Interview
with Young-Kee Kim

Interviewer: Hitoshi Murayama

Luck Doesn't Come to You Unless You Are Ready to Catch It

Murayama: The last time you were here, you were still in that little prefab building?

Kim: Yes.

Murayama: This is a huge change, right?

Kim: I saw it being constructed and coming up. I have to look at it. I hear that this is a one-floor concept.

Murayama: That's right. It seems to be working very well. People get all mixed up from one field to another and we have the central interaction area. So, people can naturally flow into that.

Kim: That's great. What do you think about the yesterday's External Advisory Committee meeting?

Young Kee Kim is Louis Block Professor at the University of Chicago and former Deputy Director of Fermi National Accelerator Laboratory (Fermilab). She received her Ph.D. from the University of Rochester in 1990. She became Assistant Professor in 1996, Associate Professor in 2000, and Professor in 2002 at the University of California, Berkeley. Since 2003, she has been Professor at the University of Chicago. She served as Deputy Director of Fermilab from July 2006 to June 2013. She received the Ho-Am Prize in Science in 2005. She has also received many other distinguished awards.

Murayama: It was very helpful. You gave me lots of ideas on how to present ourselves better and what we should argue for the 5-year extension. Of course we have to digest them—we have to chew on them and come up with a better presentation, come up with a better write-up. Nonetheless, it was extremely helpful. So, I really thank you for that.

Kim: Right. Everybody was so impressed about what you have achieved.

Murayama: Oh, good.

Kim: I remember your talk—you included the animated movie "Mr. Incredible." I was thinking that what you have done is "mission impossible" and you made it possible.

Murayama: Certainly, even looking back now, it seems like just a series of miracles.

Kim: Well, some say the miracles are simply luck but luck doesn't just come to you. Certainly luck would be good, but it won't work if you are not ready to take it.

Murayama: That's what Koshiba says all the time.

Kim: Oh really?

Murayama: He discovered the neutrinos from Supernova 1987A. Just a month before then, the background was still so high that he should have missed it, but the month after that, he had a mandatory retirement. So, there was only a 2-month window, and exactly 160,000 years before this 2-month window the supernova exploded.

Kim: Just luck is not enough. You have to be ready and prepared.

Murayama: To be prepared —that's true.

You are now back to a regular professor at Chicago, stepping down from a Deputy Director of Fermilab. So, if you reflect on those days being a Deputy Director of Fermilab, what is your feeling? What was the most challenging thing for you, what was the most rewarding thing for you, and what's the change now?

Time of Transitions at Fermilab

Kim: Okey, I think the most challenging thing was the fact that we had to face many changes.

Murayama: Time of transitions.

Kim: In 2006 when I became Deputy Director of Fermilab, we knew the Tevatron would be shut down soon after the LHC turns on, and we would need to prepare a flagship program for the future. The U.S. particle physics community then reached a consensus, moving forward with the International Linear Collider at Fermilab. This resulted in cancelling other projects such as BTeV. NOvA was also on the verge of being cancelled. The situation upset some folks in our field. Not everybody has agreed on the ILC direction.

Murayama: Oh, that is impossible.

Kim: Majority of the community wanted to focus on the ILC. DOE was supportive of the ILC and EPP2010[1] also strongly supported it. However, it was realized that the price tag was much too high for the U.S. to host the ILC. We had to come up with another plan, Plan B. One of my first tasks as Deputy Director was to help developing the plan.

Murayama: That is Project X.

Kim: It is more than Project X. Project X was part of it. The plan included neutrino, muon and kaon programs.

Hitoshi Murayama is Director of Kavli IPMU. He is also Professor at the University of California, Berkeley.

Incidentally, Pier[2] managed to keep the NOvA project alive. Without him, NOvA might have died. In any case, NOvA and short-baseline neutrino experiments were in the plan. The plan also included a muon program with Muon g-2 and Mu2e experiments. These were new directions of the lab. However, these are programs for the relatively near future, and we also needed a longer-term plan. The long-baseline neutrino experiment LBNE and a multi-megawatt proton source Project X were longer-term flagship projects in our plan. LBNE is an experiment with a 1,300 km baseline and a huge detector in South Dakota. This is not enough. We also need to have...

Murayama: High intensity.

