VISION RESEARCH
An AMETEK® Company

PHANTOM®
when it's too fast to see, and too important not to.®

CASE STUDY

LIGHTNING

Stepped leader paths during a lightning strike.

VISION RESEARCH PHANTOM® CAMERAS RECORD FORMATION OF STEPPED LEADER PATHS DURING A LIGHTNING STRIKE.

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Lighting is one of the most remarkable phenomena that this planet has to offer. To make sense of the occurrence, mankind has drawn on mythology, highlighted by Zeus, the Greek god of the sky and the weather whose symbol is the thunderbolt.

Fast forward several thousand years to one of the most notable experiments that history books have to offer: Benjamin Franklin was able to decisively prove that lightning is electric, thanks to sending up a kite and key during an approaching storm and drawing an electric charge from the clouds. A few hundred years later, substantially more is known about lightning, thanks to significant advancements in scientific research, meteorology and technology that allows researchers to dig deeper into Mother Nature's light show.

Even though research to date has amassed a multitude of valuable information both for safety and scientific use, researchers like Tim Samaras, a renowned professional storm chaser backed by the National Geographic Society, continue to raise the bar and set new standards in analyzing lightning and its underlying characteristics. With the help of Vision Research, a leading manufacturer of high-speed, high-performance digital cameras, Samaras was able to capture what's known as the "stepped leader," the process by which a lightning bolt

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- Tim Samaras,
Professional Storm Chaser

Phantom v7.3
High-speed Digital Camera

branches out from a storm cloud during a cloud-to-ground strike. The Vision Research Phantom v7.3 digital camera broke the boundaries set by other conventional high-speed imaging systems and was able to record this naturally occurring process at speeds that allow researchers to analyze a stepped leader in ways never before possible.

Samaras' research is highlighted by his work with tornadoes. Samaras made his way into the history books when he designed and deployed a probe, called a "turtle," directly in the path of an approaching F4 tornado. He is the first researcher to measure the temperature, humidity, wind speed and direction in the vortex of a tornado and also captured the biggest pressure drop ever recorded – 100 millibars. The measurements that Samaras' was able to record will provide meteorologists and organizations, such as the National Weather Service, with the data necessary to drastically improve their ability to predict the intensity and duration of future tornadoes as well as reduce their false alarm rating for warning the public.

"For over 19 years, I've been a passionate storm chaser," said Samaras. "Although I've been doing this for quite some time, I'm still fascinated by both a storm's beauty and power and I'm driven to continue to learn more and uncover details that science has yet to discover. To take my research to the next level, I turned my focus to lightning, something that I witness almost daily during the time I spend in Tornado Alley.

"Plenty of still photographs and video of lightning strikes already exist; however, when it comes to the stepped leader of a lightning bolt, none are useful enough for research purposes," he added. "I turned to the National Geographic Society, and shared my goal of recording the formation of a stepped leader. Recognizing the significance of the project, National Geographic agreed to fund my research and I immediately called on Vision Research and its high-speed digital imaging systems."

The crackling sound of a thunderous boom that follows a lightning strike is caused by its stepped leader, a downward moving negative charge forming at the base of a storm cloud. The stepped leader gets its name due to the fact that it progresses from the cloud to the ground in steps, about 100 segments each, branching outward measuring approximately 50 yards. It moves toward the ground in a zigzag pattern, starting and stopping, trying to find the path of least resistance.

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The stepped leader is invisible to the human eye, and shoots to the ground in less time than it takes to blink. As it nears the ground, the negatively charged stepped leader is attracted to a channel of positive charge reaching up, called a streamer, normally through something tall, such as a tree, house, or telephone pole When the oppositely charged stepped leader and streamer connect, a powerful electrical current begins flowing. A return stroke of bright luminosity travels about 60,000 miles-per-second back towards the cloud. The return stroke is the main flash that is associated with a lightning strike.

"Due to the speed of a lightning strike, conventional, high-speed film-based cameras were simply not up to the task as far capturing the stepped leader is concerned. The frame rates were too slow to capture the stepped leader, which travels at roughly half the speed of light, and the sensitivity of film was not high enough to adequately record the dimly lit process. The Vision Research Phantom v7.3 had enough sensitivity to pick up the weak stepped leader for good resolution, and we ran the camera at 15,000 frames-per-second, allowing us to see the phenomena for the first time ever. Using the v7.3 helped me reach my goal and record the entire process, frame-by-frame, from start to finish."

The updated Phantom v7.3 supplies the blazing speed and high sensitivity needed to record extremely fast events -those tasks that were previously the exclusive domain of rotating prism film cameras, and simply beyond the capabilities of existing high speed digital imaging systems. The v7.3's new CMOS sensor provides 14-bit depth and was exclusively designed by Vision Research for high-speed use while also supplying resolution that can exceed or match that of small and medium format motion picture film. These sensors also continue to offer the advanced features of previous designs including the on-chip circuitry that provides true "snap shot" shutter capabilities, auto exposure, and pixel level Extreme Dynamic Range® (EDR) control to extend picture quality in harsh lighting conditions.

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About Vision Research:

Vision Research designs and manufactures high-speed digital imaging systems used in applications including defense, automotive, engineering, science, medical research, industrial manufacturing and packaging, sports and entertainment, and digital cinematography for television and movie production.

The Wayne, N.J.-based company prides itself on the sensitivity, high-resolution and image quality produced by its systems, robust software interfaces, and reliability and versatility of its camera family – all which continue to stand as benchmarks for the high speed digital imaging industry.

Vision Research digital high-speed cameras add a new dimension to the sense of sight, allowing the user to see details of an event *when it's too fast to see, and too important not to®*. For additional information regarding Vision Research, please visit *www.visionresearch.com*.

Vision Research is a business unit of the Materials Analysis Division of AMETEK Inc., a leading global manufacturer of electronic instruments and electromechanical devices.

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