A Memorial for
Ulrich Becker

With his colleagues, friends and family

October 8, 2022

Memorial Schedule – October 8, 2022

9:30 Gathering at Chapel

10:00 Memorial in Chapel led by Rev. Michael Dean, MIT Chaplain

11:30 Transition to Pappalardo Room

12:00 Presentation by Prof. Samuel Ting

12:30 Speeches

1:00 Lunch

Ulrich Becker

December 17, 1938 | March 10, 2020

Ulrich J. Becker, a professor emeritus in the Department of Physics, passed away on March 10 at age 81, after a long struggle with cancer.

Becker became emeritus in 2011 after 42 years with MIT, but he never really retired; he continued to mentor students in his fourth-floor Grad Lab until shortly before he died.

Known to many as Uncle Bravo, Becker used his engineering talents and endless curiosity to discover elementary particles in his pursuit of the secrets of the universe. Becker's career in experimental high-energy physics included key contributions to the 1976 Nobel Prize in Physics for the discovery of the J particle. He was also a major contributor to the Alpha Magnetic Spectrometer (AMS) on the International Space Station, the advancement of international collaborations in high-energy physics, and other instruments and discoveries that impacted high-energy physics research.

"Ulrich Becker was a gifted physicist who made major contributions to particle physics," says Samuel C.C. Ting, the Thomas Dudley Cabot Institute Professor of Physics at MIT. "Over more than half a century of collaboration, I found him to be an exceptional physicist not only in the invention of precision instruments but, most importantly, in that he had good taste in physics."

Early life

Ulrich Becker was born in Dortmund, Germany, on Dec. 17, 1938. On that day, nuclear fission was discovered in Berlin. Just a few months before, Germany reissued to its Jewish citizens passports stamped with the red letter "J," and launched the Kristallnacht pogrom.

During World War II, Becker, with his brother Peter and parents Auguste (Bühner) and Georg Becker, took shelter in the basement of their apartment building while bombs fell overhead.

After the war, his father ran a laboratory supply business in Dortmund and would send the teenage Ulrich on deliveries. “He learned a lot of dirty secrets of industry like planned obsolescence,” says his daughter, Katharina Becker, and that left him disillusioned. He tried his hand as a coal miner, a steelworker, and an electrician, but he was also good at math and science.

“He started thinking about why would something as awful as World War II happen, and why so many were killed, and the inequity of it all — why did it have to be that terrible?” says his daugher, Katharina Becker. “In the end it was an existential question: Why would God let war happen?” Raised as a Lutheran, Becker decided that if he studied physics, he might be able to ask God a few of these questions.

After graduating from the University of Marburg, Becker pursued his PhD at the University of Hamburg, focusing on the photo-production and leptonic decays of vector mesons. He was able to show that all vector-mesons behave like heavy photons, that they displayed diffraction and converted back to virtual photons.

The Nobel pursuit

In 1964, physicists proposed the concept of the subatomic particles known as quarks. These fundamental particles and corresponding antiparticles bind together to form other particles, like protons and neutrons. There were three types of quarks — up, down, and strange — while the proposed fourth, the charm quark, remained a theory.

Samuel Ting was leading an experiment at the Deutsches Elektronen-Synchrotron (DESY) Laboratory in Hamburg, Germany when he met doctoral candidate Becker in fall 1965. The group was using the 6 billion electron volt synchrotron light to measure the size of the electron. Ting decided to sponsor Becker's research, so he joined the group. “He made important contributions to the data analysis of this experiment,” recalled Ting.

It was a complementary match: Becker was a dogged researcher, and Ting was a master in organization and politics.

They presented their results at the XIIIth International Conference on High Energy Physics at Berkeley in 1966. The results showed that electrons have no measurable size, which contradicted earlier results from both the Cambridge Electron Accelerator and Cornell University.

Becker then completed his PhD under mentor Peter Stähelin, founder of DESY and co-founder of CERN, and remained at DESY to study the photoproduction and leptonic decays of vector mesons.

