ALMA – In Search of Our Cosmic Origins		
00:00 **[Visuals start]** **[Narrator]** 1. High on the desolate Chajnantor Plateau in the Chilean Andes. One of the harshest environments on Earth. Amid volcanoes ... Desert plains ... And bitter winds ... ALMA — the Atacama Large Millimeter/sub-millimeter Array — is ready. Astronomers and scientists all over the globe have been eagerly anticipating this moment for decades. ALMA is the world's largest astronomical project. But it is not a conventional telescope. Instead of collecting and analysing visible light it looks in a different and largely unmapped part of the spectrum. By opening a new window on the cosmos, ALMA explores one of the last frontiers of astronomy — the cold and distant Universe. All in search of answers to some of the deepest questions about our cosmic origins. How do stars and planets form? How did the first galaxies form?		**Images:** Helicopter footage: Distant view of Chajnantor ALMA at the high site. Antennas move

02:06 **[Narrator]** 2. The Chajnantor Plateau in North Chile. Despite the — literally! — breath-taking altitude of 5000 metres above sea level, ALMA has flourished. Over the last few years, more than 50 antennas have been installed across the high desert plain. ALMA is a unique, giant telescope built in a partnership between Europe, North America and East Asia, in cooperation with Chile. Sixty-six state-of-the-art antennas observe the Universe at millimetre and submillimetre wavelengths — one thousand times longer than visible wavelengths. This light reaches us from some of the coldest and most distant objects in the Universe. Water vapour in the atmosphere blocks these faint whispers from the hidden Universe, so to collect them we have to go to an extremely high and dry site — like Chajnantor.		ALMA at Chajnantor Helicopter footage ALMA at Chajnantor Helicopter footage Object Animations Helicopter footage
03:25 **[Narrator]** 3. The origin of the ALMA project dates back decades. Scientists from Europe, North America and East Asia developed three individual concepts for new, large telescopes for millimetre and submillimetre observations. Eventually these concepts were merged into one. Big science takes big global collaborations. Together countries can achieve what they cannot do alone. The whole is greater than the sum of its parts. The ALMA project was born! This new telescope needed a home, and eyes turned to Chajnantor. Every aspect of the site, from the astronomical to the meteorological, was thoroughly tested and the atmosphere monitored daily. The conclusion: Chajnantor was the perfect place for ALMA.		CGI **Book of ALMA** **Chapter 1** **The Birth of ALMA** **1980s–1990s** Book opens to reveal old scenes. Three antennas, one project. **"Book of ALMA" CGI,** **Chapter 2** **Finding the Right Site** **1995** Site testing footage, CG book with video

04:46 **[Narrator]** 4. Construction began in 2003 with the groundbreaking for ALMA's Array Operations Site. Conditions here at an altitude of 5000 metres above sea level are harsh and very challenging. Strong winds. Low temperatures. Intense ultraviolet radiation. And a desperately thin atmosphere. So thin that to work here people need supplementary oxygen and have to undergo rigorous health checks.		**"Book of ALMA" CGI,** **Chapter 3** **Breaking Ground** **2003**

05:41 **[Narrator]** 5. The production of ALMA's antennas has been shared between the three ALMA partners.		**"Book of ALMA" CGI,** **Chapter 4** **Forging the Tools** **2003**
Three prototypes were put through their paces at the ALMA Test Facility, on the Very Large Array site, in the USA.		**Prototype testing at the Very Large Array site, USA.** ALMA antenna
The 66 antennas on the high plateau are a critical part of ALMA. Their big dishes collect the faint millimetre waves from space. These antennas are truly the state-of-the-art. Their surfaces are accurate to much less than the thickness of a sheet of paper.		ALMA antennas (detailed view?)
They can move precisely enough to pick out a golf ball at a distance of 15 kilometres. And they must survive, exposed to the elements, on Chajnantor!		Antennas move Aerial view

07:00 **[Narrator]** 6. Twenty-five antennas have been provided by the European Southern Observatory, 25 by the US National Radio Astronomy Observatory, and 16 by the National Astronomical Observatory of Japan.		Antenna production in France
In a truly global endeavour, the antenna components were constructed in several locations around the world, sent to Chile to be assembled... and then tested at the Operations Support Facility, in readiness for their first time observing the sky.		Transport through desert **"Book of ALMA" CGI,** **Chapter 5** **Linking the First Antennas** **2008**
The first ALMA antenna was accepted and shortly thereafter two antennas were successfully linked together.		
08:14 **[Narrator]** 7. Detectors in each antenna register the finest nuances of the faint signals collected by the dishes. These detectors are the most sensitive of their kind and are cooled using helium gas to just four degrees above absolute zero.		Instruments being integrated

