

# Science AMA Series: We are physicists Rush Holt and Frank von Hippel, here to answer your technical questions on the Iran Nuclear Deal (and anything else), AMA!

Iran<sub>NuclearDeal</sub><sup>1</sup>andr/ScienceAMAs<sup>1</sup>

<sup>1</sup>Affiliation not available

April 17, 2023

## Abstract

We recently co-authored an open letter to President Obama, which was signed by several dozen prominent scientists, supporting the nuclear deal with Iran. We are physicists and experts in nuclear issues, and are here to answer questions about the science and technology of producing fissile materials and nuclear weapons, operating nuclear power plants, and monitoring these and other activities to prevent nuclear proliferation, especially as they relate to the proposed Iran deal. Rush Holt: I am an astrophysicist and currently head of the American Association for the Advancement of Science (AAAS). I was a New Jersey congressman from 1999-2015, and a five-time Jeopardy champion who beat IBM's supercomputer Watson. I have worked on international security and proliferation issues for many years, both in and out of government. Frank von Hippel: I am a physicist and professor at the Woodrow Wilson School at Princeton, where I work on nuclear arms control, nonproliferation, and energy issues. I was founding co-chair of the International Panel on Fissile Materials (IPFM), served as assistant director for national security in the White House Office of Science and Technology Policy from 1993-4, and am a MacArthur fellow. Since there are two of us, we've enlisted a helper to collate our answers, but we'll leave our names so you know who's talking. Ask us anything! We'll start posting answers around 1pm eastern (5 pm UTC, 10 am PT) Edit: That's it for us, thanks everyone. This has been a pleasure.

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IRAN\_NUCLEAR\_DEAL [R/SCIENCE](#)

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Good afternoon and welcome,

**One common argument made in opposition of the deal is that Iran is afforded too much time between the announcement of a site inspection and closing of the appeals process. Could you give a layman's overview of the science behind the signals and signatures left behind by the operation of gas centrifuges for enrichment?**

Thank you!

[adenovato](#)

There is a lot of confusion on this point. Noone to my knowledge has asserted that Iran could build an enrichment plant or plutonium production reactor without our discovering well before it went into operation — as we did all of Iran's existing facilities.

Olli Heinonen, the former Deputy Director for Safeguards of the IAEA has expressed the concern that the Iranians could clean up a site where they were manufacturing a uranium component for a bomb. But this would mean that somehow the Iranians had already produced enough weapons material for a bomb. So it appears that Heinonen is worrying about what might happen 15 years hence when Iran

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would be allowed to have a much larger enrichment capacity and therefore a shorter breakout time. This is a valid issue and will have to be dealt with in the next 10 or 15 years — as it should for other countries that might want to acquire national enrichment facilities. We have to strengthen the nonproliferation regime in this area. -FvH

**Part of the Iran Nuclear Deal stipulates that the IAEA maintains round the clock access and surveillance of all known nuclear sites. To do this, the agency will use infrared satellite technology, environmental sensors, and cameras among other tools. If the IAEA suspects nuclear materials at undeclared sites they reserve the right inspect those sites after a maximum 24 days.**

**My question is (1) how effective is this technology at recognizing nuclear material at undeclared sites presumably deep underground and (2) will the technology still be able to detect the remnants of nuclear particles in order to verify whether Iranian's were enriching nuclear material after 24 days?**

#### [Onyakneesa Rice](#)

For undeclared facilities, the IAEA will depend to a large extent on tips provided by U.S., Israeli and other countries' intelligence such as those that surfaced the enrichment facilities at Natanz and Fordow and the Arak reactor before they came near to operation. Once, the IAEA goes to a site, it can quickly assess what has been going on there. The problem in the past has been Iran's refusing access. Now, Iran has to give access within 24 days or it risks the sanctions being "snapped back" in part or whole. - FvH

**For the people who don't understand what is actually going on (like me ;), could you please give a little overall explanation about why a lot of people are against it, and why a lot of people are for it ?**

#### [skizmo](#)

The reasons to like the agreement are 1) provisions of the agreement are more stringent and provide more transparency than existing agreements under the non-proliferation treaty, and so, the provisions should over the next decade be made part of all agreements, 2) it provides much greater assurance than the world has had in any previous proliferation situation and much greater assurance than existed with Iran up to the time of agreement that there is not a weapons program underway, and 3) without this agreement we would sitting at a distance be watching Iran sitting weeks away from having what is needed to build a nuclear weapon.

