

# Internal Quality Control in Forensic DNA Analysis

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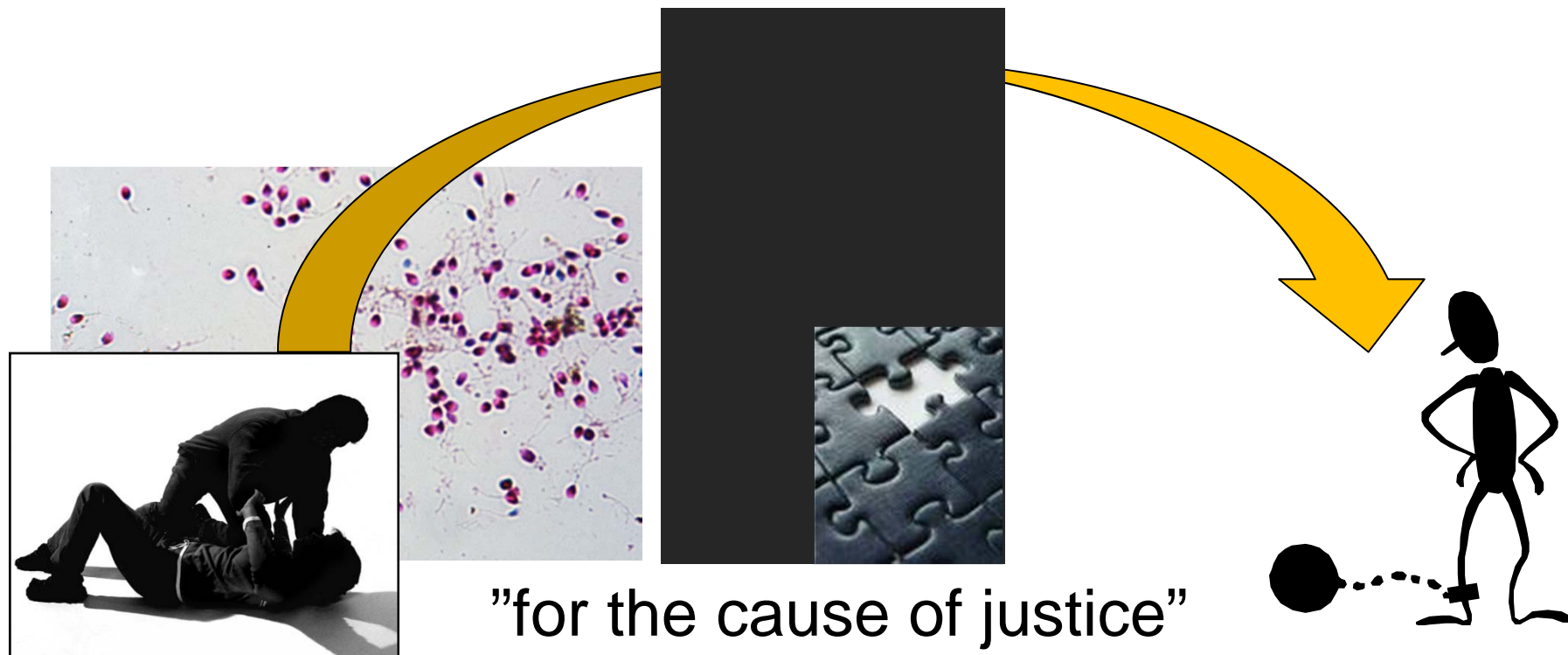


# Forensic Science

“Forensic science” is science  
used for the purpose of law

[Caddy & Cobb, 2004]

# Internal Quality Control



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

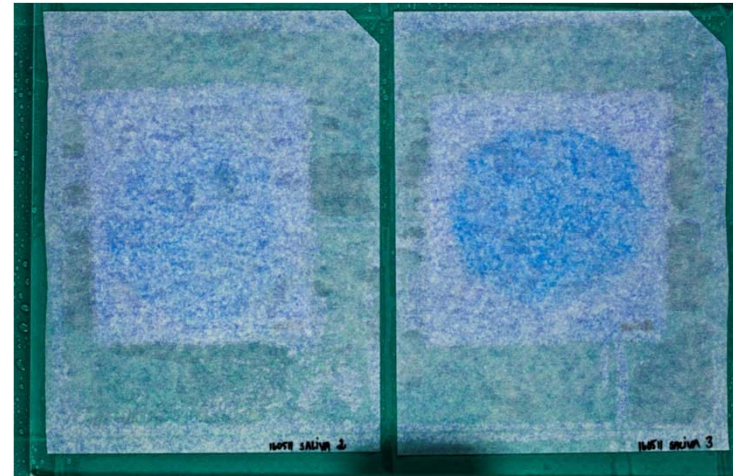
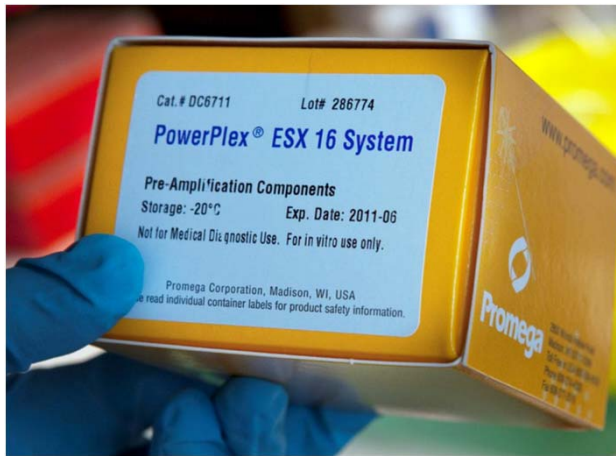
Crime scene samples/evidence



