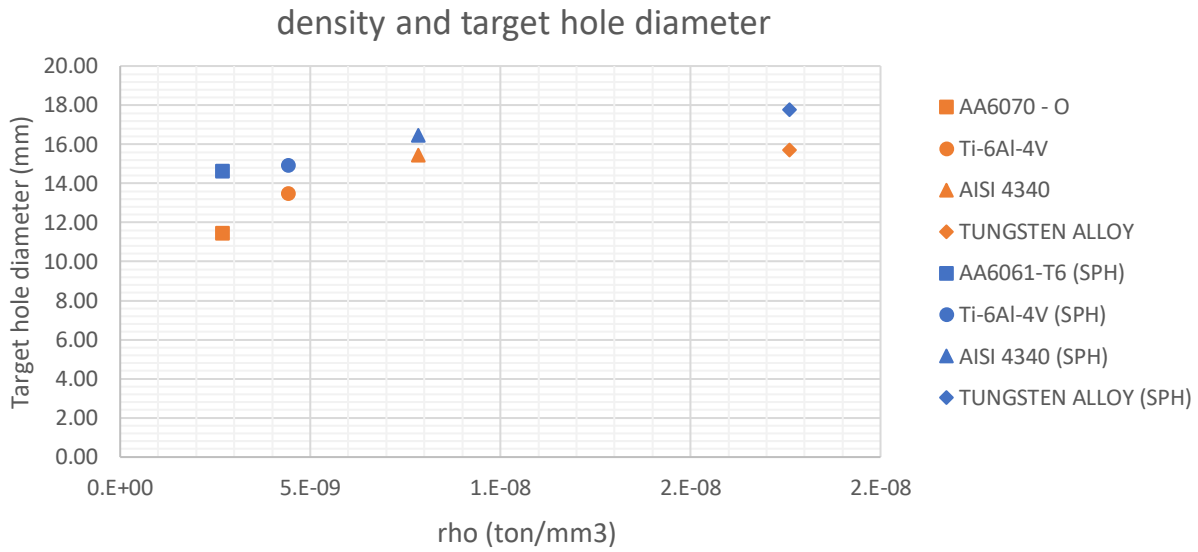
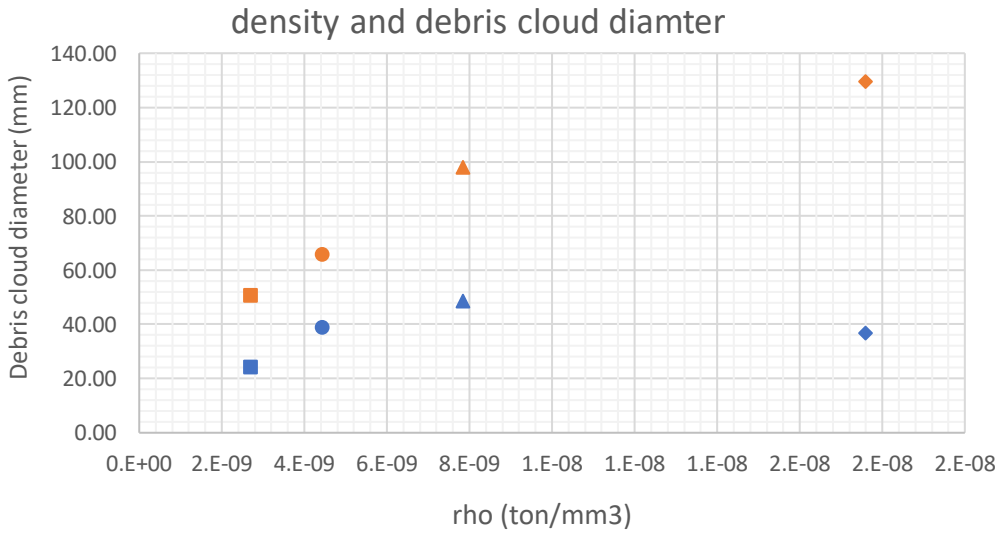
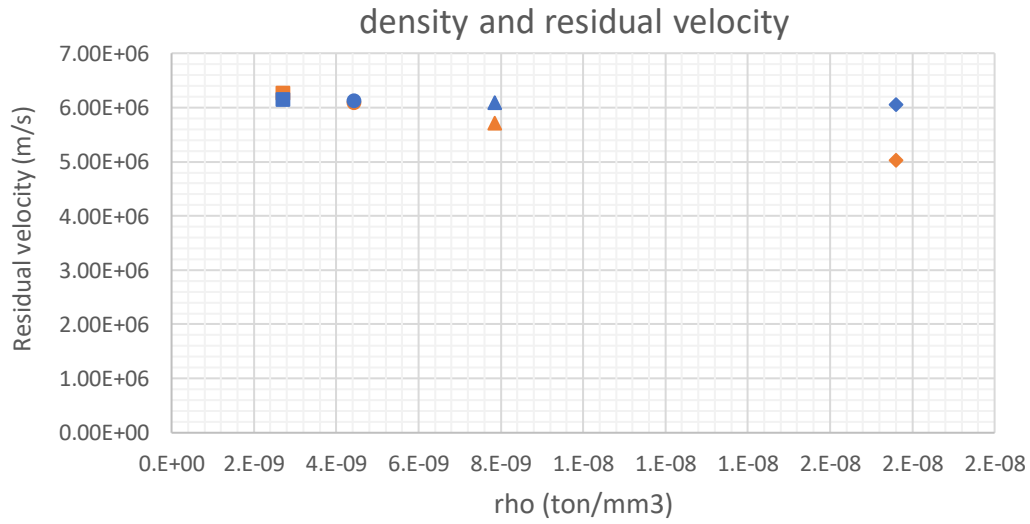
Results

