

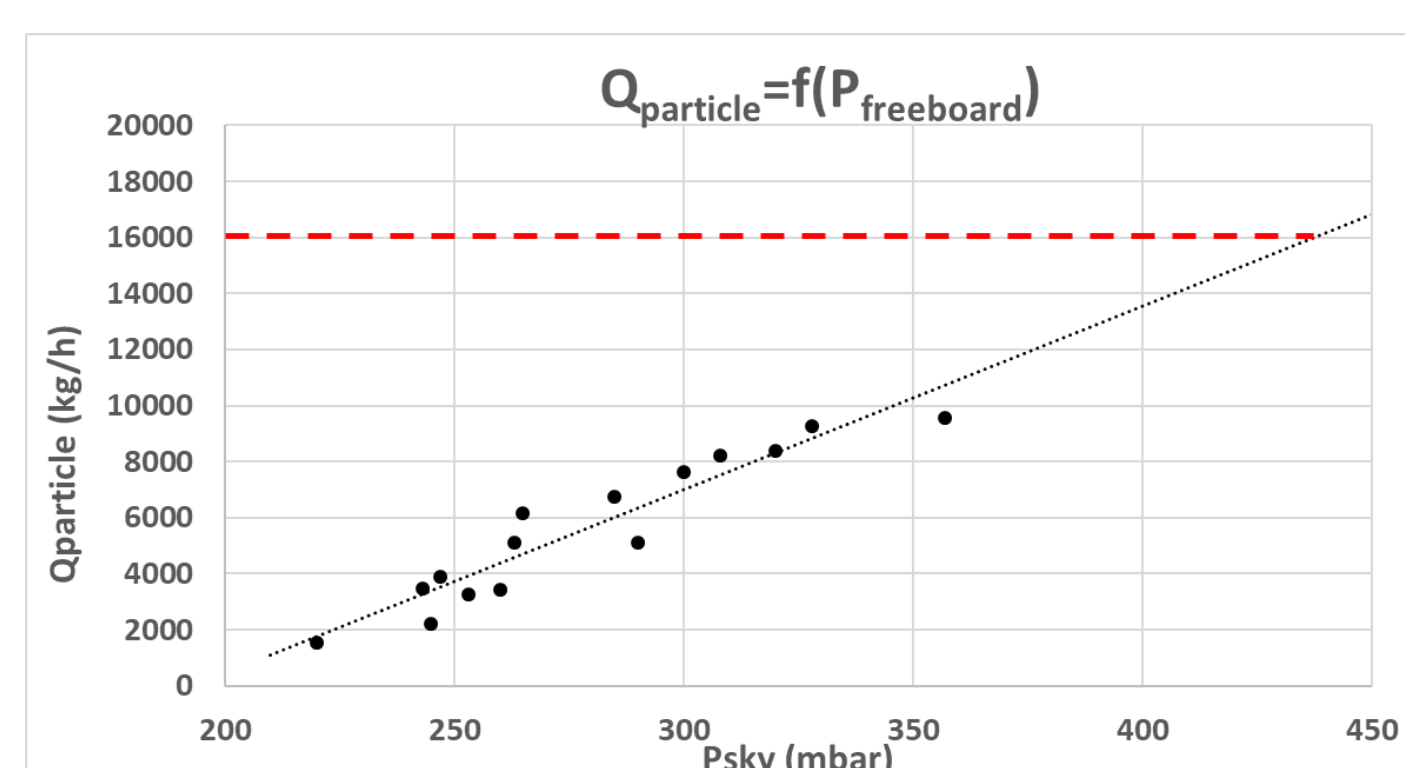
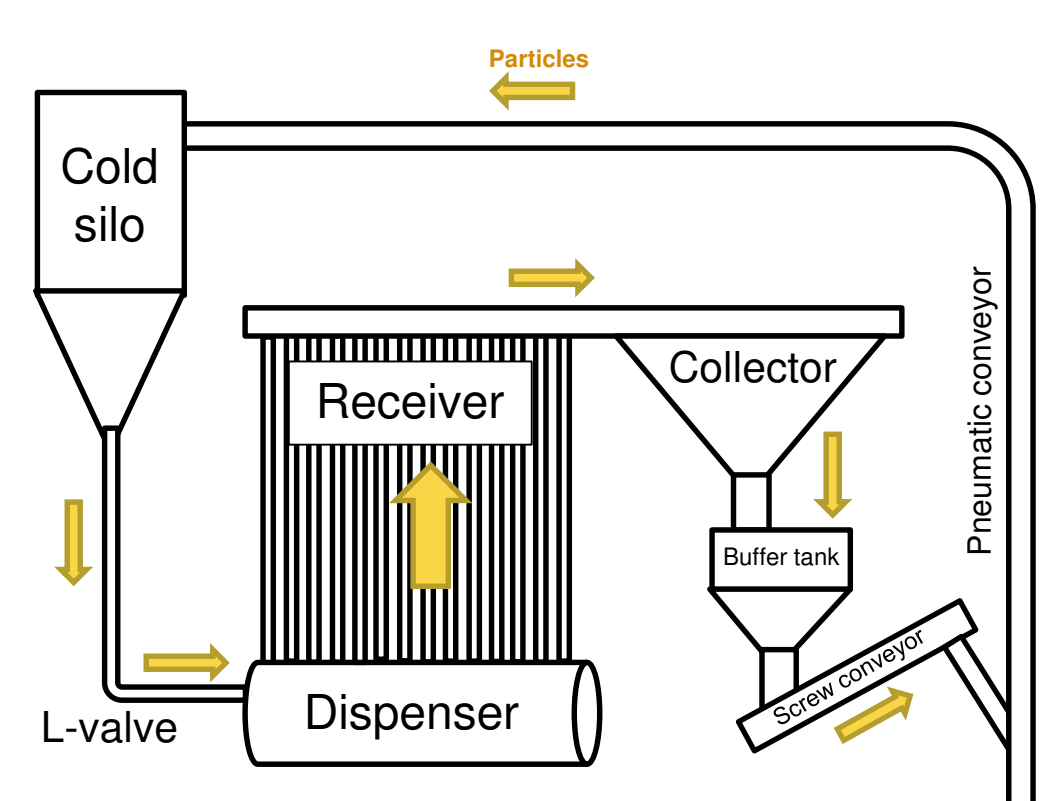
First experimental results with continuous particle circulation in the top particle-closed-loop at the Themis Solar Tower facility

