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ANNEX 1

FLAGSHIP PROJECTS DESCRIPTION

HUB 1 : PRECISION HUMAN HEALTH

PHENOMIX – Phenotypes mixing structured and unstructured data

(PI) : Grégoire Ficheur (EA2694) & Vincent Sobanski (LIRIC UMR 995)

All hospitals collect massive and original data from inpatients via Electronic Medical Records (EMRs) that could be reused. Furthermore, information on outpatients and causes of death are provided as part of the SNDS (Système National des Données de Santé - French healthcare database). To date, most of the research projects have mainly used structured data from SNDS. The search for predictive elements in EMRs requires a focus on structured data, but also on unstructured data such as free text, and changes over time in various parameters such as laboratory results.

In addition, some methods from the deep learning field make it possible to consider new representations by synthesizing information associated with patients. These new representations, built from massive data, could then be transferred to the context of prospective research. Finally, the continuous increase of applications using reinforcement learning raises the question of the applicability to healthcare, i.e. how to decide while taking into account the uncertainty regarding available information.

The PHENOMIX research program aims to develop a set of tools, models and software components that will enable firstly the construction of a "patient embedding" representation and its use to predict the severity of patients' medical interventions or identify homogeneous patient groups within a large population. Secondly, PHENOMIX will employ reinforcement-learning methods to massive health data to help clinicians making a series of decisions

HEALTH AND ENVIRONMENT –

(PI) : Corinne Gower-Rousseau (LIRIC UMR 995) & Luc Dauchet (U 1167)

Hauts-de-France area is marked by its industrial and agricultural history. The atmosphere is one of the most polluted in France. Social inequality and unemployment are important. Many pathologies are more common and life expectancy is lower than in the rest of our country. The aim of this project is to identify environmental factors affecting the health of population through a transversal and interdisciplinary territorial approach.

This project is divided into three objectives:

1) To find associations between the incidence of health events and territorial environmental exposure through ecological regression using broad environmental, social and historical databases. This study will be based on population-based studies of Crohn's Disease (Epimad), Chronic Kidney Failure (REIN) and the Cohort of Premature Children (EPIPAGE2).

2) To measure the association between air pollution, biomarkers of inflammation and oxidative stress, miRNA and health status through the ELISABET study, representative sample of 3275 volunteers aged

40 to 65, from Lille and Dunkerque. This study includes a biobank and air pollution was modelized by ATMO on the participants' home.

3) To develop innovative methods of individual measurement of microparticles exposure contributing to knowledge the distribution of these microparticles, their determinants related to the environment and people's behavior (indoor and outdoor air, transportation..) .

The knowledge gained from these studies will lead to the development of prospective epidemiological studies and ambitious interventional studies with territorial and individual measures of environmental exposure.

MOLECULAR DESIGN FOR HEALTH – (PI) : Benoît Deprez (U1177)

Le projet pilote Molecular Design For Health exploite les synergies entre trois domaines où la Région HdF dispose déjà d'une capacité de recherche d'excellence démontrée et d'une filière industrielle (biotech / medtech) largement issue du monde académique, capable de lever de capitaux pour développer des produits jusqu'à la commercialisation. Ces trois domaines sont la découverte de médicament, la création de diversité moléculaire comme source d'innovation thérapeutique, les biomatériaux vecteurs de molécules pharmacologiquement actives. Les actions proposées, sélectionnées après consultation de la SATT Nord, des acteurs académiques et industriels ont pour objectifs (1) Démontrer l'éfficacité de 2 médicaments-prototypes existants, issus de la recherche Régionale dans des modèles validés des maladies ciblées, pour augmenter leur valeur industrielle d'une part (licence) et atteindre des niveaux élevés de publication (2) Augmenter le potentiel de la plateforme de criblage Régionale (membre de l'Infrastructure Nationale ChemBioFrance) en enrichissant la chimiothèque Régionale (déjà la plus grande chimiothèque académique d'Europe) avec des molécules bio-inspirées, issues de protocoles innovants maitrisés par la communauté de chimistes organiciens Régionaux. (3) Développer des biomatériaux actifs résorbables personnalisable. Les molécules pharmacologiquement actives dans ces matériaux innovants qui peuvent être imprimés en 3D sont issues de la recherche Régionale.

