

CFD analysis

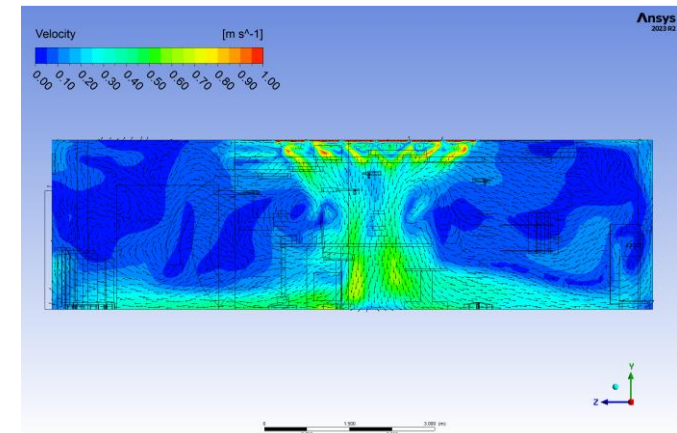
Impact and result

CFD hvad er det

En mulighed for at simulere forskellige
Parametre før man påbegynder byggefasen
Design mod virkeligheden.

Computational Fluid Dynamics (CFD) can be used to assess whether a room complies with optimal ventilation, through quantification of critical variables. Additionally, solutions tailored to specific rooms and conditions can easily be found using CFD.

Computational Fluid Dynamic (CFD) kan anvendes til at vurdere ventilationsforholdene og give en øget indsigt i luftens bevægelse omkring genstande i rummet. Ved at lave fuldskala 3D CFD kan alle variabler måles i et hvilket som helst punkt, uanset hvor kompleks geometrien måtte være.



Anvendelses områder

Anvendelse af CFD

Pharma

Laboratorier

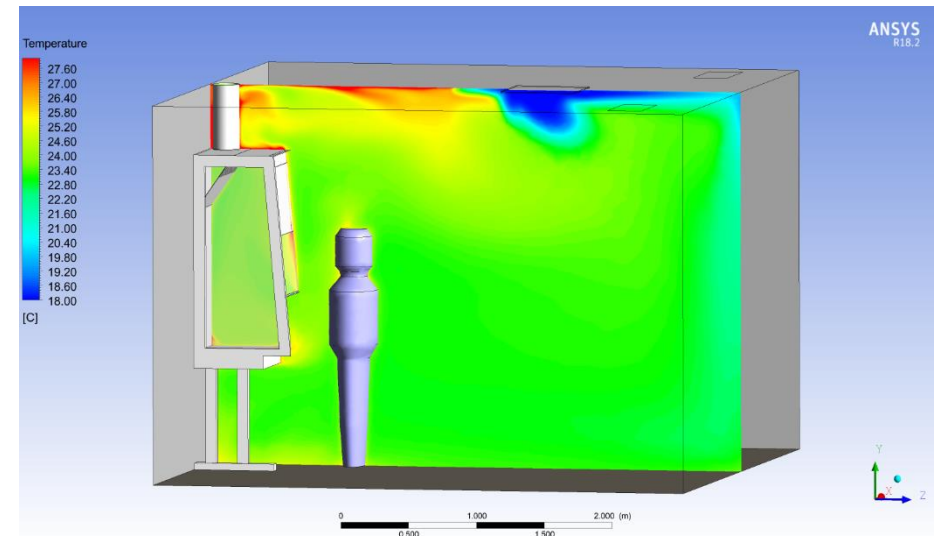
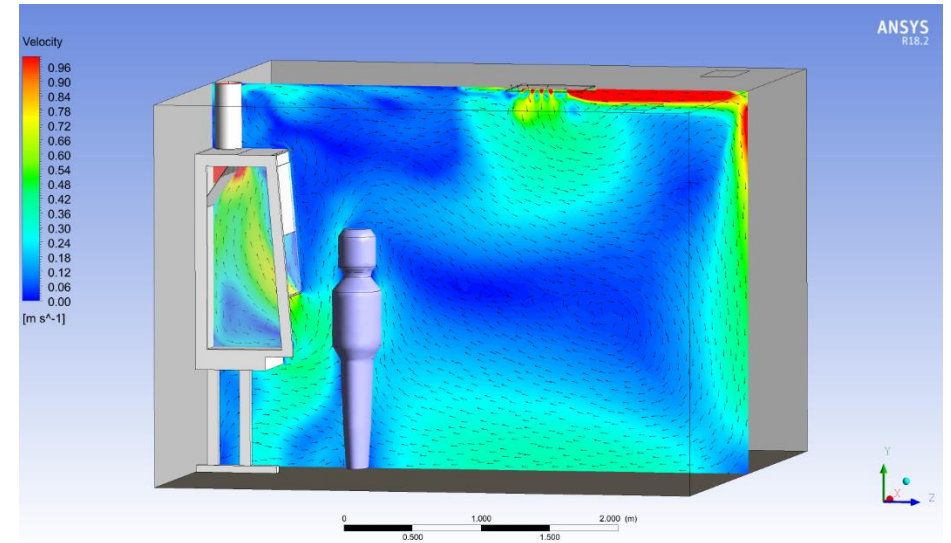
Renrum

