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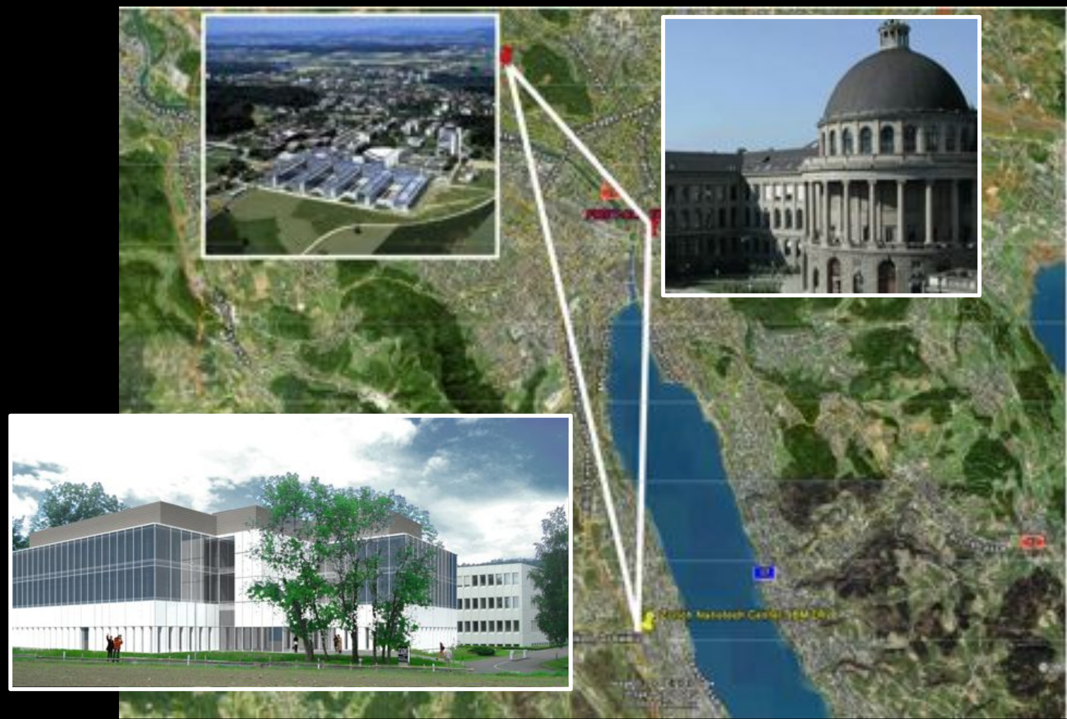
IBM

Nanoelectronics Across the Zurich Lake

IBM Research – ETH Zurich
Nanoscale Exploratory Technology Lab

Plastic Optoelectronics Workshop
Basel, Switzerland
June 25, 2010



Nanoscale Exploratory Technology Laboratory (NETL)

A unique public-private partnership between IBM and
the Swiss Federal Institute of Technology (ETH Zürich)

The Nanoscale Exploratory Technology Laboratory

- A unique facility for exploratory research not available elsewhere
  - Not a production or a pilot line with fixed processes and fixed wafer size
  - Exploratory clean room fabrication capability combined with ultra-isolated, noise-free labs
- Unique skills and expertise at the Zurich Research Lab
  - One of the birthplaces of nanotechnology: Nobel Prizes in physics for the scanning tunneling microscope in 1986 and high-temperature superconductors in 1987
- Leveraging IBM's presence in Europe
  - Leading talent in nanotechnology, major government initiatives
  - One third of world-wide investment in nanotechnology ($Bs over the next 5 years)
- Partnerships to contain depreciation and operation costs
  - Existing examples: IBM CMOS alliance, Albany Nanotech
  - ETH Zurich is primary partner at ZRL
  - **Additional partners welcome!**

The Cooperation Model

Leading-edge science requires a leading-edge infrastructure – at NETL industry and academia are creating it together.



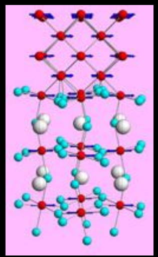
- IBM constructs building ($60 M)
- Cleanroom operated by IBM personnel
- ETH leases space (cleanroom, offices, off-line labs)
- ETH contributes to operating costs
- Capital equipment costs shared between ETH and IBM ($30 M)
- ETH professorships located at NETL
- Contract for a minimum of 10 years
- Both joint and individual research projects

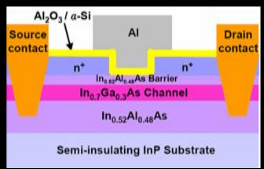
- ETH #1 technical university in Europe
  - 14000 students
  - 6300 staff
  - 21 Nobel laureates
  - $1.2B annual budget

What kind of research are we doing?

