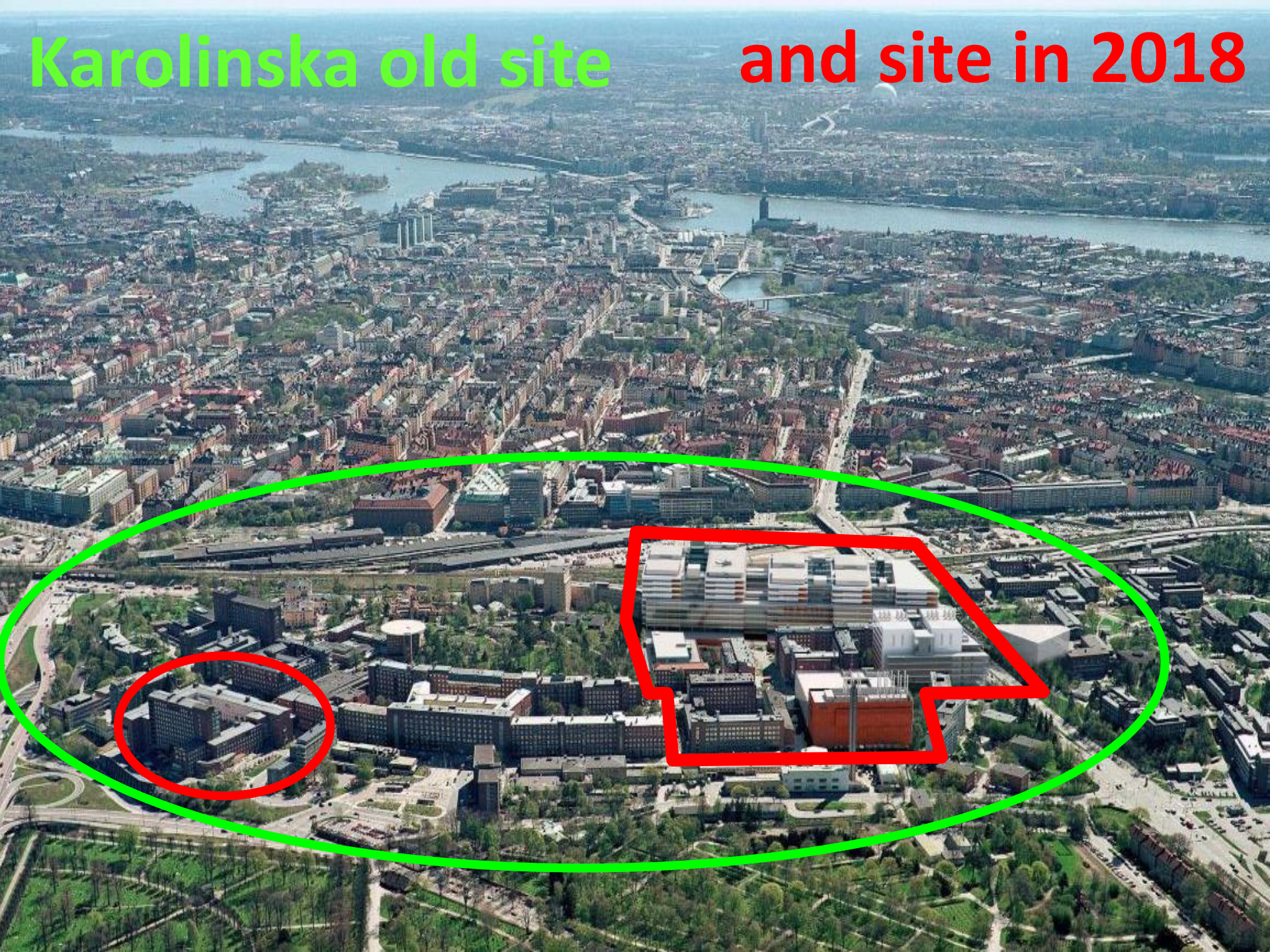
Safety Ventilation and Infection Control in Operating Roooms – comparative analyze of air diffusion strategies, medical needs, and other choices made in planning the New Karolinska Hospital Operating Rooms

Johan Nordenadler, PhD, Safety Ventilation in Operating Rooms, Karolinska University Hospital

Johan.Nordenadler@sll.se

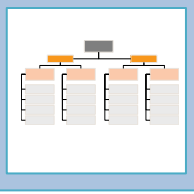
CHOSING THE ULTRA CLEAN VENTILATION SYSTEM AT THE NEW KAROLINSKA HOSPITAL, STOCKHOLM

