

Birck Nanotechnology Center

This script assumes that the tour begins at the Birck Nanotechnology Center Main Entrance on Level 1, and continues through the major open areas of the facility.

(Level 1)

Begin in Atrium by reception desk and explain the *safety information below. *The Birck Nanotechnology Center is very safe, but as a precaution, we are asking you to explain the information below in the event a siren should sound.

Safety First: If an alarm sounds,

- √ **leave the building immediately**
- √ **do NOT use elevators, unless instructed**
- √ **white and yellow strobes indicate building evacuation**
- √ **go to evacuation point: Café in the rear of Burton D. Morgan Center**

STOP 1: Atrium

There is no poster for Stop 1

Talking Points

- Mission is to provide collaborative, interdisciplinary solutions to challenges in:
 - Healthcare
 - Information access
 - Energy
 - Environment
- World-class facilities and instrumentation for collaborative, interdisciplinary nanoscale research
 - All laboratories are shared from students and staff of various academia
 - 36 schools and/or departments involved
- Over 200 graduate students have offices
 - 300 researchers
- Facility facts
 - Opened in July, 2005
 - \$58 million
 - 187,000 total square feet
- Donors
 - Michael J. & Katherine R. (Kay) Birck, lead donors
 - Donald & Carol Scifres for the Nanofabrication Laboratory (cleanroom)
 - William B. & Mary Jane Elmore for the Advanced Concept Validation Center
 - Kevin G. Hall for the nanometrology laboratory

- Building features:
 - Two separate buildings under one roof
 - North building [front side] contains offices and labs
 - South building [rear side] houses three-level cleanroom operation
 - “Community” areas complete with whiteboards to encourage collaboration
 - 21,000 square feet containing six types of laboratories
 - These are the six types of labs:
 - Chemistry and Biology: handling, preparing, and processing experimental materials and apparatus
 - Epitaxy: layer-by-layer construction of new materials/devices
 - Metrology: measurement of nanoscale materials and devices
 - Instructional: undergraduate and graduate students receive state-of-the-art training Nanotechnology
 - Incubator Lab: space dedicated to the “birth” of new companies thereby encouraging technology transfer and entrepreneurship

STOP 2: Atrium Display: The Science of Making Things Smaller

Poster 2A: (by stairwell) Built for Stability

Advanced construction methods including isolated concrete slabs, a deep waffle slab, and closely spaced columns minimize vibration and enable nanoscale measurements and microscopy. Grass has not been planted next to the building so that mowing equipment does not create any undue vibrations.

Poster 2B (behind Lego display): “Seeing” at Nanoscale

This “Lego” exhibit is a replica of an atomic force microscope (AFM). Several AFM’s are located throughout the facility, allowing users to examine surfaces of samples at the nanoscale, in three dimensions. AFM’s use micro-scale cantilevers with sharp tips or probes of near atomic dimensions, to scan specimen surfaces with atomic resolution.

Talking Points

- This exhibit, complete with framed photos, was developed for children’s museums.
- Housed here to give P-12 students — and others — a “nano” experience

(more talking points continued on next page...)

- Display includes:
 - posters that explain nanotechnology concepts, located along wall
 - computer kiosks with virtual programs about nanoscience
 - one kiosk contains “GenerationNano,” developed by our Network for Computational Technology (NCN) group
 - artwork produced by microscopes like the AFM
- As your time permits at the end of the tour, we invite you to spend some time in this exhibit.
- **Tour Guide Note: GenerationNano kiosk located in Atrium**
-Handout available in your notebook to send to groups ahead of scheduled tour, or make copies of and pass out during tour.

STOP 3: Left wall side, before glass conference rooms

Talking Points

Tools for measuring, scanning, and analyzing

- Many types of scanning microscopes are employed by the researchers here in the Birck Nanotechnology Center.
- Atomic Force Microscopy (AFM) units are located in Birck One
 - example of an AFM is may be viewed in BRK 1031.

Poster 3A (left wall of Atrium): Precise Measurements

The Kevin G. Hall Nanometrology Laboratory provides a highly controlled research environment. The Laboratory is designed with state-of-the-art technology to control temperature, reduce vibration, and virtually eliminate electromagnetic interference. The temperature in this laboratory is controlled to 0.01 degree.

Talking Points

Why are these scanning machines and images important?

-Tour Guide Note: Refer to Poster 3B

Poster 3B: “Seeing” at Nanoscale

Seeing and analyzing chemical reactions at the atomic scale while they are happening is the key to developing new nanoscale catalysts for more efficient production of chemicals, elimination of pollutants, and synthesis of self-organizing nanomaterials.

STOP 4: East window looking into the subfab

Talking Points

- ***You’re looking into the subfab, which is the first level of our three-level cleanroom.***
 - This area is NOT included in the cleanroom air-handling system.
 - Equipment here supports operations in the cleanroom, for example:
 - Vacuum pumps
 - Inert-gas cabinets
 - Chillers
 - The Subfab’s ceiling is also the cleanroom subfloor —
 - Resembles a Belgian Waffle from below and
 - Reduces vibration and provides a strong structural support

Poster 4: (by window of white water tank) Nano-Grade Water:

The complex system to the right of the window is part of the system that provides ultra-pure water to the facility. This system circulates water that has virtually all impurities removed; making it so pure that it will not conduct electricity. Plastic piping is used rather than stainless steel or copper so that no contaminants are collected as the water passes through the piping.

