

Biometric Research: From the Lab to Large Scale Deployment

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BIOMETRIC RESEARCH: FROM THE LAB TO LARGE SCALE DEPLOYMENT

- **Introduction**
- **Operational situations & challenges**
- **Addressing those challenges**
- **Conclusion**

INTRODUCTION - BIOMETRIC SYSTEM

Key Biometric Steps

Enrollment

Supervised,
Self Enrolment

Controlled /
uncontrolled
environment

Deduplication

Positive or
negative

Real time /
batch

Verification

Supervised /
Unsupervised

Occasional
/Regular

Key Technologies

Data capture



Algorithms



Decision

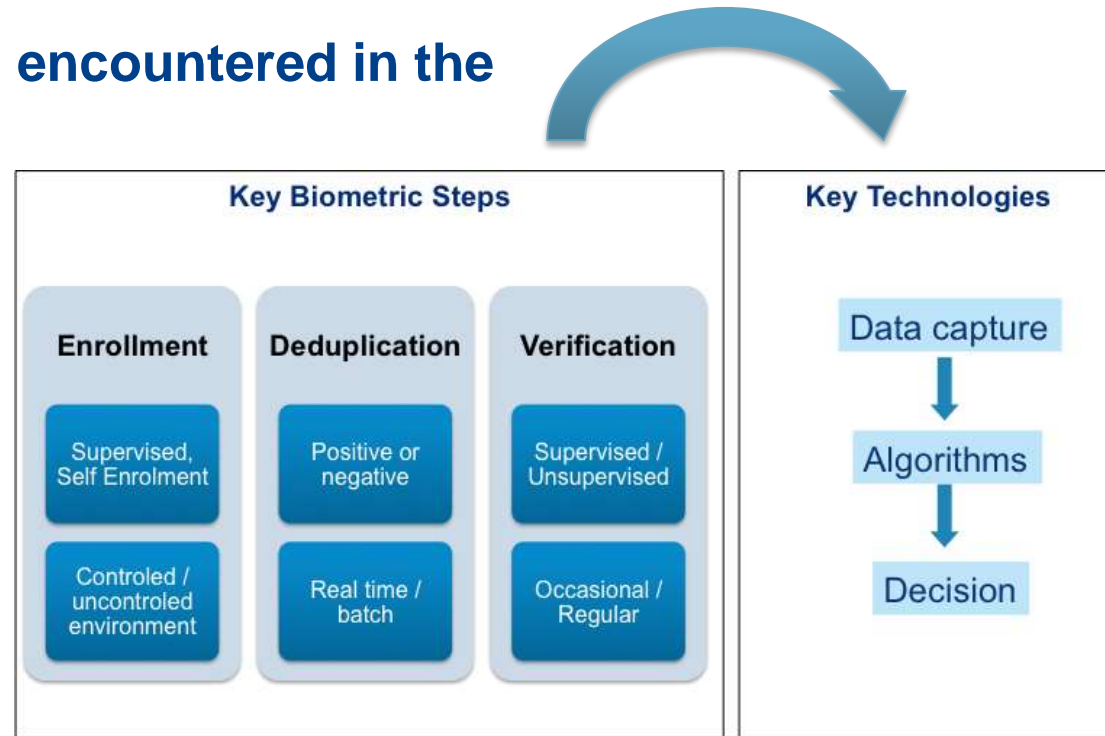
FROM THE LAB TO THE FIELD

→ Many challenging situations can encountered in the field

- Field conditions
- Performance, tuning, scalability
- High variability in data
- Fraud attempts
- ... / ...

→ Objectif of this talk

- Share some of those challenges
- Emphasize some underlying scientific problems to solve
- Raise attention of the scientific community on addressing them



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Examples of Operational Challenges

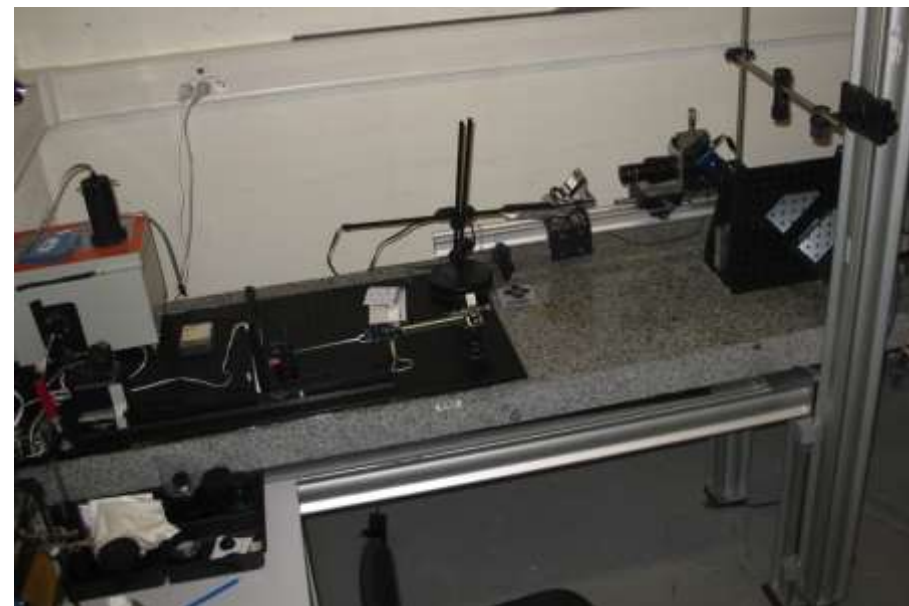
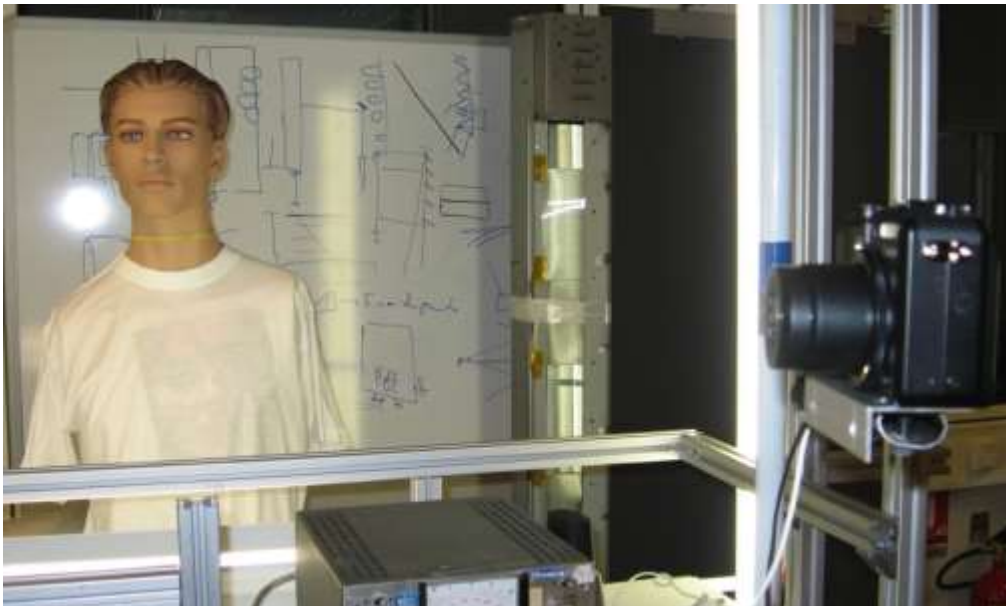
LAB CONDITIONS