Nanoscale Devices for Information Processing

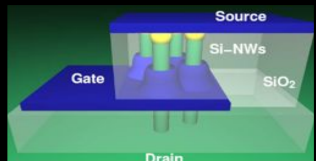
Nanoelectronics

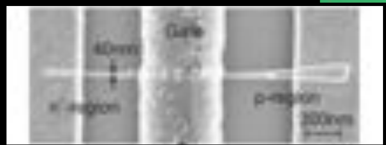


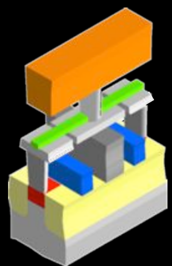


Materials for future CMOS

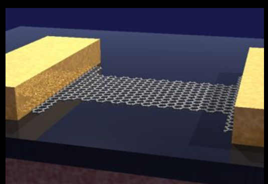
Semiconductor Nanowires

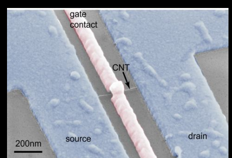






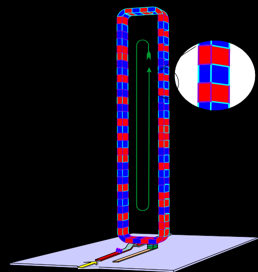
Storage-Class Memory



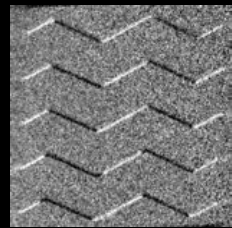


Carbon-based devices

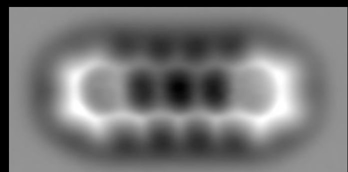
Beyond Charged-Based Logic

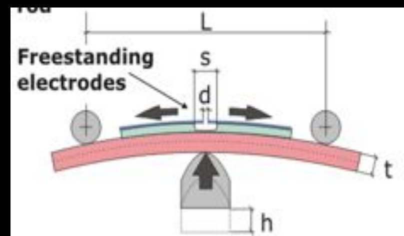


Spintronics



Molecular electronics

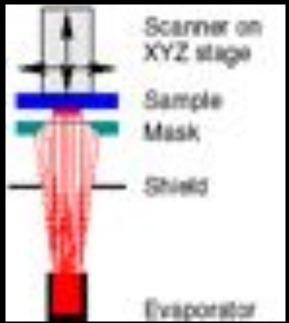




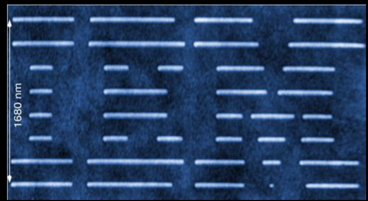
Quantum devices

Nanotechnology for Electronics

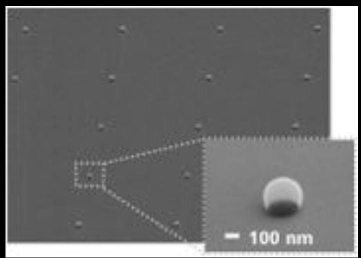
Nanofabrication

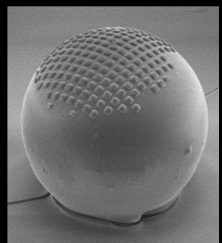


Nanostencil Lithography

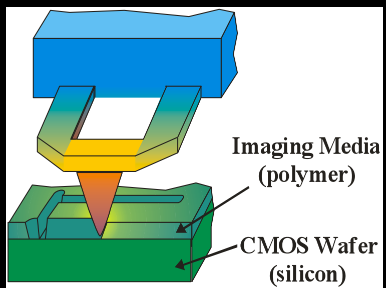


Directed Self-Assembly Platform



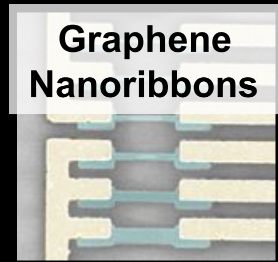


Probe-based Lithography

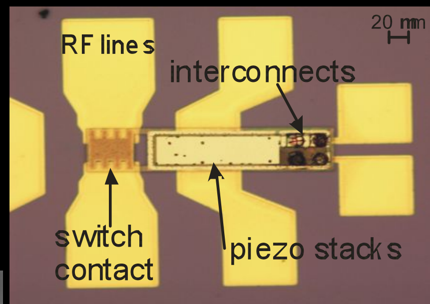


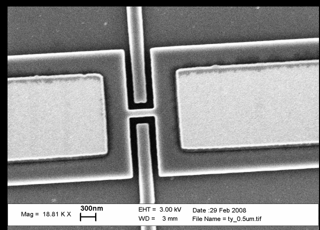
Sensors and Actuators

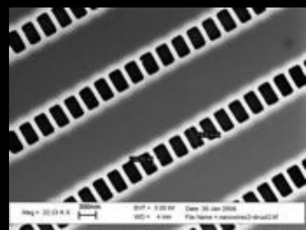
Carbon Electronics for Sensors



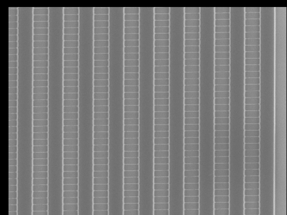
CMOS Integration of MEMS/ NEMS Sensors and Actuators

