

SOUTH AFRICAN POLICE SERVICE: FORENSIC SCIENCE LABORATORY

PERSPECTIVES ON TESTS AND MEASUREMENTS FOR LEGAL PURPOSES

Col.AAS Marais

Technical Management: Chemistry

ORGANISATIONAL STRUCTURE: DIVISION: FORENSIC SERVICES



Divisional Commissioner:
Forensic Services

Section Head:
Project Management & Strategic Planning

Section Head:
Legal Support

Head:
Criminal Record & Crime Scene Management

Head:
Forensic Science Laboratory

Head:
Quality Management

Section Head:
Support Services

Section Head:
Centralized CRC

Section Head:
Crime Scene Management

Section Head:
Criminalistic Bureau

Section Head:
Decentralized CRC

Section Head:
Explosives

Section Head:
Investigative Psychology

Commander:
Nodal Support Centre

9 X
Provincial Heads:
Criminal Record & Crime Scene Management

Section Head:
Ballistics

Section Head:
Biology

Section Head:
Chemistry

Section Head:
Victim Identification Centre

Section Head:
Scientific Analysis

Section Head:
Questioned Documents

Commander:
Nodal Support Centre

3
Decentralized Laboratories

Section Commander:
Ballistics

Section Commander:
Biology

Section Commander:
Chemistry

Section Commander:
Questioned Documents

Section Commander:
Scientific Analysis

Commander:
Nodal Support Centre

Section Head:
FSL:
Quality Manager

Section Head:
CR & CSM:
Quality Manager

Section Head:
Regional:
Quality Manager

Section Head:
Forensic Database

Section Head:
Development Facilitation

Section Head:
Technical Management

Commander:
Nodal Support Centre

Section Commander:
Financial & Administration Services

Section Commander:
Personnel Management

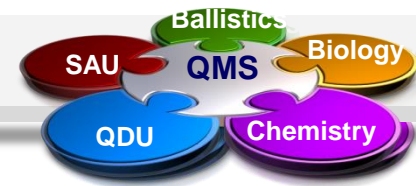
Section Commander:
Supply Chain Management

Section Commander:
Human Resource Development

Section Commander:
Human Resource Utilization



BALLISTICS

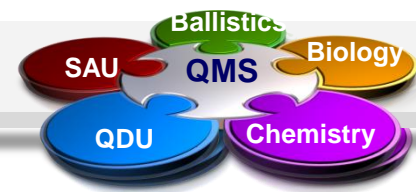


CORE FUNCTIONS:

- Firearm & Tool Mark Examination & Identification
- Identification of Firearms & Ammunition
- Restoration of Defaced / Removed Numbers on Metals [Etching]
- Internal, External & Terminal Ballistics [Angles, distances, etc]
- Research in the field of Firearm & Ammunition Technology
- Reconstruction of Vehicle Accident Scenes
- Examination of Wheels & Tyres
- Assist in Vehicle Theft-related Examinations [mechanical tests]
- Examination of Filaments / Fibre
- Reconstruction & Examination of Illegal Entries & Exits
- Queries concerning Fields of Mechanical & Metallurgical Engineering in general



BIOLOGY



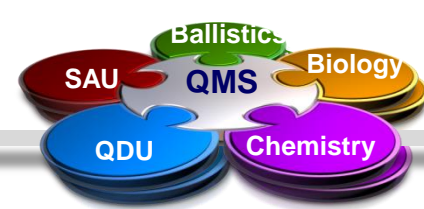
CORE FUNCTIONS:

The examination of biological exhibit material to determine the identity and relationship thereof

- Evidence Recovery: Body Fluids & Hair
- Preliminary Testing of Body Fluids
- Blood Spatter Pattern Analysis
- DNA Analysis & Comparison of DNA Profiles
- Microscopic Comparison of Hair
- 2D & 3D Facial Reconstruction
- Mummified Fingerprinting [*Decomposed Bodies*]
- Establishment of a DNA Statistical Data Base & Criminal Intelligence Data Base [*Link individuals to crime scenes*]



CHEMISTRY

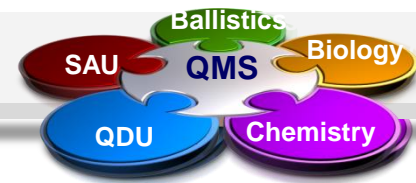


CORE FUNCTIONS:

- Identification & Classification of Drugs controlled ito Drugs & Drug Trafficking Act
- Identification & Classification of Medicines scheduled ito Medicines & Related Substances Act
- Attendance of Drug and/or Medicine Related Crime Scenes
- Identification of Substances involved in illicit [*clandestine*] synthesis & formulation of drugs and/or medicines
- Generation of Drug Intelligence Reports
- Fire Origin & Cause Determination
- Arson Chemistry [*Determination of Fuel Element*]
- Poison Analysis
- Toxicology related Crime Scenes
- Alcohol Analysis



SCIENTIFIC ANALYSIS



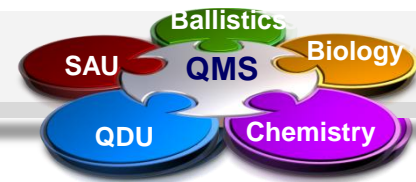
CORE FUNCTIONS:

The forensic investigation of cases concerning matters in electronic & electrical engineering, a variety of chemical analyses as well as science & physics

- Audio Enhancements on Magnetic Tapes
- Voice Comparisons & Audio Authentication
- Electrical & Electronic Investigations
- Assisting in Arson Related Investigations
- Polygraph Investigations & Truth Verification
- Specialized Forensic Photography
- Image Processing & Analysis
- Analysis of Rubber, Plastics, Polymers & Tape, Explosives, Explosive Devices & Explosive & Propellant Residues, Fibers, Ropes, Liquids, Paint, Glue, etc
- Precious Metal Analyses
- Analyses of Jewelry & Gemstones
- Analyses of Gun Shot Residue



SCIENTIFIC ANALYSIS

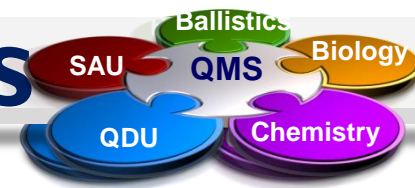


CORE FUNCTIONS (Continued):

- Analysis of Soils & Related Materials
- Analysis of Cables & Wires
- Comparison of Impressions & Prints
- Analysis & Classification of Ivory
- Examination of Glass
- Analysis of Material pertaining to Environmental Pollution & Toxic Waste
- Elemental Analysis
- Profiling of all Materials



QUESTIONED DOCUMENTS



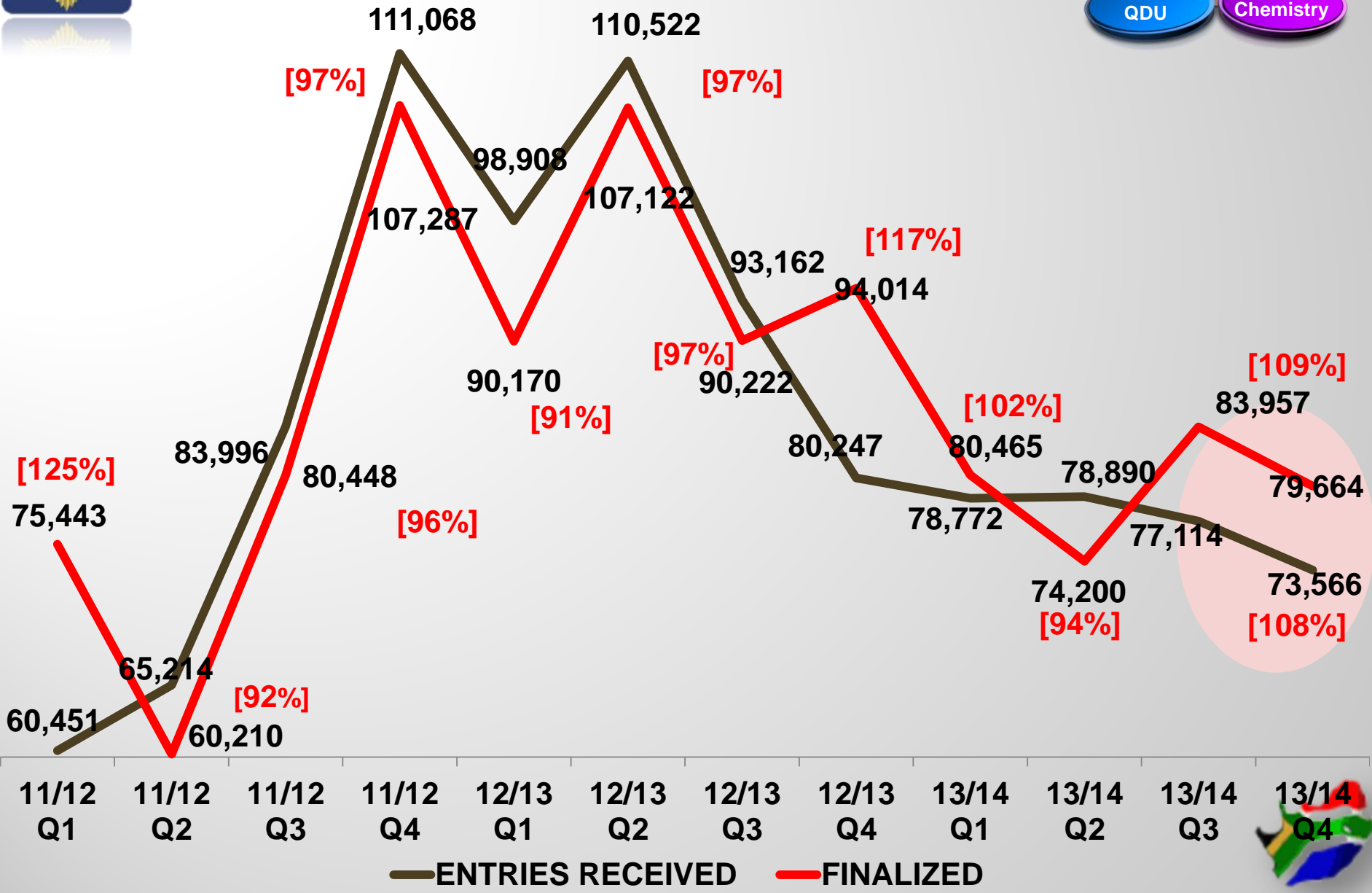
CORE FUNCTIONS:

The forensic examination of documents and document- related exhibits

- Individualization of Handwriting, Signatures, Typescript, Printed Matter & Stamped Impressions
- Identification of Forgeries, Erasures & Additions
- Examinations: Writing Instruments, Ink, Paper & other media used in committing Criminal Offences
- Identification or Elimination of Source & Output of Mechanical / Electronic Imaging Devices [Printers, Copy Machines, etc]
- Establishment of Date, Source, History, Sequence of Preparation, Alterations or additions to Documents & Relationships of Documents
- Decipherment & Restoration or both of Erasures, Deleted or Damaged Parts of Documents
- Deciphering of Obscured Writing & Indentations

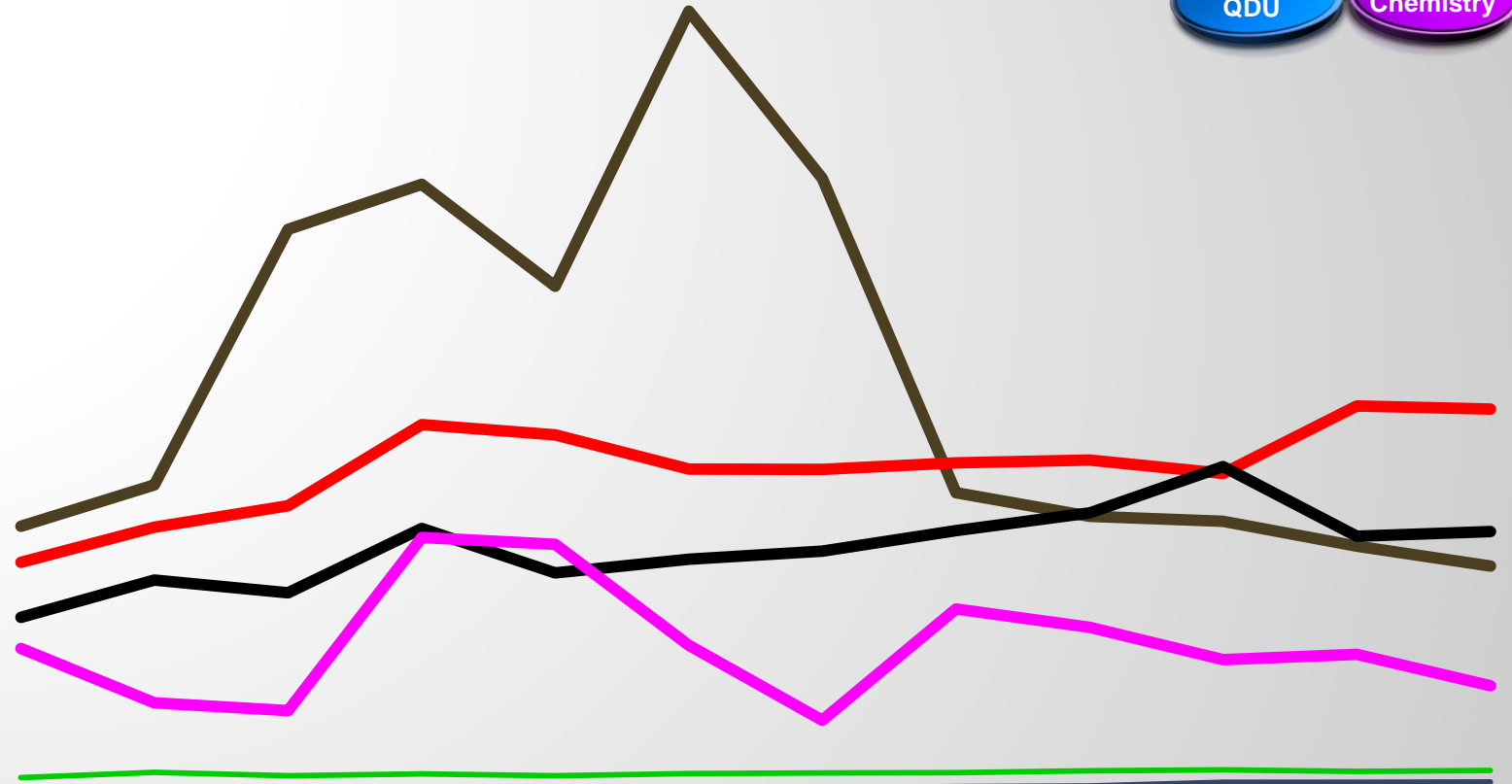


PROCESSING OF FORENSIC EVIDENCE RECEIVAL INCREASES / DECREASES

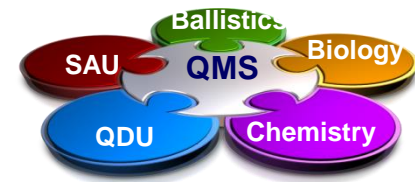




ENTRIES RECEIVED PER DISCIPLINE

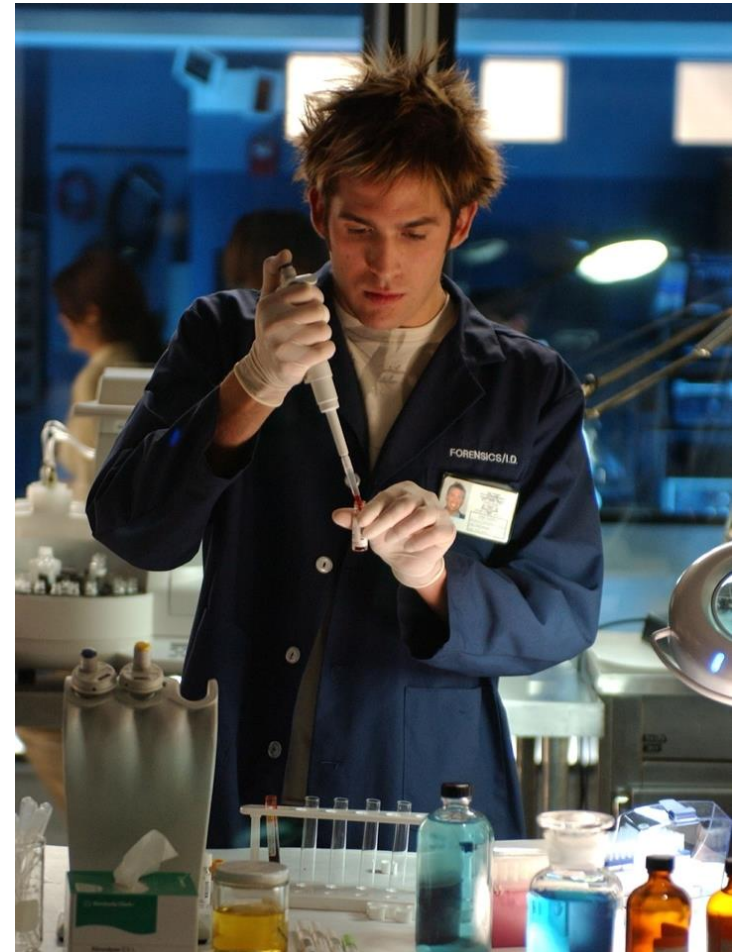


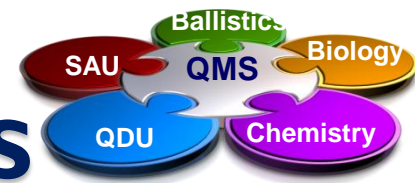
	11/12 Q1	11/12 Q2	11/12 Q3	11/12 Q4	12/13 Q1	12/13 Q2	12/13 Q3	12/13 Q4	13/14 Q1	13/14 Q2	13/14 Q3	13/14 Q4
BALL	19509	22565	41488	44834	37280	57669	45266	21988	20253	19884	18023	16550
BIO	16844	19430	21027	27030	26287	23739	23717	24202	24424	23433	28427	28200
CHEM	12768	15517	14590	19355	16051	17077	17665	19188	20489	23928	18762	19119
