



# Recent Biometric Performance Testing Results

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Biometrics Working Group  
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# Authenti-Corp Test Campaigns

- International Labor Organization Biometric Test Campaign (fingerprints at sea, 2004)



- FingerPrint 2005 (FP2005)



- DHS/NIJ Iris Recognition Study 2006 (IRIS06)



# FingerPrint 2005 Study (FP2005)

- Fingerprint images collected in standard office environment
- Offline analysis using
  - NIST MINDTCT minutiae extractor
  - NIST BOZORTH3 matching algorithm
- To emulate client scenario use:
  - Enrollment = Run 1, Attempt 1, Image 0
  - Recognition=Run 3, Attempt 1, Image 0

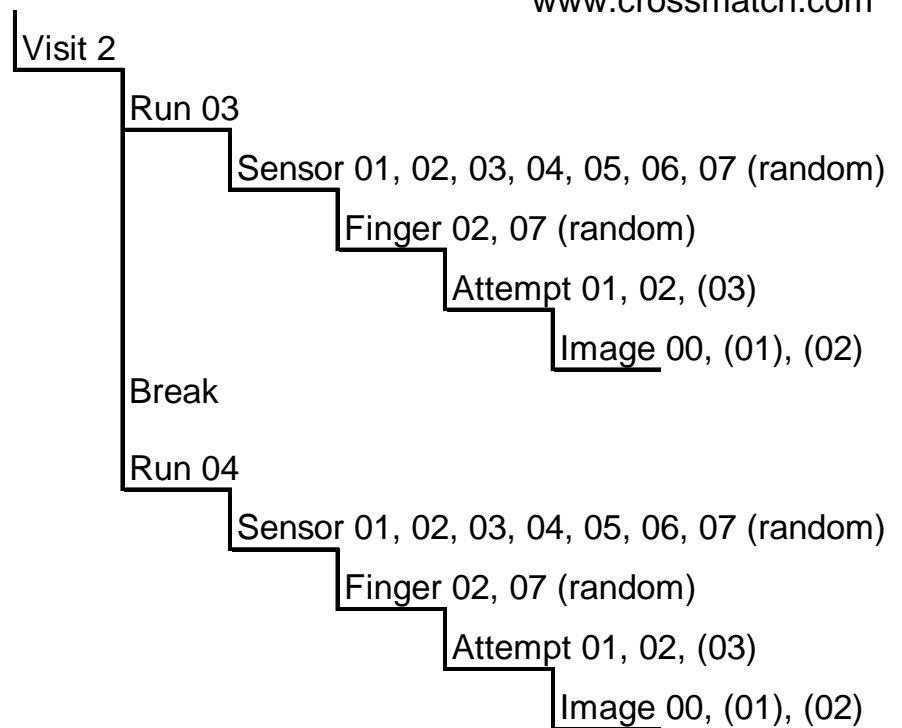
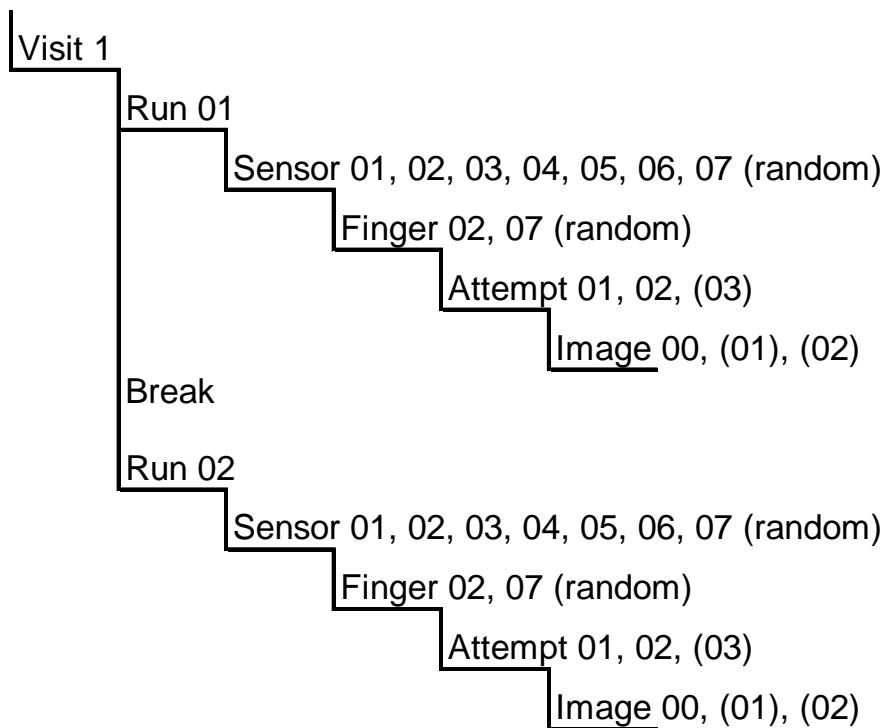


**Cross Match  
Verifier E  
(Clean & Dirty)**



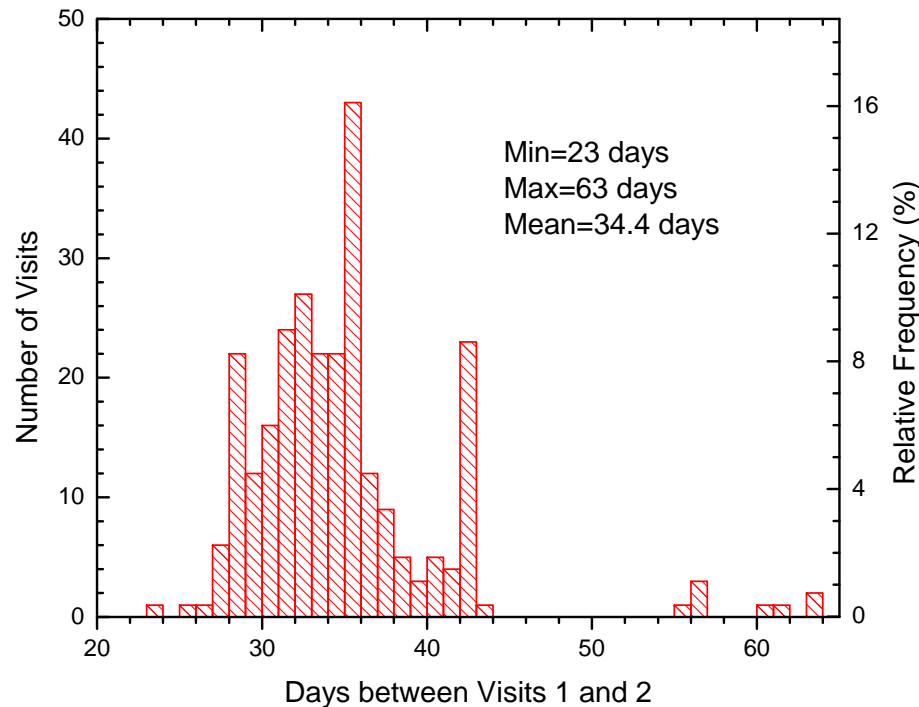
**Cross Match  
MV 5**

[www.crossmatch.com](http://www.crossmatch.com)



