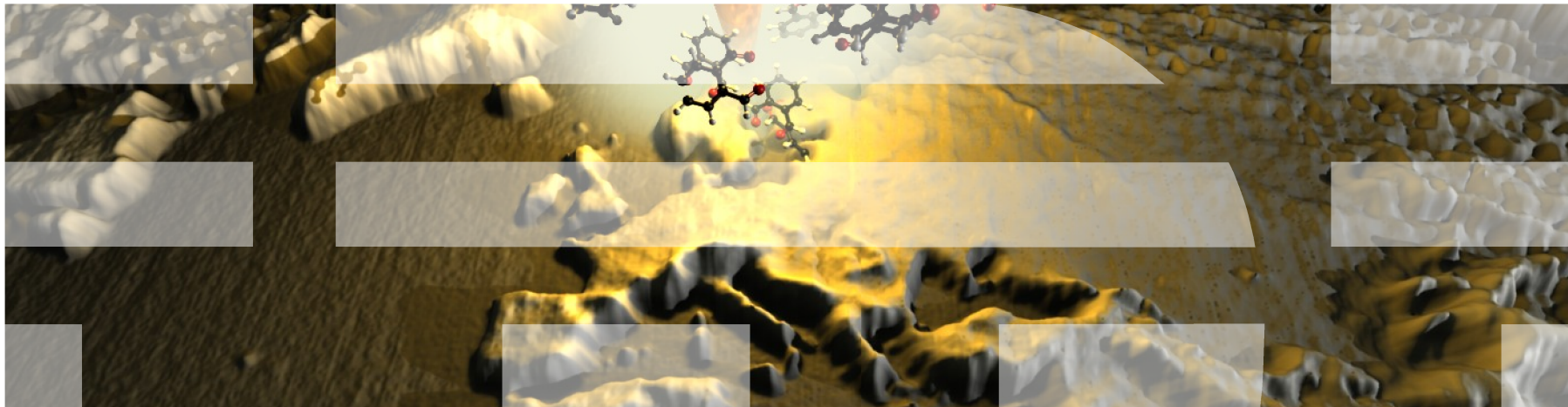


# Key Enabling Technologies: Nanotechnology

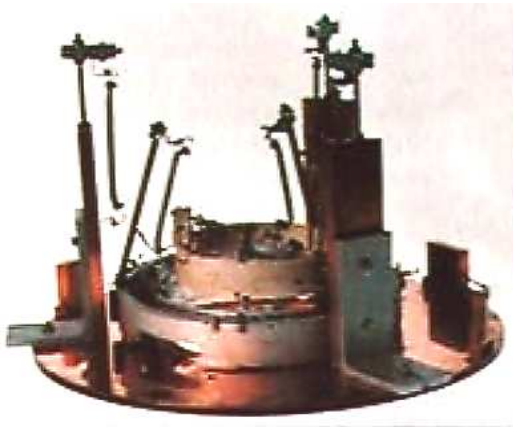
Urs Duerig, IBM Research – Zurich, Switzerland



# Nanotechnology

Heinrich Rohrer<sup>1</sup>

1981 G. Binnig, H. Rohrer



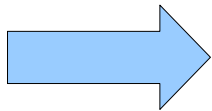
**Scanning Tunneling  
Microscope**

... Nanotechnology is mostly seen as an extension of what is done on the micrometer scale...

... Nanotechnology is more than just smaller: It is a fundamentally new domain of diversity.

... Nanotechnology links the macroscopic world of condensed matter to the world of atoms and molecules.

