Hello, everybody, welcome to the final presentation of our first day at TWSS2021. Thank you all for joining us. It's good to see so many people from all over the world. I think we're up, in the last presentation I think about 17 different countries have joined us today. So it's pretty exciting for us and we’re all excited to see you.

Today's presentation is going to be given by Dr. Ming-Chieh Lin and he received his Ph.D. in electro-physics in 2002. He's currently a professor with the Department of Electrical and Biomedical Engineering at Hanyang University in Seoul, South Korea, where he's involved in particle and cell simulations of plasmas, microwave tubes, electron emissions and terahertz wave sources and first principles, computations of surface physics and heavy ion therapy. He's also the founder of the multidisciplinary computational laboratory at Hanyang University, where he's focusing on combining computational electromagnetics in quantum mechanics for studying complex systems and biomedical applications, and providing professional training and consulting services based on over 20 years of academic and industrial experiences and related fields. So welcome, Ming-Chieh, I'm so excited that you're going to be speaking.

Thank you very much for introduction, Colleen. Today, I am great to have this opportunity to talk about our recent simulation and the development. Okay, and actually, this topic is many performed by my students, Lindy, she was, she graduated already. And to Kaviya Aranganadin for the 3D design. And Professor Xi at the National Taipei University of Technology is one of my international collaborators who provide the COMSOL multiphysics simulation support to this topic, and myself. So I'm going to present some our recent results and some publications.

First of all, I would like to recognize the institute, like actually, the years of work, we were supported by many agencies like Hanyang University, and the National Research Foundation of Korea. And especially this topic is very interesting to MASTEK corporation in Taiwan. And I also received some support from Alexander von Humboldt Foundation from Germany.

And this is the contents of my talk today. First of all, I will introduce some background and our motivations. And then I will talk about research methods we employ in the estimation model under designs. And I will give you some summary of simulation results and we'll discuss about the good design we found in the rain, I will summarize my talk and introduce some future work. So as we know magnetron has a long history. I think this is the first one developed by Hoover around 1921. So it is stored in museum. And this is like a very preliminary design but it's either consists of main concept of mechanism and there is a diode configuration. And we know let cavity magnetron is a high power vacuum tube. And I don't know if you guys are familiar with the magnetron. So I think without making it wrong, we won't be here today. So, as you can see magnetron is a vacuum device. So it should be operated in vacuum and here in the middle is the castle and the outside is called the resonator cavity. And the we rely on this high voltage apply between case oh and a no to is treated electron from the castle and we apply many fear in a short duration. We can get there this electron traveling around this interaction space between Kato and nano and there is a outside capital cavity can interact with these electron beams and we can get the resonance and we can get a iPhone output in that we design a coupler to carry out the iPhone energy for utilization and he shows you some picture of magnetron. So, Megatron today is widely use the many microwave oven. So, we have a quarter magnetron like this actually many years ago we said David Smith at the tech x so, we cutter of magnetron it does look like this. So, as you can see, this is a conventional magnetron and if you talk about your microwave oven you can find this guy and then we see power supply alright and here you can see this shaper and events okay and you can get the more understanding magnetron on Wikipedia the WEA is well known letter cavity Megatron was widely used during World War Two. So, as I mentioned that without magnetron we wouldn't be here because this airborne radar was available during World War Two so

