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Experimental investigation of residence time distribution in twin-screw granulation

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Ashish Kumar

BIOMATH, Ghent University, Belgium.

Laboratory of Pharmaceutical Process Analytical Technology, Ghent University, Belgium.

Outline

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- Background
  - Consigma™-25 system
  - Twin-Screw Granulator
  - High shear wet granulation
- Experiments
  - Objective – factors and responses
  - Set-up: CI System
  - Results
- Conclusions

Consigma™-25 system

(GEA pharma systems, Collette)

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Continuous twin screw granulator

Segmented Fluid bed dryer

Granule conditioning module

Twin-Screw Granulation

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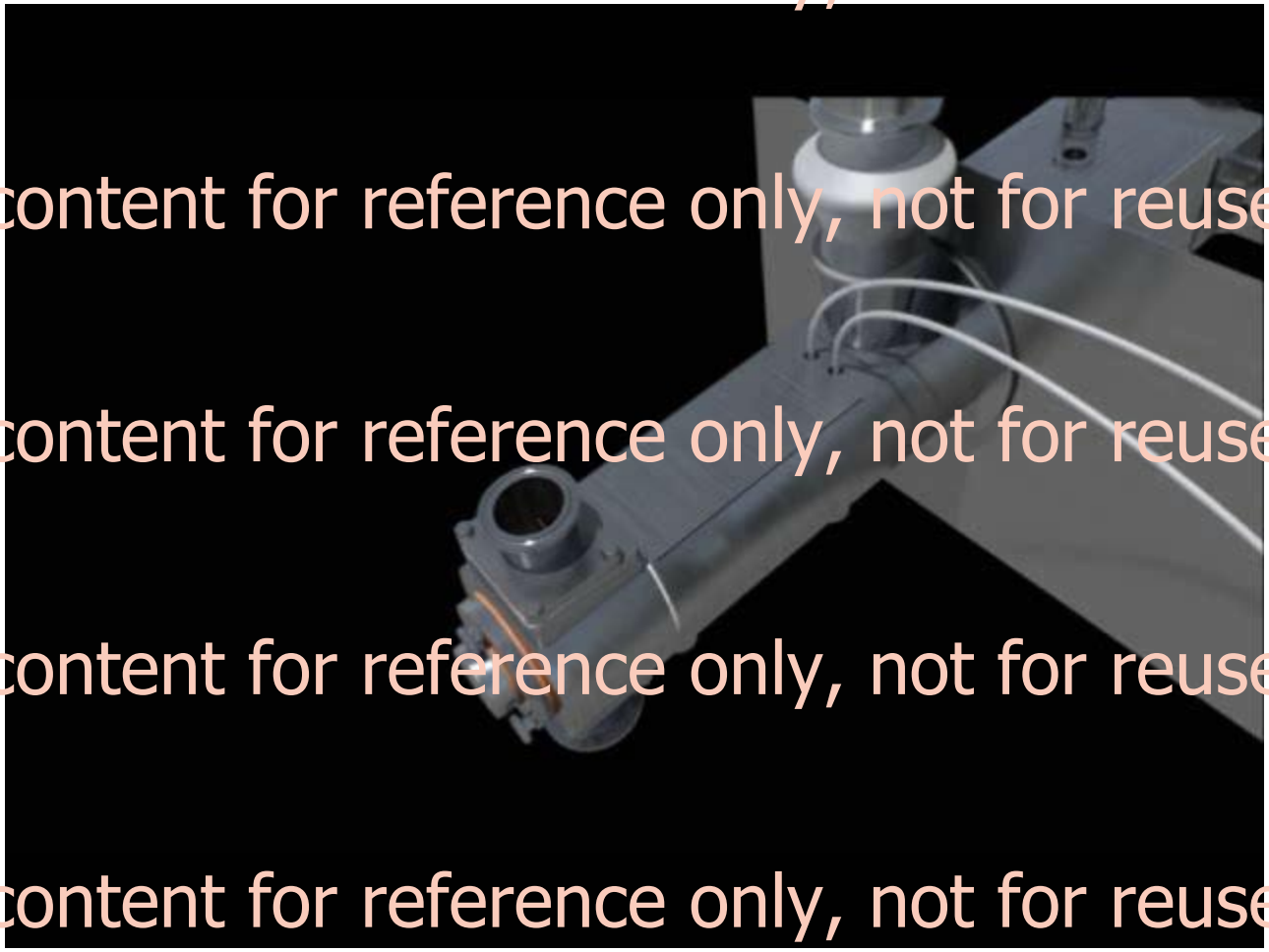

Twin-Screw Granulation – In Practice

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Setpoints (logged):

- Powder mass flow (g/min) - powder feeder
- Liquid mass flow (g/min) - liquid addition
- Screw speed (rpm)
- Barrel temperature (°C)

Granulation steady state criterion:

- Torque granulator (N-m)

Need for enhanced mechanistic understanding of the process through experiments and mathematical modelling for prediction and future control of product quality

