay any fee; The fee for sustaining members is fixed to 500 USD for 2 years (They can present ads or logos in the newsletter and on the INTDS website free of charge and can be mentioned as sustaining member at the conferences – clear differentiation from sponsors!) – Check on ethic issues before approval of a sustaining membership!
The motion was adopted unanimously and Information sent to the membership.
- c) Dannie reported on the FRANK KARASEK AWARD SCHOLARSHIP (<https://www.intds.org/karasek-fund/>) that provides financial support of people engaging in target production and is fostering working visits in target laboratories.
Some recent scholarship visitors are presented.
- d) The INTDS awarded three grants to allow the persons to attend the INTDS conference at Knoxville.

6) **By-laws** (Matthew Gott)

Matt reported on the updating process of the by-laws instated in 1992 that was necessary since there were much changes since then (e.g. E-Mail communication, virtual meeting,...).

- a) INTDS is registered as a corporation in Tennessee, USA.
- b) Renewal of By-laws necessary for application as 501c3 non-profit corporation
- c) Voted and accepted by the membership in April 2024
- d) Next (and final step) for 510c3 status: filing IRS form once new board and officers are elected
- e) This is to avoid paying to pay additional fees
- f) Board and membership enabled to suggest addendums to the by-laws
- g) Not everything needs to be legally bound in the bylaws. An example of this is...the voting process. For society procedure, we can use guidelines. These will be publicly available with the by-laws for any member to view and understand the process.

7) **INTDS web site : library, ...** (Anna Stolarz)

The INTDS website is open for everyone <https://www.intds.org/> but there is an area restricted to members which gives access to the bibliography of INTDS and there is a Board corner only accessible to Board members. Following the conference, several members offered to support the Board of Directors with its presence on the web and in social media communication.

8) **2024 INTDS Conference : Proceedings** (Matthew Gott)

<https://www.webofconferences.org/authors>

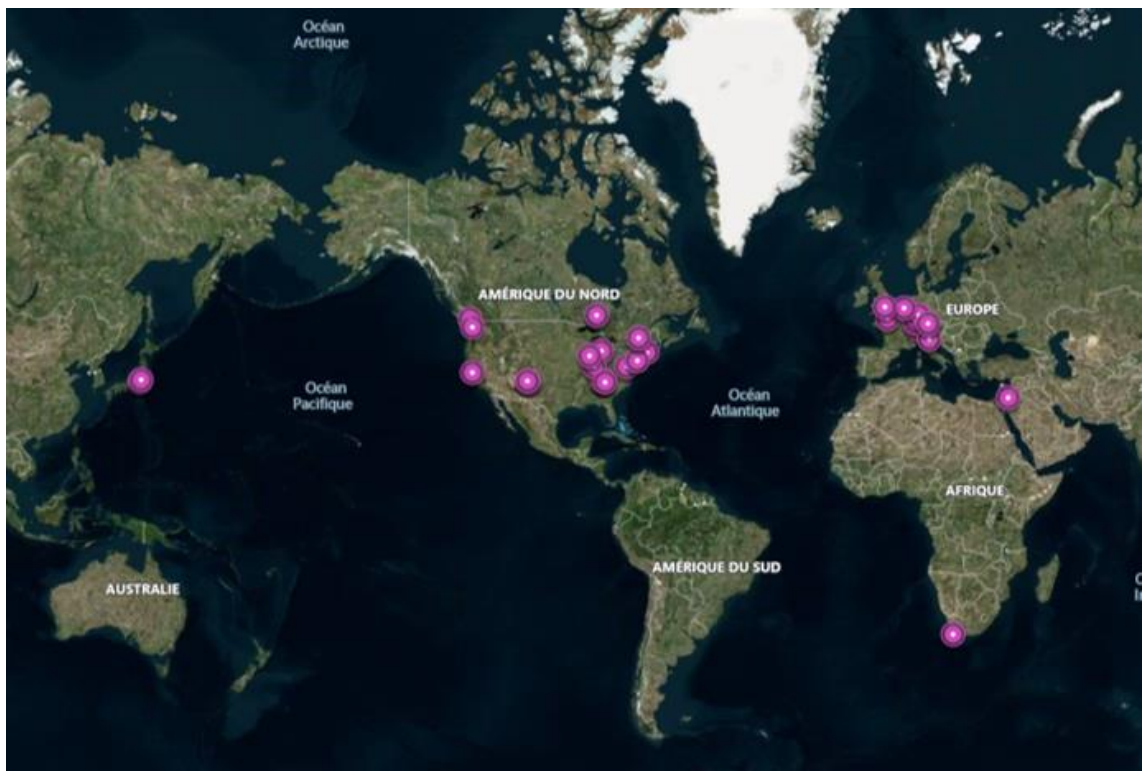
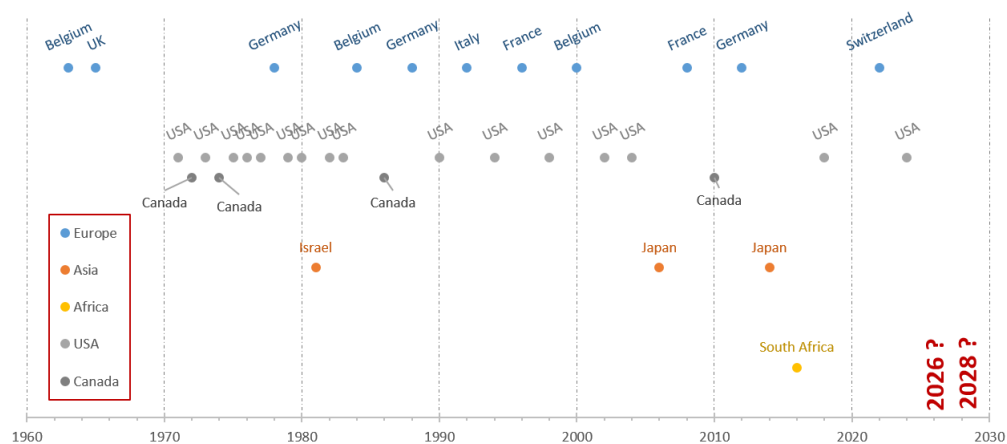
Time Frames:

- a) Manuscripts due by Nov 15th, 2024
- b) Papers to reviewers by Nov 22nd, 2024
- c) Reviews due by Jan 17th, 2025 (8-week review)
- d) Revisions due by Jan 31st, 2025 (2-week turnaround)
- e) Finalization by editors and transmit to EPJ-WOC by end of Feb 2025
- f) Single Blind Review
- g) Template link will be sent with the Participants List and information added to the conference website

9) **2026 INTDS Conference** (Christelle Stodel, Yasuto Miyake)

Christelle presented the history of the INTDS conferences and emphasized that the INTDS wants to be present worldwide where targets are fabricated and which should reflect in the choice of conference hosts. As you can see in the conference timeline, in the first 40 years the INTDS conferences nearly all were hosted in North-America or Europe. That only changed in the new millenium and we plan to change between the continents from time to time! Therefore we are very happy to announce

that the next INTDS conference in 2026 will be hosted by RIKEN in Japan, which will be presented by Yasuto Mayake representative of the Organizing Committee.



10) **2028 INTDS Conference**

No decisions yet – proposals welcome!

11) **Election results and introduction of all members of the INTDS Board**

The newly elected Board members are:

Matt Gott

Ntombizonke Kheswa

Dannie Steski

Christelle Stodel

We thank Goedele Sibbens and Masahiro Yoshimoto for their engagement in the INTDS Board and welcome the newly elected members!

12) New President

Christelle Stodel is now replaced by Ntombi Kheswa as President of the INTDS. We thank Christelle very much and are happy that she will stay in the Board as elected member. We welcome Ntombi Kheswa as new President and first African president of the INTDS!

13) Miscellaneous

Thanks to the organizers and all participants for a wonderful conference!



Summary record of the post INTDS Conference

Friday, August 23rd 2024, Knoxville, USA

Attendees: Noemi Cerboni, Matt Gott, Ntombi Kheswa, Birgit Kindler, Bettina Lommel, Emilio Maugeri, Dannie Steski, Christelle Stodel, Wim Weterings

Vote on the Vice-President:

Motion: Election of the new Vice-President with a ballot. 7 attendees are eligible to vote.

Result: 6 votes for Bettina , 1 vote for Matt

Bettina newly elected and accepted the office

Position of the Past-President:

After a short discussion Ntombi decided to keep the position of Past-President as a temporary appointed officer for counselling. She will ask Christelle if she wants to assistant for 1 year. This period can be prolonged.