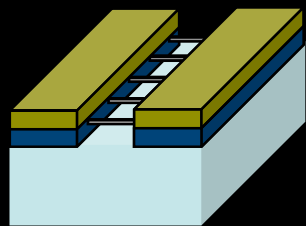






Silicon Nanowire Sensors

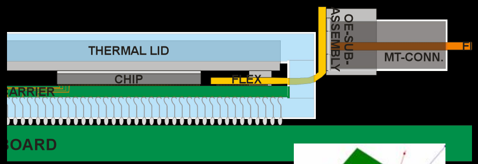


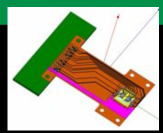


Photonics

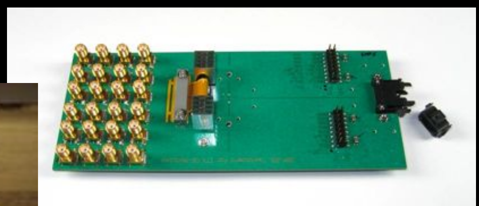
Optical Interconnects

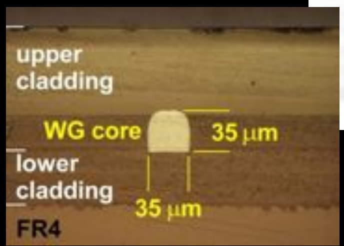
Optics to the carrier

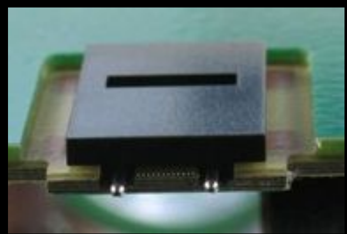




Polymer Waveguides



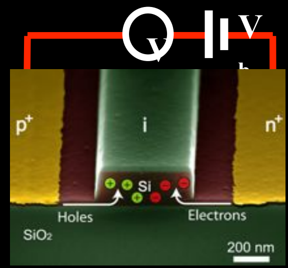




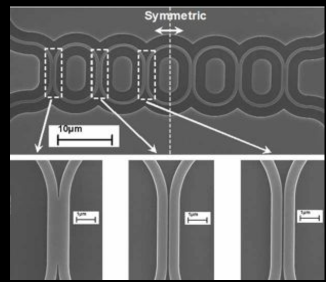
Passively-aligned Optical Connectors

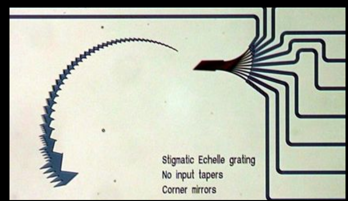
Integrated Si Photonics

Modulators



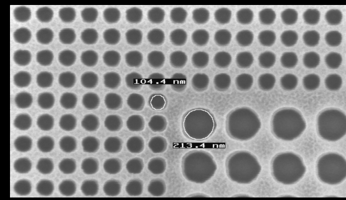
Switches



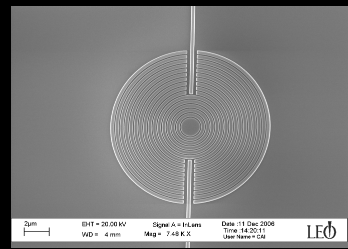


(De-)Multiplexing

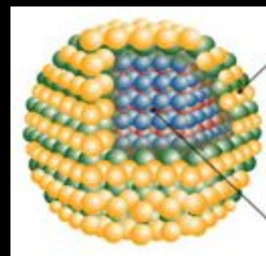
New Materials/Devices



Photonic Bandgap Structures



All Optical Switches



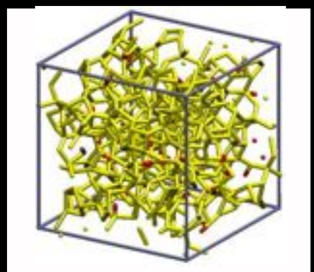
Non-linear Materials

Energy

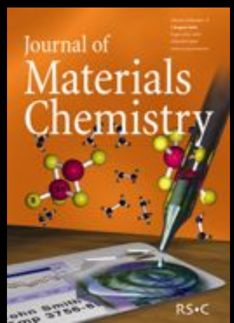
Generation	Storage	Conservation

Generation

