MATEIS
GENERAL PRESENTATION

- **Complete denomination:** Materials, Engineering and science
- **Location:** Villeurbanne (INSA), France
- **Director:** Pr. Jérôme CHEVALIER
- **Contact person in NEWGEN:** Pr. Jérôme CHEVALIER
- **Working Group involvment:** WG1, WG2, WG4
- **Staff: 90 permanent, 60 PhD, 20 Post-docs**
- **in NEWGEN :** 8 permanent staff, ~10 students involved
- **Research topics: Materials Science**
- **In NEWGEN :** biomaterials and biological interactions ('Biomaterials' group)
- **Research expertise:**
  - Clinical evaluation of medical devices; immuno-assays techniques; Surface Plasmon resonance; Bacteriology; Cell biology;
  - Biomaterials (ceramics, polymers, metals)
  - Processing, fabrication, characterisation

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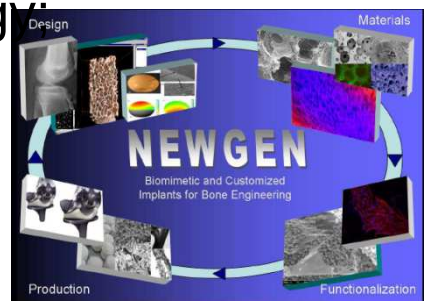
INSA-Lyon
20 avenue Albert Einstein
69621 Villeurbanne Cedex
FRANCE



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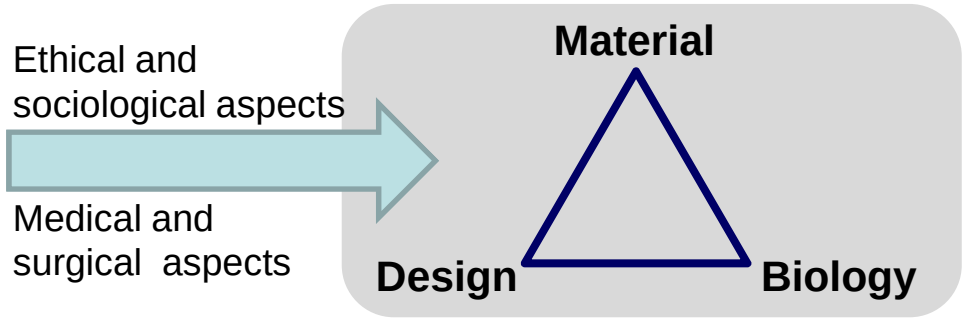
Scientific approach

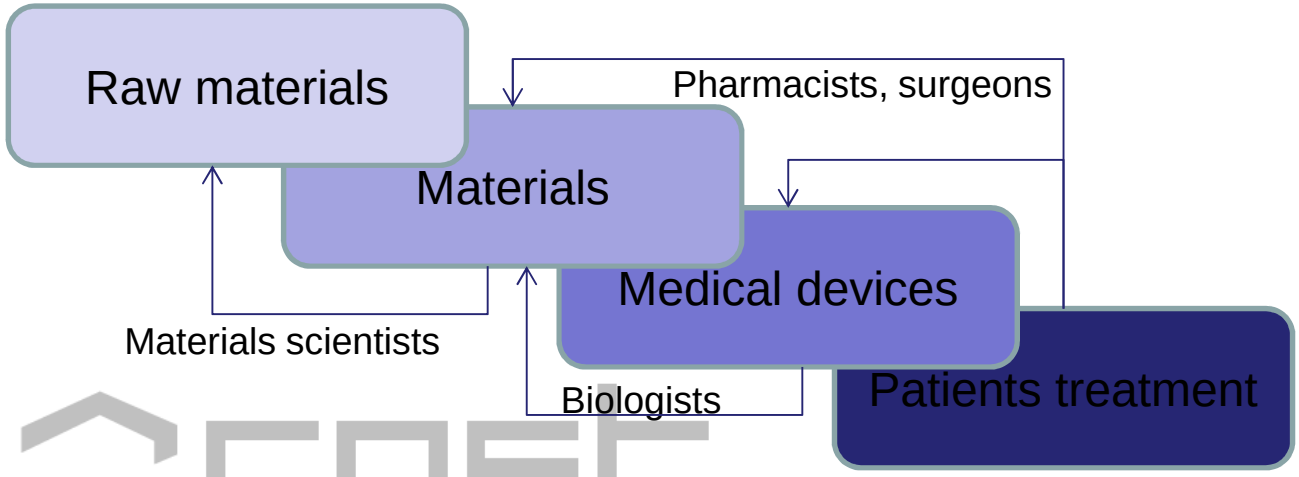
➢ Centers of interest of the 'Biomaterials' group