Johan Nordenadler, PhD, Safety Ventilation in Operating Rooms
Project Leader OR Design and MedTech-OR-Procurements at Karolinska University Hospital
Johan.Nordenadler@sll.se


Karolinska old site
and site in 2018

NEW KAROLINSKA HOSPITAL - three processes

Designing and Building the Hospital

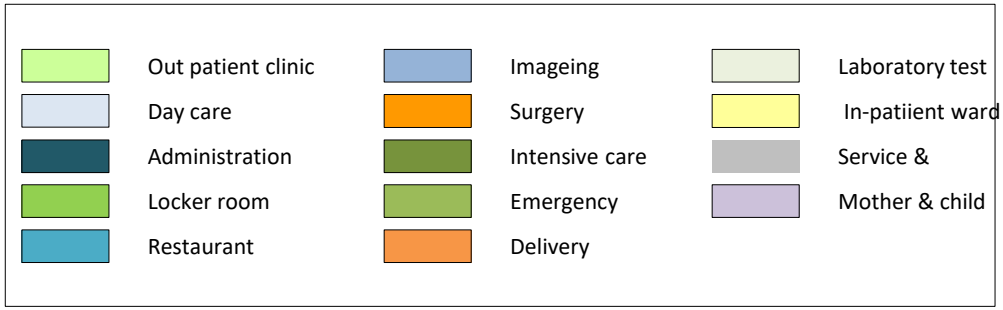


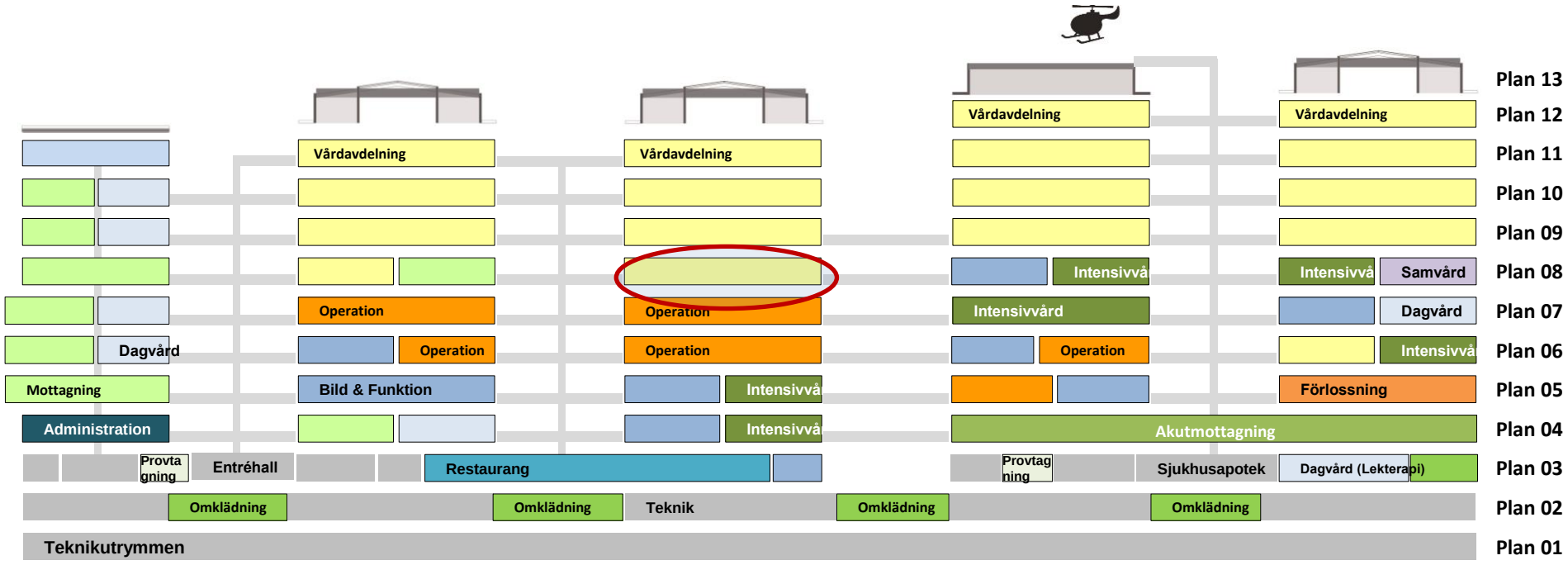
Clinical content and organisation

Supplying the hospital with medical, technical and communication equipment

NKS

Main Complex:
Max length of each building: 82m
Width of each building: 57m
10 000+ Rooms
330 000 m2





