FpVTE
Fingerprint Vendor Technology Evaluation

FINGERPRINT VENDOR TECHNOLOGY EVALUATION 2003

APPENDIX C

SYSTEM-SPECIFIC RESULTS

Table of Contents

1 Introduction

This appendix presents detailed results for each system that participated in FpVTE. The sections are in alphabetical order by company name. The content of each section varies in order to highlight any salient characteristics that were observed for each system, but generally includes the following:

- System identification
- Discussion of any incomplete or unsuccessful runs
- ROCs for a variety of partitions: 27 combinations of operational sources and image type (LST); 8 combinations of sources and image type (MST); or 2 operational sources (SST).
- Raw score distributions, including histograms of match and non-match score distributions.
- Accuracy by image quality (MST and SST only)

NOTES

- When comparing charts, please note that the scale of the Y axis varies according to the data being shown.
- For direct comparisons of the various systems, please see Section 5 of the FpVTE Analysis Report.
- Some systems encountered major or minor problems during processing. These are summarized in Section 21 of this Appendix.

Company Name	ID	Website
123 ID Inc.	123 ID	www.123id.us
Antheus Technology, Inc.	Antheus	www.antheustechnology.com
Av@lon Systems, Inc.	Avalon	www.avalonsysinc.com
BIO-key International, Inc.	BIO-key	www.bio-key.com
BioLink Technologies International	BioLink	www.biolinkusa.com
Bioscrypt, Inc.	Bioscrypt	www.bioscrypt.com
Cogent Systems, Inc.	Cogent	www.cogentsystems.com
Dermalog Identification Systems GmbH	Dermalog	www.dermalog.de
Golden Finger System	Golden Finger	www.etgoldenfinger.com/index_en.htm
Griaule Tecnologia	Griaule	www.griaule.com
Identix , Inc.	Identix	www.identix.com
SAGEM MORPHO, Inc.	SAGEM	www.morpho.com
NEC	NEC	www.nec.com
Neurotechnologija Ltd.	Neurotech	www.neurotechnologija.com
The Phoenix Group, Inc.	Phoenix	www.afix.net
Motorola	Motorola	www.motorola.com
Raytheon Company	Raytheon	www.raytheon.com
Technoimagia Co., Ltd.	Technoimagia	www.technoimagia.co.jp/e_index.htm
Ultra-Scan	Ultra-Scan	www.ultra-scan.com

Table C-1. Companies Participating in FpVTE

2 123 ID

123 ID entered one system for MST and for LST, with additional hardware for LST. The MST system was modified after an overflow error was reported by their Biometric System Search cluster system); the test was then successfully rerun.

System name: Biometric System Search

2.1 123 ID (LST) (Incomplete)

The 123 ID LST system successfully completed subtests AxA through IxI (22 out of 31 subtests, or all subtests except those involving dataset J) when they reached the three week time limit for the LST. Their incomplete results were archived as a separate LST run. Their complete results, including the results after the time limit, are reported in the next section. 123ID had two hard drive failures during the LST evaluation.

2.2 123 ID (LST) (Overtime)

123 ID (LST) ran over the allotted time for LST, taking 34 days instead of 21 days. The participant chose to continue, after being reminded of the section of the *Application to Participate in FpVTE 2003* that stated,

> *3.13. Failure to complete the test during the allotted time will be noted in the FpVTE 2003 Final Report. FpVTE personnel will decide, after conclusion of the test, if the partial test results will be reported in the FpVTE 2003 Final Report.*

This section presents the complete results including those produced after the time limit. The nine LST Subtests JxI, and CxJ through JxJ were all produced after the time limit.

Since 123 ID (LST) ran over the allotted time, it was not included in the system comparisons in the FpVTE Analysis Report. If it had been included, its comparative rank would have been as shown in Table C-2.

	Distribution of System Rank over LST Partitions where FAR = 10^{-4}							
	27 LST Partitions of Operational Data				**17 LST Partitions of Controlled (Ohio) Data**			
	Best	Average	Median	Worst	Best	Average	Median	Worst
123 ID	12	13.8	14	14	12	13.8	14	14

Table C-2. System rank results for 123ID LST (Overtime)

Configuration: Thirty-six (36) HP xw6000 search nodes, one HP a330n administrator node, running the Biometric System Search (BSS), plus Virtual Print Signature Technology. This differs somewhat from the configuration described in their System Description Document: 36 CCSI Clusteron UltraCool Athlon nodes; one CCSI Clusteron Athlon Head node.

Figure C-1 shows separate ROCs for 27 distinct operational partitions of the LST test.

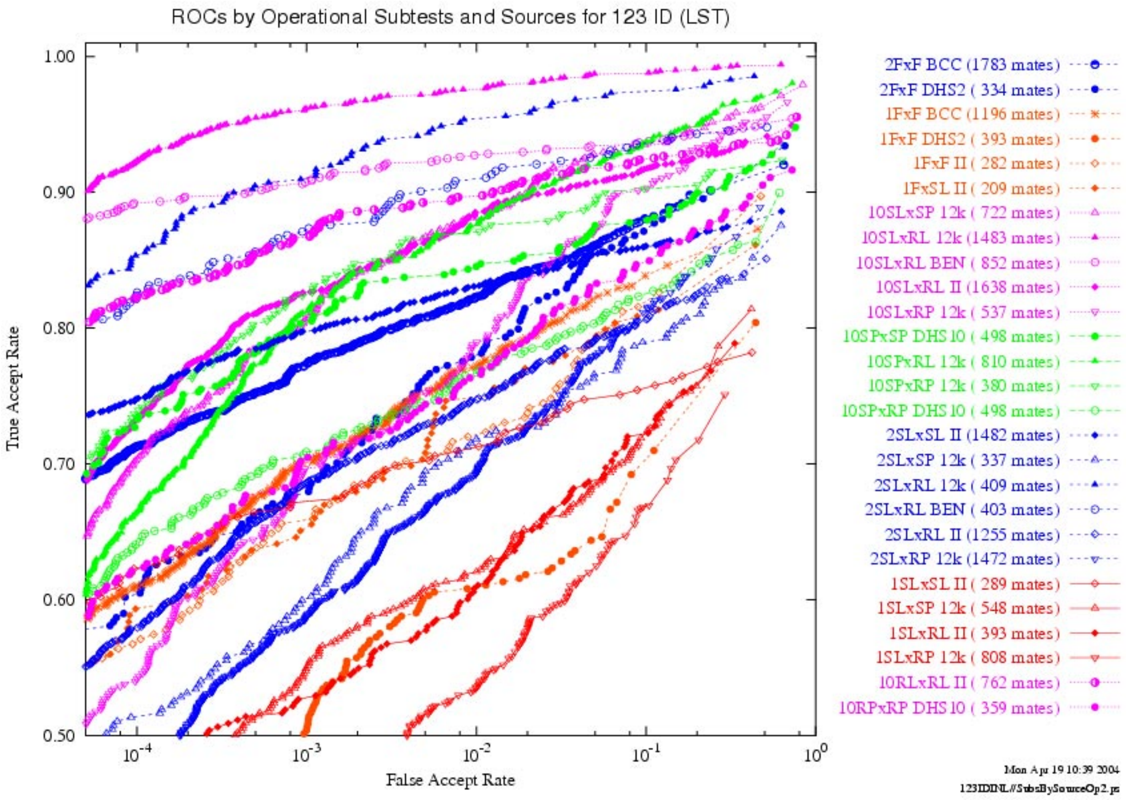


Figure C-1. 123 ID (LST) ROC for 27 Operational Partitions

Figure C-2 shows accuracy for the controlled (non-operational) Ohio data, which is much higher than for the operational data. Note that performance degraded substantially for 1 and 2-finger partitions including paper sources (xSP or xRP). Note the abrupt drop off in 10-finger performance (green and purple lines).

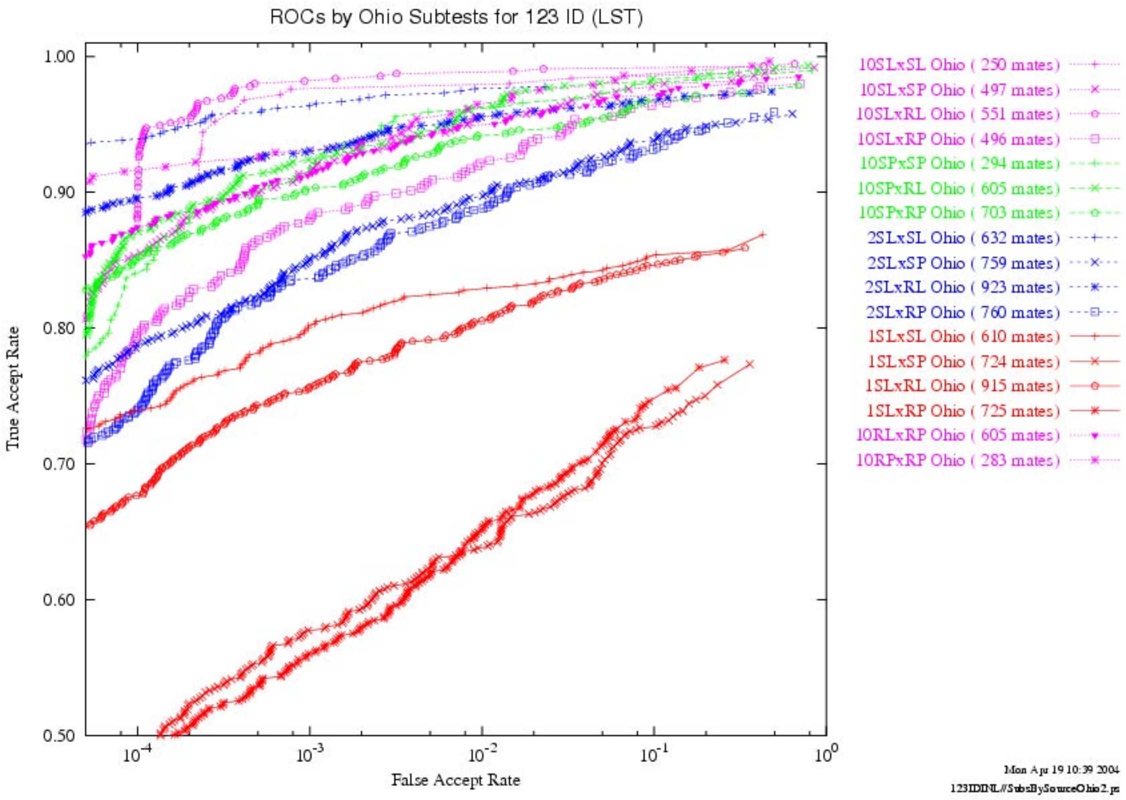


Figure C-2. 123 ID (LST) ROC for 17 Controlled Partitions

Figure C-3 shows the effect of the number of fingers on a single type of controlled Ohio data.

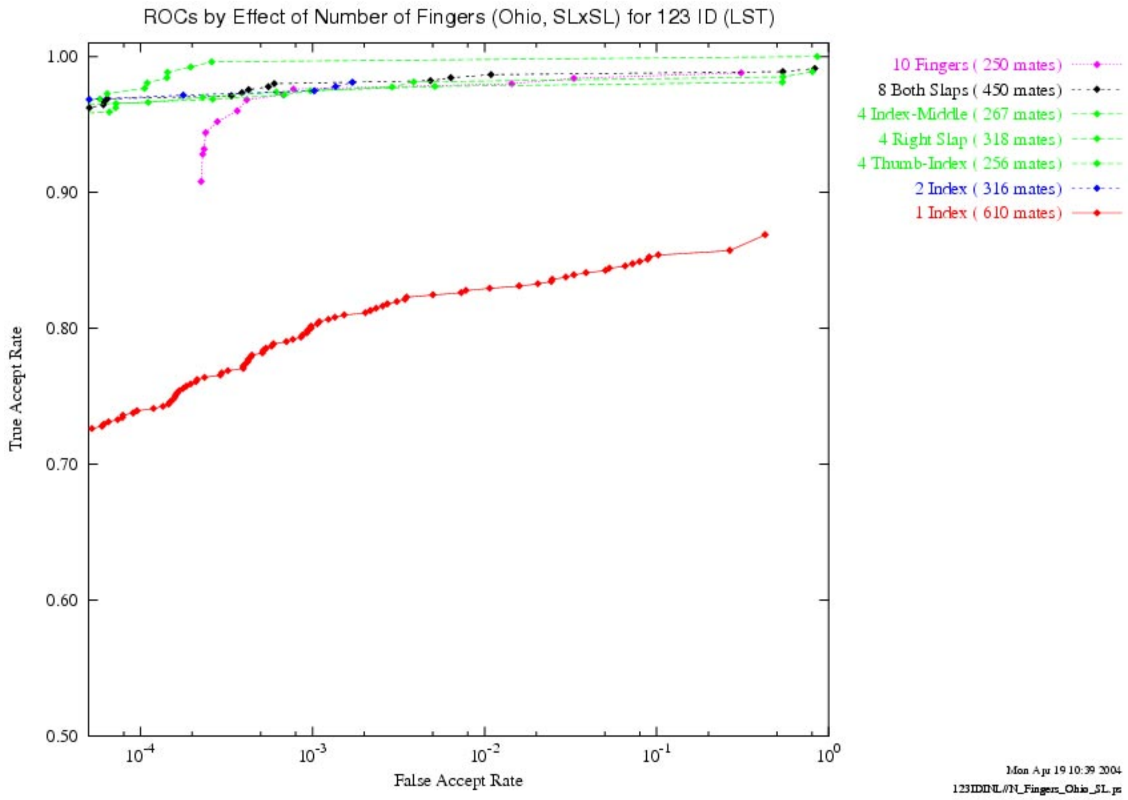


Figure C-3. 123ID (LST) ROCs by Number of Fingers for Controlled Data

The figure below shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

Note the spike in both match and non-match values at 0.0.

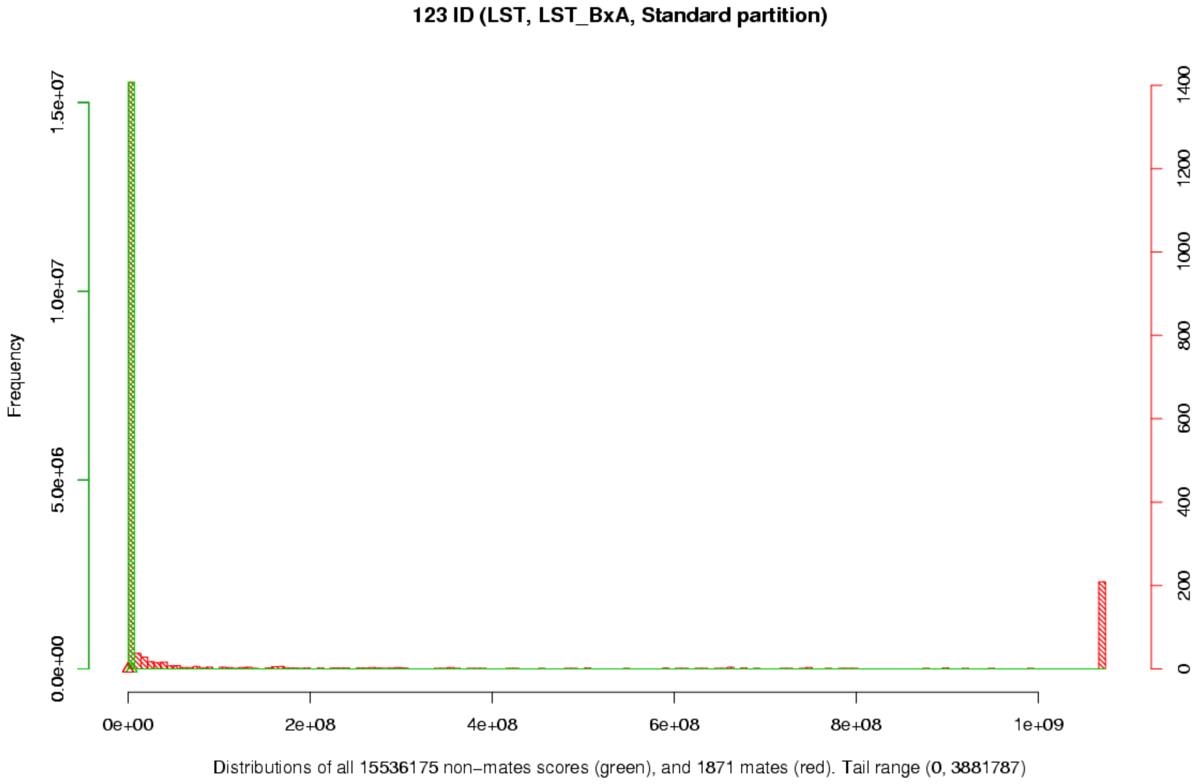


Figure C-4. 123ID (LST) Histogram of Match and Non-Match Distributions for BxA Subtest

In the System Description document, 123 ID (MST) states that this configuration assumes that a matching score of 420,000 is the acceptance score for a positive identification, based on the sample data.

2.3 123 ID M1 (MST) (Error)

In the first MST run for 123ID, the participant stated that the results were in error (overflow error reported by Biometric System Search cluster system); the test was successfully rerun as 123 ID M2 with additional hardware and improved filtering software.

As seen in Figure C-5, it appears that the matcher was not operating properly.

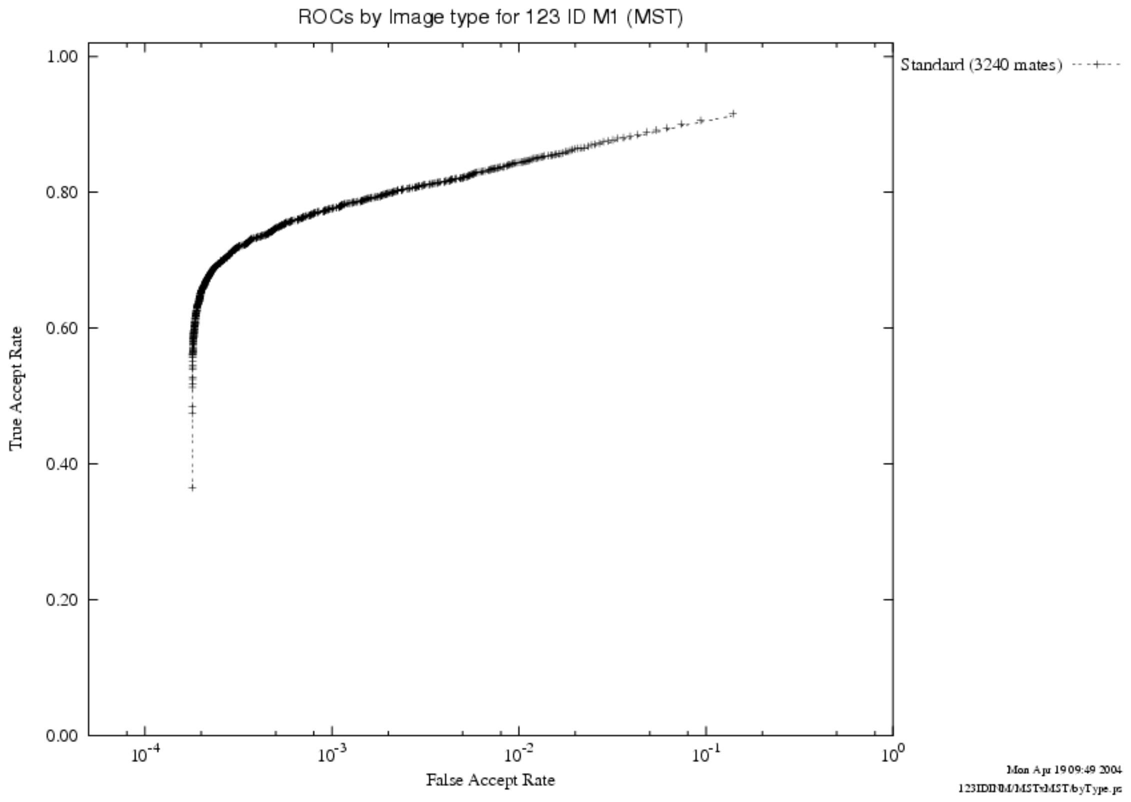


Figure C-5. 123ID M1 (MST) (Error) ROC

2.4 123 ID M2 (MST)

123 ID M2 (MST) completed processing in 1 day.

Configuration: Sixteen (16) HP xw6000 search nodes, one HP a330n administrator node, running the Biometric System Search (BSS), plus Virtual Print Signature Technology.

Figure C-6 shows separate ROCs for eight partitions of the MST data. Note that 123 ID M2 (MST) performs markedly better on the controlled Ohio data.

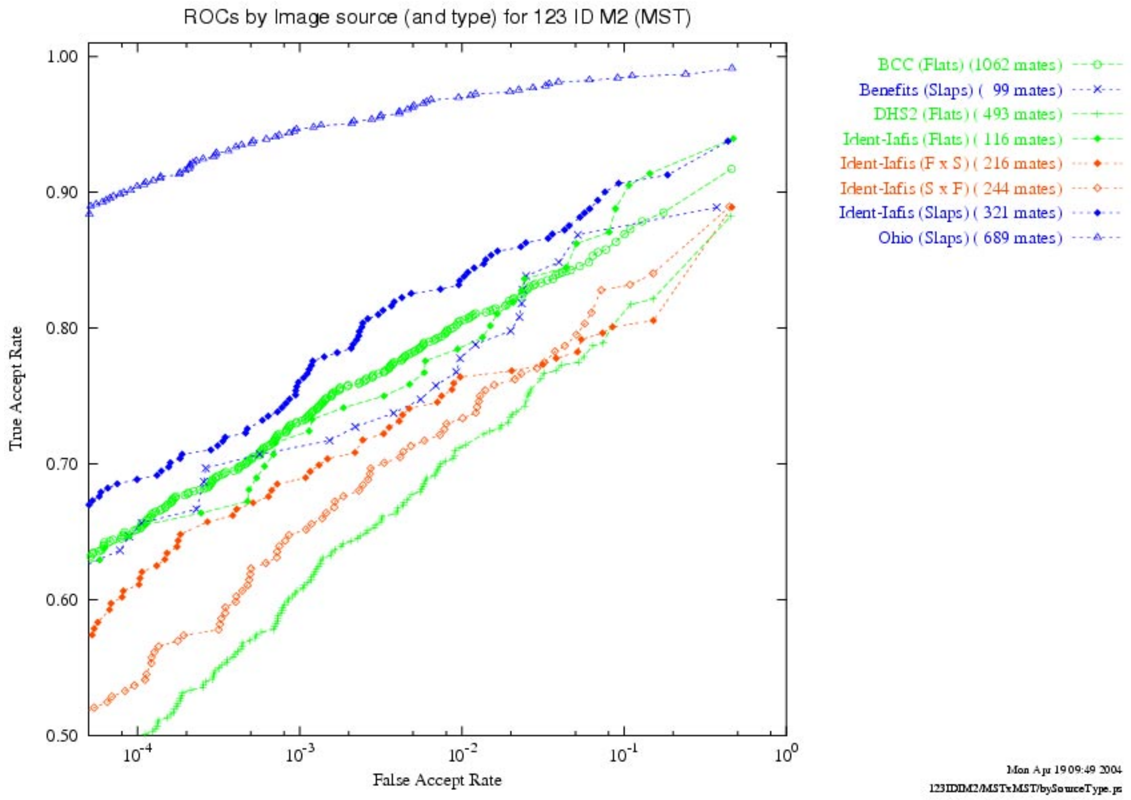


Figure C-6. 123ID M2 (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note the spike in both match and non-match values at 0.0.

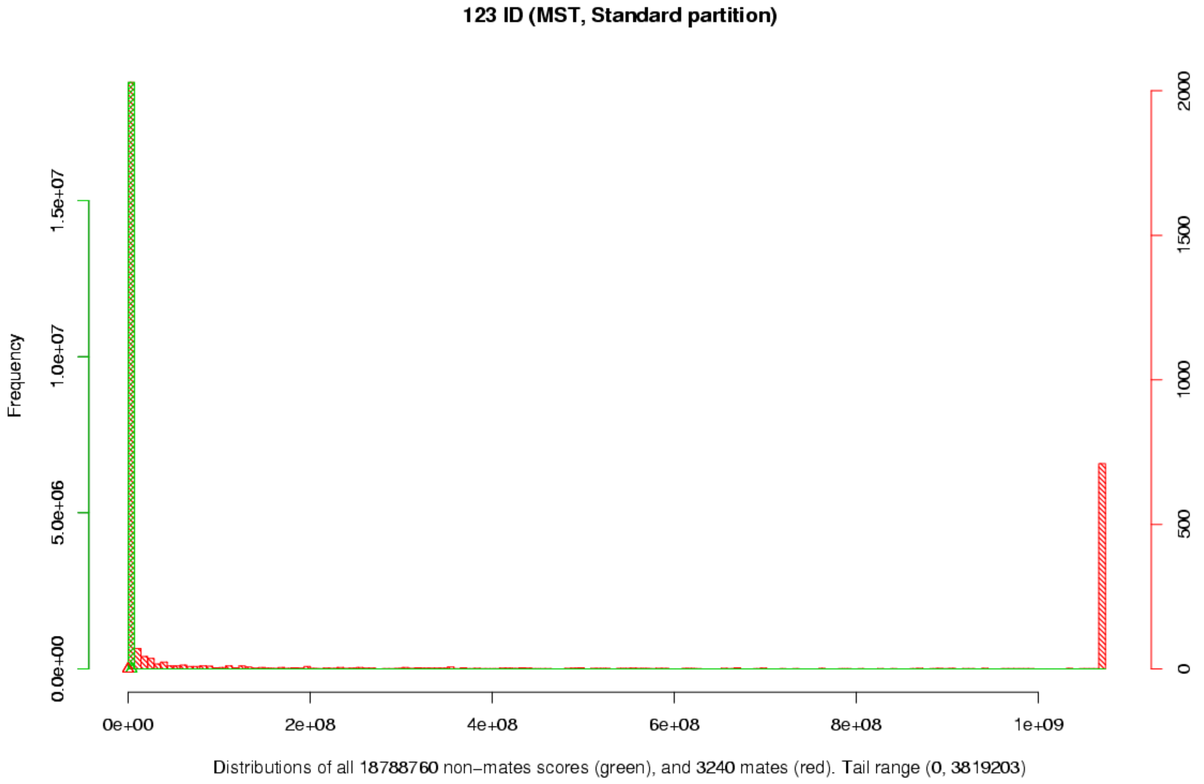


Figure C-7. 123ID M2 (MST) Match and Non-Match Distributions

The following figures show more clearly the area of overlap between high scoring non-matches and low scoring matches. Figure C-8 shows performance in the interval from 0 to 100. The leftmost bin includes 241 matches that tie for low score of 0.

Note the spike in both match and non-match values at 0.0.

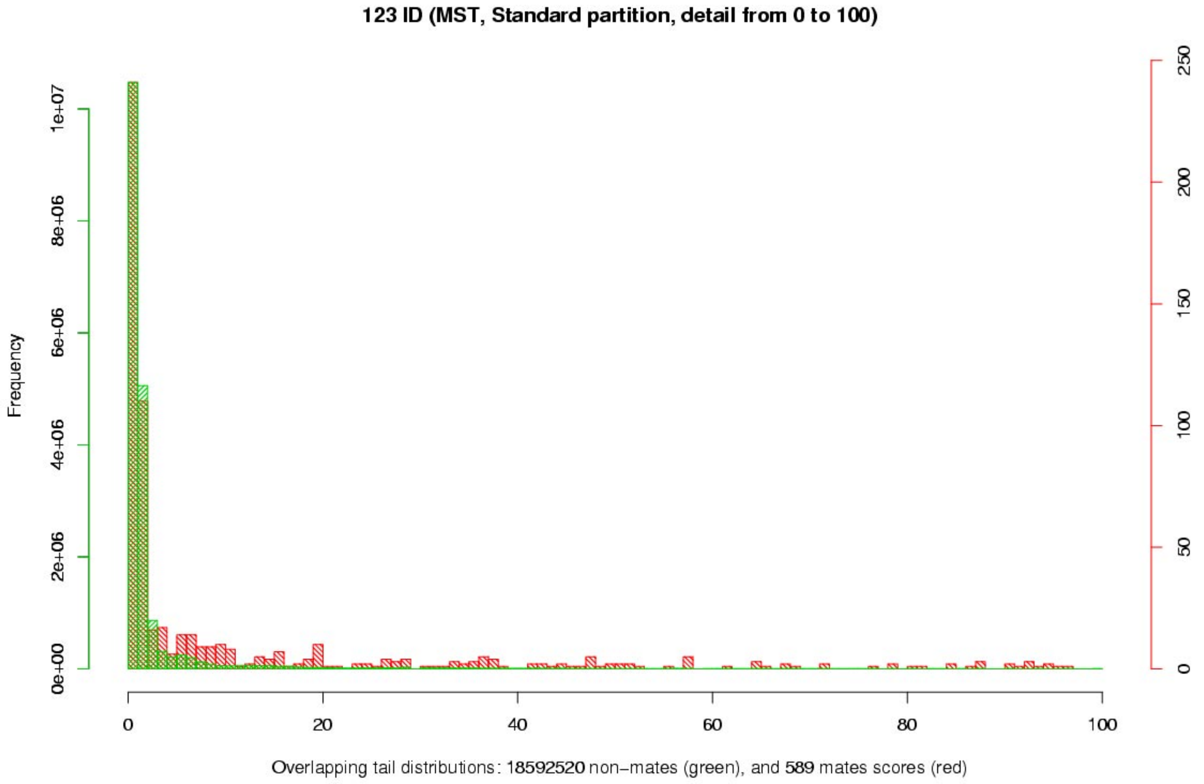


Figure C-8. 123ID M2 (MST) Match and Non-Match Distributions Detail

Figure C-9 shows performance much further to the right, in the interval from 1000 to 10000. This interval shows that the right tail of the non-match distribution remains heavy well into the mate distribution.

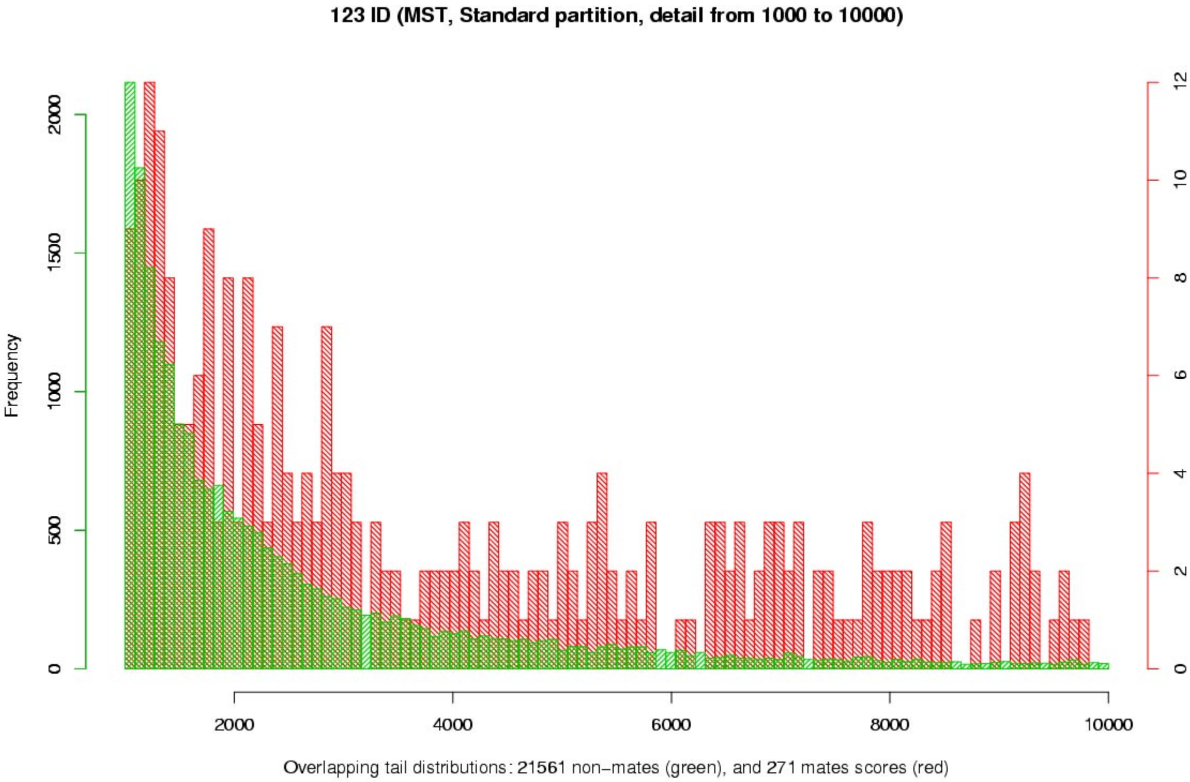


Figure C-9. 123ID M2 (MST) Match and Non-Match Distributions Detail

In the System Description document, 123 ID (MST) states that this configuration assumes that a matching score of 420,000 is the acceptance score for a positive identification.

Figure C-10 shows the effect of image quality on accuracy, using the FpVTE aggregated image quality metric.

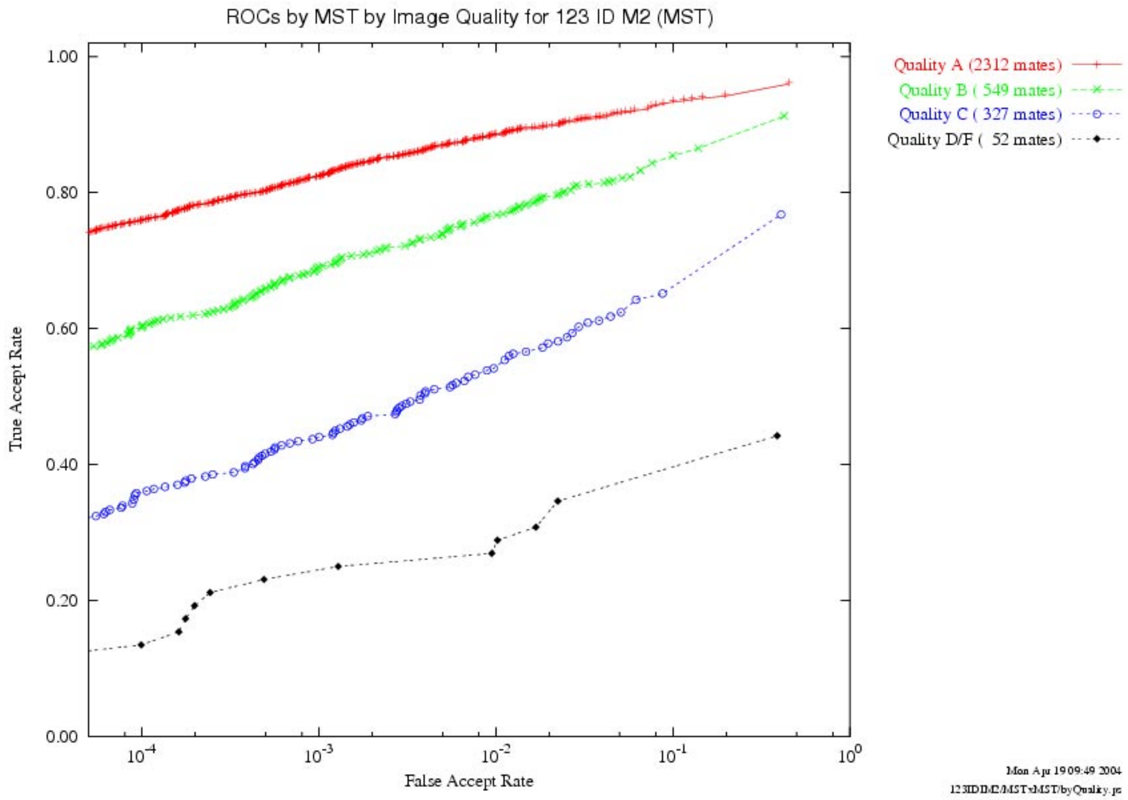


Figure C-10. 123ID M2 (MST) by Image Quality

Image quality data was provided by 123 ID M1 and M2, which differed only trivially. The 123ID M1 IQM was among the seven IQMs used in the FpVTE aggregate image quality metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
123ID M1	45.0	0.0	85.2	87.0	99.0	0.27%
123ID M2	45.0	0.0	85.3	88.0	99.0	0.25%

Figure C-11. 123ID (MST) IQM Distribution

3 Antheus

Antheus entered one system that was used for both MST and LST.

System name: Agora

Configuration: 1 Dual Pentium 4, running FpVTE Application Software, running UltraMatch AFIS and Windows 2000.

3.1 Antheus (LST)

Completion time: 14 days.

Figure C-12 shows separate ROCs for 27 distinct operational partitions of the LST test.

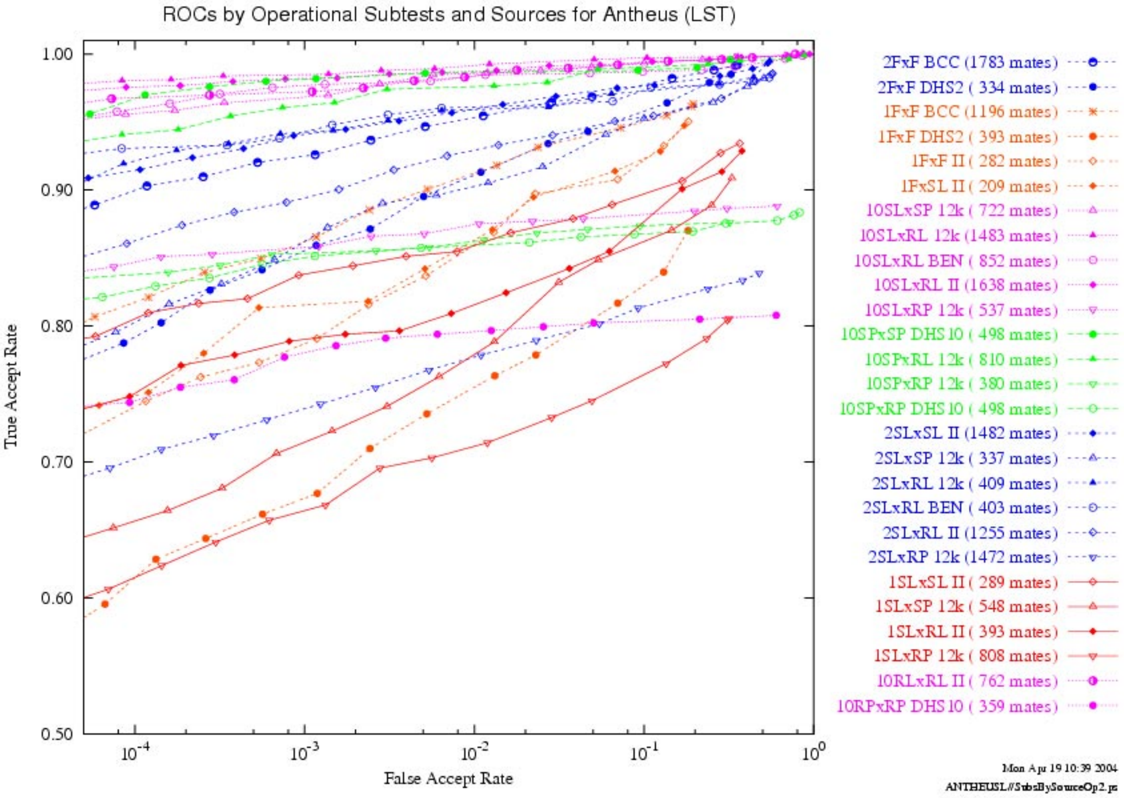


Figure C-12. Antheus (LST) ROCs for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum

non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

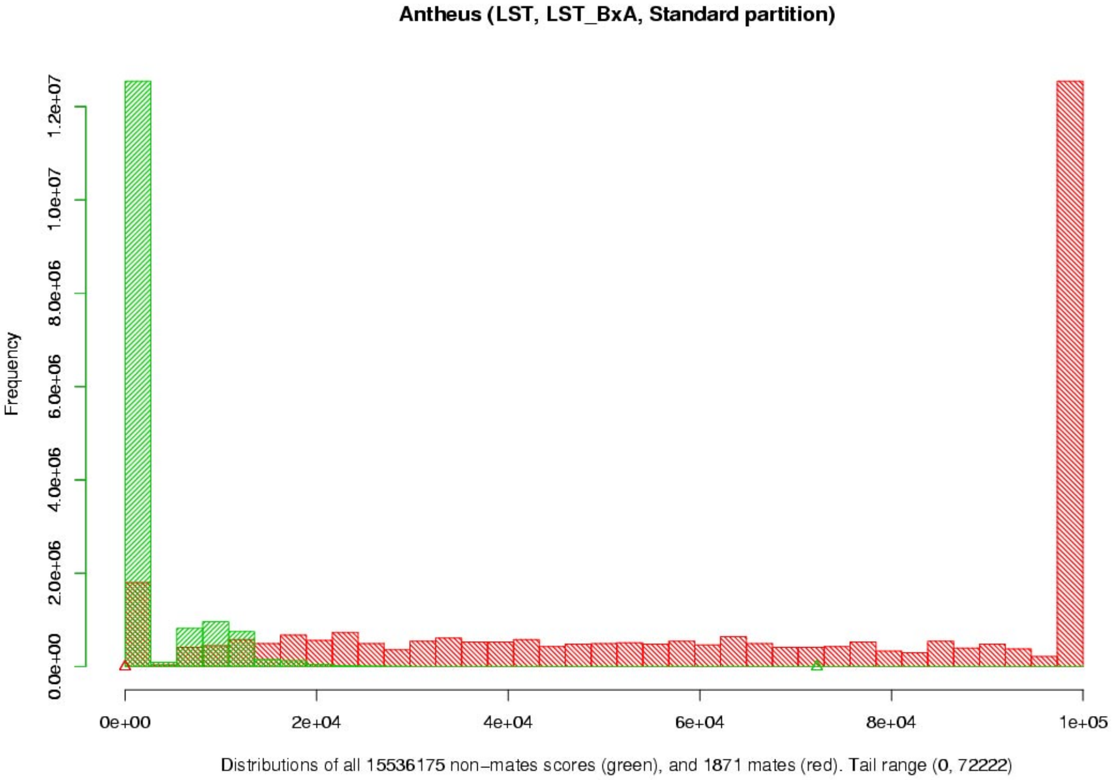


Figure C-13. Antheus (LST) Match vs. Non-Match Distribution for BxA Subtest

3.2 Antheus (MST)

Completion time: 1 day

Figure C-14 shows separate ROCs for eight partitions of the MST data.

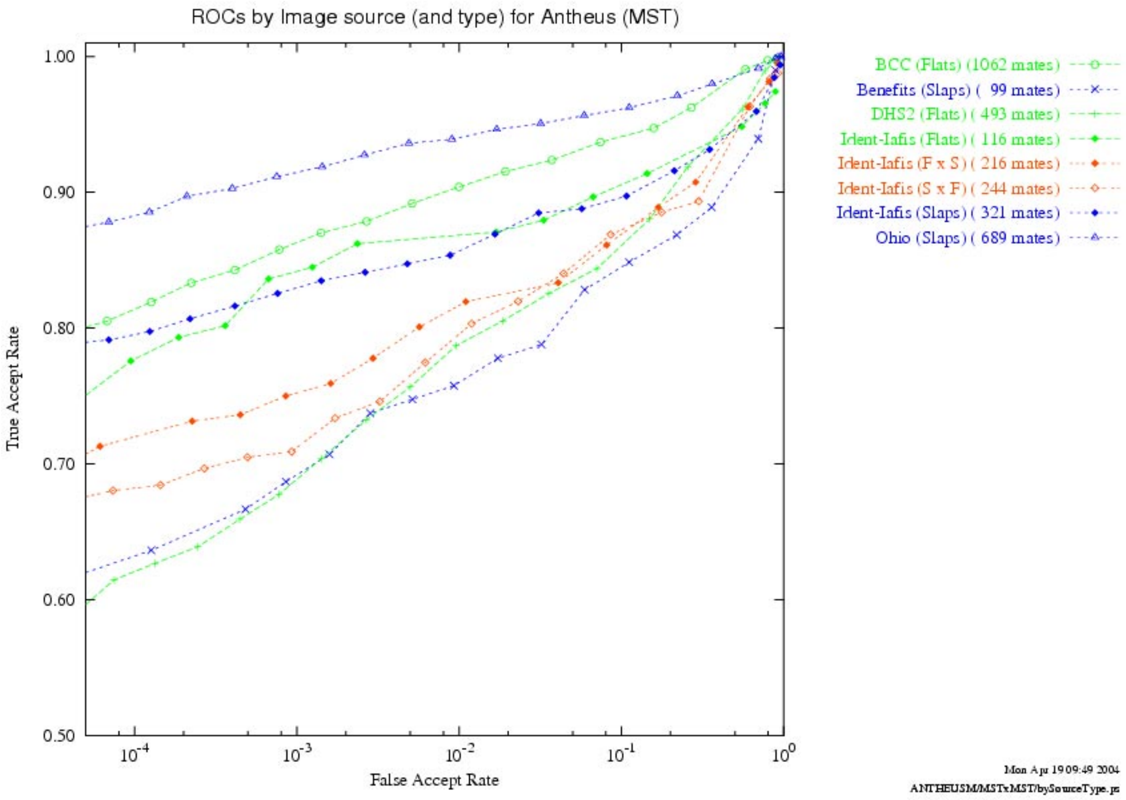


Figure C-14. Antheus (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

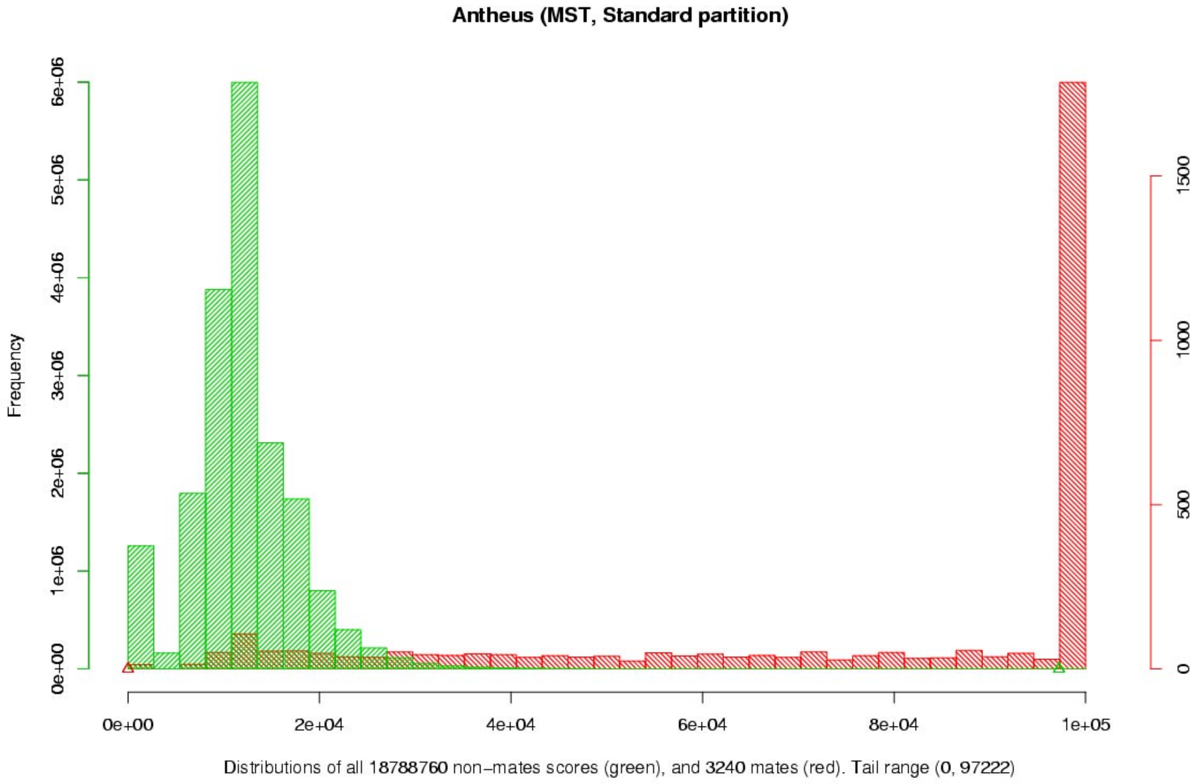


Figure C-15. Antheus (MST) Match and Non-Match Distributions

Figure C-16 shows the effect of image quality on accuracy, using the FpVTE aggregated image quality metric.

