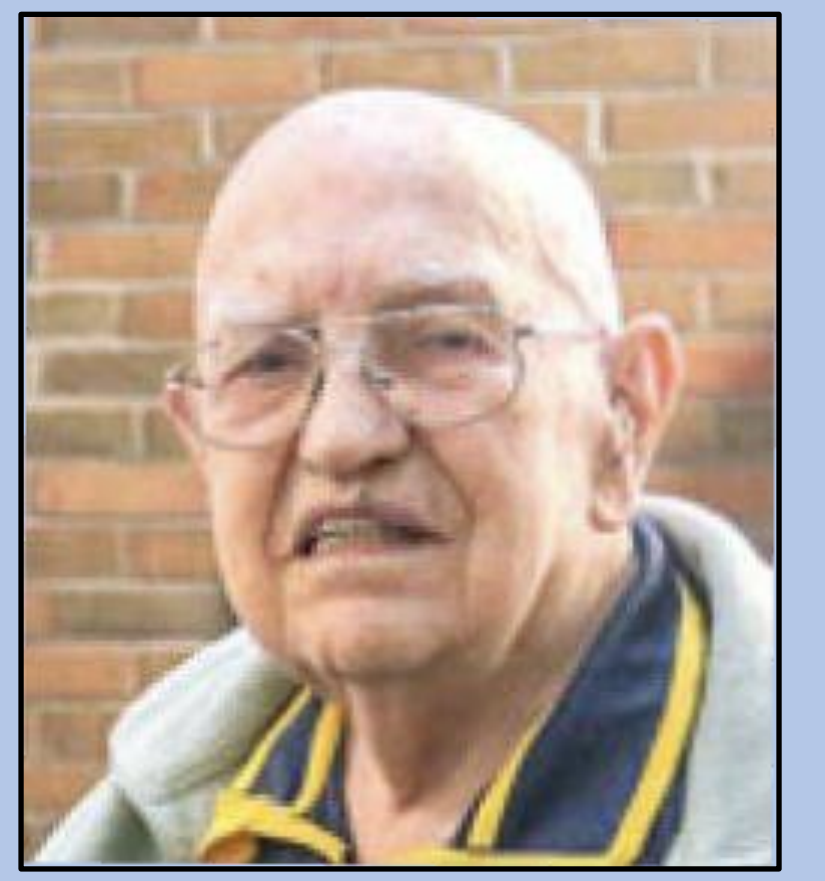


1969

Prof. Wilbur C. Bigelow at 100

Professor Emeritus
Materials Science & Engineering
University of Michigan, Ann Arbor, MI



2023



Wil with "balloon TEM"...modeled after poster picture

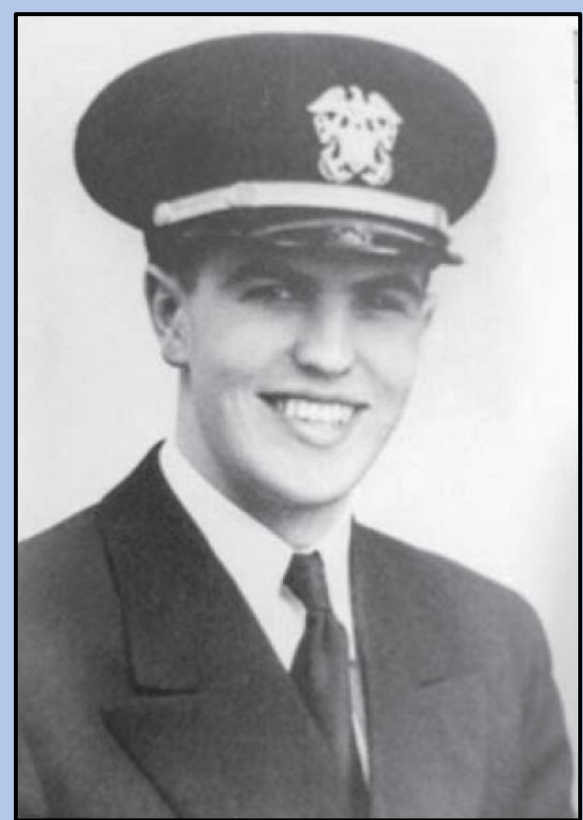
Birthday Party, MS&E Dept. Ann Arbor, March 2023



