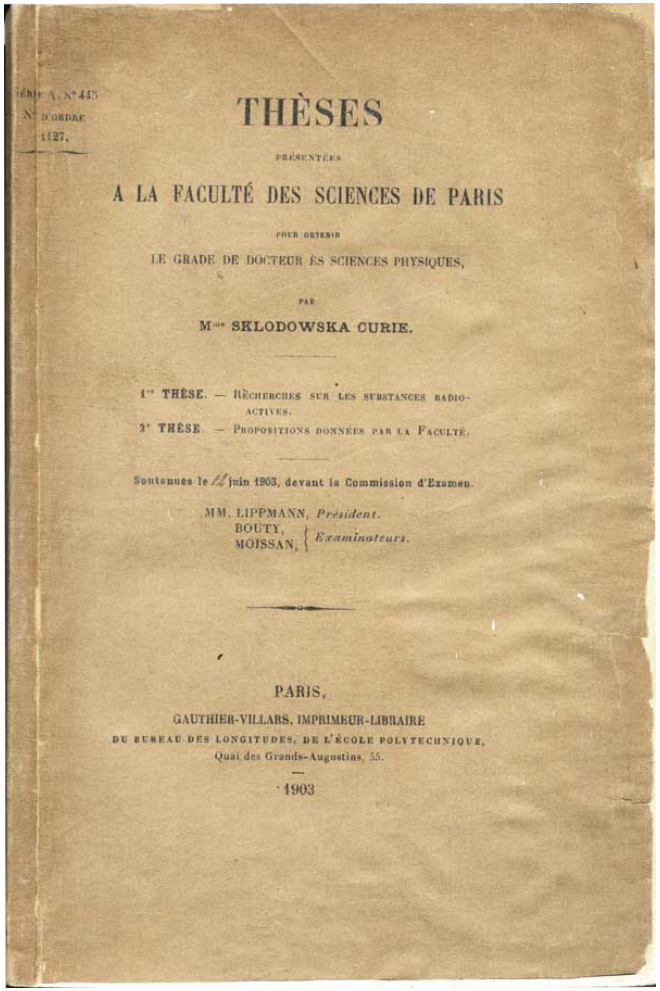
From Accelerators Physics to Nuclear Medicine

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.

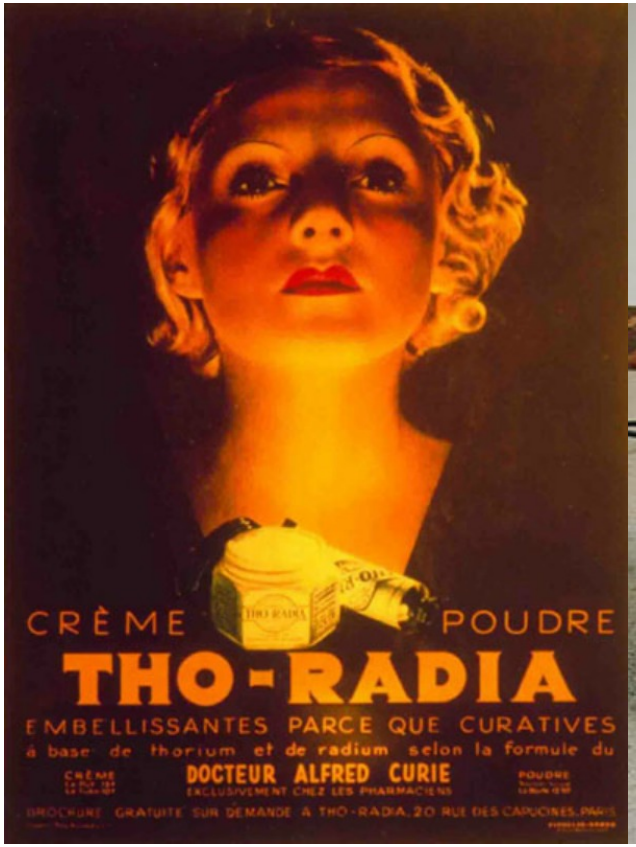
2e THÈSE. — PROPOSITIONS DONNÉES PAR LA FACULTÉ.

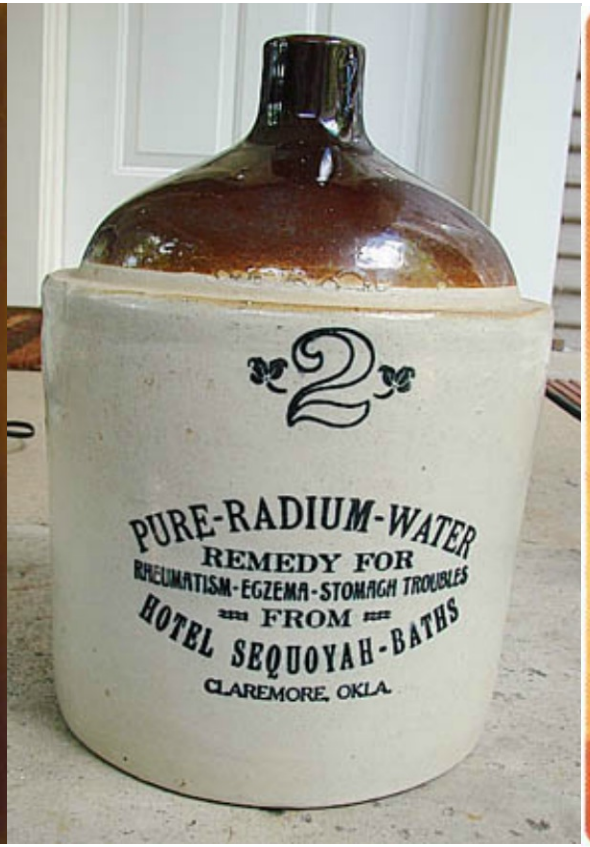
Soutenues le 14 juin 1903, devant la Commission d'Examen.