Twin-Screw Granulation - HSWG

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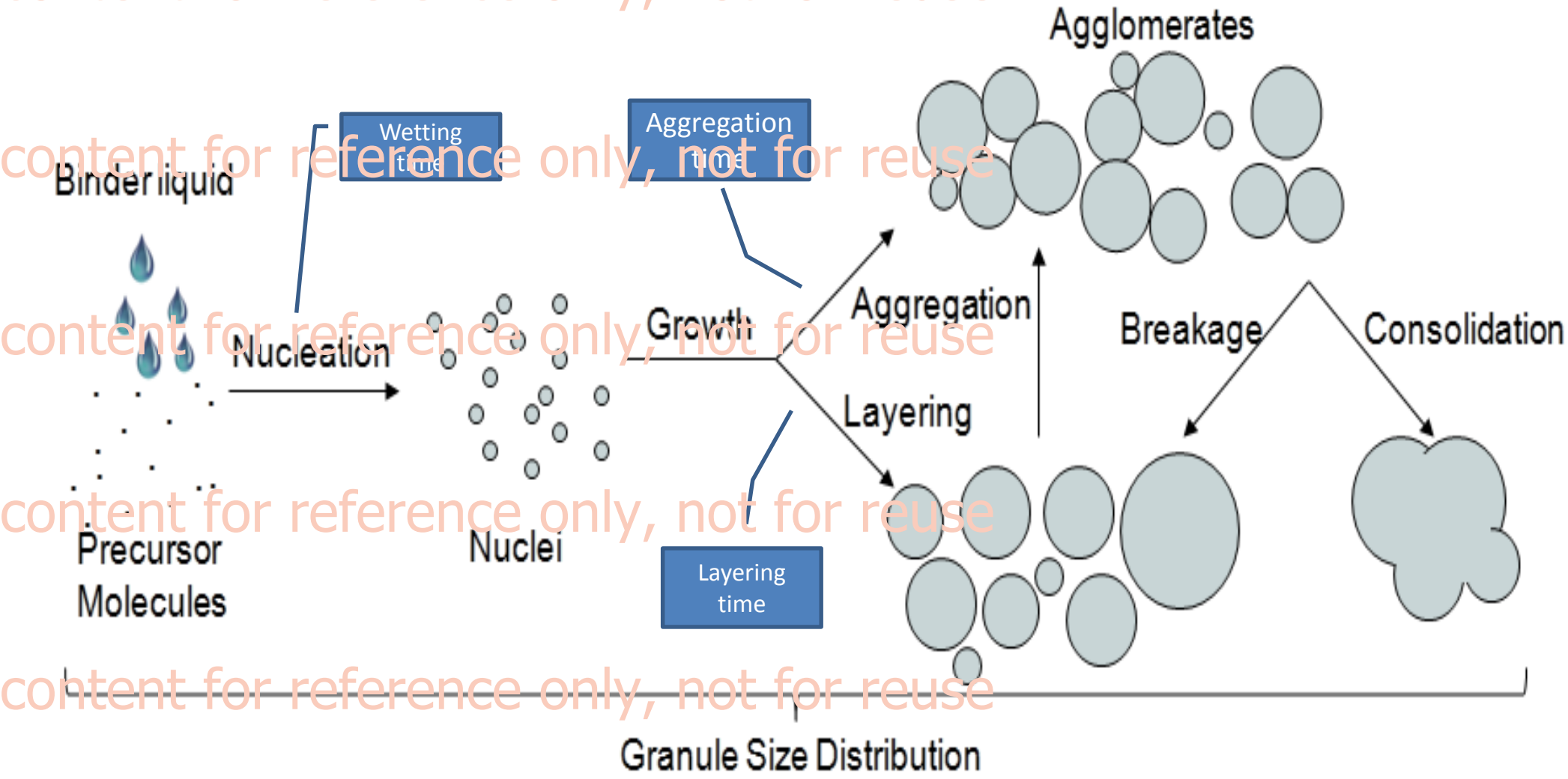

Twin-Screw Granulation - CI System

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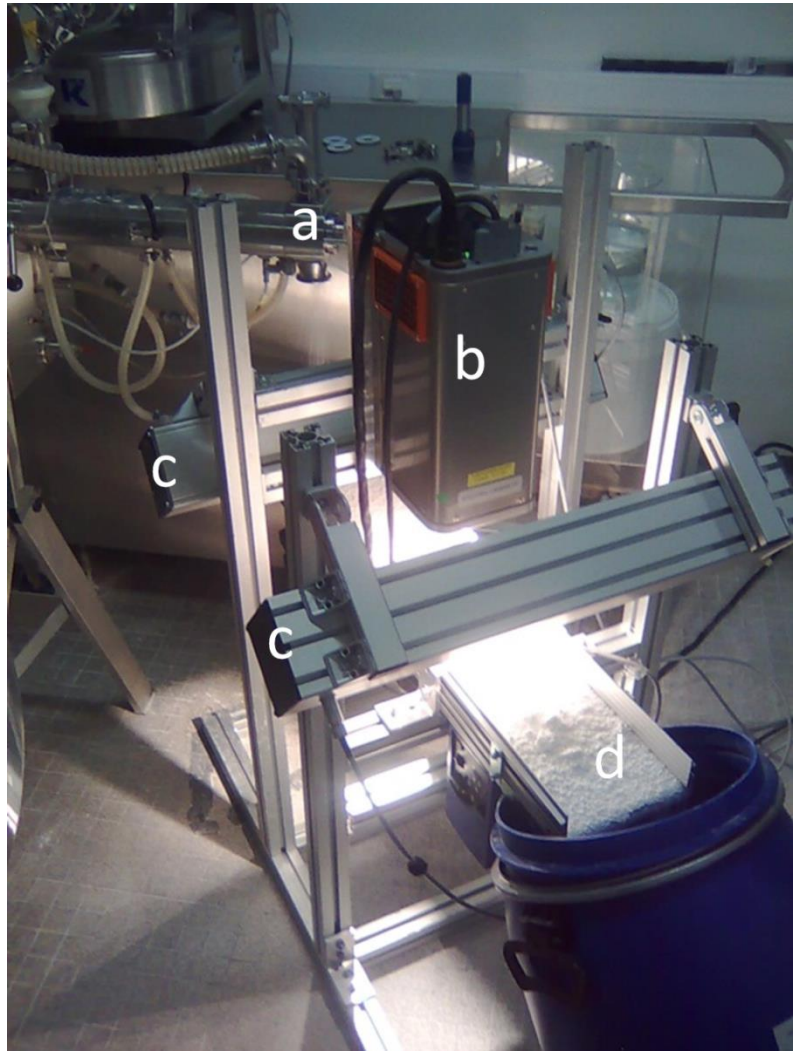
Factors:

- number of kneading elements (2, 6, 12)
- screw speed (500, 700, 900 rpm)
- powder feed rate (10, 17.5, 25 kg/h)
- stagger angle (30, 60, 90°)

Experimental Set-up :

a. CTSG
b. Chemical Imaging-camera
c. Uniform Light Source
d. Conveyor Belt



Lactose monohydrate granulated with distilled water (L/S = 10% (w/w)).

