Ongoing MINEX Report Card

Matcher 1Z

National Institute of
Standards and Technology
U.S. Department of Commerce

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Participant Details

Company: Griaule Biometrics
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Date Completed: 9/19/2007

Compliance Test Results

The following presents **PIV compliance** results per the criteria detailed in NIST Special Publication 800-76-2: Biometric Specifications for Personal Identity Verification.

PIV Level One: FAIL

- Must match templates from all certified template generators with an $\text{FNMR}_{\text{FMR}}(0.01) \leq 0.01$ using two fingers (4.5.2.1-4). ✗ *(See Table 4)*

PIV Level Two: FAIL

- Must pass PIV level one compliance. ✗
- Native template generator must pass level one compliance. ✗
- Must match templates from native template generator with an $\text{FNMR}_{\text{FMR}}(0.0001) \leq 0.02$ using one finger (4.5.3-2) ✗

Notes

- This report will be updated as new matching algorithms and template generators pass the compliance test. These updates will not change the PASS/FAIL decision above.
- NIST reserves the right to decertify a matcher if it later discovers the matcher violates PIV specifications in some previously undetected way.

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1 Introduction

This report card presents measurements of performance and interoperability for a single fingerprint matching algorithm submitted to NIST as part of the ongoing MINEX Evaluation. It reports whether the matcher passes the technical requirements for PIV-compliance described in the NIST Special Publication 800-76-2: Biometric Specifications for Personal Identity Verification.

2 Methodology

Testing is performed at a NIST facility. Each participant's submission is validated by NIST (http://www.nist.gov/itl/iad/ig/ominex.cfm) before undergoing full testing to ensure it operates correctly. If the matcher passes the validation procedure, it is then used to compare standard fingerprint templates. Performance is assessed against templates created by a template generation algorithm submitted by the participant as well as templates created by other compliant template generators.

2.1 Dataset

Testing is performed over a single dataset of sequestered fingerprint images. The images were collected by U.S. Visit at ports of entry into the United States. They consist of Live-scan plain impressions of left and right index fingers. WSQ [1] compression was applied to all images at a ratio of 15:1. The most recent capture of each subject was treated as the authentication sample, and the next most recent as the enrolled sample.

The dataset was divided into 123 962 mated and 124 994 non-mated subject pairings. Since both left and right index fingerprints are available for each subject, this provides 247 924 mated and 249 988 nonmated single-finger comparisons (after database consolidation). This also means that when left and right index fingers are fused at the score level [2, 6], the sets condense to 247 924 mated and 249 988 nonmated comparison scores.

2.2 Accuracy Metrics

Core matching accuracy is presented in the form of Detection Error Tradeoff (DET) plots [5], which show the trade-off between the False Match Rate (FMR) and the False Non-Match Rate (FNMR) as a decision threshold is adjusted. Formally, let m_i ($i = 1 \ldots M$) be the ith mated comparison score, and n_j ($j = 1 \ldots N$) the jth non-mated comparison score. Then the statistics are

$$\text{FNMR}(\tau) = \frac{1}{M} \sum_{i=1}^{M} \mathbb{1}\{m_i < \tau\}, \tag{1}$$

$$\text{FMR}(\tau) = \frac{1}{N} \sum_{j=1}^{N} \mathbb{1}\{n_j \geq \tau\}. \tag{2}$$

where $\mathbb{1}\{A\}$ is the indicator [3] of event A. Equations 1 and 2 define the curve parametrically with the decision threshold, τ, as the free parameter. In some figures and tables, FNMR is presented as a function of FMR. This relationship is determined by

$$\text{FNMR}_{\text{FMR}}(\alpha) = \min_{\tau} \{\ \text{FNMR}(\tau) \mid \text{FMR}(\tau) \leq \alpha\ \}, \tag{3}$$

which reads as the smallest FNMR that can be achieved while maintaining an FMR less than or equal to α, the targeted FMR. This method of relating the two error statistics ensures FNMR is well-defined for all $0 \leq \alpha \leq 1$. When the matching algorithm produces only a few unique comparison scores, the maximum threshold, τ_0, that elicits an $\text{FMR}(\tau_0) \leq \alpha$ may, in fact, be quite a bit lower than α. Thus, Equation 3 imposes a natural penalty on matching algorithms that produce overly discretized scores.