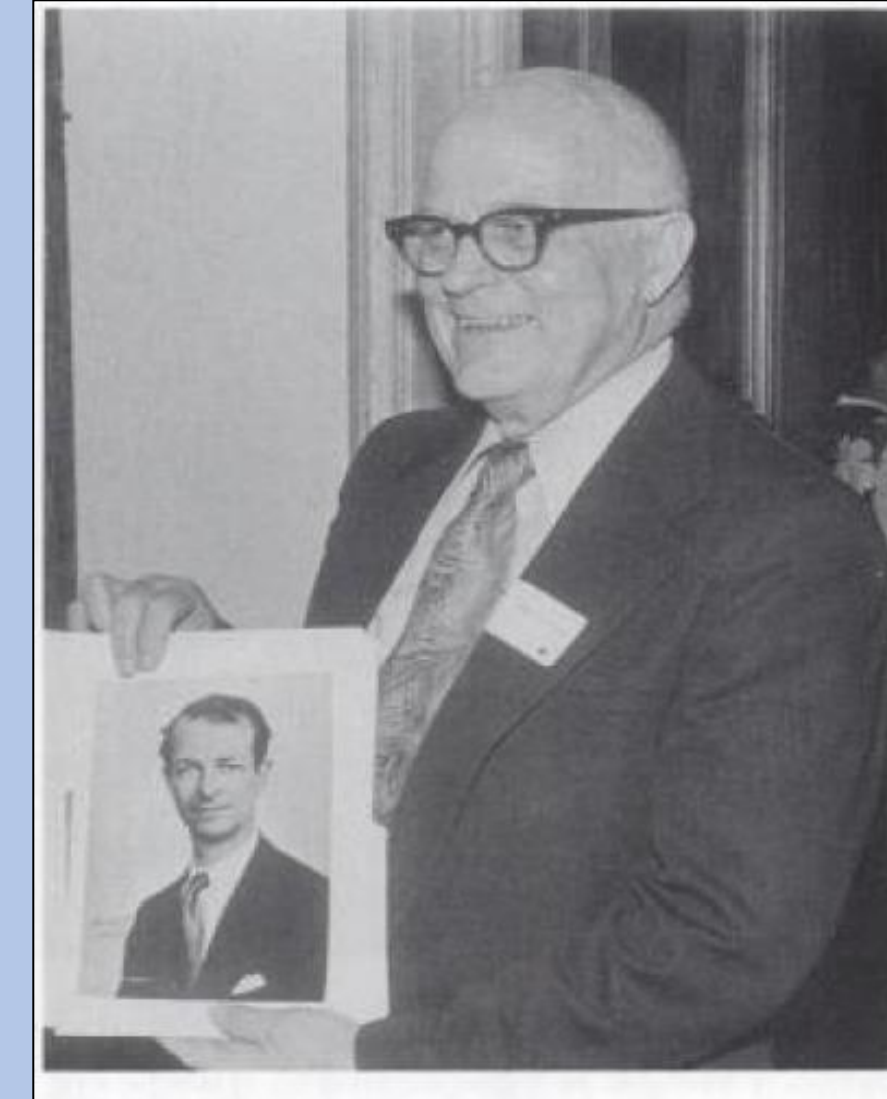
Wil with his birthday cake, March 2023

Biography

Wil Bigelow grew up in rural PA ("the hills of Pennsylvucky, just north of the of hard coal region"). He received a BS degree in Agricultural and Biological Chemistry from the College of Agriculture at the Pennsylvania State College in 1944. For the next two years he served on active duty as an Ensign in the U.S. Navy, doing research on special lubricating oils and rust inhibitors for Naval applications at the U.S. Naval Research Laboratory (NRL) in Anacostia, D. C. He then entered the University of Michigan Graduate School at as a Teaching Fellow in the Chemistry Department. During his graduate studies under Chemistry Prof. L. O. Brockway, he developed a deep interest in electron microscopy and electron diffraction. Brockway was the 2nd PhD student of Linus Pauling (pictured, 2 Nobel Prizes) at Caltech, and was the PhD advisor of Jerome Karle (Nobel Prize, Chemistry, 1985).