Task Ntombi

INTDS-Web:

Motion: Does the Board wants to establish the position of an assistant web master?

Result: Unanimously approved without abstinence in open election.

Motion: Do we want to approach Kristian Mhyre, who has already expressed interest? Yes, Ntombi will contact him. Task Ntombi

We have to investigate the status of the ownership of the domain intds.org, which still runs in the name of David Gilliam, the former treasurer. Matt will take care of the ownership with the lawyer in order to make the society the owner with a representative that can be changed easily. Task Matt Dannie will discreetly approach David's wife in that matter. Task Dannie

Extraordinary Virtual Board Meeting

Ntombi will invite for a VBM first week of December with two items: Task Ntombi

Assistant webmaster – ideas and plans. If Kristian will agree assisting in the INTDS-web he will be invited too.

Update of the conference guidelines

Christelle and Matt will prepare a draft in advance. Task Christelle and Matt
Matt will send a feedback form to collect opinions from the members. Task Matt

Emeriti:

We had a discussion about the number of emeriti listed on our website, which is quite high in relation to the general number of members. Ntombi delegated Christelle to politely contact all emeriti and ask them for a

feedback as to whether they are still interested in the emeritus status in the INTDS with the request to please an answer within 4 weeks. Task Christelle
From now on, a similar request will be asked back every 4 years to keep the list of emeriti updated.

After an updating of the list it can be discussed about new emeriti e.g. Powell Barber for his long-year engagement in target making and in hosting the INTDS-list for intercommunication concerning target making issues.

Nomination Committee:

Bettina proposed to appoint the next nomination committee already in the VBM in December. The committee could then already begin to work on setting up an online election process.

The nomination committee has not necessarily to consist of the remaining directors, in principle any INTDS-member could be appointed.

Guidelines for INTDS Director Election

The draft of the Guidelines was discussed and updated. Matt will send the updated version. Task Matt

Motion: Do we accept the updated version? Accepted with one abstention.

Social Media:

Maxim Saifulin volunteered for taking care of social media and Matt will try to find a second person from his group.

INTDS-List

We discussed how to handle the INTDS-mailinglist that was hosted bei Powell Barber for many years, but who will retire soon. We will perhaps change the list to a sort of forum on the INTDS-website. Discussions will be open for all people that registered and perhaps are approved by a webmaster.

Conference Guidelines

Matt and Christelle will work on the update of the Conference Guidelines and will send a draft in advance to the VBM. Task Matt and Christelle

Proceedings

Ntombi (?) will send an e-mail the 2026 INTDS organizers who from their side should be guest editor.

The participant's list and all information on the proceedings (Template and dates) soon, as well as a link for placing photos. (Done)

Membership list and mailing list

Anna (member's access to web site) and Birgit (mailing list newsletter) will update their mailing lists with Dannie's updated version. We will keep the old list as extended list as mailing list for advertisements.

INTDS Membership Report

August 18th, 2024

	Nov. 2023	Aug. 2024
Sustaining Members	0	2
Regular Member	69	40
Emeritus	<u>13</u>	<u>14</u>
Total	82	56
Regular Membership by Continent:		
Europe	23	20
North America	35	18
Asia	9	3
Africa	2	1
Australia	1	0
South America	0	0
Middle East	0	0

Respectively submitted,

Dannie Steski
INTDS Corresponding Secretary/Treasurer

Matt Gott
INDS Assistant Treasurer

My visit to ANL for the Nuclear Target Development Summer School 2024

Maxim Saifulin

From July 10–13, 2024, I had the privilege of attending the 2nd Nuclear Target Development Summer School (NTDSS2024) at Argonne National Laboratory (ANL). This event brought together individuals passionate about target-making and applying targets for nuclear physics experiments. As a participant, I got an invaluable opportunity to learn target-making techniques in a hands-on environment. In addition, I enjoyed meeting wonderful people and working alongside them to explore the art of target fabrication.

The school was held in the Physics Building 203, where Maria Goeppert-Mayer, who developed the “shell” model of the nucleus, worked. In the same building, I also found original parts of a neutron velocity selector developed by Enrico Fermi. This historic setting added a unique layer to the experience.



