

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

**GE Healthcare Ltd.,
Petitioner**

v.

**Johns Hopkins University,
Patent Owner**

**Case No. IPR2026-00069
U.S. Patent No. 11,938,201**

PETITION FOR INTER PARTES REVIEW

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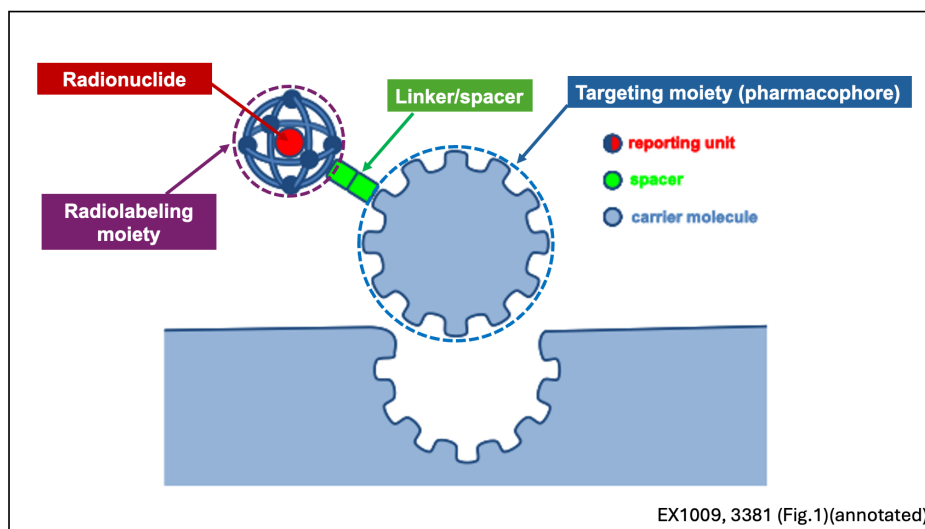
I. Introduction

Radiopharmaceuticals and optical imaging agents work by selectively accumulating in tissues and organs containing cells targeted by the agent. In radiotherapy, radiation emitted by the accumulated radiopharmaceuticals in the tissue kills the targeted cells. In diagnosis, devices are used to locate and image tissues or organs in which the agent has accumulated. In both applications, selectivity of the agent for the target cells is critical—if it binds to normal cells, it can produce inaccurate diagnoses, and in radiotherapy, can harm healthy tissue.

A common modular design used in radiopharmaceuticals and optical imaging agents combines three components (illustrated below):¹

- (i) a “reporter moiety”—either “radiolabeling moiety” attached to a radionuclide or a light-absorbing or -emitting molecule;
- (ii) a “targeting moiety” that binds to a structure selectively expressed by the targeted cells; and
- (iv) a “linker” that connects the targeting and reporter moieties.

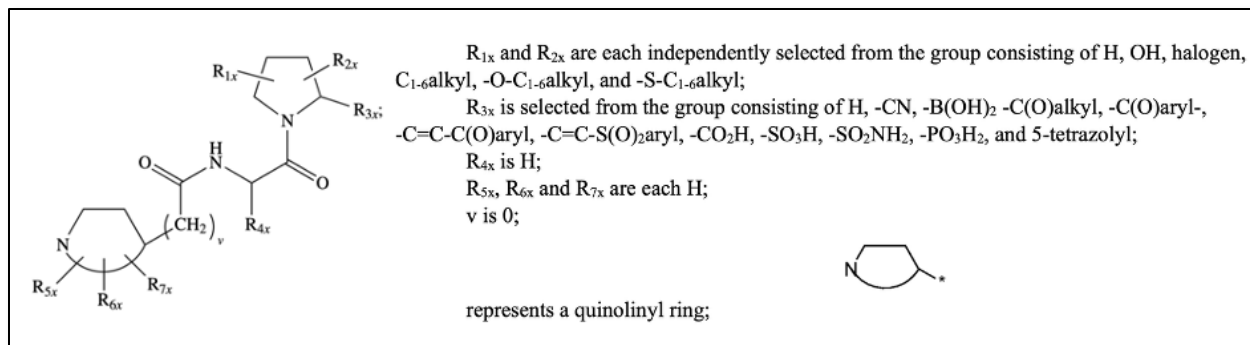
¹ EX1003, ¶¶ 27-28; EX1009, 3380 (annotated).



U.S. Patent No. 11,938,201 (the '201 Patent)(EX1001) broadly claims radiopharmaceuticals and optical imaging agents with this modular, three-component design: “low molecular weight compounds with the formula B-L-A.”

