



COURSE ON

SHORT RANGE PROPAGATION

Online, September 27 – October 1, 2021



The course on *Short Range Propagation* will be organized online by Institut für Nachrichtentechnik at Technische Universität Braunschweig in the framework of the European School of Antennas and Propagation 2021. The course will deal with channel modelling for medium/short range wireless systems and networks, including millimetre wave and Terahertz radio propagation, as well as aspects related to MIMO and UWB technologies for wireless on-body communication, medical and short range radar applications.

The teachers are from Technische Universität Braunschweig, University of Bologna, Karlsruhe Institute of Technology and Université Catholique de Louvain.

Course fees:	University Student (full time Master or Ph. D. student) :	250€
	Any other participant	440€

Registration: https://membership.euraap.org

Payment through this site is by credit card. Where it is not possible to pay by credit card it is necessary to send an email to <u>membership@euraap.org</u> to request payment by bank transfer.

Course Organisation: <u>t.kuerner@tu-bs.de</u>

Course Schedule

<u>Monday , 27.9.21:</u>

8.30 – 9.30 h	Welcome, Introduction, Overview on radio channel modelling for wireless
	communications
	Thomas Kürner, Technische Universtität Braunschweig
9.30 – 10.30 h	Fundamentals of propagation and scattering I:Maxwell's equations,
	electromagnetic waves in lossless and lossy media, polarisation, reflection,
	transmission and diffraction
	Conor Brennan – Dublin City University
10.30– 11.00 h	Coffee Break
11.00 - 12.00h	Fundamentals of propagation and scattering II: Maxwell's equations,
	electromagnetic waves in lossless and lossy media, polarisation, reflection,
	transmission and diffraction
	Conor Brennan – Dublin City University
12.00 – 13.00 h	Lunch Break
13.00 – 14.30 h	Full wave techniques for wave scattering computation I: FDTD, Discretisation
	and Stability, Courant condition, absorbing boundary conditions and
	perfectly matched layers, IE formulation and MoM, Fast Multipole Method
	and acceleration techniques, FEM
	Conor Brennan – Dublin City University
14.30 – 15.30 h	Geometrical Theory of Propagation I: Radiation and propagation in free
	space, spherical waves and local plane waves, the concept of ray, ray
	trajectories, tube of flux, divergence factor, ray polarization
	Vittorio Degli-Esposti- University of Bologna
15.30 – 16.00 h	Coffee Break
16.00 – 17.00 h	Geometrical Theory of Propagation II: geometrical description of
	electromagnetic interactions with canonical obstacles (reflection,
	transmission, diffraction, astigmatic waves and spreading factor, diffuse
	scattering).
	Vittorio Degli-Esposti- University of Bologna
17.00 - 18.00 h	Exercises
	Conor Brennan – Dublin City University

Tuesday, 28.9.21:

8.30 – 10.30 h	Implementation of a ray based prediction tool : multipath propagation and ray based modeling. Digital description of antennas and environments, ray tracing (RT) and ray launching (RL), tracking of ray trajectories. <i>Vittorio Degli Esposti – University of Bologna</i>
10.30 – 11.00 h	Coffee Break
11.00 - 12.30h	Implementation of a ray based prediction tool: Field computation along the
	rays, computational cost and prediction accuracy. Potential and limitations of
	RT/RL.
	Vittorio Degli Esposti –University of Bologna
12.30 – 13.30 h	Lunch Break
13.30 – 14.30 h	Speed up techniques for RT prediction I: Database reduction and
	simplification, Discrete, Environment-Driven Ray-Launching.
	Vittorio Degli Esposti –University of Bologna
15.00 – 15.30 h	Coffee Break
15.30 – 17.00 h	Speed up techniques for RT prediction II: Code parallelization and GPU
	exploitation. Dynamic environments and Dynamic Ray Tracing. Anticipative
	prediction.
	Vittorio Degli Esposti –University of Bologna

Wednesday, 29.9.21:

8.30 – 10.30 h	Mm-wave and Terahertz propagation I: wireless Communication Systems at
	60 GHz and beyond; Propagation Conditions and Channel Models at 60 GHz
	Thomas Kürner - Technische Universität Braunschweig
10.30 – 11.00 h	Coffee Break
11.00 - 12.30h	Mm-wave and Terahertz propagation II: wireless Communication Systems at
	60 GHz and beyond; Propagation Conditions and Channel Models at 300 GHz
	Thomas Kürner - Technische Universität Braunschweig
12.30 – 13.30 h	Lunch Break
13.30 – 15.00 h	Mm-wave and Terahertz propagation III: Stochastic channel model for THz
	frequencies, impact of antenna misalignment in THz Channels, future tasks and
	challenges
	Thomas Kürner - Technische Universität Braunschweig
15.00 – 15.30 h	Coffee Break
15.30 – 17.00 h	Multipath propagation: stochastic and multidimensional aspects, stationarity,
	Bello formalism (Channel Transfer Functions). Small-scale fading (Rayleigh,
	Rice, Doppler spectrum, spreading in time/angles, selectivity in
	frequency/space).
	Claude Oestges - Université Catholique de Louvain
17.00 - 18.00 h	Demonstration of TUBS Channel Sounder
	Johannes Eckhardt - Technische Universität Braunschweig

Thursday, 30.9.21:

8.30 – 10.30 h	MIMO channels I: MIMO channel matrix, Eigenmodes and eigenvalues,
	Analytical MIMO matrix representations (correlation matrix, Kronecker and
	eigenbeam models), Indoor MIMO channels (keyhole propagation), MIMO
	channel dynamics , multi-link properties, MIMO antenna coupling
	Claude Oestges - Université Catholique de Louvain
10.30 – 11.00 h	Coffee Break
11.00 - 12.30 h	MIMO channels II: MIMO channel matrix, Eigenmodes and eigenvalues,
	Analytical MIMO matrix representations (correlation matrix, Kronecker and
	eigenbeam models), Indoor MIMO channels (keyhole propagation), MIMO
	channel dynamics , multi-link properties, MIMO antenna coupling
	Claude Oestges - Université Catholique de Louvain
12.30 – 13.30 h	Lunch Break
13.30 – 15.00 h	MIMO channel sounding techniques: sounder architectures, parameter
	estimation (SAGE, Rimax, Kalman, etc.)
	Claude Oestges - Université Catholique de Louvain
15.00 – 15.30 h	Coffee Break
15.30 – 17.00 h	Propagation for body area network : on-body propagation, off-body and body-
	to-body propagation, stationarity and channel models
	Claude Oestges - Université Catholique de Louvain
17.00 - 18.00 h	Exercises
	Conor Brennan – Dublin City University

Friday, 1.10.21:

8.30 – 10.00 h	UWB Basics : UWB definitions, UWB signals, pulses, UWB channel definitions,
	UWB antenna characterisation
	Werner Wiesbeck - Karlsruhe Institute of Technology
10.00 – 10.30 h	Coffee Break
10.30 - 11.30 h	UWB applications: UWB communication basics, UWB radar, UWB radar for
	precise, short-range measurement, UWB for medical applications
	Werner Wiesbeck - Karlsruhe Institute of Technology
11.30 - 12.30 h	Final Exam
12.30 – 14.00 h	Lunch Break
14.00 – 14.30h	Wrap-up and announcement grant winners

Note: There are two grants available for the the best two students. This grant will consist of 250€. The final exam will include an evaluation with a score. The score will be used to select students for grants.