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HUB 2 : SCIENCE FOR A CHANGING PLANET

OVERSEE – Innovative modeling of radionuclide aerosols

(PI) : Valérie Vallet (PhLAM – UMR 8523)

The OVERSEE project aims at developing and applying innovative multi-scale numerical modeling approaches to elucidate the fate of radioactive elements that could be released into the atmosphere in the case of accidents involving nuclear installations: whether during a serious accident in a plant such as Fukushima or Chernobyl, in spent fuel storage (pools), or in a fuel reprocessing plant where there may be fires in the reprocessing solvents. This project proposes to couple different scales of nanoscopic simulations, ranging from the atomic scale (high precision quantum computations), to the nanoscopic scale by the modeling of aerosols and reactive sites in presences of charged ions (halides, radionuclides). The numerical simulation approaches developed by the OVERSEE project will be made available to the scientific community (open-source simulation codes). They will be adapted to the simulation of the most realistic systems possible, offering direct synergies with the experiments carried out by the collaborations within the Lille site (PhLAM, PC2A, UCCS, and other member laboratories of the Labex CaPPA and CPER CLIMIBIO programs) and those with other French and European partners, such as IRSN.

RECABIO – Resources : Catalysis and Bioeconomy

(PI): Robert Wojcieszak U(CCS – UMR 8207)

The 'RECABIO" project is based on the development of innovative approaches in the field of the bioeconomy, and more specifically the circular economy. It aims at the use of advanced catalytic materials and processes to transform renewable resources and wastes and obtain biosourced energy molecules, materials and vectors. It implements original scientific approaches (in particular hybrid catalysis, photo- and electro-catalysis and their combinations) thanks to (i) the thorough integration of a set of advanced skills of the Lille site, (ii) the use of unique equipment already present on our (Equipex REALCAT, etc.), and (iii) the reception of two Brazilian professors. The socio-economic and environmental rationalization of the processes thus developed must also be evaluated thanks to a close collaboration between so-called "hard" sciences and the Humanities and Social Sciences (LCA, economy, etc.). Also in this context, the hosting of two professors will support these themes, particularly on interconnected components. This convergence will allow new breakthrough discoveries and will lead to an evolution of the bioeconomy concept from a simple juxtaposition of disciplines (a necessary and largely advanced step) to a genuine integration of scientific and technical disciplines. To do this, the present project is based on an interdisciplinary research effort in "hard" sciences aimed at removing the scientific and societal barriers of the bioeconomy, and to question the consequences of ecological change and its ethical, socio-political and social aspects. The ultimate ambition is to create new disciplines, fruit of these interfaces, and this, in the perspective of a global R & D approach, where the production systems will be implanted in their social, political and environmental context.

- **TEM-ASTER** – a technological innovation for the study of sensitive and asteroidal materials at the atomic scale.

(PI) : Hugue Leroux (UMET – UMR 8207)

In 2021, we will be part of a selected international team of researchers that will receive samples from the Hayabusa2 space mission (JAXA space agency, Japan) for analysis. These will be the first samples of a carbonaceous asteroid ever returned to Earth. The samples should have preserved material from the earliest stages of solar system formation. We anticipate that the most important discoveries will require physical and chemical characterization at the nanoscale in an analytical electron microscope. However, with the currently available technology, electron beam damage significantly limits the resolution that can be achieved for the beam-sensitive materials that are of the greatest interest to the project (organic matter and hydrated silicates). To overcome this barrier, we propose to develop a novel data acquisition mode based on the combination of a new type of detector and advanced big data processing.

Beyond the context of space missions, the project proposes technological and methodological innovations that will enable the exploration of solid matter with the ultimate resolution for a wide range of electron-sensitive materials, until now impossible to study at the nanoscale. Hence, our developments will be useful to the study of a wide range of beam sensitive materials of interest. Without being exhaustive, we give some examples in direct connection with research activities of the University of Lille: pharmaceutical materials, polymers, aerosols, a wide range of materials for energy, nanoreactors for catalysis, etc ... Finally, scientific outcomes from space missions always attract the interest of the media. Therefore, we believe that our project has great potential for public outreach and, therefore, includes multiple science outreach actions.

