Ongoing MINEX Report Card

Template Generator 1Z

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

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Note: This report card is for MINEX III compliance criteria only. Ongoing MINEX never released report cards, but instead published two tables: one for all participants and one for compliant participants.

This report card shows results for an algorithm originally submitted to Ongoing MINEX being re-evaluated based on the MINEX III compliance criteria. If this report says that an algorithm has failed, it means that the algorithm did not meet the MINEX III compliance criteria and will not be included on the MINEX III Compliant Submissions list. For historical records, the old Ongoing MINEX Compliant Submissions list is still available.

Ongoing MINEX tested for compliance of NIST Special Publication 800-76-1, which was withdrawn July 2013. MINEX III tested for compliance of NIST Special Publication 800-76-2, and added additional semantic checks for compliance of ANSI/INCITS 378-2004.

Participant Details

Company: Griaule Biometrics
Date Submitted: 8/20/2007
Date Validated: 9/6/2007
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: FAIL

- All certified matchers must be able to match templates from this template generator with an $\text{FNMR}_{\text{FMR}}(0.01) \leq 0.01$ using two fingers (4.5.2.2-3). ✗ *(See Table 4)*
- Minutia density plots derived from generated templates do not exhibit a periodic, grid-like, or geometric structure without reasonable justification. (Not Tested)

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 template generator if it later discovers the template generator violates PIV specifications in some previously undetected way.

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1 Introduction

Testing is performed at a NIST facility. Each participant's submission is validated by NIST 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 generator submitted by the participant as well as templates created by other compliant template generators.

2 Methodology

Testing is performed at a NIST facility. Each participant's submission is validated by NIST before undergoing full testing to ensure it operates correctly. If the template generator passes the validation procedure, performance is assessed by using MINEX compliant matching algorithms to compare templates created by the template generator. These matchers were submitted to the ongoing MINEX program by various participants.

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 123 962 mated and 124 994 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

$$\mathrm{FMR}(\tau) = \frac{1}{N} \sum_{j=1}^{N} \mathbb{1}\{n_j \geq \tau\}, \tag{1}$$

$$\mathrm{FNMR}(\tau) = \frac{1}{M} \sum_{i=1}^{M} \mathbb{1}\{m_i < \tau\}. \tag{2}$$

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

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

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 $0 \leq \alpha \leq 1$. It also imposes a natural penalty on matching algorithms that produce heavily discretized scores.

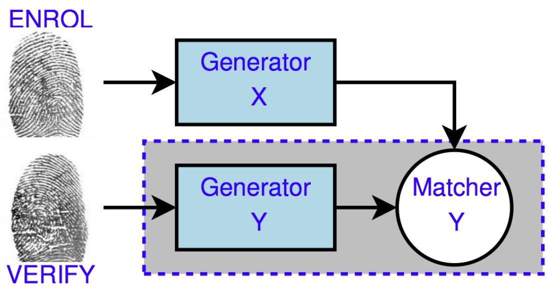

Figure 1: MINEX Interoperability Test Setup

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 as ”native” mode.

3 Results

This section details the performance of template generator 1Z. Sections 3.1 and 3.2 present accuracy results for single finger and two finger matching respectively. Section **??** presents information on the number of minutia the template generator finds in the samples.

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 template generator achieve an accuracy of $\mathrm{FNMR}_{\mathrm{FMR}}(0.01) \leq 0.01$ against all compliant matchers.

