

Master Forensic Science

Research Projects 2017-2018



Research projects 2017-2018

The University of Amsterdam's (UvA) Master's programme in Forensic Science, offered by the Faculty of Science, is unique in the Netherlands. The programme distinguishes itself from most international Master's programmes in Forensic Science by building on a range of scientific disciplines, such as Chemistry, Computer Science, Life Sciences, Mathematics, Physics, and other exact sciences. The goal of the programme is to train good scientists, armed with forensic knowledge and skills.

A part of the curriculum is a six-month internship during which scientific research is executed that is relevant to the forensic field. This document gives an overview of the capabilities of our students and the many ways in which a research project can be conducted.

For more information please contact:
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Title	Organisation	Student	Previous education
Digital Forensics			
Evaluation of the digital forensic investigation in TGO's within the police Noord-Holland	Dutch Police, police Noord-Holland	Christian van Dam	Biomedical Sciences
Detection of Deepfake Video Manipulation	Netherlands Forensic Institute (NFI)	Marissa Koopman	Liberal Arts and Sciences: biomedical
Environmental Forensics			
Neurodevelopmental effects in zebrafish embryos of pharmaceutical contaminants in the environment	National Institute for Public Health and the Environment (RIVM)	Ingrid Jense	Pharmaceutical Sciences
Forensic Biology – Human biological traces			
Multiplex Body Fluid Identification Using Surface Plasmon Resonance Imaging	Academic Medical Center, University of Amsterdam (AMC)	Charlotte Stravers	Gezondheid & Leven
Interpretation of comparison of MPS and CE based mixed STR profile - <i>Estimating the number of contributors and inference of the major genotype</i>	NFI	Anouk Backx	Biomedical Sciences
Development of the innovation project DNA success meter: Assessing the factors that influence the success of a DNA trace	NFI and University of Applied Sciences	Sabine van Doremalen	Biology and Applied Medical Laboratory Technology
Cell type-specific SNPs to associate cell type and donor	NFI	Lydia Stravers	Gezondheid & Leven
Mitochondrial DNA Typing from Rhino Horns – Developing a Multiplex Real-Time PCR Assay Using Melt Curve Analysis	Flinders University, Adelaide, SA, Australia	Carlo Nolden	Biosciences
Forensic Biology – Non-human biological traces			
Development of a lateral flow immunoassay for donor profiling of fingermarks	AMC	Melde Witmond	Biomedical sciences
Proof of Principle: Predicting the initial protein-lipid composition of an aged fingermark.	AMC	Meghna Swayambhu	Biotechnology, Chemistry, Zoology
Presumptive quantification of DNA and improving DNA analysis in fingermarks	AMC	Magdalena Birkl	Biomedical sciences
Forensic Chemistry – Drugs of Abuse			
Drug isomer analysis and differentiation: addressing the challenge with vacuum ultraviolet absorption spectroscopy (VUV)	Van't Hoff Institute for Molecular Sciences (HIMS)	Corina Kukurin	Biotechnology
Optimizing the current executed NFiDENT process	NFI	Lydia Jochems	Biology

Title	Organisation	Student	Previous education
Forensic Chemistry – Explosives			
Investigation into the simple and rapid analysis of organic explosives using ambient mass spectrometry (MS): paper spray (PS)-MS and surface acoustic wave nebulization (SAWN)-MS	HIMS	Lauren Pintabona	Chemistry
Investigating the New Year's Eve effect: Analysis of the presence and persistence of pyrotechnic explosive related ions in the background using IC-ESI-MS	NFI	Jesse Verbunt	Chemistry (Forensic Laboratory Research)
Forensic Chemistry – Fire Debris Analysis			
Vacuum Ultra Violet Spectroscopy for the Analysis of Complex Hydrocarbon Samples and its Forensic Applicability in Arson Analyses.	Shell Technology Centre Amsterdam	Robert van Vorstenbosch	Chemistry
Forensic Chemistry – Material Analysis			
Forensic Applications of laser-induced breakdown spectroscopy	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO)	Orla Rochford	Chemistry with Forensic Science
Forensic Medicine – Biomedical Engineering			
A New Method for Fat Percentage Determination for a Finite Element Body Cooling Model For Improved Post-Mortem Interval Estimation	AMC	Imane Haltout	Lifestyle Informatics
Forensic Medicine – Forensic Anthropology			
Engineering for Forensics: The Risk of Sawing in Bone	NFI / Delft University of Technology	Lucas Jimenez Bou	Biological Sciences
Analysis of Blunt Force Trauma in Human Cranial Bones: A distinction between perimortem and post-mortem fractures	Institute for Legal Medicine and Forensic Science of Catalonia (IMLCFC)	Patricia Ribeiro	Biomedical Sciences in Histocellular Pathology
Hit or burn? – Differentiating blunt force trauma fractures from heat-induced fractures in burned bones	AMC	Divya S Divya	Biomedical Sciences
Exploring new methods to determine the PMI of modern skeletal remains	AMC	Jolien Nienkemper	Psychobiology
Degradation of hair fibres: histological correlates of isotopic change	Vrije Universiteit Amsterdam & AMC	Jelle Broeders	Medical Natural Sciences

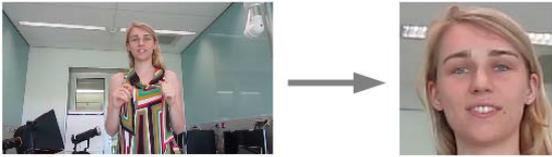
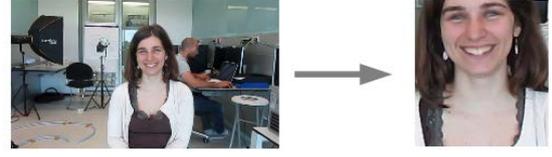


Title	Organisation	Student	Previous education
Forensic Medicine – Forensic Pathology			
Towards an In Vitro Age determination model for subdural haematomas	AMC	Jordan Rust	Biomedical Science
“Clinical Forensic Pathology- Forensic Investigation in abusive trauma cases”	Ministry of Justice, Department of Forensic Pathology Services, General University Hospital of Patras, Greece	Pinelopi Stamatakopoulou	Informatics and computer technology
Detection of Subdural Hematoma Age-Specific Biomarker Patterns Using a SPR-Based Biosensor	AMC	Choenne Straatman	Biomedical Sciences
Forensic Medicine – Forensic Pediatrics			
Post-mortem Computed Tomography Versus the Skeletal Survey in Children: a Pathology Proven Study	AMC	Esther van de Mortel	Biomedical Sciences, minor Patient-oriented research
Comparison of age estimation of injuries, related to inflicted head injury in children: a retrospective study	NFI	Jeanine Oude Elferink	Medical Physics
Evaluation of an interview technique for the detection of child sexual abuse.	AMC	Mareen Boel	Psychobiology
Forensic Physics			
Bullet impact on bare sheet steel and steel automobile body material	NFI	Sree Versha Hari	Biotechnology
The effects of shooting angle on 2D-mXRF patterns around bullet holes on non-textile materials	NFI	Christina Kashiouri	Chemistry
A pilot study comparing real crime scene toolmarks to simulated toolmarks in order to quantify the evidential value of a tool mark comparison.	NFI	Nadia Lympéri	Chemical Engineering
Forensic Statistics			
Measuring calibration of likelihood ratio systems	NFI	Yara van Schaik	Mathematics



Digital Forensics

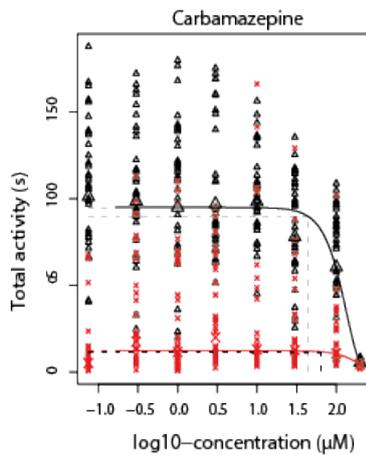
Student	Christian van Dam
<i>Research carried out at</i>	Dutch Police, police Noord-Holland
<i>Supervisor</i>	G. Brecht – ten Wolde PhD MCI
<i>Title thesis</i>	Evaluation of the digital forensic investigation in TGO's within the police Noord-Holland
<i>Abstract</i>	<p>BACKGROUND Digital forensic investigation is gaining importance in the investigation of crimes. To keep up with new developments and the increasing demand on the digital forensic investigation it is important to know the current status of the digital forensic process and ensure efficiency and effectivity of the process.</p> <p>AIM This study aims to evaluate the digital forensic process in the 'Team Large-scale investigations' (TGO) within the police Noord-Holland.</p> <p>METHOD A questionnaire is set up focussing on mapping points of improvement in the digital forensic process. The questionnaire is filled in by members of the TGO teams from the three different districts of the police Noord-Holland. To in-depth asses the motivation and importance of these points of improvement semi-structured interviews are held with participants involved in 'TGO X'. Lastly, an assessment will be made of possible alterations to improve the digital forensic process within TGO's. In focus group meetings digital experts within and outside the police discussed on the best approach of the digital forensic investigation in a TGO based on a mock case.</p> <p>RESULTS For privacy reasons the result section has been made less elaborate. The questionnaire and semi-structured interviews indicate that there are points of improvement within the process of the digital forensic investigation in a TGO. Results from the focus group meetings recommend that the digital expertises should always be a core part of the TGO team. Tactical and digital expertises should work close together and a digital coordinator should be implemented to increase the awareness of digital possibilities in the TGO team and function as link between the tactical and digital expertises.</p> <p>CONCLUSION The current digital investigation in TGO's has several points of improvement. It is recommended to permanently implement the digital investigation team, internet investigators and team multimedia, alongside a digital coordinator in the TGO team. This would improve the efficiency and effectiveness of the digital investigation in a TGO.</p>

