

A Brief History of Quantum Design's Products

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Quantum Design, Inc.

Selecting A New Product

- * Will people want to buy it? How many?
- * Can we sell it for a reasonable price?
- * Can we build it for a reasonable price?
- * Can we afford to develop it?
- * Can we afford not to develop it?

MPMS

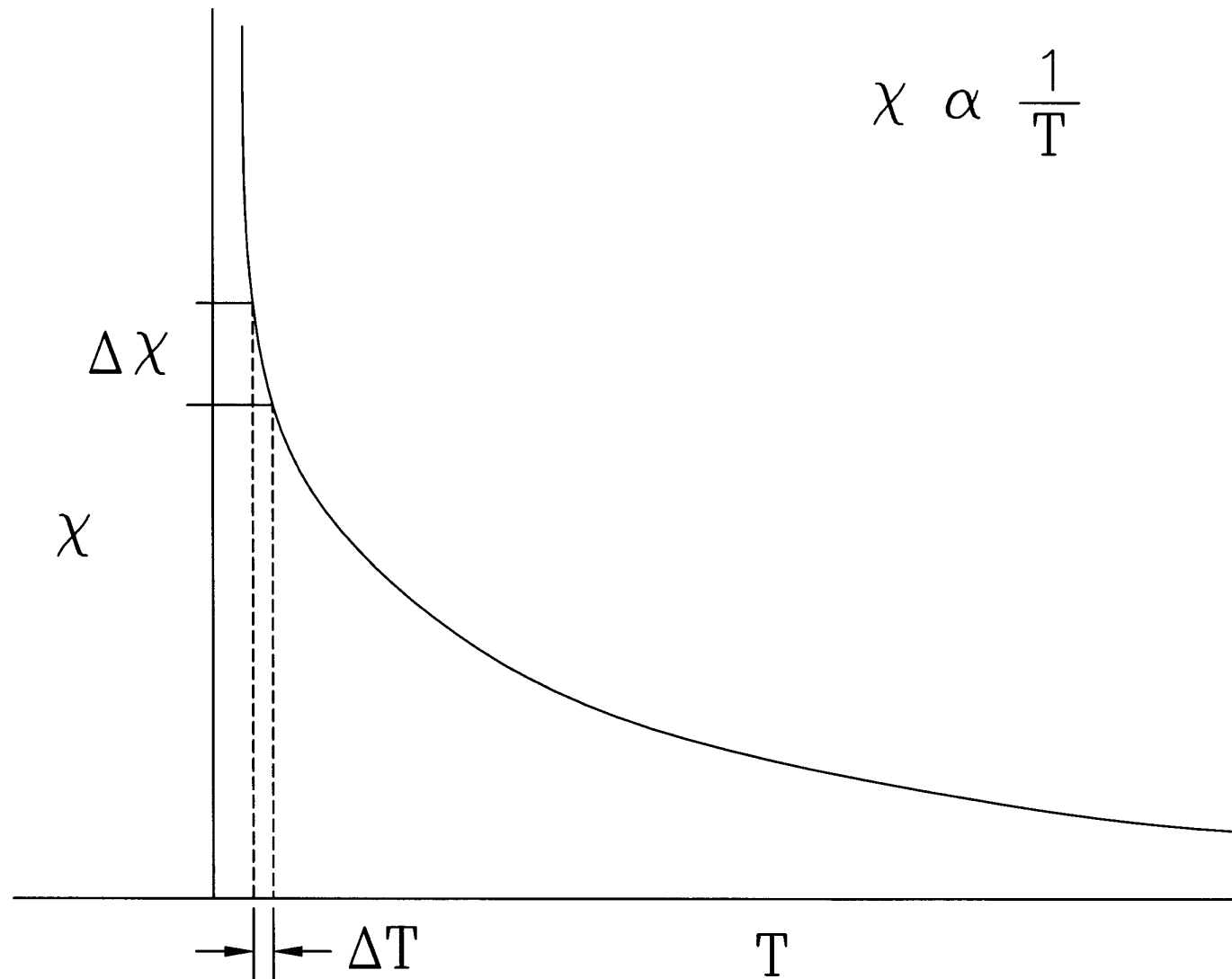
Preliminary Considerations

- * Marketing survey - called our friends
- * Total market - about 6 units / year
- * $\$100\text{K} / \text{unit} * 6 \text{ units} / \text{year} \div 4 \text{ men} = \$150\text{K} / \text{man-year}$

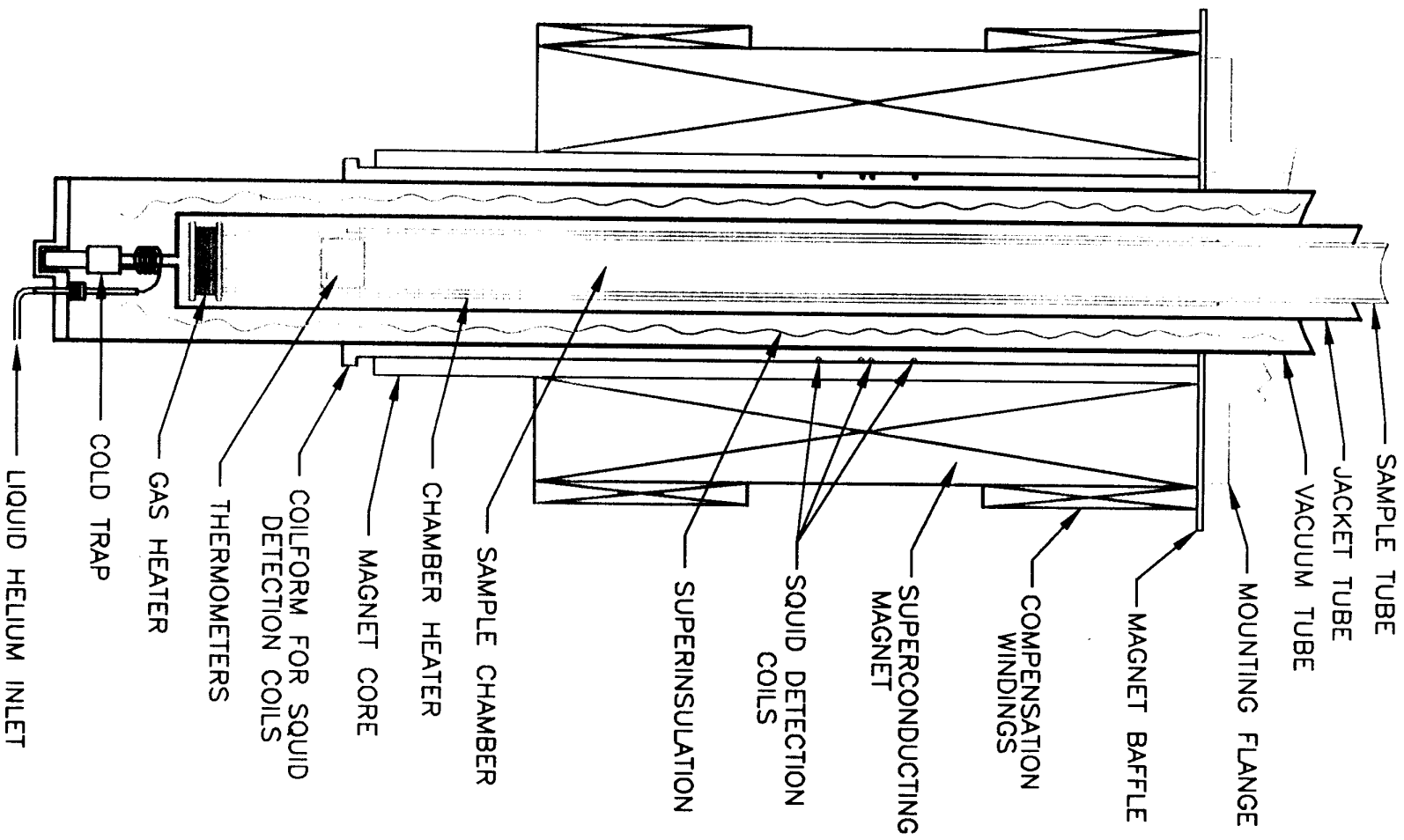
Materials Selection

- * Ceramic coil form - SQUID detection coils
- * Commercial silicon-copper alloy tubing
- * Phenolic magnet core
- * Manganin heater wire
- * Yellow mylar tape