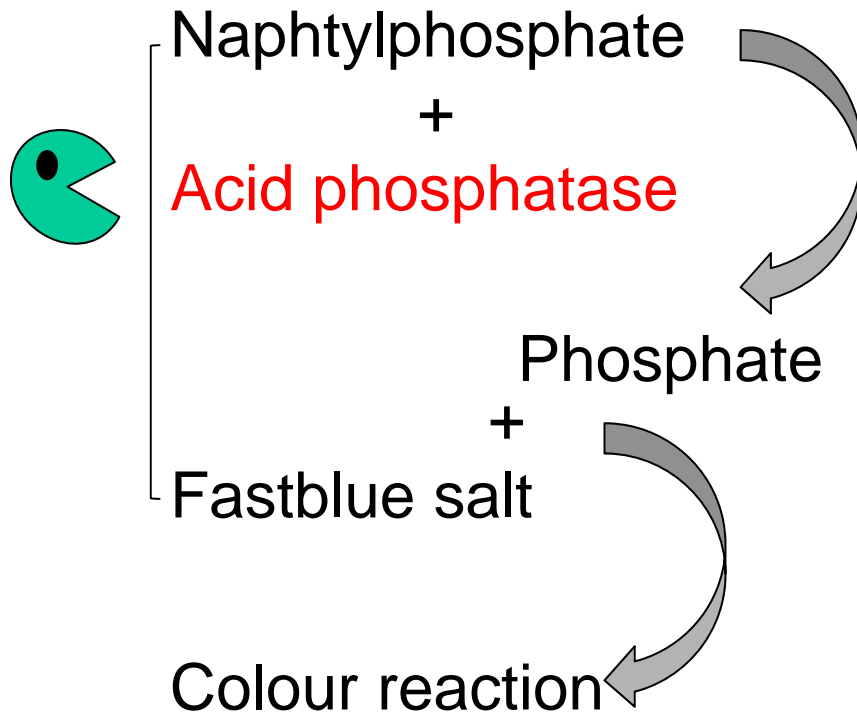
# ”Regular” Internal QC

- 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



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

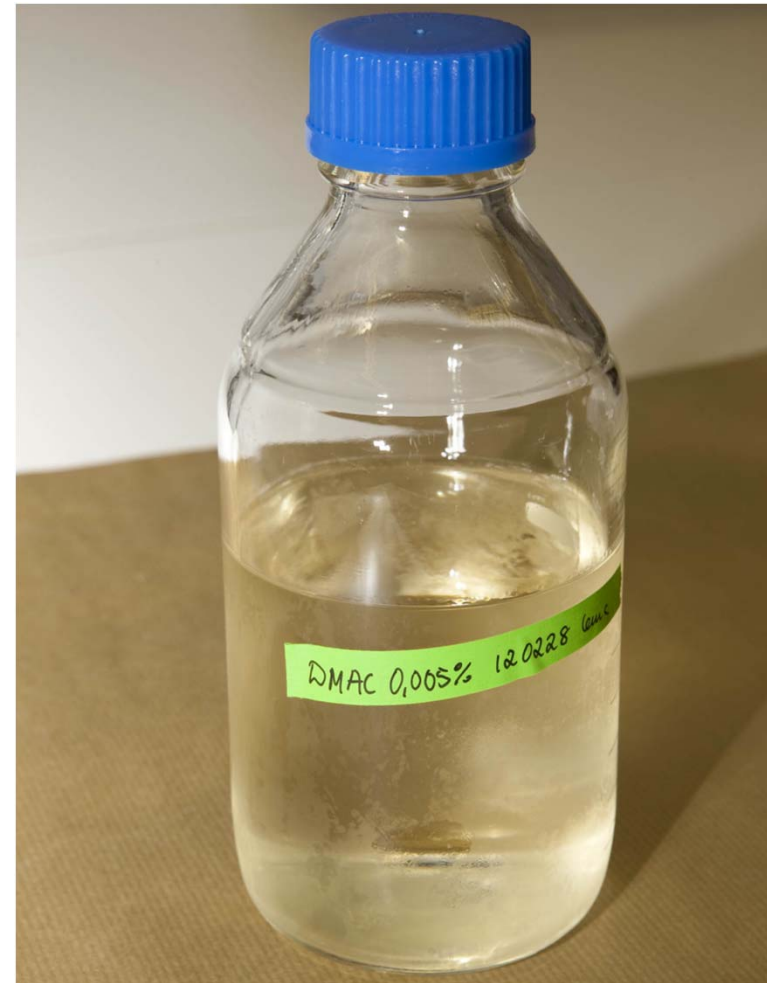
Reacts with amines/amides to a  
colour change into dark pink

