KU LEUVEN

MeBiOS

AGENTSCHAP INNOVEREN & ONDERNEMEN

Vlaanderen is ondernemen

CFD modelling of spray applications in cool rooms

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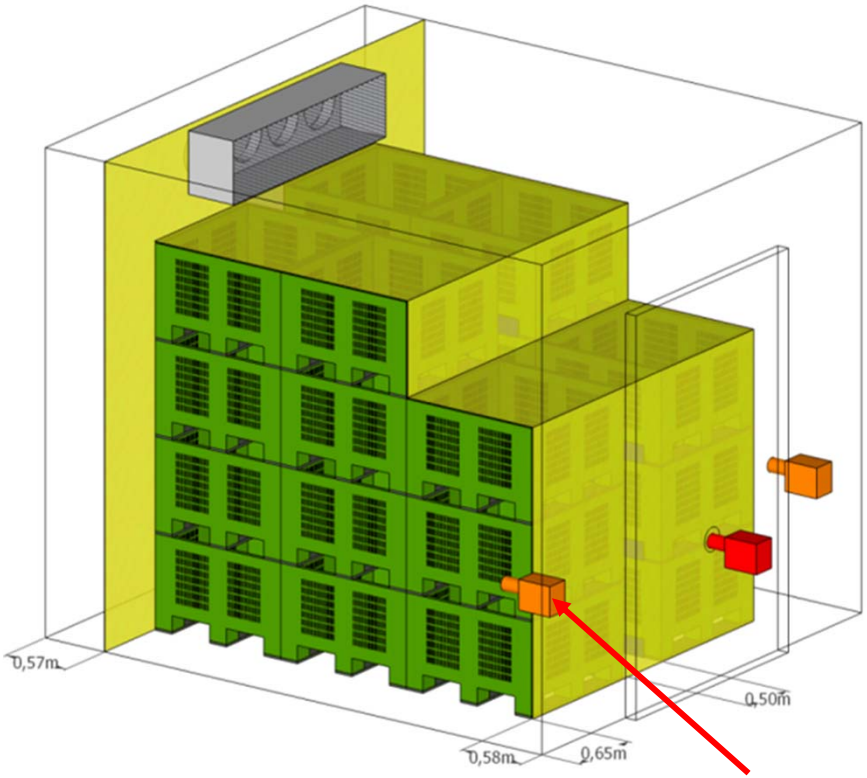
pcfruit
PROEFCENTRUM FRUITTEELT VZW

Gloeosporium infection

Field spraying

Dipping



Spray nozzle for droplet-based application (e.g. BCO)

Thermonebulisation fogging

Objectives

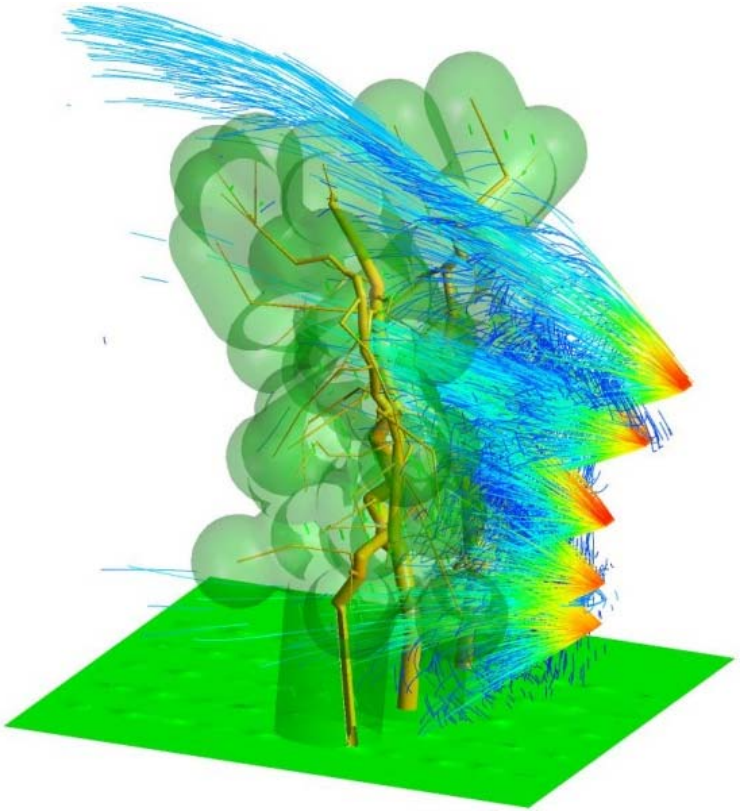
- Develop and validate a CFD model of postharvest spray application systems
- Evaluate the performance of spray applications for cold storage rooms
- Design a postharvest spray application system

CFD model of spray application systems

- Calculates
  - Airflow
  - Spray distribution
- Effect of
  - Stacking pattern
  - Position of the sprayer (single nozzle)
  - Air flowrate and suction pressure
  - Droplet size

