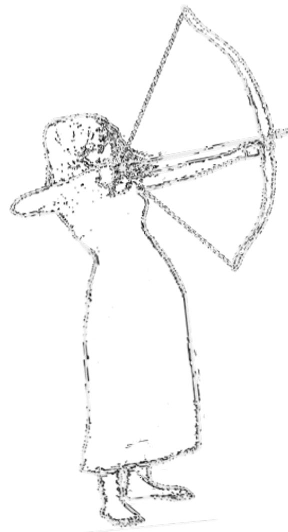
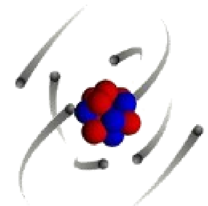
Targets with intermediary thickness.
Are they easy to prepare?

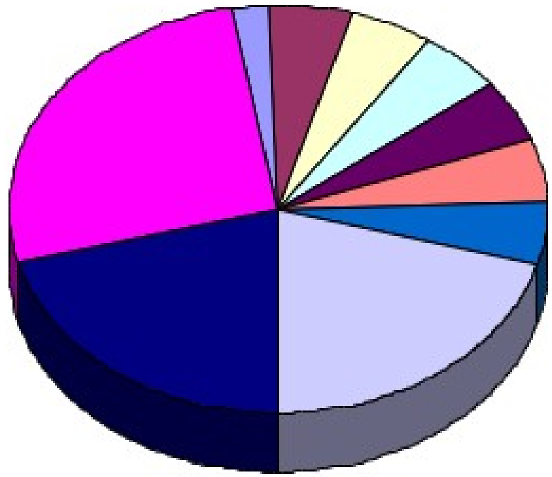




Anna Stolarz

Heavy Ion Laboratory, University of Warsaw

Second Meeting on Targets for Nuclear Physics within EURO-LABS"
May 18-19, 2026



Task 1 – New target materials selection**:**
Task 2 - Exploring new fabrication techniques**:**
Task 3 - Target characterization procedures**:**
Task 4 – Sharing of knowledge:

1	CEA	Saclay, France
2	INFN	TURIN, Italy
3	GSI	GSI, Darmstadt, Germany
4	UNI WARSAW	SLCJ/HIL, Poland
5	CNRS	IJCLab, Orsay, France
6	CNRS	IPHC-Strasbourg, France
7	IFIN-HH	TANDEM, Rumania
8	INFN	LNS, Catania, Italy
9	INFN	LNL, Legnaro, Italy
10	GANIL	GANIL, Caen France

Associated Partners
LIP, Portugal
PSI, Switzerland
Daresbury, Great Britain

HEAVY ION LABORATORY (HIL)

is an interdepartmental unit of the University of Warsaw

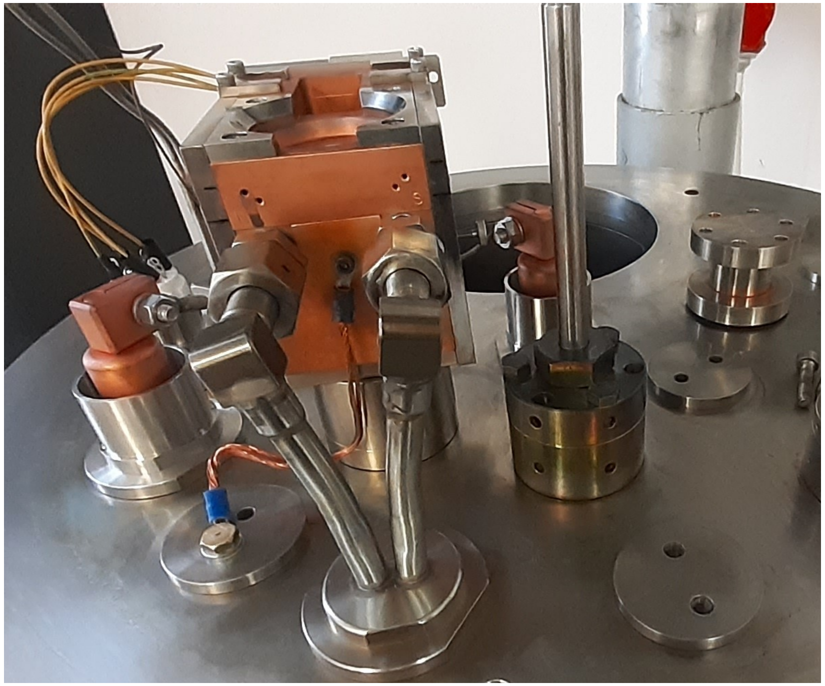
***U-200P heavy ion isochronous cyclotron**,*
accelerating ions up to mass 40 (B to Ar)
to the energies ~10 MeV/A
and Alpha internal beam, 32 MeV

