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>> Hello, and welcome to NASA's
Jet Propulsion Laboratory

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in Pasadena, California,
I'm Preston Dyches.

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We are at the end of an era
in planetary exploration.

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In less than two days,
NASA's Cassini spacecraft

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will make its
fateful, final plunge

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into the atmosphere of Saturn

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collecting data until
the very last moment,

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as it ends its 13 year
tour of the Saturn system.

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The purpose of
our briefing today

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is to provide background on
how we got here with Cassini,

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along with preparations
for the final plunge,

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and some of the science
that the Cassini team

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hopes to accomplish as
Cassini heads into Saturn.

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Our participants for
the briefing today are,

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from NASA headquarters
in Washington,

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the Director of NASA's Planetary

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Science Division, Jim Green.

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Up next, we have the
Program Manager for Cassini

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here at JPL, Earl Maize.

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To his left, the Cassini Project
Scientist, Linda Spilker.

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And finally, Team
Lead for Cassini's

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ion and neutral mass
spectrometer instrument,

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or INMS, from Southwest
Research Institute

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in San Antonio, Hunter Waite.

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Alright, a reminder to reporters
dialed in on the phones,

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please dial star one to get in
the queue to ask a question.

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And members of the public
as well as the media

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can ask questions
online via Twitter,

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using the hashtag #AskNASA.

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And with that, let's turn it
over to Jim to get started.

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>> Thank you very much, Preston.

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You know, we're here at
a very historic time,

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but it really started
with the Voyagers,

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Voyager One and Two, as we
see here in the auditorium,

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a full scale Voyager, passing
through the Saturn system,

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begging us to go back.

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And of course, in
2004, Cassini made it

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to the Saturn system.

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And as you can see, Cassini,
this is a smaller scale model,

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but if you can imagine
the antenna size

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on Voyager being
the same as Cassini,

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this is a very capable,
large spacecraft

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that has been making
fabulous measurements

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within the Saturn system.

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My first slide, please.

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Of course, Saturn, one of
the beautiful gas giants

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in our solar system,
with the beautiful rings.

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Studying the planet itself
has been incredibly important.

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The cloud dynamics and
the storms that occur,

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and in fact while Cassini was
there, a storm that lasted

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more than nine months raged
in its northern hemisphere.

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Next slide, please.

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Of course, as we were able
to get to higher latitudes,

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we were able to look
down at the polar region

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and see other
spectacular things.

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The hint of this hexagon
pattern on the north pole

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was really observed
first by the Voyagers,

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but we're now back to see
that up close and personal.

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The size of this whole hexagon,

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which is actually a jetstream
on the outer rim of it,

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is about twice the
size of our Earth.

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In addition to that,
we had opportunities

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to begin to look at the moons.

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And here, other surprises
were well in store for us.

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As seen in this image,
this is Enceladus.

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This is a small moon just
outside the rings of Saturn,

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and what we thought
was an icy ball.

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When we observed the
Southern Hemisphere,

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and geysers of water spewing
out into the Saturn system,

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it amazed us and began
changing the way we view

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the habitability or potential
habitability of moons

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in the outer part
of our solar system.

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My next image, of course,
is the beautiful Titan.

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This moon is bigger
than the planet Mercury.

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It has an atmosphere at twice
our atmospheric pressure.

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If it was orbiting the
Sun and not Saturn,

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we would call it a planet.

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It's truly a magnificent body.

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The Voyagers could
only see the haziness

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of this beautiful
object, but with Cassini,

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our ability to penetrate through
that haze with our radars,

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and seeing what the surface
structures and features are,

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and the DSA Huygens
probe going all the way

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down to the surface,
revolutionized

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our understanding of
this spectacular moon.

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This is the only other
body in the solar system

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that has liquid on its surface.

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Its seas are about the
size of our own Black Sea.

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Now, they're not full of water,

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but they're full
of liquid methane.

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This is a spectacular
world in its own right.

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Next slide, please.

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Of course, Saturn has
more than 60 moons.

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Can't see them all, but
we saw approximately

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two dozen of them in addition
to Enceladus and Titan.

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Beautiful moons, with
all sorts of structures.

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Those that even, in fact, modify
the structure of the rings,

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creating divisions, or
elements that accrete material,

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and we begin to see all those

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processes up close and personal.

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But one of the real stars
of the show is Titan.

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Our ability to fly by Titan,
which is about 20 Saturn radii

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away from Saturn, allows
us to use the very basic

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principle of gravity
assists to change

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the plane of Cassini's
orbit, provide new views,

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and therefore observe in
beautiful different ways.

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The next animation
shows you these flybys.

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Now what we normally
do on flybys

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is just get a little idea
of what that body is,

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but these flybys have
revolutionized our opportunity

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to use this concept
for other missions.

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We now know from these
flybys how to construct

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a global view of
this beautiful world,

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and we're using it on
the clipper mission

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that's going to Jupiter and
viewing the moon Europa.

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Cassini has enabled us to make

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those future missions possible.

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My next slide, please.

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Americans had a wonderful
view of an eclipse,

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where the moon passed in
front of the sun last month.

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Millions of people
appreciate now

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what eclipses are all about.

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From our view on Cassini,
this is the eclipse,

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with Saturn moving
in front of the Sun.

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This allows in the low
light of blocking the Sun,

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opportunities to see
in greater detail

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the ring structure
and other elements.

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In fact, we were even able
to see distant planets,

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and the Earth, in a beautiful
set of mosaic images

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that have been stitched
together, as shown here.

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That outer ring that you
see is called the E ring.

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We're able to illuminate
it in ways that tells us

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that Enceladus' geysers,
water being spewed out,

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is creating this ring.

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Now because of the
importance of Enceladus

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that Cassini has shown
us, and of Titan,

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another potential world that
could be habitable for life,

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perhaps not like we
know it, but perhaps

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completely different
than ours, we had to make

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decisions on how to
dispose of the spacecraft.

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And that led us,
inevitably, to the plan

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of taking Cassini and
plunging it into Saturn.

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Because of planetary protection,

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and our desire to go back to
Enceladus and go back to Titan,

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go back to the Saturn
system, we must protect

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those bodies for
future exploration.

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Next slide, please.

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Well, in the visible camera,

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we've seen more
than 450,000 images.

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Every one of them,
in their own way,

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are absolutely spectacular.

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But we made the
decision to go through

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and pick the top 100 images,
videos, and animations,

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and create an ebook,
something that allows us

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to go back and view
what we accomplished,

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and the beautiful observations
that this mission has done.

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You can download this ebook in

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several formats at

nasa.gov/ebooks.

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So with that, let's learn

how we plan to plunge Cassini

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into Saturn, and what we will

learn from that experience.

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So let me turn it

over to Earl Maize,

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the Project Manager

for Cassini, Earl?

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>> Excuse me, thank you, Jim.

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It's been such a unique

and incredible privilege

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and pleasure to operate

this spacecraft,

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that before I go

into its demise,

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I'd like to talk just
a little bit about some

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of its many accomplishments.

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As Jim pointed out,
almost half a billion,

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I'm sorry, half a
million images taken,

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4.9 billion miles logged
on this spacecraft,

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635 gigabytes of
data played back.

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Now that, by modern
standards, is not a whole lot

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bigger than a flash
drive, but you gotta think

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about 80s technology from
a billion miles away,

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and that all of a sudden
becomes pretty amazing.

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We had 162 targeted flybys,

and as Jim pointed out,

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we've been using Titan
to great advantage,

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and there have
been 127 of those.

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Could I have the
first graphic please?

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Just to show you this
incredible spacecraft.

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Now as it's half, twice
again, the size of the model

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in this auditorium
if you're here,

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but it's absolutely splendid,
just built for Saturn.

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And of course, that's the iconic

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north pole of Saturn below it.

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Now that is an animation,
we did not take

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a selfie stick with us,
although we could have put one

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on the RPWS antenna
in hindsight.

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That again was something that
the 90s didn't know about,

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so we'll have to live onward.

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But again, it's just been almost
flawless operations in both

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the instruments and the
spacecraft engineering systems,

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and then the ground
support itself, again,

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has just, I think
made this mission,

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not only do we
have an environment

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that just is overwhelming
with abundance

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of scientific
mysteries and puzzles,

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we've had a spacecraft and a
team that could exploit it.

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So again, I will probably
come back to that point,

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but it's just been an
amazing, amazing mission.

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So what are we gonna do?

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Let's get to the last few hours.

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Could I have the next animation?

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This is the so-called
ball of yarn.

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What we do, as Jim pointed
out, we have a main engine,

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and it's a great main
engine, but we've got Titan,

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and Titan is a
phenomenal main engine.

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Every time we flyby Titan,
every time we flyby Titan,

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we get a little bit
better view of Titan,

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and we get a little bit better
view of the Saturn system.

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Every one of those
course changes,

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every orbit change there
is, Titan's doing it for us,

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and it's done for us for
294 different orbits.

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127 times we've made
major orbital changes,

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and Titan's been at the
center of every one of them.

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So that's the ball of yarn,

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and if I could to
go the next one,

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let me just show you
what Titan did for us.

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This is April.

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All the time we've
been outside the rings,

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and being very careful with
the rings, and with the dust,

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because we really didn't
understand the environment well.

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But for the grand finale,
in order to exploit

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every last ounce of our
propellant and the science

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that Saturn offered inside,
we've been what we've

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been calling the proximal
orbits, or the grand finale.

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Titan gave us one last
little nudge back in April

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and pushed us, the
Cassini spacecraft,

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between the rings and
the planet itself,

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and we've been
skirting back and forth

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in that sense for 22
times since April.

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Our last one, unfortunately,
was Saturday morning,

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or Saturday evening, actually,

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we got the callback
on Saturday morning.

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We don't normally communicate

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with the spacecraft
during these passages,

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because the science
is so precious,

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we are busy gathering that.

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So the call home was Saturn
morning, we were here,

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got the call home,
spacecraft's fine,

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it did it again the
way it always has.

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Monday we got the kiss
goodbye from Titan.

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119,000 kilometer altitude
flyby from Titan took about

245

00:00:00,000 --> 23:59:59,999

39 meters per second of velocity
away from the spacecraft,

246

00:00:00,000 --> 23:59:59,999

slowed it down just
enough that what's going

247

00:00:00,000 --> 23:59:59,999

to happen on Friday is
absolutely inevitable.

248

00:00:00,000 --> 23:59:59,999

So if I could go to that next
animation, just to show this.

249

00:00:00,000 --> 23:59:59,999

There is a graphic here,
see that Titan flyby?

250

00:00:00,000 --> 23:59:59,999

Now that's behind me,
I should be pointing.

251

00:00:00,000 --> 00:00:00,697

That little Titan flyby was
enough to put us into Saturn.

252

00:00:00,730 --> 00:00:02,665

It was just distant
enough, just close enough,

253

00:00:02,698 --> 00:00:06,636

and just the right orientation
to seal Cassini's fate.

254

00:00:06,669 --> 00:00:08,304

So what's gonna happen next?

255

00:00:08,337 --> 00:00:10,506

Could I get the next
graphic, please?

256

00:00:10,539 --> 00:00:13,543

We made contact with
Cassini for the last time,

257

00:00:13,576 --> 00:00:17,447

for the penultimate
time, we ceased

258

00:00:17,480 --> 00:00:19,582

contact about 6:50 this morning.