→ Lab conditions:

- Controlled environment, High precision calibrated benches, ...
- Trained user & operator

→ But also many «lab» assumptions

- On data
- On user behavior



PENSION PAYMENT IN SOUTH AFRICA – 1995/2000

→ First large scale field positive authentication deployment

- Several million people enrolled
 - Bulk enrollement
- Monthly Authentication to trigger pension payment
- Field operation, mobile ATM

→ Characteristics

- Field operation:
 - Dust, Temperature, Light,
- Physical security concern
- Users are not IT aware
- Supervised by skilled operators
- Performance: FRR is critical



NATIONAL ID & VOTER CARD – MAURITANIA - 1999

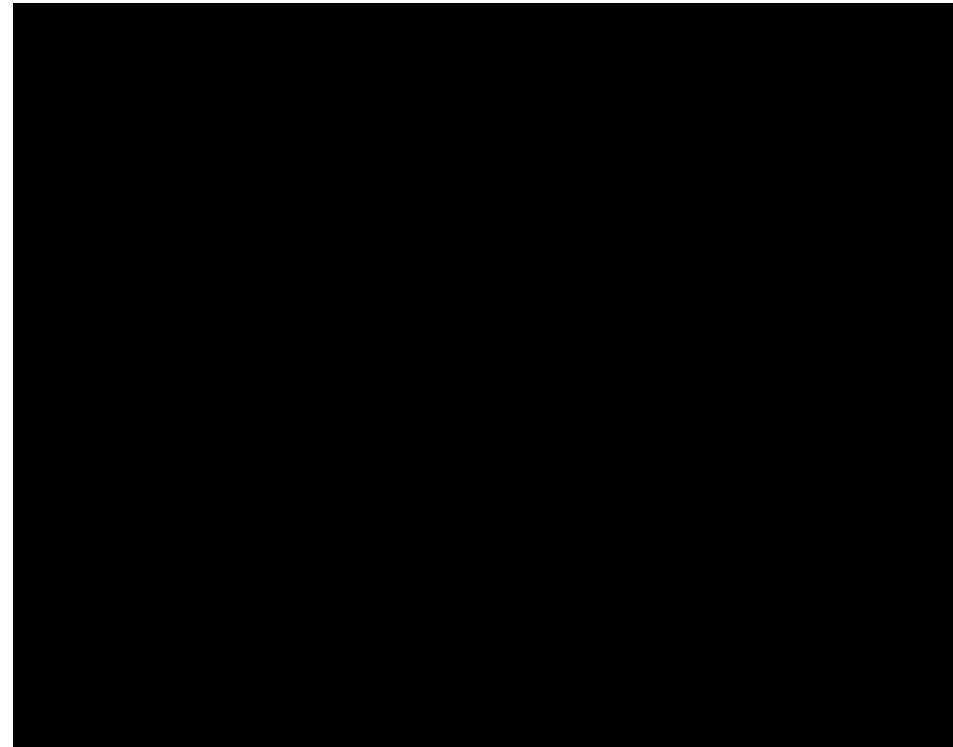


MAURITANIA



KEY FACTS

- ✍ Production of 1.5 million ID-Cards and 1.5 million voter cards
- ✍ Setting up of a civil registry and election lists
- ✍ 80 mobile and 100 fixed enrolment stations
- ✍ 15,000 registrations/day
- ✍ 10,000 cards/day produced
- ✍ One-to-many search at enrolment (AFIS)



