Fig. S1 MS and HPLC analysis of two precursors: (a) PSMA-FAPI-01: MS (ESI+) m/z 2934.10; (b) PSMA-FAPI-02: MS (ESI+) m/z 2336.86.

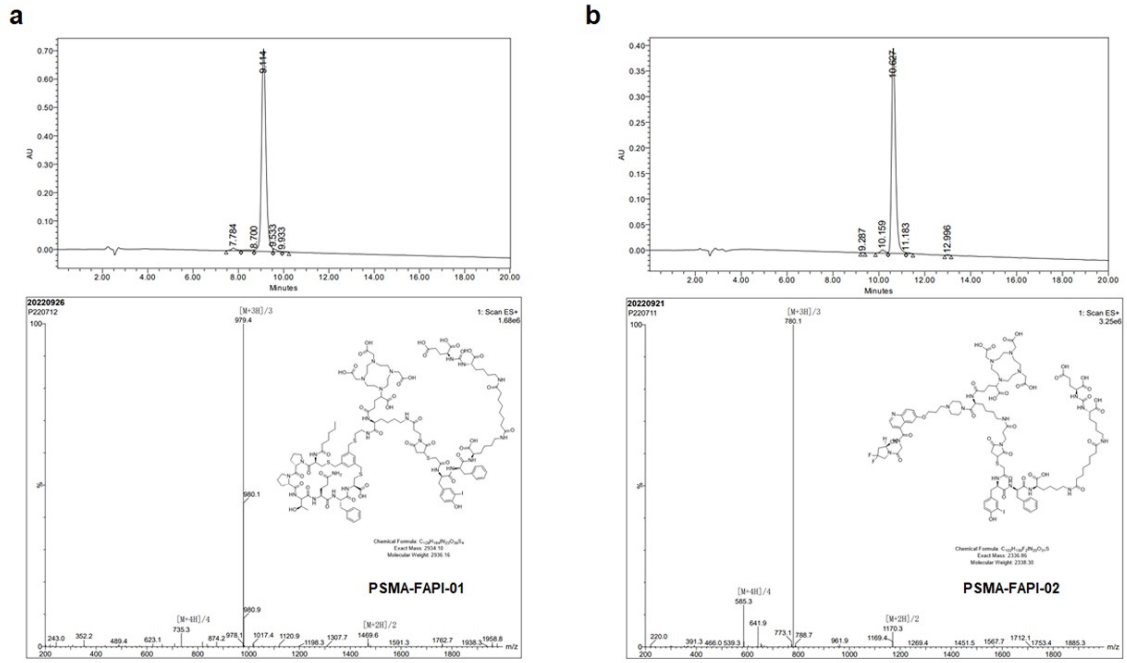


Fig. S2 The pharmacokinetic curve of [^{68}Ga]Ga-PSMA-FAPI-01 and [^{68}Ga]Ga -PSMA-FAPI-02 in normal mice was consistent with the two-compartmental model: (a) [^{68}Ga]Ga-PSMA-FAPI-01 (b) [^{68}Ga]Ga-PSMA-FAPI-02

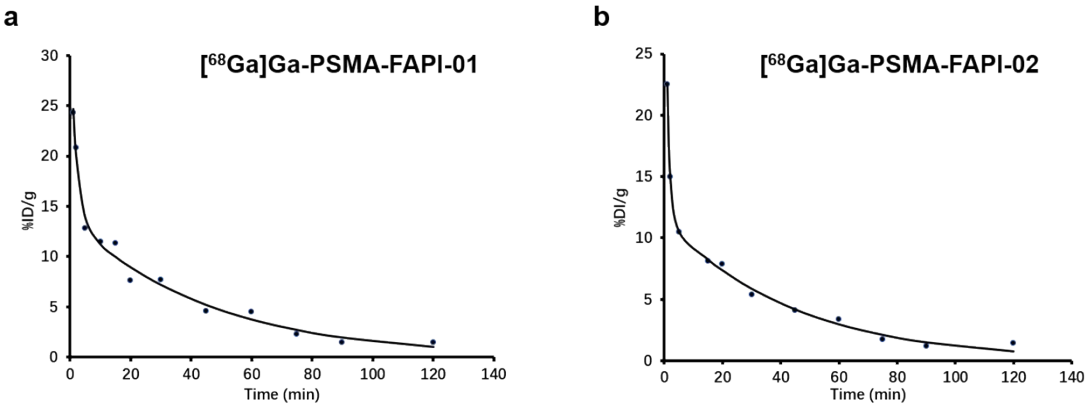


Fig. S3 IHC of PSMA or FAP expression in tumor models: (a) the expression of FAP in U87 tumor bearing model; (b) the expression of PSMA in LNCaP tumor bearing model; the brown area represents the positive expression area

