

Dr. John J. Degnan, Chief Scientist, Sigma Space Corporation

John J. Degnan received his BS in Physics from Drexel University in 1968 and his MS and Ph.D. degrees in Physics from the University of Maryland College Park in 1970 and 1979 respectively. Dr. Degnan joined Sigma Space Corporation as Chief Scientist in February 2003 following his retirement from the NASA Goddard Space Flight Center (GSFC) where he accumulated almost 40 years of technical experience and 25 years of supervisory and project management experience. At NASA, he led the development of advanced lasers and electro-optical systems for a variety of applications. He has authored over 200 publications or technical reports (including many invited review papers) on laser theory and design, optical antennas, optical resonators, satellite laser ranging (SLR), laser altimetry, 3D imaging lidars, atmospheric lidar, free space optical communications, interplanetary laser transponders, optical noise modeling, receiver design for direct detection and heterodyne/homodyne systems, and medical instrumentation. He is a recognized expert on laser theory and design, having published the first theory and invited review article on the waveguide laser (Applied Physics 1976) , his thesis dissertation on high power modelocked lasers and regenerative amplifiers for SLR in 1979, and a widely cited series of three IEEE JQE papers on the dynamics and optimization of actively and passively Q-switched lasers from 1989 through 1997. From 1989 through 1993, he held the position of Distinguished Adjunct Professor at the American University in Washington DC where he taught a two semester graduate course in Quantum Electronics. He has also written all three invited reviews on SLR, including hardware (1985), theory and mathematical modeling (1993), and history (1994).

Dr. Degnan has been engaged in areas of relevance to SLR for 50 years. In 1964, he was a junior member of the GSFC team that recorded the first laser returns from an artificial satellite (Beacon Explorer 22B). In the mid-1970's, he led the development and integration of field-worthy subnanosecond pulse modelocked lasers which resulted in the first 3rd generation sub-decimeter SLR system, NASA's STANDARD LASER (STALAS) system in 1975. From 1979 until his retirement from NASA in 2003, he supervised the development of all advanced NASA SLR instrumentation including the first true cm accuracy system (MOBLAS 4) in 1981 and the upgraded Transportable Laser Ranging System (TLRS-2) in 1984, the 4th generation of highly automated MOBLAS SLR systems in the early to mid 1990's, and, until his retirement in 2003, the 5th generation fully automated, eye-safe, photon-counting SLR2000 system. The latter is currently designated by NASA as the Next Generation Satellite Laser Ranging (NGSLR) system. The most recent version of NGSLR is successfully tracking satellites up to GNSS altitudes (20,000 km). During the 1990's he served as Deputy Manager and Chief Engineer of NASA's Crustal Dynamics Project, overseeing technical and programmatic activities in both SLR and VLBI, and planning many of the space geodetic measuring campaigns. During the same period, he chaired the CSTG Subcommittee on Satellite and Lunar Laser Ranging and served on the Technology Board for the WEGENER Commission, assuming the role of Technology Chairman in 1998. In 1998, with Dr. Bob Schutz, he led the creation of the International Laser Ranging Service (ILRS) and served as its first Governing Board Chairman from 1998-2002. The ILRS is now an Official Service of the International Association for Geodesy (IAG) and coordinates the efforts of

institutions in 30 countries in the sub-centimeter laser tracking of over two dozen artificial satellites and the Moon in support of a wide variety of science and engineering applications.

Dr. Degnan has recently applied his SLR2000/NGSLR photon-counting technology to laser altimetry, 3D imaging lidars, and interplanetary transponders. He was the NASA PI for the first successful day/night photon-counting airborne altimeter for 3D topographic imaging for which he was awarded a patent in 2002, a Space Act Award in 2003, and a NASA Certificate of Recognition in 2004. A second US patent for a Spaceborne 3D Imaging Lidar was awarded in 2007, a third in 2012 for a “Telescope with Wide Field of View Internal Scanner”, and two additional related Sigma patents are pending. Since arriving at Sigma in 2003, Dr. Degnan has successfully led the development of a second generation of UAV-based 3D imaging lidars for the USAF, Navy, Army, and NASA. He also completed a study of a future NASA spaceborne sensor and optical scanner to obtain globally contiguous, high resolution topographic and polarimetric maps of Jupiter’s Moons, and, in 2006, proposed a 16-channel photon-counting lidar intended as a technology demonstration for NASA’s ICESat-II mission. NASA has since chosen a modified version of the design (ATLAS) as the primary mission lidar on ICESat-2.

