



**FastVDO**  
*like it's meant to be...*

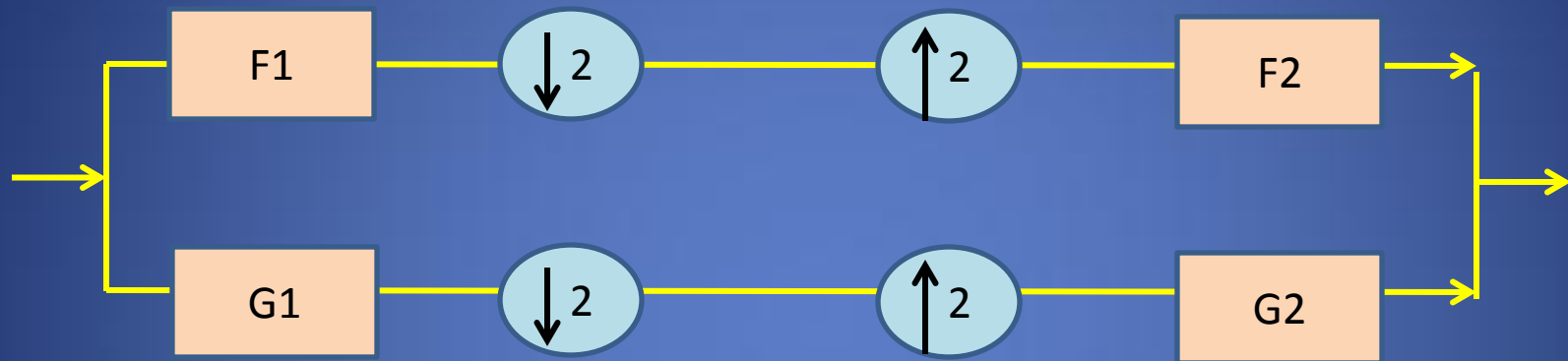
**JCTVC-J0127**

**Integer Color Transforms and Resampling Filters  
for HEVC Extensions:  
Scalability, 3DV, and Higher Chroma Coding**

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# 2-Ch Perf Recon Filter Bank (PRFB)



- 2 Ch Perfect Recon Filter Banks
  - 1980s - Smart co-design of filters allow alias cancelation
  - 1990s – discover lifting based approaches
  - 2000 – JPEG2000

# Sampling = 1-Ch FB. PR?



- Sampling (down and up) is a 1-Ch FB
  - Perf Recon is no longer possible
  - But we can still cancel some aliasing!
  - Related to Laplace Pyramid; have lifting interpretation
- Moral: can do better than half-band filters

# Standard Half-Band Filters (SVC)

- Down

- $\text{svc13} = [ 2 \ 0 \ -4 \ -3 \ 5 \ 19 \ 26 \ 19 \ 5 \ -3 \ -4 \ 0 \ 2 ] / 64$

