

# JPEG and JPEG2000 Compression for Face Recognition

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# Introduction

# Outline

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- Introduction: Performance vs. Compression
- Image Types Formats (Token and Mug Shot)
- Region of Interest (ROI) Compression
- Compression and Match Performance
- Recommendations

# Introduction

- The recognition performance degrades when the compression ratio increases.
- At some point, there may be a need to over-compress to place a face image on a storage media
- To overcome this trade-off, region of interest (ROI) compression is preferable to preserve recognition performance at file sizes.
- ROI compression is discussed in ANSI 385 informative annexes for both JPEG and JPEG2000.
- This analysis is based on the use of automated face match systems to measure performance drop-off.
- Note: the graphs in this presentation are based upon Identix FaceIt identification SDK Generation 6.
  - Compression recommendations in ANSI 385 were based upon Identix G5

# Performance and JPEG Compression

- Performance loss (Normalized top rank) vs. compression.

| Measurer                               | Values |       |       |       |       |       |       |       |
|--|--------|-------|-------|-------|-------|-------|-------|-------|
| IJG [5] JPEG Quality factor Q (1..100) | 100    | 90    | 70    | 50    | 40    | 30    | 20    | 10    |
| Compression Ratio T (T:1)              | 6      | 21    | 42    | 58    | 66    | 76    | 91    | 115   |
| Average File Size (KByte)              | 148.43 | 42.19 | 21.28 | 15.52 | 13.62 | 11.79 | 9.89  | 7.79  |
| Top Rank (%)                           | 100.00 | 98.79 | 98.31 | 98.07 | 97.35 | 94.83 | 91.23 | 81.51 |

Notes: Image file size and corresponding matching performance vary as compression ratio changes. The recognition performance is represented by the normalized top rank rate, which is obtained using Identix Identification SDK G6 and the baseline JPEG compression of the IJG library, for the Australia passport database.



# Image Types

# ANSI 385 Face Image Types

- Image Types:
  - [1] “Biometric Data Interchange Formats—Part 5: Face Image Data,” Document number ISO/IEC CD 19794-5, Mar. 2003. (or INCITS 385-2004)

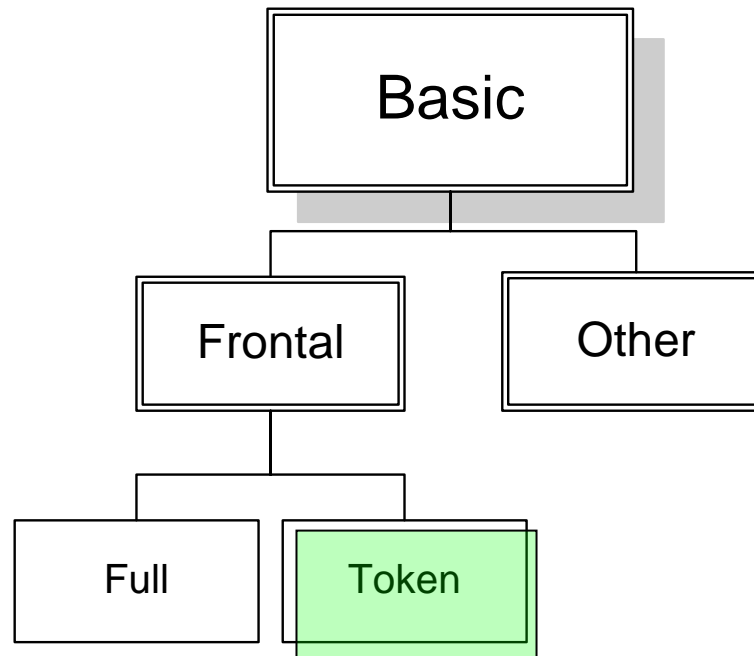


Image Types and Their Inheritance Map.

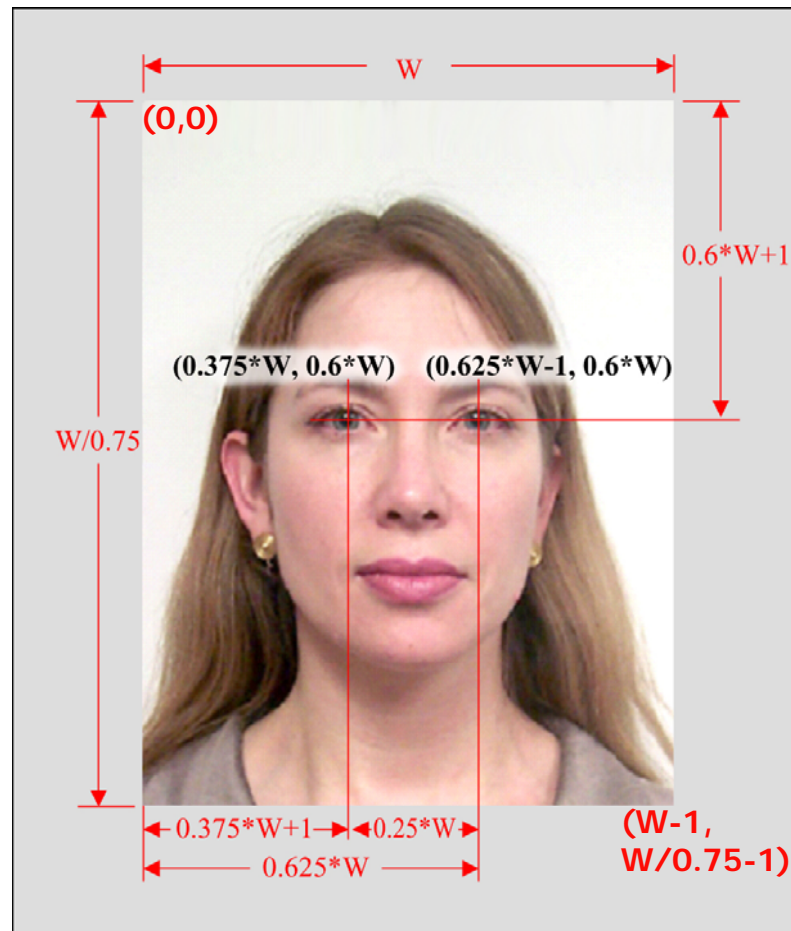
# NIST Mugshot Face Image Type

- 480 (width) x 600 (height)
  - 18 Gray background
  - 3-point lighting
  - JPEG
- 
- Closest ANSI 385 Image Type is the Token 120



# Token Image Format

- Token face image is used for this analysis:
  - Token 120 close to mug shot best practices specifications
    - Height=640 vs. height=600 Mugshot
  - Easier to evaluate compression vs. performance independent of original digital image resolution via re-sampling
  - Able to perform face-specific ROI compression since face position is well-defined.



