Just a Statistical Approach to Glass Evidence Episode Transcript

Introduction [00:00:05] Now that this recording, RTI International Center for Forensic Science presents just science.

Voice over [00:00:23] Welcome to Just Science, a podcast for justice professionals and anyone interested in learning more about forensic science, innovative technology, current research and actionable strategies to improve the criminal justice system. Just science interviews Dr. Jose Almirall, professor of chemistry and biochemistry at Florida International University, about a statistical approach for the interpretation of glass evidence. One criticism levied against trace evidence examinations is that the interpretation can sometimes be too subjective. Dr. Almirall and his team at NYU are trying to fix that. They have been working on an implementation package, including instrument specification procedures and validation assistance that can be transferred to any forensic laboratory to help standardize trace evidence evaluation. Listen along as he discusses the implementation package, the value of trace evidence and the analysis of glass. In this episode of Just Science, this season is funded by the National Institute of Justice's Forensic Technology Center of Excellence. Here is your host, Dr. Megan Grabenauer.

Megan Grebanauer [00:01:37] Hello and welcome to Just Science, I'm your host, Dr. Megan Grabenauer with the Forensic Technology Center of Excellence, a program of the National Institute of Justice. Today, our guest is Dr. Jose Almirall, a professor in the Department of Chemistry and Biochemistry at Florida International University and director of the National Science Foundation funded Center for Advanced Research in Forensic Science. Jose, welcome to the podcast.

Jose Almirall [00:02:01] Good afternoon, Megan. Thank you for having me.

Megan Grebanauer [00:02:04] To get us started, I was reading through your biography and noticed something pretty interesting. It's stated that you once served as a judge of a Department of Homeland Security challenge, detect opioids in parcels at mail facilities. Can you just talk a little bit about how you got involved with that?

Jose Almirall [00:02:19] That was a very interesting experience for me. It took place over the last two years. It started in 2018 and it was completed in 2019. It was organized by the Department of Homeland Security was an open challenge called the Opioid Detection Challenge. But it was really a collaborative effort that involved the Science and Technology Directorate in the United States, the U.S. Customs and Border Protection, U.S. Postal Inspection Service, the ONDCP. And the aim was to try to intercept the parcel mail, international mail because of, you know, we have an ongoing opioid crisis and epidemic. 50 thousand Americans died last year because of opioid abuse. And what they realized is that relatively small packages containing just a few grams of illicit drugs are getting through. So they want to find a way to intercept these these mail packages. So I was just invited as an academic and forensic scientist with experience and drug analysis, drug detection to participate. So I really enjoyed that experience.

Megan Grebanauer [00:03:38] Being a challenge, was there a prize involved or did the department of Homeland Security, adopt any of the methods that were proposed?

Jose Almirall [00:03:45] Yes. Yes, there was. First they had, I think, over 100 proposals. There was a group of judges and we narrowed it down to eight finalists who were then provided some funds, hundred thousand dollars each to develop prototypes and demonstrate how their solution work over the period of, say, 14 weeks or so, ending with a life challenge that took place in a government facility. And so the government had ground truth samples, many of them. And each of the proposed, you know, eight finalists went through their solution and a government documented true positive, false positive to negative false and negative rates. And that data was provided to the judges. And that's just the performance. But other metrics were involved measuring how well their solutions actually perform.

Megan Grebanauer [00:04:37] Well, that seems like a really neat mechanism for taking care of an academic idea and methodology and sort of jumping the line to get it into actual practice.

Jose Almirall [00:04:46] Yes, it was. So there was a final award. I think it was half a million dollars awarded to a company that uses 3-D X-ray computed tomography. And, you know, the initial group of those proposals involved all kinds of detection systems from trace detectors. So the aim was to detect opioids, fentanyl in particular. So trace detectors really couldn't compete with the imaging solutions that were put forward. And in terms of speed, in terms of also accuracy.

Megan Grebanauer [00:05:18] Your current role is a professor at NYU. And just for students that may be listening, could you please give us an overview of what the forensic educational opportunities are at NYU?