Elective flow

Acute flow

255 m

Close cooperation between Operation, Intensive Care and Imaging

Chosing the OR ventilation System

Callenges at New Karolinska Hospital

- Flexibility; Clinical activities ?
- Flexibility; Med tech equipment in the OR´s ?
- Only Technical areas at ground floor
- Economy; High energy efficiency demand
- Environment; Attractive working environment
- Ultraclean environment: < 5 CFU/m³

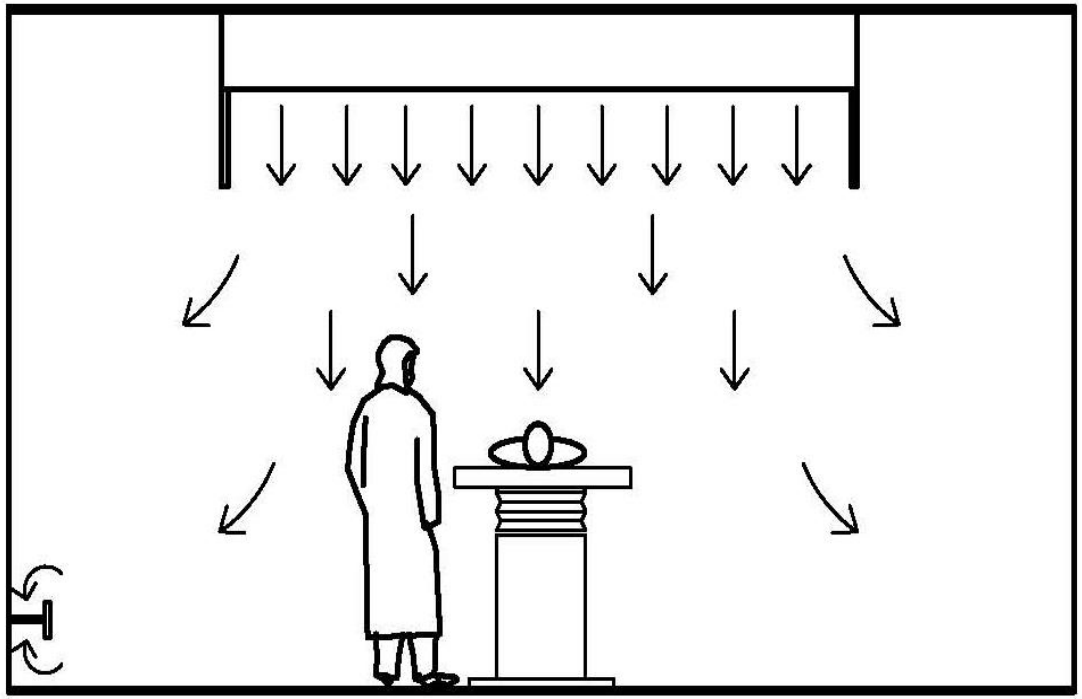
My PhD 2006-2011

Safety Ventilation in Operating Rooms

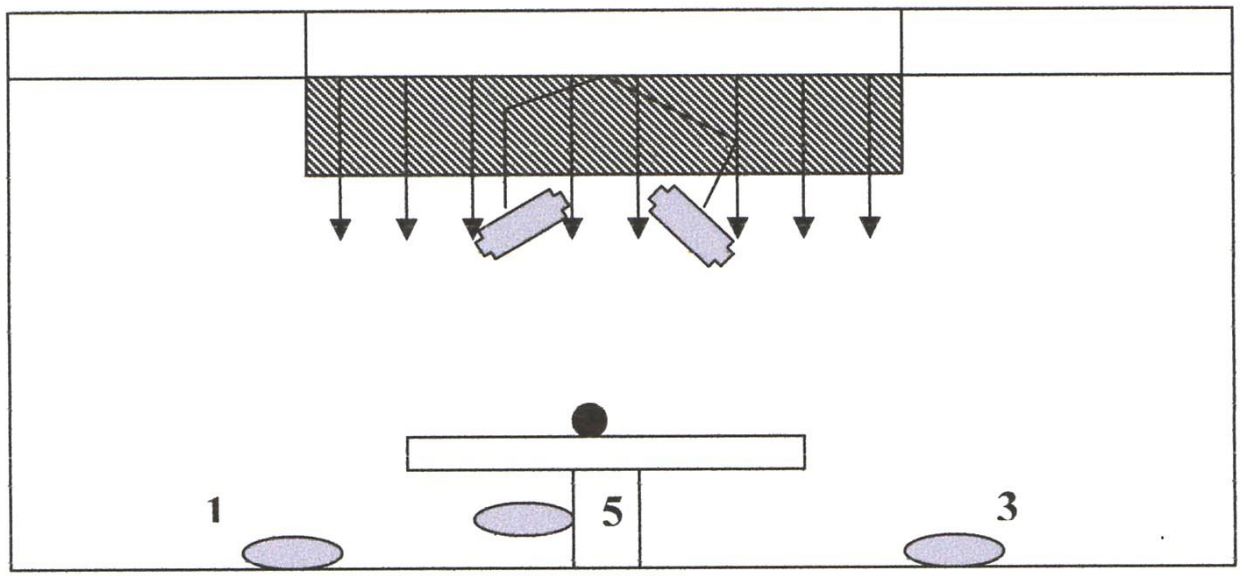
Litterature Study OR Ventilation Systems
Lab Studies – UDF-systems
Field Studies – UDF-systems
OR Clothing Systems- Fieldstudy
Door Openings in the OR – Theoretical study

