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Guest: Petra Merkel

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Welcome to this episode of "My Journey as a Physicist" podcast.

Each episode features an interview with a physicist to learn about their work, their interests outside of physics, and their professional journey of how they ended up where they are today. Season two features physicists involved in the particle physics planning community known as "Snowmass". Hope you enjoy today's episode.

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Welcome Petra Merkel. Could you briefly introduce yourself? What is your current position and work?

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Hi, I'm Petra. Um, I'm working at Fermilab. That's the national

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particle physics laboratory in the US. Um, I'm currently a senior scientist.

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I've... About 22 years ago I started here as a postdoc after getting my PhD in Germany at a

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similar lab. And then in between I was working for Purdue university as a scientist for about ten years. And after that I came back to

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Fermilab as a scientist. Okay, can you describe a little bit of the research that you do at Fermilab?

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00:01:08,790 --> 00:01:14,130

Right. So I'm working on the CMS experiment, which is one of the big experiments at the Large

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00:01:14,130 --> 00:01:17,820

Hadron Collider at CERN in Switzerland in Europe.

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00:01:17,820 --> 00:01:24,600

And Fermilab is one of the main collaborators on this experiment

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and it's an experiment that tries to answer

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00:01:28,410 --> 00:01:32,940

some of the fundamental questions, how the universe gets

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created after the big bang, what are the particles and forces that were involved in that,

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00:01:38,970 --> 00:01:43,500

and what are the particles and forces that make up our universe today.

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00:01:43,500 --> 00:01:50,070

And...my main specialty is designing and building the detectors

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00:01:50,070 --> 00:01:53,160

whenever she'd see just behind me and that post on there.

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00:01:53,160 --> 00:01:58,860

Uh that make up basically, like very large camera that detects

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00:02:02,520 --> 00:02:06,450

the particles that come out of the particle

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00:02:06,450 --> 00:02:10,500

collisions that we create in these accelerators.

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00:02:10,500 --> 00:02:16,680

And by detecting these collisions and the products that come out of them, we're trying to understand

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00:02:16,680 --> 00:02:20,610

the forces that are basically acting in between

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00:02:20,610 --> 00:02:24,210

that created the universe as we see it today.

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00:02:24,210 --> 00:02:30,510

Okay. Are you more, do you consider yourself more of an experimentalist or a theorist or somewhere in the middle?

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00:02:30,510 --> 00:02:35,850

Hundred percent experimentalist. I started out as a student basically working on data

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00:02:35,850 --> 00:02:39,600

analysis. So really sharing a large amount of

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00:02:39,600 --> 00:02:45,390

this collision data, trying to understand what happens after the collision how the different

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00:02:45,390 --> 00:02:49,980

particles that got created fly around, and after doing that,

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00:02:49,980 --> 00:02:53,580

so I was also involved in some of the Higgs boson discovery that

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happened in 2012 at, at CERN. So I was part of the team that made the discovery.

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And after that though, I specialize more in actually building the detectors that, that do

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00:03:03,810 --> 00:03:10,740

these measurements. I'm all for hardware instrumentation personnel and analyzing data only.

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00:03:10,740 --> 00:03:15,045

I'm very far from a theorist...[So you say](#)

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00:03:15,045 --> 00:03:19,530

[like working on a team can you kind of describe like how big these teams are?](#)

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00:03:19,530 --> 00:03:24,810

These teams can be very large. I mean the CMS collaboration itself has.

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several thousand, uh scientists and engineers and technicians and

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00:03:28,800 --> 00:03:32,790

so on working on them all around from all around the world.

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00:03:32,790 --> 00:03:36,270

But that obviously it gets broken up into smaller groups that work

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00:03:36,270 --> 00:03:40,200

closely more, closely together on specific topics and

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00:03:40,200 --> 00:03:44,130

areas within the experiment. There's a large group for example that works

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00:03:44,130 --> 00:03:49,290

on the data taking, making sure that detector is running day in day out because we take data 24

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00:03:49,290 --> 00:03:54,960

hours a day and we need to, since that's very expensive to do we need to be very efficient

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00:03:54,960 --> 00:04:00,300

how we do it; we don't want to lose anything. So then we need to be very efficient.

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00:04:00,300 --> 00:04:05,910

So there are several hundred people involved in that,

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00:04:05,910 --> 00:04:12,240

then you have hundreds of people working on building the detector, the next version

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00:04:12,240 --> 00:04:17,459

of the upgraded detector and let's say. And that again gets broken up into smaller groups that

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00:04:17,459 --> 00:04:23,220

work on the different parts of the detector. So mine, which is the central most part, it's in the

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00:04:23,220 --> 00:04:28,830

very center of CMS just around the interaction point where the beams collide, and they have to be

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00:04:28,830 --> 00:04:34,800

the most sensitive because you need to get the most information out as soon after the collision as possible.

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00:04:34,800 --> 00:04:39,945

And they are made out of Silicon which is a semiconductor detector which is also used for

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00:04:39,945 --> 00:04:43,950

example in the cell phone cameras and everyone's smartphone,

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00:04:43,950 --> 00:04:48,780

and in any computer around the world and many more applications. Everything is made of

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00:04:48,780 --> 00:04:55,770

Silicon and Silicon chips and so on. And that's basically how the central most part of the CMS detectors is made up of. And I'm working on that and there I would say that there's

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00:04:55,770 --> 00:05:02,170

200 people or so working on that. But again, you can break that up into smaller parts like working on the sensor,

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00:05:02,170 --> 00:05:08,170

uh the ASIC, the readout chip, or other electronics, or simulation

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00:05:08,170 --> 00:05:13,060

and so on. And then on a daily basis I would say I work maybe with 10-20 people

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00:05:13,060 --> 00:05:17,350

in the end. So you break it up into small groups, um levels

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00:05:17,350 --> 00:05:21,730

of interaction...And that makes it kind of manageable

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00:05:21,730 --> 00:05:25,330

and personal. You don't work with the

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00:05:25,330 --> 00:05:30,100

anonymous group of 500 people, but really the 10 people you know quite well.

