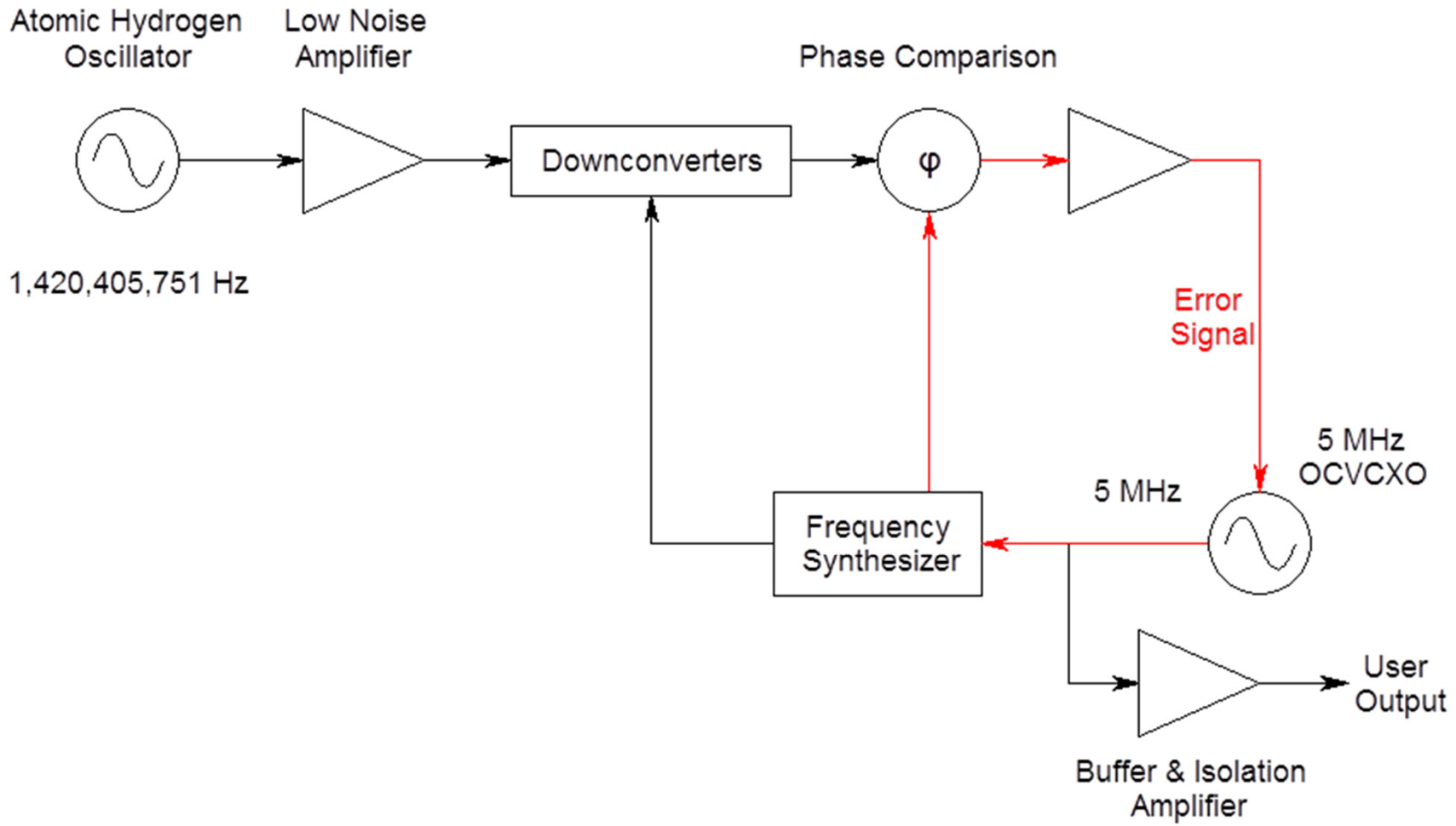
MASER

Microwave
Amplification by the
Stimulated
Emission of
Radiation

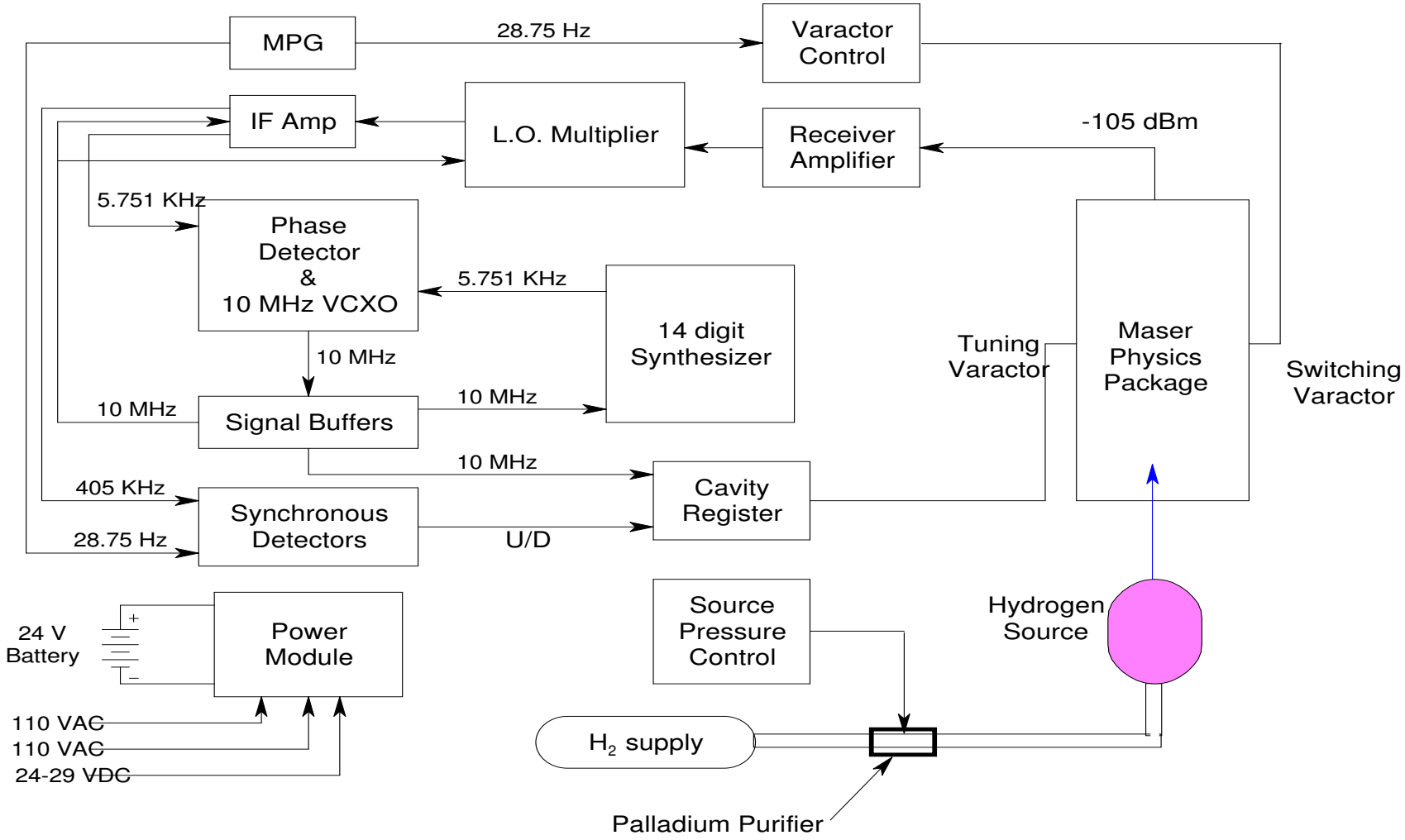
Some Uses of Hydrogen Masers

- Timing Laboratories
- International Time UTC
- Local Oscillators for Atomic Fountains
- Radio Astronomy
- Relativity Experiments
- GPS Ground Stations

