

CHEMICAL ENGINEERING

Merck Serono S.p.A. - Spectroscopy-based PAT coupled with Artificial Intelligence for pharmaceutical process design and optimization

Funded By	MERCK SERONO S.P.A. [P.iva/CF:00880701008]
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Context of the research activity	The project deals with the development of Process Analytical Technology tools coupling spectroscopic methods (NIR & Raman) and data-based models to monitor, model and control pharmaceutical processes.
Objectives	Merck-Guidonia site is center of excellence for the development of new biological entities (NBEs) and new chemical entities (NCEs) with the purpose of contributing to patient's health. Drug Products (DPs) can be delivered as liquid or freeze-dried presentations. The proposed PhD program, in collaboration with Merck, aims to advance the implementation of PAT tools, using spectroscopy techniques (e.g. Raman, NIR, hyperspectral imaging), in the development and optimization of different products. Spectroscopy techniques have demonstrated their efficacy across a wide range of fields, particularly in pharmaceuticals. This program will specifically investigate the application of these techniques to innovative products, including Antibody Drug Conjugates (ADC) and oligonucleotides. As large datasets are generated through these spectroscopic techniques, including Artificial Intelligence (AI) approaches such as Artificial Neural Networks (ANN), Principal Component Analysis (PCA), and Partial Least Squares Regression (PLS). These analytical tools will be essential for extracting meaningful chemical information from the data, thereby enhancing the understanding of product characteristics and process dynamics. A key focus of the PhD program will be to explore how spectroscopic methods can be integrated into various unit operation. The manufacturing process for biopharmaceuticals or ADC consists of several unit operations such as raw materials identification, thawing of the drug substance, compounding, filtration, filling, lyophilization, crimping, visual inspection and packaging. According to previous experience, some advance with Raman

	explored as well as the application of NIR spectroscopy to ADC for the residual moisture monitoring. In the framework of oligonucleotides, Raman spectroscopy will be examined to monitor the structuration step to assess changes in the secondary or tertiary structure of the product.
Skills and competencies for the development of the activity	Engineering background, basic knowledge of data-based models (e.g. ANN), basic knowledge of analytical methods used in pharmaceutical technology