

Science and Music: Remembering Richard Klemm, 1940–2026

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On 13 July 2026, the international radar community lost one of its most distinguished scientists—and I lost a friend whose presence had enriched my life for decades. This makes the task of writing about him deeply personal, but it also calls for an account of what his life meant far beyond the circle of those who knew him closely. Richard was a radar scientist of international stature, an influential builder of cooperative research communities within NATO, across Europe, and beyond, a respected teacher and author, and an accomplished pianist. Yet no inventory of positions, publications, honors, and achievements can adequately describe him. His scientific creativity, musical sensibility, literary wit, hospitality, loyalty, and capacity for friendship belonged together.



Richard Klemm, 27 September 1940–13 July 2026

FORMED BY HISTORY, ENABLED BY INSTITUTIONS

Richard Klemm belonged to the generation that transformed radar from an electromagnetic sensor into an adaptive information system. Born in Berlin in 1940, he studied electrical engineering at the Technical University of Berlin, receiving his *Diplom-Ingenieur* degree in 1968 and his doctorate in 1974. In the same year in which he completed his diploma, he joined the *Forschungsinstitut für Funk und Mathematik* (FFM, Research Institute for Radio and Mathematics).

From 1977 to 1980, Richard worked at the NATO SAC-LANT Anti-Submarine Warfare Research Centre in La Spezia, Italy. Ulrich Nickel, Richard's colleague and friend over many decades, recalls these three years as a decisive broadening of Richard's scientific horizon [1]. In sonar, Richard encountered

propagation and interference conditions even more complex than those familiar from radar. He learned to think across domains about wave propagation, array processing, detection, and the extraction of reliable information under harsh conditions. This experience helped prepare the conceptual ground for his later work on STAP. Richard maintained close ties with the sonar community throughout his career.

La Spezia also left a lasting personal imprint. Richard developed a deep affection for Italy, its culture and cuisine, and for the international friendships that grew around scientific exchange. The Italian radar pioneer Alfonso Farina, who first corresponded with Richard through an exchange of papers and met him at FFM in Wachtberg in late 1979, recalls Richard's work on underwater propagation, particularly in shallow water [2], while the eminent British radar scientist Hugh Griffiths emphasizes how unusual this breadth was: few engineers have worked seriously in both radar and sonar [3].

To understand the environment in which this career began, one must recall Cold War West Germany. After regaining sovereignty and joining NATO in 1955, the Federal Republic of Germany stood on the Alliance's central front and had to rebuild its defense capabilities. Moreover, civil air-traffic control accelerated the development of digital radar. Founded in 1963, FFM was intended to create the mathematical, experimental, and computer-based foundations for present and future military sensing and command-and-control systems. Richard thus began his work in a NATO-oriented research culture shaped by strategic urgency, institutional continuity, and unusual freedom for long-term experimentation [4].

Richard entered an institution in which the scientific and experimental soil for modern radar processing had already been cultivated. Wulf-Dieter Wirth (1934–2025) had acted almost like a gardener of an emerging scientific landscape. He and his colleagues first had to build much of what later generations of radar researchers could take for granted: the means to sample, digitize, record, reproduce, and analyze radar data; experimental phased-array systems; and, not least, a research culture in which new concepts could be tested against physical reality over extended periods of time [5]. Wirth created conditions in which an original mind such as Richard's could take root, grow, and eventually unfold its full potential for the benefit of the international radar community.

Richard was not the only scientist to flourish in this fertile environment. Nickel, whose work spanned array processing, measurement modeling, superresolution, and parameter estimation, shared important scientific interests and methodological foundations with Richard and became a lifelong intellectual

companion [4], [5]. Joachim Ender, recipient of the 2023 IEEE AESS Pioneer Award for seminal contributions to multichannel SAR, complemented this circle through his work in synthetic-aperture radar [6]. The complementary strengths of Richard, Nickel, and Ender helped make FFM an internationally respected center of radar science. Richard and Joachim later carried this institutional culture into the wider European radar community by founding EUSAR in 1996. Jürgen Grosche, as Director of FFM, recognized Richard's exceptional abilities and supported him within the institutional possibilities.

