INTDS NEWSLETTER

December 1997
Vol. 24, No. 2

CONTENTS

Technical contributions

Cover picture: Cold-crucible levitation melting of a nickel sample at IRMM

Editor's Note

Dear Colleagues,

Please note the date of the 19th World Conference of the INTDS: 4-9 October 1998, Oak Ridge National Laboratory, Tennessee.

The terms of office of three INTDS Board members expire during 1998 and the membership is asked and encouraged to propose candidates (See page 9).

This is your chance to contribute to the organisation and running of the INTDS.

A further announcement:

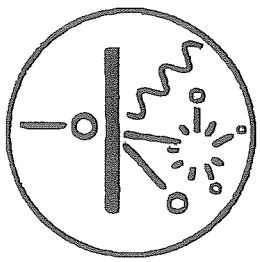
An article entitled "Targets for Particle Accelerators" has been published in the Encyclopedia of Physics vol. 20, 3-527-29301-9/97 (authors of the article are J. and J. Heagney and H. Maier). Reprints are available from:

VCH Publishing Inc.
220 East 22nd Street
New York, NY 10010-4606
Tel. 001-212-683-8333
Fax 001-212-481-0897

A happy and prosperous new year to all.

Chris Ingelbrecht
Editor

International Nuclear Target



Development Society

ornl

19TH World Conference of the INTDS

Nuclear Targets
Preparation, Characterization, and Use

Oak Ridge, TN, USA
October 5-9, 1998

First Announcement and Call for Papers

The 19th World Conference of the International Nuclear Target Development Society will be held in Oak Ridge, Tennessee, USA on October 5-9, 1998. Topics of this Conference will include the preparation, characterization, and use of targets in low, medium, and high energy accelerator experiments and will include radioactive ion beam studies.

Contributions are encouraged in the following and related areas:
- Enrichment of stable and radioactive isotopes,
- Chemical and physical processing of research materials,
- Target preparation techniques,
- Target characterization,
- Target influences on experiment design and interpretation, and
- Radioactive ion beam studies.

Program Committee:
W. Scott Aaron, ORNL, Oak Ridge, TN, USA
Harold Adair, ORNL-retired, Oak Ridge, TN, USA
John Greene, ANL, Argonne, IL, USA
Joanne Heagney, Micro Matter Co., Deer Harbor, WA, USA
Chris Ingelbrecht, IRMM, Geel, Belgium
Bill Lozowski, IUCF, Bloomington, IN, USA
Peter Maier-Komer, T. U. München, Garching, Germany

Organizing Committee:
W. Scott Aaron, Co-Chair
Harold Adair, Co-Chair
Lee Zevenbergen
Gail McNabb, Secretary
Joy Lee, Conference Office

Deadlines:		
	Preregistration	February 1, 1998
	Hotel Reservation	June 30, 1998
	Registration	June 30, 1998
	Submission of Abstracts	July 31, 1998
	Submission of Papers	October 5, 1998

Publication of Proceedings: Nuclear Instruments and Methods in Physics Research

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University of North Texas
Department of Physics
CAARI Biennial International Accelerator Conference Series

PLEASE POST

FIRST ANNOUNCEMENT SEPTEMBER 15, 1997

The Fifteenth International Conference on the Application of Accelerators in Research and Industry will be held at the University of North Texas in Denton, Texas, November 4-7, 1998 (Wednesday through Saturday). Please note that this conference is four (4) days in length. The American Institute of Physics will publish the proceedings of the conference in April 1999. The editors of these proceedings will be Jerome L. Duggan, The University of North Texas and I. L. Morgan, I^3 (International Isotopes Incorporated). The University of North Texas Press will publish the Abstracts of the manuscripts in September 1998. The University of North Texas is organizing the conference.

The purpose of the conference is to review research, and the wealth of industrial applications that are in progress with accelerators throughout the world. The conference is composed of two symposia, which run in parallel. These are the Research Symposium and the Industrial Applications of Accelerators. Some of the sessions, which are of general interest, will be held common to both groups. Participants can easily interchange between the two symposia. Five hundred invited papers will be given at these symposia and contributed papers will be accepted in the following areas: Atomic Physics and Related Phenomena, Trace & Surface Analysis with Ion Beams, Electron Beam Processing, Nuclear Physics, CTR & Related Phenomena, Neutron Activation Analysis & Bulk Analysis with Accelerators, Radiological Safety Aspects of Accelerators, Ion Implantation with Particular emphasis on Semiconductors & Metallurgical Applications, Geosciences & Related Phenomena, Charged Particle Microprobes, Super SIMS, Carbon Dating, Computed Tomography, Synchrotron Light Source Experiments, Insitu Beams, Radiation Interaction with Ion Beams, Accelerator & Component Design & Automation, Targetry, Detectors & Electronics, Medical Applications with Accelerators, Biological & Chemical Applications, Material Analysis with Ion Beams, Channeling, Stopping Power & Radiation Effects.

