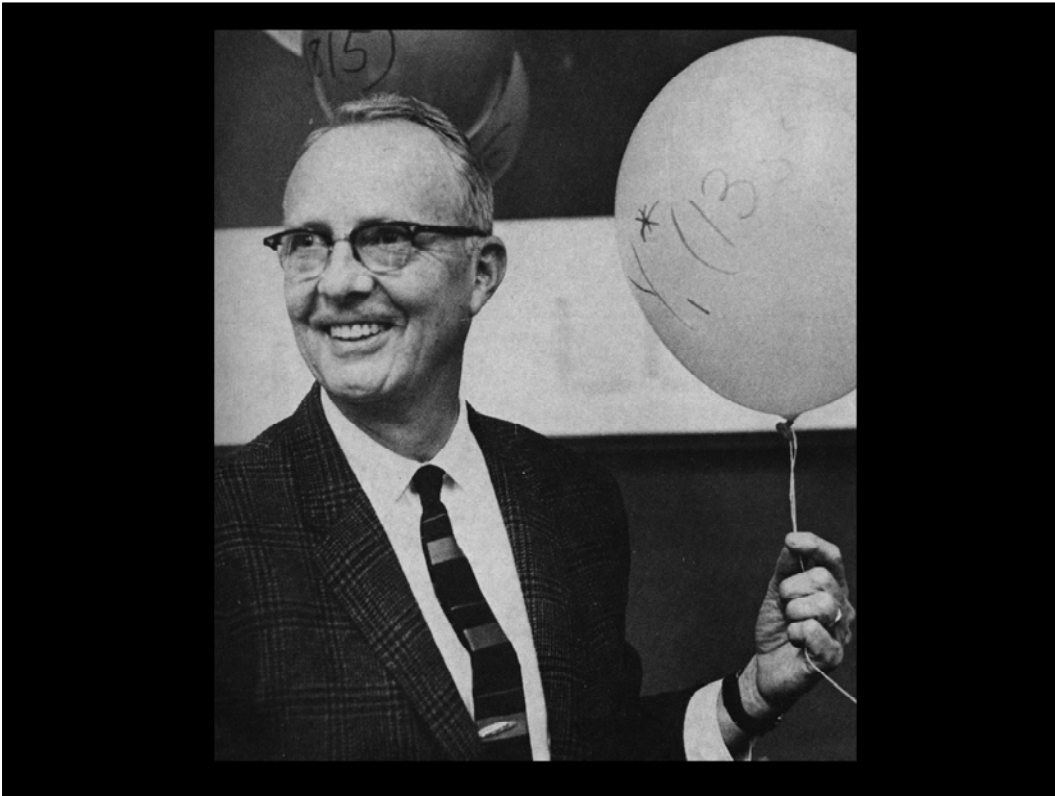


Working with Luis Alvarez



I was the last graduate student of Luis Alvarez. Everyone called him “Luie.” I couldn’t, not for a long while.

To the world he was many things – so many, in fact, that the list borders on the implausible. He was the great experimental physicist, the leader of a team whose discoveries with the liquid hydrogen bubble chamber won him a Nobel Prize.



I was his graduate student at the time. But the day of the announcement was still the most exciting day of my life.

Champagne flowed freely in his office for over a week.



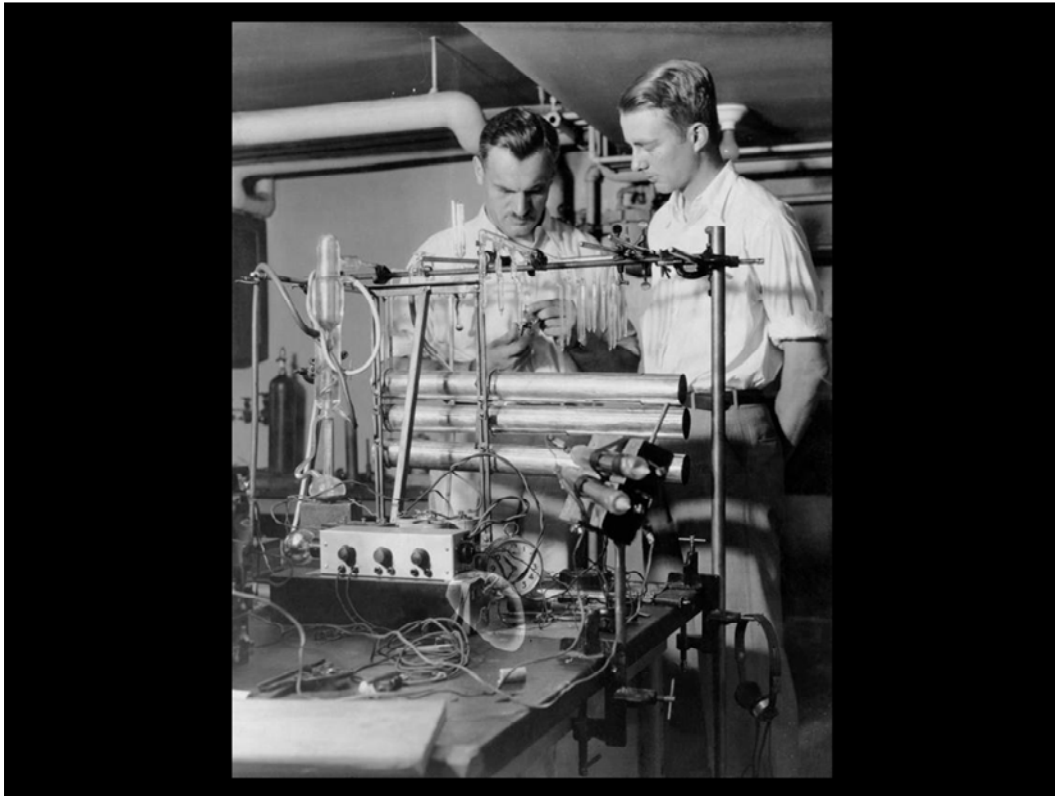
Here he is accepting the Nobel Prize. Both Art and Moishe Pripstein were there... because Alvarez felt so indebted to them that he invited them at his expense.