GE PETtrace p/d medical cyclotron
Providing protons or deuterons
(16.5 MeV/ 8 MeV)

Targets preparation techniques:

vapour deposition in the high vacuum
- -resistance heating
- -e-gun

resistance heating



e-gun

Targets preparation techniques:

mechanical reshaping:

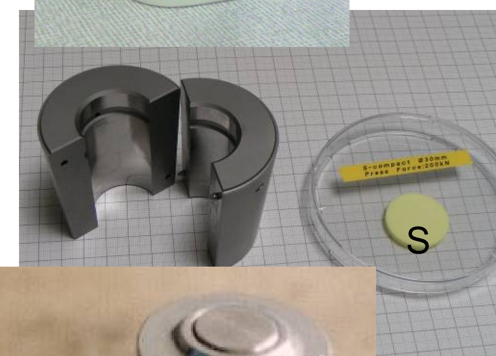
*rolling

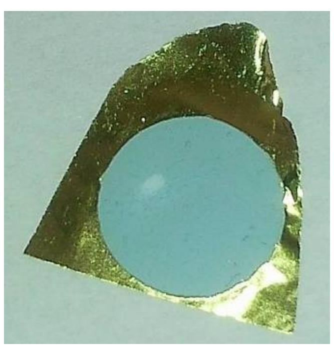
*tablet pressing

~20 mg/cm^2 - > g/cm^2

*sedimentation

~1-2 mg/cm^2- > g/cm^2





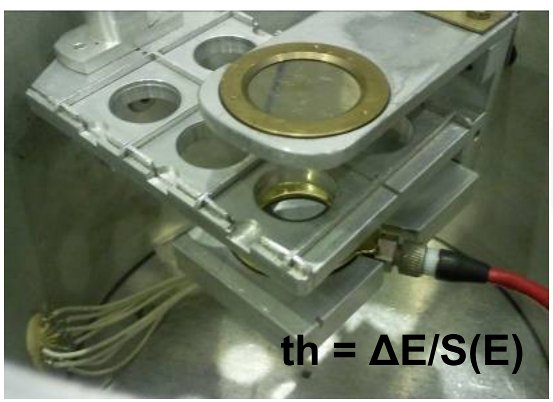
Thickness estimation:

* mechanically or electrically i.e. using caliper, micrometer screw or thickness gauge based on magnetic induction

* weighing the defined area

* in-situ, during the vapour deposition process, using the quartz microbalance

* measurement of the α particles energy loss`



Targets of few mg/cm^2

Not malleable

No added elements accepted
(mixture with third party-element as binder)

No glue - organic components as well excluded due to increasing the content of C and O

Standard loading into the pellet matrix

~27 mg of Er_2O_3 on 12 mm mylar disc

~5 mg of Si on 12 mm Al disc

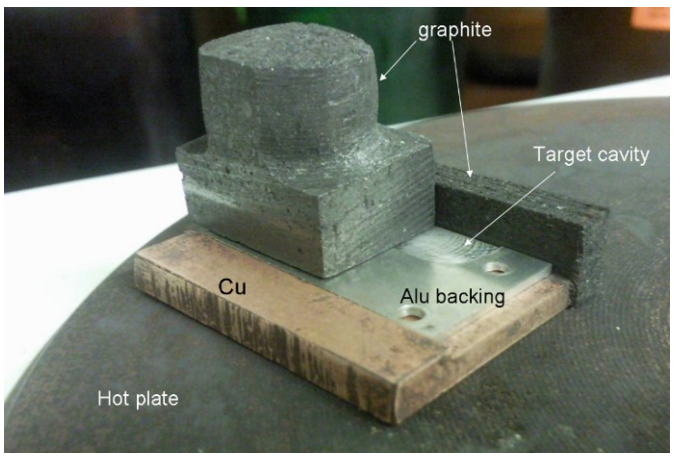
Sc radioisotopes production with protons

