 So, as we talk about this and our training in the imaging market, it's really interesting. You can see that, uh, a lot of our sales over the past several years have been in that large blue section, which is the EMC, uh, testing market, but then over here on the bottom left of our pie chart, you see that.

10 percent of our sales have been in the imaging market. And actually, if you take part of the orange slice, which is other categories, some of that has really been more imaging applications as well. So more than 10 percent of our sales have been in this imaging market space. And when we think of the imaging market, we are talking about three different submarkets.

The one is. probably the most known, well known, and that's MRI, magnetic resonance imaging. But then there's also MPI, magnetic particle imaging. And then we also sell into the NMR, nuclear magnetic resonance space. And so, we want to talk about those three different submarkets and discuss each of those. So, to begin with, we're going to start with the MRI market.

And when we think about that, we're actually talking about a small-bore MRI. That's the space that we are in, and we want to look at a little bit further. So small bore MRI, a lot of times you say MRI, magnetic resonance imaging, and people think a lot of things, but maybe what you don't know is that globally, this market is forecasted globally.

Towards some very healthy growth of 5%, and we're in the midst of that from 2023 to 2028. MRI systems have been a significant market for us and globally it's expected to be a 6.6-billion-dollar market. That's significant. And we're excited about that growth and how our systems can play a part in that. So, a lot of people think of hospital or human MRI when they hear the word MRI.

That large system that's in maybe the basement of a hospital, at least in the Americas. Uh, that's where they place those. And it's what's known as large or wide bore magnetic resonance imaging. And so, when it comes to MRI, our products are working in the MRI market a little differently. And we want to talk about that more.

So, where we play in the market is actually in the small bore or low field MRI space. On the left, you can see a standing MRI system. It's a small-bore system that's used by veterinarians to Uh, treat the legs of horses. This specific system is placed at racetracks around the world. There's been many, many of these systems in racetracks or in horse hospitals for competitive horses.

Those are obviously a very big investment. Some are worth millions of dollars. Each horse. And so they want to protect their investment and the way of treating a horse's legs. So they don't go lame, which would be devastating to the horse and also the owners. They want to treat that early on. And this MRI system allows them to treat that in a way.

That is much more humane to the horse. I have friends who are veterinarians, and they've talked about when they were in veterinarian school, the way they would, uh, image a horse's leg was to tranquilize the horse. And it would take maybe six to eight people to do this as the horse lays down, they have to assist the horse.

So, it's not injured. Then they would try to slide the horse's leg into a system. And it was very difficult. Not very good results from an imaging perspective. And so this standing system is revolutionary in the veterinarian world. On the far-right side, we see more of a portable MRI system being used in a hospital.

Again, it's not the large bore. Large human system where the entire human body is placed in the MRI system instead these kinds of developments came about because of COVID and many times people from COVID would have clots on the brain and so they needed something small that would just scan just the head of that person and, uh, scanning just a part of a body, right?

And so that's very different from the large bore systems. So, these are some of the applications we see in the case of this standing MRI system. It's being used in a harsh environment. It's a fixed magnet system, and it doesn't have sync capability in the console, which is something that's comp, a sync capability is required in the console for the large bore MRI systems.

And so then we also see that in the hospital portable systems, uh, these have very different requirements. You think of the, the large bore MRI systems for the entire human body, and you have to keep credit cards and metal objects 15 to 20 feet away from the system. Well, that's because they're working at, uh, many, like sometimes, uh, one and a half to three Tesla.

As far as the strength of their gradient coil, well, a one and a half Tesla system would have a requirement of 900 volts and 700 amps to power that system. And we don't have products that will do that. And so low field systems have one, one thousandth the gradient strength of those normal MRI systems.

So instead of one and a half to three Tesla, we're talking 0. 1 Tesla and even lower gradient strength. That's why we call that a low field MRI application. So, what do we see? Typically, the applications of these kinds of systems are often low volume, and they're the focus of research, but any one of these development projects can actually lead to a manufacturing relationship, and that's something that's significant to follow.

Right now, we're working with a research group, because they're doing a research focused project, and they're trying to develop a portable MRI system that could be taken into developing nations and developing areas of the world. That’s because far more than half of the world's population does not have access to MRI imaging services.

And so they're trying to create units that need to be small enough to fit into a plane. A van or a small truck, uh, so they can get that to those people. And so, uh, obviously it needs to be mobile and durable, uh, for and rugged in a way for them to be able to do that. But all this research is going on, we have one research group that's using some of our products in their research, but their intention is to move to a manufacturing, um, status where they would be manufacturing more than a hundred units a year.