Some figures show *pooled* DET accuracy, which is a measure of the accuracy of the matcher against all compliant template generators. Accuracy is measured by concatenating all comparison scores involving the matcher together and computing FMR and FNMR using Equations 2 and 1. This roughly simulates performance for a biometric system that employs one matcher and templates created by several template generators.

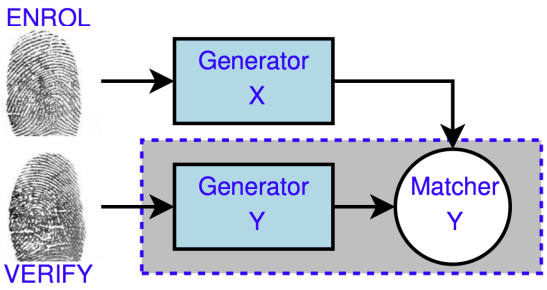

Figure 1: MINEX Interoperability Test Setup

2.3 Interoperability

Interoperability is tested in a manner similar to *Scenario 1* from the MINEX Evaluation Report [4] (see Figure 1). An enrolment template is prepared using submission X. Submission Y is used to prepare the authentication template and perform the match. The authentication template is always prepared by the same submission used to compare the templates. However, enrolment templates need not originate from the same submission. When they do, we refer to it as ”native” mode.

3 Results

This section details the performance of matcher 1Z when it compares verification templates created by its own template generator to enrolment templates created by all MINEX compliant template generators. Sections 3.1 and 3.2 present accuracy results for single finger and two finger matching respectively. Sections 3.3 and 3.4 present potentially useful statistics not directly related to the performance of the matcher.

3.1 Single Finger

Singe finger comparison results show the combined results for left and right index comparisons. For reference, *NIST Special Publication 800-76-2* requires that the matcher and template generator achieve a native accuracy of $\text{FNMR}_{\text{FMR}}(0.0001) \leq 0.02$.

Figure 2: *Single finger DET statistics for matcher 1Z. Each box shows the distribution of FNMRs at a fixed FMR across all MINEX compliant template generators. The ends of the whiskers show the minimum and maximum FNMRs. The orange DET curve shows pooled performance against all template generators.*

Figure 3: *Left index finger DET statistics for matcher 1Z. Each box shows the distribution of FNMR at a fixed FMR across all MINEX compliant template generators. The ends of the whiskers show the minimum and maximum FNMRs. The orange DET curve shows pooled performance against all template generators.*