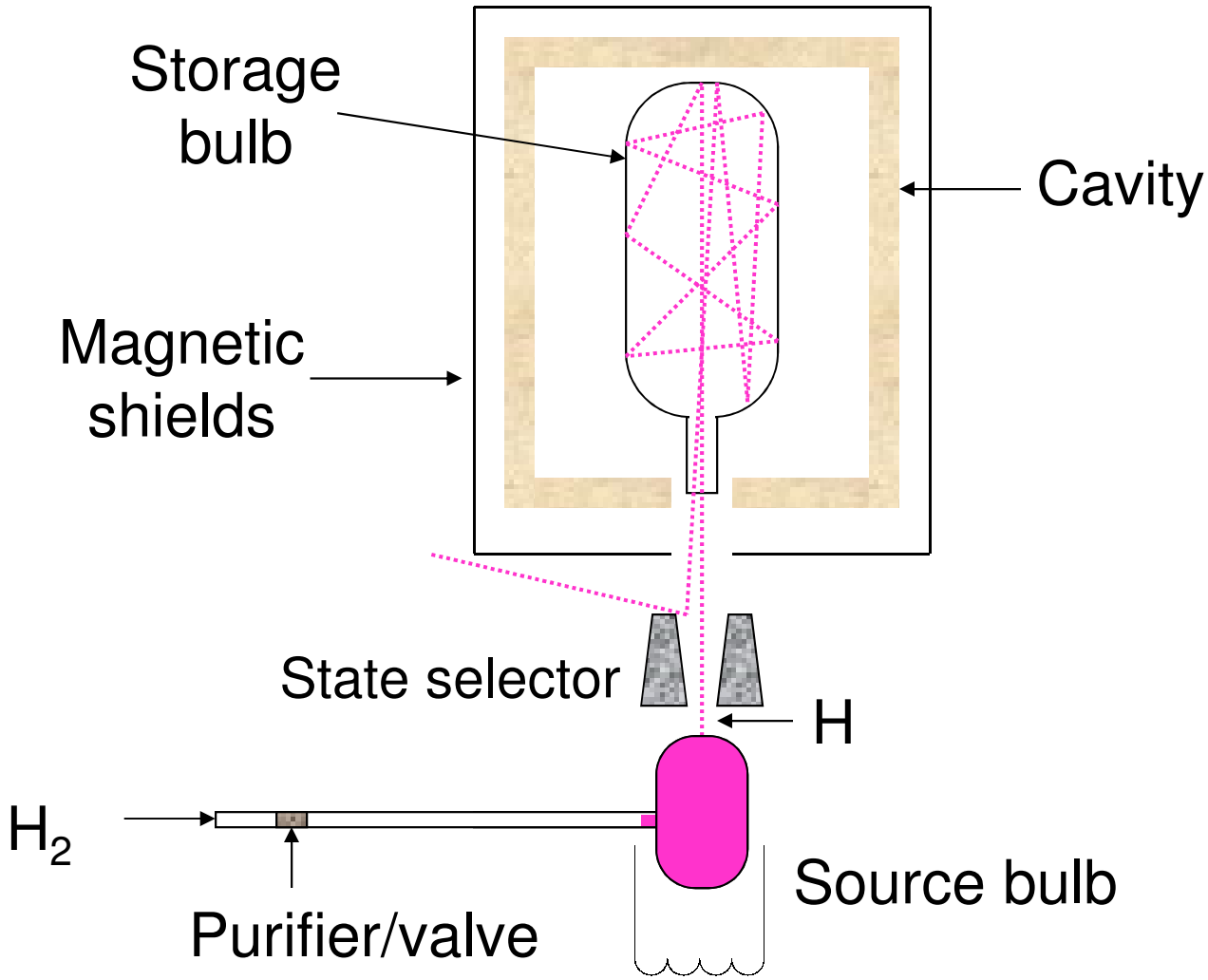
Active Device



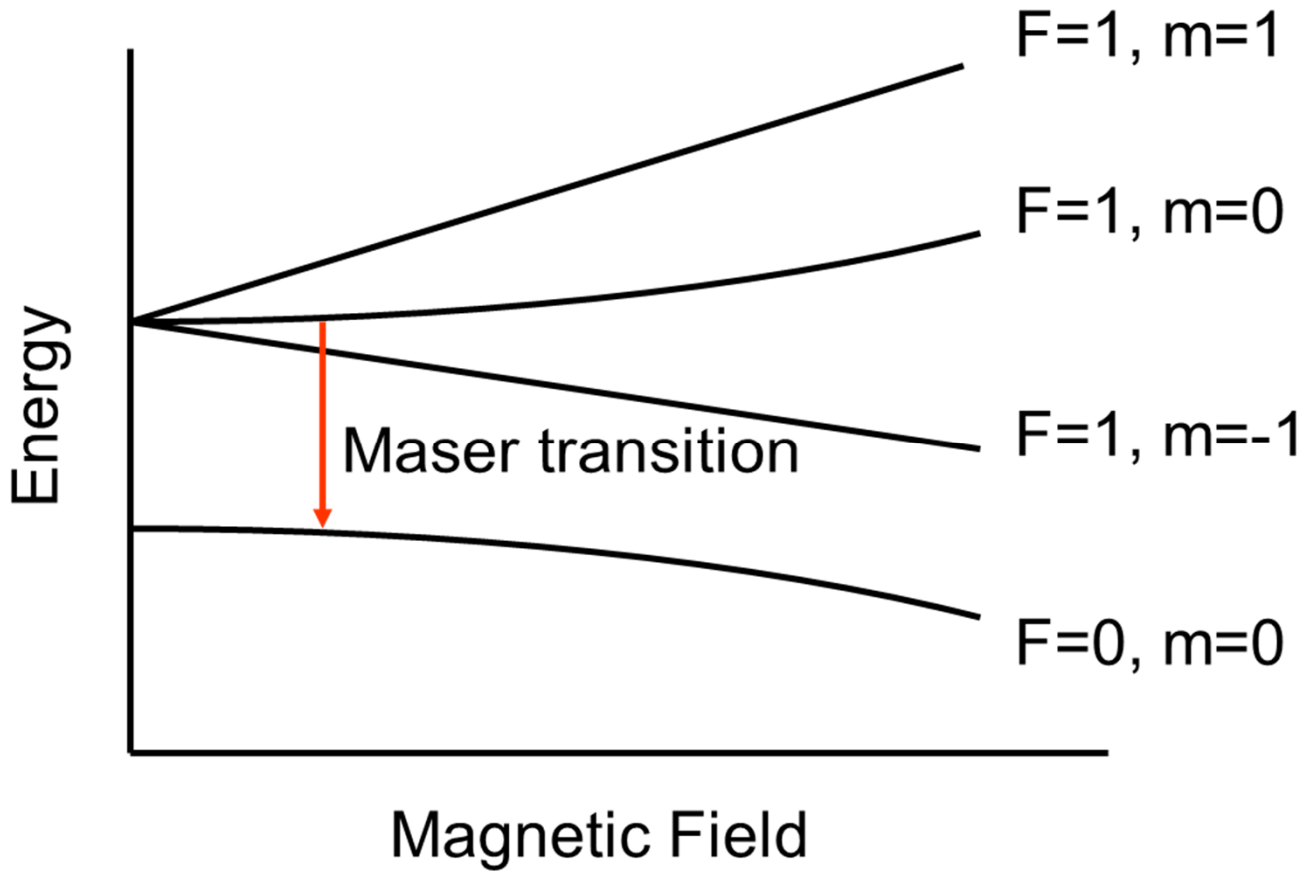
Maser Block Diagram



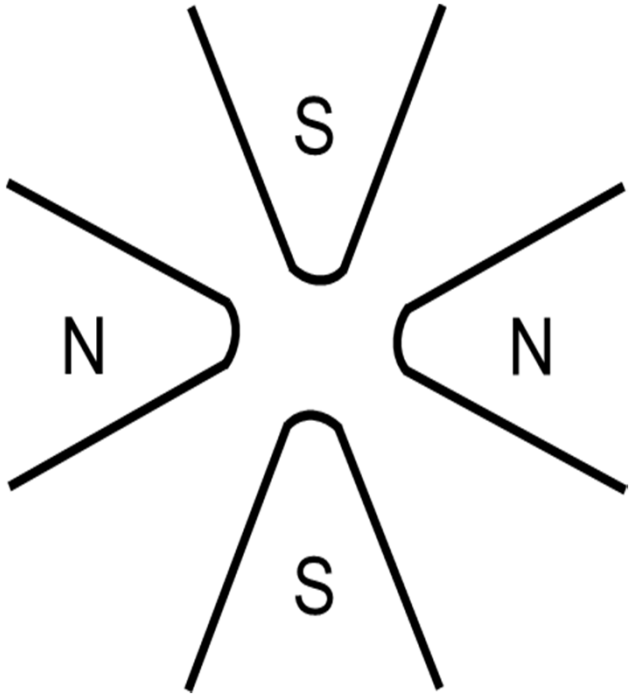
Maser Diagram



Ground State Hydrogen Atom Energy Level Diagram



