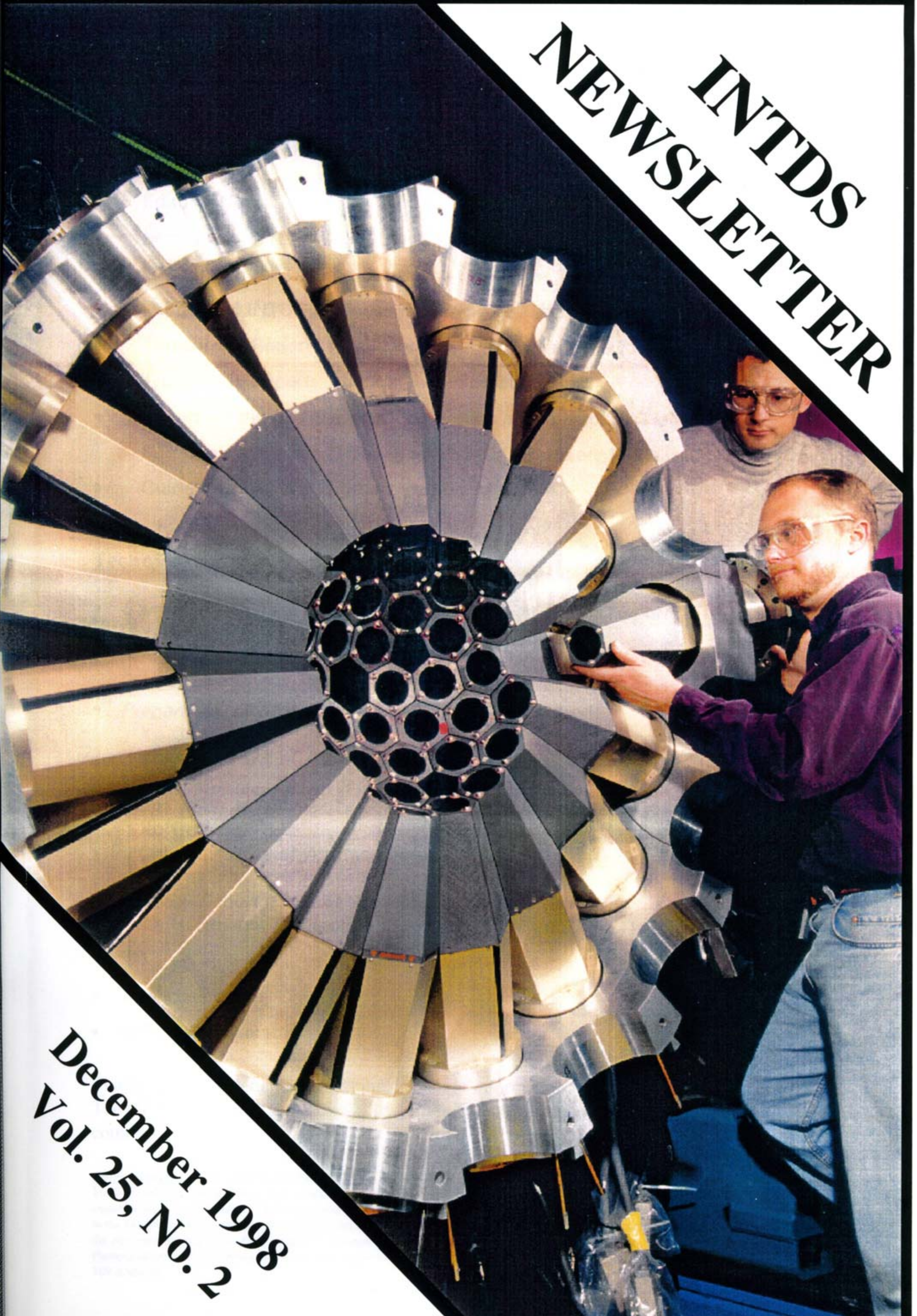
INTDS NEWSLETTER



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Cover picture: GAMMASPHERE at ATLAS

Editor's Note

The 19th World Conference of the INTDS at Oak Ridge on 5 - 9 October was a successful and enjoyable event, organised in the usual informal and friendly INDTS manner by Scott Aaron, Harold Adair and their excellent staff from ORNL. The INTDS conferences in the USA are traditionally less well attended than their European counterparts, but the membership on this occasion has remained at a very healthy 93, and it was very pleasing to see some new faces attending the INTDS conference for the first time.

