



Thermosiphon Beams

Cai Wenjian



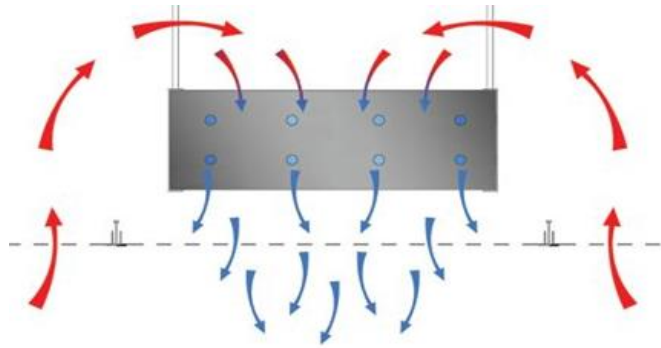


Air T&D

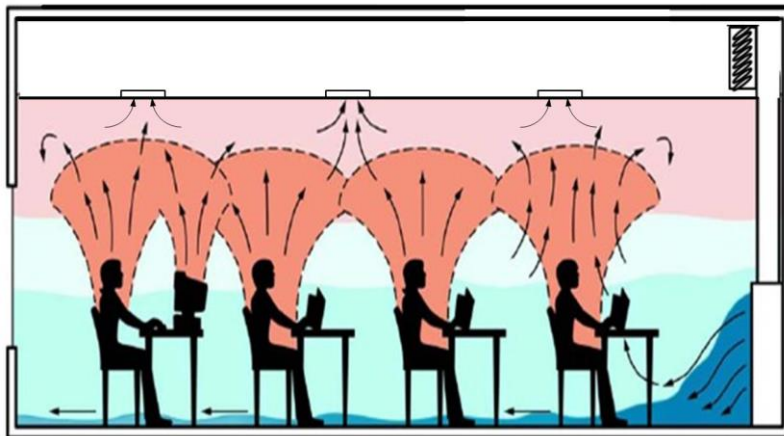
- 1 An engineering and consulting firm offering professional services and analytical expertise to global HVAC engineering projects
- 2 Incorporated in March 2015 in Singapore.
- 3 Spinoff from Green Cooling & Air-conditioning Technologies (GCAT), a joint research program of EEE and ERI@N, NTU
- 4 GCAT established in 1999 with target to achieve energy & environmental benefits through R&D
- 5 World class R&D capabilities for energy efficient products development
- 6 Several related international patents

Fundamentals of TBs

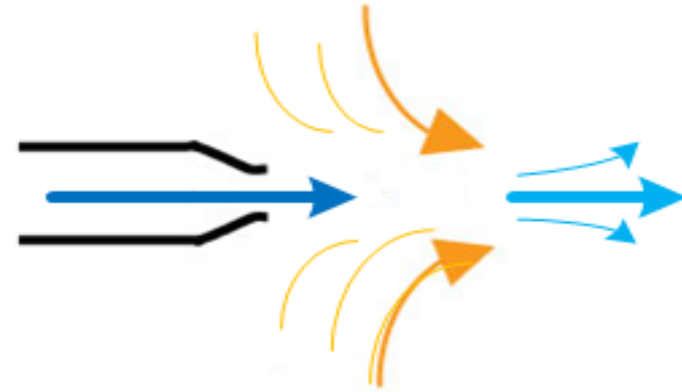
➤ Air Thermosiphon Effects



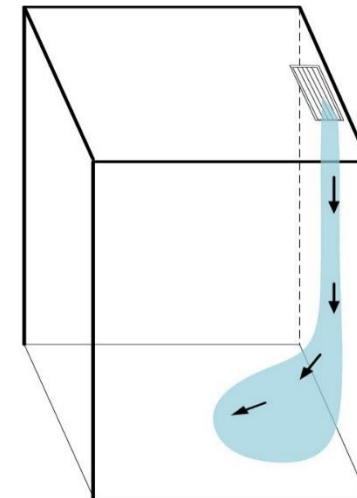
➤ Displacement Ventilation



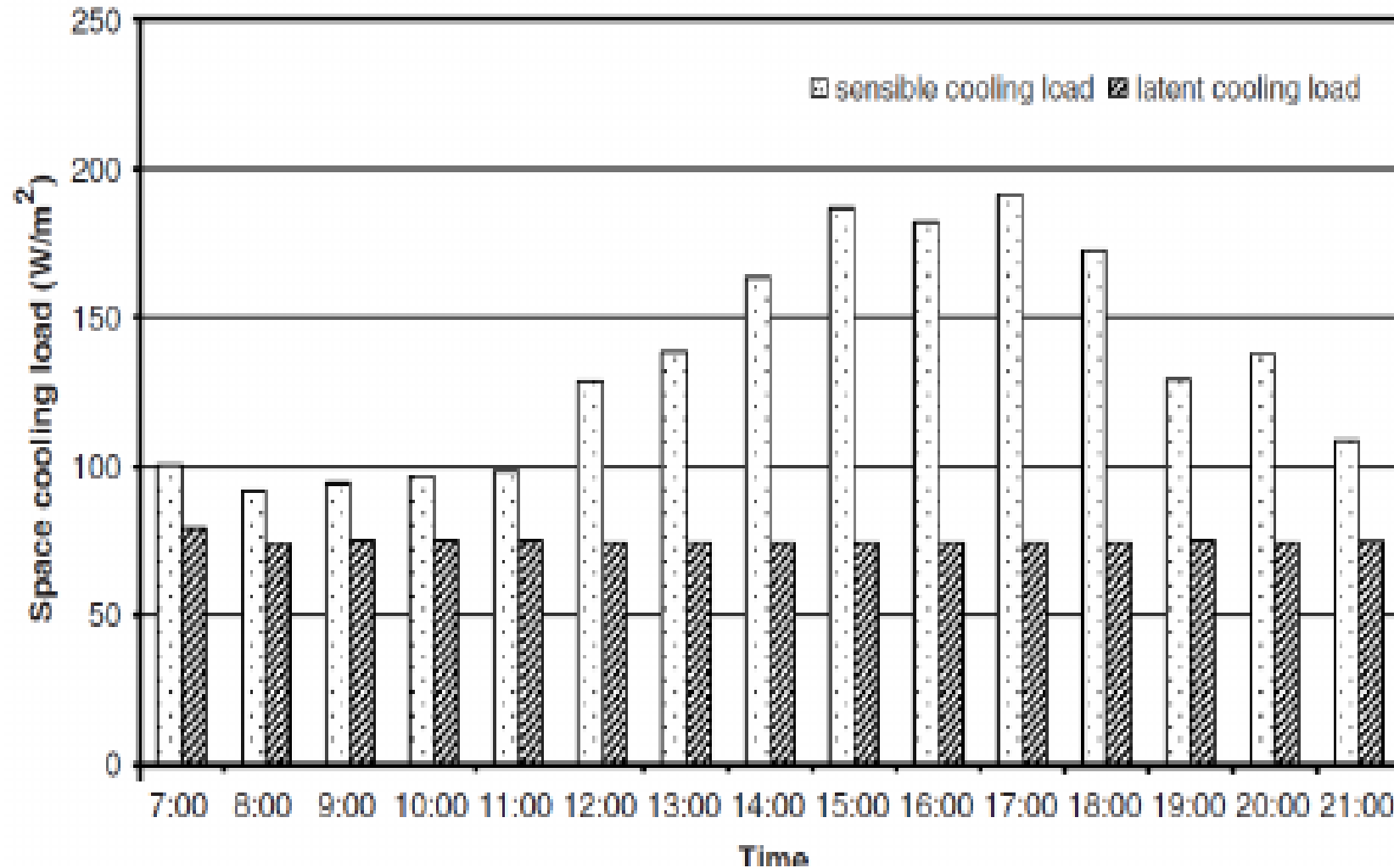
➤ Air Entrainment (Nozzle)



