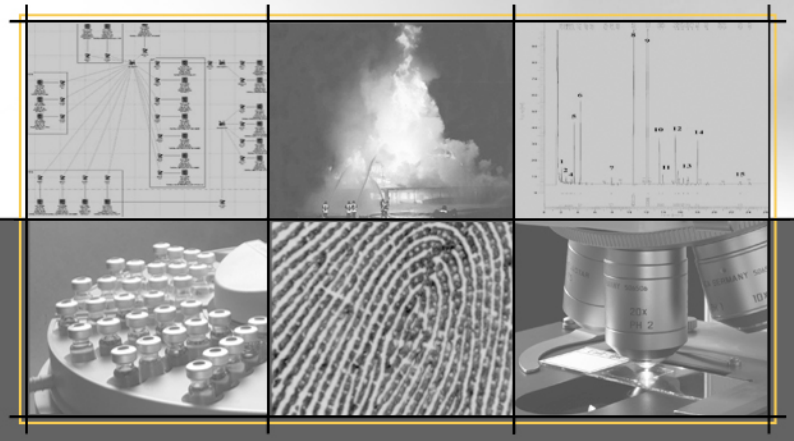
Forensic science is not an oxymoron, it is a discipline in itself

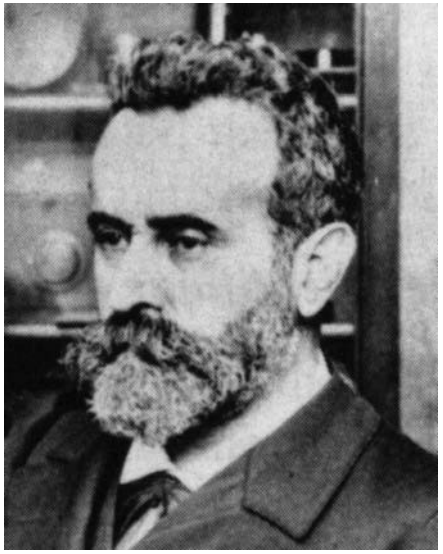
Christophe Champod & Fabiano Riva
University of Lausanne, Switzerland



R. A. Reiss

Forensic Science for the 21st Century
Sandra Day O'Connor College of Law,
Arizona State University – April 3-4, 2009

Alphonse Bertillon



"The aim is not to condemn somebody because his measurements correspond to those of another person. We provide only items of information. We provide just a name useful for the examination. It is up to the inquiry to ascertain the exactness, using criminal records, testimonies, etc. It is easy to see that if the information, obtained from anthropometric considerations, is corroborated *a posteriori* by other evidence, it will become an absolute certainty for the court."

Bertillon A. De l'identification par les signalements anthropométriques. Archives de l'anthropologie criminelle et des sciences pénales. 1886;1:193-223.

Edmond Locard: about the expert

"The physical certainty provided by scientific evidence rests upon evidential values of different orders. These are measurable and can be expressed numerically. Hence the expert knows and argues that he knows the truth, but only within the limits of the risks of error inherent to the technique.

This numbering of adverse probabilities should be explicitly stated by the expert. The expert is not the judge: he should not be influenced by facts of a moral sort. His duty is to ignore the trial."

Locard E. L'enquête criminelle et les méthodes scientifiques. Paris: Ernst Flammarion; 1920.

Edmond Locard: about the judge

"…with regard to forensic science, the duties of the judge are clear: the judge must be able to understand forensic technology and to evaluate results and their respective strengths; otherwise his personal conviction would be made relying blindly on the expert.

It is the judge's duty to evaluate whether or not a single negative presumption, against a sextillion of probabilities, can prevent him from acting."

Locard E. L'enquête criminelle et les méthodes scientifiques. Paris: Ernst Flammarion; 1920.