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00:05:30,100 --> 00:05:36,010

Yeah. Yeah for sure. And then you describe how much data is collected. So is your work,

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00:05:36,010 --> 00:05:40,780

or at least that you do specifically, is it more with data like analysis stuff or are you

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00:05:40,780 --> 00:05:45,460

actually like physically building things? Like what does sort of your day-to-day look like?

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00:05:45,460 --> 00:05:50,920

And my day-to-day right now since the last several years is really building things.

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Or rather I'm doing mostly management nowadays. I'm managing the group of people that is building the detector.

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Um, quite far away from analyzing the detector,

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00:06:05,140 --> 00:06:09,400

uh the data that comes out of the detector on the end, at the moment.

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00:06:09,400 --> 00:06:14,470

So I said as a student that's what I mostly did. I kind of moved away from that. Right now, I'm

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00:06:14,470 --> 00:06:19,270

really on the end where we design the detector and build it in a clean **home**.

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Yeah. And you said kind of move away from the **data stream**

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00:06:22,780 --> 00:06:26,185

into like more like building and stuff like, was that intentional

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00:06:26,185 --> 00:06:29,950

like kind of path or did that just kind of happen?

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00:06:29,950 --> 00:06:33,145

It was sort of intentional. **So student** that just happened.

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00:06:33,145 --> 00:06:37,030

I mean as a PhD student you don't have a lot of choice maybe

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00:06:37,030 --> 00:06:42,130

what you work on. I happened to grow up in Hamburg in Germany

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and at the **DESY** laboratory which is similar to Fermilab where

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00:06:45,400 --> 00:06:51,100

I am now. And there were accelerators there and the first time I visited there as a high school

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00:06:51,100 --> 00:06:55,090

student, I kind of fell in love with the whole environment and the whole idea of that work and that research. And so I decided that's where I wanted to be

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as a student And then I joined a group of professors that was happy to work only on data

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00:07:00,580 --> 00:07:05,335

analysis so that's what I did. But then when I came to Fermilab as a postdoc and I changed

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accelerators, I changed labs, I changed experiments, obviously

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00:07:09,280 --> 00:07:13,990

completely different environments but still particle physics,

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00:07:13,990 --> 00:07:18,760

I thought it was a great opportunity to change that and to

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00:07:18,760 --> 00:07:25,060

like enlarge my horizon and add a new thing to my skill set. I was really actually kind of

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00:07:25,060 --> 00:07:28,930

intrigued by building these large detectors the first time

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00:07:28,930 --> 00:07:33,850

I took a tour of one of these. I mean these as tall as several stories tall buildings.

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00:07:33,850 --> 00:07:38,740

It's a very massive, very large camera in a way. I was just intrigued. I saw these

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00:07:38,740 --> 00:07:41,770

millions of miles or kilometers of

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00:07:41,770 --> 00:07:46,090

cables and fibers that are providing power and reading

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00:07:46,090 --> 00:07:50,740

out all the data from the...millions and millions of channels that are in the detector and

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00:07:54,310 --> 00:07:58,450

I was really fascinated by how people could get this to work.

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00:07:58,450 --> 00:08:01,570

How does. I was very intrigued by that and I thought

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00:08:01,570 --> 00:08:04,900

when I switched to postdoc position here

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00:08:04,900 --> 00:08:10,870

that it was a great opportunity to switch and learn and that was my attitude basically. I came in,

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00:08:10,870 --> 00:08:16,660

the people interviewing me for the position ask me "you have not done any hardware in the past;

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00:08:16,660 --> 00:08:21,730

why do you think you can do this now?" I said "I believe I can learn almost anything.

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00:08:21,730 --> 00:08:26,200

Except maybe theoretical things." Um,

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00:08:26,200 --> 00:08:31,510

and I guess that kind of wins them. There's kind of self confidence that I.

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00:08:31,510 --> 00:08:36,789

So I was definitely motivated to learn and I thought I could I mean at least some decent level.

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And it turned out to be the case and then I did really well and I really enjoyed it and

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00:08:42,070 --> 00:08:46,480

I never looked back. So after that it was definitely a conscious decision to stay

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00:08:46,480 --> 00:08:50,950

with the instrumentation side more than the analysis side but it has to be said that at least in this field of physics, it's

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00:08:50,950 --> 00:08:57,340

very much encouraged to all students and lots of postdocs um to be heavily involved in

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00:08:57,340 --> 00:09:02,260

physics analysis and analyzing the data, looking for maybe new physics or doing a precision

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00:09:02,260 --> 00:09:05,635

measurement of something known, and getting that all the way to

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00:09:05,635 --> 00:09:09,610

publication level in a peer review journal.

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00:09:09,610 --> 00:09:16,600

So that is really the bread and butter of what we do. And anybody in the younger stage of the career

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00:09:16,600 --> 00:09:22,870

path, let's say, they have to do that, otherwise they have trouble finding permanent positions later on.

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So they do have to do physics analysis. But once you have reached that stage where you have

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00:09:27,610 --> 00:09:33,010

sort of tenured, you know, secure in your employment, you can sort of do whatever is needed or

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00:09:33,010 --> 00:09:38,470

whatever you want to do and work me, working as a scientist at a lab like Fermilab.

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00:09:38,470 --> 00:09:44,950

Really allows me to just focus on the instrumentation side and work on the detector

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00:09:44,950 --> 00:09:48,640

and leave the physics analysis to someone else. [Yeah, definitely sounds like the fun job.](#)

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00:09:48,640 --> 00:09:54,310

Right. Well not everybody agrees. It's actually sort of a niche. So I think it's the minority, you

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know, a few of the people that focus on the detector side.

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But for me personally it's far more fun.

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00:10:01,570 --> 00:10:05,020

because on a daily basis you get

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00:10:05,020 --> 00:10:11,230

very quick feedback of if what you're doing is working or not and

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00:10:11,230 --> 00:10:14,470

at the end of the day you kind of see what you've done.

