2 New Labs at California U. To Aid Integrated Circuitry

By RICHARD BESSACK
Special to Electronic News

BERKELEY, Calif.—Research in semiconductor integrated circuitry by the Electronics Research Laboratory of the University of California, here, will be enhanced next Spring with the addition of two laboratories, Prof. D. O. Pederson, director of ERL, said last week.

He predicted that "substantially more than the current 10 per cent of ERL's total effort will be devoted to this area," when the new semi-conductor integrated circuits fabrication laboratory and electron beam microscopy facility begin operating.

Professor Pederson was interviewed following a two-day closed meeting which reviewed for the supporting agencies, ERL's research efforts during the past year. He noted that during the next two years ERL will study the basic circuit functions which can be realised in integrated circuits and will try to understand the necessary interactions of properties needed to achieve, among others, oscillators and flip-flops.

In trying to achieve a circuit function without recourse to separate components, ERL will use the scanning electron beam microscope to inspect and study what goes on in an integrated circuit.

To absorb various integrated circuit technologies, Prof. Pederson said ERL has worked with, among others, Westinghouse Electric Corp., Youngwood, Pa., Motorola Corp.'s Semiconductor division, Phoenix, and Fairchild Semiconductor, Mountain View, Calif.

Funds for research in integrated circuitry during the past 18 months have come from the Aeronautical Systems division, Air Force Systems Command, Wright-Patterson AFB, Dayton, O., and a tri-service contract. The latter was administered jointly by the Office of Naval Research, the Air Force Office of Scientific Research and the Department of the Army Research Office and Signal Corps.

Prof Pederson said a high temperature plasma containment machine is expected to be installed shortly after Jan. 1.

Basic research in hot plasmas without regard to obtaining power from the plasma is considered along with systems theory and building interpretive computer languages as the other major research areas of interest, Prof. Pederson said. Of the 150 projects at ERL, about 25 per cent concern systems theory. About 50 per cent of the projects are concerned with experimental and analytical research in physical electronics and magnetics, he said.

The first ever university Microlab was built at UCB in 1962

R. Talcott

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D.O. Pederson	427 Cory	2302

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Please prepare cost estimate for proposed lab for integrated circuits as tentatively shown on the accompanying drawing. Work to be done in Room 432 Cory. Specifications also attached.

Would appreciate discussion prior to submission of cost estimate.

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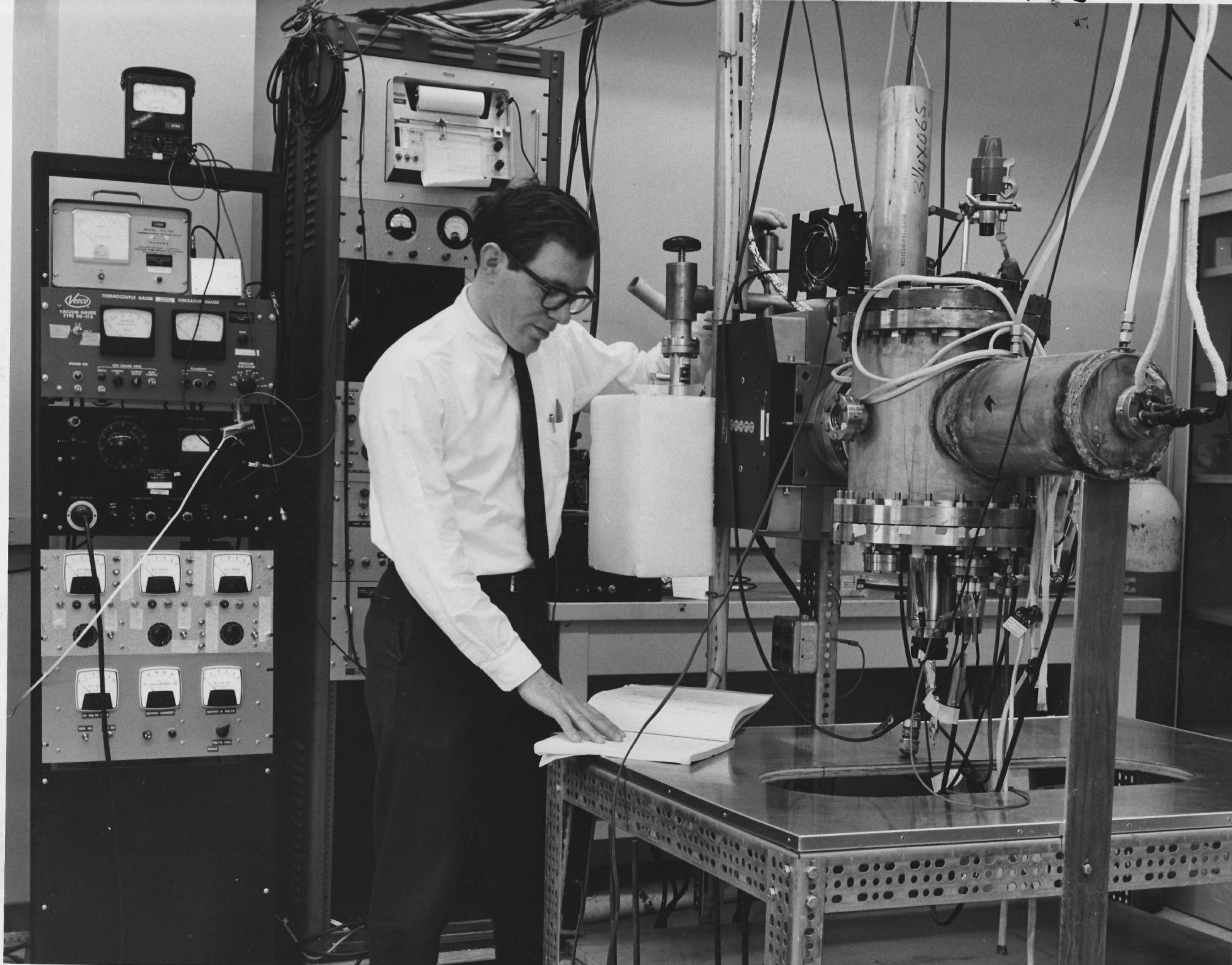
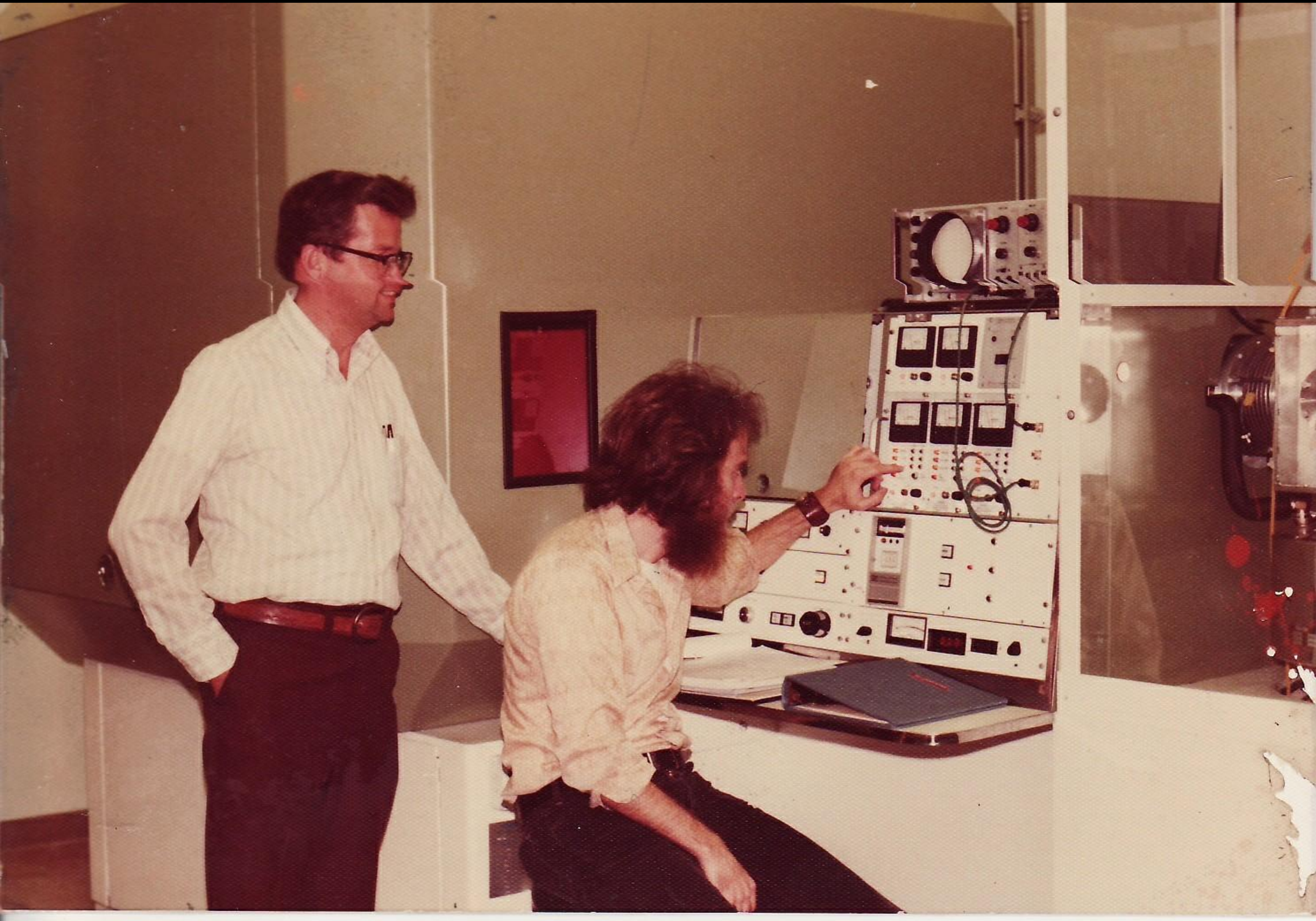
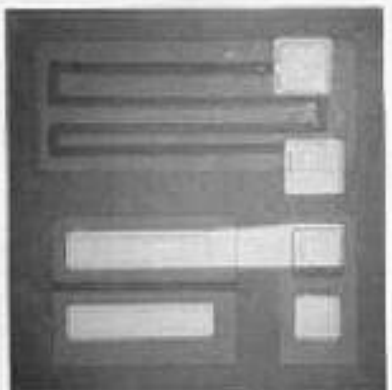
W. G. OLDHAM 1963

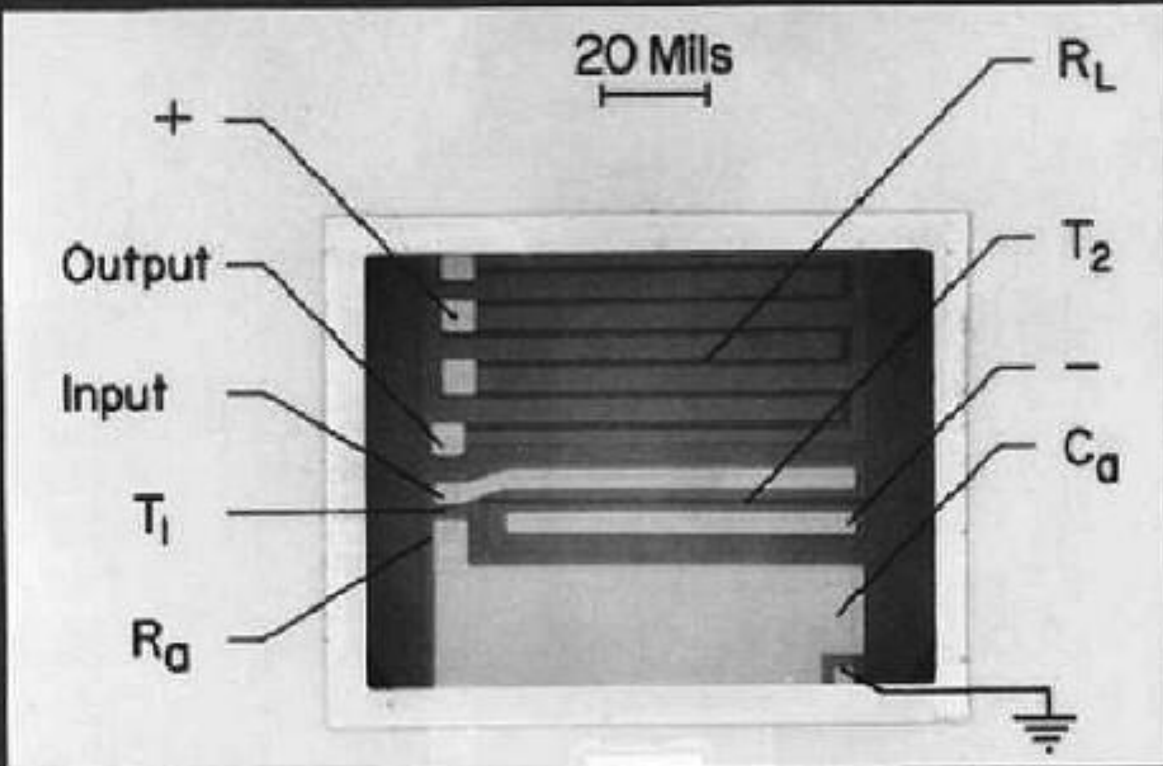




1962-1964

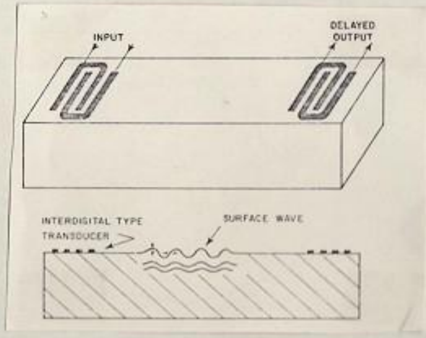
First Silicon Integrated Circuit Made at UC Berkeley
D. Hodges, Prof. Pedeson 1962



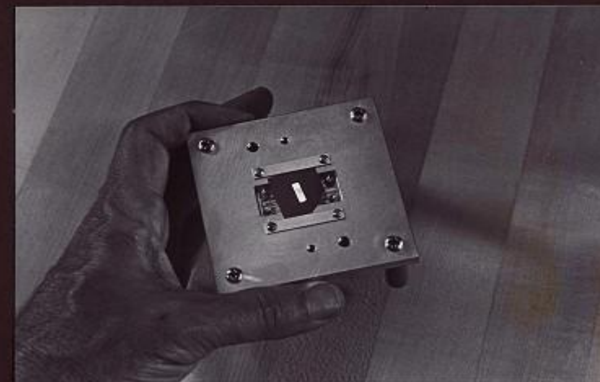


Bifet Counting Bistable Circuit D. Hodges, Prof. Pederson 1964

First Surface Acoustic Wave Device (SAW)
F.W. Voltmer, Prof. White 1965



Ultrasonic Flexural Plate-Wave Oscillator Sensor
S.W. Wenzel, Prof. White 1988



Lamb-wave delay line sensor mounted in testing package. The bright area in center is a $3mm \times 8mm$ composite membrane of ZnO($0.7\,\mu m$-thick) and Si_3N_4($2.0\,\mu m$) on which Lamb waves propagate.

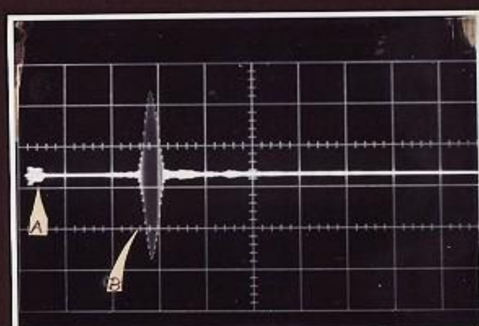
Surface acoustic wave delay line for operation at 9 MHz.

Substrate: lead zirconate-titanate ferroelectric ceramic (PZT-4).

Transducing electrodes: Aluminum.

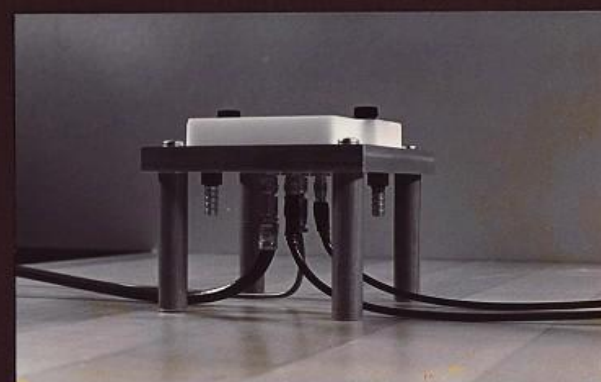
Electromechanical coupling factor: $K^2 = 0.043$ (strongly piezoelectric-polled normal to propagation surface).

Rayleigh surface wave velocity: Approximately 2×10^3 m/s.



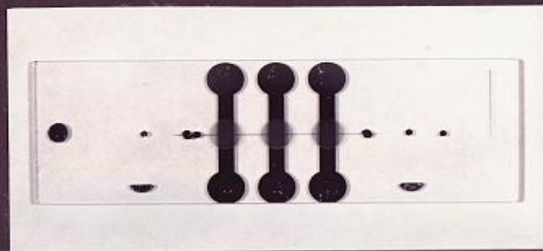
A) Direct r. f. 9 MHz. feedthrough from the input transducer. Horizontal sweep: 5 μsec/ major division.

B) Surface wave received after approx. 12 μsec. delay. This delay is equivalent to 2.4 kilometers of teflon coaxial cable (teflon coax has a delay of approx. 5 nsec./ m.).

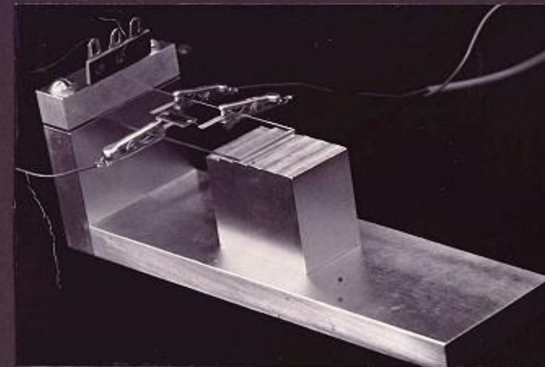


For chemical vapor sensing experiments, we use a teflon cap (white piece on top) to create a small sealed cavity, through which we flow gases via nozzles in the base. Electrical cables connect the device to an external feedback amplifier, to make an ultrasonic oscillator operating at a few MHz, and monitoring equipment.

Piezoelectric Field-Effect
Transistor Strain Transducers
J. Conragan, Prof. Muller 1969

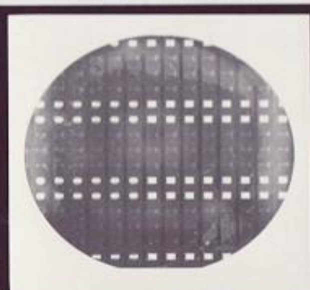


Completed Set of Three CdS TFT's
on a 1 X 3 inch slide



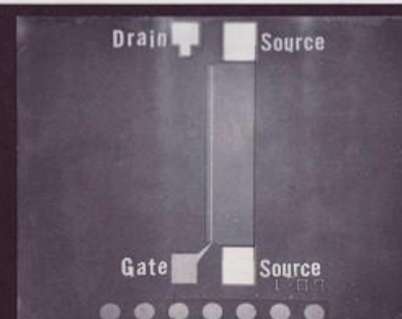
A Te PZT-5A Device in Strain Apparatus

Silicon-wafer layout of PI-DMOS
Transducers and IDT Pairs.

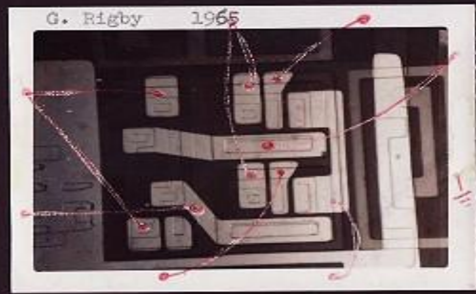


Piezoelectric Diffused
MOS Strain Transducer
K.W.Yeh, Prof. Muller 1976

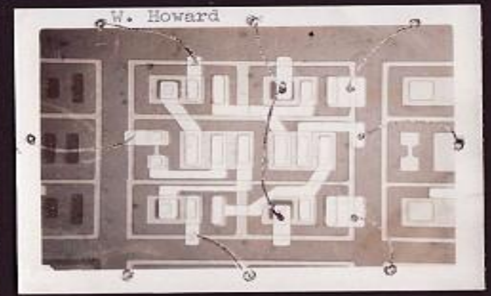
The top view of a PI-DMOS Transducer



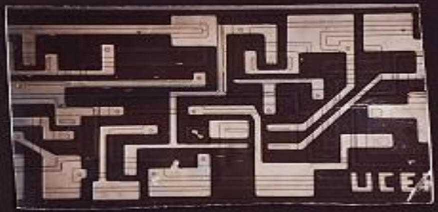
IC-Compatible
Piezoelectric Accelerometer
G.L. Halac, Prof. Muller 1982



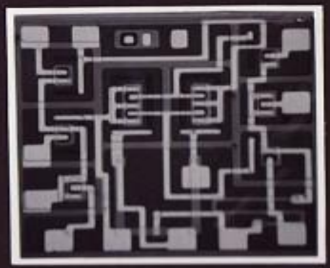
Bi-Polar Integrated Circuit
G. Rigby, Prof. Pederson 1965



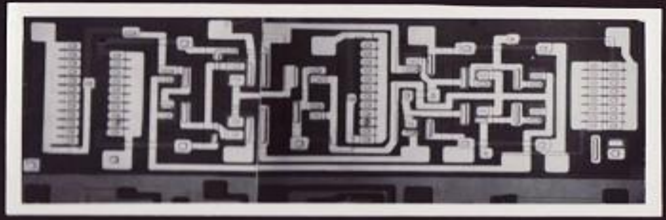
Voltage Controlled Oscillator
W. Howard, Prof. Pederson 1966



Voltage Controlled Oscillator
W. Howard, Prof. Pederson 1967



Drift Compensated
Balanced Analog Multiplier
G.L. Baldwin, Prof. Pederson 1969

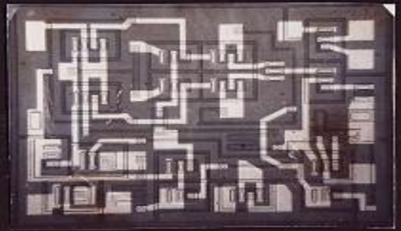


Drift/Offset Compensated Amplifier
G.L. Baldwin, Prof. Pederson 1969

Low Voltage
Micro-Power Amplifier
(Hearing Aid Amplifier)
I. Getreu, Prof. Pederson 1970

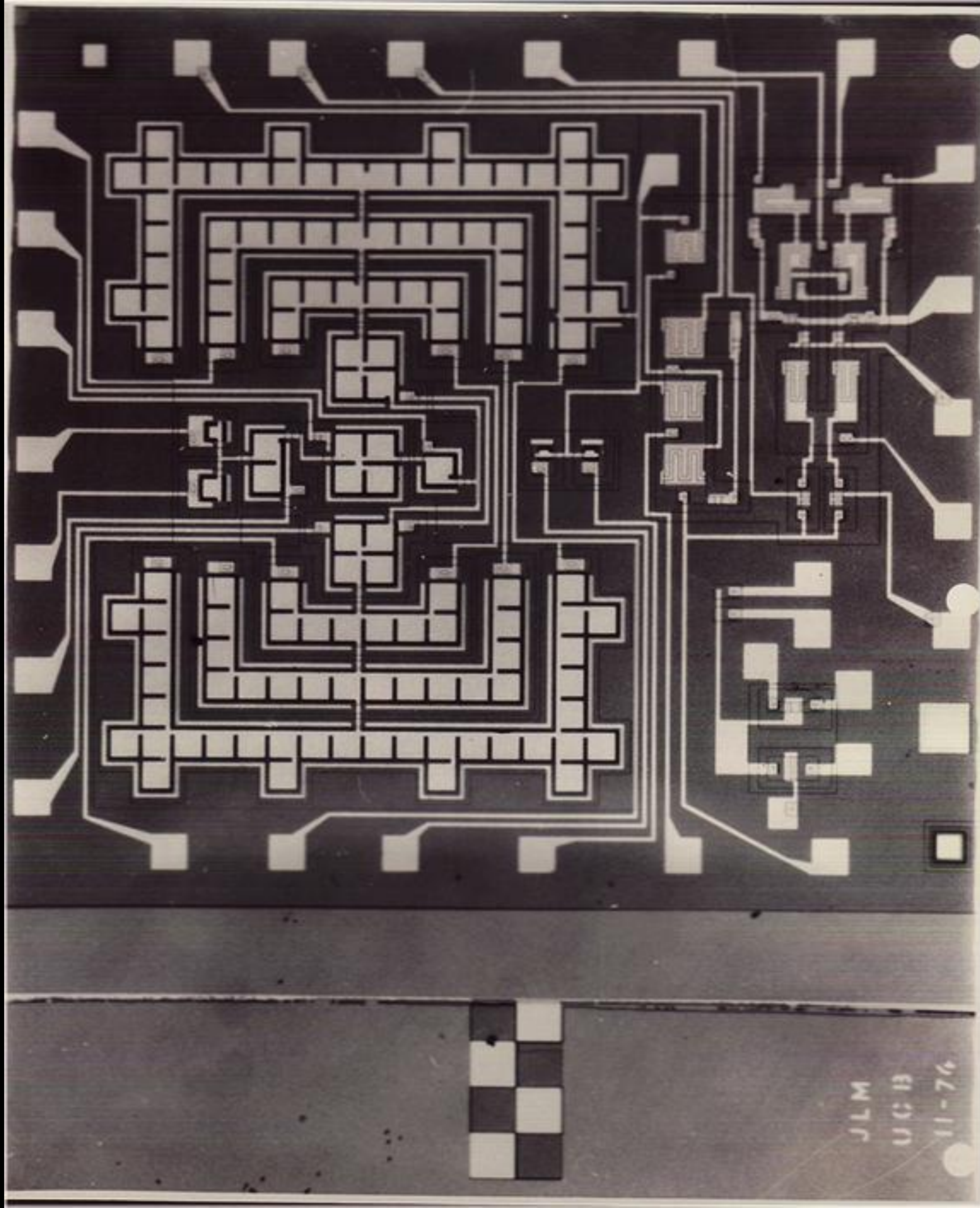
DC Coupled Broadband
Differential Amplifier
B. Wooley, Prof. Pederson 1970

