Internal Quality Control in Forensic DNA Analysis

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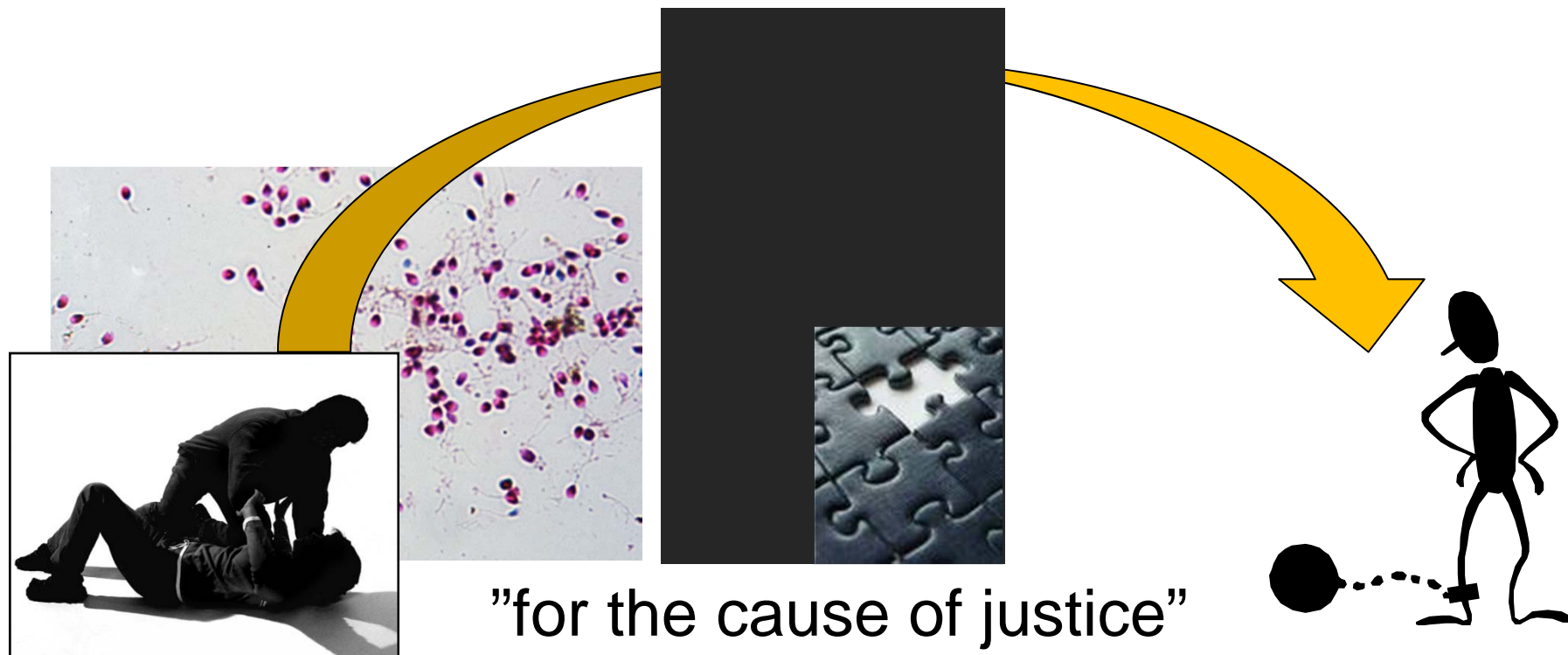
Forensic Science

"Forensic science" is science used for the purpose of law

[Caddy & Cobb, 2004]

Internal Quality Control

"for the cause of justice"

ISO 17025 generally used for forensic science laboratories

Presentation road map

- "Regular" internal QC

- "Process related" internal QC

- LIMS and expert systems

- Contamination monitoring

- "Elimination databases" (EDB)

- Non-conformance reporting

Forensic DNA analysis

Case assessment

Trace search
Trace characterization
Trace recovery

DNA extraction
DNA quantification
DNA amplification
Electrophoresis

DNA databasing

Interpretation
Reporting
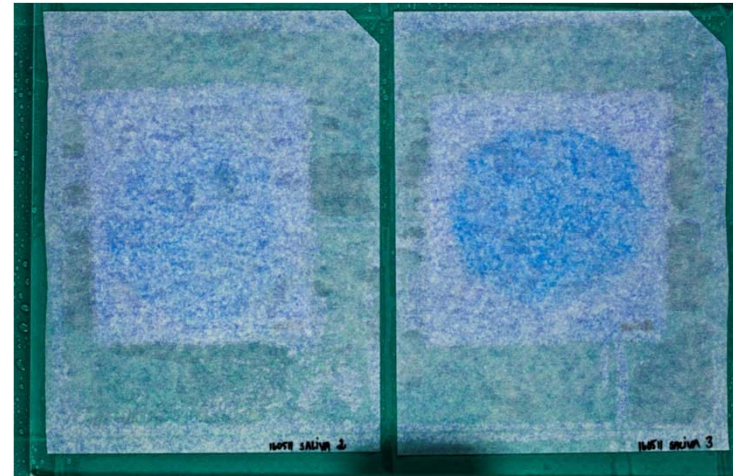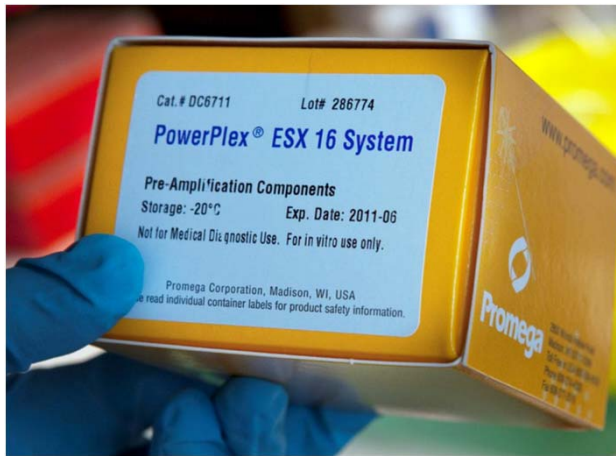Expert witness