Jose Almirall [00:05:30] So Florida International University has a chemistry and biochemistry program, and that's where the forensic science forensic chemistry program was started. Actually, we've had an undergraduate degree in criminalistics for forensic chemistry since the late 70s. At FIU. When the Miami-Dade Police Department approached the chemistry department to help develop and educate people who would be interested to work in the police department as forensic chemists. And they can actually you know, I was an undergraduate at I you before I went on to grad school at University Miami and Strathclyde University in Glasgow. So my first job was actually at the Miami-Dade Police Department. So I was recruited to come from the police department over to you you back in 1998. And that's when we started both the International Forensic Research Institute and a master of Science and Forensic Science program. In 2004, we became accredited by FeePak and I think we've now been through four cycles of. Retardation since then we started in 2005 a Phd in forensic chemistry or track in forensic chemistry within our Phd in chemistry. And I think we have one of the largest forensic chemistry Phd programs in the country right now. There are others. But we have something like almost 40 Phd students doing forensic chemistry out of a total of 120 Phd chemistry students in our department. But if you also has a interdisciplinary master of science and forensic science, which includes biology as well. So about half our students are doing forensic biology in the master's program and half are doing forensic chemistry. In addition, we have this new program will so new anymore. It's been around for six or seven years now, a professional science master's in forensic science. So 100 percent online targeting students who already have an undergraduate degree in science. They're already working in a forensic science laboratory. And they want to improve their educational background by getting a master's degree because it's a professional science master. There's additional courses in management and other areas that would be of interest to somebody who is already a working professional.

Megan Grebanauer [00:07:54] That's a nice breadth of topics there, because I feel like in the sciences in particular, a lot of the training in education is rooted in the science. But then a lot of the career options, especially as you get to master's and peach tea level, there's a large management component to the careers that are available to you. And unfortunately, a lot of our science students graduate their Phds are unprepared for the managerial and product management aspects that actual career in the real world is going to require.

Jose Almirall [00:08:23] And that's exactly right. And when we first designed this program, I was director of the Present Research Institute. That's how you every when we first put this program together, what we would do is we'd have a internal advisory board and an external advisory board. And the external board is comprised of lab directors who basically came to us and said, you know, this is this what we need in terms of education for our people who want to move up in the forensic laboratory.

Megan Grebanauer [00:08:52] So in addition to your academic responsibilities as a professor at FIU, you're also very active in the NIST funded organization of Scientific Area Committees, which we like to call OSAC. I believe you're currently serving as the chair of the Chemistry Scientific Area Committee, is that right?

Jose Almirall [00:09:12] That's correct.

Megan Grebanauer [00:09:13] So in addition to OSAC, ASTM is another scientific standards organization that we we hear a lot about. Would you mind going over how the OSAC and ASTM relate to each other and work with each other?

Jose Almirall [00:09:27] American Society for Testing and Materials, ASTM International is a Standards Development Organization with an aim to develop consensus based industry standards in all areas. So when you are building materials and industry that you want to be standardize, well, you would follow these ASTM standards. In chemistry, we have ASTM standards that are aimed, for example, calculating limits of detection, how to organize a ruggedness test. So there's all kinds of standards and different disciplines. And forensic science has a committee called it e30 that is devoted to the development of documentary standards for forensic science practice. And that's been around for a long time. And so there are some groups within ASTM that have been, you know, publishing standards in the areas of, say, fire debris analysis, document examination, drug analysis. The Forensic Science e30 Committee is composed of about 400 scientists and they involve industry, private industry. They involve government scientists. They involve academics. And so it is their job to come up with standards that address the needs and forensic science practice.

Jose Almirall [00:10:48] The OSAC has takes the work that's been developed and approved by ASTM and puts it through a an additional process and that's an OSAC approval. So there is a registry that is maintained by OSAC at NIST of those standards that have met a minimum criteria. Now, OSAC is composed of a broader, wider group of people and is different than the ASTM e30 committees. So you may have attorneys. So you have a legal perspective now. You will have quality assurance people. You will have statisticians weighing in on these standards. So they'll have a different set. View of these standards that are coming out of the SDOs and saying, yes, these are worthy to be published on the registry. And so far as. Just last month we have 25 standards and ASTM is only one standards development organization that we're working with. We also work with the American Standards Board. They assess the ASB of the American Academy of Forensic Sciences. But we're looking forward to work with other SDOs in the future.

