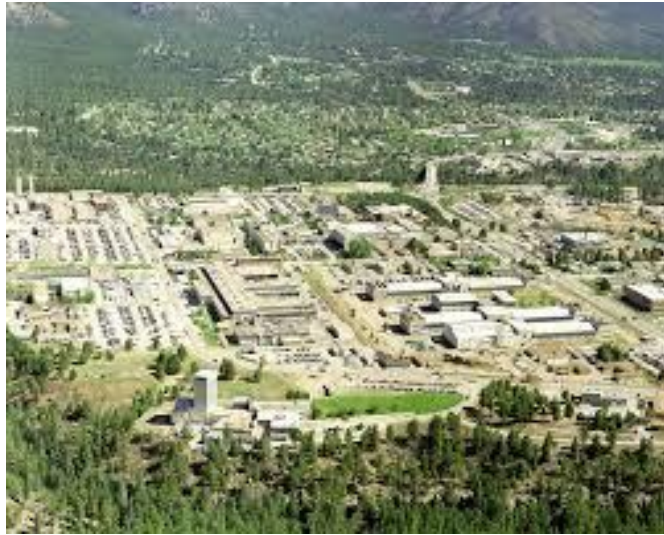


# Quantum Information Science at NIST

David Hume

12/12/2017

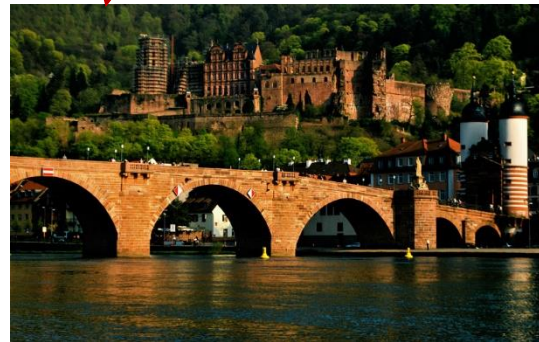
# Personal Experience



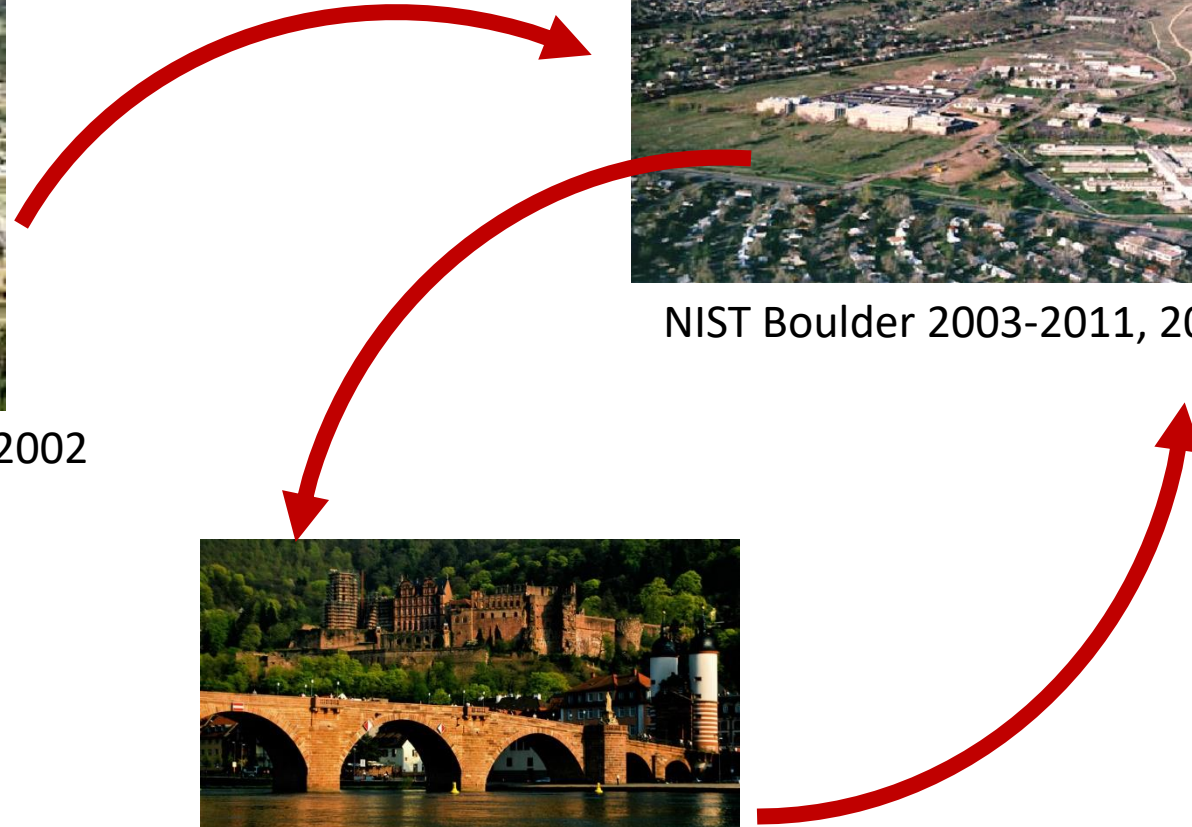
Los Alamos National Laboratory 2002



NIST Boulder 2003-2011, 2014-Present

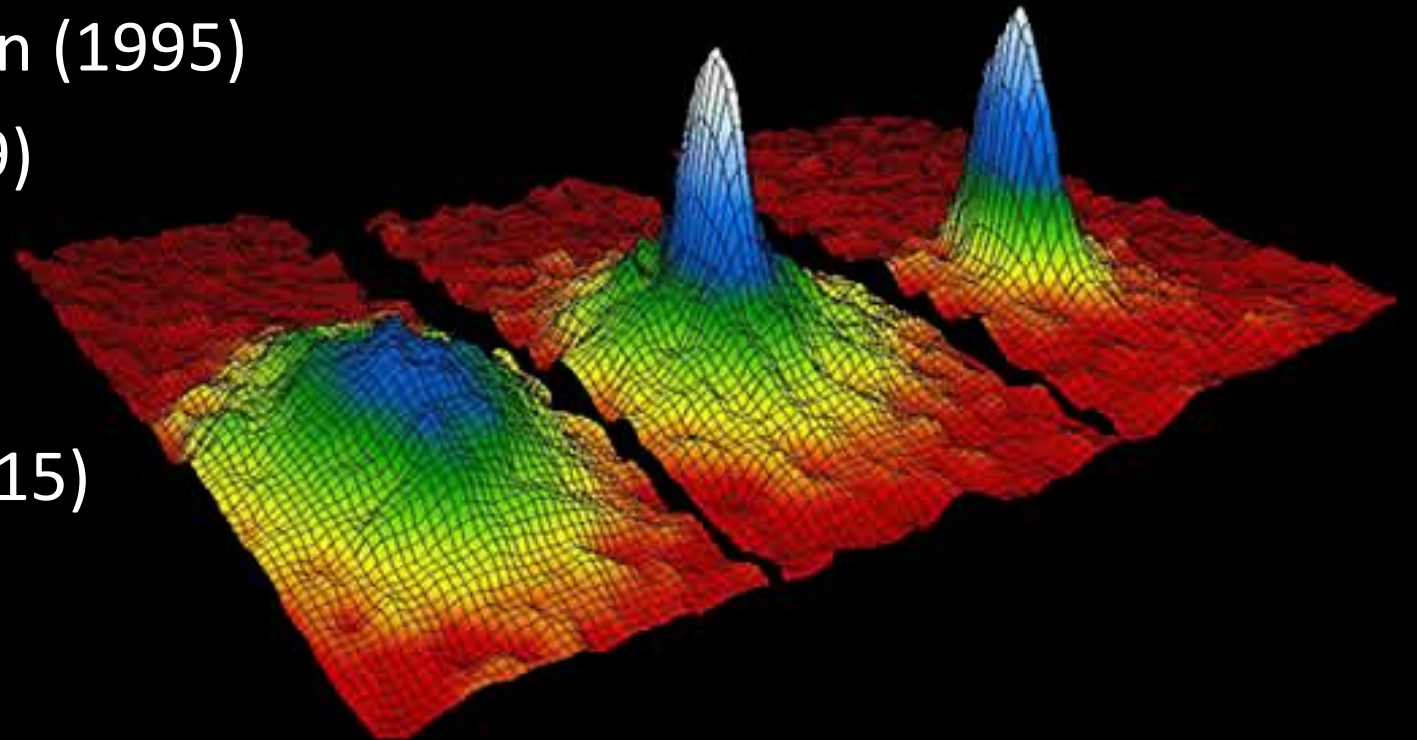


Heidelberg University 2011-2013



# Some NIST-JILA Highlights

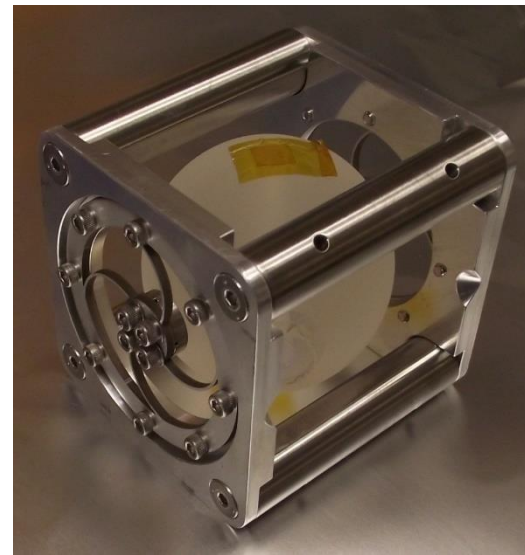
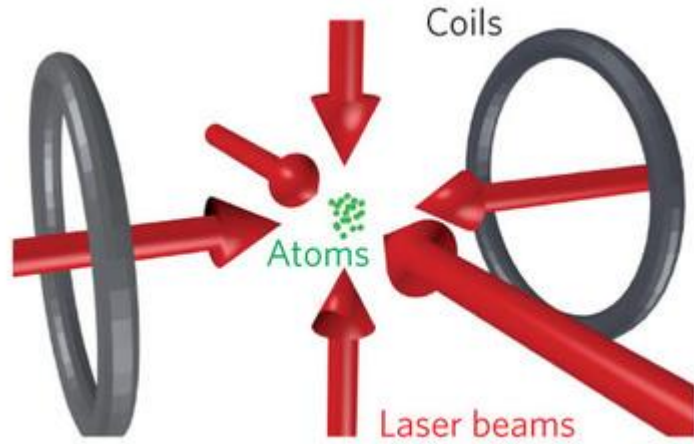
- Laser cooling (1978)
- Quantum jumps (1986)
- Spin squeezing proposal (1994)
- Bose-Einstein Condensation (1995)
- Ground state cooling (1989)
- BEC-BCS crossover (2003)
- Entangled atoms (1998)
- Loophole-free Bell test (2015)
- Femtosecond Frequency comb (2001)