CaCO3 nat & isotopic
370 mg/cm^2 -> ~1.3 mm

Targets irradiated with a beam

Targets for At radionuclide production with α particles

$^{209}Bi\ (\alpha,2n)^{211}At$ ~100 mg/cm²

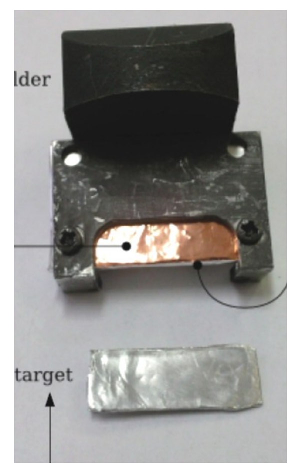


Targets for Sc radionuclides production with α particles

$CaCO_3$ nat & isotopic (108 mg/cm² ≈ 0.4 mm)

1x2.5 cm

* Calcium carbonate distribution over the pre-shaped thin aluminium foil
* wrapping the material in this foil, forming 'candy'
* and pressing with force of ~120-150 bar forming thin but stable layer of the target material.



Sedimentation from solvent

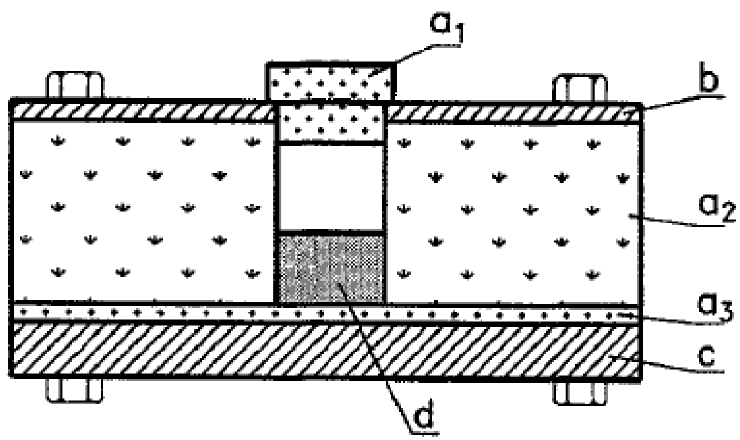
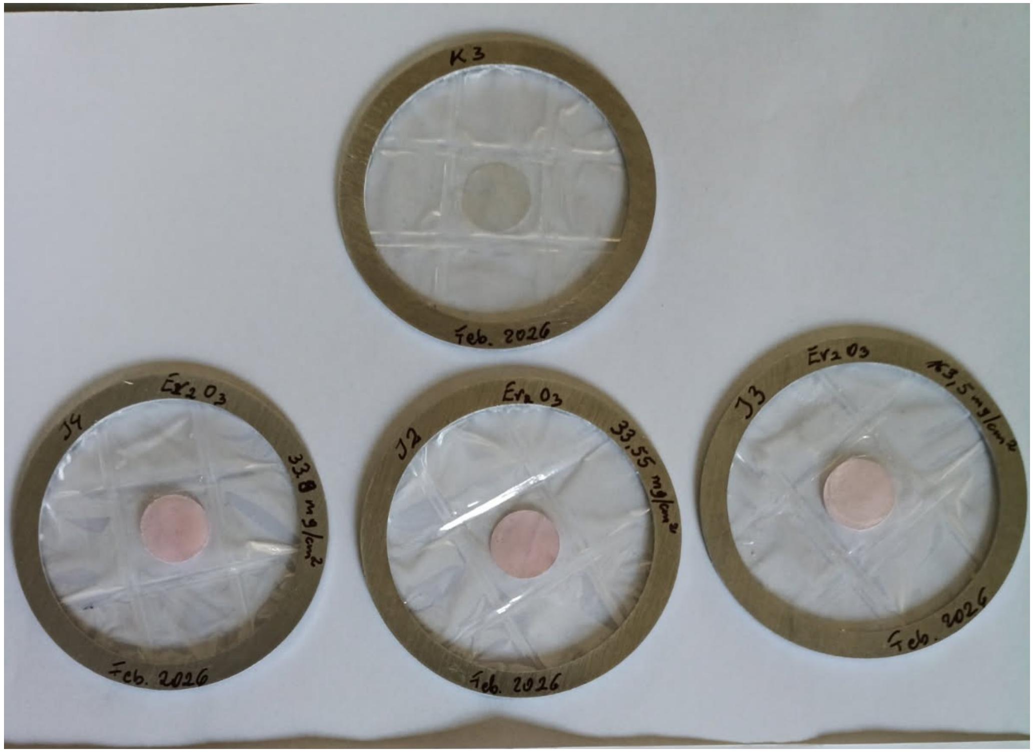


