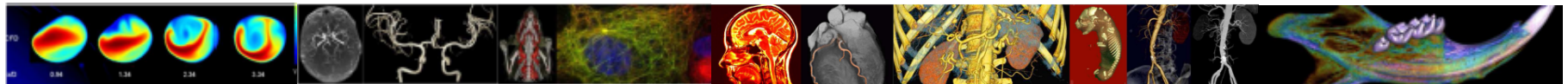


Biomedical Engineering Master Program (Bme)

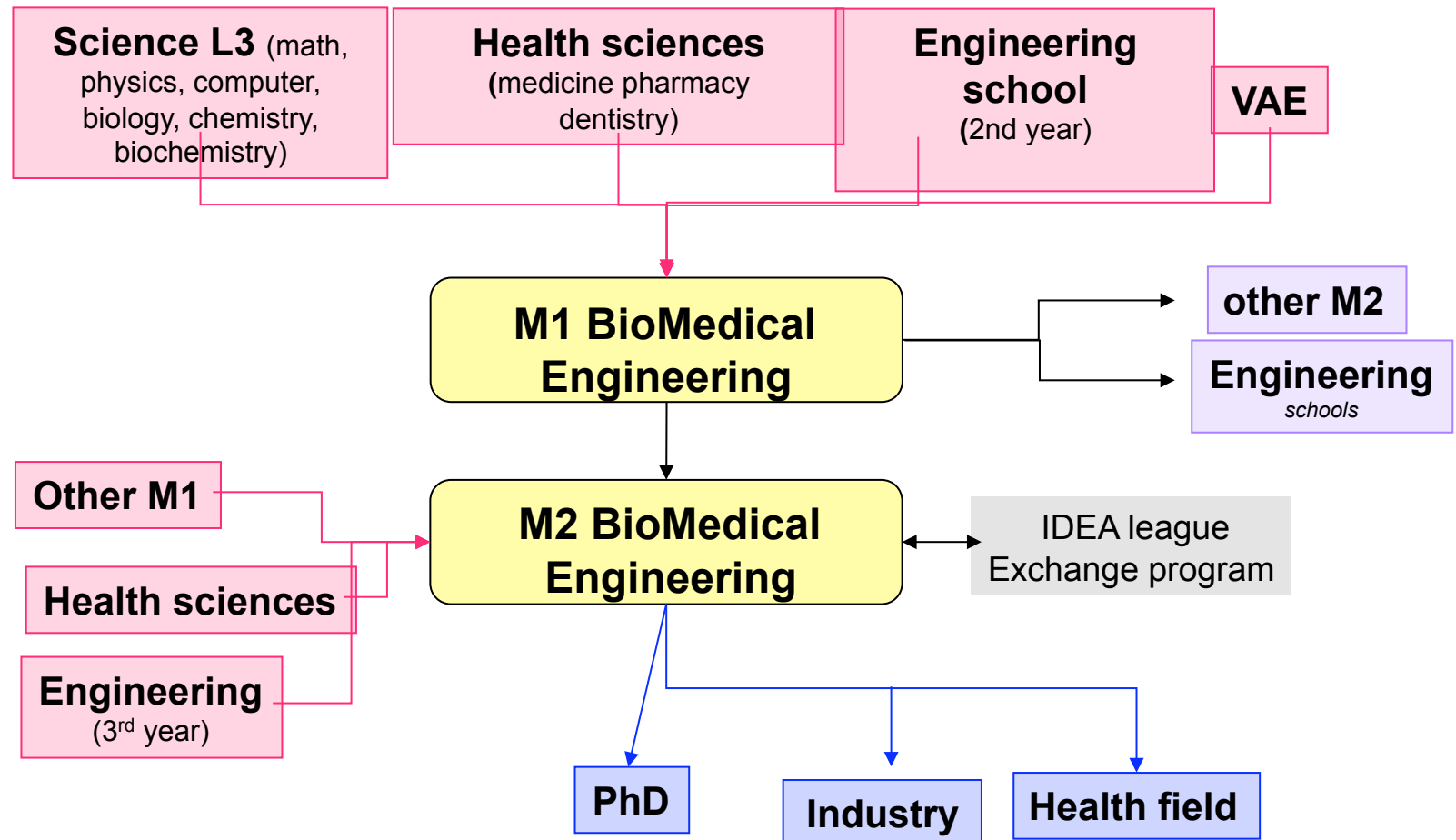
BioImaging Track (BIm)



Information Meeting
September, the 14th 2011



BME-Paris Master Program



Admission based on cursus, scientific skills, performance and sufficient English fluency. Interview when possible.