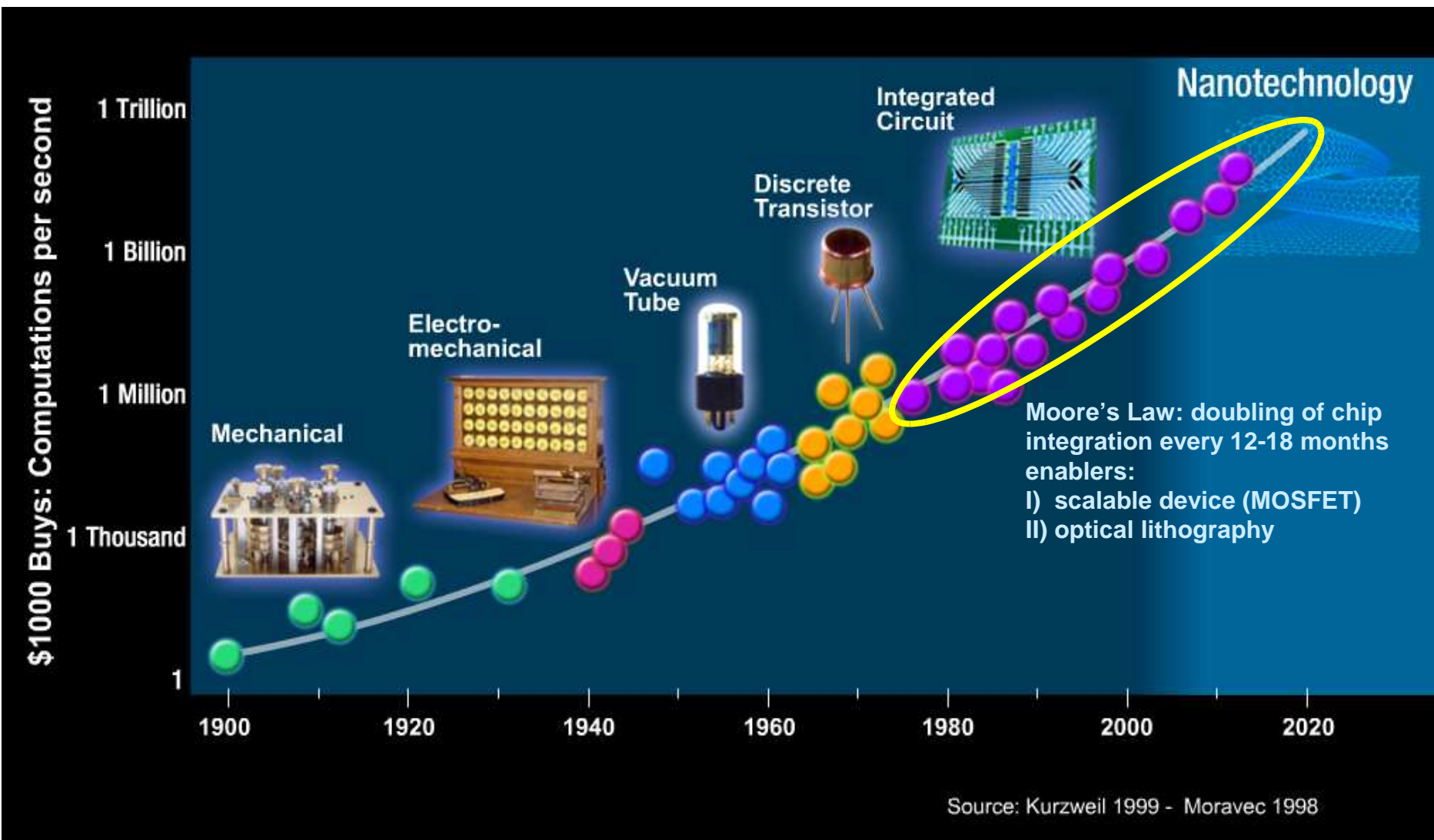
... For Nanotechnology, the **sky** is the limit- and so are the challenges and expectations.