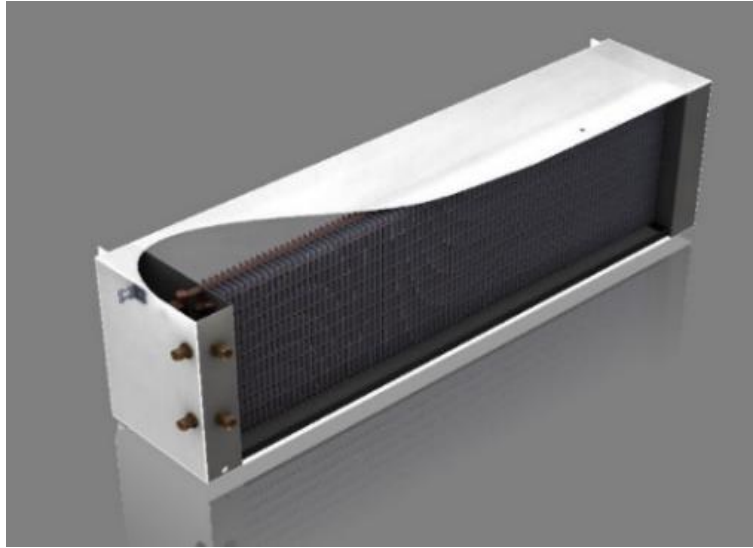
➤ Coandă Effect



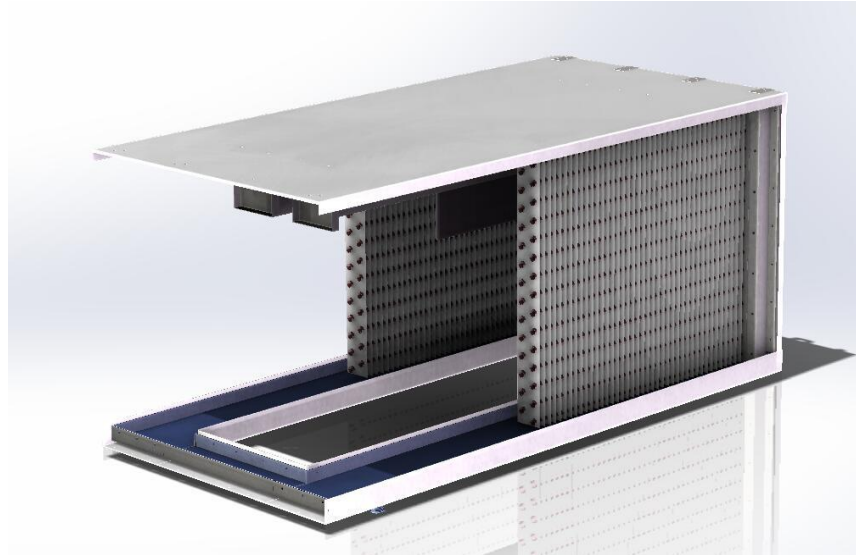
Internal Cooling Load



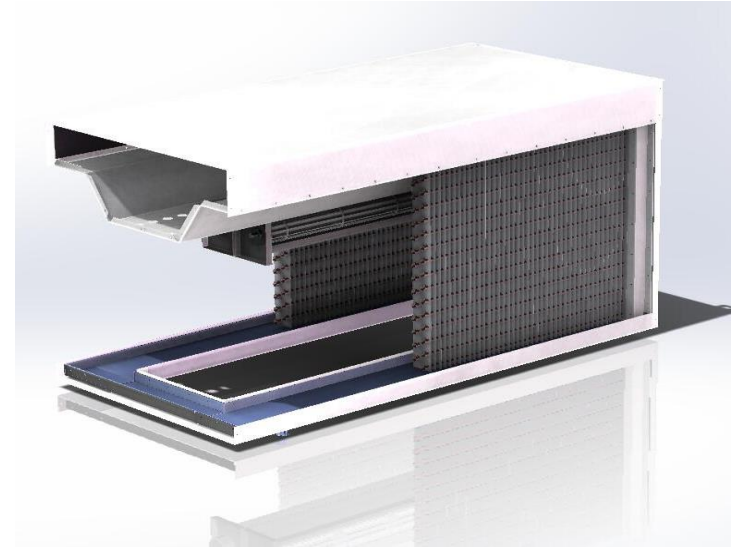
Cooling load profile of a typical room



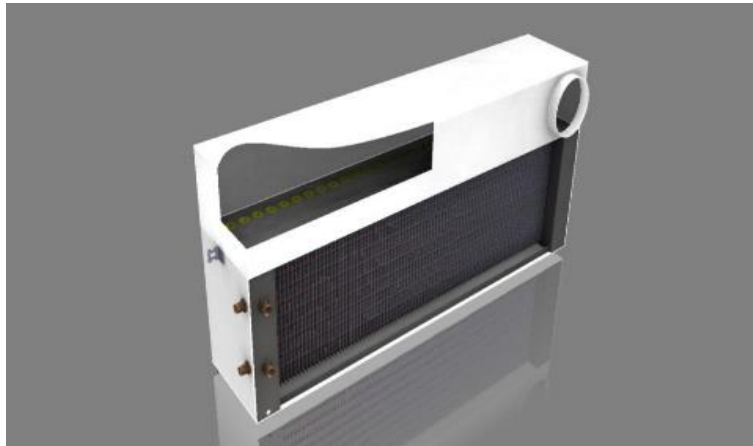
PTB-W



PTB-C



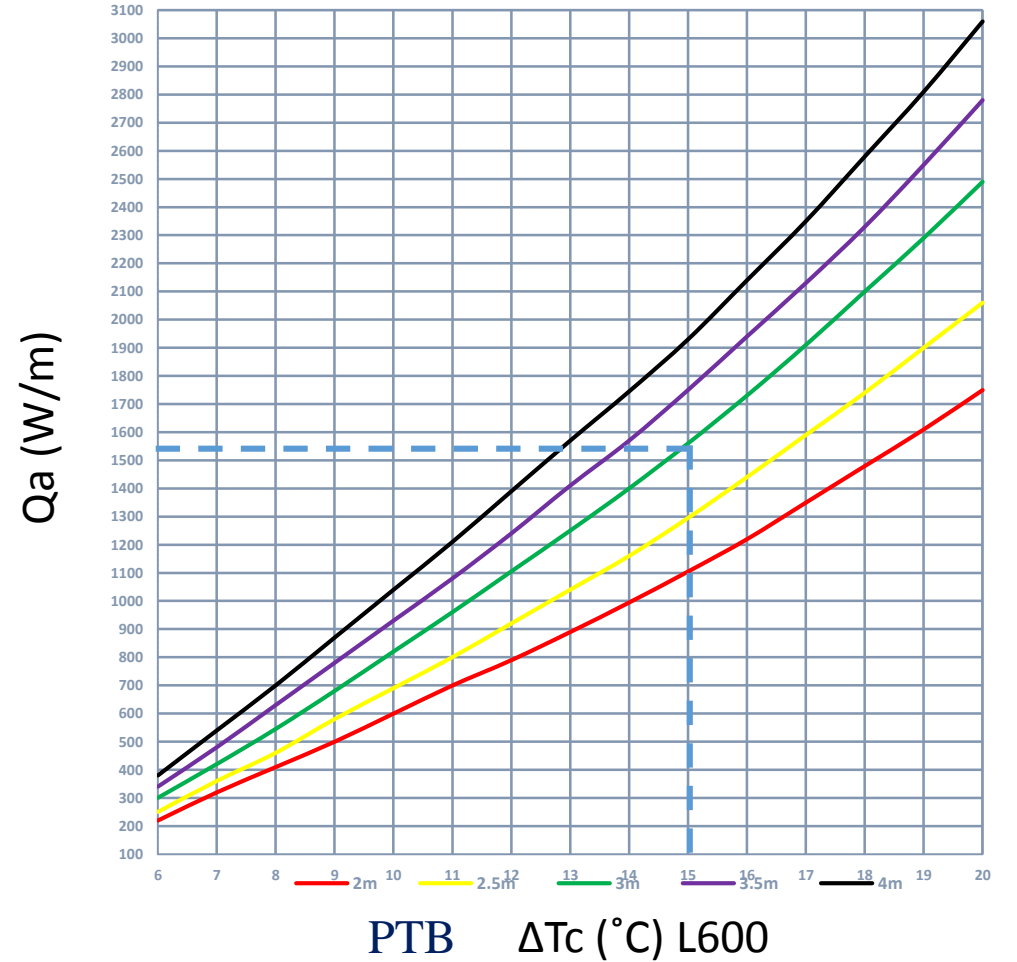
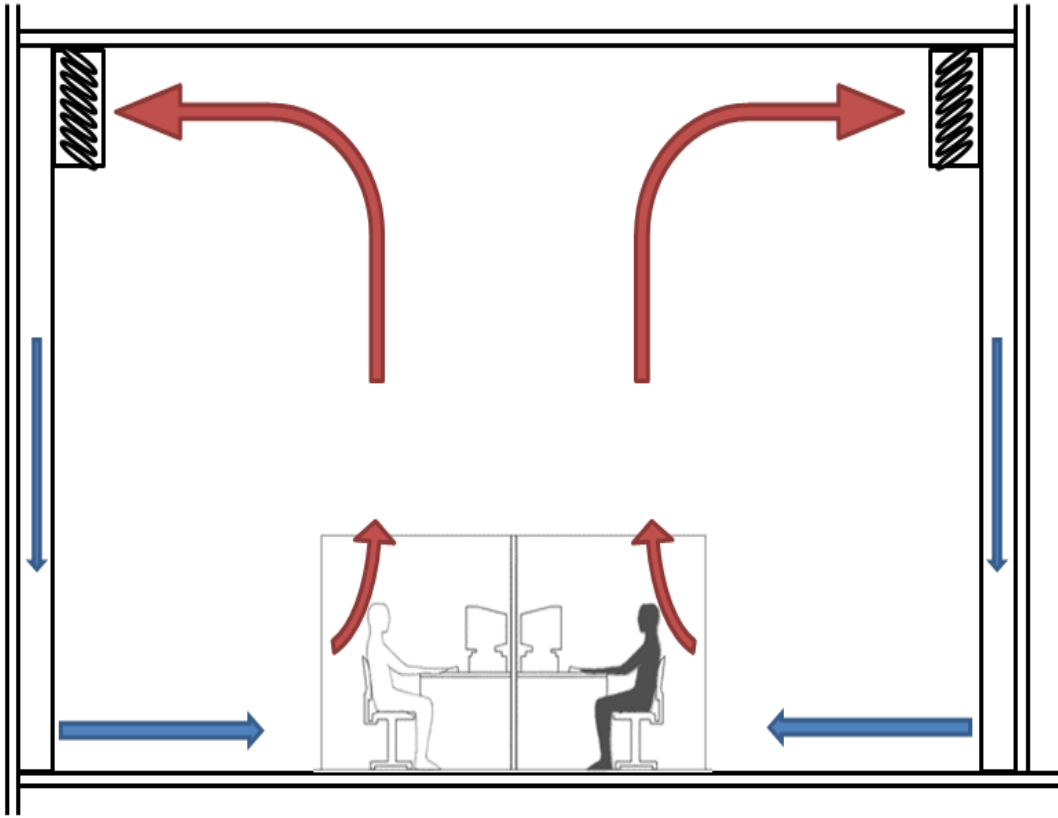