BME-Paris Master Program

- ***A two-year Master program addressing strategic issues of BioMedical Engineering***

MASTER 1 (semesters 1 & 2)



MASTER 2 (semesters 3 & 4)



Bioimaging (BIM)

Imaging from Molecule to Human (IMH)

Imaging Modalities & Processing (IMP)



Systems & Synthetic Biology, Information & Interaction (S2I2)



Molecular & Cellular Biotherapies (MCB)



Biomechanics & Biomaterials (BM²)

Impact & Injury Mechanisms (I2M)

Biomaterials & Biological Materials (B2M)

MusculoSkeletal System (MS2)

Biofluid & the Cardiovascular System (BCS)

Neuroengineering (NEC)

General BioMechanics (GBM)



Industrial Bioengineering (IBE)

BME-Paris Master Program

Master 2 ■ *Build an interdisciplinary scientific hub*

Goals

- Deep scientific knowledge
- Efficient interdisciplinary scientific dialogue
- Ethical, Industrial, and Clinical issues
- Social and cultural interaction

Tools

- Common general Bioengineering education
- Seminars, conferences & inter-track courses
- Ethical, clinical & industrial teaching, exchanges
- Interdisciplinary integration week
- Common “headquarters” & hopefully more

BIM
Bioimaging

MCB
Molecular
Cellular
Biotherapies

IBE
Industrial
Bio
Engineering

S²I²
Systems
Synthetic Bio
Information
Interactions

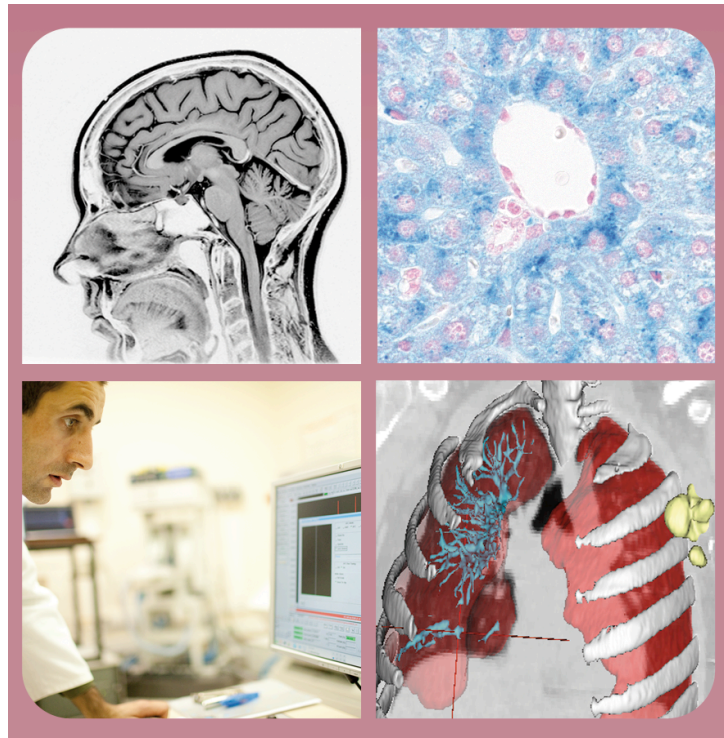
BM²
Biomechanics
Biomaterials

Each track

- Overview of the field and specialization on a specific aspect
- Theoretical and experimental approaches
- Core and advanced courses
- Lab training
- Research projects leading to scientific publications

BME Master 2 – BioImaging Track

- An interdisciplinary program for an innovative approach of biomedical imaging



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Track chairs

Florence Cloppet
Université Paris Descartes
Computer Science

Elsa Angelini
Telecom ParisTech

Catherine Oppenheim
Université Paris Descartes
Medicine

EDUCATIONAL COMMITTEE

Charles-André Cuenod
Université Paris Descartes
Medicine

Etienne Decencière
Mines ParisTech

Yves-Michel Frapart
Université Paris Descartes
Chemistry

SUB-TRACK Imaging from Molecule to Human (IMH)

