Chemistry at the service of Health : how to develop a research and education strategy in a novel University context

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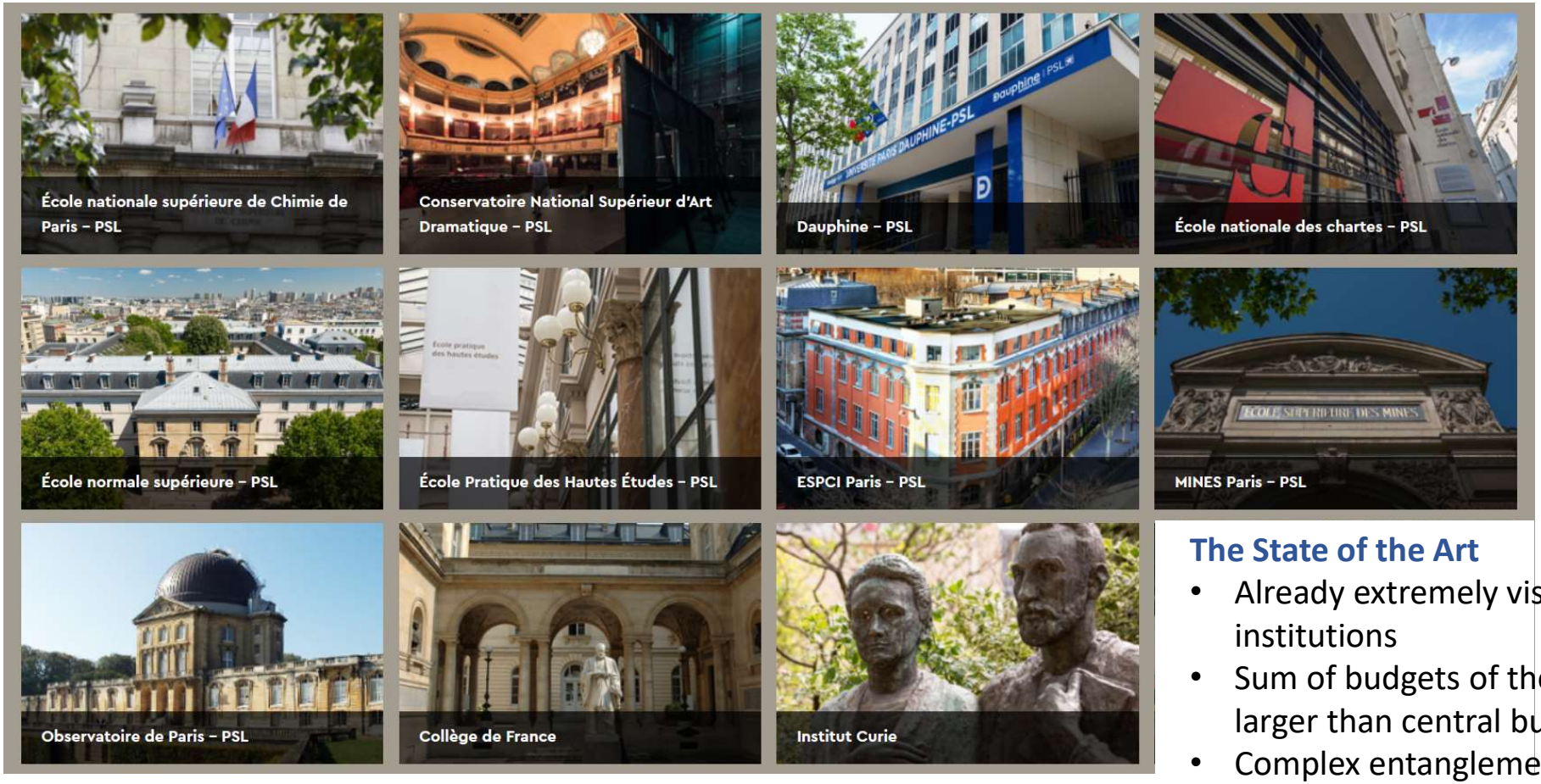
PSL : a novel University from individual excellence



The State of the Art

- Already extremely visible but sub critical institutions
- Sum of budgets of the invidual entities larger than central budget
- Complex entanglement with other local – Paris- or Regional universities

The challenge: create synergy in research and teaching programs with the incentive of the French excellence Initiative

PSL: a global player, a multidisciplinary institution

Physics, Chemistry

École normale supérieure, ESPCI Paris, Collège de France, Observatoire de Paris, Mines ParisTech, Chimie ParisTech