QDU	10450	6423	5862	18682	18169	10693	5135	13386	12023	9634	10011	7690
SAU	880	1279	1029	1167	1023	1193	1230	1261	1393	1463	1356	1430
VIC	0	0	0	0	98	151	149	222	272	548	535	577



DEFINITION

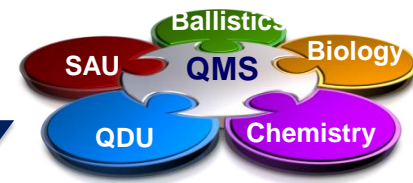
- Forensic science can be defined as the practical application of science to matters of the law
 - *Forensic*: Pertaining to law or judiciary process





FORENSIC DISCIPLINES

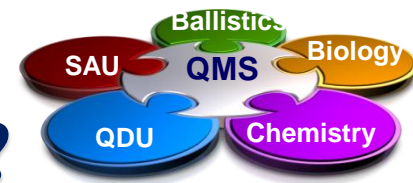
- Scientific fields that have found application in forensics
 - Largely based on instrumental analysis and measurement standards
 - Biology (DNA analysis)
 - Chemistry
 - Physics
- Forensic fields that have some scientific underpinning
 - Largely based on expert interpretation of observed patterns
 - Questioned documents
 - Toolmarks
 - Fingerprints
- Data used quantitatively or qualitatively
 - Binary responses



SCIENTIFIC VALIDITY

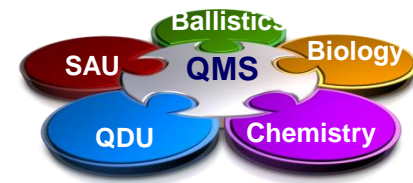
- (1) whether a theory or technique can be (and has been) tested;
- (2) whether the theory or technique has been subjected to peer review and publication;
- (3) the known or potential rate of error of a particular scientific technique;
- (4) the existence and maintenance of standards controlling the technique's operation;
- (5) a scientific technique's degree of acceptance within a relevant scientific community

