

# DR. PHILIP C. D. HOBBS

55 Orchard Road  
Briarcliff Manor, NY 10510 USA

<http://electrooptical.net>

+1.845.480.2058

[hobbs@electrooptical.net](mailto:hobbs@electrooptical.net)

## SUMMARY

Innovative expert in the design and refinement of all kinds of electro-optical systems and many other types of mixed-technology systems, with emphasis on high performance at low cost.  
Leading designer of ultrasensitive optoelectronics and other low noise analog circuitry.  
Testifying expert witness in patent and trade secret litigation.  
Team leader in multidisciplinary research and complex product development.  
Pioneer in ultrasensitive measurements, atomic force microscopy, solid-immersion microscopy, and nanoplasmonics. Extensive work in optical interconnect and novel silicon photonic devices.  
Finds creative solutions to tough problems, in fields from thermal infrared imaging to *in situ* particle detection, computer input devices, simulation software, spectroscopy, trace metal detection, photolithography, disk drive inspection, solar photovoltaics, inspection systems, laser scanning, plasmonics, silicon photonics, and back-end semiconductor processing.  
Works at all levels—inventing the concept, doing the theory, designing the instrument, writing the code, building the demo, fixing the bugs, and transferring the technology.  
Extensive economic due diligence experience: evaluating tradeoffs between present technology and new concepts, and evaluating vendor IP for build vs. buy decisions.  
Strong contributor and collaborator with existing teams: comes up to speed very fast and helps others use their ideas and expertise more productively.  
Holds 41 US patents issued or pending, with extensive experience in both sides of the patent process: drafting and prosecution as well as technical interpretation and litigation.  
Wrote a bestseller: *Building Electro-Optical Systems: Making It All Work*, described in a [major review](#) as "a new laboratory bible for optics researchers," and which has helped thousands of people make better commercial systems and research apparatus.  
Wrote 30+ technical articles on electro-optics and advanced instruments. The addendum lists patents and selected publications.

## PROFESSIONAL EXPERIENCE

**ELECTROOPTICAL INNOVATIONS LLC**, Briarcliff Manor, NY

**2009 – Present**

### Principal

Established a consultancy in electro-optical system design and debug; IP litigation; and proprietary product design for licensing; more detail at [electrooptical.net](http://electrooptical.net)

- Design of new instrument and measurement technologies for future proprietary products.
- Testifying expert witness in patent and trade secret suits: was deposed in claim construction; wrote claim construction declaration and expert reports on non-infringement, invalidity, and in an *inter partes* reexam, including finding additional prior art, detailed technical arguments and reverse-engineering disputed devices. Three cases have settled and four others are underway, all currently awaiting rulings.
- Design consultant in medical devices, single-pixel cameras, displays, spectroscopic biochips,, geophysical instruments, tactical communications, semiconductor inspection, vacuum instruments, and other advanced sensors. Examples: A line of photonic instruments for a San Francisco company, and advanced photoreceivers and biochip front ends for a large Asian consumer products manufacturer.
- Published the second edition of *Building Electro-Optical Systems: Making It All Work*.

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IBM THOMAS J WATSON RESEARCH CENTER, Yorktown Heights, NY

1987 – 2009

**Research Staff Member, Advanced Optical Interconnection**

2002 – 2009

- Invented a new silicon photonic interconnect technology for servers, based on MIM tunnel junctions coupled to on-chip optical waveguides via plasmonic metal antennas
- Demonstrated technologically-useful overall efficiencies (7%), an improvement of more than 50 times over any previous antenna-coupled tunnel junction device
- In 2007-09, helped set IBM's OI direction as a member of the Optical Interconnection Strategy team, including build/buy decisions in multichannel multimode transceivers, mostly in modified MT ferrules
- Invented several alignment technologies for inter-chip optical links, for manufacturability and yield
- Invented a novel immersion solar concentrator system and an all-passive two-axis servo system for ultrahigh performance solar photovoltaic concentrators (2300 suns). Co-PI on a [NSF GOALI](#) program to make ultrasensitive bioassay sensors. Visiting Scientist at CU/JILA and MSU. Built two special sensors that successfully solved production stoppages in IBM Z-Series servers
- Wrote POEMS (Programmable Optimizing Electromagnetic Simulator), a full 3D multi-CPU code that runs both on Linux clusters and on ordinary Windows PCs, to support the Si photonics work.

