We’re NASA experts working to send humans to the Moon in 2024. Ask us anything!

UPDATE:That’s a wrap! We’re signing off, but we invite you to visit https://www.nasa.gov/specials/moon2mars/ for more information about our work to send the first woman and next man to the lunar surface. We’re making progress on the Artemis program every day! Stay tuned to nasa.gov later for an update on working with American companies to develop a human landing system for landing astronauts on the Moon by 2024. Stay curious!

Join NASA experts for a Reddit ‘Ask Me Anything’ on Thursday, May 16 at 11:30 a.m. EDT about plans to return to the Moon in 2024. This mission, supported by a recent budget amendment, will send American astronauts to the lunar South Pole. Working with U.S. companies and international partners, NASA has its sights on returning to the Moon to uncover new scientific discoveries and prepare the lunar surface for a sustained human presence.

Ask us anything about our plans to return to the lunar surface, what we hope to achieve in this next era of space exploration and how we will get it done!

Participants include:

- Lindsay Aitchison, Space Technologist
- Dr. Daniel Moriarty III, Postdoctoral Lunar Scientist
- Marshall Smith, Director, Human Lunar Exploration Programs
- LaNetra Tate, Space Tech Program Executive

Proof: https://twitter.com/NASASocial/status/1128658682802315264
[link to AMA]

AstroManisKr:
Thanks for doing this AMA!

Why should we have confidence that a goal like 2024 is realistic? NASA was saying few months ago that it could not do this before 2028.

Marshall Smith:
Happy to be here! We had a plan for 2028 that involved decent element tests in 2023/2024, a full non-crewed test in 2026 and a crewed mission in 2028. The 2028 plan would not have required an increase in NASA's budget. Moving up to 2024 however is doable with the amended budget request and follow on funding which will be needed in the remaining years. Technically building all the required systems will be challenging, but NASA is used big challenges.

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coldfusionman:
How do you expect to get back to the moon by 2024 when commercial crew is taking over 7 years just to get back to LEO and SLS is many years behind schedule despite a massive amount of funding? I'm all for working on the goal, but 2024 seems hilariously unrealistic.

Marshall Smith:
There are two types of risk that need to be addressed when attempting to achieve a goal. First is a technical risk. I believe that NASA and the space industry working together is capable of addressing the technical risk and making the schedule. The Apollo program achieved did not have a commercial base and in nine years landed humans on the surface of the Moon. We know a lot more and have a strong commercial base that we can leverage off of to achieve our goal by 2024. It will take more funding than currently in NASA's budget. This leads to the other risk which is political. We as a nation have to have the will to achieve this bipartisan goal through various administrations, changing budgets and changing priorities. Setting an aggressive goal limits this political risk

Yes. This is challenging, but we are up to the task.

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elemental_pineapple:
Do you believe NASA is open to using potential commercial launchers like starship for manned/unmanned missions? Even if SLS is ready, it seems starship would be way more cost effective and allow NASA to accomplish a lot more with the same funds
Marshall Smith:
The 2024 plan includes using commercial launch vehicles to deliver the Gateway and the Human Landing System as well as science experiments launched under the Commercial Lunar Payload Services Program. In addition commercial launch vehicles will be required to deliver surface assets such as habitats, rovers and consumables. The Space Launch System will be used to deliver the Orion spacecraft and crew to the Gateway for the human missions. Currently the SLS is the only vehicle capable of launching Orion for long duration, deep space exploration.

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throwaway2xyz2:
Will there be another AMA from the Moon?
Lindsay Aitchison:
Dude - that would be awesome! Anything is possible with sustained exploration... but an AMA from Mars might not be as much fun with that comm delay - up to 22min one way!

Thorpester:
What are you going to do about moon dust in the spacesuits joints?
Lindsay Aitchison:
We learned a lot from the Apollo missions on how dust affects the durability of space suits. NASA is looking at a combination of passive coatings and new materials to prevent dust from collecting on the suits as well as more exotic approaches such as electrostatic pulses to actively repel the dust real-time

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EnemyFriendEnemy:
This is all incredibly exciting, so thanks for taking the time to interact with people.

Serious question, how can someone get on one of those crews to go to the moon? Have they already been selected and are training or are they yet to be decided? Thanks!

Lindsay Aitchison:

Thanks for joining in our conversation!

The crew for the next lunar mission will be selected from our NASA astronaut corps . The Astronaut Office is already working with the engineers and scientists to conduct early tests on systems and concepts to get a jump start on training, but we haven't selected the specific women and men for the first Artemis mission just yet.