AN ARCHITECT OF MATURE RADAR SCIENCE

Richard's central scientific question was deceptively simple: How can a radar sensor remain capable of detecting and estimating a target when the desired signal is buried in clutter, jamming, interference, ambiguities, and the distortions created by the motion of the sensor platform itself?

In finding answers to this question, Richard became one of the formative figures in Space-Time Adaptive Processing (STAP). By combining the spatial degrees of freedom of an antenna array with the temporal structure of successively received radar pulses, STAP enables moving targets to be separated from strong ground clutter and intentional interference. Richard helped move this methodology from an advanced theoretical concept toward an engineering discipline capable of supporting operational airborne and spaceborne surveillance systems. His work addressed adaptive clutter and jammer suppression, high-resolution radar, array processing, and the detection of moving targets from moving platforms. The IEEE Engineering and Technology History Wiki describes him as one of the most influential scientists in STAP and credits him with helping to transform the field from an "academic curiosity" into a practically relevant technology [7]. As Griffiths recalls, Richard brought to STAP a distinctive insight of his own, subtly different from the dominant US approaches of the time [3].

Within the history of German radar and information-fusion research, I have described Richard as one of the *architects of maturity* [4]. Earlier pioneers had made radar digitally controllable and had linked tracking with sensor management [8]. Richard strengthened the processing chain where it is most vulnerable: at the transition from signals to statistically reliable measurements. He understood that the quality of a situation picture is determined long before the tracking and fusion algorithms begin their work. If clutter and interference have not been properly modeled and suppressed, no processing can restore the information that has already been lost.

Richard's work on moving arrays and the fast-time/slow-time representation underlying STAP also connected synthetic-aperture radar, bistatic radar, ground-moving-target indication (GMTI), adaptive arrays, and target tracking. He regarded these as core elements of sensing systems. For him, radar was an adaptively operated source of information whose antenna configuration, waveform, processing parameters, and operating mode could be adjusted to the operational task.

Nickel recalls a characteristic source of Richard's scientific creativity: he rarely allowed himself to become trapped in formulas. He valued mathematical rigor but could step back to ask

what structure a calculation revealed, how it related to the underlying physical phenomenon, and where it belonged within the larger sensing system. This capacity to change perspective enabled him to recognize connections that remained hidden within a narrower technical view. For Nickel, Richard's comparison of STAP with piano playing as a form of musical multichannel processing illustrated a characteristic movement of his thought from the specific algorithm to the underlying structure, and from one field of experience to another. Richard's insight was strengthened, rather than diluted, by his ability to view scientific problems from a wider cultural horizon [1].

His books became enduring reference works. *Space-Time Adaptive Processing: Principles and Applications* [9], *Principles of Space-Time Adaptive Processing* [10], and the edited volume *Applications of Space-Time Adaptive Processing* [11] provided generations of researchers and engineers with a systematic intellectual framework for the field. His principal textbook appeared in several editions and was translated into Chinese. Even after his formal retirement, Richard edited the two-volume work *Novel Radar Techniques and Applications* [12]. Together with Christoph Gierull, Hugh Griffiths, Pierfrancesco Lombardo, Ulrich Nickel, and myself, he brought together complementary schools of thought in array radar, imaging radar, passive and multistatic radar, waveform diversity, tracking, and data fusion. His editorship connected generations, nations, and scientific traditions. Farina called *Principles of Space-Time Adaptive Processing* "a lighthouse on advanced radar techniques" [2], while Griffiths remembers with particular pleasure their work on *Novel Radar Techniques and Applications* [3].