The claims define the “B” and “L” components in functional terms:(i) “B” is “*any* ...radiolabeling moiety... suitable for” optical imaging, Positron Emission Tomography (PET) imaging, or Single Photon Emission Computed Tomography (SPECT) imaging, or radiotherapy, (ii) “L” is a linker “having bi-functionalization adapted to form a chemical bond with B and A”, respectively.

The claims then define the third component “A” as “a targeting moiety for FAP- α ” (“A”), which is any compound within a structurally defined genus (below):

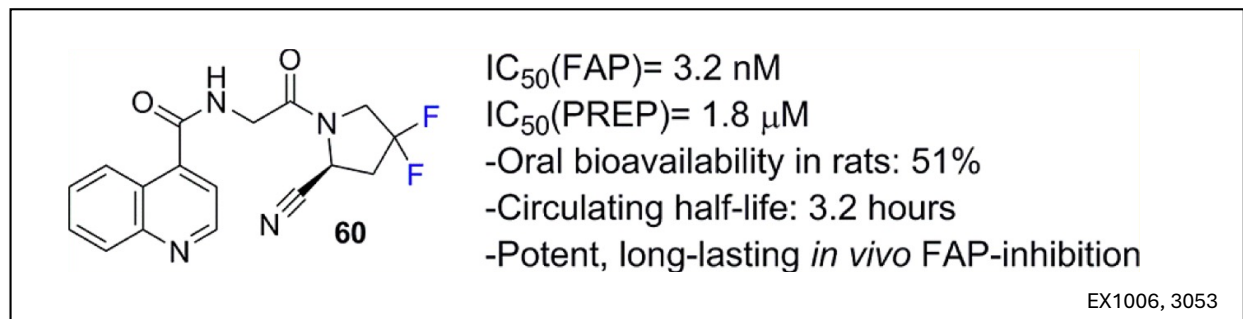


Before 2017, two different published applications—US-633 (EX1004) and US-121 (EX1005)—described low molecular weight radiotracers useful for PET or SPECT tumor imaging employing this modular three-component design. Both used small molecule targeting moieties for proteins selectively expressed on cells in tumors: (i) US-633 described radiotracers targeting fibroblast activation protein- α (FAP- α , seprase)(“FAP”), while (ii) US-121 targeted the prostate-specific membrane antigen (PSMA).² The only component of the claimed compounds not disclosed in these publications was a small molecule, highly selective FAP-targeting compound within the structural genus of the “A” component of the claims.

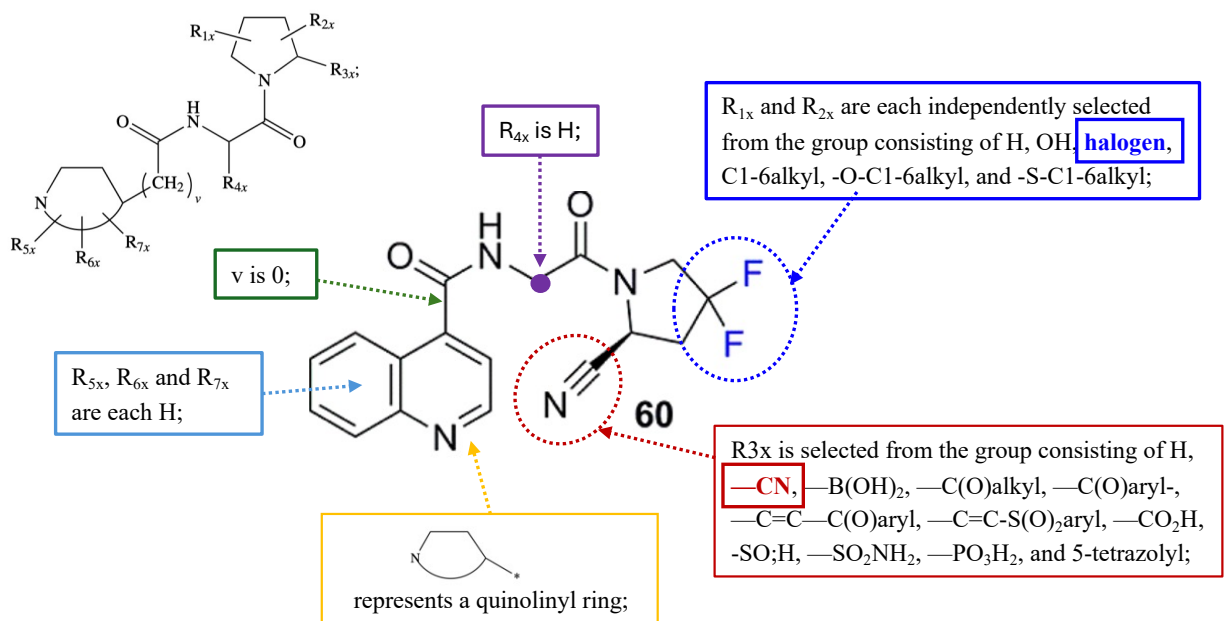
But Jansen (EX1006) did. It showcased “compound 60” in its abstract, identifying it as a potent, highly selective FAP inhibitor. And it highlighted attributes of compound 60 that signaled to the skilled artisan it would be an

² EX1004 (US2010/0098633); EX1005 (US2012/0009121).

excellent FAP-targeting moiety for a radiotracer, including its high oral bioavailability and its “potent, long lasting *in vivo* FAP-inhibition.”