Concentrator Photovoltaic Devices

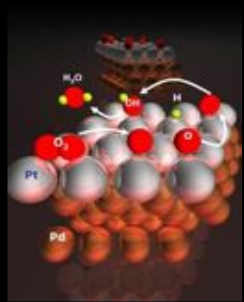


Modelling

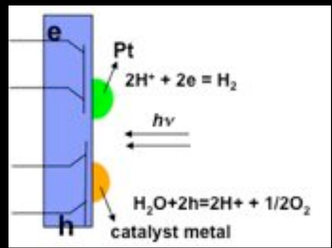


Organic & Hybrid Photovoltaic devices

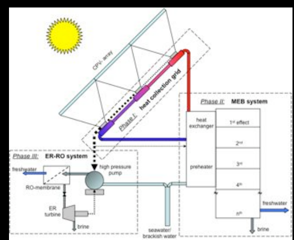
Storage



High Energy Density Batteries

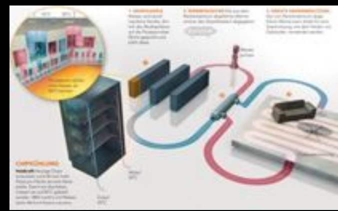


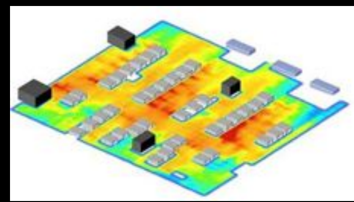
Photocatalysis



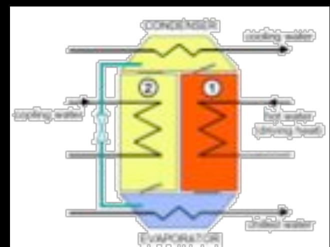
Energy Reuse For Desalination

Conservation





Zero Emission Data Center

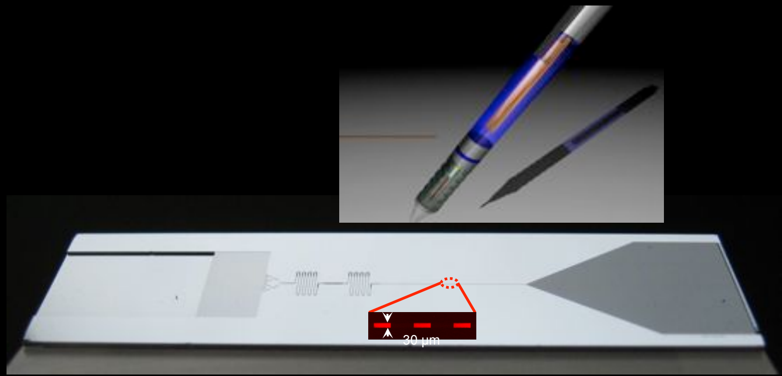


Solar Driven Adsorption Chiller

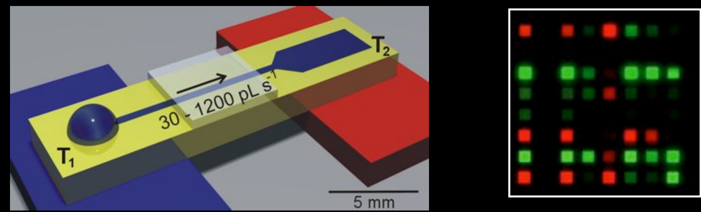
Health Care / Life Sciences

Microfluidics, Sensing, Simulations

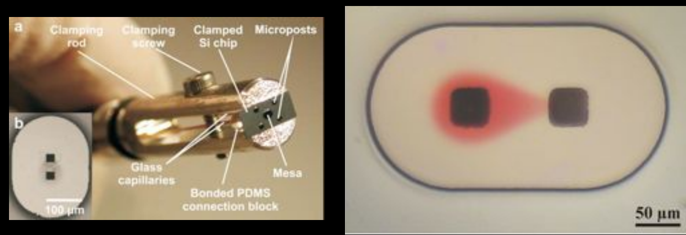
Point-of-Care Diagnostics



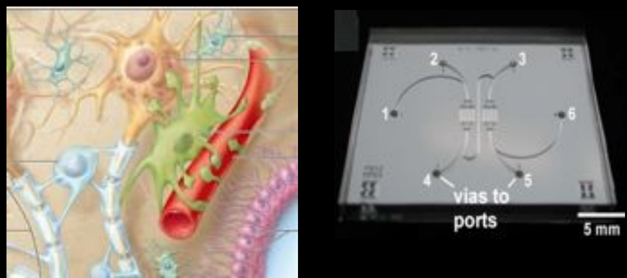
Micromosaic Immunoassays



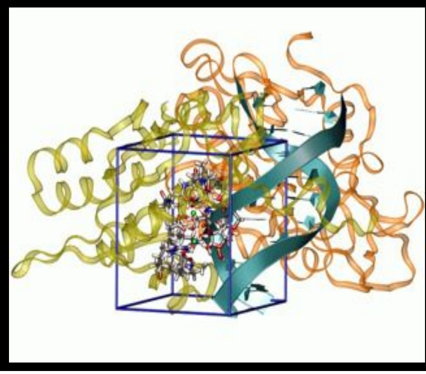
Microfluidic Probe

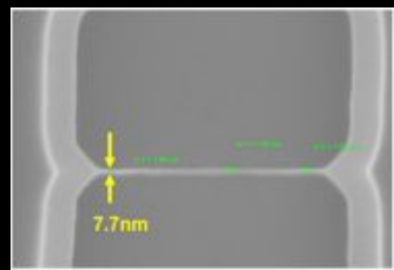


Brain Chip



Modeling



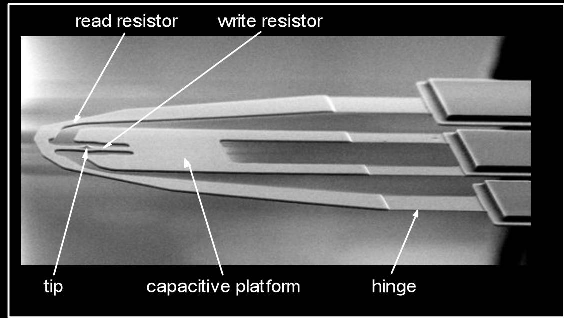


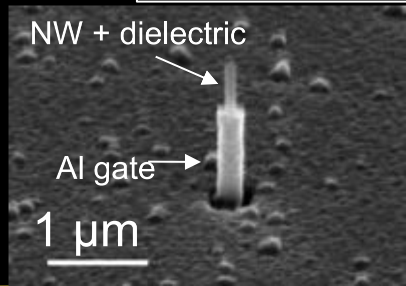
