IFPRI BRIEF TEMPLATE

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

Descriptive Title	Mill selection and process optimization for size reduction of a ductile material.
Working Title[1]	Soft Material Driven Mill Selection & Optimization
Technical Area[2]	Size Reduction
Date	06/16/25
Short Description	Soft material processing has historically played a critical role in the food industry; however, its relevance is expanding across various industrial applications due to the challenges posed by the material properties such as composites subjected to high active loading and the use of naturally derived materials. This project aims to build upon the successful application of predictive modeling incorporating material and machine functions, specifically focusing on ductile materials. The objective is to establish a representative material function that links material properties to milling performance. This material function will be utilized to select the appropriate process (milling) equipment, optimize process efficiency, and refine process (mill) design for specific materials. While the primary focus of this project is on milling processes, the developed framework holds potential applicability in other size reduction applications, both intentional and unintentional, such as breakage during pneumatic conveying.
Objectives	**Develop Material Function Framework for Mill Selection:** Establish a comprehensive decision tree or framework that integrates critical material properties (i.e. Material Function) to guide the selection and optimization of milling equipment. **Comprehensive Physical Characterization of Soft Materials:** Conduct thorough physical characterization of soft materials, focusing on key properties such as glass transition temperature, yield stress, Young's modulus, Poisson's ratio, and initial flaw size. These parameters will be augmented with breakage response determined through experimental approaches such as (single) particle impact experiments under controlled conditions.

[1] Title used in meeting agendas and file archives
[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

	Optimal Machine Function for Process (Mill) Selection: Utilize the developed material function framework to identify the optimal machine function and select the most suitable milling equipment. This selection will be based on the derived material parameters, including the material function and the size-dependent threshold energy. **Process Optimization and Validation:** Leverage the material function framework to optimize process set points for a given mill. This includes determining the optimal energy input and size reduction efficiency. The proposed process parameters can be used to validated against empirical data obtained from lab-scale milling or controlled breakage tests, ensuring alignment with theoretical predictions.
Scope	Materials to be considered include food powders, biopolymers, polymers, organic composites and multi-component granules such as inorganic loaded agglomerates. Well defined model ductile particles could form the basis of the methodology development however industrial relevant samples must be included in the study. **Out of scope**: Manipulation of the feed material. The resulting milled particle size distribution should not be less than 20 microns with the feed material not to exceed 4mm.

Recommended Contractors (2 or 3)		
Name	**Institution**	**Email Address**
Selection based on Milling Expertise	Jochen Schmidt (@FAU)	Jochen.schmidt@fau.de
Selection based on Soft Matter Expertise	Patrick Navard (Mines Paris PSL)	Patrick.navard@minesparis.psl.eu

Submitted By:	
Name	**Organization**
Matt Maille	Keurig Dr Pepper
Isabelle Deleris	Cargill
Simon Greener	P&G
Francisco Blanco	Danone
Vincent Meunier	Nestle
Chris Rueb	Aveka
Alexander Findeisen	Novonesis
Marc Thibaut	Dow
Emanuela Del Gado	Georgetown University

Other Academics under consideration:

- Patrick Navard
  - Institution : Mines Paris - PSL
  - Specialization: Rheology, polymers, mechanics of complex materials
  - Relevance: Advanced knowledge of polymer material deformation and behavior under mechanical stress (such as during grinding)
- François Puel
  - Institution: ENSIC (Nancy) – Laboratory of Reactions and Process Engineering
  - Specialty: Process engineering, crystallization, grinding, particle dynamics
  - Relevance: One of the few French experts in industrial grinding, including for ductile or brittle materials; an excellent technical partner.
- Julien Evans
  - Institution: university of Leeds, institute of Particle Science & Engineering
  - Speciality: size reduction of ductile materials, phase transitions, tribomechanical properties
- Andrea Froemmel
  - Institution: ETH Zurich, Institute of Process Engineering
  - Speciality: comminution processes and behavior of cohesive & ductile powders
- Prof. Jasper van der Gucht from
  - Institution: Wageningen University
  - Leads a group that focuses on understanding the microscopic mechanisms that underlie mechanical properties on soft materials, in particular (bio) polymers and colloidal materials.
- Paul Steinmann (paul.steinmann@fau.de),
  - Institution: FAU
  - Presented at the milling workshop, is modelling deformation and fracture soft materials. He is also characterizing filled polymers, but has no equipment for particles. He could cooperate with Jochen Schmidt. Their labs are just 2 mins apart.