Critically, compound 60 meets *every requirement* of the targeting moiety requirement (“A”) of the claimed compounds (below):



Claims 1 to 3 are unpatentable because they capture compound 60-based FAP-targeting radiotracers that would have been obvious over the prior art. Two independent grounds support this conclusion.

First, the sole distinction between the claimed compounds and the low-

molecular weight radiopharmaceuticals taught by US-633 is the latter's targeting moiety, which has a boronic acid pyrrolidine structure not within the structural genus "A" of the claims (*e.g.*, compound 1024)(below).

In 2015, Meletta (EX1008)—after citing US-633—reported that a radiotracer based on compound 1024 was insufficiently selective for FAP, rendering it unsuitable for use in FAP-targeting radiotracers. Meletta, also explained that: “[f]or future studies ***more selective inhibitors are needed*** to reduce non-specific tissue accumulation.”³ Meletta thus provided a specific motivation for skilled artisans to improve the US-633's radiotracers by finding and using more selective FAP-targeting moieties. So motivated, skilled artisans would have found Jansen's highly FAP-selective compound 60 and used it to improve the US-633 radiotracers. Claims 1 to 3 are unpatentable because those obvious radiotracers meet every requirement of those claims.

Second, a skilled artisan would have found the radiopharmaceuticals of claims 1-3 obvious based on US-121 (EX1005)⁴ with Jansen (EX1006). US-121 describes low molecular weight radiotracers targeting PSMA for use in PET and SPECT imaging that employ the same three-component design specified in claims

³ EX1008, 2089-90.

⁴ U.S. Publication No. 2012/009121.

1-3, have comparable prior art linkers and radiolabeling moieties, but again have a different targeting moiety (a urea-based structure).

By 2017, skilled artisans considered FAP as an appealing target for radiopharmaceuticals, due to its elevated expression in >90% of epithelial cancers but not normal tissue, which have motivated skilled persons to adapt proven radiotracer designs (*e.g.*, those in US-121) to produce FAP-targeting radiopharmaceuticals. Such persons, so motivated, would have considered Jansen, and its highly selective, potent FAP-inhibitor compound 60, which also has comparable size to the targeting moiety in the US-121 radiopharmaceuticals. Adapting the US-121 compounds to use compound 60 as its targeting moiety yields compounds meeting every requirement of claims 1-3.

Because each ground demonstrates that radiotracers within the scope of claims 1-3 of the '201 Patent would have been obvious, each claim is unpatentable. The Board should institute trial.

II. Compliance with IPR Requirements

A. Certification of Standing

Petitioner certifies this Petition for *inter partes* review is filed more than 9 months after issuance of the '201 Patent. Petitioner also certifies it is not barred or estopped from requesting this IPR. Petitioner and its privies have not filed a civil action challenging the validity of any claim of the '201 Patent.

B. Mandatory Notices**1. Real Party-in-Interest**

GE Healthcare Ltd. (“GE Healthcare”) and Sofie Biosciences, Inc. are the real-parties-in-interest for this Petition.

2. Related Proceedings

The ’201 Patent was the subject of two prior proceedings.

First, the ’201 Patent was the subject of PGR2025-00012. That proceeding was initiated by a different petitioner (ITM Isotope Technologies Munich SE), and raised different grounds based on different prior art. On October 16, 2025, the Board terminated PGR2025-00012 based on a joint motion of the parties to that proceeding to terminate the proceeding due to a settlement.

Second, the ’201 Patent was the subject of IPR2025-00808. That proceeding was initiated by the present Petitioner. On April 29, 2025, the parties (i) jointly requested that the Board stay all deadlines in that proceeding pending a decision of the Board on institution in the PGR2025-00012 proceeding, and (ii) agreed that if a decision to institute in the PGR2025-00012 proceeding was made by the Board, the parties would jointly request termination of IPR2025-00808 within 5 business days of that institution decision without prejudice to Petitioner filing a petition concerning the ’201 Patent at a date subsequent to termination of PGR2025-

00012.⁵ The Board granted the parties' joint request on May 2, 2015.⁶

On July 23, 2025, in view of the institution of PGR2025-00012, the parties filed a joint motion pursuant to the conditions specified in their prior request to the Board that had been granted.⁷ On the same date (July 23, 2025), the Board issued an order, in which it observed that the Parties via their Joint Motion had "requested the Board terminate the [IPR2025-00808] proceeding without prejudice to Petitioner filing a petition concerning [the '201 Patent] at a date subsequent to termination of co-pending PGR2025-000121."⁸ The Board then granted the Joint Motion of the parties and terminated the IPR2025-000808 proceeding.