Kim: High intensity, yes. That was Project X. This would be the accelerator for future neutrino and muon programs, and various other programs. In our strategy, improving the accelerator, thus providing higher intensity beams was a higher priority than LBNE which was supposed to be installed in DUSEL.[3] We thought that DUSEL, a really large, complex, and multi-purpose beyond physics project, would take a long time before it would become a reality.

Murayama: That's right. So, the idea was to go for the accelerator upgrade first, before going into a new detector.

After Tevatron Shutdown, Fermilab Aimed at an Intensity Frontier

Kim: Right. Neutrino and muon programs and accelerator improvements were the recommendations by the Steering Committee for a Fermilab strategic plan that I led in 2007. Pier accepted the recommendation from the Steering Committee and the Intensity Frontier became the primary focus for Fermilab. The U.S. based facilities would then be primarily for the Intensity Frontier program and this will likely be the case for the next couple of decades. In any case, after the Steering Committee's report, the U.S. went through the national project prioritization process P5[4] in 2008. P5 endorsed our plan of the intensity frontier focus with neutrinos and muons. However, they swapped the order between LBNE and the multi-megawatt proton source Project X, that is, they recommended to do LBNE first before the accelerator upgrade. Overall, P5 and we agreed on the idea of having both a very large neutrino detector and a very powerful accelerator. This is still the case as shown by the 2014 P5 report. DOE's thinking at that time was that Project X could start its construction about one year after LBNE construction begins. But in reality these are two very large expensive projects and it has been extremely difficult to execute simultaneously. Phased approaches were needed and international partnerships are crucial.

Murayama: That's right.

Kim: The muon program that we have launched a few years ago is well supported by the 2014 P5. The neutrino program has been going well. NOvA has been taking data. MicroBooNE construction is nearly complete and will start running in the near future. The next step is the LBNE and the accelerator improvement. I am very glad that overall the original plan has been well supported by the community and the 2014 P5.

Murayama: It's stretched out into the future years, but the overall plan is still the same.

Kim: Yes. Projects tend to be large and it takes a long time to execute any project. Only 5-6 years have passed from the last P5 to this P5. So, we did not expect any big changes in the 2014 P5 report regarding the overall strategy unless we have been going on a wrong path. I was glad that we have been on the right direction. However, there are many important messages in the current P5 report including science drivers, priorities, and execution strategies.

Murayama: That's true, but slightly getting into more details, LBNE of course has a lot of changes on the way. Initially, you wanted to have a big detector underground and the community actually favored water Cherenkov. And then there was an overturn to liquid argon; they went to surface. Now they say they have to go underground again. So what was sort of the succession in this story?

LBNE Chose Liquid Argon Technology

Kim: That is correct. Certainly water versus liquid argon, that was an important technology choice. The water technology is very advanced because Japan has this wonderful Super-Kamiokande detector which has been operating extremely well. So, the water technology is a proven and safe choice although the detector has to be much bigger and there are associated engineering challenges. Liquid argon is a relatively new and more promising technology, but it has not been proven to work until recently.

Murayama: Especially, on

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[1] EPP2010 means "Elementary Particle Physics in the 21st Century." The U.S. National Academy of Sciences surveys all branches of Physics every 10 years. It charged EPP2010 committee, a group of scientists, to recommend priorities for the U.S. particle physics program for the next 15 years. The final report was released in 2006.

[2] Pier Oddone was Director of Fermilab at that time.

[3] DUSEL means "Deep Underground Science and Engineering Laboratory," which was once a U.S. DOE's project. The Sanford Underground Laboratory at Homestake, where some physics experiments are sited, and also LBNE far detector is planned to be located, was initially planned to be part of DUSEL.

[4] P5 (Particle Physics Project Prioritization Panel) is a subpanel of the High Energy Physics Advisory Panel (HEPAP) that serves both DOE's Office of High Energy Physics and the NSF, charged with developing an updated strategic plan for the U.S., under various budget scenarios, that can be executed over a ten-year timescale, in the context of a twenty-year global vision for the field.

that scale.