**Research Staff Member, Computer Science**

1998 – 2001

- Invented Footprints, a tiled network of ultralow cost, high performance thermal imagers to track people's movements in large indoor spaces, and led a 5-person team that took it from concept through successful pilot in a large department store. The 96-pixel sensors used screen-printed pixels on PVDF film, with a single LED per pixel used as a readout switch. Each 96-pixel sensor cost \$50 complete, and achieved a NE $\Delta$ T of 0.13 K, a creditable figure even for sensors costing 100 times more.
- Wrote "*Building Electro-Optical Systems: Making it All Work*".

**Research Staff Member, Manufacturing Research**

1989 – 1998

- Developed many ground-breaking spectroscopic, lidar, and radioassay instruments for use in semiconductor and disk drive manufacturing lines. Technical details for some of these appear at <http://electrooptical.net>. They include the *In-Situ* Coherent Lidar (ISICL) sensor, which achieved quantum-limited sensitivity despite background light over 10<sup>8</sup> times brighter than the signal; Colorimetric chemical sensors for metal ions that achieved parts-per-billion sensitivity; The whole field of laser noise cancellation, allowing quantum-limited measurements with lasers up to 10<sup>7</sup> times noisier; e.g. tunable diode laser absorption spectroscopy at 1 part in 10<sup>7</sup>; Current-tuned compound raster scanning, a method for improving mechanical laser scanner performance by 10-50 times.
- Co-invented solid immersion microscopy and built the first silicon-lens solid immersion microscope prototype; developed the first closed-loop control system for lithographic line width (for 16M DRAM); designed and prototyped improved overlay alignment sensors subsequently retrofitted to 35 Perkin Elmer Censor wafer steppers, allowing one more bipolar logic generation (IBM ATX-4) to use G-line lithography (visible) instead of I-line (UV). This saved a \$125M equipment purchase.
- Invented an etalon system for simultaneous laser stabilization and intracavity measurements at the quantum limit. Invented low cost (\$10) head tracker for computer input, requiring no headgear.

**Post-Doctoral Scientist**

1987 – 1989

- Designed and prototyped the first commercial atomic and magnetic force microscope-the IBM SXM, also the first to work with 8-inch wafers, and used it to set the world's record for magnetic force resolution. A version of this microscope is still in production. Also invented the first particle-free corona point air ionizer for semiconductors.

**EDUCATION**

**PhD**, Applied Physics, Stanford University, 1987

**B. Sc.**, Astronomy & Physics, Honors, University of British Columbia, 1981

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## ADDENDUM

### SELECTED AWARDS AND RECOGNITION

IBM Outstanding Technical Achievement Award; IBM Research Division Award; IBM Master Inventor; R&D 100 Award; Photonics Spectra Commercial Technology Award

### SELECTED PUBLICATIONS

- Philip C. D. Hobbs, [Building Electro-Optical Systems: Making It All Work](#), Second Edition, Wiley-Interscience, New York, 2009.
- Philip C. D. Hobbs, "[Ultrasensitive Laser Measurements Without Tears](#)", *Applied Optics* **36**, 4, pp 903-920 (1 February 1997). ([Optics InfoBase citation](#))
- Philip C. D. Hobbs, Robert B. Laibowitz, Frank R. Libsch, Nancy C. LaBianca, and Punit P. Chiniwalla, "[Efficient waveguide-integrated tunnel junction detectors at 1.6 \$\mu\$ m](#)", *Optics Express* **15**, 25 pp. 16376-16389 (December 10, 2007). ([Optics InfoBase citation](#))
- Philip C. D. Hobbs, Robert B. Laibowitz, & Frank R. Libsch, "[Ni-NiO-Ni Tunnel Junctions for Terahertz and Infrared Detection](#)", *Appl. Opt.* **44**, 32, 6813-6822 (2005). ([Optics InfoBase citation](#))
- P. C. D. Hobbs, "[ISICL: In-Situ Coherent Lidar for detecting particles in semiconductor processing chambers](#)", *Applied Optics* **34**, 9, March 20, 1995. ([Optics InfoBase citation](#))
- Philip C. D. Hobbs, "[Reaching the shot noise limit for \\$10](#)", *Optics and Photonics News* **2**, 4 17-23 (April 1991). ([Optics InfoBase citation](#))
- Philip C. D. Hobbs, "[Photodiode Front Ends: The Real Story](#)", *Optics & Photonics News* **12**, 4, pp 44-47, (April 2001). ([Optics InfoBase citation](#))
- P. C. D. Hobbs, D. W. Abraham, and H. K. Wickramasinghe, "Magnetic force microscopy with 25 nanometer resolution", *App. Phys. Lett.* **55**, 22, pp. 2357-9 (1989)
- Philip C. D. Hobbs, "[A \\$10 Thermal Infrared Imager](#)", *Proc. SPIE* **4563**, p. 42-51, Sensors and Controls for Intelligent Manufacturing II, Peter E. Orban; Ed. (2002).
- Philip C. D. Hobbs, "[Footprints: A 'War Story'](#)", *Optics & Photonics News* **14**, 9, p. 32-37, September 2003.
- Philip C. D. Hobbs, "[POEMS: A Programmable Optimizing Electromagnetic Simulator](#)", <http://electrooptical.net/www/poems/poemsmanual.pdf>

