CERN-MEDICIS
An update

Thierry Stora, EN-STI

ENGINEERING
DEPARTMENT

The Scope

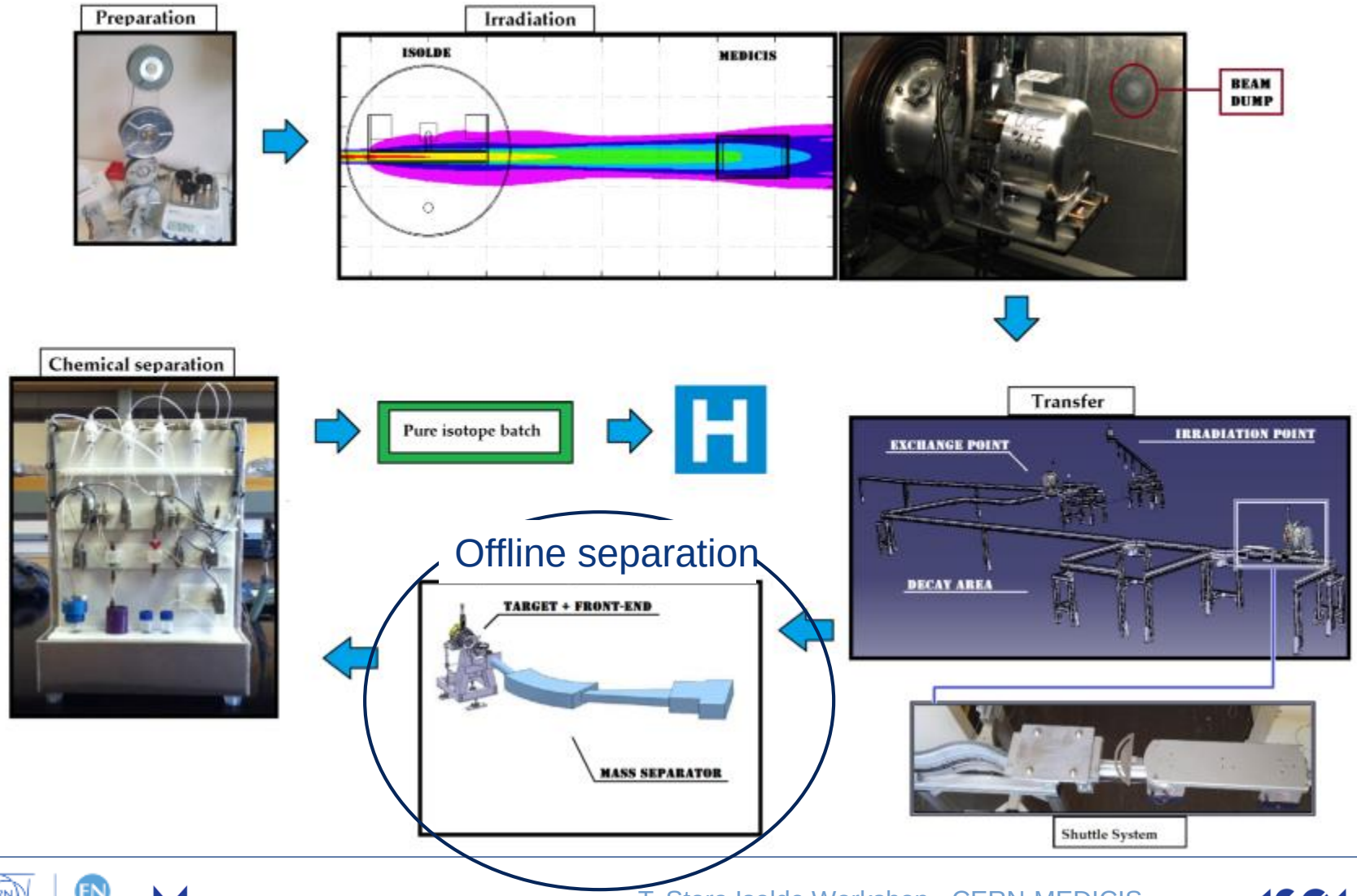
- Biomedicine
- Innovative protocols (Surgery/brachytherapy/combination)
- Innovative isotopes for imaging and treatment

Field of Application	Radiation	Chemical elements	Half lives
PET	β^+	Alkaline earth Halogen Lanthanide Transition metals …	10's min. Hours Days Months
SPECT	γ		
TAT	α		
Beta therapy	β^-		
Auger therapy	e^-		

- Studies on cells, animals (« preclinical »)
  possibly extended to clinical phases
  (needs upgrades, but this can be reached)

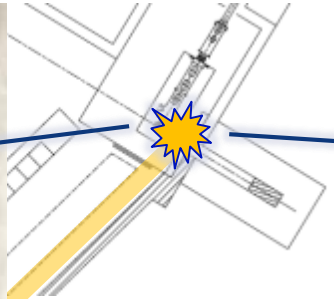
Why CERN-MEDICIS could be done *?