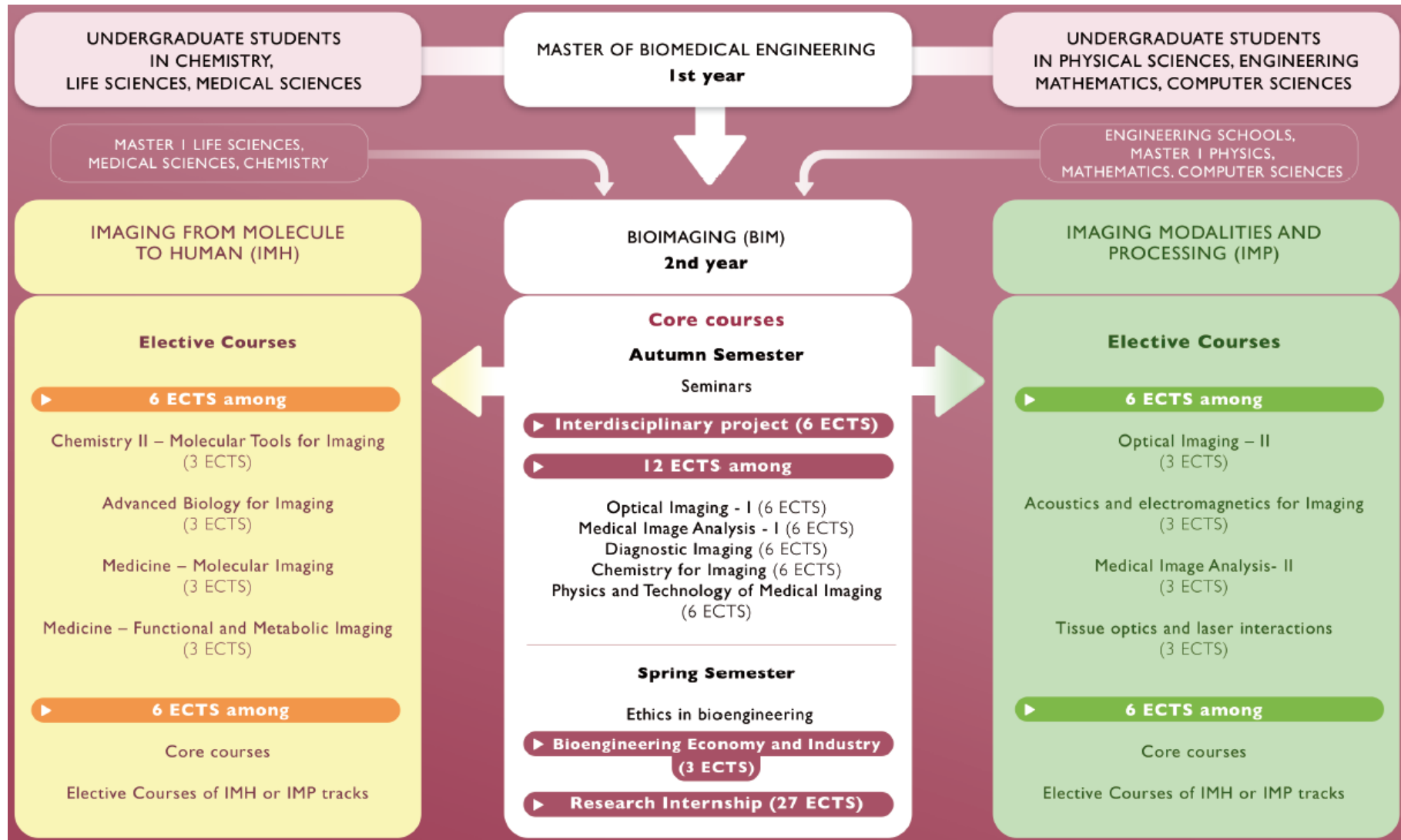
IMH@bme-paris.org

SUB-TRACK Imaging Modalities and Processing (IMP)

