Front cover from left, synthetic cannabis, cannabis heads

Back cover from left, MDMA pills, N-ethylpentylone (an ecstasy-type substance)
ESR (THE INSTITUTE OF ENVIRONMENTAL SCIENCE AND RESEARCH) IS NEW ZEALAND’S CROWN RESEARCH INSTITUTE SPECIALISING IN SCIENCE RELATING TO PEOPLE AND COMMUNITIES.

IT’S OUR SCIENCE THAT HELPS TO SAFEGUARD PEOPLE’S HEALTH, PROVIDES EXPERT FORENSIC ANALYSIS TO THE JUSTICE SYSTEM, PROTECTS OUR FOOD-BASED ECONOMY, AND IMPROVES THE HEALTH OF OUR WATER AND NATURAL ENVIRONMENT.
ACCOLADES FOR AuramerBio

A Wellington-based biotech company developing new and faster ways of testing for recreational drugs has won accolades at this year’s KiwiNet Research Commercialisation Awards.

AuramerBio Limited is developing handheld devices to detect illicit substances that can be used anywhere from the roadside to an emergency room.

Co-founder and CEO, Dr Shalen Kumar, was recognised as an upcoming entrepreneurial researcher and was presented with the Breakthrough Innovator Award.

ESR is a shareholder and collaborator with AuramerBio after becoming interested in aptamer technology while collaborating with Victoria University.

“We are really pleased to be supporting a New Zealand biotech start-up with locally developed science that can be applied to a broad range of work undertaken by our business,” says ESR’s General Manager of Forensic, John Bone.

NEW VIEW OF BLOODSTAIN PATTERNS

A new Augmented Reality (AR) app is set to change the way investigators process violent crime scenes.

ESR scientists, in collaboration with the University of Canterbury and tech company Revolution 3D, have developed a new app that uses AR technology to analyse bloodstain patterns. Impact spatter stains and cast-off patterns are typically left at a crime scene when a bloodied surface is struck or when blood comes off a moving object, such as a weapon.

Currently crime scene investigators use string to reconstruct droplet trajectories. While the process creates an effective picture of any blood spatter event, in practice, the method is time consuming and lacks precision. The Droplet Trajectory Imaging (DTI) app will enable scene investigators to efficiently and accurately analyse individual blood droplet trajectories at crime scenes.

Using the DTI app to analyse blood droplet trajectories

ESR bloodstain pattern expert Dr Michael Taylor, who leads the work says the prototype is the result of an ESR-funded research project completed this year.

“The app runs on a mobile device and is designed to be used at a crime scene to measure blood droplet trajectories,” says Dr Taylor.

“The idea is to give investigators ‘on the spot’ information about where blood could have come from, which helps them piece together the events that have taken place,” he said.

The app also offers a method of recording scene data for subsequent use in court proceedings.

The rapid advancement in virtual and augmented reality technology has seen the development of tools for a wide range of applications including education, building construction and firefighting training. But up until now its use for forensic applications has been limited.

“I've not heard of anything else like this,” says Dr Taylor. “There are examples of the use of virtual reality for crime scene examination, but I would be surprised if there’s anything like we’ve done.” As a forensic scientist and crime scene examiner with 40 years’ experience, Dr Taylor is considered an expert in the field. He frequently gives evidence on bloodstain patterns in criminal trials in New Zealand and delivers bloodstain pattern analysis training courses for forensic investigators around the world.

While the DTI prototype has already given Dr Taylor and his team a glimpse of its value to crime scene investigators, there’s still plenty more work to be done. “The next step is to refine the app, add some new features and get user feedback,” he says.

Before it can be used at crime scenes, the DTI app will require rigorous validation, it’s hoped this work will begin in the new year.

67 homicide cases (2018/2019)
**INTERNATIONAL TOXICOLOGY CONFERENCE HEADING TO NZ**

New Zealand has won the bid to host the 61st Annual Meeting and Congress of the International Association of Forensic Toxicologists in 2023.

ESR worked closely with the Auckland Convention Bureau and Tourism New Zealand to put together the winning bid which was presented at this year’s conference in Birmingham, UK.

Forensic toxicologists from across the globe will travel to New Zealand for the conference which will showcase the latest developments in forensic science and toxicology.