Megan Grebanauer [00:12:08] All right. Well, thank you very much for that background information and the standards and accrediting bodies. But the main reason we're talking here today is that you've recently presented results from an energy funded grant at the American Academy of Forensic Sciences annual meeting, a presentation entitled Validation of Novel Statistical Approaches for the Interpretation of trace evidence, facilitating the adoption of Glass Evidence Analysis and forensics laboratories was part of the NIJ Forensic Science R&D symposium. So before we get into the details, are there other researchers on this project that you'd like to acknowledge?

Jose Almirall [00:12:43] Yes, I'd like to acknowledge. Well, first of all, my group, my team members at FIU, Dr.Agu ofmine, Manna, who is a post-doc, who's been developing the code we are making available that I'll talk about in just a few minutes. Dr. Tricia Hoffman, who's a former student of mine who worked on this project, and Dr. Ruth Ekwurzel, who's currently post-doc at NIST. I also want to acknowledge Dr. Peter Weiss at the BKA in Germany, who has been a very important collaborator, Dr. James Coran, who's a professors of statistics at the University of Auckland, and Professor Daniel Ramos, who is an electrical engineer who has been working very closely with us on developing these like integrational calculation calibration codes.

Megan Grebanauer [00:13:34] As I understand it, your presentation really covered two very important topics. So one being the technical aspects of developing and validated methods for analyzing trace glass evidence and the other kind of separate being approaches to accelerate the adoption of these new methods in standardizing the methods across laboratories. So let's start with the analytical side first and then get into the adoption of standardization a little bit later. I really enjoyed your presentation. That beginning included a compelling case study of a hit and run to use to demonstrate how the glass analysis can contribute to a forensic investigation. Would you mind giving listeners a brief overview of that case study?

Jose Almirall [00:14:14] The case study is unfortunately one of those things that happen very commonly, not only in South Florida where where this particular case occurred, but all over the United States and even the world. It was a hit and run fatality. This happened in Miami Beach back in 2005, and it was after I had left the police department. But the colleagues at the Miami-Dade police had known that we were working on developing tools for analysis of glass using laser ablation ICPMS. So they worked with us by sending us some of the evidence and we analyzed it for them and eventually wrote a report and sent it out to the prosecutor and defense. And I was deposed by both sides. And just before the trial was to take place, the defendant pled guilty and admitted that he was driving. What what happened was there was a woman who was coming home after buying some groceries and she was struck on the street by a car that was going very fast. And he was gone so fast that she actually expired right there at the scene. There was eyewitnesses that saw the vehicle take off. They identified the vehicle as black BMW. And so the police went around the block away or so they found an abandoned black BMW with a huge amount of damage to the windshield. And the windshield was broken. And when we see that, we know that there is opportunity for transfer from the glass of the windshield to any of the occupants inside of the car. So the police, Miami Beach had actually taken some training from us about the value of blast transfers in situations like this. So they knew what to look for. And once you identify the owner of the car, they went to his house and they ask him some questions. And he denied driving the car. He says, yes, that's my car, but I wasn't driving. But the police went ahead and got a search warrant. They searched his house and they found some garments with a lot of glass on them. And they also searched his bathroom. They found large pieces of glass shards in the sink on the floor. So they collected all that evidence. Brought it to us and then it was our job to see if there is a way to associate this glass evidence that was found at the suspect's house. Now with windshield glass from his vehicle.

Megan Grebanauer [00:16:49] And so you mentioned laser ablation, ICPMS is a technology you use in your analysis. Can you go over what exactly that means and how that technology works?

Jose Almirall [00:17:01] Laser ablation ablation is removable, so it's the use of a very high energy laser beam that is very small in diameter. It's about 50 microns in diameter, but it's high energy and it's focused on the surface of a sample. Any any solid sample and laser ablation has been around for many, many years, decades as a tool for sampling solids and introducing the solid sample into another instrument. In this case, it's an inductively couple plasma mass spectrometer. So we couple the sampling to laser ablation to the detection tool ICPMS. And so what we do is we focus the laser onto the glass surface that starts to remove small amounts. I mean, we're talking less than a microgram total of the glass is removed from the surface of the sample and into the bulk only about 100 microns deep. And that material gets them introduced into an ICPMS where the sub micron sized particles are then ionize atomize and you're able to then detect them with a mass spectrometer and select them by mass. And the signal is proportional to the concentration. So we're able to actually calibrate the signal and convert the counts per second that we get from the master transmitter into a concentration. So convert intensity into a concentration using calibration standards. And so this technique was developed thanks to an NIJ grant and also through a collaboration with a European group called Night Crime, which I mentioned in my presentation and published I think it was back in 2005 in the Journal of Forensic Sciences. And then we did some subsequent work in Two Thousand Six and 2007, which then became the basis for the ASTM method that is now in OSAC approved registry standard for key determination of trace element composition in glass using laser ablation ICPMS.