# FP2005 Data Collection Specifics

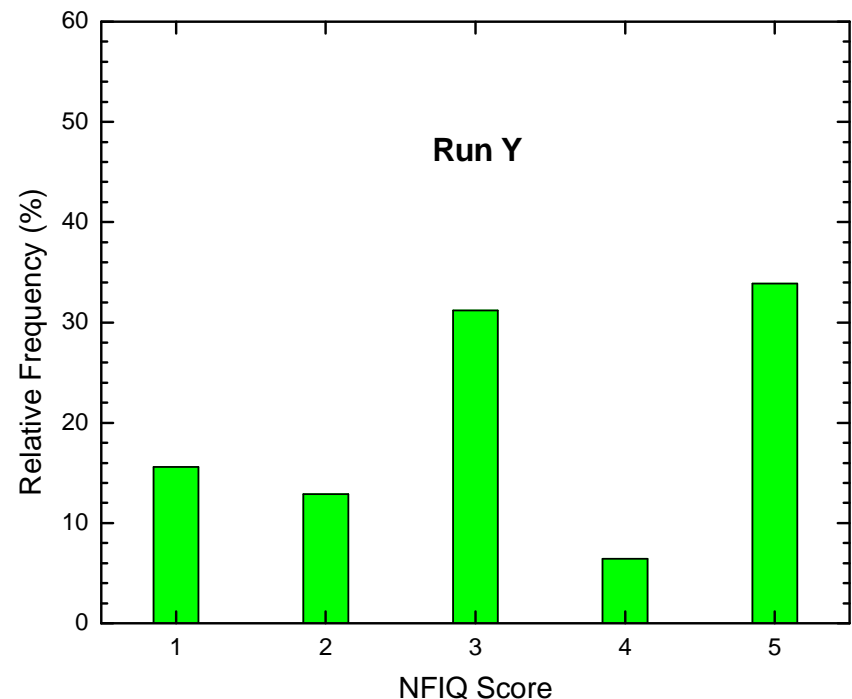
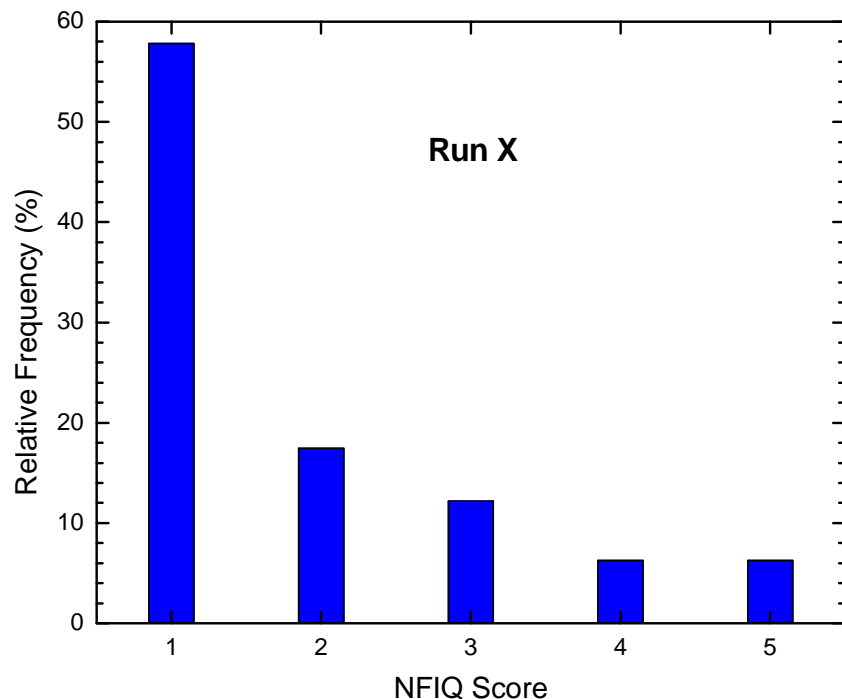
Test Subject Statistics				
	# of test subjects	Dates	# of appointment slots	no-show rate
<b>Visit 1</b>	293	Oct 12 – Nov 12, 2005	372	21.2%
<b>Visit 2</b>	265	Nov 14 – Dec 17, 2005	324	18.2%



Test Subject Demographic Profile		
	Target (%)	Actual (%)
<b>Gender</b>		
Male	50	49
Female	50	51
Total	100	100
<b>Age</b>		
18 to 24	10	9
25 to 34	20	18
35 to 44	22	20
45 to 54	19	22
55 to 64	12	13
65 to 74	9	10
75 and older	8	8
Total	100	100
<b>Race</b>		
White	70	73
Black	10	10
Asian	5	6
Middle-Eastern	5	2
Other race / Two or more races	10	9
Total	100	100
<b>Ethnicity</b>		
Hispanic or Latino (of any race)	13	11
Non-Hispanic	87	89
Total	100	100

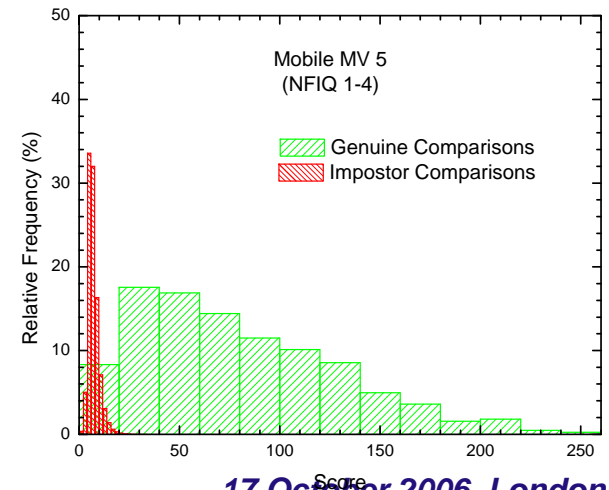
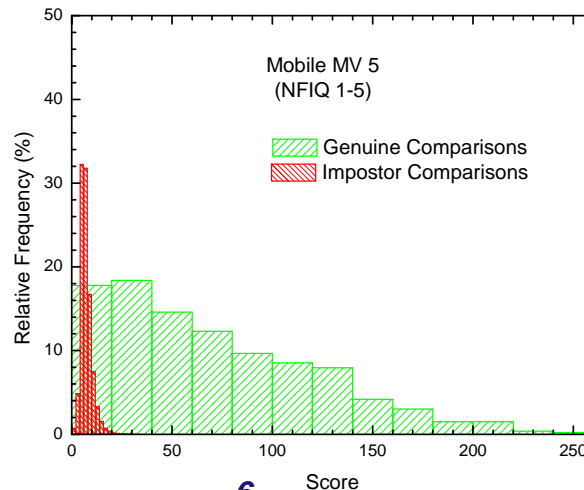
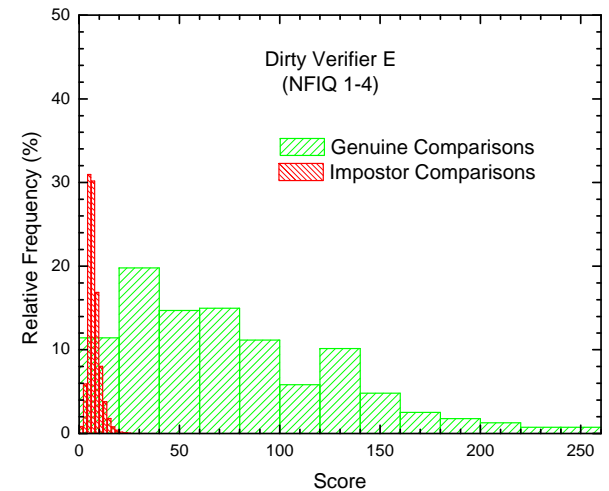
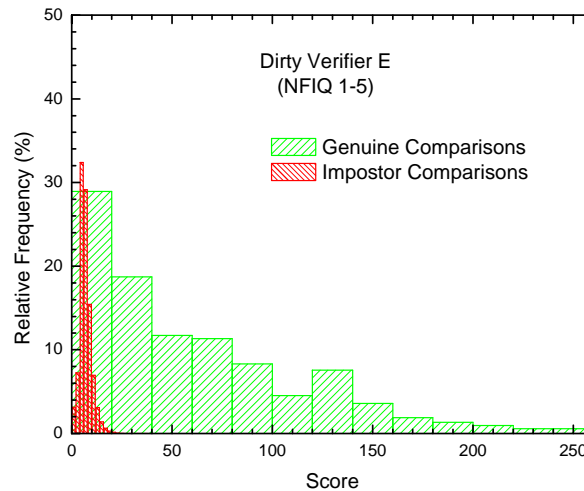
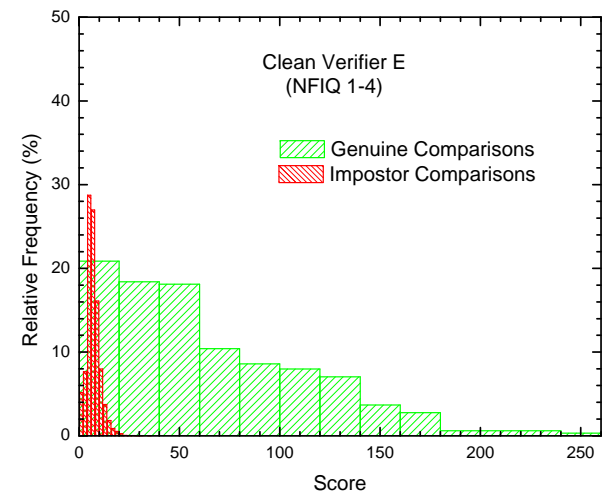
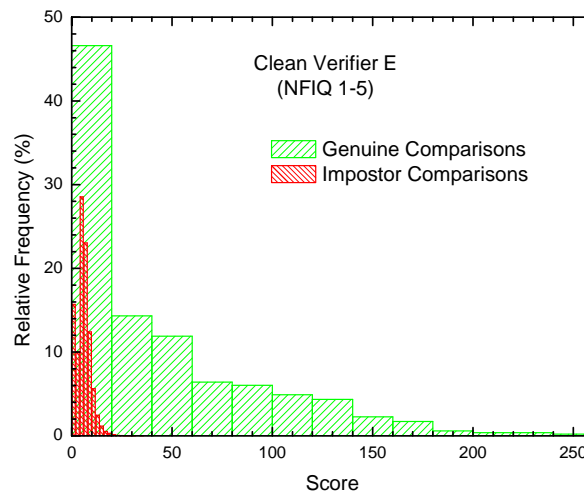
# Sample NIST Fingerprint Image Quality (NFIQ) Profiles

