

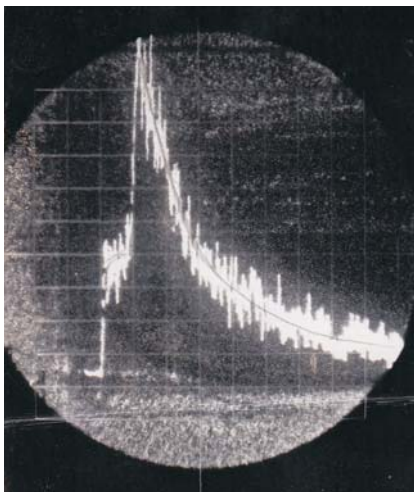
More light on ruby laser's history

[Editors' note: In the article "Bell Labs and the Ruby Laser" by Donald Nelson, Robert Collins, and Wolfgang Kaiser, which appeared on page 40 of the January 2010 issue of *PHYSICS TODAY*, a clause added to the authors' original text by our editorial staff inadvertently but significantly distorted the history of the ruby laser's invention. Our unfortunate elaboration in the article's opening paragraph asserted that work at Bell Labs in the summer of 1960 "led to the creation of the first ruby laser." In fact, the authors neither made nor intended such an assertion of priority. Indeed, their article describes Theodore Maiman's prior work in some detail.

We thank Nelson and Jeff Hecht for pointing out our error. Nelson and his co-authors, in their response below to various points made by letter writers in this department, rightly distance themselves from our mistaken assertion.]

In their account of how Bell Labs replicated the ruby laser (*PHYSICS TODAY*, January 2010, page 40), Donald Nelson, Robert Collins, and Wolfgang Kaiser cast useful light on the early history of laser development. I apologize for mistakenly scolding the Bell Labs team in my book *Beam: The Race to Make the Laser* (Oxford University Press, 2005) for failing to cite one of Theodore Maiman's publications. I want to add a few points, including a previously unpublished oscilloscope trace from Maiman's experiments, to put their story into context.

Initial doubts about Maiman's achieving laser oscillation were understandable. Maiman demonstrated a pulsed high-gain laser, not the low-gain



Oscilloscope trace of ruby laser pulse power versus time, recorded by Theodore Maiman in May 1960. (Image courtesy of Kathleen Maiman.)

continuous one sought by others, and he reported spectral line narrowing and rapid power increase as evidence of lasing, but he did not mention a narrow beam. Moreover, Hughes Research Laboratories announced Maiman's results at a 7 July 1960 press conference, before publication but after acceptance of a short note in *Nature* and a longer letter submitted to the *Journal of Applied Physics*. (The letter had to be withdrawn after *British Communications and Electronics* obtained a copy from the press conference and published it without authorization.) The early news conference was unusual, but competition was intense and *Physical Review Letters*, then the only rapid-publication physics journal, had rejected Maiman's paper without peer review and evidently without recognizing that an "optical maser" was a dramatic advance beyond microwave masers.

Nelson and coauthors may have forgotten that Amnon Yariv, then at Bell, visited Maiman soon after the Hughes press conference. Yariv wrote later that Maiman's data showed "a sudden collapse, above threshold, of the fluorescence spot diameter to a diffraction-limited spot and the corresponding sudden increase of the peak brightness"

and that he told his manager, "In my opinion, Ted had made the world's first laser."¹

Maiman did not initially report a pencil beam, and he later said his initial ruby sample suffered from optical distortion. However, he soon obtained a better sample and by the time of Yariv's visit had produced a low-divergence beam. In retrospect, the Bell group should have heeded Yariv's report. They also should have listened to Maiman, who told Collins he had a pencil beam when Collins called to ask him for a citation. In an abstract submitted to the 12–14 October 1960 meeting of the Optical Society of America, Maiman reported "a tight beam of less than 20 minutes of arc divergence"²—in other words, a pencil beam.

True, Maiman did not report relaxation oscillations, and he illustrated his pulse decay with a line drawing rather than a photo.³ However, in his autobiography, Maiman wrote that he saw spiking during laser pulses but initially attributed it to instrument problems. Spiking and a sharp threshold are evident in Polaroid photographs he preserved of oscilloscope traces, as shown in the figure. Photos Maiman published in 1961 also show sharp spiking, but at the time the features were not identified as relaxation oscillations.⁴

Irnee D'Haenens and Charles Asawa, Maiman's assistants, noted the spiking and showed it to George Birnbaum, who recognized it as relaxation oscillations. Maiman said the two could publish their observations if they could explain the phenomenon, but Asawa said they never did.⁵ Although the Hughes group saw spiking first, the Bell group was first to describe it as relaxation oscillations.

Nelson's suggestion that the 1-cm size of Maiman's crystal would have allowed him to observe "stimulated emission but not a laser oscillation threshold" (page 44 of the *PHYSICS TODAY* article) is implausible. With ruby's high refractive index and high gain when pumped by a flash lamp, avoiding laser oscillation would have been difficult. The same is true for semiconductor diode lasers, which oscillate within the tiny cavity defined by their cleaved

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edges. Diode lasers have high beam divergence because of their small emitting area, but were nonetheless accepted as lasers when developed in 1962.

The acid test of experimental science is independent replication of results. The Bell researchers' account is historically worthy because they did that, as well as adding details.

It is singularly unfortunate that an editorial error made it appear that Nelson and coauthors were trying to claim their work "led to the creation of the first ruby laser." That misperception caused considerable anguish among Maiman's friends and colleagues, who knew of past conflicts that led Maiman to complain in his autobiography of Bell Labs' "dirty tricks."⁶ With Maiman, D'Haenens, and Asawa no longer available to respond, it's time to repeat what Charles Townes said in his 1964 Nobel lecture: "The first operating laser, a system involving optical excitation of the chromium ions in ruby and yielding red light, was demonstrated by Maiman in 1960."

References

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Having worked with lasers since the early 1960s, I read "Bell Labs and the Ruby Laser" with great interest. The Bell Labs scientists retell their side of the story, but they shortchange the role of others, particularly Ted Maiman.

One tenet of Western science is that once a new breakthrough or invention is announced, it can be reproduced by one skilled in the arts. Fifty years ago that is exactly what happened at Bell Labs after they heard what had happened at Hughes Research Laboratories on 16 May 1960.

At that time scientists at Bell Labs were emphasizing continuous emission in their attempts to develop optical masers. They must have been completely surprised when they learned that a pulsed xenon flash lamp could produce, in a lightly doped pink ruby, a population inversion that resulted in

the generation of coherent pulsed laser light at ruby's 694.3-nm lower fluorescent line, via feedback from the parallel, polished, and metallized ends of the rod (an optical Fabry-Perot).

Playing catch-up, the Bell Labs team hastily put together a flash-lamp-pumped pink ruby laser with reflecting ends, and it worked even better than Maiman's. But rather than sending congratulations to their counterparts at Hughes, the Bell team chose to cast doubts on Maiman's experiment. They dismissed it as clever engineering, and the Bell folks claimed that they had invented the first visible laser.

By concentrating on the continuous-wave communication aspects of lasers, the Bell team missed the energy storage aspect of an inverted population in flash-lamp-pumped solid-state lasers.

Those of us who knew Maiman personally, and had reproduced his experiment independently, fully expected him to receive a Nobel Prize for his work. Alas, it never happened.

It is good and proper that the leap to the first visible light laser will be celebrated each year on 16 May, the day of its first reduction to practice by Theodore Maiman 50 years ago. Unfortunately he did not live long enough to

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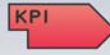
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