# Cleanliness Program @ SNOLAB

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# SNOLAB as a class-2000 clean room

## Why is SNOLAB maintain as a cleanroom?

- To observe the elusive dark matter particles and neutrinos the experiments:
  - must go deep underground to escape the cosmic ray particles from outer space
  - need to be in an ultraclean environment to avoid natural radioactivity that would interact in the detectors

## What is a cleanroom?

- A controlled environment that maintains a low concentration of airborne particulates and controls parameters:
  - airflow, pressure, temperature, humidity

## How do we classify cleanrooms?

- By the number of particles equal to and greater than **0.5µm** that are measured in **one cubic foot of air**
  - 0.5µm is about 1/100th the width of a human hair!

| Class | Maximum particles/ft$^3$ | | | | | ISO |
|---|---|---|---|---|---|---|
| | ≥ 0.1 µm | ≥ 0.2 µm | ≥ 0.3 µm | ≥ 0.5 µm | ≥ 5 µm | Equivalent |
| 1 | 35 | 75 | 3 | 1 | 0.007 | ISO 3 |
| 10 | 350 | 75 | 30 | 10 | 0.07 | ISO 4 |
| 100 | 3500 | 750 | 300 | 100 | 0.7 | ISO 5 |
| 1000 | 35000 | 7500 | 3000 | 1000 | 7 | ISO 6 |
| 10000 | 350000 | 75000 | 30000 | 10000 | 70 | ISO 7 |
| 100000 | 3.5 x10$^8$ | 750000 | 300000 | 100000 | 700 | ISO 8 |

## What does a Class-2000 cleanroom mean:

- That the number of particles of size **0.5 µm or larger** permitted per cubic foot of air is less than **2000**
  - NOTE: **Some areas at SNOLAB with restricted access have even less particulates**
  - NOTE: Ordinary room air in a home or office is approximately class 1 000 000

# SNOLAB as a class-2000 clean room or better?

## Some areas at SNOLAB have even less particulates?

- Yes, with restricted access some areas can have as low as 10 counts – example SNO+ Deck
- Most of the areas see increase in the particle counts with UG presence

## Can we upgrade the SNOLAB cleanroom class to higher standard?

- There are some ongoing efforts
- Ideal will be introducing the cleanroom zones (aka sno+ deck model)

