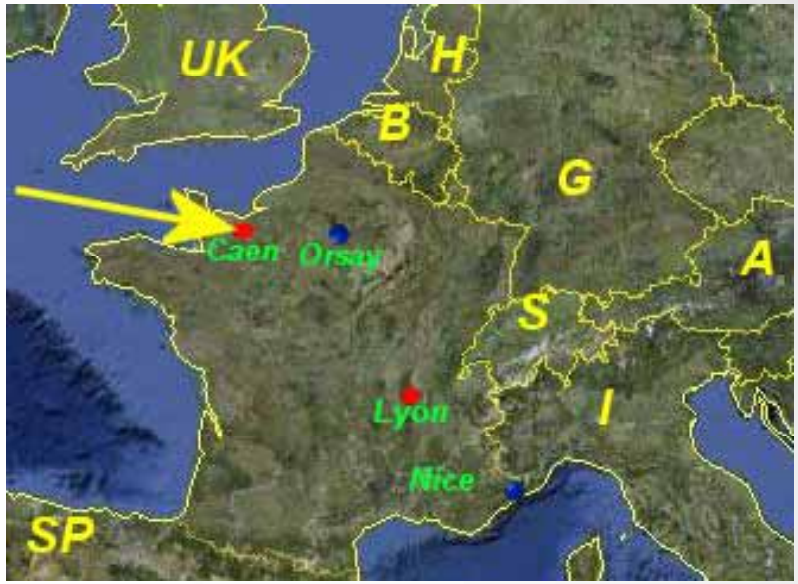
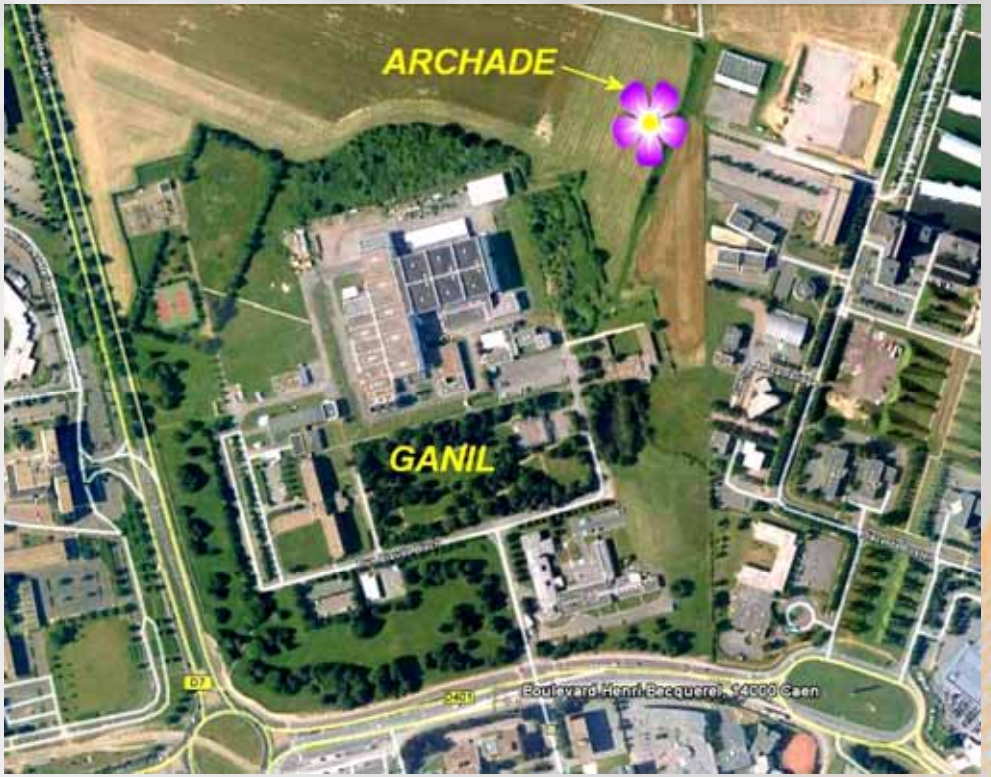
A R C H A D E

Advanced Resource Centre for HADrontherapy in Europe





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Why a resource centre for hadrontherapy?