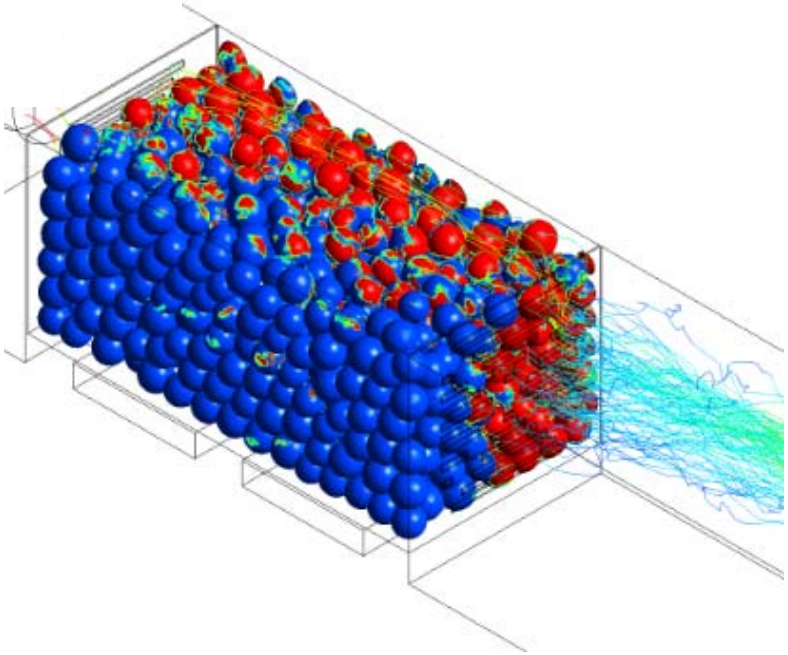
CFD spray models (2000-2017)