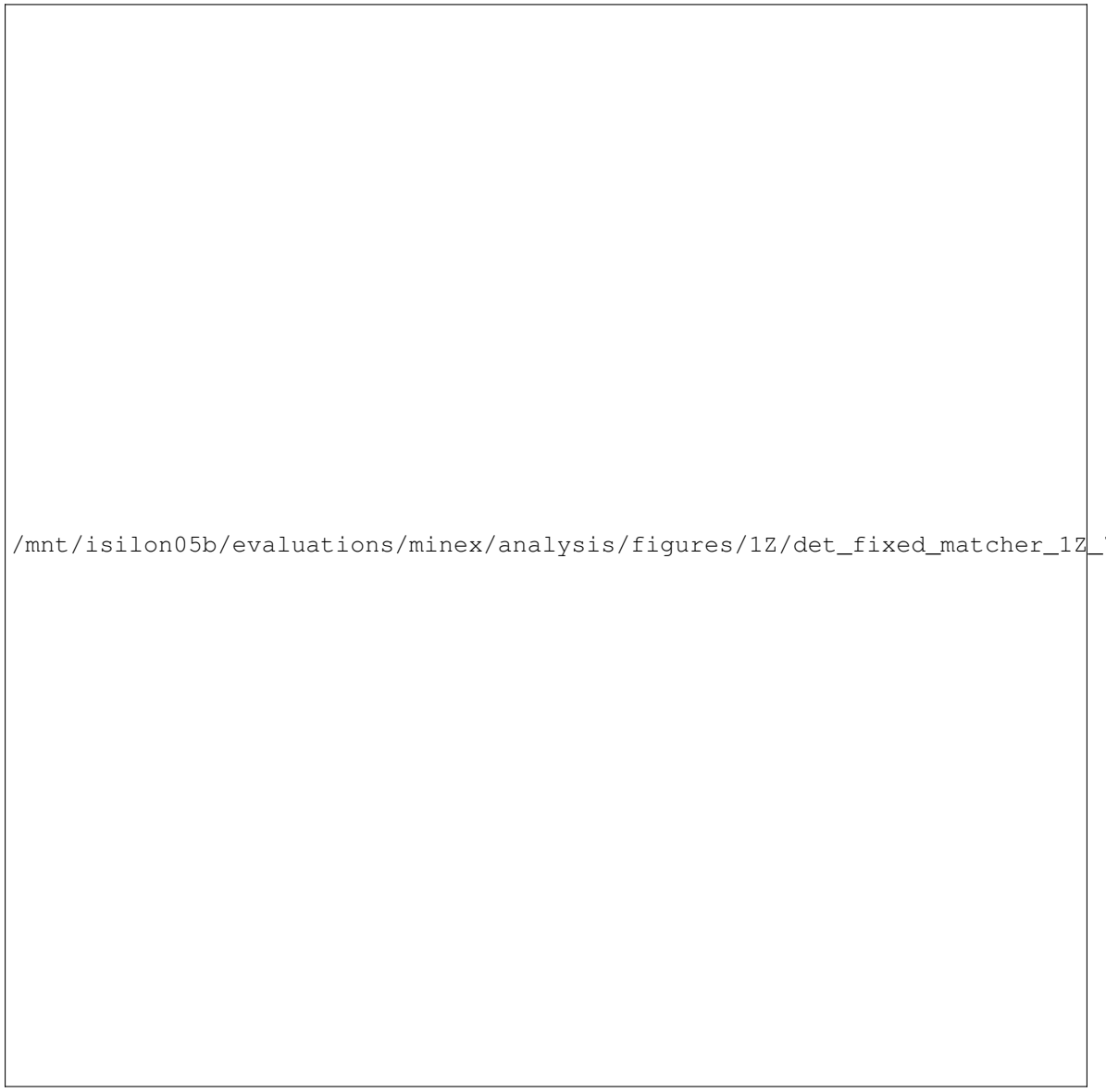

Figure 4: *Right index finger DET statistics for matcher 1Z. Each box shows the distribution of FNMRs at a fixed FMR across all MINEX compliant template generators. The ends of whiskers show the minimum and maximum FNMRs. The orange DET curve shows pooled performance against all template generators.*