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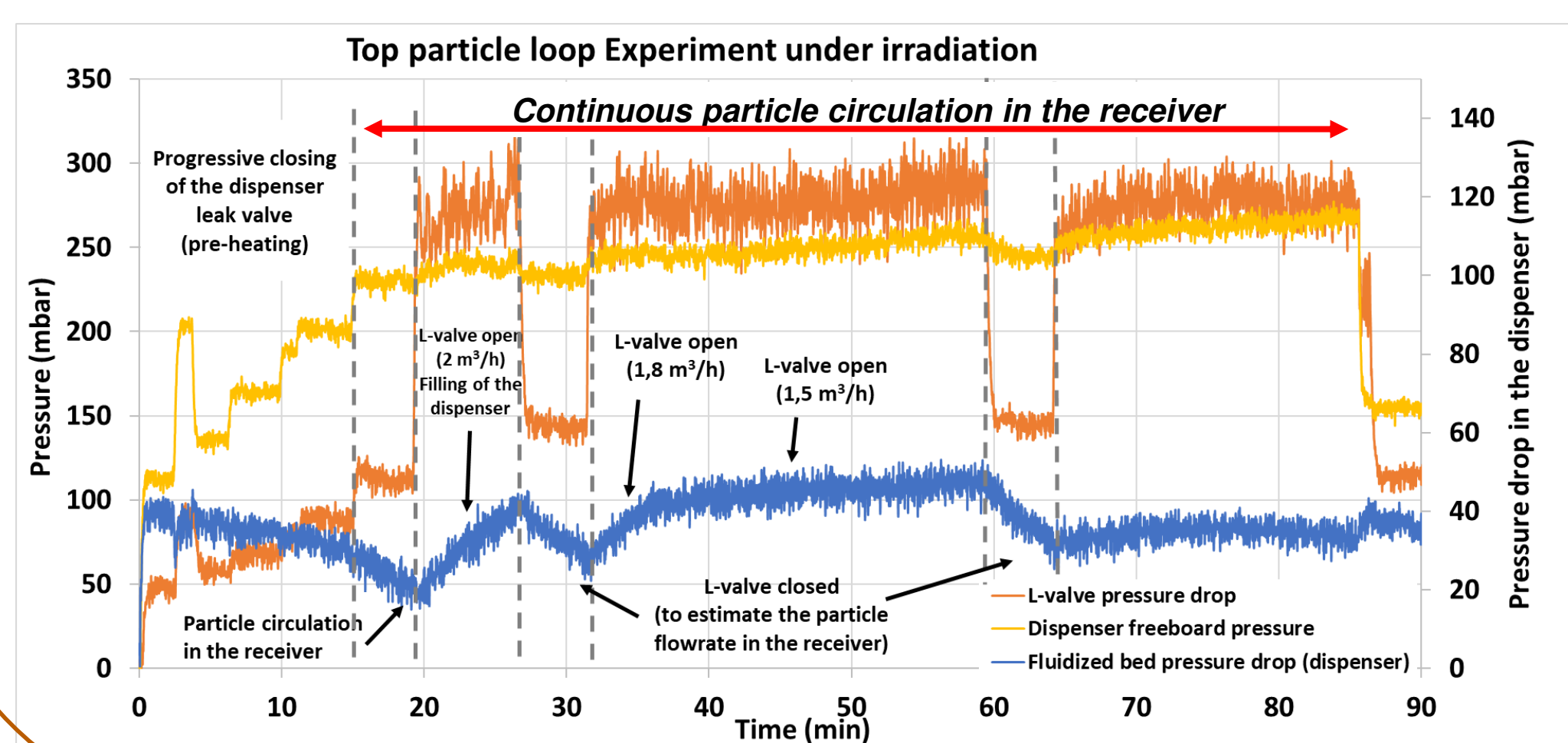
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Continuous particle circulation in the closed loop



