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Kinetic Impactor Technique: Benchmark and Validation Studies with iSALE and SPH

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28.04.2021

DART & Hera: Benchmark and Validation Studies with iSALE and SPH

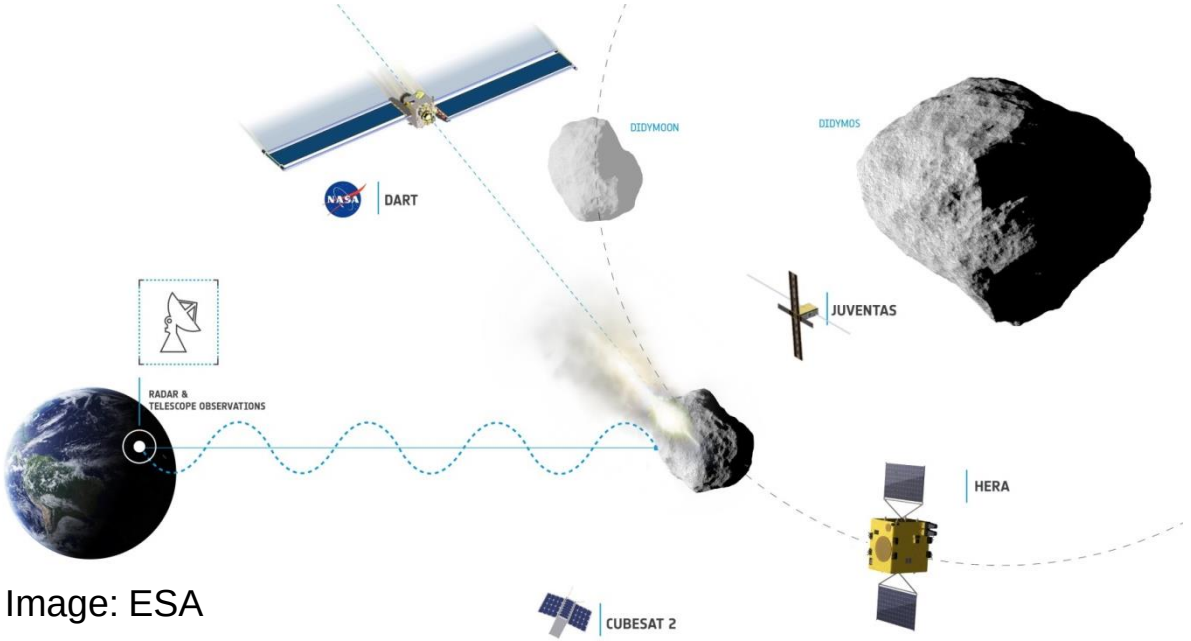
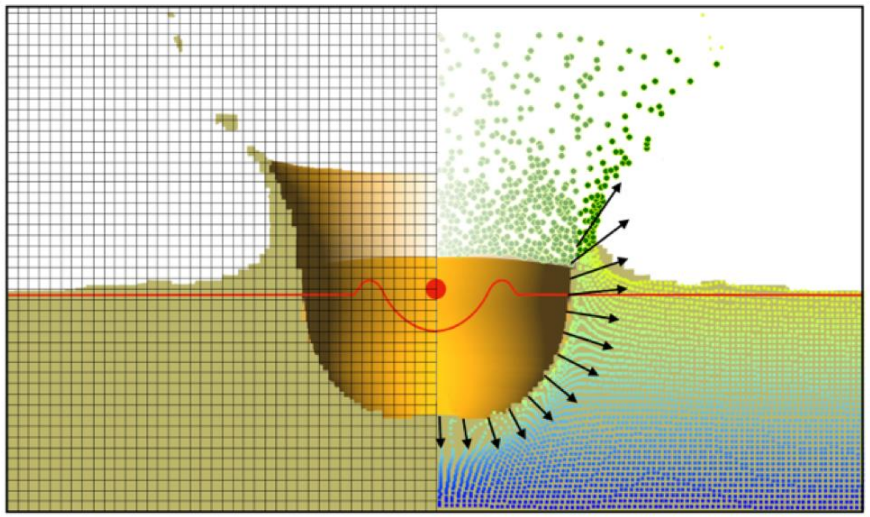


Image: ESA

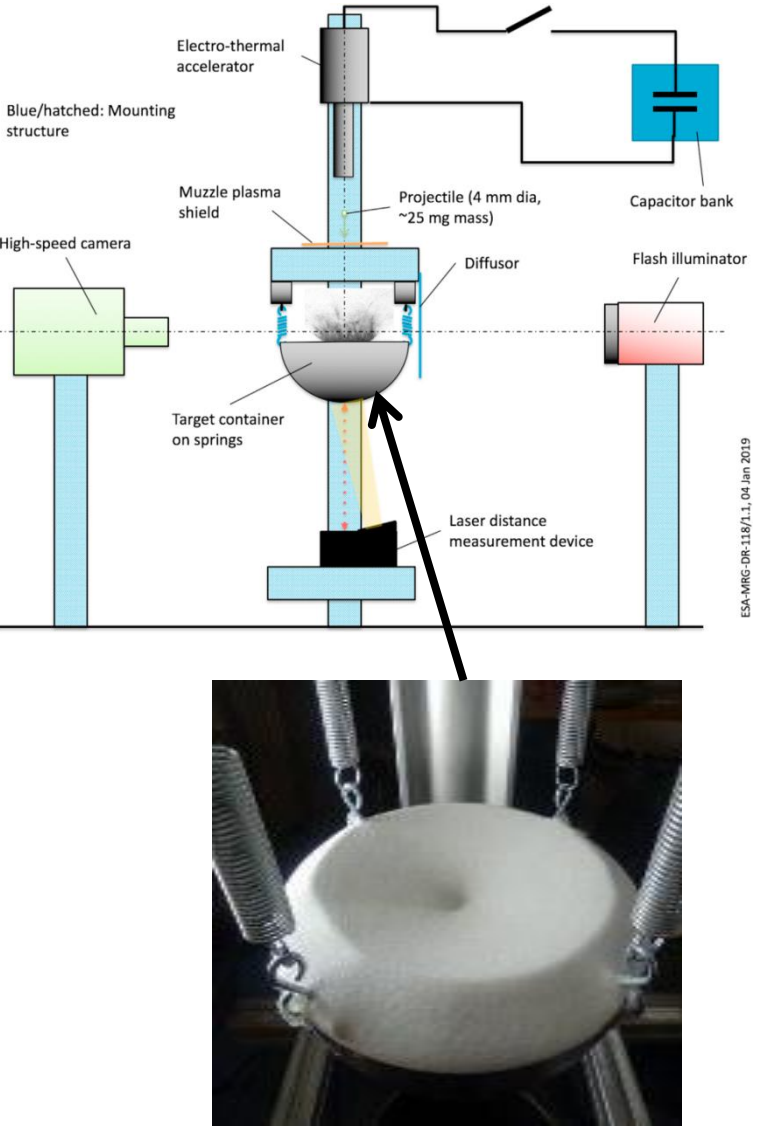
- **Objective:** relate observed orbital change with momentum enhancement and crater morphology for given material properties (low strength regime)
- Shock physics codes simulate different materials; prove accuracy by:
  → validation against experiments
  → benchmarking codes (iSALE & SPH)

iSALE (grid-based code)



SPH (particle code)

Laboratory Experiments of Impacts into Regolith Simulant & Glass Beads



Experimental Setup:

- Chourey et al. 2020, PSS:
  - v~1-3 km/s
  - target materials:
    - glass beads
    - quartz sand
    - regolith simulant
  - formation of ejecta curtain
  - crater size
  - momentum enhancement