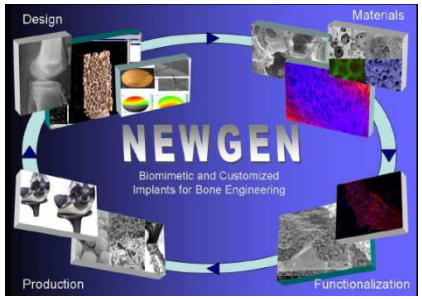
What are the interactions between a biomaterial and its biological environment?



➢ An integrated approach

from materials development to patients treatment





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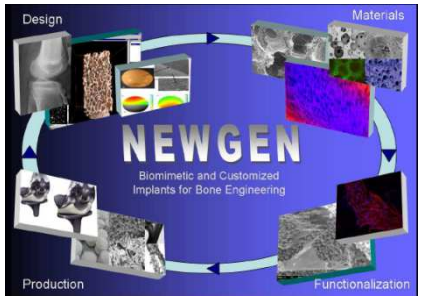
Design and fabrication of innovative biomaterials

- **Implantable ceramic materials:**
  - based on zirconia and alumina: dental, spine and total hip replacement implants: design and fabrication of new materials, lifetime assessment through multiphysics testing
- **Biocompatible metallic materials :**
  - nickel free alloys, beta' Ti alloys, processing by advanced methods (Gleeble, SPS…)
- **Polymer-ceramic composites:**
  - goal: mechanical or functionnal improvements
  - toughening and functionnalisation of pourous bio-ceramics; hydrogel mineralization
  - Collagen based materials



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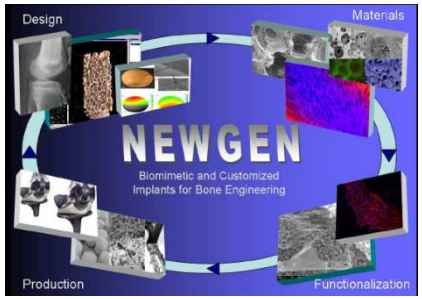
Materials interactions with the biological environment

- **Dense or (nano)particulate materials**
- **Biological environment: micro-organisms, cells, tissues**
- **Interactions between micro-organismes and surfaces**
  - Biofilm formation on intraocular implants (IOL), development of antibacterial or bacteriostatic surfaces
- **Cells-materials interactions**
  - Biocompatibility of materials
  - Targeting (nanoparticules)
  - Vectoring



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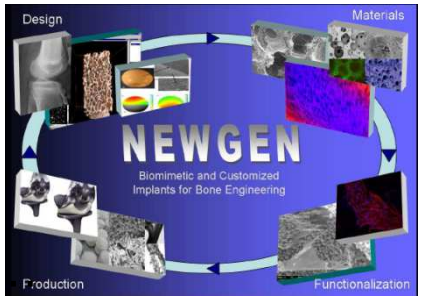
Materials science facilities

- **Processing:**
  - ceramic processing
  - advanced sintering techniques: SPS, Gleeble, Hot Press
  - 3D printing: robocasting
- **Mechanical testing:**
  - traction, compression, flexion, double torsion, static or fatigue, uniaxial or biaxial, 1N to 100 kN
  - instrumented indentation
- **Characterization**
  - physical (BET, Mercury Intrusion Porosimetry, DSC…)
  - X-Ray Difraction (SAXS, WAXS)
  - microstructural (SEM, TEM, XRay tomography)
- **In-situ characterization**
  - XRD, SEM, TEM in gas/water, controlled atmosphere and temperature, applied mechanical stress.