In 1970, Becker joined the MIT faculty, counting among his mentors Victor Weisskopf and Martin Deutsch, and was promoted to

associate professor in 1973, and full professor in 1977. The following year he joined the team of Glenn Everhart, Terry Rhoades, and Min Chen at Brookhaven National Laboratory (BNL) to design a precision spectrometer. “He developed high-precision, radiation-resistant proportional chambers which operated at a very low voltage in order to function smoothly in a high radiation environment at rates of 20 MHz,” says Ting.

Ting’s group used the spectrometer in their experiment, smashing protons into a fixed target of beryllium to produce heavy particles that would then decay into electrons and positrons. They were hoping to find heavy particles. Instead, they produced an unexpected curve in the data.

Becker and Ting worked day and night to process the data, to figure out what they had actually found: A heavy particle with a lifetime that was about a thousand times longer than predicted.

“We had no idea why the hell this was,” Becker said in a 2014 *MIT Technology Review* interview. “We were highly suspicious of it, but since it was so clear cut, there was very little room for doubt.”

Becker recalled that the announcement of what they found had been delayed, due to budget and disbelief. “Brookhaven couldn’t pay their electric bill, and I had to ask Martin Deutsch for $30,000 so they could pay the bill. He flatly refused. And then he said I had to give a seminar, so I gave a seminar in October 1974, and we had the data that showed the peak at 3.1 GeV.”

Becker's first round of findings was in September to early October, but "it wasn't something we had been expecting," Becker recalled. They were confirmed later that October, and Becker pasted one of the graphs on top of another. (Becker held onto this graph, and later, when he moved into his Grad Lab, he hung these breakthrough results on his display case.)

"Ulrich showed up at the Center for Theoretical Physics excited, in his Germanic way, with two graphs: one with a sharp peak and the other with a broad one," recalls Robert L. Jaffe, Morningstar Professor of Physics and MacVicar Faculty Fellow at MIT. "He was explaining that one graph showed their data on electron-positron-pair production at BNL and the other showed the pair-autocorrelation function. I, of course, assumed that the sharp peak was the autocorrelation function and the broad, relatively uninteresting one was the enhancement in the electron-positron mass distribution. It took a few minutes for me to figure out that the situation was the reverse and that the electron-positron pair enhancement was narrower than the experimental resolution. Ulrich smiled broadly. My jaw dropped and the world was never quite the same!"

Meanwhile, Burton Richter '52, PhD '56, was reviewing measurements of collisions of electrons and positrons at Stanford Linear Accelerator Laboratory's particle collider when he too found something surprising: a heavy particle with an unusually long lifetime.

Ting flew to Stanford that November and ran into Richter. After discussing their results, they quickly organized a lab seminar, presented their results on Nov. 11, 1974, and published their findings, separately, in the same issue of *Physical Review Letters*.

In early 1975, Becker went to Germany for a talk about their result. He recalled to *Technology Review* that theoretical physicist Werner Heisenberg interrupted his talk to comment, “Whenever they don’t know what it is, they invent a new quark.” To which Becker replied, “Look, Professor Heisenberg, I’m not arguing whether this is charm or not charm. I’m telling you it’s a particle which doesn’t go away.’ Dead silence. It got very cold in the room. Then Heisenberg said, ‘Accepted.’”

What followed were rapid changes in high-energy physics, which became known as the "November Revolution." Physicists decided that the J/Ψ consisted of one charm quark and one anti-charm quark. It also created structure and predictability for fundamental particles, which physicists dubbed the Standard Model.

Ting’s group called the new particle “J,” which is one letter away from "K," the name of the “strange” meson; "J" also resembles the Chinese character for Ting's name. Richter’s group called it “Ψ” (psi).

The discovery led to Ting and Richter sharing the Nobel Prize in Physics in 1976. According to Nobel rules, only three people at most can win for any single discovery, and if Ting's colleagues at MIT had tried to nominate a collaborator from the Ting team, then Richter’s colleagues at Stanford would have wanted to nominate a colleague from their team.