259

00:00:19,615 --> 00:00:22,285

After the Titan flyby, we
got a call home last night,

260

00:00:22,318 --> 00:00:23,653
we were all in the
mission support area,

261
00:00:23,686 --> 00:00:24,754
waiting for telemetry.

262
00:00:24,787 --> 00:00:28,291
As it has done over
and over again,

263
00:00:28,324 --> 00:00:30,760
Cassini came in on time
and in perfect shape.

264
00:00:30,793 --> 00:00:32,628
It got the flyby that it needed,

265
00:00:32,661 --> 00:00:34,397
it got the velocity
change it needed,

266
00:00:34,430 --> 00:00:37,400
and it's now on its
way into Saturn.

267
00:00:39,635 --> 00:00:43,306
But before it goes, at
about 6:50 this morning,

268
00:00:43,339 --> 00:00:47,343
it turned off of Earth back
to the job it's been at

269
00:00:47,376 --> 00:00:51,347
for the last 13 years,
observing Saturn's system.

270
00:00:51,380 --> 00:00:53,282
It's gonna be taking

the last set of pictures

271

00:00:53,315 --> 00:00:56,352
of some of the prime
targets that it's visited

272

00:00:56,385 --> 00:00:58,688
over the many years that
it's been at Saturn.

273

00:00:58,721 --> 00:00:59,689
And we'll be able to share those

274

00:00:59,722 --> 00:01:02,291
with you sometime on Friday.

275

00:01:02,324 --> 00:01:04,427
They'll be coming back tomorrow,

276

00:01:04,460 --> 00:01:07,530
at about 2:45 tomorrow
afternoon, Cassini's
gonna turn back,

277

00:01:07,563 --> 00:01:10,500
and play back those
final sets of images.

278

00:01:10,533 --> 00:01:12,602
We figure that should
take about 11 hours,

279

00:01:12,635 --> 00:01:15,204
so at about one
o'clock in the morning

280

00:01:15,237 --> 00:01:17,741
of Friday, September
15th, we will,

281
00:01:20,309 --> 00:01:23,279
the solid state recorders
onboard Cassini will be empty,

282
00:01:23,312 --> 00:01:26,349
and we will then
reconfigure Cassini

283
00:01:26,382 --> 00:01:29,385
for its very final
transmissions.

284
00:01:29,418 --> 00:01:33,322
What we're gonna do is,
Cassini is normally a mission

285
00:01:33,355 --> 00:01:36,726
that stores things on data,
like it's doing right now,

286
00:01:36,759 --> 00:01:39,595
we're not in contact, we
could look all we wanted,

287
00:01:39,628 --> 00:01:42,298
and Cassini's off busy
doing its own thing,

288
00:01:42,331 --> 00:01:45,568
stores it on the recorders
and plays it back later.

289
00:01:45,601 --> 00:01:47,303
It's doing that right now.

290
00:01:47,336 --> 00:01:49,705
But next Friday morning,
we're going to turn Cassini

291

00:01:49,738 --> 00:01:51,474
into what we call, essentially,

292

00:01:51,507 --> 00:01:53,509
a bent pipe transmission system.

293

00:01:53,542 --> 00:01:55,278
Everything that comes
from the instruments

294

00:01:55,311 --> 00:01:57,513
is going to go right into the
recorder and right back out.

295

00:01:57,546 --> 00:01:59,448
So there'll be a
few seconds' delay,

296

00:01:59,481 --> 00:02:02,318
but it's essentially now
a real time instrument.

297

00:02:02,351 --> 00:02:05,454
And that's to enable the
sampling instruments,

298

00:02:05,487 --> 00:02:09,258
particularly the ion and
neutral mass spectrometer,

299

00:02:09,291 --> 00:02:11,427
to get data as deep
into the atmosphere

300

00:02:11,460 --> 00:02:13,329
as Cassini will permit it.

301

00:02:13,362 --> 00:02:16,265
We've taken our data rate down
to as low as we can handle,

302

00:02:16,298 --> 00:02:18,501
so that no matter what antenna
we've got on the ground,

303

00:02:18,534 --> 00:02:19,735
we'll be able to receive it.

304

00:02:19,768 --> 00:02:24,674
So if it's a rainy day in at
the, in Canberra, in Australia,

305

00:02:24,707 --> 00:02:26,576
where we'll be tracked,
then we'll be able to have

306

00:02:26,609 --> 00:02:28,477
a better chance of
getting the data.

307

00:02:28,510 --> 00:02:31,547
We've also got antennas both
at the DS End Tracking stations

308

00:02:31,580 --> 00:02:33,649
on the east side of Australia,

309

00:02:33,682 --> 00:02:36,485
but also we've got the
New Norcia DSA station

310

00:02:36,518 --> 00:02:38,487
standing at the ready
on the west side.

311

00:02:38,520 --> 00:02:40,456
So if we've got a rainy day
over the entire continent,

312

00:02:40,489 --> 00:02:41,691
well we're out of luck.

313
00:02:41,724 --> 00:02:45,695
But the best we can do,
we've got ourselves covered.

314
00:02:45,728 --> 00:02:48,731
We will turn, at that
point also, to make sure

315
00:02:48,764 --> 00:02:53,402
that the high gain antenna,
the large dish you see there,

316
00:02:53,435 --> 00:02:54,604
is pointed directly
at the Earth,

317
00:02:54,637 --> 00:02:56,439
and that we've
rotated the spacecraft

318
00:02:56,472 --> 00:02:59,308
so that the ion neutral
mass spectrometer's aperture

319
00:02:59,341 --> 00:03:02,345
is pointing directly into
the oncoming atmosphere.

320
00:03:02,378 --> 00:03:03,746
So essentially, it's
getting just a full blast

321
00:03:03,779 --> 00:03:06,749
of the atmosphere
as it comes in.

322
00:03:06,782 --> 00:03:09,352

So how are we gonna,
the last few minutes?

323

00:03:09,385 --> 00:03:12,555

Cassini is not built
for atmosphere, as
you might imagine.

324

00:03:12,588 --> 00:03:15,458

We're a deep vacuum
kind of probe.

325

00:03:16,725 --> 00:03:19,295

That's not to say it
hasn't seen atmosphere.

326

00:03:19,328 --> 00:03:20,696

We've flown in the
atmosphere of Titan,

327

00:03:20,729 --> 00:03:24,600

we've used the thrusters
to battle the torques

328

00:03:24,633 --> 00:03:27,403

and the drag forces that
we've had to deal with,

329

00:03:27,436 --> 00:03:29,305

and they've been
very effective at it.

330

00:03:29,338 --> 00:03:31,707

So we know how to fly into
a little bit of atmosphere,

331

00:03:31,740 --> 00:03:33,476

and we've been doing that
for the last five orbits.

332

00:03:33,509 --> 00:03:35,645

We've actually been
dipping our toes down

333

00:03:35,678 --> 00:03:37,680

into Saturn's atmosphere
for the last five orbits,

334

00:03:37,713 --> 00:03:39,649

and the thrusters have
had to fight back,

335

00:03:39,682 --> 00:03:43,319

at what we call a duty
cycle, at a 100 percent,

336

00:03:43,352 --> 00:03:45,321

they're working as hard
as they possibly can,

337

00:03:45,354 --> 00:03:46,656

they've been up into the 40s.

338

00:03:46,689 --> 00:03:47,723

So we really have been working

339

00:03:47,756 --> 00:03:51,294

the atmospheric
effects to some extent.

340

00:03:51,327 --> 00:03:52,461

We have a good sense of these.

341

00:03:52,494 --> 00:03:54,430

But these are really
tiny thrusters.

342

00:03:54,463 --> 00:03:56,365

They're built to
move a school bus

343

00:03:56,398 --> 00:03:57,700
by just kind of tapping it.

344

00:03:57,733 --> 00:04:01,304
So you know, they're just
not gonna be able to do that.

345

00:04:01,337 --> 00:04:03,472
I think, I'm kidding,
one eighth pound.

346

00:04:03,505 --> 00:04:06,609
So this is just, you're
touching something,

347

00:04:06,642 --> 00:04:08,611
pressing on it a little bit's
about an eighth of a pound.

348

00:04:08,644 --> 00:04:11,480
You can imagine what
those thrusters have to do

349

00:04:11,513 --> 00:04:13,649
in order to deal with the
atmosphere of Cassini.

350

00:04:13,682 --> 00:04:16,218
So before I go on to
the next animation,

351

00:04:16,251 --> 00:04:20,423
let me just point out
one final moment here.

352

00:04:20,456 --> 00:04:24,527
At 4:55 AM Pacific Daylight
Time, loss of signal.

353

00:04:24,560 --> 00:04:26,362

And what's gonna
happen is the thrusters

354

00:04:26,395 --> 00:04:28,531

will eventually be
overpowered by the atmosphere,

355

00:04:28,564 --> 00:04:31,434

we won't watch Cassini burn
up, what we'll watch it do

356

00:04:31,467 --> 00:04:33,436

is slowly turn away
from us, and we'll watch

357

00:04:33,469 --> 00:04:35,471

the indicator on the
radio science displays

358

00:04:35,504 --> 00:04:39,508

that will go down flat, and
essentially loss of signal.

359

00:04:39,541 --> 00:04:42,645

The mission will be over
within a minute later.

360

00:04:42,678 --> 00:04:44,447

It's going so fast,
and the atmosphere

361

00:04:44,480 --> 00:04:47,750

is thickening so quickly that
Cassini will be vaporized

362

00:04:47,783 --> 00:04:52,288

in a few, I think may
100, maybe two minutes,

363

00:04:52,321 --> 00:04:53,522

but I think more like one.

364

00:04:53,555 --> 00:04:55,524

So it's really, it's
just inevitable.

365

00:04:55,557 --> 00:04:57,493

It's going in very
fast, very steep.

366

00:04:57,526 --> 00:05:01,364

Let's go to the next image,
just for fun, to see.

367

00:05:01,397 --> 00:05:06,302

There's the timeline of the
last 90 seconds of Cassini.

368

00:05:06,335 --> 00:05:08,404

Every 10 seconds,
tick mark there.

369

00:05:08,437 --> 00:05:10,406

And that really, that
tick mark, as you can see,

370

00:05:10,439 --> 00:05:14,543

the final one on my right
is, or on my left up there,

371

00:05:14,576 --> 00:05:17,480

I believe, is where
we lose signal.

372

00:05:17,513 --> 00:05:19,582

So you can see, very
very tenuous atmosphere.

373

00:05:19,615 --> 00:05:22,752

Where essentially, the analog
of that might be on Earth,

374

00:05:22,785 --> 00:05:25,588

that's about where the
International Space Station is,

375

00:05:25,621 --> 00:05:27,556

relative to density.

376

00:05:27,589 --> 00:05:28,758

It's very very thin air.

377

00:05:28,791 --> 00:05:31,360

But Cassini's going so
fast, and the thrusters are

378

00:05:31,393 --> 00:05:34,463

so modest for this
sort of requirement,

379

00:05:34,496 --> 00:05:36,399

it's just not gonna
last much longer.

380

00:05:36,432 --> 00:05:38,634

But you can see that about
70 seconds, 60 seconds in,

381

00:05:38,667 --> 00:05:40,403

the thrusters are
gonna start to fight.