ATB-C



ATB-W

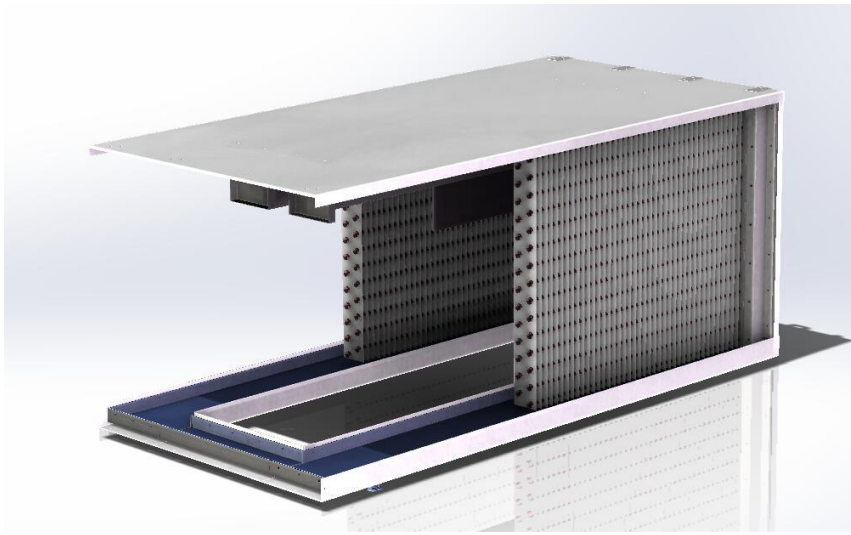
TB Products (patented)

PTB - W



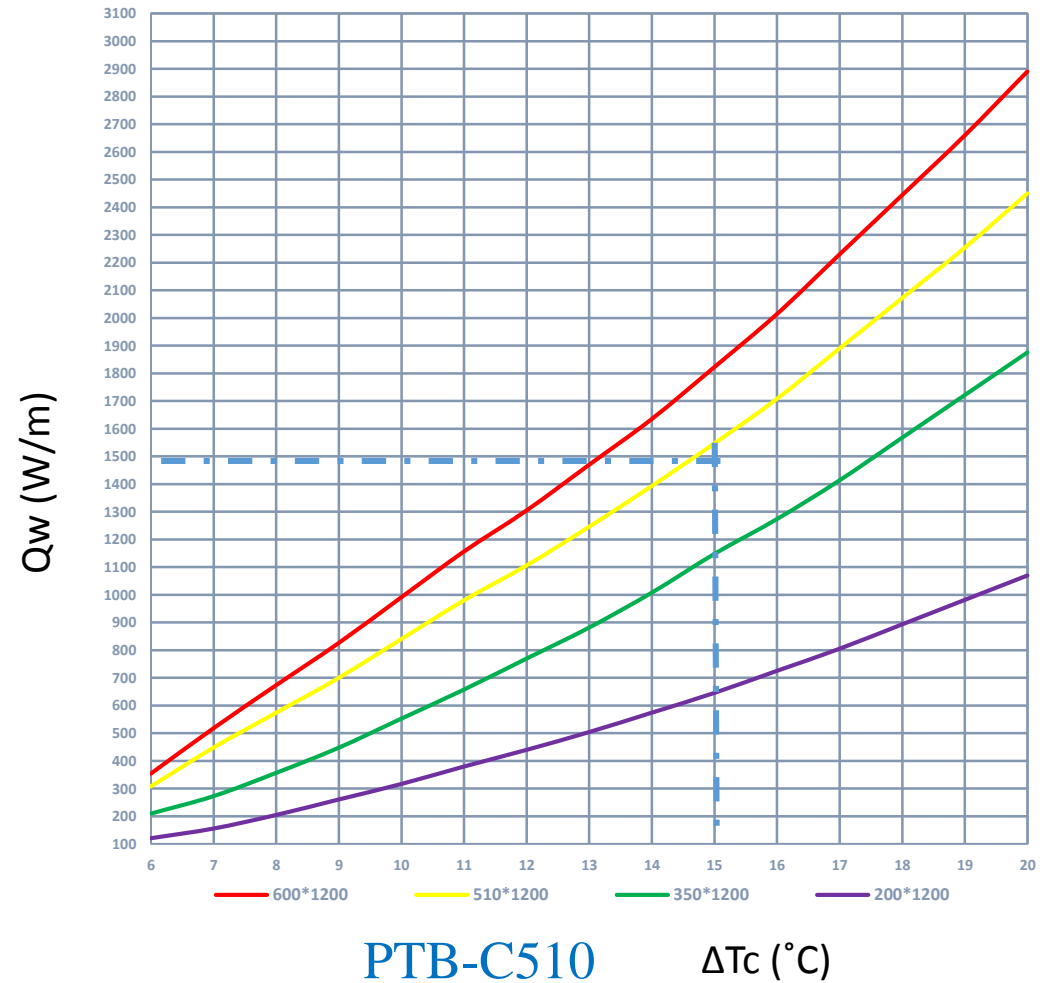
Code	Length L (mm)	Height H (mm)	Width W (mm)	Outlet width A (mm)	Dry weight (Kg)
PS200	1200	200	300	75	18
PN350	1200	350	300	100	22
PL510	1200	510	300	150	26
PE600	1200	600	300	150	30