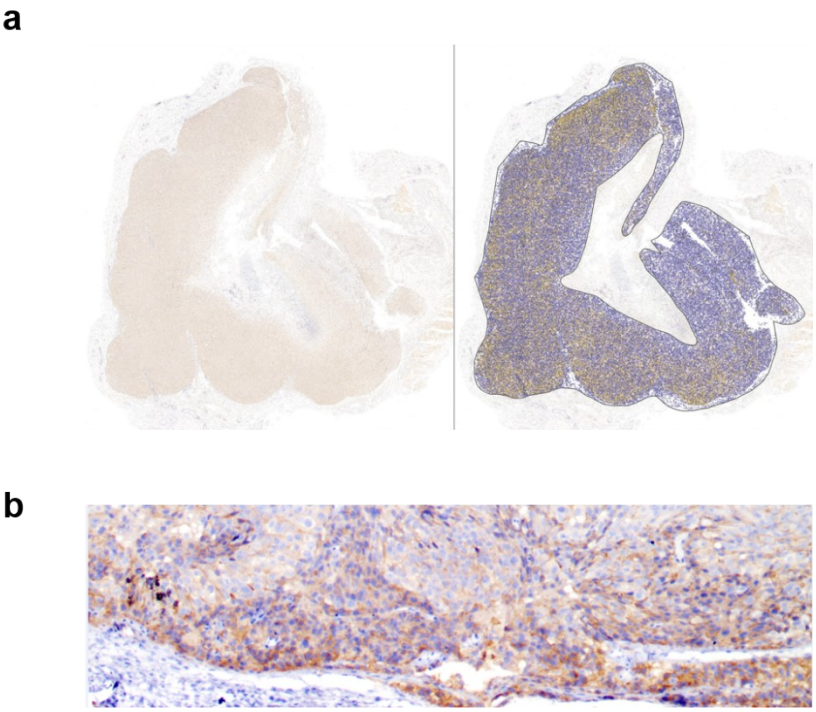
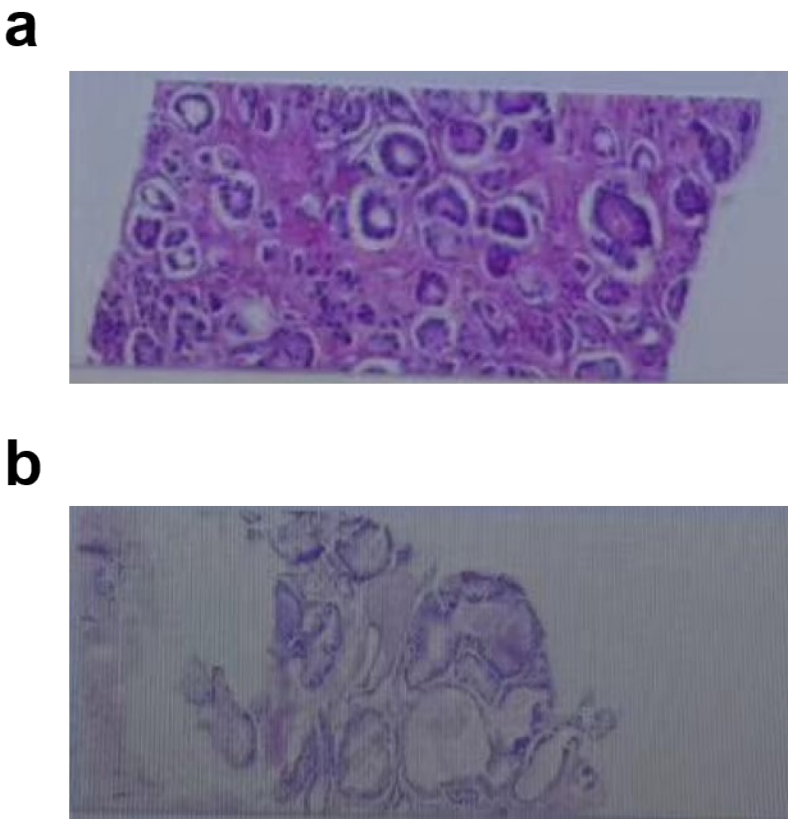
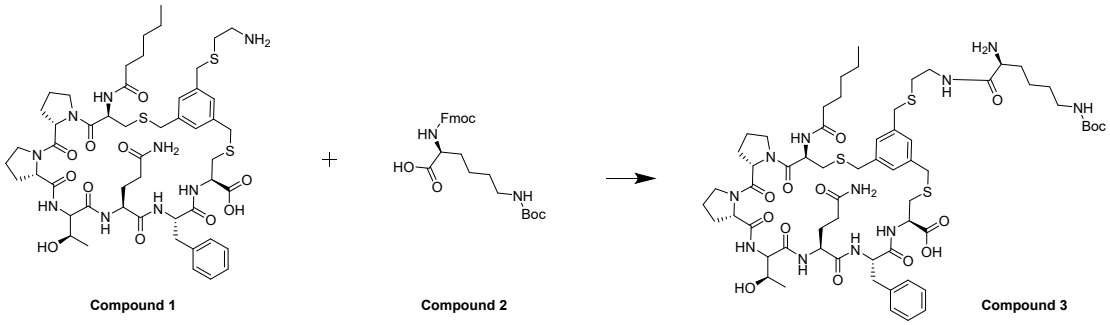


