Maintenance & Reliability

at Nouveau Centre de Protonthérapie (Orsay)

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Manager of the technical service

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Soleil, 10th November 2011

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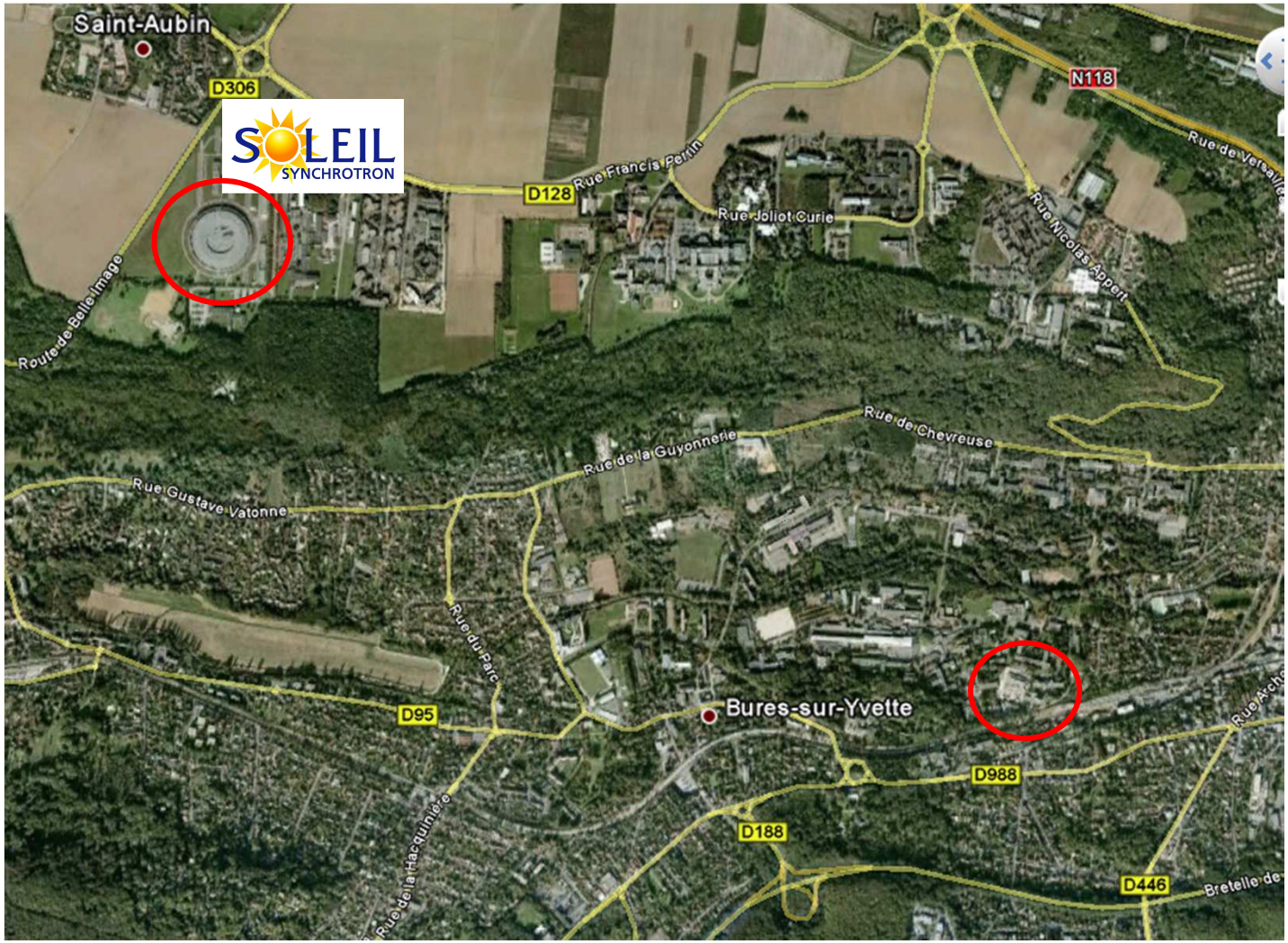

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1. Proton-therapy

2. Centre de protontherapie d'Orsay

3. **Maintenance&Reliability for protontherapy**

4. **Working with a main external Supplier**

5. **some inputs for this workshop**

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Protontherapy

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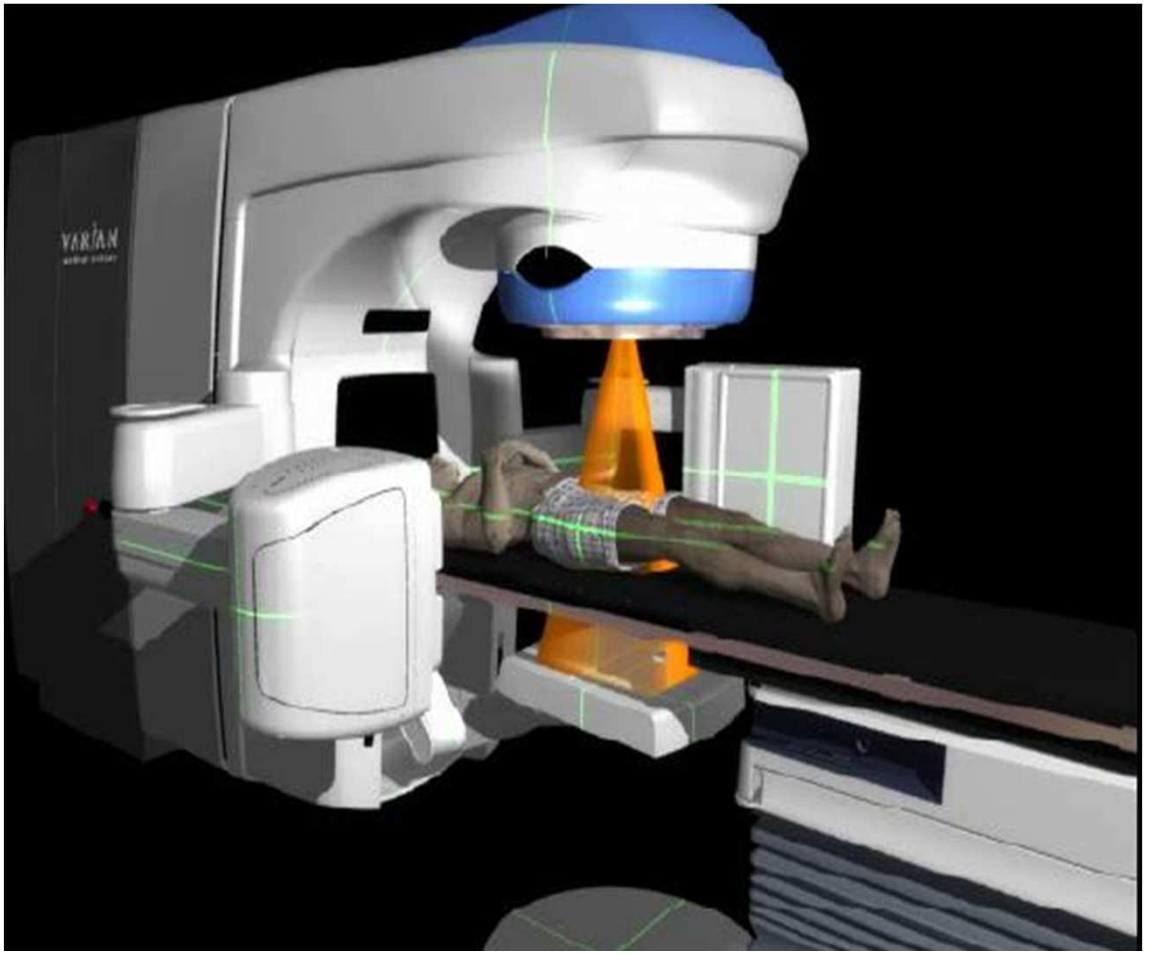
Radiation therapy (based en X or e^- 6-20 MeV)



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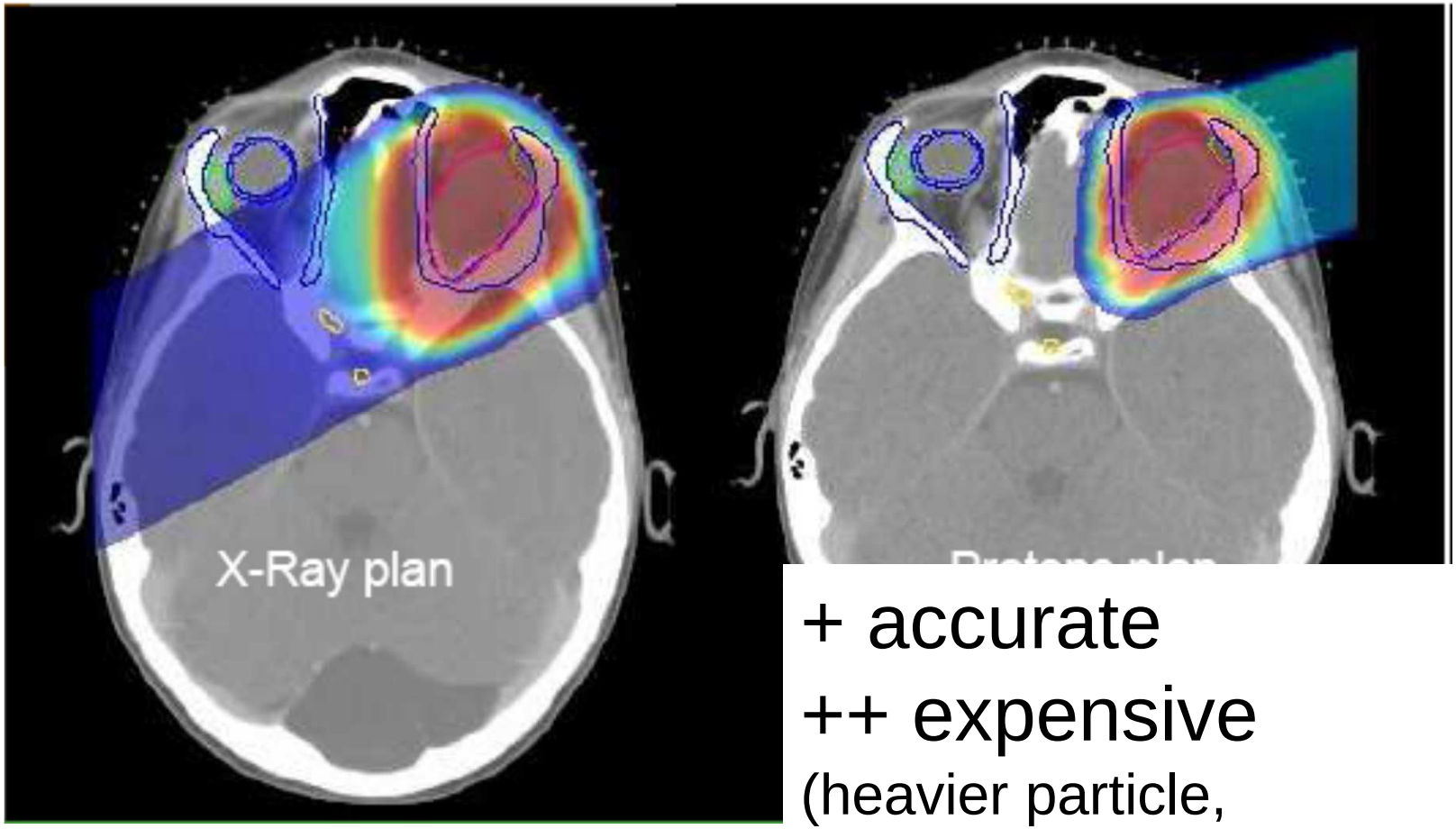
Radiation therapy with protons



+ accurate

++ expensive

(heavier particle,
more accurate treatment)

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Hadron Therapy Pioneers

The Harvard Cyclotron Laboratory
1960-2002

The Svedberg Laboratory, Uppsala
1957-1970

The LBNL 184-Inch Synchrocyclotron
1954-1986

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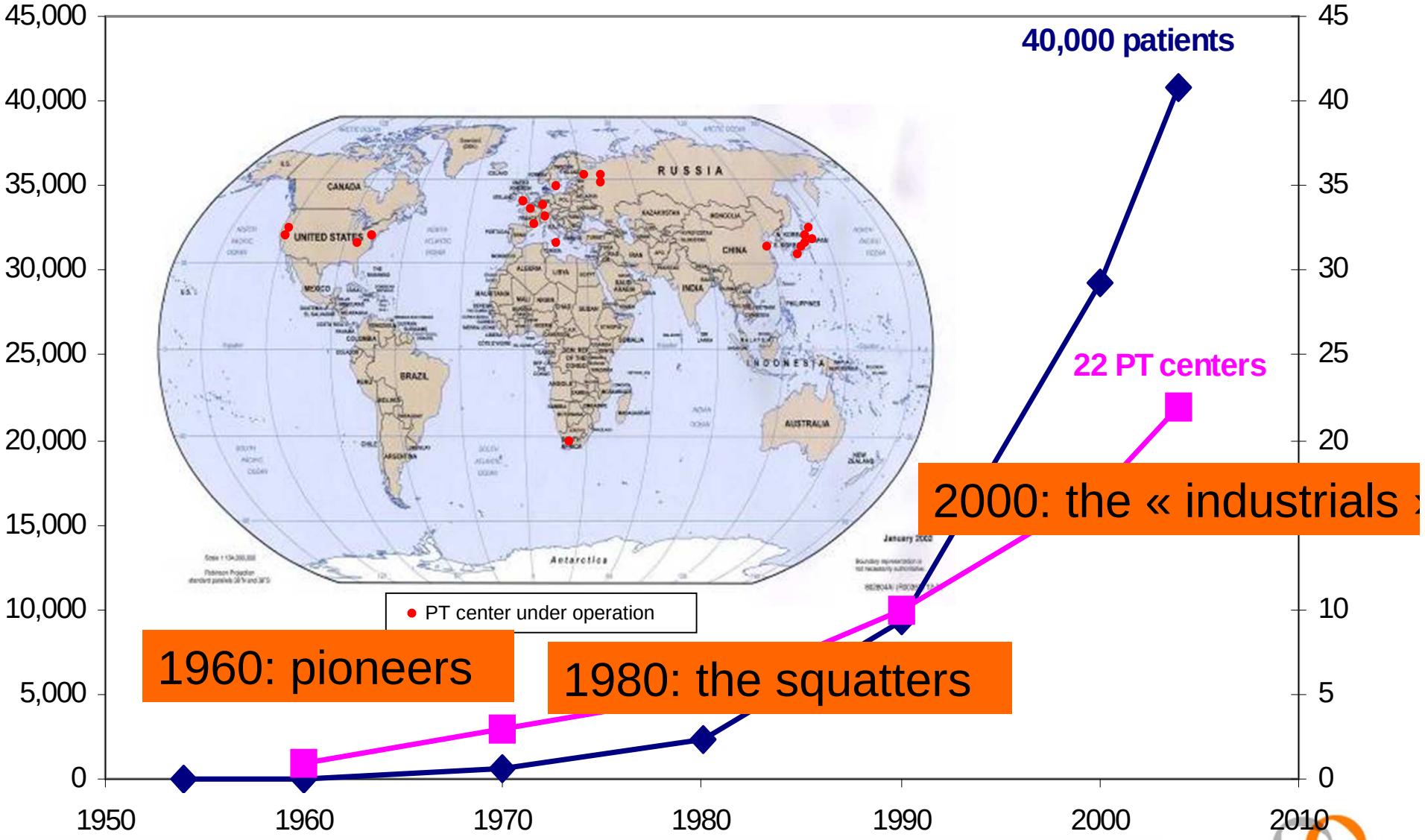
Protontherapy < 1% of radiation therapy