Most of the contributed papers will be presented in poster sessions. An abstract (invited and contributed) in APS format is required by 1 July 1998. The deadline for receipt of all manuscripts is October 1, 1998. Designated times will be assigned for the participants to be present at their poster station.

Further information, application blanks, poster information, manuscript materials, Airlines/Car rental discount travel, and other conference information can be obtained by contacting Dr. Jerome L. Duggan or Barbie Stippec at the address and phone numbers listed below. Also visit our WEB SITE for Application Blanks and Updated Conference Information.

Please note our Address & Telephone Changes:

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Status Report of the Physics Division Target Development Facility at Argonne National Laboratory

John P. Greene and George E. Thomas

The Physics Division operates a target development laboratory that produces targets and foils of various thicknesses and substrates, depending on the requirements, for experiments performed at the ATLAS and Dynamitron accelerators. The targets are prepared from both naturally occurring materials and stable isotopes which are supplied either in pure, elemental form or as stable compounds. Targets are made not only for the Physics Division but also for other divisions at the Laboratory and occasionally for other laboratories and universities.

In the past year, numerous targets were fabricated either as self-supporting foils, on various substrates or as "sandwich" targets. Targets produced included Ag, Al, Au, Be, ^{10,11}B, ^{12}C, ^{40}Ca, CD_2, CH_2, CH_4, ^{164}Er, ^{58}Fe, ^{160}Gd, ^{76}Ge, Havar, $^{176}HfO_2$, In, Kapton, ^{24}Mg, ^{92,96,98,100}Mo, ^{150}Nd, ^{58}Ni, ^{206,208}Pb, polyethylene, polypropylene, Ru, ^{144,154}Sm, ^{122,124}Sn, Ta, ^{159}Tb, ^{128,130}Te, $^{182}WO_3$, ^{170,174,176}Yb and ^{90}Zr. A major research effort has gone into hydrogen and deuterium targets, both using a gas cell target for the production of radioactive ^{17}F beams, but also solid targets for reactions with these beams on protons (and deuterons).

Numerous foils have been fabricated using our small rolling mill including targets of Ag, Au, brass, Cd, Cu, ^{160}Gd, Havar, ^{92,96,98,100}Mo, ^{58}Ni, ^{206}Pb, ^{124}Sn, ^{232}Th, Ti, ^{174,176}Yb and Zn. Rolling has become the method of choice for most of the thick targets used in ATLAS experiments where the required surface densities range from 0.5 up to several mg/cm2.

Support for GAMMASPHERE continues, with an increase in target requests for these experiments noticed. Targets of Au, C, ^{160}Gd, ^{150}Nd, ^{208}Pb, WO_3, ^{174,176}Yb were produced for Argonne runs at Berkeley. Sandwiched targets of Au-^{40}Ca-Au and Au-^{150}Nd-Au, were successfully prepared and transported under vacuum or argon for GAMMASPHERE experiments. Targets supplied for other institutions included ^{10}B, ^{40}Ca, Gd, ^{128,130}Te and ^{174}Yb. Approximately 677 targets were prepared for these various experiments during the past year.

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Visit us at our new **WEB** Site-
The **URL** is

http://www.phy.anl.gov/targetlab/homepage.htm

OR

from the **Argonne National Laboratory Homepage** -
(URL http://www.anl.gov/)

"Click" on **Divisions & Major Facilities** ... then ...
"Click" on **Physics** ... then ...
"Click" on **HEAVY-ION NUCLEAR PHYSICS RESEARCH** ... then ...
"Click" on **Target Development Facility**

