MICROELECTRONICS

Europe Starts Search for Lone Electron

PARIS—The European Union (EU) last week launched a new $3.7 million research program that will link eight high-powered research labs around Europe in an effort to remove one of the main constraints for building more powerful computers: packing more memory onto a single chip. Chip designers are now working on prototypes that can hold up to 4 gigabits of information, but they are rapidly coming up against a technological wall: Fabrication methods are reaching the physical limit of how small they can create circuits on a chip, and energy consumption of chips is becoming excessive. The new program, dubbed Fabrication and Architecture of Single-Electron Memories (FASEM), aims to tackle this problem by creating a working chip in which each bit of information is stored with a single electron. Current memory chips store information as electrostatic charges—pools of large numbers of electrons.

The ultimate aim of the project, which is part of the EU's Esprit program for information-technology research, is to produce by 2015 a single-electron memory capable of storing 10^{12} bits of information. "With a single-electron memory, you can make a large memory with low power consumption, and yet keep the speed at roughly the same level as it is today," says Haroon Ahmed of Cambridge University's Cavendish Laboratory, one of the labs involved in the project. "This is one of the more visionary projects of our program of emerging technologies," says Kostas Glinos, the project coordinator at the European Commission, the EU's executive arm in Brussels. "And it is high-risk research as well."

The key components of such a memory will be tiny conducting "islets," typically only a few nanometers, or millionths of a millimeter, across (*Science*, 17 January, p. 303). To move data around, single electrons hop from one such islet to another one nearby through a process called single-electron tunneling (SET). This hopping is controlled by changing the voltage of the islets. Project coordinator Huguette Launois of the CNRS Microstructure and Microelectronics Laboratory near Paris warns that many hurdles lie ahead: "We are not yet certain that such memories will be usable one day. ... There are still problems we haven't solved yet, such as reproducible and controllable nanofabrication methods." The shape of islets and the distance between them are critical for SET to occur, and the distance between islets will have to be controlled with a precision of 1 nanometer, which is very difficult, she says.

The FASEM program has brought together a diverse collection of labs—in the United Kingdom, France, Germany, Belgium, and Greece—to tackle the problem. John Inkson and his team at Britain's Exeter University, the only theoretical group in the project, will "look at simulating the growth of gold dots on semiconductor surfaces," as well as semiconductor-on-insulator quantum dots and wires, says team member Mauro Boero. A major problem is that SET has so far been achieved only at about 77 kelvin, and the Exeter team will look at "optimizing the geometry and various parameters that characterize these structures in order to achieve room-temperature operation," says Boero.

"This is one of the more visionary projects of our program of emerging technologies."

—Kostas Glinos

Cambridge's Ahmed says that his team will deal with the fabrication and design of the single-electron memories, while Marc Van Rossum and his team at Belgium's Interuniversity Microelectronics Center in Leuven will be responsible for the silicon substrate that will carry the tiny islets as well as the circuits that will connect the single-electron memory cells to the outside world. The first step the consortium hopes to achieve during the initial 3-year contract is a 4×4 array of single-electron devices on a substrate of silicon. "It should include the circuitry for reading and writing, and this is the challenge," says Glinos.

–Alexander Hellemans

Alexander Hellemans is a science writer in Paris.

SCIENTIFIC MISCONDUCT

The 'Gallo Case': Popovic Strikes Back

When an appeals board cleared AIDS researcher Mikulas Popovic of scientific fraud in November 1993, leading the government to drop all misconduct charges against his former boss, Robert C. Gallo, one of the most bitter and divisive sagas in science finally seemed to be over. But not quite: Now comes the epilogue. Last fall, Popovic filed a $5 million lawsuit against the United States and one of its employees, fraud investigator Suzanne Hadley, for pursuing a "baseless" investigation that caused him "severe emotional stress" and resulted in his "de facto forced exile from science for 4 years." On 31 January, the government submitted its formal response to the suit, arguing that it should be dismissed on technical grounds.