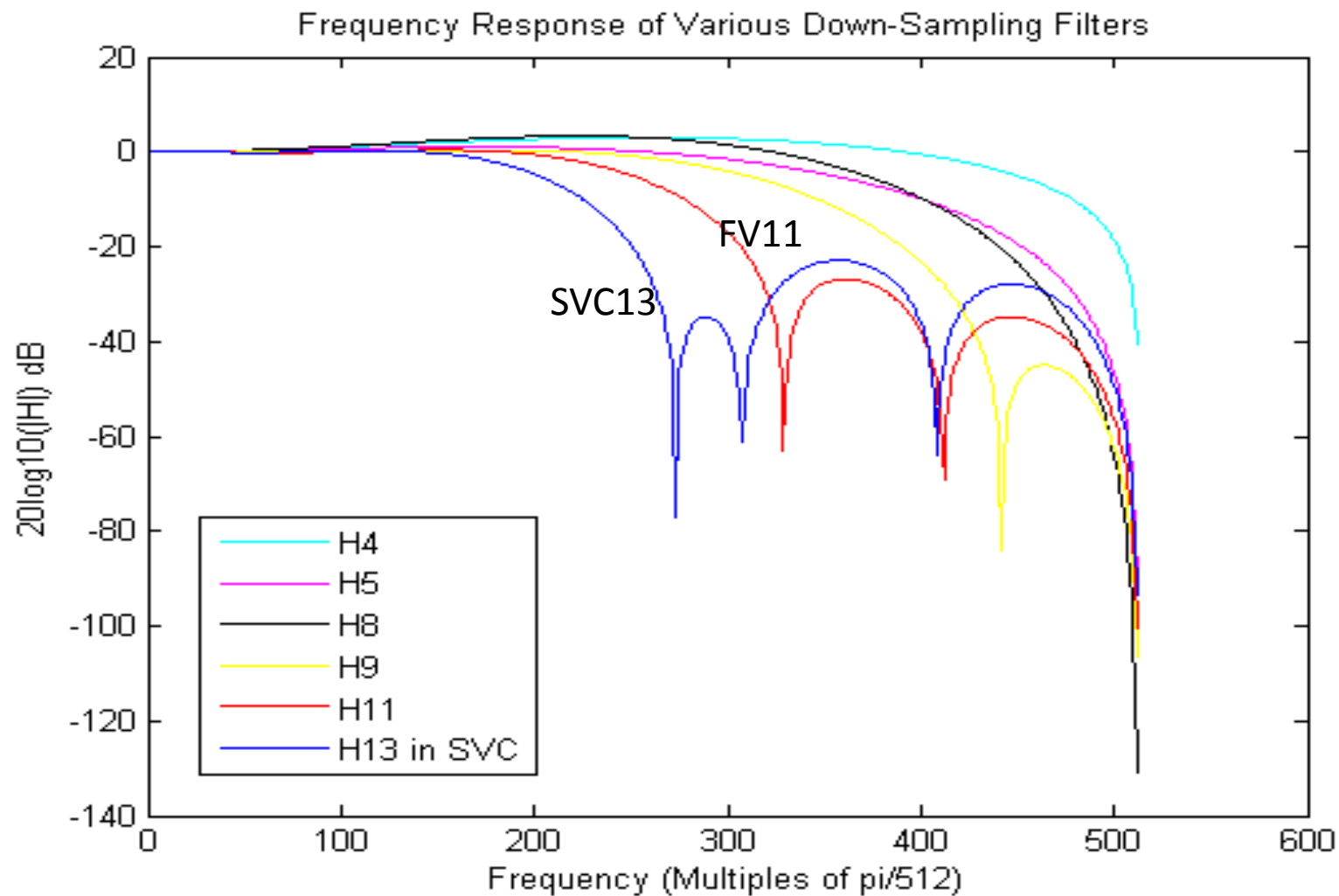
- Up

- $\text{Svc4} = [ -3 \ 19 \ 19 \ -3 ] / 32$

# FastVDO Anti-Alias Filters

- Down
  - $\text{fv11} = [1 \ 0 \ -3 \ 0 \ 10 \ 16 \ 10 \ 0 \ -3 \ 0 \ 1] / 32$
- Up
  - $\text{fv4} = [-1 \ 5 \ 5 \ -1] / 8$