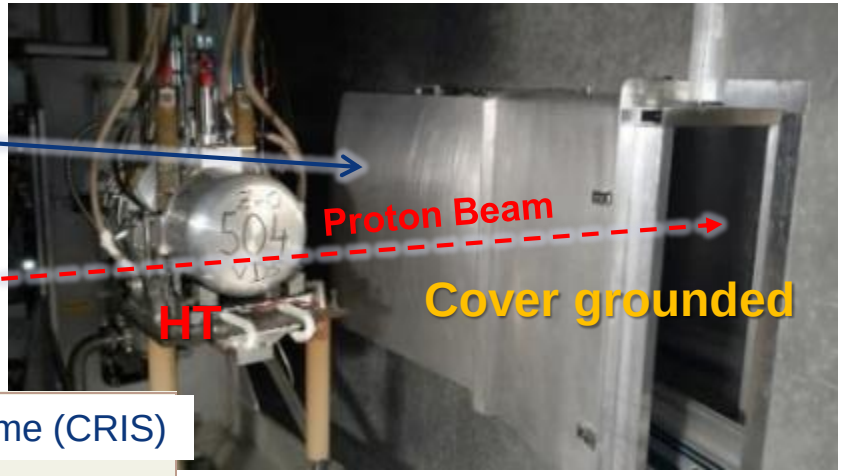
* Without an additional proton driver



Irradiation station commissioned with beam

M. Vagnoni (EN-STI fellow), et al.



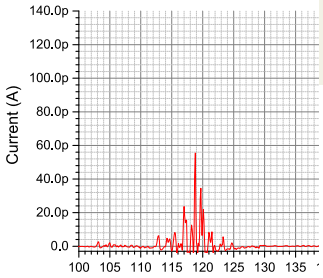


During last 2015 Isolde beam time (CRIS)

```
NORMHRS=>ISOHRS
Prot.current: 1.94uA 2936E10ppp
Total cycles: 19/40
Cycles number: 4 7 8 11 12 15 17 18 22 23 24 27 28 31 32 35 36 37 40


22:32 MEDICIS RCS : Target UC541 removed from the irradiation HRS dump position to its parking
position on RCS.
Integrated PoT 0.8e18.
Will be removed with Kuka robots on Monday.
/TS/MV
```

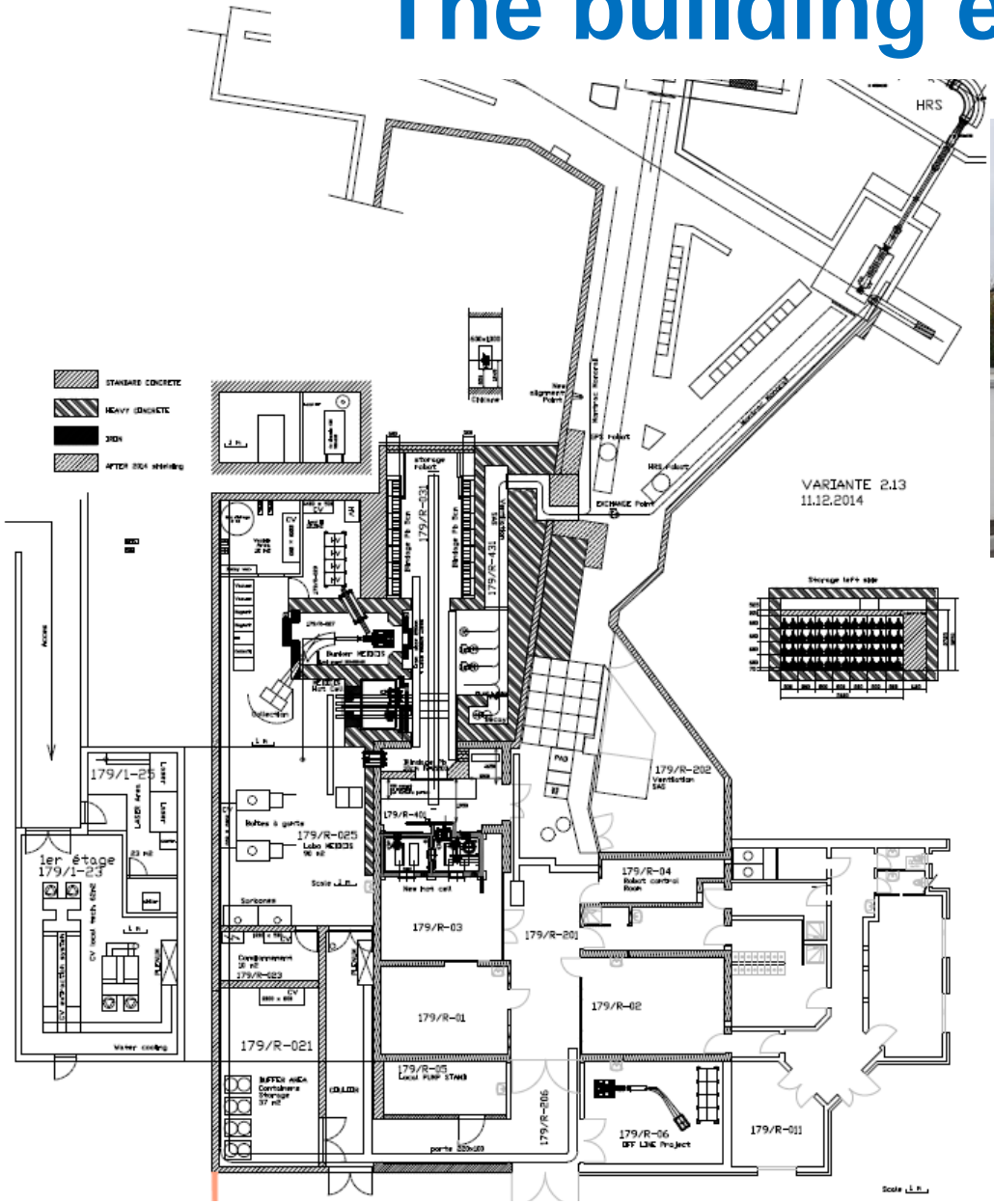
name: 20151114223532.png
desc:



& RIB separated 1 week later on GPS

Tests with protons:
Done successfully !

The building extension

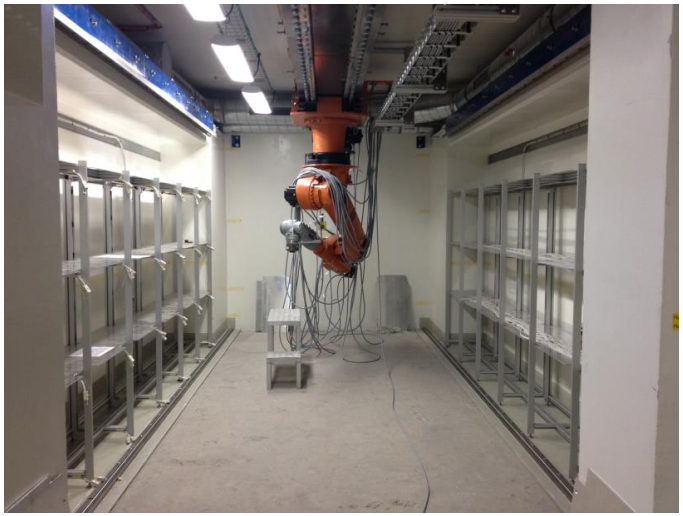


Temporary shielding removed
And final shielding/access under way

The building extension

J.L. Grenard, K, Kershaw et al.

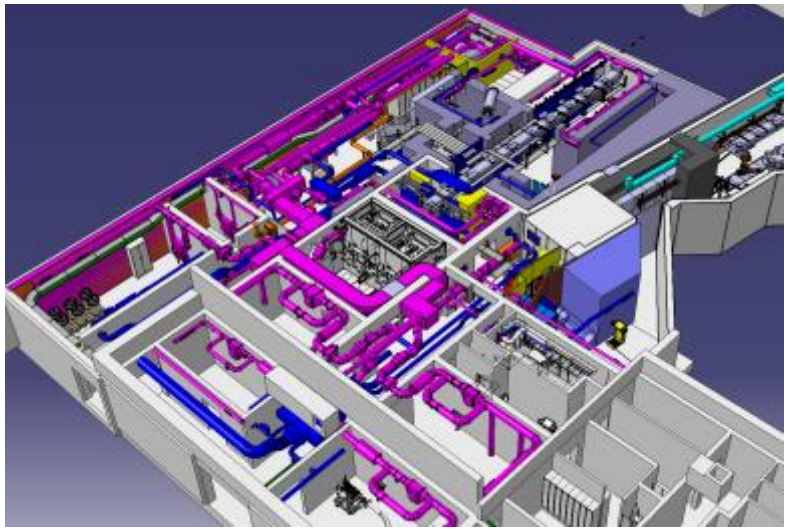
Storage shelves (V. Barozier & Y. Gavrikov)