Temperature-Sensitive
Frequency-Selective Amplifier
B. McCalla, Prof. Pederson 1971



Low-Distortion Wide-Band
Variable-Gain Amplifier
W. Sansen, Prof Meyer 1972

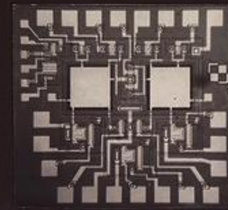
1965-1972



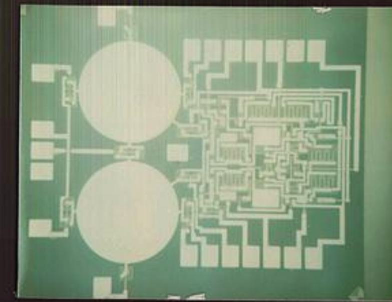
High Speed Charge Redistribution MOS A/D Converter

J. McCreary, Prof. Gray - 1974

1974-1976



N-Channel
Aluminum Gate
D/A Converter
R.E. Suarez, Prof. Gray 1974



First Silicon-Gate N-Channel D/A Converter
R.E. Suarez, Prof.Gray 1975

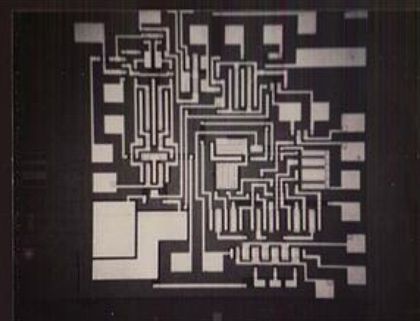
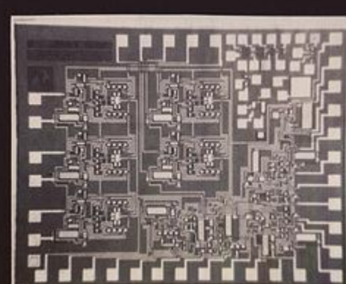
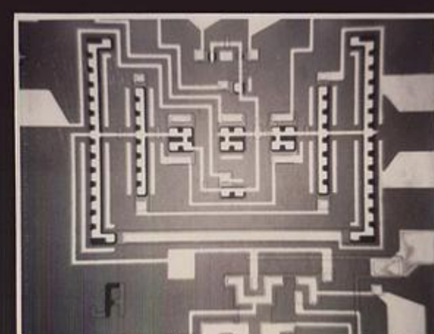


Image Contour Extractor
P. Suciu, Prof. Hodges 1975

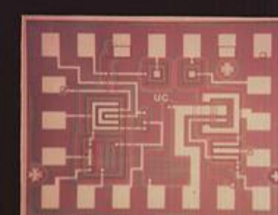
Al-Gate MOS
Operational Amplifier
J.P. Tsividis, Prof. Gray 1975



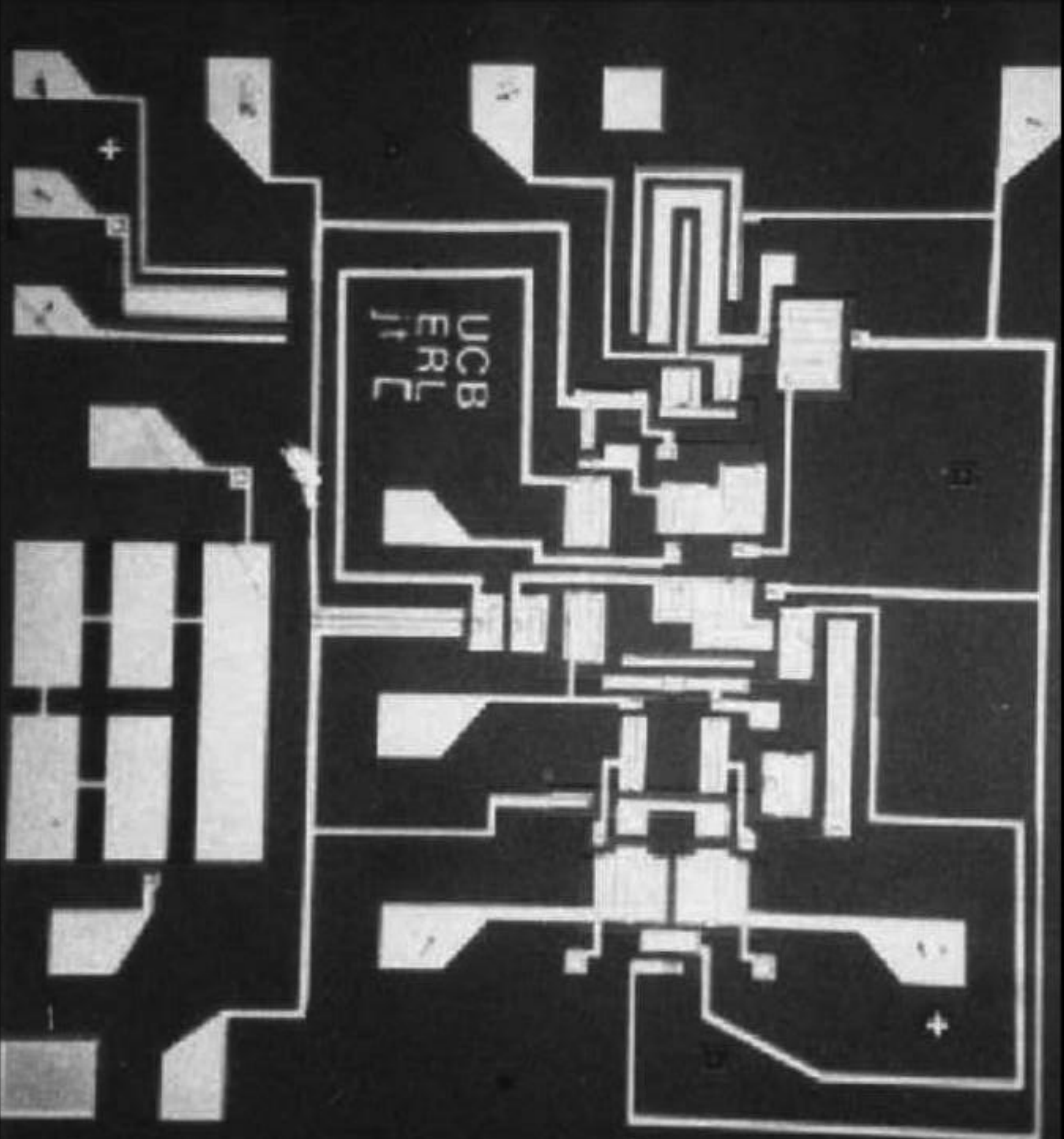
PABX Line-Finder Circuit
R.E. Suarez, Prof. Gray 1976



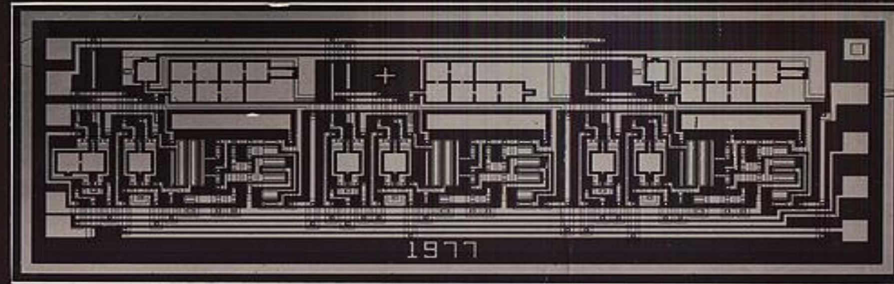
Charge-Transfer Multiplying D/A Converter
J.F. Albarran, Prof. Hodges 1976



First CMOS and
First Ion-Implanted Circuit
Made in the Microlab
W. Black, R. McCharles, Prof. Hodges 1976

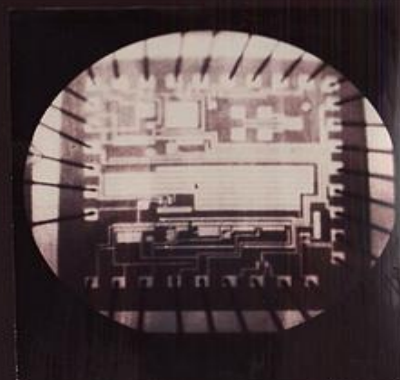


N-Channel MOS Operational Amplifier
High Gain Low Offset – K. Burns, J. P. Tsividis, Prof. Gray, 1976

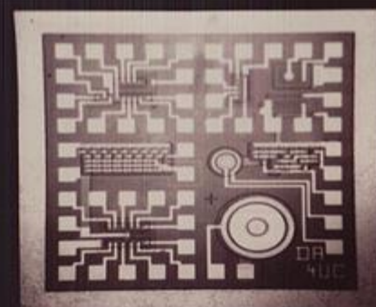


NMOS Third-Order Switched-Capacitor Precision Elliptic Low-Pass Filter
D.J. Allstot, Prof. Gray 1977

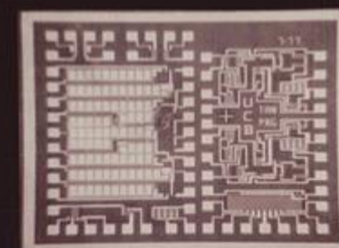
1977



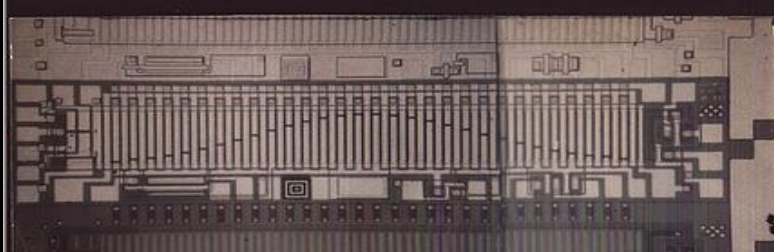
2 MOS Analog Sampled Data Recursive Filters
B.J. Hosticka, Prof. Gray 1977



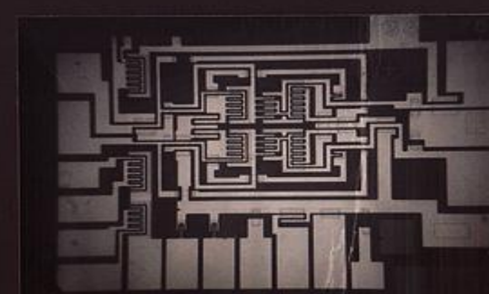
High Voltage Analog-Compatible I^2L Devices
T. Wei, D.J. Allstot, Prof. Gray 1977



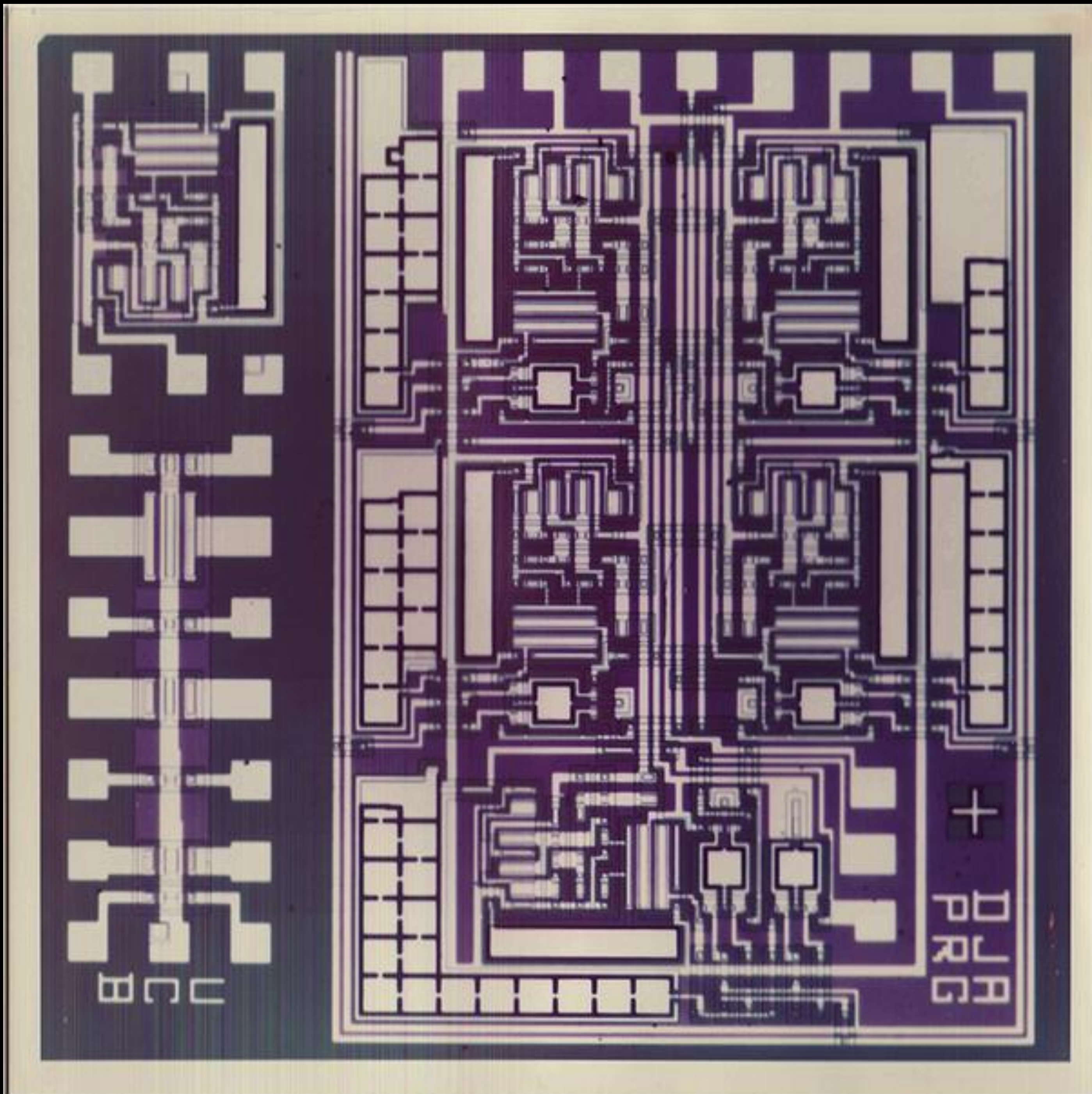
BIFET Continuous-Time Monolithic Filter
K. Tan, Prof. Gray 1977



C C D Convolver
R. Fellman, Prof. Brodersen 1977

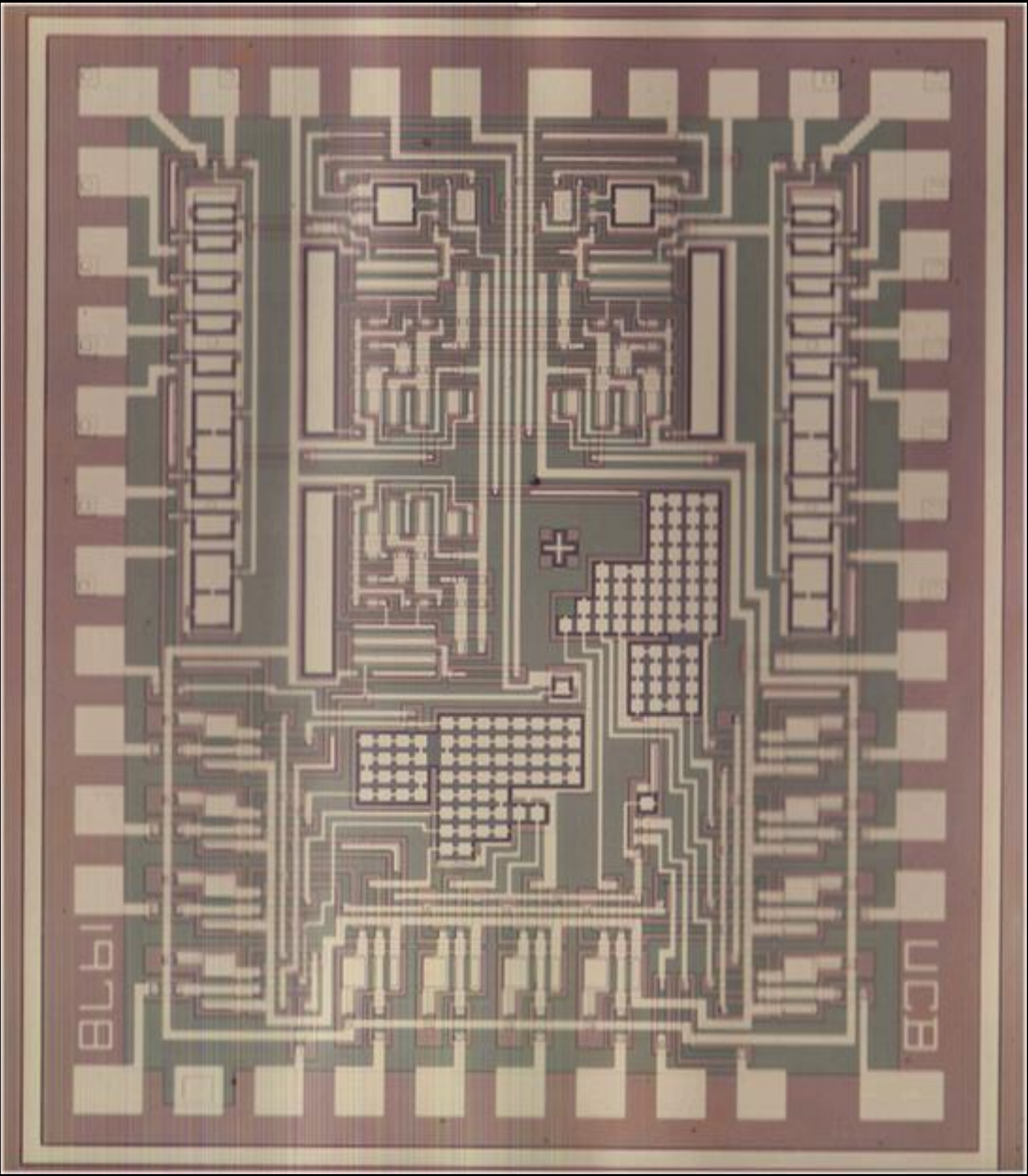


High-Frequency Low-Distortion Monolithic Wideband Amplifier
K. Chan, Prof. Meyer 1977



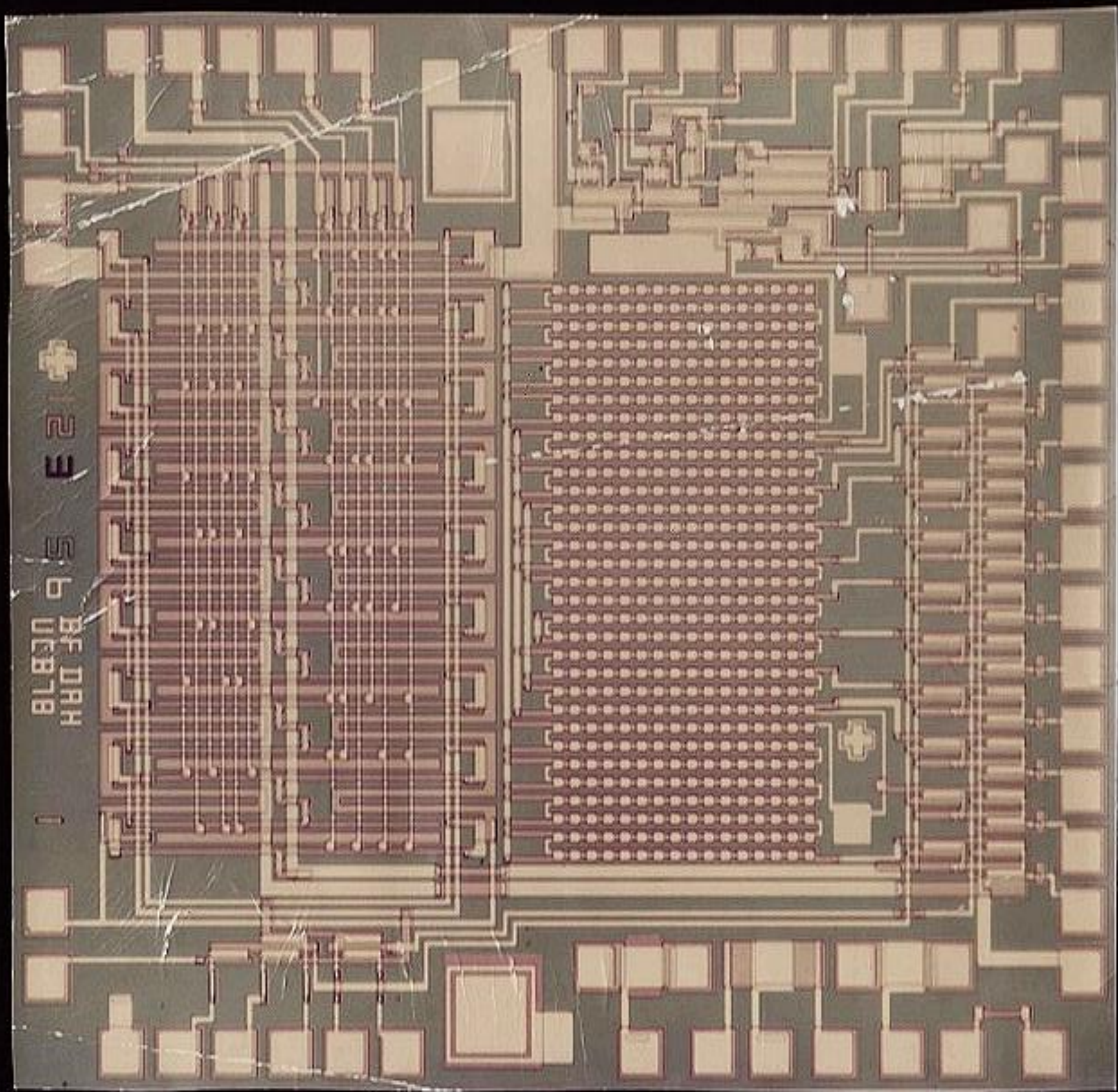
NMOS 5th Order Switched-Capacitor Ladder Filter

