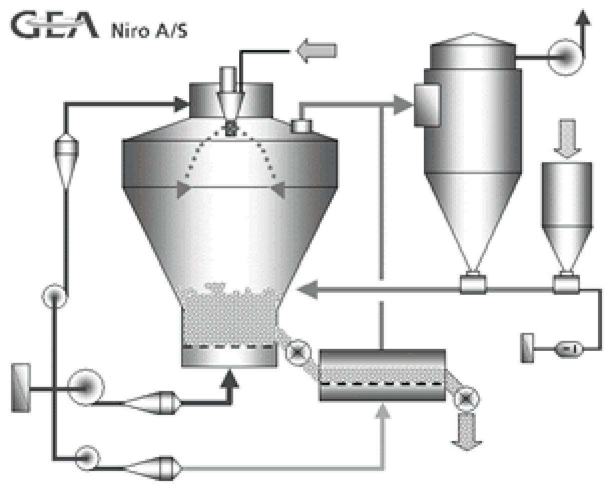
Reducing Undesirable Powder Deposition



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Commonly affected processes and industries

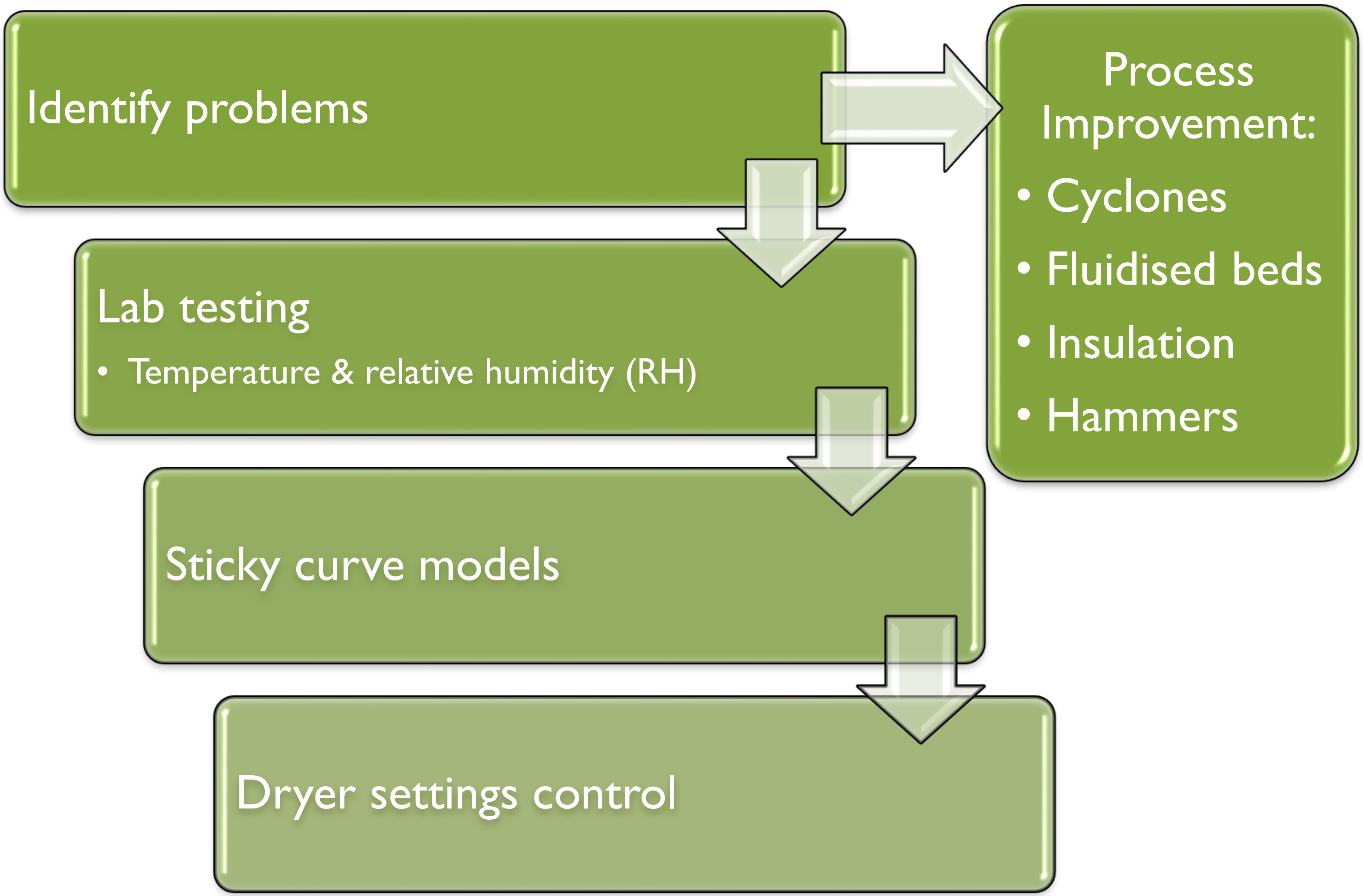
- Atomisation / spray drying
  - Food / metal / ceramics / pharmaceutical powder industries
- Boilers & furnaces
  - Many industries
- Etc.

