AIR REVERSING R744 AIR CONDITIONING SYSTEM

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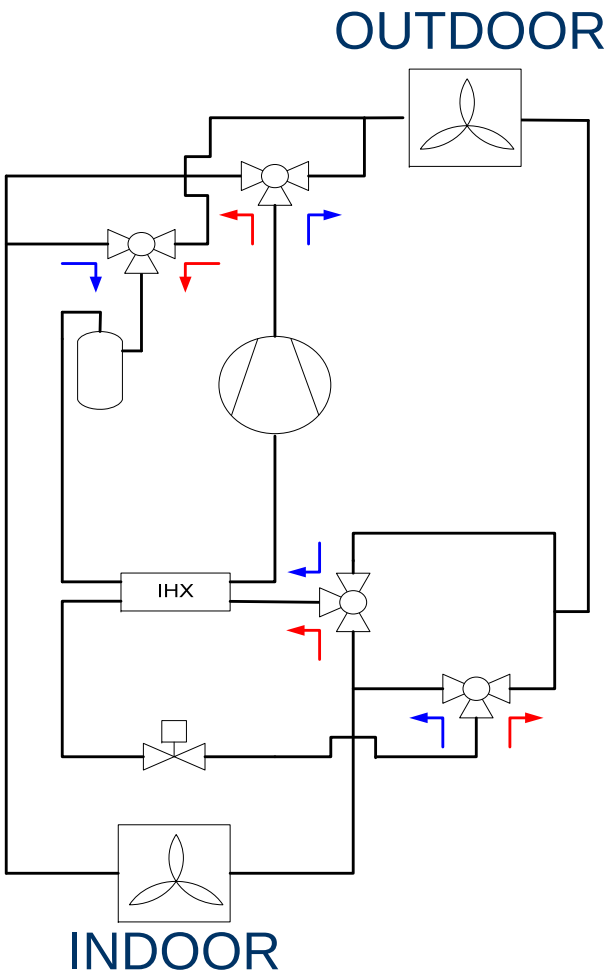
Reversible R744 systems

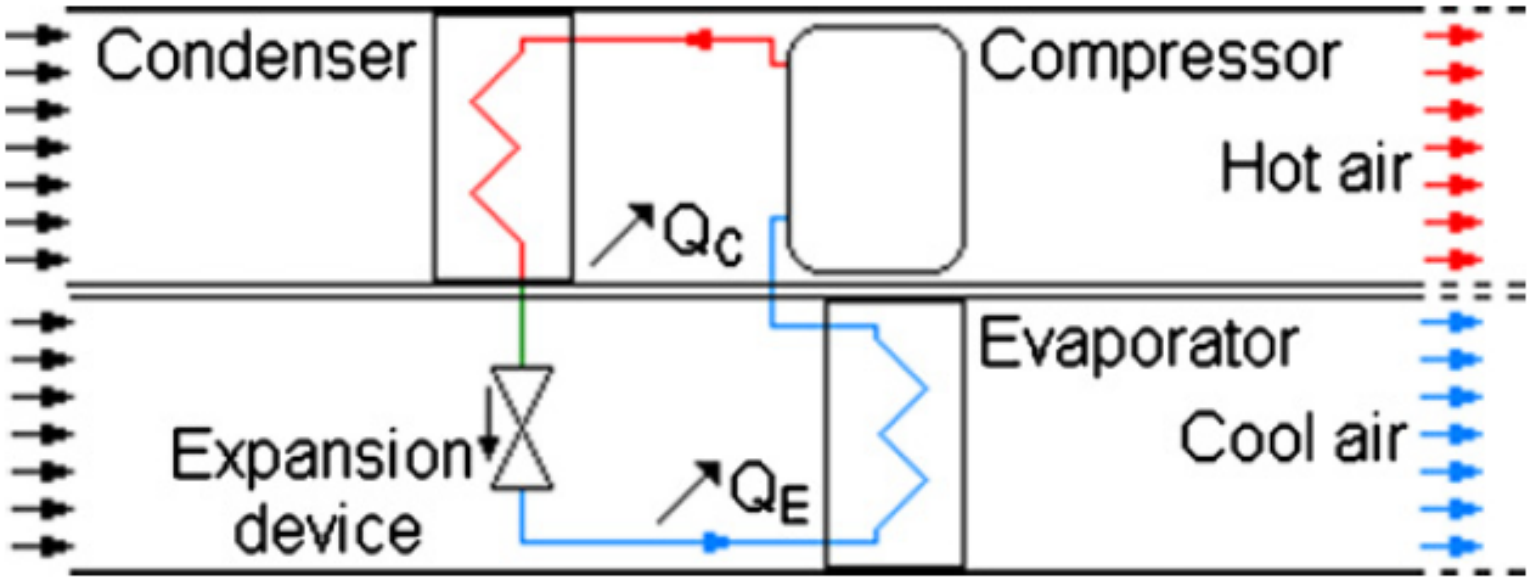


- Refrigerant reversing unit
  - Several valves required
  - Additional cost
  - Heat exchanger mode changes

Alternative:
Reverse Air flow!