That's their forecast if their research will pan out. And so obviously there's, it's, it can be a big investment to, to make this research work, but it can really pay off on the manufacturing end. And there's a lot of effort now in these smaller systems. And we get contacted repeatedly over the past 12 months.

I think we've had eight to nine conversations with researchers around the world that are each in different research projects, trying to get to that place. with their design. So, it's significant. We have then characteristics of this, which are, um, reflect the small and low field MRI space. It's low field.

So it's in that 25 to 50 kilohertz range. That's what they operate in, which is entirely our sweet spot for us. They work with 100 percent controlled current rather than controlled voltage. They're always looking for low noise. They need to have as low noise as possible. And in the small bore, low field MRI space, they need the power supplies to, to be flexible in their use because they're being used out in the field or in mobile settings many times.

So, you think about that and then the competitive space who can provide a solution like that. Well, there is actually only one competitor that we encounter. in the low field, uh, small bore MRI space, and that's PCI. They have a switch mode product, and that would be represented in the graph by the blue line.

The gray line would be our linear amplifiers, and the orange line then would be our switch mode amplifiers. PCI and AE Techron are the two main players in this space. So you have our linears and switch mode amps. You can see how our switch mode. run from 200 to 400 volts peak and then can provide 200 amps of current and PCI has products in more that 100-volt 25-amp space.

So, when we think about it, when it comes to the competition, PCI is less expensive. They only have a switch mode amplifier. Um, and because of that, that's why it's less expensive than a linear amplifier, but their amplifiers are larger. They're going to be bigger. And they're also going to be noisy and then on top of that, they're not going to be very rugged.

So, it limits them to lab use only, which if you're doing your research in a lab, that's fine. But if you have a mobile unit that you're going to be trying to load in the back of a truck, this is where you think about it from a sales perspective. You need to Talk with that researcher and maybe they say because of their budget and because of dollars or, uh, their, their, their spending, they're not able to, they say, well, we want to do this for the research.

So, we're using PCI, but that's not what we're going to use. And when we finally produce this product, you'd have to challenge them and say, well, if you're doing the research, wouldn't you want to know what product you're going to be using in the manufacturing side of this so that then your research can prove out that that's actually feasible.

It's a way to push back on them a little bit in obviously friendly ways, but, um, to challenge that thinking to say it really is wise from early on in the research to be using the product that you want to have out in the field and PCI is not going to make it out in the field for a lot of these applications.

So, the tech run solutions that we are really successful with would be our 7224 and 34 linear amplifiers. It's DC to 1 megahertz, so that frequency range is right in the sweet spot of this product. It can do up to 50 amps unless it's put into parallel, and then we can run into higher current, uh, in parallel configuration, single phase, 2U space.

And these are rugged and field ready. Uh, we'll talk more about in another imaging application how rugged the application is for our products. And how they stand up to a lot of abuse. Uh, it's just proven over and over again. So in summary, when it comes to this MRI, small-bore, low field market, the linear solution provides a lot lower noise and our linear amplifiers are the quietest in the industry.

Very compact, so it works in mobile applications, 2U in height, and there's very little competition. We only have PCI to deal with. And our rugged design becomes a huge selling point as well. Think about, for example, an MRI system being installed at a horse track. And out in a very dusty, um, not so lab friendly application.

Uh, one of our customers who, uh, is working in that veterinarian space with a veterinarian system, that was theirs that we saw, they said their system uptime worldwide is 99. 7%. Because, and they said, it's because we're using your amplifiers. Uh, they're using multiple amplifiers per system, and they said it's because of your amplifiers that we have this kind of uptime.

It's a great testimony. And so we have here an interesting interview with a friend of AE Techron and a customer of AE Techron, Matt Rosen from Harvard Medical Research.

**VIDEO INTERVIEW with Matt Rosen, Harvard**

“I'm Matt Rosen from the MGH Martino Center for Biomedical Imaging in Boston, Massachusetts. I lead the Low Field MRI and Hyperpolarized Media Lab, and I am the co-director for the Center for Machine Learning. A lot of the work we do in my lab is trying to build low-cost MRI scanners that are portable, uh, and can become ubiquitous.