CURIE LAW PARAMAGNETISM



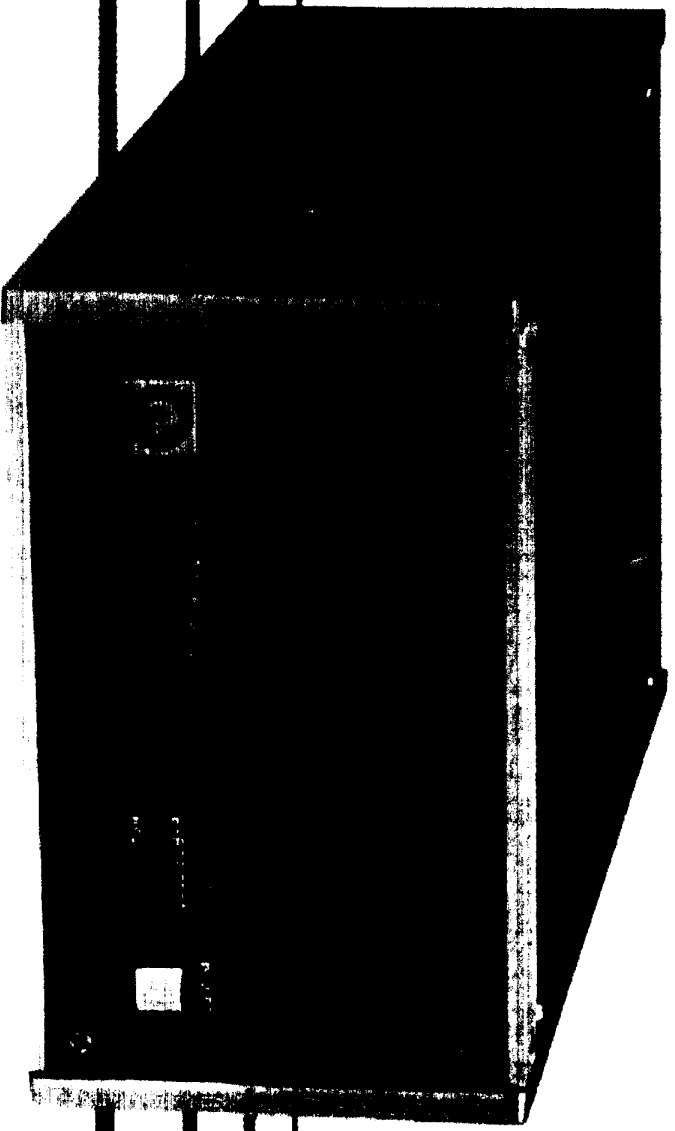
MPMS PROBE DESIGN



Digital R/G Bridge by Quantum Design

The Ultimate
in Flexibility
for precision
temperature
control

- Four sensor channels and two 15 watt control outputs in a single instrument.
- 16-Bit resolution for both sensor readout and feedback control signals.
- Resistance and conductance modes provide expanded dynamic range with ultra-low excitation powers.
- Full computer control via the IEEE-488 standard.



QUANTUM DESIGN

MPMS - The Real Thing

- * QD SQUID control system
- * Magnetic Field - 5 Tesla / improved control
- * Temperature - 1.9 Kelvin / improved control
- * Improved automation
- * New PC-based software
- * Began developing additional options

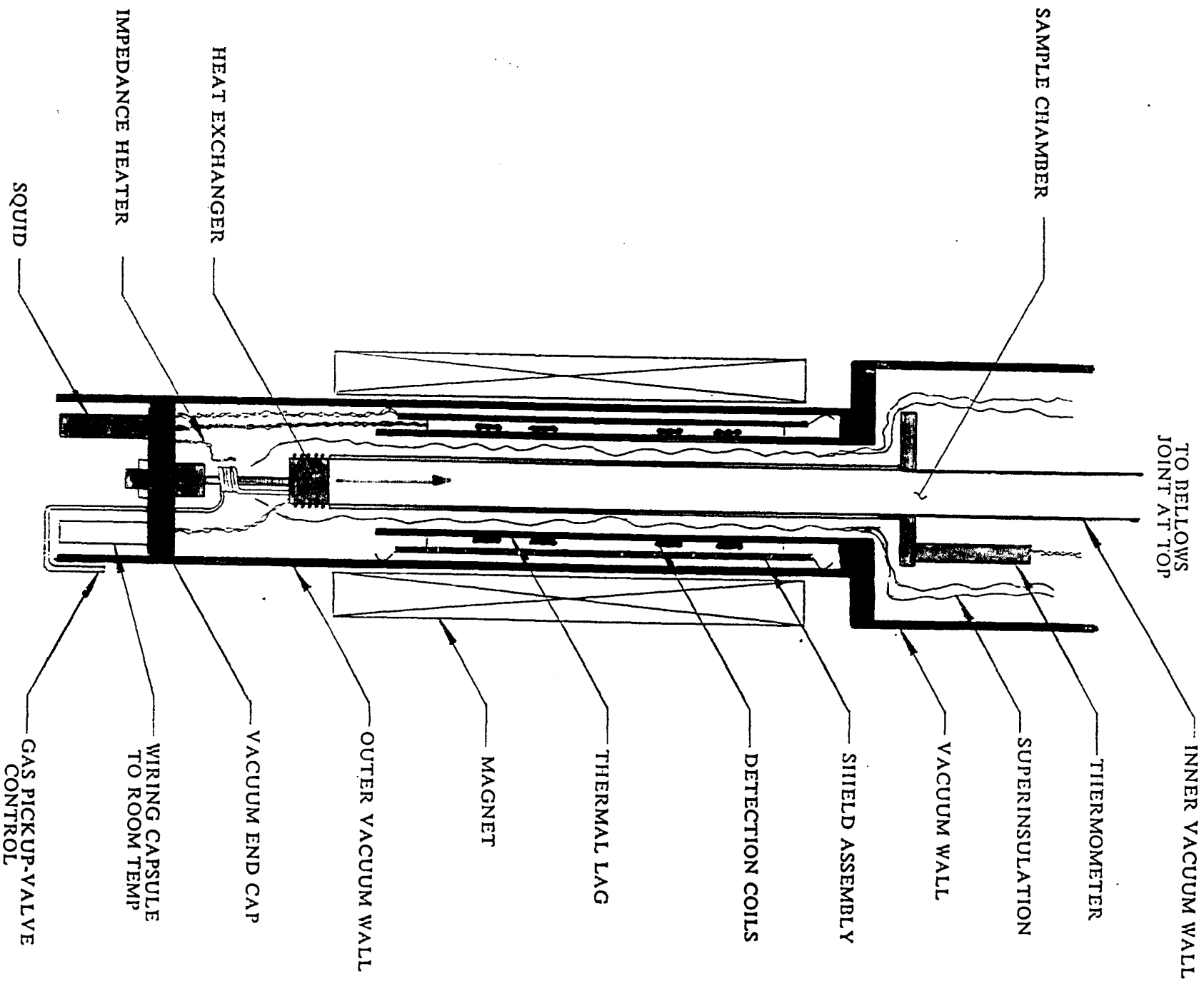
VARIABLE
TEMPERATURE
SUPERCONDUCTING
MAGNETOMETER/
SUSCEPTOMETER



SHE CORPORATION



SHE CORPORATION



MPMS - The Calm

- * Dec 1985 - Allen Goldman, Univ. of Minnesota
- * Feb 1986 - Brock University (Canada)
- * Mar 1986 - Dean Taylor, Los Alamos Nat. Lab
- * Jul 1986 - Bob Shelton, Iowa State