The present petition is filed pursuant to the terms in the agreement between the parties that was the basis of their Joint Motion to Terminate the proceedings in IPR2025-00808 that was subsequently granted by the Board.

⁵ See IPR2025-00808, Paper 7, page 2.

⁶ EX3101, page 1.

⁷ See IPR2025-00808, Paper 7, page 2.

⁸ IPR2025-00808, Paper 8, page 2.

3. Counsel and Service Information

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III. Grounds

The grounds advanced in this Petition are:

- (1) Claims 1-3 would have been obvious under 35 U.S.C. § 103 based on US-633 (EX1004) in view of Jansen (EX1006) and Meletta (EX1008).
- (2) Claims 1-3 would have been obvious under 35 U.S.C. § 103 based on US-112 (EX1005) in view of Jansen (EX1006).

The grounds are supported by the evidence advanced with this petition, including, *inter alia*, the declaration of Dr. Brian Zeglis (EX1003).

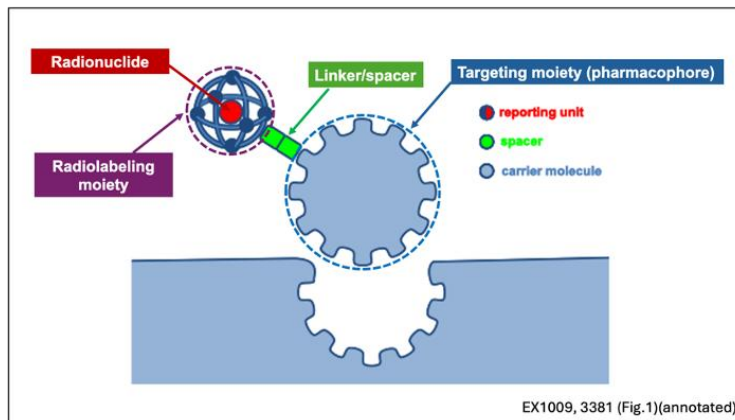
IV. Background on the Patent

A. Knowledge in the Field of the Patent

The field of radiopharmaceutical development was advanced by October 2017. The information below describes what would have been known by skilled artisans by October 2017.

1. Radiolabeling and Linker Components of Modular Radiopharmaceuticals Were Well-Known

As explained in § I, radiopharmaceuticals that used the modular, three component design illustrated in EX1009 were well-known (below, annotated).⁹



The modular three-component radiopharmaceutical design provides practical benefits, such as being able to readily alter the structure and characteristics of the radiopharmaceutical by choosing or replacing different chemical moieties for the individual components of the compound.¹⁰

(a) Targeting Moieties

The targeting moiety facilitates delivery of a radiopharmaceutical to particular cells (target cells) in the patient by binding to a chemical structure on the surface of those cells—selective binding to target cells (instead of normal cells) is

⁹ EX1003, ¶¶ 27-28.

¹⁰ EX1003, ¶ 28.

critical to ensure accurate delivery of the radiopharmaceutical.¹¹ Targeting moieties can be small molecules, peptides or antibodies, but small molecules are most commonly used in radiotracers, as they can more quickly penetrate tissues and are quickly cleared due to their rapid pharmacokinetic profiles.¹²

(b) Radiolabeling Groups

The radiolabeling moiety associates a radionuclide (a radioactive form of a metal or halogen) with a radiopharmaceutical, and consists of a chemical structure and the radionuclide. Two general classes of radiolabeling moieties were well-known: (i) chelators used with radiometals (*e.g.*, ⁶⁸Ga, ^{99m}Tc), and (ii) prosthetic groups labeled with radiohalogens (*e.g.*, ¹⁸F, ¹²³I).¹³ The purpose of both is to ensure the radionuclide does not dissociate from the radiopharmaceutical before it reaches and accumulates in tissues containing the targeted cells.¹⁴

