

Developments in Search for 0.1 meV Axions and Hidden Photons using Cu Resonant Cavities

P. L. Slocum, O. K. Baker, J. L. Hirshfield, Y. Jiang,
G. Kazakevitch, S. Kazakov, M. Lapointe, A. Martin,
S. Shchelkunov, A. Szymkowiak

Yale University

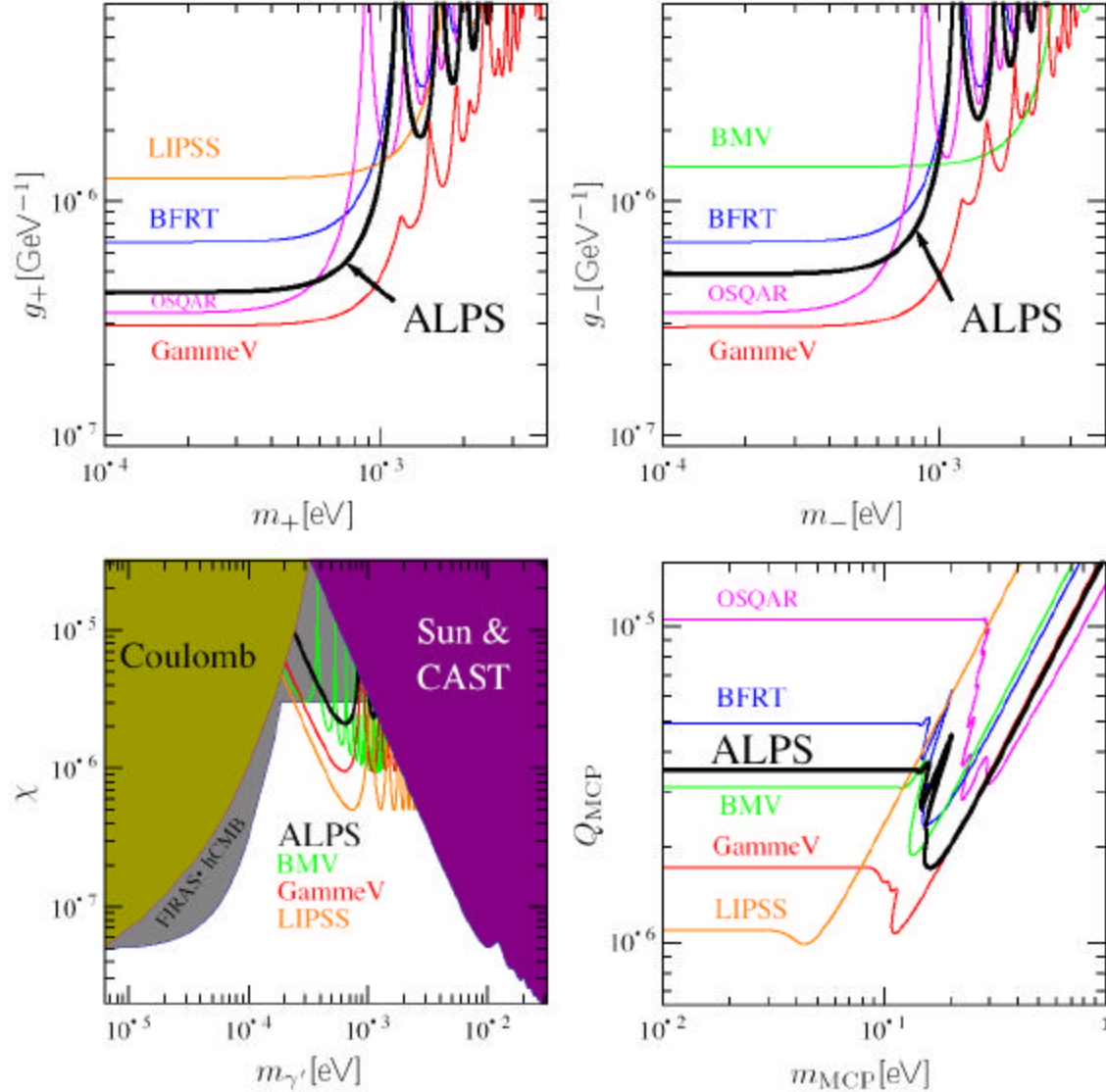
Patras Workshop
University of Durham
July 14, 2009