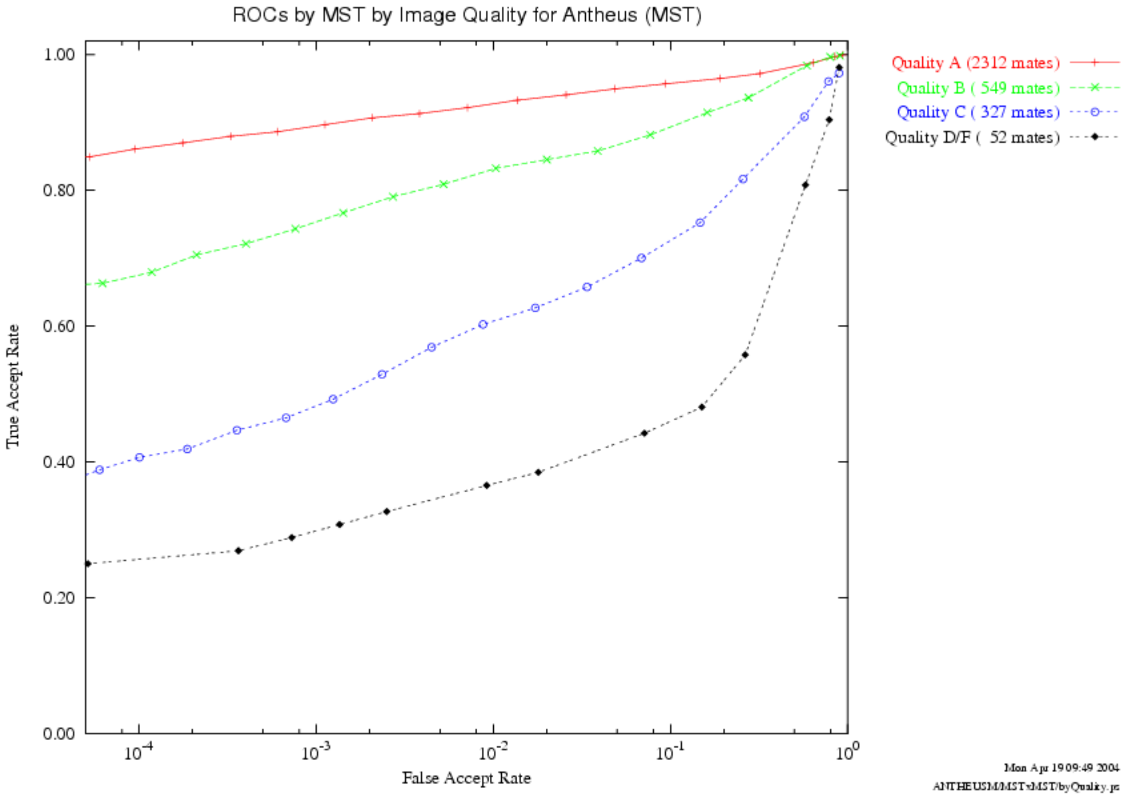


Figure C-16. Antheus (MST) by Image Quality

Antheus provided image quality data for MST, but every image was assigned an image quality value above the FTE threshold (specified by Antheus), so this data was not used to develop the aggregate metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Antheus	0.0	12.0	70.8	74.0	100.0	0.00%

4 Avalon

Avalon entered one system for MST and one for LST. These systems used the same software, but different hardware. Avalon (LST) did not complete the test.

System name: Ultramatch AFIS

4.1 Avalon (LST) (Halted)

Avalon (LST) did not complete the test. The test was halted by the participant when it became clear that the entire LST would not be completed in time. The results for Subtests AxA and BxA are included here.

Configuration: 4 Celerons + 2 Pentium 4s, running Ultramatch, Windows XP Professional

Figure C-17 shows separate ROCs for 5 of the 27 distinct operational partitions of the LST test.

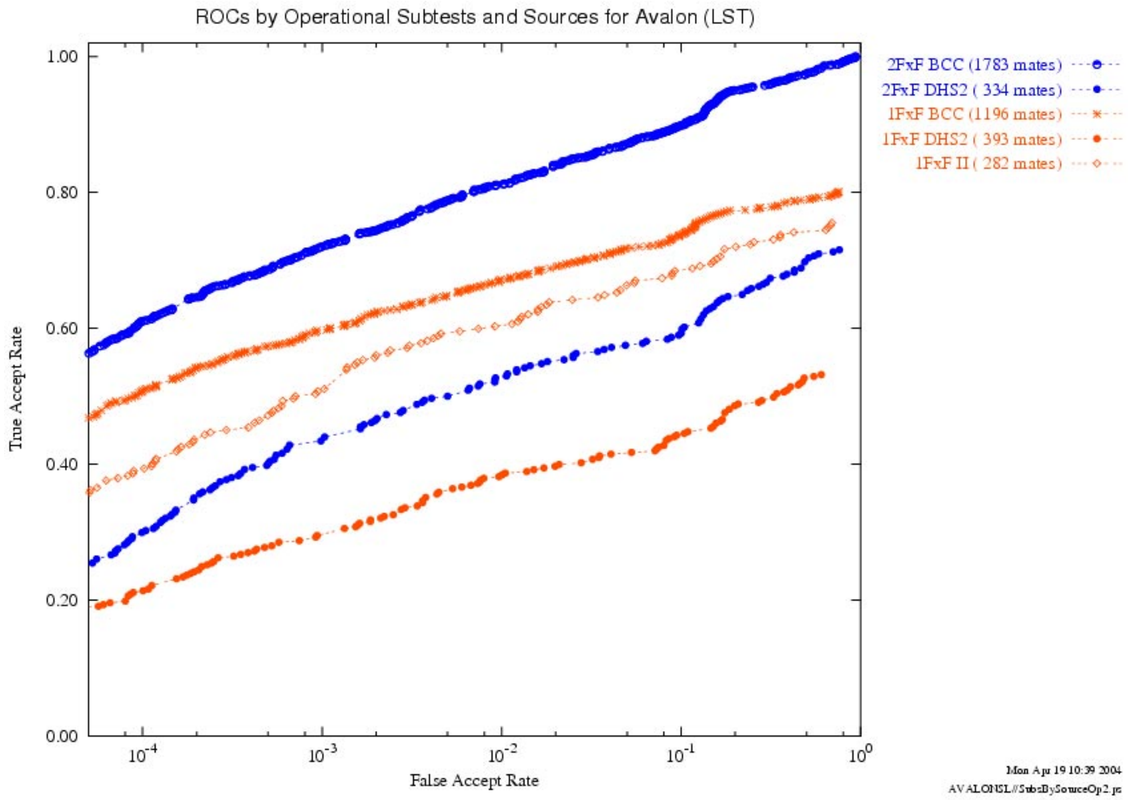


Figure C-17. Avalon (LST) ROC for 5 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the

left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note the spike in both match and non-match values at 0.0.

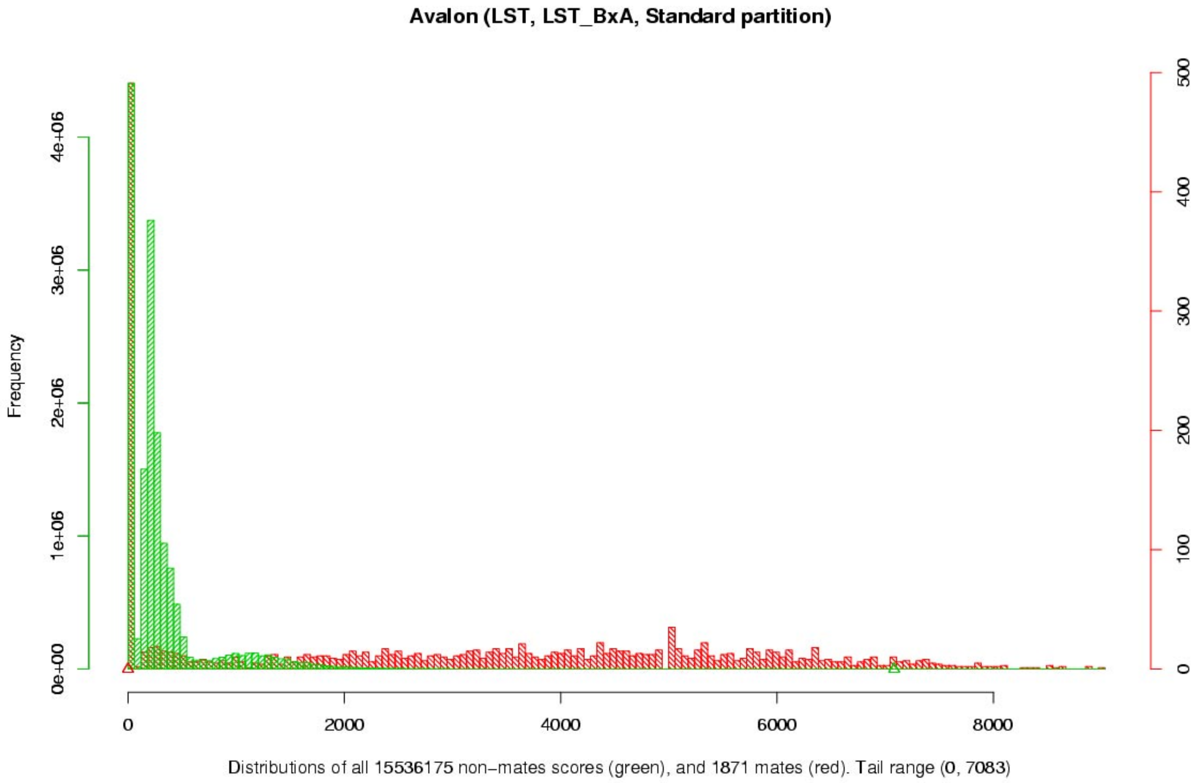


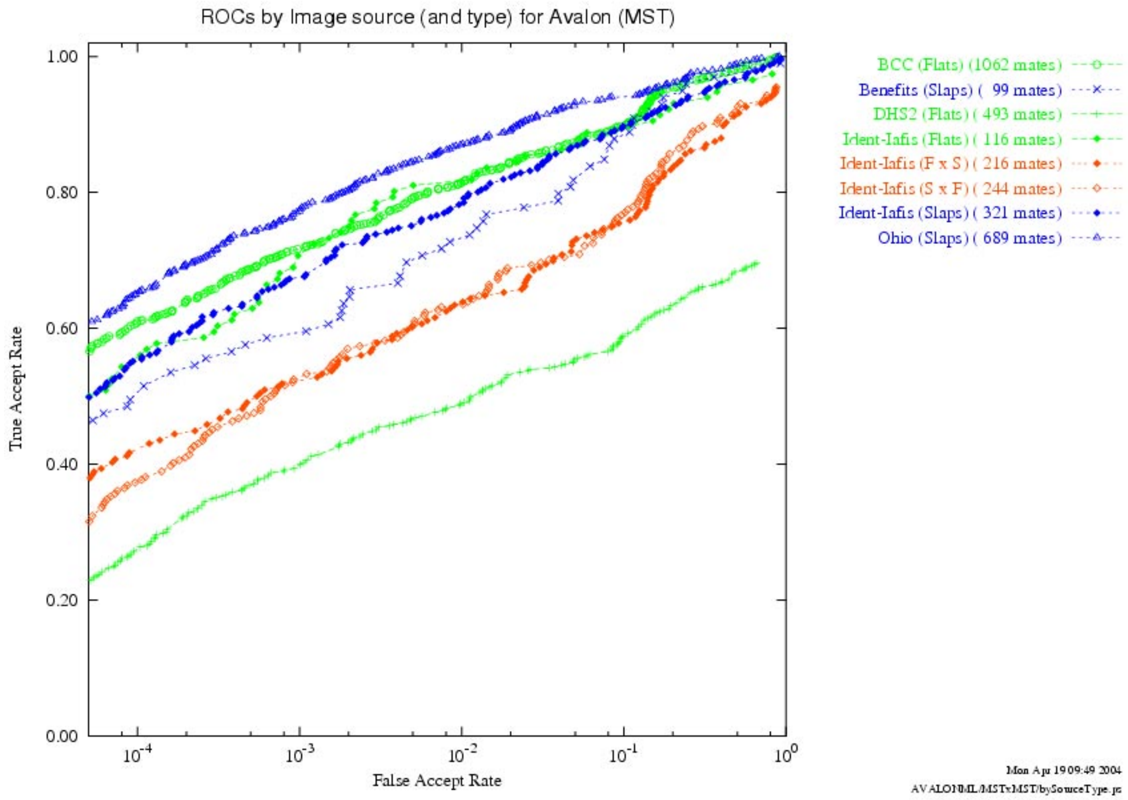
Figure C-18. Avalon (LST) Match vs. Non-Match Distribution for BxA Subtest

4.2 Avalon (MST)

Configuration: 1 Pentium 4, running Ultramatch, Windows XP Professional

Completion time: 1 day

Figure C-19 shows separate ROCs for eight partitions of the MST data.



Mon Apr 19 09:49 2004
AVALONML/MSTxMST/bySourceType.ps

Figure C-19. Avalon (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

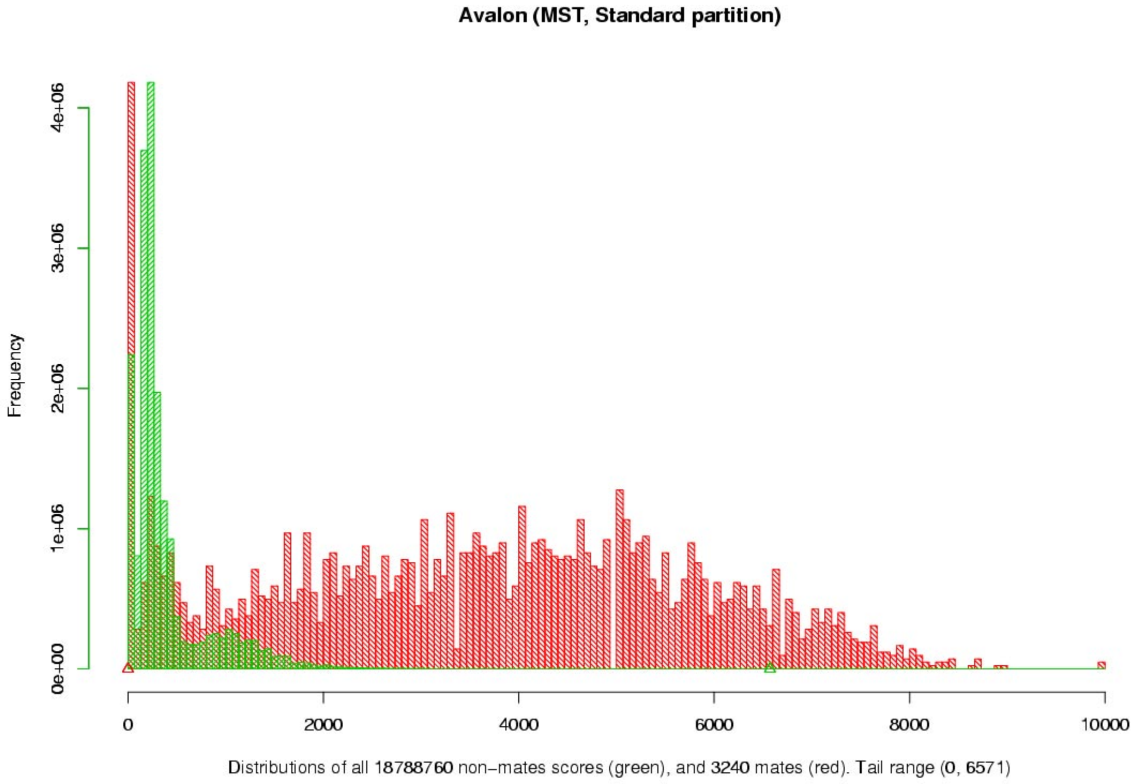


Figure C-20. Avalon (MST) Match and Non-Match Distributions

Figure C-21 shows the effect of image quality on accuracy, using the FpVTE aggregated image quality metric.

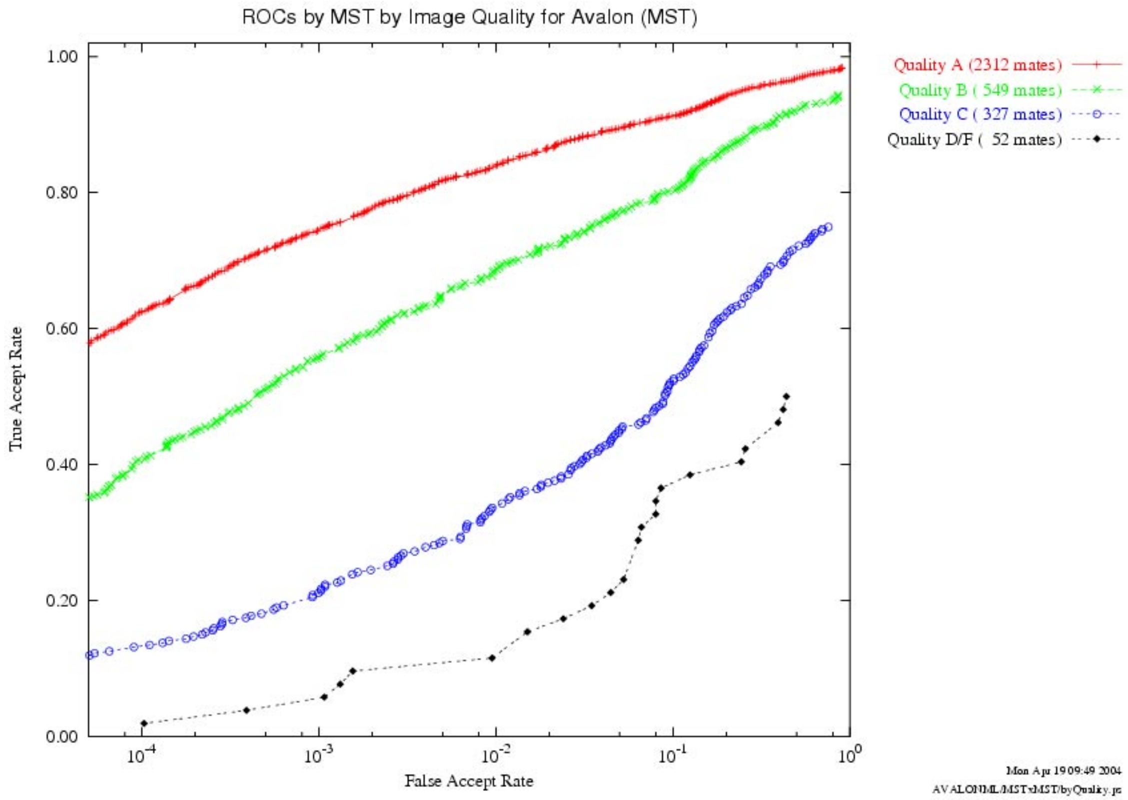


Figure C-21. Avalon (MST) by Image Quality

5 Biolink

Biolink entered one system for MST and one for LST. These systems used the same software, but different hardware.

System name: Authenteon-based FpVTE

5.1 Biolink (LST)

Configuration: A Control Front End and SQL Server database consisting of 2 Pentium 4s running Windows Server 2003; and a Search Engine consisting of 24 RLX 1200i blades (Pentium 3), running FpVTE Application Software v66 (Authenteon), Windows Server 2003

Completion time: 6 days

Figure C-22 shows separate ROCs for 27 distinct operational partitions of the LST test. (except note that none of the single-finger or two-finger results are graphed). These unusual results are explained in part by Figure C-23. LST_BxA is typical of Biolink (LST) single-finger results: after rejecting a large percentage of pairs (i.e., assigning a score of 0), it consistently achieved perfect separation of the remaining match and non-match pairs. On the ROC charts, no data can be plotted for this partition because there are only two meaningful data points: 1,1 (never plotted), and 0,0.51 (off the chart).

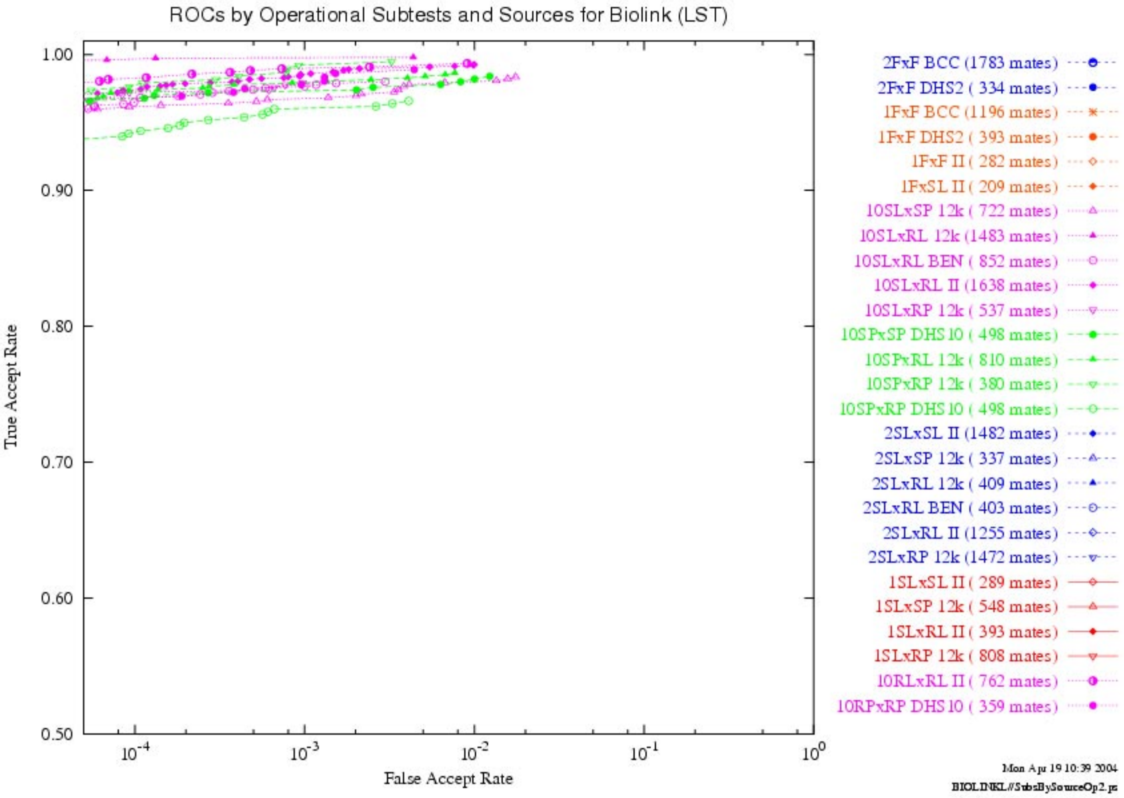


Figure C-22. Biolink (LST) ROCs for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note the spike in both match and non-match values at 0.0.

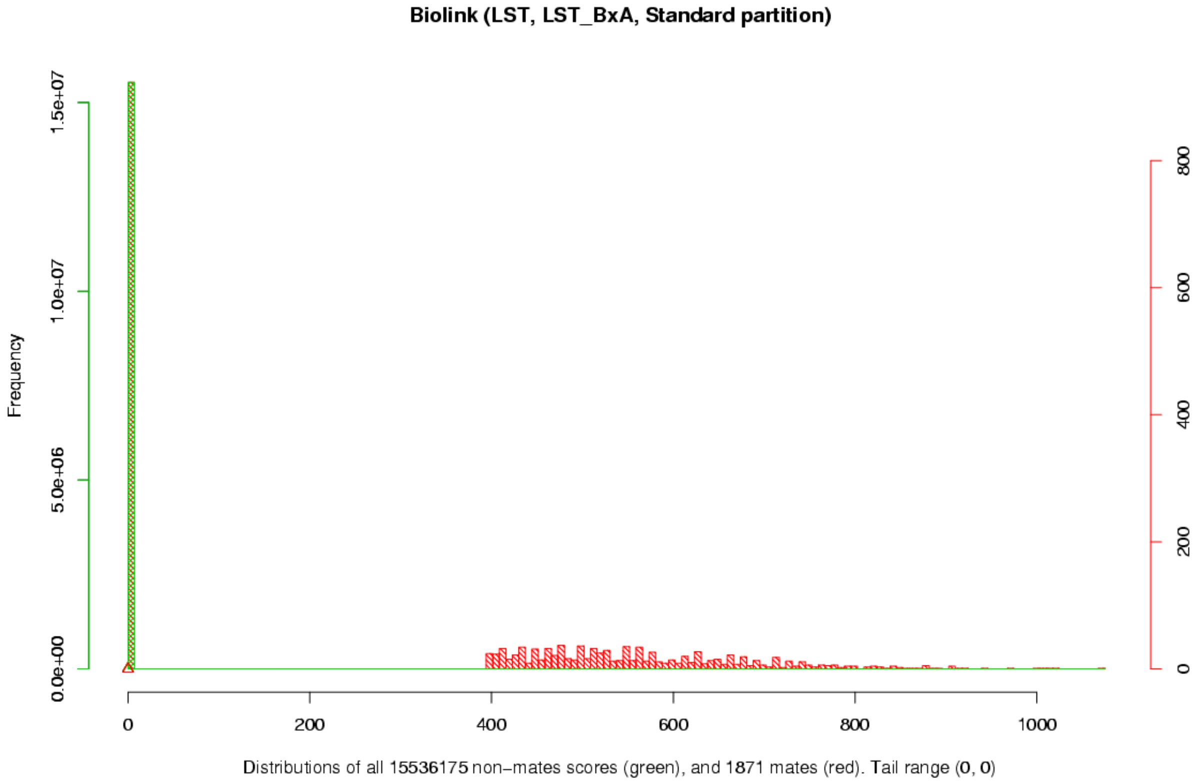


Figure C-23. Biolink (LST) Match vs. Non-Match Distribution for BxA Subtest

Although it is striking that this system managed to assign a zero similarity to every non-mate comparison, it did so while assigning zero similarity to more than half of the mate comparisons, as well.

The ROCs in this report do not generally show interpolated values. Figure C-24 shows the same results as Figure C-22, but with interpolated values added for the 2-finger results. Bear in mind that interpolations over a great range such as this cannot be precise.

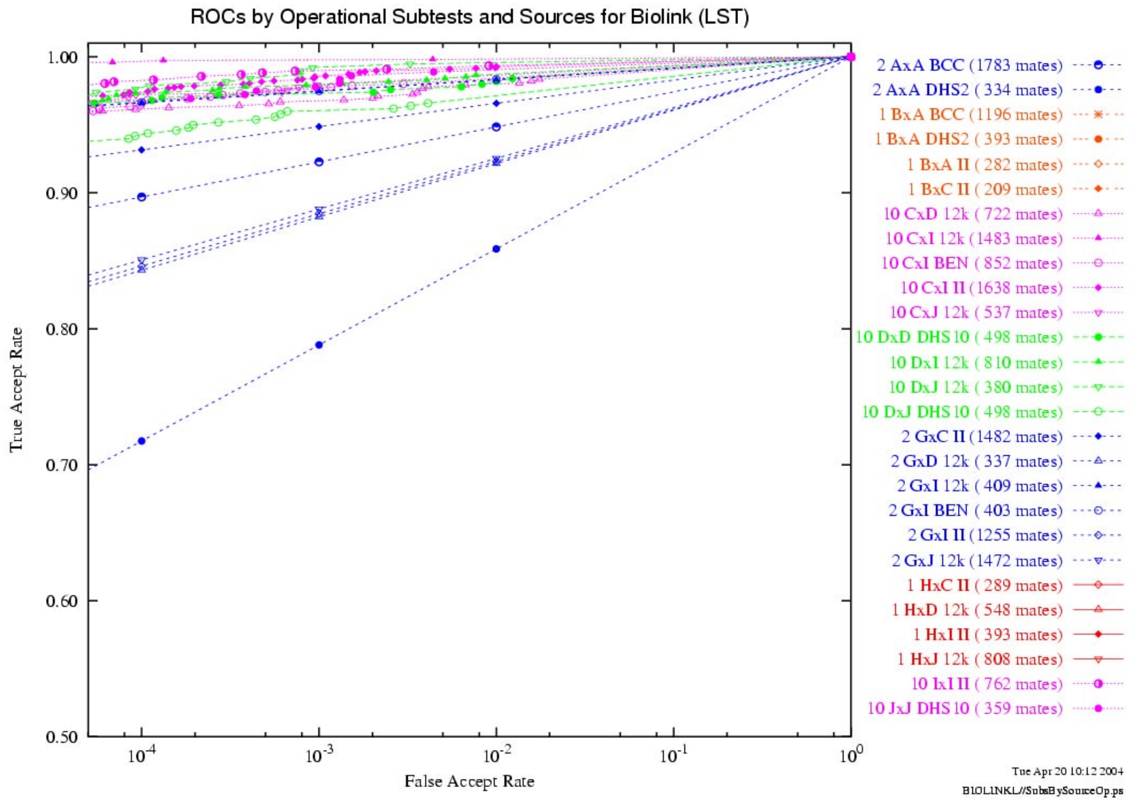


Figure C-24. Biolink (LST) ROCs for 27 Operational Partitions, with interpolated values for 2-finger results

5.2 Biolink (MST)

Configuration: A Pentium 4 PC, running FpVTE Application Software v66 (Authenteon) and Windows Server 2003.

Completion time: 4 days

Figure C-25 shows separate ROCs for eight partitions of the MST data. Note the sensitivity to DHS2 flat images, which are known to be of especially low quality.

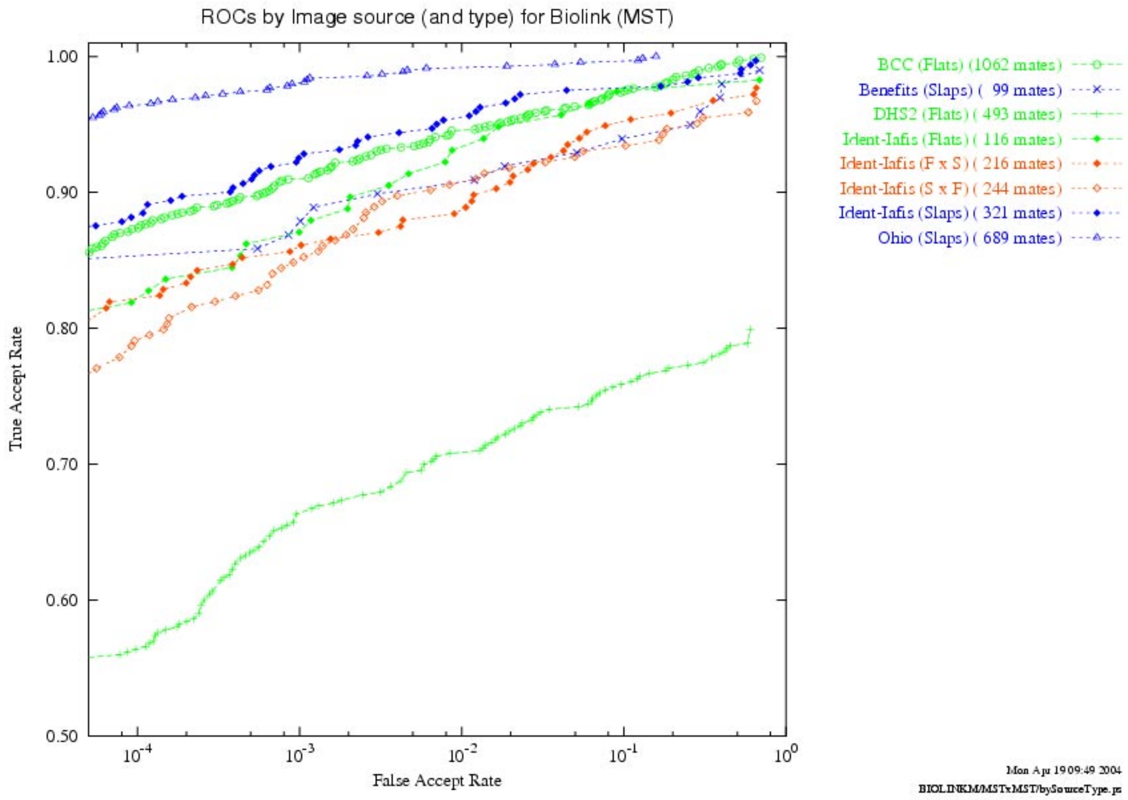


Figure C-25. Biolink (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

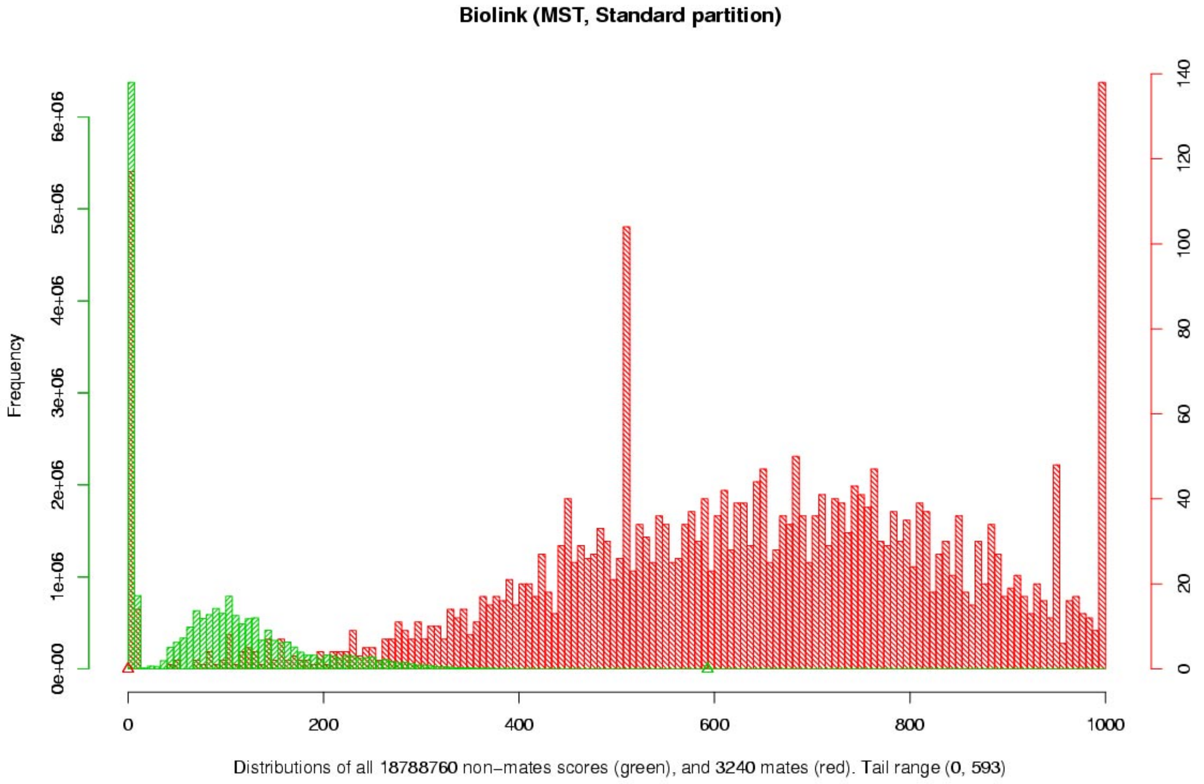


Figure C-26. Biolink (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. Biolink provided image quality data, which was used to develop this aggregate metric.

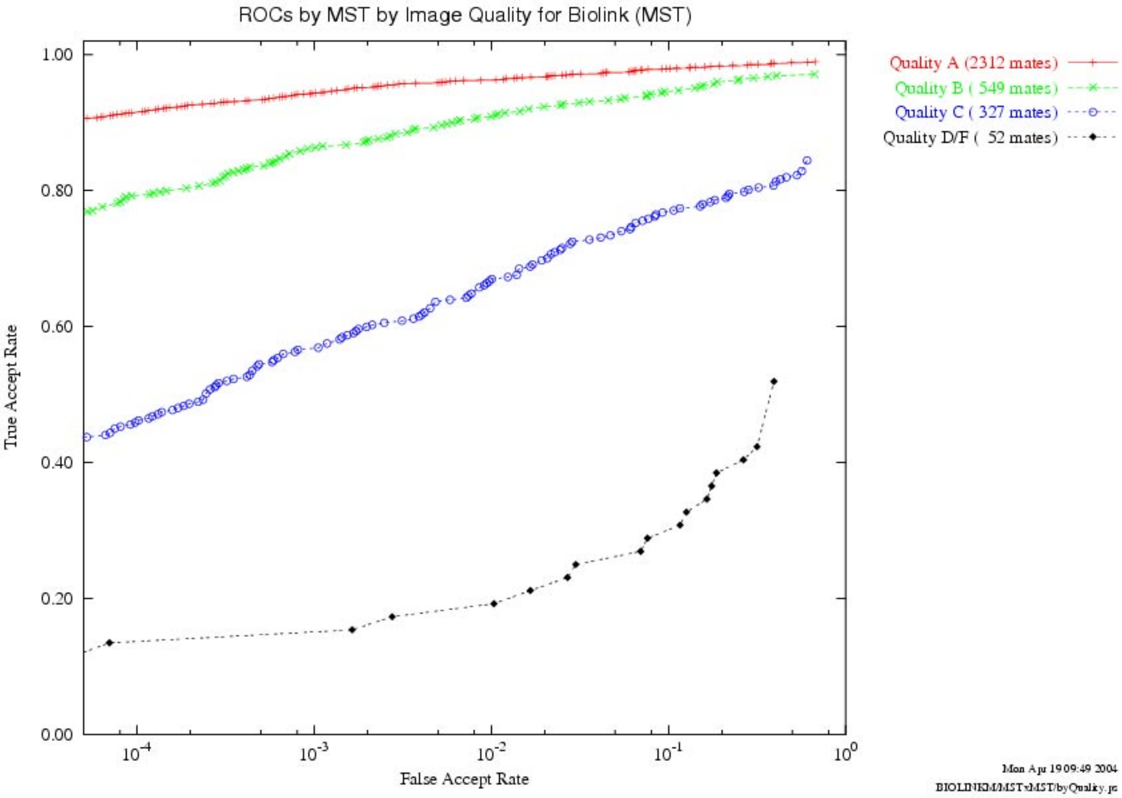


Figure C-27. Effect of Image Quality

Image quality data was provided by Biolink (MST), and was among the seven IQMs used in the FpVTE aggregate image quality metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Biolink	25.0	0.0	75.8	81.0	100.0	3.92%

Table C-3. Image Quality Distribution

6 Bioscrypt

Bioscrypt entered one system for SST.

System name: Bioscrypt Core

Configuration: 1 Dual Xeon 3.06 GHz, running Bioscrypt Core and Windows XP Pofessional.

6.1 Bioscrypt (SST)

Completion time: 5 days

Figure C-28 shows separate ROCs for the BCC and DHS2 partitions of the SST data. Standard is simply a combination of BCC and DHS2 data. Note the dramatic difference between the BCC and DHS2 results. Note also how horizontal the ROCs are after they leave the right axis.

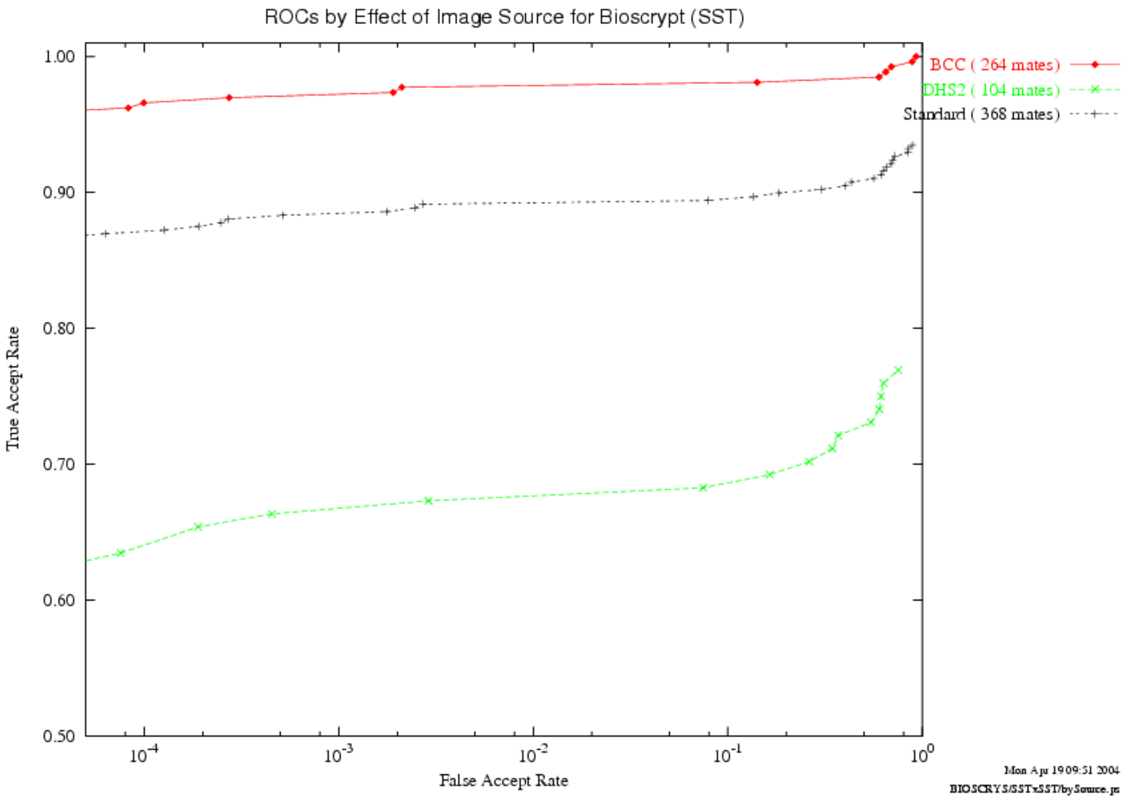


Figure C-28. Bioscrypt (SST) ROCs for SST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the SST test (single-finger flat and slap images). The y-axis on the

left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note the spike in both match and non-match values at 0.0.

