Team Aurora after the final broadcast: (L-R) the author, Liz Bonnin, Chris Parkin (director), Pete Lawrence, Ian 'Bungie' Bennett (engineer) and Ivan Lazic (assistant producer), with our pilots in the background

The aurora

CALLING TIME ON TIMELAPSE

Stargazing LIVE cameraman **Mark-Payne Gill** tells the story behind filming the first ever live, real-time aurora display

The aurora looks quite different when seen at altitude rather than from the ground. I was keen to try and capture this perspective on film

There was something strange about the evening of 13 March 1989. It was 9pm and I was alone in a field at the bottom of the garden, taking photos of a wonderful celestial scene. An unusually clear sky revealed Mars high in the southern sky alongside Jupiter, the Pleiades, Hyades and a crescent Moon – a picture postcard conjunction of celestial gems. Piggybacked on my reflector were my trusted Olympus OM2 and 28mm lens, loaded with Kodachrome 64 film. Capturing such an emotive scene would require frustratingly long exposures on the slow, high-resolution film. Little did I know then just how dramatically this scene would change with time.

This was in the days before the internet and the digital revolution. There were no digital cameras, no mobile phones, no apps and no social media to warn me of what was about to unfold before my eyes. And so it just happened, without warning or anticipation. In an instant, the skies of southern England were lit up by the Northern Lights, transforming the night sky into a dazzling sight. The horizon was filled with intense auroral curtains, which spread higher and higher until the whole sky was alight with colour, from green to blue to intense reds. For over 90 minutes I watched one of the most amazing spectacles in nature from my parents' garden. And all the while I kept my camera exposing for one minute, two minutes and so on, in the hope I would capture something of this once in a lifetime event.

How I wished I could have filmed the aurora and shared a video of my experience. I dreamed of being able to film what I saw in real time, but this was impossible in those days. Timelapse filming was possible, but just didn't do it justice.

Even with technology progressing at a relentless pace, I'd have to wait 25 years for my chance.

A dream comes true

Fast forward to 2014. It's 8 January, 21:25 local time on a Wednesday night and I'm flying at 32,000ft, 80km northeast of Tromsø, crammed inside an eight-seater twin engine aircraft packed full of broadcasting technology. I'm equipped with two video cameras and outside, to the east, an auroral arc has just appeared. The pilot banks round just in time to line up one of the cameras directly at the aurora, which to my delight and disbelief appears on my monitor – in glorious colour, in real time and as clear as can be! ▸

ABOUT THE WRITER

Mark Payne-Gill is a BBC cameraman who caught the astrophotography bug aged 16. Specialising in techniques to film deep-sky objects, his work has featured regularly on *Stargazing LIVE*.

MAIN PICTURE: PETE LAWRENCE; INSET: MARK-PAYNE GILL

With miraculous timing the clouds part and a beautiful aurora appears

CHRIS PARKIN X 2, MARK PAYNE GILL X 2, THINKSTOCK, CANON X 2, SONY

▸ This time, however, I am not alone. I'm sharing the experience and my video footage not only with TV presenter Liz Bonnin and *The Sky at Night*'s Pete Lawrence, but also an audience of three million *Stargazing LIVE* viewers, 2,250km away in the UK. Against all the odds, we have achieved a TV broadcasting first – the first live, real-time broadcast of the aurora. The excitement in the cabin was euphoric. Social media was going crazy, too, with reports that the magnetic storm causing the aurora over Tromsø could move further south and make the aurora visible over the UK.

A full 25 years after I was inspired to film and share what I saw in 1989, this was the moment I'd been waiting for – capturing the aurora as the naked eye would see it. But I can't say that I'd ever expected it to happen at 32,000ft in front of a live BBC audience! So how was all this made possible?

▲ Above: Filming in front of EISCAT's unusual four-section VHF radar antenna

Above right: Vertical antennas surround EISCAT's facility. Here, scientists have the tools to heat up the ionosphere to produce artificial aurorae for research purposes

Right: The impressive 32m UHF radar dish in Tromsø, the location for *Stargazing LIVE*'s first live aurora broadcast

Testing, testing...

My journey to the Northern Lights began early in September 2013, when I received a call from *Stargazing LIVE* series producer Paul King, confirming plans to attempt to broadcast a live auroral display from Norway for the next series.

To add to the drama, the plan was to do this not just from the ground but also from a plane, which would enable us to get above any clouds. There was no doubt this was going be a complex operation with a high risk of failure, but it was also one that was well worth attempting, considering it had never been done before.

Good planning and preparation were crucial. Perhaps the most important part was testing suitable cameras, to see if exposing for an aurora in real time was possible. Along with the BBC's camera department we came up with a shortlist of video cameras renowned for their high ISO sensitivity and good low-light performance. Our main contenders were the Canon C300, Canon 5D MkII DSLR and Sony NEX-FS700. All three are semi-professional video cameras with qualities that make them worthy of serious consideration. Crucial to their performance would be our lens choice: a set of Canon f/1.2 and f/1.4 fast prime lenses that allow maximum light to fall on the sensors.

