Pentagon-backed 'time cloak' stops the clock (Update)

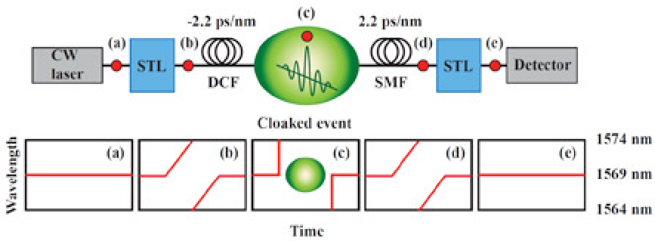
4 January 2012, By Bill Steele

In this 2011 illustration, provided by Cornell University, scientists demonstrate how they have have created, a new invisibility technique that doesn't just cloak an object _ like in Harry Potter books and movies _ but masks an entire event. It is a time masker that works by briefly bending the speed of light around an event. Cornell scientists explain what they are talking about in this 2011 illustration that shows that if this technique is ever scaled up an art thief can walk into a museum and steal a painting without setting off laser beam alarms or even showing up on surveillance cameras or your eyes. (AP Photo/Heather Deal, Cornell University)

Pentagon-supported physicists on Wednesday said they had devised a "time cloak" that briefly makes an event undetectable.

In movie magic, people and objects can appear or disappear or move from place to place in an instant. Just stop the camera, move things around and start it again. Now, Cornell researchers have demonstrated a similar "temporal cloak" -- albeit on a very small scale -- in the transport of information by a beam of light.

The trick is to create a gap in the beam of light, have the hidden event occur as the gap goes by and then stitch the beam back together. Alexander Gaeta, professor of applied and engineering physics, and colleagues report their work in the Jan. 5 issue of the journal *Nature*.



A laser beam passes through a "split-time lens" - a specially designed waveguide that bumps up the wavelength for a while then suddenly bumps it down. The signal then passes through a filter that slows down the higher-wavelength part of the signal, creating a gap in which the cloaked event takes place. A second filter works in the opposite way from the first, letting the lower wavelength catch up, and a final split-time lens brings the beam back to the original wavelength, leaving no trace of what happened during the gap. Image: Gaeta lab

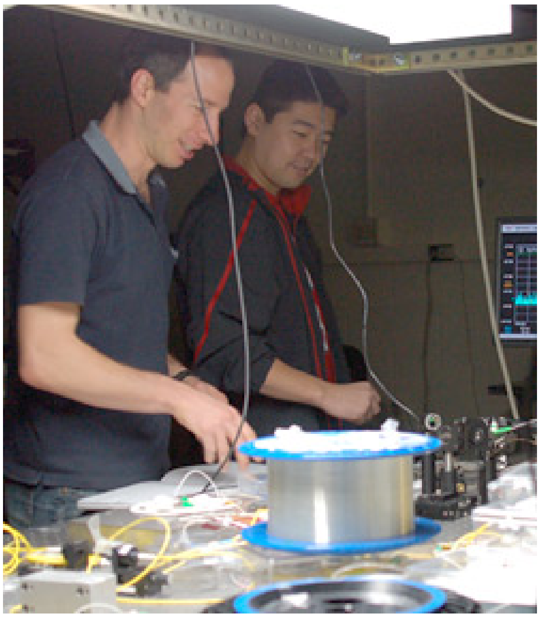
The researchers created what they call a time lens, which can manipulate and focus signals in time, analogous to the way a glass lens focuses light in space. They use a technique called four-wave mixing, in which two beams of light, a "signal" and a "pump," are sent together through an optical fiber. The two beams interact and change the wavelength of the signal. To begin creating a time gap, the researchers first bump the wavelength of the signal up, then by flipping the wavelength of the pump beam, bump it down.

The beam then passes through another, very long, stretch of optical fiber. Light passing through a transparent material is slowed down just a bit, and how much it is slowed varies with the wavelength.

So the lower wavelength pulls ahead of the higher, leaving a gap, like the hare pulling ahead of the tortoise. During the gap the experimenters introduced a brief flash of light at a still higher wavelength that would cause a glitch in the beam coming out the other end.

Then the split beam passes through more optical fiber with a different composition, engineered to slow lower wavelengths more than higher. The higher wavelength signal now catches up with the lower, closing the gap. The hare is plodding through mud, but the tortoise is good at that and catches up. Finally, another four-wave mixer brings both parts back to the original wavelength, and the beam emerges with no trace that there ever was a gap, and no evidence of the intruding signal.

None of this will let you steal the crown jewels without anyone noticing. The gap created in the experiment was 15 picoseconds long, and might be increased up to 10 nanoseconds, Gaeta said. But the technique could have applications in fiber-optic data transmission and data processing, he added. For example, it might allow inserting an emergency signal without interrupting the main data stream, or multitasking operations in a photonic computer, where light beams on a chip replace wires.



Time cloaking doesn't involve a DeLorean, just a kilometer of optical fiber coiled up on a lab table, supervised by postdoc Moti Fridman and research associate Yoshi Okawachi.

The experiment was inspired, Gaeta said, by a theoretical proposal for a space-time cloak or "history editor" published by Martin McCall, professor of physics at Imperial College in London, in the Journal of Optics in November 2010.

"But his method required an optical response from a material that does not exist," Gaeta said. "Now we've done it in one spatial dimension. Extending it to two [that is, hiding a moment in an entire scene] is not out of the realm of possibility. All advances have to start from somewhere."

Fridman's work was part-supported by the Defense Advanced Research Project Agency, or DARPA, a Pentagon unit which develops futuristic technology that can have a military use. Its achievements include DARPANet, a predecessor of the Internet.

More information: *Nature journal announcement:*

Now you detect it, now you don't (pp 62-65; N&V)

A 'time cloak' that makes an event temporarily undetectable, albeit on the picosecond scale, is described in this week's *Nature*. The work could represent a step towards the development of spatio-temporal cloaking.

Recent developments in spatial cloaking show that it is possible to hide an object by manipulating electromagnetic waves around it, creating a 'hole in space'. Such devices currently have limited functionality. Here Moti Fridman and colleagues demonstrate that a related effect, temporal cloaking, can be achieved. They manage to create a 'hole in time' for around 40 trillionths of a second (40 picoseconds).

The fibre-based system steers light 'around' an event so that no evidence (a change in the temporal or spectral properties of the light beam) of the event is detectable, by speeding up and slowing down different parts of a light beam. This effect is achieved using a split time-lens that breaks light up

into its slower (red) and faster (blue) components,
thereby creating a tiny temporal gap.

Provided by Cornell University