Negative impacts

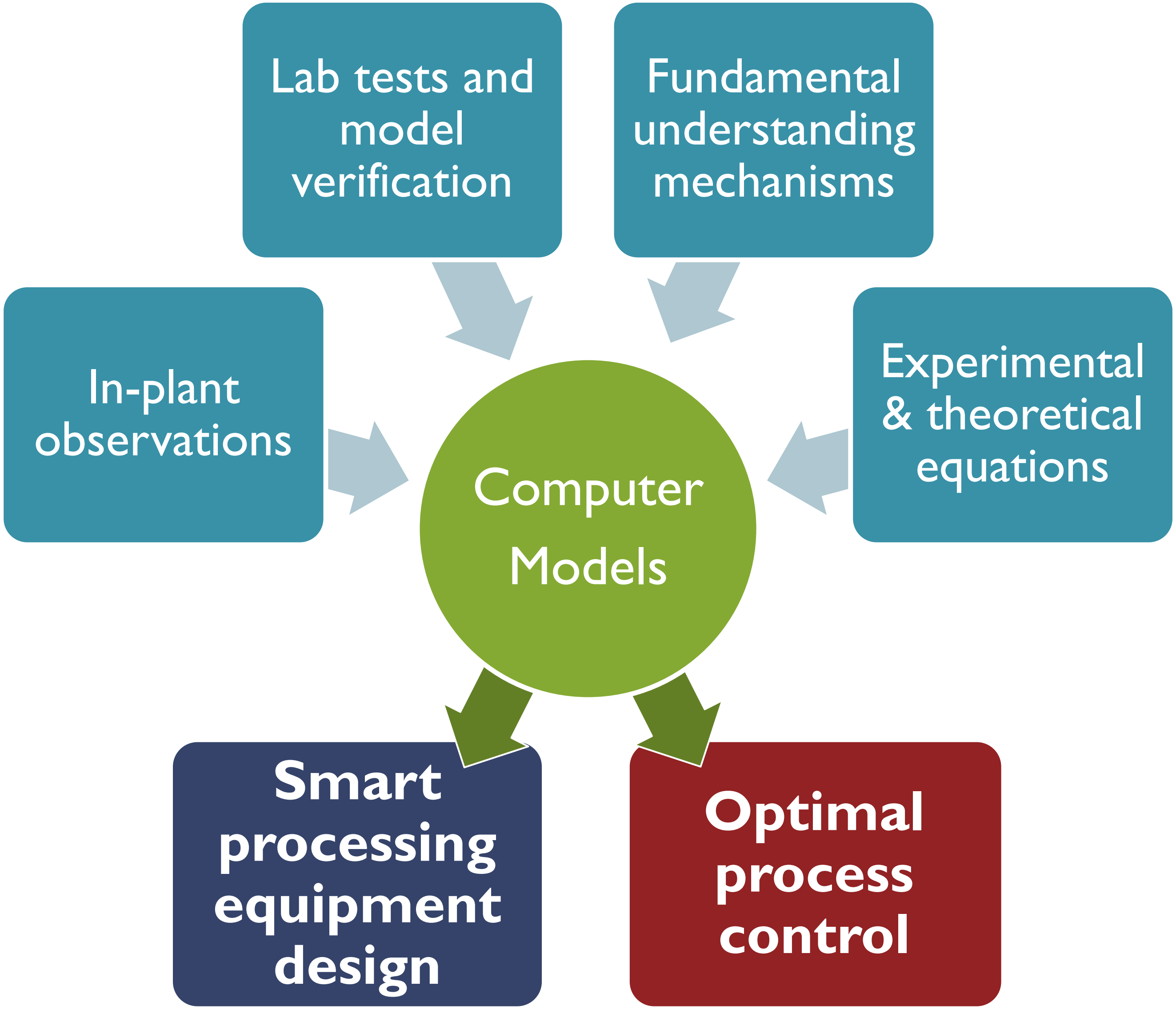
- Product yield / capacity
- Browning & oxidation / powder combustion
- Plant shut-down & cleaning
- Heat recovery opportunities