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Hospital cent

5 in USA, 4 in Japan, 1 in China, 1 in Switzerland, 1 in Germany, 1 in Korea, 1 in Italy, 1 France …

(running or financed: 50 to 130 M€/facility)

6 companies offer turn-key centres

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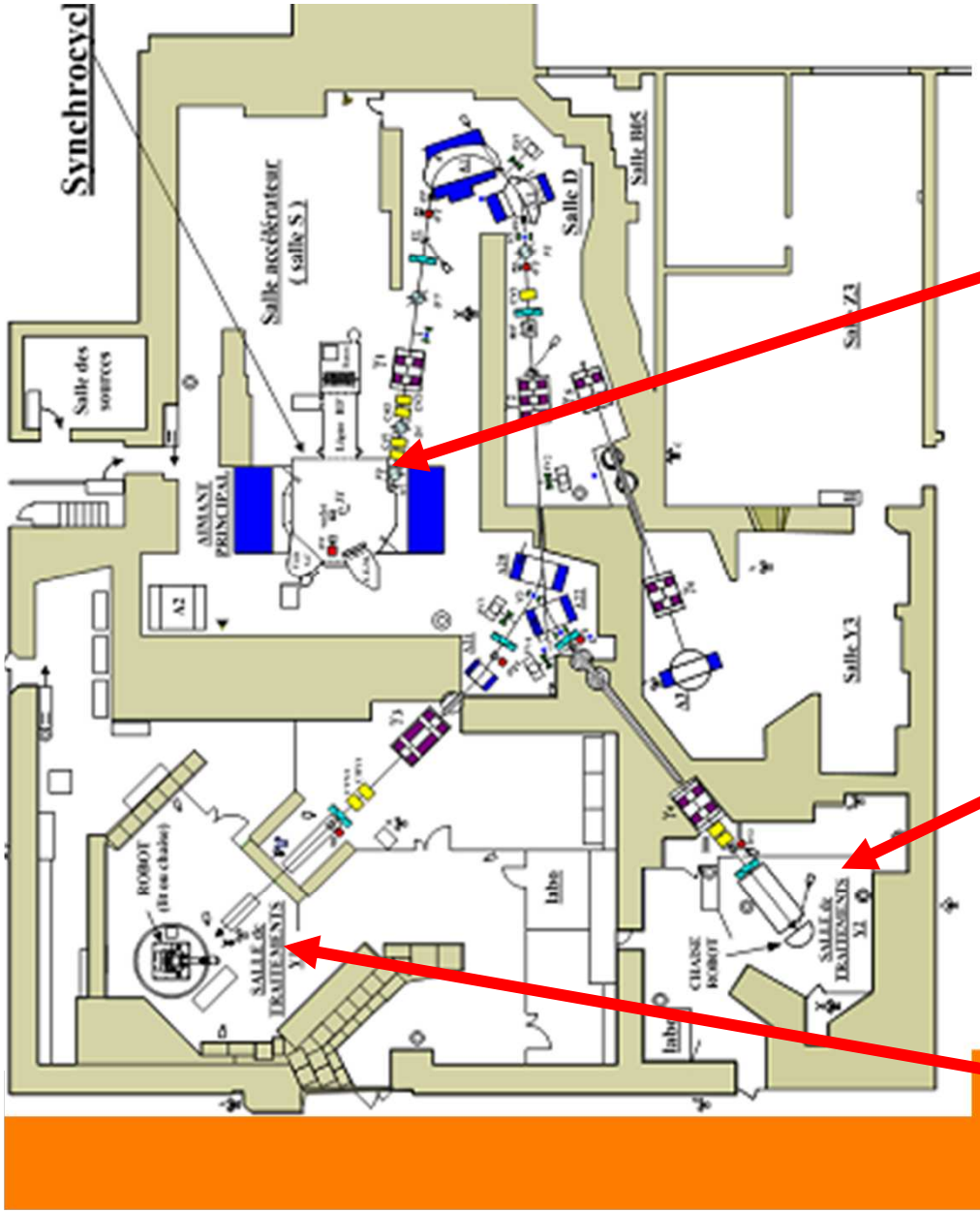
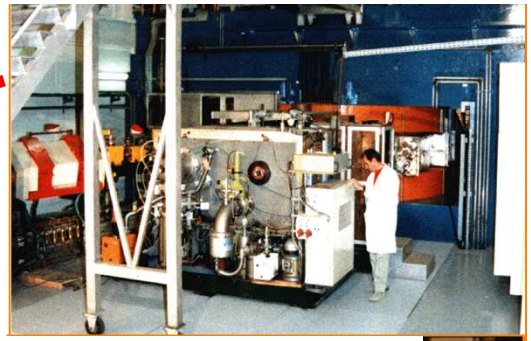
Institut Curie- Centre de protonthérapie – Orsay (45 persons, 14 for technical)

Starts 1991. Patients treated: + 4000 eye + 1000 head&neck



Synchrocyclotron 200Mev



Small fields room

Large fields room

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The medical specifications

	2006 (fixed beam)	from 2010 (with a gantry)
Eye Tumours	240	240 – 300
Base of skull	90	160 – 200
Children	10	100 – 130
Others	-	80 – 100
TOTAL	340	580 – 730

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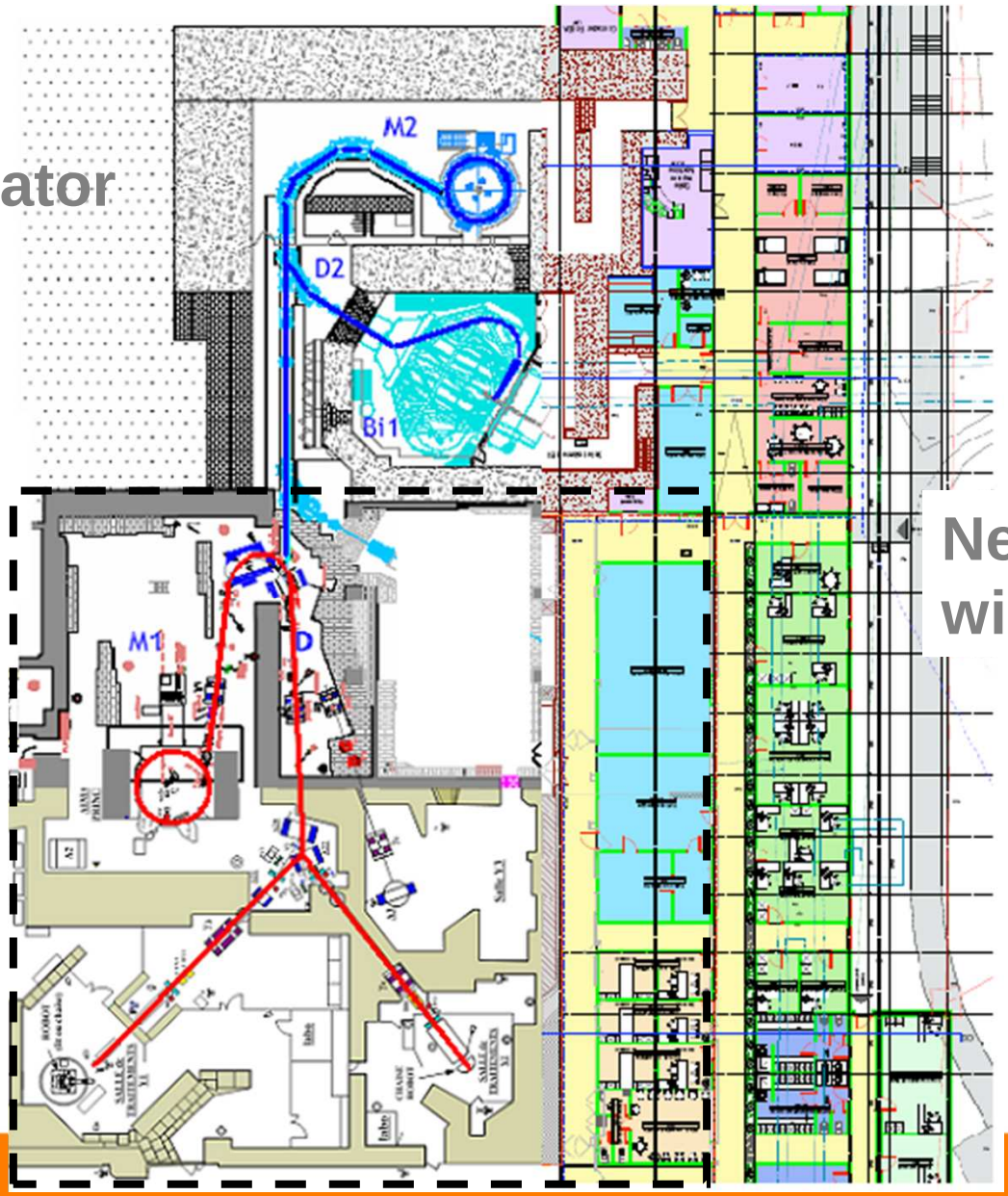
The project 2006-2010 : extension and renovation of the facility

New accelerator
+ gantry
+ beamlines



New medical wing

Existing Facility

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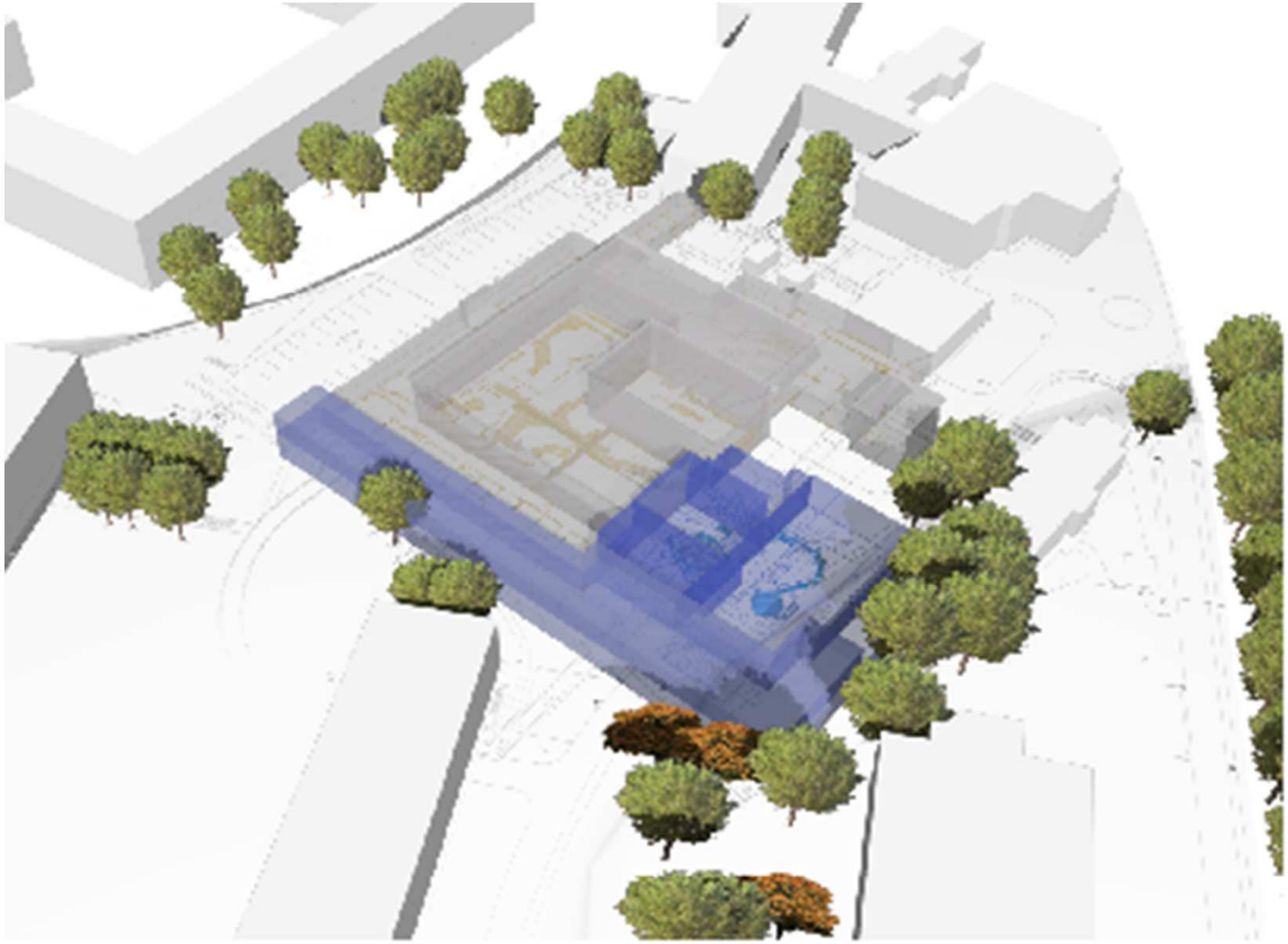
Building integration in the Campus