Fig. S4 Biopsy pathology of two patients was carried out to confirmed PSMA-positive PCa with Gleason scores: (a) 4 + 3 = 7 (HE, 100×) for patient 1; (b) 3 + 3 = 6 (HE, 100×) for patient 2



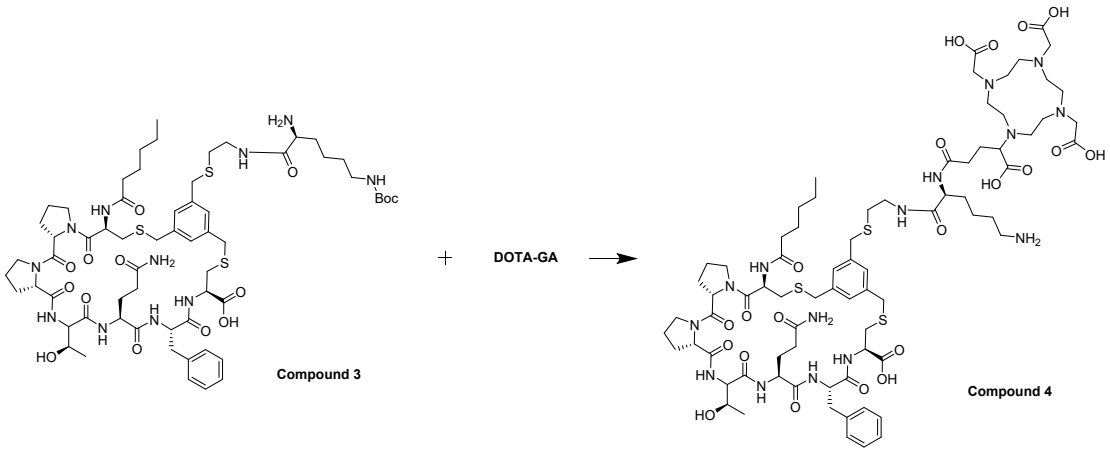
Scheme 1



Synthesis of compound 3

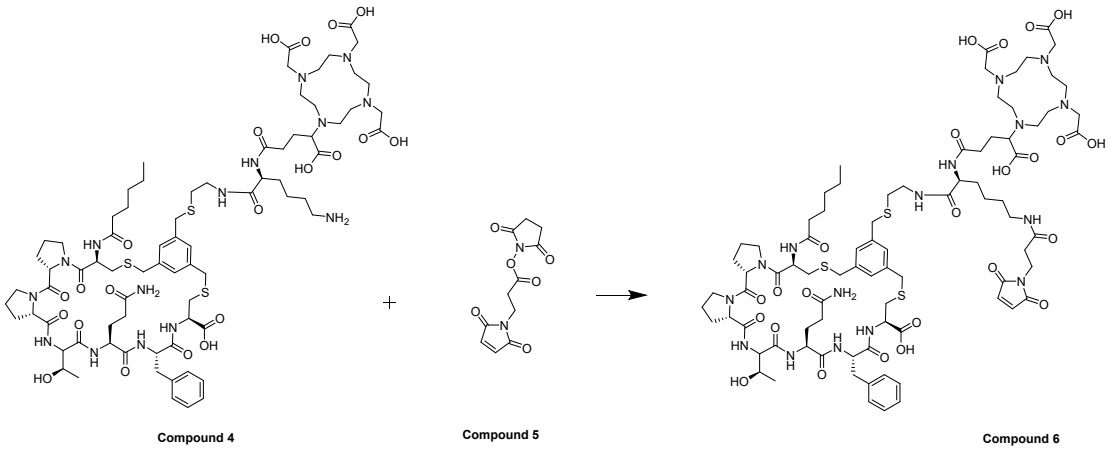
Compound 1 (100 mg), DCC (1.2 eq) and HOSu (1.2 eq) were dissolved in DMF (20 mL), and then reacted at room temperature for 6 h. The precipitated solid of the mixture were filter off, and then add (87 mg, 2.0 eq) compound 2, and TEA (2 eq) to the filtrate, reacting at room temperature for 3