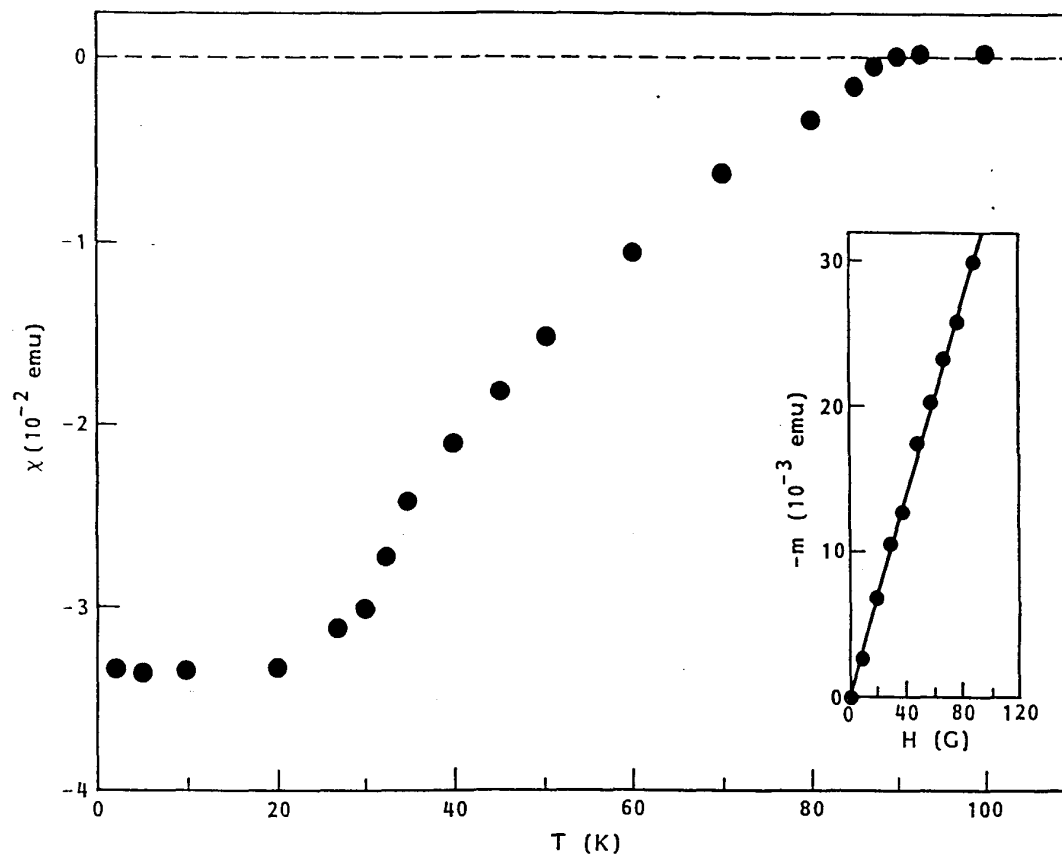
MPMS - The Wind

- * Aug 1986 - SHE discontinues VTS
- * Sep 1986 - High-Tc materials are discovered
- * Mar 1987 - APS “Woodstock for Physicists”
- * Aug 1987 - Serial #11 and 12 at NTT, Japan
- * Dec 1987 - Shipped Serial #15

10 Quantum Design :
With complements.

1988.5.21

Chao-ye Hing



Measured Feb. 7, 1987

First magnetic confirmation of 90-K superconductor. Quantum Design SQUID used.

MPMS - The Storm

- * Jan - Mar 1988 - Shipped 11 units
- * Apr - Jun 1987 - Shipped about 15 units
- * Apr - Jun 1987 - Accepted >\$4M in orders
- * Delivery schedule went to over 15 months

The QD Business Plan - Dave Cox

- * Start a company
- * Develop a really nice instrument
- * Pray for a miracle

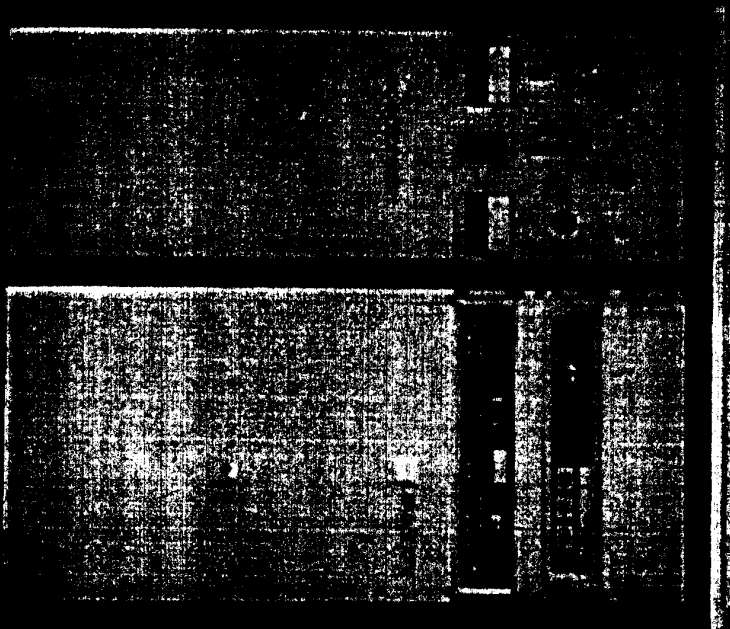
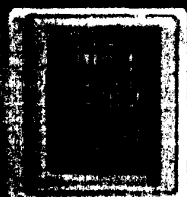
MPMS Options Developed

- * Transverse Axis Measurement
- * AC Option: 0.1 Hz to 1000 Hz
- * 800 Kelvin Oven
- * Extended Dynamic Range

What Do We Do Now?

- * MPMS is an established product
- * Annual revenues >\$5M
- * Some government (SBIR) research
- * 1988 - Formed Quantum Magnetics

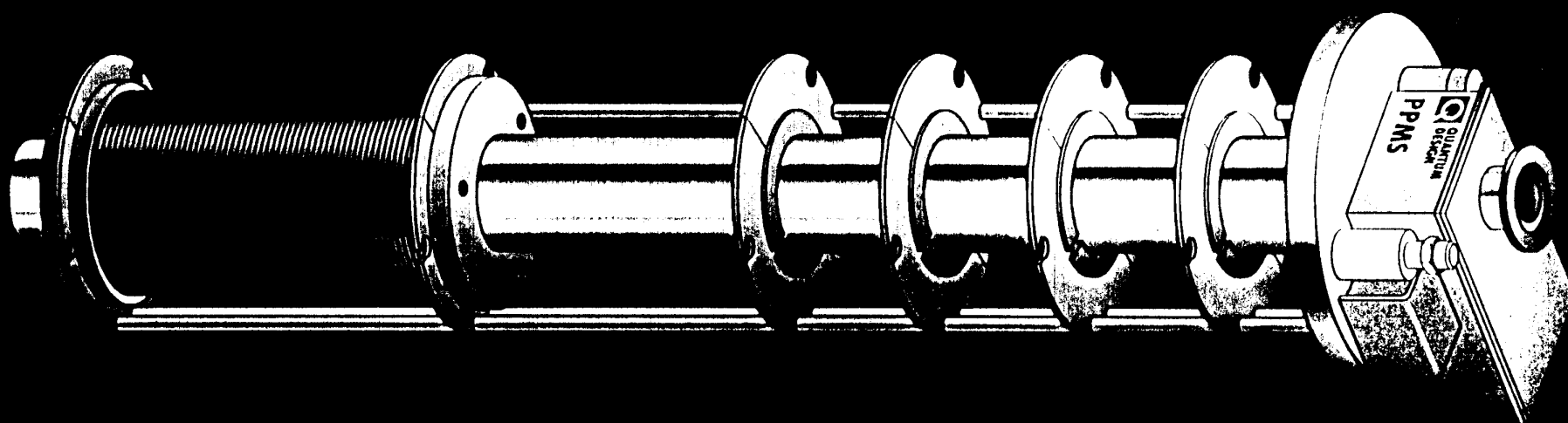
Model 7000 AC Susceptometer



Where's the SQUID?