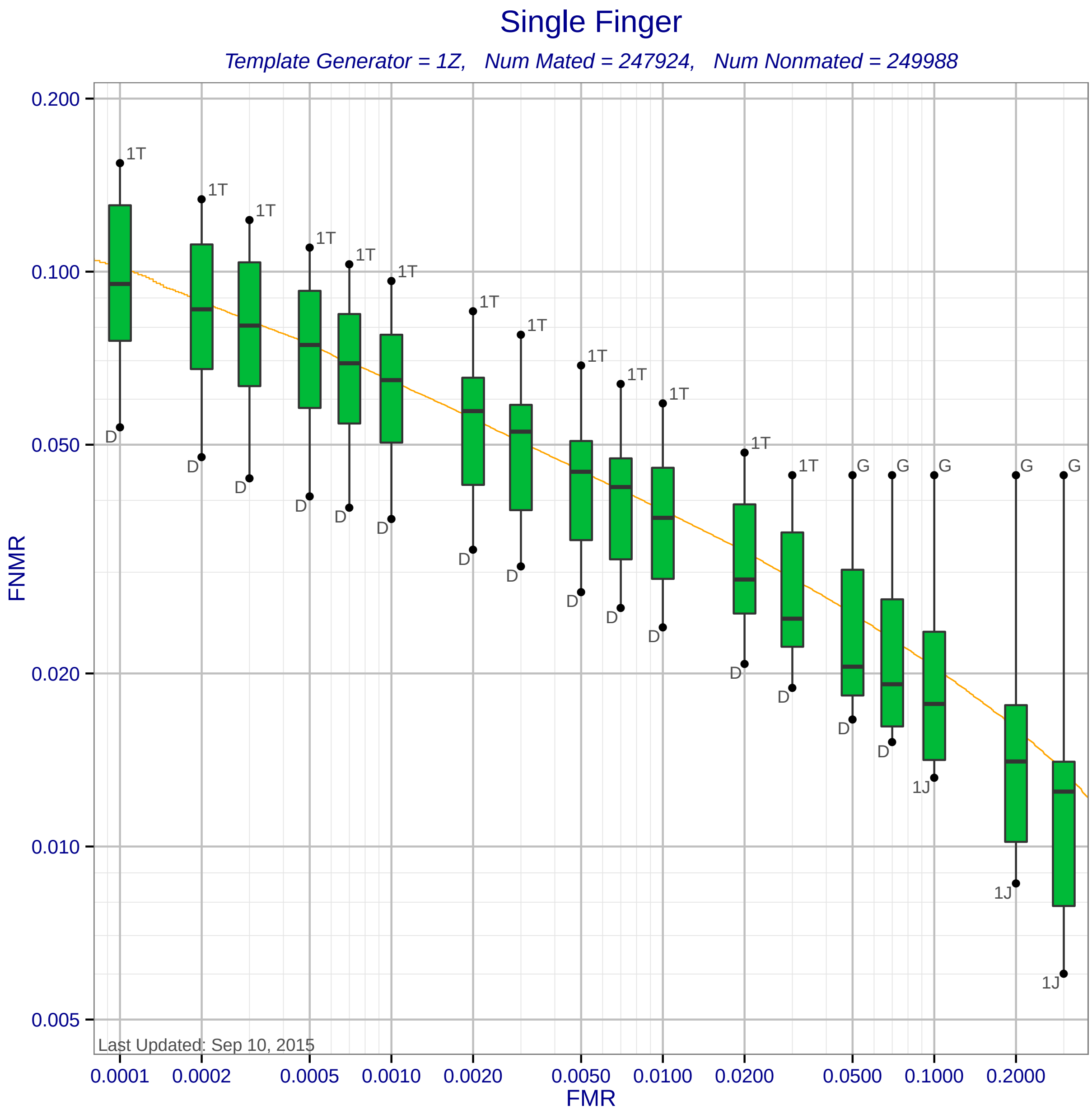

Figure 2: *Single finger DET statistics for template generator 1Z. Each box shows the distribution of FNMRs at a fixed FMR across different matchers. The whisker ends show the minimum and maximum FNMRs. The brown curve shows the DET curve when the matcher and template generators were submitted by the same participant. The orange DET curve shows pooled performance when all matchers compare templates created by 1Z.*