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

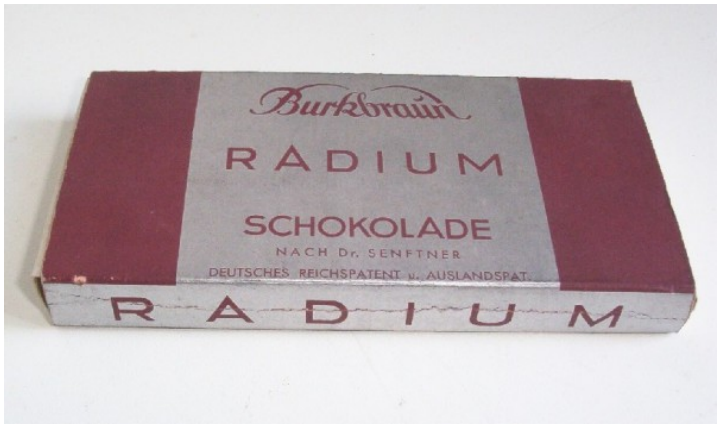
PARIS,
GAUTHIER-VILLARS, IMPRIMEUR-LIBRAIRE
DU BUREAU DES LONGITUDES, DE L'ÉCOLE POLYTECHNIQUE,
Quai des Grands-Augustins, 55.

1903

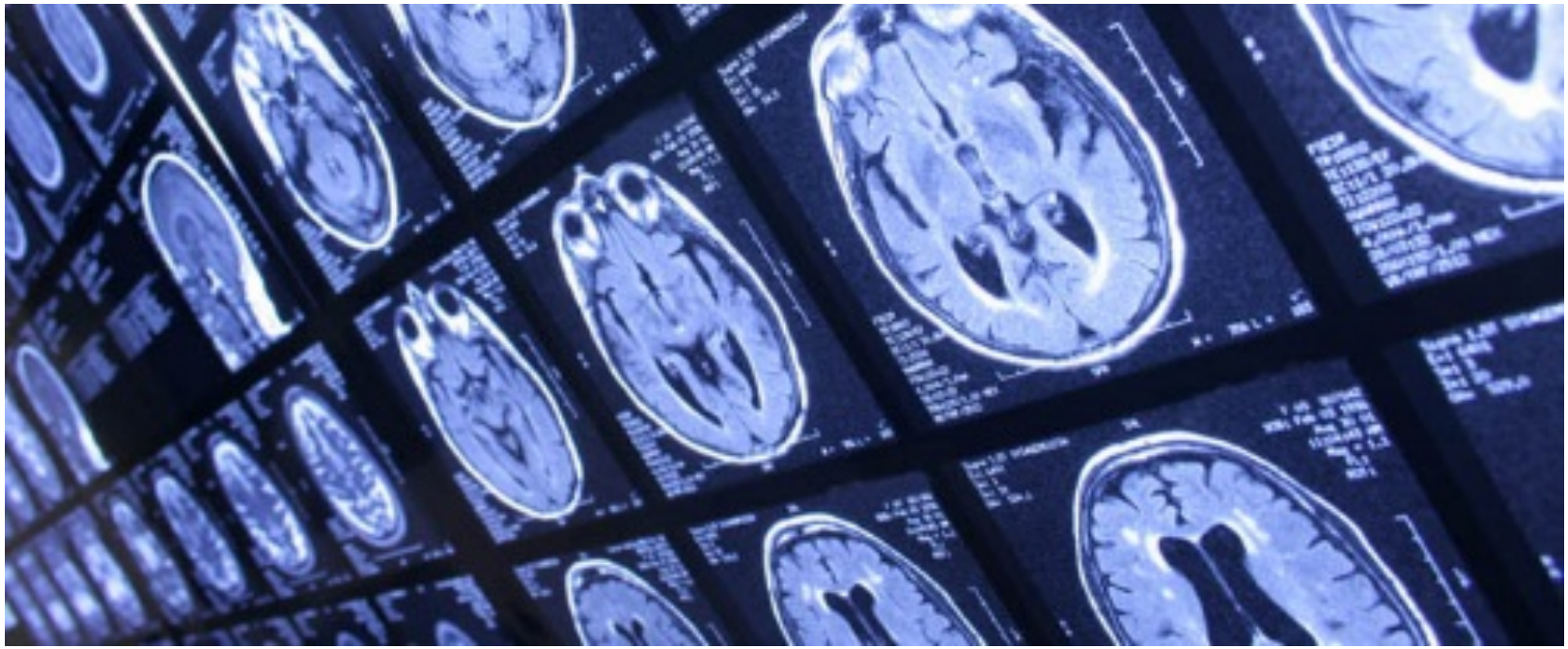

CRÈME
POUDRE
THO-RADIA
EMBELLISSANTES PARCE QUE CURATIVES
à base de thorium et de radium selon la formule du
DOCTEUR ALFRED CURIE
EXCLUSIVEMENT CHEZ LES PHARMACIENS
BROCHURE GRATUITE SUR DEMANDE À THO-RADIA, 20 RUE DES CAPUCINES, PARIS


