Quantum Microwave Engineering

Quantum Microwave Engineering for the Second Quantum Revolution: Designing Antennas, Cryogenic Circuits, and Front-Ends

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MONDAY: Quantum Fundamentals for RF Engineers

Objective: Fundamental quantum concepts tailored for an RF engineering.

- **09:00 – 10:30: Fundamentals: What is "Quantum" in RF?**
  - Microwave photon and energy discretization
  - Harmonic oscillator as an LC circuit

  Speaker: T. Roth (Purdue University).

10.30 – 11.00 COFFEE BREAK

- **11:00 – 12:30: Quantum Mechanics for the Radio Frequency Engineer.**
  - From voltages to creation/annihilation operators
  - Hilbert space as signal state space
  - Phase & amplitude uncertainty (Standard Quantum Limit)

  Speaker: T. Roth (Purdue University).

12.30 – 14.00 LUNCH

- **14:00 – 15:30: Introduction to Entanglement in RF. Part 1.**

  ● Non-classical correlations in microwave signals ● EPR (Einstein-Podolsky-Rosen) states in circuits

  Speaker: L. E. García Muñoz (UC3M).

15.30 – 16.00 COFFEE BREAK

- **16:00 – 17:30: Introduction to Entanglement in RF. Part 2.**

  ● Non-classical correlations in microwave signals ● EPR (Einstein-Podolsky-Rosen) states in circuits

  Speaker: L. E. García Muñoz (UC3M).

TUESDAY: Quantum Hardware and Front-Ends

Objective: Designing the RF chain that operates at 10 mK temperatures.

- **09:00 – 10:30: Microwave Engineering at 10 mK.**
  - Thermal loading challenges
  - Cryogenic attenuators, isolators, circulators
  - Dielectric loss management

  Speaker: Massimo Borrelli Bluefors (Industry Leader).

10.30 – 11.00 COFFEE BREAK

- **11:00 – 12:30: Computational Quantum Electromagnetics I.**
  - Atomistic modeling of light–matter interaction
  - Density Functional Theory

  Speaker: A. BOAG (Tel Aviv University).

12.30 – 14.00 LUNCH

- **14:00 – 15:30: Computational Quantum Electromagnetics. II.**
  - Quantum EM scattering
  - Characteristic mode basis

  Speaker: A. BOAG (Tel Aviv University).

15.30 – 16.00 COFFEE BREAK

16:00 – 17:30: Microwave and RF Techniques for the Control and Readout of Quantum System

- Microwave and RF techniques.

Speaker: Felice Francesco Tafuri, Quantum Engineering, Keysight

WEDNESDAY: Quantum Optimization and Analysis for Antenna Engineers

Objective: Applying quantum computing to electromagnetic problems.

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- **09:00 – 10:30: Quantum Computing: From Qubits to Algorithms I.**
  - How quantum systems solve complex problems

  Speaker: P. Rocca (ELEDIA).

10.30 – 11.00 COFFEE BREAK

- **11:00 – 12:30: Quantum Computing: From Qubits to Algorithms II.**
  - How quantum systems solve complex problems

  Speaker: P. Rocca (ELEDIA).

12.30 – 14.00 LUNCH

- **14:00 – 15:30: Backreaction of stimulated Hawking radiation in an optical analogue**
  - **Speaker:** David Bermúdez (Wiezmann Institute, Israel).

15.30 – 16.00 COFFEE BREAK

- **16:00 – 17:30: Analogue Hawking radiation stimulated by a single photon**
  - **Speaker:** David Bermúdez (Wiezmann Institute, Israel).

THURSDAY: Quantum Communications & Radar

Objective: Long-range applications and security.

- **9:00 – 10:30: Quantum Annealing & Antenna Optimization.**
  - Radiation pattern synthesis
  - Beamforming in complex environments

  Speaker: G. Gradoni (University of Surrey).

10.30 – 11.00 COFFEE BREAK

- **11:00 – 12:30: Entanglement Across Quantum Networks**
  - Creating entanglement between distant nodes
  - From simple links to larger networks
  - Stabilizer states as a network tool
  - **Speaker:** G. Gradoni (University of Surrey).

12.30 – 14.00 LUNCH

- **14:00 – 15:30: Industrial Round Table I: The Future of RF.**
  - **Content:** Guests from INDRA, BLUEFORS, and ISDEFE.
  - **Moderator:** E. Sánchez (Quantum Flagship EU Head).

15.30 – 16.00 COFFEE BREAK

- **16:00 – 17:30: Industrial Round Table II: The Future of RF.**
    - **Content:** Guests from INDRA, BLUEFORS, and ISDEFE.

      Moderator: E. Sánchez (Quantum Flagship EU Head).

    - **Social event and dinner**

FRIDAY: Metrology, Test, and Future

Objective: Validation and trends.

- **09:00 – 10:30: Rydberg atoms: giant atoms for quantum technologies**

  ● What makes Rydberg atoms special.

  Controlling Rydberg atoms with light.

  Interactions and quantum technologies.

  Speaker: Michal Paniak (University of Warsaw).

10.30 – 11.00 COFFEE BREAK

- **11.00-12.30: Beyond Maxwell: The Power of Entangled Photons**

  Speaker: Nobel Laureate John Clauser.

12.30 – 14.00 LUNCH

- **14:00 – 17:30: Rydberg sensing and microwave-to-optical conversion**

  ● Rydberg receivers for the RF engineer.

  2. Microwave-to-optical frequency conversion.

  3. Counting microwave photons at room temperature.

  Speaker: Michal Paniak (University of Warsaw).