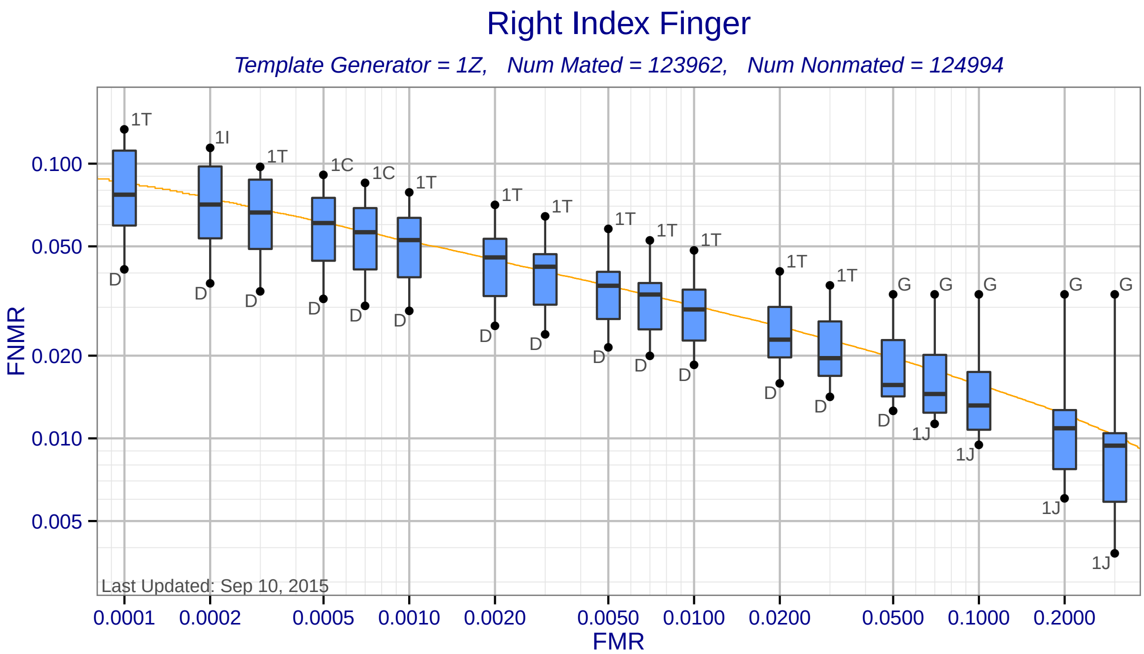

Figure 3: *Right Index Finger DET statistics for template generator 1Z. Each box shows the distribution of FNMRs at a fixed FMR across different matchers. The whisker ends show the minimum and maximum FNMRs. The brown curve shows the DET curve when the matcher and template generators were submitted by the same participant. The orange DET curve shows pooled performance when all matchers use templates created by 1Z.*

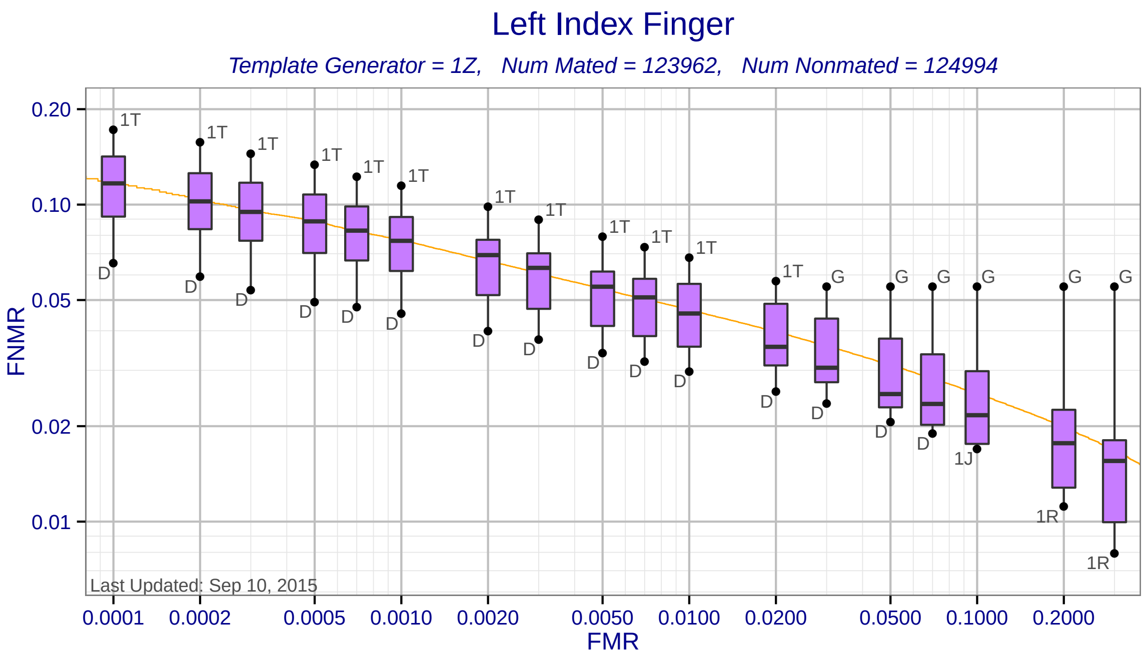

Figure 4: *Left Index Finger DET statistics for template generator 1Z. Each box shows the distribution of FNMRs at a fixed FMR across different template generators. The brown curve shows the DET curve when the matcher and template generators were submitted by the same participant. The orange DET curve shows pooled performance when all matchers use templates created by 1Z.*

