Safety and behaviour in the cleanroom

Safety and behaviour in the cleanroom

- **What is a cleanroom ?**
- **CMi cleanroom concept**
- **CMi User Manual**
- **Working in CMi cleanroom**
- **Safety at CMi**
- **Multi choice questions test to fill at your convenience (10min)**
- **Visit of the cleanroom (10h30 or 14h00)**

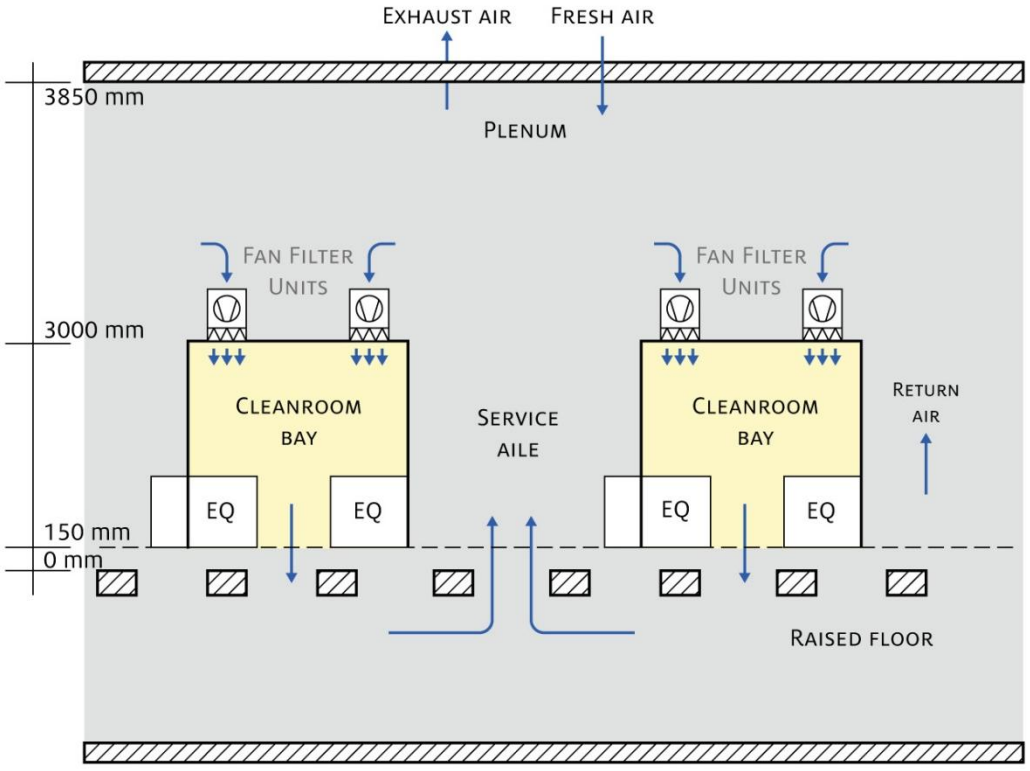
CMi video clip

Video credits: EPFL CMi

What is a cleanroom ?

What is a cleanroom?

- Continuous air supply through filters. Laminar flow top to bottom.
- Tight control of working conditions (temp, humidity, UV-light)



FRESH AIR

- 60’000 m^3/h
- filter efficiency: 99.97% for particles size: 0.1-0.3 µm

EXHAUST

- 36 ’000 m^3/h

FFU

- 0.7 m^2 active area
- filter efficiency : 99.999% for particles size 0.1-0.3 µm

What is a cleanroom?

- Continuous air supply through filters. Laminar flow top to bottom.
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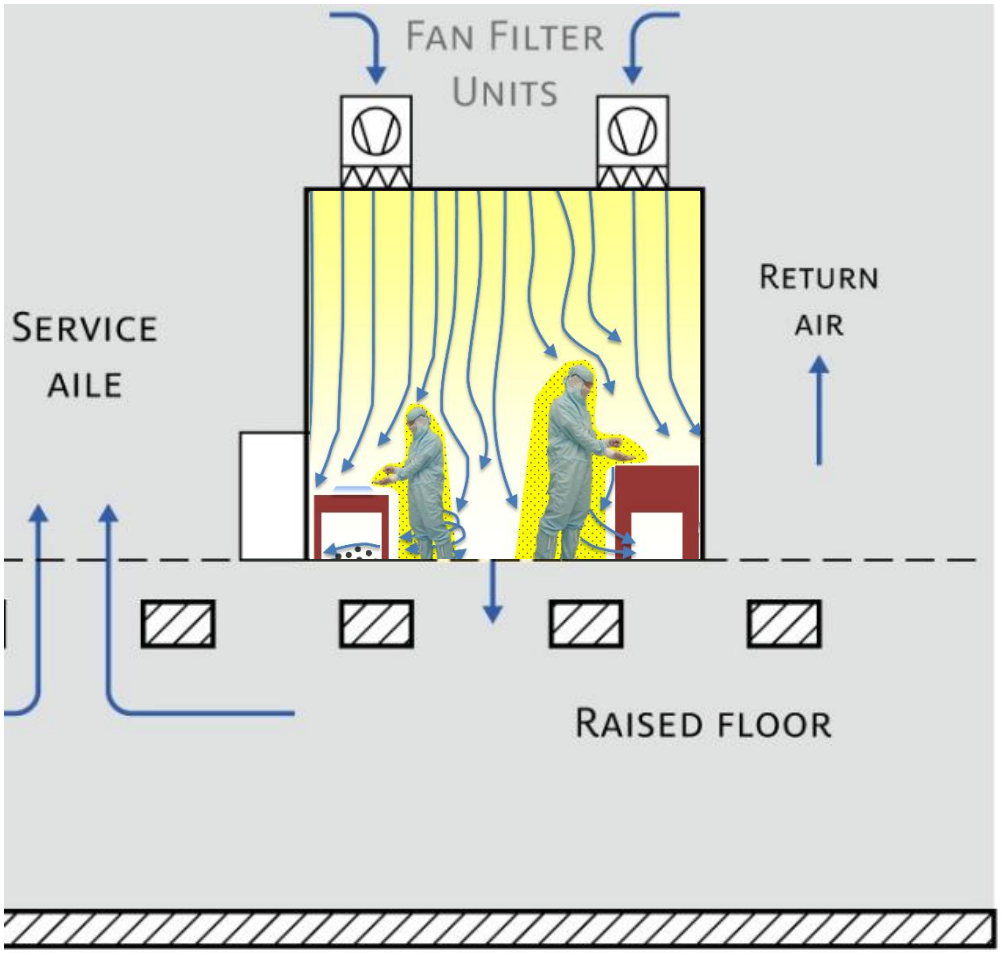


What is a cleanroom?

- Tight control of media:
  - Water (minerals, particles, dissolved ions)
  - Chemicals (purity, mobile ions)
  - Gas (purity, water vapor content, particulates)

What is a cleanroom?

