Using Video Compression to Exploit Similarities in Biometric Databases

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Content

Objective

General incentive

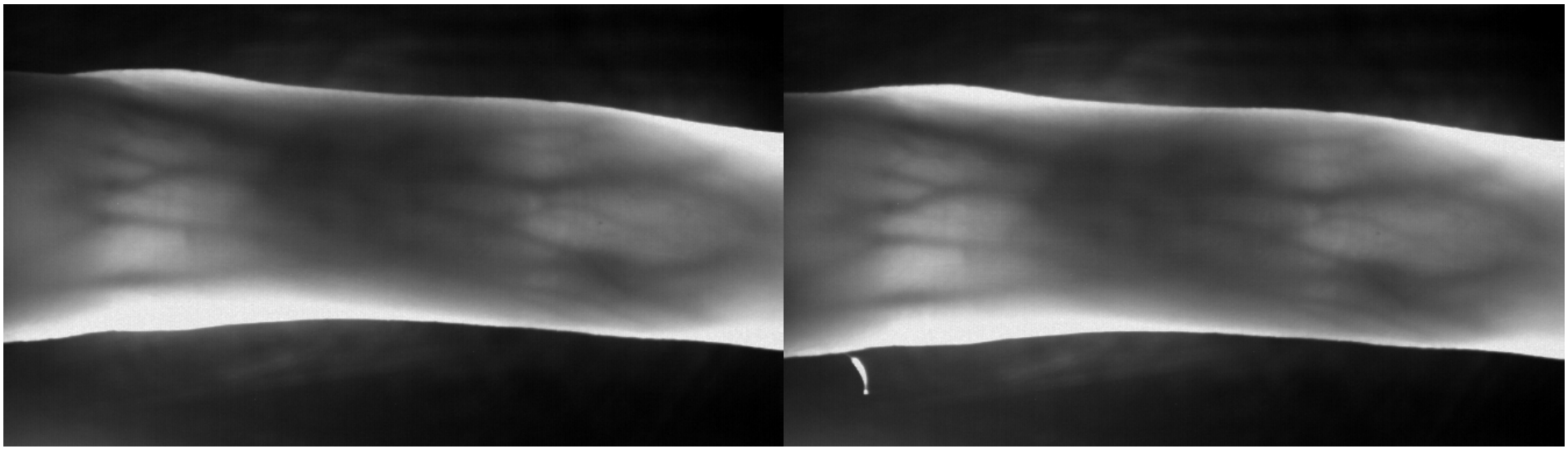
Is it possible to effectively apply **video compression** to very similar **pictures**?

→ can we achieve *better* results with video compression than with image compression?
→ which codec is best suited for our purposes?
→ how does the change of video codec parameters affect the results?
→ how to determine the quality of the results?

Dataset

The database consists of finger vein images of different fingers of different persons

- 6 fingers per person, with 4 pictures per finger $\rightarrow$ 24 pictures per person
- 60 persons at all
- we worked with a subset of those



Video Compression

Why video compression?

Video Compression

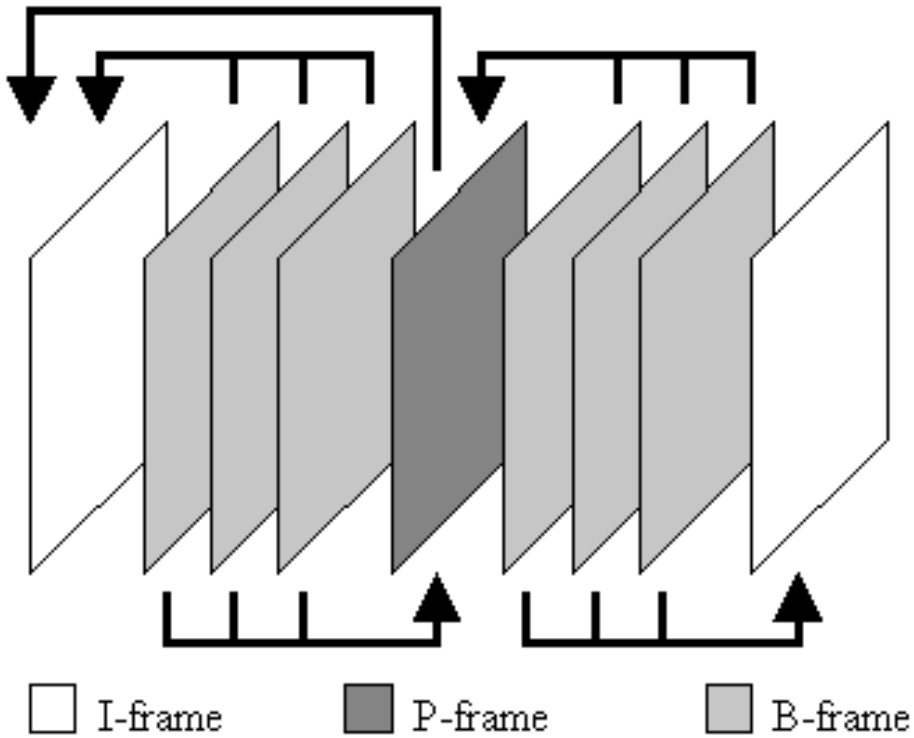
Why video compression?

- Very similar images
- Image compression only compresses individual images
- Video compression does 2 things:
  1. Compresses images
  2. Exploits similarities between images

I,P,B-Frames

3 different types of pictures

- I-Frame: Intra-coded picture
- P-Frame: Predictive-coded picture
- B-Frame: Bidirectional predictive-coded picture



Group Of Pictures

- usually defined with two numbers
  1. defines distance of two I-Frames
  2. defines distance of two anchor frames (I or P)
- we used GOP to adapt the encoding to the database
  - 24 pictures per person: use GOP 24 $\rightarrow$ 1 I-Frame per person
  - 4 pictures per finger: use GOP 4 $\rightarrow$ 1 I-Frame per finger
- P- and B-Frames allow higher compression $\rightarrow$ GOP affects the compression rate

JPEG2000

- used as a baseline for comparison
- standard encoding settings, except number of layers
- ImageMagick (7.0.5-10) with integrated OpenJPEG library
  1. encode pictures with jp2, with different compression rates
  2. determine quality of the pictures
  3. compare with pictures compressed with video codecs

