Sujet thèse / PhD subject 2025

Titre Thèse	Analyse basée sur les MEMS du transfert de force vers le noyau dans une cellule	
PhD Title	MEMS-based analysis of force transfer to nucleus in a cell	
(Co)-Directeur	TARHAN, Mehmet Çagatay	E-mail : cagatay.tarhan@junia.com
(Co)-Directeur		E-mail :
(Co)-Encadrant (s)		E-mail :
Laboratoire	IEMN	Web :
Groupe(s)	BioMEMS	Web :
Projet phare principal	Tech Santé	
Demande de fléchage IEMN ? (Energie / Nanocaractérisation / Technologies Neuromorphiques)	Oui ./ Non : Flagship choisi :	
Demande de labellisation Université de Lille (GREAL, labellisée)	Oui / Non : Label :	
Financement acquis Oui ☐ Non ☐ Partiel ☒	Si acquis (total ou partiel), préciser : (contrat, organisme, Université étrangère, , ….) : ANR PRC	
Financement demandé	Contrat Doctoral Etablissement	ULille ☐ Centrale Lille ☐ JUNIA ☒
	Région ou Autre ☒ Préciser : Région	Co financement (Préciser l'origine, demande en cours, et si acquis ou pas) : ANR PRC acquis

A. Résumé / Abstract :

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Mechanical forces have notable effects on cells within tissues at different spatial and temporal levels. Both internal and external forces influence cell life from the molecular level to embryonic development and mature tissues. These forces can trigger downstream signaling pathways that regulate cell division and growth, direct the transcriptional machinery, and drive cell differentiation, leading cells to adapt by modifying their intracellular tension through coordinated cytoskeletal rearrangement and actomyosin contraction. Mechanical tension can affect not only components of the cell surface, but also regulate molecular processes within the nucleus, such as gene expression, or even induce DNA damage.

Despite extensive research on the overall cell mechanics, we still lack a detailed understanding of how these mechanical stresses are transmitted to the nucleus and how mechanical deformation affects nuclear processes, such as chromatin reorganization and the genetic functions associated with DNA. Altered nuclear mechanics has been linked to various human diseases, including heart disease, progeria, and cancer. This study aims to investigate and quantify how nuclear mechanics can be influenced by forces from the cellular environment, potentially contributing to numerous human diseases at both the cellular and molecular levels.

MEMS technology with its superior capacity for practical analysis at the single-cell level will be combined with microfluidics for carrying cells to desired positions. This hybrid method improves analysis throughput and provide alternative tests on different subcellular elements. Integrating the system with confocal microscopy will allow the use of fluorescent reporters for real-time tracking of tagged proteins, both the *Linker of Nucleoskeleton and Cytoskeleton* (LINC) protein force-transfer outside the nucleus, and the chromatin redistribution and possible damage reporters inside the nucleus. As a result, the proposed study provides a versatile and practical tool to investigate in depth how nuclear mechanics can be altered by forces from the extracellular environment, and the key implications of such mechanical processes, potentially involved in many human diseases, from the cellular down to the molecular scale. The results of this study will be used to model such mechanisms in collaboration with biophysicists.

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