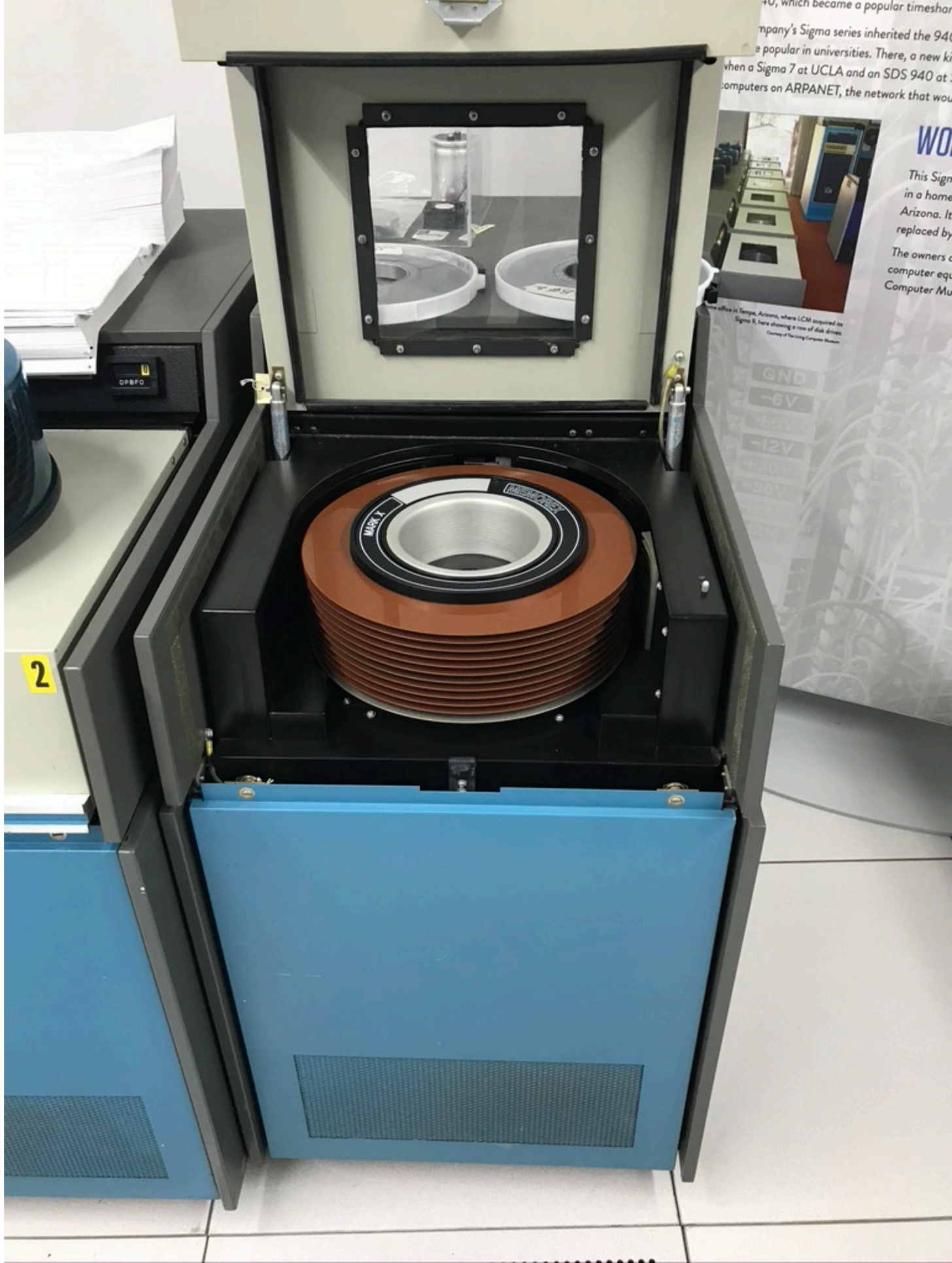
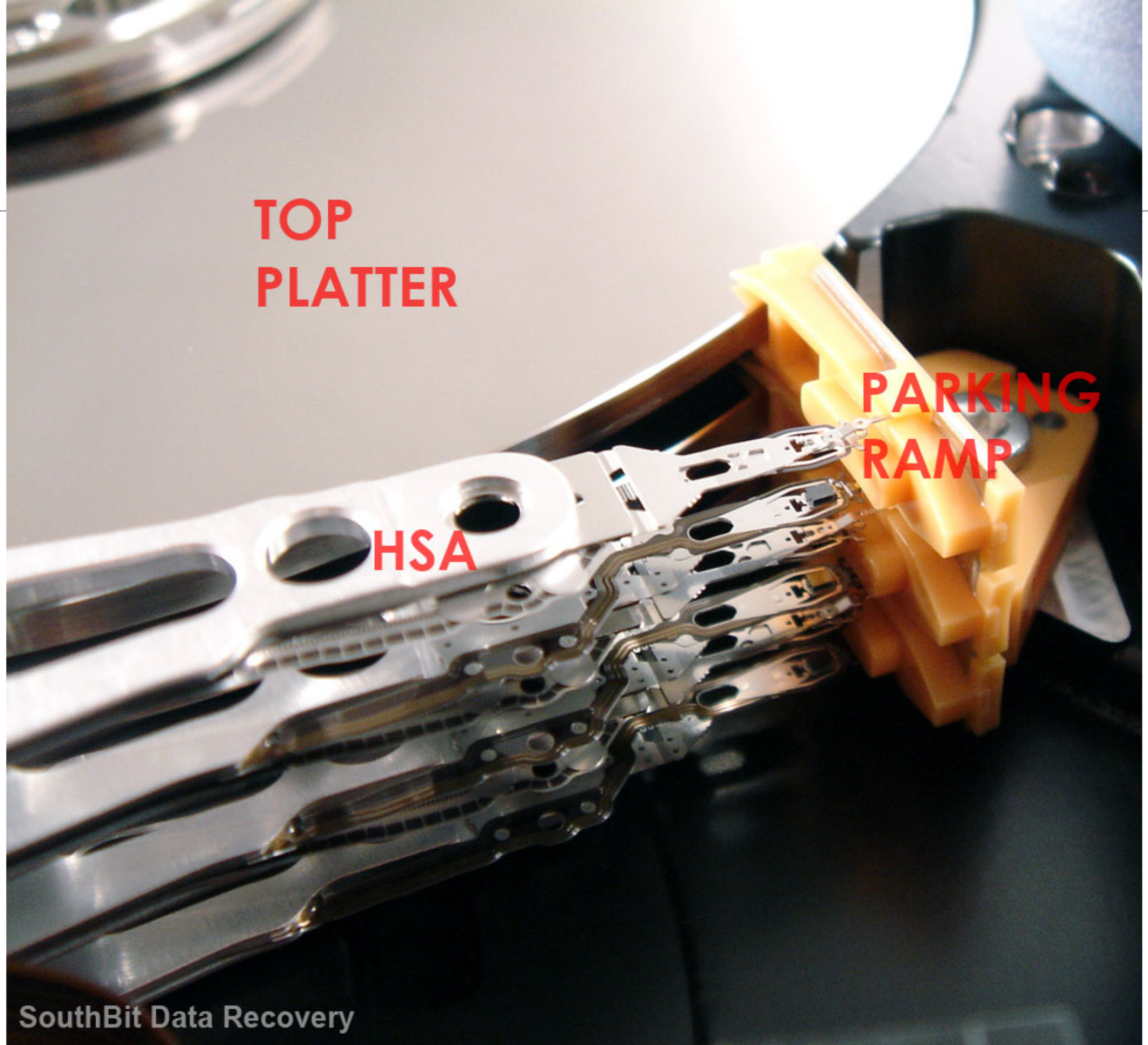
Quantum electronics