Biology, Medicine

INSERM, École normale supérieure, Institut Curie, Collège de France, ESPCI Paris

Astrophysics

Observatoire de Paris, Collège de France

Engineering

MINES ParisTech, ESPCI Paris, Chimie ParisTech

Mathematics et computer sciences

École normale supérieure, Université Paris-Dauphine, INRIA, Collège de France, Observatoire de Paris, MINES ParisTech

Social sciences and humanities

École normale supérieure, École des hautes études en sciences sociales, Ecole pratique des hautes études, Collège de France, Université Paris-Dauphine

Archaelogy and Antiquity

École normale supérieure, École nationale des chartes, École pratique des hautes études, EFEO, Collège de France

Arts

Ecole des beaux-arts, Ecole des arts décoratifs, Conservatoire national de musique et de danse, Conservatoire national d'art dramatique, Fémis

Economics, business and management

MINES ParisTech, École des hautes études en sciences sociales, Université Paris-Dauphine, École normale supérieure, Institut Louis Bachelier

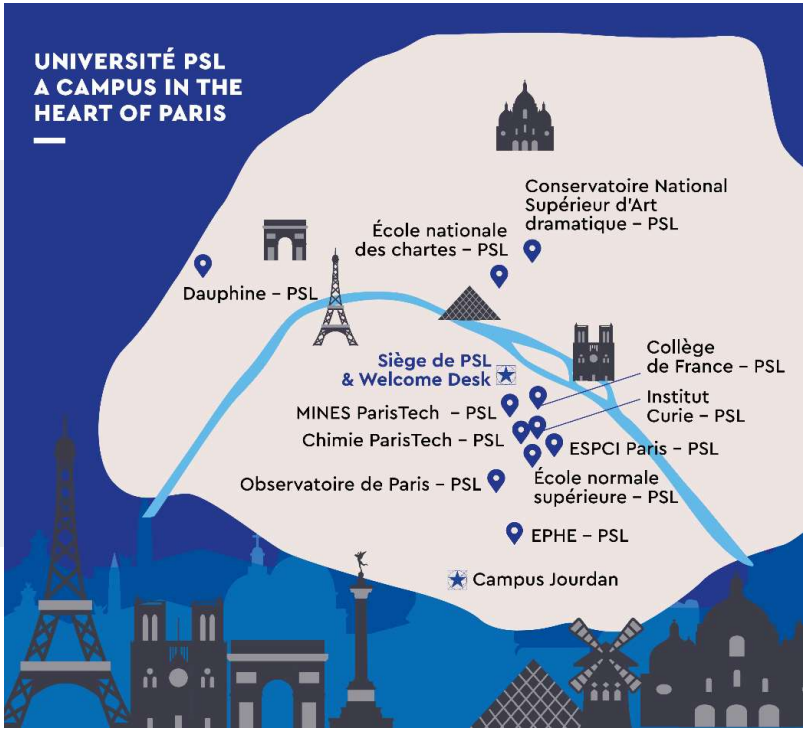
Law

Université Paris-Dauphine, Ecole normale supérieure

PSL's ambitions

PSL: facts and figures

- **11** schools
- **3** research centers
- **17,000** students
- **2,900** researchers & **140** laboratories
- **50** startups founded & **~ 70** patents/year



- **Top5 University** 50 years old or younger (QS, #3 THE)
- **Ranked in the top 50 worldwide** (Shanghai, QS, THE)
- **1st in the Millennial University Rankings** (THE)
- **Numerous international university partners**

PSL : developping synergies

At first focused on research

=> Favour inter-disciplinary inter-institutional novel programs

Initiatives de Recherches interdisciplinaires et stratégiques **(*IRIS*)**
(bottom-up approach)

IRIS exemples :
Création, cognition et société
Governance Analytics
Origines et conditions d'apparition de la vie
Histoire et pratiques de l'écrit
…

=> Identify domains needing inter-institutional collaboration

Large research initiatives (mostly top down)

