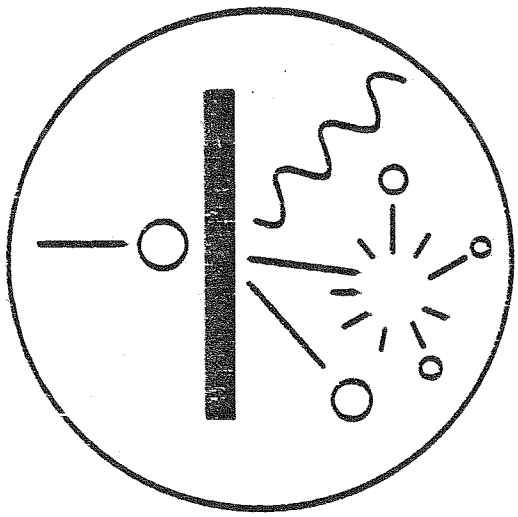
INTERNATIONAL NUCLEAR

TARGET DEVELOPMENT SOCIETY

NEWSLETTER



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CONTENTS

INTDS INFORMATION

As President of INTDS, I would like to take this opportunity to inform you of things that are occurring in the Society. Specifically, I want to update you with regard to INTDS Bylaws changes, publication of guidelines for hosts of INTDS meetings, and the publication date for the 1986 INTDS proceedings.

At the Thirteenth World Conference of the INTDS held at Chalk River, Ontario, Canada, on September 17-19, 1986, Committees were appointed to consider desirable changes to the existing INTDS Bylaws and to develop guidelines for hosts of INTDS meetings. The committee that made recommendations concerning changes to the Bylaws was composed of Jean Pauwels (Chairman), Peter Maier-Komor, and Joanne Heagney. Many of the proposed changes in the Bylaws were an outgrowth of our changing from annual to biennial conferences. The proposed changes were in accordance with Article V, Section 1, Part A, of our existing Bylaws which required a majority vote of those members voting through letter ballot. The Bylaws changes have been overwhelmingly approved by the INTDS membership. I am detailing below the transition measures for the period 1986-1988.

1. Officers:

Term of J. Van Audenhove (past president)	:	1988 instead of 1987
Term of H. Adair (president)	:	1990 instead of 1988
Term of H. Maier (vice president)	:	1990 instead of 1988
Term of J. Heagney (corresponding secretary-treasurer)	:	1990 instead of 1988
Term of W. Lozowski (recording secretary)	:	1990 instead of 1988

2. Directors:

Terms of G. Sletten and J. Pauwels	:	1988 instead of 1987
Terms of P. Dmytrenko and P. Maier-Komor	:	1988
Terms of H. Maier, E. Newman, and E. Erikson	:	1990 instead of 1989

3. Dues 1987 and Elections 1987:

Dues to be paid directly to J. Heagney as in the past. As all mandates are adapted to the new system, there will be no elections in 1987.

4. Nominating Committee for 1988 Elections

H. Adair shall appoint a nominating committee for the 1988 elections. This committee shall provide a slate of one or more candidates for each opening on the Board of Directors in 1988 (four seats). They shall transmit their proposals to H. Adair and J. Heagney before February 28, 1988.

A committee, composed of Harold Adair and Joanne Heagney, has prepared a booklet that provides guidelines for hosts of INTDS conferences. The guidelines will be finalized at the 1987 INTDS Board of Directors meeting to be held at CBNM in September. The booklets will be available at the 1988 INTDS conference in Darmstadt, West Germany.

The latest word from personnel at Nuclear Instruments and Methods is that the 1986 INTDS proceedings will be published in June 1987.

I am looking forward with great anticipation to the 1988 INTDS Conference in Darmstadt. I encourage each of you to spread the word about the meeting and begin as soon as possible preparing your presentations for which I know will be a very successful conference. The exact date and other information about the conference will be forwarded to you as soon as it is available.