Positive control:

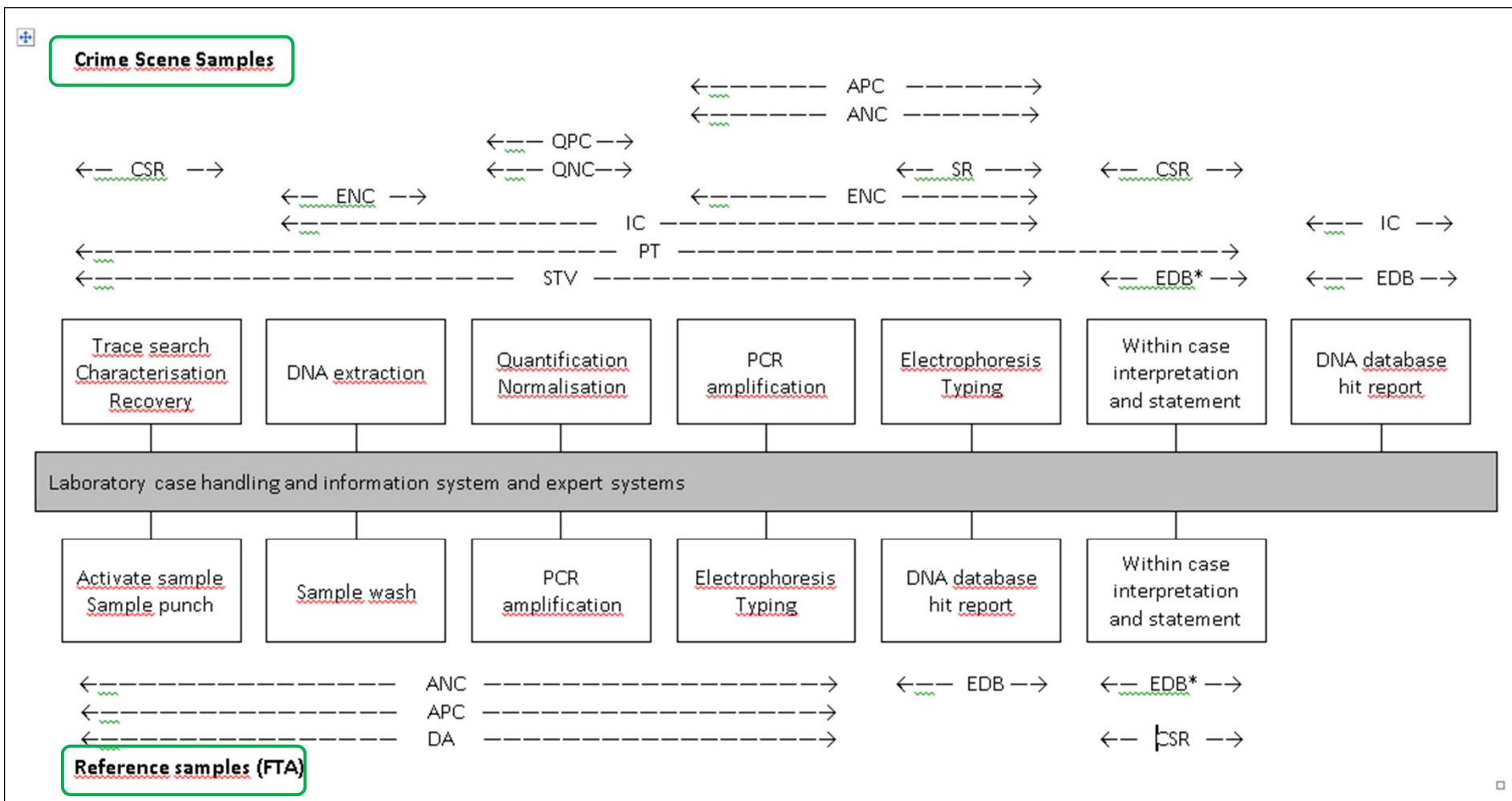
Dried urine on filterpaper

Negative control:

