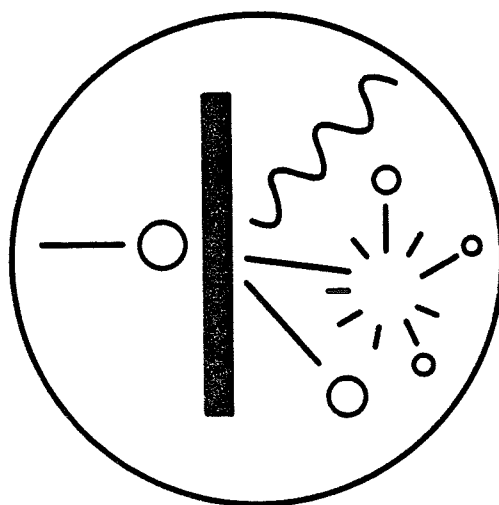


**INTERNATIONAL NUCLEAR
TARGET DEVELOPMENT SOCIETY**

NEWSLETTER



AUGUST 1983

I N T D S Newsletter

August 1983

This year the first issue of the Newsletter is rather late. This was not due to a lack of contributions but to the fact that we wanted to encourage commercial companies to advertise in the Newsletter.

Our first inquiry in this respect resulted in an encouraging number of contributions.

The Newsletter remains an informal source of information for and from our Membership describing recent work and newly developed techniques or progress made and is also open for requests for advice on, for example, obtaining special materials and making specific targets.

Our thanks are due to the Direction of the Central Bureau for Nuclear Measurements for their support in producing the Newsletter.

Editor

Jan VAN AUDENHOVE
Central Bureau for Nuclear Measurements
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IN MEMORIAM - Jerome L. LERNER

Jerry Lerner died on 11 December 1982 in Argonne at the age of 63.

He entered the Chemistry Division of Argonne National Laboratory in 1946 as a trained chemist, but soon developed skills in mathematics, statistics and electronics oriented towards measurement of nuclear constants and related instrument design. Some of the nuclear constants he measured are still the internationally accepted values.

Further work he undertook was the development and operation of an isotope separator for radioactive isotopes as well as the development of a variety of target preparation techniques.

Jerry prepared targets for scientists throughout the world as well as at Argonne.

Jerry was known as an invaluable source of advice and skills in helping others; he was a kind and comfortable person to have around.

Jerry will be missed not only by his colleagues in ANL but also by the membership of the International Nuclear Target Development Society.

W O R K S H O P 1983

INTERNATIONAL NUCLEAR TARGET DEVELOPMENT SOCIETY

The workshop originally planned at Stony Brook will be held at the Argonne National Laboratory on September 7, 8, 9, 1983.

The Members have been informed about this workshop by separate mail.

We thank George E. Thomas and Argonne National Laboratory for hosting this meeting.

This will be the meeting at which Ed Kobisk completes his term as President of the Society.

Let's make it one for him to remember.

MEETING SECRETARIAT :

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1984 WORLD CONFERENCE
OF THE
INTERNATIONAL NUCLEAR TARGET DEVELOPMENT SOCIETY

THE TWELFTH WORLD CONFERENCE OF I.N.T.D.S. WILL
BE HELD ON SEPTEMBER 24 - 28, 1984 IN ANTWERP,
BELGIUM.

MEETING SECRETARIAT :

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1. $400 \mu\text{g}/\text{cm}^2$ Carbon foils made by evaporation

The trick to avoid any stress in the foil was that we first prepared a self-supporting $40 \mu\text{g}/\text{cm}^2$ C-foil ($2 \times 2 \text{ cm}^2$) and rotated it with the aid of a small electric motor in such a way that 600 mg C evaporated from an electron gun in a distance of 15 cm condensed on both sides of the target at (nearly) the same time. We see no problem to make also thicker targets in this way. We used that foil as a backing for a $300 \mu\text{g}/\text{cm}^2$ Sn layer which was evaporated onto it.

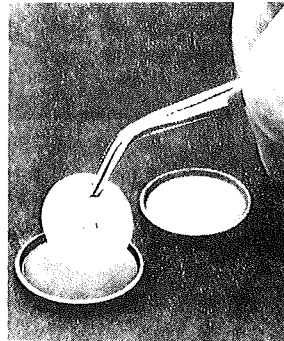
2. Other targets

With the same rotating target technique we prepared $100 \mu\text{g}/\text{cm}^2$ Pr and BaO, and $50 \mu\text{g}/\text{cm}^2$ Ru on $10 \mu\text{g}/\text{cm}^2$ C. This materials tend to destroy the carbon when only condensed on one side of it.

By evaporation with an electron gun we made self-supporting $40 \mu\text{g}/\text{cm}^2$ Fe and $15\text{-}200 \mu\text{g}/\text{cm}^2$ Cr foils (a Betainmonohydrat substrate was used) and $250 \mu\text{g}/\text{cm}^2$ V on Au, Gd, and Ta backings. By evaporation from boats and tubes we prepared $210 \mu\text{g}/\text{cm}^2$ Gd, $400 \mu\text{g}/\text{cm}^2$ La, and $100 \mu\text{g}/\text{cm}^2$ Sm and Nd all on $10 \mu\text{g}/\text{cm}^2$ C-backings, and $3 \text{ mg}/\text{cm}^2$ Ce, Sm, and Te on rolled $150 \text{ mg}/\text{cm}^2$ Bi backings which were stucked by a heat conducting resin to $100 \text{ mg}/\text{cm}^2$ Cu. The Bi-backings during evaporation usually are fixed to a Cu-block to keep them cool.

Comparison of the γ -spectra produced by Au, Ta, and Bi backings (thick targets which stop the beam and also a thin $250 \mu\text{g}/\text{cm}^2$ gold foil) in a 15 MeV α -beam showed that Bi produces the lowest γ -background at all energies.

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Targets produced this year varied in thickness from a few $\mu\text{g}/\text{cm}^2$ to several mg/cm^2 and were as follows:

Au, ^{10}B , ^{11}B , ^9Be , C, CaF_2 , ^{40}Ca , ^{48}Ca , ^{139}La , NaBr, NaCl, Na_2WO_4 , ^{192}Os , Pb, ^{208}PbS , ^{198}Pt , $^{28}\text{SiO}_2$, Si^{18}O_2 , ^{147}Sm , ^{148}Sm , ^{150}Sm , ^{120}Sn , Ta, ^{159}Tb , Th, $\text{Ta}_2^{15}\text{O}_5$, Tm and U. Sandwich targets of C- ^{148}Sm -C- ^{208}PbS -C were also made.

Approximately 600 carbon stripper foils 3-5 $\mu\text{g}/\text{cm}^2$ thick were produced as well as routine carbon foils for target backings. Large area (2 cm dia) \times 30 $\mu\text{g}/\text{cm}^2$ carbon foils, supported on wide spaced nickel mesh, were fabricated for use with a channel plate detector.