- * Precision temperature-controlled sample chamber
- * Precision magnetic field control
- * Quantum Design - defined by MPMS
- * Customers expect complete solutions





Outer Vacuum Jacket —

Inner Vacuum Jacket —

Sample chamber —

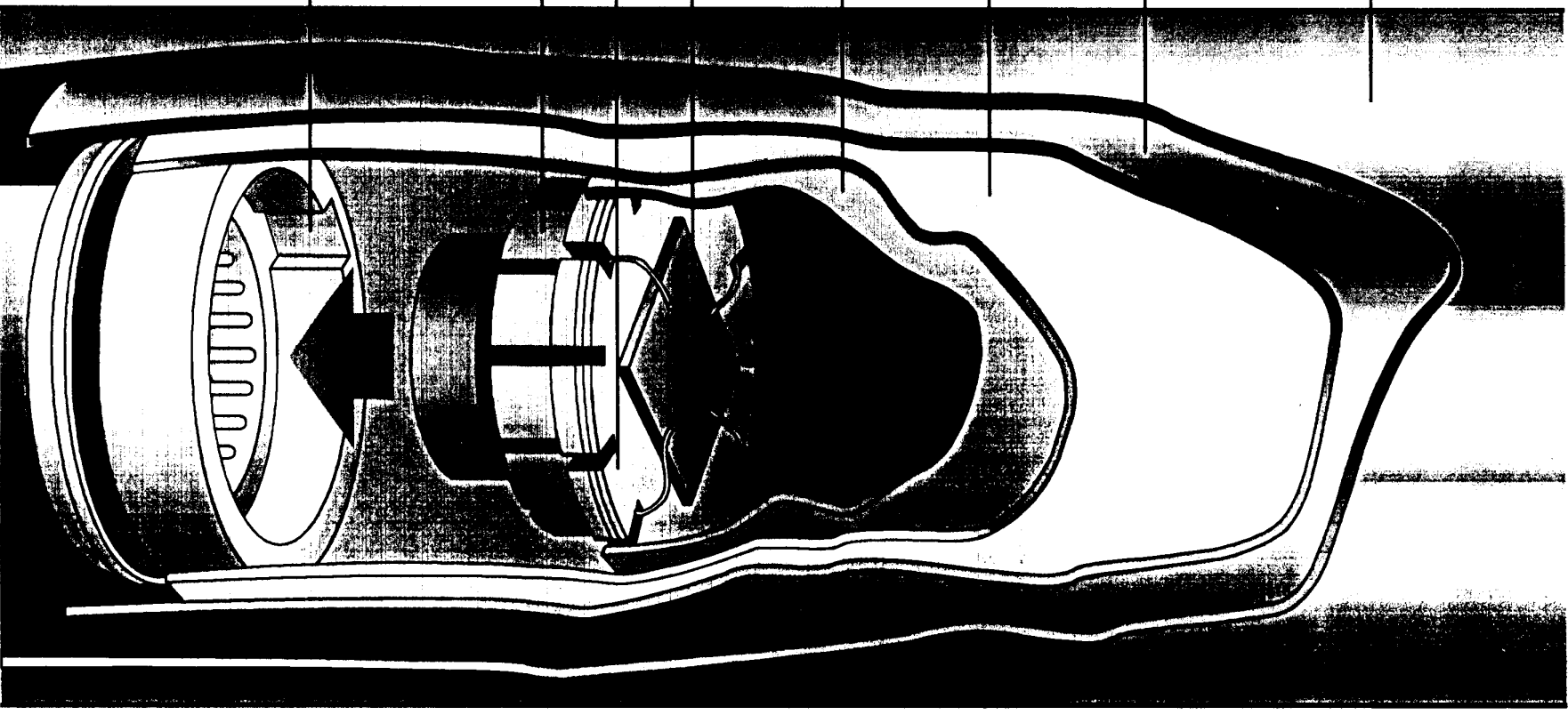
Sample Puck Insertion Tool —

Sample —

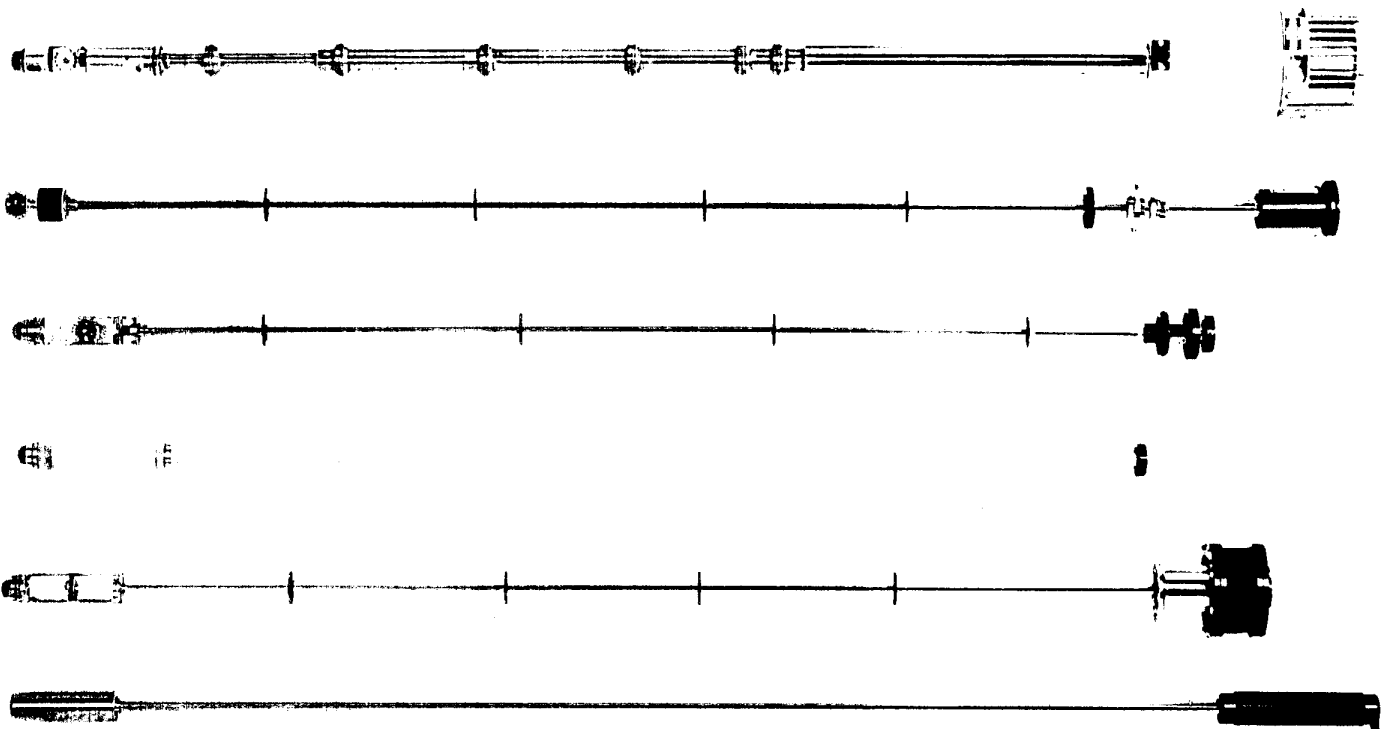