TheOneTrueMongoloid:

What kind of experiments are planned for the surface mission and what is the expected duration of the mission going to be?

Dr. Daniel Moriarty:

NASA is currently trying to optimize the science return from the 2024 mission, given the constraints of a relatively small payload and fast turnaround time. At this point, there have been no official decisions made regarding instrumentation and experiments.

As a lunar scientist, I certainly have a few opinions about this! From the Apollo missions, we've established the incredible importance of collecting diverse samples from the lunar surface. With returned samples, we can perform analyses using any instrument in any terrestrial lab on our home planet - this is a lot more efficient than carting a bunch of mass spectrometers and electron microprobes to the Moon! I'm guessing that a lot of the instruments we bring in 2024 are going to be geared towards identifying and collecting interesting samples (handheld spectrometers, hand lenses, shovels, core tubes, sample bags, etc.). The South Pole is geochemically very different than all of the Apollo sites, and samples we return from there could tell us a lot about the lunar mantle, funky volcanic products, and the poorly-understood differences between the lunar nearside and farside.

A seismometer would also be cool, using moonquakes to help us peer into the lunar interior! This could supplement great seismic data from the Apollo missions.

I believe that this mission is going to be fairly short (a few days, perhaps), but I haven't heard anything official yet.

19jperkins:

Two part question:

Given the history of the relations between NASA and the president and how the president determines the missions and directives of NASA, is there a good chance that the next president will completely change this whole directive before we get the chance to see it happen?

Also, I've seen some things about possibly 3d printing with lunar regolith. Do you think NASA would possibly want to send a test 3d printer to see how feasible it would be to actually 3d print structures on the Moon or is that not a direction you want to go?
Thanks for the event! You guys are great!

LaNetra Tate:

We partnered with Made In Space to send and test a 3D printer on the space station. We just delivered a Refabricator (that recycles plastic to print parts) to the space station as well. Much of what we learn on the space station, as well as testing on the ground, will help us design a system that we could utilize on the Moon to print both tools and infrastructure. More info below! All this technology feeds forward to inform us how to do more with different materials (plastics, metals, lunar soil)
https://www.youtube.com/watch?v=vgZymJC4a-g
https://www.youtube.com/watch?v=_iFfehELSkU

AstroManishKr:

What data do you hope to gain from new moon mission that may help with going to Mars?

Dr. Daniel Moriarty:

Really interesting question! Preparedness for Mars exploration is one of the major themes guiding the imminent lunar missions. There are a number of ways that developing technologies and geological understanding for lunar missions enable future exploration of Mars. It's a lot easier to get to the Moon than Mars, which means that technologies we'll need to explore Mars can much more easily be developed and tested on the Moon.

For instance, I can imagine a scenario where the Moon functions as a laboratory for testing new spacesuits or habitation structures in dusty, low-gravity, low-atmosphere environments. Another important technology to develop is the ability to extract and use resources on the surface of another planet. On the Moon, we can test ways to extract and purify lunar water, which could help us reduce the amount of water that would need to be supplied from Earth. We could perfect this technology on the nearby Moon before relying on it for Mars!

RoyMustangela:

Are these missions envisioned as short stays at different locations like Apollo or repeated visits to the same location with the goal of building up a base, more like ISS?

Marshall Smith:

We're sending up science instruments on a Commercial Landing Payload Systems and we'll be studying different parts of the Moon. Focusing on the South Pole. Our initial missions will be short duration stays focused on the South Pole or areas that show promising scientific and resource value. Depending upon what we learn in early missions, we will decide where we would like to focus our energy either in habitation or mobility (rovers).

VijayG619:

What is special about South Pole and the surrounding area? Can you elaborate

Lindsay Aitchison:

The South Pole is exciting because not only are we going back to the moon, but we're sending humans where they have never been before! We already know a lot about this region because robotic missions have revealed important information about its environment. Through thousands of orbits in the last decade, the Lunar Reconnaissance Orbiter has collected the precise information about the South Pole region, offering scientists precise details about its topography, temperature and locations of likely frozen water – and water is critical to future exploration missions. You can find more information on 'Why the South Pole' in our web feature: https://www.nasa.gov/feature/moon-s-south-pole-in-nasa-s-landing-sites

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Jay19167:

NASA has said it wants to go to the moon sustainably this time, though all of the lander concepts I've see still use 2 stages with an expendable landing stage and an accent module. How long before we can expect to see lunar single stage to orbit landers with full resuability?