- The increasing demand for light ion beam therapy is leading to needs in several fields:

    1. *Research in hadronbiology*
    2. *Developments in dosimetry, beam control, fast simulations, treatment planning systems, accelerator and beam transport*
    3. *Clinical research*
    4. *Training for facility users*
    5. *Consultancy and assistance for project initiators*

- This demand requires important beam time that may not easily be available in existing or planned ion beam therapy centres aiming at treatment of patients in routine practice on a large scale.

- A dedicated research centre not bound to treatment of a large flow of patients will help the hadrontherapy community to fulfill its needs

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ARCHADE has three objectives

- To create a European Centre for research, development and training in ion beam therapy

- To validate the prototype of an accelerator dedicated to therapeutic use in a collaboration frame

- To develop an industrial transfer in the field of fabrication and use of medical accelerators

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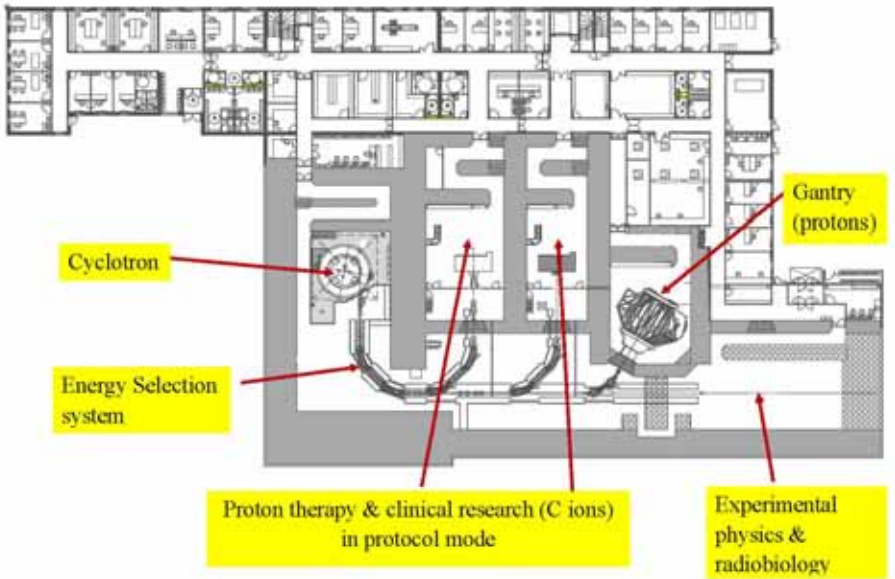
The tools

- A superconducting cyclotron
- Three ion sources
- Fast energy variations by degrader
- Two fixed-beam rooms with beam scanning for therapy & clinical research
- A gantry (protons)
- A fixed beam room for experimental physics & radiobiology



➢ Beams : 260 MeV protons, 400 MeV/n carbon ions and other light ions (α,Li,B, etc.)

- ✓ Intensities for protons and C^{6+} :
  - A few 10 to 100 nA extracted beams
  - A few 100 pA degraded beams for users
- ✓ Time to switch to another particle species 3 minutes
- ✓ Time for 5% energy steps :1.5 second
- ✓ Time for any energy change : 8 seconds