Megan Grebanauer [00:19:23] OK. So using the laser ablation, ICPMS then, you're able to tell the relative proportions of the different elements that make up a sample of glass and then you compare that to the relative proportions of say, a suspect piece of glass or a standard of glass to do some comparison. Is that right?

Jose Almirall [00:19:44] That's right. We actually use this method to do quantitative analysis. So we actually report at the end of this method. The concentration of the trace elements and we have a list of 17 or 18 elements that we know are going to provide good discrimination between different glass sources. So at the beginning of this research, what we did was, well, you know, what's the element menu? It's not going to be the entire periodic table. First of all, we can't measure the entire periodic table.

Jose Almirall [00:20:18] There are some things that ICPMS doesn't measure that well. But we started off with a list of, say, 45 different elements that we could measure in the last. But we we soon found out that some of those are very highly correlated. So there wasn't a need to measure one if you measure to other. And then the other thing we found out is that some of them are not very variable. So it's not worth measuring something that doesn't change from one windshield to another. So we focused on these 17 elements that we know we can measure very well. Number one, we get very good analytical figures of merit and we can also discriminate with these elements. So that list is what we target in the ASTM method.

Megan Grebanauer [00:21:03] Are there other properties of the glass aside from the elemental composition that are used for comparing two samples?

Jose Almirall [00:21:11] Yes, there are. Refractive index is an optical property of glass that is often measured in forensic laboratories to compare glass samples. So there's a very good technique, the measurements of refractive index. There's there's also a standard and ASTM standards that we were also involved with drafting and and championing through the ASTM process. And now that standard E1967 is going through the OSAC approval process. So what we do is we measure refractive index of very small shards using safe contrast microscopy and we compare the refractive index value. We can do this in an automated fashion. So the error, the uncertainty with the measurements of refractive index is small and known. And that's the key. And the reason I start in my presentation in Anaheim with the measurement is that if you don't take good measurements, then the rest of whatever else you do is for naught. So you must have very good measurement capability and laser ablation ICPMS and refractive index by the standard method produces very good data. Not only that, ASTM requires that you report not only what you expect to see in terms of concentrations, but what is the uncertainty associated with each of each of these measurements in order to do that we actually had to organize a series of interim laboratory trials for the ASTM method for laser ablation ICPMS. That is in my laboratory. I can come up with what the uncertainty is when I do it or when my students do it. But how does the community at large perform when we send out ground truth blind samples to the community and and and we we get the results back. So that's what's reported in the ASTM. We report what is the uncertainty that's found in a single laboratory and then what's the uncertainty or the repeatability and reproducibility that is found when other laboratories are conducting the same analysis on the same samples?

Megan Grebanauer [00:23:29] So you mentioned something there that I would suspect folks who aren't familiar with laboratory comparisons may not may not understand right away as you sent out ground truth blind samples. Can you talk a little bit more about what that means and why it's important in in a laboratory comparison study?

Jose Almirall [00:23:47] So GroundTruth means samples that we know what is the answer to the question we're asking. So in the case of glass, we have reference materials, glass that has been certified by NIST or by others. And there is data that has been generated previously with a concentration for the elements that we're interested in, as well as the uncertainty associated with those concentrations. So you can by these standards. And so we would send these reference materials where the ground truth is known out to the forensic laboratories who are conducting these analysis. And then we would see what is the bias that that is generated, what's the bias associated with their measurements? And what we find at the very beginning, when we first started trials, the performance wasn't so good. But then as we got together and we discussed, you know, and we shared information about how to do these analysis better, its performance improved. And by the end of the graph, this was an energy sponsored grant to develop these internal laboratory studies. And I talk about it in my presentation. The results are really good. So once you standardize the method and everybody's on the same page using the same procedures, we can predict what kind of results the community is going to get if everybody follows that procedure,.