“If only one of the groups — MIT — discovered it, I am convinced Becker would have been included in the Nobel Prize for it,” says Wit Busza, Francis Friedman Professor of Physics Emeritus and MacVicar

Faculty Fellow at MIT, who had worked with Ting's team alongside Becker in Hamburg.

When asked recently about missing out on the Nobel Prize, Becker just shrugged. "That's what happens."

In the late 1970s, one of Becker's chambers that he had designed for the J particle experiment was exhibited at the Smithsonian Institution.

His passion for discovery led him to build detectors and run other experiments at DESY, Brookhaven, MIT, and CERN. "He just wanted to get to the bottom of things," says his daughter.

"He was not in the limelight, he was very modest,"
says Boleslaw Wyslouch, director of the Laboratory for Nuclear Science. "He had a deep knowledge of particle physics, having contributed himself to some of the most important discoveries. His main contribution was to build the detectors that worked extremely well in experiments that led to major discoveries."

Getting the drift

Becker developed several other major instruments widely used in experimental particle physics, and that were the catalyst for many major discoveries.

His large-area drift chamber would provide large acceptance coverage for experiments, and his drift tubes enabled physicists to measure particles near the interaction point. Those developments led to Becker

to design and build the huge muon detectors for the MARK-J experiment at DESY, which resulted in the discovery of the three-jet pattern from gluon production.

This led to his leading hundreds of colleagues in designing the muon detector, one of three main outer layers of the L3 detector, one of four large detectors on the Large Electron-Positron collider (LEP), at CERN, to study the electro-weak interference. The outer layer of the L3 detector held a magnet that generated a field 10,000 times stronger than the average field on the Earth's surface. L3 started data taking in 1989 and stopped in 2000, to be replaced by the Large Hadron Collider. “The results from L3 provided accurate confirmation of the Standard Model,” says Ting.

He also made important contributions to advancing international collaboration in high-energy physics.

“The readiness of Professor Becker to help in training our colleagues, his deep understanding of the Mark-J experiment and his superb teaching skills deserves our highest recognition,” says Manuel Aguilar of the Centre for Energy, Environment and Technology. “His friendly approach, his behavior and deep understanding of physics, made all of us to feel very comfortable, and that is something we did most appreciate and will never forget.”

In 1978, Becker went to China to select 18 young physicists to work with the MIT group. This was the first group of young Chinese physics students to work outside China after the Cultural Revolution. Many of them went on to lead the Chinese high-energy physics research program and launch an international collaboration.

“Professor Becker was an old friend of Chinese high-energy physicists,” says Institute of High Energy Physics Physicist Hesheng Chen PhD ’84, who was mentored by Becker for 40 years. “He taught and advised many Chinese physicists to do the Mark-J experiment and the L3 experiment.”

Alpha Magnetic Spectrometer

Becker also worked with professor of physics and department head Peter Fisher, and MIT Electromagnetic Interactions Group senior research scientists Joseph Burger and Michael Capell, among others on building an Alpha Magnetic Spectrometer (AMS). This was another Ting project, which aimed to record the tracks of millions of cosmic ray particles, the debris released by explosions in distant stars.

The idea for the AMS was born while Becker and Ting were on a coffee break while working on the L3. "We sat in Building 44 and thought, 'How can we prove or disprove the prejudice that there is only matter?' One anti-carbon nucleus could change our whole perception of the universe," Becker said to MIT News. The idea was to search for anti-matter, but because anti-matter is destroyed in Earth’s atmosphere, the research would need to be done in space.

"I had this dream to build an experiment that would have fewer than 100 collaborators and could fit on a table," Becker told *Nature*. NASA greenlighted the project, but it ballooned to 500 scientists from 56 institutions, and would need a vastly larger table. Its 0.86-tesla magnetic field is 17,000 times bigger than Earth's. "Sam Ting doesn't like to do small things," said Becker.