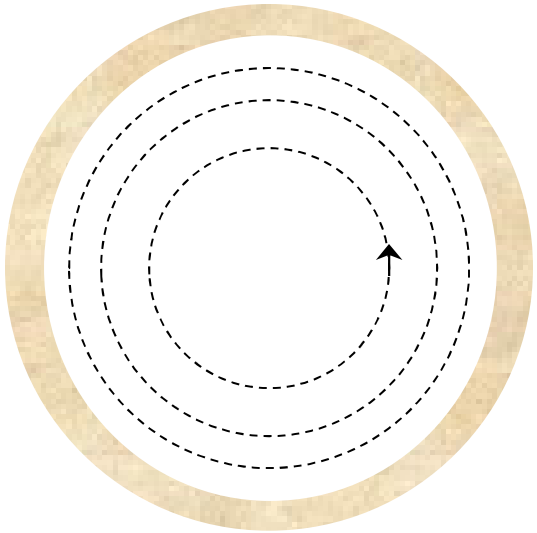
Magnetic State Selector



Hydrogen Storage Bulb

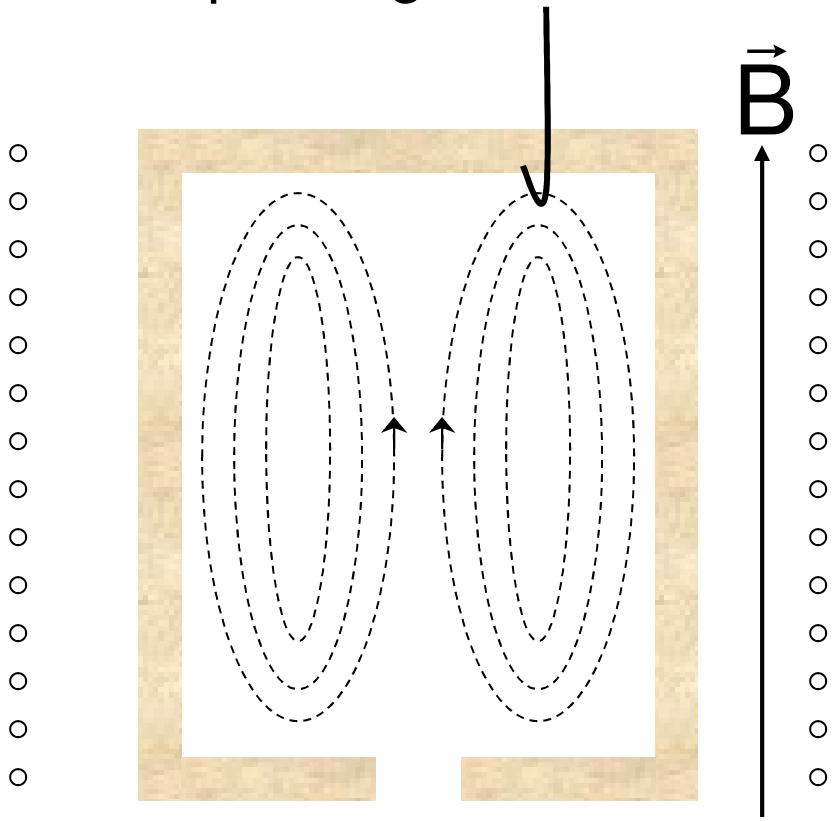
- Centrally located in cavity
- Approximately 1-2 Liters
- Generally made of Quartz
- Teflon Coated
  - Minimal perturbation to atoms from wall collision
- H atoms stay in the bulb about 1 second
  - Travels on the order of 1 Km
  - Makes on the order of 10^4 bounces off the wall

