How a Giant Telescope Works Video Transcript

ESO = European Southern Observatory (ESO is an international astronomy research group)

VLT = Very Large Telescope

Box 1 – Introduction of the VLT and Mirrors

Bigger is better - at least when it comes to telescope mirrors. But larger mirrors have to be thick, so that they don't deform under their own weight. And really large mirrors deform anyway, no matter how thick and heavy they are.

The solution?

Thin, lightweight mirrors - and a magic trick called active optics. And this is the state of the art. The mirrors of the Very Large Telescope - the VLT- are 8.2 meters across... but only 20 centimetres thick. And here's the magic: a computer-controlled support system ensures that the mirror keeps its desired shape at all times to nanometer precision.

In the middle of the Atacama Desert, ESO created an astronomer's paradise. Of course, the unique selling point of the Very Large Telescope is its unequalled view of the Universe. Without thin mirrors and active optics, the VLT wouldn't be possible.

Box 2 – The Sky Changes Observations From Space

But there's more.

Stars appear blurry, even when observed with the best and largest telescopes. The reason? The Earth's atmosphere distorts the images. Enter the second magic trick: adaptive optics. On Paranal, laser beams shoot out into the night sky to create artificial stars. Sensors use these stars to measure the atmospheric distortions. And hundreds of times per second, the image is corrected by computer-controlled deformable mirrors. And the end effect? As if the turbulent atmosphere were completely removed. Just look at the difference!

Box 3 – The VLT Helped Scientists See the Center of the Milky Way

The Milky Way is a giant spiral galaxy. And at its core - 27,000 light-years away - lies a mystery that ESO's Very Large Telescope helped to unravel. Massive dust clouds block our view of the Milky Way's core. But sensitive infrared cameras can peer through the dust and uncover what lies behind.

Assisted by adaptive optics they reveal dozens of red giant stars. And over the years, these stars are seen to move! They orbit an invisible object at the very center of the Milky Way. Judging from the stellar motions, the invisible object must be extremely massive. A monstrous black hole, weighing in at 4.3 million times the mass of our Sun. Astronomers have even observed energetic flares from gas clouds falling into the black hole. All exposed by the sheer power of adaptive optics.

Box 4 – Using Many Telescopes Together (WARNING: confusing scientific language)

So thin mirrors and active optics make it possible to build giant telescopes. And the adaptive optics take care of the atmospheric turbulence, providing us with extremely sharp images. But we're not done yet with our magic tricks.

There's a third one. And it's called interferometry.

The VLT consists of four telescopes. Together, they can act as a virtual telescope measuring 130 meters across. Light collected by the individual telescopes is channeled through evacuated tunnels and brought together in an underground laboratory. Here, the light waves are combined using laser metrology and intricate delay lines. The net result is the light-gathering power of four 8.2-meter mirrors, and the eagle-eyed vision of an imaginary telescope as large as fifty tennis courts. Four auxiliary telescopes give the network more flexibility. They may appear tiny next to the four giants. Yet, they sport mirrors 1.8 meters across. That's bigger than the largest telescope in the world just a hundred years ago!

Optical interferometry is something of a miracle. Starlight magic, wielded in the desert. And the results are impressive

Box 5. Vampires, Explosions, and Conclusion.

The Very Large Telescope Interferometer reveals fifty times more detail than the Hubble Telescope. For instance, it gave us a close-up of a vampire double star. One star is stealing material from its companion. Irregular puffs of stardust have been detected around Betelgeuse - a stellar giant about to go supernova. And in dusty discs surrounding newborn stars, astronomers have found, the raw material of future Earth-like worlds.

The Very Large Telescope is mankind's sharpest eye on the sky. But astronomers have other means to expand their horizons and broaden their views. At the European Southern Observatory, they have learned to see the Universe in a completely different kind of light.