2
PURE-RADIUM-WATER
REMEDY FOR
RHEUMATISM-ECZEMA-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

NEUTRONS FOR SCIENCE

JG|U

TÉCNICO LISBOA

CHUV

KU LEUVEN

UNIVERSITÉ DE GENÈVE
FACULTÉ DE MÉDECINE

Medicis Promed

EPFL
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Advanced Accelerator Applications

MedAustron

CERN

LEMER PAX
INNOVATIVE

OXFORD UNIVERSITY CONSULTING

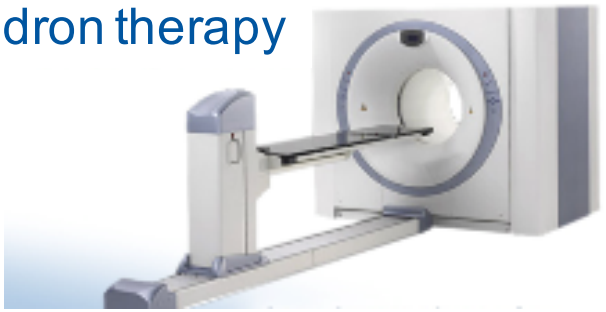
MANCHESTER 1824
The University of Manchester

fondazione CNAO

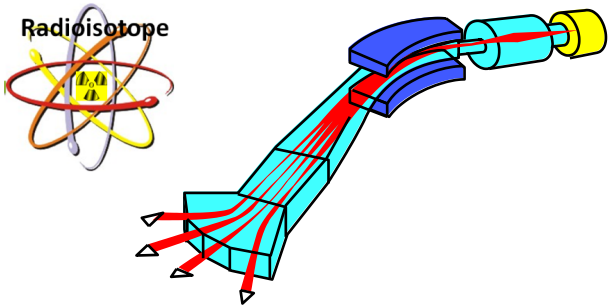
OXFORD

The scope of the MEDICIS Project

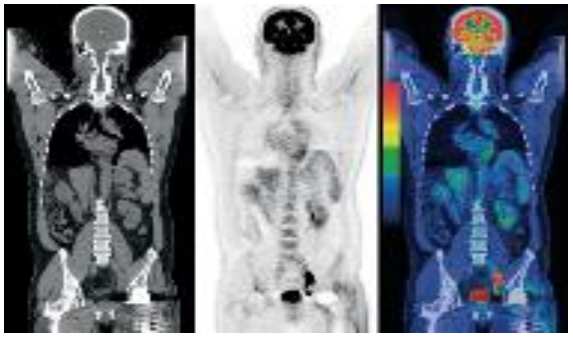
^{11}C based hadron therapy



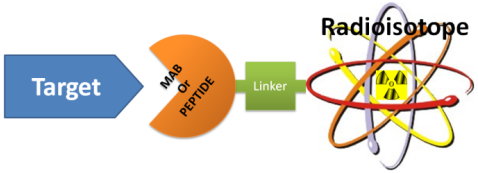
Production of innovative radioisotopes



Diagnostic Imaging
Personalized Treatment of Cancer



Development of Radiopharmaceuticals



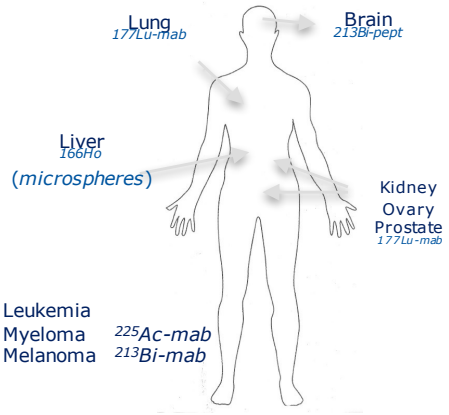
Innovative isotopes