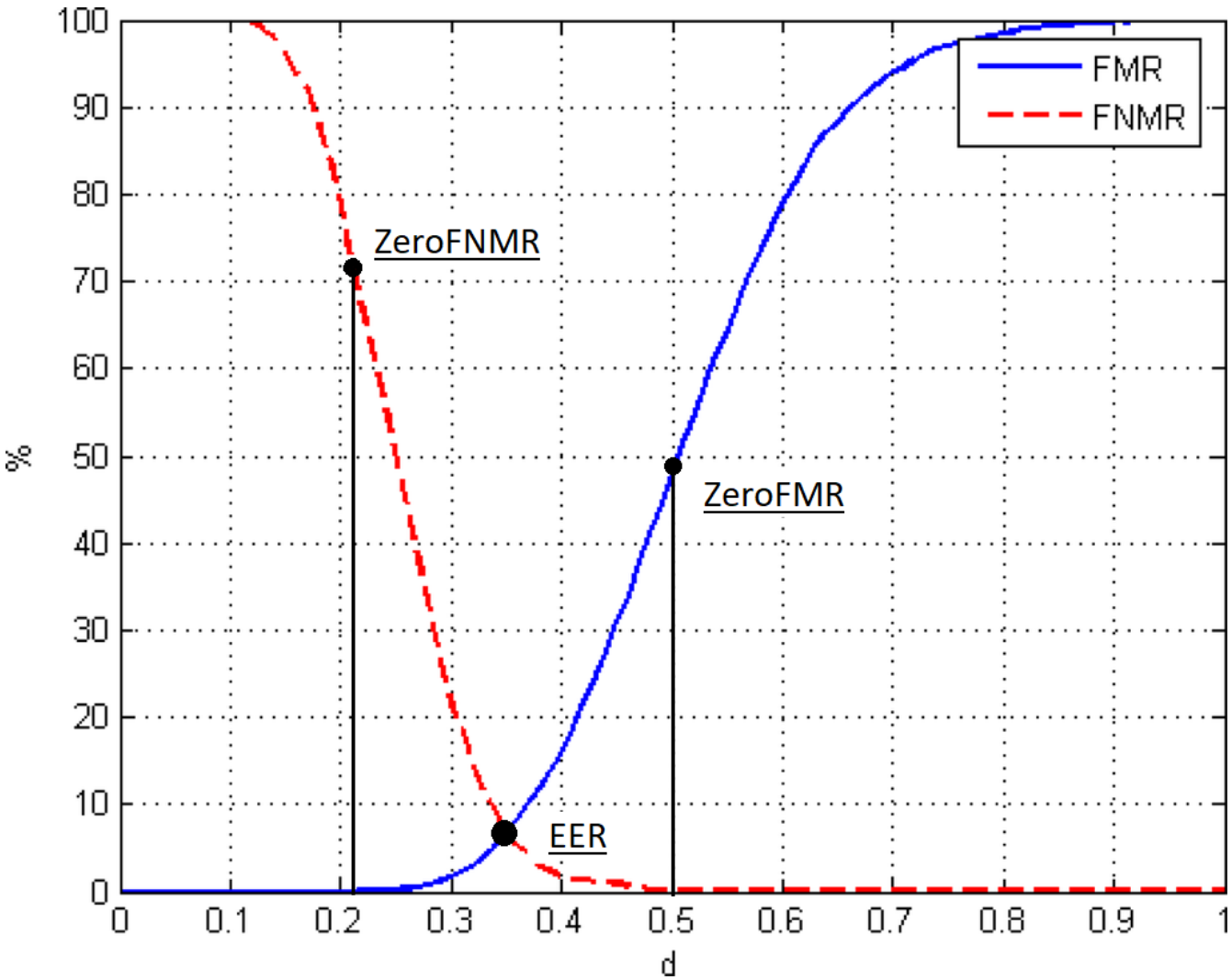
Matcher

- Used as a "black box"
- Compares original and compressed images
  $\rightarrow$ Checks if matches found
- calculates different error metrics
- Target:
  Compare results of jpeg2000 and video compression

Error Metrics

- FMR: False Match Rate
- FNMR: False Non Match Rate
- EER: Equal Error Rate
- ZeroFNMR: FNMR at FMR $= 0$
- Lower values are always better

Error Metrics



http://www.mdpi.com/sensors/sensors-11-09499/article_deploy/html/images/sensors-11-09499f22-1024.png

CRF

- CRF value (Constant Rate Factor)
  1. The range of the quantizer scale is 0-59
  2. A lower value means better quality (0 for best quality, lossless)
  3. Default value is 23
  4. A higher value means bad quality (59 for worst quality)

Presets

- presets (they provide a certain encoding speed)
  1. ultrafast , superfast , veryfast , faster , fast
  2. medium (default)
  3. slow, slower, veryslow, placebo
  4. we focused more to the slower presets (medium-veryslow)

Settings

- what are the settings behind them?

	medium	veryslow
–b-adapt	1	2
–bframes	3	8
–ref	3	16

Settings

Quick explanation of the settings :

- –b-adapt "Mod":
  - algorithm for the adaptive distribution of B-frames
  - values : 0,1,2
- –bframes "Max":
  - Defines how many B-frames can be positioned directly behind each other
  - values are between 0 and 16 (3 is default)
- –ref "frames":
  - amount of valid reference frames

Settings (qscale mpeg4)

- -qscale:v n
- configure and select a video quality level
- value for n : 1-31
- 1: highest quality and largest filesize
- 31: lowest quality for smallest filesize

Video Compression

Setup:

- Used ffmpeg v.3.3.2 (latest version)
- Compressed 240 images
- Different crf values (0-50)
- Different qscale values for mpeg4 part 2
- Varying group of pictures (1, 4, 24)
- Two presets (medium, veryslow)

Video Compression

Repeat for each (crf, gop, preset) - combination

1. Compress images into single video
2. Get videosize (for compression rate)
3. Decompress video $\rightarrow$ get images
4. Put into folder named with settings

Additional steps

- Collect image names $\rightarrow$ parameters for matcher
- Rename decompressed videos

