NEXTCHEM

UNFOLD
STAMICARBON
15TH SYMPOSIUM 2026

VIBRO PRILLING TO ENHANCE UREA QUALITY

Juan Coloma
Marco Groenewegen

AGENDA

01 WHAT IS PRILLING?

02 VIBRO PRILLING ADVANTAGES

03 SCALE-UP & MODELLING

04 INDUSTRIAL VALIDATION

05 CONCLUSIONS

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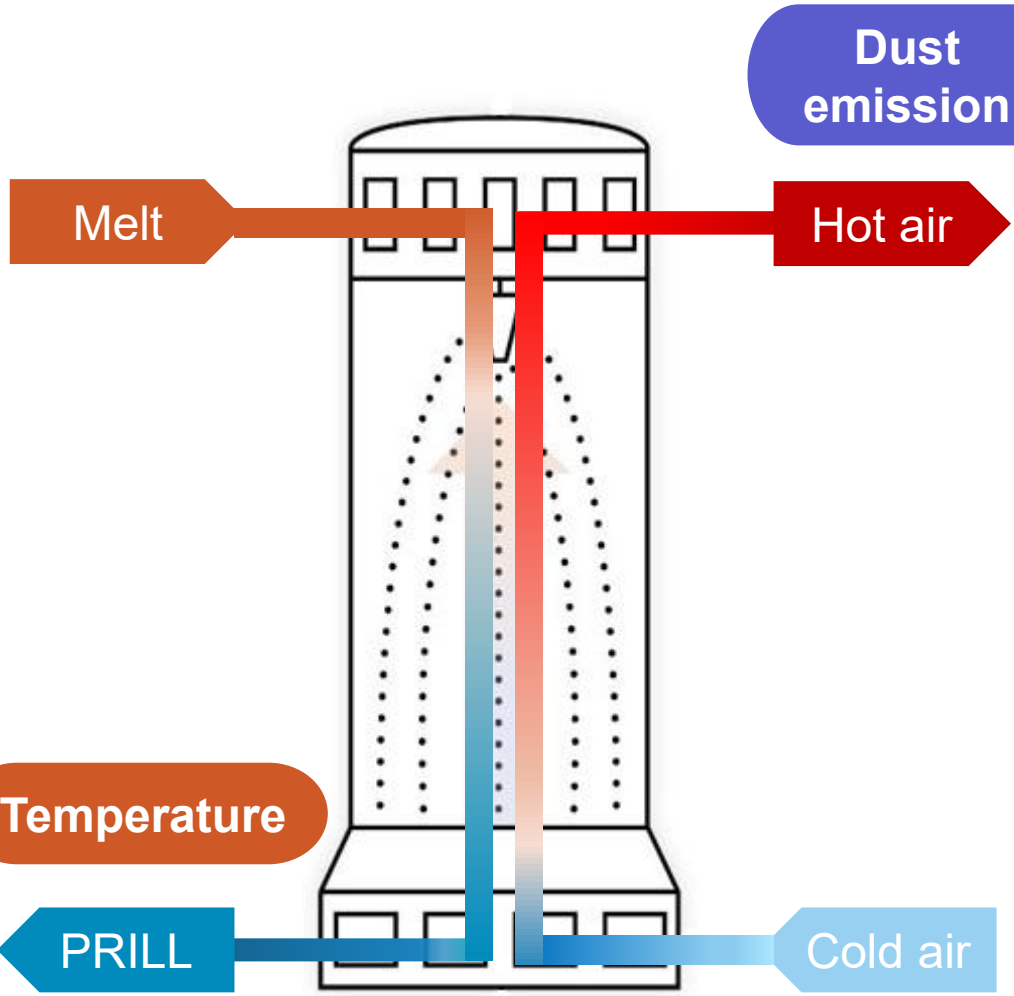
WHAT IS PRILLING?

WHAT IS PRILLING?

STAGE 1	A liquid droplet is formed
STAGE 2	Solidification starts at the shell of the droplet
STAGE 3	Solid prill A small cavity is formed in the center



IMPELLER AND VORTEX

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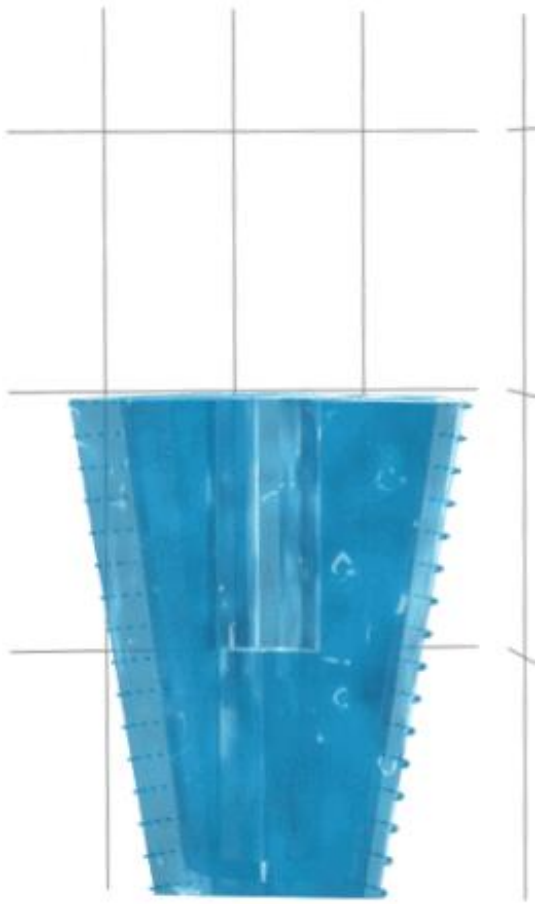
ACTUAL



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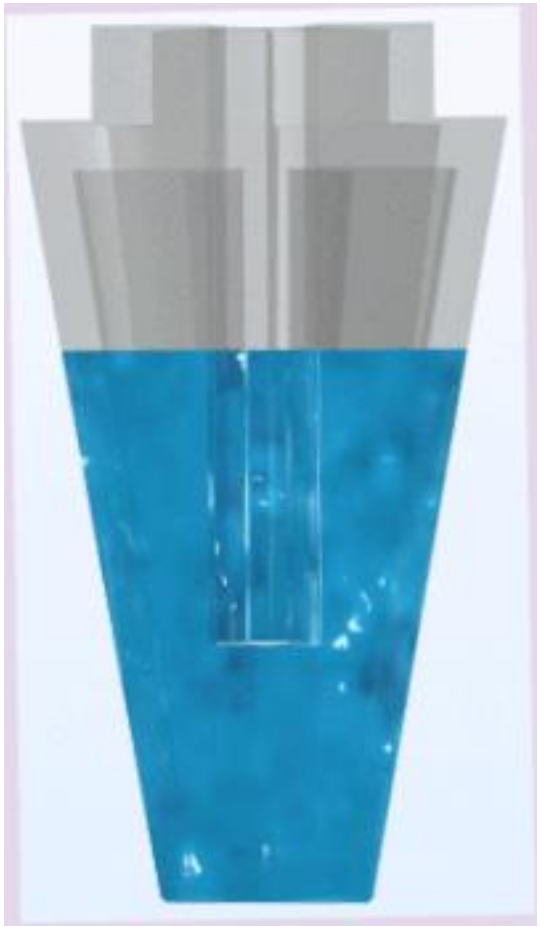
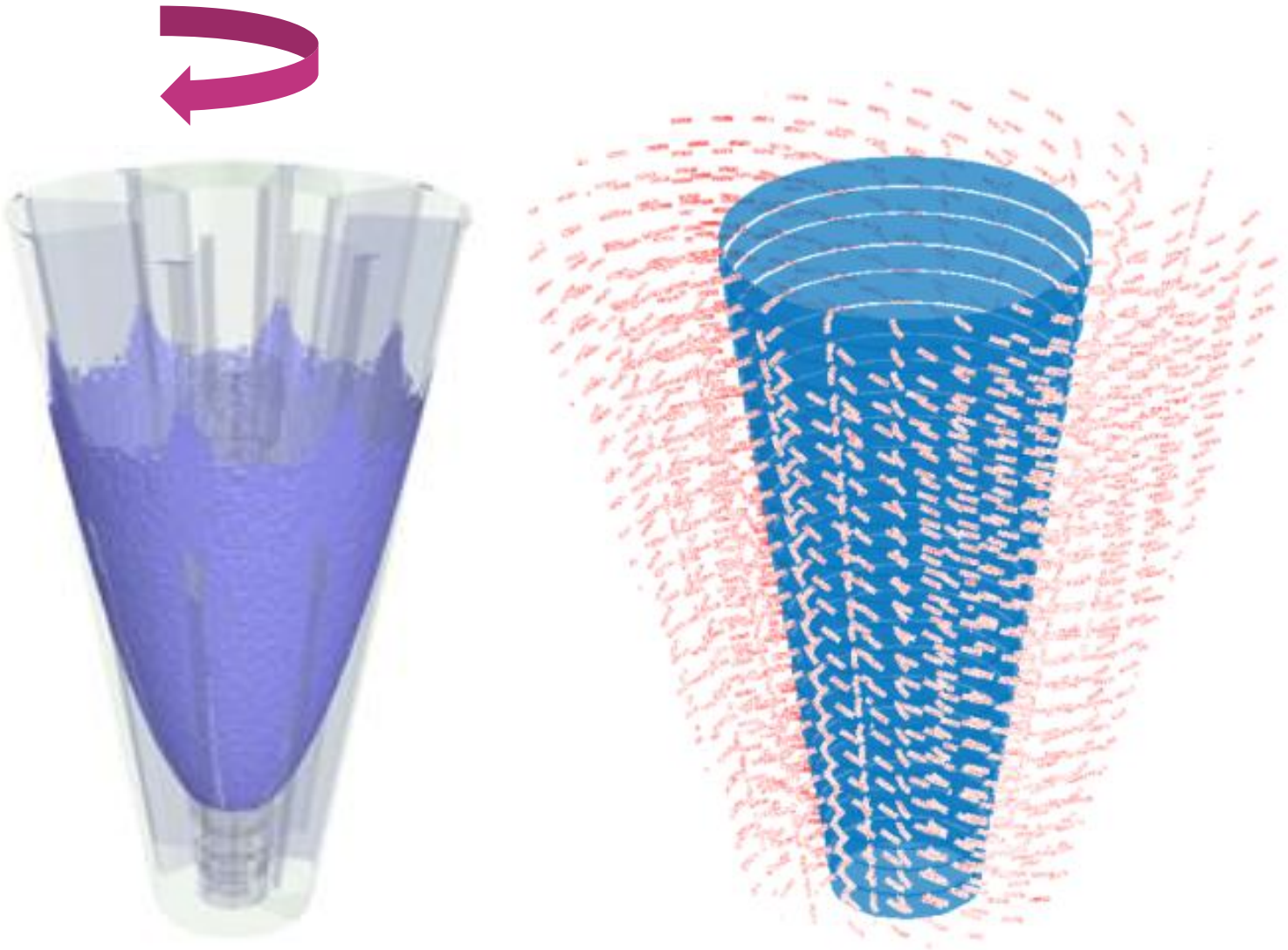