Dr. Degnan has also published extensively on the feasibility of using low power laser transponders (few 10’s of mW) for precise centimeter ranging over lunar and interplanetary scales in support of solar system science and general relativity studies, and was a key member of the NASA team that demonstrated the first two-way exchange of laser pulses between GSFC and the Messenger spacecraft at a distance of 24.3 million km in May 2005. Three months later, hundreds of laser pulses from GSFC were detected by the Mars Orbiter Laser Altimeter (MOLA) at a distance of 80 million km. NASA continues to support Dr. Degnan’s participation on several ILRS Working Groups (WGs) including the Missions WG, Networks and Engineering WG, Transponder WG (co-chair), and Signal Analysis WG. He also cochairs the Transponder Working Group.

Dr. Degnan was elected a Fellow of the International Association for Geodesy (IAG), a Senior Member of the Institute for Electrical and Electronics Engineers (IEEE), a Senior Member of the Optical Society of America (OSA), and is a Charter Member of the International Laser Communications Society (ILCS). He is also a Member of the American Geophysical Union (AGU), Sigma Pi Sigma National Physics Honor Society, and the recipient of numerous NASA, academic, and international awards. These include the Annual Moe I. Schneebaum Award for Engineering from Goddard Space Flight Center in 1987, the Russian Space Agency’s Tsiolkovsky Medal for his contributions to SLR in 2002, Drexel University’s Alumni Circle of Distinction Award in 2005, and the ILRS SLR Pioneer Award. He is included in several biographical listings of top technologists including Marquis Who’s Who in the World, Who’s Who in America, Who’s Who in Frontier Science and Technology, American Men and Women of Science, among others.

Selected Refereed Publications Relevant to SLR and Laser Transponders:

Slava G. Turyshev, William Farr, William M. Folkner, Andre R. Girerd, Hamid Hemmati, Thomas W. Murphy Jr., James G. Williams, and John J. Degnan, "Advancing Tests of Relativistic Gravity via Laser Ranging to Phobos", *Experimental Astronomy*, 2010.

J.J. Degnan, "Laser Transponders for High Accuracy Interplanetary Laser Ranging and Time Transfer", Invited Paper, in *Lasers, Clocks, and Drag-Free: Exploration of Relativistic Gravity in Space*, Eds. H. Dittus, C. Lammerzahl, and S. Turyshev (Springer, New York), pp. 231-242, 2008.

J. J. Degnan, Invited Paper, "Asynchronous Laser Transponders for Precise Interplanetary Ranging and Time Transfer", *Journal of Geodynamics* (Special Issue on Laser Altimetry), pp. 551-594, November, 2002.

J. J. Degnan, Invited Paper, "Photon-counting multikilohertz microlaser altimeters for airborne and spaceborne topographic measurements", *J. Geodynamics*, 34, pp. 503-549, 2002.

J. J. Degnan, Invited Paper, "A conceptual design for a spaceborne 3D imaging lidar", *J. e&I Elektrotechnik und Informationstechnik* (Austria), 4, pp. 99-106, 2002.

J. J. Degnan, Invited Paper, "Photon counting microlaser rangings, transponders, and altimeters", *Surveys in Geophysics*, 22, pp. 431-477, 2001.

H. P. Plag, B. Ambrosius, T. F. Baker, G. Beutler, G. Bianco, G. Blewitt, C. Boucher, J. L. Davis, J. J. Degnan, J. M. Johansson, H-G. Kahle, I. Kumkova, I. Marson, S. Mueller, E. C. Pavlis, M. R. Pearlman, B. Richter, W. Spakman, S. K. Tatevian, P. Tomasi, P. Wilson, and S. Zerbini, "Scientific objectives of current and future WEGENER activities", *Tectonophysics*, Vol. 294, pp. 177-223, 15 September, 1998.

J.J. Degnan, "Satellite Laser Ranging and Very Long Baseline Interferometry", Invited Chapter, *Encyclopedia of Earth Sciences (Vol.2)*, Marvin Kauffman (Ed.), Simon and Schuster Macmillan, New York, pp 935-941, 1996.

J. J. Degnan, Invited Paper, "Millimeter accuracy satellite laser ranging: a review", AGU Monograph Geodynamics Series, 25, *Contributions of Space Geodesy to Geodynamics: Technology*, (Eds. D. L. Turcotte and D. E. Smith), pp. 133- 162, 1993.

H. P. Plag, B. Engen, T. Clark, J. Degnan, and B. Richter, "Post-glacial rebound and present-day three-dimensional deformations", *J. Geodynamics*, pp. 263-301, May, 1998

E. Vermaat, J. J. Degnan, P. J. Dunn, R. Noomen, and A. T. Sinclair, "Satellite Laser Ranging Status and Impact for WEGENER", *J. Geodynamics*, pp. , May, 1998.

J.J. Degnan, Invited Paper, "Satellite Laser Ranging: Current Status and Future Prospects", *IEEE Trans. on Geoscience and Remote Sensing*, GE-23, pp. 398-413, 1985