Strengthening Forensic Science in the United States: A Path Forward
<http://www.nap.edu/catalog/12589.html>



QUESTIONABLE SCIENCE?

- 223 post-conviction DNA exonerations in the United States since 1989 (as of November 2008)
 - *The Innocence Project. Fact Sheet: Facts on Post-Conviction DNA Exonerations. www.innocenceproject.org/Content/351.php*
- Uniqueness of fingerprints
 - Questionable probability of $1/10^{97}$ individuals
 - Difference between 'perfect' rolled prints and 'imperfect' latent prints of greater importance
 - *DH Kaye. Questioning a courtroom proof of the uniqueness of fingerprints, International Statistical Review 71 (2003), 521-533.*
- Expert testimony under cross examination the traditional means of validity evaluation



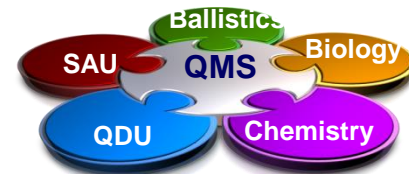
VALUE OF EVIDENCE

- Probative value defines the evidence sufficiently useful as proof in a legal proceeding
- Class characteristic evidence
 - DNA from a specific ethnicity
 - Firearm make and model
- Individual characteristic evidence
 - DNA profile of individual
 - Cartridge/Projectile from a specific firearm
- Ultimate goal of forensic science is to answer the need of the client i.e. linking a potential offender to a crime or crime scene (individual characteristics)



IDENTIFICATION (MATCHING)

