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Exchange of DNA-profiles by the Treaty of Prüm

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Contents of the presentation

- Some facts
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- Prüm-inclusion and -matching rules
- Testset
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Scope of the Treaty of Prüm

- Cross border cooperation by means of exchanging judicial and police information and mutual assistance
- Each memberstate makes its fingerprint- DNA-, and vehicle registration database available to other member states for automated searches on a hit/no hit basis
- After a hit: exchange of personal data and case information by existing mutual legal assistance procedures



Participating Countries


- Treaty was signed in May 2005 by Austria, Germany, the Netherlands, Luxemburg, Belgium, France and Spain
- In the mean time also: Finland, Portugal, Italy, Slovenia, Sweden, Bulgaria, Romania, Slovakia, Hungary and Greece have joined
- European Union has agreed to transform the Treaty of Prüm into EU-legislation




Participating EU-countries

Country	Persons	Stains
Austria	105,639	29,203
Belgium	12,515	13,101
Bulgaria	16,201	966
Cyprus	0	0
Czech Republic	12,639	4,740
Denmark	30,185	13,071
Estonia	20,558	7,159
Finland	60,959	9,875
France	506,085	27,170
Germany	524,782	123,862
Greece	0	0
Hungary	55,179	1,102
Ireland		
Italy	0	0
Latvia	0	0
Lithuania	23,757	2,764
Luxemburg	218	226
Malta	0	0
Netherlands	47,350	34,155
Poland	16,118	174
Portugal	0	2,160
Romania	2,452	41
Slovakia	6,439	3,425
Slovenia	12,120	4,040
Spain	21,432	24,800
Sweden	41,417	17,002
UK (England, Wales, Scotland and NI)	4,011,954	308,503
Total	5,527,999	627,539