- Neural-network-based algorithm designed to predict fingerprint matching performance
- NFIQ score = 1, highest quality images
- NFIQ score = 5, poorest quality images



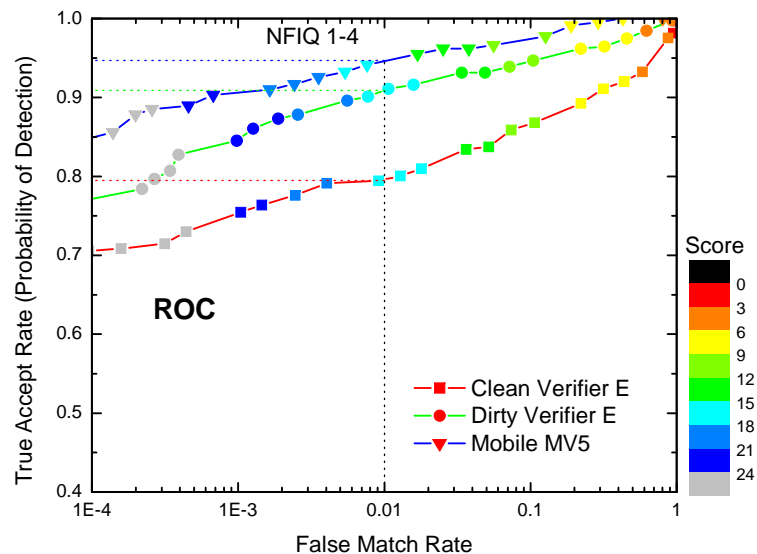
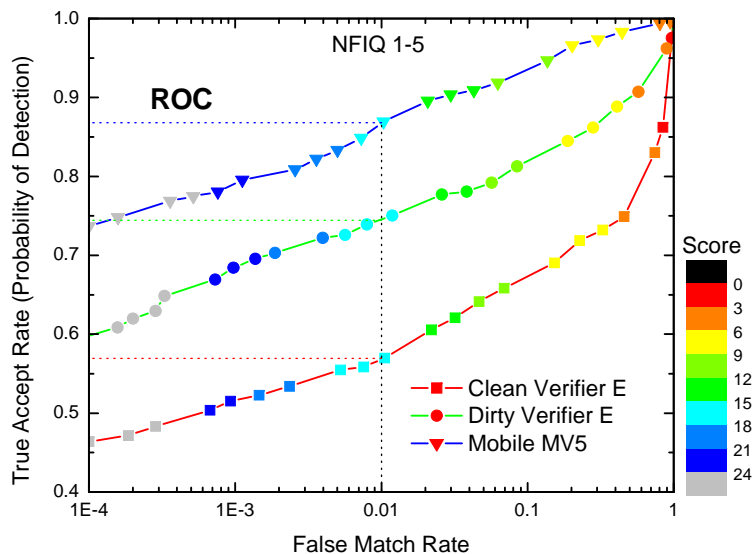
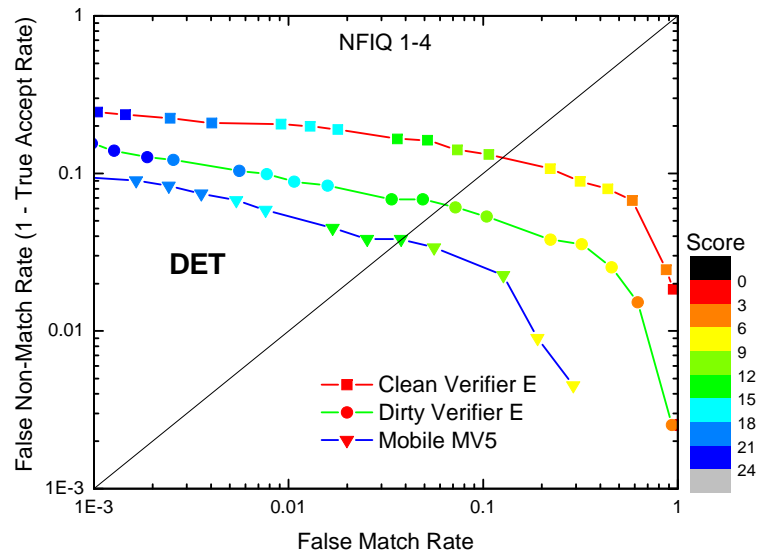
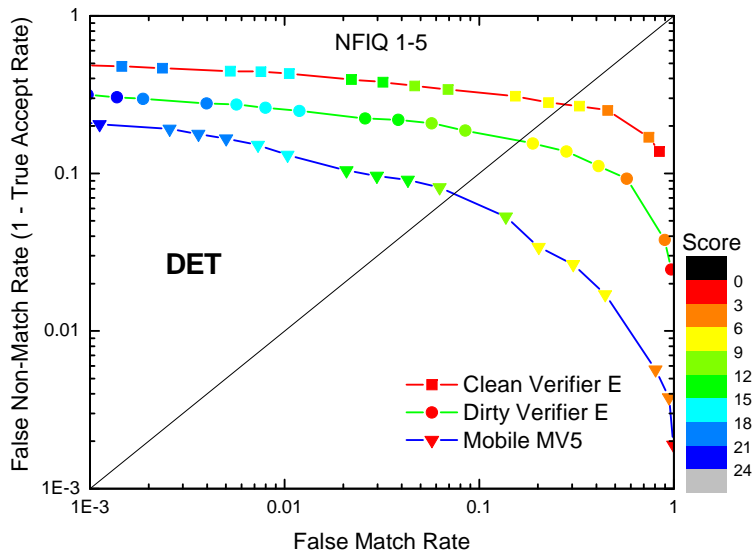
# Genuine and Impostor Score Distributions