Harold L. Adair, President
INTDS

Preparation and Investigation of Heavy-Ion Targets

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B. Goertz, Institut für Kernchemie, Universität Mainz

The increasing efficiency of UNILAC experiments at high, target destroying beam intensities demands large amounts of single targets or target wheels. The resulting development for the four basic target preparation procedures can be seen from fig.1 for the years 1980-1986. During that time the total number of target units (18x20mm) increased from 6 520 to 22 381 per year.

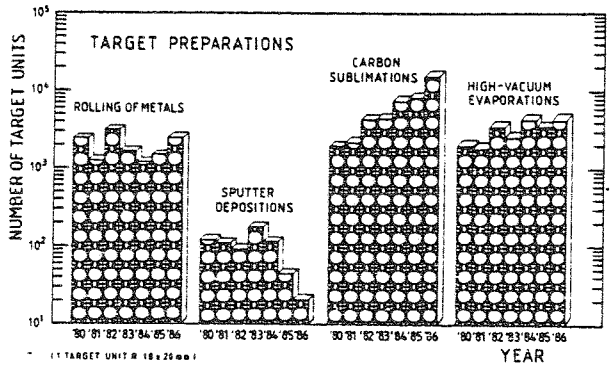

Fig.1. Target production rates for 1980-1986.

Rolling of metals is very effective especially if expensive isotopes are used as target materials in thicknesses of more than 0.3 µm. The crude isotopic material has to be pretreated in the most cases: Mo powder is molten with an e-gun; Ca-oxide has to be reduced to the metal prior to the rolling, which is then performed in a glove-box under Ar atmosphere; some metals have to be annealed in-between several steps of the rolling procedure; etc. In 1986 the 2425 rolled target units were of 34 different target substances, namely:
Ag, Al, Au, Ca, ^{40,42,44,48}Ca, Cu, Fe, ^{54,57}Fe, ^{57}Fe in stainless steel, Ho, La, Mg, Mo, ^{92,96,97,98,100}Mo, Nb, Ni, ^{58,64}Ni, Pt, ^{144}Sm, Ta, Tb, Ti, Th, W, and Yb.

Focused heavy-ion beam sputter-deposition was taken to obtain 0.5-mg/cm^2-thick ^{96}Ru targets on Nb backings and also a series of ^{102}Ru plunger targets on Cu supports. W layers of 0.5 mg/cm^2 were efficiently sputtered to Mo. (Sputtering could be performed only part of this year.)

High-vacuum carbon sublimation-condensations are the main procedures to prepare heavy-ion target backings, target-protection layers, degraders, foils for ionic charge equilibration, stripper foils, and also targets of C. In 1986 a total of 15 816 C target-units have been deposited applying two sublimation methods: 1) Resistance heating of 3-mm-ø C rods produced C of 0.002 to 0.1 mg/cm^2. The thicknesses of all backings were measured spectrophotometrically; the area densities of protective C, being produced as seen in fig.2, were determined by their weights. 2) By means of an e-gun, C was sublimed as a protection layer to C/U. Very thick ^{13}C targets of 0.1 to 1 mg/cm^2 resulted from an e-gun evaporation process as well.

High-vacuum evaporation-depositions were applied to fabricate 4416 heavy-ion targets of 52 different kinds: Ag, Ag/^{57}Fe, Ag/polyethylene, Al, Al/glass, Au, Au/C, Bi, CeO_2/C, ^{50}Cr/Mo, Cu, Cu/C, CsJ/C, ^{164}Dy/C, ^{170}Er/C, ^{153}Eu/C, Fe, Ge/Au, Ge/C, Ge/Mo, ^{160}Gd/C, Ir/glass, ^{24}Mg/Ta, Pd/^{24}Mg/Ta, NaF/C, ^{146}Nd/C, Ni, Pb, ^{208}Pb, C/^{206,207,208}Pb/C, Pb/Mo, ^{208}Pb/^{144}Sm, Pd/Ta, Pr_6O_{11}/C, ^{154}Sm/C, ^{120,124}Sn, $^{88}SrF_2$/C, SrF_2/C, Ta, Ta/C, ThF_4/C, C/ThF_4/C, C/U/C, C/$^{235}UF_4$/C, C/$^{238}UF_4$/C, Mo/W/Al, ^{170,173}Yb/C, and ZnS/C.