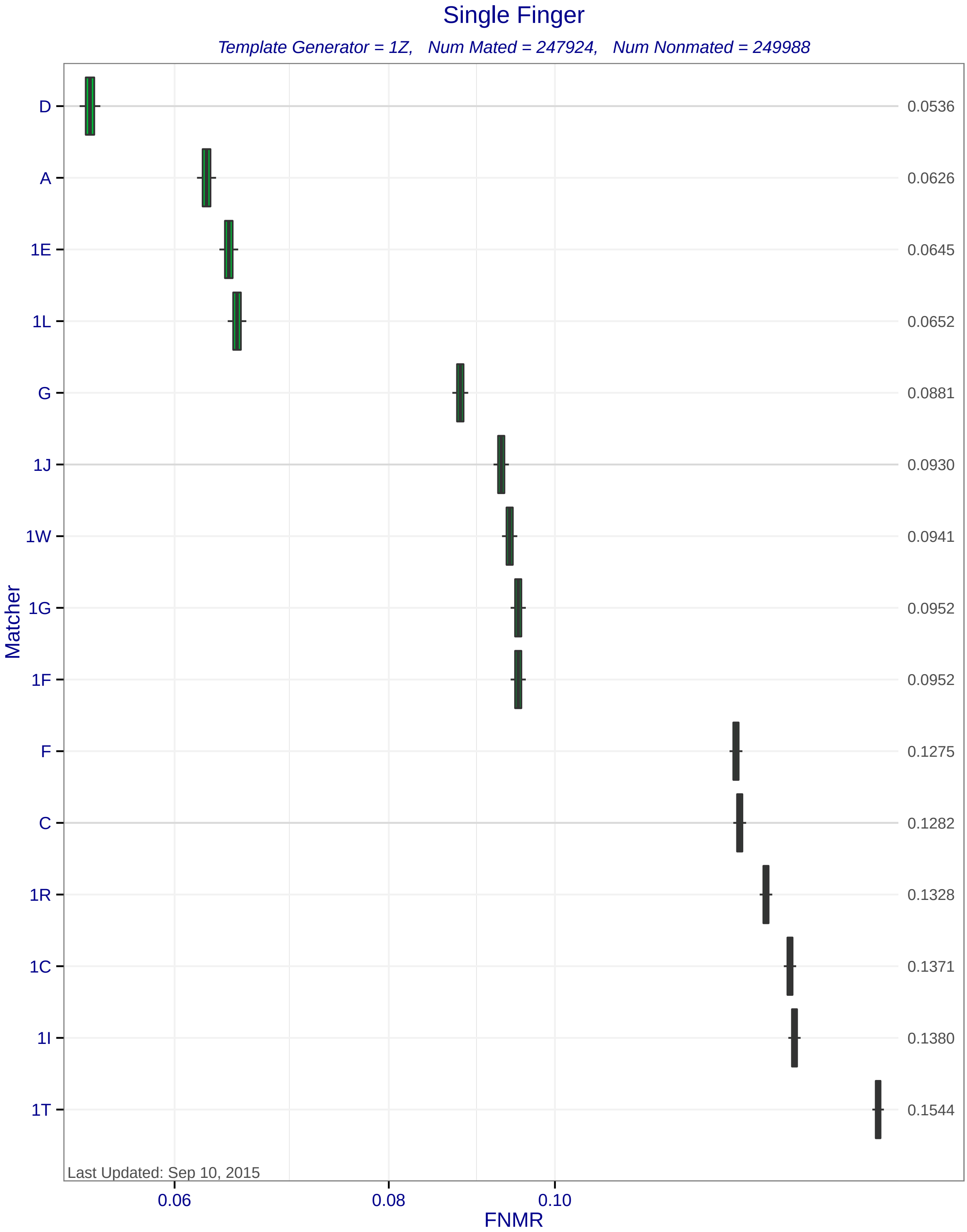

Figure 5: *Single Finger FNMRs at FMR=0.0001 when MINEX compliant matchers compare templates created by template generator 1Z. Each box represents uncertainty about the true FNMR. The box edges mark the 50% confidence intervals while the whiskers mark the 90% confindence intervals. The numbers on the right show the actual computed FNMRs.*

3.2 Two Finger

This section presents accuracy when different MINEX compliant matchers compare templates created by template generator 1Z. Two finger fusion is achieved by averaging the scores for left and right index fingers for each person.