Reference samples
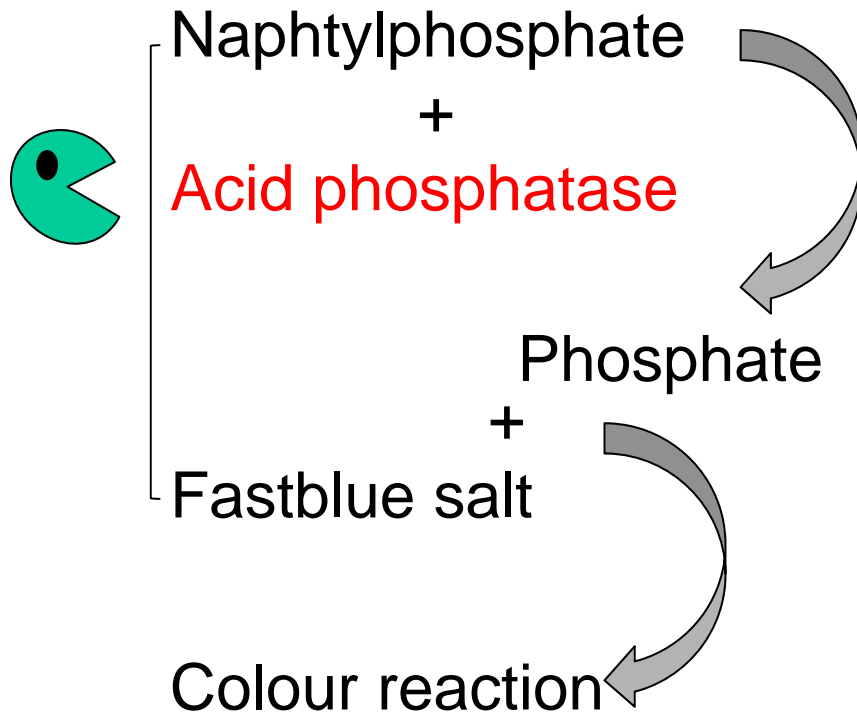Crime scene samples/evidence

"Regular" Internal QC

- Internal QC on delivered pre-made batches of chemicals, reagents etc

- Internal QC on in-house made batches of chemicals, reagents etc

- Daily Internal QC on chemicals, reagents etc

"Regular" internal QC on pre-made reagents & kits

Acid phosphatase for the presumptive test of semen

Naphtylphosphate
+
Acid phosphatase

→

Phosphate
+
Fastblue salt

→

Colour reaction

No daily control due to robustness and contamination risk

Spädning	1:40	1:80	1:180	1:640	1:1280
Batch 021217					
Batch 040609					
Batch 060607					
Batch 080610					
Batch 090514					
Batch 090925					

"DMAC" presumptive test for urine stains
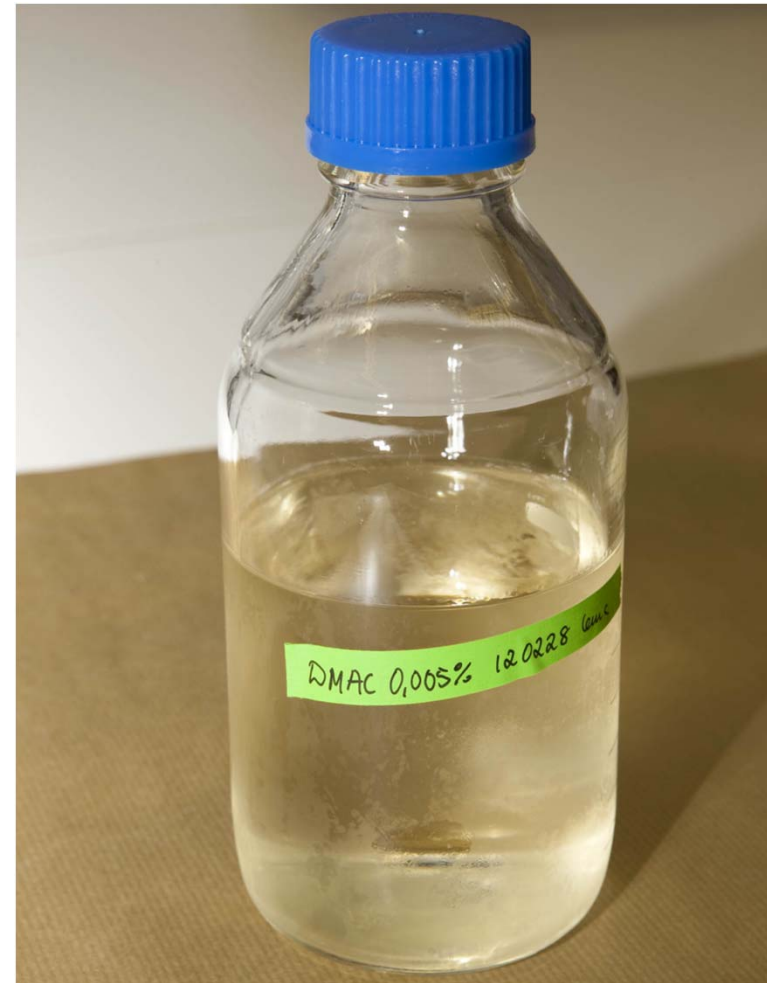
4-dimethylamino-cinnamaldehyde

