Building the Coolest X-ray Satellite
Chapter 1 Script

Chapter 1: Astro-E2: History, People, and Science

Chapter 1, Part 1: History of Astro E-2

Video

OPEN: PICTURE MONTAGE

Audio

Music

NARRATOR: In 1993, scientists and engineers from NASA's Goddard Space Flight Center and ISAS in Japan joined forces. Together they created an advanced x-ray astronomy spacecraft capable of detecting x-rays from some of the most exotic objects in the universe. This powerful research vehicle, called Astro-E would take 7 years to build—seven long years of waiting that culminated in the year 2000 when Astro-E would join two other x-ray observatories in orbit: NASA's Chandra X-ray Observatory and Europe's X-ray Multi-Mirror Mission. While physically located on opposite sides of the Earth, the Japanese and American teams worked closely in pursuit of their shared goal. Together, they developed x-ray spectrometers, x-ray telescopes, and lasting friendships. Their hard work and careful planning culminated on this day - launch day for Astro-E. A day that would bring to each of them the realities of high-risk ventures like space flight

Video

ASTRO-E ROCKET LAUNCH
FADE TO BLACK
KEVIN OC
ROCKET NOZZLE ANIMATION

Audio

KEVIN: It was okay for a while and then what happened was the lining of the rocket nozzle burned through.

Video

CURTIS OC
ASTRO E LAUNCH VIDEO – SHOWING TWISTED EXHAUST TRAIL

Audio

CURTIS: And the first stage started to cork screw.

Video

KEVIN OC

Audio

KEVIN: The Japanese people started saying, something's wrong

Video
CURTIS OC
Audio
CURTIS: We really don't know what happened to ASTRO-E.

Video
KEVIN OC
Audio
KEVIN: It was seen at the tracking station in Christmas Island in the Pacific Ocean, and there is another tracking station in Brazil that did not ever get a signal from it.

Video
ASTRO E RE-ENTRY ANIMATION
Audio
CURTIS: So we think it's somewhere in the South Pacific.

Video
ILANA OC
Audio
ILANA: We were all down. I remember I couldn't even drive home, I mean, I got a ride home.

Video
KEVIN OC
Audio
KEVIN: We all went out for Karaoke and sang and cried with each other.

Video
CURTIS OC
Audio
CURTIS: It was like a death in the family, here.

Video
KEVIN OC
PICTURES OF ASTRO E TEAM MEMBERS
Audio
KEVIN: You know it was just a bunch of hardware and so what, but then I realized that, it meant that I wasn't going to get to see these people again… maybe for a very long time.

Video
AIRPLANE LANDING
KEVIN OC

Audio

KEVIN: Well, by the time I flew back from Japan, we were all feeling a little better, because by then we had decided that we needed to write a proposal

Video

ILANA OC

Audio

ILANA: We got an e-mail saying, "Hey, there is a meeting tomorrow. Enough mourning now we are back to work."

Video

KEVIN OC

Audio

KEVIN: Well these things usually take two or three months to write but we figured we could do it in a week.

Video

CURTIS OC

Audio

CURTIS: The entire proposal was put together in a week's time and it has become a model of proposals

Video

ILANA OC

Audio

ILANA: For me I think it was the most intense experience in working with a group of people that I ever had.

Video

CLIPS OF PROPOSAL WRITING

Audio

NARRATOR: That intensity paid off – they met the deadline. Their proposal so impressed NASA management, that they awarded the team their new mission.

Video

CURTIS OC

Audio

CURTIS: And then the Japanese proposed a re-flight of ASTRO-E. We would call it ASTRO-E2.

Video

PHOTO OF ASTRO-E TEAM
ASTRO-E2 TITLE GRAPHIC

Audio

NARRATOR: The American and Japanese space agencies decided to combine the two missions, reuniting the Astro-E team, setting them on a course to build the coolest X0ray satellite: Astro-E2
MUSIC

Chapter 1, Part 2: The People of Astro E-2

Video

CLIP OF NAKED SINGULARITY BAND PLAYING

Audio

KEVIN: There are a few of us at work that we have a, a little band, we're called Naked Singularity.

Video

GRAPHIC: KEVIN BOYCE INFO
CLIPS OF KEVIN WORKING
GRAPHIC: VOYAGER MISSION

Audio

KEVIN: The first time I realized that I would kind of like to do this, was when I read a story in Scientific American many years ago, maybe in high school, about the Voyager probes and all the problems they had from the moment of launch up through the end of the mission there was difficulty after difficulty. And the way the people in the control room solved these difficulties so all the public saw was the beautiful pictures – and I thought, this is what I'd like to be doing.

Video

CURTIS OC

Audio

CURTIS: I didn't even as a matter of fact dream about a job at NASA because that seemed like too big a dream.

Video

GRAPHIC: CURTIS O'DELL INFO
CLIPS OF CURTIS IN THE OFFICE
CAR MECHANIC CLIP
BIG BEAR LAKE PHOTOS
FOOTAGE FROM THE SOLAR OBSERVATORY

Audio

CURTIS: Well, I do have a degree in Industrial Arts Education, which is what they call Tech Ed these days. But I had not applied that so much in the early years of my career, I had done a number of technical jobs and had spent several years as a car mechanic. But at some point along there I decided that I didn't want to be a car mechanic anymore and I was living in Southern California at a place called Big Bear Lake. And it turned out that there was a solar observatory at that lake operated by Cal Tech. I applied for and got a job there. I did operate

the telescopes and worked as an observer I also did machining and applied these technical skills throughout the plant. So that's how I got into science and then transferring that knowledge and skill base to Goddard.

Video

CLIP OF ILANA RIDING A TRIKKE

Audio

ILANA: This is a Trikke. It's a three-wheeler. It's a geek toy I think. It's actually a neat physics trick.