Fig. 1. Teflon vessel used for the gluing method: a – stopper (a_1) vessel wall (a_2) and bottom sheet (a_3) made of Teflon, b – stain less steel, c – aluminium or any rigid material, d – inner cavity

Isotope Target	Thickness [mg/cm2]	Diameter [mm]	Backing
Ru96	29.9	10	None
Ru104	29.7	14	Mylar
Te130	37.8	11	None
W183	40.9	11	None
Os192	65.6	11	None

Sedimentation from solvent

.... and pressing



Er_2O_3 with 35 and 160 mg/cm^2

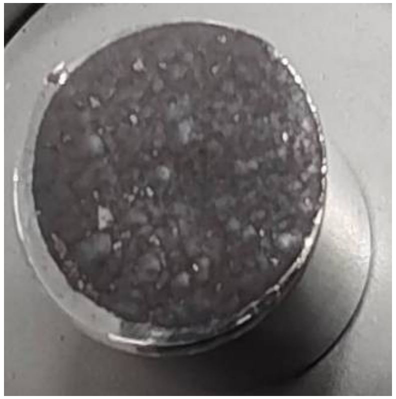
Sedimentation from solvent

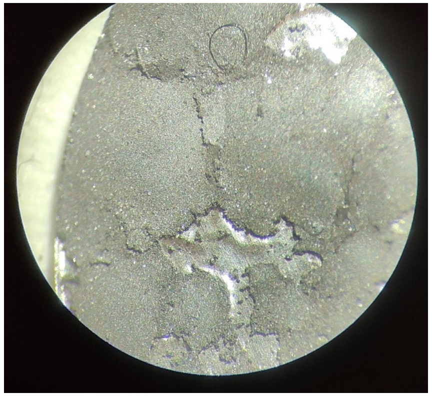
.... and pressing

3 different media

	vapour press	boiling temp
toluene	29 hPa	110.6 ºC
ethanol	60 hPa	78.3 ºC
chloroform	211 hPa	61.2 ºC

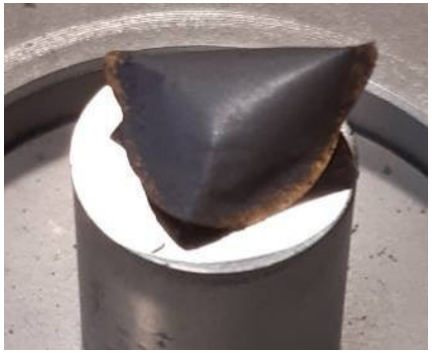
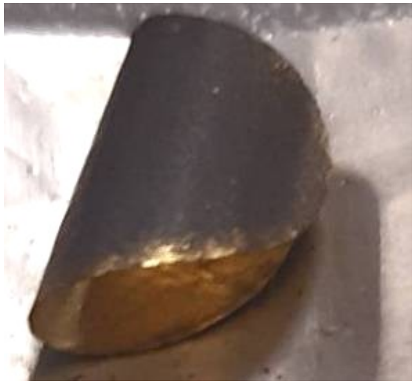
-