Reacts with amines/amides to a colour change into dark pink
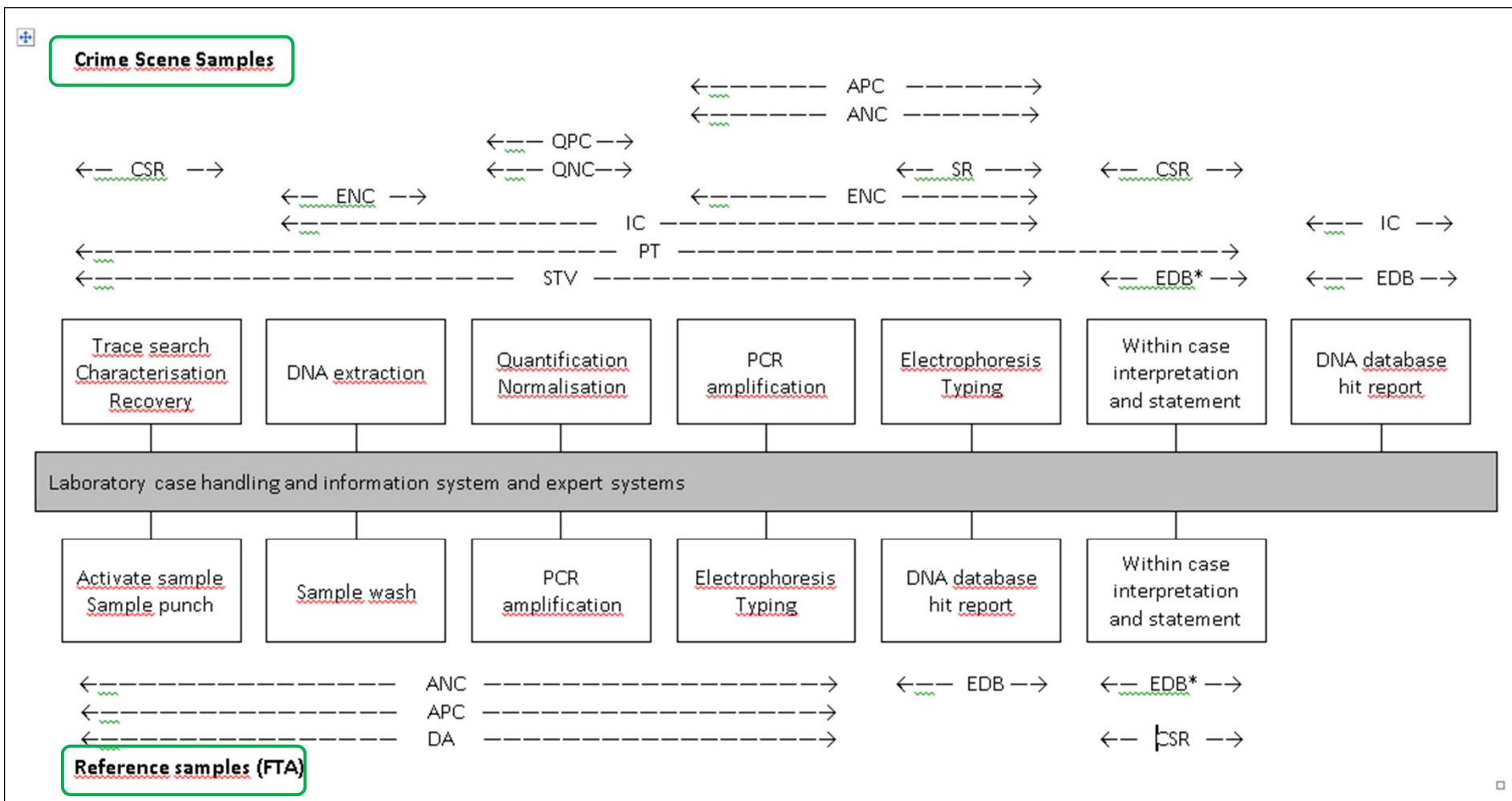
Positive control:
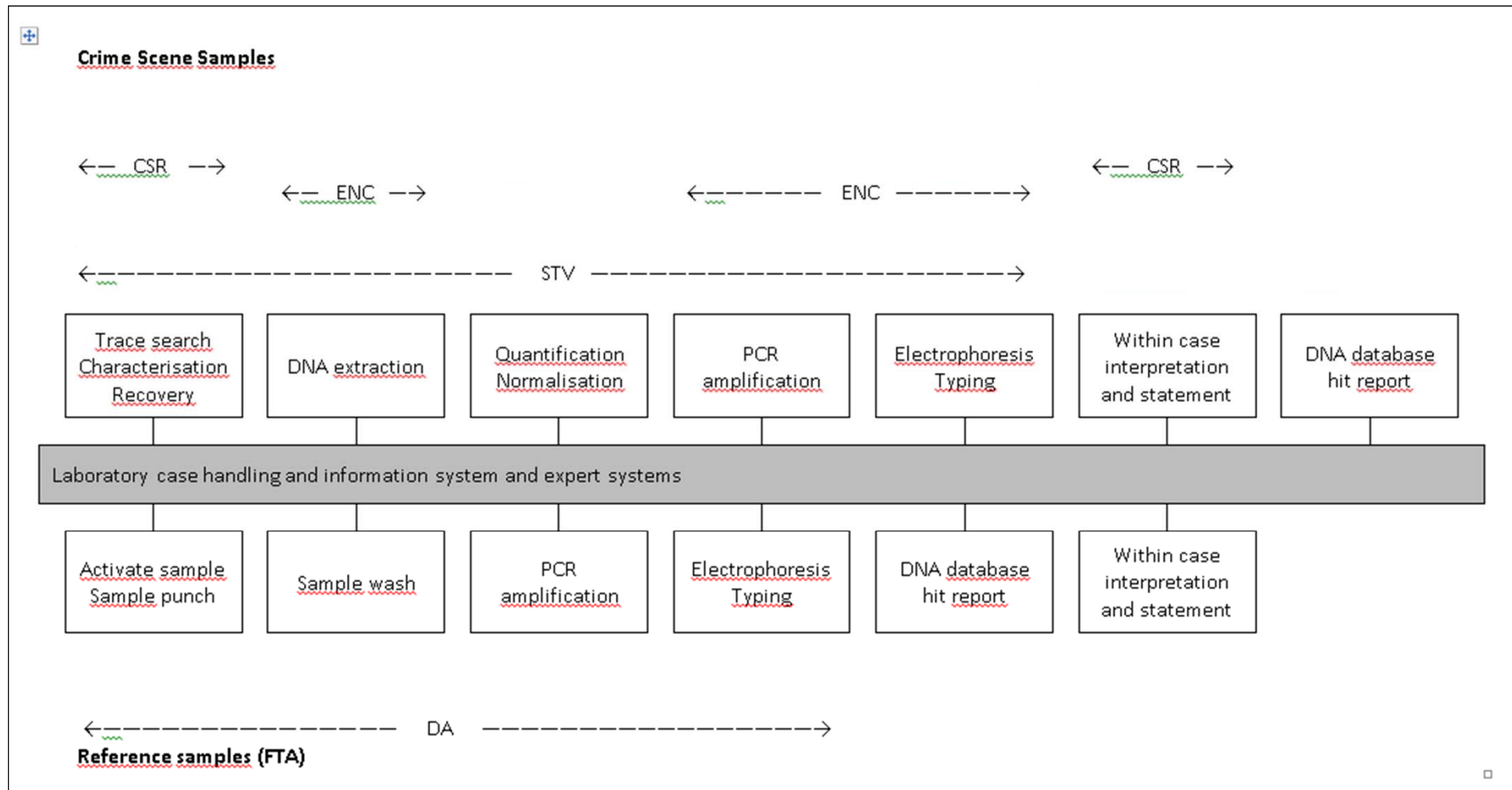   Dried urine on filterpaper