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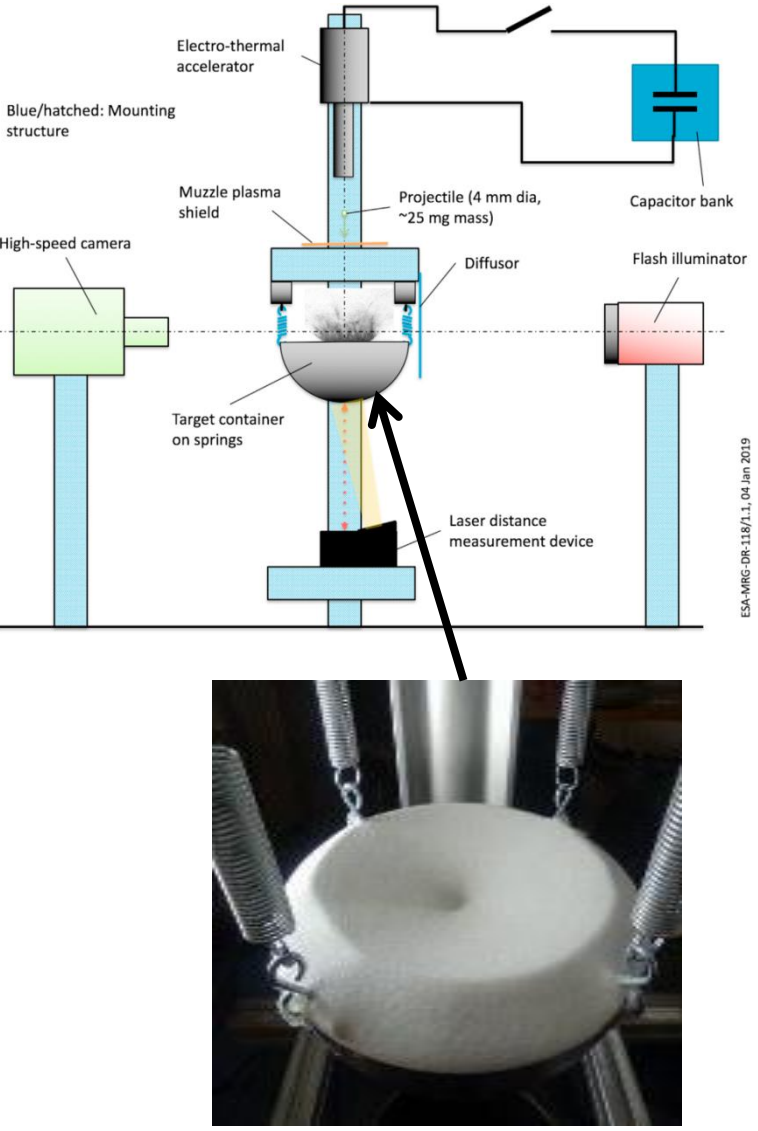