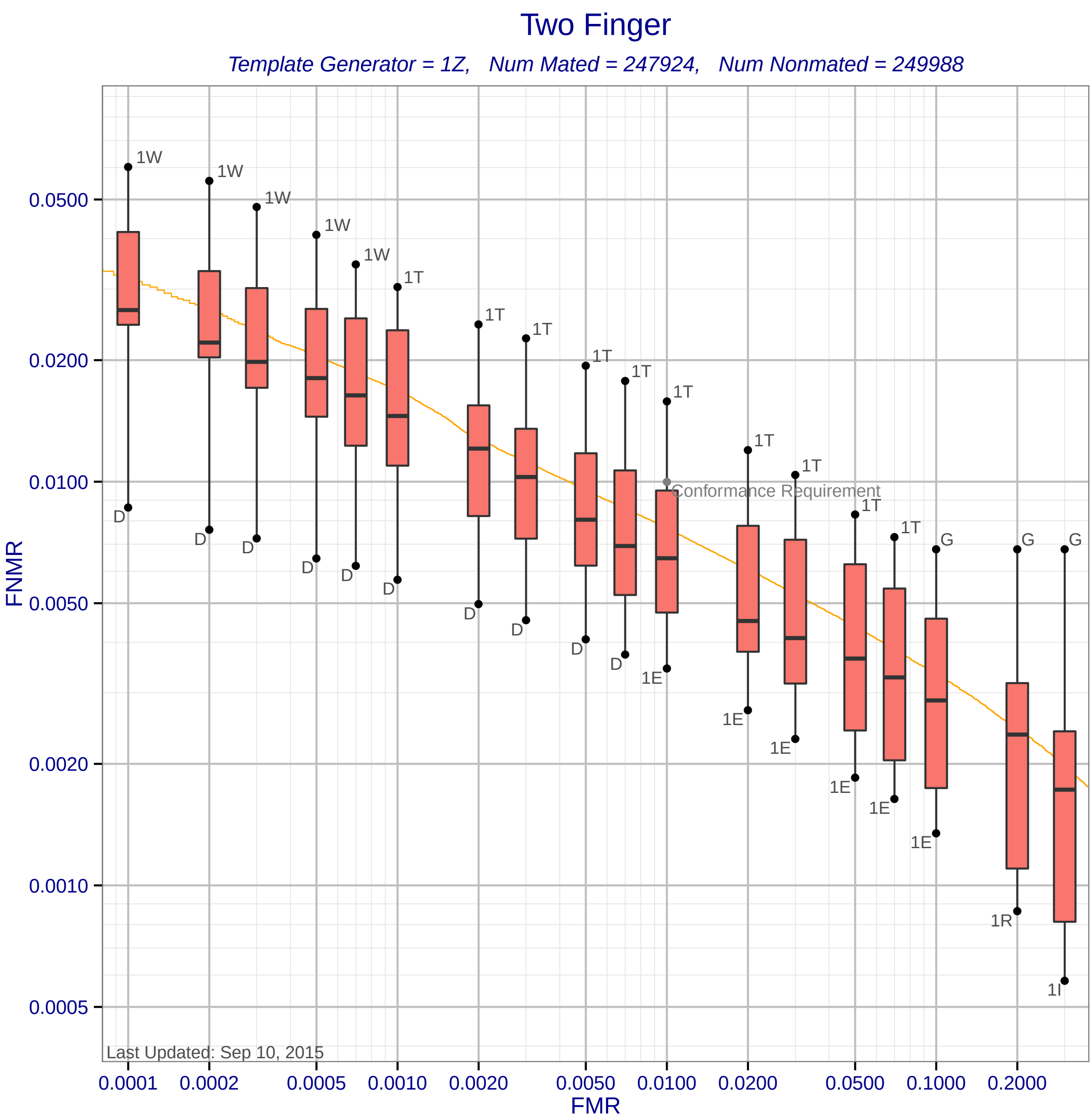

Figure 6: *Two Finger DET statistics for template generator 1Z. Each box shows the distribution of FNMRs at a fixed FMR across different matchers. The whisker ends show the minimum and maximum FNMRs. The brown curve shows the DET curve when the matcher and template generators were submitted by the same participant. The orange DET curve shows pooled performance when all matchers use templates created by 1Z. Score-level fusion is achieved by averaging the scores for left and right index fingers.*