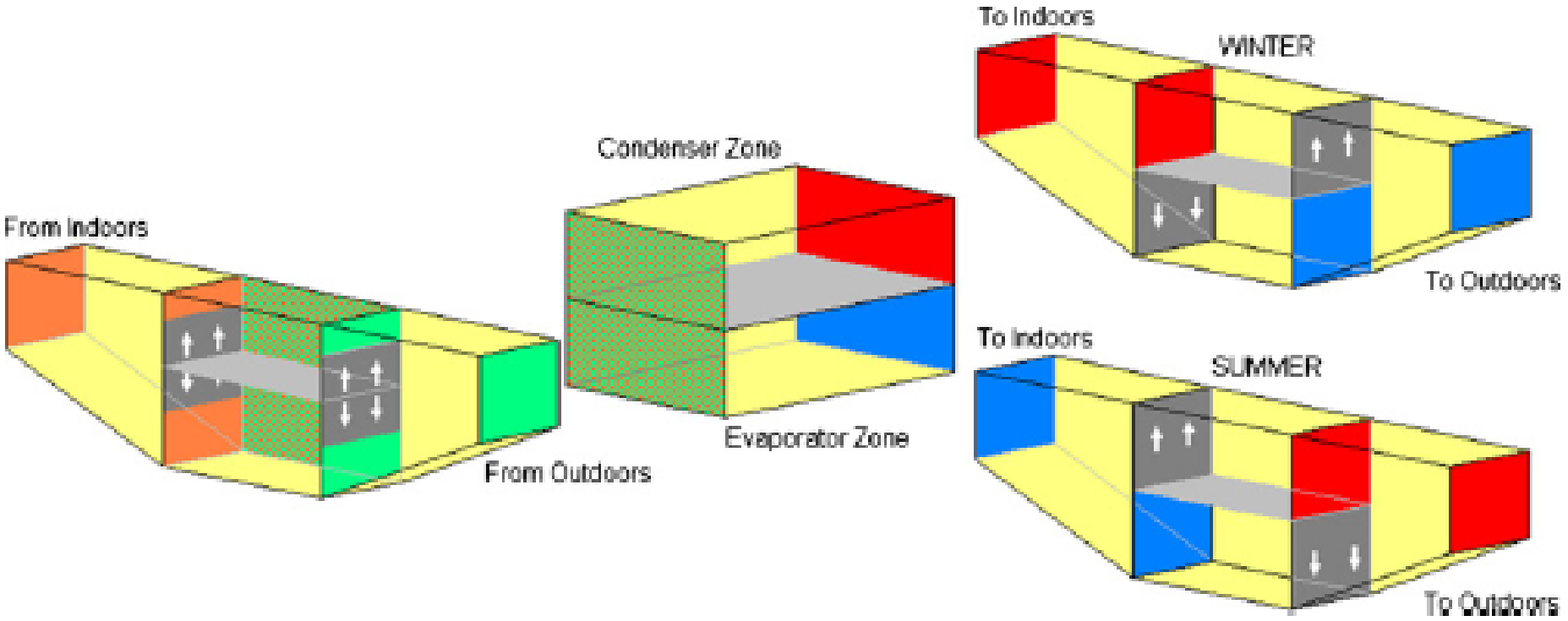
Reversible systems

- CANTABRIA = Concept of University of Cantabria
- Reversing the air flow