- Large overlap between distributions
- Substantial improvement in distribution overlap when exclude poorest quality images (NFIQ=5)



# ROC & DET Performance Curves

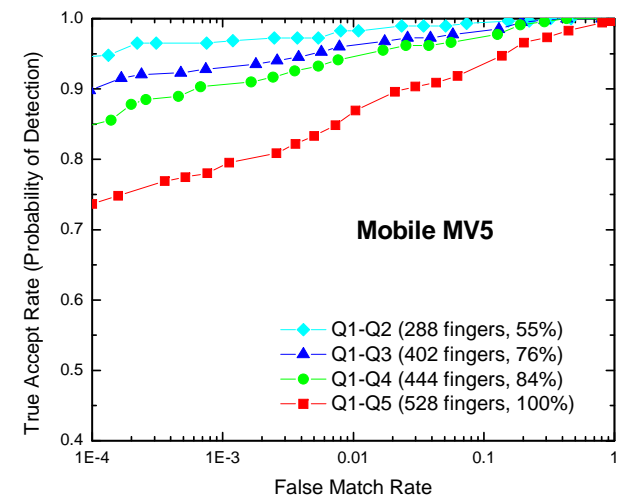
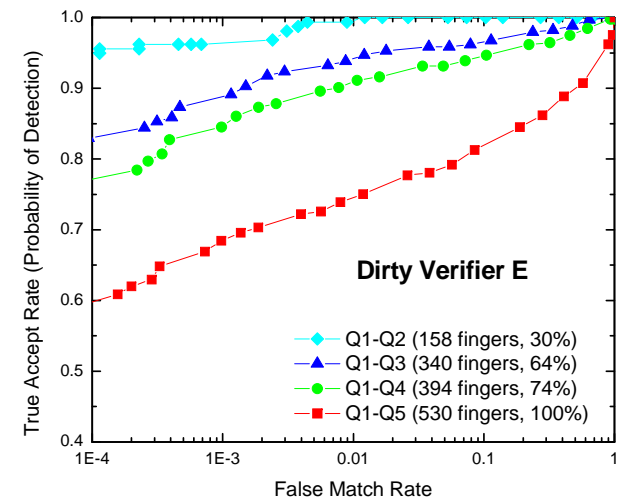
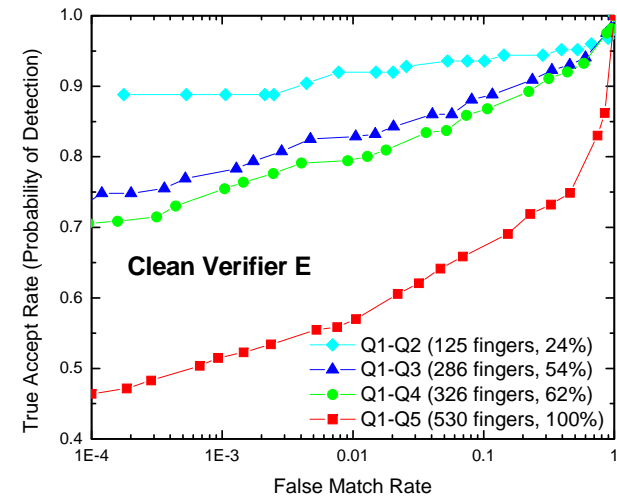
MV 5 better than Dirty Verifier E better than Clean Verifier E



**Advice:**  
Do not  
clean  
the  
platen!

# Performance as a Function of Image Quality

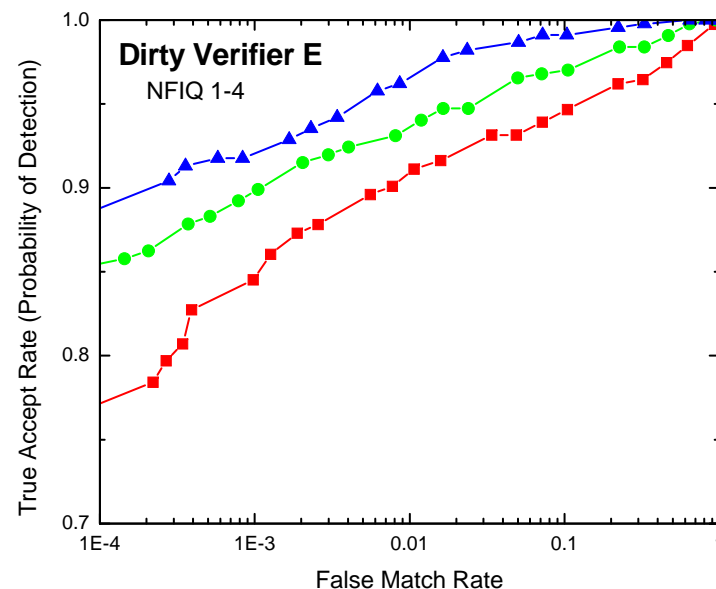
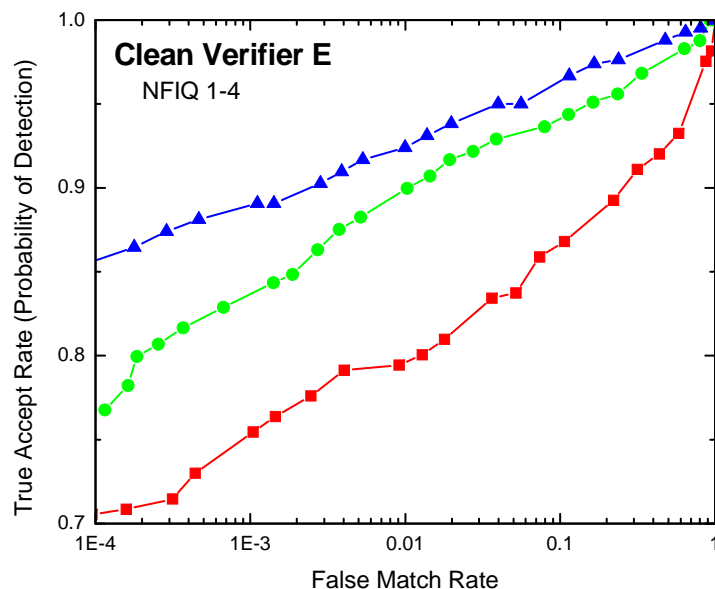
- As expected, performance improves with better image qualities
- Recommendations
  - Require enrollment images to have NFIQ < 5
  - Exclude NFIQ = 5 images from matching operations