ROTATION & JET



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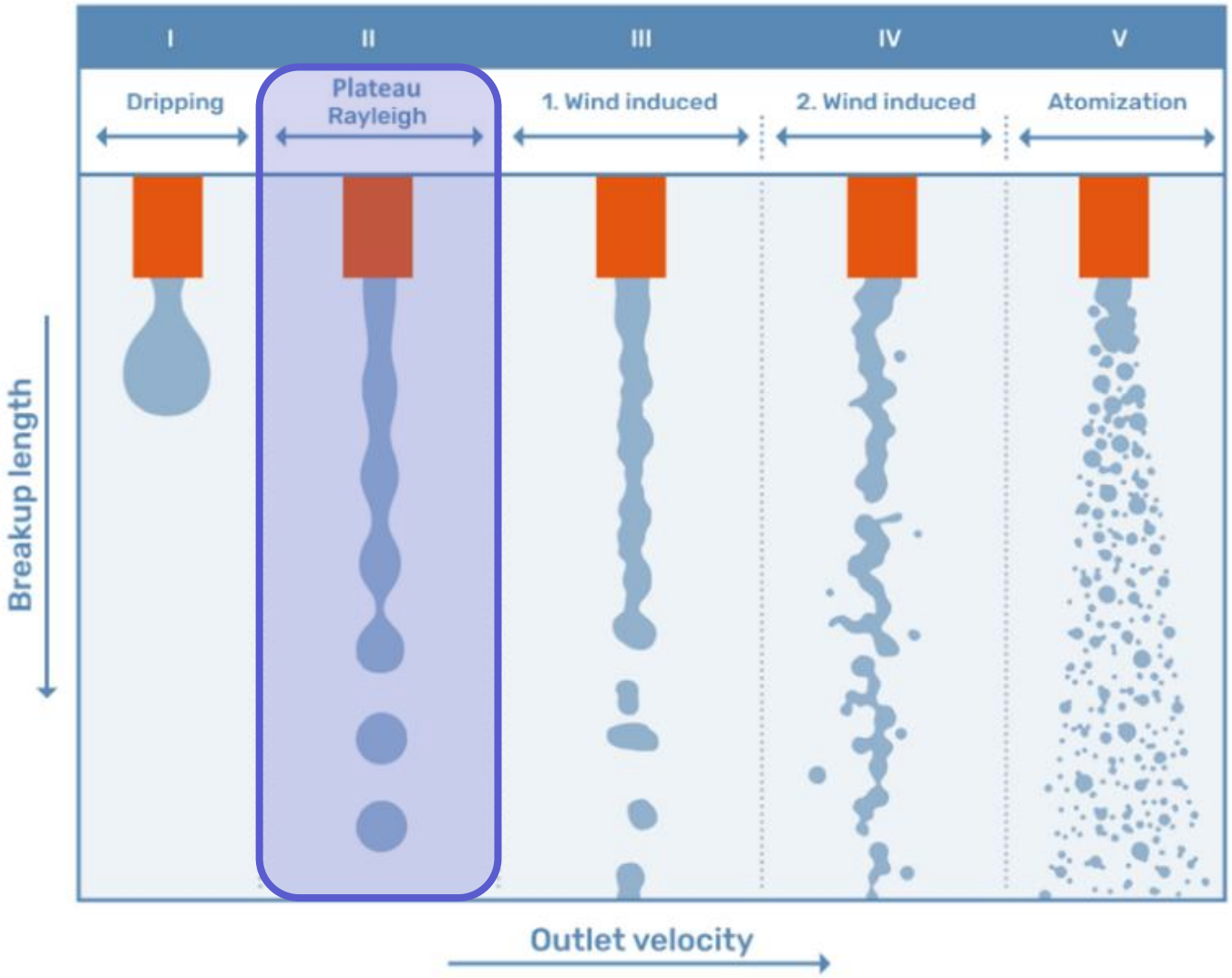
FLOW REGIME: SIZE VS. CAPACITY



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JET BREAKUP: SATELLITES

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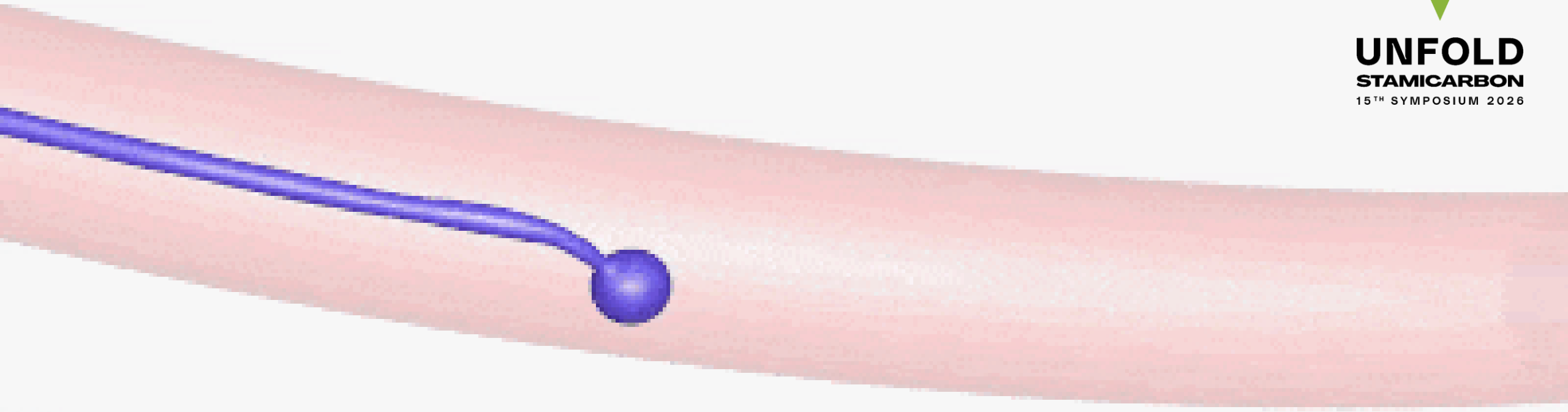