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***

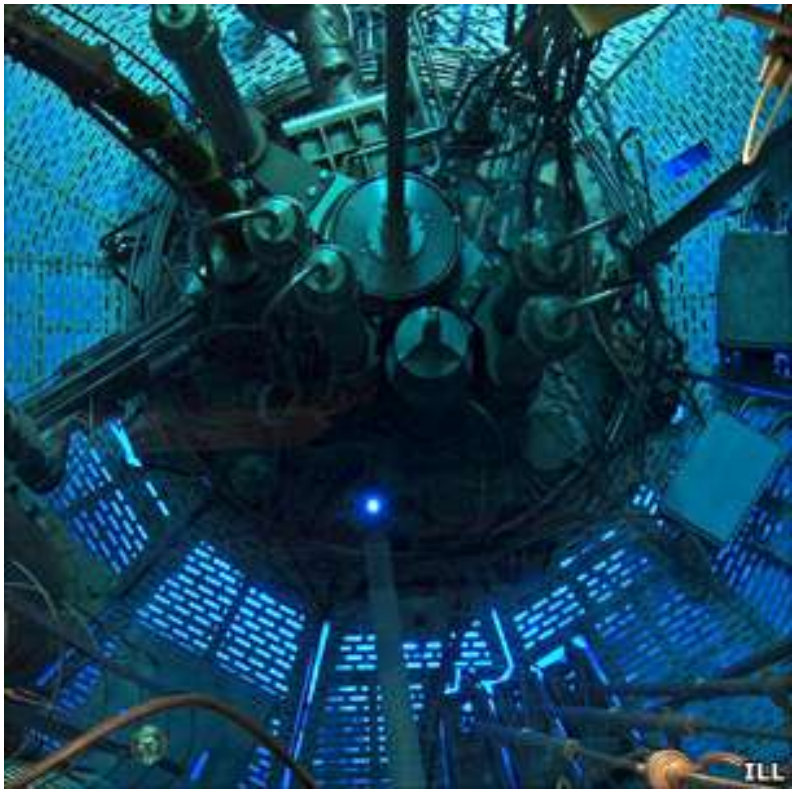
C. Muller et al.
jnumed.112.107540v1



Isotope production

Isotope production

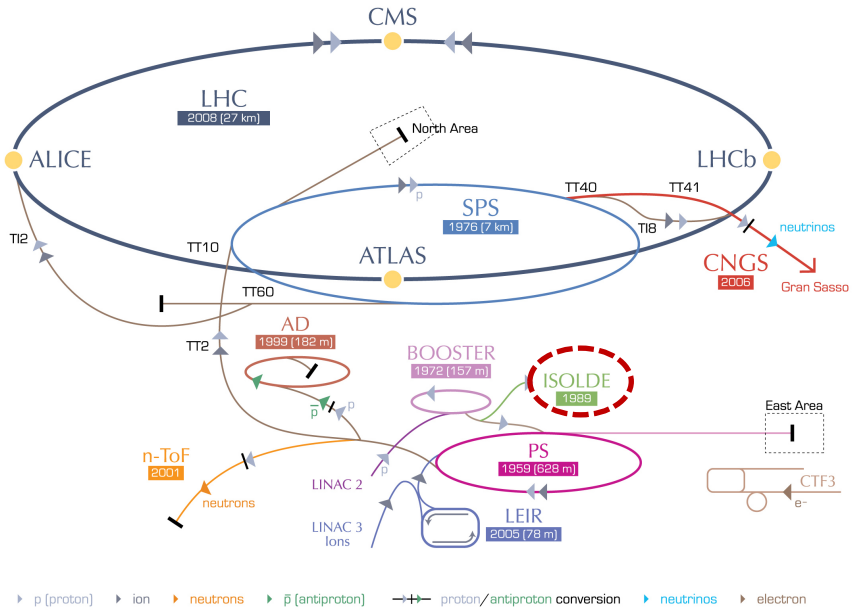
Cyclotron. Arronax, Nantes FR



Nuclear reactor. ILL, Grenoble FR

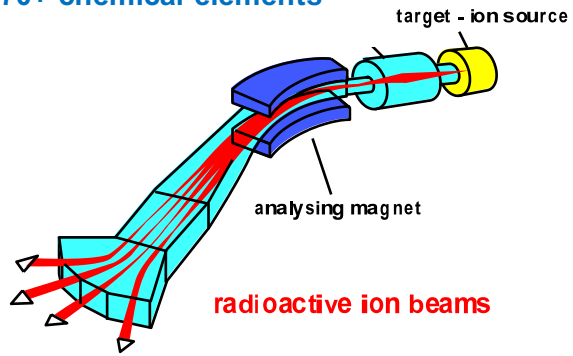
CERN

CERN's accelerator complex



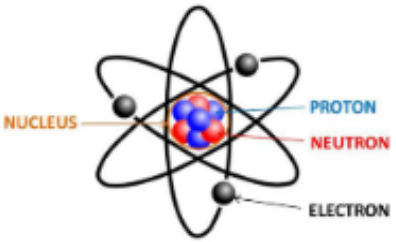
ISOLDE

1000+ isotopes
of 70+ chemical elements