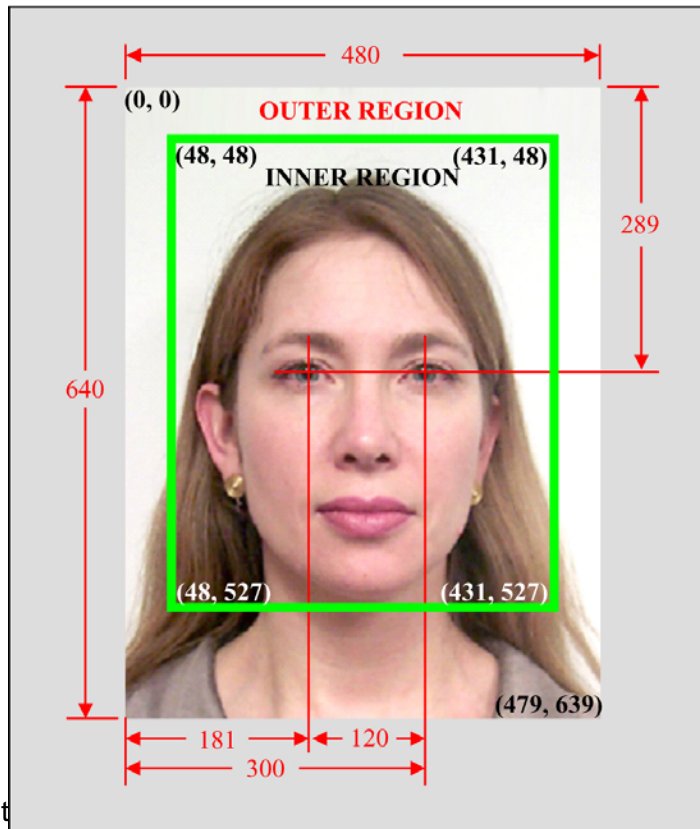
| Width      | Distance from Eye to Eye (Inclusive) |
|------------|--------------------------------------|
| 240        | 60                                   |
| <b>480</b> | <b>120</b>                           |
| 720        | 180                                  |

## Recommended Width Variables

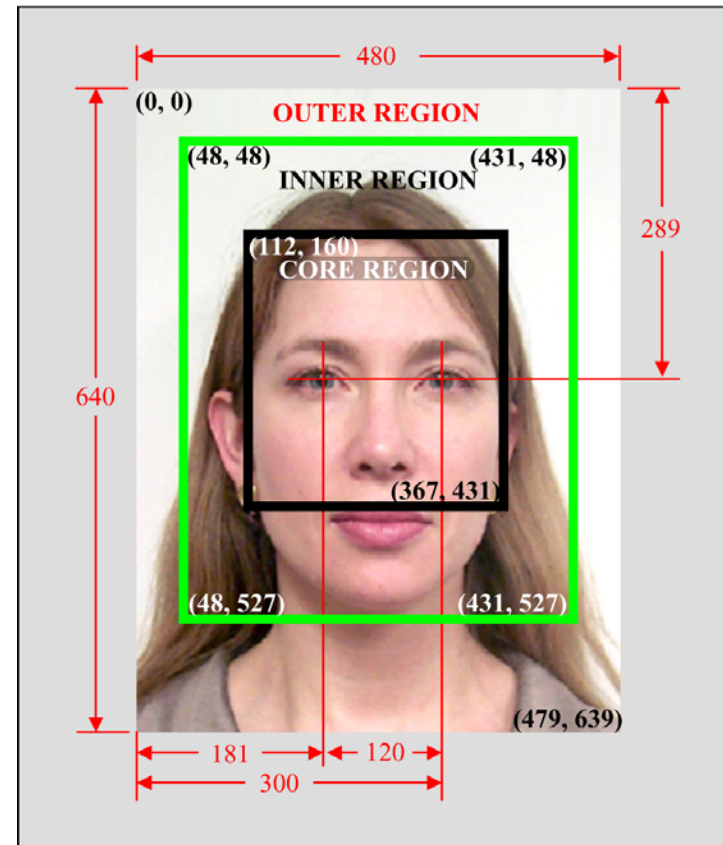
# Regions of Interest

- Regions of Interest - Token or Mugshot

(a) Two regions: Outer (background) Region and Inner (hair – chin - neck).