# Spectral Response (Downsamplers)

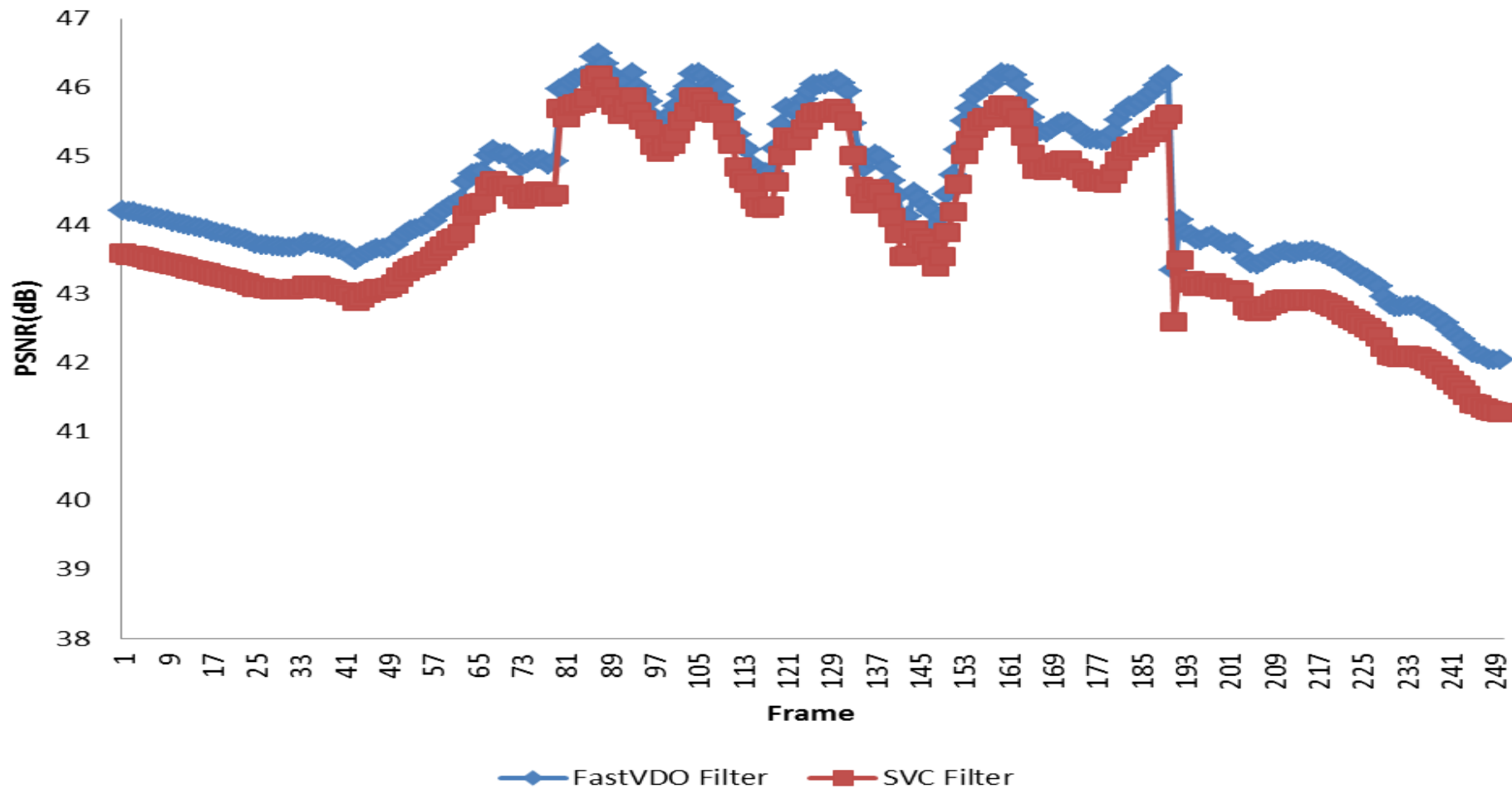


# Tests: Outperforms SVC Filters

- Consistent 0.7 – 1.2 dB gain in all test seqs
  - Outperforms SVC on every frame!
- Wide application in many domains
  - Spatial scalability
  - Adaptive Resolution Coding (ARC)
  - Adaptive Chroma Coding (ACC)
  - 3DV (depth map coding)