BIOMETRIC VOTER REGISTRATION - KENYA - 2012

14,3 M Enrollments in 1 month

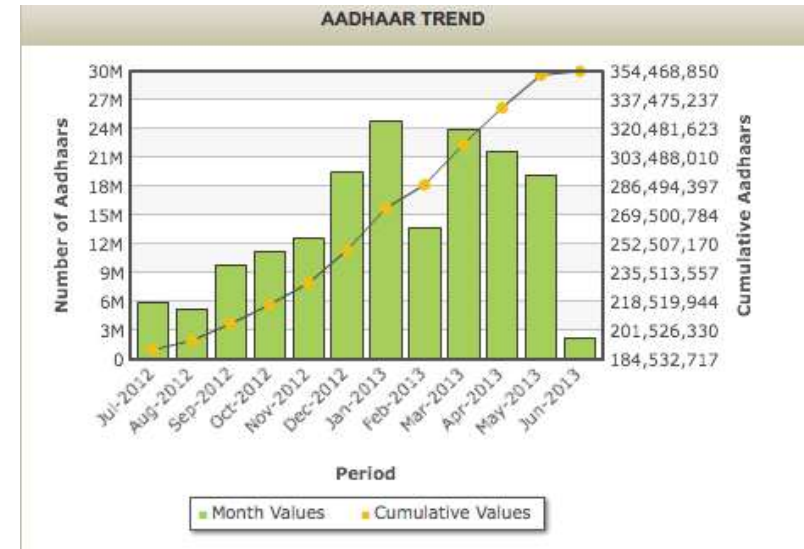
Field Conditions

30,000 operators

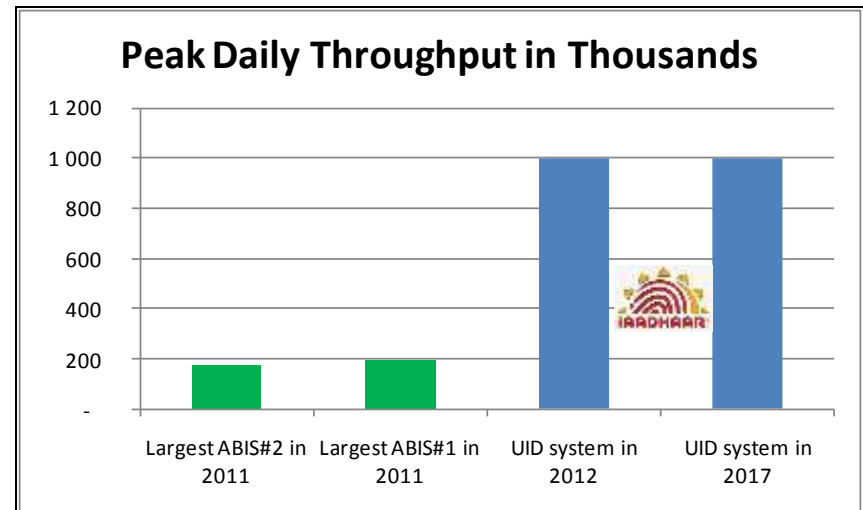
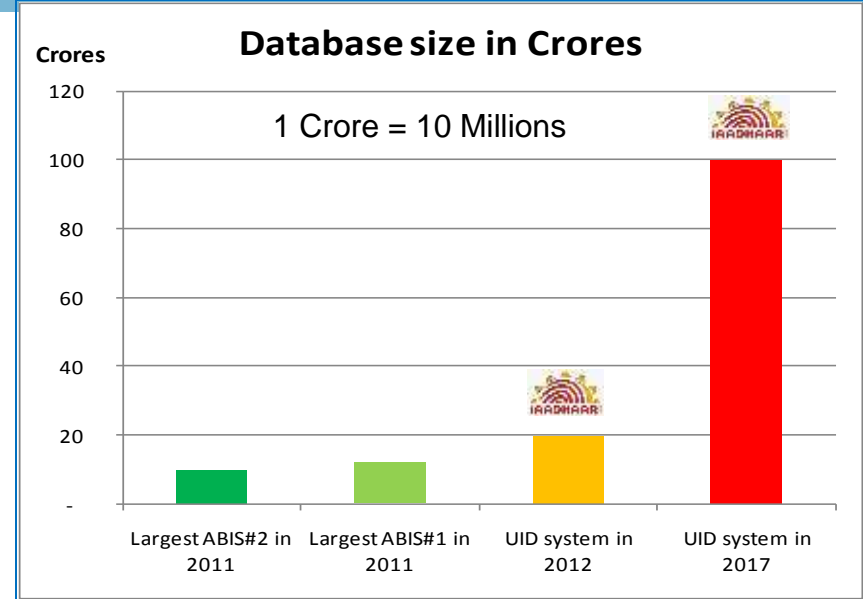
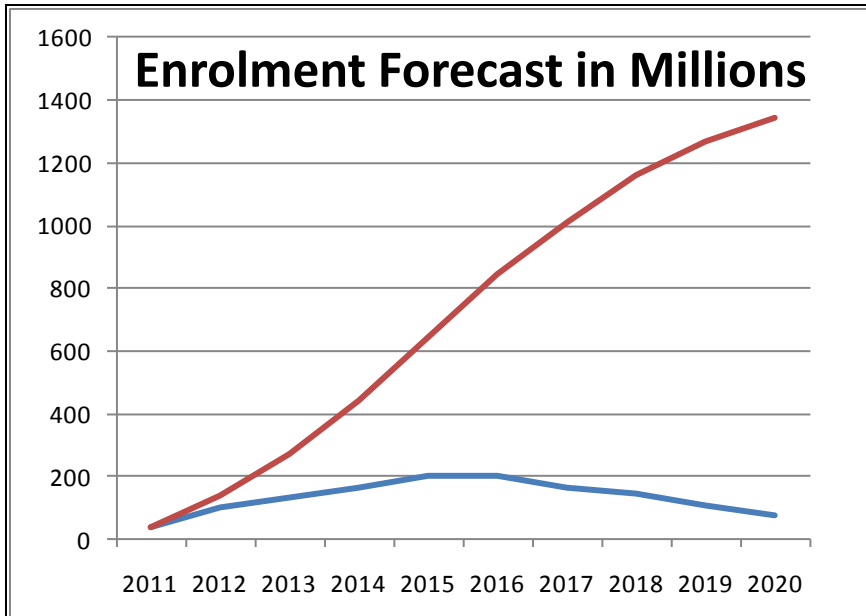


→ One of the most ambitious biometric project ever

- Massive biometric enrolment in the field
- Massive biometric deduplication
 - Up to 1.2 Billion people to enrol
 - 350 Millions already delivered
 - Over 1 Million searches / day
 - From young children to elderly people
- Massive biometric authentication in the field



UID: A SCALABILITY CHALLENGE



Need accurate thus very fast algorithms

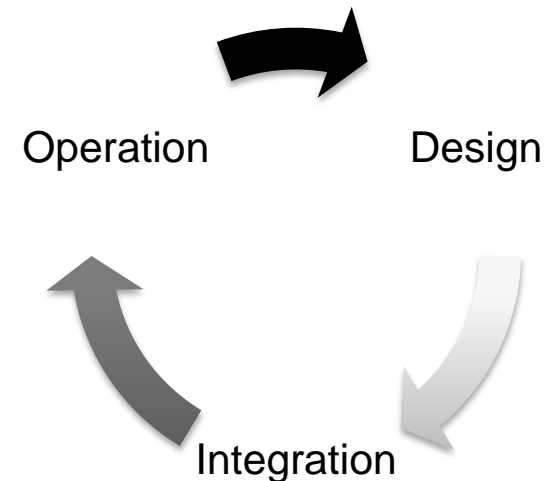
FROM THE LAB TO THE FIELD

→ Many challenging situations can encountered in operation

- Field condition
- ... but not only
 - Scalability, ergonomics, fraud, variability in data, ...

