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Fifteen years of *Servitude et Grandeur* to the application of a biophysical technique in medicine: The tale of AFMBioMed

Abstract

AFMBioMed is the founding name under which international conferences and summer schools are organized around the application of atomic force microscopy in life sciences and nanomedicine. From its inception at the Atomic Energy Commission in Marcoule near 2004 to its creation in 2007 and to its 10th anniversary conference in Krakow, a brief narrative history of its birth and rise will demonstrate how and what such an organization brings to laboratories and the AFM community. With the current planning of the next AFMBioMed conference in Münster in 2019, it will be 15 years of commitment to these events.

1 | THE HISTORICAL CORNER

AFMBioMed was first coined in 2006 to represent an international conference on Atomic Force Microscopy (AFM) in Life Sciences and nanoMedicine. AFM rose in the 1980s with the founding work of Binnig, Quate, and Gerber,¹ the same year the physics Nobel prize was awarded to Binnig and Rohrer for their development of the scanning tunneling microscope (STM) 5 years earlier²; the prize was shared with Ruska for his discovery of the electron microscope (EM). Now, 30 years later, AFM has likely not reached yet the maturity of EM, especially with the recent developments of direct electron detectors for EMs. Besides, we observe that in most institutes dedicated to life sciences, EM instruments are often present whereas AFMs are only found sporadically. Thus, AFM needs further efforts of popularization and improvements to make it one of the tools of choice life science institutes provide to their researchers to characterize biological samples.

To explain the genesis of AFMBioMed, we first share a little bit of our personal experiences at the Commissariat à l'Énergie Atomique et

aux Énergies Alternatives (CEA) which was the pivotal organization behind this conference series and the associated summer schools. We, JLP and PP, have worked at different stages of the story and on different aspects, but “we” is used to name one or both of us.

The introduction briefly covers the subjective history of the first two authors during the last 15 years ranging from naïve AFM beginners to the 10th AFMBioMed anniversary in 2017 in Krakow. The manuscript may be perceived as personal therapy for the authors, which may be quite possible, but 10 years of driving activity of the AFMBioMed association cannot be made by a single (or two) people, and we found that credit must be granted to all of those who believed in this organization and supported its activity throughout the years.

Let's start at the beginning. In 2001, we joined a department built from scratch (Service de Biochimie post-génomique et Toxicologie Nucléaire at the CEA Valrhô, later known as CEA Marcoule, a center located in the South of France near Avignon and Nîmes) by means of a reorganization of a CEA Industry company called CIS-Bio International. It was the most amazing opportunity that a researcher can have in his or her professional life: the possibility of building a laboratory from scratch with an incredible financial package including technicians, engineers, instruments, and administrative support. The shortcoming of this wondrous opportunity was the necessity to develop novel projects on Nuclear Toxicology, a topic with which neither of us was familiar for the good reason that this topic was also created from scratch. This idyllic opportunity must be further tempered by the fact that the Department was created in 2000, 1 year before our arrival, and most of the Department structure was set and the dedicated installment budget was mostly spent. After jiggling from unreachable heavy EM instruments or old-fashioned spectroscopy, we both decided to explore some new territory, at least for us. With the capacity to work in biology, physics, and chemistry, we agreed to orient our effort toward Atomic Force Microscopy (the word “Atomic” nicely fits our employer's fulfillment, CEA!). Clearly, we were younger and naïve back then.

The road from a decision to its fruitful realization is long, tortuous, and strewn with pitfalls. We had briefly imagined that we could build our own AFM machine using the knowledge of a very talented instrument designer, Michael Odorico, who joined our group at the very beginning. This path was quickly abandoned thanks to the experience of Michael who warned us that such a road is long and perilous. He spoke wisely. Thus, we decided to visit major AFM manufacturers in 2002. Our naivete made us ask these manufacturers to show us the possibility to image single isolated proteins or living cells. For some of them (ie, application engineers from semiconductor physics), it

All the coauthors are founders or organizers of AFMBioMed conferences or schools.

Jean-Luc Pellequer and Pierre Parot are co-founders of AFMBioMed.

Daniel Navajas, Sanjay Kumar, Vesna Svetličić, Simon Scheuring, Jun Hu, Bin Li, Adam Engler, Susana Sousa, Małgorzata Lekka, Marek Szymoński, and Hermann Schillers are conference chairs.

Jean-Luc Pellequer, Pierre Parot, Simon Scheuring, Małgorzata Lekka, Michael Odorico, Frank Lafont, Sebastien Janel, and Felix Rico are summer school organizers.

was the first time they heard about biology and made their first biological tests on our samples. By completing our search with literature and with some colleagues' advice, we decided to acquire two Digital Instrument (DI) AFMs, which were delivered beginning of 2003.

In November 2002, we participated in a Digital Instrument user meeting at Montpellier. In the same amphitheater that PP sat 30 years ago as a student, we listened to a talk from a young Swiss researcher who was imaging molecules, the native photosynthetic system, that PP studied for years by spectrophotometry. At the end of the presentation, PP went to congratulate the speaker, Simon Scheuring, who has been since this time a fervent supporter of our projects for the next 14 years including AFMBioMed; Simon was the organizing chairman of the 2011 Paris conference. The outstanding quality of Simon's AFM images boosted our enthusiasm upon returning to the lab. It took us quite some time to realize that imaging single isolated proteins was much more difficult than imaging highly concentrated membrane proteins. In AFM, as well as in other biophysical techniques, there are not only good experimenters but also good samples! Despite these impressive results, we did not anticipate the strong resistance of our institution against AFM. Indeed, 10 years earlier (in the 1990s), a first encounter between AFM and CEA Life Sciences division left an unaccomplished feeling with a conclusion that AFM does not fit in biology. That same instrument, acquired in the 1990s, was peacefully resting in a cellar in Saclay (a CEA center near Paris), and we were invited to come to pick it up. Some good advice from Christian Le Grimmellec (CLG), who was our first contact with AFM at the Centre de Biochimie Structurale at Montpellier, was to leave the antiquity in the cellar and to pursue our convincing campaign to get funding for our own more modern AFM instruments!

From our early AFM steps with CLG at Montpellier, we soon recognized that the French-speaking AFM community was scattered (both into various scientific fields and into various scientific societies). Thus, we decided to organize a Francophone meeting at Nîmes in 2004 at the Centre Universitaire de Nîmes with the help of Joël Chopineau. The meeting "Atelier Nanobiosciences: protéines et membranes" was (surprisingly) a very successful day with about 30 major French-speaking AFM researchers in life sciences, maybe a consequence of our "candor" in AFM or due to phototropism in June in the South of France. Searching through the archives of our laboratory, an internal report of the 2004 meeting clearly raised the topic: "Myth and reality of SPM approaches in biology," a question mostly targeted to our research institutions. Another comment from this report pointed to a truly open discussion during the second day of the meeting with a clear description of real experimental difficulties and current limitations. Another positive outcome of this meeting was the tentative to build a French GDR (Groupement De Recherche) in 2005 entitled "La microscopie à force atomique en biologie" under the leadership of Simon Scheuring (Institut Curie, Paris) and Pierre-Emmanuel Milhiet (CBS, Montpellier). In 2004, there were already several conferences dedicated to Scanning Probe Microscopies (SPM) such as the Linz winter workshop, the International SPM, SPM international workshop (NanoBioVIEWS) until 2011, and the French Forum des Microscopies à Sonde Locale (<http://www.sondeslocales.fr/acueil>). However, we soon discovered that the biological section (or AFM on biological samples) was a negligible part of each of these

meetings, and most talks and discussions required a strong theoretical physics background. Thus, it was not adapted to our growing lab of biologists. We soon realized that we were not the only ones in need of a more biologically oriented AFM conference.