# Application Example: Depth Map\*



\*Dancer sequence

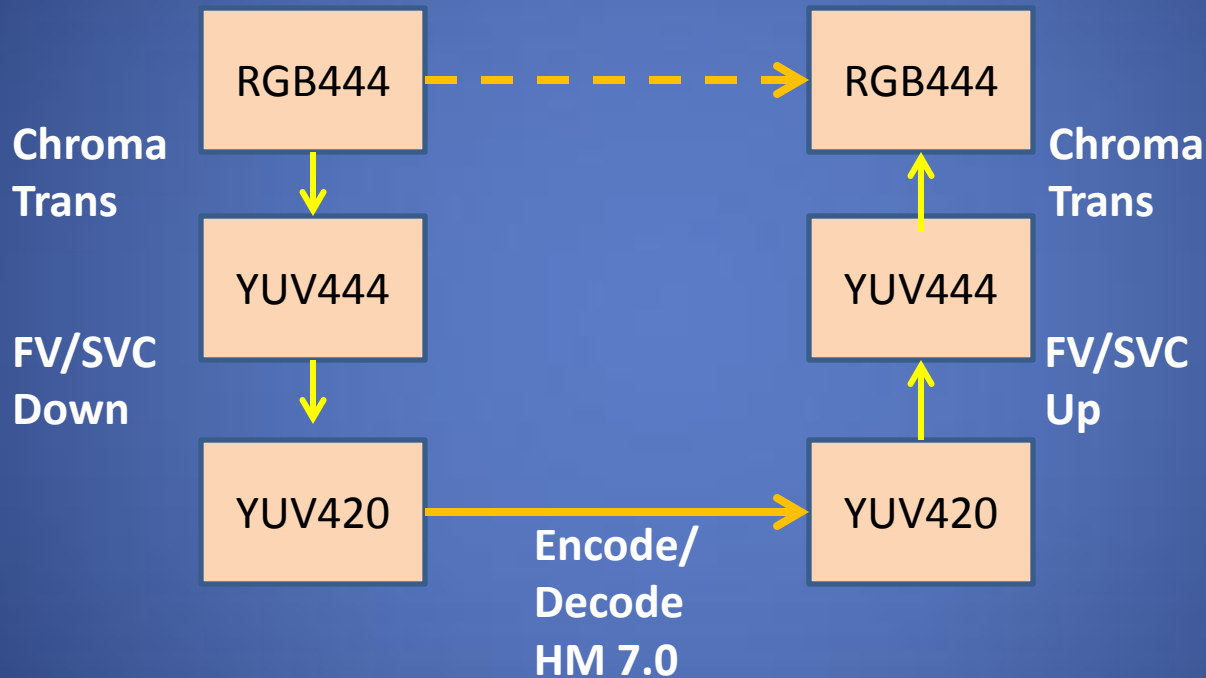
# Chroma Quality

- Sensors and displays mostly work in RGB
  - But codecs mostly work in YUV
  - We constantly pay a price in chroma quality
  - Big gains if we sample carefully!
  - Need not resort to full 4:4:4 coding to get gains