From left: Matt Hosking, Diana Kappatos and Jill Vintiner after New Zealand won the TiAFT bid recently in Birmingham, UK.

---

**REVIEWING THE DNA DATABASE**

It’s hard to believe that 30 years ago using DNA to fight crime was almost unheard of. The development of DNA profiling revolutionised forensic science and the investigation of crime worldwide.

New Zealand was only the second country in the world to create a DNA Profile Databank (DPD). Today it holds over 202,000 samples. DNA is an important tool for solving crime and as such, new and important legal and ethical considerations are being raised. Significant amendments were made to the New Zealand Criminal Investigations (Bodily Samples) Act 1995 (the Act) in the early 2000s, now the Law Commission is in the process of reviewing the Act to ensure it’s fit for purpose.

The review will consider if the legislation is keeping pace with developments in forensic science, international best practice and public attitudes. It’s also considering whether human rights and tikanga Māori are being appropriately recognised.

Dr Jill Vintiner, who leads ESR’s Forensic Police Programme, sits on the Officials Group which is working on the review and reports ESR is working closely with the Law Commission. “ESR has a deep understanding of the science behind the DNA Profile Databank. We’ve been sharing our knowledge of the databank, how it operates as legislation currently dictates and how it translates in the real world of our forensic laboratories.

“We’re looking forward to improved legislation which we hope will answer the needs of all stakeholders and continue to help solve crime and keep New Zealand safe.”

The Law Commission is expected to publish its final report in 2020.
After a distinguished and at times high profile career, former Detective Inspector John Manning retired from his role as the ESR NZ Police Liaison Advisor.

John took on the liaison advisor role after his retirement from the police in 2005. He soon launched a cold case review of serious sexual assault crimes with scientific input from Science Leader, Sue Vintiner. He’d had plenty of experience with such cases, John was part of the inquiry team that ultimately arrested an Auckland serial rapist in the mid-1990s. Soon after he was awarded the Queen’s Police Medal for Distinguished Service.

The case involved Joseph Thompson, who eventually pleaded guilty to 129 charges, including 61 sexual violations of women and young girls.

He was sentenced to 30 years’ jail. It was both the first-time criminal profiling and DNA testing had been used in New Zealand to catch a serial rapist.

By the mid-2000s and the advances in DNA technology enabled new testing to be carried out on the historic cases committed between 1990 and 1999.

Of the 46 cases that were re-opened, 80% resulted in a DNA profile being loaded to the Crime Sample Database, of which 51% resulted in a link to a person on the DNA Profile Databank.

John has always said he reckoned he solved more serious crimes since he retired than he did in over 30 years in the force!

---

Tongan Minister’s Visit

A delegation from Tonga visited ESR’s Mt Albert Science Centre to see first-hand the work staff carries out on behalf of the Tongan Government.

Tongan Minister for Police and Fire Services, the Hon Mateni Tapueluelu, and Tongan Police Commissioner, Stephen Caldwell, were shown the work involved in the analysis and processing of materials from drug seizures.

---

Unwavering Commitment Acknowledged

Senior ESR Forensic Scientist Angelica Edgley was recognised for her 33 years’ service when she retired earlier this year.

Angelica was given a certificate of appreciation from the New Zealand Police – it acknowledged her "unwavering commitment, integrity, impartiality along with a strong desire to do public good, using forensic science to resolve criminal investigation."

---

10,904 Total cases received by ESR (2018/2019)
ON THE BORDER

The rapid screening drug lab, hosted by New Zealand Customs, near Auckland Airport, is proving a valuable tool in the detection of illicit substances at our border.

It’s been five years since the joint Customs/ESR Screening Laboratory (CESL) opened. It enables Customs front-line staff to identify, appropriately manage, and seize suspected drug samples quicker and more cost effectively.

“By the end of the year, more than 10,000 suspected drug samples will have passed through the lab,” says ESR CESL Manager, Matthew Russell.

“The samples are analysed and identified with speed and confidence, which has enabled Customs to seize a large number of new and emerging illicit substances that might otherwise have remained unknown using standard drug testing tools,” he says.

The lab was originally funded through the Criminal Proceeds (Recovery) Act and it’s paying off. Many new psychoactive substances and large amounts of chemically camouflaged and concealed compounds have been identified for the first time at CESL. The lab has technology to analyse hundreds of substances in hours.