- Preharvest: tree architecture

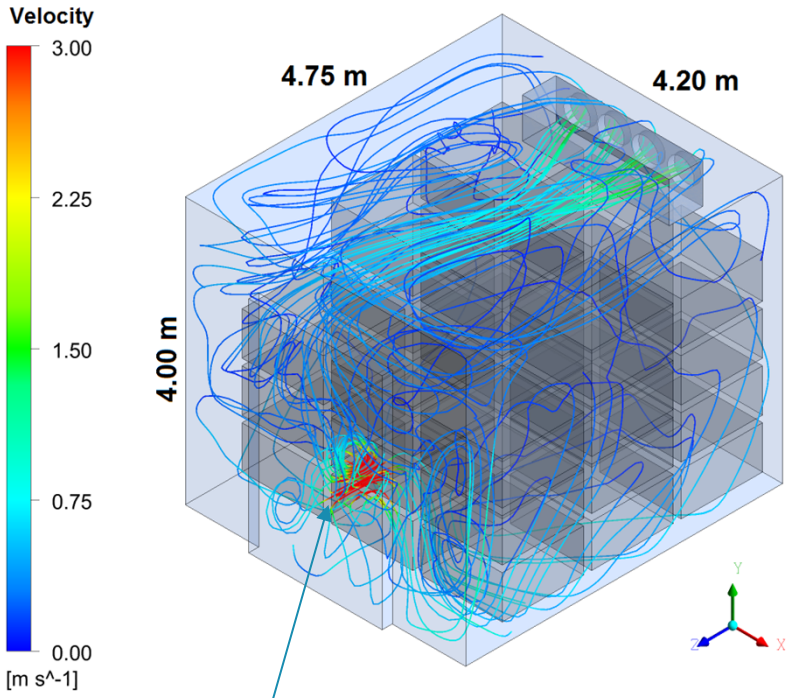


Duga et al. 2015 Crop Prot
Duga et al. 2016 Biosys Eng

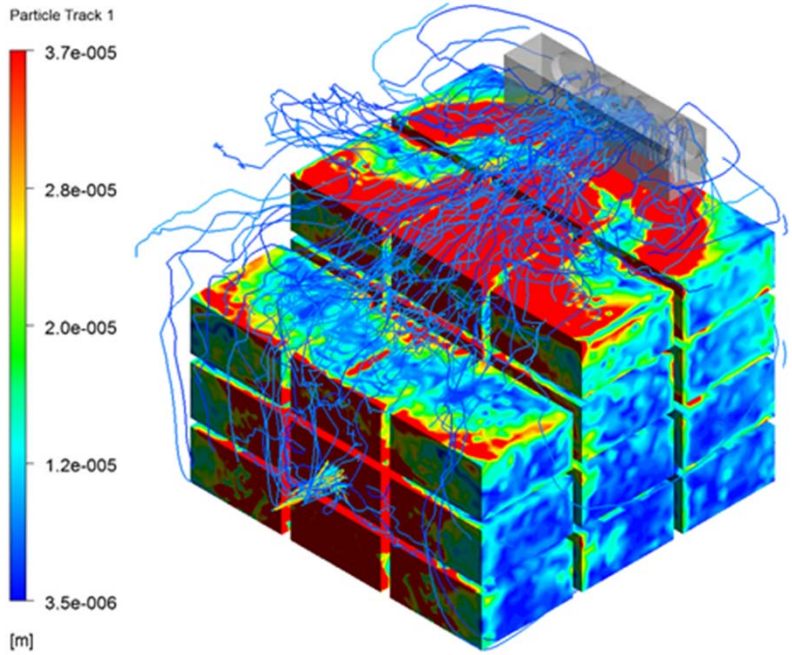
- Postharvest: fruit stacking



Ambaw et al. 2016 J Food Eng



Spray nozzle

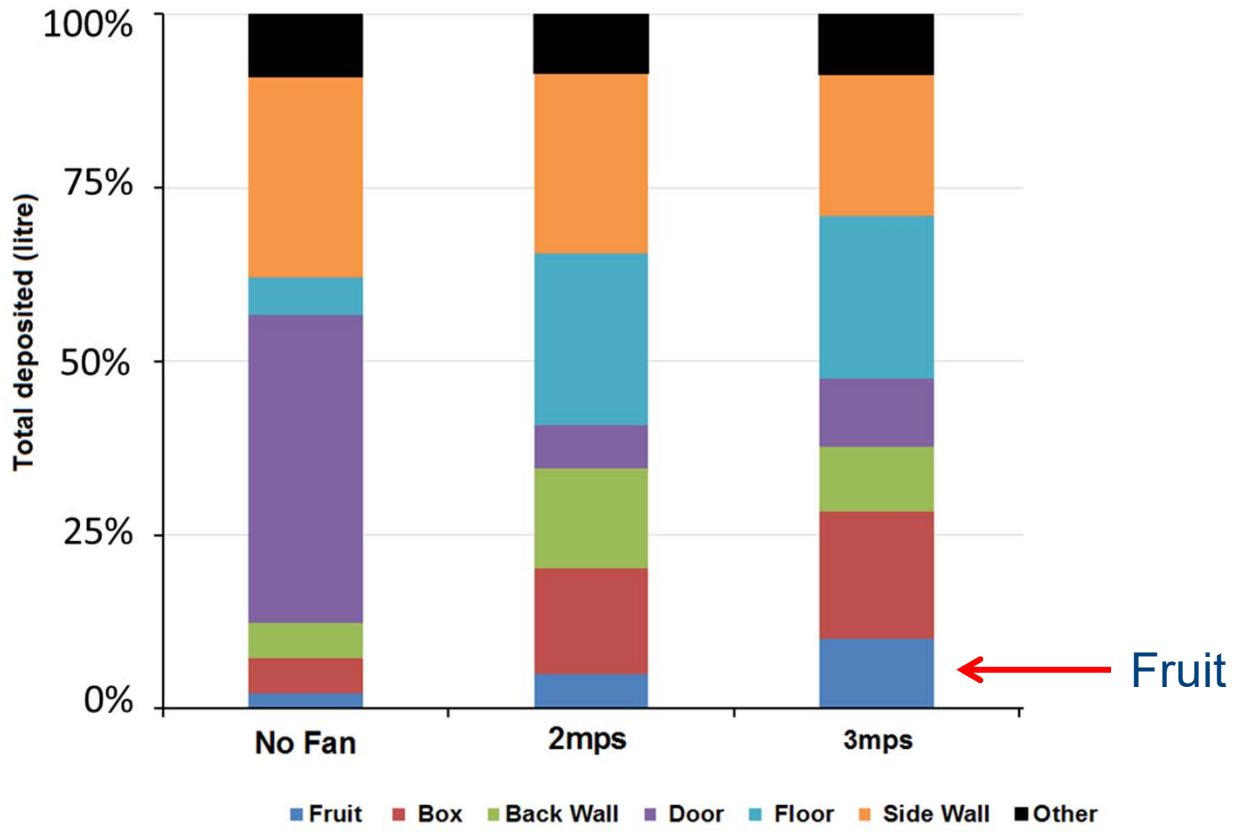