Penny L. Slocum

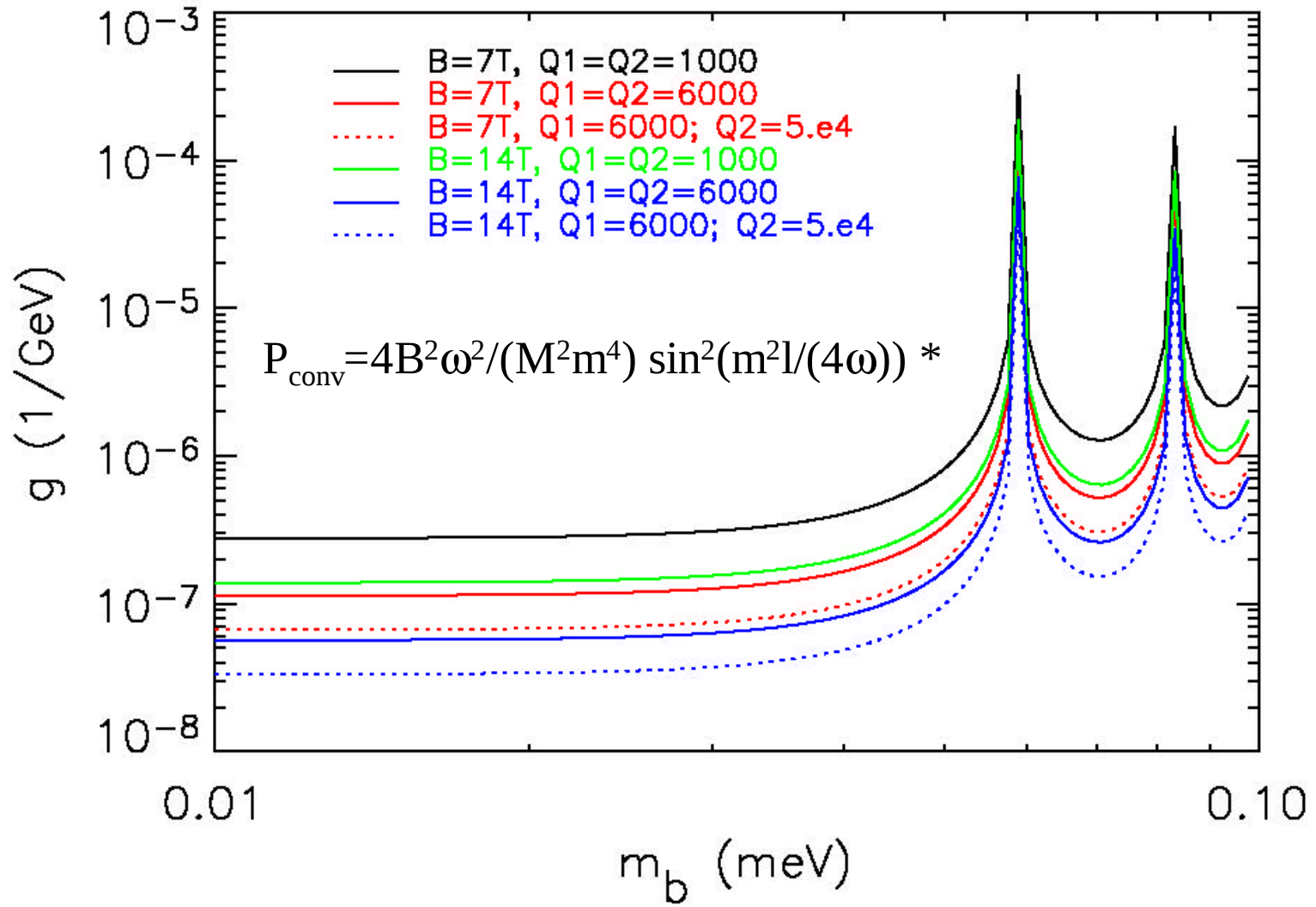


Overview

- Experiment: Simultaneous searches for
 - 0.1 meV axions
 - 0.1 meV hidden sector photons
- Bench tests
- Status of equipment and timeline

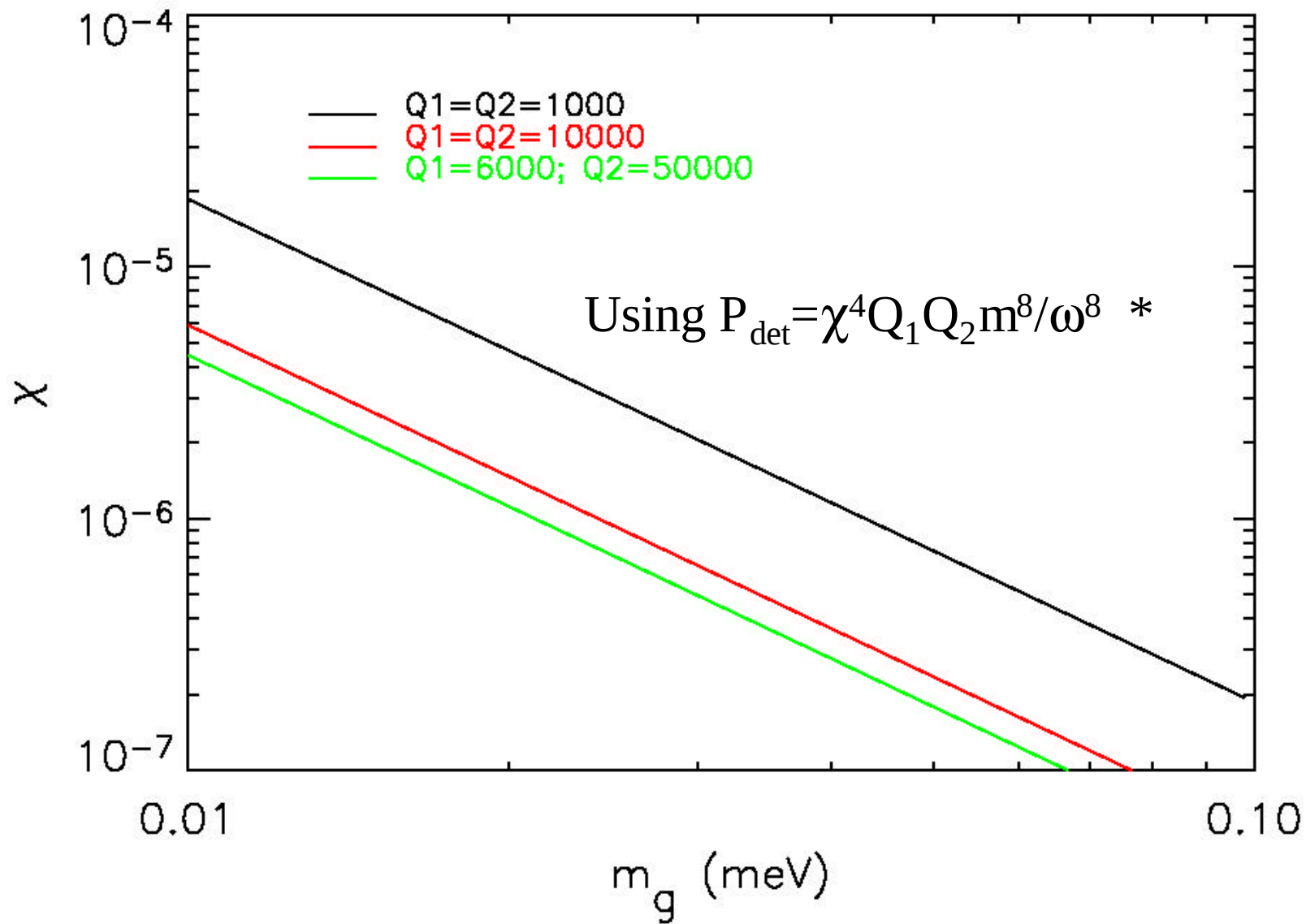


5 σ Exclusion



*Cameron et al., Phys. Rev. D (47)9, 1993

5σ Exclusion



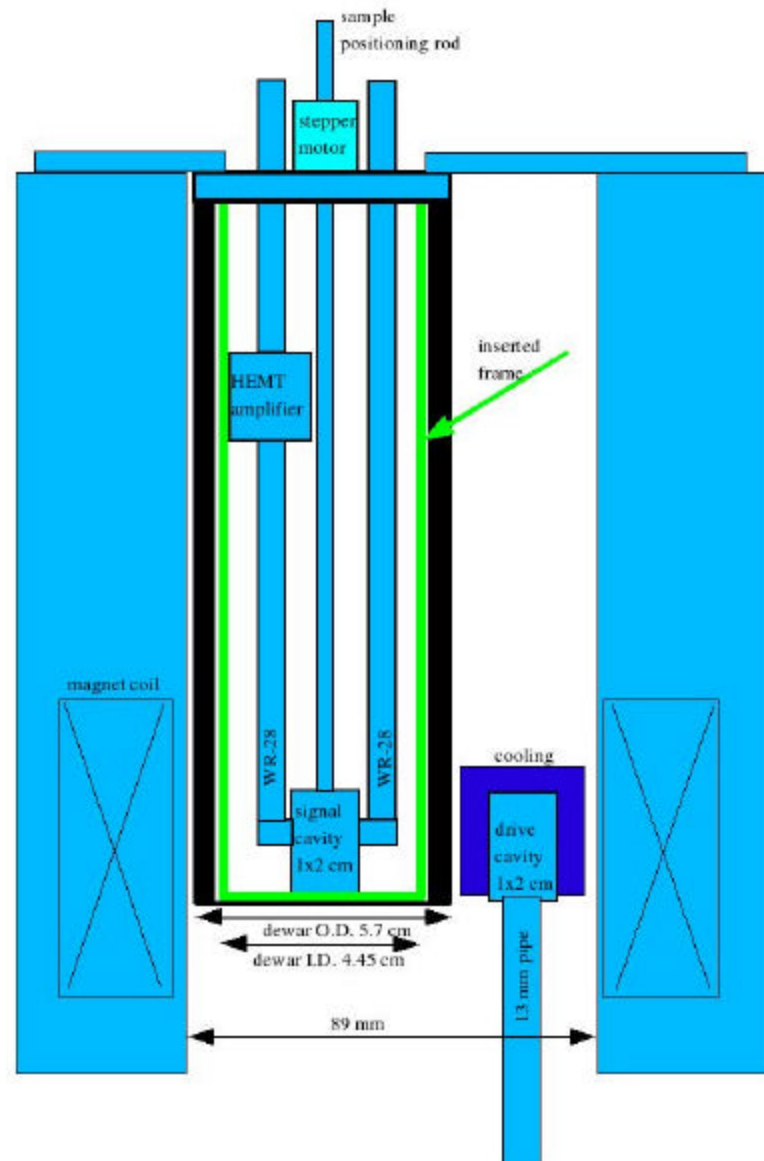
* Jaeckel and Ringwald, Phys. Lett. B 659 (2008)