Chelators are molecules that form a stable coordination complex with a

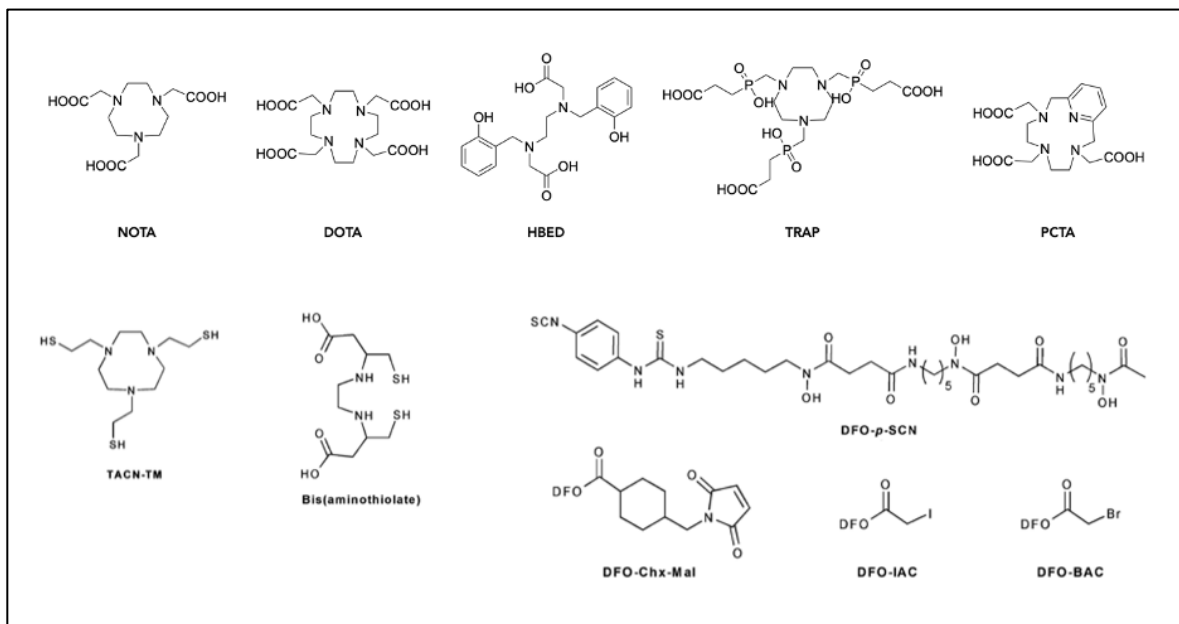
¹¹ EX1003, ¶ 29.

¹² EX1003, ¶ 30; EX1010, 1-3; EX1012, 2859.

¹³ EX1003, ¶ 32.

¹⁴ EX1003, ¶ 31.

selected radiometal; suitable chelators for each radiometal were known.¹⁵ For example, chelators suitable for ⁶⁸Ga included NOTA, DOTA, HBED, TRAP, PCTA, TACN-TM and DFO (below).¹⁶



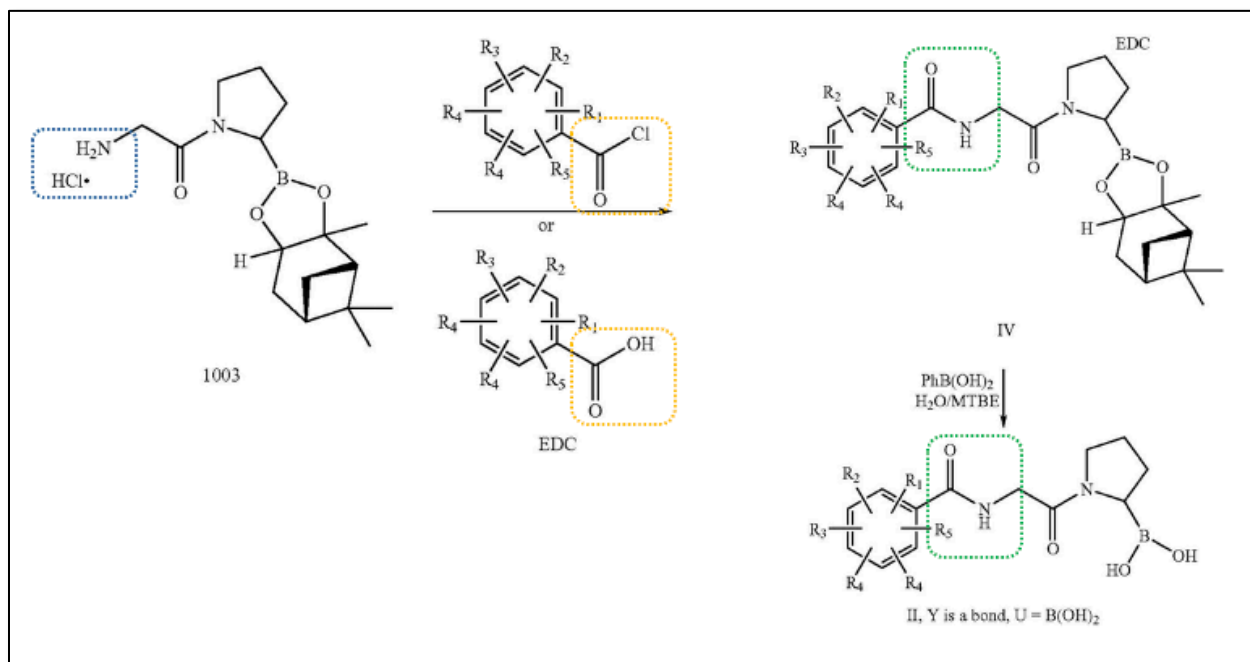
Prosthetic groups are molecules covalently labeled with a radiohalogen (*e.g.*, ¹⁸F, ¹²³I)¹⁷ that can be readily attached to the remainder of the radiopharmaceutical

