

Cleanroom



HFP

| Institute of Semiconductor
and Solid State Physics

CLEANROOM



Cleanroom

- Usage
- Definition
- Classification
- Operation: new vs. old
- New Cleanroom OIC

People as a source of contamination

- Particles
- Garment

Equipment

- Cleanroom OIC
- Cleanroom Hlphys

Usage

Cleanrooms are used in practically every industry where small particles can adversely affect the manufacturing process:

- Scientific research
- Semiconductor fabs
- Food industry
- Automobil industry
- Laser production
- Pharmaceutical industry
- Hospitals, ...

CLEANROOM

Definition

Cleanroom

room within which the number concentration of airborne particles is controlled and classified, and which is designed, constructed and operated in a manner to control the introduction, generation, and retention of particles inside the room

Classification according to size dependent particle concentration :

Most relevant standards:

- ISO 14644-1
- FED US 209E - old Particles/ft³

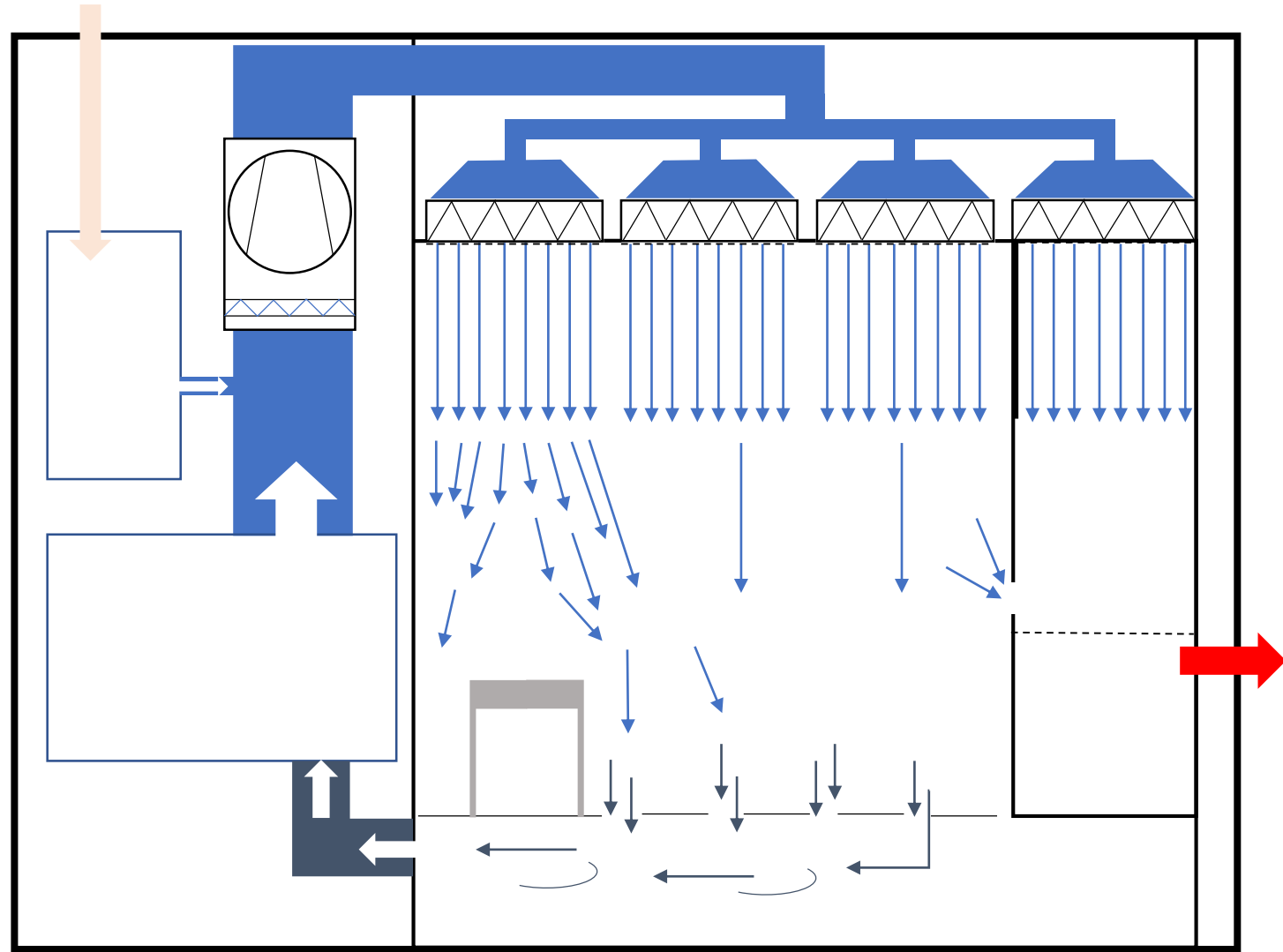
Classification

Class	Maximum particles/m ³ ^a						FED STD 209E equivalent
	≥0.1 μm	≥0.2 μm	≥0.3 μm	≥0.5 μm	≥1 μm	≥5 μm	
ISO 1	10 ^b	d	d	d	d	d	e
ISO 2	100	24 ^b	10 ^b	d	d	d	e
ISO 3	1,000	237	102	35 ^b	d	d	e
ISO 4	10,000	2,370	1,020	352	83 ^b	d	e
ISO 5	100,000	23,700	10,200	3,520	832	d,e,f	Class 100 (old CR1)
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293	Class 1,000 (old CR2)
ISO 7	c	c	c	352,000	83,200	2,930	Class 10,000
ISO 8	c	c	c	3,520,000	832,000	29,300	Class 100,000
ISO 9	c	c	c	35,200,000	8,320,000	293,000	Room air