Hard disk drives

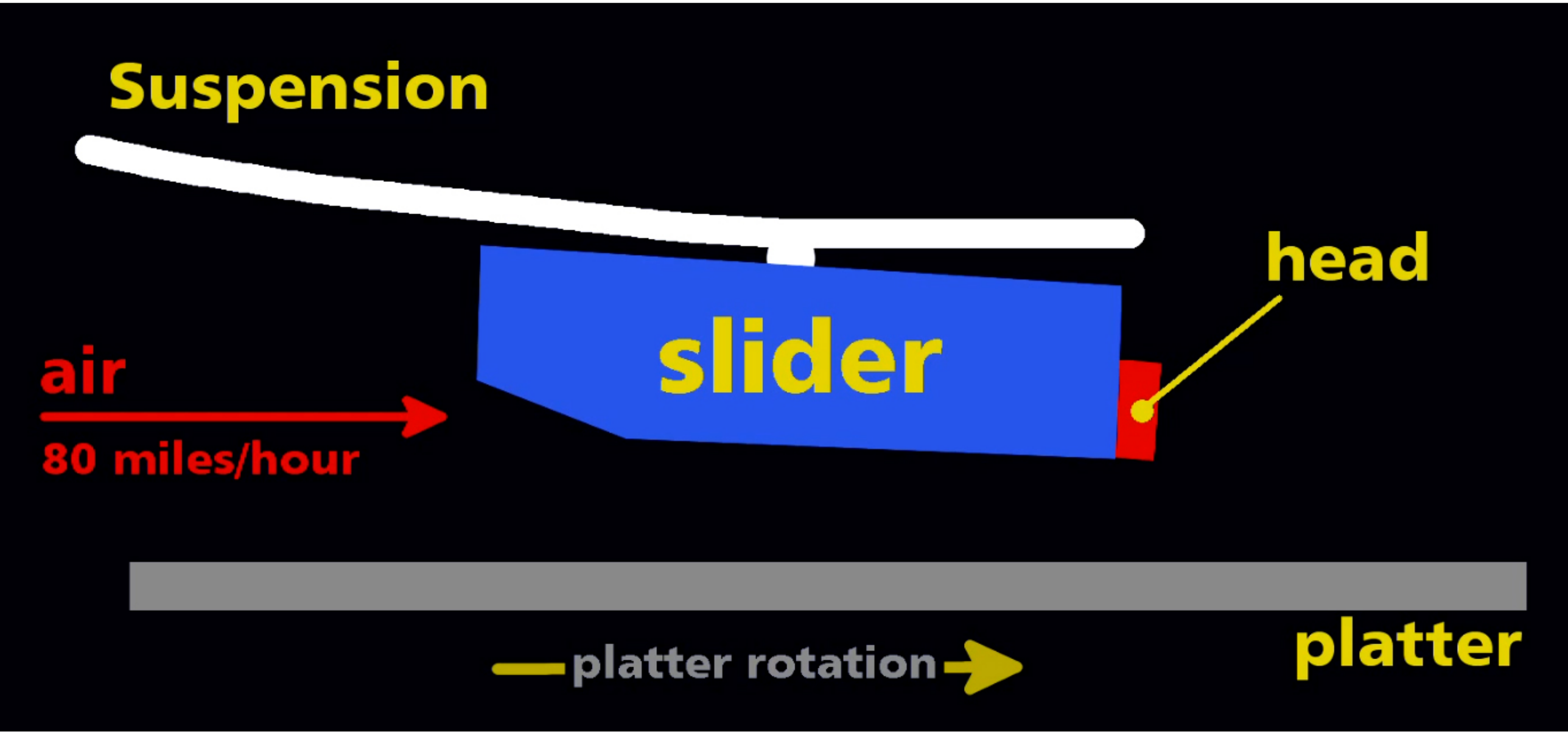
- Platters
- Magnetic material, orientation of magnetic particles records 1’s and 0’s
- Enormous progress in speed and density