	Student	Marissa Koopman
	<i>Research carried out at</i>	Netherlands Forensic Institute (NFI)
	<i>Supervisor</i>	MSc. Andrea Macarulla Rodríguez
	<i>Title thesis</i>	Detection of Deepfake Video Manipulation
<p>The Deepfake manipulation allows you to substitute an actor's face.</p>	<i>Abstract</i>	<p>The Deepfake algorithm allows a user to switch the face of one actor in a video with the face of a different actor in a photorealistic manner. This poses forensic challenges with regards to the reliability of video evidence. To contribute to a solution, convolutional neural networks (CNNs), discrete cosine transformation (DCT) coefficients, and photo response non uniformity (PRNU) analysis are tested for effectiveness at detecting Deepfake video manipulation.</p> <p>The CNN (based on GoogLeNet via NVIDIA DIGITS) is unable to distinguish between Deepfake videos and authentic videos due to persistent overtraining. A different type of neural network such as a general adversarial network (GAN) could be more successful. The DCT coefficients are unsuitable for the detection of Deepfakes, as no sign of recompression is present in the frames extracted from Deepfake videos. Three out of four PRNU analysis methods tested show a significant difference in mean normalised cross correlation scores between authentic videos and Deepfakes. Second order PRNU analysis is the most promising method of the methods tested.</p>

Environmental Forensics



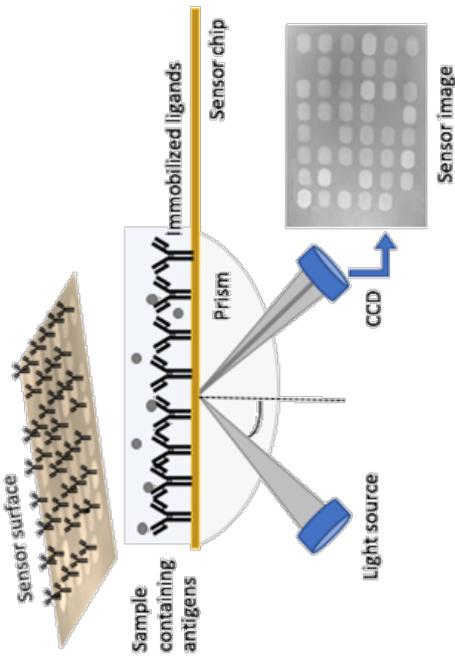
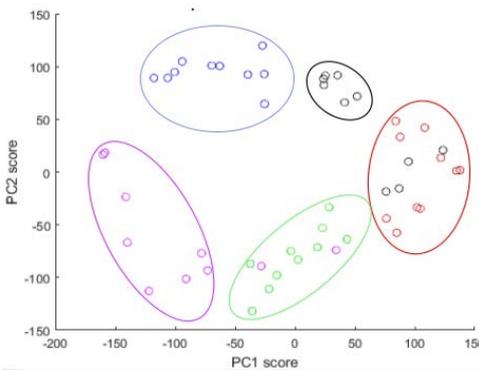
A zebrafish embryo three days after fertilization



Dose-response curve of the activity of the embryos after 5 days of exposure to different concentrations of carbamazepine. The black line represents the activity during a period of darkness and the red line during a period of light.

Student	Ingrid Jense
Research carried out at	National Institute for Public Health and the Environment (RIVM)
Supervisor	Ellen Hessel
Title thesis	Neurodevelopmental effects in zebrafish embryos of pharmaceutical contaminants in the environment
Abstract	<p>The release of psychoactive pharmaceutical residues into the environment, mainly through sewage effluents, has caused concern over their potential neurodevelopmental effects in vertebrates. Here, we screen for potential (developmental) neurotoxicity of three psychoactive pharmaceuticals of concern, fluoxetine (FLX), a serotonin reuptake inhibitor (SSRI), venlafaxine (VNX), a serotine norepinephrine reuptake inhibitor (SNRI), and carbamazepine (CBZ), a sodium channel blocker. Environmental concentrations for these compounds in the Netherlands are in the range of 0.2-8 nM.</p> <p>The study was performed using zebrafish embryos as a representative model for early vertebrate development. The first aim was to analyse general toxicity after continuous exposure to the pharmaceuticals from 0-72 hours post fertilization (hpf), measuring lethality, developmental delay and teratogenic effects. Exposure to VNX and CBZ induced no changes in morphology and mortality rate of the zebrafish embryos up to the highest tested concentrations (300 and 200 µM, respectively). However, exposure to FLX resulted in a high mortality rate at 89.9 µM. Next, effects on behavior were studied by measuring the activity of the zebrafish embryos after exposure to the compounds VNX (0.3-300 µM), CBZ (0.3-200 µM) and FLX (0.03-10 µM), from 0-120 hpf. High concentrations induced a decrease in activity, and exposure during different exposure times showed that the embryos were already affected at 96 hpf. When the pharmaceutical was removed at this stage, embryos activity recovered to normal at 120 hpf. Further activity measurements were performed at analysis of effects at environmentally relevant concentrations. These concentrations did not affect the behavior of the embryos. Finally, gene expression analysis showed that all three pharmaceuticals induced an upregulation of <i>gabra6a</i>, possibly affecting GABAergic synapse forming in the less active embryos.</p>

Forensic Biology – Human biological traces

 <p>SPRi is an optical technique that allows the monitoring of antigen-antibody interactions at multiple antibody-coated</p>  <p>The first two principal components allowed almost complete clustering of the body fluid types.</p>	<p>Student Charlotte Stravers</p>
	<p><i>Research carried out at</i> Academic Medical Centre (AMC), Amsterdam</p>
	<p><i>Supervisor</i> Dr. Annemieke van Dam</p>
	<p><i>Title thesis</i> Multiplex Body Fluid Identification Using Surface Plasmon Resonance Imaging</p>
	<p><i>Abstract</i></p> <p>Body fluid identification is a key component in forensic casework, providing important information for the reconstruction of criminal events. Body fluid identification in combination with DNA analysis allows the linking of individuals to criminal acts and can therefore be of great importance in criminal court cases. Advances of sensor-based technologies over the past decades have greatly facilitated the use of immunological-based tests for on-site body fluid identification testing. However, these immunological lateral flow tests, as well as most of the other conventional methods, are designed to detect only a single body fluid. As a consequence, multiple tests may be required for the identification of a single sample which is costly in terms of time, money, and sample usage. Therefore, the aim is to develop a method that extends the advantages of the immunological lateral flow tests with the ability to analyze multiple body fluids in a single analysis run.</p> <p>In the study, we explored, for the first time, surface plasmon resonance imaging (SPRi) with antibody-based detection to serve as a novel multiplex body fluid identification method for blood, semen, saliva, urine and sweat using minimal sample preparation. A training set of ten donors per body fluid was analysed to determine whether body fluid specific response signals could be obtained. Principal component analysis (PCA) was performed as a statistical tool to cluster the body fluid samples. Four principal components allowed complete clustering of all body fluid types. Blind testing of body fluid samples with SPRi and PCA revealed that 50% of the tested samples correctly clustered to their corresponding group.</p> <p>Although optimization of the current SPRi method is required for use in the forensic field, the study demonstrates the feasibility of SPRi to differentiate five forensically relevant body fluids.</p>

Student	Anouk Backx
<i>Research carried out at</i>	NFI
<i>Supervisor</i>	ing. Kristiaan J van der Gaag Corina CG Benschop, PhD
<i>Title thesis</i>	Interpretation of comparison of MPS and CE based mixed STR profile - <i>Estimating the number of contributors and inference of the major genotype</i>
<i>Abstract</i>	<p>Short Tandem Repeat (STR) profiles have been used in forensic DNA analysis for several years. However, the interpretation of mixed STR profiles (profiles containing DNA of more than one contributor) is challenging due to, amongst others, allele sharing between contributors. In this study, two methods for analysing large numbers of autosomal STRs were compared with regards to the interpretation of complex DNA mixtures. These methods are the PowerPlex® Fusion 6C STR kit (Promega) in combination with Capillary Electrophoresis (CE) and the the PowerSeq™ Auto System (Promega, prototype) in combination with Massively Parallel Sequencing (MPS). Both kits analyse the same set of autosomal STR loci, with the additional locus SE33 in the PowerPlex® Fusion 6C kit. At the moment of writing, CE is the gold standard for forensic DNA analysis. MPS is a promising alternative since it enables distinguishing between sequence variants within an STR locus, resulting in enlarged discriminatory power. To compare the performance of both methods, four datasets containing mixtures of two- to five- person mixtures in varying ratios were created. Each DNA mixture was amplified and analysed in triplicate with CE and MPS. In total, 219 replicates of 73 mixed profiles were analysed with both methods. Results were compared with regards to estimating the number of contributors and inference of the major genotype. When the MAC (Maximum Allele Count) method was used for estimating the number of contributors, two- and three- person mixtures were more often overestimated with MPS compared to CE. Four- and five- person mixtures were more often underestimated with CE when the same loci were considered in both kits, but when locus SE33 was added for CE, comparable results were obtained. Using computer simulations, which incorporate drop-out, to estimate the number of contributors based on MAC and TAC (Total Allele Count) with both systems, resulted in slightly more correct estimations based on MAC for CE compared to MPS (65% versus 62%) and slightly more correct estimations based on TAC for MPS compared to CE (81% versus 74%). For inference of the major genotype, the LoCIM tool was used. With this tool, the major genotype could be correctly inferred in 72% of all loci with both CE and MPS. Although comparable results were obtained for CE and MPS for estimating the number of contributors and inference of the major genotype, more different allele variants were found with MPS and slightly less drop-out of minor alleles was observed. Therefore, it is expected that MPS is a valuable technique for other types of analysis such as mixture deconvolution and Weight of Evidence calculations.</p>