The premise of AFMBioMed could be traced to a Veeco user-meeting in Dourdan in April 2006. PP presented a talk on AFM and life sciences.³ As often told, it was during a diner that Emmanuel Paris from Veeco France launched the idea of organizing a conference on AFM and Biology. However, the daunting responsibility seemed too high for us to have a go at this time. It was during the ISPM meeting at La Grande Motte in June 2006 that we decided to agree to organize such an event, with our core team Michael Odorico and Jean-Marie Teulon. We decided to orient the first conference around AFM and medicine, a topic that was emerging. Our first difficulty was to find a chairman that would accept to bear the organization, at his university, of a brand new conference on a well-defined scientific topic.

Again, the phototropism may have led us to contact Daniel Navajas (Univ. Barcelona) first and were both surprised and relieved that he immediately accepted. During our first visit to Daniel's lab in October 2006, our major discussion topic was to estimate how many researchers would come to such a conference. At that time, the sponsor Veeco Inc. suggested organizing the conference at the CosmoCaixa (Barcelona Science Museum). The CosmoCaixa proposed two amphitheatres: 500 and 200 seats. We modestly asked if they had something smaller as we expected about 50 attendants (see below for the final count of participants). Finding a name for this conference was our second challenge. It was solved at a normal lunchtime in Barcelona (3 PM) at the museum cafeteria by combining the following words: AFM, biology, life sciences, medicine, Mediterranean; and became AFMBioMed Conference. To prepare the conference scientific program, we convinced four chairmen (Yves Dufrêne, Peter Hinterdorfer, Christian Le Grimmellec, and Simon Scheuring) to help us shape this Barcelona meeting. It was during this November 2006 meeting that the basis of the AFMBioMed Conference charter was established (<http://www.afmbiomed.org/charter.aspx>).

2 | AFMBIOMED CONFERENCES

The first AFMBioMed conference was held in April 19-21, 2007, in Barcelona, Spain (at the CosmoCaixa museum). Registrations and practical details of the first conference were entirely managed by Veeco France with Stéphanie Piétri as organizational coordinator. Registration wise, the conference was a success with about 150 participants to which we added 19 invited speakers plus all the sponsors. But most importantly, the conference was a real scientific success with talks covering all the topics of AFM in biology: cells, single molecules, proteins, nucleic acids, force spectroscopy, and molecular interactions. We are indebted to the three keynote speakers: Pierre Bongrand for accepting to present the inaugural talk on "What is the biological relevance of the specific bond properties revealed by single molecule studies?"; Paul Hansma, who posed his personal aim for AFM which was to see the first time an AFM will be involved in patient care in a hospital; and Michael Horton for the closing keynote address with

his insightful talk, "A little can go a long way!" At the end of this first conference, it was decided to pursue the conference another time by selecting the timing (in 18 months) and by choosing to rotate the conference on different continents; the next one would be America.

First AFMBioMed Conference 2007

Barcelona, Spain, 19-21 April

Conference chair: Prof. Daniel Navajas (U. Barcelona)

Keynote:

Pierre Bongrand (Marseille)
Paul Hansma (Santa Barbara)
Michael Horton (London)

Chairs:

Dufrène, Yves (Louvain-la-Neuve)
Hinterdorfer, Peter (Linz)
Le Grimellec, Christian (Montpellier)
Scheuring, Simon (Paris)

Invited:

Ando, Toshio (Kanazawa)
Burns, Alan R. (Albuquerque)
Engel, Andreas (Basel)
Garcia, Ricardo (Madrid)
Gaub, Hermann (München)
Hörber, Heinrich (Bristol)
Mouritsen, Ole (Odense)
Moy, Vincent (Miami)
Müller, Daniel J. (Dresden)
Navajas, Daniel (Barcelona)
Reich, Ziv (Rehevot)
Sanz, Fausto (Barcelona)

Being on the editorial board of the *Journal of Molecular Recognition* (JMR), we contacted the editor-in-chief, Marc Van Regenmortel, to enquire if a special issue pertaining to the AFMBioMed conference presentations was possible. The answer was quick and highly supportive of the idea. In addition, Martin Rothlisberger (Wiley's Executive Commissioning Editor) suggested contributing to young investigators by providing travel bursaries (a grant of 1,500 €), which would later be renamed into The JMR Young Investigator Award. Since that first conference, Wiley and the *Journal of Molecular Recognition* have engaged in a tight partnership with the conference series. The first JMR special issue was published in the November/December volume (20:6) in 2007.⁴ This issue and the subsequent ones were edited by us (except those written by our own laboratory that were handled by Heinrich Hörber, a new editor of JMR following the addition of the keyword AFM to the journal's topic list). The first special issue contained three reviews⁵⁻⁷ and 14 research articles.⁸⁻²¹

The second AFMBioMed conference was held on 15-18 October 2008 in Monterey, CA, at the Hyatt Regency Monterey Hotel (<http://www.afmbiomed.org/monterey-2008.aspx>). The conference was organized locally by Veeco USA. It turned out that it had been a challenge to find an organizing chair, because for various reasons (personal, technical), the selected chair stepped down 9 months before the conference. We finally contacted Sanjay Kumar at the University of California, Berkeley, and he quickly accepted, to our relief. We went immediately to Berkeley to visit Sanjay's lab in February, and in this rush, one of us got stuck on a German airport due to strong weather conditions in Europe. Approximately 150 scientists from 16 countries attended the Monterey edition of AFM BioMed which was organized into five full-length oral sessions, two poster sessions, and an evening session featuring short oral presentations of a few particularly

outstanding posters, plus a spectacular privatized visit and dinner at the Monterey Bay Aquarium. The scientific sessions were (1) New AFM-Based Instrumentation for Biology and Medicine, (2) Biomolecular Force Spectroscopy, (3) AFM of Biomaterial Surfaces, (4) AFM of Cells, and (5) Biomolecular Imaging. It was a surprise to us that most attendees came from Europe. A special issue appeared in the *Journal of Molecular Recognition* in volume 22:5 in 2009.²² Eight research articles composed this special issue.²³⁻³⁰ As the AFMBioMed charter got refined, we decided after the Monterey Conference to define clearly the conference organizing committee (the present authors plus all the former conference chairs) and the scientific organizing committee (the founders plus the conference chair, selected session chairs, and local organizers). It was also decided to confirm the frequency of the conference (every 18 months, one conference in spring, and the other in fall), to rotate the conference on different continents if possible (it is not that easy), to change session chairmen and invited speakers at each conference (some last-minute defections created exceptions to this rule), and to achieve greater gender balance in conference chairs (we almost get a perfect share). The final major change in the AFMBioMed organization after 2008 was the change in the responsibility of future conference organization that was attributed to the International AFMBioMed Conference Association (IACA, A nonprofit French association defined by the 1901 Act; Loi de 1901). With these rules, we were searching a possibility to organize the next conference in Asia; however, the difficulty in getting appropriate contacts (likely a cultural matter) made us come back to Europe.

Second AFMBioMed Conference 2008

Monterrey, USA, 15-18 October

Conference chair: Prof. Sanjay Kumar (UC Berkeley)

Keynote:

Chairs:

Fletcher, Dan (Berkeley)
Grandbois, Michel (Sherbrooke)
Haugstad, Greg (Minneapolis)
Scheuring, Simon (Paris)
Yip, Chris (Toronto)

Invited:

Fuchs, Harald (Münster)
Hoh, Jan (Baltimore)
Li, Hongbin (Vancouver)
Lyubchenko, Yuri (Omaha)
Melosh, Nick (Stanford)
Müller, Daniel (Dresden)
Perkins, Tom (Boulder)
Radmacher, Manfred (Bremen)
Shao, Zhifeng (Charlottesville)
Siedlecki, Chris (Philadelphia)

The Third AFMBioMed conference was held on 12-15 May 2010 in Red Island, Croatia (Crveni Otok, near Rovinj in Istria, <http://www.afmbiomed.org/red-island-2010.aspx>). The conference chair was Vesna Svetličić from the Rudjer Bošković Institute. The idea to choose Croatia came from a student of Vesna Svetličić, Tea Mišić, who participated in the first AFMBioMed summer school in Marcoule in 2008 and Vesna and Tea volunteered. The local organizers did not wish to organize the conference in the capital city of Zagreb and instead claimed to have a better location: a privatized island on the Adriatic Sea. We immediately noticed the challenge for reaching Red Island from international destinations, so bus transportation was organized from the main local airports and train stations (Zagreb, Trieste, and

Pula). Nevertheless, participants from Canada, Japan, Russia, United States, and 17 European countries reached the Red Island. Personally, we rented a minibus and drove the 1200 km all the way from Marcoule to Red Island (with four alternate drivers on the minibus, the distance did not seem so long!). This third conference presented several novel aspects: The length was increased from 3 to 4 days and a practical tutorial day on May 11th was independently organized by the sponsor Veeco. The scientific sessions were (1) Interaction & Recognition, (2) Nanoecology & Nanotoxicology, (3) AFM Bio I, (4) Trends in Theory & Technologies, (5) AFM Bio II, (6) Nanomedicine, and (7) Round table about the future of AFM in Nanomedicine. A special issue appeared in the Journal of Molecular Recognition in volume 24:3 in 2011.³¹ Four reviews³²⁻³⁵ and 11 research articles³⁶⁻⁴⁶ composed this special issue. A posteriori, we recognized that Red Island was not so easy to reach and this conference suffered from the lowest attendance so far. To avoid this pitfall, we carefully choose the next destination, which should be in Europe according to the initial rotation schedule.