h. Subsequently, DMF was removed, and the reaction was added THF (15 ml) and DEA (5 ml), reacting at room temperature for 2 h. Then, the reaction was concentrated and purified by reverse phase liquid-phase separation (92mg compound 3; yield: 76%).



Synthesis of compound 5

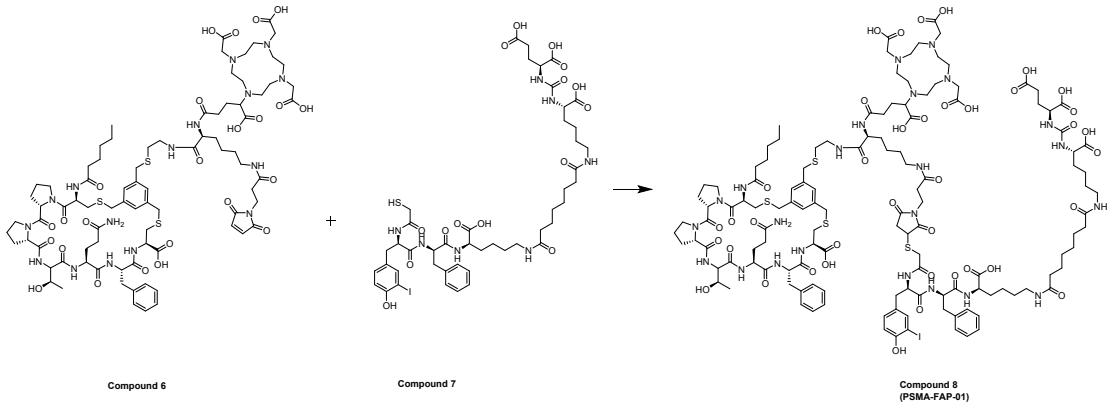
Compound 3 (92 mg), HBTU (1.2 eq), NMM (1.2 eq) and DOTA-GA (2.0 eq, 98 mg) were dissolved in DMF (20 mL), and then reacted at room temperature for 2 h. Subsequently, DMF was removed, and the reaction was added TFA (20 ml), reacting at room temperature for 2 h. The reaction was added ice ether to precipitate solid, and then centrifuge, and purify the solid by reverse phase liquid-phase separation to obtain compound 4 (79.7 mg yield: 68%).