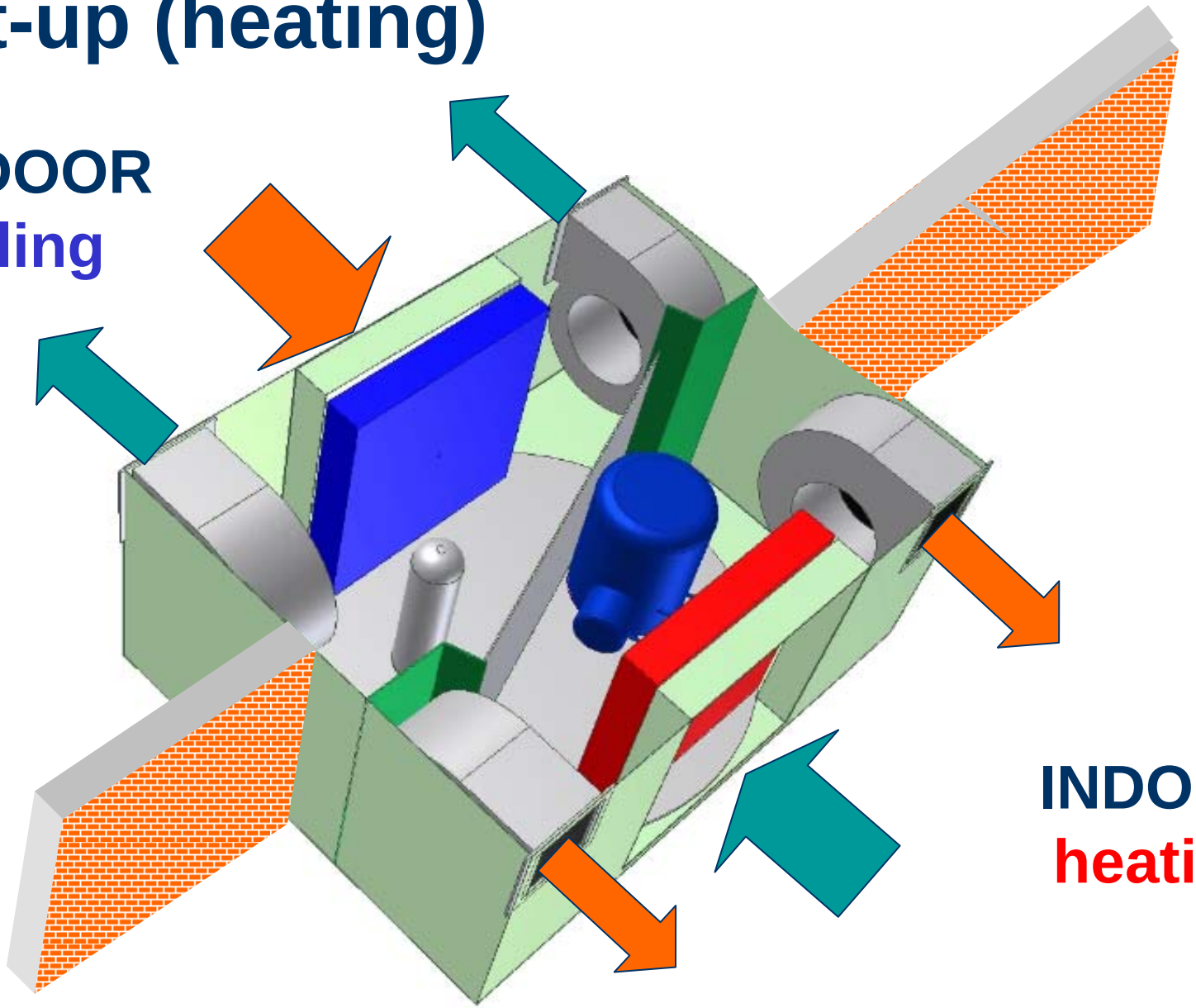
Reversible systems

- Controlling the air flow with flaps



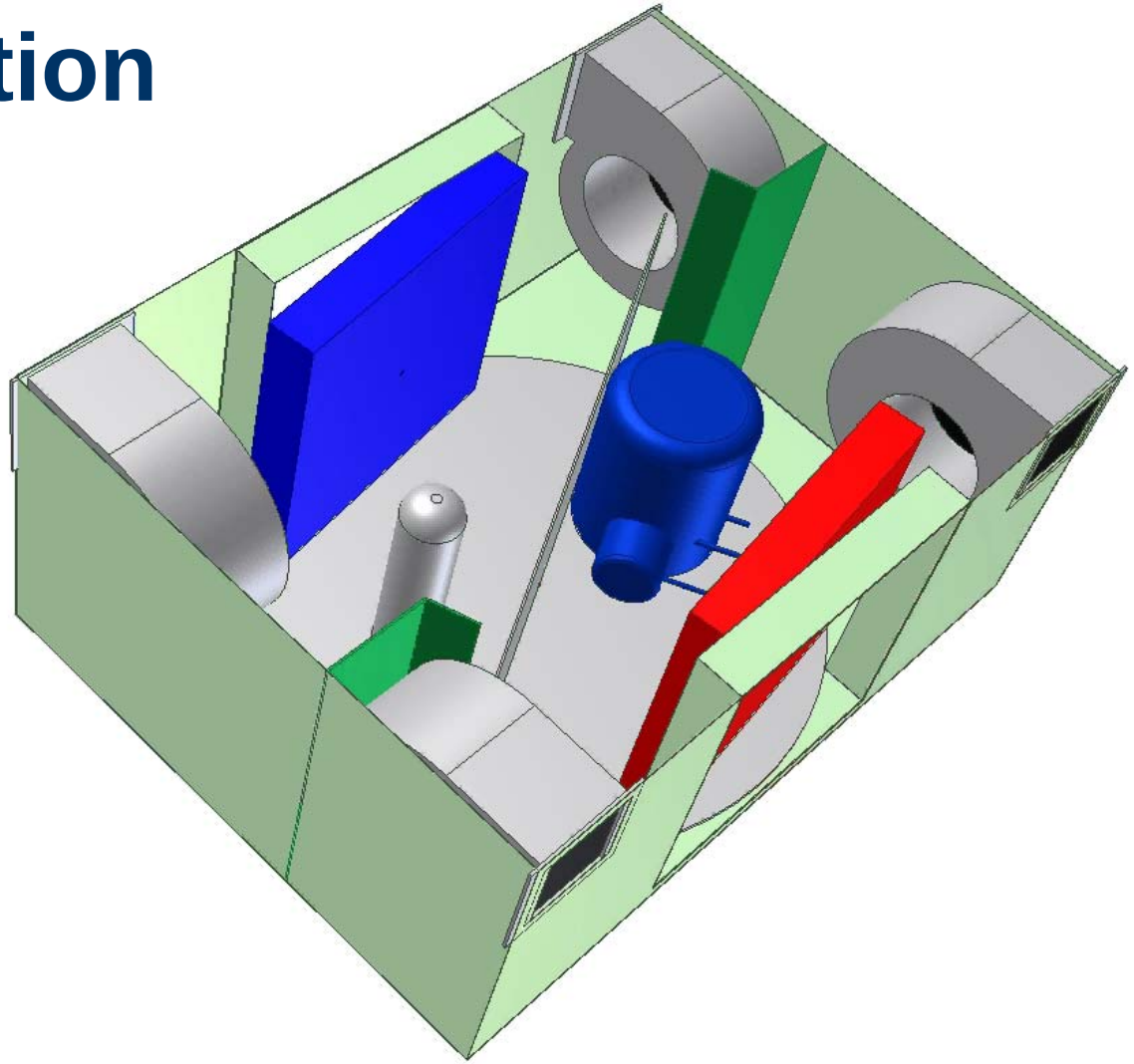
Set-up (heating)