Please do contribute your laboratory activity reports to the Newsletter (two are included in this issue), and add your web page address if you have one.

The site INTDS.org should be up and running very soon (webmaster W. Lozowski) so members should keep an eye open for this.

Chris Ingelbrecht
INTDS Newsletter Editor

Sixth National Conference On Nuclear Targets
Tongji University, Shanghai, China

Zhou Bin
Pohl Institute of Solid State Physics, Tongji University, Shanghai 200092, P.R. China

The sixth National Conference of the Nuclear Target Sub-Society of China, sponsored by Tongji University, took place from Oct. 26th to Oct. 30th in Shanghai.

More than forty delegates attended the conference, from ten institutes including the China Institute of Atomic Energy, the China Academy of Engineering Physics, the Institute of Modern Physics, the Changchun Institute of Optics and Fine Mechanics, Shanghai Institute of Optics and Fine Mechanics and the Tongji University, with a European contribution from the Institute of Reference Materials and Measurements, Belgium. Fifty two detailed abstracts were submitted and forty five papers were introduced at the conference. The content of these papers reflected the new developments on target preparation technology in China in the three years since the previous conference.

Led by the Commission on Nuclear Targets, the Conference on Nuclear Targets has become the highest ranking conference on target preparation in China. The research fields of the conference included preparation technology on nuclear targets, laser targets and radio isotope targets. At the same time the conference offered an opportunity for the researchers in the same fields to exchange experiences on target preparation technology.

Many improvements on target preparation technology have occurred in China. The researchers who work on target preparation make an important contribution to the development of Chinese Nuclear Technology and High Power Laser Technology, but there is much to be gained by strengthening the co-operation between Chinese and foreign researchers.

The new Commission on Nuclear Target was elected in this conference. They are Xu Guoji, Yin Jianhua, Wang Zhanshan, Li Hongfa, Wang Jue and Tang Yongjian. The president of the Commission is Tang Yongjian from China Academy of Engineering Physics. The vice presidents are Professor Wang Jue from Tongji University and Xu Guoji from China Institute of Atomic Energy. The next conference will be held by China Academy of Engineering Physics in 2001, at a date to be decided by the Commission.

Guidelines for INTDS Board Member Elections

H.J. Maier, Chairman of the 1998 Nomination Committee

December 21, 1998

1. Nomination of candidates

- At each world conference, the incumbant president shall appoint a nominating committee which will provide names of candidates to be elected to the Board of Directors at the next world conference.
- The slate of candidates nominated by this committee will contain at least one name for each current opening on the Board of Directors and will be made known to the membership at least 8 months prior to the conference, preferably by publishing it in the newsletter.
- The publication will include a call for nomination of additional candidates by the membership within a set time of 4 months. This right of proposal of candidates by each individual society member shall be pointed out clearly. After the time of 4 months, the nominating committee puts up the final slate of candidates, which may, but need not, include one or more additional individuals nominated by the membership.
- To provide the chance for the membership to vote for a person not nominated by the committee, the ballot allows the election of fill-in candidates.

2. Implementation of the election

- The ballots with the slate of all nominated candidates and with space for fill-in candidates are distributed by mail by the INTDS Corresponding Secretary or the chairman of the nomination committee.
- Publishing of the ballots in the newsletter seems to be less efficient, as shown by the low poll during the 1998 election.
- Election can be performed by mail, fax, or email, or by personal vote during the business meeting at the World Conference in question. Nominations from the floor are allowed. The chairman of the nomination committee collects the ballots.
- Counting of the votes is performed by the nomination committee during the INTDS business meeting. The result is made known immediately and published in the next newsletter.
- The election has to be public - as practized so far - for reasons of the US corporate law.

GAMMASPHERE at ATLAS - Target Preparation Status Report

John P. Greene and George E. Thomas
Physics Division, Argonne National Laboratory, Argonne, IL 60439, USA

Abstract

With the move of GAMMASPHERE from Lawrence Berkeley Laboratory (LBL) to Argonne one year ago, a robust experimental program is being carried out, coupling this large (110 detector) Compton suppressed germanium detector array with the Argonne Fragment Mass Analyzer (FMA). Situated at the Argonne Tandem-Linac Accelerator System (ATLAS), the need for many, high quality, thin targets for heavy-ion experiments has been realized. During this first year of operation, a large fraction of ATLAS beam time (4000 hrs.) has been dedicated to GAMMASPHERE experiments, requiring increased target preparation and support. We describe here some recent highlights.