we can win we can win the war Finally, so, without this airborne radar is impossible to defeat Japan or Germany okay and today mechanisms are widely used in radar system or heating lighting and especially industry shooting today and many weapons also rely on a magnetron like a guided missile for example. So, as you can see here, this is a cap this activity can be with a very complicated geometry and the difficulty in getting this design is to understand the interactions. So for decades we already spend a lot of time in optimizing this mechanism. So conventional magnetron can reach like 70-80% without too much problems okay and as you can see here this is a case Oh is the main is a key component for mechanism this case can produce electrons so without electrons, we won't get any power. So, normally electron could be data due to this poison in the case and then as you can see here we have antenna to cupola energy out and there is coupling is also important design and the outside you see this ring mechanism is provided the Asian magnetosphere so sometimes we call these these cross v curves fear type firm vacuum tube is different from linear types such as the Christ form or theta piece. And in recent decades we switch gear to high power devices. So this is an AC Megatron proposed by MIT researchers and it MIT is well known to be used in high power microwave applications. So as you can see these six men and the especially the castle is replaced with a code type. So previously here normally we use sirmione Castle, this mean we hit the castle and to upper like a one seven degrees Celsius or Kelvin and building redisplay trunks us ceremony with this in this case we will release the electrons by apply hypertrophy. Okay. So this is designed as a good advantage because this is like we can have festered wound up we don't have we don't need to warm up Okay, so we have faced the tongue features. However, you can see this kind of okay Tron can reach about 30% or 36% efficiency. I think for some reason, for years so we can reach a higher efficiency. And this, MIT actually proposes several configuration then I think the most well known is the 86. And this is shows you two curves one is for Carter, for the other one is hartree. So it's very important to operate a megaphone between this region and actually is better to find upper rating points along this Hachi line. So, as you can see vertical AC AC voltage and the horizontal AC system interfere. So, we have to find good fire good operating point and the actually this paper is more complicated than this one is a simplified one we only see I think these two pie motor here and they are new development they were new development proposed by Professor Shami ducru from New Mexico University of New Mexico he proposes a new type of magnetron employing transparent cattle and this can give you even faster risk risk benefits faster turnaround time in the maybe with higher efficiency by employing depression output okay. So, they argue the efficiency can increase can be increased by up to 70%

the all motivation actually is for industry applications This is an MP CVD system is a stands for microwave plasma enhanced chemical vapor deposition. So, the main goal is to develop a time on and not only time on fame, but maybe time on disk for future generations in the future. So, as you can see, here we have a microwave source at 2.45 gigahertz and there is an industry or type of magnetron So, it should be very reliable and very energy efficiency and low cost for example and the we'd lunch your microwave through web guy and then maybe we ate a circulator in between preventer Timmy g the micro microwave source and then here we have plasma generator and these two developer demand or any novel materials like a graphene and the research shows you and in industrial magnetron development mugger this manga song actually is widely used is it consists of three kilowatt 72% efficiency it's 2.45 gigahertz and we know good megatronus you have these officials like high efficiency you don't operate in life small many fear leakage and the high frequency stability low voltage though no voltage and the compact and the lightweight okay in the Okay I will skip this. So, as you can see, we we have two types of magnetron today I mean for conventional magnetron for for commercial Megatron we utilize shaper because the reason for using shaper Is this a magnetron as you can see has many copper cavities. So, these can have different resonance most so there is more competition in this magnetron. So, in order to separate a model we have to use this shaper but this shaper will break the symmetry of the magnetron. So in order to study this, you have to pursue a 3d modeling and that is very time consuming basically. And then on the right hand side this is writing some magnetron and the it's also there's also some applications or the compared to conventional Megatron This is not widely used. Either it either does or has have a lot of good features. So in this worker, we propose to use racing some magnetron to simplify the design in the ghetto, reliable industrial type or magnetrons. And in addition, we propose to use emission capital. Okay, actually we started this research in collaboration with Professor Jim Brown in Boise University Idaho in the he came out with some idea with finishing the race. So we think finishing castle can change the story of magnetrons in comparison, some ianni case so not mostly they have some poison material. For example, they have thorian mixed materials variant or other materials, those oxide may be poison if it's released in comparison we for finishing cancer we can employ like a graphene or diamond cynefin or structure the crystal diamond for example and the here Our goal is to develop magnetron the power is greater than three kilowatts and the frequency is central at 2.45 gigahertz and we hope to reach for an efficiency up to 80% Actually, this speaker was divided by mistake cooperation in Taiwan they are pursuing to have their own mechanism in the near future