My PhD 2006-20011

Vertical UDF without side walls – most common ”LAF”



1990´s and forward
UDF systems with lower air velocities (< 0,3 m/s) and without sidewalls are installed



Sidoskärm

Belastningsområden 1, 3 och 5

Mätsondens placering

Operationslampa

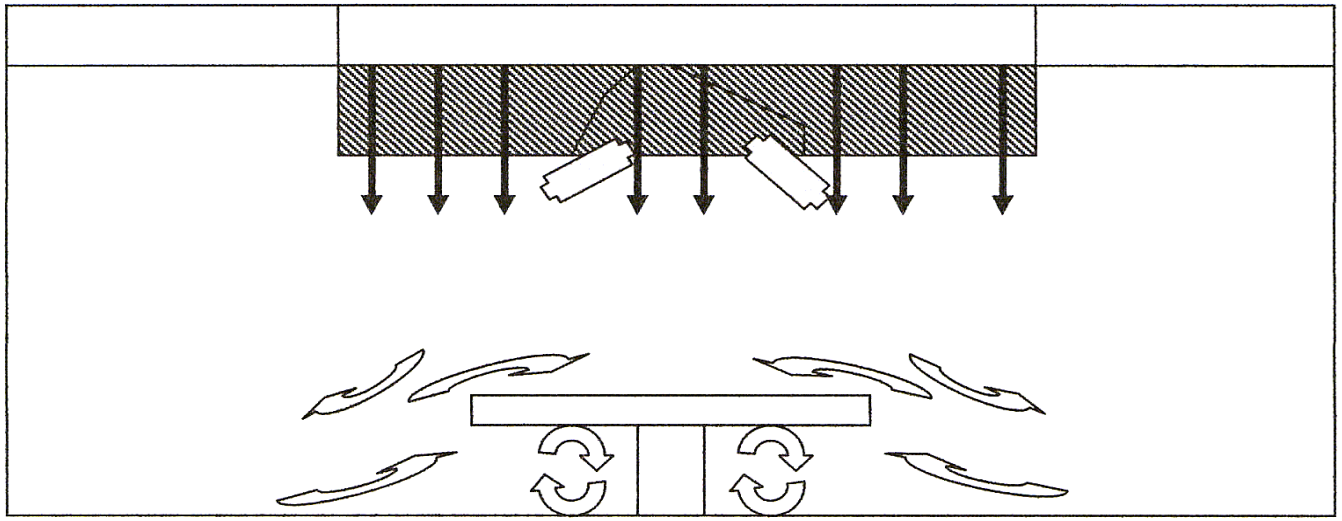
REGISTRATED PARTICLES IN 3 ORs (FOUR CASES)

PM (antal partiklar (≥ 0,5 µm) per kubic foot registrated on the OR Table

Generating smoke (0,2 m över golv)	OP A Air Velocit 0,27 m/s	OR B Air Velocity 0,27 m/s	OR B Air Velocity 0,40 m/s	OR C Air Velocity 0,50 / 0,25 m/s (inre/yttre zon)
1	> 100.000	32	1 383	56
2	4495	1	1	198
3	> 100.000	55 537	1	0
4	> 100.000	0	7	0
5 (under the table)	> 100.000	> 100.000	864	103

OBSERVED AIR MOVEMENTS

UDF (0,27 m/s)



