



PHOTONICS
FOCUS

SPIE ●

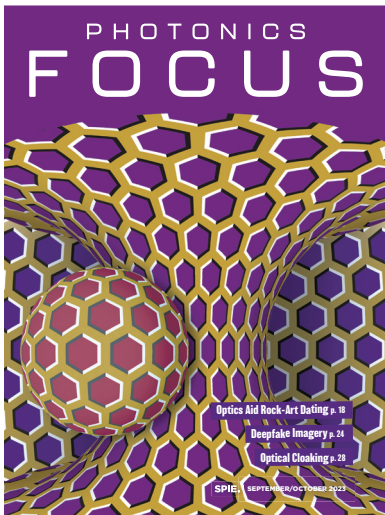
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PHOTONICS FOCUS

**Heighten brand visibility
and find qualified buyers.**

Photonics Focus, a bimonthly print and online magazine, presents a fresh and exciting view of optics and photonics technology and industry. Published by SPIE for its 20,000+ Members, the award-winning magazine — with its striking



graphics and thought provoking editorial — stakes a presence at major SPIE events, distributed to attendees at Photonics West, Optics + Photonics, and Defense + Commercial Sensing. *Photonics Focus* advertisers build visibility in the optics and photonics community, reaching industry decision makers who become customers.

Each issue of *Photonics Focus* provides articles and information aimed at helping optics and photonics professionals develop careers, maneuver the job market, and stay informed. Lavishly illustrated feature articles by some of the country's best science writers showcase scientific discovery and innovative, real-world applications from translational optics and photonics research. The magazine also keeps readers up to date on SPIE Member services, meetings, and community support.

SPIE is first for industry, with thousands of Corporate Members from 90+ countries who hold purchasing power. *Photonics Focus* advertisers reach the most influential people and organizations in the optics and photonics industry.

A section called **Field of View** spotlights the photonics industry with viewpoints and analysis from leading experts in business and policy. Executive updates, recent M&As, and our ear to the ground on what matters to photonics professionals round out our coverage.

Display System Technology Improvements are Vital to AR/VR Headset Adoption

VIRTUAL REALITY (VR), augmented reality (AR), or mixed reality (MR) headsets and smart glasses have been the subject of much anticipation for the past decade, with promises of being the "next big thing." Despite their potential, these devices have not seen widespread consumer adoption. In part due to high, unmet expectations, several key technical challenges remain.

There are usually three parts comprising the DSA. The display engine (which contains the image to present), the optical combiner, which combines the display and the see-through view, and the see-through which includes all additional optics, vision processing, eye tracking, gesture sensing, and streaming technologies (global or local).

Power consumption is a crucial concern for each glass, which will determine the average price (APR) of the device. This is especially true for AR displays, which typically have a higher APR than VR displays. The APR of the device is a key factor in determining its market success.

Micro-LEDs are a promising technology for AR displays, offering high brightness and low power consumption. However, they are currently more expensive than other technologies. OLEDs are another option, but they have lower brightness and higher power consumption. LCDs are the most common technology used in current AR displays, but they have lower brightness and higher power consumption.

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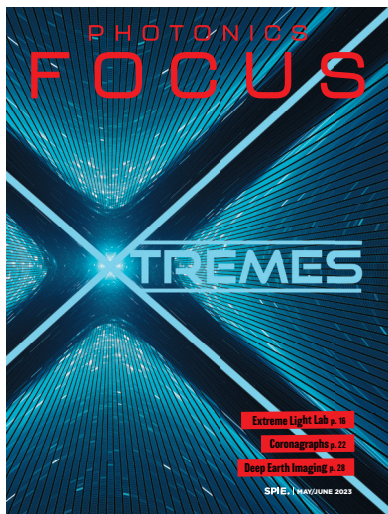
FIELD OF VIEW

Standard display: Limited field of view.

Micro-LED display: Improved field of view.

AR display: Largest field of view.

Technology	Resolution	Refresh Rate	Power Consumption	Field of View	Cost
LCD	1080p	60Hz	Low	Small	Low
OLED	1080p	90Hz	Medium	Medium	Medium
Micro-LED	1080p	120Hz	High	Large	High



Photonics Focus publishes engaging feature articles about innovative applications and advances in photonics.

