Where does the power go – Itsy vs. Laptop

- Laptop
  - Display 30-68% (backlight largely)
  - Disk 0 – 20%
  - Processor 15%
    - Clock: 30%
    - Cache: 15%
    - Control: 25%
    - Floating point 10%
    - Integer 10%
    - MMU 10%
  - Memory 10%

- Itsy
  - Low-power
    - Display 0.04W
    - Processor 0.09W
  - Mid-power
    - Display 0.04W
    - Processor 0.18W
  - Full-power
   - Display 0.604W
    - Processor 0.596

Where does the power go - TinyOS

- Communication
  - RF unit: per bit: 1uJ
- Processor
  - 5mA / pins: 1.5mA
- Sensors
  - LED 4.6mA each
  - Temp: 1mA
- Memory
  - 3 mA EEPROM

Principles of low-power computing

- Want control of performance
  - Voltage and frequency scaling
  - Sleep mode
- Compartmentalized
- Carefully use large associative structures
- Control your use of speculation
- Efficient scheduling
- Don't waste!

Power density continues to get worse
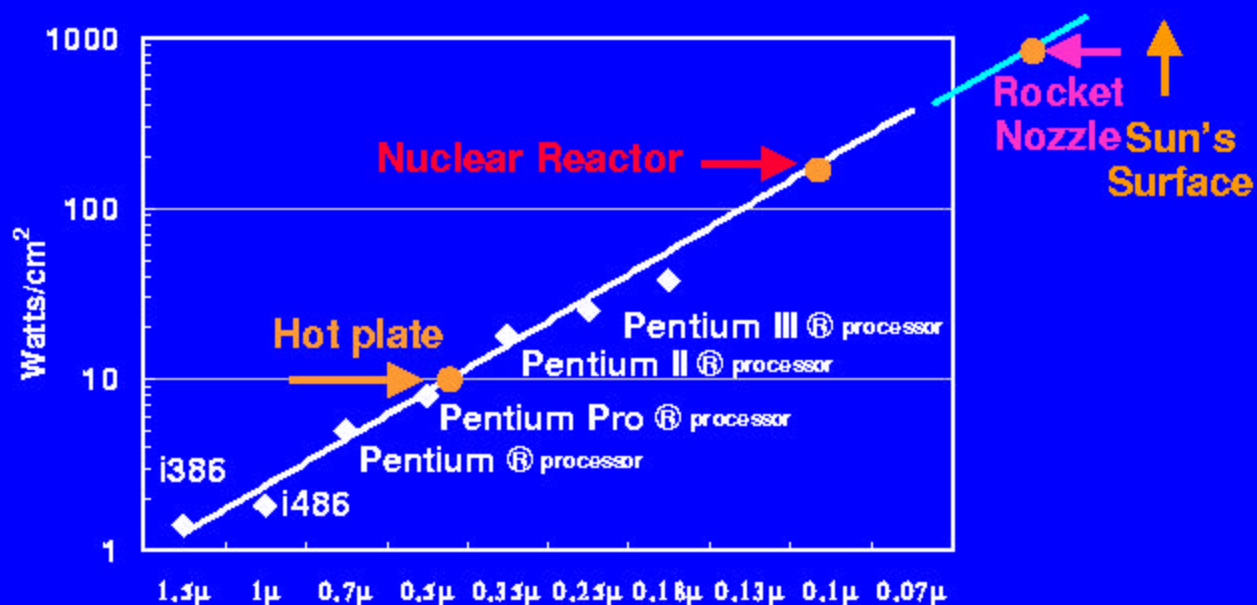
Surpassed hot-plate power density in 0.5μ

Not too long to reach nuclear reactor

intel

How to solve the power problem?

- Liquid Nitrogen
- Small Nuclear Devices
- Fuel Cell
- Gas-burning batteries
- Kinetic devices
- Inductive energy
- Typing on keyboard
- Energy gas
- Photosynthesis
- Bio-Electrical synthesis of systems

Is the Post-PC Era for real?

- Yes
  - So many opportunities for computation