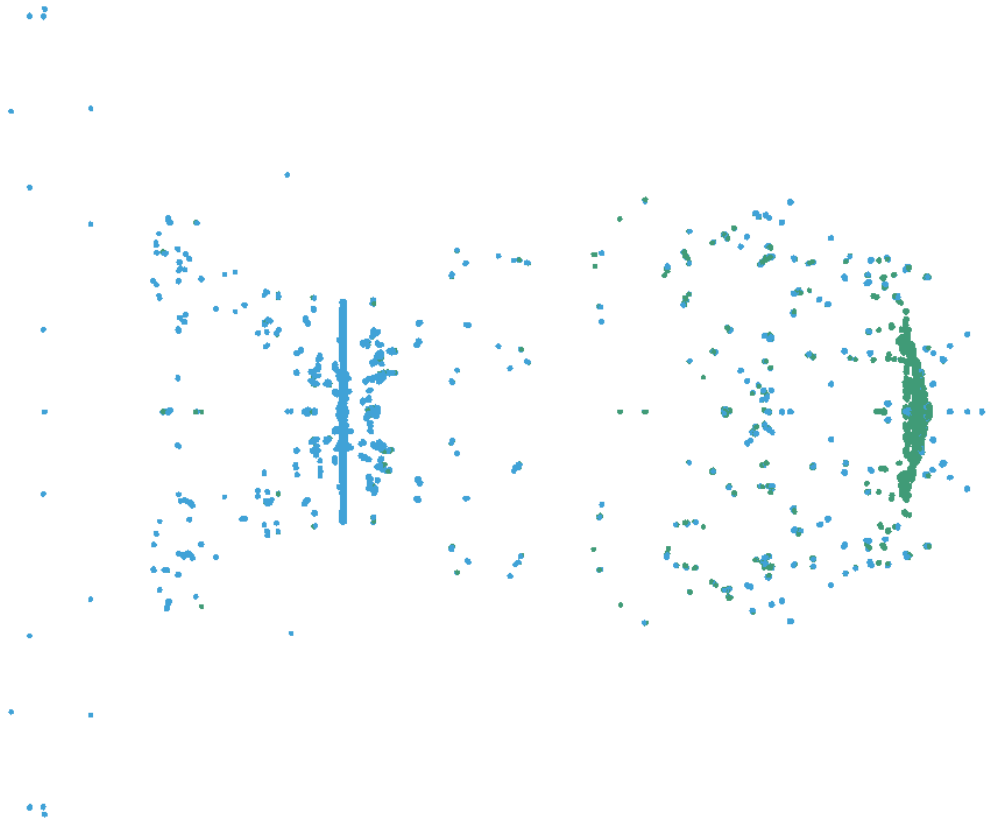
FEM/DES vs SPH - DENSITY



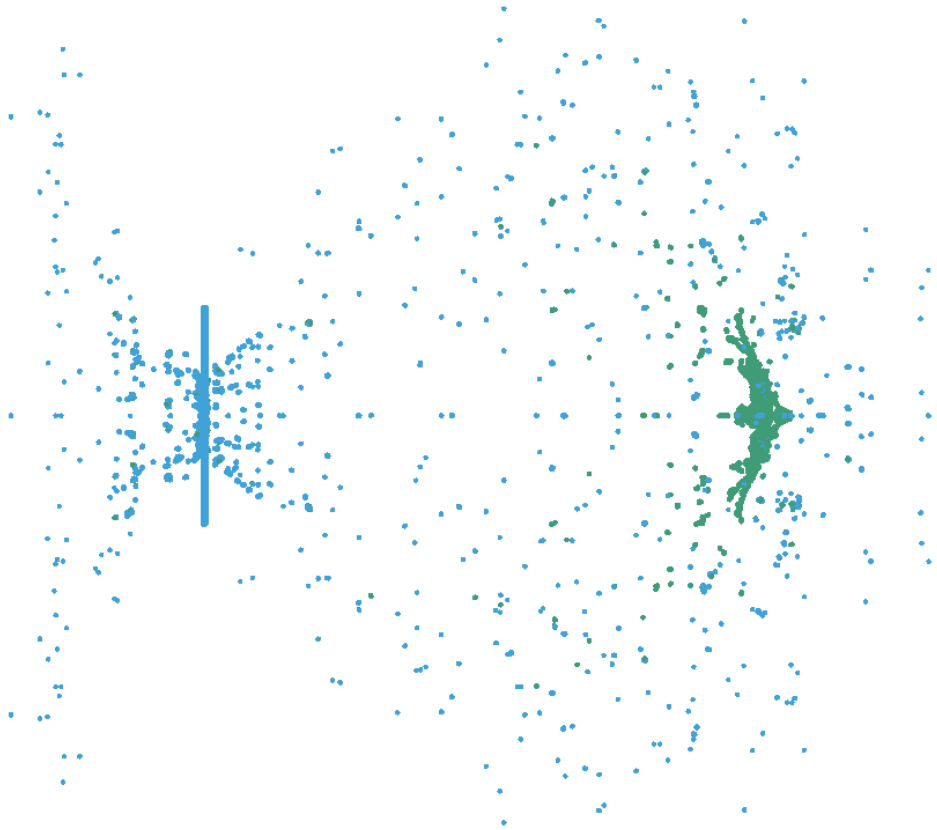




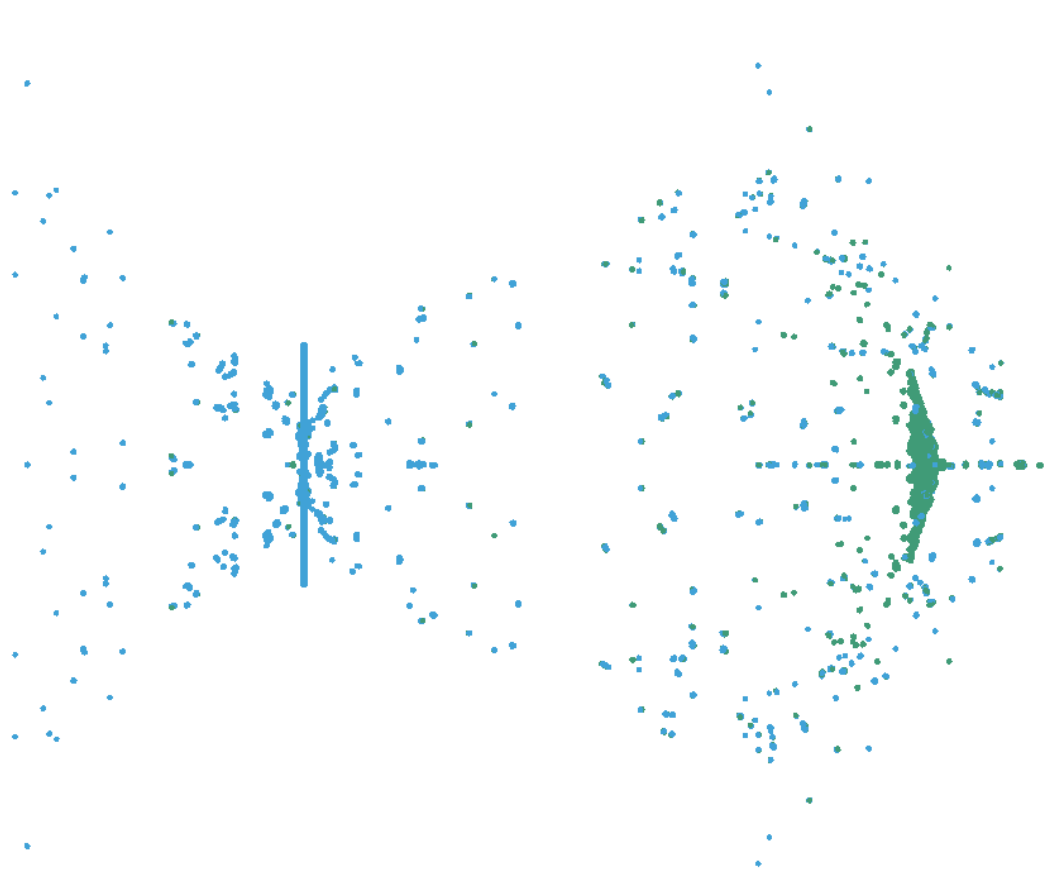
SPH STUDY