PSL Chimie, PSL Maths et PSL Environnement

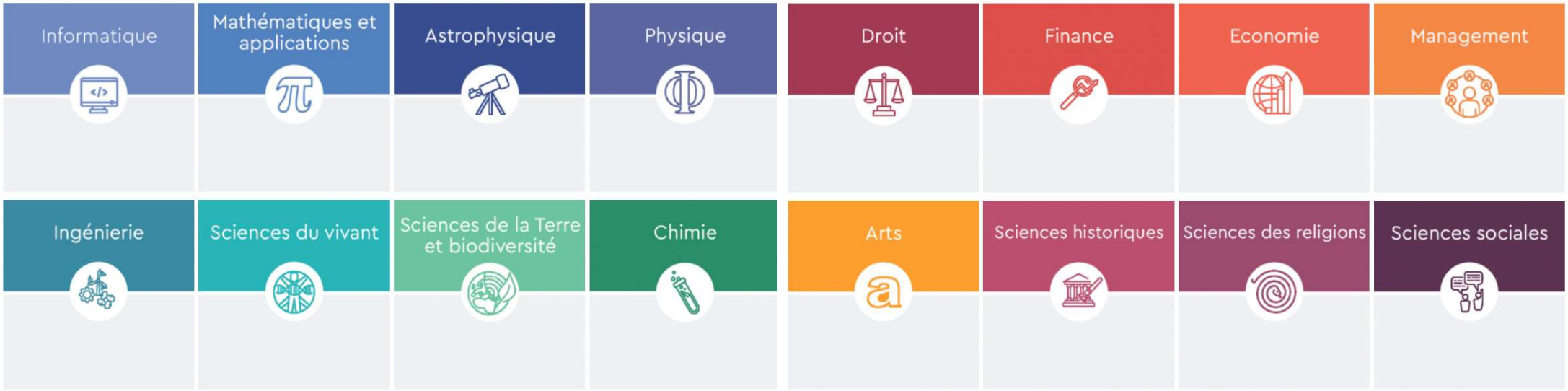
The outcome : **+** excellent science produced

- long term structuring effect limited

PSL : developping synergies

Creation of graduate schools :

Find what we can do best to optimize our M+PhD Research based curricula



The outcome : - limited (direct) impact of research

- extremely disciplinary

+ direct structuring and transforming effect in education programs (M & PhD)

+ long term structuring (communities/circulation of students)

PSL : developping synergies
Life Science and Chemistry as a showcase

What we did ….

Creation of a new Doctoral School in Life Sciences

Novel Master in Chemistry , including Life Sciences

Novel Master in BioMedical Engineering

As a result ….

+ Disentanglement from other Universities
+ Visibility
+ Community of students and Researchers
+ Direct link with the research
- Cost for individual institutions
- No direct financing of research programs

PSL : developping synergies
Back to Research

That being implemented we readdressed the research activities

1. Issued University proper project calls , using some of the excellence initiative funds (50M€) on a bottom up approach (This was possible now that the communities know better each other)

PSL : Research synergies

34 projets submitted => **14** selected

DEVINE	A DEVelopment and Immunology NEtwork to unravel tissue biology	CURIE/ENS
PSL-Neuro	Mechanisms of Learning & Adaptation	ENS/CdF/ESPCI
EngineeringLife	Artificial living systems	CURIE/ENS/ESPCI/ CdF/ENSCP
ChemCellStates	Chemistry of Cell States	CURIE/ENS/ENSCP/ CdF/ESPCI/EPHE
IPGG	Microfluidic (environment&health)	CURIE/ESPCI/ENS/ENSCP/CdF/Mines
ChemAI	Chemistry informed models: AI for chemistry	ENSCP/ENS/ESPCI
MetaSoft	functionalized actuable and active soft matter	ESPCI/ENS/Mines//ENSAD/ENSCP
Smart Waves	Waves, optics, acoustics	ESPCI/ENS/ENSCP/Dauphine/Mines
Q-Mat	Quantum Matter	ENS/ENSCP/ESPCI/CdF/Obs
SPM	Statistical Physics and Mathematics	ENS/Dauphine
TERRAE	Transition Environnementale par la Recherche, la Recherche-Action et l'Enseignement	ENS/Dauphine/EPHE/CdF/Mines
Les fabriques de l'antique	Construire et représenter les temps anciens	EPHE/ENS/Obs/ENC/CdF
Faire Collection	Making a Collection: The material order of teaching and research	EPHE/ENS/ENC/CdF/CNSMDP/ENSAPM
CultureLab	CultureLab : Computational Science of Culture	ENC/ENS/EPHE/Dauphine/Obs

PSL University Grand Programme

Chemistry of Cell States (CHEMCELLSTATE)

Names of scientific leaders of the program: Clotilde Policar, **Gilles Gasser** & Raphaël Rodriguez.

Institution Involved

Institut Curie : Raphaël Rodriguez, Ludger Johannes, Christophe Lamaze, Philippe Chavrier, Fatima Mechta-Grigoriou, Anne Houdusse, Elaine Del Nery.

Ecole Normale Supérieure : Clotilde Policar, Zoher Gueroui, Arnaud Gautier, Fabien Ferrage, Damien Laage, Manon Guille, Laetitia Mony.