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If you work on some piece of computer coding

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00:10:18,220 --> 00:10:24,565

and data analysis, it's... often for me at least it's turning in endless loops where nothing

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00:10:24,565 --> 00:10:28,825

happens, you're constantly debugging some code, nothing is working and everything takes very

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00:10:28,825 --> 00:10:32,590

long to make some progress, but that's just my personal bias maybe.

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00:10:32,590 --> 00:10:37,690

Yeah. And the type of work that you do, it kind of sounds like to me it's kind of like bridging the

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00:10:37,690 --> 00:10:41,830

gap between like physics and engineering in some senses. Does that seem

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00:10:41,830 --> 00:10:46,060

fair? Like is your group is it kind of like a mixture of

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00:10:46,060 --> 00:10:50,320

you know, engineering trained and physics trained?

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Absolutely. You need, you need a lot of

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00:10:55,000 --> 00:10:59,920

different skill sets to build these detectors. We have engineers, let's say, mechanical and

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00:10:59,920 --> 00:11:05,275

electrical engineers, you have ASIC engineers, these are the application specific **regardships**

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00:11:05,275 --> 00:11:08,740

basically that we use to read out the detector.

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00:11:08,740 --> 00:11:12,040

These are highly specialized engineers.

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00:11:12,040 --> 00:11:16,000

The **overseas** kind of electronics. We have very good

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00:11:16,000 --> 00:11:21,490

um electronica and mechanical technicians that we use to, so the engineers I'm **on** designing the

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00:11:21,490 --> 00:11:27,130

detector, the technicians are really needed to assemble the very delicate parts in the end.

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00:11:27,130 --> 00:11:31,420

And the physicists are kind of overseeing the whole thing,

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00:11:31,420 --> 00:11:36,400

also very heavily involved in the design because physicists have a lot of

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00:11:36,400 --> 00:11:40,450

experience. I'm for example right now working on my fifth

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00:11:40,450 --> 00:11:47,080

Silicon **tracker**. So this kind of detector over the last twenty years, I'm now involved in the duration of this kind of thing.

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00:11:47,080 --> 00:11:53,590

So I've gathered a lot of experience of things you have to look out for this in the design and

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00:11:53,590 --> 00:11:56,770

in the carrying out this kind of assembly and

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00:11:56,770 --> 00:12:02,170

installation and so on. So is this kind of knowledge you from all sides engineers technicians,

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00:12:02,170 --> 00:12:05,620

physicists, you bring together basically a thing

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00:12:05,620 --> 00:12:11,560

which takes years to design, many years to build and then maybe a year or two to install and

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00:12:11,560 --> 00:12:14,860

commission in, in CMS that you see here.

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00:12:14,860 --> 00:12:18,820

So it takes easily 10-15 years to build a new detector like that

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00:12:18,820 --> 00:12:23,950

and you need a lot of different skills and a lot of sort of continuity.

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00:12:23,950 --> 00:12:29,110

So most senior people like me that can oversee this over such a long time.

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00:12:29,110 --> 00:12:32,230

But then you also need a lot of young people that you train.

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00:12:32,230 --> 00:12:37,420

We bring in a lot of students that get for the first time the opportunity to be exposed

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00:12:37,420 --> 00:12:41,920

to something like this and to work on this and then bit of their own

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00:12:41,920 --> 00:12:46,900

skillset and experience and they are then the ones

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00:12:50,710 --> 00:12:54,820

10-15 years from now that will be the **experience** people

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00:12:54,820 --> 00:12:58,120

that carry this forward. So yeah that's a lot of

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00:12:58,120 --> 00:13:01,870

different people that are needed. Um, it's a lot of fun.

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00:13:01,870 --> 00:13:06,640

That's one of the major attractions for me personally, to work with so many different people from so

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00:13:06,640 --> 00:13:12,490

many different backgrounds and see something, this delicate and powerful come together.

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00:13:12,490 --> 00:13:17,110

Yeah for sure. I'm always super impressed with this just like, as you kind of talked about earlier just

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00:13:17,110 --> 00:13:20,290

how massive these just like equipment

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00:13:20,290 --> 00:13:24,640

is or these experiments, all to measure like the tiniest

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00:13:24,640 --> 00:13:29,200

bits that you could ever even imagine. It's amazing.

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00:13:29,200 --> 00:13:34,360

The further you want to look back in time, basically towards the closer to the big bang, the more

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00:13:34,360 --> 00:13:40,600

energy you need on your accelerators and the larger your experiments need to become because

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00:13:40,600 --> 00:13:45,205

it's basically a microscope as I already mentioned several times, but if you think of a small

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00:13:45,205 --> 00:13:48,820

tabletop microscope that can look at something, uh like a human hair or a cell

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00:13:48,820 --> 00:13:52,990

that everybody has done in high school, right? If you want to look at something smaller than

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00:13:52,990 --> 00:13:56,950

that like atoms, you need a much larger more powerful

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00:13:56,950 --> 00:14:01,960

microscope with a lot more energy. And if you want to look at something even smaller,

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00:14:01,960 --> 00:14:08,200

like these particles we're studying, you need a camera basically as big as

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00:14:08,200 --> 00:14:12,220

a multistory, um building.

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00:14:12,220 --> 00:14:15,370

Machines that are made up of that then of many millions of

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00:14:15,370 --> 00:14:19,840

channels that are made up of very small, very precise

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00:14:19,840 --> 00:14:23,290

measurement, I don't know sets in a way.

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00:14:23,290 --> 00:14:28,330

So we kind of touched on, or at least you touched on it a little bit earlier, of like how you ended up

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00:14:28,330 --> 00:14:31,945

from like Hamburg into Fermilab. Can you kind of

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00:14:31,945 --> 00:14:35,950

describe like what got you interested in physics in the first place? Sure.

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00:14:35,950 --> 00:14:40,450

So also school and I've always been very good at math.