and the folders as you measure the basically because we have electrons involved in this em structure. So, basically we rely on pig summations. So, let me say that we employees will know is a co finite difference time domain how to go inside of summation. So let's good review published by Professor Jamba bunco you can refer this reference. So if you want to perform this simulation, it is better to understand this route. This is a ticker simulation, fundamental pixelation. So, basically we are solving tears must be occasion. So we saw who must integrations with sawston So, we have to we have to check all the particles. So, basically, these particles they will be in a continuous space. So we have a large range in the aquarium picture and for fear we salvo in greater space. So we have orient picture. And then we need an interpretation for example, after solving this particle we gather location and velocity we have to interpret these two graders position to solve in order to solve energy fear many fear and we have to get another interpretation. If they're solving this fear, we need to get a new fear ruins a force to push these particles in the universe underage treatment for them both to bring in particles into the system or get some particles out of the system due to assumption on the surface. So, our goal is to utilize v sin because the resume has a decent framework developed and the as we know vcm has a second order accuracy on these complicated geometry for the bow and either employee damage for sale boundary algorithms and it has been tested either can give you 99% accuracy with a lower mesh okay and the this is rising some Megatron employing a fee emission. So, road designer and the developer using this accurate algorithm and actually this has a lot of advantages compared to conventional strength the magnetron for example, the one most important thing of this worker is we can use a 2d simulation to optimize the configuration and the operating points this cannot be done with a conventional strip of magnesium because the broken symmetry This is the Confirm of our finite difference time domain acquisition employed the increasing is called a mutual cause sale okay you can refer to this reference to understand more detail about this. So outside this is considered a metal insides vacuum and there's a treatment special treatment around around these boundaries. So around these boundaries these in this integration around this freshener sales instead of stairstep boundary. So we call is conformal. So the updater equations, we modify possible modify the rows so this area is the Analyze phase these were the law geometry parameters formula cost. So we replace this with conventional for the appetizer and this is unpair updater. Then we pay we do pay some penalty but we can get a more high Accuracy okay as you may know, let vissim actually today's modularized So, we have a module called v sim MD. So, it can be used for different kinds of electromagnetic or the plasma system modeling. So, you can find different examples there. And so, the work of the day we also utilize one older example to

fit our design and the in order to work on this Megatron actually more than 10 years ago we already developed some Magneto model and for a benchmark. So, at the time I was we should take case as a researcher scientist. So, this could be my first work on magnetron using wysing. So, anytime I developer This is a six megahertz on in the design specially designed external circuit with a feedback mechanism okay so, this was a steer use the this is the user today and as you can see here we can get a PI model and two pi model and you can clearly see this a bunch a bunch the electron beam the in that paper we benchmark curries against conventional FDTD they mean last employee conventionally we stair step up boundaries and we found that we can reach about 99.4% accuracy we suggest 100 by 100 mesh mesh meshes. So, this is a very good one because we can reduce the computation time a lot and there he is here shows you the a six parameter ACC results for benchmark So, he shows you there are two branches here from from first spreadsheet up to pi model is 2.2 point three five up to second branch So, two pi more is 2.4 point six and then we did the detail benchmark so either in either ensure we can get a high accuracy with this type of simulations okay so here basically we employ a resolution of one or two by one or two and we have confidence that accuracy can be 99% or better and so he'll give you some flavor of VC modeling. So today is very easy. So he shows you this to the magnetron so basically we use this is simulation there's enough for our study here and if you pursue 3d you can go to this example like a six magnetron one or two the one the first one is a code tester. The second one is hottest simulation, but since the lows are 3d modeling and it could be very time consuming. So, in this in this worker we perform only to the end so we can optimize the geometry before we pursue the 3d modeling okay so, this is a show so you walk in flow today in Beijing. So everything you can just click and going through this process you can build your own model. So here I show you geometry. So in this case this is we can create a this is Megatron model from our cater towards like a salaried worker or employee or other simulation tool. For example in this case we also use a console to developer geometry model by the students okay in the actually you can also use the CSG create constructor model inside vsam and we also work on later too and so if you want to study this Megatron you will have to develop some you have to create a some history for diagnosing the system okay so here we for example, we want to monitor the number of micro particles in the system to ensure the simple particles are in enough and we want to develop monitor for cavity case Okay, no wotg okay and we want to know how much energy is deposited on No For example, this is no electron heated water for example and we are also able to return current they can dissipate the energy on a castle