→ Solutions can be implemented at

- Operation level
- Integration level
- Design level



→ Scientific community can/must help finding solutions at design level

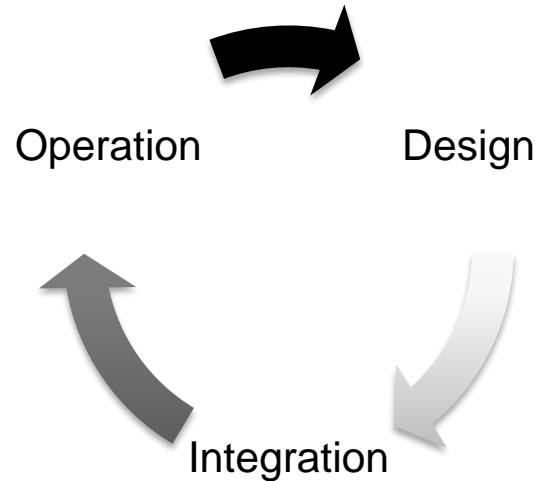
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Dealing with those challenges

ROBUSTNESS TO ENVIRONMENT – EXTREME SUNLIGHT

→ Biometric sensors operating outdoor

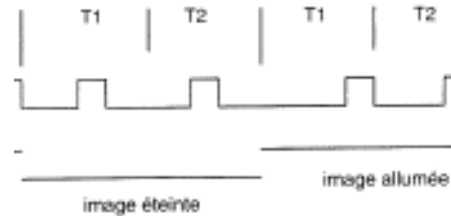
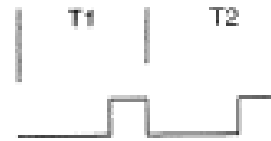
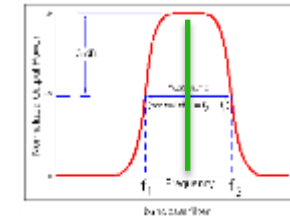
- Extreme sun light can blind/saturate the sensor (all biometrics)
- strong shadows (face), reflection of scene (iris)



ROBUSTNESS TO ENVIRONMENT – EXTREME SUNLIGHT FINGERPRINT SENSOR

→ Possible solutions at design level

- Active lighting, trying to overpower the sun ...
 - Pass band filter around wavelength of illumination
 - Flash and capture during the flash
 - Flash and frame differencing



ROBUSTNESS TO ENVIRONMENT - HUMIDITY

→ Fingerprinting wet fingers

- Finger / platen coupling by water resulting in low quality image



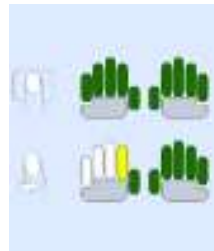
Operation



Design



Integration



POOR (too dark)

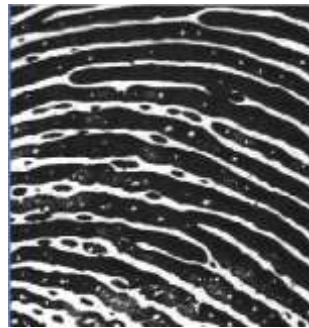
MOISTURE DISCRIMINATING OPTICS (MDO)

→ Traditional optics reflect only air

- Sweat in pores or around ridges appear same as ridges

→ MDO achieves Total Internal Reflection (TIR) for air and water;

- Sweat in pores or around ridges appears equivalent to air

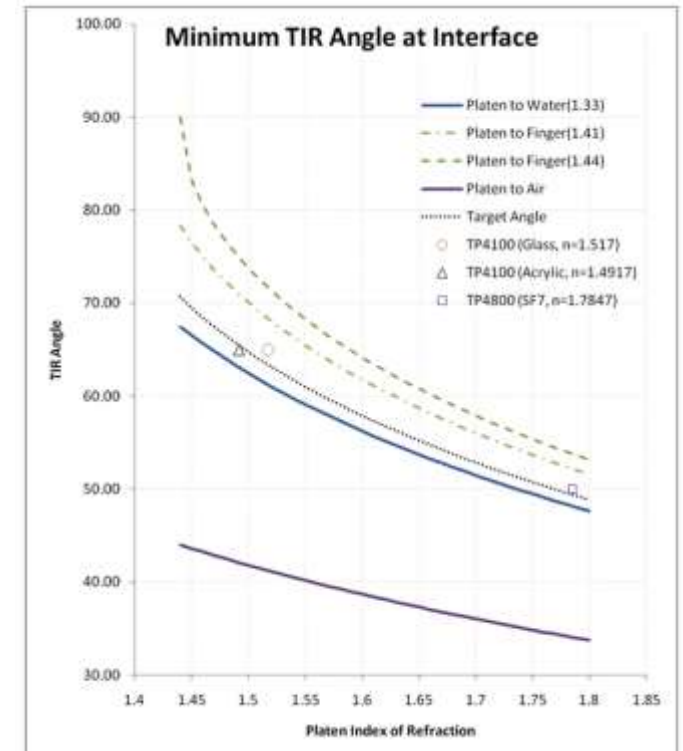
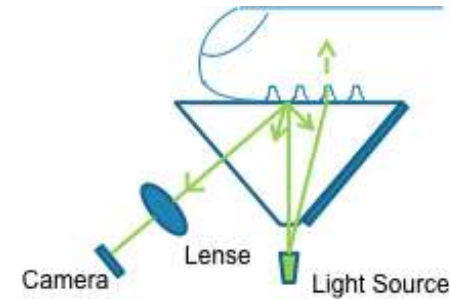