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00:14:40,450 --> 00:14:43,660

It was always easy. I always really enjoyed it. And then later kind

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00:14:43,660 --> 00:14:47,410

of the same thing carried over to sciences in general,

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00:14:52,120 --> 00:14:58,630

uh let's say biology and physics. I really hated chemistry for some reason and got rid of

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00:14:58,630 --> 00:15:01,750

that as soon as I could elect out of it.

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00:15:01,750 --> 00:15:05,740

But...biology and physics were really close in my interest level.

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00:15:05,740 --> 00:15:10,720

At some point I thought I got discouraged a bit by teachers to pair mathematics with

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00:15:10,720 --> 00:15:15,700

biology which...yeah maybe intuitively you could agree.

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00:15:15,700 --> 00:15:20,440

Although nowadays, it's not really the case anymore. I mean biology has moved

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00:15:20,440 --> 00:15:25,270

in such directions to where you need a lot of mathematics in some areas.

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00:15:25,270 --> 00:15:31,300

But anyway, so I got more encouraged by teachers to choose the math-physics combination.

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00:15:31,300 --> 00:15:35,980

And then when it came time to choose what to do at university because in Germany you have, it's

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00:15:35,980 --> 00:15:40,450

different from the US, you have to actually choose your major right away

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00:15:40,450 --> 00:15:45,595

when you start. So when, there's sort of a career day at the university where people from different professions basically spoke about the job they had out of college and I had

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00:15:45,595 --> 00:15:49,600

a mathematician talk about things that really seemed very boring,

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00:15:49,600 --> 00:15:52,660

either boring if it was applied math,

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00:15:52,660 --> 00:15:58,870

or really out of my league. It was about really fundamental theoretical math in a way.

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00:15:58,870 --> 00:16:01,990

So I knew it wasn't really for me and physics on it more

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00:16:01,990 --> 00:16:07,570

like the kind of applied math that was more than my wheelhouse. It was it seemed flexible

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00:16:07,570 --> 00:16:10,900

enough that I could decide later on the direction I wanted to go

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00:16:10,900 --> 00:16:14,680

in. So I went with that. The more, broader, flexible kind of education.

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00:16:14,680 --> 00:16:19,090

Yeah. And then what about it was like kind of the particle physics

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00:16:19,090 --> 00:16:22,900

that stood out? Why was... Why did that stand out more than like other subfields?

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00:16:22,900 --> 00:16:26,530

I think that was a bit luck because I was in Hamburg and we had this

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00:16:26,530 --> 00:16:30,250

lab as I said these either they had particular physics that

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00:16:30,250 --> 00:16:33,670

at the university had a large particle physics group.

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00:16:33,670 --> 00:16:37,195

It was a lot of research that was seemed very valid

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00:16:40,780 --> 00:16:47,725

and like current day. I was really the state of the art stuff that happened. I remember one day I

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00:16:47,725 --> 00:16:53,110

So I had an advanced particular physics seminar that I took and the professor came in one day,

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00:16:53,110 --> 00:16:57,100

it was in 1995 because that morning they had

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00:16:57,100 --> 00:17:01,840

announced from Fermilab the discovery of the top quark, which was, is

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00:17:01,840 --> 00:17:05,440

heaviest particle that we know about to date,

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00:17:05,440 --> 00:17:12,069

by far the heaviest. And it was discovered by the two experiments running at Fermilab at the time.

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00:17:12,069 --> 00:17:15,385

At the time it was the highest energy collider and the wind was

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00:17:15,385 --> 00:17:19,660

really where the cutting edge of our field was at.

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00:17:19,660 --> 00:17:23,140

And that morning they had announced the discovery of this latest particle that

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00:17:23,140 --> 00:17:26,859

we knew was there and the standard model of particle physics

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00:17:26,859 --> 00:17:32,440

predicted it had to be there. And it was finally discovered by these two experiments here.

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00:17:32,440 --> 00:17:38,470

And my professor came into the class very excited and saying "they finally did it!", and she wasn't personally involved in that, but she was involved in similar

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00:17:38,470 --> 00:17:43,990

experiments in Hamburg that contributed part of the knowledge that was needed to do this

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00:17:43,990 --> 00:17:49,060

discovery, actually, because you need many different experiments that provide knowledge about

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00:17:49,060 --> 00:17:53,620

fundamental particles that is then used in other discoveries and used in theoretical

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00:17:53,620 --> 00:17:58,030

calculations and so on. So I could just see from her reaction this

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00:17:58,030 --> 00:18:03,325

excitement, and this feeling that if I would work in this field, I would be right there

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00:18:03,325 --> 00:18:09,580

it's kind of random and it matters and you'd see...new physics and history being made,

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00:18:09,580 --> 00:18:13,870

not on a daily basis, but sort of in my lifetime and that was

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00:18:13,870 --> 00:18:18,400

very exciting to me. That together with this amazing technology, these detectors.

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00:18:18,400 --> 00:18:23,170

It was just really attracting me and then not so maybe the feeling of this very international

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00:18:23,170 --> 00:18:29,200

fears we haven't talked about that but it's extremely international. We work with people from all over the world. The US

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00:18:29,200 --> 00:18:32,995

collaborates with institutes in China and Iran

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00:18:32,995 --> 00:18:36,790

even in Afghanistan and Pakistan, in Russia too.

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00:18:36,790 --> 00:18:42,175

I know that is very hard these days. So kind of our science really goes beyond

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00:18:42,175 --> 00:18:48,130

the borders and political systems and religious beliefs and that has attracted me as well. So it

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00:18:48,130 --> 00:18:52,750

makes a large amount of the fascination I think of this field,

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00:18:52,750 --> 00:18:57,280

how we get that to work, how do we get valuable science out of this, overcoming all these .

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00:18:57,280 --> 00:19:01,685

Yeah. Kind of on that note, can you kind of describe what your experience was with that?
Especially

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00:19:01,685 --> 00:19:05,430

since like...you're moving from Germany into the US. Like,

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00:19:05,430 --> 00:19:09,270

how was that transition if you don't mind talking about that?