Matching

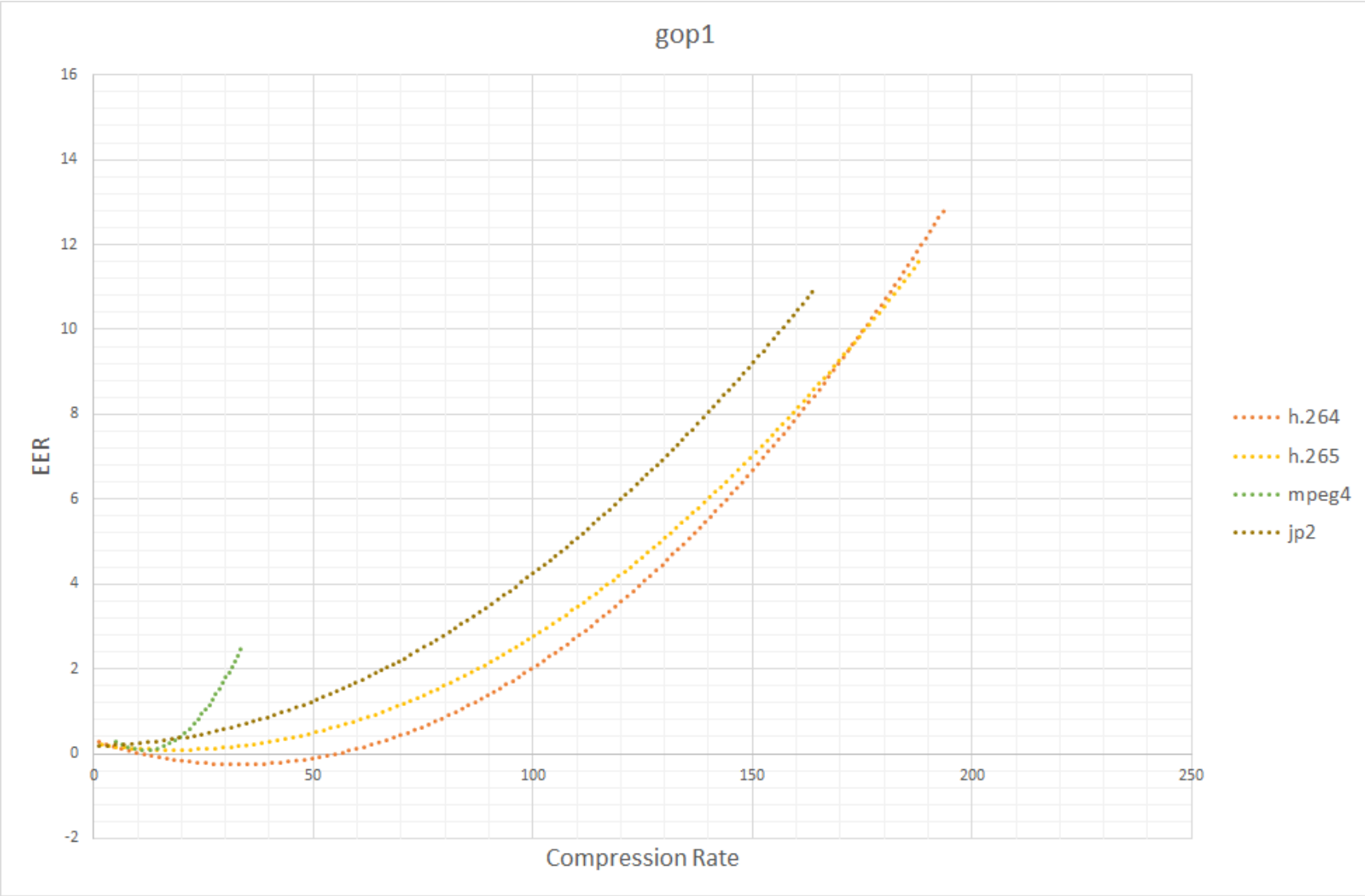
- Used matcher as "black box"
- Input:
  1. original images
  2. compression output folders (crf, gop, preset)
- Match each output folder
- Retrieve error metrics
- Evaluate Error rate dependent on compression rate