Progress in Forensic Science

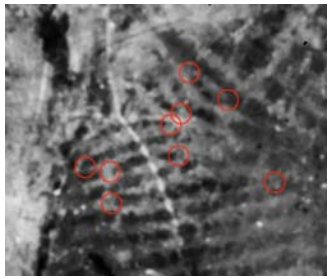
> I believe that if we want to do any progress in forensic science, we shall:

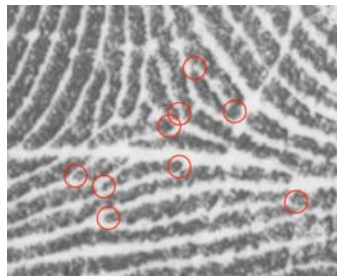
① Abandon unsupportable claims of individualization.

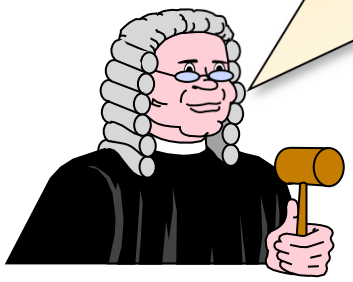
② Redefine the logical underpinning of our reporting schemes.

③ When possible, provide opinions that can be supported by empirical and disclosable data.

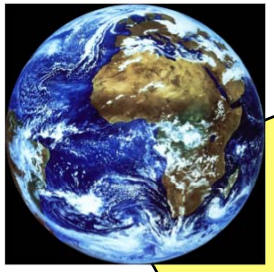
What do you mean by "certain" ?





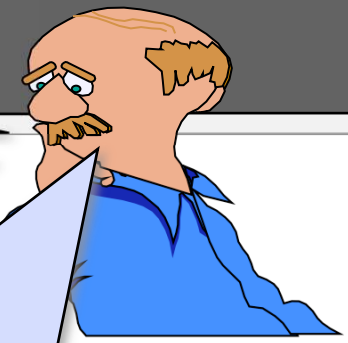


It means that, on Earth, nobody else but the suspect can be the source of the mark



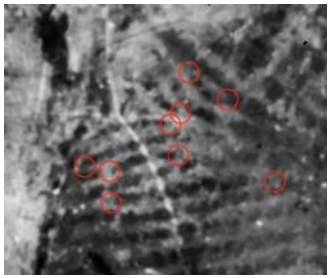
"Earth population paradigm"

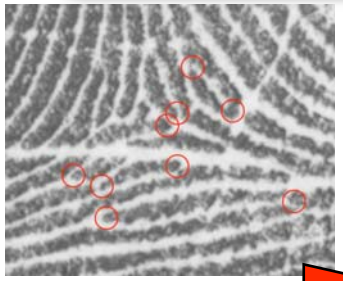
Let's consider *a priori* 10 billion individuals



Recall, this the Earth population paradigm

What strength of evidence do we need to obtain a reasonable degree of scientific certainty ?

