

**FACT
SHEET**

“NOISE-FREE” LABS

Binnig and Rohrer Nanotechnology Center

WHY SPECIAL LABS?

Research on the nanometer scale requires fabrication and characterization on the same level of accuracy. These “noise-free” labs, in which special measures have been taken to enable nanometer-scale research, promise to provide an ideal research environment for the next 20 – 30 years.

WHY DO EXTERNAL NOISE SOURCES LIMIT NANOTECHNOLOGY RESEARCH?

Research on the length scale of molecules and atoms is extremely sensitive to external sources of noise, which impose major limitations. For example,

- Temperature drifts induce expansion of the substrate and hence move the sample.
- Electromagnetic fields deflect the electron beams used for imaging and structuring.
- Seismic vibrations and acoustic disturbances lead to vibrations of the entire tool and variations in the positioning of the sample.

WHAT ARE “NOISE-FREE” LABS?

In a “noise-free” lab, the influence of external sources of noise is reduced by several shielding and compensation measures. Moreover, the layout and the construction of the labs allow a drastic reduction of tool-generated noise.

Their specifications are:

- Temperature stability: $\Delta T \pm 0.01$ °C (absolute over 24 h)
- Electromagnetic fields: $|B_{AC}| < 2$ nT AC (absolute), $\Delta B_{DC} < 20$ nT DC (fluctuations on top of the magnetic field of the Earth)
- Acoustic noise level: < 21 dBC
- Vibrations: < 100 nm/s at 1 Hz

FACTS AND FIGURES

The labs are located in the basement of the building, 8 m below street level. The floor is built directly on the bedrock.

Six “noise-free” labs with a total of 176 m² of floor space plus one lab to be shared between IBM and ETH Zurich. Five chambers with 66 m² of floor space.

HOW WERE THESE SPECIFICATIONS ACHIEVED?

To achieve the specifications mentioned above, various technical measures had to be developed and implemented. For example,

- Placement of noise-producing equipment (pumps, transformers, power supplies etc.) are housed in adjacent auxiliary rooms
- Remote operation of the tool or experiment from an anteroom or office (heat dissipation of a human being: 100 W)
- Complete magnetic metal cladding (NiFe) of every lab (including doors, electric cabinets etc.)
- Massive air-spring-suspended and actively controlled concrete seismic blocks weighing 30 – 68 tons each
- De-coupled user platform
- Active cancellation of electromagnetic fields by Helmholtz coils with three pairs in x, y and z dimensions
- Laminar and vertical air-conditioning system with minimum air flux, reduced turbulence and local cooling and heating units that are independently adjustable for each lab
- Cooling ceiling
- LED lighting

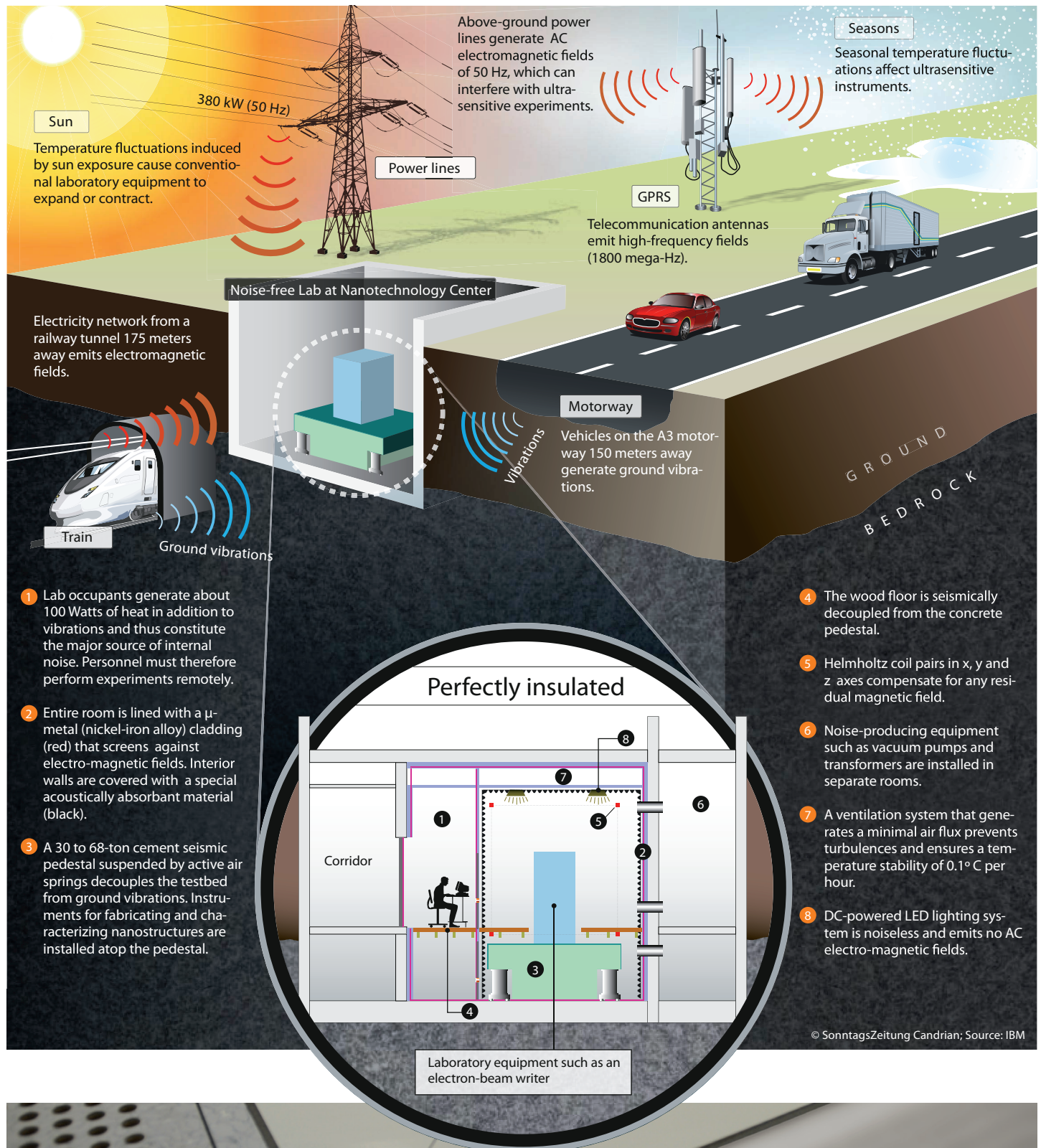
WHAT KINDS OF EXPERIMENTS ARE PLANNED FOR THESE LABS?

Both nanotech fabrication (e.g. electron beam writer) and characterization tools (e.g. spin-polarized scanning electron microscope, transmission electron microscope) are accommodated in these “noise-free” labs. Moreover, these labs house several “home-built” experimental setups that have been specially developed to leverage this unique research environment.

REFERENCE

Detailed information about the laboratory concept and the performance achieved can be found here:

Lörtscher E.; Widmer D. & Gotsmann, B.; *Next-Generation Nanotechnology Laboratories with Simultaneous Reduction of all Relevant Disturbances*, *RCS Nanoscale*, 2013, 5, 10542-10549



More information:
www.zurich.ibm.com/nanocenter

ETH

Edgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

IBM