Transcript: Why Japan Is Hollowing Out a Mountain Shocked the World

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**[00:00:00]** we're inside a giant tank that's usually

**[00:00:02]** filled to the brim with water but right

**[00:00:04]** now they're doing maintenance so they've

**[00:00:06]** drained the water and we can capture

**[00:00:07]** shots like these creating a place like

**[00:00:10]** this takes years and its construction

**[00:00:12]** involves Builders researchers and

**[00:00:13]** scientists from several countries the

**[00:00:15]** cost of such a project runs into

**[00:00:17]** millions of dollars and to achieve the

**[00:00:20]** result people are even ready to hollow

**[00:00:22]** out an entire

**[00:00:25]** Mountain a little coffee and we'll start

**[00:00:34]** don't hit the like button if you don't

**[00:00:36]** do it hit it if you do it just an

**[00:00:38]** unobtrusive reminder for those who

**[00:00:39]** forget to do this that's all the

**[00:00:41]** mountain we're talking about is called

**[00:00:43]** nugo and it's located in the city of H

**[00:00:46]** that's in gefo prefecture in Japan H is

**[00:00:49]** a small city with a population of just

**[00:00:51]** under 25,000 people the city's economy

**[00:00:54]** primarily relies on sake brewing and

**[00:00:57]** traditional Japanese candles plus they

**[00:00:59]** make meor which are rice balls on a

**[00:01:01]** stick and it was in this city that the

**[00:01:03]** Japanese decided to dig out a huge

**[00:01:05]** mountain and create an incredibly

**[00:01:07]** massive artificial cave inside it the

**[00:01:09]** biggest of its kind Humanity has never

**[00:01:12]** seen a project of this scale a gigantic

**[00:01:14]** cave 2,000 ft underground to carry out

**[00:01:18]** the project 560 researchers from 101

**[00:01:21]** institutions in 21 countries were needed

**[00:01:23]** and $600 million it all began with

**[00:01:26]** digging a tunnel to the center of the

**[00:01:28]** mountain that makes sense to make a

**[00:01:30]** cavity inside the mountain with a

**[00:01:31]** reservoir youd need to get in first and

**[00:01:34]** also check out what's going on there and

**[00:01:36]** so in 2020 with the help of a newly

**[00:01:38]** built 315 F ft long tunnel and a bore

**[00:01:41]** hole

**[00:01:42]** 2379 ft deep extensive research was

**[00:01:46]** carried out to thoroughly study the

**[00:01:47]** state of the rock apparently everyone

**[00:01:49]** was happy with the results and the

**[00:01:51]** construction continued around the

**[00:01:53]** entrance to the tunnel a yard was built

**[00:01:55]** an electrical distribution system as

**[00:01:57]** well as a water supply and drainage

**[00:01:59]** system system the digging of the access

**[00:02:01]** tunnel to the main underground cavity

**[00:02:03]** started in May 2021 it took

**[00:02:05]** approximately 9 months just to dig the

**[00:02:08]** main passage which is 1.2 M long by June

**[00:02:11]** 2022 the tunnel had reached the center

**[00:02:14]** of the Dome of the future tank but the

**[00:02:16]** tunnel digging didn't end there they

**[00:02:18]** still needed to create a bypass that

**[00:02:20]** would surround the main cave and be used

**[00:02:22]** for installing equipment another work

**[00:02:24]** the tunnel was dug and then came the

**[00:02:26]** turn of the cave its construction began

**[00:02:29]** in November 2022 this was the key stage

**[00:02:32]** of the building process essentially the

**[00:02:34]** whole project was started just for this

**[00:02:37]** cave the Dome section was dug out in the

**[00:02:39]** shape of a snail shell and anchors were

**[00:02:41]** built into the ceiling to expand the

**[00:02:43]** space and ensure the stability of the

**[00:02:45]** Rock in the end it's not just a room it

**[00:02:48]** has a specific purpose but we'll get to

**[00:02:51]** that later right now while you're

**[00:02:52]** watching the video construction still

**[00:02:54]** ongoing and the final diameter of the d

**[00:02:57]** section is supposed to be 22 6 ft the

**[00:03:00]** whole mountain is supported by over 600

**[00:03:02]** anchors because the structure has to

**[00:03:04]** handle the pressure of a 2,000t mountain

**[00:03:06]** on top and keep a stable space and if it

**[00:03:09]** all works out it'll be the largest

**[00:03:11]** artificial underground cavity in the

**[00:03:14]** world by the way the original plan was