Manufacturing at the micro/nano scale  
System integration  
Bridging the gap between traditional disciplines

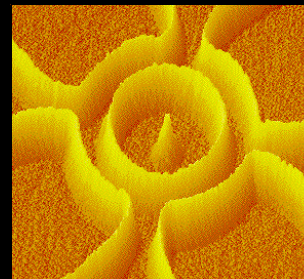
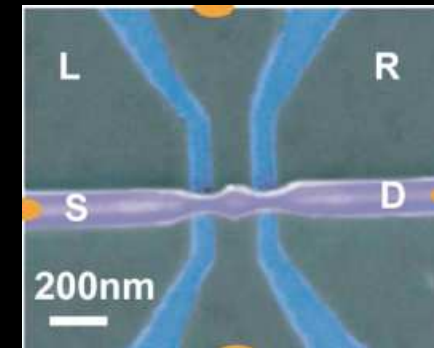
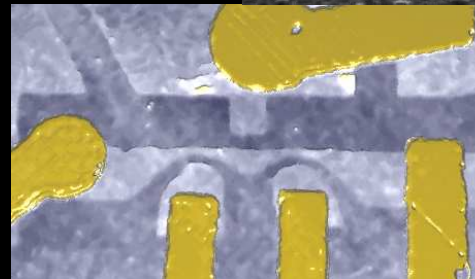
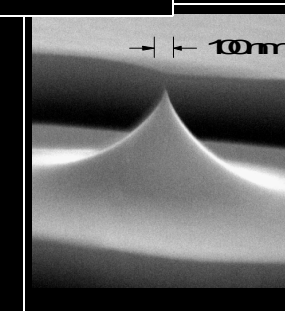
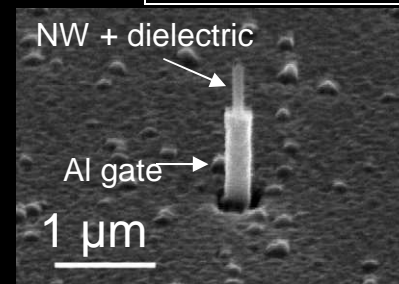
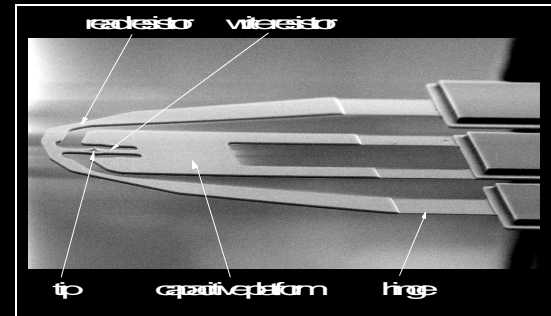
[1] "Swiss Nanotech Report" (2010), [www.sbf.admin.ch/htm/dokumentation/publikationen/forschung/Swiss\\_Nanotech\\_Report\\_2010.pdf](http://www.sbf.admin.ch/htm/dokumentation/publikationen/forschung/Swiss_Nanotech_Report_2010.pdf)

# Evolution of Information Technology



# Nanotechnology is KET for:

- 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
- Quantum devices



# The 3 commandments

## **(1) Nanotechnology builds on semiconductor manufacturing Technology:**

→ **Capital intensive infra structure**

→ **Novel schemes of collaboration and funding must  
be investigated**

→ **A healthy semiconductor industry in the EU is a  
must for long term success**



# Nanoscale Exploratory Technology Laboratory



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

## The Cooperation Model

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



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

# The 3 commandments

## (2) Nanotechnology builds on system integration

- **Engineering is key for success**
  - **There is a huge amount of valuable and important work to be done to bridge the gap between research and commercial applications**
  - **Need for funding schemes for pre-competitive research (Bridging the valley of death)**