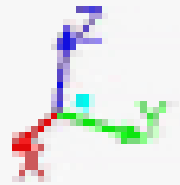

02

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VIBRO PRILLING ADVANTAGES

VIBRO PRILLING ADVANTAGES

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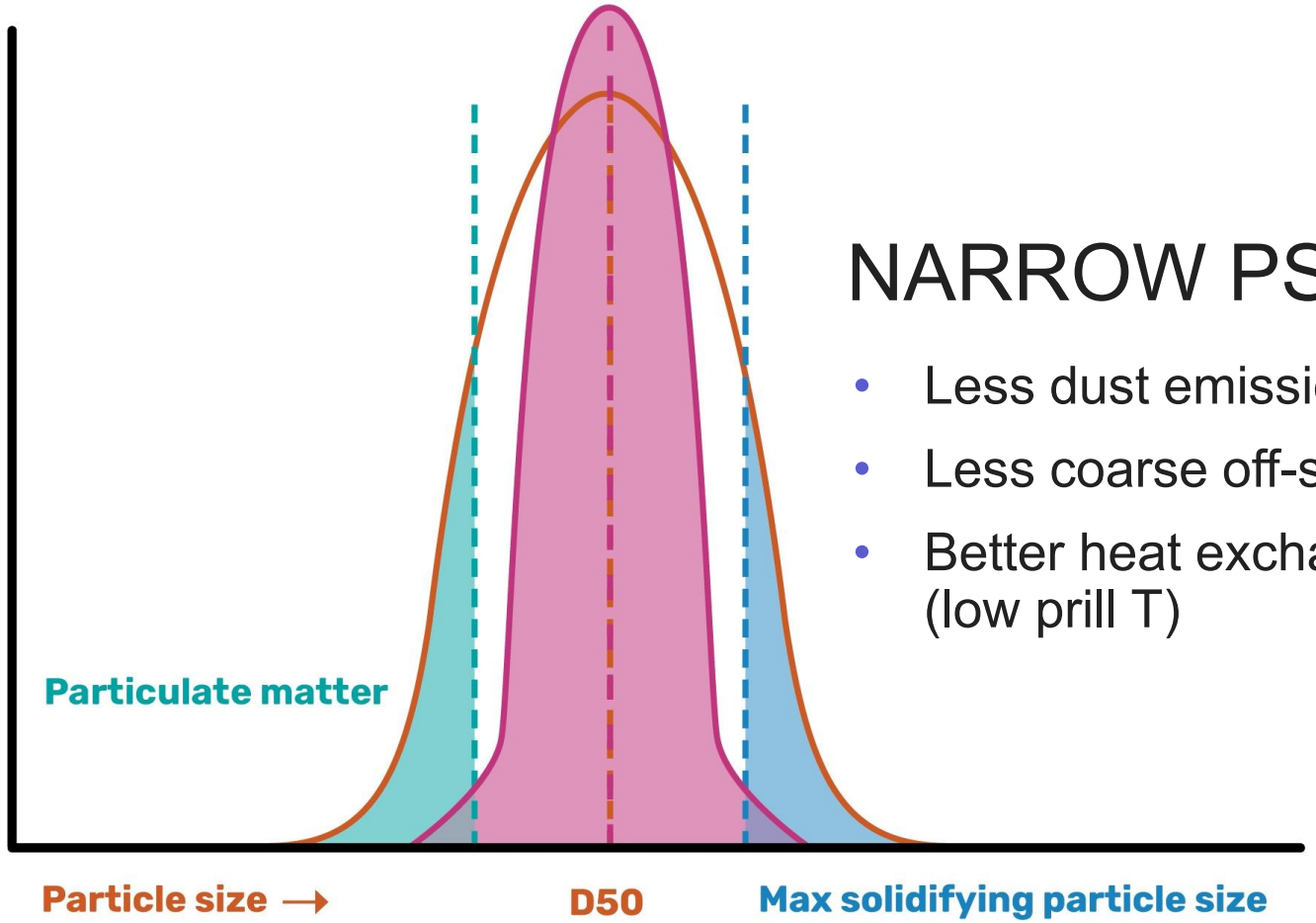
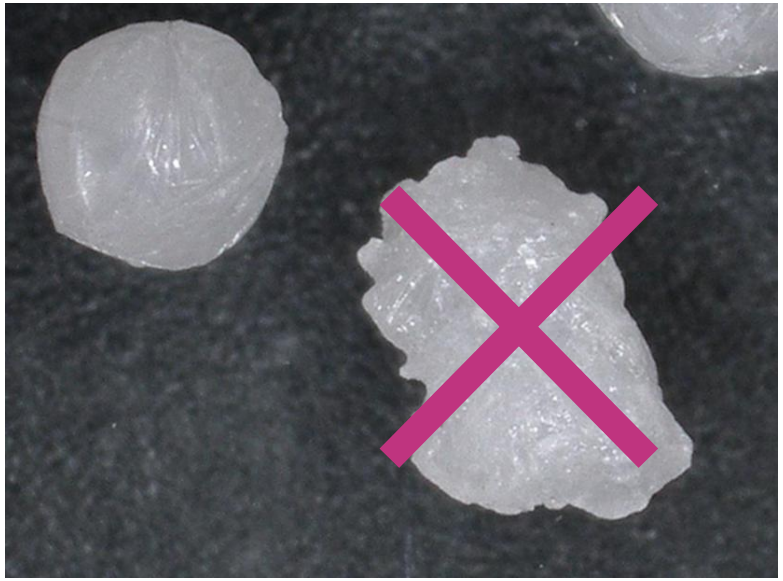


NARROW PSD

- Less dust emission
- Less coarse off-spec
- Better heat exchange (low prill T)



VIBRO PRILLING ADVANTAGES

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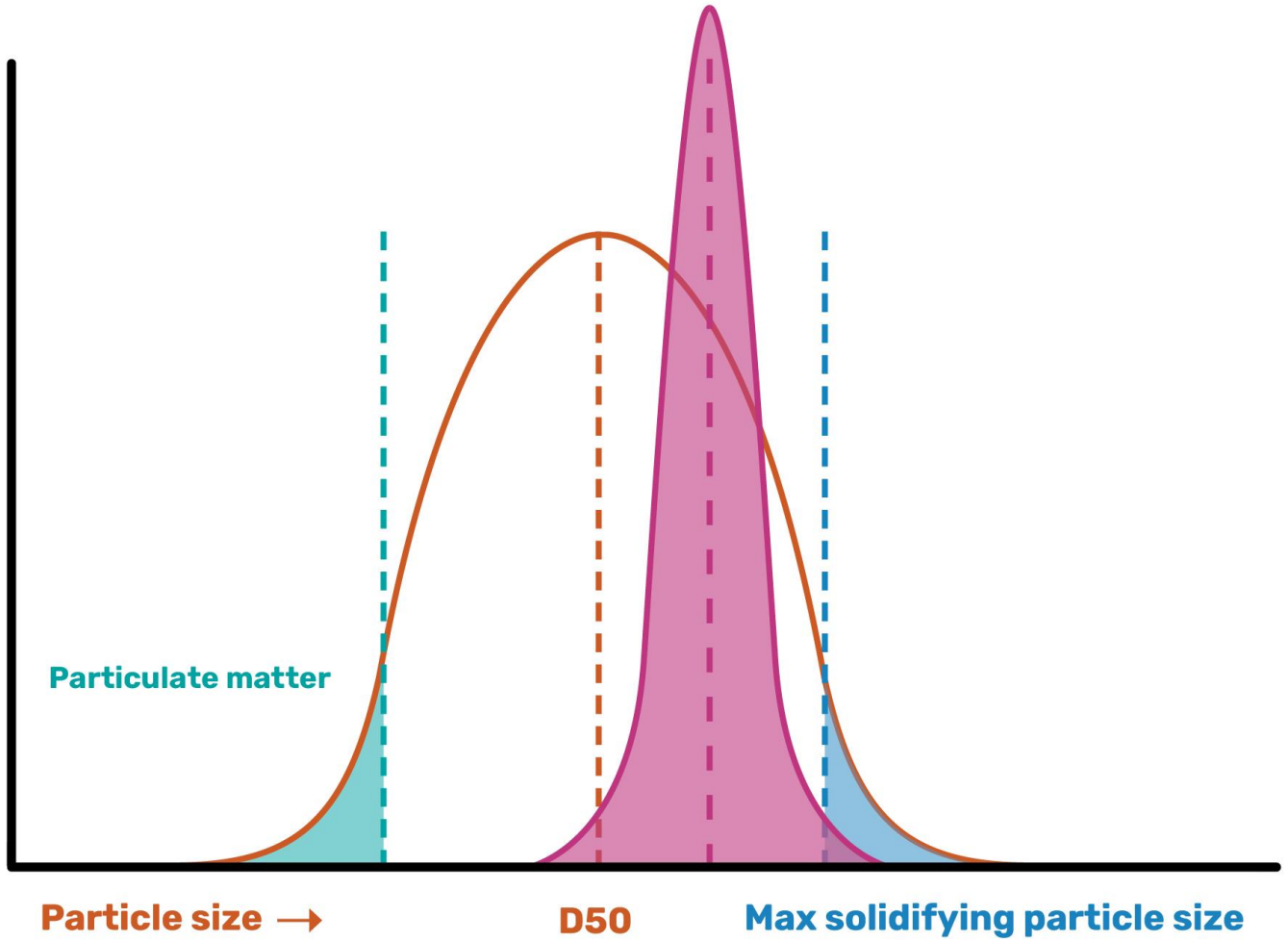