This is a photo of the young Luis Alvarez with the B ionization chamber that he built – one of the first in the U.S. Alvarez was always proud of the fact that he could build things in the shops better than any technician or machinist. He taught me with pride how to “throw” a bandsaw for storage. It’s a nice trick that I’d be happy to teach anyone here.

[And here a story about a \$20,000 photomultiplier tube....]

I recognized that Luie was truly a great teacher. That PM story was typical. He wanted to convey the legacy of Lawrence. In fact, I think he outdid Lawrence as the greatest experimental physicist of the 20th century.

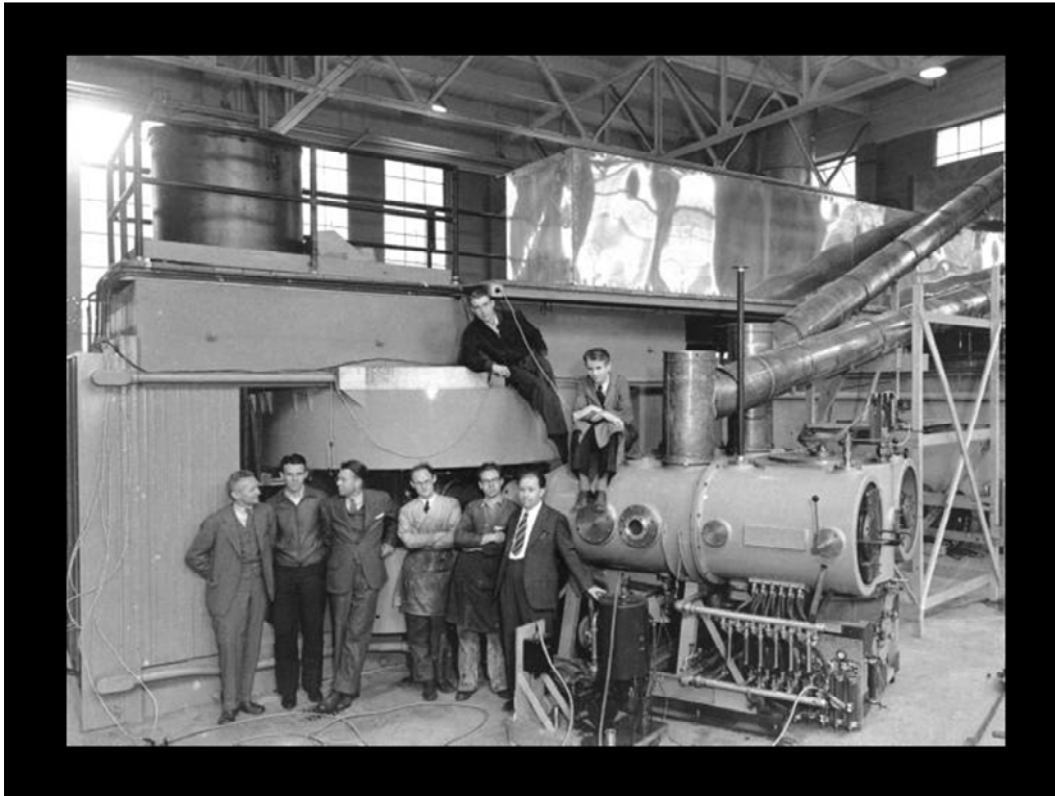


Before World War Two taught the world the meaning of the word *physics*, Luis called himself a "chemist." This is a photo of Luis with then colleague and later rival Ed McMillan – who did win a Nobel Prize in chemistry.

This is more typical garb than in the official photos. Short sleeves or rolled up. Hands in pockets. Always hands in pockets when visiting a lab.

He was always trying to teach me to think think think. Don't get lazy by just staying in the lab and doing your job. What have you learned in the last week?

His long list of important discoveries in this period – including the charge of cosmic rays, the magnetic moment of the neutron, electron capture by nuclei, and the radioactivity of tritium – were responsible in part to his election to the National Academy of Sciences at an earlier age than any of his predecessors.



That's his mentor Ernest Lawrence with Luie with one of his intermediate-sized cyclotrons – the 40-inch? That's Lawrence third from left, and Luie up on the top. In many of the old photos, Luie found a unique place to put himself.

Luie was a snooper. He would check me to see if *I* had snooped lately. If there was a nearby lab and I wasn't familiar with it, I was not doing my job. Go there. "Keep-out" sign? Go past it. If you are caught, ask the scientist what the experiment is about. Show genuine interest, and you'll have a world-class scientist telling you about his best work, and he'll (or she'll) invite you to come back again for an update.



I love this old photo. It shows Luie's playfulness. In his youth he loved limericks and practical jokes. [His] Favorite was at Chicago [involving a] Lecture in a room next to his, with a pompous professor... Set[ting] up [a] Foucault's pendulum.