Theophylline anhydrate (API) as *tracer* (2% (w/w)).

Twin-Screw Granulation – API Map

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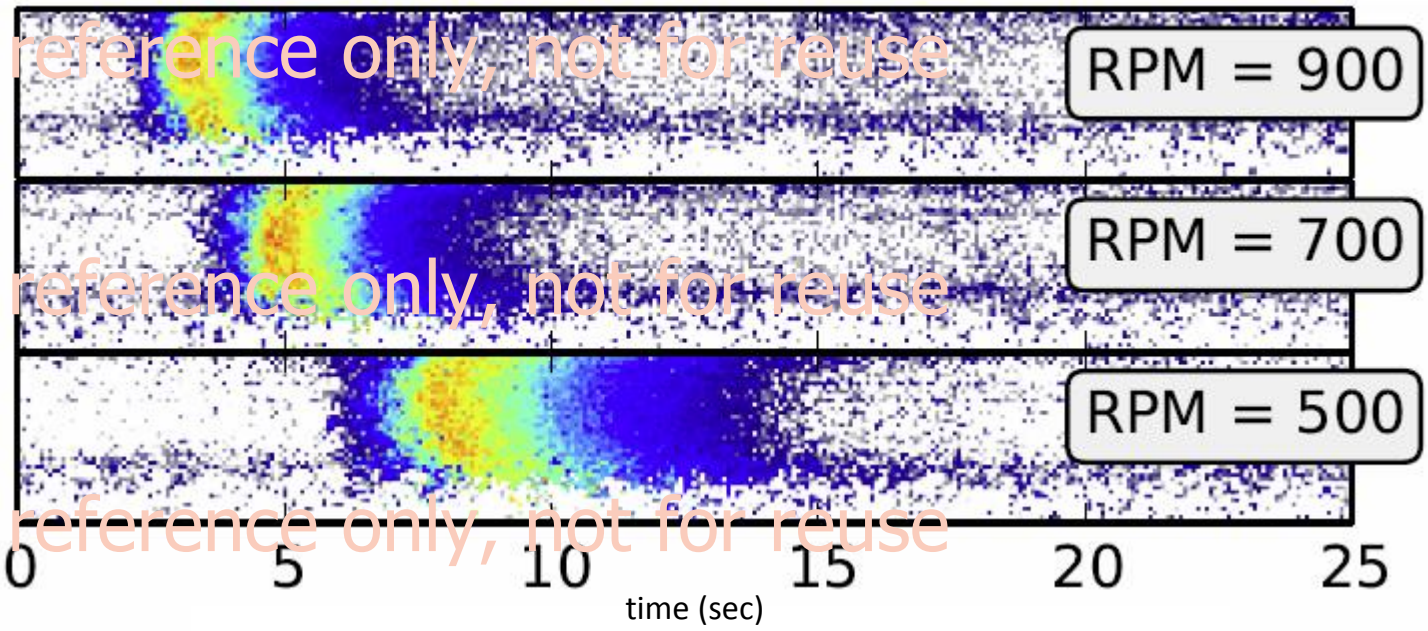
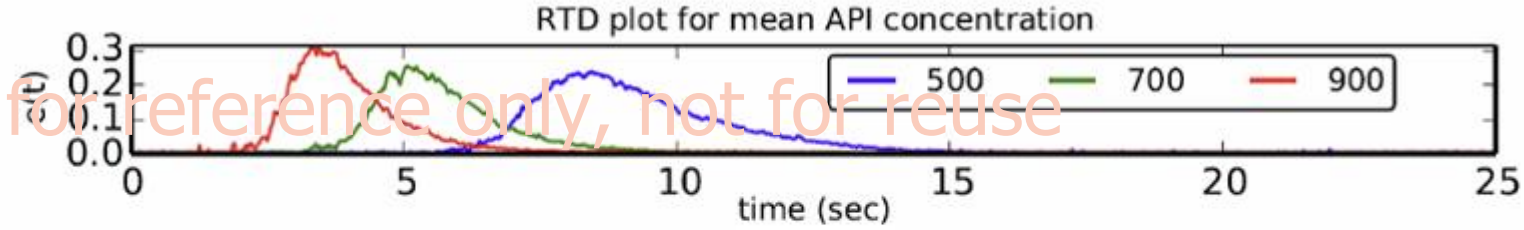
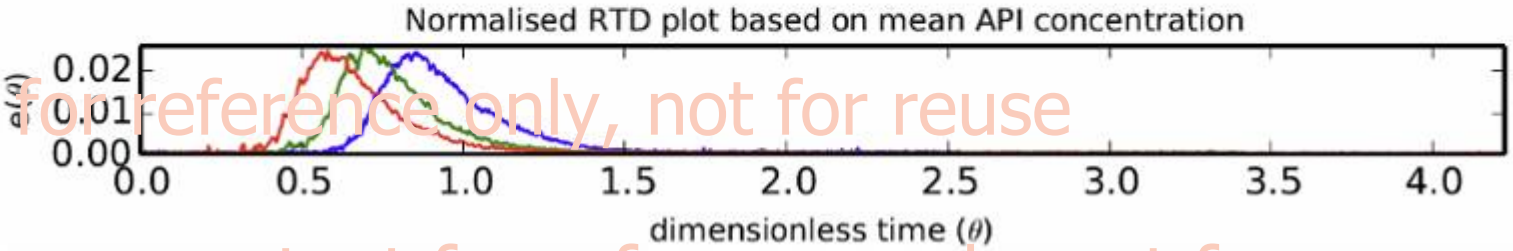
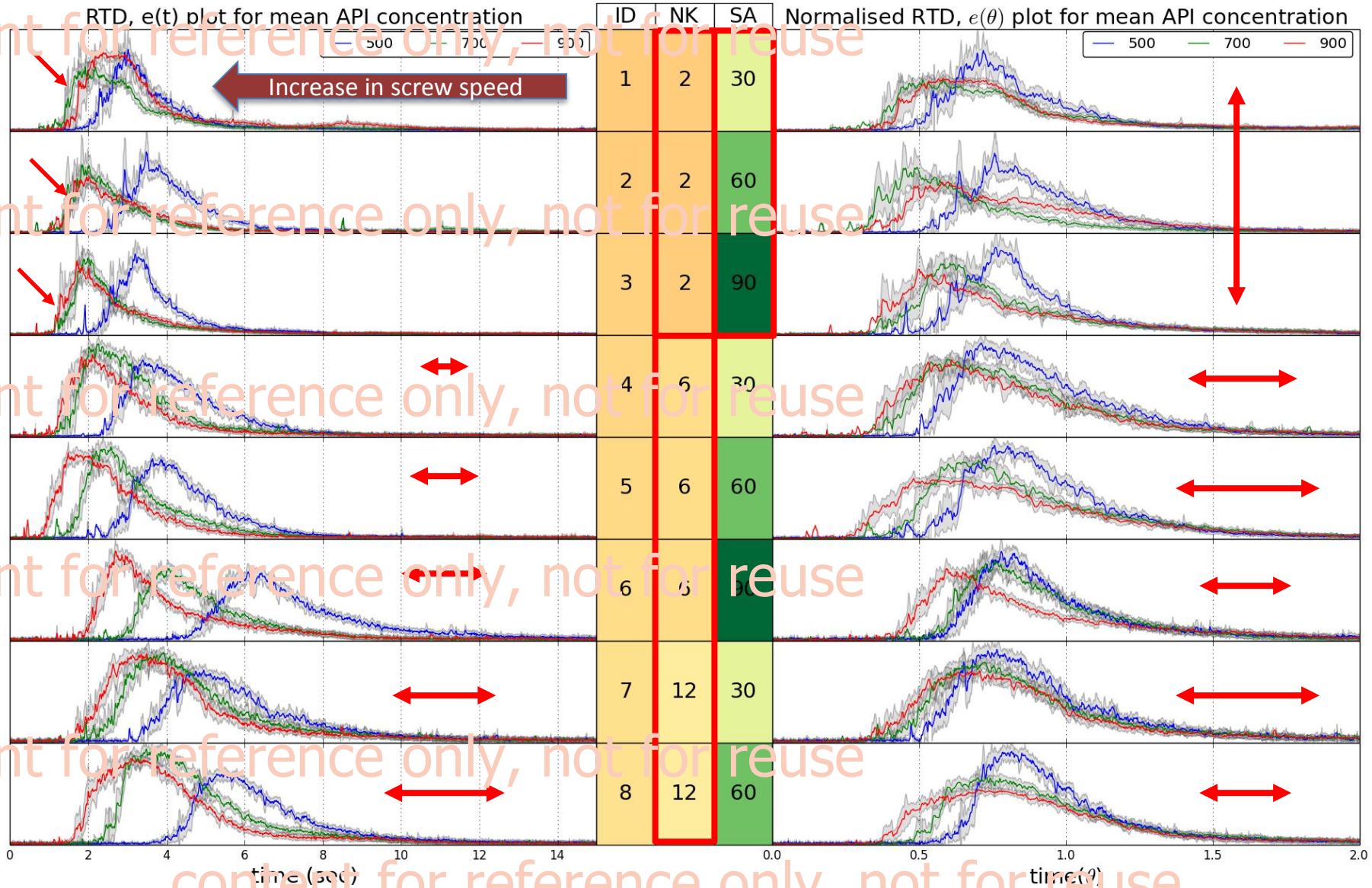