The first AMS cosmic ray detector flew in the STS-91 shuttle payload in June 1998 and gathered about 100 hours of data. The first large magnet experiment ever placed in the Earth's orbit, the AMS's instrumentation allowed researchers to measure higher-energy particles with greater accuracy. Becker was alternately excited and mystified by the results: 100 million particles were detected with four times as many positrons as electrons showing up near the Earth's magnetic equator. But not a single anti-carbon nucleus was found.

Becker then went on to help design the transition radiation detector for Ting's AMS-02, which sought to conduct a more extensive search for rare cosmic ray particles while mounted on the International Space Station in May 2011. In March 2013, Ting reported initial results, saying that AMS had observed over 400,000 positrons. By March 2020, AMS had collected over 155 billion cosmic ray events.

Becker never did set up his own research group, choosing instead to spend nearly his entire career collaborating with Ting. "They had an incredible, very complementary interaction," says Busza. "Ting is brilliant when it comes to judgment, organization, political skills, and obtaining funding. While Becker is brilliant in the design and building of experiments, in instrumentation and analysis of data. As a result of both of those people, their research program has been extraordinarily successful."

In 2002, Becker received a NASA Recognition Letter for "Success in the First AMS Flight" and in 2006 was named a fellow of the American Physical Society.

Says Ting, “Professor Ulrich Becker was a person of integrity and a good friend.” Adds Busza, “For Ulrich, physics was an essential part of life.”

A mentor to many

Becker was a mentor to many talented physicists, including thesis advisor to MIT’s Wyslouch, Capell, and Joseph A. Paradiso, and Reyco Henning from the University of North Carolina. “Ulrich was a mentor of mine, and to many of us,” notes Peter Fisher.

“He was extremely friendly but also very stern,” says Wyslouch**.** “I would have never called him by his first name. I think once I called him Ulrich, and it just didn’t work. Professor Becker exuded authority.” Wyslouch recalled trying to score “some brownie points” with his professor by spending weekends repairing a 1974 Datsun. “He really appreciated students who liked to build things and use their hands.”

Wyslouch had also worked with Becker for 10 years in Ting’s group. “He just knew everything, he had this approach to things, to check things very quickly, calculate things very quickly, we were always in awe of his knowledge and his experience,” he says. “He was a very good manager of people.”

Former student Teresa Fazio ’02 recalls his patience. “I can hear him saying, ‘Och, Teresa. This is not good,’ when I had written particularly boneheaded or incorrect things in my thesis. When someone reported an experiment had failed or equipment didn't work or something from Aachen or CERN was late, his typical response was, "Oh, well... Next?" Considering some of the things that went wrong, he remained

remarkably chill.” She also recalled him adjourning his Friday afternoon journal club every week by saying, "So, we go for beer?"

Students recalled that his idea of lab shoes were Birkenstocks and socks, and memorably, the time he fed a stray dog that turned out to be a coyote. Students also joined him in kayaking trips and were invited to his house for pizza and his wife Gerda's rhubarb tarts.

In 2013 Becker transitioned to emeritus status, but despite his battle with blood clots and prostate cancer, he came in every day to mentor students in his meticulously created fourth-floor Grad Lab that held many abandoned experiments and broken equipment, which he had rescued for repair and demonstration. At the age of 81, he even learned Python.

The Department of Physics recently held an informal ceremony where Becker officially handed over the keys to his lab. “After that, he got sick,” recalls his daughter.

Ulrich Becker is survived by his wife Gerda (Barthel), children Katharina, Peter, and Robert, and grandchildren Jarin and Hannah.

The physics department will host a memorial service at a date to be announced. The family has requested that donations in his memory may be made to the American Cancer Society.

A TRIBUTE

In memory of our father & husband Ulrich Becker

As a child, for me, my dad was the greatest. And just before he passed away, I told him he still was.

Minutes later, he whispered some of his last words: The first verse of Albrecht Goes' poem "First Steps":

Here translated:

> Small is my child, your first step.
> And small will be your last.
> The first, your father and mother will accompany,
> The last you'll take alone.
>
> **It goes on:**
> When one year has passed, you child will take,
> Many steps unguarded.
> Who knows what sort of steps those will be
> In Light or in the night?
>
> Walk with bold steps, take a courageous step,
> Great is the world and it is yours.
> We WILL my child,.. after' your last step,
> Be together again.