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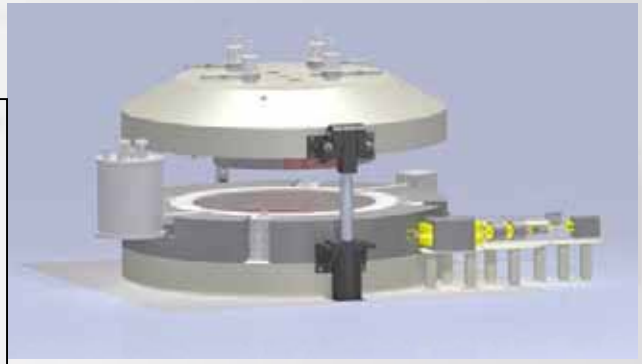
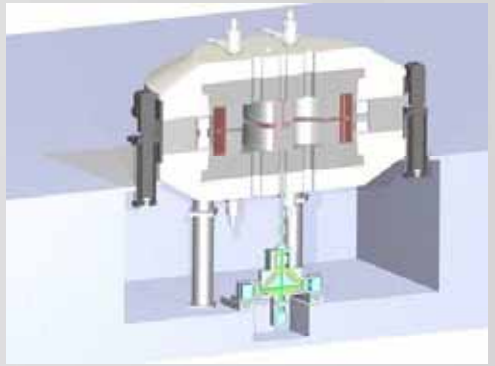
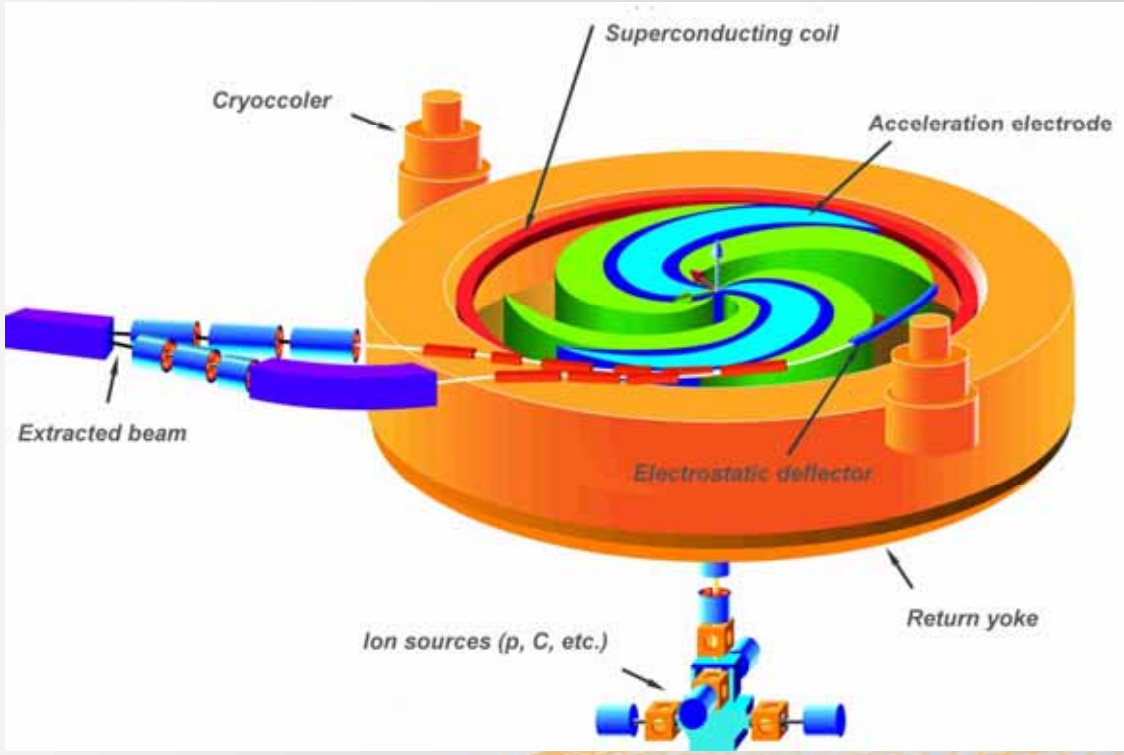
The IBA C400 superconducting cyclotron

- 6.6 m diameter, ~ 4m high
- Weight 700 tons
- Axial injection thru yoke
- Fully stripped ions (Q/A = ½)
  (except molecular $H2^+$ ions)
- Electrostatic deflector for light ions and stripper for $H2^+$
- Fixed RF frequency
- Static magnetic field
- Fixed output energy
- DC beam







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Defining beam characteristics

- Fast energy steps are obtained by a variable thickness degrader (rotating wheel of graphite or Be).

- Resultant energy spread and angular dispersion are controlled by collimators and magnetic analysing system (ESS)

- Beam properties are therefore fully controlled by the ESS and don't depend on the acceleration and extraction system

- Monte Carlo simulations show that the production rate of pollutants issuing from the fragmentation of the carbon ions in the degrader, controlled by the ESS, is less than the fragment production rate in the first centimetre of the body .