“The strength of what we do at CESL is still being realised, because we offer real time advice as seizures are examined. For example, the work we’re doing at the border allows us to monitor the threat of dangerous drugs such as fentanyl.”

This type of information is essential – the lab examines more than 100 cases each month and alerts agencies to potential risks. This enables a quicker and coordinated response in the fight against illegal drugs.

Customs Manager Northern Ports, Mark O’Toole says CESL continues to demonstrate considerable benefits to Customs by having almost real-time identification of unknown commodities detected at the border.

Customs staff are also better equipped to undertake their important role in a safe way, giving them knowledge of what they are dealing with so appropriate health and safety measures can be taken.

“Having CESL on-site has allowed Customs officers the unique ability to understand more about the controlled drugs they find and have greater confidence in the role they undertake. It also allows ESR to understand more about the risks and challenges being faced at the border. This can only benefit Customs in the future.”
MAN-MADE, MIND ALTERING DRUGS ARE CHEAP, EASY TO GET AND MORE TOXIC THAN EVER BEFORE
New Zealand’s headlines continue to put the spotlight on synthetic cannabinoids for all the wrong reasons. The man-made, mind-altering drugs are cheap, easy to get and more toxic than ever before.

Despite being similar in name and method of use, synthetic cannabis is an artificial product that bears no semblance to cannabis plant material. Synthetic cannabis is made by adding harmful, mind-altering, man-made chemicals to non-psychoactive plant material such as herbs.

People who use synthetic drugs on a daily basis often do so multiple times a day; while the effects are strong they are also short-lived. Withdrawal symptoms come on quickly, creating a strong urge to use again.

Inconsistency in the types and concentration of chemicals used to make synthetic drugs means users have a high risk of overdose. Hundreds of people have been hospitalised with severe side effects over the past two years ranging from vomiting, seizures and loss of consciousness. For some, losing consciousness is considered a normal part of the experience, making it easier for a fatal overdose to occur.

The use of illicit drugs in this country is a complex problem that requires a multifaceted approach. Working beside agencies such as Police, the New Zealand Customs Service and the Ministry of Health, ESR is using its extensive scientific expertise to identify and track harmful substances.

A two-year research project undertaken by ESR has been tracking the identity, prevalence and impact of synthetic cannabinoids across the country. The study also helped identify which of the substances were causing harm in our communities.

Alarming it also showed that between May 2017 and May 2019 synthetic cannabinoids were linked in 90 deaths referred to the Coroner.

ESR’s Forensic Specialised Analytical Services Manager Dr Mary Jane McCarthy says clear geographical differences were also found.

“One drug – AMB-FUBINACA – was detected in the bulk of drug related fatalities referred to the coroner in the north of the country, while conversely, fatalities linked to synthetic cannabinoids in the central and southern parts of the country were spread among a range of different substances,” she says.

The Border to Grave project provided an innovative perspective by identifying new drugs, intercepted by Customs staff at the border. The study then went on to follow the drugs real-time use and abuse through the community.

Using data that’s found through the New Zealand Customs Service, Police and at Emergency Departments, ESR scientists can reveal potent new synthetic recreational
drugs as they hit the drug scene, and use that information to help agencies tackle the issue faster.

The surveillance of these drugs is part of a worldwide response to the synthetic cannabinoid crisis. ESR is a contributor to the United Nations Office on Drugs and Crime (UNODC) and has Forensic Toxicologist Diana Kappatos as an expert on the International Association of Forensic Toxicologists New Psychoactive Substances (NPS) Committee.

Mrs Kappatos says frontline agencies are benefitting from ESR’s international collaboration.

“Timely data-sharing and regular updates of new substances coming on to the international market is helping all of us to predict, prevent and protect New Zealand communities from the harm caused by synthetic drugs”.

Faced with the challenge of collating and interpreting information captured from the full spectrum of drug analysis carried out at ESR, a specialised framework has been put in place.

The Integrated Drug Surveillance System (iDSS) takes all the data from across ESR’s Border lab, Drug Chemistry, Clandestine Lab and Toxicology teams as well as information from a range of different projects and combines it into one big data source.

The major benefit of the system is a centralised database that can be used to identify distinctive geographical and temporal patterns. The iDSS will also be able to feed into a multi-agency drug early warning system led by the National Drug Intelligence Bureau, ensuring ESR’s partners are well informed with timely data.