- Tour Guide Note: Refer to FAQ of notebook for further explanation of the plastic piping.

**Proceed to the main stairway and up to the second floor.
Use glass elevator, if necessary.**

STOP 5: Gowning area of the cleanroom—stop in front and talk

There is no poster for Stop 5

Talking Points

- Our 25,252-square-foot cleanroom is currently the largest and cleanest university cleanroom in the nation.
- This area behind the metal screen is the first stop in the gowning procedure:
 - Researchers put on shoe covers and then rotate on the bench, placing their feet on the inside of the area;
 - Then a bouffant cap is put on, and they proceed to the second stop;
 - Inside the entrance door, an air shower blows high-velocity air over their street clothes; they must turn around three times; then to the third stop
 - The gowning racks to put on a hood, face veil, jumpsuit, boots, gloves, and safety glasses;
 - (Blue-colored clothing if performing chemical processes; then proceed to the final stop
 - Another air shower where any particles deposited on the garments during the gowning process are blown off as they turn around three times again.
 - At last, they enter the cleanroom.

STOP 6: Second window to the west (right) of the gowning area.

Talking Points

- The cleanroom consists of bays and chases. Here you are looking into a chase.
 - These areas separate the maintenance and operations functions.
 - You'll notice the floors are different in the bays and the chases.

Talking Points

- The cleanroom is a three-level structure.
 - First level, and the lowest, is the subfab.
 - Second level is the actual cleanroom.
 - Third level contains the air-handling system.
 - Look upward through the skylight and you'll see this level.
- The air-handling system
 - Blows air down from the third-level through the bays
 - Up through the chase floors; Is pushed up through the chases to the third-floor level; **see Poster 6**

Poster 6: (by west window) Cleanest Air on Campus:

Birck's air handling system circulates and filters air to remove even the smallest particles. • the air circulates every 7 seconds. • in an average home, air is changed every 600 seconds. ISO Class 3 (Class 1) cleanroom - <1 critical particle/ft³. Specialized surgical room – <10,000 critical particles/ft³. Nanomachines must be assembled in a particle-free environment. Even nanoparticles that are too small to see can prevent a nanoscale device from working properly.

Proceed to the west entry of the observation hallway around the cleanroom

STOP 7: First set of doors along observation hallway. (Can talk and walk)

Talking Points

- The first set of doors on your left is where equipment enters the cleanroom.
 - New equipment comes up the freight elevator (behind you),
 - Is pre-cleaned in the elevator lobby, and then
 - Moved into the “blowdown room.”
 - Pre-gowned personnel enter the blowdown room from the cleanroom.
 - Equipment is cleaned again and then
 - Sits in blowdown room for 12 hours.
 - Then it can be moved into the cleanroom.

Poster 7: (in cleanroom, halfway down the hall) Journey to the Cleanroom

“Equipment enters the cleanroom through the first set of doors on your left. New equipment arrives in freight elevator (behind you)). Equipment is pre-cleaned in elevator lobby. Equipment is moved into blowdown room. Fully gowned personnel enter blowdown room from cleanroom. Equipment is cleaned again and sits in blowdown room for 12 hours. Equipment is ready to be moved into cleanroom.”

STOP 8: the first bay on the backside of the cleanroom (BRK 2168)

Talking Points

- Note the orange film on the windows: the film blocks out UV light rays
 - to control outside factors that may influence the results of experimentation.
- The bay contains a VectorBeam (VB-6) electron beam lithography tool
 - this tool could write 10,000 lines on the diameter of a human hair.
- The work in this lab has contributed to the possibility of creating an “optical cloaking” device
 - could render objects invisible by guiding light around anything inside this “cloak.”

Poster 8A: Cloak of Invisibility

Purdue researchers have taken a step toward creating an “optical cloaking” device that could render objects invisible by guiding light around anything placed inside this “cloak.” The design, resembling a round hairbrush of nano-needles radiating out from a central spoke, would bend light around the object being cloaked. Background objects would be visible but not the object surrounded by the cylindrical array of nano-needles.

Continue along the hallway

Talking Points (as you walk)

- Don't be alarmed if you see little activity today during our tour. Most students tend to work in the evenings and on weekends.
 - Lab “buddies” are personnel who work during these off hours to provide assistance and protection in emergencies.
- BRK 2160
 - An example of a chase being used as lab space
 - The equipment needs a cleanroom “type” of environment but doesn't need the ultra clean air as others do.
- You may see housekeeping staff inside the cleanroom.
 - Particles floating in the air (10 micrometers or more) are removed by the cleaning staff.
 - Special training required on methods of cleaning and
 - Work continues – eight hours per day, five days per week)

Poster 8B: Keeping the Cleanroom Clean

Special training is required for the housekeeping staff of the cleanroom, who clean the facility eight hours a day, five days a week. This cleaning is needed to remove particles that settle on surfaces generated by equipment, processes, and people in the cleanroom. The Ultra-Low Penetration Air (ULPA) filters in the ceiling remove the particles floating in the air with 99.999% efficiency.

