

THE YEAR OF PLUTO Captioning Script
May 5, 2015

(Music)

THERE'S A MYSTERIOUS ZONE, FAR OUT IN OUR SOLAR SYSTEM.

IT'S A REGION OF ICE WORLDS... SOME SOLITARY... SOME WITH MOONS.

THEIR NAMES MAY BE UNFAMILIAR...

ERIS...

MAKEMAKE...

HAUMEA... BUT THEY HOLD CLUES TO ALL OUR ORIGINS.

AND THE FIRST OF THESE WORLDS, AND THE ONE WE'LL REACH IN 2015, IS THE
"KING OF THE KUIPER BELT"

...PLUTO.

(Music, cheers and launch sounds)

THE LONG JOURNEY OF NASA'S *NEW HORIZONS* MISSION BEGAN IN 2006 ABOARD
AMERICA'S BIGGEST, BADDEST ROCKET, TRICKED OUT WITH *EVERY*
CONCEIVABLE BOOSTER.

Text super:

ALAN STERN

New Horizons Principal Investigator, SwRI

ALAN STERN:

We built a very light spacecraft and bought a very large launch vehicle, and the combination is
ferocious.

(Music change)

Dateline super:

Clyde Tombaugh's discovery of Pluto announced

BUT, IN SOME SENSE, IT ALL BEGAN IN 1930 WITH CLYDE TOMBAUGH, 24 YEARS
OLD AND FRESH OFF A FARM IN KANSAS ...BUT WILLING TO SPEND LONG HOURS
SCANNING STARFIELDS (to captioners: this is one word) TO FIND A MOVING POINT OF
LIGHT...

...HUMANITY'S FIRST GLIMPSE OF PLUTO.

(Music)

**Alan kid pic with text super:
Alan Stern, age 6**

VO:

THE DREAM OF ACTUALLY GETTING TO PLUTO BEGAN WITH A 6 YEAR OLD BOY
IN LOVE WITH SCIENCE...

...WHO GREW UP TO LEAD A TEAM OF BRILLIANT RESEARCHERS AND
ENGINEERS WITH DOGGED PERSISTENCE THROUGH DECADES OF PLANNING...

AND BUILDING...

...AND TESTING, A RACE AGAINST TIME, JUST TO GET TO THE LAUNCH PAD.

**Text super:
FRAN BAGENAL
New Horizons Co-Investigator, LASP, UC Boulder**

FRAN BAGENAL:

Exploring the outer solar system, because it's so far, takes a lot of time.

It requires a lot of patience, a lot of dedication, a lot of perseverance. But... it's the *frontier*.

ASSUMING ALL GOES WELL AT PLUTO, NASA MAY CHOOSE TO EXTEND THE
ADVENTURE, FURTHER OUT INTO THE KUIPER BELT... THE SOLAR SYSTEM'S
MYSTERIOUS *THIRD ZONE*.

**Text super:
JOHN SPENCER
New Horizons Co-Investigator, SwRI**

JOHN SPENCER:

This is maybe the one chance in my lifetime that we're going to get a spacecraft out there and
look up close at one of these Kuiper Belt Objects.

Dateline graphic
December 6, 2014

ALICE BOWMAN:

We have nominal wake-up of the NEW HORIZONS spacecraft!

DECEMBER 6, 2014... *NEW HORIZONS* WAKES UP FOR THE LAST TIME FROM HIBERNATION.

Text super:
James Green
Director of Planetary Science, NASA

James Green:
New Horizons is speeding towards Pluto at a phenomenal rate, and we can't wait for it to get there!

Dateline graphic
January 27, 2015

JANUARY 27, 2015... SIX MONTHS OF "APPROACH SCIENCE" BEGINS...

Dateline graphic
July 14, 2015

JULY 14, 2015.

NEW HORIZON'S LONG JOURNEY ...3 BILLION MILES, NINE YEARS IN FLIGHT,
AND 85 YEARS OF SPECULATION ABOUT PLUTO...

...CLIMAXES IN ONE DAY OF CLOSE APPROACH AND FLYBY.

ALAN STERN:
We're rounding 3rd base and we're headed home!

THE DREAM... THE ADVENTURE... THE PROMISE OF DISCOVERY... THAT'S WHAT
MAKES 2015 ...THE YEAR OF PLUTO

(Music crescendo and fade)

Text: 2015: THE YEAR OF PLUTO

(Music)

Titles: Act 1: THE DISCOVERERS

STUDYING PLUTO AND ITS NEIGHBORS FROM EARTH IS ONE OF THE TOUGHEST
CHALLENGES IN ASTRONOMY.

IT TAKES THE LARGEST TELESCOPES, AND MOST ADVANCED
INSTRUMENTATION, ON THE PLANET...

AND IT'S TOUGH EVEN FOR THE HUBBLE SPACE TELESCOPE.

Full screen timeline graphics:

AND IT TAKES TIME... FROM THE DISCOVERY OF PLUTO IN 1930...

TO NASA APPROVING THE NEW HORIZONS MISSION IN 2001...

TO ARRIVING AT THE PLANET IN 2015...

IT'S BEEN 85 YEARS AND TIME PASSING IS DEFINITELY AN ACTOR IN OUR STORY.

BUT IT'S THE COMBINATION OF HUMAN SKILL, CUTTING-EDGE IMAGE PROCESSING AND SHEER BLOODY-MINDED PERSISTENCE THAT HAS RESULTED IN THE MOST IMPORTANT DISCOVERIES.

AND THAT'S A TALE AS TRUE TODAY AS BACK IN 1930, WHEN PLUTO WAS FIRST FOUND ...BY CLYDE TOMBAUGH.

(Music change)

IN 2011, AT THE SETI INSTITUTE NEAR SAN FRANCISCO, MARK SHOWALTER USED HUBBLE DATA TO DISCOVER TWO NEW MOONS AROUND PLUTO ...ALTHOUGH HE WAS ACTUALLY LOOKING FOR POSSIBLE RINGS.

SHOWALTER HAS FOUND RINGS ASSOCIATED WITH SMALL MOONS AROUND OTHER PLANETS.

MARK SHOWALTER:

And that was kind of the motivation for checking out Pluto. It's got two little satellites ...Satellites raise clouds of dust ...Let's see what might be there.

IT'S EASY TO TAKE ARTISTIC LICENSE TO SHOW WHAT PLUTO'S RINGS MIGHT LOOK LIKE.

IN REALITY, IT'S INCREDIBLY HARD TO SEE FAINT OBJECTS AGAINST THE DENSE BACKGROUND STAR FIELD, AND THE GLARE FROM PLUTO AND ITS LARGE MOON, CHARON.

Text super:

MARK SHOWALTER

Sr. Research Scientist, SETI Institute

MARK SHOWALTER:

We came up with this trick where you take the images and then you rotate the camera 90 degrees and take more images. And if you do that all just right you can do this thing where all that glare cancels out and what we're left with is just the rings.

We could think of it as a stack of images. Think of it as like a cube looking down. So let's turn it on its side.

So now if we start peeling off the layers and looking downward through the stack, things suddenly become much, much cleaner.

For example, Hydra and Nix show up very, very cleanly.

But the thing that immediately caught my eye was this little dot, right there.

It's not a perfectly sharp hot pixel like over here.

And that's what made it pretty convincing to me that we had seen a very small moon of Pluto that nobody had seen before.

TO BE SURE YOU'VE DETECTED A REAL MOON OR PLANET, YOU HAVE TO SHOW IT'S MOVING, UNLIKE THE BACKGROUND STARS.

MARK:

The thing that makes moons distinctive is if we come back later they'd all have shifted. Because they all orbit the central planet.

This required a great deal of patience to then wait about six days until we got our next set of observations of the Pluto system.

Sure enough the object was still there. It had moved by just about the right amount to be something orbiting Pluto.

And we knew we had a moon.

NEXT YEAR, SHOWALTER AND COLLEAGUES WENT BACK AND BUILT ON LESSONS LEARNED TO SEE WHAT ELSE MIGHT BE THERE.

SUMMER 2012.

NOW MARK HAD 15 MORE DAYS OF HUBBLE OBSERVATIONS.

MARK:

Now, what you can see here are three time steps. Each of those time steps is actually about 45 minutes of data. That means it's long enough that the little moons move.

It's moving back and forth in this three frame sequence. Hydra's moving, Nix is moving...

I mean, it doesn't take a rocket scientist to say that that looks like a little moon of Pluto. It's moving just the way the others are. They're all going around the planet in the same direction.

And so just it was just a couple of weeks later that we made the announcement that the fifth moon had been discovered.

(Music change)

PATIENCE, PERSISTENCE, INGENUITY... THAT WAS EXACTLY WHAT LED TO THE DISCOVERY OF PLUTO, BACK IN 1930.

IN KANSAS IN THE 1920'S, CLYDE TOMBAUGH GREW UP IN HARD TIMES AND BUILT TELESCOPES USING LEFT OVER FARM IMPLEMENTS.