Each issue focuses on a theme that has broad appeal across many technical areas. These themes are often aligned with the conferences where the issue will be distributed.

ISSUE DATE	EDITORIAL FOCUS	RESERVE SPACE BY	CREATIVE DUE	BONUS DISTRIBUTION
January/ February	Autonomy: a <i>Focus</i> on artificial intelligence, machine learning, and photonics-enabled autonomous systems.	11/1/2023	11/17/2023	SPIE Photonics West SPIE Medical Imaging SPIE Advanced Lithography + Patterning SPIE AR VR MR
March/ April	Security: a <i>Focus</i> on the photonics that keep our food, jobs, information, supply chains, and nations safe.	1/3/2024	1/19/2024	SPIE Defense + Commercial Sensing SPIE Smart Structures + Nondestructive Evaluation
May/ June	Space Exploration: a <i>Focus</i> on the tools and technologies that bring the knowledge of the cosmos back to Earth.	3/6/2024	3/22/2024	SPIE Astronomical Telescopes + Instrumentation
July/ August	Sustainability: a <i>Focus</i> on the potential of photonics to advance the UN's Sustainable Development Goals.	5/1/2024	5/17/2024	SPIE Optics + Photonics
September/ October	Biomimetics: a <i>Focus</i> on photonic designs and systems that mimic nature's perfection.	7/3/2024	7/19/2024	SPIE Security + Defence SPIE Remote Sensing SPIE/COS Photonics Asia
November/ December	Lasers: a <i>Focus</i> on the basic physics and cutting-edge applications of laser technology.	9/4/2024	9/20/2024	SPIE Photonics West

Why Quantum Education?

WHETHER IT BE WATCHING THE WORLD CUP as a fan, or watching *Quantum Leap* TV, entering into the Quantum Revolution with Art Man, or choosing to follow with *Quantum Leap* Quantum Leap, "Quantum" has become a household name. However, in the history of science, quantum physics is fairly recent. Erwin Schrödinger introduced his landmark Schrödinger equation, a mathematical description of the field, only about 100 years ago. The development of quantum mechanics was a process that spanned decades and involved the work of many brilliant minds, including Albert Einstein, Niels Bohr, and Werner Heisenberg.

Even within academic circles, quantum mechanics is a complex and counterintuitive field. Its foundations are based on the idea of "wave-particle duality," where particles can behave like waves and waves like particles. Despite its pervasiveness in almost all STEM fields, including biology, chemistry, and electrical engineering—quantum mechanics is a cornerstone of the most advanced of electrical engineering. These concepts are typically taught in a way that is abstract and difficult to grasp, often leading to a sense of confusion and frustration among students.

Quantum mechanics is a field that is rapidly advancing, and its applications are becoming increasingly apparent in our daily lives. From the development of quantum computing to the use of quantum mechanics in materials science, the field is opening up new possibilities for innovation and discovery.

ANYONE WHO'S NOT SHOCKED BY QUANTUM THEORY HAS NOT UNDERSTOOD A SINGLE WORD.

The career-focused Bandwidth section guides readers on the development of soft skills, critical networking opportunities, and the many exciting and perhaps unexpected career paths in optics.

Adhesives for Cutting Edge Optical Technologies
SPRINKLED WITH DIMENSIONAL LIGHT CURING SYSTEMS
Medical optics

MASTERPIECE

Francisca Vasconcelos is a Ph.D. graduate from the University of California, Berkeley, Department of Electrical Engineering and Computer Science. She has more than 10 years of experience in the field of quantum optics and is currently a research scientist at the University of California, Berkeley.

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Squeezing Light p. 20
Quantum Clocks p. 28

SPiE | MARCH/APRIL 2023

LOUIS ESSEN

Time Lord of Precision Atomic Clocks

By Jeff Hecht

Louis Essen's 1961 invention of the first practical atomic clock changed the face of timekeeping from the periodic motion of the Earth, as recorded by astronomers, to the periodic motion of electrons in certain atoms as measured by physicists.

Essen's work was a direct result of his research starting in the late 1940s at the National Physical Laboratory in the United Kingdom. He was one of the first to use the cesium-133 atom as a frequency standard, which served as the basis for the modern definition of the second.

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Each issue highlights **Luminaries**, people who have profoundly influenced the course of optics and photonics technology.