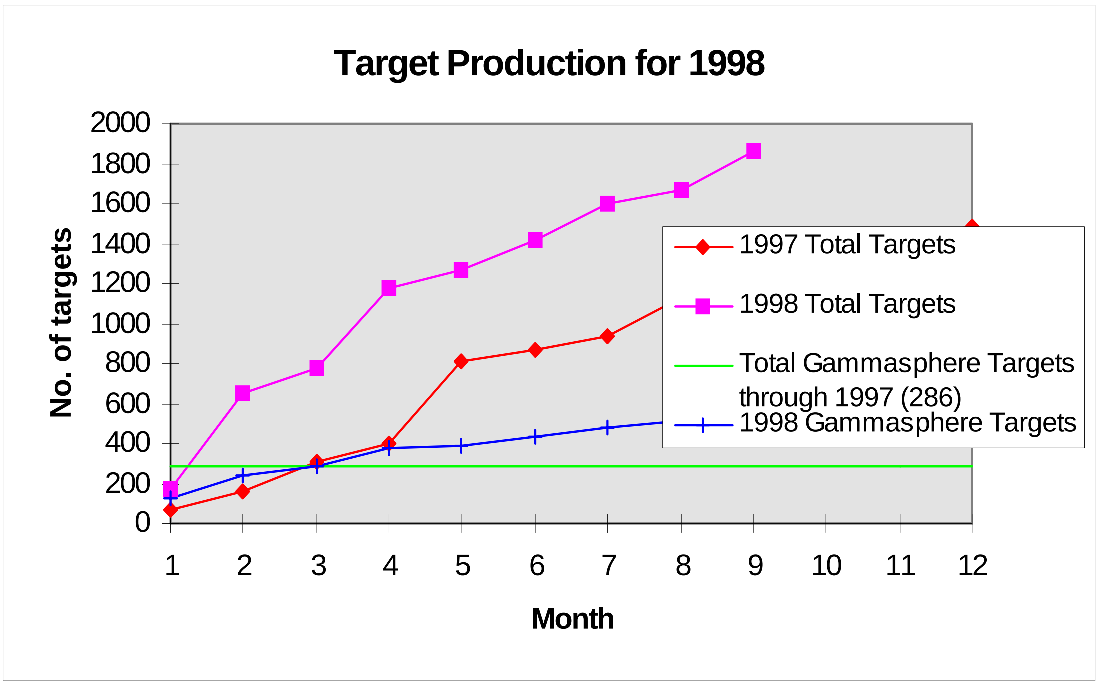
*Work supported by the U.S. Department of Energy, Nuclear Physics Division, contract No. W-31-109-ENG-38.

1. Introduction

GAMMASPHERE [1], a large (110 detector) Compton suppressed germanium detector array coupled with the Argonne Fragment Mass Analyzer (FMA) has been in operation at Argonne for approximately one year. Situated at the heavy-ion Argonne Tandem-Linac Accelerator System (ATLAS), the demand for many, high quality, thin targets needed for gamma-ray recoil coincidence experiments has been large. Much support had been provided by the Physics Division target laboratory during the GAMMASPHERE experimental program at LBL, preparing thick and backed targets (9% of targets produced in 1997). The present GAMMASPHERE investigations being carried out at ATLAS demand thin targets, allowing the recoiling nuclei to be collected and measured using the FMA [2]. The rich physics being produced with this instrumental combination is covered in the literature and too complex for this short note. We discuss here target production and support issues, and present some recent highlights.

2. Target Production

In the past year, numerous targets were fabricated for GAMMASPHERE experiments, either as self-supporting foils, on various substrates, or as "sandwich" targets. Targets produced included Au, Bi, ^{12,13}C, ^{40}Ca, ^{50}Cr, ^{54}Fe, FeS, ^{76}Ge, ^{6}LiF, ^{24}Mg, ^{92,94}Mo, ^{58}Ni, ^{208}Pb, PbS, ^{108}Pd, ^{96,104}Ru, Se, Ta, Th, ^{238}U, ^{176}Yb and ^{96}Zr. Many of these target foils have been fabricated using our small rolling mill. Rolling has been the method of choice for the thick targets used in GAMMASPHERE experiments, with surface densities ranging from 0.5 up to several mg/cm2.



