

Multiway K-Clustered Tensor Approximation: Toward High-Performance Photorealistic Data-Driven Rendering – Supplemental Materials

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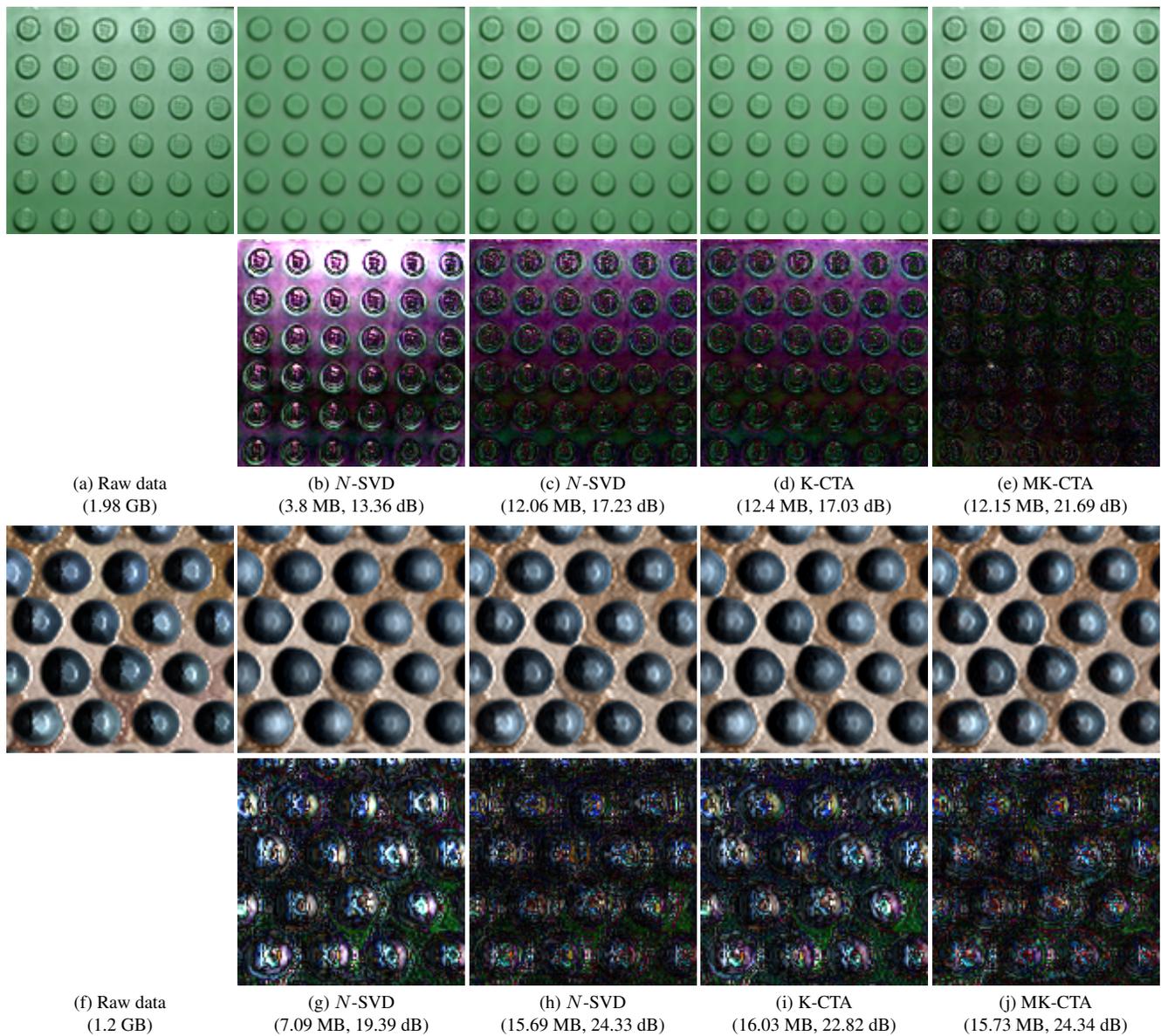
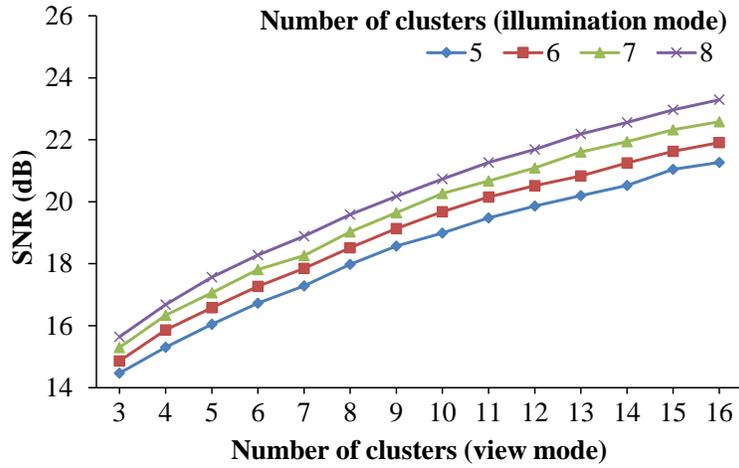
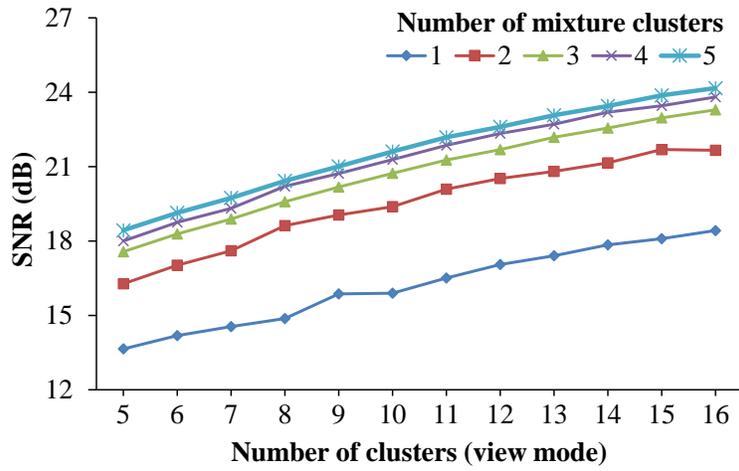


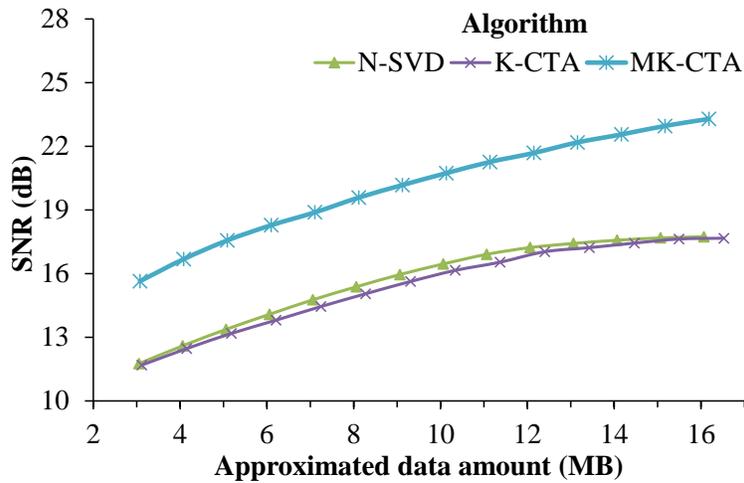
Fig. 1: Reconstructed images of approximated BTFs based on different multilinear models. Subfigures (a)–(e): the BTF "Lego" (©Volumetric Surface Texture Database); subfigures (f)–(j): the BTF "Hole" (©Dr. Xin Tong). In each subfigure, the top row shows the reconstructed image; the bottom row shows the absolute difference image (scaled by a factor of 6).



(a) $K_{\omega_l} = K_{\omega_v} = 3$



(b) $C_{\omega_l} = 8, K_{\omega_l} = K_{\omega_v} (K_{\omega_l}, K_{\omega_v} \in \{1, \dots, 5\})$



(c) N-SVD ($R_{\omega_l} = 32$), K-CTA ($R_{\omega_l} = 32, K_{\omega_v} = 3$), and MK-CTA ($C_{\omega_l} = 8, K_{\omega_l} = K_{\omega_v} = 3$)

Fig. 2: Reconstruction errors of approximated BTFs (“Lego” ©Volumetric Surface Texture Database) based on different multilinear models. Major parameters are shown under each subfigure. Readers may refer to Table I in our paper for other parameter settings. Subfigures (a), (b): different configurations of MK-CTA; subfigure (c): comparison of the SNR versus the data amount among different configurations of N-SVD, K-CTA, and MK-CTA.



(a) Raw data (1.98 GB, <0.01 FPS)

(b) *N*-SVD (3.8 MB, 13.36 dB, 142.34 FPS)(c) *N*-SVD (12.06 MB, 17.23 dB, 27.14 FPS)

(d) K-CTA (12.4 MB, 17.03 dB, 143.56 FPS)



(e) MK-CTA (12.15 MB, 21.69 dB, 139.49 FPS)

Fig. 3: Rendered images of approximated BTFs ("Lego" ©Volumetric Surface Texture Database) based on different multilinear models at similar rendering rates (subfigures (b), (d), (e)) and/or with similar compression ratios (subfigures (c), (d), (e)).

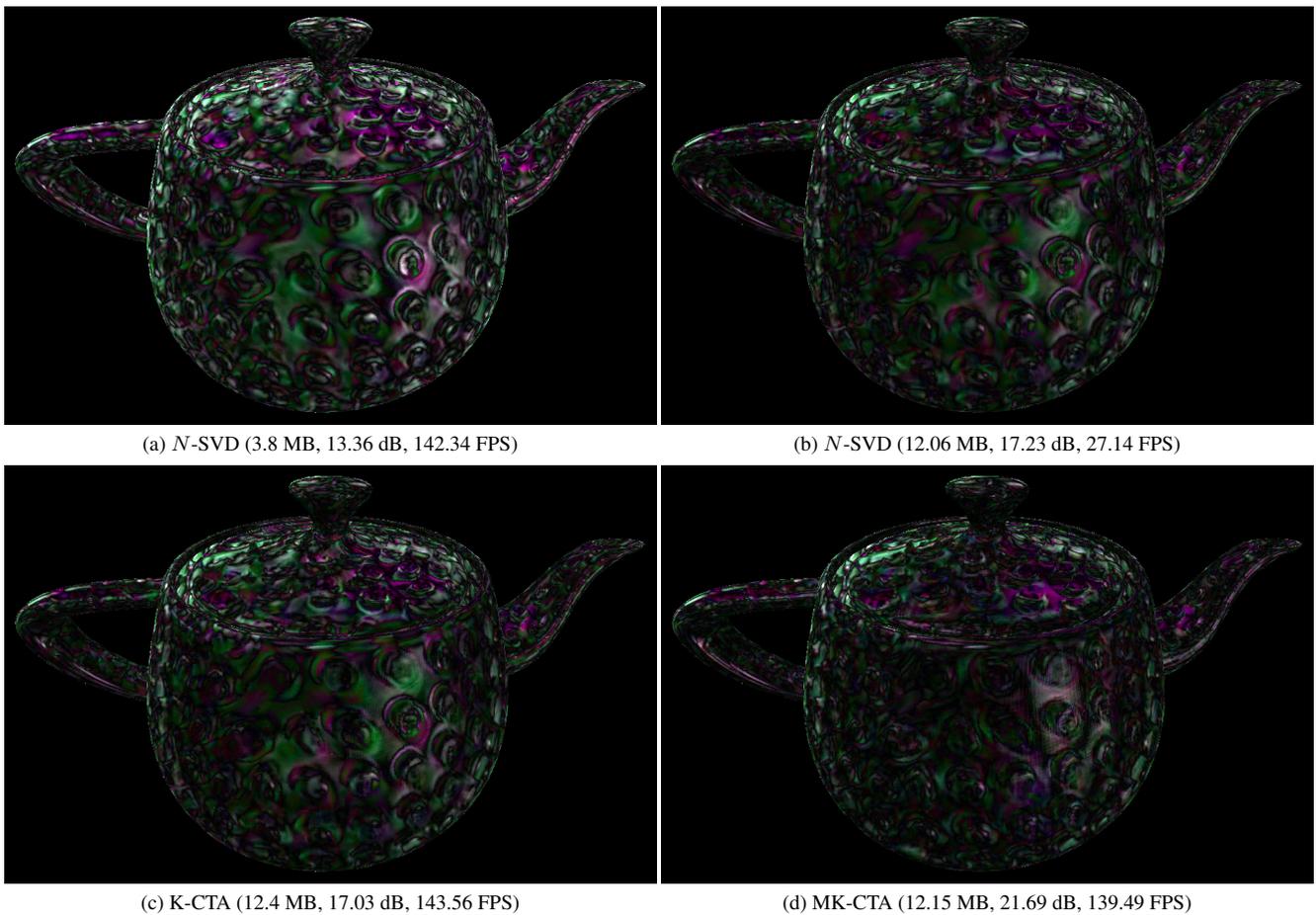


Fig. 4: Absolute difference images (scaled by a factor of 4) of rendered images of approximated BTFs (“Lego” ©Volumetric Surface Texture Database) based on different multilinear models at similar rendering rates (subfigures (a), (c), (d)) and/or with similar compression ratios (subfigures (b), (c), (d)).