Evaluation

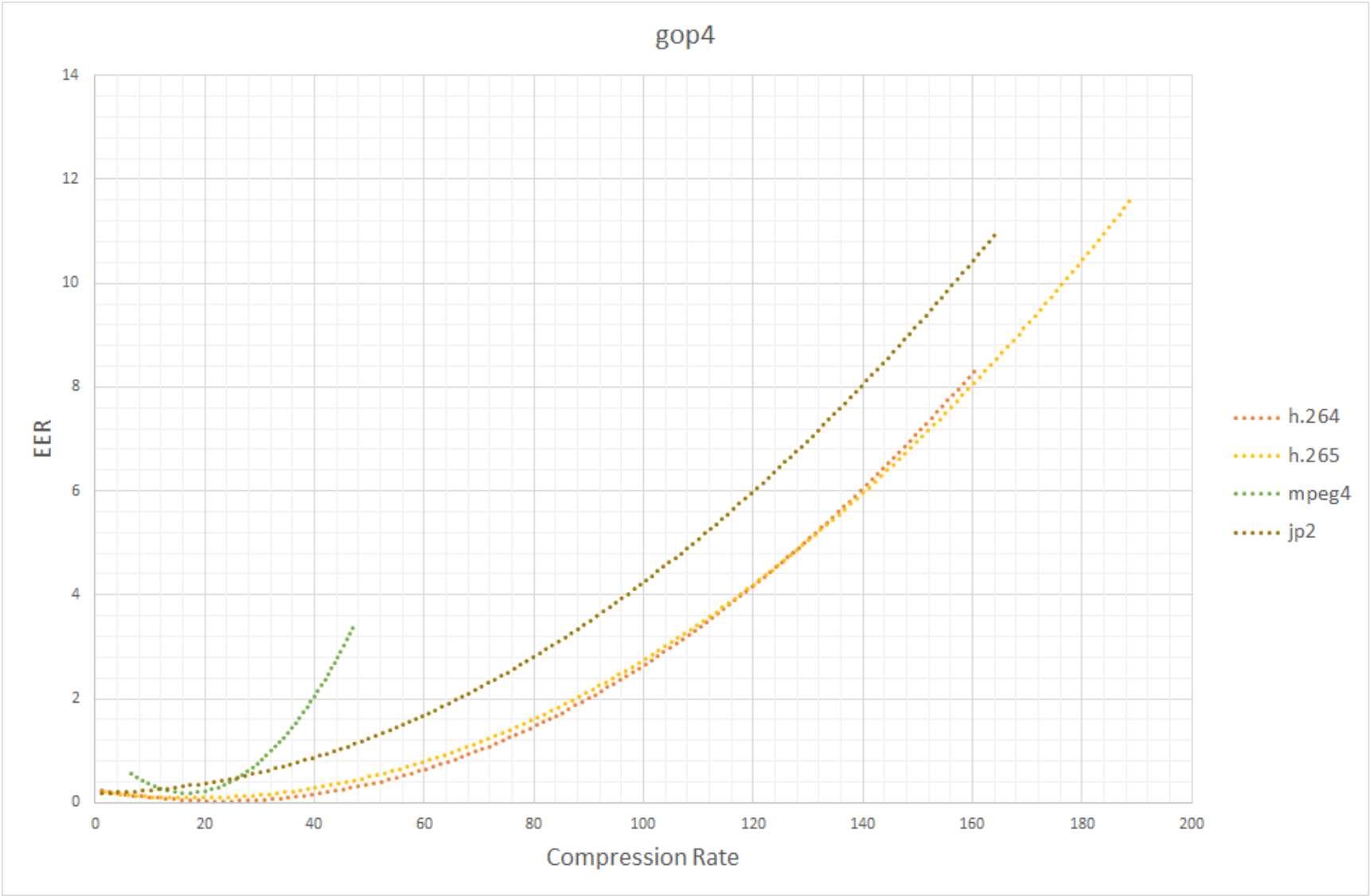
Compression rate vs. matching errors

- Group of pictures (1, 4, 24)
- Codecs (mpeg4 part 2, h.264, h.265)
- presets (medium, veryslow)