okay and the we try to understand the difference between conventional Megatron in the desert racing some Megatron. So, we try to understand that dispersion dispersion curve oh this is Megatron. So, originally we know that the commercial makers on employess cyclability with the same size for example, this is case A. So, in the by reducing this radius, we can understand how dispersion is changing. So, here's your solar dispersion curve. So, this green line give us the dispersion of a conventional megaphone and this is a straight line give us the operating curves and as you can see, we move on to case B and we reduce a little bit of a radius of one set of smaller cavities and the dispersion will be changed as you can see this dispersion with rising sun Popova is the final design of our rising sun as you can see Ito can provide the good motor separation. So, as you can see, when you apply this green one, it's difficult to separate the neighbor neighboring mode, but you see red blue line, this is the game ship. So, we operate if we operated the pie mode here then the next neighboring mode is far away I think we do have a goofy show for racing some activity in the invisible generation as I say that it returns to the to the cemetery. So we can apply to this generation, but we need to have one hour later for microwave power. So we have to add a loud loading. So, we use this sofian material here is shown here in gray This is considered a loader cavity. So, by praying with a soybean parameter you can change the for example q loader So, we can load the cavity differently to indicate either mimiko like output for 3d magnetrons. So, without this we cannot say the this is modeling and there here shows you the optimize the parameters of our configuration design. And we also use console to follow code tester to ensure efficiency and the q value corrector for our design. So, compare that with this information. So in this game you can also perform a test simulation and kohteessa simulation and then you can get the order resonance with the Q values and we did a comparison to ensure of the most correct and accurate data. In order to optimize the geometry we also consider all a promote from parameters so we sweeper different parameters like cavity radius, no radius, Kessel radius, and also angles. So by by varying this parameter setting, we can try to understand how we modify the cavities to ensure we steer it'll ride resonance into 2.45 gigahertz This diagram shows the EULA PV mapper okay this is important. So as you can see the blue one these blue curves these Hachi Hachi blinds from conventional Megatron and the red one rose for rising some magnesium and there is a red the solid circle is represent pi mode we want to operate and you can see the next more is separated for our way. Okay, and the entirety To let we try to design the magnetron which can be operated at the same

voltage as convention one So, if you draw a line across this operating point you can see another good feature is the mechanic the mechanic the fear can be reduced almost half okay and actually this is the main achievement of all law students so, she spent a lot of time to carry out these simulations as you can see there are a lot of data points here and these are data points we needed to perform very long run and since it's a 2d This can be achieved without too much difficulty okay. So, as you can see along we'll try to find out a good operating point me actually near five kilo boat okay. So, this is the voltage conventional mechatronics operated why we would like to like it, we would like to have better because we don't have to change the power supply for existing design we can just replace the easily mechanism with this is a new design okay we have we might have to change in a fear okay. So, in this case you can see the optimize the efficiency can reach about 80% Okay, so, if you don't have a good operating point efficiency will be much lower okay and this is shows you the final optimization of our parameters. So, give you wotg and many fear and the current injected and here are the most important pies, this is a simulation run time. So, we run the system up to 2000 nano second, this is difficult to be done if you have a 3d model. So, it's a very good way to use it to the simulation to optimize the geometry. So, he shows you some analysis we use the increasing so for example, we monitor electric rpp beefier the electric field in the system. So we can perform a variety to understand the resonance there. So, as you can see, this is pi mode and the is very pure. And the the only competition mode is this one. This is like a because we have 10 vents. So it's like a pi over five modes for example, visor further away. So as you can see there's at least 20 Db difference. So, this is a very pure without pure resonance without striping. So we don't have to employ any striping to break the symmetry. And therefore this is right in time we perform your time frequency analysis as you can see, at the beginning this is low the more tend to oscillator but around 40 nanosecond is gone. So it's dominated by this primordial resonance in the very pure and then he shows you this timeframe, screenshot timeframe screenshots of this operating design. So, as you can see this we have five spokes for this specialty and the from 46 nanosecond, you can see clearly Facebook in there is getting stable and most and more stable when time goes by. When there you can see clear for your pet and this is a Bz magnifier. So you can see pi model the next neighbor neighboring cavity has a pipe phase shifter. So blue can be in a negative phase and the red one shows you positive face