In time-consuming evaporations a large variety of single targets were produced. A dominant project was the large-scale production of target wheels of C/^{206,207,208}Pb/C of mostly 0.04/400/0.01 mg/cm^2 area densities, a process which has been rationalized during the last few years. It was extended to fabricate also target wheels of Au/C of 400/35 mg/cm^2 with high deposition efficiencies of up to 50% for Au. Nine target frames in the shape of a sector of an annulus are arranged on one wheel at a radius of 155 mm covering a target area of up to 120 cm^2. The wheel is given in a sectional drawing in fig.2. Wheels with targets of C/U/C of typically 0.03/200-400/0.01 mg/cm^2 were prepared using the e-gun evaporation technique. With a new, shielded set-up for the subsequent deposition of ThF_4 or UF_4 and C to C-backings on a rotating wheel within one vacuum cyclus (fig.2), homogeneous target layers and high deposition yields of up to 48% were achieved for ThF_4, $^{235}UF_4$, and $^{238}UF_4$.
The rotating-wheel system is continuously improved.

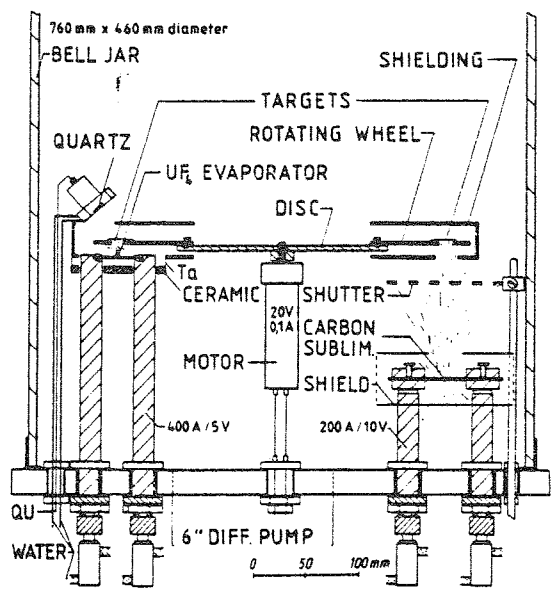

Fig.2. Shielded set-up for the subsequent high-vacuum deposition of ThF_4 or UF_4 and protective C to C-backings of 0.04 mg/cm^2 fixed to a rotating target-wheel.

From: GSI Scientific Report 1986, GSI 87-1, Ed.U.Grundinger, ISSN 0174-0814, p.265.

Investigations of heavy ion targets by proton-backscattering-spectroscopy

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H.Bokemeyer, H.Folger (GSI Darmstadt)

An exact knowledge of the target thickness and its changes caused by heavy ion irradiation is important for the interpretation of heavy ion-atom scattering experiments. Initiated by the experimental finding that the narrow positron lines /1/ might possibly be associated with a sharp resonance a program has been started to investigate the dependence of target thickness and deterioration on various parameters like the method of fabrication, warming up in the heavy ion beam, total flux, relative intensity, etc..

First investigations on the initial conditions and beam induced modifications of a target as for example the drastic change of thickness or chemical composition /2/ have demonstrated that proton backscattering spectroscopy is an adequate tool to study these effects efficiently. Targets of known composition in the thickness range between 100 and 1000 µg/cm² for the active material (U, Th, etc.) are of interest. Thus a moderate mass and depth resolution of protons is sufficient and is in fact counterbalanced by a number of advantages:

- The good proton beam quality of the 2.5 MV van de Graaff accelerator of the IKF allows short measuring periods of 5 min. per point (30 nA , 0.3x0.3 mm), 300 µg/cm² target).
- Protons of 1.6 MeV have the advantage to effectively enhance the backscattering signal from light elements (backing foil, cover foil, chemical constituents).