Concentration max allowed of particles (particles/m³ of air)
Particles sizes equal or superior to that given below

(0.5um particles/ft³ of air)

Class ISO	0.1 µm	0.2 µm	0.3 µm	0.5 µm	1 µm	5 µm	Class US FS209
ISO 1	10	2	0	0	0	0	
ISO 2	100	24	10	4	0	0	
ISO 3	1 000	237	102	35	8	0	**1**
ISO 4	10 000	2 370	1 020	352	83	0	**10**
ISO 5	100 000	23 700	10 200	3 520	832	29	**100**
ISO 6	1 000 000	237 000	102 000	35 200	8 320	293	**1 000**
ISO 7	∞	∞	∞	352 000	83 200	2 930	**10 000**
ISO 8	∞	∞	∞	3 520 000	832 000	29 300	**100 000**
ISO 9	∞	∞	∞	35 200 000	8 320 000	293 000	

CMi BM -1 ⇒ ISO 5
CMi BM +1 ISO 6, ISO 7

Standard ISO 14644-1

What is a cleanroom?

Cleanroom environment requires special cloth, compatible tools, lint free paper.

- Body may contaminate by:

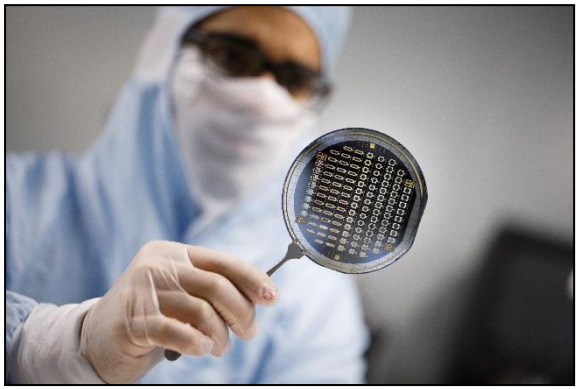
  Flakes of dead skin
  Hair
  Touch by hand
  Breathing

- Wrong cloth may release:

  Fibers
  Dust

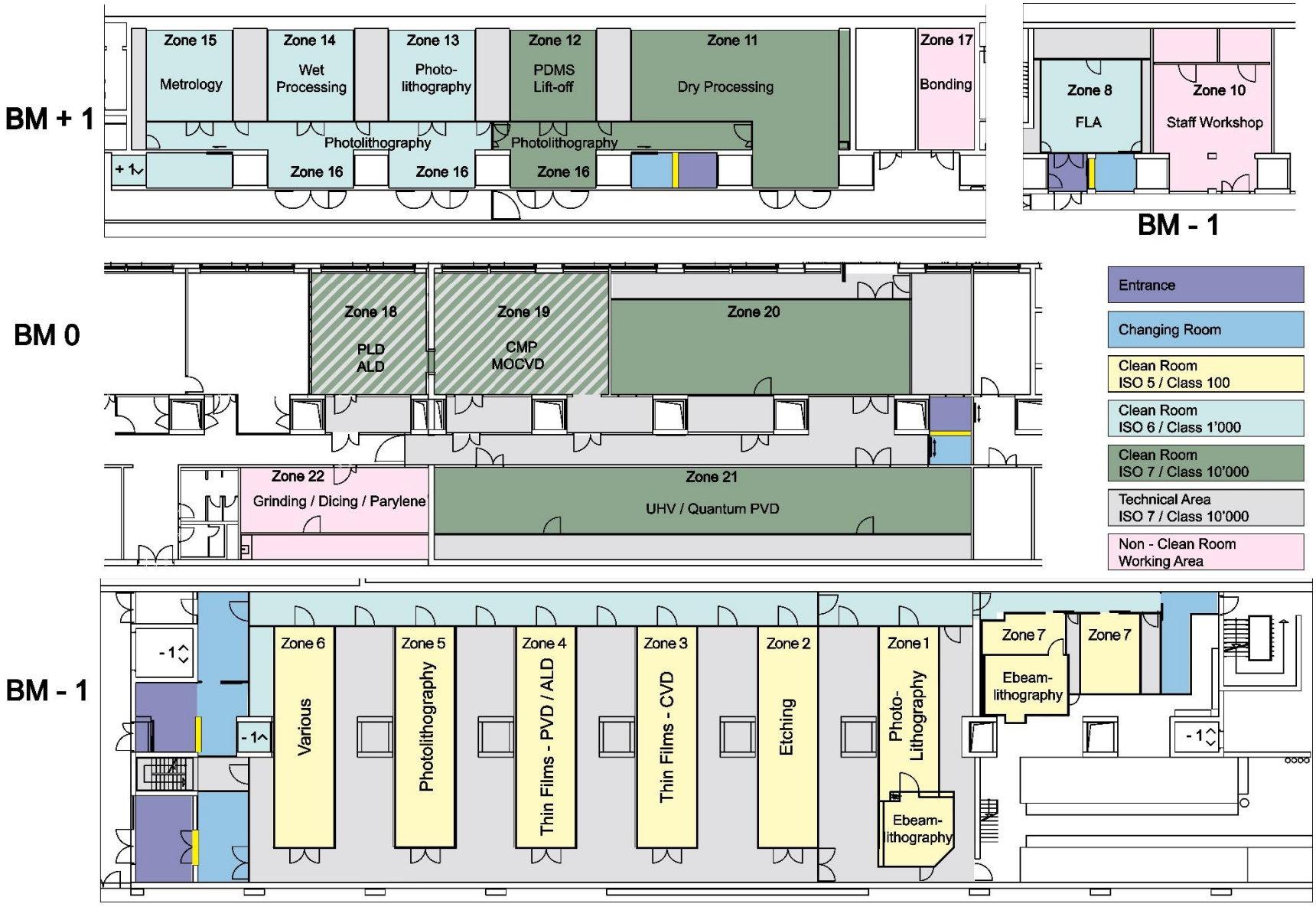
- Wrong tools may create:

  Particles
  Dust

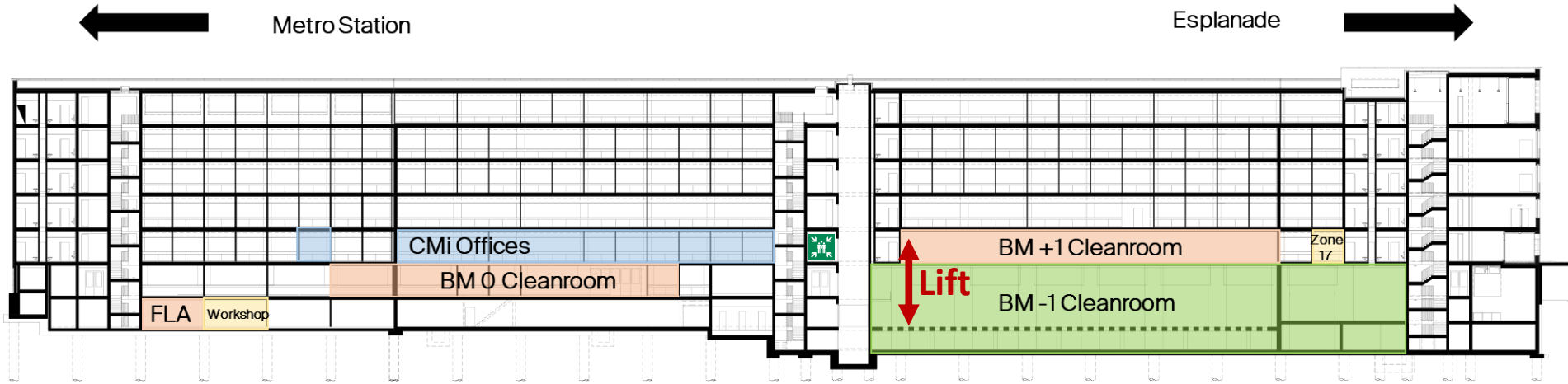


CMi cleanroom concept

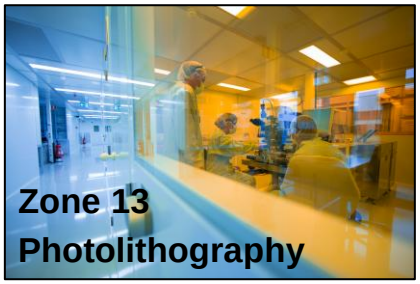
CMi cleanroom concept



CMi cleanroom concept



CMi cleanroom concept



1998	2010	2017	2025
900m2	350m2	150m2	440m2

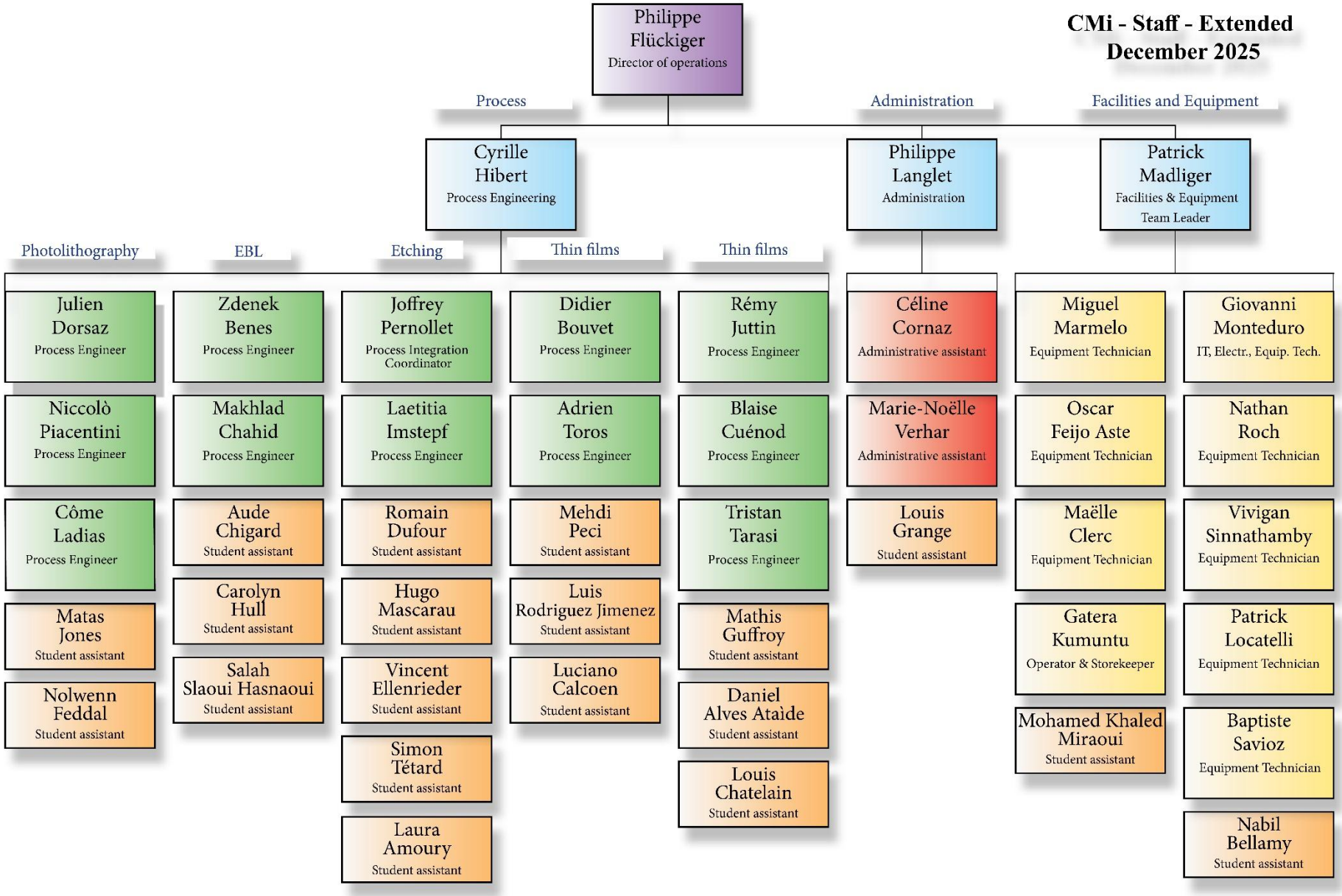
- CMi BM -1
- ISO 5
- Largest and Dedicated Equipments
- Oriented for 100mm Wafers

- CMi BM +1
- ISO 6-7
- Oriented for chips and non-conventional processes

- CMi BM 0
- ISO 7
- Backend : Dicing, Grinding, Parylene
- Zone 21 : UHV / Quantum / Supraconductor PVD
- ALD , PLD , CMP

CMi user manual

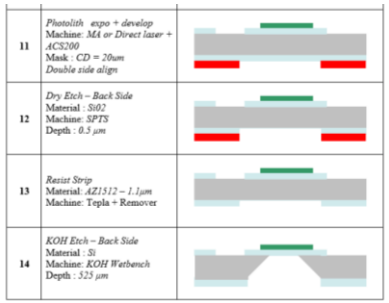
CMi cleanroom concept



CMi user manual: step by step

1. **Safety and behaviour in the cleanroom (now)**
   - Formal presentation of CMi facilities and CMi rules
   - Cleanroom visit
   - Email from CMi secretary with **process flow template + MCQ test link**

2. **Project approval by CMi process engineers (~1 week)**
   - You send a process flow or a draft to infocmi@epfl.ch
   - Process flow review by a technical committee
   - Email from CMi secretary (username, password)



11	*Photolith expo + develop* Machine: *MA or Direct laser + ACS200* Mask : *CD = 20um* *Double side align*	
12	*Dry Etch – Back Side* Material : *SiO2* Machine: *SPTS* Depth : *0.5 µm*	
13	*Resist Strip* Material: *AZ1512 – 1.1µm* Machine: Tepla + Remover	
14	*KOH Etch – Back Side* Material : *Si* Machine: *KOH Wetbench* Depth : *525 µm*	

3. **Start working in the cleanroom (few weeks)**
   - Trainings
   - Rights to book equipment
   - Work on your own according to process flow (reservation, login, processing, logout…)

CMi user manual: process flow

Process flow work

1. Process flow template
2. User's modification
3. Process flow sent to CMi
4. Technical committee if necessary
5. Process flow correction
6. Process flow final review by CMi
7. Process flow accepted

Process change ?