Traditional Optics



MDO
TM

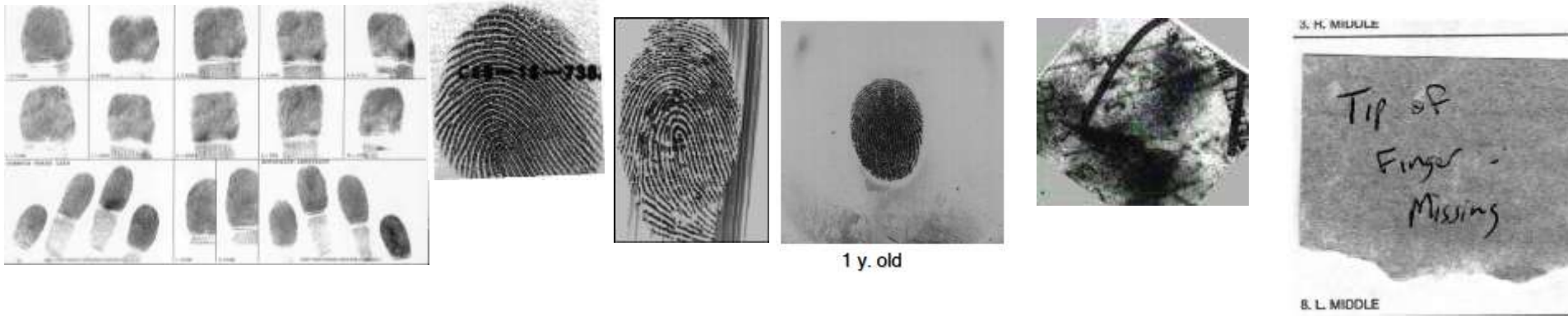
⇒ Increased robustness



ROBUSTNESS TO TYPE DE DATA

→ High variability of data

- Friction ridge

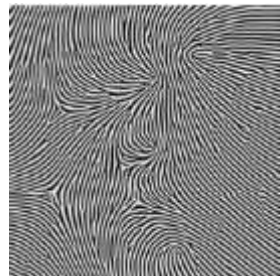


- Facial

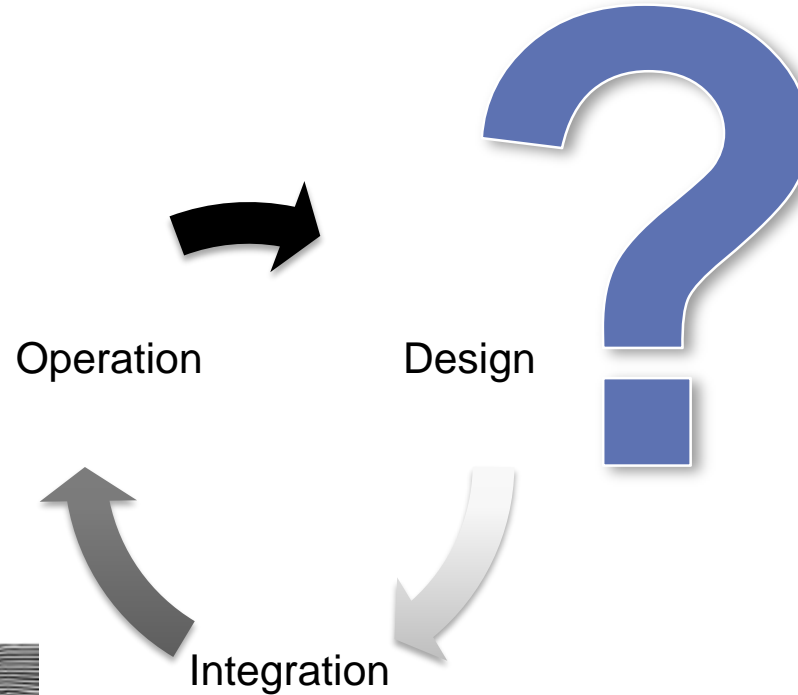


ROBUSTNESS TO TYPE DE DATA

→ Variability can be handled:



Fingerprintness detection
MSU



MITRE TECHNICAL REPORT

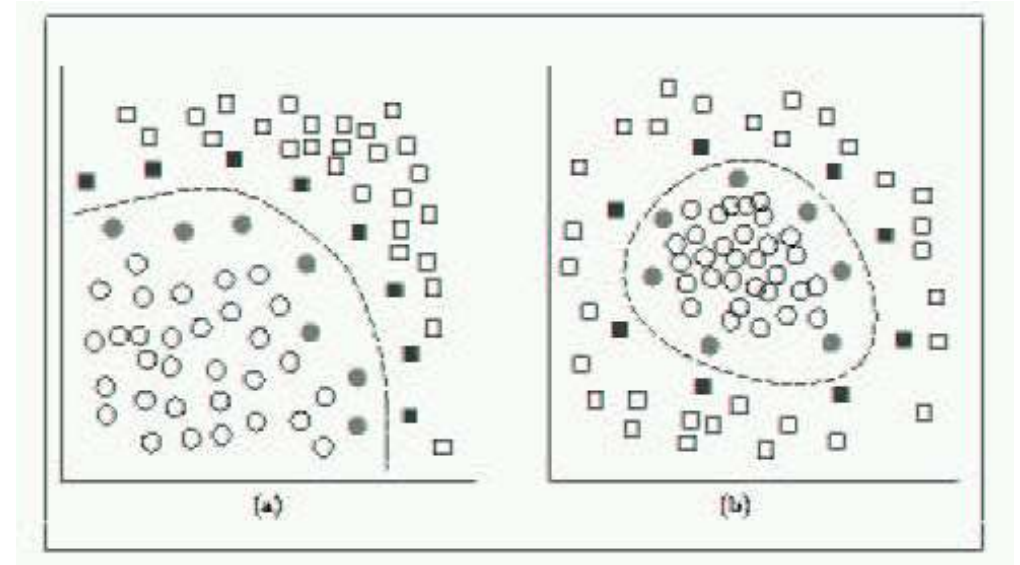
**TEST PROCEDURES
FOR VERIFYING IAFIS IMAGE QUALITY REQUIREMENTS
FOR FINGERPRINT SCANNERS AND PRINTERS**

ROBUSTNESS TO TYPE DE DATA

→ Pattern recognition techniques

- Feature space transformations
- Learning techniques

→ Very sensitive to learning set



→ Operationally a problem as unexpected / unlearned event happen quite often

→ Robustness to unexpected data is critical

ROBUSTNESS TO SCALE

→ Large Scale biometric Identification System

- Databases:
 - 100 millions to a billion people
- Throughput:
 - 100,000 to a few million searches/day
- Are they feasible ? What performance can we expect ?

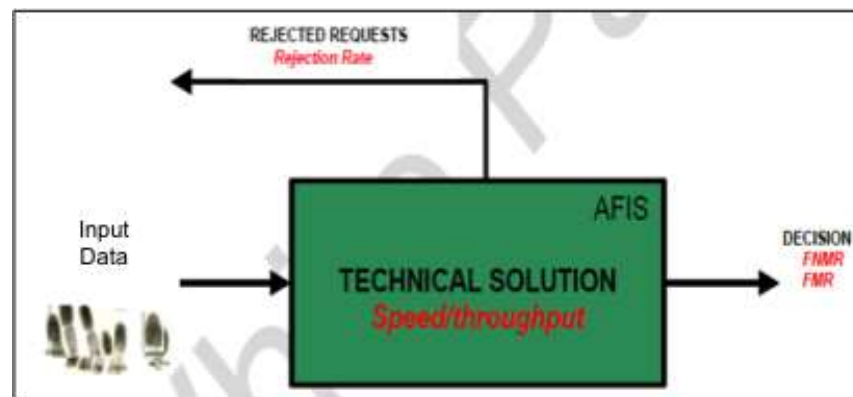
→ They are at the same time

- Large scale IT systems
- Large scale biometric systems
- => Focus on biometric specific issue: Accuracy