# Performance of Verifier E

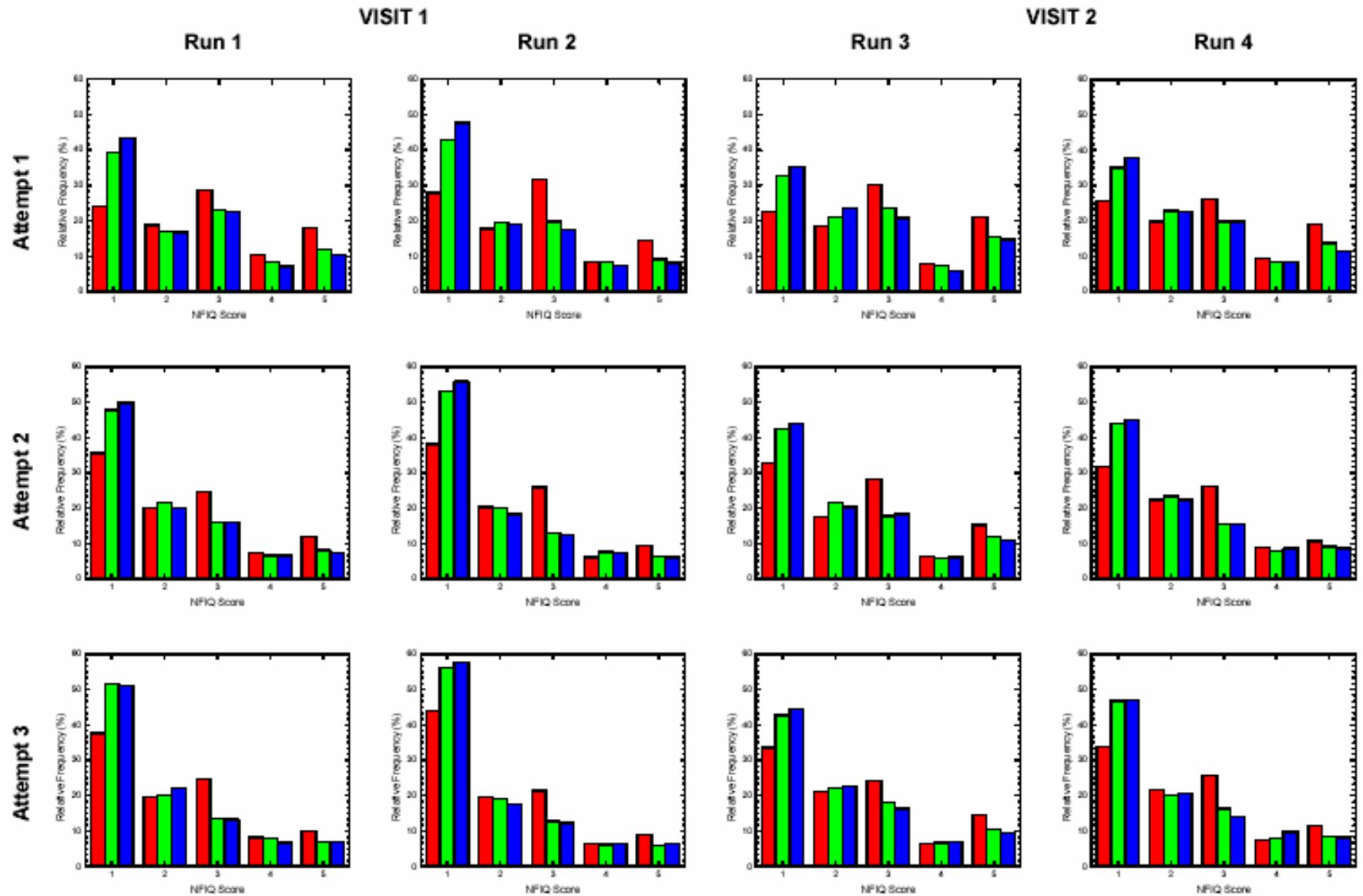
## Subsequent Images

- Subsequent images collected ~1 sec apart during a single finger placement
- Performance improves with subsequent images
- Recommendation: Leave finger on platen for ~3 seconds and use highest quality fingerprint for matching



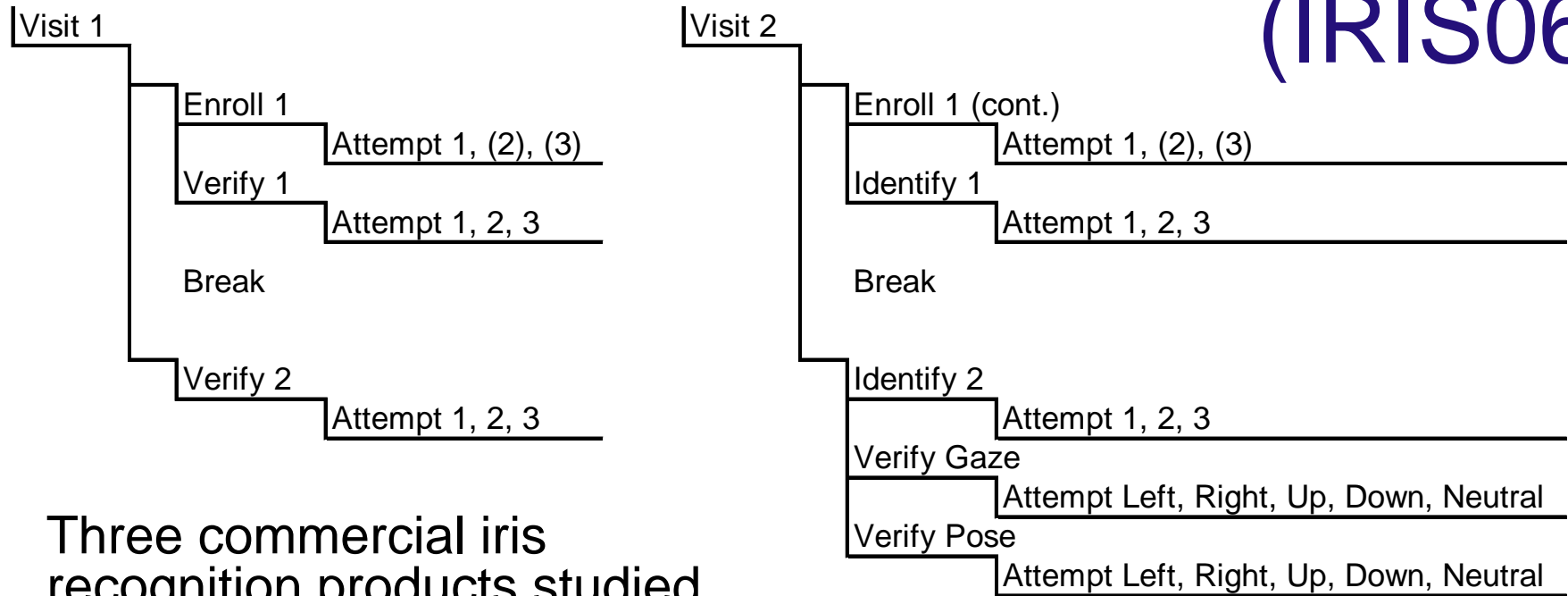
- Run 1, Attempt 1, 1<sup>st</sup> Image x Run 3, Attempt 1, 1<sup>st</sup> Image
- Run 1, Attempt 1, 2<sup>nd</sup> Image x Run 3, Attempt 1, 2<sup>nd</sup> Image
- ▲— Run 1, Attempt 1, 3<sup>rd</sup> Image x Run 3, Attempt 1, 3<sup>rd</sup> Image

# Dirty Verifier E NFIQ Profiles

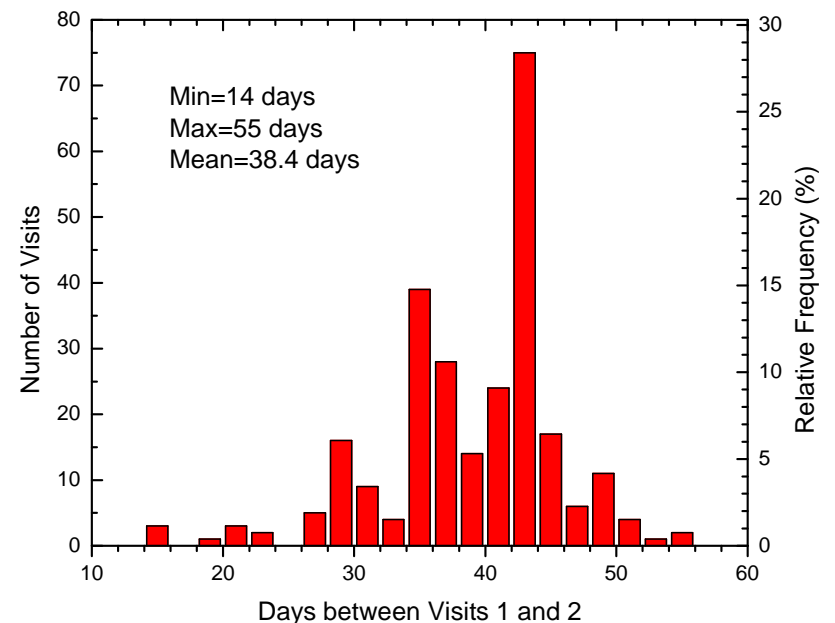


█ 1<sup>st</sup> Image  
█ 2<sup>nd</sup> Image  
█ 3<sup>rd</sup> Image

# NIJ/DHS Iris Recognition Study 2006 (IRIS06)



- Three commercial iris recognition products studied
  - Product names not identified
  - Vendors may choose to self-identify
- Standard indoor office environment
- BioAPI interface
  - BioAPI support provided by BioFoundry Division of OSS Nokalva ([www.biofoundry.com](http://www.biofoundry.com))



