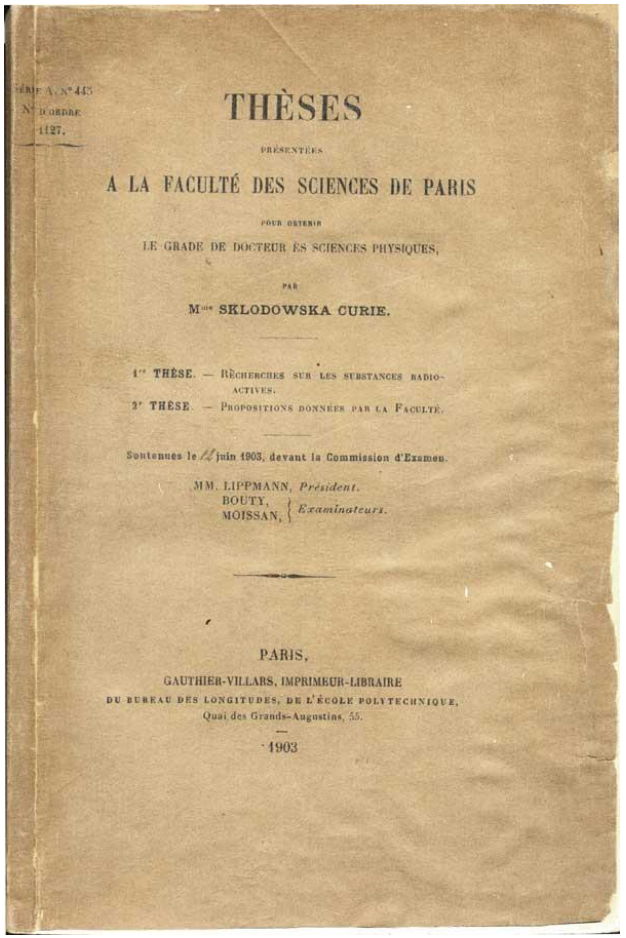
From Accelerators Physics to Nuclear Medicine

Nhât-Tân Vuong

Work Package 1: Mass separation of innovative medical isotopes

1903

Marie Sklodowska-Curie
1867-1934



THÈSES

PRÉSENTÉES

A LA FACULTÉ DES SCIENCES DE PARIS

POUR OBTENIR

LE GRADE DE DOCTEUR ÈS SCIENCES PHYSIQUES,

PAR

Mme SKLODOWSKA CURIE.

1re THÈSE. — RECHERCHES SUR LES SUBSTANCES RADIO-ACTIVES.

2e THÈSE. — PROPOSITIONS DONNÉES PAR LA FACULTÉ.

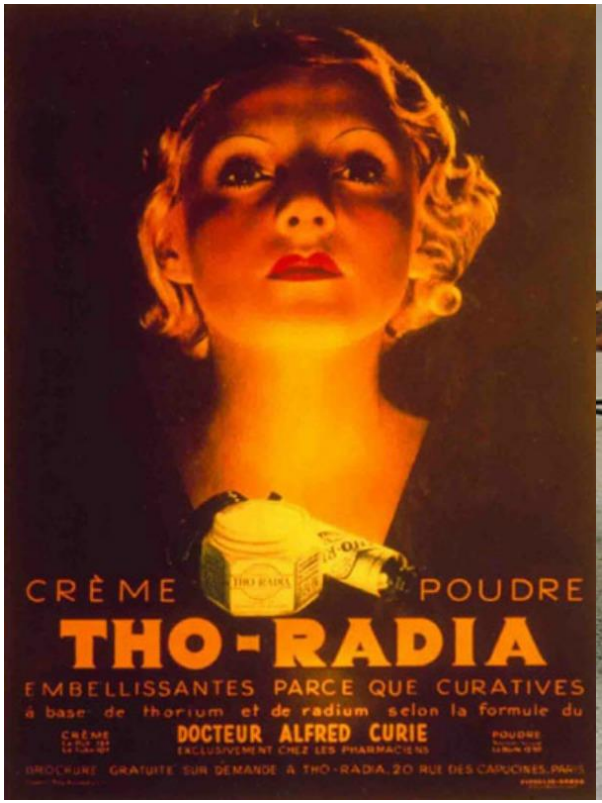
Soutenues le 25 juin 1903, devant la Commission d'Examen.

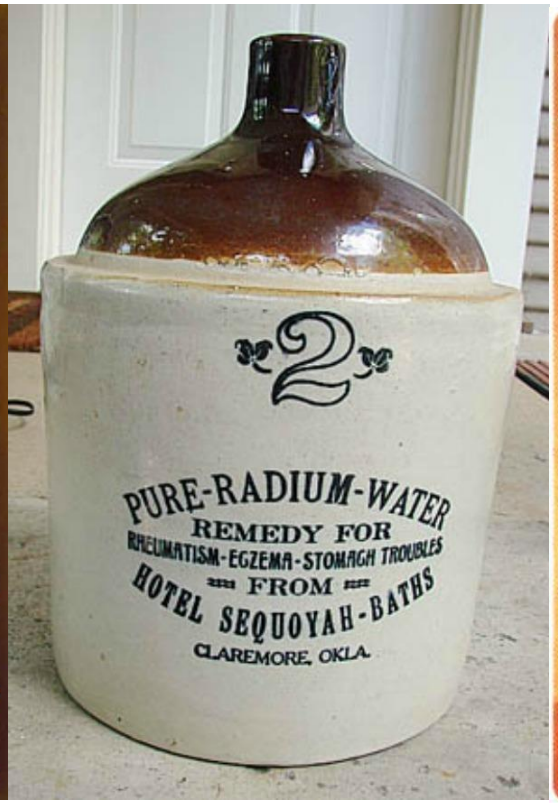
MM. LIPPMANN, *Président.*
BOUTY,
MOISSAN, } *Examinateurs.*