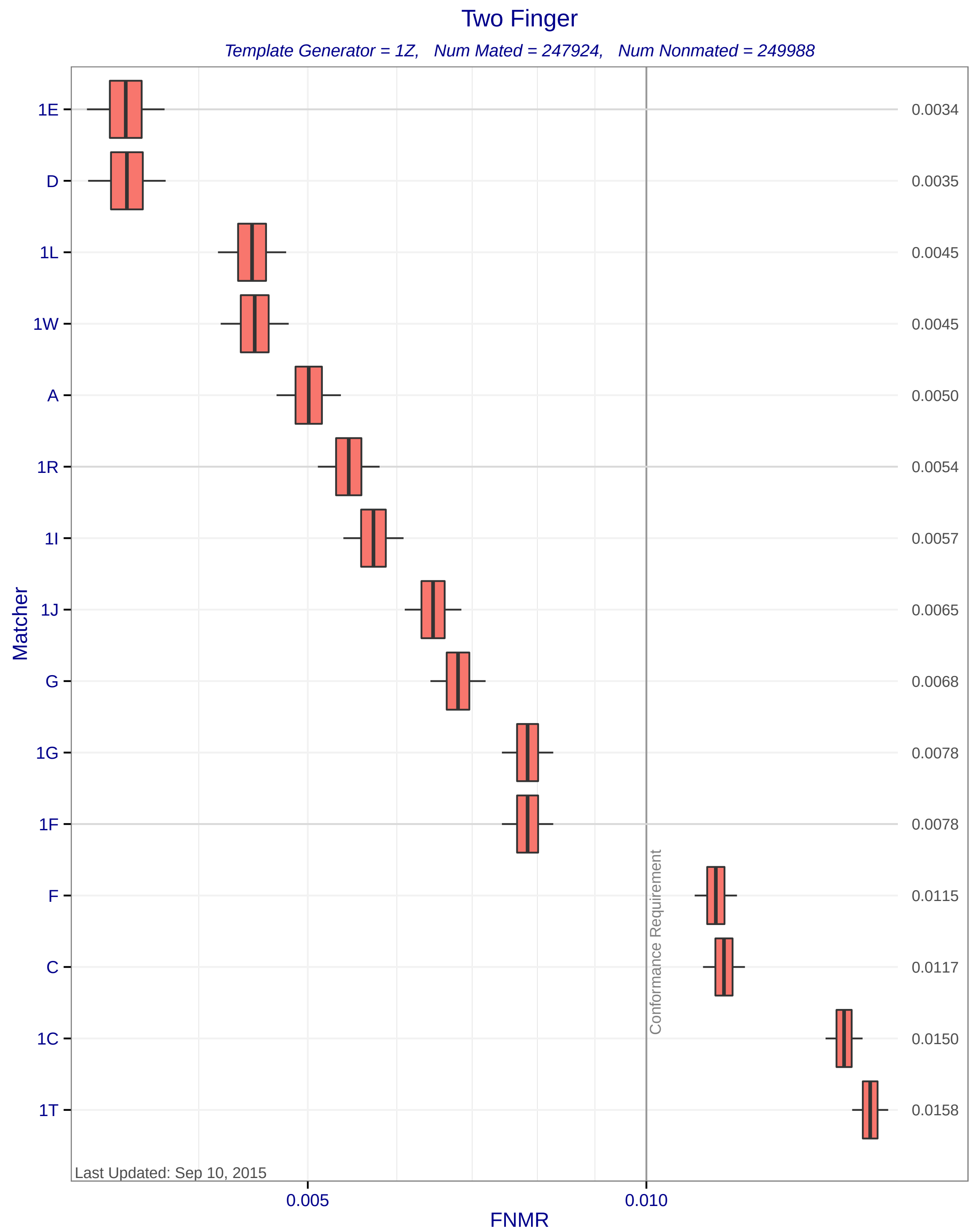

Figure 7: *Two Finger FNMR at FMR=0.01 when different matchers compare templates created by template generator 1Z. Each box represents uncertainty about the true FNMR. The box edges mark the 50% confidence intervals while the whiskers mark the 90% confindence intervals. The numbers on the right show the actual computed FNMRs. Score-level fusion is achieved by averaging the scores for left and right index fingers.*

4 Performance Tables

The following tables present accuracy numbers, 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 the report do not present actual accuracy numbers.