PTB-C



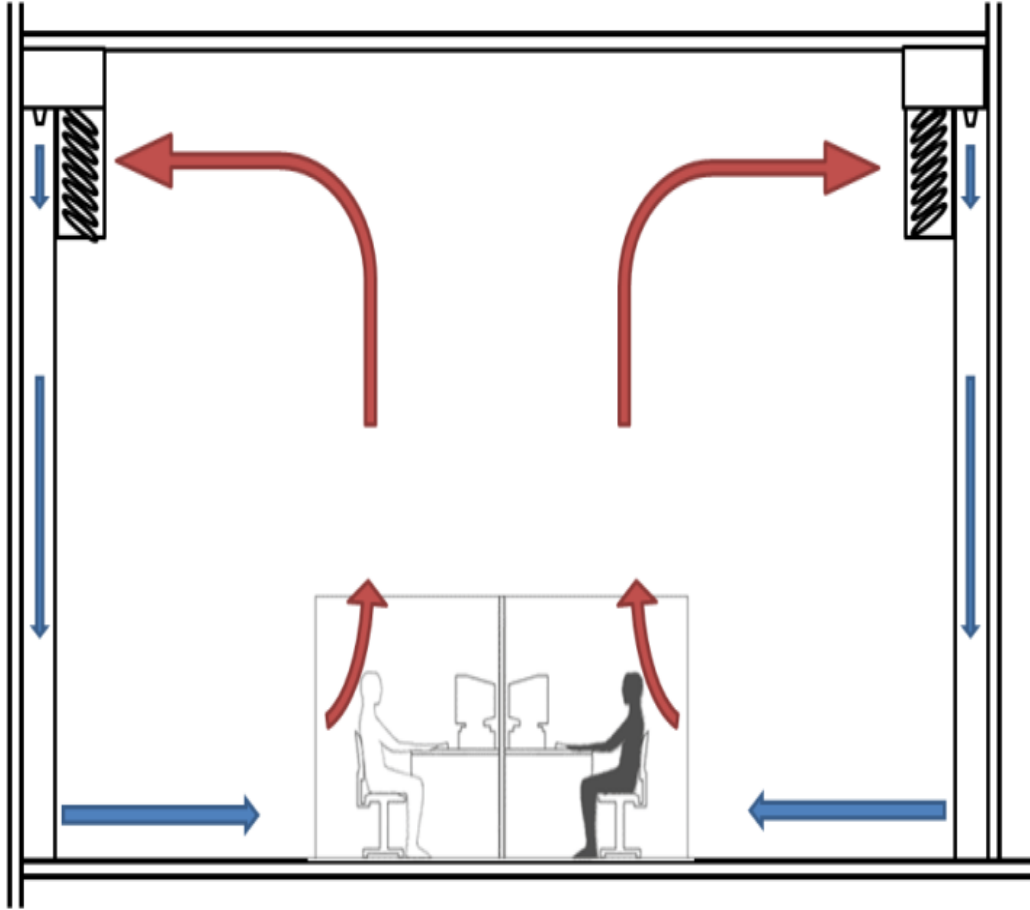
Disadvantages:

- Low capacity, high cost
- Not flexible to match the cooling load
- Space required for fall duct



Code	Length L (mm)	Height H (mm)	Width W (mm)	Outlet width A (mm)	Dry weight (Kg)
PS200	1200	200	600	150	27
PN350	1200	350	600	200	33
PL510	1200	510	600	300	39
PE600	1200	600	600	300	45

ATB-W

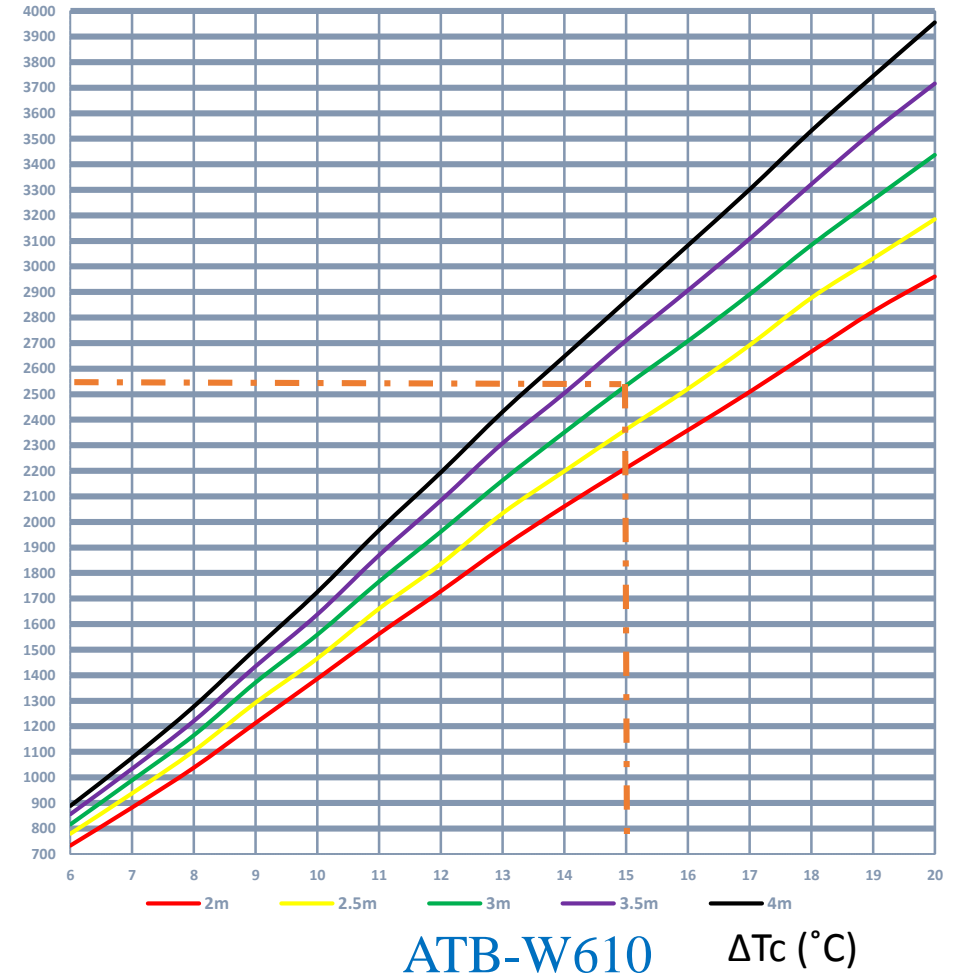


Q_a (W/m)