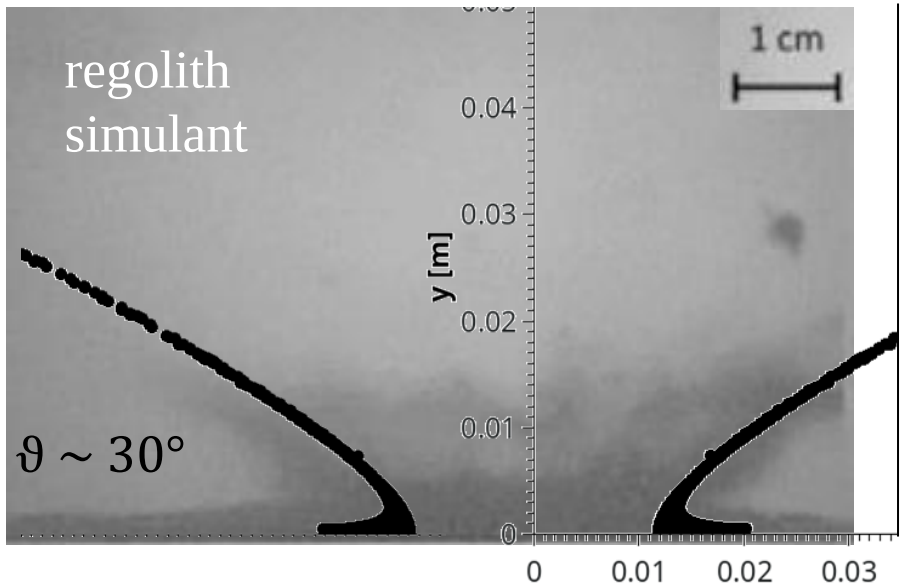

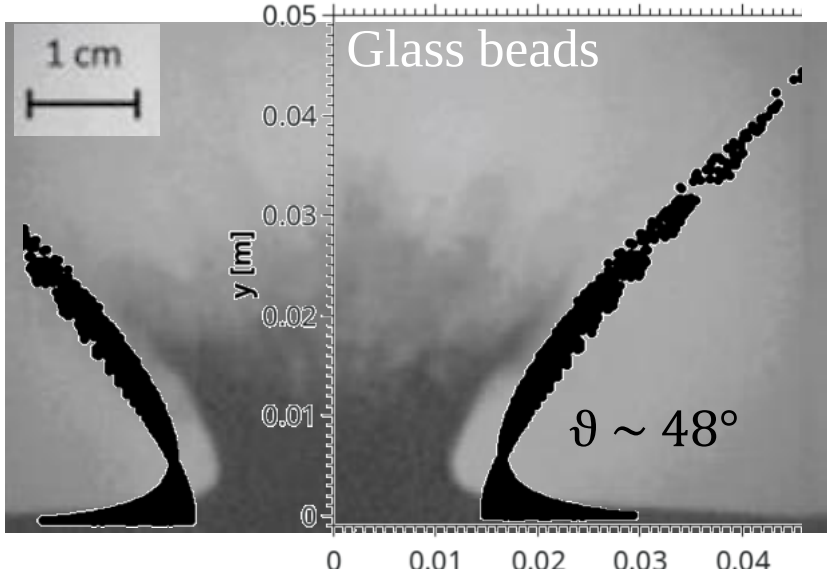

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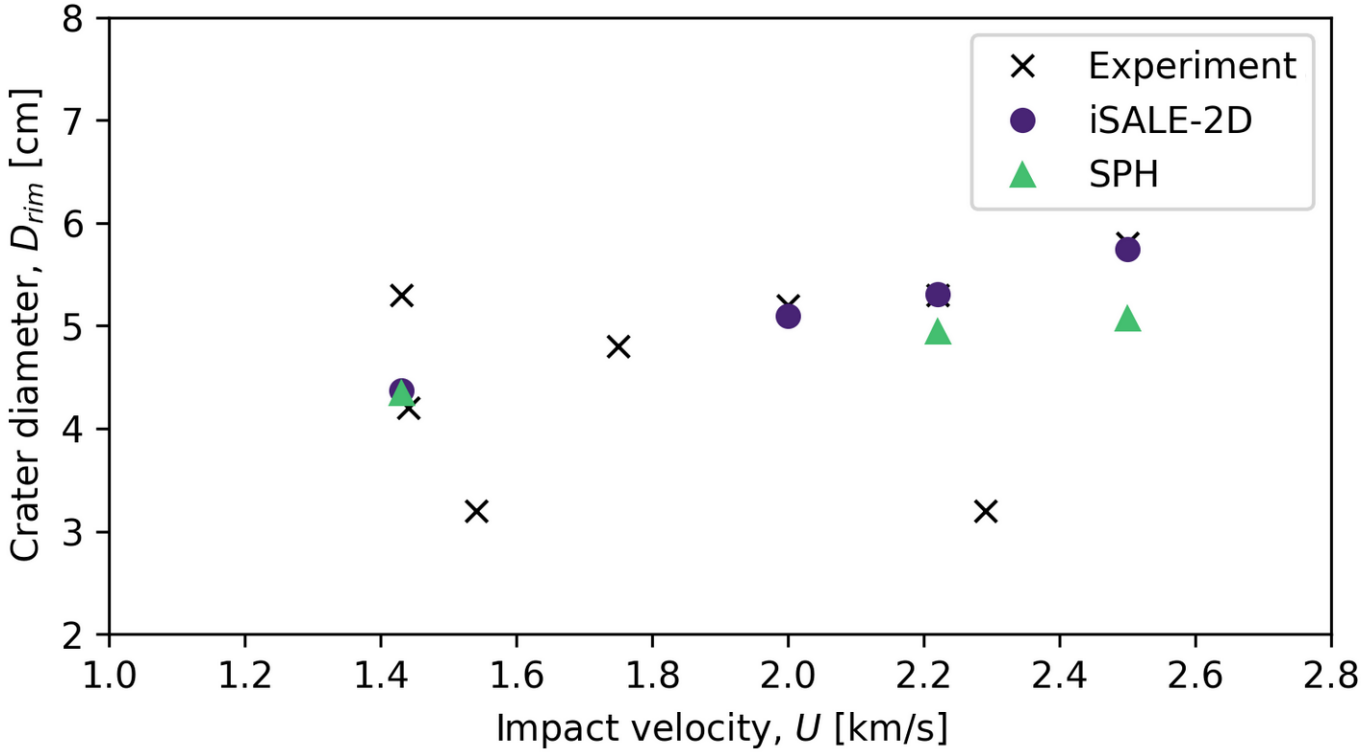
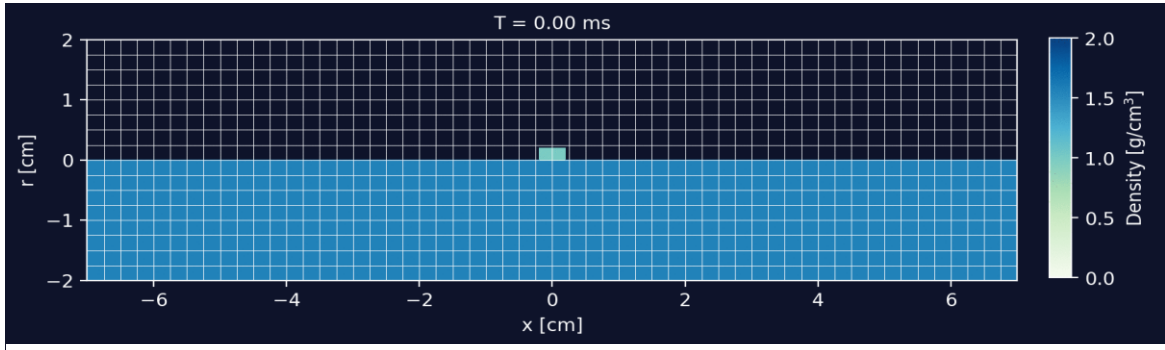
Validation Tests of Impacts into Regolith Simulant: Crater Diameter



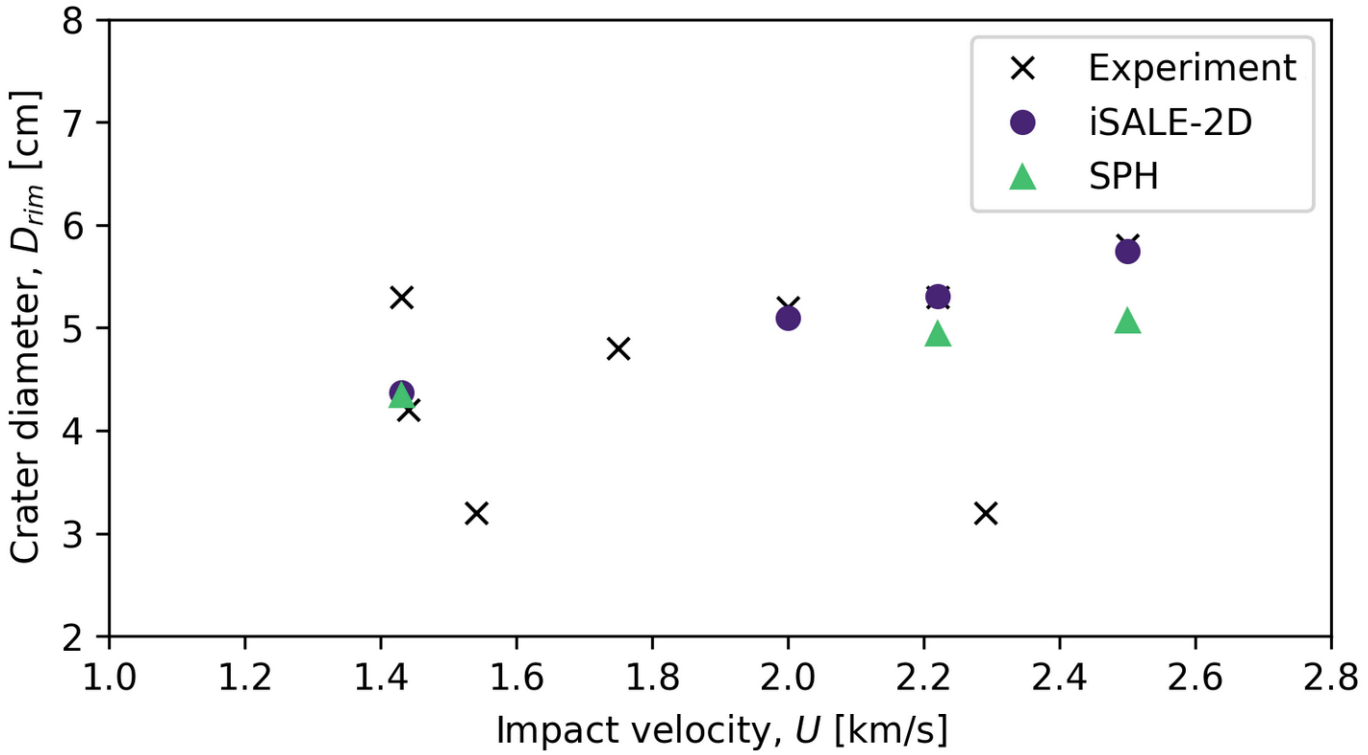
- similar material models & parameters for iSALE-2D and SPH
- both codes agree with experimental data
- some deviation towards faster impact velocity between codes



v = 2.2 km/s, m = 24 mg (PVC), regolith simulant (experiment: Chourey et al. 2020, PSS)

Strength model	Lundborg, Y_0=1.4 kPa, f=0.77
Porosity model Φ=42%	ε-α-model (iSALE), κ=0.96 P-α-model (SPH), P_e=100 Pa, P_s=1.5 GPa