## IRIS06 Test Subject Demographic Profile and Statistics (Target based on 2000 US Census)

	Visit 1				Visit 2			
	Target		Actual		Target		Actual	
# of Test Subjects	300		295		250		264	
# of Appointments	401		295		295		264	
No-Show Rate	26%				11%			
Collection Dates	5/1/06-6/10/06				6/12/06-7/15/06			
Male	147	49%	139	47%	123	49%	121	46%
Female	153	51%	156	53%	128	51%	143	54%
18-24	30	10%	29	10%	25	10%	22	8%
25-34	60	20%	54	18%	50	20%	45	17%
35-44	66	22%	69	23%	55	22%	64	24%
45-54	57	19%	58	20%	48	19%	52	20%
55-64	36	12%	38	13%	30	12%	36	14%
65-74	27	9%	24	8%	23	9%	24	9%
75+	24	8%	23	8%	20	8%	21	8%
White	225	75%	220	75%	188	75%	199	75%
Black/ African-American	36	12%	37	13%	30	12%	33	13%
Asian	12	4%	10	3%	10	4%	7	3%
Native American	3	1%	4	1%	3	1%	3	1%
Others	24	8%	24	8%	20	8%	22	8%
Hispanic	39	13%	35	12%	33	13%	33	13%
Non-Hispanic	261	87%	260	88%	218	87%	231	88%

# IRIS06 Data Analysis

- Online
  - Products in commercial mode
  - Metrics include FTE, FTA, FNMR, enrollment and recognition times
  - No DET/ROC curves because non-match scores not provided during online operation
- Offline
  - Use images collected from each product during online evaluation
  - Use template generator and all-to-all matching algorithm provided by Professor John Daugman, Cambridge University
  - Still underway

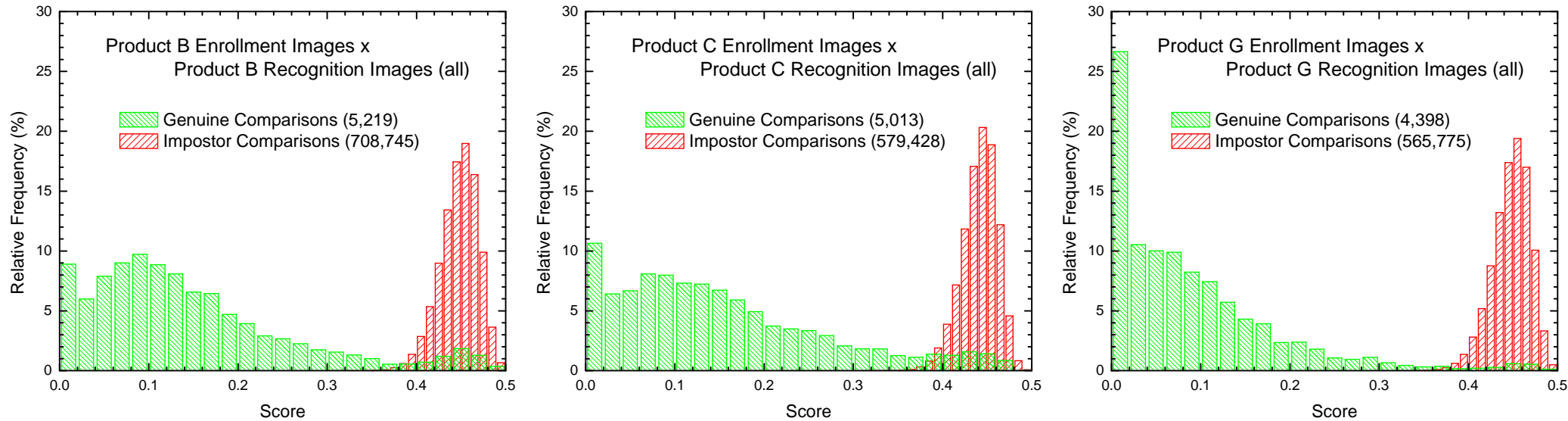
# Online Results

- Tradeoff between transaction times and error rates (accuracy)
- “Best” product depends on requirements of a given application

Cumulative False Non-Match Rate (FNMR)								
	Product B	Product C			Product G			
	L or R Eye	L Eye	R Eye	L or R Eye	L Eye	R Eye	L or R Eye	
Visit 1	<b>Verify 1</b>							
	# of Persons	276	225	229	245	272	265	272
	Attempt 1	9.8%	10.7%	16.2%	6.9%	3.7%	0.0%	2.6%
	Attempt 2	2.2%	4.4%	9.2%	3.3%	0.0%	0.0%	0.4%
	Attempt 3	<b>0.4%</b>	<b>0.0%</b>	<b>0.9%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.4%</b>
	<b>Verify 2</b>							
	# of Persons	270	225	227	244	266	268	271
	Attempt 1	12.2%	12.9%	16.7%	7.4%	2.6%	1.1%	0.0%
Attempt 2	5.2%	4.9%	4.8%	2.9%	0.4%	0.0%	0.0%	
Attempt 3	<b>2.2%</b>	<b>0.0%</b>	<b>0.9%</b>	<b>0.4%</b>	<b>0.4%</b>	<b>0.0%</b>	<b>0.0%</b>	
Visit 2	<b>Identify 1</b>							
	# of Persons	199	214	218	240	150	151	157
	Attempt 1	16.1%	17.8%	23.9%	9.6%	4.0%	2.6%	0.6%
	Attempt 2	6.5%	8.4%	11.5%	4.2%	0.7%	0.0%	0.0%
	Attempt 3	<b>3.0%</b>	<b>2.3%</b>	<b>3.2%</b>	<b>1.3%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>
	<b>Identify 2</b>							
	# of Persons	197	214	217	239	152	148	157
	Attempt 1	19.3%	18.2%	21.7%	11.3%	2.0%	2.7%	0.0%
Attempt 2	9.1%	8.4%	12.4%	5.4%	0.7%	0.0%	0.0%	
Attempt 3	<b>2.0%</b>	<b>3.7%</b>	<b>1.8%</b>	<b>1.7%</b>	<b>0.7%</b>	<b>0.0%</b>	<b>0.0%</b>	
<b>Average Recognition Transaction Time (L or R Eye)</b>								
t (sec)	6.4			8.2			13.6	

