

## **CURRICULUM VITAE of Per-Simon Kildal** (revised 110202)

**Title & name:** Professor Per-Simon KILDAL, born 4<sup>th</sup> July, 1951, Fellow of IEEE in 1995

### **Education:**

- 1975 civ.ing.(M.S.E.E.), Norwegian Inst. of Tech. (NTH), Trondheim, Norway.  
 1982 dr.ing. (PhD), "Radiation characteristics ..EISCAT VHF ..cylinder antenna", NTH.  
 1990 doctor technicae (an old style doctoral degree), "Novel ray techniques..", NTH.

### **Employment history:**

- 1975 Research Assistant and Research Scholarship Holder, NTH, Trondheim, Norway.  
 1979 Research Scientist, ELAB, SINTEF Group, Trondheim, Norway.  
 1986 Principal Research Scientist, ELAB.  
 1989 Professor, Chalmers University of Technology, Gothenburg, Sweden

### **Supervision of PhD students:**

- 18 to PhD: 1 in Norway at NTH. 17 at Chalmers.  
 10 to Lic: 7 left for industry after Lic., 3 ongoing.  
 8 Ongoing: 6 at Chalmers, 2 externally in companies.

### **External evaluator of other's PhD students:**

- 1992 TUD Denmark, 1995 NTH Norway, 2001 HUT Finland, 2002 KUL Belgium, 2003 ETH Switzerland, 2004 NTNU Norway, 2006 UNISI Italy, 2006 Supelec France, 2006 HUT Finland, 2009 TokyoTech Japan, 2010 KUL Leuven, 2011 Delft Netherlands, 2011 UPV Valencia, 2011 Nanyang Technological University in Singapore.

*In addition committee member in connection with PhD defenses in Sweden:*

- 1993 Chalmers, 1994 Lund, 2000 KTH, 2006 Chalmers, 2007 Chalmers, 2009 Luleå.

### **Personal awards and appointments:**

- 1976 Exam from NTH with highest marks with distinction and notice to the King of Norway.  
 1983 Senior Member of IEEE  
 1984 "SINTEF's annual award" for prominent research at SINTEF in 1984.  
 1985 "1985 R.W.P. King Award" for best paper by young author in IEEE Transactions on Antennas and Propagation in 1984.  
 1986 Appointed Principle Research Scientist at ELAB, SINTEF  
 1991 "1991 S. A. Schelkunoff Transactions Prize Paper Award" for the best paper in IEEE Transactions on Antennas Propagation in 1990.  
 1992 Guest researcher at Tokyo Institute of Technology, Fellowship from Japan Society for Promotion of Science (JSPS). Duration 5 weeks.  
 1991 "Distinguished Lecturer in IEEE Antennas and Propagation Society 1991-1994".  
 1995 Fellow of IEEE  
 1995 Elected member of IEEE AP-S AdCom (Administration Committee of IEEE Antennas and Propagation Society), 1995-1997.  
 1995 Associate editor of IEEE Transactions on Antennas and Propagation (3 years).  
 2003 Per-Simon Kildal and Ahmed A. Kishk received the 2003 Valued Contribution Award from Applied Computational Electromagnetics Society (ACES).  
 2004 Associate editor of special issue on "Artificial magnetic conductors, soft/hard surfaces and other complex surfaces" in IEEE Trans Antennas and Propagation. Publ. Jan. 2005.  
 2005 Lecturer in four courses (on reflector antennas, measurement techniques, conformal antennas and artificial surfaces) in European School of Antennas (ESoA). Organizer of the two courses on artificial surfaces and reflector antennas. Ongoing assignment.  
 2006 Appointed Member of NTVA (The Norwegian Academy of Techn. Sci., [www.ntva.no](http://www.ntva.no))  
 2006 The quarterly Chalmers Magazine pays attention to Kildal's success with the application resulting in the VINNOVA funded research center CHASE Antenna Systems with an expected turnover of 210 MSEK during 2007-2017, with the article "Winning Antenna Research (translated from Swedish)" about Kildal and his research. Chalmers Magazine is distributed to 40 000 alumni.  
 2007 Contributor with chapter on "Multipath Techniques for Handset/Terminal Antennas", to a book by J. Volakis (Ed.), Antenna Engineering Handbook, McGraw-Hill, June 2007.

- 2010 Appointed member of editorial board of the English journal of the Korean Institute of Electromagnetic Engineering and Science (JKIEES).
- 2011 Appointed Distinguished Lecturer of IEEE Antennas and Propagation Society for 2011-2013, offers three lectures: 1) Gap waveguides and antennas up to Terahertz, 2) OTA-MIMO measurements of wireless stations in reverberation chamber, and 3) Low noise decade-bandwidth Eleven feed for future radio telescopes
- 2011 Recipient of *2011 Distinguished Achievement Award* of the IEEE Antennas and Propagation Society "For pioneering contributions to design and characterization methods for reflectors, feeds and small antennas utilizing soft and hard surfaces, and reverberation chamber for Over-The-Air measurements"
- 2011 The quarterly Chalmers Magazine pays attention to Kildal's success with Bluetest AB and his international recognition with the IEEE APS DA Award, with the article "Simulated reality (translated from Swedish)". Chalmers Magazine is distributed to 40 000 alumni.