OUTDOOR
cooling



INDOOR
heating

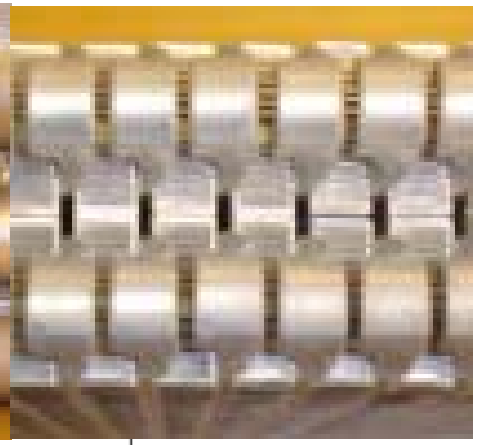
Animation



Components

Top view

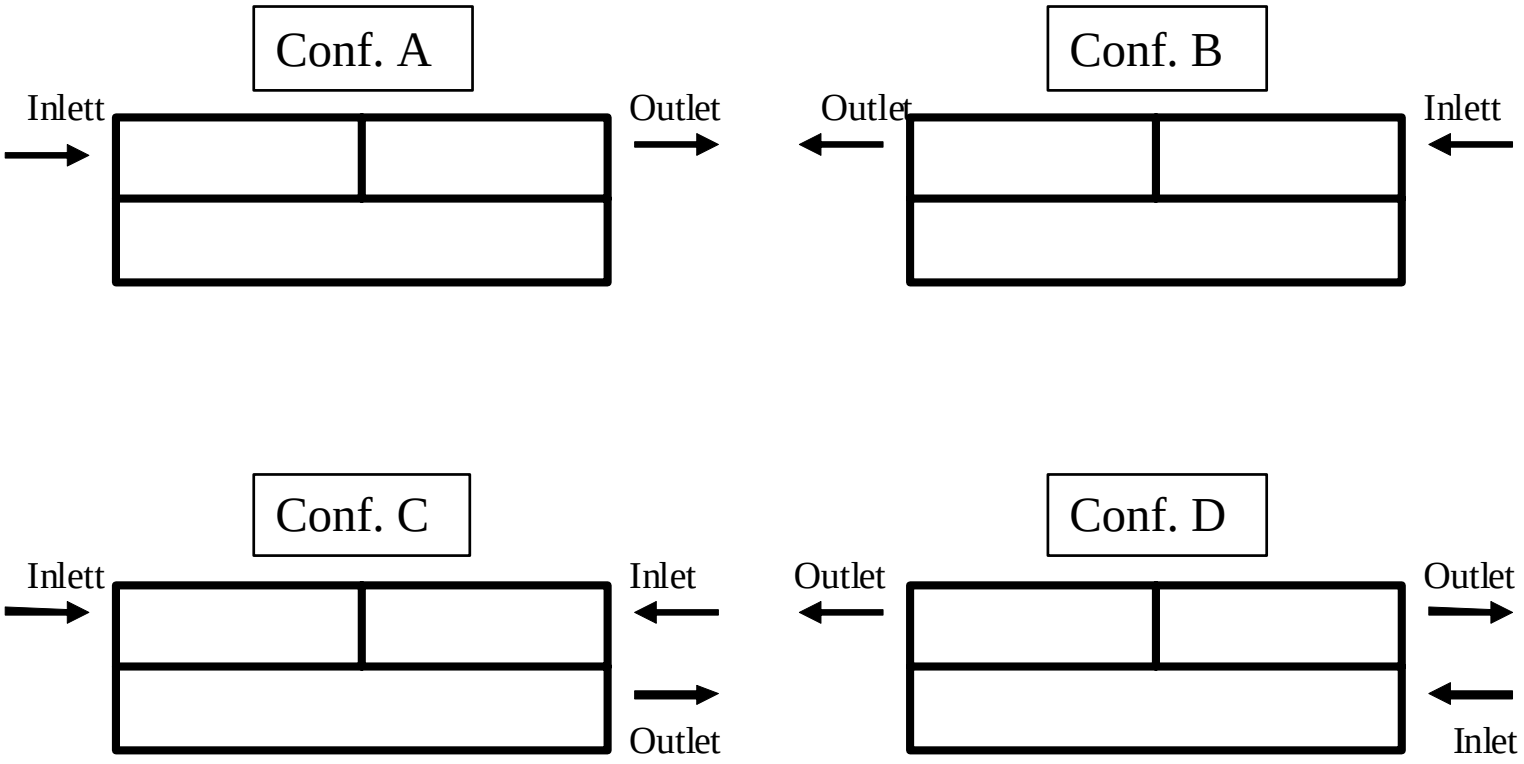
bottom view



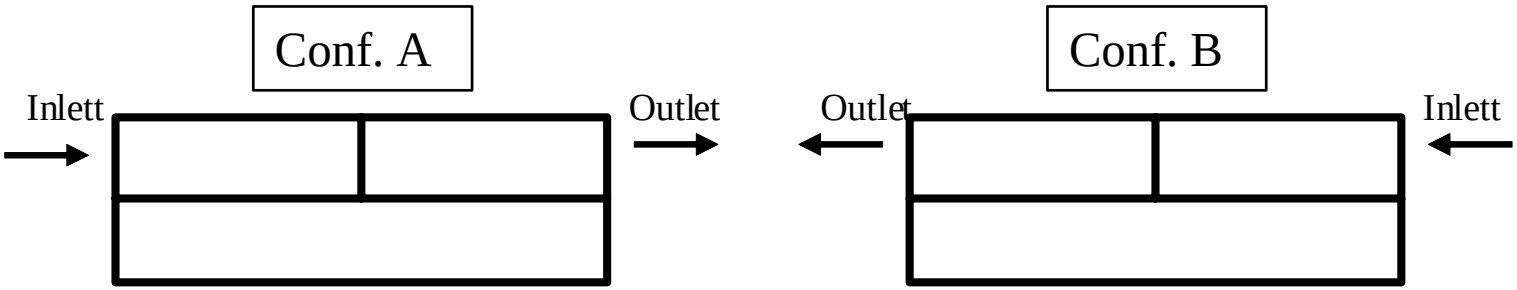
bottom view

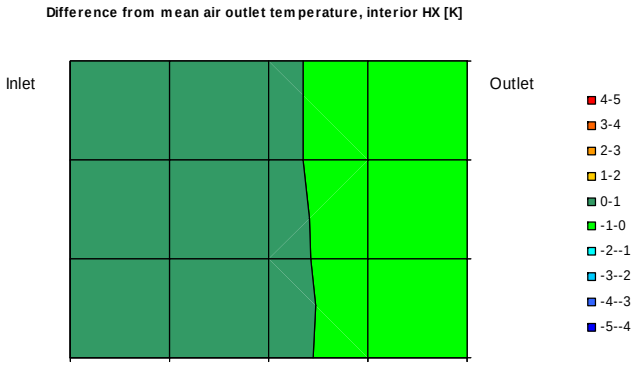
Evaporator configurations

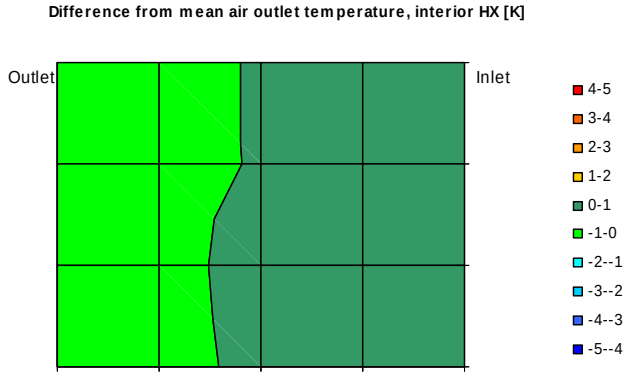
- Top view



Temperature distribution
Air side - downstream of the evap.





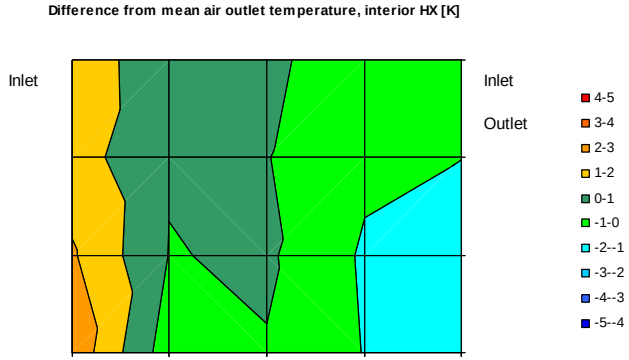


Config: A; 1.3 kg/min

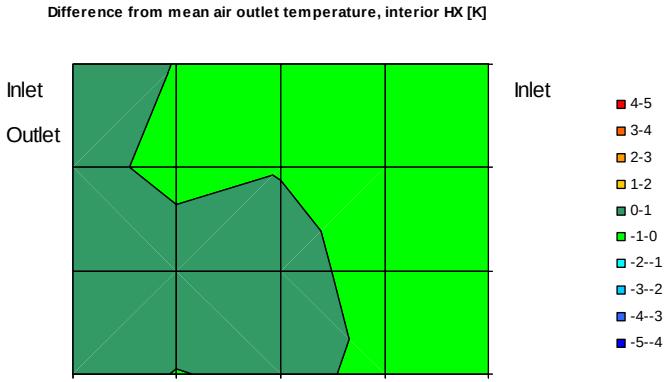
Config: B; 1.3 kg/min

Max capacity for ECU

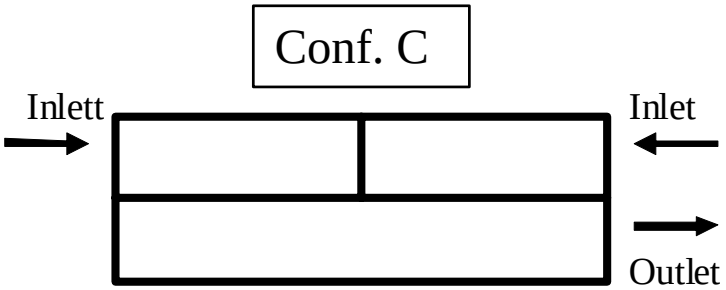
Temperature distribution
Air side - downstream of the evap.