Thus a sufficiently accurate information can be obtained also for these target components while accumulating the signal from the heavy element to good statistical accuracy.

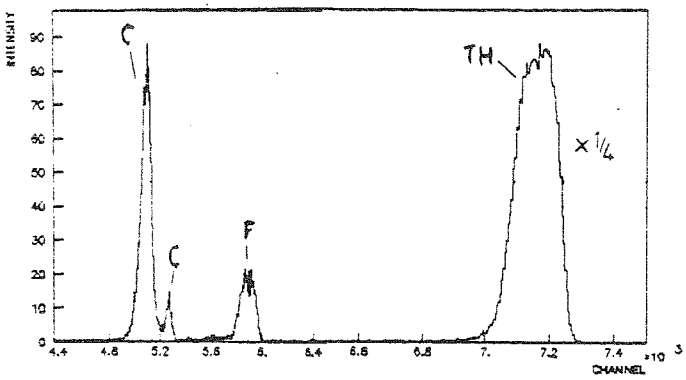

Fig. 1: Proton backscattering spectrum of a non irradiated ThF_4-target.

In Fig. 1 a non irradiated ThF_4-target is shown as it is now used in the positron experiment. The spectra are analysed by using two independent sets of information:

- the peak integrals
- the peak energies, widths and slopes.

From the peak integrals the total amount of target material integrated over the proton beam spot is calculated. Analysis of peak widths and slopes leads to energy-loss profiles of the target. A comparison between total thickness and the thickness calculated from the energy-loss profile allow to deduce a quite detailed model about the target shape and microscopic homogeneity. For non irradiated evaporated targets those thickness values agree within 5% and generally confirm those given by the GSI target laboratory. As a demonstration of sensitivity of the method an evaporated metallic uranium target sandwiched between two thin carbon layers is shown in fig. 2a . An oxygen component from the oxidation of the uranium is clearly visible. In fig. 2b the oxygen peak is displayed in an expanded scale. The form of this peak resembles the relative amount of oxygen per depth unit in the uranium layer. A clear density gradient from both sides towards the middle of the uranium layer is observed. At the same time the low-energy slope of the uranium peak becomes flatter compared e.g. to thorium peak of fig. 1. This indicates that the oxidation leads to a reformation of the microscopic structure which destroys the generally very homogenious microscopic distribution of the evaporated layers.

At an energy resolution of 6 keV the method can be applied down to thicknesses of 65 µg/cm² whereas the determination of the total target thickness, integrated over the beam spot, of course, can be traced down to very small contributions (limited only by the background countrate).

To apply this method as a standard technique a permanent experiment has been set up at the IKF 2.5 MV accelerator.

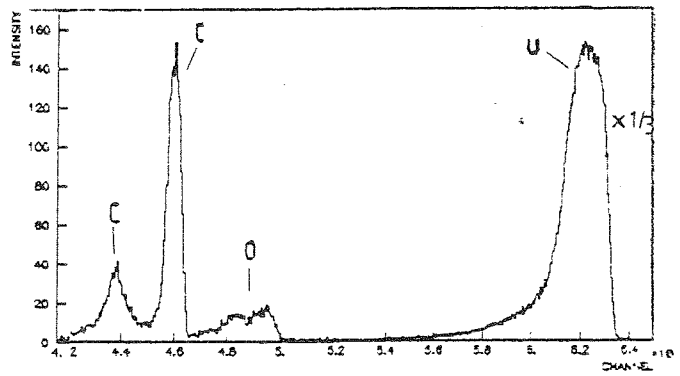

Fig.2a: Proton backscattering spectrum of a metallic ^{238}U-layer evaporated on a 35µg/cm² C-backing covered by another C-layer (5µg/cm²).