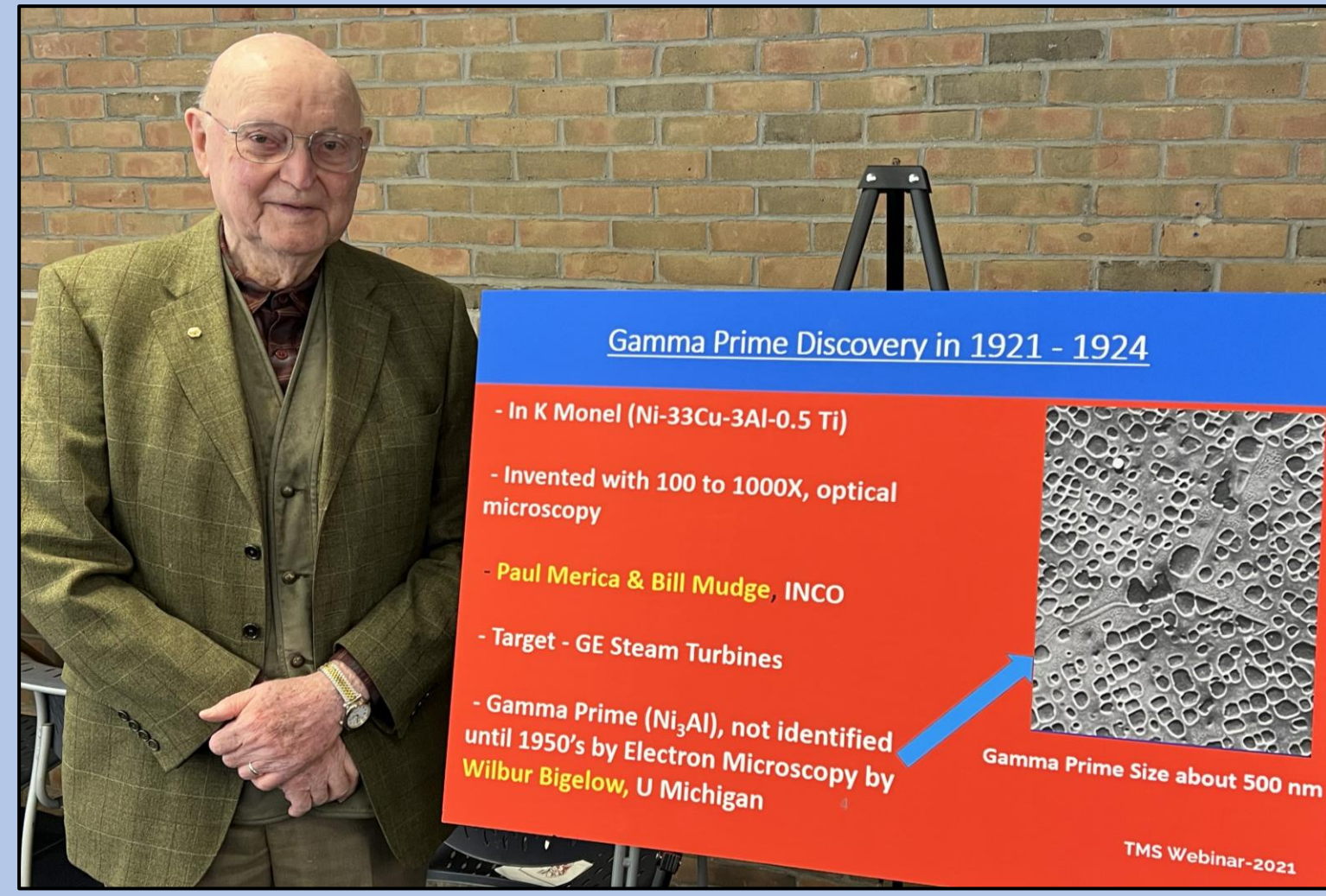
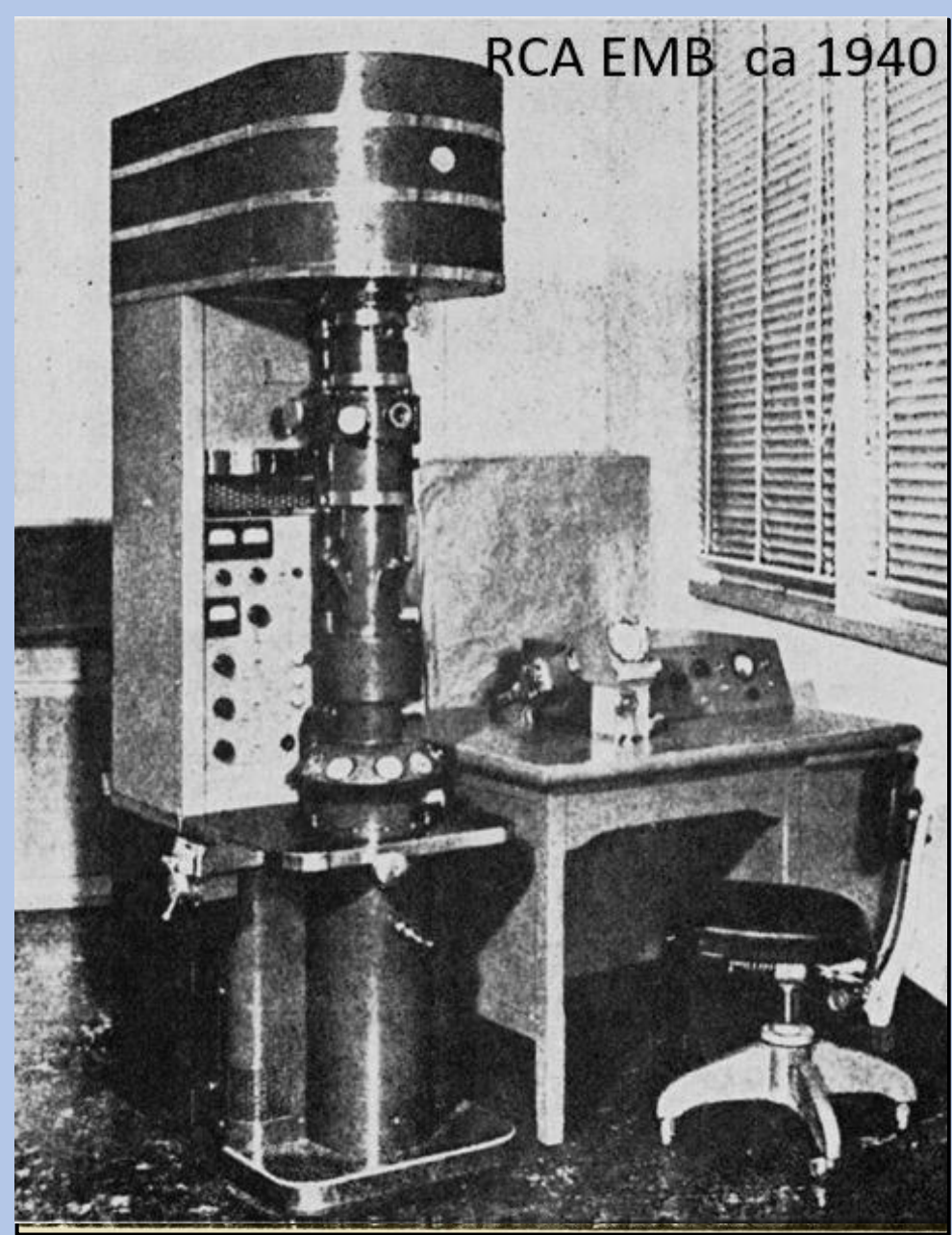