Materials change ?

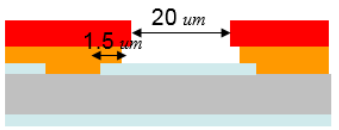
Substrate change ?

-> Update your process flow and send it for review !

Lab :
Operator Name :
Supervisor Name :

Phone :
Office :
E-mail :

CMi EPFL Center of MicroNanoTechnology

07	*Photolith expo + develop* Machine: *direct laser W + ACS200* Mask : *CD = 20 um* *Align tol: 1.5 um*	
08/09	*Metal Evaporation + lift-off* Machine: *LAB600H* Metal *:Ti / Au* Thickness : *10 / 60 (nm)* + Solvent - sonication	
10	*Photolith PR coat* Machine: *ACS200* PR : *AZ1512 – 2.0 µm*	
11	*Photolith expo + develop* Machine: *MA or Direct laser + ACS200* Mask : *CD = 20um* *Double side align*	
12	*Dry Etch – Back Side* Material : *Si02* Machine: *SPTS* Depth : *0.5 µm*	
13	*Resist Strip* Material: *AZ1512 – 1.1µm* Machine: Tepla + Remover	
14	*KOH Etch – Back Side* Material : *Si* Machine: *KOH Wetbench* Depth : *525 µm*	

CMi user manual: practical training, feedback and CMi annual review

Training on equipment

- Usually one person at a time
- On your wafers in process (no dummies)
- On the agreed technology
- Limited to the necessary equipment agreed
- Justified only for long term projects
- Planned according to staff availability
- Use training request program

Users feedback to CMi staff

- Modify or adjust technology when problem occurs
- CMi memory
- Improve CMi offer

CMi annual review

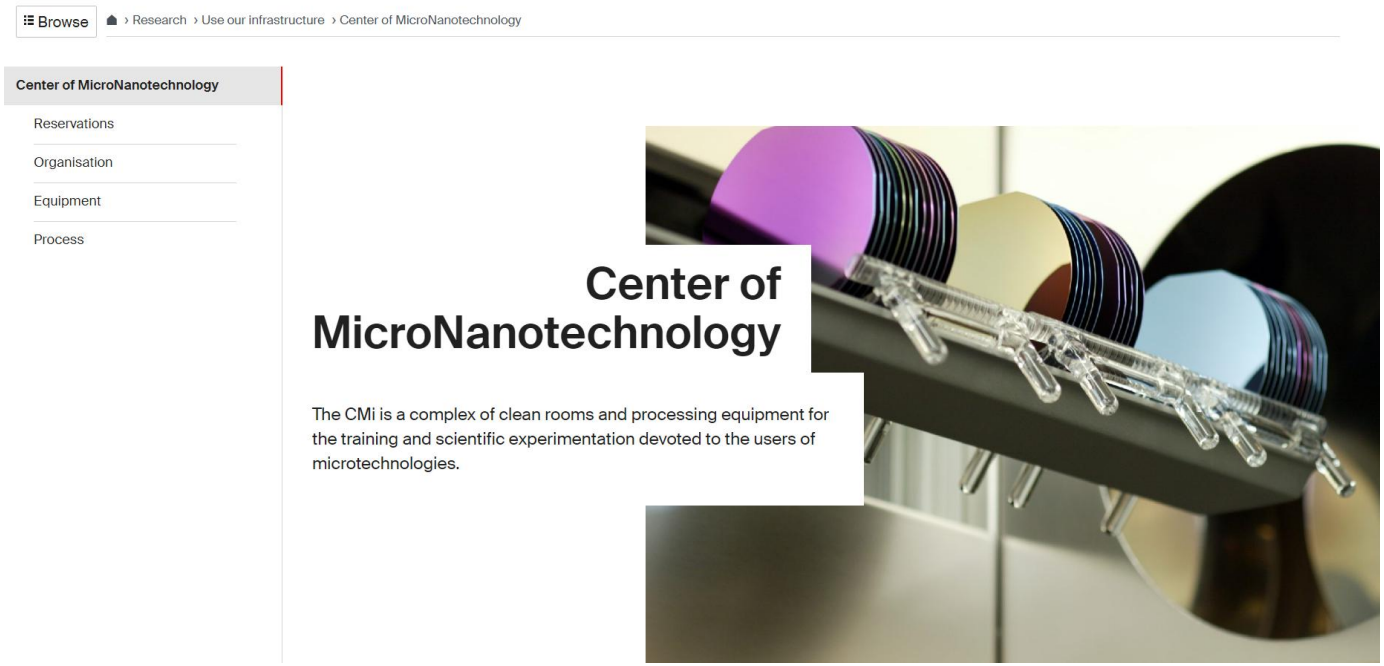
- Next one is **13th May 2025**
- Each User must provide a poster
- CMi booklet (poster collection)
- Conferences, poster session, food and drinks ☺