382

00:05:40,436 --> 00:05:42,538

For the last minute or
so, they will be fighting

383

00:05:42,571 --> 00:05:44,573

the atmosphere

increasingly, increasingly,

384

00:05:44,606 --> 00:05:48,277
as it tries to turn Cassini
into a more aerodynamically

385

00:05:48,310 --> 00:05:52,381
compatible shape, and
eventually they will overcome.

386

00:05:52,414 --> 00:05:54,683
So if I could see the
last graphic, please.

387

00:05:54,716 --> 00:05:57,486
This is an animation, so
there's Cassini coming in.

388

00:05:57,519 --> 00:05:59,422
This is about that point.

389

00:05:59,455 --> 00:06:00,689
And you can see, we're
starting, this is again,

390

00:06:00,722 --> 00:06:04,460
a bit of a artistic license
here, but the thrusters,

391

00:06:04,493 --> 00:06:06,662
as you can see down off those
extensions on the bottom,

392

00:06:06,695 --> 00:06:08,631
are fighting
extremely hard to keep

393

00:06:08,664 --> 00:06:11,667
the antenna pointed
directly at the Earth.

394

00:06:11,700 --> 00:06:13,636

And you see, it's gonna
start to feel the vibration

395

00:06:13,669 --> 00:06:15,471

of some of the
atmospheric torques.

396

00:06:15,504 --> 00:06:17,506

But it will fight, and it
will fight, and it will fight.

397

00:06:17,539 --> 00:06:19,575

The mass spectrometer's
pointing into the atmosphere,

398

00:06:19,608 --> 00:06:21,544

the antenna is
pointing at the Earth,

399

00:06:21,577 --> 00:06:25,481

and it's gonna do that
for as it possibly can.

400

00:06:28,750 --> 00:06:30,486

Those of you that have
been following this story

401

00:06:30,519 --> 00:06:32,321

for a little while
might have noticed

402

00:06:32,354 --> 00:06:34,356

that we've been a little
bit ambivalent about

403

00:06:34,389 --> 00:06:37,326

when Cassini's actually
going to lose signal.

404

00:06:37,359 --> 00:06:39,628

One of the wonders and
mysteries of Saturn

405

00:06:39,661 --> 00:06:42,465

is that we are always surprised.

406

00:06:43,732 --> 00:06:46,302

And we thought we knew what
the atmosphere was all about.

407

00:06:46,335 --> 00:06:49,405

We had models that told
us, that perhaps we were

408

00:06:49,438 --> 00:06:51,407

not going to get enough
atmosphere to even satisfy

409

00:06:51,440 --> 00:06:55,511

the ion and mass requirements
during the last five orbits.

410

00:06:56,612 --> 00:06:59,582

We had plans to pop down
into the atmosphere,

411

00:06:59,615 --> 00:07:01,383

and if it was too thick,
we had plans to pop up,

412

00:07:01,416 --> 00:07:04,353

and pop up again, and pop down,

413

00:07:04,386 --> 00:07:05,621

in order to get this
thing fine-tuned.

414

00:07:05,654 --> 00:07:07,423

Well it turned out to
be absolutely perfect,

415

00:07:07,456 --> 00:07:09,425

against all of our predictions.

416

00:07:09,458 --> 00:07:11,360

We had all these
contingencies planned,

417

00:07:11,393 --> 00:07:12,495

and we threw them away.

418

00:07:12,528 --> 00:07:14,563

But what that tells
us, also not only

419

00:07:14,596 --> 00:07:16,298

did we not know the atmosphere,

420

00:07:16,331 --> 00:07:18,467

but the atmosphere affects
when you're gonna go in.

421

00:07:18,500 --> 00:07:20,402

Every time you go into the
atmosphere and get slowed down,

422

00:07:20,435 --> 00:07:22,638

well you go in a
little bit earlier.

423

00:07:22,671 --> 00:07:26,742

So what started at 5:08 is now
at 4:55:06 AM Pacific Time.

424

00:07:32,548 --> 00:07:34,517

And that's our story,
and we're sticking to it.

425

00:07:34,550 --> 00:07:36,685

[audience laughing]

426

00:07:36,718 --> 00:07:40,589

So with that, I'd like to turn
the mic over to Linda Spilker

427

00:07:40,622 --> 00:07:42,725

to tell you about some of
the just amazing science

428

00:07:42,758 --> 00:07:45,761

that we're going to get
in these last few hours.

429

00:07:45,794 --> 00:07:47,596

>> Well, thank you
very much, Earl.

430

00:07:47,629 --> 00:07:50,533

Being part of the Cassini
mission for the entire mission

431

00:07:50,566 --> 00:07:52,568

has been an
incredible privilege,

432

00:07:52,601 --> 00:07:56,605

both for me and for many of the
scientists on board Cassini.

433

00:07:56,638 --> 00:08:00,710

We've had an incredible 13
year journey around Saturn,

434

00:08:02,344 --> 00:08:05,381

returning data like
a giant fire hose,

435
00:08:05,414 --> 00:08:07,516
just flooding us with data.

436
00:08:07,549 --> 00:08:09,218
In fact, if you
imagine all that data

437
00:08:09,251 --> 00:08:12,354
as a million piece puzzle,
Cassini has been slowly

438
00:08:12,387 --> 00:08:15,257
putting together the pieces,
we have some of the border,

439
00:08:15,290 --> 00:08:16,659
some of the regions,
and we're trying to

440
00:08:16,692 --> 00:08:19,595
put together the picture
of the Saturn system,

441
00:08:19,628 --> 00:08:22,765
but we don't have a picture
on the cover to guide us,

442
00:08:22,798 --> 00:08:25,401
to tell us what that final set

443
00:08:25,434 --> 00:08:27,469
of data will finally look like.

444
00:08:27,502 --> 00:08:29,338
And what's really great
about the grand finale

445
00:08:29,371 --> 00:08:32,608
is it's adding incredible

new puzzle pieces

446

00:08:32,641 --> 00:08:35,711
to help us better understand
the Saturn system.

447

00:08:35,744 --> 00:08:38,647
And as Earl said,
lots of surprises.

448

00:08:38,680 --> 00:08:40,549
Many of the things we
thought we knew about Saturn

449

00:08:40,582 --> 00:08:44,386
are more complicated than
we originally had imagined.

450

00:08:44,419 --> 00:08:46,455
If we look at the first graphic,

451

00:08:46,488 --> 00:08:50,759
this is an example of looking
at Saturn from the outside in.

452

00:08:50,792 --> 00:08:53,495
That's what we're doing with
the grand finale orbits.

453

00:08:53,528 --> 00:08:55,731
If you look at that blue
figure on your right,

454

00:08:55,764 --> 00:08:57,700
that's the auroral
oval at Saturn.

455

00:08:57,733 --> 00:09:00,436
The particles come in,
hit the atmosphere,

456

00:09:00,469 --> 00:09:03,372
cause this wonderful aurora.

457

00:09:03,405 --> 00:09:05,608
Just underneath it,
you have the hexagon

458

00:09:05,641 --> 00:09:07,710
with the hurricane inside it.

459

00:09:07,743 --> 00:09:10,412
If you look on the bottom
right, you can see an image now

460

00:09:10,445 --> 00:09:12,581
in the infrared where you
can see the heat energy

461

00:09:12,614 --> 00:09:15,651
coming out from
inside of the planet.

462

00:09:15,684 --> 00:09:18,721
And finally, that beautiful
image with the hexagon,

463

00:09:18,754 --> 00:09:21,724
so we're looking at
different levels from Saturn,

464

00:09:21,757 --> 00:09:23,659
almost like we've taken
a magnifying glass

465

00:09:23,692 --> 00:09:26,428
to the planet and the rings.

466

00:09:26,461 --> 00:09:28,731

We've also been looking at the interior, and in a sense,

467

00:09:28,764 --> 00:09:31,500

pulling back the curtain with our gravity

468

00:09:31,533 --> 00:09:34,336

and magnetic field data, to see what Saturn

469

00:09:34,369 --> 00:09:36,639

is like on the inside, as well.

470

00:09:37,773 --> 00:09:39,708

Well as Earl mentioned, we're going to be taking

471

00:09:39,741 --> 00:09:42,544

our last images, we hope about eight o'clock tomorrow night

472

00:09:42,577 --> 00:09:44,713

to have the images up on our raw image site.

473

00:09:44,746 --> 00:09:46,649

If we go to the next graphic.

474

00:09:46,682 --> 00:09:50,452

In that last period of time, looking around Saturn,

475

00:09:50,485 --> 00:09:54,356

what we're doing is we're taking our final picture postcards

476

00:09:54,389 --> 00:09:58,294

of the Saturn system, looking at our favorite targets

477

00:09:58,327 --> 00:10:01,764

to put these images in
our Cassini scrapbook.

478

00:10:01,797 --> 00:10:04,667

So we're going to take, if
you look at the upper left,

479

00:10:04,700 --> 00:10:08,504

a mosaic of Saturn and
the rings in color.

480

00:10:08,537 --> 00:10:11,473

Basically, our last look
at the entire system.

481

00:10:11,506 --> 00:10:13,709

Upper right, that's
Titan, we're gonna take

482

00:10:13,742 --> 00:10:15,644

some goodbye pictures of Titan,

483

00:10:15,677 --> 00:10:20,416

last look to see if there's
any weather or clouds going on.

484

00:10:20,449 --> 00:10:22,551

In the lower left, that's
the outer edge of the A ring,

485

00:10:22,584 --> 00:10:25,387

and that bright feature
is created by a grouping

486

00:10:25,420 --> 00:10:27,723

of particles that
we've nicknamed Peggy.

487

00:10:27,756 --> 00:10:31,393

We've been watching since 2012
to see if Peggy might break

488

00:10:31,426 --> 00:10:34,763

free of the rings and become
a moon in her own right,

489

00:10:34,796 --> 00:10:38,334

so we're gonna take a last
look, see what Peggy's up to.

490

00:10:38,367 --> 00:10:40,569

In the center, we're
gonna watch Enceladus set

491

00:10:40,602 --> 00:10:43,539

behind the northern
limn of Saturn,

492

00:10:43,572 --> 00:10:45,674

so very appropriate,
Enceladus setting.

493

00:10:45,707 --> 00:10:48,477

Get a look at the propellers,
that's on the lower right,

494

00:10:48,510 --> 00:10:49,712

these objects that are trying

495

00:10:49,745 --> 00:10:52,481

to open up gaps
in Saturn's rings.

496

00:10:52,514 --> 00:10:54,583

Not quite big enough to do that.

497

00:10:54,616 --> 00:10:58,387

But you can only see those
with a spacecraft like Cassini.

498

00:10:58,420 --> 00:11:00,589

And then, in our
final moments of data,

499

00:11:00,622 --> 00:11:03,759

we're gonna look on the dark
side of Saturn at the point

500

00:11:03,792 --> 00:11:07,496

where Cassini will be
plunging into the atmosphere,

501

00:11:07,529 --> 00:11:09,698

looking in the near
infrared, the ultraviolet,

502

00:11:09,731 --> 00:11:12,468

trying to get some
pictures of Cassini's

503

00:11:12,501 --> 00:11:16,638

final home inside the
planet Saturn itself.

504

00:11:16,671 --> 00:11:18,741

Now if we go to
the next graphic,

505

00:11:18,774 --> 00:11:21,377

this just came down last night.

506

00:11:21,410 --> 00:11:24,513

This is one of our looks at
Titan from the goodbye kiss.