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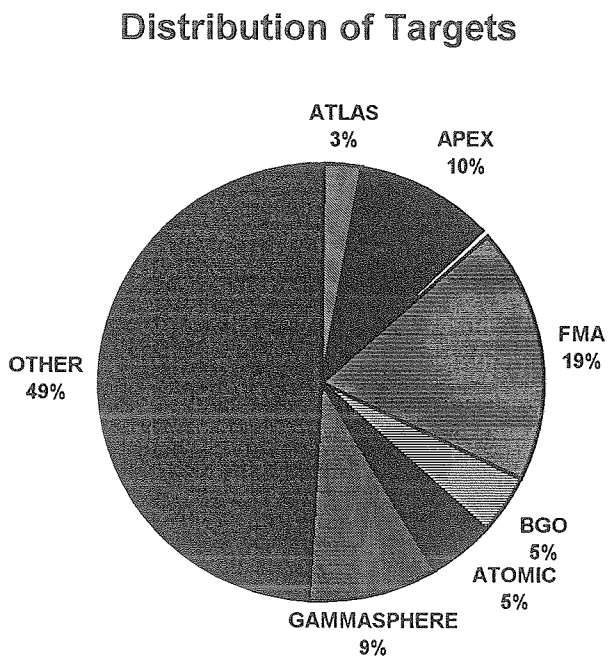
Most notably, there has been an increase in the preparation of various forms of isotopic source material for producing beams at ATLAS. Usually this takes the form of reducing separated isotope into a form and shape suitable for introduction into PIIECR (for example ^{76}Ge). This was especially evident for the preparation of various Ni/Si and Fe/Si mixtures for the SNICS source and for ^{58}Ni cones for irradiation at IPNS. A intensive effort was mounted involving the reduction of Cd and Zn oxides not only for target fabrication but also to provide usable source material for isotopic beams. There were a number of instances where in order to conserve precious separated isotope, the isotope was diluted with natural material so that extended beam times were achieved.

The target development laboratory includes state-of-the-art equipment used for thin-film fabrication. The available techniques consist of multiple resistive heating, focussed ion beam sputtering, glow-discharge plasma deposition, electron beam and electron bombardment evaporation, electrodeposition and mechanical rolling. The evaporators are maintained under high vacuum and each vessel contains a quartz-crystal film-thickness monitor with deposition rate indicators. Also included are movable shutters, quartz-lamp substrate heaters and thermocouple temperature sensors, allowing for complete process monitoring during target deposition.

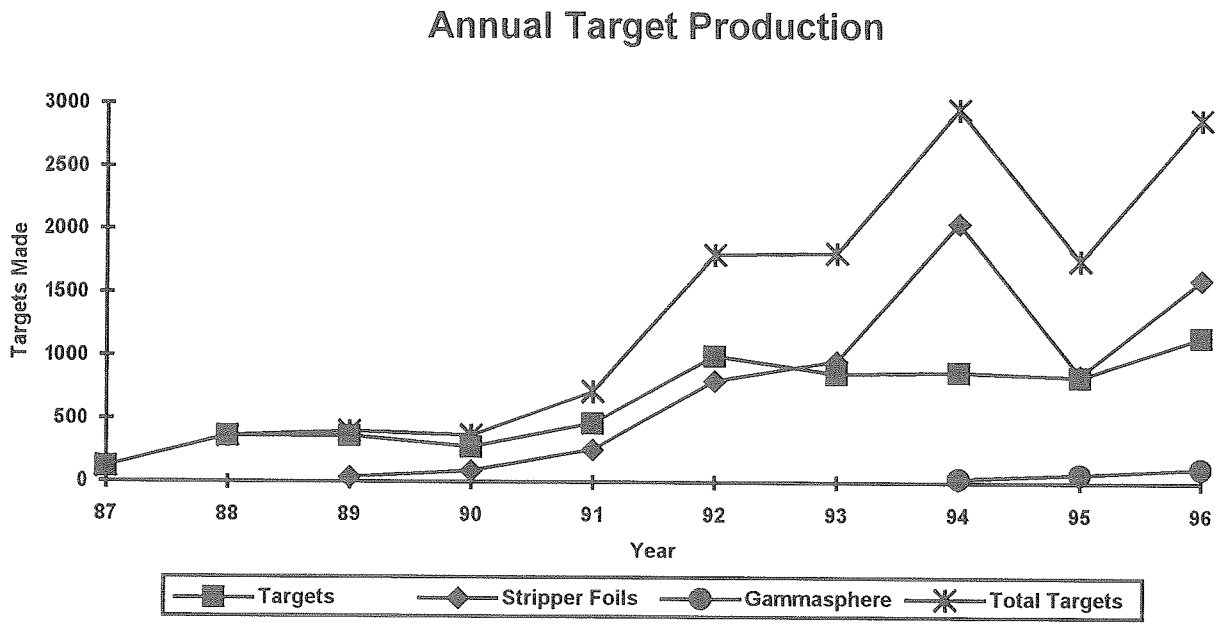
Other auxiliary equipment used for target development includes a electrodeposition equipment, a small rolling mill, an alpha particle counting chamber, inert atmosphere glove box, laminar flow clean bench, pellet press, a reduction furnace, and a variety of precision balances.