The IEEE recognized Richard's scientific achievements in 2019 with the *Dennis J. Picard Medal for Radar Technologies and Applications*, with the citation: "For contributions to high-resolution radar, adaptive clutter suppression, and publications for the international radar system community." This placed him in the small circle of scientists whose work has fundamentally advanced radar technology and its applications [13]. Griffiths remembers being especially delighted by the award, which he regarded as a particularly fitting recognition of Richard's talents and achievements [3].

EXPANDING THE INTERNATIONAL RADAR COMMUNITY

Richard's influence cannot be measured through publications alone. He possessed an exceptional ability to recognize emerging scientific topics, bring together the right people, and create durable forums in which ideas could be tested and developed.

In 1981, he succeeded Günter van Keuk (1939–2003) [8] in representing the German defense research community in the NATO Advisory Group for Aerospace Research and Development, AGARD. Richard subsequently served in the AGARD Avionics Panel and the NATO Research and Technology Organization's Sensors and Electronics Technology Panel. He initiated and chaired working groups, symposia, and lecture activities and helped make FFM's work on adaptive radar processing internationally visible. His engagement contributed substantially to the advancement of radar signal-processing technologies across NATO nations.

In 2004, Richard received the NATO Research and

Technology Organization's von Kármán Medal, awarded "for exemplary service and significant contributions to research and technology cooperation among the NATO nations" [14]. Griffiths also emphasizes Richard's exceptional contribution to NATO, where technical authority and a strong instinct for international cooperation reinforced one another [3].

A concrete example was a NATO lecture series on *Military Applications of Space-Time Adaptive Processing*, which Richard initiated in 2002. Presented successively in Istanbul, Wachtberg, and Moscow, the lecture series carried a common technical language into different national research communities. Farina lectured on STAP for SAR and real-time processing; in subsequent lecture series and related activities organized by Richard, I too had the privilege of presenting results from our joint work. The sequence of venues was characteristic of Richard's conception of scientific cooperation: knowledge was to be carried into different national communities and developed into a shared technical language. His internationalism extended well beyond NATO. He taught, for example, at leading Chinese universities and research institutes and was appointed honorary professor at the University of Electronic Science and Technology of China in Chengdu.

In this spirit, Farina warmly remembers Richard's contribution to the 2008 IEEE Radar Conference in Rome. Even after STAP had become an established field, Richard continued to teach its foundations, test its limits, and open it to new applications [2]. A particularly visible legacy is the series of European Conferences on Synthetic Aperture Radar (EUSAR), which Richard initiated with Joachim Ender. What began as a European initiative developed into one of the world's leading conferences on synthetic-aperture radar.

Richard understood that technical excellence was necessary but not sufficient for a successful conference. It also needed a recognizable culture and room for conversations that no session plan could accommodate. EUSAR therefore became both a scientific meeting place and a community. Music, naturally, formed part of that culture.

Richard's organizing talent demonstrates an often-underestimated truth about applied science. Progress depends on ingenious individuals, but ideas become capabilities only through institutions, experiments, professional networks, and mutual trust. Richard was one of those rare people who could operate at all these levels. He could discuss covariance matrices and clutter ridges with specialists, formulate the theme of an international symposium around an emerging research field, persuade institutions to support it, and then sit at the piano in the evening and remind everyone why human creativity cannot be divided into administrative categories.

A LIFE OF SCIENCE AND MUSIC

Music was an essential element of Richard's scientific career. It belonged to his family heritage and to his earliest understanding of himself.

Richard Klemm grew up in Berlin as one of three sons in the highly musical household of the cellist, composer, and professor Richard Klemm (1902–1988) and his wife Ilse [15]. His father played in the Staatskapelle Berlin, participated in chamber-

music ensembles, performed for many years in the orchestra of the Bayreuth Festival, and in 1958 became professor at the Berlin Hochschule für Musik. His compositions and arrangements for cello ensemble contributed to the musical environment from which celebrated cellists of the Berlin Philharmonic emerged.

Alfonso also shares a much more personal memory: Richard once told him of the long walk by which, at the end of the Second World War, he left Berlin with his mother and a brother with a disability [2]. The story belongs to the background of a childhood in which music, family solidarity, and the upheavals of German history were inseparably present.