### U. S. PATENTS

#### Solar Photovoltaics

- YOR920080708US1 Immersion Solar Concentrator (filed, not yet published)

#### Quantum Computing

- YOR920080707US1: Hybrid Superconductor Optical Repeater (Filed, not yet published)

#### Optical Interconnection

- [US08104468B2](#): Method and apparatus providing fine alignment of a structure relative to a support
- [US07857195B2](#): Method and apparatus providing fine alignment of a structure relative to a support
- [US07841510](#): Method and apparatus providing fine alignment of a structure relative to a support
- [US20080310808A1](#): Photonic waveguide structure with planarized sidewall cladding.
- [US20080180340A1](#): Waveguide coupling devices
- [US07542643B2](#): Waveguide alignment using waveguide fiducials
- [US07480429](#): Chip to chip optical interconnect

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**U. S. PATENTS (Continued)**

- [US07421160](#): Coupling element using waveguide fiducials
- [US07412134](#): Apparatus and methods for remakeable connections to optical waveguides
- [US07197207](#): Apparatus and method for optical interconnection
- [US07116865](#): Apparatus and methods for remakeable connections to optical waveguides
- [US06983097](#): Magneto-optical switching backplane for processor interconnect
- [US06816637](#): Magneto-optical switching backplane for processor interconnect

**Footprints: A Network of Distributed Low-Cost Infrared Imagers**

- [US06614348](#): System and method for monitoring behavior patterns
- [US06449382](#): A method and system for recapturing a trajectory of an object
- [US06399946](#): Pyroelectric film sensors

**Ultrasensitive Measurements**

- [US05134276](#): Noise cancelling circuitry for optical systems ...
- [US06259712](#): Interferometer method for providing stability of a laser
- [US05648268](#): Radionuclide exchange detection of ultra trace ionic impurities...
- [US05294806](#): Optical submicron aerosol particle detector
- [US05204631](#): System and method for automatic thresholding of signals in Gaussian noise
- [US05192870](#): Optical submicron aerosol particle detector
- [US05133602](#): Particle path determination system

**Instruments for Manufacturing and Process Control**

- [US06567172](#): System and multipass probe for optical interference measurements
- [US05691540](#): Assembly for measuring a trench depth parameter of a workpiece
- [US05516608](#): Method for controlling a line dimension arising in a photolithographic process
- [US05432670](#): Generation of ionized air for semiconductor chips
- [US05343290](#): Surface particle detection using heterodyne interferometer
- [US05316970](#): Generation of ionized air for semiconductor chips
- [US05116583](#): Suppression of particle generation in a modified clean room air...

**Advanced Scanning Technology**

- [US06118518](#): Assembly comprising a pocket 3-d scanner
- [US06057947](#): Enhanced raster scanning assembly
- [US05986759](#): Optical interferometer measurement apparatus and method
- [US05908586](#): Method for addressing wavefront aberrations in an optical system
- [US05794023](#): Apparatus utilizing a variably diffractive radiation element
- [US05638176](#): Inexpensive interferometric eye tracking system

**Solid-Immersion Microscopy (NA=2.8 to 3.2)**

- [US05220403](#): Apparatus and a method for high numerical aperture microscopic examination of materials
- [US05208648](#): Apparatus and a method for high numerical aperture microscopic examination of materials

**Scanned-Probe Microscopy**

- [US05298975](#): Combined scanning force microscope and optical metrology tool