Table 1: *Single finger FNMRs at various FMRs when 1Z and MINEX compliant matchers compare templates created by template generator 1Z.*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	0.0282 ± 0.0005	0.0424 ± 0.0007	0.0626 ± 0.0008
B	–	–	–
C	0.0471 ± 0.0007	0.0808 ± 0.0009	0.128 ± 0.001
D	0.0241 ± 0.0005	0.0372 ± 0.0006	0.0536 ± 0.0007
F	0.0470 ± 0.0007	0.0792 ± 0.0009	0.128 ± 0.001
G	0.0442 ± 0.0007	0.0557 ± 0.0008	0.0881 ± 0.0009
1C	0.0559 ± 0.0008	0.0925 ± 0.0010	0.137 ± 0.001
1E	0.0270 ± 0.0005	0.0456 ± 0.0007	0.0645 ± 0.0008
1F	0.0401 ± 0.0006	0.0648 ± 0.0008	0.0952 ± 0.0010
1G	0.0401 ± 0.0006	0.0648 ± 0.0008	0.0952 ± 0.0010
1I	0.0373 ± 0.0006	0.0762 ± 0.0009	0.138 ± 0.001
1J	0.0334 ± 0.0006	0.0612 ± 0.0008	0.0930 ± 0.0010
1L	0.0275 ± 0.0005	0.0439 ± 0.0007	0.0652 ± 0.0008
1R	0.0358 ± 0.0006	0.0710 ± 0.0008	0.133 ± 0.001
1T	0.0590 ± 0.0008	0.0963 ± 0.0010	0.154 ± 0.001
1W	0.0303 ± 0.0006	0.0563 ± 0.0008	0.0941 ± 0.0010
2A	–	–	–
2C	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2N	–	–	–
2O	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2Y	–	–	–
3A	–	–	–
3D	–	–	–
3G	–	–	–
3J	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3T	–	–	–
3W	–	–	–
3Z	–	–	–
4A	–	–	–
4H	–	–	–

Table 1: *(continued)*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
4I	–	–	–
4J	–	–	–
4L	–	–	–
4O	–	–	–
4P	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

Table 2: *Right index finger FNMRs at various FMRs when 1Z and MINEX compliant matchers compare templates created by template generator 1Z.*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	0.0214 ± 0.0007	0.0331 ± 0.0008	0.051 ± 0.001
B	–	–	–
C	0.0368 ± 0.0009	0.064 ± 0.001	0.110 ± 0.001
D	0.0185 ± 0.0006	0.0291 ± 0.0008	0.0411 ± 0.0009
F	0.0362 ± 0.0009	0.063 ± 0.001	0.113 ± 0.001
G	0.0334 ± 0.0008	0.0407 ± 0.0009	0.064 ± 0.001
1C	0.0477 ± 0.0010	0.079 ± 0.001	0.107 ± 0.001
1E	0.0210 ± 0.0007	0.0363 ± 0.0009	0.053 ± 0.001
1F	0.0315 ± 0.0008	0.053 ± 0.001	0.077 ± 0.001
1G	0.0315 ± 0.0008	0.053 ± 0.001	0.077 ± 0.001
1I	0.0295 ± 0.0008	0.064 ± 0.001	0.128 ± 0.002
1J	0.0254 ± 0.0007	0.048 ± 0.001	0.078 ± 0.001
1L	0.0216 ± 0.0007	0.0366 ± 0.0009	0.055 ± 0.001
1R	0.0291 ± 0.0008	0.058 ± 0.001	0.122 ± 0.002
1T	0.048 ± 0.001	0.079 ± 0.001	0.133 ± 0.002
1W	0.0238 ± 0.0007	0.0441 ± 0.0010	0.074 ± 0.001
2A	–	–	–
2C	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2N	–	–	–
2O	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2Y	–	–	–
3A	–	–	–
3D	–	–	–
3G	–	–	–
3J	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3T	–	–	–
3W	–	–	–
3Z	–	–	–
4A	–	–	–
4H	–	–	–

Table 2: *(continued)*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
4I	–	–	–
4J	–	–	–
4L	–	–	–
4O	–	–	–
4P	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