Marshall Smith:

The size of your lander is greatly dependent upon what you want to do at your destination. Apollo was limited to short stays and the equatorial region of the Moon. Also, it was not reusable. To return to the Moon in sustainable fashion to be able to explore it we need to carry significantly more fuel and consumables. This makes single-stage landers impractical. As there are no rockets today powerful enough to launch a single stage lander. Current launch vehicles can support two and three stage options. The key to sustainability is to enable these systems to be reusable.

There are concepts and systems in discussion that could approach a single stage capability, however it will be many years before these systems are a reality.

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mareszko:

What's a technology you are using today that would have been the biggest help if they had it back at the time of the original moon landings?

LaNetra Tate:

Apollo helped bring about the computer revolution, and I look forward to seeing what becomes possible as we come up with new space technologies in this digital age! We are partnering with DoD on High Performance Spaceflight Computing (HPSC). It is one current technology that addresses computation performance, energy management, and fault tolerance. The entire system will be about 100 times faster than today's common computers processors. During the Apollo program, we used a digital computer onboard each Apollo command and lunar module. This new technology can perform 15 billion instructions per second, compared to just 85,000 instructions per second of the Apollo Guidance Computer.

ZoreX_Yt:

Thanks for doing this AMA, so [...]

What kind of experiments are you planning on doing on the moon?

LaNetra Tate:

Hi ZoreX, the possibilities are endless! One thing we are looking into is sending a scouting robot called the Pop-Up Flat Folding Explorer Robot (PUFFER). PUFFER is an origami-inspired robot that is lightweight and capable of flattening itself. Imagine a future lunar rover having several

deployable PUFFER robots. They would deploy from the parent platform and have distributed autonomous exploration of a larger area of the surface. Check the tech out in this video: https://www.youtube.com/watch?v=nRmorQmGqVM

LolUninstall:
I'm an electronics engineer in school right now, what's some electronic systems that could use improvements for the moon 2024 mission that I could potentially try to do as my senior year project? I know this is probably a silly question since you guys have many engineers constantly working to improve things, but any thoughts would be great. thank you

Marshall Smith:
Hello, from a fellow electrical engineer! We need good electrical engineers engaged in developing avionics, guidance navigation and control systems and communication systems. I couldn't point you to a specific need, but these are areas that constantly need improvement. Good luck with your studies.

Olasg:
How many astronauts are gonna be there simultaneously. And how long will they stay.

Lindsay Aitchison:
The initial missions will have up to four astronauts going to the Gateway with at least two descending to the surface for up to 6.5 days.

ConqueefStador:
I don't have a question but I caught the "We're Going" video today and I just wanted to say thank you for the important work you're doing.

You all represent the best humanity has to offer. You are the giants on whose shoulders future generations will stand upon.

Thank you.

LaNetra Tate:
Thanks ConqueefStador. It was a great video and it was so exciting to be in the video. It is so exciting that We Are Going! To the Moon!.

Technology Drives Exploration!!!!!

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drbobbyamos:
Any chance of testing out Robert Heinlein's moon theory where tunneling was performed for the majority of the future living space in order to provide thermal and radiation protection?

Dr. Daniel Moriarty:
This is an unlikely task for the 2024 human mission, but it's certainly something that lunar scientists are exploring. For instance, the Moon Diver mission concept is looking into robotic exploration of lunar lava tubes - no tunneling required!

A4S8B7:
Are we there yet?
:) haha sorry, just had too! Do you have a location selected?
Lindsay Aitchison:
Yep- the lunar South Pole! It will be the first visit by humans to this location!

HighCalamity:
Question for Dr. Moriarty aren't you afraid of Sherlock thwarting your plans? No for real what would be the first stage of preparing the surface for human inhabitants?
Dr. Daniel Moriarty:
DRATS! Foiled again!

I don't think we're going to be able to change anything about the surface of the Moon much. Instead, I think it makes sense to work within some of the structures and resources that are already there. For instance, it could be useful to establish a base near a permanently-shadowed polar region in order to take advantage of surface water that's there. Alternatively, it could be interesting to set up shop within a pre-existing lava tube, which could provide astronauts with some shielding from temperature variations and incoming solar radiation. There are lots of cool possibilities!