1946

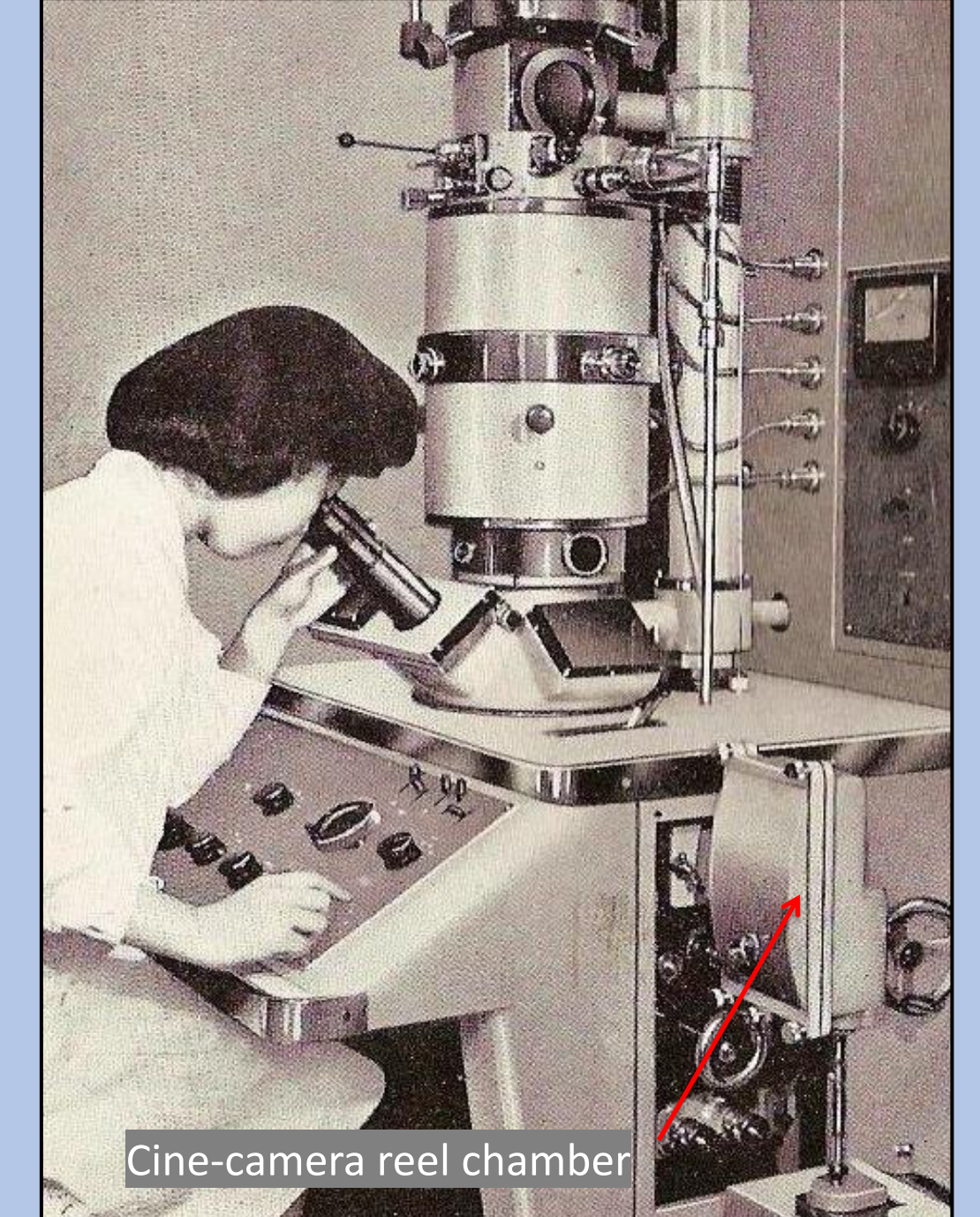
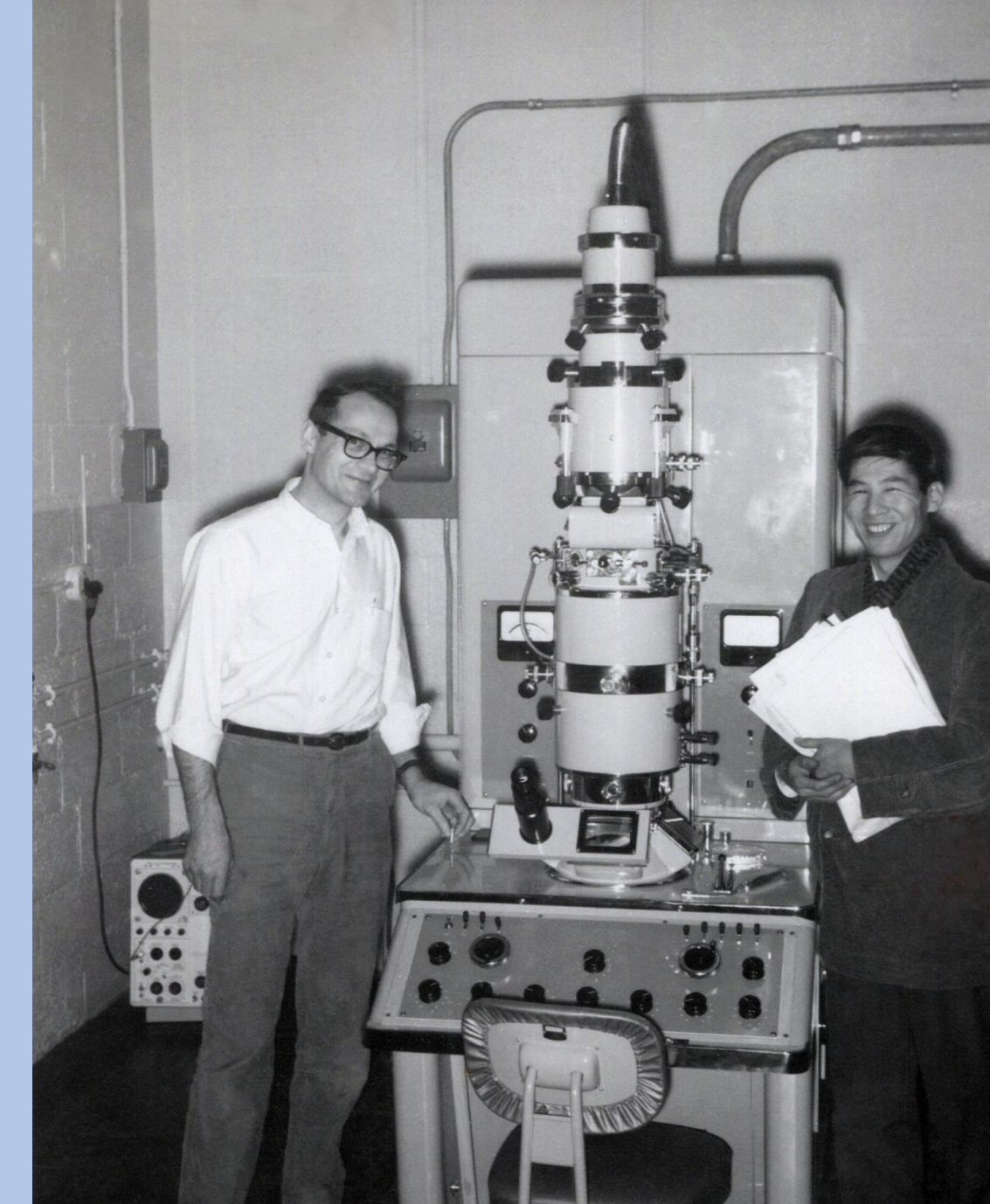