IMP@bme-paris.org

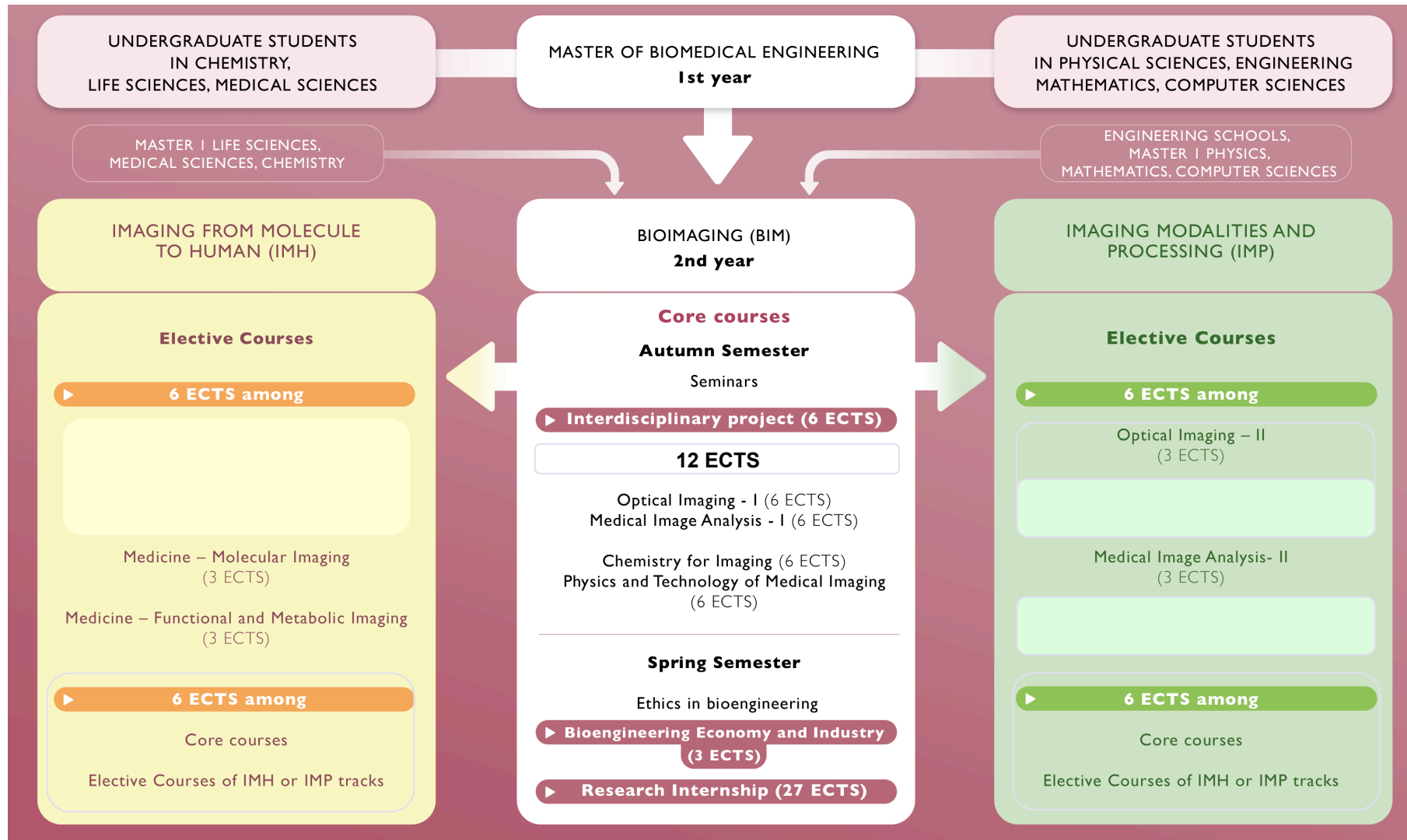
or BIM@bme-paris.org

BME-Paris – BioImaging Track



BME-Paris – BioImaging Track

Year 2011-12



Administrative Contacts

■ Registration

● Contact IMH

■ Séverine Thiery

- Tel : 01 42 86 41 37
- E-mail : severine.thiery@parisdescartes.fr
- 45 rue de Saint Pères, 75006 Paris (in front of CROUS cafeteria)
- Office Hours : 9h30-11h30 or 13h30 -15h
- Registration Fees to be paid: 12, Rue de l'École de médecine – 75006 Paris.

● Contact IMP

■ Frédéric Boulanger

- Tel. 01 45 81 80 04
- E-mail : frederic.boulanger@telecom-paristech.fr
- 46 rue Barrault, 75013 Paris (Telecom ParisTech). Office b469-1, direction de la formation initiale.

Program Content

- **Autumn Semester (30 ECTS)**
 - **Interdisciplinary project (6 ECTS)**
 - 4th-6th January 2012
 - Common to all specialties
 - Outside of Paris
 - Group projects
 - **Exams :**
 - Session 1. 16-17 november / 16-20 January
 - Session 2. 1-3 february.

Program Content

- Spring Semester (30 ECTS)
 - BioEngineering Economy and Industry (6 ECTS)
 - BioEthics
 - Research Internship – five months (27 ECTS)
 - Project defense :
 - June or September.

Schedule 2011-2012

		8	9	10	11	12	13	14	15	16	17	18	19
Sep	M 5 T 6 W 7 T 8 F 9												
Sep	M 12 T 13 W 14 T 15 F 16		Welcome Meeting - All Specialities				Welcome Meeting - BIM			Welcome Meeting - All Specialities			
Sep	M 19 T 20 W 21 T 22 F 23												
	M 26 T 27 W 28 T 29 F 30	1	Paris Descartes Rooms - 45 Rue des Saints Pères - 75006 Paris Rooms R222 and R224 were renamed Sabatier A and Sabatier B Sab. A = Sabatier A Curie C - 4th Floor Sab. B = Sabatier B					Telecom Paris Tech Rooms - 46 Rue Barrault - 75013 Paris Grenat = Amphithéâtre Grenat B316					
Oct	M 3 T 4 W 5 T 6 F 7	2	Sab. B UE 3.5 Chemistry for Imaging Sab. A UE 3.5 Chemistry for Imaging UE 3.2 Optical Imaging I UE 3.2 Optical Imaging I	UE 3.5 Chemistry for Imaging UE 3.5 Chemistry for Imaging UE 3.2 Optical Imaging I UE 3.2 Optical Imaging I		Sab. A UE 3.6 Physics and Technology Sab. B UE 3.6 Physics and Technology		UE 3.6 Physics and Technology UE 3.6 Physics and Technology		U.E. 3.0 : Seminars			