Instrumentation.

An adjustable, watercooled backing plate and modified electron gun have been designed for rare-earth evaporations and will be installed in the near future. A self-latching electromagnetic shutter, which will enable much more rigid control of the evaporation process, has been designed and is in the process of being manufactured.

Ion beam sputtering apparatus

Slow progress continues in adopting a duoplasmatron ion source to produce a satisfactory collimated ion beam for sputtering target materials. A focussed beam has been produced but more work needs to be done to reduce the beam cross section and to eliminate the halo surrounding the beam.

Investigation into the dependence of energetic ion charge-state distribution on the method of target preparation

Early measurements of 130 MeV Br charge state distributions after passing through thin carbon targets, indicated a strong dependence upon the method of target preparation. The effect was such as to produce different mean charge for targets of nominally the same thickness (pre-equilibrium thickness $\sim 10 \mu\text{g}/\text{cm}^2$ as determined by 2 MeV proton backscattering), but prepared with varying amounts of NaCl release agent. Work is continuing in order to characterise this effect and to correlate the charge state distribution measurements with scanning electron microscopy of the target.

D.W.L. Tolfree

SCIENCE AND ENGINEERING RESEARCH COUNCIL

DARESBUURY LABORATORY, WARRINGTON, ENGLAND.

Gas Release and Structure of Carbon Foils made by Glow Discharge
in Ethylene

Carbon Stripper Foils made by the Glow Discharge method are currently being used as strippers in the 20 MV Tandem Accelerator at Daresbury, and also in a number of other accelerator laboratories. These foils shrink less under ion bombardment than conventional foils made by evaporation and last longer as strippers. This phenomena may be related to foil structure and gas release from foils during early irradiation.

Thermal desorption studies have been carried out on thin films ($\sim 20 \mu\text{g}/\text{m}^2$) and the gas released in significant quantities were hydrogen and methane. A series of tempering experiments has shown this release to occur over a wide temperature range indicating that for both gases a continuum of activation energies is involved. The maximum for methane release occurred at about 600°C and for hydrogen $\sim 700^\circ\text{C}$.

Infra red absorption studies have been extended to examine absorption as a function of temperature. This provides information about bound hydrogen content (ref. NIM 203 (1982) 509). Foils are known to contain between 20-50 atomic percent of total hydrogen.

The infra red studies suggest that the majority of CH_2 and CH_3 bonds can be ruptured by annealing at 300°C , a temperature well below the hydrogen and methane release rate maximise. This structural change we estimated to correspond in a dynamic experiment to the onset of gas release. The main peak of the gas release however does not seem to be associated with these structural changes. The extended temperature range of the gas release could be associated with the high degree of disorder within the material. Further studies are to be made using the infra red spectroscopy technique.

Survey on the Production of Nuclear Accelerator Targets at GSI in 1982 ¹⁾

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and

U. Glatzel, Institut für Kernchemie, Universität Mainz, 6500 Mainz, BRD

A wide variety of nuclear accelerator targets, target systems, backings, stripper foils, beam monitors, and thin conductive or protective layers has been prepared from various chemical elements, chemical compounds, as well as from stable enriched isotopes, and from the radioisotopes ^{232}Th and ^{238}U . Layers of thicknesses from 0.001 to 300 mg/cm², that is a variation of more than 6 orders of magnitude, were fabricated as self-supported foils or as thin films on appropriate backings. The number of requested targets increased promptly by a factor of about two after the up-grading of the GSI-UNILAC in 1981. The high intensity of the heavy-ion beam often destroyed targets, so that more and more target wheels were utilized successfully to reduce radiation damages; this increased, however, the number of targets to be prepared, as can be seen from a comparison of targets requested in the last 3 years. (Standard targets are about 20x20 mm in size; larger dimensions are taken into account on this basis. Backings are regarded as separate foils.)

Target Preparation Procedure	Number of Targets in:		
	1980	1981	1982
Cold rollings	2 400	1 220	3 101
Carbon sublimation-condensations	1 961	2 190	4 292
Focused ion-beam sputterings	120	110	90
Vacuum evaporation-condensations	2 020	1 810	3 517
Total numbers of targets	6 501	5 290	11 000

Cold rolling between stainless steel sheets is very efficient in the preparation of metallic layers of more than 1 mg/cm². Among others, milligram-amounts of oxides of dysprosium isotopes have been reduced with Hf in a high-vacuum reduction-distillation process before being rolled under argon in a glove box. The different materials rolled in 1982 are listed below:

Ag, ^{109}Ag , Al, Au, ^{48}Ca , Cd, ^{106}Cd , Cu, $^{63,65}\text{Cu}$, Dy, $^{160,161,162,163,164}\text{Dy}$, Fe,

$^{56,58}\text{Fe}$, Gd, Ho, Li, Lu, $^{24,25}\text{Mg}$, Mo, $^{92,94,96,98,100}\text{Mo}$, Nb, Ni, $^{58,64}\text{Ni}$, $^{64}\text{Ni/Pb}$, Pb, ^{208}Pb , Pb/Cu, Pd, $^{102,108,110}\text{Pd}$, Ni/Pr/Ni, Rh, Sc, $^{147,154}\text{Sm}$, Sn, ^{116}Sn , Ta, Th, U, Ni/U/Ni, V, W, Y, $^{64,68}\text{Zn}$, Zr.

A substrate fixture for carbon sublimation-condensations was enlarged and improved to hold 8 substrate plates of 100x100 mm in the preparation of more than 4000 target backings, degraders, stripper foils, etc. of 0.003 to 0.1 mg/cm² in 1982.

Sputter deposition² with a focused beam of 1 mA Ar⁺ at 10 kV has been used in the preparation of some special targets, as for instance self-supported Ta and ^{184}W . Other target systems were: Ag/C, Cr/C, Nd₂O₃/C, $^{64}\text{Ni/Pb}$, $^{108,110}\text{Pd}$, $^{96}\text{Ru/C}$, Ta/Al, $^{90/94}\text{Zr/C}$.