Many factors affect performance

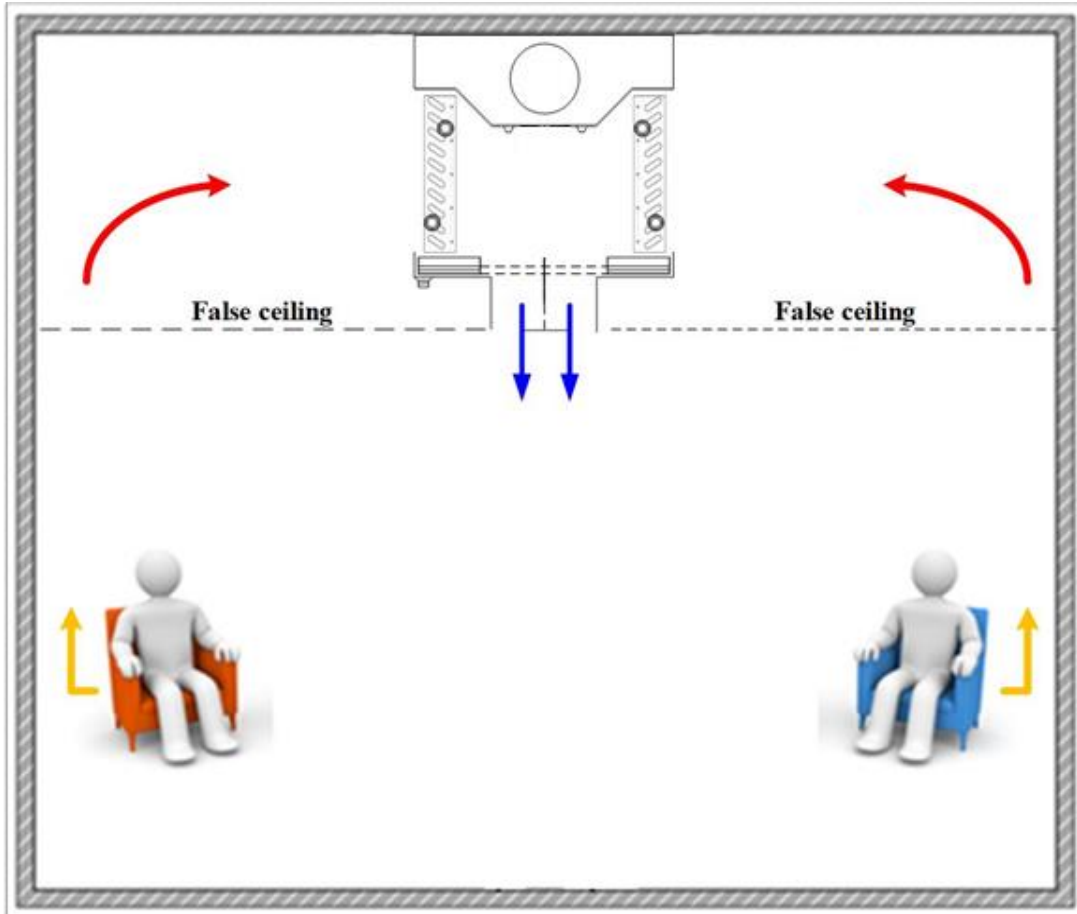
Total cooling is primary air + secondary air cooling

Configuration - Nozzle L

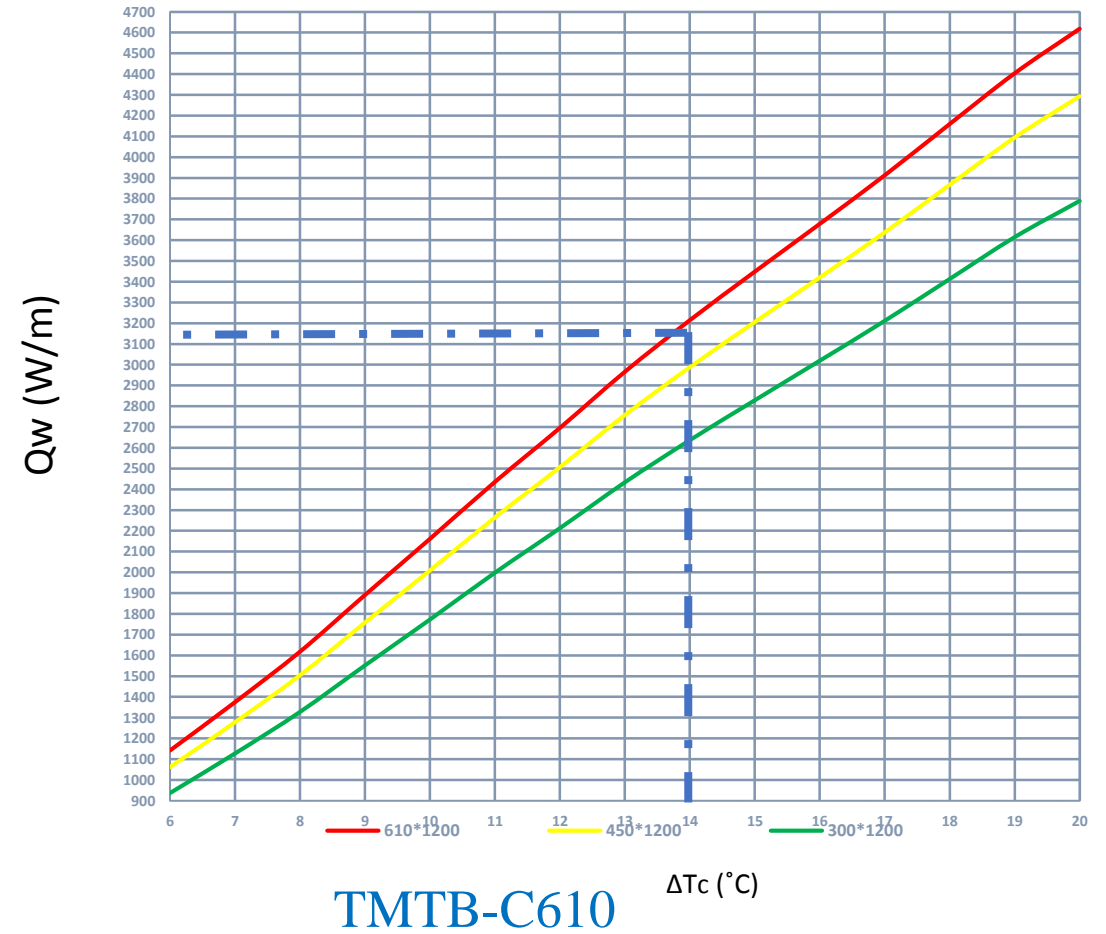


Code	Length L (mm)	Height H (mm)	Width W (mm)	Outlet width A (mm)	Dry weight (Kg)
1200L	1200	300	300	75	18
1200N	1200	450	300	100	24
1200H	1200	610	300	150	32

ATB-C

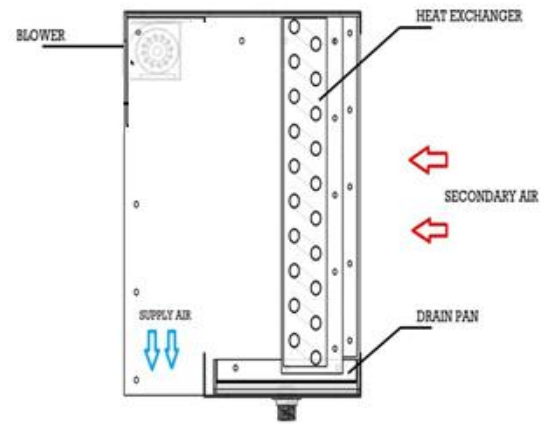
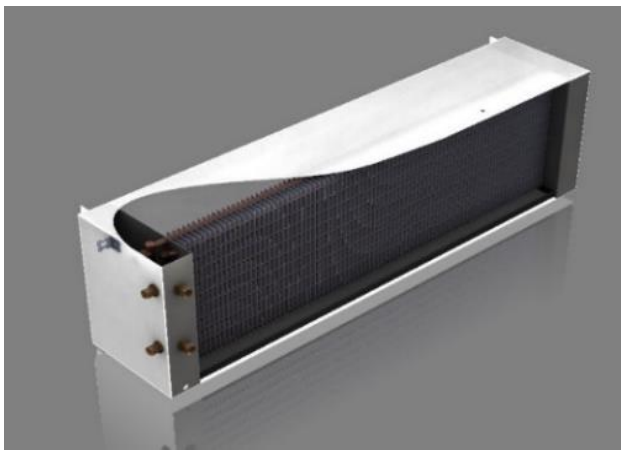