Postharvest spray evaluation

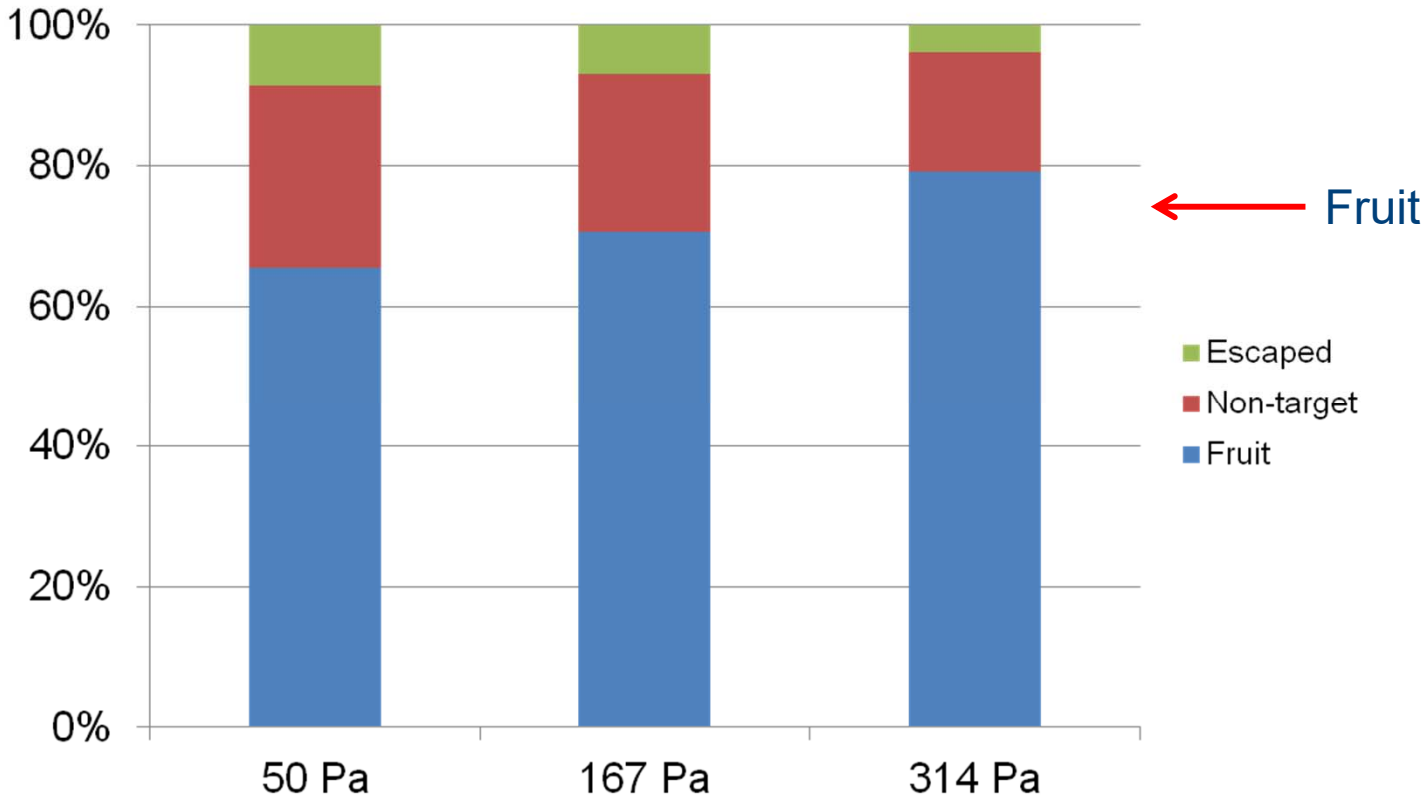
- What is the effect of airflow through bins?
- Can airflow through bins be increased in a cool room?
- Does position of the sprayer affect deposition distribution?
- Can an optimal solution be proposed for postharvest spray applications?