TE011 Cavity Mode



Electric Field Lines

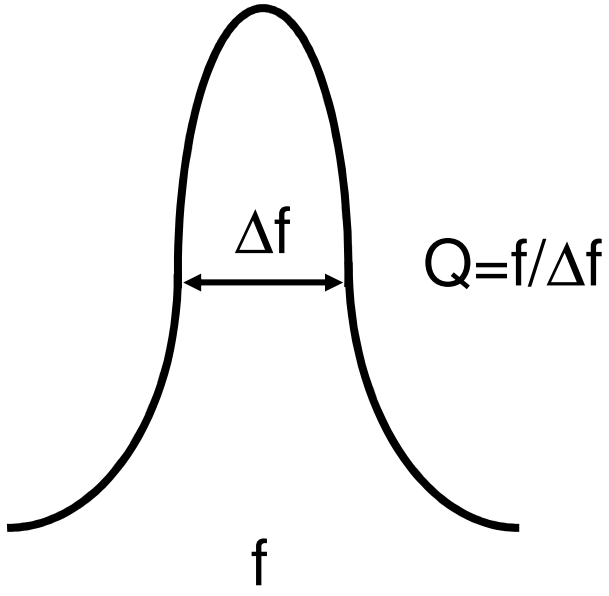
Loop orthogonal to field line couples signal out of cavity