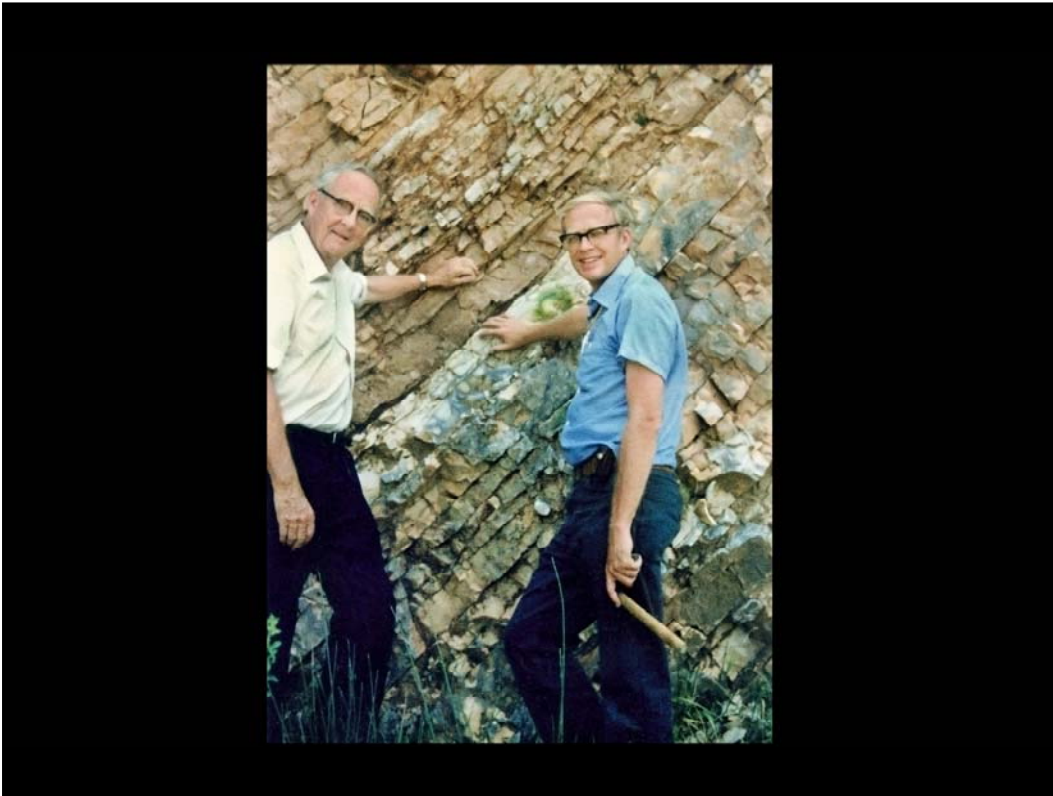
He always credited Lawrence with having invented Big Science, but in the 1960's Luie's bubble-chamber team was several hundred people strong, and the largest in the world. Luis and his colleagues were largely responsible for the vast expansion in the list of subnuclear particles, from just a handful to over a hundred. Here in this photo Luie is sitting in the middle, and you might recognize Art Rosenfeld, sitting just to his right.



“What a waste of time. Outside of his field.” The word in the hallways: he had finally gone senile. “Working on a ridiculous problem, outside his area of expertise. Just because he wanted to work with his son.” (Note the resemblance.)

I listened to his progress reports, but did not get involved. Too much a waste of time....

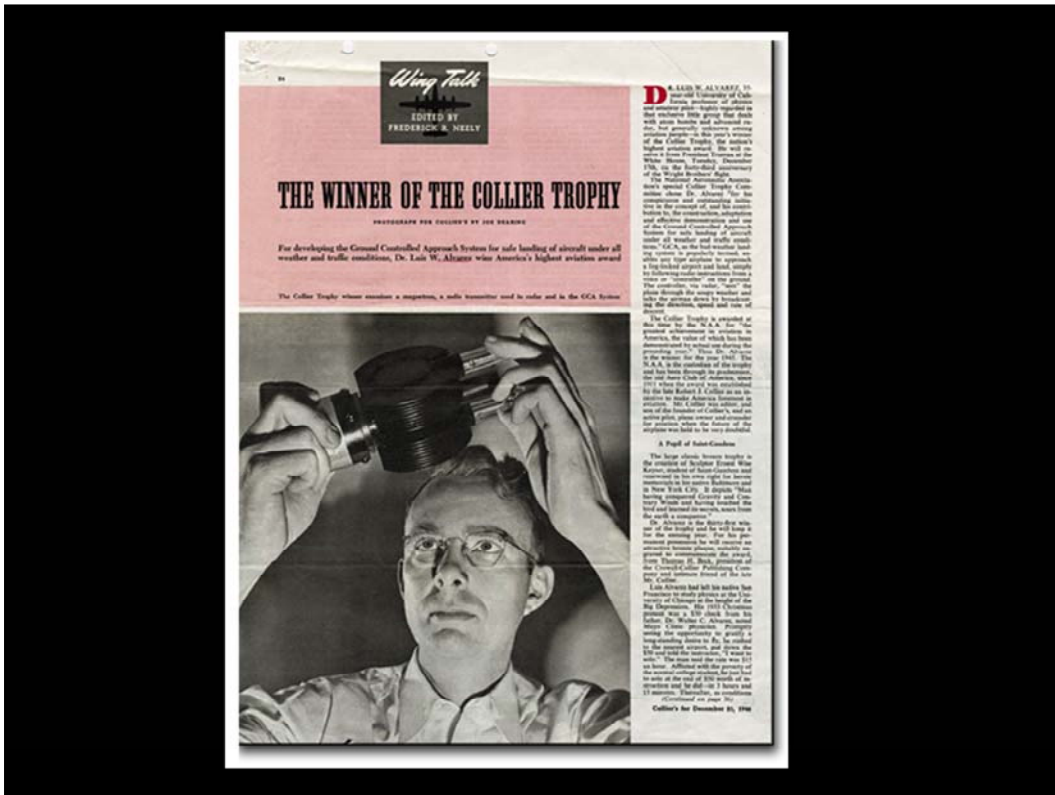
Much of the world will remember Luis as the interdisciplinary scientist whose impact discovery and theory for the Cretaceous Catastrophe has had a major impact itself on paleontology, geology, geophysics, astrophysics, and our understanding of evolution. This was born out of a collaboration with his son Walter....



Here is Luie with Walter at the KT [Cretaceous-Tertiary] boundary near Gubbio, Italy. This is where Walter took the sample that led to the discovery. Luie and Walter also set a role model for me; I am now working with my daughter Elizabeth on a new global-warming study.