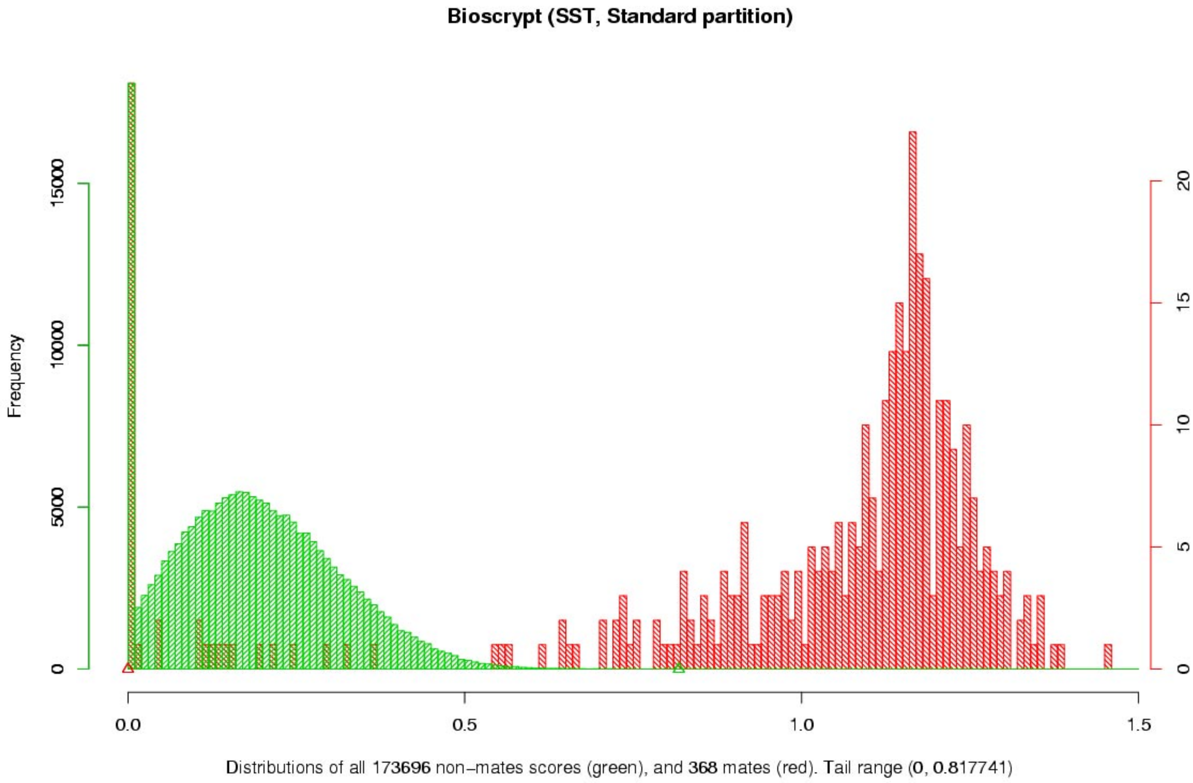


Figure C-29. Bioscrypt (SST) Match vs. Non-Match Distribution

The figure below shows Bioscrypt's sensitivity to image quality.

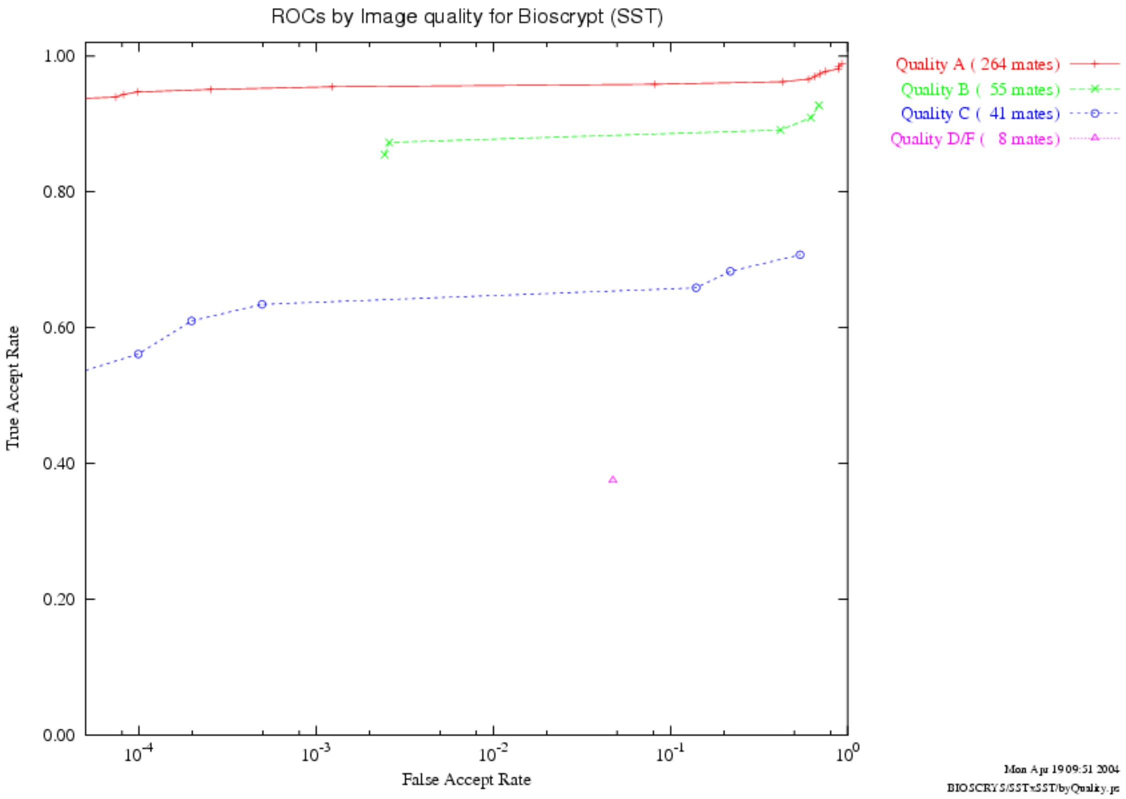


Figure C-30. Effect of Image Quality

7 Cogent

Cogent entered one system in each of SST, MST and LST.

7.1 Cogent (LST)

System name: Galaxy V8.60 for LST

Configuration: 6 IBM xSeries 335 Server, Dual CPU, running Galaxy V8.60 for LST (minutae matching) and Windows 2000.

Completion time: 8 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

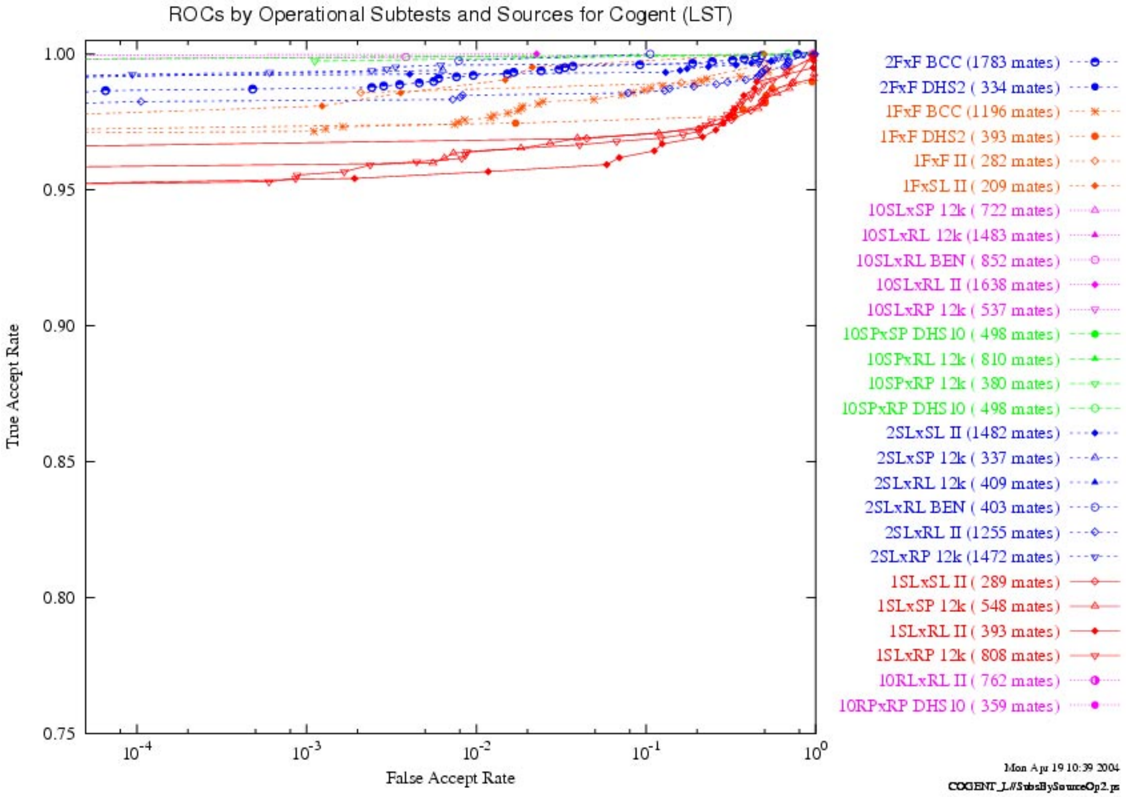


Figure C-31. Cogent (LST) ROC for 27 Operational Partitions

The figure below shows the same results in a Detection Error Tradeoff (DET) chart, in which the Y axis is in log scale, and accuracy increases down and to the left. DETs show more detail at low error rates. Note that any results with no errors cannot be graphed in a DET.

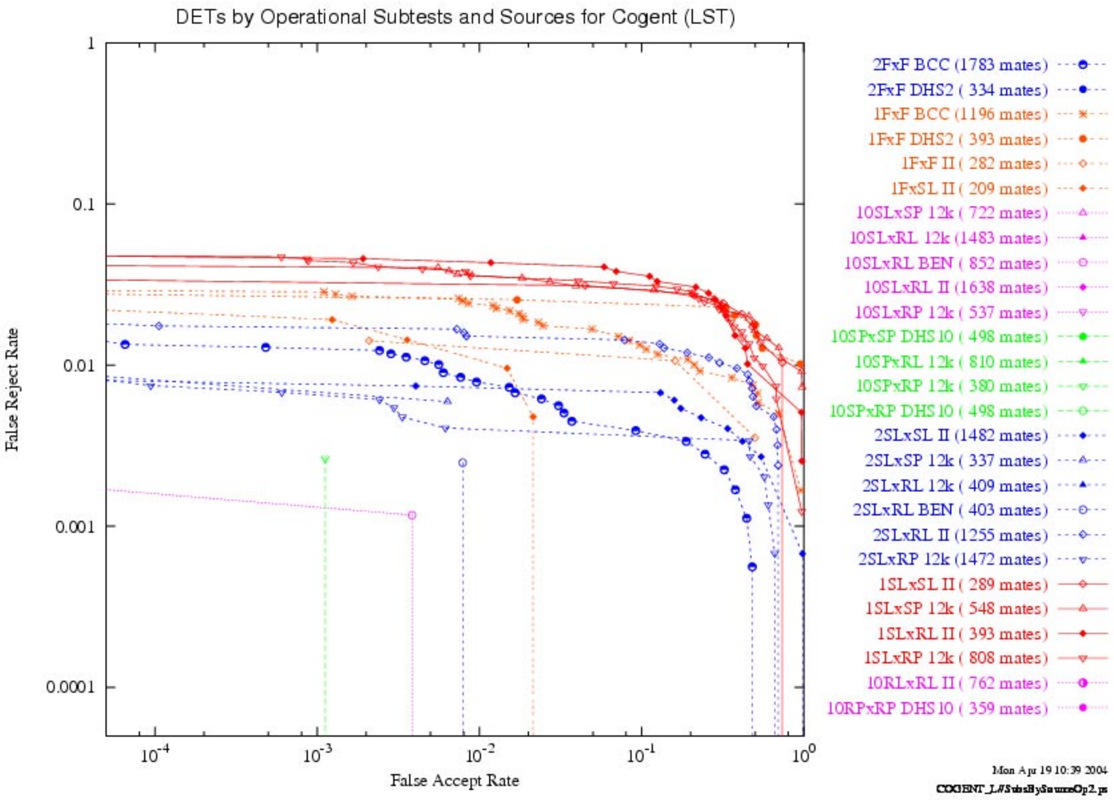


Figure C-32. Cogent (LST) DET for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

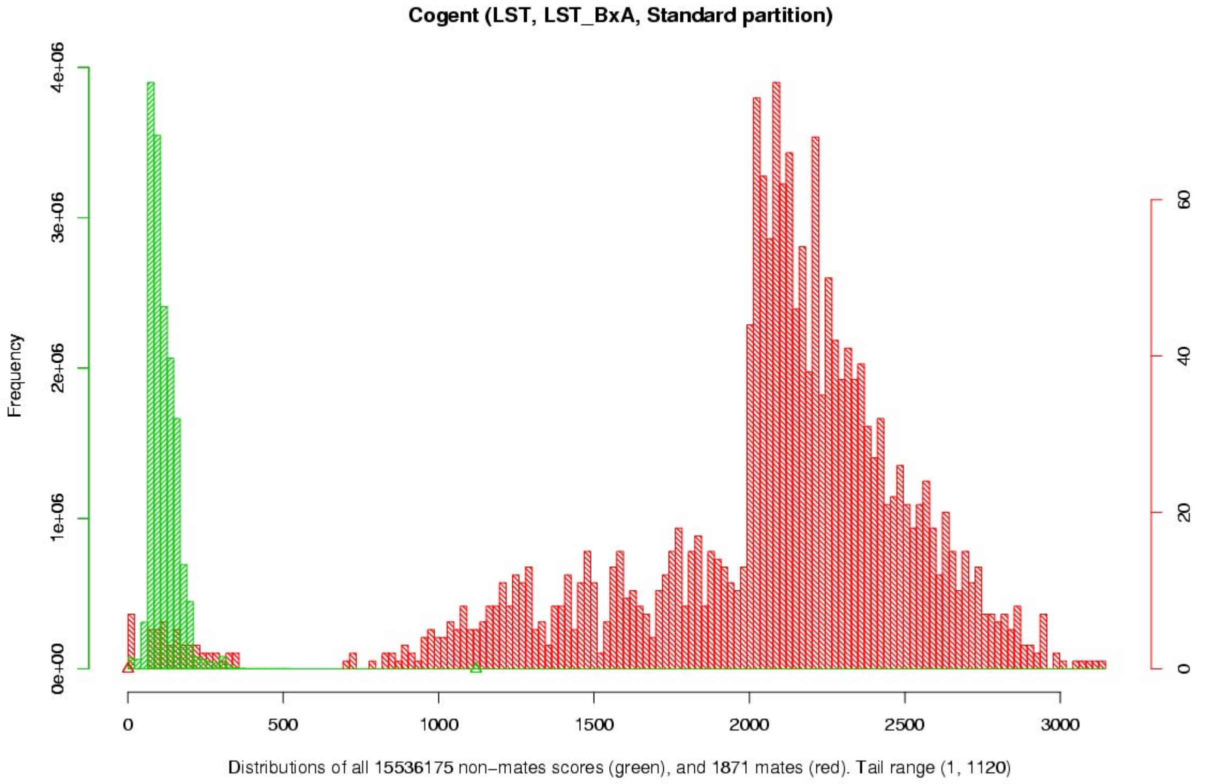


Figure C-33. Cogent (LST) Match vs. Non-Match Distribution for BxA Subtest

7.2 Cogent (MST)

System name: Galaxy V3.2 for MST

Configuration: 1 IBM xSeries 335 Server, Dual CPU, running Galaxy V3.2 for MST (template matching), Windows 2000

Completion time: 6 days

The figure below shows separate ROCs for eight partitions of the MST data.

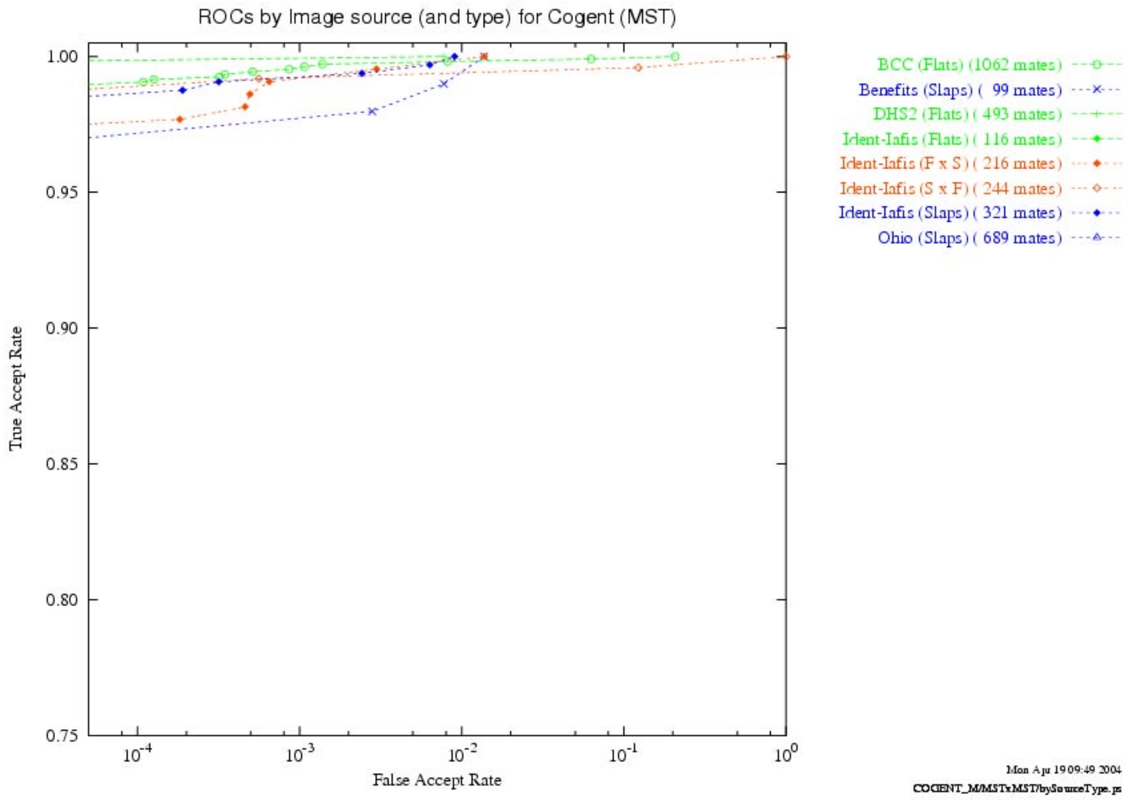


Figure C-34. Cogent (MST) ROCs for MST Partitions

The following histogram shows the score distributions for mate and non-mate scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

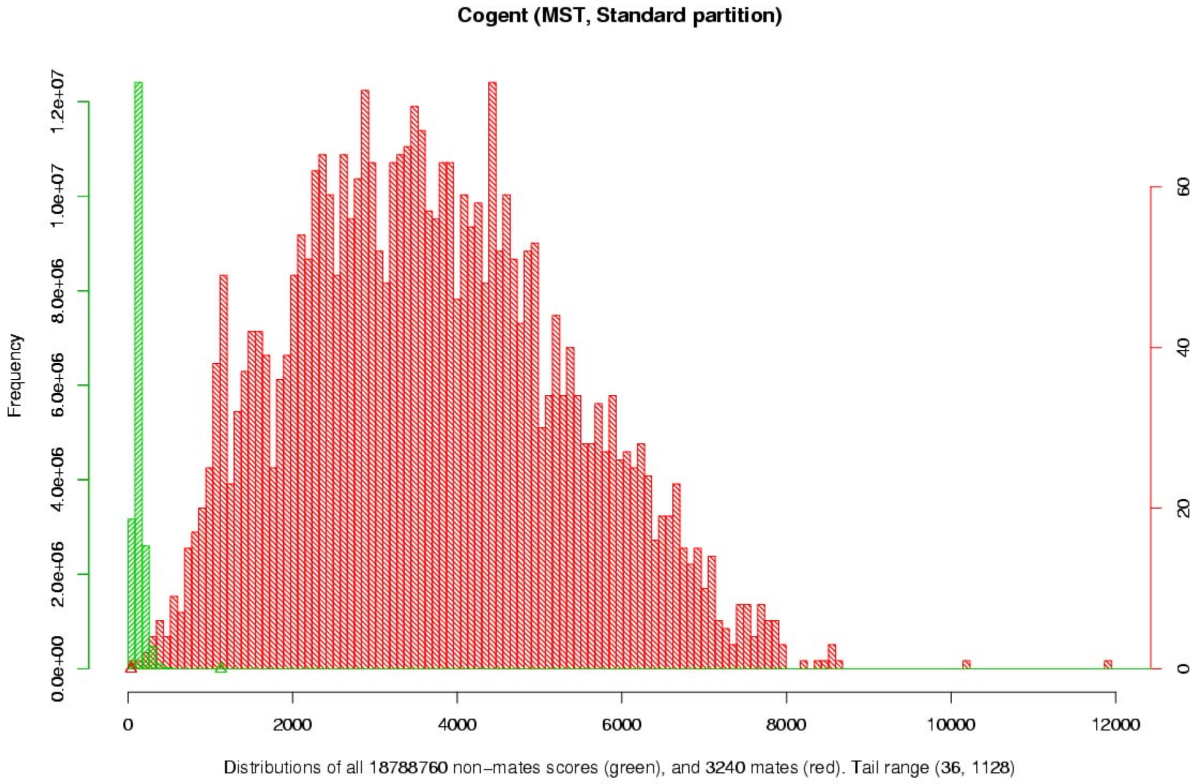


Figure C-35. Cogent (MST) Match vs. Non-Match Distribution

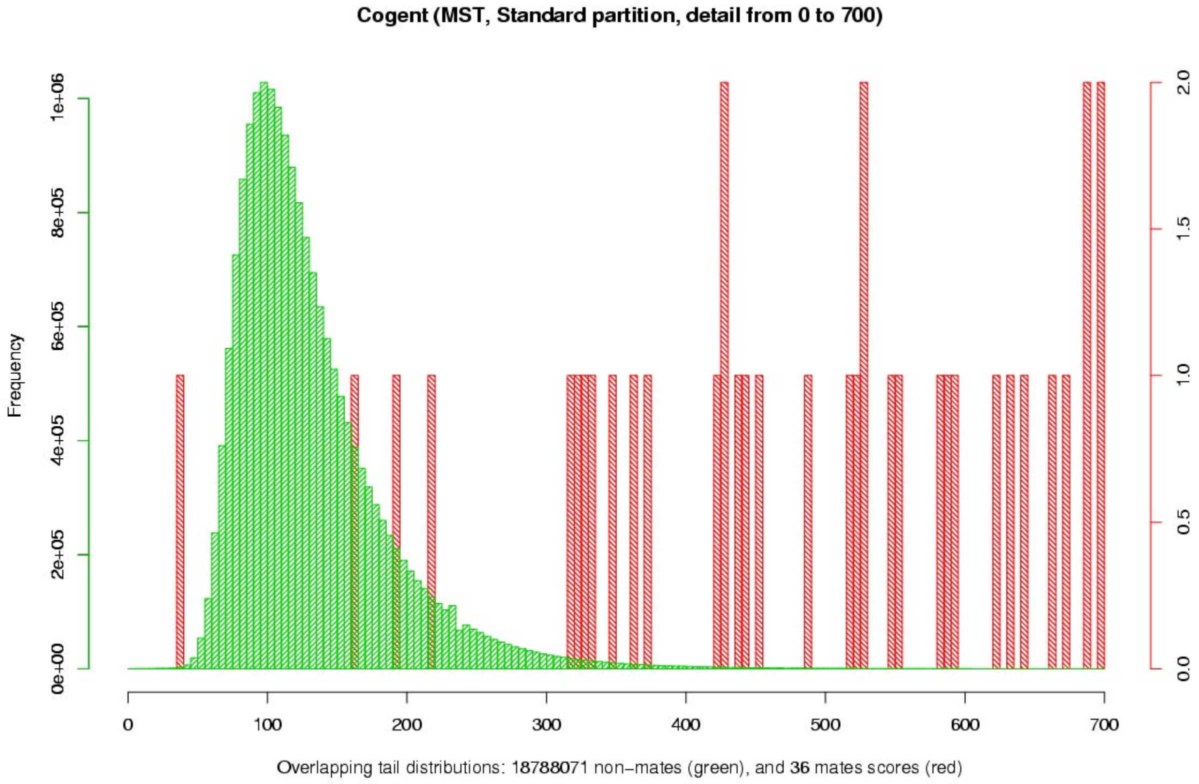


Figure C-36. Cogent (MST) Match vs. Non-Match Distribution (detail)

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from the systems that provided image quality data.

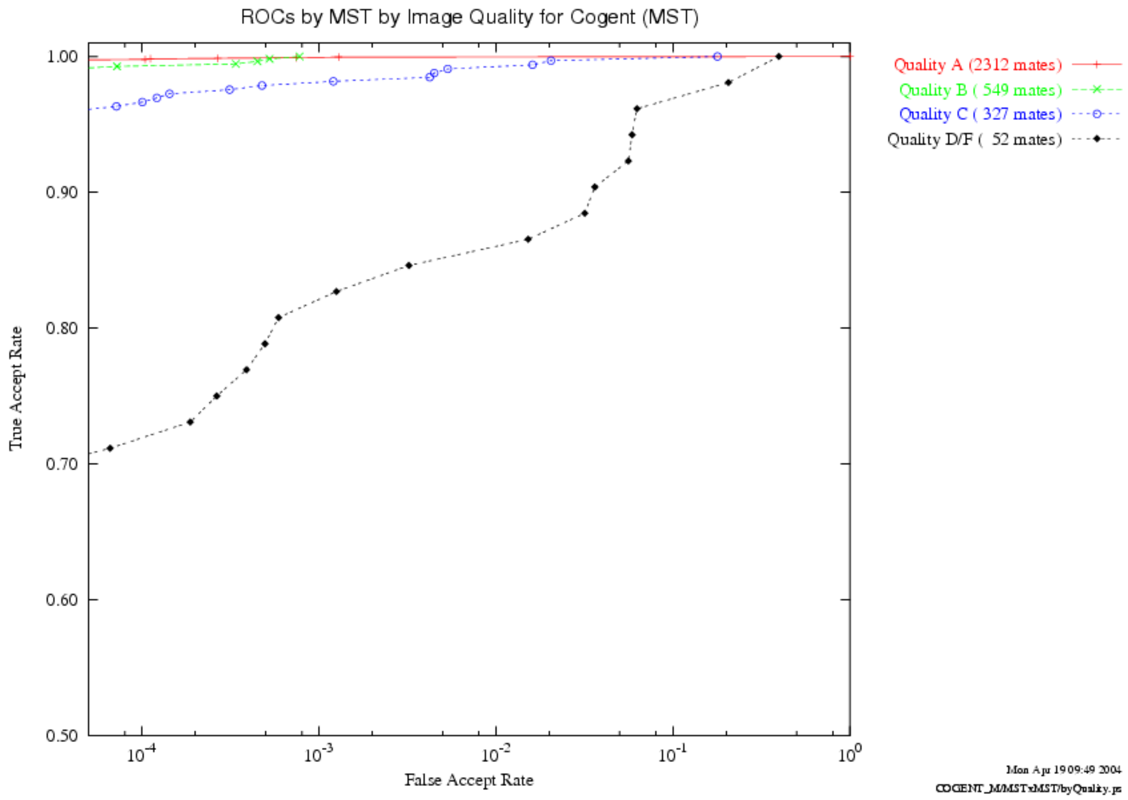


Figure C-37. Effect of Image Quality

Image quality data was provided by Cogent (MST), and was among the seven IQMs used in the FpVTE aggregate image quality metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Cogent	6.0	1.0	3.3	3.0	8.0	17.01%

Table C-4. Image Quality Distribution

7.3 Cogent (SST)

System name: Galaxy V3.2T for SST

Configuration: 1 IBM xSeries 335 Server, Dual CPU, running Galaxy V3.2T for SST (image matching).

Completion time: 7 days

The figure below shows separate ROCs for the BCC and DHS2 partitions of the SST data. Standard is simply a combination of BCC and DHS2 data. On the ROC charts, no data is plotted for DHS2 because Cogent achieved perfect separation of mate and non-matches scores on that partition (matches scored 607 or higher; non-matches all scored zero). Hence, there are only two meaningful data points: 1,1 (never plotted), and 0,0 (off the chart).

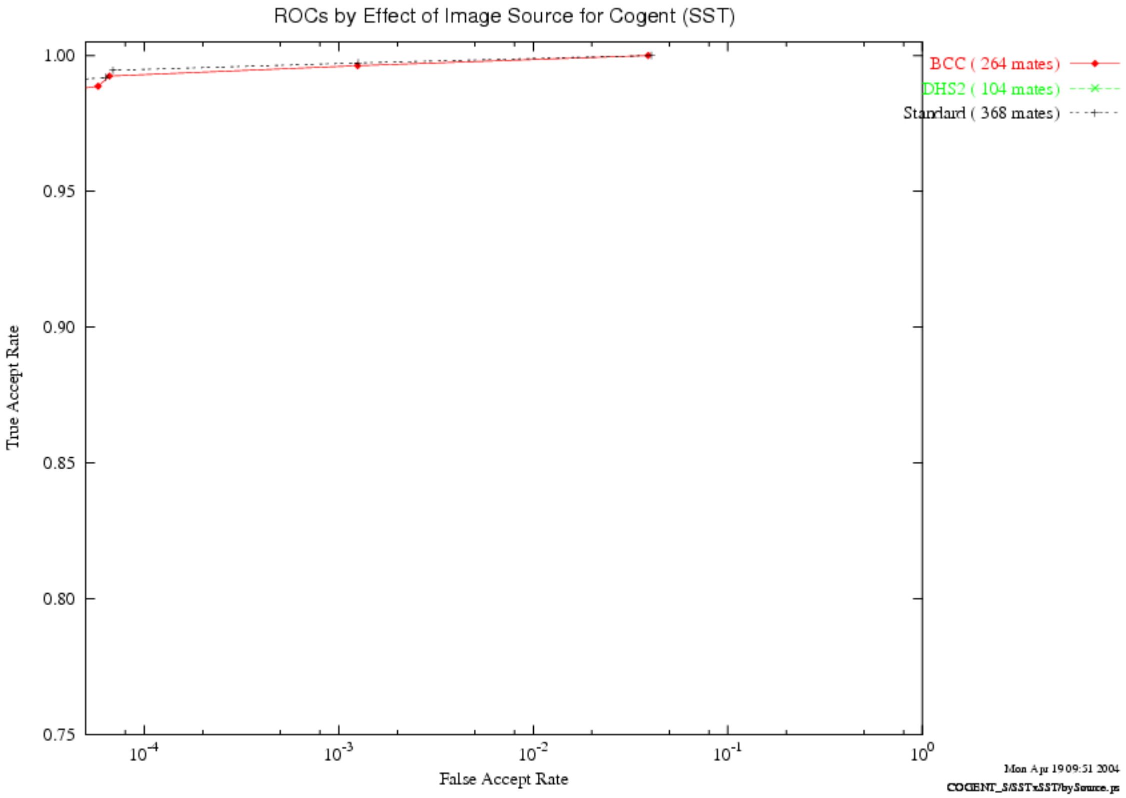


Figure C-38. Cogent (SST) ROCs for SST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the SST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

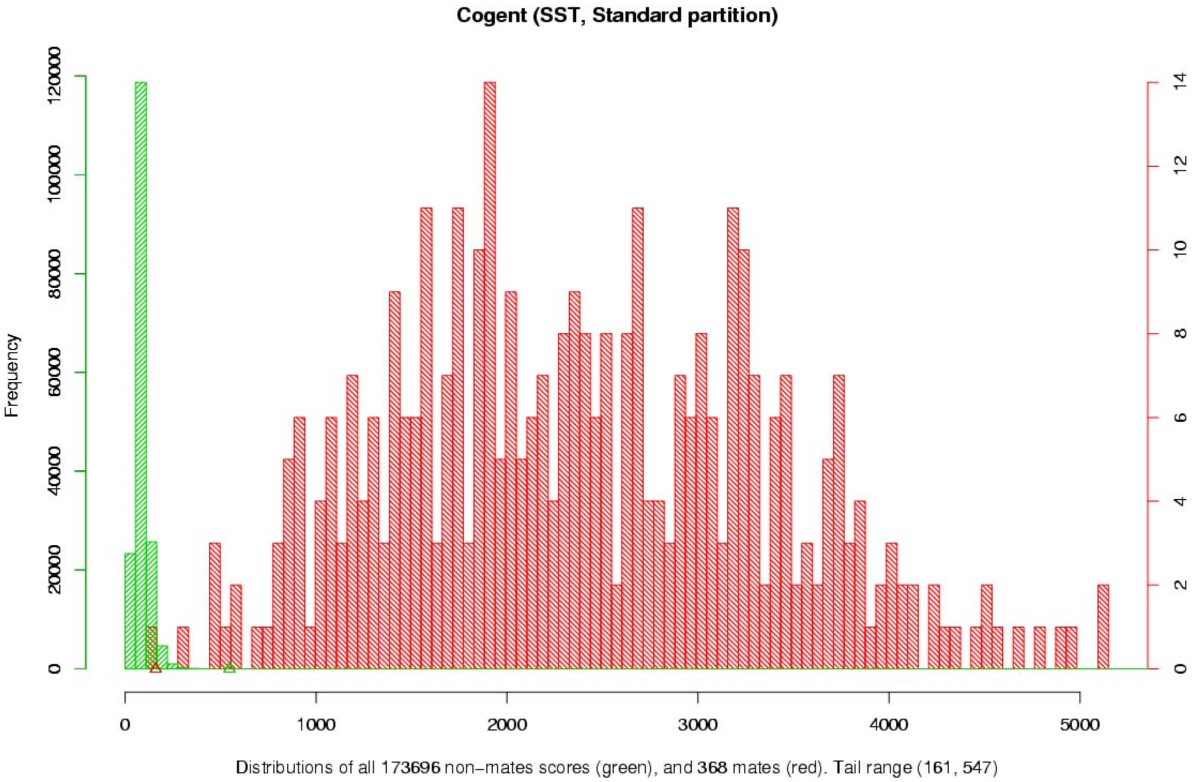


Figure C-39. Cogent (SST) Match vs. Non-Match Distribution

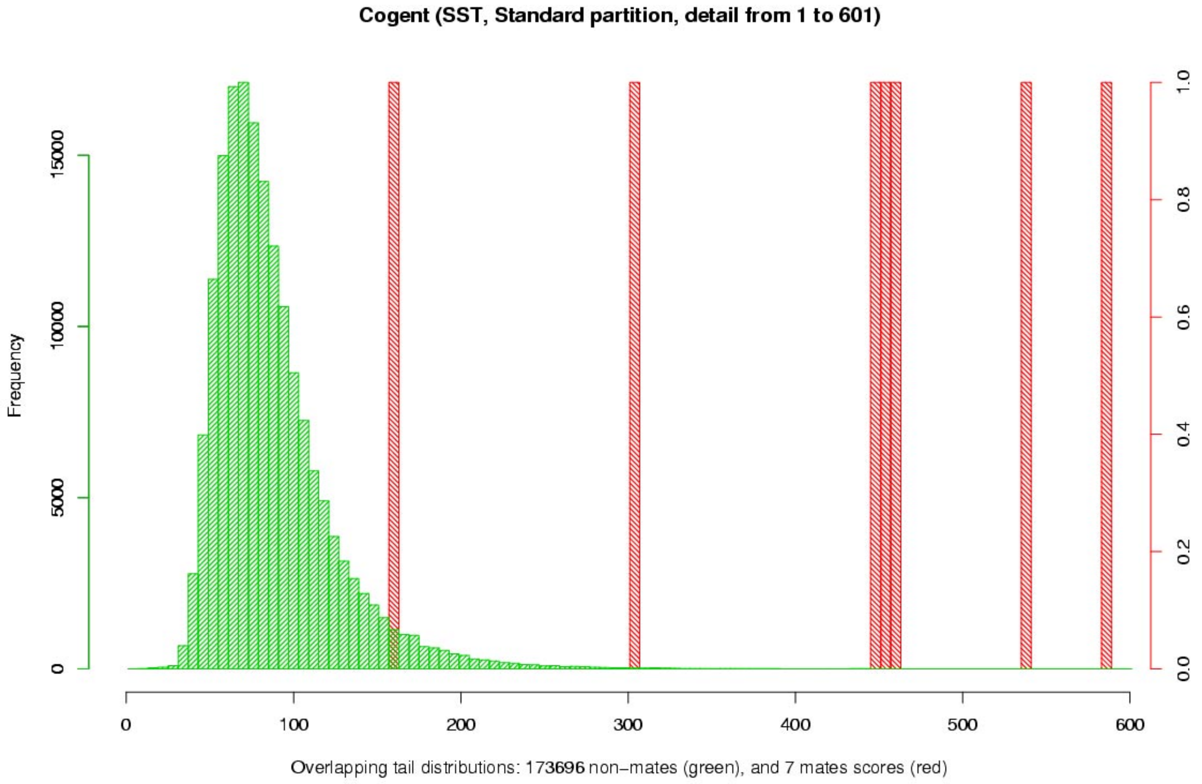


Figure C-40. Cogent (SST) Match vs. Non-Match Distribution (Detail)

The lowest mate score on the DHS2 partition was 607, giving perfect separation on that partition.

The figure below shows Cogent's insensitivity to image quality: images of all qualities performed well. The C quality cannot be graphed because of perfect separation of the match and non-match values.

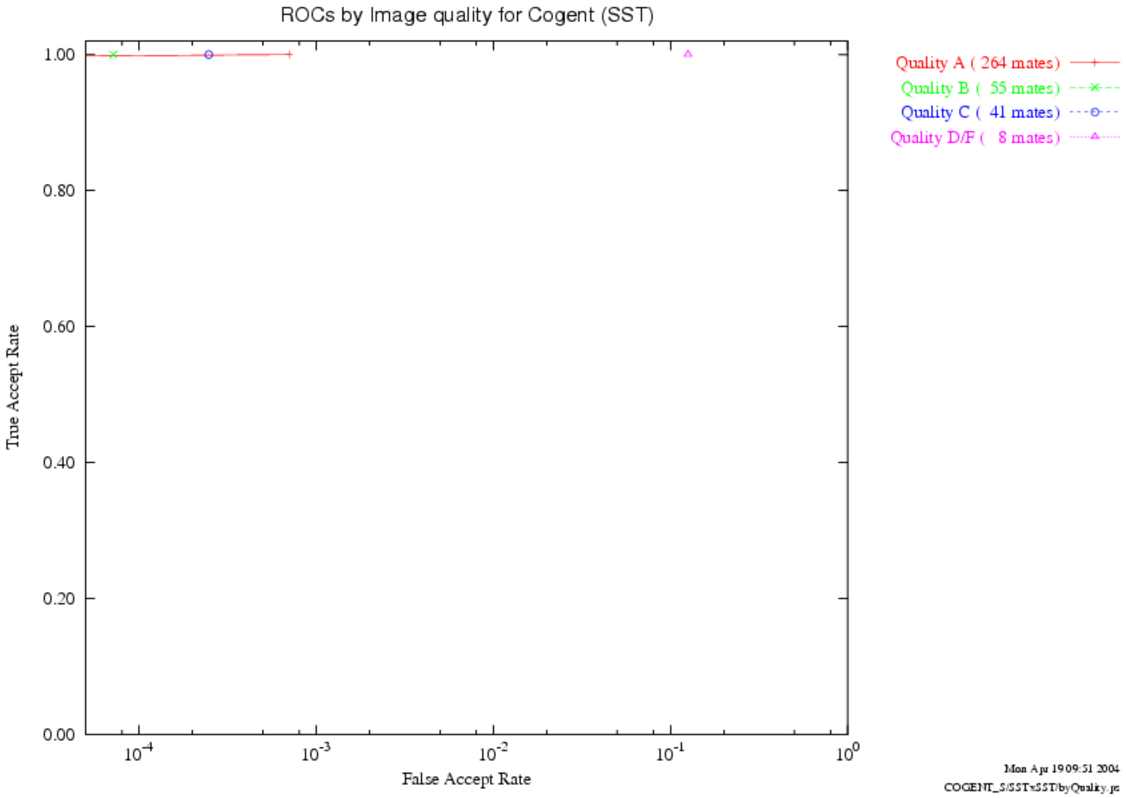


Figure C-41. Effect of Image Quality

8 Dermalog

Dermalog entered one system for MST and LST.

System name: DermalogFingerCode3

Configuration: 6 Pentium 4s, running DermalogFingerCode3 kernel and Windows XP Professional.

As compared to generally similar performance by Motorola (LST), Dermalog (LST) achieved higher accuracy on single finger, operational quality images.

8.1 Dermalog (LST) (Error)

The first run of the Dermalog LST system deadlocked on processing some subtests. Similarity matrices from a few subtests were not successfully saved; those subtests were successfully rerun and the resultant similarity matrices were added to the similarity matrices saved previously and together were called Dermalog (LST), below.

8.2 Dermalog (LST)

Dermalog (LST) includes the results from the 1st run for those subtests that were not affected by the deadlock problem, plus the results from a 2nd run on those subtests that were affected by the deadlock problem.

Completion time: 11 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

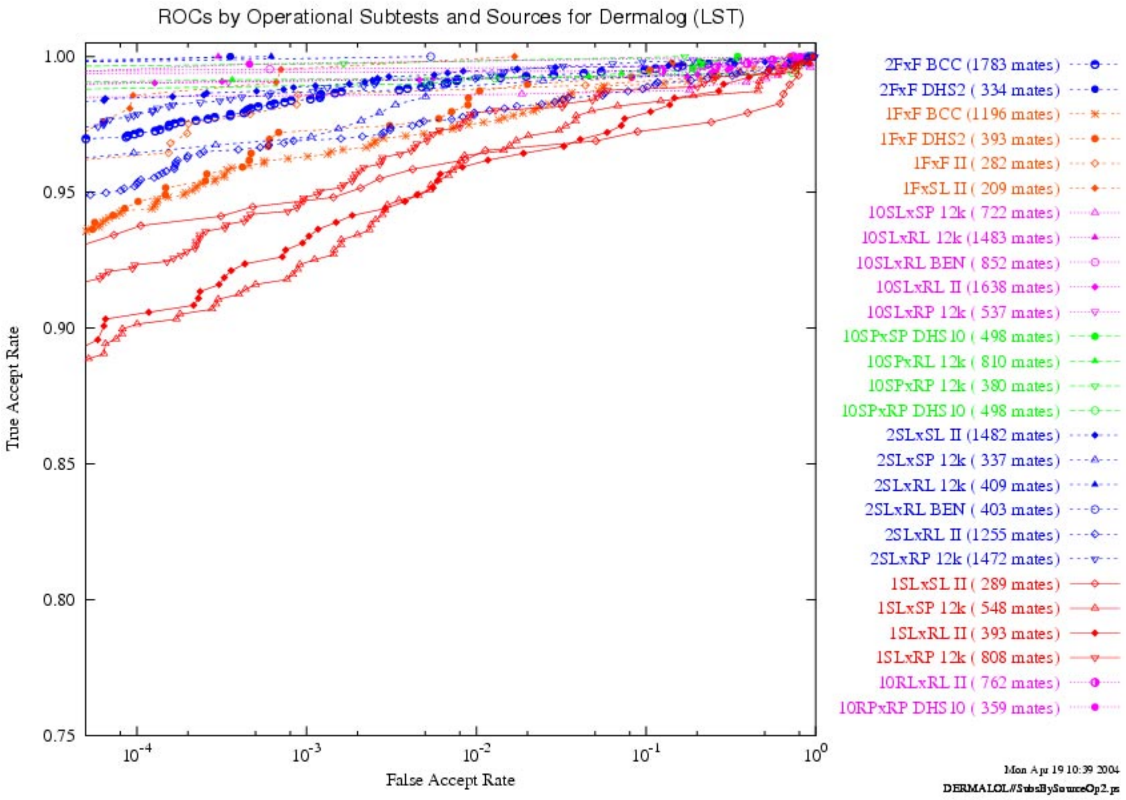


Figure C-42. Dermalog (LST) ROC for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

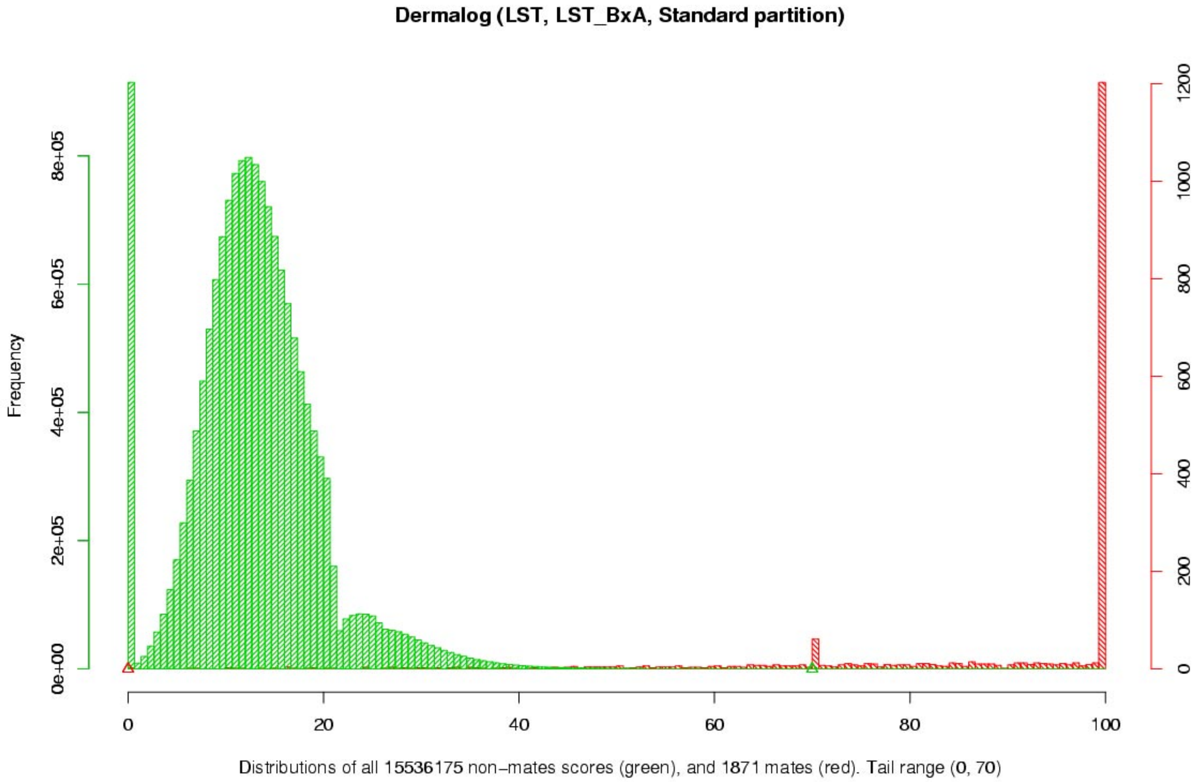


Figure C-43. Dermalog (LST) Match vs. Non-Match Distribution for BxA Subtest

8.3 Dermalog (MST) (Error)

Dermalog (MST) returned similarity files containing score value 100 on the matrix diagonal (self-identifications), and zero values for all other comparisons: a blank matrix. The MD5 signatures were validated, so the blank matrix was in fact what was produced by their system.