ROBUSTNESS TO SCALE – KEY BIOMETRIC ISSUES IN LARGE SYSTEMS

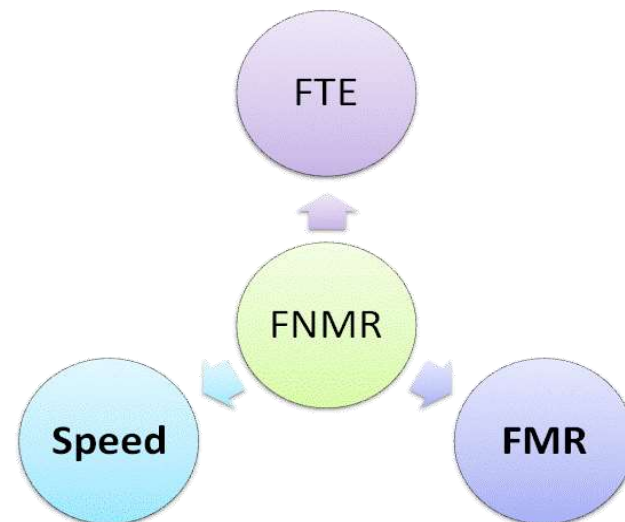
→ Classical biometric indicators:

- Rejection rate (FTE/FTA)
- Accuracy (FMR, FNMR)
- Throughput (Speed)



→ Key Indicators are linked

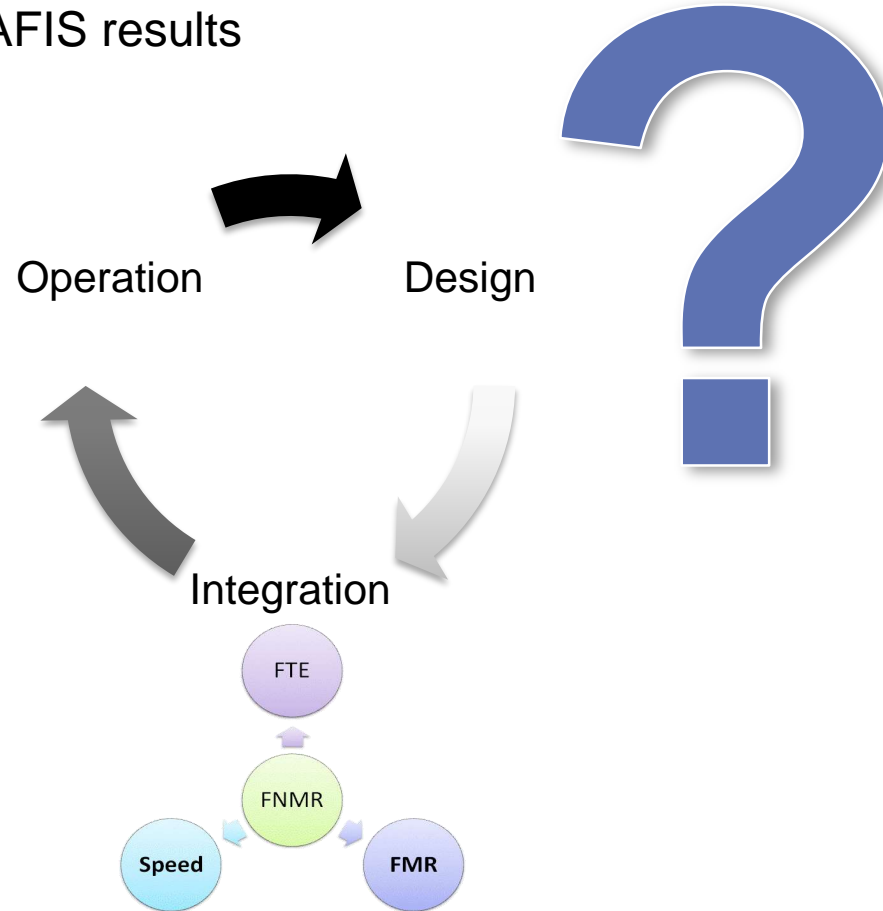
- FMR ↔ FNMR: « Decision policy »
- Speed ↔ FNMR: « Tuning policy »
- FTE/FTA ↔ FNMR: « Rejection policy »



ROBUSTNESS TO SCALE

→ Billions of comparison / day

- Automated comparaisons
- Manual verification of AFIS results



ROBUSTNESS TO SCALE

→ Predict => extrapolate

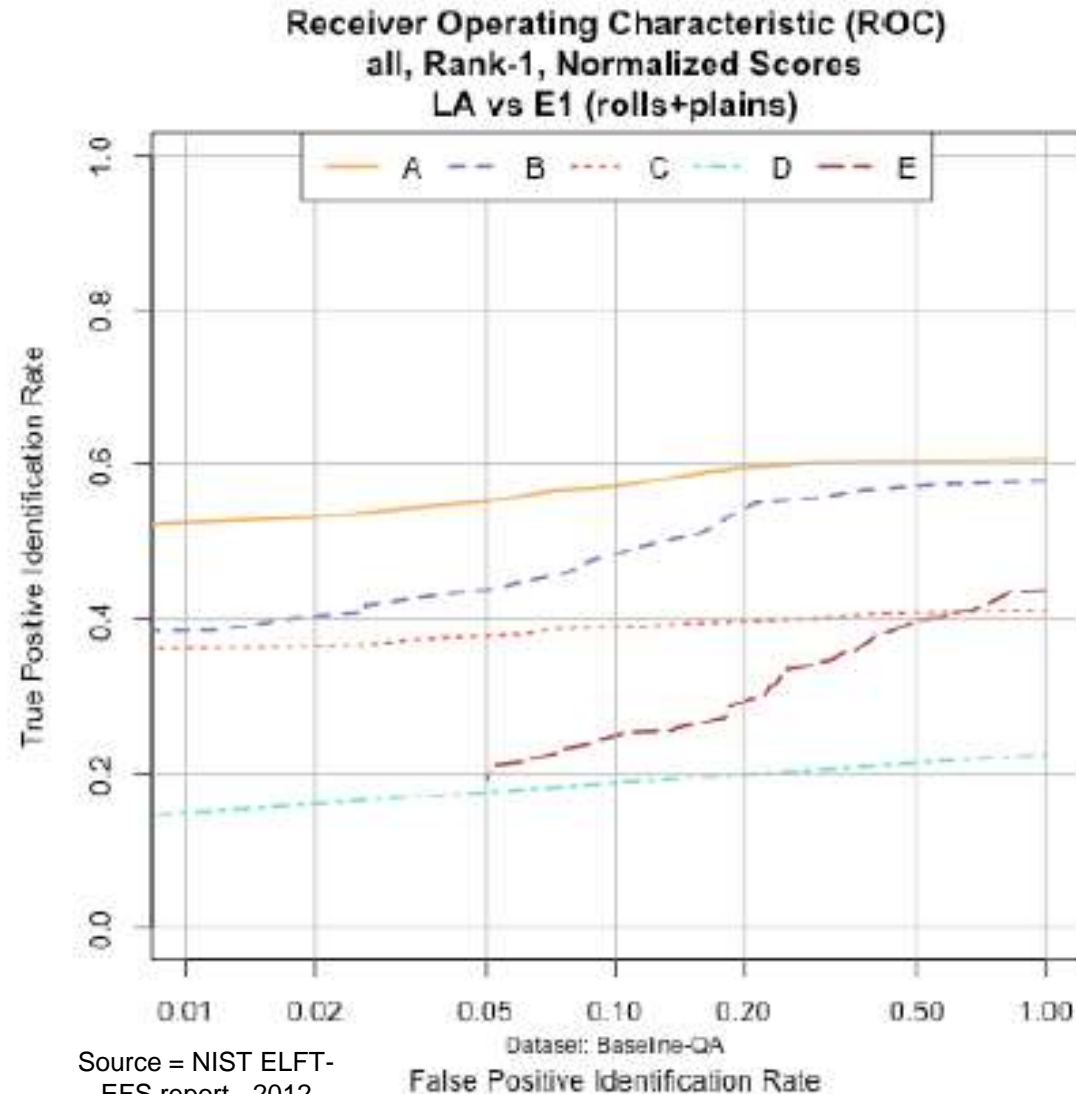
- Extreme value statistics
- Other models ?