The younger Richard received a demanding musical education from his father and from the pianist Günter Plagge (1913–1976), also a professor at the Berlin Hochschule für Musik. His gifts were such that, as a young man, Richard seriously considered whether his future should lie in music or in engineering. He chose engineering as his profession, but he never abandoned the other possibility. In fact, he preserved both vocations.

His piano playing was distinguished not merely by technical competence but by intellectual insight. He understood musical form from within: the preparation and release of tension, the relation between individual voices, the significance of timing, and the discipline required to make freedom audible. He also had a remarkable ability to make this kinship between musical and scientific thought intelligible to his colleagues in the radar community. Perhaps similar qualities shaped his scientific work. Adaptive processing, too, demands the perception of structure within interference; it separates a significant voice from an overwhelmingly complex background. I remember Richard once pointing to the keyboard and comparing the pianist's art with Space-Time Adaptive Processing. Each key occupies a distinct position in space and is associated with a particular frequency; only through the precisely timed sequence, weighting, and interaction of the individual notes does music emerge. It was a characteristically Klemmian comparison.

Under the motto *Science and Music*, Richard gave recitals at radar conferences, URSI meetings, EUSAR events, FUSION conferences, and many other scientific gatherings. These evenings changed the atmosphere of a conference. Colleagues who had debated equations and experimental results during the day encountered one another differently through Bach, Mozart, Beethoven, Schumann, Chopin, or Debussy.

Richard approached his recitals with the same intellectual care that he brought to scientific work. He designed the program booklets himself and introduced his audience to the architecture of a composition, its tensions, transformations, and inner voices before hearing them unfold at the piano. Bach occupied a central place in his musical world. Yet the composer to whom he returned most persistently was Robert Schumann. Richard repeatedly performed the *Carnaval* and the *Kreisleriana*, works whose changes of character, literary allusions, humor, inwardness, and sudden shifts of perspective corresponded closely to his own sensibility. He also took pride in having mastered *Scarbo* from Ravel's *Gaspard de la nuit*.

A musical high point was in 1999 during a NATO STO symposium in Granada, when Richard performed in the *Auditorio Manuel de Falla* by the home of the Spanish composer. At the same time as this expert meeting was taking place, NATO

began airstrikes as part of the Kosovo War (Operation Allied Force). During these missions, sensor technology played exactly the role that had been discussed theoretically on the panel.

At the RADAR 2002 conference in Edinburgh, chaired by Hugh Griffiths, Richard gave a recital and, with characteristic generosity, played as an encore a particular piece of which Hugh was especially fond. Richard later gave him recordings of his playing, which Hugh now treasures as enduring reminders of his friend [3]. Among these recitals, Alfonso remembers with particular vividness the evening of 11 July 2006 at the FUSION Conference in Florence, where Alfonso served as Executive Chair. In the *Salone dei Cinquecento* of Palazzo Vecchio, Richard played Chopin before the international information-fusion community. In that historic hall, once used by the Italian Parliament, Richard made the evening's theme—"music & science"—audible [2].

Another of the most memorable of these occasions was the "Radar Festival on the Rhine" in October 2019. The IEEE Aerospace and Electronic Systems Society and Fraunhofer had gathered scientists, engineers, historians, representatives of industry and public life, and members of Christian Hülsmeier's family to honor the inventor of radar with an IEEE Historical Milestone [16]. In Cologne's historic town hall, Richard played his own *Radar Impromptus*, inspired by Chopin. The association was entirely his own and entirely convincing: electromagnetic and musical waves, reception and processing, the fusion of individual voices into an inner image. No one in the international radar community had united advanced radar signal processing and music as Richard did.