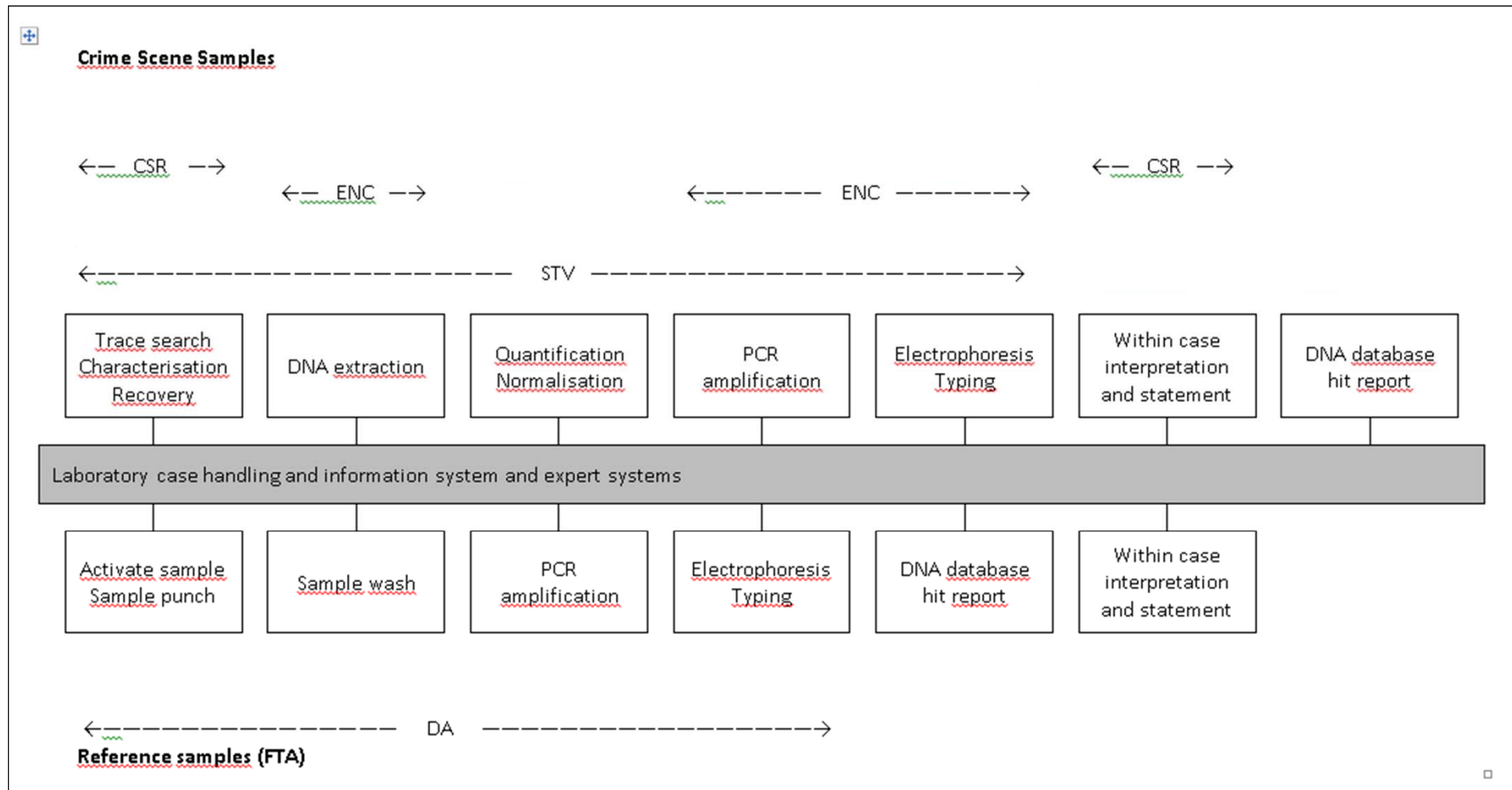
Dried water on filter papper



# "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)

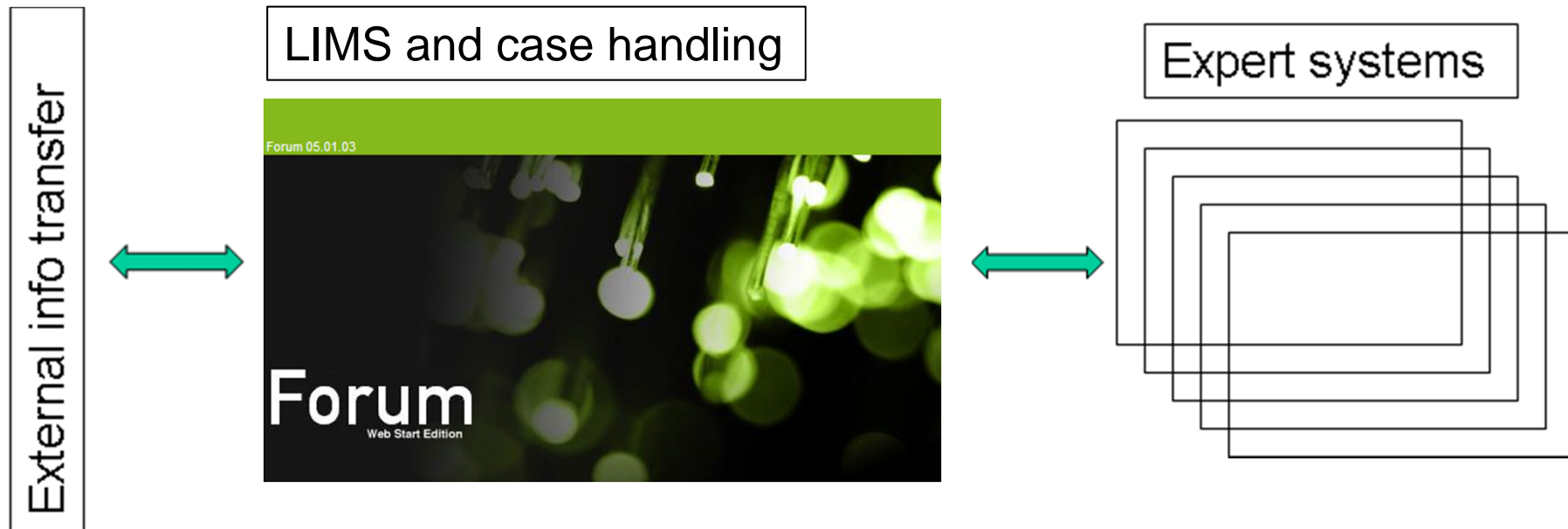
ANC - amplification negative control