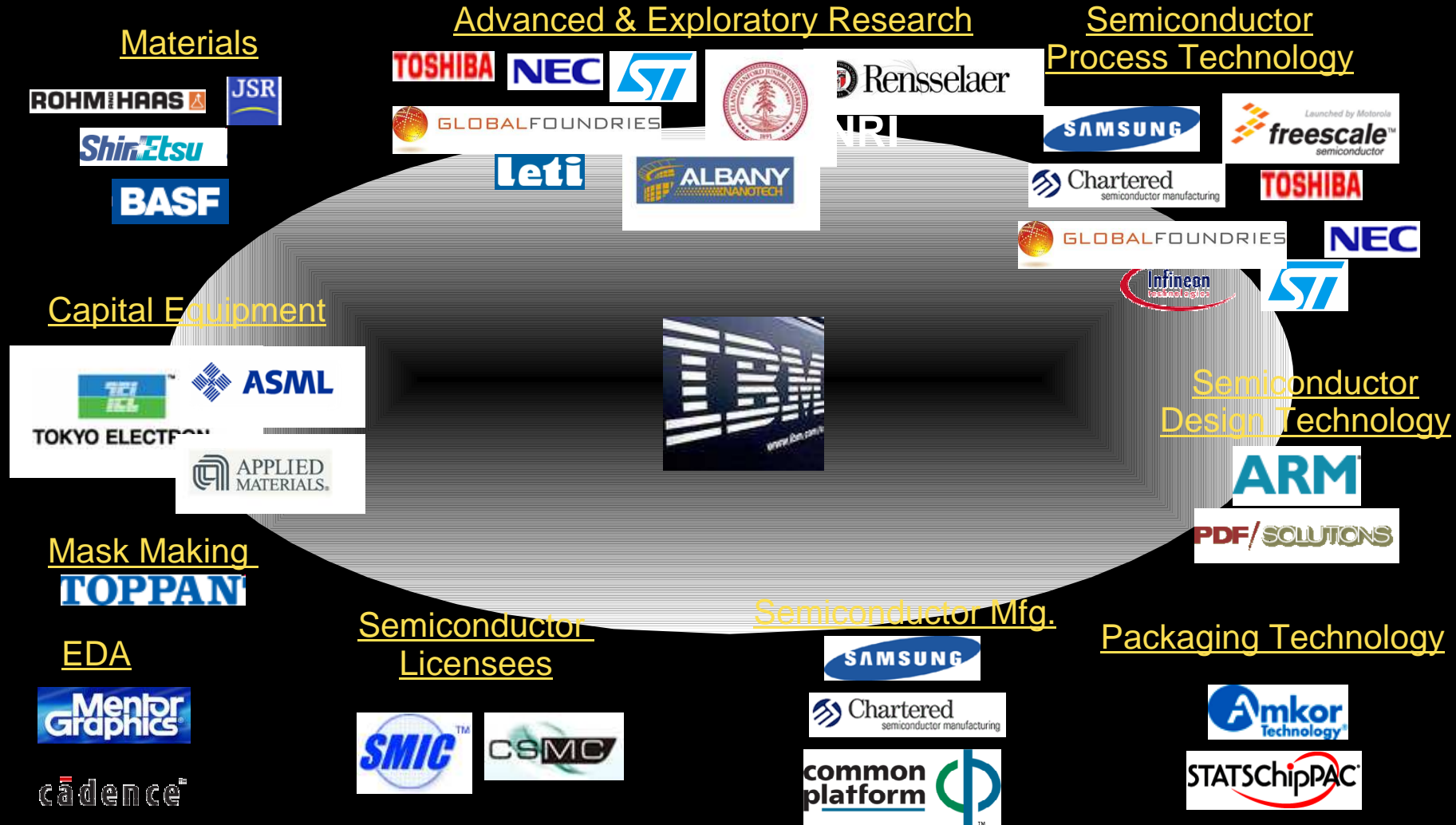
# The 3 commandments

## **(3) Nanotechnology is inherently multidisciplinary**

→ **Collaboration is essential within academia and between academia and industry**

→ **IP is a big issue – we are far from a commonly accepted standard and the trend is diverging rather than converging**

# Example from industry: Semiconductor Technology Partnerships at IBM



# Thank you for your attention