Energy ↔ $$$

Traditional methodology



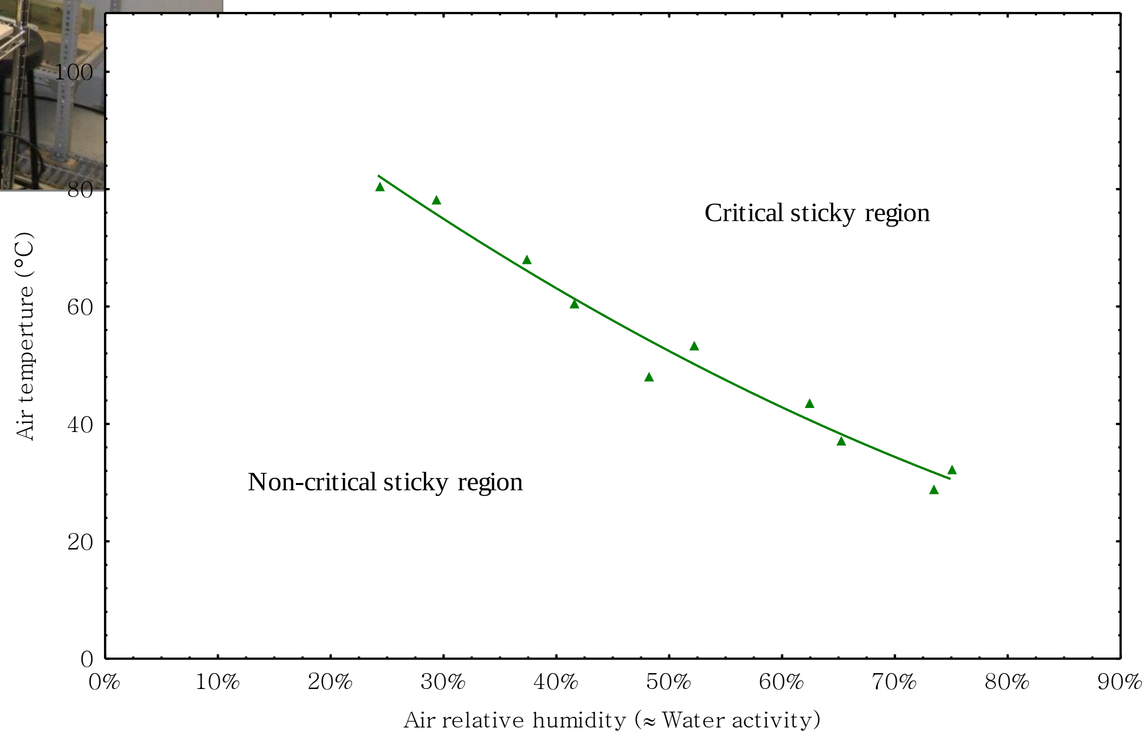
Research methodology



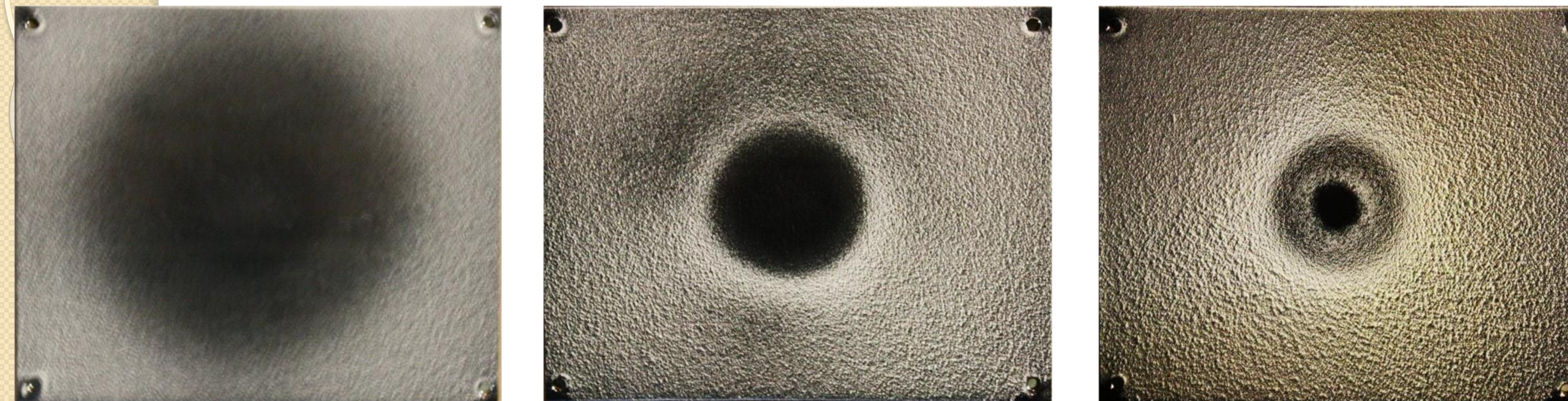
In-plant observations

- Hatches located in same position, but on different cyclones

Lab tests – Impingement jet



Impingement jet deposition morphologies



Increasing particle stickiness

Underlying mechanisms

Stickiness - adhesion