Megan Grebanauer [00:25:12] You've got really two stages in your analysis. Then you've got one the measurement themselves of a particular sample, those characteristics and properties of that sample you're looking at. Then the next stage you talk about is this what you're asked to do a lot of cases and make a determination of you've got two samples.

Can you tell if they came from the same source in your presentation? You talked a lot about a likelihood ratio. Can you describe what that is and in how that applies to this secondary portion of the analysis?

Jose Almirall [00:25:44] Yes, the ASTM e29 27 standard, which is what we're talking about. The laser ablation ICPMS measurement is very good at describing all the steps you need to take. You know how to sample how many samples and conduct the analysis. And at the end you get some quantitative analysis values. The ASTM method also has a comparison phase or stage where the result or the conclusion is either these samples are excluded or we fail to exclude them. So those are the only two opinions one can make after conducting this analysis. So that to us is a shortcoming of the ASTM e29 27 because in the end, what the court wants to know. For example, in this hit run cases, how likely is it that this glass that was found on the suspect or in this house came from this windshield? And what we can do right now, the opinion that is that is generated at the end of this ASTM method is we can exclude it. If we can definitely say, yep, it did not come from that windshield or we failed to exclude that it came from that windshield. That means that the possibility that it originated from the from that windshield cannot be eliminated. That's not exactly what the court wants to know. So our next step and we had a grant that was subsequent to the development of the analytical tools by NIJ to explore the possibility of using other methods for interpretation of glass and interpretation depends on many things. Number one, what kind of instrumental method or analytical method you're using? We know that laser ablation ICPMS is very sensitive. We know what the analytical figures of merit are not only in our hands, but out in the community. The interpretation also includes, well, you know, how many fragments did you get? How many different sources in a windshield of a single windshield? Or do you have multiple sources of glass where the glass was recovered from? How common or uncommon is the glass? That's a very important aspect of this. So if every windshield had the exact same composition by those 17 elements that we measure, then this evidence is really useless. Even if we go through the ASTM method and we say, you know, we failed to exclude. But then the next thing we say is, well, every single windshield has the same composition. That's not the case. Every windshield that we find by elemental analysis, unless it was manufactured in the same plant or on the same time, we see differences and there are many groups around the world that have found the same thing. So there are groups in Australia, New Zealand, Europe, here in the US, several groups over decades have done what we called discrimination studies and association studies, where we get very, very high discrimination per blast that originated from different sources and very, very high association for those glass samples that originated from the same source. So knowing that we feel well, what can we do to improve the opinion, the interpretation of glass beyond saying exclusion or fail to exclude? And the solution we came up with was using a lucky ratio estimation or calculation for source.

Megan Grebanauer [00:29:14] What is a likelihood ratio? Looks like that. So that's a numerical value?

Jose Almirall [00:29:18] That's right. Likelihood ratio is really a ratio of two competing propositions. So we have a numerator and a denominator industry show. The numerator is the probability of a match when the question sample from the scene is the same as the windshield, for example, in this case. So what is the probability is that these are the same and that we can do with the laser ablation ICPMS. So if we fail to exclude that, we would have you know, how close is this match that's in the numerator? And then into the denominator is that second proposition of how likely is this questioned item to come from a different source. So now we are going one step further. We are taking into account the probability that this glass is found on the suspect could have come from another source other than the windshield. And in order to know what that number is, well, you need a survey of the population of windshield's that we have. And the best service that we have is something like almost a thousand different windshield's. And part of the graph that was awarded to us from an NIJ was to improve on the sizes of these databases. And we decided to focus on windshield and automobile windows in particular, because many of the cases that came across our desk when I was working at the police department and what I hear from my colleagues are hit and run accidents.

Megan Grebanauer [00:30:49] So are you going out and sampling glass from windshields of cars on the street? I mean, imagine that's kind of difficult to do if it's still a part of the car. How do you manage to get your sample?