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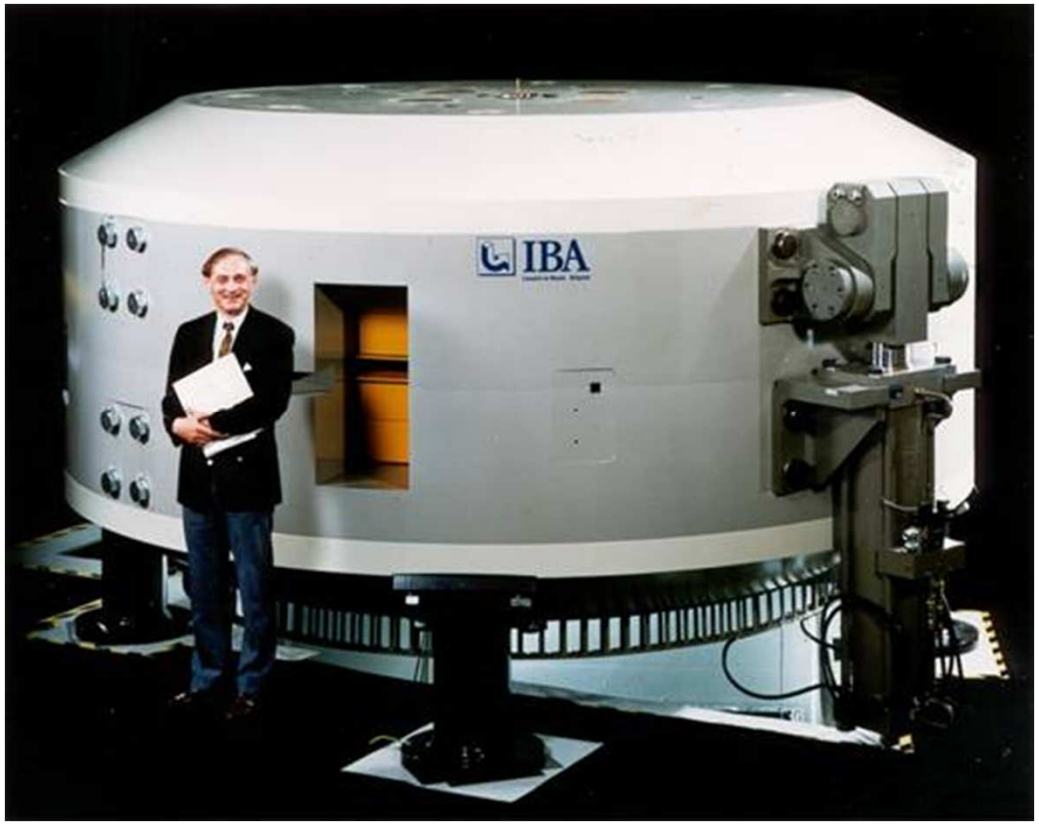
Accelerator (230 MeV, 500nA)



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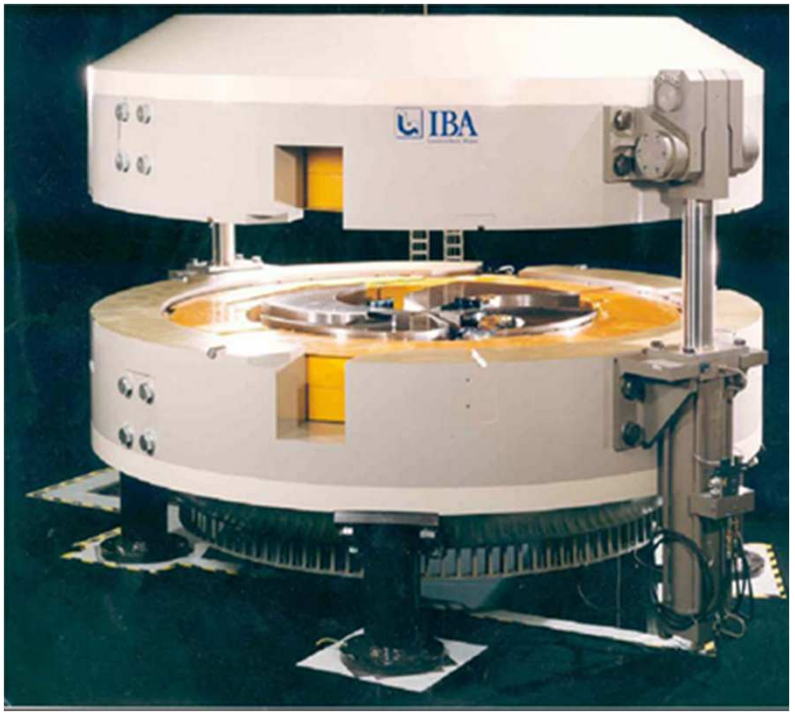
Le cyclotron (1)



Energie: 230 MeV
Courant max: 500 nA
Minimum: 0,1 nA
Emittance: 12 pi.mm.mrad
Diamètre extérieur magnétique: 434 cm
Hauteur totale magnétique: 210 cm
Poids total aimant: 220 tonnes
Consommation électrique: 446 KW

Mode harmonique: 4
Fréquence: 106,1 Mhz
Tension Dee (extraction) 130 kV peak

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Cyclotron (2)

Nombre de secteur: 4
Hauteur maximum entrefer: 96 mm
Champ maximum colline: 2,9 t
Champ maximum vallée: 0,9 t
Champ moyen à l'extraction: 2,188 t
Champ moyen au centre: 1,76 t
Induction magnétique: 5.234 10E5 At
Densité de courant des bobines: 155 A/cm2
Puissance par bobines: 110 Kw
Poids par bobines: 10,4 t
Poids d'acier: 200 t

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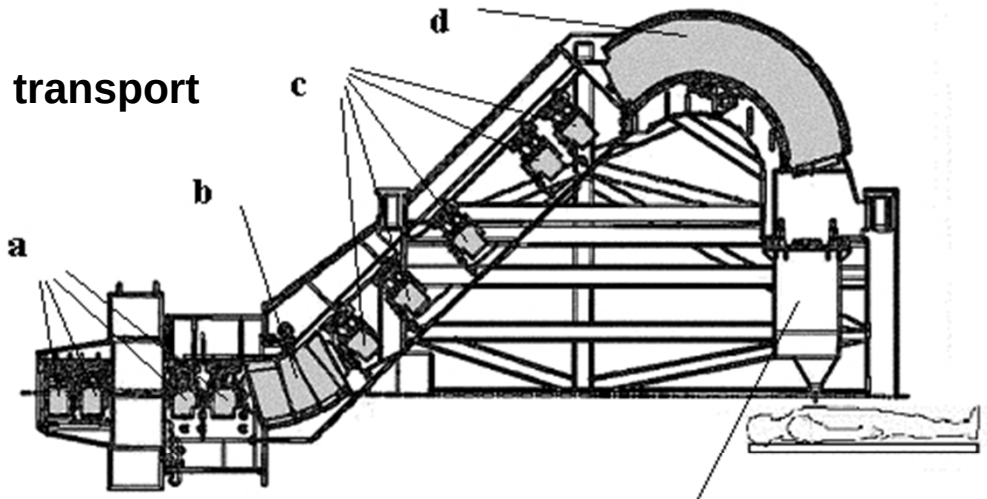
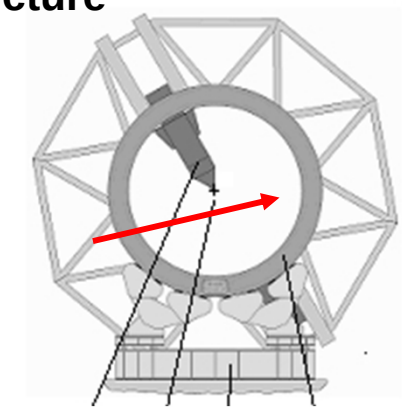
Gantry (120 tons, D = 10,5m)

Beam line transport



Rotation structure



Gantry (10 m, 120 t)

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Gantry treatments

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Systems Process Teams

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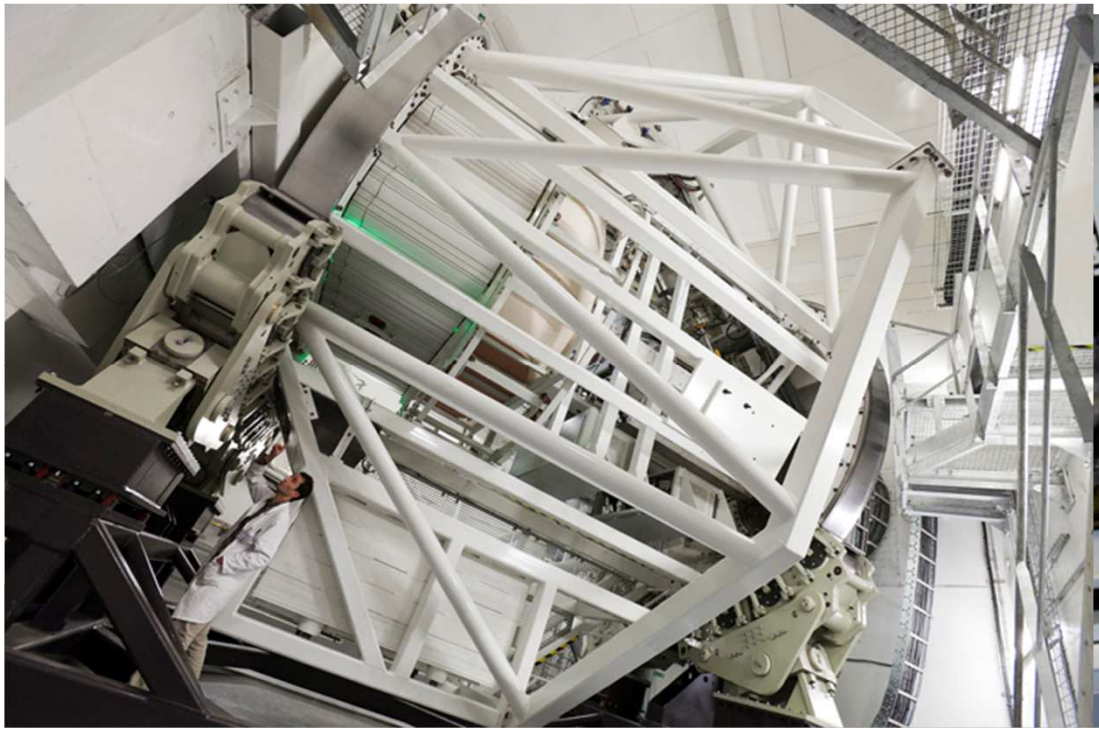
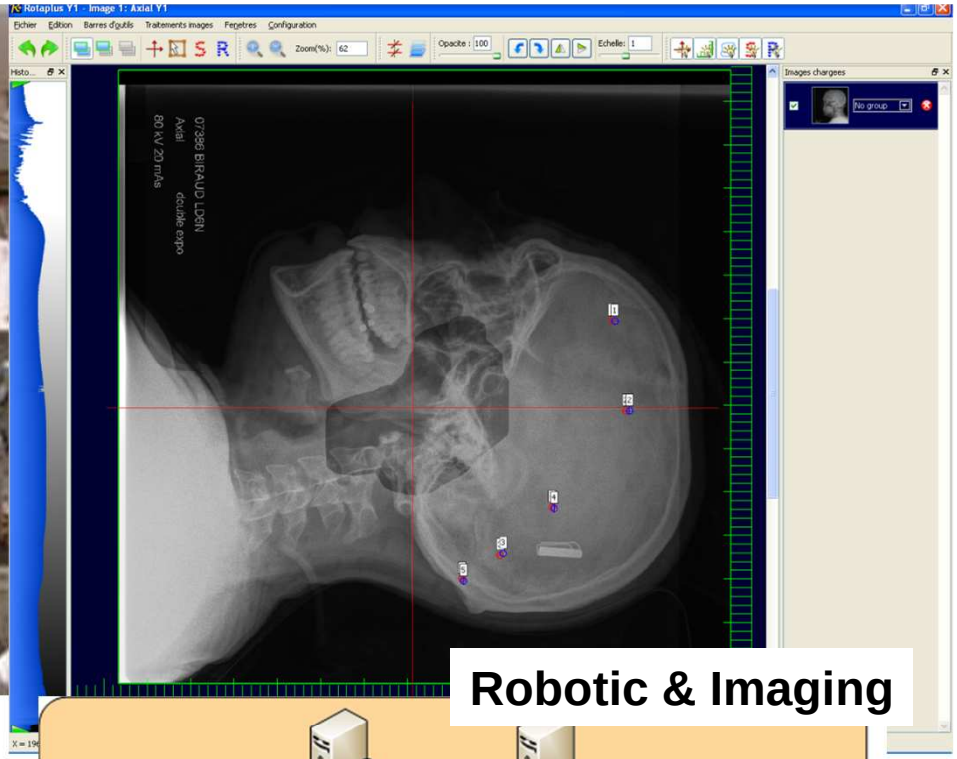
CHARGE 300Kg max.