- Viscosity (T & RH)
- Glass transition temp.
- Surface tension
- Surface energy & wetting angles (wall properties)

Kinetics

- Mass (size & shape)
- Impact velocity
- Impact angle
- Air flow patterns

Experimental & theoretical equations

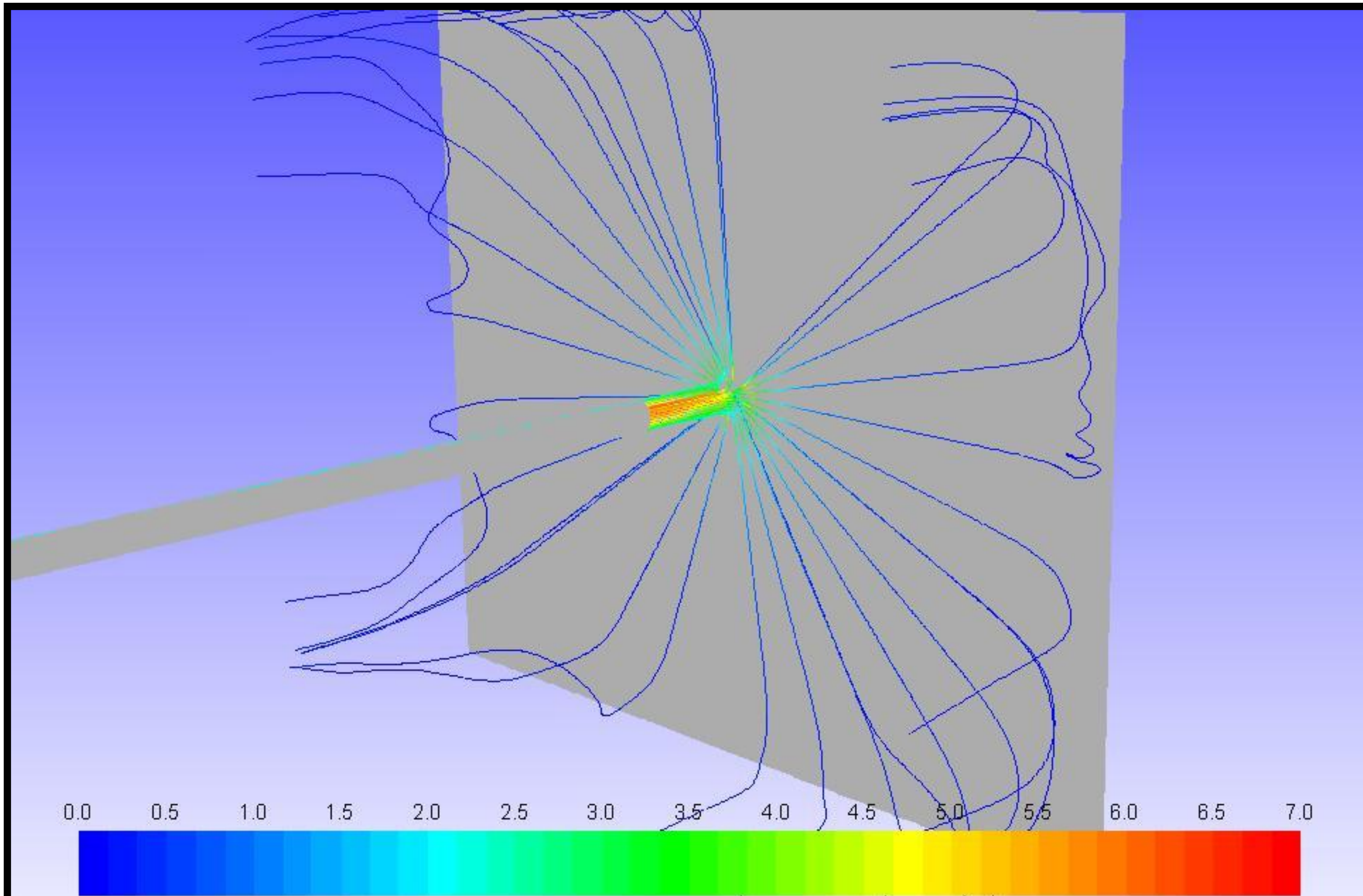
Deposition criteria:

$$U_{ad} \geq \frac{\rho}{3k^2} d_p V_{n,i}^2$$

Rebound calculation:

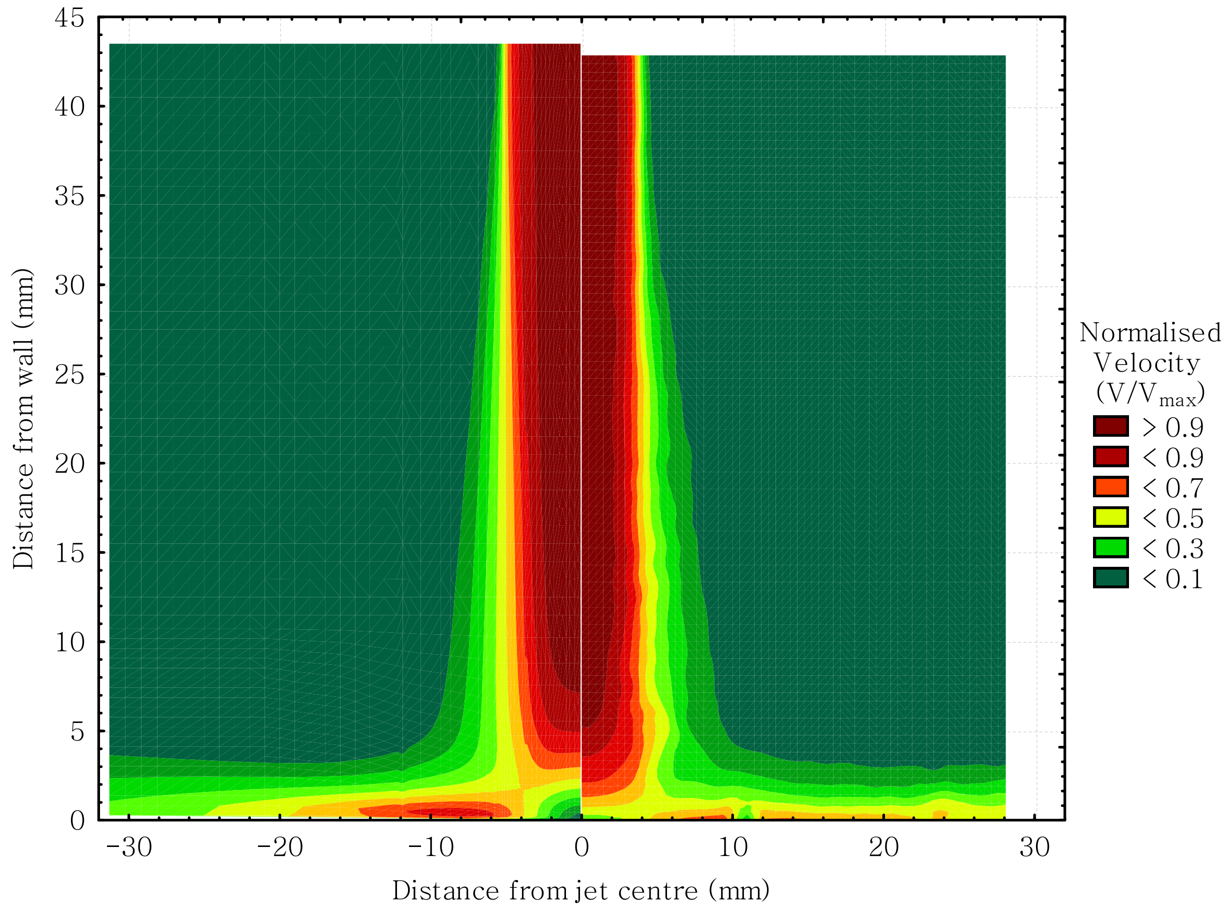
$$V_{n,r} = \sqrt{R^2 V_{n,i}^2 - \frac{2U_{ad} A_c}{m}} \text{ and } V_{\tan,r} = RV_{\tan,i}$$