With the relocation of GAMMASPHERE to ATLAS here at ANL, the support for research targets, absorbers, reset foils, etc. has increased dramatically. By the end of February, 1998, the number of targets produced for GAMMASPHERE had eclipsed the total number of targets previously made up to this time. The majority of the research effort at GAMMASPHERE employs targets fabricated by the Physics Division Target Laboratory. Until now 533 targets have been prepared for GAMMASPHERE with a projected total of over 700 for this calendar year.

3. Some Recent Highlights

3.1 Actinide Targets

The technique of molecular plating has been employed to prepare targets of actinide elements required for Coulomb excitation (COULEX) studies with GAMMASPHERE [3]. The technique is simple and reproducible, with targets of ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{244}Pu and ^{248}Cm prepared by this method. The targets were plated on 50 mg/cm^2 Au backings. The amount of material contained within the target was determined by standard counting methods. In order to avoid the spread of contamination within the target chamber, a 150 μg/cm^2 gold foil layer is placed in front of the target to contain any material sputtered by the heavy-ion beam. Table 1 gives a summary of targets produced.

3.2 A Rotating Target Wheel System

In order to be able to sustain the highest possible beam currents for the experimental runs, target rotation has been employed to increase target lifetime. In cases of low melting point target materials, rotating the target in the beam allows for increased heat dissipation reducing the loss of target material. We have recently implemented a new, low-mass, rotating target wheel system to be used with GAMMASPHERE [4]. The design is based on a previously successful implementation of rotating target wheels for the Argonne Positron Experiment (APEX) as well as the Fragment Mass Analyzer (FMA). As this rotating target system has only recently been deployed, there have been only a few experiments to date employing target wheels. Table 2 lists target wheels produced for investigations carried out at the FMA and GAMMASPHERE.

4. Auxiliary Support

In addition to the numerous targets prepared for GAMMASPHERE there are additional support activities provided by the target laboratory. One mentioned already above is the production of the numerous charge resetting foils necessary for recoil studies using GAMMASPHERE at the FMA. Simply stated, in order for the primary beam and recoiling nuclei to be separated by their charge state using the FMA, a charge resetting foil is placed just beyond the target. For the acceptance into the Fragment Mass Analyzer, these foils, by necessity must be both thin and of large aperture. An additional constraint is that they also be of low Z for reasons of energy loss and multiple scattering. Therefore, the reset foils produced have been 4 to 20 $\mu g/cm^2$ carbon foils floated onto tantalum frames with a 22 mm diameter aperture. Many dozens of these reset foils have been produced and used in experiments thus far.

Other support activities include procurement and fabrication of low-energy x-ray absorber material, consisting of disks of Ta, Cd and Cu, placed in front of each of the 110 GAMMASPHERE detectors. Too numerous to cover here have been the many calibration and experimental radioactive sources needed for the GAMMASPHERE research program.

5. Conclusion

In conclusion, the requirements for many, high-quality thin targets used in heavy-ion GAMMASPHERE experiments at ATLAS has been realized. Much support has been devoted to GAMMASPHERE operation, allowing the continuation of a successful research program here at Argonne.

Acknowledgments

The authors would like to thank Dr. Walter Henning, the Physics Division Director, and Dr. Irshad Ahmad, the Target Facility Group Leader, for their continuing encouragement and support of these efforts. This work is supported by the U.S. Department of Energy, Nuclear Physics Division, under Contract No.W-31-109-Eng-38.

References

[1] C.J. Lister, to be published.
[2] C.N. Davids, *et al*., Nucl. Inst. and Meth. **B70**, 358 (1992)
[3] J.P. Greene, Proc. of the 19th World Conf. of the INTDS, Oak Ridge, TN, USA Oct. 5-9, 1998
[4] J.P. Greene, Proc. of the 15th Int. Conf. on the Appl. of Accel. in Res. and Industry, University of North Texas, TX, USA Nov. 4-7, 1998

Table 1. Actinide Targets Prepared by Molecular Plating

Isotope	Thickness ($\mu g/cm^2$)	Backing Foil
^{248}Cm	170	50 mg/cm^2 Pb (with a Au "flash")
		53 mg/cm^2 Au
	260	50 mg/cm^2 Pb
^{239}Pu	250	53 mg/cm^2 Au
	150	48 mg/cm^2 Au
		48 mg/cm^2 Au
^{240}Pu	150	53 mg/cm2 Au
	350	63 mg/cm^2 Pb
	310	53 mg/cm^2 Au
	180	53 mg/cm^2 Au
^{242}Pu	240	53 mg/cm^2 Au
	220	53 mg/cm^2 Au
	330	53 mg/cm^2 Au
^{244}Pu	260	53 mg/cm^2 Au
	175	53 mg/cm^2 Au