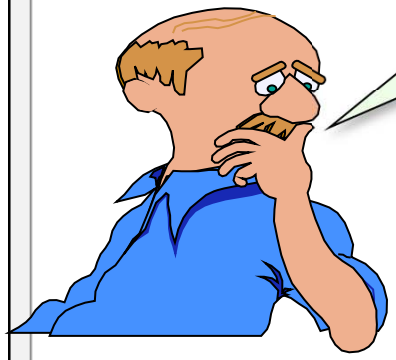




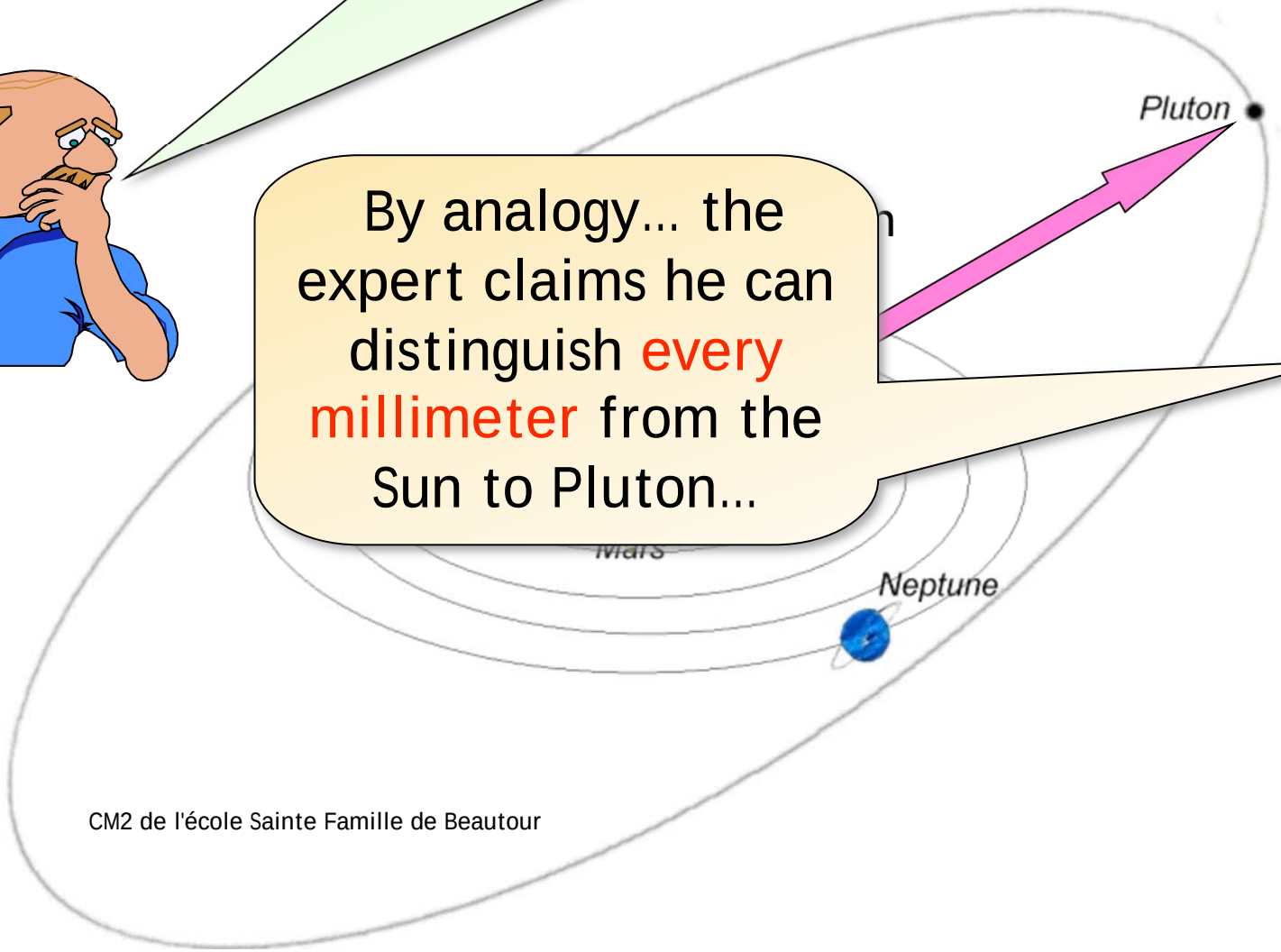
Mr DOE is one among 10 billion

Mr DOE has left the mark to a reasonable degree of scientific certainty

Hence we talk about a likelihood ratio of the order of 10^{15} or more



By analogy… the expert claims he can distinguish every millimeter from the Sun to Pluton…

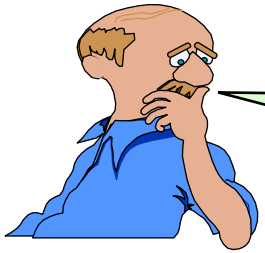


CM2 de l'école Sainte Famille de Beautour

① Individualization

We shall move away from the Earth population paradigm

And completely abandon the concept of individualisation



There is no need to be certain to be useful

The likelihood ratio associated with the features at hand exceeds 10^9

…and this provides extremely strong support for the view that the mark has been left by the same finger as the print as opposed to an unknown finger

Neumann C, Champod C, Puch-Solis R, Meuwly D, Egli N, Anthonioz A, et al. Computation of Likelihood Ratios in Fingerprint Identification for Configurations of Three Minutiae. J For Sci. 2006;51(6):1255-66.