Jose Almirall [00:31:01] Oh, we we've come up with a solution to that. There a salvage yard in Virginia that purchases all of the vehicles that have been crashed by the Highway Safety Administration. They crashed vehicles for safety reasons. And these vehicles then get transported to the salvage yard, a private sabater, and they have thousands of vehicles and there they're new. So we know that these windshields are original equipment and most of them, all of them have damaged windshields. So we go and we collect glass from the windshields. In the salvage yard, and we've we've done now, I think, three trips over the last 10 years or so to collect a targeted number of vehicles that we know representative and kind of mirror the vehicles that are out in circulation in the United States. Granted, it's a snapshot in time and we've done three groups of sampling and it is incomplete and imperfect, but it does mirror what is being manufactured. So we have samples from, you know, Japanese cars, European cars, cars that are made in the US and those that are likely to be out on the road. And so we have a good idea of the variation in elemental composition in windshields from many, many different manufacturers.

Megan Grebanauer [00:32:23] So your database, you said, has about a thousand different windshield samples in it at this point. Is that something you're continuing to expand? You have plans to continue sampling or is that going to be a static database?

Jose Almirall [00:32:34] We start off with about 400 samples and we received the grant from NIJ in two thousand and eighteen to expand that list from four hundred to a thousand. So we've completed the collection of the samples and the sorting of the samples, and we've begun to do the analysis of the samples. So at the end of this grant, in two thousand twenty, at the end of this year, we should have completed all of the analysis and populated the database, which, by the way, we will make available to anyone who wants to use it for conducting any kind of statistical analysis or data interpretation any other way than the approach that we're taking.

Megan Grebanauer [00:33:12] So the approach that you're taking is that how are you doing your data analysis?

Jose Almirall [00:33:17] We have developed our codes that we are making freely available to anybody who wants to try them out. And it's a two step process. It's a likelihood ratio calculation using a procedure that was published by Aken and Lucy back in 2004. And it uses a multivariate kernel density estimation for the population of glass that's out there. So we use laser ablation ICPMS data. And because it's quantitative data, it's concentration that is reported. That is a database that can be portable. That means that we can transfer those calculations, those concentrations and combine them with, for example, the BKA in Germany wants to search our database. They can do that or vise versa. And we've actually done some of that looked at like a good ratio of calculations using a case work database from the BKA in Germany and calculated like ratios based on their background. And the reason why we want to use a casework database is because we think that that is the kind of class that is most likely to come to the attention of the police because it came to their attention as a case.

Megan Grebanauer [00:34:31] So do you foresee any future where there might be one big come the nation database that pulls from all these different sources, or are we going to always have these smaller, independently maintained databases?

Jose Almirall [00:34:46] I think that the best situation is for every laboratory in a jurisdiction to develop and maintain their own database. For example, if you're in Australia, there's only one glass manufacturer in Australia. Now, people who are buying vehicles, they buy vehicles from everywhere in the world in Australia. But if you are comparing, you know, commercial buildings, there really is only one manufacturer. So you that is a different background database than if you were in Europe and you have glass coming from everywhere else in the world and manufactured in many different plants within Europe. So I think the best solution is to maintain your own database, but also have access to other databases and do searches on other databases. What we are finding and we did a comparison and Tricia's Phd thesis was organizing this inter laboratory study where we actually sent out samples and calculated liklihood ratios with the BKA as a background database and the FIU vehicle database as the background database. And we didn't find very significant differences in terms of the actual like the ratio that's reported in the end with what may happen is that they may not really matter when we are doing reporting and we're still improving on what we currently can do right now saying exclude or failed to exclude by saying here's a likelihood ratio, it's very high and that indicates a strong support for an association. And by very high, when we're doing databases with a thousand samples in the database that we're using, we're limited in the size of the likely ratios in the order of a thousand to ten thousand, something like that.

Jose Almirall [00:36:33] And when we calculate your ratios using the BKA as a database background, we get the same thing between a thousand ten thousand when we use the FIU database, we get a likelihood ratio is between a thousand and ten thousand. What does that say to the court? Well, now we have additional information. Well, we also see and what I reported in Anaheim is that when glass samples are made in the same plant with very short time interval between manufacturing dates, the numerator in that likely ratio is not one anymore. So when you're comparing different glass samples, different panes, you will still see associations, even though they came from a different window when they're made days apart. As you get further apart in manufacturing data, that numerator decreases. And so then you go from an association. So glass is made on the same day to two weeks later. Now, you're not associating this glass anymore, but it's not exactly an exclusion. So we see this gradation. You know, it's a good match all the way down to it's not a match. And we see that in production dates as a change, which is really an interesting phenomena to observe.