Completion time: less than an hour

9 Golden Finger

Golden Finger entered one system for MST and LST.

System name: GAFIS

Configuration: 4 Dual Xeons, running GAFIS 5.0 Engine Network Edition and Windows 2003 Enterprise Server

Golden Finger (MST) and Raytheon (MST) returned equivalent similarity matrices on MST. Except for two scores, Golden Finger (MST) scores (integer values) could be computed from Raython (MST) scores by multiplying the (floating point) Raytheon (MST) scores by 100 and rounding to the nearest integer. The two exceptions were non-matches: Golden Finger (MST) assigned score values of -1, whereas Raytheon (MST) assigned positive score values.

Golden Finger (LST) and Raytheon (LST) returned equivalent results on some subtests, but significantly different results on others. The greatest differences were on subtests involving datasets I and J.

9.1 Golden Finger (LST)

Completion time: 12 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test. Golden Finger (LST) achieved very low accuracy on the 2-finger SLxRL Ident-Iafis partition and on the 1-finger SLxRL Ident-Iafis partition.

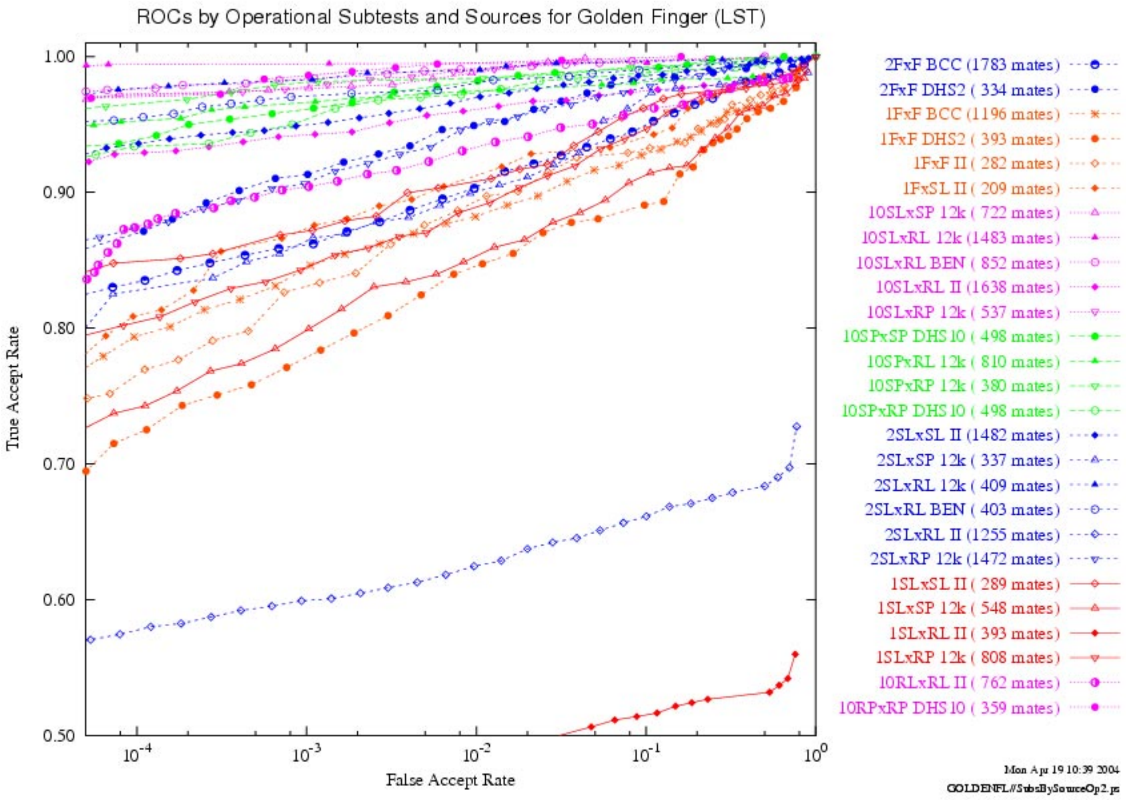


Figure C-44. Golden Finger (LST) ROC for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

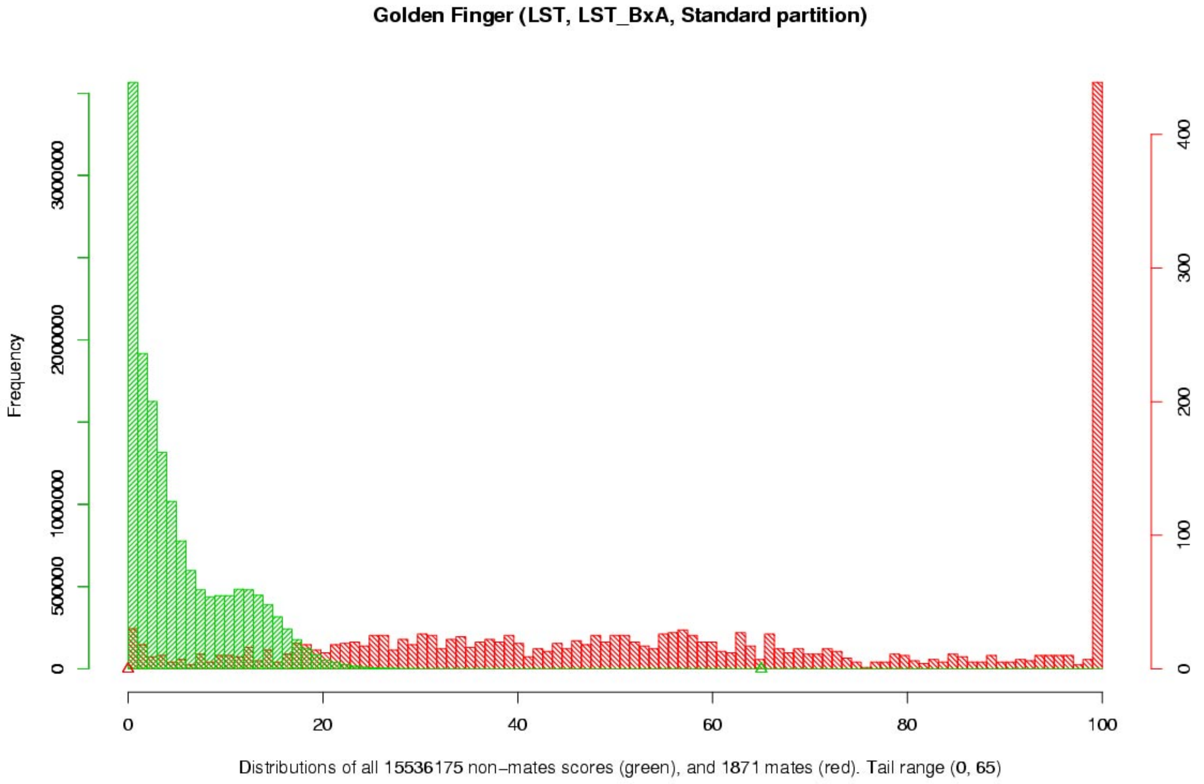


Figure C-45. Golden Finger (LST) Match vs. Non-Match Distribution for BxA Subtest

9.2 Golden Finger (MST)

Completion time: 1 day

The figure below shows separate ROCs for eight partitions of the MST data.

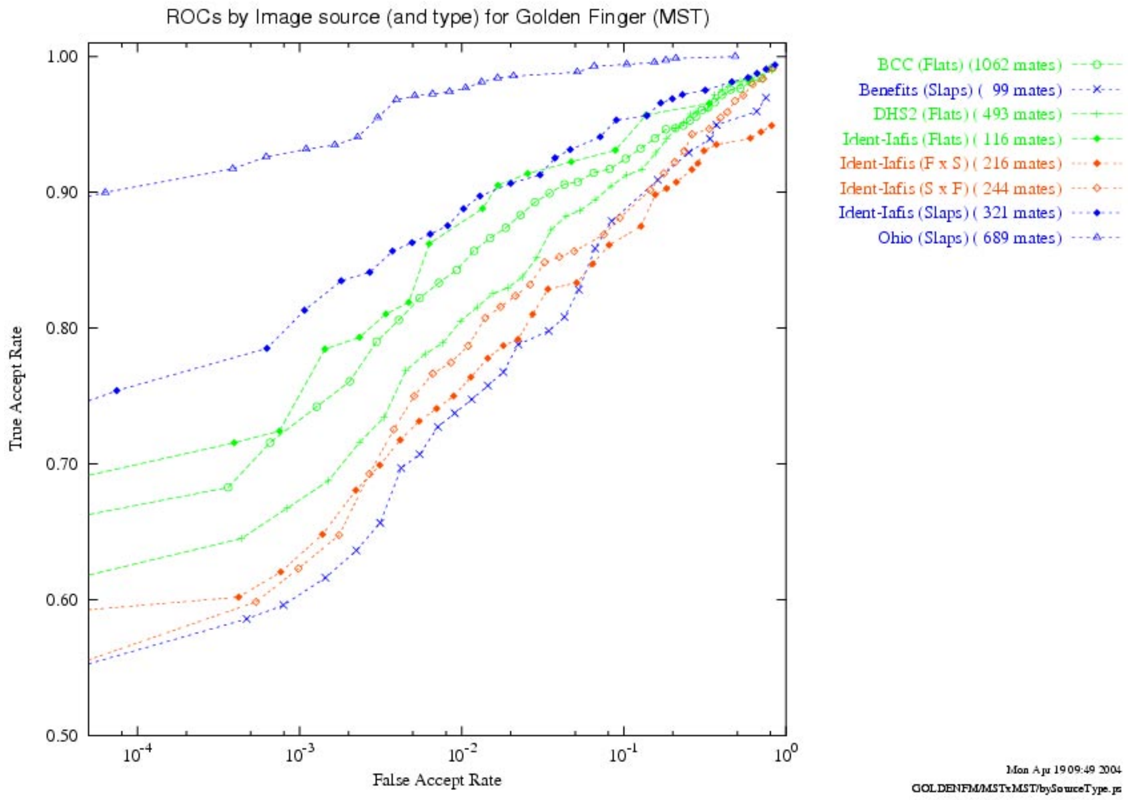


Figure C-46. Golden Finger (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

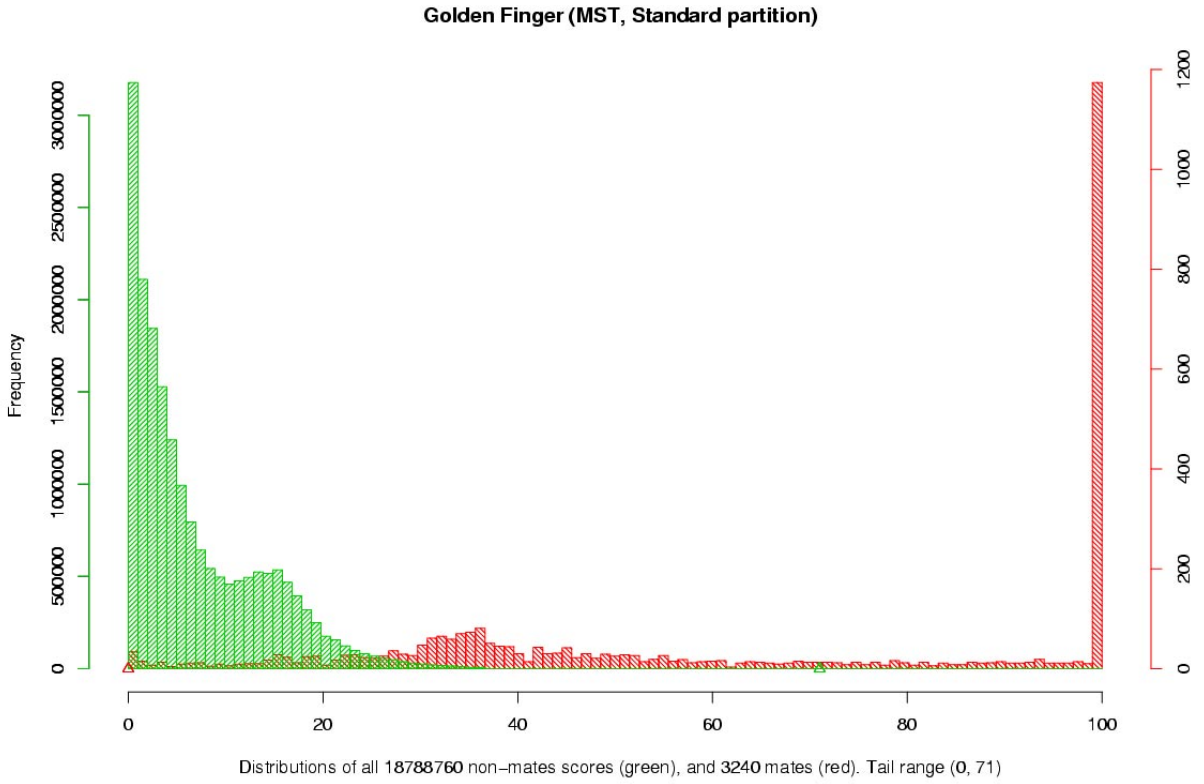


Figure C-47. Golden Finger (MST) Match vs. Non-Match Distribution

Note that the score distribution for Golden Finger (MST) is exactly 100 times the score distribution for Raytheon (MST).

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. Golden Finger provided image quality data, which was used to develop this aggregate metric. Note that the effect of image quality on accuracy is somewhat unusual as compared to many other systems: much of the degradation occurs quickly as the quality begins to drop (between A and B quality), whereas most other systems drop off sharply when the quality is especially low.

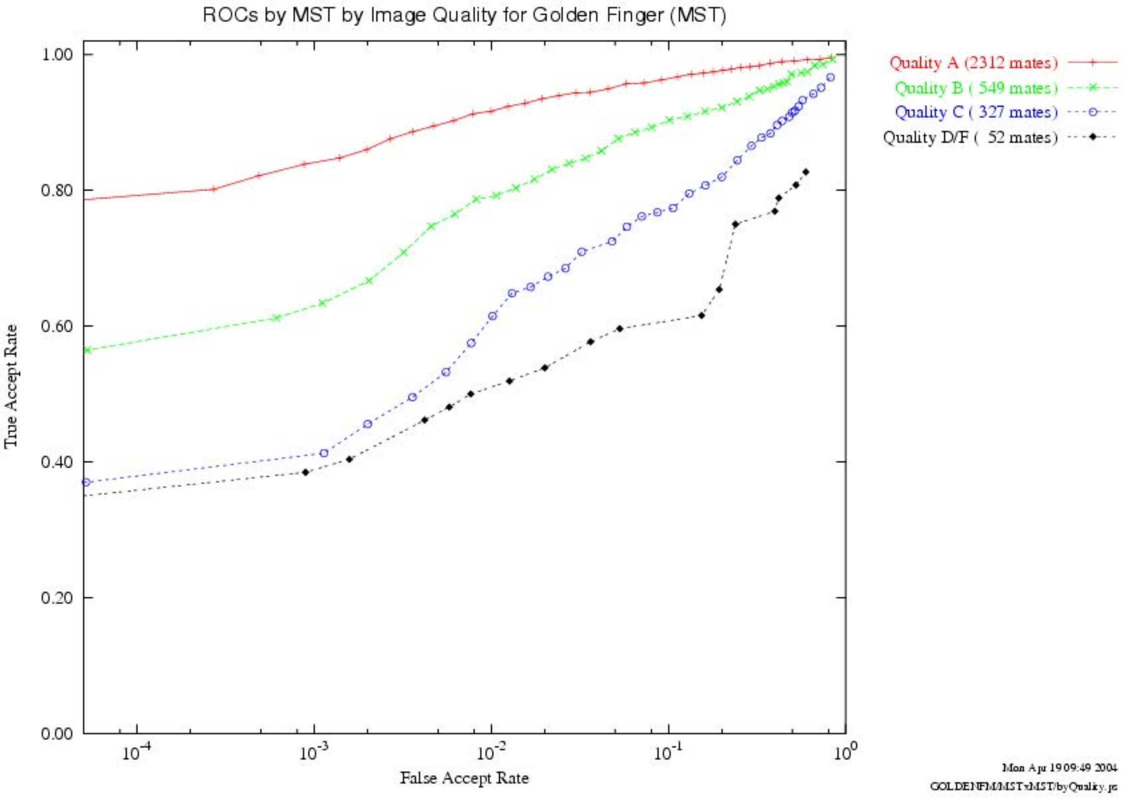


Figure C-48. Effect of Image Quality

Image quality data was provided by Golden Finger (MST), and was among the seven IQMs used in the FpVTE aggregate image quality metric. The Golden Finger image quality values were exactly 100 times the Raytheon image quality values.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Golden Finger	35.0	0.0	62.9	70.0	75.0	15.78%

Table C-5. Image Quality Distribution

10 Griaule

Griaule participated in LST only.

System name: Griaule AFIS

Configuration: 10 Itautec Inforserver PCs (Dual Xeons), running Griaule AFIS.

10.1 Griaule (LST)

Completion time: 17 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test. Note that the ROCs do not include data for large values of FAR. This is due to Griaule's assignment of a zero score to a large number of mated pairs. For further explanation of this effect, see the discussion under Biolink (LST), which has a similar issue.

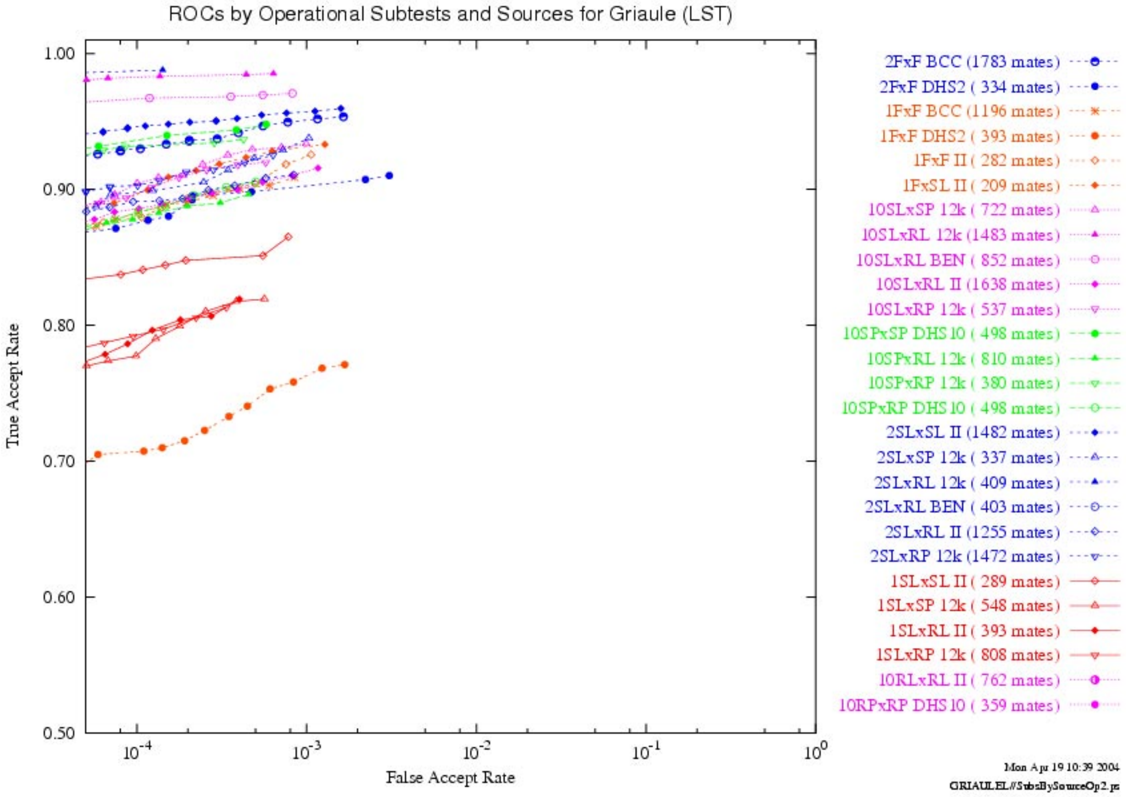


Figure C-49. Griaule (LST) ROC for 27 Operational Partitions

Griaule (LST) does not, in general, show an increase in accuracy as the number of fingers increases beyond 2. Figure C-50 clearly shows this effect on one data source. As can be seen throughout the main body of the report, on 1-finger and 2-finger tests Griaule (LST) is generally about as accurate as Identix (LST) and consistently more accurate than either Biolink (LST) or NIST VTB (LST). This relationship changes when more than 2 fingers are considered.

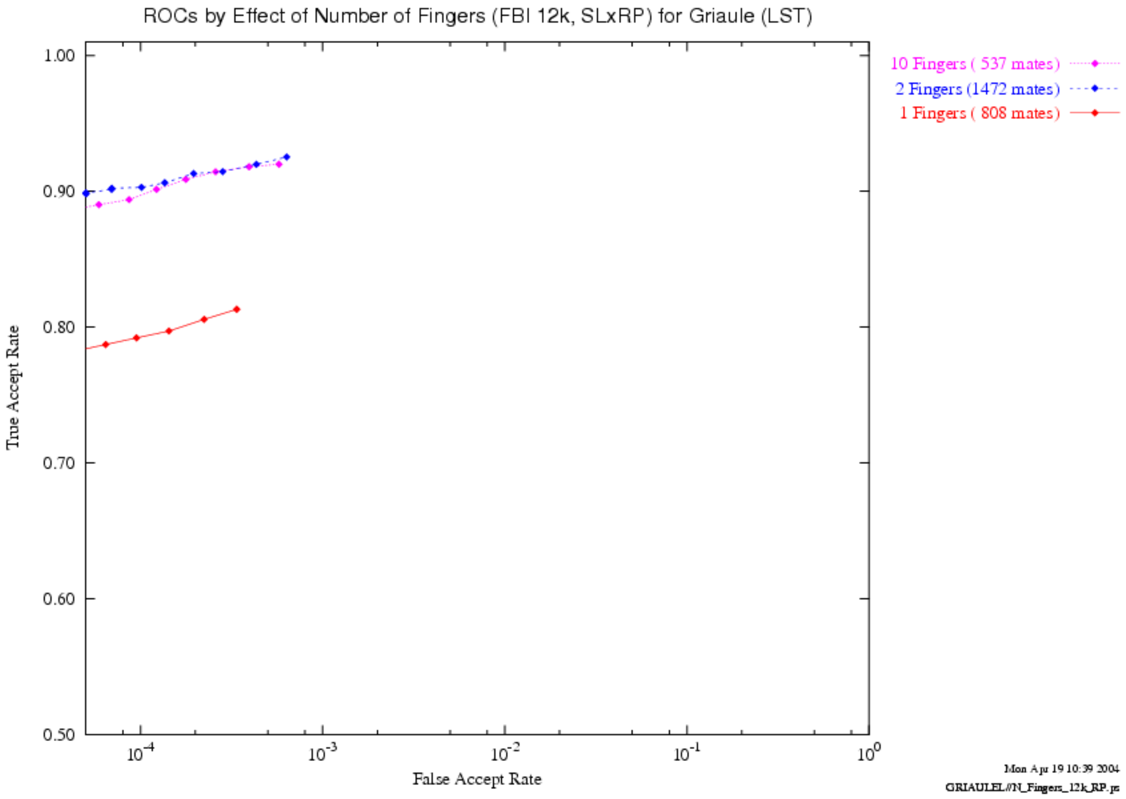


Figure C-50. Griaule (LST) Effect of Number of Fingers

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

Note the spike in both match and non-match values at 0.0. 220 matches scored 0 on the Standard partition of the LST subtest.

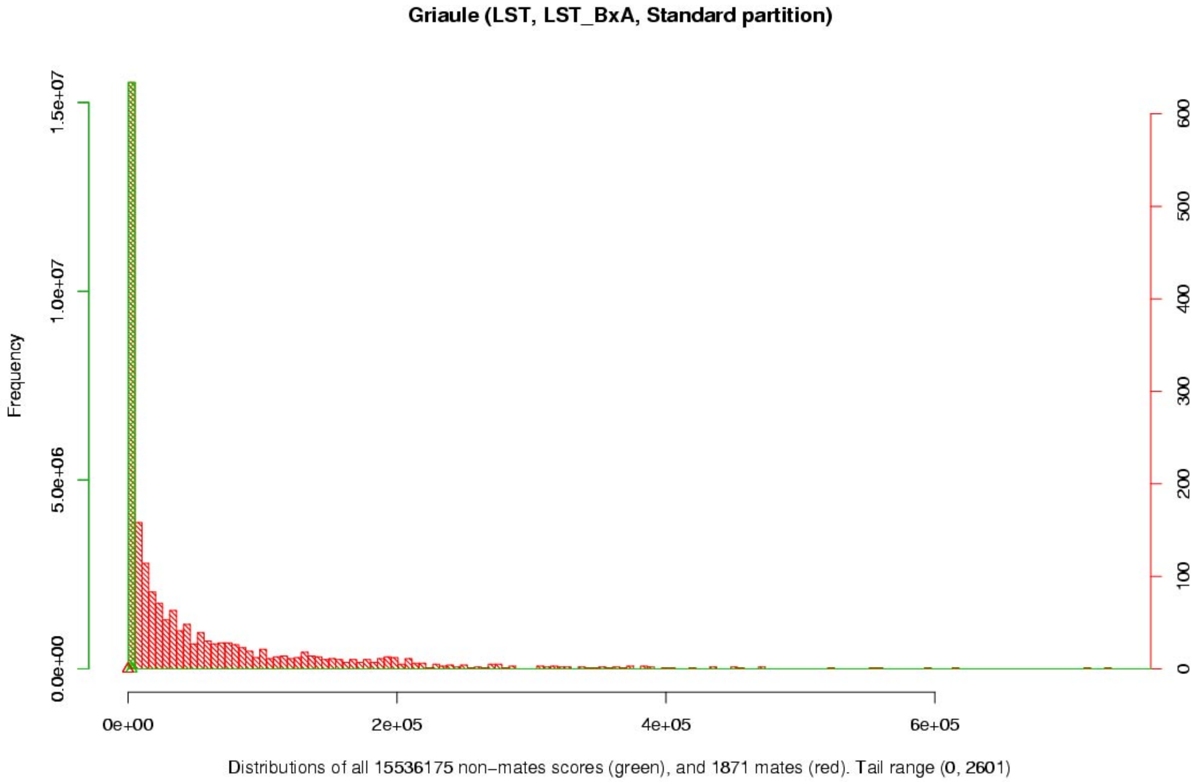


Figure C-51. Griaule (LST) Match vs. Non-Match Distribution for BxA Subtest

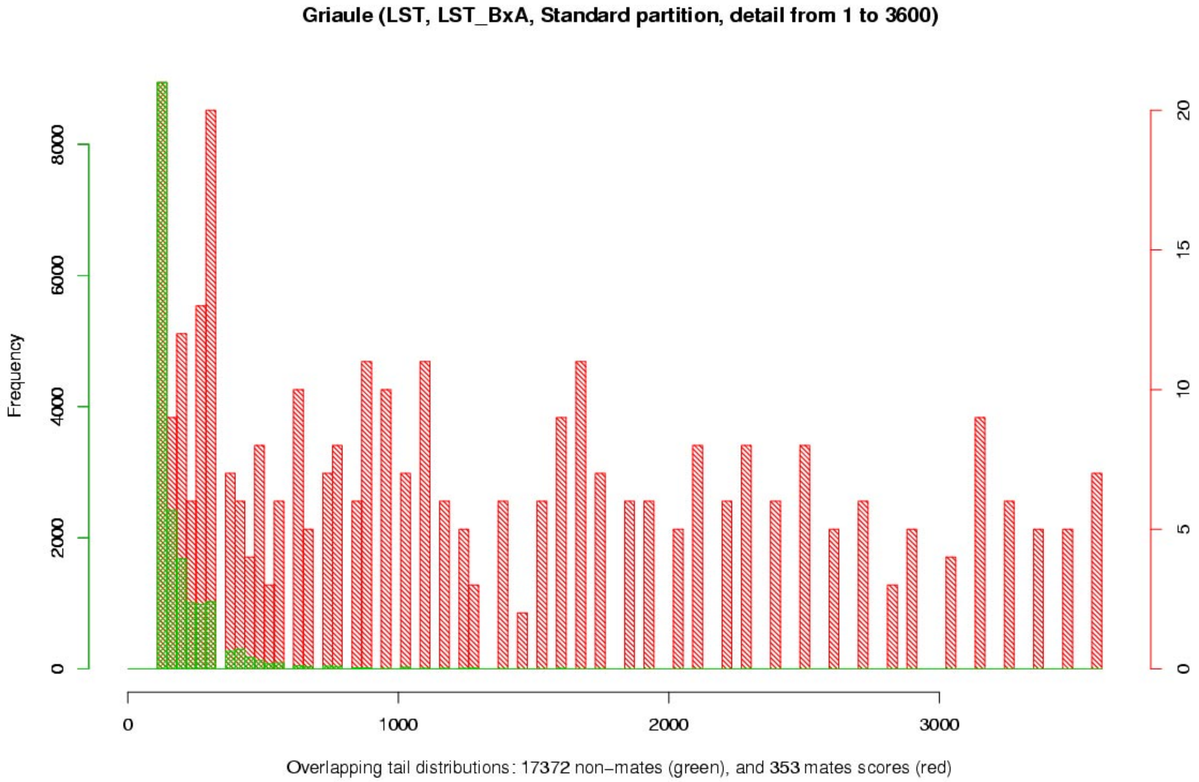


Figure C-52. Griaule (LST) Match vs. Non-Match Distribution for BxA Subtest (Detail)

11 Identix

Identix entered one system for MST and LST.

System name: BioEngine Software Developer's Kit (SDK)

Configuration: IBM X Series 8 Blade System, running BioEngine SDK v4.0 step 1 and Windows 2000 Advanced Server.

11.1 Identix (LST)

Completion time: 6 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

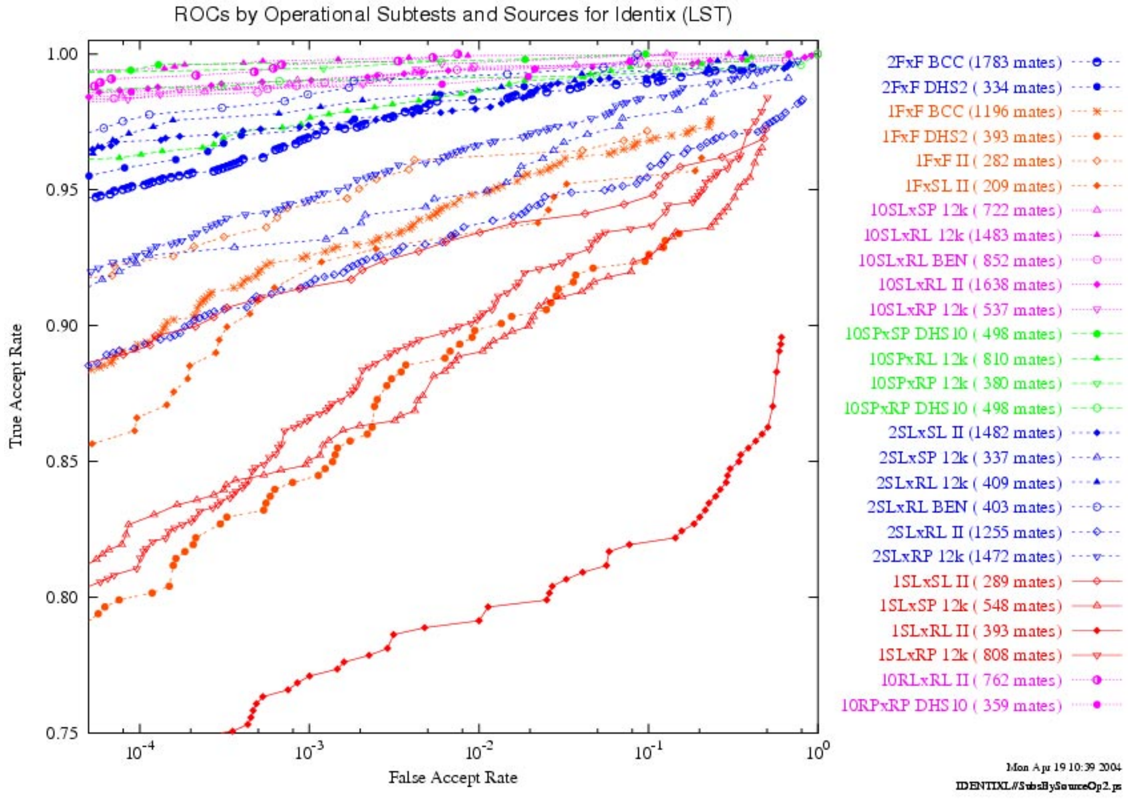


Figure C-53. Identix (LST) ROC for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum

non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note the spike in both match and non-match values at 0.0.

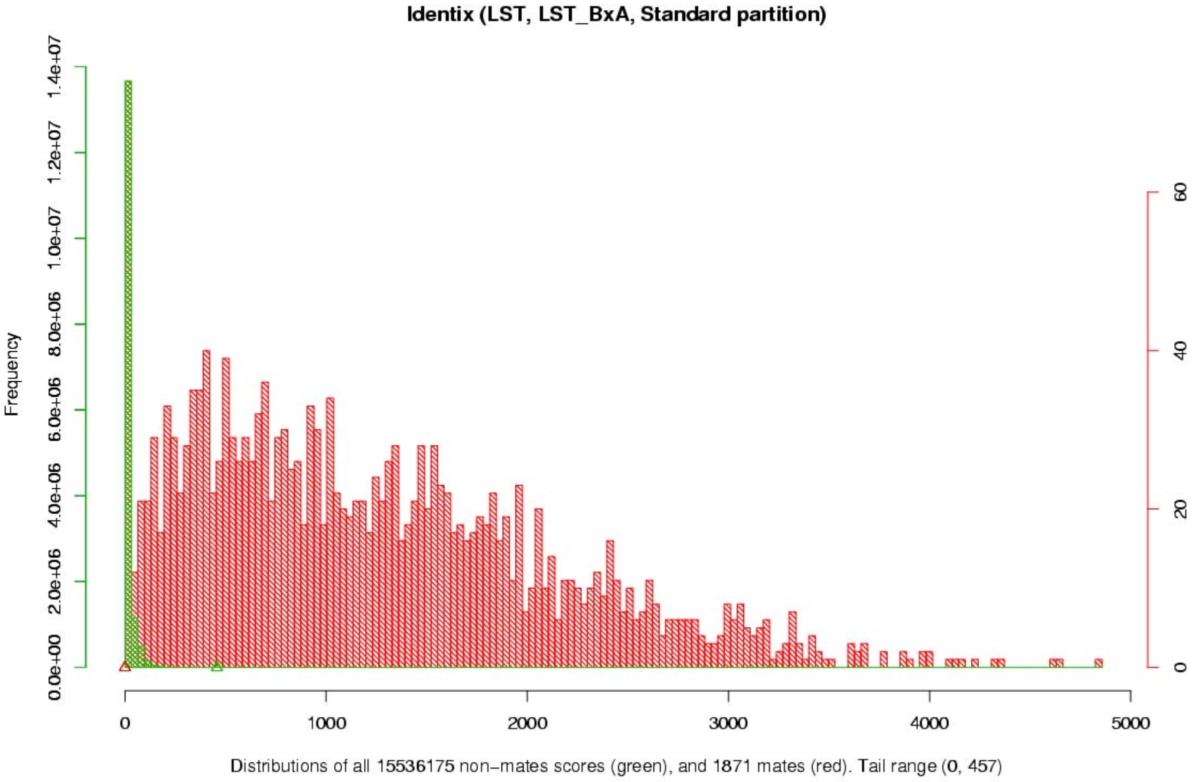


Figure C-54. Identix (LST) Match vs. Non-Match Distribution for BxA Subtest

11.2 Identix (MST)

Completion time: 1 day

The figure below shows separate ROCs for eight partitions of the MST data.

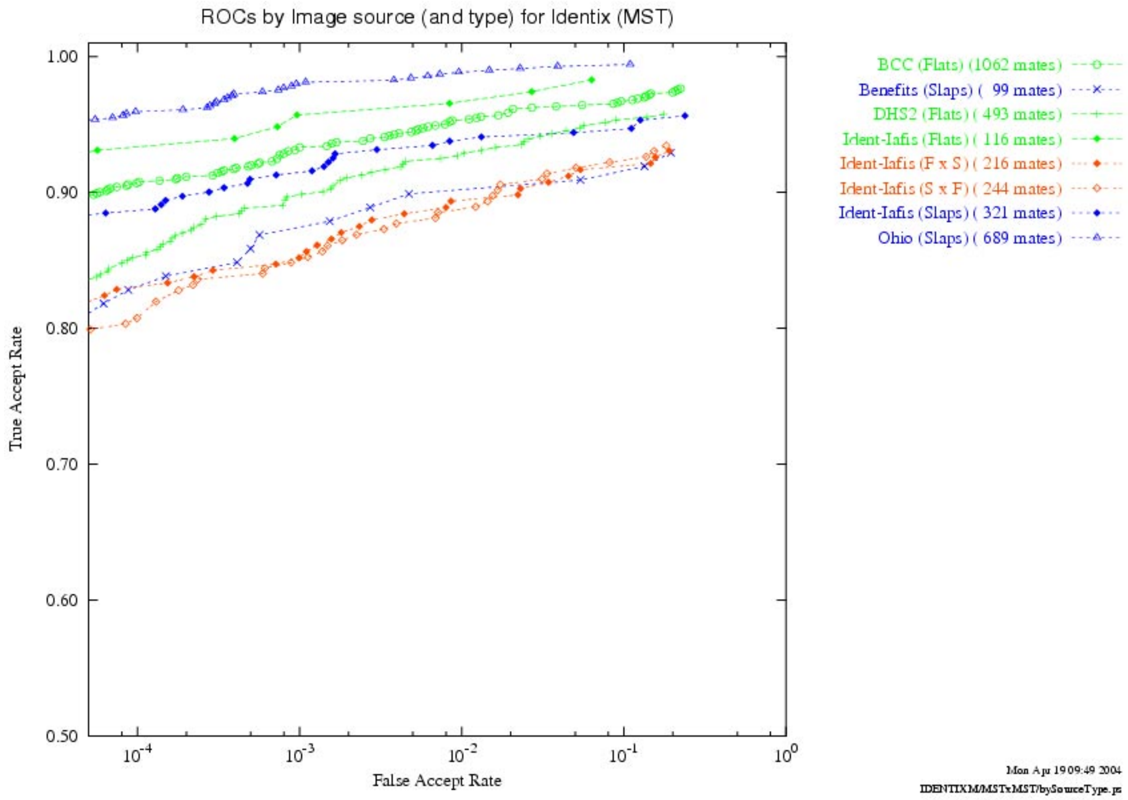


Figure C-55. Identix (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note the spike in both match and non-match values at 0.0.

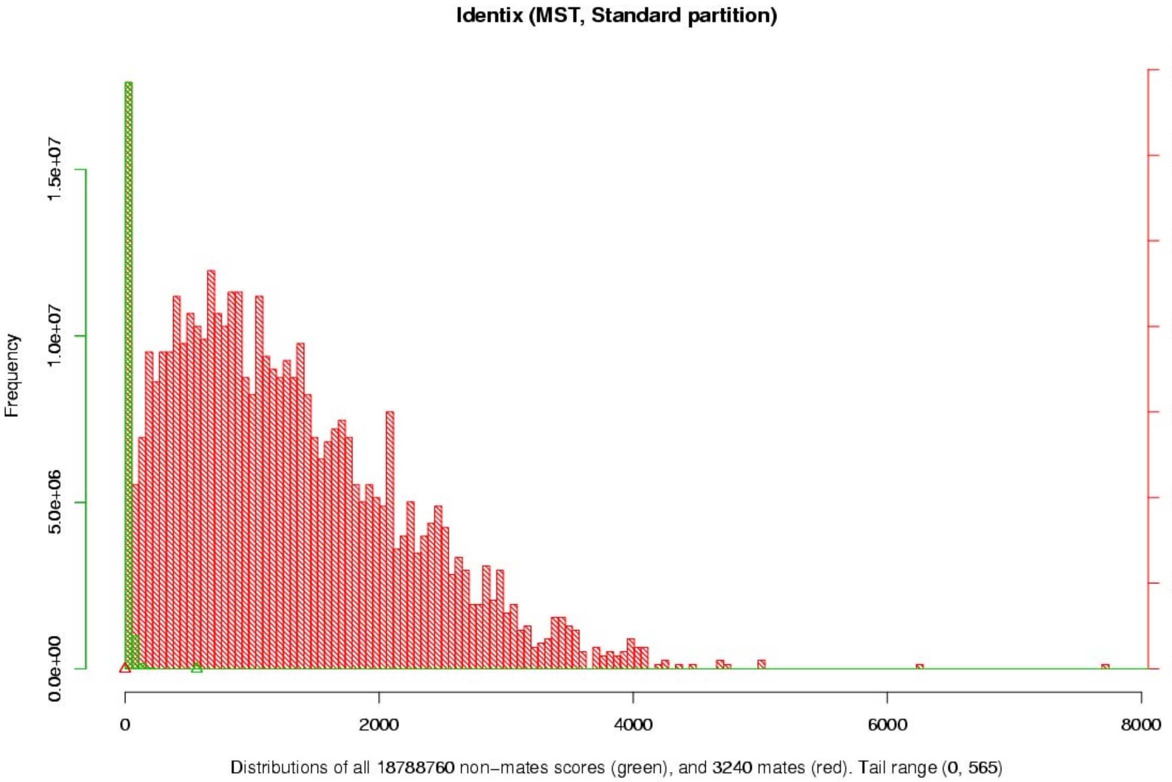


Figure C-56. Identix (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data.

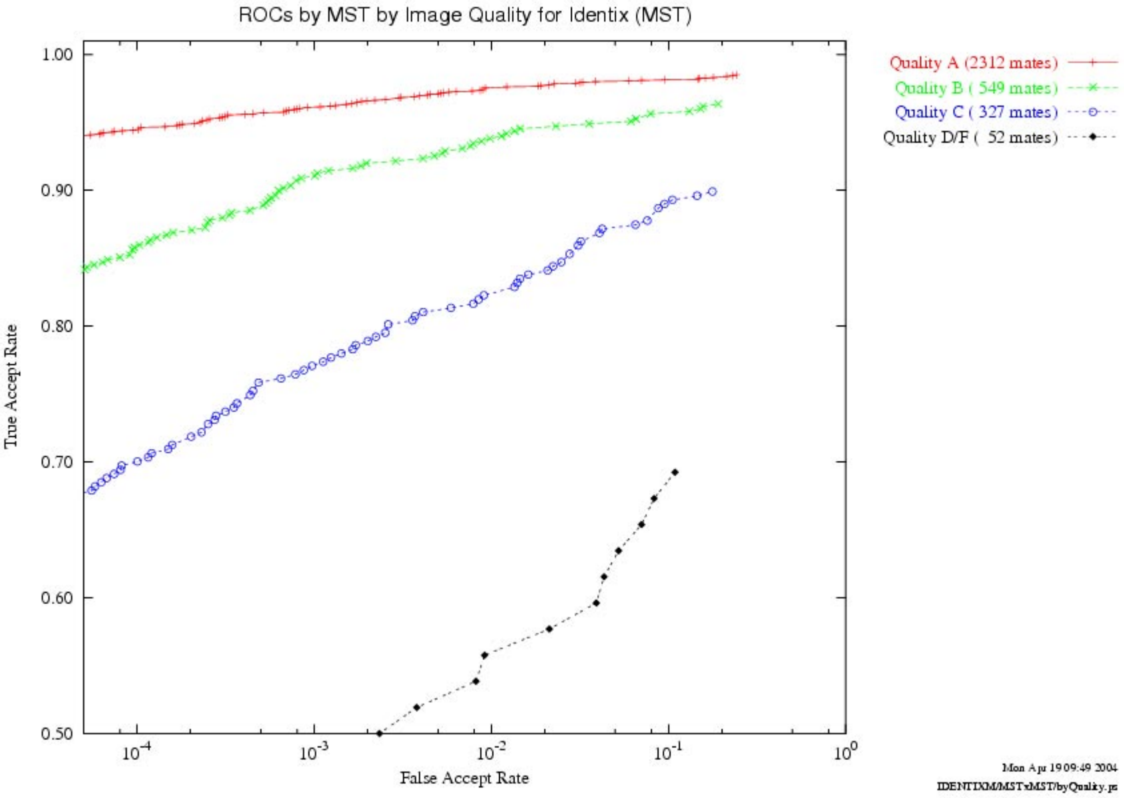


Figure C-57. Effect of Image Quality

12 Motorola

Motorola entered one system for both MST and LST

System name: Motoral Omnitrak

Configuration: 15 HP DL360G3s (dual Xeon) running Omnitrak matcher; 1 HP DL380G3 (dual Xeon) master controller. All running Windows 2000 Server.