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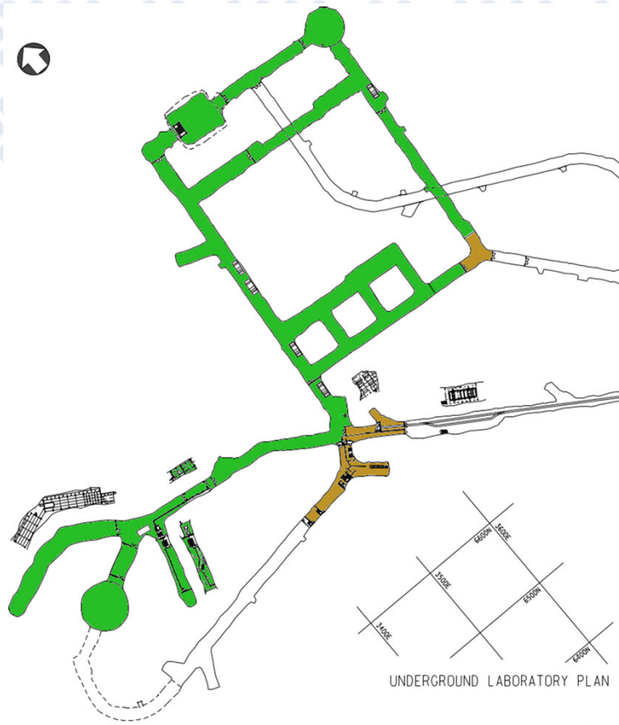
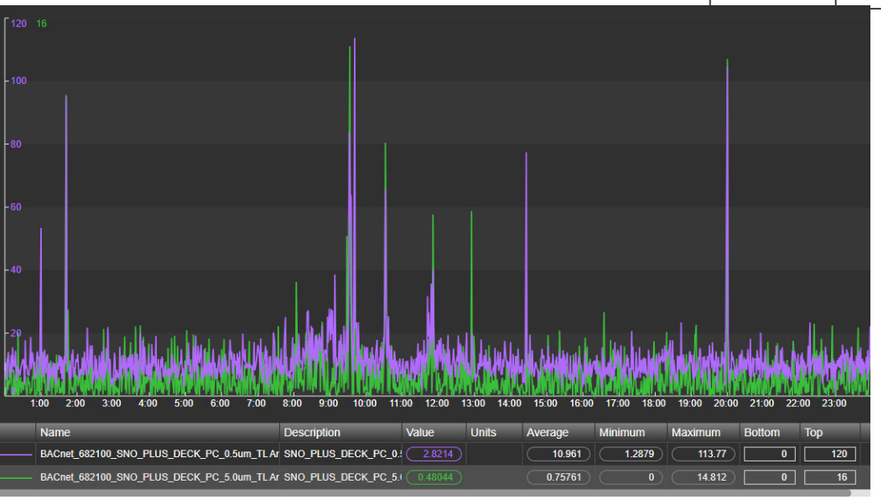
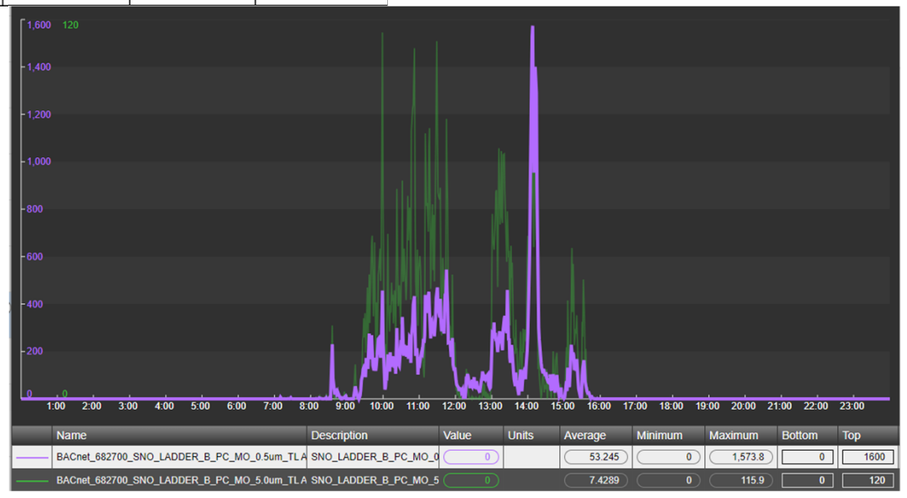


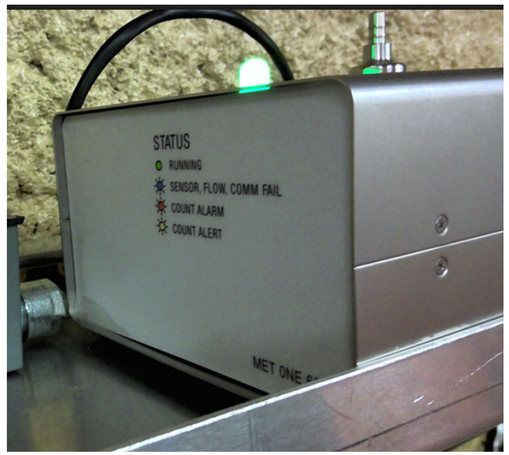
# SNOLAB as a class-2000 clean room

## How do we control the cleanliness level?

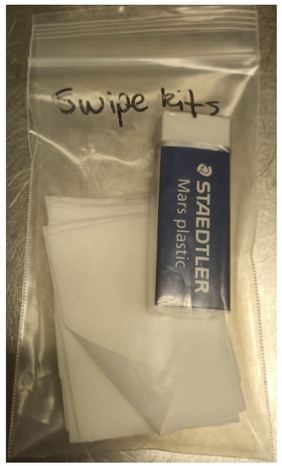
- Dust suppression - all experimental areas are shotcreted and painted to capture dust and contamination
  - Norite rock: 1.00 ± 0.13 % K, 1.11±0.13 ppm U and 5.56±0.52 ppm Th
- Single point access for materials and personnel:
  - all personnel and materials entering the lab need to be cleaned
- Minimized potential for cross-contamination of experiments from dust introduced into lab
  - maintained pressure differentials for cleanliness
- Trained personnel on cleaning and handling materials