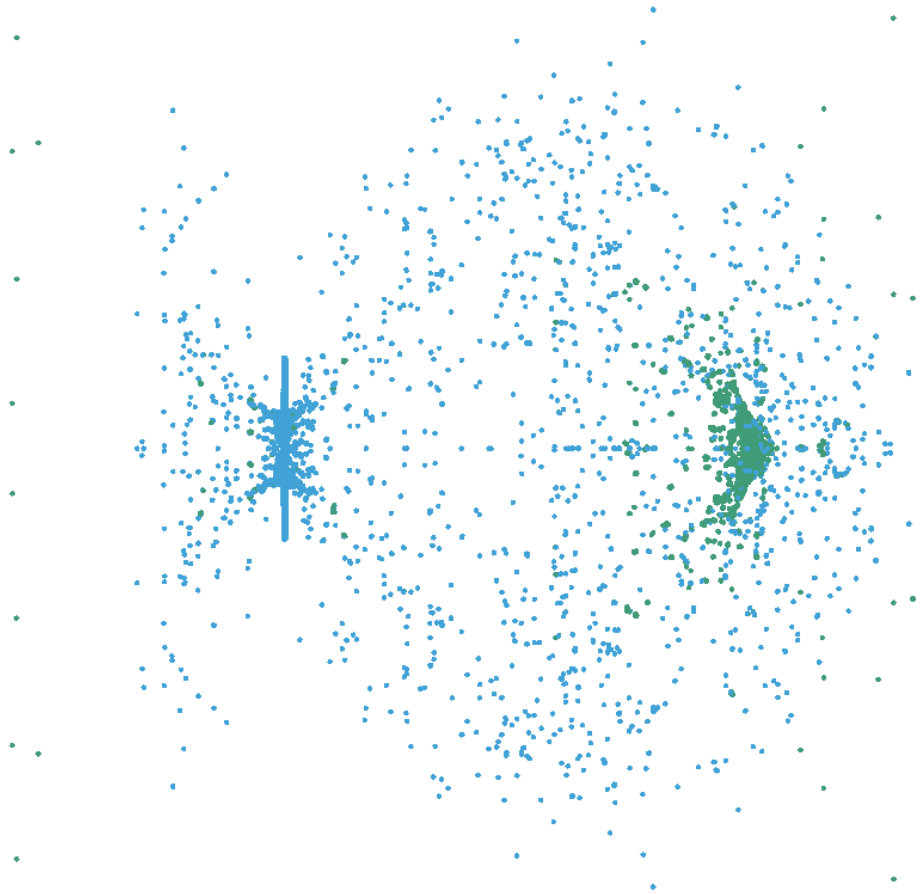
AA6061-T4



AISI 4340

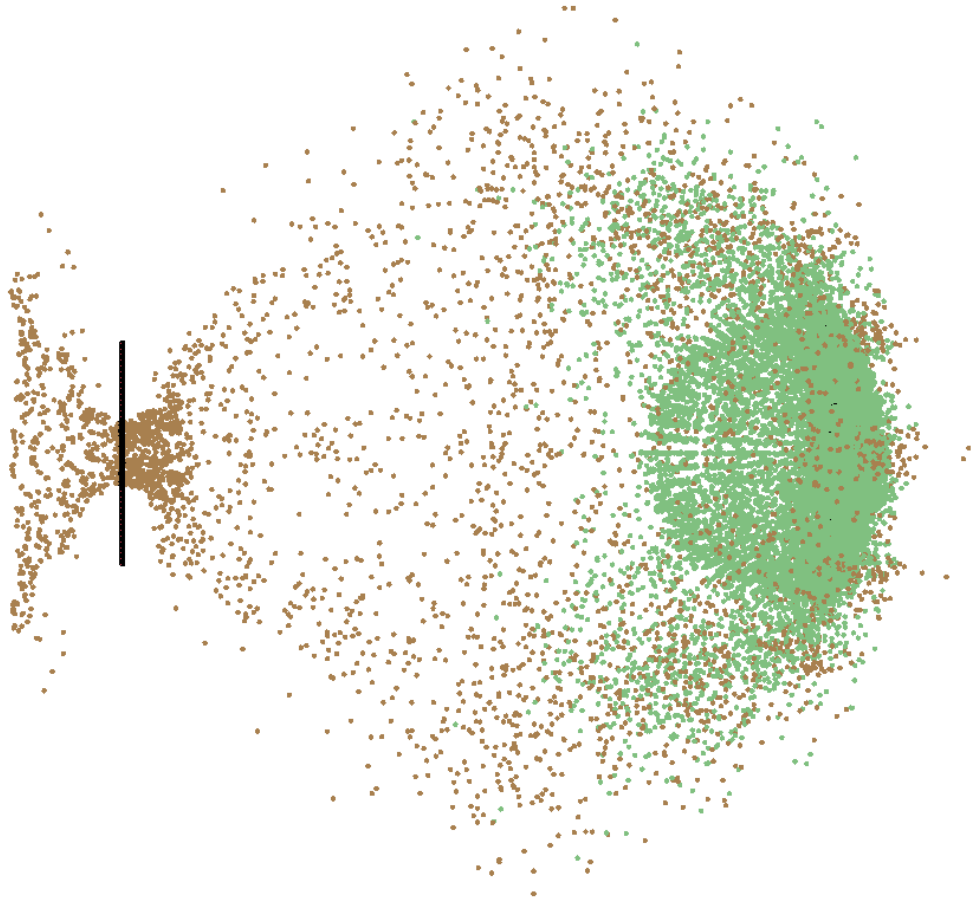


Ti-6Al-4V



TUNGSTEN ALLOY

FEM/DES OBSERVATIONS