12.1 Motorola (LST)

Completion time: 18 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

As compared to generally similar performance by Dermalog (LST), Motorola (LST) gains a slight advantage when the number of fingers is high or the quality of images is high.

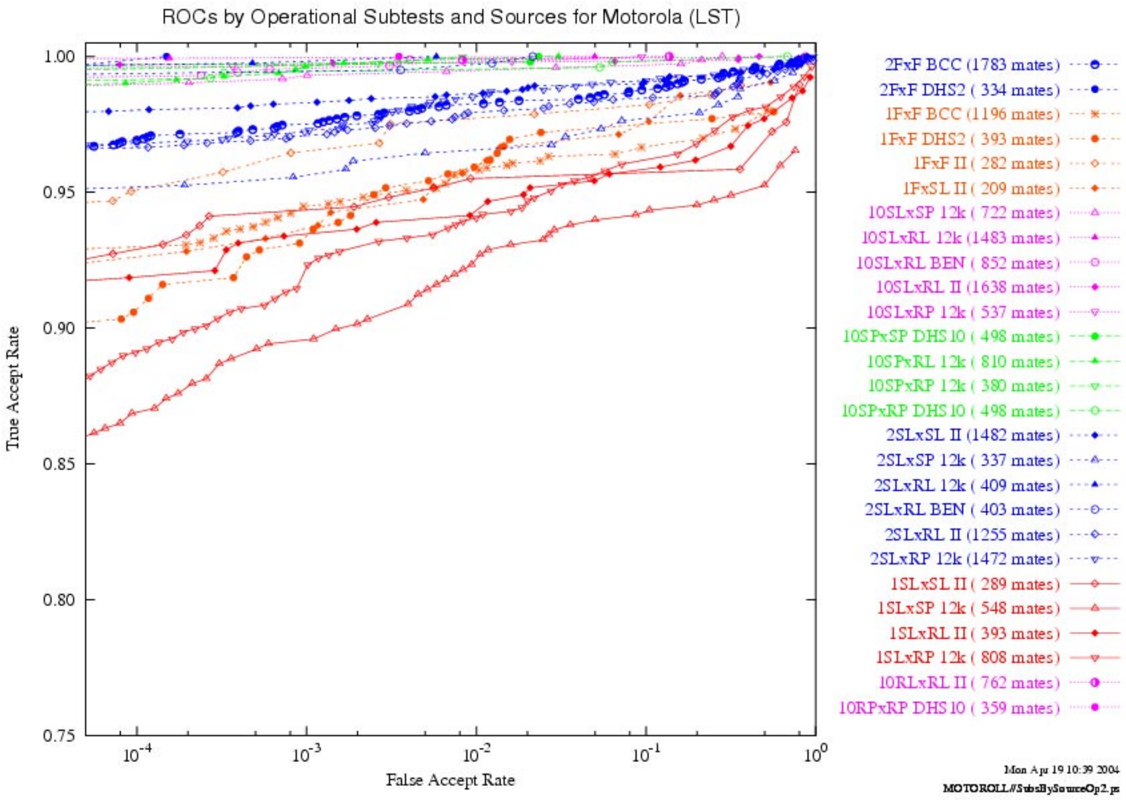


Figure C-58. Motorola (LST) ROC for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the

left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

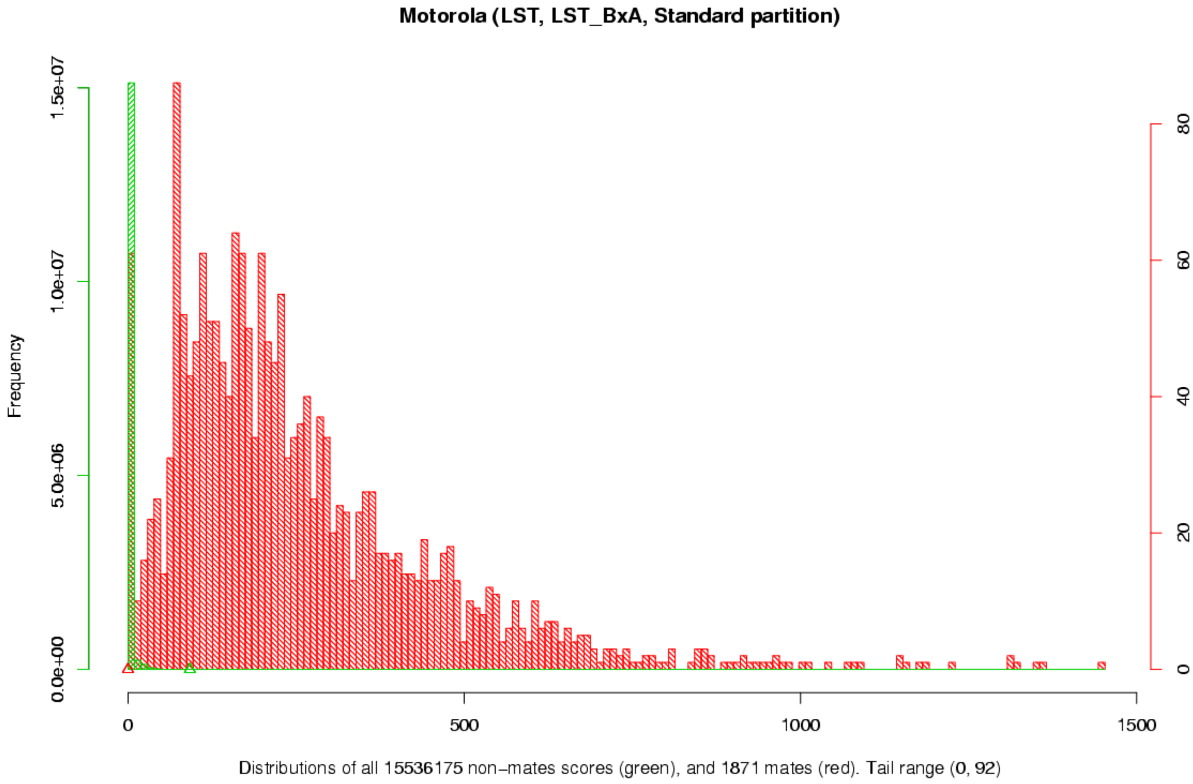


Figure C-59. Motorola (LST) Match vs. Non-Match Distribution for BxA Subtest

12.2 Motorola (MST)

Completion time: 1 day

The figure below shows separate ROCs for eight partitions of the MST data.

As compared to generally similar performance by Neurotechnologija (MST), Motorola (MST) achieved slightly higher accuracy on comparisons of flat images.

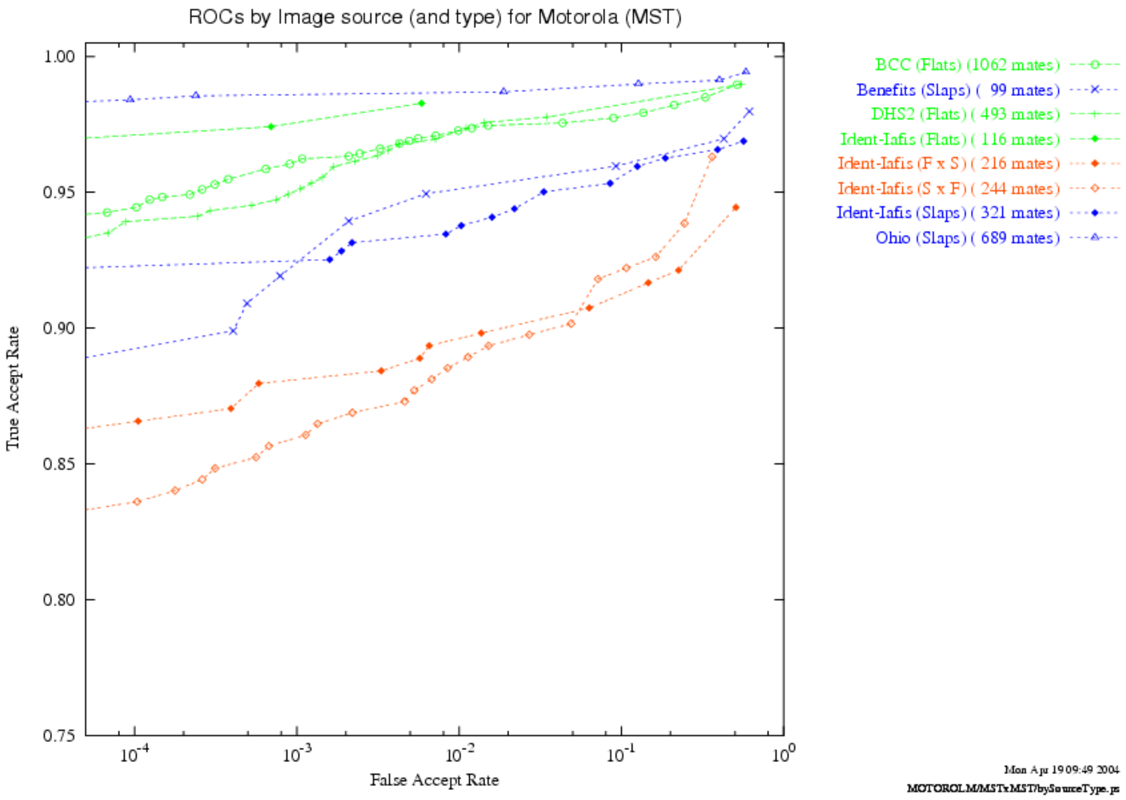


Figure C-60. Motorola (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

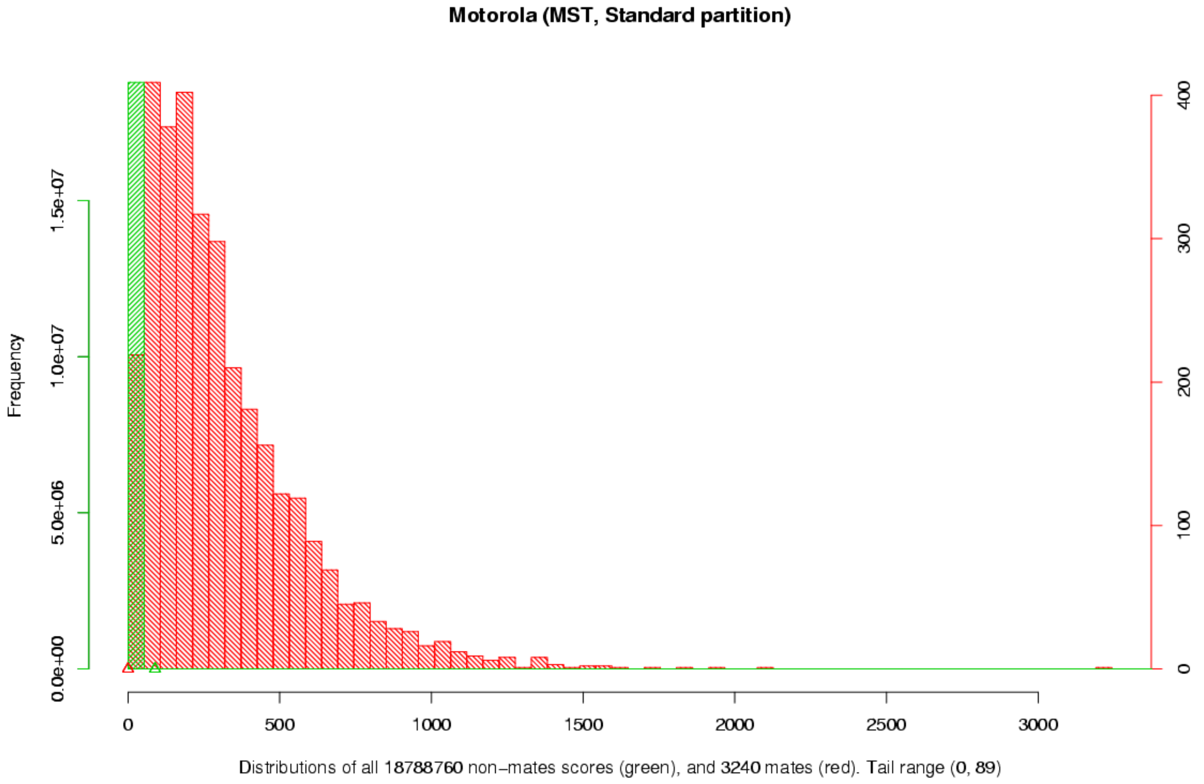


Figure C-61. Motorola (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data.

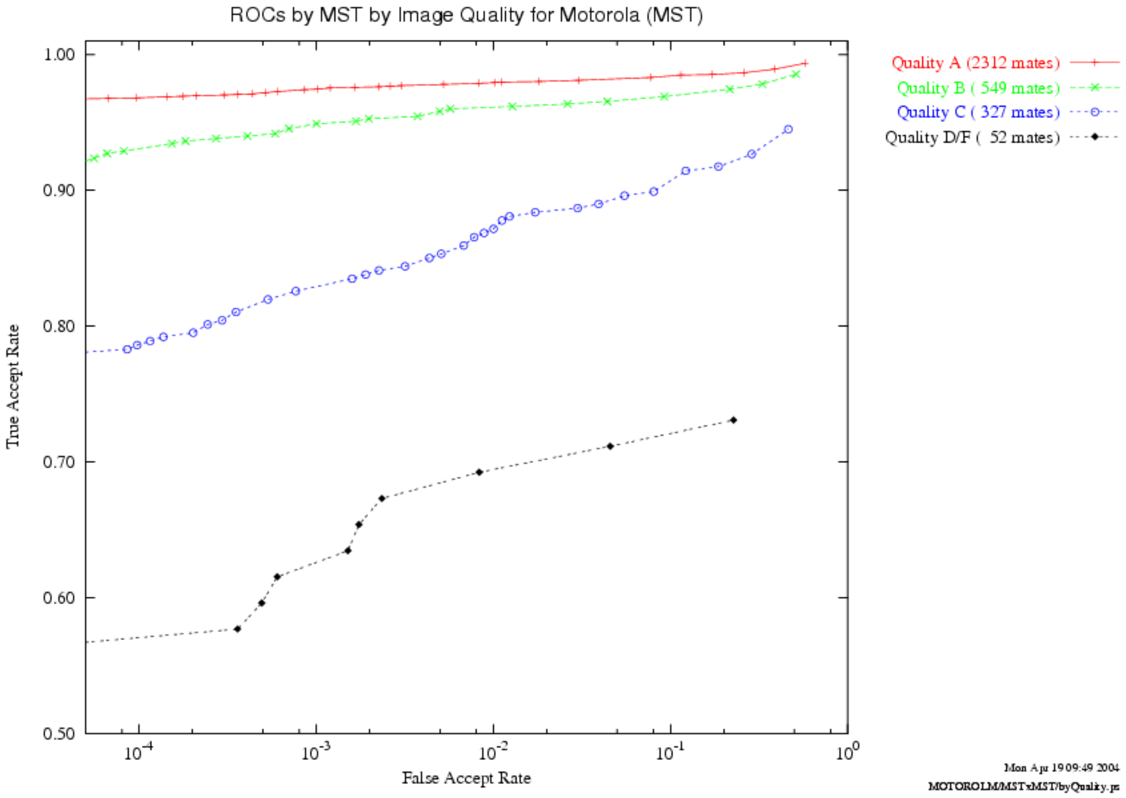


Figure C-62. Effect of Image Quality

13 NEC

NEC entered one system for the MST test and one for the LST test.

NEC consistently achieved high accuracy on all subtests, often achieving perfect or near perfect separation of match and non-match scores, and usually ranking in first place relative to the competition.

Larger tests are required to properly measure the capabilities of the NEC Cluster-PC Matching Servers. The score distributions presented in this section show how NEC's performance on many test partitions exceeded the limits of measurability for FpVTE 2003.

13.1 NEC (LST)

System name: NEC Cluster-PC Matching Server for LST

Configuration: 1 host and 9 backend servers (dual Xeon workstations), running NEC Application Software and Windows 2000.

Completion time: 19 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

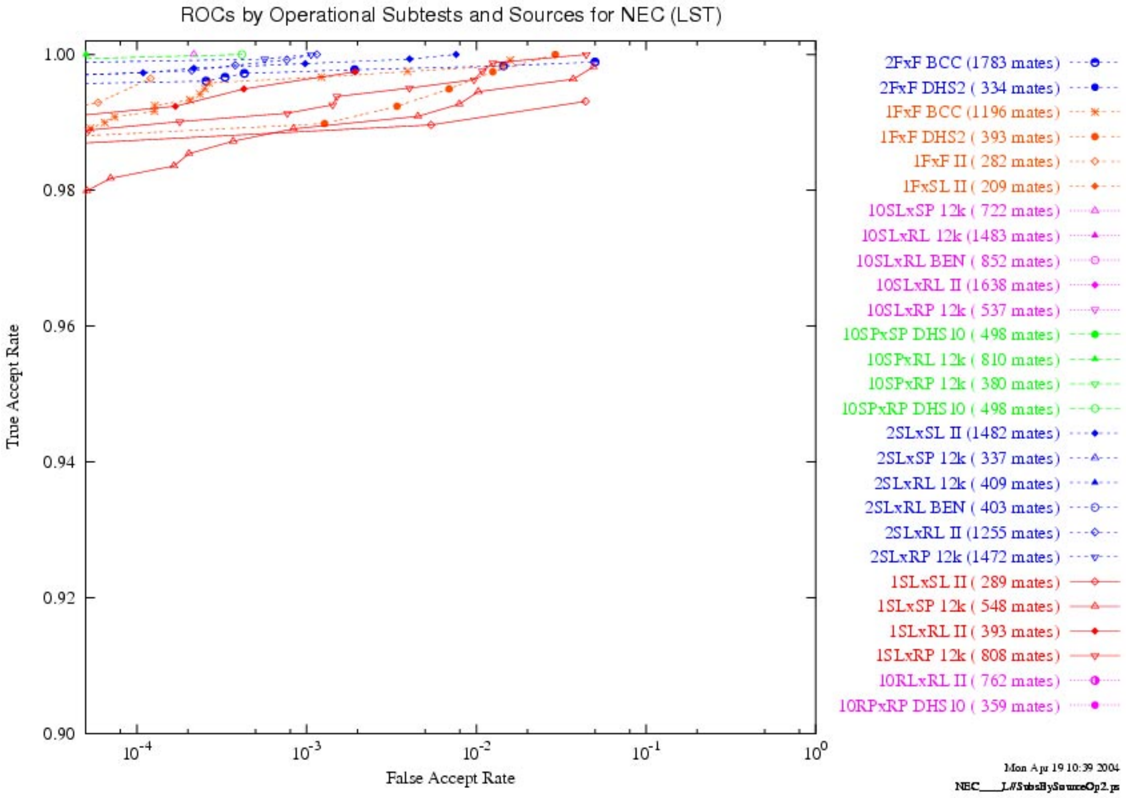


Figure C-63. NEC (LST) ROC for 27 Operational Partitions

The figure below shows the same results in a Detection Error Tradeoff (DET) chart, in which the Y axis is in log scale, and accuracy increases down and to the left. DETs show more detail at low error rates. Note that any results with no errors cannot be graphed in a DET.

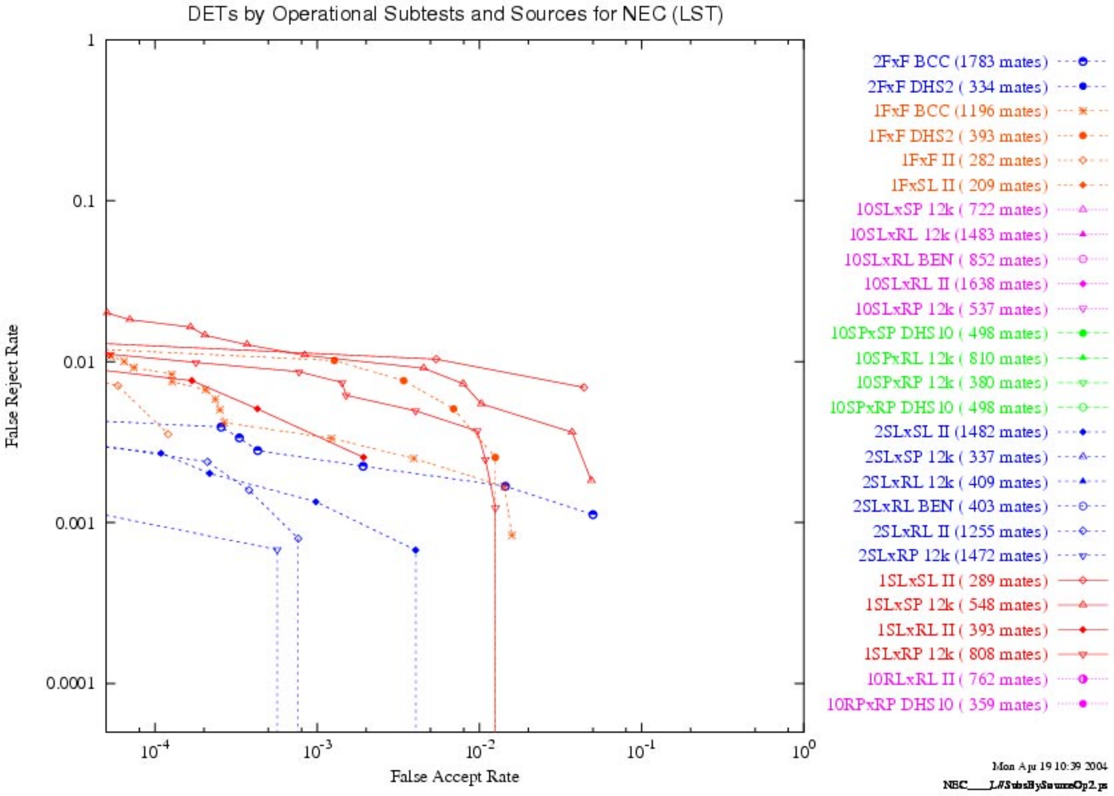


Figure C-64. NEC (LST) DET for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

The apparently irregular distribution of scores may be an artifact of the binning intervals used to create the histogram.

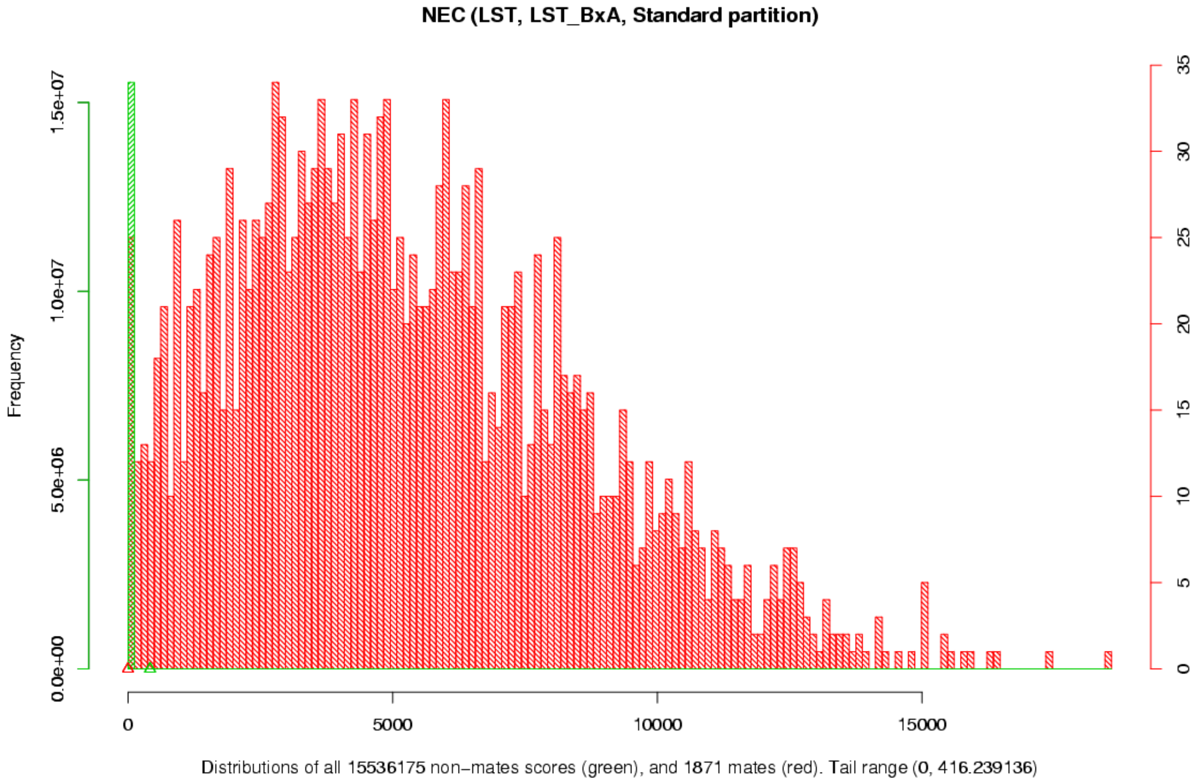


Figure C-65. NEC (LST) Match vs. Non-Match Distribution for BxA Subtest

13.2 NEC (MST)

System name: NEC Cluster-PC Matching Server for MST

Configuration: 1 host and 2 backend servers (dual Xeon workstations), running NEC Application Software and Windows 2000.

Completion time: 9 days

The following chart shows NEC (MST) accuracy on a variety of partitions. Note that there is no data for Ohio slaps or Ident-Iafis flats because NEC (MST) achieved perfect separation of match and non-match scores on these partitions.

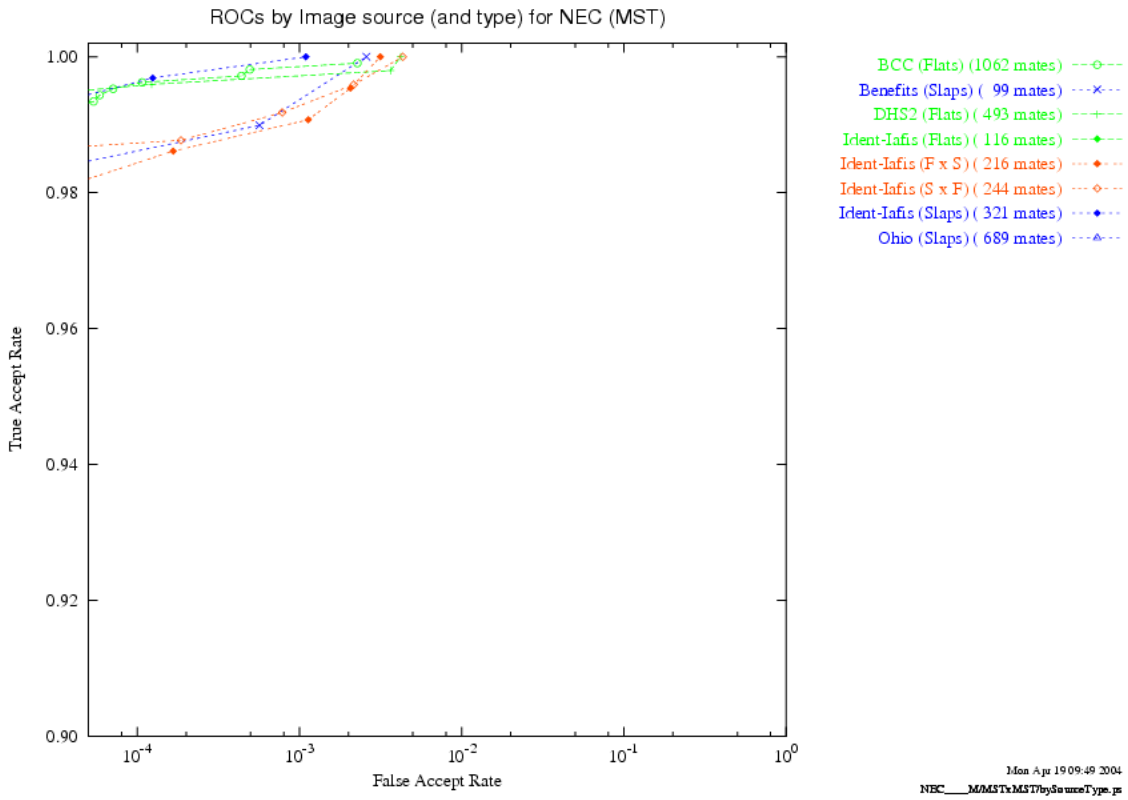


Figure C-66. NEC (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

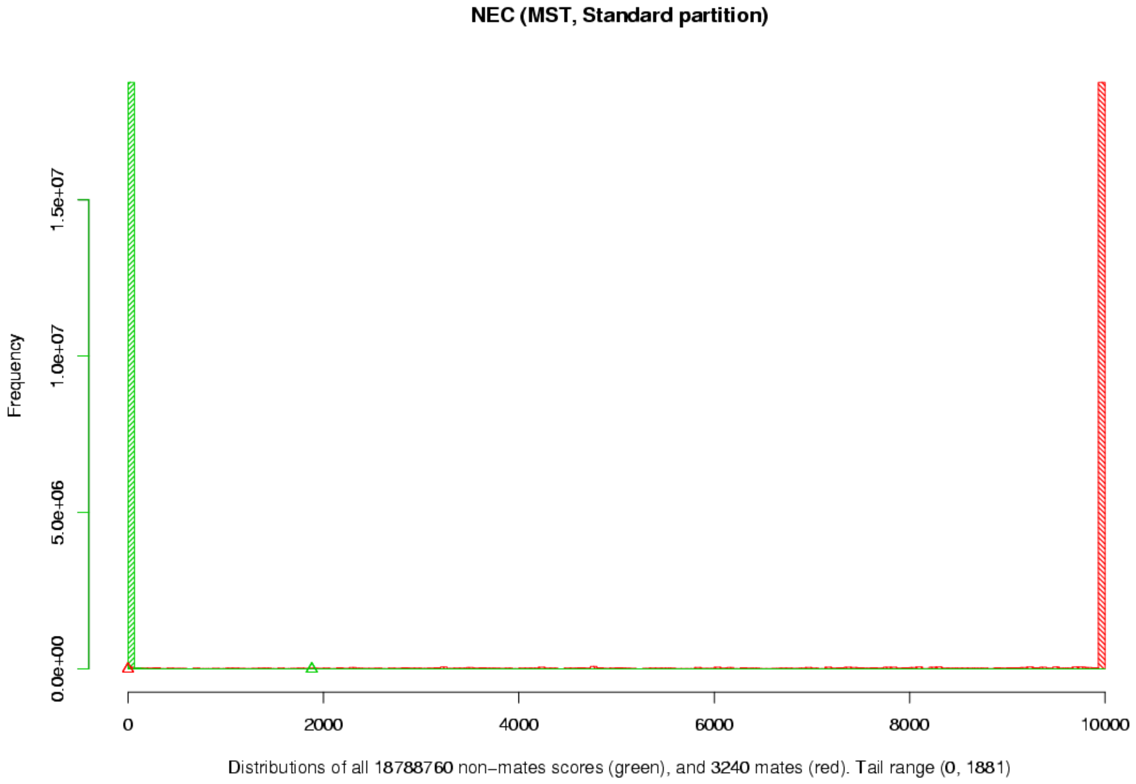
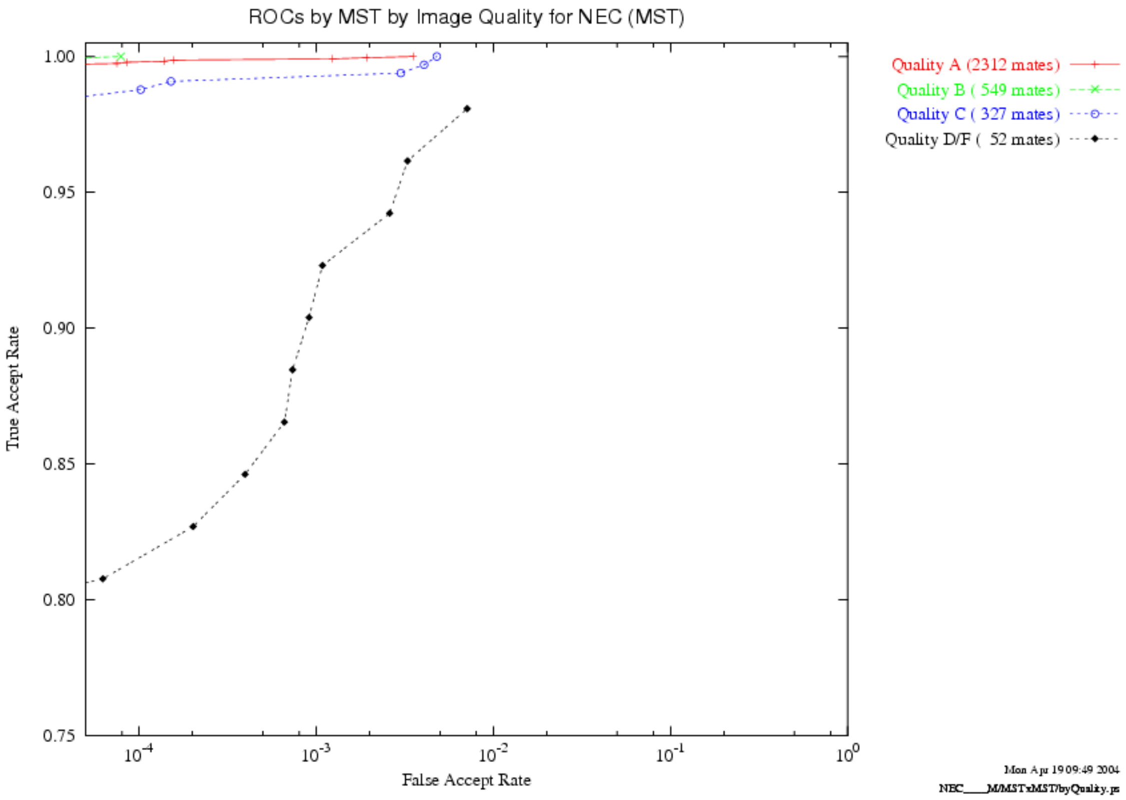


Figure C-67. NEC (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. NEC (MST) achieves high accuracy on all but the very worst quality images:



Mon Apr 19 09:49 2004
NEC_____M/MSTxMST/byQuality.ps

Figure C-68. Effect of Image Quality

14 Neurotechnologija

Neurotechnologija participated in MST only. During their first MST run (M1), they encountered problems with their WSQ decompression software, and were unable to read 33 images. After completing the M1 run, they modified their software configuration to incorporate different WSQ software and ran again; that run was labeled M2.

System name: VeriFinger

Configuration: 1 PC (Pentium 4), running VeriFinger 4.2 software test version and Windows XP Professional.

As compared to generally similar performance by Motorola (MST), Neurotechnologija (MST) achieved higher accuracy on comparisons of segmented slap images, and combinations of slap and flat images.

14.1 Neurotechnologija M1 (MST)

Completion time: 2 days

The figure below shows separate ROCs for eight partitions of the MST data.

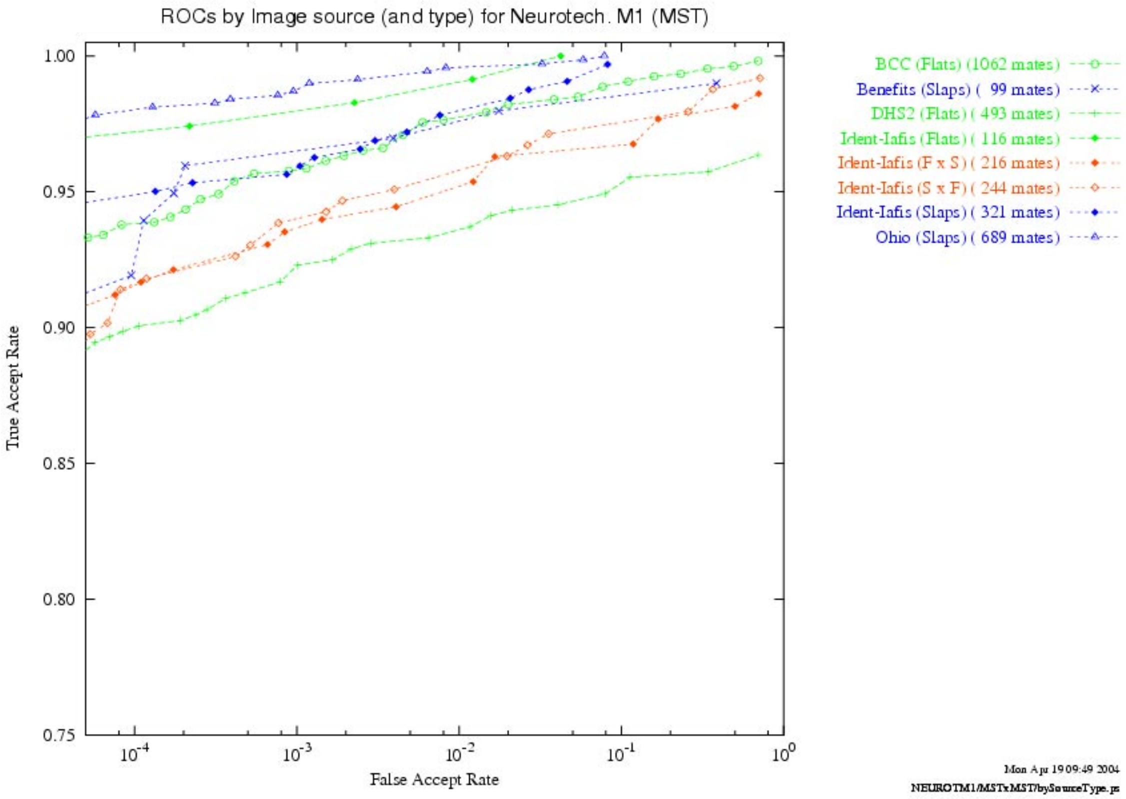


Figure C-69. Neurotechnologija M1 (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

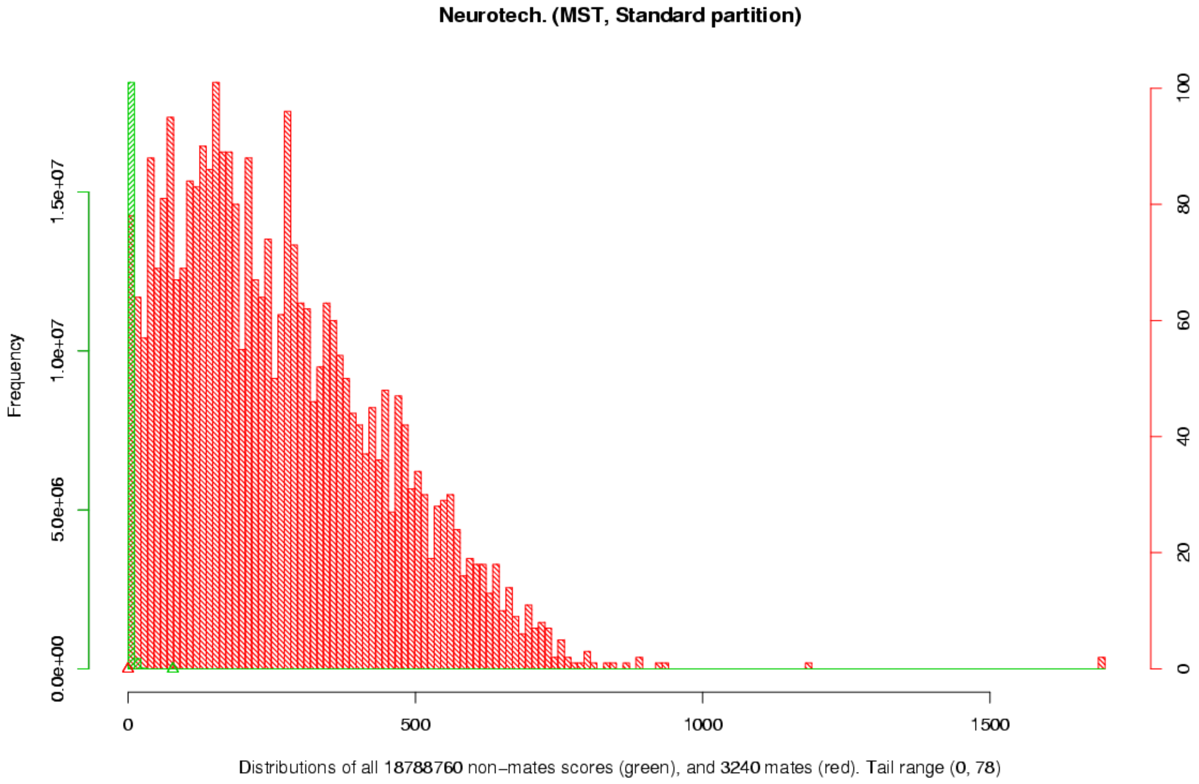


Figure C-70. Neurotechnologija M1 (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. Neurotechnologija (M1 and M2) provided image quality data, but every image was assigned an image quality value above the threshold (specified by Neurotechnologija), so this data was not used to develop the aggregate metric.

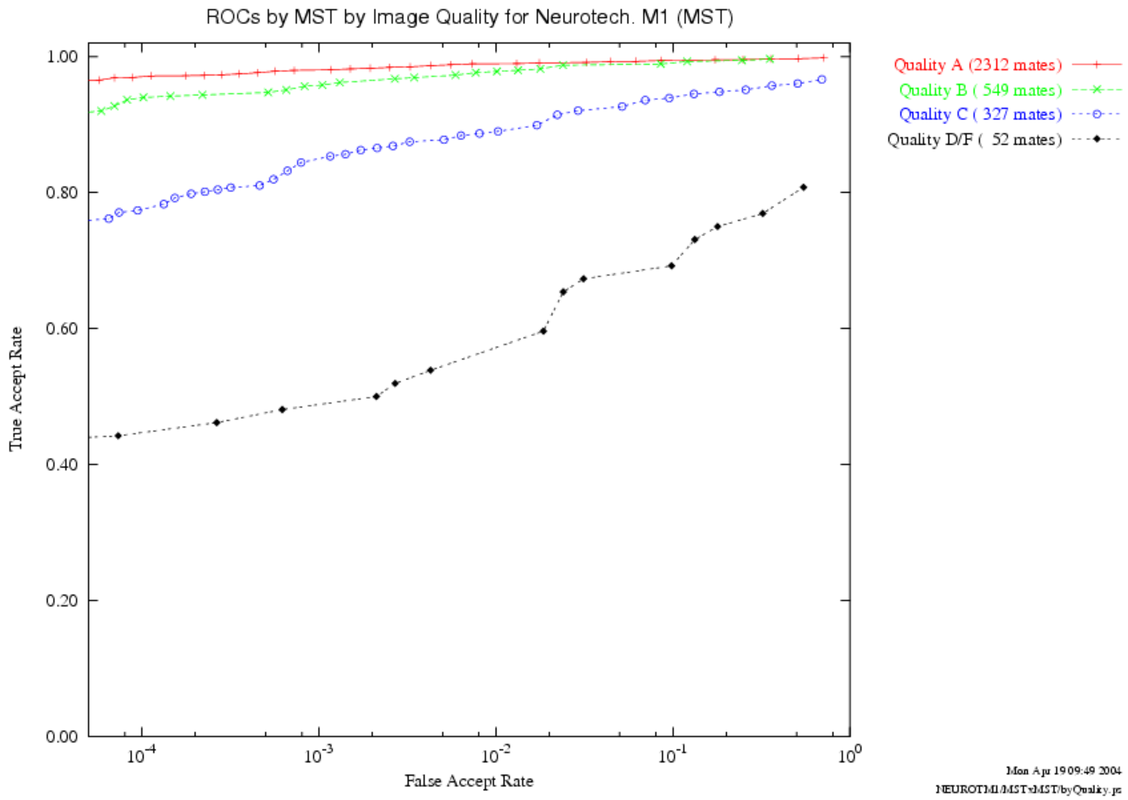


Figure C-71. Effect of Image Quality

Image quality data was provided by Neurotechnologija M1 and M2 (MST); the M1 results were among the seven IQMs used in the FpVTE aggregate image quality metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Neurotech. M1	1.0	0.0	55.4	52.0	134.0	0.31%
Neurotech. M2	1.0	21.0	55.6	52.0	255.0	0.00%

Table C-6. Image Quality Distribution

14.2 Neurotechnologija M2 (MST) (Error)

After Neurotechnologija M1 failed to decompress 31 of the images in MST, they incorporated a different WSQ encoder into their system and reran MST. Since only the WSQ decoder was changed, only the 31 problem scores from M1 were expected to be different. However, the results of M2 were clearly in error. In general, the scores in the first part of the similarity matrix were similar to those from the M1 run, but the later scores appeared to be random numbers. This is shown in Figure C-72: the curve that the slap results follow is the same line that would result if random numbers were plotted. Since the bulk of the results in the M2 run were random, they were not included in analysis.