Those who think the agreement is a failure seem to think that no agreement with Iran can be reliable; they simply do not trust the Iran government. I point out that the agreement is not about trust—if there were complete trust, we would not be talking about an agreement—it is about the assurances we gain through verification techniques that Iran will be farther from building a nuclear weapon that they were before the agreement. -RH

**Could you mention places where you feel the deal did not achieve everything it needed, and the places where it succeeded, and why so many people and the media are convinced it is a failure, even though it has many positive agreements preventing Iran from acquiring a nuclear weapon in the near future.**

#### [Bird-must-feed](#)

The main problem is that the agreement is of limited duration. The limits on Iran's enrichment and reprocessing expire after 15 years. But that was inevitable. If Iran complies with all of its obligations under the deal, eventually it should be restored to its full rights under the Nonproliferation Treaty and

those rights currently include enrichment and reprocessing for peaceful purposes.

As my answer to a previous question suggests, I think that we have to change this. The crisis over Iran's program is just one in a long series of crises including India's and Japan's plutonium programs (India went for a bomb, Japan didn't) Brazil's enrichment program (Brazil turned its back on its weapons program after a civilian government returned to power), South Korea's interest in plutonium separation and enrichment (so far we've talked them out of it), etc. We have to fix the root weakness in the nonproliferation regime. -FvH

**Could you mention places where you feel the deal did not achieve everything it needed, and the places where it succeeded, and why so many people and the media are convinced it is a failure, even though it has many positive agreements preventing Iran from acquiring a nuclear weapon in the near future.**

[Bird-must-feed](#)

The deal with Iran is innovative in the way it restricts both the supply of uranium to be enriched as well as the enrichment technology (centrifuges), in its restriction of metallurgical research, its promoting international cooperation in non-weapons research. Having international researchers is important in creating a more open, transparent scientific enterprise. Some of the provisions of the agreement are more stringent and provide more transparency than existing agreements under the non-proliferation treaty, and so, the provisions should over the next decade be made part of all agreements. Those who think the agreement is a failure seem to think that no agreement with Iran can be reliable; they simply do not trust the Iran government. I point out that the agreement is not about trust—if there were complete trust, we would not be talking about an agreement—it is about the assurances we gain through verification techniques that Iran will be farther from building a nuclear weapon than they were before the agreement. - RH

**What will happen if the US doesn't sign off on the deal?**

[Phillyb80](#)

I speculate that if the agreement is not accepted, economic sanctions on Iran will be lifted or eroded or lessened by the rest of the world, Iran will be where they were with respect to bomb making—that is, only weeks to months away from being able to make a nuclear weapon and seeing more incentive to actually do so—and we would have less, and the IAEA and other countries will have less access to Iran nuclear sites and less confidence in our knowledge of what they are doing. -RH

**Do you believe that lack of scientific literacy among politicians is a major problem holding the US back?**

[burgeoning\\_philosoph](#)

This question is related to another about misconceptions in the media. Most of the public is very uncomfortable thinking about scientific and technical matters. I could go into a long discourse about the failure of our educational system and journalism to make all Americans comfortable thinking about science and examining evidence critically for themselves. I will simply say that this leads people to say they cannot think about technical subjects critically and they will leave those to the experts. That allows for all sorts of misinformation and exaggeration and sensationalism to be peddled on all sorts of issues like this one, when the public could examine evidence for themselves and put the sensational, misleading claims to rest. So, experts like Frank von Hippel here have done important work trying to explain science and technologies to the public. -RH

**I'm curious about the process of enrichment. We'd seen where Iran was at levels of like 3% and**

**then bumped it up near 10-15%, which was defended on medical grounds. Weapons grade enrichment is said to be 95%.**

**It's not like they can just keep putting the sample through the exact same process for further refinement, right? Does the process become more and more difficult or am I wrong?**

[kyled85](#)

Iran could produce weapon-grade (>90% U-235) uranium by either recycling the material through its cascades or by feeding from one cascade into another and then another and another. But that would take about a year with the number of centrifuges that they are allowed and the very small amount of enriched uranium hexafluoride (the gaseous form of uranium that is fed into the centrifuges) that they are allowed to store. That would be more than enough time to understand what is happening and take any necessary action.

The justification for producing 3.5% enriched uranium is to fuel Iran's Bushehr power reactor. Almost all of Iran's existing stockpile and (I suppose) its future production will be shipped to Russia which fabricates the fuel for that reactor.