Numerous high-vacuum evaporation-condensations have been performed, applying resistive heating as well as direct or indirect electron bombardment in the evaporation of target materials. In one case only 10 mg of $^{130}\text{BaF}_2$ were available to prepare 3 targets of 1.3 mg/cm². Also a new procedure has been developed to prepare large amounts of 5x1 cm layers of Bi on C for the use on target wheels. All target materials evaporated in 1982 were:

Ag, Ag/C, Al, Au, Au/C, Au/CR39, Au/mica, Au/Ti, BaF₂/C, $^{130,132}\text{BaF}_2/\text{C}$, Bi, Bi/C, C/Bi/C, CaF₂/C, Cd, ^{106}Cd , $^{106,112,116}\text{Cd}$, Co, Cr, Cr/st-steel, C/CsJ/C, Cu, Dy/C, Eu/C, Fe, Fe/Al, Ge/C, $^{74}\text{Ge/C}$, Hf/Al, Ho/C, In, KBr/C, LaF₃/C, LiF/C, Lu, $^{25}\text{Mg/Au}$, Ni, ^{58}Ni , Ni/C, Pb, $^{206,207,208}\text{Pb}$, C/ $^{207}\text{Pb/C}$, C/ $^{208}\text{Pb/C}$, Pb/Cu, Pb/CR39, Pb/glass, Pd, Pd, Ni, Pd/Ti, Pt/RuO₂/Ta, Pt/Ta, $^{87}\text{RbCl/C}$, Sc/C, $^{144,147}\text{Sm}$, $^{154}\text{Sm/C}$, Sn, ^{116}Sn , Ta, Ti, C/U/C, C/Ti/U/C, Ti/U/Ti, glass/Ni/U/Ni, V, V/C, W, Y/C, Zr, stainless steel/steel, stainless steel/glass.

Examples for experiments using the targets in heavy-ion bombardments with projectiles ranging from ^{14}N to ^{238}U at energies of up to 20 MeV/u with Ar or 17 MeV/u with U are given in the GSI Scientific Report 1982.

¹From: GSI Scientific Report 1982, GSI 83-1, ISSN 0174-0814, p.216.

²H. Folger, J. Klemm and M. Müller, IEEE Trans. Nucl. Sci. Vol. NS 30, Apr 1983.

PREPARATION OF HOMOGENEOUS BEADS OF ISOTOPICALLY ENRICHED ZINC METAL*

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A new technique for preparing single beads of isotopically enriched zinc metal has been developed by the Isotope Enrichment Chemistry Laboratory of the Oak Ridge National Laboratory. The procedures are as follows: Zinc oxide is dissolved in approximately 5 N hydrochloric acid, evaporated to near dryness on a steam bath to eliminate excess HCl and diluted to approximately 0.01 N HCl with distilled water. Ammonium chloride is added to make the solution approximately 1 N and the zinc electroplated on a 5 cm² x 5 mil thick tantalum foil cathode. The plating conditions are 4 volts, 1.5 amperes. (This is considerably higher NH₄Cl normality and current density than formerly employed and results in a more granular deposit of zinc rather than the thin flakes that were formerly obtained.) The zinc metal is scraped from the cathode, washed with distilled water, and dried in argon. The resultant zinc metal is mechanically pressed into a 5-mm diameter pellet in a stainless steel die, placed in a 6-mm diameter graphite crucible and covered with approximately 10 mg of NH₄Cl crystals for each 100 mg of zinc. The graphite crucible is placed in a quartz combustion tube and thoroughly flushed with argon. While maintaining a small flow of argon, the tube is placed in a furnace which has been preheated to 600°C. When the pellet has melted, the crucible is removed and immersed in distilled water for rapid cooling and removal of residual NH₄Cl and slag. The zinc bead is washed, dried, and weighed.

Ten 100-mg samples of normal zinc were processed using this procedure. The average yield was 93% with extremes of 97% and 86%. Three samples each of 50 mg and 200 mg were also processed with average yields of 88% and 97% respectively. One sample of 100 mg of isotopically enriched ⁷⁰Zn has been processed yielding a bead weighing 92 mg.

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Nitrogen targets (^{14}N and ^{15}N)

Nitrogen targets have been prepared by the following two methods.

1. Implantation. Nitrogen ions produced in the ion source of a sputtering unit and accelerated by a voltage of 3-4 keV have been implanted in a 0.3 mm thick tantalum backing which first had been baked out in vacuum. The beam is defocussed to a diameter of 1 cm.

Water cooled ^{15}N targets (enrichment 11.7%) have been used in an investigation of the $^{15}\text{N}(p,\gamma)^{16}\text{O}$ reaction at the 897 keV resonance. After 15 h of use with a 100 μA proton beam and a 4 mm² beam spot the yield reduction amounted to 40%.

2. Reactive sputtering. Several different nitride targets have also been prepared by reactive sputtering caused by a bombardment of 9 keV ^{14}N and ^{15}N ions, the latter again enriched to 11.7%.

a. Tantalumnitride targets of 90 $\mu\text{g}/\text{cm}^2$ on 0.3 mm thick Ta backings, again for the above mentioned investigation of the $^{15}\text{N}(p,\gamma)^{16}\text{O}$ reaction.

b. Titaniumnitride targets of 75 $\mu\text{g}/\text{cm}^2$ on 0.3 mm thick Ag backings. They served for the production of radioactive ^{15}O (used in medical research) with the reaction $^{14}\text{N}(d,n)^{15}\text{O}$ ($E_d = 1 \text{ MeV}$).

c. Aluminumnitride targets of 15 $\mu\text{g}/\text{cm}^2$ on 40 $\mu\text{g}/\text{cm}^2$ carbon foils, used for investigations of the $^{15}\text{N}(p,\gamma)^{16}\text{O}$ and $^{27}\text{Al}(p,\gamma)^{28}\text{Si}$ reactions. The yield reduction in 4 h for a 900 keV 5 μA proton beam (beam spot 4 mm²) amounted to 25% for the former and 5% for the latter reaction.

The Al to N ratio in these targets was determined by means of proton Rutherford backscattering (RBS) as 7 : 1, to be compared with a 1 : 1 ratio expected if all the material is sputtered on in the form of AlN. There are two possible explanations for this discrepancy. The simplest is that the sputtering proceeds non-stoichiometrically with a preponderance of Al atoms

over AlN molecules. One might also make the assumption that part of the nitrogen has disappeared by reactions with water vapour (the targets were kept before use for several days in contact with the open air).

d. Siliconnitride targets ($20 \mu\text{g}/\text{cm}^2$ on $40 \mu\text{g}/\text{cm}^2$ carbon foils) have then been prepared to decide between the two possibilities mentioned above. This material does not react with water vapour. The RBS Si/N ratio determined as 2.3 : 1 shows that indeed the sputtering proceeds non-stoichiometrically; for Si_3N_4 the expected ratio would be 3 : 4.

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We are presently working on several types of targets for experiments at TUNL.

- 1). We have been attempting to produce a thin ($2 - 5 \mu\text{g}/\text{cm}^2$) target of ^{56}Fe which has very little carbon contamination. We have produced targets with as little as $0.1 \mu\text{g}/\text{cm}^2$ of carbon by evaporating ^{56}Fe onto thin ($10 - 20 \mu\text{g}/\text{cm}^2$) aluminum backings. The backings were prepared by evaporating Potassium Iodide onto microscope slides - to act as the release agent, and then evaporating pure aluminum wire onto the slides. The aluminum foils were then floated onto target rings and the ^{56}Fe was evaporated onto them in the usual manner. As a test, we measured the carbon content (by proton elastic scattering) and found the carbon content of the aluminum foils to be the same as that of the fully prepared targets. Any suggestions for improving on this technique would be greatly appreciated.
- 2). We have also been attempting to make thin ($1 - 3 \mu\text{g}/\text{cm}^2$)

Magnesium targets on 5 - 10 $\mu\text{g}/\text{cm}^2$ carbon backings. It remains difficult to achieve thin and uniform targets as the Magnesium does not adhere readily to the carbon. We would welcome any correspondence regarding techniques for preparing these targets.