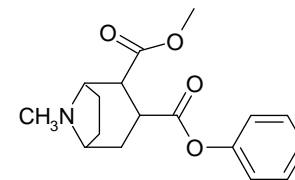
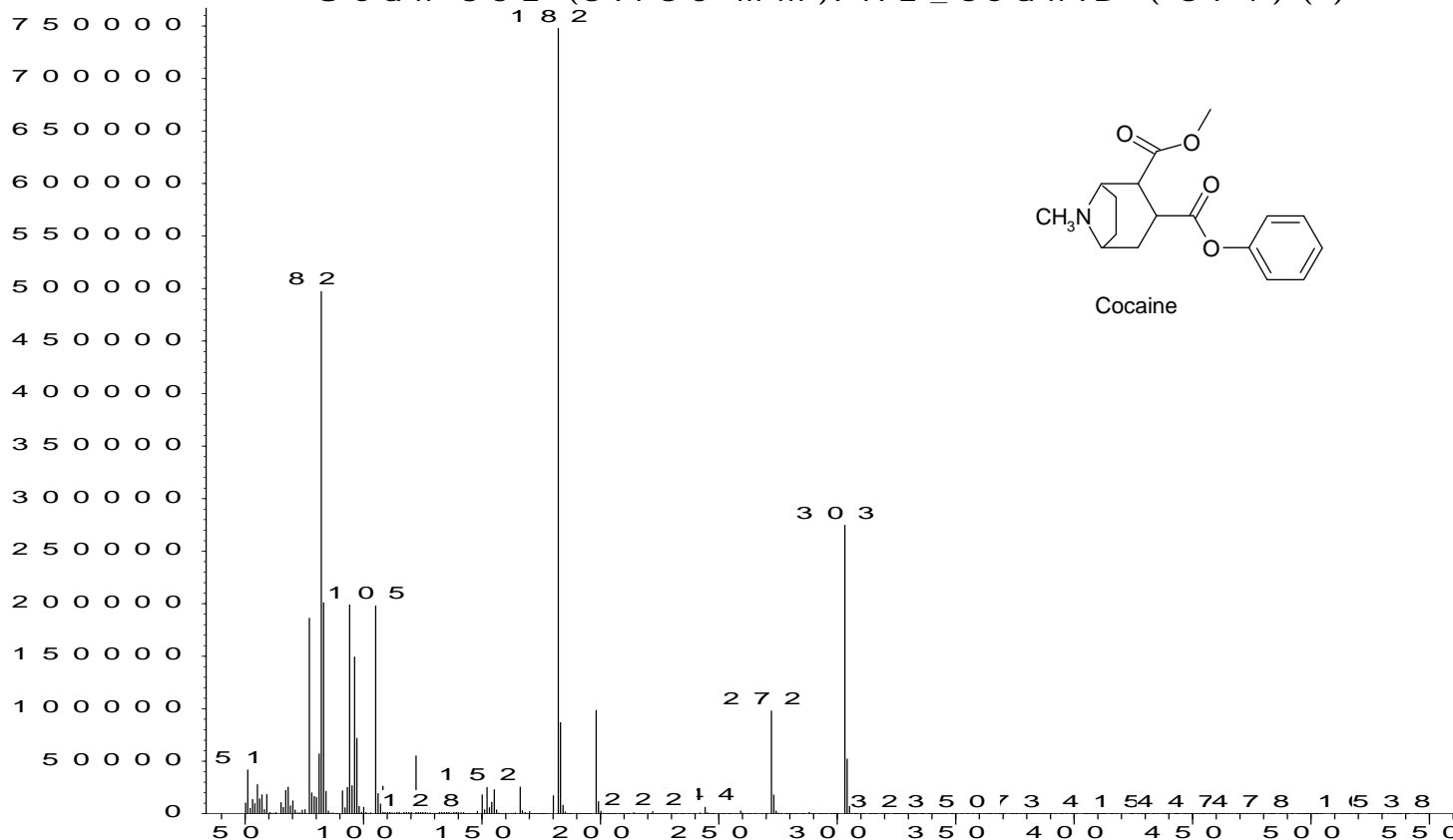
- Uniqueness determines the assignment of individual characteristics
 - Forensic discipline level of detail dependant
- Unambiguous identification of item A is the comparative match obtained for item A regarding its properties/features and the concurrent mismatch of its properties/features with those of all other items under specified conditions
 - Confirmation bias risks
 - Minimum number of properties/features needed as related to theoretical incidence in population
 - Statistical models e.g. Bayes Theorem
 - Diagnostic value of analytical process



CHEMICAL IDENTIFICATION: MS

Abundance

Scan 892 (3.180 min): A2_scan.D (-874) (-)