TO CHECK THE ACCURACY OF HIS BEST TELESCOPE HE SENT DRAWINGS OF MARS AND JUPITER TO THE LOWELL OBSERVATORY IN FLAGSTAFF, ARIZONA.

THEY WERE LOOKING FOR STAFF, AND HE WAS HIRED.

ALONG WITH OBSERVING THE STARS, HE STOKED THE FURNACE AND SHOVELED SNOW!

BUT ONE ASSIGNMENT MADE HISTORY.

DAY AFTER DAY, HE'D USE THIS MACHINE, KNOWN AS A BLINK COMPARATOR, TO LOOK FOR ANYTHING IN HIS IMAGES THAT MOVED.

IT WAS TEDIOUS, PAINSTAKING WORK.

(Starfield plates click back and forward)

BUT ON PLATES TAKEN ON JANUARY 23RD AND 29TH AND ANALYZED IN FEBRUARY, HE SAW A SMALL DOT THAT DID MOVE AGAINST THE FIXED STARS.

ANNOUNCING THE RESULTS AFTER CAREFUL CONFIRMATION, THE OBSERVATORY MADE IT EASY TO FIND THE NEW PLANET BY ADDING ARROWS.

MARK SHOWALTER:

This is an incredible work of observational astronomy. And having done something similar but with much more powerful tools, I can really appreciate his achievement.

(Music change)

FOR DECADES, PLUTO REMAINED MORE OR LESS A POINT OF LIGHT.

Dateline super:

BUT IN THE MID-70's, DALE CRUIKSHANK AND COLLEAGUES ATTACHED CAMERAS WITH INFRARED FILTERS TO A TELESCOPE AT KITT PEAK.

DALE CRUIKSHANK:

Detectors or sensors had been improved, and larger telescopes had become available.

Text super:

DALE CRUIKSHANK

New Horizons Co-Investigator, NASA Ames

DALE:

Well we did that work in 1976 and found evidence for frozen methane on Pluto's surface.

It was several years later that we found evidence for the other ices.

IN 1978, ASTRONOMERS JIM CHRISTY AND BOB HARRINGTON, ANALYZED NEW PLATES TAKEN AT THE U.S. NAVAL OBSERVATORY IN FLAGSTAFF.

CHRISTY NOTED AN ELONGATION TO THE NORTH OF PLUTO.

ONE MONTH LATER, THE BUMP HAD DISAPPEARED.

FROM THIS AND OTHER EVIDENCE THEY CONCLUDED THAT PLUTO, LIKE EARTH, HAD A MOON... CHARON.

FROM ECLIPSES BETWEEN PLUTO AND CHARON OCCURRING IN THE 1980S, ASTRONOMERS CALCULATED THAT THE MOON WAS ALMOST *HALF* THE SIZE OF ITS PARENT BODY ...SO LARGE THAT BOTH OBJECTS SPIN AROUND A CENTRAL POINT, THEIR MUTUAL CENTER OF GRAVITY, OUTSIDE PLUTO.

PLUTO AND CHARON WERE THE FIRST DOUBLE DWARF PLANET COMBO DISCOVERED IN OUR SOLAR SYSTEM.

USING THE BASIC PHYSICS OF THEIR ORBITS AND THE DISTANCE BETWEEN THEM, ASTRONOMERS COULD CALCULATE THEIR MASS AND SIZE.

PLUTO WAS A LITTLE SMALLER THAN EARTH'S MOON, ABOUT FIFTEEN HUNDRED MILES IN DIAMETER AND HAD ONLY ONE TENTH ITS MASS.

BETWEEN 1985 AND 1990, ASTRONOMERS WERE IN LUCK.

AS PLUTO AND CHARON ORBITED THEIR MUTUAL CENTER OF GRAVITY EACH PASSED IN TURN IN FRONT OF THE OTHER.

THE SO-CALLED “MUTUAL EVENTS” ALLOWED ASTRONOMERS LIKE MARC BUIE TO CAPTURE THE CHANGING PATTERNS OF LIGHT.

PATIENTLY BUIE CREATED A MAP OF PLUTO.

PLUTO TURNED TO HAVE ONE OF THE TWO MOST CONTRASTY SURFACES IN THE ENTIRE SOLAR SYSTEM.

IN THE MID-NINETIES, BUIE AND ALAN STERN USED THE HUBBLE SPACE TELESCOPE TO MAKE THE FIRST *DIRECT* IMAGES OF PLUTO’S SURFACE.

Dateline graphic:

ALAN STERN:

...it’s exciting to Marc and I and to our whole scientific team, to be able to see this object that no humans really could glimpse as a real planet, as a real object in the solar system previously.

Dateline graphic:

IN 2005, HAL WEAVER AND ALAN STERN USED THE HUBBLE FOR ANOTHER CLOSE-UP LOOK AT PLUTO AND CHARON.

THEY DISCOVERED TWO SMALL, DIM MOONS WHERE ONLY CHARON HAD BEEN SEEN BEFORE.

NOW WE KNOW, FROM MARK SHOWALTER’S WORK, THAT THERE ARE *TWO MORE* MOONS, MAKING THE CURRENT TOTAL OF FIVE, AND THAT PLUTO IS A GENUINE MINI-PLANETARY SYSTEM.

FROM ITS SIZE AND ORBIT, ASTRONOMERS ESTIMATED THAT PLUTO IS PERHAPS 70% ROCK AND 30% ICE.

THAT MAKES IT ONE OF THE LARGEST OF A WHOLE NEW CLASS OF OBJECTS, THE ICE DWARF PLANETS, MAKING UP WHAT’S KNOWN AS THE “KUIPER BELT.”

THIS REGION IS NAMED FOR GERARD KUIPER, A LEADING MID-20TH CENTURY PLANETARY ASTRONOMER.

KUIPER SUGGESTED THAT THE SOLAR SYSTEM DIDN’T END WITH NEPTUNE AND PLUTO, BUT THAT THERE SHOULD BE A DISK OF OTHER WORLDS, BEYOND THEM.

Dateline graphic:

IN 1992, FROM A MOUNTAINTOP IN HAWAII, DAVID JEWITT AND JANE LUU, FOUND THE FIRST “KUIPER BELT OBJECT.”

THEY WERE USING NEW AND HIGHLY-SENSITIVE CCD'S, LIKE THE SENSORS IN A MODERN DIGITAL CAMERA,

BUT THEIR TECHNIQUE WAS ESSENTIALLY AN UPDATED VERSION OF TOMBAUGH'S WORK.

TAKE CAREFULLY REGISTERED IMAGES OF A PATCH OF SKY, AND SEE IF ANYTHING MOVES AGAINST THE DISTANT STARS.

THIS ONE, "QB1", DID JUST THAT.

IT WAS ONLY A FEW HUNDRED KILOMETERS ACROSS, TEN TIMES SMALLER THAN PLUTO, BUT STILL HUGE COMPARED TO A COMET.

Graphics with KBO names:

SINCE THEN, TEAMS OF ASTRONOMERS HAVE FOUND AROUND TWO THOUSAND KBO'S

(Music change)

INFORMED BY CUTTING-EDGE ASTRONOMY, BUT WITH A FAIR DOSE OF ARTISTIC LICENSE, LET'S TAKE A TRIP THROUGH THIS "THIRD ZONE" OF OUR SOLAR SYSTEM.

Text super:

BONNIE BURATTI

Sr. Research Scientist, NASA JPL

BONNIE BURATTI:

We used to think of the solar system of consisting of two different types of planets. The planets we call the terrestrial planets, which are Earth-like planets.

That would be Mercury, Venus, Earth and Mars.

NEXT OUT, THE ASTEROID BELT... FRAGMENTS OF WORLDS SMASHED TO PIECES BY GRAVITATION AND COLLISIONS.

THEN COME THE FOUR GAS GIANTS...

JUPITER AND ITS MOONS...

SATURN WITH ITS MAGNIFICENT RINGS...

URANUS, ALSO RINGED...

AND NEPTUNE.

BURATTI:

Then Pluto was kind of this odd guy out. It was this little object at the edge of the solar system.

And then when we found all these other Kuiper Belt objects. This is kind of ...almost a third type of object.

Text super

JAMES GREEN

Director of Planetary Science, NASA

JAMES GREEN:

So, for the first time ever, we'll be able to fly by a brand-new object, an object that's been forming for billions of years ...and understand what outer parts of the solar system are all about.

BY JULY 2015 WE'LL KNOW, FOR SURE, WHAT PLUTO AND ITS MOONS LOOK LIKE... AND THAT WILL PROVIDE BREAKTHROUGH INFORMATION ON ALL THOSE OTHER "ICE DWARF" PLANETS ...THE MOST NUMEROUS PLANETARY OBJECTS IN THE ENTIRE SOLAR SYSTEM ...THAT MAKE UP THE KUIPER BELT.

ACTUALLY THE KUIPER BELT IS MORE LIKE A DONUT, BULGING UP ABOVE AND DOWN BELOW THE ECLIPTIC WHERE MOST OF THE PLANETS MOVE.

Name super:

JOHN SPENCER:

It's kind of like the Asteroid Belt but much bigger.

It has hundreds of times more objects in it than the Asteroid Belt...