Optical Imaging I

A. Dubois (ParisTech)

P. Bourdoncle (Paris Descartes)

UE Phys. And Technology

I Peretti (Paris Descartes)

C de Bazelaire (Paris Descartes)

E Boss (ParisTech)

UE Chemistry for Imaging

O Clément (Paris Descartes)

Y Frapart (Paris Descartes)

L Binet (ParisTech)

Schedule 2011-2012

		8	30	9	30	10	30	11	30	12	30	13	30	14	30	15	30	16	30	17	30	18	30	19
Oct		3																						
M	10	Sab. B	UE 3.5 Chemistry for Imaging					UE 3.5 Chemistry for Imaging						Sab. B	UE 3.6 Physics and Technology			UE 3.6 Physics and Technology						
T	11	Curie C	UE 3.5 Chemistry for Imaging					UE 3.5 Chemistry for Imaging						Curie C	UE 3.6 Physics and Technology			UE 3.6 Physics and Technology						
W	12		UE 3.2 Optical Imaging I					UE 3.2 Optical Imaging I																
T	13		UE 3.2 Optical Imaging I					UE 3.2 Optical Imaging I																
F	14													U.E. 3.0 : Seminars										
M	17	4	Sab. A	UE 3.5 Chemistry for Imaging				UE 3.5 Chemistry for Imaging						Sab. A	UE 3.6 Physics and Technology			UE 3.6 Physics and Technology						
T	18	Sab. A	UE 3.5 Chemistry for Imaging					UE 3.5 Chemistry for Imaging						Sab. A	UE 3.6 Physics and Technology			UE 3.6 Physics and Technology						
W	19		UE 3.2 Optical Imaging I					UE 3.2 Optical Imaging I							UE 3.3 Medical Image Analysis I			UE 3.3 Medical Image Analysis I						
T	20		UE 3.2 Optical Imaging I					UE 3.2 Optical Imaging I																
F	21													U.E. 3.0 : Seminars				(21-25 oct JFR 2011)						
M	24	5												Sab. A	UE 3.6 Physics and Technology			UE 3.6 Physics and Technology						
T	25																							
W	26		UE 3.2 Optical Imaging I					UE 3.2 Optical Imaging I																
T	27		UE 3.2 Optical Imaging I					UE 3.2 Optical Imaging I																
F	28													U.E. 3.0 : Seminars										
Oct	M 30	6	Sab. A	UE 3.5 Chemistry for Imaging				UE 3.5 Chemistry for Imaging																
Nov	T 1																							
W	2																							
T	3																							
F	4														UE 3.3 Medical Image Analysis I			UE 3.3 Medical Image Analysis I						
														U.E. 3.0 : Seminars										
Nov	M 7	7	Sab. A	UE 3.5 Chemistry for Imaging				UE 3.5 Chemistry for Imaging						Sab. A	UE 3.6 Physics and Technology			UE 3.6 Physics and Technology						
T	8	Sab. A	UE 3.5 Chemistry for Imaging					UE 3.5 Chemistry for Imaging						Sab. A	UE 3.6 Physics and Technology			UE 3.6 Physics and Technology						
W	9		UE 3.2 Optical Imaging I					UE 3.2 Optical Imaging I							UE 3.3 Medical Image Analysis I			UE 3.3 Medical Image Analysis I						
T	10														UE 3.3 Medical Image Analysis I			UE 3.3 Medical Image Analysis I						
F	11																							
M	14	8																						
T	15																							
W	16																							
T	17							Sab. B	UE 3.5 - Exam					Sab. B	UE 3.6 Exam			UE 3.3 Medical Image Analysis I						
F	18							Sab. B	UE 3.2 Exam						UE 3.3 Medical Image Analysis I			UE 3.3 Medical Image Analysis I						
														U.E. 3.0 : Seminars										