APC - amplification positive control (known  
profile)

DA - double analyses

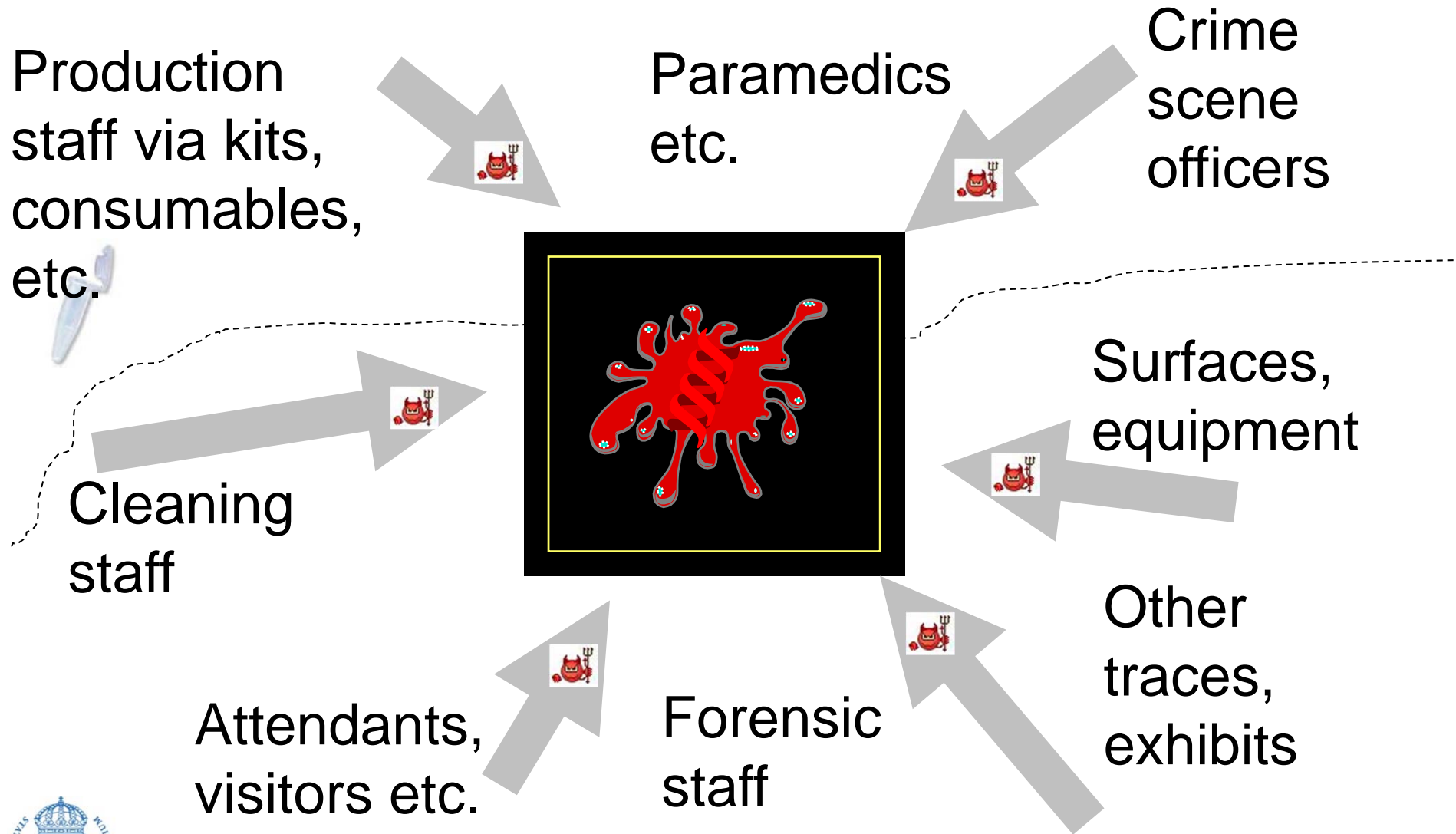


# Internal QC of LIMS and Expert systems



Validation work, implementation set-up  
and then ?