Effect of airflow through bins

- Free standing with room airflow

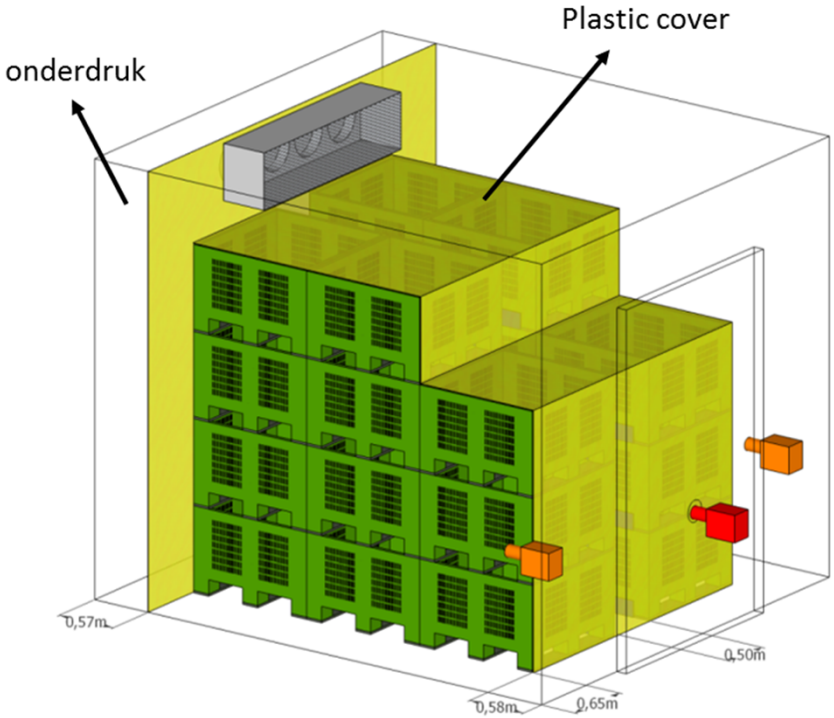


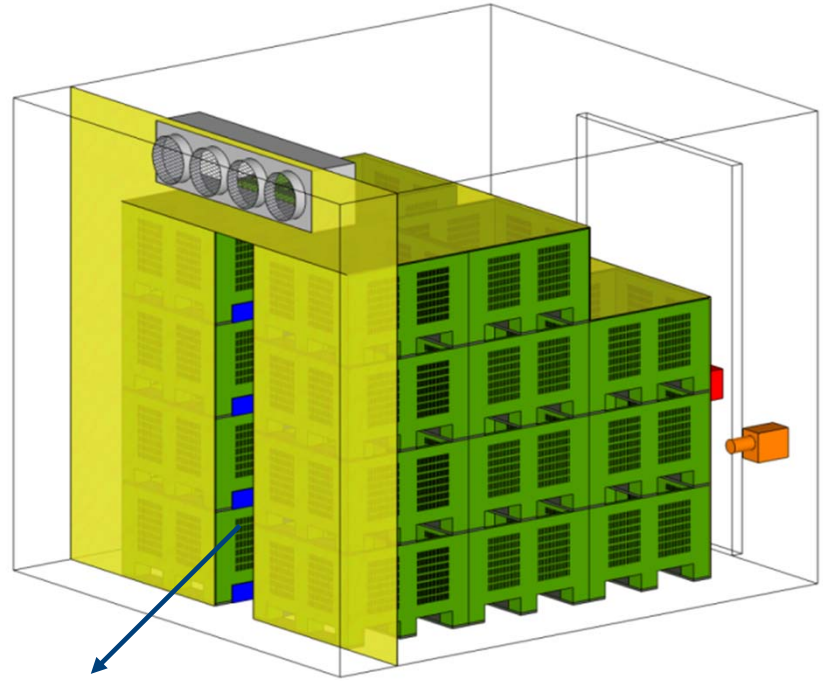
- Forced airflow by suction at different fan pressures