Schedule 2011-2012

		8	30	9	30	10	30	11	30	12	30	13	30	14	30	15	30	16	30	17	30	18	30	19
Nov	M 21	9		St Anne		UE 3.10a Med: Funct. & Metabol.		UE 3.10a Med: Funct. & Metabol.				St Anne		UE 3.10a Med: Funct. & Metabol.		UE 3.10a Med: Funct. & Metabol.								
	T 22	B316		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging						UE 3.3 Medical Image Analysis I		UE 3.3 Medical Image Analysis I								
	W 23			UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II																
	T 24			UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II																
	F 25													U.E. 3.0 : Seminars										
	M 28	10		UE 3.3 Medical Image Analysis I		UE 3.3 Medical Image Analysis I		UE 3.3 Medical Image Analysis I						UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging								
	T 29	B316												UE 3.3 Medical Image Analysis I		UE 3.3 Medical Image Analysis I								
	W 30			UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II						UE 3.3 Medical Image Analysis I										
Dec	T 1			UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II																
	F 2													U.E. 3.0 : Seminars										
	M 5	11		Grenat		UE 3.10b Med. Image Anal. II		UE 3.10b Med. Image Anal. II						Sab. B		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging						
	T 6	Sab. A		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging						Grenat		UE 3.10b Med. Image Anal. II		UE 3.10b Med. Image Anal. II						
	W 7			UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II		UE 3.7b Optical Imaging II						Grenat		UE 3.10b Med. Image Anal. II		UE 3.10b Med. Image Anal. II						
	T 8	Sab. B		UE 3.10a Med: Funct. & Metabol.		UE 3.10a Med: Funct. & Metabol.		UE 3.10a Med: Funct. & Metabol.						Sab. B		UE 3.10a Med: Funct. & Metabol.		UE 3.10a Med: Funct. & Metabol.						
	F 9													U.E. 3.0 : Seminars										
	M 12	12		Sab. A		UE 3.10b Med. Image Anal. II		UE 3.10b Med. Image Anal. II						Sab. A		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging						
	T 13	B316		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging		UE 3.9a Med: Mol. Imaging								UE 3.3 Medical Image Analysis I		UE 3.3 Medical Image Analysis I						
	W 14															UE 3.10b Med. Image Anal. II		UE 3.10b Med. Image Anal. II						
	T 15																							
	F 16													U.E. 3.0 : Seminars										
Winter public holidays : 17 dec 2011 to 2 jan 2012																								
Jan	M 2	13																						
	T 3																							
	W 4																							
	T 5																							
	F 6																							

Interdisciplinary Project

E. Angelini (ParisTech)

Y. Frappart (Paris Descartes)

L. Binet (ParisTech)

Optical Imaging II

A. Dubois (ParisTech)

K. Plamann (ParisTech)

Med Image Analysis :

F Cloppet (Paris Descartes)

E. Decenci re (ParisTech)

Molecular Imaging

CA Cuenod (Paris Descartes)

D Le Guludec (Paris Diderot)

Med: Fonct and Metabolic

N Boddaert (Paris Descartes)

B Van Der beers (Paris Diderot)

Schedule 2011-2012

Jan	M	16	Exams (UE 3.3/3.7b/3.9a/3.10a/3.10b)+ projects defense (session 1, S3)																											
	T	17																												
	W	18																												
	T	19																												
	F	20																												
SECOND SEMESTER			8	30	9	30	10	30	11	30	12	30	13	30	14	30	15	30	16	30	17	30	18	30	19					
Jan	M	23	U.E. 4.0 : Ethics à placer dans l'EDT - attente du planning de C. Hervé																											
	T	24																												
	W	25																												
	T	26																												
	F	27																												
Feb	M	30	Exams (session 2, S3)																											
	T	31																												
	W	1																												
	T	2																												
	F	3																												
			U.E. Bioengin. Economy & Industry U.E. Bioengin. Economy & Industry U.E. Bioengin. Economy & Industry U.E. Bioengin. Economy & Industry U.E. Bioengin. Eco. & Industry																											
Feb	M	6	Lab training - 20 weeks - 5 months 15 jun 2012 : deadline for lab training report																											
Jun	F	22	Defense of Lab training report																											
	M	25																												
	T	26																												
	W	27																												
	T	28																												
	F	29																												

UE 3.2 – Optical Imaging I

- Instructors:
 - **A. Dubois** – P. Bourdoncle
- Content
 - Introductory courses to optical imaging, microscopy, microarrays. Labworks.
- Course location:
 - Telecom ParisTech, Paris Descartes



UE 3.2 – Optical Imaging I

Program:

- **Introduction to optical imaging**

A. Dubois, Lab. Charles Fabry, Institut d'Optique Graduate School

(course, October 5, 9:00-12:15)

Propagation of light in biological tissues, High-penetration imaging methods (diffuse optical tomography, opto-acoustic imaging), High-resolution imaging methods (microscopy, OCT).