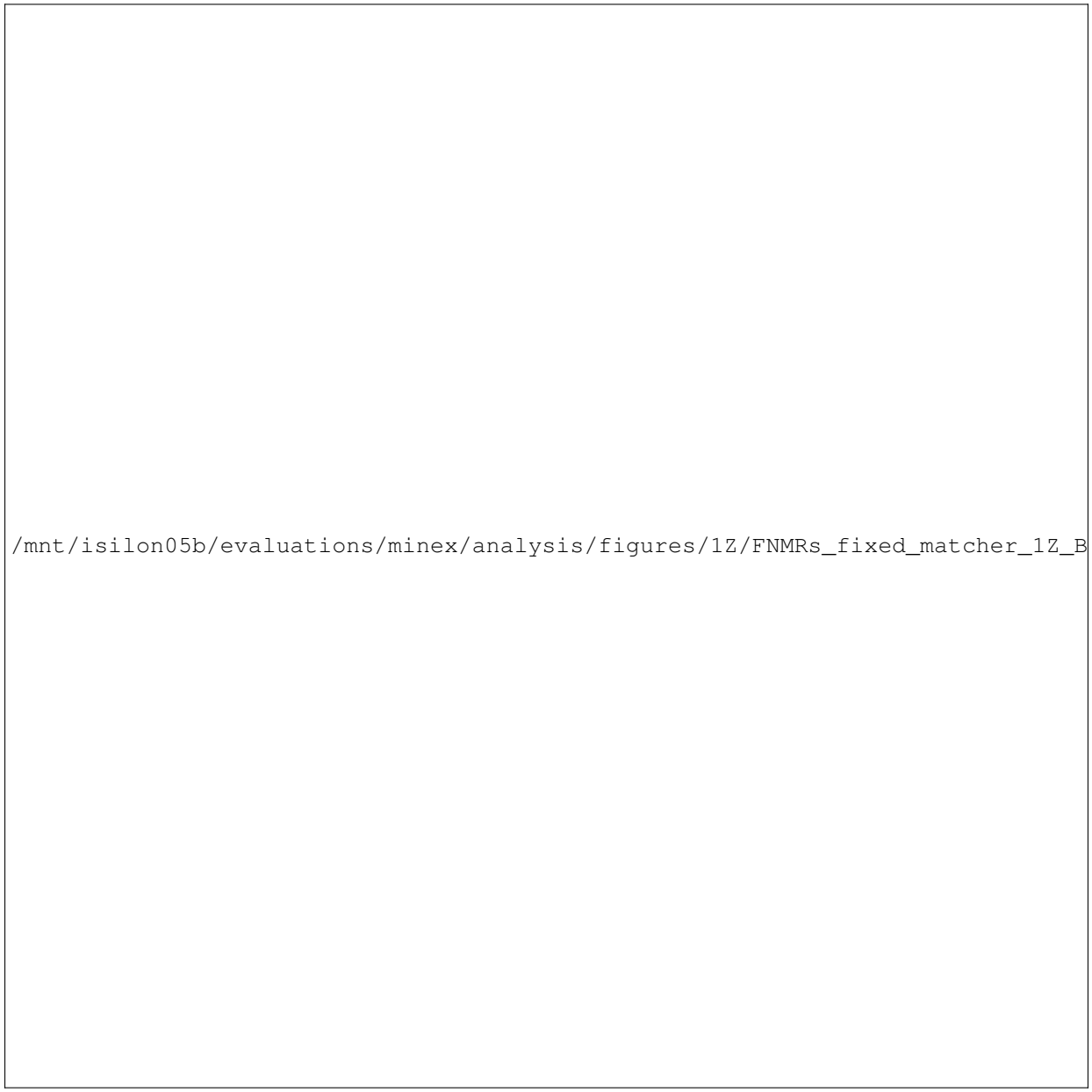

Figure 5: *Single finger FNMRs at FMR = 0.0001 when matcher 1Z compares templates created by different template generators. The ends of the whiskers show the minimum and maximum FNMRs. Each box represents uncertainty about the true FNMR. The box edges mark the 50% confidence intervals while the whiskers mark the 90% confindence intervals. The numbers on the right show the actual computed FNMRs.*

/mnt/isilon05b/evaluations/minex/analysis/figures/1Z/det_scatterplot_1Z_B.pdf

3.2 Two Finger

This section presents accuracy when matcher 1Z compares templates created by all MINEX compliant template generators. Two-finger fusion is achieved by averaging the scores for left and right index fingers for each person. *NIST Special Publication 800-76-2* requires the matcher to achieve an accuracy of $\text{FNMR}_{\text{FMR}}(0.01) \leq 0.01$ for all MINEX compliant template generators.