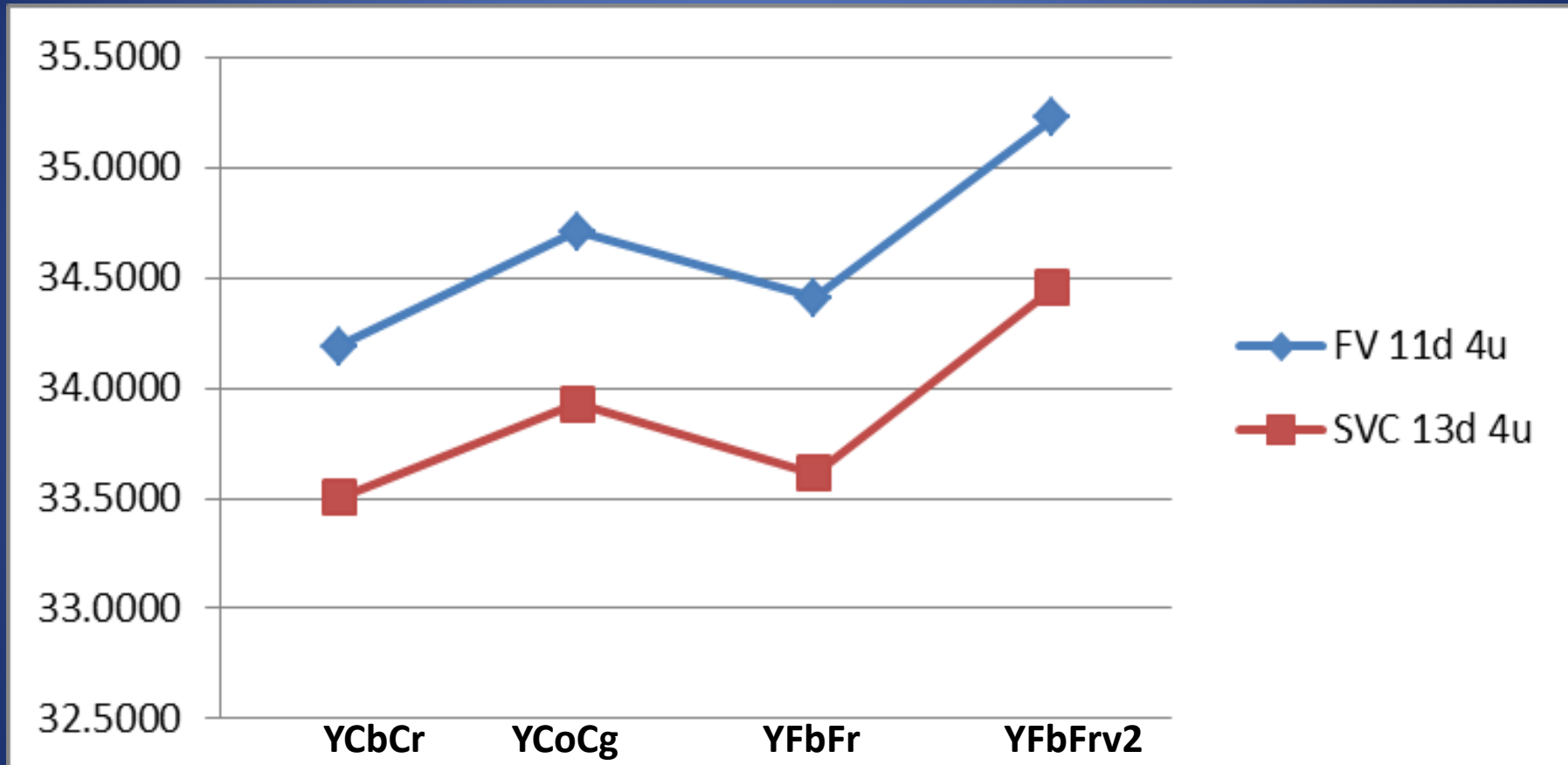
# Test Chroma Transforms

- $YCbCr = [.299 \ .587 \ .114; \ .5 \ -.419 \ -.081; \ -.169 \ -.331 \ .5];$
- $YUV = [.299 \ .587 \ .114; \ -.147 \ -.289 \ .436; \ .615 \ -.515 \ .1];$
- $DCT = [.577 \ .577 \ .577; \ .707 \ 0 \ -.707; \ .408 \ -.816 \ .408];$
- $YCoCg = [.25 \ .5 \ .25; \ 1/2 \ 0 \ -1/2; \ -.25 \ .5 \ -.25];$
- $YFbFr = [5/16 \ 3/8 \ 5/16; \ -1/2 \ 1 \ -1/2; \ 1 \ 0 \ -1];$
- $YFbFrv2 = [3/16 \ 5/8 \ 3/16; \ -1/2 \ 1 \ -1/2; \ 1 \ 0 \ -1];$
  
- Any of these can be called YUV4444
- The last 3 (and YCbCr) have a precise integer definition