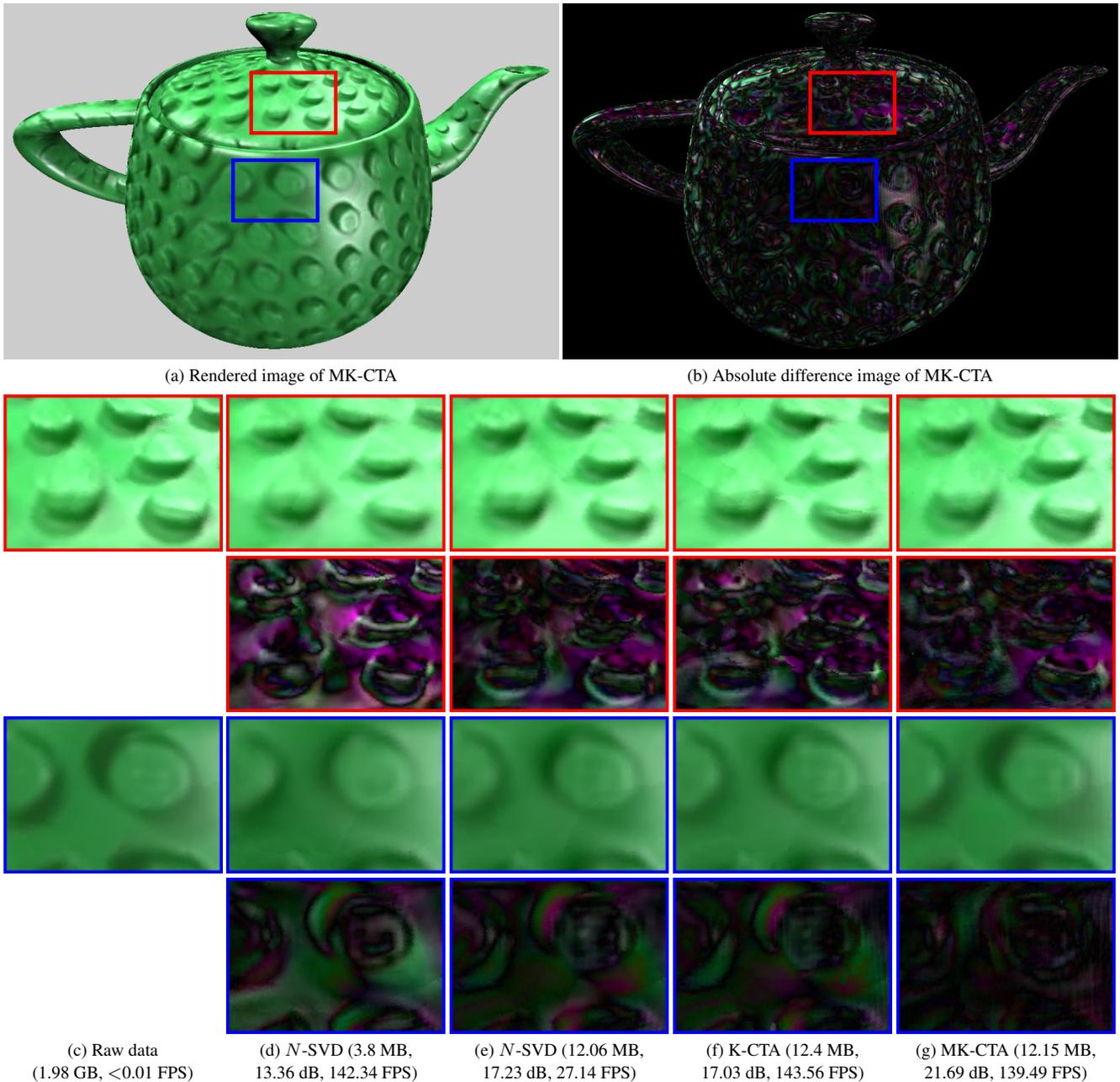
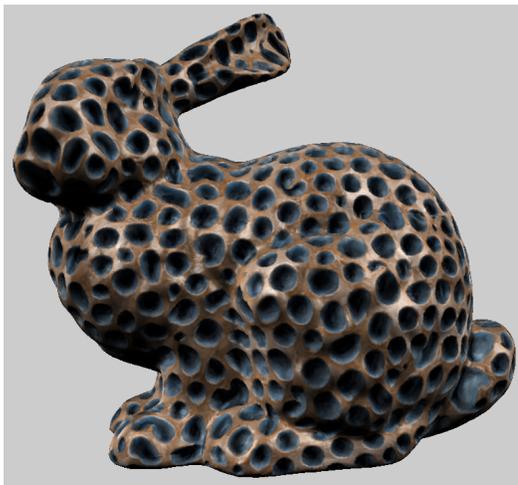


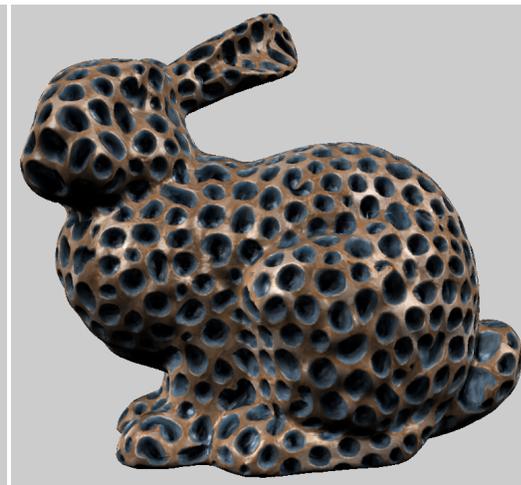
Fig. 5: Rendered images of approximated BTFs (“Lego” ©Volumetric Surface Texture Database) based on different multilinear models at similar rendering rates (subfigures (d), (f), (g)) and/or with similar compression ratios (subfigures (e), (f), (g)). In subfigures (c)–(g), the first and third rows show rendered images; the second and fourth rows show absolute difference images (scaled by a factor of 4).



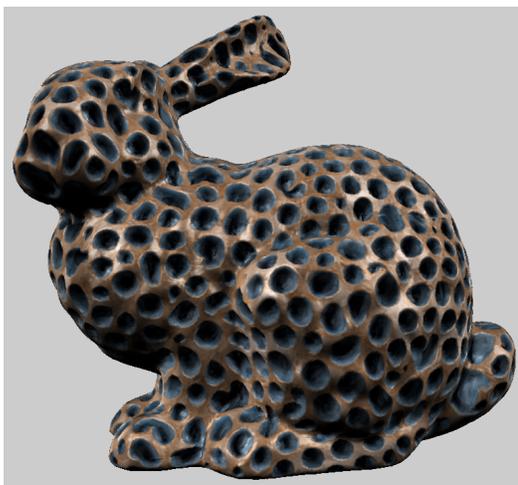
(a) Raw data (1.2 GB, 0.05 FPS)



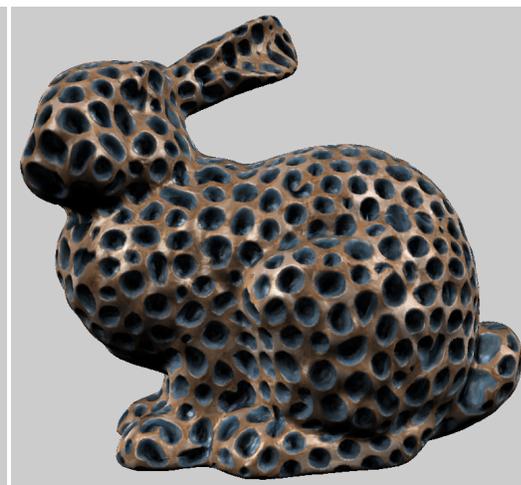
(b) *N*-SVD (7.09 MB, 19.39 dB, 65.17 FPS)



(c) *N*-SVD (15.69 MB, 24.33 dB, 28.62 FPS)



(d) K-CTA (16.03 MB, 22.82 dB, 67.39 FPS)



(e) MK-CTA (15.73 MB, 24.34 dB, 63.64 FPS)

Fig. 6: Rendered images of approximated BTFs ("Hole" ©Dr. Xin Tong) based on different multilinear models at similar rendering rates (subfigures (b), (d), (e)) and/or with similar compression ratios (subfigures (c), (d), (e)). (Model "Bunny" ©Stanford 3D Scanning Repository)