 Prüm memberstate

 Other EU-countries

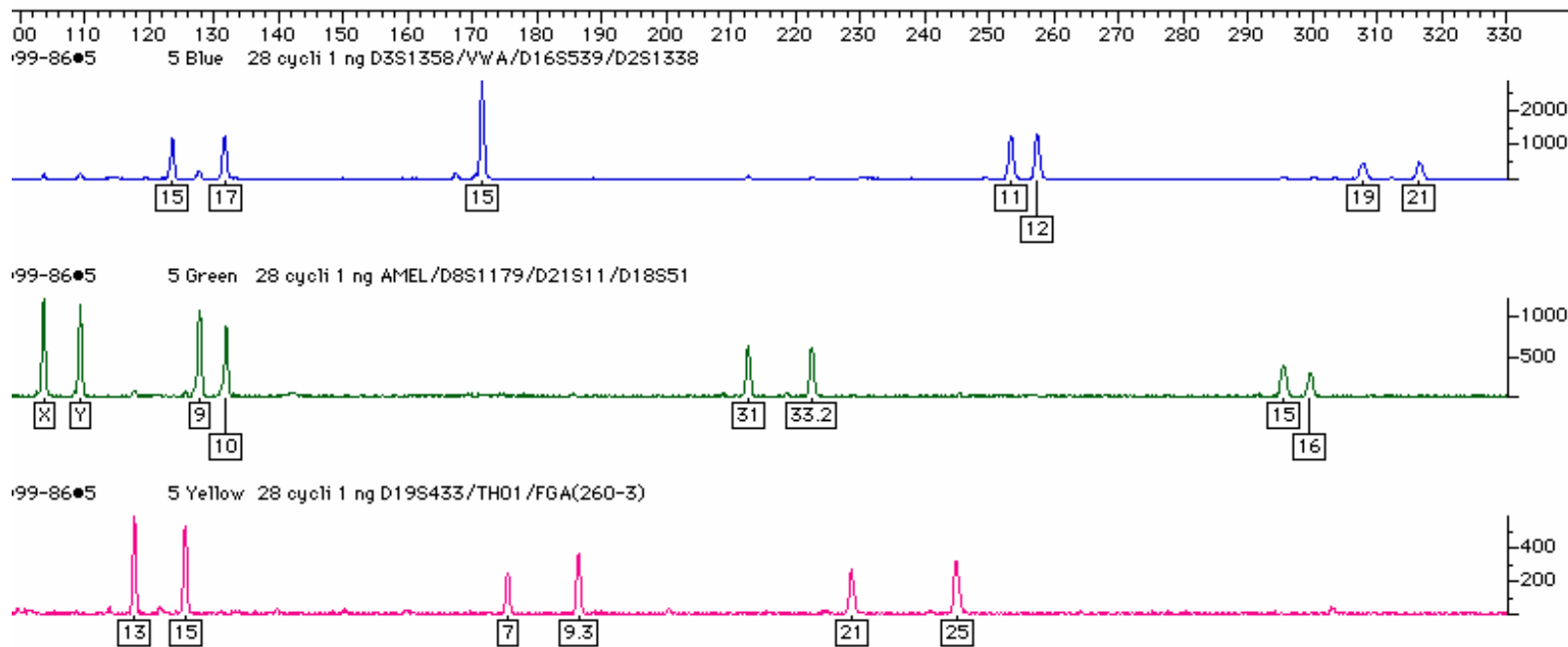


Present implementation status

- The treaty has already been ratified by the parliaments of many member countries
- DNA exchange and comparison software plus documentation has been developed and tested by Austria, Germany and the Netherlands (for CODIS using countries)
- Germany, Austria, Spain, Luxemburg and Slovenia (partly) are already in daily operation
- France, Belgium and the Netherlands are presently finalizing their implementation tests



Graphical and numerical representation of a DNA-profile (SGM-plus)



	Amel	D3	vWA	D16	D2	D8	D21	D18	D19	TH01	FGA
Type	X/Y	15/17	15/15	11/12	19/21	9/10	31/33.2	15/16	13/15	7/9.3	21/25



DNA-markers (loci) which can be used (equal to the loci used in the Interpol DNA-database)

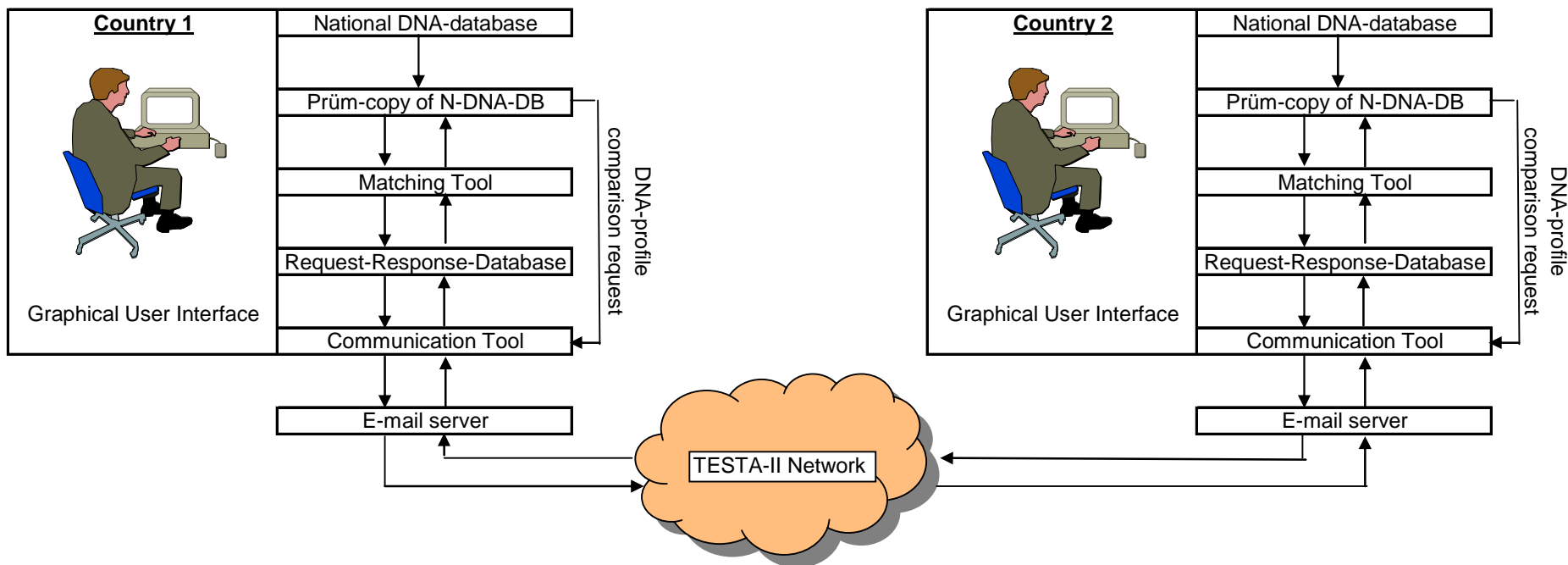
VWA	TH01	D21S11	FGA	D8S1179	D3S1358	D18S51	Amelogenin
TPOX	CSF1P0	D13S317	D7S820	D5S818	D16S539	D2S1338	D19S433
Penta D	Penta E	FES	F13A1	F13B	SE33	CD4	GABA