Chimie ParisTech : Gilles Gasser, Christophe Thomas, Ilaria Ciofini, Guillaume Lefèvre, Anne Varenne.

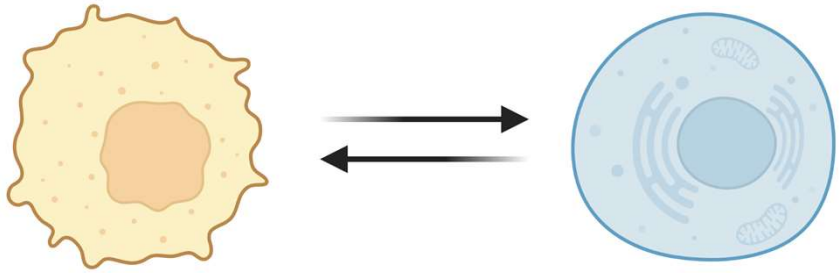
Ecole Supérieure de Physique et Chimique Industrielle : Joëlle Vinh, Amandine Guérinot.

Collège de France : Marc Fontecave, Murielle Lombard, Olivier Espéli.

École Pratique des Hautes Etudes : Sophie Thenet, Sylvie Demignot.

BUDGET: 3 011 364 €

Cell Plasticity (Darwin rule)



- *Cell differentiation and development*
- *Wound healing and tissue repair*
- *Immune cell activation and inflammation*
- *Epithelial-mesenchymal plasticity and cancer*

Brabletz, Kallury, Nieto, Weinberg *Nat. Rev. Cancer* **2018**
Park, Silvin, Ginhoux, Merad *Cell* **2022**

Program and Methodology

Axis 1: Molecular mechanisms of biological systems	Axis 2: Chemogenetic approaches for sensing and controlling cell state	Axis 3: Molecular probes & therapeutics
Axis 4: Physico-chemical methods in quantitative chemistry and modelling of biological systems		

Envisioned Initiatives

(C1) Research seed-projects

(C2) Equipment

(C3) Boost (small budget, quick input)

(C4) Research fellowship for M2 students (pre-thesis recruitm

(C5) Maturation

(C6) International outward mobility

(C7) Outreach call

PSL : Research Synergies

Based on what hat we can do **best** together
Full bottom up approach
Criteria of choice : excellence and originality

The outcomes :

+ All domains represented
+ All communities represented
+ Large adhesion of the researchers altough funding relatively low
+ Both thematic and interdisciplinary projects
+ Both established communities and novel ones