Synthesis of compound 6

Compound 4 (79.7 mg), DIPEA (2.0 eq), and compound 5 (3.0 eq, 38 mg) were dissolved in DMF (20 mL), and then reacted at room temperature for 2 h. Subsequently, DMF was removed, and the

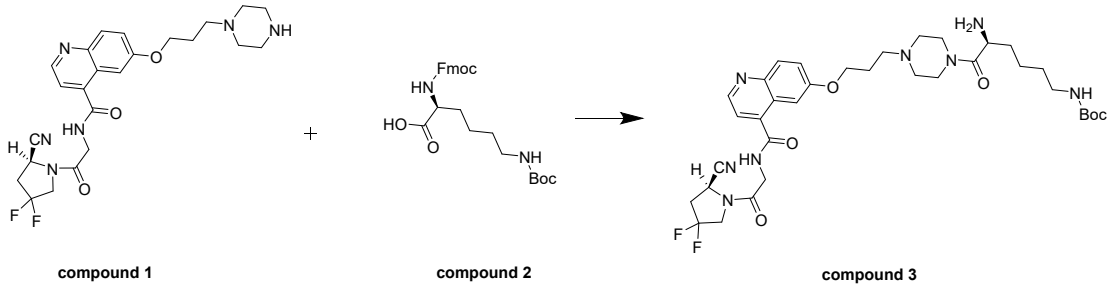
reaction was purified by reverse phase liquid-phase separation to obtain compound 6 (60.8 mg yield: 70%).



Synthesis of compound 8 (PSMA-FAP-01)

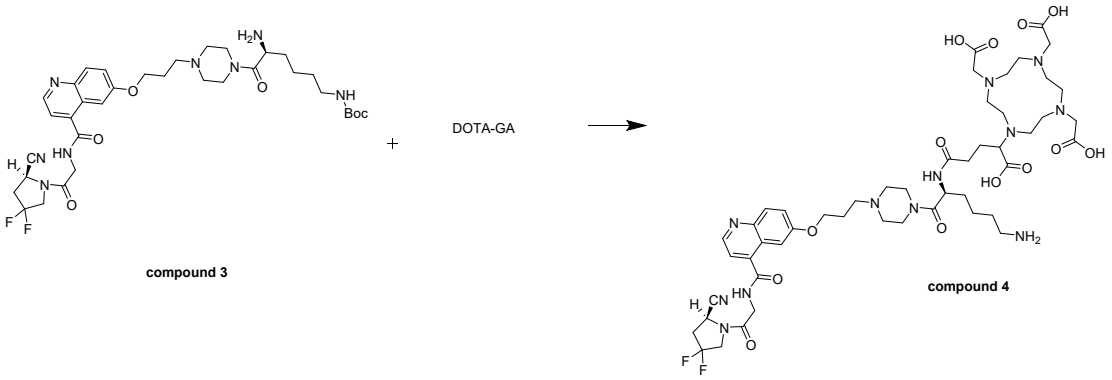
Compound 6 (60.8 mg), and compound 7 (1.5 eq, 55.8 mg) were dissolved in H_2O/ACN (20 mL), and then PBS buffer solution (0.2 mol; pH = 7.2) was added into the reaction. The reaction reacted at room temperature for 1 h. Subsequently, the reaction was purified by reverse phase liquid-phase separation to obtain compound 8 (86 mg yield: 88%).