Student	Sabine van Doremalen
<i>Research carried out at</i>	AMC
<i>Supervisor</i>	K. Colman, PhD
<i>Title thesis</i>	Development of the innovation project DNA succesmeter: Assessing the factors that influence the success of a DNA trace
<i>Abstract</i>	<p>Throughout the years, DNA-profiling has proven to be an indispensable feature within criminal investigations. The correct recognition, selection and collection of DNA traces from a crime scene, victim or suspect are crucial for reconstructing and solving criminal offenses. Many articles have been published on best-practice methodologies and procedures on examining DNA traces. The relevancy of this, often technical information, does not find its way to forensic researchers working at crime scenes and in research laboratories. For that reason, the decisions from detectives on the selection and collection of traces are profoundly based on their subjective, personal and experience-based knowledge. Currently, there is no collective insight in literature or results of DNA analysis, which does not offer the opportunity to learn. Therefore, a concise survey highlighted the urgent need for a software tool that provides detectives the most recent and reliable (objective) information on DNA traces. This concerns the recognition, collection and DNA-profiling results, given the information available in a case. The DNA succesmeter, a digital dashboard, provides accurate and up-to-date information on results that have been achieved in the past in an accessible and structural way. This always depends on the type of crime and type of biological material. The information is kept up to date by developing an adaptive system that provides the continuous addition of the latest results (from business and scientific research) of DNA research. Because the information partly comes from independent scientific research, the system has an internal control functionality that can value the balance between technical potential and the relevance of a DNA trace per type of offense. To create such a model, it is important to define the factors that influence the success of a DNA trace. The following six target variables were determined by a thorough review on literature and (laboratory) register systems: concentration of the sample, obtaining a DNA-profile that can be compared (to the DNA database), finding a match with an individual (suspect, database, victim or witness) and a DNA-profile that leads to a suspect, prosecution and conviction. As these target variables highlight the desired output of the DNA succesmeter, a framework of variables was established to gain insight into the input information of the DNA succesmeter. A total number of 38 variables were defined on the following subjects: case information, environmental factors, crime scene processing, details on exhibits, DNA analysis and results. Ranging from type of crime, weather conditions, type of exhibit and profiling results. In order to predict a possible outcome of the DNA succesmeter using these variables, a scenario was set-up including a burglary with two secured items: a bloodied jacket from the suspect and a T-shirt from the attacked victim. Regarding the jacket, the detective wants to know whether the blood originates from the victim, and which individual is the wearer of the jacket to gain insight in the possible perpetrator of the burglary. Regarding the T-shirt, the detective wants to analyse the shirt on contact traces from the individual that attacked the victim during the burglary. An analysis was performed on 240 examination forms with additional information on the following DNA results: DNA concentration and DNA match. The results show that collection of biological material from the wearer was generally performed with a stub (85,29%) on either the collar or a sleeve cuff. For any contact traces on jackets, the chest/sleeve area was mostly chosen as location for sampling biological material also with a stub. As this is just one example of providing an advice to a detective, this can be expanded by any other trace with DNA to specifics of the crime. In that way, each DNA trace and each case can be specified and categorized in the DNA succesmeter to effectively and efficiently perform criminal investigations.</p>

A solution is to focus on body fluid-specific mRNAs and look for variation in their sequence

Overview of the study

The study involves DNA/RNA co-isolation from body fluid donors (Sample set 1) and population samples (Sample set 2). The process includes optimization of DNA-specific multiplexes, design and optimization of RNA-specific multiplexes, and the use of RNA mixture samples (multiple body fluids, multiple donors; single body fluid, multiple donors). DNA SNP-profiles serve as a reference. The final step is to examine the ability to associate cell type and donor using massively parallel sequencing (MPS).

Student	Lydia Stravers
<i>Research carried out at</i>	NFI
<i>Supervisor</i>	Natalie de Jong-Weiler and Margreet van den Berge
<i>Title thesis</i>	Cell type-specific SNPs to associate cell type and donor
<i>Abstract</i>	<p>Combined forensic DNA and mRNA profiling of body fluid samples allows simultaneous identification of donors and cell types. For single donor samples, these profiling results can readily be linked, which allows the linking of individuals to criminal acts. However, when mixtures containing gender-neutral and/or same-gender body fluids are implicated, associating donors to particular cell types is currently not possible. Therefore, the study aimed to explore whether cell type-specific SNPs can be used to associate cell type and donor. First, cell type-specific marker genes that are currently used in an mRNA multiplex were examined for the presence of SNPs in their sequence. The mRNA regions (exons) with the most SNPs were selected and combined in a multiplex assay. DNA-specific multiplexes were designed to examine the presence and frequency of the SNPs. Testing on DNA has the advantage that for every donor, despite their gender or the cellular origin of the DNA, a SNP profile of all the markers can be generated. Sequencing of the markers was performed by means of massively parallel sequencing (MPS) using the MiSeq FGx instrument (Illumina). Based on the DNA sequencing results, the markers with informative SNPs will be combined in an RNA-specific multiplex and subsequently subjected to RNAs of forensically relevant body fluids and body fluid mixtures.</p>

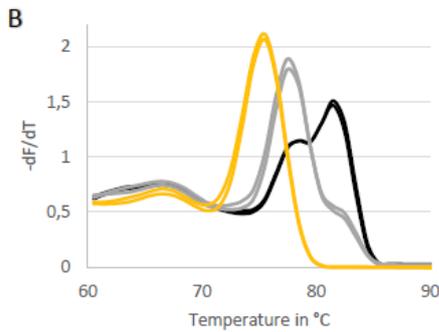


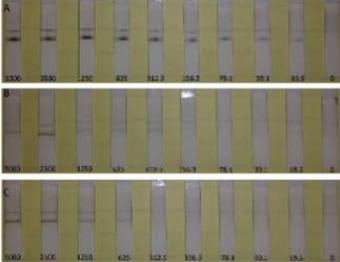
Figure 1: Melting curve profile for *Diceros bicornis* and *Ceratotherium simum*.



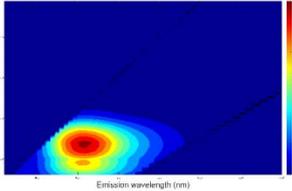
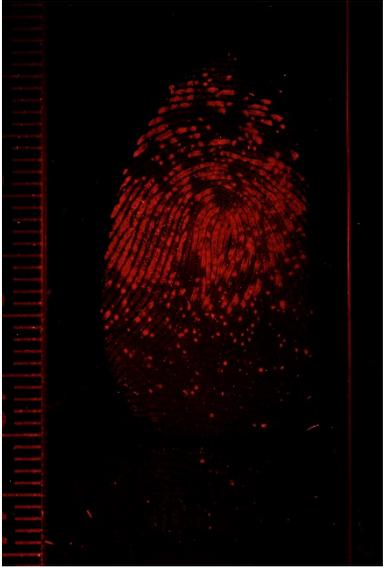
Figure 2: Primer assay design strategy

Student	Carlo Nolden
<i>Research carried out at</i>	Flinders University, Adelaide, SA, Australia
<i>Supervisor</i>	Professor DPhil Adrian Linacre
<i>Title thesis</i>	Mitochondrial DNA Typing from Rhino Horns – Developing a Multiplex Real-Time PCR Assay Using Melt Curve Analysis
<i>Abstract</i>	<p>According to the IUCN (International Union for Conservation of Nature), all five rhino species are in a critical decline, despite multiple conservation attempts by regulation of rhino horn trade by CITES (Convention on International Trade in Endangered Species of Flora and Fauna). Aim of this study is to develop a multiplex real-time PCR assay using melt curve analysis (HRM) of mitochondrial SNPs (single nucleotide polymorphisms) for forensic use. The presence or absence of melting peaks specific to the family of Rhinocerotidae and the underlying species will be used for identification.</p> <p>Using the intercalating dye SYBR Green I, a multiplex real-time PCR based melt curve assay was designed consisting of two different primer sets amplifying for two different genetic markers, 71 and 156 bp long. These can be clearly identified. In its current form, the assay is not yet finalized. It still needs to be optimized or modified and verified. Potentially, at the end there is a real chance that the forensic wildlife community is equipped with strong weapon in the fight against illegal poaching and trade of rhinoceros products.</p>

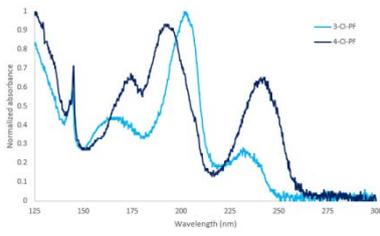
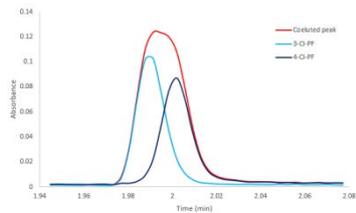
Forensic Biology – Non-human biological traces

	Student	Melde Witmond
	<i>Research carried out at</i>	AMC
	<i>Supervisor</i>	Dr. Annemieke van Dam
	<i>Title thesis</i>	Development of a lateral flow immunoassay for donor profiling of fingermarks
 <p data-bbox="236 855 579 965">Figure 1: Dose-response curves of control samples (A) and extracted spiked fingermark samples (B + C), made with the developed LFIA strips.</p>	<i>Abstract</i>	<p>In forensics, fingermarks are used for the identification of the donor via ridge patterns and DNA. When identification via these methods is not possible, the chemical composition of the fingermark residue might provide information on the donor that can aid in the identification, such as gender, blood types, and health status. Obtaining information on the donor from a fingermark is not only important in forensic science, it has also many applications in medical diagnostics, such as point-of-care testing for disease biomarkers. The main objective of this proof of principle study is to demonstrate the feasibility of a lateral flow immunoassay (LFIA) for the detection of compounds present in fingermark residue. The compound investigated in this study is C-reactive protein (CRP), a well-known biomarker for inflammation. In collaboration with Wageningen University & Research, an LFIA for fingermark samples was developed with a test line for CRP and a control line. In this research, CRP spiked fingermarks have been successfully analysed with the LFIA technique for the first time. The developed LFIA was tested on spiked fingermarks (detection limit 150-300 ng/mL; 1.5-3.0 ng protein), prior to analysing natural fingermark samples. As it was unknown whether CRP is present in natural fingermark residue, immunolabelling of CRP in natural fingermarks was performed. Detection of CRP in natural fingermark samples was achieved with immunolabelling. CRP was not detected in natural fingermarks with the LFIA, although CRP was detected in serum and saliva samples. In conclusion, the main objective of this research has been achieved by developing an LFIA that was able to detect CRP in spiked fingermark samples. This proof of principle study shows much promise and opens up many opportunities for further research, such as additional improvements on the LFIA for CRP and the detection of other biomarkers, with forensic and/or medical relevance, in fingermark residue.</p>