**[00:03:16]** to dig out space for a reservoir using

**[00:03:19]** explosives just imagine how skilled the

**[00:03:21]** demolition experts would need to be to

**[00:03:23]** pull off something like that blowing up

**[00:03:24]** something under a mountain with tunnels

**[00:03:27]** already dug around and it could all

**[00:03:29]** collapse

**[00:03:30]** s but let's get back to our cave in the

**[00:03:33]** end the main underground chamber is

**[00:03:34]** basically a cylinder with a diameter of

**[00:03:36]** 226 ft and a height of 240 ft and a dome

**[00:03:40]** shaped support that's 69 ft high or to

**[00:03:43]** put it simply it's just huge it's

**[00:03:46]** planned that the excavation for the

**[00:03:48]** cylindrical part of the water tank will

**[00:03:50]** continue throughout 2024 and then the

**[00:03:52]** tank will need clading they have

**[00:03:54]** scheduled it for 2025 so in total

**[00:03:57]** 260,000 tons of water will be poured

**[00:04:00]** into the cylindrical tank and as you

**[00:04:02]** might imagine filling such a tank is a

**[00:04:05]** not so simple task in 1996 when Japan

**[00:04:08]** completed the construction of the

**[00:04:10]** younger brother of this project it took

**[00:04:12]** 2 months to fill a 55ton tank and here

**[00:04:15]** we have a volume 5,000 times bigger but

**[00:04:18]** let's say modern technology will allow

**[00:04:20]** getting it done faster however after

**[00:04:23]** filling it up it'll take several more

**[00:04:24]** months before the water is purified to

**[00:04:26]** the right State because you can't just

**[00:04:28]** drink it it needs to have a a special

**[00:04:30]** quality the shots you were seeing were

**[00:04:32]** filmed inside the little brother of the

**[00:04:34]** tank under construction and it also

**[00:04:35]** holds ultra pure water the cleanest

**[00:04:38]** water on the planet with so few

**[00:04:39]** impurities turns costic because nobody

**[00:04:42]** spends millions of dollars just to

**[00:04:44]** excavate a huge pool inside a mountain

**[00:04:46]** and then I don't know let tourists in no

**[00:04:48]** it's way more interesting including the

**[00:04:50]** water give it enough time such pure

**[00:04:52]** water can dissolve metal scientists

**[00:04:55]** discovered this when they dropped a

**[00:04:56]** hammer into the tank I wonder whether

**[00:04:59]** this was done on purpose or someone just

**[00:05:01]** accidentally dropped it anyway after

**[00:05:03]** years they took out the hammer inside it

**[00:05:05]** was Hollow only the Chrome plated shell

**[00:05:08]** of the tool remained and I also want to

**[00:05:10]** point out the mountain because the

**[00:05:12]** construction site was chosen for a

**[00:05:14]** reason when you're building something

**[00:05:16]** inside a mountain and you're not a dwarf

**[00:05:18]** from Duran's line there's always a risk

**[00:05:20]** of very serious problems even with Dome

**[00:05:23]** expansion because one mistake a minor

**[00:05:26]** crack in safety and that's it hundreds

**[00:05:28]** of people could be buried under into the

**[00:05:29]** mountain with no chance to be rescued

**[00:05:32]** and this mountain was chosen

**[00:05:33]** specifically for safety reasons the

**[00:05:35]** reason is that it's known as heat nice

**[00:05:38]** one of the most solid rock formations in

**[00:05:40]** Japan this rock type formed under

**[00:05:42]** immense pressure way back in ancient

**[00:05:44]** times and should be able to endure all

**[00:05:46]** the work done inside well then there are

**[00:05:48]** also abundant supplies of fresh water

**[00:05:50]** nearby so let's get back to the

**[00:05:52]** structure itself I've already mentioned

**[00:05:54]** that it's gigantic talked about its

**[00:05:56]** height diameter and all that but I know

**[00:05:58]** from experience that it's hard to

**[00:05:59]** imagine such scales so let's use some

**[00:06:02]** references our underground cylinder has

**[00:06:04]** a height of 240 ft that's roughly the

**[00:06:06]** height of a 23 story building which is a

**[00:06:09]** lot for example let's take Tokyo Dome a

**[00:06:12]** massive structure a covered stadium in

**[00:06:14]** Tokyo with an internal height of 184 ft

**[00:06:17]** so if you put the Dugout cylinder inside

**[00:06:19]** the stadium it'll go through the ceiling

**[00:06:21]** and besides the height there's also the

**[00:06:23]** impressive width the