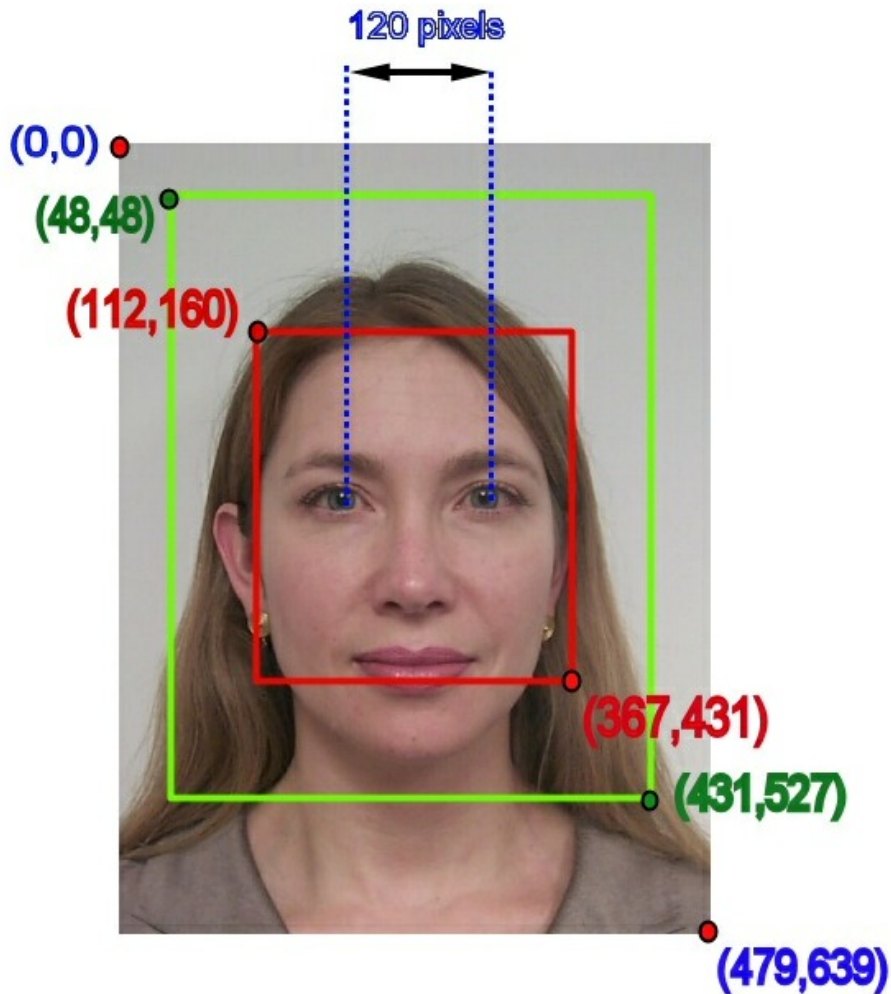


(b) Three regions: include an extra Core (forehead-eye-nose) Region.



# Regions of Interest (Cont'd)

- Three Regions of Interest



# ROI Compression—JPEG

- Re-quantization of Regions of High Compression Ratios:
  - To avoid the grainy artefacts, one selects high-compression-ratio quantization steps as an integer multiple of the low-compression-ratio quantization steps
- ROI Compression at Limited File Size:
  - New JPEG code can automatically search the best compression ratios for multiple regions
- Examples JPEG ROI compressed images:



**155KB**  
**5.8:1, Q100**



**17KB**  
**53:1, Q76**



**14KB**  
**66:1, Q64**



**12KB**  
**77:1, Q60**

# ROI Compression—JPEG2000

- JPEG2000 can also accomplish compression to specific file sizes
- Transition from region to region is much improved
- Examples of JPEG 2000 ROI compressed Token images:



**99KB**  
**9:1**



**17KB**  
**53:1**



**14KB**  
**66:1**



**12KB**  
**77:1**

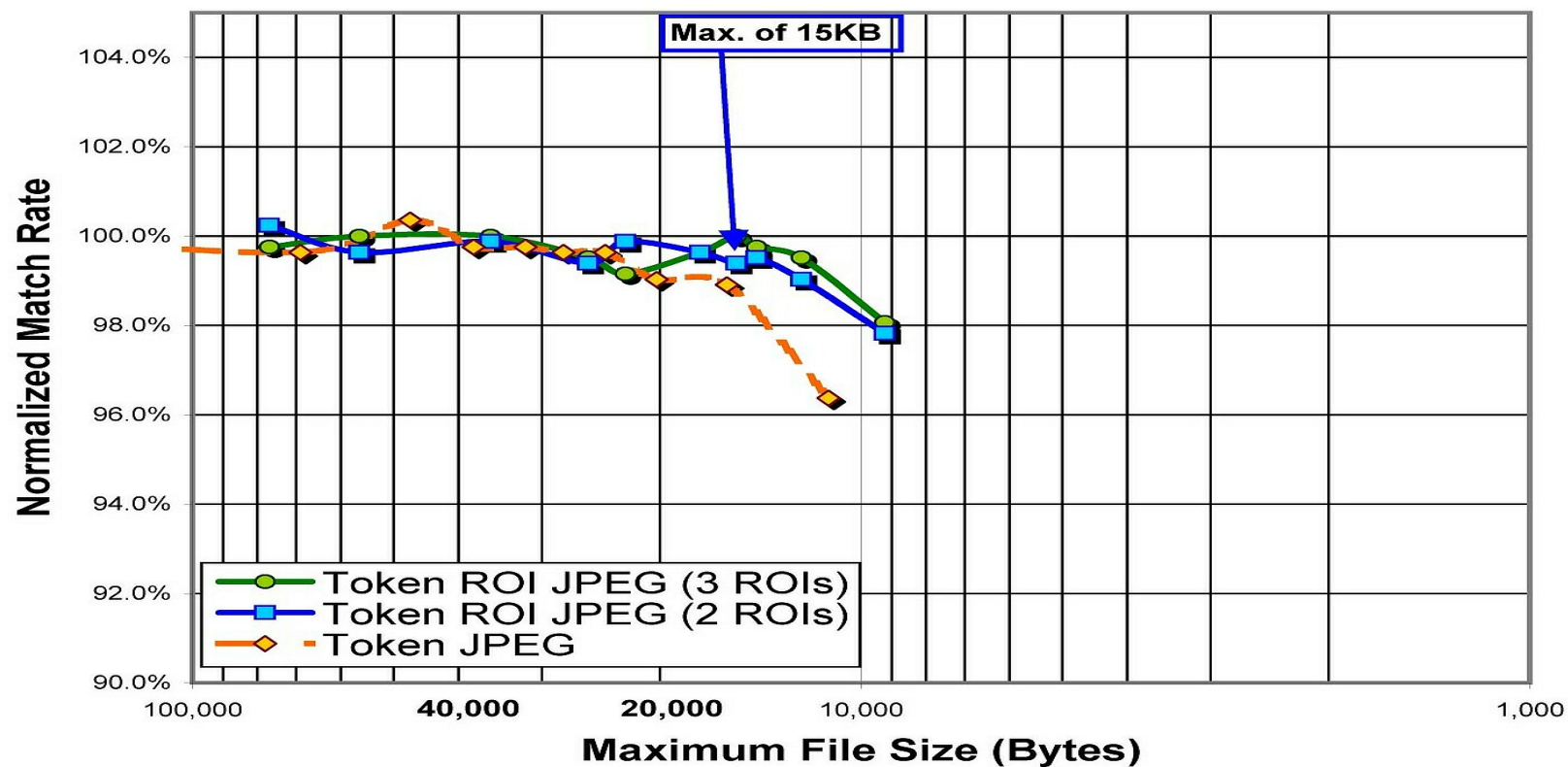
# Compression and Match Performance

# Data Analysis

- Databases
  - Australia passport (1000 gallery and 1000 probe images)
  - FERET High Resolution set (1364 gallery and 1358 probe images)
  - XM2VTS (295 gallery and 885 probe images).
- Compression of Images after conversion to Token 120
  - Gallery sets: the uncompressed token images are compressed at increasing compression ratios using the baseline JPEG compression, and at file size limits of 75KB, 55KB, 35KB, 25KB, 22KB, 17KB, 15KB, 14KB, 12KB, and 9KB.
  - YUV 411 assures significant information in luminance
  - Probe sets: uncompressed token images are compressed at a compression ratio about 5.3:1 (i.e., 170KB).
- Examples shown on next few slides. For complete analysis, see reference listed at the end of the presentation.

