**Betrisey adjusts his clock with the vacuum chamber removed. The 33-pound glass bell sits to the clock's left and was the most expensive part at $1,000. Its 0.4-inch walls keep a near-perfect vacuum inside so that only light rays push the pendulum.**

# The Power of Light

## Radiometric clock

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| MAKER | **Marcel Betrisey** | COST | €2,500 ($3,000) |
| OCCUPATION | Contract electronics developer | TIME | 6–12 months |
| LOCATION | Sion, Switzerland | MORE | betrisey.ch |

He may be Swiss, but Marcel Betrisey, 44, wasn't exactly groomed from birth to be a clockmaker. The son of grape farmers, Betrisey spent half his life wandering, backpacking through 67 countries before turning 30. Returning to his small hometown nestled in the Alps, he started a household appliance repair shop and started tinkering with gadgets on the side. He fashioned a CD player from an antique typewriter (keys controlled the functions), and created a pendulum that responded to the Earth's rotational momentum. In 1997, he turned to clocks and discovered his medium of choice.

To prove himself to the clockmaking world, he welded and machined a 660-pound timekeeper driven by 95 large ball bearings. Then, he made one from stainless steel pipes and an old saucepan; tiny gusts of air kept the pendulum in motion. Lacking a clockmaker's tools, he created his own, including saws hacked together from a photocopier motor. "I don't know why I always need to improve every tool I have, even the new ones. It must be a kind of disease, I guess," he says.

One day in 2001, Betrisey decided to take on the biggest horological challenge of his career. It would be a radiometric clock, using a little-understood trick of visible light to keep the pendulum in motion. In the 19th century, scientists discovered that if you shine a bright light on a thin black element inside a vacuum, the power of light will give it a little push. Though some scientists disagree on why this works, most accept the theory of "thermal creep." Inside the vacuum chamber, small volumes of gas heat up and slip around the edges of the thin sheet, creating unequal pressure.

"It arose out of an unsolved question," says the clockmaker. "That was the most interesting." Betrisey knew he needed to keep the pendulum swinging with precision, so he attached a bar of ivar, an alloy prized by clockmakers for its resistance to distortion in various temperatures. He drilled and welded stainless steel globes to the pendulum's bottom for weight, and glued on four tiny mica sheets. Betrisey then blackened the mica with candle smoke, sealed up the glass hemisphere with silicon glue, and brought the pressure inside the clock to 0.01 bar with a vacuum pump.

In his repair shop, Betrisey started the clock with a powerful magnet. The radiometric effect applies a tiny force to keep the 4-kilo pendulum moving. Once swinging, two 35-watt halogen bulbs mounted to one side flashed when the pendulum swung away from it. When the pendulum swung toward the lamps, an infrared sensor triggered a relay to turn on halogens on the opposite site, giving it a push in reverse.

"It started!" Betrisey wrote in his notes of that day. "And it works so well that I do not even dare touch it."

Someday, Betrisey wants to lower the pressure inside his clock a great deal to see if it will perform an entirely different light-powered trick. "I don't have the expensive vacuum pumps to do it yet," he says. "But when the vacuum inside is quasi perfect, the power of photons will move the pendulum — the same power used by the solar sails moving an interplanetary probe."

Until then, repair and engineering jobs beckon. And in December 2004 he had his first child, a little boy who keeps him and his wife busy. The baby's birth started him thinking about his own life wandering and inventing. Will the boy leave school and become a tinkerer like his dad? "Maybe he won't like tools?" Betrisey wonders. "Maybe he'll be a poet?"