So I was wrong [about that “waste of time”].

It is particularly wonderful that Luis and his son Walter received a special honor, an honor that is extremely rare for living scientists. In honor of them and their great contributions, the International Astronomical Union accepted the recommendation of Dr. Eugene Shoemaker, the discoverer of a new asteroid, that the asteroid be named Asteroid Alvarez, not just after Luis but after the father-and-son team of Luis and Walter. I believe that the greatest joy in the last decade of Luis' life came from working closely, professionally, and creatively with his son Walter.



Others think of Luis as an inventor, the holder of 40 patents, patents notable for their diversity and importance, including GCA (Ground Controlled Approach), the Microwave Early Warning System, the Alvarez Linear Accelerator, the tandem version of the van de Graaff [accelerator], the Materials Testing Accelerator (MTA), and numerous clever optical devices.

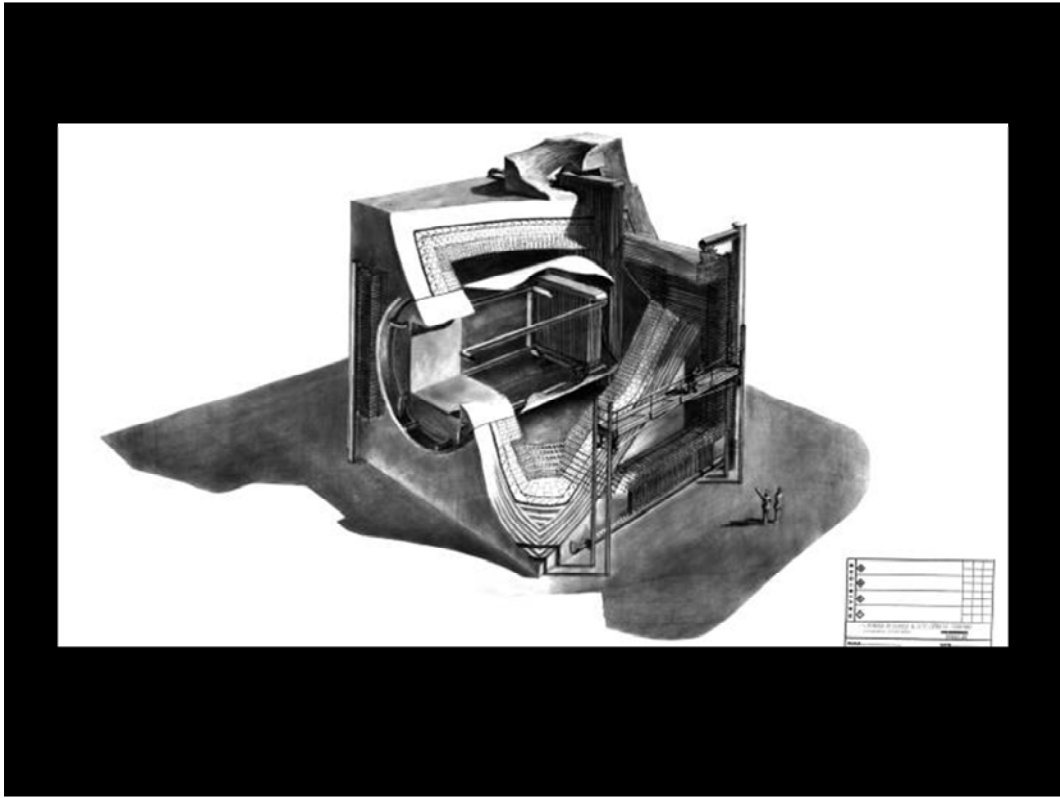
WWII. He worked in the MIT Rad Lab in his own division, devoted to his inventions. In the UK, at Los Alamos, and in the Pacific.

[Here, two stories: 1/r3 radar [and] Trigger for the Nagasaki bomb.]

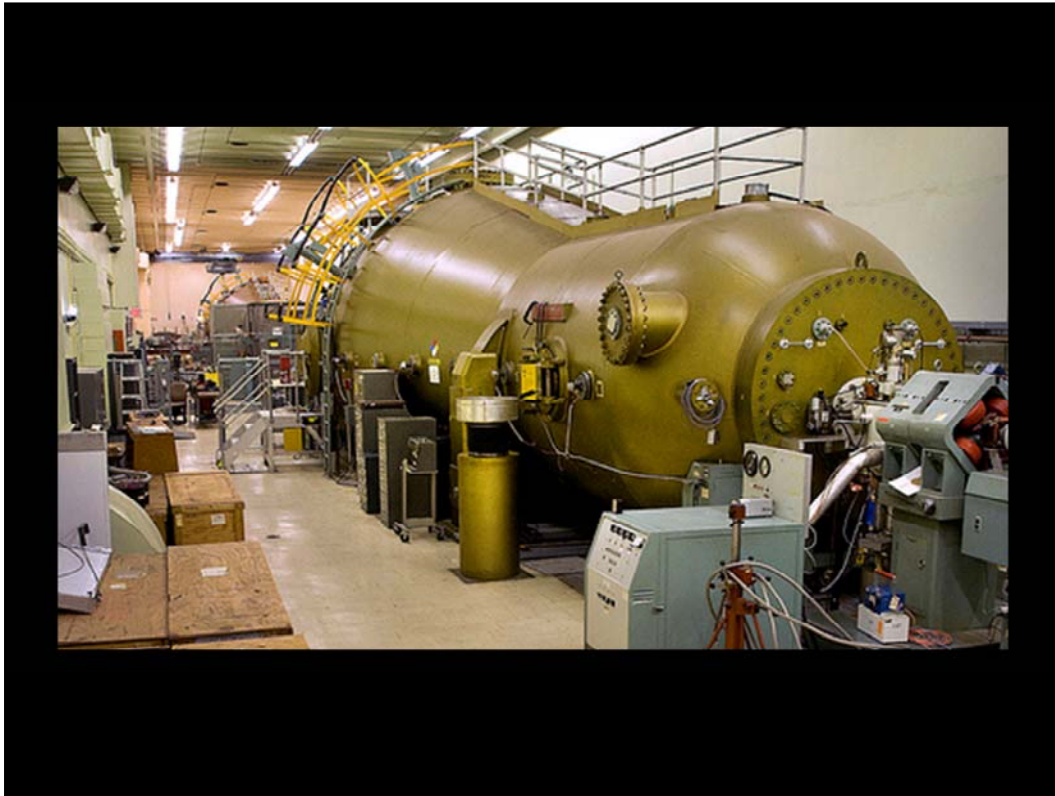
Many times during his life, and more than once when I was present, someone told Luie that his invention of GCA, a radar system that allowed landings in the fog, had saved his life during World War II.