Kim: Right. The ICARUS, although it took a long time, eventually became a very successful liquid argon detector. That was the effort and experiment initiated in Italy. On the U.S. side there has been a lot of R&D effort going on in the recent years and a lot of progress has been made. MicroBooNE, the short-baseline experiment I mentioned earlier, is based on the liquid argon technology. The ICARUS experience and recent U.S. efforts provided high confidence in the liquid argon technology by the time when the final technology choice for LBNE was made. At Fermilab a small liquid argon detector called ArgoNeuT was put into a test beam and beautiful results came out.

Murayama: I see. How big was it?

Kim: Liquid argon mass was less than a ton.

Murayama: Very small.

Kim: Yes. For the same sensitivity, a liquid argon detector could be much smaller than a water Cherenkov detector. This was another attractive element. It does not mean that the Liquid argon detector will be cheaper. In fact, they cost about the same. But the liquid argon technology is new and future technology, and people get more excited about this. This can be used for not only neutrino experiments but also dark matter experiments and other areas.

Murayama: That's right and you have to be excited about that.

Kim: It was pretty much a close call, but in the end there had to be a decision and the liquid argon technology was chosen. That was a big change on the way. After that there was another change because of the project cost. The overall cost for a 34-kton Liquid argon detector was estimated to be very high, too high for DOE to swallow. We were asked to come up with a two-phase strategy. We were then asked to go through the DOE review process with the Phase-1 project. The DOE system uses a process called critical decisions or CDs, and it ranges from the CD-0 science case stage to the CD-4 construction completion stage. We already had the CD-0 approval. CD-1 was the next step with a conceptual design of the project. For us to go through the DOE CD-1 review and approval process, we had to assume no other contributions than DOE even though in reality we would likely get contributions from collaborating countries and institutions. It is because the amount of contributions is uncertain. Other countries won't commit any significant contributions until the U.S. takes this project seriously and makes their commitment first, in other words until the CD-1 is approved. The problem is then that the scope of the project for the CD-1 approval is smaller than that of the final, most-likely project with other contributions, thus it looks less attractive to the international community. In any case, our thinking was that if we get the CD-1 approval from DOE, other countries might join us and together we could make a bigger and better, thus scientifically more powerful detector.

Murayama: That's right. To some extent, it's a gamble.

With CD-1 Approval, LBNE Seeks More International Collaboration

Kim: Gamble? Right. Seeing the CD-1 approval they have more confidence in the U.S. commitment and thus would make their commitment to make a better project. So, this was a tactic. In the CD-1 process, we were asked to look at alternative options beyond the option that we proposed, a detector in South Dakota with a baseline of 1,300 km. We considered an alternative location such as Ash River where the NOvA detector is located or the Soudan mine where the MINOS detector is located. These are about 800 kilometers from Fermilab. We demonstrated that the proposed 1,300 km baseline option has stronger physics sensitivities. With a longer baseline, there would be more matter effects and the longer baseline option provides a better sensitivity to new physics beyond the three-generation standard model paradigm in the oscillation pattern. The minimum detector mass of 10 kton is required for any initial physics. DOE's budget given to us was not sufficient enough to put this detector underground, thus the project reviewed for the CD-1 approval was a 10 kton detector on surface. The plan was that after receiving the CD-1 approval, we would be able to attract the international community to this project and with their contributions, we would enable to put the detector underground and increase the total mass. I know that some misunderstood this plan and a serious concern was raised by the community regarding the surface detector which would not be sensitive to proton decay and other non-accelerator based sciences.

We received the CD-1 approval from DOE. With this in our hands, we met many physicists and funding agencies from other countries, including Italy, Japan, U.K., CERN, and Brazil. We discussed stronger involvements from them in the project and their potential contributions. The liquid argon technology has been an attractive element for many from other countries, although the European community has been developing a slightly different version of a liquid argon technology.

Murayama: Yes, two-phase.

Kim: Right. The two-phase is the technology that they desire to use. This is a bit more advanced than the

U.S. option, thus requires a longer R&D time period. We wanted to give flexibility and freedom for the international community. So, we thought about a modular design of the detector, each module with 5 kton to 10 kton mass. We would construct a long underground tunnel, leaving places for modular detectors which could be built and instrumented later. Neutrino detectors are different from collider detectors in a sense that we do not have to make the entire detector at once, but detectors can be added while taking data. In this concept, Europeans or others, if they like, could build a detector with their own design.