LET'S NOW VISIT 5 NAMED KBO'S IN THE EXACT POSITIONS THEY'LL BE IN ON JULY 14TH 2015, THE DAY WHEN NEW HORIZONS FLIES BY PLUTO.

Text graphic reads on with KBO details:

QUAOAR WAS ONE OF THE FIRST KUIPER BELT OBJECTS DISCOVERED.

IT'S ABOUT ONE THOUSAND KILOMETERS IN DIAMETER, A REDDISH WORLD, COVERED IN WATER ICE, METHANE AND ETHANE.

AND, LIKE MANY KBOS, IT HAS A TINY MOON OF ITS OWN, WEYWOT.

Graphic disappears:

UP ABOVE AND DOWN BELOW THE PLANE OF THE SOLAR SYSTEM, NUMEROUS KBOS HAVE BEEN FLUNG ABOUT BY NEPTUNE'S GRAVITY.

THIS REGION IS KNOWN AS THE "SCATTERED DISC."

Text graphic reads on with KBO details:

ONE OF THE LARGEST OF THESE KBOS, ERIS, IS CLOSE IN SIZE TO PLUTO, AND IS MADE OF ROCK AND METHANE ICE.

Lose graphic:

ASTRONOMERS CATEGORIZE KBOS BY THE TILT OF THEIR ORBITS RELATIVE TO THE PLANE OF THE SOLAR SYSTEM.

Text graphic reads on with KBO details:

AND ONE OF THE MORE HIGHLY *INCLINED* ORBITS BELONGS TO MAKEMAKE NAMED FOR A HAWAIIAN CREATION DEITY.

JOHN SPENCER:

Some of these have methane or water ice on their surfaces. Some of them just seem to be covered in some brownish gunk. There are grey objects out there... There are brown objects out there that seem to be distinct populations.

Name super:

FRANCIS NIMMO:

Some of them seem to be very spherical, and so they probably have warm interiors. And then others are peculiar shapes, which suggests they're very cold and strong.

PERHAPS THE MOST BIZARRE AND UNEXPECTED KBO IS HAUMEA...

Text graphic reads on with KBO details:

...A KBO SHAPED LIKE AN AMERICAN FOOTBALL ...MADE OF ROCK AND ICE.

IT'S WHITE WITH RED SPLOTCHES, AND ORBITED BY AT LEAST TWO MOONS.

Lose graphic:

ONE OF THE STRANGEST ORBITS OF ANY KBO BELONGS TO SEDNA, DISCOVERED IN 2003.

Text graphic reads on with KBO details:

ITS ORBIT IS THE MOST ECCENTRIC OF ANY KBO NOW KNOWN, BRINGING IT AS CLOSE AS 76 AU TO THE SUN, BUT THEN CARRYING IT OUTWARD TO 936 TIMES THE “EARTH/SUN” DISTANCE.

SEDNA’S STRANGE, ELEVEN-THOUSAND-YEAR ORBIT SEEMS TO LINK IT TO AN EVEN VASTER CLOUD OF OBJECTS, READY FOR EXPLORATION BY FUTURE GENERATIONS.

Text super:

THE OORT CLOUD IS AN IMMENSE ICE-BOX OF LONG-PERIOD COMETS, FROM TEN TO ONE HUNDRED TIMES MORE DISTANT THAN THE KUIPER BELT, SURROUNDING ALL THE KNOWN WORLDS OF OUR SOLAR SYSTEM.

SPENCER:

There’s a real record of the early history of the solar system out there in cold storage, at the edge of the solar system.

BURRATTI:

This is what was left over. Pluto is the first member of that group.

BUT TO BEGIN HUMANITY’S EXPLORATION OF THE KUIPER BELT, YOU FIRST HAVE TO GET TO PLUTO.

...AND THAT MEANS GETTING A MISSION APPROVED...

...A SPACECRAFT DESIGNED AND BUILT...

...AND DELIVERED TO THE LAUNCH PAD ON TIME.

AND NONE OF THAT WAS EASY.

(Music)

Titles: **Act 2: HOW TO GET TO PLUTO**

(Music)

2015 MAY BE THE YEAR OF PLUTO... BUT GETTING THERE HAS TAKEN MANY LONG YEARS OF EFFORT.

AND FOR *NEW HORIZONS*, THERE’S A DATE WHEN THINGS GOT STARTED...

Text super:

...1989

IT WAS THE YEAR WHEN GEORGE HERBERT WALKER BUSH BECAME PRESIDENT...

AND THE BERLIN WALL FELL.

Dateline super:

August 1989

NASA JPL

FAR FROM EARTH, IT WAS ALSO THE YEAR WHEN NASA'S VOYAGER SPACECRAFT FLEW BY NEPTUNE AND RETURNED THE FIRST IMAGES OF ITS MOON, TRITON.

HAIR STYLES OF SOME NEW HORIZONS SCIENTISTS WERE VERY DIFFERENT

...BUT, FOR THEM, MAY 5TH 1989 WAS A MOST IMPORTANT DATE.

Text super:

ALAN STERN

New Horizons Principal Investigator, SwRI

Alan:

...that's the day that I marched into the then Division Director for Planetary Science at NASA headquarters Geoff Briggs, as a graduate student, and asked him why we aren't studying a mission to Pluto.

And he responded, "Because no one's ever asked me before. That seems like a brilliant idea. Why don't we do that?"

(Music hit)

SPACE MISSIONS RELY ON HUNDREDS IF NOT THOUSANDS OF PEOPLE, BUT SOMETIMES IT TAKES SOME *ONE* WITH PASSION AND PERSISTENCE TO MAKE THINGS HAPPEN.

AND FOR *NEW HORIZONS*, THAT'S ALAN STERN.

Timeline graphic:

2004

ALAN:

I was interested in this when I was a boy, so I've been somewhere between "in the groove" and "stuck in a rut" for 40 years!

THERE'D BEEN SOME THOUGHT ABOUT SENDING ONE OF THE TWIN VOYAGER SPACECRAFT PAST PLUTO, TO COMPLETE THE EXPLORATION OF THE KNOWN SOLAR SYSTEM.

BUT IN THE 70'S, THE SCIENTIFIC ESTABLISHMENT WASN'T CONVINCED PLUTO WAS ALL THAT INTERESTING.

YOUNG GRAD STUDENTS LIKE ALAN ...MARC BUIE ...AND FRAN BAGENAL THOUGHT DIFFERENTLY.

Text super:
FRAN BAGENAL
NEW HORIZONS CO-INVESTIGATOR, LASP, CU BOULDER

Fran:
Back in, oooh, about late 1989 or so, there was a bunch of us who were really keen to go to Pluto.

Text
MARC BUIE
NEW HORIZONS CO-INVESTIGATOR, SWRI

MARC:
And the thing that drew me to it the most was the fact that we knew so little. Here's the frontier.

FRAN:
So it was a bit of an opportunity for young people to come in and say, "Hey, where are we going to go next?"

"What's the next great frontier that we should go explore?" And it was clear ...out to the Kuiper Belt.

ALAN, FRAN, MARC AND A SMALL BAND OF ENTHUSIASTS BECAME KNOWN AS THE "PLUTO UNDERGROUND."

FRAN:
So we realized to make this happen we had to get together and campaign hard to make the case to go there and explore this little planet with all its moons.

ALL THROUGH THE '90S THERE WERE MANY COMPETING PLANS FOR A PLUTO MISSION...

LIKE THE "PLUTO FAST FLYBY"...

...THE "PLUTO KUIPER EXPRESS"

A PLUTO MISSION WAS ON, THEN OFF, THEN ON, THEN OFF...

(Music hit)

ALAN STERN:

If the Pluto mission had been a cat, it would have been dead long time ago, because they only get nine lives. And we've had significantly more than nine stoppages, and odd twists and turns.

WHAT FINALLY TURNED THE TIDE WAS THE NATIONAL ACADEMY'S DECADAL SURVEY, A CONSENSUS DOCUMENT FROM LEADING PLANETARY SCIENTISTS THAT RANKED A "KUIPER BELT-PLUTO" MISSION HIGHEST IN PRIORITY FOR MEDIUM CLASS BUDGETS.

FINALLY, AFTER COMPETITIVE PROPOSALS WERE EVALUATED, NEW HORIZONS , WHICH TEAMED ALAN STERN WITH THE JOHNS HOPKINS APPLIED PHYSICS LABORATORY, APL, AND SEVERAL OTHER INSTITUTIONS ACROSS THE COUNTRY, WAS SELECTED BY NASA ON NOVEMBER 29, 2001

NOW PLANS ON PAPER BECAME METAL IN CLEAN ROOMS.

IN 2004, LEAD SCIENTIST ALAN STERN DESCRIBED THE MISSION'S KEY SCIENCE OBJECTIVE.

ALAN STERN:

Well, you know, the key to planetary science is that you really have to go places to get the resolution, to get up close enough to really see what's going on.

We want to get up close and personal.

THE VERY BEST RESOLUTION OF CURRENT TELESCOPES LOOKING AT PLUTO WOULD GIVE THIS KIND OF FUZZY IMAGE OF A MUCH MORE FAMILIAR WORLD.