- BRK 2100J
 - Note that this room contains an AFM, just as downstairs.
 - Placed here so that researchers don't need to exit the cleanroom to scan what they've been working on.
- BRK 2100H
 - Will be used to teach undergraduate students cleanroom user procedures.

STOP 9: BRK 2100G

There is no poster for Stop 9

Talking Points

- Atomic Layer Deposition (ALD)
 - The ASM F-120 costs about \$250, 000 to buy and the ASM F-450 brought from Bell Labs cost \$860, 000 (purchased in 1998).
 - A great example of the need to share equipment among researchers as not all researchers get the amount of funding to purchase an ALD; by sharing and charging a fee to users, the maintenance fees may be spread out among many users.
 - ALDs are frequently used in semiconductor industries like IBM and Intel to deposit a layer of nanomaterials onto another material.

Continue along the hallway

Talking Points

- BRK 2100F
 - Tool cleaning must take place inside the cleanroom to avoid taking instruments in and out of the cleanroom.

STOP 10: Biological Cleanroom

There is no poster for Stop 10

Talking Points

- Because of the location of the Bindley Bioscience Center and the location of this biological cleanroom, collaboration is facilitated.
- 2,500 square feet, isolated from the rest of the cleanroom
 - Different air handling that contains additional filters.
- Separate entry and gowning procedures.
 - Gowns are thrown away instead of cleaning for reuse.
- Pass-through door for the entry of biological agents into the space.
- Processing and testing of biological structures that interact with or detect biological agents.

Head to the right as you exit the cleanroom, toward the skywalk, and gather in open area.

STOP 11: Open Area as you exit the clean room

Talking Points

- This wing, with its close approximation to the Bindley Bioscience Center and our Cleanroom, has been designed for biological studies.

Poster 11: Microfluidics

"The study of microfluidics is important to biological research as it: -Allows for smaller fluid samples (like blood)-Eases the separation of elements for analysis -Enables earlier detection of bacteria, cancer, viruses, and food-borne germs."

STOP 12: Head towards 2nd floor conference room, half way down, on right side wall

Poster 12A: Systems, Devices, and Materials Experimentation

Birck's second-floor operations focus on the creation of nanoscale devices with applications in areas such as information/computer technology, healthcare, environmental safety, and protection from bioterrorism. These devices can enhance the performance of existing systems, or provide the basis for the development of entirely new systems."

Poster 12B: West and East Wings, 2nd floor

"West: Making electronic components smaller, faster, and cooler, which translates into smaller cell phones and higher performance computers. Enhancing techniques to electrically characterize DNA, improving DNA delivery into cells. East: Improving glucose regulation for diabetes. Developing drug delivery systems. Pioneering novel cancer therapies"

(talking points continued on next page...)

- East wing emphasis
 - biological and chemical studies
 - glucose regulation for diabetes
 - drug delivery systems
 - novel cancer therapies.
- West wing emphasis
 - how can we make things smaller and cooler
 - micro-electronics for smaller cell phones, computers, etc.
 - how we can enhance techniques to electrically characterize DNA
 - Impacts the understanding of DNA sensing
 - Enhances DNA delivery into cells
 - Impacts molecular electronic
- Bio-MEMS (micro-electronic-mechanical systems)
 - Study the dynamics of liquid droplets on solid surface

Head towards conference room and turn left to the other side of Atrium

Poster 12C: Micro-Electro-Mechanical Systems (MEMS)

"Purdue engineers are working with the U.S. Air Force to develop tiny wireless sensors that are resilient enough to survive the harsh conditions inside jet engines. These sensors can detect when critical bearings are close to failing in order to prevent breakdowns far earlier than conventional sensors. The technology also has potential applications in commercial products, including aircraft and cars"

Continue towards top of Atrium stairs

STOP 13: West wall, before top of Atrium stairs

Talking Points

- Use Poster 13A for talking points.

Poster 13A: Network for Computational Nanotechnology (NCN)

"Funded through a ten-year, \$33 million grant from the National Science Foundation and led by Purdue University, the NCN is a network of universities with a vision to pioneer the development of nanotechnology from science to manufacturing through innovative theory, exploratory simulation, and novel cyberinfrastructure."

Poster 13B: NanoHub

"The nanoHUB (www.nanohub.org) is a rich, web-based resource for research, education and collaboration in nanotechnology. It hosts over 790 resources, including learning modules, podcasts and device simulations to help users learn and teach about nanotechnology. Resources come from nearly 400 contributors and are used by thousands of users from over 180 countries around the world"

- The NCN is most noted for the nanoHUB, where scientists around the world are about to utilize available simulations and modeling capabilities for their data. The NcN receives over 3000 visitors every month.

Descend Stairwell and End Tour

Thank you for visiting the Birck Nanotechnology Center and Discovery Park.