LARGER PRILL

- Homogeneous product
- Less waste
- Low bottom T
- Decreased scaling

03

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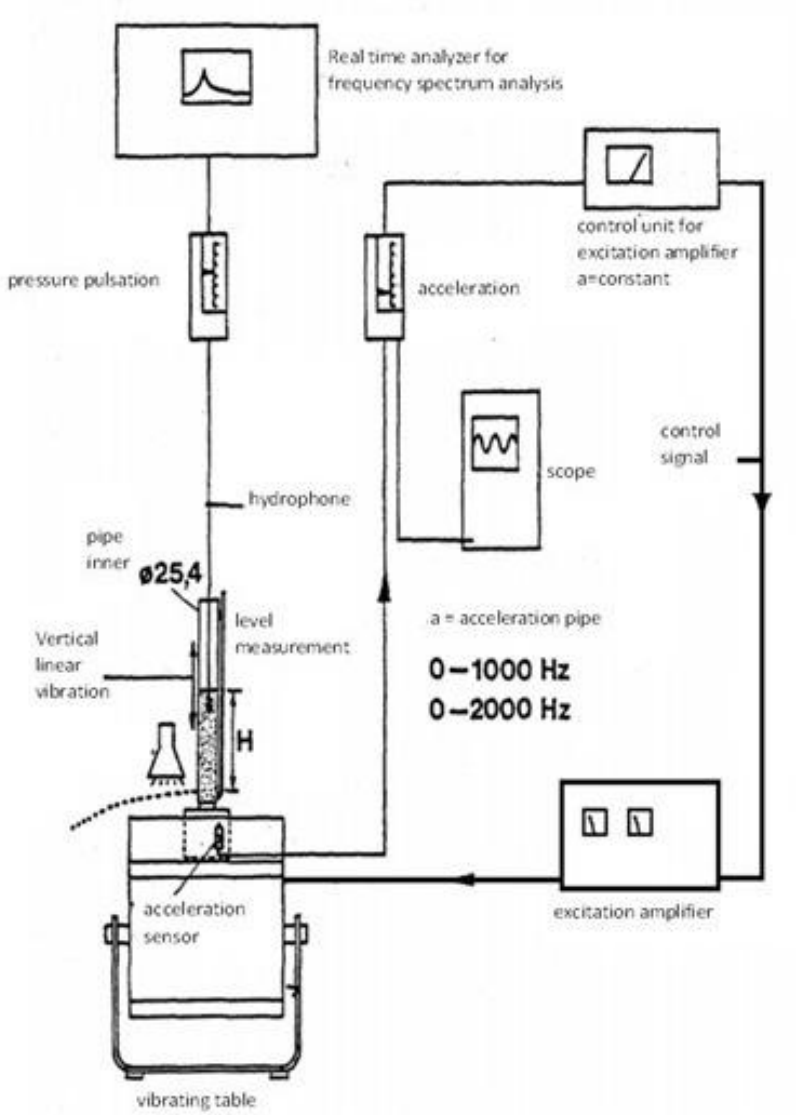
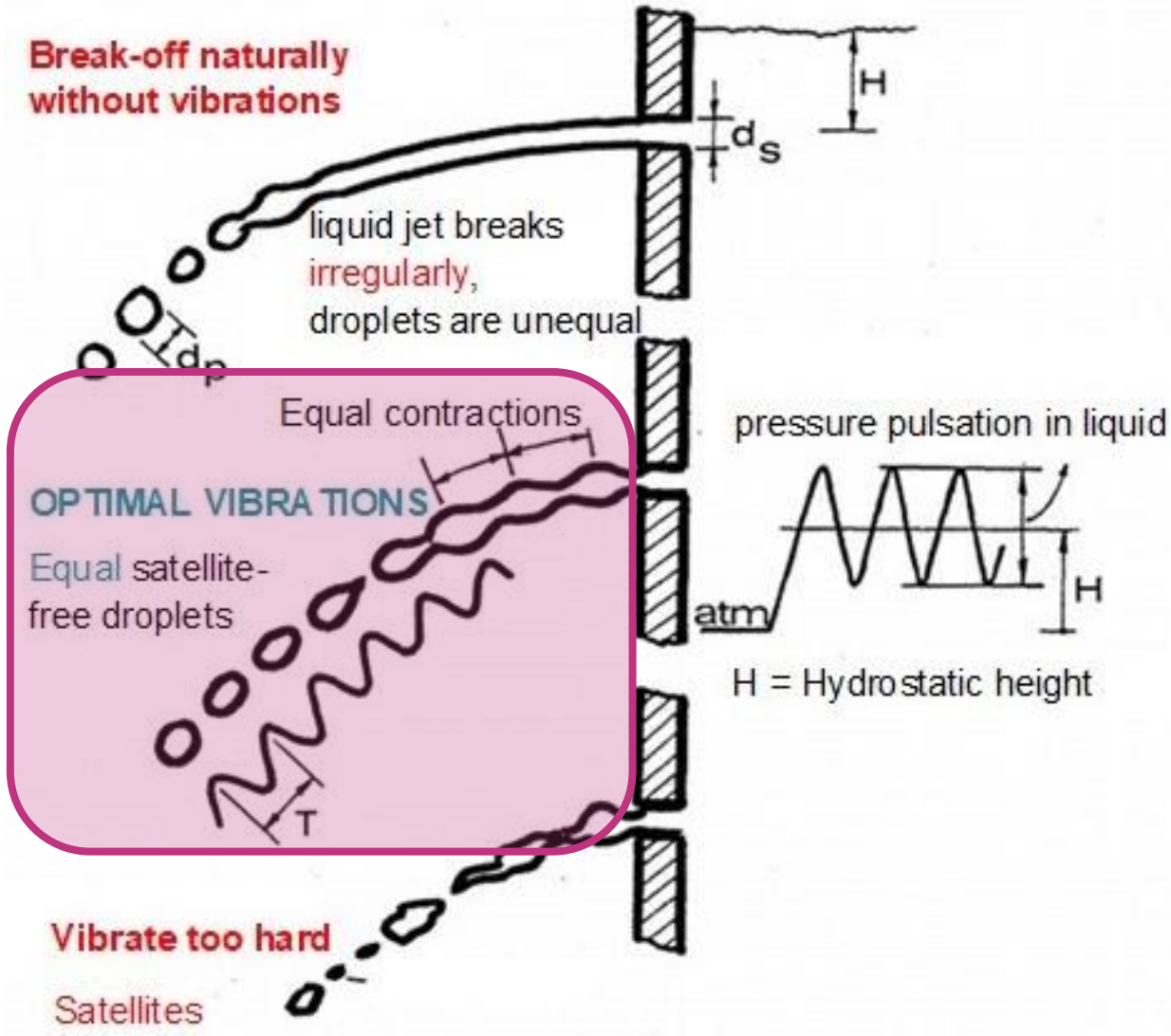
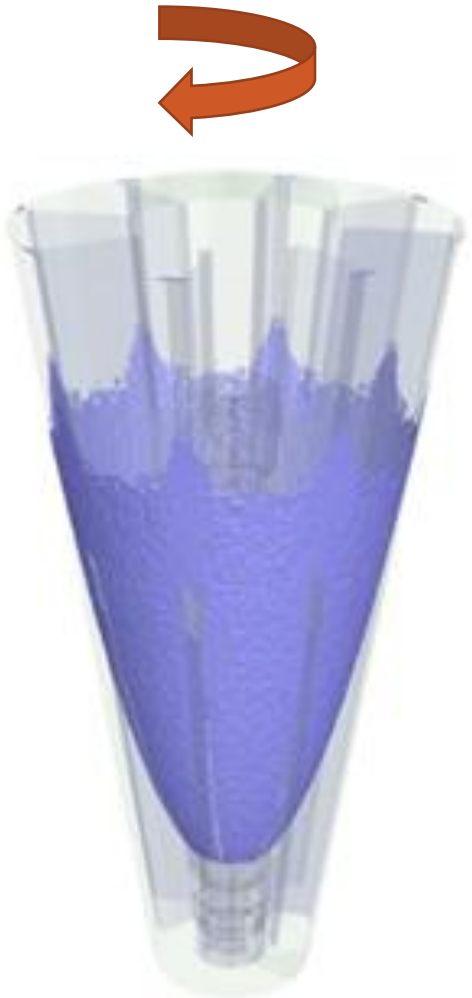
SCALE-UP & MODELLING