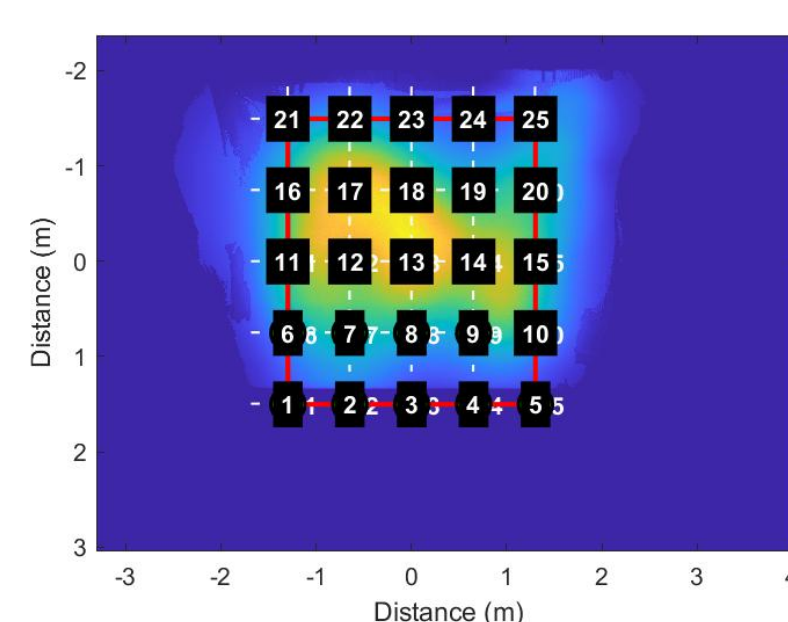
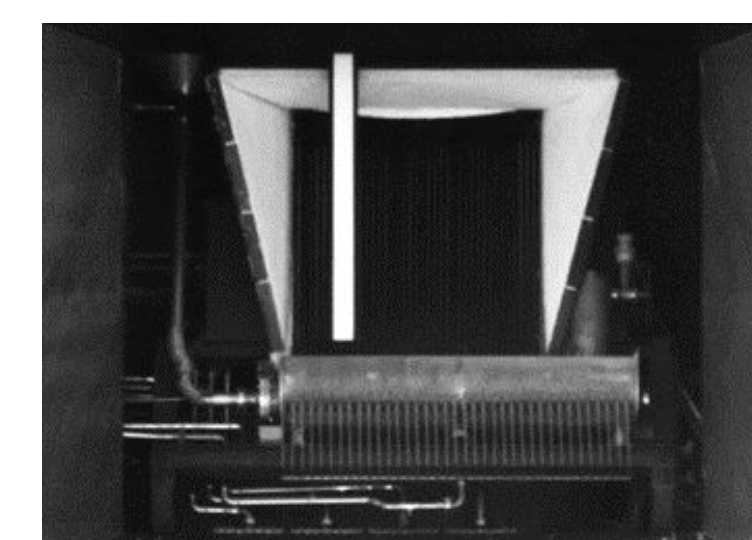
- Precise particle circulation control inside the receiver tubes
- L-valve used to fill the dispenser simultaneously
- Pneumatic conveying system to close the loop