Validation Tests of Impacts into Regolith Simulant: Crater Diameter



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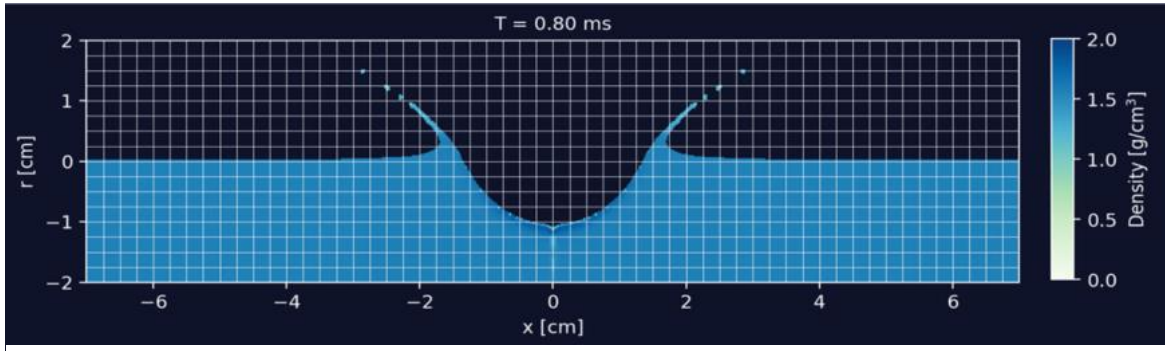

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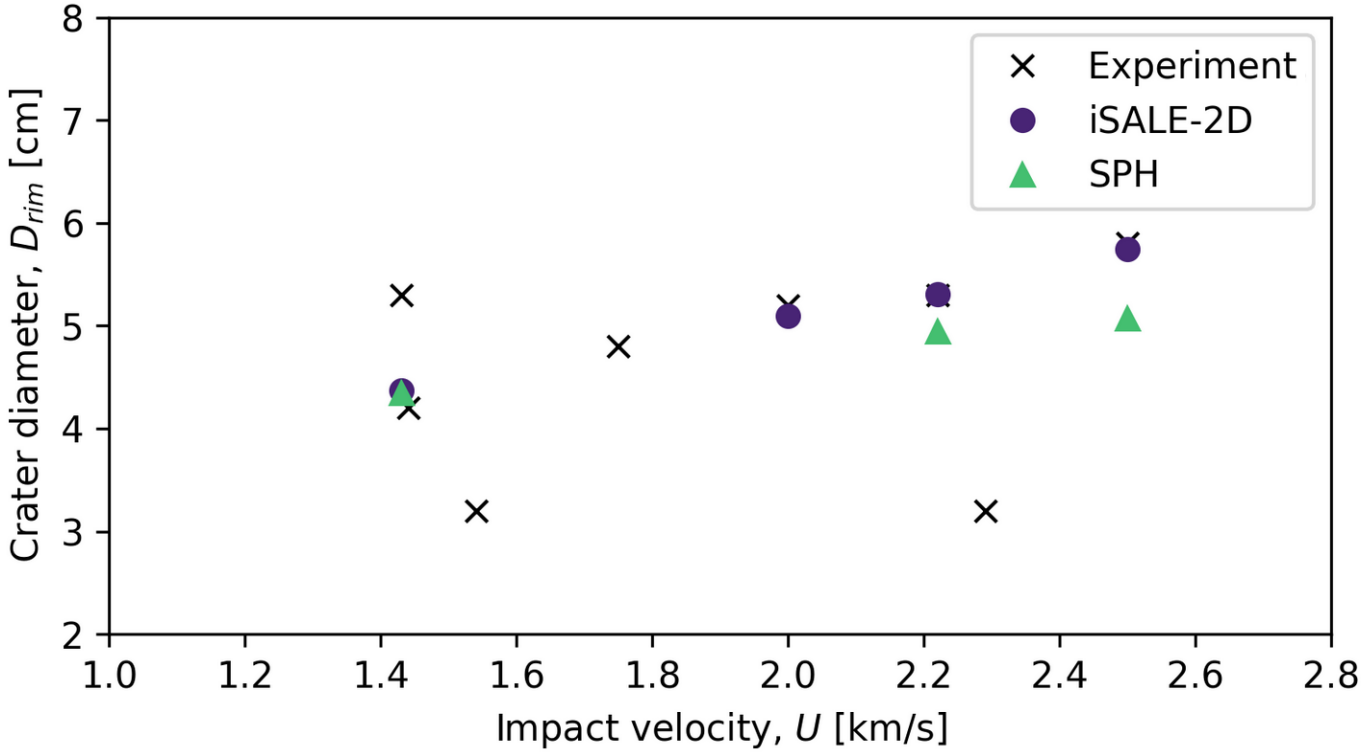

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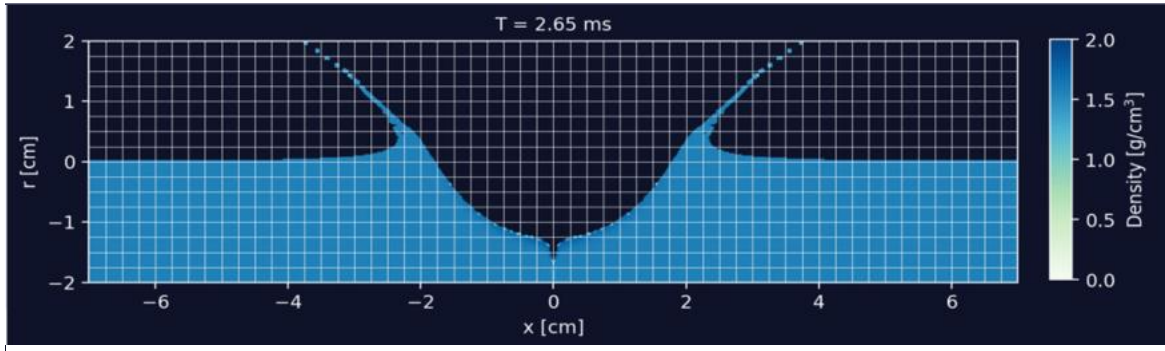