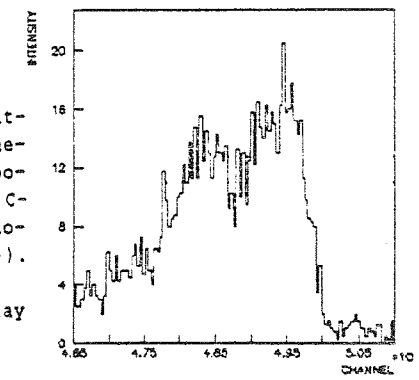

Fig.2b: Expanded display of the ^{16}O peak

In order to handle a large number of targets, the spectra are analysed using a computer program which facilitates the OFF-LINE analysis of the data. The program pursues a peak find algorithm, calculates the total thickness of the target layers (from intensity) and the energy-loss profiles, and converts the energy-loss scale into element specific depth scales. A graphical display of measured of calculated thickness can be chosen.

A computer controlled positioning of the target has now been installed to scan the target automatically. The positioning will then be operated ON-LINE together with the fast pre-analysis.

/1/ Schweppe et al. , Phys.Rev.Lett. 51 (1983) 2261
/2/ IKF Annual Report (1985) p.37

From: GSI Scientific Report 1986, GSI 87-1, Ed.U.Grundinger, ISSN 0174-0814, p.266.

ACTIVITY REPORT

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Further modifications have been made to the laboratory's fine beam saddle field ion sources to improve system stability and reduce HV breakdown. Targets of HfO_2, La, Nd, Os, Pt, Th and W have all been successfully produced by these sources. It has been found that foils greater than 1 mg/cm^2 tended to peel from the backings during deposition or else break the thin carbon foils supporting them. No attempt has been made so far to thermally stress relieve the foils during deposition.

An ultra-clean, hydrocarbon-free vacuum system has been designed and is now fully operable. The system is rough pumped by means of a carbon vane pump and cooled molecular sieve, followed by a cryogenic pump resulting in a final system base pressure less than 5×10^{-5} Pa. This system will be used for the preparation of clean, hydro-carbon free nuclear targets either by vacuum evaporation or ion-beam sputtering.

Targets Produced

Targets listed below have been prepared in the target laboratory during the year. Over 280 targets have been produced by various techniques, including vacuum evaporation, ion-beam sputtering, cold rolling and pressing.

Target	Starting	Method	Backing	Target Thickness ($\mu g/cm^2$)
Au	Au	a	C & SS	2-1000
BaCl	BaCl	a	C	100
^{130,138}BaCl	$Ba(NO_3)_2$	a	C	2-40[d]
C	C	a	SS	2-80
^{48}Ca	$CaCO_3$	a	C	100[e]
Ce	Ce	a	Gd foil	1000
$Ba^{35,37}Cl$	BaCl	a	C	150
^{168}Er	Er_2O_3	c	SS	1500
$^{176,177,178,180}HfO_2$	HfO_2	g	C	1000
In	In	a	Cu & Bi foil	100-25000
La	La	g	C	10
^{6,7}Li	Li	a	C	15-45
LiCl	LiCl	a	C	100
NaCl	NaCl	a	C	100
^{150}Nd	Nd_2O_3	c	SS	2000
^{144}Nd	Nd_2O_3	g	Cu foil	1000
^{192}Os	Os	g	C	20
^{208}Pb	Pb	h	SS	1000
$PbCl_2$	$PbCl_2$	a	C	100
^{192,194,196}Pt	Pt	a	C	1-100
^{196}Pt	Pt	g	SS	100
^{198}Pt	Pt	h	SS	1500
$Ag_2{}^{32}S$	^{32}S	a	C	100[f]
^{144,149,150}Sm	Sm_2O_3	c	SS	1000-3000
^{150}Sm	Sm_2O_3	a	C	30
$Si^{18}O_2$	$Si^{18}O_2$	a	C	100
^{130}Te	Te	a	S	1500
^{232}Th	Th	a	C	400
^{182}W	W	g	Fe foil	1000
$^{90}ZrO_2$	ZrO_2	a	C	2-5

a. Vacuum evaporation.
b. Cold rolling between stainless steel plates.
c. Reduction of the oxide using Th or La and simultaneous vacuum evaporation of the resulting metal. Metal condensed, collected, and cold rolled between stainless steel plates.
d. Barium nitrate chemically converted to barium chloride which was vacuum evaporated.
e. Carbonate converted to oxide which was reduced to the metal by mixing with Y powder. Metal then evaporated.
f. Silver film evaporated onto carbon backing. When heated in a sulphur atmosphere the silver film was converted to Ag_2S.
g. Sputtered using fine beam saddle field ion source.
h. Cold rolled between stainless steel plates.