Electrical Leads —

Sample Puck —

"Keyed" Bottom Connector —



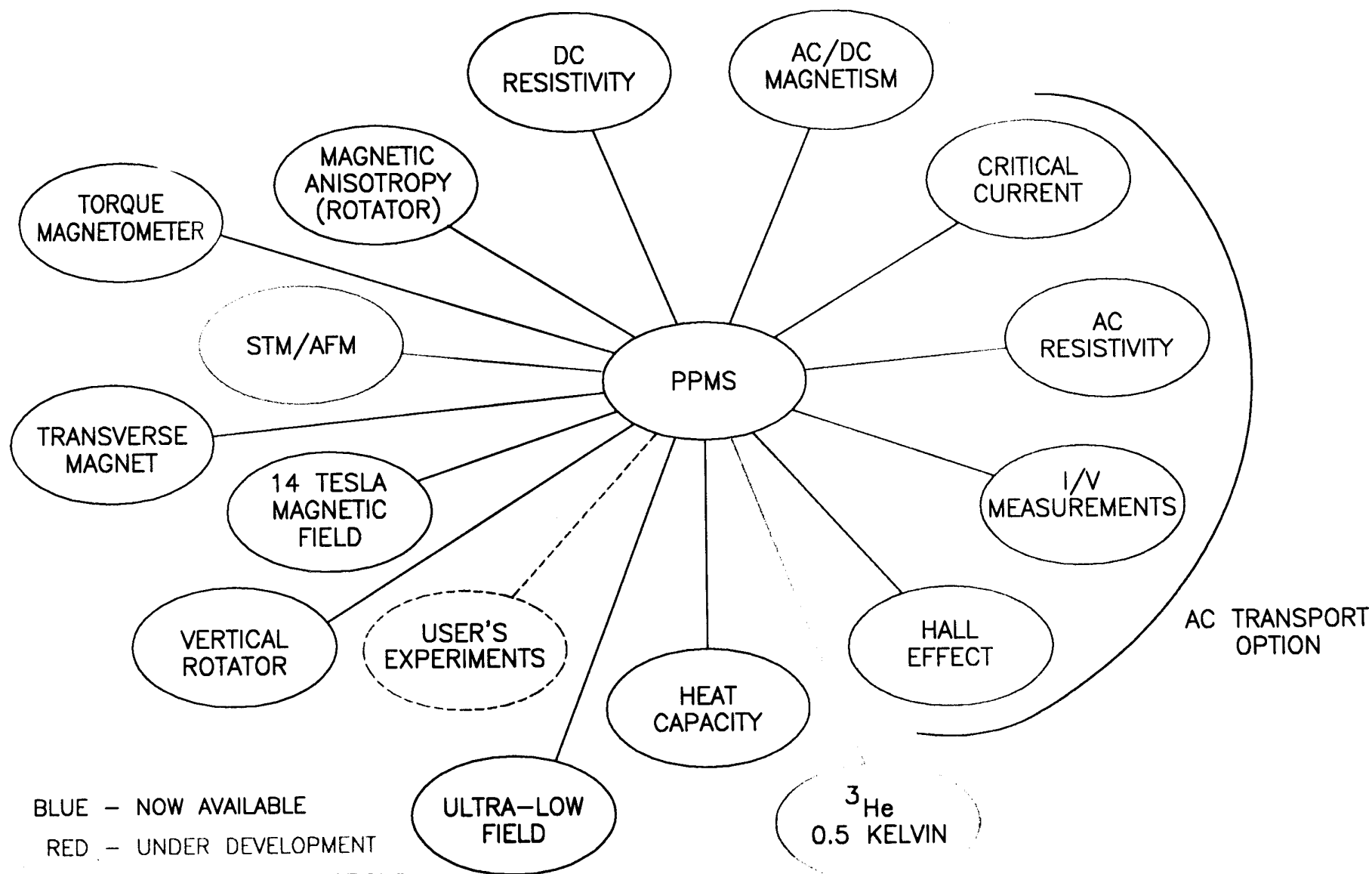




Quantum Design

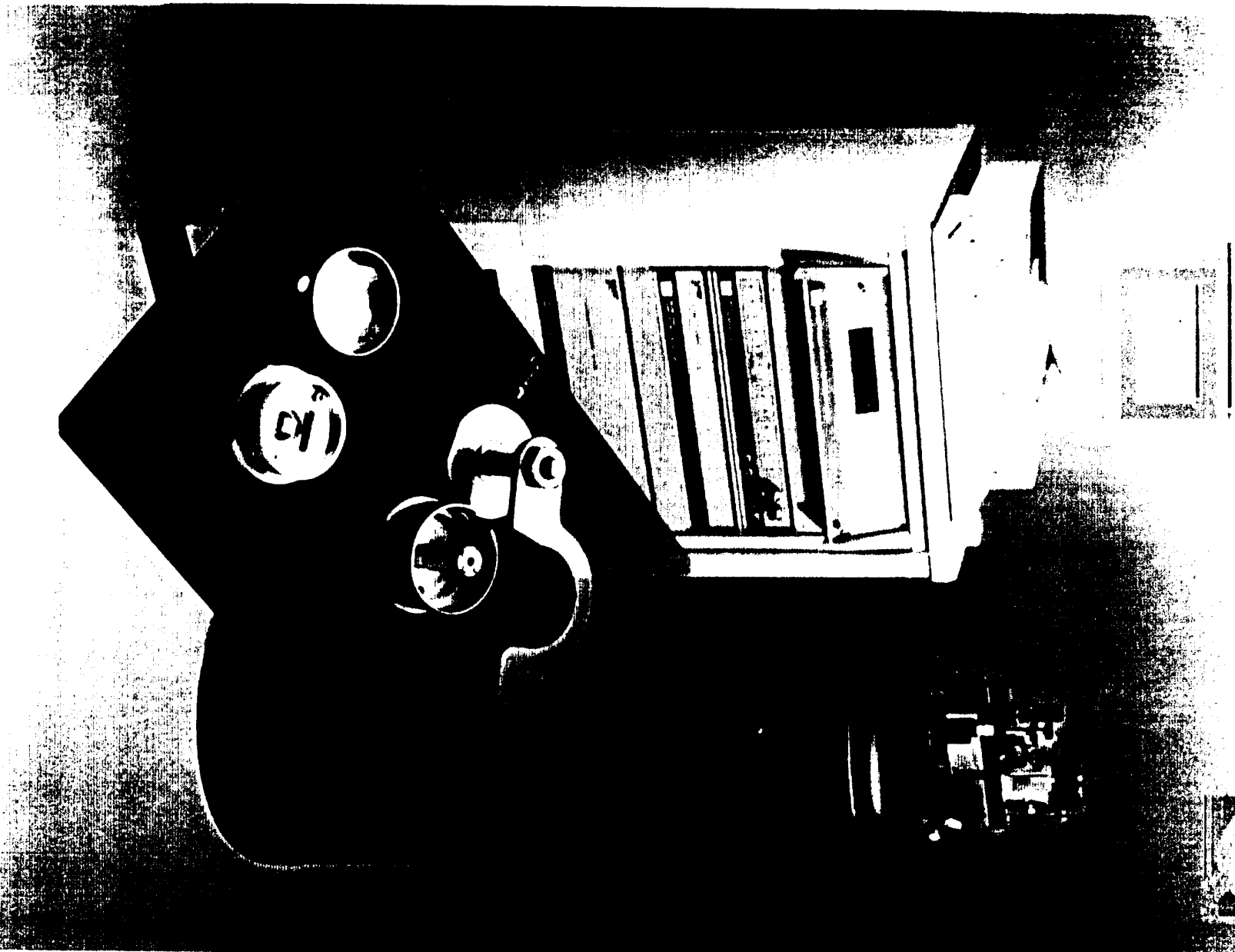
Various PPMs inserts

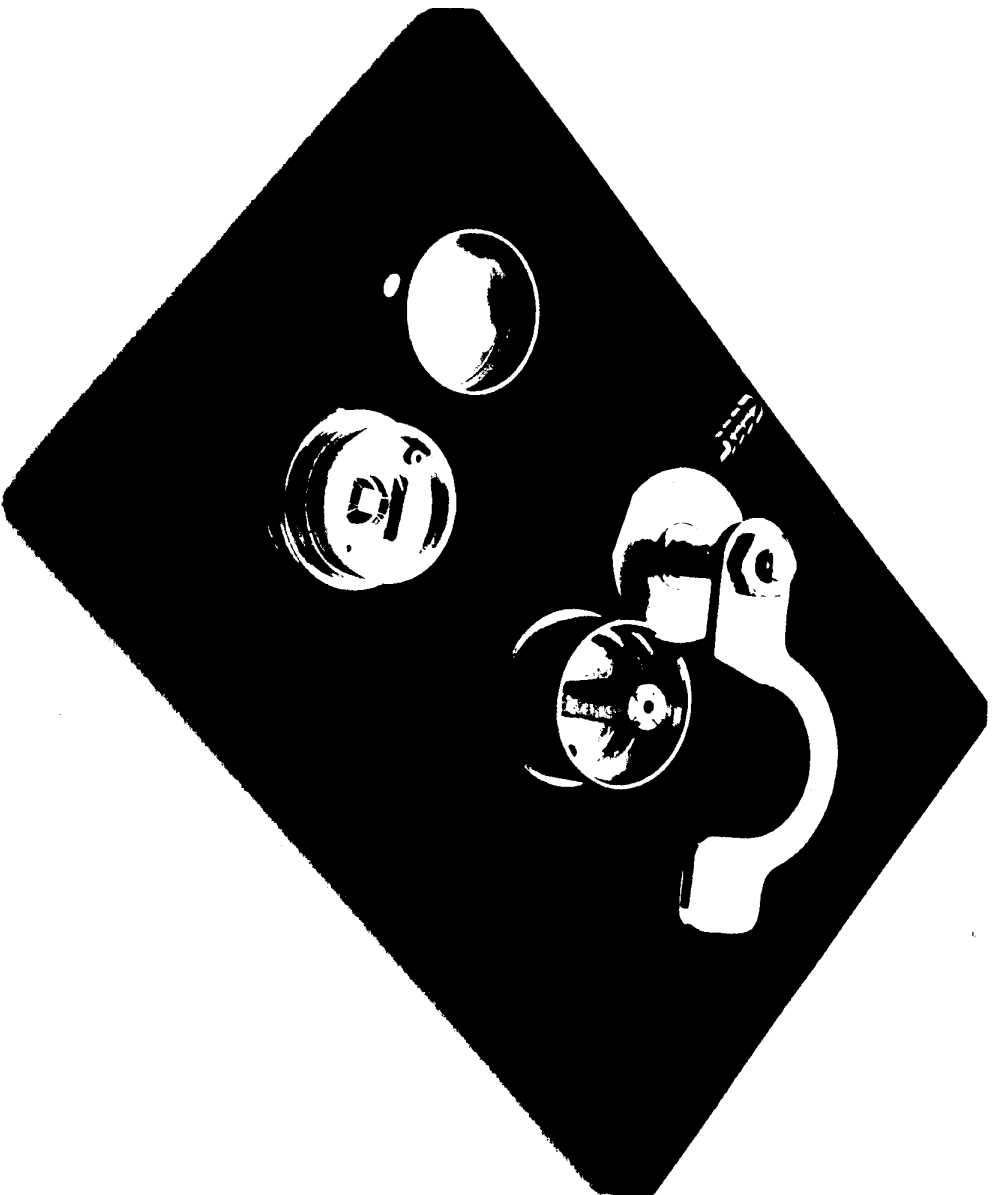
THE PPMS MEASUREMENT FAMILY



Quantum Design

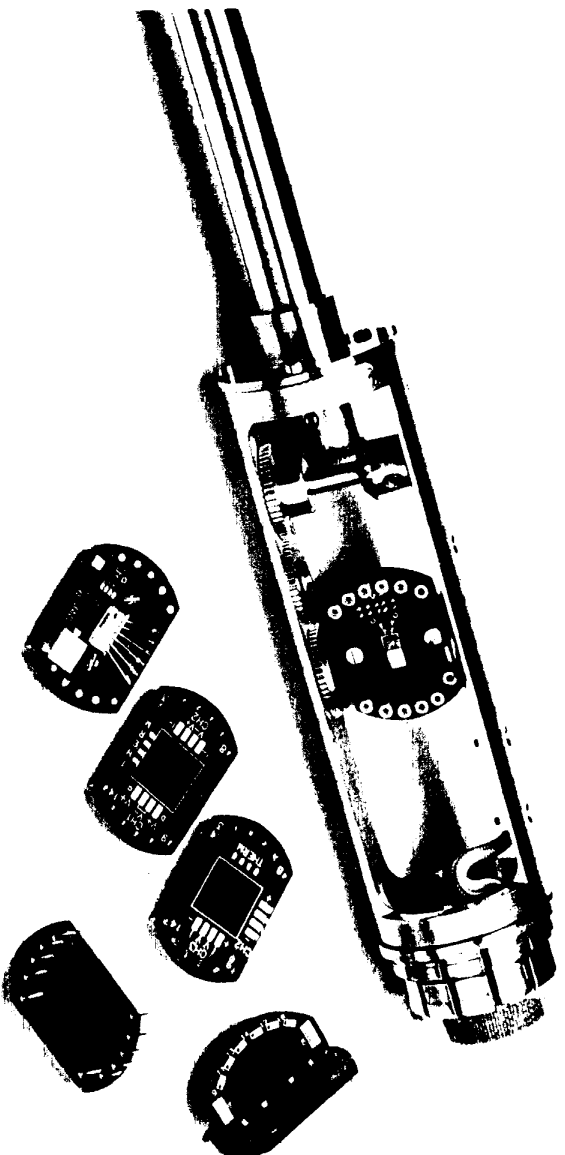
Heat Capacity