CLEANROOM Old @ Semiconductor Building

Ventilation system

- Laminar flow
- Low – turbulence displacement flow



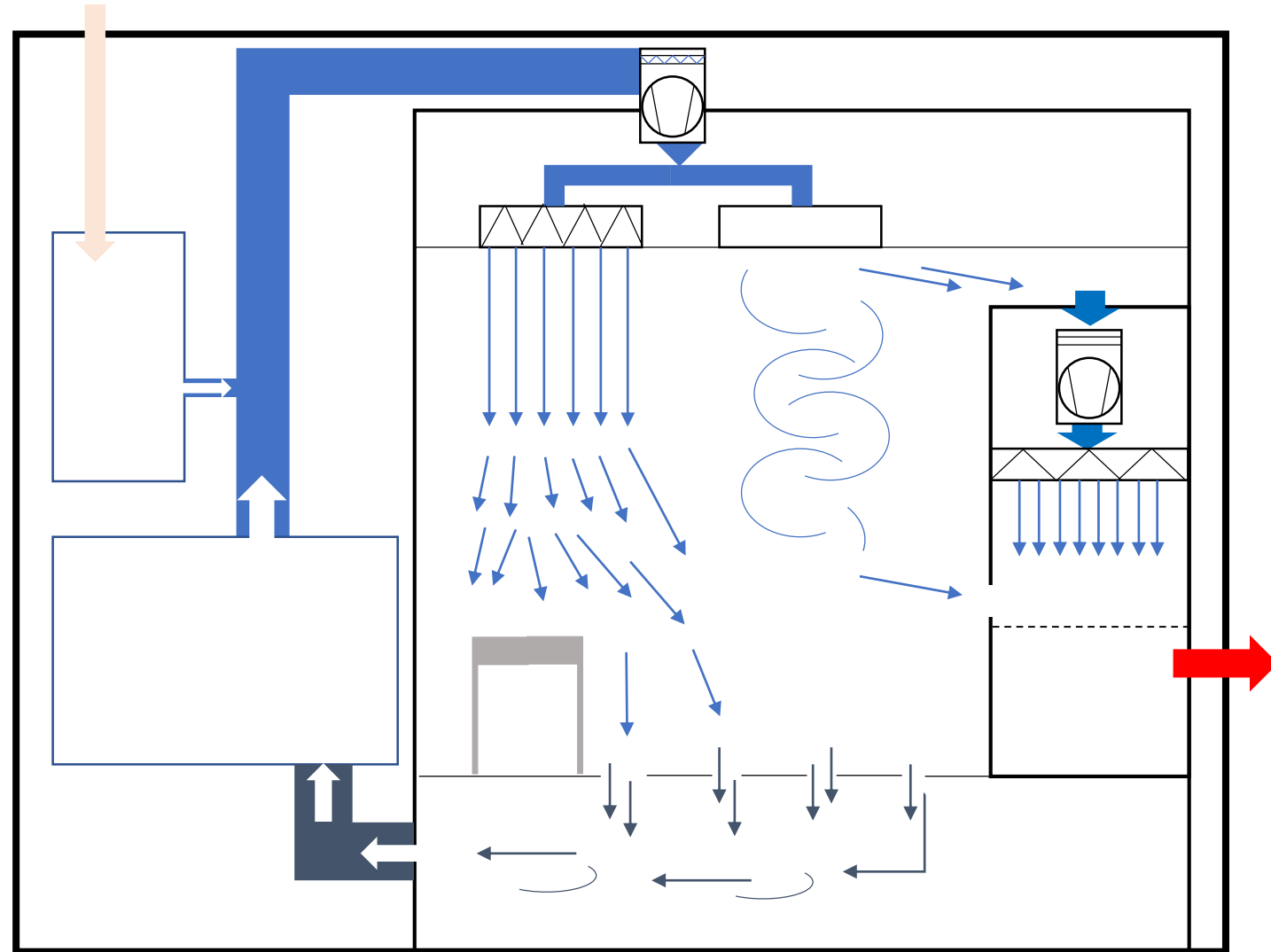
CLEANROOM New @ LIT-OIC

Ventilation system

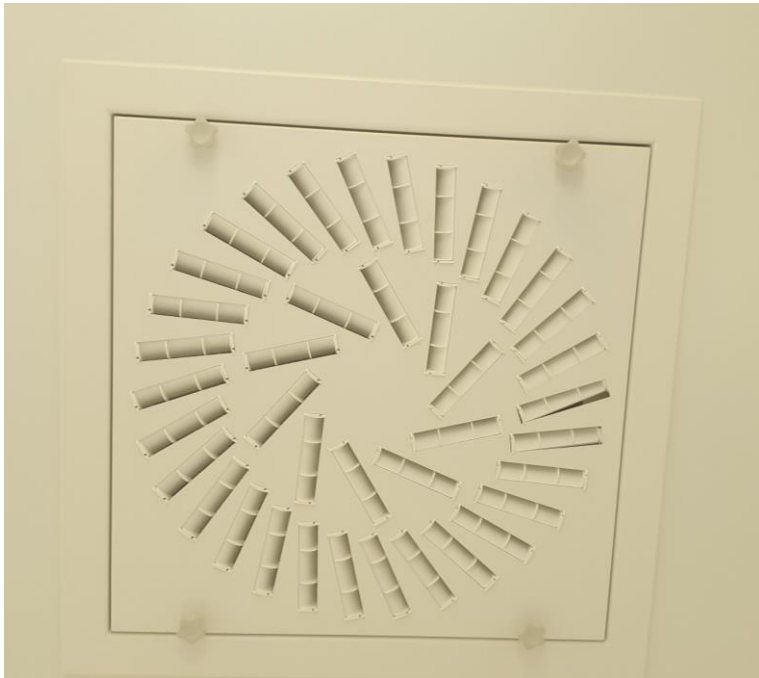
- Combined flow:
 - Turbulent dilution flow
 - Swirl diffuser
 - Laminar flow
 - Laminar filter only or filter fan unit (FFU)

Aircondition

Recirculation air machine



CLEANROOM OIC



Swirl diffuser

Laminar filter

~ ISO 5 (below filters) in CRs 1-3



LIT OIC, CR 2

CLEANROOM OIC

CR1 Lithographie ISO 6 & ISO 5 (in wet benches)

CR2 Device processing ISO 6 & ISO 5 (in wet benches)

CR3 Analytics ISO 6 & ISO 5 (in wet benches)

CR4 Wet chemistry ISO 7

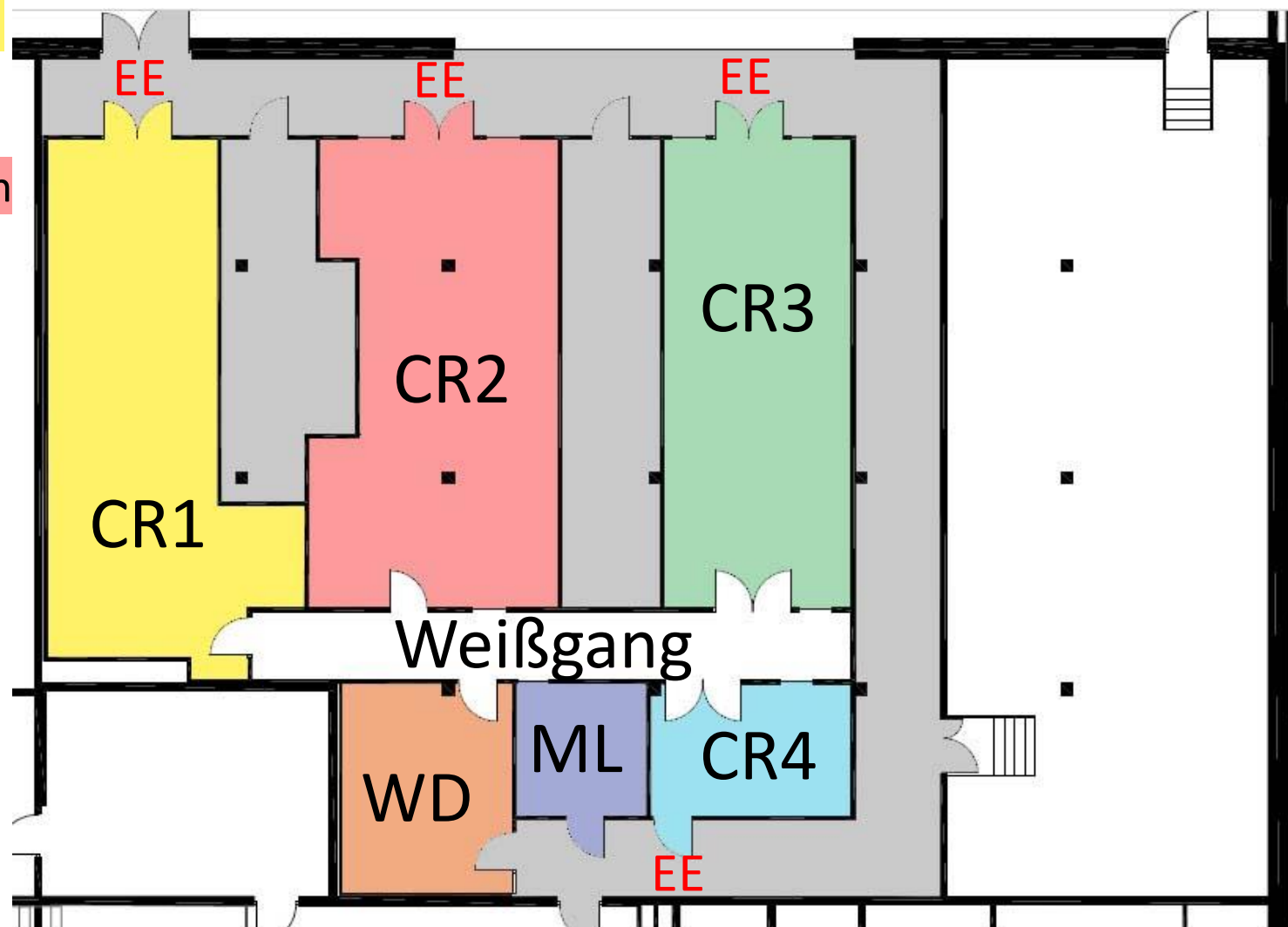
Weißgang ISO 7 (white corridor)

WD Wardrobe ISO 8/7

ML Material lock ISO 9/8

Grey room area

EE: Emergency exit, closed during normal operation

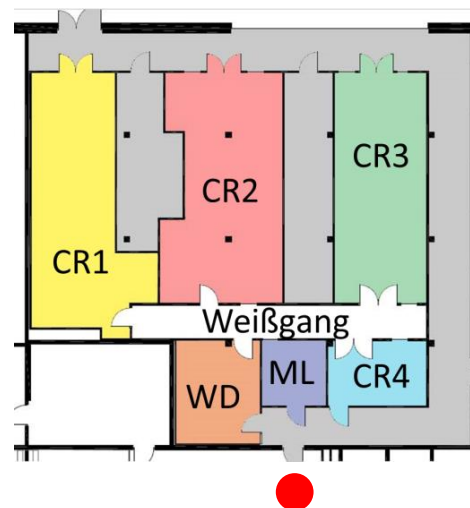


CLEANROOM OIC

Entrance

Main Door

Key card control



Slightly press before pulling:

Due to the overpressure in the grey room, the door latch might be blocked, it is released if you press the door. Pulling might not be necessary in case of elevated overpressure.