API map- Powder feed rate 10 kg/h



API map- Powder feed rate 25 kg/h

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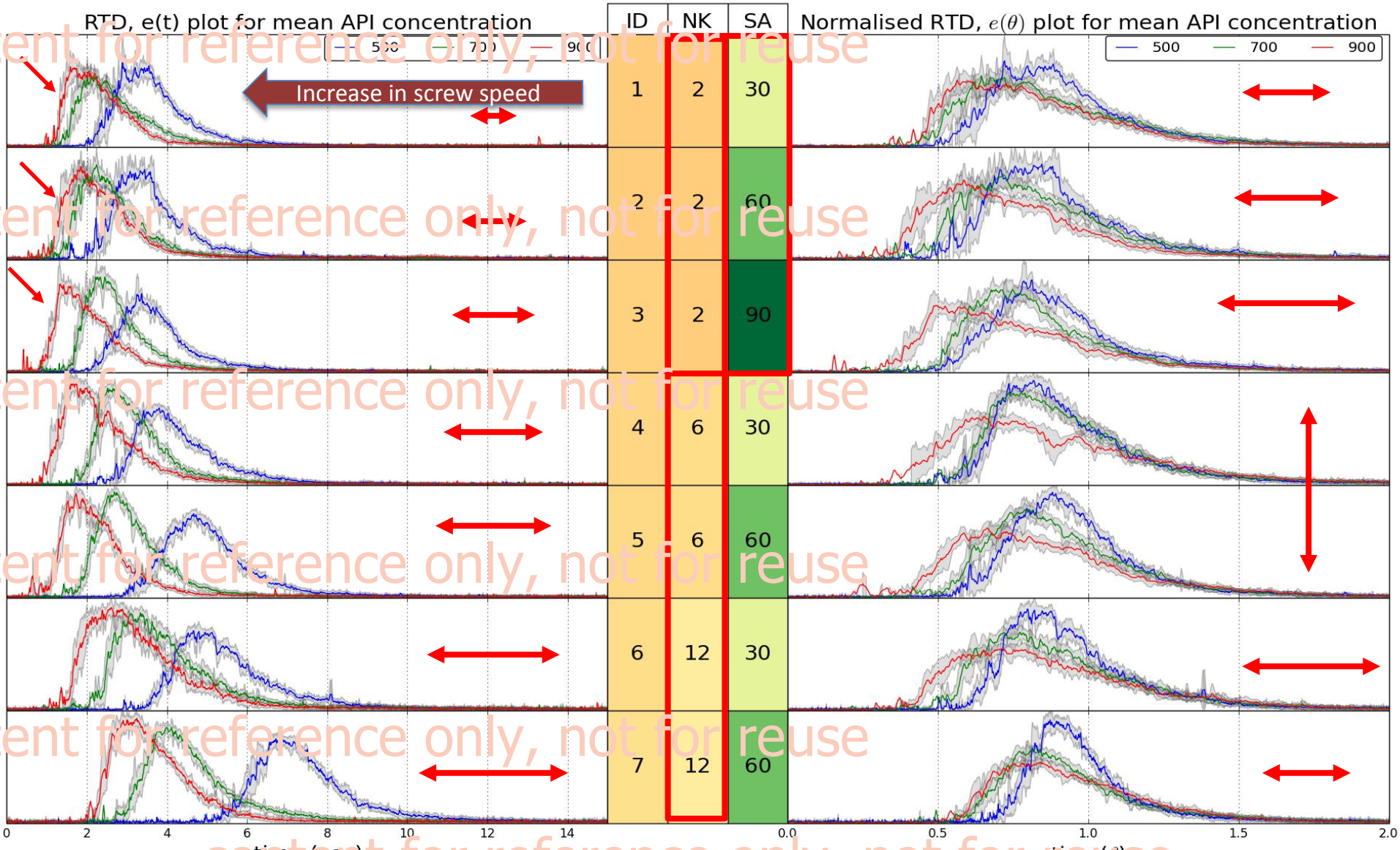