Luis was one of the first inductees to the Inventors Hall of Fame. He never stopped inventing. In his last two years he was working on methods to prevent airplane collisions, and devices to detect explosives at airports.

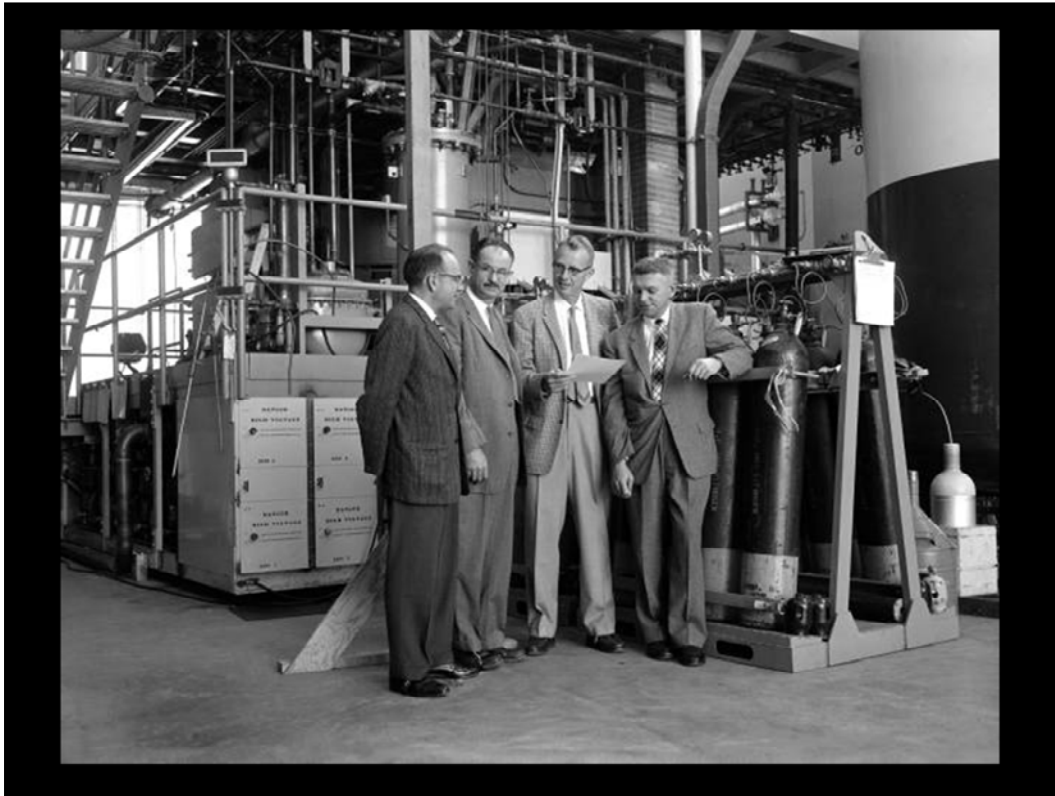
One evening I heard on the news about cracks found in the recently completed Alaska pipeline. Luis heard the same news, but unlike me, he started thinking. By the next day he had invented a device that could travel through the pipeline and automatically find the cracks. It was never used. In fact, nine-tenths of his ideas were never used. That didn't discourage him. He believed you needed to work that way to get the ones that really worked.



This is the MTA – the Materials Testing Accelerator that Luis invented.



Alvarez also invented the Tandem Van de Graaff accelerator. For anyone else, this would be the most famous contribution of an entire career. For Alvarez, it is so lost among his other work that it is virtually forgotten. Tandems are now the primary means for radiocarbon dating – a development that I played a bit of a role in.



Luie's colleagues in the National Academy of Engineering undoubtedly think of him as a clever and daring engineer, who maintained a perfect safety record while building and operating the huge liquid-hydrogen bubble chamber. Here he is with the bubble chamber, the device that led to the discoveries of the nucleus that earned him his Nobel Prize. He is not in typical dress, of course.

Many of Luis' associates, his employees, and his investors, think of Luis Alvarez as an entrepreneur, who started several successful companies, including Humphrey Instruments and Schwem Technologies. Luis trained his physics students in entrepreneurial skills, necessary these days just to obtain funding from the National Science Foundation. Luis always delegated to his colleagues more responsibility than they thought they were ready for.

Just as many of his protégés are busy today in the high-tech business world as in the academic world.