CHRIS SANDERS

Seeking damages. Popovic is suing the government.

The suit could be another grueling test for the Department of Health and Human Services' (HHS's) Office of Research Integrity (ORI), which has seen some of its highest profile cases ignominiously tossed out by the same appeals board that cleared Popovic. The case has also led to speculation that it could be the leading edge of a wave of suits from other scientists who were charged with research misconduct and later exonerated. Lawyers involved with misconduct cases say, however, that such suits are difficult to win, and they doubt that many researchers will want to reopen a painful chapter of their lives. Barbara Mishkin of the Washington, D.C., firm of Hogan & Hartson, who represented Popovic before the appeals board, says the Popovic case "is probably the strongest case to take against the government of any of them that went through ORI."

Popovic, a Czech immigrant who worked in Gallo's lab at the National Institutes of Health (NIH) in the 1980s, was first investigated for scientific misconduct in 1989 after allegations surfaced that Gallo had stolen the HIV virus from a French lab. Early on, the government dropped charges of misappropriation against the two scientists. But ORI concluded that Popovic and Gallo had made false statements in several 1984 AIDS articles in *Science*. In a scathing decision, however, the appeals board overturned the findings against Popovic, saying it had found no "residue of palpable wrongdoing" (*Science*, 12 November 1993, p. 981). That embarrassing setback led ORI to abandon its case against Gallo.

Popovic filed his suit with the U.S. District Court in Greenbelt, Maryland, under the Federal Tort Claims Act, which waives

the government's "sovereign immunity" in certain cases. The suit contends that ORI's investigators violated Popovic's rights to due process and privacy. It claims he was not initially informed of the charges against him and that HHS and ORI officials leaked his name and details of their case against him to the press. The suit also contends that the Office of Scientific Integrity—ORI's predecessor—accidentally sent Popovic a tape of a discussion indicating that just after interviewing Popovic, Hadley, then acting OSI director, and her staff were already leaning toward finding him guilty. (Hadley declined to comment on the suit.) "The manner in which this was handled was just atrocious," says Washington, D.C., attorney Paul Thaler, whose firm is representing Popovic.

The suit also claims that the government illegally refused to hire Popovic. He had left NIH just before the probe began for a job that didn't pan out. Gallo then offered him his old position, but NIH said he couldn't return until the investigation was completed. After about 4 years of unemployment, Popovic eventually found work as a visiting scientist at the Karolinska Institute in Sweden, and last July he joined Gallo's new Institute of Human Virology at the University of Maryland, Baltimore.

Popovic's suit says his losses include legal fees of $350,000 during the ORI investigation and 4 years of salary; he has asked the government and Hadley for at least $5 million in compensatory damages and legal costs. (Thaler's firm has taken on the case on a contingency basis.) Popovic referred a reporter to his attorneys, saying only that the matter is "very painful," but Gallo says Popovic has indicated that he would spend any award on research. "He was hurt badly and very unjustly. He certainly could use a little help to get started," says Gallo.

In the government's response to the suit last month, the U.S. attorney in Baltimore cited technical reasons why the case should be dismissed. The response says that Popovic waited longer than a 2-year statute of limitations to sue; that several claims amount to libel or slander, for which the government has immunity; and that others, such as NIH's failure to rehire Popovic, do not violate any Maryland law. Thaler says "Nothing in it [the brief] was a surprise to us," and that he is "confident that the claims will survive."

Others aren't so certain. "I think the government may have some strong technical defenses, which is too bad," says Washington, D.C., attorney Joseph Onek, who has represented defendants in several high-profile science fraud cases, including the Gallo case. "Of all the people [investigated by ORI], Dr. Popovic perhaps deserves compensation the most because he was harmed so much," Onek says. Thaler says the average life for a federal civil lawsuit is 12 to 18 months, and 90% are settled out of court. If there is a trial, he expects it would take place next winter.