And in order to do that, we operate on We've incorporated very low magnetic fields, typically around 500 times lower magnetic field than a typical, than a clinical scanner. We're very much trying to detect signals that are deep in the noise floor of our electronic instruments. The amplifiers that provide the high current sources for doing imaging and coding are also low noise.

And that's the AE Techron product and the role of the AE Techron product in my laboratory. For us, they have enough flexibility and performance that in the early days, we were not taxing, for instance, the maximum slew rate or the maximum gradient strength at all. But now in 2021, we actually are using a lot of those features that were there all along.

I think we have an interesting sort of advantage in the research community when we build our laboratory around very flexible, high-performance instruments. You know, today you might have a certain need, but people come to my lab and with all sorts of crazy ideas, you might say, okay, well, we have to write a grant.

We need to get more money to upgrade that system. And for us, we have this incredibly flexible system, uh, doing large measure to the performance of those grading amplifiers.”

We will be sharing that video with you. It's on our YouTube channel. And we'll have a link to that after the training to provide to you in case you want to share that with potential customers. So, we've looked at the submarket of MRI and now we want to talk about the sub market of MPI, magnetic particle imaging.

Magnetic particle imaging is an interesting market because it's emerging. It's not nearly as developed as MRI, and so we want to look at it yet at the same time. It still has the same kind of growth potential as the low field MRI space. Think about this. Um, it's interesting to see what they share on the far right of this report.

They talk about continuous innovation and preclinical imaging technologies. Can lead to the development of more affordable and portable systems, making them accessible to a wider range of researchers and institutions. Sound familiar? A lot of research in this space and innovation is happening and they're trying to, um, provide something smaller and more mobile, um, for the people who need this kind of technology.

So, we see a lot of growth potential. In the MPI space, um, application wise, uh, MPI offers a lot of applications as an emerging market. It's typically a low volume research, but right now there is some small scale manufacturing that's starting to happen. And it's interesting to see what. What is going on and why this technology is, is, um, moving and growing quickly.

It's because it provides 3d images at millisecond intervals and real time 3d imaging in vivo. So, it's amazing to see. I'm excited to see that because there was a time in my life, I had cancer and at the end of treatment, had a PET scan. Well, this technology is 1000 times faster than a PET scan.

And so, it's able to provide much better imaging for those who are, uh, Providing treatment. So that's exciting. The characteristics for this kind of imaging technology is again a very high duty cycle and it's in the 20 to 40 kilohertz range and they'll run this then continuously for 45 minutes.

when they use this system and this kind of technology. So MPI systems use changing magnetic fields to generate a signal from SPIO nanoparticles. Those are superparamagnetic iron oxide nanoparticles being used as tracers. So, if you can wrap your head around that, more power to you. And so, at these frequencies, and with this kind of demand, as far as that high duty cycle and continuous power driving a magnetic coil, um, linear amplifiers can become cost prohibitive.

And so the efficiency of switch mode amplifiers becomes very important. And so, the competitive space then of who is providing those kinds of power supplies for this imaging technology. Well, we are the worldwide leader in this market. And we are the only ones who have switch mode amplifiers that operate in these kinds of frequency ranges.

Uh, there's different companies that are, you know, working on their research to design us into their system. So, if you've heard anybody talking about MPI, the thing is again, that frequency range of 20 to 40 kilohertz, and they need power continuously for 45 minutes. And in the case of one company, we're going to take them from their linear solution, which had 14 rack units.

Um, and very tall rack units down to maybe three rack units and we're half the cost of the amplifiers they were using those old linear amplifiers. So, that's the kind of opportunities that are out there if you can begin to look for those companies who are doing this kind of research or product development or even beginning down the manufacturing path.

So, it's an exciting opportunity. If you know anybody who's doing MPI research, our 8504 is what many people have been using. And now we're ready with our 9305, which will be a very powerful solution in this space. 8504 provides 80 amps, 400 volts. It does require a sync cable and a preamplifier, which is in addition to the amplifier itself.

And then our 9305 provides 50 amps, three-phase at 200 volts. I'm sorry, three channels. So, you really wouldn't have any competition here. In summary, it's very much an emerging market and it's really where MRI was in the 80s. Because MRI was an emerging market at one time and has become very developed.

So, there's a lot of university research going on right now in MPI, uh, imaging. Uh, there's a couple of companies like Bruker or Magnetic Insights. They're trying to develop a product, and it wouldn't surprise me if there isn't someone in your territory MPI system as well. This would be a great opportunity to let them know you have the solution that they would need.

