Fast magnetic pulses trigger bits' flips

Like doomsday prophets, experts in the quest to pack data ever more quickly and densely onto conventional computer hard disks are again proclaiming, "The end is near!" They warn that current magnetic-recording methods are approaching fundamental limits on how quickly magnetic domains can reverse and how closely they can squeeze together.

New research by Swiss and American scientists, however, suggests that there is still a future for the technology. Experiments reported in the Aug. 6 SCIENCE raise the possibility of a 1,000-fold increase in the speed of writing magnetic data.

Christian H. Back of the Swiss Federal Institute of Technology (ETH) in Zurich and his colleagues created rapidly changing magnetic fields by using electrons accelerated to nearly the speed of light at the Stanford (Calif.) Linear Accelerator Center. They demonstrated that magnetic pulses as short as 2 picoseconds (ps) trigger reversal of magnetization—the equivalent of writing a new bit—in thin cobalt films. Today's fastest write heads require roughly 2 nanoseconds to switch a bit between 0 and 1.

Once the magnetization shift begins, notes team member Wolfgang Weber of ETH, it takes a much longer period—up to 500 ps—to fully reverse direction. However, "what counts in writing bits is only the time to trigger them," he says.

Although conventional wisdom dictates that ultrafast bit writing should require very high magnetic field strengths, the team triggered reversals using fields no greater than those from today's write heads, the scientists report.

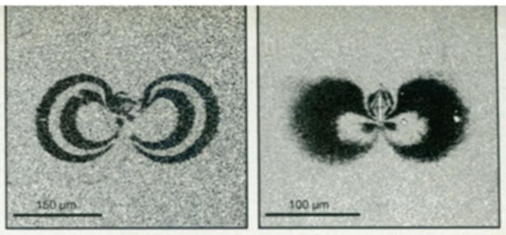
"Getting the time down by a factor of 1,000 is just incredible. I'm impressed," comments H. Neal Bertram of the Center for Magnetic Recording Research at the University of California, San Diego. He notes that magnetic-recording experts had thought that a write pulse must endure at least 100 ps to induce a magnetic domain to switch polarity.

"There's hope this result can give [magnetic-recording-device designers] guidance and optimism," he says. "The industry needs that right now."

To achieve such rapid triggering, Back and his coworkers tapped a well-established phenomenon that enabled their brief magnetic-field pulse to induce lingering effects. Zapping a thin film with a field lying both in the plane of the film and perpendicular to the existing direction of magnetization was known to tilt the magnetization out of the plane.

The new experiments demonstrate that once that tilt gets started, the pulse's job is done. Intrinsic magnetic effects take over, and the magnetization swivels into the opposite orientation. Because the applied pulse's role is limited, fast triggering becomes possible without especially strong external field pulses, Weber explains.

At this stage, no one expects these findings to trigger commercial products any time soon. Dieter Weller of the IBM Almaden Research Center in San Jose, Calif., another researcher on the team, jokes that the write head used in the experiment—a 2-mile-long linear accelerator—"is a bit clumsy." Whether ordinary write heads can generate magnetic field pulses like those made by the electron beam remains to be seen, he cautions. —*P. Weiss*



An electron beam pierced these cobalt films at centers (small irregularities). A brief, induced magnetic pulse triggered magnetization flips from left-oriented (white) to right-oriented (black) in some areas.

Botanists uproot their old tree of life

A shrub so obscure that most botanists have never seen one appears to represent the long-sought first branch at the base of the family tree of flowering plants.

The lineage of the seemingly ho-hum *Amborella*, often forced to nestle with the avocado and sassafras in the family tree of living relatives, deserves to be moved way down the trunk, according to several lines of genetic evidence.

Some 200 botanists from 12 countries have been collaborating for the past 5 years to refine various sections of the tree of life. Members of this Green Plant Phylogeny Research Coordination Group unveiled their conclusions this week at the XVI International Botanical Congress in St. Louis.

"One of the most practical things to know about a plant is what it's related to," explains one of the group's co-leaders, Brent Mishler of the University of California, Berkeley. Evolutionary relationships offer clues to a plant's properties. Mishler points out that when cancer-drug prospectors found promising qualities in the bark of a yew tree, they turned to related species to find a more readily available compound.

Some of the phylogeny group focused on the origin of flowering plants, which Charles Darwin called an "abominable mystery." In the past 10 years alone, botanists have published at least 15 arrangements of early flowering-plant lineages.

Now, a collaboration including Pamela Soltis and Douglas Soltis of Washington State University in Pullman and Yin-Long Qiu of the University of Zurich reports analyses of the similarities across more than a hundred species for at least six genes in chloroplasts, mitochondria, and cell nuclei. Their work pushes *Amborella* to the bottom of the flowering-plant tree. Water lilies branch out next, and then comes a group with star anise.

Amborella, essentially a living fossil, grows wild only on the island of New Caledonia in the South Pacific. The Pullman botanists know of just one plant in the United States; it's in Santa Cruz, Calif.

The surge of genetic data thrills Michael J. Donoghue of Harvard University. "I think we've finally got a resolution on a problem that looked as if it was not going to be resolved ever," he says.

He's found some other surprises in the tree that's emerging from the 200-scientist collaborative effort. The lotus, *Nelumbo*, appears not to be related to water lilies as previously thought. Instead, several genetic analyses place it with sycamores. "It's bizarre," shrugs Donoghue.

Looking with an outsider's perspective, mycologist John W. Taylor of the University of California, Berkeley cautions, "It's a huge advance, but it's not over." The first comparisons of a fungal gene yielded a tidy family tree, he recalls, but as more people analyzed more genes, conflicts developed.

The boom in phylogeny may swamp the traditional Linnean system of plant names, Mishler warns. The intricate relationships scientists are discovering are overwhelming that hierarchical system, with its families, orders, phyla, and so on. Mishler favors dropping these ranks entirely.

Despite the challenges of modern, fast-moving phylogeny, Donoghue says, "this is truly the greatest time to be alive with respect to these problems." —*S. Milius*

Peter K. Endress/U. of Zurich

Amborella, *a living fossil, grows wild only on one island.*