 European Standard Set (ESS)

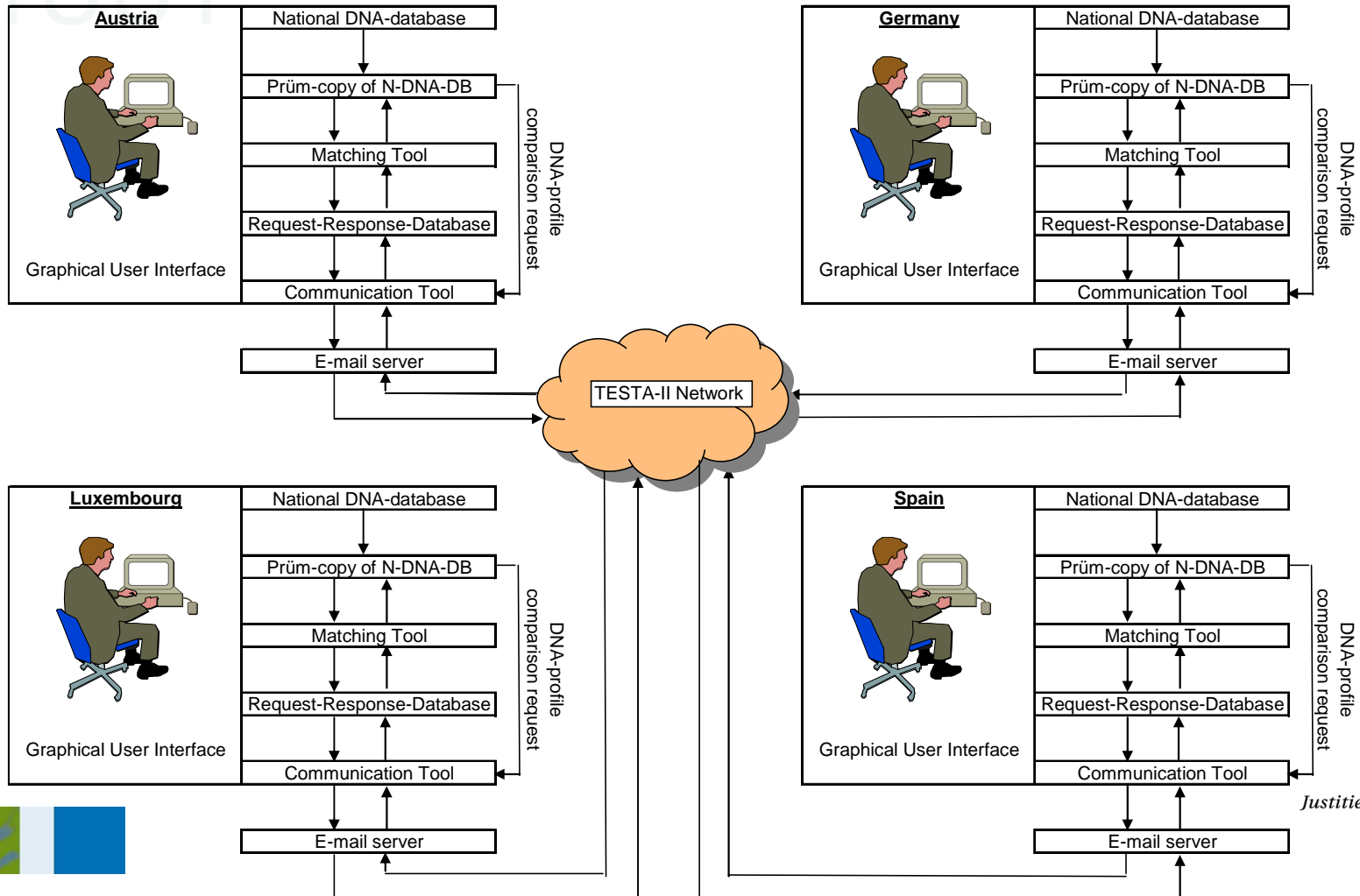
ESS + Amelogenin = Interpol Standard Set of Loci (ISSOL)



Prüm process (I)



Prüm process (II)



Prüm inclusion rules

- At least 6 of the 7 ESS-loci for known persons
- At least 6 loci for crime scene stains
- Any other of the 24 Interpol loci
- One allele of a locus can be a wild-card
- No mixed profiles (only 2 values per locus)
- No stains that have already matched a person
- No profiles that a country does not want to make available (e.g. elimination known, etc.)