aquaciaPOWER

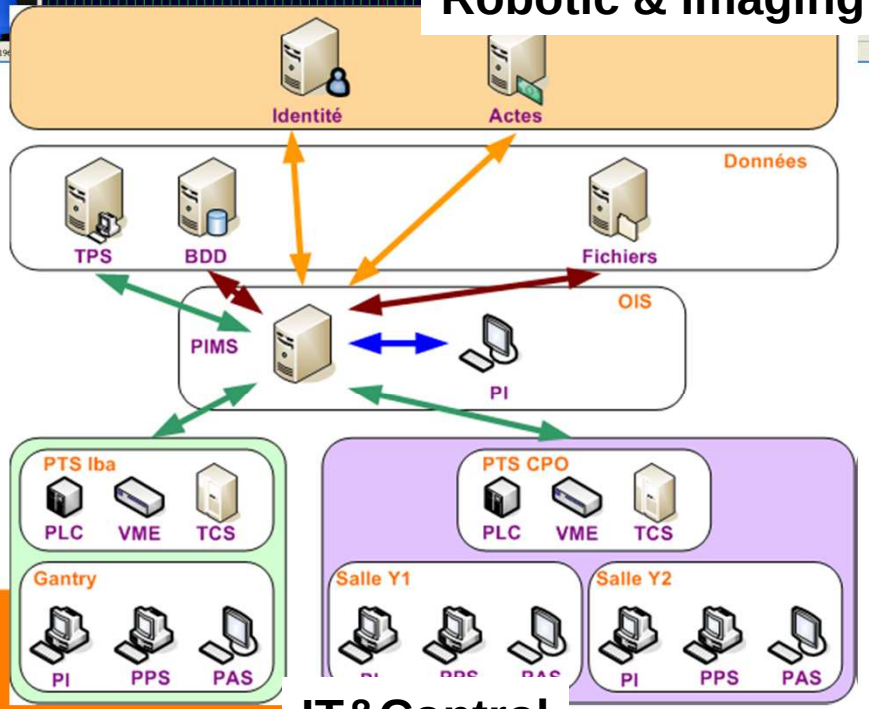


Cyclotron&Beamline)



Robotic & Imaging

R&D physics &Technology



IT&Control

Intracrânien — Contrôle colli

Contourage	Balistique	Usinage	Contrôle orientation et forme	CQ	Cliché RX Colli	Scan des accessoires	Double expo	Stockage
•Radio-thérapeute •Radio-thérapeute •Contourage volumes cibles et OAR •Dossier patient isogray	•Physicien ou dosimétriste •Physicien et radio-thérapeute •Modélisation 3D volume cible •Dossier patient Isogray	•Mécanicien •Mécanicien •Contrôle forme et orientation avec transparent isogray. Collage code barre •Suivi faisceau dans PI	•Manipulateur •Physicien •Contrôle forme et orientation •Suivi faisceau dans PI	•Manipulateur ou physicien •Physicien •Mesure de la dose et du parcours à un point donné •PI	•Manipulateur •Physicien •Cliché RX pour valider forme et orientation du collimateur si cliché axial impossible • Rotaplus Y1/Verisuit Temp gantry	•Manipulateur •Manipulateur •Scanne code barre •PI	•Manipulateur •Radio-thérapeute •Contrôle du cliché RX •MEDCOM pour Gantry • ROTAPLUS pour Y1	•Technicien

Intracrânien — Contrôle bolus

•Radio-thérapeute •Radio-thérapeute •Contourage volumes cibles et OAR •Dossier patient isogray	•Physicien ou dosimétriste •Physicien et radio-thérapeute •Modélisation 3D volume cible •Dossier patient Isogray	•Mécanicien •Mécanicien •Superpose le transparent des isoniveaux sur le compensateur Collage code barre •Suivi faisceau dans PI	•Manipulateur •Physicien •Contrôle forme et orientation •Suivi faisceau dans PI	•Manipulateur ou physicien •Physicien •Mesure de la dose et du parcours à un point donné •PI	•Manipulateur •Manipulateur •Scanne code barre •PI	•Technicien

Légende pour chaque étape

- •Responsable de l'action
- •Responsable du contrôle
- •Détail du contrôle
- •Support de traçabilité

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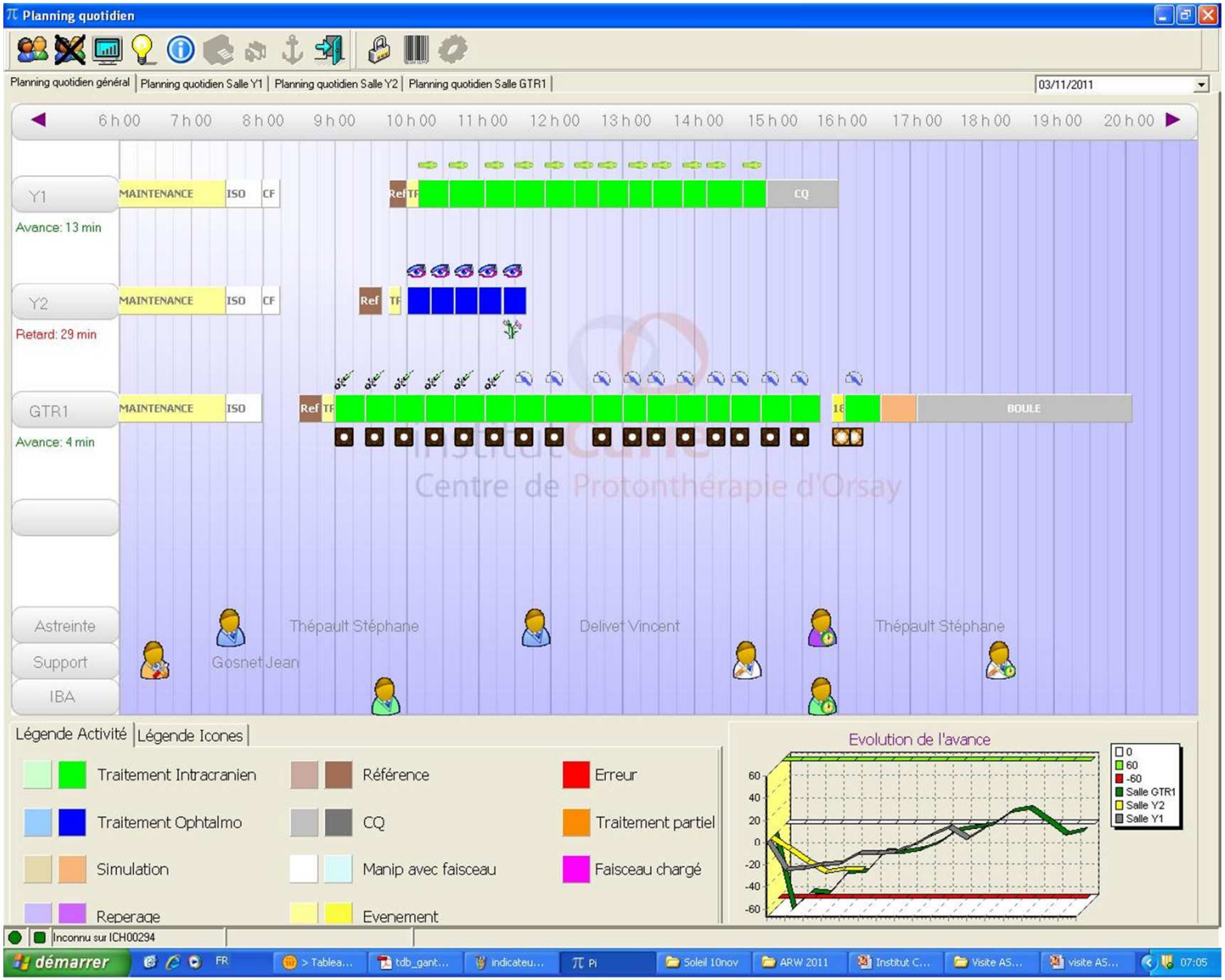

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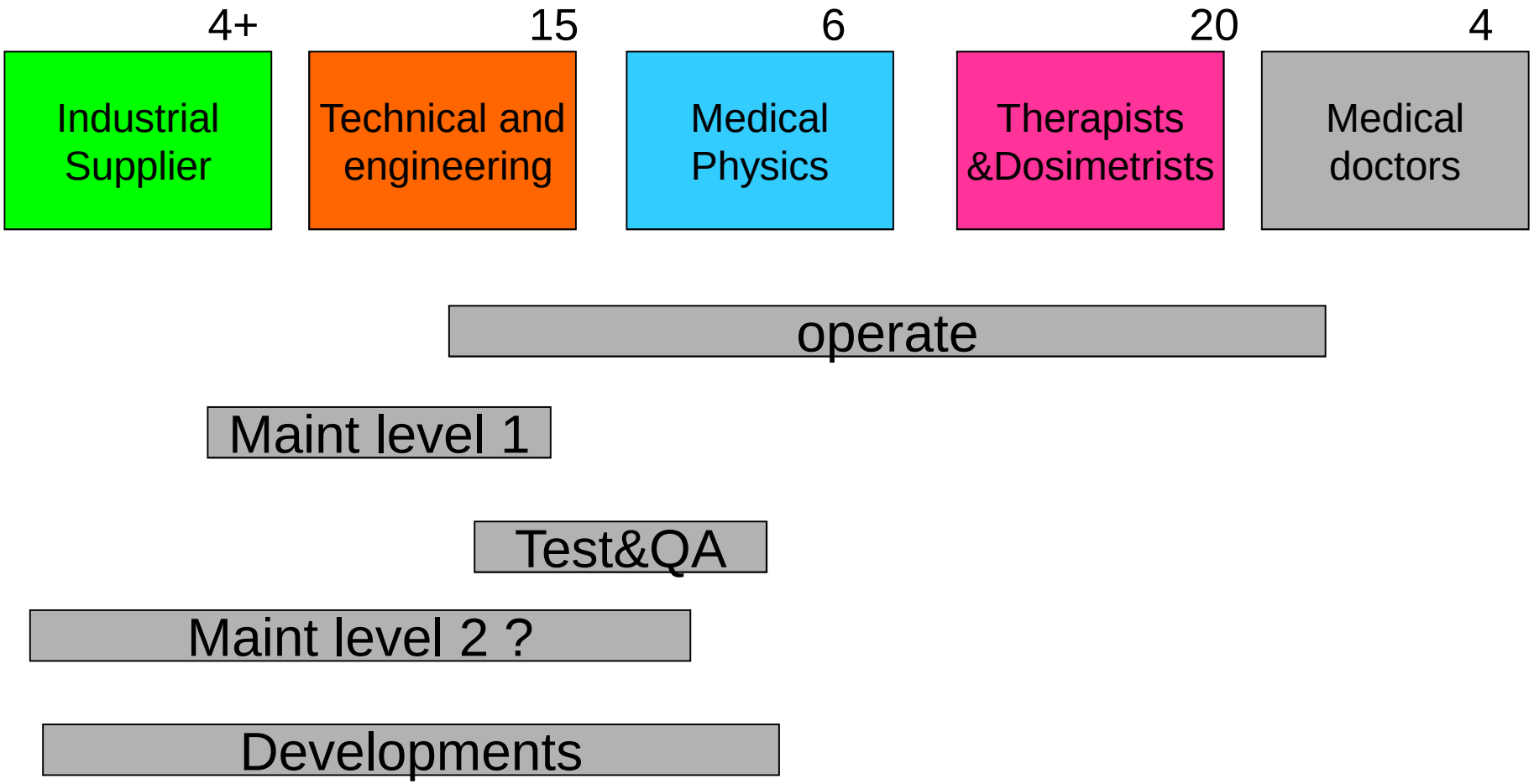

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Organic distribution of the team

kinds of activities		machine-lines	IT-control	mechanical	tt rooms	utilities
operation-production	3	2		1		
support	3	1	0,5	0,5	0,5	0,5
maintenance-consolidation	3,5	1,5	0,5	0,5	0,5	0,5
development	5,5	1	2,5	1	1	
	15					

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Reliability&Maintenance for protontherapy

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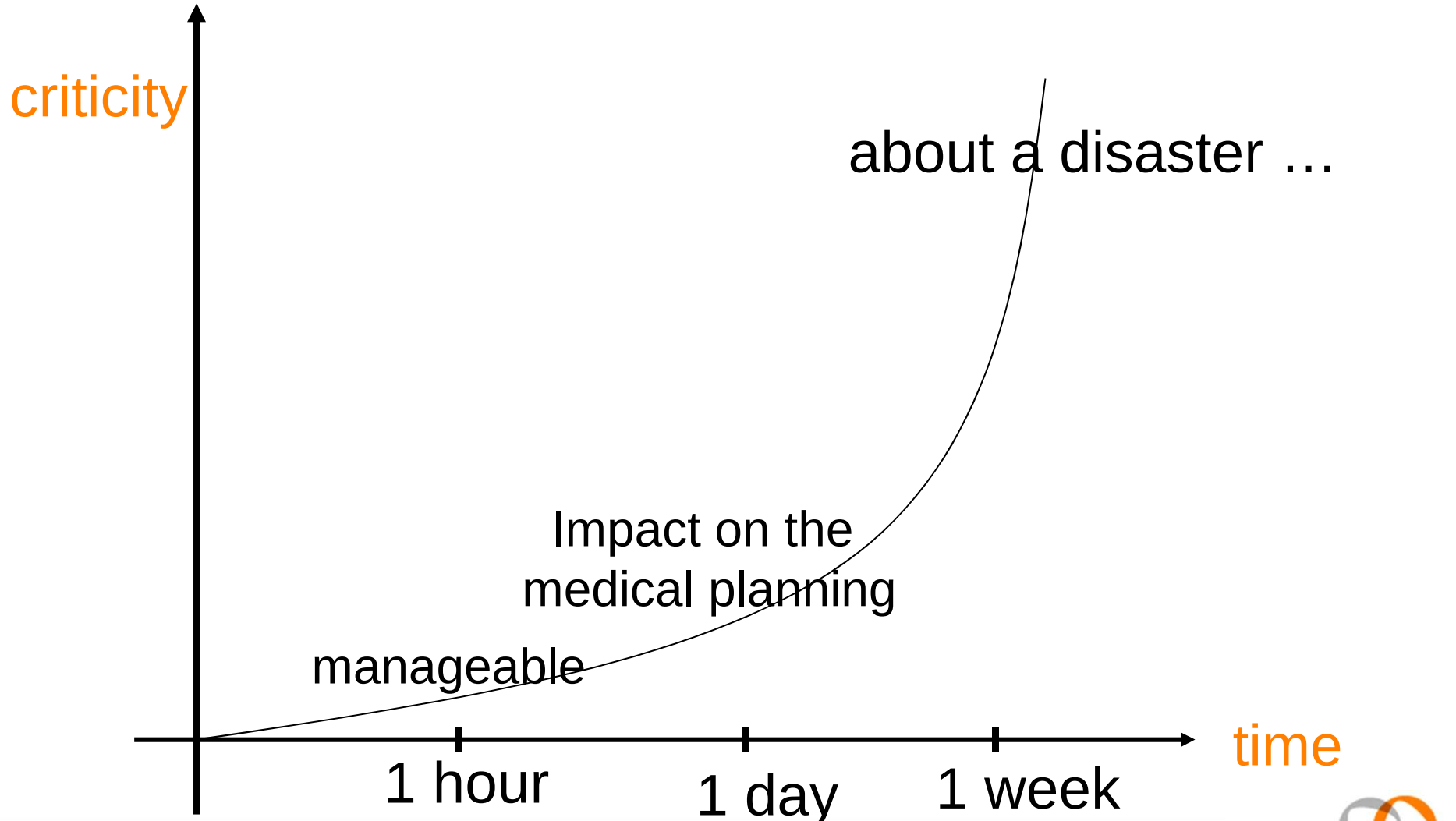
Criticity of breakdowns in a radiotherapy facility