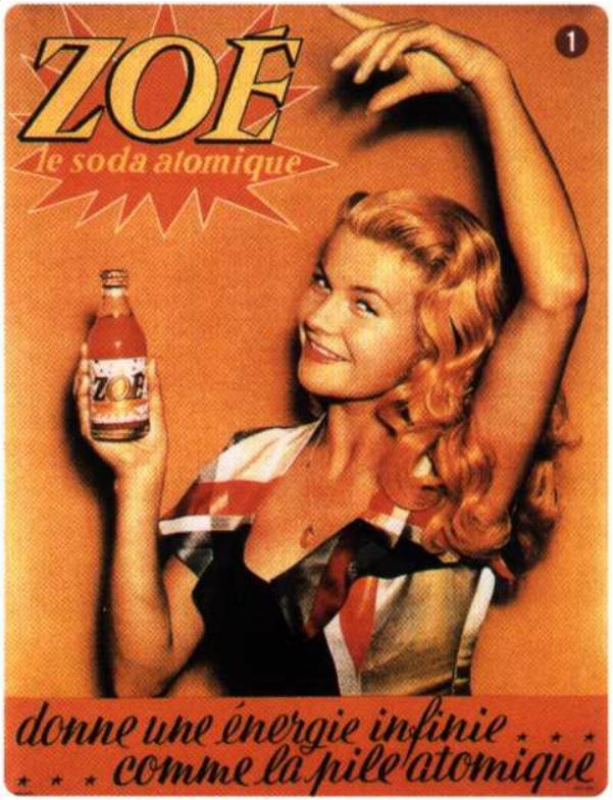
PARIS,

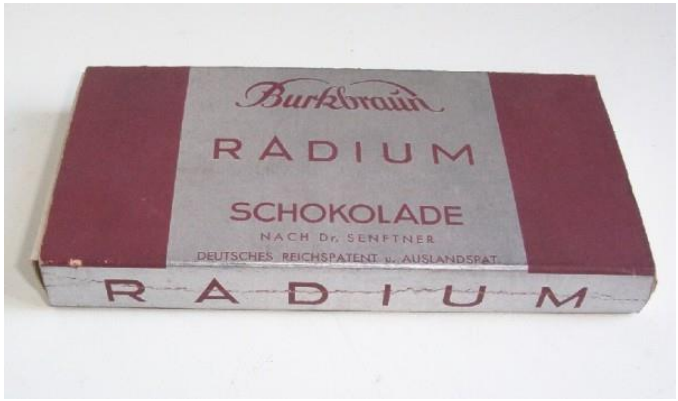
GAUTHIER-VILLARS, IMPRIMEUR-LIBRAIRE
DU BUREAU DES LONGITUDES, DE L'ÉCOLE POLYTECHNIQUE,
Quai des Grands-Augustins, 55.

1903

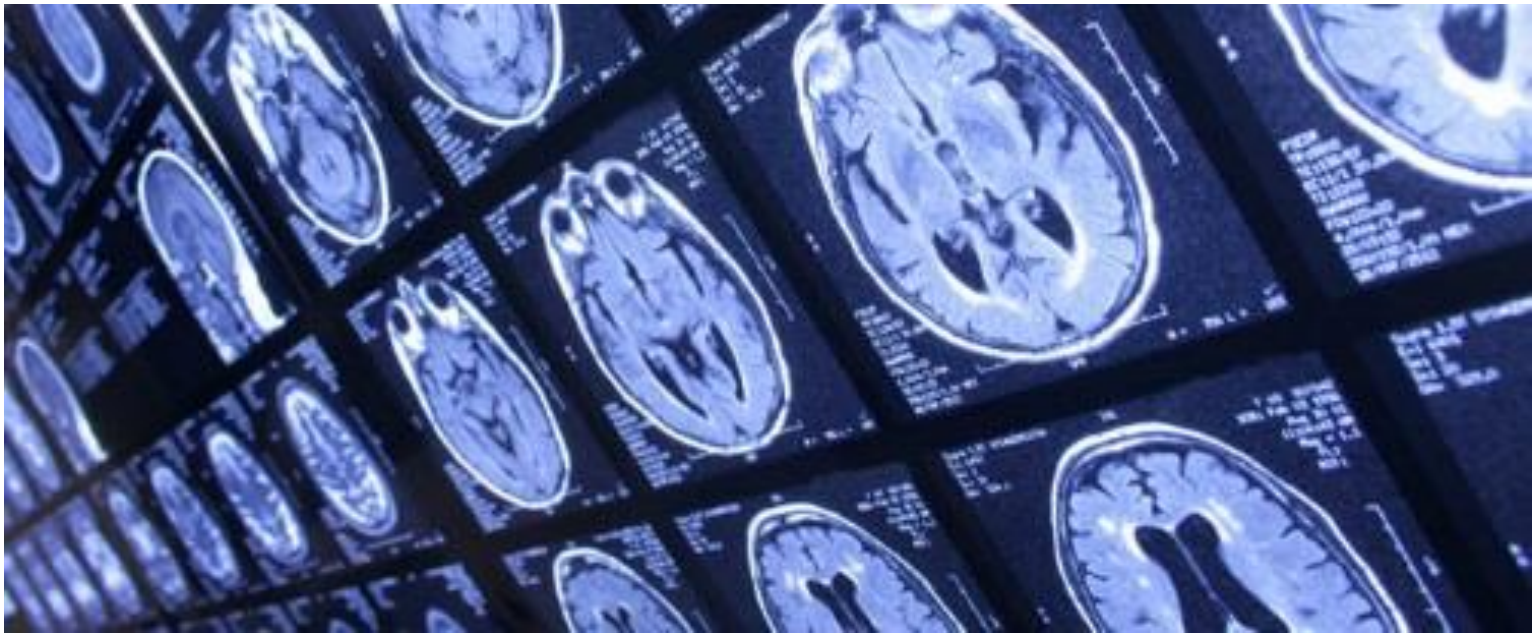

CRÈME
POUDRE
THO-RADIA
EMBELLISSANTES PARCE QUE CURATIVES
à base de thorium et de radium selon la formule du
DOCTEUR ALFRED CURIE
EXCLUSIVEMENT CHEZ LES PHARMACIENS
BROCHURE GRATUITE SUR DEMANDE A THO-RADIA, 20 RUE DES CAPUCINES, PARIS