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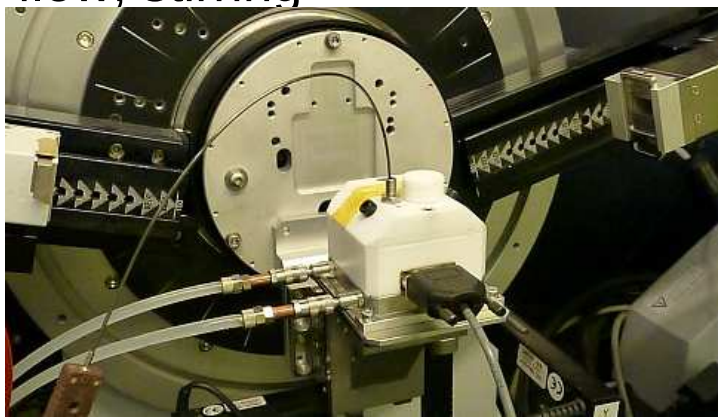
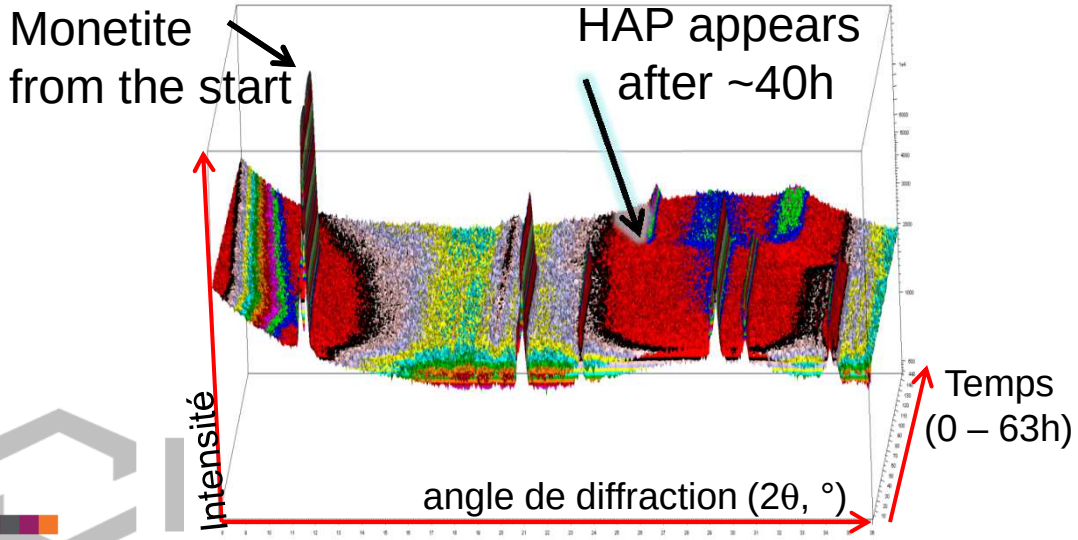
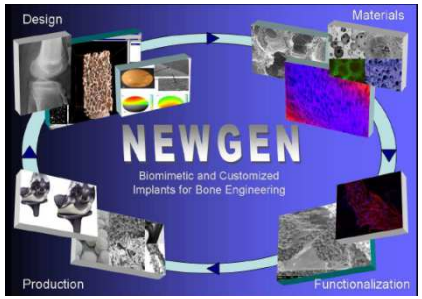
Example of in-situ characterization

- **Example: X-ray diffraction reactor**
  - Controlled: temperature, pH, gas flow, stirring
  - XRD in liquids (in reflexion)