Isolation stuer

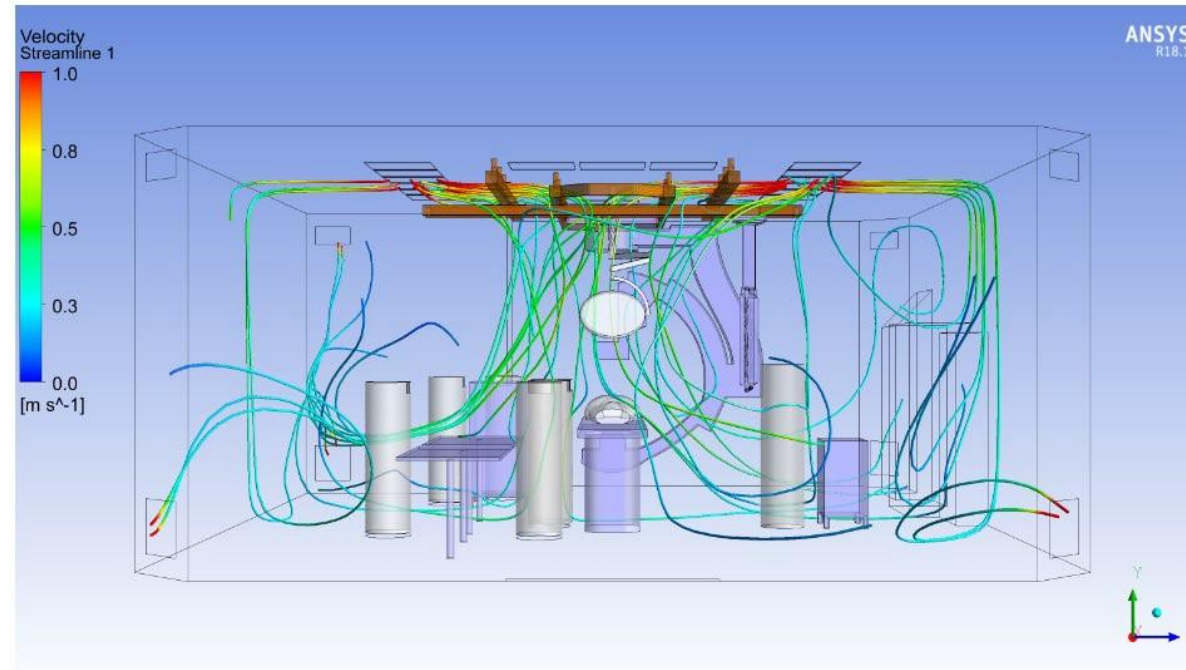
Protective airflow

Patient stuer

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-
-
-
-
-



2. CFD simulations



2. CFD Simulations

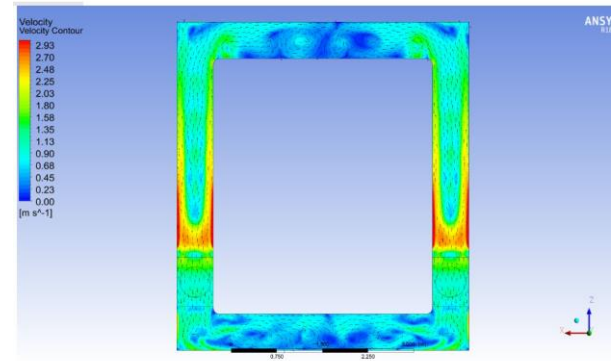
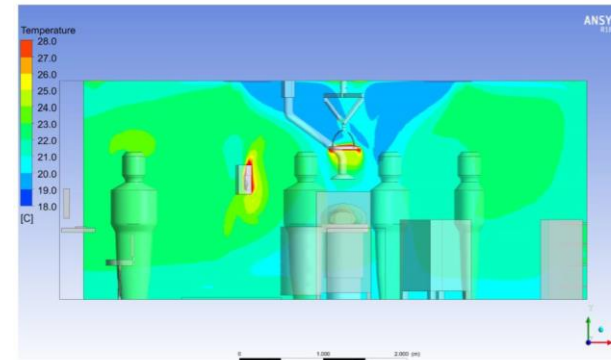
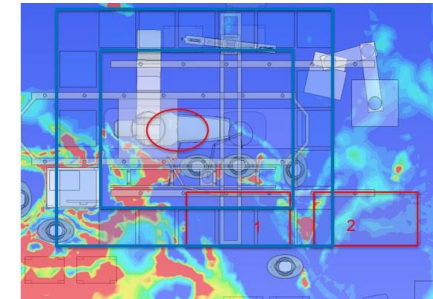
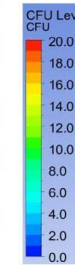
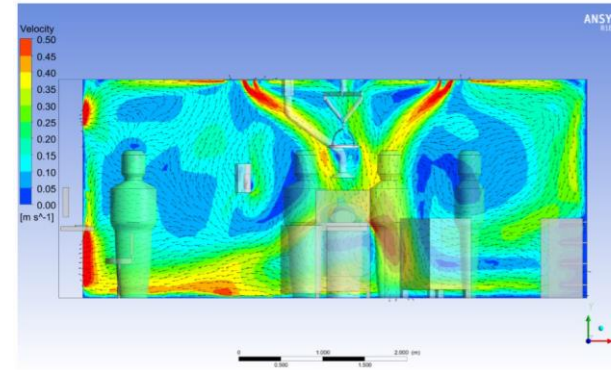
- To ensure, in beforehand, that ventilation system will fulfil the set criteria in designed operating room
 - Clean/ ultra clean air cleanliness
 - Adequate air flow rate
 - Desired air flow pattern
 - Total mixing in the hole room
 - No stagnant areas
 - Optimal nozzle setting
 - Thermal comfort conditions
 - Reasonable air velocities
 - Evaluate the affect of surgical lights, medical equipment, windows, personnel etc. to air flow pattern
- To help and to understand how the ventilation system will work

When CFD simulation is recommended?

- When room design is unusual
 - Room layout
 - Special equipment
 - When the positioning of supply/ exhaust units is problematic
- Always recommended for hybrid rooms