Figure 1: Memorial plate for Maria Goeppert-Mayer, theoretical physicist and Nobel prize winner who worked in ANL (*left*) and original parts of the neutron velocity selector developed by Enrico Fermi (*right*).

During the summer school, I participated in a series of hands-on laboratory modules:

- Thermal evaporation techniques: using resistive heating and e-beam gun with Claus Mueller-Gattermann and Connor Mohs;
- Electroplating techniques taught by Alexander Chemey;
- Hydrogen/deuterium-containing targets with Scott Marley and Kelly Chipps;
- Crafting carbon foils and exploring methods for self-supported target production, led by Constance Stoner and Clayton Jolivet;

- Rolling, pressing, and various other techniques with John Greene;
- Analytic methods for target characterization with Peter Bender.

These modules allowed us to produce a range of stable-element targets from both natural and enriched isotopic materials. I was delighted to bring my self-made targets back to share with colleagues and friends, and they now sit on my desk as a nostalgic reminder of the time spent at ANL.

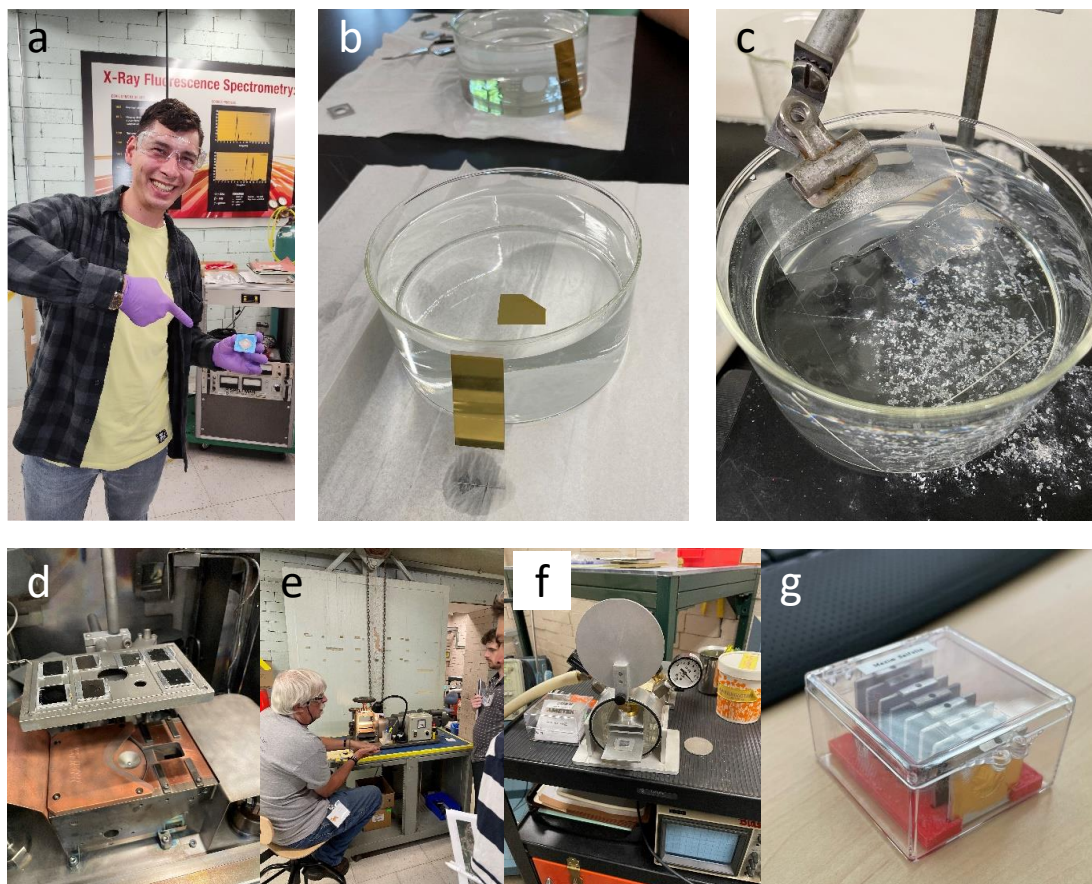


Figure 2: Selection of photos from lab activities. (a) I am happy to see my first electroplated Dy-target. (b, c) Floating Au- and C_2D_4 -targets. (d) Evaporating Ni-targets on C-backing using e-beam gun. (e) Rolling Al foil with John Greene. (f) Measuring the thickness of targets using alpha-source. (g) My box with targets by the end of the school.