DM aka Sherlock's archnemesis

RoyMustangela:
Are there any firm plans for mission goals besides "boots on the ground in 2025" yet? Are you looking at testing ISRU technology, building a permanent base with regolith for radiation shielding, long term stays (maybe through the night), anything that makes this substantially different than Apollo?
LeNetra Tate:
We are most definitely looking to mature technologies and capabilities that will support ISRU on the surface of the Moon. We will initially focus on converting polar ice to water and oxygen extraction from lunar soil as initial demonstrations, testing them here on Earth and then on the Moon. Building a permanent base with regolith for radiation shielding is an interesting concept that has been discussed within the ISRU community.

8andahalfby11:
Many discussions mention landing at the lunar poles to explore craters that are in "perpetual night" to look for water resources. Does the 2024 plan include exploring a Dark Crater? If so what's the plan for getting into and out of one, and what changes need to be taken into account for operating in those conditions, since Apollo operated during the lunar "day"?
Dr. Daniel Moriarty:
Right, the permanently shadowed regions at the poles are really the only places where we expect to find stable water at the lunar surface. This has been confirmed by recent missions such as LCROSS and the Moon Mineralogy Mapper. It isn't certain if the plan for 2024 is to go

to a permanently shadowed region, but I think access to these areas in something being considered amongst a larger list of priorities.

If and when we do journey to a permanently shadowed region, we'll need technology that can withstand BRUTAL cold. These permanently shadowed regions are some of the coldest places in the entire solar system.

SgtDreadnought:
What's the long term goal regarding a sustained human presence? i.e. What are the main benefits?
Lindsay Aitchison:
The primary goal of going to the Moon is to test the technologies and strategies needed for human exploration of Mars. The farther humans venture into space, the more critical it becomes to manufacture materials and products with local resources. The Moon will allow us to practice that increased crew autonomy as the astronauts learn to work with robotic partners and "live off the land" with less dependence on Mission Control.

Additional benefits of exploring the moon are that it helps to expand US global economic impact by growing US industry and international partnerships , and it will provide opportunities for groundbreaking science and technology development which will inspire the next generation to careers in STEM.

Ziomax25:
What path of study and career have you taken to get to work on such a project?
Dr. Daniel Moriarty:
Great question!

For my undergrad degree, I studied Astronomy and Physics at the University of Massachusetts (GO UMASS)

I was interested in getting into something a little more "hands-on," but I still wanted to work in space-related fields. One of my professors suggested planetary geology, and it was perfect. I got to work with power tools and environmental vacuum chambers and play in the dirt. I studied lunar geology at Brown University for grad school.

Before NASA, I taught oceanography and geology at the Community College of Rhode Island. I think it's important to communicate how exciting and important our Earth is, and I did my best to communicate this to my students!

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lordflores:
Hi! I'm a student at SBCC studying to become a mechanical engineer and desperately looking for an internship. Do you have any available?
Lindsay Aitchison:

I started as a NASA intern myself - it's a great way to get involved with space! A full list of internship and fellowship opportunities can be found here: https://intern.nasa.gov/index.html

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RocketRundown:
Do you believe that the current NASA budget is sufficient to fund the Moon 2024 mission. And what NASA programmes do you think are likely to suffer as a result if it's not?
Marshall Smith:
The current NASA budget is approximately $21 billion per year and require a plus up to fund our return to the Moon to stay. NASA submitted a $1.6 billion dollar amendment for FY20. This is a down payment to get us started and hold to a 2024 schedule. Budget for future years will be worked throughout the following year.

This budget does not impact other science and technology programs.

AGentlemanScientist:
Do you have any insight on future opportunities for private enterprise in these endeavors? Should we expect more requests for proposals in the subsystem, component and research elements?
Lindsay Aitchison:
Commercial Partners will play a key role in the success of the lunar exploration program. We are currently using the NextSTEP-2 contract mechanism to accelerate demonstrations of core technologies including the Power and Propulsion Element of the Gateway and the Human Landing System Elements. We will continue to engage with private industry to get to the Moon in the next five years and beyond.

RoyMustangela:
Are you guys looking at using Kilopower on the surface?
LaNetra Tate:
We are looking to utilize surface power on the Moon. We are exploring several options for surface to include solar arrays, batteries and fission surface power. We are currently working with the Department of Energy to develop safe and reliable systems that build on the Space Technology Mission Directorate (STMD) funded Kilopower project.