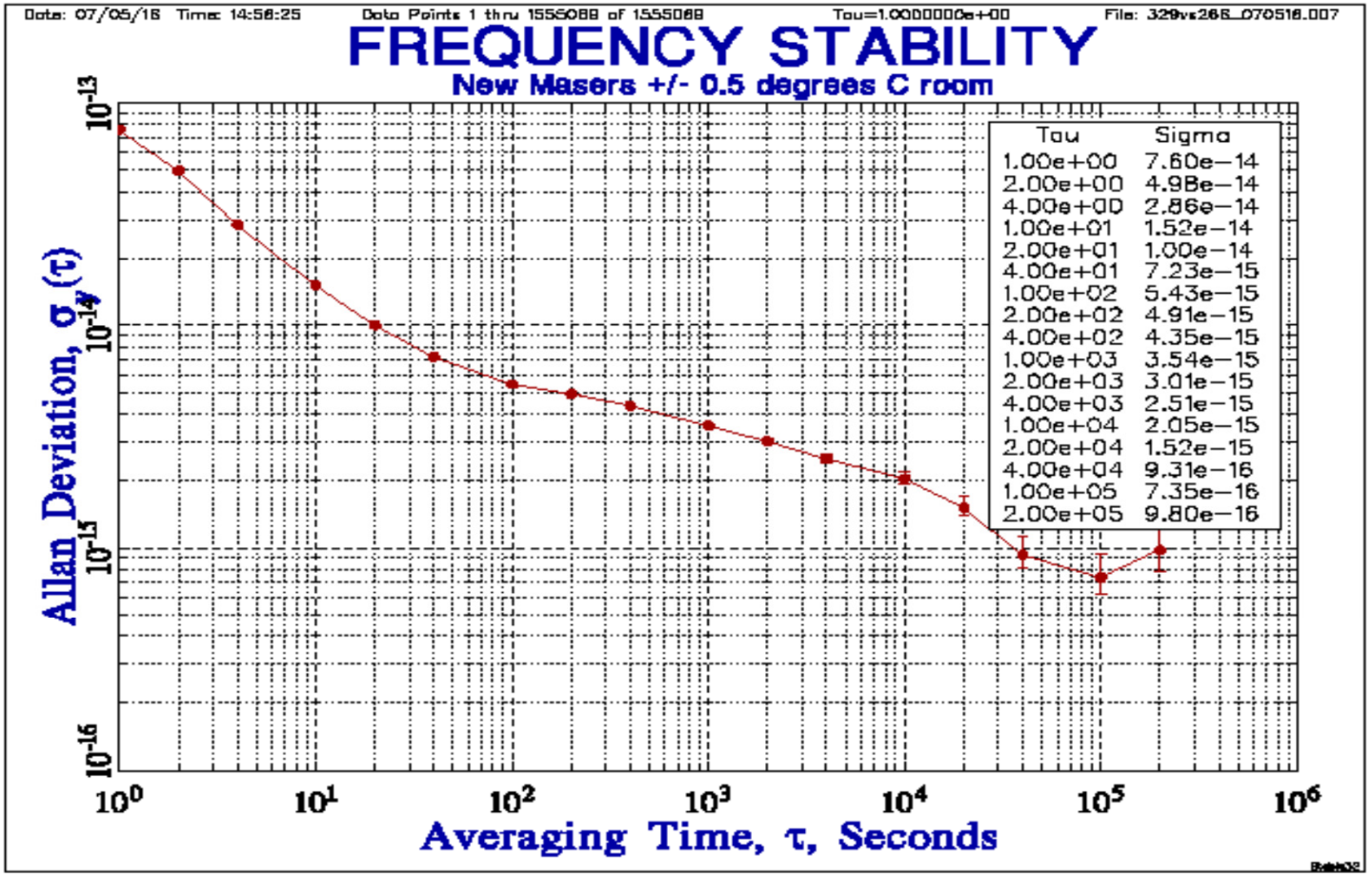
Magnetic Field Lines

Maser Q's

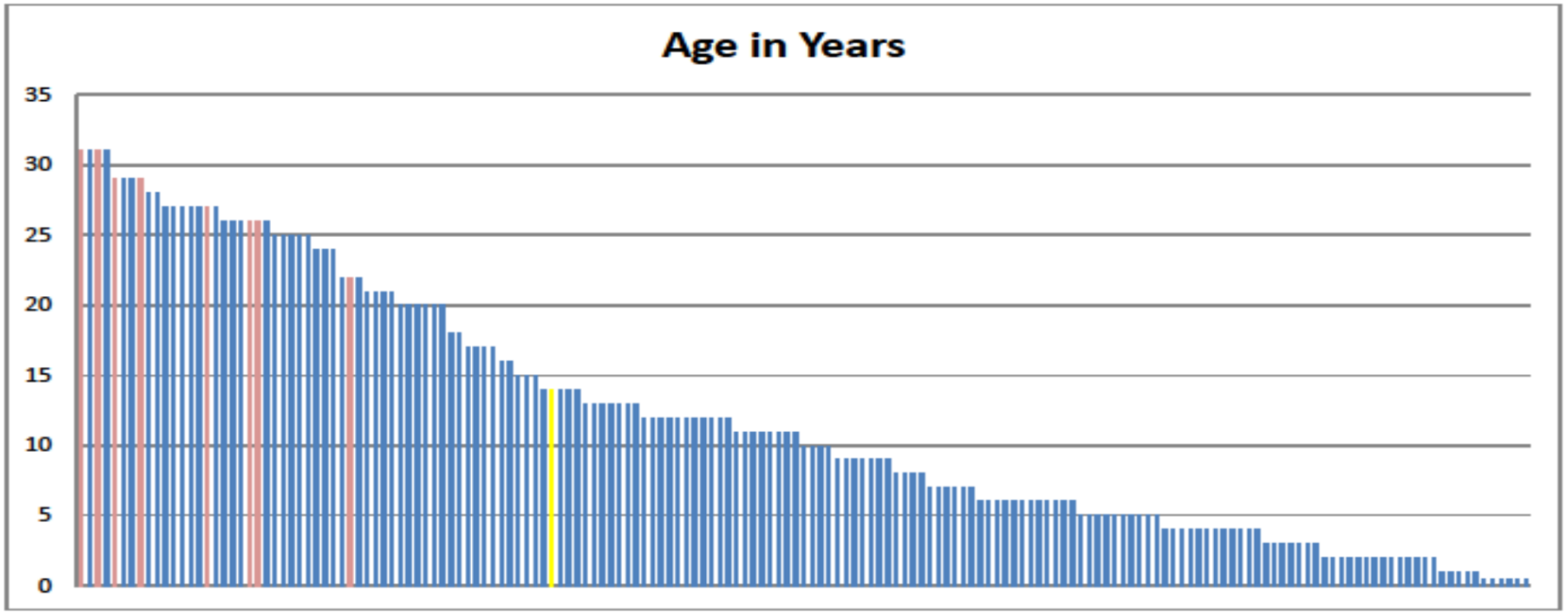
- Atomic line Q
  - Q_l is approx. $2x10^9$
- Cavity Q
  - Q_c is approx. 40,000
    - About 20k needed to sustain oscillation
- Q_c/Q_l is approx. $2x10^{-5}$