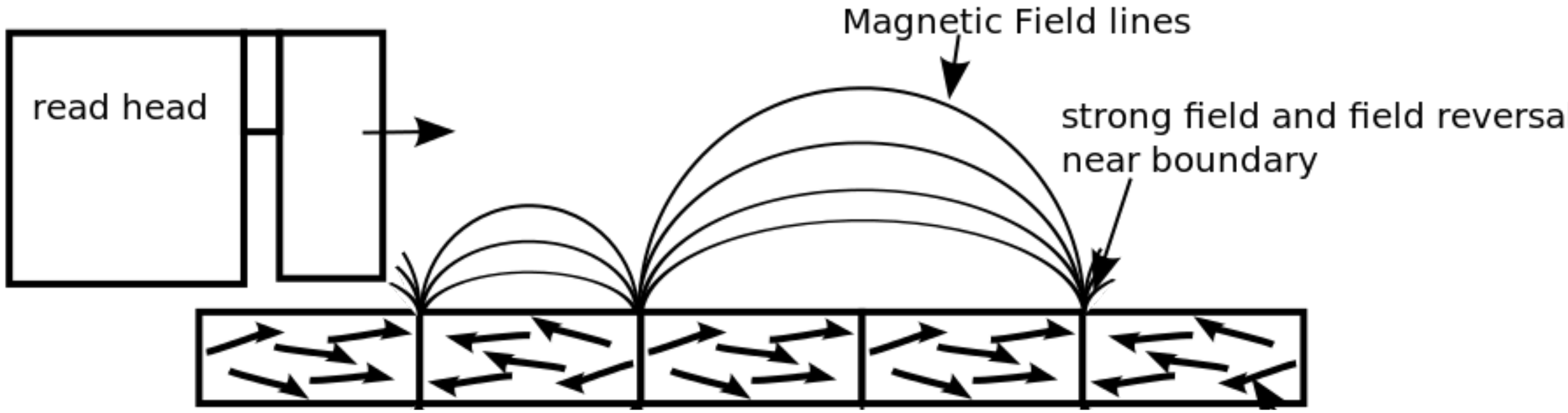
Hard disk drives


TOP
PLATTER
PARKING
RAMP
HSA
SouthBit Data Recovery

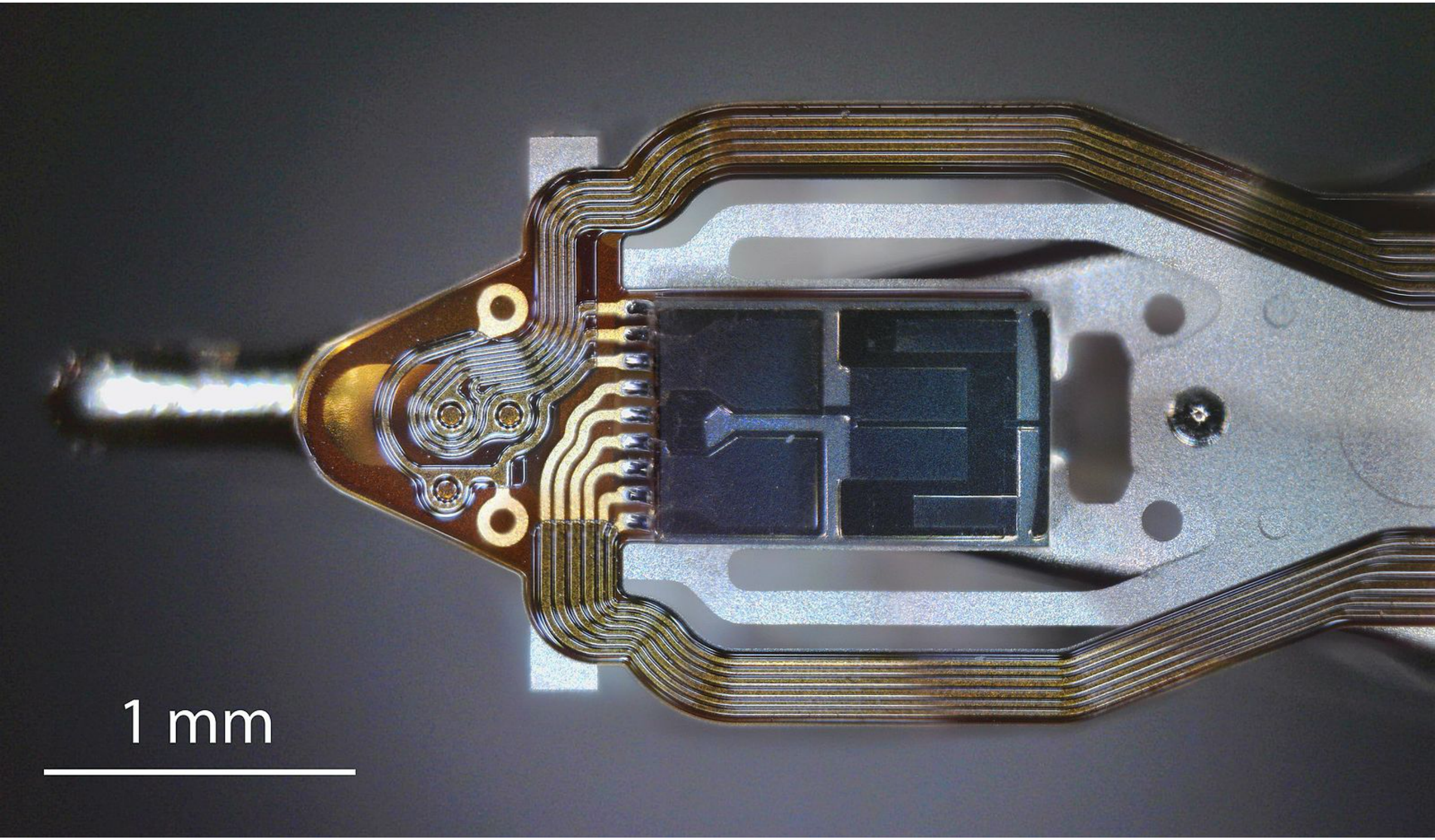
Floating head



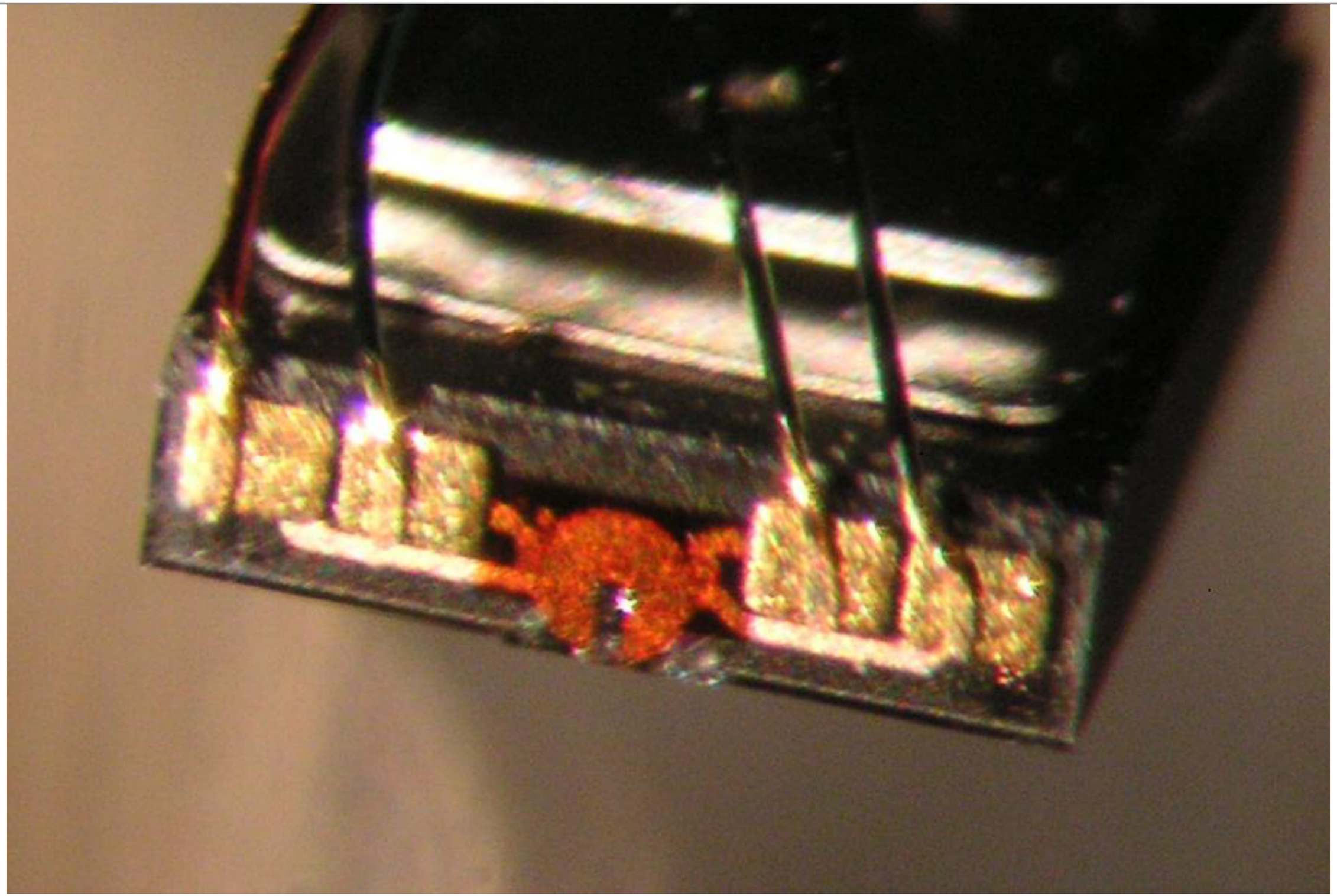
Data storage



Read head



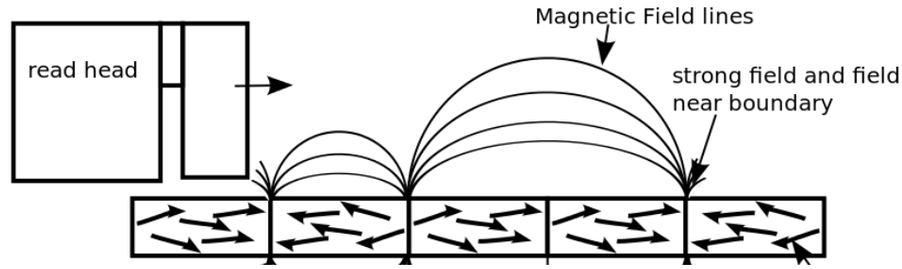
Read head



Modern drives

- Up to 18 trillion bytes per disk (stack of platters)