ANNUAL REPORT

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Most of the 200 targets prepared in our laboratory are reported in the following table.

Target chemical form	Starting materiel	Backing	Preparation method	Thickness ($\mu g/cm^2$)
^{107}Ag	Ag	ss*	Rolling	1000
		Pb	Sticking by rolling	
C	C	ss	Arc evaporation	5-200
	C_2H_4	+ collodion	Cracking and slacking	5-10
^{116}Cd	CdO	Pb	Electrolytic reduction Rolling - sticking by rolling	1000
$^{161,162,163,164}Dy$	Dy_2O_3	Au 0.1 mm	Reduction with Th + evaporation 1)	700-6000
^{168}Er	Er_2O_3	ss	Reduction with Th + rolling	700
Fe ferro-magnetic	Fe	Ag	Evaporation	600-2000
Gd ferro-magnetic	Gd	Ag	Rolling + annealing	2000-3000
^{156}Gd	Gd_2O_3	ss	Th reduction + rolling	600
^{76}Ge	GeO_2	ss	H_2 reduction + evaporation	300-1000
^{24}Mg	MgO	ss	Th reduction + rolling	300

.../...

$^{144, 146, 150}Nd$	Nd_2O_3	ss Pb	Th reduction + rolling Sticking by rolling	300-800
$^{58, 60, 62}Ni$	Ni	ss	Rolling	500
$^{106, 110}Pd$	Pd	ss Au	Rolling Sticking by rolling	450-1500
^{208}Pb	$Pb(NO_3)_2$	ss	H_2 reduction + evaporation	1000
Sc	Sc	ss	Rolling	500
$^{80, 82}Se$ 2)	Se	sandwich Au	Evaporation	300
$^{144, 148, 150}Sm$	Sm_2O_3	ss Au	Th reduction + rolling Sticking by rolling	400
$^{120, 122, 124}Sn$	SnO Sn	ss Au	H_2 reduction + evaporation Rolling	300-1200 1200-2000
^{125}Te 2)	Te	Pb C sandwich	Evaporation	300-1000
^{89}Y	Y	ss	Rolling	350
^{176}Yb	Yb_2O_3	ss	Th reduction + rolling	700

* self-supporting

1. The sticking method doesn't work for the Dy.
2. To avoid the Se or Te evaporation under the beam, this target has been prepared as a sandwiche between C or Au layers.

$Fe_2{}^{13}C$, $Fe^{34}S$, $Cd^{80}Se$ sputter targets for the MP ion source have also been prepared.

SAMPLES AND TARGETS FOR NUCLEAR MEASUREMENTS DELIVERED BY CBNM DURING 1986

J. VAN AUDENHOVE and J. PAUWELS

830 **samples and targets** were delivered covering 41 different requests. Details are given in Table 1. Films and foils were prepared by electrolysis, electrospraying, vacuum deposition, cathodic sputtering or centrifugation. Alloys with accurately defined composition or bulk samples were produced by melting - including levitation melting - rolling, powder metallurgy and conventional machining.