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00:19:09,270 --> 00:19:13,080

But that transition was really easy, of course it was.

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00:19:13,080 --> 00:19:16,695

I learned English in school. I was then getting used to the as a student and

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00:19:16,695 --> 00:19:21,120

hammock was hard to getting used to actually speaking English,

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00:19:21,120 --> 00:19:25,500

and giving presentations in English for the first time

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00:19:25,500 --> 00:19:28,890

was really hard. Um, but eventually you get used to it and then

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00:19:28,890 --> 00:19:33,120

moving to the US was just like an adventure, a big adventure of course.

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00:19:33,120 --> 00:19:36,900

So the language was not a hurdle. But work culture was very different.

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00:19:36,900 --> 00:19:41,310

It was a lot more aggressive in the US. It's more aggressive but you get the feeling there's a lot more freedom. Anybody,

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00:19:41,310 --> 00:19:44,340

no matter your background, can really come. If they have great ideas and a

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00:19:44,340 --> 00:19:47,850

great work ethic, they can get almost anything done.

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00:19:47,850 --> 00:19:52,170

So you always find this kind of support for your ideas and for your work,

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00:19:52,170 --> 00:19:58,890

much more than I've ever felt in Europe. That said, of course, you have to have, you have to be lucky.

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00:19:58,890 --> 00:20:03,790

with your background, right? You have to have the right education, have gone to the right

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00:20:03,790 --> 00:20:08,110

colleges and...landed in the right research groups there

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00:20:08,110 --> 00:20:11,110

that you get maybe a powerful professor

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00:20:11,110 --> 00:20:16,000

somewhere, at a powerful university so that you personally as a student maybe can have some

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00:20:16,000 --> 00:20:19,720

insurance and some work on some really interesting things.

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00:20:19,720 --> 00:20:25,330

If you're coming from a smaller college, with a less well known professor with

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00:20:25,330 --> 00:20:31,240

not so many resources, it's much harder, of course. You still can get lucky and if you have great

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00:20:31,240 --> 00:20:35,800

ideas and work hard, you can still get to the top.

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00:20:35,800 --> 00:20:40,600

I know people like that too, with. But,

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00:20:40,600 --> 00:20:45,625

it's definitely harder. And I want to acknowledge that. But then I can add the other part. So when

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00:20:45,625 --> 00:20:51,730

I was working for Purdue, we were building the **enemas** part of this detector, the pixel detector, Silicon pixels,

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00:20:51,730 --> 00:20:55,300

that is very, very, the most precise detector part we have

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00:20:55,300 --> 00:21:01,990

and it's the very center part. And once we finished building that we got asked to move to CERN. We are shipping this

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00:21:01,990 --> 00:21:08,620

detector to CERN to be installed in CMS in the ground. And we were asked to actually move with the detector there

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00:21:08,620 --> 00:21:13,990

and help install it. And because we were really experts on this detector, right?

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00:21:13,990 --> 00:21:18,010

We designed it. We knew how it worked, how to operate it. We went to CERN.

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00:21:18,010 --> 00:21:22,330

We had it installed in the ground and connected other cables and commissioners which

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00:21:22,330 --> 00:21:28,210

means get it to work basically in its environment. And the plan was to go there for one year to

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00:21:28,210 --> 00:21:34,660

do this and if I say we it's basically because I was married at the time to a colleague. So we were

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00:21:38,560 --> 00:21:43,270

Both working on the same project. Um and we had two little kids,

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00:21:43,270 --> 00:21:46,780

really preschool age and we agreed to this,

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00:21:46,780 --> 00:21:50,170

before they went to school we said this is the perfect moment to do something like that.

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00:21:50,170 --> 00:21:54,850

It's easy to move little kids around. And so we did this for one year.

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00:21:54,850 --> 00:22:01,030

So we didn't sell our house in Indiana. We rented it out. We moved but then the Large Hadron

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00:22:01,030 --> 00:22:04,720

Collider, there was some incidents and the schedule got delayed a

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00:22:04,720 --> 00:22:08,470

lot. So then we had to stay another year because everything got delayed,

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00:22:08,470 --> 00:22:11,500

anyway this first year eventually turned into over six.

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00:22:11,500 --> 00:22:14,770

We lived at CERN for over six years. The kids

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00:22:14,770 --> 00:22:20,230

spent more than half the life at that point in France, living in France, going to a

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00:22:20,230 --> 00:22:24,310

little French village school, which they adapted to beautifully,

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00:22:24,310 --> 00:22:31,045

I'm a say. Um but then professionally, we had to kind of integrate into life at CERN and

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00:22:31,045 --> 00:22:35,170

compared to Fermilab it's definitely a different working environment,

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00:22:35,170 --> 00:22:41,290

more like what I was used to from Hamburg. I loved it and it was beautiful. It's a great place to live in the middle of Europe and the nature's beautiful.

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00:22:41,290 --> 00:22:46,060

So life was definitely great. Work was different but it was very exciting getting all this to

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00:22:46,060 --> 00:22:50,995

work from scratch. And then with the excitement of making new physics discoveries, right? Because

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00:22:50,995 --> 00:22:55,375

the LHC, the large Hadron Collider had this enormous potential. And then actually being there in

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00:22:55,375 --> 00:23:02,200

2012 and working on the Higgs and while it's being discovered, that was really exciting. I mean that was

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00:23:02,200 --> 00:23:08,260

just once in a lifetime experience. So this whole thing that was in '95 and my professor came in

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00:23:08,260 --> 00:23:12,430

when I had discovered the top quark this because that was expected, I mean the Higgs was also

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00:23:12,430 --> 00:23:17,230

expected but we knew it should be there, but it was a little bit less certain I would think

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00:23:17,230 --> 00:23:20,350

it was and to actually finally find it and

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00:23:20,350 --> 00:23:24,370

seeing all this excitement that was fantastic. Yeah very lucky that I was there.