Cocaine

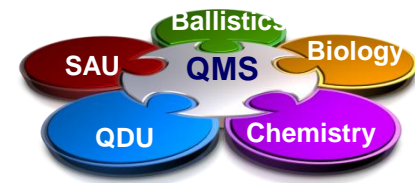
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STANDARDISATION

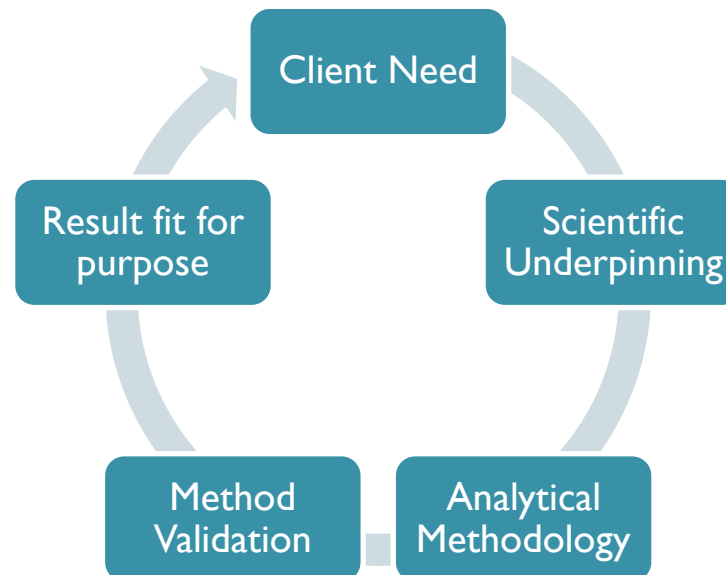


- Accreditation to a standard such as ISO 17025:2005 highly beneficial
 - Processes applicable to all forensic disciplines
 - Measurement traceability
 - Fitness for purpose of tests and measurements equally evaluated by statistical models across all disciplines
- Forensic science hindrances
 - Variable nature of sample substrates and types
 - Focus on examiners and not on processes
 - Limited testing materials for developmental validation
 - Expectations within the legal system (CSI effect)



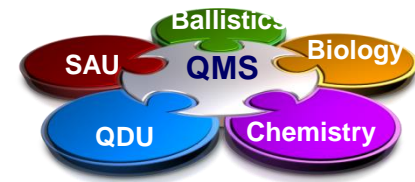
FITNESS FOR PURPOSE

- The intent of any analytical procedure is to provide accurate and reliable data to answer a specific need
- Method validation supports this intent by:
 - The specification of analytical method performance criteria
 - Objective assessment of suitability for intended purpose





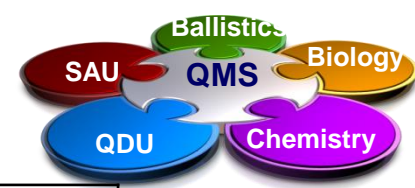
DEFINING A TEST PROCESS



Analysis Purpose	<ul style="list-style-type: none">• DNA profile based on STR
Sample Matrix / Sample type	<ul style="list-style-type: none">• Semen• Non-Semen
Sampling	<ul style="list-style-type: none">• Statistical• Non-Statistical
Preliminary analysis/findings	<ul style="list-style-type: none">• Luminol• Brentamine
Sample Preparation	<ul style="list-style-type: none">• DNA extraction
Analytical technique	<ul style="list-style-type: none">• PCR / Q-PCR / CE
Test Result	<ul style="list-style-type: none">• DNA profile