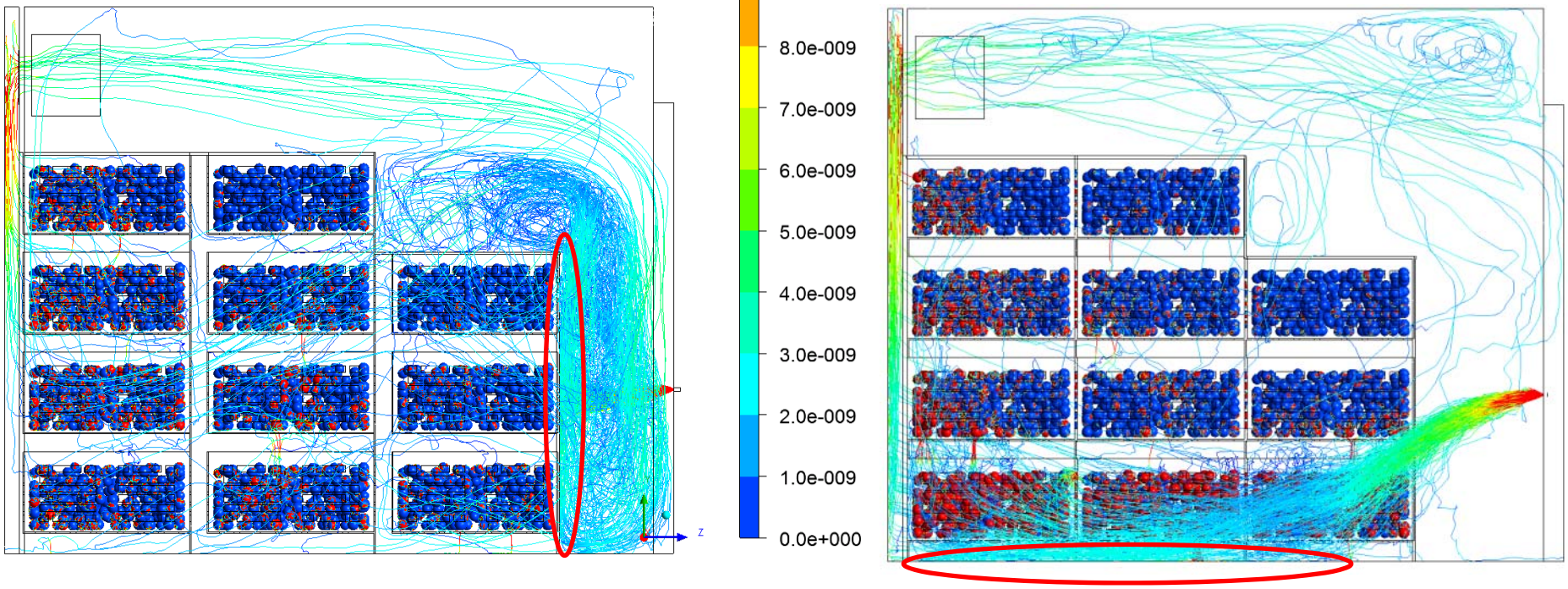
Increasing airflow through bins

- Creating a suction tunnel





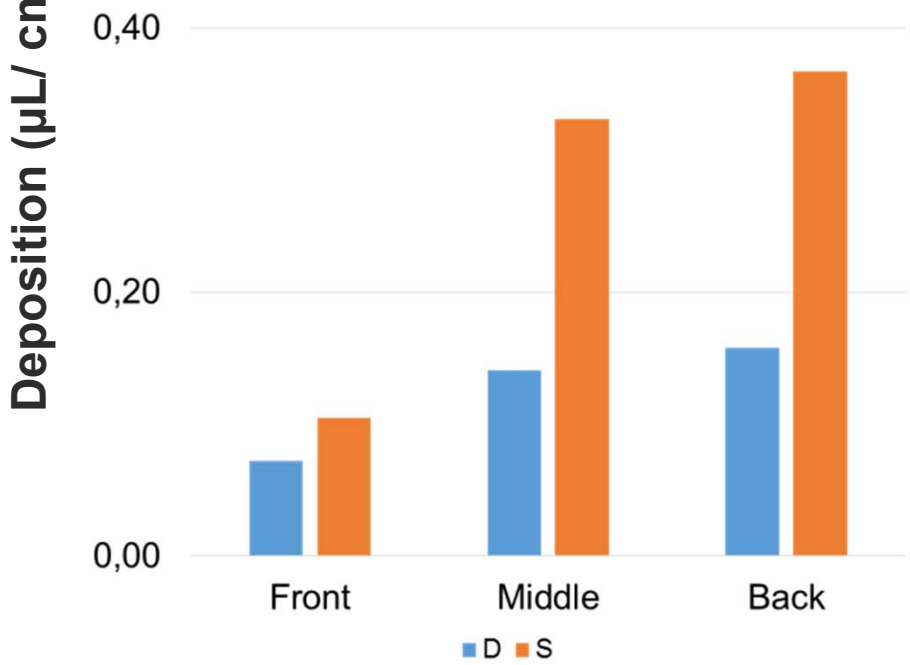
Effect of position of the sprayer



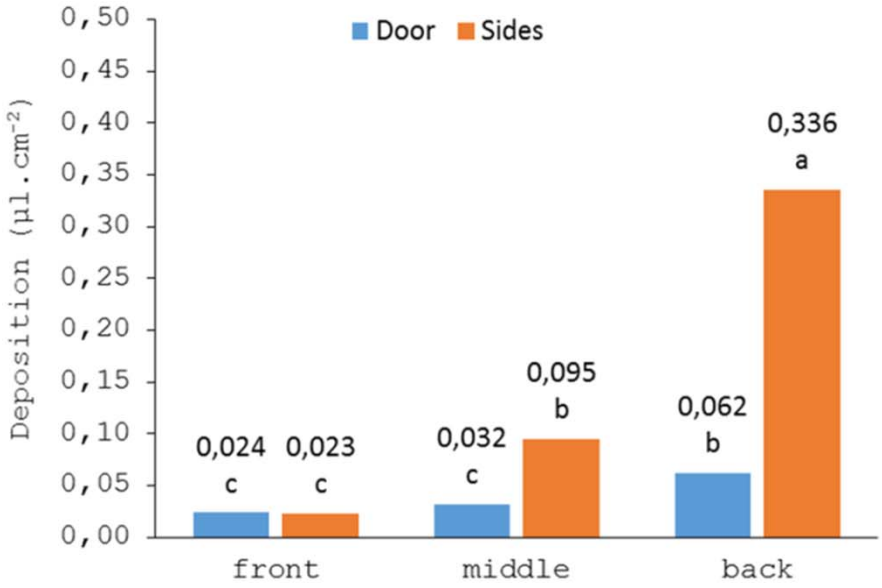
Door fogging

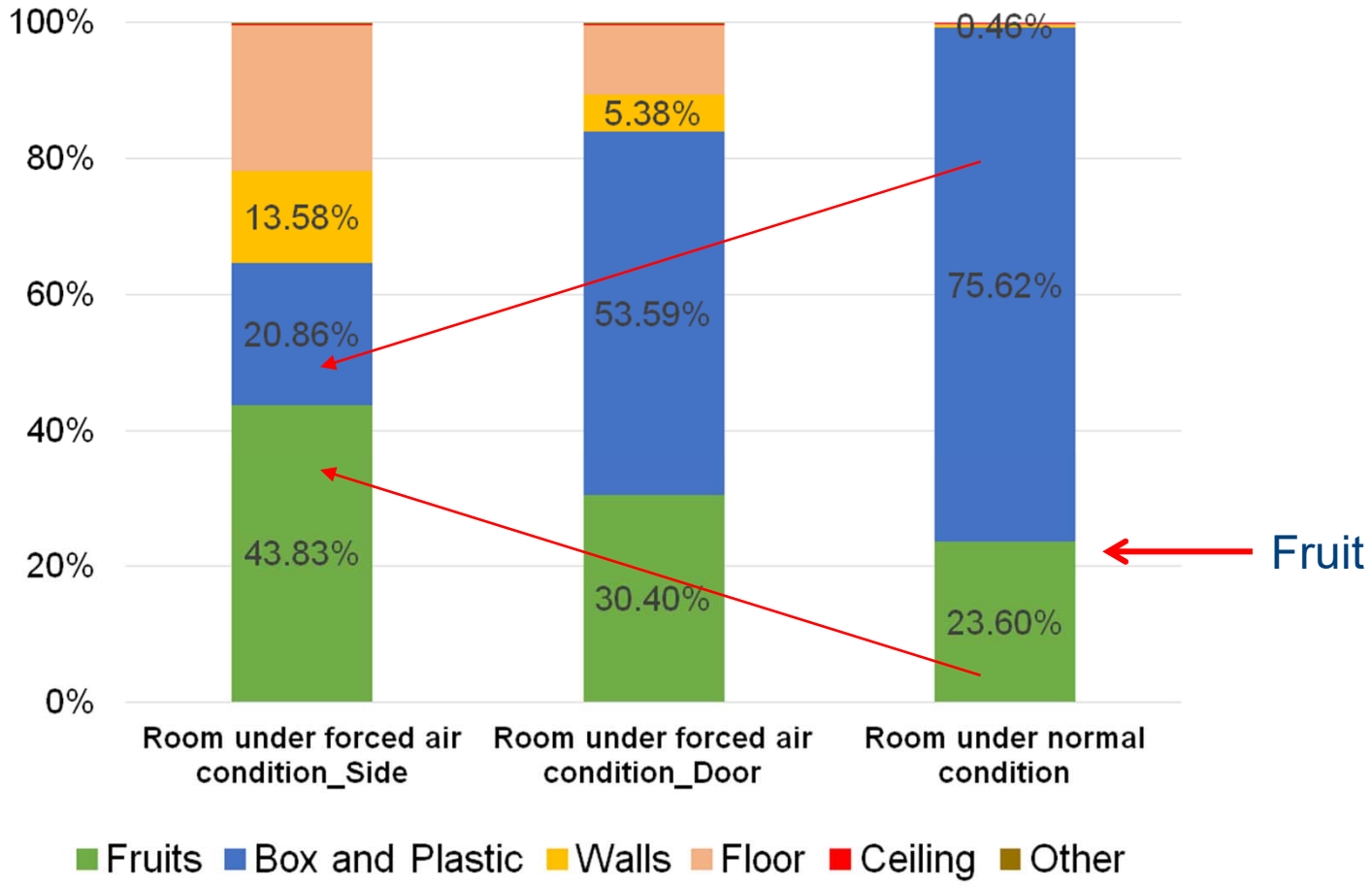
Side fogging

CFD


Deposition (µL/ cm-2)
0,40
0,20
0,00
Front
Middle
Back
D S

Exp.