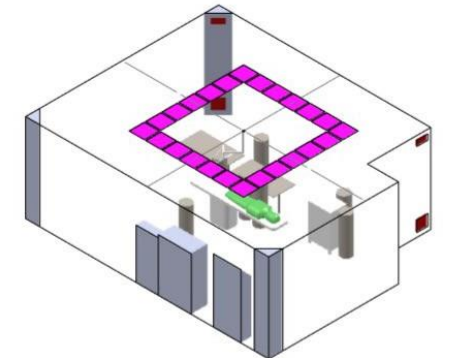
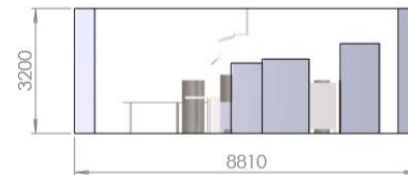
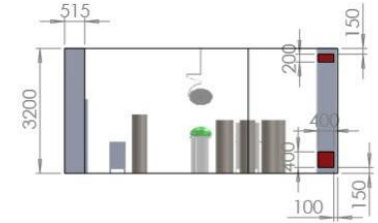
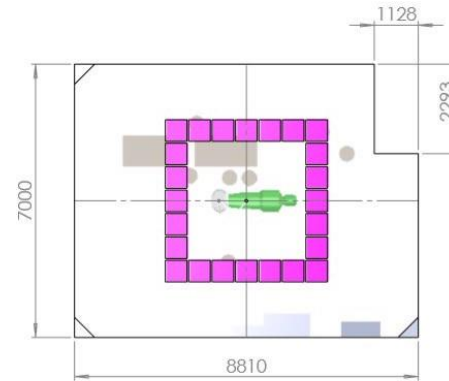
2. CFD Simulations

- What can be simulated/visualised?
 - Air flow
 - Direction of flow
 - Affect of surgical lights or other medical devices
 - Air temperatures
 - Air velocities
 - Age of air
 - Ventilation effectiveness
 - Air cleanliness
 - Particle cleanliness
 - Microbial cleanliness



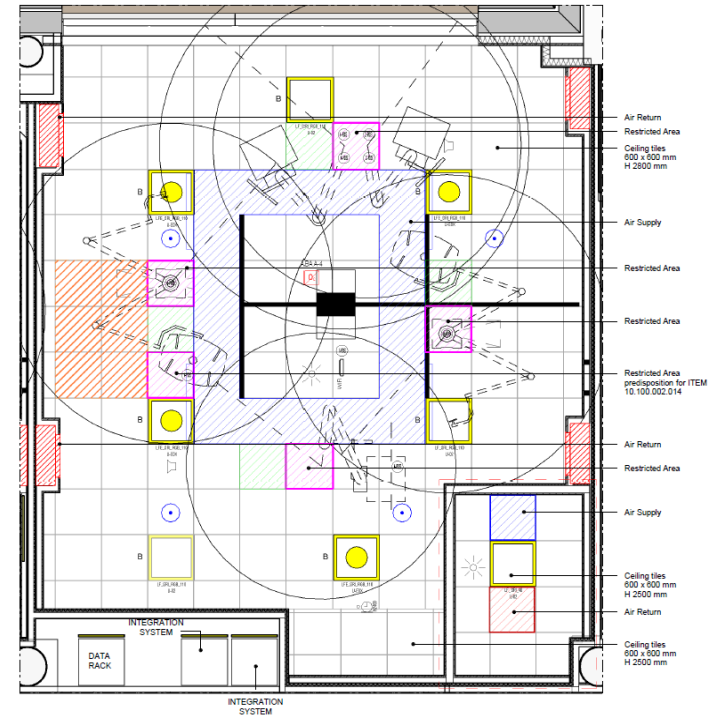
2. CFD Simulations

- What is required to make a simulation
 - Room layout
 - Plan drawing/ 3D drawing
 - Room height
 - Windows, doors
 - Ventilation design
 - Air flow rates
 - Location of supply air and exhaust air devices
 - Design temperatures
 - Room temperature
 - Supply air temperature
 - Location of personnel and medical devices
 - Internal heat loads
 - External heat loads