The program also included tours of the ATLAS accelerator, a hot-cell tour, and a visit to the Center for Nanoscale Materials, all of which added depth to the learning experience. This summer school broadened my perspective on target-making approaches, especially in comparing methods at GSI and ANL.

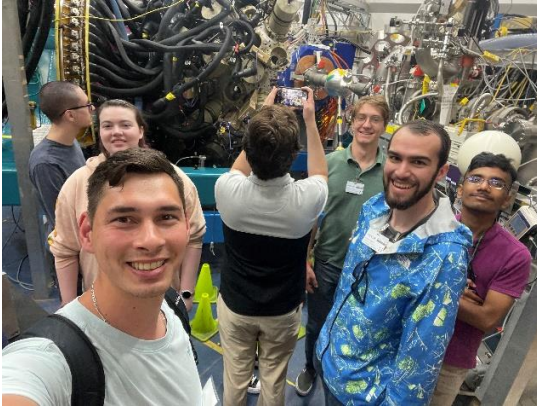


Figure 3: Excursion to ATLAS accelerator (*left*) and hot-cell tour (*right*).

I am deeply grateful to all the organizers, tutors, and participants for making NTDSS2024 such a memorable and enriching experience!

The school was supported by ANL/ATLAS, DOE, CENTAUR, and ACF.

In the future, the Nuclear Target Development Summer School is planned to be held in the odd years. The next (regular) school will be in 2027. However, in 2025 the organizers plan a special edition with Texas A&M adjacent to the Low Energy Community Meeting.

Announcement for the target fabrication workshop



Target Fabrication Workshop 9 Targ 6 Conference

**7th – 11th April
2025**

**The Queen's
College
Oxford, UK**

A joint meeting to discuss the latest development in target manufacture, characterisation and applications including IFE.

Oral and Poster presentations are welcomed



Abstract submission and further booking information will follow shortly.

For any enquiries:
Pawala.Ariyathilaka@stfc.ac.uk

Photo credit: David Fisher

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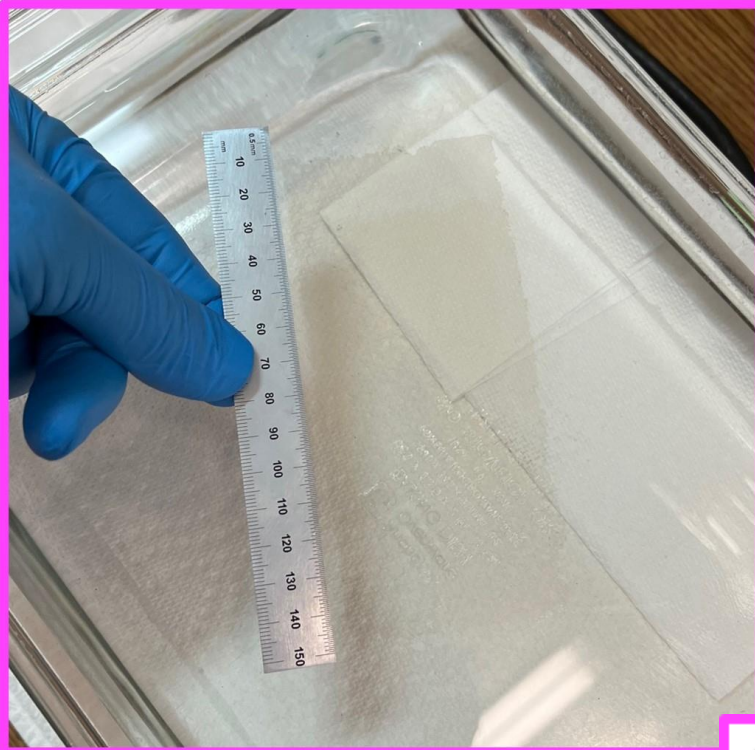


Photo: $0.1\mu\text{g}/\text{cm}^2$ Arc evaporated carbon foil, 70mm x 140mm floating successfully and waiting for pick up.

Photo has been enhanced so the foil is more visible.



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For further information on the INTDS, please refer to our website: www.intds.org.