 <p>Fingermark samples from five different donors stained with upper-half stained with ninhydrin and lower-half stained with Nile red solution at t₀ analysed for RGB values..</p>	<table border="1"> <tr> <td>Student</td> <td>Meghna Swayambhu</td> </tr> <tr> <td><i>Research carried out at</i></td> <td>AMC</td> </tr> <tr> <td><i>Supervisor</i></td> <td>Mrs. Nihad Achetib</td> </tr> <tr> <td><i>Title thesis</i></td> <td>Proof of Principle: Predicting the initial protein-lipid composition of an aged fingermark.</td> </tr> <tr> <td><i>Abstract</i></td> <td> <p>Estimation of the age of a fingermark can be of immense importance in a forensic investigation. It can be pivotal in terms of supporting or refuting testimonies, reconstructing a timeline of events or as an exclusionary test. Despite attempts to develop a technique for age estimation of fingermarks, currently there are no successful methods. A fundamental limitation in developing a universal method for fingermark age estimation is the highly variable composition. Recently, a ratio of proteins and lipids and the progressive change in the ratio due to oxidation was used. The changes were found to occur based on the initial protein-lipid composition at t₀; irrespective of any inter and intra-individual variability.</p> <p>The aim of the present study is to determine the initial protein-lipid composition of an aged fingermark. To this end, the intensity of coloration using two staining methods- ninhydrin and Nile red for staining proteins and lipids respectively are used. Subsequently, the intensity of coloration was quantified using RGB (Red, Green, Blue) pixel values for samples stained with both staining solutions. Autofluorescence of proteins and lipid oxidation products in fingermarks is used as the indicator of the age of the fingermark. The strength of Hoeffding's correlation between the values obtained from autofluorescence measurements and the intensity of coloration was investigated. Additionally, the stability of the interaction of the solutions with fingermarks aged at different time points was studied by conducting a one-way ANOVA with Bonferroni post-hoc testing.</p> <p>The results display a moderate correlation between the values obtained from autofluorescence measurements and the intensity of coloration from both ninhydrin and Nile red stained samples. A significantly variable interaction between ninhydrin and aged fingermarks was obtained in contrast to a stable interaction of Nile red with aged fingermarks. Although, a moderate correlation has been established, the method is not strong enough to be used in forensic practice.</p> </td> </tr> </table>	Student	Meghna Swayambhu	<i>Research carried out at</i>	AMC	<i>Supervisor</i>	Mrs. Nihad Achetib	<i>Title thesis</i>	Proof of Principle: Predicting the initial protein-lipid composition of an aged fingermark.	<i>Abstract</i>	<p>Estimation of the age of a fingermark can be of immense importance in a forensic investigation. It can be pivotal in terms of supporting or refuting testimonies, reconstructing a timeline of events or as an exclusionary test. Despite attempts to develop a technique for age estimation of fingermarks, currently there are no successful methods. A fundamental limitation in developing a universal method for fingermark age estimation is the highly variable composition. Recently, a ratio of proteins and lipids and the progressive change in the ratio due to oxidation was used. The changes were found to occur based on the initial protein-lipid composition at t₀; irrespective of any inter and intra-individual variability.</p> <p>The aim of the present study is to determine the initial protein-lipid composition of an aged fingermark. To this end, the intensity of coloration using two staining methods- ninhydrin and Nile red for staining proteins and lipids respectively are used. Subsequently, the intensity of coloration was quantified using RGB (Red, Green, Blue) pixel values for samples stained with both staining solutions. Autofluorescence of proteins and lipid oxidation products in fingermarks is used as the indicator of the age of the fingermark. The strength of Hoeffding's correlation between the values obtained from autofluorescence measurements and the intensity of coloration was investigated. Additionally, the stability of the interaction of the solutions with fingermarks aged at different time points was studied by conducting a one-way ANOVA with Bonferroni post-hoc testing.</p> <p>The results display a moderate correlation between the values obtained from autofluorescence measurements and the intensity of coloration from both ninhydrin and Nile red stained samples. A significantly variable interaction between ninhydrin and aged fingermarks was obtained in contrast to a stable interaction of Nile red with aged fingermarks. Although, a moderate correlation has been established, the method is not strong enough to be used in forensic practice.</p>
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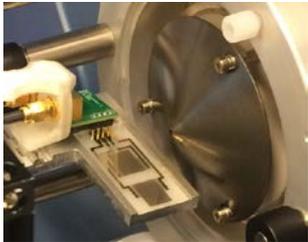
 <p>Excitation-Emission-matrix of Diamond Dye</p>  <p>Fingerprint labelled with anti-dermcidin antibody before DNA profiling</p>	Student	Magdalena Birkl
	<i>Research carried out at</i>	AMC
	<i>Supervisor</i>	Dr. Annemieke van Dam
	<i>Title thesis</i>	Presumptive quantification of DNA and improving DNA analysis in fingerprints
	<i>Abstract</i>	<p>Two significant means of identification in forensics are DNA and fingerprints. To generate a usable DNA profile, a minimum amount of DNA is necessary. Usually, the DNA concentration in biological samples at the crime scene is unknown. A presumptive quantification method for DNA can aid in a pre-selection of crime scene traces and can result in an increased success rate of DNA typing. In many cases, the visual features of fingerprints are used to identify the donor of a fingerprint. For the visualisation, different techniques, like for example the use of dusting powder or antibodies, can be used. However, it can also be necessary to generate a DNA profile from a fingerprint after the visualisation. It is not yet known if it is possible to generate a DNA profile from fingerprints which were previously treated with antibodies. The first part of the research focussed on the investigation whether, first, the fluorescence intensity of the DNA-binding dyes 4',6-diamidino-2-phenylindole (DAPI) and Diamond™ Nucleic Acid Dye and, secondly, the amount of the protein markers telomere repeat factor-1 (TRF1) and -2 (TRF2) showed a correlation with the DNA concentration of a sample. It was not yet possible to establish a linear correlation between neither the DNA-binding dyes and the DNA concentration, nor the protein markers and the DNA concentration. The second part of the research investigated the applicability of DNA typing after the treatment of fingerprints with antibodies. Fingerprints were deposited on different substrates, visualised with antibodies and DNA profiles were generated. It was possible to generate full and partial profiles from 18 of 27 fingerprint samples.</p>

Forensic Biology – Drugs of Abuse

	Student	Corina Kukurin
	<i>Research carried out at</i>	Van't Hoff Institute for Molecular Sciences (HIMS), University of Amsterdam
	<i>Supervisor</i>	Alan García Cicourel
	<i>Title thesis</i>	Drug isomer analysis and differentiation: addressing the challenge with vacuum ultraviolet absorption spectroscopy (VUV)
<p>Figure 1: VUV spectra of 1-(3-chlorophenyl)propan-1-one and 1-(4-chlorophenyl)propan-1-one</p>	<i>Abstract</i>	<p>With the growing number and amount of New Psychoactive Substances (NPS) that annually emerge on the global illegal drug market, the use of GC-MS is no longer sufficient for the unequivocal chemical identification of substances in forensic illicit drug casework. MS suffers from the lack of spectral specificity for the isomeric and isobaric compounds like NPS, which often exhibit highly similar electron ionization mass spectra. Therefore, many forensic institutes employ GC-IR in addition to GC-MS. However, the IR has some limitations, such as lower sensitivity (not all compounds express IR activity) and technical complexity of coupling GC and IR.</p>
		<p>The recently introduced bench-top VUV (vacuum ultraviolet absorption spectroscopy) detector for gas chromatography also has the ability to discriminate isomers on the basis of small differences in the chemical structure. The detector obtains full absorption spectra from 120 to 430 nm where all compounds, including isomers and isobars, express characteristic spectra, which makes this detector universal. Although the VUV spectra typically do not allow full structure elucidation, the VUV detector offers good stability and sensitivity and allows for an accurate quantitative analysis.</p>
<p>Figure 2: Deconvolved peaks of 1-(3-chlorophenyl)propan-1-one and 1-(4-chlorophenyl)propan-1-one (VUV Model & Analyze software)</p>		<p>In this study, GC-VUV and GC-MS performance characteristics for a selection of drug isomers and precursors were compared; they were demonstrated to be very similar in terms of linearity, sensitivity, and repeatability. Additionally, it was shown that noise reduction is beneficial for improving the shape of the VUV spectra at low concentrations, which consequently allowed for accurate identification and robust differentiation between closely related isomers even at low concentrations. Finally, the VUV software deconvolution in case of GC peak coelution proved a valuable tool to address mixture problems. MCR-ALS tool is, however, superior for the deconvolution when no prior information is known about the sample. Nevertheless, for subsequent identification of the deconvolved spectra, both programs require the reference spectra in the VUV library. In conclusion, the VUV detector provides what appears to be useful complementary information to the commonly used MS detector.</p>

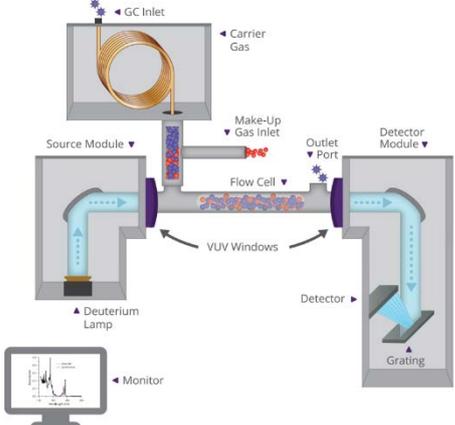
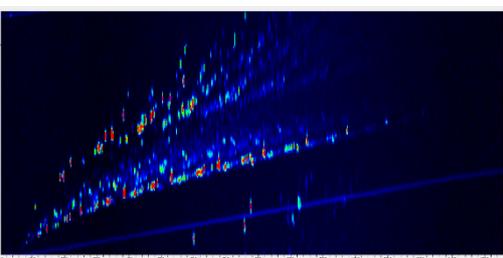
<p>Conventional process (left) versus the NFIDENT process (right)</p>	<p>Student</p>	<p>Lydia Jochems</p>
	<p><i>Research carried out at</i></p>	<p>NFI</p>
	<p><i>Supervisor</i></p>	<p>Jerien Koopman and Saskia Verheij</p>
	<p><i>Title thesis</i></p>	<p>Optimizing the current executed NFIDENT process</p>
	<p><i>Abstract</i></p>	<p>This research project aims to optimize the new process for illicit drug identification, called NFIDENT. This new process should decrease the turnaround time and increase the efficiency compared to the conventional process. The new process is currently in use at four police units. The first implementation was assessed in order to further improve the process. During this project the current execution and performance was determined for the process at the police and NFI. The performance was determined using turnaround time (TAT) data. This information was used to determine the bottlenecks of the process and provide recommendations for optimization. The NFIDENT process is a pioneering process in the forensic field and is a unique example of cooperation in the forensic chain.</p>