Negative control:
    Dried water on filter papper

"Process related" internal QC in forensic DNA

”Process related internal QC in forensic DNA

Abbreviations

TRACES

ANC - amplification negative control

APC - amplification positive control
      (known profile)

CSR - case and statement review

EDB - elimination database

EDB* - elimination database, control under
      certain conditions

ENC - extraction negative control

IC - internal controls (known trace
      type/profile)

PT - proficiency tests

QNC - quantification negative control

QPC - quantification positive control
      (known concentration)

SR - second reading

STV - sample transfer verification
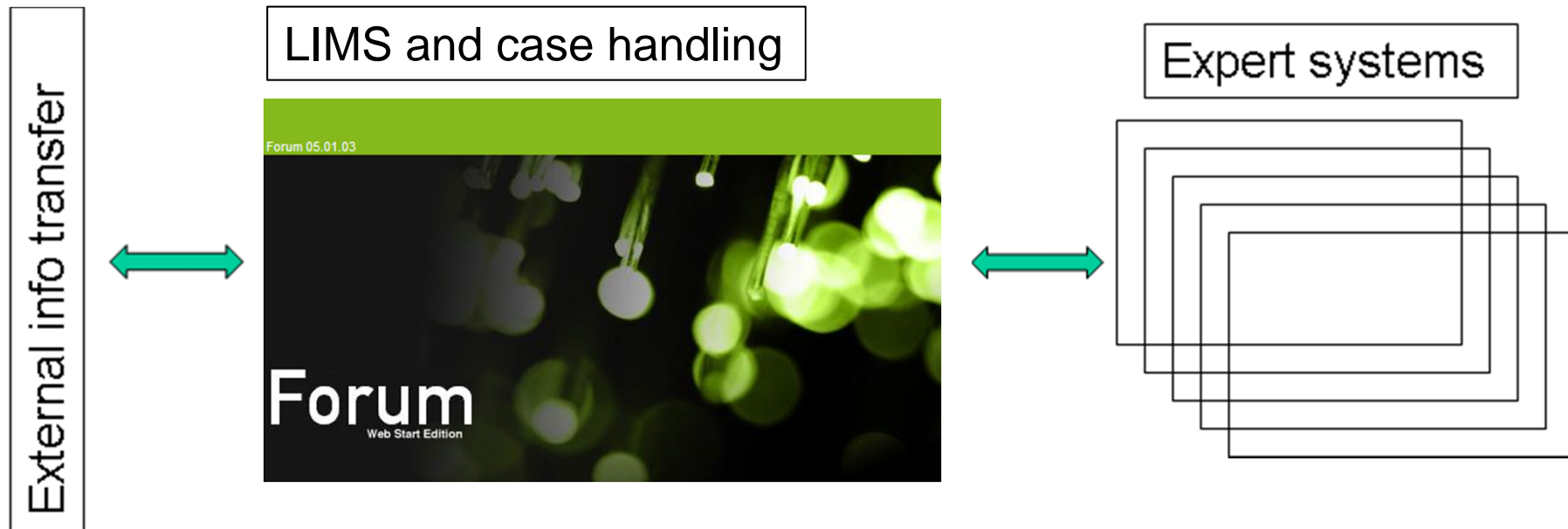
REFERENCE SAMPLES (FTA)

