

CERN-MEDICIS:

Production d'isotopes selon l'approche « ISOLDE » pour la recherche médicale

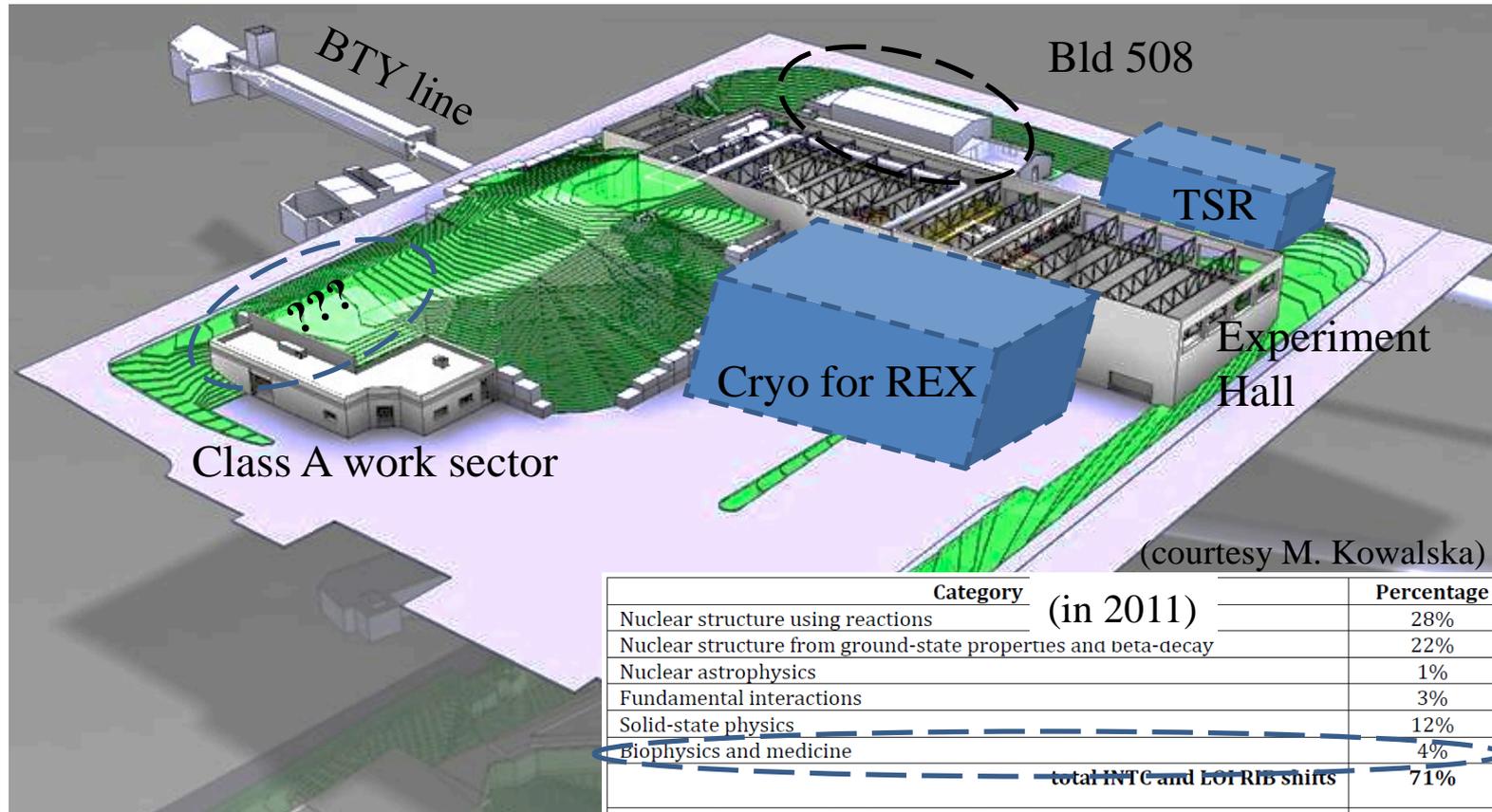
Thierry Stora

JRC CERN meeting

Jan 2014

The Philosophy behind

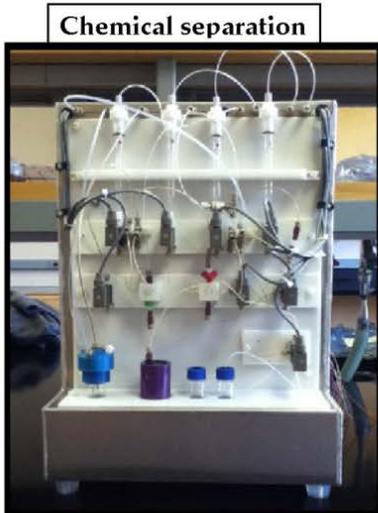
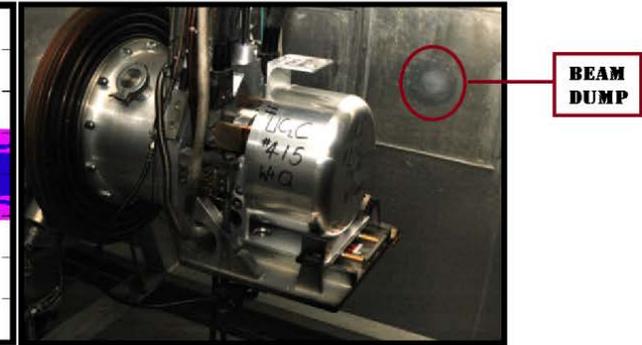
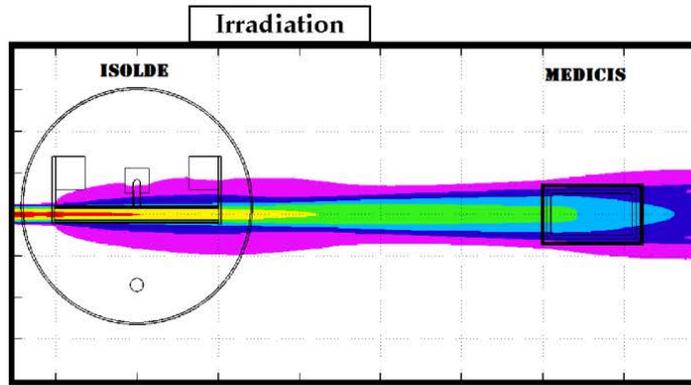