2
PURE-RADIUM-WATER
REMEDY FOR
RHEUMATISM-EGZEMA-STOMACH TROUBLES
FROM
HOTEL SEQUOYAH-BATHS
CLAREMORE, OKLA.


ZOÉ
le soda atomique
1
donne une énergie infinie
comme la pile atomique


Burkbraun
RADIUM
SCHOKOLADE
NACH Dr. SENFTNER
DEUTSCHES REICHSPATENT u. AUSLANDSPAT.
RADIUM

Nuclear Medicine



Medicis-Promed

An Innovative Training Network

Biology

Radiochemistry

Engineering

Physics

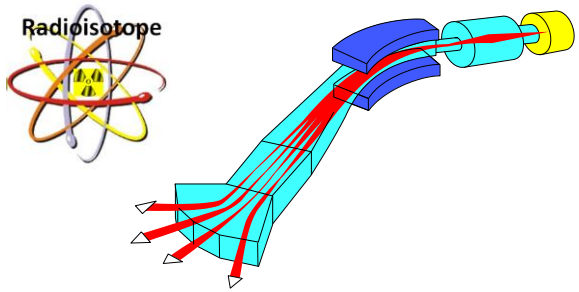
Medicine

MARIE CURIE ACTIONS

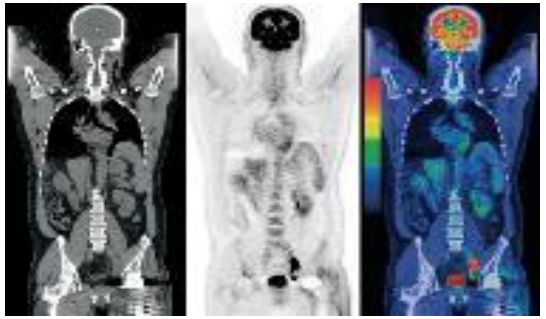
The scope of the MEDICIS Project

^{11}C based hadron therapy

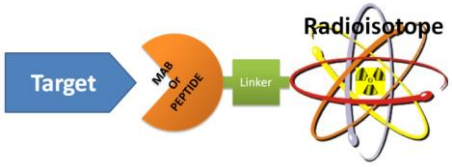
Production of innovative radioisotopes



Diagnostic Imaging
Personalized Treatment of Cancer



Development of Radiopharmaceuticals



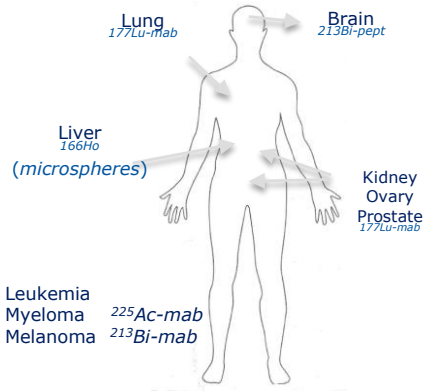
Innovative isotopes

Medical Application	Isotope half-life	Parent isotope beam	Target ion source	ISOLDE † In-target Production rate (pps)	ISOLDE † In-target Activity$_{EOB}$ (Bq)	RIB ε_{ext} ** (%)	CERN-MEDICIS † In-target Activity$_{EOB}$ (Bq)	CERN-MEDICIS † Extracted Activity#$_{EOB}$ (Bq)	CERN-MEDICIS 2GeV 6 µA Possible gain ε_{ext} (%)	CERN-MEDICIS 2GeV 6 µA In-target Activity$_{EOB}$ (Bq)	CERN-MEDICIS 2GeV 6 µA Extracted Activity#$_{EOB}$ (Bq)	Comments
α,β therapy/ SPECT/	^{213}Bi 45.6 m	^{225}Ac	UC_X-Re	1.5 E9 *	7.2 E8	^{221}Fr 10	2.8 E8	2.8 E7	50	8.4 E8	4.2 E8	Only mass separation
α,β therapy	^{212}Bi 60.6 m	^{224}Ac	UC_X-Re	1.5 E9*	1.4 E9	^{220}Fr 10	1.7 E9	1.7 E8	50	5.1 E9	2.5 E9	Only mass separation
β therapy	*^{177}Lu 6.7 d*	*^{177}Lu RILIS/VD*	*Ta-Re/ Re-VD5*	*3.3 E9*	*7.4 E8*	*^{177}Lu 1*	*6.4 E8*	*6.4 E6*	*20*	*8.3 E8*	*1.7 E8*	*Chemical purification*
Auger therapy	^{166}Yb 56.7 h	^{166}Yb	Ta-Re	1.4 E10	5.4 E10	^{166}Yb 5	4.1 E10	2.1 E9	20	5.4 E10	1.1 E10	Chemical purification
β therapy	*^{166}Ho 25.8 h*	*^{166}Ho*	*Ta-Re*	*1.4 E7*	*1.2 E7*	*^{166}Ho 5*	*9.6 E6*	*4.8 E5*	*20*	*2.9 E7*	*6.0 E6*	*Chemical purification*
β therapy /Auger therapy	*^{161}Tb 6.9 d*	*^{161}Tb*	*UC_X-Re*	*2.1 E7*	*2.7 E7*	*^{161}Tb 5*	*1.9 E7*	*9.5 E5*	*20*	*2.7 E7*	*5.4 E6*	*Chemical purification*
PET	*^{156}Tb 5.35 d*	*^{156}Tb*	*Ta-Re*	*2.5 E8*	*8.9 E7*	*^{156}Tb 1*	*5.5 E7*	*5.5 E5*	*20*	*6.3 E7*	*1.3 E7*	*Chemical purification*
SPECT/ CT diagnosis	^{155}Tb 5.33 d	^{155}Dy/ Tb	Ta-Re	3.2 E9/ 7.4 E8	7.9 E9	^{155}Dy 1	5.3 E9	5.3 E7	20	3.4 E9	6.8 E8	RILIS Dy
β therapy	^{153}Sm 46.8 h	^{153}Sm	UC_X-Re	1.5E8	2.2 E9	^{153}Sm 5	2.8 E9	1.4 E8	20	5.2 E9	1.0 E9	Chemical purification
PET/CT	^{152}Tb 17.5 h	^{152}Dy/ Tb	Ta-Re	1.3 E10/ 3.3 E9	5.6 E10	^{152}Dy 1	3.7 E10	3.7 E8	20	1.1 E11	2.2 E10	RILIS Dy
α therapy	^{149}Tb 4.1 h	^{149}Tb	Ta-Re	1.1 E10	6.0 E10	^{149}Tb 1	3.8 E10	3.8 E8	20	1.2 E11	2.4 E10	Chemical purification