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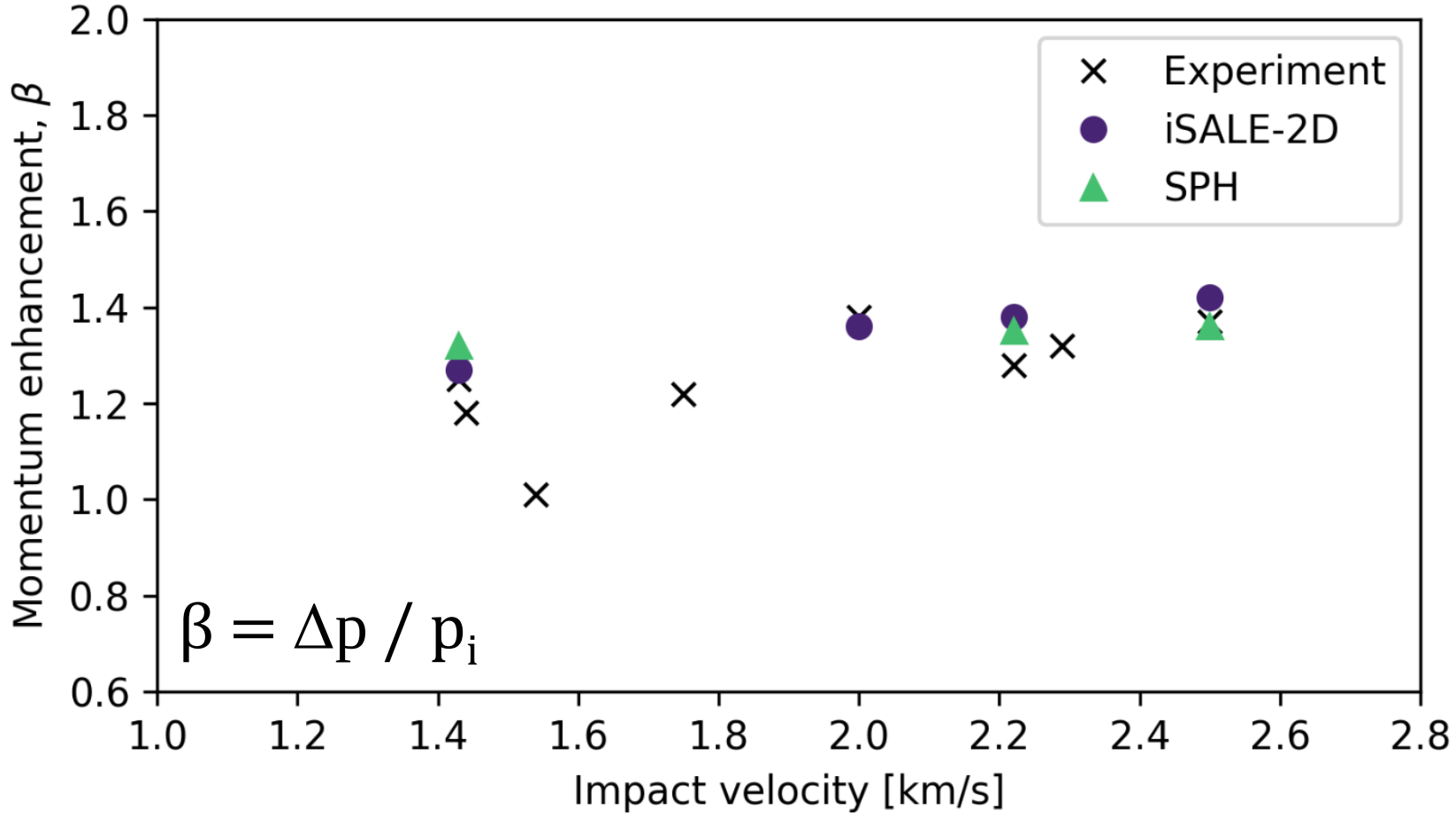
Validation Tests of Impacts into Regolith Simulant: Momentum Enhancement



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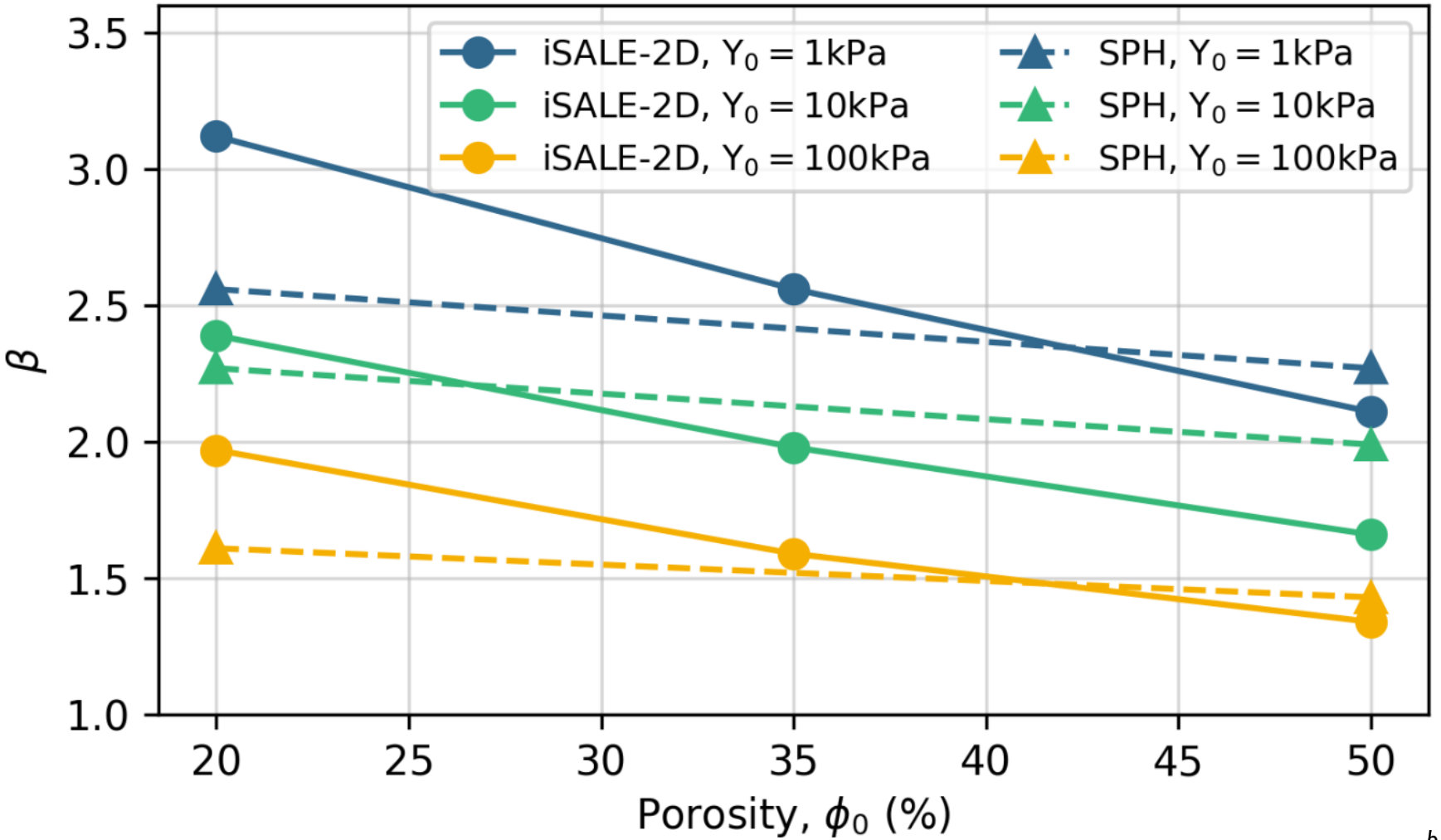
Benchmark study of DART-like Vertical Impacts on Regolith Targets



- Similar material models for iSALE-2D and SPH
- results from both codes agree with each other for a range of material parameters
- some deviations occur for small porosities (Y_0=1 kPa & 100 kPa) and at 50% (Y_0=10 kPa)