# Contamination



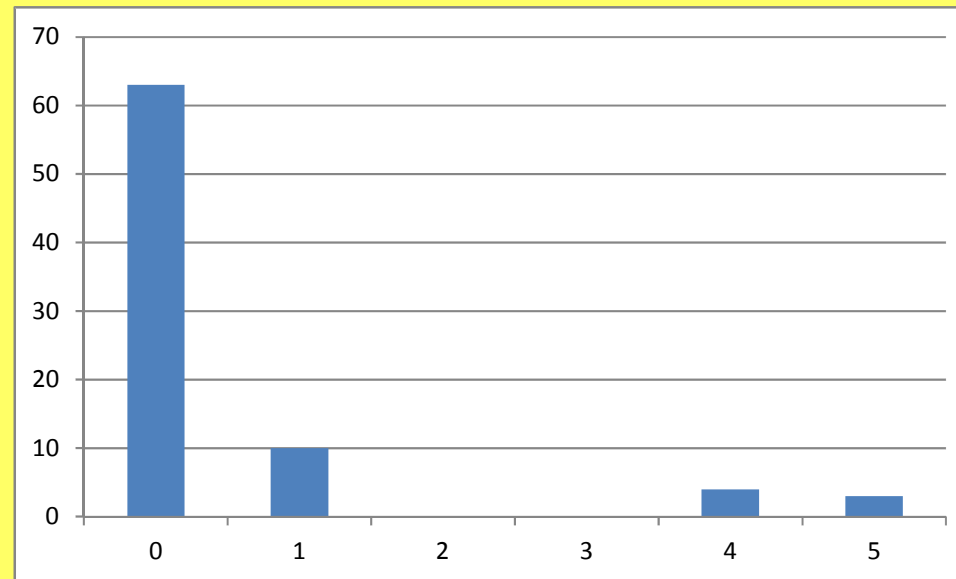
# Contamination monitoring

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)



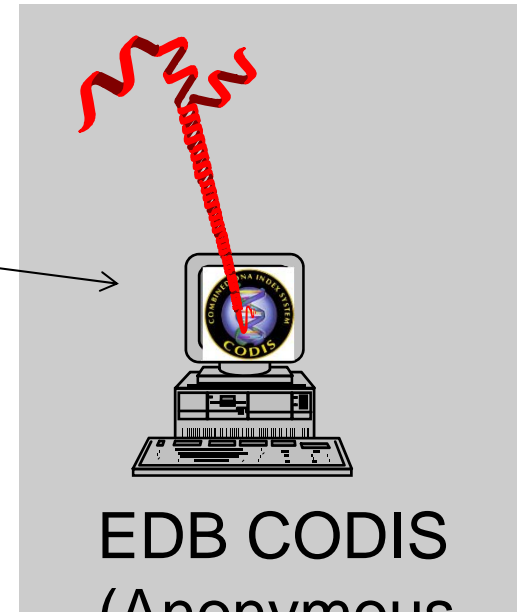
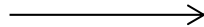
# Some "background" DNA

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)

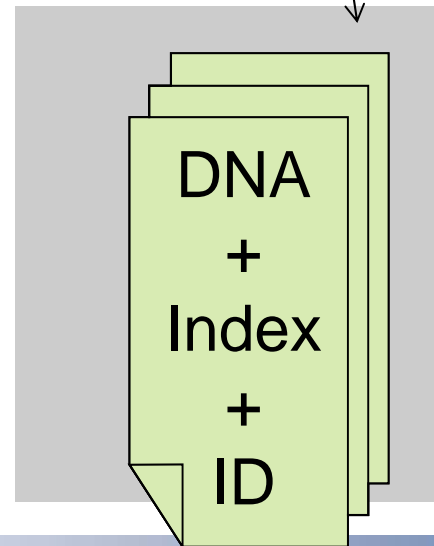
# DNA elimination database (EDB)