None of us knew that this would be his last public concert. In retrospect, it appears almost providential that his final appearance at the piano should have honored the inventor of radar, in the city where radar had first been publicly demonstrated. Richard gave the historical celebration its musical brilliance and, at the same time, showed that radar had become part of human culture, a means by which humanity extended its capacity to perceive the world. The IEEE video of the Hülsmeier ceremony preserves Richard's performance [17]. For Hugh, who remembers that occasion with particular emotion, it has become a permanent reminder of his friend [3].

THE HUMAN WORLD OF RICHARD KLEMM

The public scientist and musician was sustained by a remarkably rich private world. At its center stood his wife Erika. They had known each other since their student years, and it was in the home of Richard's piano teacher Günter Plagge that they first encountered the kind of hospitality they would later practice themselves. Erika was a teacher and remained one all her life. Almost every evening the two of them went through their day over a bottle of wine — she with her school and the world of their family, he with the adventures of the institute. For decades, and out of nothing but concern, Richard tried to acquaint her with a scientific finding on the differing capacity of the male and the female liver. Erika insisted, to the last, on exactly half the bottle. The scene is small, but it shows the equilibrium of that marriage: two people of quite different gifts who completed one another, and a scientist who could carry an argument in the

international radar community but not at his own table. Their children — Lisel, Franz, and Dorothea — and later the grandchildren formed the world to which he remained most deeply attached, and he took pride in their different gifts and paths.

Many members of the international radar community knew Richard's home simply as "Haus Klemm." Its doors seemed always open. Visitors encountered books, scores, lively conversation, good wine, and, of course, music. Richard was also a passionate and imaginative cook. His house concerts were invariably accompanied by a generous buffet, and the conversation continued long after the final notes had faded. He understood hospitality as an art of composition: music, food, wine, conversation, and friendship were to form a coherent whole.

Richard also played regularly in my own home, where members of the fusion community joined us. These concerts belong to my most treasured memories. Yet the evenings were never solemn. Richard could move from the concentration of a Beethoven sonata to an anecdote, a parody, or a mischievous observation delivered with perfect timing.

Ulrich remembers how Richard helped turn FFM from an institution into a community: theatrical pieces written for celebrations, informal working lunches, the department's tea round, and many shared journeys [1]. Such rituals may appear peripheral to serious scientific work. In reality, they softened hierarchies, created trust, and allowed colleagues to encounter one another beyond their formal functions. Richard understood that creativity also depends on the culture in which people work together. Humor, performance, conversation, and shared experience did not replace technical rigor; they created some of the human conditions in which intellectual risk and unconventional ideas became possible.

Richard's humor was characteristically dry, ranging from the barely perceptible to the delightfully absurd. The same breadth marked his literary tastes. He was a passionate reader and delighted in polished prose, unexpected turns of phrase, original coinages, and striking verbal images. Language, like music and mathematics, was for him a medium in which structure, ambiguity, and surprise could be explored.

His literary and satirical gifts found a special outlet in the vocal ensemble *Die Mittwochssänger*—the "Wednesday Singers," named after their regular meetings on Wednesdays in my department. For the ensemble he wrote the *Mittwochslieder*, or "Wednesday Songs": witty ballads and satirical texts for five voices and piano. The humor was playful but never crude, the texts literate, the musical arrangements demanding. Their success required exact ensemble singing, alertness to language, and the ability to maintain musical seriousness while producing comic effects. Richard wrote the texts and music, accompanied the ensemble, and gave it its distinctive spirit. The *Mittwochssänger* revealed yet another aspect of Richard's creativity: he could treat a radar ambiguity with mathematical rigor, yet also recognize the ambiguities of human behavior and turn them into affectionate satire [18].

FRIENDSHIP, MEMORY, AND HOPE

What made friendship with Richard so precious was the unity of intellectual seriousness and personal kindness. He listened

attentively and could criticize an argument sharply without diminishing its author. He was always curious about new ideas. His judgment was independent, sometimes stubborn, and usually tempered by humor. Scientific cooperation with him was therefore inseparable from friendship. Ideas emerged during formal meetings, but also over meals, during walks, and in conversations that moved freely between radar, politics, literature, family, and music. This was the soil from which research grew.