- Magnetism is read by a little loop of wire

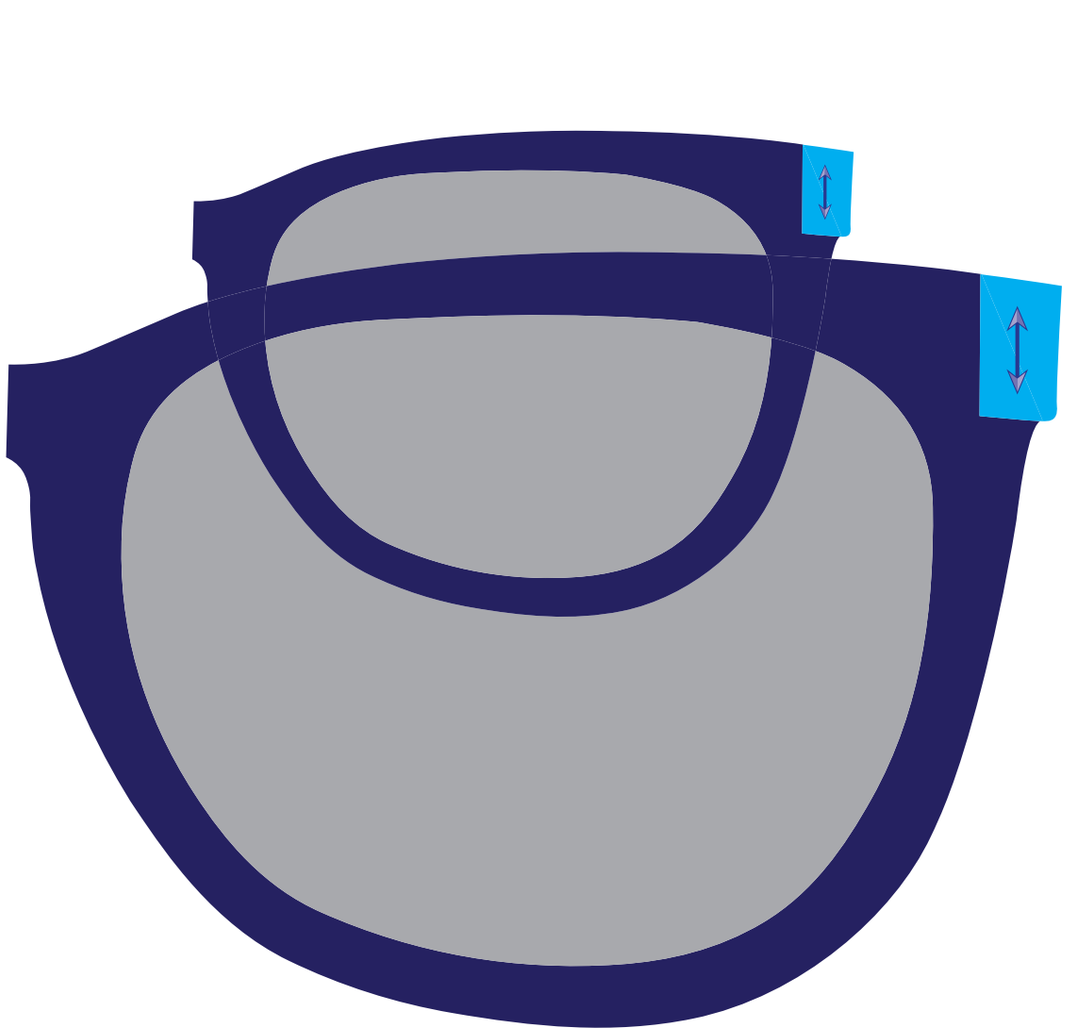


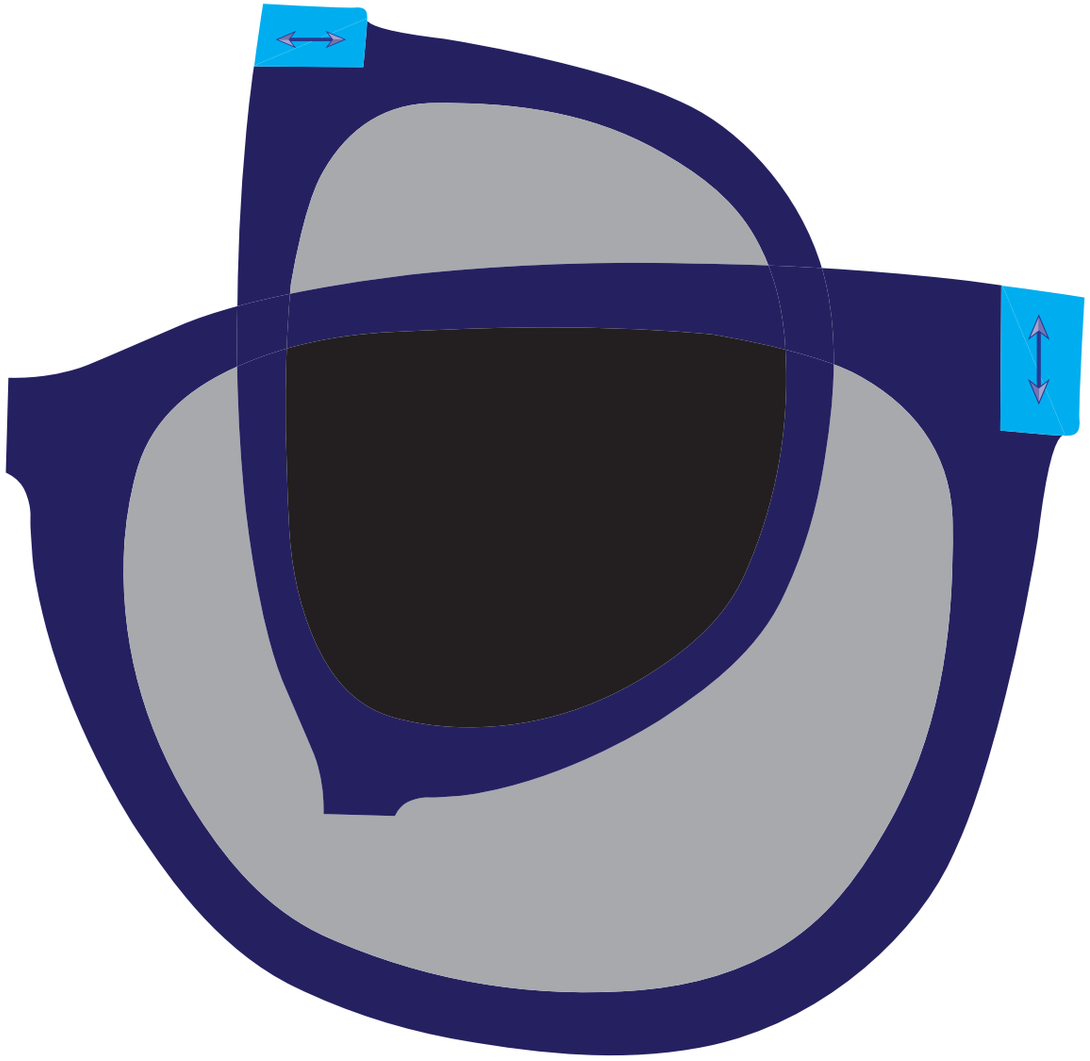
- As magnetic particles (bits) get smaller, signal in loop gets smaller and smaller