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Maintenance

Electricity + cooling (1.5 MWH)
Building Facilities
Accelerator Technologies
Beamlines + PowerSupplies
Control & IT systems
Imaging&robotics
mechanical
Dosimetry&instrumentation
…

3 treatments rooms

Smaller than light sources
Big diversity

2h Monday + Thrusday Morning
4h some Saturday Morning
1,5 days each 3 months
8 days each year

50 weeks of treatments / year

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Loops of progress
« LEAN » method

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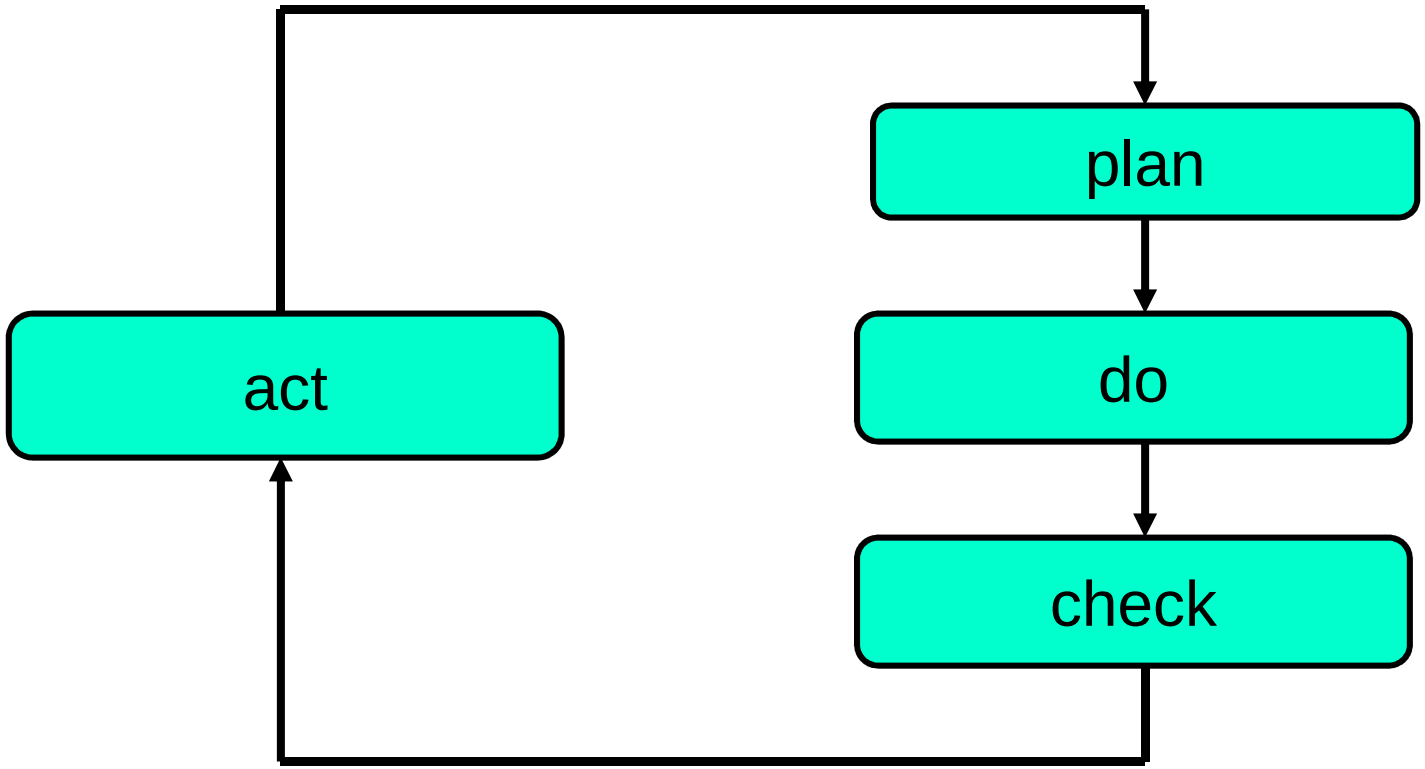
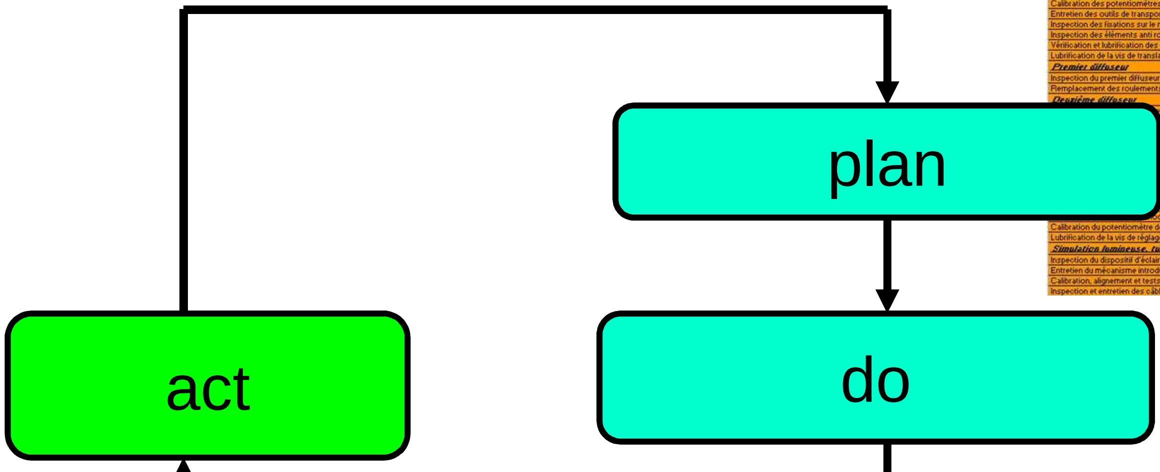
Loop of progress: PDCA (weekly)

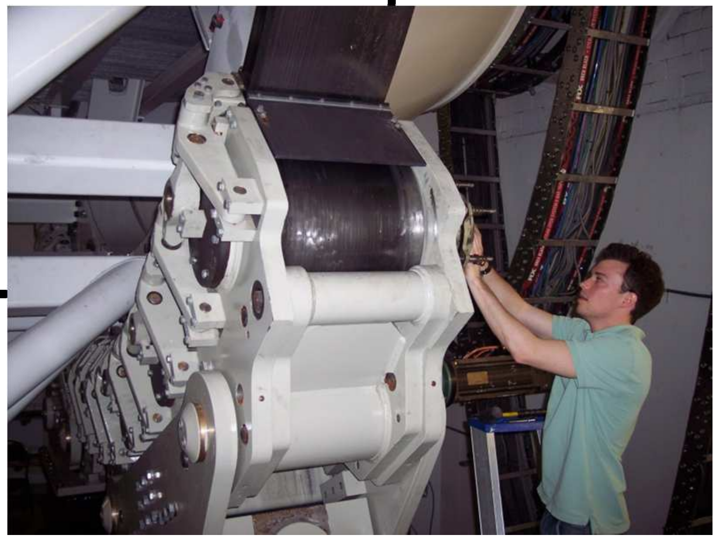


Example 1: maintenance on mechanical

Institut Curie - Centre de Protonthérapie Maintenance Database Lin | today 23 03 11 | PAP start 19/02/2009 | PAT start 01/04/2009

Titre des procédures	rocedure	v.	durée	uency (Mon	System	Salle (s)	lieu	condition	nsignati	Type	Date	next dat
Extrémité du bras isocentrique (Nozzle & Snout)												
Contrôle de la connectique et des réglages de l'extrémité du Nozzle (snout)	13515	A	1h	1 à 3	Nozzle	Gantry	Snout			mécaélec	20 11 10	
Contrôle des connexions de puissance électrique du nozzle	13917	B	1h 30'	6	Nozzle	Gantry	Snout		photos !	élec	01 07 10	
Inspection des sous systèmes du nozzle	13919	B	?	6	Nozzle	?	?	Pas de notice !!!		?		
Calibration des potentiomètres de l'extrémité du nozzle de la gantry	13901	B	30' 1h 30'	6	Nozzle	Gantry	Snout			mécaélec	08 10 10	
Entretien des outils de transport et d'installation de l'extrémité du nozzle (snout)	13837	B	50'	6	Nozzle	Gantry	Snout			méca	30 08 10	
Inspection des fixations sur le nozzle	13900	B	30'	6	Nozzle	Gantry	Nozzle			méca	17 09 10	
Inspection des éléments anti rotation de l'extrémité du nozzle	13831	B	1h	6	Nozzle	Gantry	Snout			méca		
Vérification et lubrification des éléments de positionnement du snout	13575	B	30'	6	Nozzle	Gantry	Snout			méca	16 09 10	
Lubrification de la vis de translation de l'extrémité du nozzle	13834	B	30'	6	Nozzle	Gantry	Snout			méca	10 06 10	
Premier diffuseur												
Inspection du premier diffuseur	13790	C	20' 3h	6	Nozzle	Gantry	RT Snout			mécaélec	25 10 10	
Remplacement des roulements des Lollipops du premier diffuseur	13793	B	1h	6	Nozzle	Gantry	Nozzle			méca		
Deuxième diffuseur												
…eur	13803	B	20' 3h	6	Nozzle	Gantry	Nozzle			mécaélec	30 10 10	
…ième diffuseur	13806	B	20'	6	Nozzle	Gantry	Nozzle			méca	30 10 10	
… deuxième diffuseur	13899	B	1h 1h 10'	6	Nozzle	Gantry	Nozzle			mécaélec	08 10 10	
…r variables												
…ble de profondeur	13801	B	20' 3h	6	Nozzle	Gantry	RT Snout			mécaélec	25 10 10	
…roir du modulateur variable	13794	B	20'	6	Nozzle	Gantry	Nozzle			mécaélec	11 12 10	
…dulateur variable de profondeur	13825	B	30'	6	Nozzle	Gantry	Nozzle		photos !	élec	23 03 10	
…ement du modulateur variable	13907	B	10'	6	Nozzle	Gantry	RT Snout			mécaélec	08 10 10	
…e la petite roue du modulateur variable	13913	D	1h	6	Nozzle	Gantry	Snout			mécaélec	25 10 10	
…e la petite roue du modulateur variable	13796	B	1h	6	Nozzle	Gantry	Snout			mécaélec	11 12 10	
…odulateur variable de profondeur	13798	B	30'	6	Nozzle	Gantry	Nozzle			méca	11 12 10	
Calibration du potentiomètre de réglage de la grande roue du modulateur variable	13898	B	20' 30'	6	Nozzle	Gantry	Snout			mécaélec	08 10 10	
Lubrification de la vis de réglage du collimateur variable	13823	B	1h 30'	6	Nozzle	Gantry	Nozzle			méca	30 08 10	
Simulation lumineuse, tubes RX et chambres d'ionisation												
Inspection du dispositif d'éclairage (fibre optique, simulation lumineuse)	13826	B	30'	6	Nozzle	Gantry	Snout			mécaélec	23 12 10	
Entretien du mécanisme introduction / extraction du tube RX du nozzle	13916	B	45'	6	Nozzle	Gantry	Nozzle			mécaélec	16 09 10	
Calibration, alignement et tests rayons X	12291	A	3h	3	gantnoz	Gantry	gantry nozzle		photos !	mécaélec	08 09 09	
Inspection et entretien des câbles HT des tubes à rayons X	18822	A	2h	6	gantnoz	Gantry	gantry nozzle			méca	30 10 10	