A turbo-pumped target storage facility is in operation for maintaining, under high vacuum, those targets which can readily oxidize in air. This system utilizes computer-controlled circuitry to prevent targets from exposure to atmosphere during power interruptions. A second storage system employs a bank of vacuum dessicators connected to a mechanically-pumped manifold for use by individual experimenters. Duplicates of both these systems have been constructed and installed just inside Target Area II at ATLAS.

A low-level radioactive source and target preparation laboratory is established at a separate location within the Division dedicated to the production of these sources and targets. Available preparation techniques include multiple resistive heating, electrodeposition and mechanical rolling. A diffusion-pumped vacuum evaporator is presently installed with plans for the addition of an electron beam evaporator system in the near future. A second much smaller evaporator system was constructed for close proximity evaporations of higher activity materials, to be used not only as targets, but for radioactive source development as well. The size of this system allows for minimal contamination and is presently installed within a hood. A modest inventory of radioactive targets and sources are stored in the laboratory and are available for use within the Division.



As part of ATLAS support, carbon stripper foils of 2 ug/cm^2 for use in the Tandem as well as other thickness for additional stripping are being routinely produced by the target lab. A total of 2204 carbon stripper and gold foils of various types were prepared during the past year.



Activity Report 1997
Nuclear Sample Preparation Group, Institute for Reference Materials and Measurements

C. Ingelbrecht, R. Eykens, A. Moens, F. Peetermans, K. Teipel, J. Van Gestel, A. Dean, H. Mast, S. Clifford

During 1997 a total of **954** samples were delivered in response to **106** requests from IRMM and external customers (Table 1). Samples for neutron cross-section measurements using the GELINA linear electron accelerator were alloy or metal discs or pressed and canned powder samples. Targets for charged particle or fission fragment studies were thin deposits on metallic or plastic substrates prepared by spray painting, evaporation or electrodeposition. Particular projects were the "molecular plating" of plutonium isotopes onto aluminium foil substrates, impovement of methods for high yield reduction of oxides to metals (reduction/distillation, electrolytic and H_2 gas) and work on electrodeposition of small quantities of stable isotopes.

Most of the samples delivered to external users were activation or fission monitors for reactor neutron fluence rate measurements, which were either high purity metals or dilute aluminium alloys. Other reactor samples were melt wire temperature monitors, which are alloys of eutectic composition, or of other well defined melting point, often based on lead.

Sample characterization was by α and γ-spectrometry, neutron activation analysis (P. Robouch) and by differential scanning calorimetry.

Another activity was the preparation and distribution of reactor neutron dosimetry reference material. Fifteen reference materials are currently available (high purity metals, alloys, actinide microspheres and uranium glass) including Ti metal (Sc <0.1 mg·kg^{-1}), certified during 1997.

Other projects were U-Pu metal 'spikes' reference materials for assay of U and Pu in reprocessing plant input solutions and U-glass for use as a contaminated "synthetic soil" reference material.

Table 1: **Samples prepared during 1997**

Material	No of samples
Natural isotopic composition	
Pb, Bi, Cu, Sc, Fe, Ni, In, Mn, Al, W, Ti, Mo, Mg, Au, S, V, Ag, Gd Al alloys: Cu, Au, Dy, In, Mn, Ag, Lu, Eu, Sc, La Pb-In, Au-Fe, Pb-Fe, Nb-Zr, Cu-Ni Plastic: polyacetal, polythene, polyimide, VYNS Li_2CO_3	884
Stable isotopes	
^{7}Li, ^{10}B, ^{91}Zr	13
Actinides	
$^{238}PuO_2$, $^{239}PuO_2$, $^{241}PuO_2$, $^{242}PuO_2$, $^{235}UO_2$, $^{238}UO_2$, ^{NAT}U $^{237}NpO_2$, $^{241}Am_2O_3$, Al-^{NAT}U, Al-^{235}U, Al-^{NAT}Th	57

The UHV pump system for the box coater for VUV reflective coatings on mirror substrates of up to 95 cm in diameter

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In [1] a large UHV box coater was described, which is needed for VUV reflecting coatings (Al plus MgF_2 as protective layer) on mirror substrates.