Forensic Chemistry – Explosives

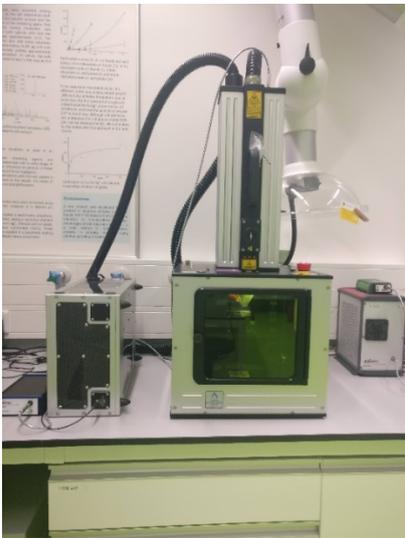
 <p>SAWN device and chip. Arrow indicates the pins which provide power to the electrodes.</p>  <p>Paper spray cartridge attached to the inlet of the MS, with alligator clip supplying voltage to the inserted paper.</p>	Student	Lauren Pintabona
	<i>Research carried out at</i>	HIMS
	<i>Supervisor</i>	Dr. Alina Astefanei
	<i>Title thesis</i>	Investigation into the simple and rapid analysis of organic explosives using ambient mass spectrometry (MS): paper spray (PS)-MS and surface acoustic wave nebulization (SAWN)-MS
	<i>Abstract</i>	<p>In forensic investigations, there is need for the rapid analysis of explosives. Mass spectrometry is a highly selective and sensitive technique that is able to identify a wide range of these compounds. However, a suitable ionization technique is needed for identification to occur. Previously, this required a high vacuum environment; ambient ionization (AI) techniques now allow for ionization to occur under atmospheric conditions.</p> <p>This research investigates paper spray (PS) and surface acoustic wave nebulization (SAWN) as AI techniques to be coupled with MS for the identification of explosives. These simple techniques require small sample volumes, and no preparation prior to analysis. For PS, ionization is simply induced through a voltage rather than through the use of controlled environments, characteristic of other AI methods. In comparison, no direct voltage is applied to the sample itself for SAWN. Instead, electrical energy applied to a chip is converted to mechanical energy, which in turn initiates ionization.</p> <p>The aim of this study is the development, optimization, and application of SAWN-MS and PS-MS for the identification of organic explosives. Both of these techniques are rapid, simple, and sensitive, all ideal aspects for the analysis of trace residues. Low sample amounts are required for analysis, with limits of detection reaching as low as 102.6 ng/mL. Furthermore, testing can be carried in as little as 1 minute. The results show significant advantages over methods such as ESI and APCI, and include higher signal intensities, more identified analyte ions, and higher S/N ratios.</p> <p>This research highlights the use of SAWN and PSI to be suitable alternatives to methods currently employed for similar applications. The analysis of 7 explosives (TATP, HMTD, PETN, ETN, TNT, HMX, and RDX) yielded results favorable to those obtained using comparable techniques, as molecular ions and their adducts were successfully identified at higher intensities. Degradation products were also present in the spectra of these explosives, indicating the potential of both systems investigated here to analyze pre-, as well as post-, explosion samples.</p>

 <p>Sample locations throughout the Netherlands</p>	Student	Jesse Verbunt
	<i>Research carried out at</i>	NFI
	<i>Supervisor</i>	Dr. Carlos Martín-Alberca
	<i>Title thesis</i>	Investigating the New Year's Eve effect: Analysis of the presence and persistence of pyrotechnic explosive related ions in the background using IC-ESI-MS
	<i>Abstract</i>	<p>The custom of the Dutch to ignite a lot of fireworks at New Year's Eve (NYE) may cause problems in the interpretations in forensic explosive casework. Similar compounds as encountered in casework will fall back to earth, likely increasing the background levels of these ions. This study determined the presence, significance and relevance of this effect which we named the New Year's Eve Effect (NYEE). Employees of the Explosives group of the Netherlands Forensic Institute (NFI) collected samples before NYE (reference) and at 7 intervals in January by swabbing an A5 sized surface on different objects using an isopropanol swab. After sample preparation according to a standard procedure of the NFI, the samples were analysed using a new state-of-the-art ACN-enhanced stepwise gradient ion chromatography coupled to electron spray ionisation mass spectrometry (IC-ESI-MS) anion method. It is observed that the NYEE is present and tendencies can be recognized for ions relatable to fireworks like chloride, nitrate, sulfate, thiocyanate, thiosulfate, chlorate and perchlorate. Although the effect is present, only 1 out of 84 changes in ionic concentrations analysed seems to be statistically significant. The significant change is found for perchlorate present on lamp posts. These results are obtained under the specific conditions as present during this study. Whether the effect has an impact on forensic casework depends in the case related context, less decreasing influences or higher pyrotechnic activity will lead to a higher significance and therefore larger possible impact on case work.</p>

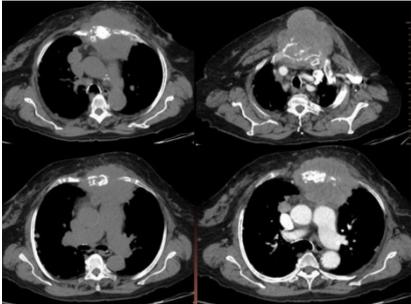
Forensic Chemistry – Fire Debris Analysis

 <p>A schematic overview of the Vacuum Ultraviolet Spectrometer in line with a GC system.</p>  <p>GCxGC-VUV chromatogram of kerosene.</p>	<p>Student Robert van Vorstenbosch</p>
	<p><i>Research carried out at</i> Shell Technology Centre Amsterdam</p>
	<p><i>Supervisor</i> Jan Blomberg (Shell)</p>
	<p><i>Title thesis</i> Vacuum Ultra Violet Spectroscopy for the Analysis of Complex Hydrocarbon Samples and its Forensic Applicability in Arson Analyses.</p>
<p><i>Abstract</i></p> <p>In this study the forensic applicability of the new Vacuum Ultra Violet detector (VUV) was looked into with regard to arson analysis. Also, a Shell separation methodology was created to obtain comprehensive data for similar samples to replace complex instrumentation.</p> <p>The field of arson analysis is experiencing some problems because Mass spectrometry cannot distinguish all the isomers present in complex ignitable liquid samples. The new technology of the VUV promises to tackle these problems. Due to the unique spectral fingerprint of all molecules, this would no longer be a problem.</p> <p>This project found the VUV to be very interesting for forensic applications. The technique is already good enough to implement it with GC (gas chromatography), where it could very successfully replace complex Shell instrumentation. However, the instrument used was not (yet) mature enough for implementation with a GCxGC system. Current updates of the VUV, however, are very likely to result in a mature enough technique for GCxGC and thus for arson analysis.</p>	

Forensic Chemistry – Material Analysis

	Student	Orla Rochford
	<i>Research carried out at</i>	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO) Utrechts
	<i>Supervisor</i>	Sjaak van Veen, MSc., Prof. Dr. Antoine van der Heijden.
	<i>Title thesis</i>	Forensic Applications of LIBS
	<i>Abstract</i>	<p>This study focuses on the forensic application of laser-induced breakdown spectroscopy (LIBS) in two areas: the removal and detection of arsenic and phosphonate anions from water, and the elemental profiling of fireworks. LIBS combined with adsorption onto a ceramic surface has been utilised for the efficient removal and detection of arsenic and ethyl methylphosphonic acid (EMPA) in water. Several adsorbents such as zinc oxide (ZnO), zirconium oxide (ZrO), hydrous cerium oxide nanoparticles (HCO), cerium impregnated silica monoliths have been used with varying success. Arsenic and phosphonate adsorption were investigated using two approaches: an active sampling approach (column or stirring) and a passive sampler approach ('dip stick'). A ZnO 'dip stick' showed the best results for arsenic detection. ZrO provided the best results for passive phosphonate detection and HCO provided the best results for active phosphonate detection. Of the two species of arsenic, arsenite showed stronger adsorption to ZnO than arsenate. Using an active column sampler, ZnO showed arsenic adsorption saturation sooner than the passive ZnO sampler, however, the development of a passive sampler demonstrates the scope of LIBS as an analytical tool in field testing. The arsenic adsorption capacity of ZnO was found to be 0.001334 mg/g. Phosphonate's adsorption trend was inexplicable for both ZrO and HCO; adsorption was strong, but there was no correlation with the concentration of EMPA. Finally, the use of LIBS for elemental profiling of plastic firework caps has potential. LIBS analysis provided results that both agree and disagree with LA-ICP-MS analysis. Out of the 22 elements detected by LA-ICP-MS, LIBS identified 14, plus nine more that were not identified with LA-ICP-MS. Moreover, when comparing LIBS to XRF, LIBS performed well. Out of 35 elements XRF detected 16, while LIBS detected 27. This result shows that LIBS is more sensitive than XRF even while using a limited selection of wavelengths, highlighting its potential to verify LA-ICP-MS results more accurately than XRF.</p>

Forensic Medicine – Biomedical Engineering

 <p>CT scan images where multiple tissues are represented</p>  <p>The influence of the body fat percentage on the posture of an individual with the same length</p>	<table border="1"> <tr> <th>Student</th> <th>Imane Haltout</th> </tr> </table>	Student	Imane Haltout
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Forensic Medicine – Forensic Anthropology



Setup used for bone dust measurements

Student	Lucas Jimenez Bou
<i>Research carried out at</i>	NFI / Delft University of Technology
<i>Supervisor</i>	Reza R.R. Gerretsen MD / Dr.ir. Arjo J. Loeve
<i>Title thesis</i>	Engineering for Forensics: The Risk of Sawing in Bone
<i>Abstract</i>	When biological material is aerolised, particle sizes may fall within the human respirable range and act as vectors for concerning diseases to prosectors. The goal of this study was to explore the potential effects between sawing parameters and amount and size of bone particles becoming airborne. The methodology involves the use of an oscillating saw with variable saw blade frequencies and contact forces on dry human femora. Released airborne particles were measured on diameter size as well as concentration by a particle counter inside a closed and controlled environment. Results corroborated with proposed hypotheses, combination of higher frequencies and lower contact forces can extensively increase the production of total amount of aerosol. However it is indicated that even in the best-case scenario measured for low aerosolisation of dry bone, aerosol production is still high enough to provide a potential risk. That being stated, protective breathing gear such as respirators and biosafety protocols are recommended to be put into practice to prevent forensic practitioners from acquiring pathologies or other biological hazards when performing autopsies.