Geometry Factor

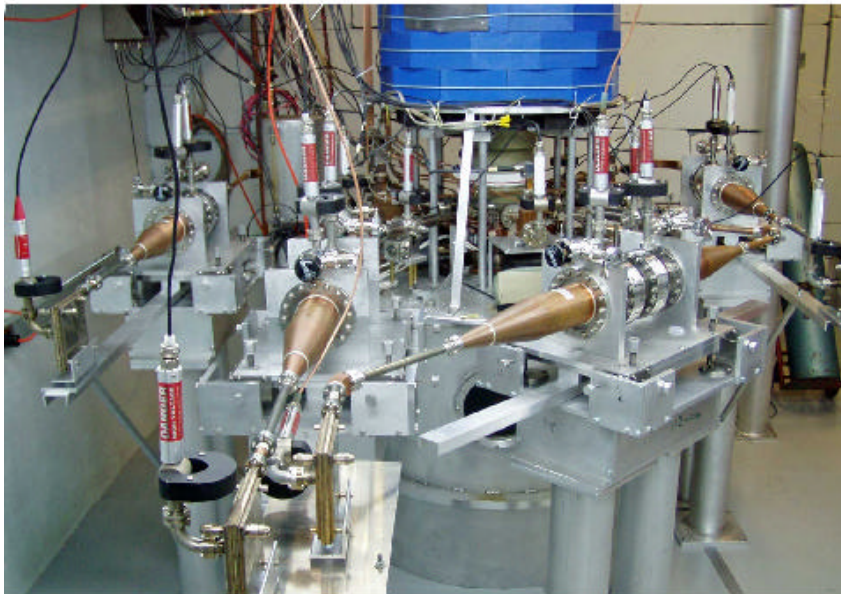
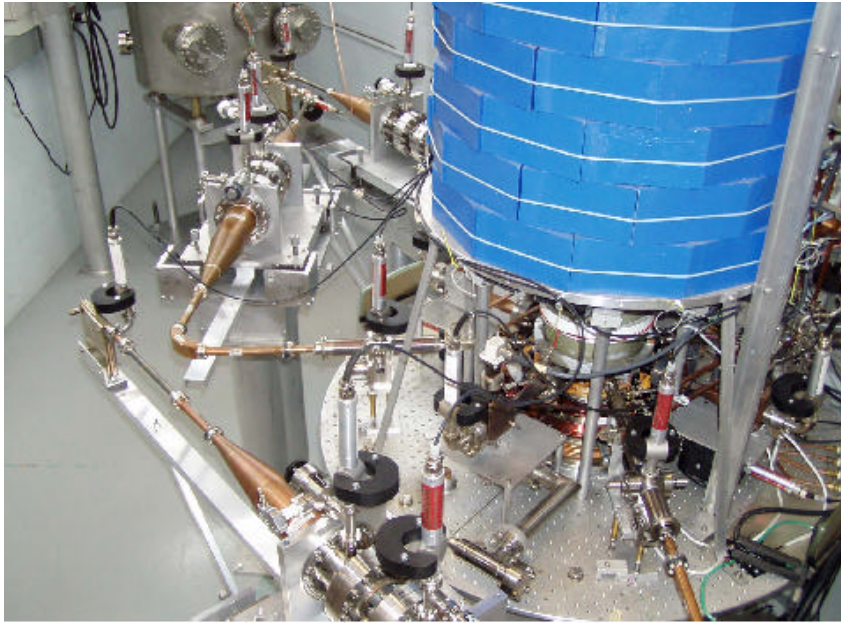
$$G(k/\omega_0) \equiv \omega_0^2 \int_{V'} \int_V d^3\mathbf{x} d^3\mathbf{y} \frac{\exp(ik|\mathbf{x} - \mathbf{y}|)}{4\pi |\mathbf{x} - \mathbf{y}|} A_{\omega_0}(\mathbf{y}) A'_{\omega_0}(\mathbf{x})$$

$$P_{\text{trans}} = \frac{\mathcal{P}_{\text{det}}}{\mathcal{P}_{\text{em}}} = \frac{Q}{Q'} \frac{|a_{\text{det}}^0|^2}{|a_{\text{em}}^0|^2} = \chi^4 Q Q' \frac{m_{\gamma'}^8}{\omega_0^8} |G|^2$$