¹⁵ EX1003, ¶¶ 32-33; EX1011, 1882; EX1012, 2865, 2869; EX1013, 260-262, 266-269.

¹⁶ EX1003, ¶ 82; EX1011, 1882-1883, 1887-1888; EX1013, 267, 272, 275, 276.

¹⁷ EX1003, ¶¶ 34, 83, 85; EX1042, 410-411; EX1043, 12439-51; EX1034, 2792-93, Figure 2.

compound (below).¹⁸



(c) Linkers

A linker is a chemical moiety that connects the radiolabeling moiety to the targeting moiety. Linkers serve three purposes: (i) they spatially separate the targeting and radiolabeling moieties to avoid impairing the selective binding of the radiopharmaceutical, (ii) they facilitate the efficient assembly of the radiopharmaceutical, and (iii) they can enhance the stability, solubility and other characteristics of the radiopharmaceutical compound.¹⁹ Linkers use functional

¹⁸ EX1004, [0134]-[0135]; EX1003, ¶ 84.

¹⁹ EX1003, ¶¶ 35-36.

groups at either of their termini to form covalent bonds with corresponding functional groups on the targeting and radiolabeling moieties.²⁰

2. Radionuclides

Radiopharmaceuticals deliver a radioactive element (a radionuclide) to targeted cells, either to kill the cells (therapy) or to enable their detection (nuclear imaging). The particular radionuclide used is dictated by the purpose of the radiopharmaceutical.²¹ For radiotracers (radiopharmaceuticals used in nuclear imaging), the radionuclide must (i) work with the imaging device (*e.g.*, a PET or SPECT scanner) and (ii) have a half-life compatible with the half-life of the radiopharmaceutical in the body.²² Common radionuclides used in PET and SPECT imaging are shown below, along with their half-lives.²³

²⁰ EX1003, ¶ 37.

²¹ EX1003, ¶ 38.

²² EX1003, ¶¶ 39-41.

²³ EX1003, ¶ 39; EX1010, 3, Table 2 (⁶⁸Ga and ⁸⁹Zr), Table 1 (¹⁸F and ¹²⁴I); EX1034, 2795 (^{99m}Tc); EX1012, 2860, Table 2 (⁶⁴Cu), Table 1 (⁶⁷Ga); EX1013, 262, Table 1 (¹¹¹In).

	Isotope	Type	Emission	Half-Life
S P E C T	^{99m} Tc	Metal	Gamma	6.0 h
	¹⁸⁸ Re	Metal	Gamma	16.9 h
	¹²³ I	Halogen	Gamma	13.2 h
	¹¹¹ In	Metal	Gamma	67.2 h
	⁶⁷ Ga	Metal	Gamma	78.3 h
P E T	⁶⁸ Ga	Metal	Positron	1.1 h
	¹⁸ F	Halogen	Positron	109 min
	⁶⁴ Cu	Metal	Positron	12.7 h
	⁸⁶ Y	Metal	Positron	14.7 h
	⁸⁹ Zr	Metal	Positron	78.4 h
	¹²⁴ I	Halogen	Positron	100.3 h

3. Fibroblast Activation Protein (FAP)

FAP is a member of a family of enzymes called prolyl oligopeptidases (below), which selectively cleave peptide bonds after proline residues.²⁴

Table 1. Characteristics of known post-prolyl peptidases

Prolyl peptidase	Enzymatic activity	Cellular localization	References
DPPIV	Dipeptidase	Membrane	(25, 36–38)
FAP	Dipeptidase/endopeptidase	Membrane	(25, 36, 38)
DPP6	Inactive	Membrane (K _v ⁺ channel)	(25, 37)
DPP8	Dipeptidase	Cytoplasm	(25, 37, 38)
DPP9	Dipeptidase	Cytoplasm	(25, 37, 38)
DPP10	Inactive	Membrane (K _v ⁺ channel)	(25, 37)
AAP	Acylpeptide hydrolase	Cytoplasm	(38, 39)
POP	Prolyl oligopeptidase	Cytoplasm	(38)
DPPII (DPP7)	Dipeptidase	Intracellular vesicles	(37, 38)
PCP	Prolyl carboxypeptidase	Lysosome	(38)

²⁴ EX1003, ¶¶ 56-57; EX1006, 3053; EX1016, 259 (Table 1); EX1024, 454.

