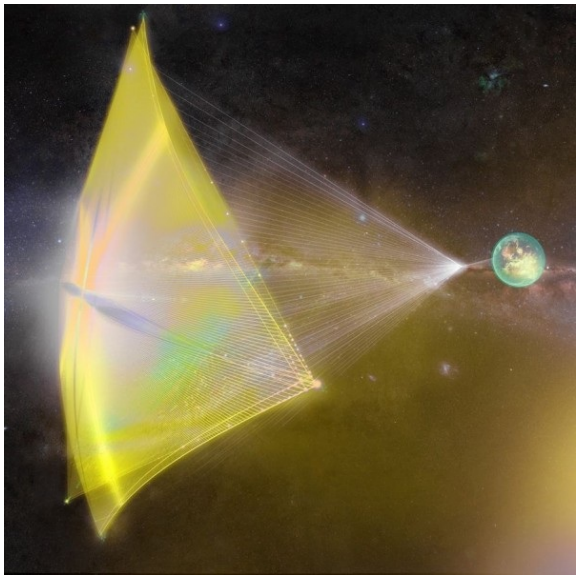
BREAKTHROUGH STARSHOT FOR ALPHA CENTAURI



The dream of traveling to the stars is alive and well. Artist's concept via BreakthroughInitiatives.org

The Breakthrough Starshot Project seeks proof of a concept for a 100-million-mile-per-hour mission – using light-propelled nanocrafts – to reach the nearest star in 20 years.

Earlier this month, Russian high-tech billionaire **Yuri Milner** and others announced Breakthrough Starshot, a plan to spend $100 million to take a next step forward toward star travel in our time. They'll use the funds to begin **proof-of-concept studies for a 100-million-mile-per-hour flyby mission to the next-nearest star system, Alpha Centauri, located about 4 light-years or 40 trillion km away**. They will be seeking confirmation that it's possible to use a 100-gigawatt light beam to propel approximately 1,000 ultra-lightweight nanocraft to 20 percent of light speed. If it's shown to be possible, this fleet of nanostarships could reach Alpha Centauri within about 20 years of launch.

Due to the finite travel speed of light (including radio waves), we would then wait 4 more years to hear back from any nanocraft that successfully swept through the Alpha Centauri system.

This plan to launch our human ships into the vastness of space is being led by the same organization that – in July, 2015 – announced an unprecedented $100 million new effort in the Search for Extraterrestrial Intelligence (SETI).

Breakthrough Initiatives describes itself as:

- A program of scientific and technological exploration, probing the big questions of life in the universe
- Are we alone?
- Are there habitable worlds in our galactic neighborhood?
- Can we make the great leap to the stars?
- And can we think and act together – as one world in the cosmos?

Russian billionaire Yuri Milner. Born on 11 November 1961 in Moscow, is a major funder of Breakthrough Initiatives. He was an early investor in Facebook and Twitter and has funded other large endeavors, for example, the largest award in the world in the field of Biomedicine and Life Sciences, called the Breakthrough Prize.

Pete Worden, a former director of NASA AMES Research Center, will lead Breakthrough Starshot, advised by a committee of stellar scientists and engineers. The board consists of Yuri Milner, physicist **Stephen Hawking** and Facebook's **Mark Zuckerberg**. **Ann Druyan**, **Freeman Dyson**, **Mae Jemison** and **Avi Loeb** also participated in the announcement at One World Observatory in New York City on April 12, 2016.

Scientists believe there are 3 stars in the Alpha Centauri system *Alpha Centauri A, Alpha Centauri B and Proxima Centauri*. Although there's only one planet known so far in the Alpha Centauri system, orbiting *Alpha Centauri B*, you can bet that – if we were aiming to send nanocraft there – astronomers would turn their attention to seeking more planets in this nearby star system.

Why haven't we visited the Alpha Centauri system already? It's because 40 trillion kilometres is a long, long way from here. Using existing technology, our fastest current spacecraft would require some 30,000 years to get there. But all existing spacecraft are huge and clunky in contrast to the gram-scale nanostarships – dubbed StarChips – being proposed here. Breakthrough Starshot hopes to establish whether tiny, light ships, on sails pushed by a light beam, could fly a thousand times faster than the fastest spacecraft built up to now. The Starshot concept is truly visionary, leaps and bounds beyond what's been proposed so far for star travel, and yet still grounded in current, cutting-edge science and technology.