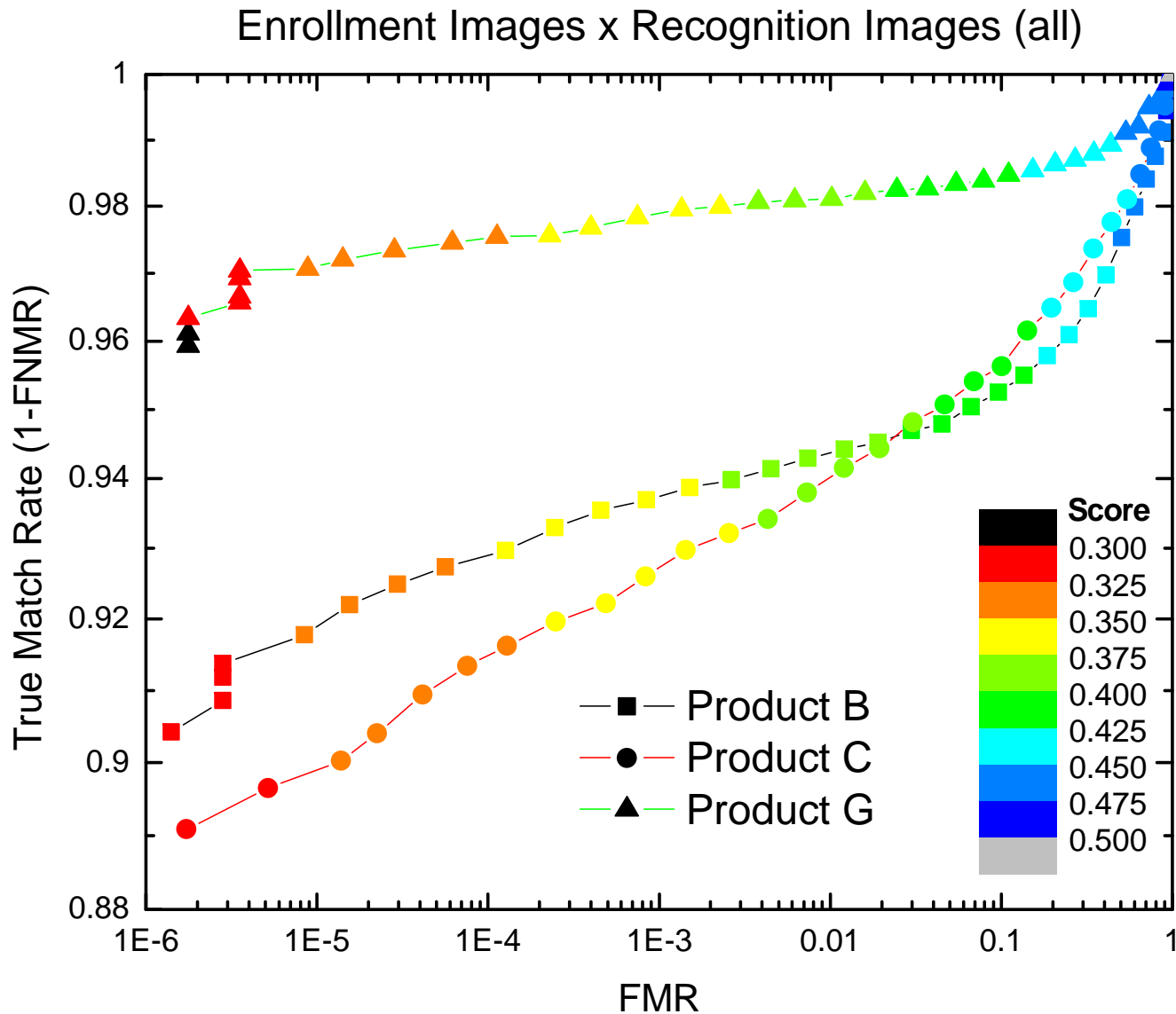
# Offline Results

## Single-Attempt Genuine and Impostor Histograms



- Enrollment images from each product compared with all 3 attempts from all 4 transactions (Verify 1, Verify 2, Identify 1, & Identify 2) from the same product
- Left and right eyes treated as separate individuals
  - Person-based (left or right eye) performance analysis underway
- Each recognition attempt treated as a separate transaction
  - 3-attempt transaction performance analysis underway
- Some overlap exists between genuine and impostor distributions

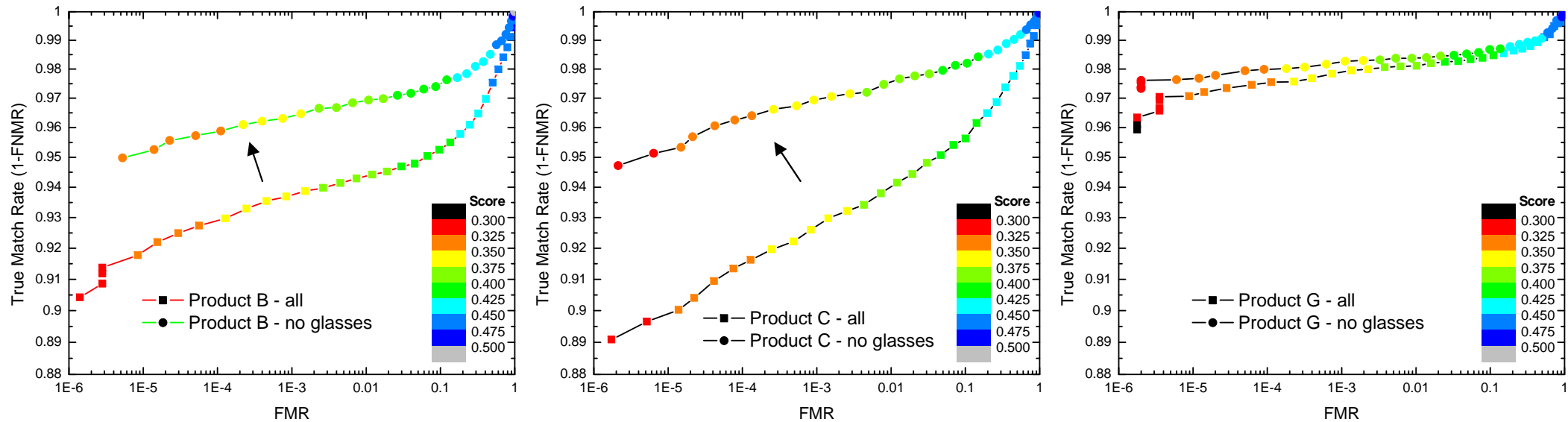
# Single-Attempt Native Performance



Product G exhibits lowest error rates (highest accuracy)

Product B exhibits fastest performance

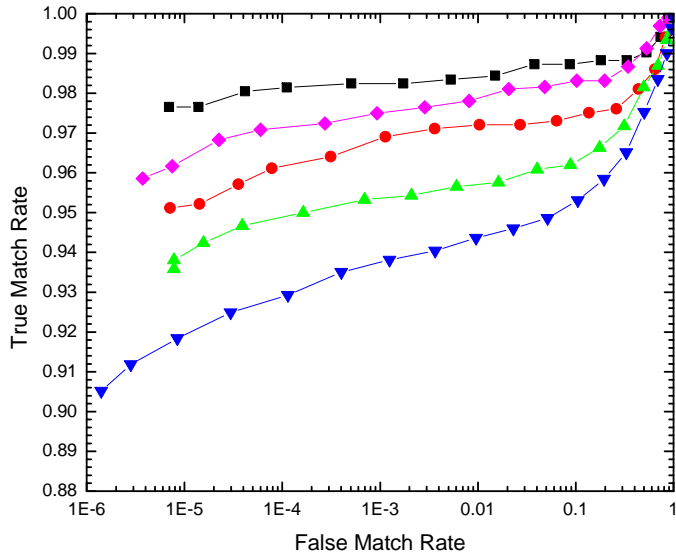
# Influence of Glasses



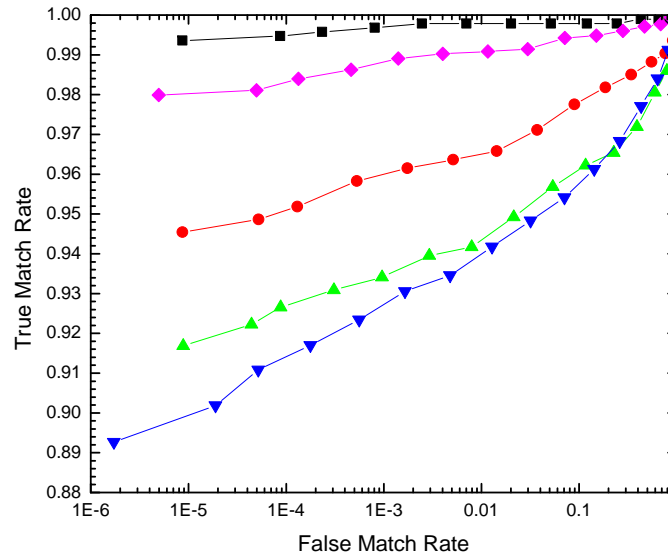
Single-attempt performance improved for all products when images with glasses were excluded from offline analysis