API map- quantitative assesment

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Mean residence time , τ

(a measure of the mean of the distribution)

$$\tau = \frac{\int_0^\infty t \cdot e(t)dt}{\int_0^\infty e(t)dt}$$

Variance, σ^2

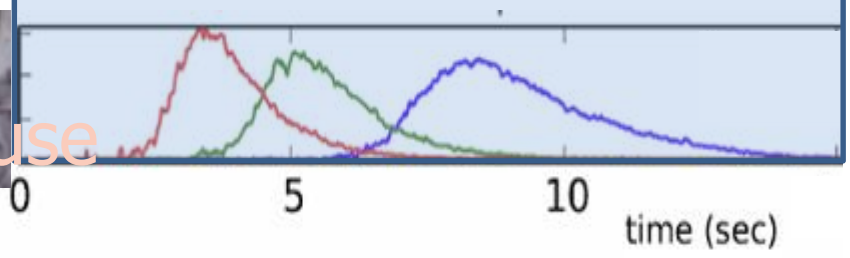
(width of the distribution)

$$\sigma^2 = \frac{\int_0^\infty (t-\tau)^2 \cdot e(t)dt}{\int_0^\infty e(t)dt}$$

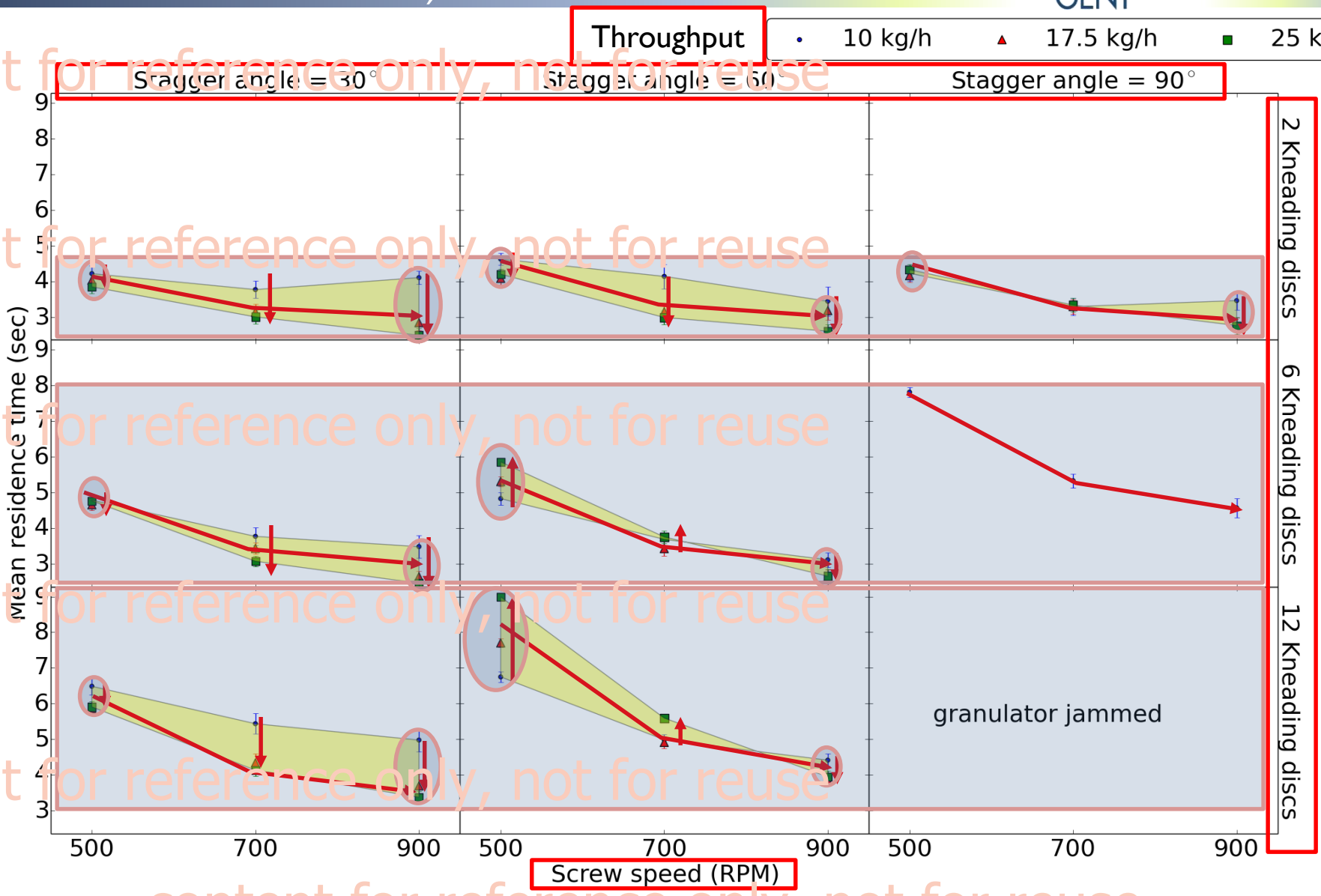
Péclet Number, Pe

$$\left(\frac{\text{Rate of axial transport by convection}}{\text{Rate of axial transport by dispersion}}\right)$$