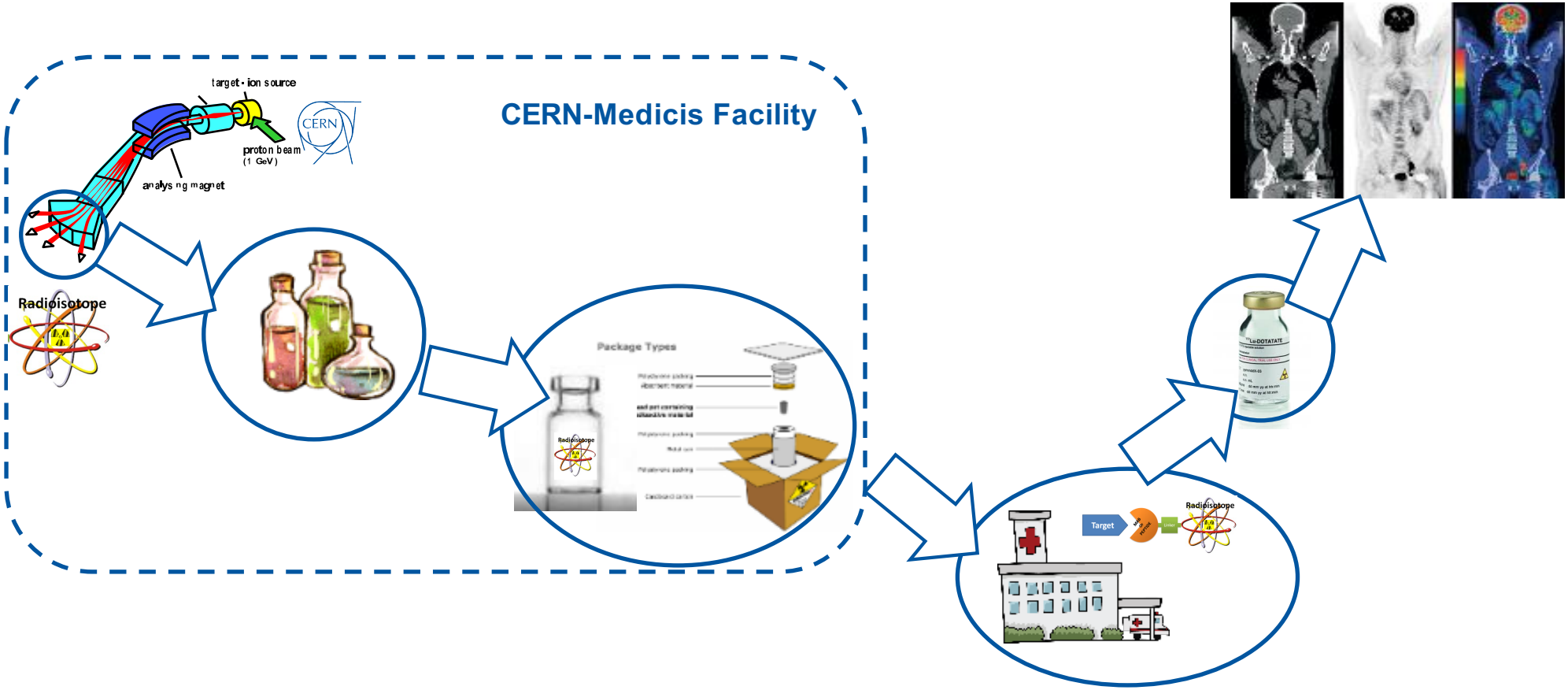
radioactive ion beams

Nuclear Physics

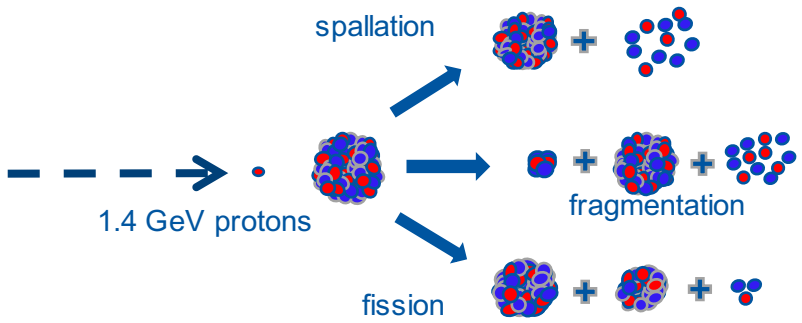


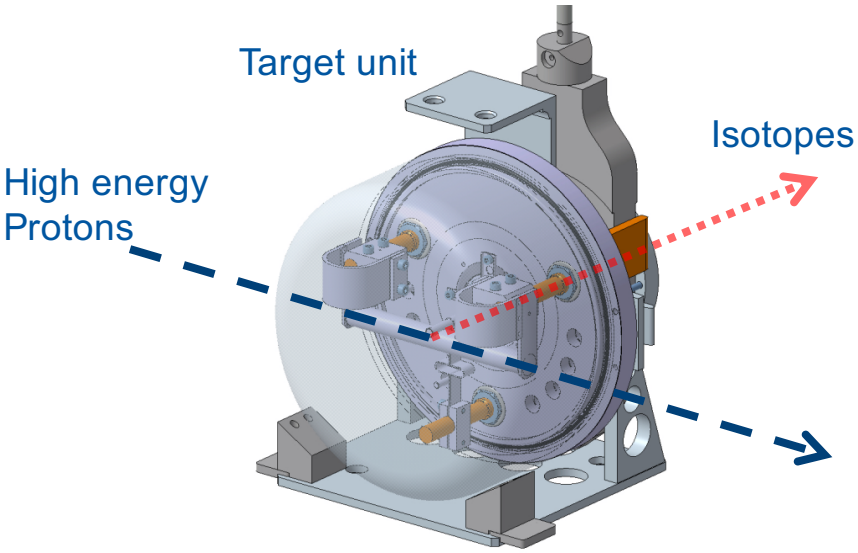
CERN-MEDICIS: a new facility

From Accelerator Physics to Nuclear Medicine



Production of isotopes



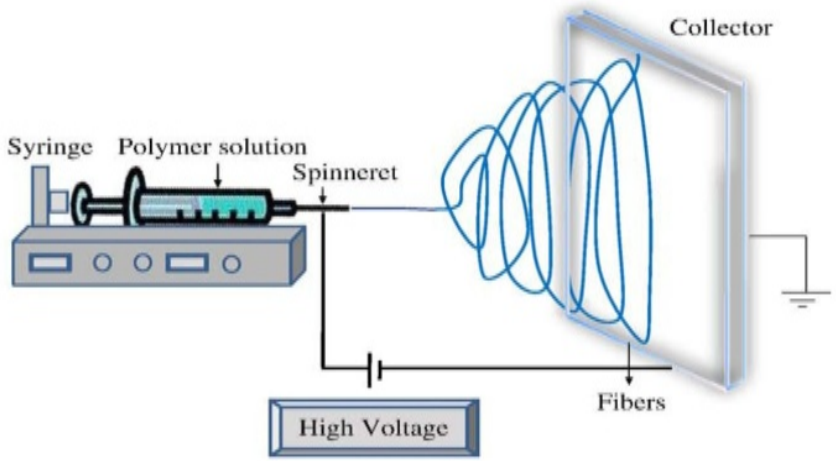


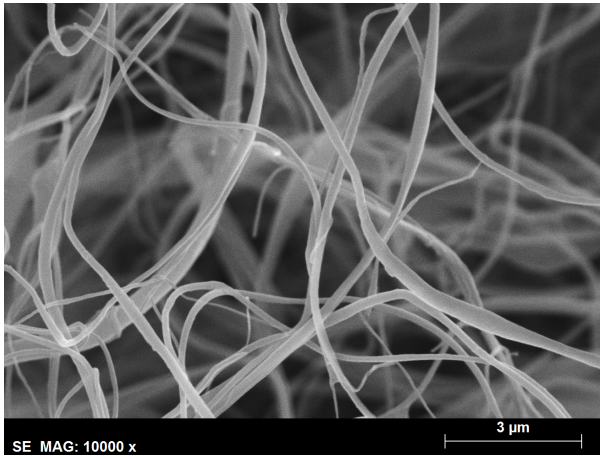
Example of target materials

UC_2 pellets

Ta rolls

Nano-fibrous target material