While the use of synthetic cannabinoids continues to grab the headlines, other illicit drugs are far from forgotten. The emerging science of wastewater analysis is being used by ESR to provide a clearer picture of the volume of illicit drugs consumed in our communities.

The National Wastewater Testing Programme provides new data that’s allowing agencies to better understand drug-use patterns, which in turn enables them to develop targeted and more effective intervention programmes.

Commissioned by the Police, the nationwide project collecting samples from over 30 sites and capturing 73 percent of the population, is testing for methamphetamine, cocaine, heroin, MDMA and fentanyl.

Carried out by ESR scientists, the wastewater analysis showed that between February and April this year approximately 15kgs of methamphetamine was consumed in an average week. MDMA was the second most commonly detected illicit drug across the country, with an estimated consumption rate of 5.7kg on average each week.

ESR Chemist Andrew Chappell says in seven months of sampling – seven consecutive days per month – produced interesting results. In each seven-day period, patterns could be identified both daily and in the longer term.

“Instead of taking months or years to test thousands of samples of urine and analyse them in any one study, analysing wastewater can provide results about a population in near real time, enabling interventions that can save lives,” he says.

The pilot identified other valuable information for Police and other agencies. Methamphetamine use was relatively constant day to day, suggesting habitual use, while MDMA showed very distinct usage spikes at the weekends, suggesting recreational use. This information is vital to assist authorities with resource allocation, drug education and minimisation efforts.

As the drug market continues to evolve, so too does ESR’s tools and expertise. Kevan Walsh, Manager of ESR’s Drug Chemistry and Clandestine Laboratory teams, says that use of cutting-edge technology is important to be able to understand the make-up of drugs being used on the street.

“Our teams have recently added two new Ultra-High Performance Liquid Chromatography (UHPLC) systems to our laboratories to enable their use to cost-effectively separate, identify, and quantify drug compounds” he says.

“Among many other things, UHPLC can be used for testing cannabis. Scientists break up the dried cannabis leaf and extract the various cannabinoids, such as Tetrahydrocannabinol (the principal psychoactive substance in cannabis) and Cannabidiol (a non-psychoactive substance in cannabis and hemp that is believed to have potential health benefits). The high-speed UHPLC allows scientists to rapidly and accurately quantify these substances”.

The illicit drug landscape is continually moving. As suppliers change their methods and users switch between substances, agencies must keep changing their approach to the matter. Leading-edge and reliable science is critical to keep on top of new trends. ESR’s extensive expertise allows their frontline partners to have better insights into education and intervention tactics, and advice on risks and responses. Working together, the aim is to make a positive impact into the wellbeing of our communities.
With a referendum on the legality of cannabis for personal use coming in the 2020 general election and the amendment of the Misuse of Drugs Act 1975 allowing for a much broader use of medical marijuana given the greenlight, cannabis reform is a hot topic.

In a submission on the Medicinal Cannabis Scheme, ESR’s forensic toxicologists said it is of primary importance that robust quality standards are in place to protect patients who are prescribed medicinal cannabis products.

At present, the proposal allows cannabis-based products to bypass some of the usual processes for medicines in New Zealand and go directly to market without proof of clinical safety or effectiveness.

Dr Mary-Jane McCarthy, ESR’s Forensic Specialised Analytical Services Manager says that it is crucial that an evidence-based regulatory process is developed that defines strict quality standards.

“The lack of demonstrated clinical safety and efficacy of these products means that robust quality standards are incredibly important. Quality standards for medicinal cannabis products should be no different than those required for all medicines,” she says.

The submission also made clear that without safety and efficacy data for these products there needs to be intensive monitoring of potential patient reactions. ESR would like to see a more comprehensive surveillance system that can monitor the prescribed concentration and dose, product formulation, prescribing patterns and consumer demographics.

Another area of concern is the lack of detail on the maximum allowable cannabinoid/THC content within licenced cannabis products. The Scheme as currently described, has no detail on the dosing regimen, conditions and indications of use, and the limitations for vulnerable people. This means it is up to doctors prescribing this medication to do so, and if they are not suitably trained in this area, then they could be putting their patients at risk.

Dr McCarthy says there is a lot of confusion about medicinal cannabis.

“One of our concerns is that people don’t necessarily know or understand what is in the product they are taking.”