Sketch of Experiment



34 GHz Microwave Source

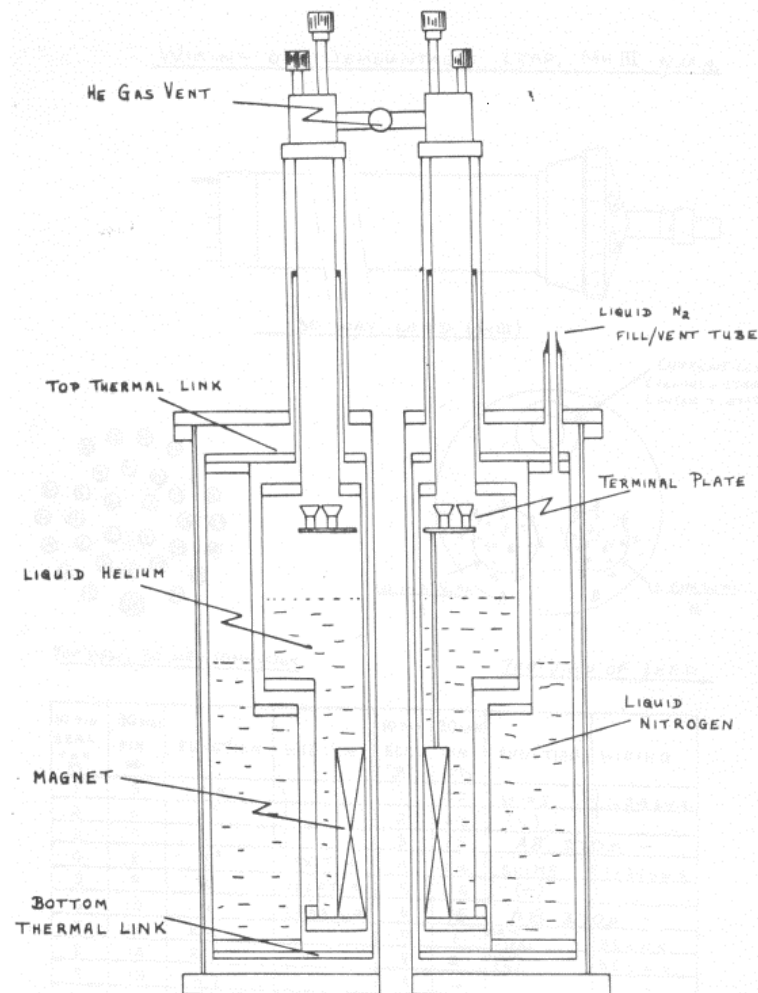


- Output: 10 MW, $1\mu\text{s}$ pulses at 10 Hz. Bandwidth=1 MHz.
- 500 kV, 215 A e- beam transverse deflection system:
 - Drive cavity (11.4 GHz), 3 gain cavities, and two final cavities.
 - Transverse beam momentum is transferred to RF fields at high efficiency.

O. A. Nezhevenko et al., IEEE Transactions on Plasma Science, 0093-3813/04, 2004.

Photos courtesy of M. Lapointe

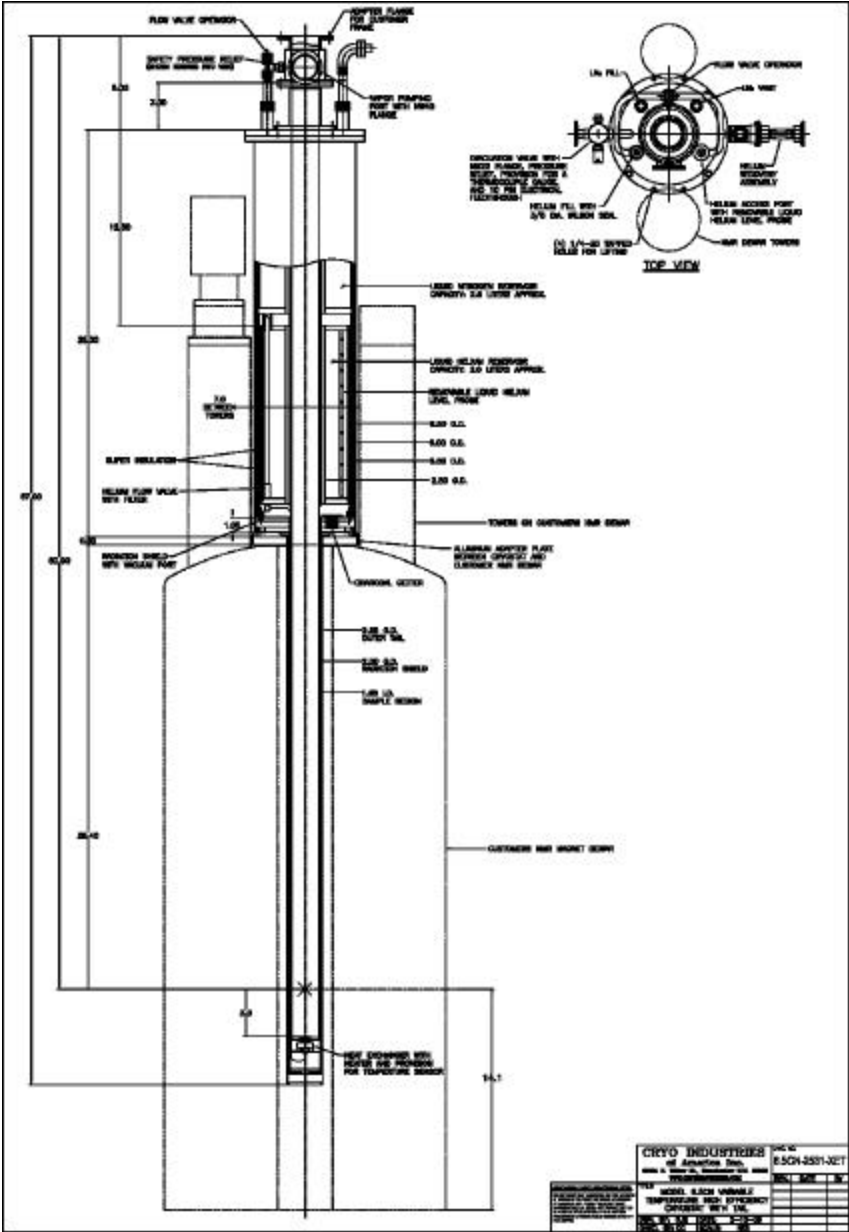
7 T Magnet



NMR CRYOMAGNETIC SYSTEM

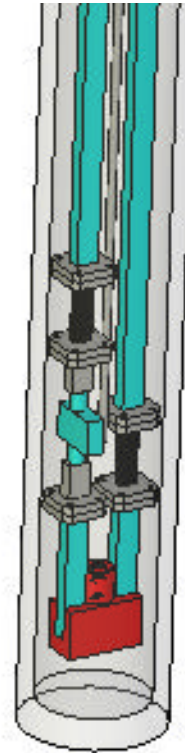
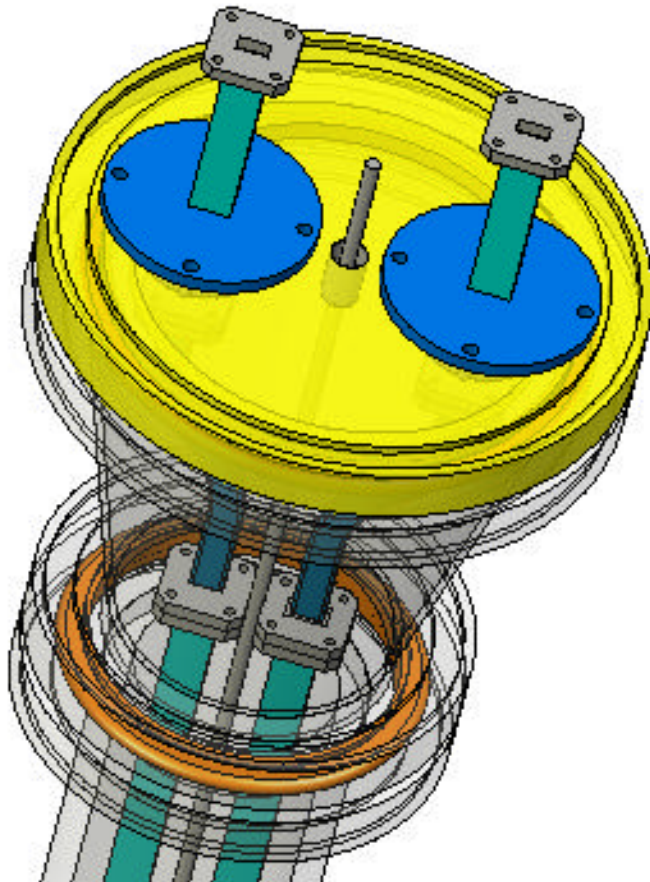
FIGURE 2.2