The first images via nanocraft of the Alpha Centauri system would be rudimentary, perhaps like this first image of Earth from space, October 24, 1946

Starshot envisions launching a mothership carrying the 1,000 tiny spacecraft to a high-altitude orbit. Each craft is a gram-scale wafer, carrying cameras, photon thrusters, power supply, navigation and communication equipment, and constituting a fully functional space probe. Mission controllers would deploy the nanocraft – send them on their way – one by one. A ground-based laser array called a light

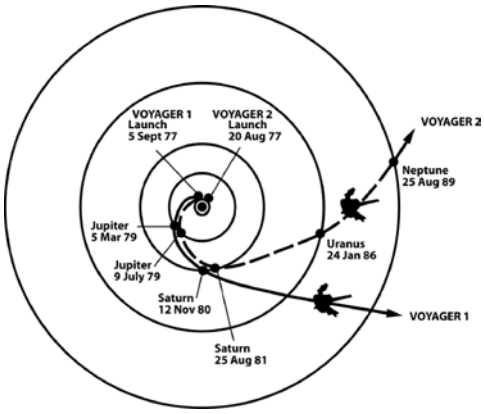
beamer would be used to focus light on the sails of the ships, to accelerate individual craft to the target speed within minutes.
The plan is to stick four cameras (two-megapixels each) on a chip that will allow for some elementary imaging. The data would be transmitted back to Earth using a retractable metre-long antenna, or perhaps even using the lightsail to facilitate laser-based communications that could focus a signal back towards Earth.
Breakthrough Starshot brings the Silicon Valley approach to space travel, capitalizing on exponential advances in certain areas of technology since the beginning of the 21st century. The lightsails would be made possible by advances in nanotechnology that are producing increasingly thin and light-weight metamaterials, which promise to enable the fabrication of metre-scale sails no more than a few hundred atoms thick and at gram-scale mass.
The research and engineering phase for Breakthrough Starshot is expected to last a number of years. In the initial phase the plans are to build:

- a prototype laser array in the 10- to 100-kilowatt class
- gram-scale 'star-chips' with imaging and other sensors
- a laser communication system
- prototype sails,
- and explore the many technical challenges to building a full system.

Following that, development of the ultimate mission to Alpha Centauri would require a budget comparable to the largest current scientific experiments. Project leader Pete Worden mentioned a figure of about $10 billion. The full-scale effort will involve:

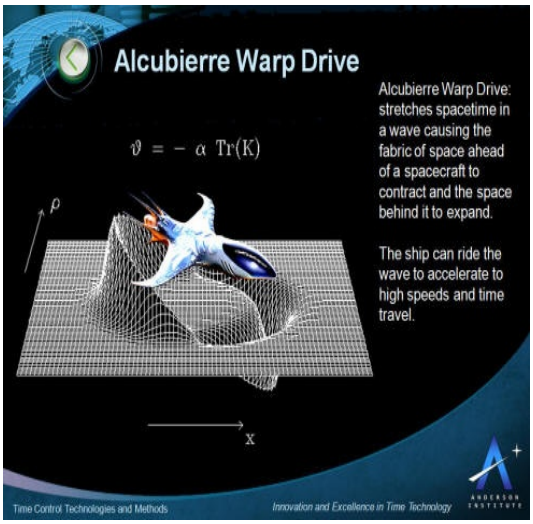
- Building a ground-based kilometre-scale light beamer at high altitude in dry conditions
- Generating and storing a few gigawatt hours of energy per launch
- Launching a 'mothership' carrying thousands of nanocrafts to a high-altitude orbit
- Taking advantage of adaptive optics technology in real time to compensate for atmospheric effects
- Focusing the light beam on the lightsail to accelerate individual nanocrafts to the target speed within minutes
- Account for interstellar dust collisions en route to the target
- Capture images of a planet, and other scientific data, and transmitting them back to Earth using a compact on-board laser communications system
- Using the same light beamer that launched the nanocrafts to receive data from them over 4 years later

Yuri Milner says, the human story is one of great leaps. Just 55 years ago **Yuri Gagarin** became the first human in space. Today, we are preparing for the next great leap, to the stars.
Stephen Hawking says, Earth is a wonderful place, but it might not last forever. Sooner or later, we must look to the stars. Breakthrough Starshot is a very exciting first step on that journey.
Pete Worden says, we take inspiration from Vostok, Voyager, Apollo and the other great missions. It's time to open the era of interstellar flight, but we need to keep our feet on the ground to achieve this.



The Voyagers' paths out of the solar system

Why won't a conventional rocket work?
How about a Space Shuttle? At a maximum speed of 28,300 kph it would take a Space Shuttle 165,000 years to reach Alpha Centauri.
How about the Voyager spacecraft? Launched in 1977 they're now just heading out of our solar system. No, it would take 100,000 years.
What about the New Horizons spacecraft, the first spacecraft ever to visit Pluto? At 58,536 km/h it would take 78,000 years to get there.
So conventional rockets are out. But what if we could travel faster than light? Warp Drive?
Dr. Harold White – who leads NASA's Advanced Propulsion Team at Johnson Space Center – claims to have made a discovery which makes plausible the idea of faster-than-light travel, via a concept known as the Alcubierre warp drive. This concept is based on ideas put forward by Mexican physicist **Miguel Alcubierre** in 1994. He suggested that faster-than-light travel might be achieved by distorting spacetime, as shown in this illustration and let negative energy push the craft forward. If it was feasible, it would reduce travel time to Alpha Centaury to days.



It would reduce the travel time to Alpha Centauri from thousands of years to just days

AK with Notes and pictures from EarthSky and Wikipadia