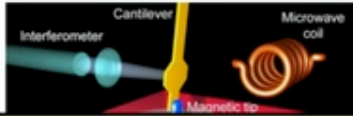
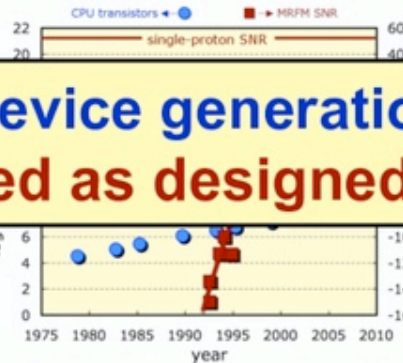


The Quantum System Engineering Roadmap: FAQ

Q3: What is a reliable technical path to practical quantum spin microscopy? A3: The path is smaller, colder, quieter device generations



Moore's Law Progress in MRFM



Every MRFM device generation has performed as designed

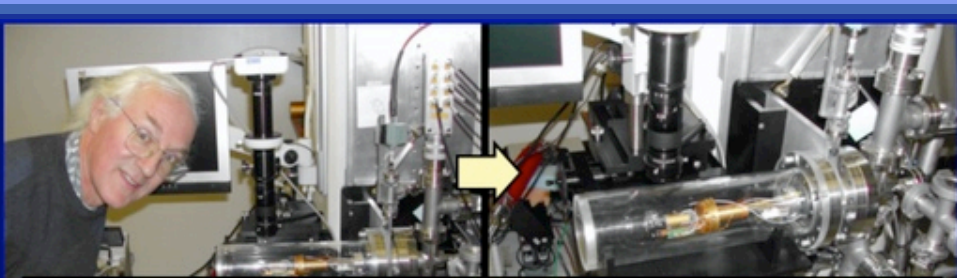
- MRFM sensitivity has improved by 140 dB in twelve years
- Equivalent to doubling sensitivity every 3.1 months for 46 doublings
- MRFM has Moore's Scaling: smaller, colder, quieter devices work better

Moore's Law design rules

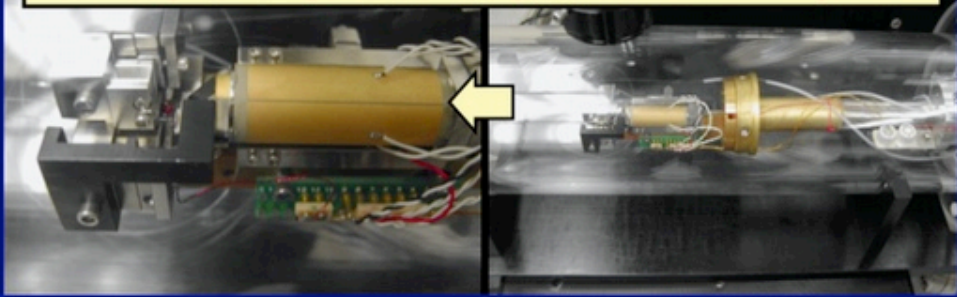
$$S_{\mu} = \frac{m}{g^2 \tau} 2k_B T$$

m cantilever mass
 T temperature
 g magnetic gradient
 τ damping time

- smaller
- colder
- quieter



MRFM devices are desktop spacecraft that explore the vast new frontiers of nanospace, quantum space, and biospace.



The 1952 Roadmap of von Braun, Ley, and Bonestell

Total available payload in circum-Martian orbit approx. 600 t

Total available payload on Mars' surface 149 t

Next stages of the QSE Roadmap:

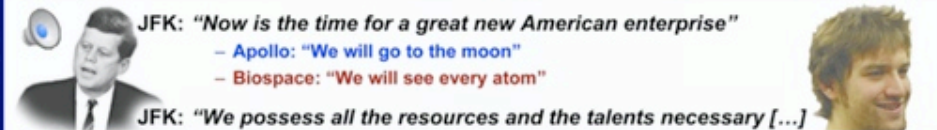
- Detailed quantum design studies
- Unify the strategic objectives
- Build a strong sponsor federation

Required number of ferry flights 950

Required time on ferrying operation approx. 8 months

Propellant cost for ferrying operation approx. 500 million dollars

Q4: When might this technology reasonably be ready? A4: The technology is in-place now for Apollo-style innovation and discovery



The new frontier is unbounded; its challenges are tough; its parallels are compelling; our missions are urgent; our opportunities are unlimited