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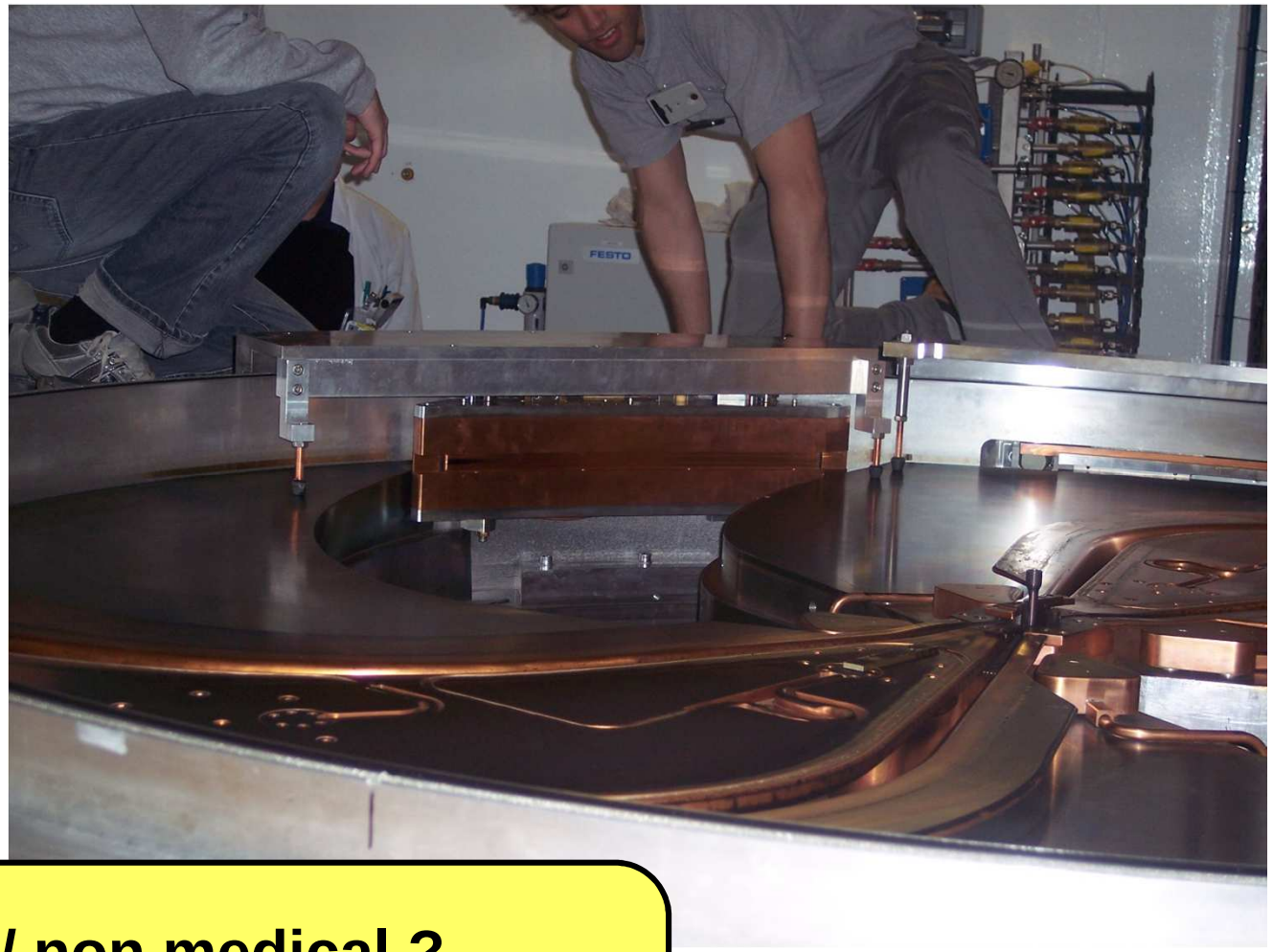
Example : work on sensible part of the machine



Medical / non medical ?
Who will aware the impact on beam ?
Who will define the test ?

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« integral » approach of considerations

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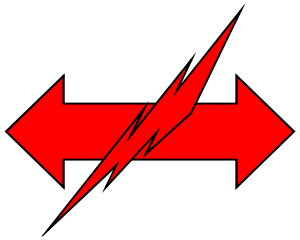
Considerations for treatment

safety

conformity

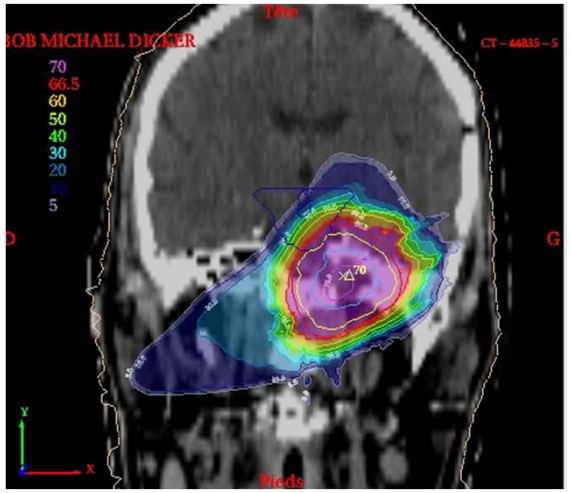
reliability

productivity



development

safety in radiation therapy (a major issue)



- **a safe treatment**
  - good beam (1-settings , 2- read-outs)
  - good position
  - good patient
  - …
- **safety helped by risk analysis**
  - analytical (FMEA, number of defence barriers)
  - retrospective (real facts, REX)
- **safe if … reliable**
  - Many sessions (days) of beam for a patient

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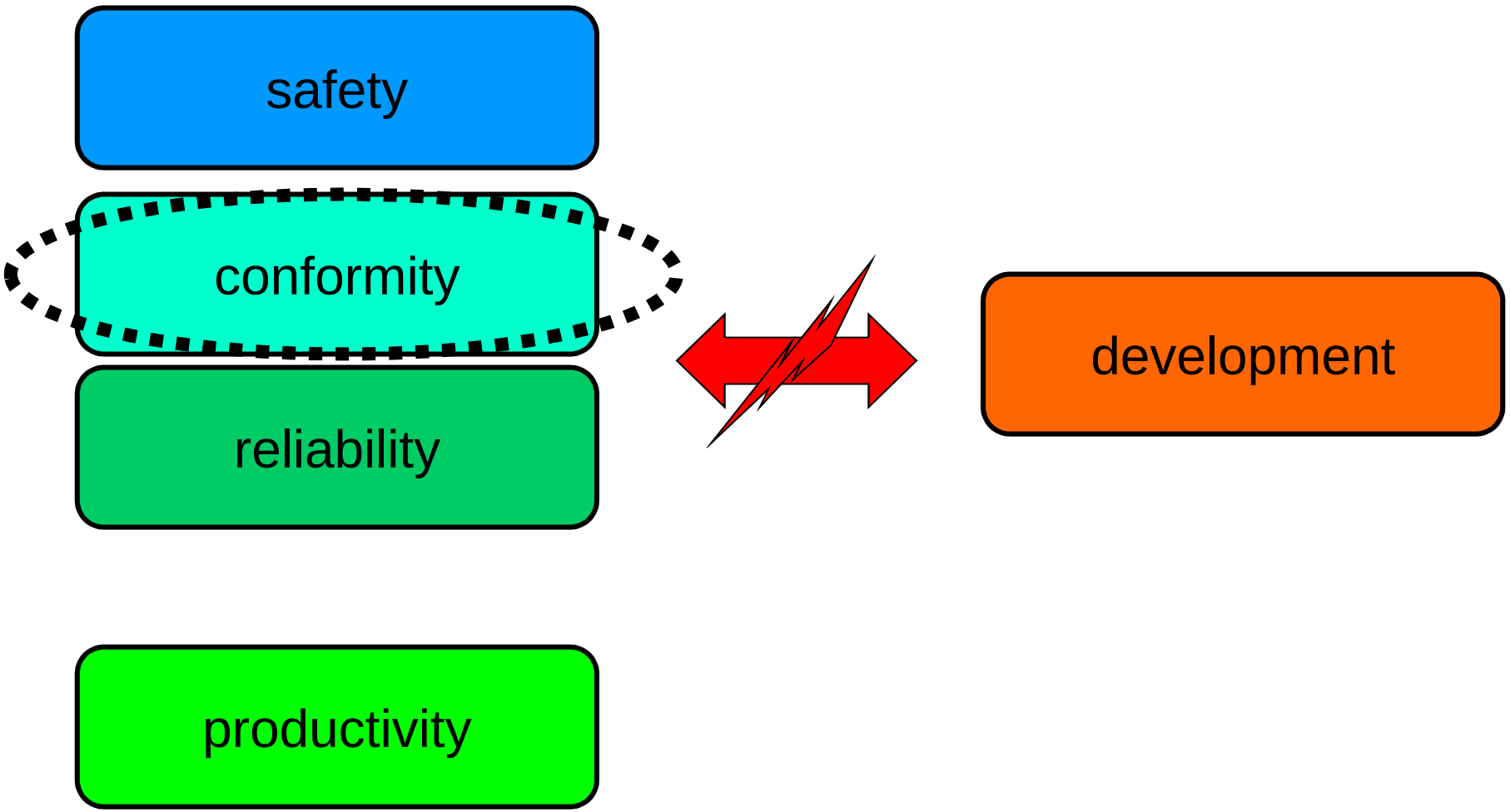
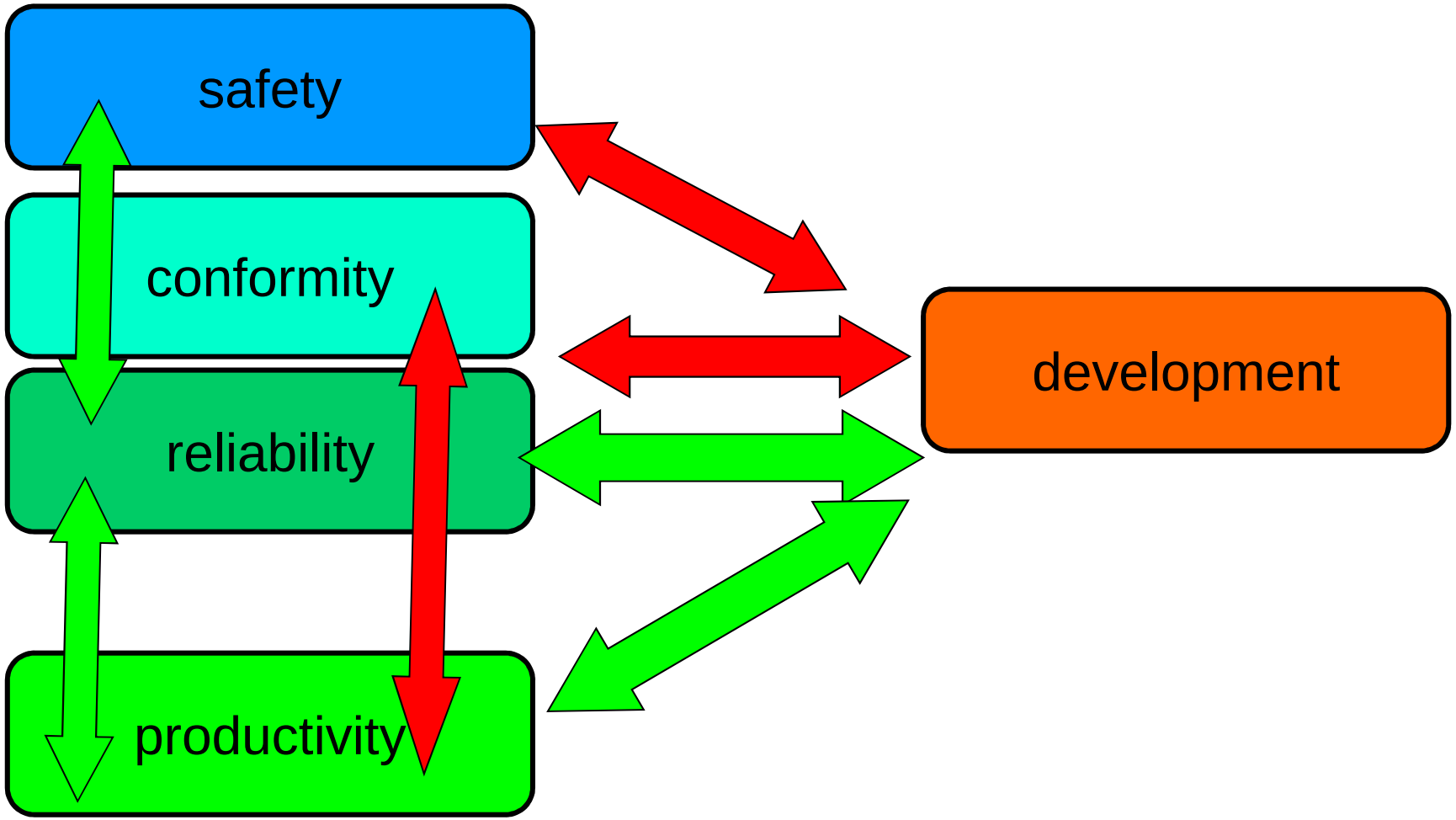

safety
conformity
reliability
productivity
development


safety
conformity
reliability
productivity
development

Working with a main external supplier

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IBA: leader in Protontherapy, 5 facilites as Orsay in the world

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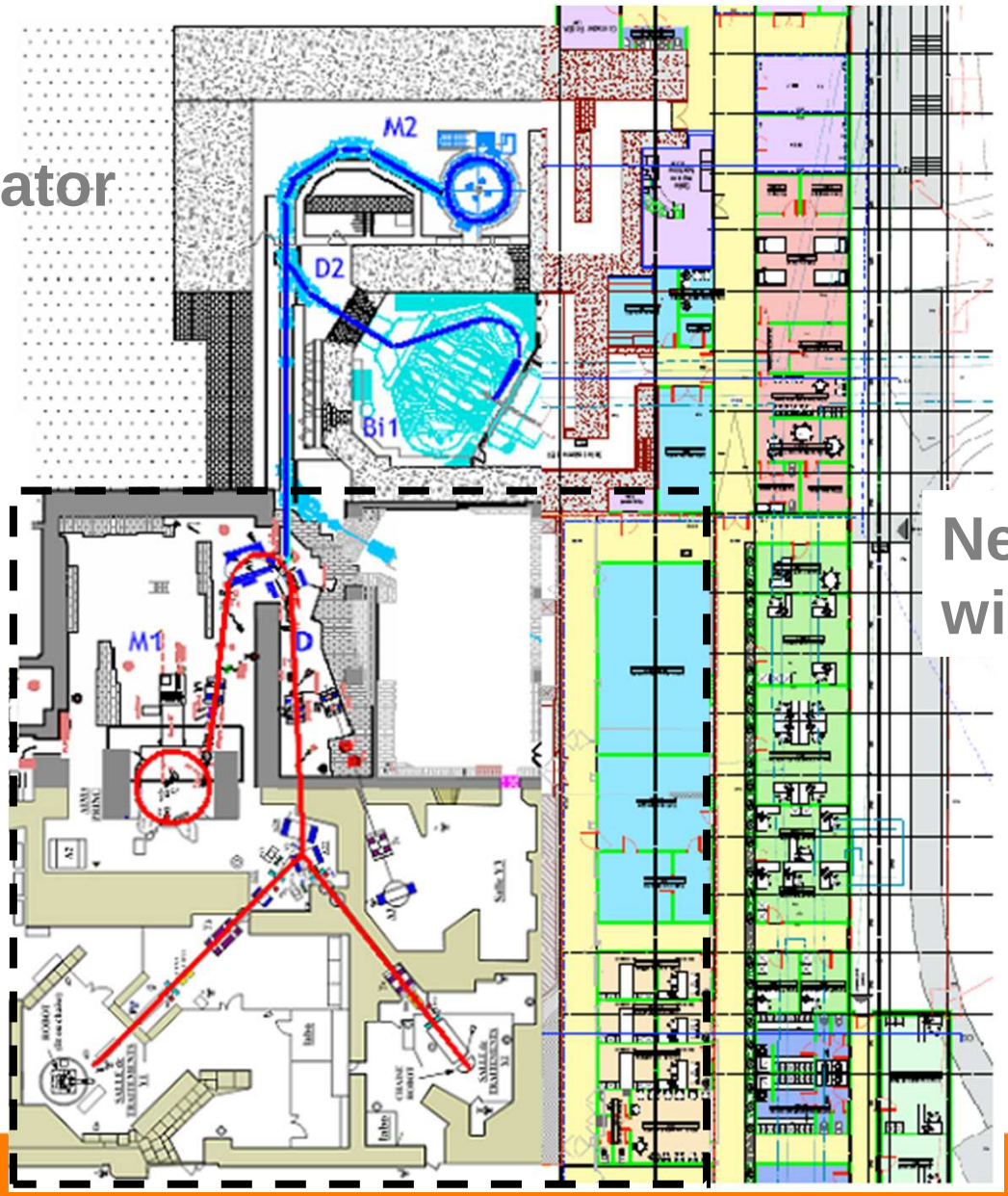
The project 2006-2010 : extension and renovation of the facility