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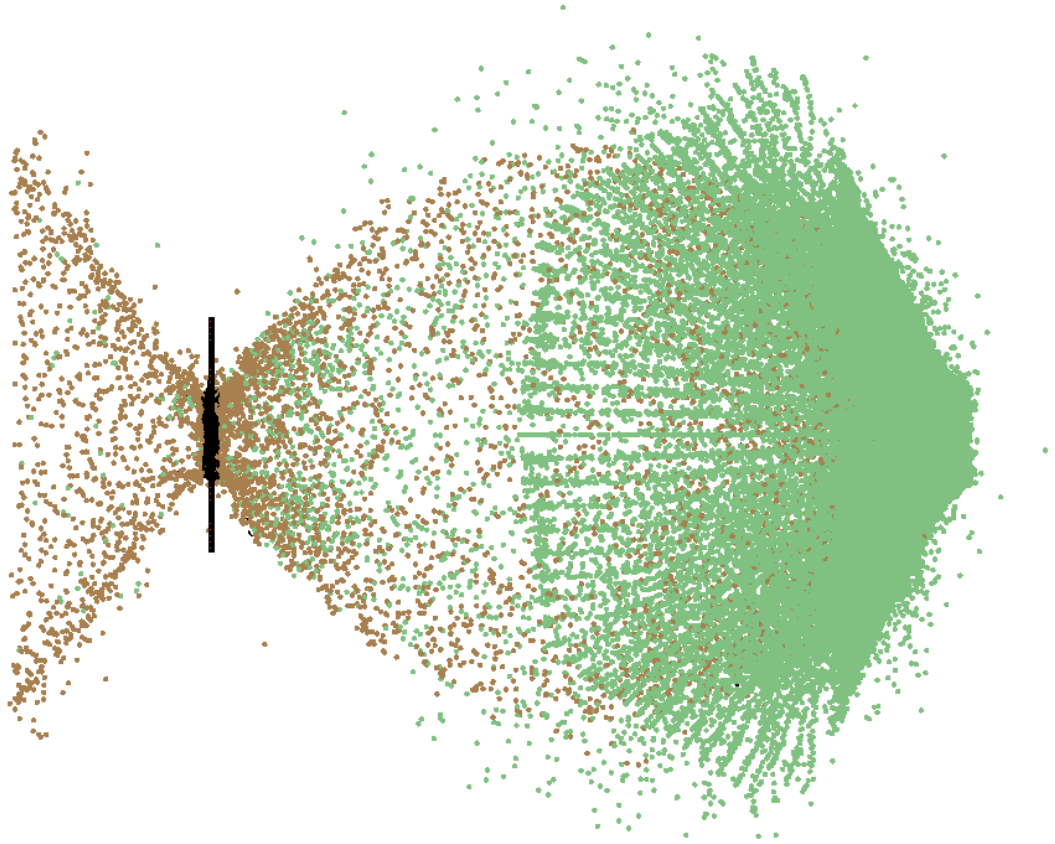

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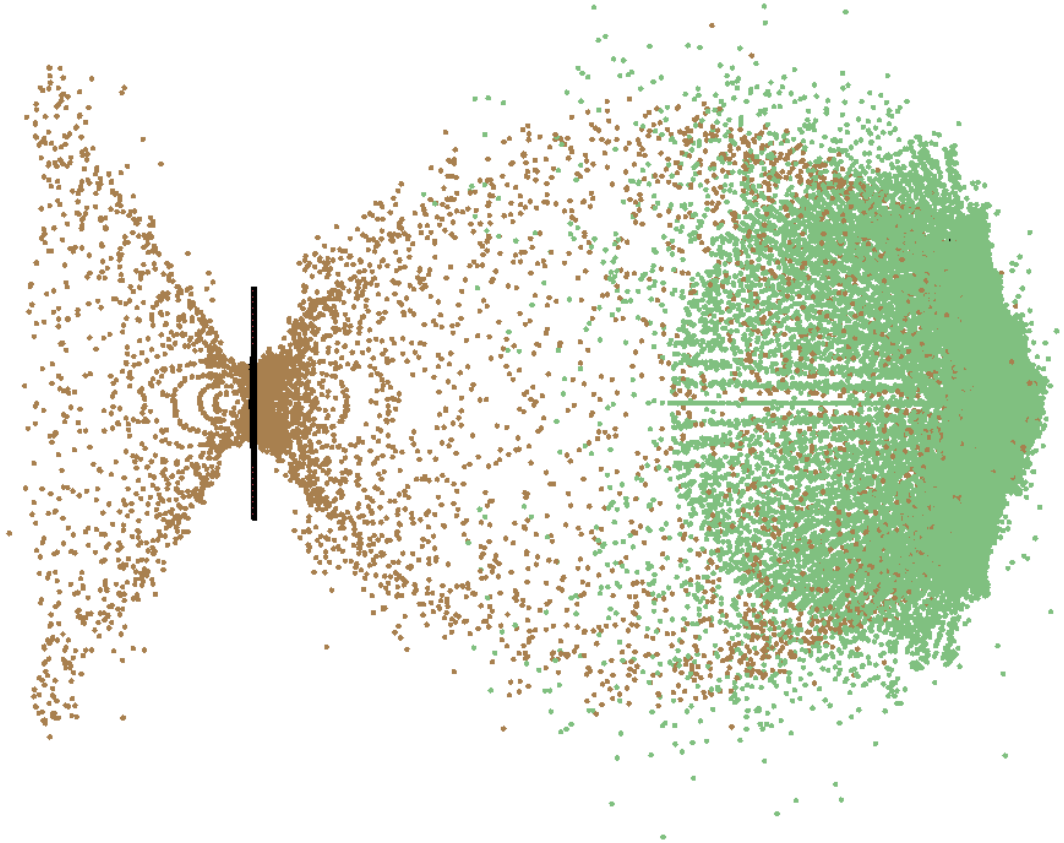