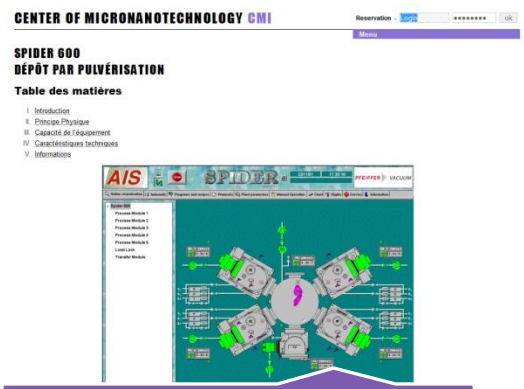
CMi user manual

CMi web site

https://cmi.epfl.ch/

+ fees
+ training request
+ visit authorisation
+ my bill



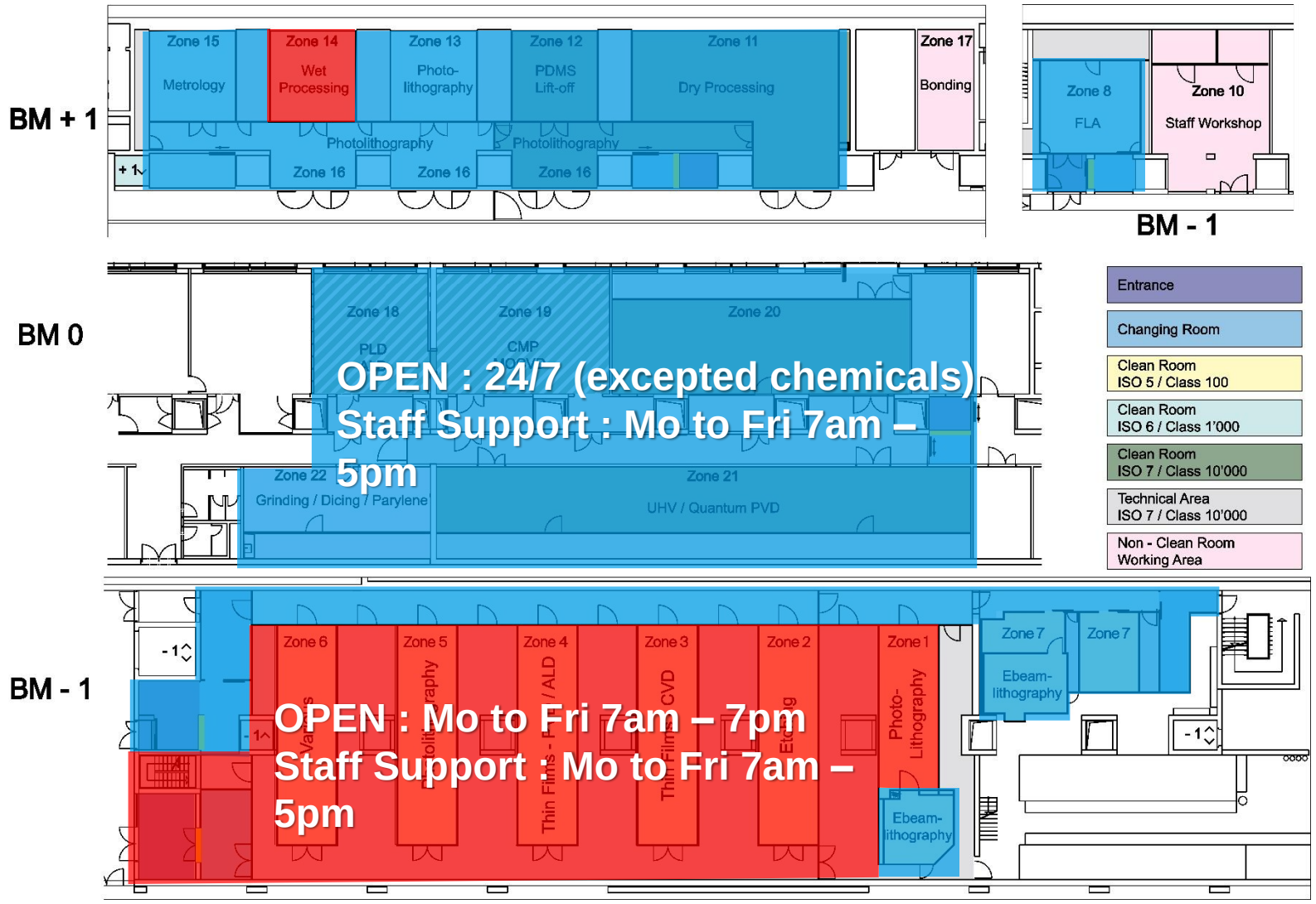


Equipment user manual

Equipment reservation

Material ordering …

CMi user manual: working hours & staff support



CMi user manual: working hours & staff support

- Work **prohibited** after 7pm
- Few exceptions on critical tools for **advanced users on request**
- Staff support from Monday to Friday 7am to 5pm

- Access 24h/7 days **on request**
- Staff support from Monday to Friday 7am to 5pm
- Lone worker device to wear from **7pm to 7am**

Lone worker devices in the BM+1 entrance

CMi user manual: fees

Academics
(Practical training, Semester & Master students, PhD students and Researchers)

Tools are charged per run and usage time,
Hourly rate depends on tools (see table),
Materials and consumables are charged.
Manual tools: metals and
PDMS charged separately.

Companies

Hourly fees (see table).

Categories	EPFL		Swiss Academics		International Acad.		Industry	
	CHF/run	CHF/hour	CHF/run	CHF/hour	CHF/run	CHF/hour	CHF/run	CHF/hour
E-Beam Writer & DUV Stepper	30.00	46.00	36.00	55.20	48.00	74.00	80.00	207.00
Packaging	30.00	46.00	36.00	55.20	48.00	74.00	80.00	81.00
Laser Writer & Mask Aligner	15.00	34.00	18.00	40.80	24.00	54.00	32.00	86.00
Coater Developer (Auto)	15.00	113.00	18.00	135.60	24.00	181.00	32.00	205.00
Coater Developer (Manual)	15.00	113.00	18.00	135.60	24.00	181.00	32.00	199.00
Dry Etcher	15.00	40.00	18.00	48.00	24.00	64.00	32.00	99.00
LPCVD, ALD, PVD	15.00	63.00	18.00	75.60	24.00	101.00	32.00	133.00
Thermal Process	15.00	28.00	18.00	33.60	24.00	45.00	32.00	65.00
Wet bench	15.00	37.00	18.00	44.40	24.00	59.00	32.00	70.00
Measurement tools	15.00	18.00	18.00	21.60	24.00	29.00	32.00	40.00
Other Tools	3.00	12.00	3.60	14.40	5.00	19.00	6.00	26.00

➢ All rates (machines, reservation fees, consumables) are available on your CMi user account.

Problem on a processing equipment

General rules:

- Check **after each process step** that you got your desired results.
- **Report** any defects or problem **immediately** to the staff in charge of the equipment.

What to do in case of problem on a processing equipment:

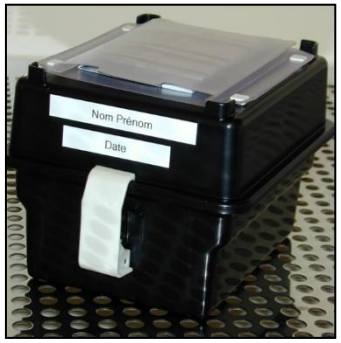
1. The user immediately **reports to CMi staff** so the concerned equipment can be checked and preventively put to maintenance state.
2. The user **sends an email** to the staff member in charge the same day with:
   a. User login
   b. Machine
   c. Date
   d. Time
   e. Related process flow document mentioning the concerned process step
   f. If possible, a picture of the sample
   g. The requested adjustment of the invoice
3. The user transmits the sample to the staff in charge for inspection.
4. If applicable, the user checks the ongoing invoice that agreed refund is effective, before the billing at the end of the month.

Invoice / Billing:

- **Any complaint about an invoice**, concerning or not defective process or equipment, **must be addressed to CMi within 24h** (one business day).
- CMi may refund the cost concerning a process step, but will not refund the cost of all proceeding process steps, nor the cost of lost samples.
- Users are asked to **regularly check** their current month's invoice, and to address to CMi any request for corrections **before the billing at the end of the month.**
- **Once** the final invoice is **issued**, no request for refund can be treated and **no modifications are possible**.