The On-Line Isotope Mass Separator ISOLDE is a facility dedicated to the production of a large variety of radioactive ion beams for a great number of different experiments, e.g. in the field of nuclear and atomic physics, solid-state physics, life sciences and material science



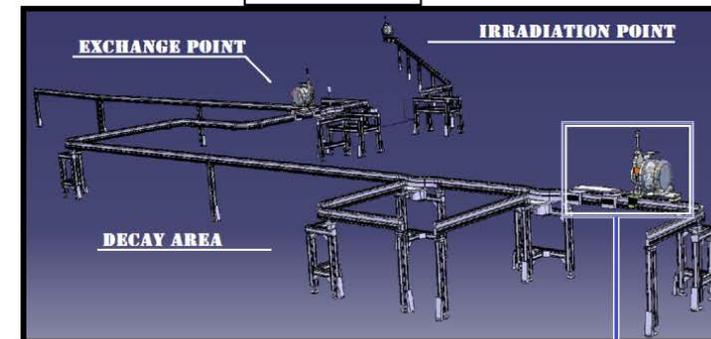
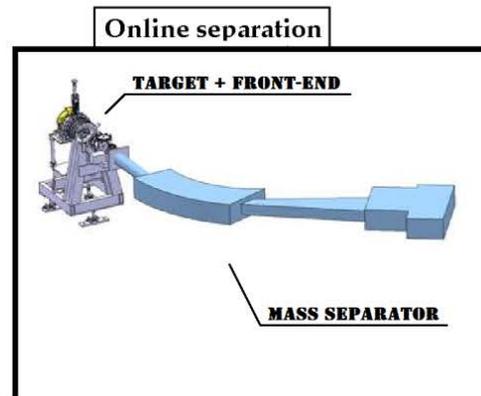
(courtesy M. Kowalska)