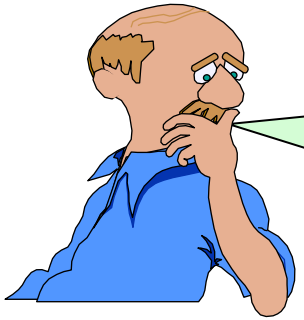
Egli NM, Champod C, Margot P. Evidence evaluation in fingerprint comparison and automated fingerprint identification systems--Modelling within finger variability. Forensic Sci Int. 2007;167(2-3):189-95.

Neumann C, Champod C, Puch-Solis R, Egli N, Anthonioz A, Bromage-Griffiths A. Computation of Likelihood Ratios in Fingerprint Identification for Configurations of Any Number of Minutiae. J For Sci. 2007;52(1):54-64.

Forensic Expert Opinion

Balance?

Logic?

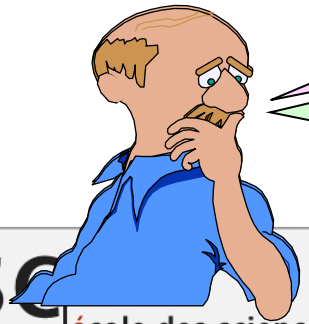


If we can get the logic right – then this helps us to maintain balance

Probability of the evidence given the prosecution case

Probability of the evidence given the defence case

The single most important advance in forensic science thinking is the realization that the scientist should address the *probability of the evidence*



The ratio (called the likelihood ratio - LR) of these two determines the way that the scales of justice are tilted by the scientific evidence

② Reporting Scheme

> It should based on sound logical principles

LR	
> 10^6	Extremely strong evidence to support H_p
10^5 to 10^6	Very strong evidence to support H_p
10^3 to 10^5	Strong evidence to support H_p
10^2 to 10^3	Moderate evidence to support H_p
>1 to 10^2	Limited evidence to support H_p
1	Inconclusive, the findings does not help to progress towards H_p or H
	o 1
	to 10^{-6}
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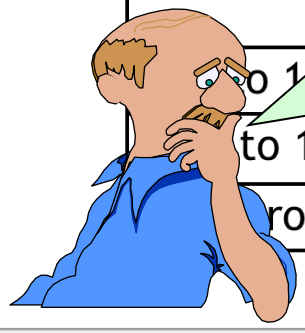
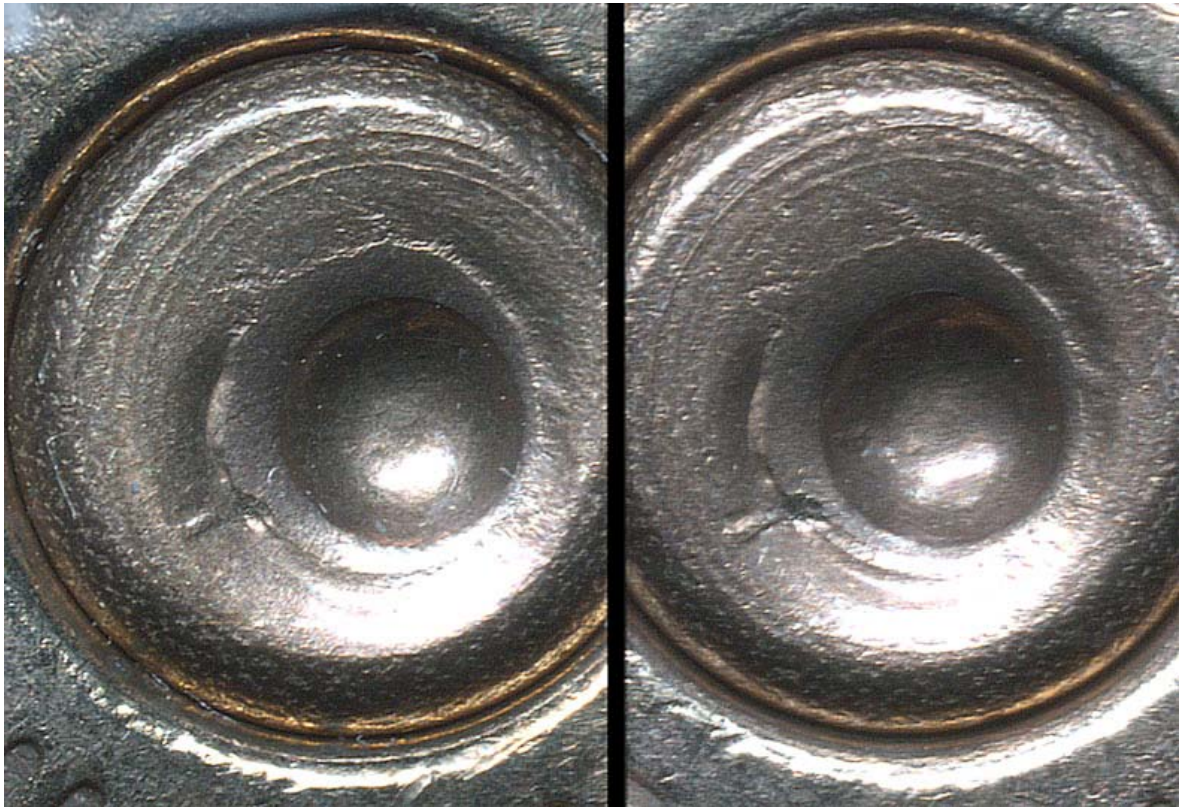