diameter of the

**[00:06:25]** cavity is 223 to 226 ft which is like

**[00:06:29]** the width of the soccer field well if we

**[00:06:31]** keep it really simple the Statue of

**[00:06:32]** Liberty will fit comfortably inside our

**[00:06:34]** cylinder but without the pedestal with

**[00:06:36]** the pedestal it would stick out by 66

**[00:06:40]** ft so the big question is why did they

**[00:06:43]** do that in the first place what exactly

**[00:06:45]** are they planning to study and why did

**[00:06:47]** it require digging out the inside of a

**[00:06:49]** mountain the answer lies in a word you

**[00:06:52]** might have heard nutrino do you know

**[00:06:54]** what that is Imagine an ancient particle

**[00:06:56]** zooming through space after a star

**[00:06:58]** explodes this particle has been speeding

**[00:07:01]** through space for billions of years

**[00:07:03]** coming from a massive Supernova eight

**[00:07:05]** times bigger than our sun the particle

**[00:07:07]** is called a neutrino or little Neutron

**[00:07:10]** in Italian a very small one neutrinos

**[00:07:12]** are one of the most mysterious particles

**[00:07:14]** in nature able to pass through objects

**[00:07:16]** as if they don't exist neutrinos are

**[00:07:19]** even called ghost particles because they

**[00:07:21]** barely interact with anything yet

**[00:07:23]** they're the most common particles in the

**[00:07:25]** universe after light so they're

**[00:07:27]** everywhere but we know damn little about

**[00:07:29]** about them approximately 100 trillion

**[00:07:32]** neutrinos every second pass through your

**[00:07:34]** body completely harmlessly and mind too

**[00:07:37]** and actually through all sorts of

**[00:07:39]** objects a lot of neutrinos come to earth

**[00:07:41]** from the sun and stars neutrinos are

**[00:07:44]** also produced when cosmic rays collide

**[00:07:46]** with Earth's atmosphere even bananas

**[00:07:48]** emit neutrinos also neutrinos are

**[00:07:51]** incredibly small and don't interact with

**[00:07:53]** electromagnetic force to put it in

**[00:07:55]** perspective incredibly means they are

**[00:07:58]** smaller than atoms

**[00:08:00]** however in very very rare instances

**[00:08:02]** neutrinos can release charged particles

**[00:08:04]** when they hit matter on their path when

**[00:08:06]** this happens we observe a faint ring

**[00:08:09]** like cherenov radiation that is unusual

**[00:08:12]** glowing but even with this radiation in

**[00:08:14]** mind neutrinos are very hard to study

**[00:08:16]** they're 100,000 times smaller than

**[00:08:18]** electrons and so particles are

**[00:08:20]** incredibly difficult to detect even with

**[00:08:23]** the most modern equipment nutrino were

**[00:08:25]** first discovered around 2000 and since

**[00:08:28]** then there's been a lot of effort to

**[00:08:30]** study them but as we learn more more

**[00:08:32]** questions keep popping up it's obvious

**[00:08:34]** that they're key in particle physics

**[00:08:36]** Stellar physics black holes in the

**[00:08:38]** universe but if we can really study

**[00:08:40]** neutrinos scientists might also be able

**[00:08:42]** to investigate our own Beginnings this

**[00:08:45]** is precisely why the work is underway in

**[00:08:47]** the mountain hyper kamio which is the

**[00:08:50]** reason all this effort is made will be

**[00:08:52]** the largest underground neutrino

**[00:08:54]** detector globally and we'll look for

**[00:08:56]** proton decay this will be a gigantic

**[00:08:58]** water filled tank lined with sensors

**[00:09:01]** that'll catch flashes occurring when

**[00:09:02]** neutrinos collide with electrons or

**[00:09:05]** Atomic nuclei in the water especially

**[00:09:07]** pure water remember it's needed to

**[00:09:09]** increase the number of interactions

**[00:09:11]** between neutrinos and yeah with

**[00:09:13]** everything else protons neutrons

**[00:09:15]** electrons I won't go into details it's

**[00:09:17]** all pretty complicated and very

**[00:09:20]** scientific but those light bulbs you see

**[00:09:23]** on the walls are actually photo

**[00:09:24]** multiplier tubes and despite their

**[00:09:26]** appearance they don't emit light but

**[00:09:28]** serve as eyes yes it's a wall with an

**[00:09:32]** incredible number of eyes Eerie however

**[00:09:35]** the job of the bulbs is to notice

**[00:09:37]** flashes of light that are invisible to

**[00:09:39]** the human eye they are so