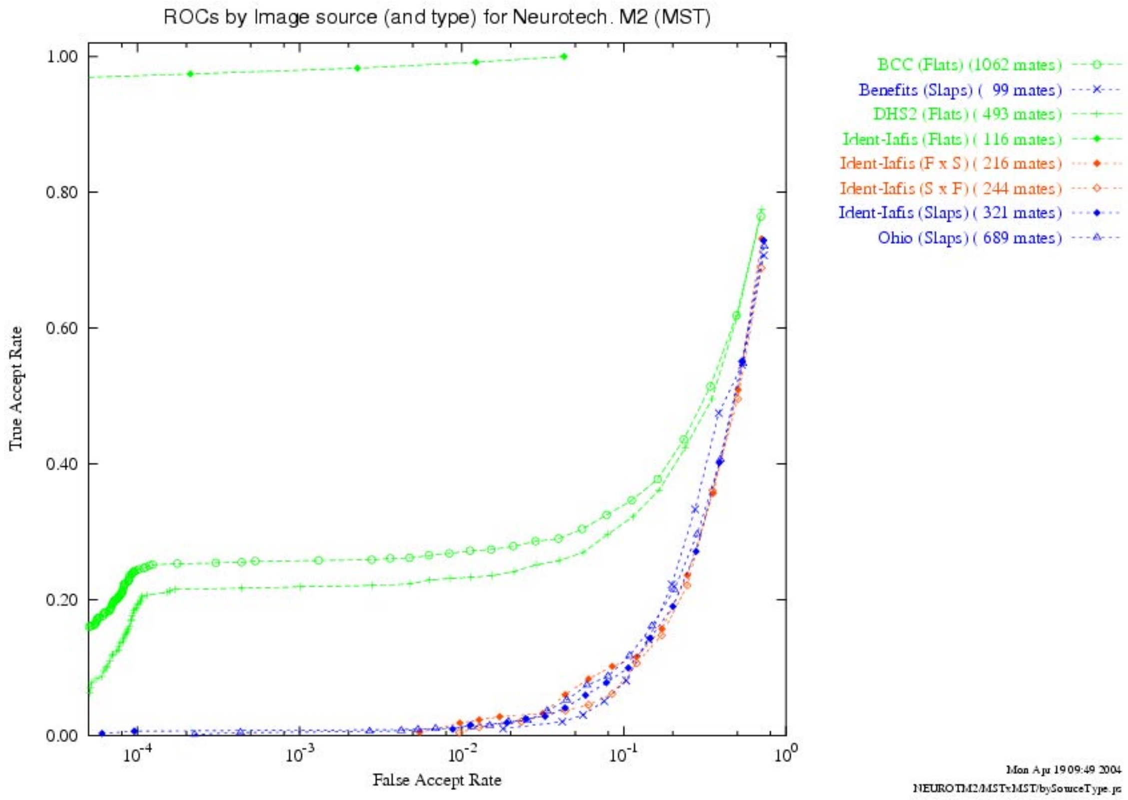


Figure C-72. Neurotechnologija M2 (MST) ROCs for MST Partitions

15 NIST

NIST ran all three tests on the VTB as a benchmark.

System name: NIST VTB

Configuration: 16 PCs (dual Xeon), running the VTB matcher (Bozorth98) and Red Hat Linux 7.2.

15.1 NIST VTB (LST)

Completion time: 21 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

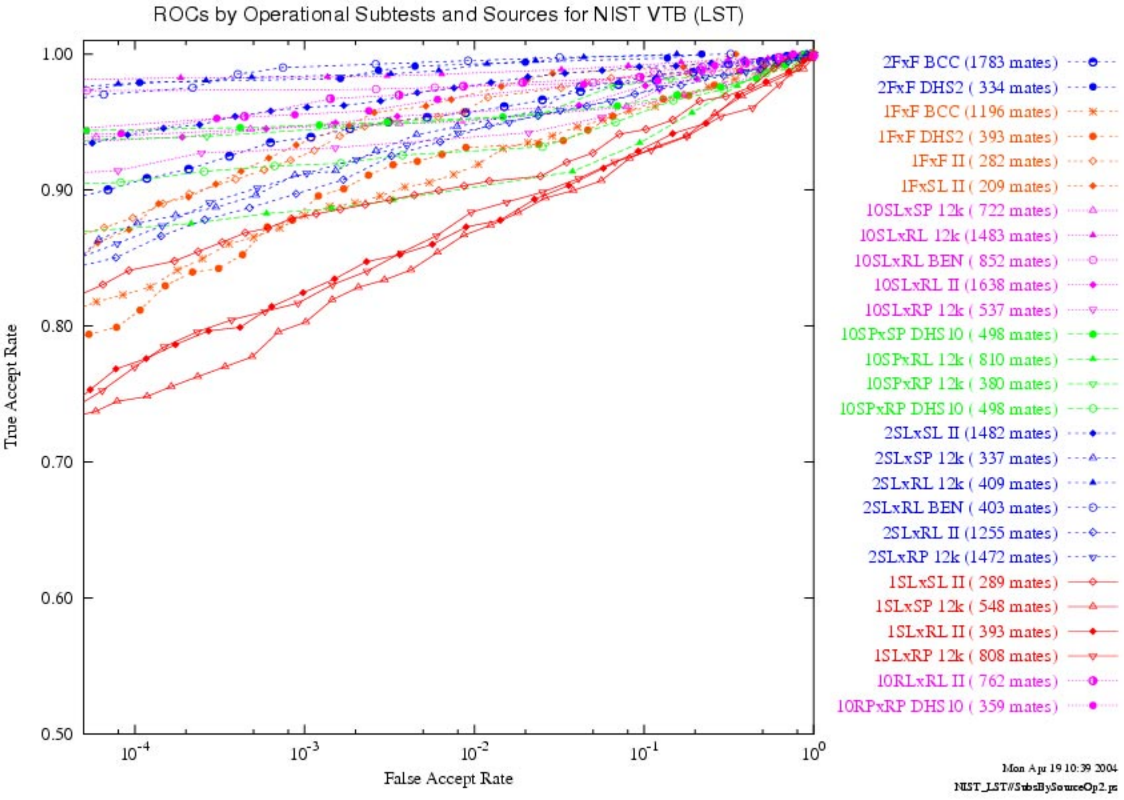


Figure C-73. NIST VTB (LST) ROC for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum

non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

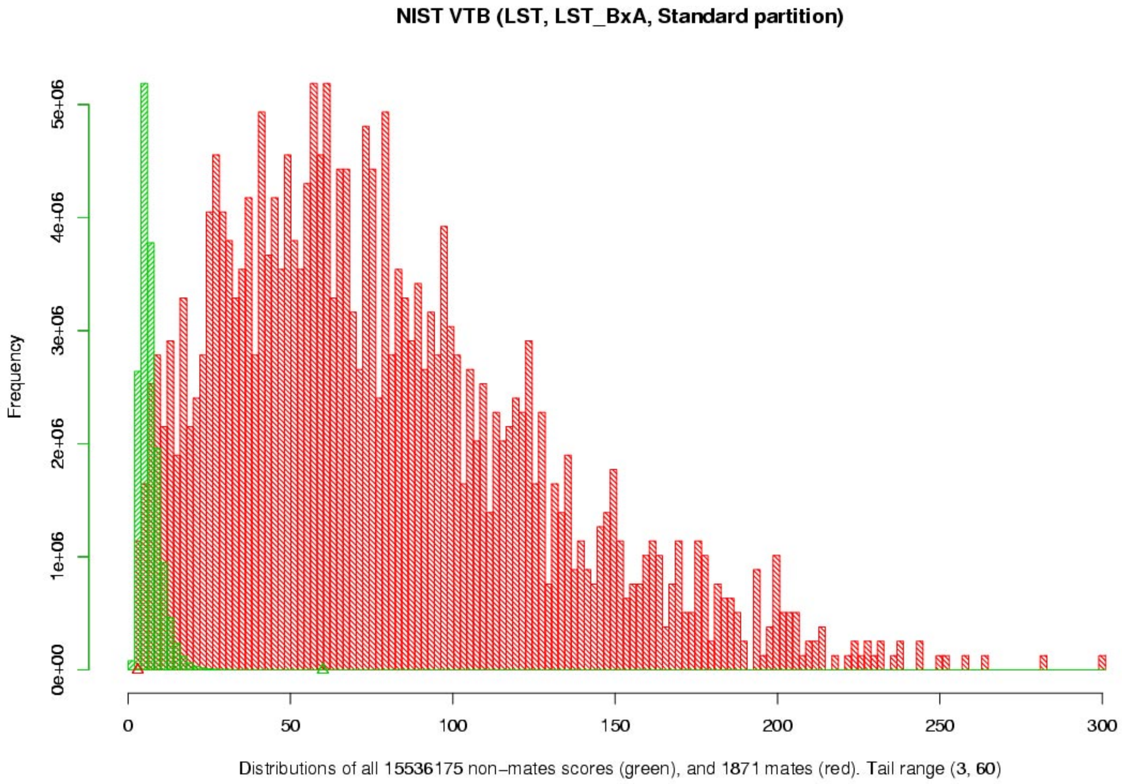


Figure C-74. NIST VTB (LST) Match vs. Non-Match Distribution for BxA Subtest

15.2 NIST VTB (MST)

Completion time: 12 days

The figure below shows separate ROCs for eight partitions of the MST data.

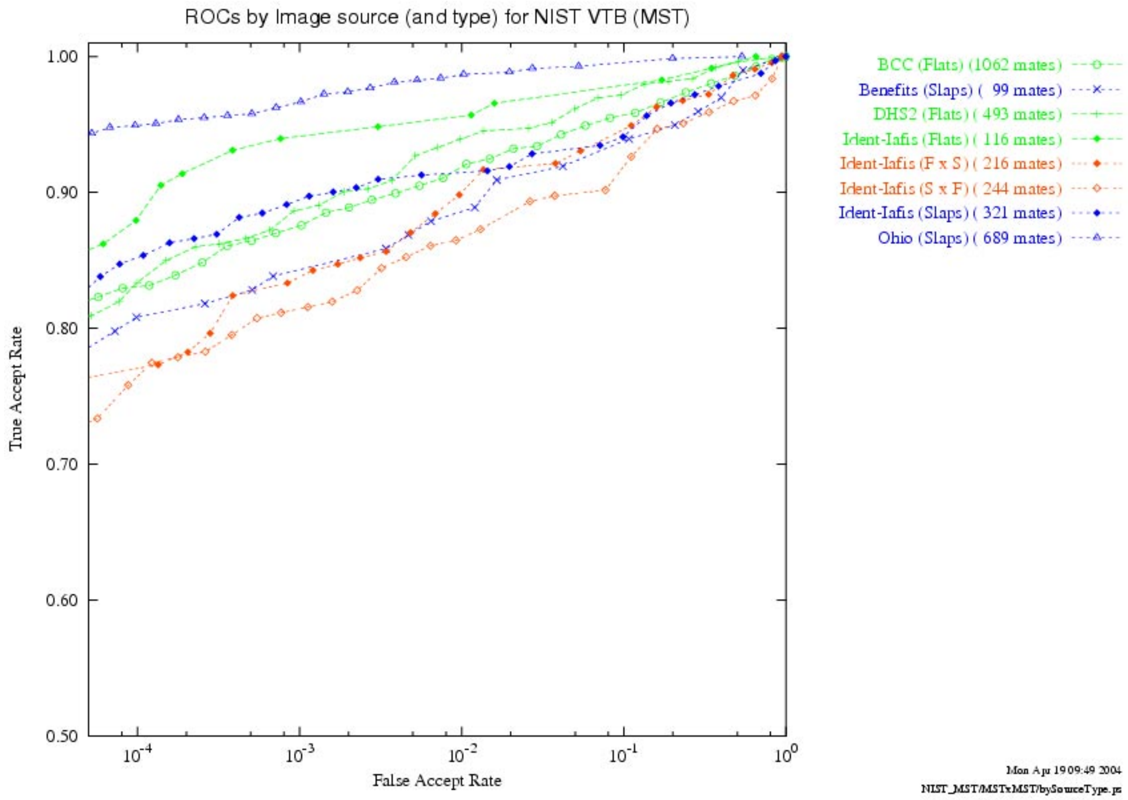


Figure C-75. NIST VTB (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the “tail.”

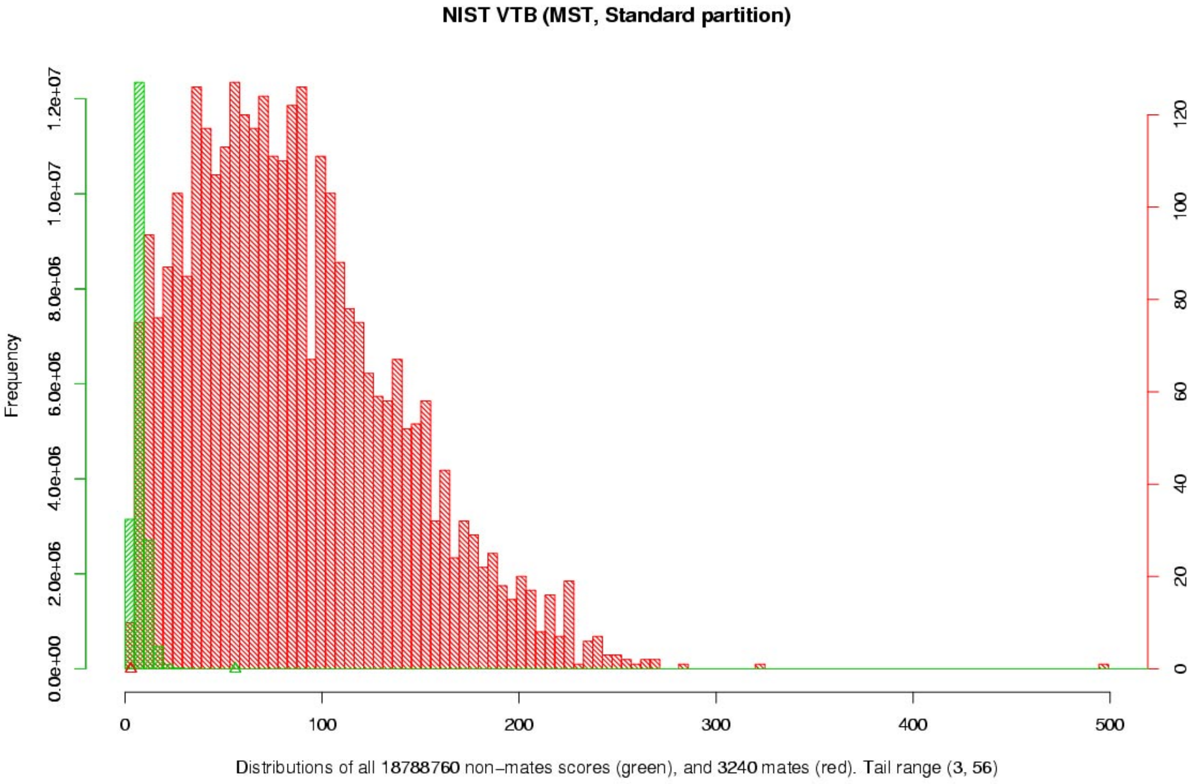


Figure C-76. NIST VTB (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data.

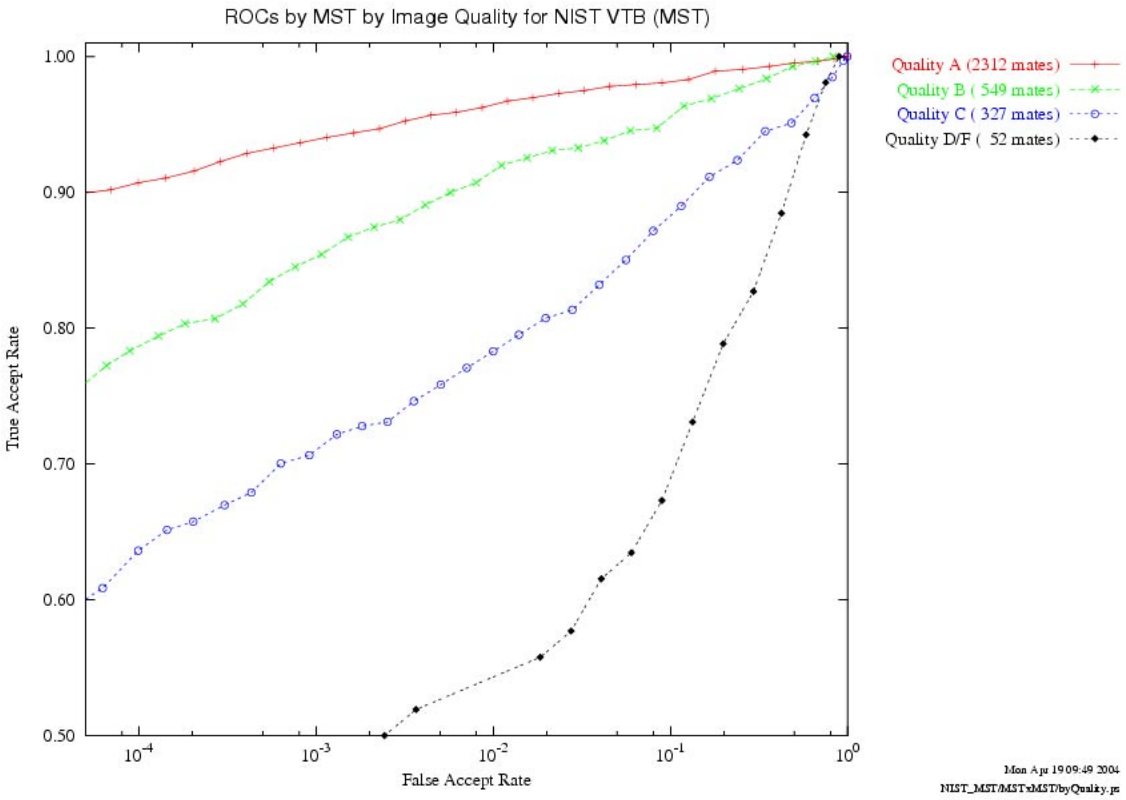


Figure C-77. Effect of Image Quality

15.3 NIST VTB (SST)

Completion time: 1 day

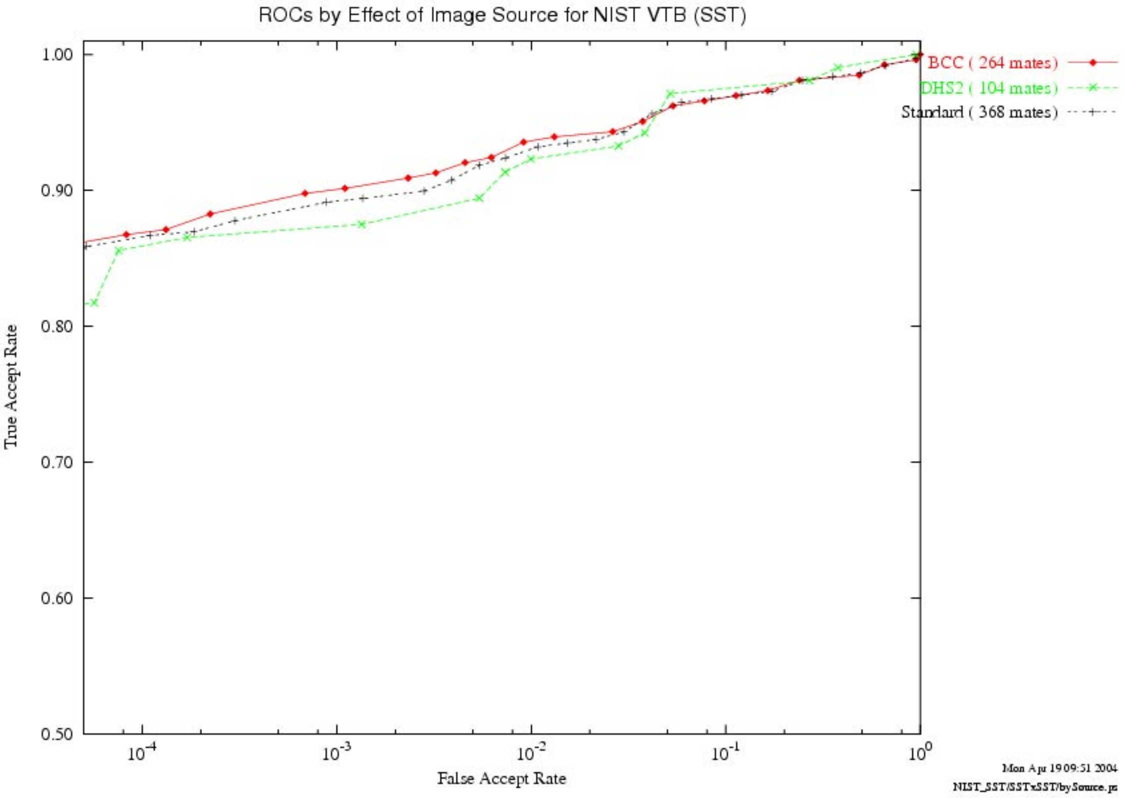


Figure C-78. NIST VTB (SST) ROCs for SST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the SST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

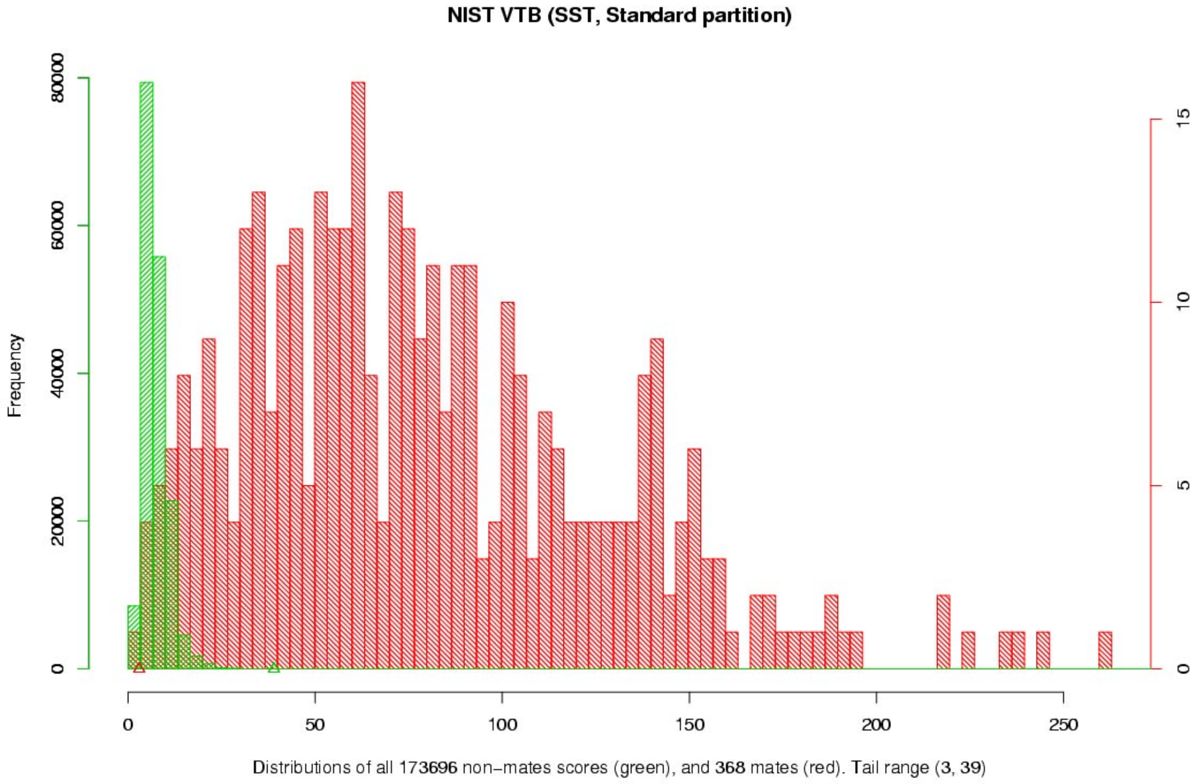


Figure C-79. NIST VTB (SST) Match vs. Non-Match Distribution

16 Phoenix Group

Phoenix Group participated in MST only.

16.1 Phoenix (MST)

System name: AFIX Tracker

Configuration: 1 PC (Pentium 4), running AFIX Tracker v4.4 and Windows XP Professional.

Completion time: 5 days

The figure below shows separate ROCs for eight partitions of the MST data. The separation in accuracy between the Ohio data (high quality) and the operational data is unusually large (as compared to other systems).

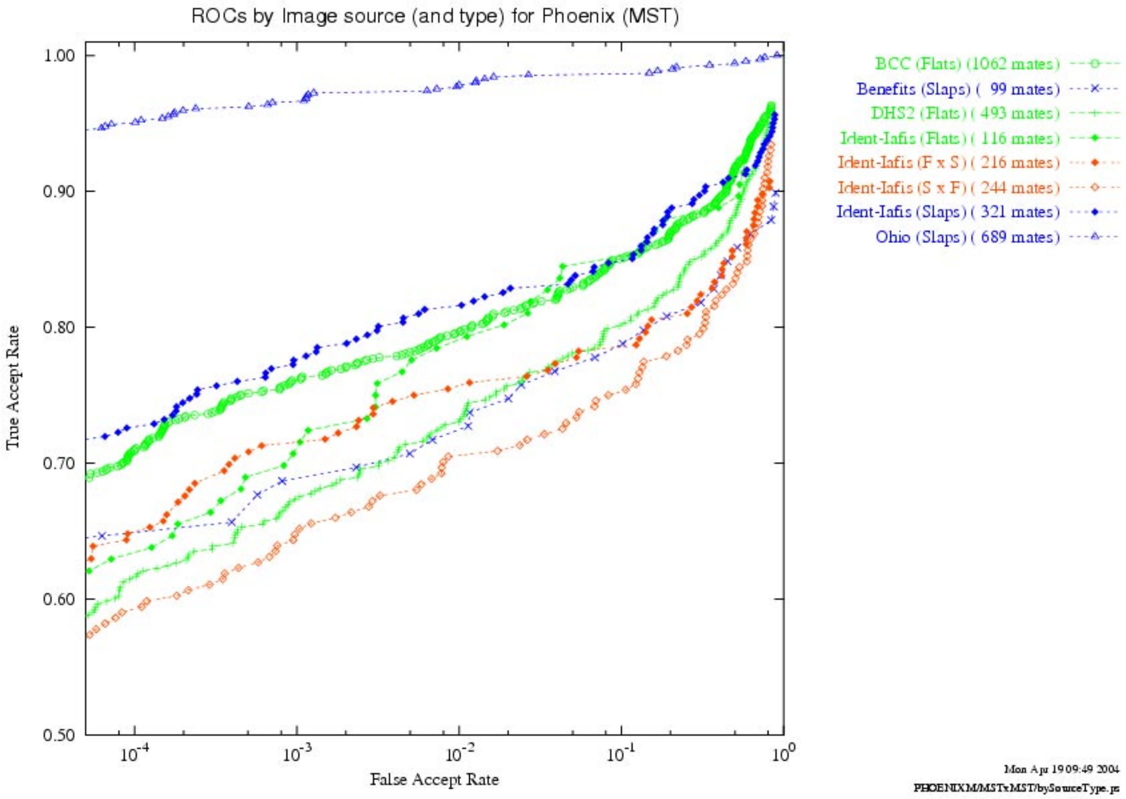


Figure C-80. Phoenix (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note the spike in both match and non-match values at 0.0.

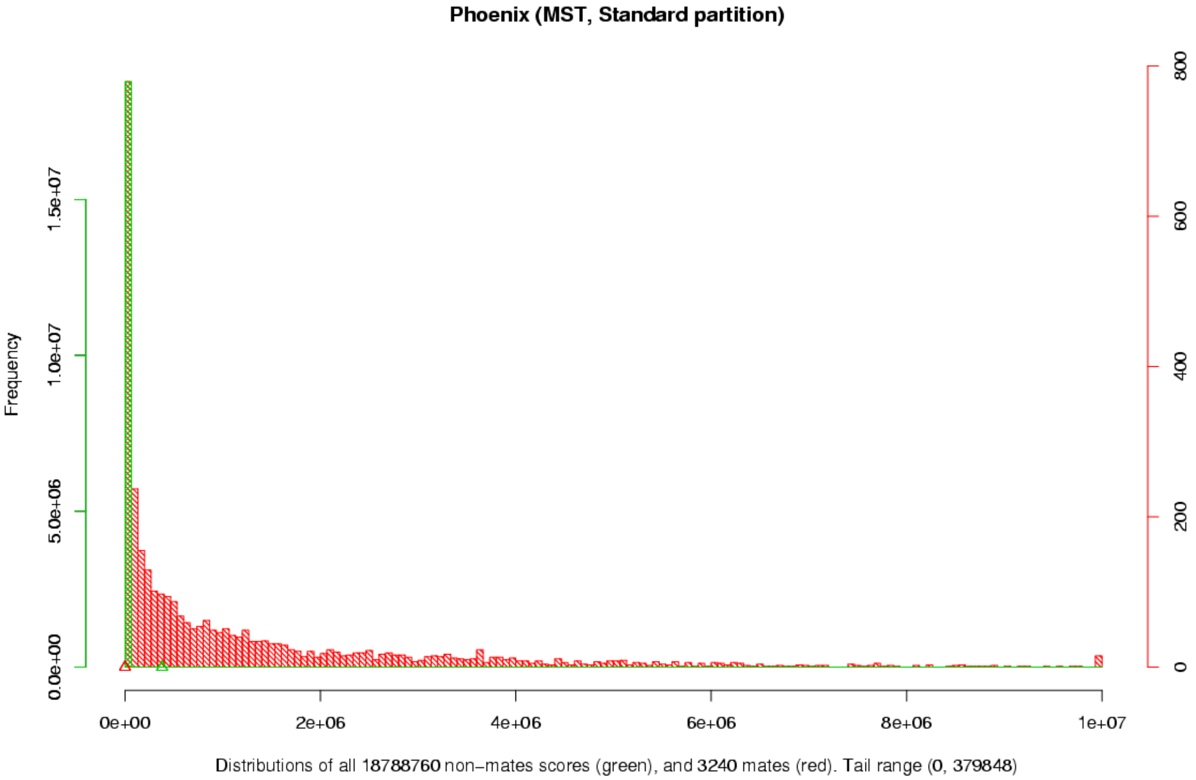


Figure C-81. Phoenix (MST) Match vs. Non-Match Distribution

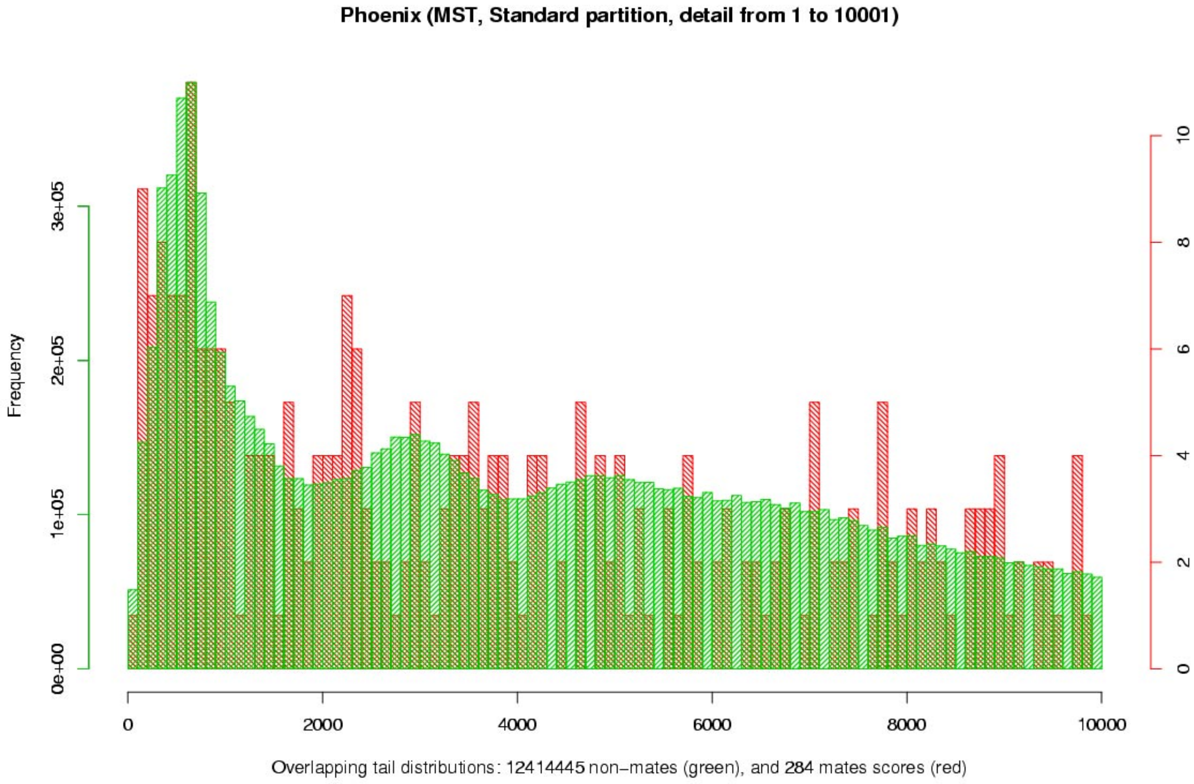


Figure C-82. Phoenix (MST) Match vs. Non-Match Distribution (Detail)

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data.

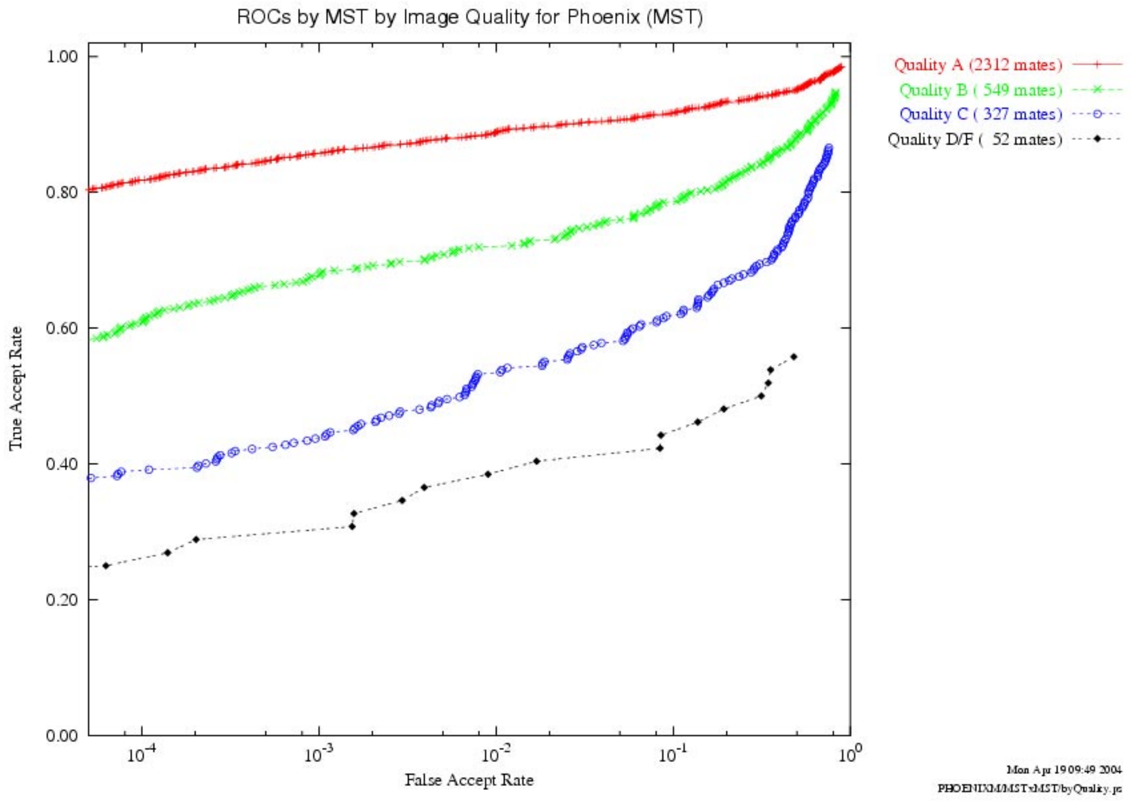


Figure C-83. Effect of Image Quality

Phoenix provided image quality data, but every image was assigned an image quality value above the threshold specified by Phoenix, so their image quality results were not used to develop the aggregate metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Phoenix	0.0	1.0	7.7	9.0	9.0	0.00%

Table C-7. Image Quality Distribution

17 Raytheon

Raytheon participated in MST and LST. These systems used the same software, but different hardware.

System name: RAYAFIS

Raytheon (MST) and Golden Finger (MST) returned equivalent similarity matrices on MST. Except for two scores, Golden Finger (MST) scores (integer values) could be computed from Raython (MST) scores by multiplying the (floating point) Raytheon (MST) scores by 100 and rounding to the nearest integer. The two exceptions were non-matches: Golden Finger (MST) assigned score values of -1, whereas Raytheon (MST) assigned positive score values.

Raytheon (LST) and Golden Finger (LST) returned equivalent results on some subtests, but significantly different results on others. The greatest differences were on subtests involving datasets I and J.

17.1 Raytheon (LST)

Configuration: 4 matchers (2 Pentium 4 and 2 dual Xeon) and 1 PC (1 Pentium) controller, running RAYAFIS Software and Microsoft Server 2003.

Completion time: 15 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test. Raytheon (LST) achieved very low accuracy on the 2-finger SLxRL Ident-Iafis partition and on the 1-finger SLxRL Ident-Iafis partition.

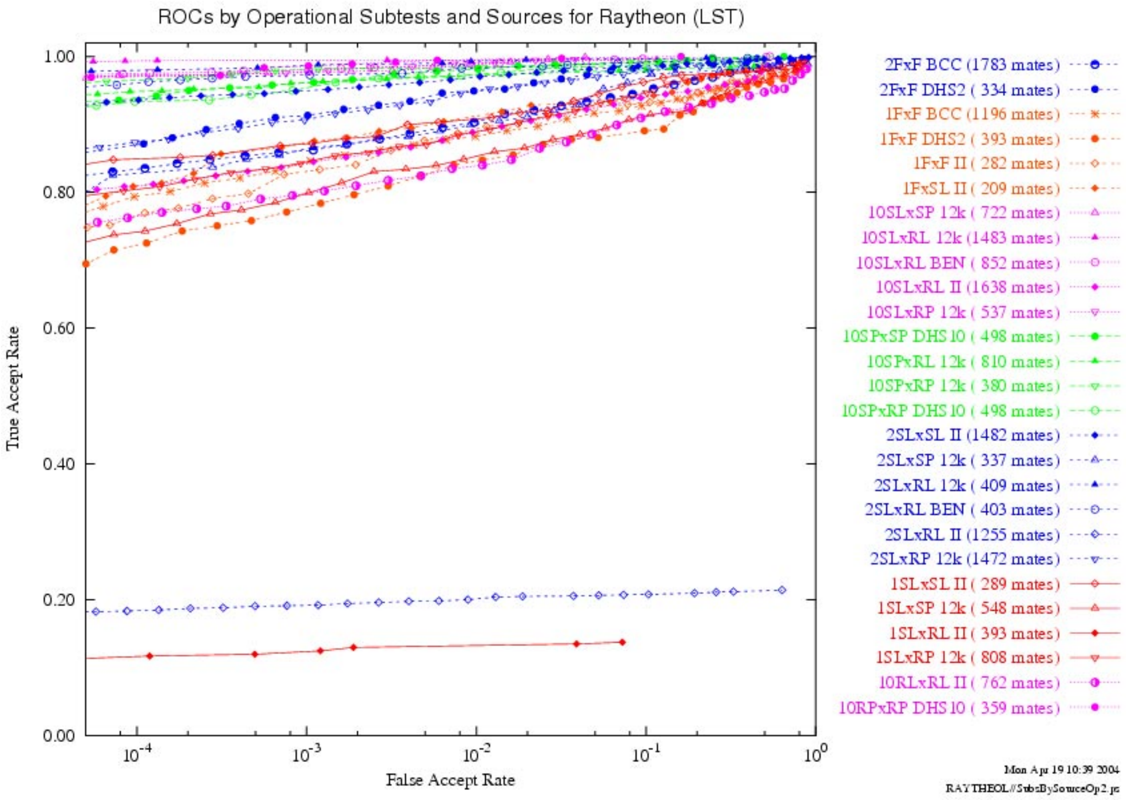


Figure C-84. Raytheon (LST) ROC for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

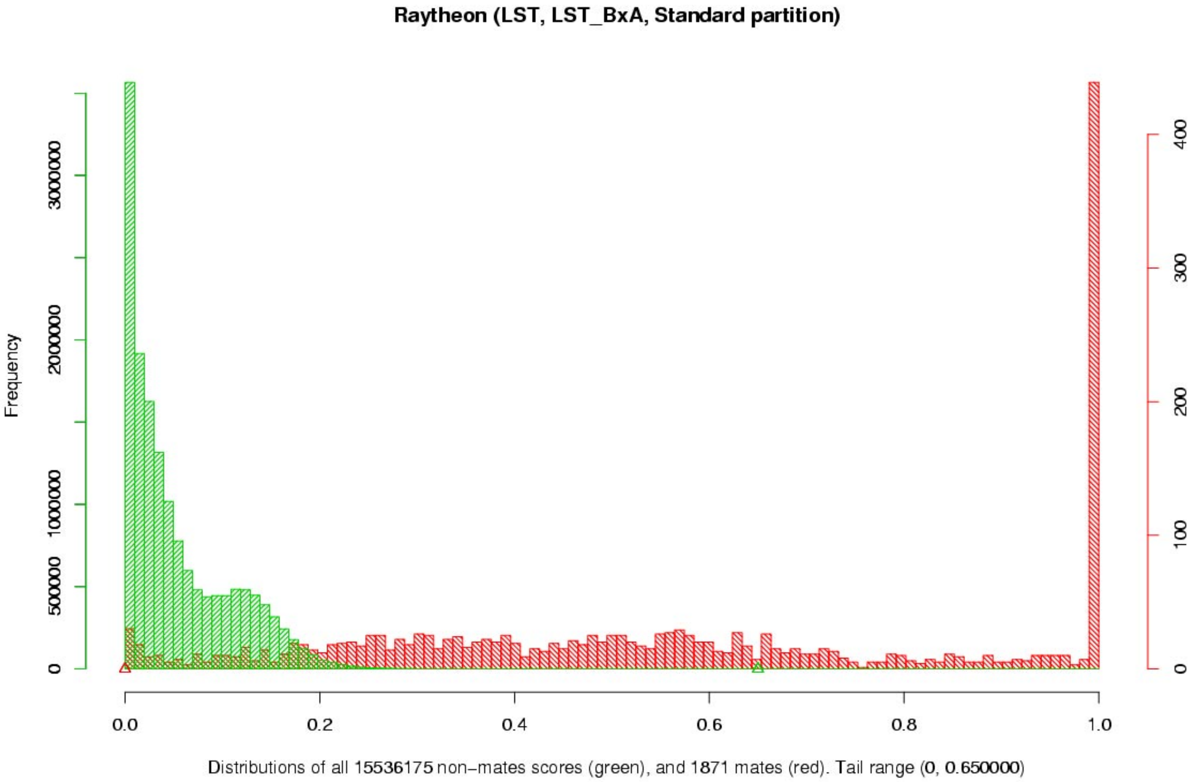


Figure C-85. Raytheon (LST) Match vs. Non-Match Distribution for BxA Subtest

17.2 Raytheon (MST)

Configuration: 2 matchers (Pentium 4), running RAYAFIS Software and Microsoft Server 2003.

Completion time: 1 day

The figure below shows separate ROCs for eight partitions of the MST data.

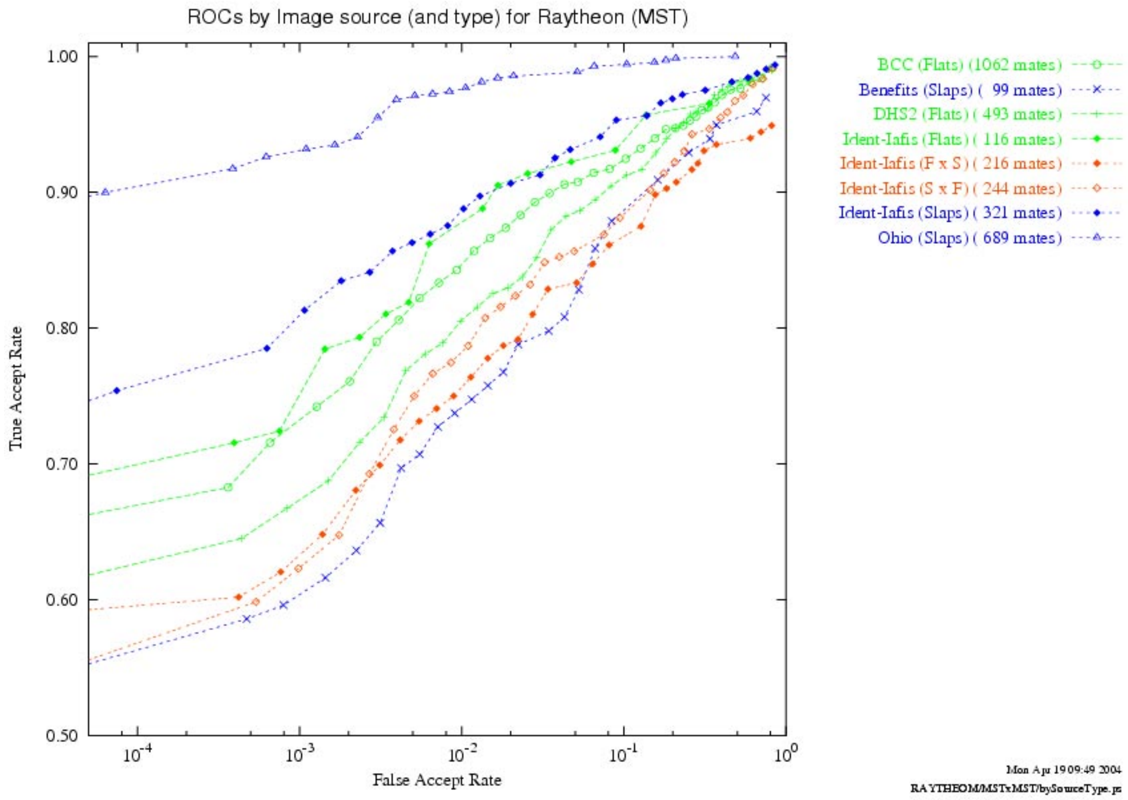


Figure C-86. Raytheon (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

Note that the score distribution for Golden Finger (MST) is exactly 100 times the score distribution for Raytheon (MST).