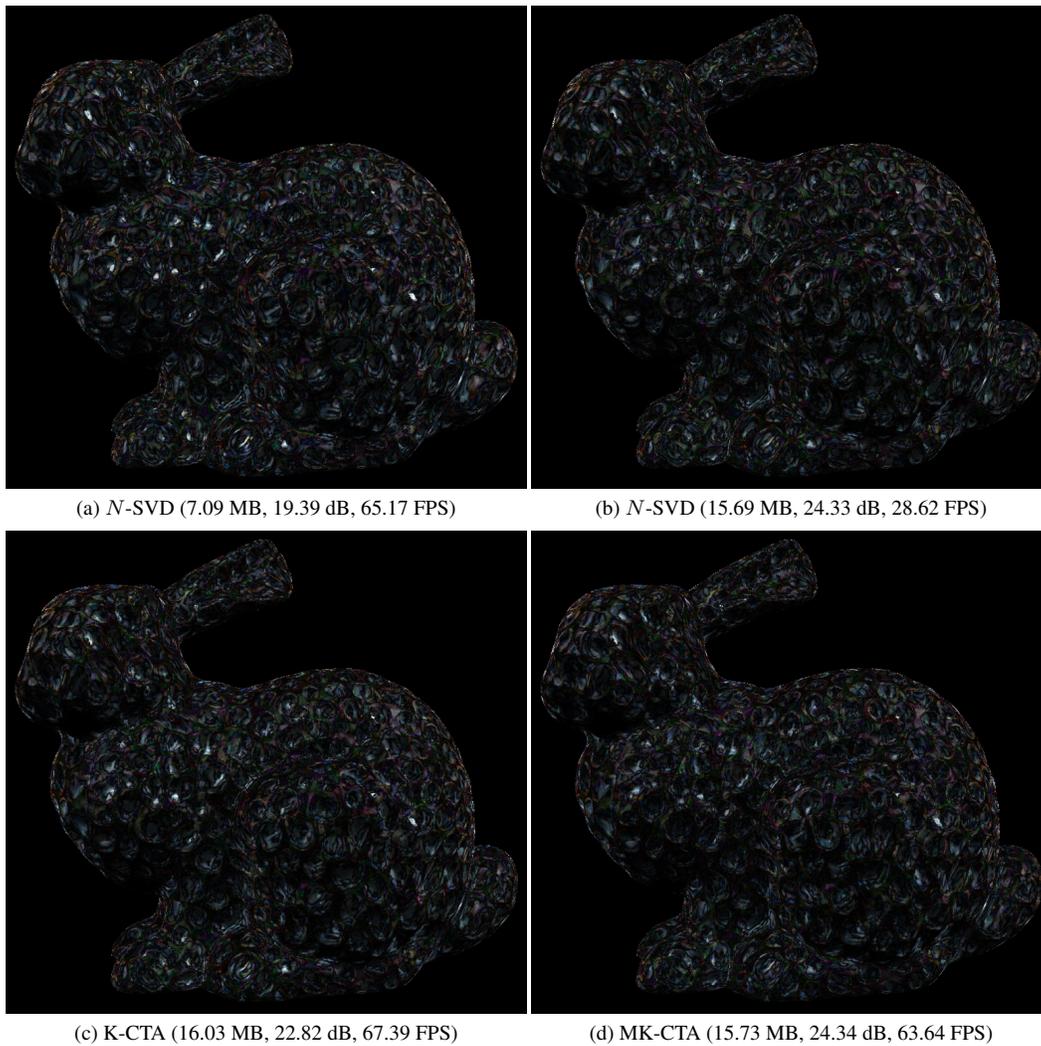
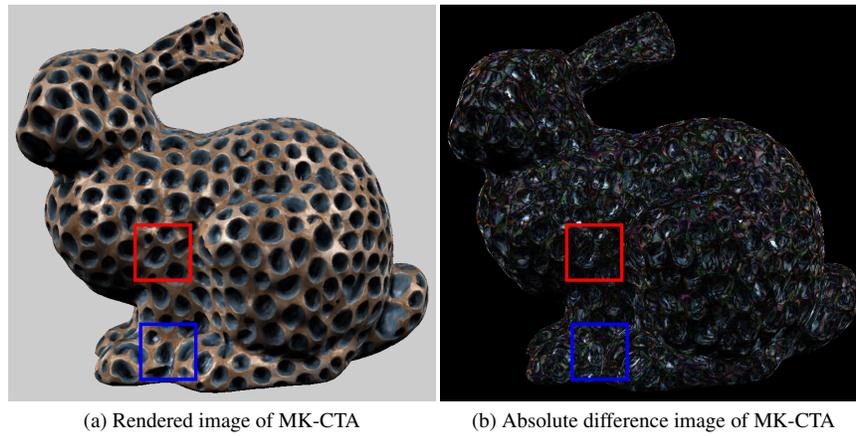
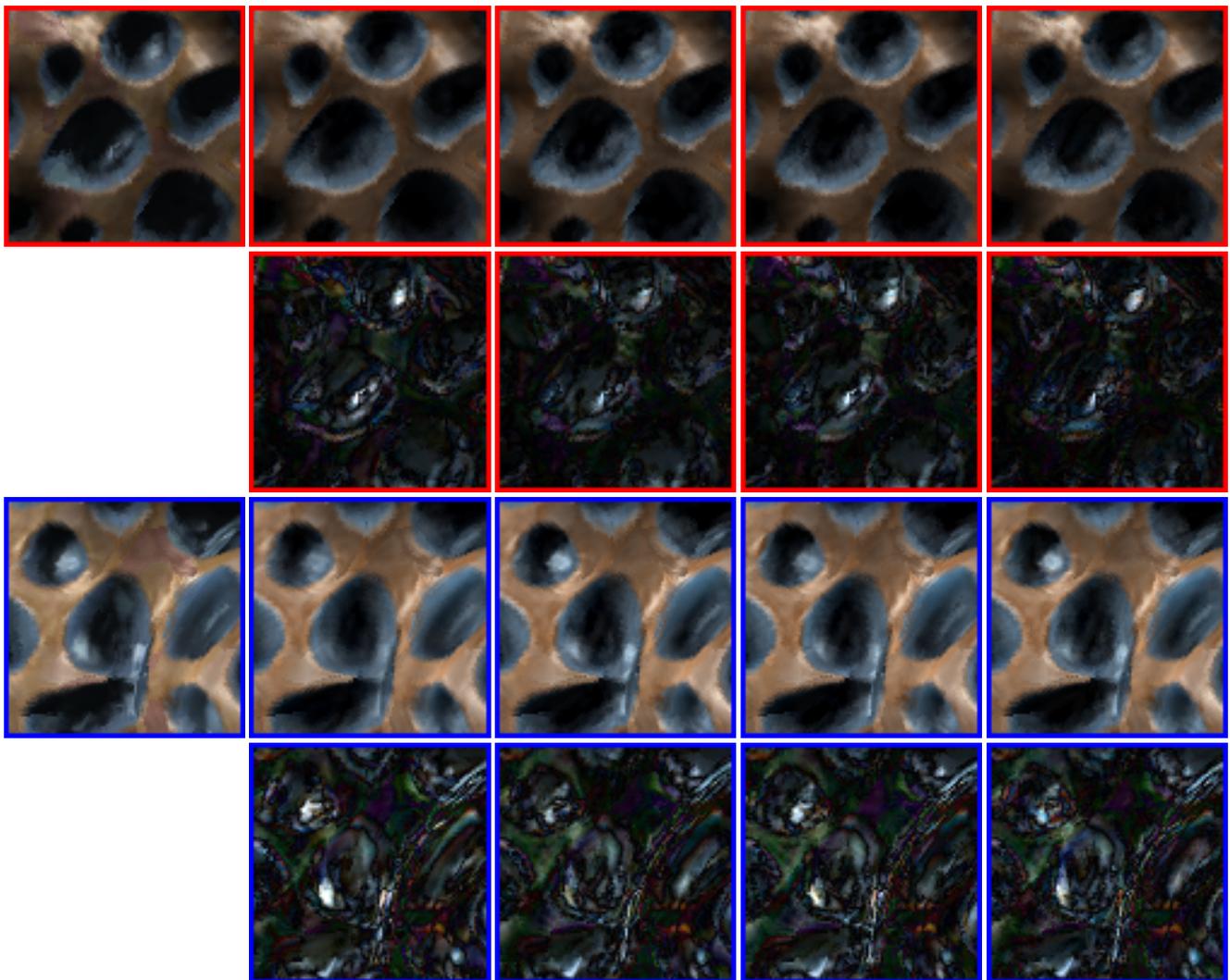


Fig. 7: Absolute difference images (scaled by a factor of 4) of rendered images of approximated BTFs ("Hole" ©Dr. Xin Tong) based on different multilinear models at similar rendering rates (subfigures (a), (c), (d)) and/or with similar compression ratios (subfigures (b), (c), (d)). (Model "Bunny" ©Stanford 3D Scanning Repository)



(a) Rendered image of MK-CTA

(b) Absolute difference image of MK-CTA



(c) Raw data
(1.2 GB, 0.05 FPS)

(d) *N*-SVD (7.09 MB,
19.39 dB, 65.17 FPS)

(e) *N*-SVD (15.69 MB,
24.33 dB, 28.62 FPS)

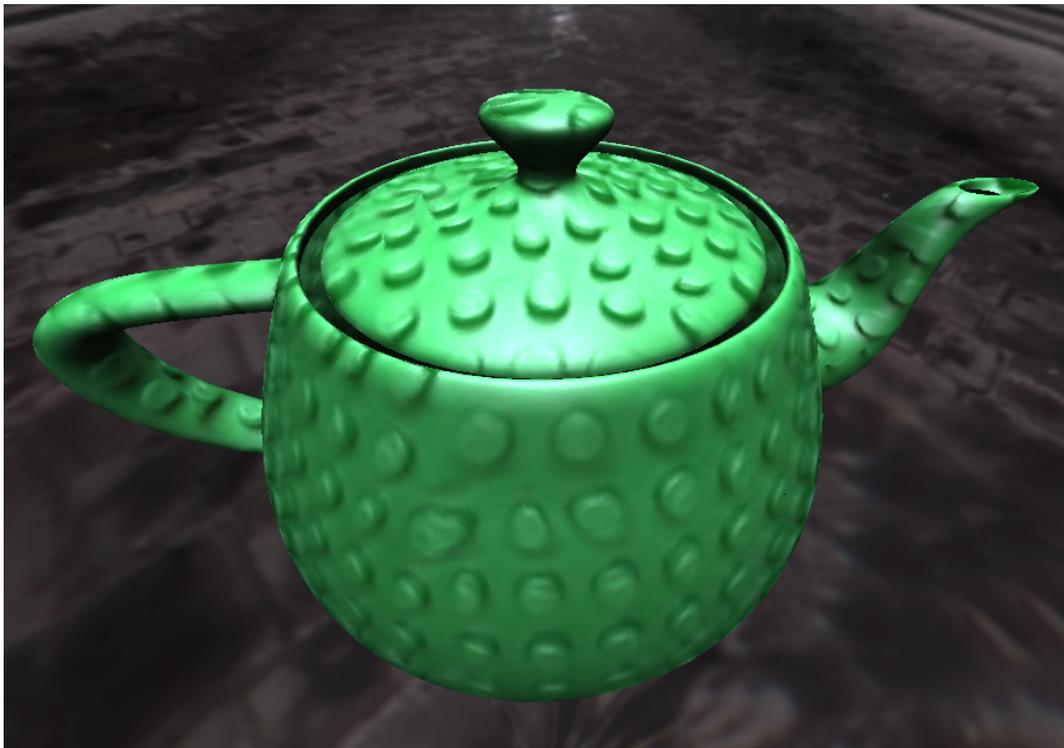
(f) *K*-CTA (16.03 MB,
22.82 dB, 67.39 FPS)

(g) MK-CTA (15.73 MB,
24.34 dB, 63.64 FPS)

Fig. 8: Rendered images of approximated BTFs (“Hole” ©Dr. Xin Tong) based on different multilinear models at similar rendering rates (subfigures (d), (f), (g)) and/or with similar compression ratios (subfigures (e), (f), (g)). In subfigures (c)–(g), the first and third rows show rendered images; the second and fourth rows show absolute difference images (scaled by a factor of 4). (Model “Bunny” ©Stanford 3D Scanning Repository)



(a) Bunny with "Hole" (98.64 FPS)



(b) Teapot with "Lego" (236.62 FPS)

Fig. 9: Rendered images of approximated BTFs based on MK-CTA with HDR environment lighting. (BTF "Hole" ©Dr. Xin Tong, BTF "Lego" ©Volumetric Surface Texture Database, model "Bunny" ©Stanford 3D Scanning Repository, HDR maps "Grace Cathedral" and "Uffizi Gallery" ©Light Probe Image Gallery)

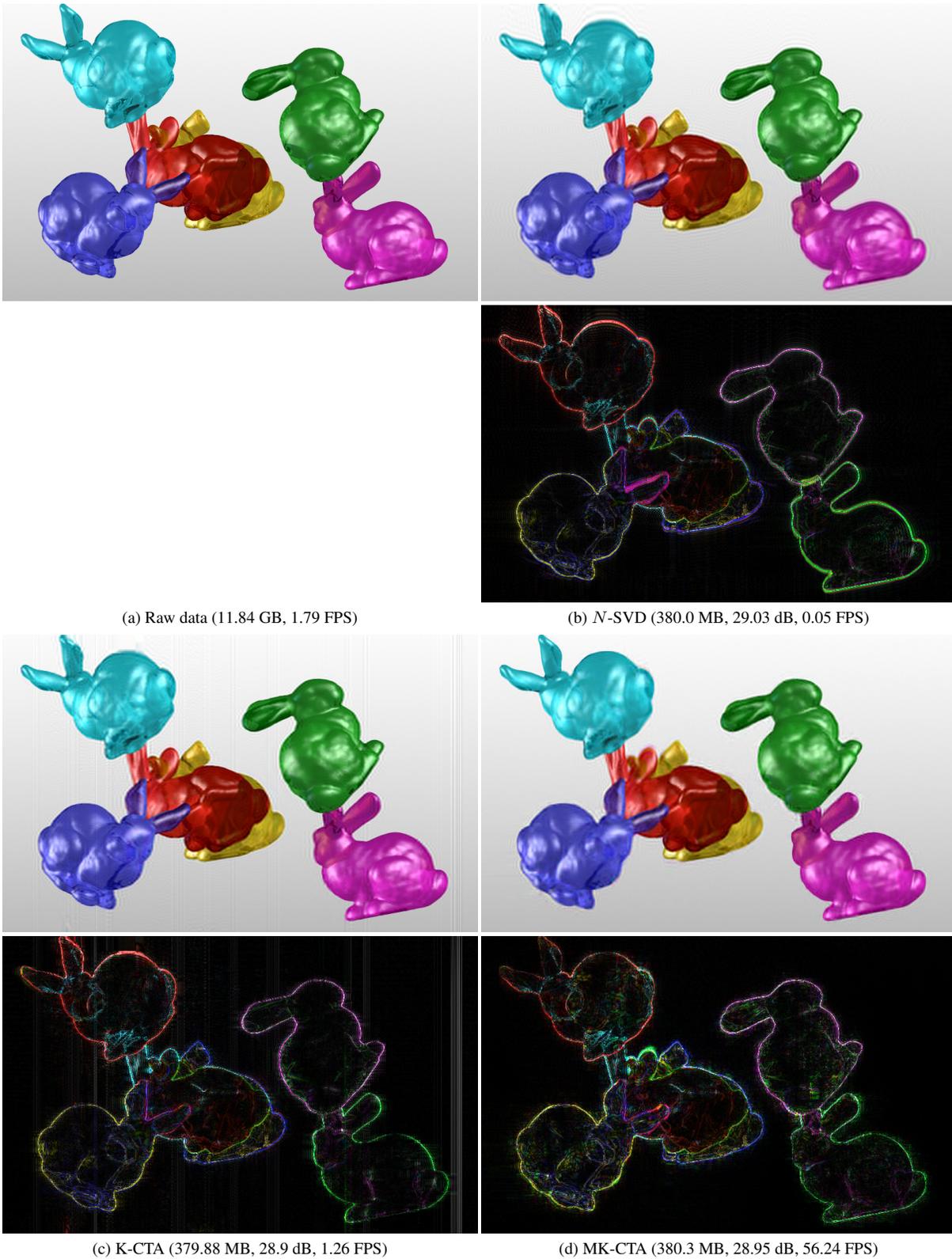


Fig. 10: Rendered images of approximated TVLFs (“AnimatedBunnies” ©Synthetic Light Field Archive) based on different multilinear models with similar compression ratios. In each subfigure, the top row shows the rendered image; the bottom row shows the absolute difference image (scaled by a factor of 4).