#### **Group members awards:**

- 2006 Kildal's external PhD student Charlie Orlenius received a prize for the best research integration within ACE (Antenna Center of Excellence in Europe) at EuCAP2006.
- 2007 Kildal's Master student Martin Denstedt received the prestigious Prize "Lilla Polhemspriset" for the best Master thesis in Sweden in 2006.
- 2008 Collaborator Marianna Ivashina received the 2<sup>nd</sup> Best Paper Award during the 30<sup>th</sup> ESA Antenna Workshop, May 2007, for paper that was built on collaboration with Kildal.
- 2010 Kildal's PhD student Ahmed Hussain receives Chalmers Pedagogical Award for work related to Kildal's textbook used in the course Antenna Engineering at Chalmers.
- 2011 RFID Nordic Scholarship Award to my Master students Jacob Hidén Rudander and Ikram E-Khuda for their Master project "RFID Measurements in Reverberation Chamber", finalized in Dec 2010. The award amounted to SEK 20000. The project was performed at Chalmers and resulted in the scientific paper J. Hidén Rudander, Ikram-e-Khuda, P.-S. Kildal, C. Orlenius, "Measurements of RFID Tag Sensitivity in Reverberation Chamber", that now has been accepted for publication in IEEE Antennas and Wireless Propagation Letters

#### **International collaborations:**

*The following researchers at foreign universities and companies have stayed for one or more periods in Dr. Kildal's group at Chalmers and have joint publications with him:*

- 1990 Prof. Sembiam Rengarajan at California State University in Northridge
- Since 1993 Dr. Sergej Skobelev, Radiofysika, Moscow
- Since 1994 Prof. Ahmed Kishk at University of Mississippi, stayed 2 sabbaticals at Chalmers during 1994/1995 and 2009/2010.
- Since 1994 Prof. Jiro Hirokawa at Tokyo Institute of Technology, stayed at Chalmers 1994/1995.
- Since 1994 Prof. Stefano Maci at University of Siena
- Since 1997 Prof. Angelo Freni at University of Florence
- 2000 Dr. Naftali (Tuli) Herscovici at AnTeg Inc.
- Since 2000 Dr Zvonimir Sipus, University of Zagreb
- Since 2004 Dr Eva Rajo Inglesias, Carlos III Univ. in Madrid
- Other collaborators who have not stayed at Chalmers:*
- Since 1984 Prof. Tor Hagfors, most of the time Professor at Cornell University. He died in 2007.
- Since 2002 Prof. Sander Weinreb, California Institute of Techn. (Life Fellow IEEE)
- Since 2006 Dr. Marianna Ivashina, ASTRON, The Netherlands, from 2011 employed at Chalmers.
- Since 2007 Prof Alejandro Valero, University of Valencia, Spain

#### **Spin-off companies:**

- 1998 Founded Comhat AB ([www.comhat.se](http://www.comhat.se)) together with Bengt Gustafsson, based on the hat antenna invention, granted patents. Products: hat antennas and filters. Comhat had 40 employees when Arkivator AB took over on 1 March 2007. The products live there.
- 2000 Founded Bluetest AB ([www.bluetest.se](http://www.bluetest.se)). Main product is reverberation chambers and control software. Granted patents in US, Japan, Europe. Bluetest had in January 2011 twelve employees, and had sold about 50 chambers worldwide. Expected turnover 20 MSEK in 2010/2011. Technology considered for standardization by CTIA.

- 2010 Founded Elevenantenna AB ([www.elevenantenna.com](http://www.elevenantenna.com)) together with 3 partners from Chalmers. The business idea is to provide Kildal's patent protected Eleven antenna for use in future VLBI2010 and SKA radio telescopes.
- 2010 Founded Gapwaves AB ([www.gapwaves.com](http://www.gapwaves.com)). The business idea is to commercialize the promising patent protected gap waveguide technology for use in millimeter and submillimeter wave applications.

### **Publications:**

Author of 155 published or accepted journal articles or letters, most being available in IEEE Xplore.  
 Author of more than 200 conferences papers.  
 Author of 1 textbook: "Foundations of Antennas –A Unified Approach"  
 Contributor to J. Volakis "Antenna Engineering Handbook", McGrawHill 2007