Our test location, Basildon Park near Reading, offered us plenty of dark areas with good views of the night sky. Light pollution from nearby city lights also gave clouds some illumination, giving a useful guide for aurora exposure levels. If any of the cameras could record cloud detail at night, I knew we would be on the right track.

As luck would have it, the weather provided both cloud cover and clear skies, giving ideal conditions. To begin with, cameras were set at their maximum ISO setting, shutters left open and lenses set to their maximum aperture. After hours of testing, scrutinising and discussing, it was the Sony NEX-FS700 that grabbed our attention in these real-world conditions. Each camera easily exposed faint cloud cover in real time, and to my surprise many stars during clear spells, but the Sony had the edge.

Now what we needed was an auroral display to confirm we had the right tool for the job.

Dummy run

We hoped that a short trip to Tromsø in October would give us this opportunity. We filmed at the EISCAT (European Incoherent Scatter Scientific Association) research facility, which was to be our location for the first, ground-based episode of *Stargazing LIVE*. Scientists here create and study artificial aurora, high up in the ionosphere.

I soon discovered these were far too faint for our camera to record. However, despite poor solar wind conditions, luck was again on our side and late one night a faint but real aurora appeared over the Tromsø rooftops. Minutes later, with the video camera set up, a bright green aurora appeared in my viewfinder, subtly pulsing and shifting its way across the screen, changing shape and intensity in seconds. The colour changed from shimmering greens to subtle blues, which were beautifully recorded in real time.

This was the 'proof of concept' that we needed, and despite heavy light pollution I continued filming bright shimmering arcs and rays, framing a city landscape with cars and people. I remembered how I struggled to capture the aurora all those years ago with exposures lasting minutes – now I could do it in a fraction of a second with a video camera! I was reassured that if a magnetic storm did appear on the night and weather allowed, we would get the footage we needed. Next, we had to prepare our auroral chasing plane and maximise our chances of achieving this from the air.

Our plane was a modified King Air light aircraft specialising in live broadcast events. Further modifications were needed to improve our camera's chances of filming an aurora through one of the windows. We removed the perspex inner window to improve clarity. A low-power heater was installed just below this to prevent ice forming on the inside of the outer window, which would obscure the ▸

THE CAMERAS

The semi-professional video cameras we tested, and how they measured up

CANON C300

A DSLR/camcorder hybrid with a price tag of £12,000, the C300 is aimed at low-budget documentary film-makers. The large sensor offered great low-light performance at ISO 20,000, but its pictures were deemed a little noisier than the Sony's.

CANON EOS 5D MKII

This £2,300 DSLR with video mode and good low-light capability was able to record constellations and subtle cloud detail at night. But its lack of professional input/output ports and the overlaid camera data on the pictures ruled it out for our broadcast needs.

SONY NEX-FS700

This high frame rate camera is costly at £6,000, but offered great low-light performance and the Speed Booster gave extended exposure and 0.7x focal reduction. At ISO 16,000 it produced the brightest, cleanest pictures in our tests.

▸ camera's view. Next, our NEX-FS700 aurora cam with a 35mm f/1.4 lens and tripod were ratcheted firmly to the floor, framed up and covered with a blackout tent to eliminate internal reflections. Finally, the cabin's interior lights were covered with dark filters to keep ambient light to a minimum.

The success of our quest now hinged on elements we couldn't control: the weather and solar activity.

▲ **Above: The modified King Air turboprop plane used in our quest to make television history**

Above right: The Sony NEX-FS700 was installed with the internal window removed and shielded to keep reflections away from the lens

Right: Our 'aurora cam' as seen from outside the plane. Removing the internal polarising plastic window greatly enhanced the camera's view