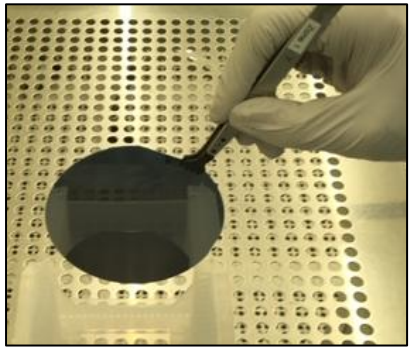
Cleanroom general rules

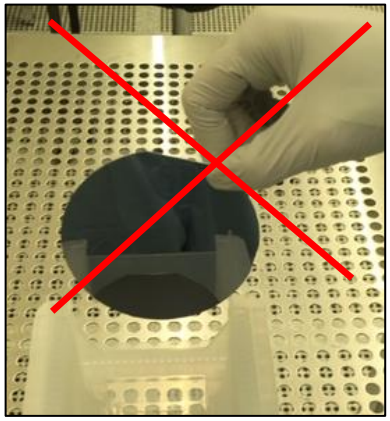
- Material should be stored in labelled basket
- All wafers should be stores in boxes
- Every item (Wafer Box / Tweezer box etc) has to be **properly labelled with username and lab/company.**

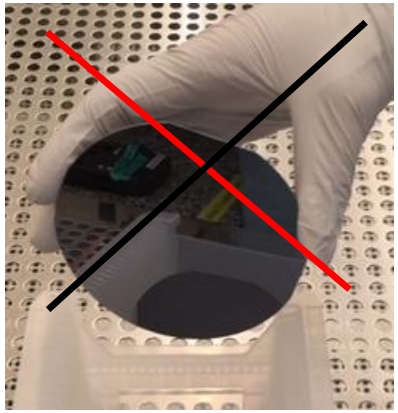


- **<u>Black Boxes</u>** stays in the **<u>main cleanroom</u>** !
- Lost and found shelf

- Good Working Practice (GWP): wafers/samples **must** be handled with vacuum or mechanical tweezers

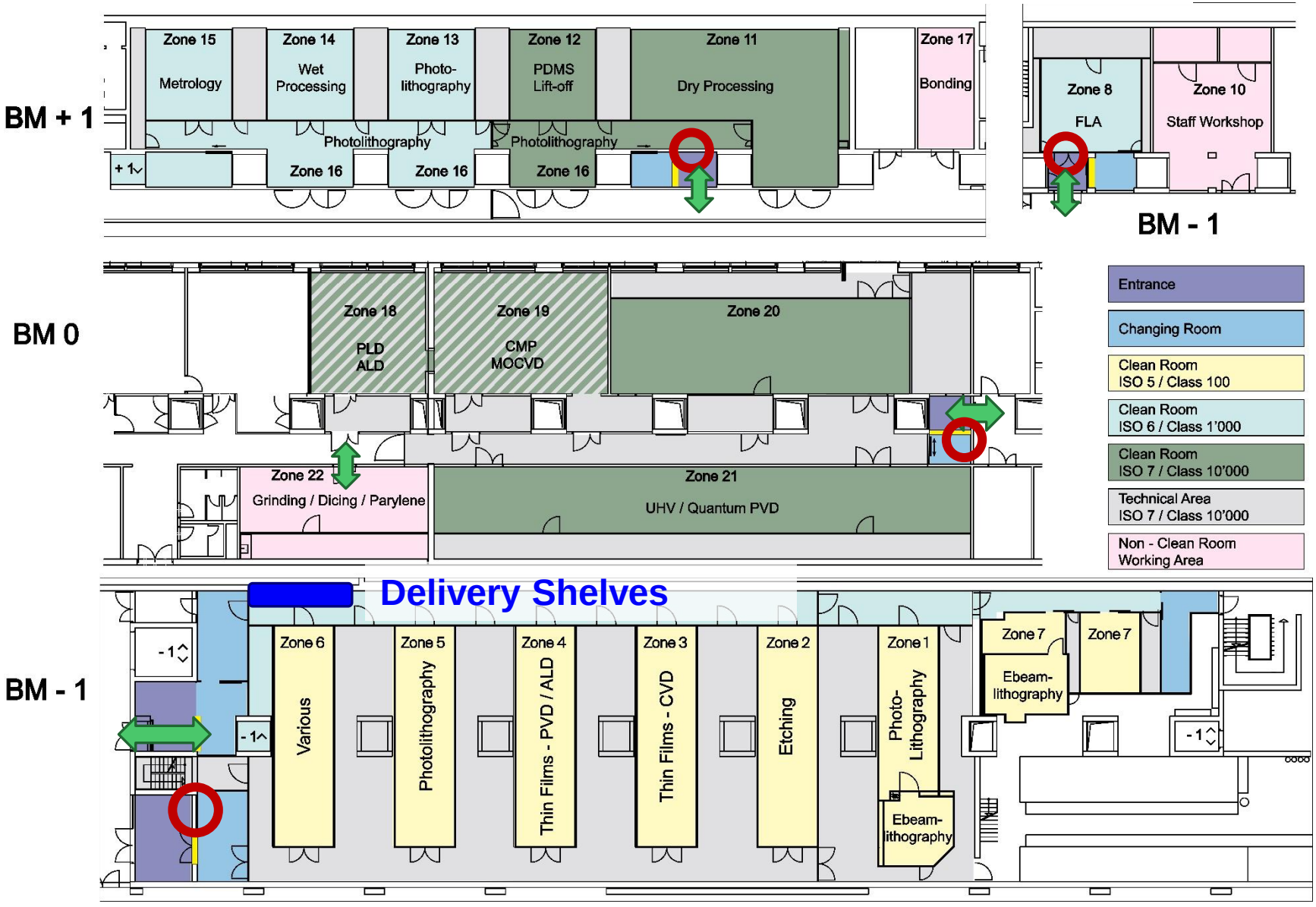






Entering CMi cleanroom

Accesses, main delivery place and material introduction into cleanroom



Enter only through entrance specified in your authorization email. Exit only through the same entrance you used for entry.

CMi ENTRY procedure

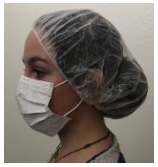
IF YOU HAVE ANY SYMPTOMS OF FLU
DO NOT ENTER CLEANROOM !!!

1. (Disinfect your hands)

2. Put on new clean white face mask.

3. Put on blue shoe cover and pass the bench.

4. Put on hair net.



5. Put on your private suit from your locker.

6. Put on boots.
Boots are shared.

7. Put on your personal safety or medical glasses.

8. Put on the gloves.

9. Check everything again.
You should look like this.
Enter the cleanroom.

CMi EXIT procedure

1. Remove boots and put them back on the shared shoe shelf.

2. Trash your gloves and remove your suit and place it and your glasses in your locker.

3. Remove hair net and trash it.

4. Cross over the bench and trash the blue shoe covers.

5. Pick your stuff from the locker, if you used it.

6. Exit cleanroom.

Material introduction into cleanroom

- All material introduced in CMi cleanroom:
  - Must be announced to infocmi@epfl.ch for the first time
  - Must be decontaminated:
    - in dedicated material room for BM -1
    - in dressing room for BM +1 and FIB room

- Outside the cleanroom: **decontamination**

1. Put on gloves.
2. Wipe with IPA.
3. Place inside the cabinet, on appropriate shelf.
4. Get dressed to access the cleanroom.
5. Collection from inside the cleanroom.

Operate the other way around to get the material out.

Mobile phone policy

No phones in <u>all processing areas</u> !

You may:

- Use an earpiece headset, (only 1 allowed, no listening to music in cleanroom!)
- The mobile phone can only be used in the dressing rooms and its usage has to be limited as much as possible.
- **<u>Gloves have to be removed before using the phone and changed after usage !!</u>**

Remark: staff may use mobile phones in the processing area for alarms and repairing/diagnosing tools.
Not a privilege but an exception!