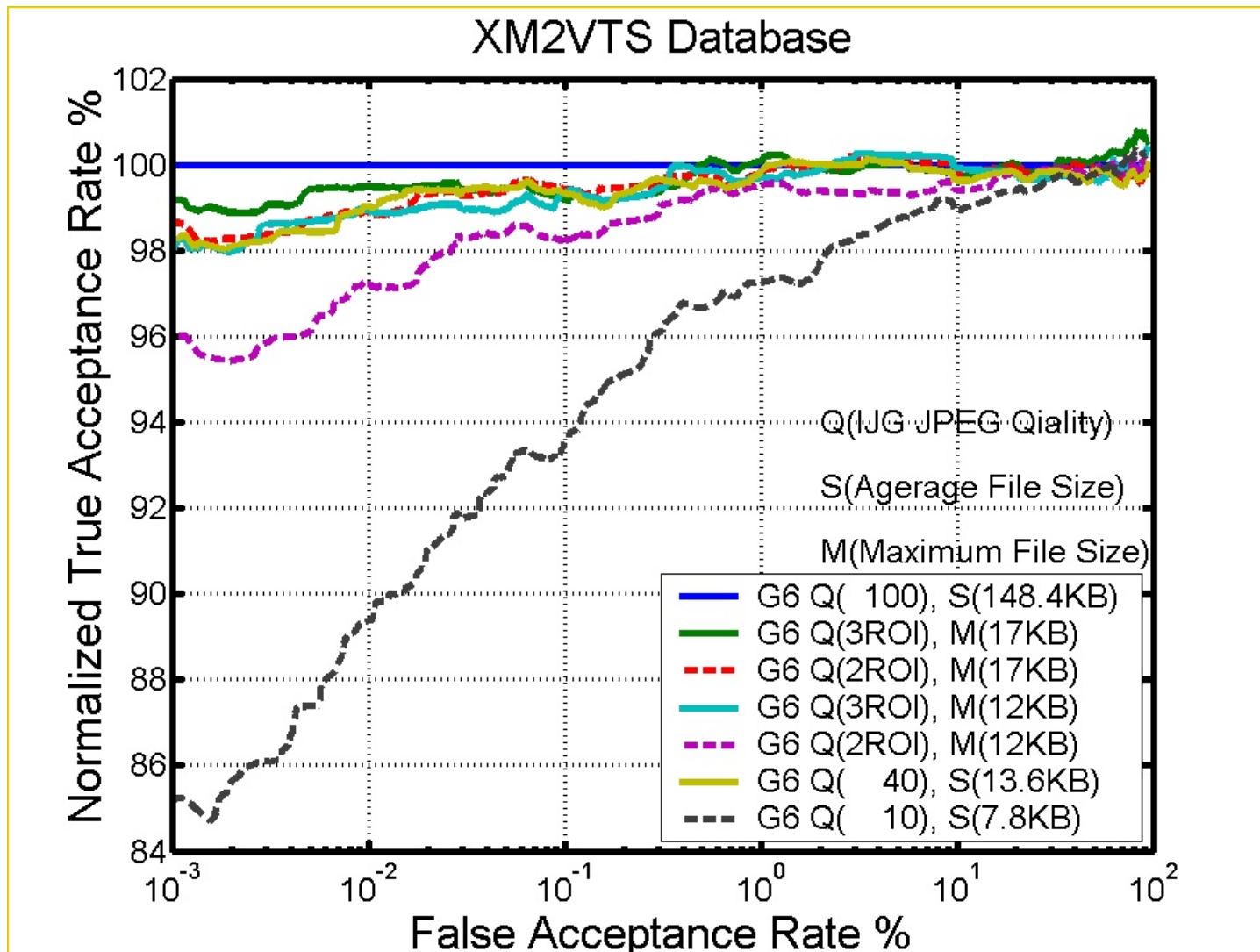
# Rank 1 Performance

## Compression of Token Images, XM2VTS Database

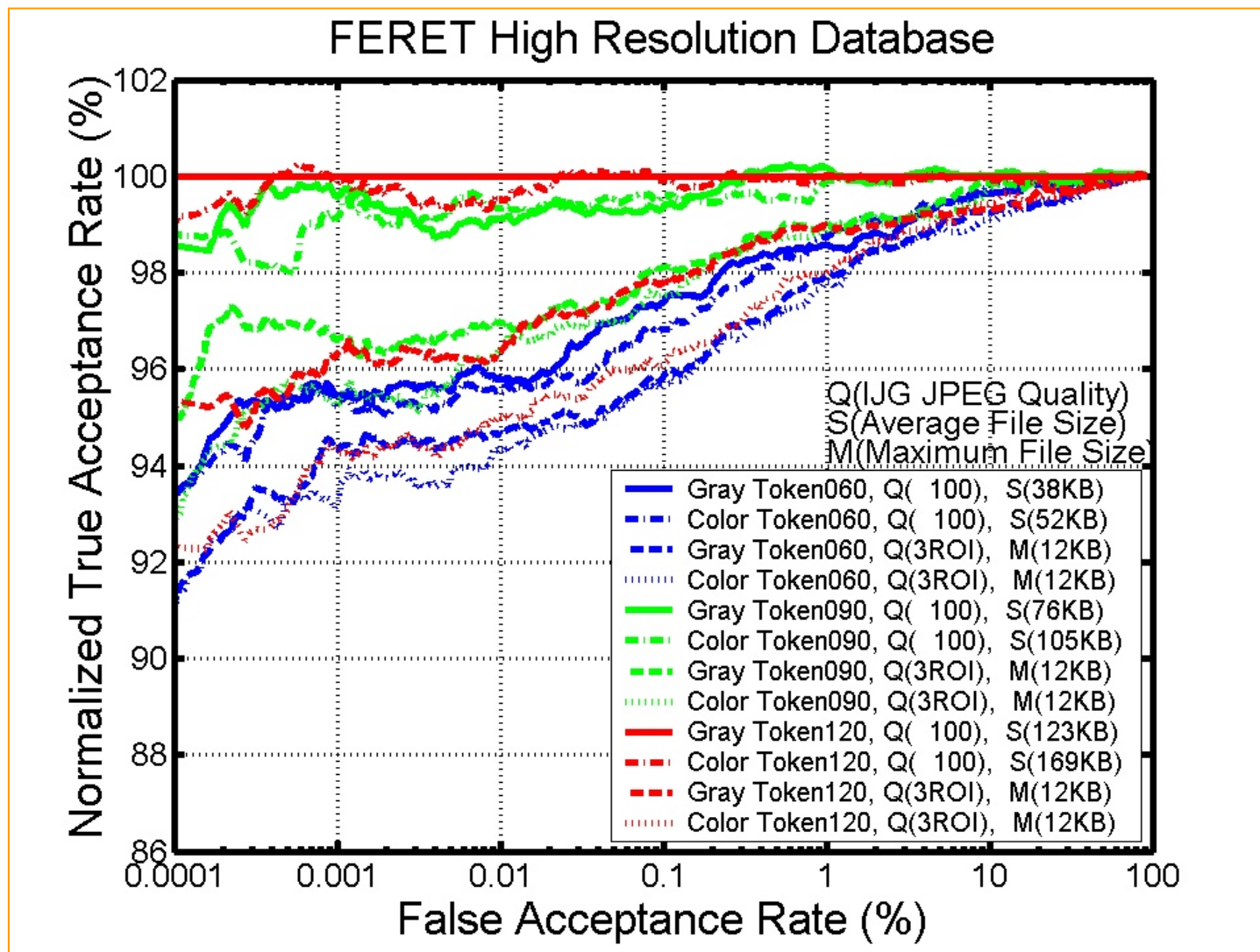




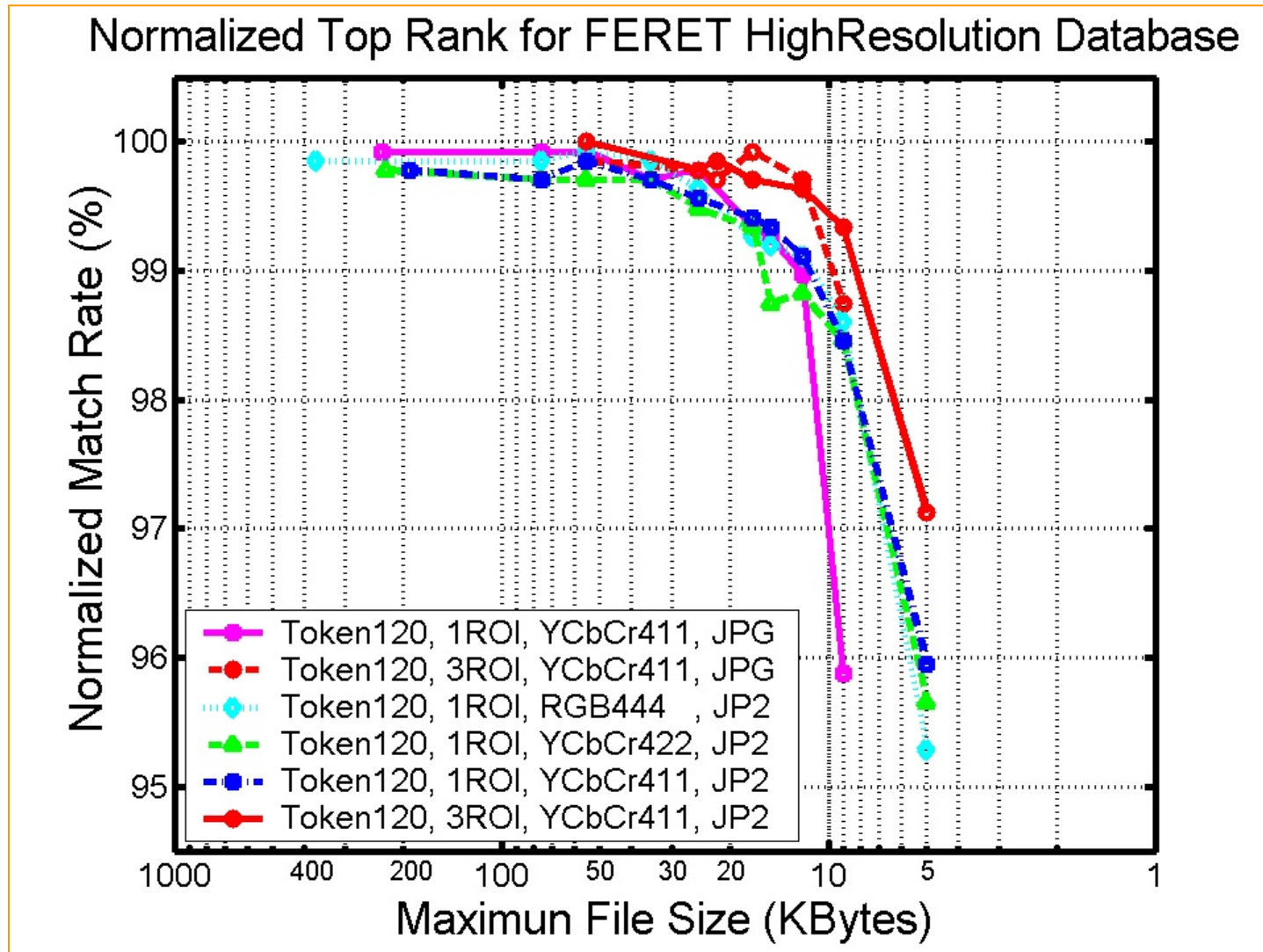
# Example ROC Performance



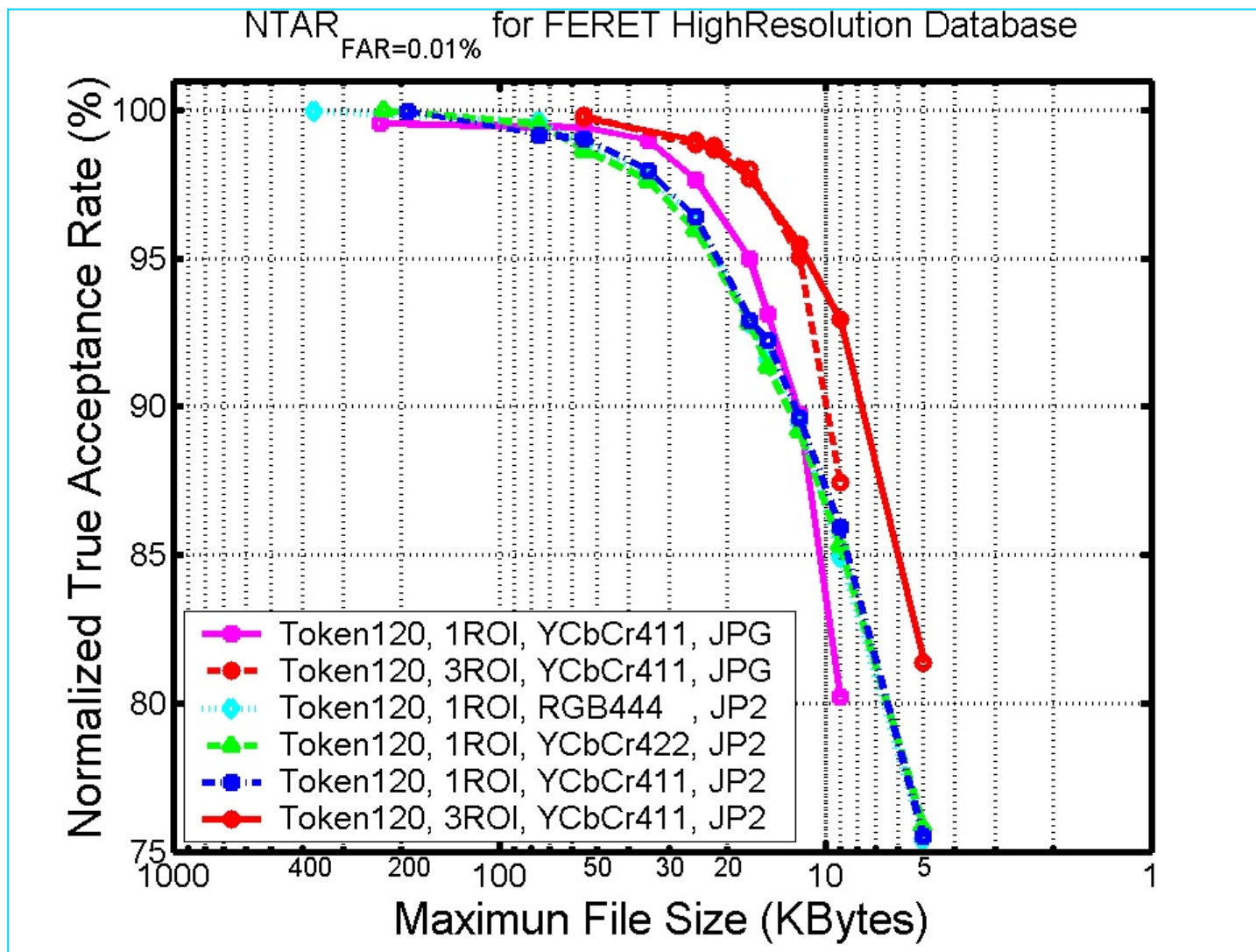
# Example: Grayscale VS. Color Image



# JPEG VS. JPEG 2000 – Normalized Top Ranks

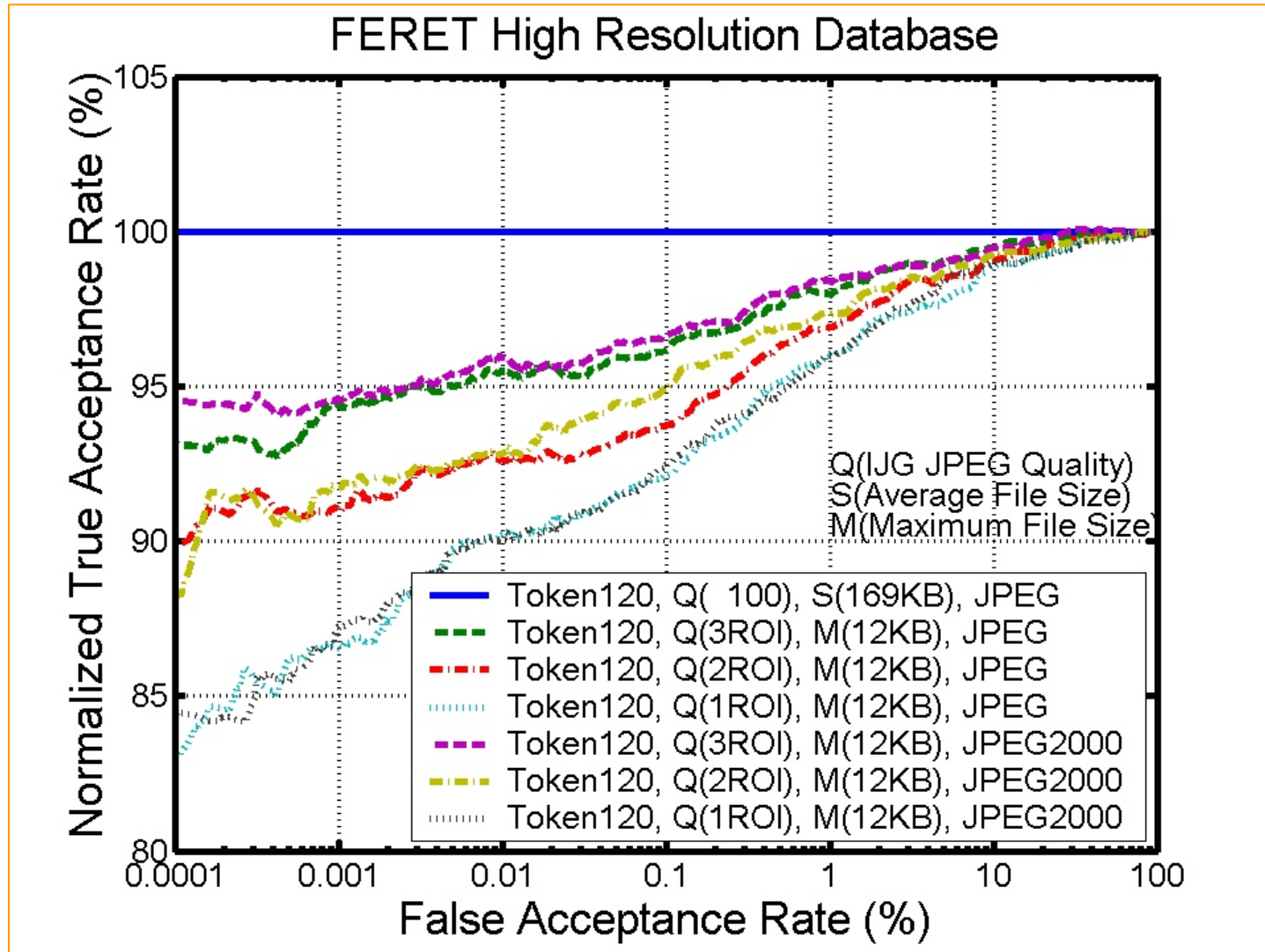


# JPEG VS. JPEG 2000 – Normalized TAR



# JPEG 2000 ROI Compression

## – Normalized ROC





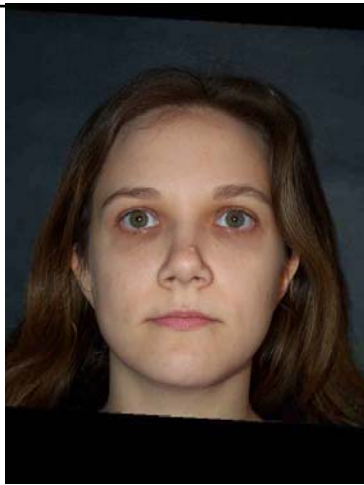
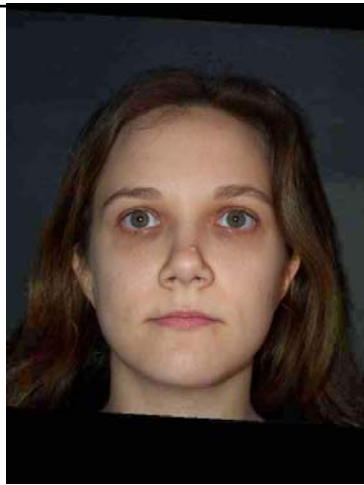
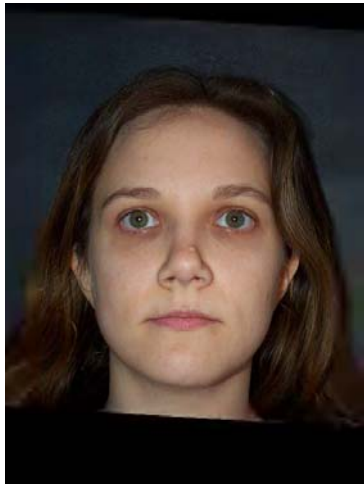