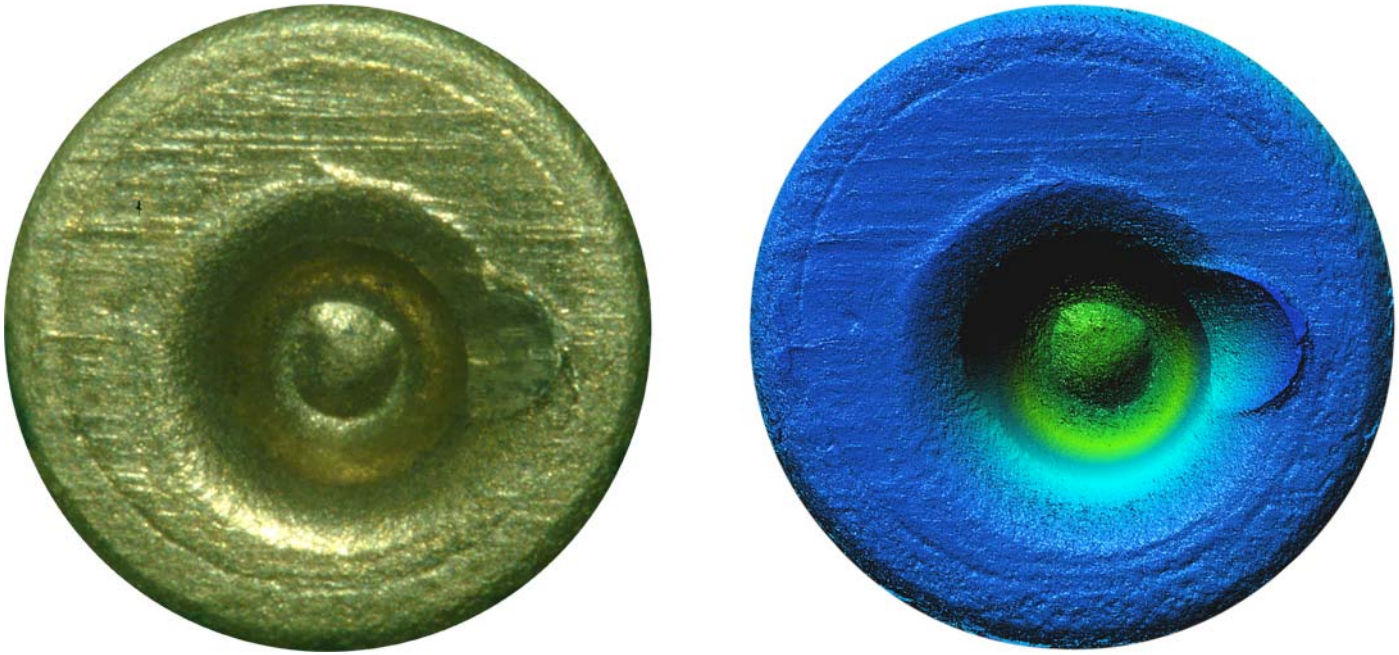
Unfortunately, the reporting scales currently proposed by document examiners, footwear mark examiners, firearms/toolmarks examiners do not stand scientific scrutiny