Prof. Brockway was also a **Founding Member of EMSA**, in 1942. Wil received an MS degree in Chemistry in 1948 and a PhD. in Physical Chemistry in 1951, then served on the research staff in the Michigan Engineering Research Center (UMERC), in Prof. Jim Freeman's High Temperature Metallurgy group. He joined the faculty in Chemical & Metallurgical Engineering in 1955, and became Professor of Materials Engineering in 1962. He retired from active teaching in 1993 as **Professor Emeritus** of Materials Science & Engineering.

Early Microscopy History



Dr. Raymond Decker (Bigelow student, member NAE, inventor of maraging steels) exhibiting a poster at the birthday party with an early Bigelow micrograph...the first to show details of gamma-prime morphology.

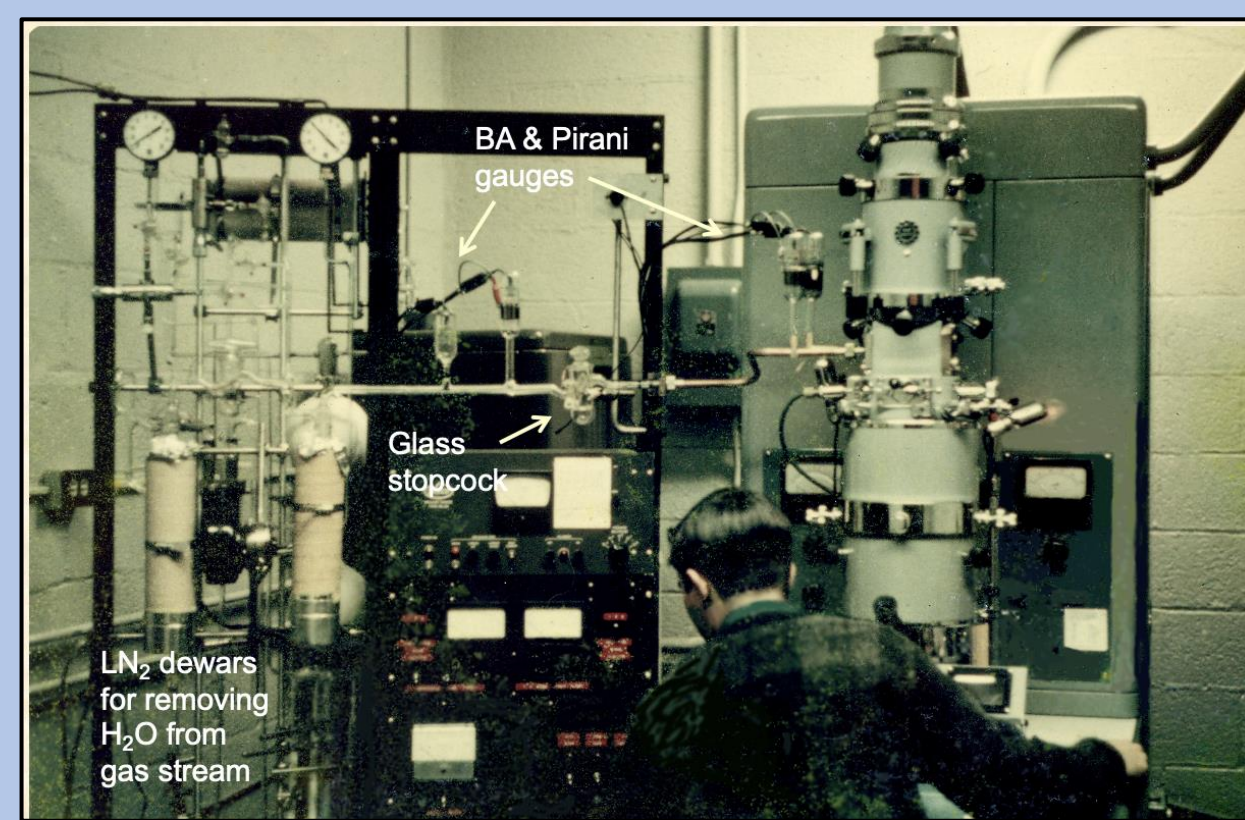


Wil learned EM initially in **1948** using the **#2 RCA-EMB** instrument in the world, delivered to the Physics Dept. at Michigan in late 1940. During his tenure in Prof. Freeman's group in the UMERC, he performed reflection low-energy diffraction at a grazing angle on nickel-based