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Exposing Deepfake Imagery

By Neil Savage

In May, an image of an explosion at the Pentagon circulated, causing stocks traded on the S&P 500 to drop by \$500 billion in value. But the explosion didn't really happen. The photo was quickly debunked as an AI-generated fake, and fortunately the stock market recovered.

Other such instances have popped up. In late spring 2022, a video showed up on a Ukraine news website depicting President Volodymyr Zelenskyy apparently being kidnapped by Russian forces and carried to Belarus. Again, the fake was quickly exposed, but it demonstrated the potential for deepfake technology to cause significant damage.

Deepfakes are becoming increasingly common, and their use is becoming more sophisticated with each passing month and have led to widespread concern among consumers and government officials. The technology that was used to create the fake was a deepfake, a type of artificial intelligence (AI) that can generate realistic-looking images and videos that are indistinguishable from the real thing.

Feature articles written by top science journalists delve into photonics applications, future missions, and technologies that will impact the world. Exciting graphics and beautiful photography highlight our editors' mission to deliver an unparalleled experience for *Photonics Focus* readers.

In addition to interesting thematic feature articles, *Photonics Focus* publishes useful articles in the following editorial departments:

- Sources**
Recent and notable research highlights
- Bandwidth**
Helping you grow in your career or begin a new one
- Field of View**
Insight into the photonics industry
- Luminaries**
The institutions and people who lit the way for photonics
- Member Lens**
SPIE events, awards, and news for Members
- See the Light**
Images of photonics in society from readers' hometowns and travels.

1 PLEASE PROVIDE COMPLETE BILLING INFORMATION

My company is an SPIE Corporate Member No Yes Corporate ID# _____ P.O. (if required for billing) _____

Advertising Company _____ Bill to **Advertising Company** (not Ad Agency)

Address _____

City _____ State/Prov. _____ Zip _____

Contact _____ Title _____

Telephone _____ Fax _____ Email _____

Ad Agency _____

Address _____

City _____ State/Prov. _____ Zip _____

Contact _____ Title _____

Telephone _____ Fax _____ Email _____

2 SPECIFY ISSUE Jan/Feb Mar/Apr May/June Jul/Aug Sep/Oct Nov/Dec

Ad size	Four Color - 1x	Four Color - 2x	Four Color - 4x	Four Color - 5x	Four Color - 6x
Full page trim size (8" x 10 7/8") bleed size (8 1/2"x 11 3/8")	<input type="checkbox"/> \$2,800	<input type="checkbox"/> \$2,670	<input type="checkbox"/> \$2,540	<input type="checkbox"/> \$2,410	<input type="checkbox"/> \$2,290
2-page spread bleed (16 1/2" x 11 3/8")	<input type="checkbox"/> \$5,070	<input type="checkbox"/> \$4,820	<input type="checkbox"/> \$4,560	<input type="checkbox"/> \$4,330	<input type="checkbox"/> \$4,120
2/3-page vertical (4 5/8" x 10")	<input type="checkbox"/> \$2,210	<input type="checkbox"/> \$2,090	<input type="checkbox"/> \$2,000	<input type="checkbox"/> \$1,890	<input type="checkbox"/> \$1,800
1/2-page vertical (3 1/2" x 10")	<input type="checkbox"/> \$2,070	<input type="checkbox"/> \$1,970	<input type="checkbox"/> \$1,860	<input type="checkbox"/> \$1,770	<input type="checkbox"/> \$1,670
1/2-page horizontal (7" x 4 7/8")	<input type="checkbox"/> \$1,810	<input type="checkbox"/> \$1,720	<input type="checkbox"/> \$1,620	<input type="checkbox"/> \$1,540	<input type="checkbox"/> \$1,460
1/3-page vertical (2 1/4" x 10")	<input type="checkbox"/> \$1,370	<input type="checkbox"/> \$1,240	<input type="checkbox"/> \$1,230	<input type="checkbox"/> \$1,180	<input type="checkbox"/> \$1,120
1/6-page vertical (2 1/4" x 4 7/8")	<input type="checkbox"/> \$1,040	<input type="checkbox"/> \$980	<input type="checkbox"/> \$930	<input type="checkbox"/> \$890	<input type="checkbox"/> \$840
Premium positions (full-page back cover bleed size - 6 1/2"x 11 3/8")					
Cover 4 - back cover	<input type="checkbox"/> \$3,380	<input type="checkbox"/> \$3,210	<input type="checkbox"/> \$3,030	<input type="checkbox"/> \$2,890	<input type="checkbox"/> \$2,740
Premium positions (full-page bleed size - 8 1/2"x 11 3/8")					
Cover 2 - inside front	<input type="checkbox"/> \$3,110	<input type="checkbox"/> \$2,950	<input type="checkbox"/> \$2,790	<input type="checkbox"/> \$2,660	<input type="checkbox"/> \$2,520
Cover 3 - inside back	<input type="checkbox"/> \$3,110	<input type="checkbox"/> \$2,950	<input type="checkbox"/> \$2,790	<input type="checkbox"/> \$2,660	<input type="checkbox"/> \$2,520
Page 2	<input type="checkbox"/> \$3,110	<input type="checkbox"/> \$2,950	<input type="checkbox"/> \$2,790	<input type="checkbox"/> \$2,660	<input type="checkbox"/> \$2,520