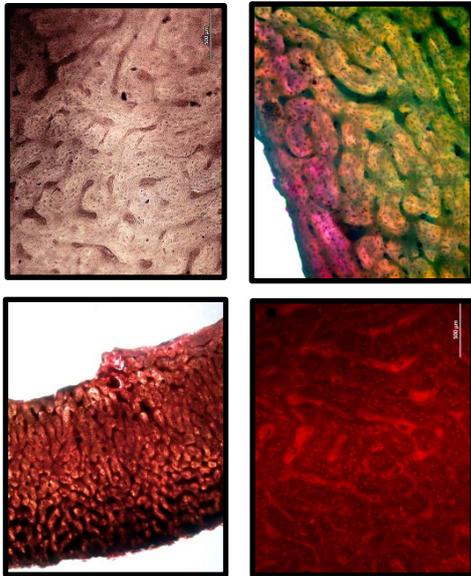
Comminuted fracture assembled to observe the general fracture pattern on a



Comminuted fracture assembled to observe the general fracture pattern on a fresh cranium

Student	Patricia Ribeiro
<i>Research carried out at</i>	Institute for Legal Medicine and Forensic Science of Catalonia (IMLCFC)
<i>Supervisor</i>	Ignasi Galtés
<i>Title thesis</i>	Analysis of Blunt Force Trauma in Human Cranial Bones: A distinction between perimortem and post-mortem fractures
<i>Abstract</i>	<p>For a forensic anthropologist it is important to distinguish peri- from post-mortem fracture. These differences are crucial to determine the time when a fracture occurred, reconstruct the events and provide possible scenarios of the fractures inflicted on the victim. There are studies that provide this information on long bones and ribs, but there is no literature on cranial bones. The main aim of this study is to obtain fracture pattern of cranial bones that might allow us to characterize a perimortem fracture. This was performed through macroscopic assessment of comminuted fractures between 123 fragments from autopsies, 100 fragments of experimental post-mortem fractured and 20 fragments of experimental fresh fractures.</p> <p>The evaluation resulted in 6 traits associated with perimortem fractures: wave lines, peels, flake defects, fissures, crushed margins and bone scales. In addition, an algorithm was designed to predict the period of a fracture based on the frequency and significance of these traits.</p> <p>Given the evolution of technology and the need to find a better method to evaluate cadavers in poor conditions, eight fragments from autopsy cases were submitted to 3D CT-scans. It was possible to distinctly observe 6 traits on a 3D CT scan: wave lines, bone scales, peel, bevelling, laminar breakage and bridge.</p> <p>The preliminary results of the experimental fresh bones evaluation showed that there might be a correlation between the fracture morphology and the biomechanism of the injury. In this study, it is suggested that peels and flake defects occur due compressive forces. On the other hand, fissures might occur due to tensile stress.</p>

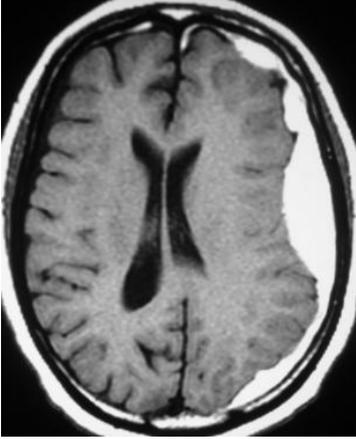
 <p>Experimental setup for burning experiment in firehouse. Bones subjected to BFT and unaltered bones wrapped as bone packages.</p>  <p>Appearance of bones before (top) and after (bottom) burning. The heat-caused discolouration can be seen in the burned bones.</p>	Student	S. Divya
	<i>Research carried out at</i>	AMC
	<i>Supervisor</i>	Drs. Ing. Tristan Krap
	<i>Title thesis</i>	Hit or burn? – Differentiating blunt force trauma fractures from heat-induced fractures in burned bones
	<i>Abstract</i>	Trauma interpretation from burned remains, being a persisting challenge, affects events reconstruction in forensic casework. The similarity, the co-existence and overlapping of features of traumatic fractures and heat-induced fractures (HIFs) accounts for this problem. Scarce literature exists for this issue, particularly for blunt force trauma (BFT) and these studies utilized animal bones. To address this problem, this project aims to distinguish the characteristics of BFT-fractures (focused only on complete fractures) and HIFs (and situational fractures) in burned bones. Defleshed fresh-frozen human cadaveric forearm bones were subjected to BFT (using pendulum-like contraption) and/or burning (wooden pyre in firehouse). The resulting fractures were scrutinized using a checklist of features (fracture morphology, colour and dimensional changes) derived from prior studies to determine these differences. Macro- and microscopic analyses were done. Colour changes were assessed using a colourimetric model. Traumatic fractures showed rough fractures edges with some smooth curved/slanted regions while HIFs displayed smooth surfaces, post-burning. Some longitudinal HIFs and longitudinal situational fractures mimicked the fracture lines of traumatic fractures, which could lead to misidentification of fracture type. Other overlapping features between the BFT-fractures and HIFs (and situational fractures) include smoothness seen in both fracture edges, situational fracture outlines being similar to transverse BFT-fracture outlines and fracture angles below 90°. Interestingly, situational fracture margins were elevated on one side whereas HIFs penetrated into the medullary cortex. The former also showed even richly-coloured edges while BFT-fractures had uneven discolouration of fracture edges. No distinct trend was observed between fracture presence/formation, colouration and temperature range. Most of the observed features agreed with former studies. This study shows the effectiveness of a checklist of both quantitative and qualitative features for fracture differentiation and successful analysis using a stereomicroscope, a simpler and cheaper technique. Since fracture formation and/or alteration during burning are influenced by inter-individual variability and many environmental factors, further research is needed to understand the above differences. Conclusively, differentiation of traumatic fractures from HIFs is possible through meticulous analysis. However, experimental results may not always be applicable to forensic casework as they are not entirely representative of forensic case conditions.

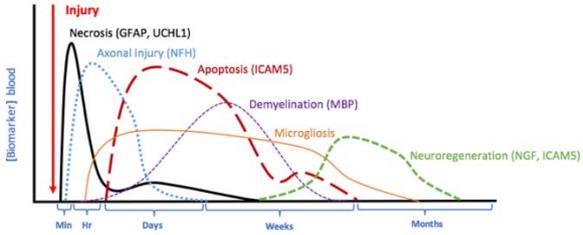


A. shows a cross-section of a bone without any dye applied. B. is a cross-section stained with Sirius Red/ Fast Green. C. depicts an image of a cross-section stained with Eosin and D. is a cross-section stained with Nile Red, seen from under a fluorescence microscope.

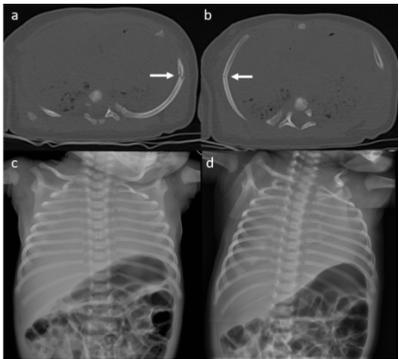
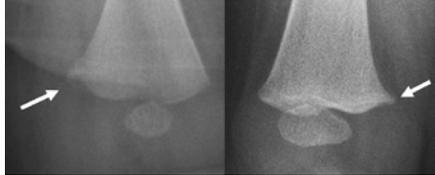
Student	Jolien Nienkemper
<i>Research carried out at</i>	AMC
<i>Supervisor</i>	Dr. ing. Tristan Krap & Dr. Annemieke van Dam
<i>Title thesis</i>	Exploring new methods to determine the PMI of modern skeletal remains
<i>Abstract</i>	<p>An indication of the post-mortem interval (PMI) of skeletal remains can be of tremendous help to forensic investigators. However, at present, few methods exist which are capable of estimating the PMI of modern remains. The present study will explore new methods which can potentially contribute to estimating the PMI. This is achieved by applying multiple different dyes to pig bones which have been exposed to the environment up to twenty months in an open field. Sirius Red and Fast Green stain collagen pink and non-collagenous proteins green, Eosin stains proteins pink, collagen being its main target, while Nile Red is known to fluoresce red when bound to lipids. Fluorescence and absorption spectrometry was used to quantify the bound dyes. Sirius Red/ Fast Green staining showed a significant correlation with PMI, yet results contradict with previous research. Through absorption measurements a significant correlation was found between Eosin-quantity and PMI, yet, fluorescence measurements were not able to confirm this relationship. Lastly, Nile Red staining was not proven to correlate to PMI statistically, but observations suggest an interrelation between lipid-quantity and PMI.</p>