Configuration - Nozzle L



Code	Length L (mm)	Height H (mm)	Width W (mm)	Outlet width A (mm)	Dry weight (Kg)
1200L	1200	300	600	150	27
1200N	1200	450	600	200	36
1200H	1200	610	600	300	48

DMTB



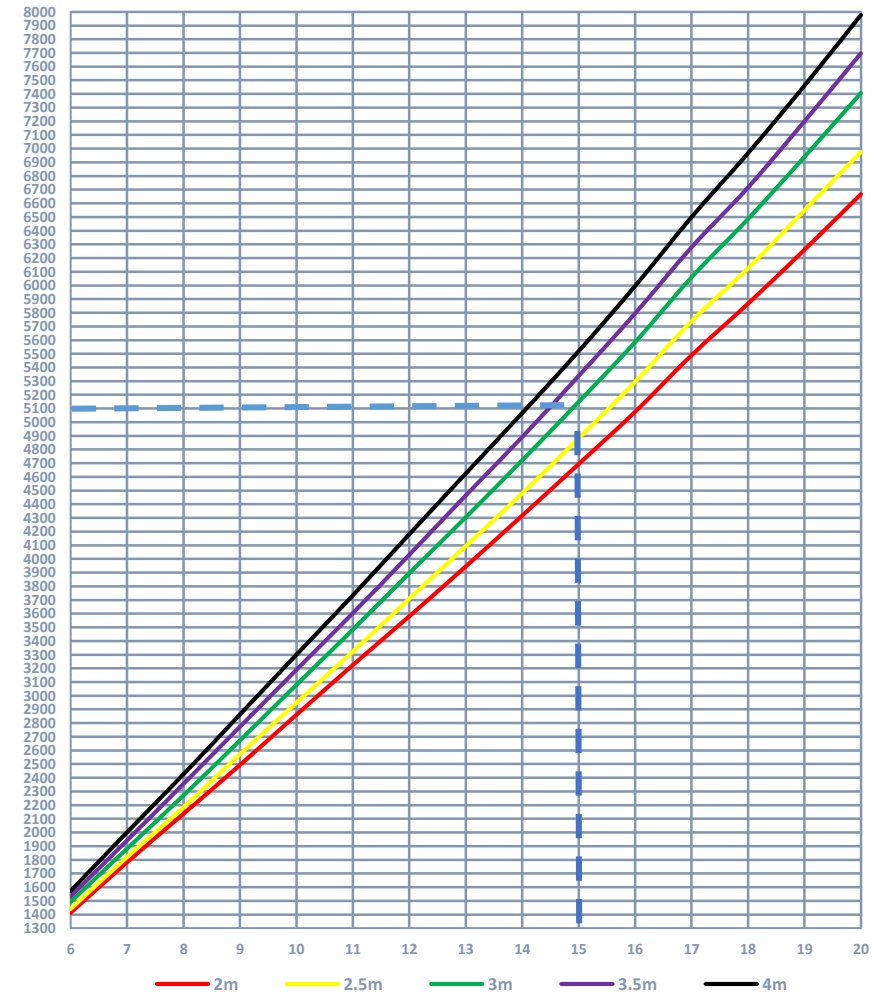
DMTB— add fan inside or outside PTB

fan off PTB fan on DMTB fan energy <10w

DMTB: Fan performs three functions:

- 1) initialize or speed up formation of airflow circulation in startup phase;
- 2) provide better match load variation through control of air flow rate;
- 3) push air through coil and drop to floor level for heating applications

❖ Full fall duct becomes unnecessary

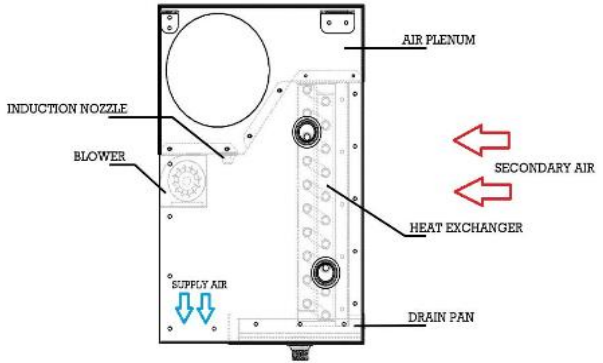
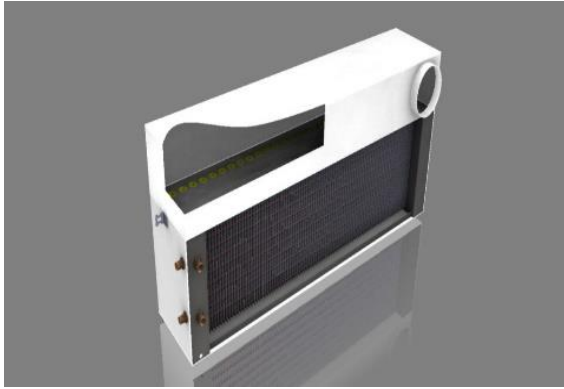


L510 Fan=150L/S

Model	Length (L/mm)	Width (W/mm)	Height (H/mm)	Weight (kg)
PS200	1200	300	200	18
PN350	1200	300	350	22
PL510	1200	300	510	26
PE600	1200	300	510	30

TMTB

- Fan on vent off
- fan off
- fan on (dominant)



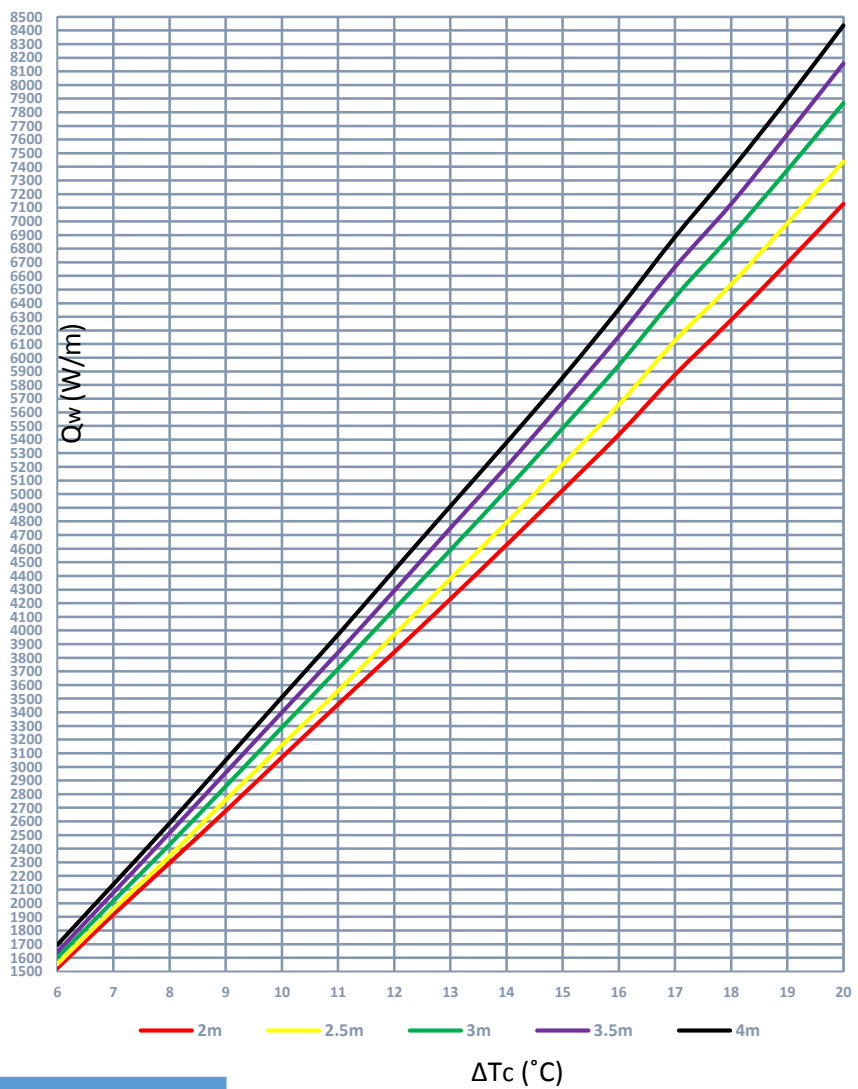
Tri-mode PDV Features

1. (ATB) Ventilation air to enhance PTB performance
2. Fan to provide better match load variation through control of the air flow rate
3. Push air through coil and drop to the floor level for heating applications