Megan Grebanauer [00:37:48] So is that just the environment at the manufacturing facility, that the composition of the window slowly changing over time?

Jose Almirall [00:37:56] Yes, it's the it's the formulation. It's the raw materials change over time. You know, glass production facility is making 400 tons of glass per day. And so the raw materials that comes in may have some slight differences in the elemental composition, especially at the trace elements that we're looking at. And the other thing that's happening is that the manufacturing process itself. So the melt tanks, the tanks that are used to melt glass, they start to corrode and they start to infuse some of the elements from the bricks that compose this furnace. So we see zirconium increasing over time and we see other other elements over time changing the composition of the final product plus.

Megan Grebanauer [00:38:48] All right. Well, you mentioned that you have R code and software tools you're making freely available for calculating these liklihood ratios. Someone was interested in trying those out. How do they access those tools? Where would they find them?

Jose Almirall [00:39:01] First, the easiest way is just to contact me at my email address. Almirall@fiu.edu.

Jose Almirall [00:39:11] We have developed a very user friendly user interface using R where we would make available the user interface and all it is is you enter your laser ablation ICPMS data with one button and you enter your background database with another button or you can use ours and it just spits out the light ratio. And the reason we make this is to accelerate the adoption because these are not trivial. These computations for calculating likelihood ratios using both the multivariate kernel density estimate and the calibration procedure that we use that was developed in conjunction with Professor Ramos's group. They require quite a bit of calculation. So we publish what we're doing in the background, in the papers. But it's not necessary for the typical practicing forensic scientists to conduct these calculations themselves when they can be all done in the background. And so these user friendly user interfaces were developed and are available from us for anybody who wants to try them out without having to go through that learning curve of writing our code or learning how to do the calculations themselves. But you can still go back and see what's going on behind the scenes.

Megan Grebanauer [00:40:32] Yeah this kind of gets into the second aspect of your work, the adoption standardization of these technologies. So what is the benefit, you think, to folks adopting a same methodology for calculating likelihood ratios?

Jose Almirall [00:40:46] Well, I mean, the overall goal with any standardization process is that if you provide the same evidence to a group of people, say 10 different laboratories, that all 10 different laboratories will come up with the same result and conclusion, an opinion about that evidence. So that's the overall aim, is that given the same evidence, everyone will come up with the exact same result and report in the same way to the court. And I think that's not happening today. We have pulled the trace evidence community, for example, and the current state of the art is is using a virtual scale, but verbal scale varies depending on, you know, a lot of factors. So we want to see we can improve that and. Have everybody report the same exact opinion about any given set of evidence. And so we're working towards that by not only providing the user interface, the standards, the documentary standards, the procedures for how to calculate them and take the measurement. As I said before, everything starts with taking good measurements and we want to make sure that everybody's taking good measurements and that they know that they're taking good measurements and then providing people with the opportunity to participate in interlocutory trials. We still have some going on right now. So if anybody's listening that is interested in participating. They can also contact me and we can include you in this next round of inter-library exercises for class analysis. But also our aim is to develop a better opinion beyond what's currently available using the ASTM 29 27, which is exclude or fail to exclude by improving even on the verbal scale that is currently the state of the art.

Megan Grebanauer [00:42:36] It is notoriously difficult to get new technologies and methodologies adopted across a large swath of forensics laboratories. What do you think some of the hurdles are to getting these new technologies implemented?