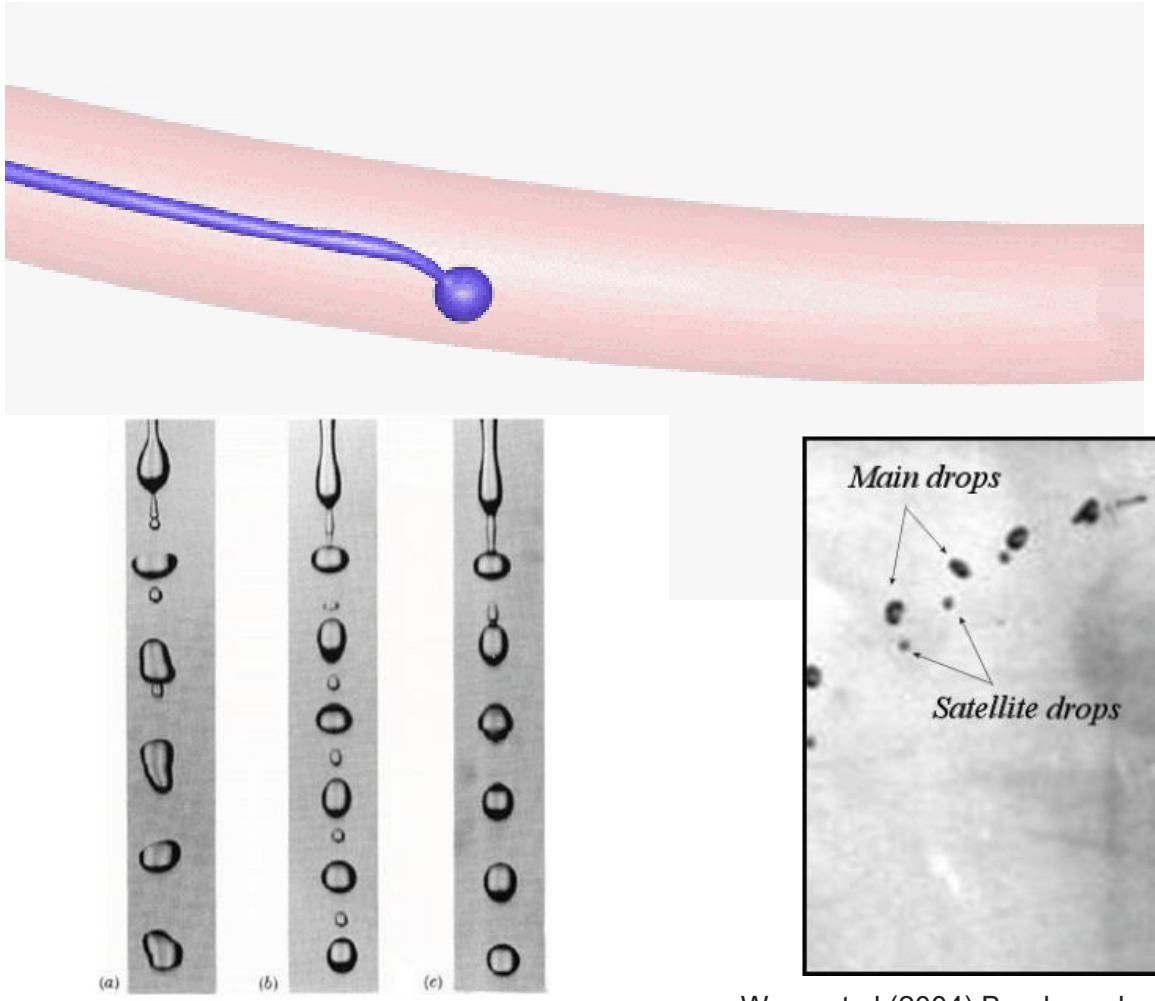
LAB SCALE


Real time analyzer for frequency spectrum analysis
control unit for excitation amplifier a=constant
pressure pulsation
acceleration
control signal
scope
hydrophone
pipe inner
ø25,4
level measurement
Vertical linear vibration
H
a = acceleration pipe
0–1000 Hz
0–2000 Hz
acceleration sensor
excitation amplifier
vibrating table


Break-off naturally without vibrations
H
d_s
liquid jet breaks irregularly, droplets are unequal
d_p
Equal contractions
OPTIMAL VIBRATIONS
Equal satellite-free droplets
T
pressure pulsation in liquid
atm
H
H = Hydrostatic height
Vibrate too hard
Satellites

FROM LAB TO FULL-SCALE





Vasallo and Ashgriz (1991)
Example of a) rear merging, b) no merging and c) forward merging satellite droplets

Wong et al (2004) Break-up dynamics and drop size distributions created from spiralling liquid jets.

IMPROVING JET BREAKUP

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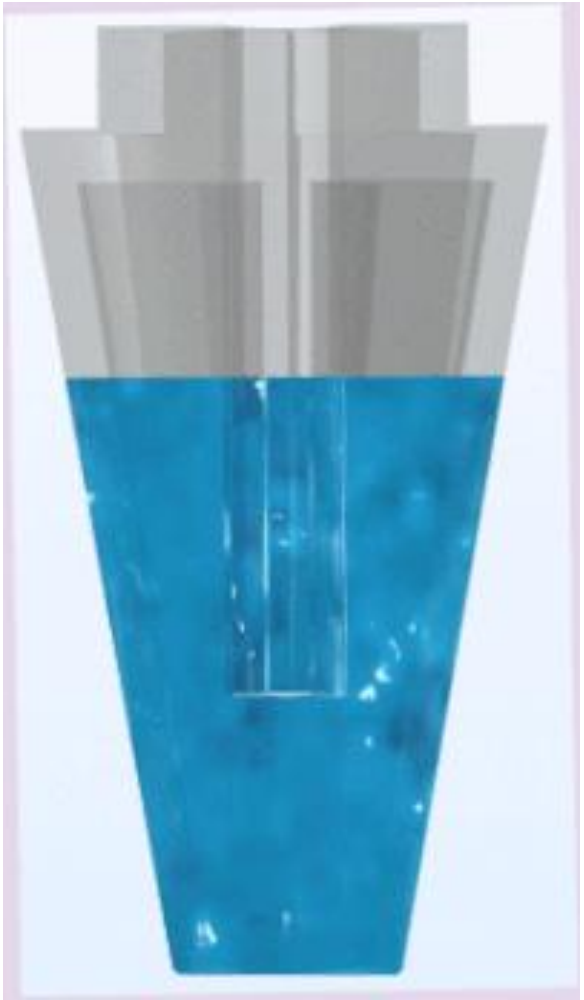
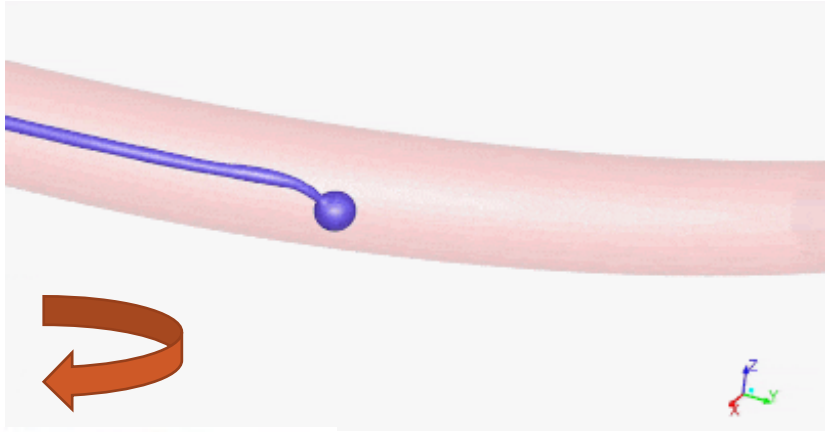
- Calculating optimal wavelength
  - Fixed parameters
    - Priller shape
    - Nozzle diameter
    - Melt properties
  - Operational parameters
    - Rotary Priller RPM
    - Flowrate
    - Feed temperature

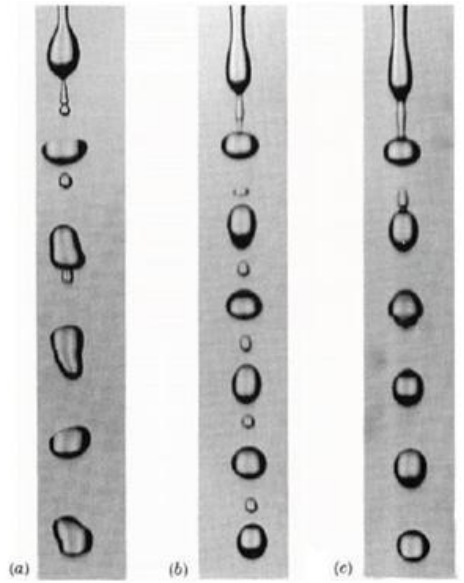
SIMPLIFIED



IMPROVING JET BREAKUP

- Spiraling jet vs straight jet
- Gravitational forces
- Optimizing merging





Vasallo and Ashgriz (1991)
Example of a) rear merging, b) no merging and c) forward merging satellite droplets