## How do we monitor the cleanliness?

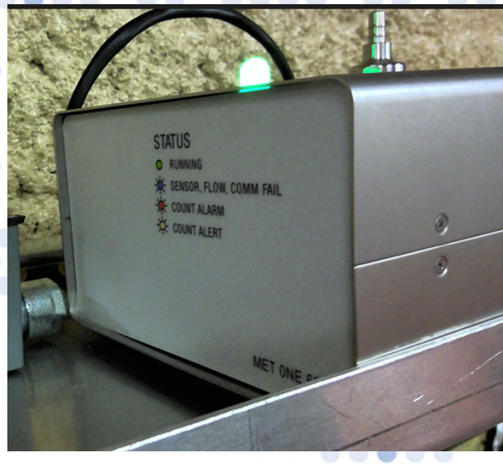
- We use laser particle counters, witness plates, swipe tests







# Monitoring tools: Laser Particle Counters (PC)

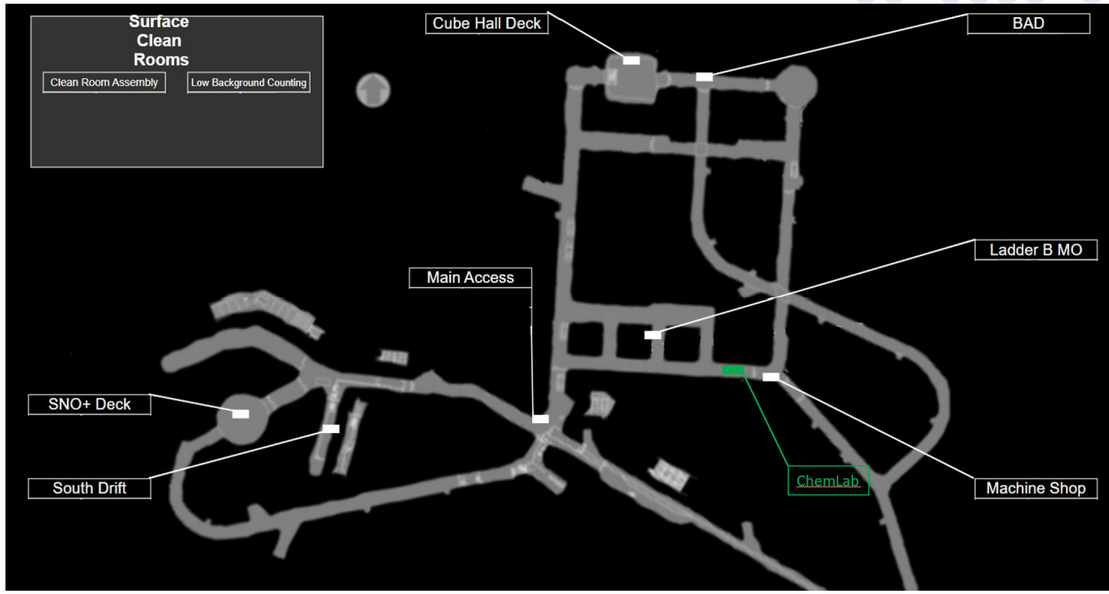



## How it works?

- You are all familiar with the sight of dust flickering in a sunbeam:
  - air carries the dust → sunlight illuminates the dust → your eye sees the dust (light reflected by the dust)

## How do we use information from the PC?

- Particle counters track gradual or sudden changes in the number of particles
  - helps in monitoring the activity in the lab
- When the particulate counts crosses some levels → an alarm is triggered
  - average of 2000 counts for 1 day
  - 5000 counts for 2 hours
  - 19500 counts for 5 min
- When alarms is triggered, few people gets notification:
  - The area is investigated for the source of the possible contamination
    - ➢ Finding solutions to the problem
  - Soon the scientists are going to be notified also




## Where are the particle counters located in the lab?

- Surface Lab: Clean Room Assembly, Low Background Counting Room
- Underground Lab: SNO+ Deck, Low Background Lab, Main Junction, Ladder Labs, ChemLab, Cube Hall, BAD, Machine Shop

## How to access the particle counters readings/trends?

- They are available to all on PI Vision: https://pivision.d.snolab.ca/PIVision/#/Displays/465/Particle-Counters