Be sure, that door is closed after entry (to prevent alarm in LIT building)



CLEANROOM OIC

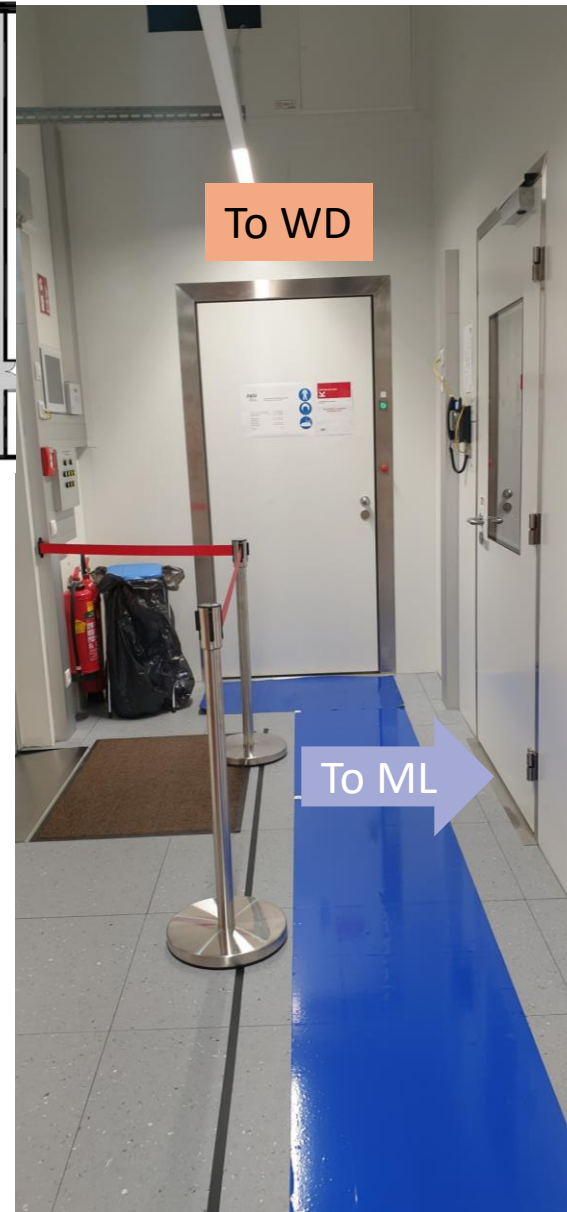
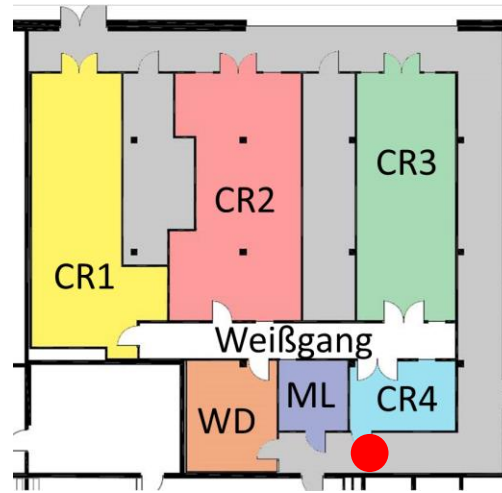
Wardrobe entrance

In Greyroom:

- Flexi barrier tape
- Shoe rack
 - For slippers
- Hallstand
- Sticky mat

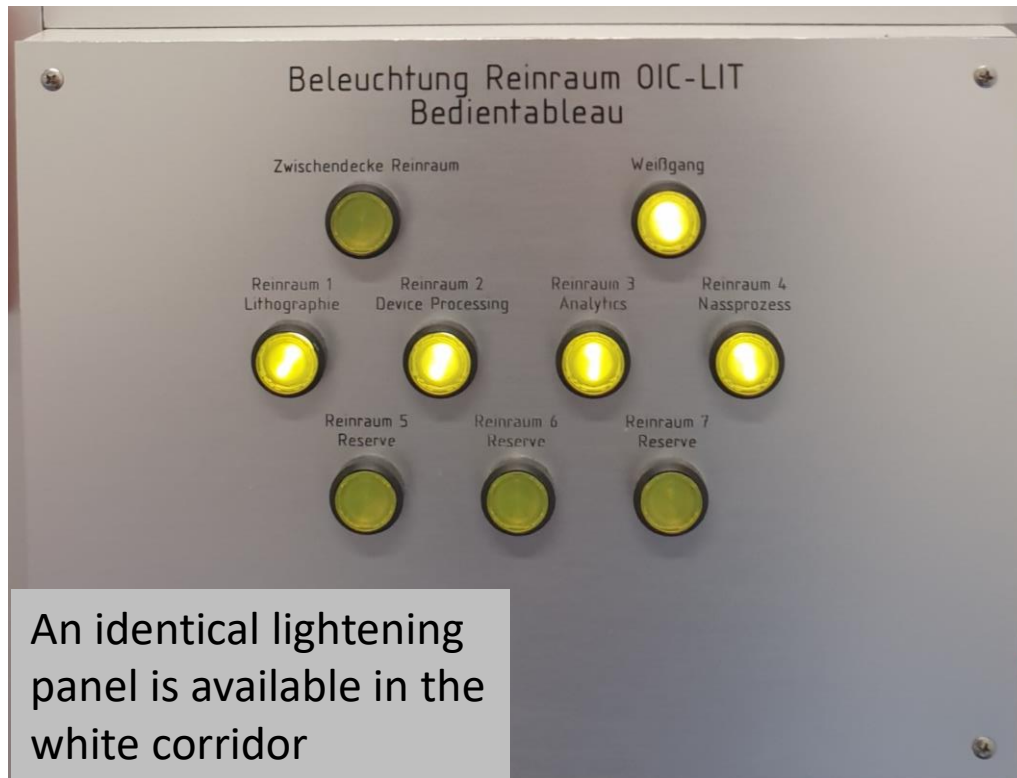
Never walk on sticky mat with your shoes used for entering the grey room. Use your slippers or walk in socks only.

(In socks, you are not allowed to enter the material lock due to chemical hazards.)



CLEANROOM OIC

Wardrobe entrance



CLEANROOM OIC

Wardrobe entrance

Cleanroom status display



Please report red fields





CLEANROOM OIC

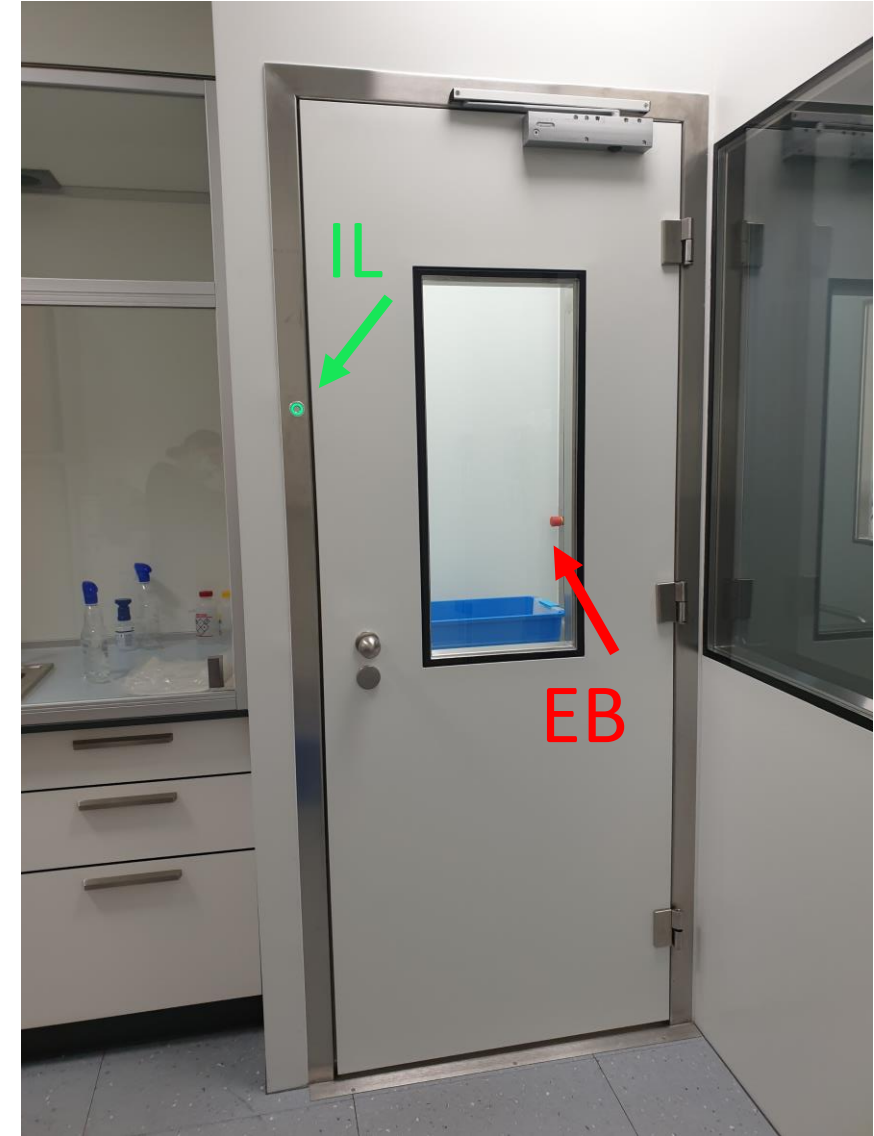
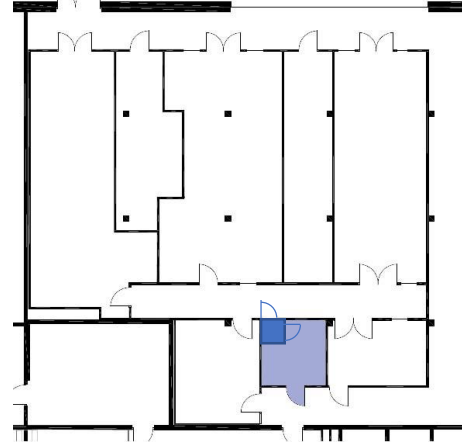
Materials lock (ISO 9) & material transfer cabinet (ISO 7)