Other premium positions upon request (5% increase over full-page, four-color ad rate).

I have advertised with SPIE in the past 12 months. Please pick up my ad materials from:

3 AGREEMENT *By signing, you agree to abide by the policies listed. (Handwritten signature required.)*

Ordered by _____ Title _____

Authorizing Signature _____

4 PAYMENT INFORMATION *(Billed after publication prints.) Please check one of the following options:*

Check/money order enclosed (payable to SPIE) for entire amount. = \$ _____

Credit card. SPIE accepts VISA, MasterCard, American Express, Diners Club, and Discover cards.

Wire transfer for entire amount *(Bank wire transfer information will be sent to you upon receipt of this contract.)* = \$ _____

Please send invoice.

Contact
SPIE Sales

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33543

Melissa Valum | Tel: +1 360 685 5596 | Fax: +1 360 647 1445 | melissav@spie.org | spie.org/advertising

AD SIZE	INCHES	MILLIMETERS
Magazine trim size	8 × 10 ⁷ / ₈	212.725 × 273
Full-page back cover bleed	6 ¹ / ₂ × 11 ³ / ₈	165 × 283
Full-page bleed	8 ¹ / ₂ × 11 ³ / ₈	222 × 283
Full-page non-bleed	7 × 10	178 × 254
2-page spread bleed	16 ¹ / ₂ × 11 ³ / ₈	419 × 289
2/3-page vertical	4 ⁵ / ₈ × 10	117 × 254
1/2-page vertical	3 ¹ / ₂ × 10	89 × 254
1/2-page horizontal	7 × 4 ⁷ / ₈	178 × 124
1/3-page vertical	2 ¹ / ₄ × 10	57 × 254
1/6-page vertical	2 ¹ / ₄ × 4 ⁷ / ₈	57 × 124

TRIM Size - Magazine will be cut to this size.

BLEED Size - Background images need to be slightly larger than trim so it looks like it goes off the edge.

IMPORTANT: PLEASE REMOVE ALL PRINTER MARKS INCLUDING REGISTRATION AND CROP MARKS FROM YOUR AD FILE. KEEP ESSENTIAL TEXT OR IMAGES AT LEAST 1/4" INSIDE TRIM SIZE.

ELECTRONIC FILE REQUIREMENTS

- Ad should be furnished as a high-resolution pdf (at least 300 dpi). Fonts must be embedded, outlined, or included. All colors should be CMYK builds. Note: eps, jpg, and tif files will be accepted but PDF IS PREFERRED.
- Keep essential matter of an ad (text or image) inside the live area or 1/4" inside trim, except for full-page ads.
- PLEASE REMOVE ALL PRINTER MARKS INCLUDING REGISTRATION AND CROP MARKS FROM YOUR AD FILE.

AD MATERIAL SUBMISSION GUIDELINES

- Ads can be emailed (files <5 MB may be emailed to advertising@spie.org).
- Please contact advertising@spie.org with questions about ad submissions.