Computational Fluid Dynamics (CFD) Computer models



Verification of airflow models

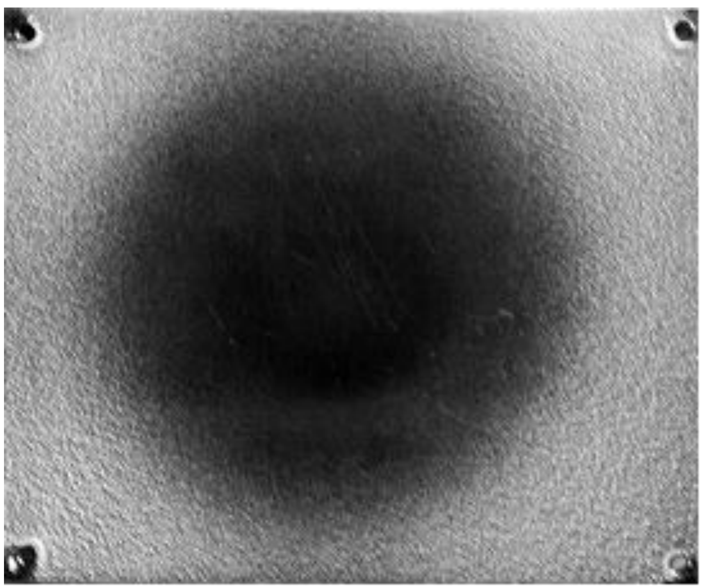
- Particle Image Velocimetry (PIV)