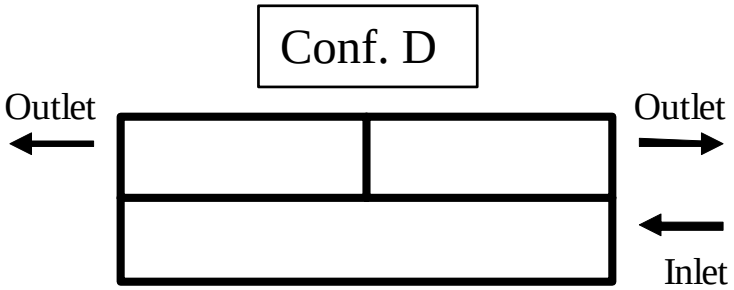


Config: C; 3 kg/min



Config: D; 3 kg/min

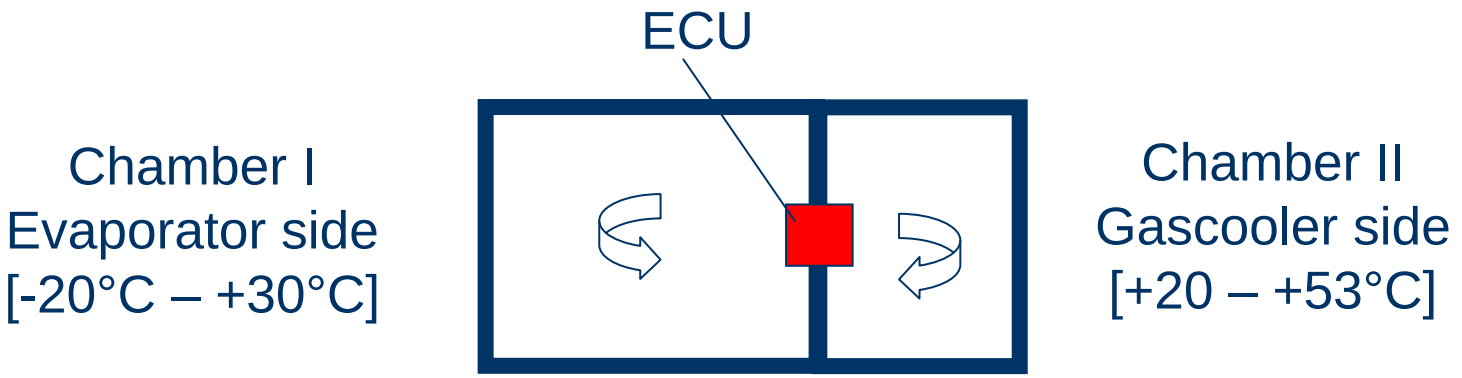




If applied in other applications

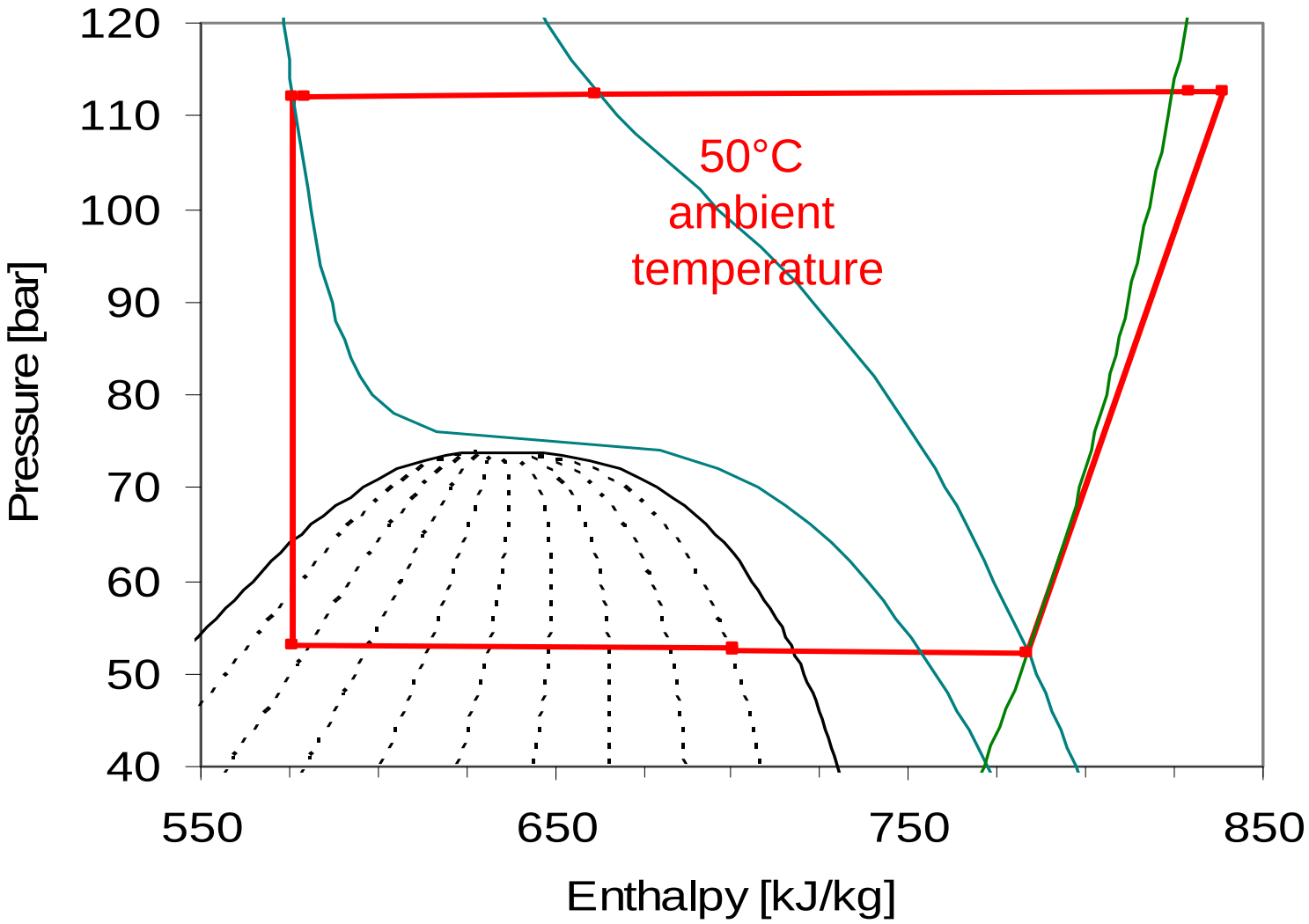
Measurement set-up

- Entire ECU between two climate chambers

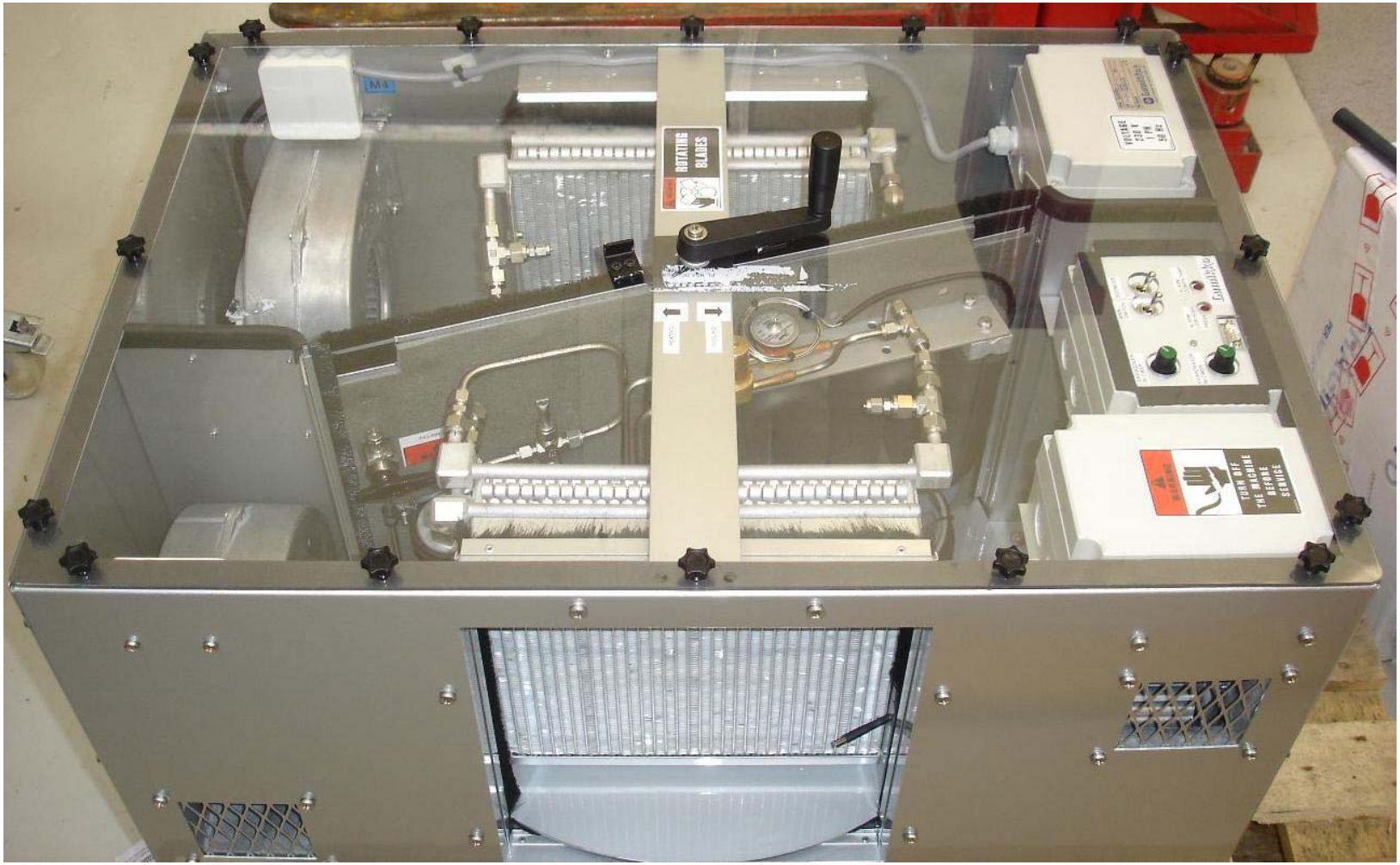


- Refrigerant mass flow meter and calorimetric energy balance applied to calculate capacities