BUT HERE'S WHAT NEW HORIZONS WOULD SEE IF FLYING OVER NEW YORK CITY.

...LAKES IN CENTRAL PARK.

...WHARVES ON THE HUDSON RIVER.

FRAN BAGENAL:

New Horizons is the first, really, of a whole new breed of spacecraft that is focusing on a very specific task.

FOR THIS FIRST MISSION TO PLUTO THE QUESTIONS ARE BASIC:

WHAT DO PLUTO AND CHARON LOOK LIKE?

WHAT ARE THEY MADE OF?

HOW DO THEIR ATMOSPHERES BEHAVE?

FRAN:

We have to really be disciplined and say, “We can’t do everything. Let’s focus on the primary questions, and design the instruments to answer those primary questions.

Text:

LORRI

Long Range Reconnaissance Imager

THE LONG RANGE IMAGER, LORRI, WILL BE USED FOR NAVIGATION APPROACHING PLUTO, AND CLOSE-UP VIEWS DURING THE FLYBY.

Text:

Ralph

MVIC

Multispectral Visible Imaging Camera

LEISA

Linear Etalon Imaging Spectral Array

THE WIDE ANGLE CAMERA, RALPH, HAS BOTH VISIBLE LIGHT AND INFRARED SENSORS TO MAP PLUTO AND CHARON ...AND CHARACTERIZE THEIR ICY SURFACES.

Text:

SWAP

Solar Wind At Pluto

Text:

PEPSSI

Pluto Energetic Particle Spectrometer Science Investigation

THERE ARE TWO FIELDS AND PARTICLES DETECTORS, TO PROBE THE SOLAR WIND AT PLUTO.

Text:

REX

Radio Experiment

THE LARGE RADIO ANTENNA IS AN ESSENTIAL COMMUNICATIONS DEVICE...

...BUT BOTH REX AND ALICE, AN ULTRAVIOLET IMAGING SPECTROMETER, ARE PART OF EXPERIMENTS TO ANALYZE PLUTO’S ATMOSPHERE.

Text:

SDC:

Venetia Burney Student Dust Counter

AND THERE'S THE "VENETIA BURNEY STUDENT DUST COUNTER"

...BUILT BY UNDERGRADS AT UC BOULDER

...AND HONORING THE SCHOOLGIRL WHO NAMED PLUTO, BACK IN 1930.

TOGETHER THE SEVEN SCIENCE INSTRUMENTS COMPRISE THE MOST POWERFUL SET OF DETECTORS EVER SENT ON A FIRST FLY-BY OF ANY WORLD IN OUR SOLAR SYSTEM.

BUT THEIR INNOVATIVE AND HIGHLY MINIATURIZED DESIGN MEANS THAT EVEN WHEN ALL ARE OPERATING, THEY DRAW LESS POWER THAN HALF A SIXTY WATT BULB.

AND THEY'RE INTENDED TO WORK TOGETHER SEAMLESSLY.

(Music)

AFTER BUILDING COMES TESTING, BUT ALWAYS WITH AN EYE ON THE CLOCK AND THE CALENDAR.

Text super:

2004

Text:

HAL WEAVER

Project Scientist, NEW HORIZONS, JHU APL

HAL:

It's very, very important that we launch in either 2006 or 2007. We have to make that deadline.

ALAN STERN:

If you want to fly to Pluto on the quickest route, you need Jupiter in position, and that means we have to launch in January of 2006.

It feels a little bit like being strapped to train going 500 miles an hour.

THE TEST PROGRAM INVOLVES TEAMS OF ENGINEERS AT JOHNS HOPKINS APL... AND THEN AT NASA'S GODDARD SPACEFLIGHT CENTER.

Text

MARK PERRY
Mission Systems Engineer, JHU APL

MARK PERRY:

Once we launch this we can't go after it with a screwdriver. We can't go fix anything that isn't working.

ALAN:

We make sure that we carry plenty of spare equipment on board the spacecraft. If our main computer breaks, we have a back-up. If our main transmitter breaks, we have a backup.

(Rattling sounds)

MARK:

One of the things we do is we put the whole spacecraft on a gigantic vibration table, a paint shaker, and shake it. And then test it after that and shake it again, and test it again.

So that's what we're doing from now until launch.

ALONG WITH TESTING THE SPACECRAFT, NEW HORIZONS NEEDS TO TRAIN AND TEST ITS HUMAN OPERATORS.

AND FOR A MISSION PLANNED TO REACH PLUTO IN 2015, IT'S IMPORTANT TO HAVE YOUNG PEOPLE ON BOARD EARLY, SO THEY'LL BE AROUND AT CLOSE APPROACH.

Text super:
GLEN FOUNTAIN

GLEN FOUNTAIN:

It's good that we can do that so they will have both the time, the focus, to stay with the mission over this long period of time.

MANY OF THE FACES YOU SEE AROUND MISSION CONTROL IN 2004 AND 2005 ARE YOUNG AND ENTHUSIASTIC SPACECRAFT ENGINEERS.

Text super:
ALICE BOWMAN

ALICE BOWMAN:

Normally we're focused on subsystems, and instruments and the spacecraft surviving that duration but, y'know, for people we need to have a longevity plan.

Date supers and video wipes

THEY'D BE COMMITTING THE PRIME OF THEIR CAREERS TO THIS MISSION TO

PLUTO... KNOWING THEY'D BE A DECADE OLDER WHEN *NEW HORIZONS* REACHES ITS PRIMARY TARGET.

GLEN:

The ability to practice things in those years far out there are all part of the planning now, to ensure mission success, then.

(These two are intentionally not supered with name IDs.)

Ann Harch:

How old are you going to be?

Gabe Rogers:

In two thousand and fifteen?

Ann:

Yeah.

Gabe:

I dunno... something... somewhere in my forties!

Ann:

Oh, you're a youngster!

Gabe:

Yes.

IN LATE 2005, THE ACTION SHIFTS TO CAPE CANAVERAL.

NEW HORIZONS MAY BE LIGHT, AND RELATIVELY SMALL... BUT LAUNCHING IT TO PLUTO REQUIRES AMERICA'S MOST POWERFUL, THE ATLAS V (FIVE.)

NEW HORIZONS WOULD BE TRAVELING SO FAR FROM THE SUN THAT SOLAR PANELS WOULDN'T BE SUFFICIENT.

SO THE DEPARTMENT OF ENERGY DELIVERED AN R.T.G. (Note to captioners: RTG is OK) THAT WOULD POWER THE PLUTO MISSION BY TURNING HEAT FROM THE RADIOACTIVE DECAY OF PLUTONIUM INTO ELECTRICITY.

Date super:

Dec 17, 2005

WORKING ROUND THE CLOCK, THEY ARRIVE AT PAD 41 BEFORE DAWN.

ON BEHALF OF NASA AND THE ENTIRE NEW HORIZONS TEAM, STERN WANTED TO BE THE LAST TO BID THE SPACECRAFT “BON VOYAGE” BEFORE CLOSING UP THE HATCH.

ON JANUARY 19TH, 2006, AFTER SEVENTEEN YEARS OF PLANNING, BUILDING AND TESTING, A PICTURE-PERFECT LAUNCH THAT THRILLED ONLOOKERS IN FLORIDA...

(Cheers and applause)

...AND THE MISSION OPERATIONS TEAM, BACK AT JOHNS HOPKINS IN MARYLAND.

NASA KSC announcer:

“We have ignition... and liftoff of NASA’s New Horizons spacecraft on a decade-long voyage to visit the planet Pluto and then beyond.”

DESPITE IMMENSE TECHNICAL AND TIMETABLE CHALLENGES, THE MISSION HAD MADE ITS WINDOW AND WAS ON ITS WAY.

NEW HORIZONS’S VELOCITY AT LAUNCH WAS THE FASTEST EVER, TRAVELING ALMOST SIXTY TIMES FASTER THAN A JETLINER.

IN JUST NINE HOURS IT PASSED THE ORBIT OF THE MOON.

APOLLO HAD TAKEN ALMOST TEN TIMES THAT LONG.

ONE YEAR LATER A SLINGSHOT GRAVITY ASSIST FROM THE GIANT PLANET, JUPITER, PROVIDED ANOTHER TWO KILOMETERS PER SECOND BOOST, CUTTING TRAVEL TIME TO PLUTO BY THREE FULL YEARS.

**Date super:
February 26, 2007**

BUT THIS WAS MORE THAN JUST A JUMP IN SPEED.

THE JUPITER FLY-BY WAS A SCIENTIFIC DRESS REHEARSAL FOR PLUTO.

NEW HORIZONS’S INSTRUMENTS RETURNED DETAILED IMAGES OF JUPITER’S CLOUDS ...MOONS ...AND RINGS.

THEN, IT WAS OFF ACROSS THE EMPTY OCEAN OF SPACE, WITH NO NEW LAND IN SIGHT TILL PLUTO IN 2015.

THE SPACECRAFT HAD BEEN TESTED, AND PASSED WITH FLYING COLORS.

