Award Achievements
The 4th Heinrich Rohrer Medal –Grand Medal–
Prof. Franz J. Giessibl

"For the invention of the qPlus force sensor, which proved that sub-atomic spatial resolution is achievable in atomic force microscopy (AFM) and scanning probe microscopy (SPM), revolutionizing their range of applications for both AFM and SPM."

Prof. Giessibl has improved atomic force microscopy (AFM) to achieve true atomic resolution. He obtained a PhD with Gerd Binnig, Heinrich Rohrer's colleague, friend and co-recipient of the Nobel Prize in Physics 1986 for the invention of the scanning tunneling microscope (STM). In his thesis, Giessibl demonstrated for the first time true atomic resolution by AFM using a home built low-temperature AFM to image atomic defects on KBr. He then joined a Stanford spin-off company to develop an ultra-high vacuum AFM. He achieved the first atomically resolved image of the Si 7x7 reconstruction by AFM with this device, important as the first 7x7 image by STM convinced the world about the prowess of STM. The 7x7 result by AFM launched the field of atomically resolved Noncontact-(NC) AFM, the NCAFM conference is still conducted annually since 1998. After resolving 7x7 by AFM, Giessibl did not immediately see another big goal for AFM and left physics for new lands, joining management consultancy McKinsey. The new experiences with benchmarking in the consulting practice triggered his idea to build an AFM that utilizes a key innovation of the watch industry. Parallel to his work as a consultant, he set up a home laboratory and invented a novel sensor for the AFM that is based on the time keeping element of a quartz watch, he called it the qPlus sensor. To see if this could give a fresh boost to AFM, he joined the University of Augsburg. Only a few years later, he established the qPlus sensor as a new core of the AFM that even achieves subatomic resolution, i.e. it resolves single electron clouds in an atom. The result even sparked the interest of Gerhard Richter, one of the most influential painters of our time, and led to an ongoing exchange resulting in Giessibl's contributions to three works of Richter: *First View* (2000), *Graphite* (2005) and *Two grey double mirrors for a pendulum* (2018) and inspirations to *Silikat* (2004) and *Strontium* (2006). At Richter's 90th birthday, a book appeared that reports about the fruitful exchanges between artist and scientist. The qPlus sensor not only increases spatial resolution with respect to the previously used silicon cantilever, it is also self sensing via the piezoelectric effect so it is easy to use in challenging environments such as low temperatures and ultrahigh vacuum. The high stiffness of the quartz sensor and the relatively large size allows to use metal tips that oscillate at sub-Angstrom amplitudes, thus reuniting STM and AFM for simultaneous current and force experiments.

To open new applications, Giessibl reached out to Gerhard Meyer and Leo Gross at IBM Rüschlikon and to Andreas Heinrich at IBM Almaden. The Rüschlikon group used the qPlus sensor to image the charge state of single atoms and to atomically resolve organic molecules by terminating the qPlus tip with a CO molecule, opening a new field in its own. The Almaden team measured the force needed to move an atom by replacing the metal tip of an STM designed by Don Eigler with a qPlus sensor. This also opened a new avenue to grasp the physics behind atomic manipulation. Giessibl spent a sabbatical with Joseph Stroscio at NIST and helped to build a millikelvin STM/AFM for high magnetic fields. Together with his Regensburg team, Giessibl used the qPlus to standardize subatomic resolution, gain more knowledge on atomic manipulation, perform spin-resolved AFM, combine inelastic electron tunneling spectroscopy with AFM, explore the possibilities of atomically resolved lateral force microscopy, resolve metal clusters atomically and measure their site-dependent reactivity, study the bonding properties of electrons in a quantum corral, obtain atomic resolution in ambient and electrochemical environments etc.. Giessibl also supported commercial manufacturers of low temperature STMs to outfit their products with the qPlus sensor and thereby expanded their utility dramatically. Today, approximately 500 low temperature qPlus STM/AFMs are in operation globally.