Up to 50% of total CERN proton are delivered to ISOLDE

Category	Percentage
Nuclear structure using reactions	28%
Nuclear structure from ground-state properties and beta-decay	22%
Nuclear astrophysics	1%
Fundamental interactions	3%
Solid-state physics	12%
Biophysics and medicine	4%
total INTC and LOI RIB shifts	71%
Target and ion source development and Coordinator's reserve	29%



Pure isotope batch



Shuttle System

The Philosophy

- Scope : Life sciences, Medicine
- Innovative protocols (Surgery/brachytherapy/combination)
- Innovative isotopes for imaging and treatment

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

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

The Project



"Noah, tell me again who's your project sponsor?"

Planning proposal*

**subject to modification...*

	Construction	2013-2015
PHASE I	Commissioning : No beam	end 2015
PHASE II	Commissioning with beam and light targets to gain operational experience	2016
PHASE II B	Isotope production with light targets	mid 2016
PHASE III	Extending to heavy targets up to Tantalum	end 2016
PHASE IV	Collection of short lived alpha emitters (e.g. ^{149}Tb)	2017
PHASE IVB	Operation with Lasers	
PHASE V	Operation with Uranium targets/possible proton beam upgrade	2018

Team overview

MEDICIS' team @CERN:

T. Stora (MEDICIS), S. Marzari (Building), R. Catherall (HIE-DS coord), A.P. Bernardes (g-al safety), K. Kershaw (remote systems), Z. Lawson (KT aspects)

M. Vagnoni (RCS), R. Augusto (Fluka), A. Polato (Ventilation, cooling), E. Perez-Duenas (Bld), V. Barozier (Integration), R. Necca (EL), J.L. Grenard (Robot), M. Stachura (Bio R&D), J. Vollaire (RP), A. Dorsival (RP), F. Loprete (doors), Y. Martinez (isotope separator), tbcont'd

A new office for biomedical applications at CERN



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Streamlining the path from physics to medicine



Rolf Heuer

We all know them: the well-established cases of knowledge transfer from physics to medicine in which CERN has played an important role. From technology for PET scanners to dedicated accelerator designs for cancer therapy, we have contributed a lot over the years. But until

Interview with Steve Myers

Oct
20
2013

Medical applications play an important role at CERN and recently the DG has decided to structure them under a common umbrella. Steve Myers, CERN's Director of Accelerators and Technology has been appointed as the first Head of CERN's Office for Medical Applications. We have decided to dedicate October's issue of the PH Newsletter to this interesting field and asked Steve Myers for an interview. Following his long-standing career on accelerators and his experience from LEP and the LHC, Steve discusses about his future ambitions and the challenges of his new role.



What do you think about your new role and what is your greatest ambition?

This is the first time that CERN has put (into its medium-term) a budget line for medical applications. It is a small budget line but can be the seed for important projects. Over the last years, many medical activities have been going on at CERN; however these efforts were not focused. There are several activities related to CERN's technologies including the design of specialized accelerators for cancer therapy, the conversion of the Low Energy Ion Ring (LEIR) into a biomedical facility, radio-isotope production using ISOLDE, medical imaging and applications to improve dosimetry for patients and finally large scale computing applications. The DG thought that the time had come to put these projects under one umbrella and asked me to be the coordinator.