Many of our most fruitful discussions took place late on Friday afternoons in Richard's office. We returned repeatedly to the close connection between STAP and GMTI tracking—in particular, to the need to model Richard's clutter notch within the likelihood function used for Bayesian track updates.

Two ring binders on Richard's shelf assisted the process. One was labeled "Software." Behind it stood a bottle of sherry. The other bore the label "Hardware" and was reserved for the intellectual nuts that had to be cracked. Behind it Richard kept an unusual vodka, a gift from a Ukrainian colleague whom he had enabled to attend EUSAR through a scholarship. The arrangement was characteristically Richard: technically precise in its labeling, quietly humorous in its meaning, and linked to an act of generosity toward a younger scientist. The drink, however, never replaced the argument; it marked the point at which an argument became a conversation between friends. Our common scientific adventures—including back-to-back conference papers and contributions to major handbooks—were possible because professional respect had developed into friendship.

Ulrich wrote to me that a whole chapter of his own life was inseparably bound up with Richard and the many activities they had shared. He remembered him as a person of rare versatility and warmth, whose company was always a pleasure. This captures something essential about the loss. Richard's death is felt not only as the absence of a distinguished scientist, but also as the closing of a whole world of work, travel, music, humor, conversation, and friendship [1].

The loss of a beloved friend interrupts the current of everyday life and prompts a more fundamental question: What conditions make possible the gift of a person such as Richard? No institution can manufacture originality. It can, however, recognize, cultivate, challenge, and protect originality—or stifle it.

Richard embodied the truth "nothing more practical than good theory." Wirth, the great gardener, recognized that potential before it had fully unfolded and pointed him toward fertile fields. Grosche, the prudent enabler, gave him freedom and protection, while also steering him away from roles that might have consumed rather than developed his particular gifts. Around them stood the engineers who translated scientific impulses into hardware, software, experiments, demonstrators, and usable systems—for radar science seeks knowledge that gives decision-makers sound grounds for action, and such knowledge arises only from the disciplined interaction of both.

Yet Richard's theoretical vision drew nourishment from more than radar science. Music, literature, humor, history, and friendship enlarged the sources of his technical imagination. Alfonso's memories show how Richard repeatedly transformed scientific cooperation into lasting friendship over more than four decades.

The international radar community will remember Richard Klemm as a pioneer of STAP, adaptive clutter suppression, and high-resolution radar; as the author and editor of foundational books; as an initiator of EUSAR; as a leading contributor to NATO research cooperation; and as the recipient of the von Kármán and Dennis J. Picard Medals.

Those who knew him personally will remember more: his smile at the end of a successful musical phrase, his delight in a clever formulation, his generous hospitality, his loyalty, his quietly satirical view of human pretensions, and the seriousness with which he treated both scientific truth and friendship.

Richard's life demonstrated that science and music are not opposing vocations. Both require disciplined listening. Both search for structure within complexity. Both depend upon individual voices and their meaningful interaction. And both can create forms of understanding that no one could produce alone.

To have been the friend of such a man was a rare privilege. His death leaves a silence. Yet in the science he advanced, the institutions he shaped, the music he shared, and the friendships from which new ideas were born, Richard Klemm's voice will continue to be heard. Hugh Griffiths expressed the most personal dimension of this loss in words of striking simplicity:

"But I remember him best as a person. I can see his face and hear his laughter. I shall miss him."

—Hugh Griffiths

Alfonso, Richard's friend and scientific companion since the late 1970s, found words that unite professional admiration, personal grief, and Christian hope. They may most fittingly close this remembrance:

"That said, I personally miss a friend—Dr. Richard Klemm—a distinguished, top-level scientist, an outstanding pianist, and a very fine gentleman. May the Lord bless him and his family. One day—we do not know when—we will find ourselves in the joy of Christ, of the Holy Spirit, and of the Lord."

—Alfonso Farina, Rome, Italy

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