

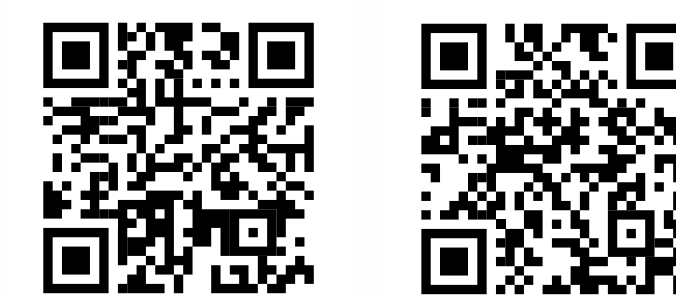
DEM-Based Modelling and Experimental Validation of Particle Comminution in a Planetary Ball Mill

Poster based on: Attanayake, D., Würpel, F., Krüger, M., van Wachem, B., 2027. Powder Technology 485, 123101.

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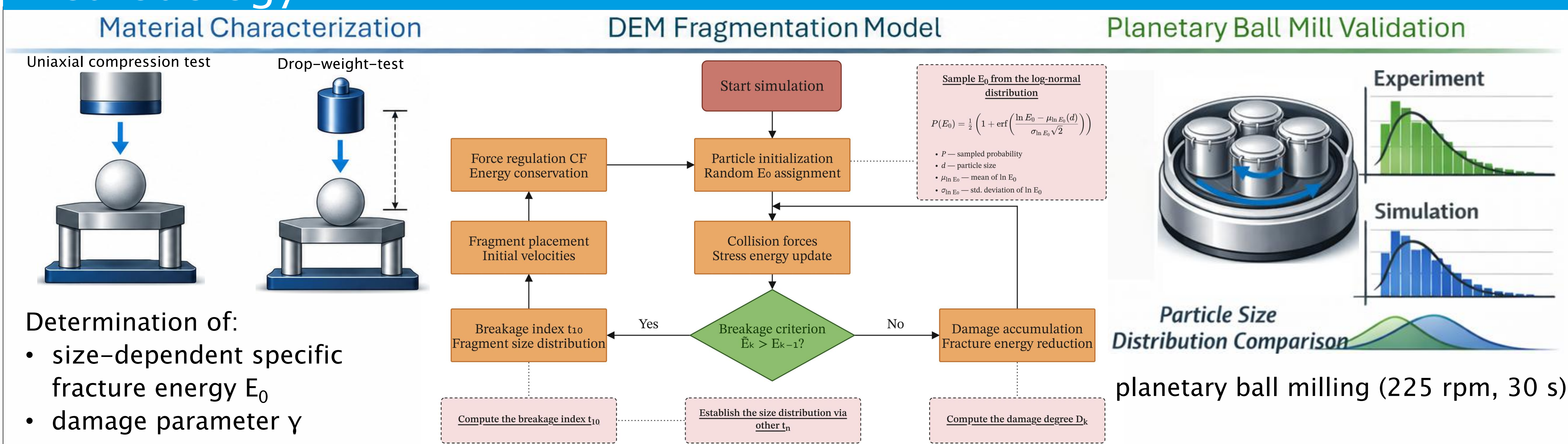
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Introduction