Cryogenic Dewar

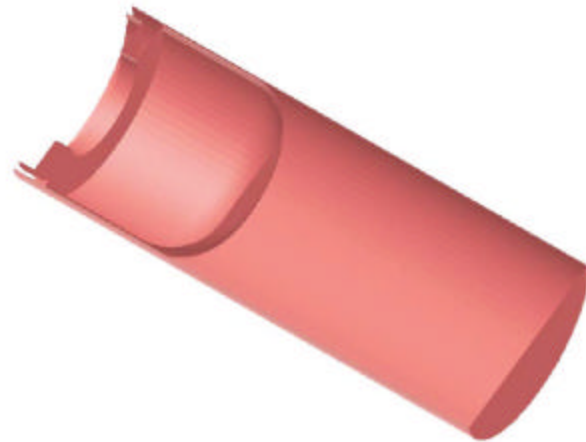
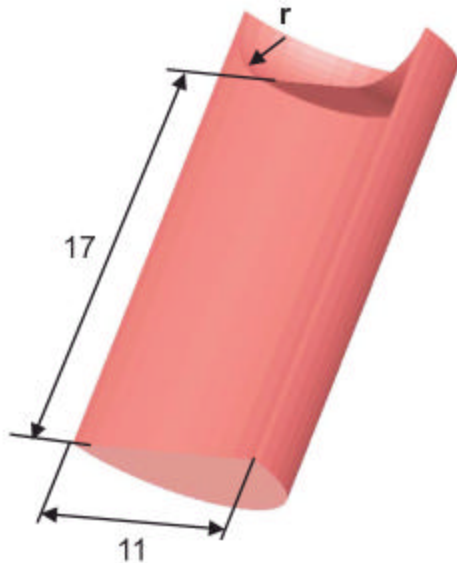
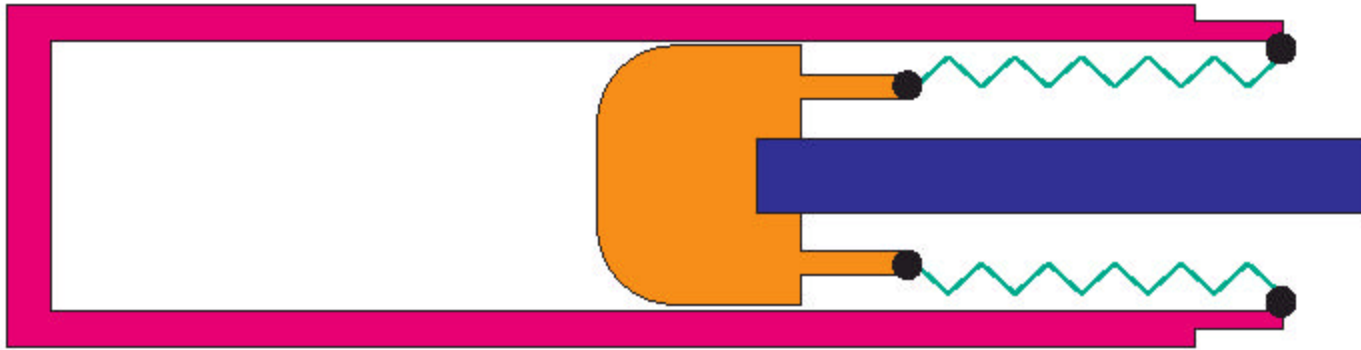


Courtesy of
Cryo Industries, Inc.