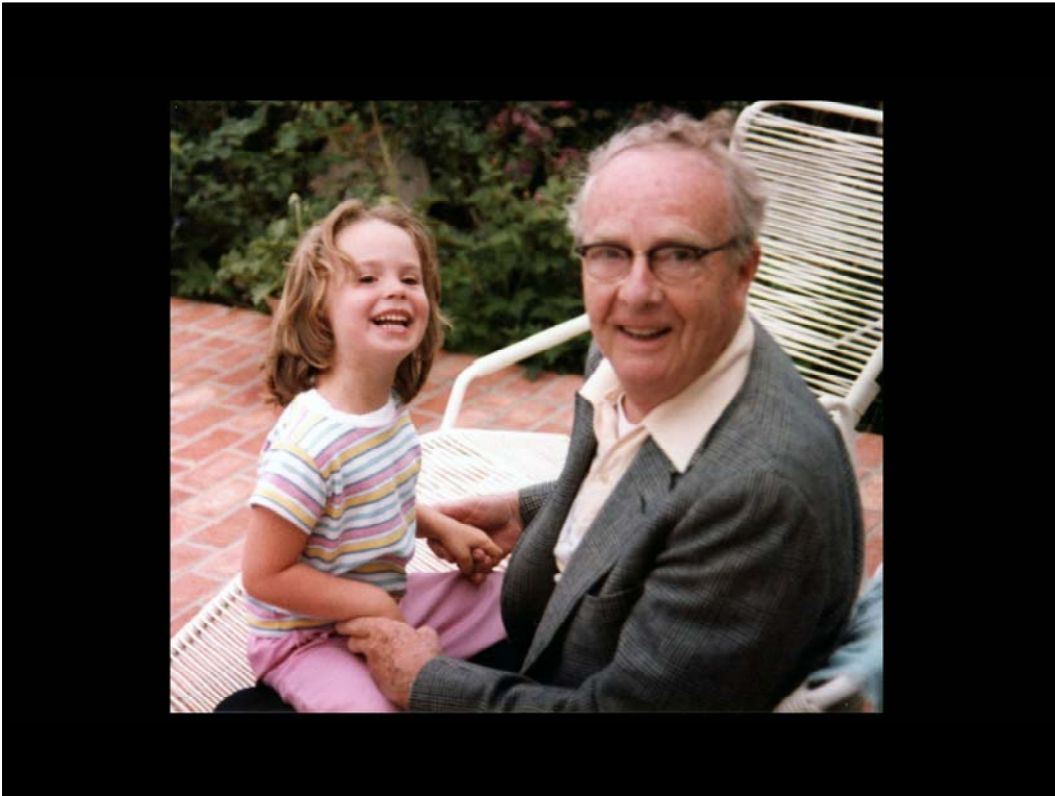


Others properly remember Luis Alvarez as a detective, who used physics as a tool to search for new chambers in the pyramids. This is a Sunday comic done in the 1960s about his pyramid project. I imagine that is Luie Alvarez down there in the lower right frame – poking into the chamber he discovered. Unfortunately, he found none. He always corrected people who said he didn't find any. In fact, he found that there were none. That was an important difference.

Incidentally, one of his staff, Buck Buckingham, brought in some razor blades to see if the pyramid would sharpen them. Even the Great Pyramid itself failed at that task.

Another bit of detective work: Alvarez's clever analysis of the films of the Kennedy assassination help clarify uncertainties in the Warren Commission investigation.

Perhaps some of you think of him as the past president of the American Physical Society, or as the professor who scored a "perfect 7" from his students in the last physics course he taught.



My children remember Luis Alvarez as the man who bounced them faster and faster on his knee, while reciting “This is the way the ladies ride; this is the way the gentlemen ride; this is the way the cowboys ride....” This game has become a Muller family favorite.



Alvarez had been in the chase plane over Hiroshima when the bomb was dropped – his job, to measure the energy output of the blast.

He had also designed the trigger for the Nagasaki bomb. He wrote a note that was dropped with the Nagasaki bomb, addressed to the top Japanese nuclear physicist, asking him to explain the physics of the destruction to the emperor and to implore him to surrender.

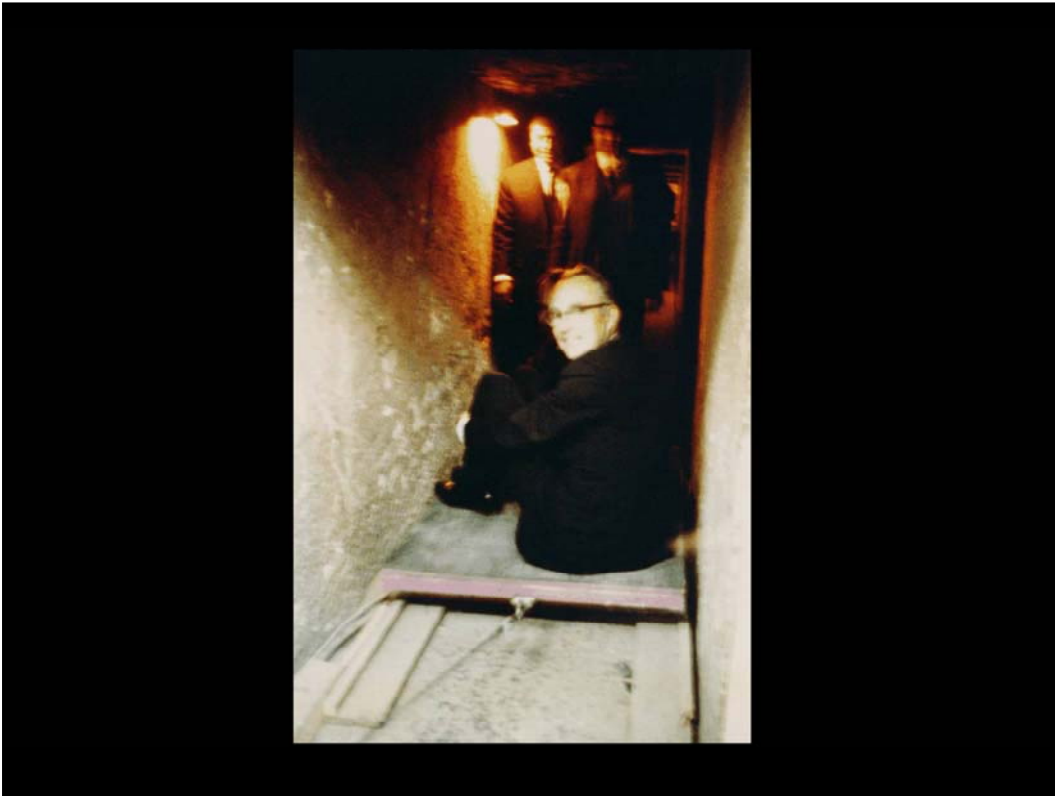
Luis Alvarez was a complex man, one of very few people I know whose opinion on an issue could not be guessed until I discussed it with him, no matter how well I knew his position on other issues. He was not a liberal, conservative, or moderate. Had he run for office, his diversity of opinions would have had something to offend every voter. He was strongly opposed to the Vietnam War, and he just as strongly felt that the atomic bomb had preserved peace between the U.S. and Russia. He could not be characterized in any simple way; he had no foolish consistencies, and when he gave advice it was usually surprising, original, and incisive.