Deposition (µl.cm-2)
Door Sides
0,50
0,45
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00
0,024 c
0,023 c
0,032 c
0,095 b
0,062 b
0,336 a
front
middle
back

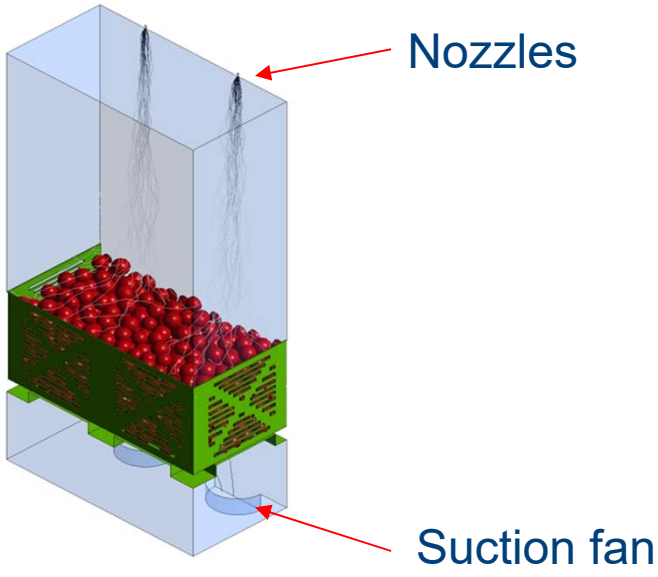

100%
80%
60%
40%
20%
0%
13.58%
20.86%
43.83%
5.38%
53.59%
30.40%
0.46%
75.62%
23.60%
Room under forced air condition_Side
Room under forced air condition_Door
Room under normal condition
Fruit
Fruits
Box and Plastic
Walls
Floor
Ceiling
Other

Discussion

- Forced airflow and smart position of the spray nozzle increases deposition on fruit
- In an optimized cool store configuration, still a large heterogeneity across bins is found
- Max. 40% deposition on fruit

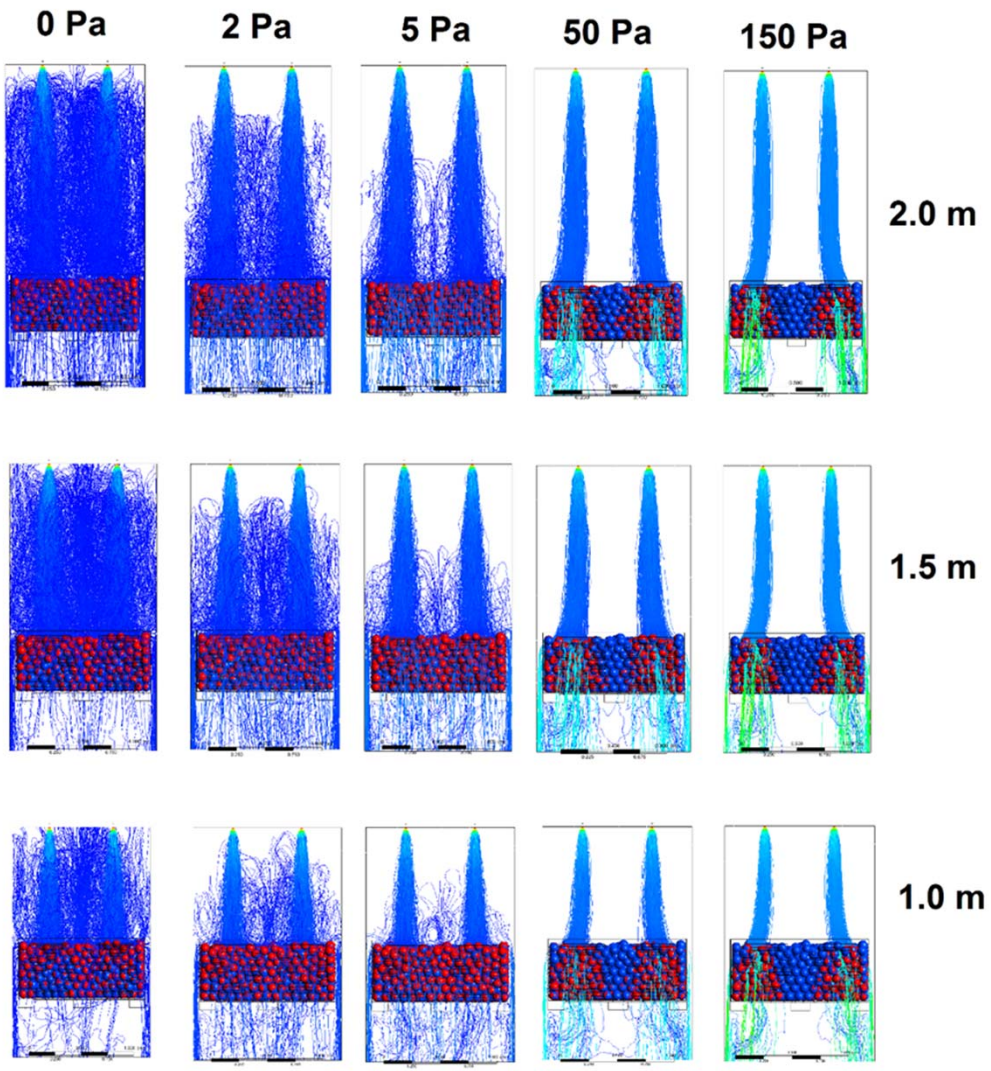
Treatment of single bins

- Development of application system on individual bins
- Investigate the factors that influence the uniformity of droplet depositions on fruits in single bin for a vertical flow setup