Murayama: Just keep adding it.

Kim: Yes, keep adding as time goes. Detector modules that come later could use even an improved design. Of course, if we could build a 34 kton detector at once, that will be the best scientifically, but we thought the modular design would be less risky, technically and financially. Making one big detector has more technical risks. The ICARUS and MicroBooNE are only a few hundred ton scale detectors. A 34 kton detector is about two orders of magnitude larger than them.

Murayama: It's a big jump.

Kim: Yes. The modular design is technically safer. While you are building one, you can probably improve the design for the next one and in that way Europeans can build a modular detector with their own design. This can be true for other countries. India and Brazil have been interested in designing and building a near detector. There have been many conversations in the past about this, but having the CD-1 approval, we have a much better position to discuss with foreign participants. The plan was to design and build a near detector primarily by India, the underground facility and the beamline by the U.S. and a far detector with multiple modules by the U.S., Europe, South American countries et cetera. Each country or region can be a primary driver for each module. Say, a U.S. module, a European module, and a South American module. Japan could build one, too.

Murayama: Yes, that's right.

Kim: The new P5 stated the importance of an underground detector with large mass. The P5 report emphasized the international organization and governance of the project. I think that this would really help the U.S. start making discussions with other countries in a more formal manner, and making more formal steps.

Murayama: Yes, I believe that's the right thing to do. So, given that how globally everything is these days, you want to start global, rather than having one country just studying and going down the line and say "Well, we don't have enough money, why don't you join?" That's actually not an equal partner. So, this way hopefully things will work better.

Kim: Right. If you look at our previous particle physics experiments, we were pretty good at international collaboration. CDF is one such case that I know the best. This was back in 70s and 80s. The design was done together. Italy and Japan were big contributors from the beginning. Their ideas were implemented in the design. A good example was the projecting tower concept which has been successfully used in CDF and it has widely been used in calorimeters in particle physics experiments.

Murayama: Yes, that is what's great about being part of this community.

Kim: Yes. Going back to LBNE, the reason why we had to get the CD-1 approval by DOE in the very U.S. centric way first was because the international community has been very concerned whether the U.S. would stick to their plan and they would like to see the U.S. commitment at some level before they can seriously consider joining the project. As you know, the U.S. cancelled a number of projects and has a bad reputation. The recent U.S. situation is quite different from what it was during the CDF time. In addition, the U.S. based facilities have shifted their focus from the Tevatron or the Energy Frontier to the Intensity Frontier. This is a huge change and change makes people very nervous because it comes with uncertainties. For Fermilab's non-scientific staff, this is tough. Scientists at least know the nature of uncertainties. This is what research is about.

Murayama: Nothing is guaranteed. You would not know until you do it.

Kim: Exactly. If you are certain, why do you do research? Research by construction is an uncertain thing. At Fermilab, there are many more non-scientists than scientists. Engineers, technicians, computer specialists and administrative staff. Uncertainty is a hard thing to take, especially for them. Fermilab staff was used to see the Tevatron operating for about three decades. Of course, a lot of other things were going during that period, but the Tevatron was the symbol of the lab.

Murayama: The dominant activity.

Kim: And the Tevatron ring is out. I mean it stopped operations. I think this has been a huge impact on staff psychologically.

Murayama: I am sure, yes.

Kim: Also changing directions required reduction in workforce, which no one wants to hear. We had to spend more money to build new facilities and experiments to build the future. Money had to shift from Tevatron operations, which is people dominant, to materials and equipment. This was a real impact on people at the lab. Managing this complex situation was a huge challenge. It was very very painful. But this was inevitable to build the future.

Murayama: You made it happen.

Kim: Yes, we did that. I hope no more reduction in workforce would be necessary in the future. When I left the lab last Summer, the muon g-2 ring was on the way from Brookhaven to Fermilab. That was very nice.

Murayama: Oh yes, that was a dramatic event.

Back to Normal: Doing Something Real

Kim: By then the building for the muon g-2 ring was under construction, the Mu2e project made good progress, NOvA construction was nearly completed, and MicroBooNE was well under construction. Also a new building called the Illinois Accelerator Research Center was well under construction. A lot of implementation for our initial strategy plan was on its way. Going back to the university as full time faculty was relatively easy...