D. J. Alstott, Prof. Gray - 1977



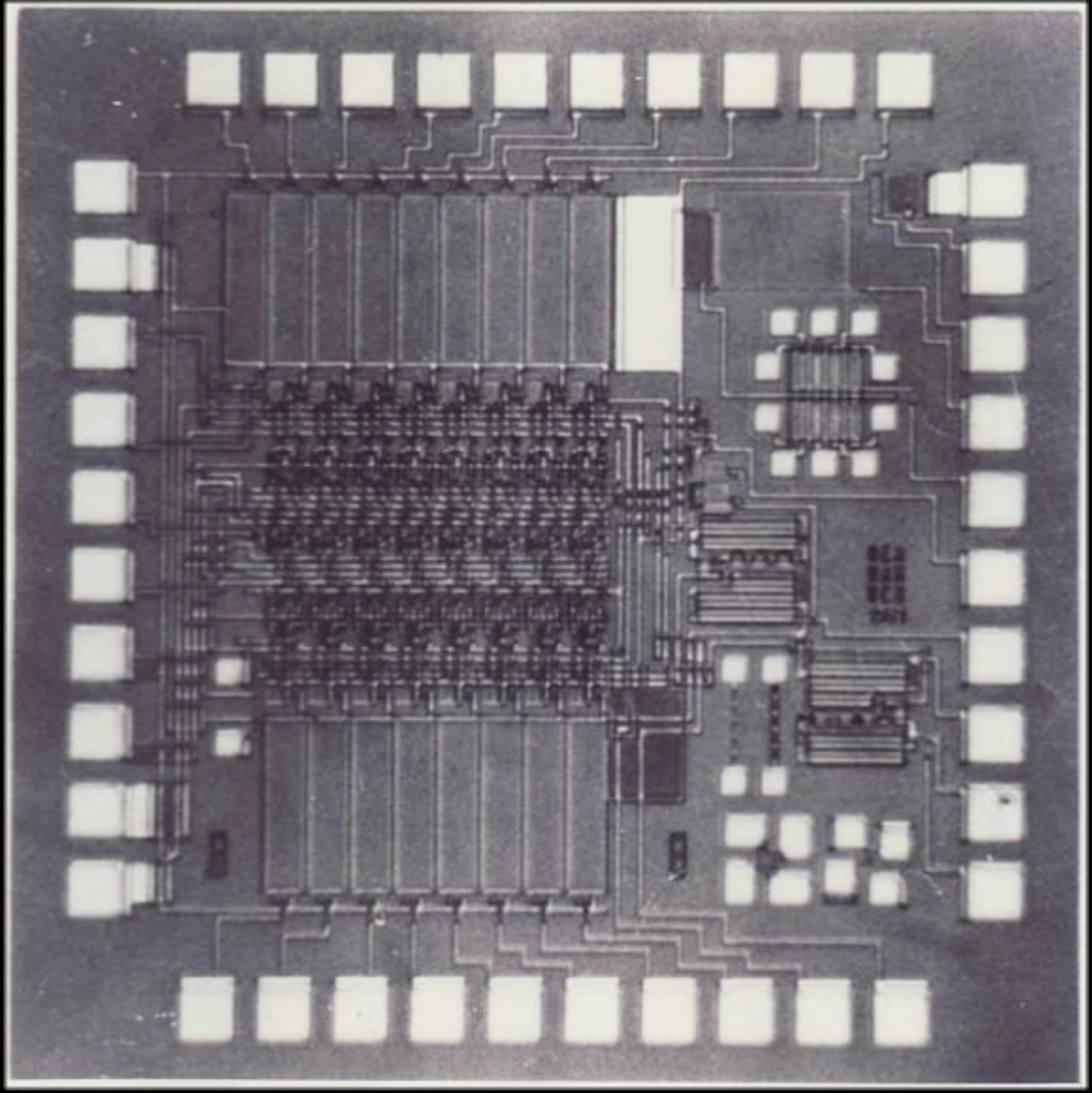
NMOS 3rd Order Programmable
Switche-Capacitor Filter

D. J. Alstott, Prof. Gray - 1978



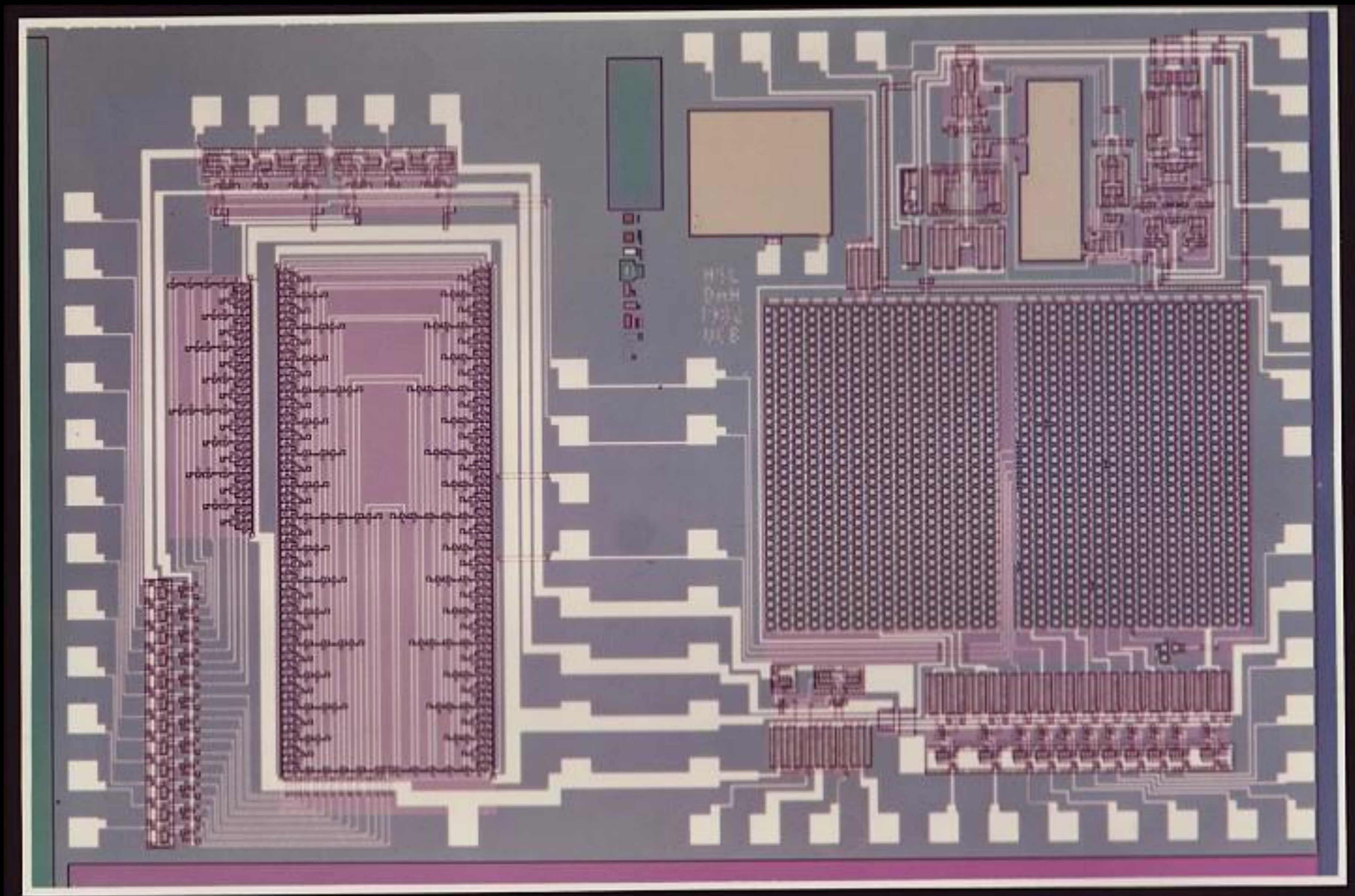
NMOS 12-Bit Inherently Monotonic A/D Converter

B. Fotouhi, Prof. Hodges - 1978



First Echo Canceller for Integrated Services Digital Network

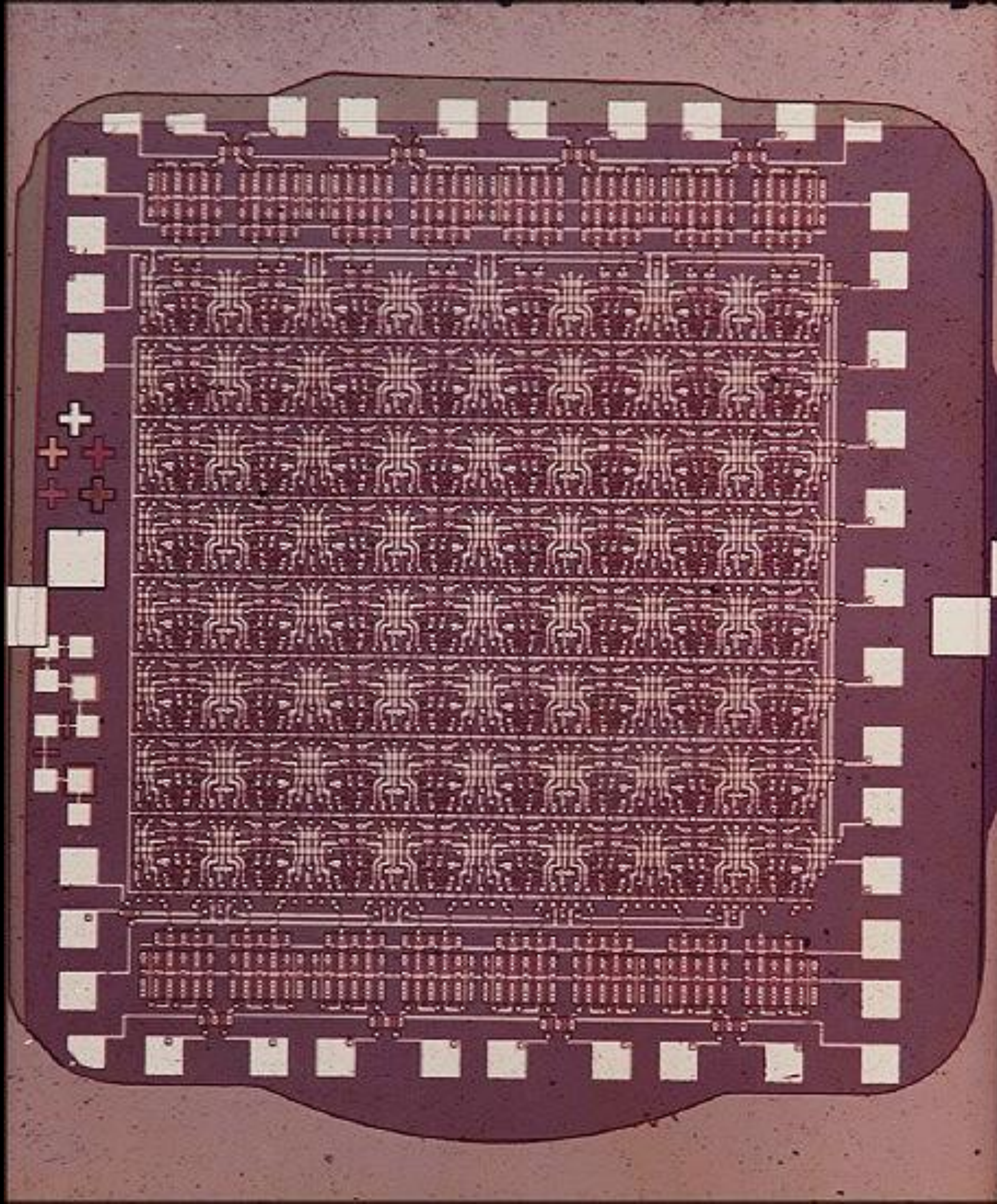
O. Agazzi, Prof. Hodges - 1981



Self-Calibrating 15-Bit A/D Converter
H. S. Lee, Prof. Hodges - 1982

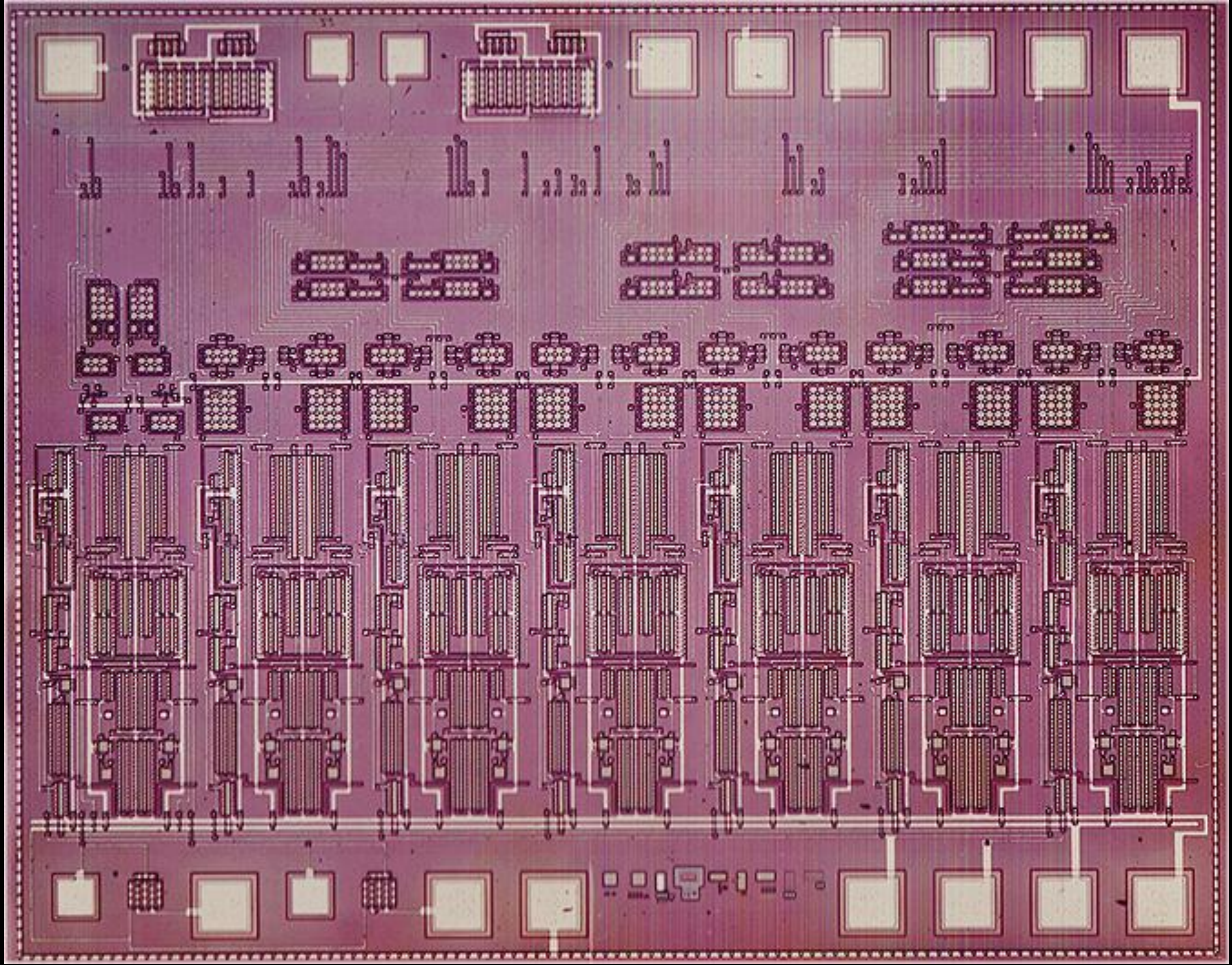
New Microlab built in 1982

Ready for students - 1983



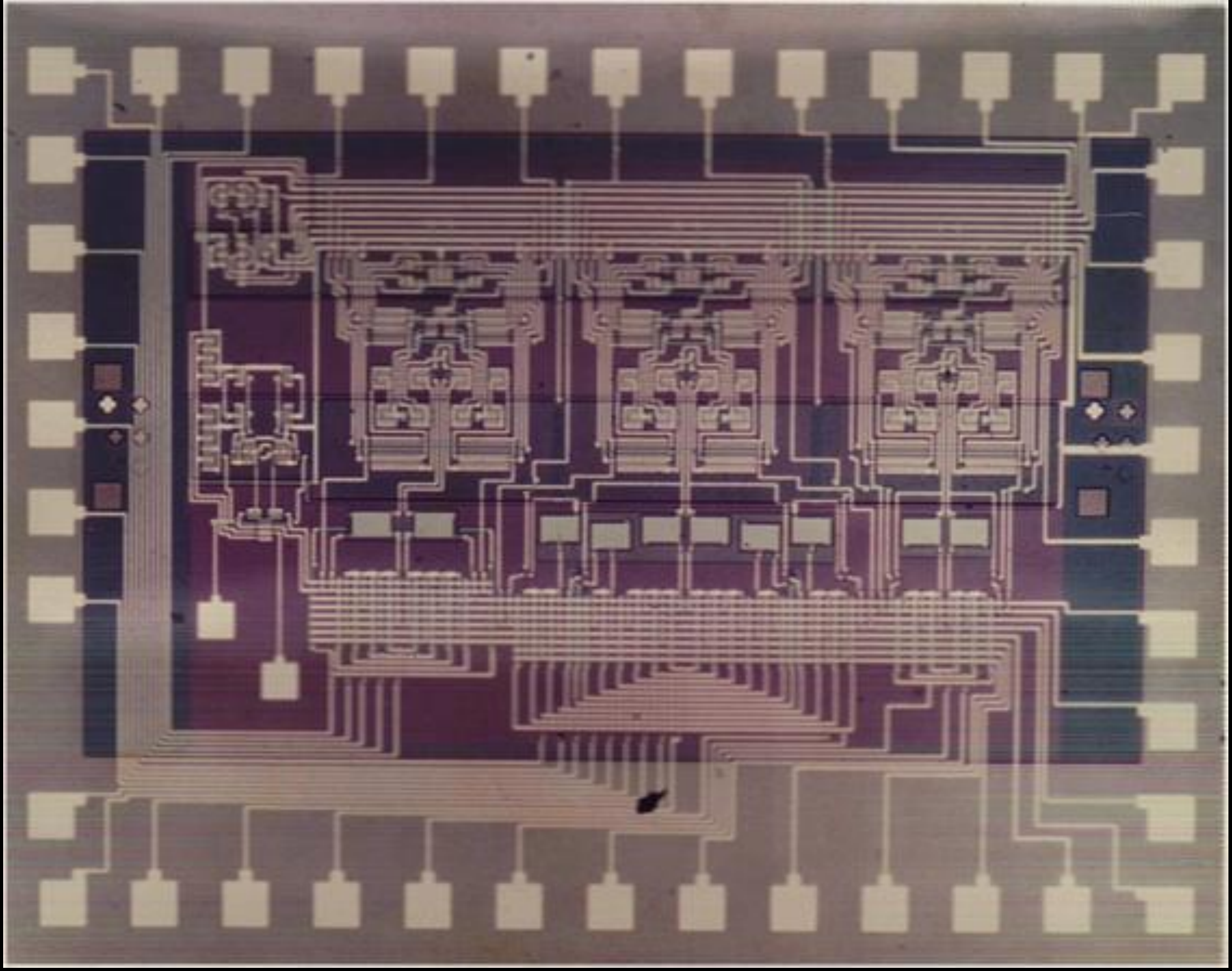
NMOS Segmented Video D/A Converter

Vivian Shen, Prof. Hodges - 1983



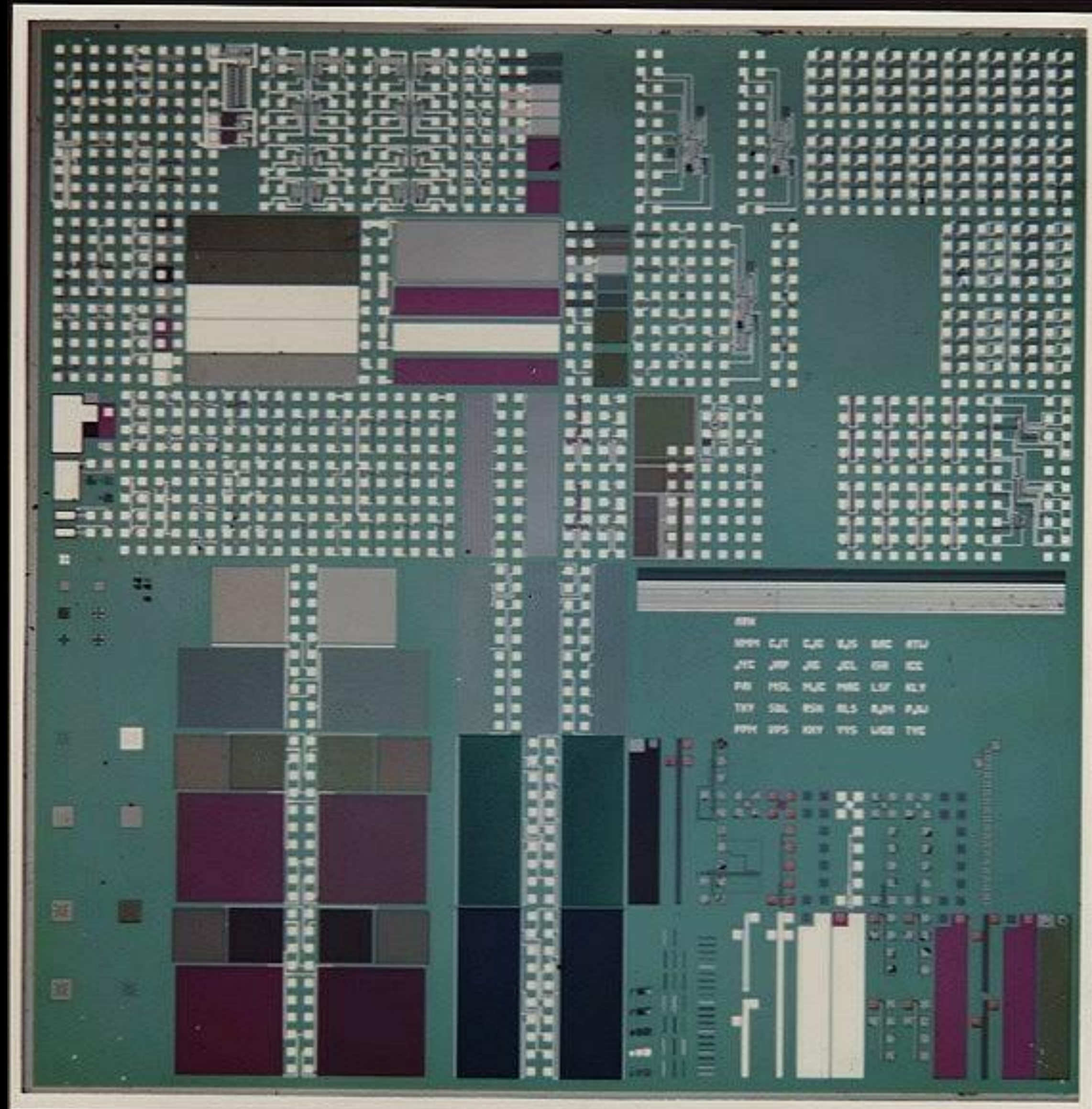
256 KHz Bandpass Switched Capacitor Filter

T. Choi, R. Kaneshiro, Profs. Gray & Pederson - 1983



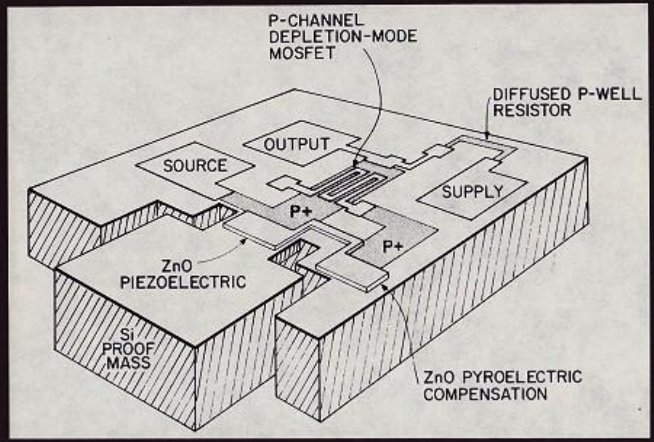
CMOS 12-Bit A/D Algorithmic Converter

P.W. Li, Prof. Gray - 1983

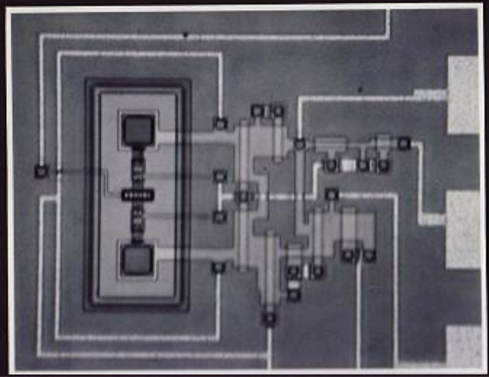


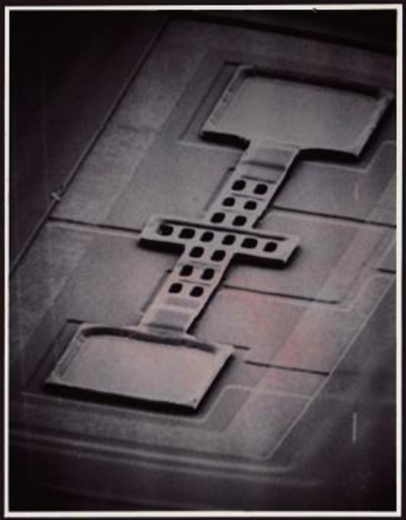
First CMOS Test Chip Fabricated in the New Microlab by Students of the EE 290 Class