Robot hardware installed

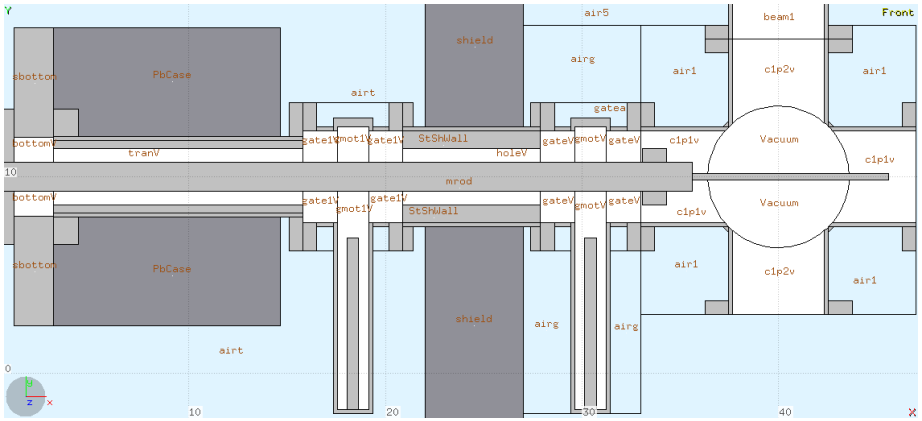
Last shielded door

The nuclear ventilation

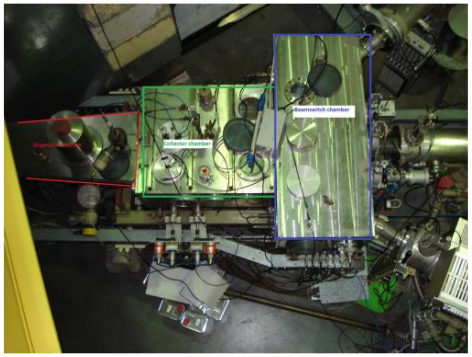


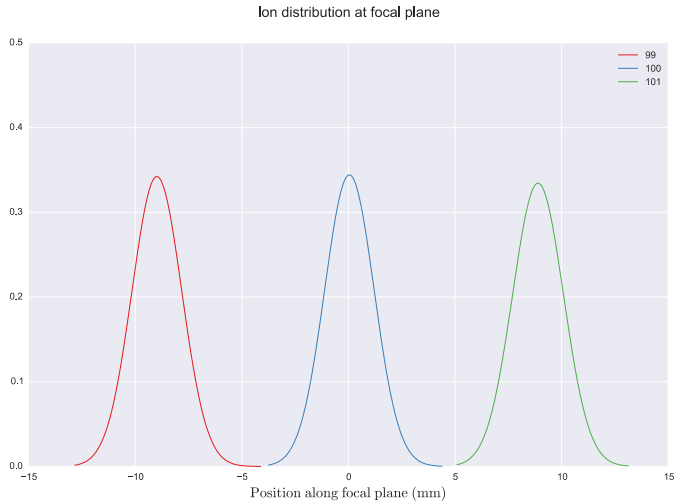
The Mass separator

LISOL dipole ready for shipment
In Louvain La Neuve



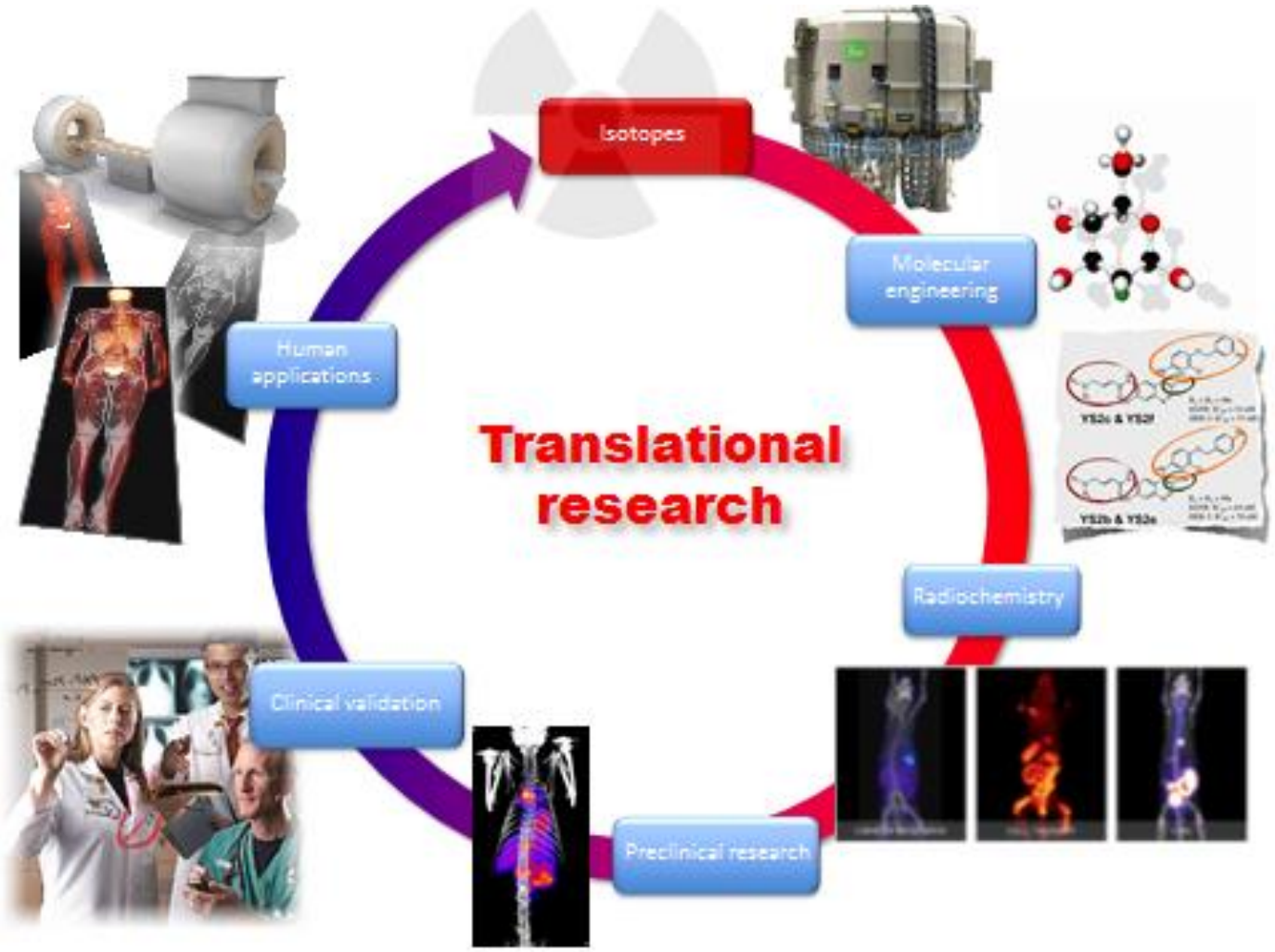
Conceptual design – collection chamber (A. Brown)