ANC - amplification negative control

APC - amplification positive control (known
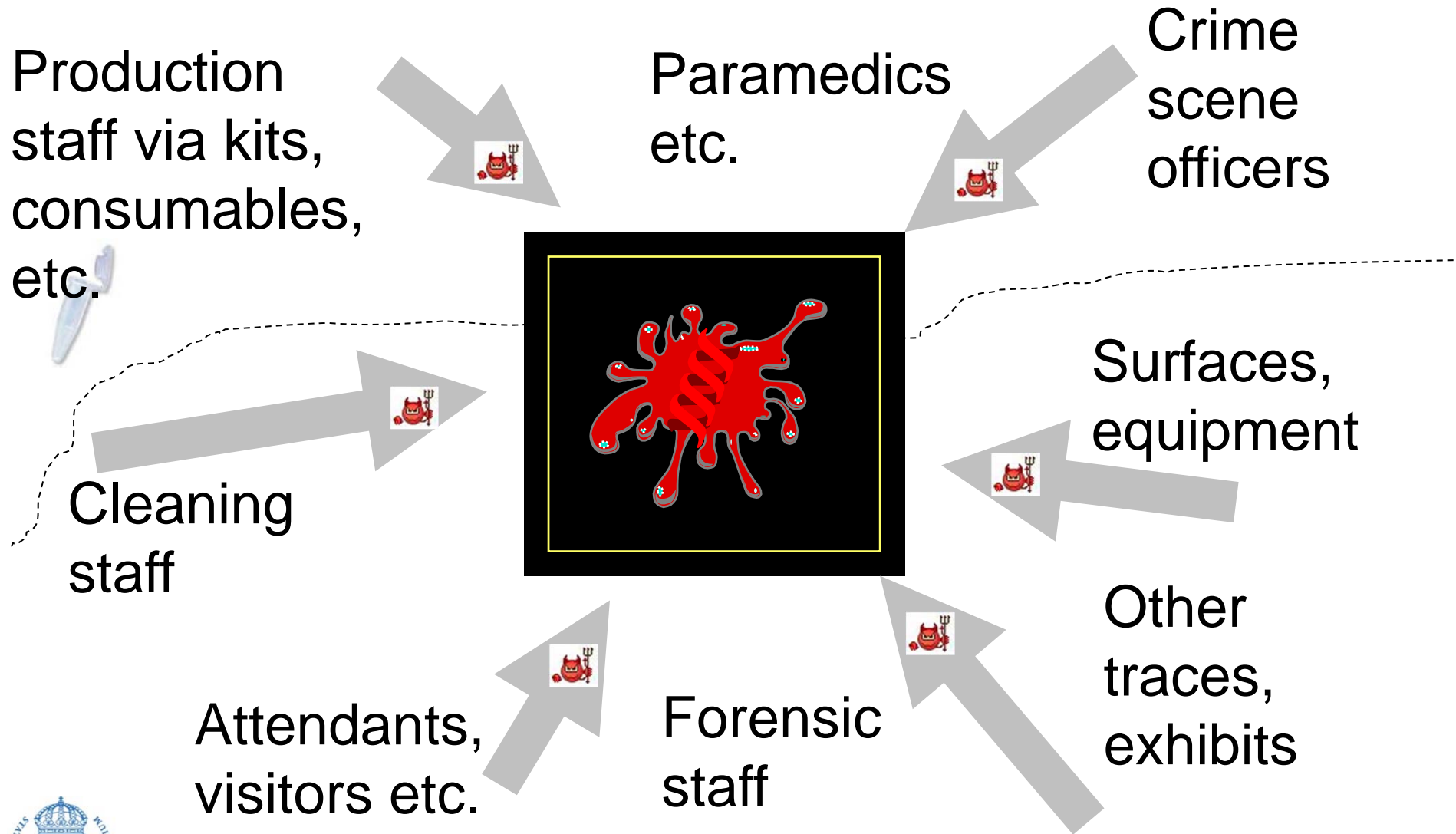   profile)

DA - double analyses

Internal QC of LIMS and Expert systems

External info transfer

LIMS and case handling

Forum 05.01.03

Forum
Web Start Edition

Expert systems

Validation work, implementation set-up
and then ?

LIMS: Laboratory Information Management System

Contamination

Production staff via kits, consumables, etc.

Paramedics etc.