Sidoskärm

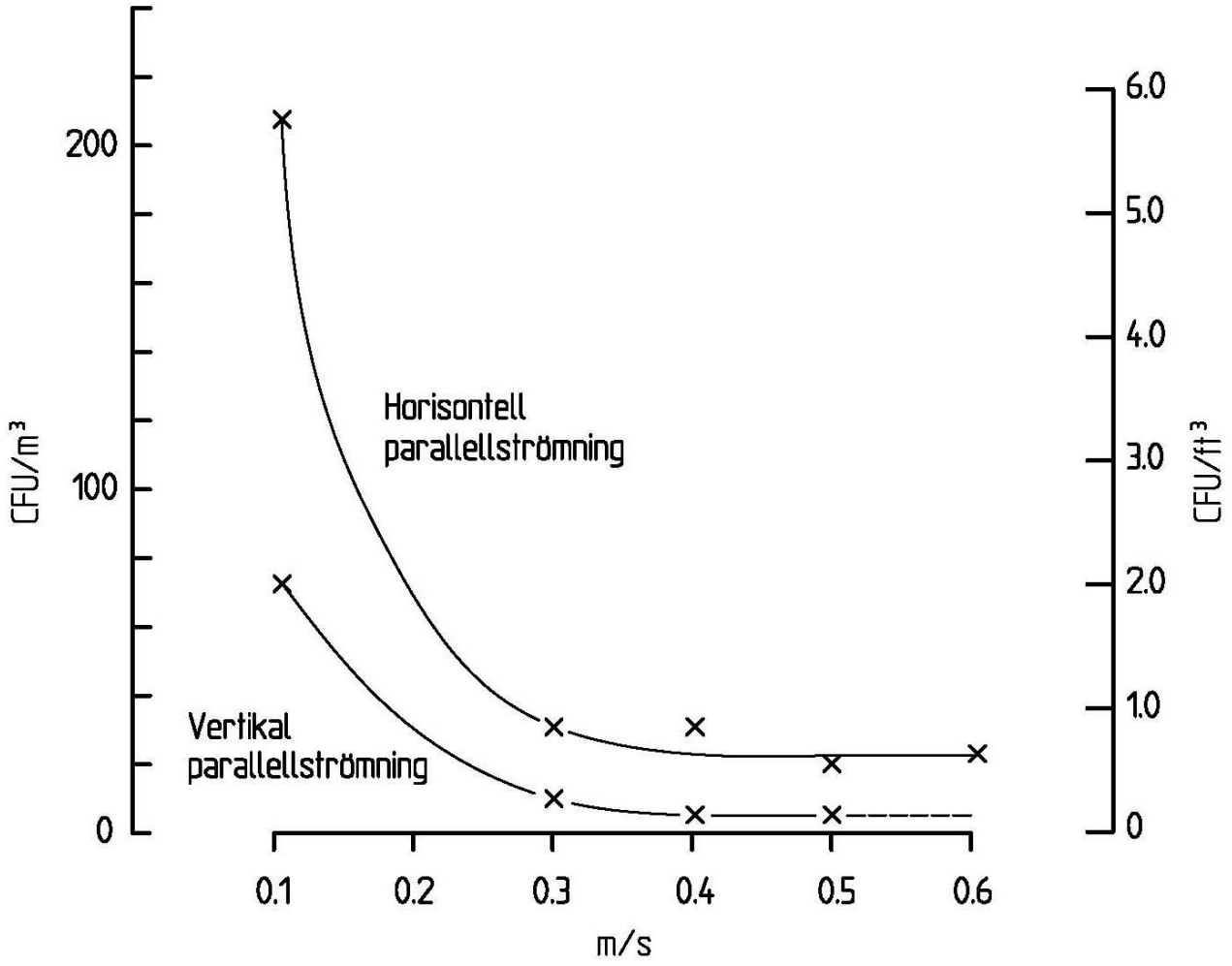
Parallellströmning

Observerade luftrörelser

Operationslampa

Measured CFU/m³ at different air velocities in operating rooms with UDF systems

- Whyte et al (1973)



Conclusions of my PhD

Air velocities > 0,4 m/s = parallell flow (UDF)

(we have a so called sweeping action over the OR table)

Air from the so called ”non-sterile” zone in the OR may come into the so called ”sterile zone” if UDF-systems with low air velicities (< 0,3 m/s) are used

