MARTY ROSENBERG
January 22, 2024
GridTalk #408

KRAMER AKLI INTERVIEW

Hi, and welcome to GridTalk. Today we're very pleased to have with us with us Kramer Akli who's with the U.S. Department of Energy in their Fusion Energy Sciences Program; he's a program manager and he's very involved in the news story that came out that many of you may have noticed in December that the Department of Energy funding three laser fusion research hubs and we're going to get into the nitty-gritty of what that means.

Q: Welcome, Kramer. How are you?

A: Doing well, thank you.

Q: So, first I'm going to ask you for a definition and you don't have to get too far in the weeds with us but you're manager of the government's Inertial Fusion Energy Science Program. What is meant by inertial fusion science?

A: Yeah, so basically inertial fusion energy is a fusion where you use the inertia of the fuel to confine it. The other way is the magnetic fusion where you use magnets to confine it. So this is different concept.

Q: Okay. So, listeners to GridTalk know that we were excited a year ago to have Annie Kritcher from Lawrence Livermore talk about her breakthrough in fusion research and specifically in ignition and that was a year ago and we're very pleased to have you, Kramer, to give us an update on this which is the announcement that the Department of Energy is starting three different projects to further the work that Annie and her team did. Can you describe what's going to be happening at Lawrence Livermore, Colorado State, and the University of Rochester?

A: Yes, so just for clarification.There are two programs: there is the Inertial Fusion Energy within the Fusion Energy Sciences; it's a new program we initiated. But there is the ICF Program. The ICF Program is stewarded by the National Security Administration and that's been going on for decades so what we are doing from the fusion part is we are leveraging the basic results from the national fusion facility to advance fusion for energy applications. and we established three hubs. It was a competitive process and these hubs are geographically distributed throughout the U.S.; one on the West Coast at Livermore; the other one on the East Coast in New York; and the third one is in the Midwest at Colorado State University.

Q: So, at the outset you mentioned the difference between inertial and the use of magnets. I was at the Élysée Palace 17 years ago in March 2007 when they launched the ITER Project of Seven Nations and there they're using magnets to contain the fusion project, so we have the United States backing that effort; it's one of the seven as well as this effort. Could you describe which do you think will be more successful or do you have no way of knowing? I mean, their twin paths are very different. Why is the Department of Energy even trying this different path if it's involved in ITER and committed to that path?

A: I think it's hard to tell at this point; it's too early to tell which concept will go forward and be successful. so the more diverse portfolio you have the less the risk and also you increased the likelihood of success. The U.S. is involved in magnetic fusion program including the ITER tokamak but the U.S. never had a IFE program and because of the results of the National Ignition Facility where for the first time ever, as humans, we can actually get more energy out of the fuel than we put in. If you remember it was a 1.5 gain and actually, they repeated the experiment and to the gain is almost a two, 1.9 to be exact. So, I think as the science develops and the technology develops and we should take parallel paths, I think diversification is so important.

Q: So, I mean there's a lot of science here. I don't people to lose the poetry of it as well so I'm going to quote briefly what

Annie had to say about what’s actually happening here. This is Annie speaking, “What we’re doing here is essentially creating a miniature star in a lab about the size of the human hair to half the size of a human hair. We have 192 giant lasers and when we say giant, that means the whole system that is used to create this laser energy and all the details associated with it, it’s the size of three football fields when you put all of the 192 laser beams together.” That’s quite an experiment.

A: It is.

Q: Where’s that going now? Give us a sense and just also to give context, the DOE has put a heavy emphasis on fusion while these three programs we’re discussing today are $42 million, DOE is spending $500 million dollars a year on fusion so this is a major emphasis and there’s a lot of consensus in the world that renewables while are important, they’re not sufficient and some kind of nuclear energy will have to play a back-up role and just to state it for the record the promise of fusion is it’s inherently safer and less radioactive waste-generating than what we know of as nuclear is that correct?

A: Yes, yes, absolutely.

Q: So, talk about what Annie did and where this is going now because you talked about the desirability of getting more energy output for energy input, that’s the name of the game here.