Safety at CMi

Safety rules: General

CAMIPRO required for each person entering or leaving the cleanroom

Never work alone: a buddy is required in the cleanroom at all times

Only one emergency phone number **from fixed phone** :

115

or

from mobile phone

021 693 3000

Safety and security responsibles (COSEC) at CMi

Patrick Madliger
021 693 77 48

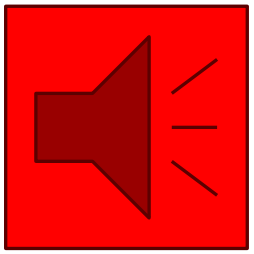
Vivigan Sinnathamby
021 693 76 42

Email : cosec.cmi-ge@epfl.ch

Please report any safety problems or incidents you encounter

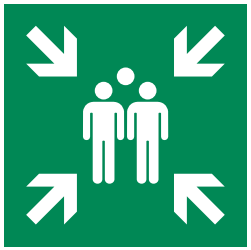
Please wear your protective or medical glasses all the time

Safety rules: alarms & Evacuation in CMi BM -1 / BM 0



Double tone horn
Flashing red light
➔ Evacuate immediately **with cleanroom clothing**

Toxic gas
Fire



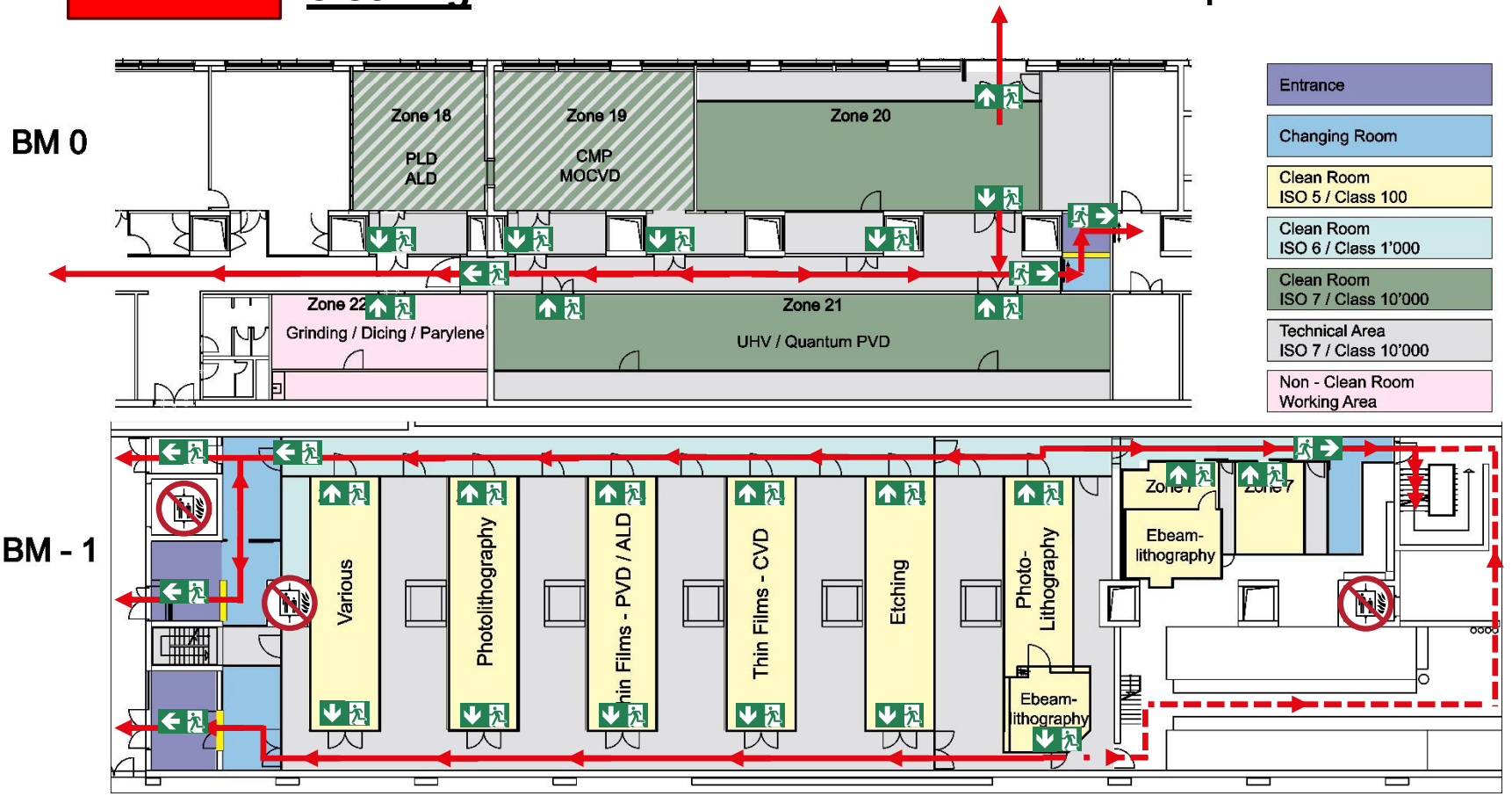
Meeting point : BM 1.124 (CMi secretariat office) / BM 194.6 (BM+1 Central Entrance)
wait there to be accounted for

Red alarm can be activated by the push-buttons

Safety rules: alarms & Evacuation in CMi BM -1 / BM 0

Double tone horn
Flashing red light
➔ Evacuate immediately **with cleanroom clothing**

Toxic gas
Fire



Safety rules: chemicals and trash

NO CHEMICALS in personal lockers or in personal storing baskets!!!

Dedicated bins for Silicon wafers and other glass parts

NEVER trash sharp objects in regular bin with plastic bag

Safety rules: chemistry

- INFORM yourself (SDS).
- Do NOT crowd fume hoods/wet benches!
- Only **ONE user at a time** for “strong” chemistry (concentrated acids/bases).
- Do NOT stress operator for quick finish.
- Finish clean and safe (workplace, bottles, wares…)

Extra dressing

- nitrile gloves
- safety apron
- face shield
- long gloves

SOP - Standard Operation Procedure

Product: Trimethylchlorosilane (TMCS)

User name: Joffrey Pernollet
Creation Date: February 18, 2011

Review Date: *Not yet done*

IMPORTANT NOTE
This document is a standard operation procedure; **it is not** a substitute of the Material Safety Data Sheet (MSDS). Therefore, it is strongly advised to refer with great attention to the MSDS of the product before going further.
Filled by the user
Filled by the CMi staff

1. Standard Operation Procedure

1.1. Procedure name and description

SOP name: TMCS anti-sticking
This product is mainly used in PDMS casting processes as a surface conditioning treatment to prevent sticking between piece parts which come to contact for molding purposes but which need, in the end, to be easily separated from each other.
Proceed on the dedicated wet bench as point out below.