Still to be optimized : backward interaction GP on PG and viceversa

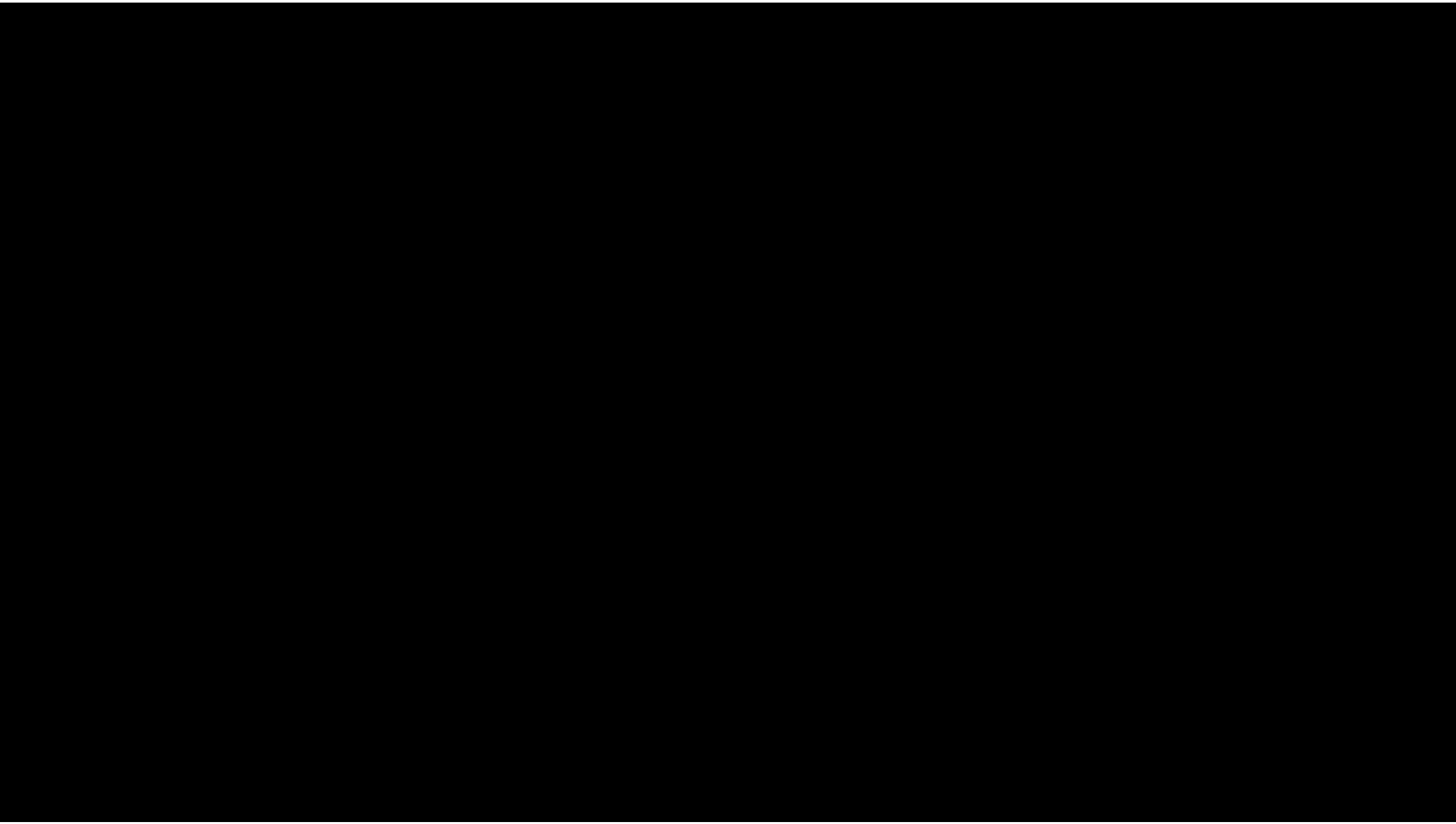
PSL : Research Synergies

1. Issued University proper project calls , using some of the excellence initiative funds (50M€) on a bottom up approach (This was possible now that the communities know better each other)

2. Made full use of research calls issued by the Government e.g.
   - Q Life institute on Life Sciences
   - Joint University Hospital initiative on Women Cancers
   - …

PSL-Qlife Institute

(2018-2027)



Rationale and goals

- Biological processes can now be analyzed **in a truly quantitative fashion** at multiple spatial and temporal levels

- This analysis requires the **close collaboration** of life scientists with chemists, physicists, computational scientists, mathematicians and engineers

Goals:

- Develop interdisciplinary approaches to **understand and model** how biological systems operate

- Structure a world-class integrated centre **for research, training and innovation** in quantitative biology

Missions and strategy

- **Support highly innovative interdisciplinary research**
  - high-risk interdisciplinary projects
  - development of new approaches

- **Train future leaders** able to navigate across:
  - disciplines
  - methodologies

- **Strengthen the socio-economic impact** of this research by accelerating the innovation value chain

Main actions

Research	• Grants for Interdisciplinary projects • Interdisciplinary workshops and conferences
Transfer/ Socio-eco. impact	• “Pre-maturation” program
Teaching and training	• Master scholarships • Qlife winter schools • PhD fellowships • Qlife-Qbio joint training activities
Outreach	• Art & Science projects • Scientific mediation videos

The Institute of Women's Cancers, an ambitious 10-year program to transform the understanding, prevention and treatment of women's cancers

Women's cancers: an unmet medical need and a major public health issue

The situation

In France (per year):
78 000 new cases
20 000 deaths

5 years overall survival:
Ovarian cancer : 43%
Vaginal cancer : 45%
Triple neg breast cancer: 12%

The decrease in cancer mortality:
-2% per year in men
-0,7% per year in women

Increase gender inequalities
Chronic fatigue : women (56%), men (36%).

The need

- ✓ **Transform** the scientific **understanding of women's cancers;**
- ✓ Fully revisit **women's cancer care and prevention;**
- ✓ **Increase awareness** & work with **patients' advocates;**
- ✓ Set-up a **large network of multidisciplinary partners dedicated to Women's Cancers**.