NOW IT WAS TIME TO TEST THE HUMANS AND THE GROUND SYSTEMS.

(Music change)

Dateline graphic:

JULY 5, 2013.

IT'S DAY ONE OF A NINE DAY ENCOUNTER REHEARSAL...

ALAN STERN:

The main success criteria for this rehearsal is for the spacecraft to flawlessly perform its activities as if it were at Pluto, with everything the same except that Pluto's not there.

THE DATES IN 2013 WERE CAREFULLY CHOSEN SO THAT "EARTH RECEIVED TIMES" WOULD BE IDENTICAL TO THOSE FOR THE REAL ENCOUNTER, IN 2015.

MISSION MANAGERS WANTED SCIENTISTS AND ENGINEERS TO EXPERIENCE THE STRESS OF TIME CRITICAL, 24/7, OPERATIONS EXPECTED FOR JULY 2015.

Text:

MARK HOLDRIDGE
ENCOUNTER MISSION MANAGER, JHU APL

MARK:

We are flying by an object that is a huge distance from Earth. And we are trying to hit a box that is 100 x 150 km wide. And that then leads into maneuver planning and trajectory control needed to thread that needle and hit that small box. It's way the heck out there

THIS REHEARSAL WOULD ACTUALLY BE UPLOADING COMMANDS TO NEW HORIZONS TO INSTRUCT THE SPACECRAFT TO RUN THROUGH THE EXACT SAME SET OF OBSERVATIONS AS IN 2015.

Text super:

NICK PINKINE
DEP. MISSION OPS MANAGER, JHU APL

NICK PINKINE:

There definitely is an element of risk involved. But from one standpoint if you didn't do any simulation with the real spacecraft at all, you could argue that could pose more risk because you don't want such a critical activity only being done once, in flight.

ALAN STERN:

Those are all invaluable to get us ready and practiced for the one and only shot we'll have to explore the Pluto system.

We've been waiting 12 years since we wrote the proposals to do this rehearsal. It's the *last* big step before we can do the Encounter.

Text super:
GABE ROGERS

GABE:
We think that we are about 10 million miles out from Pluto and closing.

ALAN:
So far, so good. We're off to the races...

(Music montage)

ALAN:
Today is our 2,724th day in flight... This has been a long time coming, literally. I only want to say, thanks for all the work. Let them eat cake!

(Music crescendos over cake cutting)

TITLE Act 3: WHAT MIGHT WE SEE?

(Music)

“JULY 12 2013”, STANDING IN FOR “JULY 14 2015.”

THIS IS IT... A MINUTE-BY-MINUTE SIMULATION OF “ENCOUNTER DAY.”

(Tense drum beats)

IT'S MAKE OR BREAK.

Text super:

GABE ROGERS:
Well, it's the most important because we've just been spending the 24 hours of the most intense activities that we've been running on the spacecraft and this is the longest that we've been out of contact since we've entered Encounter Rehearsal.

THIS MAY BE A REHEARSAL... BUT NEW HORIZONS HAS BEEN FIRING ITS THRUSTERS AND SPINNING IN SPACE, IDENTICAL MANEUVERS TO THOSE PLANNED FOR 2015.

ON “ENCOUNTER DAY” THE SPACECRAFT WILL BE TOO BUSY TAKING DATA TO SEND BACK IMAGES.

THAT'S WHY ITS FIRST SIMPLE "I'M ALIVE" MESSAGE WILL BE SO IMPORTANT.

(Tense music)

Sub-title:

KARL:

Some time within the next minute DSS 43 should lock up on the signal.

(Background sounds and tense music.)

(At 29:21, a BEEP as the signals lock up.)

ALICE BOWMAN (off camera):

We're good, we're nominal. Spacecraft is nominal, and it looks like...

ALICE BOWMAN:

...all the observations we have planned between the last track and this track happened.

GABE ROGERS:

So this gives us good confidence that at least the spacecraft has been performing all of those twists and turns that we have been anticipating it to over the last 7 days.

ALAN STERN:

I like to say that at the flyby... I don't want to be leaning anything about the ground system or the spacecraft, or the team, I want to be learning only about the Pluto system.

Text

ANN HARCH
SCIENCE OPERATIONS PLANNER, CORNELL

ANN:

No spacecraft has ever been to Pluto nor will ever go back in our lifetime.

Text:

JEREMY BAUMAN
Navigation Team, KinetX

JEREMY:

Pluto is every child's favorite planet. You know, you ask anyone under the age of six, and they're going to say Pluto.

KATIE (off camera):

We don't exactly know what Pluto looks like, but it looks very exciting from the images we have from the Hubble Space Telescope so far.

Text super:
KATIE BECHTOLD
MISSION CONTROLLER, JHU APL

KATIE BECHTOLD:

We really can't wait to get there and see what it actually looks like. So if anybody says that Pluto is boring, or not important, now way!

BEFORE NEW HORIZONS ARRIVES AT PLUTO, MOST EVERYTHING WE THINK WE KNOW ABOUT THE PLANET AND ITS MOONS IS UP FOR GRABS.

Dateline super:
2004 / New Horizons under construction at Johns Hopkins APL

ALAN STERN:

Virtually every place we have sent a spacecraft on a first reconnaissance mission like this, that we find out that our Earth-based notions were flat wrong.

So I'll tell you what we expect, but before anything, what we expect is to be surprised.

FROM THE 1990'S THROUGH TODAY, STERN HAS BEEN CONSISTENT IN AVOIDING SPECULATION.

STERN:

You get the same answer everybody's gotten from me for almost 20 years. I don't make predictions. Except for one. My best guess is, we're going to find something wonderful.

BUT IN THE FINAL MONTHS LEADING UP TO THE JULY 2015 ENCOUNTER, IT'S HARD FOR MOST HUMANS NOT TO IMAGINE WHAT WE'LL SEE.

MANY PLANETARY SCIENTISTS, LIKE PAUL SCHENK, BASE THEIR EXPECTATIONS ON WHAT WE SAW WHEN VOYAGER TWO REACHED NEPTUNE...

...AND SPECIFICALLY AS IT FLEW BY ITS MOON, TRITON.

PAUL SCHENK:

Voyager was a 10 year long exploration of the outer solar system. And every time, they got to a planet, it was, basically, the first time anybody had really seen those bodies.

Text super:
PAUL SCHENK
LUNAR AND PLANETARY INSTITUTE, HOUSTON

SCHENK:

So when they got to Jupiter, they were greeted with enormous surprises.

The erupting volcanoes on Io were just completely unexpected.

Text:
Miranda

SCHENK:
And so when they got to Uranus, there were more surprises.

Text:
Ariel

The exotic terrains of Miranda and Ariel, for example, were not expected.

SCHENK:
So by the time they got to Neptune, they were kinda accustomed to the idea that they were going to be surprised, and, sure enough, Triton completely blew them away.

BONNIE BURATTI WAS AT NASA'S JET PROPULSION LAB AS THE FIRST IMAGES OF TRITON, A MOON OF NEARLY 1700 MILES DIAMETER, CAME DOWN.

Name super:
BONNIE BURATTI
Sr. Research Scientist, NASA JPL

BONNIE BURATTI:
Triton is almost a twin of Pluto... it's about the same size, about the same brightness.

Text:
FRANCIS NIMMO
PROF., PLANETARY SCIENCES, UC SANTA CRUZ

NIMMO:
Originally Triton was probably a Kuiper Belt Object just like Pluto, floating around in space, but then it got too close to Neptune, and it got captured by Neptune's gravitational field.

RECENTLY PAUL SCHENK ENHANCED THE ORIGINAL VOYAGER DATA TO CREATE THIS DETAILED FLYOVER OF TRITON.

SHENCK:
It has odd patches and odd blob-like features, kind of like amoebas crawling around on the surface.

Triton has very few impact craters, its surface is extremely young, geologically.

NIMMO (off camera):
And it actually has geysers spurting material off into space.

BONNIE:

Here is a body that is hundreds of degrees below zero, so cold, it's forlorn, it's barren.

We just didn't expect to see this activity on Triton.

It was quite a surprise.

NIMMO:

If you just assume that Pluto was going to look exactly like Triton, which is the most similar object we know about, then you might expect to find a very interesting body.

BUT TRITON IS NOT THE ONLY DYNAMIC ICE WORLD IN THE OUTER SOLAR SYSTEM.

Text:

Enceladus

SIXTEEN YEARS LATER, THE CASSINI SPACECRAFT SENT BACK IMAGES OF SATURN'S MOON, ENCELADUS, ABOUT 300 MILES ACROSS.

BONNIE:

This is a tiny little moon. And Enceladus is actually a winter wonderland. It's very bright. It reflects almost all the radiation that falls on it.

And it has these huge ice volcanoes spewing out from its South Pole.

NIMMO (off camera):

And Enceladus is continuously giving off puffs of water vapor. And so if you start to see puffs of water vapor coming off Pluto...

NIMMO on camera:

...as New Horizons gets closer, that would be exceedingly interesting.