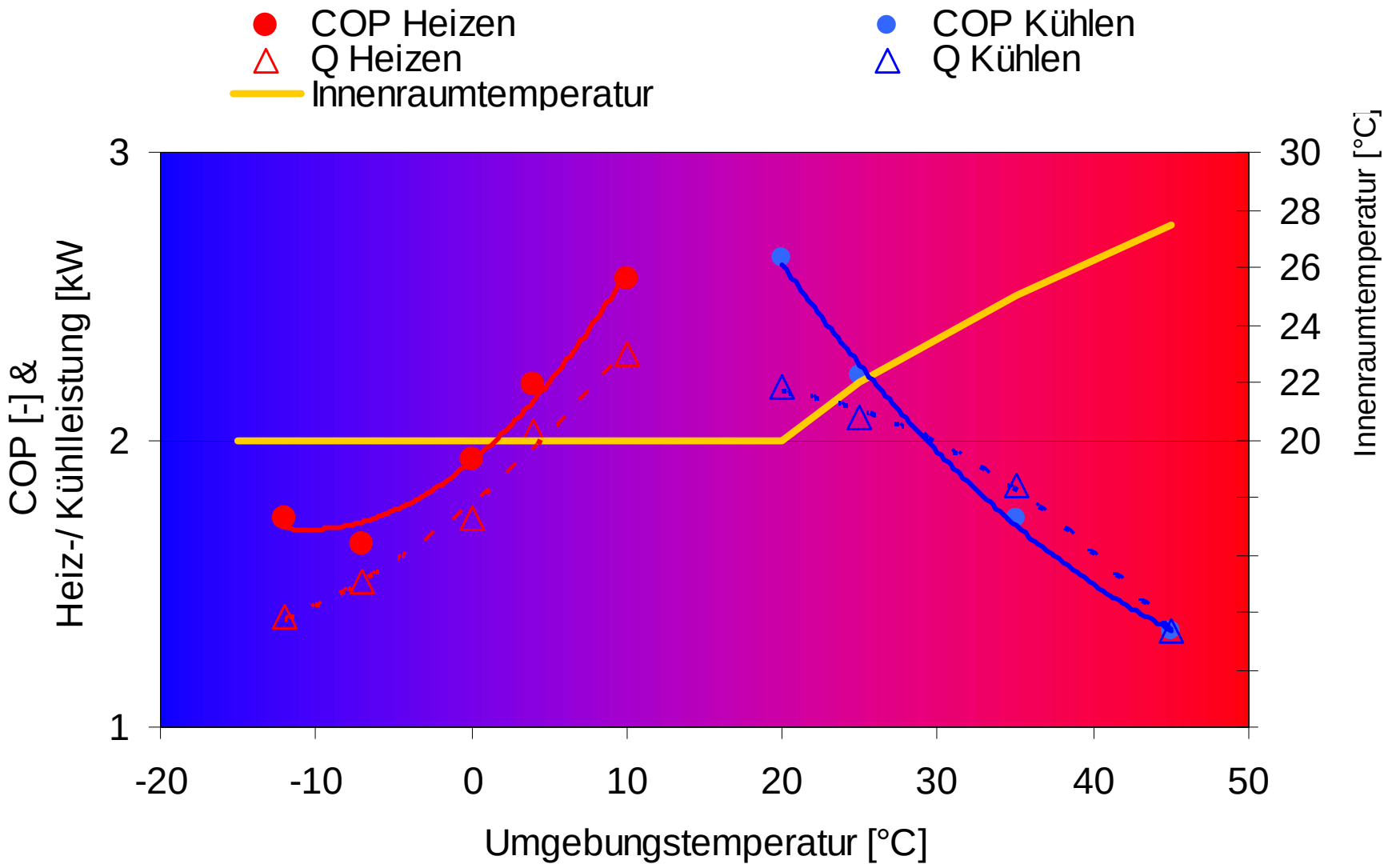
Gascooler Temperature Profile



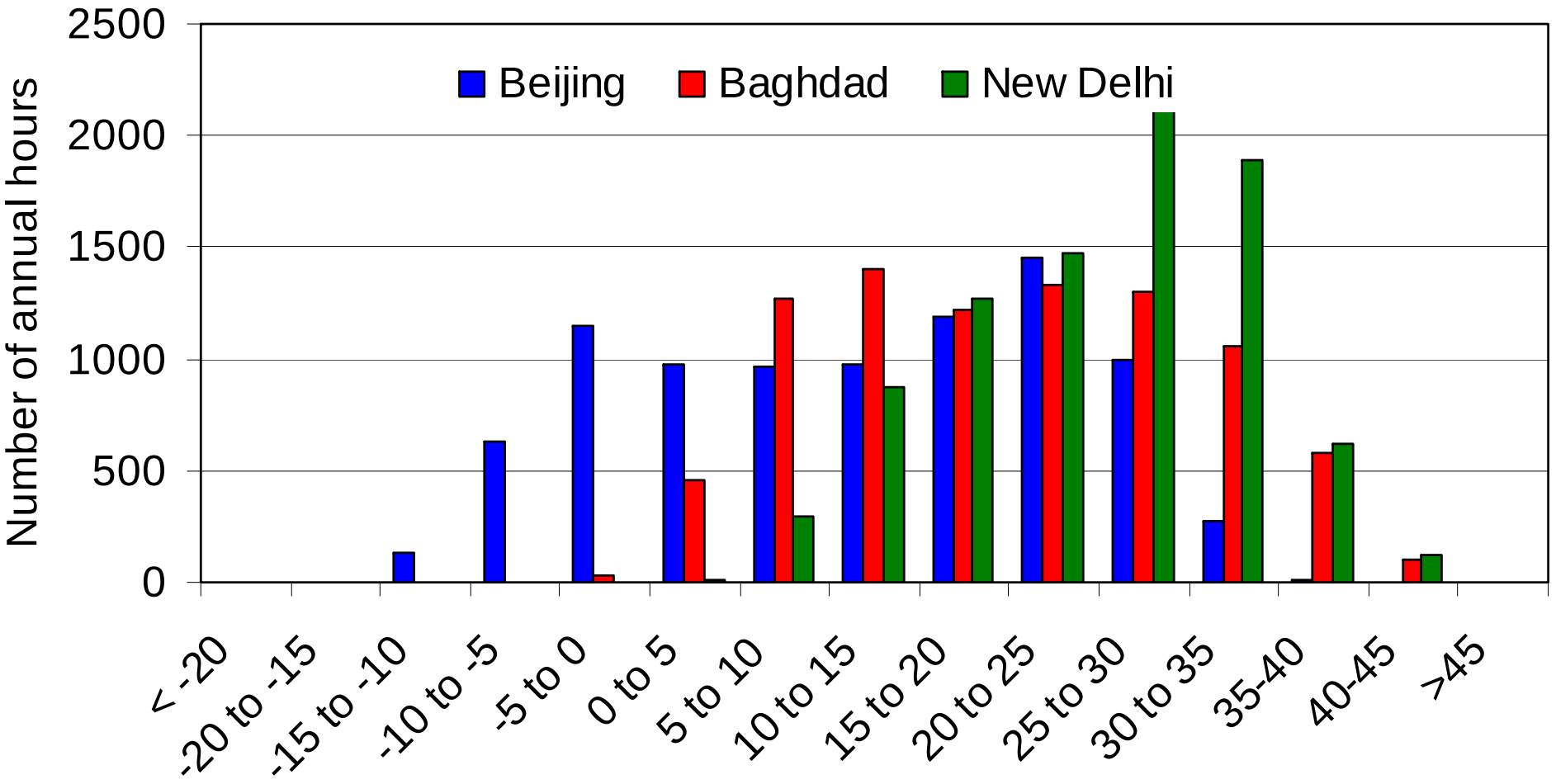
Picture of the R744 turn-table ECU



Results


COP Heizen
Q Heizen
Innenraumtemperatur
COP Kühlen
Q Kühlen
COP [-] &
Heiz-/ Kühlleistung [kW