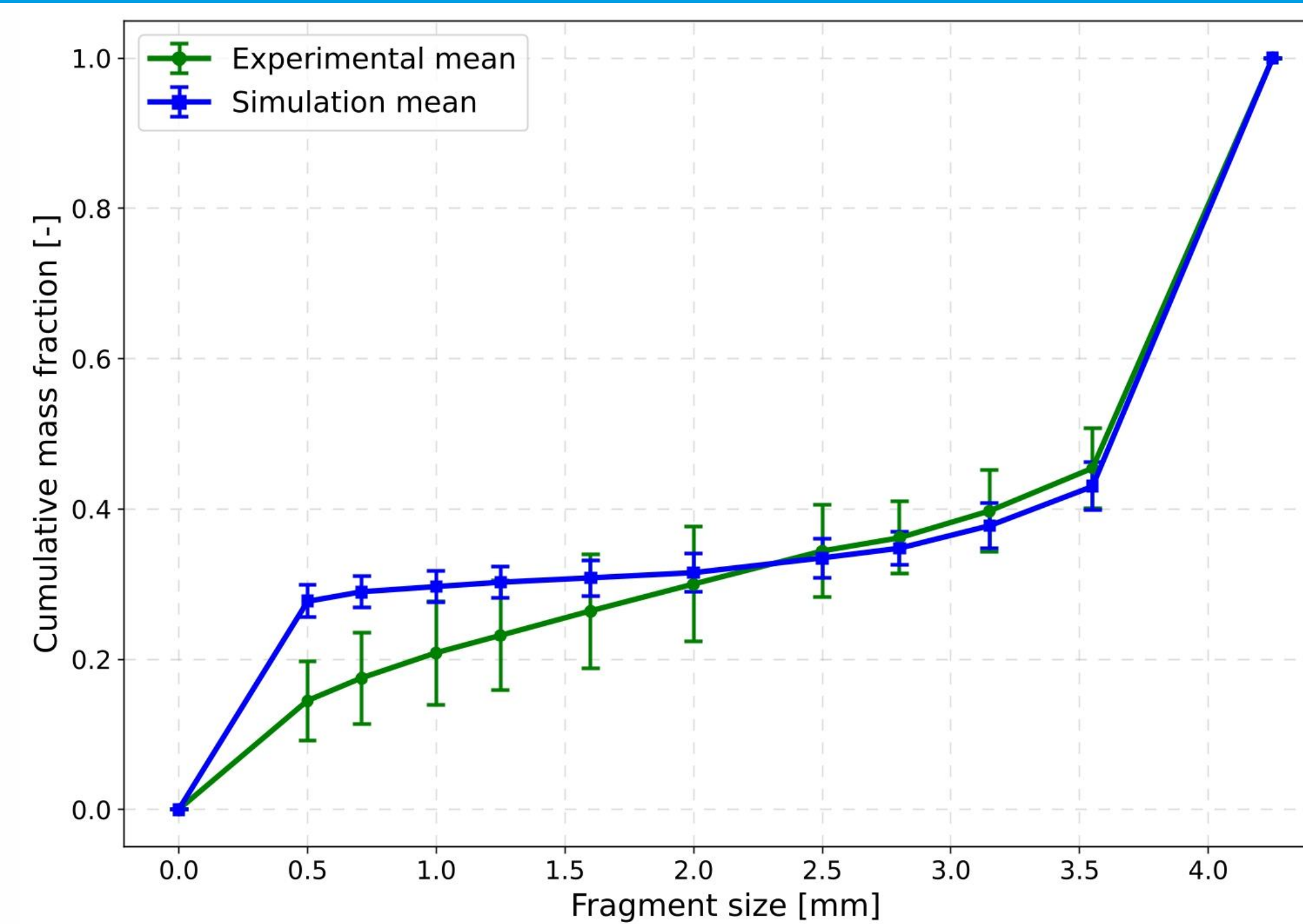
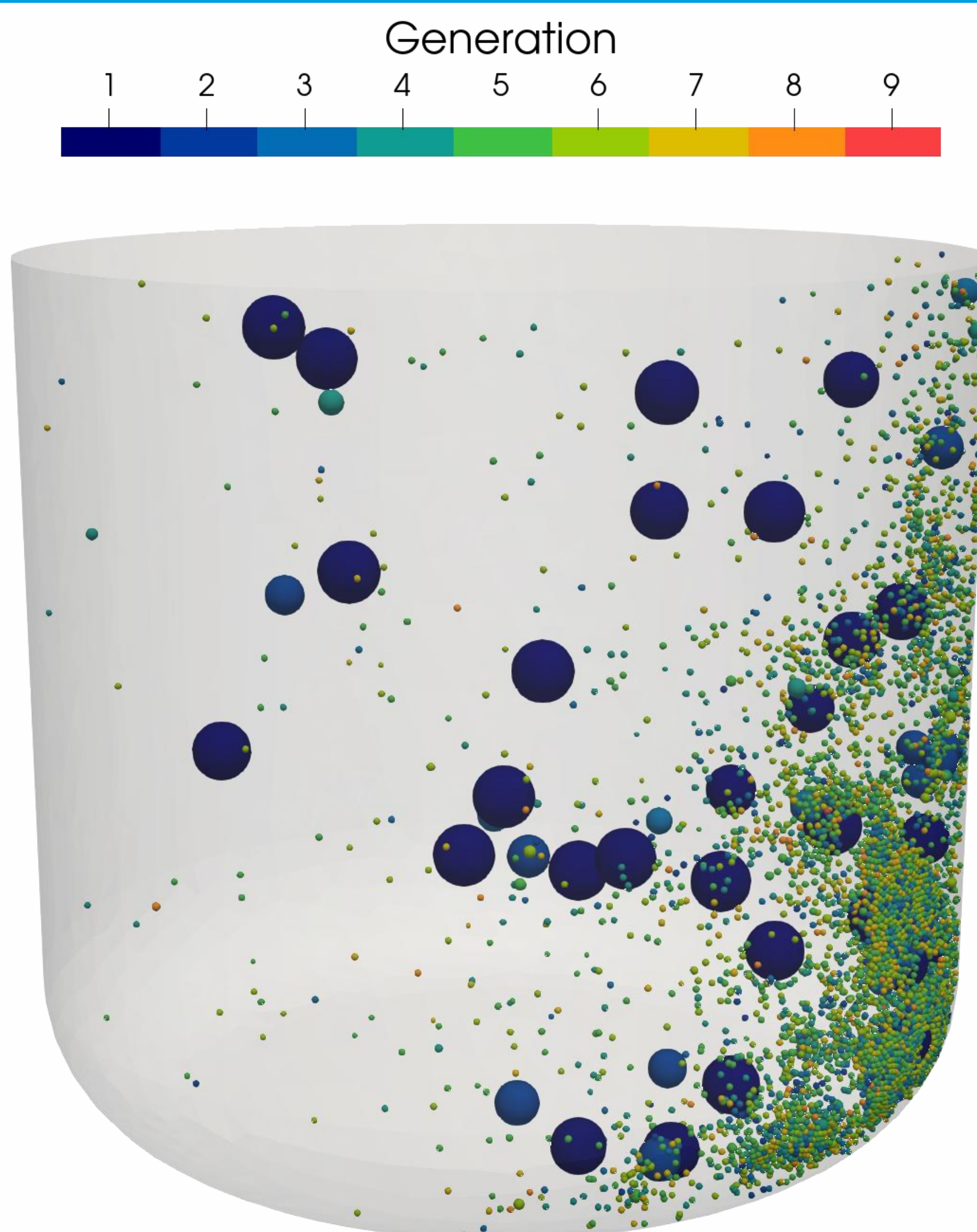
Particle fragmentation plays a crucial role in many industrial processes involving particulate materials, such as milling and fluidized bed biomass pyrolysis [1]. Fragmentation continuously alters the particle size distribution and, consequently, the overall process behaviour through size-dependent processes such as heat, mass, and momentum transfer [2]. Ignoring particle breakage in Discrete Element Method (DEM) simulations can therefore lead to inaccurate predictions of process kinetics and product properties [3]. To address this challenge, a physically consistent DEM particle replacement model for brittle particle fragmentation was developed using zeolite particles and validated against planetary ball mill experiments.