Separator in CERN-MEDICIS Configuration (Y. Martinez)

The scientific case

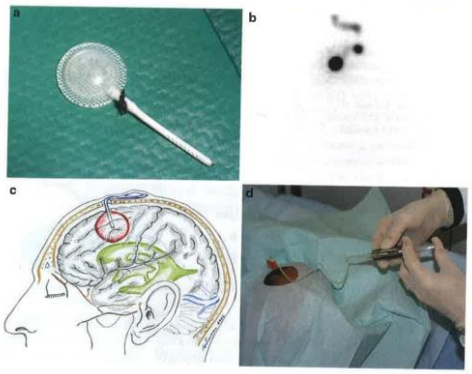


Courtesy prof. Ratib, in the context of the CERN-MEDICIS project

Collaboration with JRC-ITU
Intracavity injection
+resection of Glioblastoma

Targeted alpha-radionuclide therapy of functionally critically located gliomas with ^{213}Bi-DOTA-[Thi^{8},Met(O$_2$)^{11}]-substance P: a pilot trial

D. Cordier · F. Forrer · F. Bruchertseifer · A. Morgenstern · C. Apostolidis · S. Good · J. Müller-Brand · H. Mäcke · J. C. Reubi · A. Merlo



12th SWISS EXPERIMENTAL SURGERY SYMPOSIUM

New Radio Isotopes for Diagnosis & Treatment

In Pre-clinical and Clinical Research

Organized by the HUG and the University of Geneva

With the participation of:

L. Buhler, Ph. Morel, B.H. Walpoth

Co-organized with CERN, CHUV, EPFL, ISREC

With the participation of:

D. Hanahan, J. Prior, O. Ratib, T. Stora

Friday, 15 January 2016

08h30 – 17h00

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Letter of Intent to the ISOLDE and Neutron Time-of-Flight Committee

Radium and Francium beam tests to produce ^{225}Ac/ ^{213}Bi generators at CERN-MEDICIS

14 October 2015

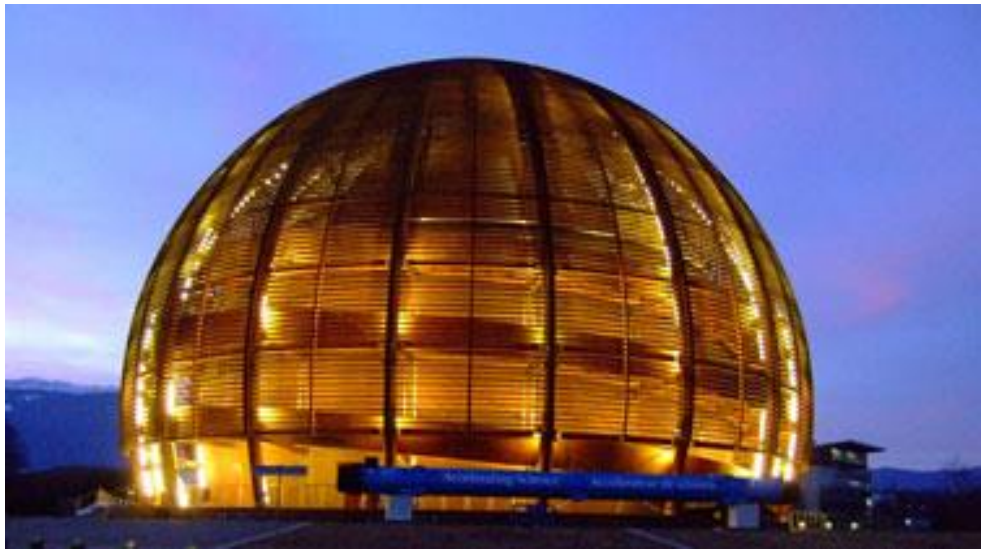
F. Bruchertseifer[1], A. Morgenstern[1], Y. Martinez[2,3], T. Cocolios[2], T. Stora[3] and the CERN-MEDICIS collaboration