The justification for producing 20% enriched uranium in the past (Iran has agreed not to produce any more and to convert its existing stocks into fuel or downblend them to 3.5%) was to fuel the Teheran Research Reactor that the U.S. originally supplied Iran in 1967. Iran has produced enough 20% uranium to fuel that reactor for about a decade and has agreed that it will use imported 20% enriched uranium to fuel it in the future. That material would be delivered for manufacture into fuel in small batches on a just-in-time basis. -FvH

**My question is for Mr. Holt. You were my congressman when you were elected back in 1999, and this AMA reminded me of a question I wish I could have asked you back then. As a scientist, why did you want to get into politics? Did you think your scientific background would be considered an asset in congress? How did your colleagues in congress treat your scientific viewpoints?**

**Also, is Rush Holt your real name? And if so, why didn't you become an action movie star?**

[stravadarius](#)

I got into politics because it was too important not to do so. I did not run for a ninth term last year because it was time for me to step aside and let someone else represent the people of central NJ (and we got a good person in Bonnie Watson Coleman, who by the way, yesterday said she approved of the Iran nuclear agreement). I am pleased to be doing something else important now—heading the American Association for the Advancement of Science (look us up at AAAS.org)

I am named Rush for my father, who was named for his grandfather, in a line of Rush's that goes back to Benjamin Rush, a signer of the Declaration of Independence and a chemist and doctor. (I do not think I have a blood line to Benjamin Rush.) -RH

**Is it true that some of the details of the deal are classified and restricted from you and our own congress to view? Also is it true that Iran will be performing their own inspections of the facility and not an outside organization. If true, how do neither of those things bother you?**

[bombhood](#)

The details of the deal, i.e. the Joint Comprehensive Plan of Action, are public. What is not public is the details of the agreement between Iran and the IAEA on how to clarify Iran's mostly pre-2003 nuclear activity relating to nuclear weapons design. The controversy has focused on the IAEA's inspections at the Parchin facility where Iran is suspected of having conducted implosion tests. My understanding is that the Iranians will take the samples for the IAEA but that they will do so under the close supervision

of IAEA inspectors. Apparently this is standard practice because countries do not want foreigners touching their facilities (in this case, the Iranians may be worried about foreign agents sneaking in incriminating evidence) and the IAEA does not want its inspectors to be exposed to occupational hazards. -FvH

**Can you give your estimates on how easy/difficult would it be, and how long it would take, for Iran to build either proper thermonuclear weapons or a "dirty bomb" given the technology they now have and the technology this new deal will enable them to build/buy?**

[Astroner955](#)

Building a thermonuclear weapon—that is, a so-called hydrogen bomb, where a fission bomb generates enough heat to cause tritium isotopes of hydrogen to fuse and release still more energy—is very difficult. Furthermore the activity likely would be detected far in advance of a successful device. A dirty bomb can mean almost anything that spreads radioactive material. It might be a nuclear explosion that is very low yield, or more likely, it would be just a conventional explosion that spreads radioactive material that has been gathered previously, say from spent fuel from a power reactor. That kind of dirty bomb would not be very hard to make, but it would not be much use militarily. -RH

**One of the biggest arguments against the Iran deal is the lack of "anytime, anywhere" inspections. How important is monitoring in the Iran deal and how reliable are regular inspections?**

[-TheLiberator-](#)

For the declared nuclear facilities, which are what the International Atomic Energy Agency normally spends its time on, there will be continuous, round-the-clock monitoring, with on-demand inspections in Iran. For undeclared, but suspected nuclear sites, this agreement goes well beyond anything ever negotiated before. Only in an occupied, non-sovereign nation could another nation demand to walk in anywhere, anytime. Nevertheless, Iran has agreed to allow inspections after a procedure of claims and counterclaims that would be completed in sufficient time to be assured that significant weapons material production is not taking place. -RH

**What are the main differences between this agreement and the North Korean agreement that hopefully will give this one a different outcome?**

[JeffTheJourn](#)

We were able to negotiate a halt in North Korea's plutonium program from 1994 till 2003 but North Korea never agreed to a verification regime like the one that this agreement establishes with Iran. -FvH

**The US built a bomb fairly quickly with WW II technology. What is taking Iran so long? Do they already have nuclear bombs? Did the US use centrifuges in the 1940's and if so, how many?**

[hawkwings](#)

In my view, Iran has not decided to get a nuclear bomb but it does want a nuclear-weapon option — and perhaps for understandable reasons. The US and UK orchestrated the overthrow of a democratic Iranian in 1953, invaded Iraq in 2003 and put Iran on its list of "Axis of Evil" countries along with Iraq and North Korea. So the negotiation has been over how long it would take Iran to make a bomb if it decided to do so and the compromise has been on about one year.