Simultaneous flux measurement

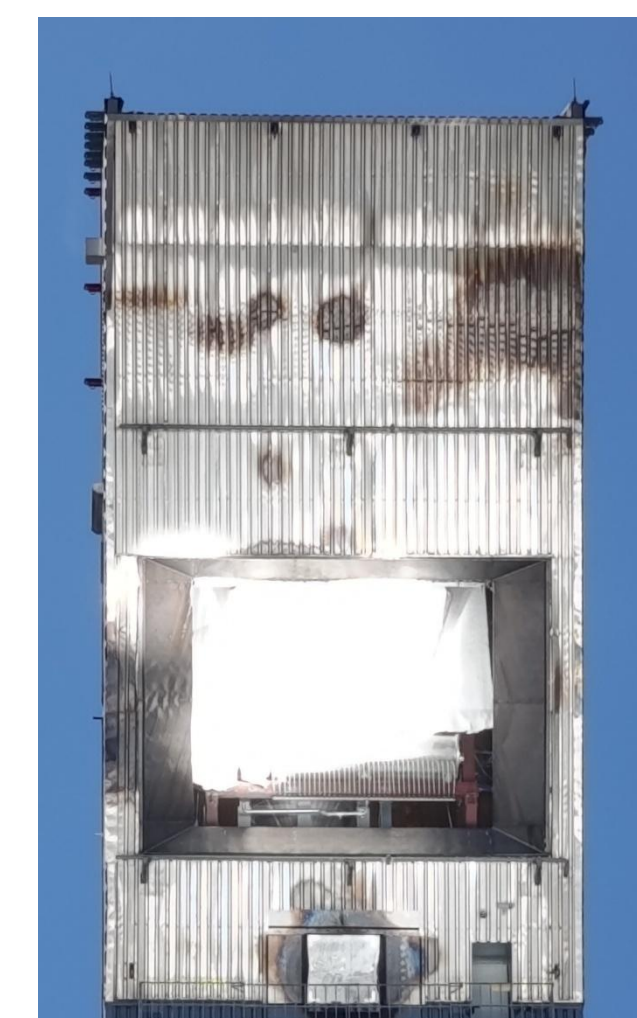
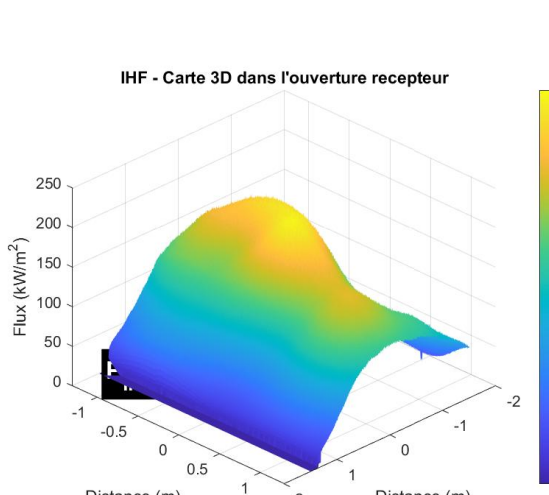
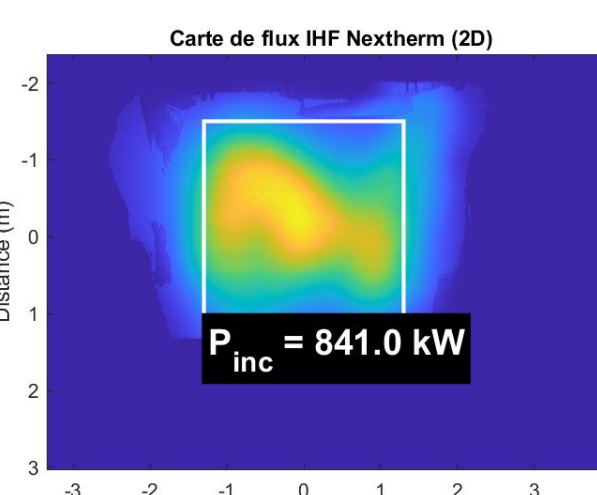
Non-stationary method :