sensitive that

**[00:09:41]** they can detect the light from a

**[00:09:42]** flashlight on the surface of the Moon in

**[00:09:45]** total they plan to place 40,000 Ultra

**[00:09:48]** sensitive Optical sensors there to well

**[00:09:50]** solve the mysteries of the universe and

**[00:09:52]** bring Japan another Nobel Prize in

**[00:09:54]** physics in this field nothing too

**[00:09:56]** complicated they plan to start

**[00:09:57]** collecting data in 202 7 how about the

**[00:10:00]** little brother of the huge Reservoir

**[00:10:02]** under the mountain in central Japan

**[00:10:04]** there's already a similar experiment

**[00:10:06]** that cost 140 million it used to be one

**[00:10:09]** of the largest zinc mines in Japan and

**[00:10:11]** now it's one of the most successful

**[00:10:13]** scientific experiments this by the way

**[00:10:15]** is a second generation detector the

**[00:10:17]** first one spurred rapid development in

**[00:10:19]** nutrino research worldwide the second

**[00:10:21]** one revealed nutrino properties one

**[00:10:23]** after another it's no wonder that a lot

**[00:10:25]** of hopes are pinned on the third

**[00:10:27]** detector science is advanced scientists

**[00:10:30]** are using the experience from the first

**[00:10:31]** two devices and the detector itself as

**[00:10:33]** bigger meaning more water more bulbs

**[00:10:36]** basically it should be even better than

**[00:10:38]** before given that both previous

**[00:10:40]** experiments led to Nobel prizes in

**[00:10:41]** physics the expectations among

**[00:10:43]** scientists are high by the way why do

**[00:10:46]** they build all this stuff underground

**[00:10:48]** first a mine and then a mountain can't

**[00:10:50]** they just find some field and put up a

**[00:10:52]** huge Warehouse there it's possible but

**[00:10:54]** the research results will be very

**[00:10:56]** questionable the Japanese plac their

**[00:10:57]** detectors deep under ground to minimize

**[00:11:00]** the interference coming from other

**[00:11:01]** particles besides neutrinos there are

**[00:11:03]** other Elementary particles a total of 17

**[00:11:07]** most of these particles lose energy in

**[00:11:09]** the soil and stop but neutrinos can pass

**[00:11:12]** through anything that's why detectors

**[00:11:14]** are placed underground or in a mountain

**[00:11:16]** this way scientists will know for sure

**[00:11:19]** that the detected particles are

**[00:11:20]** neutrinos but scraping out the inside of

**[00:11:22]** a mountain isn't the first construction

**[00:11:24]** Marvel people have done to study these

**[00:11:26]** particles imagine a neutrino travels 7

**[00:11:29]** 50 million light years and ends up

**[00:11:31]** buried underneath Antarctic Ice why

**[00:11:35]** because Ice Cube is here no not the

**[00:11:37]** wrapper it's the neutrino Observatory at

**[00:11:39]** the South Pole it's a particle detector

**[00:11:42]** made from Antarctic ice and why not use

**[00:11:44]** ice when there's plenty of it around the

**[00:11:46]** detector is located not far from the

**[00:11:48]** Emmon Scott station just very deep

**[00:11:50]** underground about 88,200 ft down of

**[00:11:53]** course there's no need of using water

**[00:11:55]** here we have ice here instead

**[00:11:57]** essentially it's billions of tons of ice

**[00:11:59]** embedded with a grid of sensors they

**[00:12:01]** light up when they detect a passing

**[00:12:03]** nutrino and by looking at where they're

**[00:12:05]** located scientists can determine the

**[00:12:07]** energy and direction of the nutrino that

**[00:12:09]** caused the burst with this information

**[00:12:11]** they can attempt to uncover the origins

**[00:12:13]** of neutrinos in the universe this

**[00:12:15]** detector is also set for an upgrade but

**[00:12:17]** that won't be completed until the

**[00:12:20]** 2030s detector versus

**[00:12:22]** earthquake as already mentioned one of

**[00:12:25]** the detectors is inside a mountain in

**[00:12:26]** Japan one of the most seismically active

**[00:12:29]** countries each year around 1,500

**[00:12:32]** earthquakes occur in the country isn't

**[00:12:34]** there a risk that one of them might be

**[00:12:35]** strong enough to bring down everything

**[00:12:37]** that's been built up for so long so one

**[00:12:39]** time an earthquake really damaged the

**[00:12:41]** equipment broke 60% of the photo

**[00:12:43]** multiplier tubes in the old