# Multiple-Attempt Native Performance

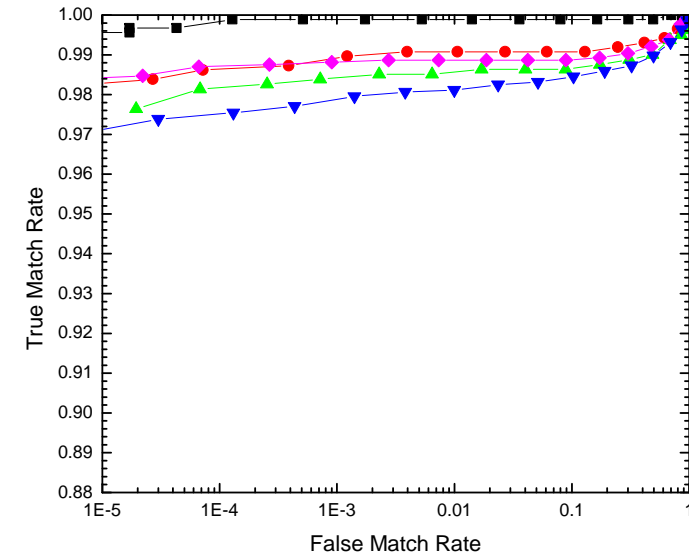
Product B



Product C

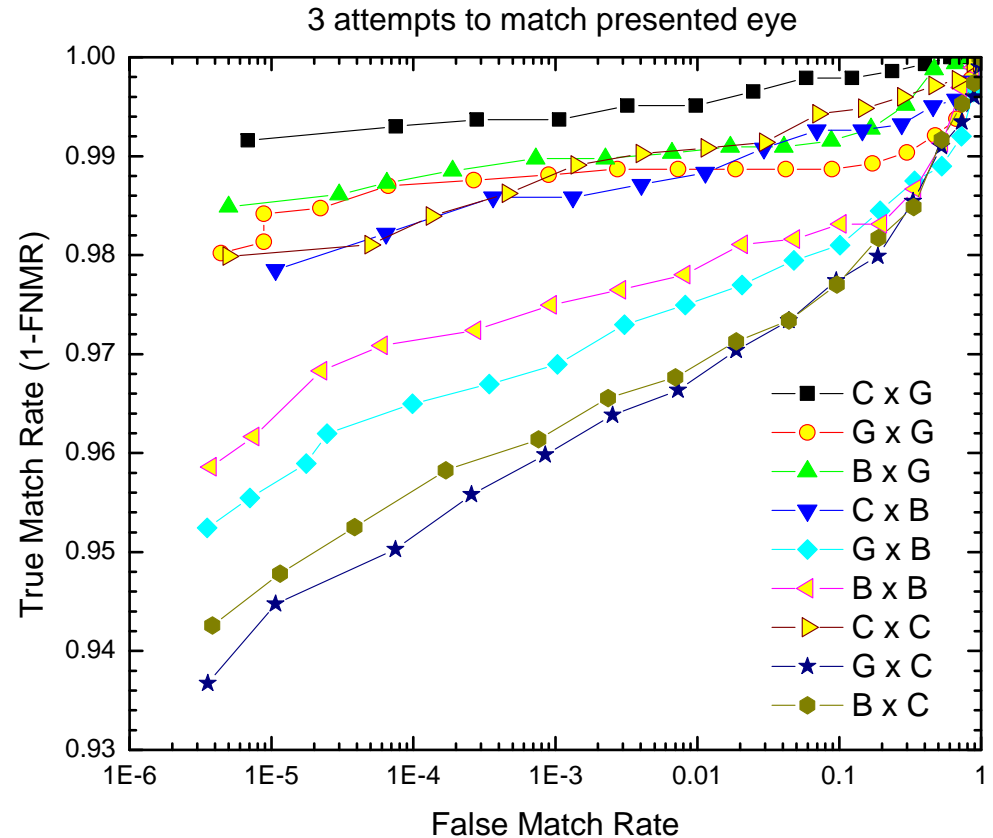
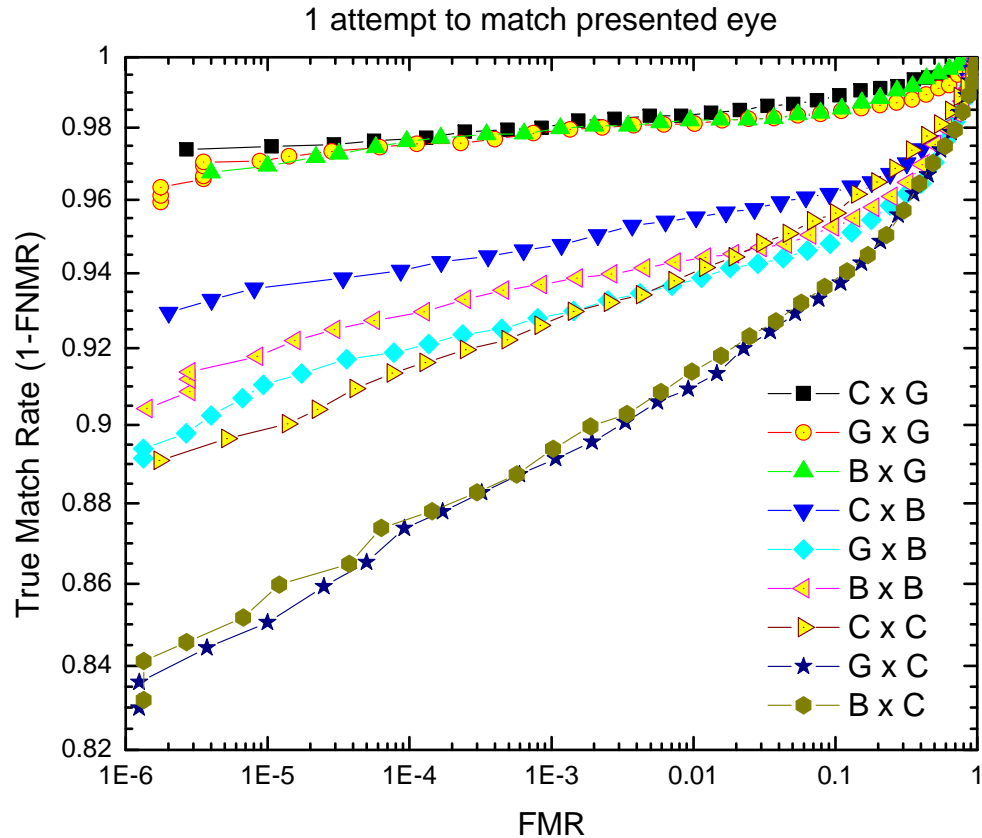


Product G



- Left and Right eyes presented simultaneously
- 3 attempts to match Left or Right eye
- 2 attempts to match Left or Right eye
- ▲— 1 attempts to match Left or Right eye
- Left and Right eyes presented individually
- ◆— 3 attempts to match presented eye
- ▼— 1 attempt to match presented eye

# Interoperability Performance



- Product C enrollment images exhibit best performance
- Product G recognition images exhibit best performance
- Interoperable performance better than native performance in some cases!

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- The opinions, findings, conclusions, and recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Department of Justice or the Department of Homeland Security.



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