3). We are also planning to prepare some thin Sulfur targets. Because of the low melting point of Sulfur and our need to subject these targets to several microamperes of proton beam, we are looking at various Sulfur compounds - i.e. CdS.

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Nuclear Target Making and Development

The Physics Division has a facility which produces very thin targets for experiments at the tandem-linac and Dynamitron accelerators, for experiments of other members of the Division, any other divisions at the Laboratory needing this service and occasionally for other laboratories and universities.

This year we again produced targets varying in thickness from a monolayer to several mg cm^{-2} . The different elements, isotopes or compounds evaporated, sputtered, rolled, anodized or oxidized included Al, Au, Ba, BaF_2 , $^{10,11}\text{nat}_B$, CaF_2 , C, CH_2 , $^{156}\text{Gd} + \text{Pb}$, $^{155,156,157}\text{Gd} + \text{Au} + \text{Pb}$, K, $^{6,7}\text{nat}_{Li}$, $^{6,7}\text{LiF}$, LiH, $^{24,26}\text{nat}_{Mg}$, $^{92,94,95}\text{Mo} + \text{Pb}$, ^{15}N (malamine), $^{58,62}\text{Ni} + \text{Pb}$, $^{206,208}\text{nat}_{Pb}$, $^{96}\text{Ru} + \text{Au} + \text{Pb}$, $^{28,29,30}\text{nat}_{Si}$, ^{144}Sm , $^{144}\text{Sm} + \text{Pb}$, $^{119,120,122,124}\text{Sn}$, $^{122,124}\text{Sn} + \text{Au}$, $^{122}\text{Sn} + \text{Bi}$, $^{122}\text{Sn} + \text{Pb}$, $^{125}\text{Te} + \text{Pb}$, ^{238}U , $^{92,96}\text{Zr} + \text{Pb}$.

Of the more than seven hundred targets produced this year those made for experiments at the heavy-ion facility were often much more complex and time consuming to produce. The methods used to produce both "sandwich" and "stretched" targets for these experiments have been improved. They must have the various layers, often up to 15 mg cm^{-2} , evaporated onto the base material to insure no voids between them.

The new sputter system is now operational. It is especially useful when only small quantities are available or it is a high-melting material or when it is desirable to stick the evaporant onto some surface.

A new "clean" evaporator using a cryo-pump is being built with the intent of producing higher purity targets. Also, the present systems for storing readily-oxidized targets are being upgraded. They will use turbo pumps and have improved electronics to both protect the targets from power failures and to help prevent accidental exposure to the atmosphere. Our plans for the future include the fabrication of a multi-target evaporation system and as always to continually improve target quality.

A WINDOWLESS WATER TARGET FOR "IN - BEAM" EXPERIMENTS

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This target was developed in connection with a parity violation experiment in ^{18}F (ref. 1,2) produced with the reaction $^{16}\text{O} (^3\text{He}, p) ^{18}\text{F}$ at a ^3He energy of 3 MeV.

The general scheme of the target and the pumping system is reported in fig.1 while in fig. 2 details of the water stream assembly are shown.

At first deionized water is introduced in the water reservoir and outgassed by the roughing pump P1. The water has to be carefully outgassed since even small quantities of diluted gas produce bubbles which explode (with instabilities of the water stream geometry), just in correspondence of the beam entrance hole (see fig. 2) as a consequence of the high pressure gradient existing there. Special care was taken to the choice of the water circulation system in order to avoid cavitation which easily arises owing to the requested high flow and to the operation under vacuum. The finally adopted set-up consisted of high flow, low pressure commercial pump followed by a high pressure centrifugal jet pump. Water pressure in the nozzle is about $3 \cdot 10^5$ Pa. The water pipeline as well as the reservoir are made of stainless steel, standard "pneuop" couplings are used along the pipeline.

The water stream is in equilibrium with a vapour pressure of about 900 Pa owing to the working temperature of 1 °C, controlled within 0.1 °C.

The vacuum in the region between the entrance aperture (3.0 mm diameter) of the water stream chamber and the 3rd diaphragm (2.5 mm diameter) is kept at 8 Pa by a refrigerated condenser working at - 53 °C .

A $16 \text{ m}^3/\text{h}$ two-stage roughing pump works on the condenser in order to prevent accumulation of non condensable gases. The condenser capacity is 15 Kg of ice. 700 g of vapour per day are condensed so that the accumulated ice has to be removed and the water reservoir (30 l) refilled every 15th day. Between 3rd and 2nd diaphragms two cascaded Roots pumps R_1 ($1200 \text{ m}^3/\text{h}$) and R_2 ($500 \text{ m}^3/\text{h}$) maintain a vacuum of 10^{-1} Pa; they use the refrigerator as forevacuum pump and provide a compression ratio of ~ 100 . They act in turn as forevacuum for the Turbomolecular pump (450 l/s) which works in the subsequent section (between 2nd and 1st diaphragms). In this section the vacuum is of $2 \cdot 10^{-4}$ Pa. Finally the vacuum measured in the main beam pipe, where the turbomolecular pump T2 (220 l/s) operates, is 10^{-4} Pa (a value as good as the one obtained with normal targets).

The water vapour present in the various sections gives rise to a diffused target having the following characteristics:

- 1) water jet chamber : pressure 900 Pa, water vapour density $7.4 \mu\text{g}/\text{cm}^3$, length 0.35 cm, thickness $2.6 \mu\text{g}/\text{cm}^2$;
- 2) region between beam entrance aperture and 3rd diaphragm: 8 Pa, $0.066 \mu\text{g}/\text{cm}^3$, length 2.5 cm, thickness $0.16 \mu\text{g}/\text{cm}^2$;
- 3) region between 3rd and 2nd diaphragms: 10^{-1} Pa, density $0.8 \text{ ng}/\text{cm}^3$, length 40 cm, thickness $32 \text{ ng}/\text{cm}^2$;
- 4) region between 2nd and 1st diaphragms: pressure 10^{-4} Pa, density $8 \cdot 10^{-4} \text{ ng}/\text{cm}^3$, length 40 cm, thickness $3 \cdot 10^{-2} \text{ ng}/\text{cm}^2$.

The total diffused target thickness is therefore of the order of $3 \mu\text{g}/\text{cm}^2$ which corresponds, for ^3He ions of 3 MeV, to an energy loss of 2.4 KeV.