Even if the main pump of this box coater is a refrigerator cryopump hydrocarbon impurities could be detected in the Al layer as demonstrated in fig. 6 of [1]. The reason for this impurity was oil backstreaming from the roughing pump due to the use of a two-stage sliding vane pump. The roughing cycle was applied only down to a vacuum of about 10 Pa, where the backstreaming should be neglidible, nevertheless due to the base metal properties of Al gettering of hydrocarbons could not be prevented. Even low carbon impurities could negatively influence the VUV reflectivity of Al. There is a second source of hydrocarbon impurities which comes from the outgassing of the walls of the vacuum vessel and which will be defeated by heating the walls to about 470 K prior deposition. The only solution, however, against oil backstreaming is the use of dry vacuum pumps.

Most dry vacuum pumps for the rough and medium vacuum range are expensive. For minor demands, however, scroll pumps and diaphragm pumps can be utilized. Scroll pumps have sufficient pumping speed ($\approx$ 10 l/s) and reach an ultimate vacuum of < 1 Pa. Such a pump is suitable for roughing of the large boxcoater with its volume of $\approx$ 1.5 m^3, but cannot be used for the continuous pumping of the differential volume between the two viton O-rings of the front gate. Unexceptable often replacements of the scroll tip seals would be necessary. In order to pump the differential volume a cheap long lasting diaphragm pump with a pumping speed of $\approx$ 1 l/s is sufficient, but its high ultimate total pressure of 200 Pa must be tolerated. There are, however, hybrid turbomolecular pumps on the market for which a backing vacuum of 200 Pa is sufficient to reach an ultimate vacuum of < 10^{-6} Pa. For this setup a HY.CONE 200 of LEYBOLD VAKUUM is used with a pumping speed of 205 l/s on its DN 100 CF flange. This is mounted via a short DN 100 CF tube and a bellows sealed gate valve with 10 cm diameter free opening directly on the deposition chamber.

The complete setup of the vacuum pump system is schematically shown in fig. 1. The UHV box coater (1) is connected to the DN 500 ISO refrigerator cryopump (4) via a DN 500 ISO bellows sealed gate valve (3). These flanged couplings are the only ones which could not be made by CF-flanges and were sealed instead by gold wire rings with a 1 mm cord diameter. In order to obtain sufficient pressure on the DN 500 ISO flanges the threefold amount of M 12 screws which means 48 screws per flange pair were used and these flanges were built with a thickness of 25 mm for more rigidity. The other two bellows sealed gate valves (6 and 10) are flanged to the deposition chamber via CF flanges. All three gate valves are electro-pneumatically driven. The five bellows sealed right-angle valves are manually operated, because they are not

used in every pumping cycle. Thus with the vent valve (13) the flow can be dosed, but venting cannot be started before the gate valve (10) is opened.

Starting the vacuum system means first the regeneration of the cryopump. In this mode all valves are closed with the exception of the valves (5) and (11). The scroll pump (14) is evacuating the cryopump (4) to a vacuum of ≈ 5 Pa which is measured by a convection vacuum gauge (18). In the meantime the diaphragm vacuum pump (8) and the turbomolecular pump (7) are started. When in addition the thermocouple vacuum gauge (17) shows a vacuum of ≤ 5 Pa the valve (11) is closed and the scroll pump is switched off. Instead valve (9) is opened and the cryopump (4) is further pumped down by means of the turbomolecular pump (7) to a vacuum of 5×10^{-2} Pa which can be controlled by the ionization vacuum gauge II (16) after the vacuum gauges (17) and (18) have reached their limits. At this vacuum valves (5) and (9) are closed and the cryopump (4) is started.