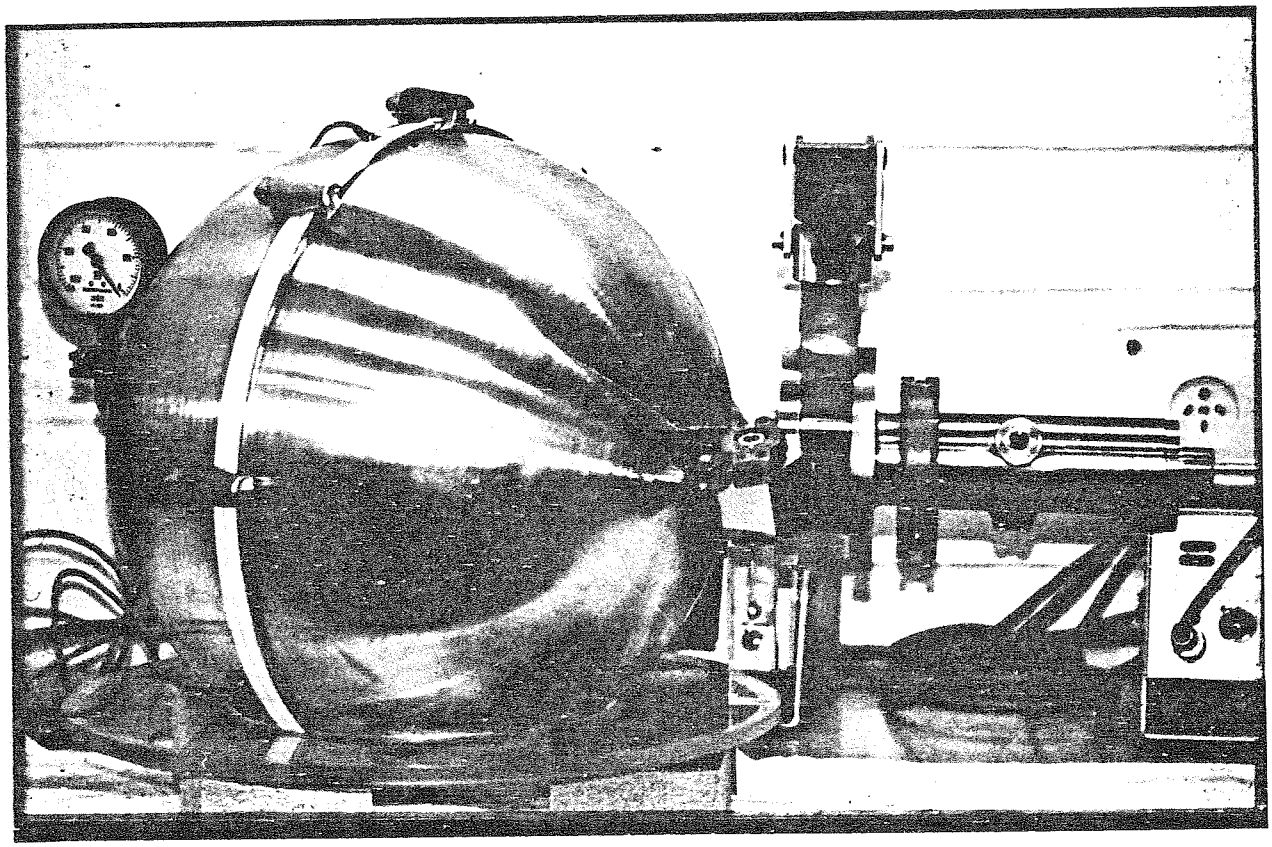

Fig. 1. View on the aluminium sphere; the inner surface is coated with $^{239}PuF_3$