Air velocities < 0,3 m/s = Turbulent Mixing Ventilation

Teknisk specifikation

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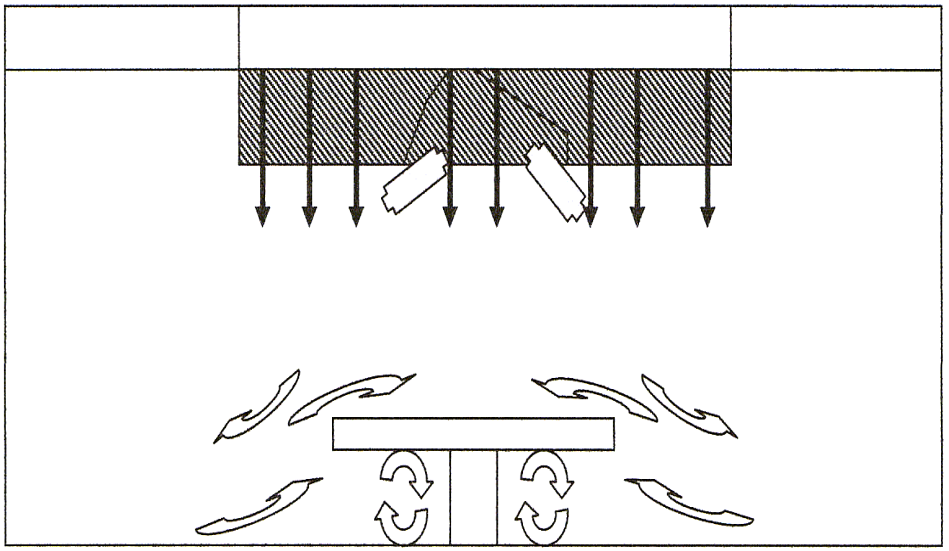
Mikrobiologisk renhet i operationsrum – Förebyggande av luftburen smitta – Vägledning och grundläggande krav

Microbiological cleanliness in the operating room – Preventing airborne contamination – Guidance and fundamental requirements

In Sweden Technicians can choose of
2 different Ventilation Systems:
- Turbulent Mixing
- UDF

Observed air movements



Side screen

Parallel flow

Observed air movements

Operation lamp

Unidirectional air supply
- 0,27 m/s

Medelvärden av antalet bakteriebärande partiklar per kubikmeter luft vid olika ventilationssystem och operationsklädsel (enligt Lidwell et al (1982))

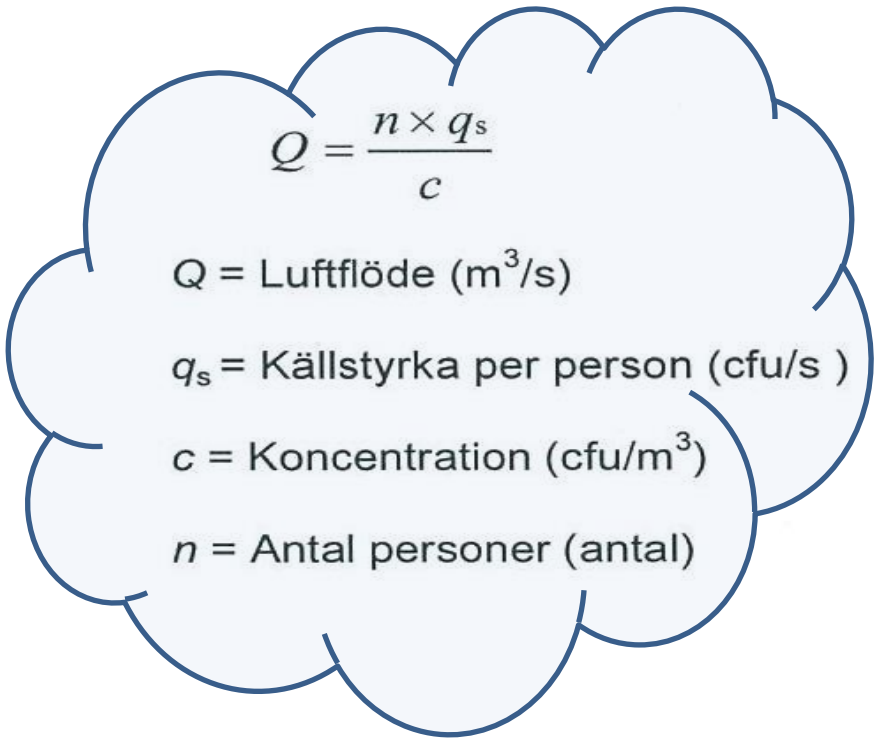
Ventilation System	CFU/m3	
	CS Normal/ Vanlig klädsel	CS Special
Conventionell (turbulent)	164	51
Allander System	49	14
Horisontell luftföring (UDF)	22	1
Vertical UDF w no side walls	10	-
Vertical UDF w walls	2	0,4