→ Increase robustness to scaling

- Flatteness: a measure of scalability

=> Important to try to extrapolate

=> Important to optimize scalability

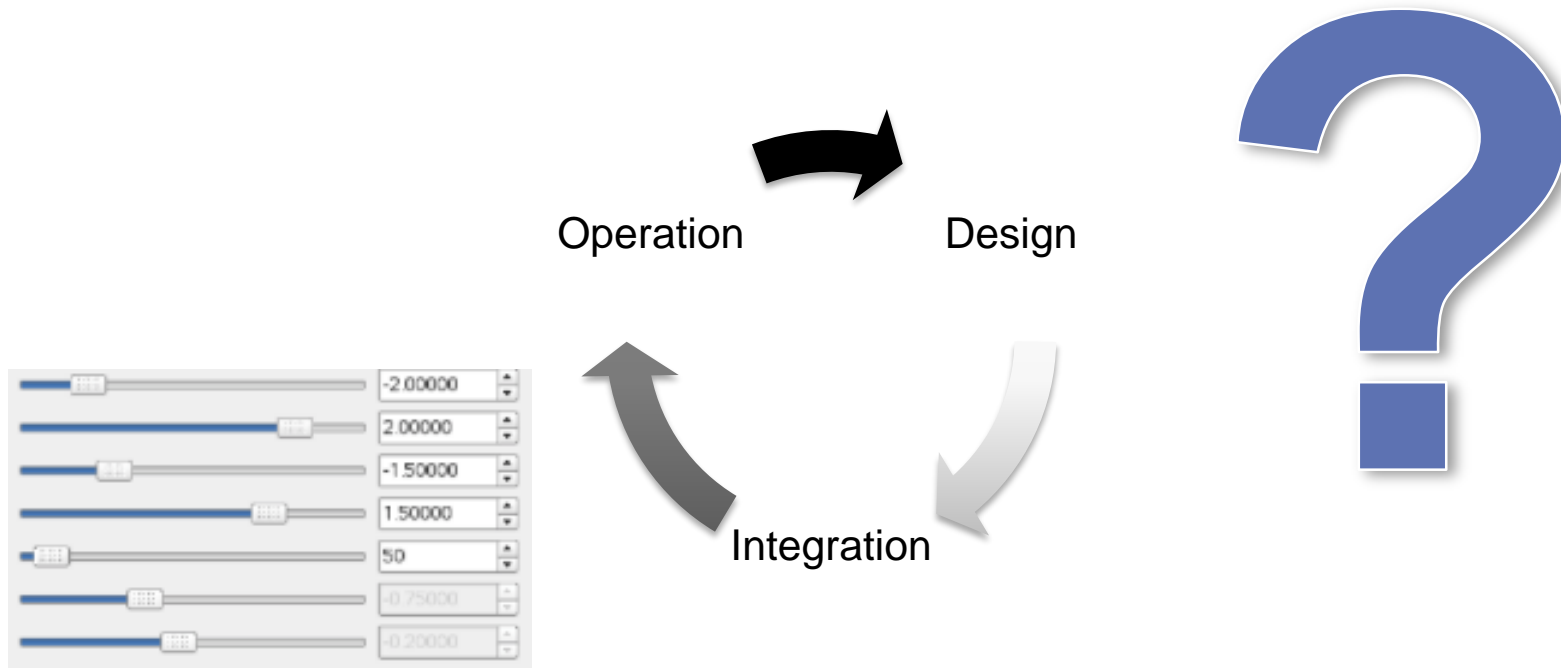


ROBUSTNESS TO SCALE

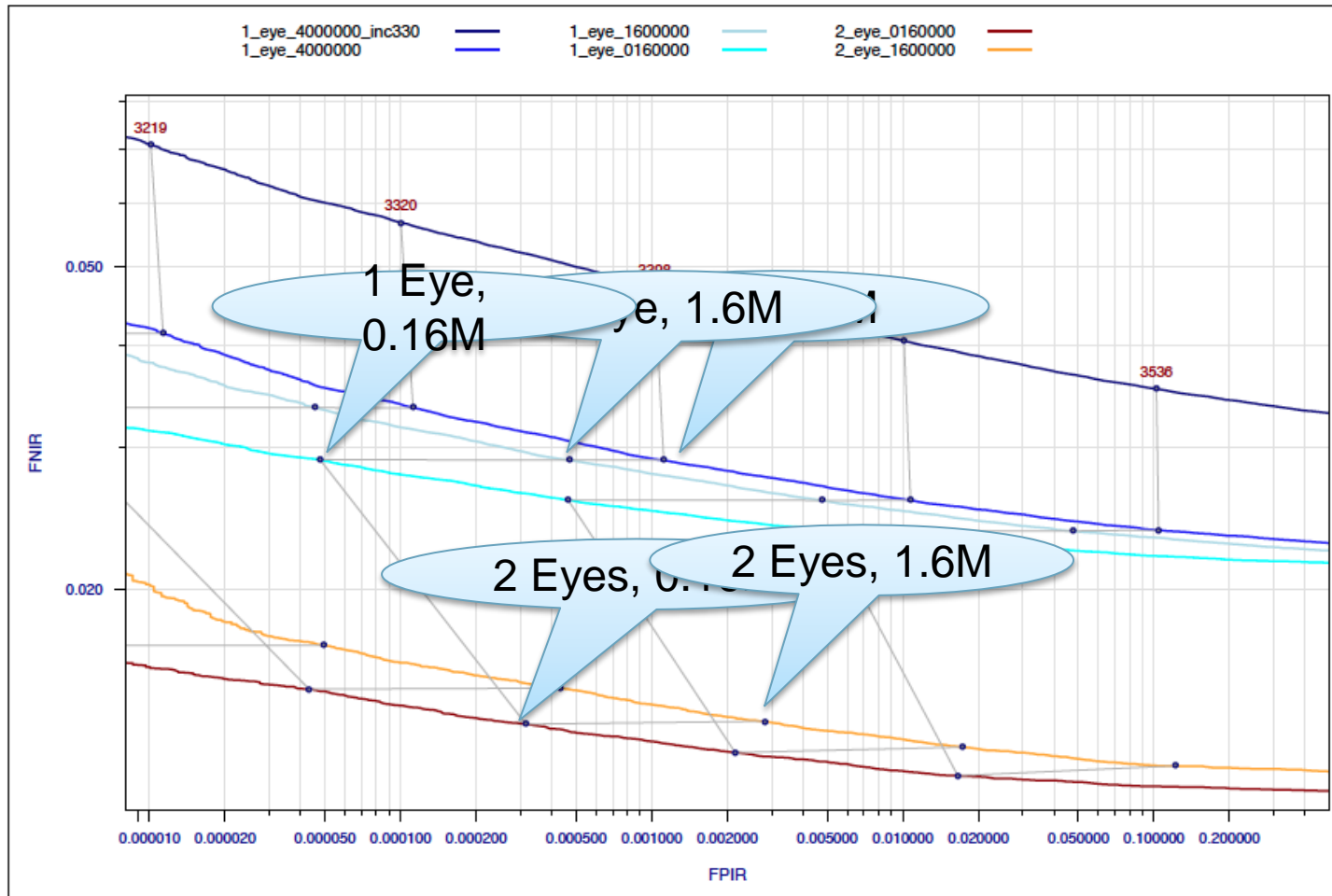
BEYOND ROC/DET CURVES

→ Beyond DET curves

- 20 years ago EER used as main performance metric
- Obviously not sufficient => ROC/DET
- However operationally we must choose a operating point/threshold



ROBUSTNESS TO SCALE - BEYOND ROC/DET CURVES