MODEL JET BREAKUP

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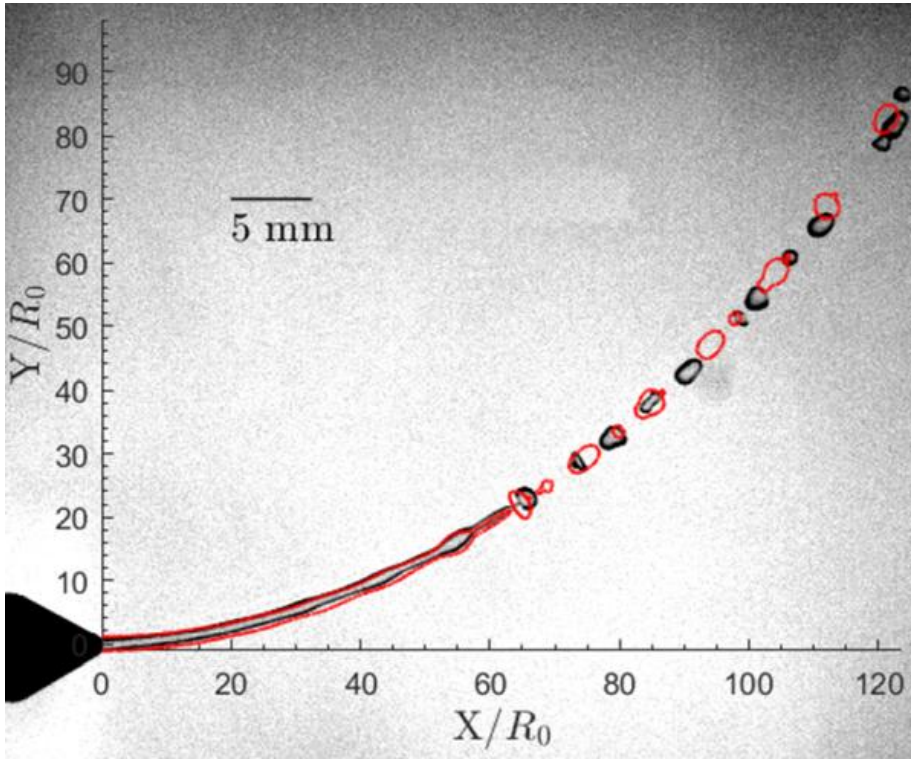
JM PAPERS

Controlling the breakup of spiralling jets: results from experiments, nonlinear simulations and linear stability analysis

Yavuz Emre Kamis[1],†, Suriya Prakash[1], Wim-Paul Breugem[1] and Hüseyin Burak Eral[1]

[1]Process & Energy Department, Delft University of Technology, Leeghwaterstraat 39, 2628 CB Delft

TU Delft



MODEL JET BREAKUP

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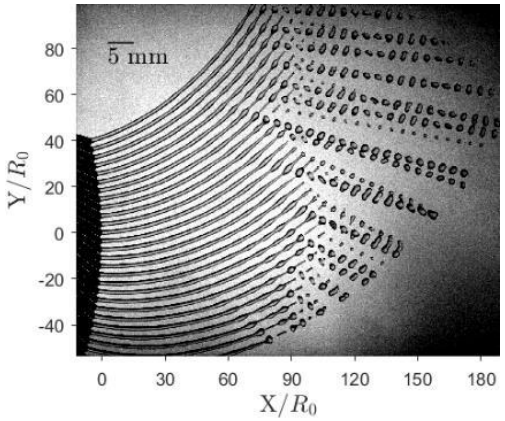
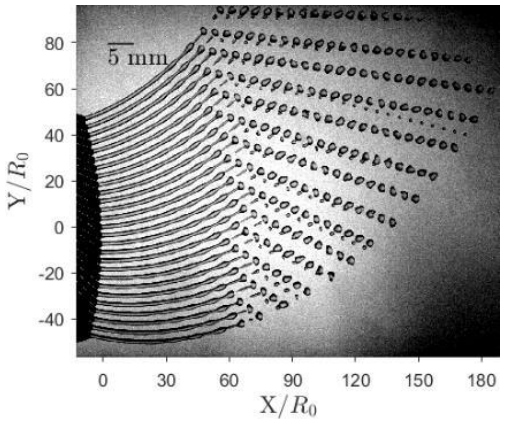
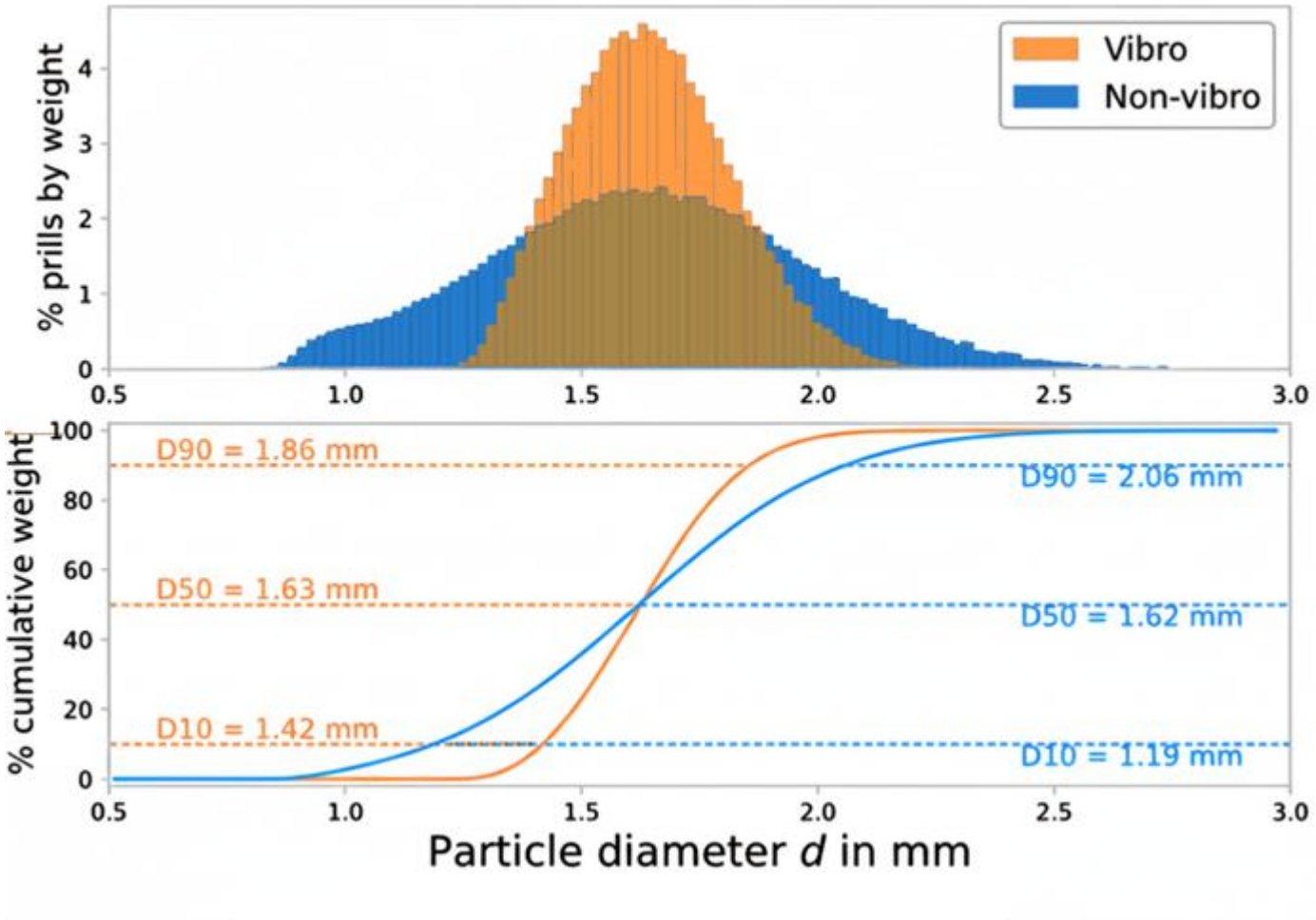
NO VIBRATION