I want to set a common goal and try to coordinate these

Kick-off meeting 22 Nov 2013

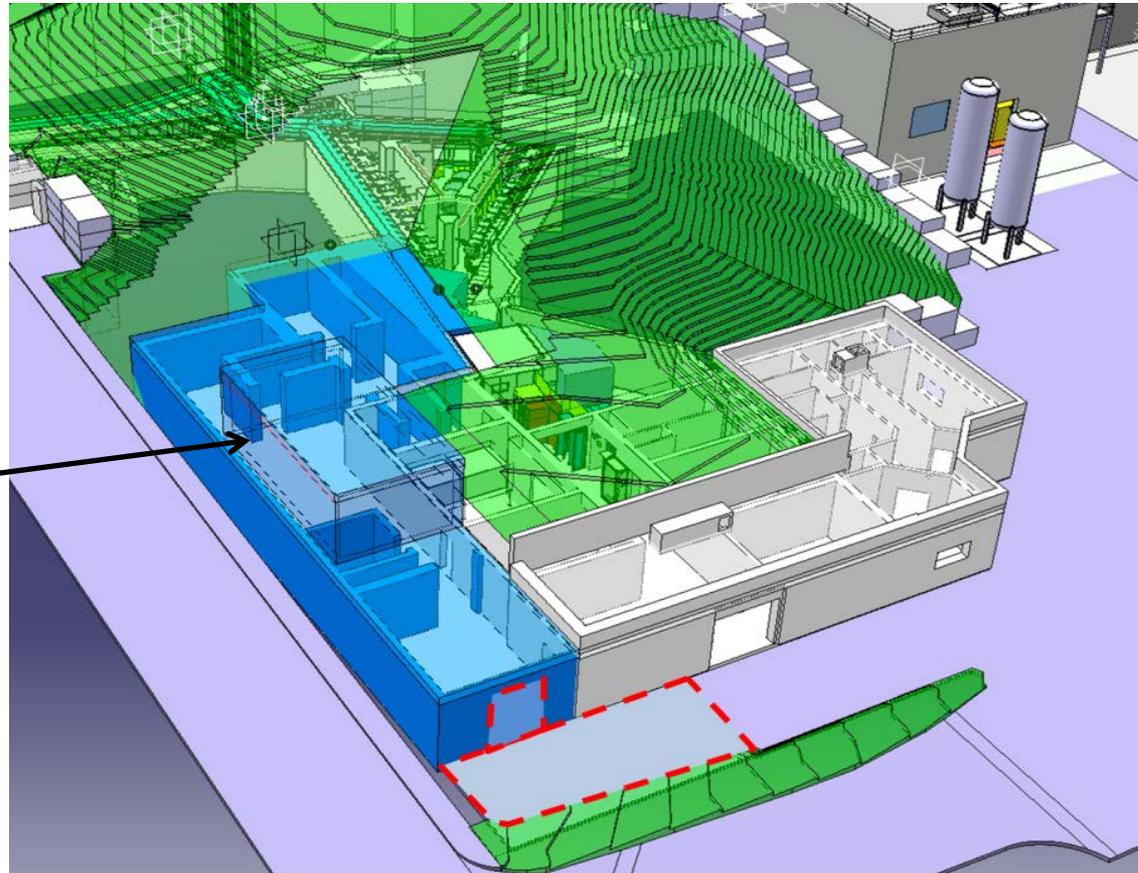
Some Progress(es)



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3D Building layout and integration



(Empty)
Laser barack

Positive safety review in summer 2013

CERN-2014

Civil Engineering has started



Have you ever made your own garden shed ?



September 4th 2013

The Rail Conveyer System and Kuka Robot



Tested for 5 years of operation
during the CERN open days
last September

Medical application	Isotope half-life	Parent isotope beam	Target - Ion source	ISOLDE [†]		RIB ϵ_{ext}^{**} (%)	CERN-MEDICIS [†]		CERN-MEDICIS 2GeV 6μA		Comments
				In-target			In-target Activity ^{EOB} (Bq)	Extracted Activity ^{EOB} (Bq)	Possible gain ϵ_{ext} (%)	In-target Activity ^{EOB} /Extracted Activity ^{EOB} (Bq)	
				Production rate (pps)	Activity ^{EOB} (Bq)						
3- therapy/ T/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
α 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
α 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
α 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

^{40}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
3 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
7, 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
3 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 ⁰	-	-	- 15	-	1.4E9	-	-	4.2E9	Only mass separation

The Scientific case

External partners

Dr. Forni (Clin. Carouge, Geneve)