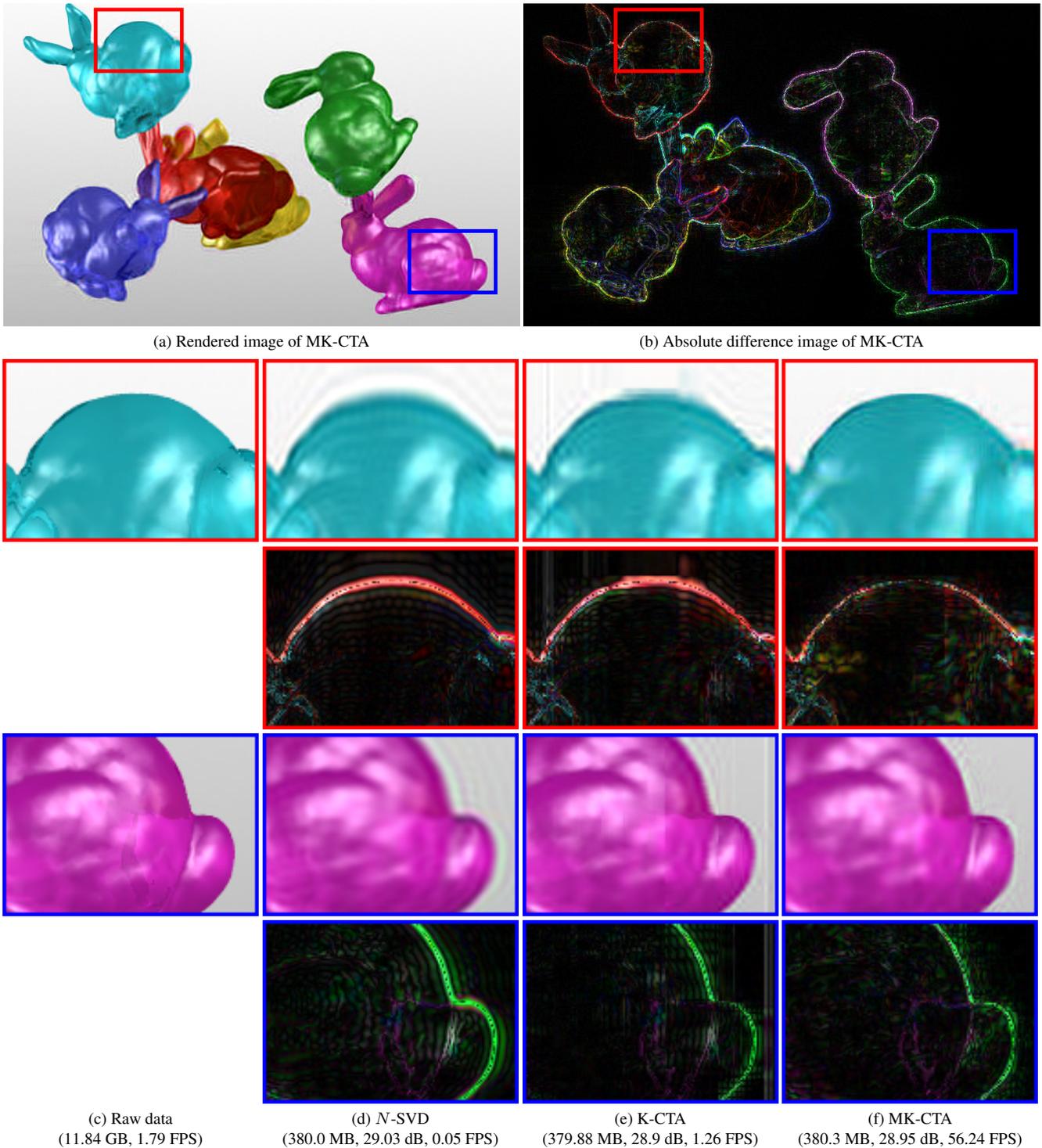


Fig. 11: Rendered images of approximated TVLFs (“AnimatedBunnies” ©Synthetic Light Field Archive) based on different multilinear models with similar compression ratios. In subfigures (c)–(f), the first and third rows show rendered images; the second and fourth rows show absolute difference images (scaled by a factor of 4).

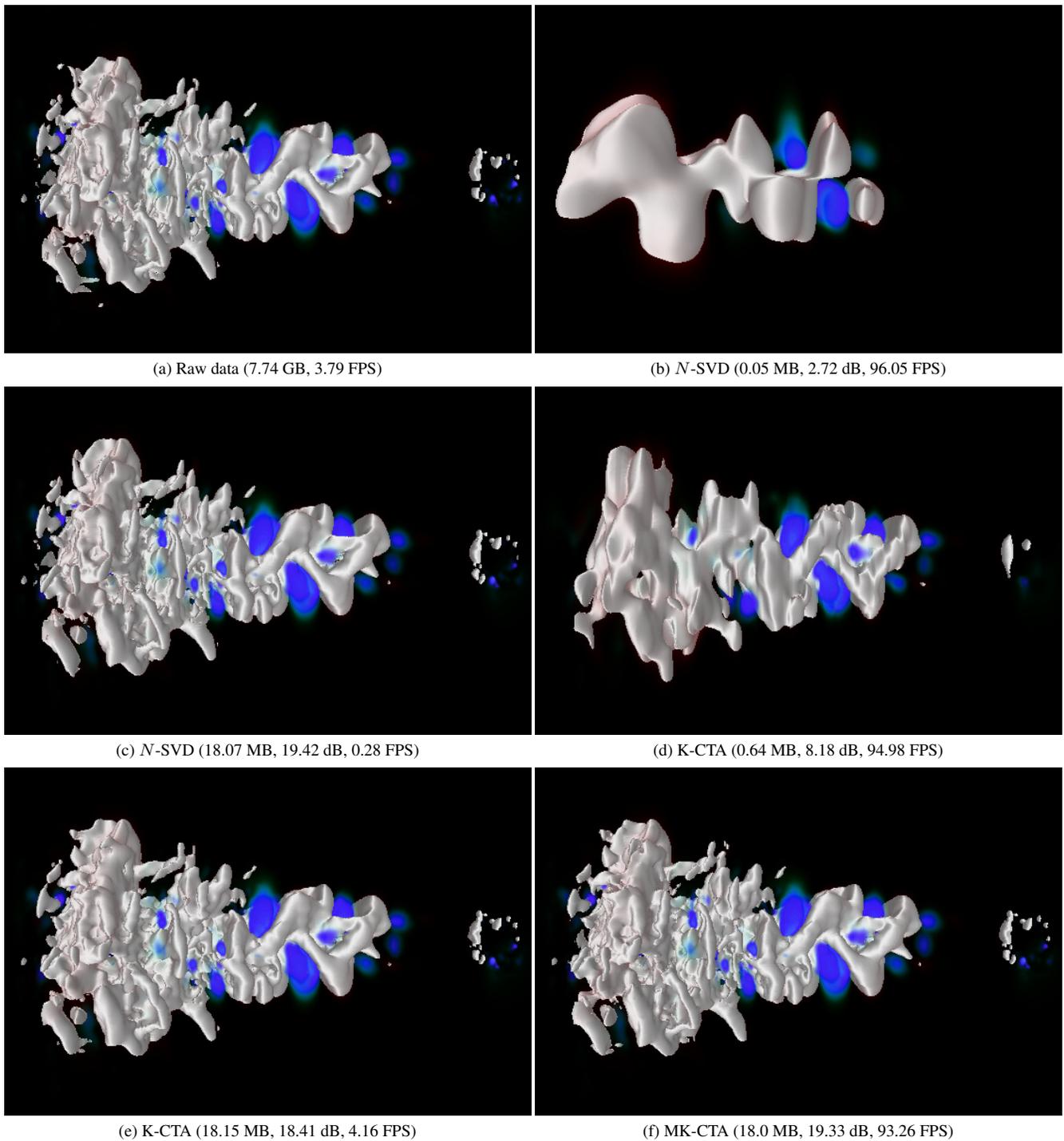
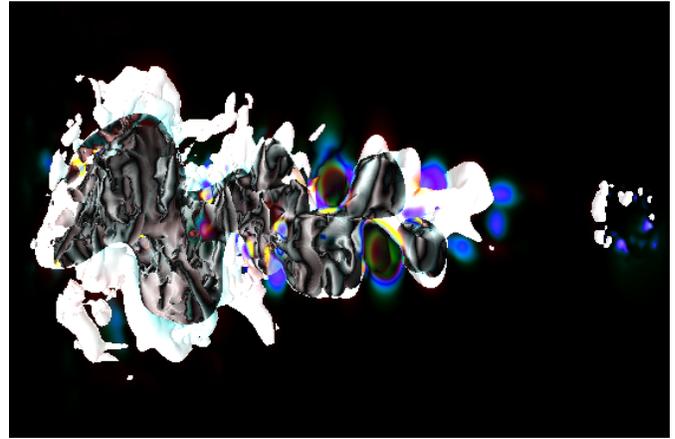
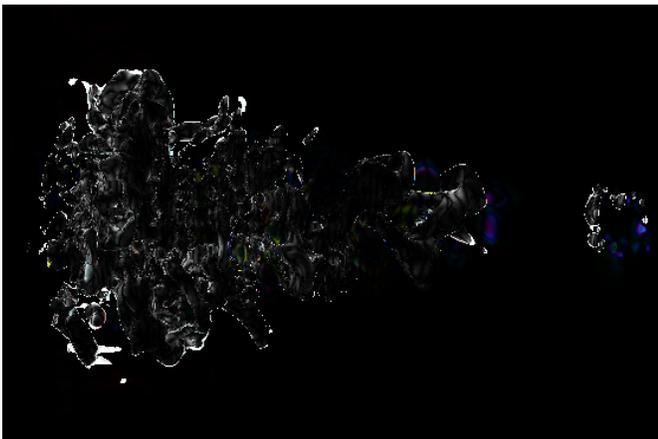
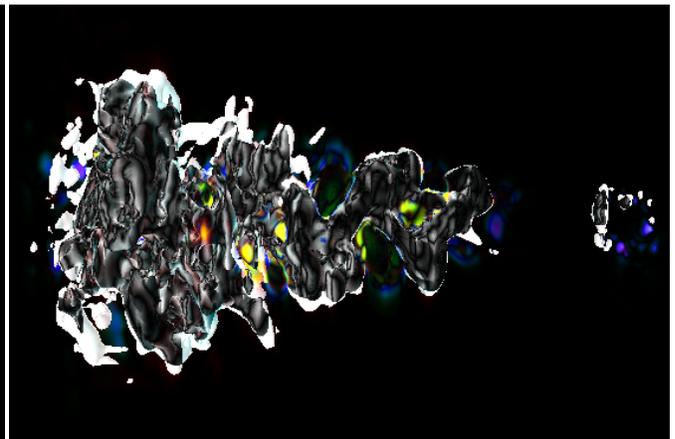
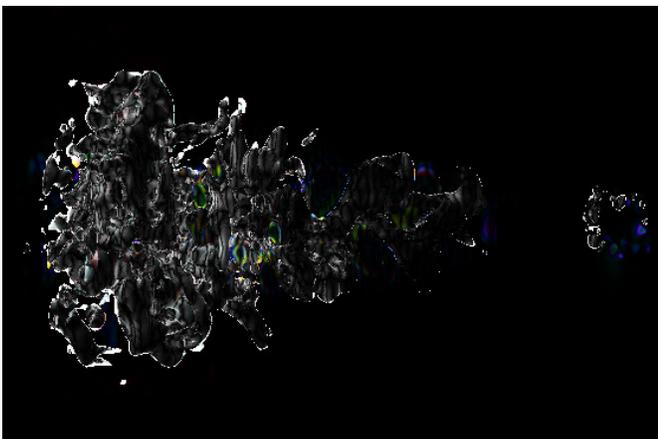


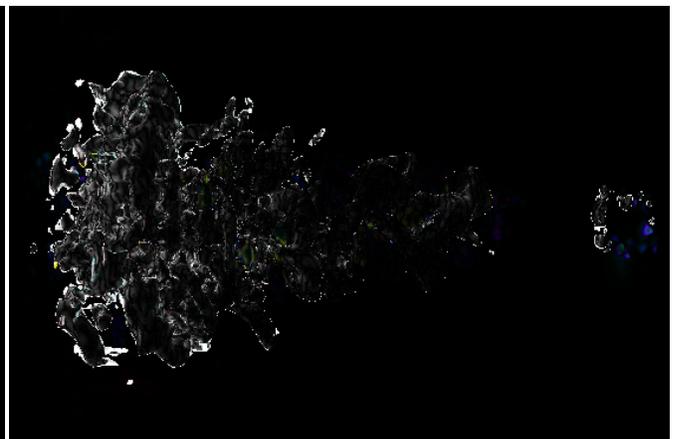
Fig. 12: Rendered images of approximated TVVD (“TurbJet” ©Time-Varying Volume Data Repository) with isosurfaces based on different multilinear models at similar rendering rates (subfigures (b), (d), (f)) or with similar compression ratios (subfigures (c), (e), (f)).