and that here shows you the no voltage we applied in the system. So this is from diagnostics. And then here we observe this no current and this is actually we see some post processing and the nowadays invasive you can gather this average data from enterprise tape. So, you can just click and select the quantity physical quantity you want to average. So, by this post processing we can determine the power and the efficiency of the design. So, basically we can also monitor output power. So, before this load the material we set a point vector diagnostic This is also monitored by here this upper power actually we up we acquire this power by using energy conservation okay. So, we measure the annual current and then we measure energy deposited on a no in the case oh and we can calculate the IFO output power energy then we know input power we can determine the efficiency and we also test the we also try to study this emission current we affect the efficiency and also lower the Q So, as you can see low the Q can change the efficiency dramatically. So, we have to choose the queue carefully in this design and for mania for current density around this region it doesn't vary too much. So, we can get around efficiency of 80% okay and this is a 2d summation, but of course in real world that we like to have a 3d design so, because this has a symmetry So, we can just estimate the 3d output. So, we buy just because right now this design is with the current density about point six MPR per square centimeter This is achievable with finishing array okay our case today and the we I think we get we use three centimeter of height we can reach II three kilowatt okay. So, this is very feasible designed for industry applications we believe and the result is to publish the in vsdb last year. So, if you want to know more detail please refer to this paper and then finally, summary the design and simulation of fee emission best pricing mechanism has been conducted using the 2d CFD dp simulations as implemented in the sim and for industry application this Rising Sun magnetron cavity has been optimized to point four five gigahertz and we optimize the configuration geometric configuration and also cover the loading and the density is about point six which is achievable in discriminants. Today without too difficulty and from the test Tatis the simulation results we achieve efficiency about 80% so basically it reaches our goal for industrial applications and with achievable current density of emission array or we may also pursue unccd there's a kind of diamond theme for this Rising Sun magnetron then I think after we make sure the 3d simulation we this can be a prototype can be manufactured.

So he shows you some future workers so students were creating geometry. So in this case, we use different software to create geometric input to VC as you can see it's working well. And you can also use this CSG to create a nice model so like this is very simple. For example you can create create a wedgie first and the copy this wedgie to be five ends and the do the same thing for smaller cavity, smaller cavities. Then, you can unite all this and with a cylinder then you can get this rising song So inside vcm you can use this as DSG and the Boolean functions you can create a cylinder we can either big cylinder as metal, and you can substrate this geometry, you can get this cavity in our cavity and the inside or not okay? So analysing the rod as a castle in the UK can get a 3d. So this work is ongoing we, we would like to, if they're optimizing the 2d geometry, we'd like to test the 3d model, but we need to to design operators where more realistic output antenna for applications. And another challenging part is the formation. So formation usually is not so stable if we apply hypertrophy. So, several years ago, when I was a 30 case, I also have a developer some famous and algorithm. So we are going to continue this study to get a more reliable information from this kettle, then we can see how finishing can affect these operations. And then he shows you some references in this work. And thank you very much for your attention.

Okay, so if anyone has any questions, thank you so much Ming, che for presenting with us. It's good to see you know, some of the results and everything that you've presented here, if anyone has any questions, they can type them into the q&a box in the bottom. If you would prefer to ask your questions I can give you can raise your hand and I can allow you to talk if that would be easier. And we have maintained for just a little while where he can answer any questions. I should also I want to mention that we do offer free trial evaluations of all of our software products, we send you seminar Sim, so if you have not tried v sim before and you would like to, and all you have to do is go to the tech x website at tx corp.com. So tx corp.com, then you can request an evaluation free for 30 days. And that evaluation software will have all four packages. So it comes with all of the capabilities. And that's a way for you to try it out and see if this is something that would work for your problem. So let me see here. I can hear looks like john has a question.

Yeah, you know, that was a very nice Talk. Thank you so much.

Okay, thank you.