- In 1997 the particles became to small to read…

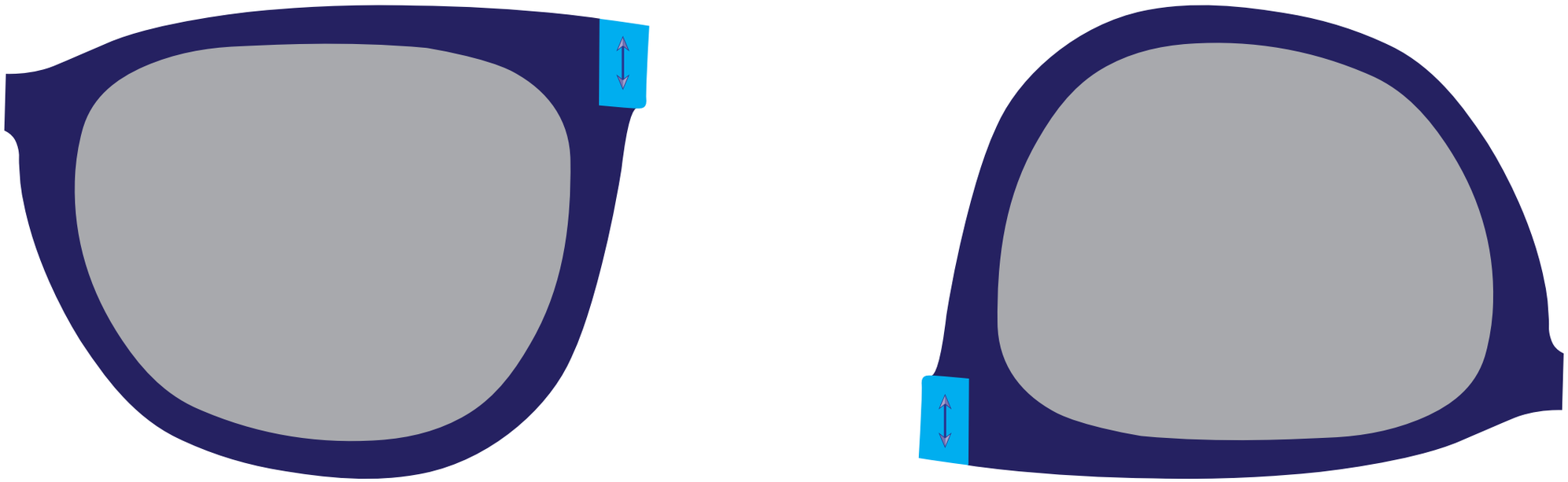
Polarized particles

Light polarization

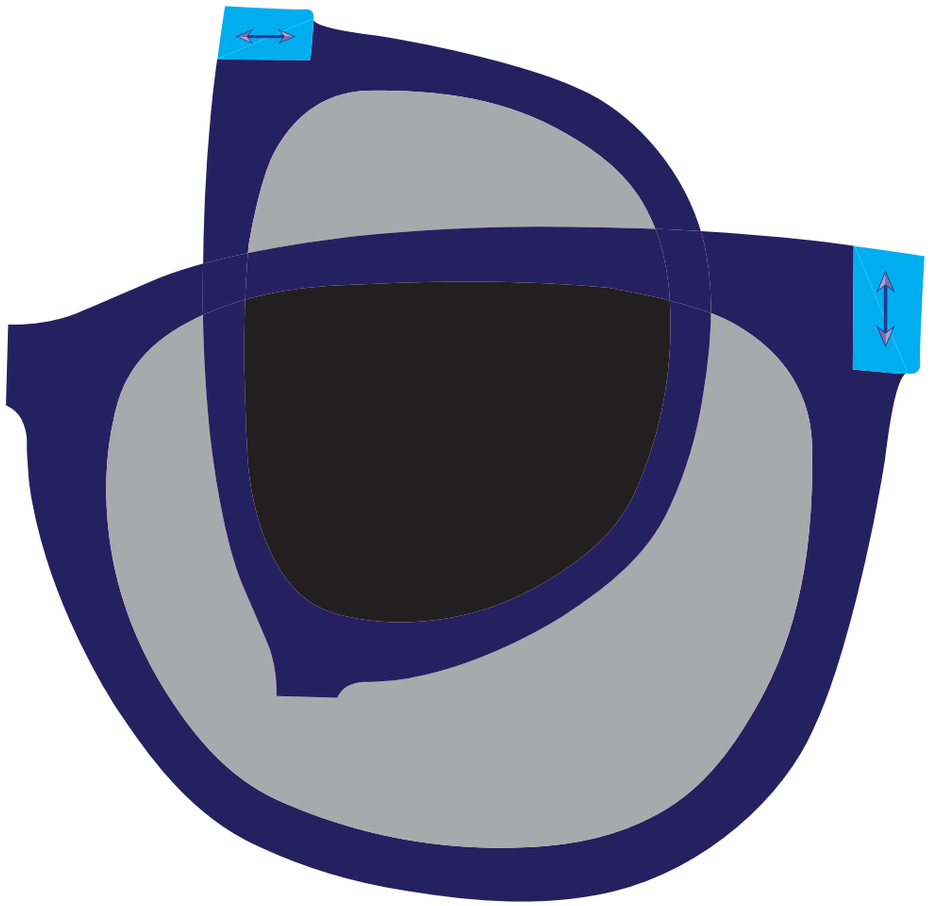


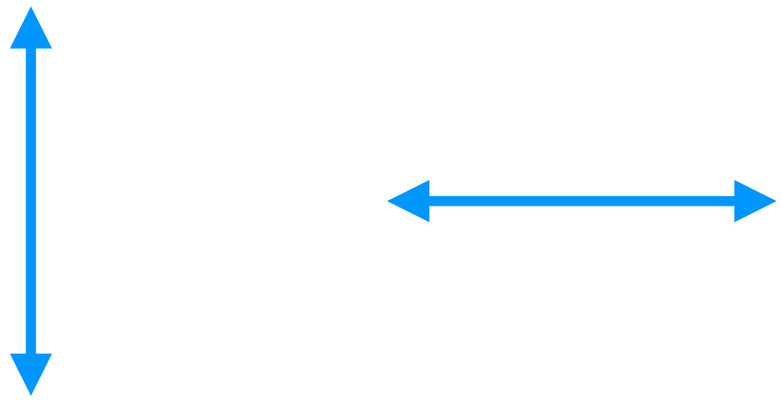


Same polarization if rotated 180°



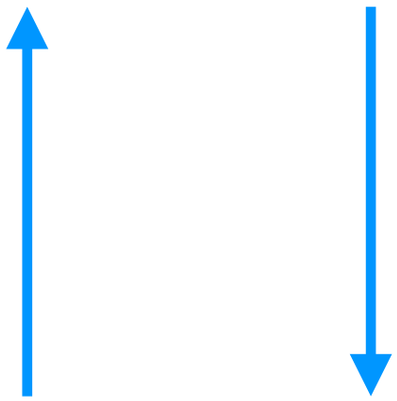
‘Opposite’ polarization for photons





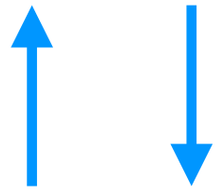
90°

Electrons ‘opposite’ with 180°



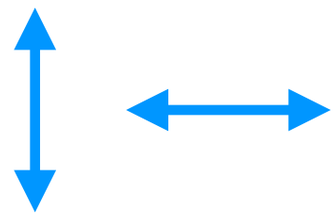
Other combinations

- electrons, protons, neutrons, quarks, …



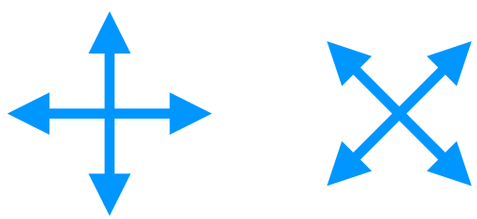
180°

- photons, pions, gluons, mesons…



90°

- Graviton



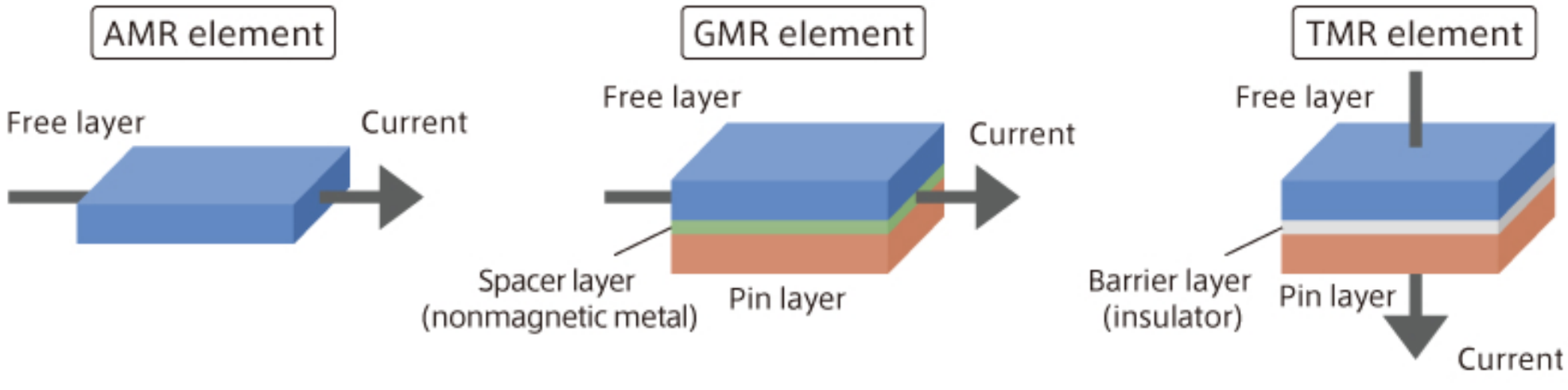
45°

- Higgs boson has no polarization at all

Back to hard drives

Since late 1990's all hard drive heads use electron polarization to read bits

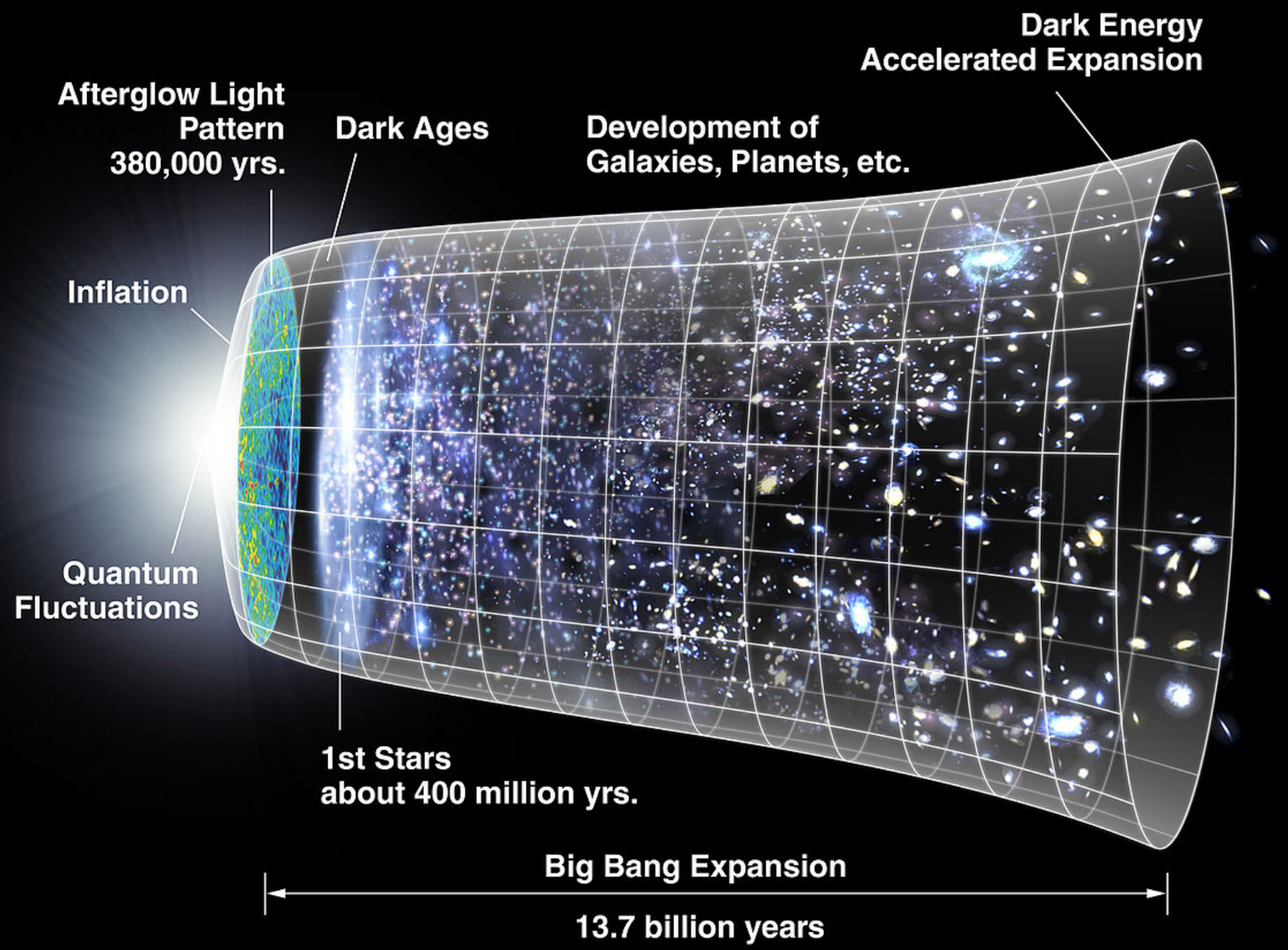
- Giant magneto resistance 1997
- Tunnelling magneto resistance 2004
- All modern hard drives *require* quantum mechanical read heads