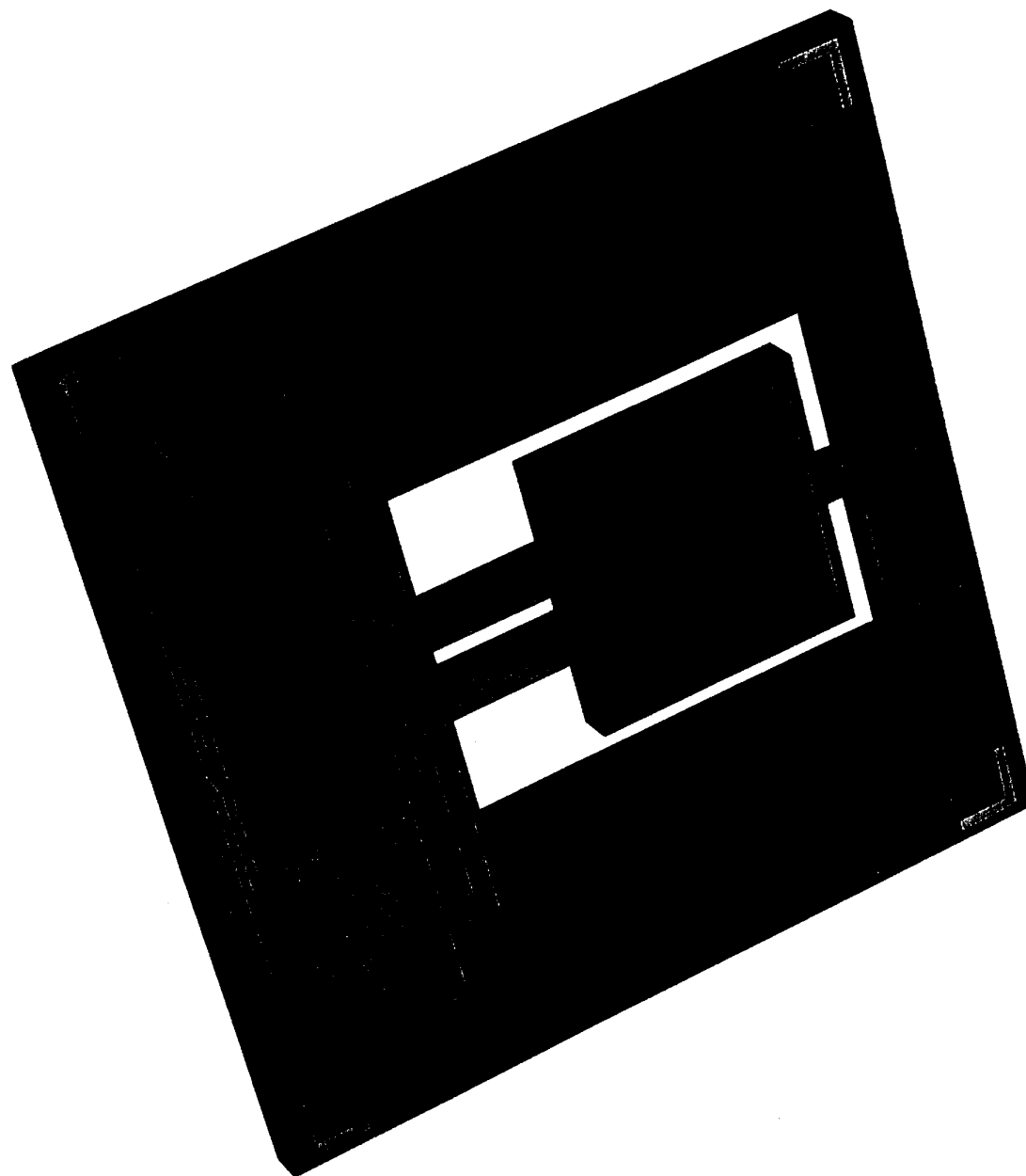
Quantum Design

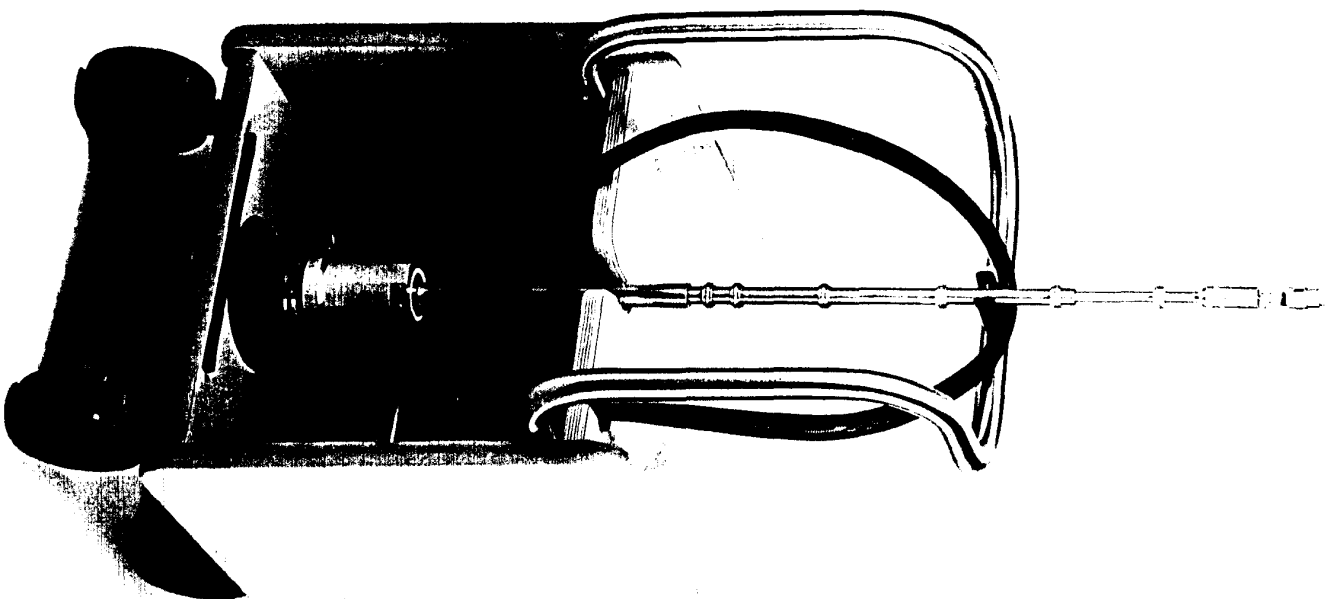
Heat Capacity



Quantum Design

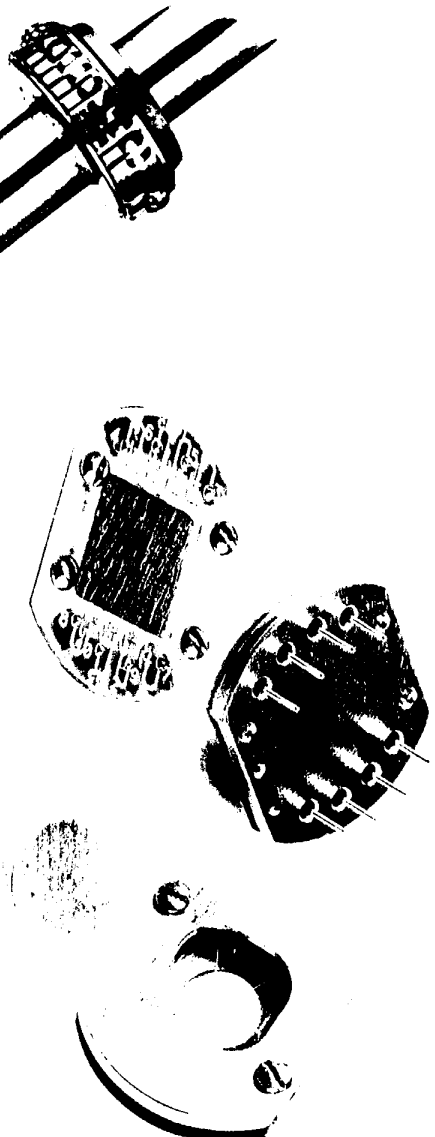
Horizontal Rotator



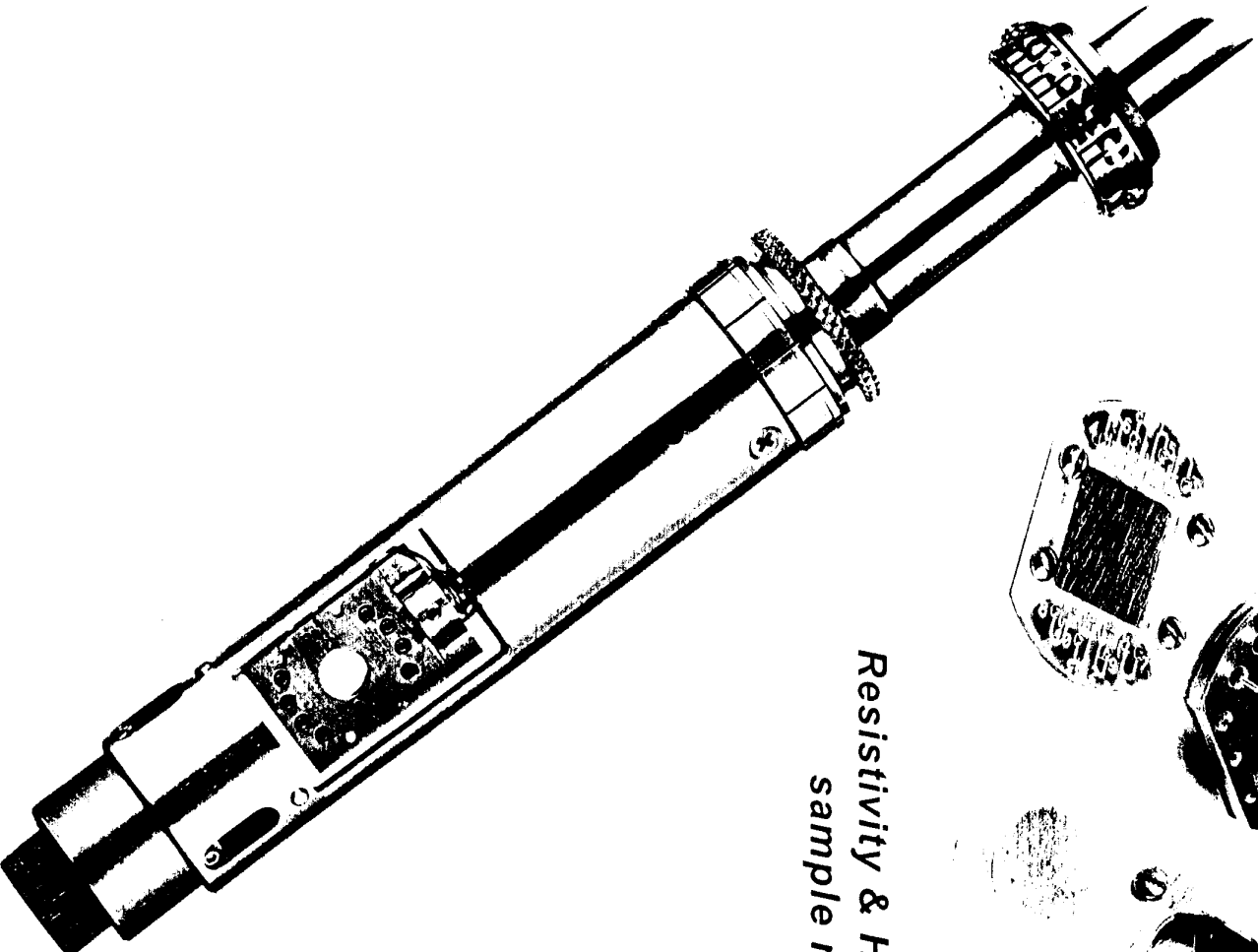


Quantum Design

Helium-3 System



*Resistivity & Heat Capacity
sample mounts*