The Operating Room and Halton Vita OR Space

Det begynder med en tegning



1 Plan 1 (01)_ARK - DP100.04.0067 - Operationsstue, Medium, Type 2

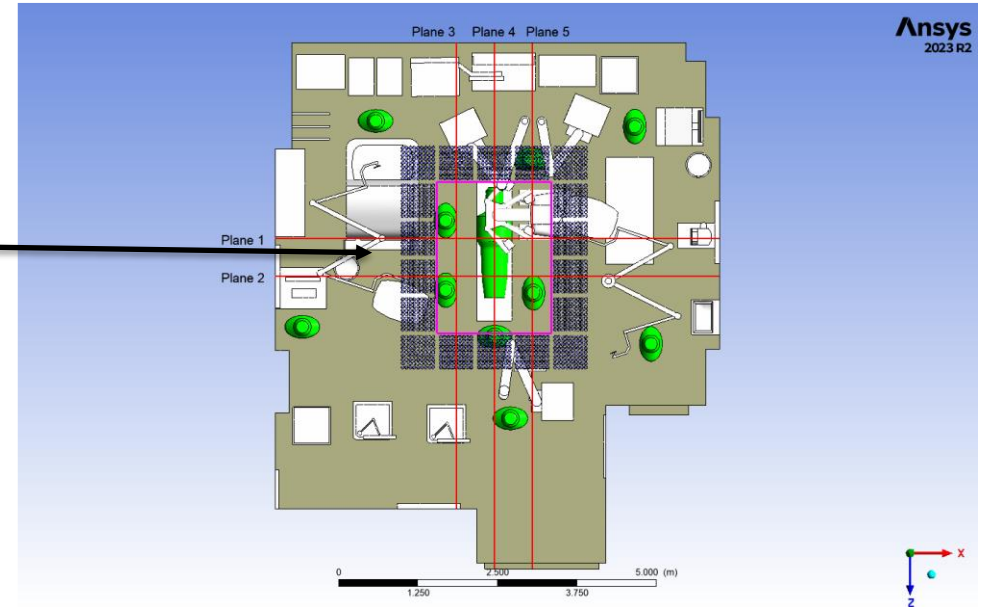
Initial Values	
Room size	49 m ²
Supply Air Temperature	20,5 °C
Total Supply Air Flow Rate	6050 m ³ /h
Total Equipment Heat Load	4500 W
Medical Staff Heat Load	600 W
External Heat Load	640 W
General Lighting Heat Load	160 W
Number of Persons in the Room	10
Total CFU Release Rate (1,5 CFU/s per person)	15 CFU/s