[1] JRC-ITU, Karlsruhe, Germany

[2] KULeuven, Leuven, Belgium

[3] CERN-MEDICIS project, CERN, Switzerland

Outreach



1st yearly Grace-MEDICIS collaboration/public lecture took place on 15th October 2014

The 2nd one is in preparation:
Prof. W. Weber, Memorial Sloan Kettering Cancer Center New York

Prof Doug Hanahan

Director ISREC Lausanne

AACR's Lifetime Achievement Award

Tentative planning

Phase	Action	Date
PHASE I	Commissioning: without beam (*)	2016
PHASE II	Commissioning with beam and light targets to gain operational experience	2017
PHASE II B	Isotope production with light targets	Mid 2017
PHASE III	Extending to heavy targets up to Tantalum	End 2017
PHASE IV	Collection of short lived alpha emitters (e.g. 149Tb)	2018
PHASE IV B	Operation with lasers	2018
PHASE V	Operation with uranium targets/possible proton beam upgrade	2019

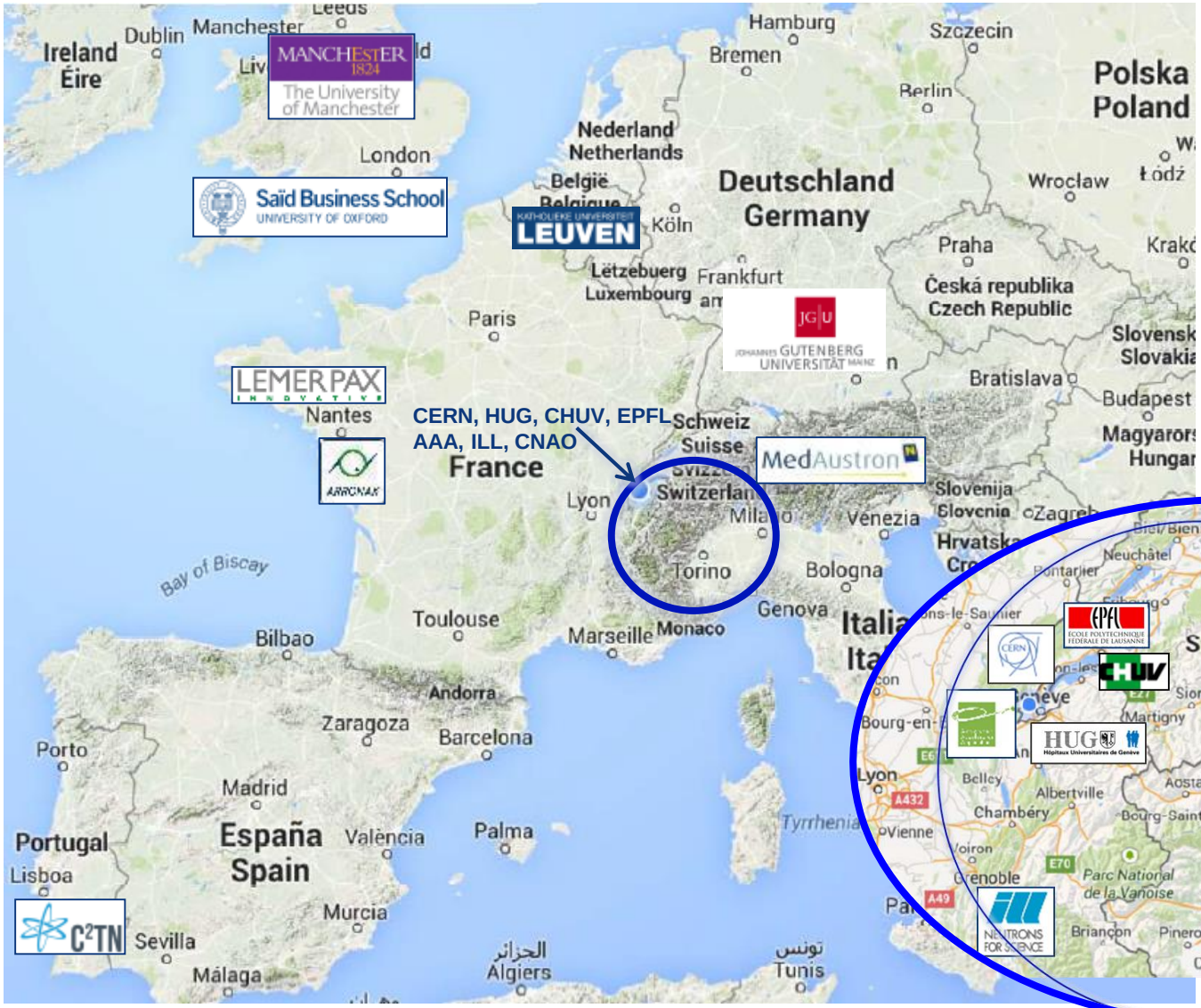
* Preferable but may be hard to achieve

MEDICIS-PROMED

« MEDICIS-Produced radioisotope beams for medicine »