(Materialschleuse & Durchreiche)

Both doors of the transfer cabinet are equipped with **electrical interlock** and emergency buttons inside (**EB**) to break the interlock.

Interlock prevents:

- both doors being open at the same time.
- contamination of white corridor (ISO 7) by particles from ML (ISO 9).



CLEANROOM OIC

Materials lock

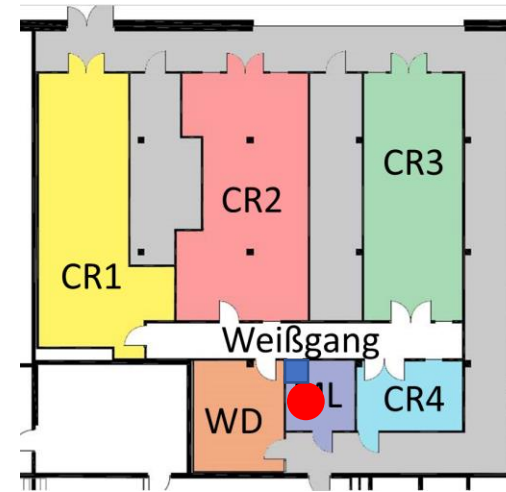
Small fume box:

- Clean all your items here before bringing them into the cleanroom
- Use material transfer cabinet

Storage:

- Glassware,...
- Instruction Manuals

Chemicals safety cabinets



CLEANROOM OIC

Wardrobe entrance

Door:

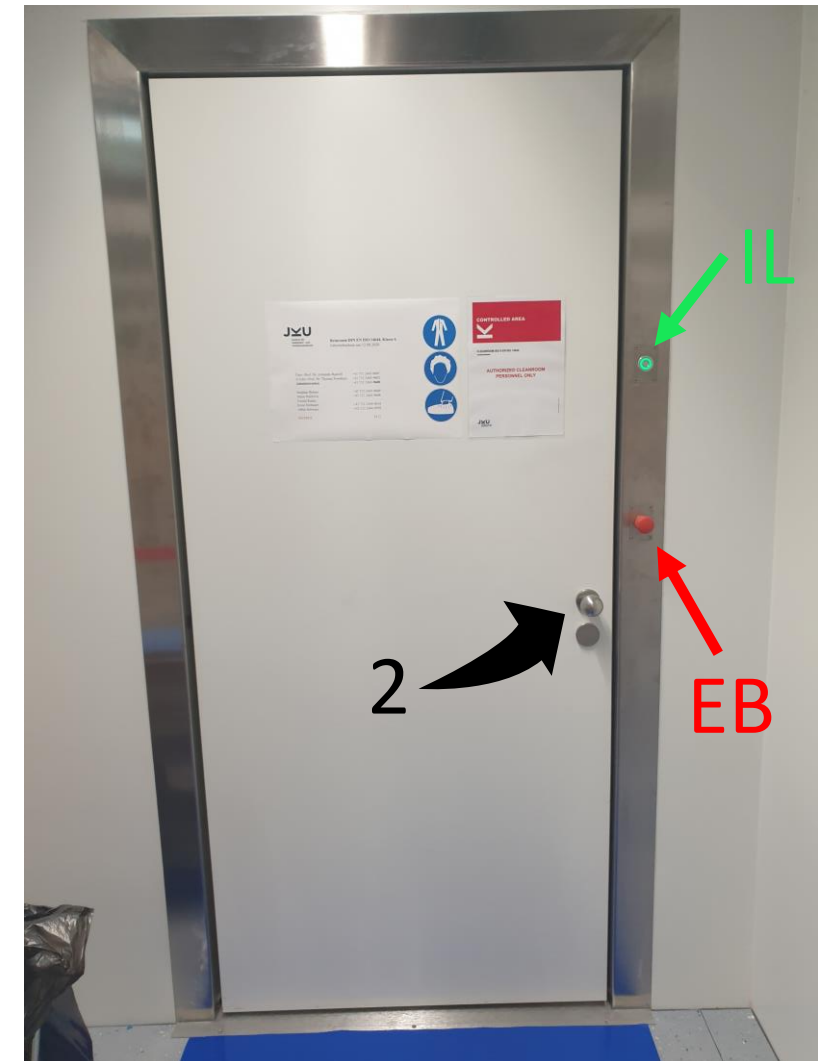
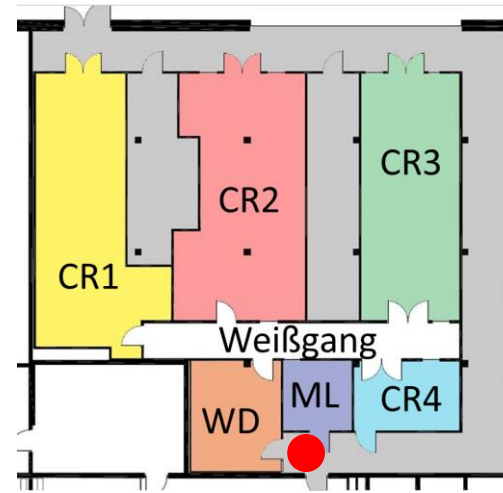
- 1. press the green interlock button (IL)
 - If it is lit red: wait, the door to the white corridor is most likely open.
- 2. push the door

Emergency button (EB): deactivates electric interlock

Use only if:

- IL button is red, but you have to open due to an emergency situation

Report after usage!