Third AFMBioMed Conference 2010

Red Island, Croatia, 12-15 May

Conference chair: Prof. Vesna Svetličić (IRB, Zagreb)

Keynote:

Discher, Dennis (Philadelphia)

Chairs:

Facci, Paolo (Modena)
Lafont, Frank (Lille)
Lee, Gil (Dublin)
Milhiet, Pierre-Emmanuel (Montpellier)
Oberleithner, Hans (Münster)
Pellequer, Jean-Luc (Marcoule)
Scheuring, Simon (Paris)
Su, Chanmin (Santa Barbara)
Svetličić, Vesna (Zagreb)

Invited:

Cohen Simonsen, Adam (Odense)
Dufréne, Yves (Louvain-la-Neuve)
Kumar, Sanjay (Berkeley)
Lead, Jamie (Birmingham)
Navajas, Daniel (Barcelona)
Sokolov, Igor (Postdam)
Uchihashi, Takayuki (Kanazawa)
Van Noort, John (Leiden)

The fourth AFMBioMed conference was held on 23-27 August 2011 in Paris, France, at the Curie Institute (<http://www.afmbiomed.org/paris-2011.aspx>). The conference chair was Simon Scheuring from Curie Institute. During this conference, further efforts were made to improve the organization, and the Paris conference established the current organization of AFMBioMed conferences. In particular, the length was confirmed at 4 days. The conference had four sessions, each divided in two half-day sessions. A session chairman chairs both half-day sessions including his or her personal presentation of 30' plus an invited speaker presentation of 30'. A half-day session is completed by abstract-based selected presentations of 10' or 20'. Usually, each conference allowed for 50 to 60 selected oral presentations. The four scientific sessions were (1) Molecular Imaging, (2) Force Measurements/Mechanics, (3) Nanomedicine, and (4) Technology/Theory. A special issue appeared in the Journal of Molecular Recognition in volume 25:5 in 2012.⁴⁷ Ten research articles composed this special issue.⁴⁸⁻⁵⁷ The last change that was made during the Paris conference was the decision to announce at the end of the current conference, the location of the next one (in 18 months). The Paris conference combined both excellence in the scientific program with a refinement of the social events, which included a free visit of Paris or a

visit of the Louvre Museum, and a night diner on a cruise boat on the Seine River. The Paris conference attained the largest attendance of all AFMBioMed conferences. It was announced at the end that the next conference will be held in Shanghai with Zhifeng Shao as the organizing chair.

Fourth AFMBioMed Conference 2011

Paris, France, 24-27 August

Conference chair: Dr. Simon Scheuring (Inst. Curie, Paris)

Keynote:

Gerber, Christoph (Basel)

Chairs:

Ando, Toshio (Kanazawa)
Bustamante, Carlos (Berkeley)
Radmacher, Manfred (Bremen)
Shao, Zhifeng (Charlottesville)

Invited:

Kasas, Sandor (Lausanne)
Kodera, Noriyuki (Kanazawa)
Samori, Bruno (Bologna)
Zenobi, Renato (Zürich)

The fifth AFMBioMed conference was held on 8-11 May 2013 in Shanghai at the Shanghai Institute of Applied Physics (<http://www.afmbiomed.org/shanghai-2013.aspx>). The conference chair was Jun Hu with the help of Bin Li from SINAP. From an organization point of view, Zhifeng Shao, who recently moved from Charlottesville to Shanghai, suggested that Jun Hu was better suited as the acting chair. The choice of China, among Asian countries, was linked to the flourishing Chinese economy. The scale of Shanghai metropolis is beyond the grasp of most European citizens, at least to us. It took us several days of visiting to select the location of the conference with the generous help of Bin Li and two helpful students. This preliminary visit could have been a breeze if one of us did not lose his credit card in an ATM on the first day in Shanghai. The conference was nicely organized. The four scientific sessions were (1) High-resolution & High-speed Imaging, (2) Molecular Force Spectroscopy & Recognition, (3) Cellular MechanoBiology, and (4) AFM in Nanomedicine. Similarly to Paris, a cruise-boat diner was the central attraction of the social events. Similarly to Monterey, we observed that most registered participants came from Europe with a lower number of Chinese researchers than expected. The information did not travel easily as we involuntarily discovered during the trip in the Beijing subway that brought us to the airport where we were talking with a Chinese researcher who was going to the USA for a conference. After presenting ourselves and explaining our presence in China, he told us that he was a Biophysicist working 100 km away from Shanghai in a laboratory using AFM; he unfortunately was not aware of the conference. At the end of the conference, it was announced that the next one would be organized in San Diego. A noticeable change has been made in the conference special issue that appears in the Journal of Molecular Recognition, where the special issue is now a virtual issue meaning that accepted manuscripts were published along the line of regular manuscripts. This allows a quicker publication time since it was not necessary to wait for the last manuscript to be accepted in order to make a specific volume. These virtual issues are labeled on the JMR website (<https://onlinelibrary.wiley.com/page/journal/10991352/homepage/VirtualIssuesPage.html>), which provides quick links to published articles.⁵⁸ This new special virtual issue contained eight research articles.⁵⁹⁻⁶⁶

Fifth AFMBioMed Conference 2013

Shanghai, China, 8-11 May

Conference chair: Dr. Jun Hu (Shanghai Inst. Appl. Phys.)

Keynote:

Chairs:

Dietler, Giovanni (Lausanne)
Gerber, Christoph (Basel)
Navajas, Daniel (Barcelona)
Yamada, Hirofumi (Kyoto)

Invited:

Ando, Toshio (Kanazawa)
Fang, Xiaohong (Beijing)
Gu, Ning (Nanjing)
Jia, Jinfeng (Shanghai)
Lim, Roderick (Basel)
Osmulski, Pawel (San Antonio)
Thomson, Neil (Leeds)
Zhang, Wenke (Jilin)

The Sixth AFMBioMed conference was held on 14-17 December 2014 in San Diego at the Roth Auditorium of Sanford Consortium for Regenerative Medicine (<http://www.afmbiomed.org/san-diego-2014.aspx>). The conference chair was Adam Engler from UCSD. Similar to Monterey in 2008, there was a change in the conference chair, but it did not change the location. Since one of us spent 7 years in San Diego, we did not need a preliminary visit. We met Adam the day before the conference. The conference was perfectly organized including the social event in the privatized beautiful Birch Aquarium at Scripps overlooking breathtaking ocean views. The four scientific sessions were (1) Imaging, (2) Forces and Biomechanics, (3) Biomedical Applications, and (4) Integrative AFM developments. As with Paris, the location of San Diego possessed all the ingredients for a successful conference: international-connected destination, spacious conference facilities, close to many hotels. We should have added the weather, however, to the major relief of San Diegians after a severe drought, it rained during half the conference, which was quite unexpected for such duration. A virtual issue appeared in the Journal of Molecular Recognition in 2016.⁶⁷ Six research articles composed this special issue.⁶⁸⁻⁷³