Noone to my knowledge believes that Iran already has a bomb. The U.S. did centrifuge R&D in the 1940s but they didn't work very well and we produced the highly enriched uranium for the Hiroshima bomb with other technologies. (The Nagasaki bomb was made with plutonium.) The modern gas centrifuge was developed around 1950 by Russian and captive German scientists in the Soviet Union.

- FvH

**It has become evident that many politicians, both sides, are lacking in scientific literacy. Schools teach science (mitochondria is the powerhouse of the cell) but avoid teaching how to read research and understand what they are saying (such as the basics of confidence intervals, etc). What do you think is the best way to teach our youth, so that we can avoid this in the future?**

**P.S. Shoutout from District 12, you were by far my favourite politician to vote for.**

**[RustyFuzzums](#)**

As I mentioned, we could have a long discussion about just this question. What I would say, briefly, is that every student, every citizen, every consumer should have a reverence for evidence and willingness to evaluate the reliability of evidence by considering the evidence for themselves and by asking how the experts have evaluated the evidence. And I mean evidence on anything from what detergent to buy to whether we should restrict carbon burning to protect the climate.

And thanks for the shout out from New Jersey's 12 congressional district! -RH

**I am not against working with Iran and developing stable diplomatic relations, but if what Iran needs is advanced energy technology, why isn't solar on the table rather than nuclear which although cheap and efficient, produces lethal waste that remains for centuries, makes its neighbors and enemies nervous, and opens the door for accidents (see Chernobyl) and/or acts of terrorism which could be devastating to the region?**

**Also, thank you congressman Holt for representing New Jersey with honor. We need more leaders like you.**

**[NathanielYork](#)**

I agree that it would make more economic sense for Iran to pursue solar or natural-gas-fueled power plants (Iran has huge deposits of natural gas). I think that Iran pursued nuclear power in part to have a nuclear-weapon option (not necessarily actual nuclear weapons) as a virtual deterrent against attack by the U.S. or Israel. I have commented at more length as to why Iran might feel the need for such a deterrent in a previous answer. -FvH

**Some opponents of the deal claim that Iran could manufacture nuclear weapons in secret facilities while keeping fake 'clean' facilities to fool inspectors. Is that a possibility/likely? if not, what prevents this?**

**Thank you in advance for your time and effort.**

**[Feurisson](#)**

The agreement focuses on blocking Iran from making enough highly enriched uranium or plutonium to make a bomb. The main criticism I have heard is that, after 15 years or so, as the limit on Iran's enrichment capacity is raised and its commitment not to separate plutonium expires, the time it would take Iran to make enough material for a bomb would shorten again. That is correct. Japan is already in a situation because of its plutonium recycle program where it could quickly make 1000 bombs. This is therefore a more general problem with the nonproliferation regime that we should fix over the next 10 to 15 years. The obvious proposal that has been on the table since 1946 is to ban national ownership of enrichment plants. I would also ban reprocessing (plutonium separation) plants since, unlike enrichment plants, they have no economic justification. -FvH

**I understand that IAEA-country deals regarding inspections are supposed to be confidential, but many are worried about the prospect of Iran self-inspecting. I have heard the counter argument that some sort of residue is left in the air in the presence of enriched uranium, which would make it difficult for Iran to fudge or manipulate the results of their own inspection.**

**My question is, what measures do we have to verify the type of data that Iran is giving us? Also, if you could explain this "residue" phenomenon it'd be much appreciated.**

[coocooforcoacoapuffs](#)

Your "self-inspecting" question probably refers to the Parchin facility where previous nuclear weapons work has occurred. IAEA officials say they are completely satisfied with arrangements for inspections there. I don't know the details of the inspection. For historical information I don't think one needs the same level of intrusive inspections that one needs to have for assurances of on-going compliance; so, I don't see the need press the IAEA or the Iranians further on that. -RH

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[coocooforcoacoapuffs](#)

The "self-inspecting" impression appears to have been a misunderstanding of the unpublished agreement between the IAEA and Iran on what Iran needs to do to clarify the history of its nuclear activities prior to 2003. There is no such assertion that I am aware of with regard to the published agreement on inspections of Iran's current and future nuclear activities. As I explained at greater length in a previous answer, even with regard to the historical activities, when Iran takes samples, IAEA inspectors will be closely supervising the process.