BUT WHAT FORCES CAN POWER VOLCANOES IN THE DEEP FREEZE OF THE OUTER SOLAR SYSTEM?

NIMMO:

Triton and Pluto are both balls of ice, with presumably rock in the center. And so one of the sources of energy is radioactive decay inside the rock, which gives off heat just like the Earth is heated.

If you just let Pluto sit there and pump the heat out of the rocks, you generate enough energy to melt a couple of hundred kilometers worth of ice.

It's still possible to have an ocean beneath a relatively thick ice shell. The ice shell might be 100 miles thick or so.

Over billions of years, the ice shell gets thicker, and thicker, and thicker as Pluto cools.

And as it does so, it squeezes the water underneath, and if you squeeze the water too much, then it may well actually create fractures and the water could jet out to the surface.

SHENCK:

When you're going out to the edge of the solar system, you kind of have to expect some surprises and we're going to see them at Pluto as well.

JUST AS TRITON AND ENCELADUS WERE MERE DOTS BEFORE SPACECRAFT REACHED THEM, UNTIL NOW PLUTO HAS BEEN AN "ASTRONOMER'S PLANET."

THAT'S ABOUT TO CHANGE.

L3

JOHN SPENCER

NEW HORIZONS CO-INVESTIGATOR, SwRI

JOHN SPENCER:

We are going to start off as astronomers. And we'll be using astronomical tools to try and sharpen up our images and pull every last little bit of detail out of these fuzzy blobs.

We gradually turn from astronomers into geologists, as we get closer and it becomes a real world.

JEFF MOORE WAS IN THE ROOM AT JPL AS THOSE TRITON IMAGES CAME DOWN.

BUT HE ALSO ENJOYS FIELD WORK ...AND THINKS WE'LL RECOGNIZE SOME SIMILAR PLANETARY PROCESSES AT WORK ON PLUTO AS BACK ON EARTH.

text

JEFF MOORE

NEW HORIZONS CO-INVESTIGATOR, NASA AMES

JEFF MOORE:

So, I'm a geologist. And although we don't expect to see oceans on Pluto, there are common processes which operate on this planet which are likely to operate also on Pluto and its moons.

WHILE THE SCALES ARE VERY DIFFERENT, EROSION SHAPES LANDFORMS HERE ON EARTH, AND ALL ACROSS THE SOLAR SYSTEM.

JEFF MOORE:

There are these little finger-like projections that are formed by the process of erosion, where wind and water have sculpted this landscape by taking advantage of small differences in the strength of the original rock, creating large, huge, fantastic landscapes, such as on Jupiter's moon, Callisto, and we can anticipate that we may perhaps also see landscapes like this on Pluto and its moons.

PLUTO'S 248-YEAR ORBIT IS MORE ECCENTRIC THAN OUR SOLAR SYSTEM'S TERRESTRIAL AND GAS GIANT PLANETS, GREATLY VARYING ITS DISTANCE TO THE SUN.

BUT IT'S TYPICAL OF MANY OTHER OBJECTS IN THE KUIPER BELT, AND NEWLY-DISCOVERED PLANETS AROUND OTHER STARS.

THAT, PLUS ITS HIGHLY-ANGLED POLAR TILT, COMBINE TO PRODUCE STRONG SEASONAL EFFECTS.

MOORE:

In fact, the seasons of Pluto are amongst the most extreme of any seasons on any world that we know of, orbiting the Sun.

AND THOSE EXTREMES MAY BE ONE REASON WHY ITS SURFACE IS ALSO EXTREMELY CONTRASTY.

MOORE:

Pluto is perhaps one of the most intensely bright and dark place that we've seen in the solar system.

MOORE:

This dark surface collects more heat, it warms up, like asphalt does on a sunny day here on the Earth, and if there were frost that had settled on this dark surface, they're being heated up and driven off and the transportation of this material could also be creating winds, so you might see small dunes oriented along the periphery of the dark surface, showing this process in action.

FOR PLANETARY SCIENTISTS, COLOR CAN BE A CLUE TO THE COMPOSITION OF SURFACES THAT CAN'T BE SAMPLED DIRECTLY.

MOORE:

On the Earth these kinds of colors from red to dark gray are generated entirely by the presence or absence of rust.

On Pluto we see also the same ranges of colors from gray to bright white to yellow to red to black, but there it must be due to a completely different process.

AT NASA'S AMES RESEARCH CENTER, NEAR SAN FRANCISCO, LONG-TIME PLUTO RESEARCHER, DALE CRUIKSHANK AND POSTDOC CHRIS MATARESE CONDUCT EXPERIMENTS TO SEE WHAT PROCESSES MIGHT CREATE THE COLORS WE SEE

ON PLUTO... STARTING WITH GASES, LIKE METHANE AND NITROGEN, AND THE EXTREME LOW TEMPERATURES WE KNOW ARE FOUND THERE.

Text super

DALE CRUIKSHANK

NEW HORIZONS Co-INVESTIGATOR, NASA AMES

DALE CRUIKSHANK:

In our cold chamber, we can produce a thin film of ice, and then, after that, expose them to a beam of electrons which are charged particles comparable to what comes in to Pluto's surface from space.

(Music transition)

We find that when we shine ultraviolet light or electrons on simple molecules, before too long, the simple molecules are broken apart and—by natural processes—they reassemble into more complex chemicals.

So far, the colors we make in the lab from irradiating these ices is fairly close to what we see on Pluto.

There are tones of yellow, light brown up through fairly dark red.

And if we carry the processing by ultraviolet light to an extreme degree, the material actually turns black. And this is almost the color of pure carbon.

SEEING HOW RADIATION TRANSFORMS SIMPLE ICES INTO COMPLEX AND COLORFUL ORGANIC MOLECULES SHOULD HELP INTERPRET THE CLOSE-UP VIEWS OF PLUTO'S SURFACE THAT'LL BE SENT BACK BY NEW HORIZONS.

DALE:

Color translates to the duration of the exposure of these otherwise colorless ices over a year, 10,000 years, 10 million years...

That may in turn tell us more about the nature of the exposure of Pluto's surface, and even the age of Pluto's surface.

DALE CRUIKSHANK BEGAN OBSERVING PLUTO BACK IN 1976... NOW, 39 YEARS LATER, HE'S READY FOR ITS CLOSE UP.

DALE:

We can say that Pluto is chemically active, chemically dynamic. We don't know yet if it's geologically active or dynamic, but that's what New Horizons is going to tell us.

We've been surprised in that way before as we've passed other planetary bodies that we had thought were totally cold, dead, inert worlds and find that there are geysers, there are ice flows, there are cracks, and all kinds of evidence for geological activity.

BONNIE BURATTI:

I can still remember the first time I saw Pluto in a telescope, and it was just a little dot that you could barely see.

It will be amazing that within a period of hours, it will be transformed from this tiny dot that I studied as an astronomer to this huge geologic world. That we'll be able to see volcanoes. and faults, and ices, mountains and craters.

I mean, it will be truly an amazing experience to see it transformed.

SO, FROM SOPHISTICATED LAB EXPERIMENTS, FROM EXPLORING OTHER WORLDS, AND FROM APPLYING INSIGHTS FROM TERRESTRIAL PROCESSES, WHAT SHOULD WE EXPECT WHEN WE GET TO PLUTO IN JULY 2015?

MOORE:

About the only thing that would surprise me... would be if we turned out not to be surprised.

BUT ENJOYING THE SCIENTIFIC SURPRISES TO COME MEANS AVOIDING DANGERS ON THE LAST FEW MILLION MILES TO PLUTO...

(Music crescendo)

THAT'S NEXT.

Title: Act 4: Unknown Hazards

(Music)

**Text super:
Johns Hopkins Applied Physics Lab
Laurel MD**

DECEMBER 6, 2014

**Dateline super:
12/6/2014 / New Horizons wakes up from hibernation**

IN MISSION CONTROL ALICE BOWMAN AND HER TEAM WAIT TO GET CONFIRMATION THAT NEW HORIZONS HAS EXITED WHAT'S CALLED "HIBERNATION."

FOR TWO THIRDS OF ITS 3 BILLION MILE JOURNEY, MOST SPACECRAFT SYSTEMS HAVE BEEN TURNED OFF, SAVING WEAR AND TEAR ON THE SCIENCE INSTRUMENTS.

NEW HORIZONS SENDS A SIMPLE SIGNAL ONCE A WEEK JUST TO SAY “I’M STILL A-OK.”

ALICE’S TEAM HAS A UNIQUE WAY OF SHOWING SPACECRAFT STATUS.

WHEN NEW HORIZONS IS HIBERNATING, THEIR BEAR MASCOT IS SAFELY ASLEEP.

WHEN THE SPACECRAFT “WAKES UP” THEY PUT ON ITS PARTY HAT!

IF ALL GOES WELL, THIS WILL BE THE 18TH TIME SPACECRAFT AND BEAR HAVE WOKEN UP.

BUT DECEMBER 2014 IS DIFFERENT. VIP’S FROM NASA HQ ARE ON HAND.

TWO FILM CREWS DOCUMENT THE ACTION, AS ALAN EXPLAINS THE BENEFITS OF HIBERNATION.