Nogle Værdier / data

CFD Geometry

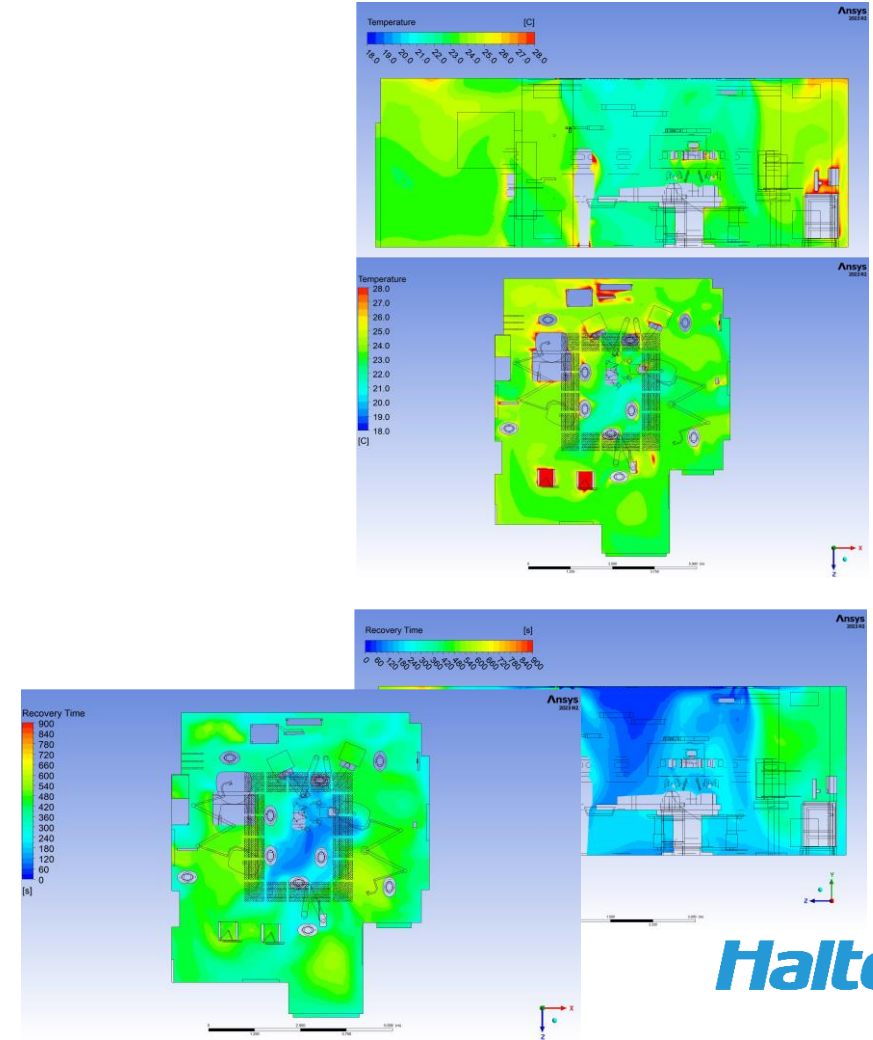