“We’ve had a number of the medicinal cannabis products available here in New Zealand – supplied to us by concerned patients and parents – and our tests have shown that there’s quite a lot of variability in the quality of products with some difference in the concentrations of the active ingredients,” Dr McCarthy says.

That includes tetrahydrocannabinol (THC), the psychoactive component of cannabis, and cannabidiol (CBD), which is not psychoactive. CBD has now been rescheduled so that it is no longer a controlled drug and is a prescription medicine under the new law changes. Products containing it should become more available to patients from now on.

“We see a range of products – imported and homemade. Some of them have much higher concentrations of THC than they state.

“We really do need to be testing and understanding the safety of these products and make sure they are effective for the condition which they are being used for, and won’t cause harm,” she says.

She cites one instance when a worried grandfather contacted ESR about the product his grandchild was using for uncontrolled epilepsy.

“In this case, there should have been high CBD and low THC – in fact it was the opposite. I would be very worried about a child taking a product like that.”

ESR has extensive expertise in the testing of illicit drugs for both NZ Police and NZ Customs, and undertakes the New Zealand Medicines Testing Programme on behalf of the Ministry of Health.

ESR’s Pharmaceutical Programme contributes to the ongoing safety of medicines and other therapeutic products on the New Zealand market through provision of testing services.
benchmarked against international quality and safety standards.

The organisation has a long association with the industrial hemp sector and is currently the only approved laboratory to conduct compliance testing under the Misuse of Drugs (Industrial Hemp) Regulations 2006.

The Programme also provides regulatory advice and third-party testing services to companies currently licenced to cultivate cannabis for medicinal or scientific research purposes.

ESR’s scientific expertise means it is well-placed within New Zealand to provide comment and feedback on the proposals outlined in the Medical Cannabis Scheme public consultation document.

Public consultation closed on 7 August. The Ministry of Health is now analysing the feedback and consulting with the Medicinal Cannabis Advisory Group before providing advice to the Government on the outcomes of the consultation, including any proposed changes.

The Ministry will then seek approval from Cabinet on the regulatory proposals and the Parliamentary Counsel Office will draft the proposed Misuse of Drugs (Medicinal Cannabis) Regulations. The Ministry is aiming to have the above regulations made by 18 December 2019 and the Medicinal Cannabis Scheme operational in the first quarter of 2020.
Changes to New Zealand’s drug driving testing and enforcement regime are in the works with the Government reconsidering the current approach. The Government is expecting to receive a report with recommendations from the Ministry of Transport by the end of the year.

ESR Forensic Toxicologist, Dr Helen Poulsen, carried out the toxicological analysis of blood samples of drivers killed in crashes between January 2013 and May 2018 for cases where drugs analysis was requested by a pathologist. She found that of those who had died, 29 percent had used alcohol, 27 percent had used cannabis, 10 percent had used methamphetamine and 15 percent had used other drugs.

‘Drug driving is obviously an issue. In addition to the findings on deceased drivers, we found that between 2014 and 2018, of those drivers hospitalised or determined to be impaired, our analysis of their blood samples showed nearly 60 percent had used cannabis and over 40 percent used methamphetamine,” she says.

Dr Poulsen has over 30 years’ experience in the analysis of drugs and the involvement of sudden death. She also acts as an advisor to Ministry of Transport and Police on matters relating to drug driving.

She says that any introduction of a legal and regulated cannabis market following the referendum must also include discussion around reducing the likelihood of drug driving.

“Random roadside testing is one way to discourage people not to drive under the influence of alcohol. This is an easy-to-use test that takes less than 30 seconds to administer. Roadside drug testing is another story. Oral fluid (saliva) drug tests, such as those used at the roadside in Australia, do not establish impairment. Neither are they 100% accurate and currently they can identify only three substances – methamphetamine, MDMA (Ecstasy) and cannabis.

“There are many other drugs that can affect a person’s ability to drive safely. Synthetic cannabinoids and other illicit drugs (heroin and cocaine) and prescription medication such as opiates (morphine and codeine) and benzodiazepines (such as diazepam and clonazepam) are not covered by the roadside oral fluid tests.

