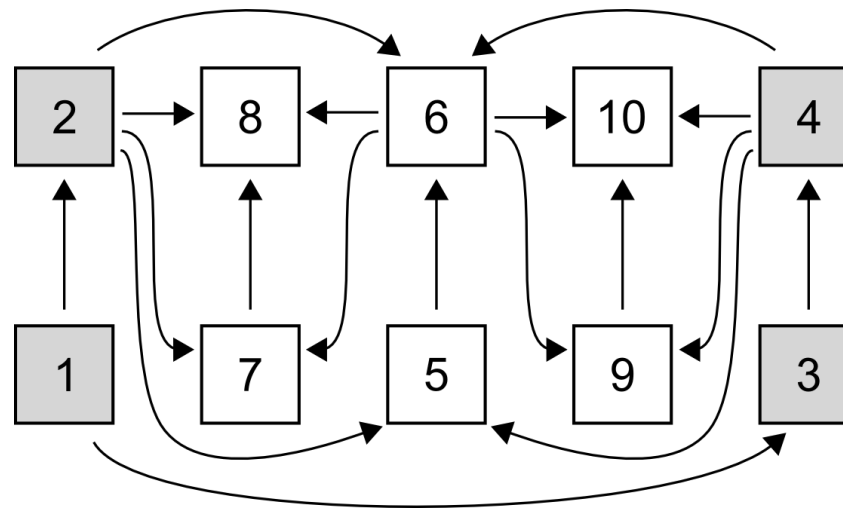


# Single-loop SNR scalability using Binary Residual Refinement Coding

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- Dual loop approach for SNR scalability not suitable
  - Two full decoding loops (MC, transforms, Intra prediction, entropy coding, loop filters)
  - Worst case: double complexity
- Proposed design:
  - Single loop decoding
  - Perform residual refinement in transform domain
  - Allows re-writing of multi-layer residual signal



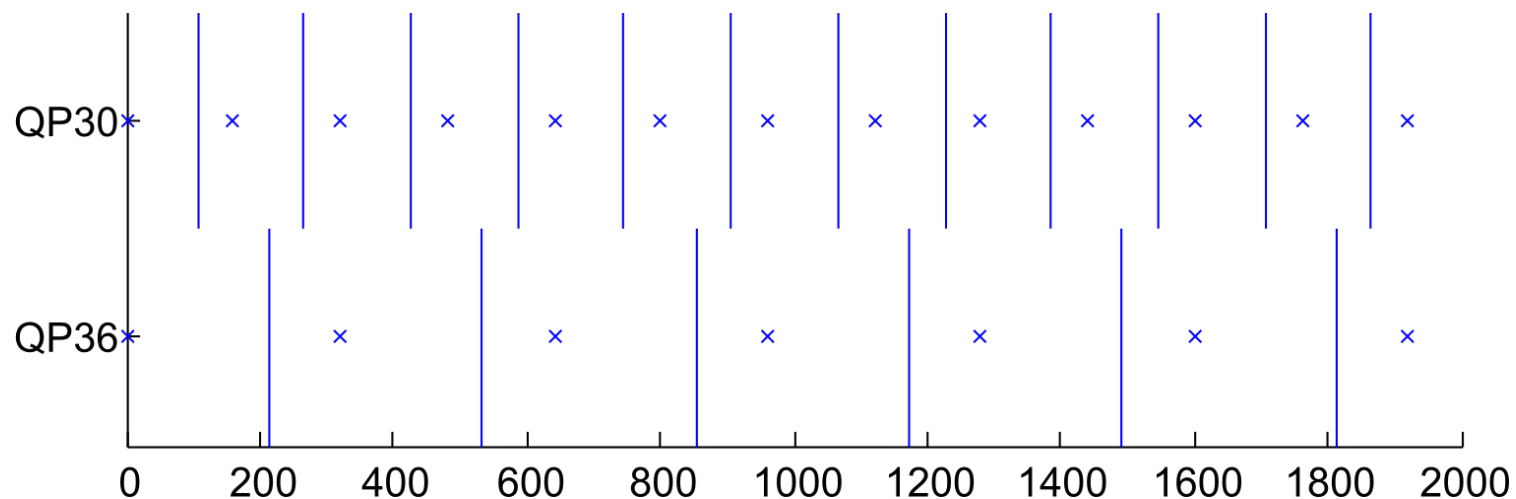
- Key picture concept (Gop size 8)
- Use enhancement layer reconstruction in base layer
- Use base layer motion info in base layer
- Inherit CU tree, prediction info and TU tree from base layer