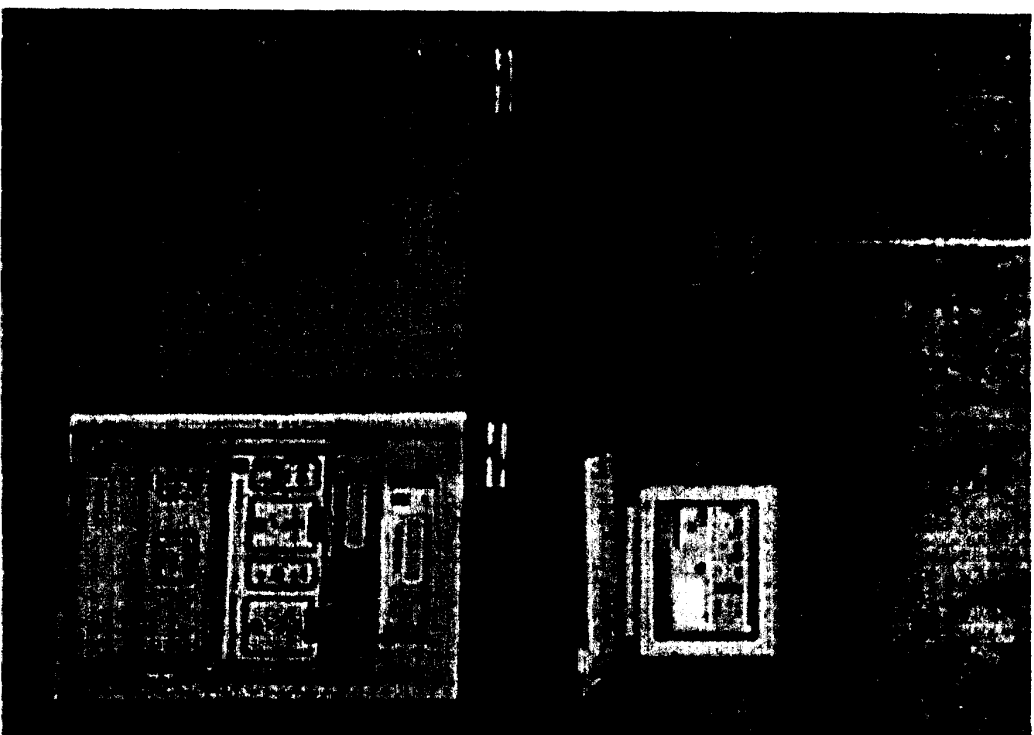


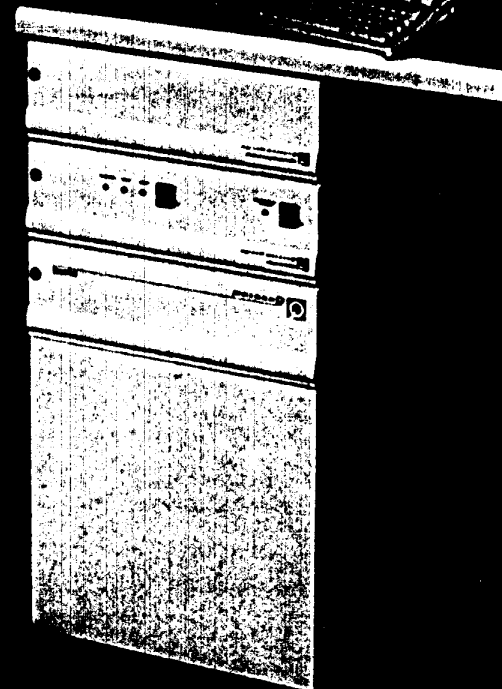
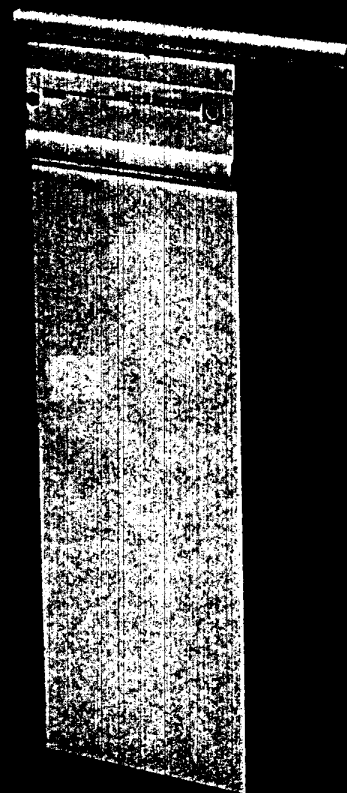
Quantum Design

Helium-3 System

X

MAG™





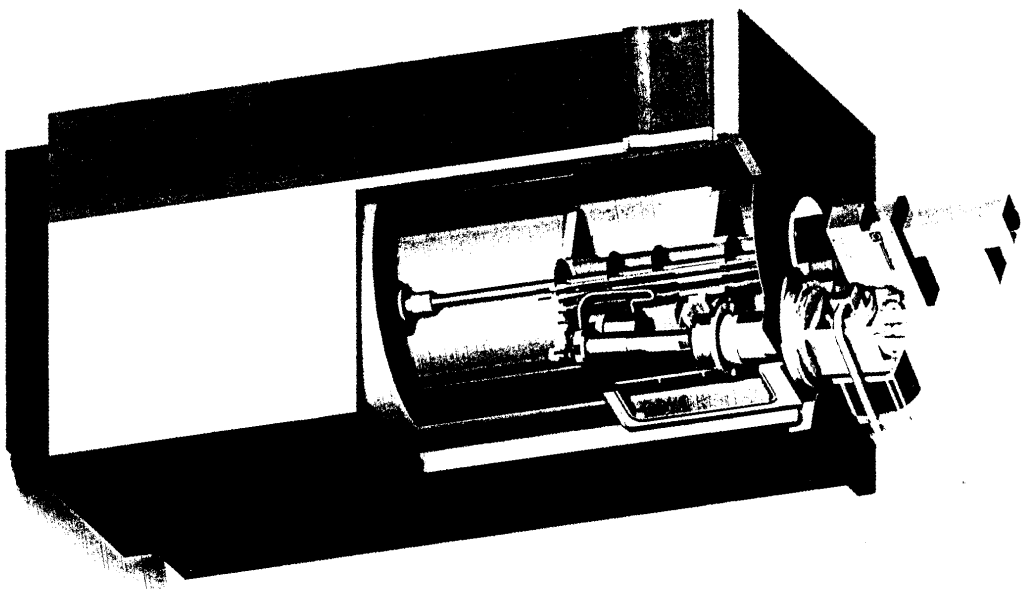
The MPMS-XL

- * Temperature Control
 - Temperature slewing
 - Continuous operations for $T < 4.2$ kelvin
 - Improved thermometry
- * Measurement Control
 - Oscillating sample measurement (RSO)
 - Data collection during temperature sweep
 - Faster data collection

MPMS & PPMS

Liquid HE Consumption

- * Operating expense (continuous operation)
 - US - \$10,000 / year
 - Japan / Europe - \$20,000 - \$40,000 / year
- * Limits market for the instruments



Quantum Design

MPMS-XL EverCool