The water stream target is currently bombarded with a ^3He beam ($0.2 \div 20 \mu\text{A}$, 3 MeV); the beam spot has a diameter of $\sim 2 \text{ mm}$ with no significant halos.

Neither detectable variations in the measured pressures nor mechanical

instabilities of the water stream have been observed even at the 60 W dissipated power.

1) C. A. Barnes et al.

Phys. Rev. Lett. 40 (1979) 840

2) P. G. Bizzeti et al.

Lett. Nuovo Cimento 29 (1980) 167

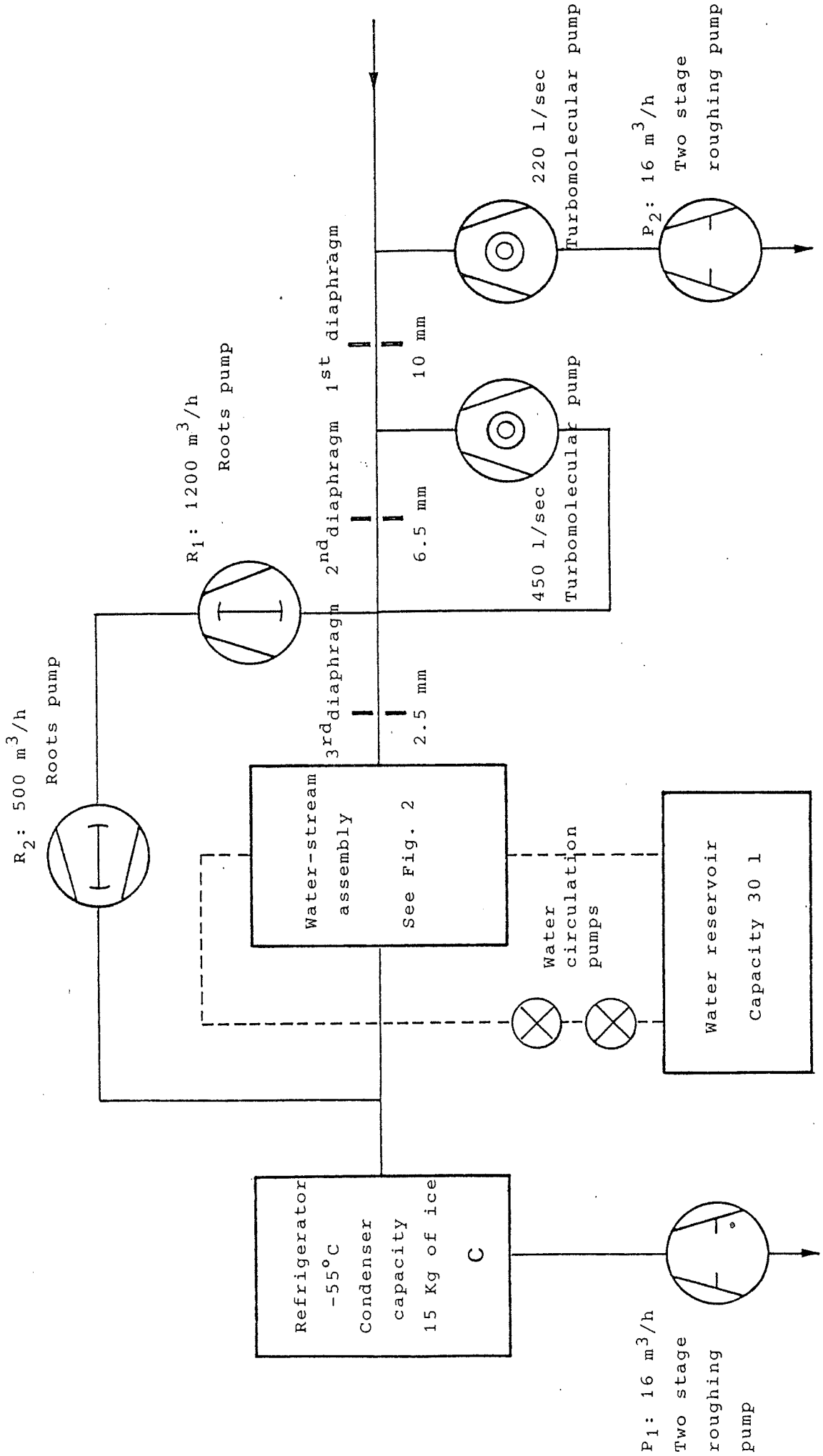


Fig. 1

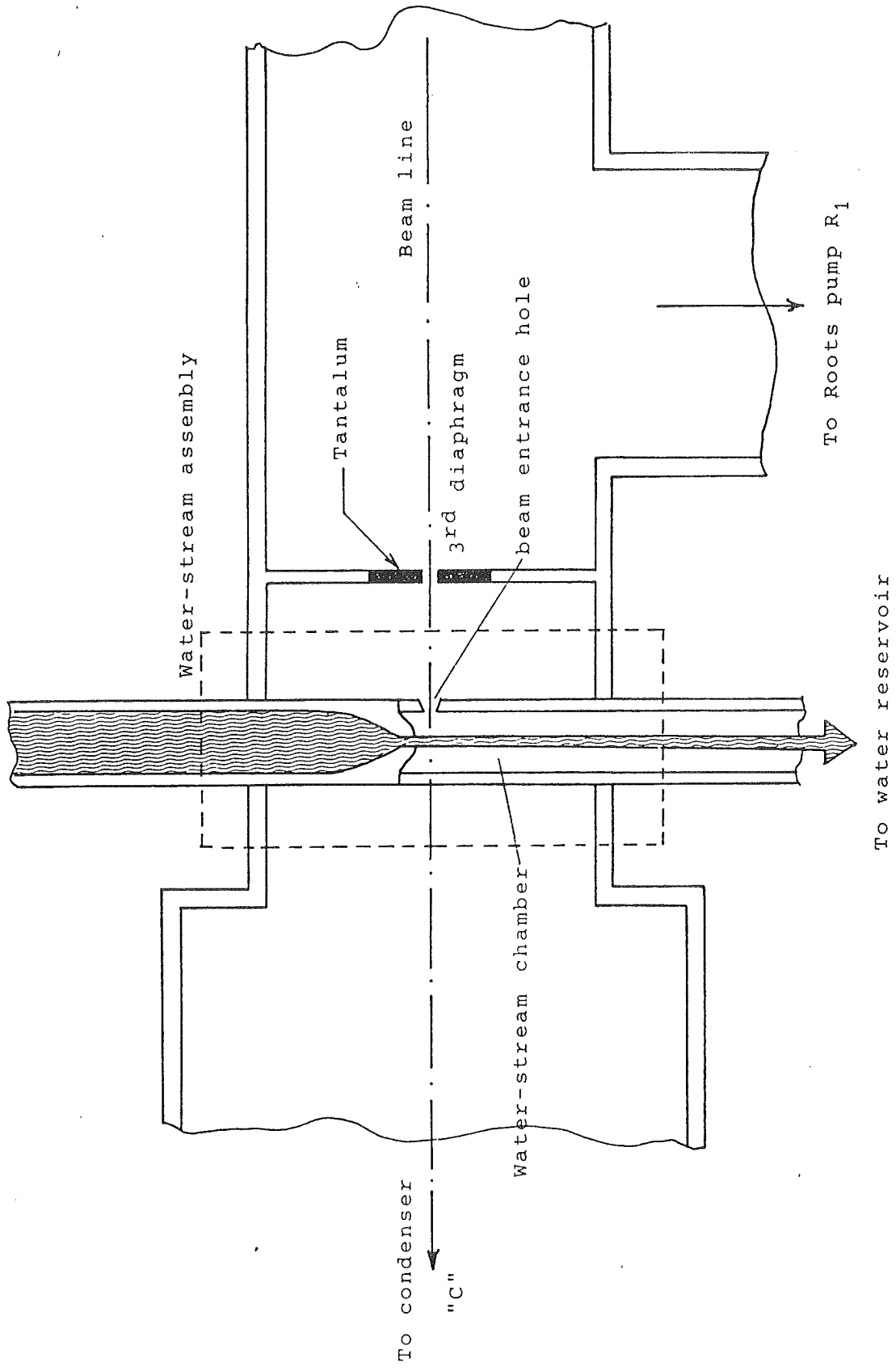


Fig. 2

A QUICK BELL-JAR REPAIR METHOD

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MicroMatter Co.
Rt. 1, Box 72-B, Eastsound, WA, U.S.A. 98245

The sealing surface of the usual Pyrex bell-jar used with vacuum evaporators in target making laboratories is prone to chipping. These chips can be removed by grinding and removing enough material from the entire rim to eliminate the chipped area. In the absence of the proper equipment or in the interest of time, it is possible to repair this area using Epoxy patch.

The chip crater should be cleaned with alcohol or other non-residue solvent and blown dry. The Epoxy we have used with good success is Torr-Seal^R, a filled, low vapor pressure resin used for such purposes. This product is distributed by Varian Associates, Vacuum Division, Palo Alto, CA, U.S.A. The epoxy is placed in the crater with a small amount of excess and allowed to set. When the material is completely set, the excess can be filed and sanded smooth with the adjacent sealing surface.

We have used bell-jars repaired in this manner with no sign of reduced performance. The filling of small, non-leaking chips at the same time is also desirable due to the reduced possibility of damaging the Viton L-gasket.

PRODUCTION OF SILVER COATED POLYMERIC THIN FOILS

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Exactly one year ago I put aside target-making to assist with the installation of a new General Ionex 400 k.V. ion source on our F.N. Tandem Van de Graaff. All beam lines were also disassembled and completely upgraded along with the pumping equipment. The finishing touches were put on the superconducting linac and a ^{32}S 60 MeV beam from the tandem was accelerated to 211 MeV in early April. More on the details of this in the next Newsletter.