# NIST Technology: Some Examples

- Superconducting single-photon detectors (Nam, Ullom)
- Femtosecond frequency combs (Diddams, Newbury)
- SQUIDS, Josephson junction qubits (Simmonds)
- Ion traps (Wineland, Bollinger, partnership with Sandia National Labs)
  - ARTIQ, digital control hardware/software (through contract/partnership with M-labs) currently being adopted by many research groups worldwide
  - FPGA-based digital servo (David Leibbrandt, Jason Heidecker, Till Rosenband)

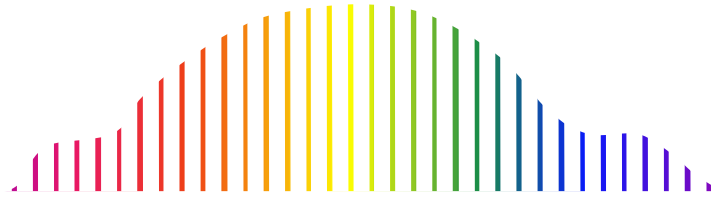
# Case studies from AMO



- Laser cooling and trapping
  - Demonstrated at NIST Boulder (ions) and Gaithersburg (neutral atoms)
  - Developed for microwave atomic clocks and BEC
  - Deployed in atom-trap trace analysis of, e.g., Ar-39 for dating ground water

- Ultrastable lasers based on optical cavities
  - Demonstrated at NIST and others
  - Developed for optical atomic clocks
  - Deployed now commercially for a range of scientific and technological applications

# Case studies from AMO cont. .



- Self-referenced femtosecond frequency comb
  - Demonstrated at JILA/MPQ 2001
  - Developed in measurements between optical frequency standards
  - Deployed commercially for applications from laser ranging to trace gas detection

# What about quantum metrology?

- Theory developed in the context of gravitational wave detectors and optical clocks
- Demonstrations with photons and atoms have been performed in numerous labs
- As far as I know (corroborated by statements from John Doyle's talk) there has not been an application in precision sensing.
- Deployment in instruments?