“The initial oral fluid test for drugs takes around 5 to 10 minutes to administer. Random roadside testing for drugs would cause lengthy delays at a checkpoint. The roadside testing device is also costly with each disposable unit costing up to $40 each. They do not provide an evidential test, so can’t be used in a court of law. Any positive result would still need to be confirmed by laboratory analysis of either oral fluid or blood,” she says.

Dr Poulsen said that blood is the best sample for analysis but taking blood at the roadside is considered more invasive than oral fluid.

But there is hope that technology will soon be able to solve this issue. ESR is currently working with a New Zealand biotech company on developing technology, which could quickly and efficiently test drug-impaired drivers using oral fluid.
Young scientists from Pūhoro STEM Academy have been exploring the fusion of Māori culture and western science and ESR is helping them on their exciting journey.

Pūhoro was launched in 2016 and provides Māori students with navigation and opportunities to pursue science, technology, engineering and maths. ESR supports Pūhoro by offering interactive opportunities for students to learn about forensic science.

Kate Stevenson, one of ESR’s forensic scientists has been a part of wānanga in both Palmerston North and Albany with students from a variety of schools in years 11-12. She says it’s great to be connecting with young New Zealanders interested in science.

“They tend to be really engaged and ask challenging questions which is always quite rewarding when you get that feedback from the students,” says Kate.

As well as talking about the forensic work ESR does, students get the hands-on experience of dressing up in appropriate protective clothing, analysing shoe prints as well as playing with a game nicknamed ‘DNA Cluedo’.

“We do practical activities with the students to highlight that sometimes evidence is not always visible to the human eye and that several different analyses may be required to help piece together a forensic investigation.’

Kate also talked to the students about ESR’s 3D scanning work how the technology can be used in a non-forensic application.

“We talked about the 3D imaging project at the Matatā marae, showing them the work that’s been done to provide an archival record of the Māori taonga and the history of the marae and wharenui.”

Working with these students is a rewarding experience for Kate.

“To get that feedback, questions and that interest; even if they don’t pursue forensic science, you know that you’ve opened their eyes to something different.”
REAL-TIME DRUG SCREENING

ESR is developing a real-time drug screening service to enable frontline police to analyse suspected illicit drug samples in the field.

The service combines a hand-held device, and cloud-based drug detection models connected via a mobile phone app.

The device uses near infrared light (NIR) to scan compounds to detect the presence of drugs.

ESR is working with the developers of the portable NIR technology to harness the power of the device by combining it with ESR’s extensive drug chemistry expertise.

Forensic Research & Development Manager Dion Sheppard says ESR is building a set of machine learning models to be used with the device, based on its database of illegal drugs, to provide an accurate and efficient screening service that can provide a result in seconds.

“The NIR device records a signal – or ‘spectral fingerprint’ – from the sample that is then sent to the cloud via a phone app. Our machine learning model interprets the signal and returns a result back to the phone.”

Because the NIR signal can transmit through a clear plastic container there is no need to handle the sample. This maintains the integrity of the contents and protects the health and safety of the person conducting the test.

New Zealand Police currently seize approximately 10,000 suspect drug samples a year. While some samples are tested in the laboratory, the new service would allow a rapid screening in the field when samples have been intercepted and uncertainty exists about what the substance is.

“At the moment when Police intercept a sample they rely on their experience or circumstances to tell them if it is a drug. This service enables scientific analysis to directly support the reliability of the decision they make.”

The service, which has been financially supported by a recent KiwiNet innovation award, is being developed in partnership with the New Zealand Police as part of the Evidence-Based Policing Centre collaboration.

“The funding allows ESR to develop the prototype device in to a commercial product which solves a problem for officers in the field.” Machine learning models are being built which will enable the device to screen for methamphetamine, cocaine and MDMA.

“These drugs are really good targets because they represent the majority of the powdered drugs police come across and they are typically traded in ‘point’ (clear plastic) bags.”

Mr Sheppard says the project draws on the collective expertise across ESR’s drug chemistry and data science fields.

“We are packaging our science expertise to make it accessible to meet our customers’ needs.”

He says the rapid delivery of results will help police to reduce the harm caused by the drugs, and direct users to health and other services where appropriate.

A field pilot is being planned and it’s hoped the service is available within 12 months.
**STRmix™ 2.7**

The latest version of ESR’s award winning forensic software system, STRmix™ has been launched with new features making it even better than before.