507

00:11:24,546 --> 00:11:27,349

The north pole, you can

see the lake region,

508

00:11:27,382 --> 00:11:29,518

we're looking at the
north pole of Titan,

509

00:11:29,551 --> 00:11:30,652

looking through the haze.

510

00:11:30,685 --> 00:11:32,621

The haze has cleared remarkably

511

00:11:32,654 --> 00:11:35,524

as summer solstice
has approached.

512

00:11:35,557 --> 00:11:37,726

And then if we go to
the final graphic,

513

00:11:37,759 --> 00:11:41,296

these are the instruments that
will be on and sending back

514

00:11:41,329 --> 00:11:45,300

data during those final
moments with Cassini.

515

00:11:45,333 --> 00:11:46,602

And we have eight
of them, including

516

00:11:46,635 --> 00:11:50,339

the gas ion and neutral
mass spectrometer,

517

00:11:51,473 --> 00:11:53,542

the magnetospheric
imaging experiment,

518
00:11:53,575 --> 00:11:55,644
the radio science system will be

519
00:11:55,677 --> 00:11:58,313
sending back its last
gravity measurements.

520
00:11:58,346 --> 00:12:00,449
The radio and plasma
wave antennas,

521
00:12:00,482 --> 00:12:03,619
and then the ultraviolet
and infrared spectrometers

522
00:12:03,652 --> 00:12:06,355
will also be taking data
in that time period.

523
00:12:06,388 --> 00:12:10,626
The magnetometer and the
dust analyzer, as well.

524
00:12:10,659 --> 00:12:12,694
Now in these very final seconds,

525
00:12:12,727 --> 00:12:15,264
we'll be plunging deeper
into the atmosphere

526
00:12:15,297 --> 00:12:18,367
of Saturn than we've
ever gone before.

527
00:12:18,400 --> 00:12:19,768
In fact, you can
think of Cassini

528
00:12:19,801 --> 00:12:23,305

as becoming the
first Saturn probe.

529
00:12:23,338 --> 00:12:25,574
And to tell you more about
sniffing the atmosphere

530
00:12:25,607 --> 00:12:28,410
of Saturn, I turn it
over to Hunter Waite,

531
00:12:28,443 --> 00:12:30,345
and he's the
principal investigator

532
00:12:30,378 --> 00:12:33,415
for the ion and neutral
mass spectrometer, Hunter?

533
00:12:33,448 --> 00:12:34,750
>> Thanks, thanks Linda.

534
00:12:34,783 --> 00:12:36,485
The ion neutral
mass spectrometer

535
00:12:36,518 --> 00:12:40,622
is actually the sensitive
nose of the spacecraft.

536
00:12:40,655 --> 00:12:44,727
If we go to the next
graphic, and zoom in on INMS,

537
00:12:48,330 --> 00:12:49,731
you can also see it here.

538
00:12:49,764 --> 00:12:54,403
Gas enters into this front
portion of the instrument,

539

00:12:54,436 --> 00:12:58,540

and inside, the molecular
composition is determined.

540

00:12:58,573 --> 00:13:00,442

And that's, so we
have to be pointed

541

00:13:00,475 --> 00:13:02,711

in the forward direction,
in the direction motion

542

00:13:02,744 --> 00:13:06,482

of the spacecraft, as
Earl's already indicated.

543

00:13:06,515 --> 00:13:08,383

We've done this
on many occasions,

544

00:13:08,416 --> 00:13:12,454

we explored the atmosphere
of Titan in the same manner,

545

00:13:12,487 --> 00:13:14,690

we've explored the
plumes of Enceladus

546

00:13:14,723 --> 00:13:18,594

with the ion neutral mass
spectrometer as well,

547

00:13:18,627 --> 00:13:20,696

and found out about
the composition there,

548

00:13:20,729 --> 00:13:24,633

and made some inferences
about the internal ocean.

549

00:13:24,666 --> 00:13:26,435

And now, we get a
chance to actually look

550

00:13:26,468 --> 00:13:30,472

at the atmosphere that's
created in the rings itself,

551

00:13:30,505 --> 00:13:32,341

and the atmosphere of Saturn.

552

00:13:32,374 --> 00:13:35,377

So we're sampling both
in this last stage.

553

00:13:35,410 --> 00:13:38,514

If you go to the next
graphic, there's some idea

554

00:13:38,547 --> 00:13:41,383

of the sampling
that we're doing.

555

00:13:42,651 --> 00:13:47,322

So the five dots indicate
the five previous orbits,

556

00:13:47,355 --> 00:13:48,624

where we were at
the lowest point,

557

00:13:48,657 --> 00:13:51,693

or closest to the
atmosphere so far.

558

00:13:51,726 --> 00:13:55,664

Earlier, we were closer
to the rings, and we were,

559

00:13:55,697 --> 00:13:58,600

well we were close to the
rings, there's kinda like

560

00:13:58,633 --> 00:14:01,570

three bands that
we actually sample.

561

00:14:01,603 --> 00:14:05,340

So we've had a chance to look
more at the ring atmosphere,

562

00:14:05,373 --> 00:14:09,444

and to look and progressively
see more and more

563

00:14:09,477 --> 00:14:12,447

of the atmosphere
of Saturn itself.

564

00:14:12,480 --> 00:14:14,216

And you can see that
line on the graphic,

565

00:14:14,249 --> 00:14:15,517

it's called
well-mixed atmosphere.

566

00:14:15,550 --> 00:14:17,419

That's where the
atmosphere becomes kinda

567

00:14:17,452 --> 00:14:19,521

homogenous in terms
of composition.

568

00:14:19,554 --> 00:14:21,623

And we're not gonna
quite make it there,

569

00:14:21,656 --> 00:14:25,427

but we'll make it close,
and in that period of time,

570

00:14:25,460 --> 00:14:27,629

we'll be able to make
our cleanest sample

571

00:14:27,662 --> 00:14:30,766

of the atmosphere
of Saturn itself.

572

00:14:30,799 --> 00:14:34,670

So if we go to the final
graphic, this is a very pretty

573

00:14:34,703 --> 00:14:37,573

picture of the rings,
and of the atmosphere.

574

00:14:37,606 --> 00:14:41,543

You can see kind of a haze,
which is the atmosphere,

575

00:14:41,576 --> 00:14:44,613

just above the
edge of the planet.

576

00:14:44,646 --> 00:14:48,317

And one of the most important
scientific things that we're

577

00:14:48,350 --> 00:14:52,554

trying to figure out is a
concept called ring rain.

578

00:14:52,587 --> 00:14:56,358

And this concept was
introduced in the early 80s

579

00:14:56,391 --> 00:14:58,594

to actually explain
some observations

580

00:14:58,627 --> 00:15:02,731

that we made by both Pioneer
and Voyager as they flew by.

581

00:15:02,764 --> 00:15:07,336

And this particular ring
rain was actually water vapor

582

00:15:11,339 --> 00:15:14,309

and ice grains from the rings
falling into the atmosphere,

583

00:15:14,342 --> 00:15:18,347

and making modifications to
the atmosphere and ionosphere.

584

00:15:18,380 --> 00:15:21,483

Well, as Cassini has
always delivered,

585

00:15:21,516 --> 00:15:24,319

ring rain is much more
extensive than that,

586

00:15:24,352 --> 00:15:26,688

it's much more complicated,
we're getting great new data,

587

00:15:26,721 --> 00:15:29,658

we're trying to find out
exactly what is coming

588

00:15:29,691 --> 00:15:32,327

from the rings and what
is due to the atmosphere.

589

00:15:32,360 --> 00:15:35,297

And that final plunge
will allow us to do that.

590

00:15:35,330 --> 00:15:37,466

The other thing that we'll
do during that period of time

591

00:15:37,499 --> 00:15:40,469

as we move closer to
the mixed atmosphere,

592

00:15:40,502 --> 00:15:43,772

we'll be able to look at
some important constituents

593

00:15:43,805 --> 00:15:46,742

that we know are there, and
we've been measuring them,

594

00:15:46,775 --> 00:15:50,646

but we'll get a better idea of
the hydrogen to helium ratio.

595

00:15:50,679 --> 00:15:53,615

And this is important in
terms of the formation

596

00:15:53,648 --> 00:15:56,284

and evolution of Saturn itself.

597

00:15:56,317 --> 00:15:58,620

So we have an extensive
set of science objectives

598

00:15:58,653 --> 00:16:02,290

that we're going to execute
on this final plunge,

599

00:16:02,323 --> 00:16:04,393
and we're looking
forward to getting

600
00:16:04,426 --> 00:16:06,762
the data in near real time.

601
00:16:06,795 --> 00:16:09,531
Thanks, I'll pass
it back to Earl.

602
00:16:09,564 --> 00:16:11,466
>> Thanks, Hunter.

603
00:16:11,499 --> 00:16:15,470
After nearly four decades
of planning, execution,

604
00:16:15,503 --> 00:16:19,708
implementation, and execution,
we are now within 48 hours

605
00:16:19,741 --> 00:16:23,512
of the end of the
Cassini mission.

606
00:16:23,545 --> 00:16:27,382
The work of three space
agencies, 17 member nations,

607
00:16:27,415 --> 00:16:30,585
hundreds of suppliers,
thousands of engineers,

608
00:16:30,618 --> 00:16:33,555
scientists, and support
staff are about to come

609
00:16:33,588 --> 00:16:37,526
to a fiery end high above

the clouds of Saturn.

610

00:16:38,760 --> 00:16:43,398

The current Cassini team,
or family as it has become,

611

00:16:43,431 --> 00:16:45,701

comprised of hundreds of
engineers, scientists,

612

00:16:45,734 --> 00:16:47,636

and support staff, has
worked for many years

613

00:16:47,669 --> 00:16:51,506

to bring us to this point,
and has done a phenomenal job.

614

00:16:51,539 --> 00:16:53,341

As I emphasized
at the beginning,

615

00:16:53,374 --> 00:16:56,378

this is about a
spacecraft and a team

616

00:16:57,479 --> 00:17:00,315

that has just been
absolutely the best one

617

00:17:00,348 --> 00:17:01,717

you could ever ask
for in both cases,

618

00:17:01,750 --> 00:17:04,519

and it's coming to an
end, unfortunately.

619

00:17:04,552 --> 00:17:07,456

We'll be saddened,

there's no doubt about it,

620

00:17:07,489 --> 00:17:09,558

at the loss of such
an incredible machine.

621

00:17:09,591 --> 00:17:13,228

But I think all of us, we're
going to have a great sense

622

00:17:13,261 --> 00:17:16,398

of pride in, a little
bit corny perhaps,

623

00:17:16,431 --> 00:17:18,300

a mission accomplished.

624

00:17:18,333 --> 00:17:20,402

We set out to do something
at Saturn, we did it,

625

00:17:20,435 --> 00:17:23,705

we did it extremely well, and
we delivered more and more,

626

00:17:23,738 --> 00:17:28,343

and we've left the world
informed, but still wondering.

627

00:17:28,376 --> 00:17:30,278

And that, I couldn't ask for me.

628

00:17:30,311 --> 00:17:32,447

We gotta go back, we know it.

629

00:17:32,480 --> 00:17:33,715

We've been gathering all week.

630

00:17:33,748 --> 00:17:36,585

We'll be staffing up the
mission control center tomorrow,

631
00:17:36,618 --> 00:17:38,386
standing vigil through
the night as we

632
00:17:38,419 --> 00:17:40,355
prepare to say goodbye,
both from here,

633
00:17:40,388 --> 00:17:44,626
and a large crowd of our
team members at Cal Tech,

634
00:17:44,659 --> 00:17:49,397
as our faithful traveler from
Earth makes its final goodbye.