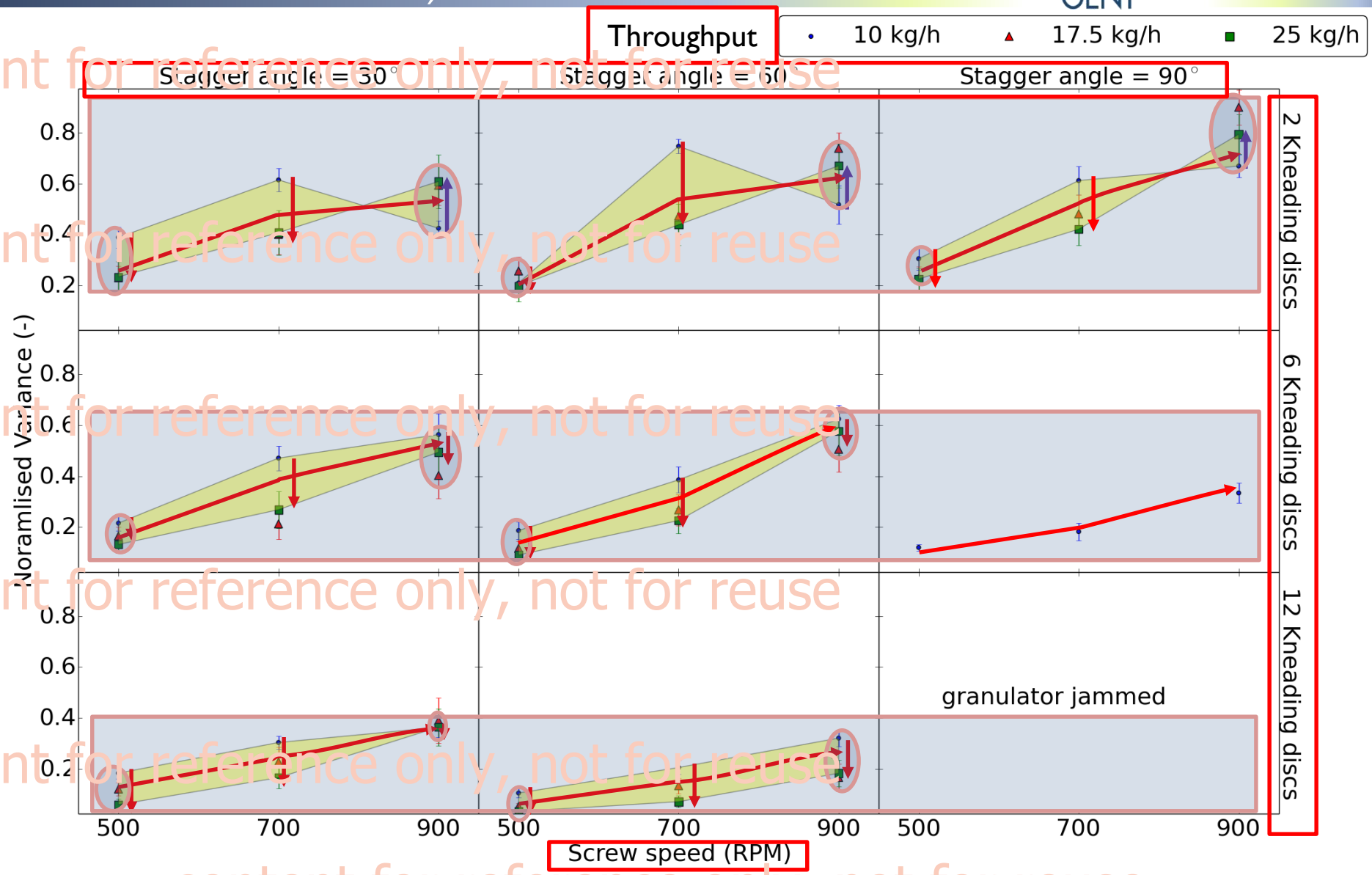
$$\text{Pe} = \frac{UL}{D}$$



Mean Residence Time
(the mean of the distribution)