Institute for Women's Cancers

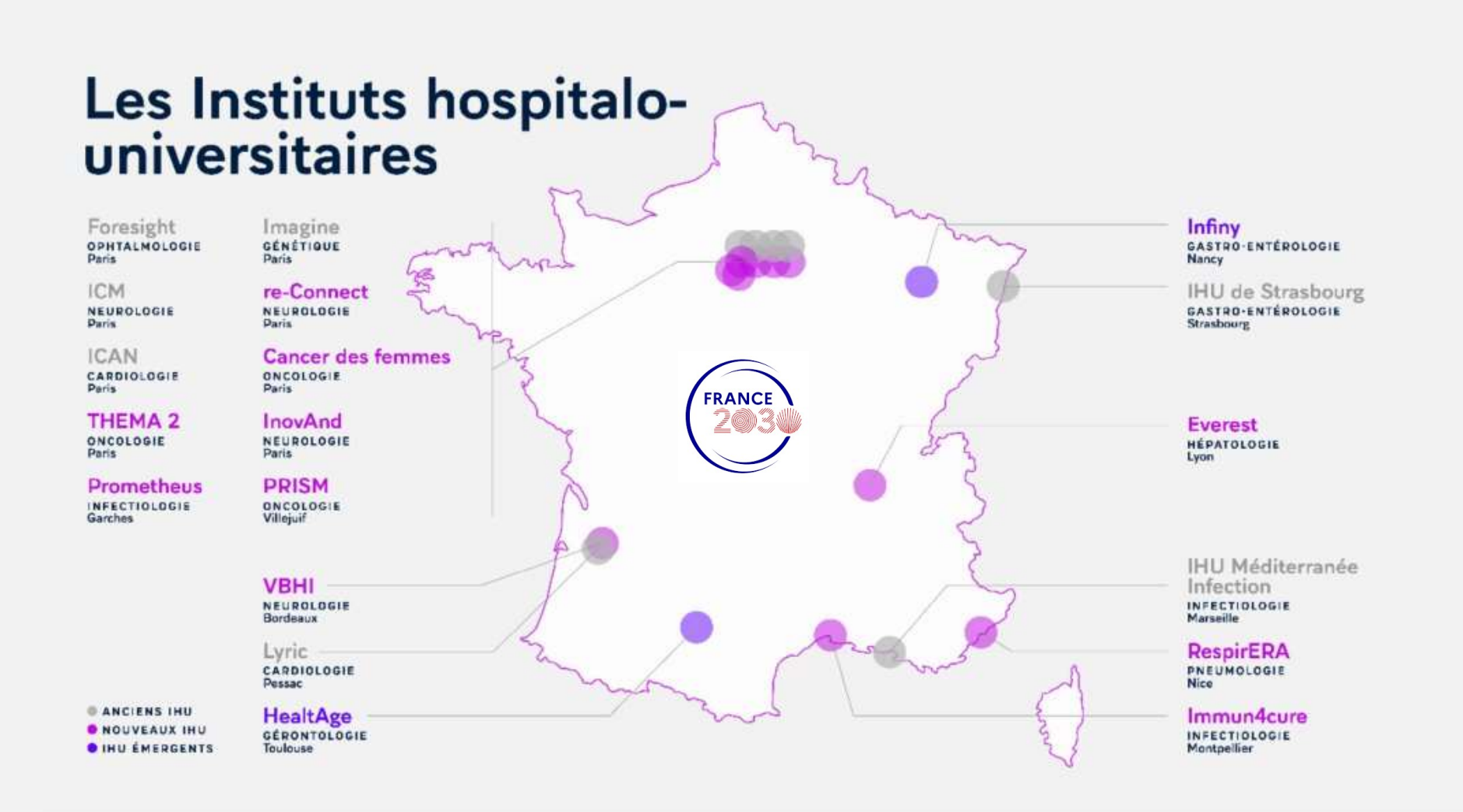
Together: Synergize our research and medical strengths, so far unprecedented in Europe

institut Curie · PSL Université Paris · Inserm

Inter-disciplinarity | **Patient-centered & Personalized care** | **Technology Transfer** | **Training**

The Women's cancers institute: the national reference center on women's cancers

The Hospitalo-Universitary Institutes, a French State initiative to strengthen excellence on research-care continuums



An ambitious program, bringing together existing initiatives and accelerating them through new structuring actions