Suicidals. market potentials. All right, so we have one more imaging submarket, and that's the NMR, nuclear magnetic resonance submarket of imaging. Well, that's a very different kind of market. We have, uh, again, growth potential worldwide in this market as well. These are some of the companies who are known for their magnetic resonance.

nuclear magnetic resonance imaging. It's different from the other two in some ways, and yet like MRI as well. The applications where we see it being used is in the area of mining applications. One of our customers is doing just that. They're a mining company. Deep earth geological deposit scanning.

We see core sample analysis. One of our customers uses Our power supplies for a core sample scanning test system, and then we have organic chemistry as well. These are the applications of NMR imaging and the characteristics then of NMR imaging is really a one channel and MRI system. And functionally what that is, well MRI takes an X, a Y, and a Z axis and combines it so that you get a three-dimensional picture.

Well in NMR you do the similar thing but only on one axis because many times, for example, this mining company, what they're doing is looking for hydrocarbons like oil in the ground, let's say. Well, you're not trying to create a picture as in a 3D image of that. Instead, you're simply asking, is that hydrocarbon deposit there or not?

And we need to know that it's there. And at what depth. So, from a technical point of view, really, that's the only difference from MRI technology. It's a little simpler in that way. It's again, working at the 25 to 50 kilohertz frequency range. And from a competitive space, the industry covers a diverse range.

There are lab applications for NMR. And that's what some of our customers are working on. And then there's also incorporating our products into their units that then they make available for sale as well. But then there's also on the other side. Uh, this mining company in the northern Canadian wilderness has literally, at times, put a large coil of cable, very thick cable, about a half kilometer across, they just run that, that over and over again to create a coil, and then they stack some of our amplifiers on the back of a four wheel drive ATV riding through the forest trails with those tied on the back, and they get out to this location with the coil in the, In the Canadian wilderness connected to that coil and power it to see what they can find deep in the earth surface.

So that's why AE Techron does very well. We're able to function very well in the lab application and we get used there many times. But then also. rugged and portability would be our selling points as well. So different applications, but we, we do well across the board in the nuclear magnetic resonance imaging space.

And so, we have different products that are effective there. We have, when you think of our solutions, the 7224 is used. We have the 7548 being used in new magnetic resonance systems. And then also our 7796. It would be one of our linear amplifier products to use, depending on their power requirements and how mobile this application might need to be.

So, in summary on this with NMR, it's an emerging market and again, no known competition and you're looking for research and development, but it's important to stay with that long enough to follow it through the development of a manufacturing relationship. You can see some commonalities across these different submarkets.

**Q&A**

Leander Rabe: It's been good to talk about these. So, I just want to open this up and throw it out to you guys to learn what you're seeing, what you need to, discuss from a Q& A perspective. What are some of those things, questions that you have? I haven’t seen anything in the chat just yet, but Larry's joined us, and he's happy to, uh, discuss these things with you.

Larry Shank: So, a couple of key things. Leander touched on how MPI is emerging right now, so you'll find it in universities. Is where you would go to look for that in the imaging in universities that have imaging sciences. And at this point, as far as we know, all the leaders in the MPI research are using our products.

So that would be a real, a really easy one to do a quick check on similarly with NMR. We have, Leander mentioned, a couple of manufacturers, I'm not sure we've got NDA, or who we have NDA signed with, but, uh, we're all already being used in factory equipment. So, any university that's trying to build their own system would be a real logical choice.

Larry, now with the release of our 9305 and its application on the MRI side of this, what, what do you see coming with that? What would be the opportunities there? We made a conscious choice. We've been approached by several people that are wanting to get into the MRI space. And in high volume and that's really not a good fit for us where they want to order 100 at a time and they want to pay like 10 cents, you know, 10 cents, 10 cents on the dollar for it.

So, where we fit in this space is really the university. Systems we like, for example, Oxford creates has a system that they sell to universities where a person can, you know, a student can learn how to do MRI. That's one of our, our customers is an example, um, where you, you will find people interested in our products if you have somebody that can, like, wind their own coil, and they're trying to build their own system from the ground up.

We're also compatible with Tecmag consoles. Is another would be another thing to look for if you can explain just a tiny bit more about Tecmag console. Some people may not be familiar with the significance of that. Yeah. Yeah. So, in the MRI system, there's kind of 3 big parts. There's the coil that actually generates the magnetic field.