Stern, to the VIPs:

It lowers our cost because we don’t need to have people baby-sitting the spacecraft 24/7.

OUTSIDE INTEREST IN NEW HORIZONS IS BUILDING.

IF ALL GOES WELL, NEW HORIZONS WILL STAY AWAKE, FLYING BY PLUTO IN JULY 2015, AND THEN RETURNING DATA UNTIL OCTOBER 2016.

Alice, off camera:

“Copy that, thank you, G&C.”

TONIGHT DATA TRICKLES IN... AND ALICE HAS TO WAIT TO BE CERTAIN NEW HORIZONS IS FULLY AWAKE.

Alice:

We should be getting it momentarily.

Text super:

KARL WHITTENBURG

Dep. Mission Ops Manager, JHU APL

Karl:

Should be any minute now...

Alice:
It's like watching paint dry.

Alice, off camera:
Figure if I stare at this screen long enough...

Subtitle:
And packet 5 just came in! There we go.

Karl:
Packet 5 just came in! There we go.

Alice:
“PI... PM... “MOM” on “Pluto 1”: we have a nominal wakeup of the New Horizons spacecraft on its way to Pluto...”

(Applause in the far room)

Alice continues:
...we are ready for our next leg of the journey.

Sarah:
He's awake!

Alice:
Ah, our bear! He's going to be here for a while.

Alan:
This is a watershed day... we have completed the cruise across 3 billion miles of space. The spacecraft is now awake...

Name super:
HAL WEAVER
New Horizons Project Scientist, Johns Hopkins APL

Weaver:
Finally after 9 years, I am glad to see hibernation behind us and active ops ahead. On to Pluto!

BUT THERE ARE STILL HUNDREDS OF TASKS TO ENSURE A SAFE FLYBY IN JULY 2015.

Dateline graphic:
1/27/2015 / First new science images of the Pluto Encounter

JANUARY 27th...

NEW HORIZONS HAS BEEN SENDING BACK TECHNICAL DATA, AND ALL SEEMS FINE.

...BUT TODAY IS THE FIRST TIME HAL WEAVER AND ANDY CHENG WILL BE SEEING NEW SCIENCE IMAGES.

Hal: (actuality)
Also I thought I saw it pop up here... let's try that again.

CHENG IS LEAD SCIENTIST FOR THE LORRI CAMERA.

Text
ANDY CHENG
New Horizons Co-Investigator & LORRI Lead Scientist

Cheng:
LORRI is used for navigation, to find the targets and to correct the trajectory, so we get to the right place, at the right time.

Text:
STEVE CONARD
LORRI Lead Engineer, JHU APL

Steve:
Voltages, temperatures all look normal. Er... No error messages...

Hal:
This is it... let's check out the very first images.

And then Charon right there... Peak pixel... 55. That's right!

Hal:
OK?!?

(Happy laughter)

Hal:
Alright, there they are... let's look at the whole field.

FOR PROJECT SCIENTIST, HAL WEAVER, EVEN THE JUMP IN SIZE FROM ONE TO TWO PIXELS WAS SIGNIFICANT.

Hal to camera:
This is a real milestone in the New Horizons mission, the very first images of Pluto in the Pluto encounter year.

Hadn't turned LORRI on, hadn't gotten any images since last summer, last July. But this is it, this is the start of it.

(Actuality scenes)

Hal:

“Thar she blows!”

ANDY CHENG:

We really don't know what we're going to see... that's what this mission is all about, what is the surface of Pluto really like... how big is it, what are the orbits really?

So it's nothing but delightful surprises coming for us.

BUT SOME OF THE SURPRISES MAY NOT BE QUITE SO WELCOME.

(Electronic music)

AS NEW HORIZONS GETS STILL CLOSER TO THE PLUTO SYSTEM, LORRI WILL BE ABLE TO IDENTIFY SMALL MOONS AND POSSIBLE RINGS THAT CAN'T BE SEEN FROM EARTH.

(Music)

Dateline graphic:

2/19/2015 / “UHaz” Operations Readiness Test

JOHN SPENCER IS LEADING THE “UHAZ” CAMPAIGN.

“UHAZ” STANDS FOR “UNKNOWN HAZARDS.”

Name text

JOHN SPENCER

New Horizons Co-Investigator, SwRI

JOHN SPENCER:

We may find new moons, or even rings around Pluto. And if we see anything like that, we're going to want to determine whether it poses a threat to the spacecraft.

Because if it does, if there's debris that we might run into that might damage or kill the spacecraft, then we want to evaluate that hazard and determine whether we should take any evasive action.

Place super:

White Sands Test Facility

NASA

TO FIND OUT JUST HOW VULNERABLE NEW HORIZONS MIGHT BE TO EVEN TINY DUST PARTICLES, THE MISSION SENT SAMPLES OF SPACECRAFT COMPONENTS TO THE WHITE SANDS TEST RANGE.

TECHNICIANS AT WHITE SANDS SET UP GUN TESTS, TO ASSESS HOW VULNERABLE NEW HORIZONS'S OUTER COVERS AND CABLES MIGHT BE.

Name super
GLEN FOUNTAIN

GLEN FOUNTAIN:

We went to two facilities that could shoot things into parts, er, models of the spacecraft.

(Impact sound effect)

WHILE THE RESULTS MIGHT LOOK DANGEROUS, THE MISSION HAS OPTIONS TO TAKE EVASIVE ACTION.

SPENCER:

One of the backup strategies we have if we feel we need to give the spacecraft extra protection is that we orient it so that the High Gain Antenna here, which is literally pretty bulletproof and can protect the spacecraft, is going to be facing forward in the Ram direction. This is "ram" in the sense of battering ram. It's the direction in which stuff will be coming at us and ramming into the spacecraft.

And if that is facing forward, then any dust particles that hit the spacecraft are most likely to hit that antenna where they won't cause us problems, and only a small part of the spacecraft around the edges is going to be exposed to those particles.

THAT WOULD PROTECT THE GUTS OF THE SPACECRAFT, BUT LIMIT THE POINTING OF THE CAMERAS.

SPENCER:

The cameras are fixed to the spacecraft, so if the spacecraft has to point in one direction, the cameras can only point in a limited range of directions.

This limits the amount of times we photograph the system as we go past, because we can only photograph objects when they're just in the right angle that we can look at them while protecting the spacecraft with the main antenna.

ANOTHER OPTION IS TO TAKE DIFFERENT TRAJECTORIES THROUGH THE PLUTO SYSTEM.

THAT'S CALLED THE "SHBOT" PLAY...

Text super:
SHBOT
Safe Haven By Other Trajectory

ALAN STERN
SHBOT is the best acronym in the space business. (Laughs)

Text super: SHBOT

It stands for “Safe Haven By Other Trajectory.” And it is the word we use to represent our backup plans at Pluto.

The second SHBOT takes us much closer to Pluto, into the region where atmospheric drag depletes orbits of any debris, which we think would be the safest “Hail Mary” pass that we could fly if we have to do something different than the nominal.

We are coming into the Pluto system with the ability, if we learn something that we don’t expect, to be able to make a change and get the goods.

BUT THOSE DECISIONS CAN ONLY BE MADE IN THE LAST MONTH BEFORE CLOSEST APPROACH...

AND THERE’LL BE LIMITED TIME TO EVALUATE THE BEST OPTIONS.

SO, IN FEBRUARY 2015, SPENCER’S “UHAZ” TEAM, INCLUDING RING SPECIALIST MARK SHOWALTER AND POST DOC, SIMON PORTER, ARE RUNNING THROUGH A READINESS TEST.

NOW THEY’RE ON THE CLOCK, AND BEING “SCORED” FOR WHETHER THEY CAN WORK THROUGH THE CALCULATIONS FAST ENOUGH TO DECIDE ON A TRAJECTORY CORRECTION MANEUVER THAT MIGHT PREVENT “LOSS OF MISSION.”

AND THAT MAKES THIS EXERCISE MORE CRITICAL THAN ANY THAT HAVE GONE BEFORE.

SPENCER:

The difference between this and previous Operational Readiness Tests is that this is where we have to demonstrate the project to NASA that we can do this.

BUT THE ONLY “TEST” THAT REALLY MATTERS COMES ON JULY 14TH 2015.

THAT ONE DAY WILL PAY OFF 26 YEARS OF DREAMS, AND NINE YEARS IN FLIGHT.

Text super:

Act 5: PORTAL TO THE KUIPER BELT

Dateline graphic:

1/17-19/2015 / First Science Team Meeting of The Year of Pluto

FOR THE SCIENCE TEAM, “THE YEAR OF PLUTO” BEGAN WITH ANOTHER MEETING TO REVIEW THE LATEST DATA ON THE PLUTO SYSTEM, AND TO HEAR UPDATES ON HOW THE SPACECRAFT WAS PERFORMING.

MISSION MANAGER GLEN FOUNTAIN, WHO’D BEEN WITH THE PROJECT FROM ITS START, SUMMARIZED REMAINING RISKS.