Prüm Matching rules

- At least 6 fully matching loci
- 1 mismatching allele allowed (near match)
- 1 basepair difference allowed (microvariants)
- Any type of profile sent in for comparison will be compared to any type of DNA-profile made available for comparison



Match between a German and a Dutch DNA-profile

Locus	SE33	VWA	TH01	D21	FGA	D8	D3	D18	Amel	D16	D2	D19
Nederland		17/18	6/9.3	29/30	21/23	13/14	15/17	14/15	X/Y	9/13	19/23	13/15
Duitsland	17/19	17/18	6/9.3	29/30	21/23	13/14	15/17	14/15	X/Y			



Prüm Testset

- A set of 150 candidate and 23 target DNA-profiles has been developed by the Netherlands to test whether the software properly handles the inclusion and the matching rules
- 41 of the 150 candidate profiles should be included in the Prüm-copy of the N-DNA-DB
- Searching with the 23 target profiles should result in 19 matches with 29 candidates



Prüm Report contents

- Responding country
- Full or near match
- Both DNA-profiles involved in the match
- Stain or reference sample
- Sample code to enable further steps
(mutual legal request)



Prüm Quality Control Measures

- Compliance of DNA-profile production with ISO 17025 or equivalent quality standard
- Compliance with European data protection directive or national law derived from this directive
- Estimation of the expected number of adventitious matches after a search action

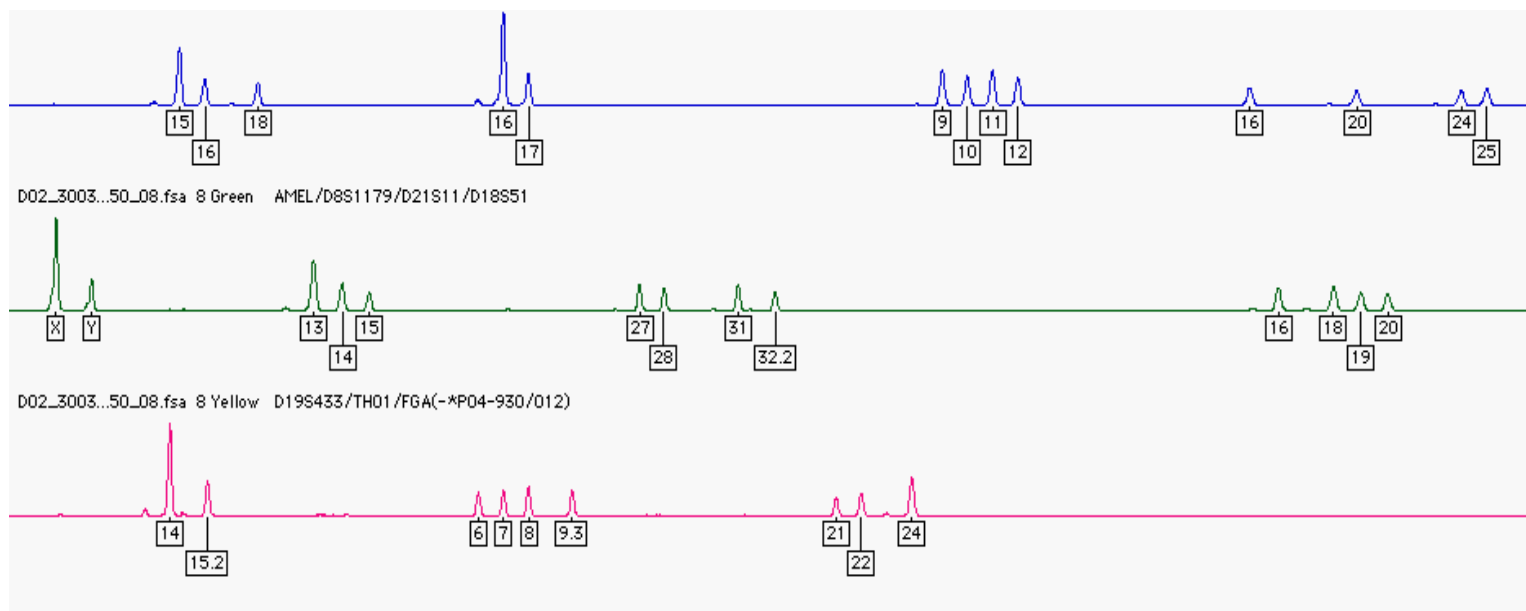


Points of attention

- Mixed DNA-profiles cannot be processed automatically
- Partial DNA-profiles may result in adventitious matches