# Monitoring Tools: Witness Plates


## What is a Witness Plate and what do we learn from them?

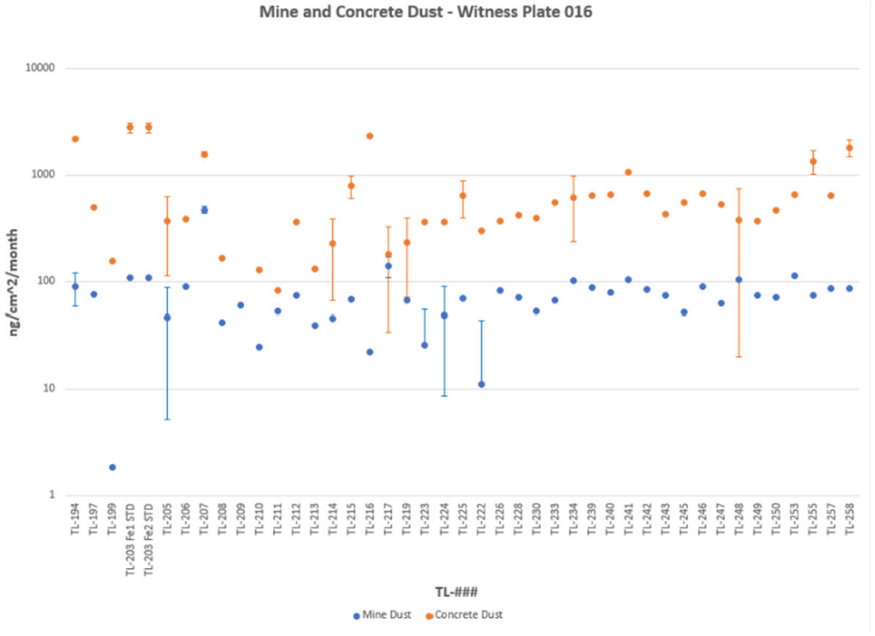
- HDPE plates that are used to monitor the dust deposition rate
- Tape lifts from the surface are analyzed using XRF spectrometer
  - The amount of mine dust deposited is obtained by measuring the amount of iron
  - Compared to the dust from concrete (Ca)

## How many and where they are?

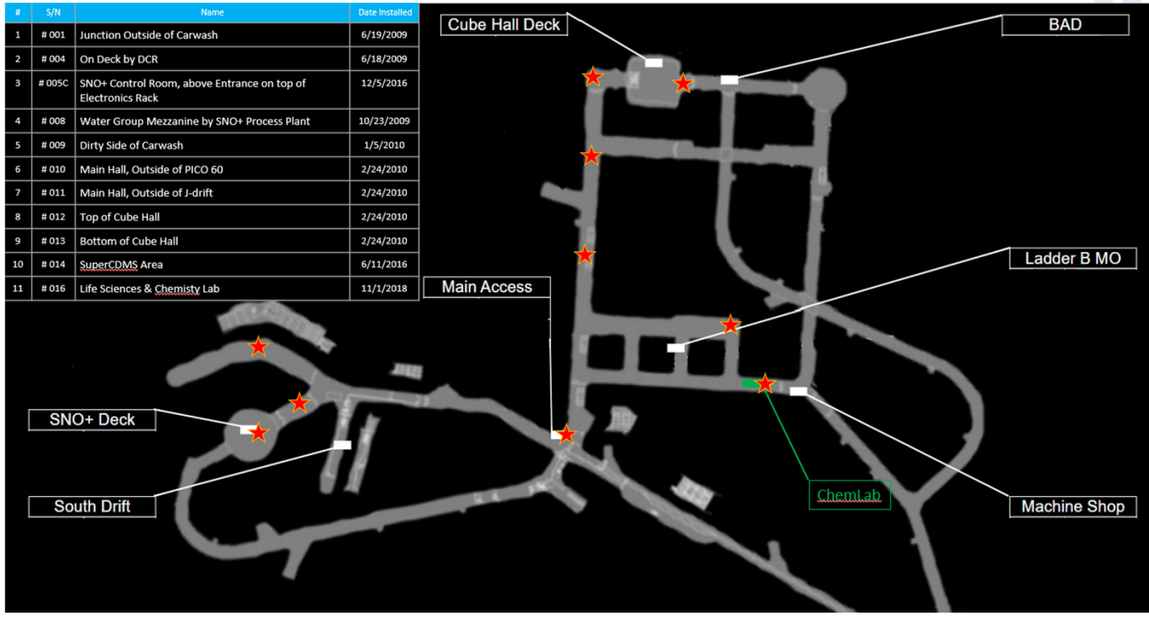
- They are in 11 plates within the lab (see the map)