- Put on single use additional gloves.
- Fetch the TMCS bottle in the "solvent" cabinet located on the right side of the wet bench.
- Place 2 or 3 drops of TMCS in the small glass receptacle located in the glass desiccator (single use pipettes are available for that purpose).
- Place the silicon/SU8 mold in this very same desiccator.
- Close the desiccator and place it under vacuum (this causes the TMCS to evaporate and to form a passivation layer on the mold surface).
- Close the TMCS bottle and put it back in the "solvent" cabinet. **Fill-in the "chemicals follow-up" document.**
- When desired time is reached, vent the desiccator once. **DO NOT** open it yet. Put it back under vacuum for a while so all TMCS vapors are suck away.
- Vent it and open it. **DO NOT** breath directly above the open desiccator.
- Take your mold back and close the desiccator.

1.2. Working hours restrictions

~~Allowed under "strict buddy rule". A buddy may be any authorized user of the clean room in visual contact with the authorized user. Strictly apply personal protective behavior of point 2.4.~~

1.3. Storage Location

~~TMCS bottle is located in Z12, in the "solvent" cabinet on the right side of the PDMS wet bench.~~
~~Carefully close any open container and store it vertically to prevent any flow in case of leakage. **DO NOT** rinse with water.~~

1.4. Recycling procedure

~~Dedicated recycling container is located in zone 12, by the TMCS desiccator on the wet bench.~~

2. Safety

2.1. Material Safety Data Sheet: see concerned document

2.2. Hazards associated to the chemical *(choose according to MSDS)*

2.3. Risk and Safety phrases

R11	Easily flammable
R14	Reacts violently to water contact
R35	Provokes serious burns

2.4. Protective behavior and equipment needed

Respiratory protection
Always wear the clean-room facial mask. Do not breathe vapors. gases. Ensure correct ventilation, manipulate under a venting hood.

Hands protection
In addition to the standard clean-room gloves, always manipulate using extra single-use gloves.

Eyes protection
Always wear the clean-room safety glasses.

Safety rules: chemistry

Specific CAMIPRO access for:

- **HF** Hydrofluoric Acid
- **HNO_3** Nitric Acid
- **TMAH** Tetramethylammonium Hydroxide
- Mixtures

Chemicals use authorization - CMi

This paper must be signed by all cleanroom users working in zone 14 (BM 1.116) with one or more chemicals (included mixtures) mentioned below:

Please check the appropriate box.

- ACID - Hydrofluoric acid (HF)
  CAS number: **7664-39-3**

☐

- ACID - Nitric acid (HNO3)
  CAS Number: **7697-37-2**

☐

- BASE - Tetramethylammonium hydroxide (TMAH)
  CAS Number: **75-59-2**

☐

The signing person hereby confirms to have read the MSDS of these chemicals (available here https://cmiaccess.epfl.ch/restricted) and understood risks. The user also commits to respect CMi Safety rules and never provide these chemicals to someone else.

When requested, CMi commits to give access to the above-mentioned chemicals stored under lock.

Date _____

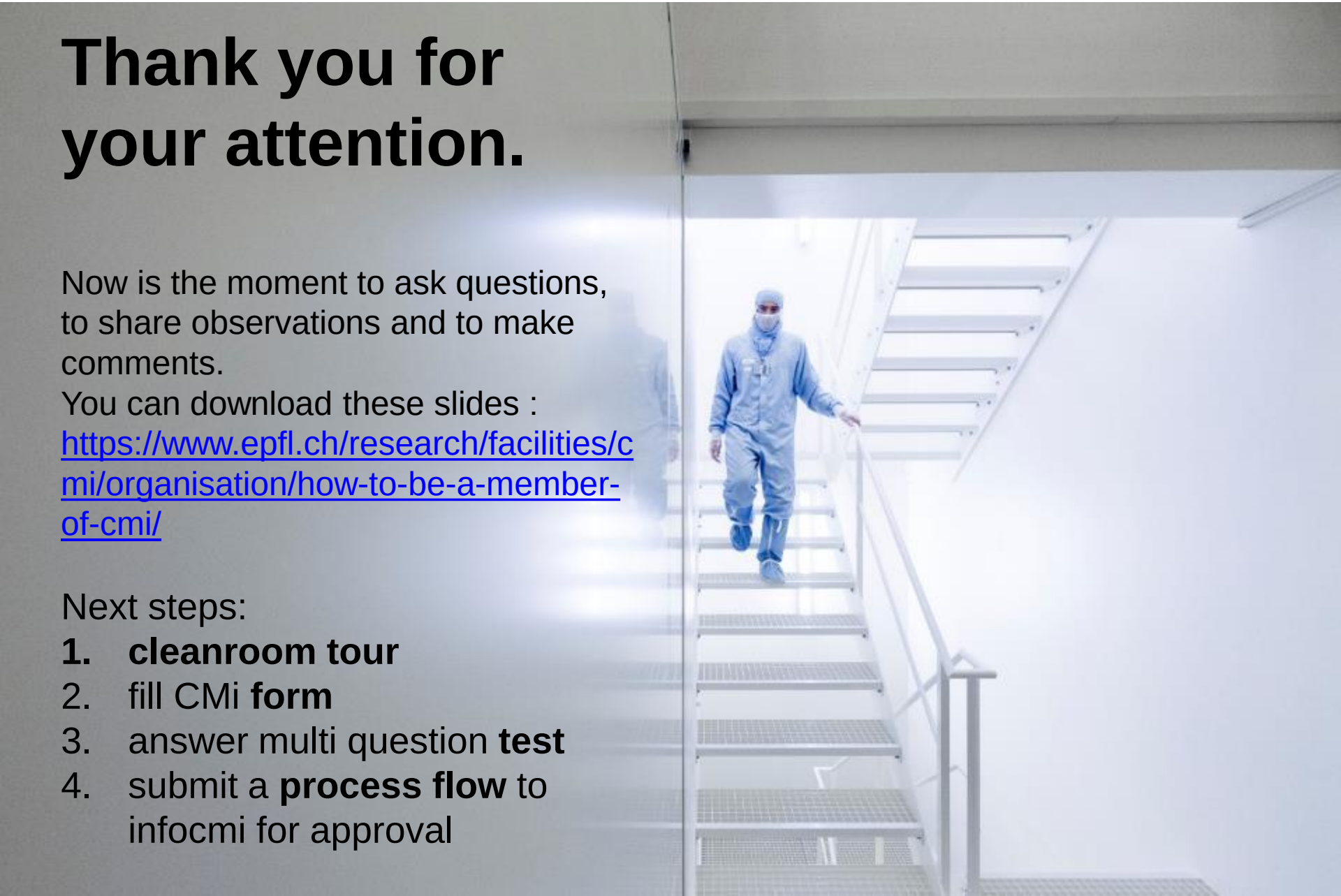
Name user (in block letters please) _____

Lab / Compagny _____

Signature user _____

Signature CMi staff - Etching Dept _____

Cleanroom tour



Thank you for your attention.

Now is the moment to ask questions, to share observations and to make comments.
You can download these slides : https://www.epfl.ch/research/facilities/cmi/organisation/how-to-be-a-member-of-cmi/

Next steps:

1. **cleanroom tour**
2. fill CMi **form**
3. answer multi question **test**
4. submit a **process flow** to infocmi for approval