Sixth AFMBioMed Conference 2014

San Diego, CA, 14-17 December

Conference chair: Prof. Adam Engler (UC San Diego)

Keynote:

Chairs:

Franz, Clemens (Karlsruhe)
Gimzewski, James (UC Los Angeles)
Ros, Robert (Tempe)
Schillers, Hermann (Münster)

Invited:

De Yoreo, James (Richland)
Li, Hongbin (Vancouver)
Oberleithner, Hans (Münster)
Schäffer, Tilman (Tübingen)

The seventh AFMBioMed conference was held on 12-15 April 2016 in Porto at the Biblioteca Municipal Almeida Garrett (<http://www.afmbiomed.org/afmbiomed-porto-2016.aspx>). The conference chair was Susana Sousa from INEB|3S, Instituto nacional de Engenharia Biomédica, Instituto de Investigação e Inovação em Saúde. We met Susana Sousa during the last member committee management of the COST Action AFM4NanoMed&Bio in 2014 in Paris (European network on applications of Atomic Force Microscopy to NanoMedicine and Life Sciences, TD1002,⁷⁴). According to the rotation schedule of the conference, the next one was supposed to occur

in Europe and Susana Sousa immediately volunteered. The organization was perfect both at the scientific and social level. The four scientific sessions were (1) Health and disease, (2) Mechanobiology and disease, (3) Nanomedicine, and (4) Bioimaging. The social event was a visit diner at the Taylor's Port Wine Cellars. A novel addition to this conference was a scientific image competition where the winner (Hermann Schillers) and the picture can be found at www.afmbiomed.org/afmbiomed-scientific-image-competition.aspx. A virtual issue appeared in the Journal of Molecular Recognition in 2017.⁷⁵ Nine research articles composed this special issue.⁷⁶⁻⁸⁴ At the end of the conference, it was announced that the next one will be organized in Kraków, in 2017. Given our experiences with conferences in the USA and in China, Europe appears as the logical choice for holding the conferences with the most active AFM community in Biology and Medicine susceptible to join the events.

Seventh AFMBioMed Conference 2016

Porto, Portugal, 12-15 April

Conference chair: Prof. Susana Sousa (INEB, Porto)

Keynote:

Scheuring, Simon (Marseille)

Chairs:

Hinterdorfer, Peter (Linz)
Lekka, Małgorzata (Kraków)
Schillers, Hermann (Münster)
Williams, Phil (Nottingham)

Invited:

Engler, Adam (San Diego)
Hoogenboom, Bart (London)
Navajas, Daniel (Barcelona)
Pêgo, Ana Paula (Porto)
Radmacher, Manfred (Bremen)
Santos, Nuno C. (Lisboa)

The eighth AFMBioMed conference was held on 4-8 September 2017 in Kraków (<http://www.afmbiomed.org/krakow-2017.aspx>). The conference chairs were Małgorzata Lekka from the Polish Academy of Sciences (PAN) and Marek Szymoński from the Jagiellonian University. During this conference, the 10th anniversary of AFMBioMed conferences was celebrated during the gala dinner in the sumptuous salt mine of Wieliczka. Ten years of images from conferences and summer schools were displayed in a movie cycling during the diner and highlighting the inexorable effect of time! The four scientific sessions were (1) Bioimaging, (2) Health and disease, (3) Molecular forces, and (4) Cellular mechanobiology. A virtual issue appeared in the Journal of Molecular Recognition and is linked with this editorial. Ten research articles composed this special issue.⁸⁵⁻⁹⁴

- Pleskova S. N., Gorshkova E. N., and Kriukov R. N.

Dynamics of formation and morphological features of neutrophil extracellular traps formed under the influence of opsonized *Staphylococcus aureus*. DOI: 10.1002/jmr.2707 (Edited by JL Pellequer).

- Viji Babu P. K., Rianna C., Belge G., Mirastschijski U., and Radmacher M.

Mechanical and migratory properties of normal, scar, and Dupuytren's fibroblasts. DOI: 10.1002/jmr.2719 (Edited by JL Pellequer).

- Bui V. C. and Nguyen T. H.

DNA aggregation induced by Mg(2+) ions under different conditions. DOI: 10.1002/jmr.2721 (Edited by JL Pellequer).

- Milani P., Chlasta J., Abdayem R., Kezic S., and Haftek M.

Changes in nano-mechanical properties of human epidermal cornified cells depending on their proximity to the skin surface. DOI: 10.1002/jmr.2722 (Edited by JL Pellequer).

- Kolodziejczyk A., Jakubowska A., Kucinska M., Wasiak T., Komorowski P., Makowski K., and Walkowiak B.

Sensing of silver nanoparticles on/in endothelial cells using atomic force spectroscopy. DOI: 10.1002/jmr.2723 (Edited by JL Pellequer).

- Kozlova E., Chernysh A., Sergunova V., Gudkova O., Manchenko E., and Kozlov A.

Atomic force microscopy study of red blood cell membrane nanostructure during oxidation-reduction processes. DOI: 10.1002/jmr.2724 (Edited by JL Pellequer).

- Dinarelli S., Girasole M., Spitalieri P., Talarico R. V., Murdocca M., Botta A., Novelli G., Mango R., Sangiulo F., and Longo G.

AFM nano-mechanical study of the beating profile of hiPSC-derived cardiomyocytes beating bodies WT and DM1. DOI: 10.1002/jmr.2725 (Edited by JL Pellequer).

- Dutta S., Rivetti C., Gassman N. R., Young C. G., Jones B. T., Scarpinato K., and Guthold M.

Analysis of single, cisplatin-induced DNA bends by atomic force microscopy and simulations. DOI: 10.1002/jmr.2731 (Edited by JL Pellequer).

- Zemla J., Stachura T., Gross-Sondej I., Gorka K., Okon K., Pyka-Fosciak G., Soja J., Sladek K., and Lekka M.

AFM-based nanomechanical characterization of bronchoscopic samples in asthma patients. DOI: 10.1002/jmr.2752 (Edited by JL Pellequer).

- Chièze L., Le Cigne A., Meunier M., Berquand A., Dedieu S., Devy J., and Molinari M.

Quantitative characterization of single-cell adhesion properties by atomic force microscopy using protein-functionalized microbeads. DOI: 10.1002/jmr.2767 (Edited by JL Pellequer).

Eight AFMBioMed Conference 2017

Kraków, Poland, 5-8 September

Conference chair: Prof. Małgorzata LEKKA (Inst. Nucl. Phys., Polish Academy of Sciences) and Prof. Marek Szymanski (Inst. Phys., Jagiellonian University)

Keynote:

Gimzewski, James (UC Los Angeles)

Chairs:

Guthold, Martin (Winston-Salem)
Podestà, Alessandro (Milano)
Roos, Wouter (Gröningen)
Wójcikiewicz, Ewa (Boca Raton)

Invited:

Alsteens, David (Louvain-la-Neuve)
Kasas, Sandor (Lausanne)
Kulik, Andrzej (Lausanne)
Nowak, Wiesław (Torun)
Radmacher, Manfred (Bremen)
Rico, Felix (Marseille)
Sokolov, Igor (Medford)
Zenobi, Renato (Zürich)

3 | AFMBIOMED SUMMER SCHOOLS

As mentioned earlier, AFM originated from physicists, and although some early developments were oriented toward biological samples (for instance, the tapping mode⁹⁵), most technical details of AFM escape mainstream biologists. It was clear at the first AFMBioMed conference in Barcelona that there was a strong demand for AFM conferences with and for biologists. With our beginner status, we immediately pondered about the possibility of organizing summer schools to demystify the AFM techniques to biologists and to train the next generation of skilled AFMists that address more complex biological questions. We thus decided to launch the AFMBioMed summer schools. The first school was organized in Marcoule in 2008 at our department location. Since then, nine more schools have been organized in different locations with different sponsors or frameworks such as a nascent institute called ICSM (Institut de Chimie Separative de Marcoule), the education institute of CEA (INSTN), the European COST Action TD1002, the Institut Pasteur de Lille (IPL), the Institute of Nuclear Physics PAN in Kraków, and the INSERM Marseille (Institut National de la Santé et de la Recherche Médicale). In this year 2018, we celebrated the 10th AFMBioMed summer school at Marseille under the local organization of Felix Rico who created a special AFMBioMed engraving on an AFM cantilever (Figure 1). Lately, with our move to Grenoble, the school alternates between the cities of Marseille and Grenoble; it will likely move to other cities as well. Along the years, various manufacturers of AFM instruments or cantilevers participated in the schools, essentially by providing instruments or samples. Since the first school in 2008, Veeco, then BRUKER, was a generous sponsor/contributor by not only providing instruments but also assigning one or two engineers during the whole duration of a school. Again, this was likely a critical step toward the success of this summer school. Other AFM manufacturers did participate to various schools including JPK and Oxford Instruments.