Forensic Medicine – Forensic Pathology

 <p><A CT image of blood pooled between the subarachnoidal layer and the dura mater></p>  <p><UV-VIS Spectroscopy samples 'stamped' and drying pre-measurement></p>	<table border="1"> <tr> <td>Student</td> <td>Jordan (Antonius Matheus) Rust</td> </tr> </table>	Student	Jordan (Antonius Matheus) Rust
	Student	Jordan (Antonius Matheus) Rust	
	<table border="1"> <tr> <td><i>Research carried out at</i></td> <td>AMC</td> </tr> </table>	<i>Research carried out at</i>	AMC
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	<table border="1"> <tr> <td><i>Supervisor</i></td> <td>Dr. Ir. Bram Coolen</td> </tr> </table>	<i>Supervisor</i>	Dr. Ir. Bram Coolen
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<table border="1"> <tr> <td><i>Title thesis</i></td> <td>Towards an In Vitro Age determination model for subdural haematomas</td> </tr> </table>	<i>Title thesis</i>	Towards an In Vitro Age determination model for subdural haematomas	
<i>Title thesis</i>	Towards an In Vitro Age determination model for subdural haematomas		
<table border="1"> <tr> <td><i>Abstract</i></td> <td> <p>Head Trauma is a prevalent cause of mortality in our society, be it from domestic sources or from criminal intent. When it's the latter it can be of great medicolegal importance to be able to determine the time-since-incident exactly, on the basis of clinical information. For this research, 4 subjects were asked to donate 5 vacutainers of blood, with which we attempted to compare different ex vivo research methods, to see if the results show a pattern that could result in feasible aging of blood to determine time-since-incident, and whether or not this pattern is comparable to in vivo results. For this, protocols for each method (MRI, NMR & UV-VIS Spectroscopy) were designed and tested. In addition, the effect of cooling/freezer storage is examined to provide more logistically feasible experimental setup for future research. Both NMR and Spectroscopy showed promising aging patterns, but show both big interpersonal as well as measurement variability, and show no initial correlation to in vivo work nor has comparable in vitro research been done. MRI seemed most promising with results comparable to both literature and relatable in vivo circumstance. However, T2 relaxation times are found to rise consistently, but uniquely in MRI measurements when under the effect of cooled storage. More work is needed with regards to using SDH samples ex vivo, the effect of neuron/glia – blood cell interaction and the extent of HbO saturation influence between in vivo and ex vivo measurements. Moreover, the mechanical underpinning for the apparent rise in T2 relaxation under cooled conditions warrants further examination.</p> </td> </tr> </table>	<i>Abstract</i>	<p>Head Trauma is a prevalent cause of mortality in our society, be it from domestic sources or from criminal intent. When it's the latter it can be of great medicolegal importance to be able to determine the time-since-incident exactly, on the basis of clinical information. For this research, 4 subjects were asked to donate 5 vacutainers of blood, with which we attempted to compare different ex vivo research methods, to see if the results show a pattern that could result in feasible aging of blood to determine time-since-incident, and whether or not this pattern is comparable to in vivo results. For this, protocols for each method (MRI, NMR & UV-VIS Spectroscopy) were designed and tested. In addition, the effect of cooling/freezer storage is examined to provide more logistically feasible experimental setup for future research. Both NMR and Spectroscopy showed promising aging patterns, but show both big interpersonal as well as measurement variability, and show no initial correlation to in vivo work nor has comparable in vitro research been done. MRI seemed most promising with results comparable to both literature and relatable in vivo circumstance. However, T2 relaxation times are found to rise consistently, but uniquely in MRI measurements when under the effect of cooled storage. More work is needed with regards to using SDH samples ex vivo, the effect of neuron/glia – blood cell interaction and the extent of HbO saturation influence between in vivo and ex vivo measurements. Moreover, the mechanical underpinning for the apparent rise in T2 relaxation under cooled conditions warrants further examination.</p>	
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<p>SPR biosensor with printed biomarker-specific antibodies</p>  <p>Biomarker temporal profiles potentially applicable to SDH age determination</p>	<p>Student Choenne Straatman</p>
	<p><i>Research carried out at</i> AMC</p>
	<p><i>Supervisor</i> Dr. Annemieke van Dam</p>
	<p><i>Title thesis</i> Detection of Subdural Hematoma Age-Specific Biomarker Patterns Using a SPR-Based Biosensor</p>
	<p><i>Abstract</i> In traumatic brain injury (TBI), the presence of a subdural hematoma (SDH) strongly indicates trauma. In case of trauma caused by physical abuse, a subsequent legal investigation is initiated in which age estimation of the injury is of great evidential value, i.e. for supporting/ refuting witness statements. However, due to the complex nature of SDHs, current applied neuroimaging methods are insufficient for age estimation of SDHs, mostly by lacking objectivity. In this respect, TBI-specific biomarkers might provide a solution, as temporal profiles have previously been demonstrated in serum obtained during the acute phase of TBI. In this study, temporal profiles of six TBI-specific biomarkers have been demonstrated in six non-acute SDH serum samples with estimated ages ranging from 33 to 480 days old, using a Surface Plasmon Resonance (SPR) biosensor. The biomarkers of interest included: Myelin Basic Protein (MBP), Glial Fibrillary Acidic Protein (GFAP), Ubiquitin C-terminal Hydrolase L1 (UCHL1), Neurofilament Heavy chain protein (NFH), Intercellular Adhesion Molecule-5 (ICAM5) and Nerve Growth Factor (NGF). Furthermore, it was possible to distinct SDH serum and control samples based on their biomarker patterns, using PCA analysis. As biomarker patterns and temporal profiles have not been demonstrated before in non-acute SDH serum samples, this study provided new information and insights applicable to the development of an objective method for age estimation of SDHs, which is of great forensic value.</p>

Forensic Medicine – Forensic Pediatrics

 <p>Two lateral rib fractures seen on CT (a-b) but missed on conventional radiography (c-d).</p>  <p>Two CMLs that were missed on CT but seen on conventional radiography</p>	<p>Student Esther van de Mortel</p>
	<p><i>Research carried out at</i> AMC</p>
	<p><i>Supervisor</i> Prof. dr. R.R. van Rijn</p>
	<p><i>Title thesis</i> Post-mortem Computed Tomography Versus the Skeletal Survey in Children: a Pathology Proven Study</p>
	<p><i>Abstract</i> Annually, between 118.000 and 180.000 children in the Netherlands are exposed to a form of abuse, of which 18% are physically abused. It has been shown that child abuse not only has short term-, but also long term effects on the (mental) health of a child. Therefore, it is important to detect child abuse as early as possible to protect the health of the child and to prevent further injuries, of which death is the most extreme outcome. In order to do this, non-accidental injuries should be recognized correctly by the physician and an imaging technique should be available to accurately detect abuse-related injuries. Although a skeletal survey (conventional radiography) is still the golden standard in a (post-mortem) radiological examination, it has been shown that post-mortem CT (PMCT) has several advantages over conventional radiography (CR). Therefore, the aim of this research was to determine whether it was possible to (partly) replace the skeletal survey by a PMCT scan. For this research, children younger than five years in which both a skeletal survey and a PMCT scan were obtained, were included in this study. The cases were retrospectively reviewed by an experienced paediatric radiologist. The fracture patterns on CR and CT were scored and evaluated. In 24 cases, fractures were observed (16 males, 8 females). It was shown that CT detects significantly more rib fractures than CR or autopsy ($p=0.01$ and $p=0.004$, respectively). Also, CT detected more skull fractures than CR. These results suggest that radiographs of the thorax and skull can be excluded from the skeletal survey. However, it is shown that PMCT cannot completely replace the skeletal survey; classic metaphyseal lesions (CML) were easily missed on CT. It can be concluded that PMCT is of great value in detecting rib fractures when compared to the skeletal survey. As CMLs were easily missed on CT, a suggestion for the protocol is to perform a whole body PMCT with additional radiographs of the metaphyseal parts of the long bones. Eventually, this could hopefully be implemented in the examination of the living.</p>

	Student	Jeanine Oude Elferink	
	<i>Research carried out at</i>	NFI	
	<i>Supervisor</i>	R.A.C. Bilo	
	<i>Title thesis</i>	Comparison of age estimation of injuries, related to inflicted head injury in children: a retrospective study	
	<i>Abstract</i>	<p>Purpose Knowledge of the reliability of dating injuries related to inflicted head injury in children may aid forensic pediatrics and criminal court to protect a child or to find a suspect. The aim of this study is to establish the reliability of dating injuries in the clinical setting compared to dating in the forensic setting.</p> <p>Methods A retrospective study was performed of all post-mortem cases in which children under the age of 5 were autopsied at the Netherlands Forensic Institute (NFI) between the years 2007 and 2017. Pre-mortem and post-mortem data were evaluated, in which clinical symptoms, neuro-radiological findings, and (neuro)pathology findings were compared. The strength of evidence was obtained by determining the likelihood ratio, which is important in the forensic setting.</p> <p>Results Dating of head injury based on neuro-radiological findings is not reliable according to medical literature. In 38% of the cases clinical radiologists did date head injury, however in their reports there was no consistency in the used definitions. The clinical symptoms were compared to dating in neuropathology, in which the findings of clinical symptoms at more than 1 moment “acute admission to hospital with previous non-specific or specific symptoms” was slightly more probable in case of recent and old brain injury (> 1 moment) dated by the neuropathologist than in case of recent brain injury (1 moment) dated by the neuropathologist.</p> <p>Conclusion The findings illustrate the importance of the history of clinical symptoms in dating inflicted head injury. Therefore, in deceased children the history of clinical symptoms should be used as indicator for dating brain injury in conjunction to dating brain injury in neuropathology. Neuroradiology should be used to diagnose brain injury and support neuropathology and the clinical history.</p>	

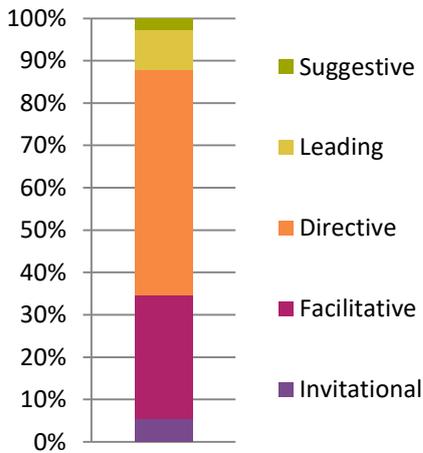


Figure 1. The average distribution of utterance types over all of the interviews. The proportions of utterance types are shown as percentages. The directive prompts make up more than half of the interviews, followed by the facilitative utterances, the leading, invitational and suggestive utterances.