So, you know, some of the recent work on emission, by Kevin Johnson has talked about how you can sort of transition between, you know, channeling their emission, and Richardson dushman emission, you know, filament kind of emission. And I'm wondering, have people done any studies on how having emission vary as a function of temperature, and would affect your results?

Oh, that's a very good question. Thank you, john. So actually, when I was cases, I went through those partners or, actually, that official has been developer in this in and I carefully benchmark the acquisition. So is the cove general fee admission model in vsam. And actually, I found that some pneumococci disabilities, there are two singularities in the in the algorithm developer, Kevin Jensen. And I also discussed this with Kevin and the and I also show a benchmark of VC against this theory. So I think I presented the letter several years ago when I was a ticket. It's it has some major conferences. And we plan to use later acquisition, of course, so I'm testing some formation because especially in particle in sales, I mentioned this is C emission fact sometimes we may have a hybrid high that we fear at the edges. So this he can cause some security and the rest can fail the efficient algorithm. So we have to be careful about this. This could cause a numerical artifacts in some way.

Very nice. Thank you. So do you have just a follow up? One little question Do you have some sort of guidelines for people you mentioned? have to be careful, you have some sort of guidelines for Yes, primary reasons where they should be curious.

Yes. For example, actually in information model developer in this in I think this is the best image and echoes available in Pico at this moment, because I also implement for bus model for for for for bus model football is a professor in UK. In recent years he developed an improved a fee emission model and the why why why I was the case I implemented that with john rubbishy in leasing so in this game you should be careful setting these fee emission parameters. So for me fee emission conventionally we use parameters developed by sprinter yes it is Denver researchy Institute as I okay, so there's a I think there's a manual in visiting some people interested can refer to the manual there it is shows you how to design this shocking no one parameters.

Okay, thank you very much. Yes, I'm aware I've spent thank you very much and thank you, thank you.

Yes, looks like we have another question here How long is was the simulation run of the Rising Sun magnetron model

Okay, you may see you may see that we have all different kinds of simulations. So, if you want to get a quick run for example, 200 nano second, you can get a killer result within like 10 minutes. But, I mean, you need to employ parallel computation. So, most money we can use sitting core, so you can get a result about 10 minutes. But for longer wrong, usually for optimization, because it takes a long time. Because we have to arrange a lot of parameters. So basically, we use one core for each parameter, then up to two sovereign, it takes 12 hours for each data. And the as a, you know, student can mess up police. So actually, you have a, you have to be careful about the settings to do the Enable spend three months and the Gimme, like a lot of garbage data, because they mess about mess around, mess up around the mesh setting. So if we don't, you are not careful about setting any arrow could fail data. So basically, it will for optimization, we use one core like a previous worker, I also concerned about optimization using AI. I think actually, one core per task is good for optimizing the geometry or operation.

Have you Did you ever compare vcm simulation results with other software?

Yes, a long time ago. Actually, I was the medical use of before I didn't use the metric for many years. So at the beginning I don't when I first joined take a warning 10 years ago I don't because before I walk in on some before I work on some research topic I will carefully study the tool. So the time I try to study wheezing yeah and actually the time vissim is now so easy to use like today and I have a harder time in learning VSAN compared to magic, but it turns out for years we can get a better simulation from being compared to magic. So I have a benchmark actually vcm and the magic on basic mechatronics simulation. So if you use magical you may see some arrows now because this is their stepper boundary and we do get a second order accuracy from missing summation with a with a smaller summation time Okay.

Okay. And one more question I have is how do you calculate the efficiency and the output power?

Okay, so as I mentioned, okay, this is this go to the cavity So, here we have loaded cavity. So, there are two ways there are two ways to calculate this efficiency or opera power. So, we sit with specially set point invector here diagnostic here two major power raw power going through this loaded cavity. So, if you don't have a motor combination this lumber will be consistent with energy conservation method that we apply here. So, we double check the output power without losing this validity. So, we the way we calculate efficiency is like race. So we measure immediately the current from Cato and the deposit the current on both the angel and kaithal. Okay, so we know how much current you know current is a deposit is moving from case to a no. So this will consist of income input power, we know p equal to IV is an input power. And we know energy conservation. So we also carefully check our conservation in the simulation. So, by subjecting no heat and the castle heat, we can determine the if power generator in the sense that there is no competing model in this case, because the next neighboring mode is very weak. So, we assume all the energy is belong to the PI mode. So, we double chicories with PowerPoint in vector measurement. So, this is consistent. So we have complete confidence that the design can reach 80% of efficiency.