detector and

**[00:12:46]** they had to pause the research for a

**[00:12:47]** while to fix it but they promised to

**[00:12:49]** take this into account when building the

**[00:12:50]** new detector Sunny

**[00:12:53]** Italia did you know that a similar

**[00:12:55]** detector was set up deep under a

**[00:12:56]** mountain in Italy smaller of course the

**[00:12:59]** device called borexino consists of a

**[00:13:01]** tank about 59 ft High which contains 254

**[00:13:05]** tons of scintilating liquid and it was

**[00:13:07]** right here that for the first time in

**[00:13:09]** the history of physics rare ghostly

**[00:13:11]** particles were discovered that are

**[00:13:13]** formed as a result of nuclear fusion

**[00:13:15]** inside the Sun these are also neutrinos

**[00:13:18]** but special ones solar ones such a

**[00:13:21]** discovery brings Humanity one step

**[00:13:22]** closer to understanding the fiery

**[00:13:24]** nuclear reactions that power our home

**[00:13:27]** star a snapshot from inside the Sun our

**[00:13:30]** star keeps smashing atoms together deep

**[00:13:33]** inside to create its blazing light but

**[00:13:35]** because this internal chaos is buried

**[00:13:37]** under thick outer layers of the sun

**[00:13:39]** scientists have few ways to find out

**[00:13:42]** what's actually happening but neutrinos

**[00:13:44]** can shoot straight out from the center

**[00:13:46]** of the Sun and it's with their help that

**[00:13:48]** researchers got one of the most detailed

**[00:13:50]** pictures of the sun's mysterious inner

**[00:13:52]** world ever made by the way they created

**[00:13:54]** this picture using borxo the first map

**[00:13:57]** of the Milky Way the don't think that

**[00:13:59]** achievements belong only to borxo not

**[00:14:02]** long ago scientists tracked the galactic

**[00:14:04]** origin of 60,000 neutrinos with Ice Cube

**[00:14:07]** and created the first ever portrait of

**[00:14:09]** the Milky Way and it's a completely new

**[00:14:11]** image because all the pictures we got

**[00:14:13]** before were taken using visible light in

**[00:14:16]** the case of neutrinos it's a map made of

**[00:14:18]** matter hunting on the bottom neutrinos

**[00:14:22]** are everywhere even in the largest

**[00:14:24]** freshwater lake in the world it was

**[00:14:26]** there in Lake B that Russian researchers

**[00:14:29]** emerg the world's biggest underwater

**[00:14:31]** detector the spherical device named bico

**[00:14:33]** gigaton is designed to detect and

**[00:14:35]** observe elusive neutrinos but why this

**[00:14:38]** Lake it's simple the location of the

**[00:14:40]** lake and the seasonal ice cover which

**[00:14:42]** lasts for 2 months make it a perfect

**[00:14:44]** place to detect neutrinos in fact B is

**[00:14:47]** the only Lake where you can place a

**[00:14:49]** nutrino detector because only here it's

**[00:14:51]** deep enough area is rich in water and

**[00:14:54]** ice like lakes and Glaciers are the best

**[00:14:56]** places to detect nutrino anyway you

**[00:14:59]** already realized the more water the

**[00:15:00]** better you owe me a like see you later

**[00:15:04]** [Music]

# Full Text (without timestamps)

we're inside a giant tank that's usually filled to the brim with water but right now they're doing maintenance so they've drained the water and we can capture shots like these creating a place like this takes years and its construction involves Builders researchers and scientists from several countries the cost of such a project runs into millions of dollars and to achieve the result people are even ready to hollow out an entire Mountain a little coffee and we'll start don't hit the like button if you don't do it hit it if you do it just an unobtrusive reminder for those who forget to do this that's all the mountain we're talking about is called nugo and it's located in the city of H that's in gefo prefecture in Japan H is a small city with a population of just under 25,000 people the city's economy primarily relies on sake brewing and traditional Japanese candles plus they make meor which are rice balls on a stick and it was in this city that the Japanese decided to dig out a huge mountain and create an incredibly massive artificial cave inside it the biggest of its kind Humanity has never seen a project of this scale a gigantic cave 2,000 ft underground to carry out the project 560 researchers from 101 institutions in 21 countries were needed and $600 million it all began with