STRmix™ is a powerful analytical tool used to identify individuals as possible contributors to a complex, mixed crime sample. It’s also used to exclude individuals, reducing the likelihood of their wrongful implication in criminal activities.

Version 2.7 of STRmix™ launched in early September, comes after a full year of technical development and training. New key features include the addition of a variable number of contributors (varNOC) for multi-kits and the ability to compare two or more DNA mixtures to find a common contributor.

“The new features are in direct response to recommendations made by forensic labs to better address the on-the-job needs they regularly encounter,” says ESR scientist and STRmix™ co-creator Dr John Buckleton.

Forensic labs are increasingly turning to STRmix™ which has now been used in more than 120,000 cases worldwide since 2012. STRmix™ is used in eight state and territory agencies in Australia, as well as labs in England, Scotland, Ireland, Finland, Switzerland, Dubai, Denmark, and Canada. In the US the breakthrough technology is used by the FBI and the Bureau of Alcohol, Tobacco, Firearms, and Explosives.

Back here at home STRmix™ has accounted for a 30 to 50 per cent improvement in the New Zealand’s DNA profiling success rate. Earlier this year the team behind the science was awarded the Prime Minister’s Science Prize, it’s awarded for a transformative scientific discovery that has significant impacts on New Zealand or internationally.

**SUPERFAST DBLR™**

DBLR™, an application for calculating millions of likelihood ratios in seconds when used in conjunction with STRmix™, was introduced earlier this year. Likelihood ratios are used to assess the strength of DNA evidence and how likely it is that DNA found at a crime scene belongs to specific individuals.

**TAKING THE GUESSWORK OUT OF FINDING DNA**

Imagine a crime scene strewn with clothes and crumpled fizzy drink cans. There’s a glass table with zip lock bags and wrinkled disposable gloves. A crime scene technician surveys the area but there’s no way to visualise DNA on any of the items.

Biological stains plus the circumstances of individual cases are often the only information to help figure out what samples to take. As there’s no way to see DNA on surfaces it’s difficult to target a specific area for swabbing.

Now, new research is underway that aims to take the guesswork out of finding that DNA. ESR researcher Alicia Haines and Masters students Katrina Betty and Neha Kumar are testing out the use of Diamond™ Nucleic Acid dye, which binds to DNA and allows it to be seen under a fluorescent light. Their research examines how the dye can be used to find DNA on non-porous objects as well as on different types of fabric. They’re also testing different methods to apply the dye; it could be sprayed on the surface directly or applied to adhesive tape used to take samples from fabric.

Katrina’s work is looking at the distribution of DNA on worn nitrile gloves. “I’ve been using the dye to look at the fingertips, webbings and palm of worn gloves. It’s pretty exciting to see that use of diamond dye we can target different areas of gloves for sampling.”
3D VANTAGE POINT

For the last several years ESR has been using laser scanners to document crime scenes, but now new 3D processing software is bringing those scenes to life.

SmartSite takes the laser scanning technology used to capture full colour scenes and turns it into a full 3D representation of what’s been scanned. It might be a warehouse, a heritage building or even a crime scene. This technology produces extremely high detail visualisations for both police and juries and laser scanning expert Kurt McManus says the 3D imagery puts crime scenes in context.

“Being able to see where things were in relation to each other allows juries to have a better understanding of the scene,” says Kurt. “You can see viewpoints from the eyes of witnesses or look straight down to get a floorplan of the scene, the opportunities are endless once you have a 3D crime scene.”

Coupled with the use of virtual reality (VR) headsets, SmartSite allows people to be fully immersed into the scanned environment.

Now ESR is expanding the use of the technology beyond forensic applications. By layering 3D data with various pieces of relevant information it can be used for health and safety training, construction planning and environmental monitoring. Recently scientists have been working with the New Zealand Medical Assistance Team (NZMAT) to scan hospital tents to help ensure a high level of readiness.

“It takes a lot of time to put up the tents, it’s a big space and costs a lot of money but NZMAT needs to show people what it looks like. So, by laser scanning it and then using SmartSite their people can be standing in that space and visualising what it looks like.”

NZMAT is a volunteer civilian-based disaster medical assistance team comprising of clinical and non-medical members such as logisticians. The government initiative was established in 2012 following the Samoa Tsunami three years earlier, to provide coordinated assistance in the wake of domestic or international disasters.