635
00:17:49,430 --> 00:17:52,401
So thank you,
Cassini, and farewell.

636
00:17:54,569 --> 00:17:56,338
>> Alright, well
thank you very much

637
00:17:56,371 --> 00:17:57,639
to our speakers,
just phenomenal.

638
00:17:57,672 --> 00:18:00,475
We're gonna go ahead and
open it up for questions,

639
00:18:00,508 --> 00:18:04,279
first of all to reporters
here in the auditorium.

640
00:18:04,312 --> 00:18:05,413

Please wait for the mic,

641

00:18:05,446 --> 00:18:08,517

and give us your
name and affiliation.

642

00:18:08,550 --> 00:18:12,287

Any questions here?

We'll start down front.

643

00:18:14,455 --> 00:18:16,558

>> Hi, Irene Klotz
with Aviation Week.

644

00:18:16,591 --> 00:18:20,729

The last image that's gonna
be taken from Titan, is it,

645

00:18:22,497 --> 00:18:26,601

from Cassini, is it the image
of where it's going to impact?

646

00:18:26,634 --> 00:18:30,338

And what is the speed that
Cassini will be traveling

647

00:18:30,371 --> 00:18:33,509

relative to Saturn
in the final descent?

648

00:18:35,376 --> 00:18:37,679

>> I think the answer is
yes to the first question.

649

00:18:37,712 --> 00:18:40,348

>> Yes, the final
image is the place

650

00:18:40,381 --> 00:18:41,449

where Cassini will plunge.

651

00:18:41,482 --> 00:18:43,385

It'll be dark, but that'll be,

652

00:18:43,418 --> 00:18:44,586

we'll take an image there, yes.

653

00:18:44,619 --> 00:18:45,654

>> And in miles per
hour, we're going

654

00:18:45,687 --> 00:18:48,323

about 76,000 miles per hour.

655

00:18:49,691 --> 00:18:51,459

>> We'll actually have
an image with our visual

656

00:18:51,492 --> 00:18:53,495

and infrared mapping
spectrometer,

657

00:18:53,528 --> 00:18:56,565

and that image can sense
the heat of Saturn as well.

658

00:18:56,598 --> 00:18:58,466

So we may see some details

659

00:18:58,499 --> 00:19:01,536

of the atmosphere in
the near infrared.

660

00:19:01,569 --> 00:19:05,641

>> Thanks, and the 4:55:06,
that's Pacific Daylight Time,

661

00:19:06,774 --> 00:19:09,444

what is the actual

time on with the

662

00:19:10,545 --> 00:19:12,414

>> It's about an
hour and 21 minutes.

663

00:19:12,447 --> 00:19:14,316

It takes the signal
an hour and 20,

664

00:19:14,349 --> 00:19:18,320

sorry 23 minutes, to get
from Saturn to Earth.

665

00:19:19,420 --> 00:19:22,558

But as far as we're
concerned, what we see

666

00:19:23,791 --> 00:19:28,296

and what we live with is
the signal from Cassini.

667

00:19:28,329 --> 00:19:29,631

So in that last
signal comes down,

668

00:19:29,664 --> 00:19:32,634

that's when things'll
happen for us.

669

00:19:32,667 --> 00:19:34,669

>> Okay, another question here
in the audience, down front.

670

00:19:34,702 --> 00:19:37,472

>> Frederick Castel, journalist.

671

00:19:37,505 --> 00:19:40,675

Two questions, when you
look at the ephemeris

672

00:19:40,708 --> 00:19:44,679
of the different moons,
do we see some kind

673

00:19:44,712 --> 00:19:48,317
of Pioneer effect on
the Saturn system?

674

00:19:50,485 --> 00:19:52,587
And the other question
is, on the long term,

675

00:19:52,620 --> 00:19:56,291
for next mission,
future mission,

676

00:19:56,324 --> 00:19:59,294
what's the strategy
about plutonium?

677

00:20:00,395 --> 00:20:02,697
>> I'll start with
the Pioneer effect,

678

00:20:02,730 --> 00:20:05,533
but I'm going to let
Jim handle the next one.

679

00:20:05,566 --> 00:20:06,701
No, we have not.

680

00:20:06,734 --> 00:20:10,205
Because we have so many
different perturbations

681

00:20:10,238 --> 00:20:13,208
in the system from the moons,
from our own thrusting,

682

00:20:13,241 --> 00:20:17,412
from the thermal pressures
of the RTG, even more subtle,

683

00:20:17,445 --> 00:20:20,348
we're just too busy perturbing
that trajectory to actually

684

00:20:20,381 --> 00:20:23,718
be able to see something as
subtle as the Pioneer effect.

685

00:20:23,751 --> 00:20:28,290
It's just too much going
on in the Saturn system.

686

00:20:28,323 --> 00:20:30,558
>> Several years ago,
we were able to work

687

00:20:30,591 --> 00:20:33,461
with the administration and
Congress to get the approval

688

00:20:33,494 --> 00:20:36,732
to restart the production
of plutonium-238.

689

00:20:38,499 --> 00:20:42,737
We've already done a number of
tasks, and in 2019 we'll get

690

00:20:42,770 --> 00:20:45,740
back into the production
on a regular basis.

691

00:20:45,773 --> 00:20:49,578
We also have approximately
30 kilograms plus

692

00:20:51,546 --> 00:20:56,384

of plutonium available to
us for future missions.

693

00:20:56,417 --> 00:20:59,387

The next plutonium
mission that we've planned

694

00:20:59,420 --> 00:21:02,657

is a Mars mission,
it's Mars 2020.

695

00:21:02,690 --> 00:21:05,660

But I think we're
in really good stead

696

00:21:05,693 --> 00:21:08,430

for the next several decades.

697

00:21:08,463 --> 00:21:11,633

Our plan is to keep
a stock of plutonium

698

00:21:11,666 --> 00:21:15,570

and not let that be a
mission limiting factor.

699

00:21:17,271 --> 00:21:20,608

>> Okay, other questions
here in the audience?

700

00:21:20,641 --> 00:21:24,479

Right here, we'll go
inside and then outside.

701

00:21:26,814 --> 00:21:29,584

>> Hi, thank you for doing this.

702

00:21:29,617 --> 00:21:32,654

Will we be able to tell anything
from the livestream data

703

00:21:32,687 --> 00:21:35,323

on the way into the
atmosphere right away?

704

00:21:35,356 --> 00:21:39,327

And if not, how long
will it be before we know

705

00:21:39,360 --> 00:21:42,597

a vague idea of what
it's telling us?

706

00:21:42,630 --> 00:21:46,401

>> Well, the data the
operations team lead

707

00:21:46,434 --> 00:21:48,770

for the INMS tells me
that she will display it

708

00:21:48,803 --> 00:21:52,640

20 minutes after
the time we take it.

709

00:21:52,673 --> 00:21:56,745

So we're going to get
it streamed to us from,

710

00:21:56,778 --> 00:21:59,781

down link to JPL,
be transferred to

711

00:21:59,814 --> 00:22:02,317

Southwest Research
Institute, and then we'll

712

00:22:02,350 --> 00:22:05,687

have it on a computer
down at Cal Tech.

713

00:22:05,720 --> 00:22:08,690

>> Understanding it might
take a little bit longer.

714

00:22:08,723 --> 00:22:11,526

>> It could, but
that's our plan.

715

00:22:13,628 --> 00:22:15,597

>> Lee Hokes, Wall
Street Journal.

716

00:22:15,630 --> 00:22:18,433

You mentioned that Cassini has,

717

00:22:18,466 --> 00:22:19,734

among its many accomplishments,

718

00:22:19,767 --> 00:22:22,704

enabled a series of
missions to come.

719

00:22:22,737 --> 00:22:25,774

I wonder if you'd expand
on that for a moment.

720

00:22:25,807 --> 00:22:27,742

>> Well, as I mentioned
earlier, the concept

721

00:22:27,775 --> 00:22:31,312

of the gravity assists
that we were able to get

722

00:22:31,345 --> 00:22:34,716

with Titan allowed
our instruments to get

723

00:22:34,749 --> 00:22:37,753

a global view of
that beautiful moon.

724

00:22:39,454 --> 00:22:41,689

That's really spectacular,
because that means,

725

00:22:41,722 --> 00:22:44,659

when we take it to the
Jupiter environment

726

00:22:44,692 --> 00:22:47,662

where the radiation
belt is really harsh

727

00:22:47,695 --> 00:22:50,598

all through the area where
the Galilean moons are,

728

00:22:50,631 --> 00:22:53,334

we want to be able to
get in and get out.

729

00:22:53,367 --> 00:22:55,637

And so then, if
we orbit Jupiter,

730

00:22:55,670 --> 00:22:58,740

we can do multiple
flybys of the moons,

731

00:22:58,773 --> 00:23:02,444

and the one we're
planning to do is Europa,

732

00:23:02,477 --> 00:23:04,679

and from those multiple flybys,

733

00:23:04,712 --> 00:23:08,249
actually create a global view

734

00:23:08,282 --> 00:23:11,219
of that moon as if
we were in orbit.

735

00:23:12,453 --> 00:23:14,622
And so Cassini has really
pioneered that whole concept,

736

00:23:14,655 --> 00:23:17,425
and that will be our
first next attempt

737

00:23:17,458 --> 00:23:19,761
in using that to great effect.

738

00:23:22,563 --> 00:23:24,466
>> Alright, actually we're
gonna go to the phones now for a

739

00:23:24,499 --> 00:23:26,568
couple of questions, but we'll
come back to the auditorium.

740

00:23:26,601 --> 00:23:30,338
I think we have Marsha
Dunn, from the AP, Marsha?

741

00:23:30,371 --> 00:23:31,473
>> Marsha: Yes, can you hear me?

742

00:23:31,506 --> 00:23:32,674
>> Sure.

743

00:23:32,707 --> 00:23:36,377
>> Marsha: Yes, for either
Jim or Earl or both,

744

00:23:36,410 --> 00:23:39,614

there seems to be a, the
outpouring of love for

745

00:23:39,647 --> 00:23:43,751

Cassini seems to be growing
in these last hours and days.

746

00:23:43,784 --> 00:23:46,287

I'm wondering if you
had a chance to hear

747

00:23:46,320 --> 00:23:48,656

the Cassini opera from
the Planetary Society.

748

00:23:48,689 --> 00:23:50,658

What did you think about that?

749

00:23:50,691 --> 00:23:53,528

And how do you feel
hearing from the public,

750

00:23:53,561 --> 00:23:56,398

who's so sorry to
see Cassini go?

751

00:23:57,698 --> 00:23:59,634

>> I have heard
the opera tribute

752

00:23:59,667 --> 00:24:02,470

from the Planetary
Society, and I loved it.

753

00:24:02,503 --> 00:24:04,539

It's very heartwarming to us.

754

00:24:04,572 --> 00:24:06,741

As a matter of fact,
we've recently posted

755

00:24:06,774 --> 00:24:09,410

a letter from a six year
old boy who invited us

756

00:24:09,443 --> 00:24:12,647

to his Cassini party
in Florida on the 15th.

757

00:24:12,680 --> 00:24:16,284

Feeling the love, if
I can be so corny,

758

00:24:17,552 --> 00:24:19,588

is just very heartening.