Scheme 2



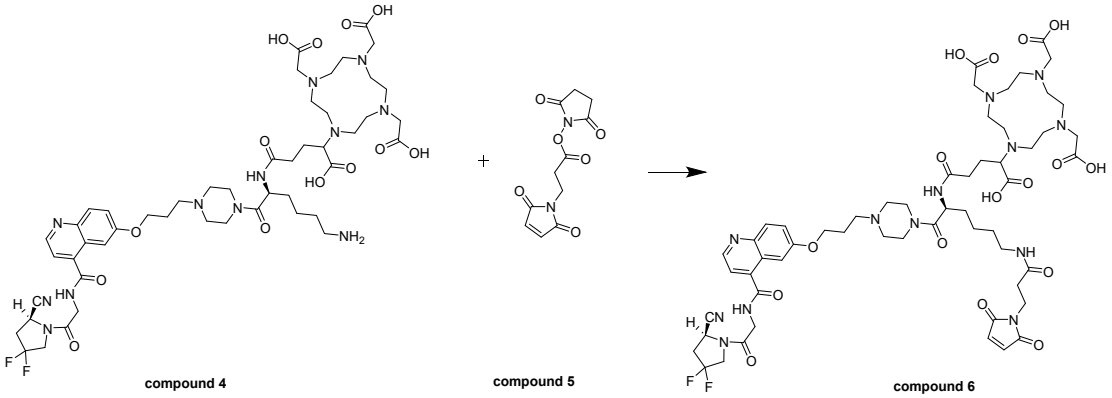
Synthesis of compound 3

Compound 1 (100 mg), compound 2 (288 mg), HBTU (1.1 eq) and NMM (3.0 eq) were dissolved in DMF (20 mL), and then reacted at room temperature for 0.5 h. Subsequently, DMF was removed, and the reaction was added DEA/THF (25 %), reacting at room temperature for 4 h. Then, the reaction was concentrated and purified by reverse phase liquid-phase separation (308 mg compound 3; yield: 70%).



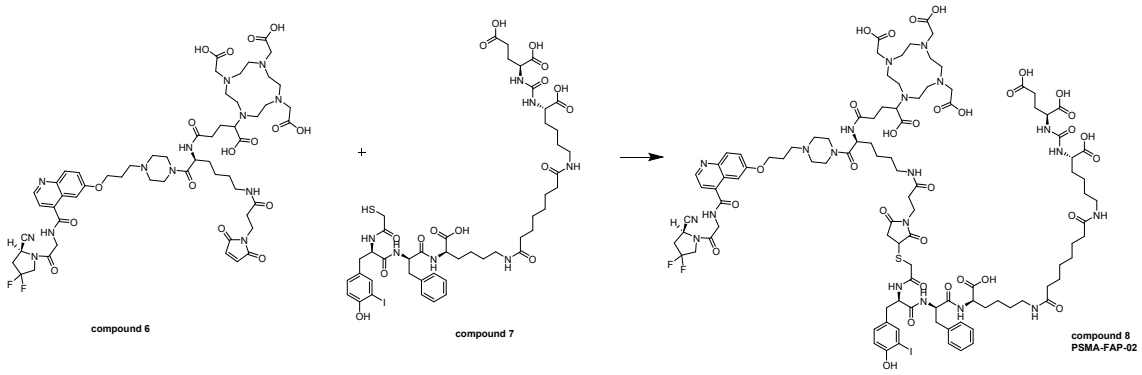
Synthesis of compound 4

Compound 3 (308 mg), HBTU (1.1 eq), NMM (3.0 eq) and DOTA-GA (302 mg) were dissolved in DMF (20 mL), and then reacted at room temperature for 0.5 h. Subsequently, DMF was removed, and the reaction was added TFA (20 ml), reacting at room temperature for 2.5 h. The reaction was added ice ether to precipitate solid, and then centrifuge, and purify the solid by reverse phase liquid-phase separation to obtain compound 4 (268 mg yield: 58%).



Synthesis of compound 6

Compound 4 (268 mg), DIPEA (3.0 eq), and compound 5 (3.0 eq, 66 mg) were dissolved in DMF (15 mL), and then reacted at room temperature for 3 h. Subsequently, DMF was removed, and the reaction was purified by reverse phase liquid-phase separation to obtain compound 6 (227 mg yield: 68 %).



Synthesis of compound 8 (PSMA-FAP-02)

Compound 6 (227 mg), and compound 7 (1.5 eq, 240 mg) were dissolved in H_2O/ACN (15 mL), and then PBS buffer solution (0.2 mol; pH = 7.2) was added into the reaction. The reaction reacted at room temperature for 1 h. Subsequently, the reaction was purified by reverse phase liquid-phase separation to obtain compound 8 (216 mg yield: 50%).

