IN SATURN'S RINGS

TECHNOLOGY BEHIND THE FILM

BY THE NUMBERS

- **14 BILLION:** The distance in light years traveled through the universe in *In Saturn's Rings*. One light year equals the distance light travels in one Earth year, equivalent to nearly 6 trillion miles.
- **7.5 MILLION:** The number of individual photographs from telescopes and spacecraft combined to create photo-realistic motion in the film. No computer-generated imagery or 3-D modeling was used. More than 50 million photographs were examined and evaluated for use in the film.
- **675 TERABYTES:** The approximate amount of data used to make the film. 1 terabyte equals one million million bytes.
- **8.3 TERAPIXELS:** The number of pixels (one million million) that make up the background tiles used in the film – the largest composite imaging ever done for a film.
- **32 BITS:** The color depth of the final film. This is equivalent to more than 16.5 million colors, more than the human eye can see, with improved gradients (transitions between colors), shadows, and transparencies.
- **19:** The number of computers in writer/director Stephen Van Vuuren's basement on which he composed the film. In all, over 30 computers were used, up to 21 at one time, in addition to 150 processing cores.
- **MORE THAN 1,000** individual donors helped finance *In Saturn's Rings*, the first crowd-sourced giant screen film.
- **MORE THAN 100** volunteers have contributed their efforts to the creation of the film.

RESOLUTION

- The film is being produced at a resolution of 8000 x 8000 pixels, beyond the maximum resolution that can be recorded for 1570 (or IMAX-format) film stock.

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RESOLUTION (Continued)

- By comparison, the resolution of a DVD is 720 x 480 pixels, 2K digital cinema, most HD televisions and blu-rays are 1920 x 1080, and 4K digital cinema and UHD televisions are 3840 x 2160. The more pixels, the more detailed an image.

MULTIPLANE FILMMAKING

- The Walt Disney studios started using the multiplane camera in 1937 on animated shorts and features. By separating the foreground, midground, and background of an image into separate transparent panels (or planes) laid out one after the other below the camera, the studio could create a realistic sensation of both three-dimensional space and movement through a scene from a two-dimensional piece of art.
- In 2001, filmmakers devised a digital live action version of the multiplane camera using Photoshop. The problem that arises from this technique is that cutting out a foreground image can often result in a blank space in the background. This problem is usually resolved using "cloning," a digital photo editing equivalent of cutting and pasting of a texture or feature. Because of the high-resolution images used on *In Saturn's Rings*, cloning was not used on all segments (see "Achievements")
- The final version of *In Saturn's Rings* has one shot that features 10,000 foreground planes, 12 background planes, and 4.2 million midground planes, a factor of more than 1,500 more planes than used on a Disney animated feature shot with the multiplane camera.

ACHIEVEMENTS

- **SATURN'S RINGS**
    - Saturn's rings are at a 90% angle to the body of the planet, making multiplane imaging of the planet almost impossible. However, "impossible" is not a word in writer/director Stephen Van Vuuren's vocabulary. Stephen's solution was to trick the human brain, inspired

ACHIEVEMENTS (continued)

by the flats used in live plays (flat background scenery designed to give the illusion of depth) and the forced perspective used by Peter Jackson to film shorter and larger races of characters in the same shot in his *Lord of the Rings* films.

- Images of Saturn and its rings were too low resolution for Stephen to create a successful multiplane animation. The Cassini spacecraft has taken over 350,000 photographs of Saturn in its more than a decade of operation. With these as a source, Stephen spent ten-hour days, six to seven days a week, over a four-month period creating a high enough resolution mosaic image with high enough resolution to create a multiplane animation of Saturn and its rings
- Read the full story of Stephen's quest to animate Saturn's rings and his history of the film, spanning almost two decades of effort, online at https://www.insaturnsrings.com/film-history

- **MILKY WAY TIME-LAPSE**
  - Colin Legg's passion is photography, time-lapse and generally enjoying the night sky - preferably from exotic locations around the world, but usually from his beautiful, dark home state of Western Australia. Colin utilized a custom-built 5 camera rig using high-end DSLRs (Digital Single Lens Reflex cameras) and specialized electronics that captured some of the best dark sky time-lapse footage ever made. Read about Colin's expedition to shoot the Milky Way online at https://www.insaturnsrings.com/milky-way-time-lapse
  - Approximately 111,000 photographs were shot in Canon raw format, 5 photographs per frame with each camera firing simultaneously. Each set of 5 images were stitched using a program called PTGui into a single 10K resolution image. In the end there were approximately 20,000 images and 10,000 of them were used in the film.