Time was found, however, to develop reliable conductive Ag films on polypropylene and mylar for a parallel plate avalanche detector being built here by R. Freifelder and P. Braun-Munzinger.

The Detector: Briefly, the unit consists of two electrodes separated by a gas filled gap with a potential difference across the electrodes. There are two pressure foils and a vacuum chamber which seals the detector from the main vacuum and insures that the thin electrode foils remain parallel. Charged particles first enter the pressurized section creating ion pairs. Gas pressures and voltages are chosen to liberate more e^- ion pairs and an avalanche results at the anode. A fast signal rise time results (a few nanoseconds) which can be used for timing and energy loss information.

The detector can be made to yield two dimensional position information on the particles where abouts inserting wire grids between the electrodes as shown in the exploded view.

Foils: DuPont mylar and stretched polypropylene were used. Mylar was either 1/10 mil ($\sim 330 \mu\text{g}/\text{cm}^2$) or 6/100 mil ($\sim 250 \mu\text{g}/\text{cm}^2$). Stretched films were epoxied to large Al hoops for ease of handling. The mylar foils were essentially pin hole free.

Polypropylene foils were made from 1 mil stock stretched on a heated ($\sim 100^\circ\text{C}$) teflon coated Al cap, ~ 50 cm in dia.¹ Which was driven slowly up by a rack and pinion gear for a few feet while the perimeter of the foil is held fast at the base. With practice foils of 20 cm x 30 cm x $80 \mu\text{g}/\text{cm}^2$ can be easily accomplished with a 30% uniformity of thickness.

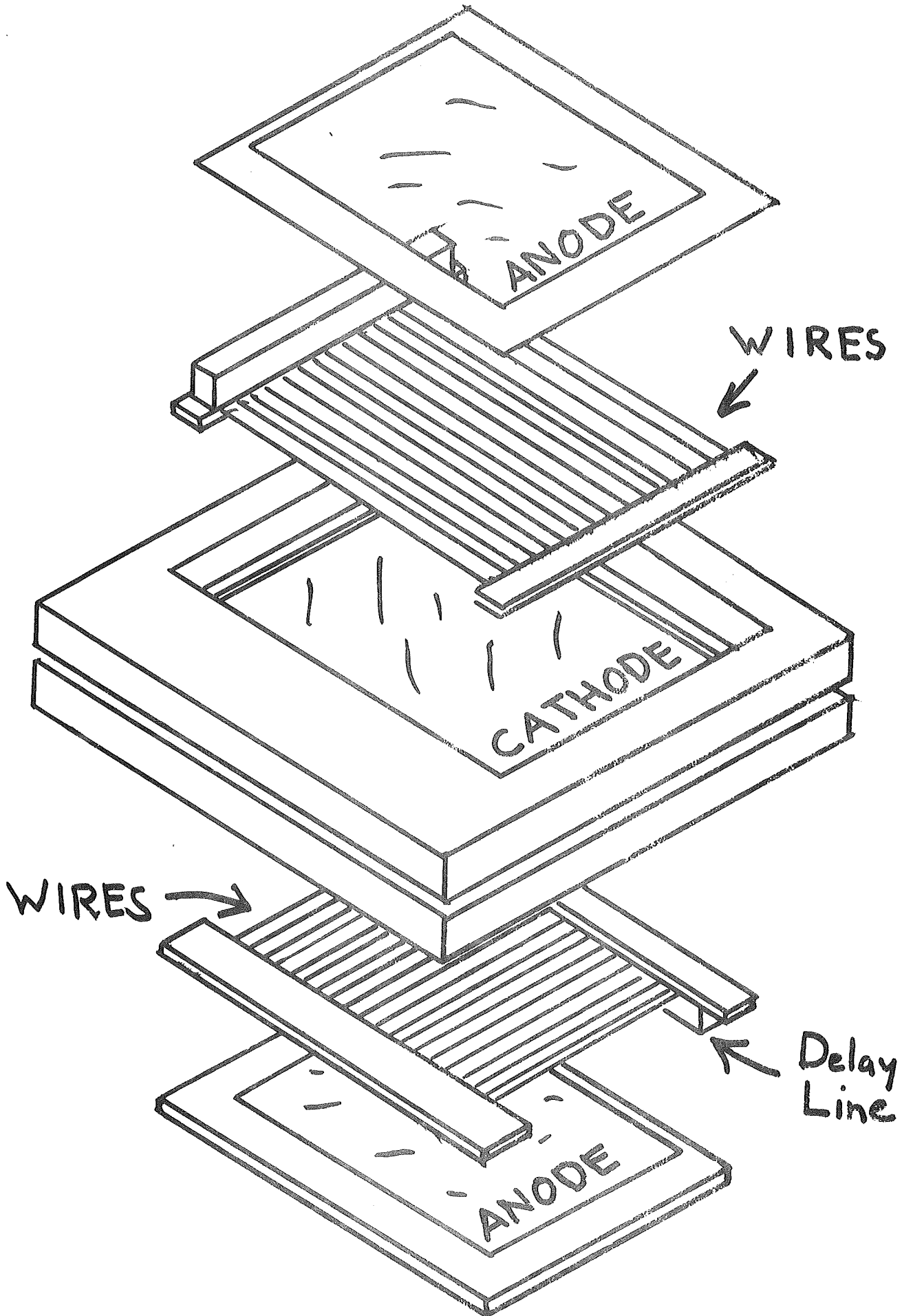
Evaporation: For uniformity two Ta boats are run in series and filled with equal amounts of pure Ag. A large radiant heat shield with two small holes for the boats is put directly above them. A hoop mounted foil is suspended from a small motor running at ~ 3 RPM's 50 cm above the boats. Thicknesses were determined with a Sloan crystal monitor.