CLEANROOM OIC

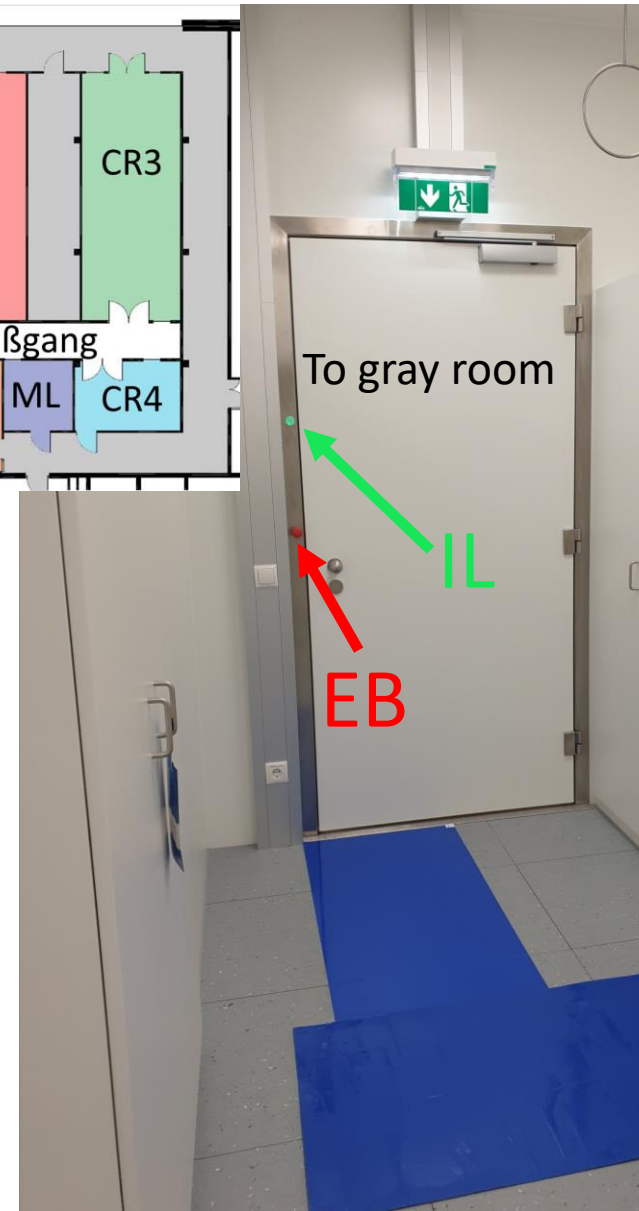
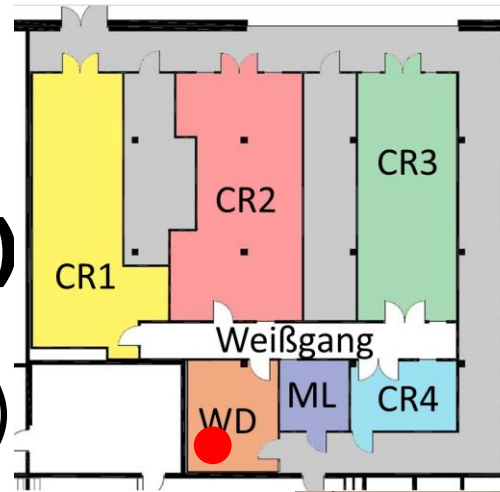
Wardrobe (ISO 8)

Garment cabinets (ISO 7)

Shoe racks

Sit-over with shoe compartments

- Sticky mat



Wardrobe

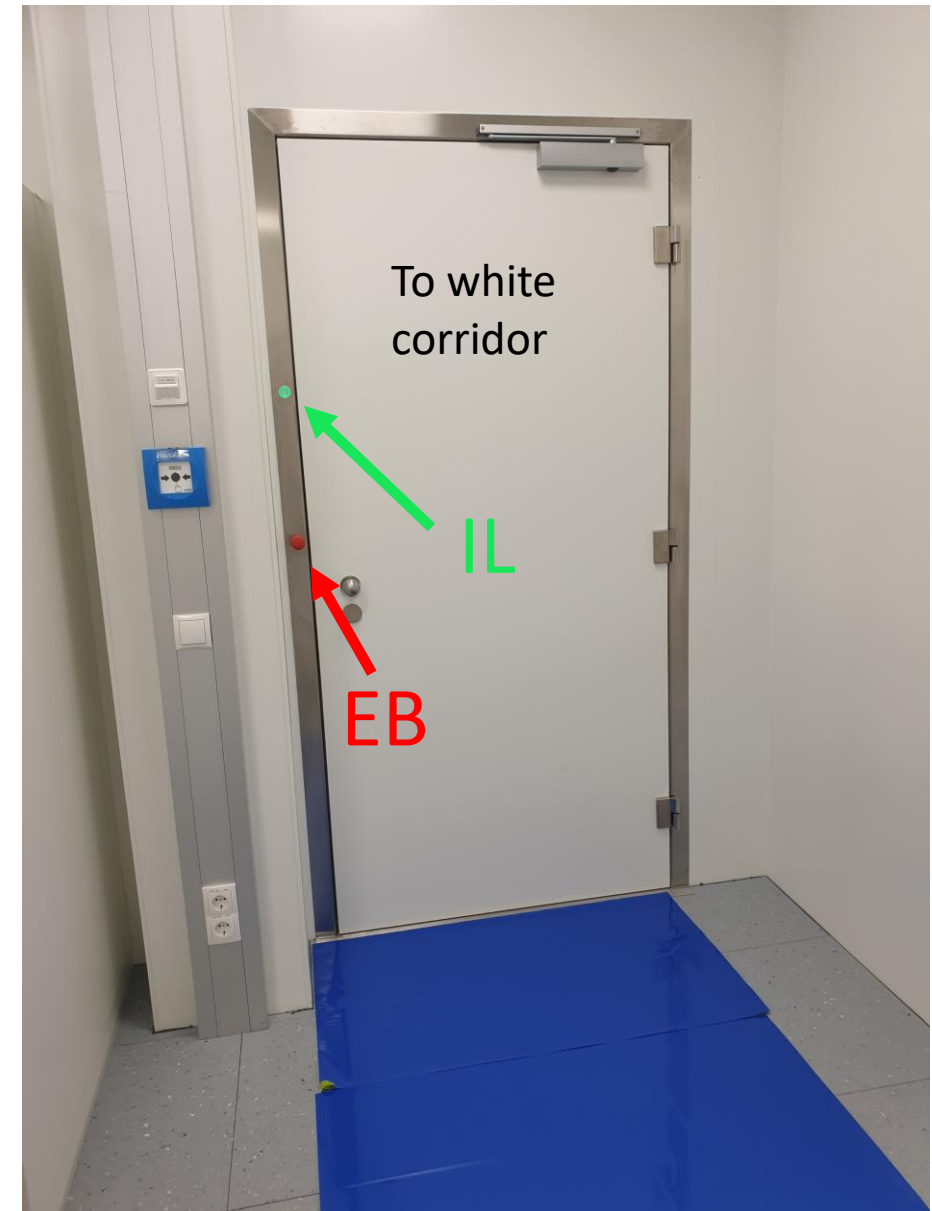
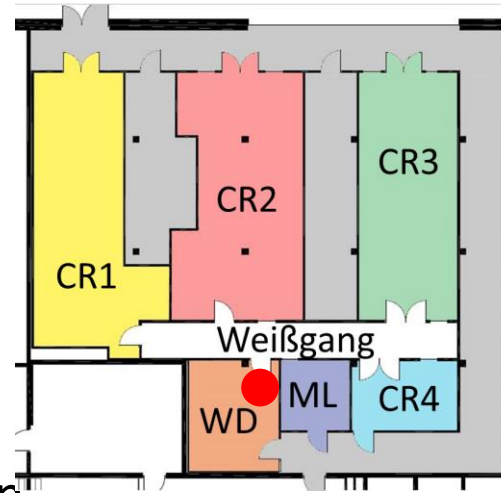
Door:

- 1. press the green IL button
 - If it is lit red: don't pull, check entrance door
- 2. pull the door

Use EB only if:

- Button is red, but you have to open due to an emergency situation

Report after usage!



CLEANROOM OIC

Emergency Alarm

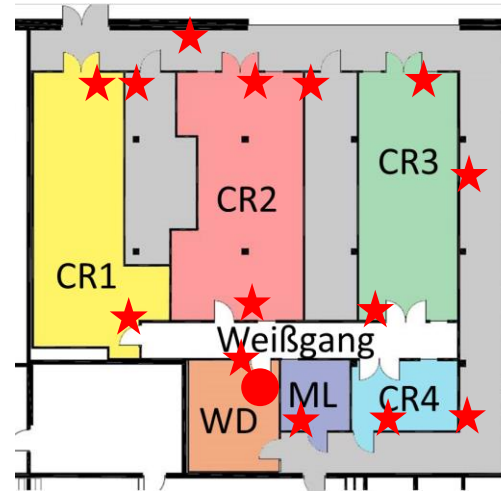
Located at every door and every emergency exit, both in clean and grey rooms.

Don't hesitate to use it in situations endangering you and/or colleagues in the neighbouring clean rooms:

- Fire,
- chemical accidents including spilling and strong fuming,
- injury requiring assistance,
- ...