Informed consent



Staff & others

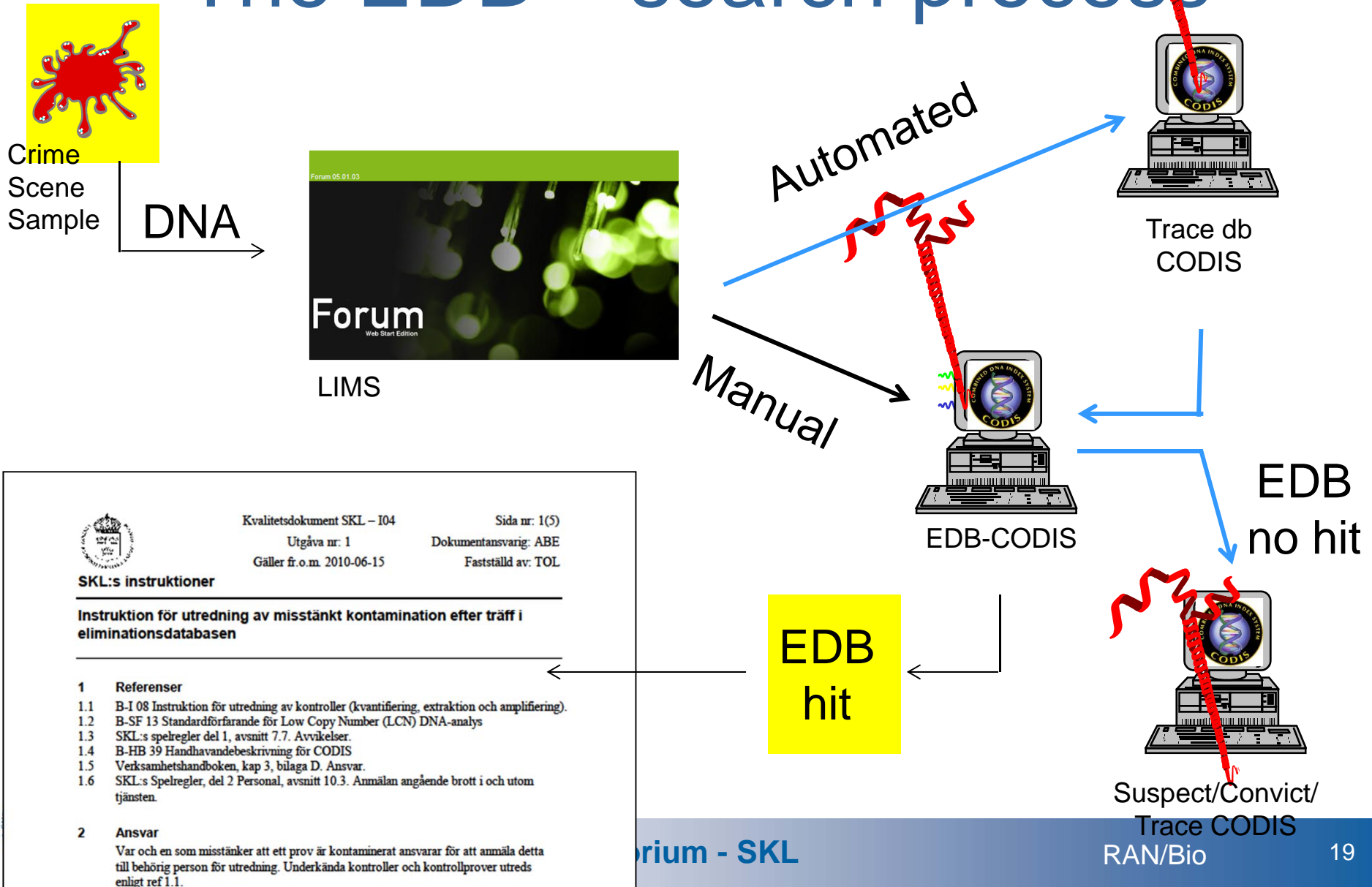
Removal from EDB upon request



EDB CODIS (Anonymous with index)



# The EDB – search process



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

	<b>SKL staff</b>	<b>Police</b>	<b>Supplier</b>
2009	7	-	1
2010	1	-	2
2011	6	3	3
2012*	6	2	-

\* Data until September 30<sup>th</sup>.

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”**



**Yttrande** 1 (8)


Datum 2012-04-13	Vårt diarienummer 2012200314
Ert datum 2012-03-23	Ert beteckning 514-2012

Datainspektionen  
Nicklas Hjertonsson  
Box 8114  
104 20 STOCKHOLM

**Angående ”Tillsyn mot SKL:s behandling av personuppgifter i den s.k. eliminationsdatabasen för DNA”**

**Bakgrund**  
En dna-profil kan utgöra ett mycket starkt bevis och med stor tillförlitlighet visa om en person kan ha avsatt ett visst biologiskt spår på en brottsplats, eller inte. Tilltron till dna-bevis är generellt sett hög inom såväl rättsväsendet som samhället i stort.