Redovisning av beräkningar på källstyrkan per person för respektive klädsystem som använts i operationsrum F under pågående operation vid luftflöde ***0,54 m³/s.***

Clothing System	Medelvärde CFU-halt (CFU/m³)	Medelvärde antal personer (st)	Källstyrka (CFU/s)
Mertex	58,9	5	6,4
Konventionellt klädsystem	26	7	2,0
Clean Air Suit	13,4	8	0,9
All in Clean Room	2,4	7	0,2

2010: Chosen Ultraclean System at New Karolinska

Formula for ”Turbulent mixing ventilation system”
or UDF < 0,3 m/s



Concentration: < 5 cfu/m^3

10 persons in the OR

We chosed a clothing system with a source strenght of
1,0 cfu/s

Air flow rate:
2000 l/s (2500 l/s)

NKS = Turbulent Mixing System was chosen (2500 l/s)


L. Boni, MD, FACS
L. Boni, MD, FACS

Chosing the OR ventilation System

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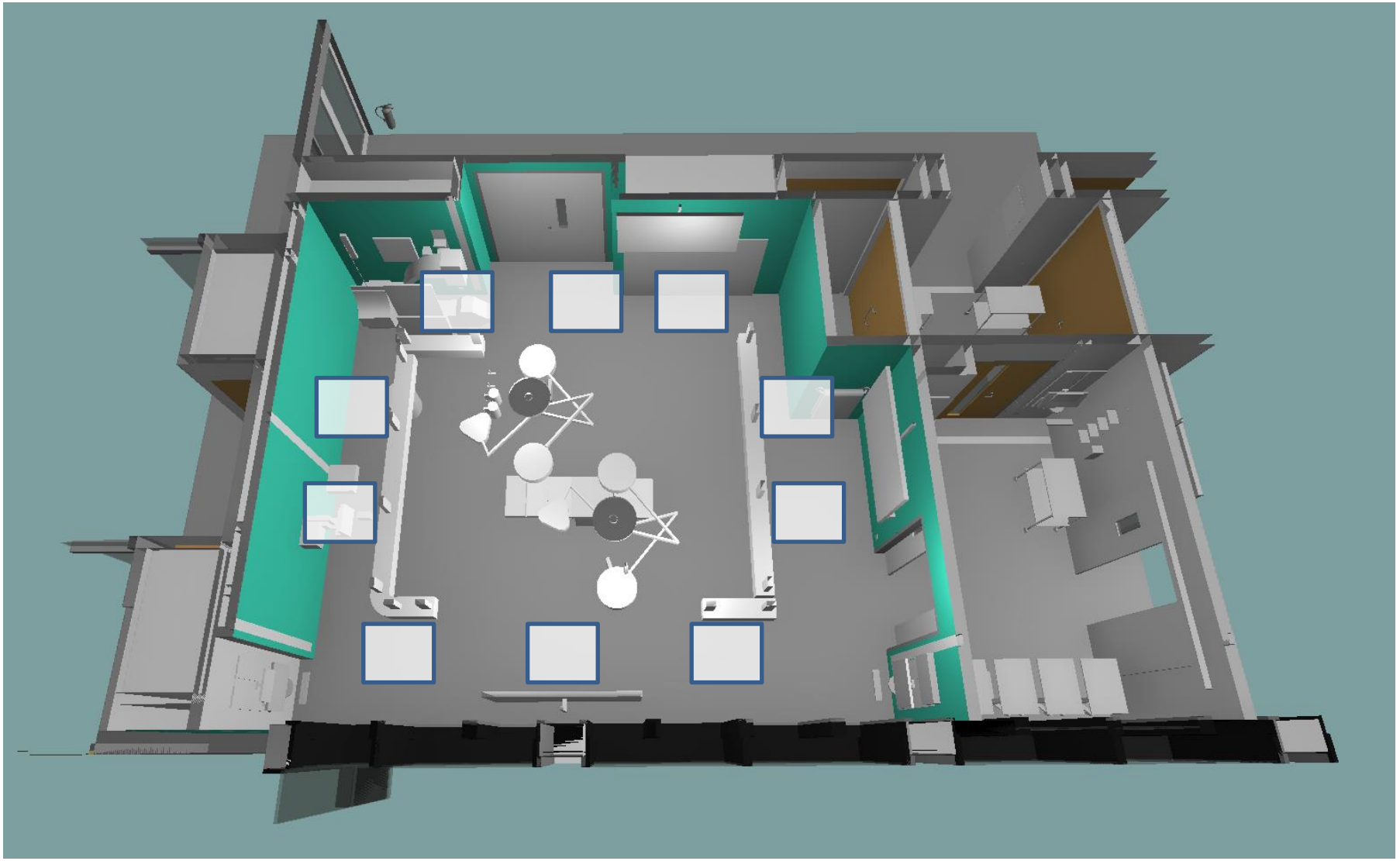