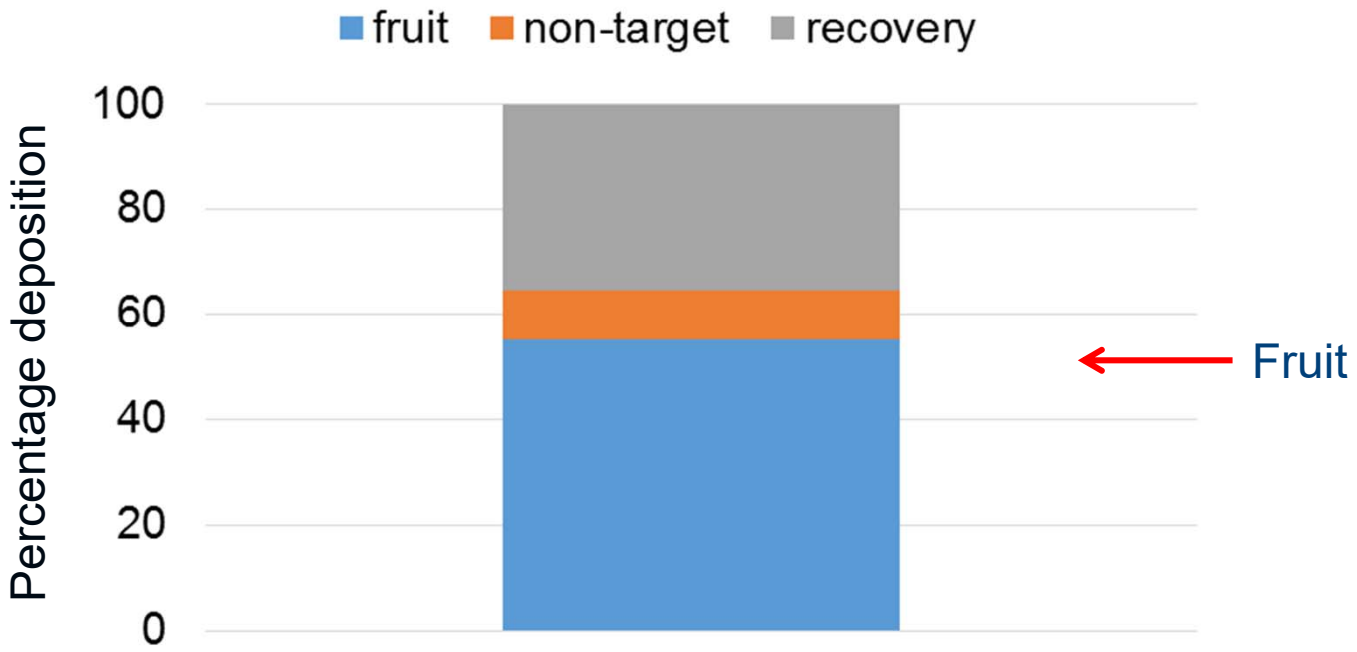


Design study

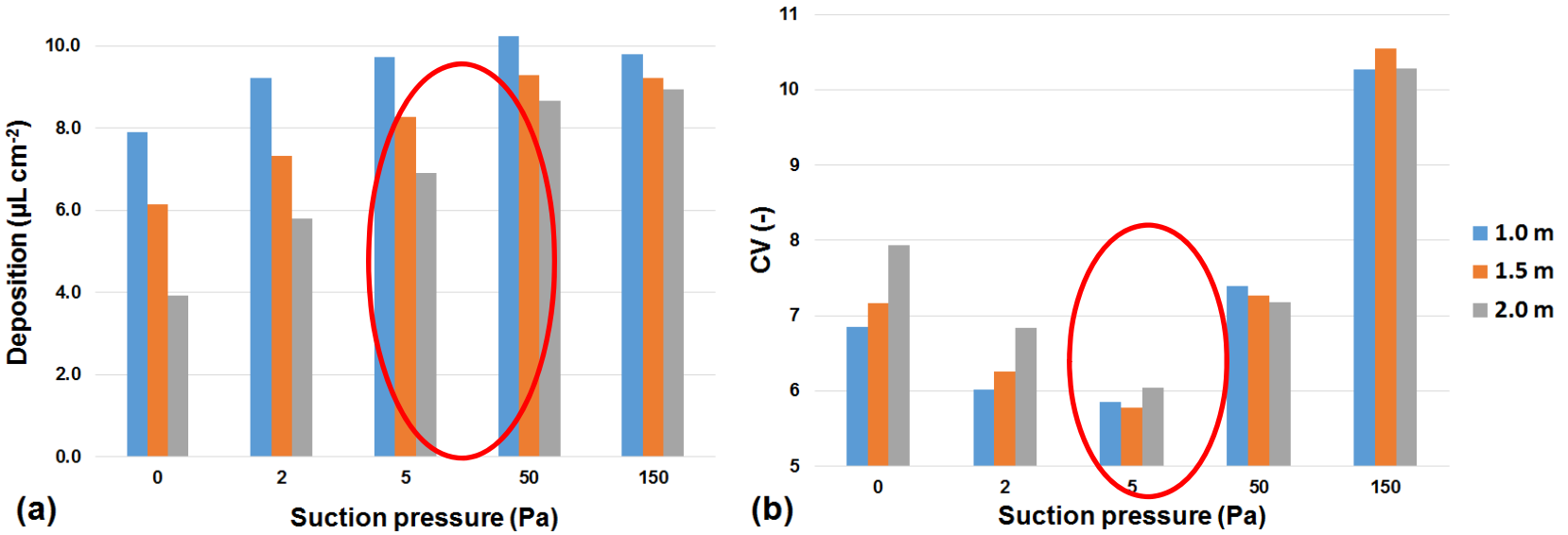
- Suction pressure
- Nozzle height
  - Four spray nozzles
  - Placed symmetrically 1 to 1.5 m above the stack
  - suction fan placed underneath operated at 5 to 50 Pa



- At 50 Pa suction pressure



- Results of single bin treatment



Conclusions

- Difficult to obtain high and uniform deposition in cool rooms
  - Airflow rate & pattern
  - Stacking pattern
  - Sprayer position and characteristics
- Single bin treatment system proposed
  - > 50% fruit deposition + recovery of spray
  - Design and operation optimized to reduce variability

THANK YOU