A: Yes.

Q: How will these three fusion projects help move us along that?

A: Yeah, that is a really very good question so with these three national hubs, we have leading institutions but they bring together more than 30 institutions from national labs, universities, and private sector to tackle some of these challenges. and the challenges you can put into three areas: one is the driver, the second one is the target, and the third one is the subsystems. The driver is what you use to deliver energy to your fuel and in this case it is either laser or Ion-beam or some other device. For example, for the National Ignition Facility uses laser beams to deliver a lot of energy, like two megajoules of energy. You put in two magajoules of energy to get three megajoules out, so what is the challenge for us to make this IFE relevant? So, the National Ignition Facility is a scientific facility that built with 1990s technology and it was built for specific purpose for national security mission. If you want to do this for energy applications, we need a lasers that are more efficient. Just to give you an example, the laser that the National Ignition Facility uses, you start with 400 units of energy to get two units to the target. Today, if we were to build the same laser, there is a technology that is 10% efficient. so instead of starting with 400 megajoules you can start with only 40 or 20 megajoules, so and we have to do it at a repetition rate and we are trying to take the science from the inertial confinement and do it at a high repetition rate that is relevant for let's say energy production in the future and that's what these hubs will be doing.

Q: So, one of the things and again, I'm a journalist, I'm not a scientist, you're going to be pulsing this energy at 10 pulses a second. That's not something that was done in the initial experiment a year ago, that's in…

A: One shot a day yeah, that was one shot a day.

Q: And you're going to move that to 10 pulses a second?

A: Well, that's what the hubs are going to be working on. So the hubs will be working on laser technology for example that will allow us to make big lasers that will operate, say at one shot per second or 10 shots per second.

Q: So, the article that I referenced where I found you in *The New York Times* in November quotes from Tammy Ma, the plasma physicist at Lawrence Livermore, as saying, "I think at the end of four years, we can lay out a promising path forward for the U.S. to really demonstrate a full-scale pilot plant." Now the rap against fusion is everybody has said for decades that it's a decade off. Do you think it's getting closer now and do you think this effort that you’re involved with at these three institutions will make this happen faster than decades from now?

A: Yeah, I think this is a really good question and people always ask when is fusion going to be here and the answer is not straight forward, we are very optimistic for the following reasons so for the first time in history we have achieved ignition and that you can get more energy out of the target. In the magnetic fusion, there was a breakthrough in superconducting magnets.. Additionally, what we have today that we didn’t have let’s say five or 10 or 20 years ago is we have a private sector. there are more than 40 companies that are pursuing a fusion energy and have attracted more than $6 billion dollars in investments. And also, the governments have started to take fusion a little bit seriously by having roadmaps, for example, the U.S. has the Bold Decadal Vision that was announced by the White House. The U.K. has a roadmap and another country too. so it’s promising.

Q: So, what is the U.S. roadmap? Can you tell us a little more?

A: So, basically the U.S., the White House put in this roadmap for the development of commercial fusion energy within like 10 years or so and the idea is to have partnerships between the private sector and the public sector to advance concepts for different fusion pilot plants. And last year, or a couple of years ago, we had awarded about I think it was eight awards for eight different companies that have different concepts and now will be working together with the government, it's a milestone-based program similar to what the NASA did with SpaceX, at a smaller scale.

Q: So, also in *The New York Times*, it quotes you as saying that these three institutions: Lawrence Livermore, Rochester, and Colorado were some of many applicants that you reviewed for this $42 million dollar seed funds. Give us a sense of the ecosystems that's developing in universities; you said there are many. I think you used the words 30 or more?

A: Yeah.

Q: Is this a hotbed of research for the most promising young scientists out there?

A: Absolutely and what we are doing is we are developing the framework. Actually, we have a name for it, it's called the IFE-STAR, IFE Science and Technology Accelerated Research and the idea is to have a framework where in addition to the hubs we can have smaller institutions from our field and from other fields join in to solve some of the challenging problems. We would build bridges between larger institutions and smaller institutions and we would actually go beyond the fusion. We want to go to other areas like material scientists that could have solutions for us or the AI and machine learning or the other disciplines that might not work on fusion but that might have something to contribute.