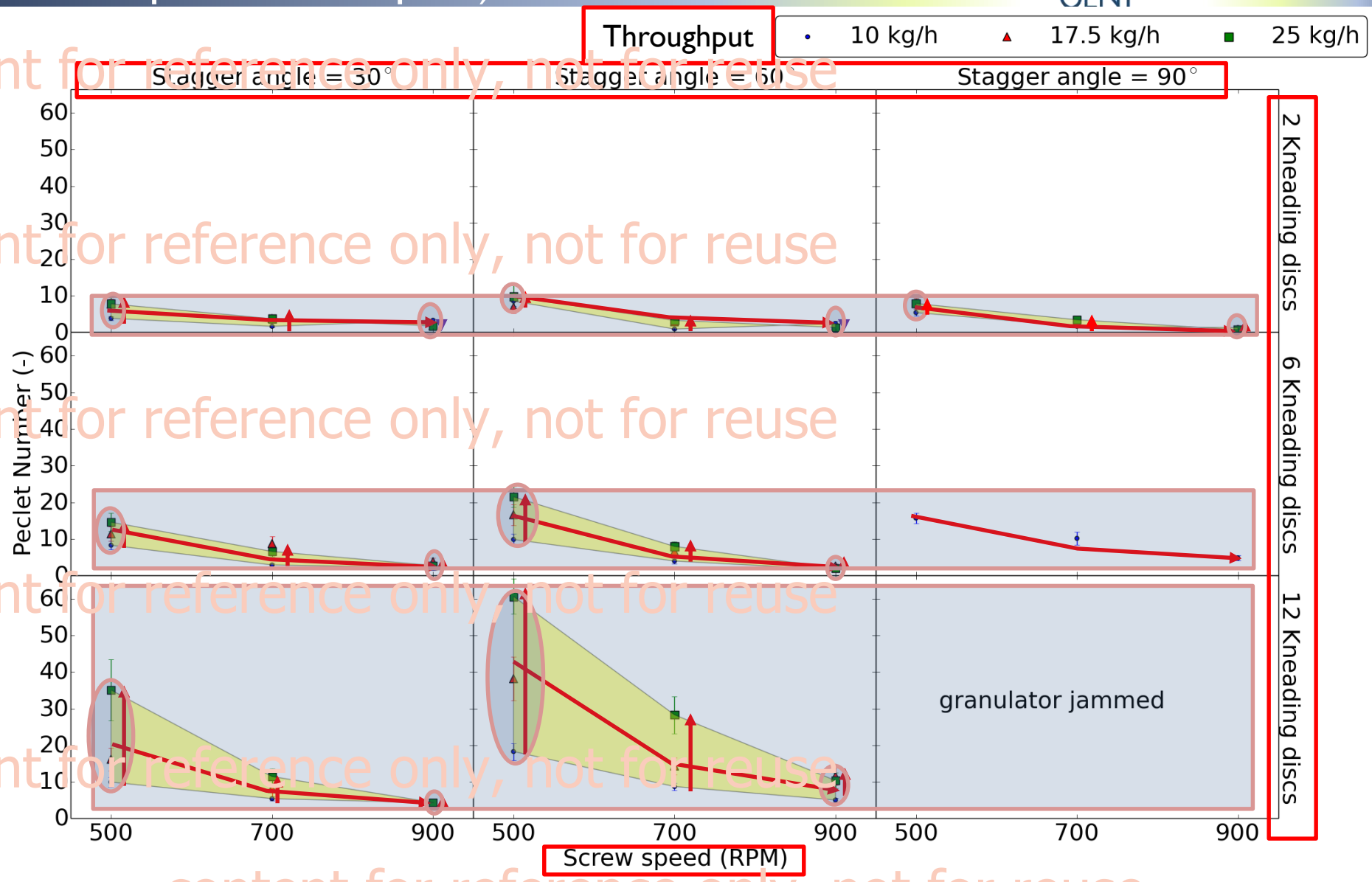
Normalised Variance
(the width of the distribution)



For well-mixed system, NV = , For poorly-mixed, NV = 0

Dispersion Model-Peclet Number

(convective/dispersive transport)



Conclusions

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- It is not (always) true that, *"the extent of axial mixing in the mixing zones of the granulator does not change for different configurations and process conditions (Lee et al. 2012)"*. In fact they have a direct influence on both RTD and the axial mixing in TSG.

- Together with a PSD study it can be confirmed which mixing regime is most desirable for granulation purposes.

- In further study we will investigate material properties influence on the RTD and mixing.

- The results obtained will be used in our future work on mechanistic modeling of the granulation process in TSG.

Aknowledgements

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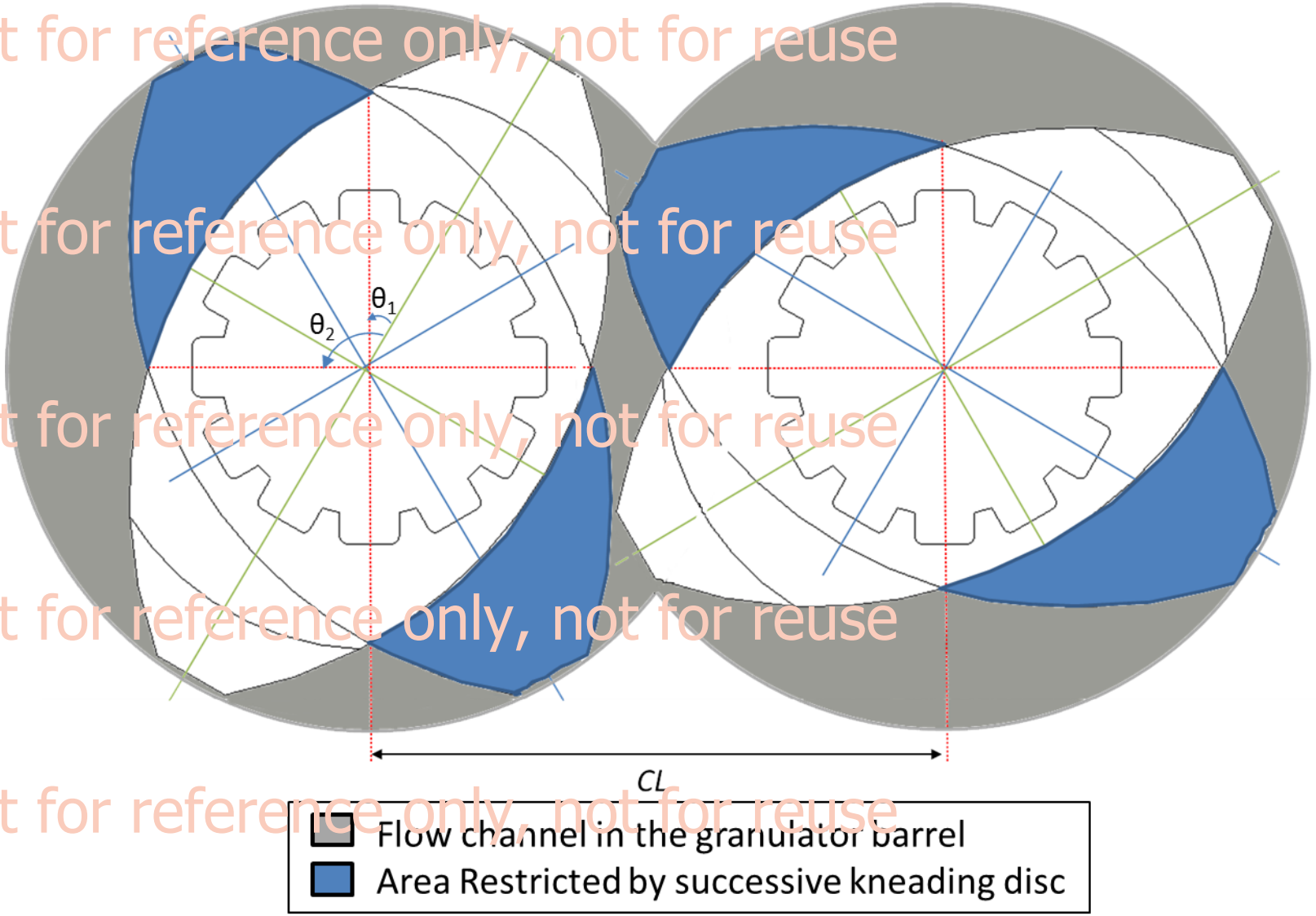
Q&A