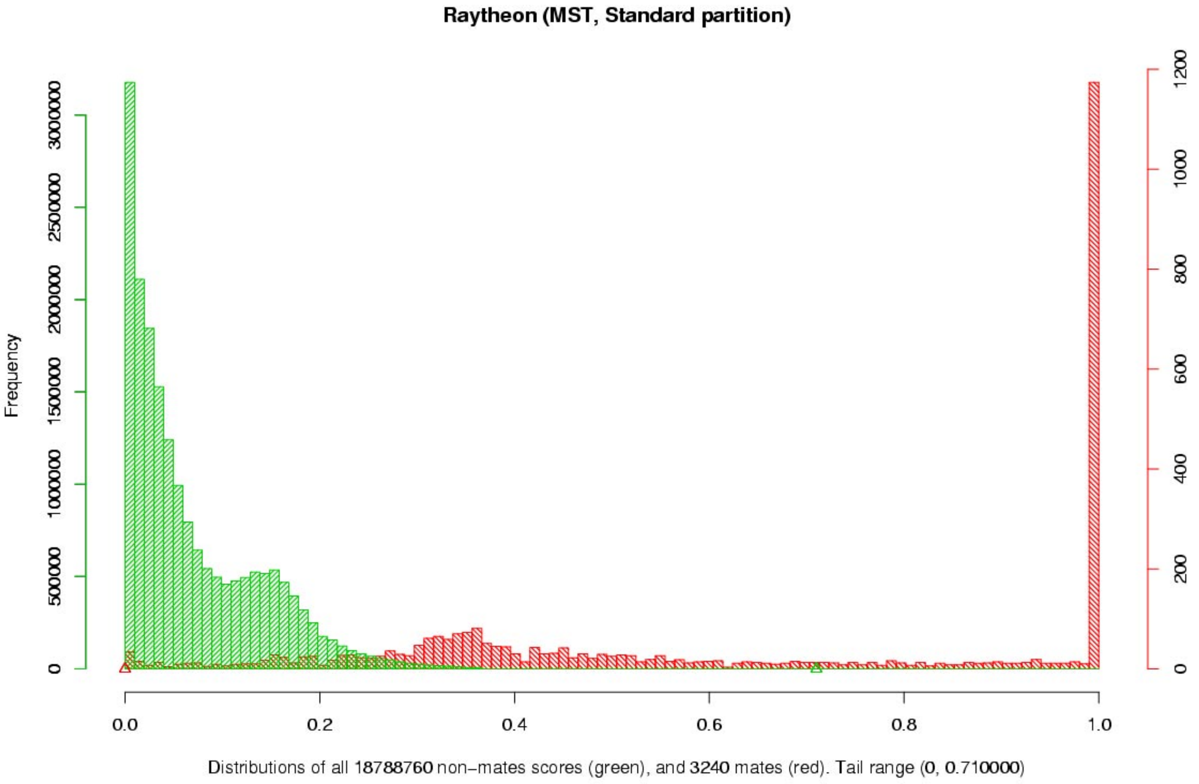


Figure C-87. Raytheon (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. Raytheon provided image quality data, but every image was assigned an image quality value below the threshold (specified by Raytheon), so this data was not used to develop the aggregate metric. Note that this distribution is somewhat unusual as compared to many other systems: much of the degradation occurs quickly as the quality begins to drop, whereas many systems drop off sharply when the quality is especially low.

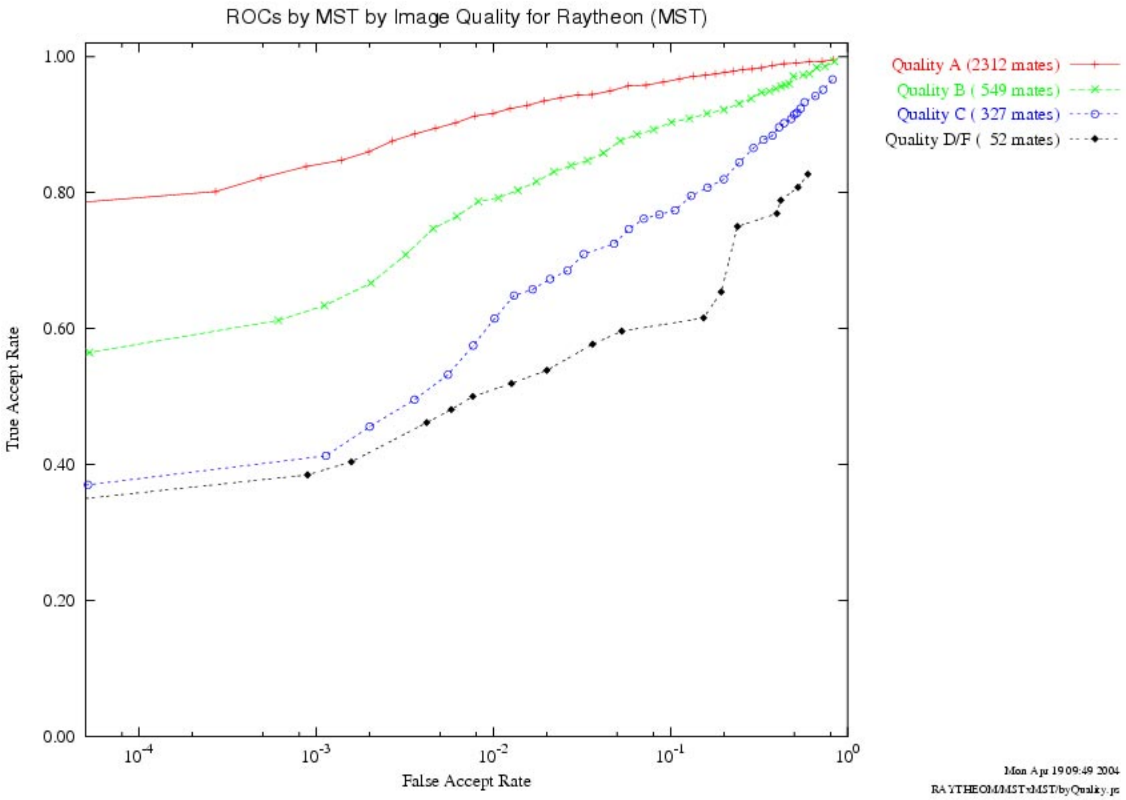


Figure C-88. Effect of Image Quality

Image quality data was provided by Raytheon (MST). Raytheon (MST) set its image quality threshold to 1. All images in the standard partition scored below this threshold, meaning that all images were of unsatisfactory quality. Presumably the image quality threshold was set incorrectly. For this reason, this was not among the seven IQMs used in the FpVTE aggregate image quality metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Raytheon	1.0	0.0	0.6	0.7	0.8	100.00%

Table C-8. Image Quality Distribution

18 SAGEM

SAGEM entered two systems in each of MST and LST.

System name: SAGEM MetaMorpho

Configuration: 7 Pentium 4s, running MetaMorpho Software version 3.1.2A.NST.3A, Windows 2000 Professional

18.1 SAGEM L1 (LST)

Configuration: 1 Workflow Control station (Pentium 4) and 6 Fingerprint Processing stations (Pentium 4), running MetaMorpho Software and Matcher Engine version 3.1.2A.NST.3A, and Windows 2000 Professional.

Completion time: 7 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

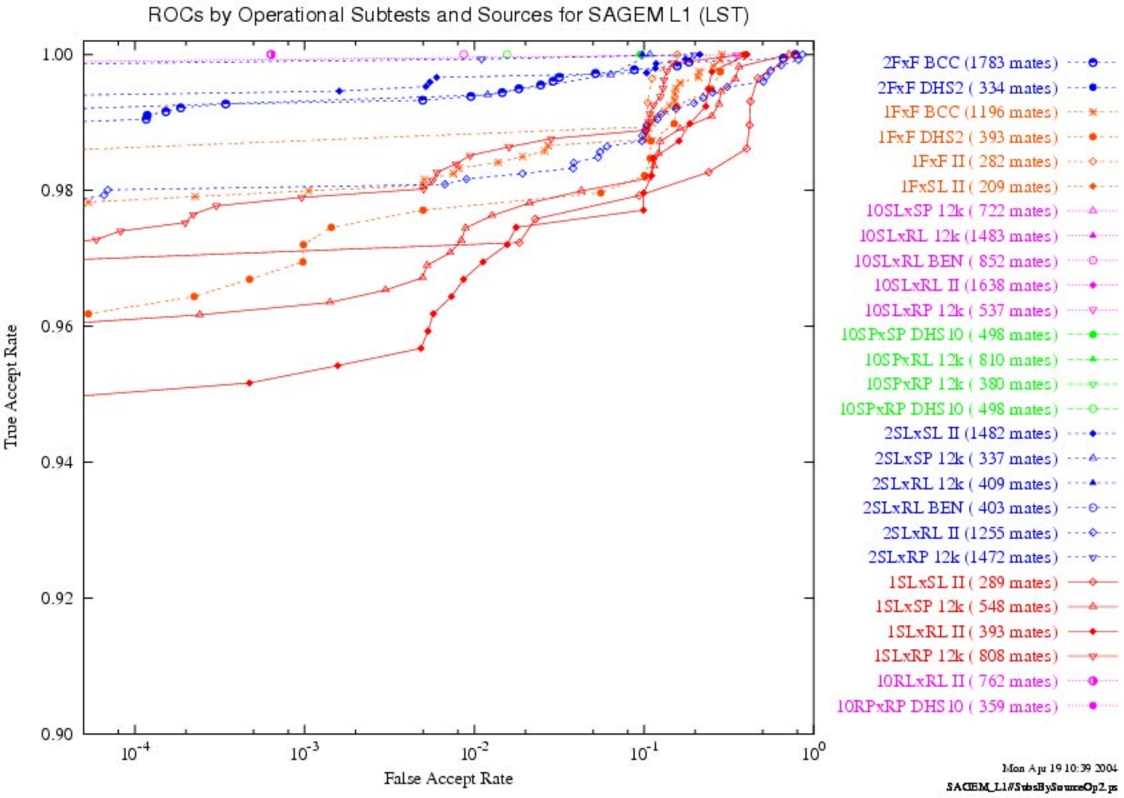


Figure C-89. SAGEM L1 (LST) ROC for 27 Operational Partitions

The figure below shows the same results in a Detection Error Tradeoff (DET) chart, in which the Y axis is in log scale, and accuracy increases down and to the left. DETs show more detail at low error rates. Note that any results with no errors cannot be graphed in a DET.

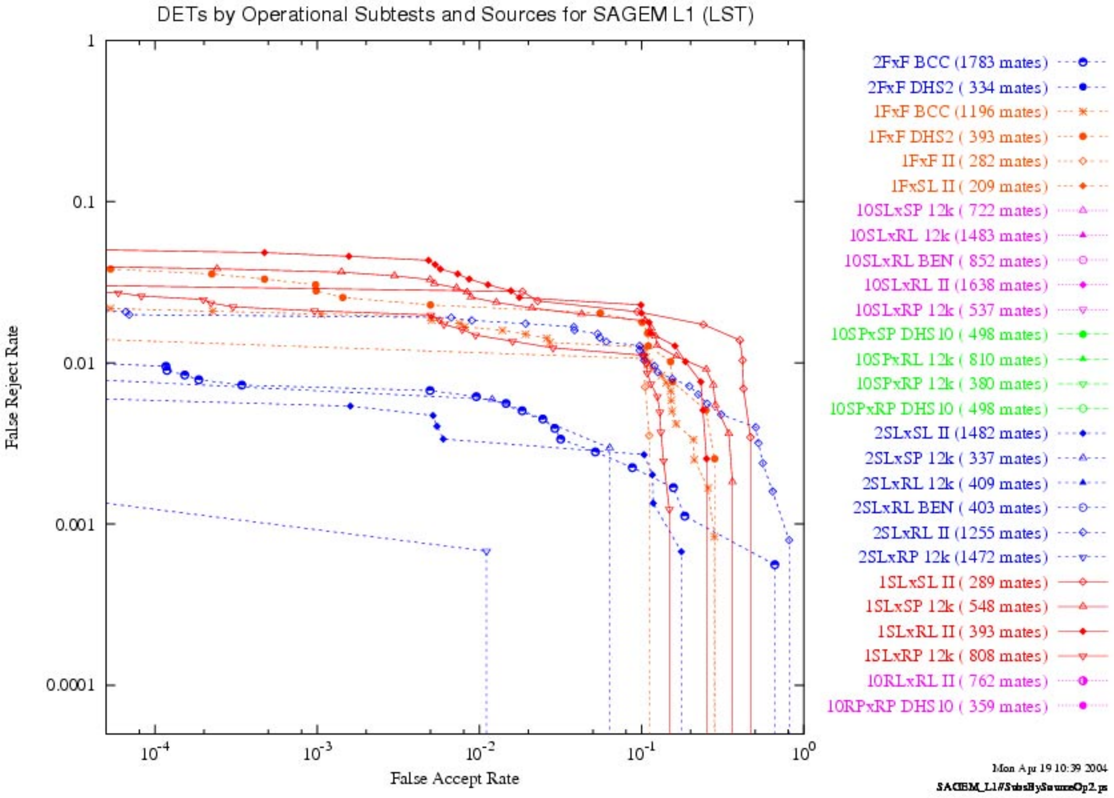


Figure C-90. SAGEM L1 (LST) DET for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

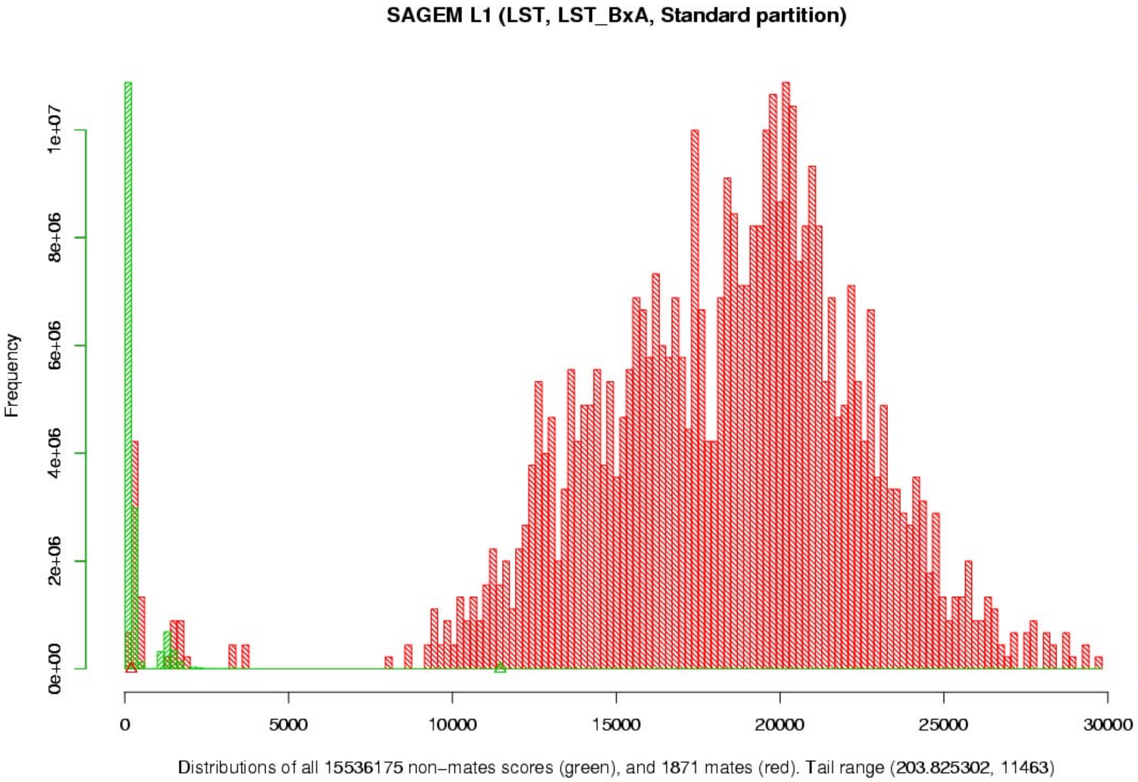


Figure C-91. SAGEM L1 (LST) Match vs. Non-Match Distribution for BxA Subtest

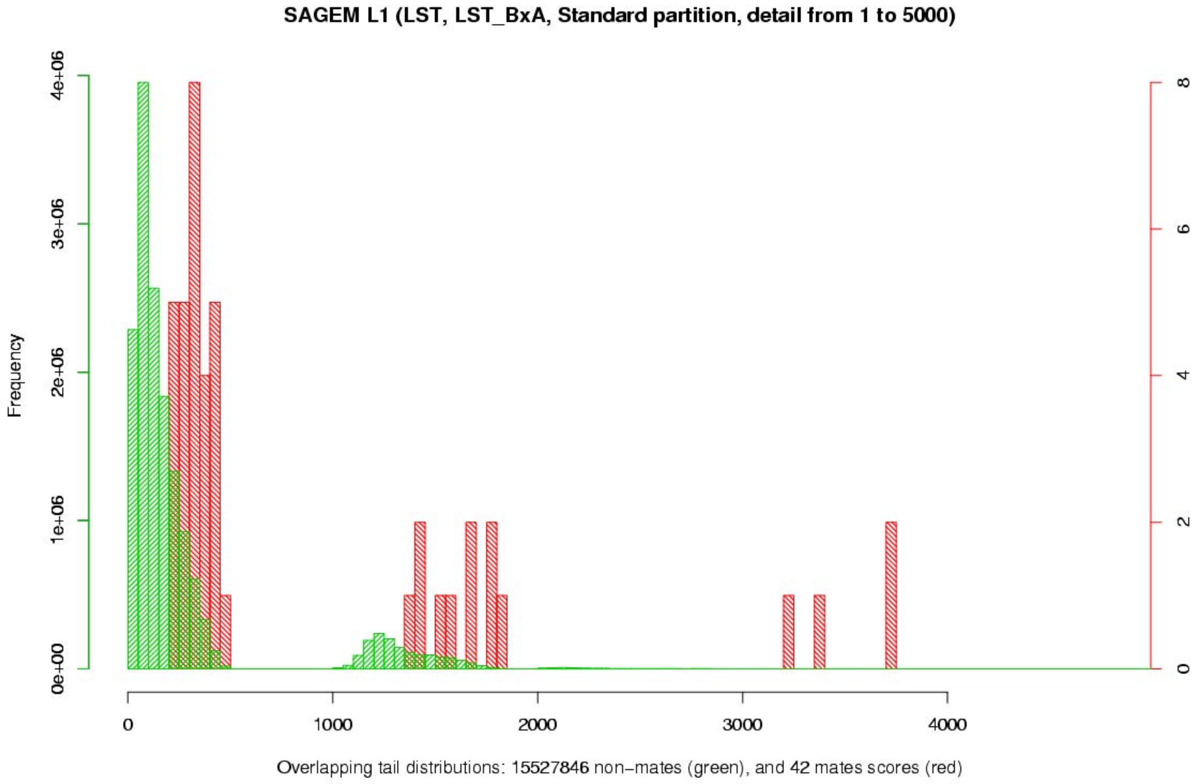


Figure C-92. SAGEM L1 (LST) Match vs. Non-Match Distribution for BxA Subtest (Detail)

18.2 SAGEM L2 (LST)

Configuration: 1 Workflow Control station (Pentium 4) and 2 Fingerprint Processing stations (Pentium 4), running MetaMorpho Software and Matcher Engine version 3.1.2A.NST.3A, and Windows 2000 Professional.

Completion time: 6 days

The figure below shows separate ROCs for 27 distinct operational partitions of the LST test.

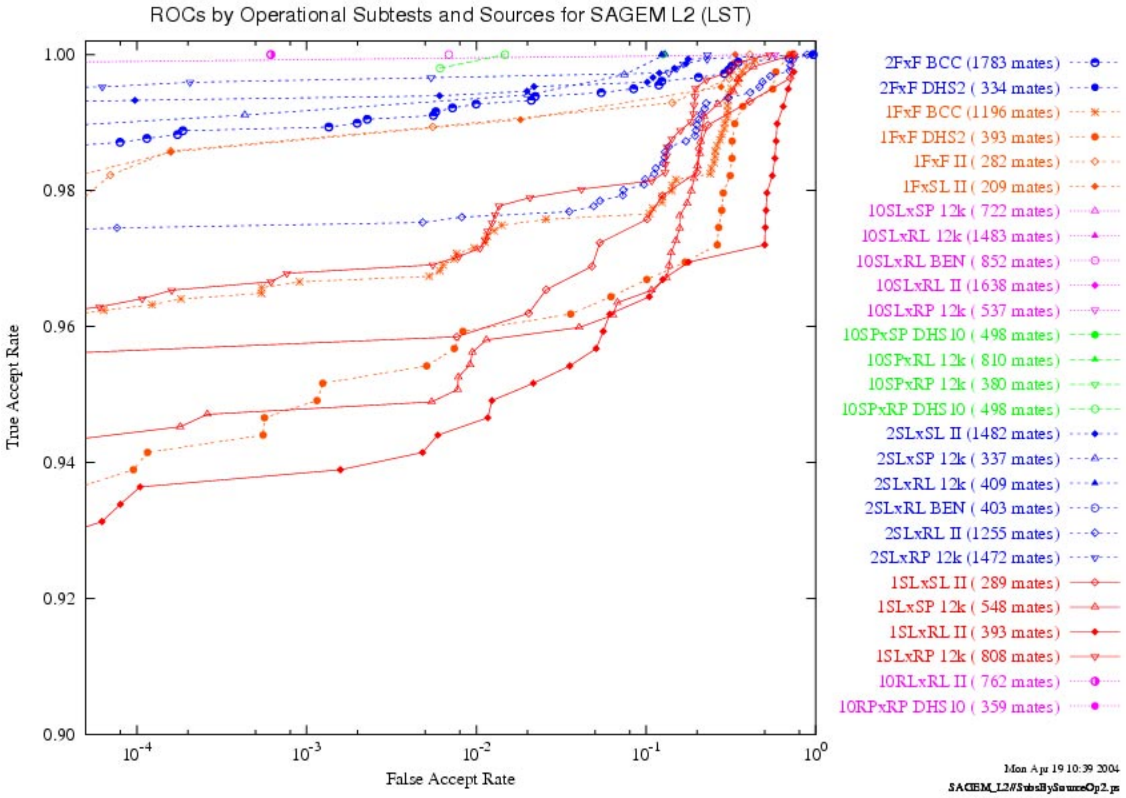


Figure C-93. SAGEM L2 (LST) ROC for 27 Operational Partitions

The figure below shows the same results in a Detection Error Tradeoff (DET) chart, in which the Y axis is in log scale, and accuracy increases down and to the left. DETs show more detail at low error rates. Note that any results with no errors cannot be graphed in a DET.

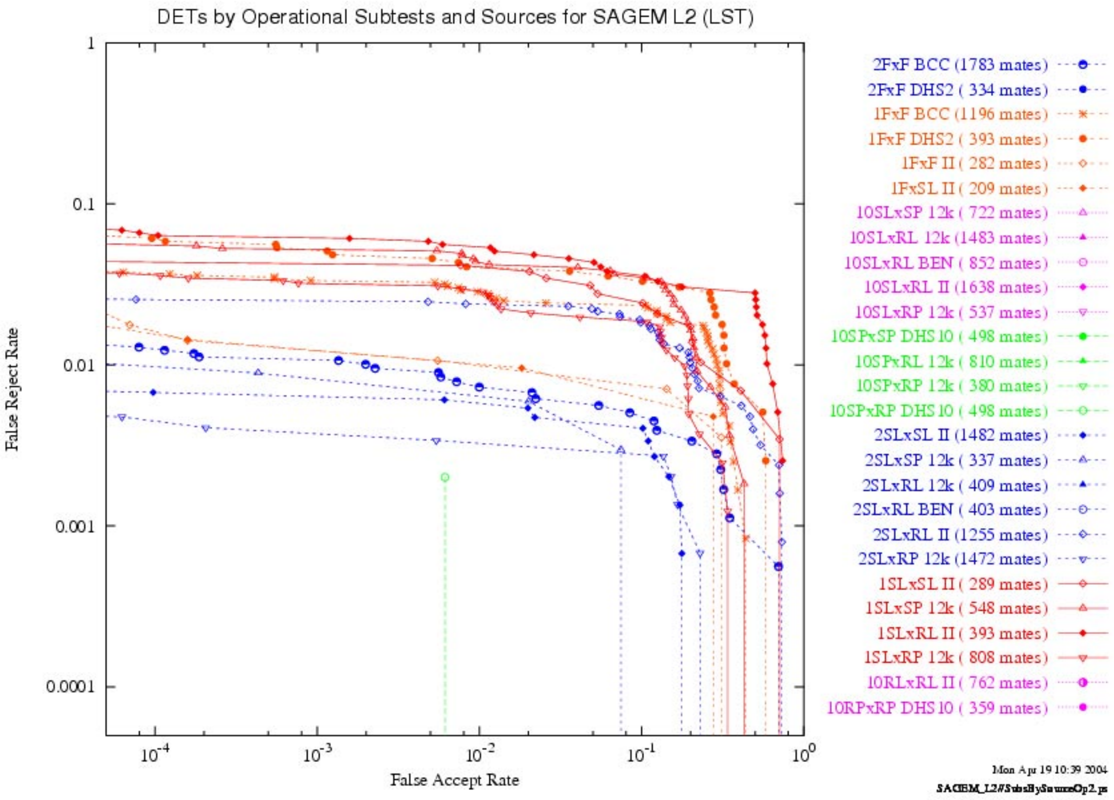


Figure C-94. SAGEM L2 (LST) DET for 27 Operational Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the LST_BxA subtest (single-finger flat images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

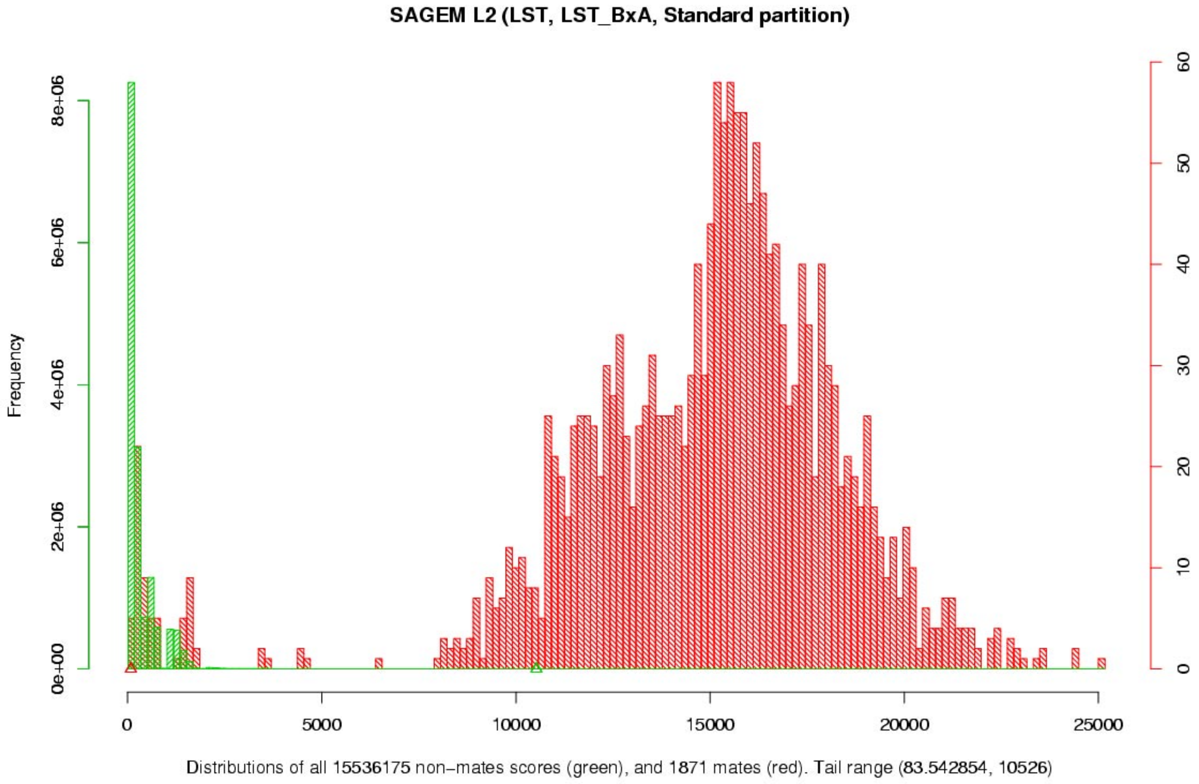


Figure C-95. SAGEM L2 (LST) Match vs. Non-Match Distribution for BxA Subtest

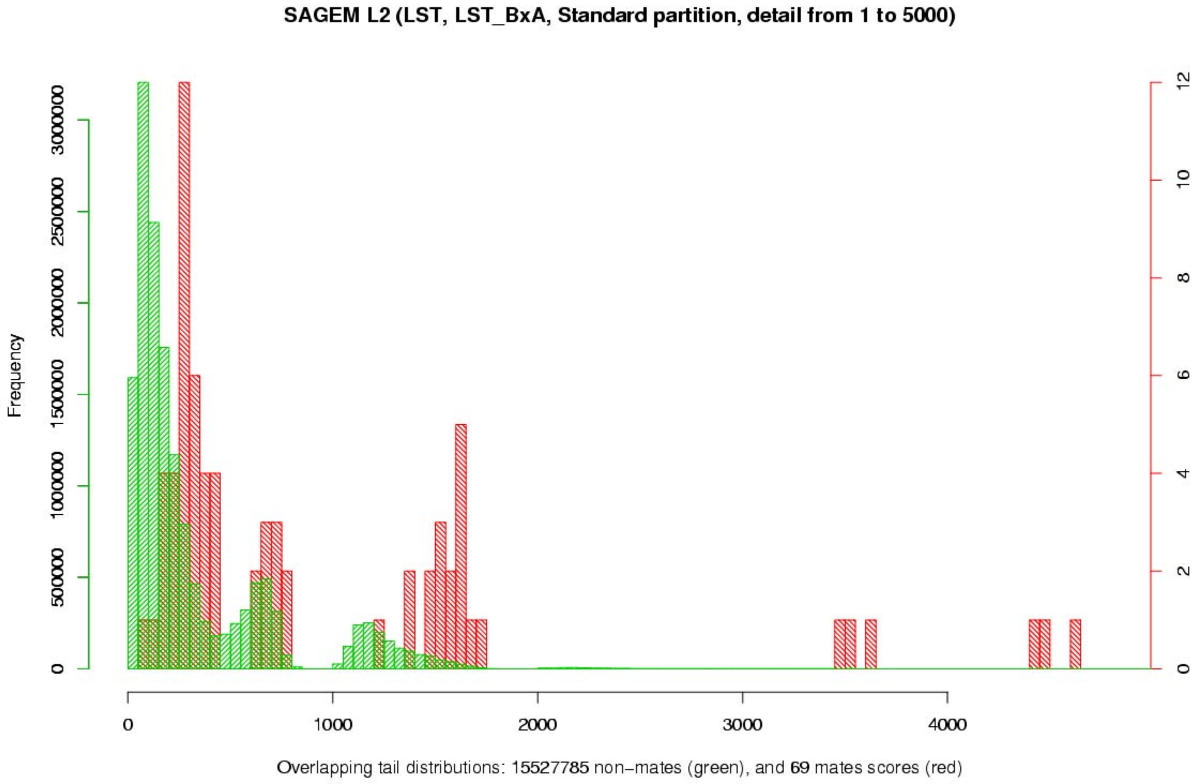


Figure C-96. SAGEM L2 (LST) Match vs. Non-Match Distribution for BxA Subtest (Detail)

18.3 SAGEM M1 (MST)

Configuration: 1 workstation for Workflow Control and Fingerprint Processing (Pentium 4), running MetaMorpho Software and Matcher Engine version 3.1.2A.NST.2A, and Windows 2000 Professional.

Completion time: 4 days

The figure below shows separate ROCs for eight partitions of the MST data.

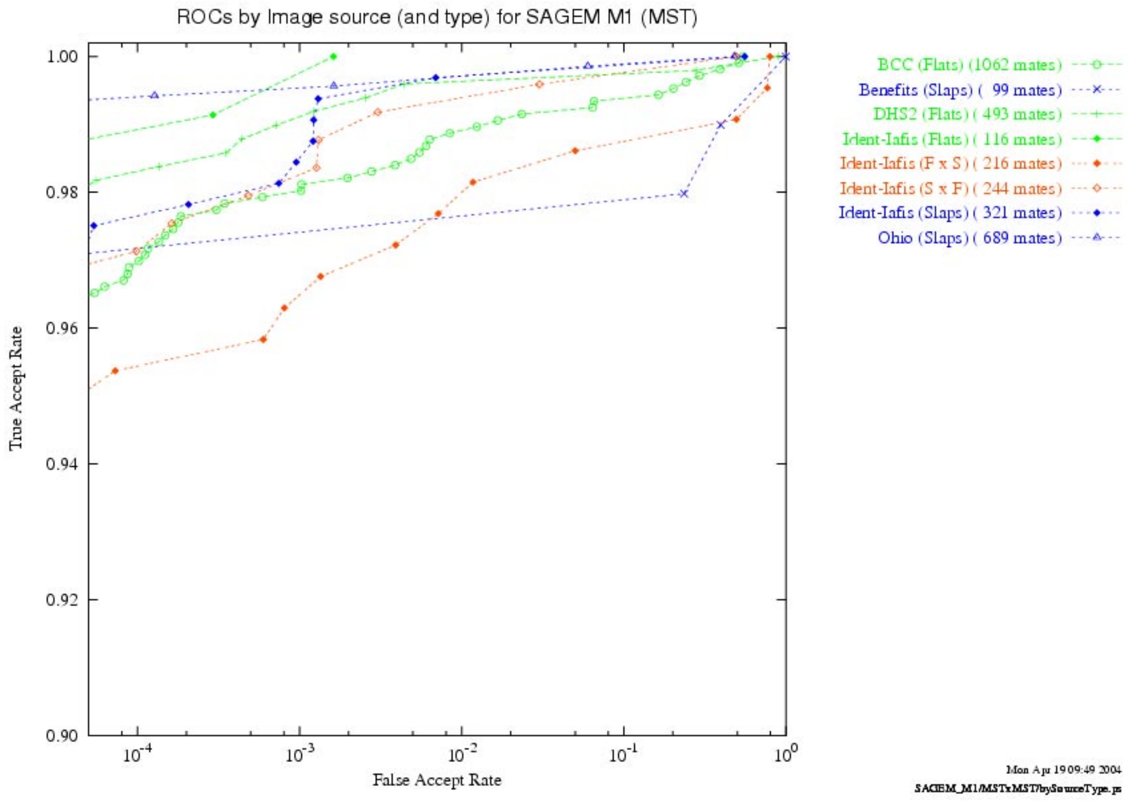


Figure C-97. SAGEM M1 (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

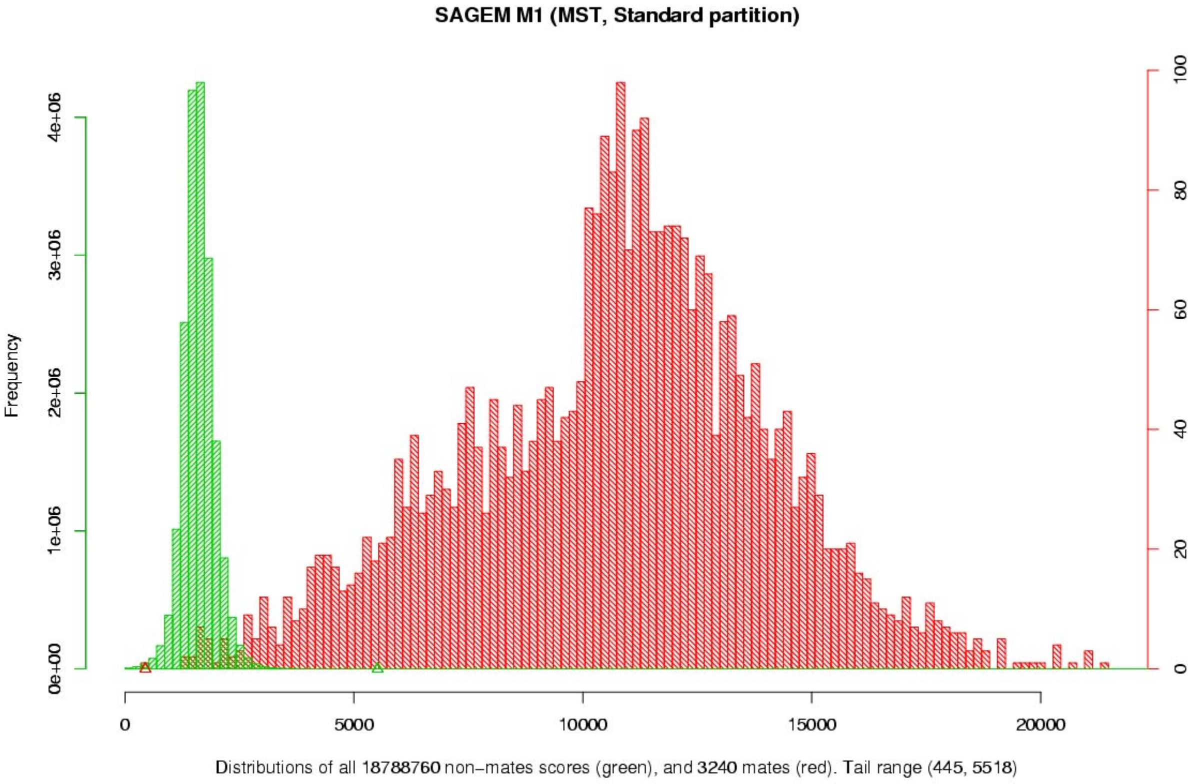


Figure C-98. SAGEM M1 (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data.

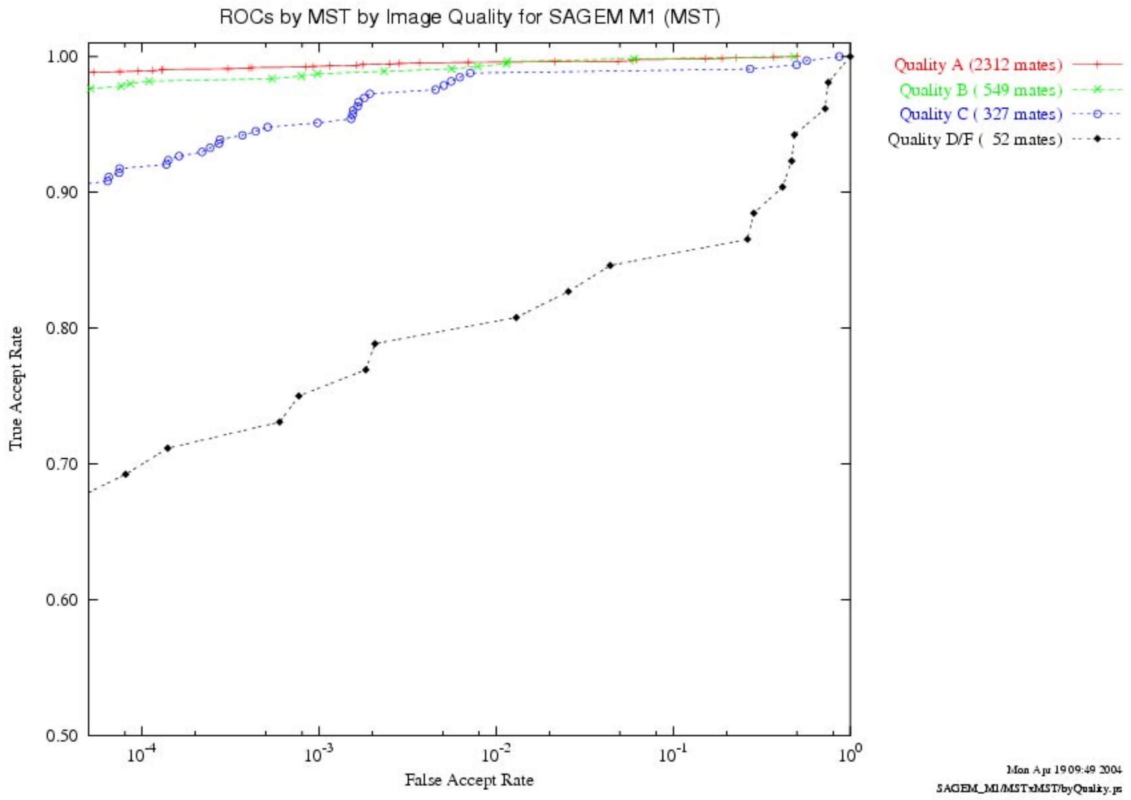


Figure C-99. Effect of Image Quality

18.4 SAGEM M2 (MST) (Halted)

SAGEM encountered a variety of problems in their initial 3-workstation configuration for MST M2. They reconfigured to run using a single machine, then ran successfully.

18.5 SAGEM M2 (MST)

Configuration: 1 workstation for Workflow Control and Fingerprint Processing (Pentium 4), running MetaMorpho Software and Matcher Engine version 3.1.2A.NST.2A, and Windows 2000 Professional.

Completion time: 10 days

The figure below shows separate ROCs for eight partitions of the MST data.

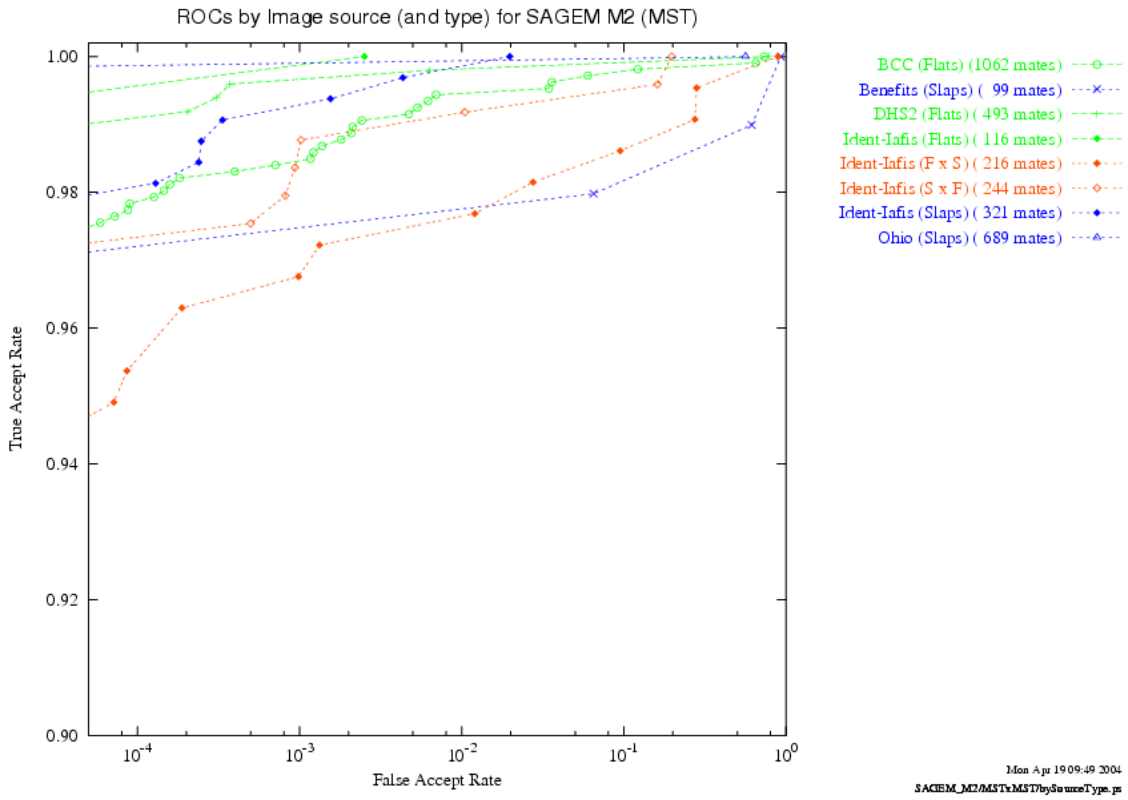


Figure C-100. SAGEM M2 (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

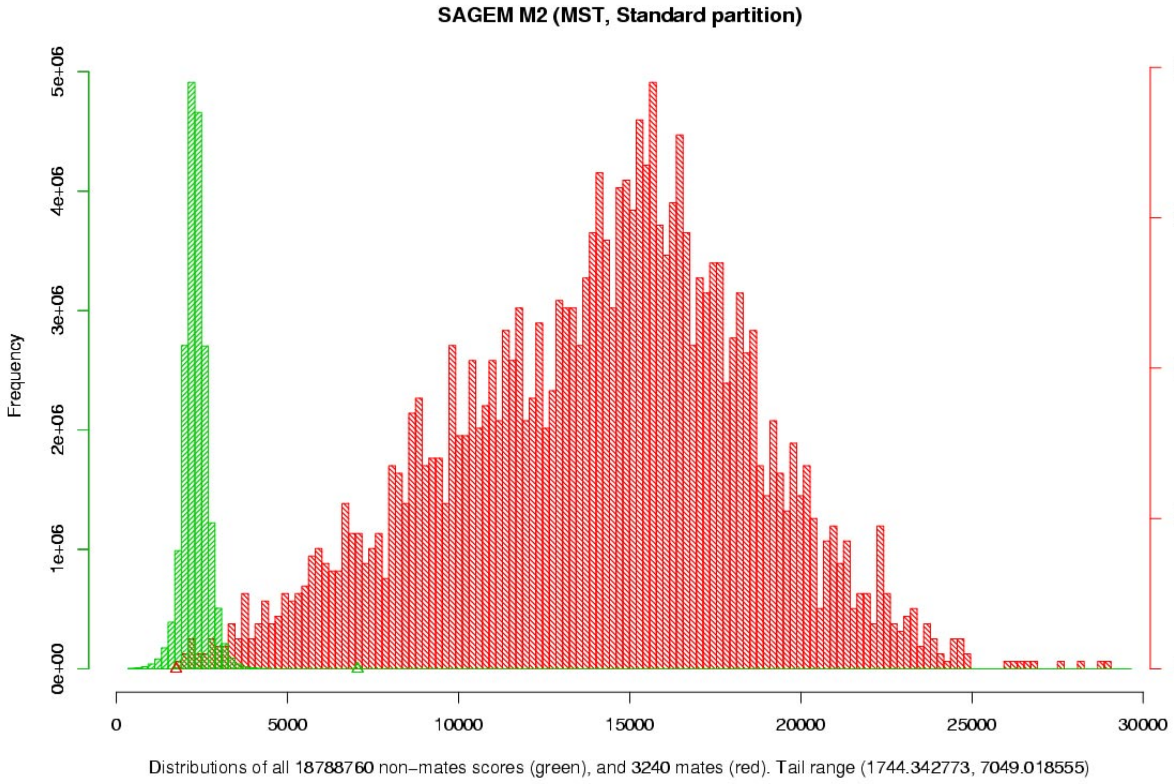


Figure C-101. SAGEM M2 (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data.