Prof. Morel, Prof. Buehler, Prof. Y. Seimbille, Prof. Ratib (HCUGE, Geneve)

Prof. D. Hanahan (ISREC, EPFL, Lausanne)

Prof. F. Buchegger, Prof. J. Prior (CHUV, Lausanne)

Prof M. Huyse, prof. P. van Duppen (KUL, Univ. Leuven)

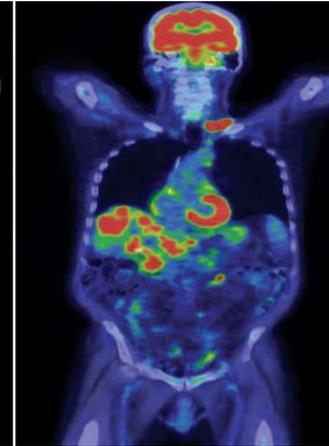
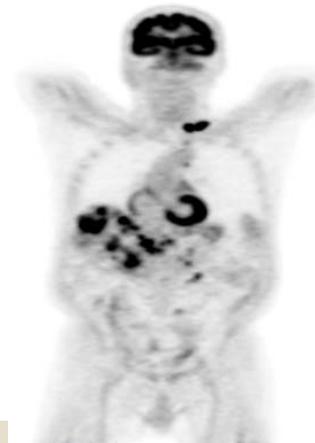
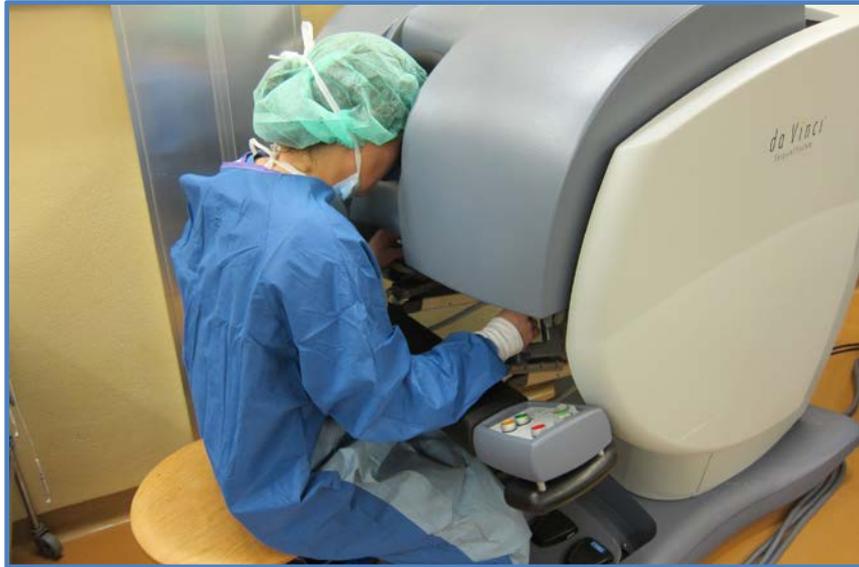
Prof. S. Lahiri (SINP, Kolkata)

Prof. I. dos Santos (CT2N, Lisbon)

Prof. E. Piperkova (Nucl. Medicine, Sofia)

...

Protocols



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Prof D. Hanahan, Swiss Inst. For Exper. Cancer Research