(a) *N*-SVD (0.05 MB, 2.72 dB, 96.05 FPS)(b) *N*-SVD (18.07 MB, 19.42 dB, 0.28 FPS)

(c) K-CTA (0.64 MB, 8.18 dB, 94.98 FPS)

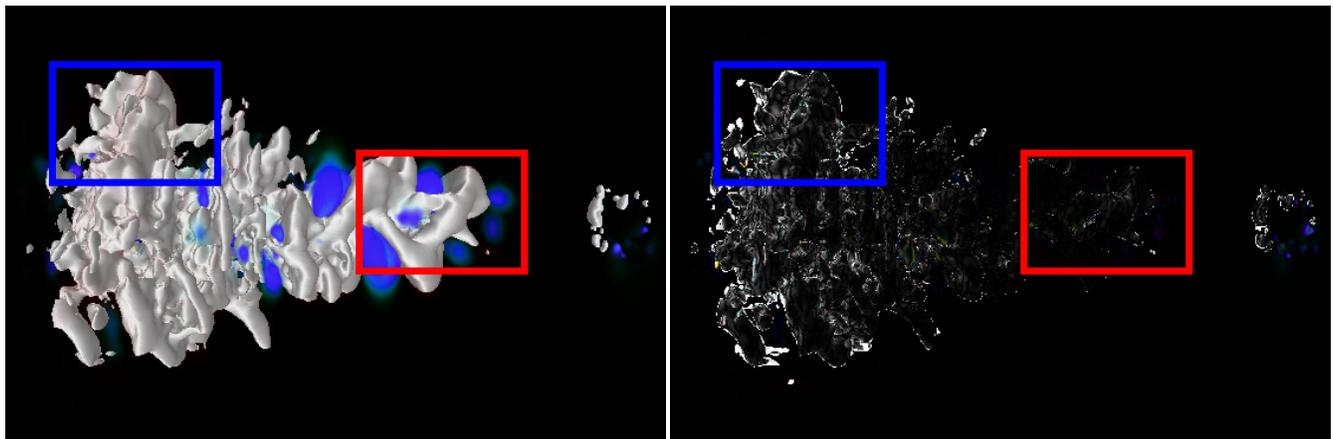


(d) K-CTA (18.15 MB, 18.41 dB, 4.16 FPS)



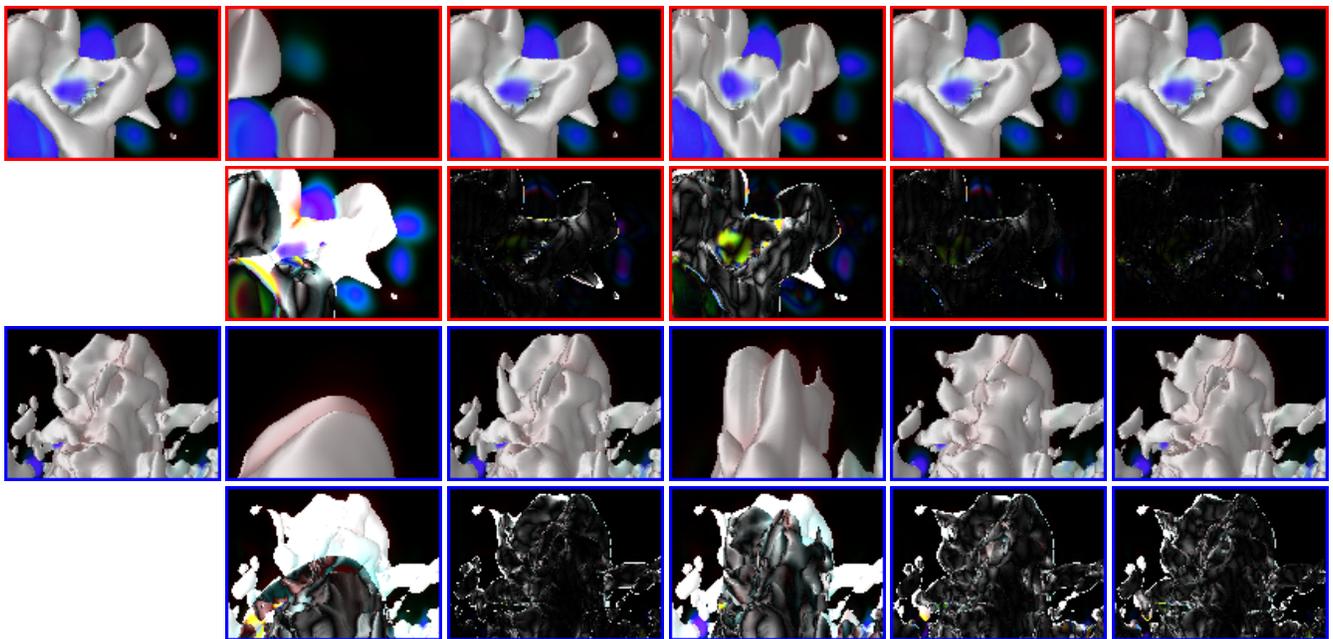
(e) MK-CTA (18.0 MB, 19.33 dB, 93.26 FPS)

Fig. 13: Absolute difference images (scaled by a factor of 2) of rendered images of approximated TVVD ("TurbJet" ©Time-Varying Volume Data Repository) with isosurfaces based on different multilinear models at similar rendering rates (subfigures (a), (c), (e)) or with similar compression ratios (subfigures (b), (d), (e)).



(a) Rendered image of MK-CTA

(b) Absolute difference image of MK-CTA



(c) Raw data
(7.74 GB, 3.79 FPS)

(d) *N*-SVD (0.05 MB,
2.72 dB, 96.05 FPS)

(e) *N*-SVD (18.07 MB,
19.42 dB, 0.28 FPS)

(f) K-CTA (0.64 MB,
8.18 dB, 94.98 FPS)

(g) K-CTA (18.15 MB,
18.41 dB, 4.16 FPS)

(h) MK-CTA (18.0 MB,
19.33 dB, 93.26 FPS)

Fig. 14: Rendered images of approximated TVVD (“TurbJet” ©Time-Varying Volume Data Repository) with isosurfaces based on different multilinear models at similar rendering rates (subfigures (d), (f), (h)) or with similar compression ratios (subfigures (e), (g), (h)). In subfigures (c)–(h), the first and third rows show rendered images; the second and fourth rows show absolute difference images (scaled by a factor of 2).

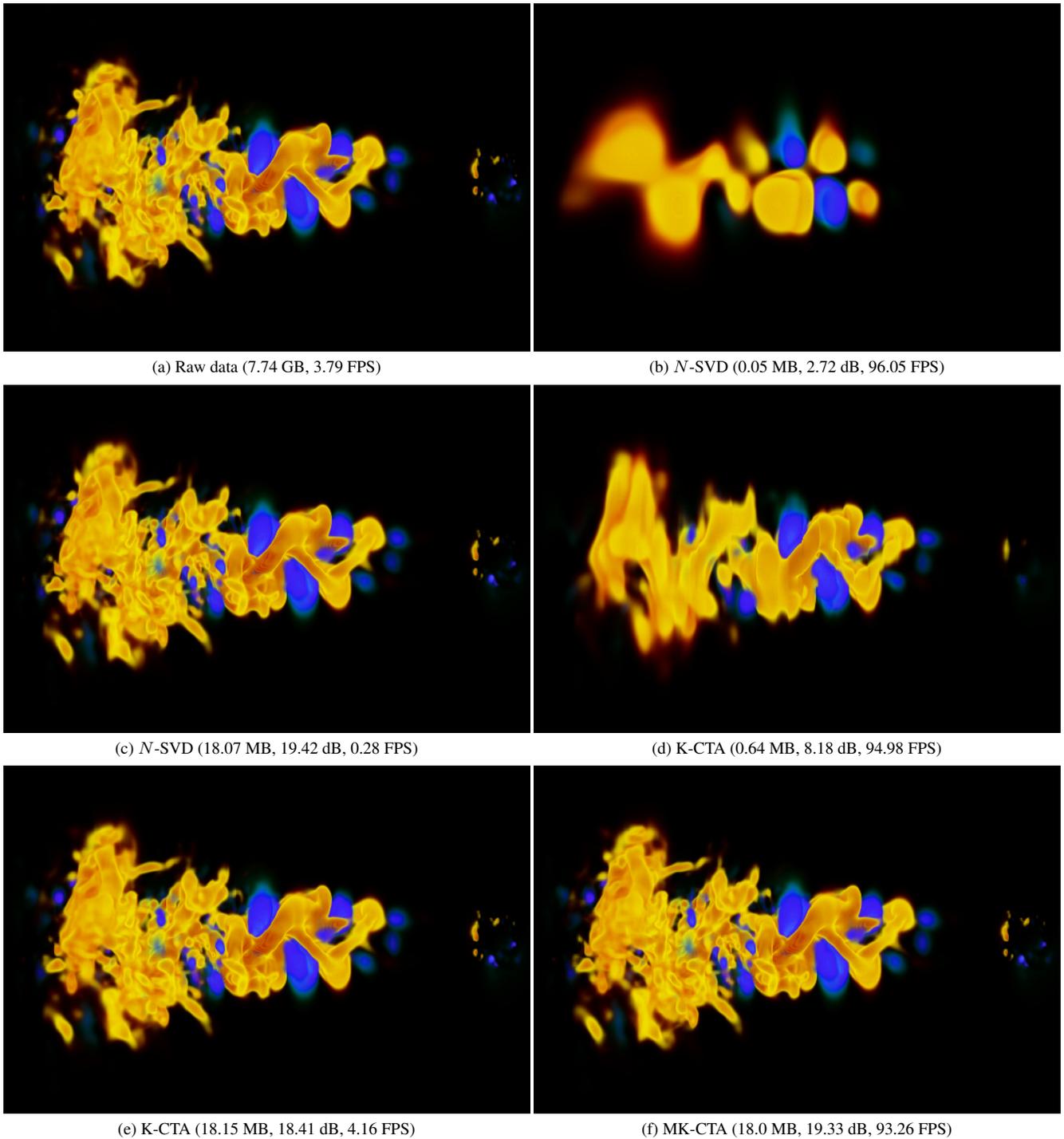
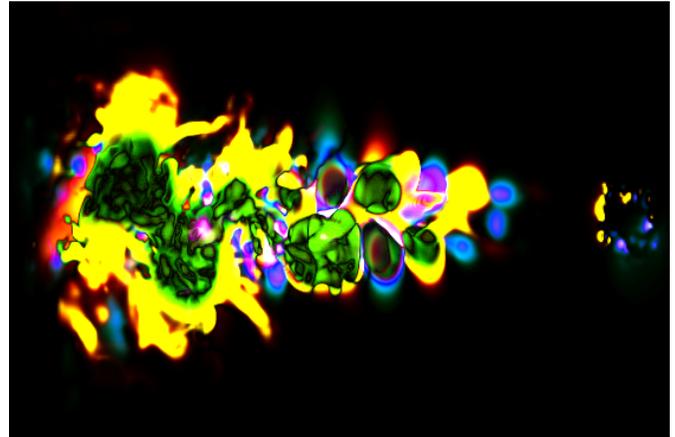
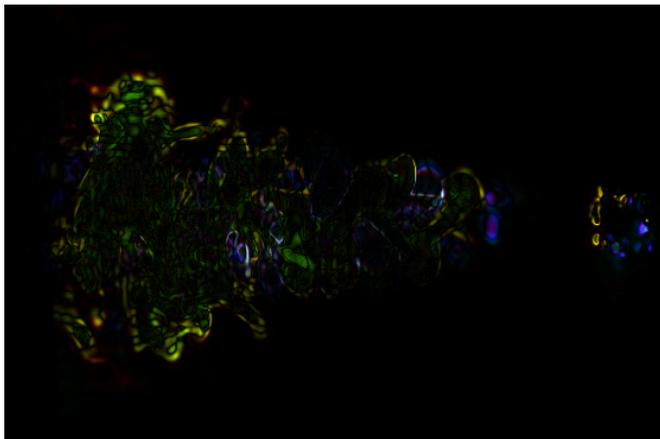


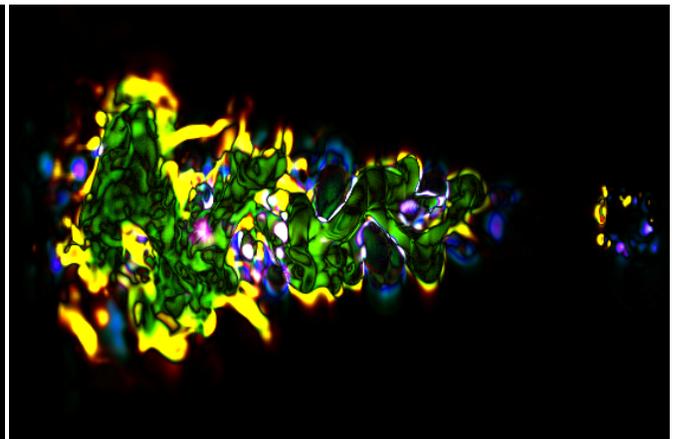
Fig. 15: Rendered images of approximated TVVD (“TurboJet” ©Time-Varying Volume Data Repository) without isosurfaces based on different multilinear models at similar rendering rates (subfigures (b), (d), (f)) or with similar compression ratios (subfigures (c), (e), (f)).