## Prediction modes in enhancement layer

- HEVC Intra prediction
- HEVC Inter prediction
  - Use base layer motion info in AMVP and Merge
- Base layer mode
  - If no coefficients in BL → code HEVC residual
  - Skip residual coding and copy BL reconstruction
  - Use BL prediction and refine existing BL residual

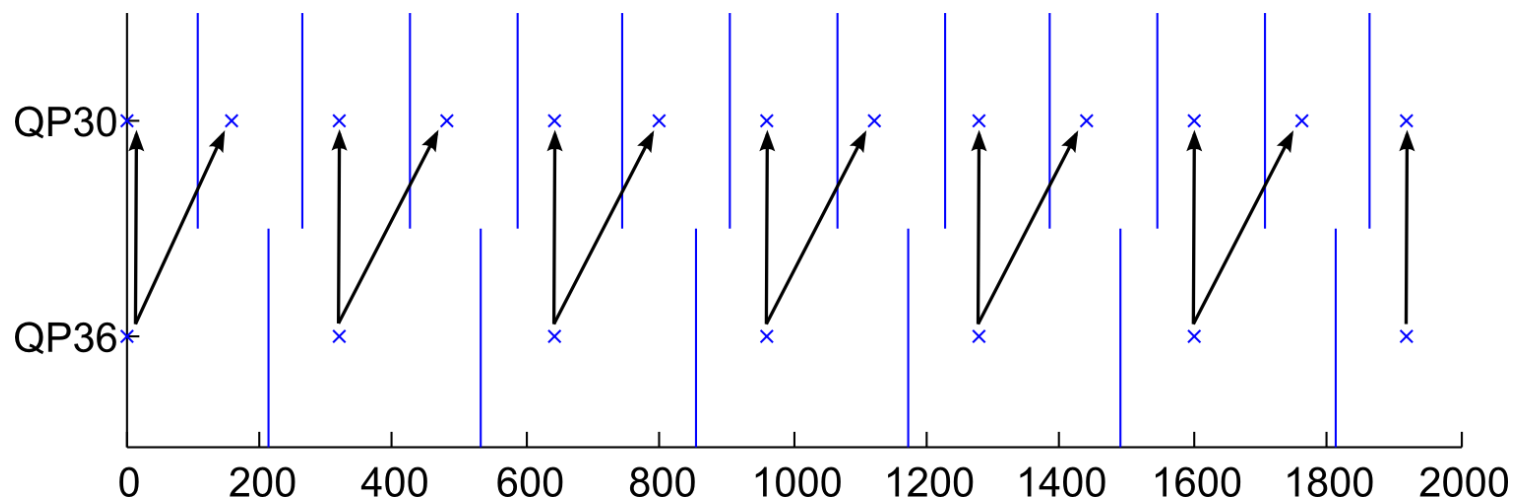
# Residual Coding

- Use same transform as BL  $\rightarrow$  BL transform coefficients are reused
- Different quantizer
- Code binary mapping from BL reconstruction to EL reconstruction
- Example: QP difference 6