Basic & Translational Research

WP1 The **specificity** of women's cancer **biology**

WP2 Improving the **diagnosis** of the primary tumor and preventing **relapse**

Partnerships & Networking

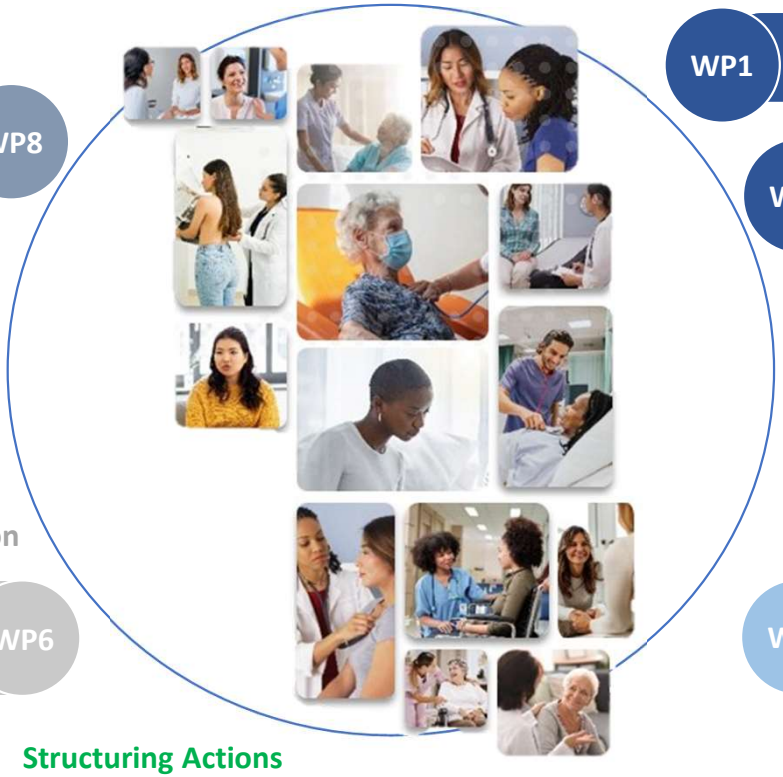
A **reference center** for the care of women's cancers **WP8**

Innovation & Tech transfer

Technology transfer and **entrepreneurship** **WP7**

Training & Education

New innovative programs for researchers, medical doctors, nurses and students **WP6**



Clinical Research & Care Pathways

WP3 **New therapeutic approaches** from fundamental science to clinical applications

WP4 **Personalized care pathways** for elderly and very young women

Structuring Actions

WP5

- Women's Cancers **Atlas**
- Patient-derived **preclinical models**
- **Clinical** Fast Track
- Women's **Living Lab** facility

PSL : Impact of the university structuration on individual institutions

What being in PSL changed for ChimieParisTech?

Advantages :
Benefit from other expertises
Better develop science at the interfaces (biology, physics)

Needs :
Define clearly internal strengths wrt other institution
Better organize the research structures and training to target specific actions developped at University level

e.g. Creation of a new research units , together with the CNRS :
Chemistry at the interface with Health and Life Sciences

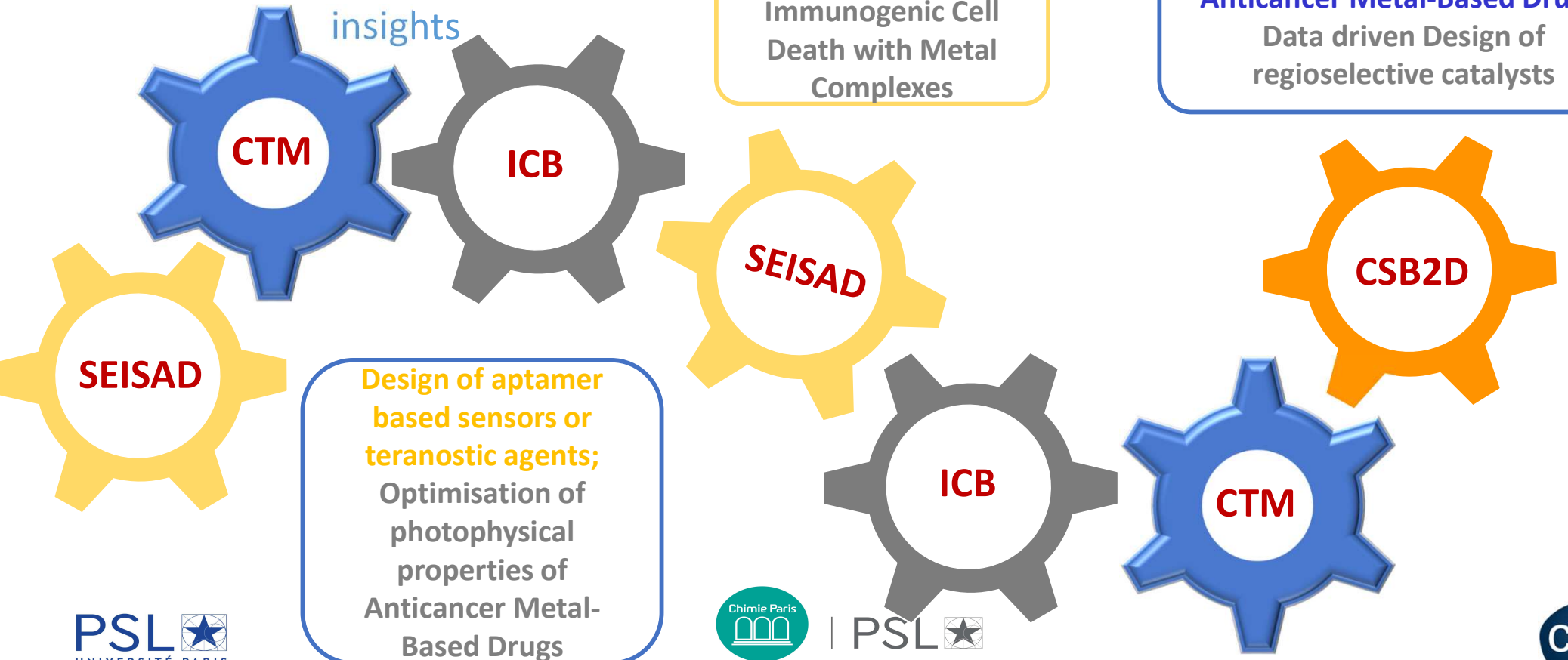
PSL : Chemistry for Health and Life Science @ ChimieParisTech