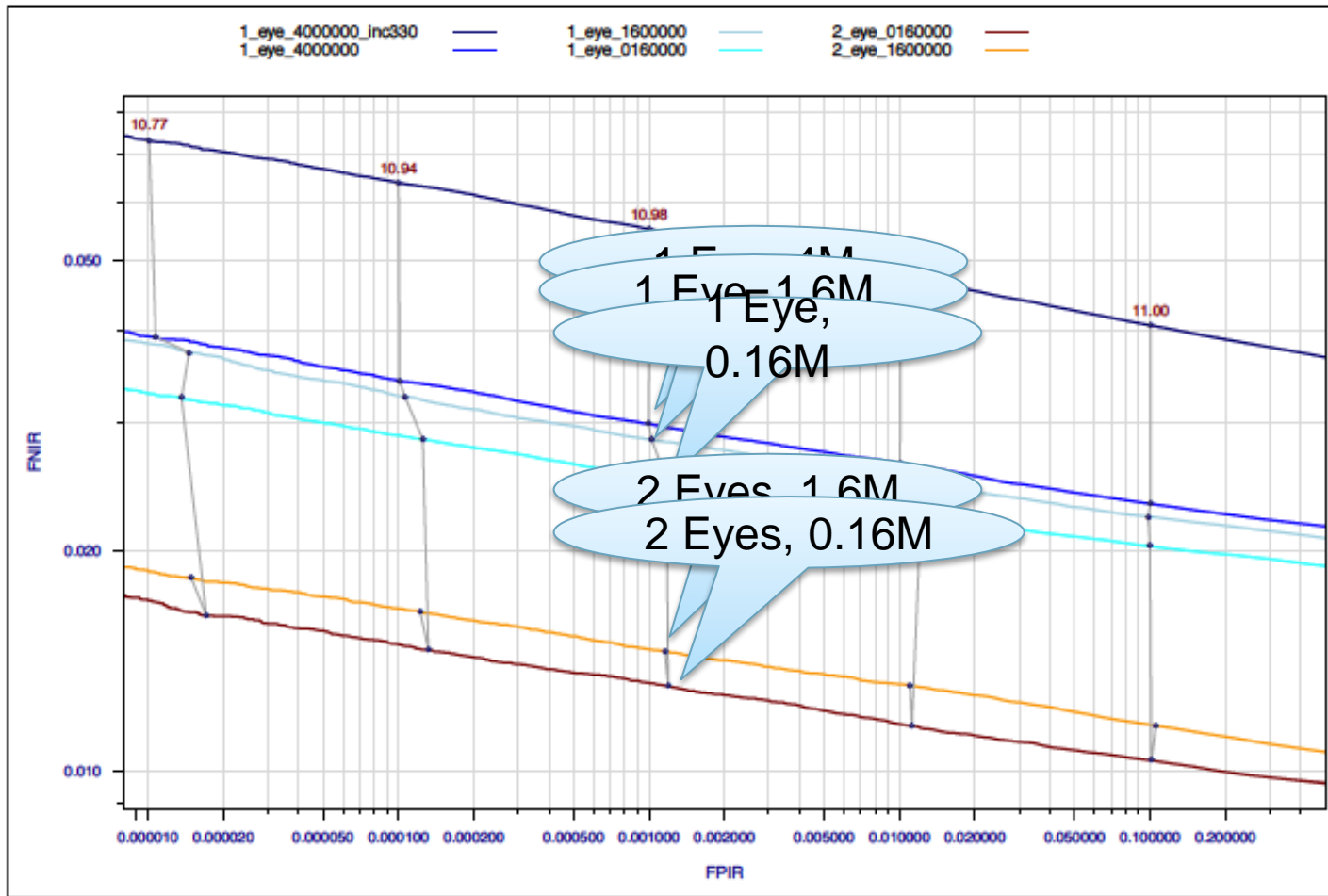


Source = IREX III
report

(a) R12A

→ Normalization problem, FPIR is unstable

ROBUSTNESS TO SCALE - BEYOND ROC/DET CURVES



Source = IREX III
report

(b) U04A

→ Good Normalization is critical, FPIR is stable

CONCLUSION

- **Many challenging situations can encountered in the field**
- **Solutions can be implemented at operation/integration/design level**
- **Robustness to those situations is critical**
- **Scientific community must contribute to measure & improve robustness**