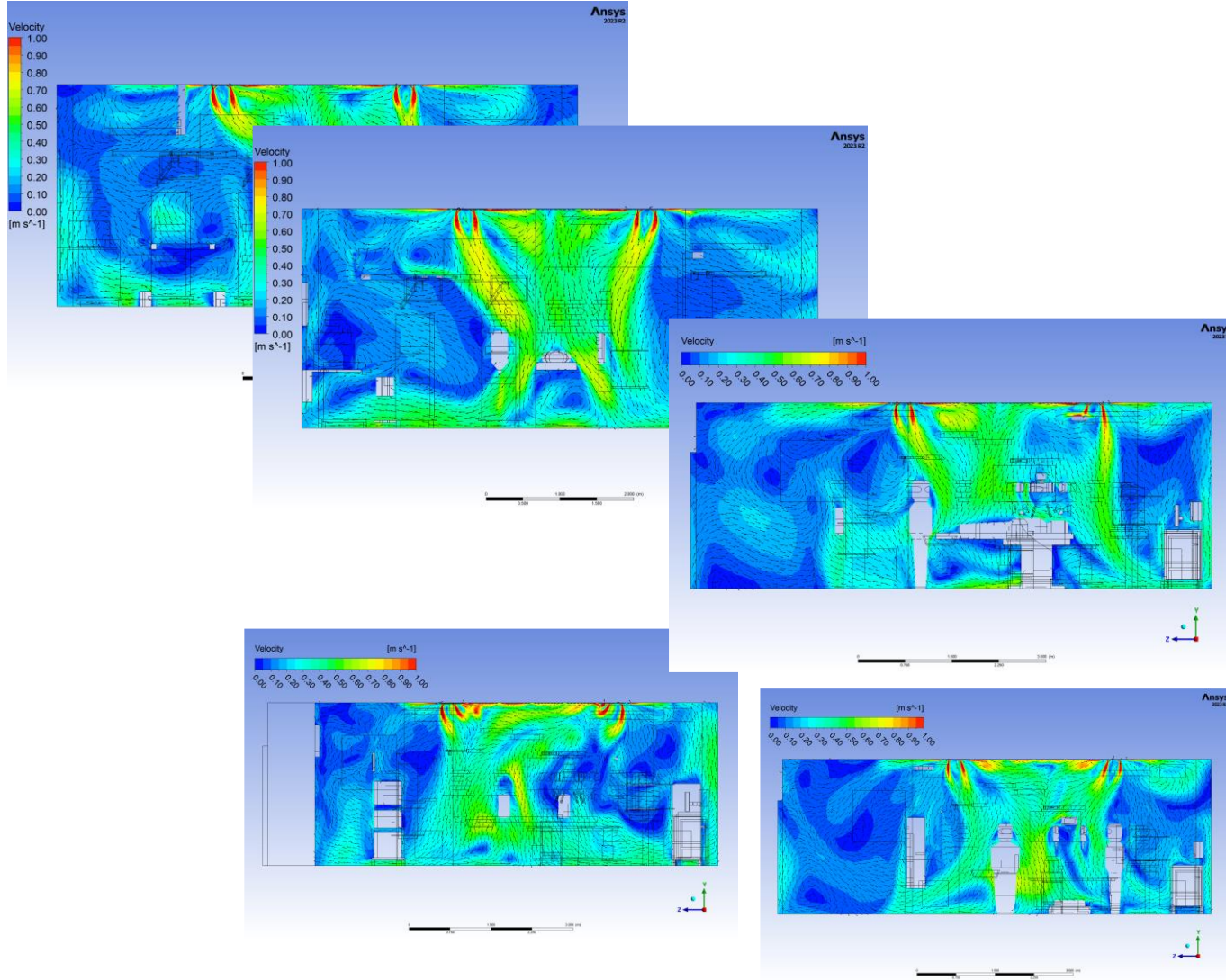