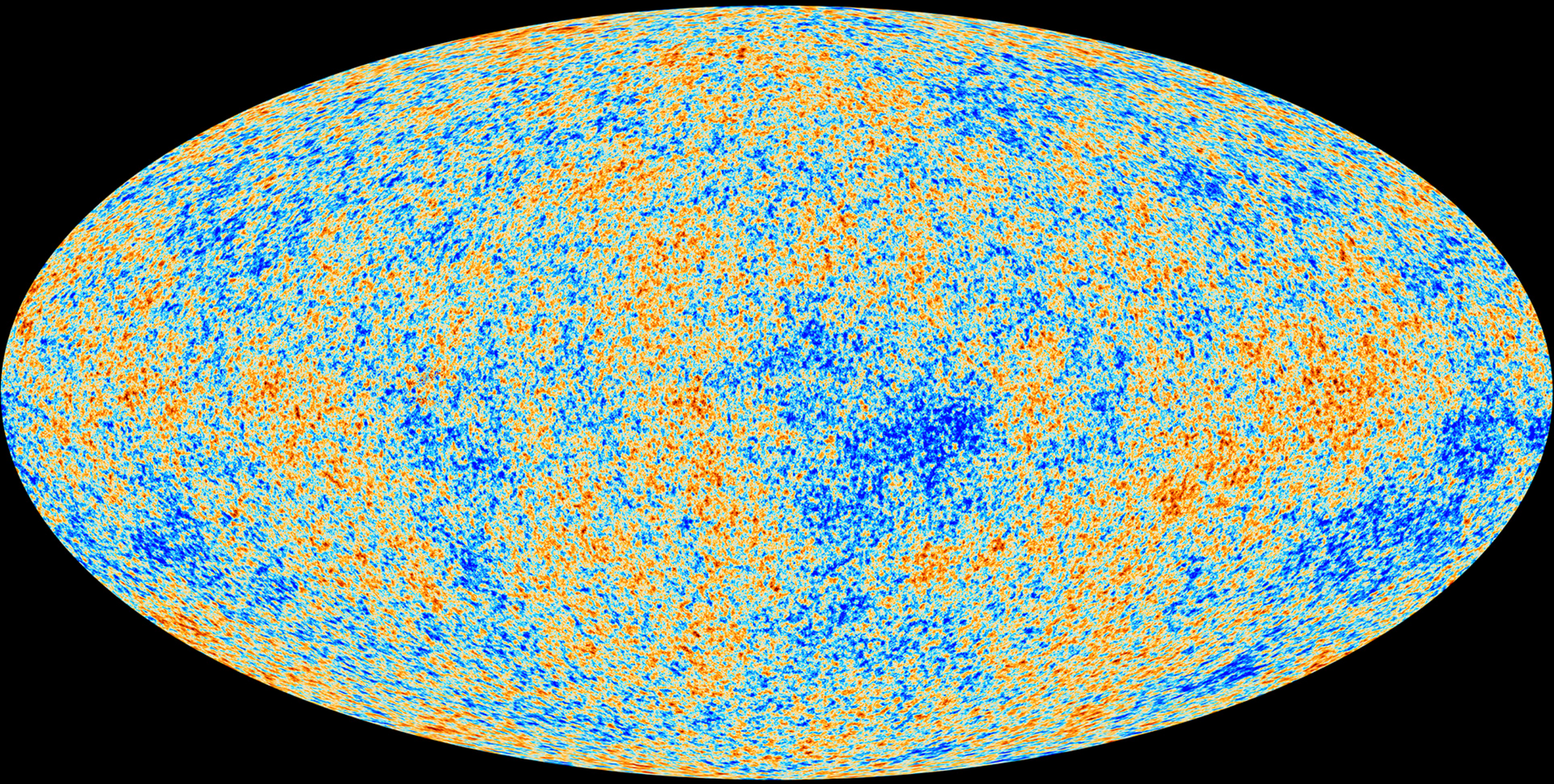
Quantum electronics

Quantum electronics

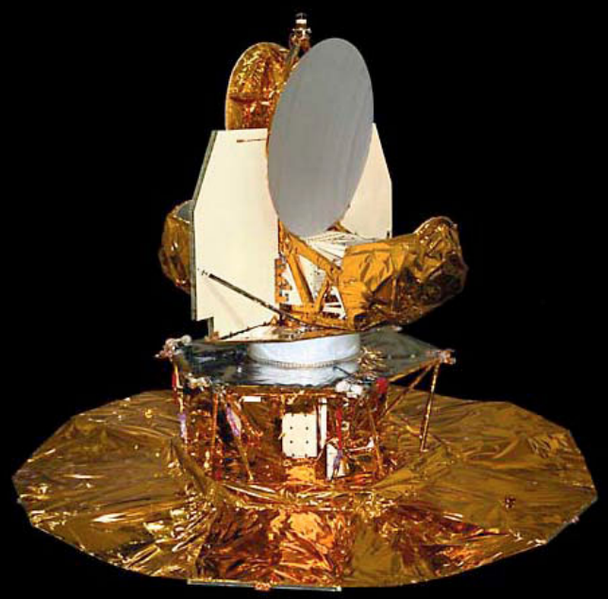
- Spintronics (use electron polarization)
- Tunneling electronics (use electron waviness)
- Super-conducting electronics (use superconductors)
- Quantum electronics (require all the above)


Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
380,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.7 billion years