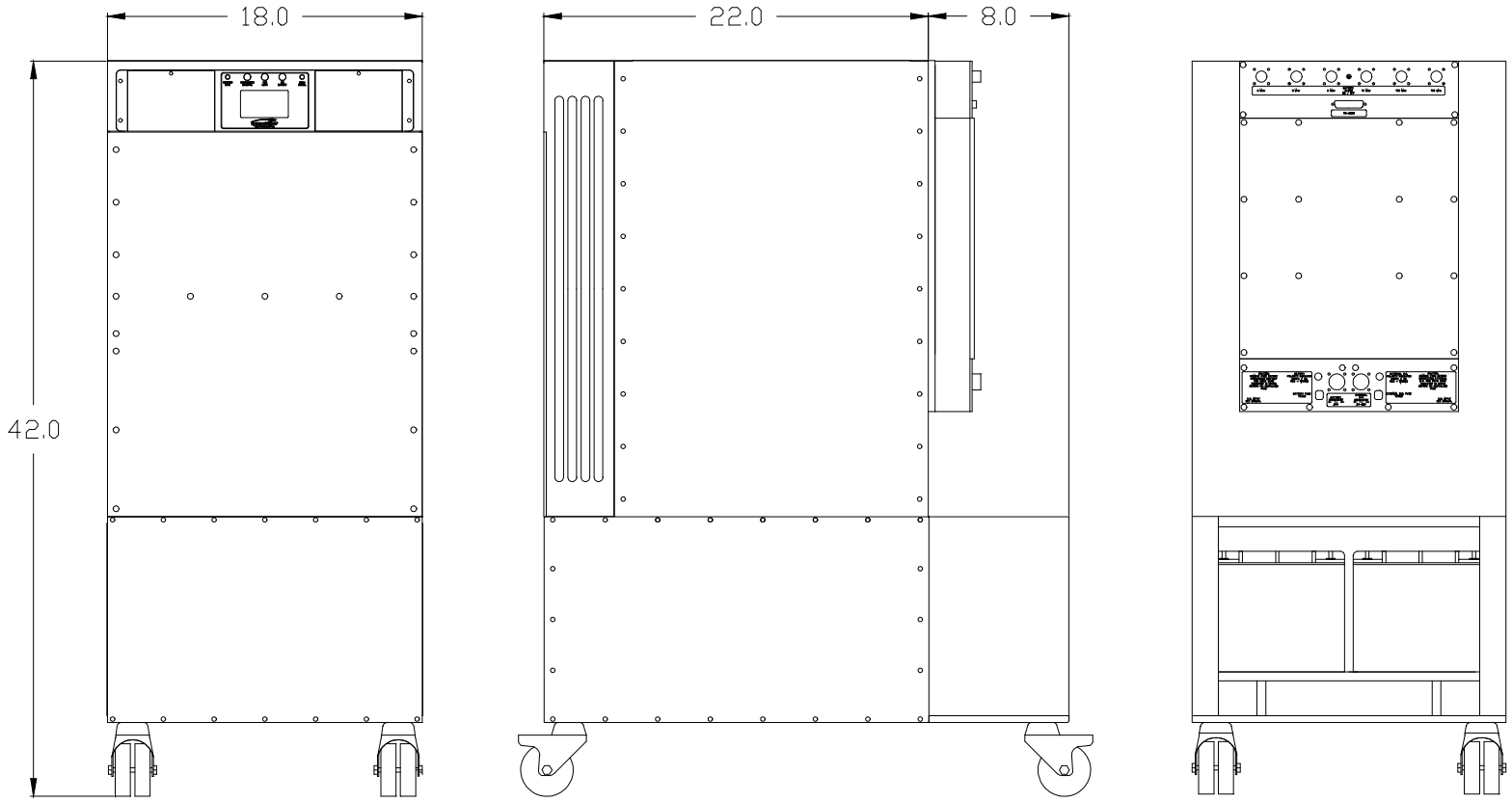
Active Hydrogen Maser Stability



Maser Operating Lifetime



Maser Outline



Hydrogen Maser Summary

- Very Good Short Term Frequency Stability
- Low Phase Noise Option
- “Mature” Technology
- Very Long Service Life
- Field Serviceable