Unlike other members of this protein family (*e.g.*, PREP/POP), FAP expression is limited in normal cells but elevated in cancer associated fibroblasts (CAFs) and certain diseases associated with activated stroma.²⁵ “FAP is [] highly expressed on activated fibroblasts in over 90% of common human epithelial tumors” and has been linked to a variety of cancers.²⁶

Before 2017, several publications had identified FAP as being a compelling target for radiopharmaceuticals, and particularly radiotracers used in nuclear imaging of tumors.²⁷ A 2011 publication observed:

Due to the highly restricted and specific expression of FAP, particularly within tumor stroma, FAP is *clinically interesting as a target for* immunotherapy in the treatment of cancer and *non-invasive bio-imaging*. ... It appears that *FAP shows more promise as a biomarker and target for non-invasive imaging of tumours* or for use as site-directed targeted cancer radiotherapy.²⁸

²⁵ EX1003, ¶ 58; EX1022, 124; EX1024, 456; EX1023, 288; EX1041, 2

²⁶ EX1006, 3053; EX1022, 124; EX1024, 456; EX1016, 260.

²⁷ EX1003, ¶ 59; EX1046, 26. *Also* EX1024, 454, 455; EX1022, 124; EX1045, 2427; EX1016, 264.

²⁸ EX1046, 26.

Before 2017, FAP's unique profile induced skilled artisans to discover small molecule compounds that selectively bound to and inhibited the enzymatic activity of FAP ("FAP inhibitors"), including one designated "compound 60" reported in Jansen (EX1006).²⁹

B. Person of Ordinary Skill in the Art

A person of ordinary skill in the art ("a skilled artisan") would have had (i) an undergraduate degree and a Ph.D. in chemistry, biochemistry, medicinal chemistry or a comparable field, and (ii) experience with and/or knowledge of chemical synthesis methods (including organic synthesis, radiometal chelation and radiohalogen labeling of prosthetic groups), assessment of cellular targets for radiopharmaceuticals, and other techniques relevant to the design, development, testing and/or evaluation of radiopharmaceuticals. The person would also be familiar with how radiopharmaceuticals are distributed and used in patients to perform therapy or nuclear imaging of diseases, including cancer.³⁰

C. Prosecution History

The prosecution history of the '201 Patent is described in § VII, below.

²⁹ EX1003, ¶ 61; EX1006, 3053.

³⁰ EX1003, ¶¶ 12-14.

D. The Challenged Claims

The '201 Patent has three claims.³¹ Claims 1 and 3 differ slightly in the preamble: in relation to the phrase “B-L-A”, claim 1 recites “of” while claim 3 (below) recites “consisting essentially of.” As such, the genus of claim 1 is fully encompassed within the genus of claim 3. Claim 2 limits the B component to “any radiolabeled functional group suitable for” PET or SPECT imaging.

³¹ EX1001 contains the certificate of correction with corrected claims 1 and 3. EX1002, 502-504.

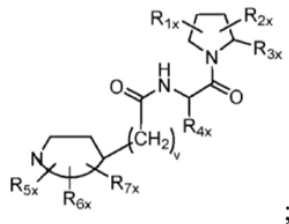
Claim 1, Column 64, Lines 47-67, Column 65, Lines 1-62 should read:

1. A low molecular weight compound of Formula (I):

B-L-A (I)

wherein:

A is a targeting moiety for FAP- α , wherein A has the structure of:



wherein:

R_{1x} and R_{2x} are each independently selected from the group consisting of H, OH, halogen, C₁₋₆alkyl, -O-C₁₋₆alkyl, and -S-C₁₋₆alkyl;

R_{3x} is selected from the group consisting of H, -CN, -B(OH)₂, -C(O)alkyl, -C(O)aryl-, -C=C-C(O)aryl, -C=C-S(O)₂aryl, -CO₂H, -SO₃H, -SO₂NH₂, -PO₃H₂, and 5-tetrazolyl;

R_{4x} is H;

R_{5x}, R_{6x} and R_{7x} are each H;

v is 0;



represents a quinolinyl ring;

B is any optical or radiolabeled functional group suitable for optical imaging, positron-emission tomography (PET) imaging, single-photon emission computed tomography (SPECT) imaging, or radiotherapy; and L is a linker having bi-functionalization adapted to form a chemical bond with B and A; or

a stereoisomer, tautomer, racemate, salt, hydrate, or solvate thereof.