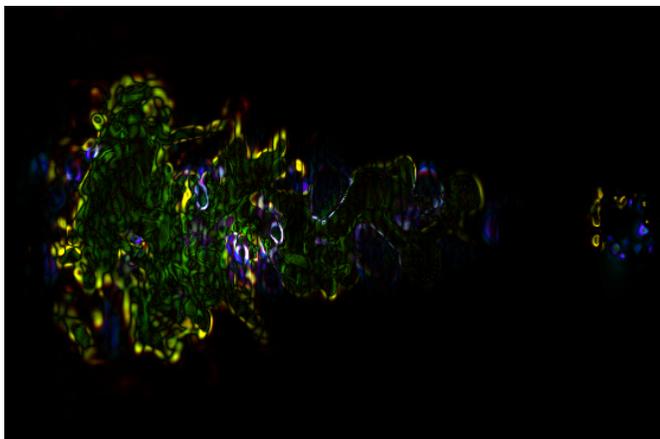
(a) *N*-SVD (0.05 MB, 2.72 dB, 96.05 FPS)



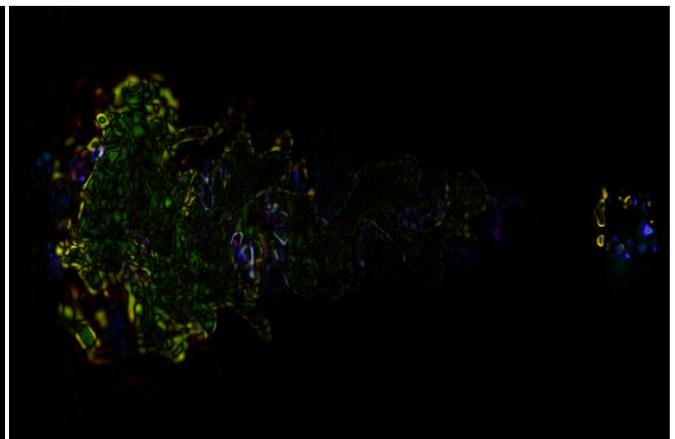
(b) *N*-SVD (18.07 MB, 19.42 dB, 0.28 FPS)



(c) K-CTA (0.64 MB, 8.18 dB, 94.98 FPS)

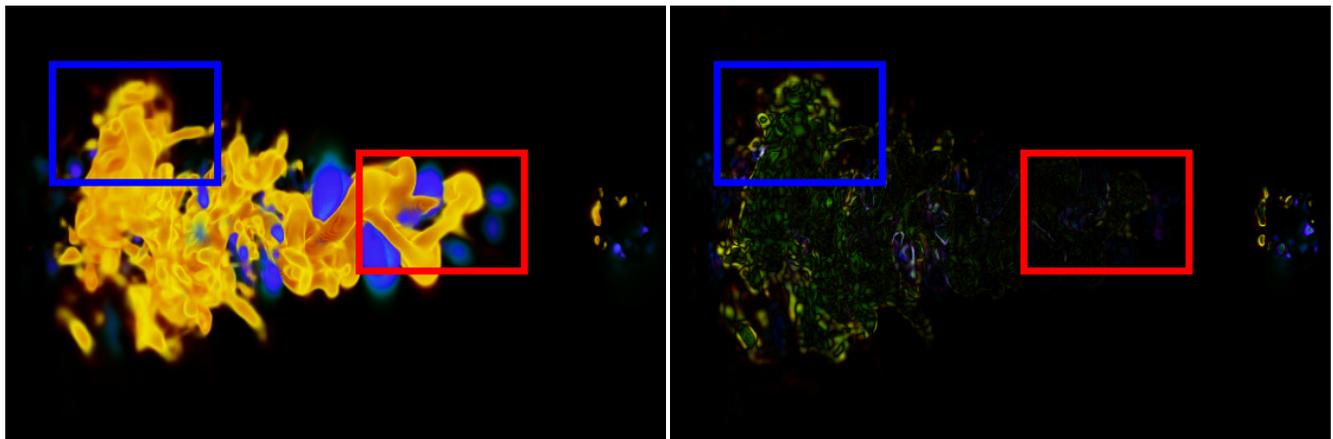


(d) K-CTA (18.15 MB, 18.41 dB, 4.16 FPS)



(e) MK-CTA (18.0 MB, 19.33 dB, 93.26 FPS)

Fig. 16: Absolute difference images (scaled by a factor of 3) of rendered images of approximated TVVD ("TurbJet" ©Time-Varying Volume Data Repository) without isosurfaces based on different multilinear models at similar rendering rates (subfigures (a), (c), (e)) or with similar compression ratios (subfigures (b), (d), (e)).



(a) Rendered image of MK-CTA

(b) Absolute difference image of MK-CTA

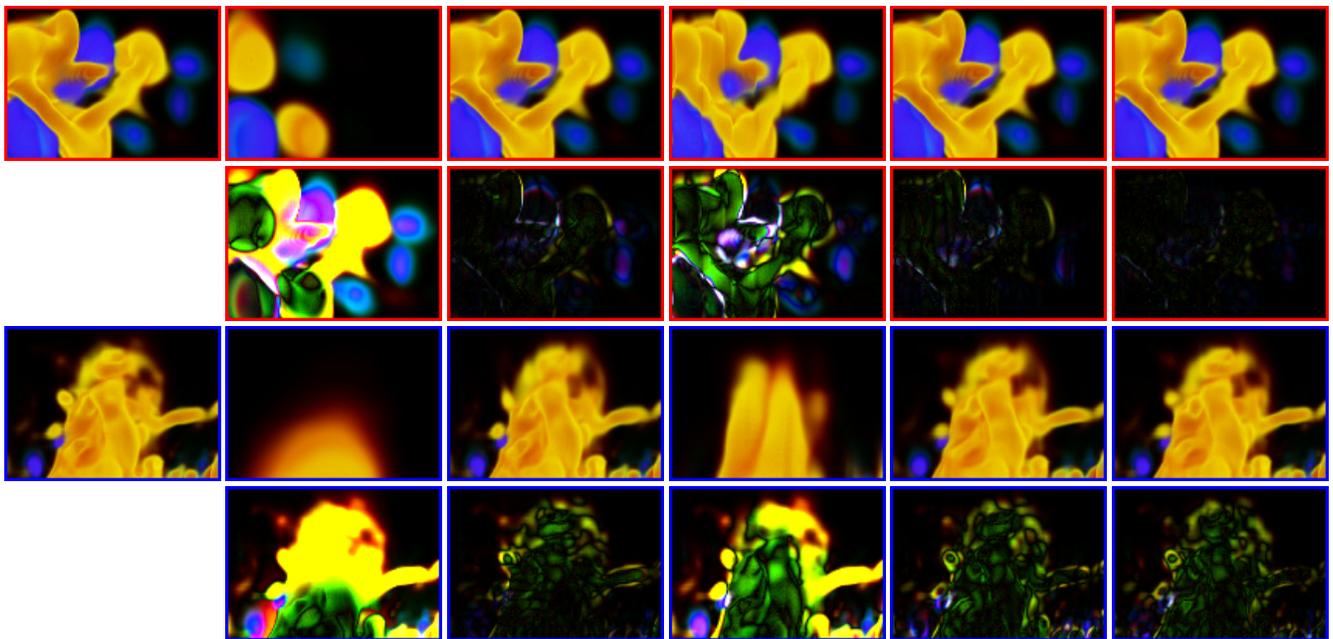
(c) Raw data
(7.74 GB, 3.79 FPS)(d) *N*-SVD (0.05 MB,
2.72 dB, 96.05 FPS)(e) *N*-SVD (18.07 MB,
19.42 dB, 0.28 FPS)(f) K-CTA (0.64 MB,
8.18 dB, 94.98 FPS)(g) K-CTA (18.15 MB,
18.41 dB, 4.16 FPS)(h) MK-CTA (18.0 MB,
19.33 dB, 93.26 FPS)

Fig. 17: Rendered images of approximated TVVD (“TurbJet” ©Time-Varying Volume Data Repository) without isosurfaces based on different multilinear models at similar rendering rates (subfigures (d), (f), (h)) or with similar compression ratios (subfigures (e), (g), (h)). In subfigures (c)–(h), the first and third rows show rendered images; the second and fourth rows show absolute difference images (scaled by a factor of 3).

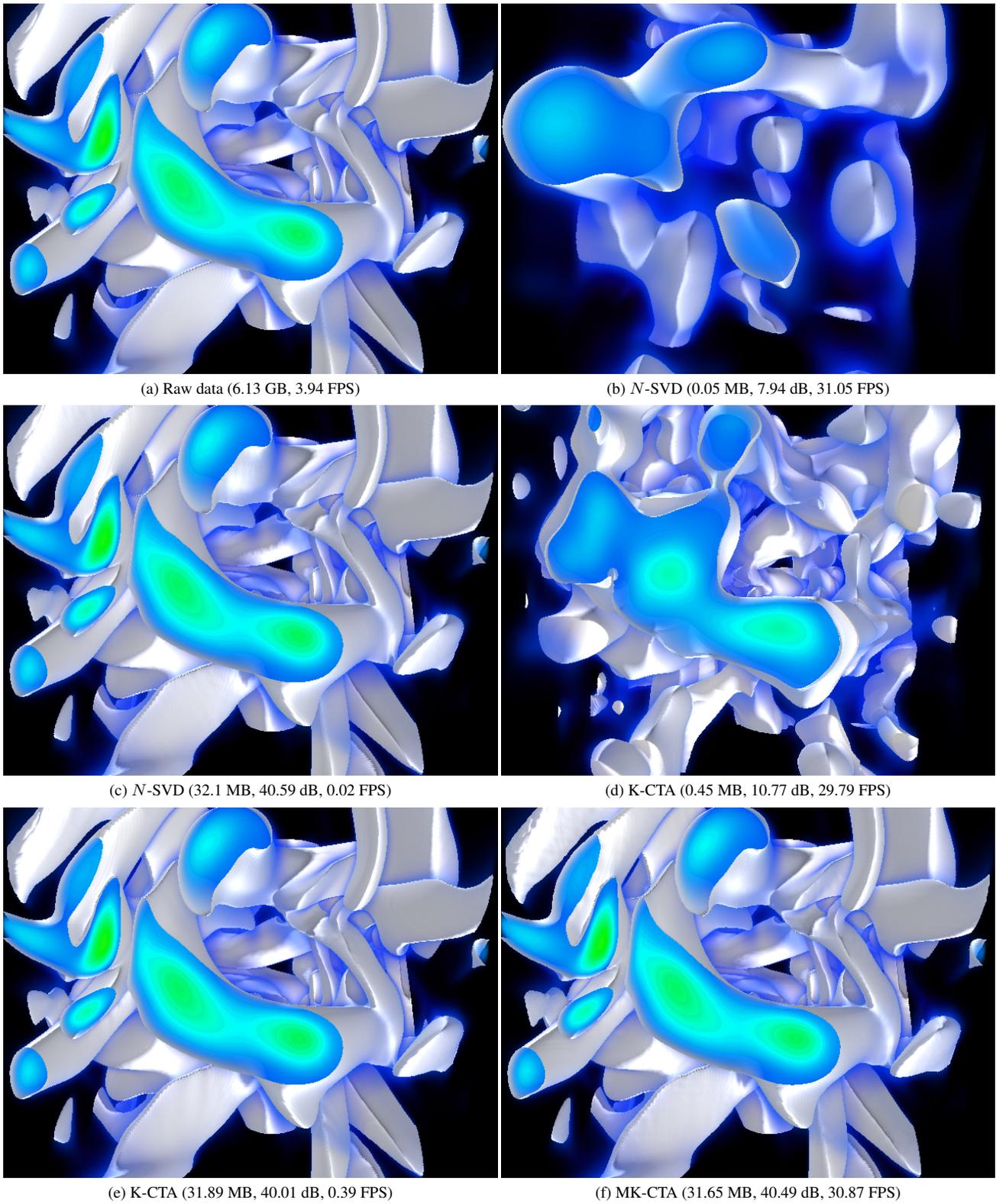
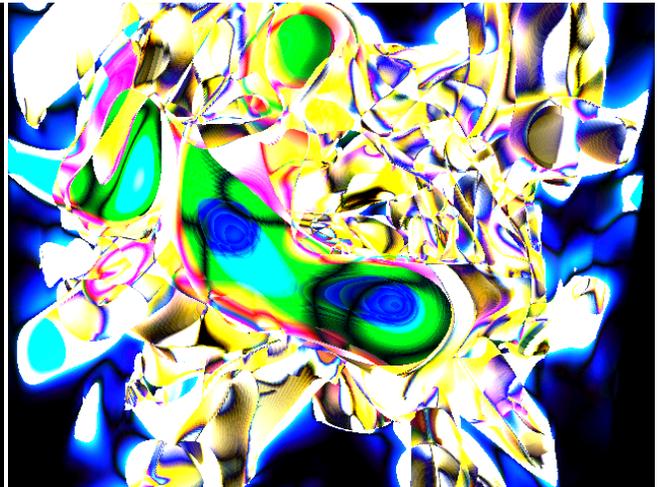
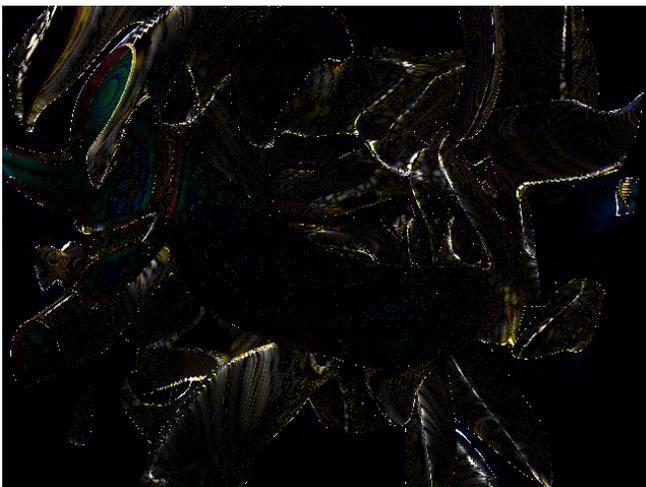