HUB 3 : HUMAN-FRIENDLY DIGITAL WORLD

- **DYDICO:** Dynamics for disruptive communications and connectivity

(PI) : Marc Lefranc (PhLAM -UMR 8523)

Data production and exchange are essential in our modern societies, where ever more mobile users and intelligent objects must be connected. This calls for multi-scale communication infrastructures, combining optical fibers for massive data transport on long distances and wireless links for connecting the final user on short distances, with the highest throughput and the smallest energy consumption possible. In the optical domain, throughput is raised by parallelizing transmission channels (multi-core or multi-mode fibers), while for wireless communications, ultra-high frequencies in the TeraHertz (THz) domain, are used, at the border between electronics and optics. Moreover, the proliferation of connected objects, together with demands for low latency and data security make it necessary to process information inside the transmission loop, however conventional processors are too greedy and not suited to this task. Current telecommunication networks are close to their limits, calling for the design of radically new solutions for the connectivity of tomorrow, be it for transmitting or processing data. The goal of DYDICO is to harness the scientific excellence at the PhLAM, IEMN and Painlevé laboratories to tackle these challenges and elaborate disruptive technologies that will constitute the bricks of future networks.

- **HUMAIN@LILLE :** (PI) Olivier Colot (CRISTAL – UMR 9189)

Ce projet vise à développer des systèmes d'IA « human friendly ». Ce deuxième projet viendra faire écho à l'appel à proposition de chaires en IA de l'ANR. L'objectif général de ce projet est de développer des systèmes qui veillent à ce que les résultats qu'ils fournissent puissent être explicables (possibilité de justification du résultat produit) et certifiables (respect des contraintes spécifiées). Les méthodes d'IA numérique permettent de résoudre des problèmes de la vie courante avec une très grande efficacité, mais il est actuellement impossible d'obtenir une compréhension macroscopique de leur fonctionnement. Il s'agit ainsi (1) de développer des modèles causaux s'apparentant à des réseaux bayésiens acycliques mais différents sur deux aspects : les réseaux causaux sont parcimonieux (pour expliquer les décisions) et l'orientation des arcs dans la structuration du modèle causal est importante (la causalité ne se réduit pas à une corrélation statistique) ; (2) de concevoir des modèle d'apprentissage automatique garantissant des propriétés quant à la probabilité de succès, la vitesse pour les données complexes de grande dimension ; (3) de proposer des méthodes de raisonnement avec explication des données manquantes ; (4) de proposer des méthodes généralisées d'apprentissage par renforcement capables de s'adapter et résoudre des familles de problèmes et ne nécessitant plus un apprentissage pour chaque problème.

- **DISYKNOW :** Digital systems for human knowledge

(PI) Isabelle Paresys (IRHIS – UMR 8529) Virginie Hoel (IEMN – UMR 8520)

The purpose of the project « DiSyKnow-Digital systems for Human Knowledge» is to enhance and to develop innovative numerical models in order to provide new information and results on material cultures and a new visual perceptive experience dealing with past and actual civilizations. Focusing on their human interpretations and uses, perceptual, cognitive and social aspects will benefit of a deeper understanding. To reach these targets, the consortium intends to : (1) develop a 3D model related to a major cultural patrimony of the Hauts-de-France region known as The Field of Cloth of Gold (1520) to reconstitute its architecture, textiles and light effect by instructing the TGIR Huma-Num data base; (2) to model the 3D environment visual perception to get a better understanding of the perceptual appearance phenomenon and in the same time to work on new self-powered neuro biomimetic systems dedicated to restore vision; (3) create dynamic numerical predictive models which model the behavioral interactions with 3D digital content involving virtual agents.

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SOCIAL SCIENCES AND HUMANITIES

CULTURES, SOCIETIES AND PRACTICES IN TRANSFORMATION.

Projects may develop original, theoretical and empirical research, based on the following stakes:

- question the transforming dynamics in space and cultures (present or past, close or distant) from the perspective of representations and/or individual and collective practices

- measure, in a reflexive and critical point of view, the prominent evolutions of our contemporary society in the light of existing political structures, of emerging environmental and social issues, and of the organization modes and self-recognition of social agents

- explore all the vulnerabilities entailed by contemporary mutations as well as alternative experiences or possible solutions to improve the well-being in society at macro, meso ou micro levels

- define practical dimensions (individual or collective) of the social agents' commitment in the changing dynamics of social, political, and economic relations

- evaluate the specific input of the HSS and LEM in the comprehension of evolutions/ transformations of human practices (within society, economy, politics and cultural dimension) evolving in the present time or in longer historical period.