❖ Full fall duct becomes unnecessary

Code	Length L (mm)	Height H (mm)	Width W (mm)	Outlet width A (mm)	Dry weight (Kg)
AS300	1200	300	300	75	18
AN450	1200	450	300	100	24
AL610	1200	610	300	150	32

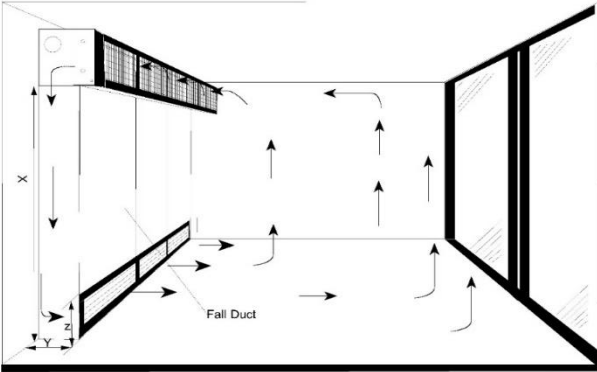
Configuration – Fan 150 (air flow = 150 L/S)



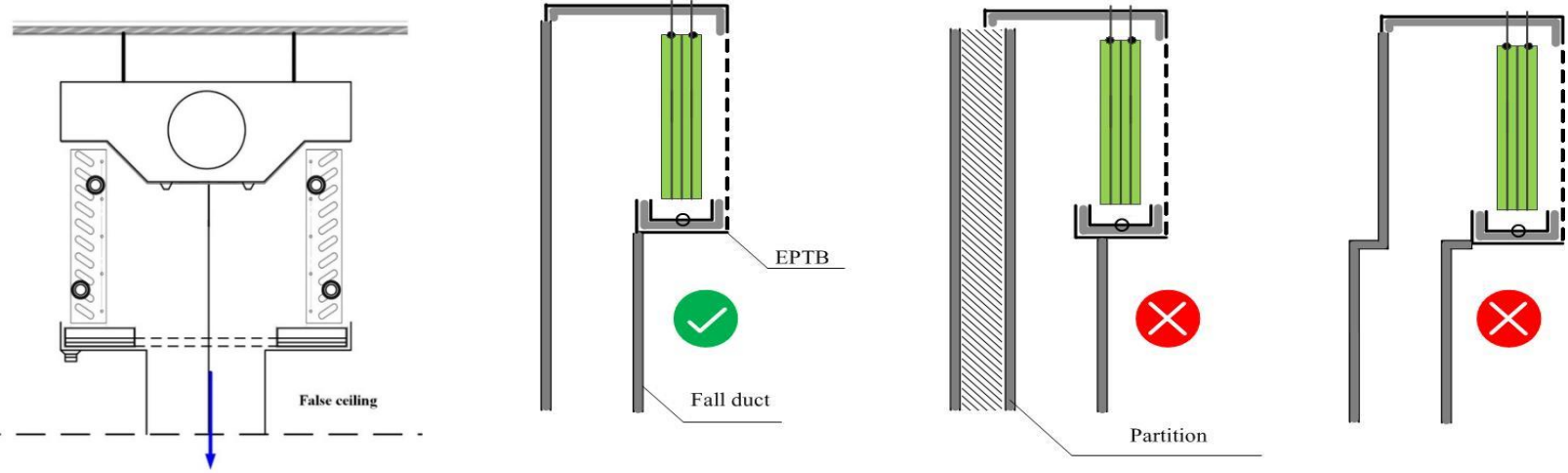
AL610

Installation

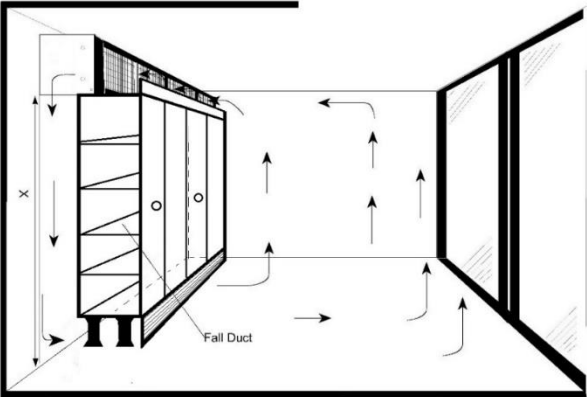
- Must be tightly sealed: air can only enter from heat exchanger and primary air chamber (ATB, TMTB only), and exist from linear bar grill
- Depth of fall duct is optimal designed, whole depth must be kept in any case



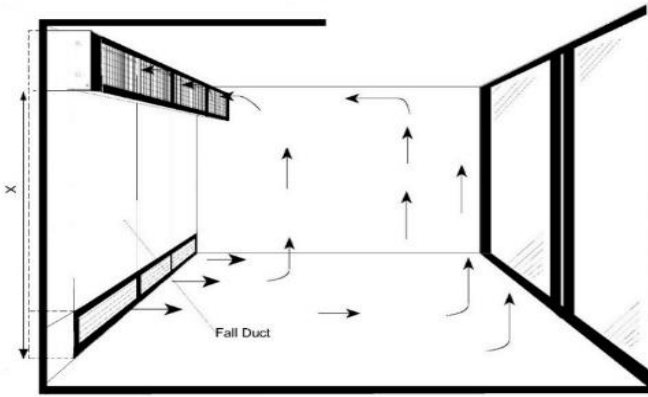
Basic installation



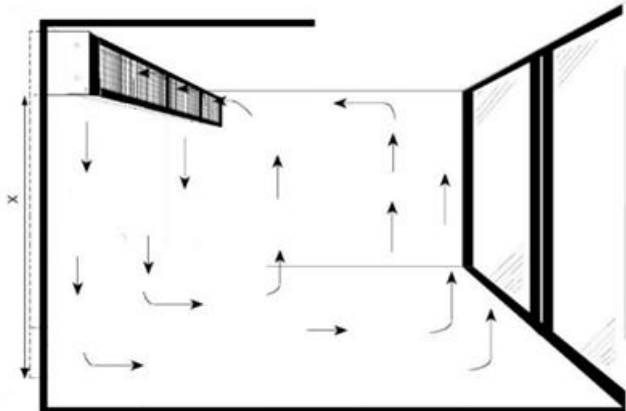
Ceiling mounted



integrated with furniture



integrated with partition wall



without fall duct

Features

➤ Energy saving:

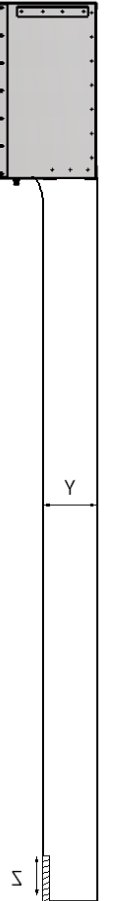
- ✓ Need for the air recirculate to AHU plant room is eliminated

➤ Better IEQ

- ✓ Better acoustics than mixed-flow systems
- ✓ Better temperature gradient throughout the whole space (nature ventilation)
- ✓ Higher ventilation effectiveness than mixed-flow systems (no short circuit)