## Were to find the results?

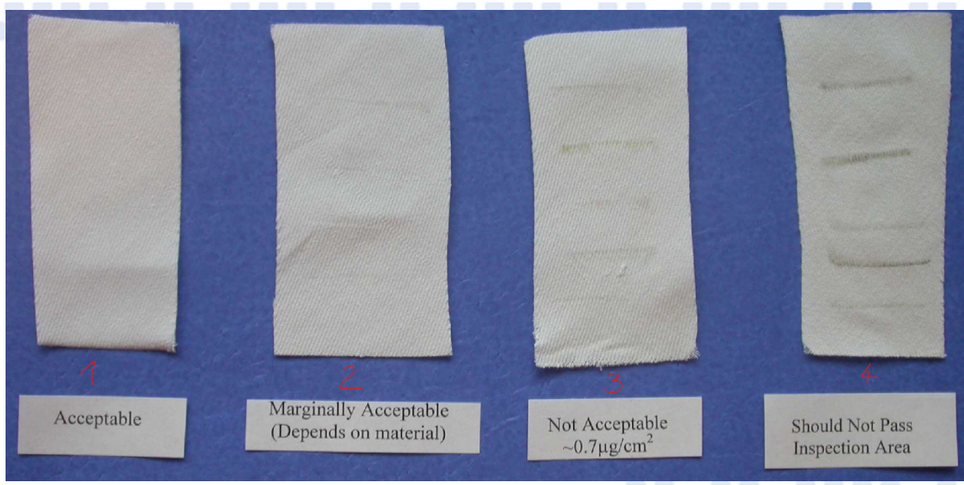
- They are available on DocuShare: https://www.snolab.ca/docushare/dsweb/View/Collection-1293




| # | S/N | Name | Date Installed |
|---|---|---|---|
| 1 | # 001 | Junction Outside of Carwash | 6/19/2009 |
| 2 | # 004 | On Deck by DCR | 6/18/2009 |
| 3 | # 005C | SNO+ Control Room, above Entrance on top of Electronics Rack | 12/5/2016 |
| 4 | # 008 | Water Group Mezzanine by SNO+ Process Plant | 10/23/2009 |
| 5 | # 009 | Dirty Side of Carwash | 1/5/2010 |
| 6 | # 010 | Main Hall, Outside of PICO 60 | 2/24/2010 |
| 7 | # 011 | Main Hall, Outside of J-drift | 2/24/2010 |
| 8 | # 012 | Top of Cube Hall | 2/24/2010 |
| 9 | # 013 | Bottom of Cube Hall | 2/24/2010 |
| 10 | # 014 | SuperCDMS Area | 6/11/2016 |
| 11 | # 016 | Life Sciences & Chemistry Lab | 11/1/2018 |



# Monitoring Tools: Swipe Tests




## What is a swipe test?

- A technique that is used to monitor presence of the dust on a surface
  - ➢ a quick test to see if the cleaned item meets the cleanroom standards

## How is the swipe test done?

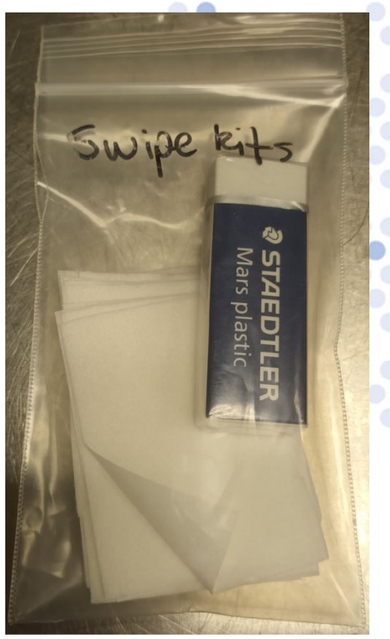
- A lint free white cloth strip is placed over the square edge of a rubber eraser
- With a moderate pressure it is moved over a tested surface for a distance of 6 inches (15 cm)

## How can the results look like and how they are interpreted?

- The tested surface that **passed** the swipe test should have **no visible** “line” of dust on the swipe
- Results 3 & 4 are unacceptable in the cleanroom → further cleaning required
  - NOTE: After each cleaning new swipe tests should be done till the results are accepted.