Year	Date	Location	Organizers	Co-sponsors
2008	28 Aug-3 Sep	Marcoule	Parot/Pellequer	CEA-SBTN/ CEA-INSTN/ VEECO

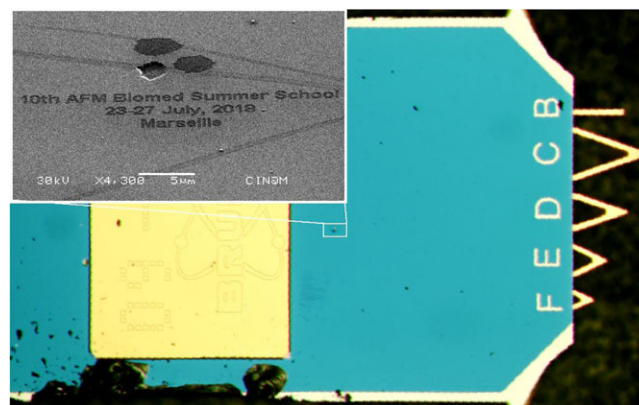


FIGURE 1 A 25 μm focused ion beam engraving of the 10th anniversary of AFMBioMed Summer School in Marseille. The FIB milling has been performed by the CINaM laboratory in Marseille

(Continued)

Year	Date	Location	Organizers	Co-sponsors
2009	13 Sep-19 Sep	Marcoule	Parot/Pellequer	CEA-SBTN/ CEA-INSTN/ VEECO
2011	28 Aug-2 Sep	Marcoule	Parot/Pellequer	COST Action TD1002/CEA- INSTN/VEECO/ Nanosciences GSO/IPL
2012	14 Sep-21 Sep	Krakow	Lekka	COST Action TD1002/ IFJPAN/BRUKER
2013	1 Sep-6 Sep	Marcoule	Odorico/Parot/ Pellequer	COST Action TD1002/CEA- SBTN/BRUKER
2014	25 Aug-29 Aug	Lille	Janel/Lafont	COST Action TD1002/BRUKER/ IPL/JPK/ZEISS/ ABBERRIOR
2015	24 Aug-29 Aug	Grenoble	Pellequer/ Teulon	CEA-IBS/ESRF/ Labex GRAL/ BRUKER/ NANOANDMORE
2016	18 Jul-23 Jul	Marseille	Scheuring	INSERM, Labex INFORM, Fondation AMU
2017	21 Aug-26 Aug	Grenoble	Pellequer/ Teulon	CEA-IBS/ILL/Labex GRAL/UGA/SFμ/ BRUKER/OXFORD INST.
2018	23 Jul-27 Jul	Marseille	Rico	INSERM, Labex INFORM, BRUKER, JPK, OXFORD INST., Optics11, AMU, NanoAndMore, GDR ImaBio

Abbreviations: CEA, Commissariat aux Energies Atomiques et Energies Alternatives; SBTN, Service de Biochimie post-génomique et Toxicologie Nucléaire; INSTN, Institut National des Sciences et Technique Nucléaires; GSO, Grand Sud-Ouest; IFJPAN, Institute of Nuclear Physics Polish Academy of Sciences; IPL, Institut Pasteur de Lille; IBS, Institut de Biologie Structurale; ESRF, European Synchrotron Radiation Facility; GRAL, Labex, Grenoble Alliance for Integrated Structural & Cell Biology; INSERM, Institut National de la Santé Et de la Recherche Médicale; ILL, Institut Laue Langevin. UGA, Université Grenoble Alpes; SFμ: Société Française de Microscopie; AMU, Aix Marseille University; GDR ImaBio, Group de recherche Microscopy and imaging for biology.

The summer school welcomes usually a maximum of 20-25 attendees, among them, a majority of PhD students, but also Postdocs, Technicians, Engineers, and Researchers. The organization of the school is all-inclusive with a 4.5 days' schedule where lectures are given in the mornings and practical training during the afternoons. Instructors are leading researchers in AFM in biology, and they participate to each school as volunteers and benevolently. There are between 10 and 15 instructors (for courses and practical training). It is the tradition that instructors remain present during the entire week duration of the school. Besides, instructors are usually requested to participate to the practical trainings; a much appreciated experience according to the positive returns obtained from students. During the school, students are welcome to bring their samples. Unexpectedly, testing novel (and often rebellious) samples could end up with a

potential collaborative work between instructors and attendees and sometimes with a joined publications.⁹⁶

4 | BENEFITS OF AFMBioMED?

Science and social activities have been covered. What is remaining? Maybe the most important question: Was it worth it? Is there a need for small and highly focused conferences or schools? How does one gain visibility among major society's conferences or among the half-dozen invitations we received every day by email to participate in "all kinds of conferences"? Let's start with the AFMBioMed summer schools. Participation to these schools has been a constant self-satisfaction in part due to highly motivated students, PhD level, or more experienced researchers, from all the continents (Africa, America, Asia, Europe, and Oceania). The richness of the cultural exchanges mixed with various scientific backgrounds made these weeks' long-lasting memories in our professional lives. It is important to stress that many of the school trainees remained in the nanobioscience field and several became group leaders in various universities and institutions, a particular satisfaction for all the trainers of the school.

Regarding the conference, it is a rare opportunity to help build a scientific community and see it growing. We, all the conference organizers, had the chance to develop strong, close relationships with people across the world who we almost definitely would not have met would this conference not have existed. Maybe the success of the first AFMBioMed conference motivated us to initiate a European COST Action, accepted in 2010, and known as COST Action TD1002: European network on applications of Atomic Force Microscopy to NanoMedicine and Life Sciences.⁷⁴ Although this COST Action deserves another editorial, it is worthy to mention that a strong biomechanics topic emerged from this Action which is currently pursued by another European Innovative Training Network grant: Phys2BioMed (Biomechanics in health and disease: advanced physical tools for innovative early diagnosis), led by Alessandro Podestà at Univ. Milano. Some part of this ITN training work package (WP 7) capitalized on the existence of AFMBioMed conferences and summer schools.

It is safe to say that the AFMBioMed community is around 200 to 300 people making an average of 100 attendees per conference. From participant comments, the small size of the conference is a major attractiveness, since scientific and social exchanges are more efficient than in large parallel-session conferences. AFMBioMed is a single-track conference, so everyone attends all the presentations, and by rule, social events are open to all participants. Due to its appropriate size, the conference welcomes about 50 to 60 scientific oral presentations from young and senior researchers. The importance to younger scientists is particularly emphasized since they often present their results for the first time at an international conference. Oral, as well as posters, presentations are the "psychological therapy" of researchers; in modern management terms, it is called a deliverable! Presentation at conferences is the unique opportunity for researchers (young and senior) to summarize recent experiments, try to make sense of them, and then confront results and potential conclusions to their peers.