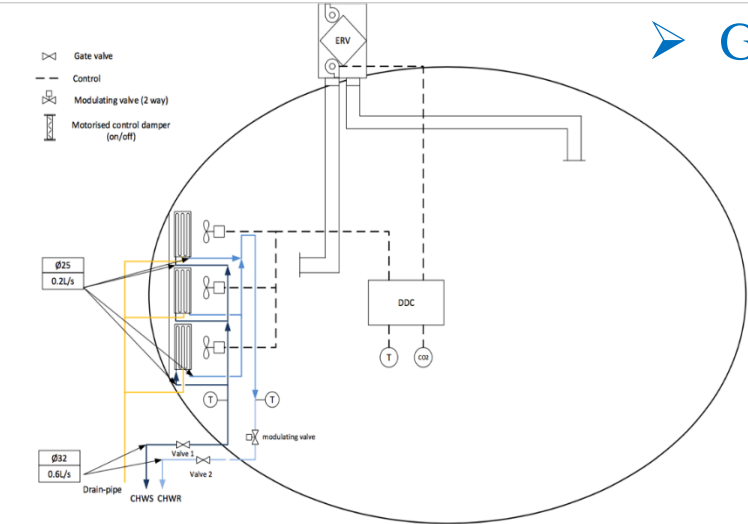
➤ Cost saving:

- ✓ Significant savings in terms of ceiling space
- ✓ Much smaller foot print of primary air handling unit



NTU Tutorial Rooms, TMTB

- 12 tutorial rooms
- Total over 600 m²
- Cost savings
- Energy savings
- Good air quality



Operation mode:
 Chilled water loop: 8°C supply chilled water controlled to keep the temperature within 1°C of the setpoint.
 Temperature control: the operation of the damper is controlled to keep the room temperature within 1°C of the setpoint.
 CO2 level control: the operation of the damper is controlled to increase/decrease till the room CO2 level is according to the supply air CO2 level.

Home
 ACMV
 Electrical
 Plumbing
 Fire Alarm
 DDC Network
 Floor Plan
PTB

Room
 TR+ 13
 TR+ 14
 TR+ 31
 TR+ 32
 TR+ 33
 TR+ 34
 TR+ 35
 TR+ 36
 TR+ 53
 TR+ 54
 TR+ 55
 TR+ 56

Room Temp: 24.9
 RH: 68.9
 Motion: Occ
 CHWR Temp: 11.6
 CO2: 757.0
 Valve Feedback: 0.00 %
 Temp Setpoint: EABS, Non
 Schedule: [arrow]
 Schedule Feedback: 0.0
 EABS Feedback: 0.0
 Spare Set 1: 0.0
 Spare Set 2: 1.0
 Spare Set 3: 0.0

PSA Tuas Terminal Maintenance Base Building



AIR T&D
Engineering perfect indoor climate
— Our relentless pursuit



ENWAE ENGINEERING PTE LTD

GreenA
Consultants

Provide ACMV Solution:

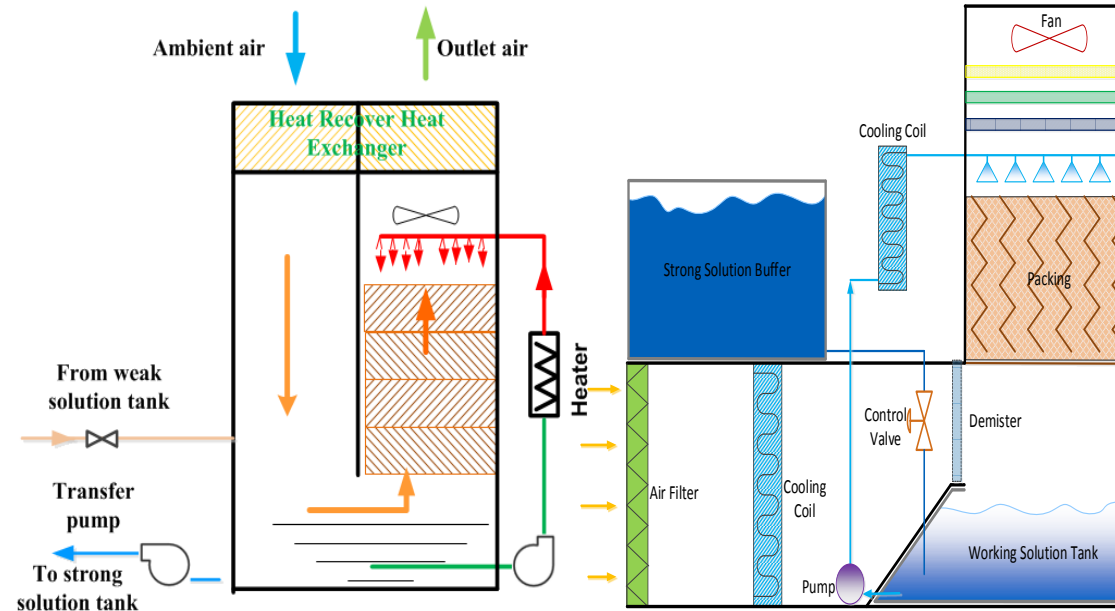
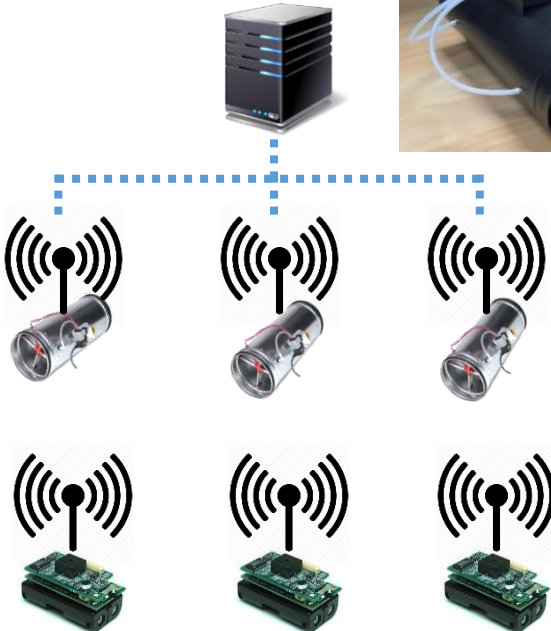
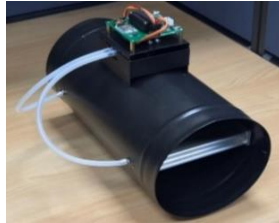
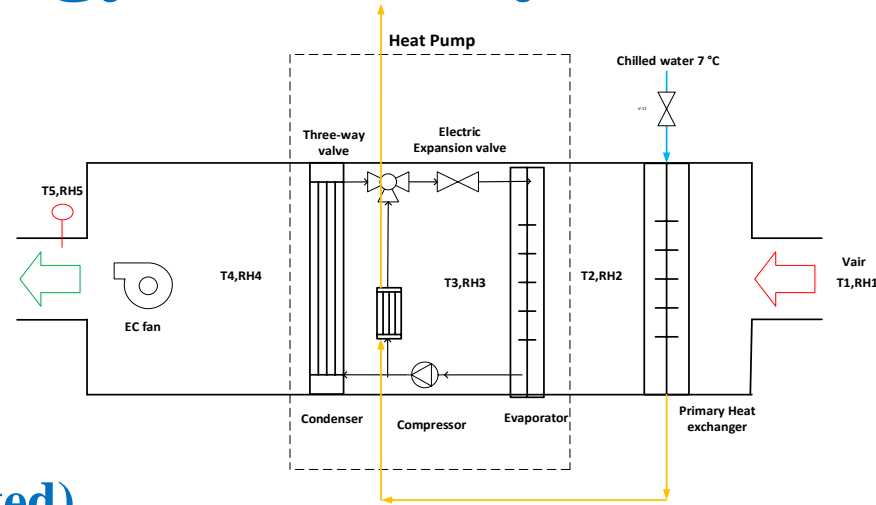
- System design (including piping & ducting)
- Supply terminal unit (more than 300 sets)
- Installation
- Testing and commissioning



System Integration for Energy efficiency

➤ Products

- **Air Treatment System (DOAS, patented)**
 - Liquid Desiccant Air-Conditioning System
 - Dual Cycle Air-conditioning System
- **Intelligent Air Distribution System (patented)**



Thank you !