**Check One: ☒Project ☐Review ☐Collaboration**

**☐Workshop ☐Other**

| **Descriptive Title** | AI-Assisted Particle and Powder Characterization using Computer Vision |
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| **Working Title[[1]](#footnote-0)** | AI-Assisted Characterization |
| **Technical Area[[2]](#footnote-1)** | Characterization |
| **Date** | 16/06/2025 |
| **Short Description** | This project aims to develop an AI-assisted computer vision model that employs advanced feature extraction techniques to evaluate bulk powder characteristics. By enabling early predictions of properties like flowability, the model minimizes material usage, allowing analysis with limited quantities.  The focus is on capturing images of powders during small-scale processes (e.g., dispersion, shearing, discharge) and using AI algorithms to link these images to powder flow characteristics, both quasi-static and dynamic. Additionally, easily measurable data at the particle level, such as primary size and shape distribution and density, could be incorporated as input to enhance the model's robustness. Furthermore, the small quantity of material makes this approach suitable for calibrating Discrete Element Method (DEM) and Computational Fluid Dynamics (CFD) simulations, advancing the field towards more robust digital twin simulations.  To enhance analytical capabilities, the principal investigator (PI) should consider utilizing cutting-edge computer vision algorithms, such as auto-encoders or vision transformers. Once trained, these models can analyze various processes, like powder discharge from hoppers, providing insights into how physical properties affect performance in industrial applications.  For improved success, the PI is encouraged to select small-scale systems that capture inter-particle forces such as friction, cohesion, and electrostatics, as these factors influence imaging results. By addressing these multifactorial aspects, the model aims to deepen the understanding of bulk powder behavior, leading to enhanced material processing strategies across diverse industries. |
| **Objectives** | **Integrate Particle-Level Data:** Incorporate essential parameters like size, shape, bulk density, and dispersion metrics to enhance predictive accuracy for powder flowability.  **Diverse Powder Analysis:** Analyze a variety of powder types, considering differences in particle size distribution, shape, and adhesion, to improve model robustness across industrial applications.  **Real-World Validation:** Conduct tests with industrially relevant powders to validate model predictions in practical applications, particularly during hopper discharge and screw feeding processes.  **Analyze Flow Behavior:** Utilize imaging systems to capture and assess the effects of forces like friction and cohesion on powder flow behavior, providing insights into handling and processing dynamics.  **Utilize Advanced AI-Algorithms:** Implement auto-encoders and vision transformers to analyze powder dispersal and flow patterns, revealing insights into flowability factors during processing.  **Create an Open Database:** Develop an open-access database to compile project findings, models, and data, benefiting future research and collaboration in the field. |
| **Scope** | In Scope:   * Dry or/and Wet systems * Use of existing industrial characterization tools both for imaging and characterization   Out Scope:   * DEM/CFD modelling * Traditional image analysis * Pure data driven approaches * PCA/PLS |

| **Recommended Contractors (2 or 3)** | | |
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1. Title used in meeting agendas and file archives [↑](#footnote-ref-0)
2. One or more from the following list: W = wet systems; D = dry systems; F = particle formation; SR = size reduction; M = modeling; SE = systems engineering [↑](#footnote-ref-1)