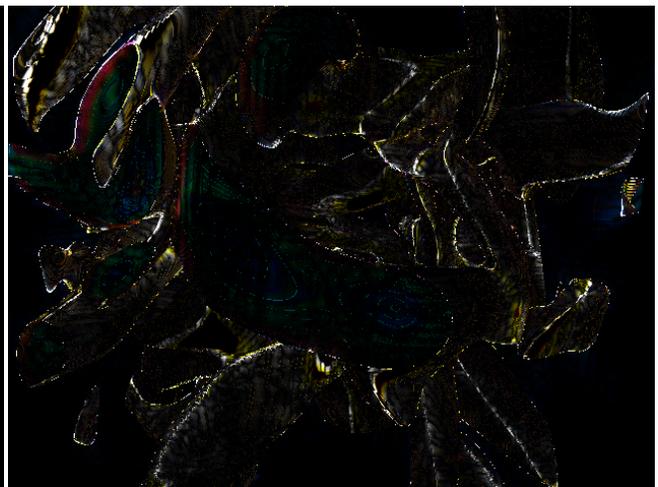
Fig. 18: Rendered images of approximated TVVD (“TurbVortex” ©Time-Varying Volume Data Repository) with isosurfaces based on different multilinear models at similar rendering rates (subfigures (b), (d), (f)) or with similar compression ratios (subfigures (c), (e), (f)).

(a) *N*-SVD (0.05 MB, 7.94 dB, 31.05 FPS)(b) *N*-SVD (32.1 MB, 40.59 dB, 0.02 FPS)

(c) K-CTA (0.45 MB, 10.77 dB, 29.79 FPS)

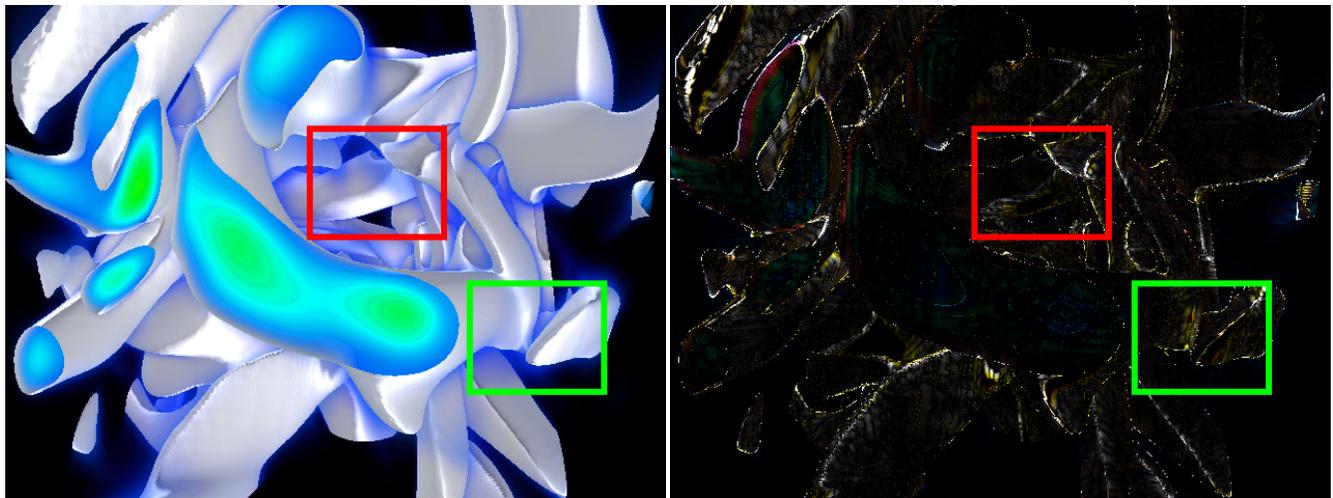


(d) K-CTA (31.89 MB, 40.01 dB, 0.39 FPS)



(e) MK-CTA (31.65 MB, 40.49 dB, 30.87 FPS)

Fig. 19: Absolute difference images (scaled by a factor of 8) of rendered images of approximated TVVD ("TurbVortex" ©Time-Varying Volume Data Repository) with isosurfaces based on different multilinear models at similar rendering rates (subfigures (a), (c), (e)) or with similar compression ratios (subfigures (b), (d), (e)).



(a) Rendered image of MK-CTA

(b) Absolute difference image of MK-CTA

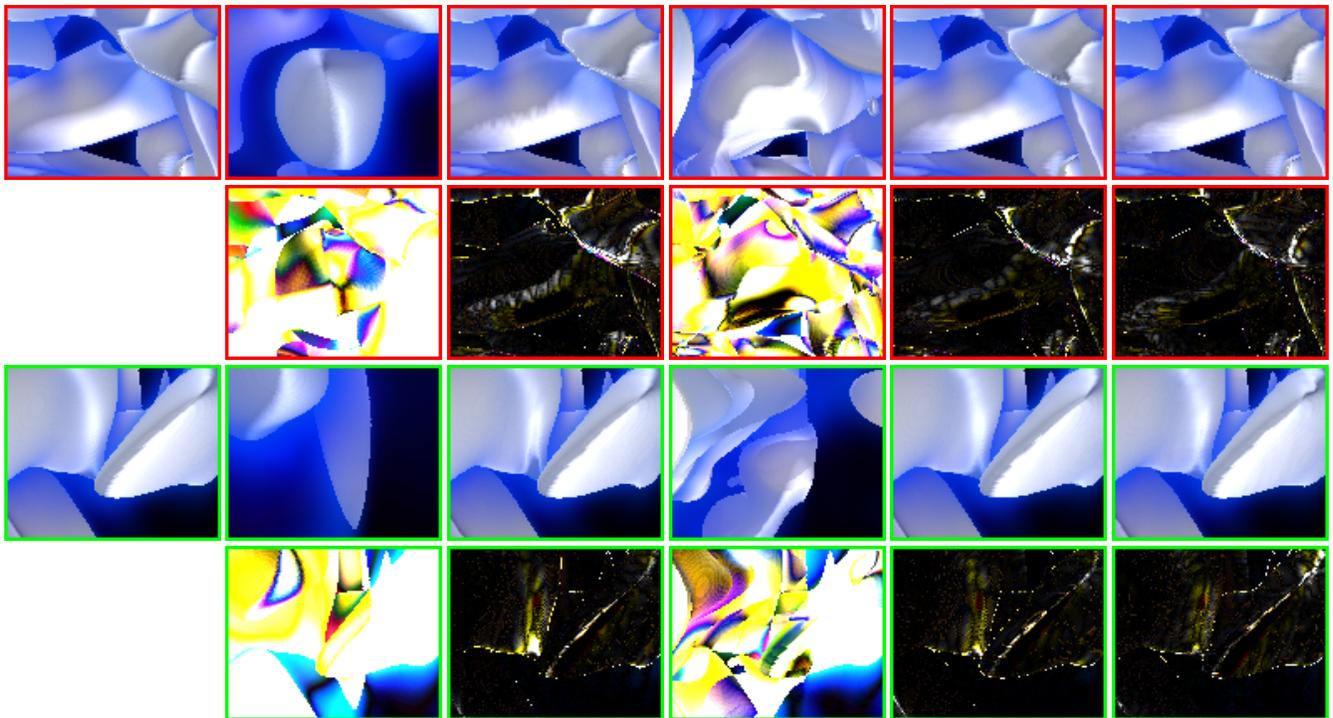
(c) Raw data
(6.13 GB, 3.94 FPS)(d) *N*-SVD (0.05 MB,
7.94 dB, 31.05 FPS)(e) *N*-SVD (32.1 MB,
40.59 dB, 0.02 FPS)(f) K-CTA (0.45 MB,
10.77 dB, 29.79 FPS)(g) K-CTA (31.89 MB,
40.01 dB, 0.39 FPS)(h) MK-CTA (31.65 MB,
40.49 dB, 30.87 FPS)

Fig. 20: Rendered images of approximated TVVD (“TurbVortex” ©Time-Varying Volume Data Repository) with isosurfaces based on different multilinear models at similar rendering rates (subfigures (d), (f), (h)) or with similar compression ratios (subfigures (e), (g), (h)). In subfigures (c)–(h), the first and third rows show rendered images; the second and fourth rows show absolute difference images (scaled by a factor of 8).