- Best result of jpeg2000 compression as baseline

Comparing codecs



Comparing codecs



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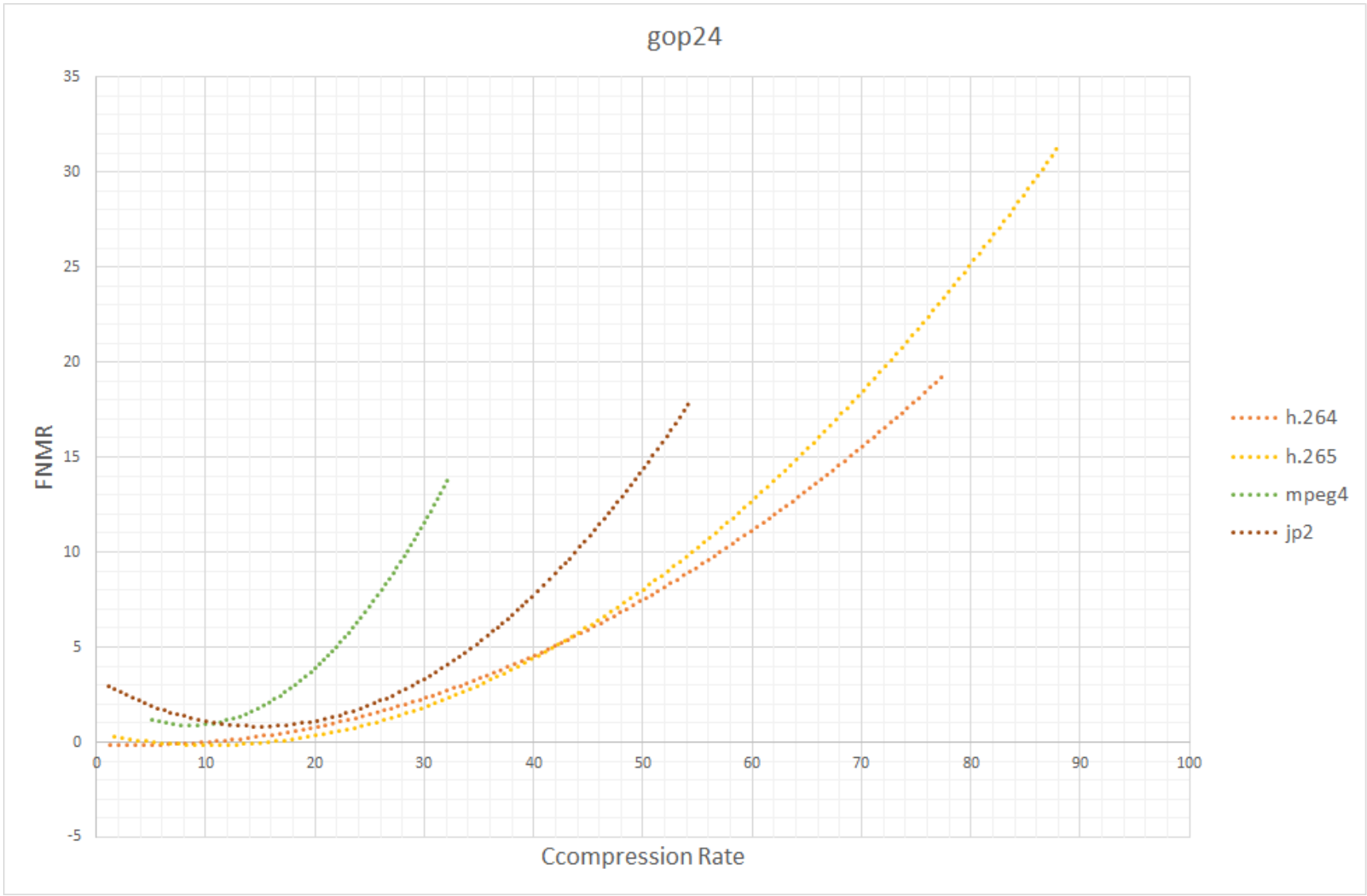
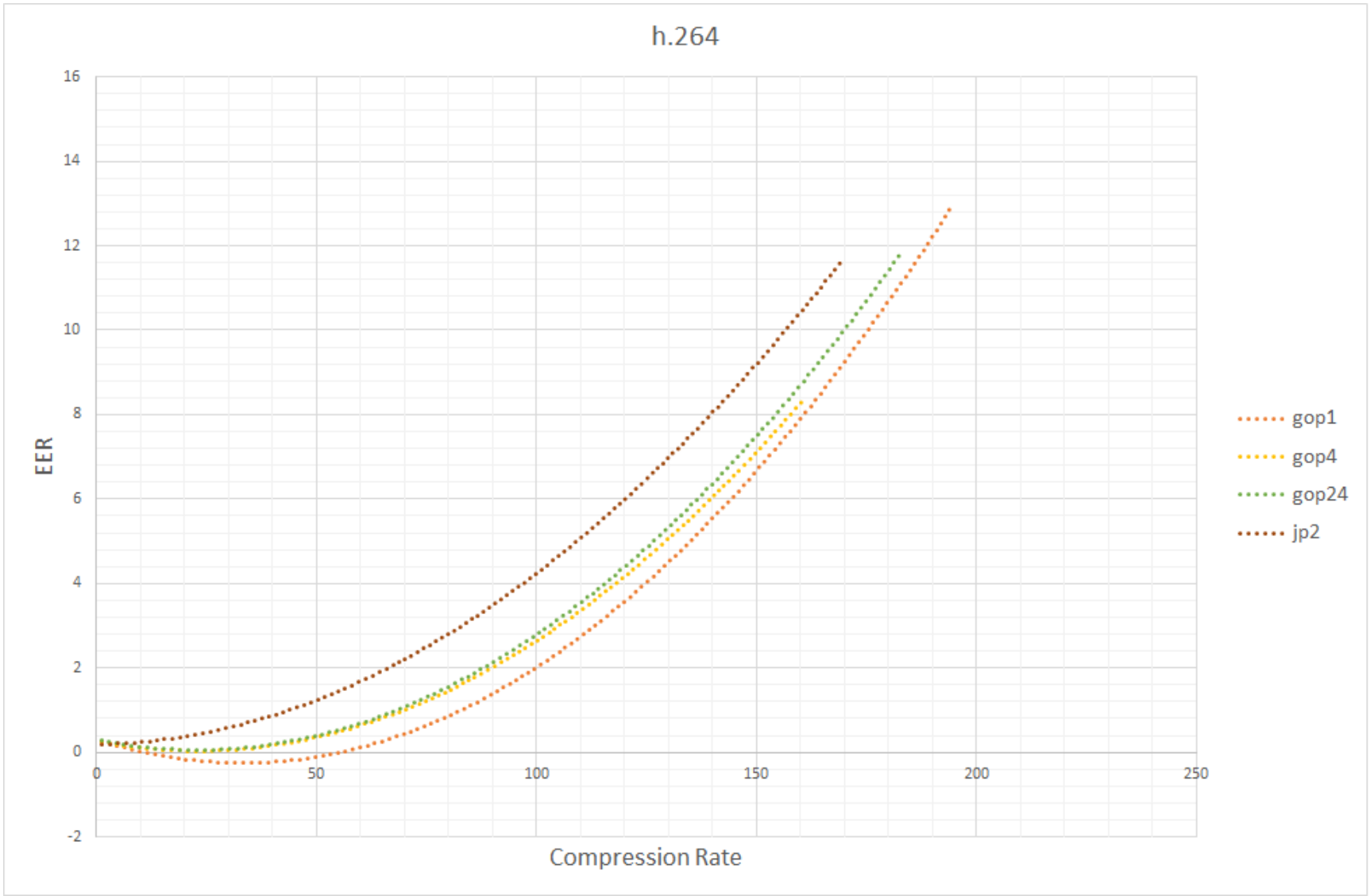