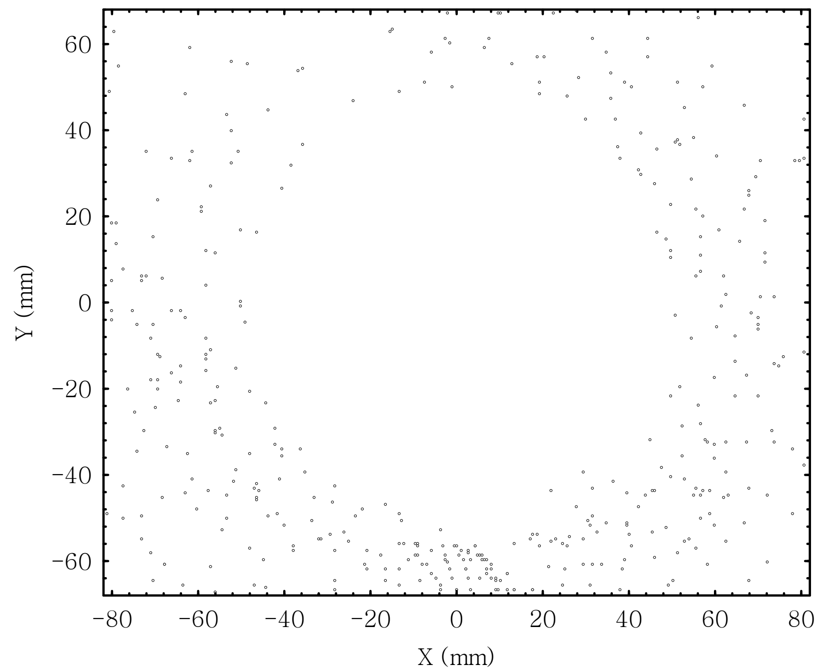


CFD PIV

Verification of models

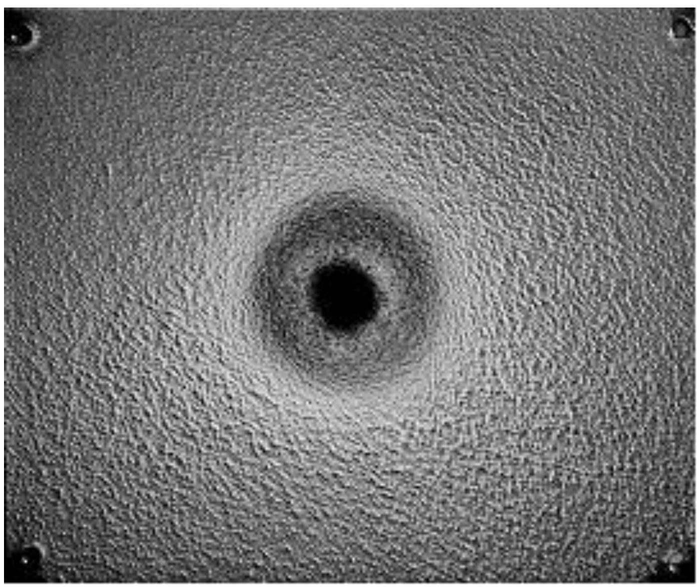
- Experimental morphologies

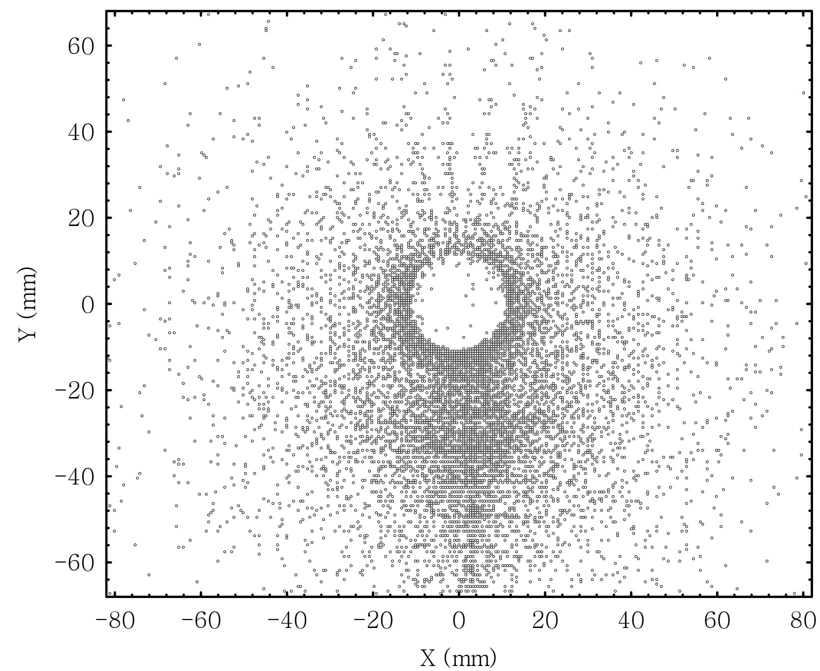




Verification of models

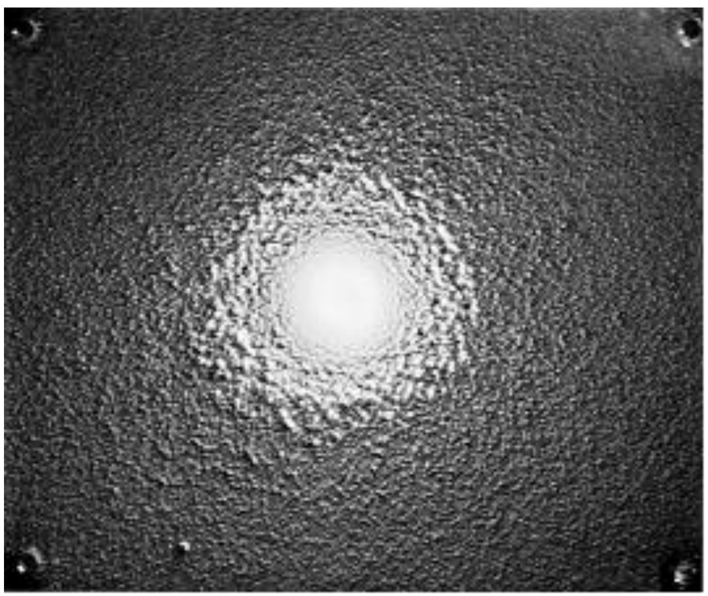
- Experimental morphologies

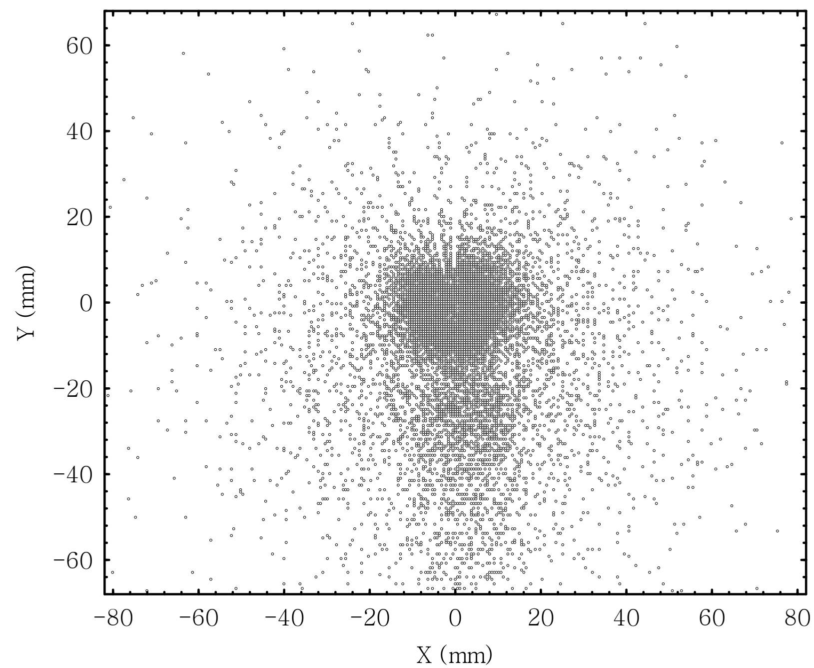




Verification of models

- Experimental morphologies





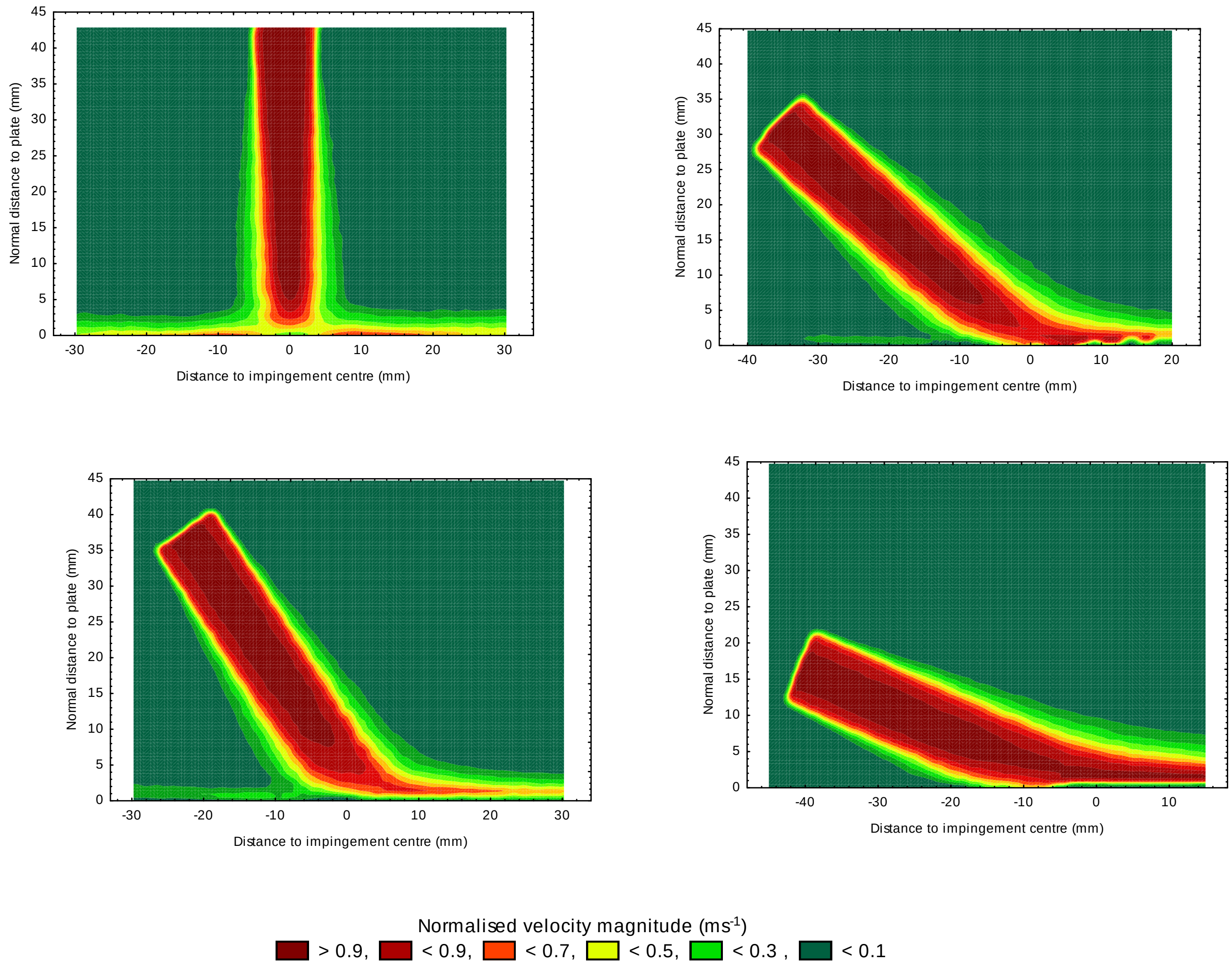
Bend geometry

The next steps…

- Continue in-plant work & lab tests
- Improve computer model accuracy
- Verify results for complex geometry
- Apply models to industry

Summary

- Powder deposition is costly to industry
- Traditional control is simple, but not optimal
- Verified computer models can help minimise deposition problems



Normal distance to plate (mm)
Distance to impingement centre (mm)
Normalised velocity magnitude (ms-1)
> 0.9, < 0.9, < 0.7, < 0.5, < 0.3 , < 0.1