With regard to environmental sensing, the IAEA does routinely take "swipes" of dust at enrichment facilities to see whether there are particles of uranium with higher enrichment than agreed. The IAEA can also sample the air downwind or the water downstream or the vegetation around a facility.-FvH

**Do you think it is fair that the nations who were first to weaponize atomic power should now decide who does or does not get access to nuclear fuel in the open market?**

[ghazal\\_listener](#)

The current division of countries into weapon states and non-weapon states is neither fair or sustainable. That was recognized in the Nonproliferation Treaty (NPT) where the weapon states committed that they would pursue nuclear disarmament if the non-weapon states agreed not to pursue nuclear weapons. The non-weapon states also agreed to accept IAEA monitoring of their peaceful nuclear programs. However, no timeline was specified for disarmament. The NPT had to be renewed in 1995. At that point, the Cold War had ended and the U.S. and Russia had made dramatic reductions and the parties to the treaty agreed that, despite the limited progress on disarmament, the treaty was valuable and it was made permanent. That does not mean, however, that it can be sustained indefinitely without more dramatic progress toward nuclear disarmament. -FvH

**Would building neutrino detectors in bordering nations help monitor the nuclear output of Iran, and is this being given consideration?**

[iorgfeflkd](#)

Neutrino detectors have sufficient sensitivity, I think, to tell in a short time if someone is shifting the fuel mix in a reactor, for example, to make more plutonium, if the detector is close to the reactor. I do not know that detectors have sufficient sensitivity to detect that from many miles away. -RH

**Rush, from the outside it seems Congress is filled with people that actively reject evidence, both in policy and science, in favor of ideology. Do you think this view is valid, and if so what are the causes and can it actually be fixed?**

[fullofwind](#)

Members of Congress are generally smart and dedicated and altruistic (not everyone, though), but they are no better than most Americans in their aversion to science and their lack of reverence for evidence. For them ideology usually trumps. -RH

**Most everyone i know assumes that this is only a bad thing. What are some good talking points to help alleviate concerns of those who automatically assume that this is only to give Iran nuclear weapons?**

[cutrateslashjob](#)

Anytime in the past couple of years Iran, if they wanted and if they made a strong effort, could have made the materials for a weapon in weeks, or at most months. Without this agreement that is where the world would be—and without good assurance that the IAEA and western intelligence knew what is going on. This agreement provides assurance that Iran is at least many months away from that. This is a large improvement over the situation existing before the agreement. Furthermore, the agreement advances the overall movement toward non-proliferation of nuclear weapons by providing new, more stringent and more transparent provisions that can be part of all future agreements.

Is it 100 percent assurance? Probably not, but it is much greater assurance than the world has had in any previous proliferation situation and much greater assurance than existed with Iran up to the time of agreement. When asked about the argument that under the agreement after ten or fifteen years Iran could build a bomb quickly, Sec Kerry said something like, “Without the agreement, that time would be not a decade from now, but today.”

Some critics complain that the agreement does not stop Iranian aid to terrorists. That is and would be a problem with or without this nuclear agreement. So, too, violations of human rights are and would be a problem. The agreement certainly does not make those problems any greater, and it can remove anything nuclear from that. This is an agreement to reduce the chance of nuclear weapons and nuclear terrorism, and it does that well. So, it seems to me, this agreement has only upsides. -RH

**What are some of the lies/misconceptions that are being portrayed in the media about this deal? Sensationalism and propaganda have taken their toll on the media in too many ways, and knowing what *isn't* happening is just as important as what actually *is* happening. Thank you for your response!**

[Kipp4220](#)

This is related to another question, the answer to which I'll paste here. Most of the public is very uncomfortable thinking about scientific and technical matters. I could go into a long discourse about the failure of our educational system and journalism to make all Americans comfortable thinking about science and examining evidence critically for themselves. I will simply say that this leads people to say they cannot think about technical subjects critically and they will leave those to the experts. That allows for all sorts of misinformation and exaggeration and sensationalism to be peddled on all sorts of issues like this one, when the public could examine evidence for themselves and put the sensational, misleading claims to rest. So, experts like Frank von Hippel here have done important work trying to

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