Optimisation through Mechanistic insights

Data Driven Optimisation

ML-Assisted Discovery of Anticancer Metal-Based Drugs;
Data driven Design of regioselective catalysts

Induction of Immunogenic Cell Death with Metal Complexes



Design of aptamer based sensors or teranostic agents;
Optimisation of photophysical properties of Anticancer Metal-Based Drugs

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JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
pubs.acs.org/JACS
Article

Rationally Designed Long-Wavelength Absorbing Ru(II) Polypyridyl Complexes as Photosensitizers for Photodynamic Therapy

Johannes Karges, Franz Heinemann, Marta Jakubaszek, Federica Maschietto, Chloé Subecz, Mazzarine Dotou, Robin Vinck, Olivier Blacque, Mickaël Tharaud, Bruno Goud, Emilio Viñuelas Zahínos, Bernhard Spingler,* Ilaria Ciofini,* and Gilles Gasser*

ICB and CTM Teams

JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
pubs.acs.org/JACS
Article

Increasing the Cytotoxicity of Ru(II) Polypyridyl Complexes by Tuning the Electronic Structure of Dioxo Ligands

Anna Notaro, Marta Jakubaszek, Nils Rotthowe, Federica Maschietto, Robin Vinck, Patrick S. Felder, Bruno Goud, Mickaël Tharaud, Ilaria Ciofini, Fethi Bedioui, Rainer F. Winter, and Gilles Gasser*

ICB, CTM and SEISAD Teams

Chemistry–A European Journal
Full Paper
doi.org/10.1002/chem.201904877
Chemistry Europe

Antitumor Agents

A Maltol-Containing Ruthenium Polypyridyl Complex as a Potential Anticancer Agent**

Anna Notaro,[a] Marta Jakubaszek,[a, b] Severin Koch,[c] Riccardo Rubbiani,[c] Orsolya Dömötör,[d] Éva A. Enyedy,[d, e] Mazzarine Dotou,[a] Fethi Bedioui,[f] Mickaël Tharaud,[g] Bruno Goud,[b] Stefano Ferrari,[h, i] Enzo Alessio,[j] and Gilles Gasser*[a]

ICB and SEISAD Teams

nature COMMUNICATIONS
ARTICLE
https://doi.org/10.1038/s41467-020-16993-0 OPEN

Rationally designed ruthenium complexes for 1- and 2-photon photodynamic therapy

Johannes Karges[1], Shi Kuang[2], Federica Maschietto[3], Olivier Blacque[4], Ilaria Ciofini[3], Hui Chao[2✉] & Gilles Gasser[1✉]

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PSL : Summary
Lessons to be taken

Synergies come from
-A continuous dynamics between research and education
-Institutions that have similar culture and values
-Proximity
-Incentives in research (money and HR)
-Good students and academic staff (CPJ, Chaire d'excellence, …)

We have to adapt the structures to the activities and not only consider that the structure will do it
HR is an issue in terms of potential duplication of skills
And we have to give it the time

Next steps : Continue to develop the training offering
Bachelor
Erasmus mundus together with our EELISA partners

PSL :

Thank You

TIME

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