- only pencil beam scanning is envisioned

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Building

- 3 horizontal beam lines
- one gantry
- one building designer approached, taking into account IBA's interface requirements : cyclotron, beam transport system, power supply, water-cooling, etc., and user's requirements (physics & radiobiology)
- shielding and activation questions have already been thoroughly studied (IBA)

Outside view of ARCHADE

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Who does what ?

- IBA decided to create a local company (« IBA hadronthérapie ») in the Caen area in view of integrating regional factories and companies in the construction of the cyclotron prototype

- In the meantime, the ARCHADE team and contributors are doing preliminary work according to the scientific programme

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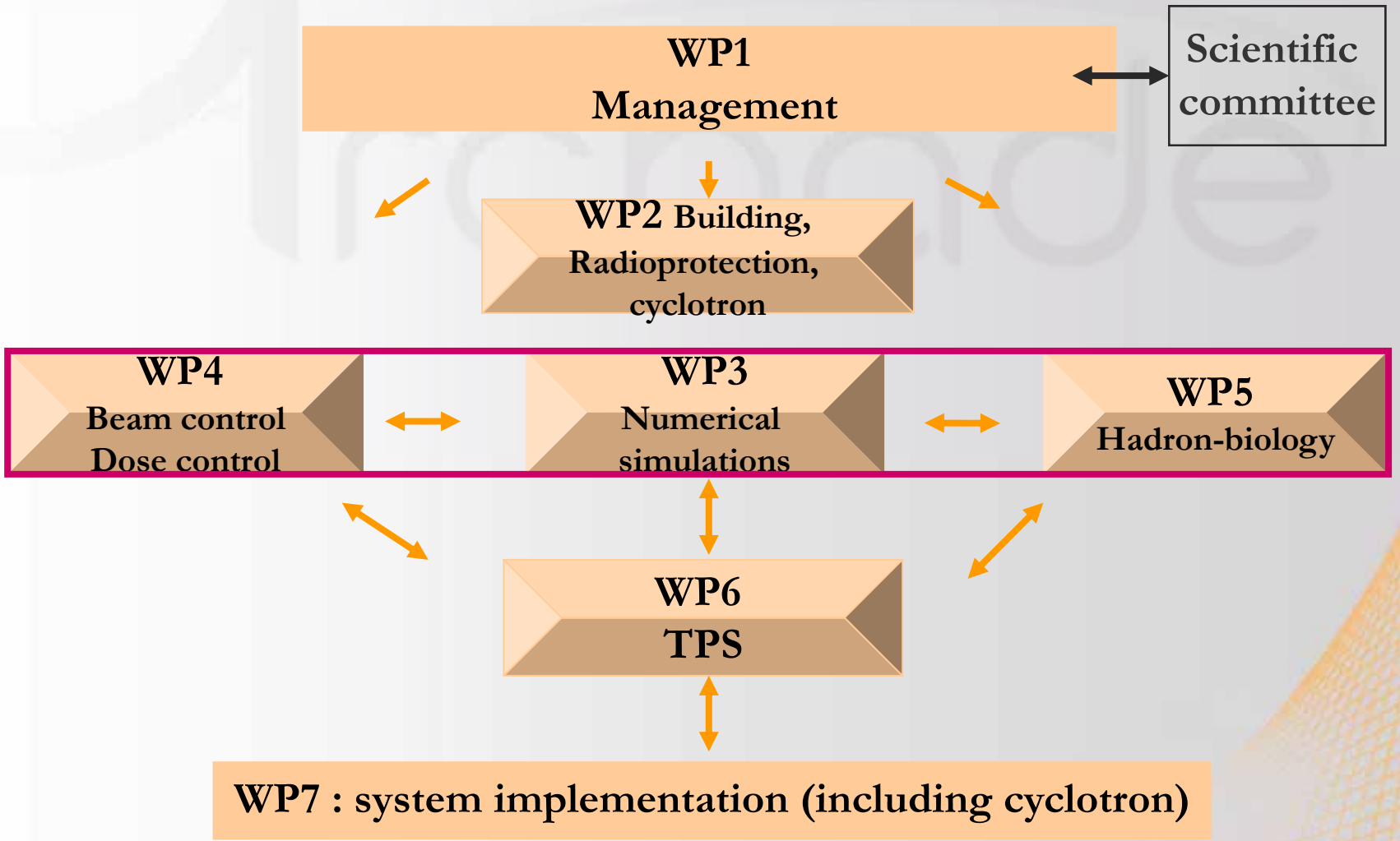