Methodology

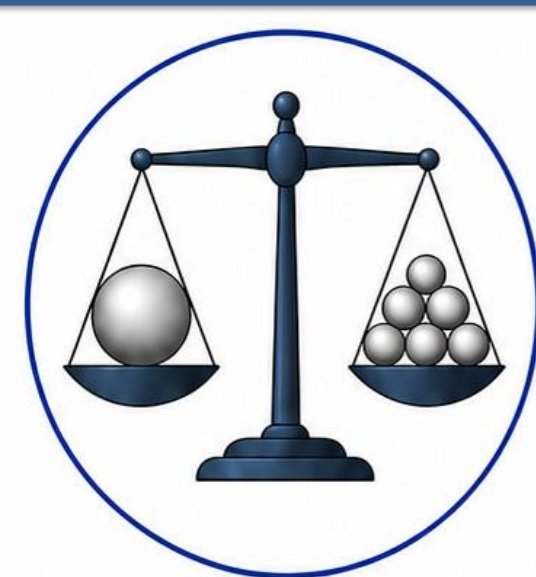


Results

- Breakage behaviour governed by collision energy and accumulated damage
- Particle-size-dependent fracture behaviour represented through E_0
- Damage accumulation enables repeated breakage events
- Fragmentation captured up to nine particle generations
- Progressive evolution of particle size distribution from t_{10} -based breakage description

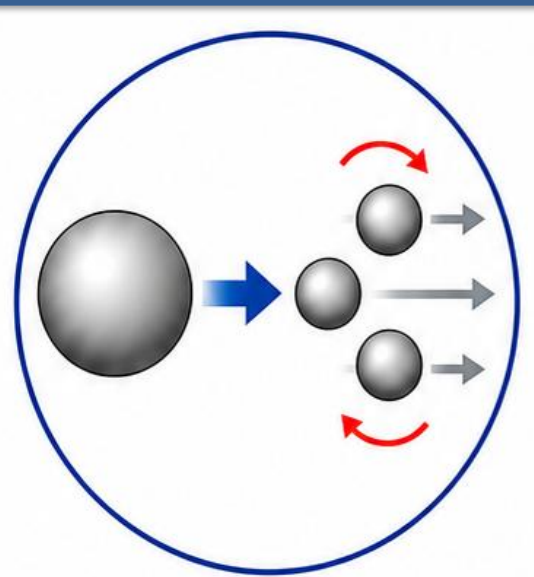


- Good agreement between simulated and measured particle size distributions
- Unbroken particle fraction predicted with high accuracy (57.0 % simulated vs. 54.6 % measured)
- Overall breakage behaviour successfully reproduced
- Deviations increase for fine particles due to the model's assumption of spherical fragments



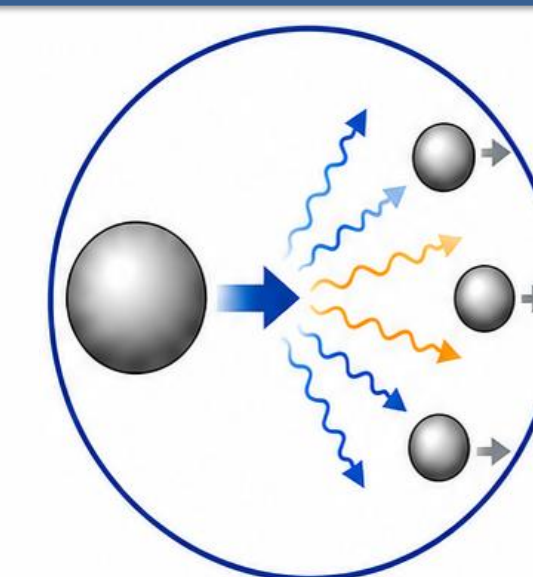
MASS CONSERVATION

The total mass is conserved during fragmentation by replacing a parent particle with its fragments.



MOMENTUM CONSERVATION

Both linear and angular momentum are conserved by distributing the parent particle's momentum and angular momentum to all fragments.



ENERGY CONSERVATION

The fracture energy required to break the particle is balanced by the kinetic energy of the fragments and the dissipated energy.

Key Findings

- Validated DEM particle replacement model for brittle particle breakage
- Conservation of mass, momentum and energy during fragment generation
- Accurate prediction of particle size distribution after ball milling

Acknowledgement

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