digging a tunnel to the center of the mountain that makes sense to make a cavity inside the mountain with a reservoir youd need to get in first and also check out what's going on there and so in 2020 with the help of a newly built 315 F ft long tunnel and a bore hole 2379 ft deep extensive research was carried out to thoroughly study the state of the rock apparently everyone was happy with the results and the construction continued around the entrance to the tunnel a yard was built an electrical distribution system as well as a water supply and drainage system system the digging of the access tunnel to the main underground cavity started in May 2021 it took approximately 9 months just to dig the main passage which is 1.2 M long by June 2022 the tunnel had reached the center of the Dome of the future tank but the tunnel digging didn't end there they still needed to create a bypass that would surround the main cave and be used for installing equipment another work the tunnel was dug and then came the turn of the cave its construction began in November 2022 this was the key stage of the building process essentially the whole project was started just for this cave the Dome section was dug out in the shape of a snail shell and anchors were built into the ceiling to expand the space and ensure the stability of the Rock in the end it's not just a room it has a specific purpose but we'll get to that later right now while you're watching the video construction still ongoing and the final diameter of the d section is supposed to be 22 6 ft the whole mountain is supported by over 600 anchors because the structure has to handle the pressure of a 2,000t mountain on top and keep a stable space and if it all works out it'll be the largest artificial underground cavity in the world by the way the original plan was to dig out space for a reservoir using explosives just imagine how skilled the demolition experts would need to be to pull off something like that blowing up something under a mountain with tunnels already dug around and it could all collapse s but let's get back to our cave in the end the main underground chamber is basically a cylinder with a diameter of 226 ft and a height of 240 ft and a dome shaped support that's 69 ft high or to put it simply it's just huge it's planned that the excavation for the cylindrical part of the water tank will continue throughout 2024 and then the tank will need clading they have scheduled it for 2025 so in total 260,000 tons of water will be poured into the cylindrical tank and as you might imagine filling such a tank is a not so simple task in 1996 when Japan completed the construction of the younger brother of this project it took 2 months to fill a 55ton tank and here we have a volume 5,000 times bigger but let's say modern technology will allow getting it done faster however after filling it up it'll take several more months before the water is purified to the right State because you can't just drink it it needs to have a a special quality the shots you were seeing were filmed inside the little brother of the tank under construction and it also holds ultra pure water the cleanest water on the planet with so few impurities turns costic because nobody spends millions of dollars just to excavate a huge pool inside a mountain and then I don't know let tourists in no it's way more interesting including the water give it enough time such pure water can dissolve metal scientists discovered this when they dropped a hammer into the tank I wonder whether this was done on purpose or someone just accidentally dropped it anyway after years they took out the hammer inside it was Hollow only the Chrome plated shell of the tool remained and I also want to point out the mountain because the construction site was chosen for a reason when you're building something inside a mountain and you're not a dwarf from Duran's line there's always a risk of very serious problems even with Dome expansion because one mistake a minor crack in safety and that's it hundreds of people could be buried under into the mountain with no chance to be rescued and this mountain was chosen specifically for safety reasons the reason is that it's known as heat nice one of the most solid rock formations in Japan this rock type formed under immense pressure way back in ancient times and should be able to endure all the work done inside well then there are also abundant supplies of fresh water nearby so let's get back to the structure itself I've already mentioned that it's gigantic talked about its height diameter and all that but