www.cern.ch/medicis-promed

The intersectorial distributed network



The intersectorial "regional" network

Overview of the Research Network

>7/15 young researchers have been hired : recruitment → Dec 2015

MEDICIS_PROMED training network

"Timely Coordination Dr. T. Stora, CERN Medical coordination : PhD, MD J. Prior, CHUV

Innovations" **WP3 : theranostic pharmaceuticals/surgery for new ovarian cancer personalized treatment**

Terbium isotope theranostic pairs
Biological targets for ovarian cancers

AAA (FR) lead- radiopharmaceuticals - ESR6
IST (PT)/dna targetting - ESR8
CERN MEDICIS (EU)/molecular break-up - ESR1
HUG (CH)/surgery - ESRCH3
CHUV(CH)/preclinical tests - ESRCH2

"Timely Innovations"

WP 1 : mass separation of new medical isotopes

Graphene
CERN-MEDICIS
Ti:Sa Ion sources
α-isot. Transp.

JOGU (DE) lead - laser purification - ESR5
UNI MANCHESTER (UK)/adv material- ESR4
CERN MEDICIS (EU)/ production safety - ESR2
Lemer-Pax (FR) /transport - ESR10
IST (PT)/nanofibers - ESR7

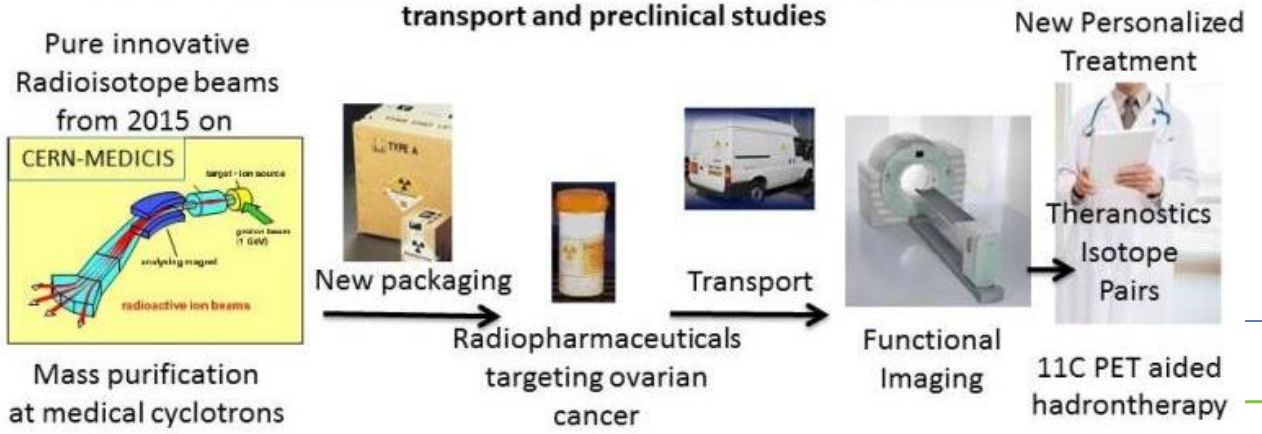
WP 2 : Pet aided 11C hadrontherapy

CNAO (IT) lead - 11C hadrontherapy - ESR9
KUL (BE) - mass sep 11C - ESR11
CERN MEDICIS (EU) - 11C acceler. - ESR3
HUG (CH) - imaging tests -ESRCH1
EPFL (CH) - biochemical synthesis - ESRCH4
Medaustron (AT) - hadrontherapy

"Timely Innovations"

Medaustron animal models

MEDICIS-PROMED: Innovative treatments based on radioactive ion beam production, transport and preclinical studies



Training : Events and models

Kick-off week – CERN (EU) 1st half feb 2016, and ICTR-PHE 2016

General training 1 – Manchester (UK)

Workshop on functional multimodal SPECT/PET imaging – Lausanne/Geneva (CH)

Specialized training 2 – Leuven (BE)

Summer school 1 at CNAO – Pavia (IT).