Jose Almirall [00:42:51] I think that you have to have the leadership in the laboratory make the decision that they're going to invest in equipping the laboratory, training the people to conduct the analysis. Laser blayse recipe. And this is a technique that requires some background in conducting the technique. And so you need to have people trained and make sure that they're performing well. So the first step is the leadership has to make a decision in making the investment, which is not cheap. And then the second is you have to have buy in from those venture chemists. But just because you have the equipment available in your lab, the best chemists, they can decide whether or not they want to use it in any particular case. So you have to have some drivers there. You have to have the crime scene people bringing the cases. So in Miami Beach, they know that this can be valuable evidence and lead to some just prosecution of people who are guilty of hit and run accidents, for example. But in many other cases involving glass. So they they go out and collect it so that if they don't collect it out on the crime scene, it's never going to get to the laboratory and it's never going to be analyzed. So there has to be an education of those crime scene investigators that are out there and that they are aware of the value of glass evidence and other trace evidence so that they collect it and they bring it to the lab. And so there is raising awareness of the community of how valuable this could be. And the best way to demonstrate that is to have some successful cases going through the courts.

Megan Grebanauer [00:44:27] Beyond your work and then the methods for glass analysis, have you worked on any other efforts to standardize practices across laboratories?

Jose Almirall [00:44:35] Yes. Back some some years ago, we drafted a standard method for doing fire debris analysis, igniter liquid residue analysis in fire debris using solid phase micro extraction. That's a twenty twenty one fifty four. That's an ASTM method as well. It's a pretty concentration method of inaudible liquids to improve on the detection of ignorable liquids and the residues from fire debris. We've also been involved with the IAEA of the United Nations looking at food products. So one of my students actually looked at element composition in milk products. And we're also working with someone on other foods and other materials for doing not only the in organics, but also the organics and food products.

Megan Grebanauer [00:45:28] That's a pretty broad range of application. It's amazing how far chemistry can reach.

Jose Almirall [00:45:34] There is another effort that's going on too I was going to say in the security community, looking at chemical threats, nerve gas, and I belong to this group that meets every American chemical society that is interested in standardizing the practice.

Jose Almirall [00:45:53] And there are laboratories around the world to do these measurements. And it's a very, very small area of security, but that's another area of interest of mine.

Megan Grebanauer [00:46:03] If you have any other final thoughts you'd like to share with the listeners.

Jose Almirall [00:46:07] Well, I want to thank you for inviting me to join this podcast. I listen to just science all the time.

Jose Almirall [00:46:14] And I also want to say that we have started a new journal of forensic chemistry. The purpose of this journal is to address the specific concerns of the not only the researcher or the academic community, but also the practitioner community. We know how important it is to get these. Laboratory trials and validation studies published. And sometimes some analytical chemistry journals are willing to publish validation studies. But we are in forensic chemistry and my Co editor in chief Glenn Jackson from West Virginia University and I about four years ago started forensic chemistry for this purpose. And in fact, the American Society of Crime Lab, three directors as determined forensic chemistry as a preferred journal for their society. And we are looking forward to working with the practitioner community and bring the academic researchers closer to working closely with the partition community to publish these very important validation trials of validation studies and interlocutory studies so that we can promote the standardization of practice and improve forensic science practice in general.

Megan Grebanauer [00:47:25] That is a great resource. I have often appreciated the details of the validation studies that are presented in a lot of those articles that as you write in the more broadly targeted analytical chemistry journals, a lot times those aren't included, those kinds of articles or those necessary details at the bench chemist level. Well, that's all we have time for today. I'd like to thank our guests, Dr. Jose Almirall, for sitting down with just science to discuss his NIJ funded grant.

Megan Grebanauer [00:47:51] So once again, thank you Jose.

Jose Almirall [00:47:53] Thank you, Megan, for having me.

Megan Grebanauer [00:47:55] And I would also like to thank you, the listener, for tuning in today. If you enjoy today's conversation, be sure to like and follow just science on your podcast platform of choice. And for more information on today's topic and resources and the forensics field, visit forensiccoe.org. And also, please follow the Forensic Technology Center of Excellence on Facebook, Twitter and LinkedIn or sign up for our newsletter for release dates on resources. I'm Megan Grabenauer and this has been another episode of Just Science.

Voice over [00:48:28] In the next episode of the 20/20 R&D season, just science interviews Kimberly Sturk Andreaggi research scientists at the Armed Forces, Medical Examiner Systems, Armed Forces DNA Identification Laboratory about the development of entire Mito genome reference data using automated high, thorough put sequencing workflows. Opinions or points of views expressed in this podcast represent a consensus of the authors and do not necessarily represent the official position or policies of its funding.