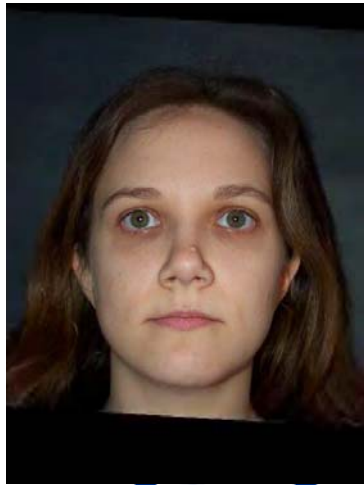
# Recommendations

# Recommendations — Compression Ratio

The recommendations of compression for three types of Regions of Interest compression on YUV411 Token 120 Images (keeping rank degradation within 1% on all measured databases, and <1% FRR increase at FAR=0.1%)




| ROI<br>Standards | Single ROI |           | 2 ROIs     |           | 3 ROIs     |           |
|------------------|------------|-----------|------------|-----------|------------|-----------|
|                  | Max. Ratio | Min. Size | Max. Ratio | Min. Size | Max. Ratio | Min. Size |
| JPEG             | 20:1       | 45KB      | 20:1       | 30KB      | 20:1       | 17KB      |
|                  |            |           | 120:1      |           | 88:1       |           |
|                  |            |           |            |           | 126:1      |           |
| JPEG 2000        | 20:1       | 45KB      | 20:1       | 30KB      | 20:1       | 17KB      |
|                  |            |           | 120:1      |           | 93:1       |           |
|                  |            |           |            |           | 300:1      |           |