POLICIES

- Changes or modifications to submitted ad materials may be subject to production charges.
- SPIE does not guarantee reproduction quality for late ads or ads that do not meet the mechanical and electronic file requirements.
- Ad materials are stored for 12 months, unless other arrangements have been made in writing.
- No refunds on ads cancelled after insertion order due dates.
- No guaranteed ad placement other than accepted special cover positions.
- SPIE reserves the right to cancel or reject any advertisement; this includes solicitation by organizations for membership and event attendees, authors or exhibitors, or products unrelated to the event.
- Simulation of the publication's format is not permitted.
- SPIE reserves the right to place the word "advertisement" with copy that, in the publisher's opinion, resembles editorial matter.

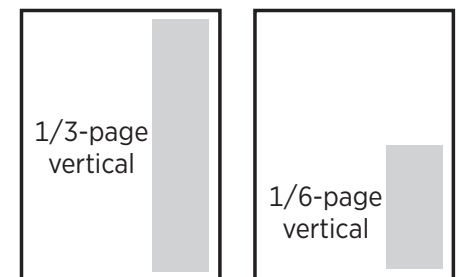
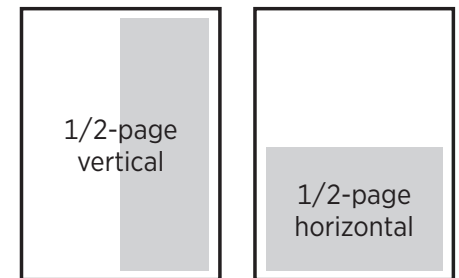
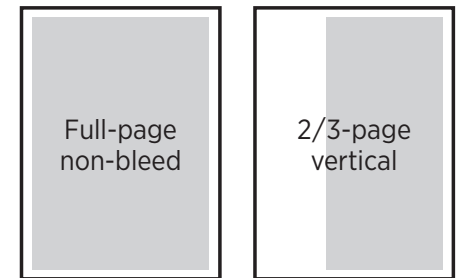
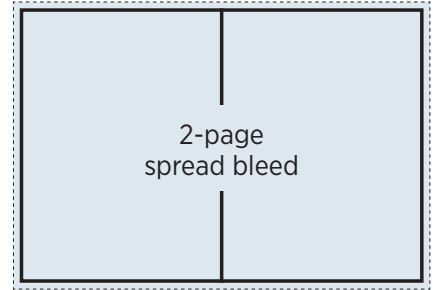
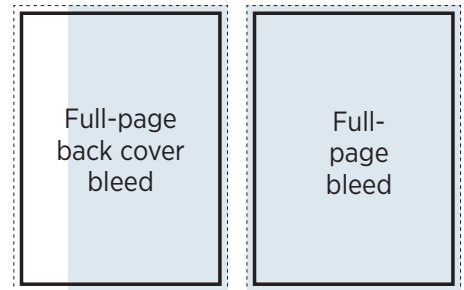
- All advertising is subject to publisher's approval and agreement by the advertiser and agency to indemnify and protect the publisher from and against any claims, loss, liability, or expense, including reasonable attorney's fees, arising out of publication of such advertisement.
- Ads received after the materials due dates are subject to a 10% surcharge.
- Recognized ad agencies will receive a 15% commission. Commissions given to ad agencies will be forfeited if payment is not received within 60 days of invoice date.
- Account delinquency may affect advertiser's and agency's ability to book space in future issues.
- For accounts with more than one unpaid invoice, all cash received will be paid to oldest invoice first.
- Advertiser and agency agree to pay all collection costs that result from our collection efforts on delinquent balances, including reasonable attorney's fees.

LIABILITY

The publisher reserves the right to hold the advertiser and advertising agency jointly liable to SPIE for payments due hereunder. The advertiser is at all times liable for payment of all account balances due and all other liabilities and deemed to receive refund payments, adjustments, notices and all other documents when the same are delivered to their advertising agency. Payments by the advertiser to the advertising agency for services does not constitute payment to SPIE. Any language to the contrary in any advertising agency's insertion orders or other documents is void and without effect.

BILLING AND DISCOUNTS

- Billing and tear sheets will be mailed after the piece has been published. Payment must be made to SPIE within 30 days of invoice date. After 30 days, a 5% late fee will be added to all unpaid balances.
- Multiple ad placements per issue receive a 10% discount for each additional ad.
- SPIE Corporate Members receive a 5% discount on published rates.
- All prices are in US dollars.





SPIE.