New accelerator
+ gantry
+ beamlines



New medical wing

Existing Facility

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Principles of maintenance
Services contracted to the supplier

Year 0 + Year 1:

training for operating and maintenance level 1

Year 1:

warranty of uptime
shared operating + shared maintenance level 1
all the other maintenances
Spare part package

Year 2 and +

hotline support
support for maintenance level 2
Support for corrective maintenance (delays + numbers)
Spare parts services
updates of software

Principles of maintenance
Services contracted to the supplier

Year 0 + Year 1:

training for operating and maintenance level 1

Year 1:

warranty of uptime
shared operating + shared maintenance level 1
all the other maintenances
Spare part package

Year 2 and +

hotline sup
support for
Support fo
Spare part

2011: New deal for year 2:

-still 3 engineers on site

-3 cooperations group to improve workflow, maintenance & diagnostic

- inject feedbakc of others site

++++

-Industrial approach (systems, maintenance proceedures, spare parts, …)

-Big community ok knowledge and feedback

- complementary approach (ex:obligation to formalize needs) and expert teams

-- - - -

-Time response for upgrade and bug corrections

- where is the right information ?

- on integral approach of the problem

- cost and sometimes differents interests

Inputs for this workshops

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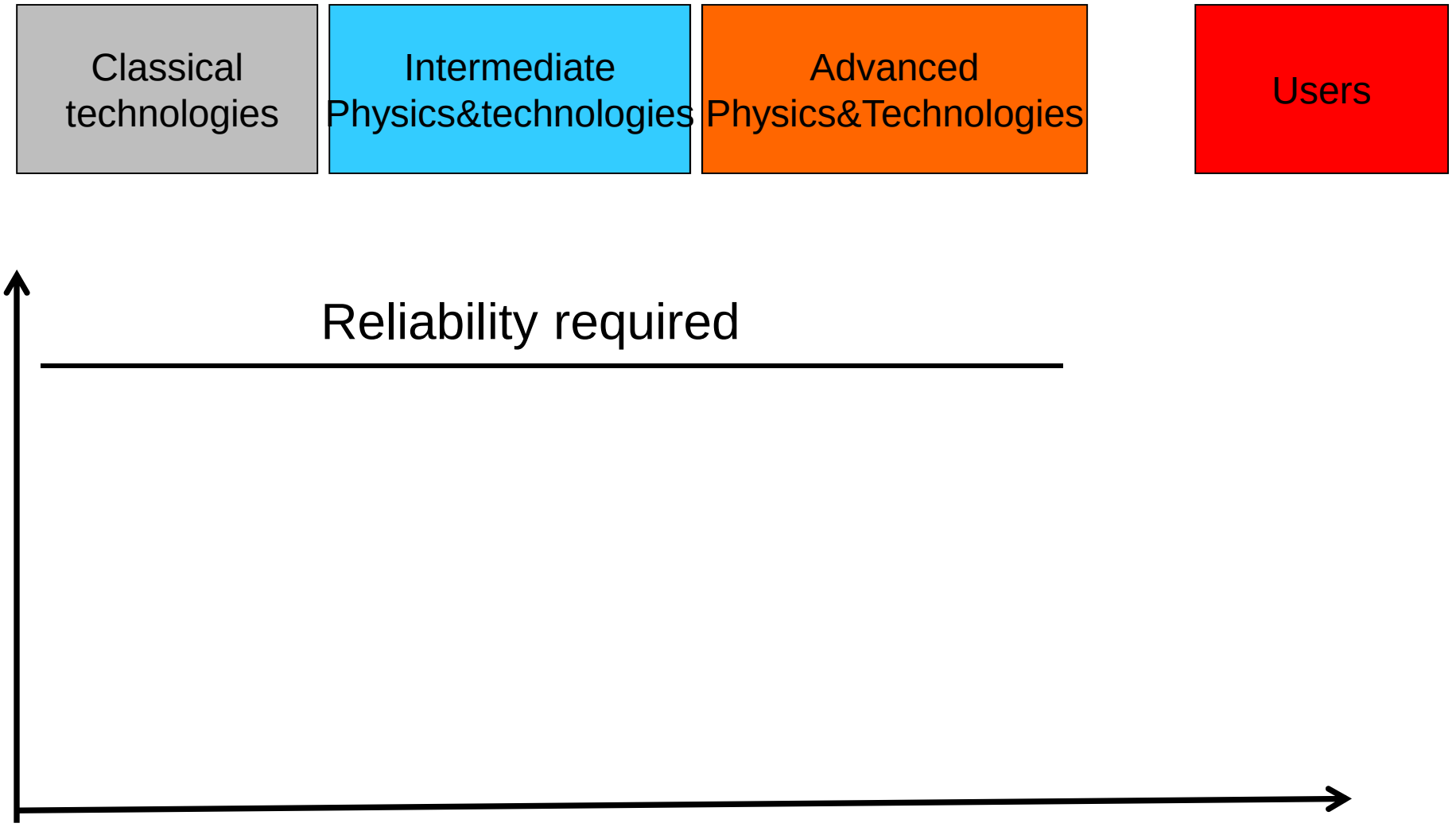
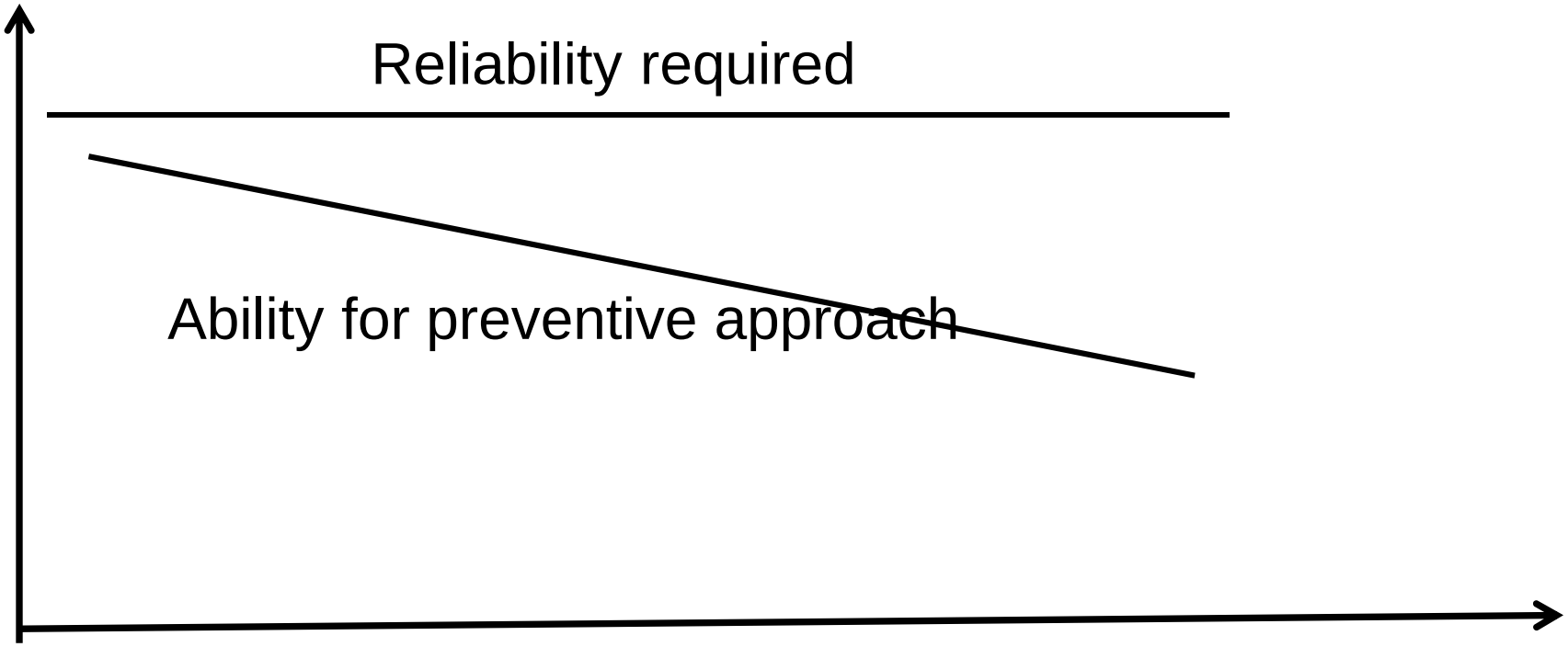

Classical technologies
Intermediate Physics&technologies
Advanced Physics&Technologies
Users
Reliability required

Classical technologies	Intermediate Physics&technologies	Advanced Physics&Technologies	Users



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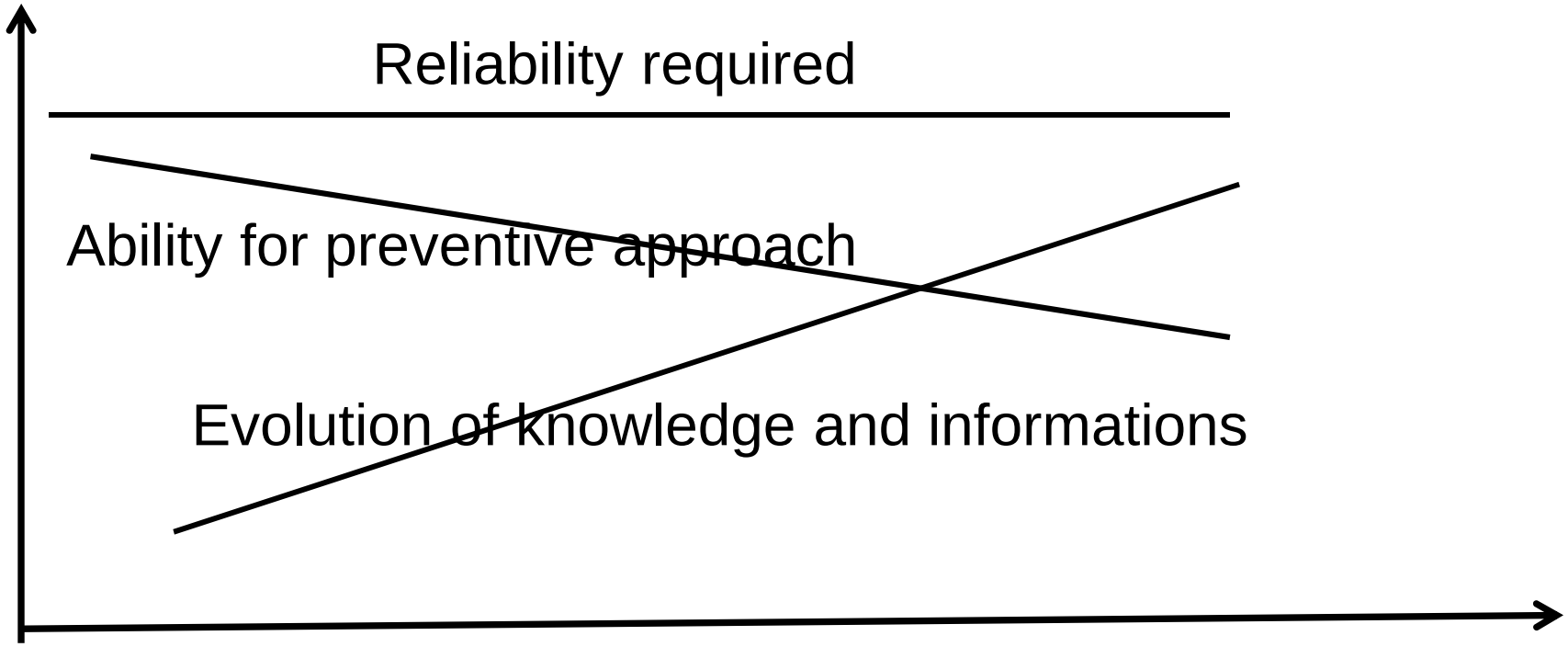
Classical technologies	Intermediate Physics&technologies	Advanced Physics&Technologies	Users



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What is good to centralize ?:

- Decision of planning (week, annual)
- Main indicators for customers (reliability, …)
- Decision on budget, upgrades

What is good to de-centralize ?:

- Specific know-how
- Working groups
- …

What is good to promote ?