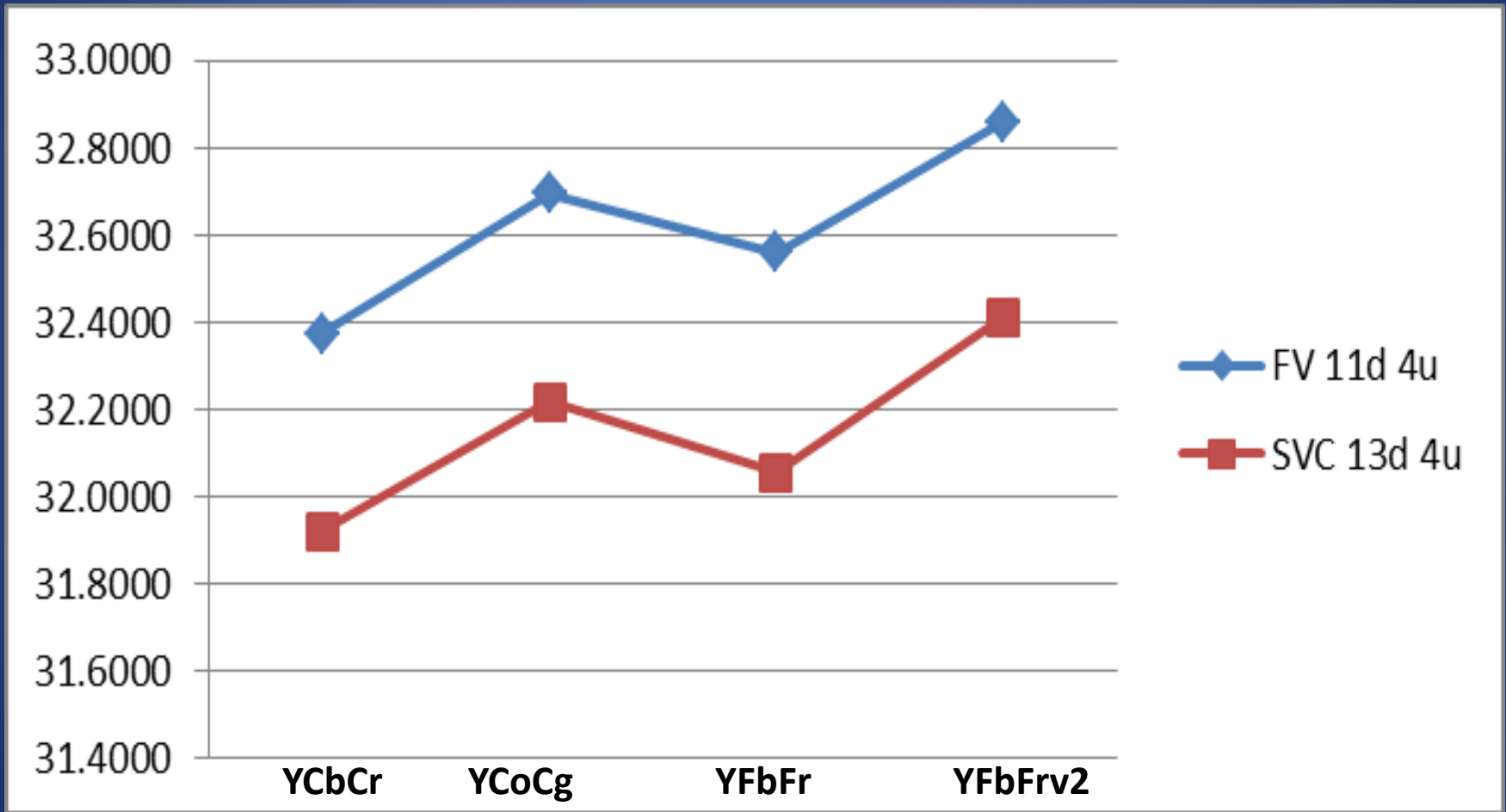
# Test Methodology



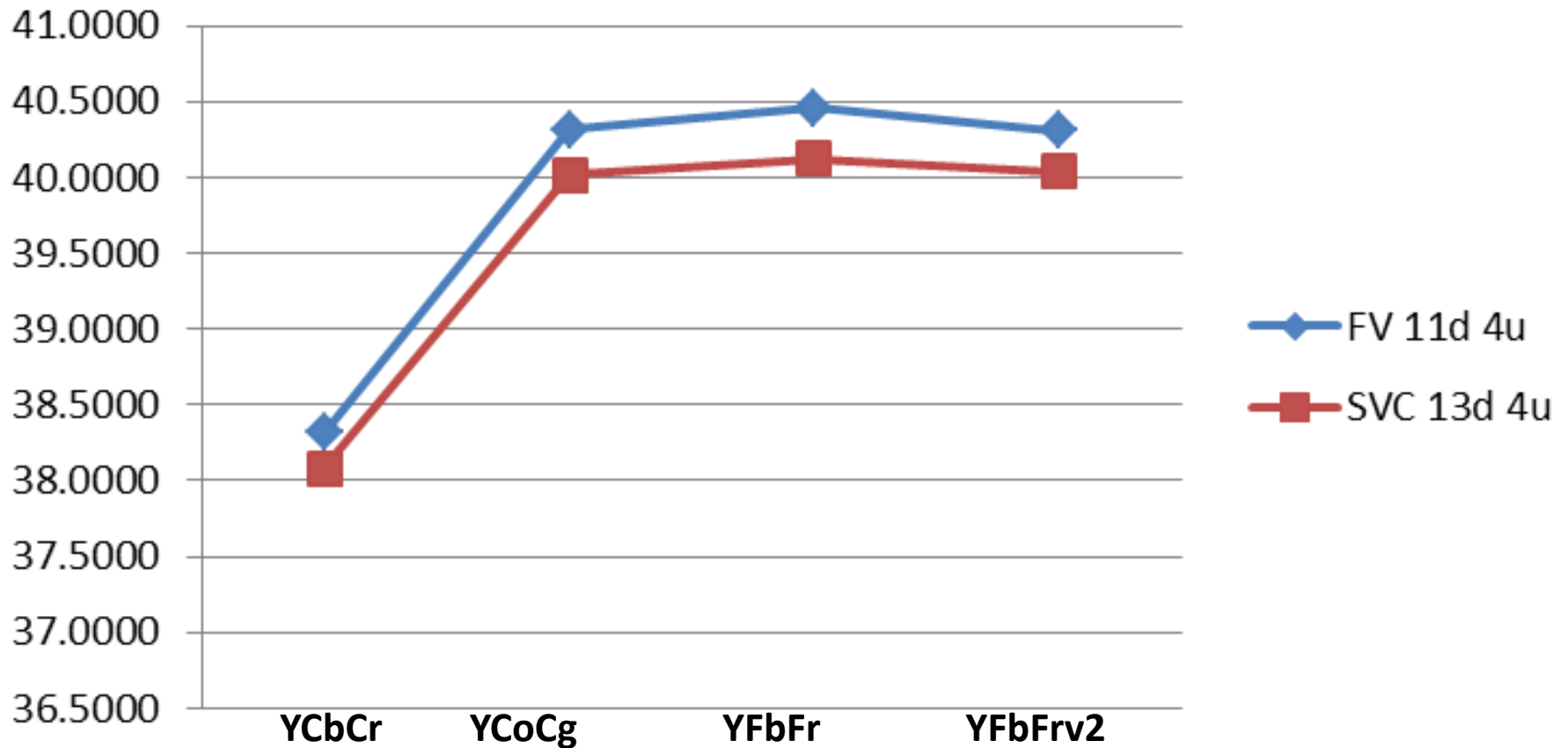
# Example Result (No Comp): Crowdrun



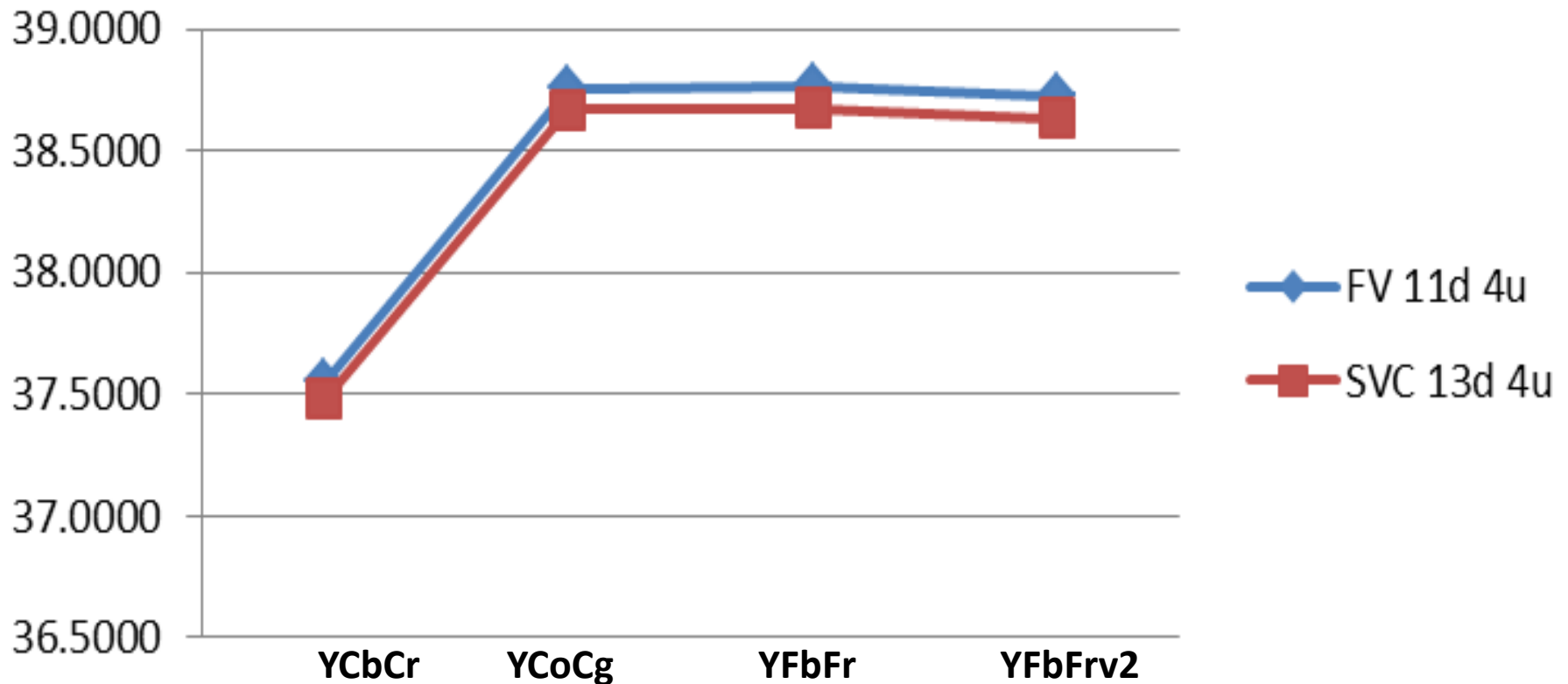
# Crowdrun, w/ $Q_p = 22$



# Example: KungFu Seq. Over 40dB!



# KungFu w/ $Q_p = 22$





# Possible Usage Models

- Method 1. Low Complexity
  - RGB444 as I/O
  - Use our YUV420 intermediates for coding
- Method 2. Adaptive Chroma Coding (ACC)
  - Use separate color plane coding
  - Adaptively convert to optimize performance

# Conclusion

- Powerful spatial and chroma sampling filters
- Powerful chroma transforms
- Combination can provide useful gains for free
  - Careful sampling / colour management
- Benchmarks for 444 and 422 tool testing

# Suggestion

- Adopt as testing tools for Prof Extensions
- Prof extension tools must outperform these
  - And justify their complexity vs these tools