Valgte indblæsning metode
Udsugning
2/3 ved gulv
1/3 ved loft



Derefter sættes computeren i gang
Og der ventes

Målinger og visning



Hvad anvender vi dem til ?

Konstaterer om vore teoretiske beregninger holder hvad de lover
 Tilrette på luftmønsteret, letter vores arbejde under commissioning (dysser er sat)
 Tjekke temperaturen i rummet
 Konstatere træk påvirkninger



© Halton

Project		Default values														Ultra clothing (cfu/s)			clean clothing (cfu/s)			Normal clothing (cfu/s)			Halton									
Room description	Floor plan name	Cleanliness Class	Target CFU level* (cfu/m ³)	Target Recovery time* (min)	ISO Class*	Floor area (m ²)	Room height (m)	Room volume (m ³)	Personel max (stk)	Clothing factor (cfu/s)	Room Pressure (Pa)	Internal Heat load (kW)	Room Temperature min (°C)	Room Temperature max (°C)	Fresh air volume (l/s)	fresh air temp	water 45/30°C	water 7/12°C	<31 dB(A) per unit to achieve <38 dB(A)															
Operating room	Theatre 1	Clean	100	20	ISO 7	69,0	3,0	207,0	12	2,9	15	5	18-26	6,1	350	18	45/30°C	7/12°C	<31 dB(A) per unit to achieve <38 dB(A)															
			N/A	N/A	N/A				0																									
			N/A	N/A	N/A				0																									
			N/A	N/A	N/A				0																									
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			N/A	N/A	N/A				0																									
			N/A	N/A	N/A				0																									
* Based on Cleanliness Class															m ³ /h	m ³ /h	m ³ /h																	
															1260	14580	15840																	
qs value depends on what kind of clothing material is used by the personnel, see values (*) below															#VÆRD!!	#VÆRD!!	#VÆRD!!																	
- clean room operation clothing, 99 % polyester, 1 % carbon fibre => qs= 0,7 CFU/s															#VÆRD!!	#VÆRD!!	#VÆRD!!																	
- disposable operation room clothing, 100 % polypropylen => qs= 1,15 CFU/s															#VÆRD!!	#VÆRD!!	#VÆRD!!																	
- common operation room clothing, 50 % cotton, 50 % polyester => qs= 1,9 CFU/s															#VÆRD!!	#VÆRD!!	#VÆRD!!																	
- operation room clothing, 99 % polyester, 1 % carbon fibre => qs= 2,9 CFU/s															#VÆRD!!	#VÆRD!!	#VÆRD!!																	
- standard operation room clothing, 69 % cotton, 30 % polyester, 1 % carbon fibre => qs= 5,0 CFU/s															#VÆRD!!	#VÆRD!!	#VÆRD!!																	
*) Values are from Practical Safety Ventilation in Operating Rooms- An Introduction by Ljungqvist & Reinmuller, 2013, Chalmers University of Technology															#VÆRD!!	#VÆRD!!	#VÆRD!!																	

Resultat

CFD Simulation Results	
Average Temperature in CFD	23,7 °C
Average Recovery Time at Upper Exhausts	7,0 min
Average Recovery Time at Lower Exhausts	5,9 min
Theoretical value of Recovery Time	6,4 min
Average CFU Level in Operating Area	3,5 CFU/m ³
Average CFU Level in Central Region	7,5 CFU/m ³
Average CFU Level in Whole Room	8,6 CFU/m ³