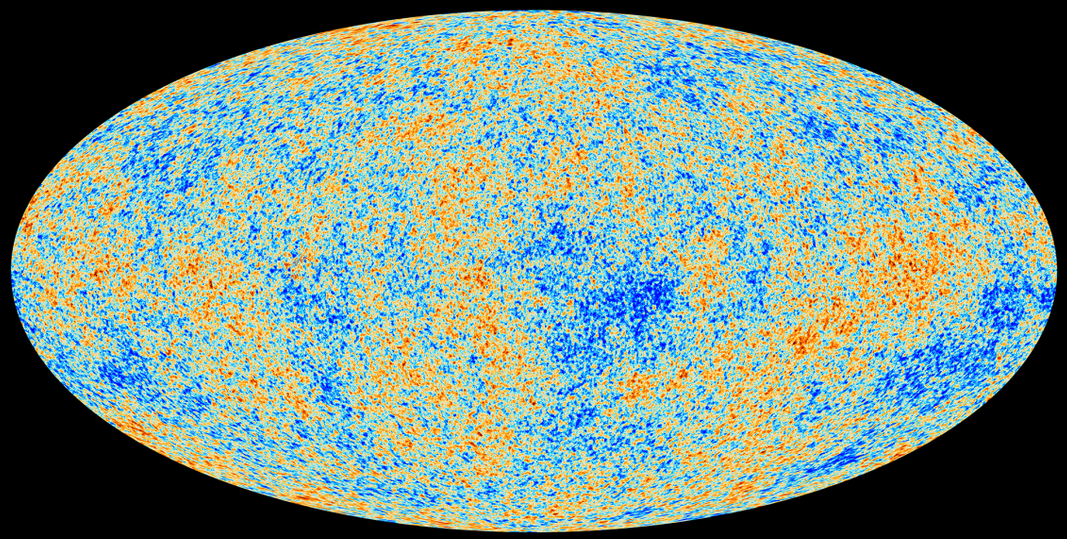
NASA

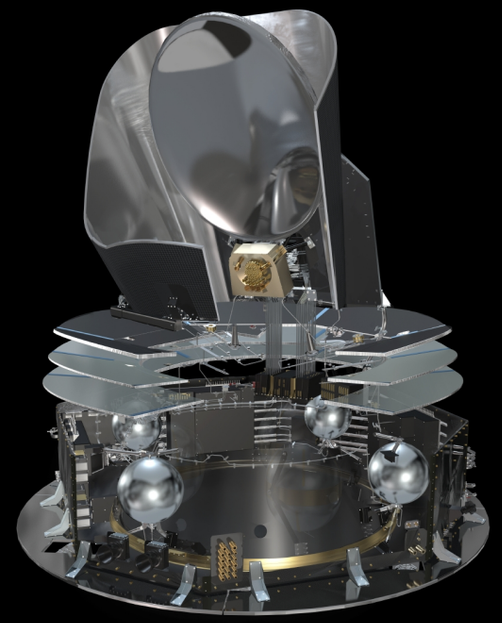


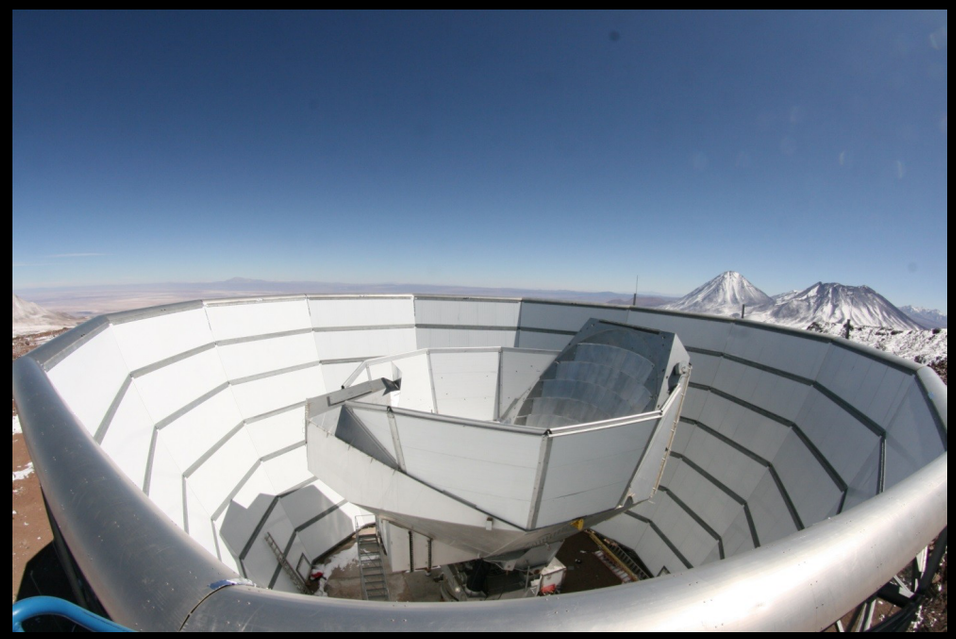
Planck



MAP990389

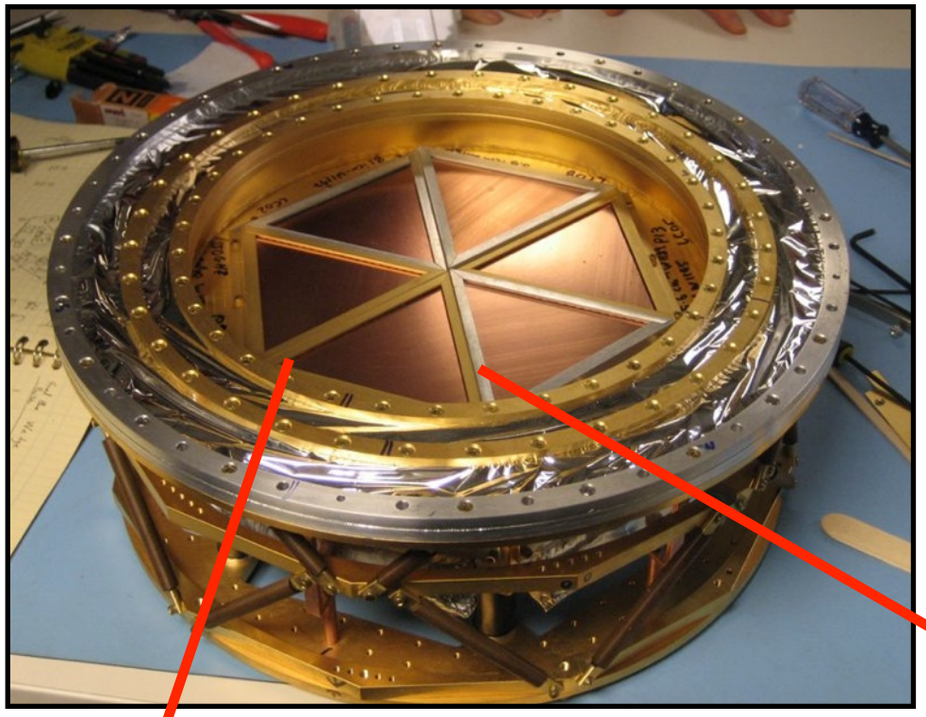


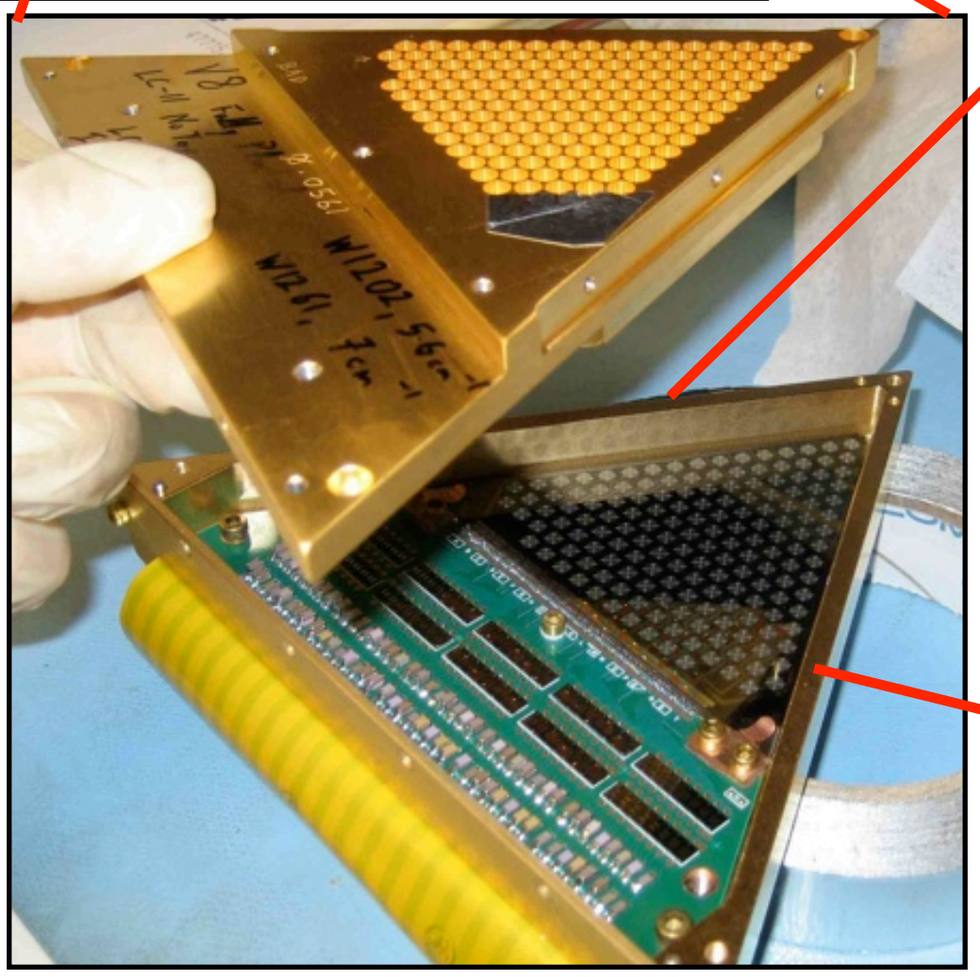




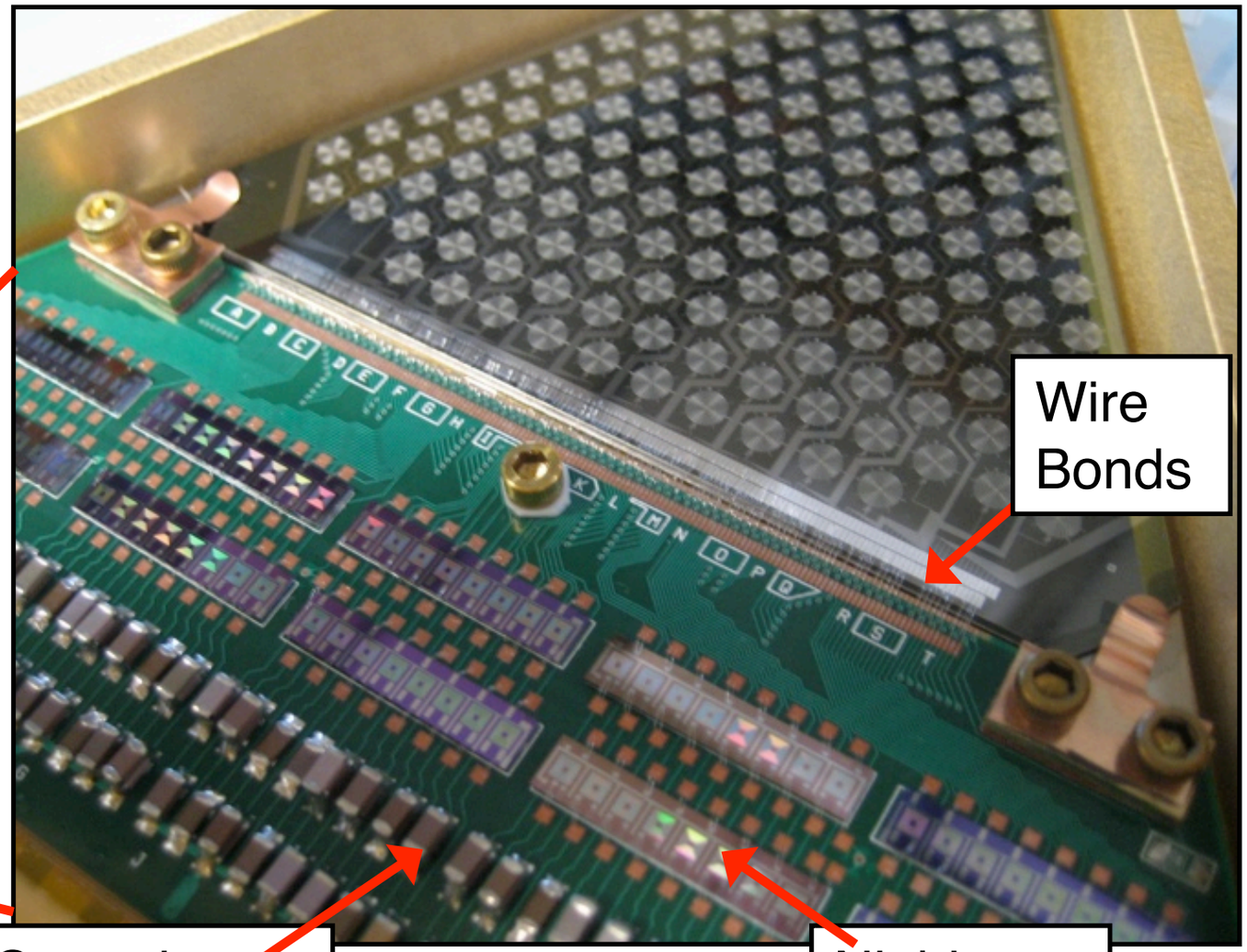