Med dagens tekniker går det att ta fram dna-profiler från spår med mycket små mängder dna. Det kan räcka med att någon hållit i eller tagit på ett föremål. Detta medför att processen med spårbehandling, spårhantering och analys blir ytterst känslig för kontamination, dvs. en oönskad överföring av dna. Särskilt känslig är den s.k. Low Template-tekniken där dna från enstaka celler kan analyseras. Om någon av de som direkt eller indirekt hanterat ett brottsplats-spår tillför sitt dna, så är det troligt att det görs i en kvantitet som kan detekteras och därmed påverka det slutliga analysresultatet. Detta medför att den ofta begränsade mängd dna som fanns i det omstridda spåret från början, och som utan kontamination skulle ha kunnat kopplas till gärningsmannen, kan komma att helt döljas av det kontaminerande dna:t, alternativt att resultat är ett blandat dna med ett reducerat värde



**BESLUT** 2012-05-28

Diarienum  
514-2012  
Ert diarienum  
2012200314

Statens kriminaltekniska laboratorium  
581 94 LINKÖPING

**Tillsyn mot elimineringsdatabasen vid Statens kriminaltekniska laboratorium**

Datainspektionen meddelar följande

**BESLUT**

Datainspektionen konstaterar att den jämförelse som Statens kriminaltekniska laboratorium gör mellan DNA-profiler i laboratoriets elimineringsdatabas och det spårregister som förs med stöd av 4 kap. 5 § polisdatalagen (2010:361) inte är förenlig med gällande rätt.

Datainspektionen förelägger Statens kriminaltekniska laboratorium att



# ”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

- Two major goals;
  - To solve the specific issue at hand
  - Draw conclusions, improve and avoid

The screenshot shows a web application interface for reporting non-conformance. The title is 'Registrera ny avvikelse' with a sub-note 'Obligatoriska fält är markerade med en asterisk (\*).'. The form includes the following fields:

- Upprättad av: Ansell; Ricky; [RAN]
- Upprättande enhet/enhetsgrupp: Biologienheten;
- Rubrik: \* (empty text box)
- Beskrivning av avvikelse: \* (max 65535 tecken) (empty text area)
- Upptäckt av: \* (dropdown menu with [Välj])
- Datum för upptäckt: \* (calendar icon) [ÅÅÅÅ-MM-DD]
- Avvikelse hos enhet/enhetsgrupp: \* (dropdown menu with [Välj])
- Prioritet: \* (dropdown menu with [Välj])
- Initierad: \* (dropdown menu with [Välj])
- Ursprung: \* (dropdown menu with [Välj])
- Område: \* (dropdown menu with [Välj])
- Avvikelse mot kvalitetsdokument: (empty text box)
- Relaterade avvikelser: (empty text box)
- Diarienummer rel. till avvikelse: (empty text box)
- Fil att bifoga: (max 8 MB) (file upload button: Bläddra...)
- Skicka avvikelser till: \* (dropdown menu with [Välj])
- För kännedom till: (dropdown menu with a list of names: Adolfsson; Niklas; [NIAD], af Forselles; Joakim; [JOFO], Ahlenius; Cecilia; [CEAH], Ahlsten Andersson; Anna; [AAH], Al Naher; Hanin; [HAAL], ...)



# ”Non-conformance” categories

## Category

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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

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# DNA-related non-conformance reports 2010-2012

Category	2010			2011			2012 <sup>c</sup>		
	No.	Cause <sup>a</sup> I/E	Found <sup>b</sup> I/E	No.	Cause <sup>a</sup> I/E	Found <sup>b</sup> I/E	No.	Cause <sup>a</sup> I/E	Found <sup>b</sup> 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	
<b>Total</b>	<b>106</b>	96/10	94/12	<b>117</b>	105/12	104/13	<b>52</b>	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



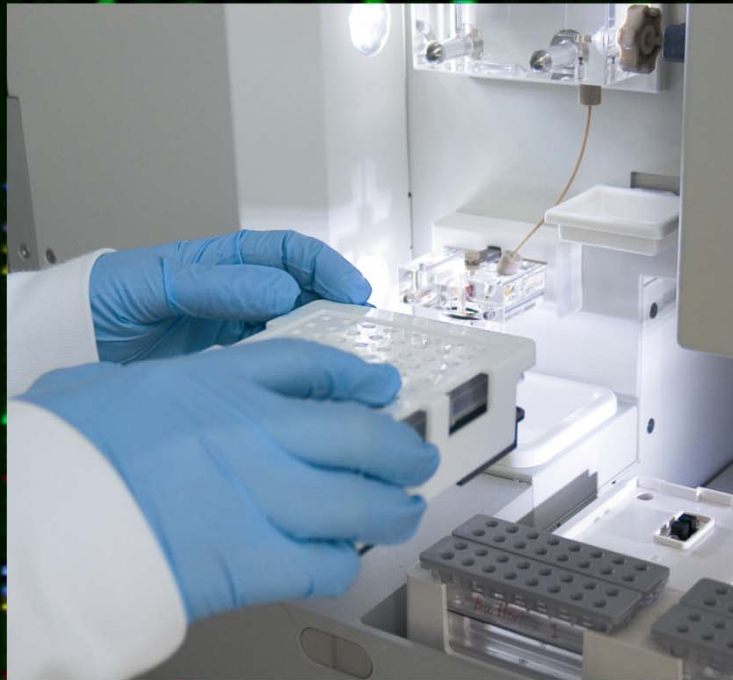
# Major conclusions

- 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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