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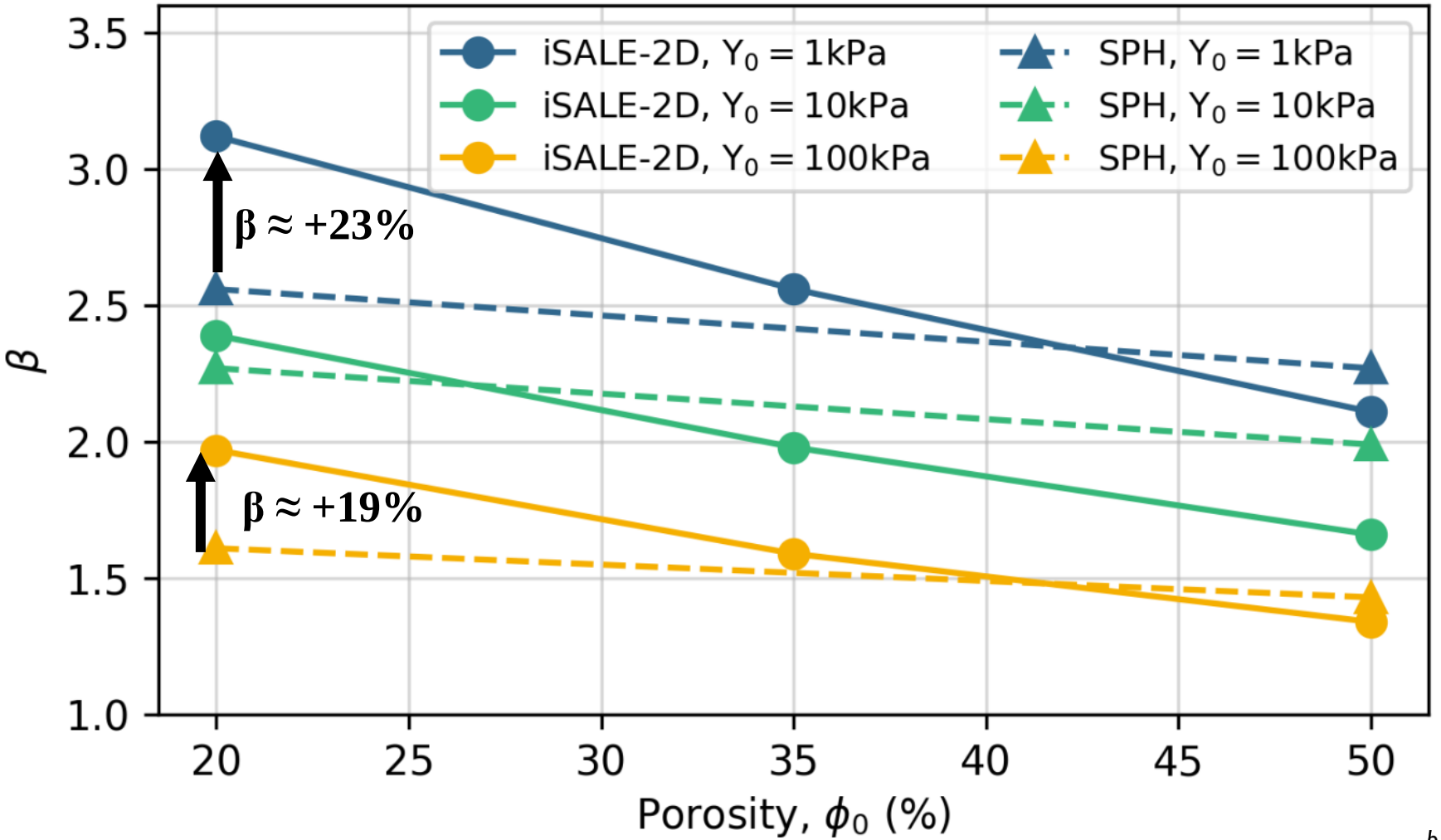

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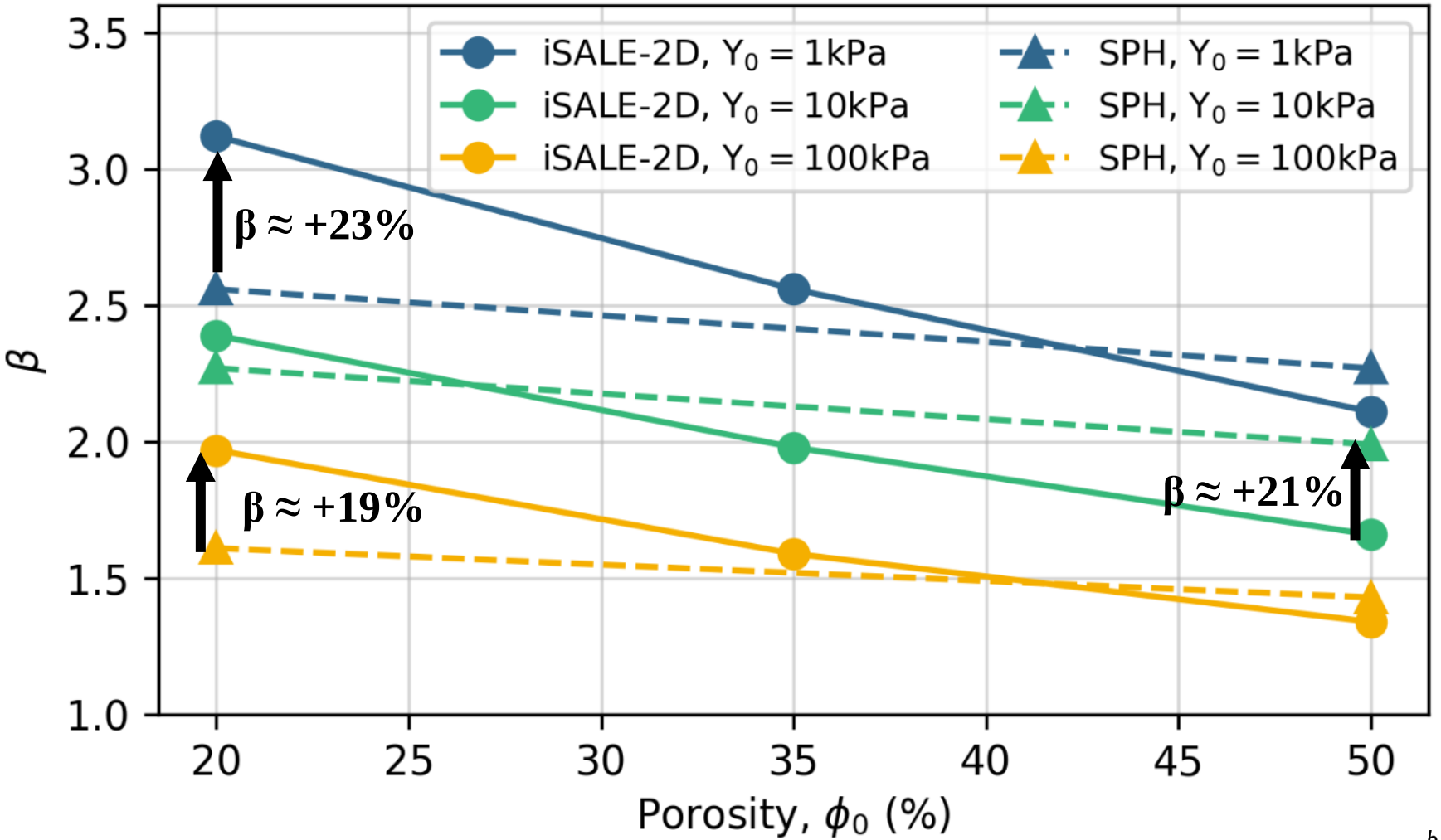