Carbon Nanotube Sensors

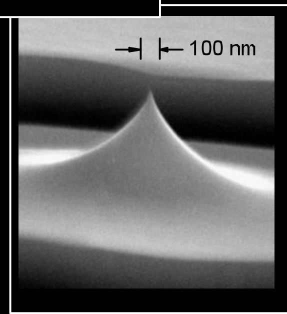
The Infrastructure

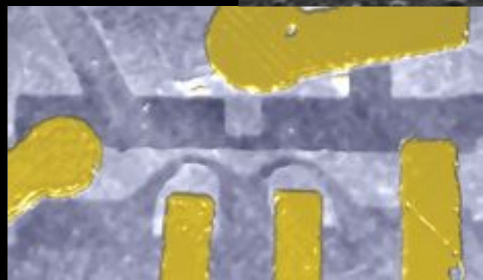
Identified technologies

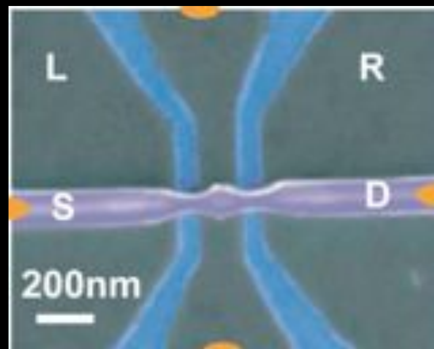
- MEMS/NEMS
- Spintronics/Magnetism
- Nanowires
- Carbon-based devices
- Organic electronics
- Functional materials
- Directed self-assembly
- Packaging for
  - Thermal management
  - 3D integration
  - Optical interconnects
- Photonics
- Nanobiology
- Simulation and theory











Process capabilities

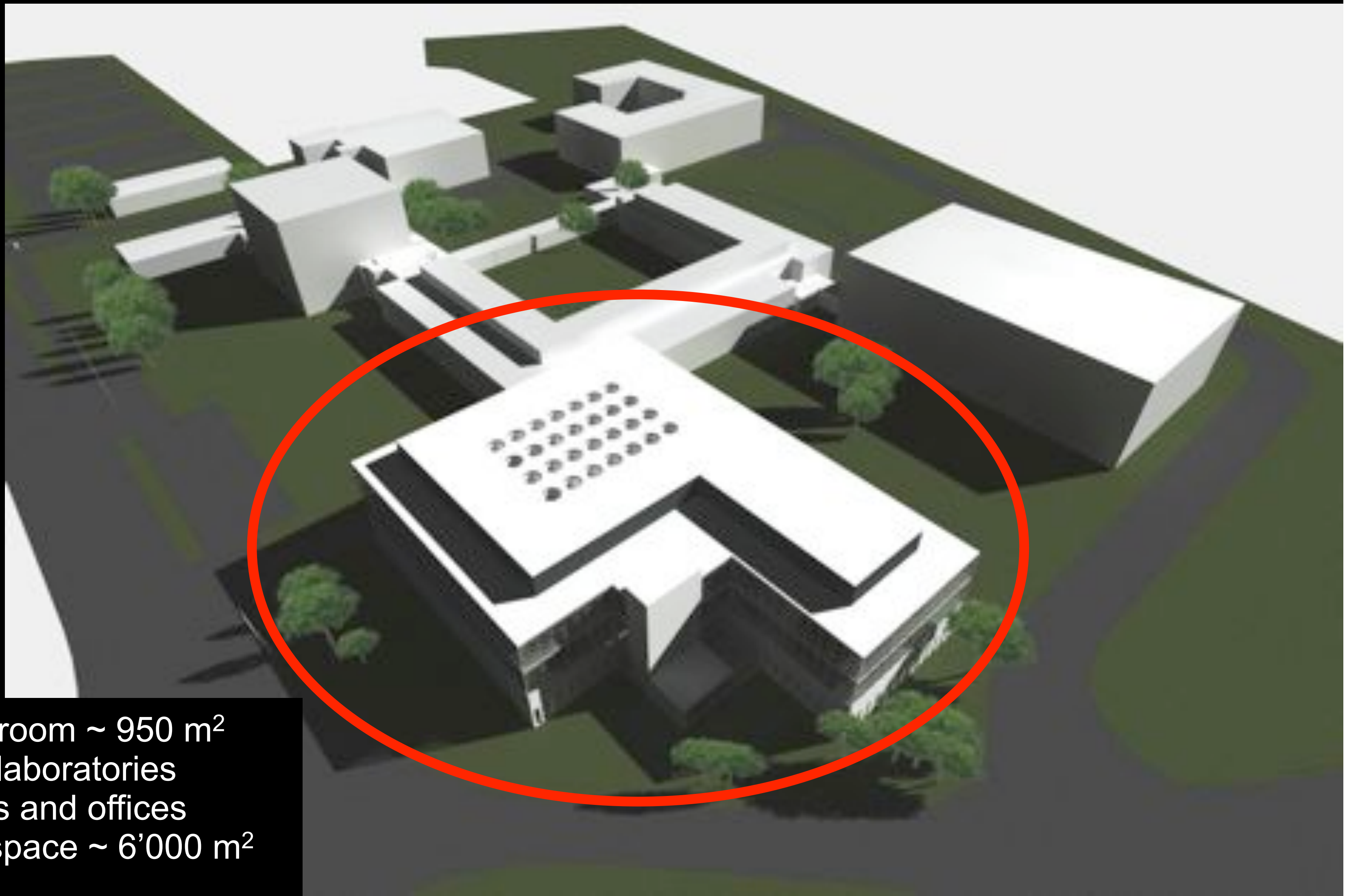
- Most processes will be semiconductor based (Silicon, III/V)
- Materials similar to those used in standard semiconductor technology (Si, metals, isolators, polymers, organics, oxides, ...)
- No fixed wafer size, flexibility is important, maximum 6 inch
- Not a manufacturing/pilot line, but a lab for exploratory research
- Cleanroom class 100/1000 is good enough
- Small effort on biology planned, no biology in cleanroom