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WP3 & WP4 :Physics research

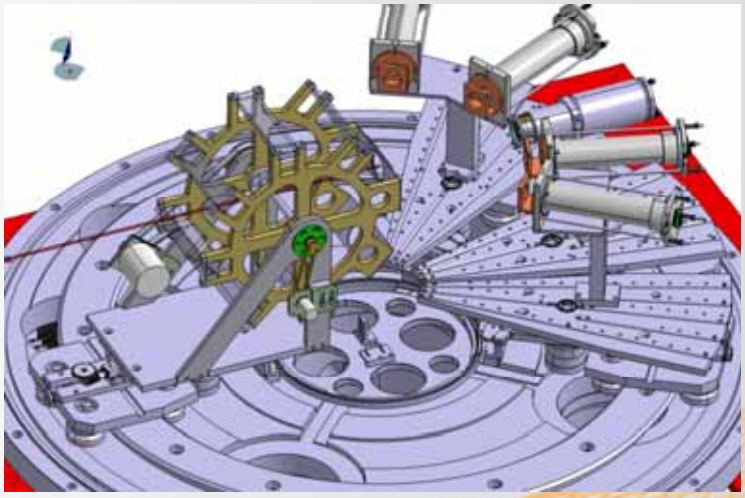
- Development and mastery of new, more powerful tools for digital simulation

  WP3 coordinates this research in simulation of dose deposition, taking into account basic physical data

- Optimisation of measurement of the irradiation dose and quality control of the carbon ion beam (WP4)

  - New experimental devices for beam control and dosimetry will be developed. Online devices to control dose deposition will be designed using the latest imaging techniques (positron emission tomography).

  - A Scientific Interest Group (GIS) has recently been set up with IN2P3/CNRS.



Experimental device for fragmentation cross section measurements

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WP5. Hadronbiology research

Goal: to coordinate research designed to clarify and deepen understanding of the biological parameters that determine the response of tumours and healthy tissues to carbon ions

This work :

- will involve the setting up of cell and animal models for the comparative evaluation of carbon ion beams and other types of radiation
- will carry the development of new biological models for specific research programmes to compare the biological effects of X-rays *, protons and C ions.
- should lead to the incorporation of biological data into the treatment planning system, thereby taking into account more accurately the biological advantage of carbon ions in treating tumours that are usually resistant to conventional therapies

** A 225 kV X-ray generator with imaging system was recently purchased.*

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WP6 Clinical research (therapy with carbon ions)

The clinical contribution of ARCHADE will be strictly limited to research.

- **Goal: to incorporate all the tools and models developed so that, by 2018, ARCHADE is in a position to treat the first patients *in a research protocol mode.***

- **Treatment-resistant tumours of the ear, nose and throat, skull base tumours, and brain tumours will be the research models used, in a biology–imaging–clinical research continuum that will optimise the use of carbon ions to treat these types of cancer.**