## What is tested with that method and who is doing that?

- **Any** material that is cleaned in the carwash should be verified by a swipe test before it enters the cleanroom.
- The swipe kits are available in the carwash for that purpose
  - Test done by cleaners or users
- Random surfaces/items in the UG lab and in the surface clean room on the **monthly** bases for monitoring purpose
  - Test done by Scientific Support



# Monitoring Tools: Swipe Tests

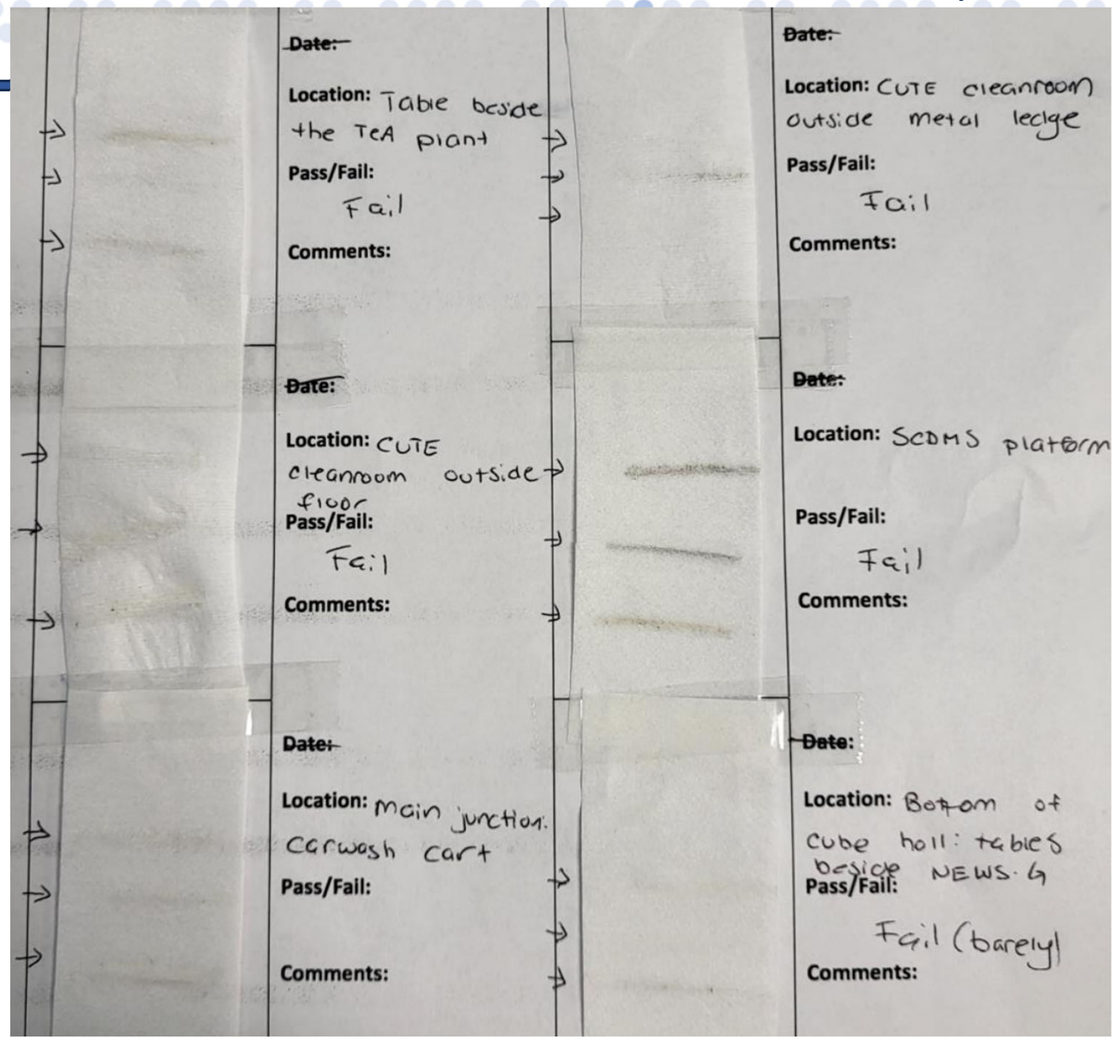
## Do we store the results and who has access to them?

- The monthly swipe tests results are available for everybody:
  - https://www.snolab.ca/docushare/dsweb/View/Collection-10344 (UG)
  - https://www.snolab.ca/docushare/dsweb/View/Collection-10406 (Surface clean room)

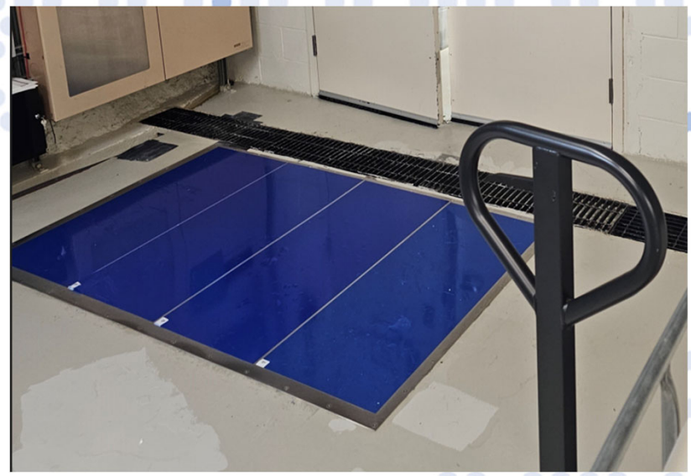
- Swipes taken from any items that are moved to the surface cleanroom for longer time are recorded in the logbook located in the vestibule