759

00:24:22,323 --> 00:24:24,559

Because it's part of
what we try to do,

760

00:24:24,592 --> 00:24:27,662

is to extend everybody
out to Saturn.

761

00:24:27,695 --> 00:24:31,466

It's not science for, you
know, in the ivory tower,

762

00:24:31,499 --> 00:24:34,769

it's for humanity, and it's
for everybody to get on,

763

00:24:34,802 --> 00:24:38,306

ride, come with us,
is just phenomenal.

764

00:24:38,339 --> 00:24:40,408

So I'm very heartened by that.

765

00:24:40,441 --> 00:24:43,444

I wish, well never
mind, I don't even

766

00:24:43,477 --> 00:24:46,348

want to go there,
one more orbit.

767

00:24:47,682 --> 00:24:51,452

So it is where it is,
we've gotten this,

768

00:24:51,485 --> 00:24:54,355

and again I couldn't
be more heartened

769

00:24:54,388 --> 00:24:57,325

by the outpouring we've had.

770

00:24:57,358 --> 00:24:59,394

>> Absolutely, you know
the Cassini family,

771

00:24:59,427 --> 00:25:01,362

as Earl mentioned,
is those people

772

00:25:01,395 --> 00:25:05,467

that have worked many years,
decades, to get to this point,

773

00:25:07,301 --> 00:25:09,637

and we are absolutely
delighted to have

774

00:25:09,670 --> 00:25:14,275

an extended family to
share the experiences

775

00:25:14,308 --> 00:25:18,413
that have really enabled
enormous science to be done.

776

00:25:20,514 --> 00:25:23,718
In fact, you know,
really the science

777

00:25:23,751 --> 00:25:25,720
is not done until we share it.

778

00:25:25,753 --> 00:25:28,323
This is really just the
beginning of a number

779

00:25:28,356 --> 00:25:31,492
of discoveries that
the data will reveal,

780

00:25:31,525 --> 00:25:33,695
as we try to figure out
what the physical phenomena

781

00:25:33,728 --> 00:25:37,765
are that are being described
in those observations.

782

00:25:37,798 --> 00:25:41,636
Those will live on for
many decades afterwards,

783

00:25:41,669 --> 00:25:46,374
and already they're
beckoning us to go back.

784

00:25:46,407 --> 00:25:49,611
You know, between Voyager
and Cassini was 30 years.

785
00:25:49,644 --> 00:25:51,680
And I believe that will be

786
00:25:53,314 --> 00:25:55,750
much shorter the
next time around.

787
00:25:55,783 --> 00:25:56,751
>> Okay, we're
gonna take a couple

788
00:25:56,784 --> 00:25:58,620
of questions from social media.

789
00:25:58,653 --> 00:26:00,455
We've got Jason Townsend
from NASA headquarters.

790
00:26:00,488 --> 00:26:01,689
Jason, what's going on?

791
00:26:01,722 --> 00:26:04,325
>> Indeed, there's a lot
of interest online here.

792
00:26:04,358 --> 00:26:08,396
Our first question here
comes from Salma on Twitter,

793
00:26:08,429 --> 00:26:10,498
who asks, "Will Cassini
completely evaporate

794
00:26:10,531 --> 00:26:12,400
"in the atmosphere
of Saturn, or will it

795
00:26:12,433 --> 00:26:14,669
"crash into the

surface of the planet?"

796

00:26:14,702 --> 00:26:16,771

>> It will be
completely vaporized,

797

00:26:16,804 --> 00:26:19,307

like many meteorites hit Earth.

798

00:26:19,340 --> 00:26:21,442

If there's a surface at Saturn,

799

00:26:21,475 --> 00:26:24,679

it's at a hellishly hot
pressure and temperature,

800

00:26:24,712 --> 00:26:28,683

and anything from Cassini
will vaporize long before.

801

00:26:28,716 --> 00:26:30,518

>> Wonderful, lots of
other questions here,

802

00:26:30,551 --> 00:26:32,420

asking about images here.

803

00:26:32,453 --> 00:26:34,389

So Evelyn on Twitter asks,
"Will Cassini be able

804

00:26:34,422 --> 00:26:38,426

"to take a close-up image
of Saturn as it plunges?"

805

00:26:38,459 --> 00:26:40,428

>> No, we don't
have the data rate

806

00:26:40,461 --> 00:26:43,464
to support sending back
images in real time.

807
00:26:43,497 --> 00:26:46,267
So the instruments that I
showed you did not include

808
00:26:46,300 --> 00:26:49,737
the cameras for those final
few moments for the plunge.

809
00:26:49,770 --> 00:26:51,572
So we'll be getting
those images back,

810
00:26:51,605 --> 00:26:54,676
the final image will be of the
place where Cassini will go,

811
00:26:54,709 --> 00:26:59,280
but it'll be from
about 14 hours earlier.

812
00:26:59,313 --> 00:27:00,481
>> Alright, next
question here comes

813
00:27:00,514 --> 00:27:02,650
from Twitter user
Bilemon, who asks,

814
00:27:02,683 --> 00:27:05,653
"Would it be possible to
use a low gain antenna

815
00:27:05,686 --> 00:27:07,422
"at a very low bit
rate to monitor

816

00:27:07,455 --> 00:27:10,258

"a heartbeat from Cassini
just a little longer?"

817

00:27:10,291 --> 00:27:13,261

[audience laughing]

818

00:27:15,563 --> 00:27:18,633

>> I'll repeat that
for the audience.

819

00:27:18,666 --> 00:27:21,536

The spacecraft engineer
is in the second row,

820

00:27:21,569 --> 00:27:24,472

and the answer is
a resounding no.

821

00:27:24,505 --> 00:27:26,641

If we had done
that, we would have

822

00:27:26,674 --> 00:27:28,643

given up some science data.

823

00:27:28,676 --> 00:27:33,381

And really, for a few seconds'
more to get those last

824

00:27:33,414 --> 00:27:38,319

packets of spectrometer data
was much more important.

825

00:27:38,352 --> 00:27:39,520

>> Okay, we're gonna
go back to the phones.

826

00:27:39,553 --> 00:27:41,556

I think we've got Leo Enwright

from Irish Television.

827

00:27:41,589 --> 00:27:43,658

Leo, can you hear us?

828

00:27:43,691 --> 00:27:44,759

>> Leo: Yeah, thanks very much.

829

00:27:44,792 --> 00:27:47,462

In fact, my question
isn't entirely unrelated

830

00:27:47,495 --> 00:27:49,731

to the last one,
because I'm wondering,

831

00:27:49,764 --> 00:27:53,368

there has been some speculation
that a good telescope

832

00:27:53,401 --> 00:27:55,303

on Earth, and I presume a league

833

00:27:55,336 --> 00:27:57,472

with one would be able
to see this happen.

834

00:27:57,505 --> 00:27:59,407

Is that the case?

835

00:27:59,440 --> 00:28:01,776

>> Well, we're going to try
and look with telescopes

836

00:28:01,809 --> 00:28:04,312

from the Earth,
we're just not sure.

837

00:28:04,345 --> 00:28:06,748

This flash will be occurring
on the day side of Saturn,

838

00:28:06,781 --> 00:28:09,684
and we've done some
calculations about brightness.

839

00:28:09,717 --> 00:28:12,253
We think it's not very likely,

840

00:28:12,286 --> 00:28:14,622
but we're sure
gonna look anyway.

841

00:28:16,624 --> 00:28:18,226
>> Okay, one more
question on the phones.

842

00:28:18,259 --> 00:28:21,396
I'm gonna, I think
we've got Dave Mosher

843

00:28:21,429 --> 00:28:23,331
from Business Insider.

844

00:28:25,366 --> 00:28:26,300
>> Dave: Can you guys hear me?

845

00:28:26,333 --> 00:28:28,269
>> Yeah, we sure can.

846

00:28:28,302 --> 00:28:29,670
>> Dave: Alright great, I
actually had a follow up

847

00:28:29,703 --> 00:28:32,640
to the previous question,
and one more new one.

848

00:28:32,673 --> 00:28:34,742
Do we know which observatories

849
00:28:34,775 --> 00:28:37,478
in the Southern
Hemisphere or wherever

850
00:28:37,511 --> 00:28:39,680
on Earth are gonna be
trying to see this thing?

851
00:28:39,713 --> 00:28:43,384
That's my first question, for
whoever can best answer it.

852
00:28:43,417 --> 00:28:45,353
And then, sorta related to that,

853
00:28:45,386 --> 00:28:47,655
but about the data
that's coming back.

854
00:28:47,688 --> 00:28:50,758
I just checked the
forecast for Australia,

855
00:28:50,791 --> 00:28:52,527
and it does look like
there's a little clouds

856
00:28:52,560 --> 00:28:56,531
and rain in the forecast
for the next few days.

857
00:28:56,564 --> 00:28:59,500
I'm curious if you guys are
worried about that at all,

858
00:28:59,533 --> 00:29:03,571
or if you're confident that

you're gonna get this data back.

859

00:29:04,738 --> 00:29:06,307

>> Well the observatories we're gonna

860

00:29:06,340 --> 00:29:08,643

be using are mostly in Australia.

861

00:29:08,676 --> 00:29:12,313

Australia, of course, Canberra has a great view of Cassini.

862

00:29:12,346 --> 00:29:14,649

Also, we're gonna be using some smaller telescopes,

863

00:29:14,682 --> 00:29:16,350

we're gonna try and look from India,

864

00:29:16,383 --> 00:29:19,387

from China, possibly from Taiwan.

865

00:29:19,420 --> 00:29:21,556

We're really encouraging our amateurs, too,

866

00:29:21,589 --> 00:29:24,325

to get out there and look with their telescopes.

867

00:29:24,358 --> 00:29:25,760

We don't have any giant telescopes

868

00:29:25,793 --> 00:29:28,629

in that region where

we can see Cassini.

869

00:29:28,662 --> 00:29:30,398

So we're just saying
hey everybody,

870

00:29:30,431 --> 00:29:34,602

go out and take a look,
and we'll see what we see.

871

00:29:34,635 --> 00:29:37,371

>> We have every confidence

872

00:29:37,404 --> 00:29:38,673

that we're gonna
get the data back.

873

00:29:38,706 --> 00:29:40,541

It's gonna take a
pretty hellacious

874

00:29:40,574 --> 00:29:43,377

rainstorm to take out the data.

875

00:29:43,410 --> 00:29:45,580

We've got our data rates
down at a very low level.

876

00:29:45,613 --> 00:29:48,549

If we can maintain
the 70 meter antenna,

877

00:29:48,582 --> 00:29:50,418

we have a lot of margin.

878

00:29:50,451 --> 00:29:52,320

If we do lose the 70 meter dish,

879

00:29:52,353 --> 00:29:53,721

then our margin is
a little bit lower,

880
00:29:53,754 --> 00:29:56,424
but we're still, I
believe, comfortable.

881
00:29:56,457 --> 00:30:01,395
Worst case, we still have
the New Norcia complex over

882
00:30:01,428 --> 00:30:03,364
on the other side
of the continent

883
00:30:03,397 --> 00:30:06,300
that is not really
prepared to decommutate

884
00:30:06,333 --> 00:30:08,536
our telemetry immediately,
but all the data

885
00:30:08,569 --> 00:30:10,304
will be on the ground,
and we can build

886
00:30:10,337 --> 00:30:11,672
the right system to
take it back apart.