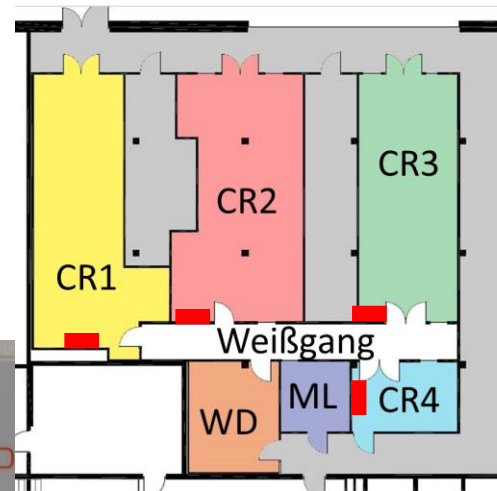
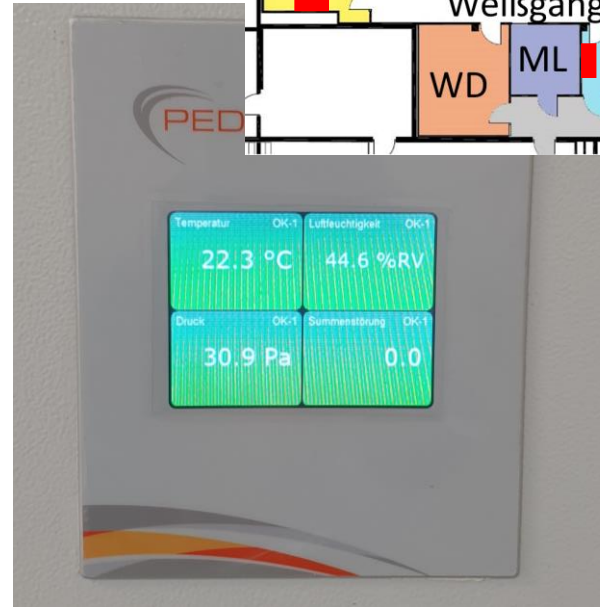
Be aware that colleagues in neighbouring cleanrooms will leave their working place in case of an alarm and are not obliged to check other cleanrooms for victims.

Only the fire brigade is equipped to enter from outside in case of an alarm.



CLEANROOM OIC

Distribution board



Doors contain displays/warnings for :

- temperature
- moisture
- over pressure
- general cleanroom status

General cleanroom status alarm:

Most likely, cleanroom entrance door is not completely closed, please check !

It is unsafe to work in cleanroom, if entrance is not properly closed, since room ventilation will not be adapted to air exhaust in this situation. As a consequence, over/under pressure and insufficient supply of fresh air might occur.

Wet bench (WB)

Operating conditions:

- Red
- Yellow
- Green

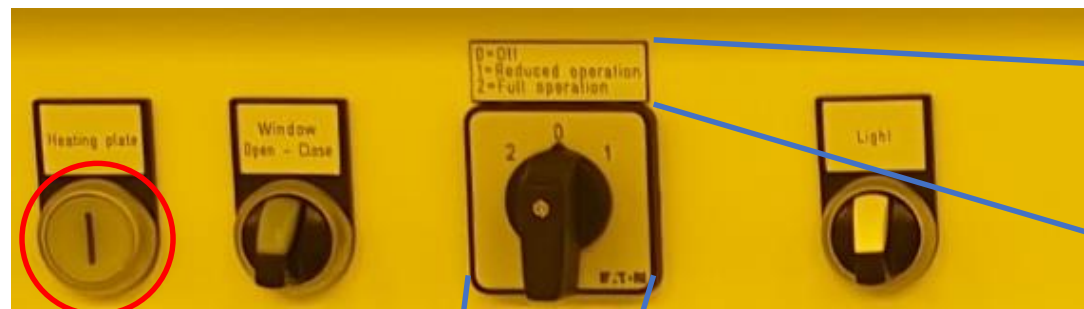
Hotplates* work only under
operating condition “green” !

*in WB 1 & 4



LIT OIC, CR 1, similar WBs in CR2,3

Wet bench

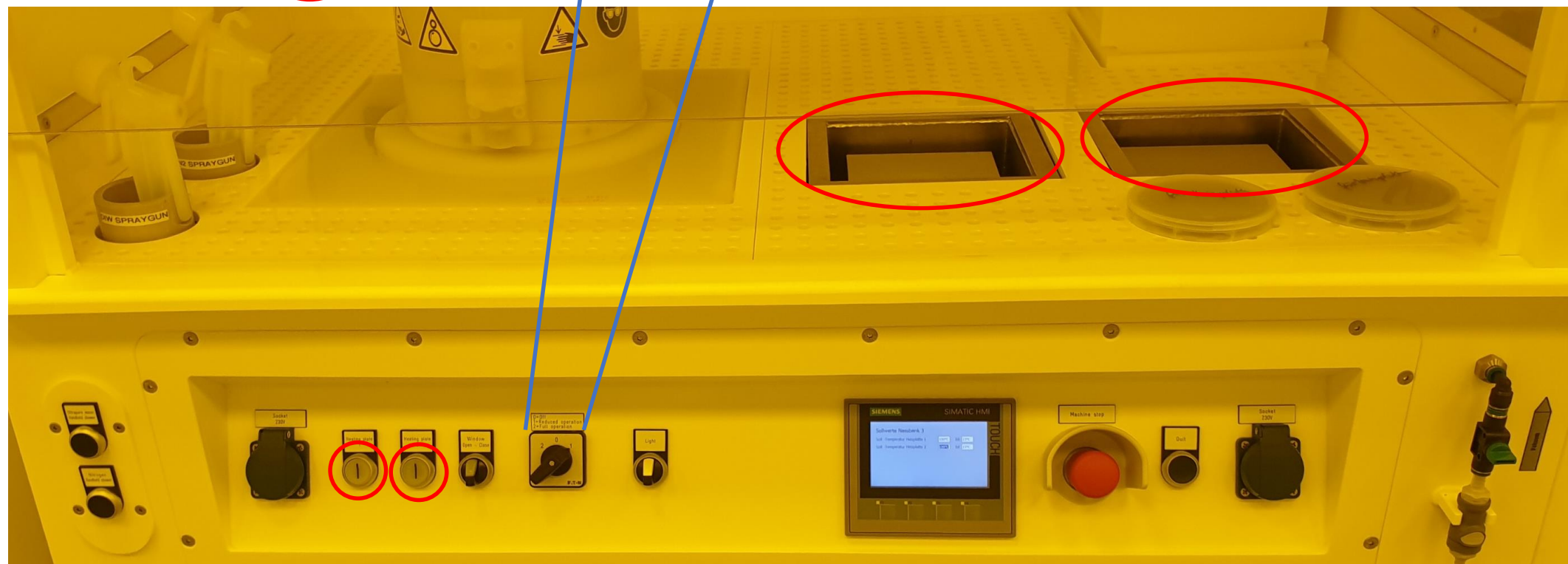


Operating conditions:

0: red

1: yellow

2: green



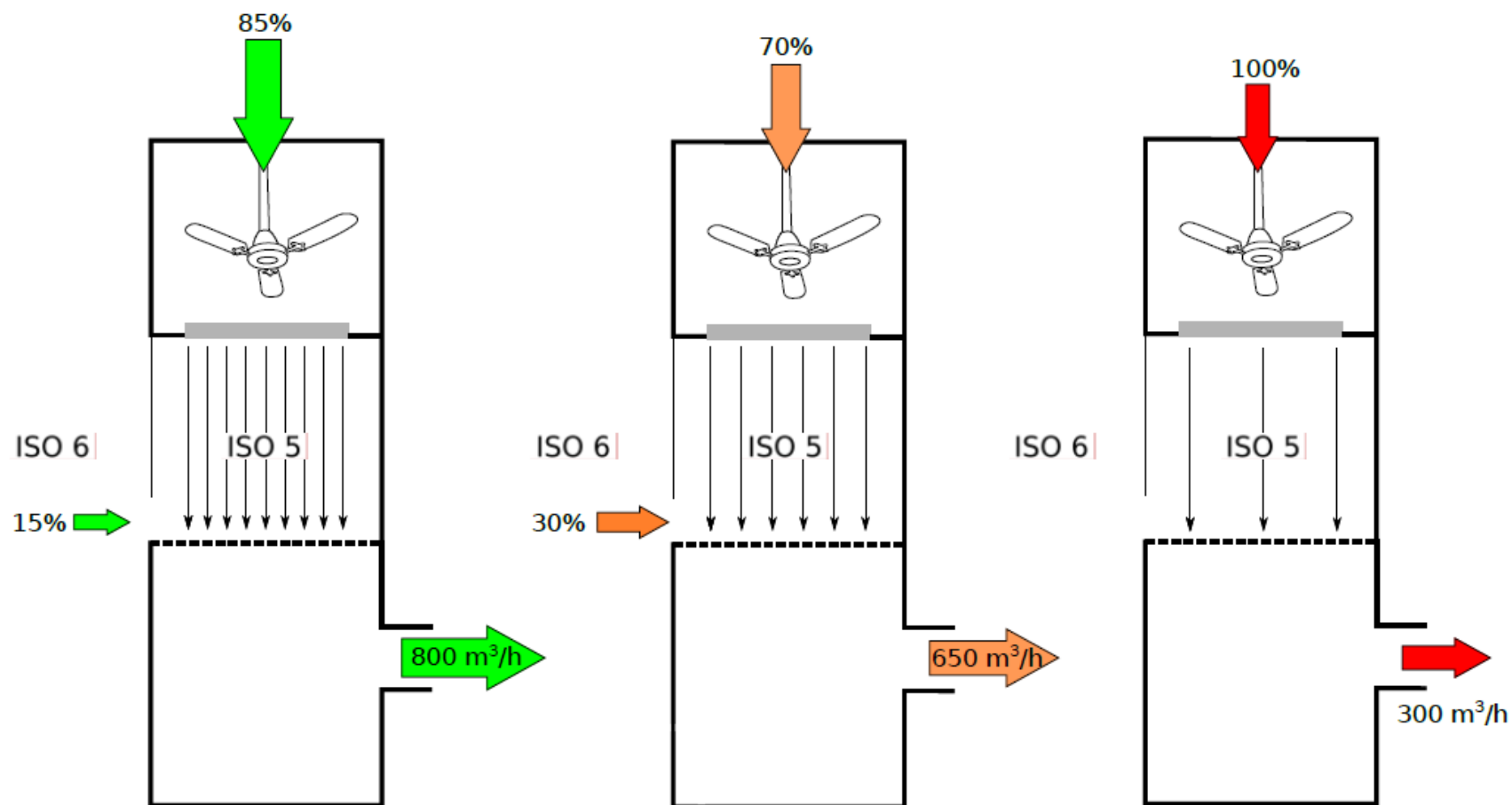
Hotplates work only under
operating condition "green" !