- White coated moving bar
- Equipped with two calibrated sensors:
 - A heat-flux microsensor (HFM6-Vatell)
 - An inertia heat fluxmeter (IHF-Nextherm)
- A CCD camera
- Digital reconstruction



Target points used for the heliostats aiming strategy

$Q_{\text{solar}} = 840 \text{ kW}$ reached during an experiment



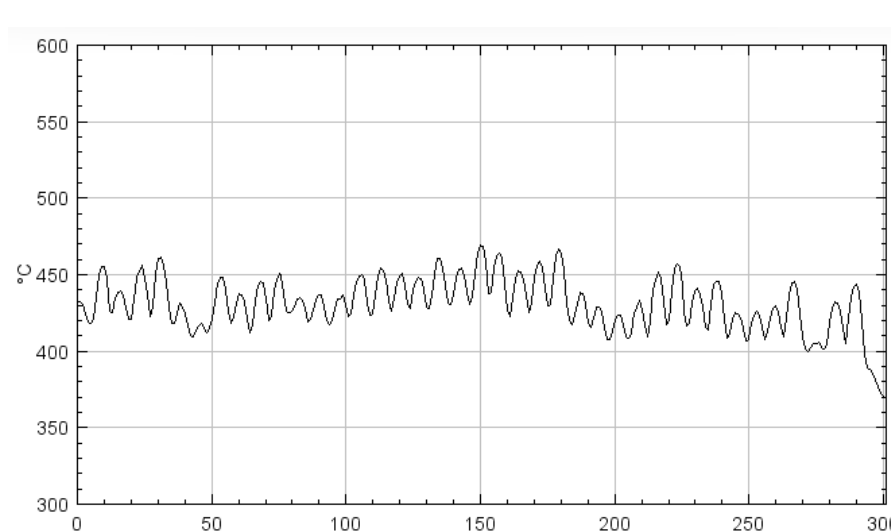
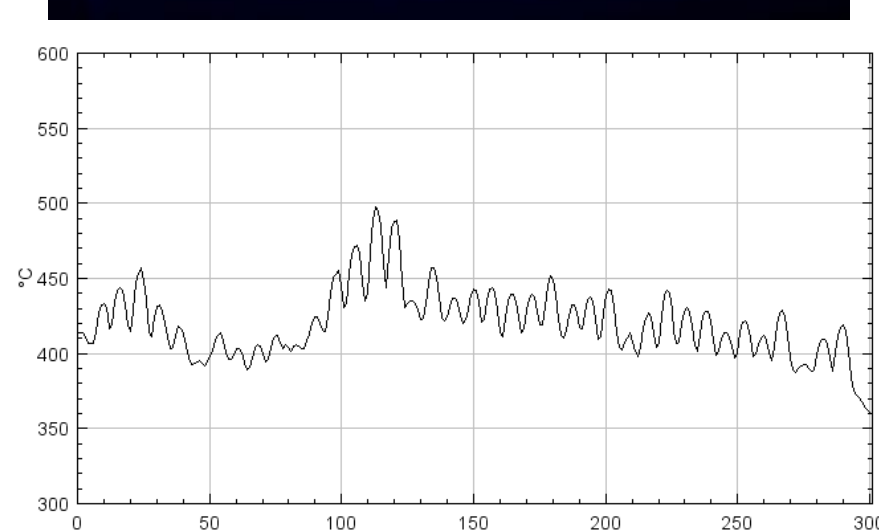
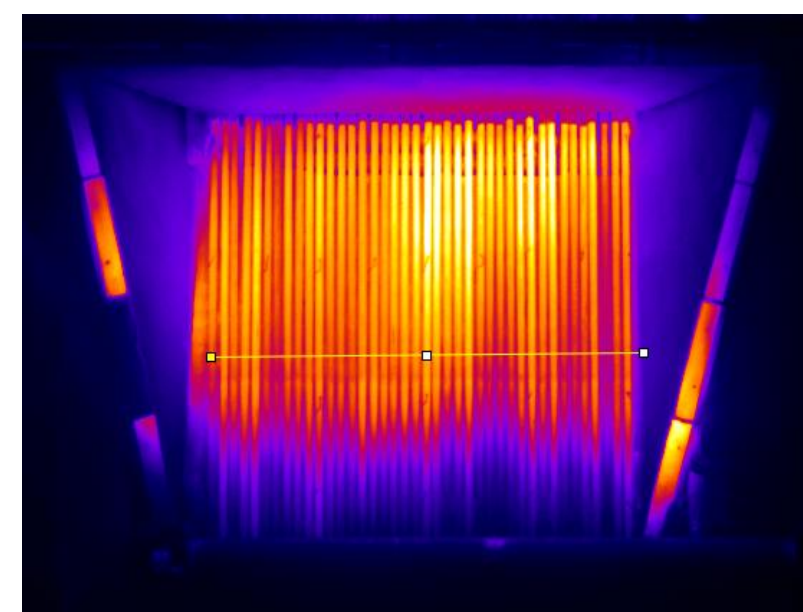
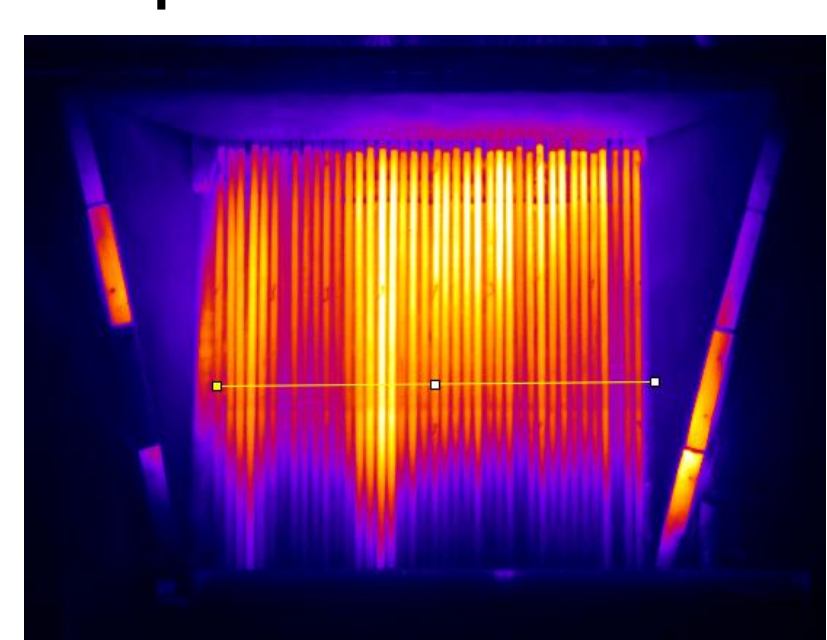
Receiver individual tube temperature control

Individual secondary aeration to control particle flowrate in each tube

- To stabilize fluidization regime along the tube height
- To avoid tube emptying due to thermal disequilibrium
- To homogenize receiver temperature even with inhomogeneous flux distribution

IR camera to control hot spots and to observe temperature discrepancies

- Noxant radiometric infrared camera
 - Very high resolution at 150m
 - Direct observation during experiments
 - Hot spot detection



Pneumatic conveying system

Semi-dense pneumatic conveying system ($m_{\text{solid}}/m_{\text{air}} = 15$)