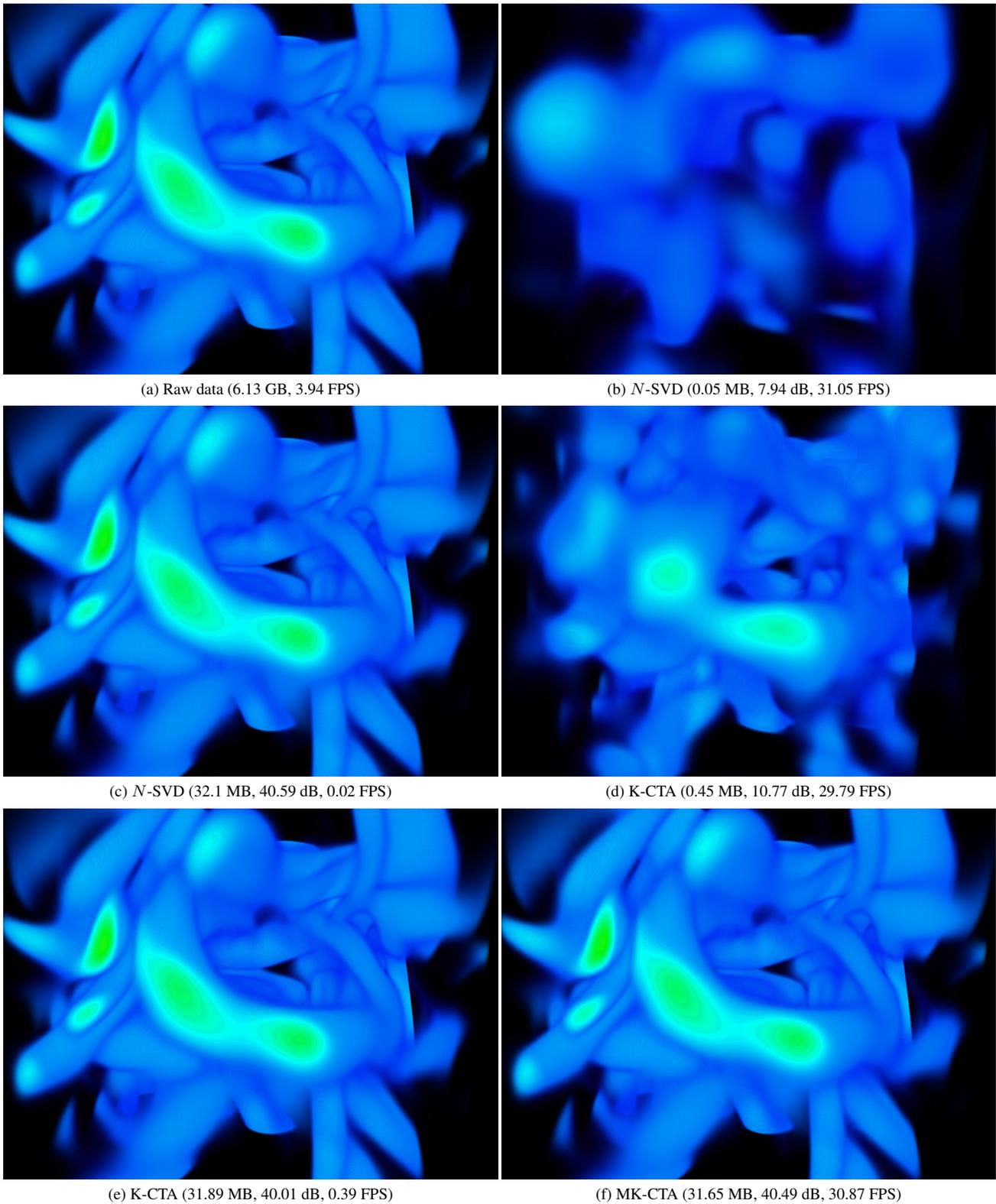
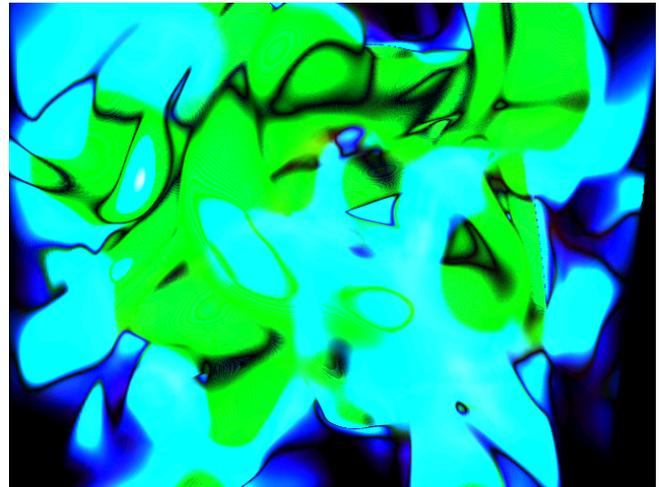
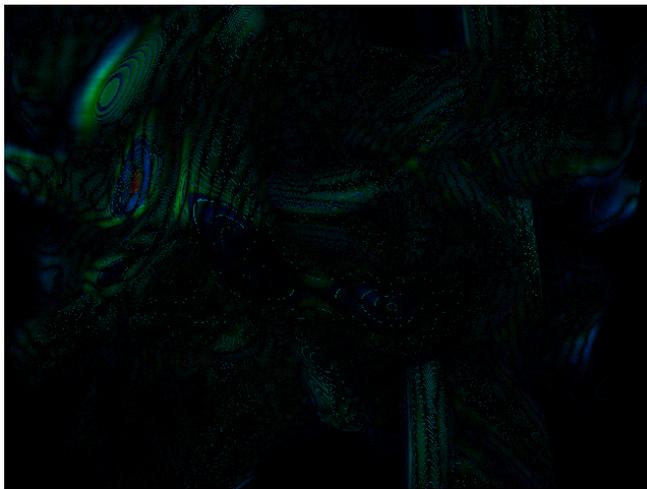


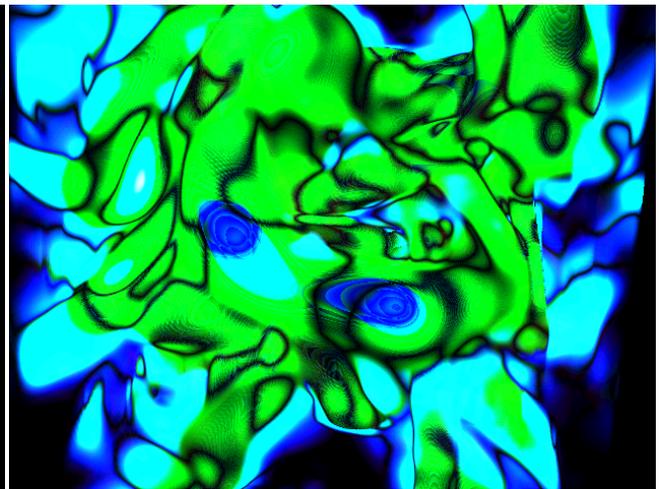
Fig. 21: Rendered images of approximated TVVD ("TurbVortex" ©Time-Varying Volume Data Repository) without isosurfaces based on different multilinear models at similar rendering rates (subfigures (b), (d), (f)) or with similar compression ratios (subfigures (c), (e), (f)).



(a) *N*-SVD (0.05 MB, 7.94 dB, 31.05 FPS)



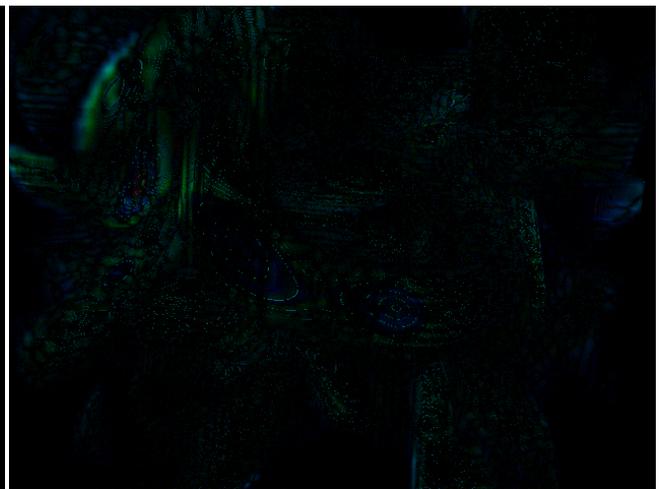
(b) *N*-SVD (32.1 MB, 40.59 dB, 0.02 FPS)



(c) K-CTA (0.45 MB, 10.77 dB, 29.79 FPS)

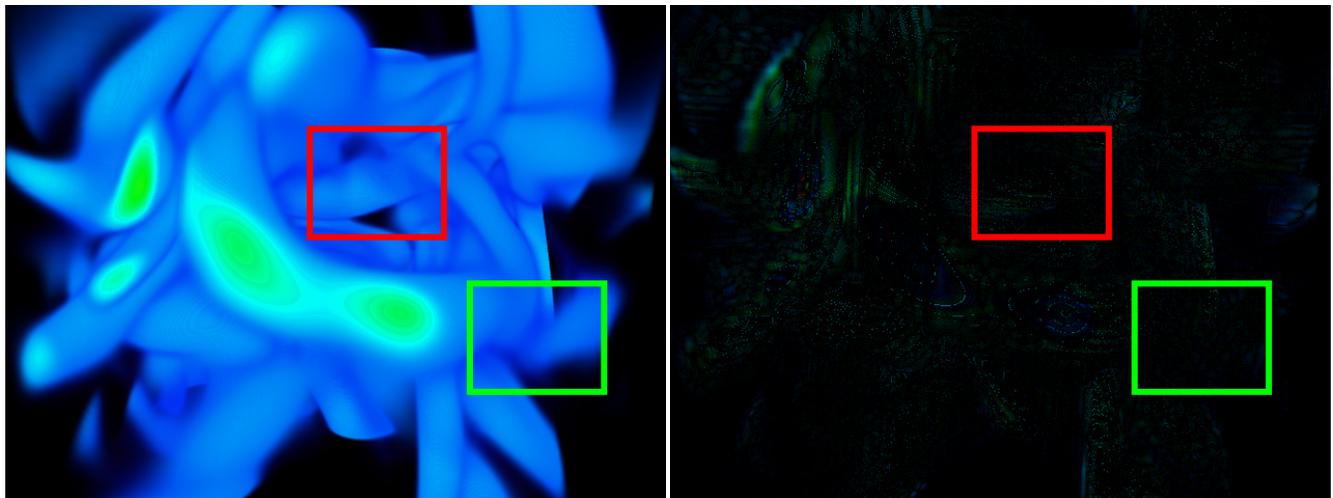


(d) K-CTA (31.89 MB, 40.01 dB, 0.39 FPS)



(e) MK-CTA (31.65 MB, 40.49 dB, 30.87 FPS)

Fig. 22: Absolute difference images (scaled by a factor of 10) of rendered images of approximated TVVD ("TurbVortex" ©Time-Varying Volume Data Repository) without isosurfaces based on different multilinear models at similar rendering rates (subfigures (a), (c), (e)) or with similar compression ratios (subfigures (b), (d), (e)).



(a) Rendered image of MK-CTA

(b) Absolute difference image of MK-CTA

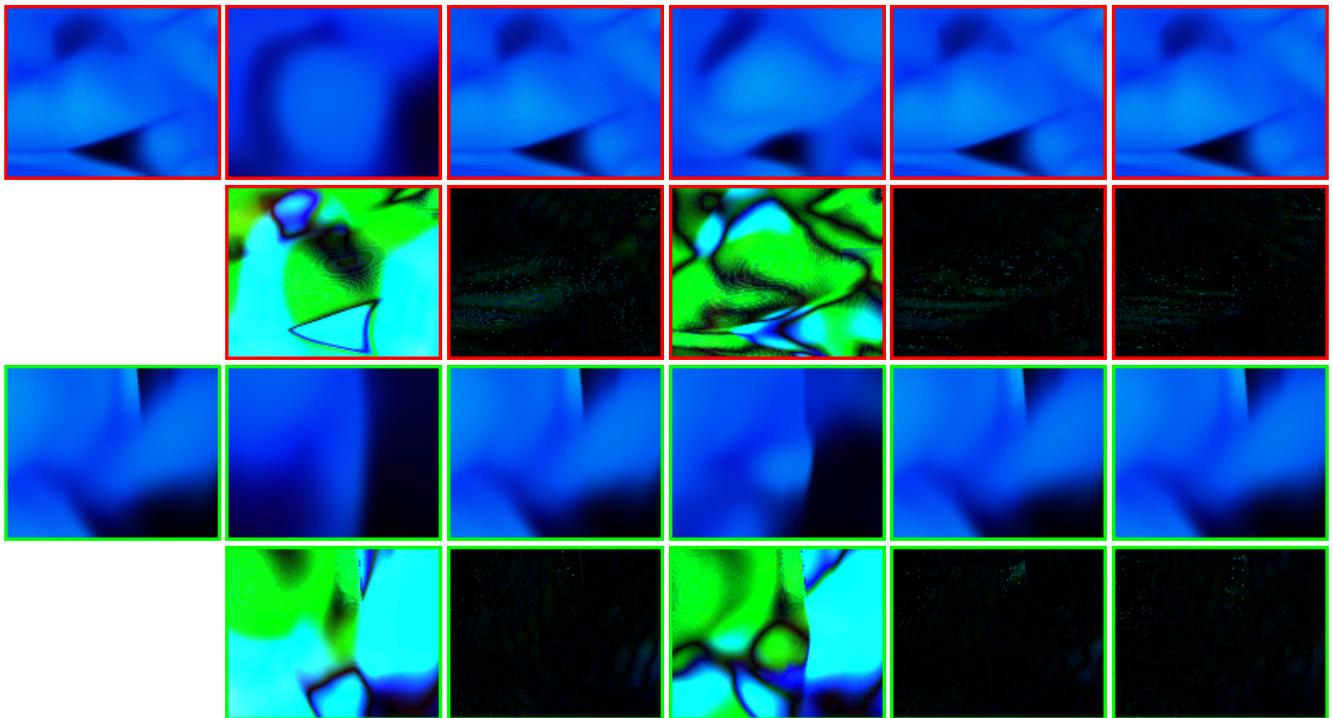
(c) Raw data
(6.13 GB, 3.94 FPS)(d) *N*-SVD (0.05 MB,
7.94 dB, 31.05 FPS)(e) *N*-SVD (32.1 MB,
40.59 dB, 0.02 FPS)(f) K-CTA (0.45 MB,
10.77 dB, 29.79 FPS)(g) K-CTA (31.89 MB,
40.01 dB, 0.39 FPS)(h) MK-CTA (31.65 MB,
40.49 dB, 30.87 FPS)

Fig. 23: Rendered images of approximated TVVD (“TurbVortex” ©Time-Varying Volume Data Repository) without isosurfaces based on different multilinear models at similar rendering rates (subfigures (d), (f), (h)) or with similar compression ratios (subfigures (e), (g), (h)). In subfigures (c)–(h), the first and third rows show rendered images; the second and fourth rows show absolute difference images (scaled by a factor of 10).