and many others…*

*** CERN-MEDICIS : A New Facility. R.S. Augusto *et al***

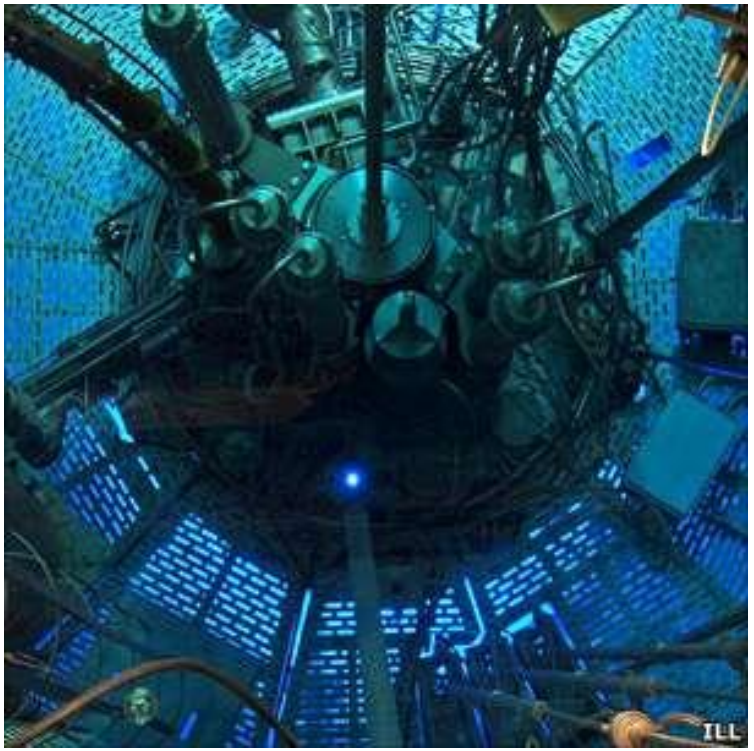
C. Muller et al.
jnumed.112.107540v1



Isotope production

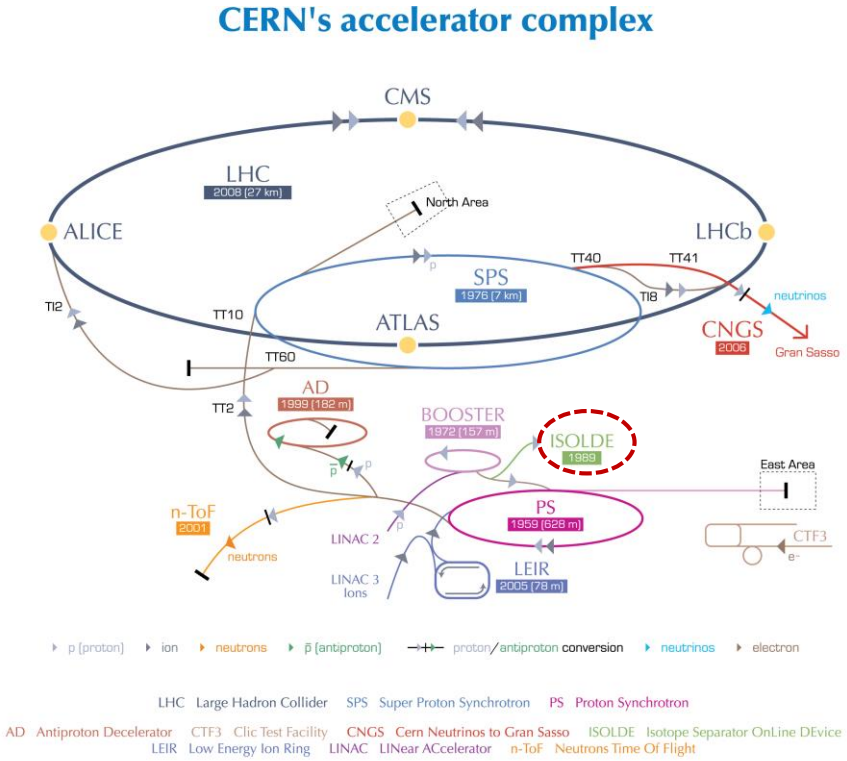
Isotope production

Cyclotron. Arronax, Nantes FR

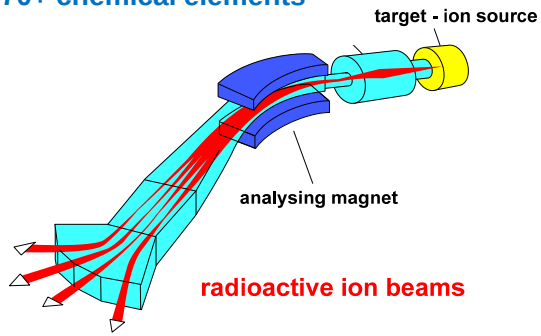


Nuclear reactor. ILL, Grenoble FR

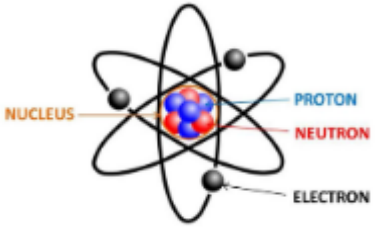
CERN



1000+ isotopes
of 70+ chemical elements