When depositing onto thin polymers it is of vital importance to keep them relatively cool otherwise the Ag forms large electrically isolated islands.² This can be accomplished by increasing its heat capacity by simply slipping a piece of 5 mil acetate on top of the polymer. $30 \mu\text{g}/\text{cm}^2$ of Ag is layed down in a continuous evaporation at a rate of $\sim 1 \mu\text{g}/\text{cm}^2/3$ sec. The boats are preheated and outgassed first with a shutter interposed which is used to start and stop the deposition. 80% of the foils made in this way are usable.

"Crazy glue", a cyanoacrylate base, is applied to a final mounting frame and the (hoop) stretched foild placed on top of it. After the glue has set it has been found that the perimeter of the foil is best trimmed with the hot tip of a soldering iron. The initial punch through of a knife blade will more often than not cause a quick tear which generates past the glue line into the face of the detector.

References

1. "Thin Stretched Polypropylene Foils", R. Didriksson, L. Einarsson, J. Kjellberg, B. Sundqvist, Nucl. Inst. & Meth. 167 (1970 113; Proceedings of the Munich World Conference, 1978.
2. "Vacuum Deposition of Thin Films", L. Holland, Chapman & Hall Ltd., 1966.



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SAMPLES FOR NUCLEAR MEASUREMENTS DELIVERED IN 1982

In 1982 632 samples were delivered covering 96 different applications. Details are given in Table 1 and 2. Thin films and foils were prepared by electrospraying, including suspension spraying, spraypainting, vacuum deposition or rolling. Alloys with accurately defined composition or bulk samples were produced by melting, including high frequency levitation melting, rolling, powder metallurgy and conventional machining techniques. The characterization of the samples and targets depended on the application. It varied from a crude film thickness measurement by an oscillating quartz device to the extremely accurate mass assay by alpha-counting and isotope dilution mass spectrometry.

Table 1. Samples delivered during the first semester 1982

Materials	Applicants (See list (a))	Number of samples	Definition Method (See list (b))	Preparation Method (See list (c))
Al-0.5 % nat. U	(1)	5	QA	LM - R
nat. UO ₂	(1)	1	DC	MA
nat. UO ₂ on Al	(2)	30	MD	SU
nat. UO ₂ on Mylar	(2)	6	MD	SU
²³⁵ U ₃ O ₈ canned in Al	(11)	70	MD - DC - IA	PR - C - M - W
Al - 10% ²³⁵ U	(3)	2	QA	LM - R
Al - 4.5% ²³⁵ U	(4)	1	QA	LM - R
²³⁵ UF ₆ on Stainless Steel	(1)	20	AC - IA	VD
²³⁸ UO ₂ on Al	(5)	1	MD	SU
²³⁶ U-acetate Al	(5)	2	AC	SO
²³⁵ U ₃ O ₈ on Al	(5)	1	AC	SU
²³⁴ U-acetate on Al	(5)	2	AC	SO
²³³ U-acetate on Al	(5)	1	AC	SO
²³⁰ ThO ₂ on Al	(5)	2	AC	SU
²³⁹ PuF ₃	(6)	1	AC - IA	VD
Al - 10% Th	(4)	1	QA	LM - R
⁷ Li in Al	(1)	28	MD - IA - DC	R - MA - C
⁷ LiF on Ag	(1)	22	MD - SF	VD
⁶ LiF on Al	(1)	2	MD - SF	VD
CaCO ₃	(1)	1	MD	SU
Tristearine on Ta	(1)	6	MC	VD
Au on Mylar on Al	(1)	4	MD	VD
Polyimide	(7)	2	SF	PC
Polysulfone	(7)	2	SF	CE
¹⁰¹ Ru on Al	(1)	1	MD	SU
³³ S on Formvar	(1)	1	MD	VD
¹⁷⁷ HfO ₂ on Al	(1)	1	MD	SU
¹⁷⁶ HfO ₂ on Al	(1)	1	MD	SU
¹⁷⁹ HfO ₂ on Al	(1)	1	MD	SU
¹¹⁵ SnO ₂ on Al	(1)	1	MD	SU
⁹¹ ZrO ₂ on Al	(1)	1	MC	SU
¹²⁵ Te on Al	(1)	1	MD	SU
¹³⁵ Ba(NO ₃) ₂ on Al	(1)	1	MD	SU
nat. K ₂ CO ₃ on Al	(1)	1	MD	SU
PbF ₂	(1)	2	MC	PR
⁵⁷ Fe ₂ O ₃	(1)	1	MD	SU
Nb (low Ta content)	(4)	2	DC	R
p-terphenyl on Quartz	(1)	2	MD	VD
²² NaCl canned in Fe	(9)	4	--	C - W
V	(8)	13	DC	R - MA
Ta	(1)	1	DC	MA
Cr on glass	(1)	97	--	VD
Fe - 0.5 at % Ti	(10)	4	QA	LM
1 at % Ti				
2 at % Ti				
4 at % Ti				
Fe - 0.5 at % Pt	(10)	4	QA	LM
1 at % Pt				
2 at % Pt				
4 at % Pt				
Fe - 0.5 at % Mn	(10)	4	QA	LM
1 at % Mn				
2 at % Mn				
4 at % Mn				
Fe - 0.5 at % V	(10)	4	QA	LM
1 at % V				
2 at % V				
4 at % V				