We participate in today's chapel service to honor Ulrich's Christian devotion, and we also stand here at MIT among an extraordinary cast of friends, colleagues, and former students, as witnesses. The bold and

courageous steps he took in his journey here, is evidence that he too was remarkable.

Ulrich's first humble steps began in 1938, born in Dortmund Germany where WW II leveled the scene and his parents and brother survived bombing raids by fleeing to the countryside and keeping a low profile. Hunger marked times in father's childhood. During Germany's reconstruction, his parents, and later our mother Gerda, supported him as he strode many uncertain steps through the many challenges. He began as an average student in the intermittent schooling after the war. Ulrich often recounted how one teacher, it later turned out, came from an asylum, placed a loaded gun on his desk to ensure discipline. And how another teacher, a severely disfigured former SS soldier, detailed man's base capability for cruelty, having participated in, and having been one in a handful that survived the battle of Monte Casino. Amazingly, He was able to extract and reflect the beauty of Christ from this experience, like no other to Ulrich.

His grades improved later as he competed with his older brother Peter, first as students and then as aspiring physicists in the University of Marburg. After surviving polio, the sudden death of his brother due to a climbing accident in 1960 was tragic and pivotal. Father buried his grief by doubling his effort in physics, I suppose to continue his brother's legacy and honor his parents for both. Thankfully, Gerda was there to help catch the fall, having danced her way into Ulrich's life years earlier in Bückings garden located in the romantic castle grounds of Marburg. She will always remember the scene: How someone, (not dad) sent her a beer, just as our penniless Father asked her to dance - quick lucky steps for him, Gerda, and us three! His company and the interesting conversations, -also with friends, were enchanting, and so it came that they stepped and then strode together tying the knot on the 30th of April, 1966. Mother and father's faithful steps never wandered far from each other's side even when distance separated them.

A flip of the coin led Ulrich to study in Hamburg, and later work at DESY, where our mother followed. At first the ideas he wanted to pursue were rebuffed at DESY, until Sam Ting's group was formed, where ideas, interests and motivation matched, and he was invited to join. Years later, Peter Stähelin his PhD advisor noted, that via the group, he was one of the few that managed to consistently get also *his* ideas built, time and again, and that this would have been unlikely had he remained at DESY.

Mother recalls the excitement, and stress of working on the famed Brookhaven bound spectrometer in the early 70's culminating in months of 48h working days; made possible by coffee, and an endless supply of constantly lit cigarettes. Ulrich recalls the pace and the adventure: Acquiring the electronics from CERN and improving them by himself soldering 10,000 resistors to them, and finally bending the experiment into shape, that upon arriving at Brookhaven didn't fit! financial struggle to foot the electricity bill delayed data taking. And on top of it all, his poor habits finally landed him under the knife in the hospital where he narrowly escaped death. Complications from smoker's leg led to several more equally serious operations years later and instilled a sense of urgency in Ulrich's life hence forth. It was Mothers angelic unwavering love and support that carried him through these illnesses, And it was she that carried us through life much of the time when he was healthy.

When his health returned, we missed him.

After recovery and finally with raw data in hand: An exuberant Terry Rhoades and Ulrich climbed through an open window at night to access MIT's only IBM main frame in order to process their data, knowing that the student taking night shift there, would be fast asleep! For hours they loaded their punch cards and ran their data! Mothers

clearly remembers the sparkling moment, when walking late on a warm October night, dad mentioned, “I think we have found something!”

As a child I didn’t register the importance of the Group´s discovery, nor the gravity of father’s poor health. As children we admired what we could see, building model boats and planes, constant car repair, his interest in archeology and the ascent of man, and walking. At home, we saw this bundle of energy and curiosity trapped in a body, scrambling to find clues and answers for the questions his interests posed! There was no doubt he was passionate for the wonders of the universe and life also outside of physics.