NASA/ESA/NSF

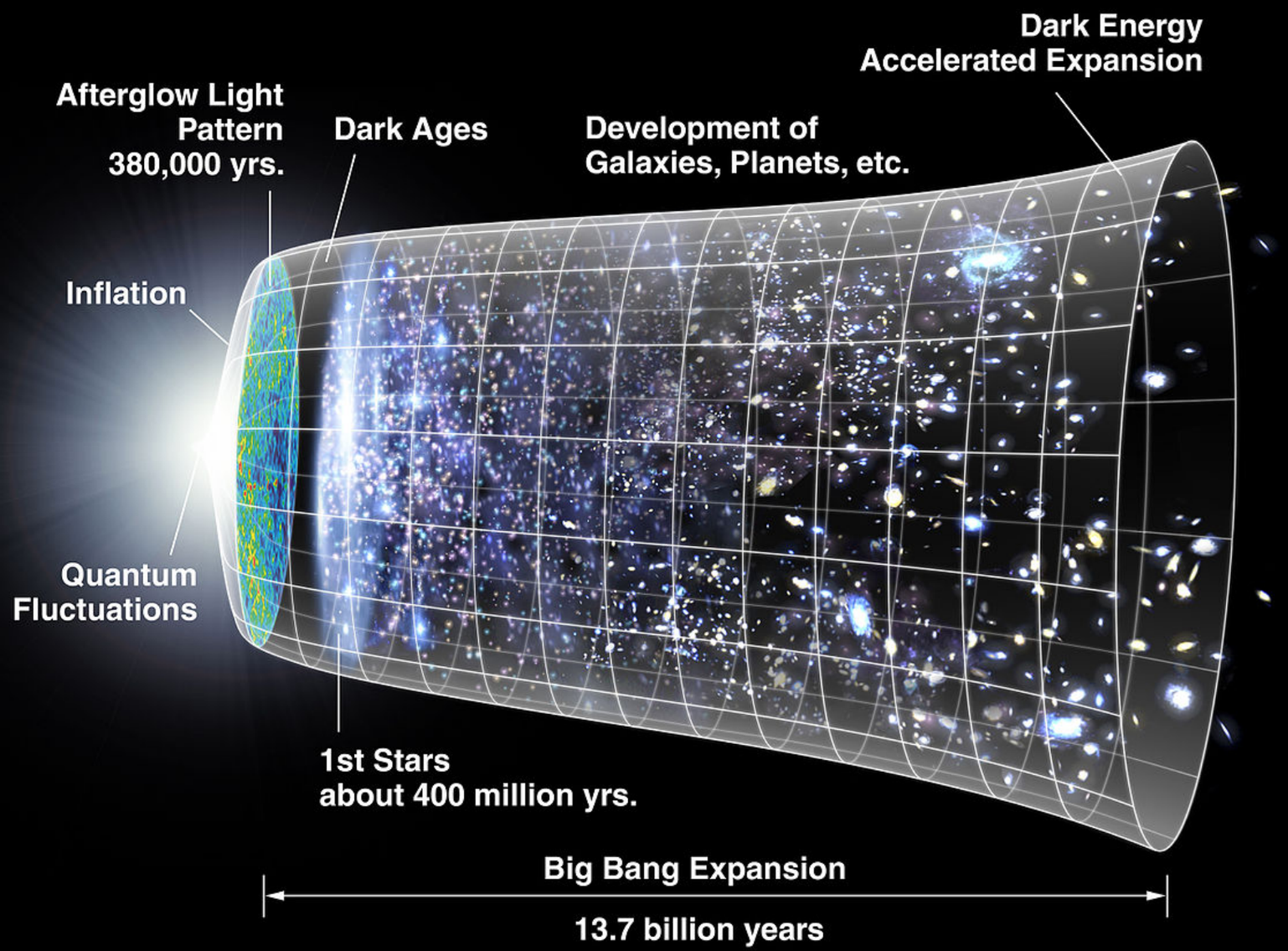
SPT-SZ Detector Module and LC Board





•Wafer wire-bonded to circuit board with LC circuit, which sets each bolometer's resonant frequency for frequency Multiplexing (fMUX)

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