Summer school 2 at C2TN-IST – Lisbon (PT)

K. Novoselov, Graphene Institute – Physics Nobel Prize 2010 – Scientific Innovation and Advanced Materials

U. Koester, ILL- chairman of the NuPECC working group for *Nuclear Physics for Medicine-Radioisotope production*– Production of medical radioisotopes

P. Van Duppen, KUL – Adv ERC – Radioactive Ion Beams and Lasers

S. Buono, AAA – Radiopharmaceuticals marketing and Entrepreneurship

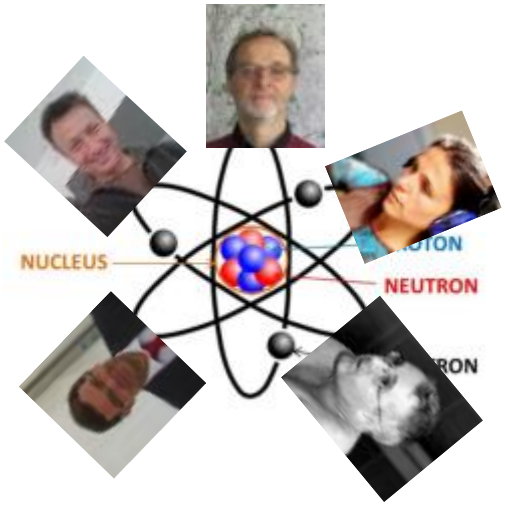
G. Coukos, CHUV – Adv. ERC – Immunotherapy and cancer treatment

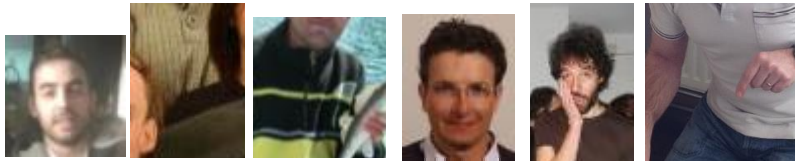
P. Lecoq, CERN – Adv ERC – Detectors and Medical imaging

K. Noda-san – NIRS – PET-aided hadron therapy with carbon ions

Program cohesion : Oxford University Said Business School (ECTS, PhD)

CERN | EN ENGINEERING DEPARTMENT





And many orthers

Thank you, questions , comments ?

Some yield estimates

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

^{140}Pr-PET/ ger therapy	^{140}Nd 3.4d	^{140}Nd	Ta-Re	1.8E9	2.0E10	^{140}Nd 5	1.2E10	6.0E8	20	2.0E10	4.0E9	Chemical purification
- therapy	^{89}Sr 50.5d	^{89}Sr	UCX-Re	1.2E10	2.3E9	^{89}Sr 5	2.0E9	1.0E8	20	2.7E9	5.4E8	Only mass searation
PET	^{82}Sr 25.5d	^{82}Sr	UCX-Re	3.6E10	4.6E9	^{82}Sr 5	1.7E9	8.5E7	20	2.0E9	4.0E8	Only mass separation
- therapy	^{77}As 38.8h	^{77}As	UCX-VD5	5.7E9	1.1E10	^{77}As 5	5.8E9	2.9E8	20	9.4E9	1.4E9	Chemical purification
PET	^{74}As 17.8d	^{74}As	Y_2O_3 -VD5	6.5E9	1.2E9	^{74}As 5	3.8E8	1.9E7	20	4.5E8	9.0E7	Chemical purif
PET	^{72}As 26.0d	^{72}As	Y_2O_3 -VD5	1.6E10	2.8E10	^{72}As 5	9.1E9	4.6E8	20	1.5E10	3.0E9	Chemical purification
PET	^{71}As 65.3h	^{71}As	Y_2O_3 -VD5	1.8E10	1.8E10	^{71}As 5	5.9E9	3.0E8	20	8.0E9	1.6E9	Chemical purification
therapy	^{67}Cu 61.9h	^{67}Cu	UCX-Re	2.7E9	3.4E9	^{67}Cu 7	1.5E9	1.1E8	20	2.7E9	5.4E8	Chemical purification
PET	^{64}Cu 12.7h	^{64}Cu	Y_2O_3 -VD5	1.1E10	2.3E10	^{64}Cu 5	7.1E9	3.6E8	20	2.1E10	3.6E9	Chemical purification
, dosimetry	^{61}Cu 3.3h	^{61}Cu	Y_2O_3 -VD5	7.7E9	1.7E10	^{61}Cu 5	5.1E9	2.6E8	20	2.1E10	4.0E9	Only mass separation
therapy	^{47}Sc 3.4d	^{47}Sc	Ti	6.4E10	5.0E10	^{47}Sc 5	4.2E10	2.1E9	20	5.9E10	1.2E10	Evaporation
PET	^{44}Sc 4.0h	^{44}Sc	Ti	4.4E10	6.6E10	^{44}Sc 6.4	5.7E10	2.9E9	20	1.6E11	3.2E10	Evaporation
PET	^{11}C 20.3m	^{11}CO	NaF-LiF-VD5◊	-	-	- 15	-	1.4E9	-	-	4.2E9	Only mass separation