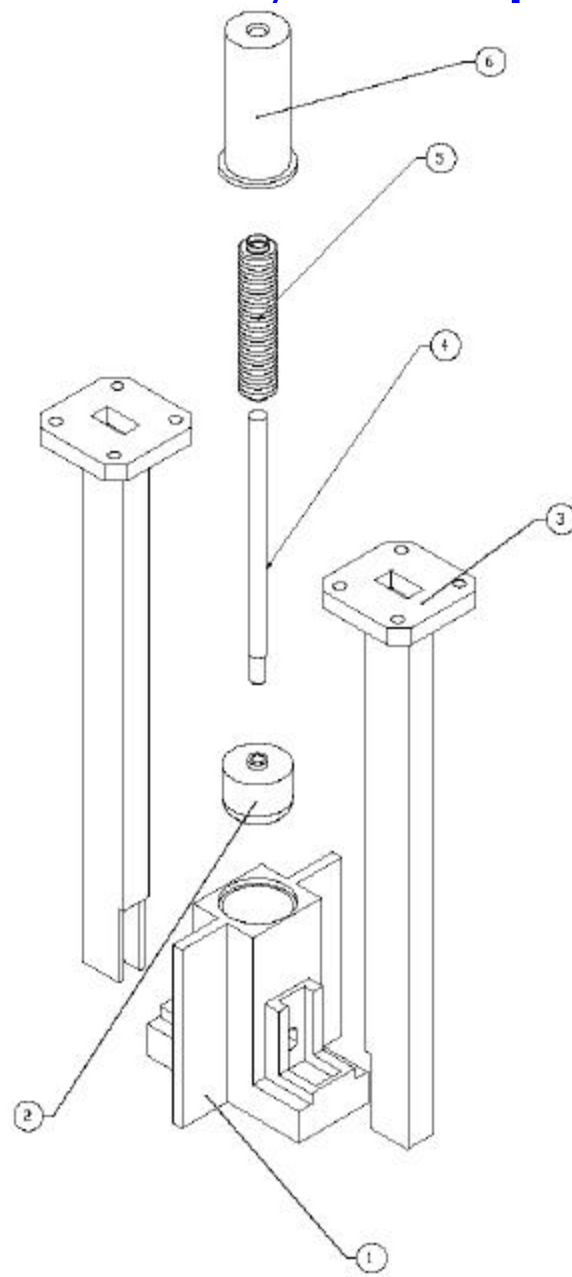
WR-28 Waveguide Input/Output

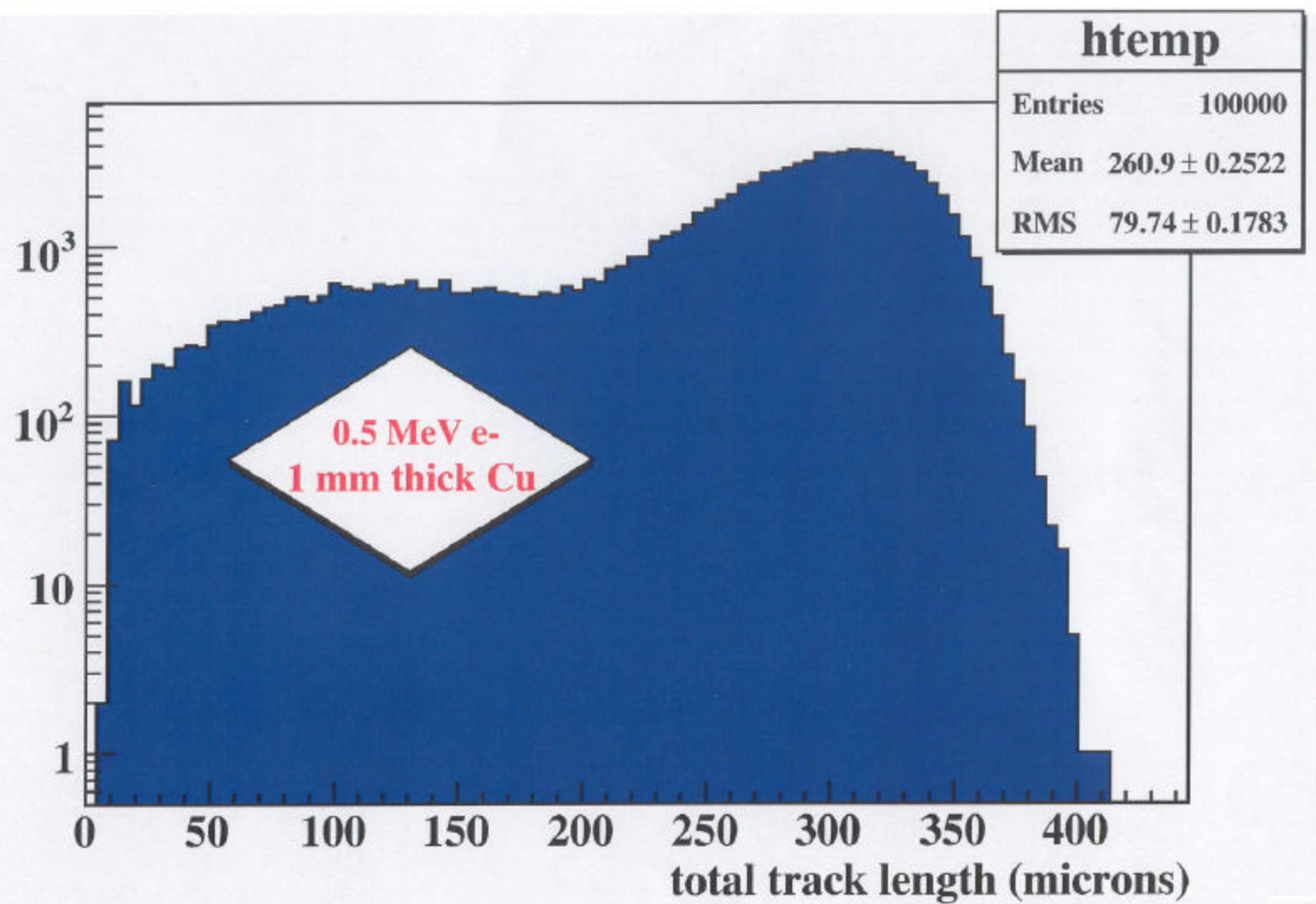


Cu Cavity with Tuning Plunger

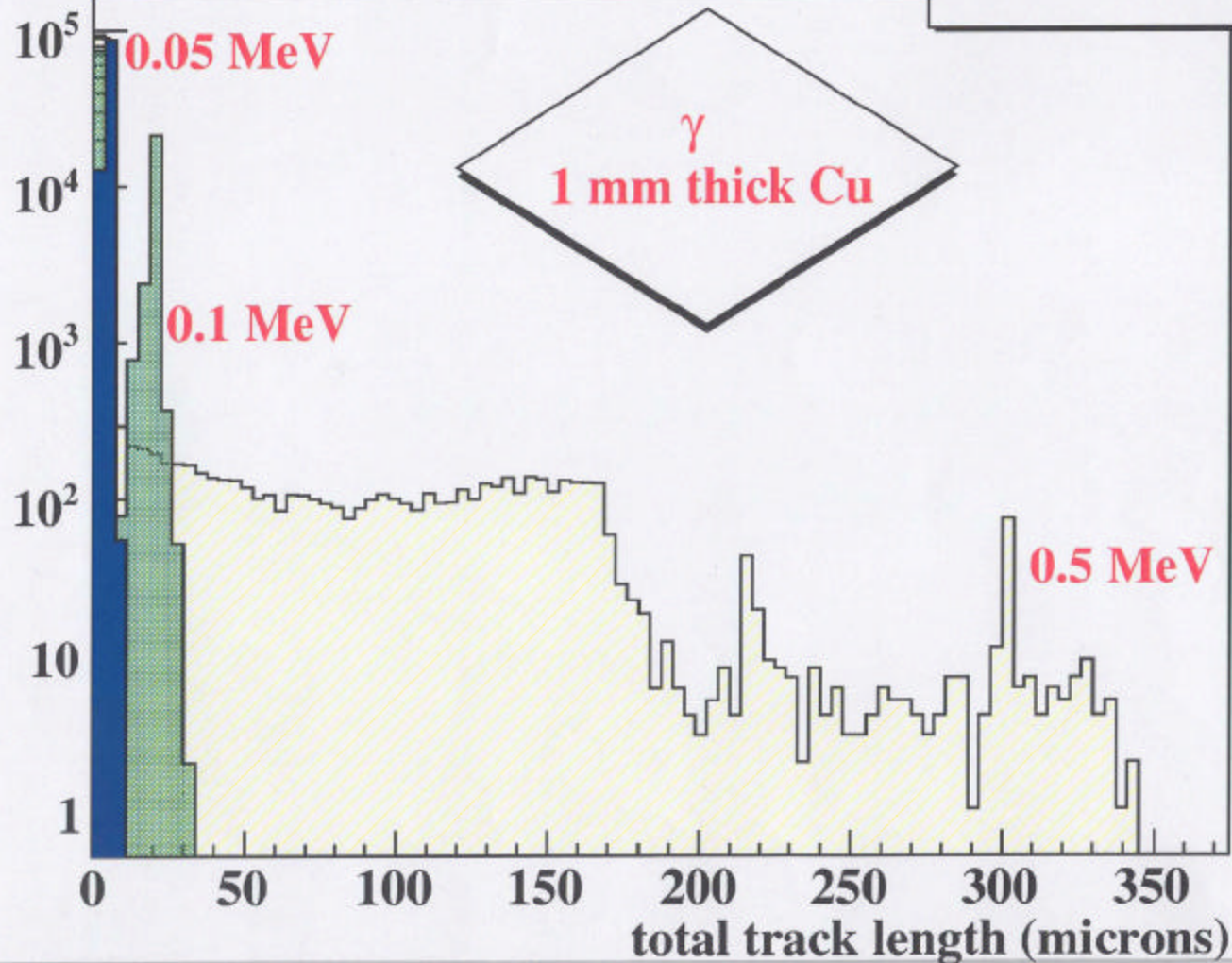


Resonant Cavity – Exploded View

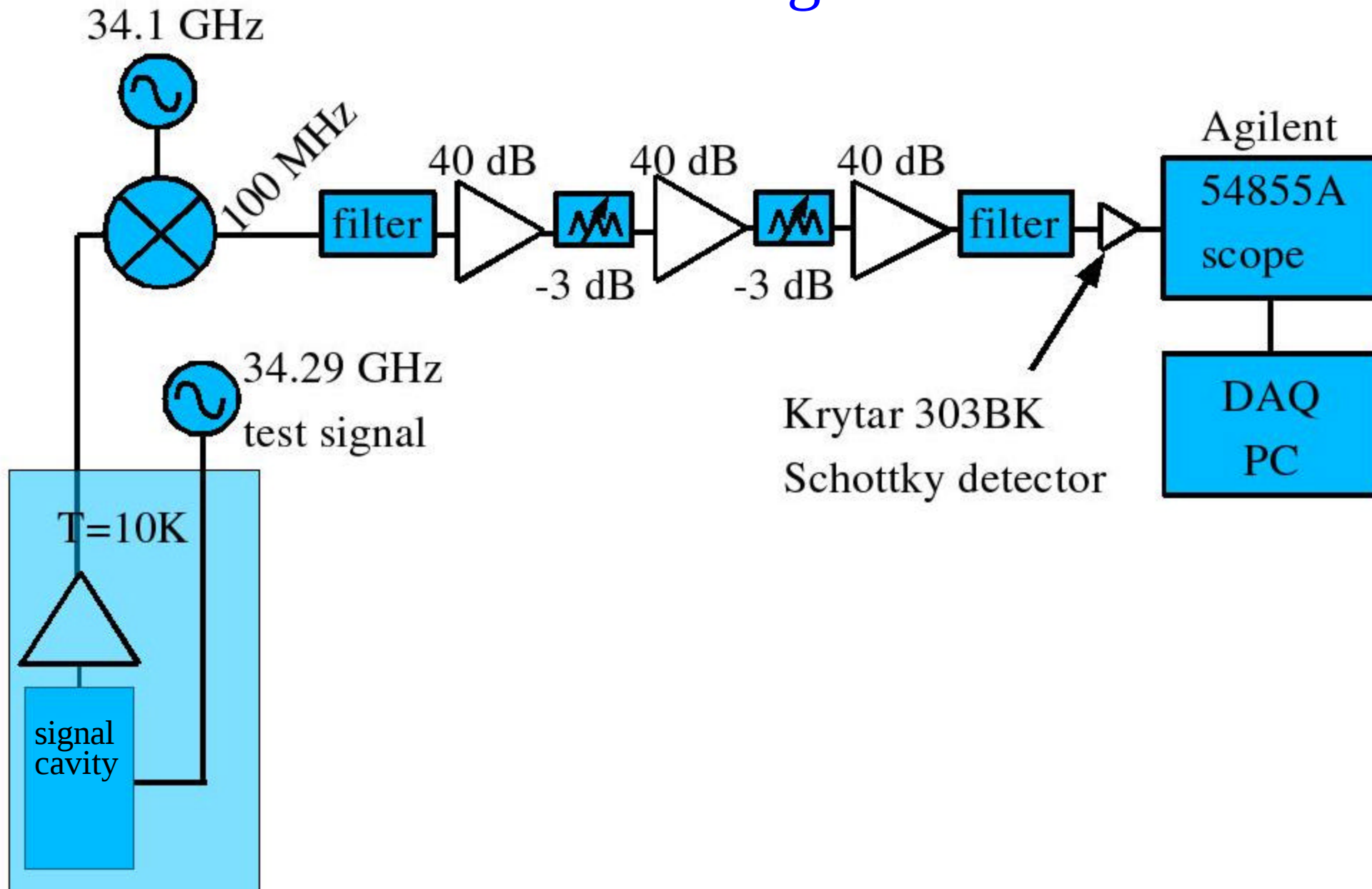