Constructing the Outpatients Fixed Camp facility is a large logistic undertaking and is not often done. Laser scanning and use of 3D technology gives NZMAT the ability to show case the facility to all NZMAT personnel as well as other interested parties.

Y- CHROMOSOME PROFILES ENHANCE CRIME SAMPLE DATABANK

The National Crime Sample Databank is getting a boost with Y-STR DNA profiles obtained from crime samples now added to the mix.

The test is extremely helpful for cases of sexual assault where a large amount of female DNA can make it difficult to obtain any profiling information from any male DNA. By targeting the Y-chromosome, it may be possible to obtain a result from the male DNA where standard testing would not.

Around 300 profiles have been added to the Databank so far; that number will continue to rise as suitable profiles are added as a matter of course from now on.
SPOTLIGHT ON A FORENSIC SCIENTIST

When forensic scientist, Steve Cordiner, processed his first crime scene back in 1983, the science was pretty basic.

“My tools of trade consisted of paper, pens, rulers and a blood testing kit.” Steve’s first homicide case involved a deceased female located in a pool of blood and with paint flakes found in her hair. “Back then we couldn’t even determine whose blood it was, just the blood type,” he said.

The case was solved by matching the paint flake to a hockey stick covered in blood found elsewhere on the property, along with blood covered shoes and clothes of the perpetrator.

Fast forward 36 years and Steve is no longer a young scientist straight out of Victoria University with a PhD in biochemistry. He is one of the most respected forensic scientists in the business managing the three ESR forensic service centres in Auckland, Wellington and Christchurch.

Forensic science has changed remarkably during that time and Steve reflects on the innovations that have carried forensic science into a different realm. “Our team at ESR have done some remarkable research and brought state-of-the-art innovations into the work we do processing crime scenes.”

Steve says that ESR has a reputation world-wide for first class forensics work which is all the more amazing since a lot of the research and the application of new innovations is done from a very small funding pool. “We take the Kiwi No. 8 wire approach.”

“My first forensics toolbox now looks very primitive to me. Instead of the bag I carried around, our team has a fully packed ute with sophisticated equipment and gear.”

DNA profiling and interpretation has revolutionised the way crime is solved. He says that DNA evidence can be taken from the minutest of samples, processing can take days rather than weeks and reveal more about a criminal that just their identity.

Steve says that the technology is getting more and more sophisticated. “ESR has trialled rapid, point-of-use devices that enables work to be done at the crime scene rather than back in the lab.

“We’re also researching phenotyping, which is when genetic information such as hair and eye colour can be identified from DNA. Artificial Intelligence capability and machine learning is also being harnessed to help improve the speed in which we process samples.”

Steve says technology and new science is changing the forensic game. “From our perspective anything science can do to help solve crime, exonerate the innocent and keep our community safe is a good thing.”

1999
DNA Profile Databank solves its first homicide case

Operation Sundown – DNA caught under the deceased’s fingernails yielded a mixed profile which was resolved, entered and matched on the DNA Profile Databank.
ESR SCIENTIST AWARDED PRESTIGIOUS FELLOWSHIP

ESR Senior Forensic Scientist, Cameron Johnson has been named as one of the recipients of the prestigious 2020 Winston Churchill Memorial Trust Fellowships.

The Fellowship will allow Mr Johnson to travel to the United States to study performance and image enhancing drugs (PIEDs), and the latest techniques for detecting them.

The opportunity to consult with experts in the field will enable Mr Johnson to bring back new insights and understanding that will benefit our communities.

“The Fellowship opens up the possibility of future collaboration, and the sharing of expertise and knowledge,” says Mr Johnson.

“As well as learning more about the latest techniques and procedures for detecting PIEDs, I’ll be able to gain a better understanding of how to use that information to address the social and recreational challenges the drugs create,” he says.

The challenges associated with detecting and legislating PIEDs shares many similarities with other controlled substances that Mr Johnson deals with daily. To expand on this knowledge will ensure ESR is up to date with current technologies and strengthen New Zealand as a recognised expert in this field.

“This Fellowship will be key to learning about drug trends experienced internationally and applying them to the New Zealand landscape, and I couldn’t be happier to be granted this opportunity,” says Mr Johnson.

The Winston Churchill Memorial Trust was established in 1965 to honour the memory of Sir Winston Churchill.