Crime scene officers

Cleaning staff

Surfaces, equipment

Attendants, visitors etc.
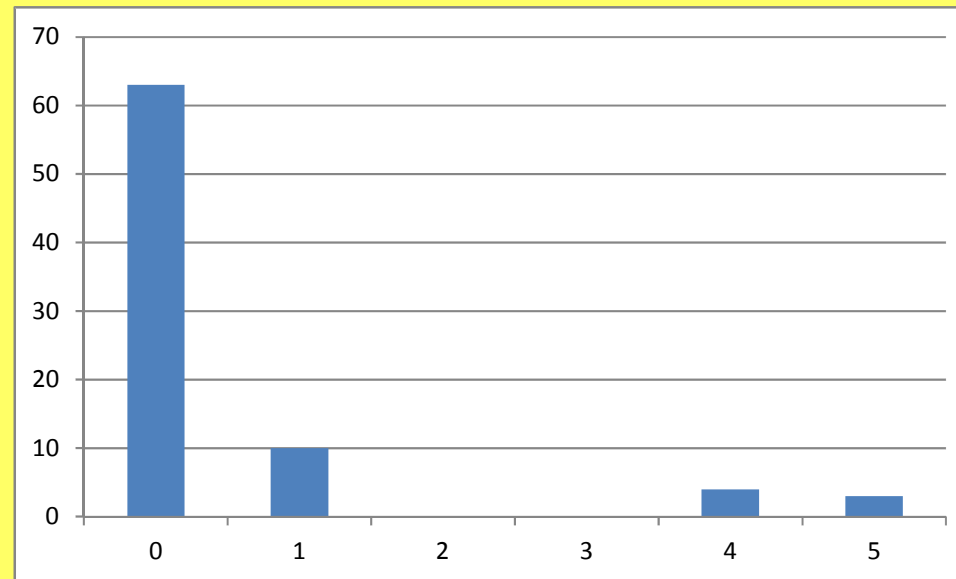
Forensic staff

Other traces, exhibits

Contamination monitoring

ENFSI DNA WG recommends regular monitoring for DNA presence in the laboratory environment

Surfaces, lab items and equipment are regularly sampled and analysed regarding (background) DNA

Classification model according to Digréus *et al* (2011) simplifies a standardised reporting and follow-up

80 monitored samples

Classification/ranking 1-5, according to Digréus et al (2011)
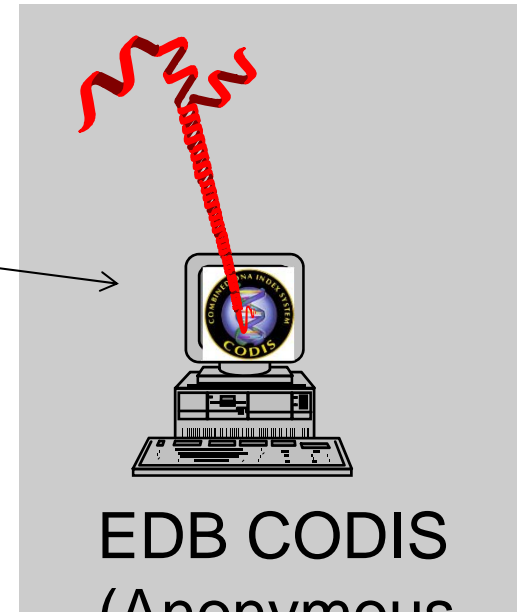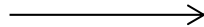
Some "background" DNA

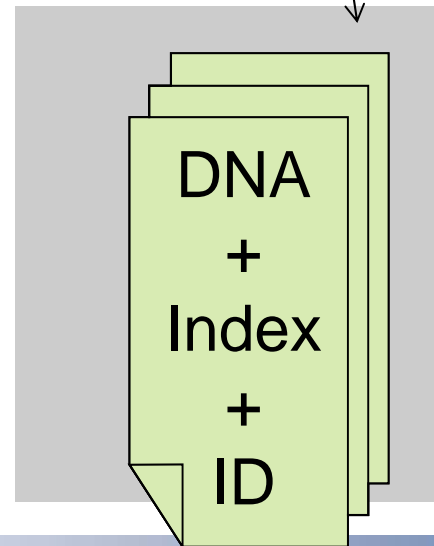| No	Description	Comments	Class	Comments
1.	Lab bench	Two alleles	1	
2.	Lab bench	Two alleles	1	
3.	Holder for fibre tapes	Five alleles	1	
4.	Lab coat, arm region	Two alleles	1	
5.	Lab coat, tummy region	Six alleles	1	
6.	Handle to lab drawers'	Seven alleles	1	
7.	Microfuge, tube holder	Two alleles	1	
8.	Shelf in refrigerator	Three alleles	1	
9.	Door handle, refrigerator	Three alleles	1	
10.	Pipette	Three alleles	1	
11.	Holder, presumptive test reagents	Mixture, partial	4	EDB search not possible
12.	Switch, lab bench height adjustment	Mixture, partial	4	EDB search not possible
13.	Shelf, clean tube racks	Mixture, partial	4	EDB search not possible
14.	Lab coat, tummy region	Genotype, partial, female	4	EDB: staff (lab)
15.	Lab coat, arm region	Genotype, partial, female	5	EDB: no match-unknown
16.	Lab coat, arm region	Genotype, partial, female	5	EDB: staff (service)
17.	Stain marker pencil	Genotype, partial, female	5	EDB not searched