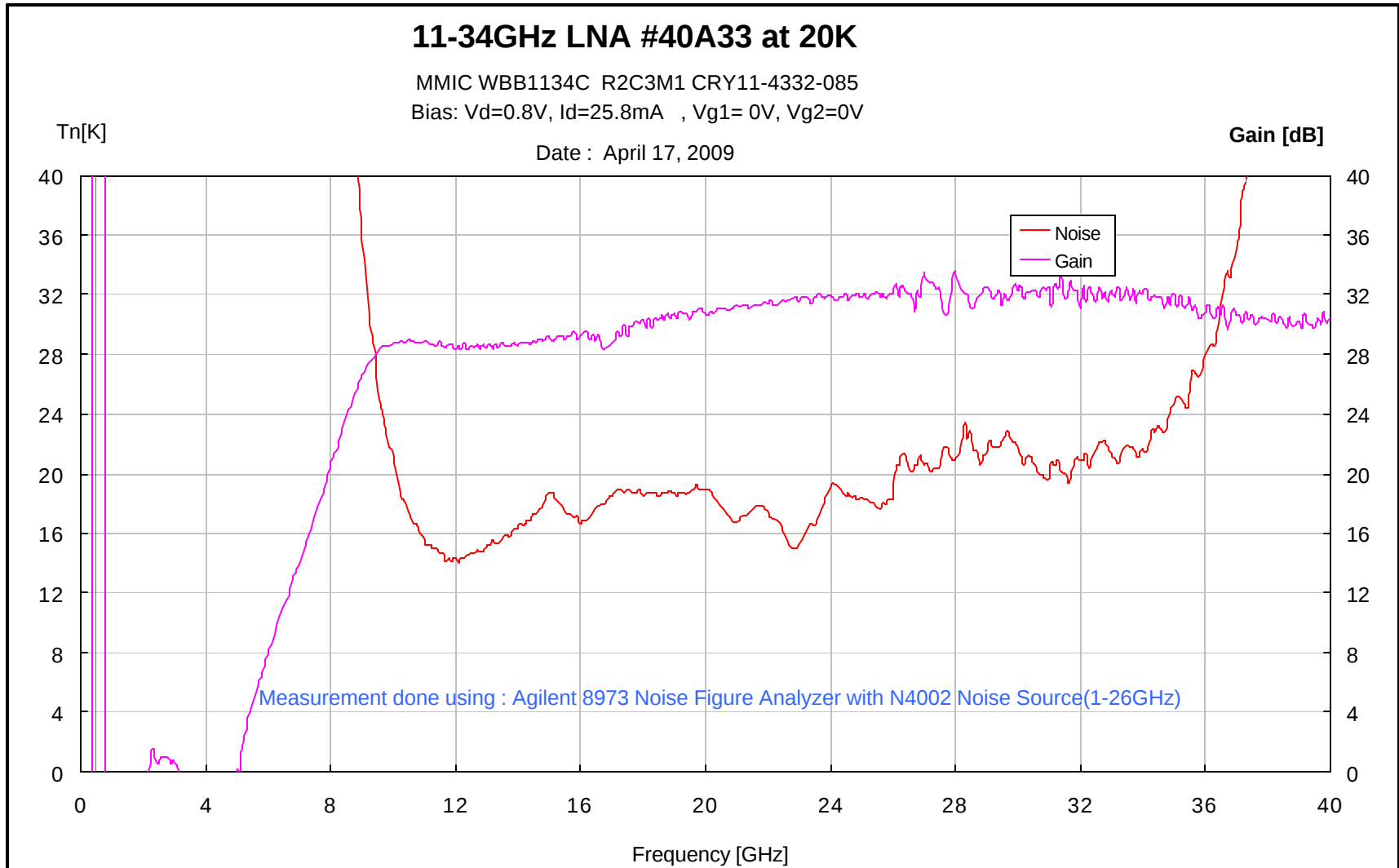
Entries 100000



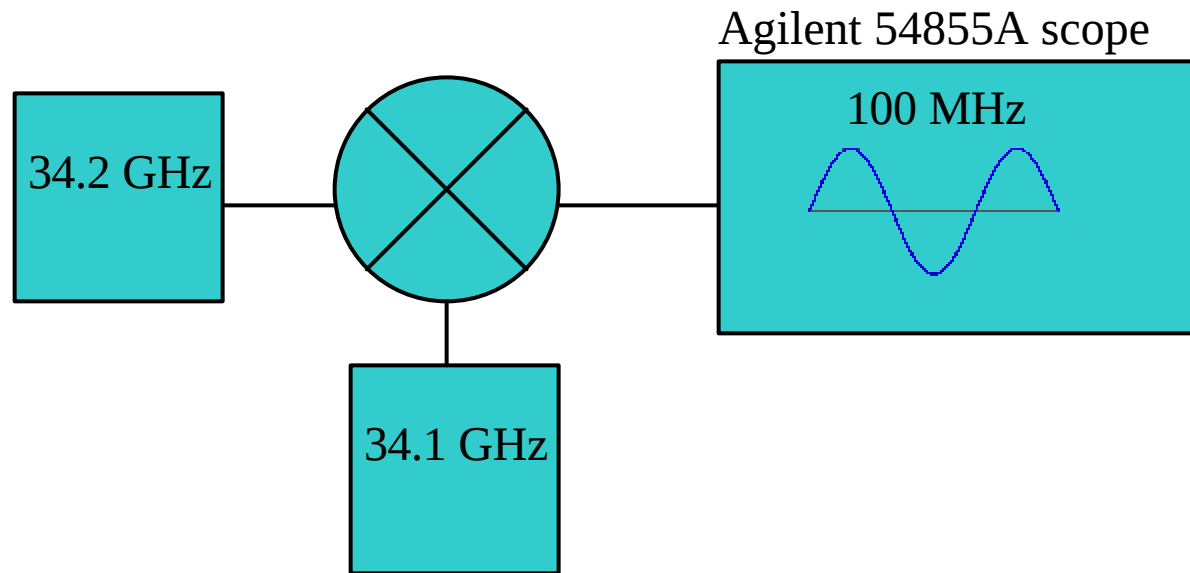
Receiver Diagram



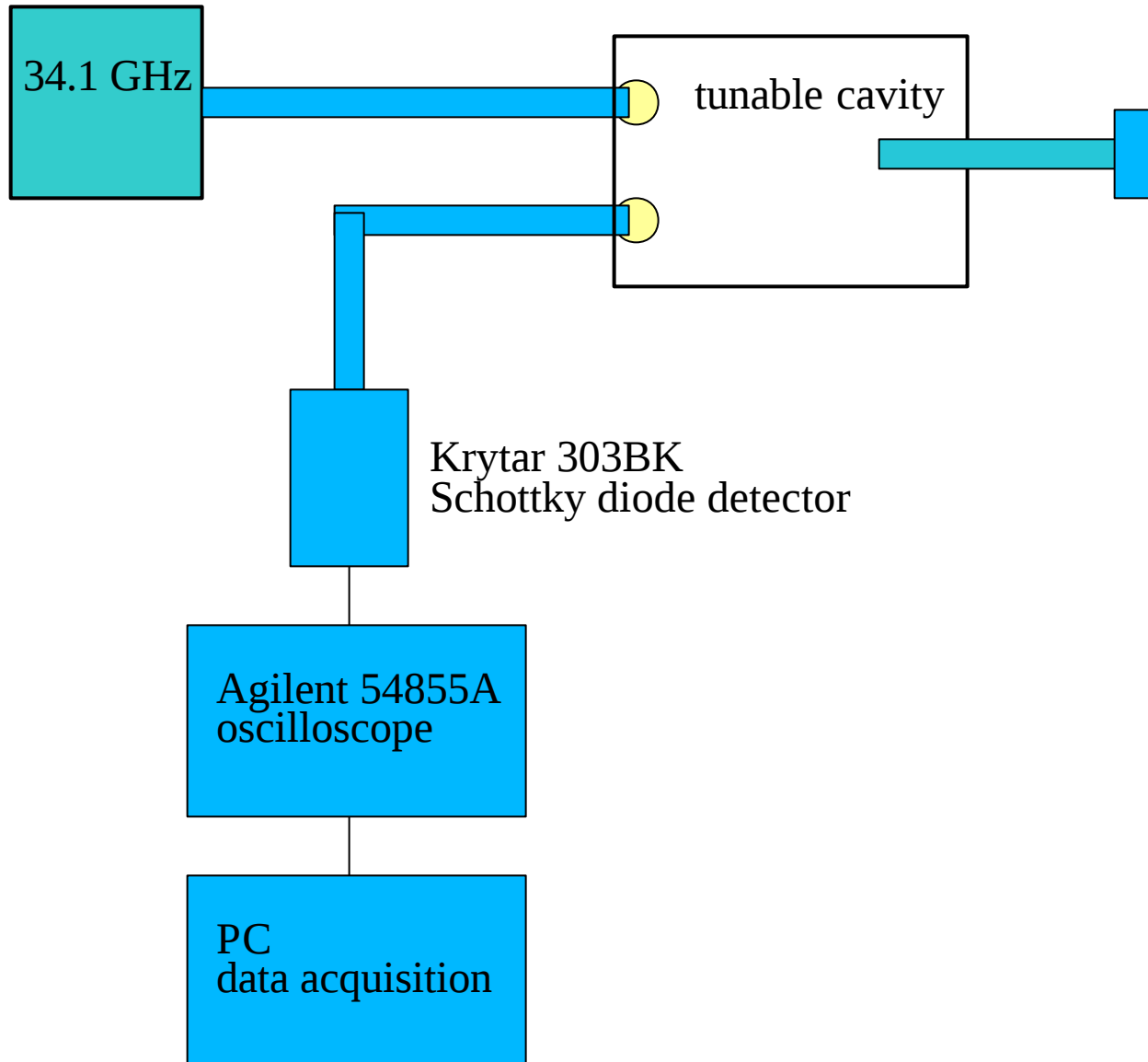
Cryogenic HEMT Amplifier



Bench Tests



Test Cavity



Summary

- Experiment 0.1 meV axions and hidden sector photons
- Bench tests of receiver electronics have been successful.
- Equipment:
 - Receiver electronics - in house.
 - Cu signal cavity - July 2009.
 - Beamline parts and drive cavity - October 2009.
- => Run in November 2009.