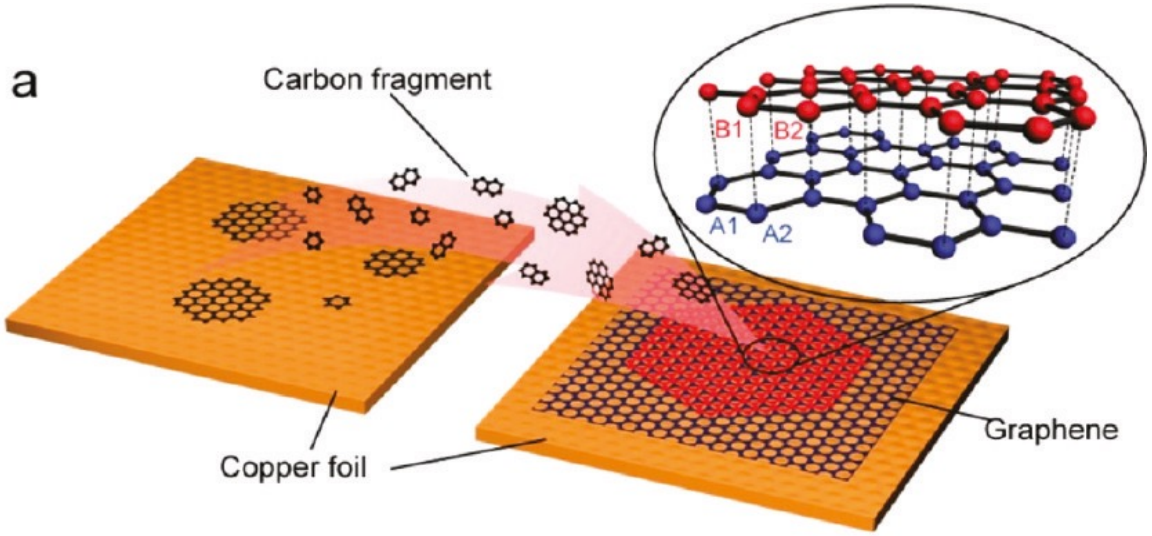




Y-ac. nanofibers

- Sanjib Showdhury - Portugal - Instituto Superior Técnico

Graphene coated target material



- Marina Nazarova - UK - University of Manchester

Radioactive waste

UC_2 pellets

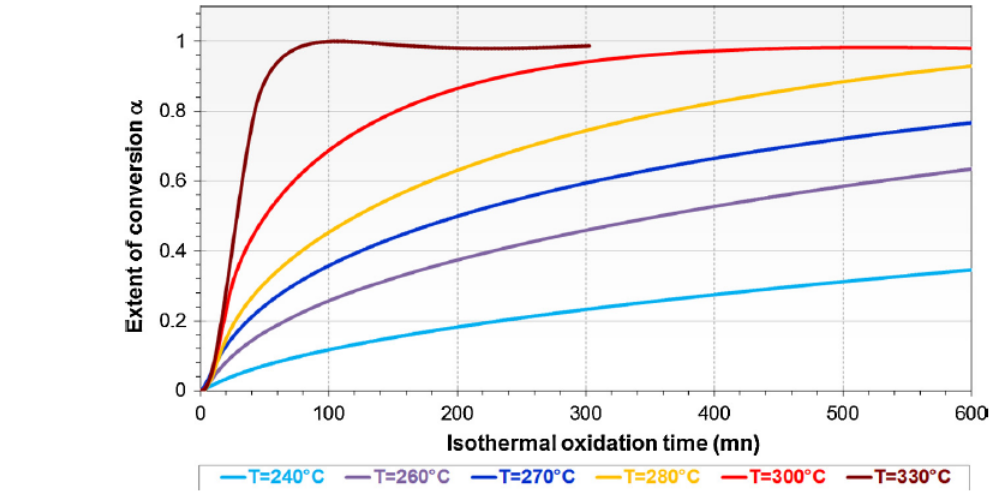
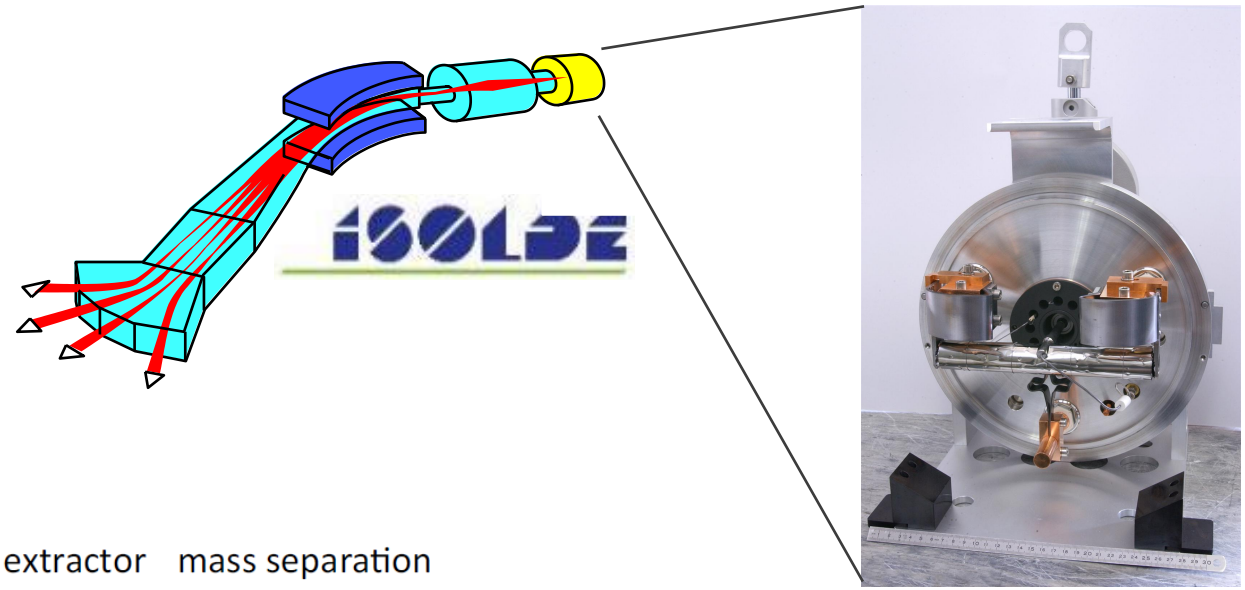


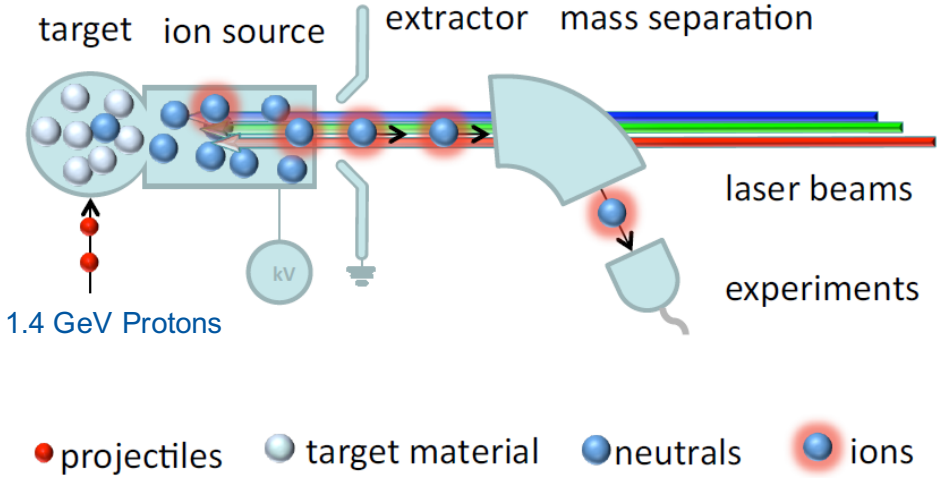
Fig. 2. Isothermal weight gain curves versus time during oxidation of UC_2.