API map- qualitative assesment

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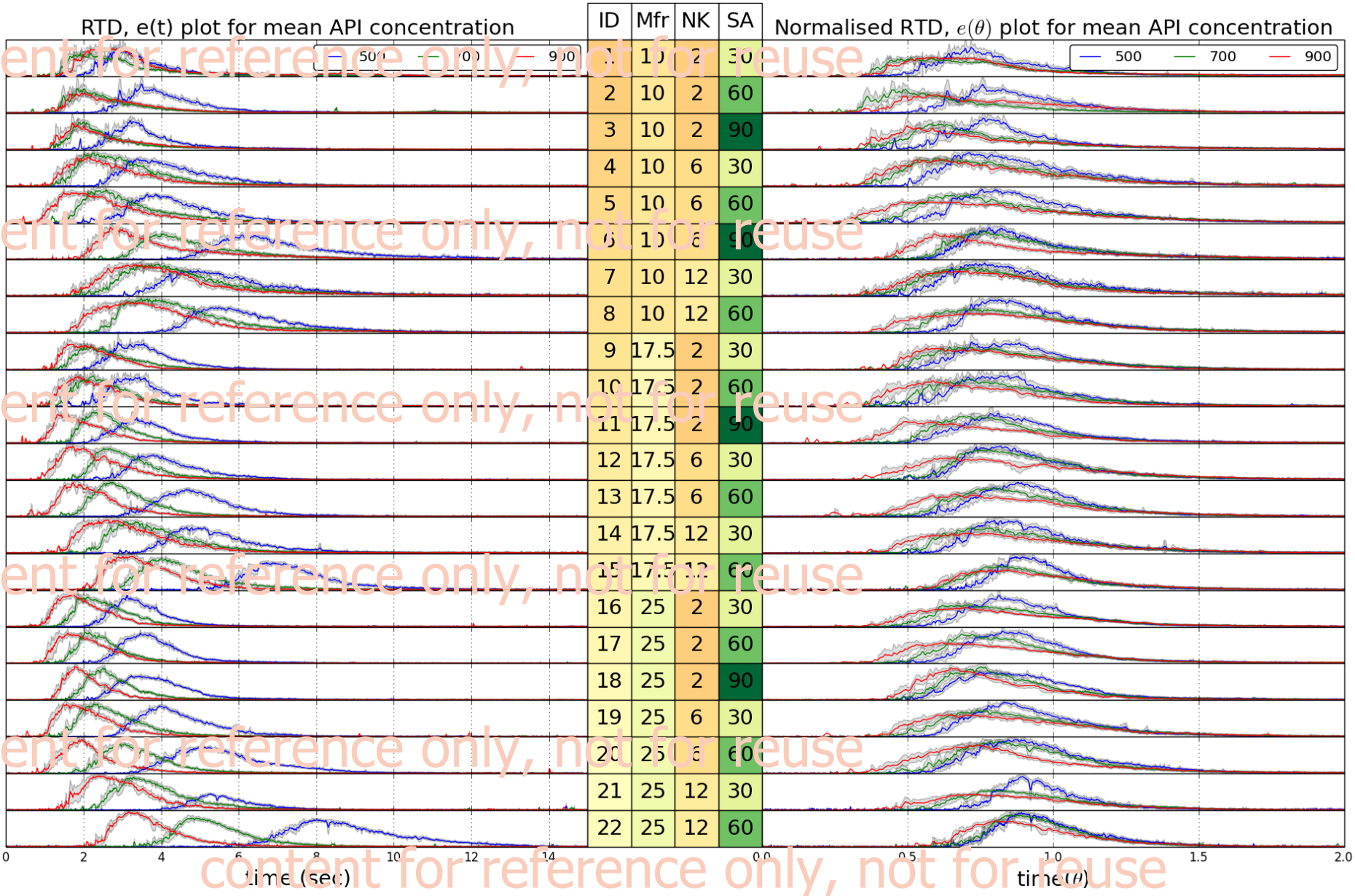

ID	Mfr	NK	SA
1	10	2	30
2	10	2	60
3	10	2	90
4	10	6	30
5	10	6	60
6	10	6	90
7	10	12	30
8	10	12	60
9	17.5	2	30
10	17.5	2	60
11	17.5	2	90
12	17.5	6	30
13	17.5	6	60
14	17.5	12	30
15	17.5	12	60
16	25	2	30
17	25	2	60
18	25	2	90
19	25	6	30
20	25	6	60
21	25	12	30
22	25	12	60

API map- Powder feed rate 17.5 kg/h

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