Support opinions with relevant data

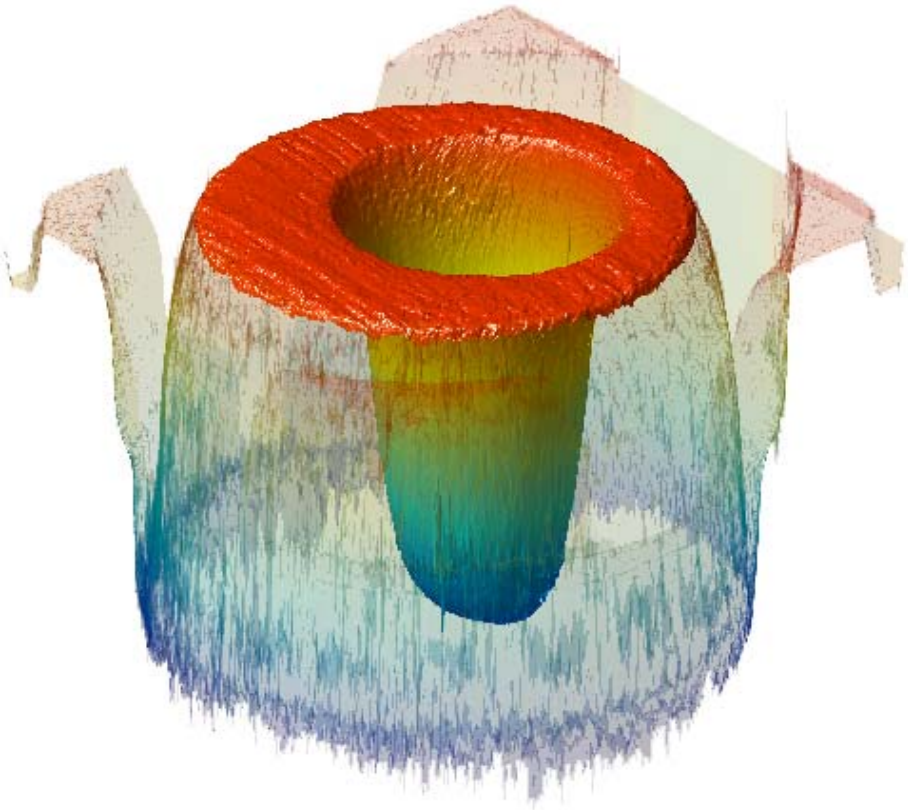


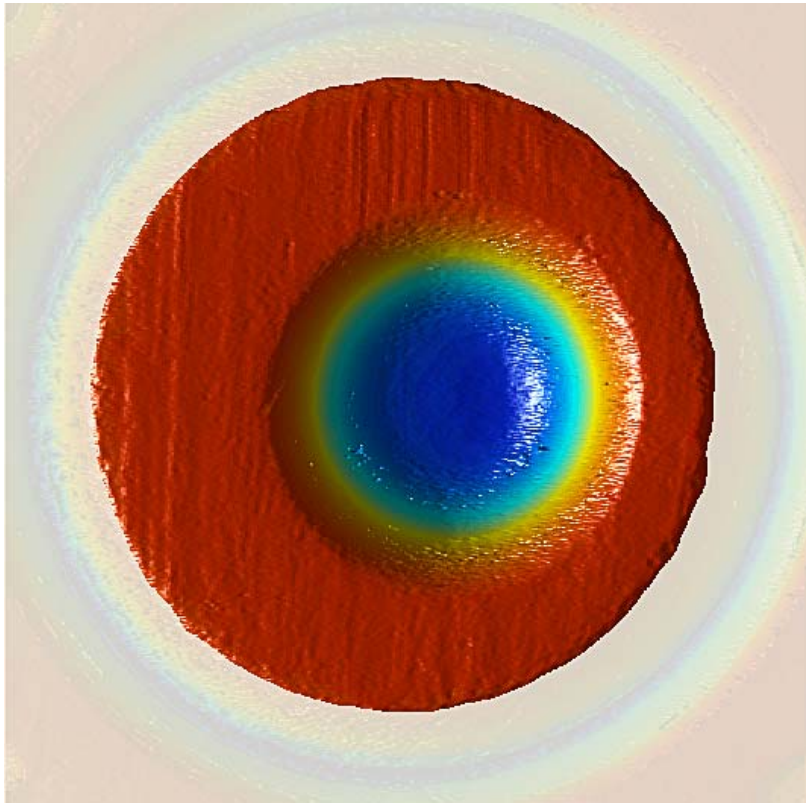
Was Q (left) fired by the same gun (SIG 9mm parabellum) as K (right)?