Profs. Neureuther & Oldham, 1983-84

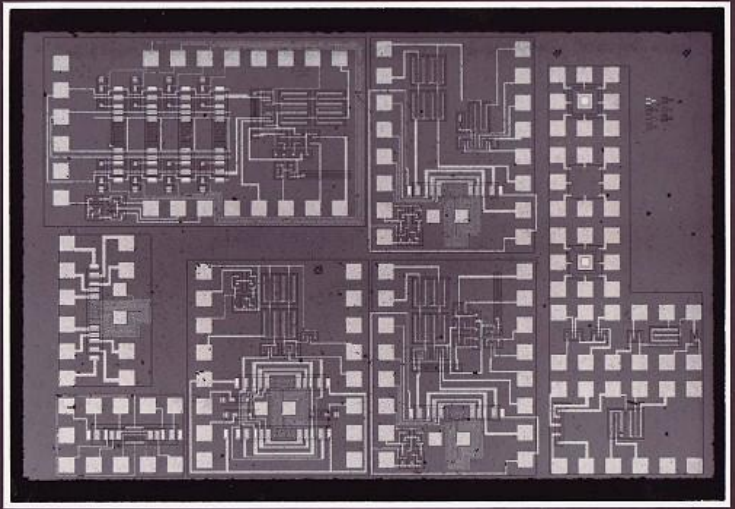


PI-FET Integrated Accelerometer Structure
P. Chen, Prof. Muller 1983

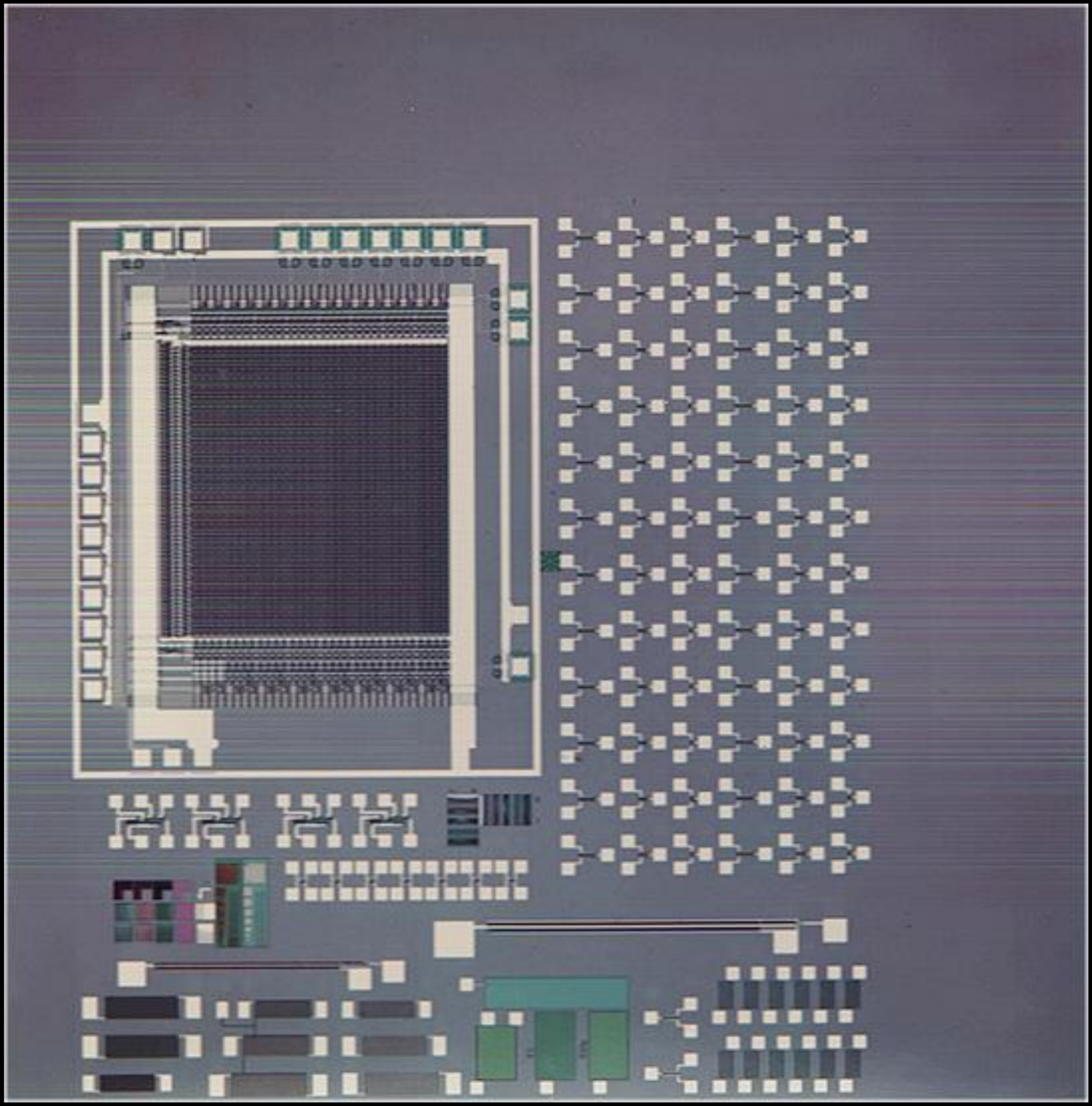




Integrated Organic Vapor Sensor
R.T. Howe, Prof. Muller 1984

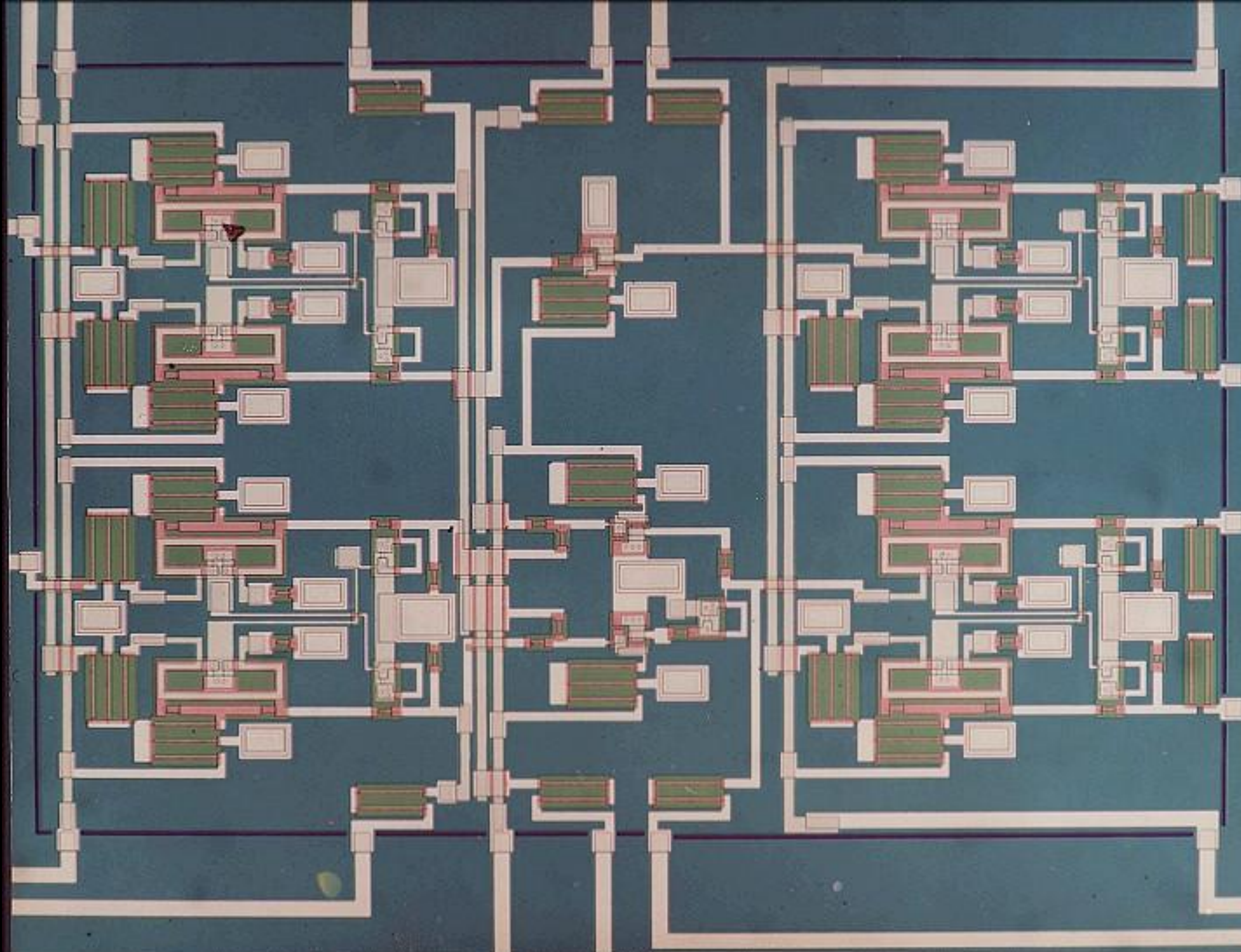


Integrated Carrier-Domain Magnetometer
J.I. Goicolea, Prof. Muller 1986



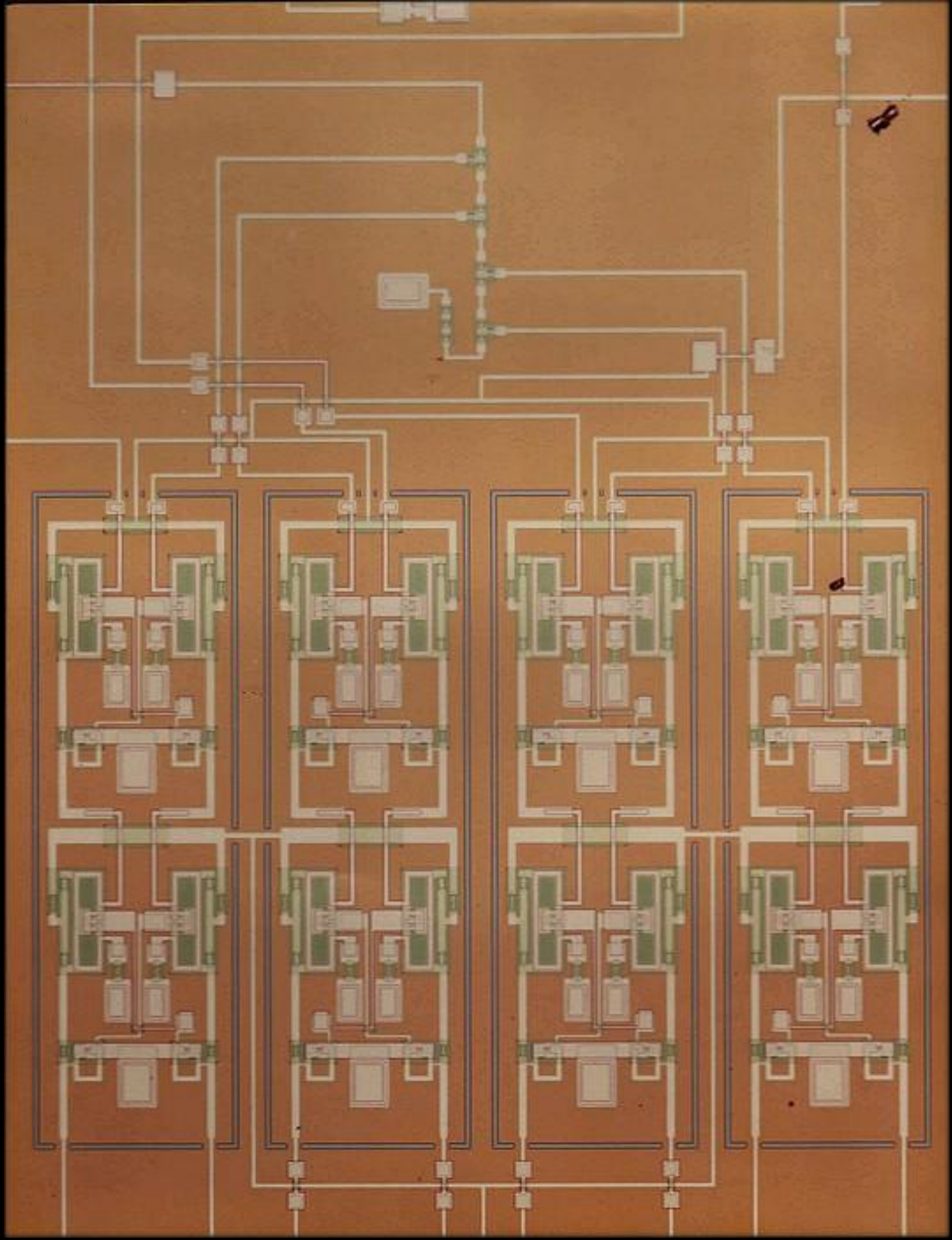
First NMOS Test Chip, Including a 512x8 Bit RAM, Made in the New Microlab

P. W. Li, P. Ruetz, Profs. Brodersen & Gray - 1984



Superconducting Two-Bit Gray-Code to Natural Binary Decoder, Lead-Alloy Process

J. Spargo, Prof. Van Duzer - 1984



Superconducting Four-Bit A/D Converter Using Lead-Alloy Process

H. Ko, V. Nandakumar, D. Petersen, Prof. Van Duzer - 1984

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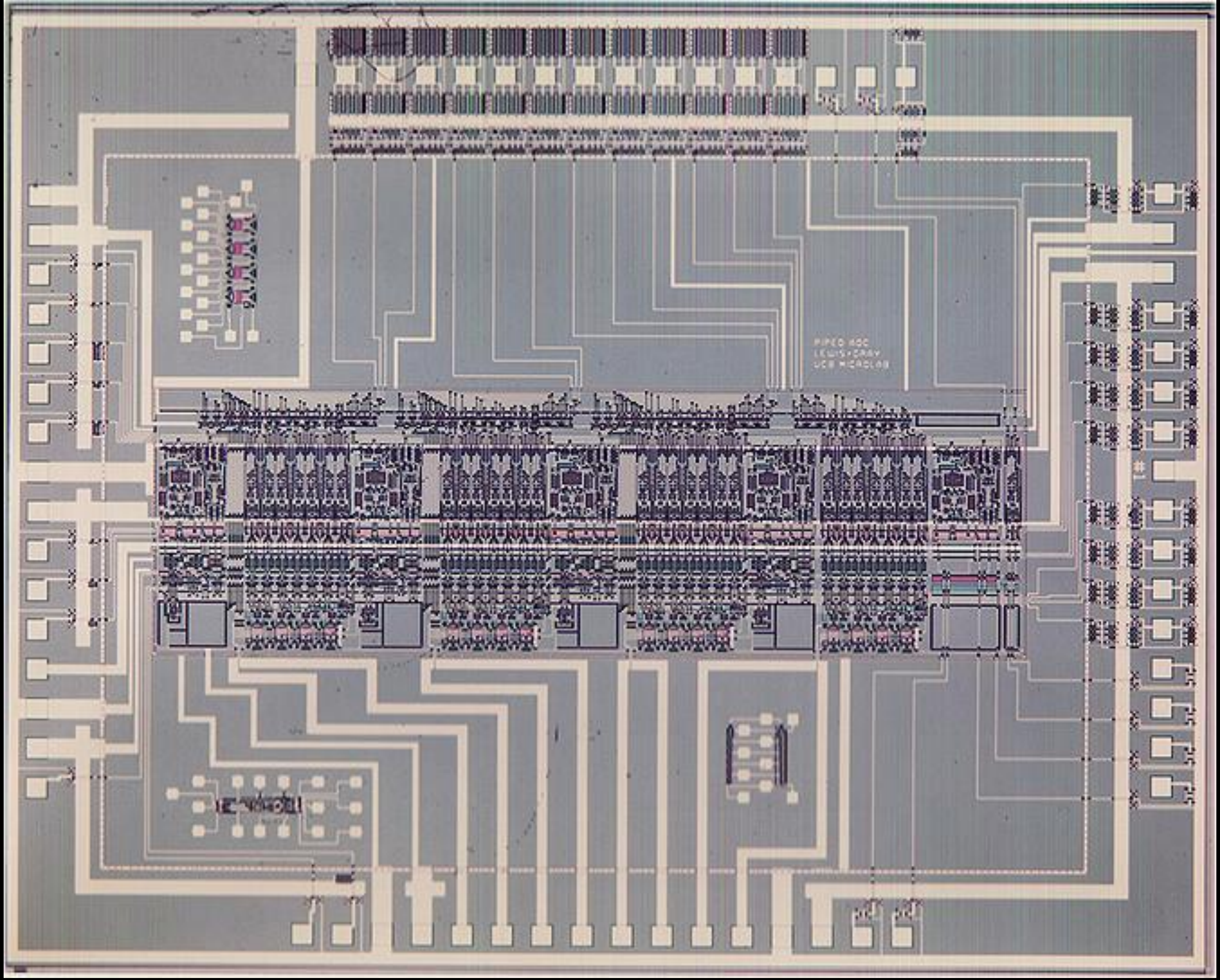
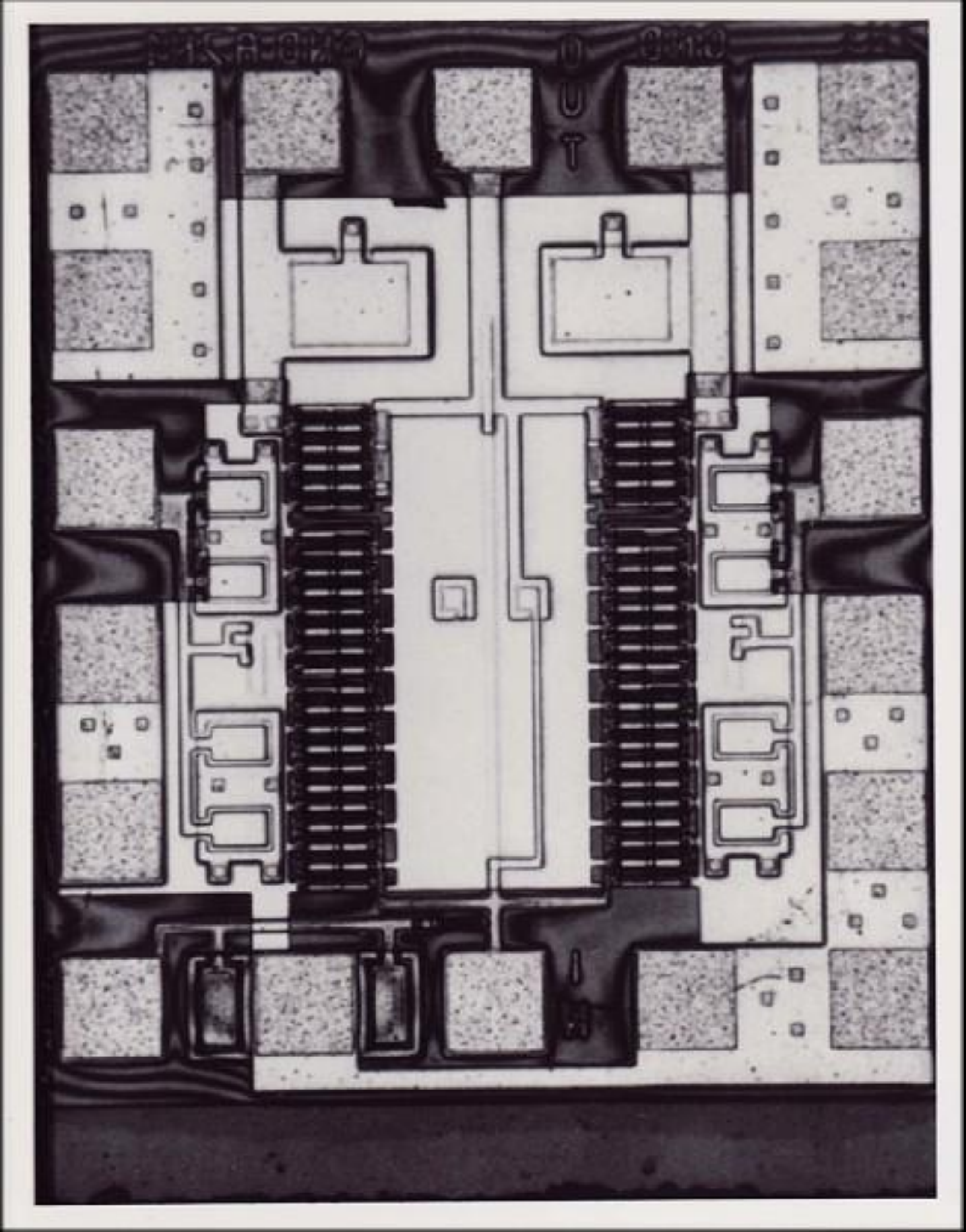
Prof. David Patterson
527 Evans
2-6587