## Do we act on the results from the swipe tests?

- Yes, the report from the test is sent to Cleaners Supervisor or specific individuals with a request for additional cleaning of the items that failed the swipe test
- The "failed" areas are re-tested one month later and every few months



# Monitoring Tools: Blue Matts



## What are those blue mats?

- They are multi-layer adhesive mats also called sticky/tacky/blue mats

## What are they for?

- As they are adhesive, they can effectively capture dirt/dust/debris from boots or other equipment
  - They are placed before entry to a more dust-controlled environment
- They can be used as a dirt monitoring tool, as they show if some areas requires more cleaning

## How should we use them?

- Step on the mat at least twice with each foot and make sure the entire sole presses firmly on the mat
- Don’t avoid them when you see a nice fresh layer, they are there to keep the dirt away from the cleaner part of the lab
- After walking on the mat, check how dusty your boots are and step more on the mat if needed

## When should the top layer be peeled off?

- The good practice would be to remove when the mat is visibly dirty or damaged as the new dirt will not adhere to it

## Who can remove the top layer?

- Usually, the cleaners will make sure the soiled or damaged layers are removed and disposed.
  - But this can be done by **anybody**! Notify Cleaners Supervisor if mats are very soiled (to find the source of contamination)

## How to remove the top layer?

- Peel it slowly rather than rip it off fast, as that causes dirt and dust to fly off into the air.
- Find the tab with the number and pull up slowly, peel from all the corners to contain the dirt and dust inside
- Dispose of the sheet at the end

# What can we do better? Educate, remind, remind….

## Training:

### SNOLAB Site Specific Training (SSST):

- There are 4 pages in the online training (part 2) that talk about the general cleanliness rules in the UG lab
  - **It sends the trainee to two documents on DocuShare for more detailed information:**
    - Cleanliness Policy SL-SCI-RES-20-001-P
    - Cleanliness Protocol Entering and Leaving the UG Lab: SL-SCI-RES-20-010-SOP

### SNOLAB Surface Lab Cleanroom Orientation Training (SLOT):

- This training gives a much broader information about the cleanliness
- Only people who had SLOT can work in the Surface CleanLab
- Renewed every 2 years (from now on)

## Ongoing additional efforts:

### Cleanliness Flashes:

- Monthly(-ish) short reminder about some cleanliness topic
  - Topic can be requested via link or directly to me
- If any ProSapien event happens – there is a short reminder on the divisional meeting

### Updating the Cleanliness Policy:

- Moving towards Cleanliness Program that is mandatory document that needs to be reviewed yearly

### Cleanliness walk:

- Monthly walk through the lab to review the cleanliness state of the lab (maybe inviting other scientist for it)

# Reminder: Entering the UG laboratory


## On Surface:

- Double-bag your articles (first white bag then black bag)

## At the Double Track Area:

- wash your boots, use provided brushes to fully remove the dirt

## Enter the Dirty Boot Area:

- remove and store your boots, hat, belt, gloves, safety glasses and backpack
- remove and dispose the outer (black) bag from the double-bagged articles

## Enter the Dry:

- remove and store your mine gear
- shower and wash your hair thoroughly using SNOLAB approved products
- clean your eyewear and watch if you take them with you inside the lab
- secure your hair with an elastic if they are long, done hairnet and make sure it covers well your hair
- dress in the cleanroom underwear, socks, coveralls, clean safety boots, safety glasses
- remove and dispose the inner (white) bag from the articles

## Enter the Refuge (Lunchroom)

- store your tablet and headphones bags on the shelf as those items should stay in the Refuge
- wipe your tablet/headphones/phone if you take them outside of the Refuge

# Reminder: Best Cleanliness Practices

## What are the main sources of contaminants in the Cleanroom?

- Tools and materials that produce debris, dust or contain oil/grease
- People working in the lab → we carry some of those contaminants on our bodies and clothes
  - skin cells, hair, cosmetics/perfumes