Mixed DNA-profiles (I)



Mixed DNA-profiles (II)

Locus

allele

Mixed stain

Reference

D3S1358			
1	2	3	4
15	16	17	18
15	16		

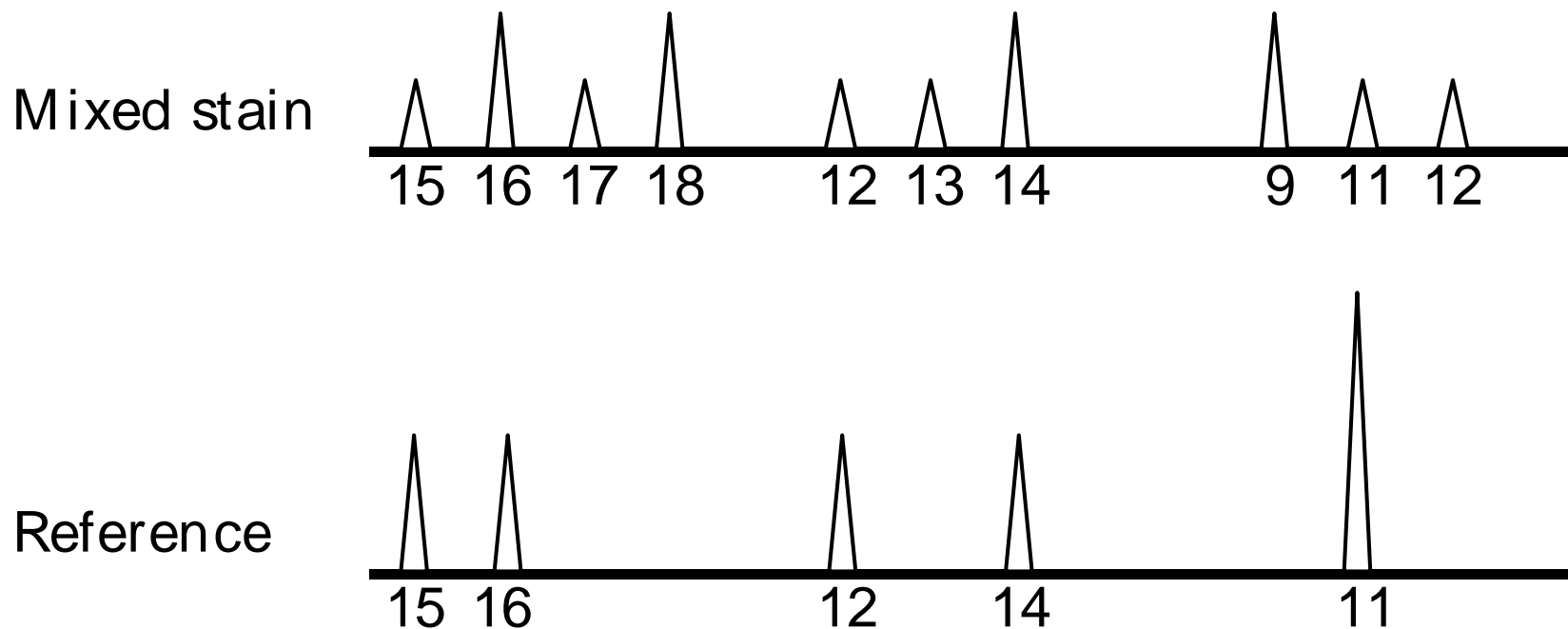
VWA			
1	2	3	4
12	13	14	
12		14	

D16S539			
1	2	3	4
9	11	12	
	11		

Based on allele values the reference matches the stain



Mixed DNA-profiles (III)



Conclusion: No Match



Adventitious match definition

- A match between DNA-profiles of a crime scene stain and a person (in a DNA-data-base) who is not the donor of that stain
- The word “adventitious” is actually not an appropriate word as its meaning is “accidental” or “unexpected”
- The occurrence of adventitious matches however is not unexpected and can be predicted and even estimated based on the following parameters