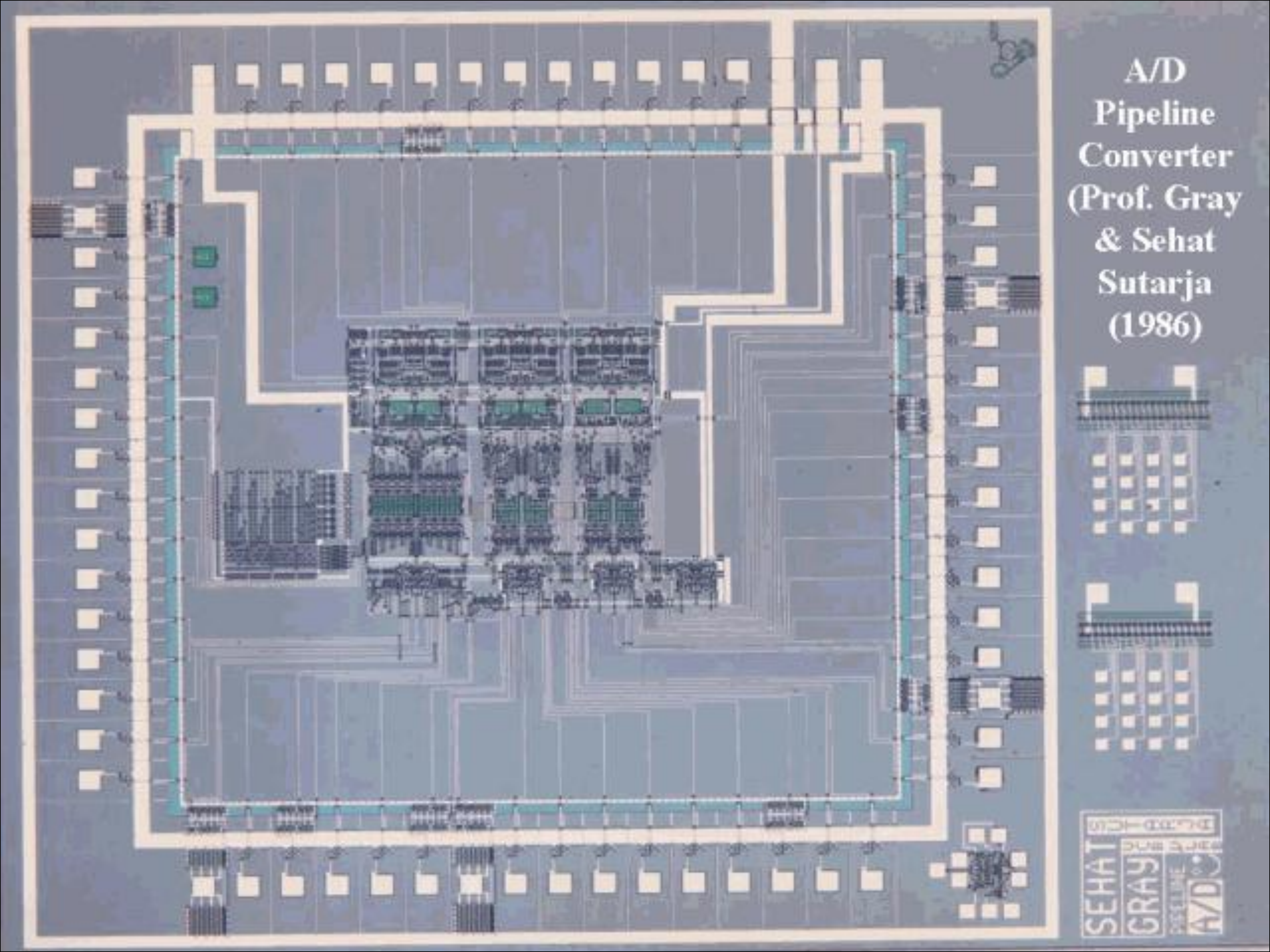
Pipeline 9-Bit CMOS A/D Converter

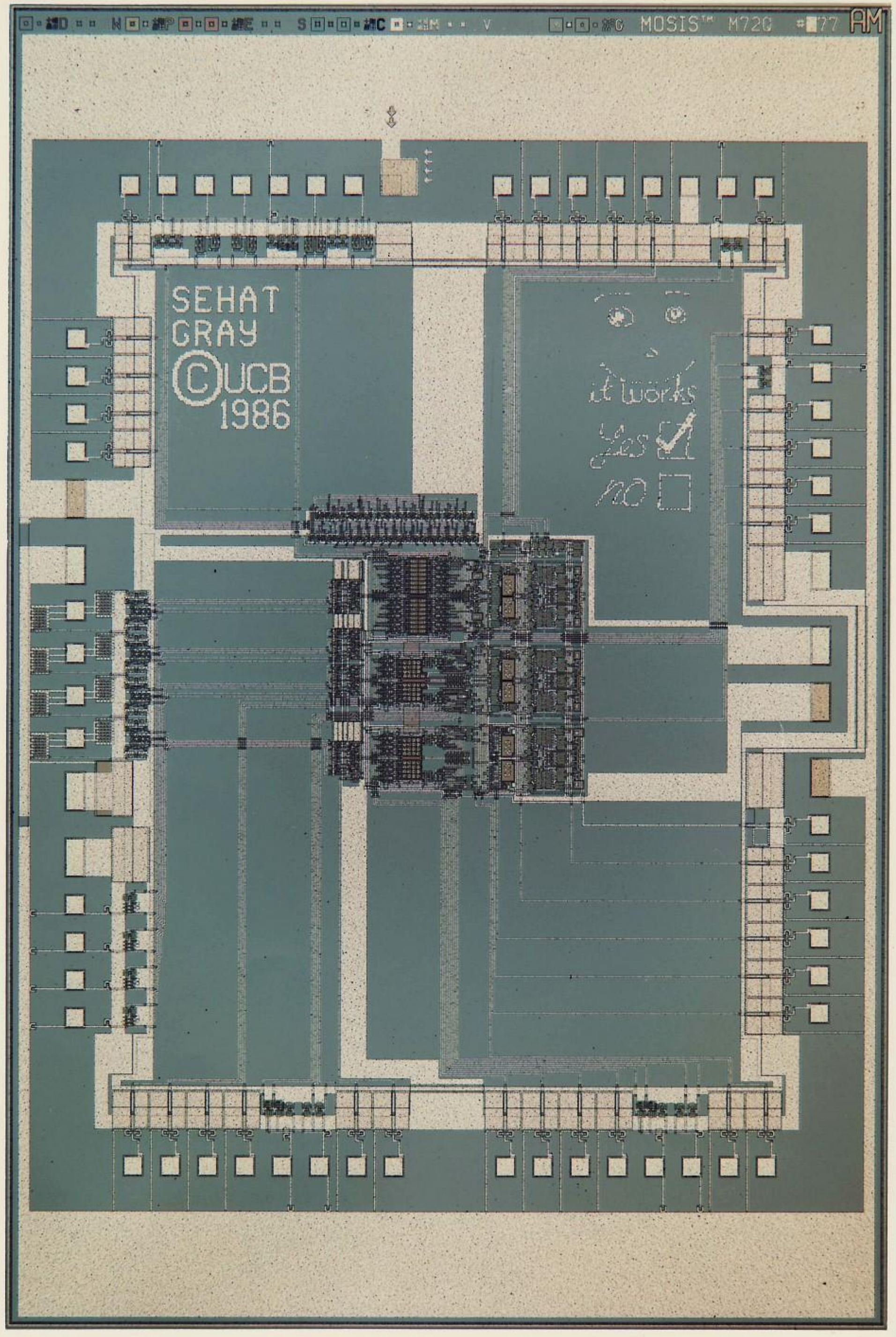
S. H. Lewis, Prof. Gray - 1986

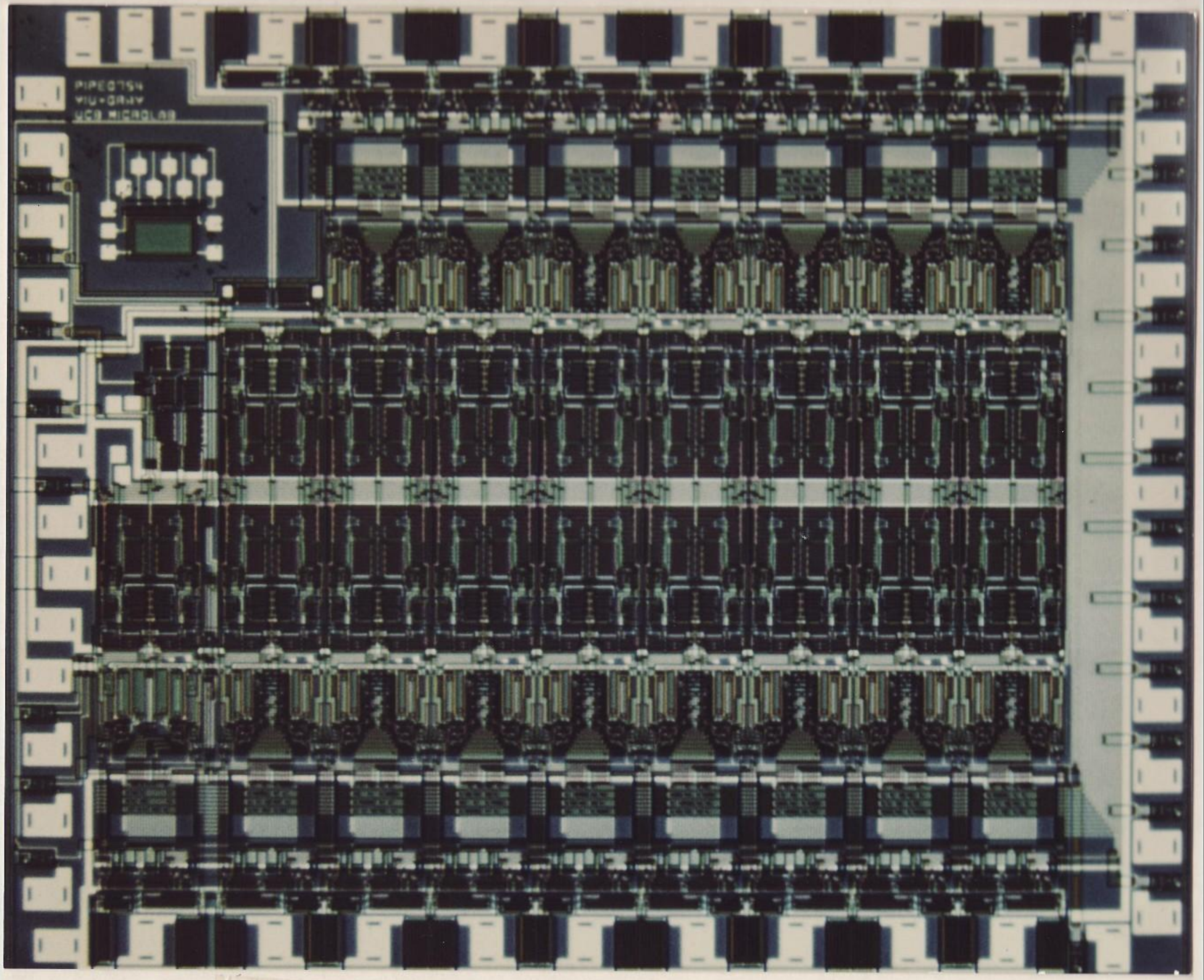


Wide Band, Low Noise, Matched Impedance Amplifier in Submicron NMOS Technology

K.Y. Toh,
Prof. Meyer - 1986

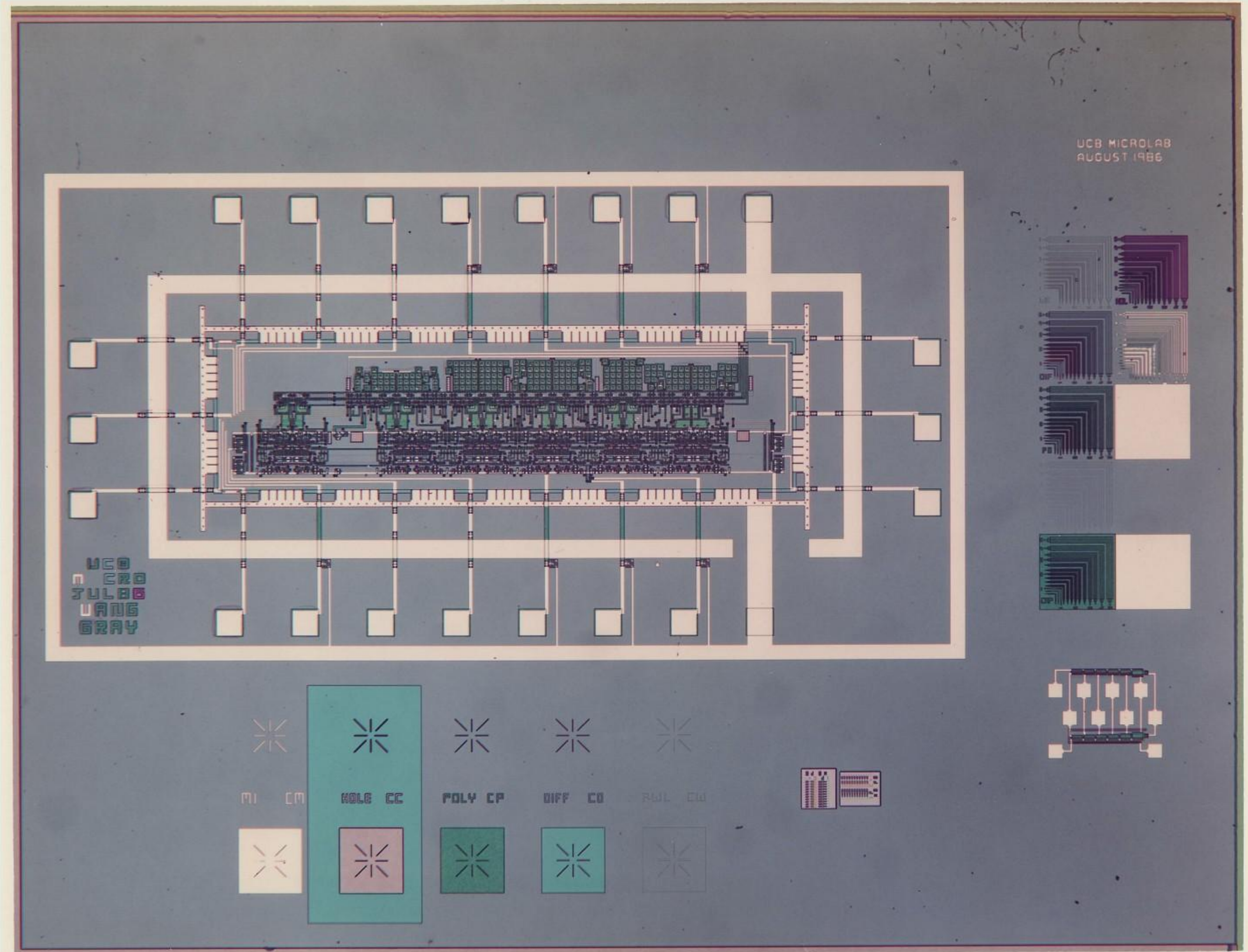

A/D
Pipeline
Converter
(Prof. Gray
& Sehat
Sutarja
(1986)
SEHAT
GRAY
A/D


MOSIS™ M720
AM
SEHAT
GRAY
©UCB
1986
it works
yes
no



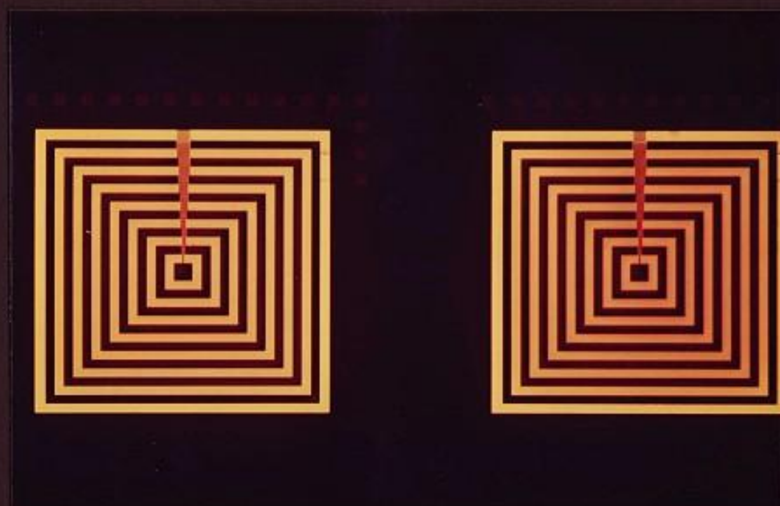
Piped A/D designed by L.C. Yiu

Made in the Microlab

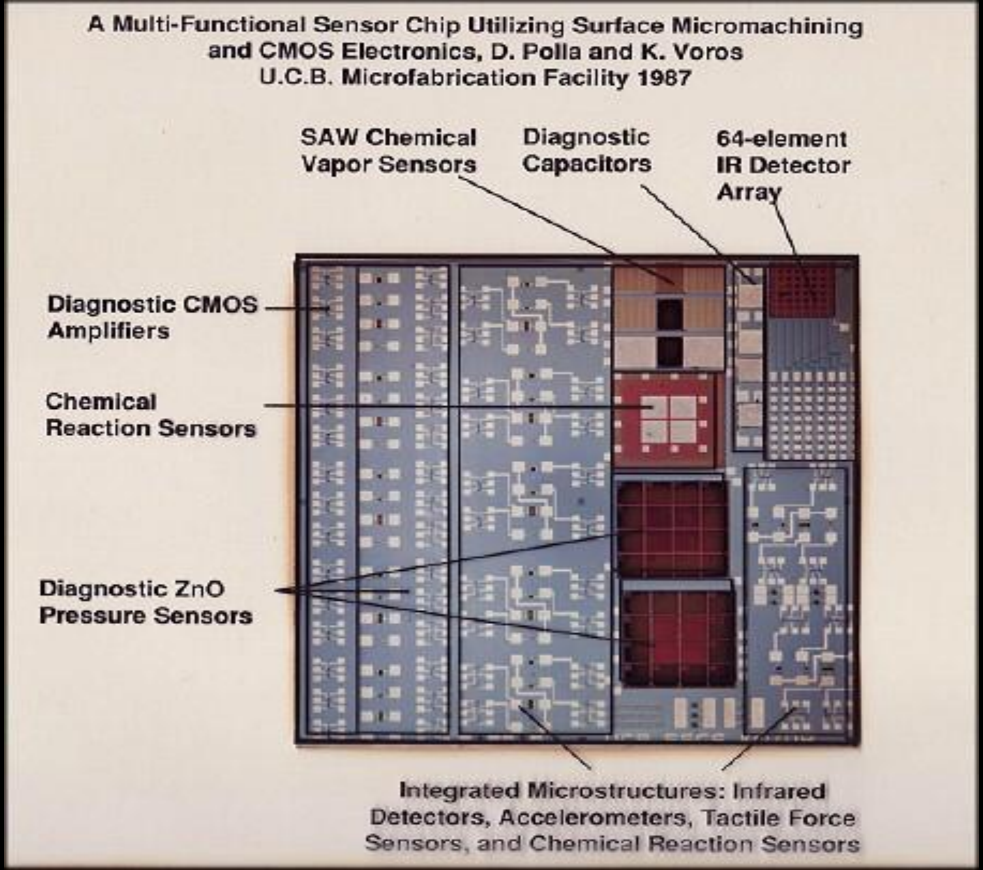

UCB MICROLAB
AUGUST 1986
UCB
JUL86
GRAY
MI CM
HOLE CC
POLY CP
DIFF CD

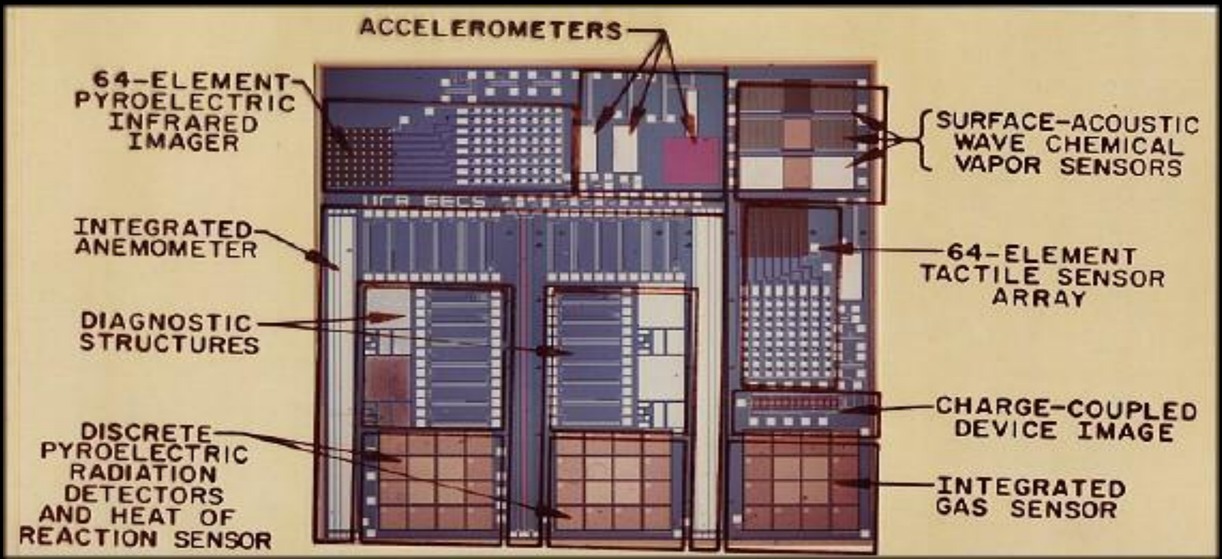
Poly-Silicon Bridge
Thermal Sensor
Y.C. Tai, Prof. Muller 1985

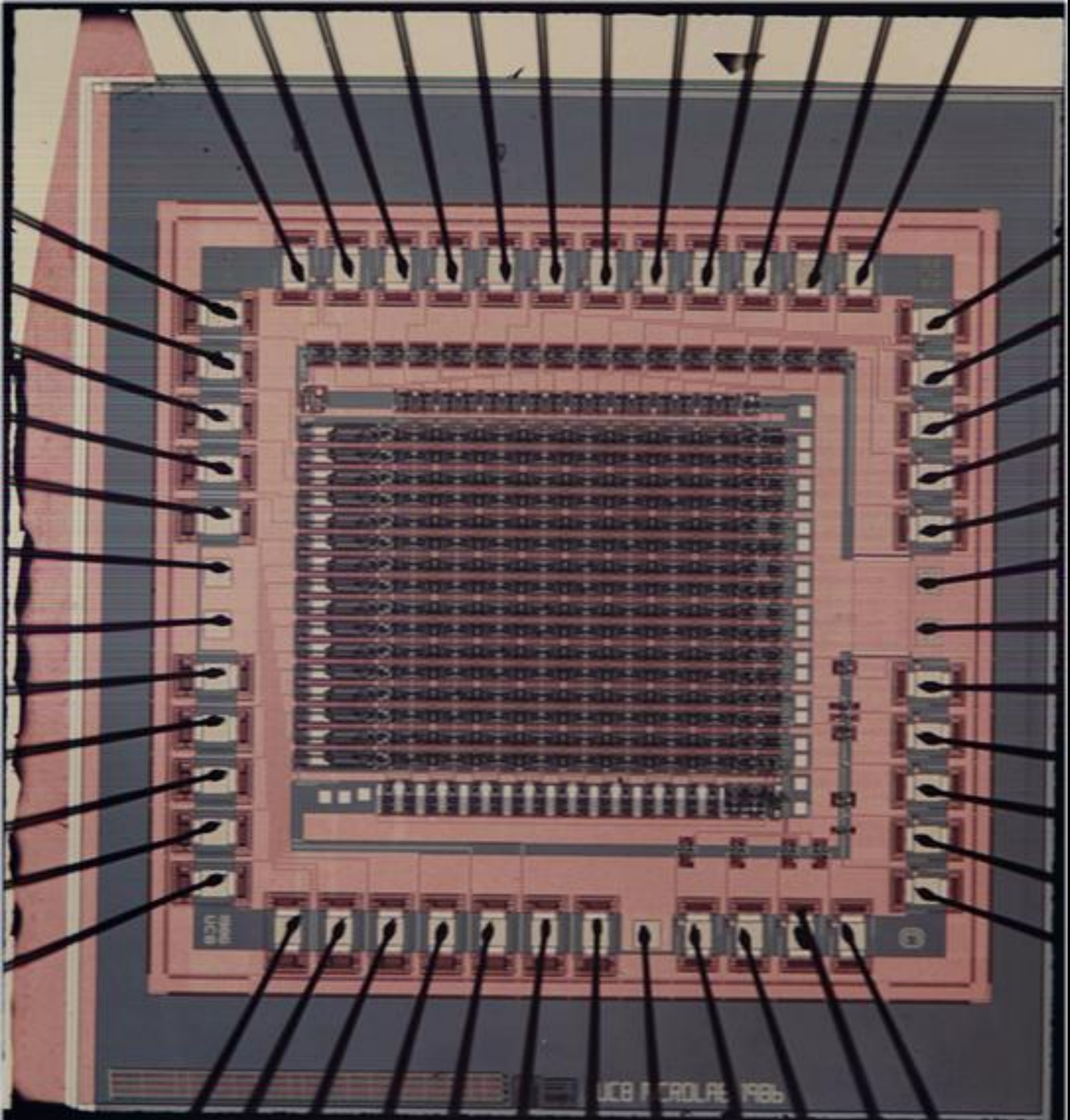
Top view photograph of IC Processed Piezoelectric Microphone taken with back-side illumination. Eun Sok Kim 1986



IC Processed
Piezoelectric Microphone
E.S. Kim, Prof. Muller 1986


A Multi-Functional Sensor Chip Utilizing Surface Micromachining and CMOS Electronics, D. Polla and K. Voros
U.C.B. Microfabrication Facility 1987
SAW Chemical Vapor Sensors
Diagnostic Capacitors
64-element IR Detector Array
Diagnostic CMOS Amplifiers
Chemical Reaction Sensors
Diagnostic ZnO Pressure Sensors
Integrated Microstructures: Infrared Detectors, Accelerometers, Tactile Force Sensors, and Chemical Reaction Sensors


ACCELEROMETERS
64-ELEMENT PYROELECTRIC INFRARED IMAGER
SURFACE-ACOUSTIC WAVE CHEMICAL VAPOR SENSORS
INTEGRATED ANEMOMETER
64-ELEMENT TACTILE SENSOR ARRAY
DIAGNOSTIC STRUCTURES
CHARGE-COUPLED DEVICE IMAGE
DISCRETE PYROELECTRIC RADIATION DETECTORS AND HEAT OF REACTION SENSOR
INTEGRATED GAS SENSOR