RED BOXES ARE POSSIBILITIES THAT COULD KILL THE MISSION.

BUT NOW IN 2015 THERE ARE MORE AND MORE GREEN BOXES... RISKS THAT HAVE BEEN MINIMIZED.

GLEN FOUNTAIN

New Horizons Project Manager, Johns Hopkins APL

GLEN FOUNTAIN:

Something that we haven’t thought of still might happen.

But I’m confident that whatever happens, whatever fate throws at us, this team will be able to resolve it. And we’ll go on to get wonderful data when we get to Pluto.

Name super

Alan Stern

ALAN STERN

We have a fantastically talented team of people who have worked very hard, and we’ve tested the sequences inside and out.

Dateline graphic:

2005 / "SIM" (Simulation) of the 2015 Pluto flyby

And while there are always “unknown unknowns”, I’m very confident and really looking forward to the curtain rising.

ALONG WITH MIND-BENDING TECHNICAL DETAILS, THERE ALSO WAS A SENSE OF HISTORY IN THE MAKING.

TO DOCUMENT THE LONG YEARS OF EFFORT TO GET THIS CLOSE TO PLUTO, THE MISSION RECREATED A TEAM PHOTOGRAPH TAKEN IN 2004.

AS GLEN, ALAN AND ALICE HAD CAREFULLY PLANNED BACK THEN, MANY OF THE SCIENTISTS AND ENGINEERS WERE STILL ACTIVELY ENGAGED IN *NEW HORIZONS*, AND LOOKING FORWARD TO JULY 2015.

GLEN FOUNTAIN:

We have worked hard to get a coherent team, because if you don't have a good team to operate the spacecraft, to do the planning, you will fail.

Dateline graphic:

2005 / "SIM" (Simulation) of the 2015 Pluto flyby

And so we worked a plan, early in the mission, to have younger people with the right amount of experience to be on the mission.

Dateline graphic:

7/12/2013 / Team breakfast upon completion of rehearsal for the Pluto flyby

GLEN FOUNTAIN:

And it's just like watching your kids grow. It's like all of a sudden...

Glen on camera:

"Where did the time go?"

Y'know, they are older. They're more mature. And they're now the very experienced veterans.

BUT THE HARD WORK OF MISSION PLANNING WAS BY NO MEANS OVER, EVEN THIS CLOSE TO JULY 2015.

WHILE EXPLORING PLUTO IN 2015 IS EXCITING IN ITSELF, NEW HORIZONS WAS RECOMMENDED IN PART AS A MISSION THAT MIGHT CONTINUE ON, FARTHER OUT INTO THE KUIPER BELT.

THAT TAKES IDENTIFYING *POTENTIAL* TARGETS NOW FOR A STILL MORE DISTANT FLYBY, SHOULD NASA APPROVE AN EXTENDED MISSION.

THIS CHALLENGING TASK WAS ASSIGNED TO JOHN SPENCER, MARC BUIE AND A TEAM OF YOUNG POSTDOCS.

AND, LIKE EVERYTHING ABOUT THIS MISSION, IT WASN'T EASY.

Place super:

Magellan Telescopes

Las Campanas Observatory, Chile

BUIE AND JOHN SPENCER HAD BEEN USING EARTH'S LARGEST TELESCOPES IN HAWAII AND CHILE, BUT EVEN EARTH'S BEST COULDN'T CRACK THIS TASK.

Name super
MARC BUIE
New Horizons Co-Investigator, SwRI

MARC BUIE:

But the basic problem is the Earth's atmosphere is just a mess at these scales ...there's a limit. And that's what we've been beating our heads against.

Now, with time running out we had to turn to Hubble. And so we, sort of not so jokingly, talk about "Hubble to the rescue." Without Hubble we would not have these objects.

MARC AND HIS YOUNG COLLABORATORS CAME UP WITH INNOVATIVE SEARCH TECHNIQUES, USING CUSTOM SOFTWARE.

Marc:

What that does is makes the stars smear out and makes the Kuiper Belt Objects hold still.

L3
SIMON PORTER
New Horizons post-doc, SwRI

Simon Porter:

It's been a lot of work, but to do something as exciting as this has been just so much fun.

I've been plugging through the data today, because it's fresh data and I just really, really wanted to know what the answer was.

L3
AMANDA ZANGARI
New Horizons post-doc, SwRI

AMANDA ZANGARI:

Well, we would have been in big trouble if we didn't find the KBO in time. So there was this pressure but, honestly, we had the best people in the world working on the problem and we did it.

MARC BUIE:

We just do the math, write the software, crunch the pixels, and then I create this graphic...

And from that point on, it's what I call "wetware," it's what you've got in your head.

IN REALITY, KBOS ARE MOVING AGAINST THE FIXED STARS.

MARC CAME UP WITH A WAY OF MAKING THEM MORE OBVIOUS BY FLIPPING THAT AROUND, AND MAKING THE STARS APPEAR TO MOVE ...AND ANY KBOS STAND STILL.

MARC BUIE:

Right in the middle there's something, it's just holding dead constant. And that's the Kuiper Belt Object. You can't argue with that!

IT WAS A HIGH-TECH VARIANT OF THE APPROACH THAT HAD BEEN INSTRUMENTAL IN EXPLORING THE PLUTO SYSTEM RIGHT FROM THE START.

MARC:

But at the core, it's a technique that hasn't really changed since Tombaugh's day. You have two pictures of the sky taken at different times, and you're looking for the stuff that moves.

As soon as you see something real there is absolutely no question about it.

As soon as it flashes on the screen, in just a millisecond, there it is, it's real, and you know, "I've found another Kuiper Belt Object."

BUT FINDING A KBO IS ONLY HALF THE BATTLE.

IS IT LOCATED WHERE NEW HORIZONS CAN REACH IT WITH AVAILABLE FUEL?

SIMON PORTER:

Once you have the orbit and we know where the spacecraft is and where it's going to be, we can figure out how much fuel the spacecraft is going to need to use to get to these objects.

WITH MORE HUBBLE TIME, NEW HORIZONS GOT A PLEASANT SURPRISE!

Marc:

It looked like we might actually have to burn the engines to miss the object (LAUGHS) which was a pretty exciting concept.

It's a good thing we looked because you wouldn't want to run into one of these things.

Dateline graphic:

2018-19 / Possible KBO flyby subject to NASA approval of Extended Mission

Simon, voice over:

These "cold classicals" they are pretty much as they were 4.5 billion years ago. They're little fossils.

To camera:

That's incredible. We have no idea what they're going to look like.

SO WITH POTENTIAL TARGETS FOUND AT LAST, IT WAS ON TO PLUTO.

Spencer name super:

JOHN SPENCER:

I'm feeling pretty exhilarated at this point. You're at the top of the roller coaster. You're about to go down that dizzying, thrilling ride into the system

...just seeing Pluto there getting bigger and bigger, it gives me goose bumps.

JAMES GREEN:

Today we're only a few months away from the Encounter. We're less than an astronomical unit, the distance between the Earth and the Sun, that distance away from this fascinating object.

Name super:

JAMES GREEN:

It's the last major body in our solar system that we really need to visit.

ALAN STERN:

To be putting a capstone on the initial reconnaissance of the solar system, it's heart-warming and it feels like it's something that makes a career worthwhile...

LESLIE YOUNG:

As spacecraft go, New Horizons is a very small team, but still we have been working on this for over a decade

L3

LESLIE YOUNG

New Horizons Pluto Encounter Planning Lead, SwRI

...and you add it all up and it's about two and a half million work hours to get ourselves to Pluto.

GLEN FOUNTAIN:

We have waited, first the four years that we couldn't hardly think about, because we were running so fast.

And then it is, "Oh," we wait, and we wait, and now we are ready to begin the encounter.

We have had "delayed gratification."

ALAN STERN:

"The Year of Pluto" is simultaneously a beginning and an ending. It's an ending in that we are completing our objective.

We're accomplishing the flyby of the Pluto system for the first time.

Alan to camera:

But it's also the beginning of a whole new chapter for science, of really being able to explore these objects as the data comes down over a period of months.

ALAN:

You know, in bringing in postdocs and the younger scientists, some of whom were in high school when we started this project, and now they have their PhDs and they are spectacular experts and very talented at what they do.

AMANDA:

I was in preschool when Alan first started talking about a Pluto mission and finishing high school and starting college when it was built...

...and in grad school for the cruise.

GLEN:

Having young people come into these programs gain the experience ...they're going to be the next generation of explorers.

SIMON:

We've never been to a KBO. We've never been anywhere close to a KBO. This is the most unexplored area of the entire solar system, which is another way of saying, "This is the most unknown area that we, as humans, can reach with spacecraft."

L3

CATHY OLKIN

New Horizons Dep. Project Scientist, SwRI

CATHY:

We can't wait to get to Pluto and to July 14th and to see what the surface looks like. We're ready to go and it's show time.

GLEN:

We are capable of continuing an adventure that humanity began hundred thousand years ago as our ancestors walked out of Africa. And we are continuing that exploration. And this country is in the forefront of doing that.

Music crescendo and fade black.

CREDITS