887
00:30:11,705 --> 00:30:16,277
So we'll get the data, it's
just a question of how soon.

888
00:30:16,310 --> 00:30:17,378
>> Okay, thanks guys.

889
00:30:17,411 --> 00:30:18,479
We're gonna go

back to social for

890

00:30:18,512 --> 00:30:21,382

a couple more questions, Jason?

891

00:30:21,415 --> 00:30:24,352

>> Alright, Twitter
user Jason asks,

892

00:30:24,385 --> 00:30:27,689

"When will a spacecraft
visit Saturn again?"

893

00:30:29,657 --> 00:30:31,759

>> So that's for me.

894

00:30:31,792 --> 00:30:33,628

[audience laughing]

895

00:30:33,661 --> 00:30:36,531

I sorta begged
for that question.

896

00:30:37,631 --> 00:30:39,567

The observations by
Cassini have been

897

00:30:39,600 --> 00:30:43,671

so remarkable for Enceladus
and Titan that indeed,

898

00:30:45,372 --> 00:30:48,543

last year we announced the
inclusion of those two objects

899

00:30:48,576 --> 00:30:52,613

in our focused science
program called New Frontiers.

900

00:30:52,646 --> 00:30:55,616

Those proposals are in, and
currently under evaluation,

901

00:30:55,649 --> 00:30:59,487

and they do indeed
include proposals

902

00:30:59,520 --> 00:31:02,390

to go back to Titan
and Enceladus.

903

00:31:03,724 --> 00:31:07,428

So we'll look through
this competition and
see what happens.

904

00:31:08,629 --> 00:31:10,498

>> Okay, you've got another
question there, Jason?

905

00:31:10,531 --> 00:31:13,601

>> Sure, this one comes
from Pietro, who asks,

906

00:31:13,634 --> 00:31:16,237

"If you could go back and
change something in Cassini,

907

00:31:16,270 --> 00:31:19,440

"an instrument or skill,
what would it be?"

908

00:31:19,473 --> 00:31:21,509

>> Hunter, you wanna take that?

909

00:31:21,542 --> 00:31:23,778

[audience laughing]

910

00:31:23,811 --> 00:31:26,280

Okay, if I could
go back and change

911
00:31:26,313 --> 00:31:29,417
some instruments on
Cassini, I think I'd select

912
00:31:29,450 --> 00:31:32,587
flying some more capable
mass spectrometers.

913
00:31:32,620 --> 00:31:35,590
You know, if we had
known about the geysers

914
00:31:35,623 --> 00:31:38,526
on Enceladus ahead of time,
that would have perhaps

915
00:31:38,559 --> 00:31:42,363
guided us, something to go
back and perhaps look for,

916
00:31:42,396 --> 00:31:45,766
amino acids, fatty acids,
possible evidence of life.

917
00:31:45,799 --> 00:31:47,468
So if I could change one thing,

918
00:31:47,501 --> 00:31:49,403
it'd be to carry
some spectrometers

919
00:31:49,436 --> 00:31:53,374
that could do some work
for looking for life.

920
00:31:53,407 --> 00:31:54,709
>> I wouldn't have

touched a damn thing.

921

00:31:54,742 --> 00:31:57,712

[audience laughing]

922

00:31:59,446 --> 00:32:01,782

You know, we went in with
everything we possibly could.

923

00:32:01,815 --> 00:32:05,519

We had the Swiss Army knife,
and now we know so much more,

924

00:32:05,552 --> 00:32:07,588

now we can fine tune it.

925

00:32:07,621 --> 00:32:11,592

But this spacecraft, like I
said, I couldn't have asked

926

00:32:11,625 --> 00:32:15,262

for anything, I couldn't
have asked for anything more.

927

00:32:15,295 --> 00:32:19,400

>> Alright, we're gonna come
back to the room, I think Emily.

928

00:32:21,635 --> 00:32:24,271

>> Hi, I'm Emily Loctawalla
from the Planetary Society,

929

00:32:24,304 --> 00:32:26,340

with a couple of
science questions.

930

00:32:26,373 --> 00:32:27,575

Hunter, I'm wondering
if you could tell us

931
00:32:27,608 --> 00:32:29,410
a little bit more
about that ring rain

932
00:32:29,443 --> 00:32:31,512
concept that you're
trying to test,

933
00:32:31,545 --> 00:32:33,514
and what you're
learning about it.

934
00:32:33,547 --> 00:32:35,449
And Linda, I know that
there's a science team

935
00:32:35,482 --> 00:32:37,518
meeting going on this week,
I'm wondering if you can

936
00:32:37,551 --> 00:32:39,453
share any of the early exciting

937
00:32:39,486 --> 00:32:42,623
results from the
proximal mission.

938
00:32:42,656 --> 00:32:45,660
>> Well, the ring rain
concept, as I mentioned,

939
00:32:45,693 --> 00:32:48,696
was first introduced
in the 1980s,

940
00:32:48,729 --> 00:32:53,300
and it was a concept of
material from the rings,

941

00:32:53,333 --> 00:32:55,670

mainly water vapor
and ice grains,

942

00:32:55,703 --> 00:32:57,605

descending into the atmosphere

943

00:32:57,638 --> 00:33:00,441

and causing changes
in the atmosphere.

944

00:33:00,474 --> 00:33:03,511

And we have measured that,
and we do see the water.

945

00:33:03,544 --> 00:33:06,647

But we see other
constituents as well.

946

00:33:06,680 --> 00:33:10,451

So it's much more complex
than we imagined before.

947

00:33:10,484 --> 00:33:13,688

And we'll be, you
know, we're trying to,

948

00:33:13,721 --> 00:33:16,490

we're traveling at 31
kilometers per second,

949

00:33:16,523 --> 00:33:19,527

and gas is coming into
our instrument very fast,

950

00:33:19,560 --> 00:33:21,562

and with a lot of energy.

951

00:33:22,663 --> 00:33:25,299

And so there's potential

to break it apart.

952

00:33:25,332 --> 00:33:29,270

So we're working very
carefully to understand

953

00:33:29,303 --> 00:33:33,374

that before we go out and tell
the public what we're seeing.

954

00:33:34,475 --> 00:33:35,509

>> Yes Emily, we're
having one of our

955

00:33:35,542 --> 00:33:36,744

project science group meetings,

956

00:33:36,777 --> 00:33:39,513

in fact it's the 73rd
meeting we are having

957

00:33:39,546 --> 00:33:42,283

of this group since
we first got started.

958

00:33:42,316 --> 00:33:45,486

And there have just been
some tremendous presentations

959

00:33:45,519 --> 00:33:49,523

about the grand finale science,
some of it only days old.

960

00:33:49,556 --> 00:33:52,626

And what I can tell you is
that many of our models,

961

00:33:52,659 --> 00:33:54,662

we're finding out,
are too simple,

962

00:33:54,695 --> 00:33:56,464
or just out and out wrong.

963

00:33:56,497 --> 00:33:58,365
And so the scientists
are carefully looking at

964

00:33:58,398 --> 00:34:01,268
and calibrating their
data, and comparing notes,

965

00:34:01,301 --> 00:34:03,604
and discussing it, and
there's nothing to make

966

00:34:03,637 --> 00:34:07,608
a scientist happier than finding
out hey, my model is wrong,

967

00:34:07,641 --> 00:34:10,411
I have to sorta start
over and work it through.

968

00:34:10,444 --> 00:34:12,480
So we have a lot of very
very happy scientists.

969

00:34:12,513 --> 00:34:15,516
We're meeting down at Cal
Tech, and so hopefully

970

00:34:15,549 --> 00:34:17,651
in the coming months
we'll have some answers.

971

00:34:17,684 --> 00:34:20,287
But in particular, the
interior of the planet

972

00:34:20,320 --> 00:34:22,423

is very different
than we expected,

973

00:34:22,456 --> 00:34:23,624

its gravity field is not at all

974

00:34:23,657 --> 00:34:25,693

what we expected
from our models.

975

00:34:25,726 --> 00:34:27,561

Also, the magnetic
field, we're finding

976

00:34:27,594 --> 00:34:30,331

that the rotation axis of Saturn

977

00:34:30,364 --> 00:34:34,368

and the magnetic field axis
are almost perfectly aligned.

978

00:34:34,401 --> 00:34:36,337

Everything we think
we know tells us

979

00:34:36,370 --> 00:34:38,405

that if you don't have
at least a small tilt,

980

00:34:38,438 --> 00:34:40,341

you can't maintain
those currents

981

00:34:40,374 --> 00:34:42,510

that sustain a magnetic field.

982

00:34:42,543 --> 00:34:46,647

So we have some more thinking

and some more work to do.

983

00:34:46,680 --> 00:34:47,782

>> Okay, questions here?

984

00:34:47,815 --> 00:34:50,718

I think there's one
in the third row.

985

00:34:52,719 --> 00:34:55,422

>> Hi, Robert Perlman
Collect Space.

986

00:34:55,455 --> 00:34:57,558

Not that there'd be any
way of verifying this,

987

00:34:57,591 --> 00:35:01,295

but has there been any modeling
or any even best guesses

988

00:35:01,328 --> 00:35:03,397

of how Cassini's
going to come apart?

989

00:35:03,430 --> 00:35:07,368

And what might be the
last piece to survive?

990

00:35:07,401 --> 00:35:10,504

>> Yes, there's been
very thorough analysis,

991

00:35:10,537 --> 00:35:15,442

a piece by piece deconstruction,
if you will, of Cassini.

992

00:35:15,475 --> 00:35:18,445

And we believe that
the final components

993

00:35:18,478 --> 00:35:23,317
to be destroyed will be
the aero shell components

994

00:35:23,350 --> 00:35:26,353
that are wrapped
around, Cassini has

995

00:35:26,386 --> 00:35:28,656
these radioactive
power supplies.

996

00:35:28,689 --> 00:35:32,526
And each little slug of
plutonium is wrapped around,

997

00:35:32,559 --> 00:35:34,628
is wrapped with iridium,
and then they're

998

00:35:34,661 --> 00:35:37,731
put inside an aero
shell, in order to avoid

999

00:35:37,764 --> 00:35:41,635
any possible release during
a launch accident or reentry.

1000

00:35:41,668 --> 00:35:44,672
And the iridium has a
very high melting point,

1001

00:35:44,705 --> 00:35:47,474
and the material around
them is even higher.

1002

00:35:47,507 --> 00:35:48,742
So those will be
the last pieces.

1003

00:35:48,775 --> 00:35:52,479

Other than that, taking those,
the parts of the spacecraft

1004

00:35:52,512 --> 00:35:55,649

that will be shielded away
will last a little bit longer.

1005

00:35:55,682 --> 00:35:57,585

But, you know, a lot of
the spacecraft is aluminum,

1006

00:35:57,618 --> 00:35:59,353

it's going to melt very quickly.

1007

00:35:59,386 --> 00:36:03,490

A lot of it's carbon fiber and
Mylar and things like that,

1008

00:36:03,523 --> 00:36:06,627

and they're gonna
go very quickly.

1009

00:36:06,660 --> 00:36:10,297

>> Okay, how about some
more social media questions?

1010

00:36:10,330 --> 00:36:11,465

>> Sure, here's
two good ones here.

1011

00:36:11,498 --> 00:36:14,368

The first one comes from
user Anshell, who asks

1012

00:36:14,401 --> 00:36:15,636

"What is the last bit of data

1013

00:36:15,669 --> 00:36:19,406

"that we will receive
from Cassini?"