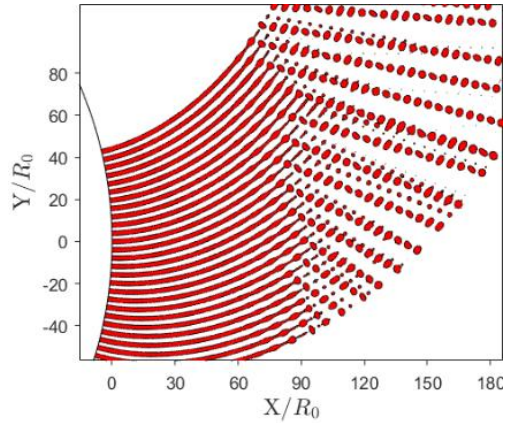
VIBRATION

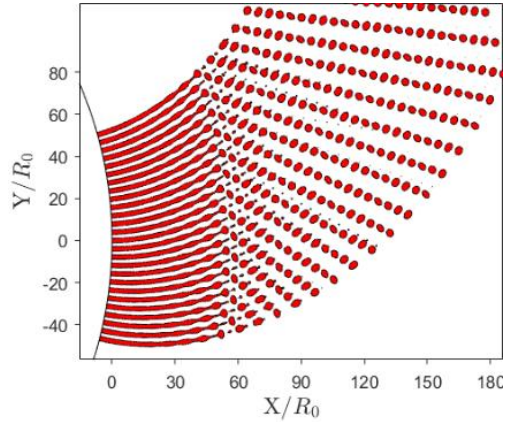
MODEL JET BREAKUP











BENCH SCALE

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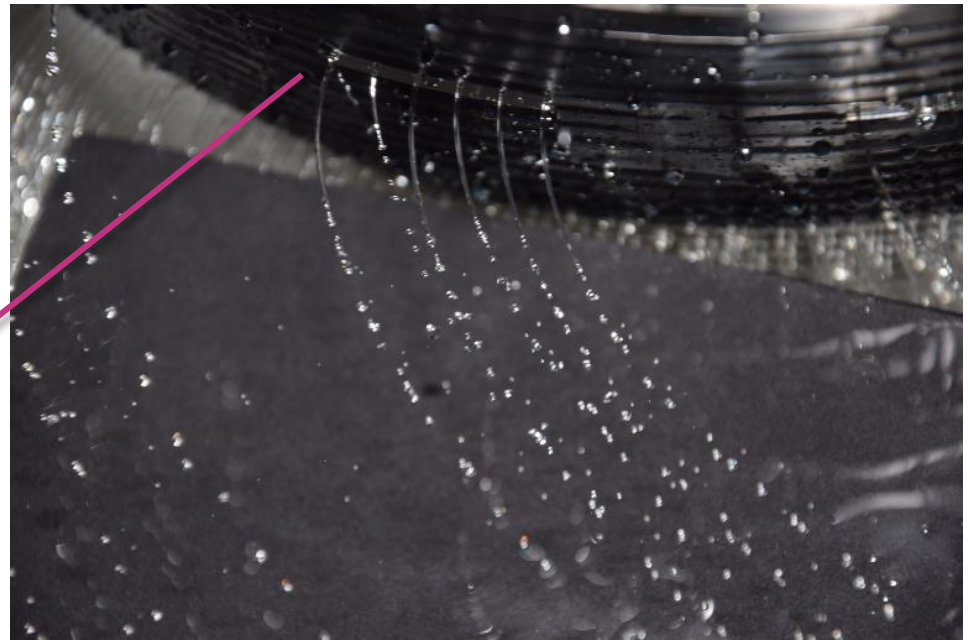
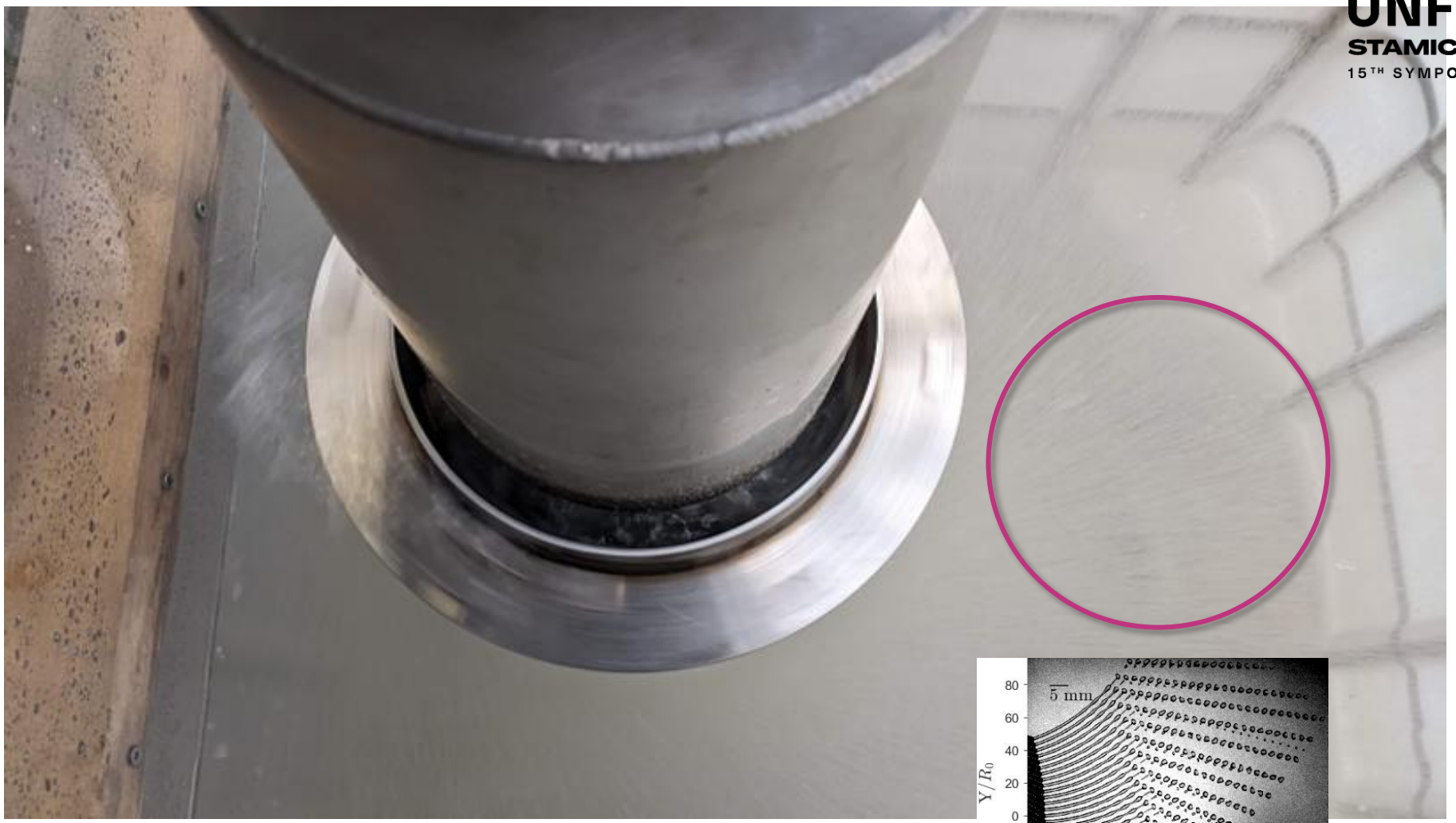
NO VIBRATION



VIBRATION

BENCH SCALE



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BENCH SCALE

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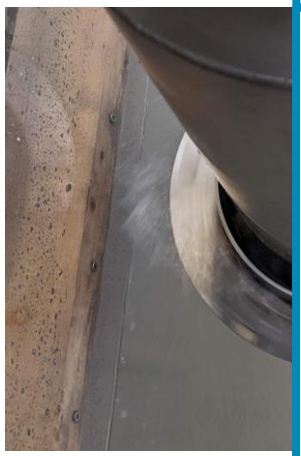
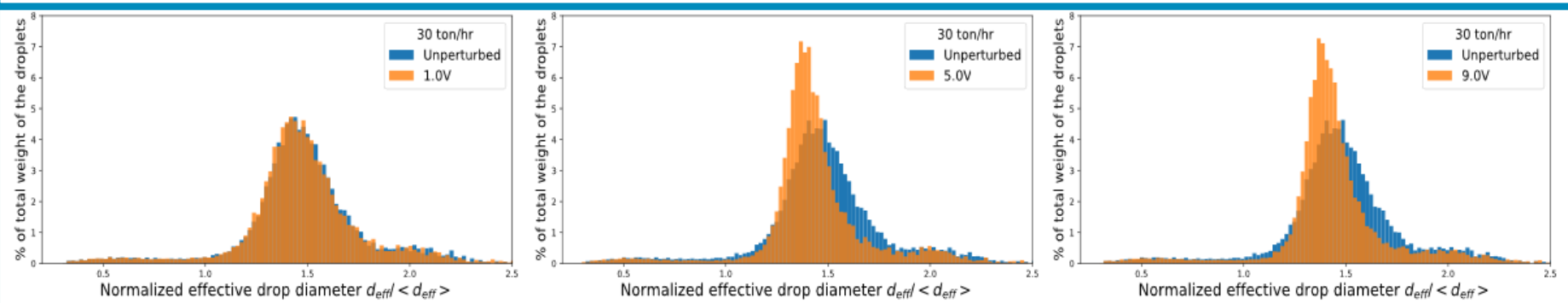
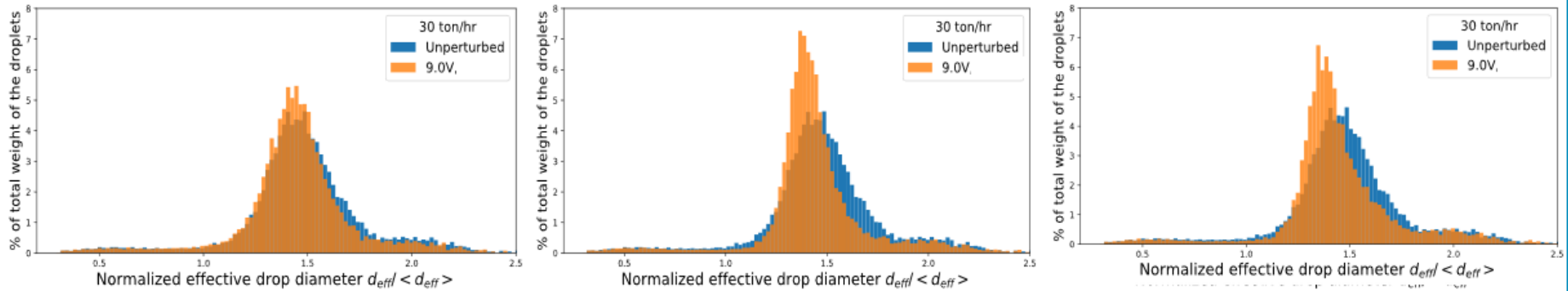
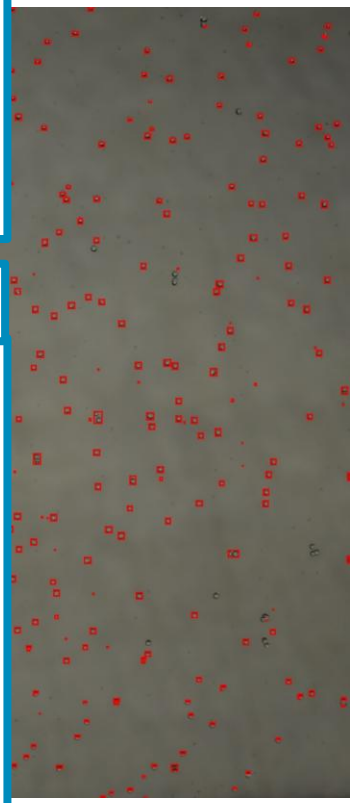