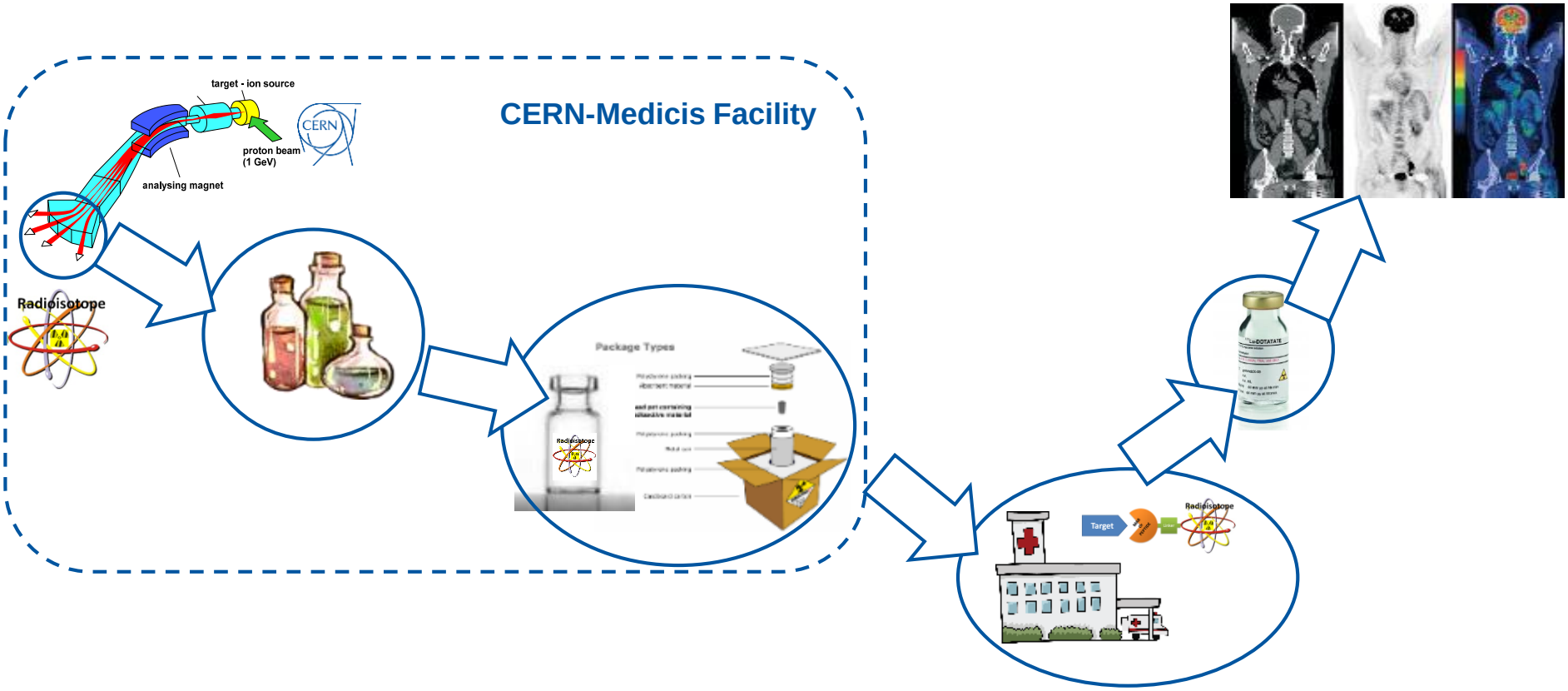


Nuclear Physics

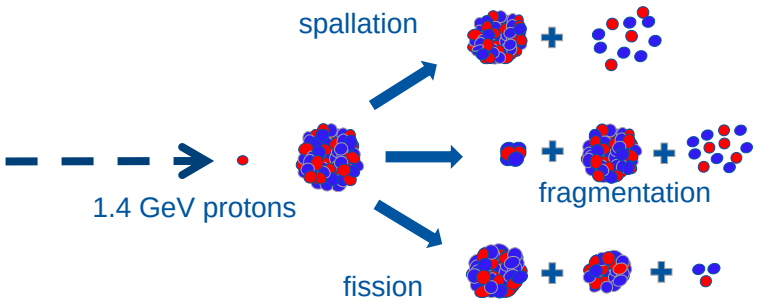


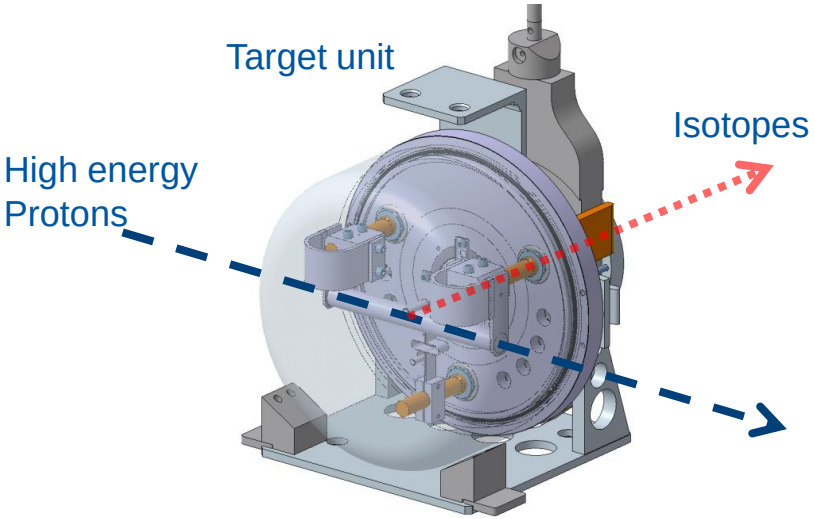
CERN-MEDICIS: a new facility

From Accelerator Physics to Nuclear Medicine



Production of isotopes



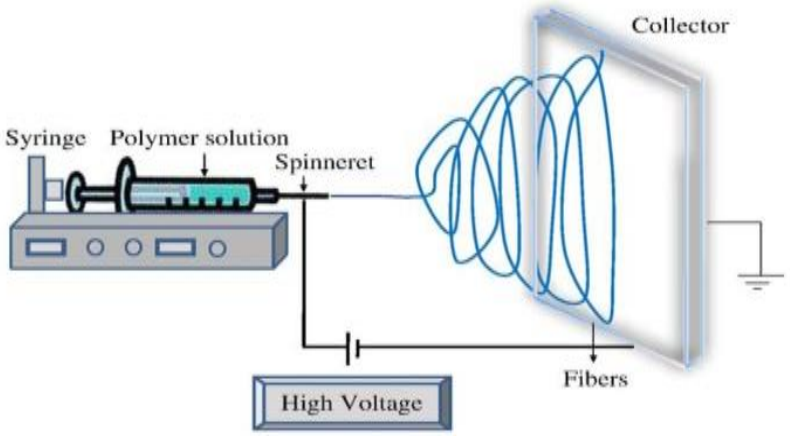


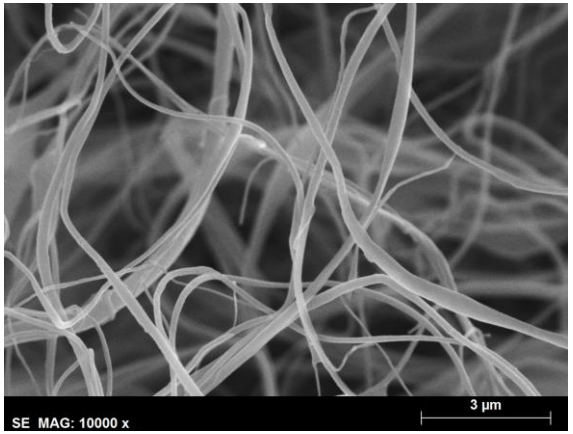
Example of target materials

UC_2 pellets

Ta rolls

Nano-fibrous target material

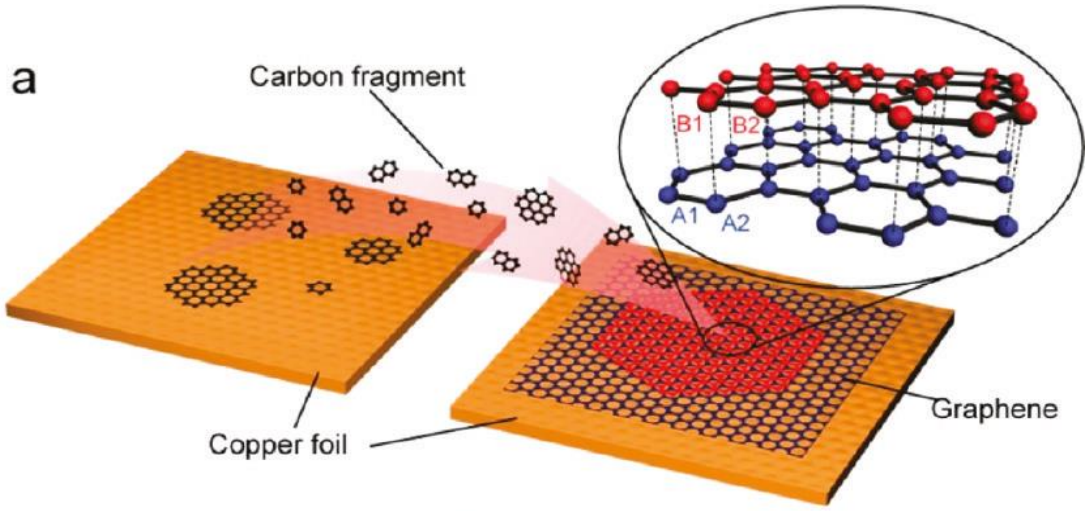




Y-ac. nanofibers