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00:23:24,370 --> 00:23:30,730

Yeah. Yeah. So I know that you are also a part of the Snowmass like meeting.

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00:23:30,730 --> 00:23:34,360

Can you kind of describe what your involvement with Snowmass is?

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00:23:34,360 --> 00:23:38,200

Right. So, in addition to building these tracking detectors

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00:23:41,755 --> 00:23:45,610

like for CMS that I mentioned which is kind of my bread and butter.

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00:23:45,610 --> 00:23:50,770

part of the job. With the other half of my time, professional time,

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00:23:50,770 --> 00:23:56,380

I'm working on organizing the generic detector R&D for future experiments

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00:23:56,380 --> 00:24:01,930

at Fermilab to start with. So I started this about six years ago at Fermilab and that means beyond

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00:24:01,930 --> 00:24:05,320

collider detectors also astrophysics

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00:24:05,320 --> 00:24:09,400

experiments, neutrino detector technologies,

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00:24:09,400 --> 00:24:13,780

things like now more recently quantum sensors for

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00:24:13,780 --> 00:24:19,570

novel kind of experiments. I'm involved in all those things which is really exciting because I get to learn about

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00:24:19,570 --> 00:24:24,520

lots of different technologies and physics you can do with that. And that kind of, so doing this

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00:24:24,520 --> 00:24:30,160

for Fermilab, this kind of morphed into me being asked to do similar things, coordinating roles

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00:24:30,160 --> 00:24:34,270

more on a national level. Since a couple of years, I'm one of the chairs of CPED, which is a coordinating panel for advanced detectors,

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00:24:34,270 --> 00:24:39,595

which is a sub panel of the DPF in the US. And that's organizing basically generic detector

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00:24:39,595 --> 00:24:45,970

technologies for future applications across the country. So I'm organizing that. And then since I'm

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00:24:45,970 --> 00:24:52,240

had that experience that kind of morphed again into this Snowmass role, I'm co-leading the

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00:24:52,240 --> 00:24:58,210

instrumentation frontier. So again looking out for detector technologies for the various

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00:24:58,210 --> 00:25:01,960

applications of high energy physics, collider physics, astroparticle physics,

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00:25:01,960 --> 00:25:08,710

neutrino physics, rare experiments, **colliders base**, or other other kinds

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00:25:08,710 --> 00:25:14,740

of quantum technologies and all these things. So in the instrumentation frontier, IF, we're

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00:25:14,740 --> 00:25:20,770

coordinating that work. And so the IF is split up in 10 sub groups dealing with a different kind

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00:25:20,770 --> 00:25:24,940

of technologies mostly. And I'm one of the three conveners of

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00:25:24,940 --> 00:25:29,350

the instrumentation frontier. [Yeah. And what has Snowmass like really meant to you?](#)

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00:25:33,400 --> 00:25:38,140

So I was really hesitant going into that, because I already had my hands full a lot of other

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00:25:38,140 --> 00:25:42,940

responsibilities and didn't really have any time take on another major thing and I was told it

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00:25:42,940 --> 00:25:48,190

would be a major thing. It would be a lot of time, at least 20-25% of my time.

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00:25:48,190 --> 00:25:53,170

I did not really have that but got convinced that it's really an important part.

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00:25:53,170 --> 00:25:57,910

One has to play. Somebody has to play this part because it's very important as I told you

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00:25:57,910 --> 00:26:01,870

before it takes long time to design new detectors and build them

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00:26:01,870 --> 00:26:06,250

but it takes even longer if you have to make technological breakthroughs and have to make new

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00:26:06,250 --> 00:26:11,590

inventions and maybe work with industry to develop a new kind of technology for large-scale

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00:26:11,590 --> 00:26:17,290

application and maybe in some areas even do R&D in order to bring down costs of some

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00:26:17,290 --> 00:26:21,070

technology in order to make it even applicable for high energy physics.

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00:26:21,070 --> 00:26:24,130

'Cause if it's exists in industry, but we can't pay

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00:26:24,130 --> 00:26:27,430

for it because it's outrageously expensive, it doesn't really help us, right?

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00:26:27,430 --> 00:26:31,390

So there are lots of different developments that have to go on and they can take even longer.

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00:26:31,390 --> 00:26:36,160

So in addition to this long design and construction phase you have to add

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00:26:36,160 --> 00:26:41,740

another 5-10 years before, to develop these new technologies that you might need in 20

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00:26:41,740 --> 00:26:47,155

years from now. And as I said before too, it's as important, really to train a new generation of

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00:26:47,155 --> 00:26:52,360

physicists and engineers that know how to carry out this kind of R&D. So in my mind, it was

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00:26:52,360 --> 00:26:55,540

very important, now that I'm in a stage in my career with

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00:26:55,540 --> 00:27:02,290

half of this experience behind me, that I kind of give back and help organize the next generation
buffets

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00:27:02,290 --> 00:27:08,980

physicists and experiment and kind of make a roadmap of technologies that we need to work on
developing and so on.

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00:27:08,980 --> 00:27:14,020

So I saw that it was very important and it had a lot of synergies which with what I was

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00:27:14,020 --> 00:27:17,380

already doing and so I thought maybe it's not actually that

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00:27:17,380 --> 00:27:21,040

much extra time out of my day to do this. And

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00:27:21,040 --> 00:27:26,920

I'm glad I did it but it is a lot of work. And so then I'm just kinda curious, in your career as a
physicist,

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00:27:26,920 --> 00:27:33,160

like, if you feel comfortable were there obstacles that you had to overcome

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00:27:33,160 --> 00:27:38,620

along the way that you feel comfortable sharing. So yeah I can share some. I

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00:27:38,620 --> 00:27:43,480

mean, I've never until recently I never felt I was very motivated by

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00:27:43,480 --> 00:27:48,460

women only kind of movements in physics, as personally I was never much affected,

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00:27:48,460 --> 00:27:53,350

I felt. Maybe I got really lucky. My first professor, my PhD advisor,

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00:27:53,350 --> 00:27:58,930

it was a woman. So I sort of grew up scientifically in an almost all female group.