Q: So, talk a little bit about the companies that are starting to emerge in this space. How many are there? Who’s active? Who are the people that are funding it?

A: Yes, so basically for fusion in general I think there are more than 40 companies. For inertial fusion energy, it’s like six or seven companies and at least three or four of them are part of our national hubs so it would be a really good partnership between the IFE private sector and the IFE hubs.

Q: What’s your job going to be in administering this $42 million dollars? How will you set it up? What would you judge to be successful? What would you judge to be failure?

A: Yeah, I think my job is to try to bring the community to work together. You know historically because this is interdisciplinary field it’s really hard for…people to work together. we want to eliminate red tapes. Also, people don’t know about each other. so my job is really to make sure that there’s a framework where people can go to and find information. For example, areas of common interest. because we want to avoid duplication. if there is a challenging problem that is common if we can put more brains on it and more resources then we have a chance of solving it. Then we can move to next step.

Q: So, I want to ask you a question that really doesn't rely on your day-to-day responsibilities but you're a lot closer to fusion than all of us; most of us, let's say. And a year ago when I talked to Annie, I also talked to somebody at ITER who generally described fusion and said the physics don't allow a meltdown or that kind of thing. You can place it or in fact, place it in greater proximity to cities, to industry if you get the regulatory authorities to agree. Tell us how fusion when it arrives assuming it does and I assume that a lot of hardworking people are making it happen. When it arrives, it's going to look a lot different than nuclear power as we know it today. Could you paint a picture of what that might look like?

A: Yeah, I mean in terms of the work and it's going to be probably different, is the regulatory framework so fusion right now will be regulated in the U.S. as an accelerator or as a hospital where you have some small isotopes so that's one difference. But in terms of energy delivery, I think for fusion you will not have a long-lived radioactive material that you have to store. for example we'll be using the deuterium and tritium and tritium is a little bit radioactive so we have to worry about that and we have to be honest about it; how much of it's going to be and we’re going to have to talk to communities. We cannot just go and put in a power plantIn a community. You have to talk to the community, the ones that are going to be impacted by the economy or impact from the environment side, but we don’t foresee any huge problems because as you mentioned, fusion is not a chain reaction so there is no way you can have a meltdown and it’s really hard to get the fusion started. At one time you only have like one gram or a few milligrams of fuel in your chamber so if you stop the fuel, fusion stops.

Q: And in terms of waste, the volume is significantly less and the life of waste is too, it’s not thousands of years, is that correct?

A: It depends on what you use for your chamber material but you’re right, it’s confined to that chamber so it’s smaller volume area so the material in the chamber is not determined yet. There are people going to use steel, some tungsten so it’s still being debated and so on, but the amount that you have to worry about in terms of the chamber is really smaller than what you have in fission.

Q: Parallel to the work that’s being done on fusion there’s new technology emerging on small modular reactors of conventional nuclear technology. Do you see that emerging ahead of fusion or in parallel? If you come back in a time machine 50 years from now, do you think they'll be both out there? What will be the winning technology?

A: I don't think we're going to have a winning technology. I think we're going to need all the above approach because if you look at the energy demand and the energy increase. so you can just look at the GDP per capita. For every 1% you increase it, you will need a 1% or 1.5% increase in energy so by 2050 our energy demand is going to be huge and just solar by itself or wind or nuclear, we're going to have to have the mix to meet the current demand and the demand for the future so I think really, it's going to be very hard if we don't have another _solution let's say if we stop it making nuclear. If we don't have the nuclear energy from fission, I think it's going to be very hard to meet the demand.

Q: So, anyone listening to this conversation probably knows by now that you have an interesting accent. When you and I were chatting ahead of the broadcast that you're from Morocco. You spent your undergraduate years learning in Moscow and then you came to the United States to get your PhD. Talk a little bit about the world pursuit of fusion and where the United States stands or is it because we have ITER outside of Marseilles in Cadarache, France where you have Koreans and Japanese and European countries and India, as well as the United States and others, so it’s a global race really to develop fusion. How do you access the U.S. role in that global effort?