- Sanjib Showdhury - Portugal - Instituto Superior Técnico

Graphene coated target material



- Marina Nazarova - UK - University of Manchester

Radioactive waste

UC_2 pellets

U_3O_8

M. Marchand et al./Journal of Nuclear Materials 437 (2013) 310–316

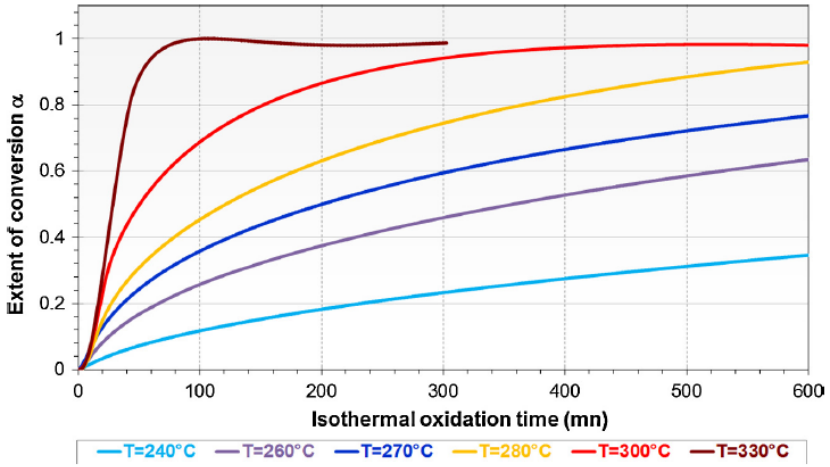
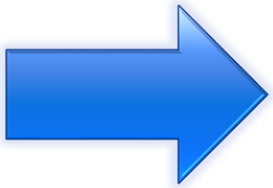


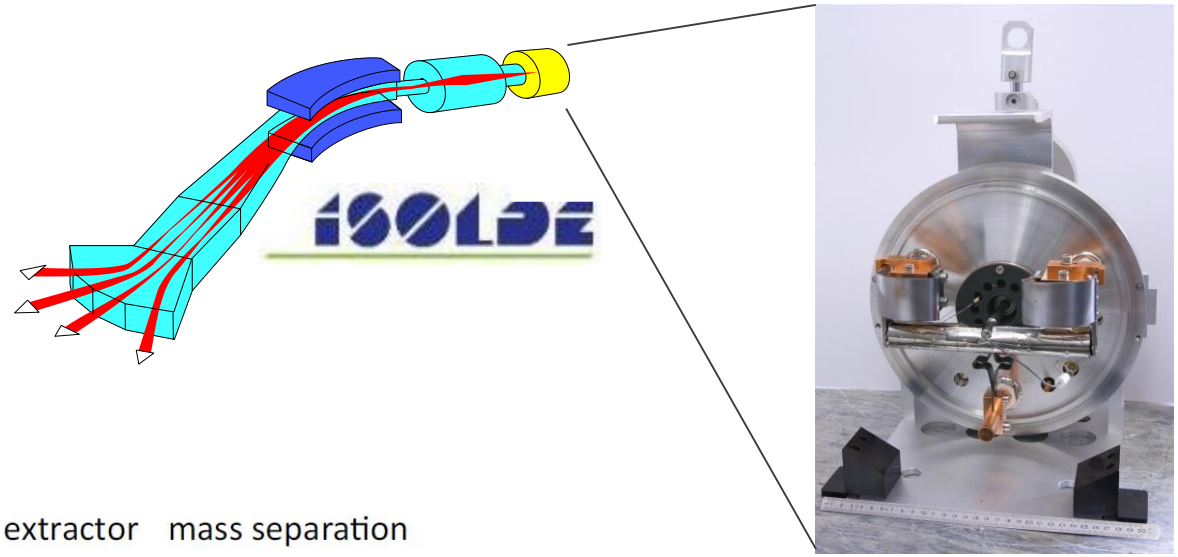
Fig. 2. Isothermal weight gain curves versus time during oxidation of UC_2.