- Customers needs
- The maintainers involved in the results
- The efficinet silent works
- The « just » level of documentation
- …

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Nouveau Centre de Protonthérapie

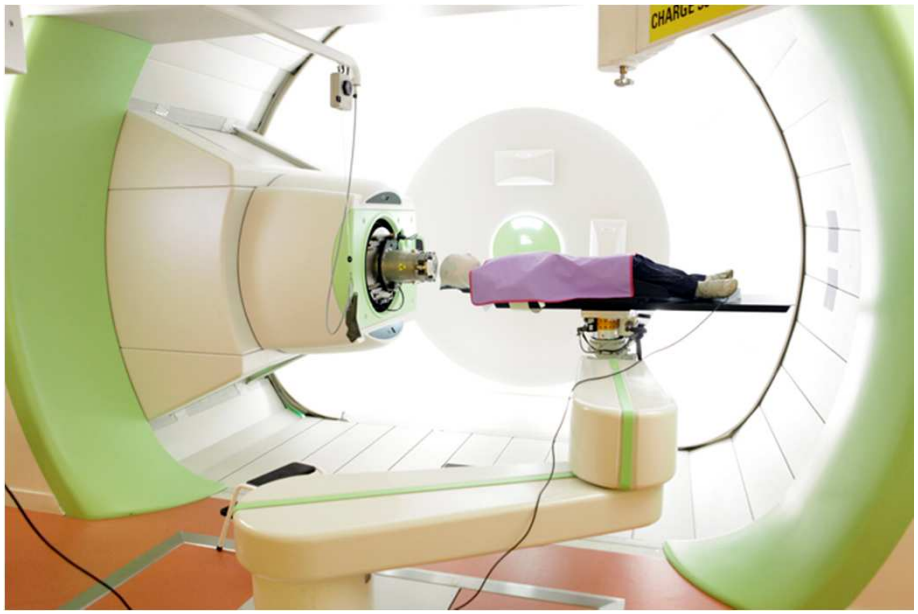
1er treatment ophtalmo: juillet 2010

1er treatment gantry: octobre 2010

1st treatment fix beamline: juillet 2011

5 days/50 weeks / year

<u>224 / 230 days (97,4%)</u> où tous les traitements planifiés ont été effectués le jour prévu (6 jours où ils ont été décalés)
464 patients traités au 30/09/2011.



CPO: J. Argaud, M. Auger, JD Bocquet, E. Brot, V. Delivet, C. Devalckenaere, H.Dupuis, L. Fugeray, J. Gosnet, E. Hierso, A. Maroni, F. Martin, S. Meyroneinc, A. Patriarca, S. Thepault,
+ Physicens Médicaux + Manipulateurs + Médecins
IBA: G. Chau, JB Ruaud, B. Van Lierde, N. Brixko, …

Thank you for your attention

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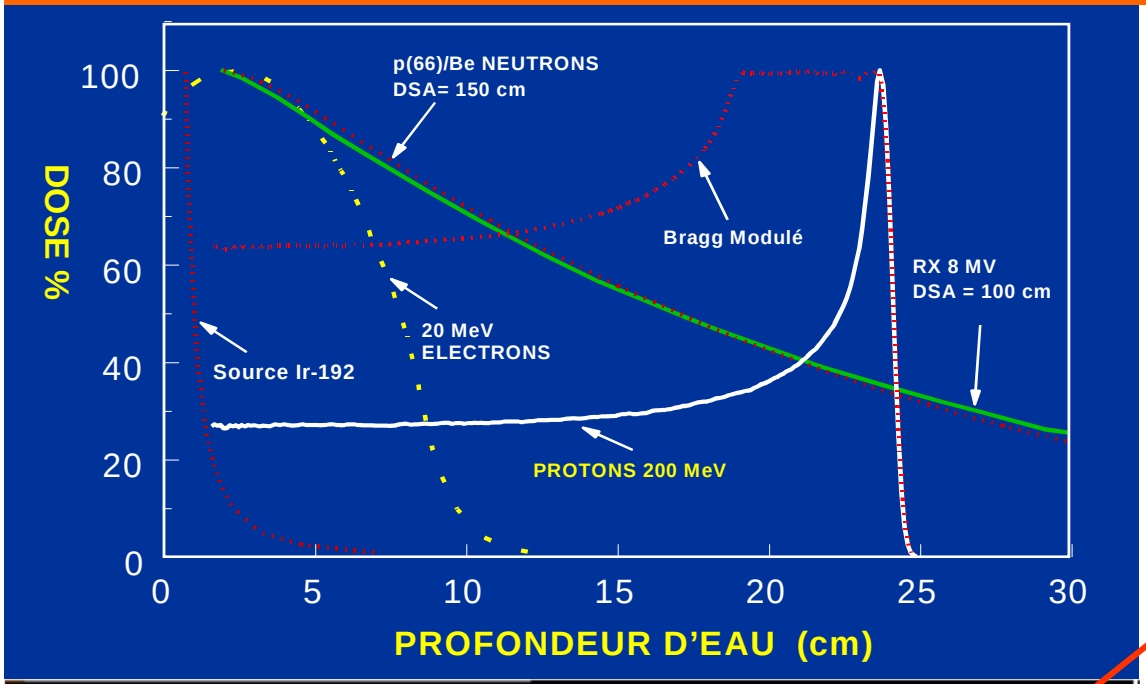
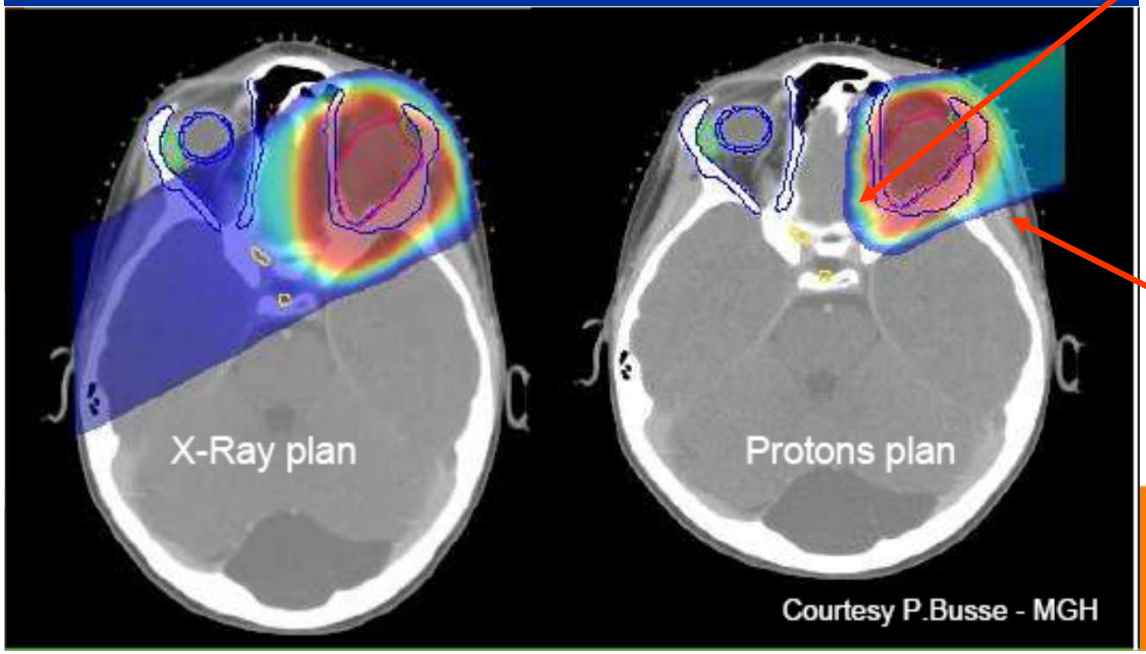
INTERET DES PROTONS



Parcours fini

Protection OAR à l'arrière



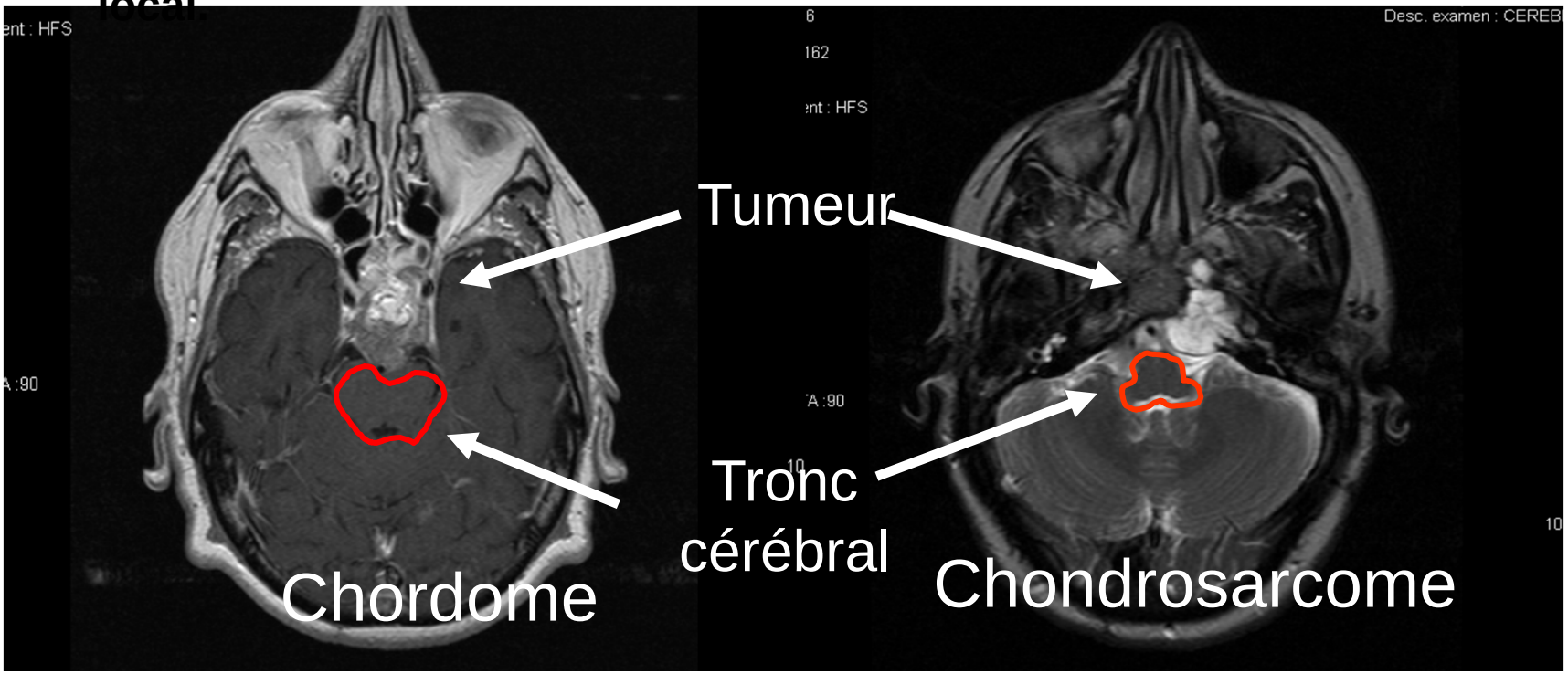
Faible pénombre latérale

Protection OAR adjacents

Indications Classiques (HAS)

Tumeurs radiorésistantes proches d'organes critiques

- **Possibilité de traiter des tumeurs proches d'organes à risque (tronc cérébral, chiasma, nerf optique, cerveau, cochlée, …)**
- **Possibilité de réaliser une escalade de dose afin d'augmenter le contrôle local**



Traitement : 5 séances/semaines pendant 6 à 8 semaines

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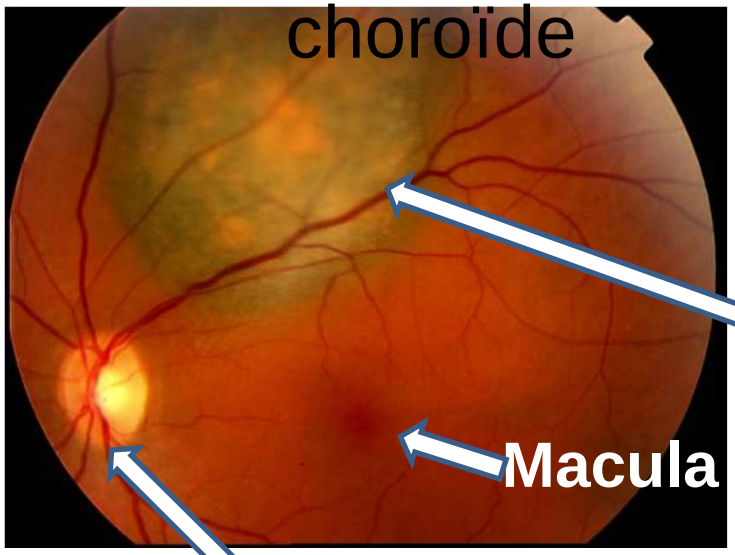
Indications Classiques (HAS)

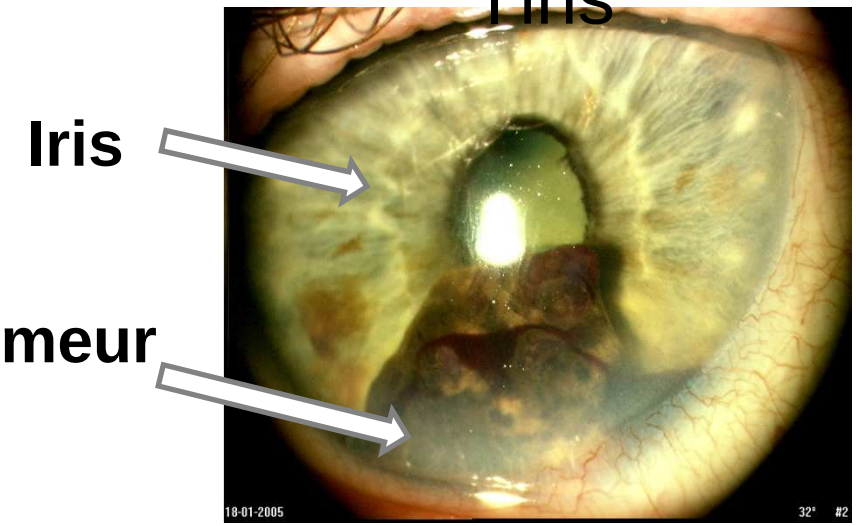
Tumeurs radiorésistantes proches d'organes critiques

- **Possibilité de traiter des tumeurs proches d'organes à risque (cristallin, Macula, papille, nerf optique)**
- **Possibilité de réaliser une escalade de dose afin d'augmenter le contrôle local.**

Mélanome de la choroïde



Mélanome de l'iris



Traitement : 4 séances/semaine pendant 1 semaine

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