



# Scientific Instruments

— and —

# Phase Noise and Frequency Stability in Oscillators

Lectures for PhD Students and Young Scientists

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Part 1: General

Part 2: Phase noise and oscillators

Part 3: The International System of Units SI

home page <http://rubiola.org>

# Program (spring 2021)

	Date	No	Contents
P1: Oscillators & SI	Mon 1/3	1	Noise: quantum, thermal, shot
	Thu 4/3	2	Flicker. Instrument (structure). Rothe Dahlke. Guarding & shielding. Noise temperature, factor, figure
	Mon 8/3	3	Photodiode. NEP. Analog meets digital (no architectures). Fourier analysis
	Thu 11/3	4	Cross spectrum: theory and applications
	Mon 15/3	5	Spectrum analyzer. Time-to-digital and frequency-to-digital converters
P2: Oscillators	Thu 18/3	6	Phase noise, basic concepts. Allan variances, start
	Mon 22/3	7	Allan variance (cont.). Experimental methods, problem with the Rohde oscillator
	Thu 25/3	8	Interferometer. Amplifiers. Noise in digital systems
	Mon 29/3	9	The Leeson effect
	Thu 1/4	10	The Pound Drever Hall frequency control
P3: SI	Mon 26/4	11	Uncertainty. Int'l coordination of metrology
	Thu 29/4	12	Time
	Mon 3/5	13	Length, mass, introduction to electrical units
	Thu 6/5	14	Quantum electrical standards. Practical electrical references.
	Mon 10/5	15	Temperature, fundamental and practical stuff. (Skip mole). Candela (quite short). Goodbye.

# Origin and Purposes

## The contents originates from

- My tutorials at int'l conferences and my lectures as a guest scientist in other labs
- Long term interests in the foundation of metrology
- Lab experience which does not fit elsewhere

Formally, a series of lectures for PhD students

In practice, [open to everybody](#)

No need to be a university student

Mandatory [e-mail registration](#) at

[formations \[dot\] doctorales \[at\] univ-fcomte \[dot\] fr](mailto:formations[dot]doctorales[at]univ-fcomte[dot]fr)

(replace [dot] and [at] as appropriate, and remove spaces)

They are instructed to accept everybody

# Learning Material

## Lectures

- PhD Lectures



<b>Contents</b>
<b>News</b>
<b>Enrico's Noise Chart</b>
<b>Publications</b>
• books
• open literature
• journal articles
• conference articles
• conference slides
• seminar slides $\geq 1H$
<b>EFTS</b>
<b>Lectures</b>
• PhD lectures
• Regular courses
• U. Henri Poincaré
• Politecnico di Torino
<b>Oscillator noise</b> support material for my book (Cambridge, 2008)
<b>Affiliations</b>
<b>Links</b>



## Enrico Rubiola home page

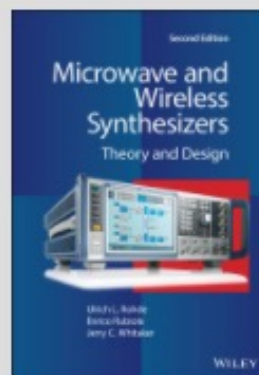
<http://rubiola.org>  
also <http://rubiola.net>

e-mail: [enrico\[at\]rubiola\[dot\]org](mailto:enrico@rubiola.org)  
replace "at" = "@" and "dot" = "."

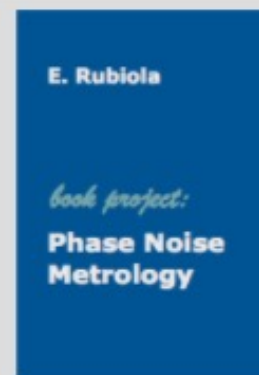
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## PUBLICATIONS

### Books



U. L. Rohde, E. Rubiola,  
J. C. Whitaker  
*Microwave and wireless  
synthesizers*  
John Wiley & Sons, Nov. 2020  
ISBN  
978-1-119-66600-4 Hardcover



E. Rubiola  
*Phase noise metrology*  
Book project