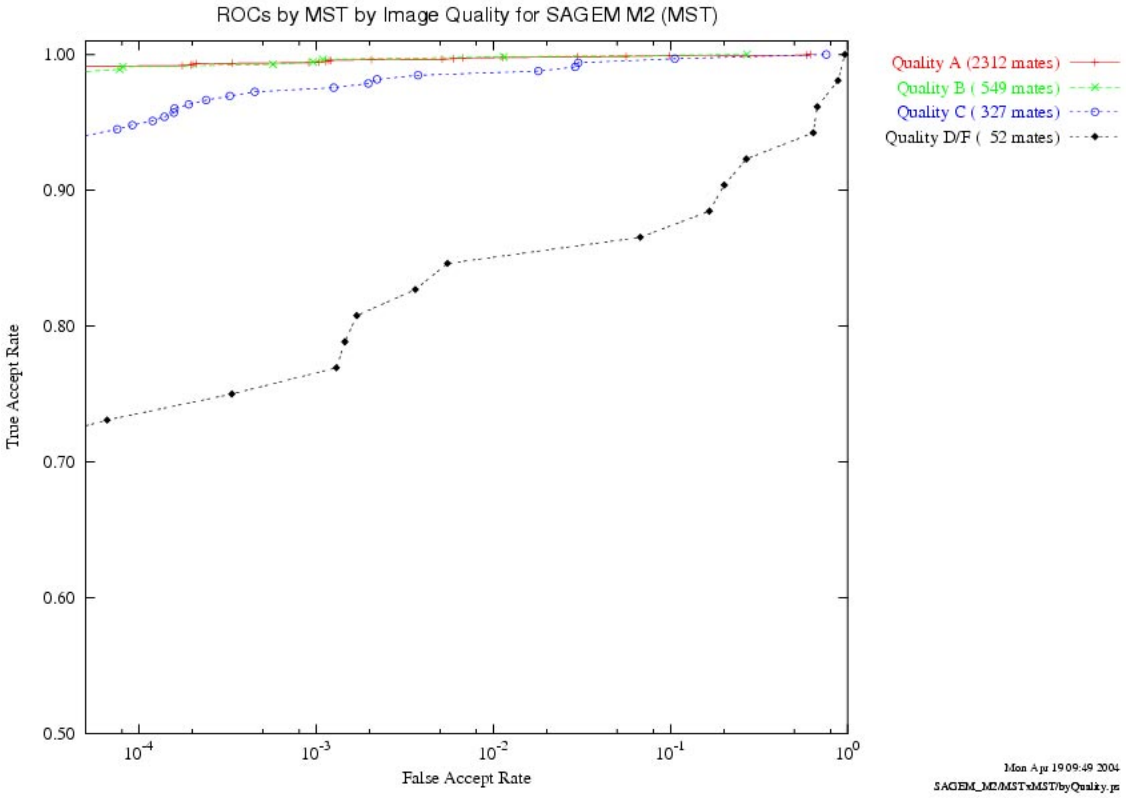


Figure C-102. Effect of Image Quality

19 Technoimagia

System name: FP-Workstation

Configuration: 1 HP xw6000/CT workstation (dual Xeon), running Fingerprint Aunthentication System Tool21 ("FAST21") and Windows XP.

19.1 Technoimagia (MST)

Completion time: 5 days

The figure below shows separate ROCs for eight partitions of the MST data. Technoimagia (MST) achieved very low scores on DHS2 (low quality flat images). The flat images, in general, show a marked drop in accuracy when the operational threshold is set high.

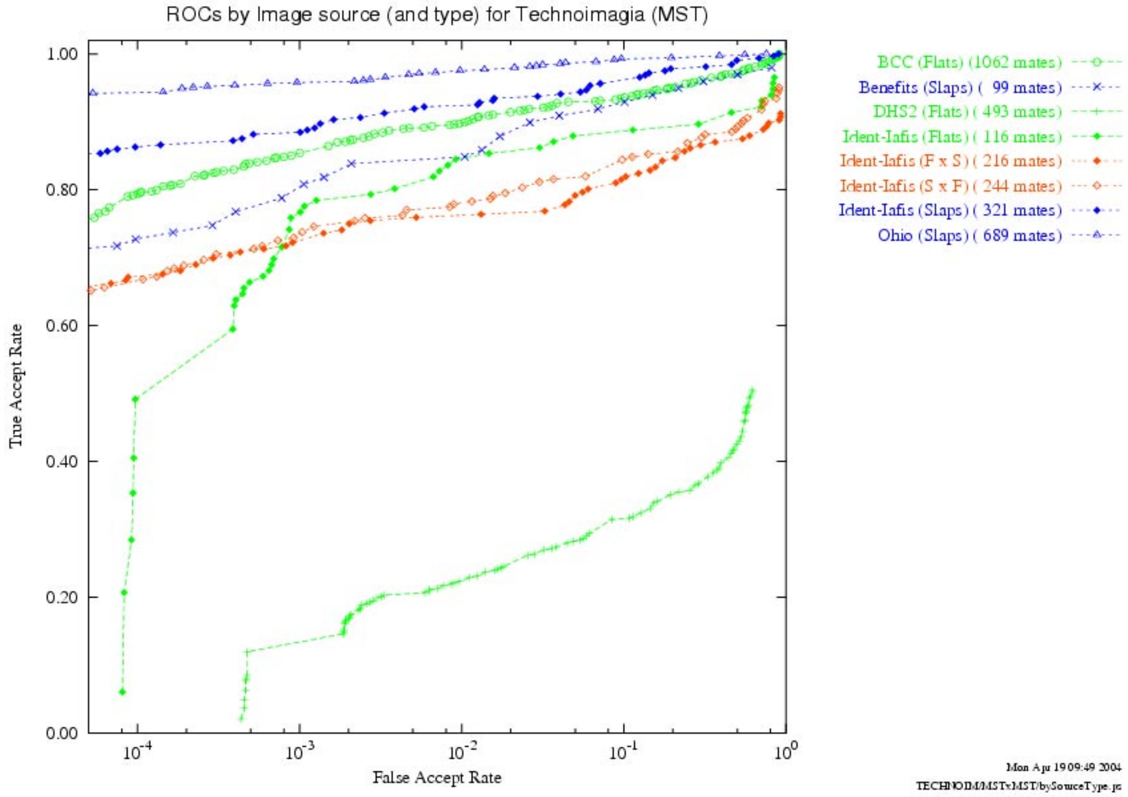


Figure C-103. Technoimagia (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail." Note that the ranges of the match and non-match distributions are identical. Note the large number of 0 scores for mates.

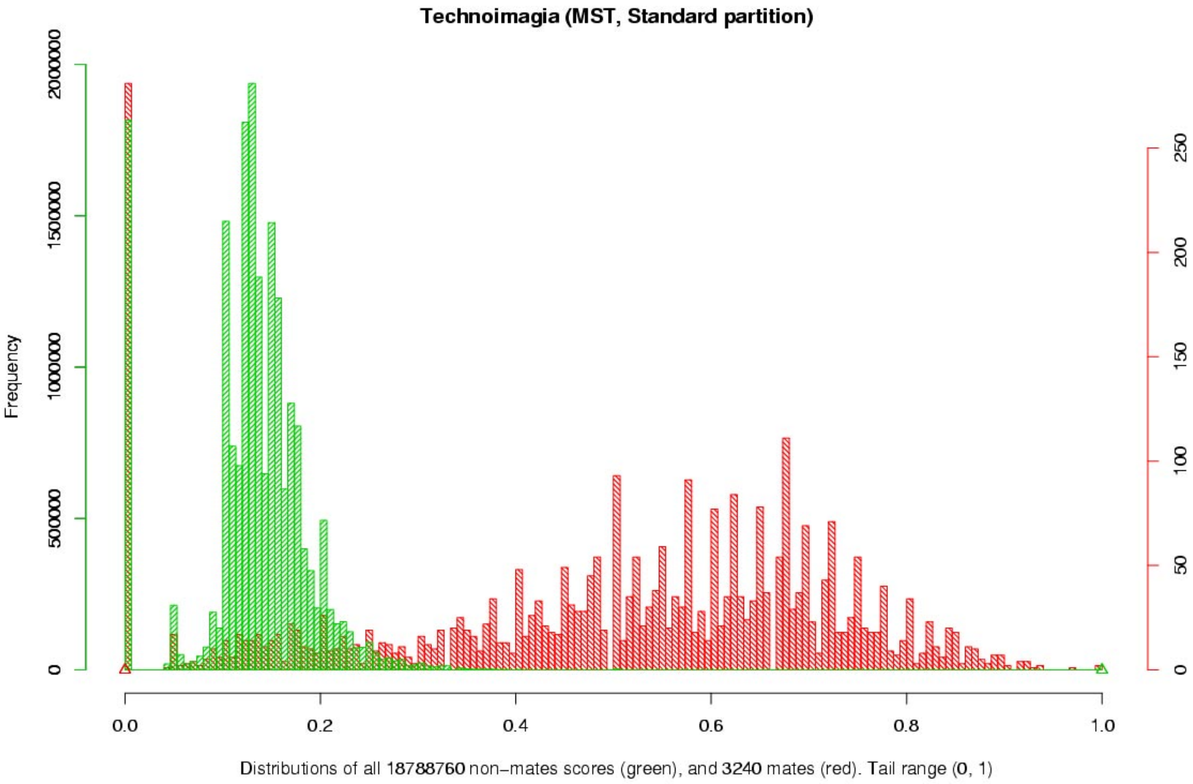


Figure C-104. Technoimagia (MST) Match vs. Non-Match Distribution

The following detailed histogram of the BCC results shows a significant peak in non-match scores at 0.5 and 1.0, which may account for the distinct shape of Technoimagia's BCC ROC.

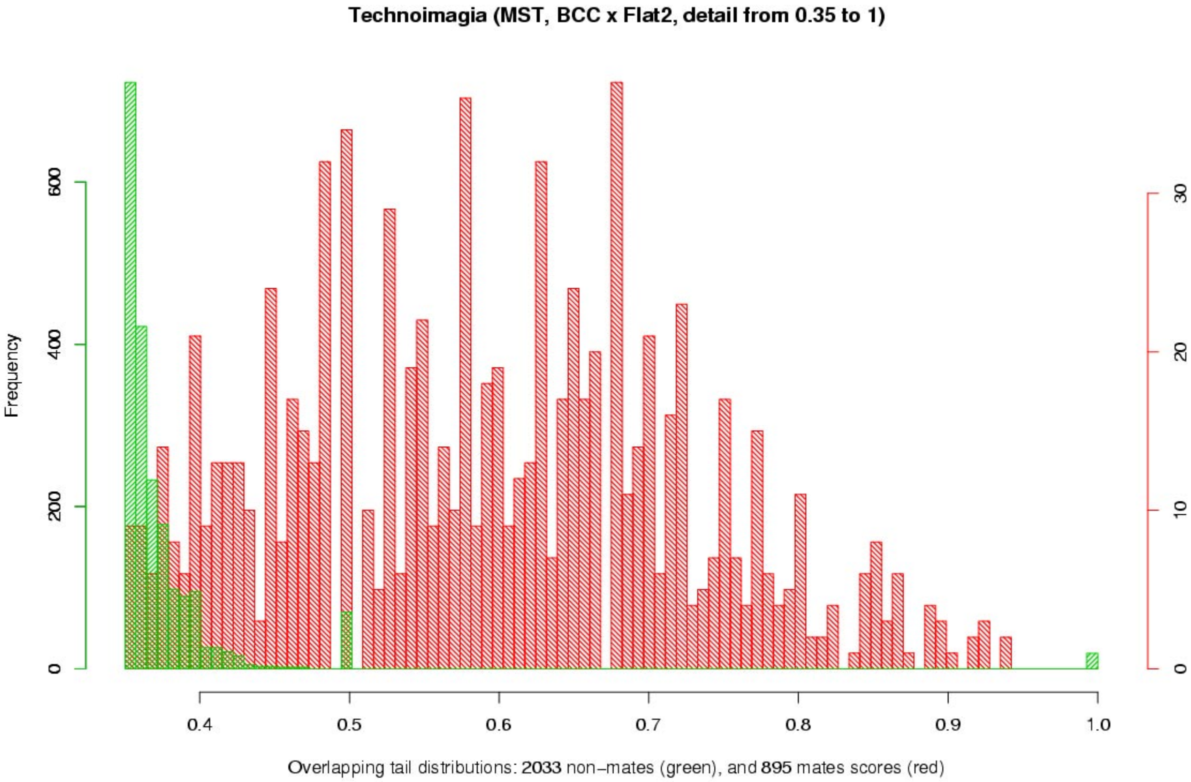


Figure C-105. Technoimagia (MST) Match vs. Non-Match Distribution (Detail)

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. Technoimagia provided image quality data, which was used to develop the aggregate metric.

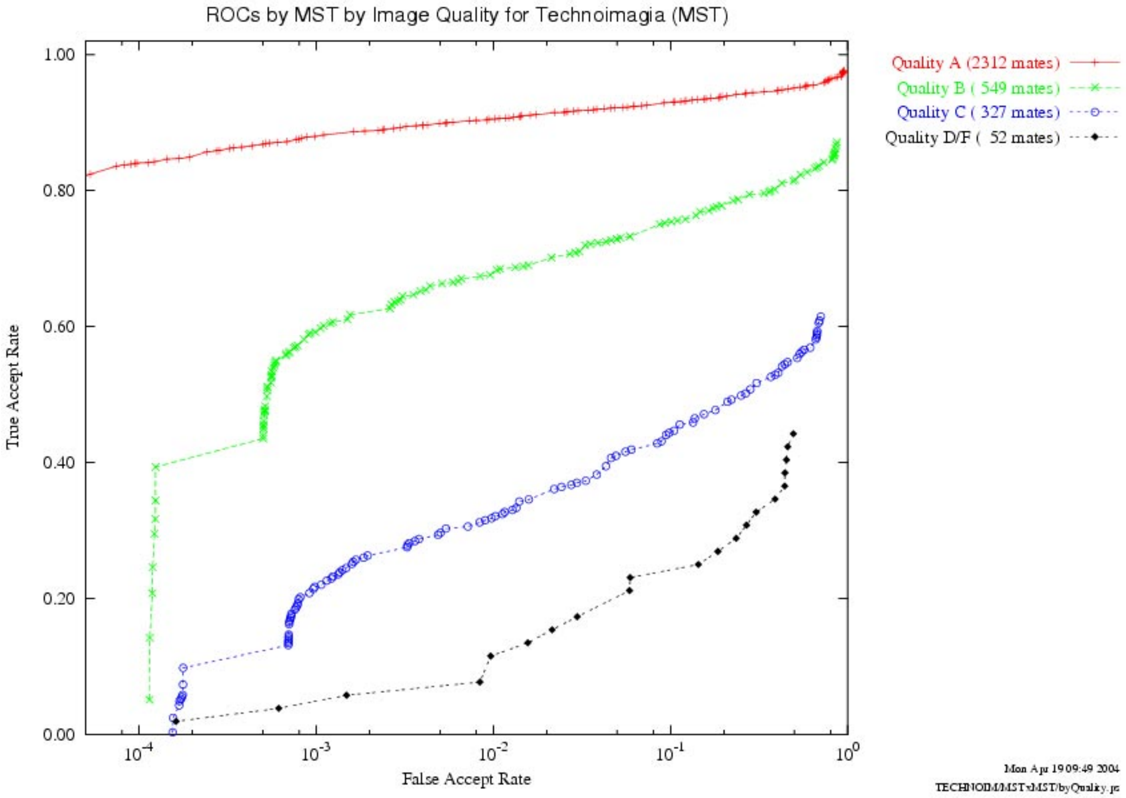


Figure C-106. Effect of Image Quality

Image quality data was provided by Technoimagia (MST), and was among the seven IQMs used in the FpVTE aggregate image quality metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Technoimagia	1.0	0.0	1.6	1.8	2.0	8.55%

Table C-9. Image Quality Distribution

20 UltraScan

20.1 UltraScan M1 (MST)

System name: IDExpress Developer

Configuration: 1 PC (Pentium 4), running IDExpress Developer version 1.5.3 and Windows XP Professional.

Completion time: 2 days

The figure below shows separate ROCs for eight partitions of the MST data.

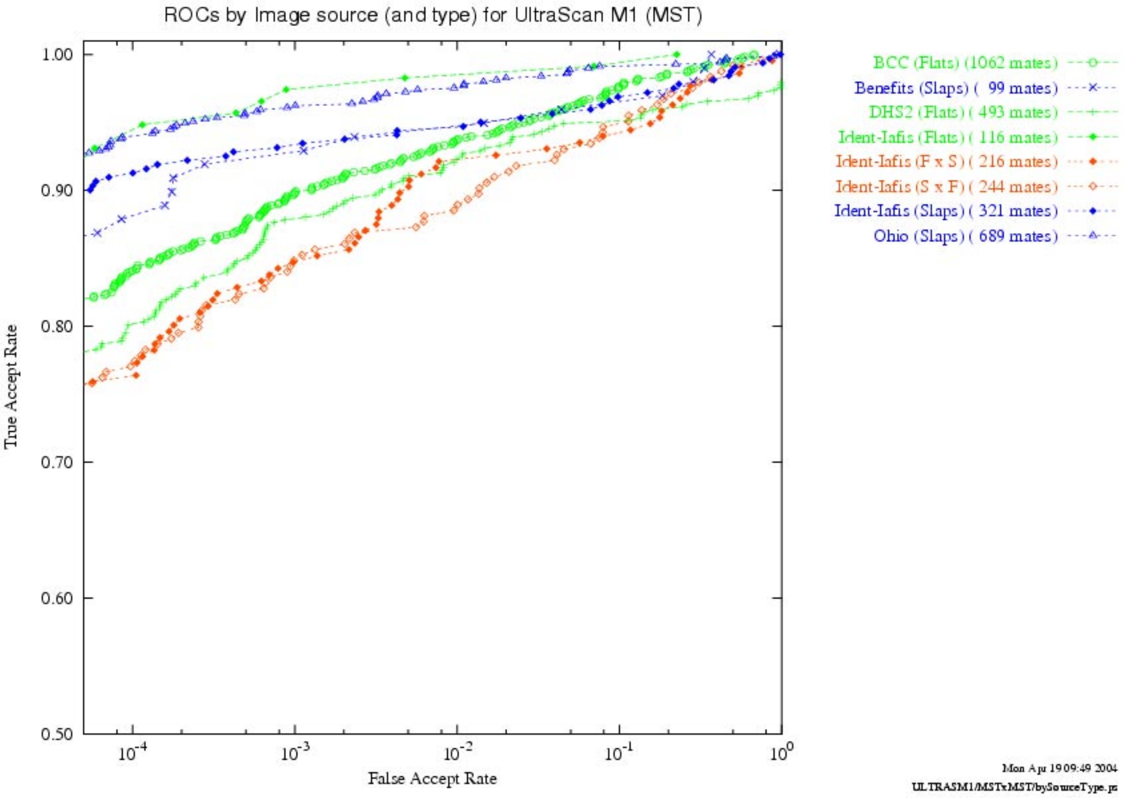


Figure C-107. UltraScan M1 (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

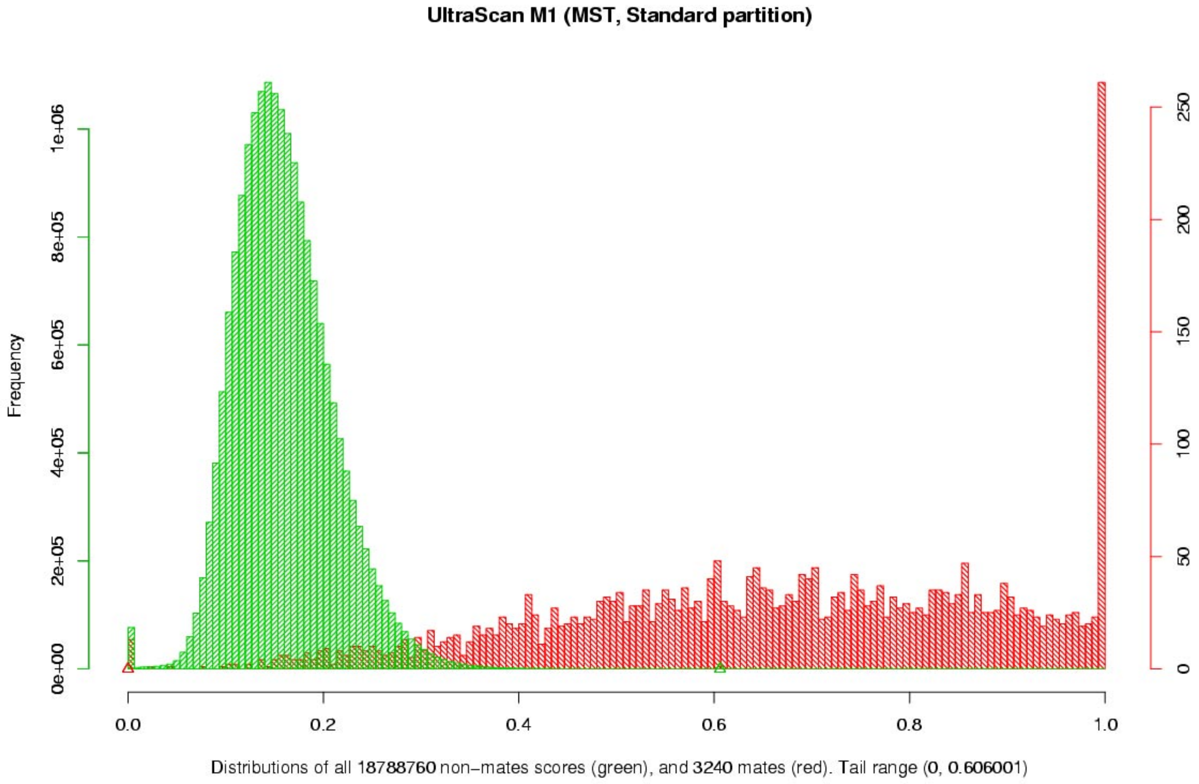


Figure C-108. UltraScan M1 (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. UltraScan (M1 and M2) provided image quality data; the UltraScan M1 image quality data was used to develop the aggregate metric.

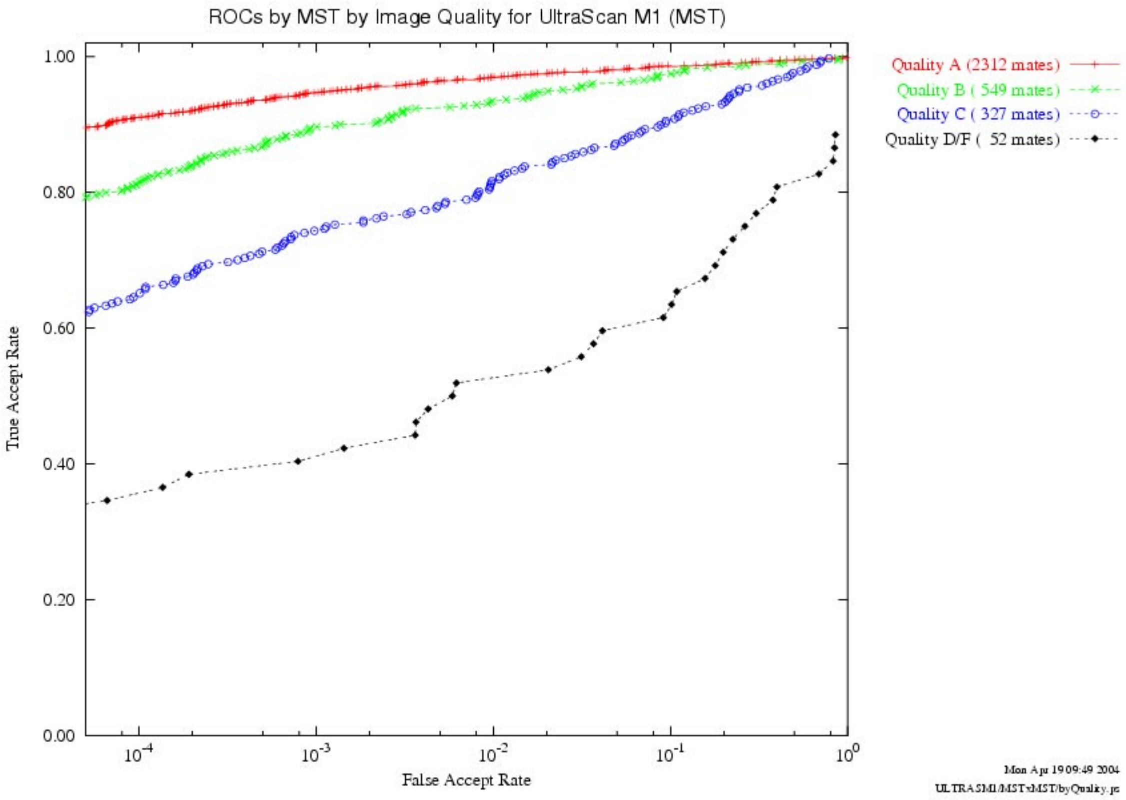


Figure C-109. Effect of Image Quality

Image quality data was provided by UltraScan M1 and M2 (MST). Because of the similarity of these measures, only UltraScan M1 was among the seven IQMs used in the FpVTE aggregate image quality metric.

Participant	Threshold	Min	Mean	Median	Max	% FTE
Ultrascan M1	0.7	0.0	0.9	0.9	1.0	1.23%
Ultrascan M2	0.7	0.0	0.9	0.9	1.0	1.21%

Table C-10. Image Quality Distribution

20.2 UltraScan M2 (MST)

System name: IV &V

Configuration: 1 PC (Pentium 4), running IVV version 2.00 and Windows XP Professional.

Completion time: 2 days

The figure below shows separate ROCs for eight partitions of the MST data.

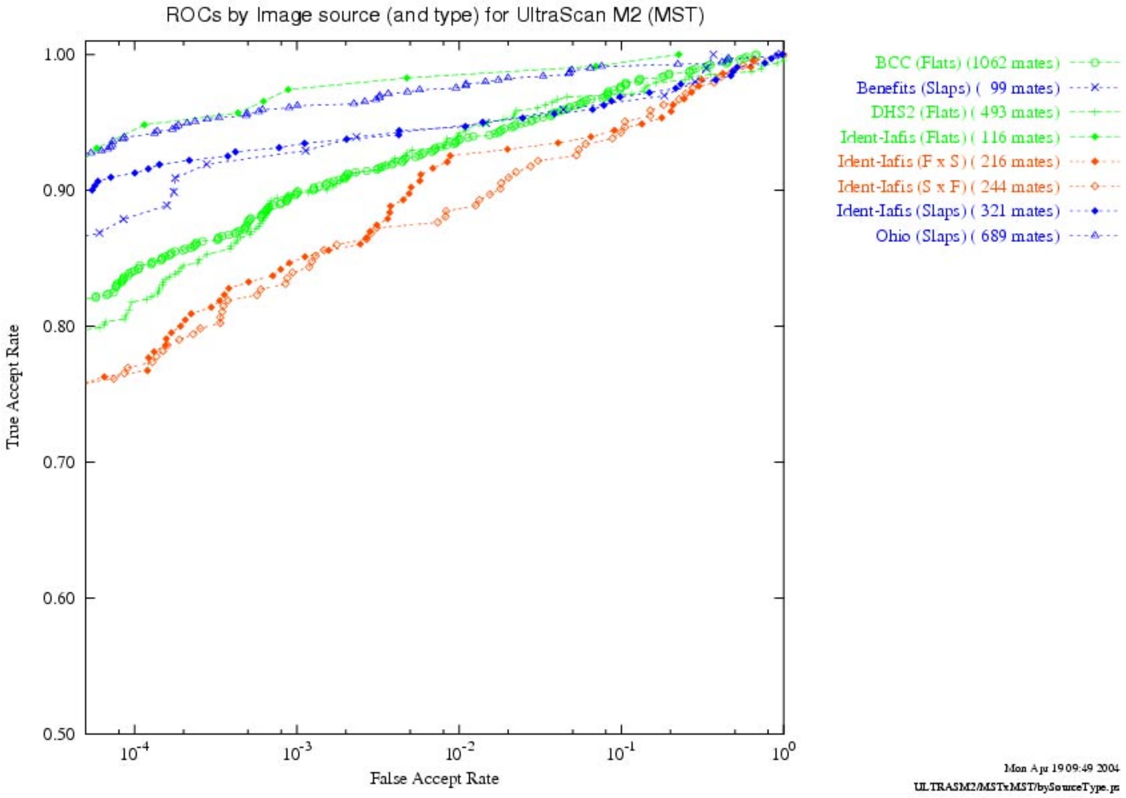


Figure C-110. UltraScan M2 (MST) ROCs for MST Partitions

The following histogram shows the score distributions for match and non-match scores on the Standard partition of the MST test (single-finger flat and slap images). The y-axis on the left indicates the number of non-match scores (green data). The y-axis on the right indicates the number of mate scores (red data). Note that the minimum match score and maximum non-match score are indicated with red and green tick marks in the chart; this area of overlap is described in the caption as the "tail."

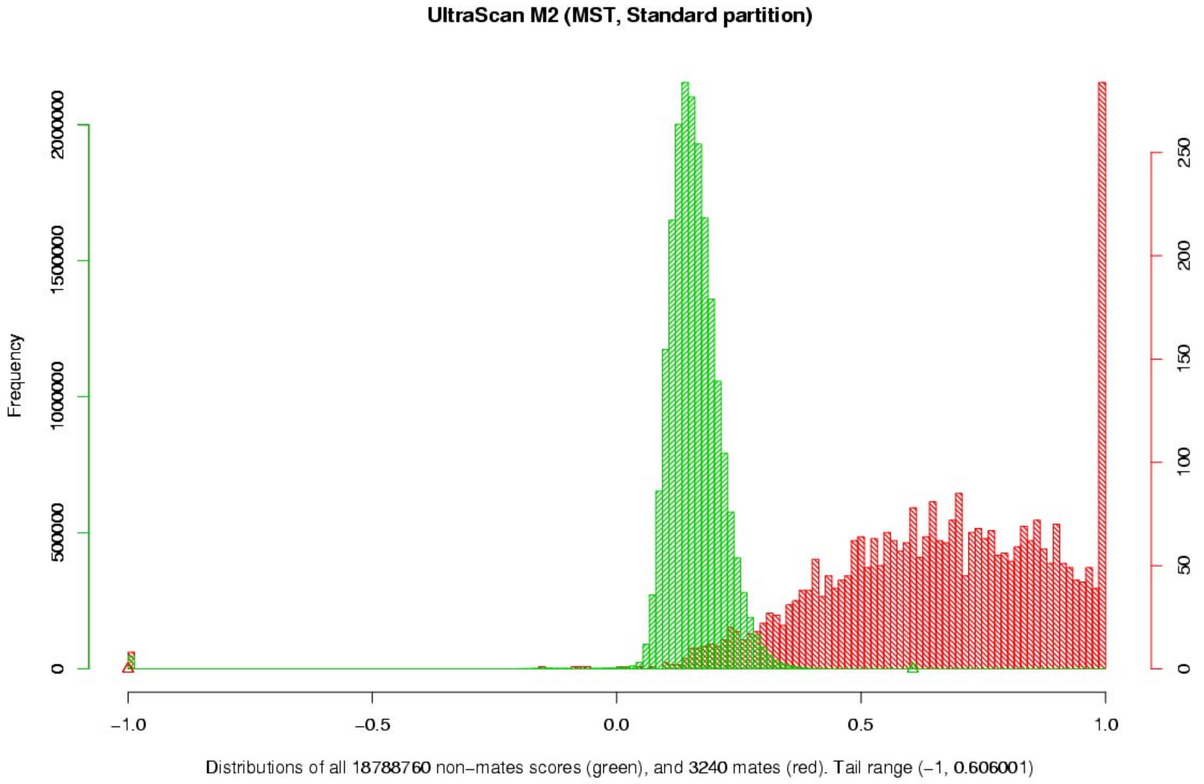


Figure C-111. UltraScan M2 (MST) Match vs. Non-Match Distribution

The following figure shows sensitivity to image quality, where the image quality metric represents an aggregate of responses from seven systems that provided image quality data. UltraScan provided image quality data, which was used to develop this aggregate metric.

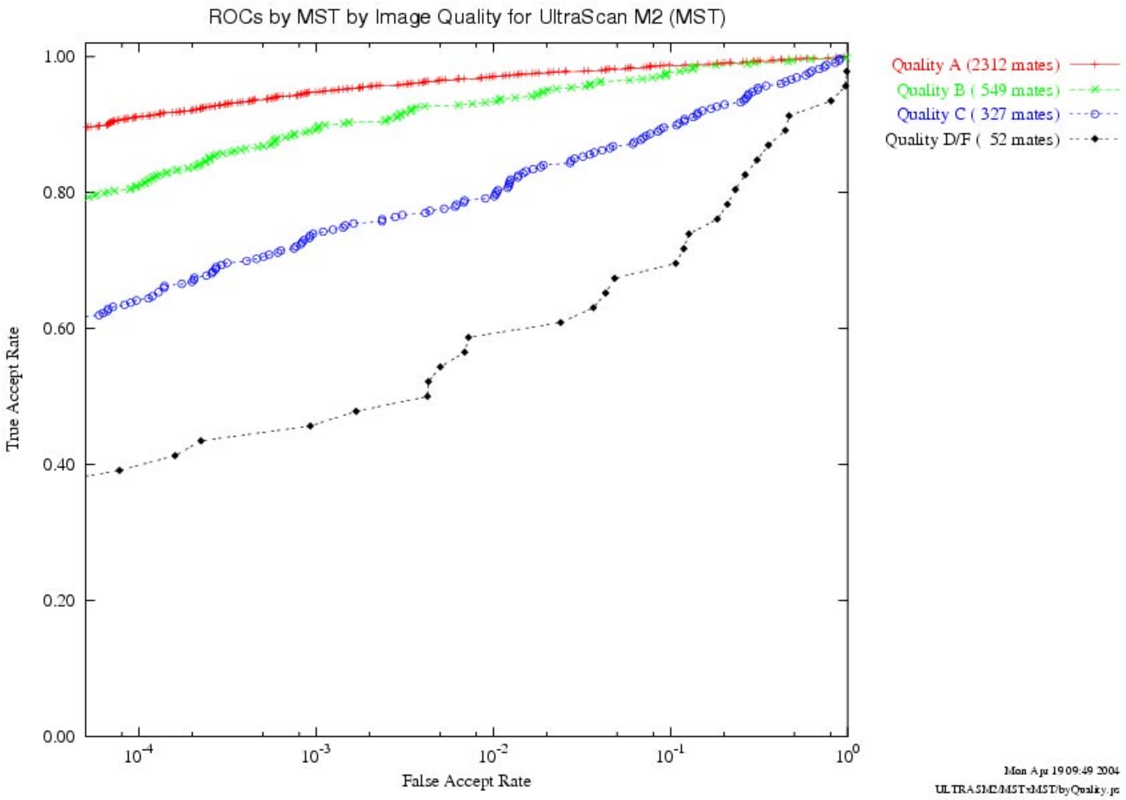


Figure C-112. Effect of Image Quality

21 Test Processing Issues

Several of the systems encountered problems while the evaluation was being conducted. A summary of the issues is included in Table C-11.

Several systems encountered WSQ decompression problems. The sample, trivial, and evaluation images came from a variety of sources, and therefore were compressed using various WSQ implementations. All of the images in FpVTE could be decompressed using NIST's WSQ toolkit [LFIS], as well as Aware's WSQ. Some other WSQ implementations had problems decompressing some of the images in FpVTE.

Several systems encountered errors writing to USB drives. The MD5 files provided proof that the similarity matrices as written by the system were not corrupted, and in several cases indicated that similarity matrices needed to be recopied.

Several systems had scripting problems that were uncovered when the trivial datasets were run. These were resolved before the start of the evaluation itself, so they are not reported here.

Two systems submitted results that were subsequently, during analysis, shown to be in error; these are noted with asterisks (*).

System	Level of Problems	Summary of Issues
123 ID (LST)	Major	Memory problems; node crash; hard drive problems; did not complete in time
123 ID M1 (MST)	Major	Memory overflow problems; updated code; reran as 123 M2
123 ID M2 (MST)	None	
Antheus (LST)	Minor	Writing directly to USB drive during test was unsuccessful
Antheus (MST)	None	
Avalon (LST)	Major	Multiple system crashes; halted test
Avalon (MST)	None	
Biolink (LST)	None	
Biolink (MST)	None	
Bioscrypt (SST)	None	
Cogent (LST)	Medium	System crash; manual combination of results and load balancing
Cogent (MST)	None	
Cogent (SST)	None	
Dermalog (LST)	Medium	Network deadlock required reboot and affected some subtests; affected subtests were rerun
Dermalog (MST)	None*	(No problems during tests, but the resulting similarity matrix contained only zeros)
Golden Finger (LST)	Minor	Crash during decompression of WSQ image, restart
Golden Finger (MST)	None	
Griaule (LST)	Major	System could not recover after failures to enroll; multiple reboots; updated code and ran successfully
Identix (LST)	Medium	System failed to automatically merge results from different nodes

System	Level of Problems	Summary of Issues
Identix (MST)	None	
Motorola (LST)	Major	Unable to decompress 3 images; changed WSQ software; problems with load balancing and throughput; multiple restarts; updated code
Motorola (MST)	None	
NEC (LST)	Minor	Problem with one node
NEC (MST)	None	
Neurotechnologija M1 (MST)	Medium	Unable to decompress 31 images; ignored those images and completed test, but reran with different WSQ decoder as M2
Neurotechnologija M2 (MST)	None*	(No problems during tests, but much of the resulting similarity matrix contained apparently random results)
Phoenix (MST)	Minor	One similarity file had to be recopied
Raytheon (LST)	Minor	Problem processing one file; restarted
Raytheon (MST)	None	
SAGEM L1 (LST)	None	
SAGEM L2 (LST)	None	
SAGEM M1 (MST)	None	
SAGEM M2 (MST)	Major	Problems transferring files between machines; reconfigured to run using single machine, restarted successfully
Technoimagia (MST)	None	Ran two identical systems simultaneously for redundancy; results were identical
UltraScan M1 (MST)	None	
UltraScan M2 (MST)	None	

Table C-11. Summary of Processing Issues

Further detail of issues encountered during processing is included below.

123 ID LST

- Memory low, template create failed on some nodes; patched, restarted
- Found memory leak, new patch, restarted
- Node crashed—missing 40% of data from that node; installed spare, restarted other nodes
- Applied patch to redo data lost on bad node; restarted each node
- Replaced bad node
- Another node had hard drive errors—pulled from system
- Did not complete LST by deadline; completed after time ran out
- These overtime results are not included in the main body of the report

123 ID MST

- Program that collects results from each of the nodes failed
- Brought in new application to collect results from nodes
- Discovered memory overflow problems
- Asked to rerun MST with additional hardware and improved filtering—Test Agents agreed

- Reran. Results presented in main body of report are from this second run (M2)

ANTHEUS LST

- Planned to read and write to USB on the fly
- System stopped matching during test; was rebooted and restarted writing to system disk rather than USB
- No other problems

ANTHEUS MST

- MST ran with no problems

AVALON LST

- System appeared to get stuck on WSQ conversion; shut down and restarted
- Had to copy templates to 2 nodes because automatic process failed
- System crashed, restarted
- System crashed again—major problems
- Installed program to generate more extensive logging information
- Continued to have problems processing subtests involving dataset C
- Installed another program with more extensive logging and restarted
- Continued to have problems
- Decided to halt test

AVALON MST

- Ran MST with no problems

BIOLINK LST

- Did MST and LST simultaneously
- LST ran with no problems

BIOLINK MST

- Did MST and LST simultaneously
- MST ran with no problems

BIOSCRYPT SST

- Ran SST with no problems

COGENT LST

- Ran SST, MST, and LST simultaneously
- Combining of preprocessed files failed to execute on some subtests. Had to manually combine and restart matching
- Crashed at one point, had to be restarted, and files manually combined
- Moved input files around to make room for results
- Performed manual load balancing among nodes

- Completed LST with no further problems

Cogent MST

- Ran SST, MST, and LST simultaneously
- MST ran with no problems

Cogent SST

- Ran SST, MST, and LST simultaneously
- SST ran with no problems

Dermalog LST

- Networking was in a deadlock at one point. Rebooted and restarted.
- Found that results from some subtests were affected by the network problem
- Saved first results (with a few bad subtests) as Dermalog 1st run
- Reran the affected subtests
- Combined reprocessed subtest with good subtests from 1st run to form results analyzed in main report

Dermalog MST

- Ran MST in less than an hour
- MST ran with no apparent problems
- (No problems during tests, but the resulting similarity matrix contained only zeros)

Golden Finger LST

- Ran LST over AC outage weekend
- LST system crashed over AC outage weekend while trying to do a WSQ conversion. Restarted ignoring problem file
- No other problems

Golden Finger MST

- Ran MST with no problems

Griaule LST

- Some machines were not responding so had to reboot 9 nodes
- Same problem again, had to reboot 9 nodes
- Discovered that not all images were enrolled because the system didn't recover after an FTE; revised code
- Reboot and restart required after problem in watchdog program
- Finished LST with no further problems

Identix LST

- Several nodes stuck on preprocessing; restarted
- Failed to create templates for several files

- System failed to automatically merge sim files from different nodes. Stopped processing, restarted; still failed to merge. Wrote script to merge
- Successfully completed LST

IDENTIX MST

- Ran MST with no problems

MOTOROLA LST

- Image processing got stuck; stopped and restarted processing
- Image processing got stuck again; determined that 3 images were causing problems
- Finally got one of the 3 images to process, still had problems with other two
- Switched to Aware for WSQ decompression; images processed
- LST matching progressed at 1/10th expected speed; stopped, restarted process
- Reduced logging requirements, ran much faster
- Processes stuck on all nodes; found secondary processing was using original WSQ decompression routine; changed to Aware; restarted
- Still running slowly, applied patch; restarted
- Applied another patch to fix logging problem; restarted
- Problems with load balancing; revised configuration, restarted
- System writing scores to both text log files and sim files; corrected
- No further problems with LST

MOTOROLA MST

- Ran MST with no problems

NEC LST

- Found problem with one node; moved files to another node
- Ran LST with no other problems

NEC MST

- Stopped processing over AC outage weekend, then restarted
- Ran MST with no problems

NEUROTECHNOLOGIJA MST

- Software developers in Lithuania could not come due to visa problems, so sent US sales rep to take the test
- Had problems with WSQ decompression on some images
- Modified script to skip images it can’t read; ran MST
- Skipped 31 images in MST (first run)
- Wiped disk, then updataed software and reran MST (2nd run)
- First run results are reported in body of report (with skipped images) because second run had results in error.

PHOENIX MST

- Ran MST with no problems
- After MST completed, the last sim file was not written to the CD (error run)
- Closed message window saying run was complete and last sim file was written
- The results in the body of the report include the last sim file

RAYTHEON LST

- Ran over the AC outage weekend with portable AC units
- Had problem preprocessing a file; rebooted and restarted
- Finished LST with no other problems

RAYTHEON MST

- Ran MST with no problems

SAGEM LST 1

- LST output also had trivial output—had to separate
- No other problems running LST

SAGEM LST 2

- LST output also had trivial output—had to separate
- No other problems running LST

SAGEM MST 1

- Ran MST with no problems

SAGEM MST 2

- RAM problems in one machine of 3 machine configuration
- UPS battery found to be low
- Later discovered real problem was transfer of files among the 3 machines
- Saved partial results; reconfigured to use only 1 machine; reran
- Results reported in body of report are from reconfigured 1 machine run

TECHNOIMAGIA MST

- Set up two redundant systems in case one crashed
- Ran MST on both systems with no problems

ULTRA-SCAN MST1

- Set up two separate systems
- Ran MST on with no problems

ULTRA-SCAN MST 2

- Set up two separate systems
- Ran MST on with no problems