Table 2. Target Wheels Produced for FMA and GAMMASPHERE Experiments

Target	**Thickness** (μg/cm^2)	**Backing Foil**	**Thickness** (μg/cm^2)	**Number of Wheels Prepared**
^{11}B		Ta		
^{209}Bi	nom 1400	C	250 μm	1
^{12}C	400		40	2
FeS	50	C		1
^{62}Ni	156		35	1
^{208}Pb	nom 1000	C		2
	300	C	40	2
	300	C	42	2
	400	C	nom 8	5
	400	C	40	5
	500	C	7	7
	600	C	40	4
^{124}Sn	1000	C	7	1
^{96}Zr	nom 500		40	4
	nom 700			1

Preparation of stripper foils by carbon-arc method

Xu Guo Ji,

China Institute of Atomic Energy, 102413 Beijing, China

For experiments with heavy-ion beam at the CIAE foil strippers are required to obtain high charge states and thus high energies. The short lifetimes of foils prepared by the contact sparking method are a serious limitation to experiments. Therefore the investigation of carbon stripper foils made by carbon-arc method was started.
Fig. 1 shows schematically the carbon-arc deposition equipment which is modified from a standard evaporation machine. The arc-discharge is 27V. The arc gap between the electrodes is controlled by adjusting one electrode with a handle that is located outside the vacuum chamber. The substrate, a glass plate of 260 mm diameter, are coated with betaine and rotated during carbon deposition. The film thickness is monitored with a crystal thickness monitor. The foil consists of a 0.005 mg/cm² layer made by DC arc-discharge. After removal from vacuum chamber the glass plate with deposited carbon film is coated with dilute solution of cellulose nitrate and then slackened by a procedure developed by Maier-Komer.

Self-supporting carbon foils of 0.007 - 1.4 mg/cm² have been made by AC arc-discharge with the apparatus mentioned above.

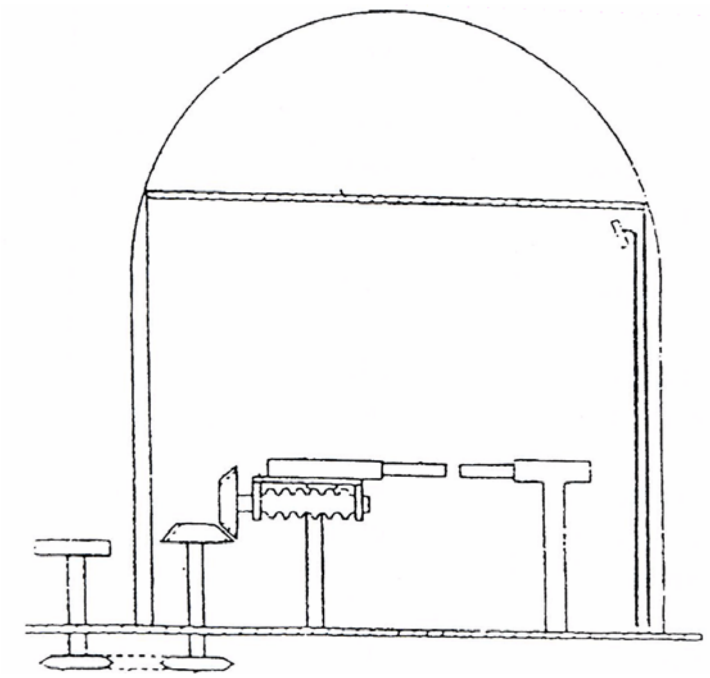


Fig. 1 Carbon-arc deposition set-up

Preparation of nuclear targets with electricity vibration

Xu Guo ji

(China Institute of Atomic Energy, 102413 Beijing, China)

We have set up a electricity vibration apparatus which is similar to the one originally appled by I.sugai[1]. The deposition process is carried out in the open air. Self-supporting targets were obtained by means of the following procedure. The target foil with the copper backing was annealed at 400 ℃ for 1h in a vacuum chamber. After cooling the backing was dissoluted in solution of CCl_3CO_2H(100g)+H_2O(500ml) +NH_4OH (500ml 25%) and the target foil was rinsed in distilled water. The present method has not successful for materials of Au, Pt, Al, Sn ,Nb, Ti, Fe, Pb, Re, Se, S, and C, these powders did not display any vibrational motion ever when operating at voltages up to 15kv.Tested targets prepared with electricity Vibration are given in table 1.