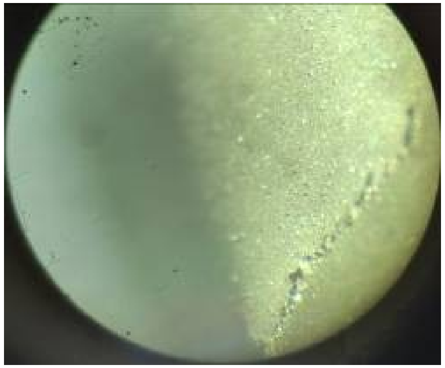




Si deposit by suspension in toluene after pressing

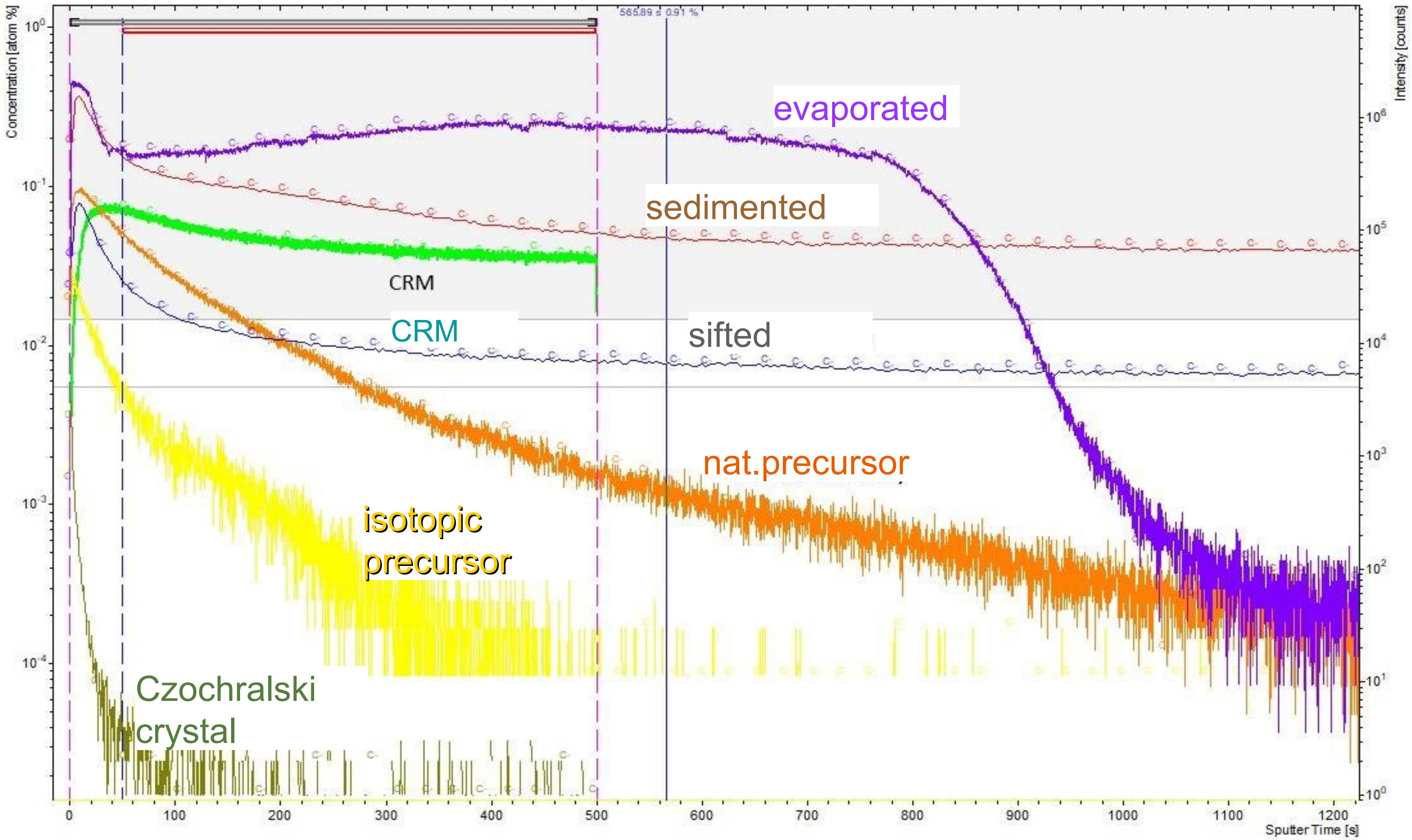
Sifted powder



The C and O content estimation was performed using the Secondary Ion Mass Spectrometry.

Carbon content



sputter time [s]

quick drop of C in the evaporated sample after ~800 s of eatching is due to its thickness (~0.5 mg/cm^2). After this time the backing Ta was already reached

Sample		C content %
Czochralski		0
natural precursor		< 5e-3
isotopic precursor		< 5e-4
Sifted natural		~ 10e-3
Sedimented natural		~ 50e-3
Evaporated ^{28}Si		~ 200e-3

$$\frac{sieved}{nat.\,precursor} = 2$$

$$\frac{sedimented}{nat.\,precursor} = 10$$

$$\frac{evaporated}{nat.\,precursor} = 40$$

On average ~5 mg of isotopic material was used for single target of 3.5-4.5 mg/cm^2

Comparing to thermal methods applied one gives over **300 times** higher efficiency ([Johnstone] 85 mg per 220 μg/cm^2 with e-gun)

or ~50 times (private info: 90 mg for 1.6 mg/cm^2) referring to resistive heating that has more favourable evaporation geometry but is much more „dirty".

The developed method keeps as well the carbon and oxygen content much below 1 % while Johnstone reported 2-3 % of those elements in the final target.

Thank you

INTDS International Nuclear Targets Development Society