How would Luis Alvarez remember Luis Alvarez? I think one of the previous images shows how Luis Alvarez felt about himself. Which one? Can you guess?

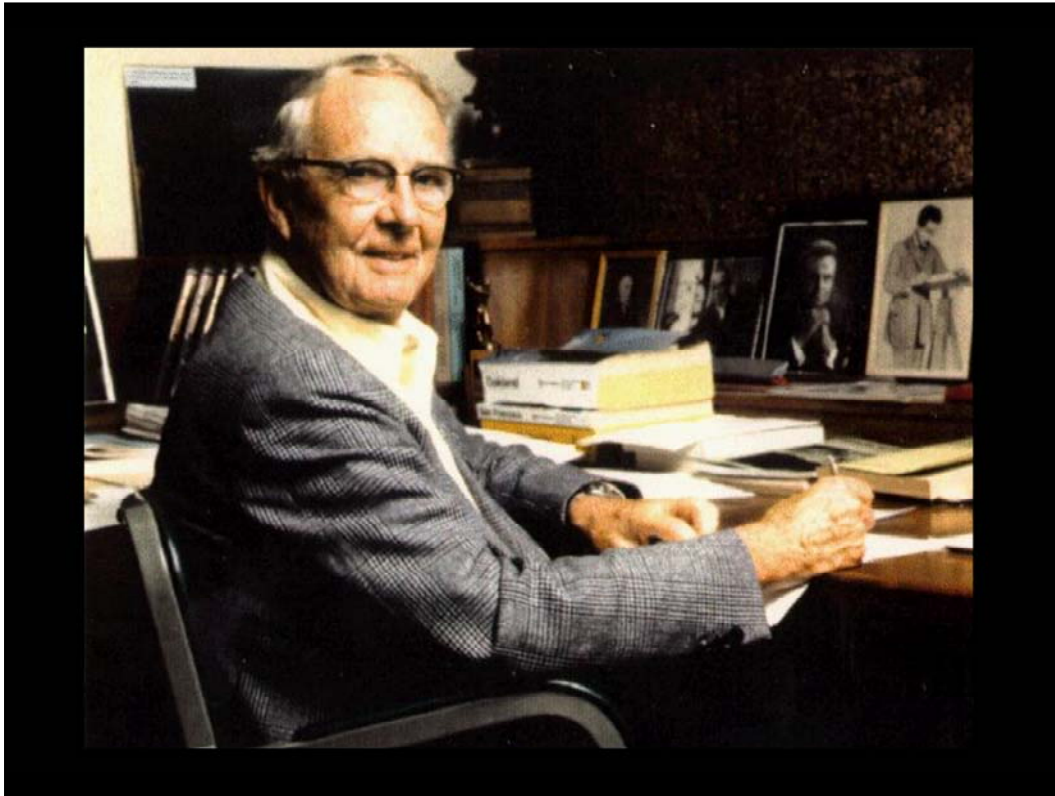


I think this is the one he would pick.

Luis believed that he had inherited the quest of the great explorers, of Captain James Cook, the English explorer of the Hawaiian Islands and the South Seas, and of Sir Richard Burton, the first non-Muslim to penetrate and explore the secrets of the Kaaba in Mecca. Luis was intimately familiar with the journals of the great explorers, but he was born too late to be one of them. The last place on earth, the South Pole, was reached in 1911, the year that Luis was born.



Here's a photo of Luis Alvarez in the pyramid!