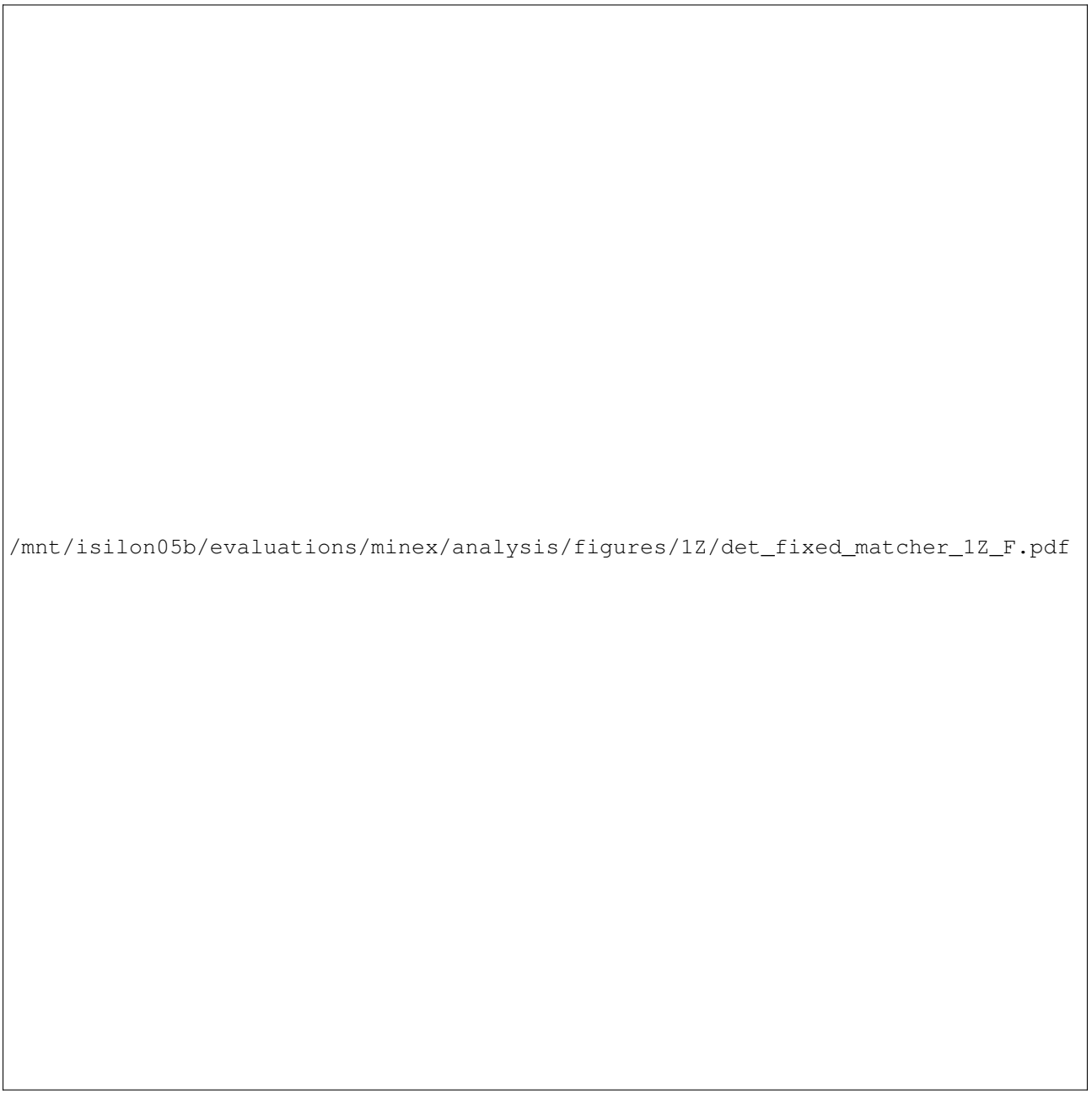

Figure 7: *Two finger DET statistics for matcher 1Z. Each box shows the distribution of FNMRs at a fixed FMR across all MINEX compliant template generators. The whisker ends show the minimum and maximum FNMRs. The orange DET curve shows pooled performance against all template generators. Score-level fusion is achieved by averaging the scores for left and right index fingers.*