Comparing group of pictures



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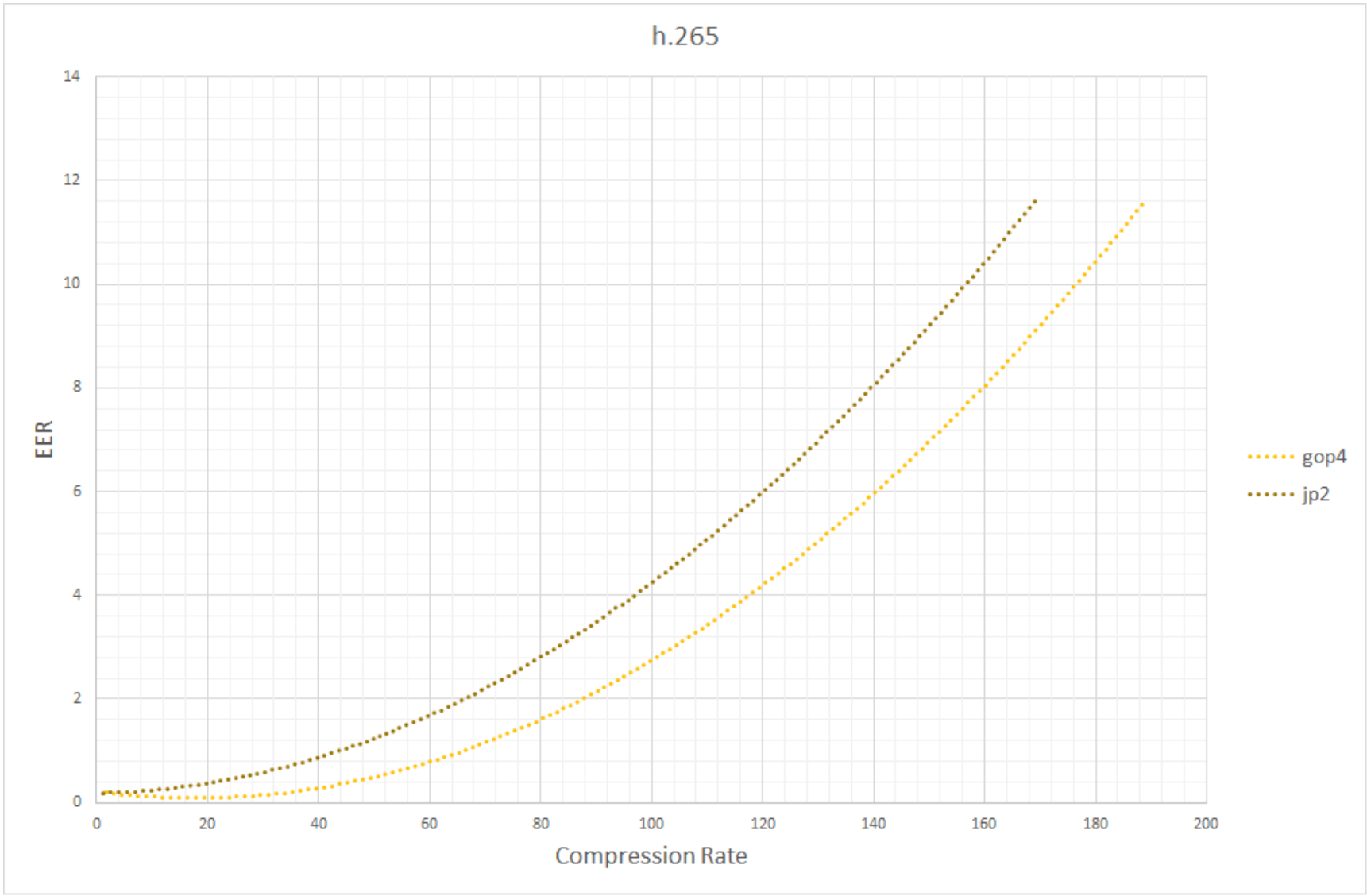

