SUPPLEMENTAL FIGURE 1. Comparison of estimated motion vectors generated by different approaches at small tumor region of the ^{18}F-FMISO study. Background for each subfigure is the gated-PET AIM at end-expiration (EE). Blue arrows represent motion vectors ("real") generated by registration between EE and end-inspiration (EI) 4D-CT, and are repeated for each sub figure. Yellow arrows represent motion vectors generated by registration between EE and EI gated-PET using different approaches. All vectors point from EI to EE phase. AIM shows the best alignment between estimated motion vector and real motion vector.
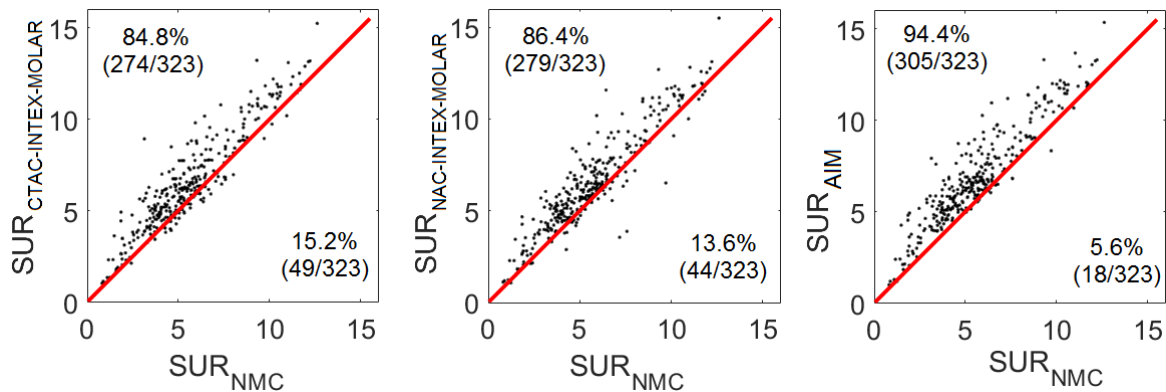
SUPPLEMENTAL FIGURE 2. SUR-improvement results of all ROIs from all ^{18}F-FDG studies for three correction methods. Each dot represents one ROI. Dots above the red line of identity indicates a SUR increase after motion correction while below indicates a decrease. Percentage Values number shows percentage/numbers of ROIs falls above or below the red identity line.
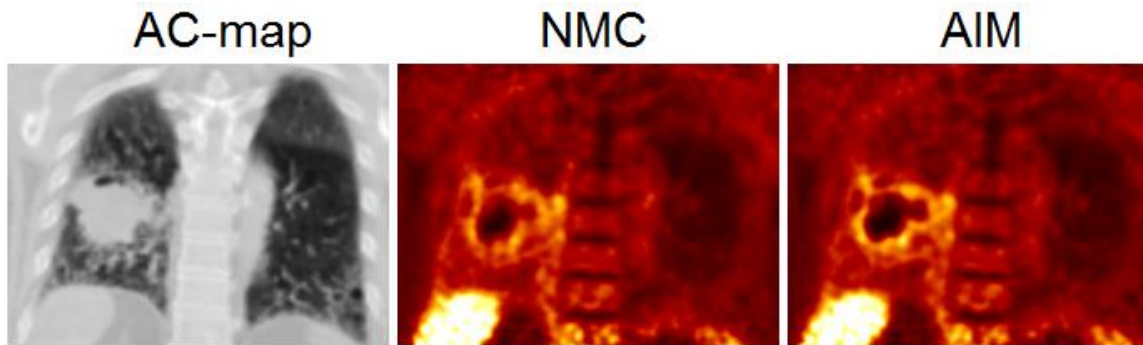
SUPPLEMENTAL FIGURE 3. Reconstruction results of the ^{18}F-FMISO study. A coronal slice through the center of the large hypoxia tumor is shown. Attenuation map (AC-map) is shown as the reference. AIM shows great improvements over NMC (no motion correction) in terms of tumor contrast, delineation of the avid hypoxic area. AIM results could more accurately guide radiation therapy planning, in particular dose painting.

SUPPLEMENTAL TABLE 1. Reference phase determination results

Tracer	Study	Determined reference phase using the proposed method (Predefined phase based on acquisition protocol)
^{18}F-FDG	1	1(F)
	2	1(F)
	3	1(F)
	4	1(F)
	5	1(F)
	6	2(F)
	7	1(F)
	8	1(F)
	9	3(F)
	10	1(F)
^{18}F-FP(+)DTBZ	1	5(5)
	2	1(5)
^{18}F-FMISO	1	3(5)

Note, phase 1 presents end-inspiration (EI) and phase 5 represents end-expiration (EE), phases 2-4 are between EI and EE. F presents free-breathing.

SUPPLEMENTAL TABLE 2.

Coefficient of Variation (CoV) and percent increases in signal-to-noise ratio (SNR).

Tracer	Study *	Body Parts Covered by PET FOV	CoV of background				# of ROIs	SNR$_{mean}$+%		
			NMC	CTAC-	NAC-	AIM		CTAC-	NAC-	AIM
^{18}F-FDG	1	Abdominal	0.24	0.23	0.22	0.23	17	23.9±20.7	27.7±20.8	29.3±19.6
	2	Abdominal	0.24	0.24	0.23	0.24	106	25.9±26.8	25.8±24.2	27.2±28.5
	3	Thorax	0.30	0.30	0.30	0.33	1	9.2	7.2	12.9
	4	Abdominal	0.24	0.22	0.23	0.22	25	55.5±54.8	42.7±53.2	59.1±56.3
	5	Thorax	0.42	0.40	0.40	0.42	28	23.5±21.2	25.4±22.8	28.6±22.2
	6	Thorax	0.23	0.22	0.21	0.22	3	14.1±3.7	10.9±6.4	16.8±4.1
	7	Thorax	0.22	0.19	0.19	0.20	3	16.3±10.9	16.7±10.4	15.2±9.2
	8	Thorax	0.42	0.43	0.43	0.43	88	29.3±19.2	28.1±18.7	31.0±21.0
	9	Abdominal	0.26	0.25	0.25	0.25	36	1.5±7.4	2.6±6.3	12.6±12.5
	10	Thorax	0.32	0.30	0.31	0.31	16	14.5±13.1	9.2±14.1	13.6±12.7
							Study Level mean 10 studies (323 ROIs)	**21.4**	**19.6**	**24.6**
^{18}F-FPDTBZ	1	Abdominal	0.11	0.10	0.10	0.10	Kidney	29.9	34.9	34.2
							Pancreas	28.7	34.2	33.7
							Spine	1.3	-16	1.4
	2	Abdominal	0.12	0.12	0.12	0.12	Kidney	31.2	25.7	34.4
							Pancreas	17.5	17.7	17.9
							Spine	-0.7	-35.6	-1.6
^{18}F-FMISO	1	Thorax	0.15	0.15	0.15	0.15	Large tumor (avid area)	10.1	11.6	11.5
							Small tumor	15.5	21.9	22.1

For abdominal FOV, noise is defined as the standard deviation inside a ROI placed on the liver. CoV is defined as the standard deviation divided by the mean within the liver ROI; For thorax FOV, noise is defined as the standard deviation inside a ROI placed in the lung. CoV is defined as the standard deviation divided by the mean within the lung ROI.