# Examples 1,2,3 ROI




| (Source 368KB)   | 45KB   | 30KB   | 17KB   |
|--|--|--|--|
| JPEG<br> |   |   |   |
| JPEG 2000  |  |  |  |



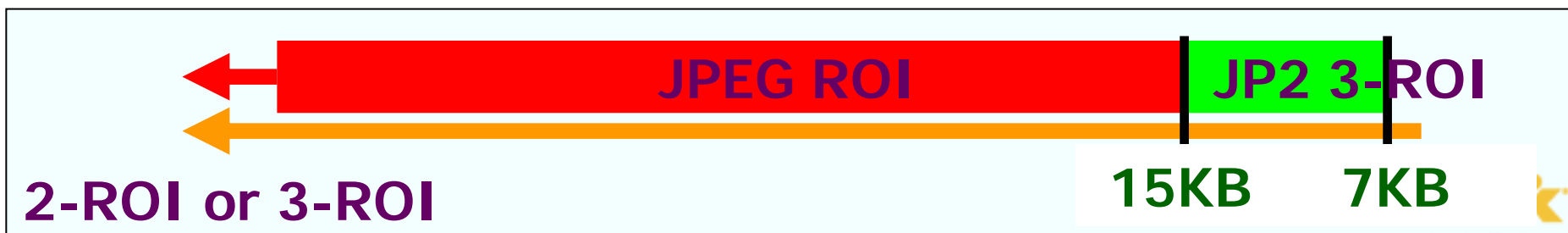
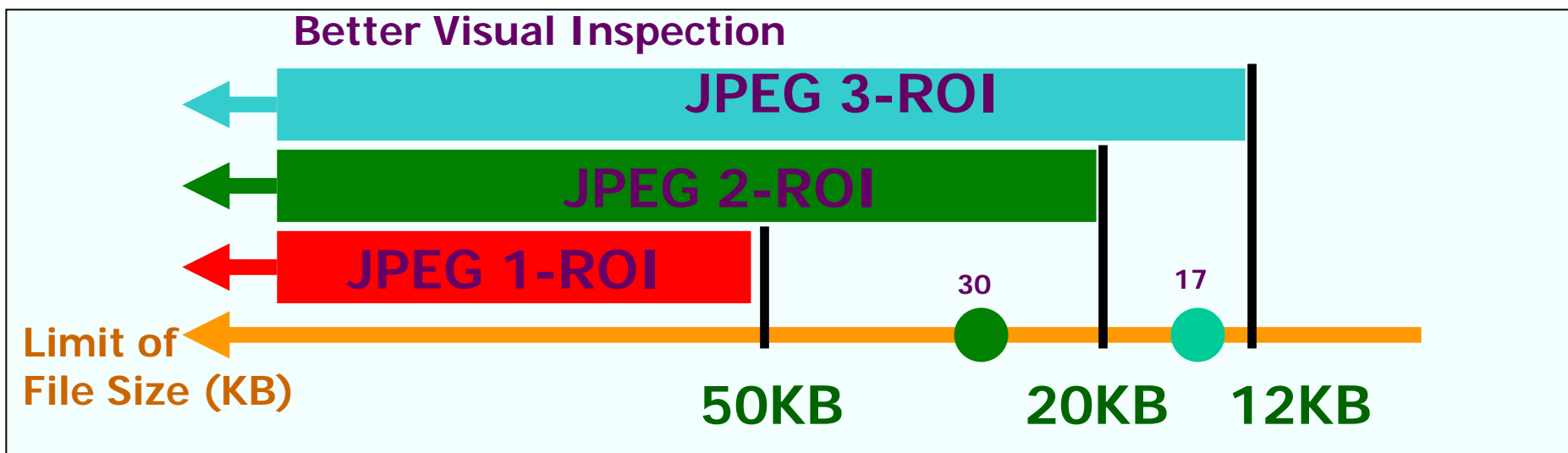
# Recommended Compression – Zoomed JPEG

|      | 45KB   | 30KB  | 17KB   |
|------|--|---|--|
| JPEG |  |  |  |

# Recommended Compression – Zoomed JP2

|           | 45KB   | 30KB  | 17KB   |
|-----------|--|---|--|
| JPEG 2000 |  |  |  |

# ROI type and JPEG/JP2 verses Size



# Summary

- Face recognition performance is a strong function of compression
- Therefore, maximum compression is determined using face recognition
- We studied token/mug shot images with an inter-eye distance of 120 pixels with JPEG or JPEG2000 ROI compression.
- A recursive search of compression ratios of all regions can meet a limit of file size for JPEG as well as JPEG2000.
- Use of multi-region compression improves visual clarity without compromising recognition.
- Minimum files sizes for both JPEG and JPEG2000 are
  - **45 KB (1 region), 30 KB (2 region), 17 KB (three region)**
  - **Maximum central face compression is always 20:1**

# For More Information

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**JPEG and JPEG2000 code available from Identix:**

**JROI Web Page:** <http://www.identix.com/research/>

**JROI Document:**  
<http://www.identix.com/research/JROI.pdf>

**JROI Package:**  
<http://www.identix.com/research/JROI.exe>

**Presentation:**  
<http://www.identix.com/research/JROI.ppt>

# JPEG Compression

- JPEG Standards:
  - [2] “Digital Compression and Coding of Continuous-Tone Still Images, Requirements and Guidelines,” Document number ITU-T T.81 or ISO/IEC 10918-1.
  - [3] “Digital Compression and Coding of Continuous-Tone Still Images, Compliance testing,” Document number ITU-T T.83 or ISO/IEC 10918-2.
  - [4] “Digital Compression and Coding of Continuous-Tone Still Images, Extensions,” Document number ITU-T T.84 or ISO/IEC 10918-3.
- JPEG 2000 Standards:
  - [5] “JPEG 2000 image coding system: Core coding system,” [ISO/IEC 15444-1:2004](#) or ITU-T Rec. T.800.