Classification 1-5, according to Digréus et al (2011)
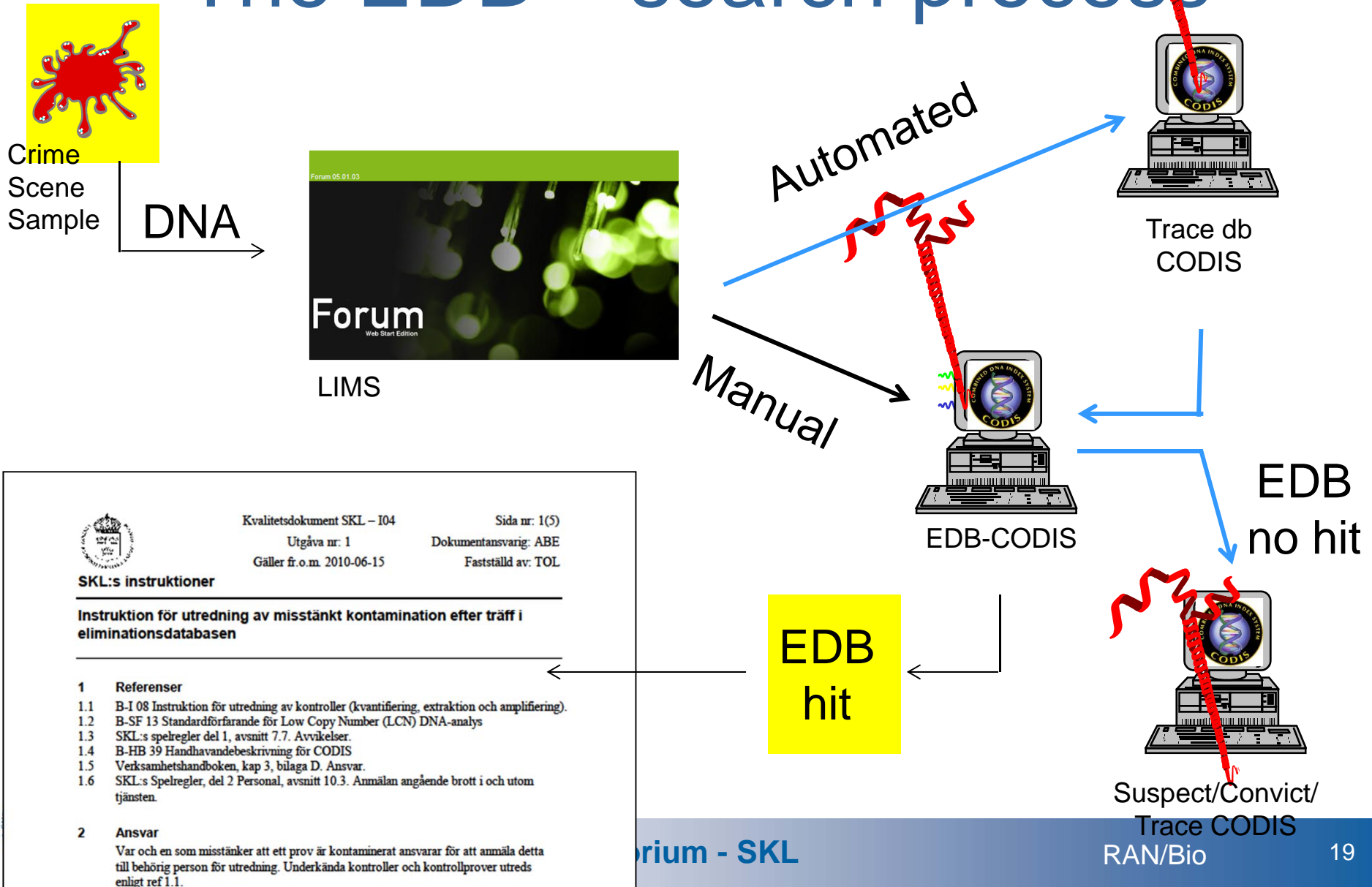
DNA elimination database (EDB)

Informed
consent

Forum 05.01.03

Forum
Web Start Edition

LIMS

Staff & others

DNA
+
Index
+
ID

EDB CODIS
(Anonymous
with index)

Removal
from EDB
upon request

The EDB – search process

Crime Scene Sample

DNA →

Forum 05.01.03

Forum
Web Start Edition

LIMS

Automated

Manual

Trace db CODIS

EDB-CODIS

EDB no hit

EDB hit

Suspect/Convict/ Trace CODIS

Kvalitetsdokument SKL – I04   Sida nr: 1(5)
Utgåva nr: 1   Dokumentansvarig: ABE
Gäller fr.o.m. 2010-06-15   Fastställd av: TOL

SKL:s instruktioner

Instruktion för utredning av misstänkt kontamination efter träff i eliminationsdatabasen

1   **Referenser**
1.1   B-I 08 Instruktion för utredning av kontroller (kvantifiering, extraktion och amplifiering).
1.2   B-SF 13 Standardförfarande för Low Copy Number (LCN) DNA-analys
1.3   SKL:s spelregler del 1, avsnitt 7.7. Avvikelser.
1.4   B-HB 39 Handhavandebeskrivning för CODIS
1.5   Verksamhetshandboken, kap 3, bilaga D. Ansvar.
1.6   SKL:s Spelregler, del 2 Personal, avsnitt 10.3. Anmälan angående brott i och utom tjänsten.

2   **Ansvar**
Var och en som misstänker att ett prov är kontaminerat ansvarar för att anmäla detta till behörig person för utredning. Underkända kontroller och kontrollprover utreds enligt ref 1.1.

EDB matches 2009-2012

	SKL staff	Police	Supplier
2009	7	-	1
2010	1	-	2
2011	6	3	3
2012*	6	2	-

* Data until September 30th.