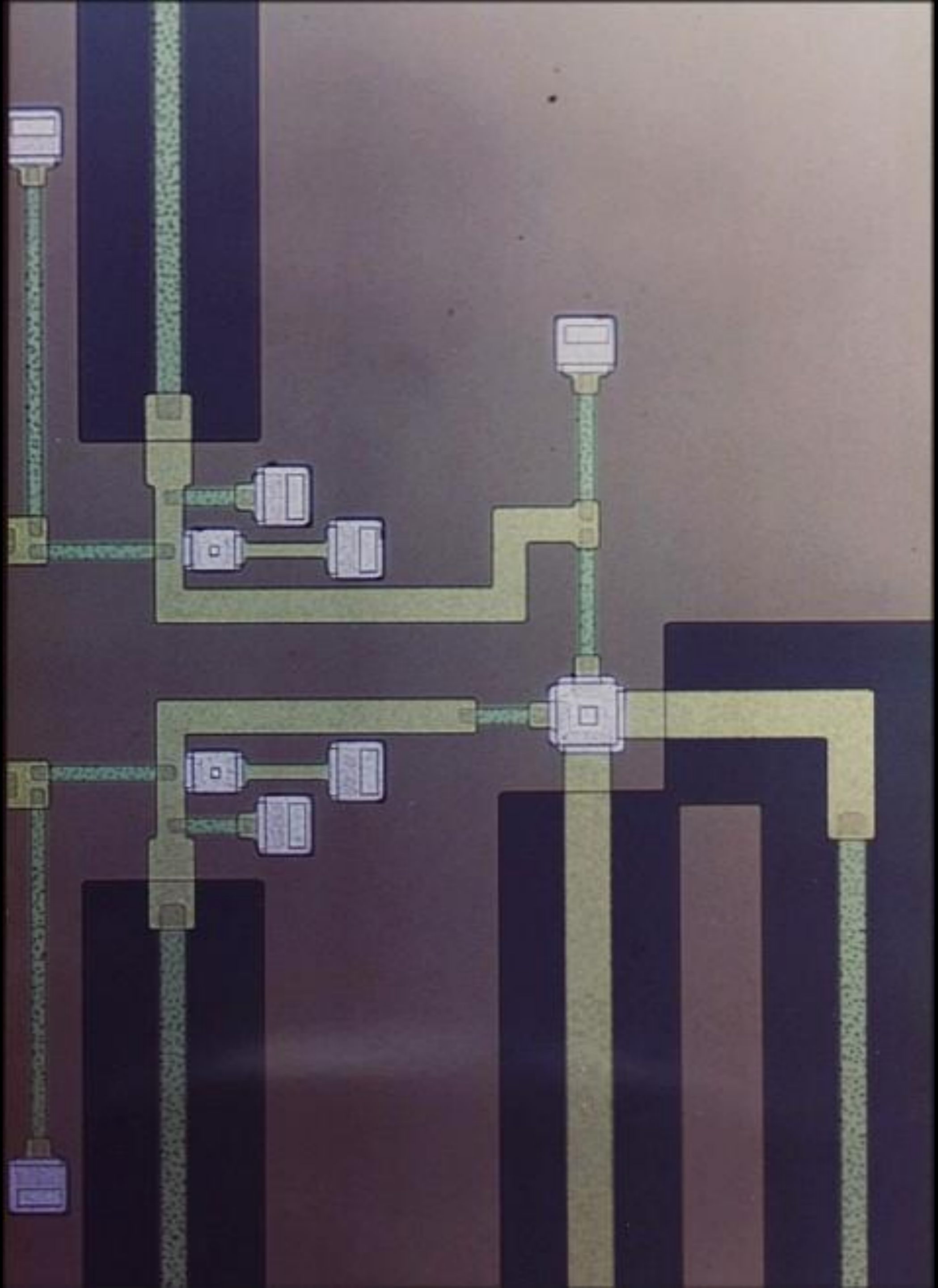


CMOS 250 Mb/s Crosspoint Switch

H. J. Shin,

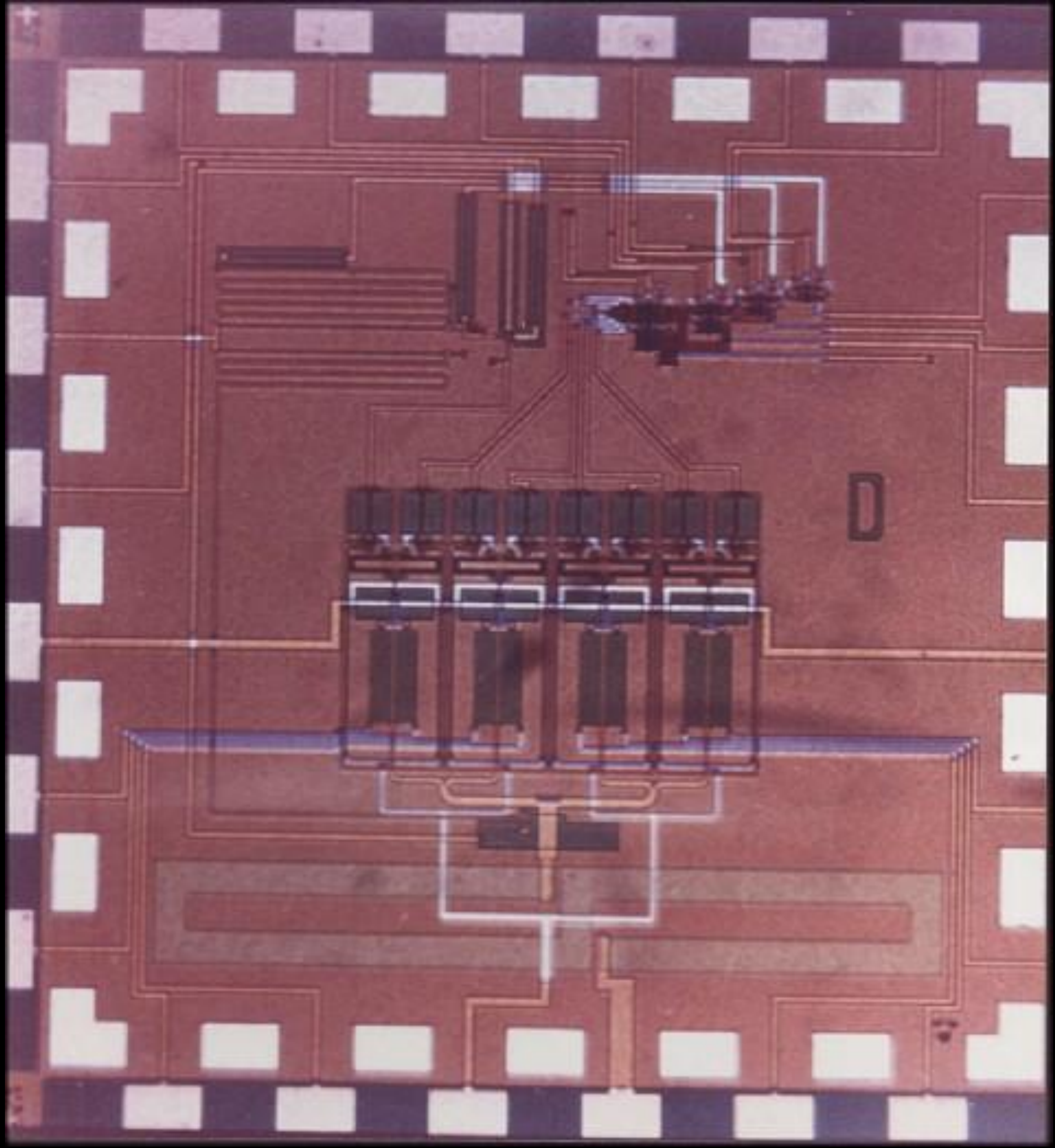
Prof. Hodges

1987



Superconductive Picosecond Pulse Sampler, Lead-Alloy Process

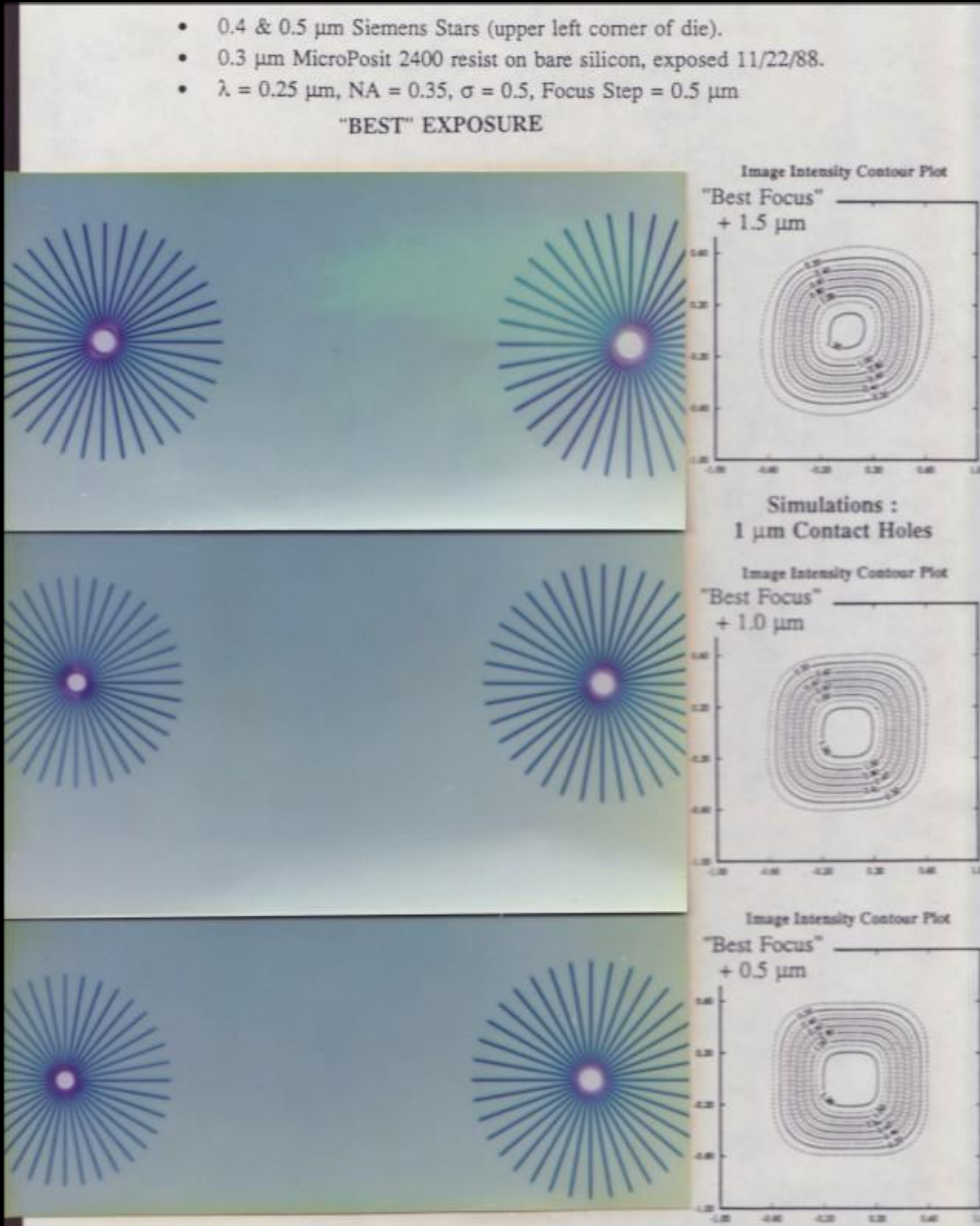
D. Peterson,
Prof. Van Duzer - 1988



Superconducting Three-Bit A/D Converter Using Lead-Alloy Process

D. Petersen, Prof. Van Duzer - 1988

Siemens Star (Experimental Results)

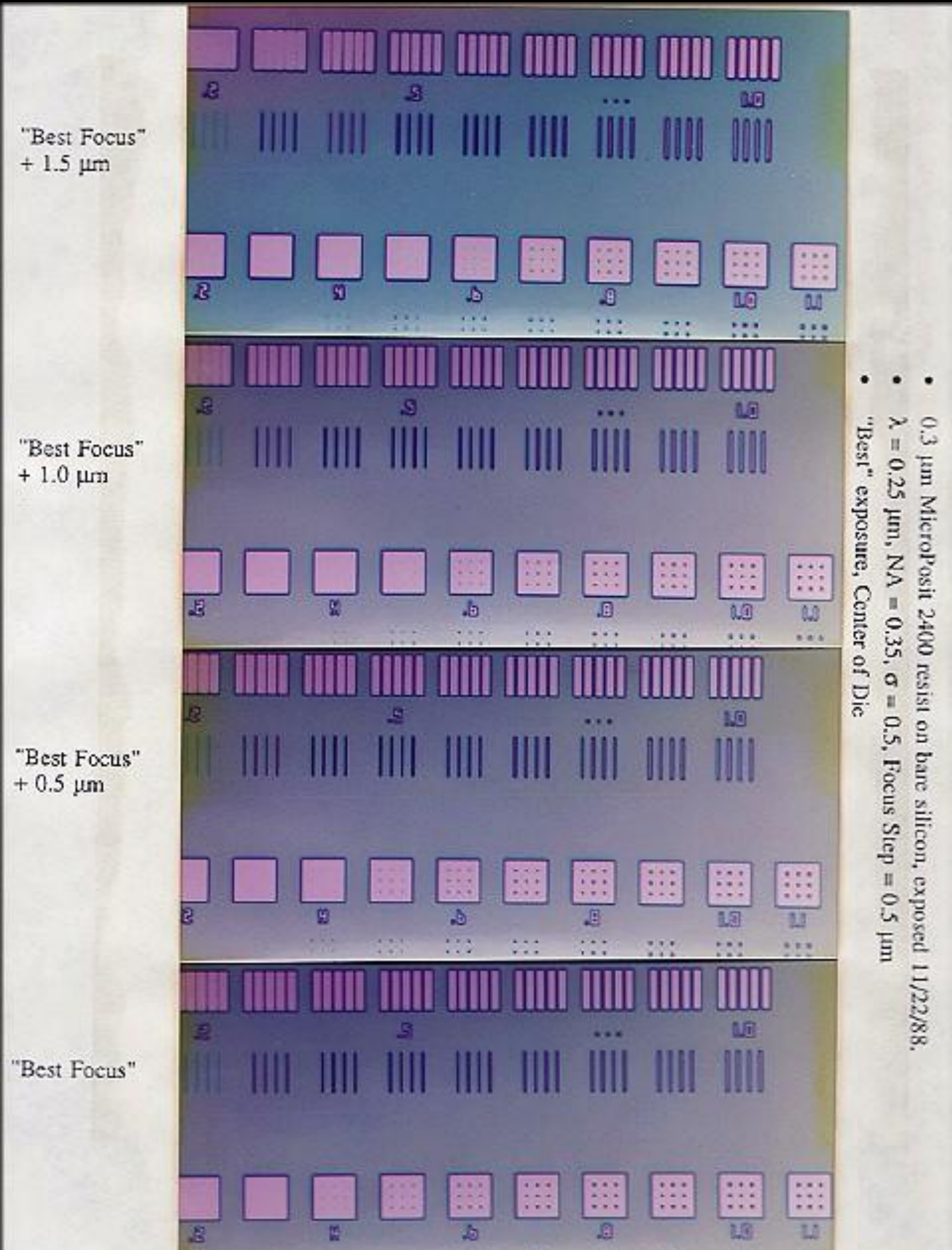


Optical Lithography Simulation & Its Application to Stepper Characterization

Exposure Target Experiment

K.H. Toh,
Prof. Neureuther - 1988

Focus Targets (Experimental Results)