Table.S1 Biodistribution data of [^{68}Ga]Ga-PSMA-FAPI-01, [^{68}Ga]Ga-PSMA-FAPI-02, [^{68}Ga]Ga-PSMA I&T and [^{68}Ga]Ga-PSMA-11 LNCaP tumor-bearing model

Tissue (%ID/g)	[^{68}Ga]Ga-PSMA-FAPI-01	[^{68}Ga]Ga-PSMA-FAPI-02	[^{68}Ga]Ga-PSMA I&T	[^{68}Ga]Ga-PSMA-11
Blood	8.90 ± 0.61	7.10 ± 0.74	5.15 ± 0.40	2.56 ± 0.24
Muscle	1.44 ± 0.13	1.55 ± 0.22	1.65 ± 0.03	0.78 ± 0.11
Bone	9.66 ± 0.73	9.57 ± 1.10	7.05 ± 0.63	6.53 ± 1.45
Kidney	34.68 ± 2.01	56.09 ± 1.96	94.69 ± 6.44	127.65 ± 9.42
Spleen	7.91 ± 1.46	3.85 ± 0.44	18.43 ± 2.18	13.98 ± 1.14
Liver	7.89 ± 0.64	3.25 ± 0.40	0.91 ± 0.07	0.63 ± 0.12
Intestine	4.46 ± 0.13	3.45 ± 0.26	10.14 ± 0.58	6.65 ± 0.97
Heart	2.83 ± 0.30	1.19 ± 0.22	1.04 ± 0.16	0.24 ± 0.01
Lungs	6.45 ± 1.14	3.25 ± 0.56	2.27 ± 0.24	1.10 ± 0.18
Stomach	2.66 ± 0.19	1.83 ± 0.06	0.90 ± 0.12	0.36 ± 0.01
Tumor	19.01 ± 0.60	11.63 ± 0.50	17.79 ± 1.11	18.72 ± 0.90
T/K	0.55	0.21	0.19	0.15

Table.S2 Biodistribution data of [^{68}Ga]Ga-PSMA-FAPI-01, [^{68}Ga]Ga-PSMA-FAPI-02, [^{68}Ga]Ga-PSMA I&T and [^{68}Ga]Ga-PSMA-11 U87 tumor-bearing model

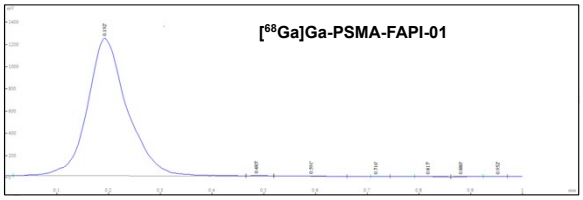
Tissue (%ID/g)	[^{68}Ga]Ga-PSMA-FAPI-01	[^{68}Ga]Ga-PSMA-FAPI-02	[^{68}Ga]Ga-FAPI04
Blood	5.18 ± 0.40	7.29 ± 0.46	4.15 ± 0.40
Muscle	1.30 ± 0.14	2.95 ± 0.10	1.55 ± 0.03
Bone	9.81 ± 0.72	8.68 ± 0.39	8.53 ± 0.63
Kidney	72.91 ± 3.97	75.94 ± 2.73	84.70 ± 6.45
Spleen	11.64 ± 1.81	8.08 ± 1.75	10.43 ± 2.18
Liver	1.78 ± 0.07	1.53 ± 0.29	0.82 ± 0.04
Intestine	11.74 ± 0.77	7.96 ± 1.36	9.72 ± 0.58
Heart	3.25 ± 0.75	1.53 ± 0.14	1.25 ± 0.16
Lungs	1.73 ± 0.02	2.21 ± 0.15	3.46 ± 0.24
Stomach	1.26 ± 0.17	1.61 ± 0.26	1.90 ± 0.12
Tumor	7.78 ± 0.44	11.74 ± 0.47	10.69 ± 1.11

Quality Control for Human PET/CT Study

For IIT radiotracers preparation, we ensured compound quality through stringent quality control. Specifically, the radiotracers were filtered through a sterile 0.22 μm filter to ensure safety. Radio thin-layer chromatography (radio-TLC) was employed as the analytical method for the quality control of our radiopharmaceutical preparation. The results of the radio-TLC analysis are depicted in the attached picture. Notably, no distinct peak for free radionuclides was observed in the picture, which indicates a high level of radiochemical purity in our preparation.

Fig. S5 The radio-TLC results of (a) [^{68}Ga]Ga-PSMA-FAPI-01 and (b) [^{68}Ga]Ga-PSMA-FAPI-02

a



b