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00:27:58,930 --> 00:28:02,050

So maybe I was a bit sheltered by problems that

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00:28:02,050 --> 00:28:08,380

female students might encounter normally. I did have one strange episode so one morning as a student I came in,

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00:28:08,380 --> 00:28:13,180

I tried to log into my computer. I logged in. I tried to CD into the home directory.

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00:28:13,180 --> 00:28:17,710

It was in the, at the end of my seasons where I was basically writing up my see this. I am

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00:28:17,710 --> 00:28:22,420

writing out three years worth of work and it told me it didn't exist, my home directory. So it was

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00:28:22,420 --> 00:28:26,110

all gone. Basically the disc where that was stored on had

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00:28:26,110 --> 00:28:29,800

crashed overnight

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00:28:33,040 --> 00:28:37,345

and most of my data and theses had all sat there.

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00:28:37,345 --> 00:28:41,920

So it was all gone. So, full of panic, I was calling the IT support

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00:28:41,920 --> 00:28:45,040

office and the first thing the guy asked me on the phone

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00:28:45,040 --> 00:28:50,920

if I had asked one of my male colleagues for help. I thought I made my my **sin** just fell to the

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00:28:50,920 --> 00:28:54,970

floor. I could not believe my eyes. I was, that was really offensive But

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00:28:54,970 --> 00:28:59,050

I do admit I'm not really a super computer expert but I knew as much

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00:28:59,050 --> 00:29:02,320

I did everything to tell that was just gone

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00:29:02,320 --> 00:29:08,740

and yeah. So that was really offensive but I complained and the guy got, I don't know what happened.

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00:29:08,740 --> 00:29:14,050

I don't think he got fired but he definitely got a talking to. And then it was I mean that's 25 years ago.

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00:29:14,050 --> 00:29:19,420

That's been a while but other than that not much negative happened to me that I'm aware of.

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00:29:19,420 --> 00:29:24,910

But more recently I'm definitely feeling more duty to be a role model for women and in general

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00:29:24,910 --> 00:29:29,920

look out for any kind of discrimination and inequalities in our field and then work on taking some active steps to try to be more supportive.

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00:29:29,920 --> 00:29:34,630

EDI issues. So that's definitely the case. But the other challenge I would say I personally

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00:29:34,630 --> 00:29:39,220

experience is really being married to a colleague finding permanent jobs

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00:29:39,220 --> 00:29:43,870

because you have this two body problem, you have to find two good jobs, roughly in the same place,

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00:29:43,870 --> 00:29:49,870

roughly at the same time so you can set it down for the long haul and that worked out nicely. We got lucky. We got

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00:29:49,870 --> 00:29:53,590

basically, we fared. We tried finding jobs back in Europe.

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00:29:53,590 --> 00:29:59,920

Although coming back to Europe from the US, that failed. We had some interviews, we had some offers but never two

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00:29:59,920 --> 00:30:04,120

in the same place, the same time. Eventually I got basically hired

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00:30:04,120 --> 00:30:07,465

at Purdue by my husband's employee. He was already working there

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00:30:07,465 --> 00:30:11,260

and they hired me as well because they didn't want to lose him.

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00:30:11,260 --> 00:30:14,830

That was probably the main motivation but it all worked out really well and I got a really good

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00:30:14,830 --> 00:30:20,410

job. I was very happy with how everything went down. The next major hurdle was really then

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00:30:20,410 --> 00:30:25,960

building up my career as a young scientist after being a poster by building up a career, making

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00:30:29,020 --> 00:30:33,760

a name for myself, getting leadership positions while really having two small children at

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00:30:33,760 --> 00:30:39,040

home, that I was sort of the main caretaker of. So that was definitely hard. And then later on, I

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00:30:39,040 --> 00:30:42,070

became a single mom because my husband passed away.

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00:30:42,070 --> 00:30:46,750

And so as a single mom of two teenagers, with a career,

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00:30:46,750 --> 00:30:52,270

but that now it didn't really have to be built but maintained in a way so that was a different kind

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00:30:52,270 --> 00:30:56,080

of challenge because in this field of work you're supposed to travel a lot.

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00:30:56,080 --> 00:30:59,755

At least before COVID you were supposed to do that

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00:30:59,755 --> 00:31:04,270

and it wasn't really possible as a single mum. I couldn't just leave home

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00:31:04,270 --> 00:31:07,870

for a whole week. So I could manage small. Thanks to a

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00:31:07,870 --> 00:31:13,570

really awesome support network of friends, I could travel domestically maybe for 2-3 days.

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00:31:13,570 --> 00:31:16,810

Um that would work but I couldn't really go to CERN for a whole week.

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00:31:16,810 --> 00:31:21,250

So I lost a bit of touch with the work at CERN and what's going on,

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00:31:21,250 --> 00:31:26,710

but I compensated by focusing more on Fermilab and **Turnover I would say.** So I focus more on that and that's where this whole instrumentation leadership came out of, right? 'Cause then I did this tech to R&D coordination at

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00:31:26,710 --> 00:31:30,490

Fermilab because for that I didn't really have to travel in Madison and in the end again it all

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00:31:30,490 --> 00:31:33,820

worked out really well but there were definitely challenges on the way.

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00:31:33,820 --> 00:31:38,590

Thank you. Thank you for sharing. That's really powerful to hear. Yeah. Thank you So I guess sort of

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00:31:38,590 --> 00:31:45,550

like on that note a little bit, do you have any advice for students or young researchers? You

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00:31:45,550 --> 00:31:50,530

had kinda sorta talked about like building up your own lab, but even as like a student even

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00:31:50,530 --> 00:31:56,740

thinking about like, pursuing physics as a grad schooler or a career or something like that. Do you have any advice?