Applying amplitude sweep, with fixed frequency value (optimum wavelength)



Applying frequency sweep, with fixed amplitude value





IMPROVING JET BREAKUP

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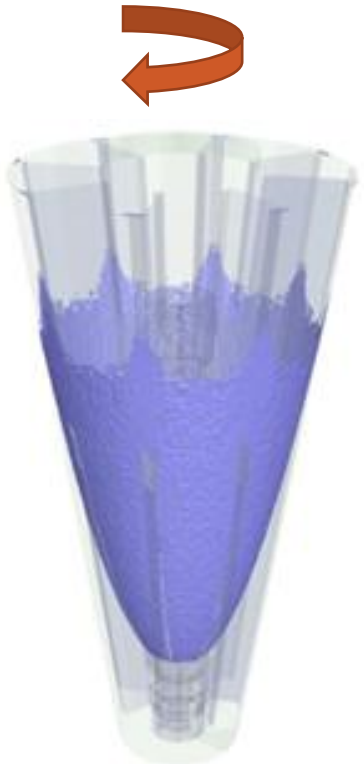
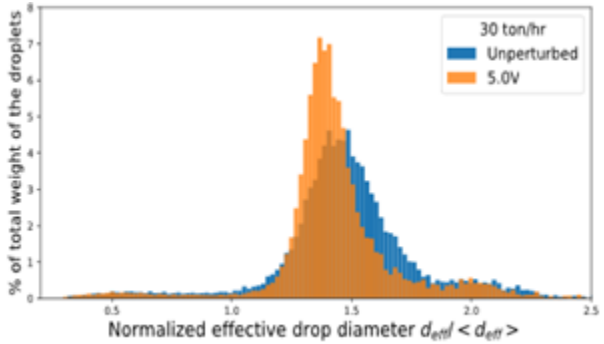
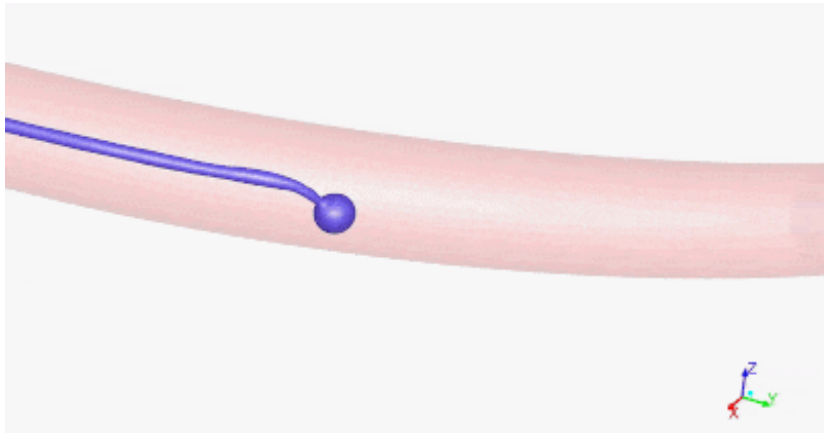
- Kreber in-house model
  - Jet breakup simulation
  - Main and satellite droplet dynamics
- Vibro actuation narrows PSD
- Merging under optimal perturbation
  - Less satellite droplets
  - More uniform droplets







04

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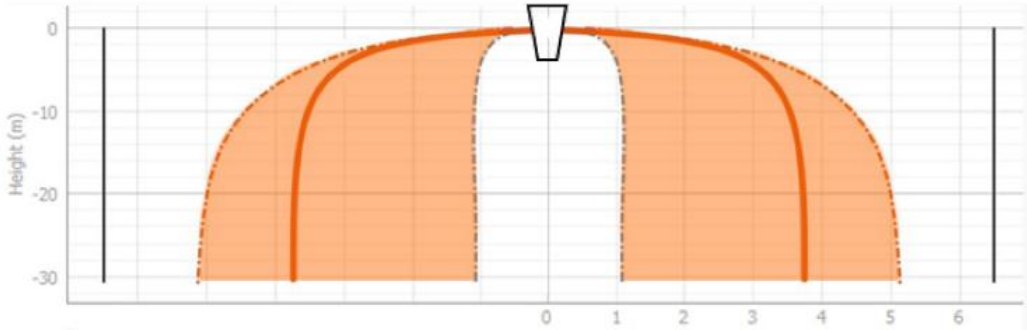
INDUSTRIAL VALIDATION

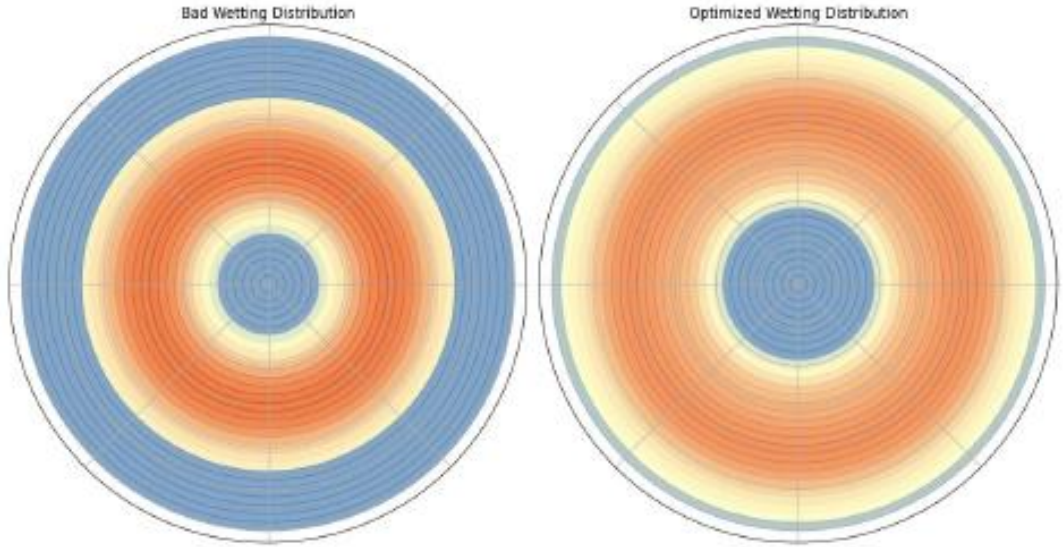
INDUSTRIAL VALIDATION & REVAMP

UNFOLD STAMICARBON 15TH SYMPOSIUM 2026

- **Commercialized** in South Asia (3850 MTPD)
- **Revamp opportunities:**
  - Switch on/off
  - Improve on-spec
  - Lower prill temperature
  - Less dust emissions
  - Optimized wetting



%w distribution of prils @ bottom



05

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CONCLUSION

CONCLUSIONS

UNFOLD STAMICARBON 15TH SYMPOSIUM 2026

INNER IMPELLER VIBRO PRILLING achieves a NARROWER PSD leading to:

- **Less dust emission**
- **Less coarse off-spec** (increased capacity)
- **Low prill T** (improved heat exchange)
- **Larger prill size**
- **Revamp opportunities** (switch on / off)
- **Commercialized** in South Asia (3850 MTPD)

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MAIRE Sustainable Technology Solutions

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THANK YOU

QUESTIONS?

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