I know from experience that it's hard to imagine such scales so let's use some references our underground cylinder has a height of 240 ft that's roughly the height of a 23 story building which is a lot for example let's take Tokyo Dome a massive structure a covered stadium in Tokyo with an internal height of 184 ft so if you put the Dugout cylinder inside the stadium it'll go through the ceiling and besides the height there's also the impressive width the diameter of the cavity is 223 to 226 ft which is like the width of the soccer field well if we keep it really simple the Statue of Liberty will fit comfortably inside our cylinder but without the pedestal with the pedestal it would stick out by 66 ft so the big question is why did they do that in the first place what exactly are they planning to study and why did it require digging out the inside of a mountain the answer lies in a word you might have heard nutrino do you know what that is Imagine an ancient particle zooming through space after a star explodes this particle has been speeding through space for billions of years coming from a massive Supernova eight times bigger than our sun the particle is called a neutrino or little Neutron in Italian a very small one neutrinos are one of the most mysterious particles in nature able to pass through objects as if they don't exist neutrinos are even called ghost particles because they barely interact with anything yet they're the most common particles in the universe after light so they're everywhere but we know damn little about about them approximately 100 trillion neutrinos every second pass through your body completely harmlessly and mind too and actually through all sorts of objects a lot of neutrinos come to earth from the sun and stars neutrinos are also produced when cosmic rays collide with Earth's atmosphere even bananas emit neutrinos also neutrinos are incredibly small and don't interact with electromagnetic force to put it in perspective incredibly means they are smaller than atoms however in very very rare instances neutrinos can release charged particles when they hit matter on their path when this happens we observe a faint ring like cherenov radiation that is unusual glowing but even with this radiation in mind neutrinos are very hard to study they're 100,000 times smaller than electrons and so particles are incredibly difficult to detect even with the most modern equipment nutrino were first discovered around 2000 and since then there's been a lot of effort to study them but as we learn more more questions keep popping up it's obvious that they're key in particle physics Stellar physics black holes in the universe but if we can really study neutrinos scientists might also be able to investigate our own Beginnings this is precisely why the work is underway in the mountain hyper kamio which is the reason all this effort is made will be the largest underground neutrino detector globally and we'll look for proton decay this will be a gigantic water filled tank lined with sensors that'll catch flashes occurring when neutrinos collide with electrons or Atomic nuclei in the water especially pure water remember it's needed to increase the number of interactions between neutrinos and yeah with everything else protons neutrons electrons I won't go into details it's all pretty complicated and very scientific but those light bulbs you see on the walls are actually photo multiplier tubes and despite their appearance they don't emit light but serve as eyes yes it's a wall with an incredible number of eyes Eerie however the job of the bulbs is to notice flashes of light that are invisible to the human eye they are so sensitive that they can detect the light from a flashlight on the surface of the Moon in total they plan to place 40,000 Ultra sensitive Optical sensors there to well solve the mysteries of the universe and bring Japan another Nobel Prize in physics in this field nothing too complicated they plan to start collecting data in 202 7 how about the little brother of the huge Reservoir under the mountain in central Japan there's already a similar experiment that cost 140 million it used to be one of the largest zinc mines in Japan and now it's one of the most successful scientific experiments this by the way is a second generation detector the first one spurred rapid development in nutrino research worldwide the second one revealed nutrino properties one after another it's no wonder that a lot of hopes are pinned on the third detector science is advanced scientists are using the experience from the first two