- **Example: XRD follow-up of the cristallization of a Ca-P solution**





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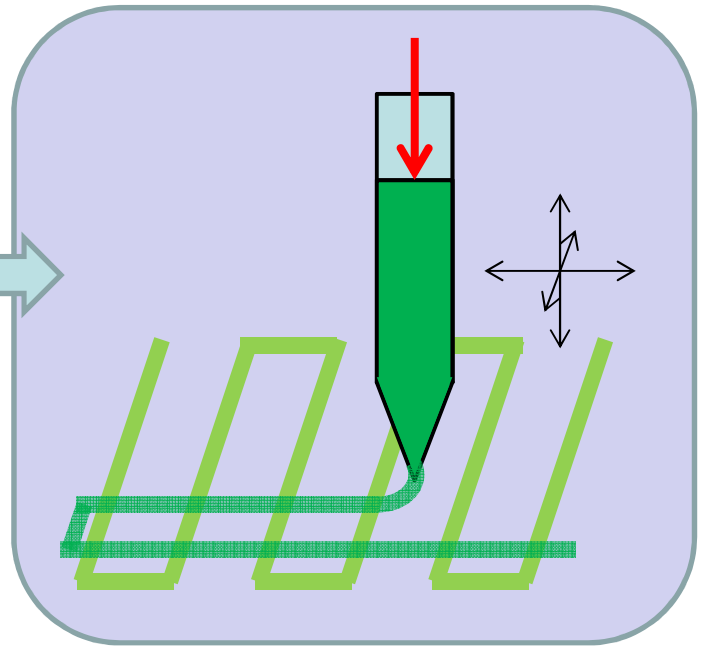
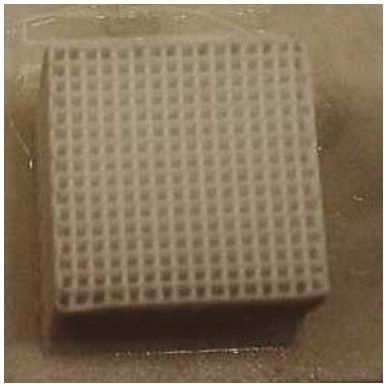
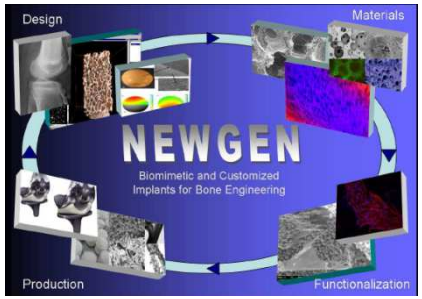
Robocasting

➢ **or « micro-extrusion » or « direct deposition »**

- **Numerica model**
  - of the desired piece
- **Printing**
  - of a paste, by layer-bay layer deposition
- **Thermal treatments**
  - Debinding, sintering
- **Result**
  - centimetric pieces
  - Resolution: porosity and strut sizes > 50 µm;
  - Porosity < 70%







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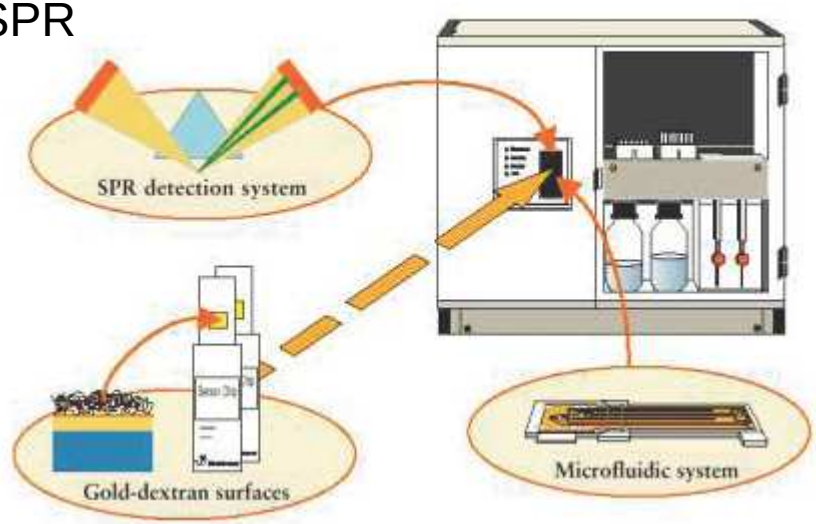
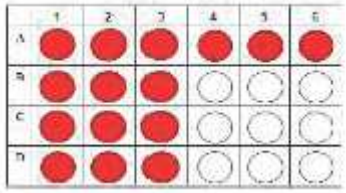
Specific biological facilities