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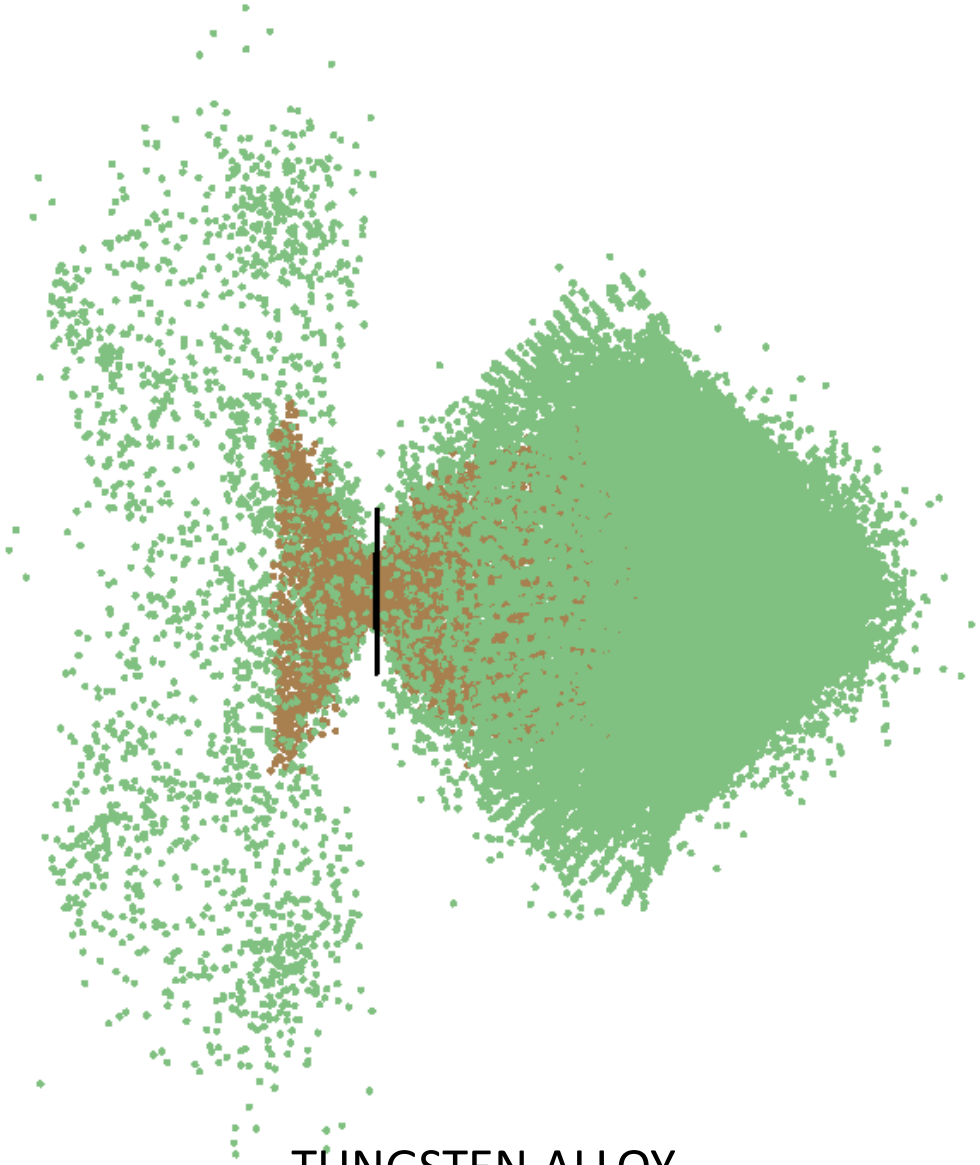
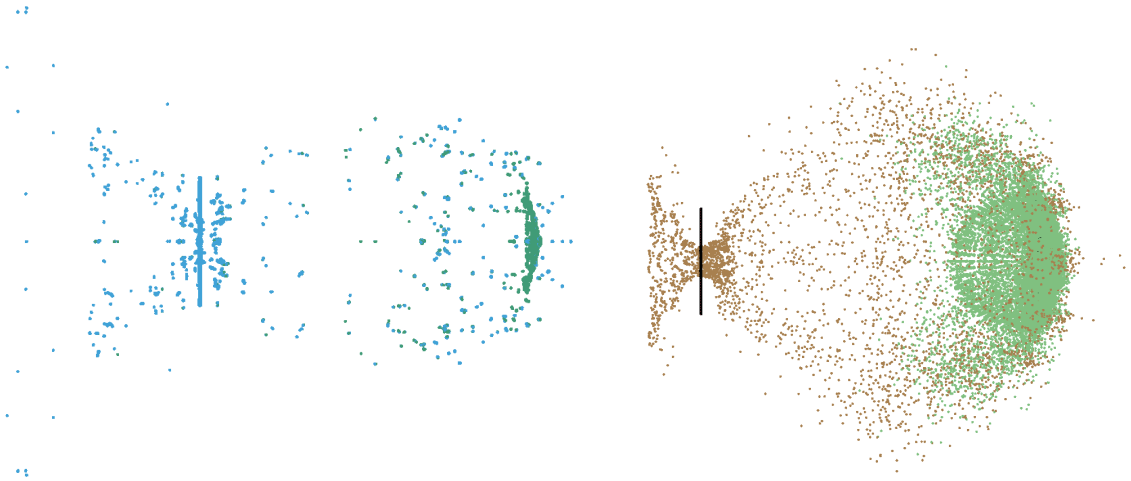


TUNGSTEN ALLOY



AA6061-T4

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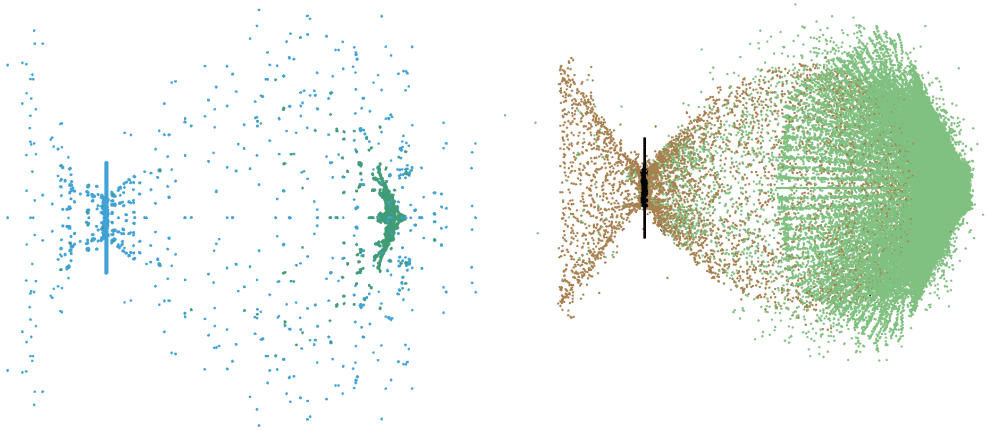

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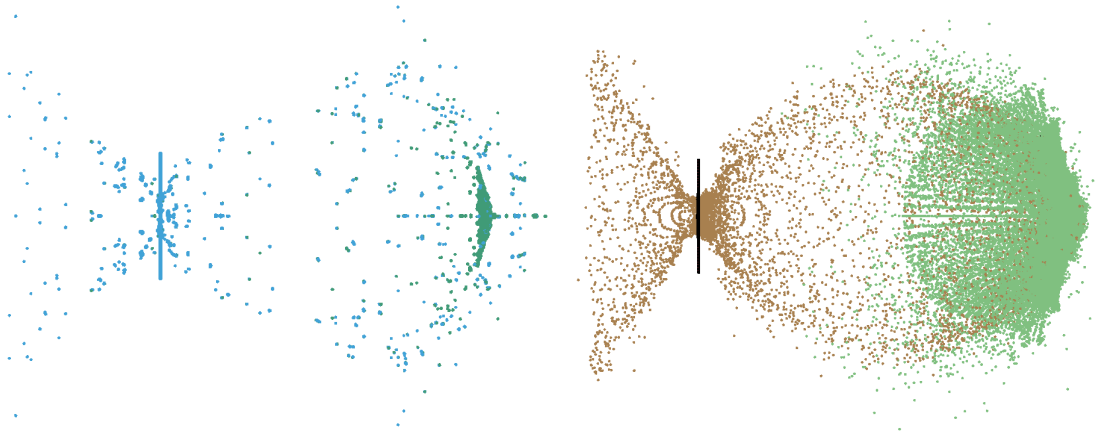