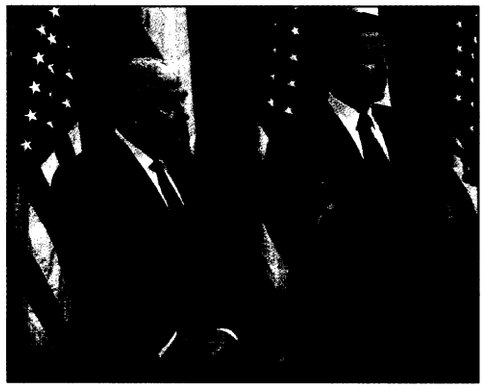
The glacial pace of such suits is not always the result of legal skirmishing. A year before filing the suit, Popovic's lawyers sent HHS a letter notifying the agency of their intent to sue—a standard step that normally would trigger an agency investigation. Popovic never received a response, however. According to the government's brief, "[I]t was confirmed that the mail room had received this letter ... and subsequently had misplaced it."

–Jocelyn Kaiser

SPACE STATION

Russian Money Woes Endanger Project

When Russia was brought into the international space station program in 1993, the move gave the controversial orbiting laboratory a new lease on life by holding out the promise of reduced U.S. costs. But 4 years later, progress on the multibillion-dollar effort is being threatened by Russia's failure to come up with money to build critical portions of the station. If this impasse continues, it could take an additional bite out of NASA's wallet and credibility, and U.S. legislators are now demanding that the White House do something about it.



RON EDMONDS/AP

Limited partners. Gore and Chernomyrdin hope to preserve Russia's role in space station.

Last week, U.S. Vice President Al Gore won a promise from Russian Prime Minister Viktor Chernomyrdin that the funding will be freed up soon. But supporters have heard that refrain before. They worry that the Russians won't be able to fix their financial problems before Congress votes later this year on U.S. funding for the station, for which the first components are slated to be launched at the end of this year.

The concern centers on the Russian Service Module, which contains many of the station's control functions. Although the Russian parliament, or Duma, has appropriated the necessary money, the funding has not found its way to the Russian Space Agency (RSA) or to the contractors who are building key components of the module. The original launch date was to be spring of 1998, but it has now slipped to late fall. "This situation has placed the international space station in a quandary for well over a year now," a group of legislators complained in a 4 February letter to Gore.

The lawmakers—who include House Science Committee Chair James Sensenbrenner (R–WI) and Representative Jerry Lewis (R–CA), who chairs NASA's funding panel—demanded a "definitive resolution" of the problem during Chernomyrdin's visit last week to Washington. In response, Gore and Chernomyrdin said on 7 February that both sides "are working diligently to overcome the difficulties," and that the Russian government will provide RSA with the money to complete its part of the program. "The prime minister has promised to give us the money," RSA Director Yuri Koptev told *Science*. NASA Administrator Daniel Goldin said the agency could begin reaching contractors before March, and it could even speed up the schedule by a few months.

In the meantime, frustrated NASA officials are trying to be flexible. They have agreed, for example, to advance RSA $20 million from a fund the U.S. agency has set aside to cover future NASA work on the Mir space station. They are also working frantically on various contingencies, such as adapting existing U.S. and Russian hardware to make up for the delay in the service module. Goldin said he expects the agency to decide by March which path makes the most sense.

Sensenbrenner, who scheduled a House hearing on the subject earlier this week, will visit Paris, Bonn, and Moscow later this month to press the Russians to act quickly. Lewis says he expects Russia "to give this commitment a high priority" despite its financial woes. It would be harder to sell the station to Congress without Russian participation, Lewis admits, "but I'm convinced members would still go along with the program." Senator Barbara Mikulski (D–MD), ranking minority member of the Senate panel that funds NASA, agrees with Lewis that the station could survive a Russian pullout, but she's betting that Gore can convince the Russians to ante up.

–Andrew Lawler