

## HABILITATION A DIRIGER DES RECHERCHES

Date de la soutenance : **13 janvier 2025**

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Titre des travaux : « *Les impulsions bêta corticales motrices pour la planification et l'évaluation des mouvements : mécanismes, rôles fonctionnels et développement* »



### Résumé

This work investigates the neural dynamics of motor cortical beta bursts, focusing on their generation mechanisms, waveform diversity, and developmental trajectory. Through advanced techniques, such as biophysical modeling and high-precision magnetoencephalography (hpMEG), it presents an in-depth analysis of beta bursts' role in motor planning and evaluation. The research initially identifies that high-amplitude beta bursts originate from distinct excitatory synaptic inputs in the deep and superficial layers of the motor cortex, aligning with existing models of somatosensory beta bursts. It goes on to reveal that beta bursts are not homogeneous, showing significant variability in amplitude, duration, and waveform shape. Dimensionality reduction techniques categorize these bursts into distinct motifs, suggesting that waveform diversity may indicate different neural mechanisms or functional roles.

The developmental aspect of the study traces beta burst maturation from infancy to adulthood, showing that while the fundamental mechanism of burst generation remains constant, features such as lateralization and burst characteristics evolve significantly with age. This highlights the importance of beta bursts in motor control development and underscores the potential of beta waveform analyses to provide insights into sensorimotor processes across the lifespan. Furthermore, this research suggests that analyzing beta bursts at the waveform level could offer valuable insights for interventions in neurodevelopmental disorders and advance brain-computer interface (BCI) technologies.

The study's contributions are multifaceted, bridging the gap between cortical microdynamics and large-scale neural networks, offering a more nuanced understanding of motor control and sensorimotor integration, and demonstrating the potential of beta burst analysis for future clinical and technological applications.