(a) List of applicants

- (1) C.B.H.M. Geel
- (2) C.F.N. Saclay
- (3) C.E.R.N. Geneve
- (4) E.C.N. Petten
- (5) K.V.I. Groningen
- (6) Benelux Analytical Instruments
- (7) J.L.L. Grenoble
- (8) S.C.K. Mol
- (9) L.U.C. Diepenbeek
- (10) K.U.L. Leuven
- (11) LUR - USA - IAEA (NDA-RM's)

- (EUR)
- (F)
- (CH)
- (NL)
- (NL)
- (F)
- (B)
- (B)
- (B)
- (B)

(b) List of Definition Methods

- DC : Dimensional Control
- MD : Mass Determination
- AC : Alpha Counting
- IA : Isotope Analysis
- SF : Spectrophotometry
- QA : Quantitative Alloying

(c) List of Preparation Methods

- PR : Pressing
- VD : Vacuum Deposition
- SU : Suspension Spraying
- SO : Solution Spraying
- M : Melting
- MA : Machining
- C : Canning
- LM : Levitation Melting
- R : Rolling
- W : Welding
- PC : Polycondensation
- CE : Centrifugation

Table 2. Samples delivered during the second semester 1982

Materials	Applicants (See list (a))	Number of samples	Definition Method (See list (b))	Preparation Method (See list (c))
$^{235}\text{UF}_4$ on polyimide + Au	(1)	6	AC - IA - SF	VD - PC
$^{235}\text{UF}_4$ on stainless steel	(2)	4	AC - IA - IDMS - DC	VD
$^{235}\text{UF}_4$ on polyimide	(3)	6	AC - IA - SF	VD - PC
$^{235}\text{U}_3\text{O}_8$ on polyimide + Au	(4)	3	AC - MD	SU - PC - VD
$^{235}\text{UF}_4$ on Al	(1)(17)	12	AC - IA - IDMS	VD
$^{235}\text{U}_3\text{O}_8$ canned in Al	(18)	70	MD - DC - IA	PR - C - MA - W
$^{235}\text{UF}_4$ on Ni	(5)	2	AC - IA - IDMS	VD
$^{235}\text{UF}_4$ on stainless steel	(6)	12	AC - IA - IDMS	VD
U nat. disc	(1)	1	DC	MA
$^{238}\text{UF}_4$ on Al	(17)	10	SF - IA	VD
$^{230}\text{ThO}_2$ on polyimide + Au	(7)	5	AC - IA - IDMS - SF	SU
$^{238}\text{UF}_4$ on polyimide + Au	(1)	4	SF - IA	VD
$^{237}\text{NpF}_4$ on Ni	(5)	2	AC	VD
$^{237}\text{NpF}_4$ on stainless steel	(8)	18	AC	VD
$^{239}\text{PuF}_3$ on stainless steel	(9)	1	AC - IDMS - IA	VD
$^{240}\text{PuF}_3$ on stainless steel	(9)	1	AC - IDMS - IA	VD
^{239}Pu - ^{240}Pu mixt. on PI	(1)	7	AC - SF - IA	VD
^{241}Pu acetate on polyimide + Au	(10)	1	AC - IA	SO - PC - VD
$^{242}\text{PuF}_3$ on polyimide + Au	(10)	1	AC - IA - IDMS	VD - PC
$^{242}\text{PuF}_3$ on Ni	(5)	1	AC - IA - IDMS	VD
^{10}B on Al	(1)	2	MD	VD
^{10}B on stainless steel	(11)	5	MD	VD
^{10}B on Al	(1)	2	MD	VD
nat. B on Ta	(12)	15	MD	VD
^{10}B on stainless steel	(6)	6	MD	VD
$^{22}\text{NaCl}$ canned in Fe	(10)	6	--	C
^{182}W on C	(13)	2	MD	SU
^{184}W on C	(13)	3	MD	SU
$^{149}\text{Sm}_2\text{O}_3$	(1)	1	MD - DC	C
Polysulfone	(3)	14	SF	PC
Polyimide	(3)	3	SF	PC
V - 1% Co	(14)	1	QA	LM - R
Ni - 3% ^{235}U	(15)	8	QA	LM - R
V - 2% ^{238}U	(16)	1	QA - IDMS	LM - R
V - 1% ^{232}Th	(16)	1	QA	LM - R
Al - 0.6% B	(10)	5	QA	LM - R
Al on Quartz and plexi	(1)	21	MD	VD
C	(1)	108	DC	POL

(a) List of applicants

- (1) C.B.N.M. Geel
- (2) A.N.L.
- (3) I.L.L. Grenoble
- (4) NUCOR Pelindaba
- (5) Univ. Bonn
- (6) NBS Washington
- (7) CEA Saclay
- (8) Westinghouse Harford
- (9) JRC Ispra
- (10) R.U. Gent
- (11) K.U. Leuven
- (12) U.C. Louvain
- (13) U.L. Bruxelles
- (14) K.F. Jülich
- (15) C.E.N. Grenoble
- (16) U.K.A.E.R.E. Harwell
- (17) K.V.I. Groningen
- (18) EUR USA - IAEA (NDA-RM's)

(b) List of Definition Methods

- (EUR)
 - (USA)
 - (F)
 - (S.A.)
 - (FRG)
 - (USA)
 - (F)
 - (USA)
- DC : Dimensional Control
 - MD : Mass Determination
 - AC : Alpha Counting
 - IA : Isotope Analysis
 - SF : Spectrophotometry
 - QA : Quantitative Alloying

(c) List of Preparation Methods

- (B)
 - (B)
 - (B)
 - (B)
 - (FRG)
 - (F)
 - (GB)
 - (NL)
- VD : Vacuum Deposition
 - SH : Suspension Spraying
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 - MA : Machining
 - C : Canning
 - LM : Levitation Melting
 - R : Rolling
 - W : Welding
 - PC : Polycondensation
 - POL : Polishing
 - PR : Pressing

RECENT PUBLICATIONS

DL/NUC/P 169 A

Preprint Dec. 1982

Hydrogen in Carbon Foils made by D.C. Glow Discharge in Ethylene by P. Bailey and D.G. Armour, University of Salford, J.B.A. England, University of Birmingham and N.R.S. Tait and D.W.L. Tolfree, Daresbury Laboratory

GSI-82-41

Preprint Dec. 1982

Preparation of Nuclear Accelerator Targets by focussed Ion Beam Sputter Deposition by H. Folger, J. Klemm and M. Müller to be published by IEEE in Trans. Nucl. Sci. Vol.NS 30 April 1983.