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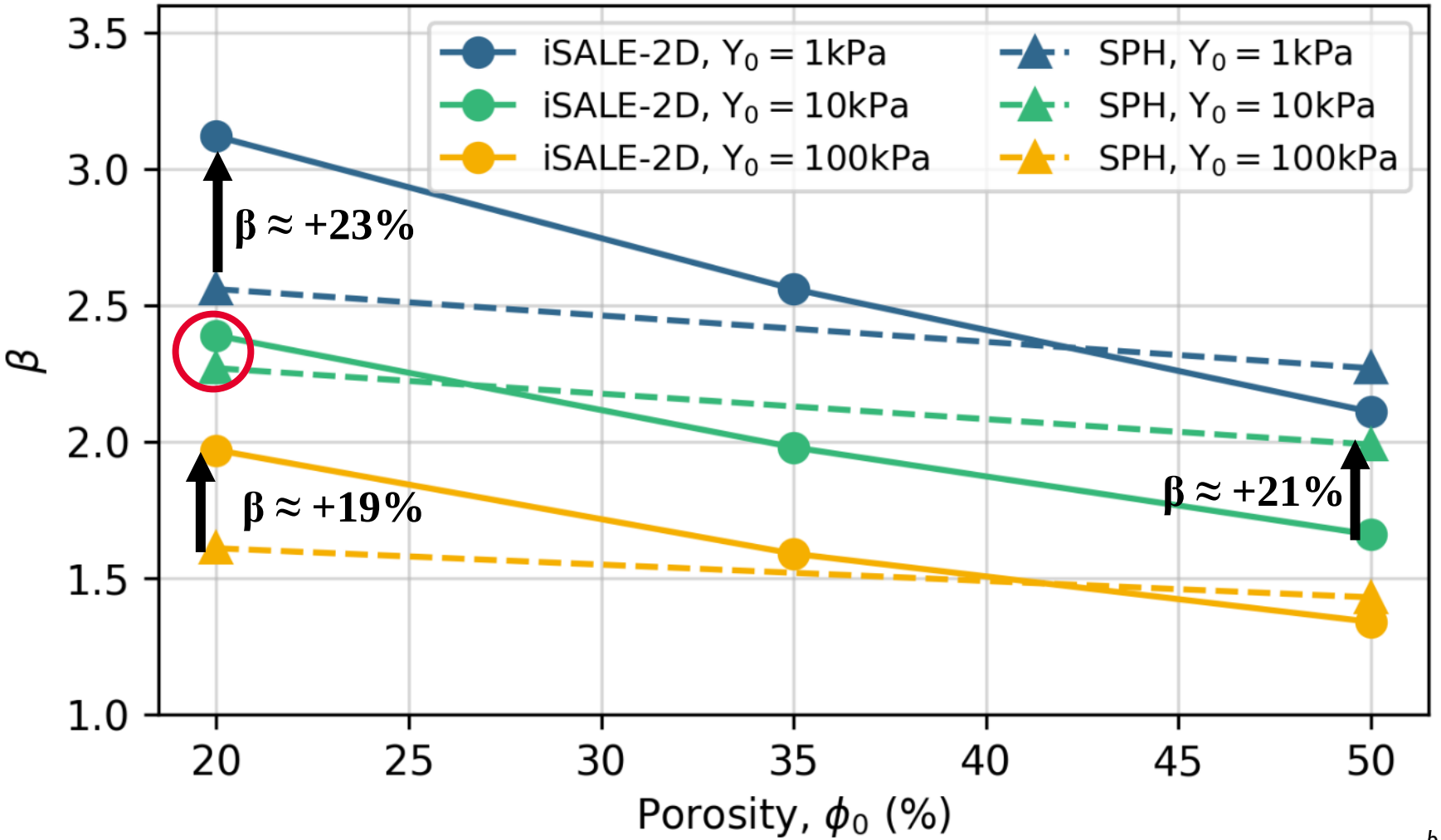

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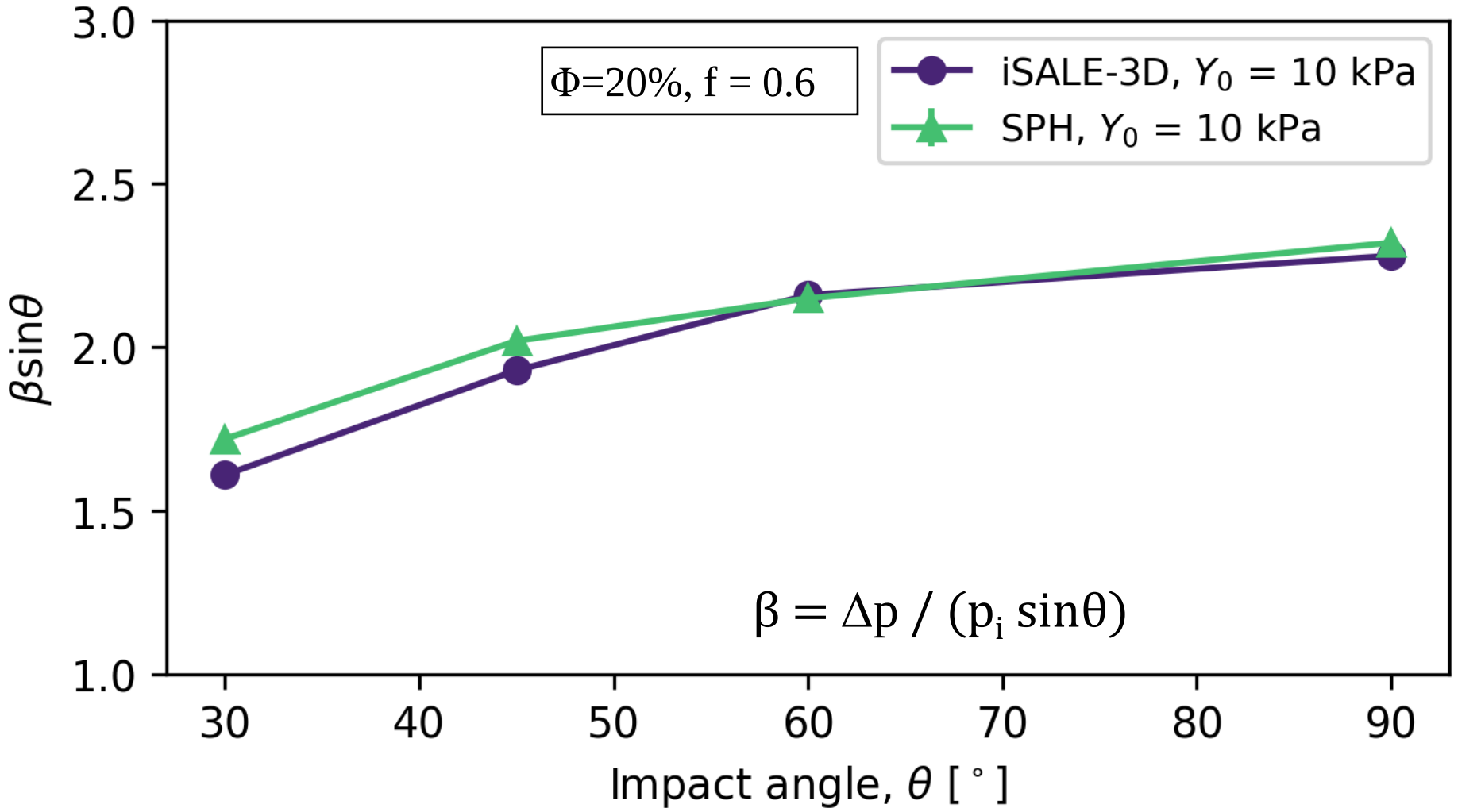
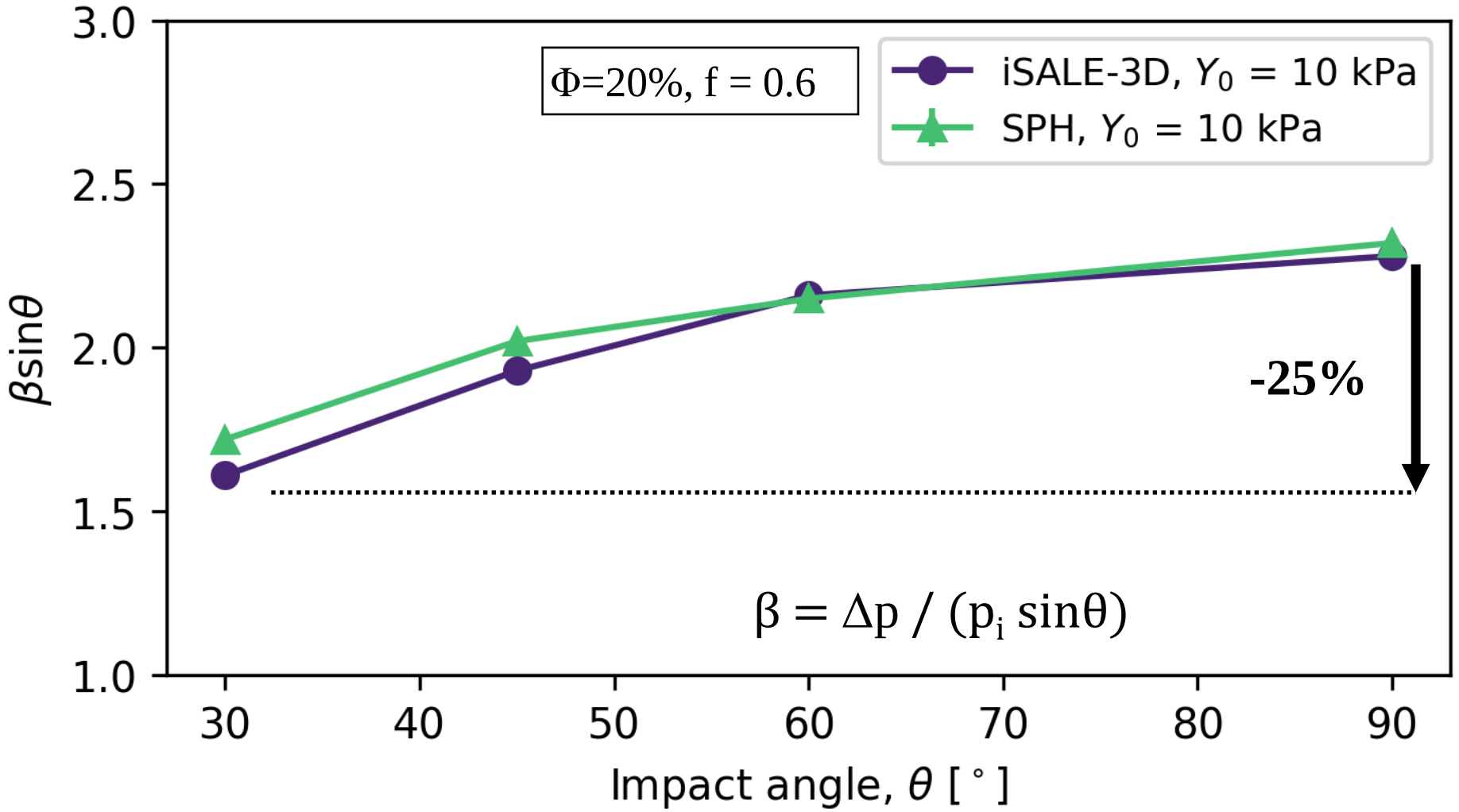
Effect of impact angle?