Cell

Leading Edge
Review

Hallmarks of Cancer: The Next Generation

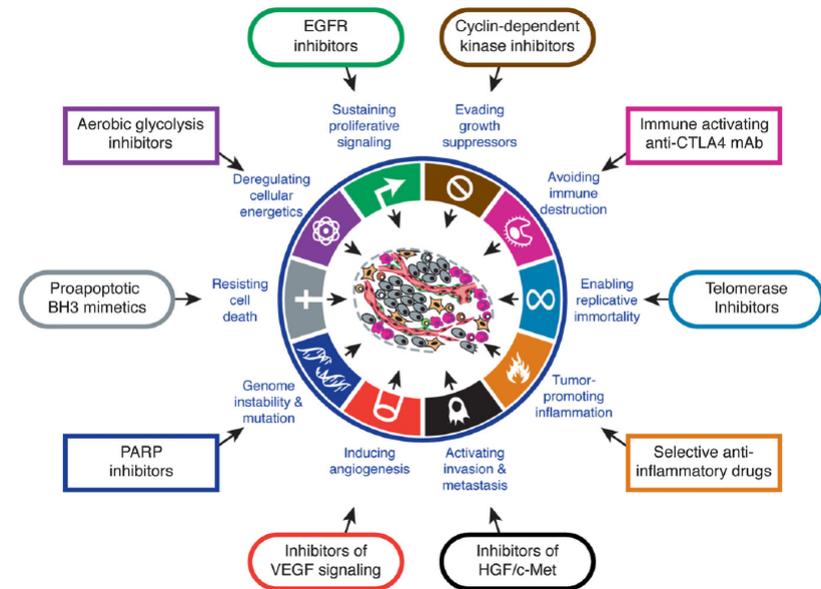
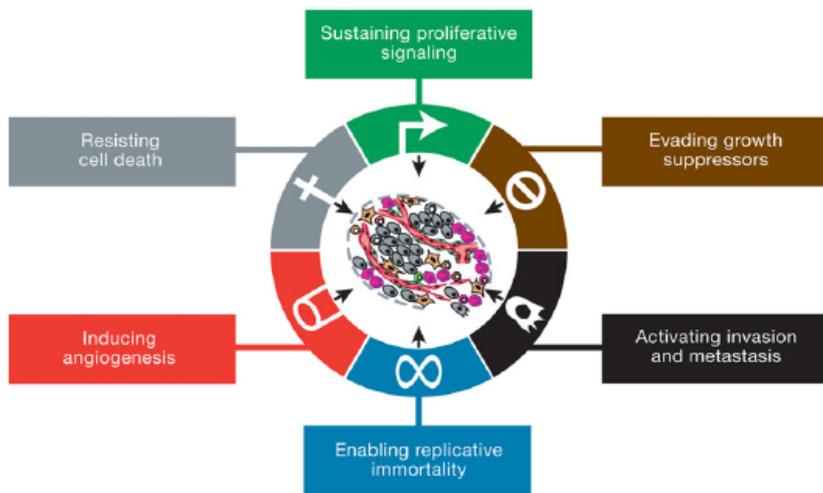
Douglas Hanahan^{1,2,*} and Robert A. Weinberg^{3,*}

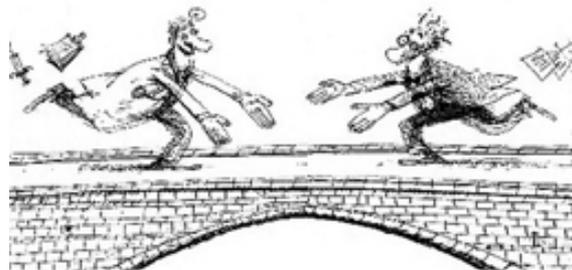
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²The Department of Biochemistry & Biophysics, UCSF, San Francisco, CA 94158, USA

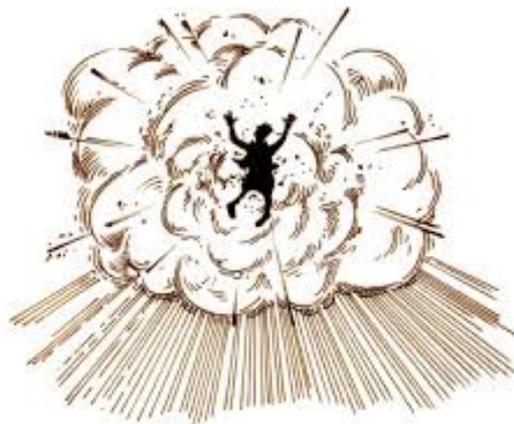
³Whitehead Institute for Biomedical Research, Ludwig/MIT Center for Molecular Oncology, and MIT Department of Biology, Cambridge, MA 02142, USA

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New ideas



Critical mass



The (un)expected breakthrough

Thank you !