Okay, great. See, I'm like we have Oh another question. I'm going to see. Alex, if you want to unmute, you can ask your question. I go

Thank you. I was still muted.

There you go. I hear you now.

I recognize your voice.

Hi, man, gods. I wanted to to talk to you. So I'm talking to you. But and that was that was great to hear your voice and and watch this this really great presentation. So thanks for that. I don't have a really great question to ask. But I was curious in I don't know if you mentioned this. Do you have future plans for using VSM to do to simulate other other things besides besides magnetron, like, plasmas and other, perhaps other electron devices, or?

Okay, it's good question. Actually. This is a very good question. I think we met 20 years ago it has slugger, right? Yeah. So actually, there are a lot of research topics ongoing even several years ago when I was at a tech I said, Actually we ever study, high strong magnetron pwd and the last worker attack case is fusion jurusan. So I think you'll be seen today is the best estimation tool for microwave devices. And since I think no other tool was again simulator largest scale, where can electronic devices like leasing and the use You see, preparation is a scaled well in provision. And for example, for jurusan, future jianzhong we model the either Texas like one day, we can finish the hottest model no fusion jurusan is a very, very high order model. And the I think this is a steer water record today. Other software cannot reach Oh, and I have some ongoing research on gelatin. So this is actually this is my continuing worker at Hanyang University and in collaboration with Kitt in Germany. And so I think later on because the tickets, I didn't publish it too many papers On gelatins so later on, I may publish more so people will see this cool features. Because I can say that if you are interested in making a strong resume right now is the best tool for that purpose. Because I also tried to CST before and in my research work at Germany, I also benchmark our simulation investing with CFD simulation. Actually vishing can catch in more detail physics compared to other software.

Mm hmm. Yeah, we have at Raytheon we have CST. And we and we have mostly used icepick for the really rigorous simulations of vacuum devices but we're trying to see if CST can can also do some of what I speak does I'm not very hopeful and so I'm very interested in getting the same here at Raytheon. But it's a process when you're when you're in a big corporation like this.

Yes because I do have some collaborators using CST so I can give you many fail story. Yeah, yeah. Yeah. Because like a Megatron simulation might be okay for simple case. And for judge on simple configuration, like a lot more is okay. By the higher the more the like micro integrator in Korea. They cannot get good results from CST and my Cobra in Taiwan, they also give up they switch to resume already.

Yeah, yeah. I've heard some similar horror stories. So

yeah, by the way, I remember we have a calibration work on Windows, if you recall. Oh, yeah. Yeah. window, you remember? Yeah. We talked your paper layer. And actually we have we are continuing work. We are trying to study time domain response, our roof the transmission. So it's we try to study post the model effect on this directory windows first month. Yeah. So actually originally planned to attend PPC in Denver in person. But right now he's going to virtual.

Yeah. Well, let me know when you're stateside. Okay. regard to me.

Yeah. If you have any question, please. Contact me. I am available. Mostly.

Yeah. I just need your email or something. Yeah. No problem. Great. Thanks.

Thank you.

All right. I think that may be a great place to end it on such a high note. Thank you. Thank you for your words, Alex, as well maintain what a great presentation. And it is always good to see you. And actually I haven't actually seen you present before. So very nice. One last thing, if you want to try out our products, I'm going to say one more time, go to T x corp.com. And you can get a free 30 day evaluation. anything you've seen here. We will be back tomorrow morning at 830. And tomorrow we are starting out with a presentation by Jared Letty on our fluid model. In VSAN. Sorry, let me say it the correct way in modeling neutral incharge fluids and VSAN. Thanks so much, everyone. We will see you tomorrow.

Okay, thank you, Connie, organizing this. Oh, absolutely.

Thanks me. Hey, Mike.

Thank you.