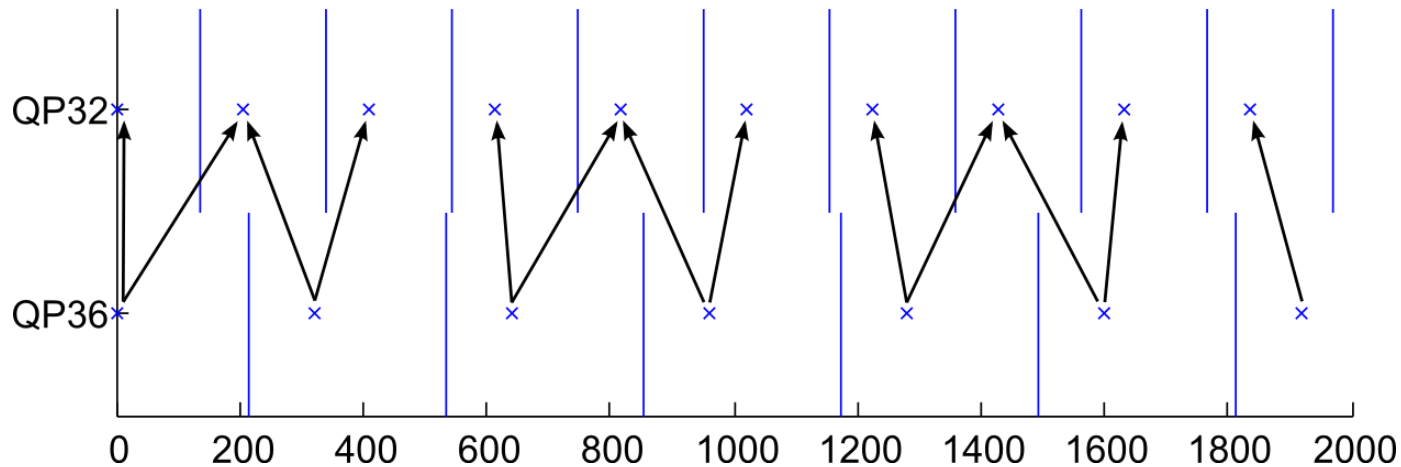


# Residual Coding

- Use same transform as BL  $\rightarrow$  BL transform coefficients are reused
- Different quantizer
- Code binary mapping from BL reconstruction to EL reconstruction
- Example: QP difference 6



- Example: QP difference 4



- Possible mapping from QP36 to QP32
- Mapping could be fixed or signalled to decoder

- Last significant coefficient
  - Code difference to BL last significant coefficient
- Significance Scan
  - Skip BL significant coefficients
- Sign of new significant coefficients coded in bypass
- Refinement
  - Code binary mapping decision
- Advantages:
  - No new sign flag for significant BL coefficients
  - No significance scan for significant BL coefficients
  - Only binary flags coded for new and refined coefficients



## Simulation conditions

- SMuC-0.1.1 used for comparison
- CfP test conditions but:
- RDOQ and Sign data hiding off
  - Not yet implemented in single loop scheme
- Delta QP>6 not tested
  - Not yet implemented in single loop scheme
- AMP turned off
  - Not yet implemented in single loop scheme

## Performance of deactivated tools

- SMuC-0.1.1
- Random access configuration

	Y	U	V
No RDOQ	-6.37%	-4.33%	-4.55%
No Sign Bit Hiding	-0.74%	-0.52%	-0.55%
Constrained Intra	-1.21%	-1.15%	-1.19%

- HM-6.1 random access configuration
- QP values (26, 30, 34, 38)

	Y	U	V
No RDOQ	-4.84%	-4.29%	-4.68%
No Sign Bit Hiding	-0.57%	-0.59%	-0.94%
Constrained Intra	-1.94%	-2.33%	-2.50%