U_3O_8

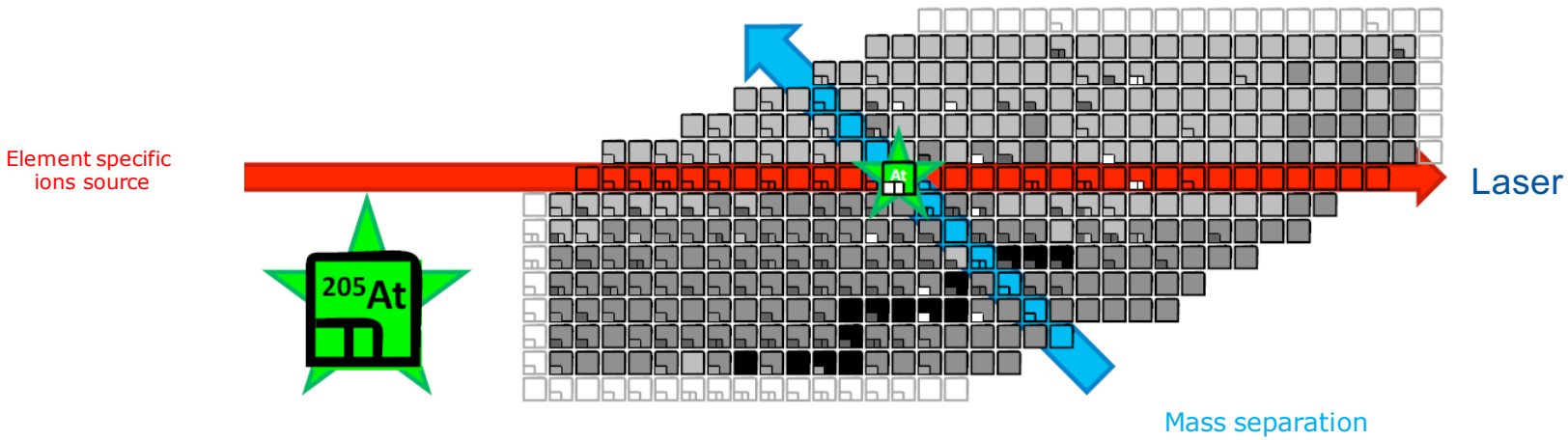
PAUL SCHERRER INSTITUT

Isotope Separator On-Line (ISOL)

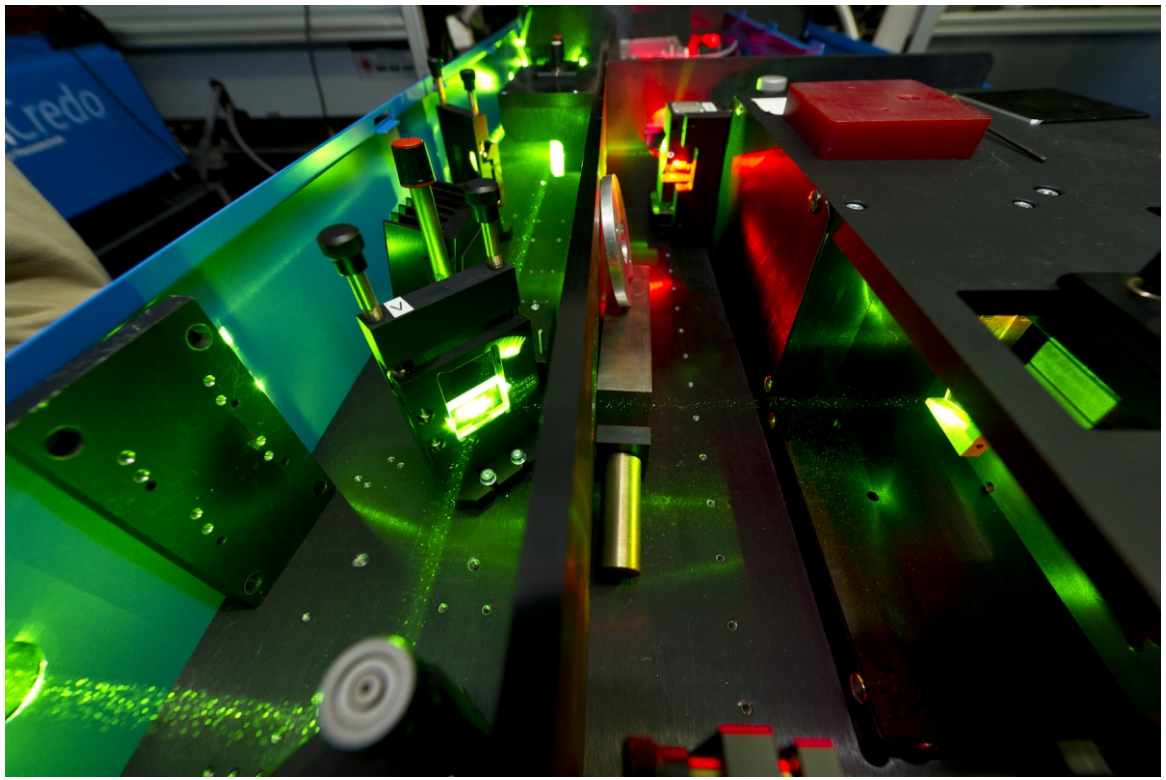




Isotope separation



High purity laser ionization scheme



RILIS at CERN

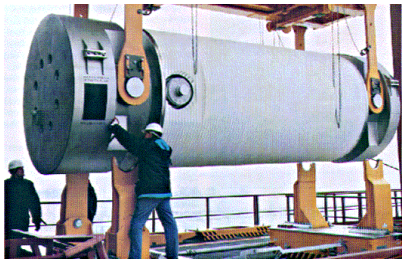
- Vadim Gadelshin - Germany - Johannes Gutenberg-Universität Mainz

Chemical separation

- Nhât-Tân Vuong – Switzerland - CERN

Transportation

Type A package



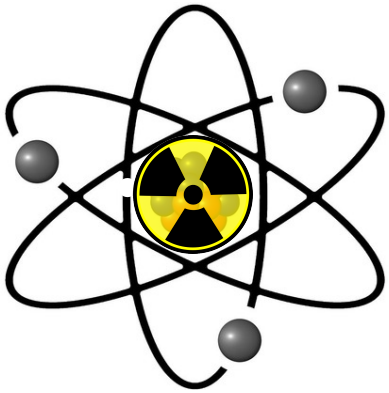
Type B Package

- **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



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