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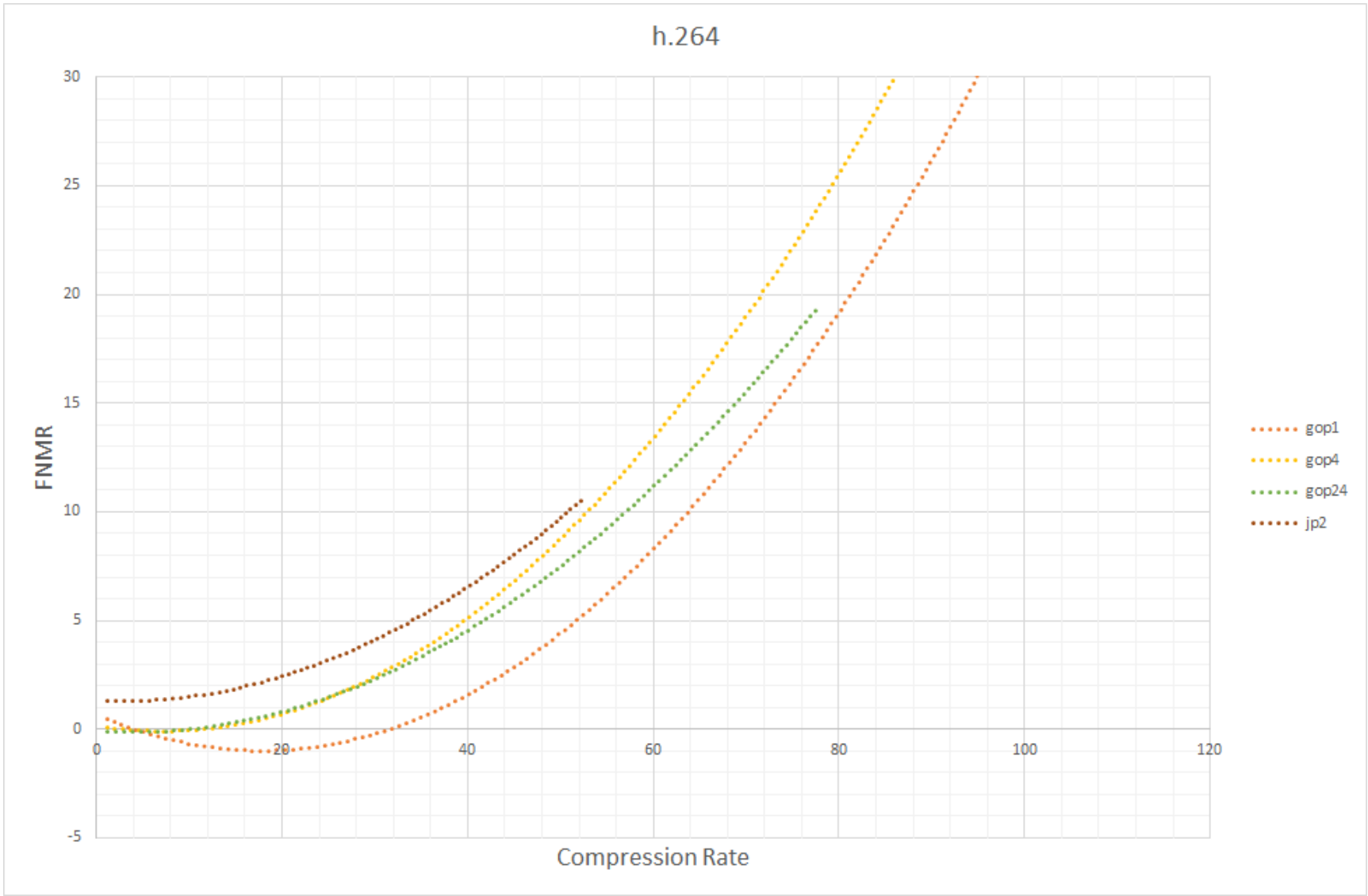
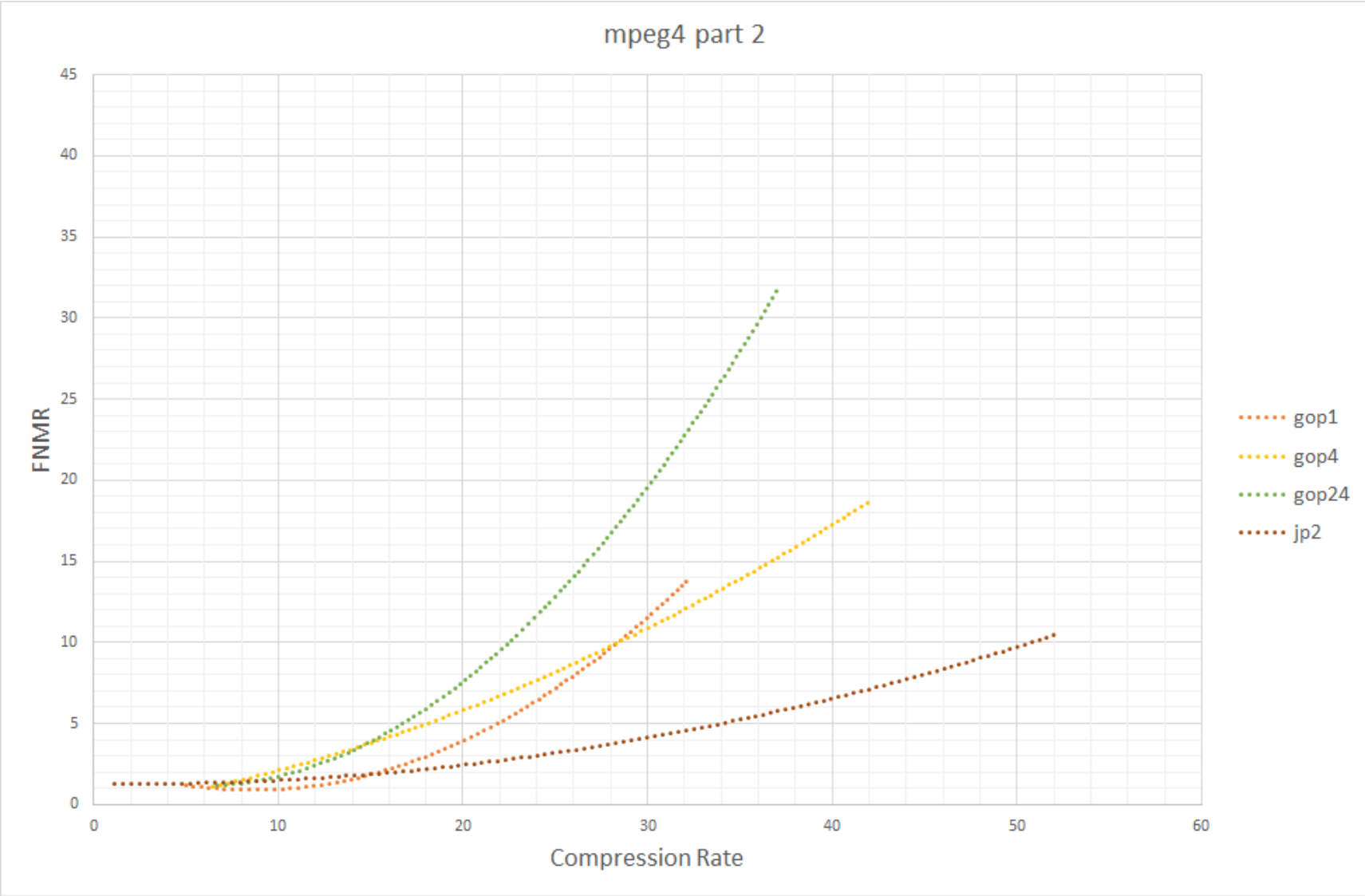
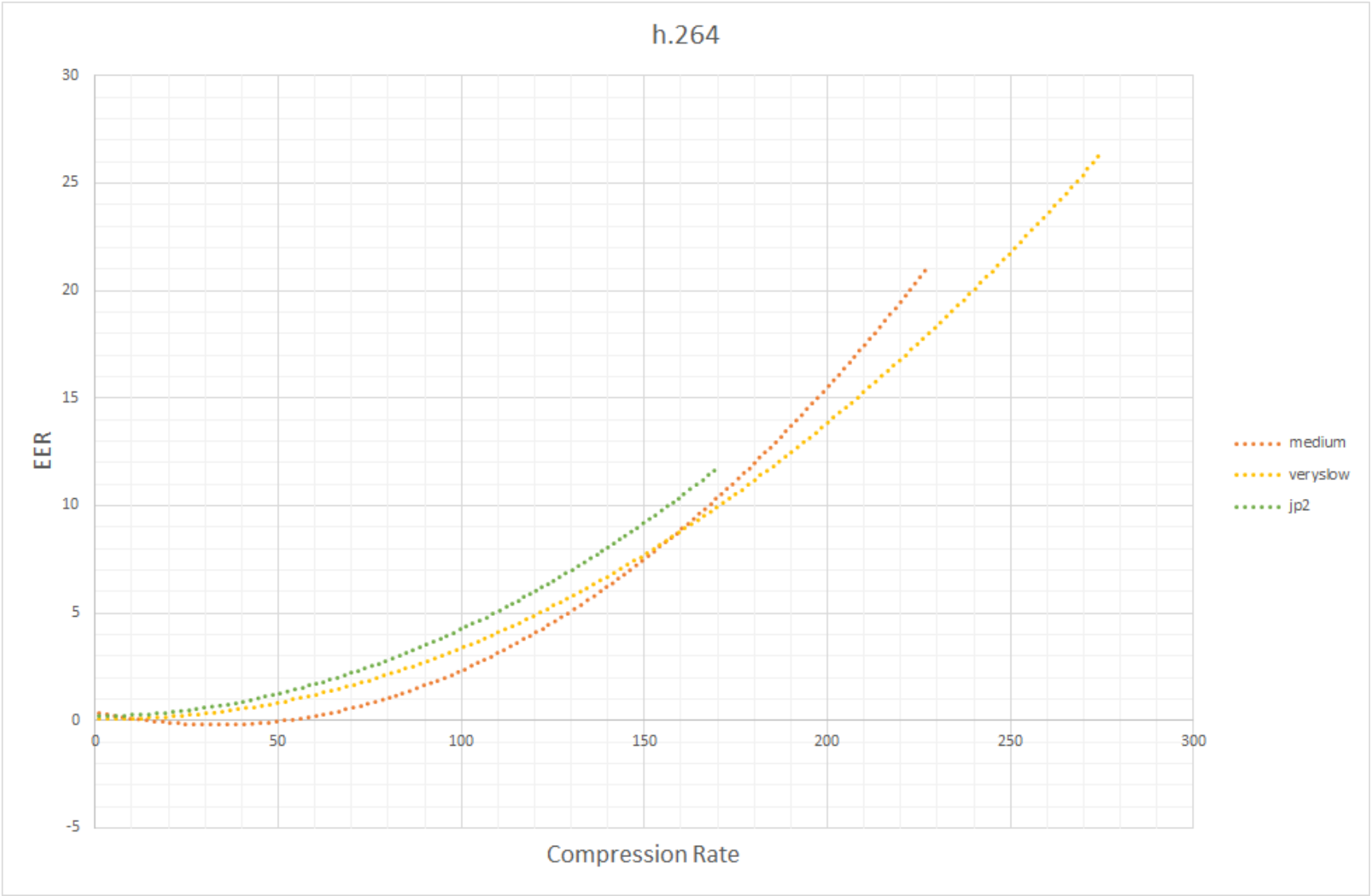