EURO-LABS EUROPEAN LABORATORIES FOR ACCELERATOR BASED SCIENCES

Training

- **XVII Heavy Ion Acceleration and Application Workshops**
  - Nationwide training workshops for third- and fourth-year physics students interested in nuclear physics

The students were divided into groups to practice experimental topics:

- *Gamma Spectroscopy*
- *Fast-timing measurement*
- *Target production and its thickness measurement*
- *Study of the effects of ionizing radiation on biological material*
- *Gas/Si telescopes in charge particle spectroscopy.*
- *Neutron measurements*

Each excercise last 5 days and ends with a presentation of the results and their analysis.

Jon	Energia min [MeV]	Energia max [MeV]	Energia max [MeV/nukl]
$^{10}B^{+2}$	51	55	5.5
$^{11}B^{+2}$	40	50	4.5
$^{12}C^{+2}$	38	50	4.2
$^{12}C^{+3}$	53	92	7.7
$^{13}C^{+3}$		90	6.9
$^{14}N^{+2}$	32	50	3.6
$^{14}N^{+3}$	57	91	6.5
$^{15}N^{+3}$		43	2.9
$^{16}O^{+3}$	46	80	5.9
$^{16}O^{+4}$	80	120	7.5
$^{18}O^{+4}$	100	120	6.7
$^{19}F^{+3}$	50	66	3.5
$^{20}Ne^{+3}$	45	68	3.4
$^{20}Ne^{+4}$	68	115	5.8
$^{20}Ne^{+5}$	130	160	8.0
$^{22}Ne^{+3}$	44	55	2.5
$^{24}Mg^{+4}$		77	3.2
$^{32}S^{+5}$	79	110	3.4
$^{32}S^{+6}$	*120(*)*	150	4.7
$^{32}S^{+7}$	*120(*)*	225	7.0
$^{40}Ar^{+6}$	*90(*)*	132	3.7
$^{40}Ar^{+7}$	*130(*)*	164	4.1
$^{40}Ar^{+8}$	*180(*)*	200	5.0

From B to Ar with energy 5-8 MeV/nucl