Hotplate temperature control

Wet bench

Operating conditions:

- **Green:**
2=Full operation
working with front window in any position allowed. For safety reasons, close as much as possible !
- **Yellow:**
1=Reduced operation
working with open front window forbidden.
- **Red:**
0=Off
Any work in WB forbidden !



High Efficient Particulate Air (HEPA) Filter:
> 99,995 % efficient removal of 0.1-0.3 µm particles (Class 14)

Ventilation system

Ventilation system coupled to WB operation condition:

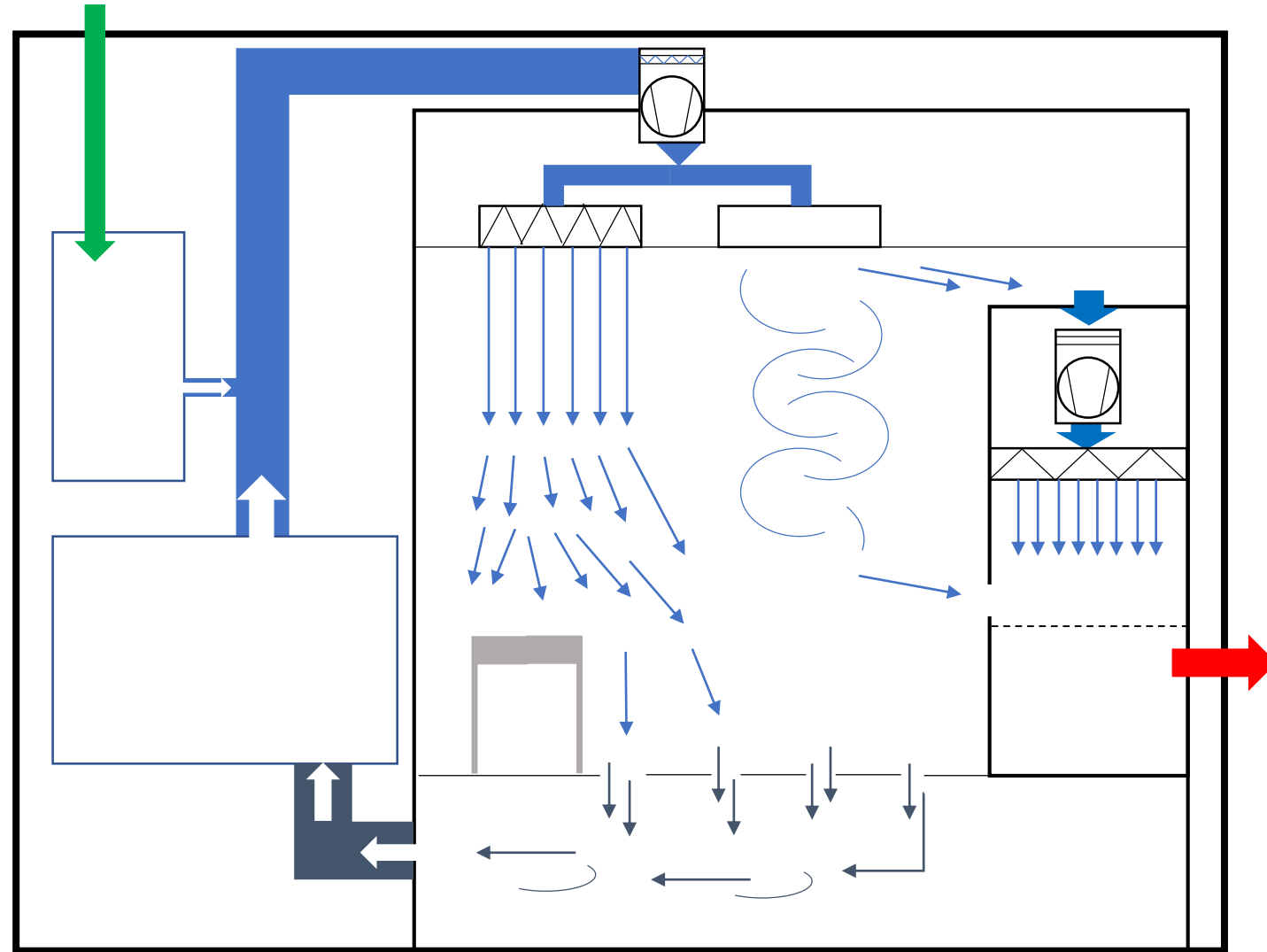
Main air flow in CR: recirculation & filtering

CR exhaust mainly through WB :

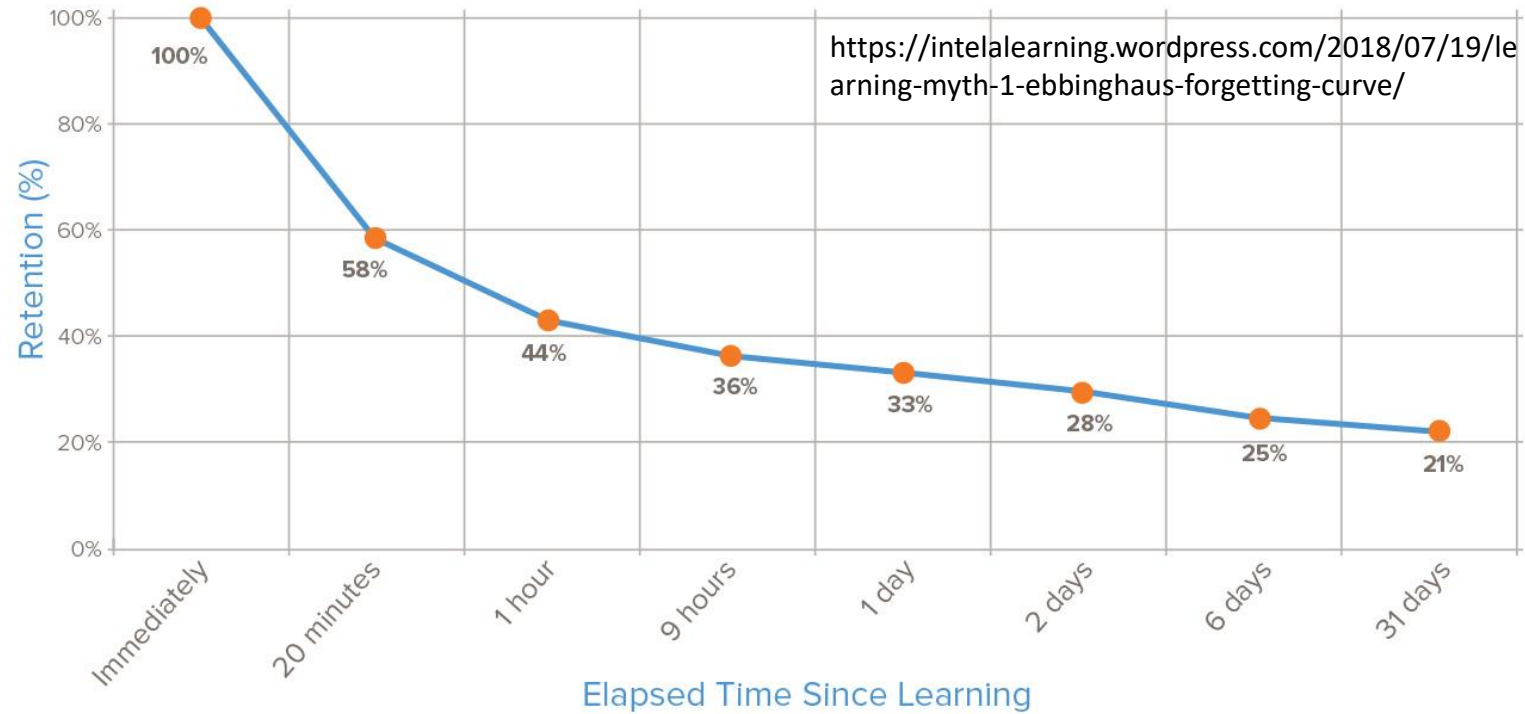
Supply of fresh air controlled by exhaust via WB.