super-alloys. Coupled with imaging shadow-cast surface replicas, he was the first to identify the structure and morphology of gamma-prime precipitates, in the early '50s (Decker poster above). Brockway was known for his work on electron diffraction by gases under Pauling, and he acquired an early **RCA EMD** instrument, which was specially configured for gas and reflection diffraction studies. Wil utilized the EMD instrument for most of his superalloy studies.

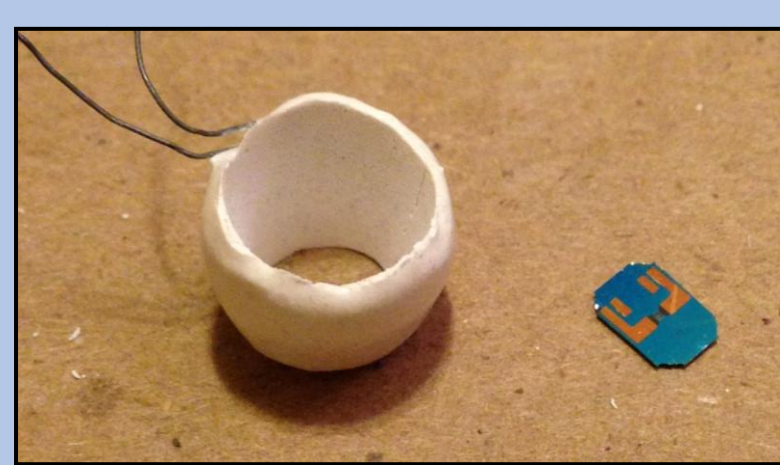
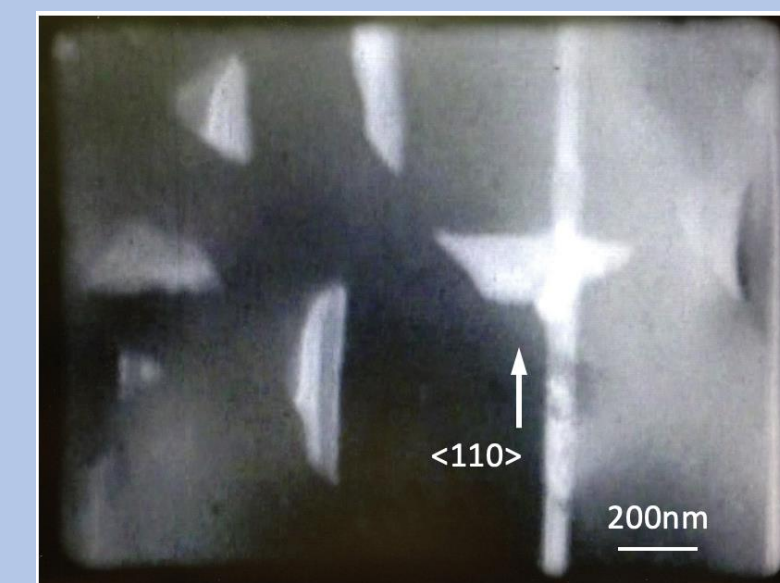
As Assistant Professor, Wil acquired an RCA EML microscope, operated at 50kV; and his early EM courses were taught on this instrument. In 1961, for \$37,000, he acquired a 100kV **JEOL JEM-6A** microscope, fully equipped with all available holders and a 16-mm cine camera (instrument just after installation shown above, with JEOL photo showing cine camera). The next year, the EML was sold to Biology for \$10K, and a second basic JEM-6A was added, for \$20,000. This established the department's **Electron Microscopy facility**.