Table 1. Samples delivered during 1986

Materials	Applicants (See list (a))	Number of Samples	Definition Method (See List (b))	Preparation Method (See List (c))
Al - 1 % Ag	(1)	2	QA	LM - R
Al - 0.1 % Co	(1)	2	QA	LM - R
Al - 1 % Co	(1)	2	QA	LM - R
Al - 1 % Cu	(1)	2	QA	LM - R
Al - 1 % Mn	(1)	2	QA	LM - R
Al - 1 % Au	(2)	3	QA	LM - R - WD
Al - 2 % Co	(2)	3	QA	LM - R - WD
^{241}Am on Al	(3)	2	AC	SU
^{41}Ca on Al	(3)	1	IDMS	SU
Co	(3)	1	DC	M
^{237}Np on Stainless Steel	(4)	12	AC	VD
Polyimide (PI) foils	(5)(3)(6)	43	SF	PC
PI + Au	(3)(7)	619	SF	VD - PC
PI on glass	(8)	2	SF	PC
^{242}Pu on Stainless Steel	(4)	6	AC	VD
^{239}Pu + ^{244}Pu on PI	(3)	1	SF - AC	VD - PC - SO
^{239}Pu on Al	(7)	2	AC	VD
^{239}Pu on Si	(3)	1	AC	SO
^{239}Pu on Ti	(9)	6	AC	SP
^{239}Pu on Ti covered with Ta	(9)	10	AC	SP - CS
^{239}Pu on Ti covered with Ta	(10)	3	AC	SP - CS
^{232}Th on Al	(11)	1	MD	SU
^{232}Th on PI	(6)	2	SF - AC	VD
^{233}U on Al_2O_3	(9)	5	AC	SP
^{233}U on Ni	(12)	1	AC	VD
^{233}U on PI	(9)	4	AC	VD
^{233}U on Ti	(9)	17	AC	SP
^{234}U on Ni	(12)	1	AC	SU
^{235}U - 1 % ^{239}Pu	(3)	30	QA	LM - C - Can
^{235}U on Al	(3)	22	AC	VD
^{235}U on PI	(9)	2	SF - AC	VD - PC
^{235}U on PI + Au	(9)	1	SF - AC	VD - PC
^{235}U on Ti	(9)	6	AC	SP
^{235}U on Ti covered with Ta	(9)	6	AC	SP
^{236}U on Ni	(12)	2	AC	ES
^{238}U on Ni	(12)	1	AC	VD
^{nat}U on Al	(11)	1	MD	SU
^{nat}U on Stainless Steel	(3)	3	AC	VD

(a) List of Applicants

(1)	ECN, Petten	(NL)
(2)	INW, Rijksuniv. Gent	(B)
(3)	CBNM	(B)
(4)	Westinghouse, Hanford	(USA)
(5)	Univ. Mainz	(FRG)
(6)	GANIL, Caen	(F)
(7)	SCK/CEN, Mol	(B)
(8)	Naval Research Inst.	(USA)
(9)	ILL, Grenoble	(F)
(10)	KFA, Jülich	(FRG)
(11)	ULB, Bruxelles	(B)
(12)	Univ. Bonn	(FRG)

(b) List of Definition Methods

QA	Quantitative Alloying
SF	Spectrophotometry
AC	Alpha Counting
MD	Mass Definition
DC	Dimensional Control
IDMS	Isotope Dilution Mass Spectrometry

(c) List of Preparation Methods

LM	Levitation Melting
R	Rolling
WD	Wire Drawing
SU	Suspension Spraying
PC	Polycondensation
SO	Solution Spraying
SP	Spray Painting
CS	Cathodic Sputtering
C	Cutting
Can	Canning
VD	Vacuum Deposition
M	Machining

A special ^{239}Pu mother source for the production of ^{235m}U targets was prepared. One of the major difficulties to study the properties of ^{235m}U is its short half-life ($T_{\frac{1}{2}}$ = 26.1 min), so that an easy to operate system of routine production of appropriate targets installed close to the measuring facility is required. Such a system was realized - in cooperation with and on behalf of SCK/CEN Mol - in the form of a 40 cm diameter aluminium sphere (Fig. 1.) internally coated by vacuum deposition with $^{239}PuF_3$. The ^{235m}U recoils are collected in vacuum on gold coated polyimide foils which are introduced via a movable target holder and are put at a negative potential to increase the collection efficiency. At 1 kV and 1 Pa the number of collected nuclei after one half-life is $8 \cdot 10^9$. Contamination by ^{239}Pu is negligible. The cross-section measurements are carried out at the ILL Grenoble in the frame of an international collaboration involving physicists of SCK/CEN Mol, ILL Grenoble, the University of Tübingen and LASL Los Alamos. A communation on this work was made at the 13th World Conference of the INTDS in Chalk River (Sept. 1986).

Source : CBNM Programme Progress Report 1986 (pp 58 - 60)