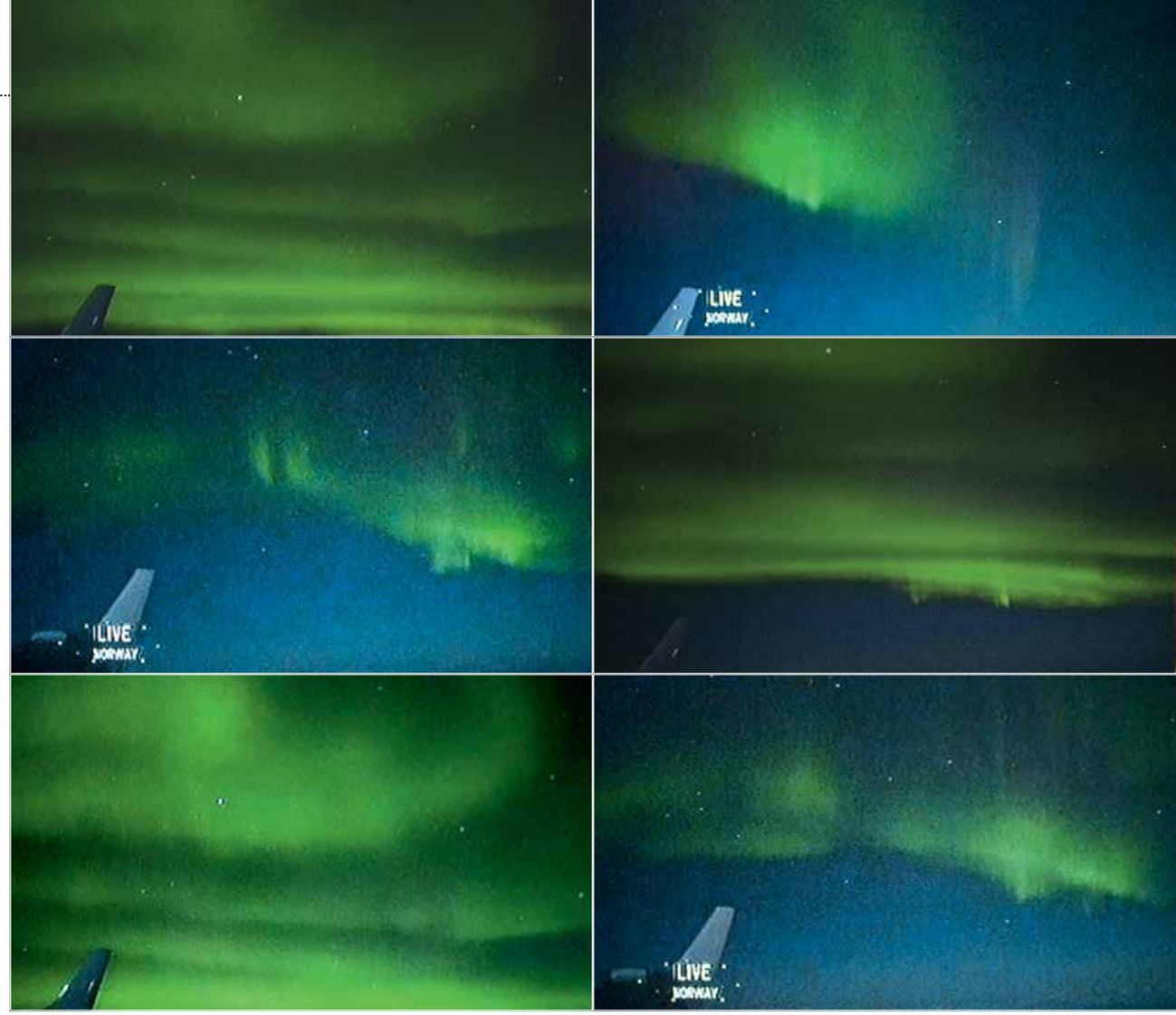
Going live

With no adverse weather forecast in the days before going live, relief turned to expectation and excitement as we took off into the cloudy skies above Tromsø for our first airborne broadcast. By coincidence, an X-class flare (the most powerful class) had been released by sunspot group AR1944 the day before and was heading our way. The timing was hard to believe: its arrival at 20:00 UT would coincide with our broadcast the following evening! As it turned out, however, we didn't need to wait.

Right on cue as we flew high above the clouds at around 21:25 local time, with *Stargazing LIVE* on air, a faint aurora appeared low in the east. With only minutes to go before we were due to go live, the plane had to bank round to put us on the right course for our TV signals to reach the satellite truck and place the glowing auroral arc in the field of view of our aurora cam.

Liz and Pete were buzzing with excitement, as we all were, while the countdown began for Dara O'Briain to hand over to Liz from Jodrell Bank. After what seemed an eternity, Liz could finally and proudly announce to the studio and the three million viewers back home that we had an aurora visible outside the plane. Best of all, we could share the experience thanks to my live camera that was transmitting breathtaking footage in real time. This was TV history being made, and it went flawlessly.

Even though the Sun was at its most active for many years, no one would have dared predict this outcome. Yet despite the odds stacked against us, we were able to share with millions of others the beauty of the Northern Lights – an outcome that would once have been beyond my wildest dreams.



▲ **The aurora developed expanding bands as we filmed it with the NEX-FS700 camera and viewed it on our monitor inside the plane**

Liz, Pete, Chris and myself, jubilant after recording our successful first live aurora broadcast from 32,000ft

LIVE **VS** TIMELAPSE

How real-time footage of the aurora differs from timelapse views

Real-time and timelapse videos produce entirely different perspectives of an aurora. Until recently, the only way to film an aurora was by using long-exposure photography and combining the frames at 25fps to make a timelapse movie. The results of this technique can certainly be mesmerising, as several hours' worth of activity can be condensed into seconds of playback. What might appear static to the casual eye turns into a hyperreal scene, with blazing colour and shifting patterns dancing and fidgeting along dynamic magnetic field lines.

But although spectacular, timelapse footage gives a distorted view of reality. With today's extended ISO ranges, many cameras can pick up the aurora using only 1/50th second exposures, allowing real-time movies to be shot just as the naked eye would perceive. The result is more serene and mysterious but still dynamic, as over the course of a few seconds colours and patterns can gently shimmer and pulse across the sky in a far more emotive fashion.

▲ **Conventional timelapse films, such as this one, capture the splendour of the aurora but give a speeded-up view of real displays**

MARK PAYNE GILL X 4, THINKSTOCK, WILL GATER X 3, AURORA FOOTAGE PICTURES: ©BBC/TAKEN FROM STARGAZING LIVE X 6