- ✓ **Cell culture (prestoblue technique)**
- ✓ **Bacteriology laboratory**
- ✓ **Immuno-assays (ELISA)**
- ✓ **Surface Plasmon Resonance (Biacore 2000)**

SPR

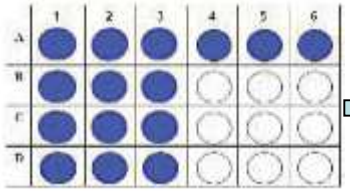


1) Cell seeding on the materials

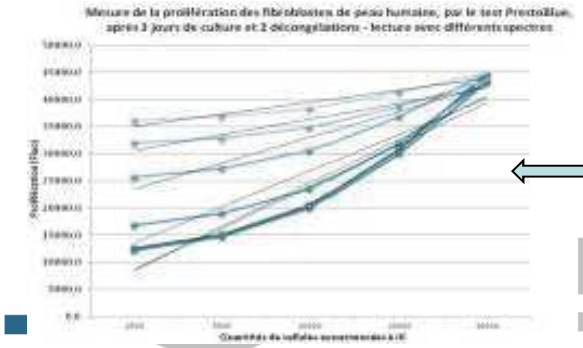


3, 6, 10 days

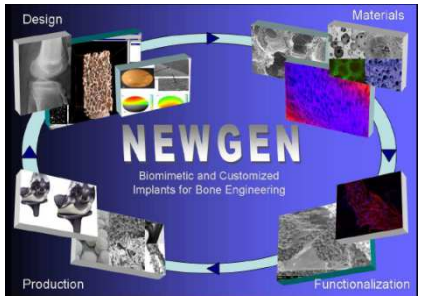
2) add prestoblue



3) Incubation:
Mitochondrial metabolic activity of living cells ➔ reduction of Reazurine (blue) to Resorufine (Pink, fluorescent)



4) Reading



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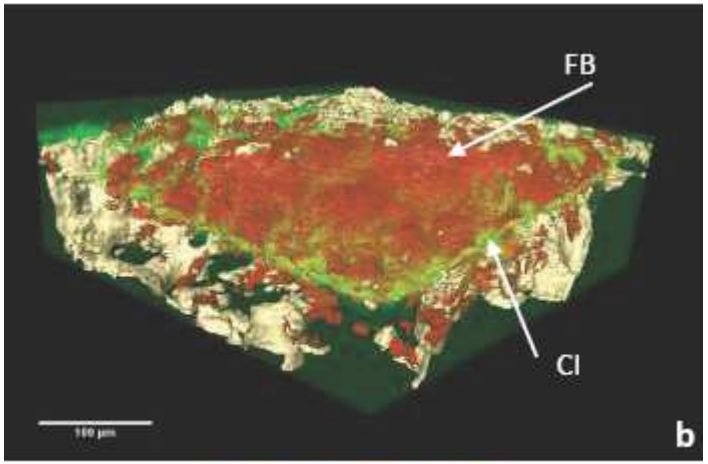
Shared biological facilities

- **Confocal microscopy**
  - Centre de quantimétrie - UCBL
- **Tissue analysis (histology and immuno-histology)**
  - Novotec
- **Molecular boilogy (PCR)**
  - Novotec
- **Animal experimentations**
  - Institut Claude Bourgelat – Vetagrosup
  - Animaleries (Laennec, Gerland, IUT Doua)



Example:
Formation of extracellular matrix around fibroblasts in a bioactive glass porous scaffold (confocal infrared microscopy)