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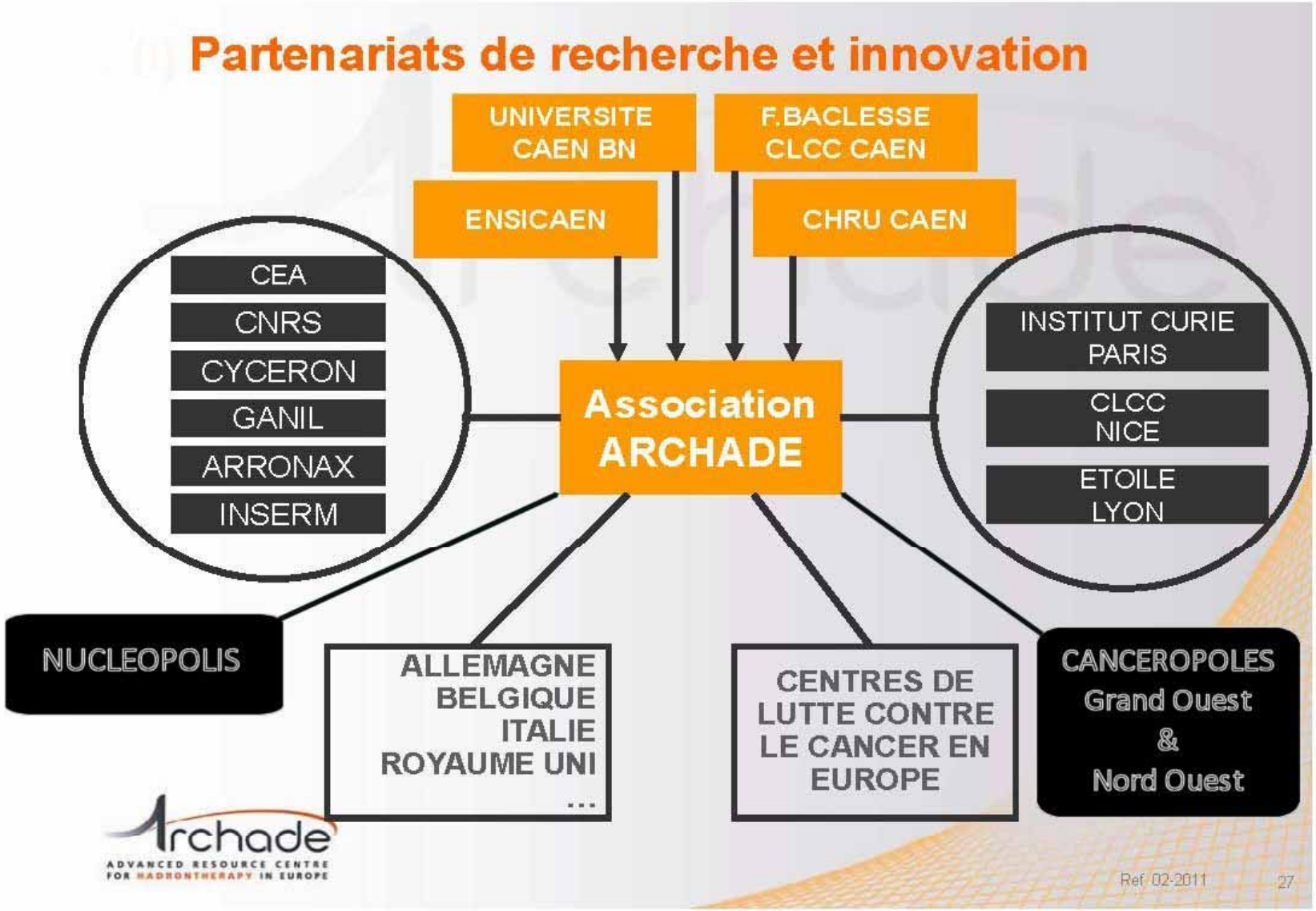
Scientific Collaborations

Cette figure est à refaire avec l'introduction de NUCLEOPOLIS dans ARCHADE



Collaborations

❑ Industrial development and applications

- Partnership for the construction of the prototype
- Technology transfer towards industrial firms

❑ Research

Research programs to be carried jointly on a wide international basis.
NB : the project is open to collaborations with research centres, clinical centres, industrials on the following fields:physics, radiobiology, medical physics, etc.