1014

00:36:19,439 --> 00:36:22,343

>> The very last bit
of data will include

1015

00:36:22,376 --> 00:36:24,445

the ion and neutral
mass spectrometer data,

1016

00:36:24,478 --> 00:36:26,714

but they come down in
packets, so we don't know

1017

00:36:26,747 --> 00:36:28,682

if the INMS packet
will be the last one,

1018

00:36:28,715 --> 00:36:31,318

or a magnetometer
packet, or whatever.

1019

00:36:31,351 --> 00:36:32,753

But they'll be coming
back as quickly

1020

00:36:32,786 --> 00:36:34,521

as we can send them back.

1021

00:36:34,554 --> 00:36:37,424

So we'll find out
with that final bit.

1022

00:36:37,457 --> 00:36:41,495

>> Well actually, and we'll
see the radio signal dissipate.

1023

00:36:42,596 --> 00:36:44,665

So our very last
bit of science data,

1024
00:36:44,698 --> 00:36:46,433
if we don't get a
complete packet,

1025
00:36:46,466 --> 00:36:49,470
could very well be
the radio science.

1026
00:36:49,503 --> 00:36:52,439
>> Alright, lots of folks are
asking about what happens next.

1027
00:36:52,472 --> 00:36:54,708
So Lisa here says, "What
happens to the team working

1028
00:36:54,741 --> 00:36:56,744
"with Cassini Saturn
after the mission's end?"

1029
00:36:56,777 --> 00:36:58,579
"Are they just reassigned
to new projects

1030
00:36:58,612 --> 00:37:01,415
"or missions at NASA, or
are they off job hunting?"

1031
00:37:01,448 --> 00:37:02,783
[audience laughing]

1032
00:37:02,816 --> 00:37:05,619
>> Well most of the engineers,

1033
00:37:05,652 --> 00:37:09,390
there is an active planetary
program here at JPL,

1034

00:37:09,423 --> 00:37:11,425

and a lot of our engineers
have already kind

1035

00:37:11,458 --> 00:37:15,496

of half semi migrated over
to these other opportunities.

1036

00:37:15,529 --> 00:37:19,566

We're not having big layoffs
or anything like that.

1037

00:37:19,599 --> 00:37:21,502

There's lots of
work for everyone.

1038

00:37:21,535 --> 00:37:23,671

Some of us have some
paperwork to do.

1039

00:37:23,704 --> 00:37:25,706

[audience laughing]

1040

00:37:25,739 --> 00:37:27,375

And not just me.

1041

00:37:28,375 --> 00:37:30,477

[audience laughing]

1042

00:37:30,510 --> 00:37:32,613

So there's a lot of
documentation, and of course,

1043

00:37:32,646 --> 00:37:36,517

the science data, to the
extent that it can be funded

1044

00:37:36,550 --> 00:37:40,487

by research grants will
continue for decades.

1045
00:37:40,520 --> 00:37:43,524
So those opportunities
for both our current

1046
00:37:43,557 --> 00:37:45,726
and young scientists
will be at least

1047
00:37:45,759 --> 00:37:47,594
for another couple
of decades, gotta be.

1048
00:37:47,627 --> 00:37:49,363
>> Right, and the Cassini
scientists are funded

1049
00:37:49,396 --> 00:37:52,466
for the next year,
basically to make sure

1050
00:37:52,499 --> 00:37:54,735
they carefully calibrate
and understand all

1051
00:37:54,768 --> 00:37:56,670
of this grand finale
data, to put it

1052
00:37:56,703 --> 00:37:58,472
in the planetary data system.

1053
00:37:58,505 --> 00:38:00,374
And from there,
it'll be accessible

1054
00:38:00,407 --> 00:38:01,642
to future scientists, you know.

1055

00:38:01,675 --> 00:38:05,312

Who knows how many PhD
theses will be written

1056

00:38:05,345 --> 00:38:08,582

in the coming decades
with Cassini data?

1057

00:38:08,615 --> 00:38:11,251

>> Indeed, you know, Cassini's
really given everyone

1058

00:38:11,284 --> 00:38:15,356

on the job training on
operating spacecraft

1059

00:38:15,389 --> 00:38:18,692

and keeping our instruments
healthy and analyzing the data,

1060

00:38:18,725 --> 00:38:23,331

and so we have a cadre of
highly capable scientists,

1061

00:38:25,632 --> 00:38:29,637

engineers, that we'll keep
busy for many decades.

1062

00:38:32,739 --> 00:38:36,343

You know, planetary
program is doing well.

1063

00:38:36,376 --> 00:38:38,412

We have tremendous support
by the administration

1064

00:38:38,445 --> 00:38:41,715

and Congress, we have missions
that we're planning now.

1065

00:38:41,748 --> 00:38:45,753

And we really have a
very bright future.

1066

00:38:45,786 --> 00:38:48,355

>> Alright, we've got time
for another quick followup

1067

00:38:48,388 --> 00:38:51,726

from Leo Enwright from
Irish Television, Leo?

1068

00:38:54,528 --> 00:38:57,765

>> Leo: I've a question for
Earl and Linda about Enceladus,

1069

00:38:57,798 --> 00:39:01,335

which is a tiny
moon not much bigger

1070

00:39:01,368 --> 00:39:04,304

than Ireland, I
have to point out.

1071

00:39:04,337 --> 00:39:08,442

And it's just astonishing
that it's so active.

1072

00:39:08,475 --> 00:39:11,545

Earl, do you know,
do you have any idea

1073

00:39:11,578 --> 00:39:14,481

of the chances
that Cassini would

1074

00:39:14,514 --> 00:39:18,485

have actually collided
with this tiny moon?

1075

00:39:18,518 --> 00:39:20,487

And for Linda, really,
if you wouldn't mind

1076

00:39:20,520 --> 00:39:23,424

just telling us on
the scale of things

1077

00:39:23,457 --> 00:39:27,494

that you've seen in your
extraordinary career,

1078

00:39:27,527 --> 00:39:29,630

I mean where does
Enceladus fit in

1079

00:39:29,663 --> 00:39:32,633

as the amazing
surprise, as it were?

1080

00:39:36,570 --> 00:39:41,375

>> Well, we didn't do the math,
actually I take that back,

1081

00:39:41,408 --> 00:39:43,744

we did do the math several
times for Enceladus,

1082

00:39:43,777 --> 00:39:47,381

and as long as we could control
the spacecraft, no problems.

1083

00:39:47,414 --> 00:39:51,285

But we had a big challenge
in an uncontrolled spacecraft

1084

00:39:51,318 --> 00:39:53,287

not hitting within a chance

1085

00:39:53,320 --> 00:39:56,590

of one in a million Enceladus
in the next 50 years.

1086

00:39:56,623 --> 00:39:58,759

The issues are, of course,
that once it's uncontrolled,

1087

00:39:58,792 --> 00:40:00,727

you've got Titan out
there pushing it around,

1088

00:40:00,760 --> 00:40:03,564

it could push it just about,
as you saw in those graphics,

1089

00:40:03,597 --> 00:40:05,399

just about anywhere
you'd want it to go,

1090

00:40:05,432 --> 00:40:08,436

and Enceladus was a
good sized target.

1091

00:40:09,569 --> 00:40:12,239

So we didn't do the
actual math for any

1092

00:40:12,272 --> 00:40:14,641

of those others to
convince ourselves

1093

00:40:14,674 --> 00:40:17,578

that an uncontrolled spacecraft
either had to be well

1094

00:40:17,611 --> 00:40:21,749

outside of Saturn, I mean
way way outside, or inside.

1095

00:40:24,651 --> 00:40:26,687

>> Well let me answer
the second part.

1096

00:40:26,720 --> 00:40:30,390

For Enceladus, I would
say Enceladus' discoveries

1097

00:40:30,423 --> 00:40:32,459

made by Cassini
are certainly one

1098

00:40:32,492 --> 00:40:33,627

of the most astonishing set

1099

00:40:33,660 --> 00:40:36,430

of discoveries for
planetary science.

1100

00:40:36,463 --> 00:40:40,334

To find that there's
an ocean world so tiny,

1101

00:40:40,367 --> 00:40:43,370

with the possibility of
life, so far from the Sun,

1102

00:40:43,403 --> 00:40:45,405

10 times further from
the Sun than the Earth,

1103

00:40:45,438 --> 00:40:49,276

has opened up our paradigm of
where you might look for life,

1104

00:40:49,309 --> 00:40:50,744

both within our own solar system

1105

00:40:50,777 --> 00:40:53,747

and in the exoplanet
systems beyond.

1106

00:40:53,780 --> 00:40:55,782

So these ocean
worlds, Enceladus,

1107

00:40:55,815 --> 00:40:58,752

Titan also has a liquid
ocean, has really changed

1108

00:40:58,785 --> 00:41:02,523

our thinking about
where to look for life.

1109

00:41:03,623 --> 00:41:05,626

>> Okay, well actually
I think that's about

1110

00:41:05,659 --> 00:41:08,495

all the time we have for
today for our briefing.

1111

00:41:08,528 --> 00:41:10,230

Thanks again to our
speakers, and to all

1112

00:41:10,263 --> 00:41:11,698

of you for your questions.

1113

00:41:11,731 --> 00:41:15,335

Here's how you can
watch Cassini coverage

1114

00:41:15,368 --> 00:41:16,570

that NASA television
has to offer

1115

00:41:16,603 --> 00:41:18,405

over the next couple of days.

1116

00:41:18,438 --> 00:41:21,275

Tomorrow, September 14th,
we'll have a speaker program

1117

00:41:21,308 --> 00:41:24,478

as part of our NASA
social event on Cassini,

1118

00:41:24,511 --> 00:41:26,547

from one to two PM Pacific time,

1119

00:41:26,580 --> 00:41:29,416

that's four to five PM Eastern.

1120

00:41:29,449 --> 00:41:30,717

Then on Friday, we'll
have live commentary

1121

00:41:30,750 --> 00:41:34,354

from Mission Control from four
to five-thirty AM Pacific,

1122

00:41:34,387 --> 00:41:36,623

that's seven to
eight-thirty Eastern.

1123

00:41:36,656 --> 00:41:38,392

And following loss
of signal, we'll have

1124

00:41:38,425 --> 00:41:39,760

a post-mission
briefing right here,

1125

00:41:39,793 --> 00:41:42,496

starting at
six-thirty AM Pacific.

1126

00:41:42,529 --> 00:41:47,334

You can watch live
at [NASA.gov/live](https://www.nasa.gov/live).

1127

00:41:47,367 --> 00:41:50,571

More info about Cassini
is available at [NASA.gov](https://www.nasa.gov),

1128

00:41:50,604 --> 00:41:52,472

and you'll find a
detailed online toolkit

1129

00:41:52,505 --> 00:41:55,542

about Cassini's grand finale
and end of mission on the

1130

00:41:55,575 --> 00:41:59,647

mission website at
saturn.jpl.nasa.gov/grandfinale.

1131

00:42:01,815 --> 00:42:04,451

And I think we've got
a couple more minutes

1132

00:42:04,484 --> 00:42:06,687

before the end of the hour,
we'll end now with a replay

1133

00:42:06,720 --> 00:42:09,223

of some of the images and video

1134

00:42:09,256 --> 00:42:10,490

we've shared during
our presentation today.