Cleanroom processes/equipment

Tools/process sectors

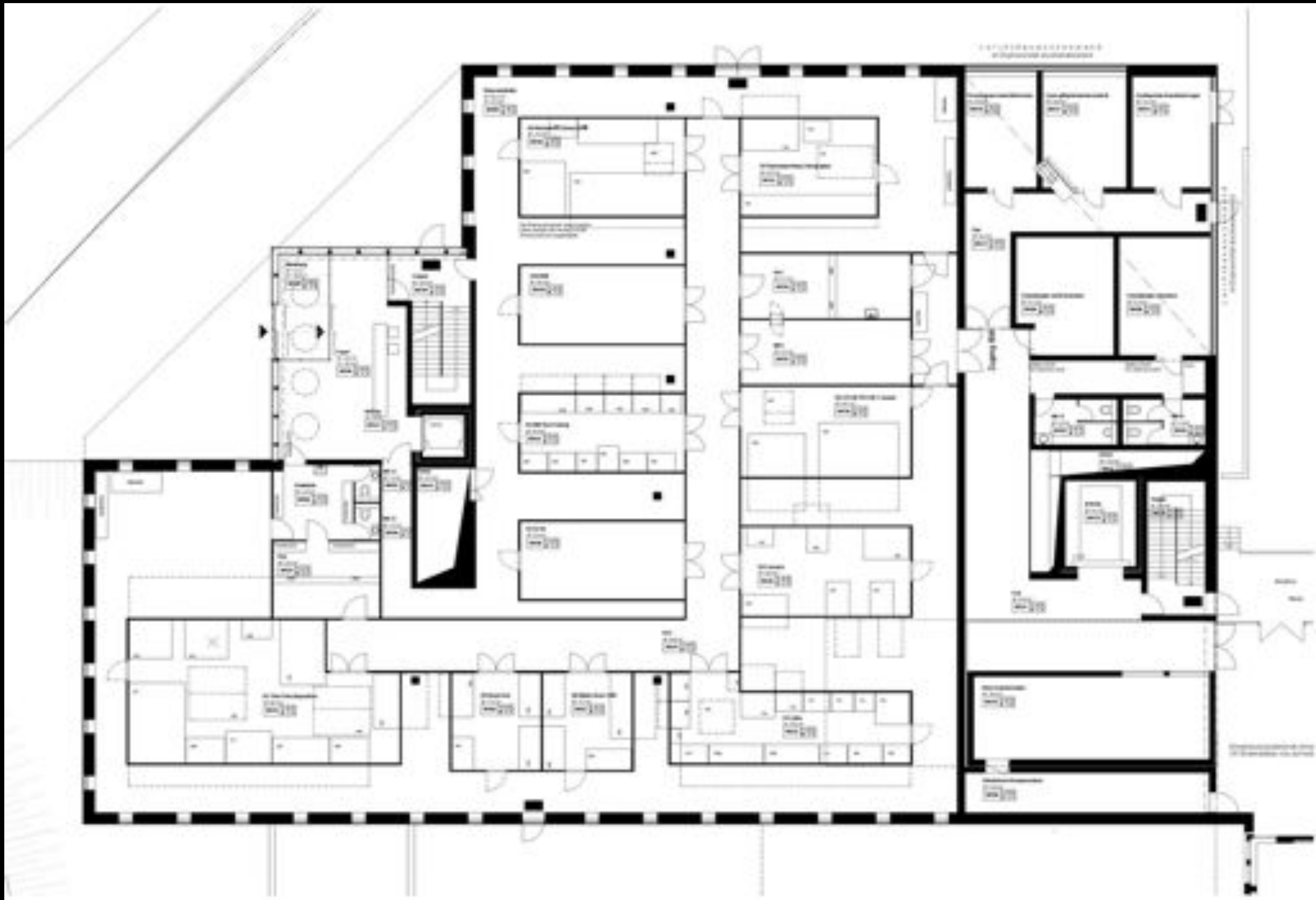
- Lithography
  - Pattern definition
- Wet processing
  - Substrate cleaning, wet chemical etching
- Thin film deposition
  - Metals, isolators, ...
- Dry etching
  - Material removal using (reactive) gases
- Thermal processing
  - Oxidation, annealing, vapor phase deposition
- Metrology/inspection
  - Optical and electron microscopes, surface topology
  - Thickness measurements, ...
- Backend
  - Plating, lapping/polishing, dicing, bonding
- IBM sector
  - Polymer waveguide processing for optical interconnects