Table 1 Tested targets made with electricity vibration

Element	Applied Voltage/KV	Thickness/μgcm^{-2}	Deposition rate/$\mu gcm^{-2}h^{-1}$	Backing/μm
Mn	10	20 — 650	18	Cu 20
Mn	12	450	21	
Cr	10	30 — 510	6	Cu/20
Cr	12	140	8	
Pd	10	20 — 450	15	Al/10
Pd	12	350	18	
Ru	10	30 — 410	6	Cu/20
Ru	12	230	7	
Ta	14	10 — 100	4	Al/10
B	14	10 — 140	5	Cu/20
Zn	10	20 — 105	5	Cu/20
Co	14	15 — 280	6	Al/10
Hf	10	15 — 150	3	Cu/20
Hf	12	110	4	
W	12	20 — 680	30	Al/10
Si	10	10 — 110	6	Cu/20
Lu	12	215	35	
Ge	10	10 — 370	48	Cu/20
Ni	12	210	26	
Bi	10	15 — 1370	58	Al/10
Gd	10	340	9	
Gd	8	10 — 360	7	Cu/20
Mo	8	10 — 260	36	Cu 20
Ag	10	200 — 270	14	
Cu	9	10 — 230	13	Al/10
Tb	14	10 — 250	10	Al/10
Os	12	15 — 270	44	Cu/20

References

[1] I.Sugai,Nucl.Instr.and Meth A397(1997)91.

Activity Report 1998 of the Target Laboratory at GSI

Willi Hartmann, Birgit Kindler, Josef Klemm, Bettina Lommel, Werner Thalheimer

Self-supporting targets were produced through thermal evaporation and electron-beam gun evaporation. On several backings, but mainly carbon, thin films were deposited through thermal evaporation, electron-beam gun evaporation and sputtering. There was a large demand on cold-rolled thin films and mechanically prepared targets. The variety of the produced material is shown in the list below:

Evaporated self-supporting targets	Al, Au, C, ^{144}Sm
Evaporated targets on backing	Al, Bi, C, $CaWO_4$, Cermet, Cr, CsJ, Ge, ^{178}Hf, ^{208}Pb, Ta, Ti,
Cold-rolled or mechanically prepared targets	Al, Ag, Au, Bi, ^{48}Ca, Cd, $(CH_2)_n$, Co, ^{50}Cr, Cu, Fe, Gd, Hf, Mg, Mo, ^{150}Nd, Nb, Ni, ^{60}Ni, Pb, ^{206}Pb, ^{208}Pb, Pt, Re, Sn, SrO, Ta, Ti, ^{46}Ti, ^{238}U, V, W, Y, Zn

We produced mainly targets for nuclear physics experiments at the FRS, at SHIP, for EUROBALL, for the on-line mass separator and for HADES. Beside these, the plasma physics group, the atomic physics group, the biophysics group as well as the material research group needed mainly carbon foils over a large thickness range.

The detector laboratory as well as different groups from the accelerator department were supported with the production of adhesive thin films deposited on glass and ceramics. In close collaboration with the ion source group we were involved in the selection of the material, in the preparation of the samples and the efficient recycling of the remains, which is especially important for expensive source materials.

For a special purpose we experienced on different very thin fluorescent coverings used as a new diagnosis elements.

In 1998 the largest amount of targets was prepared for experiments at GSI. The request for external experiments with GSI participants was attended to as well. The request from outside was fairly low.

We were able to enlarge the target laboratory with a further scientist, Birgit Kindler,

on a post-doc position. She started her work with us in August 1998. In a close contact with the SHIP group she is going to develop targets, which can stand higher beam intensities needed for the future heavy element production.
At the end of this year we purchased two new evaporation units, Edwards Auto 306® Thin Film Deposition System. One of them is shown here.

Edwards Auto 306® Thin Film Deposition System (photo by G. Otto, GSI)

We plan to transfer the deposition process for the target wheels mainly applied at SHIP from one of the older units to the new one. This new machine can be adapted for the production of target wheels up to twice the present diameter. The other one which is equipped with a cryogenic pump is meant to be used for the reduction of isotopically enriched material.

Our website address is:

English: http://www-wnt.gsi.de/kindler/targetho.htm
German: http://www-wnt.gsi.de/kindler/default.htm