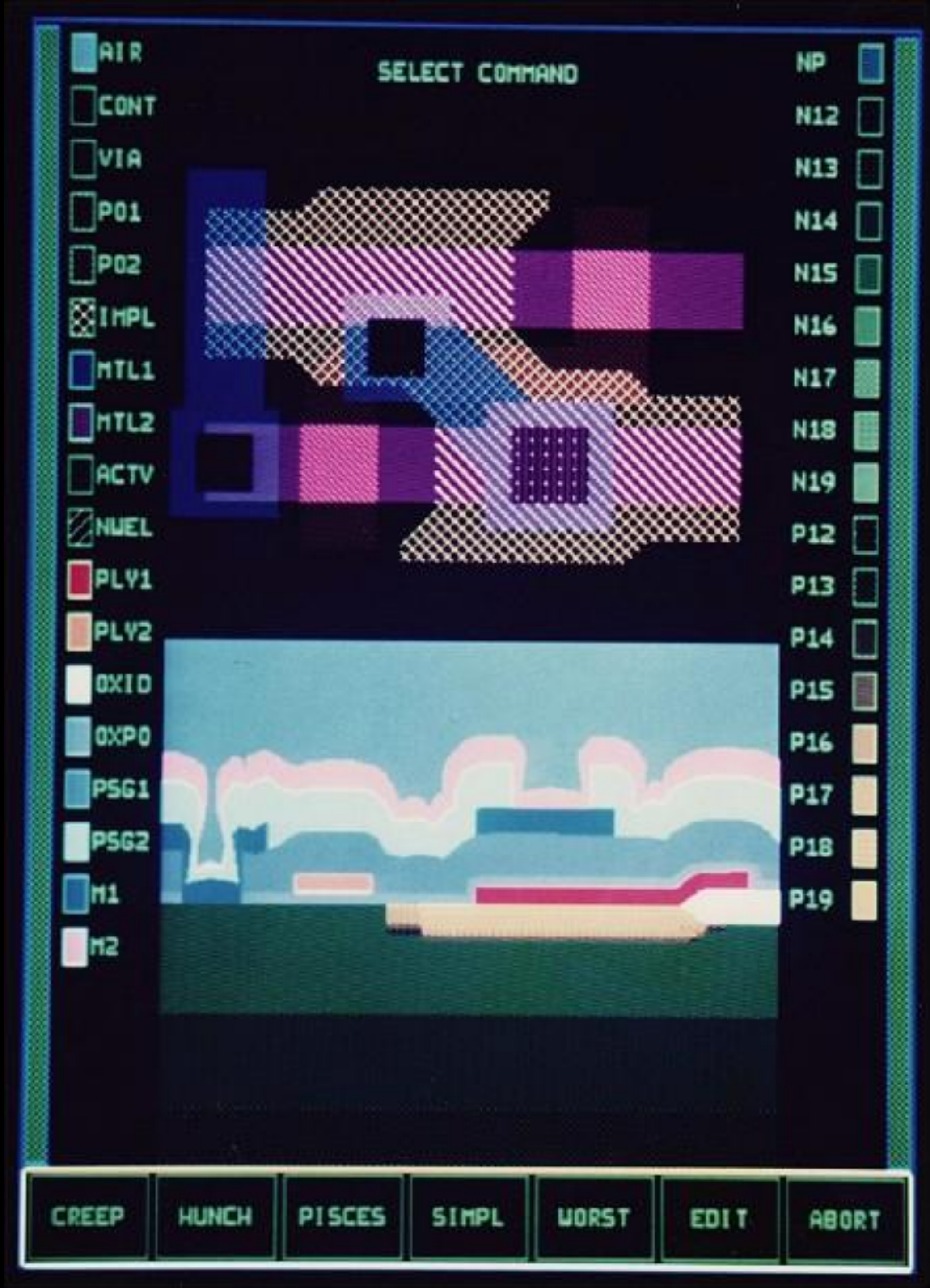


Optical Lithography Simulation & Its Application to Stepper Characterization

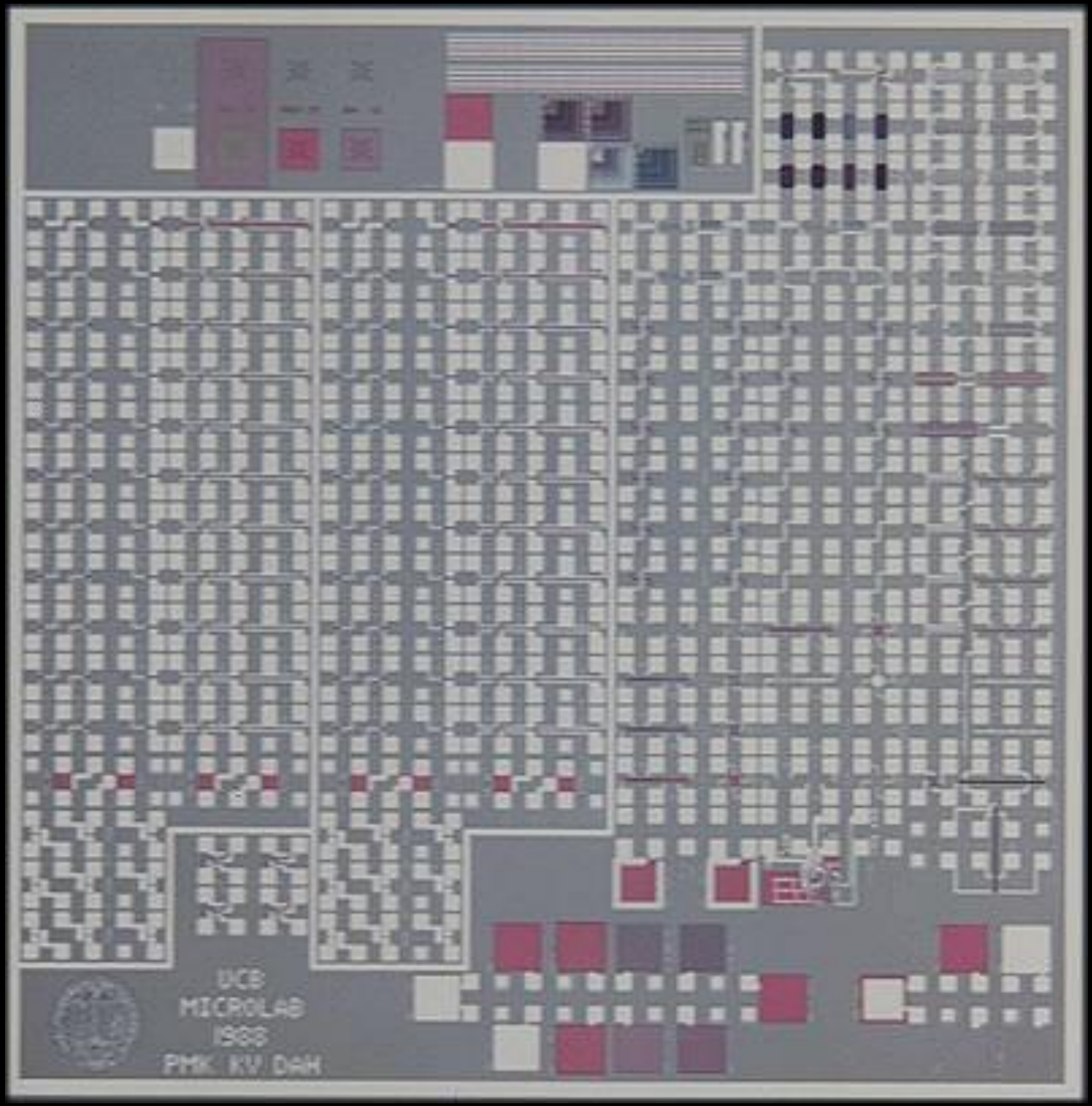
Focus Target Experiment

K.H. Toh,
Prof. Neureuther - 1988

SIMPL – DIX Layout & Cross- Section of a CMOS DRAM Structure

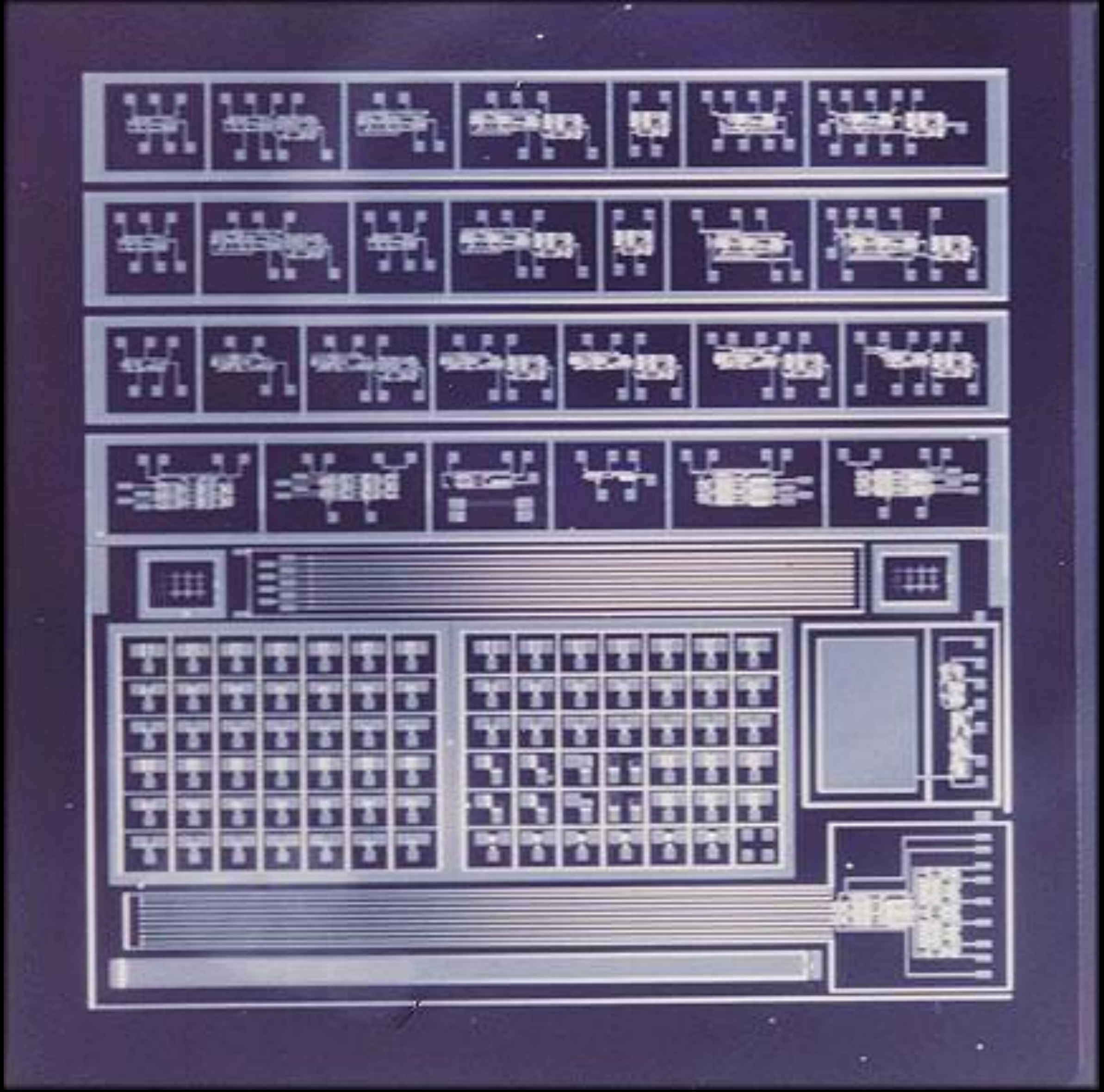


A.S. Wong,
Prof. Neureuther - 1988



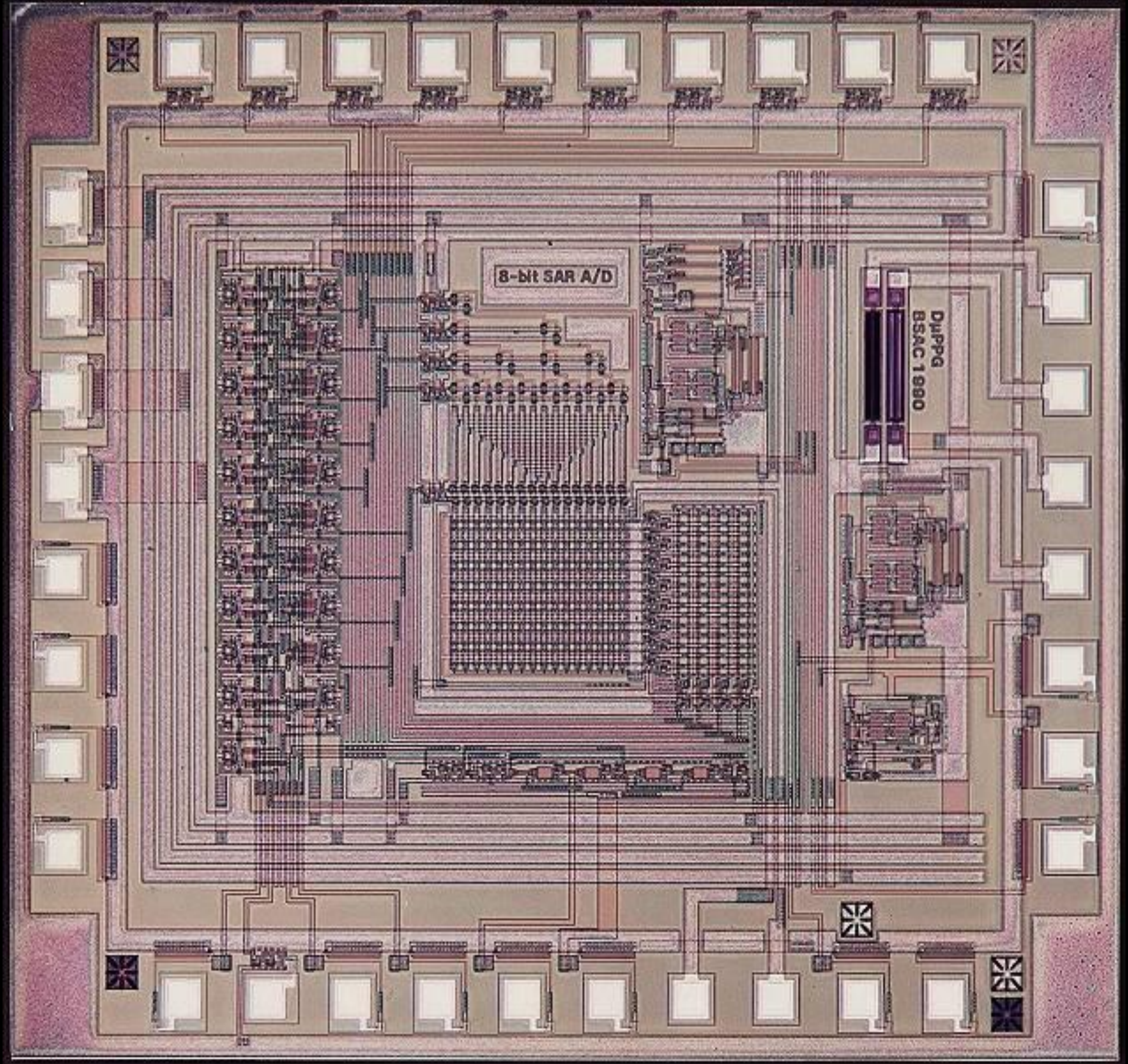
CMOS Test Chip for Automatic Data Extraction for Process Modeling

P.M. Kruger, Prof. Hodges - 1988



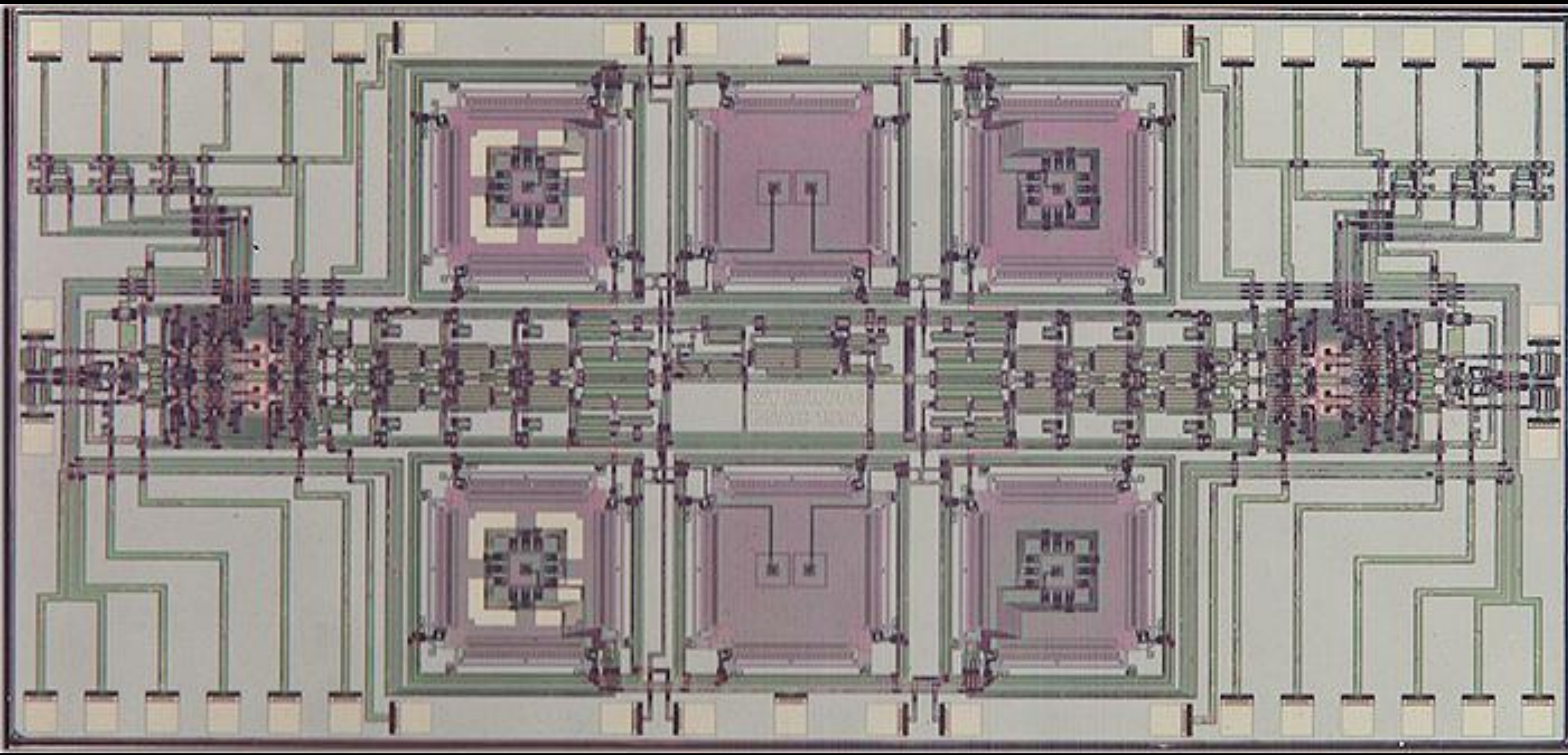
High-Energy Radiation Detector with Charge-Sensitive Preamplifier Implemented on the Same Substrate

Steve Holland (LBL) - 1989



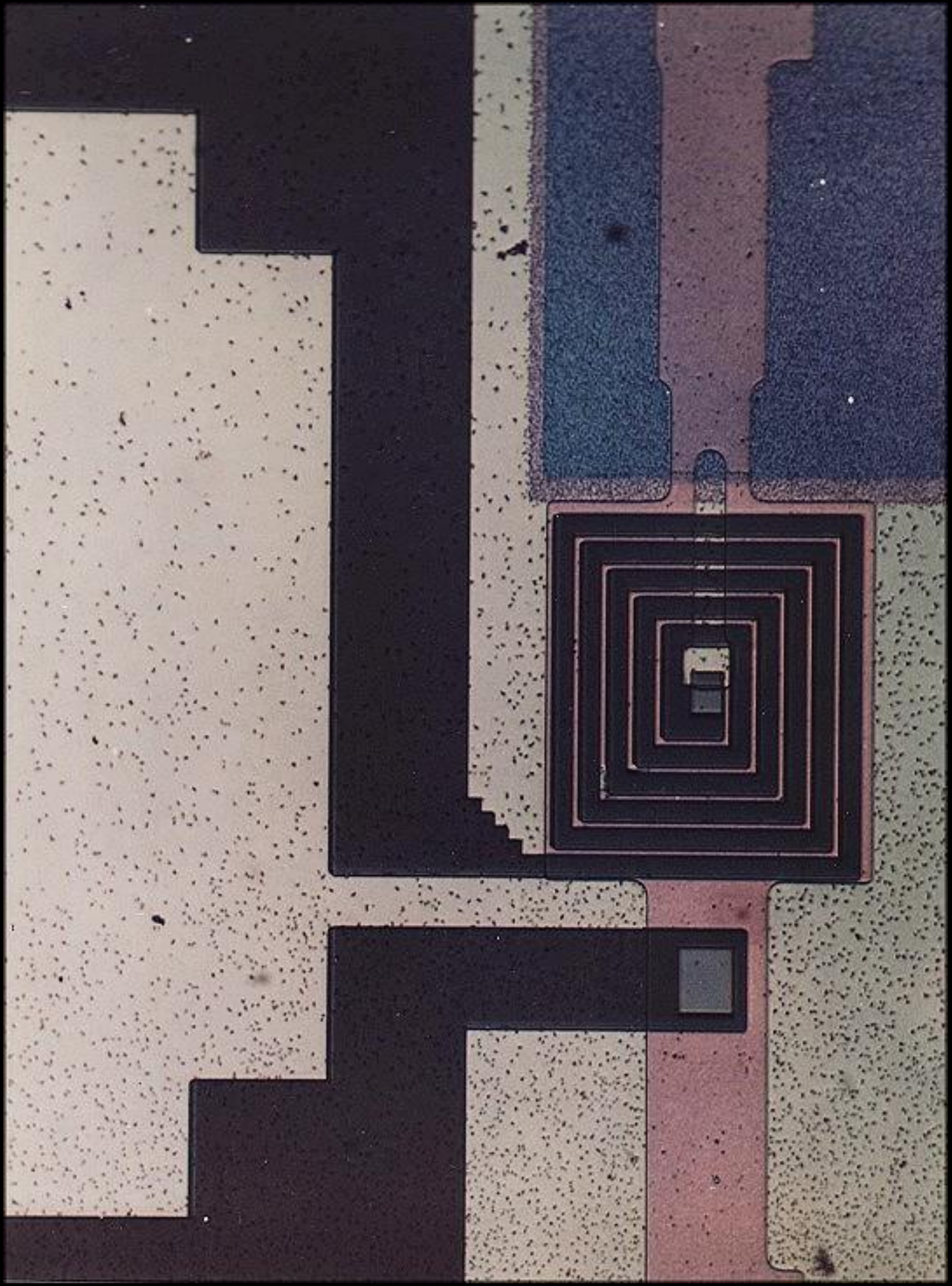
Thermal Absolute Pressure Gauge with On-Chip Signal Processor

C. Mastrangelo, Prof. Muller - 1990



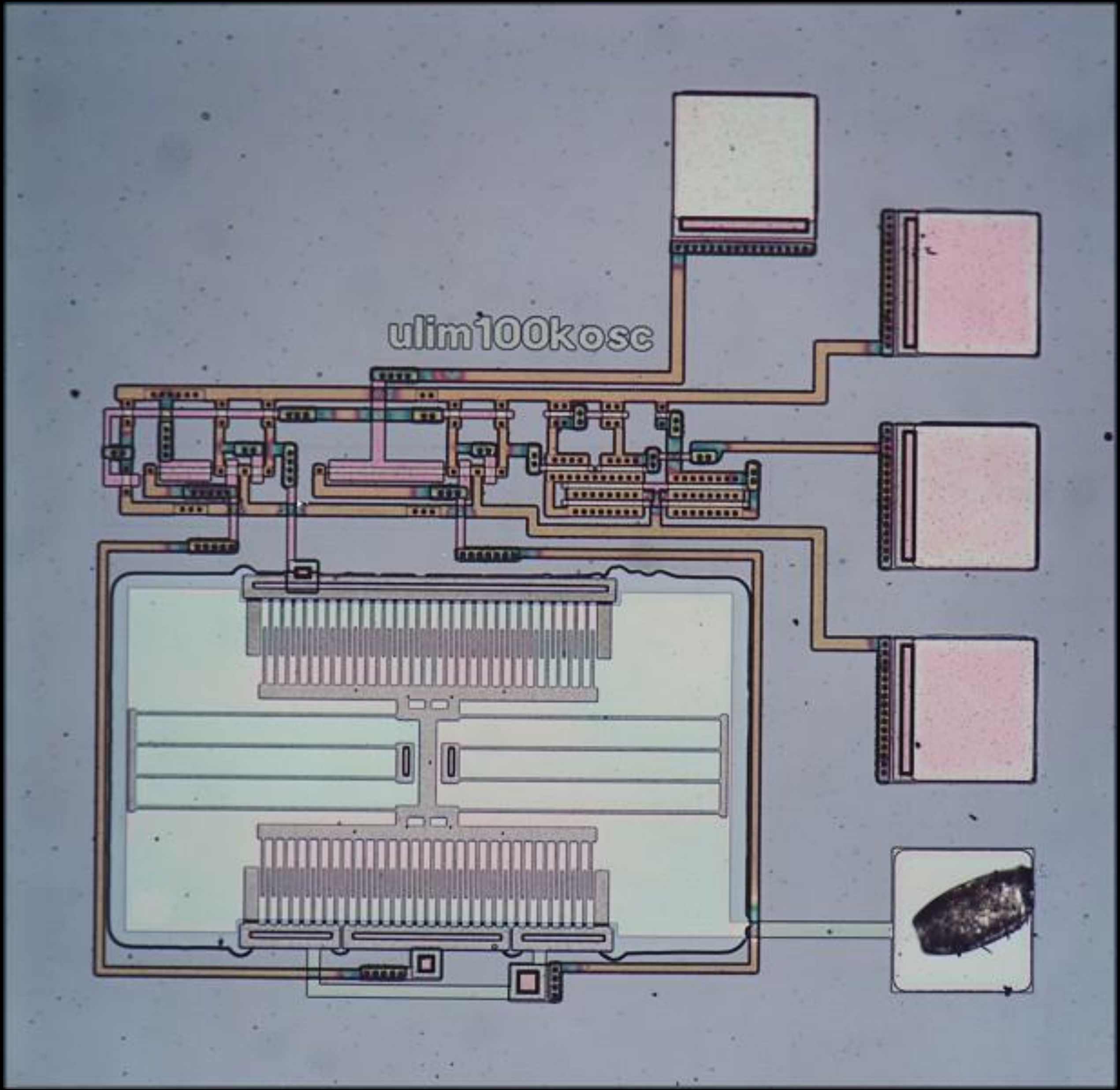
Surface Micromachined, Force-balance Accelerometer With On-chip Σ – Δ Modulator Using MICS Process

Weijie Yun, Profs. Howe & Gray - 1991



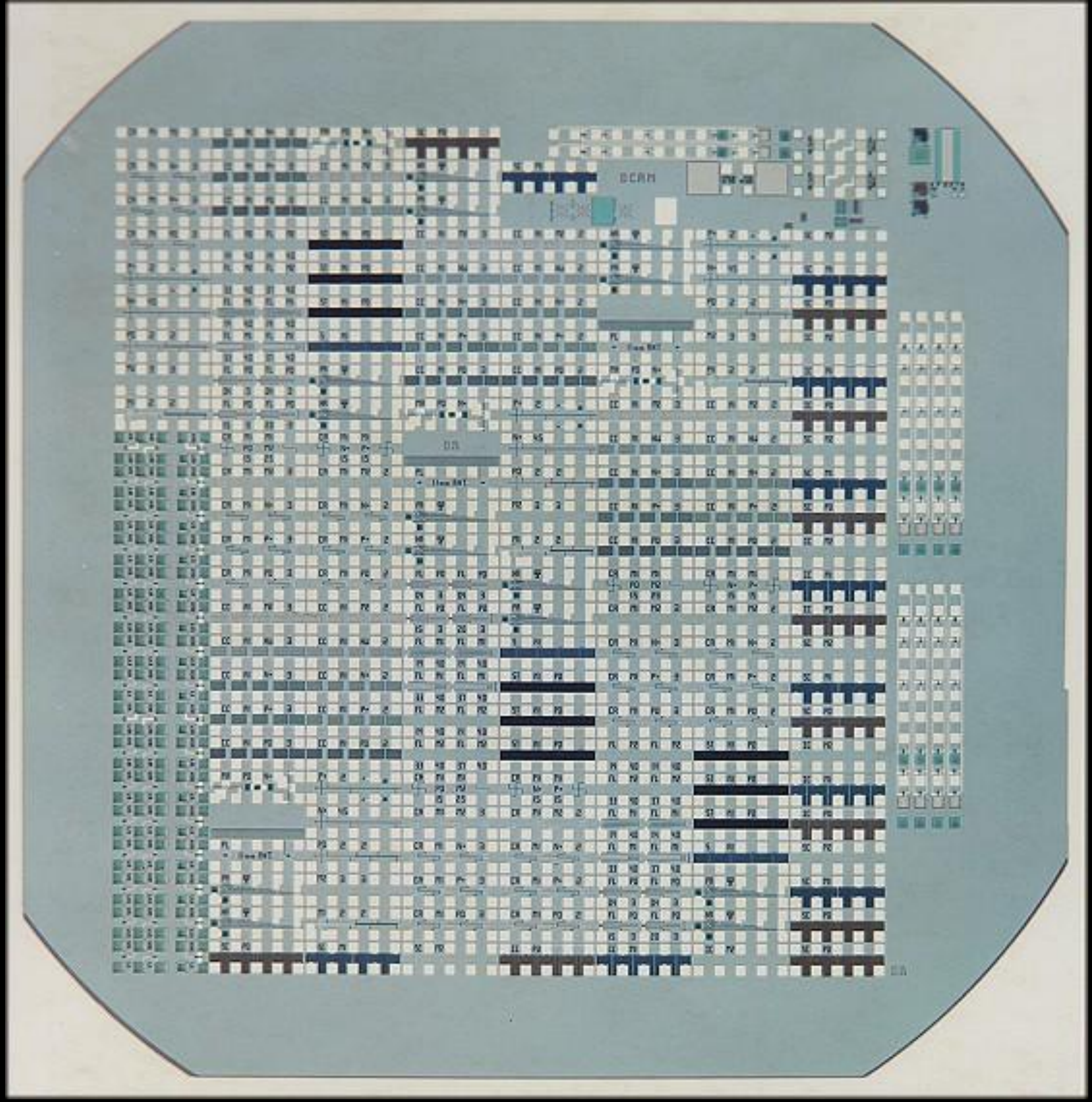
SQUID Magnetometer Fabricated from the High T_c Superconductor $YBa_2Cu_3O_{7-x}$ by Laser Deposition

J.J. Kingston, F.C. Wellstood, R.F. Kromann, Prof. John Clarke
1991



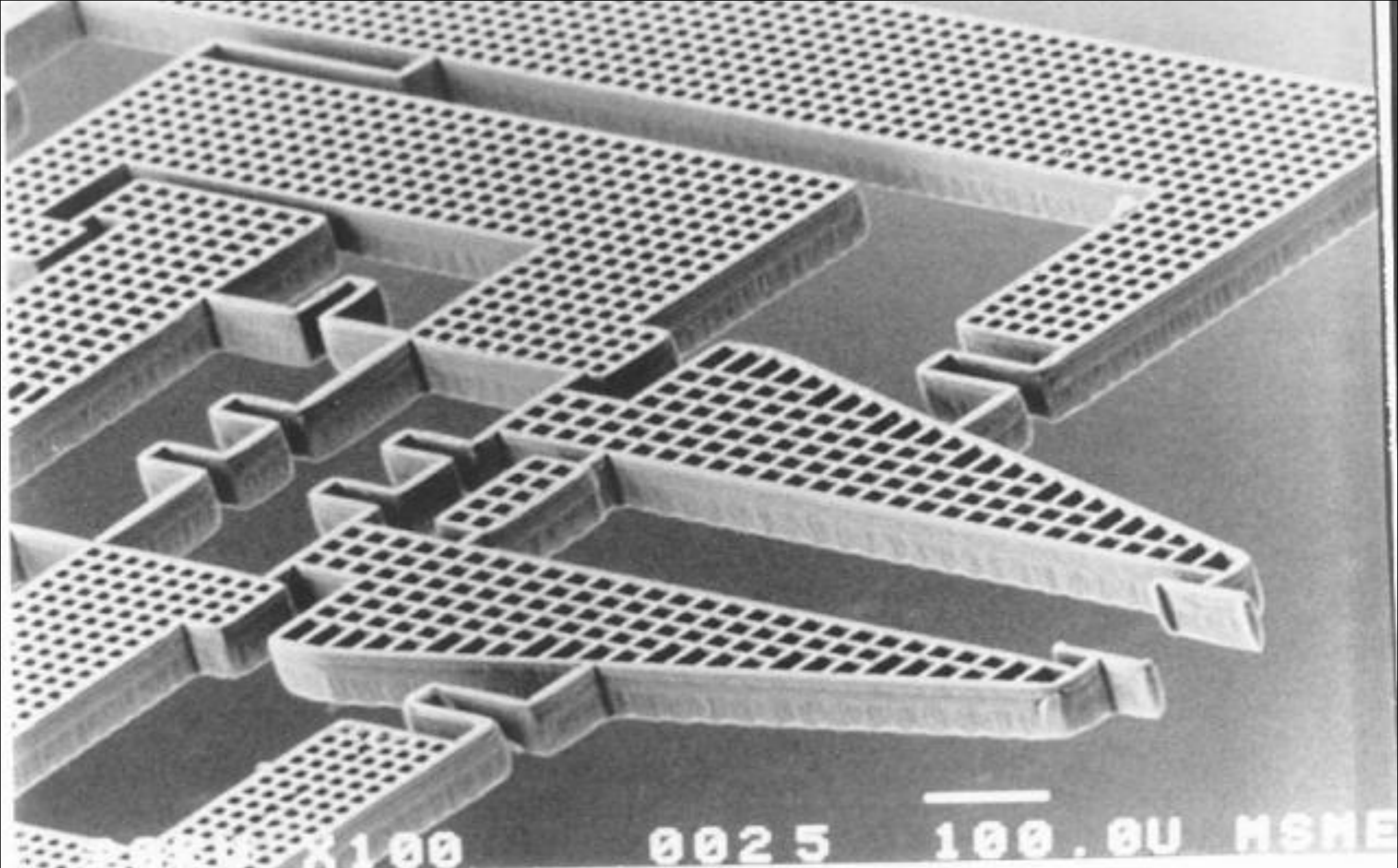
Integrated CMOS Micromechanical Resonator Oscillator