The Building



- New clean room ~ 950 m^2
- Noise-free laboratories
- Off-line labs and offices
- Total floor space ~ 6’000 m^2

Level 1: Cleanroom, chemical storage, partner entrance



Level 0: Noise-free Labs

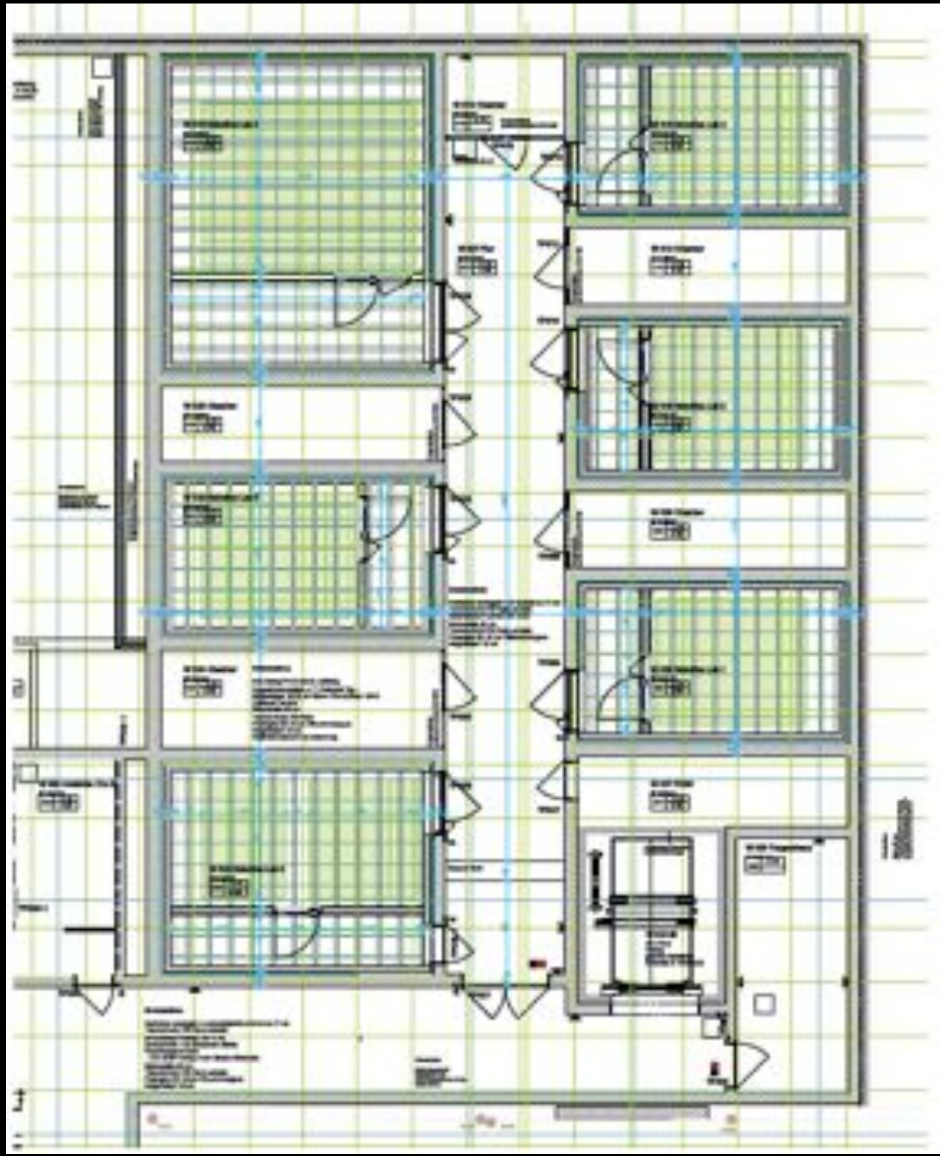
Ultrastable labs for sensitive tools

Goals:

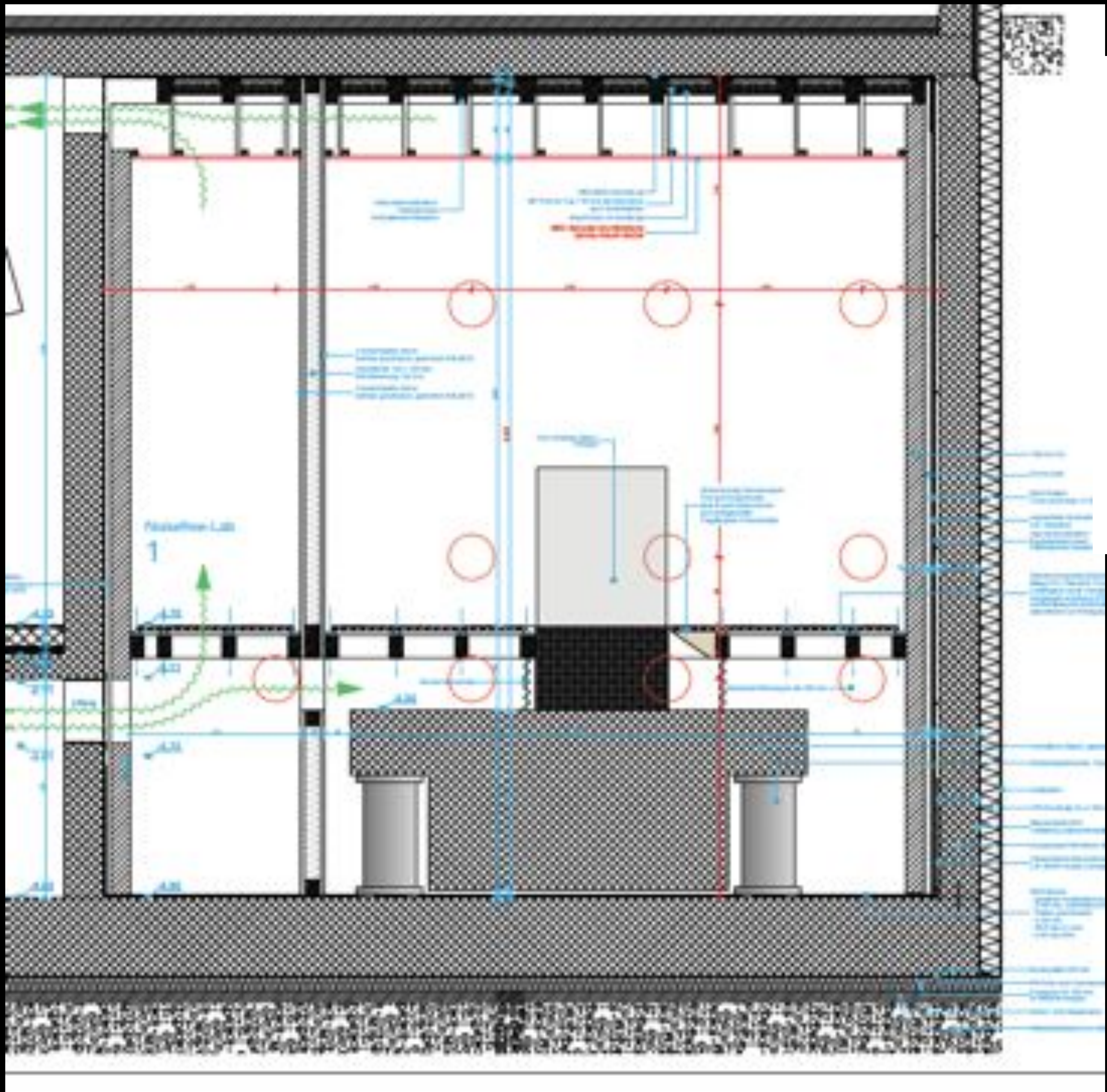
-Mechanical vibrations:
 0.5 um/s (x,y), 5 nm/s (z) below 16 Hz
-Acoustic noise: <50 dBc (<55 dBc / f>100Hz
-Electromagnetic fields: B < 5 nT
-Temperature: 0.1 C/h

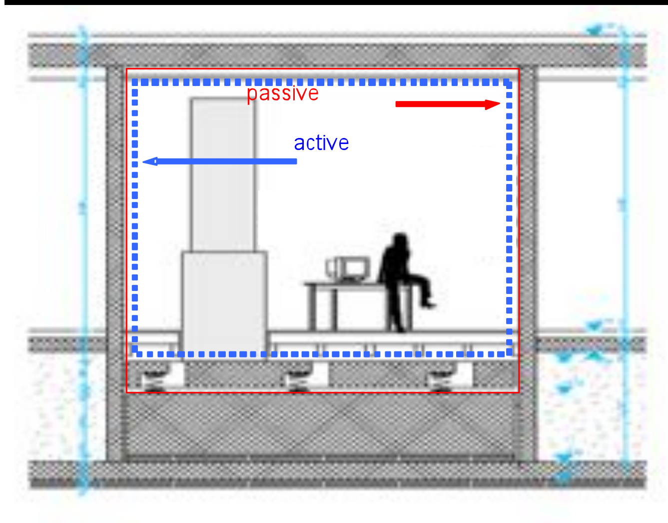
Measures:

-Passive mechanical damping, f>2Hz
-Active mechanical damping, f=0.5-0.8 Hz
-Passive EM shielding (Faraday cage), 20 nT
-Helmholtz coils with active compensation for
 B<20 nT



Noise-free Labs





Building status June 24, 2010

www.zurich.ibm.com/netl/

Thank you for your attention.

Additional partners welcome!

Contact information:

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