devices and the detector itself as bigger meaning more water more bulbs basically it should be even better than before given that both previous experiments led to Nobel prizes in physics the expectations among scientists are high by the way why do they build all this stuff underground first a mine and then a mountain can't they just find some field and put up a huge Warehouse there it's possible but the research results will be very questionable the Japanese plac their detectors deep under ground to minimize the interference coming from other particles besides neutrinos there are other Elementary particles a total of 17 most of these particles lose energy in the soil and stop but neutrinos can pass through anything that's why detectors are placed underground or in a mountain this way scientists will know for sure that the detected particles are neutrinos but scraping out the inside of a mountain isn't the first construction Marvel people have done to study these particles imagine a neutrino travels 7 50 million light years and ends up buried underneath Antarctic Ice why because Ice Cube is here no not the wrapper it's the neutrino Observatory at the South Pole it's a particle detector made from Antarctic ice and why not use ice when there's plenty of it around the detector is located not far from the Emmon Scott station just very deep underground about 88,200 ft down of course there's no need of using water here we have ice here instead essentially it's billions of tons of ice embedded with a grid of sensors they light up when they detect a passing nutrino and by looking at where they're located scientists can determine the energy and direction of the nutrino that caused the burst with this information they can attempt to uncover the origins of neutrinos in the universe this detector is also set for an upgrade but that won't be completed until the 2030s detector versus earthquake as already mentioned one of the detectors is inside a mountain in Japan one of the most seismically active countries each year around 1,500 earthquakes occur in the country isn't there a risk that one of them might be strong enough to bring down everything that's been built up for so long so one time an earthquake really damaged the equipment broke 60% of the photo multiplier tubes in the old detector and they had to pause the research for a while to fix it but they promised to take this into account when building the new detector Sunny Italia did you know that a similar detector was set up deep under a mountain in Italy smaller of course the device called borexino consists of a tank about 59 ft High which contains 254 tons of scintilating liquid and it was right here that for the first time in the history of physics rare ghostly particles were discovered that are formed as a result of nuclear fusion inside the Sun these are also neutrinos but special ones solar ones such a discovery brings Humanity one step closer to understanding the fiery nuclear reactions that power our home star a snapshot from inside the Sun our star keeps smashing atoms together deep inside to create its blazing light but because this internal chaos is buried under thick outer layers of the sun scientists have few ways to find out what's actually happening but neutrinos can shoot straight out from the center of the Sun and it's with their help that researchers got one of the most detailed pictures of the sun's mysterious inner world ever made by the way they created this picture using borxo the first map of the Milky Way the don't think that achievements belong only to borxo not long ago scientists tracked the galactic origin of 60,000 neutrinos with Ice Cube and created the first ever portrait of the Milky Way and it's a completely new image because all the pictures we got before were taken using visible light in the case of neutrinos it's a map made of matter hunting on the bottom neutrinos are everywhere even in the largest freshwater lake in the world it was there in Lake B that Russian researchers emerg the world's biggest underwater detector the spherical device named bico gigaton is designed to detect and observe elusive neutrinos but why this Lake it's simple the location of the lake and the seasonal ice cover which lasts for 2 months make it a perfect place to detect neutrinos in fact B is the only Lake where you can place a nutrino detector because only here it's deep enough area is rich in water and ice like lakes and Glaciers are the best places to detect nutrino anyway you already realized the more water the better you owe me a like see you later [Music]