Innenraumtemperatur [°C]
3
2
1
30
28
26
24
22
20
-20
-10
0
10
20
30
40
50
Umgebungstemperatur [°C]

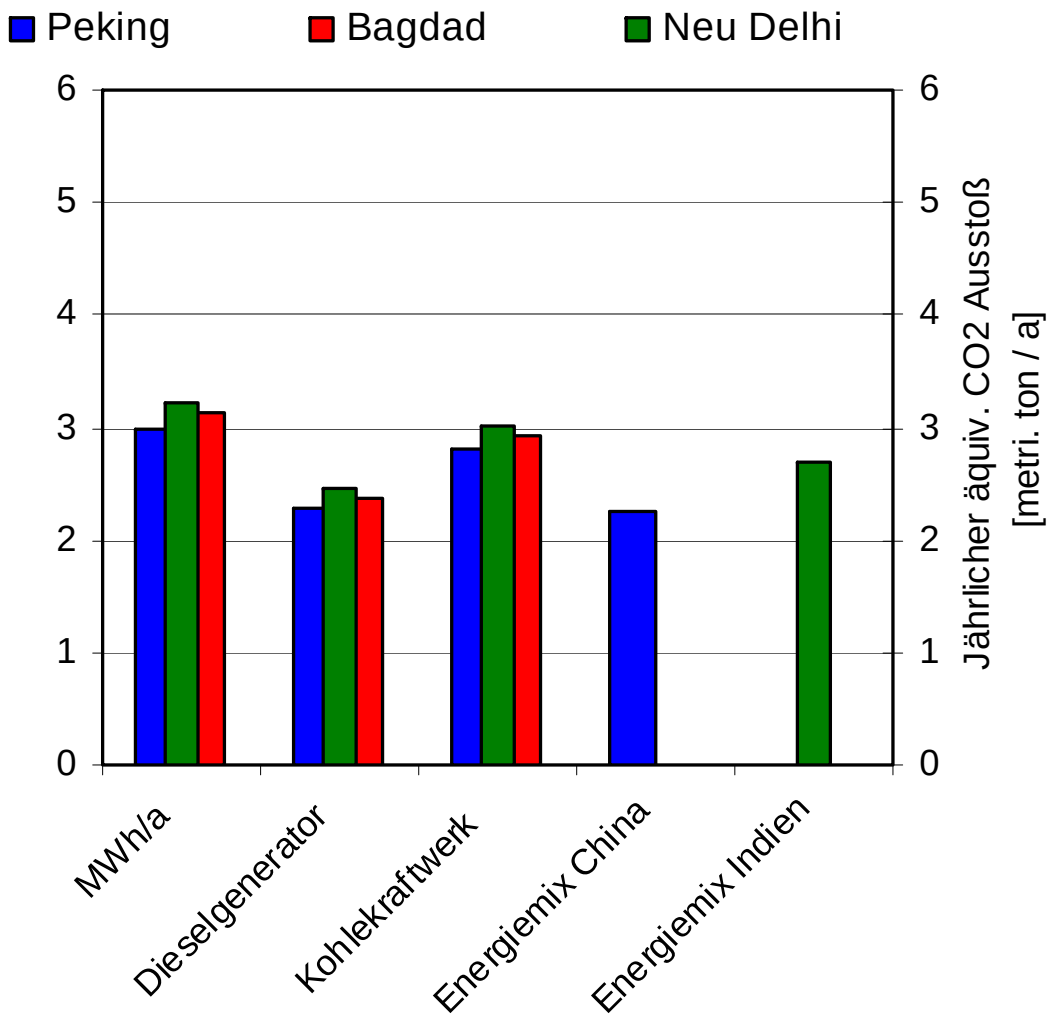
Temperature bin / Climate / Location



Energy Demand & CO2 Emissions

Office hours
(8 a.m. – 5 p.m.)