There are the gradient amplifiers, which powers the coil, and then there's the console, which is what generates the images. Generates the pulses and then converts the information, uh, into images that are, are useful. And Tecmag and RRI are another place.

Yeah, they're a coil. So you'll see, you'll see TechMag, you'll see Doty Scientific. They specialize, Doty specializes in small animal coils and TechMag and the consoles. And then, uh, in, we are often included in those kinds of systems as the gradient. Feel free to fire away with your questions. This is your opportunity.

Yeah, we have seen a lot of universities in India, they buy the NMR system, they buy the complete NMR system. What I'm trying to say is that, like for example, Jio, Jio is the big manufacturer of NMR system, they sell the complete package including their own amplifiers. So, I mean, uh, I want to understand how do we find an opportunity wherein we can fit in only for the amplifier part, not the complete part.

Yeah, so there's two levels. It's, um, if the university's prospect for geo or for, um, Oxford, they don't really have the technology themselves. They're just going to teach the basic concept, um, like at Harvard, uh, Matt Rosen is a great example. Maybe they have only that label there? Well, where I was headed is Matt Rosen actually is a thought leader in low, low field MRI.

So a normal MRI system will have a magnetic field of 1. 5 Tesla to maybe 7 or 8 Tesla, depending on, uh, whether you're high field or open core. Where Matt works is in the 100 millitesla range, a conference at NIST in Boulder, Colorado, that we attended recently, and I got a chance to interact with some people.

And like, one of the gentlemen that I was, I spoke to there was developing something that looked a little bit like a electric pencil sharpener, and the hole in it was just big enough to get your finger into. And they were using that, they were developing that coil system for doing So, MRIs of the first tenth of an inch of your finger depth, and they were looking at, uh, the health of your, the veins and arteries in your finger, and from that deducing if you were pre diabetic.

So, somebody doing that kind of work, That's developing those kinds of coils. There was another person who presented their, uh, I learned, I learned a lot that weekend. Um, or that week, uh, tomatoes are all harvested roughly the same time and they're squished and they go into two barrels and it's, and they're stored so we can make ketchup year round.

Well, one of the problems with that is some, some barrels go bad. And so another person had created a coil that was, it looked like a hockey puck that they could stick on the outside of, a 50 gallon drum. And it did an MRI image through the steel and looked at the first couple of tenths of an inch inside the barrel.

And if it saw water there, it knew that that barrel had spoiled, and they didn't need to open or deal with it. They just disposed of it. And so, they could rapidly go right down the, so it's people that are developing those kinds of technologies. Hyperfine is another company that we worked with.

They, they currently went off and have done their own amplifier, but we, they bought 150, 000 worth of product from us to start with. Hyperfine, they're the ones that have a portable MRI system that, uh, like it was like with COVID, and people were on respirators, and they wanted to see if there had been any brain damage.

They could roll, it was a little cart, and it would literally roll into the hospital room and slide over the guy's head, and they could do an MRI. And, uh, another spinoff from that, uh, was for doing MRIs on the battlefield because you're looking for concussions from IEDs. So, people developing that kind of technology, doing that kind of research, that's where you'd want to, that's, those would be the, where the prospects, those would be where your, your customers would be.

It wouldn't be we're just going to offer an MRI course and we're going to, I've checked the box and I got it approved. I'm going to order a pre-done system. So, sorry for being wordy

Leander: There's a lot of really exciting things going on in that area right now. Speaking of research and technologies, and I think you heard Larry say it's developing new technologies.

We had, I believe they were out of Switzerland. It might have been a research project there somewhere in Europe, where they wanted to inject nanobots into test rats and control the nanobots with a magnetic field to deliver a drug to a part of that rat in some part of its body. But at the same time, they wanted to use MPI imaging to be able to guide the nanobots. They needed to scan the body of the rat.

All at the same time, simultaneously, so very complex. To power that, no one's doing that. So that, that's another research application and they were reaching out because of that. So it's things like that. We will be, uh, sending this recording out to everyone. So, thank you for being here.

We will make this training available. And so, you can also share with any of your, uh, teammates as well. We'll have a transcript of this and a link to the Matt Rosen interview. And, uh, if you wish to share that as well with anyone out in the field, and we're always available for questions and many times it might mean talking with our application support when you do find a research project to see if it's feasible and which solutions might work best.

We do have those conversations in this area all the time. So, it's good to see everyone. Thank you for your time.