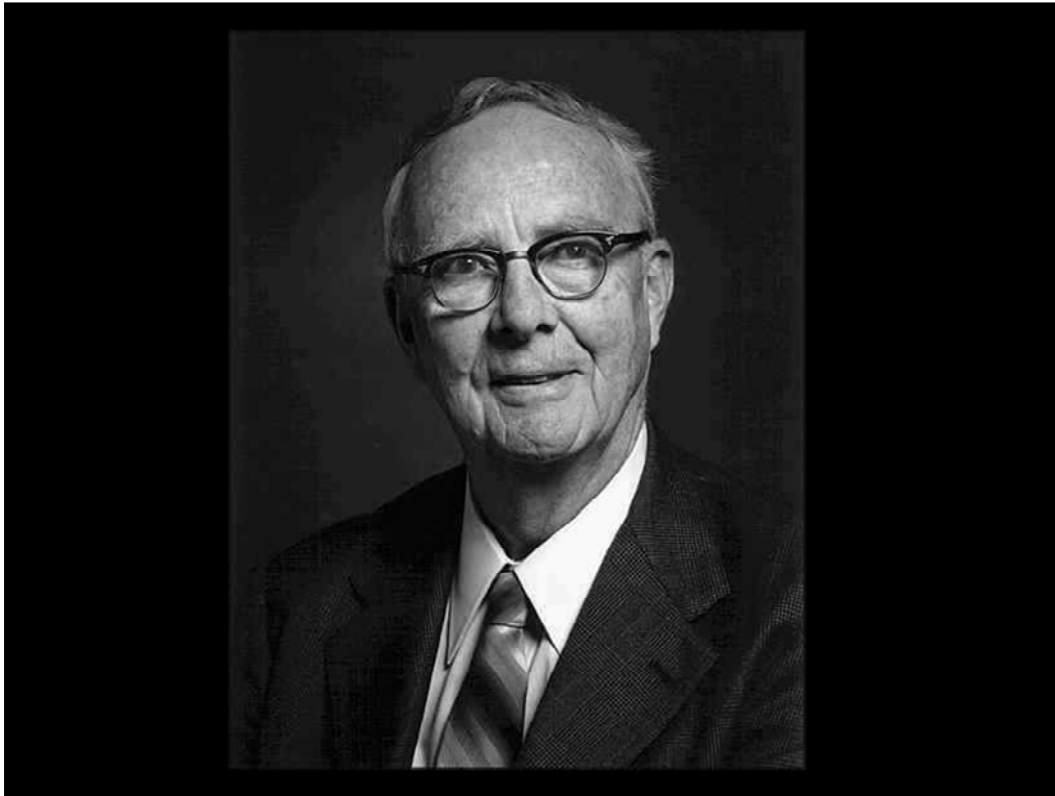


Others knew Luis as a great nominator. In the 23 years that I knew him, I found him just as likely to be writing a nomination for someone as working on a physics problem. He was constantly working for the recognition of other scientists and engineers, usually for someone that he thought had been slighted by the rest of the community. Sometimes these were colleagues (certainly I personally benefited), but more often they were just people whose major contributions had gone unrewarded. His campaigns for some scientists spanned decades, and frequently met with frustration. Few people knew how hard and persistently he worked at this.



The great mysteries of the 20th century no longer lay in geography, but in science. Luis went after these mysteries with the same enthusiasm, excitement, and sense of wonder, adventure, and determination that had driven the explorers of the Earth. He spent his life trying to put together a map of this unknown world.

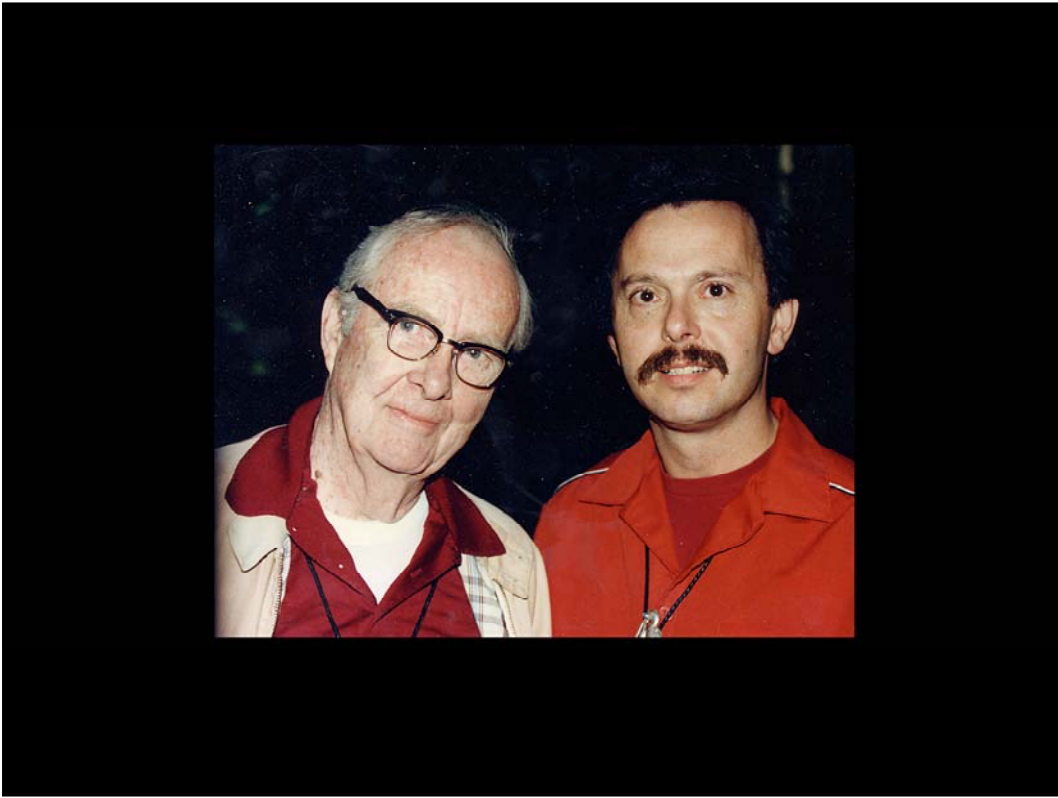
Particularly in recent years, while working on the mass extinctions – the farthest from his home of physics that his wanderings ever took him – he often suffered the same hardships as the great explorers, namely shortages of supplies and attacks by the natives. But it was worth it, for in this last great effort Luis Alvarez and his crew discovered a new continent, that many other scientists are just now beginning to exploit.



I shall always remember Luis Alvarez as a man who loved thinking above all else. He was always thinking. Only one out of 10 ideas, he said, is worth pursuing. Only one of 10 of these would last a month. Only one out of 10 of *these* would lead to a discovery. If these figures are true, then Luis must have had tens of thousands of ideas. But it is not his ideas and discoveries that are his greatest legacy. The greatest legacy he has left to his friends and colleagues is his example.

I remember him as a great teacher – the man who taught me how the entire physical universe was open for exploration – how to sniff out important problems that nobody else was noticing, how to learn what you needed to know to attack those problems. He taught me how to take the road less traveled by.

And that had made all the difference.



(Luis Alvarez and Rich Muller)