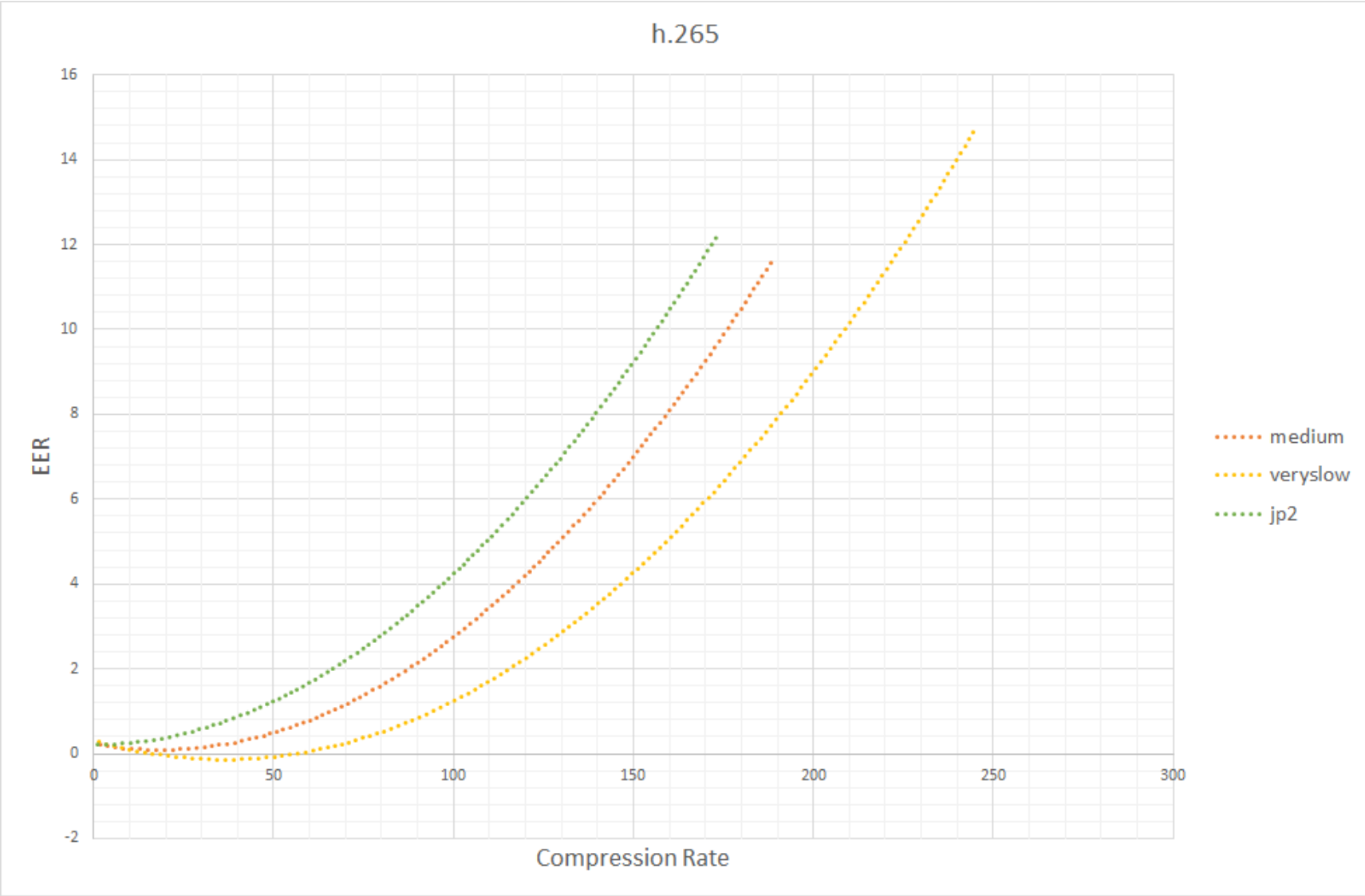
Comparing group of pictures



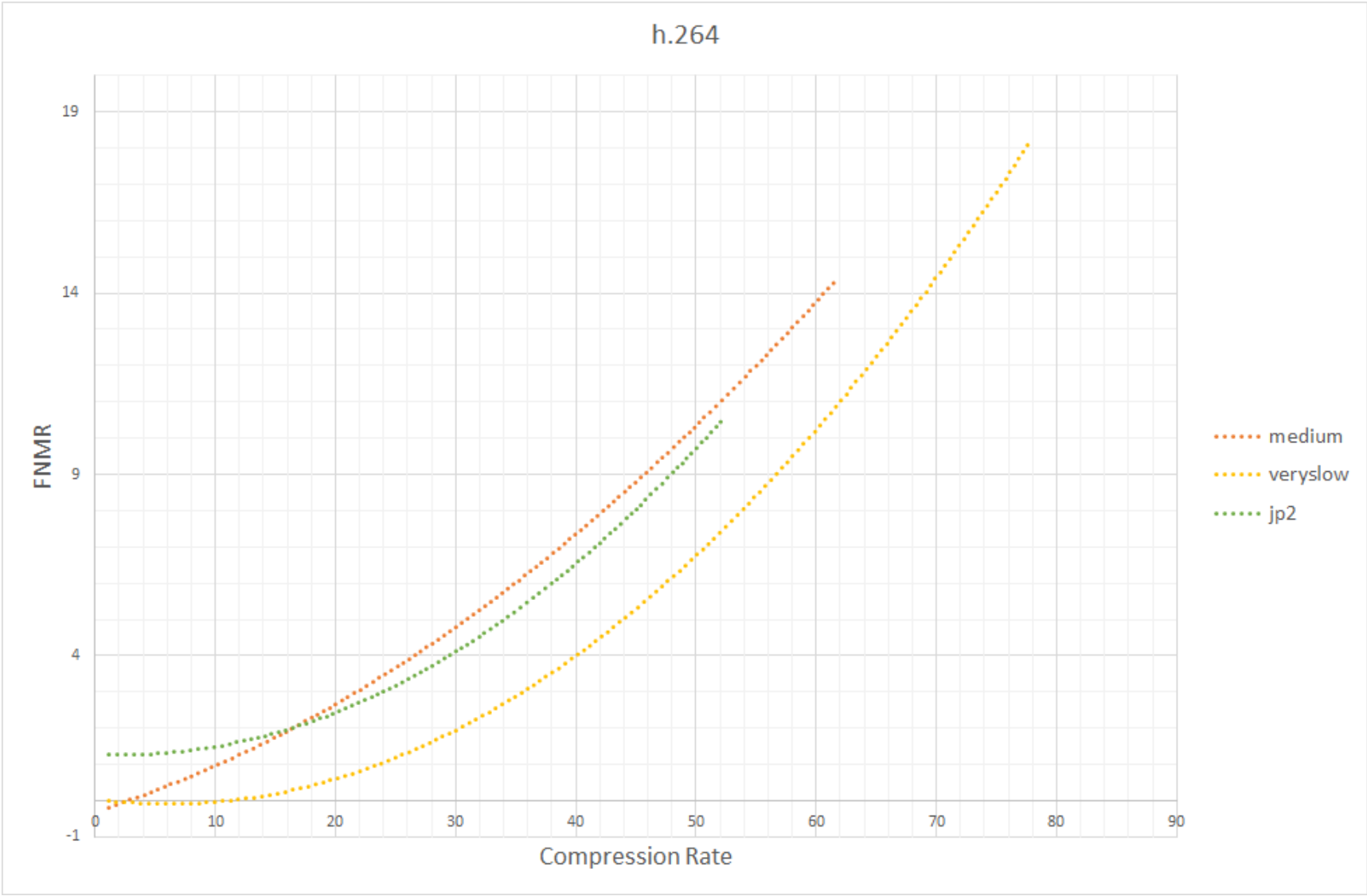
Comparing presets



Comparing presets



Comparing presets



Conclusion

Best Results:

- GOP 1 or GOP 4
- h.264 or h.265
- veryslow

40% higher compression at same EER (h.265 veryslow)
30% higher compression at same FNMR (h.264 veryslow)

Thank you for your attention!