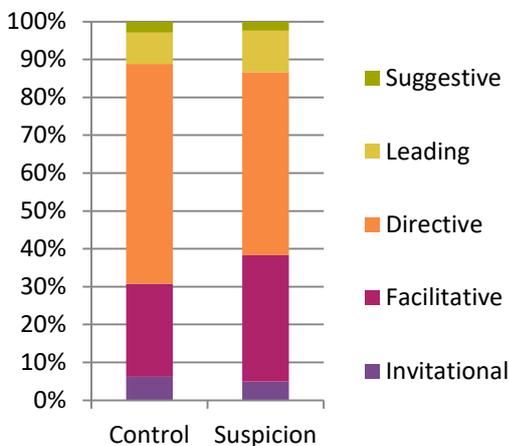


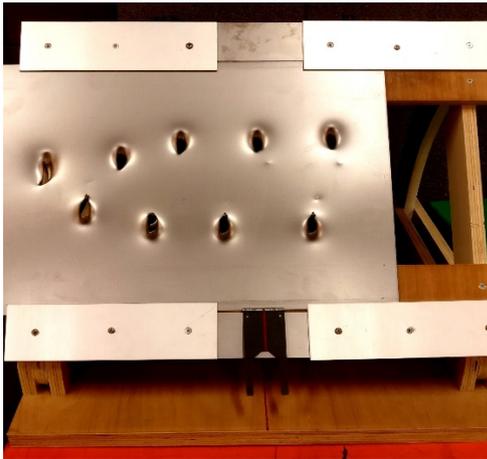
Figure 2. The average distributions of utterance types in the control and suspicion group. The proportions of utterance types are shown as percentages. No significant differences were found between the two groups.

Student	Mareen Boel
Research carried out at	AMC
Supervisor	K. van Ham
Title thesis	Evaluation of an interview technique for the detection of child sexual abuse.
Abstract	Identifying victims of child sexual abuse (CSA) is very challenging because physical indicators are not always present and psychosocial symptoms appear non-specific for CSA. In many cases the verbal disclosure of the child may be a last resort, but a limited amount of methods is available to elicit and assess a verbal disclosure and they make use of interviewing techniques, which is precarious. The quality of the information provided by the child in an interview setting is highly dependable on the conductance of the interview and the type of questions asked, which may lead to false allegations or reduced credibility of the child. The quality of a semi-structured interview technique of one of the available methods, the Sexual Knowledge Picture Instrument (SKPI) method is assessed in this study. The composition of the interviews is explored by scoring five types of utterances; invitational, facilitative, directive, leading (introducing new information) and suggestive (signalling a desired answer). Additionally, it is investigated whether the composition of interviews differs between a control group and a group with children with suspected exposure to CSA. The results showed more than half of the interview consists of directive questions and roughly 12% of the interview involves leading or suggestive utterances. No differences were found between the distributions in the two groups, implying that the knowledge of the interviewers does not affect their performance. This study thusly shows consistent performances, indicating an adequate quality, but also room for improvement. More and expanded evaluations of other protocoled interview techniques are recommended for the future to provide our society with a well-founded approach for the detection of CSA, which is urgently needed.

Forensic Medicine – Forensic Physics

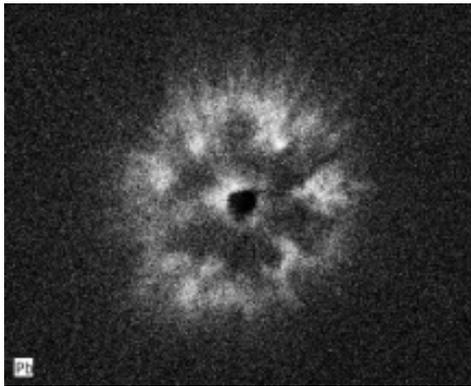


Experimentation setup for shooting at car bonnets

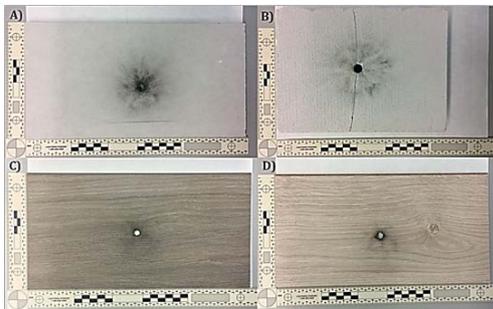


Results obtained from shooting on sheet metal mounted on a cradle.

Student	Sree Versha Hari
<i>Research carried out at</i>	NFI
<i>Supervisor</i>	Wim Kerkhoff
<i>Title thesis</i>	Bullet impact on bare sheet steel and steel automobile body material
<i>Abstract</i>	<p>The primary focus of the study was to assess whether bare sheet metal is a suitable substitute for car body material in forensic/ballistic experimentation. To answer this question, we have investigated various factors that can influence the bullet behaviour on car bonnets. We have assessed these factors by statistically comparing the bullet deflection after perforation, ricochet on car bonnets and bare sheet metal. In addition, the accuracy and precision of the lead-in method was also studied. The results from statistical comparison showed that there was a significant difference in deflection angles for almost all the bonnets at 16° and 24° incident angles and almost all bonnets had no significant difference at 8° and 32°. These aberrations have been explained with the difference in critical angles between bonnets and sheet metal along with other factors. The results of this study will help researchers in unfolding the complete potential of bare sheet steel as a substitute for car parts in future.</p>



Pb distribution of an ACC sample shot from 5cm distance and 90°, as visualised with mXRF.

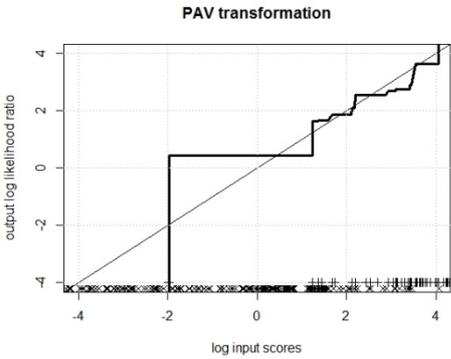
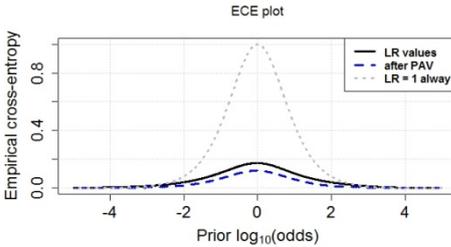


Photos taken after the shooting of the four materials from a distance of 5cm and 90°.

Student	Christina Kashiouri
Research carried out at	NFI
Supervisor	Dr. Alwin Knijnenberg
Title thesis	The effects of shooting angle on 2D-mXRF patterns around bullet holes on non-textile materials
Abstract	<p>The main focus of this study was the distribution of GSR on non-textile surfaces and the variation thereof with shooting angle, in an attempt to establish a complementary method for the estimation of the angle of incidence. The investigation included six angles of incidence (15°, 30°, 45°, 60°, 75°, 90°) and an unknown angle and four different non-textile materials; ACC, sheetrock, vinyl and laminate. The analysis of the prepared samples was performed with millimetre X-Ray Fluorescence (mXRF). In general, the visualised Pb, Cu and Ba patterns showed a shift to the side from which the shot was fired, when the shooting angle decreased. In particular, Pb displayed more distinct patterns which changed with angle and was thus used as the main indicator for the estimation of unknown angles. Although the estimation of the unknown samples proved to be successful, this approach was found to be limited to short range shootings. Furthermore, comparisons between the GSR distributions of different materials, showed that the properties of the material affected the deposit of GSR on the target surface as well as the visualisation of GSR traces with mXRF. Additional experiments illustrated that the method can be potentially applied to real casework. At last, comparisons of the mXRF results with the results of a chemographic method, displayed the advantages of mXRF over the other method, when used for the visualisation of GSR traces on non-textile materials.</p>

Student	Nadia (Konstantina) Lympéri
<i>Research carried out at</i>	NFI
<i>Supervisor</i>	Martin Baiker, NFI
<i>Title thesis</i>	A pilot study comparing real crime scene toolmarks to simulated toolmarks in order to quantify the evidential value of a tool mark comparison.
<i>Abstract</i>	<p>The traditional way of comparing striated toolmarks is an observer based technique and therefore is subjective as the comparison and conclusion is based on the expertise and knowledge of the examiner. To render the comparison of toolmarks more objective, an automated method was developed at the NFI which generates a quantifiable measure for the degree of similarity between two toolmarks in the form of a score. The primary goal of the current project, is to obtain the distribution of the scores for the known matching and known non-matching real crime scene toolmarks as well as the distributions of the toolmarks simulated in the lab under crime scene-like conditions. The aim of this project is a comparison between the distributions of these two different sets of scores (crime scene and simulated) in order to investigate how similar they are. The results indicated that the distributions of scores do not differ significantly although it has to be emphasized that the population of samples was considerably small therefore no strong statistical conclusions can be drawn. However, it is an indication that perhaps in the future a database of scores could be built from simulated crime scene marks to serve as a reference for the evaluation of evidence in real case work</p>

Forensic Statistics

<div style="text-align: center;">  <p>PAV transformation</p> </div> <div style="text-align: center;"> <p>A PAV transformation of LRs</p> </div> <div style="text-align: center;">  <p>ECE plot</p> </div> <div style="text-align: center;"> <p>An ECE plot of a set of LRs</p> </div>	<p>Student</p>	<p>Yara van Schaik</p>
	<p><i>Research carried out at</i></p>	<p>NFI</p>
	<p><i>Supervisor</i></p>	<p>Dr Peter Vergeer</p>
	<p><i>Title thesis</i></p>	<p>Measuring calibration of likelihood ratio systems</p>
	<p><i>Abstract</i></p>	<p>When forensic evidence is examined, the conclusions are summarized by a weight of evidence, most commonly the likelihood ratio. There are several methods to calculate these ratios and good performance of such models is essential. Calibration is a performance characteristic and this property can be measured. Different methods to measure the calibration of an LR system are available, and four of them are explored in this work. One metric is based on moments and another is based on rates of misleading evidence. The other two measures are PAV and ECE. We propose a new numerical calibration measure corresponding to the PAV transformation algorithm.</p> <p>A simulation study is performed to examine the performance of the calibration metrics, with the goal to find pros and cons for each measure and to provide guidelines on which measure to use in what situation.</p> <p>The first two methods do not behave as desired and PAV and ECE perform better. On the basis of this work, PAV is more sensitive than ECE.</p>