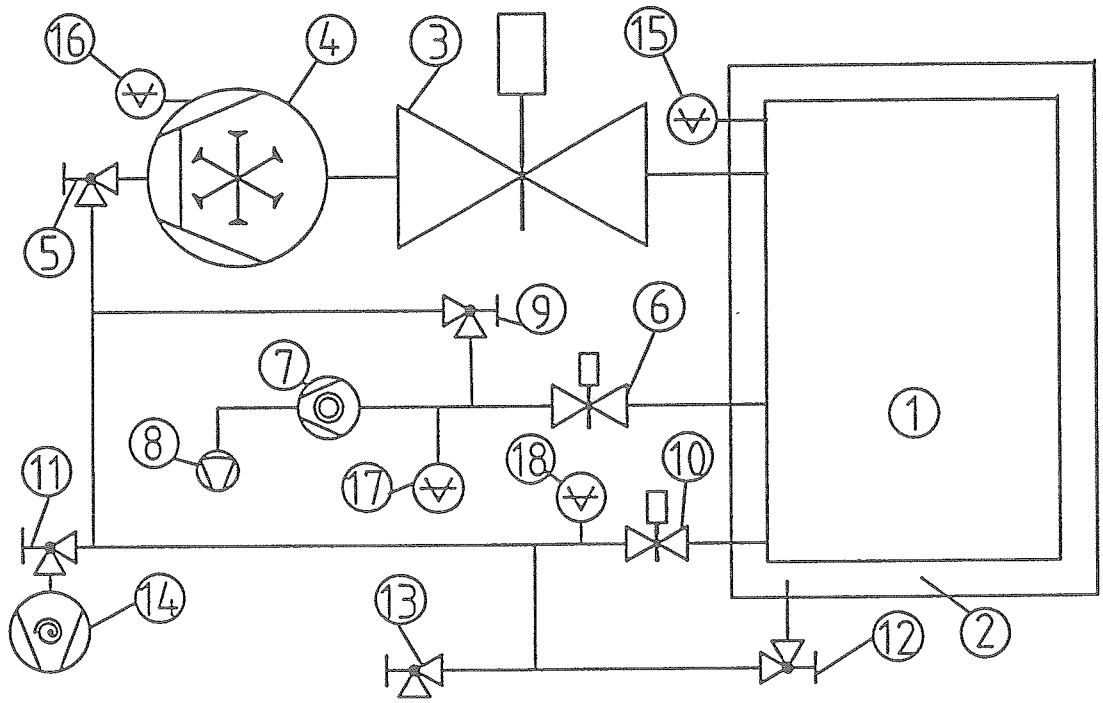

Fig.1. Outline of the UHV pump system:
(1) deposition chamber, (2) differential pumping volume for the front gate, (3) bellows sealed gate valve with 50 cm diameter free opening, (4) cryopump, (5) regeneration valve of cryopump, (6) bellows sealed gate valve with 10 cm diameter free opening, (7) turbomolecular pump, (8) diaphragm vacuum pump, (9) differential high vacuum valve, (10) bellows sealed gate valve with 7 cm diameter free opening for roughing of the UHV chamber, (11) right angle valve for isolation of the scroll pump, (12) right angle valve for isolation of the differential volume, (13) vent valve, (14) scroll pump, (15) ionization vacuum gauge I, (16) ionization vacuum gauge II, (17) thermocouple vacuum gauge, (18) convection vacuum gauge.

The roughing of the deposition chamber can be started now. For this the vent valve (13) is opened, after completion of the venting the gate valve (10) is opened the vent valve (13) is closed again and the scroll pump (14) is started. Opening valve (11) starts the roughing cycle. After a few seconds valve (12) can be opened to pump in addition the differential volume (2). When the convection vacuum gauge (18) shows a vacuum of < 5 Pa valve (10) can be closed and valve (6) can be opened for further pumping down by means of the turbomolecular pump (7). The scroll pump (14) can be switched off again. When the ionization vacuum gauge I (15) shows a vacuum of < 10^{-2} Pa the halide lamps can be switched on for outgassing, if new equipment was installed which might be a source of hydrocarbons. In this case the cryopump is not loaded with the hydrocarbons and the gas load is generally lower compared to a roughing of only to 5 Pa. Before the cryopump (4) can prepare the UHV the gate valve (6) must be closed. Now the gate valve (3) can be opened. The gate valves (3), (6) and (10) are protected by an interlock system. Next valve (9) can be opened again. The turbomolecular pump (7) keeps now all vacuum tubings under high vacuum conditions. In this way the differential volume (2) has only a very little diffusion leakage through the viton O-ring into the UHV chamber and also the viton O-ring gate seals of valves (5), (6) and (10) which see the UHV present in this way neglidible diffusion leakage. The power consumptions of the diaphragm vacuum pump (8) and the turbomolecular pump (7) are quite small in comparison to the cryopump and it can be tolerated therefore that they run in addition, whereas the scroll pump (14) is only used for the short roughing cycles.

References

[1] P. Maier-Komor, A. Bergmaier, G. Dollinger, J. Friese, S. Karsch, P. Kienle, H. J. Körner, Proceedings (18th World Conf. of the INTDS, Strasbourg, France, 1996) Nucl. Instr. and Meth. A 397 (1997) 194-199.

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