Early In Situ Microscopy

Profs. Bigelow and Brockway collaborated on a study of the oxidation of thin copper single crystals, initially using a benchtop UHV reactor. In 1965, they extended the study to *in situ* electron microscopy using the JEM-6A cine camera. A special home-built stage and furnace system was fabricated, and a manifold for gas supply incorporated (figures).

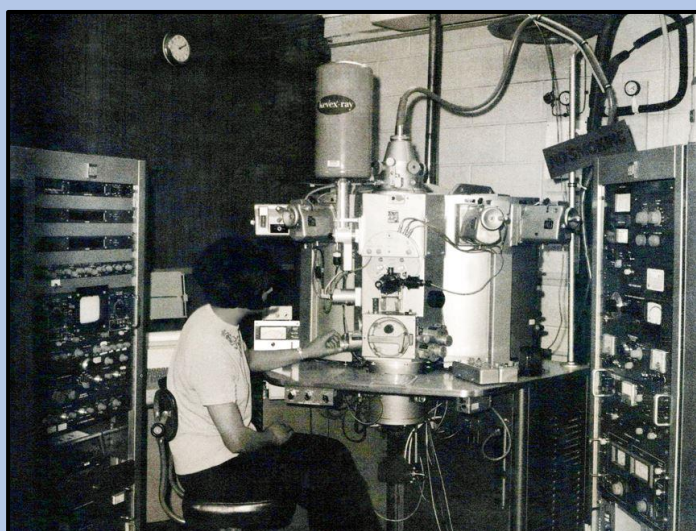


Undergraduate student Larry Allard running a gas-reaction experiment on the JEM-6A in 1965. Single frame from 16-mm film, and furnace compared to modern heater are shown.