To answer the question about the value of 10 years of AFMBioMed, let's look at the dark side, or at the difficulties for us. The first obvious difficulty is the financial risk of organizing an independent conference. Although the risk was reduced during the first two editions (2007 and 2008), all subsequent conferences were locally organized. The major difficulty remains the estimation of the number of attendees that directly impacts the cost of the registration fee, and thus the income of the conference (although the past experiences tend to indicate an asymptotic number). The second difficulty is to find a conference chair and appropriate conference location. Because we aim to minimize registration costs, AFMBioMed conferences are mostly organized within university facilities that provide modest user fees and consequently impose a certain burden on the local organizers. All these parameters make the choice of a location strongly linked to a volunteer local organizing laboratory. Our experience has shown that geographical attractiveness was not the major criteria for a successful conference!

The near constant participation of researchers at AFMBioMed conferences could be seen as a result of a stable community and a well-organized scientific event. Indeed, AFMBioMed does not use mass mailing to scout for potential participants; it all started with the list of participants at the first and second AFMBioMed conference. Since then, all the AFMBioMed conference and summer school participants are added to our list as well as our coverage of the scientific literature to identify who may be interested in this conference. Sometimes, a misidentified researcher requests to be removed from our mailing list, and this is diligently done. The list is curated continuously as many addresses become obsolete (PhD students who graduate and postdocs who move to other institutes) and a recent update has been performed to respect the recent European General Data Protection Regulation. Only emails are stored, they will never be given to a third party, and their usage is strictly for AFMBioMed announcements: conferences, summer schools, and announcements of position openings.

A multi-day international conference cannot survive without financial support. Except for the first two conferences that were fully supported by Veeco, all the remaining events have been financially managed by local organizers. Currently, BRUKER is the AFM instrument platinum sponsor of the conference. Its financial contribution is targeted to prepare conferences, reserve conference auditorium, invite speakers, maintain the website, etc. We consider that its contribution is generous enough to make it the only AFM corporate invited to present instruments during the conference. The list of all academic sponsors can be found at the conference webpage (www.afmbiomed.org). We would like to thank all the major sponsors of the conference, the host institutions for generously providing attractive venues and by providing a significant task force for the local organization. In particular, we are indebted to Institute of Bioengineering of Catalonia and the University of Barcelona (2007), The California Institute for Quantitative Biosciences (QB3, 2008), The Ruder Bošković Institute (2010), Institut Curie (2011), The Chinese Institute of Applied Physics and the Chinese Academy of Sciences (2013), The Sanford Consortium for Regenerative Medicine and the University of California San Diego (2014), Instituto de Investigação e Inovação em Saúde and Universidade do Porto (2016), Institute of Nuclear Physics (Polish

Academy of Sciences) and Institute of Physics (Jagiellonian University) in Kraków (2017). The ethics of the conference is detailed in its charter, which can be downloaded from the conference website (<http://www.afmbiomed.org/charter.aspx>). Despite the presence of a unique AFM instrument sponsor, no restriction is allowed in the selection of researchers, presenters, invited speakers, or chairmen regarding instruments used in their research. Since the creation of AFM BioMed conference, the scientific committee has always been entirely in charge and unique responsible for the scientific content and the selection of invited and selected speakers.

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Atomic Force Microscopy; Single molecules, biomechanics, force spectroscopy, high-speed AFM, Imaging, nanoindentation, nanomedicine, nanotoxicology

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REFERENCES

- Binnig G, Quate CF, Gerber C. Atomic force microscope. *Phys Rev Lett.* 1986;56(9):930-933.
- Binnig G, Rohrer H, Gerber C, Weibel E. Surface studies by scanning tunneling microscopy. *Phys Rev Lett.* 1982;49(1):57-61.
- Parot P. Interactions ligands—récepteurs: études morphologiques et mesures de forces par Microscopie à Force Atomique (AFM); 2006 29 Avril; Dourdan, France.
- Pellequer JL, Parot P, Dufrene Y. Editorial. *J Mol Recognit.* 2007;20(6):417.
- Ando T, Uchihashi T, Kodera N, et al. High-speed atomic force microscopy for observing dynamic biomolecular processes. *J Mol Recognit.* 2007;20(6):448-458.
- Parot P, Dufrene YF, Hinterdorfer P, et al. Past, present and future of atomic force microscopy in life sciences and medicine. *J Mol Recognit.* 2007;20(6):418-431.
- Robert P, Benoliel AM, Pierres A, Bongrand P. What is the biological relevance of the specific bond properties revealed by single-molecule studies? *J Mol Recognit.* 2007;20(6):432-447.
- Andre G, Brasseur R, Dufrene YF. Probing the interaction forces between hydrophobic peptides and supported lipid bilayers using AFM. *J Mol Recognit.* 2007;20(6):538-545.
- Brezeanu M, Taucher-Scholz G, Psonka K, Trager F, Hubenthal F. SFM studies of carbon ion induced damages in plasmid DNA. *J Mol Recognit.* 2007;20(6):502-507.
- Domenech O, Redondo L, Picas L, Morros A, Montero MT, Hernandez-Borrell J. Atomic force microscopy characterization of supported planar bilayers that mimic the mitochondrial inner membrane. *J Mol Recognit.* 2007;20(6):546-553.
- Giocondi MC, Besson F, Dosset P, Milhiet PE, Le Grimmelc C. Temperature-dependent localization of GPI-anchored intestinal alkaline phosphatase in model rafts. *J Mol Recognit.* 2007;20(6):531-537.
- Kubinek R, Zapletalova Z, Vujtek M, et al. Sealing of open dentinal tubules by laser irradiation: AFM and SEM observations of dentine surfaces. *J Mol Recognit.* 2007;20(6):476-482.
- Matyka K, Matyka M, Mroz I, Zalewska-Rejdak J, Ciszewski A. An AFM study on mechanical properties of native and dimethyl suberimidate cross-linked pericardium tissue. *J Mol Recognit.* 2007;20(6):524-530.
- Patil S, Martinez NF, Lozano JR, Garcia R. Force microscopy imaging of individual protein molecules with sub-pico Newton force sensitivity. *J Mol Recognit.* 2007;20(6):516-523.
- Pelling AE, Veraitch FS, Pui-Kei Chu C, et al. Mapping correlated membrane pulsations and fluctuations in human cells. *J Mol Recognit.* 2007;20(6):467-475.
- Rico F, Moy VT. Energy landscape roughness of the streptavidin-biotin interaction. *J Mol Recognit.* 2007;20(6):495-501.
- Rico F, Roca-Cusachs P, Sunyer R, Farre R, Navajas D. Cell dynamic adhesion and elastic properties probed with cylindrical atomic force microscopy cantilever tips. *J Mol Recognit.* 2007;20(6):459-466.
- Tang J, Krajcikova D, Zhu R, et al. Atomic force microscopy imaging and single molecule recognition force spectroscopy of coat proteins on the surface of *Bacillus subtilis* spore. *J Mol Recognit.* 2007;20(6):483-489.
- Teulon JM, Odorico M, Chen S-W, Parot P, Pellequer J-L. On molecular recognition of an uranyl chelate by monoclonal antibodies. *J Mol Recognit.* 2007;20(6):508-515.