Clarke Nguyen, Prof. Roger Howe - 1993



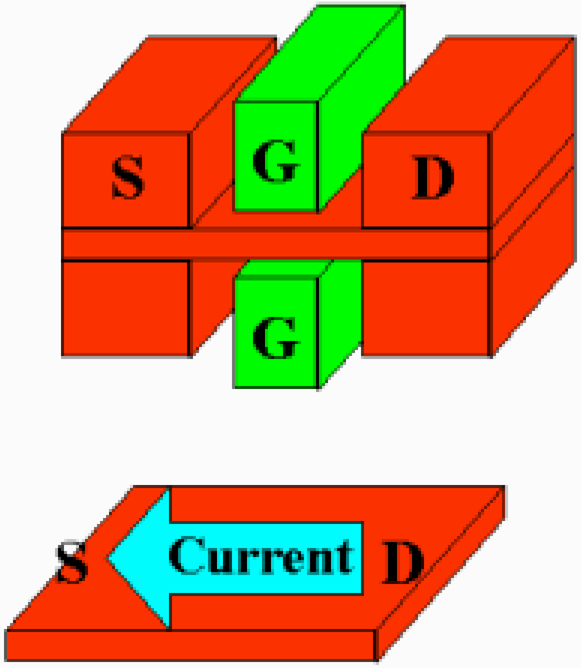
Chip Layout of a New Set of Electrical Test Structures Designed for Autoprobe Measurement

David Rodriguez - 1994

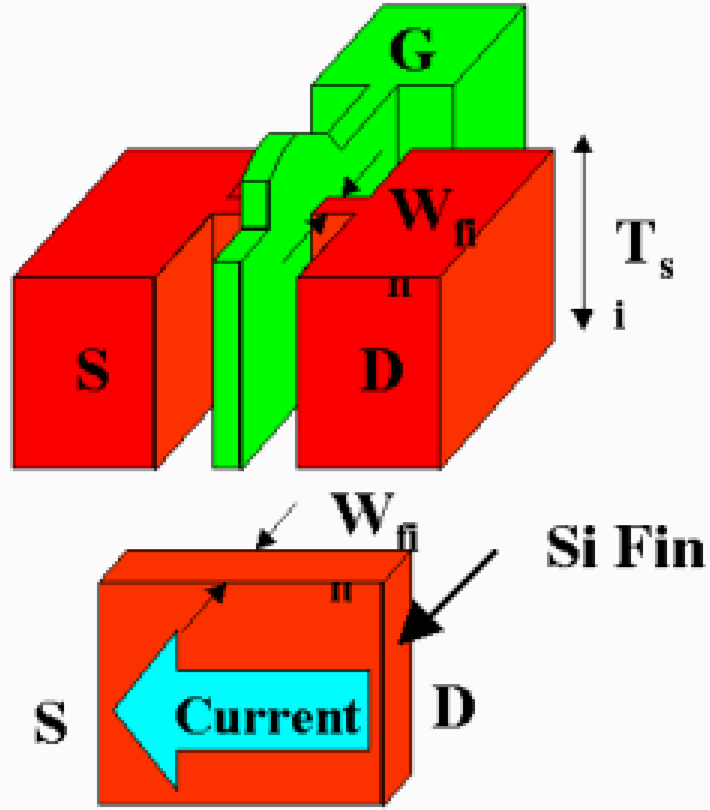


MOLDED POLYSILICON THERMALLY ACTUATED TWEEZERS WITH INTEGRATED CONDUCTING, SEMICONDUCTINGS, AND NON-CONDUCTING BEAMS Chris Keller/Roger Howe
80 µm tall beams with electroless nickel, doped polysilicon, or undeoped polysilicon composition

Device Structure

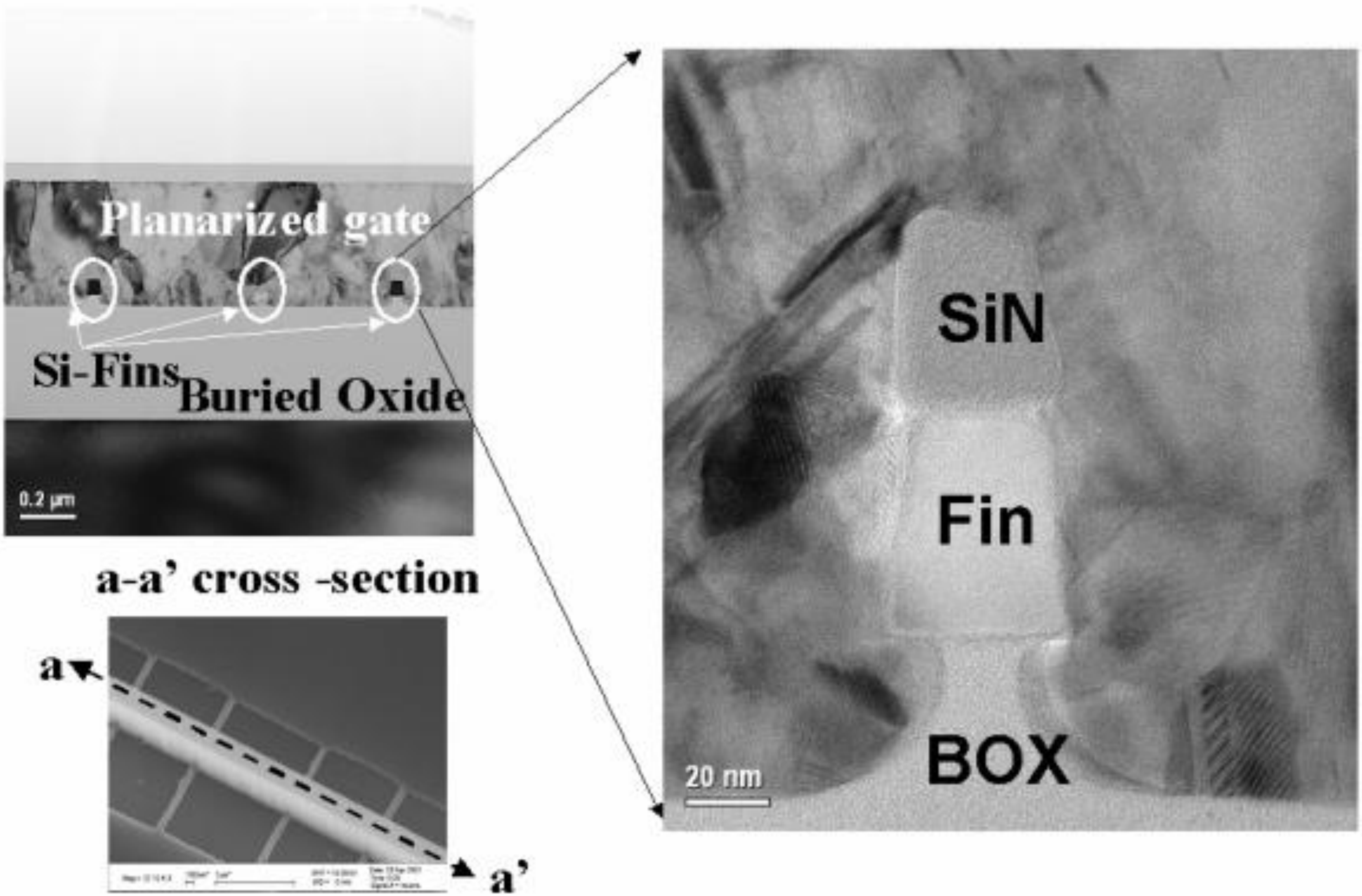


Horizontal Double Gate

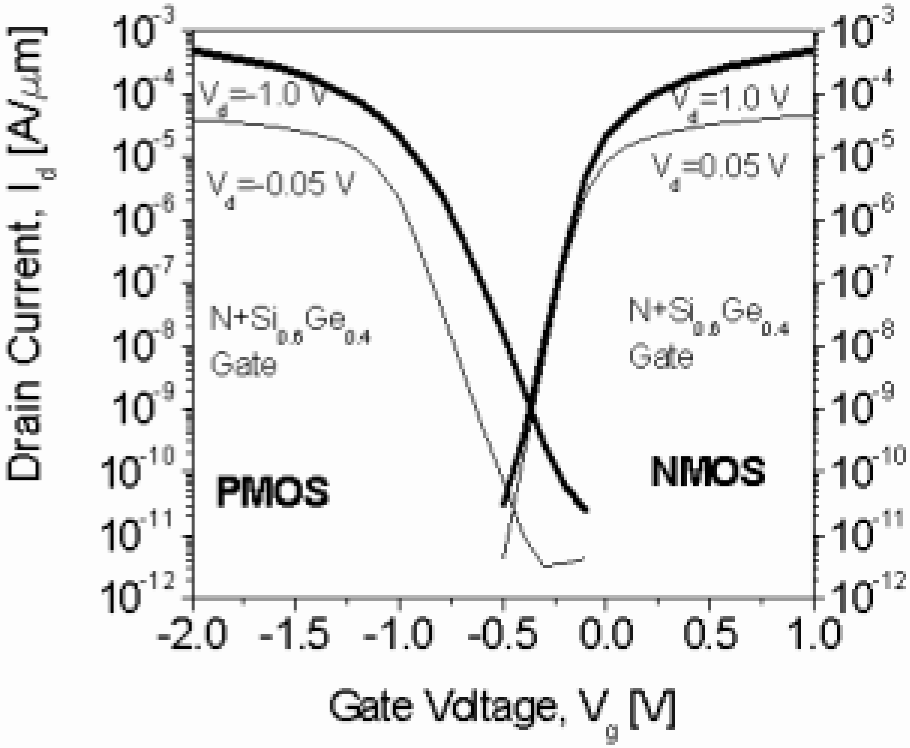


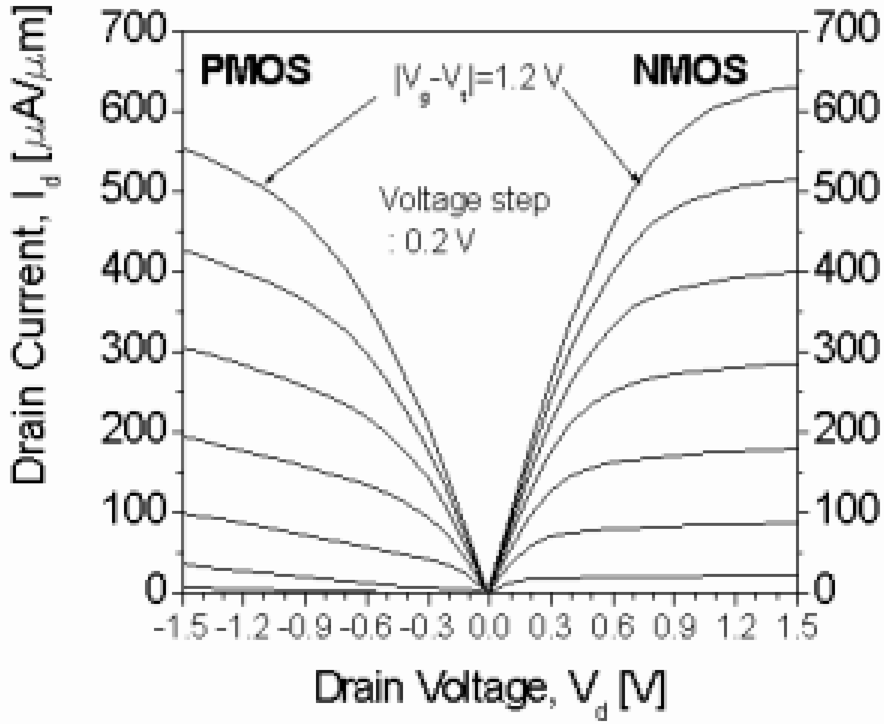
Vertical Double Gate (FinFET)

TEM Profile of Si-Fins



I-V Characteristics (L_g=60nm, W_{fin}=40nm, T_{ox}=2.5nm)



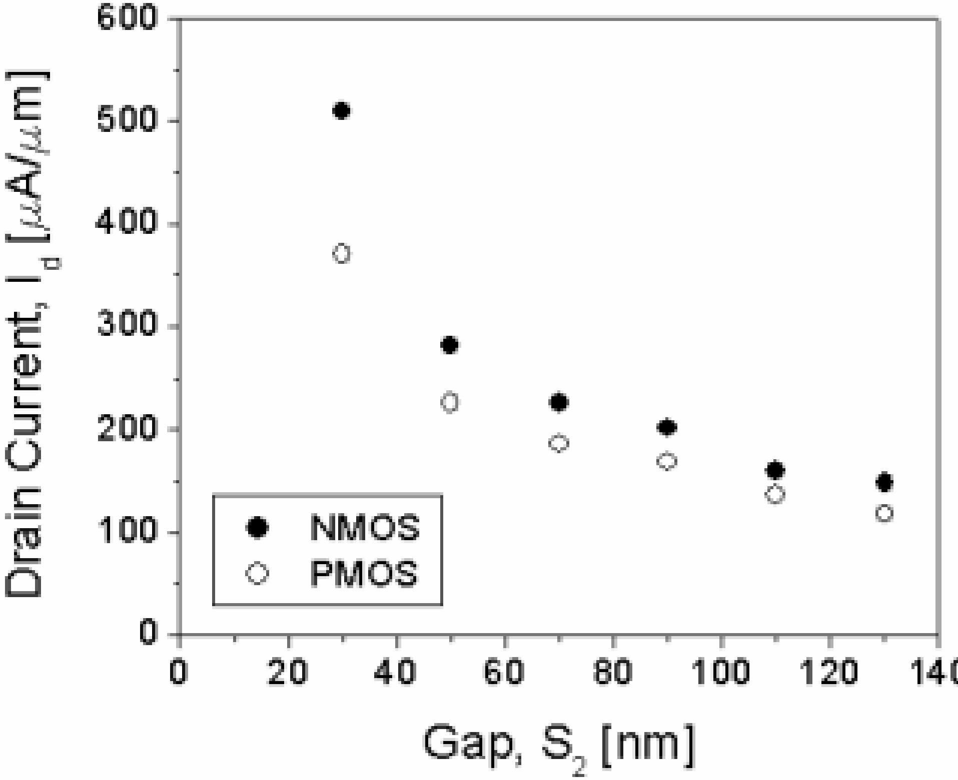


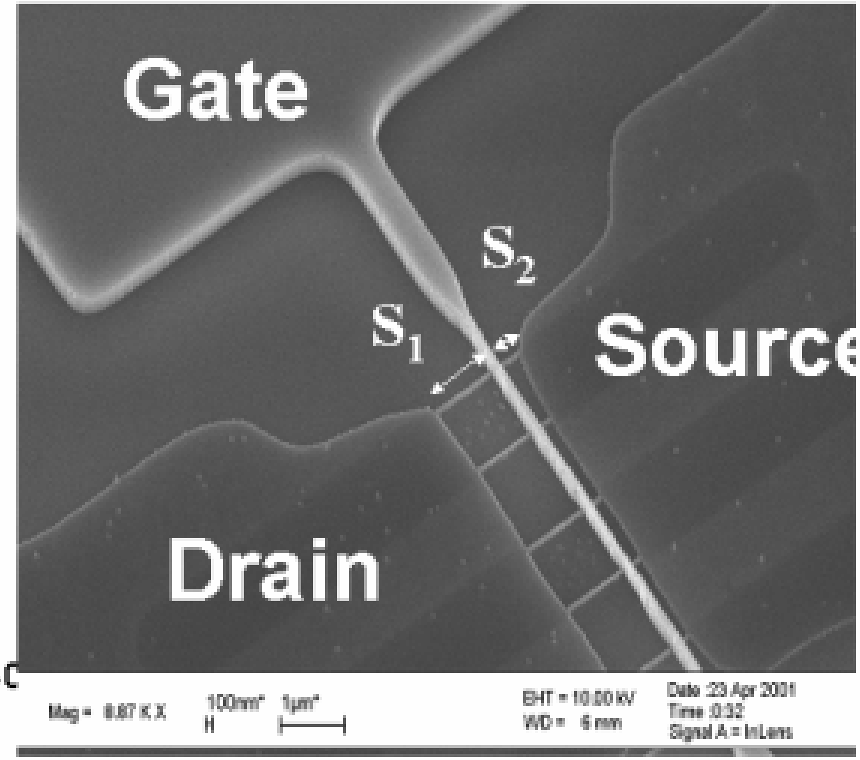
NMOS I_{on} is 500uA/um @V_g-V_t=1V and V_d=1V

PMOS I_{on} is -400uA/um @ $|V_g$-$V_t|$=1V and V_d=-1V or

***NMOS* I_{on} is 1mA/um and PMOS I_{on} is -0.8mA/um for the definition of double gate channel width.**

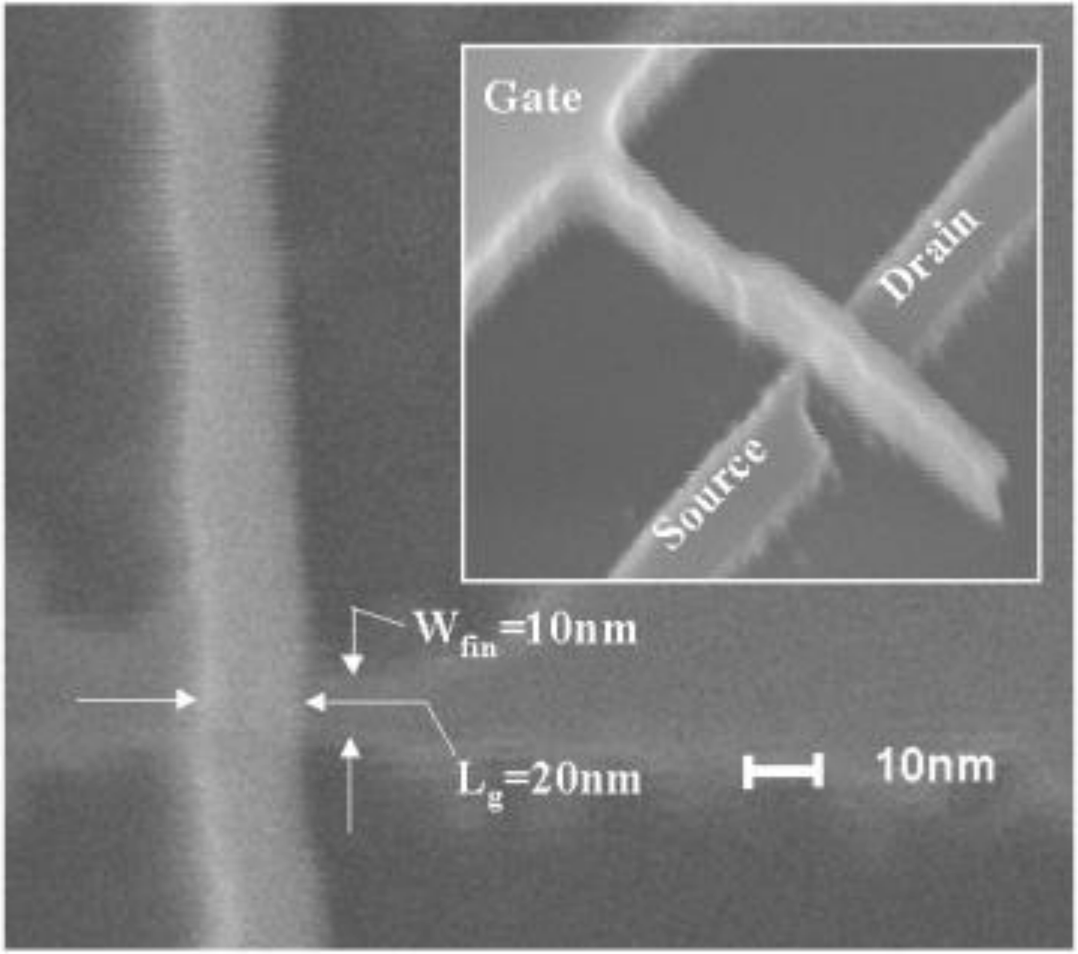
Drive Current vs. Extension Length





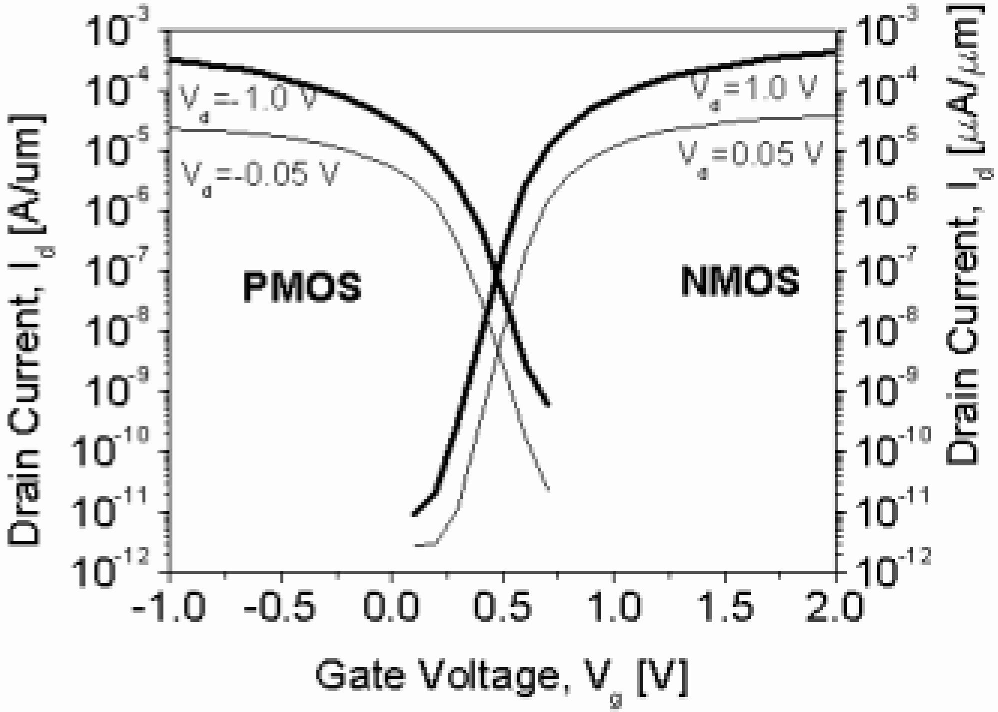
- **Smaller gap shows higher drive current.**

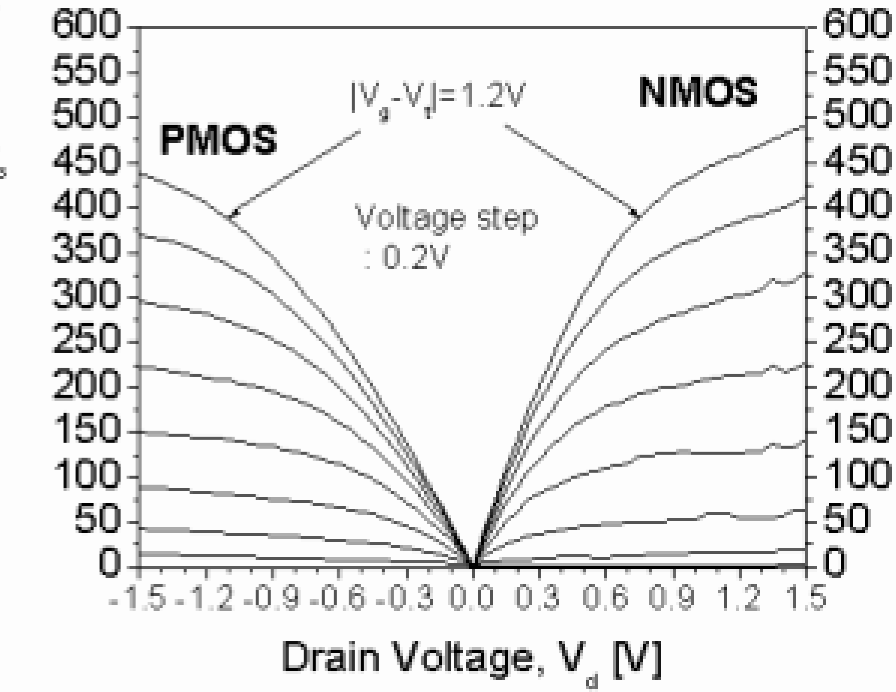
SEM for L_g=15nm and W_{fin}=10nm



- **The smallest MOSFET all over the world!**

I-V Characteristics (L_g=15nm, W_{fin}=10nm, T_{ox}=2.1nm)





NMOS I_{on} is 400uA/um @V_g-V_t=1V and V_d=1V

PMOS I_{on} is -330uA/um @ |V_g-V_t|=1V and V_d=-1V or

NMOS I_{on} is 800uA/um and PMOS I_{on} is –660uA/um for the definition of double gate channel width.

MOCVD Lab Opening

November 11, 1997