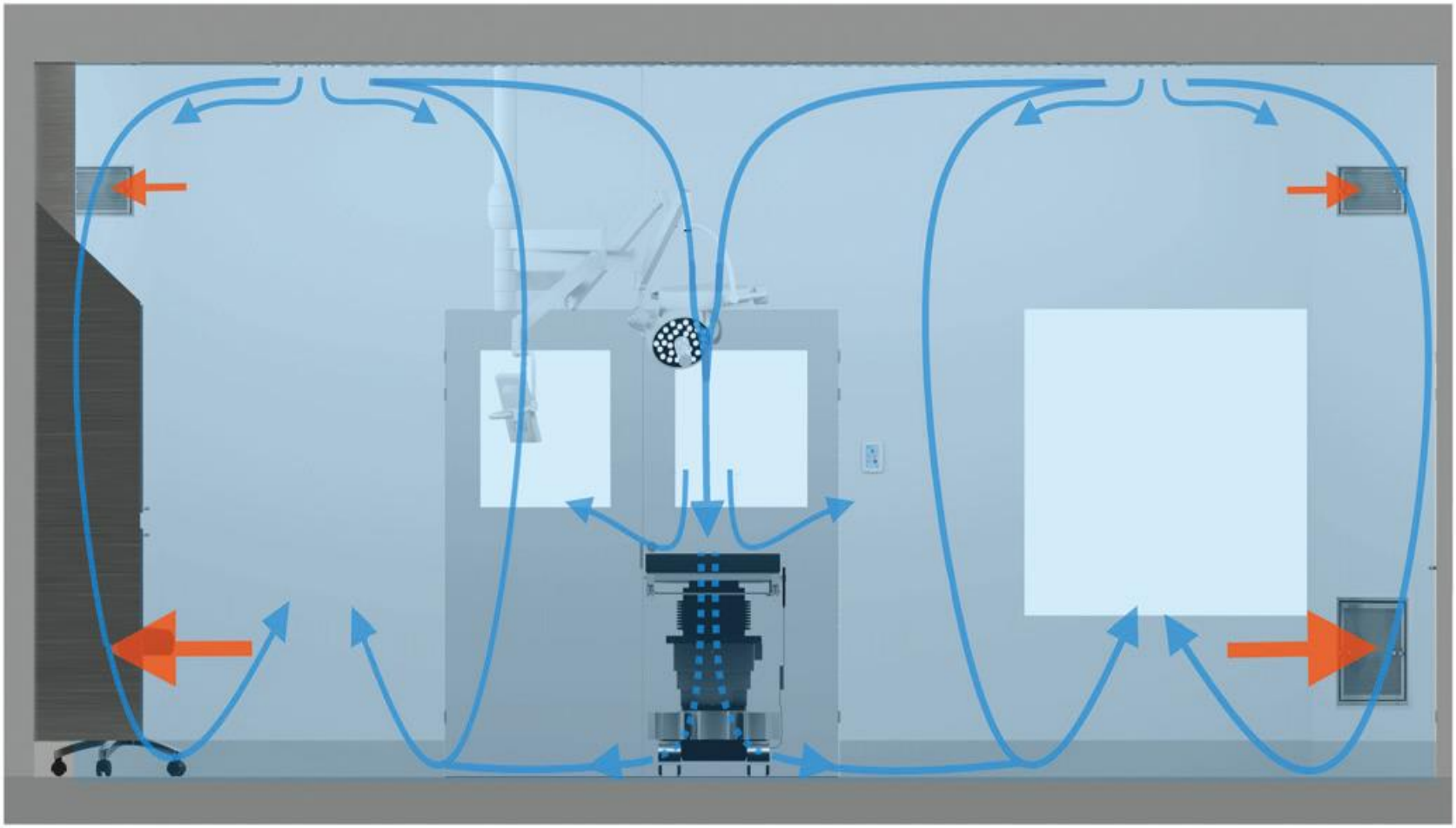

Skanska Chosed the Halton VITA System

Does it work?

SIMULATED < 5 cfu/m3 LIVE < 5 CFU/m3

Infection Control by Air in the OR:

Operating Room Ventilation System
OR Clothing Systems
Climate Control (working conditions)
Number of People in the OR
Filter Quality
Activity of the People in the OR