A: Yeah, just for our reference so on the magnetic fusion side the word tokamak, it’s really a Russian term they were invented and started in the Soviet Union in the 1970s and basically the world basically started building this tokamak. there are a lot of them throughout the world even some in the U.S., some in other countries. So, ITER is the biggest one of them all. the private sector is very active so some of them they are in the inertial area, some in the magnetic area, some in between. Some of them are complex, some are simple but in terms of the inertial fusion energy I think the U.S. is the leader because of the ICF Program. For the magnetic fusion, we lead in certain areas and we don’t lead in certain areas. That’s why it’s really an international adventure. it is a very challenging and it’s a very hard problem and you’re going to need domestic and international cooperation to advance it.

Q: So, I really want to spend the last few minutes bring you back to what Tammy Ma said, “At the end of four years, we could lay out a promising path forward.” What do you think that’s going to look like four years out? Will you be briefing utilities? Will you be…where will you be going at that point?

A: Yeah, absolutely and I don’t think that’s what Tammy meant, Tammy Ma. I think that really what we are hoping on for the hubs in four years is to give us a clear picture which inertial fusion approach we can pursue. Just within fusion, inertial fusion, there like five or six approaches; one using lasers, one using heavy Ion, and one using just pulse power and just within lasers, there’s like three or four so hopefully within four years, we’re going to have some evidence or some data so we can really make decisions to focus on the program into the next steps so that we can build something after that.

Q: So, it would be demonstration at that point still, it’s not commercial technology?

A: Yeah, so from there we have just foundational science and technology because we’re just getting started in IFE, we never had an IFE program in the U.S. so we’re just getting started so hopefully by…

Q: So, Kramer if I could ask, how old are you?

A: I’m about 50.

Q: You’re about 50?

A: Yeah.

Q: Do you think that by the time you’re 75 there’ll be commercially operated fusion reactors in the United States?

A: Well, that is a really tricky question because it depends on what you mean by it, if you mean by that, we're going to have a pilot plant that we can let's say demonstrate all the bells and whistles for fusion and you can run it for a few hours, or are you talking about having something that delivers electricity to a power plant, are you saying that we're going to have 50% of it while so this is different but I'm very hopeful that we need fusion, if not for us, we need it for future generations so we're going to have to solve this problem. We might as well get on it right now.

Q: So again, do you think in a decade we're going to have commercial plants out there or is it too hard to say at this point?

A: It's very hard to say so there are some private companies who are building some devices, , they're going to turn one device in 2025-2026, so the next one in 2032 that will be deliver electricity. There is Helion which actually they are promising to have something by 2028 and they have a contract to sell electricity to Microsoft already and there are others that go as far as 2050; some to 2035 so we'll just have to wait and see.

Q: So, lastly, I want you to talk about your personal fascination with this technology. You're sitting in Washington, is that correct?

A: Yes.

Q: And you are overseeing programs in California, in Colorado, in Rochester, NY. How will you be on the road visiting these, rolling up your sleeves, and how excited are you by what this $42 million dollars is going to put in place?

A: Yeah, I’m very excited with the initial investment. As I said, we’ve never had an IFE program.it’s going to be very coordinated and will bring people together, all the stakeholders and we’re going to have a plan how to move forward., I’m just very lucky that I have some of the brightest talent in my field including Annie Kritcher that you mentioned and Tammy Ma, bright, young scientists that will move this forward.

Q: Okay and just to make sure we’re on the same page, IFE, Inertial Fusion Energy is what we’re talking about?

A: Yes, so there is inertial fusion energy and there is inertial confinement fusion and they are different.

Q: Okay. Thank you, Kramer and it’s been a pleasure talking to you.

A: Thank you, Marty.

We’ve been talking to Kramer Akli who’s program manager for the Department of Energy’s Fusion and Energy Sciences and for our purposes, he manages the government Inertial Fusion Energy Science Project.

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END OF TAPE