We also enjoyed the many friends, students, and colleagues he invited to the house, where great conversations abounded. We also understood he was a good high-level teacher, the many students that visited and canoed, or capsized & went swimming, was indicative of that! However, I rarely asked him for help with homework. The one time I did in chemistry, it was hours later, and still, the universe was too young to give me a clue of what a certain chemical reactions product might be.

We had many good times together. Especially we remember vacations all over, mostly taking us to conferences or work locations. My siblings and I remember poshly swinging tennis rackets in Brookhaven, or mountain life in Saint Cerque, Switzerland, and the many adventurous road trips in early years crisscrossing the nation singing in the back of the old dodge station wagon.

Ulrich never rested long though. And Colleagues, friends, and we, often asked why he kept working in this stressful environment that was so taxing to his health. He was after all, offered serious options elsewhere!

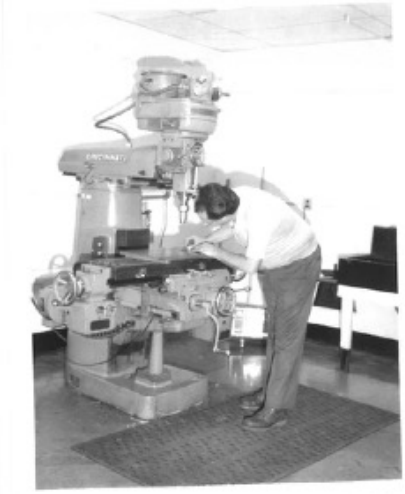
Peter Stähelin already answered the good match with the group as a reason, and it is father's faith that answers how he kept an even keel within this ambitious group.

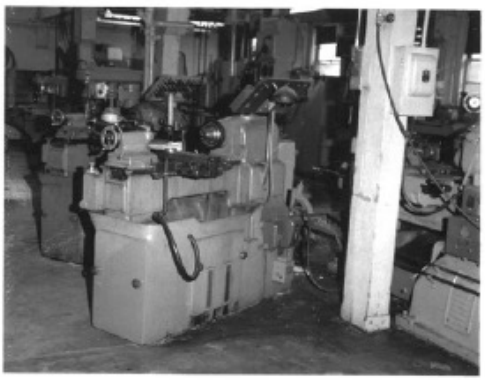
I have always admired my father's humility. He saw and treated everyone as equals, the local folks in his hometown, the students knocking at his office door, just as any of the important academics many of you are or know. However great the discovery, or as advanced their experiments were, he knew that man, and that he, was small, and despite the enormous pains and effort, that he was simply fortunate to have witnessed tiny pieces of nature revealed. He understood that within the limits of a lifetime, one can only comprehend the tiniest speck of god's creation.

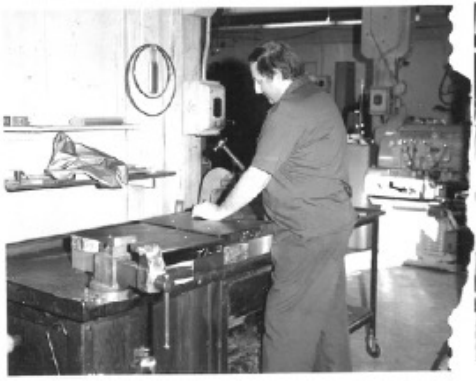
Even though physics and teaching remained central until the end of his life, we saw father's tough side melt and be replaced with ever more gentile strength as he reached out towards us children to better understand us. He was grateful for every summer in which he could visit Europe and spend time with this grandchildren Jarin and Hannah, playing and rough housing with them. He loved them dearly, and even two hours before his passing, Hannah cooed and Jarin exclaimed that he loved him on skype, -Also for his grandchildren he was one of the greatest!

We are grateful to have had the opportunity to say good-bye and accompanying him for his second to last step, and together we grieved as he took his last.

We are proud of Father's great achievements and thankful for his humor and charm. But it was his deep faith-based humility rooting him in honesty and integrity that made him strong and so accessible for the many that walked with him, that impressed me most.
It is why he remains the great giant I saw as a child.







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