receive this acknowledgment from the scientific and engineering communities.

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The account of ruby laser activities at Bell Labs in 1960 was fascinating. During the same period, the group working under Charles Townes at Columbia University's Radiation Lab (CRL) was pursuing a different, and ultimately failed, track to the first laser.

Herman Cummins and I were the graduate students assigned to make the IR continuous-wave potassium laser and, later, the cesium vapor laser outlined in the 1958 paper Townes wrote with Arthur Schawlow.[1] Townes brought in Oliver Heavens, a thin-film expert from Royal Holloway College in the UK, to help us produce our own reflecting films. We began in 1958, but we had difficulty pumping potassium with a high-pressure mercury lamp at 404.7 nm, so we turned to cesium vapor pumped with a helium discharge tube at 388.8 nm. We used an elliptical reflecting cylinder and tried sapphire tubing and sapphire windows to avoid cesium darkening in glass.

By June 1960 we had measured gain but no laser oscillation. Heavens attended the June spectroscopy meeting in Rochester, New York, and gave an overly optimistic progress report of the cesium work. We later learned that Malcolm Stitch from Hughes Research Laboratories was at the meeting, and thus the Hughes group heard that the Columbia group was "about to succeed." That probably helped stampede Maiman into the now famous press conference. But the cesium laser never did work at Columbia.

I learned of the Maiman ruby laser through a telephone call from Walter Sullivan, then science editor of the *New York Times*. He often called Townes, who that day was in Washington, DC, so I took the call. Depressed, I thought, "There goes my PhD thesis." Townes called me the next day, and I was given an open account to spend what it took to make a ruby laser. Bill Rose at CRL had a pink ruby boule for use as a maser amplifier in his radio telescope. We cut and polished a slice for my laser and evaporated silver reflective films on the rod ends. The lab bought the flashtubes, storage capacitors, and power supply. My laser worked in about two months, just before Labor Day.

We published two papers' worth of work, enough for a thesis.[2,3] Then Sven Hartmann, Norm Kurnit, and I did the first experiment that observed photon echoes in ruby.[4]

In retrospect, Townes made the correct decision to abandon the cesium laser project.

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It was disturbing and disappointing to read "Bell Labs and the Ruby Laser." Although the article adequately describes the authors' views of the events of 1960, it can be interpreted as casting a shadow over Theodore Maiman's seminal achievement. That is unfortunate, since it amounts to stirring up the old controversy. The events of 1960 have been discussed extensively, and all the key issues and questions have been addressed and, in all essentials, settled. I certainly do not wish to engage in further polemics and revisit all the old arguments. Of course, there can be no objections to the authors' desire to share their views, as Maiman did in his book, *The Laser Odyssey* (Laser Press, 2000). However, I think that presenting a one-sided report during this anniversary year when we are celebrating the remarkable achievements of 1960 (including those of the Bell Labs laser team) is inappropriate, tactless, and not in especially good taste. The sooner we put all this behind us, the better.

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The feature article "Bell Labs and the Ruby Laser" is marvelous. As a brand new assistant professor at the time, I learned of the events described via *Physical Review Letters* and the physics grapevine. It was an exciting time. And the article demonstrates how messy the progress of physics can be. Physics is done by human beings, not automatons.

I cannot resist noting one unmentioned aspect of the times. In all the laboratory pictures, the physicists at work were wearing dress shirts and neckties. That might have been the Bell Labs dress code, but I don't think so. It's a superficial indicator of how times have changed.

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The paper "Who Invented the Laser: An Analysis of the Early Patents," by Robert Myers and Richard Dixon,[1] is a thorough scholarly assessment of laser history. It will be of considerable interest to readers of "Bell Labs and the Ruby Laser."

Reference

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Nelson, Collins, and Kaiser reply: Apart from the enjoyment of three old men looking back at their youthful efforts of 50 years ago, our purpose in writing "Bell Labs and the Ruby Laser" was to describe how our efforts came about and were carried out, so that we might bring "a modicum of peace" to the controversy that has gone on far too long. We wished to make it clear that we gave Theodore Maiman credit for the key ideas of the ruby laser—and we listed them in our article—by citing official, printed Bell Labs statements of 1960 and a later history of Bell Labs.

Jeff Hecht was initially offended by an errant phrase in our article's first paragraph: "led to the creation of the first ruby laser." As stated in the editorial note above, that phrase was not in our submitted manuscript, and we apologize for our poor proofreading of the editor's reworking of it. We disavow the phrase and are pleased that Hecht is willing to put it behind all of us.

However, he still does not want to give us the credit for the first publication of attaining threshold with the accompanying pencil beam and relaxation oscillations because he does not appreciate that scientific credit is based on publication in peer-reviewed journals. Instead he wishes to base judgment on unpublished observations, personal conversations, and much delayed claims. That approach forces us to be more specific in quoting the record than we were in our search for "a modicum of peace." In his 2000 book,[1] Maiman states in a footnote on page 150, "Before going into publication of this manuscript, I hooked up the original laser, which I still retain. Of course, as always, I used a non rod-like 'stubby ruby' (about 9 × 18 mm). That laser still works. It meets the Townes criteria of a red spot on the wall. It meets the Nelson specification of 'spiking behavior.' *And, even meets the Maiman demand of effortlessly boring a hole in a Gillette razor blade!*" Those claims are in sharp

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