### **Granted and recently applied patents and patent families (year of priority is given to the left):**

- 1979 "Kreuzdipolreihe mit reflektor". Patent in Norway and W-Germany. MBB in Munich applied it to 120m x 40m EISCAT VHF antenna, Tromsø.
- 1984 "Dipole antenna with beam-forming ring". Patent in Norway and UK. Licensed to the Norwegian company EB and applied 1984 -1996.
- 1990 "Reflector antenna" (improved reflector panels with corrugated edges). Swedish patent.
- 1986 "Reflector with self-supported feed" (original hat antenna invention). Patents in Norway, USA, 10 more European countries and Japan. Licensed to NERA, Fissler, Ericsson AB (1997), Comhat AB (1998).
- 1996 "... " (improved hat antenna). US Patent licensed to Comhat AB and Ericsson AB.
- 1998 "... " (further improvements of hat antenna). Patent granted in USA, China and Europe, applied in some other countries. Licensed to Comhat AB and Ericsson AB.
- 2000 "... " (measurements in reverberation chamber). Patents applied in Sweden, Europe, Japan, USA. Licensed to Bluetest AB. The US patent was granted in 2008, and a Continuation in Part of the same application was granted in USA already in 2007. Patent in Japan was granted May 2010, and Notice of Allowance will be issued in Dec 2010 for EPO patent.
- 2003 "Broadband multi-dipole antenna .."(the Eleven antenna), patent applications granted in USA, and Japan, pending in Europe.
- 2005 "Horn antenna", multimode hard horn antenna for cluster-fed reflectors. Patent applied in Sweden. Withdrawn.
- 2008 "Improved broadband multi-dipole antenna with frequency-independent radiation characteristics", Withdrawn.
- 2008 "Waveguides and transmission lines in gaps between parallel conducting surfaces", European patent application EP08159791.6, 7 July 2008. Improved version resubmitted in 2009. Applied in several countries.
- 2010 "Packaging of active and passive microwave circuits using lid or bed of curved posts" (3 inventors, Kishk, Kildal and Rajo), EPC patent application 10163740.3, 25 May, 2010.
- 2011 "Improved method and apparatus for measuring the performance of antennas, mobile phones and other wireless terminals" (2 inventors: Kildal and Orlenius), PCT patent application PCT/EP2011/059953, 15 June 2011
- 2011 "Improved broadband multi-dipole antenna with frequency-independent radiation characteristics" (2 inventors, Kildal and Jian Yang), ..... June 2011.

### **Huge research grants:**

- A. 2007-2016: Projects within the Chalmers Antenna Systems Excellence Center "CHASE". Kildal wrote the application for CHASE that is funded by the Swedish industrial research council VINNOVA. The CENTER involves the research of ten Chalmers professors, and the total funding including in kind contributions from industry is about 21 MEuro.
- B. 2006-2011: Projects within Chalmers Strategic Antenna Systems Research Center "CHARMANT" funded by Swedish Foundation for Strategic Research. Kildal's research group is the major group in CHARMANT, and the total grant is worth nearly 6 MEuro.
- C. 2009—2013: Prof Kildal received in 2009 a prestigious grant from Swedish Research Foundation VR of totally 12 MSEK (appr. 1.2 MEuro), in order to perform research on his newest invention, the gap waveguide.

**List of main research activities:**

- A. 1976-1982: Electrical design of the large reflector antennas of European Incoherent SCATter Association (EISCAT) for ionosphere studies. Results: IEEE best paper award and patent.
- B. 1982-present: Characterization and invention of primary feeds for reflectors. Several patents. Dipole with beam-forming ring and hat feed are used in industry. Eleven feed was developed on contract with Caltech and is now candidate for use in Square Kilo meter Array (SKA) and VLBI 2010 radio telescopes. Contributed to work on focal plane arrays for use in SKA together with researchers at ASTRON The Netherlands Institute for Radio Astronomy.
- C. 1982-1997: Design of the dual-reflector feed for the 300m radio telescope in Arecibo on contract with Cornell University. Resulted in IEEE best paper award on reflector synthesis.
- D. 1986-present: Inventor of the artificially soft and hard surfaces; the first metamaterial concept. Demonstrated sidelobe reduction effects later known as electromagnetic bandgaps, and invisibility later known as cloaking. The work on soft and hard surfaces has recently resulted in a new very wideband so-called gap waveguide for mm/submm waves.
- E. 1995-2001: Development of spectral domain methods for sources (e.g. antennas) in multilayer planar, cylindrical and spherical multilayer structures, referred to as the G1DMULT algorithm (Green's functions of 1D MULTilayer structures). Work continued by Dr Sipus in Zagreb, applied to many conformal antenna structures and resulted in several publications.
- F. 1989-2002: Development of spectral domain methods for sources (e. g. antennas) on cylindrical structure, referred to as a spectrum of two-dimensional solutions. Has been applied to several different antenna types for different applications, also in industry.
- G. 2000-present: Development of the accurate reverberation chamber measurement method for antennas and wireless terminals used in multipath environment with fading. See Bluetest AB.
- H. 2007-2008: Chalmers Industriteknik (CIT) had a project funded by VINNOVA to verify the commercialization of Kildal's patent protected Eleven antenna. The experience gained on this project resulted in the formation of the company Elevenantenna AB in 2010.
- I. 2008-present: Research on gap waveguides for mm/submm waves. Patent application.