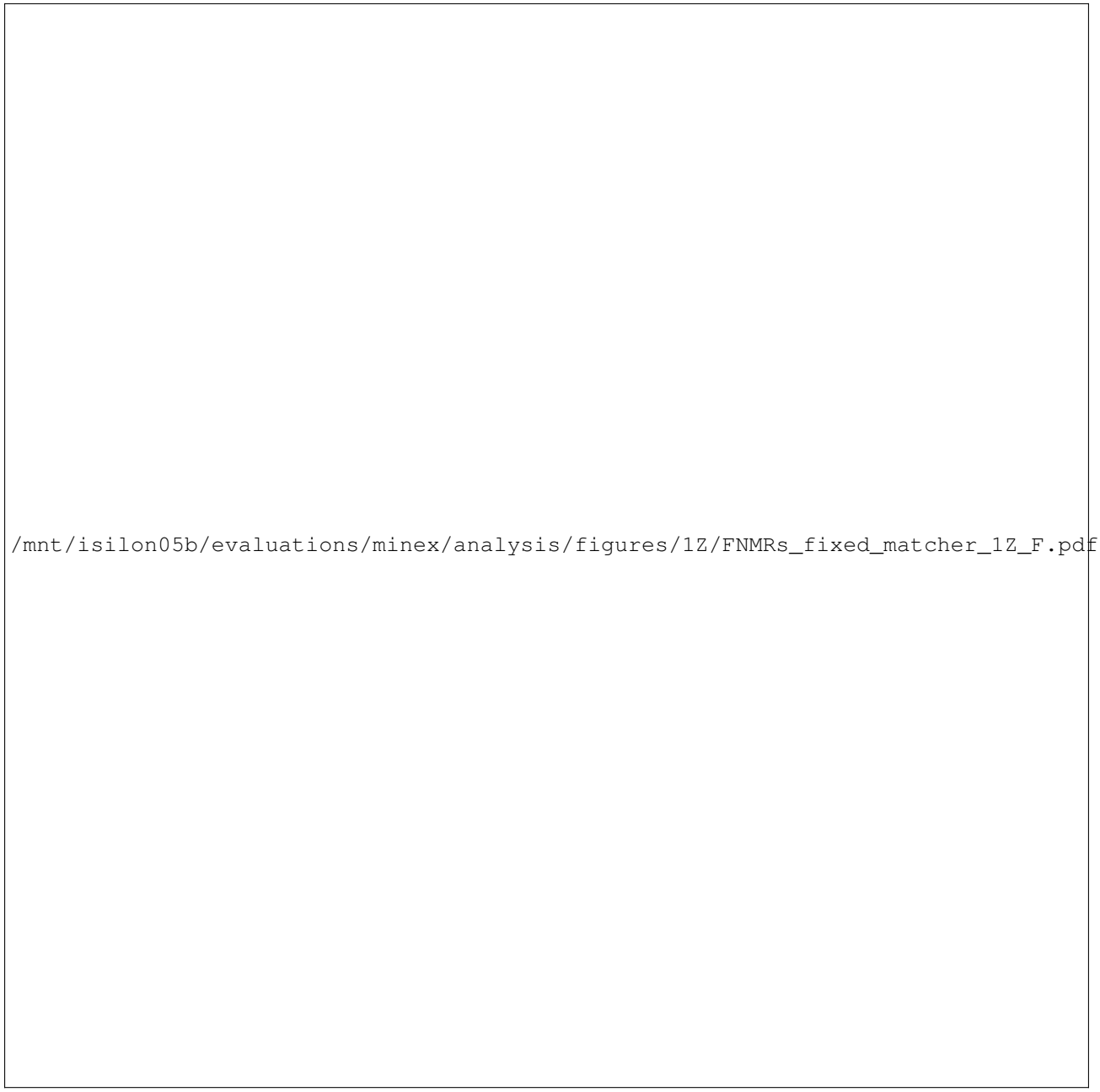

Figure 8: *Two finger FNMR at FMR=0.01 when matcher 1Z compares templates created by different template generators. Each box represents uncertainty about the true FNMR. The box edges mark the 50% confidence intervals while the whiskers mark the 90% confindence intervals. The numbers on the right show the actual computed FNMRs. Score-level fusion is achieved by averaging the scores for left and right index fingers.*

/mnt/isilon05b/evaluations/minex/analysis/figures/1Z/det_scatterplot_1Z_F.pdf

3.3 Threshold Statistics

Results in this section are computed by concatenating comparison scores for matcher 1Z across all MINEX compliant template generators.

Figure 10: *Single finger FMR and FNMR as a function of score threshold for matcher 1Z using templates created by all MINEX compliant template generators. Separate curves are presented for left and right index fingers.*

Figure 11: *Two finger FMR and FNMR as a function of score threshold for matcher 1Z using templates created by all MINEX compliant template generators. Score-level fusion is achieved by averaging scores for the left and right index fingers.*

3.4 Q-Q Plot

The Q-Q plot compares two probability distributions. It plots the quantile of one distribution as a function of the other. If the curve follows the $y = x$ line, then the distributions are identical. If the FMR curve is above the $y = x$ line, then the right index finger tends to produce lower non-mated scores than the left index finger. If the FNMR curve is above the $y = x$ line, then the right index finger tends to produce lower mated scores than the left index finger.

Figure 12: *Q-Q plot comparing score distributions for left and right index fingers.*

4 Performance Tables

The following tables present accuracy number, including estimates of uncertainty in the form of 90% confidence bounds. These tables are provided because most of the figures in the main body of this report do not present numerical results.