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ACHIEVEMENTS (continued)

- **TITAN**
  - Ian Regan hails from Plymouth, Great Britain. He has a long-time passion for astronomy, particularly for the Apollo Lunar Program and unmanned exploration of the outer planets. A contributor to the Apollo Lunar Surface Journal, he is also an image-processor for *In Saturn's*
  - *Rings*. Read Ian’s full account of creating a tour of Titan online at https://www.insaturnsrings.com/titan-seam-blending
  - One of Ian’s projects on the film was to process the imagery for a multiplane flyover of the surface of Titan, to the site of the first human-launched spacecraft to land on this moon of Saturn. Regan created a tiled mosaic using near-infrared strips of images shot by the Cassini spacecraft. He divided the full image into 105 rectangular blocks for easy editing and image manipulation.
  - Easily available images of Titan’s polar region were not detailed enough for use in the film. Ian went through thousands of Cassini photos to find ones suitable to construct photo mosaics that could be blended with what he had completed for the rest of the planet.

- **HUBBLE FLY-THROUGH**
  - Jason Harwell is the Segment Producer and team lead for the Hubble Telescope images fly-through sequence. He started as a volunteer image processor doing many of these by himself and worked his up to segment producer by working through the initial tech issues, developing a production pipeline, and ultimately coordinating a talented team who brought many of their own techniques. Read Jason’s full account of creating the Hubble fly-through online at https://www.insaturnsrings.com/hubble-fly-through-sequence
  - The goal of the image processors was to approximate as best as possible the most natural image that your real human eye would see,

ACHIEVEMENTS (continued)

were you present at the camera's point in space or looking through a real physical (and incredibly powerful) telescope eyepiece.

- During the multiplane process, highlighted stars had to be pulled from the Hubble images, with the background area covered over using Photoshop's cloning application and other software techniques. Target stars and background stars, based on distance, were now placed on different plates in the computer for multiplane compositing.

- **CREATING A 3-DIMENSIONAL MODEL OF THE UNIVERSE**
  - Bill Eberly is a software engineer who led the team behind the film's fly-through of the galaxy, using the Sloan Digital Sky Survey (SDSS), an image collection of over 200 million galaxies as mapped from the Northern Hemisphere. Read Bill's full account of creating the 3-Dimensional universe model at https://www.insaturnsrings.com/5-million-galaxies-model
  - Although SDSS has images of 200 million galaxies, it only has a spectrum analysis, needed to determine distance, for a small percentage of those. In addition to those with accurate spectrums, 78 million galaxies in the SDSS have had their spectrums estimated by scientists. Those 78 million galaxies worth of data crashed the computer catalogs built for the *In Saturn's Rings* production. To prevent further crashing, the team decided to use only 10% of the SDSS data.
  - Occasionally, there would be a poor image due to a bright star or airplane interfering with the image, or corrupted data. Since an automated program would take time to write, the film's writer/director Stephen Van Vuuren reviewed each of the 5.5 million images collected for the segment over a nine-month period.

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KEY PLAYERS:

- **Stephen Van Vuuren (Filmmaker):** Stephen has directed, produced and/or shot over twenty feature and short narrative, documentary, experimental and animation films that have screened at numerous festivals and in cyberspace. Stephen founded SV2 Studios in 2000, which focuses on indie filmmaking and post-production, including digital cinema mastering.

  He first read about Saturn and Titan in Carl Sagan’s *Cosmos* as a child. In 2004, Cassini arrived at Saturn barely noticed by the world. Both exulted by the stunning images and disappointed by the lack of interest, he committed to finding a way to make a film that showcased the incredible beauty of Saturn and our entire universe, while exploring the reasons why most people know so little about it.

- **Pieter Schlosser (Composer):** Pieter’s work is featured in Destiny 2, NBC's *You, Me And The Apocalypse* and Freeform's *The Lying Game*, Lifetime's *The Client List* and music on the *Transformers* franchise, *Resurrection* and *Desperate Housewives* to name a few. He composed Infinitum, the opening music of *In Saturn’s Rings*.

- **LeVar Burton (Narrator):** LeVar is an Emmy, Grammy, Peabody, and NAACP award-winning actor best known for his roles in *Roots*, *Star Trek The Next Generation*, and as host of the PBS children’s series *Reading Rainbow*. With his dedication to science and education, he serves as narrator of *In Saturn’s Rings*.