- **Optical microscopy**

A. Alexandru, LOB, École Polytechnique
(course, October 6, 9:00-12:15)

Conventional microscopy, Confocal microscopy, Nonlinear microscopy (multi-photon, harmonic generation).

- **Fluorescence techniques**

A. Alexandru, LOB, École Polytechnique
(course, October 12, 9:00-12:15)

Organic/inorganic fluorophores, Single-molecule tracking, Fluorescence Recovery After Photobleaching (FRAP), Fluorescence Correlation and Cross-Correlation (FCS, FCCS), Fluorescence lifetime imaging (FLIM), Fluorescence Resonant Energy Transfer (FRET).

- **DNA and protein microarrays**

H. Benisty, Lab. Charles Fabry, Institut d'Optique Graduate School

(course, October 13, 9:00-12:15)

Readout techniques: fluorescence and Surface Plasmon Resonance, Biochip specifications and realizations, Data processing and interpretation.

- **Optics Labwork**

P. Bourdoncle, Université Paris Descartes
(Labworks, Oct 19, Oct 20, Oct 26, Oct 27, Nov 9, 9:00-12:15)

Various microscopy techniques including:

- confocal, fluorescence,
- two-photon excitation fluorescence,
- second-harmonic generation

UE 3.2 – Optical Imaging I

- Exam
 - Written exam.

UE 3.3 Medical Image Analysis

- Instructors:

- E. Decenciere, F. Cloppet



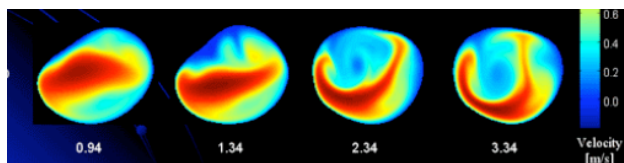
- Content

- Main objective : to provide the students with the means to understand and use the most common tools used in bio-medical image analysis

- Theoretical courses and practical training sessions

- Course location:

- Telecom ParisTech



UE 3.3 Medical Image Analysis

- Main topics
 - Foundations of image processing
 - Linear image processing
 - Morphological image processing
 - Segmentation
 - Quantification and shape characterization
 - Beyond the second dimension : 3D image and temporal sequences

- Exam
 - Written test (40% of evaluation)
 - Project (30%)
 - Practical sessions (30%)

UE 3.5 Chemistry for Imaging

- Instructors:

- Y.-M. FRAPART, O. CLEMENT, L. BINET



- Content

- Modern imaging, especially molecular and functional imaging using chemical contrast agents, and development from small animal imaging.

- Course location:

- Paris Descartes University



UE 3.5 Chemistry for Imaging

- Program
 - Molecular probes and contrast agents for imaging
 - Synthesis, functionalisation, vectorisation, metabolism ...
 - Kinetics and pharmaco kinetics
 - Agreement aspect, scaling up, ...
 - Application in different modalities.
 - State of the art of small animal imaging modalities and their applications
 - MRI,CEST, DNP
 - Computed Tomography,
 - Ultra-sounds,
 - Nuclear imaging,
 - EPR imaging,
 - Visit of the different platforms.

UE 3.5 Chemistry for Imaging

- Exam
 - Quizz (2 hrs) (2/3 of evaluation)
 - Plate-form visits with short report (1/3 of evaluation)
 - Technical principle, applications, limitations, on one modality (10-20 p) per student.
 - Visits can be organized in groups of three students.

UE 3.6 Physics and Technology of Medical Imaging

- Instructors:

- I. Peretti, C. De Bazelaire, E. Bossy



- Content:

- Physics and technology of ultrasonic imaging, magnetic resonance imaging, nuclear medicine, X-ray imaging

- Courses location:

- Paris Descartes University



UE 3.6 Physics and Technology of Medical Imaging

- Program
 - imaging with non-ionizing radiation
 - ultrasonic imaging : ultrasound physics, image reconstruction, transducer technology
 - magnetic resonance imaging : physical bases of NMR, conventional imaging sequences, chemical shift, high speed imaging, functional imaging
 - imaging with ionizing radiation
 - radiation physics,
 - different types of X-ray detectors,
 - X-ray computerized tomography
 - nuclear tomographic imaging
 - single photon emission computed tomography
 - positron emission tomography

UE 3.6 Physics and Technology of Medical Imaging

- Exam
 - written* exam (60% of evaluation)
 - project (40% of evaluation)

* (oral or written at the second session)

UE 3.7b – Optical Imaging II

- Instructors:
 - A. Dubois – **K. Plamann**
- Content
 - Advanced courses on optical imaging. Labworks.
- Course location:
 - Schools within ParisTech



UE 3.7b – Optical Imaging II

Program:

- **Non-linear microscopy / Super-resolution imaging**
E. Beaufrepair, A. Alexandrou, Laboratoire d'Optique et Biosciences, École Polytechnique
(course + visit, November 23, 8:30-12:45)
Two-photon excitation fluorescence microscopy, Harmonic generation microscopy, Coherent Anti-Stokes Raman Scattering (CARS) microscopy.
Total Internal Reflection Fluorescence microscopy (TIRF), 4π microscopy, Stimulated Emission Depletion microscopy (STED), Stochastic Optical Reconstruction Microscopy (STORM), PhotoActivated Localization Microscopy (PALM)..
- **Optical Coherence Tomography**
Arnaud Dubois, Laboratoire Charles Fabry, Institut d'Optique Graduate School
(course + visit, November 24, 8:30-12:45)
Time-domain OCT, Frequency-domain OCT, Full-field OCT, Extensions (polarization-sensitive, doppler, spectroscopic), Applications in biology and medicine.
- **Optical tweezers**
N. Westbrook, Laboratoire Charles Fabry, Institut d'Optique Graduate School
(course + visit, November 30, 8:30-12:45)
The physics of optical tweezers, technical issues, characteristics of optical tweezers, application in microbiology and single molecule manipulation.
- **Light propagation in tissues**
R. Carminati, Institut Langevin, ESPCI ParisTech
(course + visit, December 7, 8:30-12:45)
Light scattering by small particles, scattering cross sections, orders of magnitude, multiple scattering, ballistic and diffuse intensity, mean free paths, time and length scales, modelling light transport in tissues, diffusion approximation.
- **Holographic microscopy / Optics of ocular tissues**
B. Forget, UFR Biomédicale, Université Paris Descartes; K. Plamann, Laboratoire d'Optique Appliquée, ENSTA ParisTech
(course + visit, December 14, 8:30-12:45)
Historical introduction, the wavefront reconstruction problem, Gabor and Leith-Upatnieks holograms, image location and magnification, digital holography
Anatomy of the anterior segment of the eye, transparency and light scattering of corneal tissue: initial work by David Maurice, transparency and microstructure, consequences for laser surgery, transparency of the crystalline lens.

UE 3.7b – Optical Imaging II

- Exam
 - Written exam.

UE 3.9a Molecular Imaging

- Instructors:
 - **C.A. Cuenod**, D. Leguludec



- Content
 - Description of the growing field of molecular imaging.
 - Description of specific targets for molecular imaging and the way visualize them.
 - The targets will be illustrated in the context of a specific medical field and when applicable to therapeutic implications.
- Courses location:
 - Paris Descartes University



UE 3.9a Molecular Imaging

- Program

- Definition of molecular imaging.
- Membrane, cellular metabolism and intercellular interactions,
- Value of molecular imaging in biology and medicine,
- In vivo maging modalities and multimodal imaging
- Receptor imaging
(Applications in neurology)
- Anti-bodies and membrane motifs
(Applications in oncology)
- Cellular metabolism, trans-membrane transport and viability
(Applications in cardiology)
- Non-membranous motifs and enzyme targets
(Applications in liver fibrosis and arterial thrombosis)
- Cell Migration and tissue (re)generation, Cell therapy,
- Imaging of macrophagic cells
- Drugs tagging , evaluation of therapeutic effects

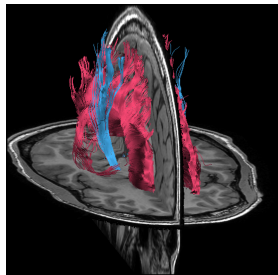
UE 3.9a Molecular Imaging

- Exam
 - Written answers to 3 to 4 questions regarding the course content.

UE 3.10a Functional & Metabolism Imaging

■ Instructors

- **N. Boddaert,**
- **B. Van Beers**



1 day on Brain imaging:

- DT Imaging
- fMRI
- TEP
- Clinical application.
- Post processing tools:
Hands-on.

- A COMPLETER

UE 3.10a Functional & Metabolism Imaging

■ Course locations:

- 1 day at St Anne Hospital
- 1 day at Paris Descartes



■ Exam

- Written exam: 2 hours.
- Multiple choices questions

UE 3.10b Medical Image Analysis II

- Instructors:

- **E. Angelini**, L. Moisan, C. Oppenheim, I. Bloch



- Content

- Advanced image processing for specific diagnostic tasks. Sessions on clinical applications taught jointly by experts clinicians and image processors.

- Course location:

- Telecom ParisTech



UE 3.10b Medical Image Analysis II

■ Program

- Cerebral tumors
- Cardiovascular imaging
- Mammography imaging
- Patch-based image denoising
- Validation methods for medical image processing

■ Exam

- Bibliographic report.
- Course attendance.