Table 1: *Single finger FNMRs at various FMRs when matcher 1Z compares templates created by its template generator and PIV-compliant template generators.*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	–	–	–
B	–	–	–
C	–	–	–
D	–	–	–
E	–	–	–
F	–	–	–
G	–	–	–
N	–	–	–
1C	–	–	–
1D	–	–	–
1F	–	–	–
1G	–	–	–
1J	–	–	–
1L	–	–	–
1M	–	–	–
1N	–	–	–
1T	–	–	–
1Y	–	–	–
2A	–	–	–
2C	–	–	–
2D	–	–	–
2F	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2K	–	–	–
2L	–	–	–
2M	–	–	–
2N	–	–	–
2O	–	–	–
2P	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2W	–	–	–
2Y	–	–	–
3A	–	–	–
3B	–	–	–
3D	–	–	–

Table 1: *(continued)*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
3F	–	–	–
3G	–	–	–
3H	–	–	–
3M	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3S	–	–	–
3T	–	–	–
3V	–	–	–
3W	–	–	–
3Z	–	–	–
4C	–	–	–
4F	–	–	–
4K	–	–	–
4L	–	–	–
4M	–	–	–
4N	–	–	–
4O	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4W	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

Table 2: *Right index finger FNMRs at various FMRs when matcher 1Z compares templates created by its template generator and PIV-compliant template generators.*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	–	–	–
B	–	–	–
C	–	–	–
D	–	–	–
E	–	–	–
F	–	–	–
G	–	–	–
N	–	–	–
1C	–	–	–
1D	–	–	–
1F	–	–	–
1G	–	–	–
1J	–	–	–
1L	–	–	–
1M	–	–	–
1N	–	–	–
1T	–	–	–
1Y	–	–	–
2A	–	–	–
2C	–	–	–
2D	–	–	–
2F	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2K	–	–	–
2L	–	–	–
2M	–	–	–
2N	–	–	–
2O	–	–	–
2P	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2W	–	–	–
2Y	–	–	–
3A	–	–	–
3B	–	–	–
3D	–	–	–

Table 2: *(continued)*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
3F	–	–	–
3G	–	–	–
3H	–	–	–
3M	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3S	–	–	–
3T	–	–	–
3V	–	–	–
3W	–	–	–
3Z	–	–	–
4C	–	–	–
4F	–	–	–
4K	–	–	–
4L	–	–	–
4M	–	–	–
4N	–	–	–
4O	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4W	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

Table 3: *Left index finger FNMRs at various FMRs when matcher 1Z compares templates created by its template generator and PIV-compliant template generators.*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	–	–	–
B	–	–	–
C	–	–	–
D	–	–	–
E	–	–	–
F	–	–	–
G	–	–	–
N	–	–	–
1C	–	–	–
1D	–	–	–
1F	–	–	–
1G	–	–	–
1J	–	–	–
1L	–	–	–
1M	–	–	–
1N	–	–	–
1T	–	–	–
1Y	–	–	–
2A	–	–	–
2C	–	–	–
2D	–	–	–
2F	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2K	–	–	–
2L	–	–	–
2M	–	–	–
2N	–	–	–
2O	–	–	–
2P	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2W	–	–	–
2Y	–	–	–
3A	–	–	–
3B	–	–	–
3D	–	–	–

Table 3: *(continued)*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
3F	–	–	–
3G	–	–	–
3H	–	–	–
3M	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3S	–	–	–
3T	–	–	–
3V	–	–	–
3W	–	–	–
3Z	–	–	–
4C	–	–	–
4F	–	–	–
4K	–	–	–
4L	–	–	–
4M	–	–	–
4N	–	–	–
4O	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4W	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

Table 4: *Two finger FNMRs at various FMRs when matcher 1Z compares templates created by its template generator and PIV-compliant template generators.*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	–	–	–
B	–	–	–
C	–	–	–
D	–	–	–
E	–	–	–
F	–	–	–
G	–	–	–
N	–	–	–
1C	–	–	–
1D	–	–	–
1F	–	–	–
1G	–	–	–
1J	–	–	–
1L	–	–	–
1M	–	–	–
1N	–	–	–
1T	–	–	–
1Y	–	–	–
2A	–	–	–
2C	–	–	–
2D	–	–	–
2F	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2K	–	–	–
2L	–	–	–
2M	–	–	–
2N	–	–	–
2O	–	–	–
2P	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2W	–	–	–
2Y	–	–	–
3A	–	–	–
3B	–	–	–
3D	–	–	–

Table 4: *(continued)*

Enroller	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
3F	–	–	–
3G	–	–	–
3H	–	–	–
3M	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3S	–	–	–
3T	–	–	–
3V	–	–	–
3W	–	–	–
3Z	–	–	–
4C	–	–	–
4F	–	–	–
4K	–	–	–
4L	–	–	–
4M	–	–	–
4N	–	–	–
4O	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4W	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

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