Table 3: *Left index finger FNMRs at various FMRs when 1Z and MINEX compliant matchers compare templates created by template generator 1Z.*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	0.0346 ± 0.0009	0.051 ± 0.001	0.074 ± 0.001
B	–	–	–
C	0.057 ± 0.001	0.097 ± 0.001	0.142 ± 0.002
D	0.0297 ± 0.0008	0.0452 ± 0.0010	0.065 ± 0.001
F	0.058 ± 0.001	0.096 ± 0.001	0.146 ± 0.002
G	0.055 ± 0.001	0.073 ± 0.001	0.110 ± 0.001
1C	0.064 ± 0.001	0.107 ± 0.001	0.158 ± 0.002
1E	0.0330 ± 0.0008	0.055 ± 0.001	0.076 ± 0.001
1F	0.049 ± 0.001	0.077 ± 0.001	0.117 ± 0.001
1G	0.049 ± 0.001	0.077 ± 0.001	0.117 ± 0.001
1I	0.0453 ± 0.0010	0.087 ± 0.001	0.138 ± 0.002
1J	0.0419 ± 0.0009	0.075 ± 0.001	0.110 ± 0.001
1L	0.0337 ± 0.0008	0.051 ± 0.001	0.076 ± 0.001
1R	0.0431 ± 0.0009	0.083 ± 0.001	0.142 ± 0.002
1T	0.068 ± 0.001	0.115 ± 0.001	0.172 ± 0.002
1W	0.0366 ± 0.0009	0.069 ± 0.001	0.110 ± 0.001
2A	–	–	–
2C	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2N	–	–	–
2O	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2Y	–	–	–
3A	–	–	–
3D	–	–	–
3G	–	–	–
3J	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3T	–	–	–
3W	–	–	–
3Z	–	–	–
4A	–	–	–
4H	–	–	–

Table 3: *(continued)*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
4I	–	–	–
4J	–	–	–
4L	–	–	–
4O	–	–	–
4P	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

Table 4: *Two finger FNMRs at various FMRs when 1Z and MINEX compliant matchers compare templates created by template generator 1Z.*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
A	0.0050 ± 0.0002	0.0093 ± 0.0003	0.0252 ± 0.0005
B	–	–	–
C	0.0117 ± 0.0004	0.0237 ± 0.0005	0.0418 ± 0.0007
D	0.0035 ± 0.0002	0.0057 ± 0.0002	0.0086 ± 0.0003
F	0.0115 ± 0.0004	0.0238 ± 0.0005	0.0412 ± 0.0007
G	0.0068 ± 0.0003	0.0129 ± 0.0004	0.0237 ± 0.0005
1C	0.0150 ± 0.0004	0.0276 ± 0.0005	0.0431 ± 0.0007
1E	0.0034 ± 0.0002	0.0065 ± 0.0003	0.0102 ± 0.0003
1F	0.0078 ± 0.0003	0.0141 ± 0.0004	0.0255 ± 0.0005
1G	0.0078 ± 0.0003	0.0141 ± 0.0004	0.0255 ± 0.0005
1I	0.0057 ± 0.0002	0.0164 ± 0.0004	0.0397 ± 0.0006
1J	0.0065 ± 0.0003	0.0150 ± 0.0004	0.0266 ± 0.0005
1L	0.0045 ± 0.0002	0.0085 ± 0.0003	0.0139 ± 0.0004
1R	0.0054 ± 0.0002	0.0145 ± 0.0004	0.0395 ± 0.0006
1T	0.0158 ± 0.0004	0.0303 ± 0.0006	0.0535 ± 0.0007
1W	0.0045 ± 0.0002	0.0291 ± 0.0006	0.0603 ± 0.0008
2A	–	–	–
2C	–	–	–
2G	–	–	–
2I	–	–	–
2J	–	–	–
2N	–	–	–
2O	–	–	–
2Q	–	–	–
2R	–	–	–
2S	–	–	–
2T	–	–	–
2Y	–	–	–
3A	–	–	–
3D	–	–	–
3G	–	–	–
3J	–	–	–
3N	–	–	–
3O	–	–	–
3Q	–	–	–
3T	–	–	–
3W	–	–	–
3Z	–	–	–
4A	–	–	–
4H	–	–	–

Table 4: *(continued)*

Matcher	FNMR @ FMR=0.01	FNMR @ FMR=0.001	FNMR @ FMR=0.0001
4I	–	–	–
4J	–	–	–
4L	–	–	–
4O	–	–	–
4P	–	–	–
4Q	–	–	–
4S	–	–	–
4T	–	–	–
4U	–	–	–
4X	–	–	–
4Z	–	–	–
1Z	–	–	–

5 References

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