20. Thormann E, Simonsen AC, Nielsen LK, Mouritsen OG. Ligand-receptor interactions and membrane structure investigated by AFM and time-resolved fluorescence microscopy. *J Mol Recognit.* 2007;20(6):554-560.
21. Verbelen C, Gruber HJ, Dufrene YF. The NTA-His6 bond is strong enough for AFM single-molecular recognition studies. *J Mol Recognit.* 2007;20(6):490-494.
22. Kumar S, Parot P, Pellequer JL. Second international AFM BioMed Conference on AFM in life sciences and medicine, 16-18 October 2008, Monterey, CA, USA. *J Mol Recognit.* 2009;22(5):345-346.
23. Afrin R, Zohora US, Uehara H, Watanabe-Nakayama T, Ikai A. Atomic force microscopy for cellular level manipulation: imaging intracellular structures and DNA delivery through a membrane hole. *J Mol Recognit.* 2009;22(5):363-372.
24. Calderon CP, Harris NC, Kiang CH, Cox DD. Analyzing single-molecule manipulation experiments. *J Mol Recognit.* 2009;22(5):356-362.
25. Cuerrier CM, Gagner A, Lebel R, Gobeil F Jr, Grandbois M. Effect of thrombin and bradykinin on endothelial cell mechanical properties monitored through membrane deformation. *J Mol Recognit.* 2009;22(5):389-396.
26. Ebenstein Y, Gassman N, Kim S, Weiss S. Combining atomic force and fluorescence microscopy for analysis of quantum-dot labeled protein-DNA complexes. *J Mol Recognit.* 2009;22(5):397-402.
27. Frewin CL, Jaroszeski M, Weeber E, et al. Atomic force microscopy analysis of central nervous system cell morphology on silicon carbide and diamond substrates. *J Mol Recognit.* 2009;22(5):380-388.
28. Jungbauer LM, Yu C, Laxton KJ, LaDu MJ. Preparation of fluorescently-labeled amyloid-beta peptide assemblies: the effect of fluorophore conjugation on structure and function. *J Mol Recognit.* 2009;22(5):403-413.
29. Pinzon-Arango PA, Scholl G, Nagarajan R, Mello CM, Camesano TA. Atomic force microscopy study of germination and killing of *Bacillus atrophaeus* spores. *J Mol Recognit.* 2009;22(5):373-379.
30. Strauss J, Burnham NA, Camesano TA. Atomic force microscopy study of the role of LPS O-antigen on adhesion of *E. coli*. *J Mol Recognit.* 2009;22(5):347-355.
31. Svetličić V, Parot P, Pellequer JL. AFM BioMed Conference: Red Island Croatia, May 2010. *J Mol Recognit.* 2011;24:i-iv.
32. Alessandrini A, Facci P. Unraveling lipid/protein interaction in model lipid bilayers by atomic force microscopy. *J Mol Recognit.* 2011;24(3):387-396.
33. Casuso I, Rico F, Scheuring S. Biological AFM: where we come from--where we are--where we may go. *J Mol Recognit.* 2011;24(3):406-413.
34. Lishkovich I, Hafezi W, Kuhn JM, Oberleithner H, Shahin V. Nuclear delivery mechanism of herpes simplex virus type 1 genome. *J Mol Recognit.* 2011;24(3):414-421.
35. Mišić Radić TM, Svetličić V, Zutić V, Boulgaropoulos B. Seawater at the nanoscale: marine gel imaged by atomic force microscopy. *J Mol Recognit.* 2011;24(3):397-405.
36. Berthier A, Elie-Caille C, Lesniewska E, Delage-Mourroux R, Boireau W. Label-free sensing and atomic force spectroscopy for the characterization of protein-DNA and protein-protein interactions: application to estrogen receptors. *J Mol Recognit.* 2011;24(3):429-435.
37. Buzhynskyy N, Salesse C, Scheuring S. Rhodopsin is spatially heterogeneously distributed in rod outer segment disk membranes. *J Mol Recognit.* 2011;24(3):483-489.
38. Favre M, Polesel-Maris J, Overstolz T, et al. Parallel AFM imaging and force spectroscopy using two-dimensional probe arrays for applications in cell biology. *J Mol Recognit.* 2011;24(3):446-452.
39. Graham JS, Miron Y, Grandbois M. Assembly of collagen fibril meshes using gold nanoparticles functionalized with tris (hydroxymethyl)phosphine-alanine as multivalent cross-linking agents. *J Mol Recognit.* 2011;24(3):477-482.
40. Murvai U, Soos K, Penke B, Kellermayer MS. Effect of the beta-sheet-breaker peptide LPFFD on oriented network of amyloid beta25-35 fibrils. *J Mol Recognit.* 2011;24(3):453-460.
41. Pires RH, Saraiva MJ, Damas AM, Kellermayer MS. Structure and assembly-disassembly properties of wild-type transthyretin amyloid protofibrils observed with atomic force microscopy. *J Mol Recognit.* 2011;24(3):467-476.
42. Pletikapić G, Radić TM, Zimmermann AH, et al. AFM imaging of extracellular polymer release by marine diatom *Cylindrotheca closterium* (Ehrenberg) Reiman & J.C. Lewin. *J Mol Recognit.* 2011;24(3):436-445.
43. Seantier B, Dezi M, Gubellini F, et al. Transfer on hydrophobic substrates and AFM imaging of membrane proteins reconstituted in planar lipid bilayers. *J Mol Recognit.* 2011;24(3):461-466.
44. Teulon JM, Delcuze Y, Odorico M, Chen S-W, Parot P, Pellequer J-L. Single and multiple bonds in (strept)avidin-biotin interactions. *J Mol Recognit.* 2011;24(3):490-502.
45. Trinh M-H, Odorico M, Bellanger L, Jacquemond M, Parot P, Pellequer J-L. Tobacco mosaic virus as an AFM tip calibrator. *J Mol Recognit.* 2011;24(3):503-510.
46. Vegh AG, Fazakas C, Nagy K, et al. Spatial and temporal dependence of the cerebral endothelial cells elasticity. *J Mol Recognit.* 2011;24(3):422-428.
47. Scheuring S, Parot P, Pellequer JL. AFMBioMed conference: Paris, France, August 2011. *J. Mol. Recognit.* 2012;25:239-240.
48. Bertoncini P, Le Chevalier S, Lavenus S, Layrolle P, Louarn G. Early adhesion of human mesenchymal stem cells on TiO₂ surfaces studied by single-cell force spectroscopy measurements. *J Mol Recognit.* 2012;25(5):262-269.
49. Costa LT, Vilani C, Peripolli S, Stavale F, Legnani C, Achete CA. Direct immobilization of avidin protein on AFM tip functionalized by acrylic acid vapor at RF plasma. *J Mol Recognit.* 2012;25(5):256-261.
50. Girasole M, Dinarelli S, Boumris G. Structural, morphological and nano-mechanical characterisation of intermediate states in the ageing of erythrocytes. *J Mol Recognit.* 2012;25(5):285-291.
51. Husain M, Boudier T, Paul-Gilloteaux P, Casuso I, Scheuring S. Software for drift compensation, particle tracking and particle analysis of high-speed atomic force microscopy image series. *J Mol Recognit.* 2012;25(5):292-298.
52. Longo G, Rio LM, Roduit C, et al. Force volume and stiffness tomography investigation on the dynamics of stiff material under bacterial membranes. *J Mol Recognit.* 2012;25(5):278-284.
53. Mescola A, Vella S, Scotto M, et al. Probing cytoskeleton organisation of neuroblastoma cells with single-cell force spectroscopy. *J Mol Recognit.* 2012;25(5):270-277.
54. Pletikapić G, Žutić V, Vinković Vrček I, Svetličić V. Atomic force microscopy characterization of silver nanoparticles interactions with marine diatom cells and extracellular polymeric substance. *J Mol Recognit.* 2012;25(5):309-317.
55. Roduit C, Longo G, Benmessaoud I, et al. Stiffness tomography exploration of living and fixed macrophages. *J Mol Recognit.* 2012;25(5):241-246.
56. Rosso G, Negreira C, Sotelo JR, Kun A. Myelinating and demyelinating phenotype of trembler-J mouse (a model of Charcot-Marie-Tooth human disease) analyzed by atomic force microscopy and confocal microscopy. *J Mol Recognit.* 2012;25(5):247-255.
57. Targosz-Korecka M, Biedron R, Szczygiel AM, Brzezinka G, Szczerbinski J, Zuk A. Stiffness changes of tumor Hep2 cells correlates with the inhibition and release of TRAIL-induced apoptosis pathways. *J Mol Recognit.* 2012;25(5):299-308.
58. Hu J, Parot P, Pellequer JL. Fifth International AFMBioMed Conference on AFM in Life Sciences and Medicine, 7-11 May 2013, Shanghai, China. *J Mol Recognit.* 2014;27:1-2.
59. Aghayee S, Benadiba C, Notz J, Kasas S, Dietler G, Longo G. Combination of fluorescence microscopy and nanomotion detection to characterize bacteria. *J Mol Recognit.* 2013;26(11):590-595.
60. Chaves RC, Teulon J-M, Odorico M, Parot P, Chen S-W, Pellequer J-L. Conformational dynamics of individual antibodies using computational docking and AFM. *J Mol Recognit.* 2013;26(11):596-604.