## Results vs. Simulcast both layers

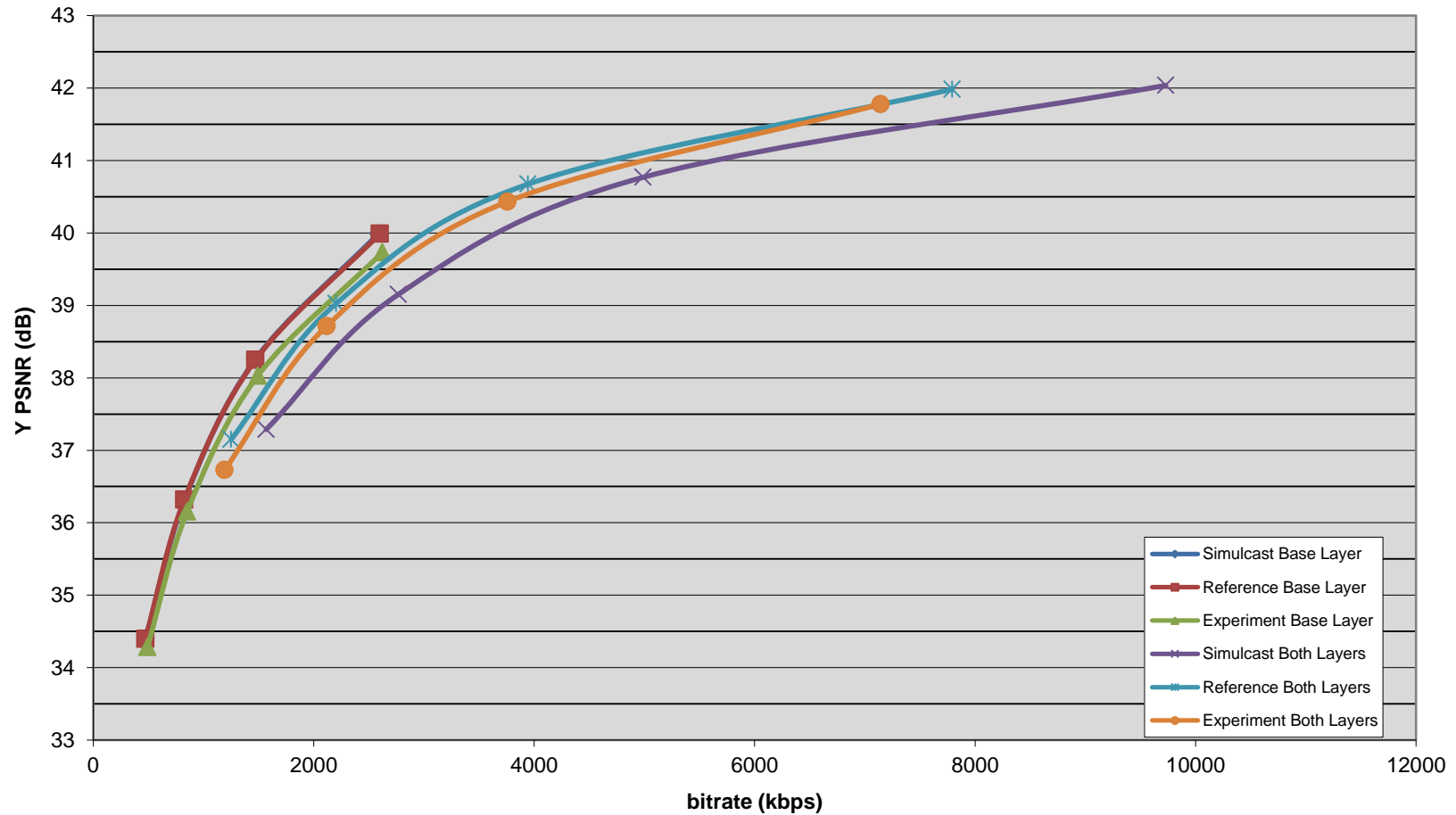
### Random Access

	SMuC reference			Proposal		
	Y	U	V	Y	U	V
<b>Kimono</b>	-24.64%	-22.35%	-19.09%	-21.76%	-24.33%	-25.52%
<b>ParkScene</b>	-23.02%	-20.89%	-20.11%	-19.98%	-23.10%	-24.10%
<b>Cactus</b>	-21.51%	-19.27%	-16.01%	-17.09%	-20.71%	-18.06%
<b>BasketballDrive</b>	-23.52%	-15.38%	-17.48%	-17.76%	-18.79%	-17.85%
<b>BQTerrace</b>	-16.92%	1.52%	5.76%	-12.47%	-16.77%	-11.91%
<b>Average</b>	-21.92%	-15.27%	-13.39%	-17.81%	-20.74%	-19.49%