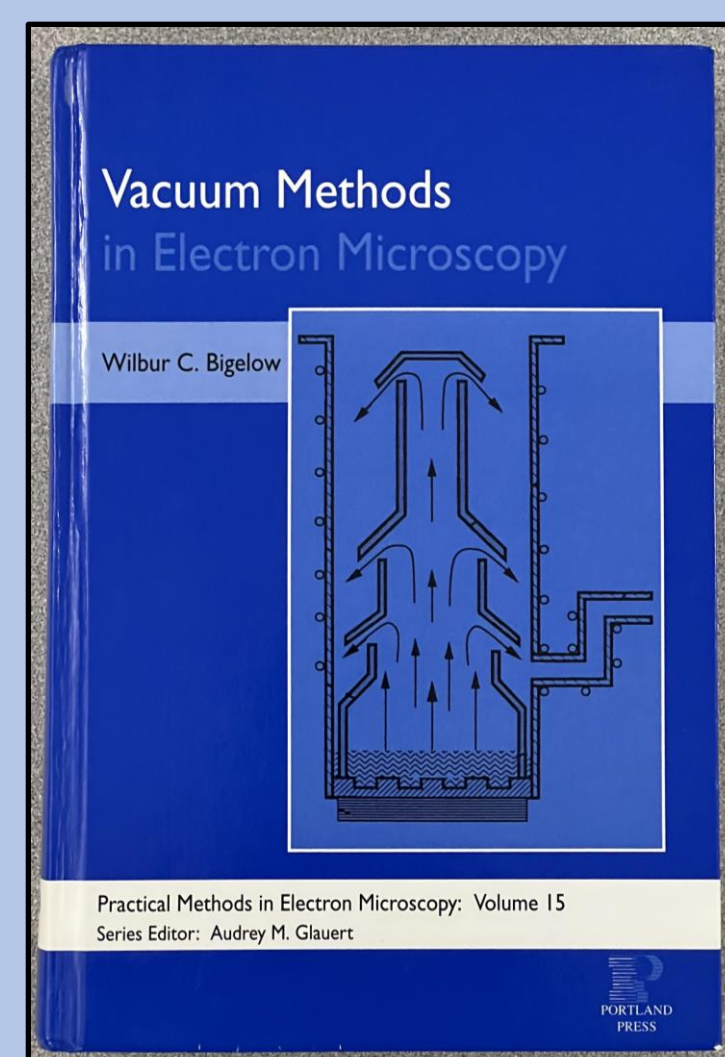
Microscopy Management

In 1969, Wil expanded the MME Department's EM facility with additional instruments, to establish the University's **Electron Microbeam Analysis Laboratory (EMAL)**, which he directed until 1987. The EMAL became a central University research facility that provided access to advanced electron optical instruments to researchers throughout the University. The laboratory was established with the acquisition of Michigan's *first* electron microbeam X-ray spectrochemical analyzer (an ARL EMX-SM Castaing microprobe), the *first* scanning electron microscope (a JEOL JSM-U3), the *first* AEM (a JEOL JEM-100CX), and the first surface-analysis instrument (PHI 5400 XPS).



In Retirement

Soon after retirement in 1993, at age 70, Wil's textbook "**Vacuum Methods in Electron Microscopy**" was published. He also became a consultant to the High Temperature Materials Laboratory at Oak Ridge National Laboratory (ORNL), for > 2 decades, and to several Universities and industrial companies. He specialized in the design and production of special-purpose devices for electron microscopes. In more than 45 projects, his devices have included a number of special-function specimen rods, reactors for exposing electron microscope specimens to reactive gases at high temperatures, high speed electron-beam shutters, cryogenic pumps and traps, and an electron holography biprism. To facilitate some of this work he established the consulting firm, **WCB Designs LLC**.



Modern In Situ Microscopy

In 2006, at age 83, Wil embarked on the next phase of his "retirement career" when he partnered with ORNL colleague Dr. Larry Allard and the founders of Protochips Co. on the development of novel heater devices based on microelectro-mechanical systems (MEMS) fabrication methods, a technology that has led to a dramatic expansion in the field of *in situ* heating and gas-reaction microscopy. Wil designed and fabricated the first single-tilt heating holder for the beta-test Protochips devices, compatible with the narrowest gap (2mm) pole piece of the JEOL TEMs. He followed with designing the first double-tilt heating holder, among several other holders he built for other microscopes. He guided the both the design of the first gas-handling manifold and the understanding of gas flow phenomena in the heating holders. He also contributed to the development of methods for handling water vapor in gas reactions (selected publications shown here).

MICROSCOPY RESEARCH AND TECHNIQUE 72:208-215 (2009)

A New MEMS-Based System for Ultra-High-Resolution Imaging at Elevated Temperatures
LAWRENCE F. ALLARD¹, WILBUR C. BIGELOW², MIGUEL-JOSE YACAMAN³, DAVID P. NACKASHI⁴, JOHN DAMIANO⁵, and STEPHEN E. MICH⁶
¹Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831
²Department of Materials Science & Engineering, University of Michigan, Ann Arbor, Michigan 48109
³Department of Chemical Engineering, The University of Texas at Austin, Austin, Texas 78712
⁴Protochips Inc., 840 Main Campus Drive, Suite 5000, Raleigh, North Carolina 27606

Microsc. Microanal. 18, 656-666, 2012
doi:10.1017/S144676812001249

Microscopy in Microanalysis
MICROSCOPY SOCIETY OF AMERICA 2012

Novel MEMS-Based Gas-Cell/Heating Specimen Holder Provides Advanced Imaging Capabilities for In Situ Reaction Studies
Lawrence F. Allard,¹ Steven H. Overbury,¹ Wilbur C. Bigelow,² Michael B. Katz,³ David P. Nackashi,⁴ and John Damiano⁵
¹Physical Science Directorate, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
²Department of Materials Science & Engineering, University of Michigan, Ann Arbor, MI 48106, USA
³Protochips Inc., 617 Thomas St., Suite 111, Raleigh, NC 27606, USA

Microscopy and Microanalysis 20(20), 206-219
doi:10.1017/S1446768120001885

Original Article
Introducing and Controlling Water Vapor in Closed-Cell *In Situ* Electron Microscopy Gas Reactions
Kinga A. Unocic¹, Franklin S. Walden², Nelson L. Marthe³, Abhaya K. Datye⁴, Wilbur C. Bigelow⁴ and Lawrence F. Allard⁵

Society Service and Honors

- (E)MSA:
- Executive Council, 1950s
 - Program Chair, 1960
 - Director Physical Sciences, 1961-1963
 - President Michigan Chapter, 1965
 - National Membership Secretary, 1966-67
 - President of "EMSA," 1969
 - Elected **MSA Fellow**, 2019



Wil delivering the President's remarks at the EMSA Banquet, Minneapolis, 1969 (Age 46)



- MAS:
- Charter Member of the Society
 - Named 1 of 28 MSA "Legends" 2018
- Wil receiving the "Legend" plaque from MAS President Masashi Watanabe, Baltimore, 2018 (Age 95)