Benchmark study of DART-like Oblique Impacts on Regolith Targets



- same material models & parameters for iSALE-3D and SPH
- results from both codes agree with each other for all impact angles

Benchmark study of DART-like Oblique Impacts on Regolith Targets



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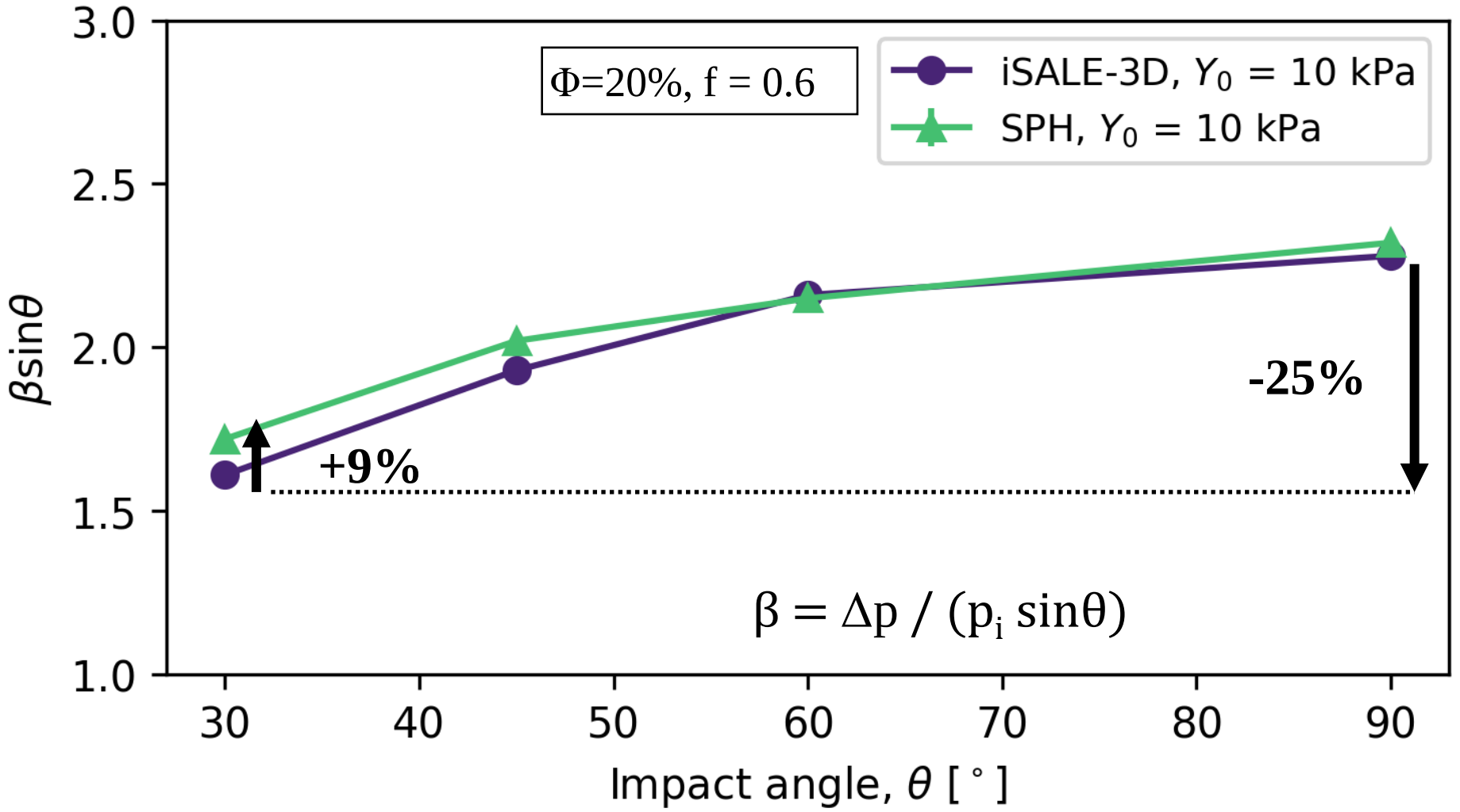

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DART & Hera: Kinetic Impactor Technique

Conclusion

Thank you.

- We have run **validation** tests in the Hera-relevant low strength regime for iSALE & SPH against experimental results for regolith simulant, **including measured values of β**
  → **both codes agree** with independent experimental data in terms of diameter, ejection behaviour and momentum enhancement
- Expanding the **benchmark** to **further materials** (Y_0=1, 10, 100 kPa, Φ=20-50%) shows **good agreement** between the codes (<23% deviation in β, in agreement to Stickle et al. 2020)
- Deviations for the impact angle scaled momentum between both codes for different **impact angle** are below 9%
- We plan further validations with other materials

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NEO-MAPP

Near Earth Object Modelling And Payloads for Protection

Thank you.