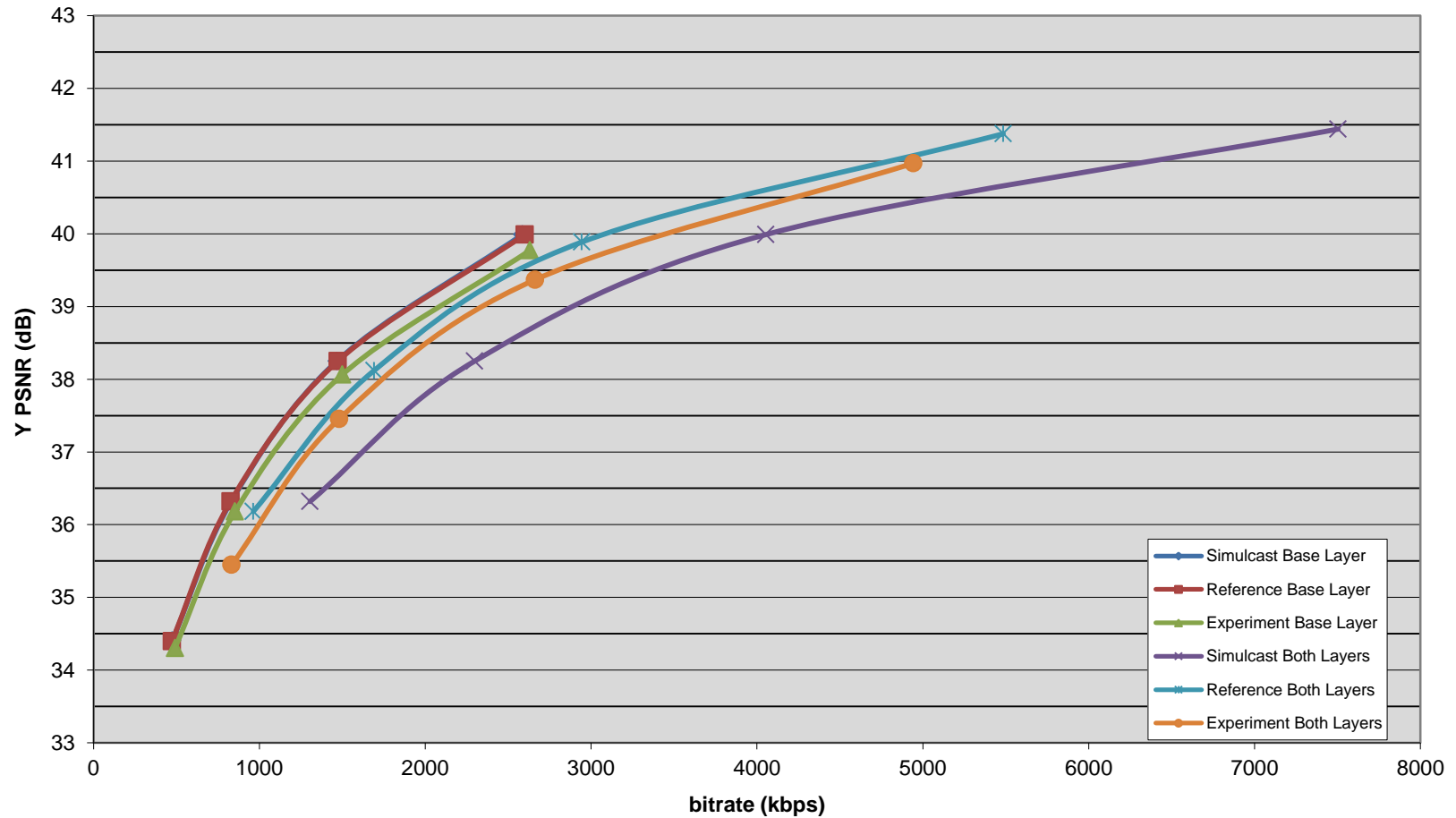
### All Intra

	SMuC reference			Proposal		
	Y	U	V	Y	U	V
<b>Kimono</b>	-33.78%	-33.45%	-34.23%	-31.21%	-29.34%	-30.91%
<b>ParkScene</b>	-31.63%	-34.55%	-35.18%	-30.85%	-31.74%	-33.27%
<b>Cactus</b>	-30.78%	-33.46%	-33.01%	-30.92%	-31.58%	-27.79%
<b>BasketballDrive</b>	-28.93%	-31.66%	-30.50%	-28.64%	-28.43%	-27.33%
<b>BQTerrace</b>	-30.51%	-33.16%	-35.08%	-30.50%	-34.34%	-32.00%
<b>Average</b>	-31.12%	-33.26%	-33.60%	-30.42%	-31.08%	-30.26%