Parameters influencing the expected number of adventitious matches

- Match probability of the DNA-profile
- Size of the DNA-database
- Frequency of searches
- Presence of relatives in the database



Match probability & size of the DNA-database (I)

- If the match probability of a given DNA-profile = 1 : 1.000.000 and the size of a DNA-database = 3.000.000, the expected number of adventitious matches = 3
- None or one of these three matches may be the donor of the crime related stain



Match probability & size of the DNA-database (II)

Number of profiles in the DNA-database 3,000,000
 Match probability of DNA-profile 1: 1,000,000

Chance to find **N** adventitious matches

N	Binomial
0	0.050
1	0.149
2	0.224
3	0.224
4	0.168
5	0.101
6	0.050
7	0.022
8	0.008
9	0.003
10	0.001
Total	1.000

“**Birthday problem**”



Match probability & size of the DNA-database (III)

		Size of the DNA-database			
		10.000	100.000	1.000.000	10.000.000
Match Probability (1:X)	10.000	1	10	100	1.000
	100.000	0,1	1	10	100
	1.000.000	0,01	0,1	1	10
	10.000.000	0,001	0,01	0,1	1
	100.000.000	0,0001	0,001	0,01	0,1
	1.000.000.000	0,00001	0,0001	0,001	0,01
	10.000.000.000	0,000001	0,00001	0,0001	0,001

Expected number of adventitious matches



Frequency of searches (I)

- Numbers in previous slides refer to a single search
- The expected number of adventitious matches in a certain period is equal to the number of searches times the expected number of adventitious matches for those searches
- Problem: MP of every search is different (full profiles, partial profiles, mixed profiles)



Frequency of searches (II)

Theoretical example: DNA-database with 4 million reference samples and 70.000 searches per year with different kinds of crime related stains

DNA-database size	Match probability crime related stain	Exected. nr of Adventitious Matches (for a single search)	Annual number of searches	Annual exp. nr of Adventitious Matches
4.000.000	1 : 10.000.000.000	0.0004	50,000	20
	1 : 1.000.000.000	0.004	10,000	40
	1 : 100.000.000	0.04	5,000	200
	1 : 10.000.000	0.4	3,000	1,200
	1 : 1.000.000	4	2,000	8,000



Frequency of searches (III)

- Practical example: The Netherlands will soon start exchanging DNA-profiles with Germany under the terms of the Treaty of Prüm
- As a start the Netherlands will compare ± 20.000 DNA-profiles from crime related stains with ± 500.000 DNA-profiles from German reference samples



Frequency of searches (IV)

- The DNA-profiles in the DNA-database of Germany consist of the 7 loci of the European Standard Set plus SE-33
- The DNA-profiles in the DNA-database of the Netherlands consist of the loci of the SGM-plus-kit
- Hence the maximum number of loci that can match is 7



Frequency of searches (V)

German DNA-database size	Dutch match probability of the crime related stain	Expected. nr of Adventitious Matches (for a single search)	Total number of searches	Total exp. nr of Adventitious Matches
500,000	1 : 100,000,000	0.005	18,000	90
	1 : 10,000,000	0.05	2,000	100
Total			20,000	190

The number of adventitious matches of Dutch DNA-profiles with other Prüm member states will be less because they also use the SGM-plus-kit to generate DNA-profiles



Presence of relatives (I)

The presence of relatives in a DNA-database increases the expected number of adventitious matches because the match probability with a relative is higher than with a random person

Relationship	Match probability (full SGM+ profile)
no relationship	1 in 10 billion (random match probability)
cousin	1 in 1 billion
half sib	1 in 100 million
parent or child	1 in 10 million
full sib	1 in 100.000

By simulation it can be shown however that the presence of family members in a DNA-database results in only a relatively small additional increase in the expected number of adventitious matches



Summary and conclusions (I)

- The two step Prüm mechanism of data-exchange meets the principle of availability and at the same time it meets personal data protection requirements by only providing personal data on request after a match
- In this second step existing mutual legal assistance procedures are used which creates a moment of evaluation against the national legislation of the requested country



Summary and conclusions (II)

- More or less frequently (depending on the parameters discussed in this presentation) adventitious matches are to be expected
- Therefore the criminal justice system should only consider (Prüm) DNA-database matches in combination with other types of evidence