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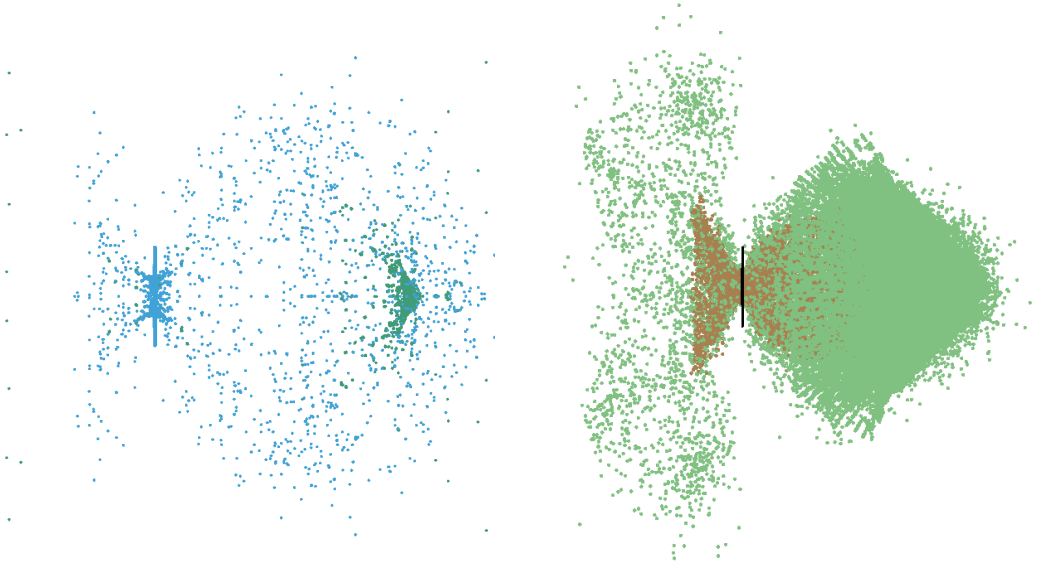
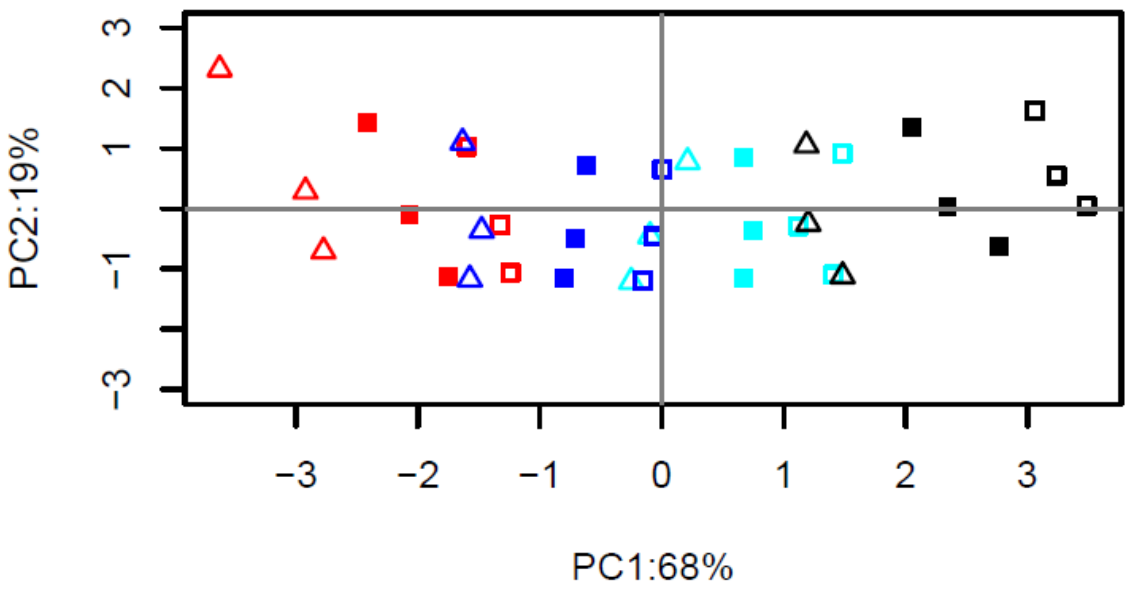


TUNGSTEN ALLOY

CROSS-PARAMATER STUDY

- 4 MATERIALS:
  - AA6070-O
  - STEEL 4340
  - Ti-6Al-4V
  - TUNGSTEN ALLOY
- 3 t/d RATIOS:
  - 0.042
  - 0.084
  - 0.126
- 3 VELOCITIES [km/s]:
  - 5.5
  - 6.7
  - 7.5