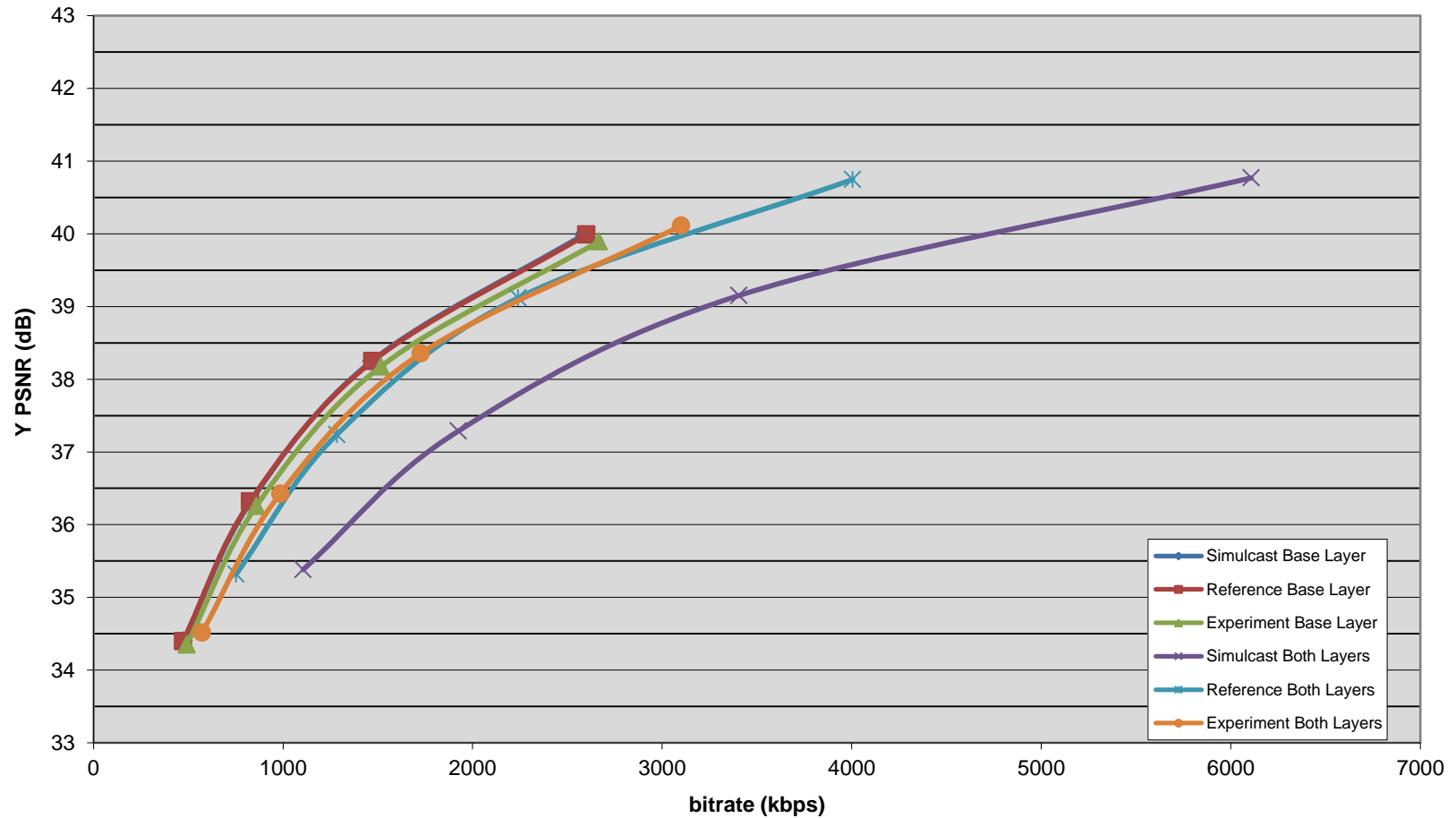
Y PSNR vs Bitrate



Y PSNR vs Bitrate



Y PSNR vs Bitrate



## Conclusions

- Proposal enables single-loop decoding for SNR scalability with binary residual refinement coding
  - Small signaling overhead
- Performance impact
  - some RD loss compared to multi-loop for large QP deltas
  - comparable performance to SMuC for small QP deltas
- In next step add RDOQ, Sign Bit Hiding, AMP, QP > 6 support
- Suggestion to continue investigation and set up a tool or core experiment for a single loop coding approach for SNR scalability