08:34 **[Narrator]** 8. The first completed antenna makes its way up to the Array Operations Site. Two custom-built transporter vehicles — Otto and Lore — move the 100-tonne antennas around. Otto carefully climbs the winding road, carrying the high-tech antenna up to its final home on the high plateau. This first antenna was soon joined by many more.		"Book of ALMA" CGI, **Chapter 6** **Reaching New Heights** **2009** First antenna transport to high site,
09:14 **[Narrator]** 9. The first observations using two, and then three, antennas in unison were made. Key tests for the ALMA array. And all passed with flying colours!		"Book of ALMA" CGI, **Chapter 7** **Beating Expectations** **2009** Footage of two or three antennas at Chajnantor
09:36 **[Narrator]** 10. Millimetre and submillimetre wavelengths give astronomers a unique window on the Universe. But to see them with the sharpness astronomers need, a single-dish telescope would have to be kilometres across (and impossible to build)! Instead, ALMA uses 66 separate antennas which can be spread out over the plain with separations of up to 16 kilometres. The antennas are linked and their signals combined. The result: one giant telescope as wide as the whole array, observing with unprecedented sensitivity and resolution.		ALMA animation
10:21 **[Narrator]** 11. Making sense of these intertwined signals takes the highest-altitude supercomputer in the world. With 134 million processors, performing 17 quadrillion operations per second — as many as the fastest supercomputer in the world — the ALMA correlator, on Chajnantor, combines and compares the signals from every antenna.		Correlator room

10:55 **[Narrator]** 12. As more and more antennas arrive at Chajnantor, the Operations Support Facility, the control centre of the observatory, takes shape at the slightly more hospitable altitude of 2900 metres. The site is busy around the clock. Operating the telescope. Testing and maintaining antennas and other equipment. And home for the ALMA staff during their day- and night-shifts at the observatory.		Antennas at the high site Activities at the OSF Astronomers at work
11:38 **[Narrator]** 13. In the capital of the host nation, Chile, the ALMA Santiago Central Offices were built. Here the technical, scientific and administrative staff of the Joint ALMA Office is working.		**Chapter 8** **Santiago Central Offices** **2010** ALMA Santiago footage

12:10 **[Narrator]** 14. Even before the construction stage was complete, the first scientific observations began with a partial array of antennas. ALMA had opened its eyes! Thousands of scientists from around the world competed to be among the lucky few to use the facilities first. Even with just 16 antennas ALMA was already the most powerful telescope of its kind.		"Book of ALMA" CGI, **Chapter 9** **Proving Excellence** **2011** Antennas moving Scientists at work Antennas moving
13:00 **[Narrator]** 15. The first scientific observations fulfilled everyone's hopes. The Antennae Galaxies, a pair of colliding galaxies with dramatically distorted shapes. Visible light can show us the stars in the galaxies, but ALMA reveals the clouds of cold, dense gas from which new stars are born. The heart of the distinctive galaxy Centaurus A. ALMA peers through the opaque dust lanes that obscure its centre.		Music peaks in a crescendo. Astronomical results (material from press releases) Antennae Galaxies Centaurus A.

13:48 **[Narrator]** 16. A view of the nearby star Fomalhaut provides clues as to how planetary systems form and evolve.		Fomalhaut
Cosmic dust grains found around a brown dwarf suggest that rocky planets might be even more common in our Universe than we thought.		Cosmic dust
Sugar molecules, spotted around a young, Sun-like star for the first time: the building blocks of life in the right place, at the right time, to be part of new planets forming around the star.		Sugar molecules
An unexpected spiral structure in the material around the old star R Sculptoris revealed the secrets of this dying star.		Spiral

Vast streams of gas flowing across a gap in the disc of material around a young star. A key stage in the birth of giant planets, observed for the first time. And all this before the array was fully complete!		Gas streams
15:05 **[Narrator]** 17.ALMA's inauguration celebrates its coming of age. The journey has been a long one. ALMA has grown from an idea, to a construction project, to a fully operational observatory, and to a truly global scientific partnership. In the serene and lonely beauty of the Chilean Atacama desert, ALMA is ready for the future. By using this marvellous telescope, the world's astronomers will peer deep into the hidden secrets of the cosmos. In search of our own cosmic origins!		"Book of ALMA" CGI, **Chapter 10** **Towards New Horizons** **2013** Impressive ALMA footage Credits

16:34
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