Increasing / decreasing air supply is slower than increasing / decreasing exhaust rate.

➔ Avoid simultaneous change of WB operation conditions, under / over pressure in CR might result.



Ebbinghaus Forgetting Curve



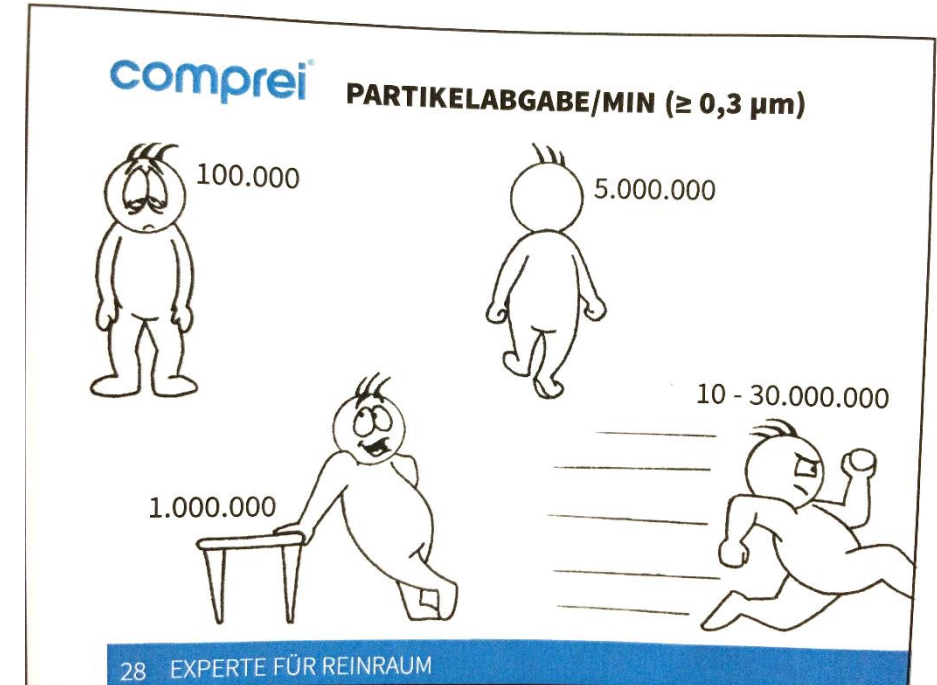
More details during hands-on training

People as a source of contamination

Movement:	Particles/min
Rest	100 000
Small action	1 000 000
Walking 3,5 km/h	5 000 000
Running 8-9 km/h	10 000 000 - 30 000 000

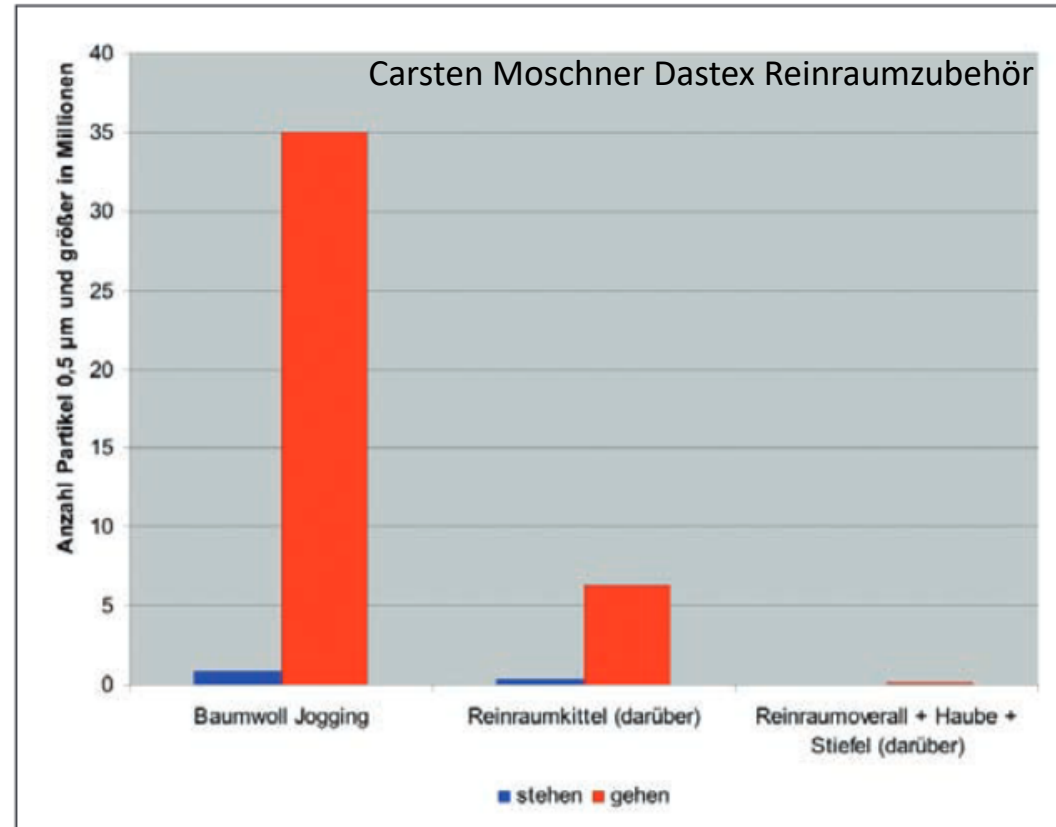
Make up:

One blink of the eyelashes with mascara – 20 000 Particles



People as a source of contamination

Influence of garment:



◀ Graphik 1:
Anzahl abgegebener
Partikel $\geq 0,5 \mu\text{m}$
pro Minute „Personen
in unterschiedlichen
Bekleidungssystemen“
in Abhängigkeit zur
Bewegung

Proper dressing

dress

- 1) Mask
- 2) Cap or hood (beard, long hair)
- 3) Overall
- 4) Gloves
- 5) Shoes (behind sit-over)

undress



Proper dressing

- No over-shoes
- Special shoes will be provided by Albin and ??



**Personal protective equipment for
working with hazardous chemicals**



Equipment

Cleanroom 1: Lithography

- eLine Plus
- Mask aligner Süss MJB 4
- Mask aligner Süss MJB 3
- Microscope: Olympus BH 2
- FineTech Bonder

Equipment

Cleanroom 2: Device processing

- Atomic layer deposition
- Physical vapor deposition: Metals
- Physical vapor deposition: Oxides
- PECVD Abscheider
- ICP-RIE
- RIE
- Oxygen Ashing
- Profilometer
- RTP Rapid thermal processor
- Ozoncleaner?

Equipment

Cleanroom 3: Analytics

- SEM Leo Supra35
- AFM
- Microscope Keyence
- ALD 2D Alberta

Cleanroom 4: wet chemistry Prof. Hild

Equipment

Cleanroom 4:

- **Molecular Beam Epitaxy**
 - SiGeC
 - IV-VI elements
 - III-V elements

Access control

Your Kepler Card needs to be activated:

- Ursula & Stefan for access to LIT-OIC clean room
- LIT service desk for entrance to LIT building

Cleaning duties

Similar organization as in old HLFKP cleanroom:

- Weekly duties, to be defined by Alma and Ursi, different users each week.
- General CR cleaning 2 (?) times / semester.