**Items not allowed in the Cleanroom:**

- Paper, cardboard, unfinished wood
- Tissue except lint-free
- Cotton, wool, non-lint free materials
- Makeup, nail polish, perfumes
- Unsealed fiberglass
- Styrofoam products
- Chalk, powders (unless approved)
- Aerosol sprays
- Erasers (except for the swipe test), pencils
- Anything that can easily be shredded
- Any materials from a hot lab

## How to prevent contamination?

**Putting on cleanroom gear in the correct order matters:**

- Start with doing your hair by securing them with an **elastic or two** if they are long
- Done the hairnet and make sure it covers your hair well (FYI: we also provide beard-nets!)
- Put on cleanroom coveralls and do not let the sleeves touch the floor

**Cleanliness and housekeeping of the laboratory is the responsibility of the entire team:**

- An important part of the cleanroom program is cleaning of the cleanroom
- Experiments should keep their area tidy as that helps cleaners to clean surfaces
- If your work may create dust, make sure you have:
  - vacuum cleaner that can be used at all times, build a shield to prevent dust from entering the larger area, informed Cleaning Supervisor to get help from the cleaning team

**Avoid cross-contamination:**

- Always check your carts, toolboxes, coveralls and boots for dirt when moving to different area of the lab
- Refuge is the place where we all meet, eat and use the same place to sit. Do not make others walk away with “your dust”
- Change your coverall if contaminated before entering the lunchroom area
- Do not walk away from the lunchroom with your food – shake your coverall from crumps/change coverall if stained with food

# Reminder: Cleanroom Supplies - wipes

## What is the difference between cleanroom wipes and standard wipes?

- cleanroom wipes:
  - specifically engineered for use in controlled environments
  - made from materials with low particle generation and low levels of chemical extractability to minimalize contamination
- standard wipes:
  - intended for general-purpose cleaning tasks in everyday environments
  - may contain additives (fragrances, surfactants, preservatives) which could compromise the integrity of sensitive parts

## What kind of wipes do we use in the SNOLAB underground cleanroom?

- SNOLAB provides several types of wipes with different cleanroom standards – see the table below for their specifications

## Which wipes and where should they be used?

- In most places in the lab using Kimwipes is your first and best choice
- **BUT** some areas close to the experiments have very well-defined rules about the use of specific type of wipes:
  - it is advised to **always** consult with the scientists working on the experiment before you start cleaning/wiping some parts

| |  |   |  |  |
|---|---|---|---|---|
| Name/Brand | Airlaid Merfin | Kimwipes/ Kimtech | Fisherbrand/ Fisher Scientific | Ultimate 70/Hight-tech |
| Cleanroom ISO | -- | | 5-8 | 3-5 |
| Material | Airlaid bonded cellulose | virgin wood pulp | nonwoven Poly-Cellulose | 100% virgin polyester fibers |
| Features/Use: | High absorbency and softness | Low-lint softness | extremely low particle generation and chemical extractables | |
| | Medium-duty routine industrial cleaning & maintenance | won't degrade under acid, bases, and solvents | compatible with any solvent or solution for cleaning and wiping | |
| | Perfect for spills (holds 2x its weight in grease, liquid or oil) | cleans lenses, glass surfaces, electronics and equipment with no residue<br>easily wipe up liquid and dust | tough, absorbent and abrasion resistant | Wiping and cleaning all aspects of cleanroom |

# Summary

## Cleanliness is essential:

- Substantial effort goes to the selection of ultrapure materials for the experiments
  - ➢ mishandling and/or exposure to the cleanroom contaminants can compromise them
- Cleaning and maintaining of the cleanroom is a huge effort
  - ➢ everybody can help by following the protocols

*SNOLAB is a cleanroom laboratory located in the active mine, where world-class experiments are searching for very rare events. Reducing to minimum the radioactive backgrounds is one of the challenges those experiments are facing. The mine dust is one of the contributor containing isotopes of uranium and thorium. To keep that large laboratory as a one dust-free cleanroom surrounded by dirty mine requires a lot of effort from everybody. For that reason, we implemented the cleanliness protocols that applies for any personnel and items entering the lab. It is to eliminate the levels of radiation that are emitted from the dirt that accumulates on clothes, skin or hair during the walk through the mine. All the personnel and visitors before entering UG lab has to shower, clean their hair, change to clean clothes and wear hairnets. It is very important to us and the science we are conducting that everybody obey the rules we have.*

*Thank you,*
*Aleksandra*
*SNOLAB Cleanliness Coordinator*