Murayama: It was, I see.

Kim: …because I continued to have my research group with postdocs and students at Chicago even though I didn't have a lot of time for them. I used to meet them either evenings or weekends. My students understood my situation and accommodated my tight schedule. Having students made a huge difference in transitioning. The Chicago high energy physics group has been supported by NSF and last Fall was the time to renew our 3-year NSF grant. So, my last Summer was occupied by working on the proposal as PI. This also helped me for the transition. Good timing. Last Fall I spent 3 months at CERN and worked on hardware in the pit with one of Chicago graduate students. We installed and tested some of the electronics

boards for the trigger upgrade. We went down to the pit, unplugged cables, removed existing boards, installed new boards, plugged cables, and tested boards. Very physical work! And labor work makes you feel that you've done something useful. Great feeling.

Murayama: I am sure that felt great. You are doing something real.

Kim: Yes. I like to touch things. But when you are doing an administrator job, you spend most of your time meeting people, lots of people. This is stimulating in some ways, thinking about strategies, worrying about budget and safety, figuring out how to overcome budget and safety issues, and making sure that everything is operating smoothly. Many interesting challenges since there are always hiccups here and there. But the job does not require much of hands-on work. It is an intense and somewhat stressful job. By working on hardware last Fall, I felt toxic has been removed from my body. After 3 months at CERN I came back to Chicago and organized a conference for undergraduate women in physics.

Murayama: Oh, I see.

Kim: This conference was held at eight universities in the U.S. simultaneously during the Martin Luther King holiday weekend. I believe they were Chicago, Berkeley, Florida, Maryland, Stony Brook, Louisiana, Pennsylvania and Utah. About 1,000 girls altogether. Can you imagine?

Murayama: Wow, 1,000!

Kim: Ours was the biggest one. We had about 220 girls. Eight universities organized together so that students could attend the closest location from where they were. Anyhow this was a lot of work but it was really good to see so many women students majoring physics at the same time. We had one keynote speaker for every participant. For that we were all connected via video. Everyone was able to see 1,000 girls all at once. I think for them to see these many girls doing physics is a big encouragement. They usually see only a few women in their physics classes and they feel somewhat isolated, questioning whether they are in the right place.

Murayama: I'm sure that is very encouraging.

Kim: Yes, it was. Of course they heard wonderful talks at the conference, but just seeing so many of them together is very exciting and encouraging. That was in January and Spring this year I was fully occupied with teaching. As soon as the Spring quarter was over, I went to CERN for work related to the trigger upgrade. I am now enjoying and having more time with students and postdocs. At CERN two students, two postdocs, and I are sharing one office. This is great. Just sharing the office with them itself is great. I do not know how to explain, but it just feels great.

Murayama: I am sure it does. I can see it. What do you see as your future? I understand that you are also involved in science policy in Korea.

Kim: Korea launched the Institute for Basic Science a couple of years ago. Under IBS, there will be 50 research centers, covering all areas of basic sciences. So far, about twenty centers were established. Under IBS, there is also a rare isotope accelerator project. This is primarily for nuclear physics research but also for many applications ranging from medical to materials. Particle physics experiments with very low energy muons can also be done at this accelerator facility. Hopefully a lot of great scientific results will come out from those centers and the accelerator. We cannot predict what they are, but if you put excellent people together, good things will come out.

Murayama: Yes, that's right. Can Korea and Japan work better together?

Kim: They would be great. I thought Kavli IPMU has some Korean connections.

Murayama: We have some connection with KIAS, not very strong, but we send people back and forth.

Kim: Yes. I know there is a large Korean community working at Japanese facilities. I heard that there were about 200 participants in the J-PARC session of the Korean Physical Society meeting a few years ago. I am not sure if this is a correct number, but certainly I had an impression that there are quite a few Koreans whose research is associated with the J-PARC facilities, primarily from the nuclear physics community. There is also a continuous effort with Belle 2 at KEK. What else? Super K. So there are quite a few. However, I don't know whether Japanese and Koreans have ever got together to see if we could do something together coherently. That kind of exercise could be useful, but scientists do things based on their own interests.

Murayama: Exactly. You can't force things on them.

Kim: Right. In any case I think there are a lot of opportunities and possibilities.

Murayama: Very good.