❑ Sponsorship

Supporting the ARCHADE project which is:
- fighting against cancer by research
- contributing to the economical development of the Normandy Region

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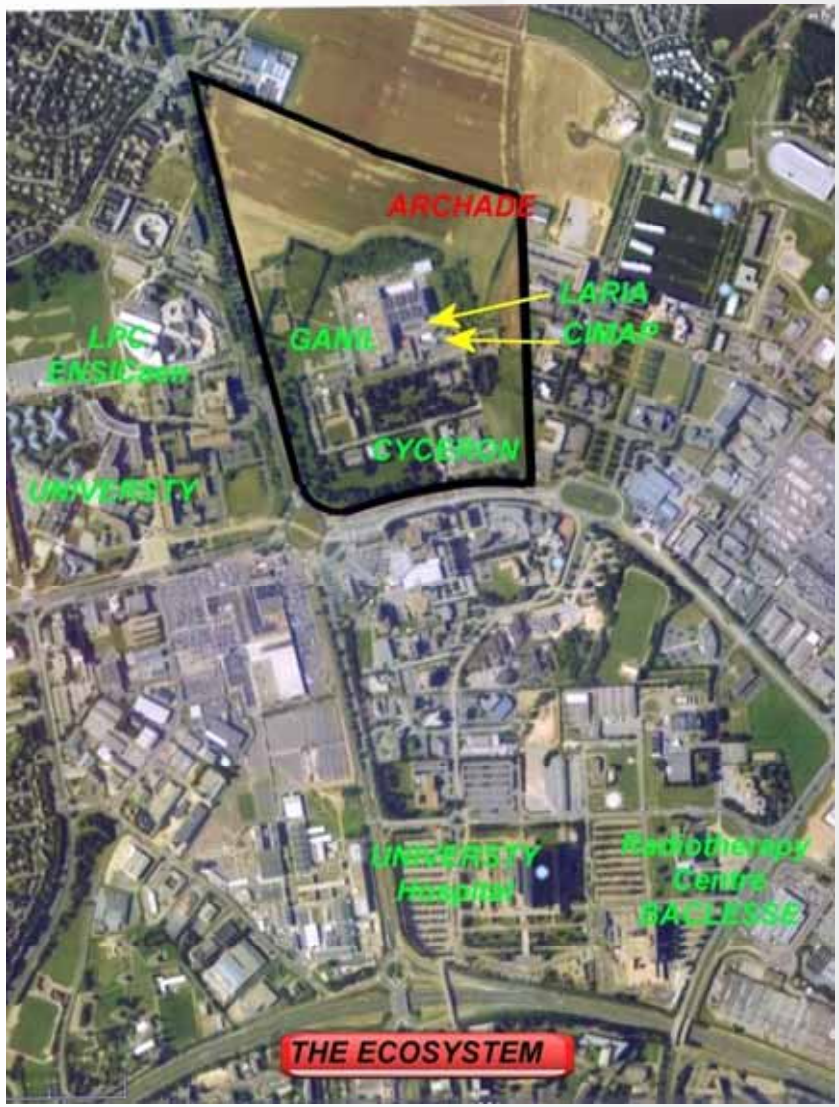
Environment



GANIL,National research centre in heavy ion physics

CIMAP,interdisciplinary centre for laser ion research

LARIA, Host laboratory in radiobiology with accelerated ions

LPC, particle Physics Laboratory

ENSICAEN, advanced national school for engineers

CYCERON,center for cerebral imaging and research in neurosciences

Caen University

CHU, Caen University hospital

BACLESSE: François Baclesse comprehensive cancer treatment centre.

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ARCHADE

- ARCHADE was created in 2004; it is an association driven by the 1901 French law

- Members of the association :
  - Comprehensive cancer treatment centre F. Baclesse
  - Caen University Hospital (CHU)
  - ENSICaen
  - Caen University
  - NUCLEOPOLIS

- Financial resources of the project:
  - Normandy Region
  - European funds
  - Beam time leasing for protontherapy
  - Sponsorship
  - Archade is participating in the European programme ULICE

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Schedule

- September 2, 2010 — Signature with IBA
- End 2012 — Signature of the financial contract with the banks and investors
- July 2014 — Beginning of building works
- October 2015 — IBA delivers the equipment
- April 2016 — Building ready
- January 2018 — equipment is operational

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September 2nd 2010 : Yves Jongen (IBA) and Laurent Beauvais, President of the Regional Council of the Normandy Region sign the agreement for implanting ARCHADE at Caen. On the right: Michel Drouet, former project director.

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Main actors

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A. Batalla
Pr J-l. Habrand, scientific coordinator of the project
Pr K. Meflah, president of ARCHADE

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