Some additional hits found in LT/LCN cases (within cases)

EDB matches 2012 (Jan-Sept)

Sample type	Part of process	Staff category	Comment
Crime scene sample	Trace recovery	SKL staff	Staff witnessing trace recovery
Crime scene sample	Trace recovery	SKL staff	Staff recovering trace
Crime scene sample	Trace recovery	SKL staff	Staff regularly working in that room
Crime scene sample	Pre-lab	Police	Low template sample
Crime scene sample	Pre-lab	Police	Low template sample
Reference sample	FTA process	SKL staff	Staff regularly working in process/vicinities
Reference sample	FTA process	SKL staff	Staff regularly working in process/vicinities
Reference sample	FTA process	SKL staff	Staff regularly working in process/vicinities

The Swedish Data Inspection Board (DI) made an enquiry March 23rd 2012 on the set-up and use of the EDB

Statement sent from SKL March 30th

Supplementary statement sent from SKL April 27th

Decision from DI May 28th: **"No legal support for EDB"**

"To err is human"

- The American "Expert Working Group on Human Factors in Latent Print Analysis" (NIST/NIJ 2012):

"Management should foster a culture in which it is understood that some human error is inevitable and that openness about errors leads to improvements in practice"

Reporting non-conformance

- ## <u>Two major goals;</u>

- To solve the specific issue at hand

- Draw conclusions, improve and avoid

"Non-conformance" categories

Category

Case registration

Case management (within department)

Case management (between departments)

Chemicals/gases

Contamination

Equipment

Internal IT systems

Internal service

Interpretation

Laborative failures

Item/evidence handling

Reporting

Routines

Security

Miscellaneous

DNA-related non-conformance reports 2010-2012

Category	2010 No.	Cause [a] I/E	Found [b] I/E	2011 No.	Cause [a] I/E	Found [b] I/E	2012[c] No.	Cause [a] I/E	Found [b] I/E
Case registration	1			-			-		
Case management (within department)	1			5		4/1	1		-/1
Case management (between departments)	4	3/1		2		1/1	1		-/1
Chemicals/gases	-			4			-		
Contamination	20	19/1		31	28/3		17	15/2	
Equipment	7	6/1		1			2	1/1	
Internal IT systems	14			7			6		
Internal service	-			-			-		
Interpretation	2			9		7/2	-		
Laborative failures	18			21	20/1		12		
Item/evidence handling	13	9/4	7/6	6	5/1	4/2	3	2/1	2/1
Reporting	7		3/4	4		2/2	4		1/3
Routines	6		5/1	9		7/2	3		
Security	2		1/1	3	2/1		-		
Miscellaneous	11	9/2		15	9/6	12/3	3	2/1	
Total	**106**	96/10	94/12	**117**	105/12	104/13	**52**	47/5	46/6

"Near failures"

Near failures

Reparable minor mistakes (often operator induced)

Reparable minor technical failures or artefacts

Specific kind of faults (high through put FTA process)

"Cause analyses light" for "near failures"

Can "add up" to a non-conformance

"Near failures"

Reason unclear + filter device

E: Mainly operator induced

Q: Mainly too strong QPC

E/T: Contaminated ENC & samples

Category	2010	2011	2012*
Pre-examination	1	1	-
Trace search & recovery	1	3	
Extraction	35	43	8
Quantification	22	5	14
Electrophoresis & typing	50	68	29
Interpretation	5	1	3
DNA database/hit	7	3	1
"DNA redovisning"	1	3	3
"Resultatsökning"	6	2	3
Miscellaneous	5	6	4
Total	133	135	65

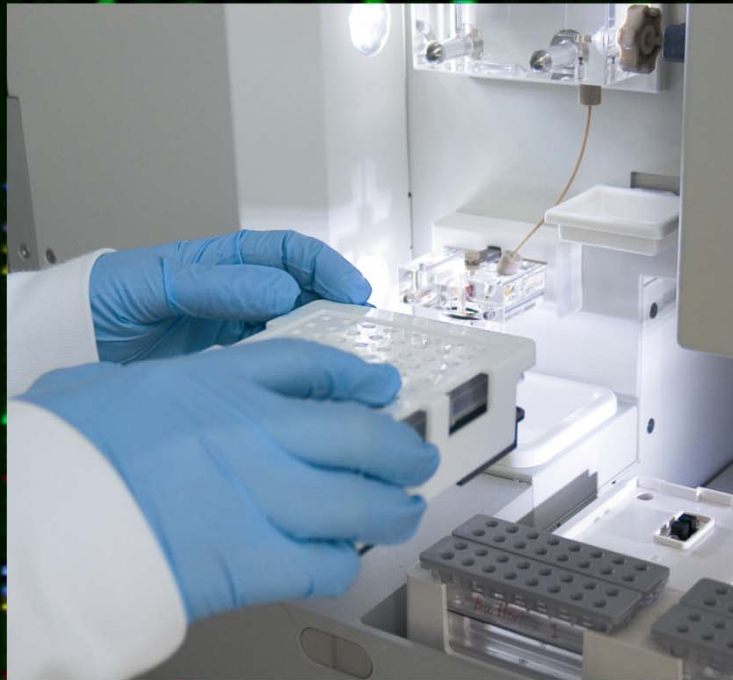*** Data Jan/June 2012**

QF Kit related

Major conclusions

- Internal QC is an important tool for high quality forensic DNA analyses

- A variety of different Internal QC is need to cover the different activities and processes of the forensic DNA laboratory

- Internal QC of LIMS and expert systems need to be further explored

Major conclusions (cntd)

- Contamination monitoring is an "eye opener" that e.g. helps improving routines and cleaning procedures

- Eliminationdatabases (EDB) helps to avoid reporting contaminations as "true" evidence and can be used for quality improvements

- Non-conformance reporting for improvements and trust!

Questions?

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