61. Costa L, Rodrigues MS, Newman E, Zubieta C, Chevrier J, Comin F. Imaging material properties of biological samples with a force feedback microscope. *J Mol Recognit*. 2013;26(12):689-693.
62. Dao L, Gonnermann C, Franz CM. Investigating differential cell-matrix adhesion by directly comparative single-cell force spectroscopy. *J Mol Recognit*. 2013;26(11):578-589.
63. Jiao F, Fan H, Yang G, Zhang F, He P. Directly investigating the interaction between aptamers and thrombin by atomic force microscopy. *J Mol Recognit*. 2013;26(12):672-678.
64. Park S, Hwang IW, Makishima Y, et al. Spot14/Mig12 heterocomplex sequesters polymerization and restrains catalytic function of human acetyl-CoA carboxylase 2. *J Mol Recognit*. 2013;26(12):679-688.
65. Sicard D, Chevotot Y, Souteyrand E, Imbert A, Vidal S, Phaner-Goutorbe M. Molecular arrangement between multivalent glycocluster and *Pseudomonas aeruginosa* LecA (PA-IL) by atomic force microscopy: influence of the glycocluster concentration. *J Mol Recognit*. 2013;26(12):694-699.
66. Wu N, Wang Q, Zhou X, et al. Probing tethered targets of a single biomolecular complex with atomic force microscopy. *J Mol Recognit*. 2013;26(12):700-704.
67. Engler A, Parot P, Pellequer JL. Sixth International AFMBioMed Conference on AFM in Life Sciences and Medicine, 13-17 December 2014, San Diego, USA. *J Mol Recognit*. 2016;29:404-405.
68. Borrell JH, Montero MT, Morros A, Domenech O. Unspecific membrane protein-lipid recognition: combination of AFM imaging, force spectroscopy, DSC and FRET measurements. *J Mol Recognit*. 2015;28(11):679-686.
69. Chen S-W, Teulon J-M, Godon C, Pellequer J-L. Atomic force microscope, molecular imaging, and analysis. *J Mol Recognit*. 2016;29(1):51-55.
70. He J, Wang J, Hu J, Sun J, Czajkowsky DM, Shao Z. Single molecule atomic force microscopy of aerolysin pore complexes reveals unexpected star-shaped topography. *J Mol Recognit*. 2016;29(4):174-181.
71. Schillers H, Medalsy I, Hu S, Slade AL, Shaw JE. PeakForce tapping resolves individual microvilli on living cells. *J Mol Recognit*. 2016;29(2):95-101.
72. Seghezza S, Dante S, Diaspro A, Canale C. High resolution nanomechanical characterization of multi-domain model membranes by fast force volume. *J Mol Recognit*. 2015;28(12):742-750.
73. te Riet J, Reinieren-Beeren I, Figdor CG, Cambi A. AFM force spectroscopy reveals how subtle structural differences affect the interaction strength between *Candida albicans* and DC-SIGN. *J Mol Recognit*. 2015;28(11):687-698.
74. Parot P, Pellequer JL. 2014. European network on applications of Atomic Force Microscopy to NanoMedicine and Life Sciences. In: COST Action TD1002, editor. <http://www.afm4nanomedbio.eu/>
75. Sousa SR, Parot P, Pellequer JL. Seventh International AFMBioMed Conference on AFM in Life Sciences and Medicine, April 11 to 15, 2016, Porto, Portugal. *J Mol Recognit*. 2017;30(12):e2681.
76. Apte K, Stick R, Radmacher M. Mechanics in human fibroblasts and progeria: Lamin A mutation E145K results in stiffening of nuclei. *J Mol Recognit*. 2017;30(2):e2580.
77. Malek-Zietek KE, Targosz-Korecka M, Szymonski M. The impact of hyperglycemia on adhesion between endothelial and cancer cells revealed by single-cell force spectroscopy. *J Mol Recognit*. 2017;30(9):e2628.
78. Nguyen TH. Single-molecule force spectroscopy applied to heparin-induced thrombocytopenia. *J Mol Recognit*. 2017;30(3):e2585.
79. Oh YJ, Plochberger B, Rechberger M, Hinterdorfer P. Characterizing the effect of polymyxin B antibiotics to lipopolysaccharide on *Escherichia coli* surface using atomic force microscopy. *J Mol Recognit*. 2017;30(6):e2605.
80. Pesi M, Pribyl J, Caluori G, et al. Phenotypic assays for analyses of pluripotent stem cell-derived cardiomyocytes. *J Mol Recognit*. 2017;30(6):e2602.
81. Pires RH, Saraiva MJ, Damas AM, Kellermayer MS. Force spectroscopy reveals the presence of structurally modified dimers in transthyretin amyloid annular oligomers. *J Mol Recognit*. 2017;30(3):e2587.
82. Spengler C, Thewes N, Nolle F, et al. Enhanced adhesion of *Streptococcus mutans* to hydroxyapatite after exposure to saliva. *J Mol Recognit*. 2017;30(7):e2615.
83. Varga B, Fazakas C, Molnar J, et al. Direct mapping of melanoma cell-endothelial cell interactions. *J Mol Recognit*. 2017;30(6):e2603.
84. Zapotoczny B, Owczarczyk K, Szafranska K, Kus E, Chlopicki S, Szymonski M. Morphology and force probing of primary murine liver sinusoidal endothelial cells. *J Mol Recognit*. 2017;30(7):e2610.
85. Bui VC, Nguyen TH. DNA aggregation induced by Mg(2+) ions under different conditions. *J Mol Recognit*. 2018;31(9):e2721.
86. Chièze L, Le Cigne A, Meunier M, et al. Quantitative characterization of single-cell adhesion properties by atomic force microscopy using protein-functionalized microbeads. *J Mol Recognit*. 2018;e2767.
87. Dinarelli S, Girasole M, Spitalieri P, et al. AFM nano-mechanical study of the beating profile of hiPSC-derived cardiomyocytes beating bodies WT and DM1. *J Mol Recognit*. 2018;31(10):e2725.
88. Dutta S, Rivetti C, Gassman NR, et al. Analysis of single, cisplatin-induced DNA bends by atomic force microscopy and simulations. *J Mol Recognit*. 2018;31(10):e2731.
89. Kolodziejczyk A, Jakubowska A, Kucinska M, et al. Sensing of silver nanoparticles on/in endothelial cells using atomic force spectroscopy. *J Mol Recognit*. 2018;31(9):e2723.
90. Kozlova E, Chernysh A, Sergunova V, Gudkova O, Manchenko E, Kozlov A. Atomic force microscopy study of red blood cell membrane nanostructure during oxidation-reduction processes. *J Mol Recognit*. 2018;31(10):e2724.
91. Milani P, Chlsta J, Abdayem R, Kezic S, Haftek M. Changes in nanomechanical properties of human epidermal cornified cells depending on their proximity to the skin surface. *J Mol Recognit*. 2018;31(9):e2722.
92. Pleskova SN, Gorshkova EN, Kriukov RN. Dynamics of formation and morphological features of neutrophil extracellular traps formed under the influence of opsonized *Staphylococcus aureus*. *J Mol Recognit*. 2018;31(7):e2707.
93. Viji Babu PK, Rianna C, Belge G, Mirastschijski U, Radmacher M. Mechanical and migratory properties of normal, scar, and Dupuytren's fibroblasts. *J Mol Recognit*. 2018;31(9):e2719.
94. Zemla J, Stachura T, Gross-Sondej I, et al. AFM-based nanomechanical characterization of bronchoscopic samples in asthma patients. *J Mol Recognit*. 2018;31(12):e2752.
95. Zhong Q, Inniss D, Kjoller K, Elings V. Fractured polymer/silica fiber surface studied by tapping mode atomic force microscopy. *Surf Sci Lett*. 1993;290:L688-L692.
96. Ciofani G, Danti S, Genchi GG, et al. Pilot in vivo toxicological investigation of boron nitride nanotubes. *Int J Nanomedicine*. 2012;7:19-24.