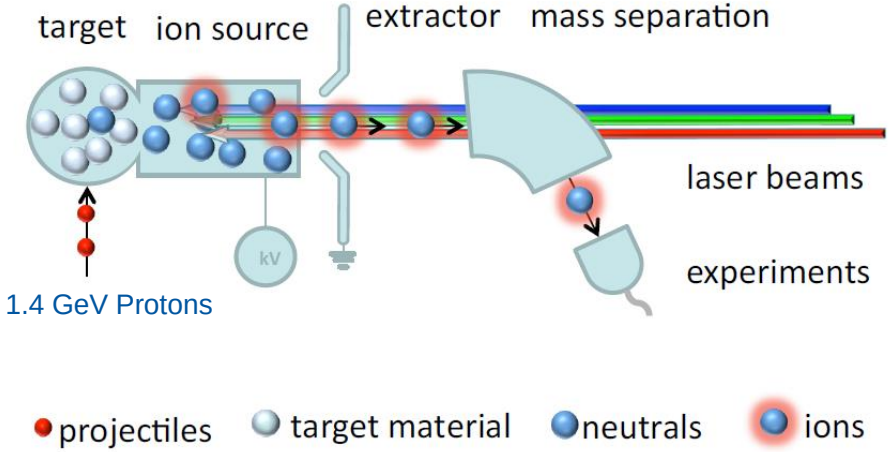


PAUL SCHERRER INSTITUT

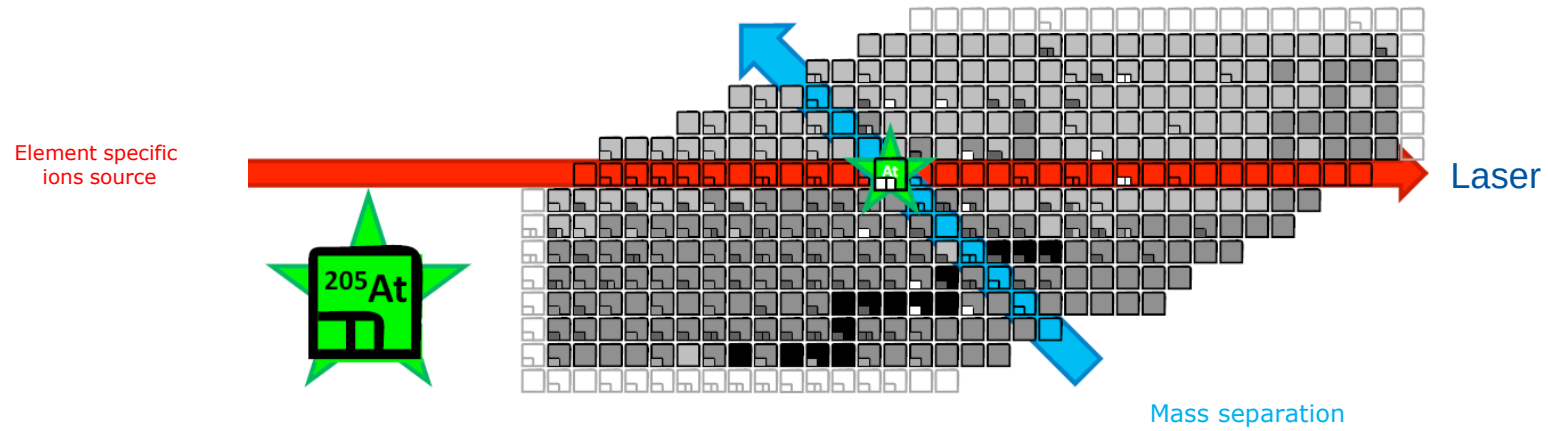
PSI

Isotope Separator On-Line (ISOL)

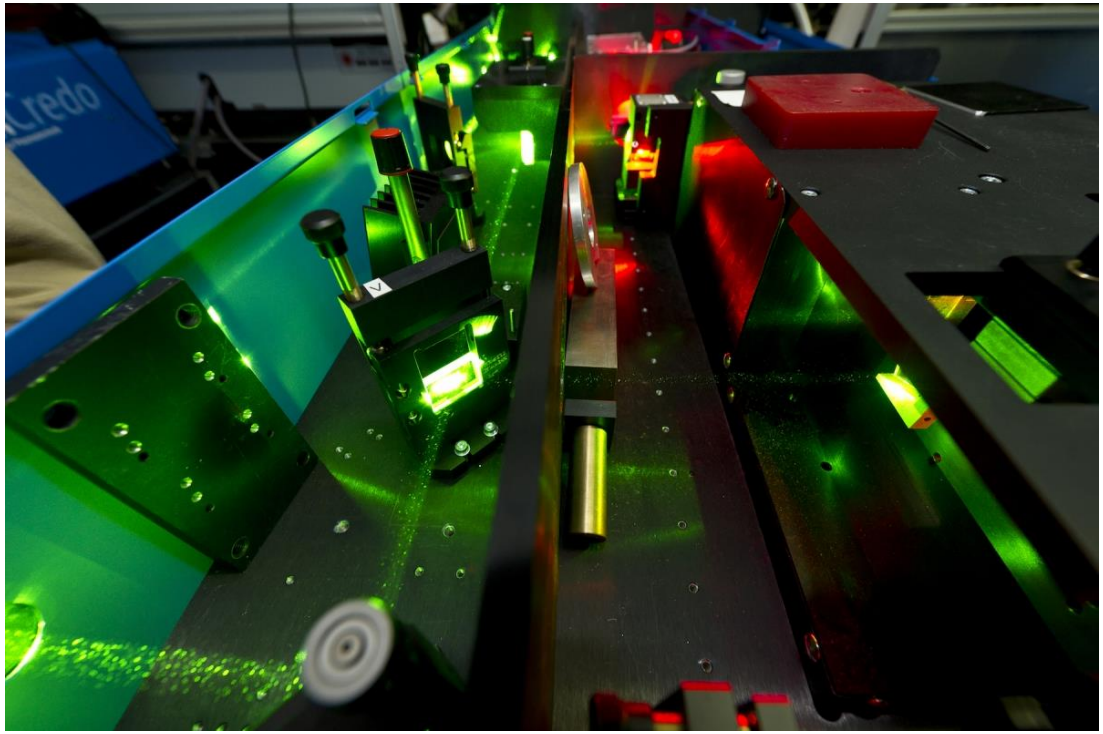




Isotope separation



High purity laser ionization scheme



RILIS at CERN

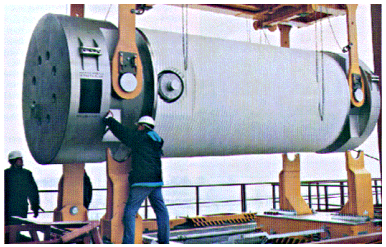
- Vadim Gadelshin - Germany - Johannes Gutenberg-Universität Mainz

Chemical separation

- Nhât-Tân Vuong – Switzerland - CERN

Transportation

Type A package



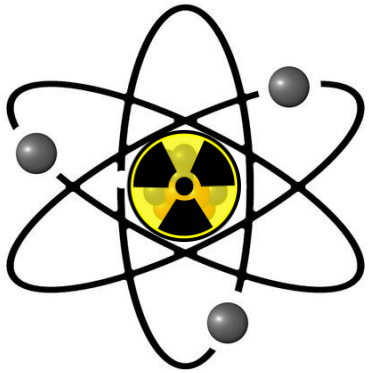
Type B Package

- **larger dimensions, weight and radioisotope volume**
- **Radiopharmaceuticals to radiopharmacies or intermediate processors who prepare unit doses**

- air shipments primarily but also road

- Maddalena Maietta - France - Lemer Pax

THANK YOU



“This research project has been supported by a Marie Skłodowska-Curie Innovative Training Network Fellowship of the European Commission’s Horizon 2020 Programme under contract number 642889 MEDICIS-PROMED”