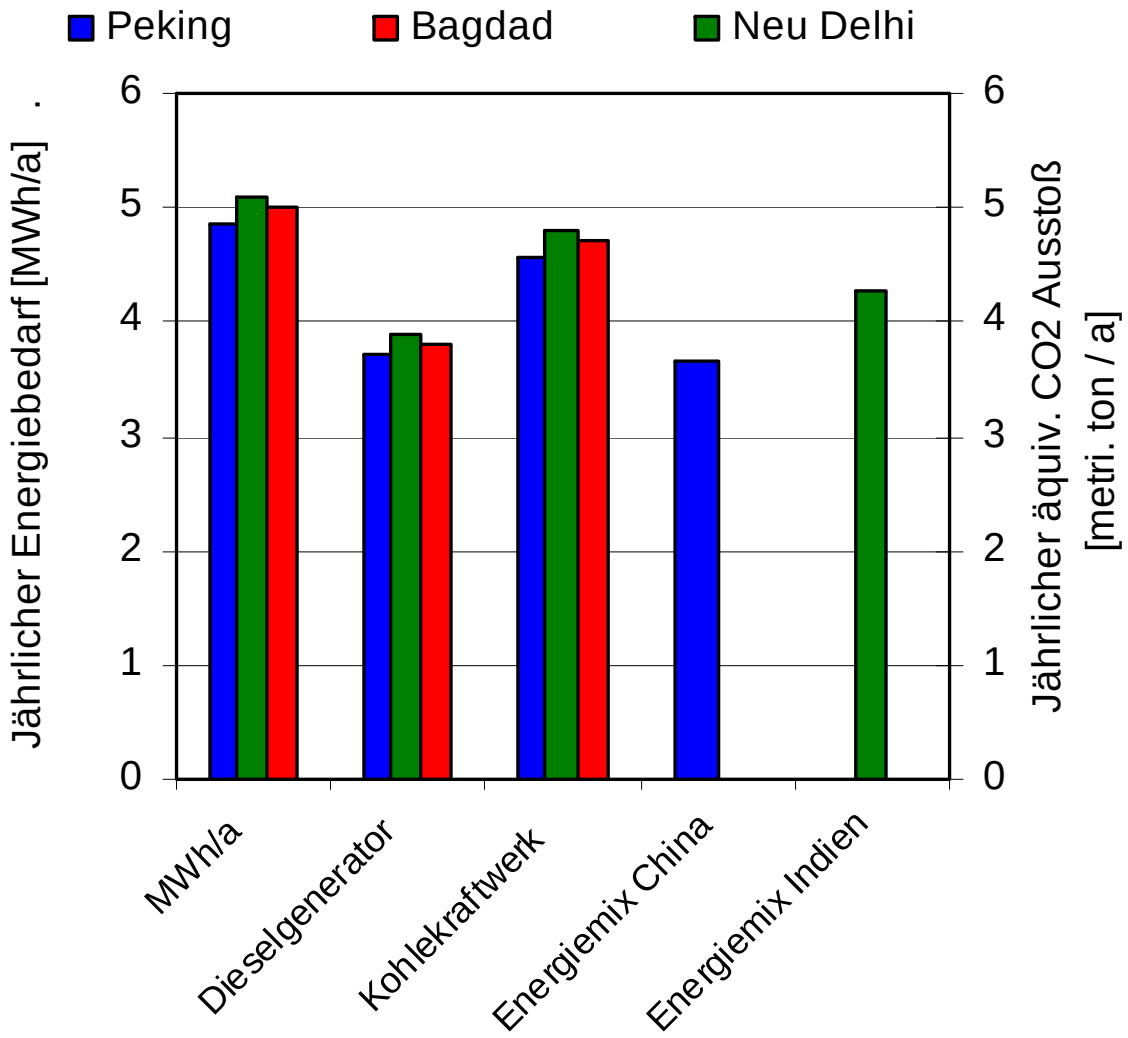
- 3-3.2 MWh/a
- Dieselgenerator
  2.3-2.5 m.ton/a
- Coal power p.
  2.8-3 m.ton/a
- China / India
  2.25 / 2.7 m.ton/a



Energy Demand & CO_2 Emissions

Non-office hours
(5pm – 8am)

- 4.9 - 5.1 MWh/a
- Dieselgenerator
  3.7 - 3.9 m.ton/a
- Coal power p.
  4.6 - 4.8 m.ton/a
- China / India
  3.7 / 4.3 m.ton/a



COP & Capacity limiting factors

- Lines = ok
  - no disadvantage due to current fitting technology
- Gascooler => ok (low temperature approach)
- Evaporator
  - fin pitch adjustment required (frosting)
  - refrigerant side distribution => ok
- Expansion devices
  - TBR = small adjustment of temperature pressure curve
  - MBR = ok
- Receiver = ok
- IHX (internal heat exchanger) = ok
- Compressor (3cm^3 proto-type)

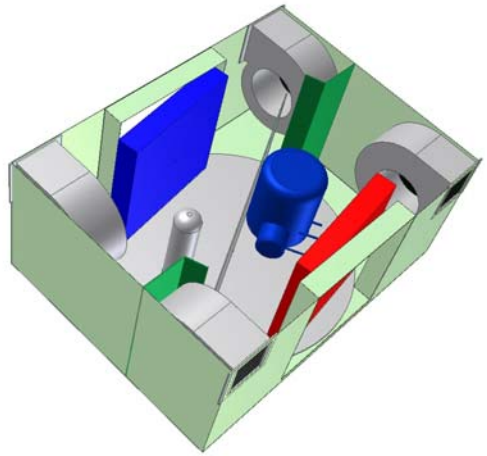
Summary

- An air reversing, turn-table ECU was **designed and experimentally investigated.**
- The refrigerant circuit can be unchanged, when directing the air through the designated heat exchanger by rotating the entire refrigeration unit. Therefore **the function of the heat exchanger does not change**, i.e. the gascooler can be optimized for a low temperature approaches. Refrigerant charge issues can be handled since no ‘dead’ lines are present.

Conclusion

- This concept study showed that a turn-table residential AC-unit, applying R744 as working fluid, is **a viable option for many global areas**, where both heating and cooling is required during a year.
- This concept is also feasible for ‘mobile’ HVAC system in busses and trains…

Thank you for your attention!



Questions are welcome!!!

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Acknowledgement:

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Thanks to **Embraco** for the compressor.

A special thanks to the team at **Lumikko OY**, which build up this compact unit, for their cooperation and good workmanship.

More real facts at www.R744.com