Measurements with Nanofocus µscan



Primer Cup Cutting

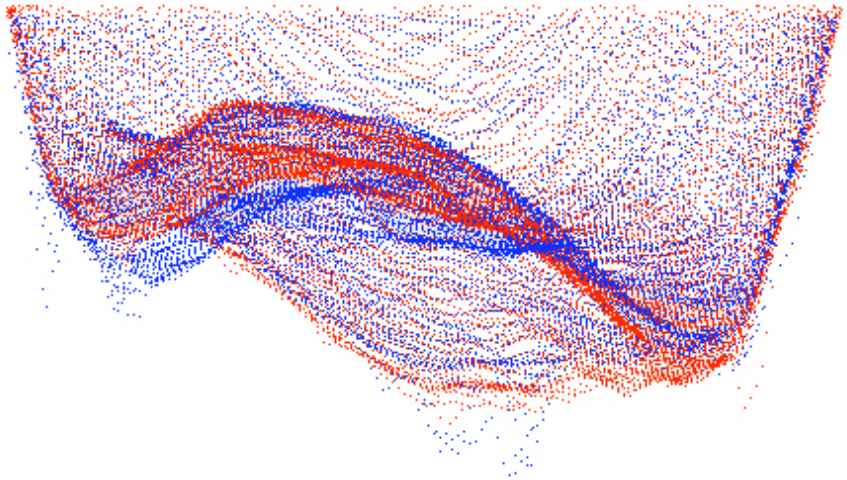




Automatic segmentation of the primer cup by exploiting normal vectors

ICP – Iterative Closest Point

Firing Pin Mark Alignment