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00:31:56,740 --> 00:32:01,570

Right. Yeah. I often get asked that by even high school students. They're so young.

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00:32:01,570 --> 00:32:06,925

And grads. The first thing I usually say is just follow your heart. Just do what

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00:32:06,925 --> 00:32:11,125

you're passionate about. And then 'cause then usually you do really well in those things. And I

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00:32:11,125 --> 00:32:16,570

think that's more important than having constantly strategic thoughts about your career and what

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00:32:16,570 --> 00:32:20,980

what's the right next step? What should I do? Should I work on this in order to have a better CV?

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00:32:20,980 --> 00:32:25,450

Maybe nowadays it's harder and you need to do that more, I don't know. For me it worked out really

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00:32:25,450 --> 00:32:28,870

well to just do what I really like to do because then in the end,

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00:32:28,870 --> 00:32:32,980

you do spend a lot of time at this kind of work.

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00:32:32,980 --> 00:32:36,430

Usually it's way more than 40 hours a week.

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00:32:36,430 --> 00:32:41,080

And you don't have to, but if, if you want, you can do that and it's definitely a lot more fun

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00:32:41,080 --> 00:32:44,740

if you do something you're really passionate about. That would be my main advice,

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00:32:44,740 --> 00:32:48,280

however I do understand that nowadays it might be harder, the fewer

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00:32:48,280 --> 00:32:52,060

jobs, higher level jobs, post even postdocs,

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00:32:52,060 --> 00:32:55,600

postdoc position is harder to get than it was than it was when I was a postdoc,

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00:32:55,600 --> 00:32:59,020

so it might be you have to be maybe more a little bit more strategic than that.

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00:32:59,020 --> 00:33:03,610

I do think it's important to do more than one thing.

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00:33:03,610 --> 00:33:07,870

Different things, right? Don't only focus on analysis maybe.

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00:33:07,870 --> 00:33:13,840

If you don't like hardware, at least focus on maybe some computing techniques, uh some theoretical

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00:33:13,840 --> 00:33:17,635

things. So they are the people that do a lot of analysis but then work with theorists

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00:33:17,635 --> 00:33:21,610

for example, and...with phenomenologists,

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00:33:21,610 --> 00:33:26,590

and write theory papers together with one or two

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00:33:26,590 --> 00:33:30,790

uh theorists and I think those experiences are also very valuable.

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00:33:30,790 --> 00:33:36,550

But yeah, one should be as broad as possible. I'd still becoming an expert in something.

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00:33:36,550 --> 00:33:41,530

I have to try to achieve that kind of thing. I know you've discussed like your your love of physics and

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00:33:41,530 --> 00:33:46,480

and what you do. Do you have any, like what do you do outside of physics? Do you have any hobbies?

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00:33:46,480 --> 00:33:49,690

Do you relax at all when you leave the lab?

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00:33:49,690 --> 00:33:55,690

Actually yeah. I must say since I may be a bit unusual, I don't know. I know a lot of colleagues that work a lot.

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00:33:55,690 --> 00:33:59,080

I don't work really that much more than forty hours a week.

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00:33:59,080 --> 00:34:04,405

Since the kids were little, I refuse to work in weekends and even evenings

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00:34:04,405 --> 00:34:07,570

and nights. When I get home I stop, and I found out,

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00:34:07,570 --> 00:34:11,469

it's very small exceptions, sometimes there's a deadline you cannot get around

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00:34:11,469 --> 00:34:14,710

working on a Sunday but that's really a small exception.

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00:34:14,710 --> 00:34:18,460

I find it's very important to relax at home and so actually two years working from home during the pandemic was

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00:34:18,460 --> 00:34:22,135

killer for me, It blurs this boundary between home and work and

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00:34:22,135 --> 00:34:25,810

I could not handle that very well. So I'm very happy to be back at the lab.

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00:34:25,810 --> 00:34:29,830

So during a pandemic I started playing the piano,

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00:34:29,830 --> 00:34:34,929

trying to. So I've always done some music when I was younger but I always wanted to learn the piano and

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00:34:34,929 --> 00:34:40,105

I've finally started that but...I don't know, maybe I'm too old. Oh there's left-right hand thing

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00:34:40,105 --> 00:34:45,340

coordination and my brain doesn't really...So I have a new respect for

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00:34:45,340 --> 00:34:50,695

really good pianists. I read a lot. Usually novels but recently I got into reading history books

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00:34:50,695 --> 00:34:53,739

and like far back history, like **anthropology**.

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00:34:53,739 --> 00:34:57,220

Phonological and and so on. Um, I hang out with

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00:34:57,220 --> 00:35:01,900

friends, lots of dinners and parties and just chatting. Binge-watching

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00:35:01,900 --> 00:35:05,500

TV shows with my kids, that's also very relaxing, probably too

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00:35:05,500 --> 00:35:09,370

much time spent on that, but it does relax me,

453

00:35:09,370 --> 00:35:13,120

so I don't think about it. Yeah. The piano to me always seems like it's so

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00:35:13,120 --> 00:35:16,960

difficult with you know,

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00:35:21,040 --> 00:35:25,540

there's so many keys and I don't know how you able to get one hand to do one thing and the other

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00:35:25,540 --> 00:35:28,750

to do something different. That's my main challenge.

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00:35:28,750 --> 00:35:33,760

To answering two different things. But it's fun. It's fun to learn something new.

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00:35:33,760 --> 00:35:40,510

Yeah. Yeah. Well, thank you for coming on and doing and taking the time to talk about your

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00:35:40,510 --> 00:35:46,390

experiences as a physicist. This was really great to hear your story. Thank you for doing this.

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00:35:46,390 --> 00:35:50,922

You're very welcome. It was fun like talking about it.

462

00:35:50,922 --> 00:36:04,922

We hope you enjoy today's episode. This podcast was created by Bryan Stanley and Professor Huey-Wen Lin. Season two was edited by Varalee Sakorikar. Thank you for listening.