Video

GRAPHIC: ILANA HARUS INFO
CLIPS OF ILANA IN THE OFFICE
CLIP OF NEWTON'S CRADLE TOY
TEXT: NEWTON'S THIRD LAW

Audio

ILANA: I grew up in Paris and my parents took me to a Lapadi due Covert, which is like a science museum. And I remember one time, I was doing, there was this experiment, when you take one ball and it goes and then one ball goes up. And the guy said, "who can predict what will happen, and you know, to me it seemed totally obvious that if you take two, the two will… So I say that and the guy goes "you're good!" And so then I thought, Oh I see this is something that I can do. It did occur to me that physics was actually linked to anything that moves.

Video

CLIPS OF DRAMA CLUB WITH KIM DIRECTING

Audio

NARRATOR: While not directly on the Astro-E2 team, NASA astrophysicist Dr. Kim Weaver is eager to work with Astro-E2 data. She explains what got her interested working at NASA.

Video

GRAPHIC: KIM WEAVER INFO
KIM OC

Audio

KIM WEAVER: When I was 5 years old, we landed on the moon and I was hit by a car that day and put in the hospital. And I remember being so upset that I was not going to see the moon landing.

Video

ARCHIVE FOOTAGE OF ARMSTRONG LANDING ON THE MOON

Audio

ARMSTRONG SOT: That's one small step for man, (under) one giant leap for mankind.

Video

KIM OC

Audio

KIM WEAVER: That was a fundamental turning point for me, ever since that day, I wanted to work for NASA. So, I'm here now today.

Chapter 1, Part 2: The Science of Astro E-2

Video

ANIMATION OF ASTRO-E2 IN SPACE; TEXT: "WHAT WILL ASTRO-E2 DO?"
IMAGES OF SUPERNOVA EXPLOSION, BLACK HOLE WITH ACCRETION DISK, SUN'S CORONA DURING ECLIPSE, CLUSTER OF GALAXIES

Audio

KIM WEAVER: Astro-E2 will is going to be looking at a number of things. It'll be looking at supernova remnants to understand the chemical elements created when a star explodes. It's going to be looking at accretion disks around black holes to study the gravitational effects of a black hole on the accretion disk. It's going to be looking at the corona of stars. Our sun has a really hot corona and it give off x-rays, so we'll be looking at coronae of other stars to see how they behave if they're similar to the sun. And also Astro-E2 will look at clusters -the hot x-ray gas in the center of clusters - to understand the temperature of the cluster, the mass of the cluster and that way you can sort of probe the universe by looking at cluster of galaxies.

Video

TEXT: WHAT IS X-RAY ASTRONOMY?
GRAPHIC OF ELECTROMAGNETIC SCALE

Audio

KIM WEAVER: X-rays are light. It's electromagnetic radiation, just like optical light, but it's at a different wavelength. X-rays have a shorter wavelength and they carry much more energy. So, each x-ray photon has much, much more energy than an individual optical photon.

Video

CLIP OF DENTAL OFFICE, TAKING X-RAYS
KIM OC
ANIMATION OF ASTRO-E2 IN SPACE

Audio

KIM WEAVER: In x-ray astronomy, it's not like going to the dentist. The dentist takes an x-ray by shooting x-rays at you and on the other side they have a piece of film that collects the x-rays and that's how you see the x-ray shadow. In astronomy, we're not producing the x-rays ourselves, the objects out there, the stars, the supernovae, the galaxies; the black holes are producing the x-rays. And then we send up a telescope that just detects the x-rays.

Video

ANIMATION OF FLYING INTO A BLACK HOLE

Audio

KIM WEAVER: Black holes have extreme gravity and they have a lot of intensity and heat and energy around them, and so the regions around a black hole are going to be producing x-rays as opposed to optical light, so if you are going to probe a black hole – you need to be able to see x-rays.

Video

CENTAURUS A VISUALIZATION WITH BLACK HOLE ANIMATION AT THE END
GRAPHIC: CENTAURUS A OPTICAL LIGHT
GRAPHIC: CENTAURUS A X-RAY LIGHT
GRAPHIC: ARTIST'S CONCEPT OF BLACK HOLE

Audio

KIM WEAVER: A galaxy is filled with all sorts of stars and gas and dust. And that gas and dust blocks our view to the center of the galaxy. So if we look at it in optical light, we can't see the center of the galaxy, because there's all the dust in the way. But in an Active Galactic Nucleus that has a huge black hole in the center that gives off x-rays around it, around it in an accretion disk, you can use those x-rays to probe into the center of the galaxy. So, you can see the through the gas and dust.

Video

ANIMATION THE REGION AROUND A BLACK HOLE WITH ACCRETION DISK AND JETS

Audio

KIM WEAVER: If you could see a black hole it would cast a shadow to you eye. So, you would see the disk and you would see a little black spot in the middle, that would be the shadow of the black hole, but what you are really seeing in x-ray light is the disk itself.

Video

KIM OC
ANIMATION OF MATERIAL SWIRLING INTO BLACK HOLE AND JETS

Audio

KIM WEAVER: The black hole has a huge amount of gravity, so it brings material toward it. And what happens is it accretes material. Material comes in and falls into the black hole. And that's why you can see the black hole, because as material comes into the black hole it also emits light and gives off energy. So the black hole produces it's own, sort of it's own signature, if you will, by the fact that it is eating stuff and as it eats stuff it heats stuff up and the stuff that's left outside the black hole swirls around it and that's how you detect the black hole. You detect the stuff from this accretion disk, and you also see jets. The black hole can not only eat material, but it can cause material to be pulled in a spiral upward and be shot away from it, into jets on opposing sides.