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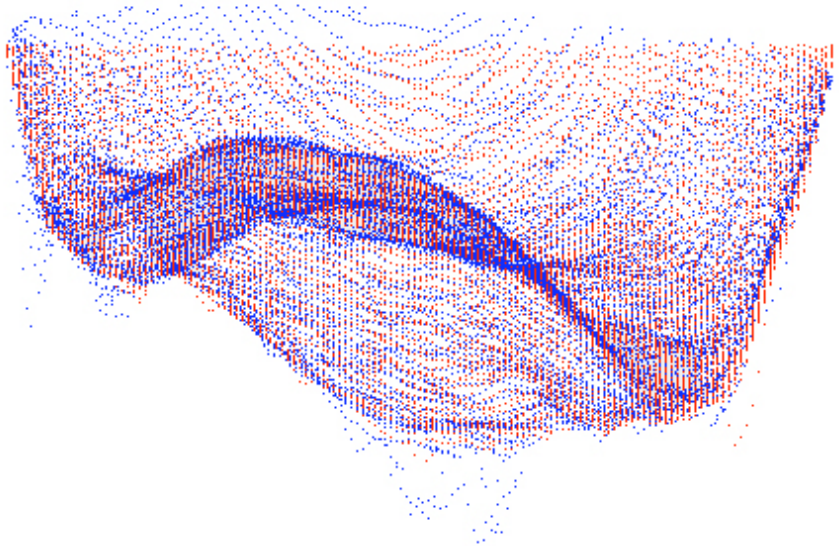
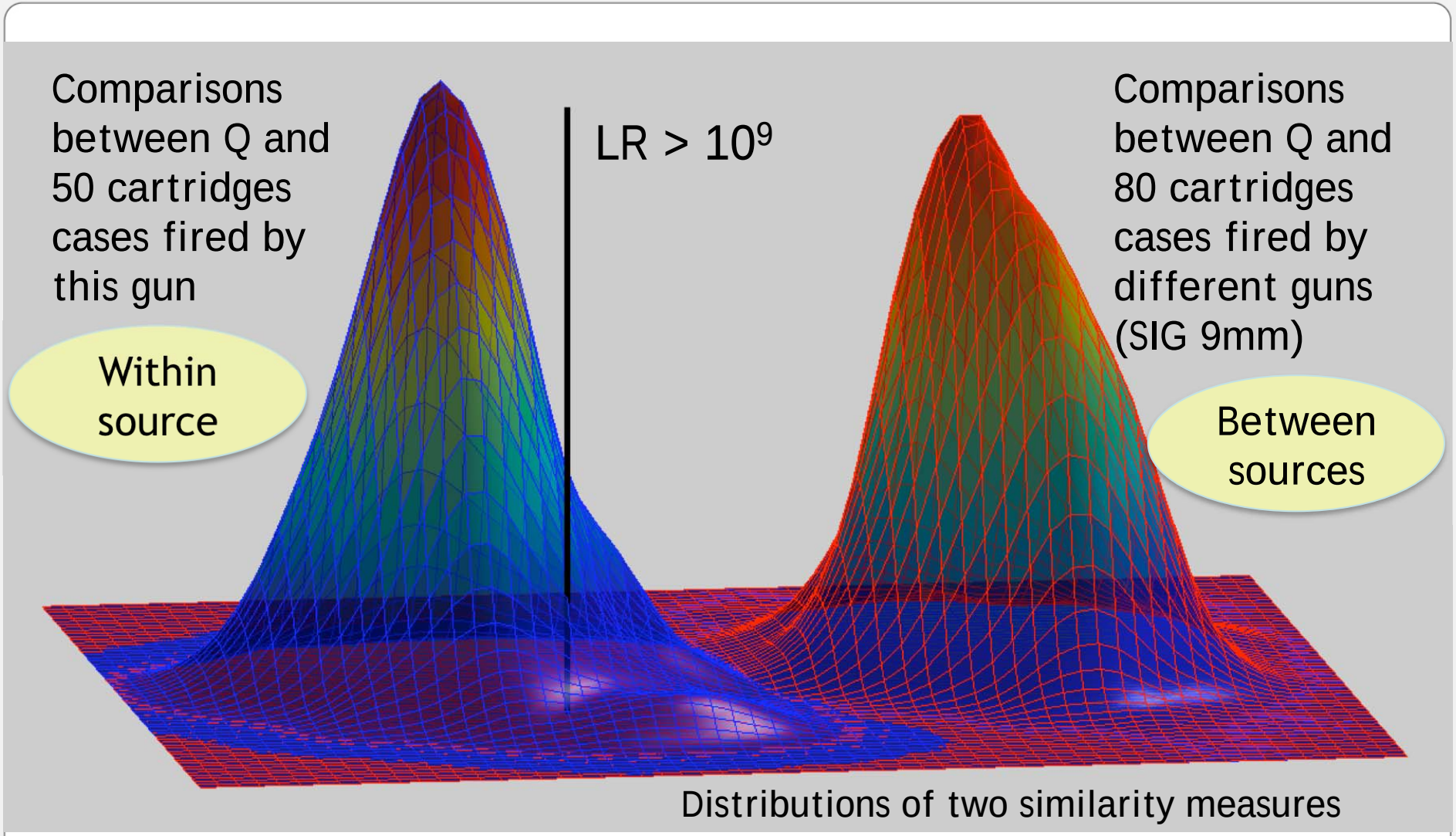


③ Informed opinion with data



Distributions of two similarity measures

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