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brysontech:
Why does it seem as if there are no plans for a reusable lunar transfer vehicle and reusable decent/assent vehicles? It seems very unsustainable to always send all your equipment and vehicles in one go each time.
Marshall Smith:
We intend for the lunar system to eventually be fully reusable. The initial system may not be reusable but will evolve in the course of a few years. The assent element and transfer element will be the first reusable elements. Decent elements could be reusable should we find and be able to produce fuel on the lunar surface. The Gateway will provide the capability to enable reusability by allowing the lander to aggregate at the Gateway and then perform maintenance activities between missions.

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ifcarscouldspeak:

Thanks a lot for taking your time out for this. I have been reading up on rovers recently, and I was wondering what experiments you have planned that would not be possible with rovers or automated bots. In fact since the communication delay to moon is not huge, I would assume rovers could even be controlled from earth. So what would a human be able to do in addition to what rovers can already do?

Dr. Daniel Moriarty:

Great question - this is a subject of frequent discussion across planetary science. From the Apollo missions, we saw the huge benefits of having boots on the ground. For instance, Apollo 17 astronaut Jack Schmitt was a trained geologist at the time of the mission. The insight he provided from the lunar surface was invaluable in terms of identifying what samples to prioritize, and establishing the geological context for those samples. In general, humans offer much better decision-making, intuition, and mobility than current rovers are capable of.

I think there are huge benefits from a coordinated program of rover and human explorers. Rovers excel at exploring new, dangerous, and distant areas. Going forward, I think there is going to be great synergy between rovers and humans in our continuing exploration of the solar system.

KishoreVenugopal:

1. Do you expect water to undergo sublimation when you extract it, due to low pressure? Is it correct to assume that ice might be existing now as it didn't have a heat source yet, not even sunlight? Are you planning any very special and sophisticated equipment to extract water?

2. If water has to be extracted from such low-temperature ice where the ambient would extremely cold (as not even sunlight would reach there) and low pressure, energy required will be huge. Are you planning energy intense nuclear sources to be taken up there?

Dr. Daniel Moriarty:

1. Under normal conditions, water ice is not stable at the lunar surface. The only place we expect to find significant amounts of water ice is in permanently shadowed regions at the poles, where the absurdly low temperatures trap ice over long timescales. A few recent experiments and analyses (for instance, the LCROSS mission and data from the Moon Mineralogy Mapper) demonstrate that there is a lot of water in these permanently shadowed regions. Accessing this water seems to be a high priority going forward, but as of right now there aren't any specific strategies or instruments that have been officially designated for this task.

2. This is not my area of expertise, but I don't think we'll need nuclear energy sources to liberate the water. Something as simple as transporting the permanently-shadowed icy material out of the shadows and into sunlight should be enough to liberate water!

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kinnection:

This is very inspiring!

How exactly will private industry aid NASA in reaching the 2024 goal? As many have pointed out, this deadline seems very tight.

Marshall Smith:

The President challenged us to have the first woman and the next man on the lunar surface in five years and we accepted the call. To do this, we will need to work very closely with our industry partners and leverage their capability extensively. Learn more about our #Moon2024 plans here: https://www.nasa.gov/specials/moon2mars/

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thereisnocenter:

Are lunar spacesuits going to be ready for a 2024 landing?

Lindsay Aitchison:

Yes. Space suits are critical to our plans for human lunar exploration. NASA has been investing in surface space suit technology for several years, including test runs with multiple prototype designs in the Neutral Buoyancy Laboratory and vacuum testing of an exploration portable life support system. We're still evaluating specific design options, but the technologies are ready for integration to meet a 2024 mission.

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thereisnocenter:

They're not going to be ready in time. And the obviously political motives for the schedule pressure are going to end up killing people.

Marshall Smith:

I am friends with a number of astronauts, and I would not put them on a vehicle that I didn't feel was safe. Everybody at NASA considers crew safety paramount from the program manager down to the machine technician assembling the systems. I just personally reviewed the requirements for human rated certification, and we will work with the landing system providers to ensure that the vehicle is human rated, meaning safe for crewed missions.

Remideza:

Based on the materials present on the moon, is it possible to gather and "print" shelters like it's planned to do with mars? And is it considered?

LaNetra Tate:

We are looking at ways to 3D print (or additively construct) structures on the Moon, using lunar soil. Constructing landing pads (to mitigate dust plume effects), small shelters, and more are all possibilities. We have recently concluded the Additive Construction for Mobile Emplacement (ACME) effort that focused on construction of both 2D and 3D infrastructure needed for planetary surfaces. We are engaging communities outside of NASA in this effort as well. One way is with NASA's prize challenges and competitions. Check out the 3D Printed Habitat Challenge to learn more.