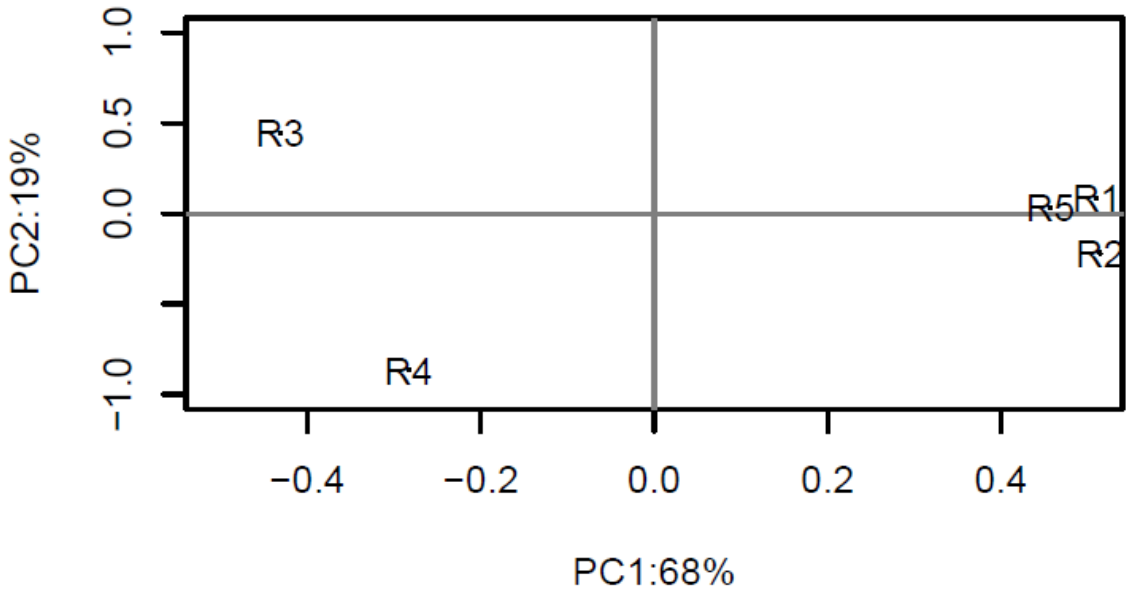
PCA scores



Red – Aluminium, Blue– Titanium, Cyan – Steel, Black – Tungsten

Δ - t/d = 0.0418, ▪ - t/d = 0.0835, ▫ - t/d = 0.1253

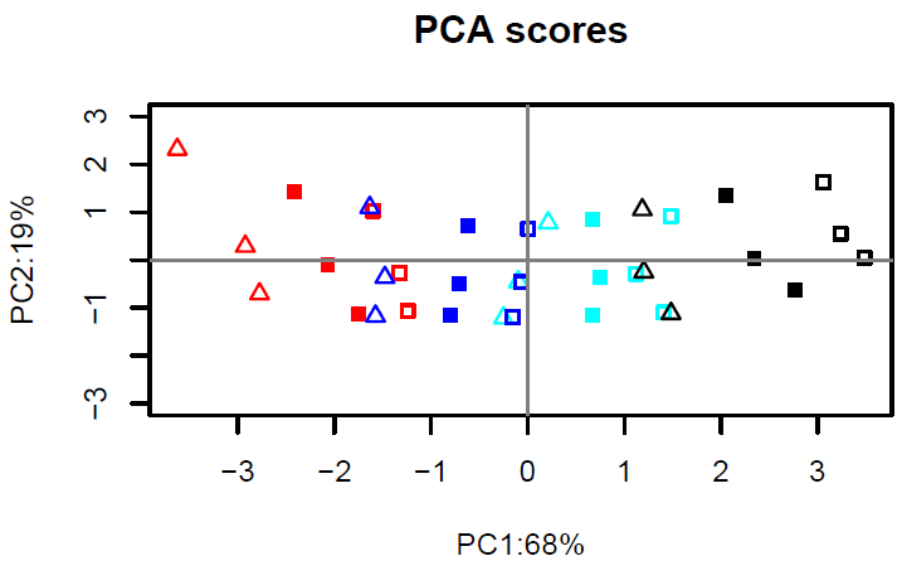
PCA loadings

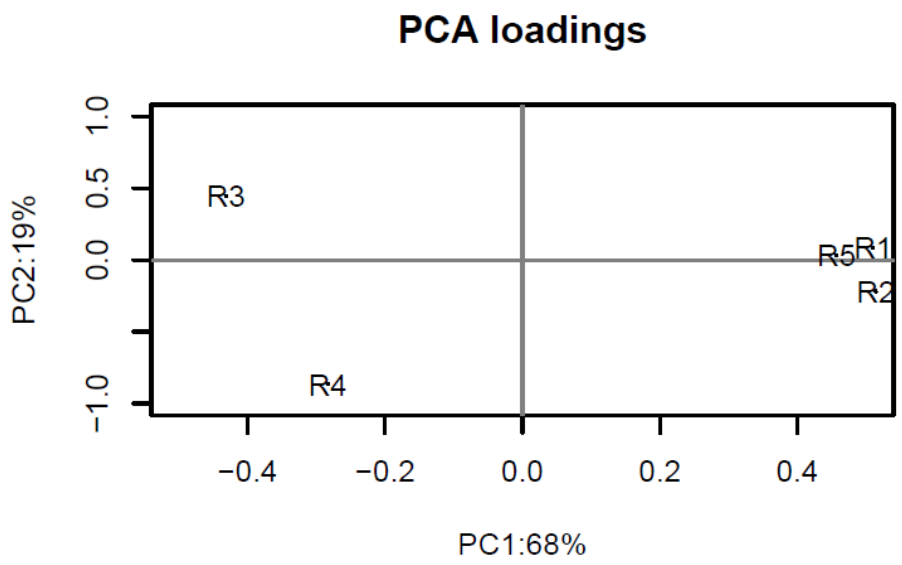


R1 = Target hole diameter
R2 = Debris cloud diameter
R3 = Percentage of solid material
R4 = Residual velocity
R5 = Conversion due to temperature

Observations:

- PC1 > 3PC2
- Equal spacing between material groups
- Overlap between groups
  - E.g. Thick wall Alu. low vel. ≈ Thin wall Ti. low vel.
- Material properties and t/d ratio affect all
  - Percentage of solid material more sensitive than residual velocity (horizontal axis)





R1 = Target hole diameter
R2 = Debris cloud diameter
R3 = Percentage of solid material
R4 = Residual velocity
R5 = Conversion due to temperature

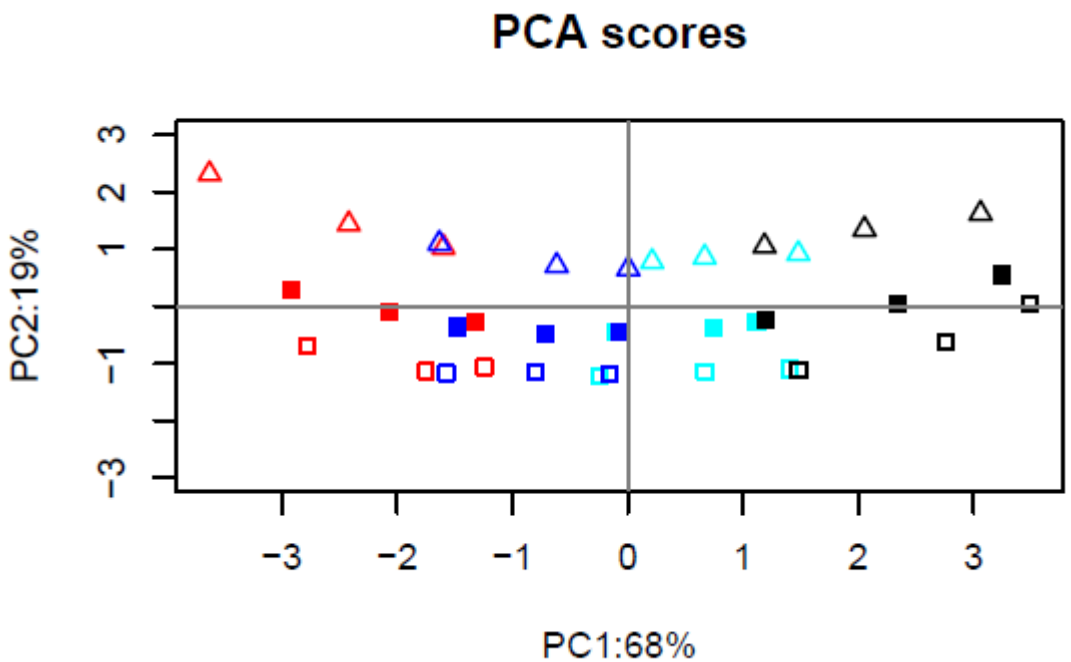
Observations:

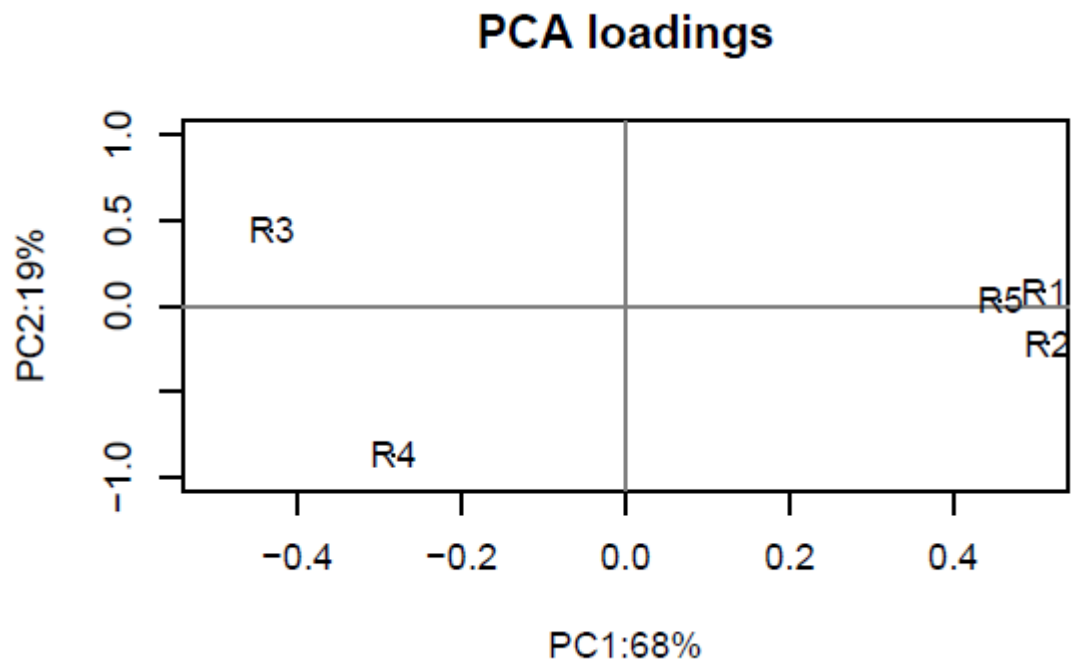
- **Input velocity has little impact on**:
  - Hole diameter
  - Cloud diameter
  - Conversion due to temperature
- Input velocity affects: percentage of solid material & residual velocity
- Inverse correlation between percentage of solid material and residual velocity
- Target hole diameter, debris cloud diameter and conversion due to temperature are equally sensitive to all input parameter changes

- Lower velocity simulations have a higher percentage velocity decrease
- Increasing velocity does not strictly result in larger target hole diameter
- Increasing t/d leads:
  - to lower percentage of solid material
  - higher conversion due to temperature
  - decreasing residual velocity
  - increased cloud diameter
  - increased hole diameter

Alternative plot

Order = Material, velocity, t/d





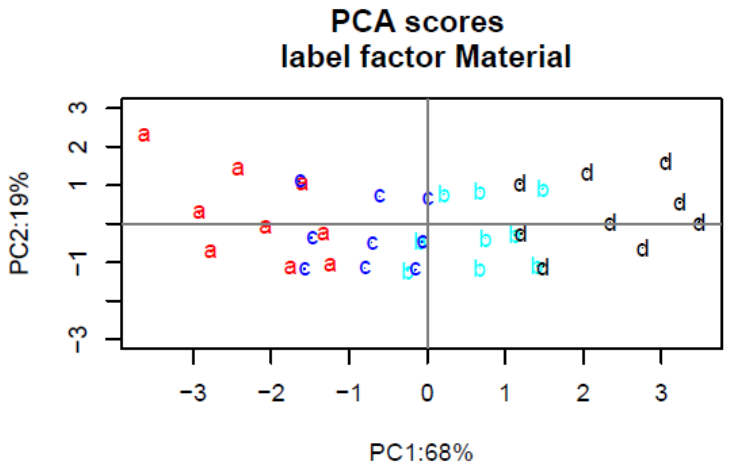
Next steps

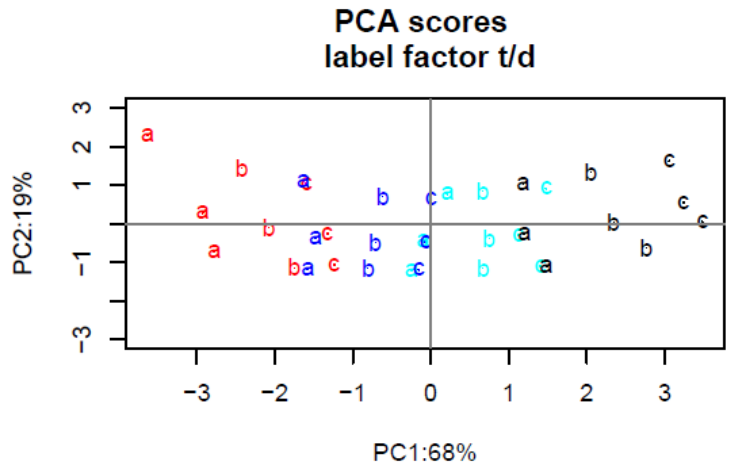
- Ideally: Perform high velocity impact experiments to validate numerical simulations

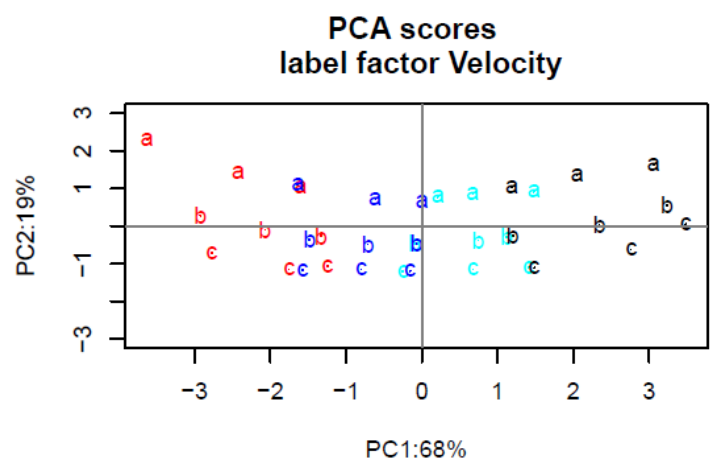
- Extent material parameter study:
  - Mesh size
  - Different set of materials
  - Different impactor material
  - …

- Impact under an angle

- Impactor shape


PCA scores
label factor Material
PC2:19%
PC1:68%


PCA scores
label factor t/d
PC2:19%
PC1:68%


PCA scores
label factor Velocity
PC2:19%
PC1:68%