Particle feeding in the system via an endless-screw conveyor

Stairmand-type cyclone at the outlet to separate particles and air

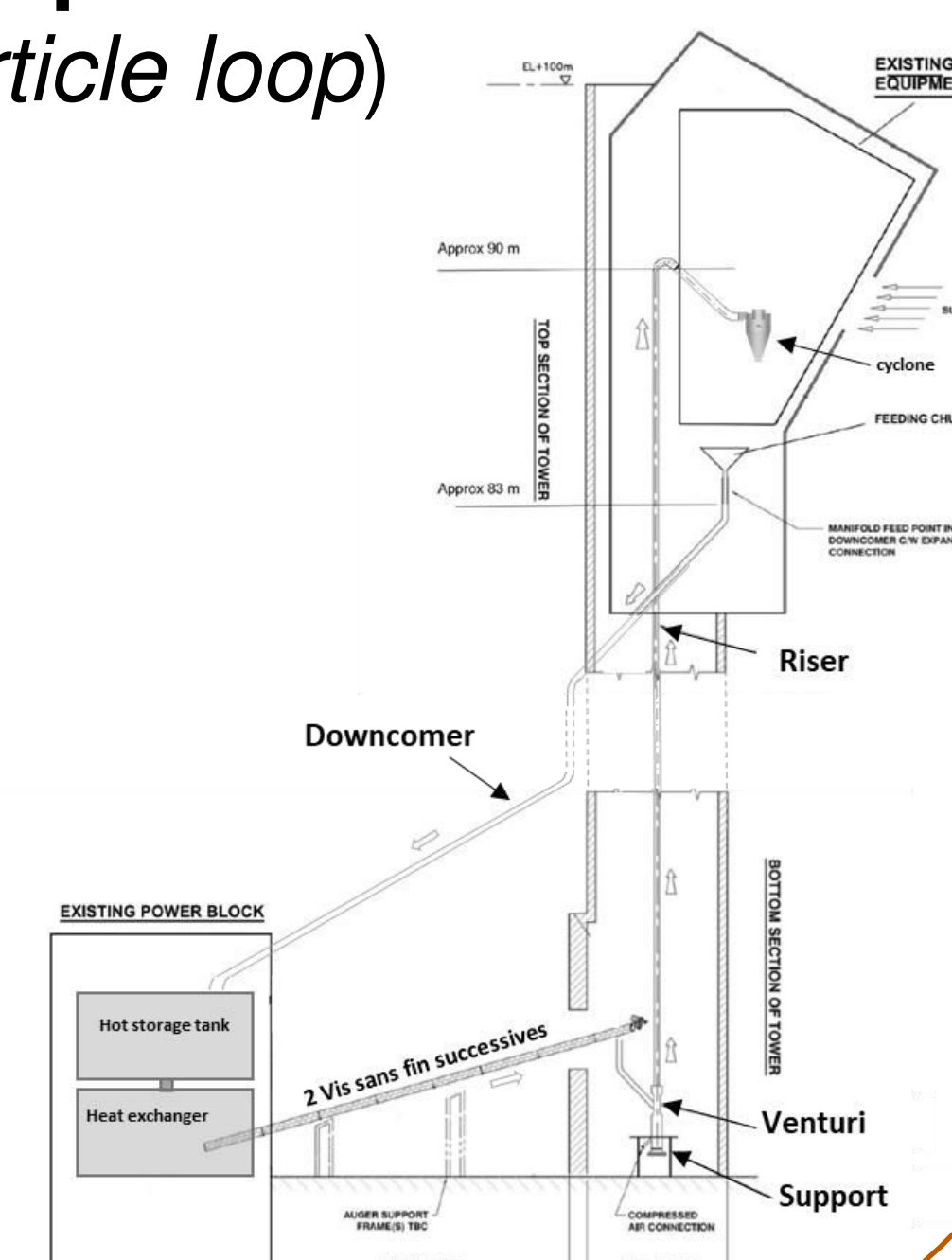
Designed to work at 50°C and 300°C.

Chocking velocity < Particle velocity < Erosion limit velocity
6.8 m/s < Particle velocity < 15 m/s

Successful tests at small scale, concept validated
(12 meters-high to close the top particle loop)

Next step: upscaling

- Height = 90 meters
- Particle flowrate to convey = 16 t/h
- Particle temperature = 300°C
- $\Delta P = 241 \text{ mbar}$
- Power = 6.2 kW (60-70% compared to a mechanical conveying system)



ACKNOWLEDGEMENTS

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