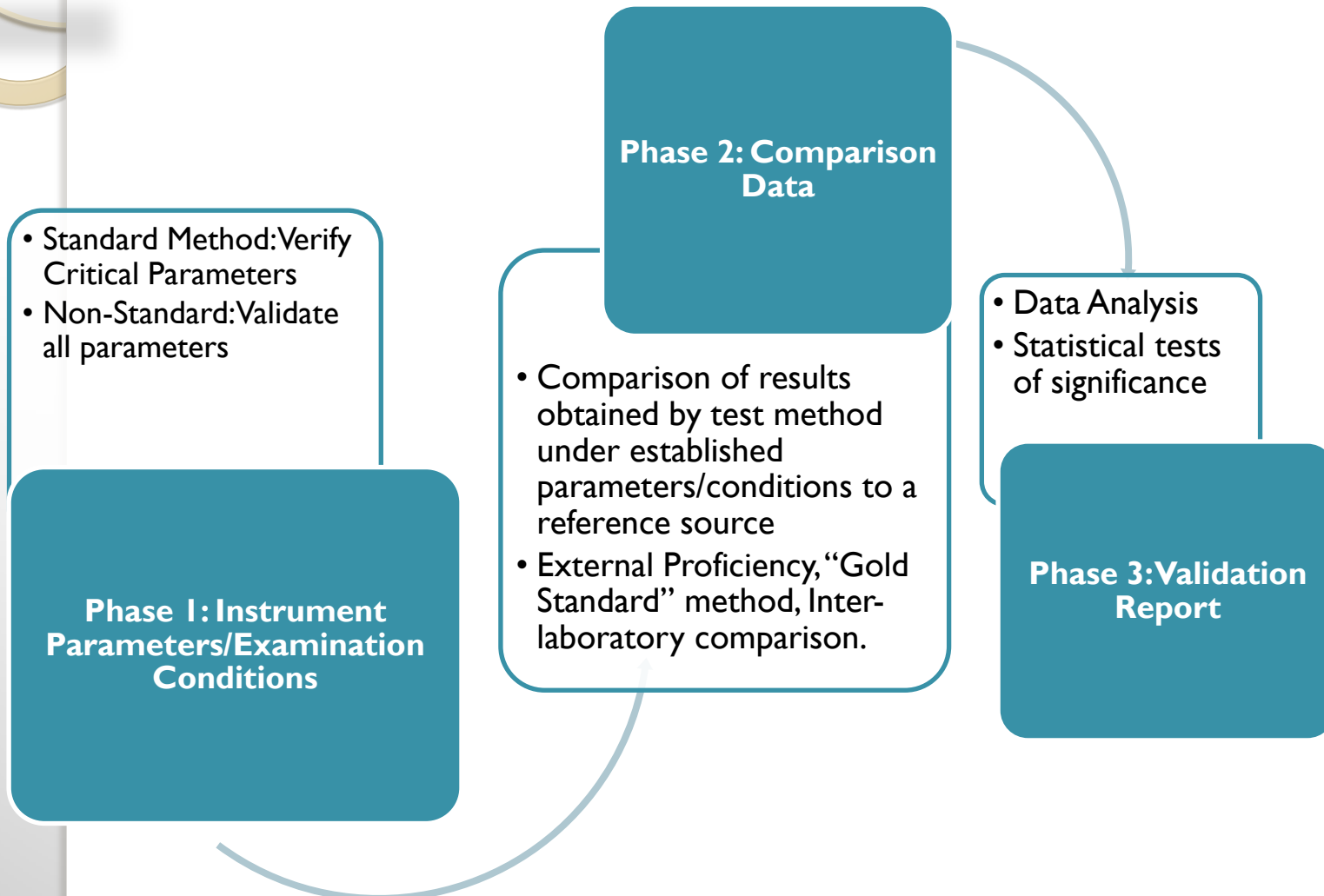
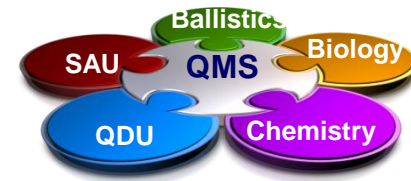
FSL VALIDATION APPROACH



	Relevant Validation Figure of Merit	Test Method Process	Method Category	Validation Model
1) Specificity 2) Sensitivity 3) Positive Predictive Value 4) Negative Predictive Value	Selectivity (Identity) Accuracy (Recovery) Linearity	Sample Matrix Sample type	Standard Non-Standard	Qualitative Quantitative (3 Phases)
	Selectivity Precision	Sampling		
	Selectivity Precision Accuracy Limit of Detection	Preliminary analysis/findings		
	Linearity Accuracy Precision Limit of Detection Limit of Quantification	Sample preparation		
	Selectivity Linearity Accuracy Precision Limit of Detection Limit of Quantification Measurement Uncertainty	Analytical technique		

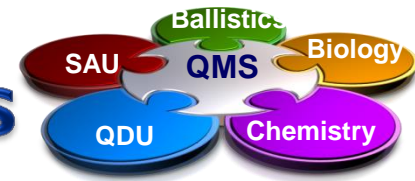


QUALITATIVE VALIDATION MODEL





LEGISLATION AND ROLEPLAYERS



- Increased interaction between the relevant NMI and forensic science bodies required
- Reviews to legislation
 - The Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, Act 19 of 2006
 - The Measurement Units and Measurement Standards Act, Act 18 of 2006
 - Trade Metrology Act, Act 77 of 1973 (Legal Metrology Bill)