E. Claim Scope and Construction of Terms

The terms in the claims generally employ objective language that requires no special construction. Two terms (*i.e.*, components “B” and “L”) warrant observations to illustrate their breadth.

Petitioner anticipates Patentee may contend the phrase “low molecular weight compound” requires a special construction. It does not—the grounds show that radiopharmaceuticals with a comparable size to those exemplified in the disclosure would have been obvious over the prior art. Petitioner nonetheless

addresses the meaning of this term that is conveyed by the intrinsic evidence.

1. Radiolabeling Moiety (“B”) and Linker (“L”) Components Are Defined in Functional Terms

Claims 1 to 3 use functional language (below) to define the “B” and “L” components of the claimed compounds.

B is any optical or radiolabeled functional group suitable for optical imaging, positron-emission tomography (PET) imaging, single-photon emission computed tomography (SPECT) imaging, or radiotherapy; and L is a linker having bi-functionalization adapted to form a chemical bond with B and A; or

Each identifies only the *purpose* of the component in the compound:

- The “B” component (*i.e.*, the radiolabeling moiety) can be “any optical or radiolabeled functional group *suitable for*” optical, PET or SPECT imaging, or for radiotherapy.
- Likewise, the “L” component (*i.e.*, the linker) must have “bi-functionalization adapted *to form a chemical bond with B and A.*”

The unambiguous claim language precludes limiting the “B” or “L” components to any particular chemical structures for each component.

The specification reinforces this conclusion. Regarding radiolabeling

moieties (“B”), it reiterates the functional definition in the claims,³² and then identifies three broad classes of “B” compounds: (i) “radiolabeled prosthetic groups comprising a radioisotope” (*e.g.*, ¹⁸F, ¹²³I), (ii) “chelating agent[s]” and (iii) an “optical dye”.³³ The specification illustrates each class with (known) examples, but repeatedly emphasizes B compounds “are not limited to” to those examples.³⁴ Regarding linkers (“L”), the specification repeats the “bi-functionalization” attribute of linkers from the claims.³⁵ It does not, however, define linkers as requiring use of any structural attributes (*i.e.*, there are no minimum or maximum size parameters, or restrictions/requirements on the makeup of the chemical moiety). And while the specification states that “[s]uitable linkers are disclosed in” two published U.S. applications (including US-121), neither identifies any required *structural* attributes of linkers.³⁶ There was no substantive prosecution history, and thus no basis for altering the definitions in the claim language and specification.

³² EX1001, 2:3-12.

³³ EX1001, 17:55-18:45, 18:46-20:9.

³⁴ EX1001, 17:57-59, 20:9-11.

³⁵ EX1001, 2:10-12, 8:24-25.

³⁶ EX1001, 17:45-53 (citing US2011/0064657) and US-121(EX1005)).

Nothing in the prosecution history concerned the chemical structures that can be “B” or “L” components. Rather, claim amendments addressed the size of the compounds as a whole (“low molecular weight” compounds) and the structure of the targeting moiety.³⁷ The claim language and the specification thus foreclose interpreting the terms “B” and “L” in the claims as requiring or excluding any particular radiolabeling or linker structures, respectively, for the B and L components of the claimed compounds.

2. “Low Molecular Weight” Need Not Be Construed

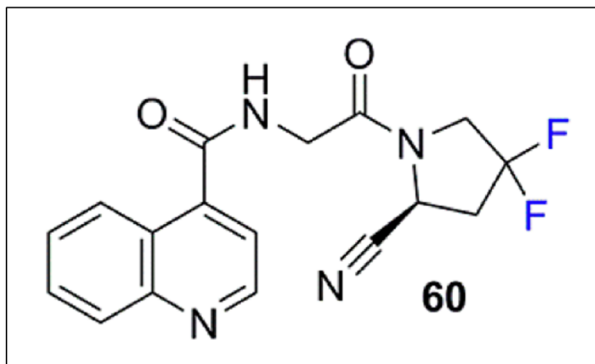
While it is theoretically possible the phrase “low molecular weight” might exclude some combination of a targeting moiety (“A”), radiolabeling moiety (“B”) and a linker (“L”), that theoretical possibility is irrelevant to the present grounds, which are based on obvious radiopharmaceutical compounds containing the FAP-targeting small molecule designated “compound 60” in Jansen (EX1006). Compound 60 is *identical* to one of the “A” structures exemplified in the specification (below, right).³⁸ The illustrative obvious compounds used in the grounds are “low molecular weight” compounds for the same reasons this example in the ’201 Patent is.

³⁷ EX1002, 415-420, 400.

³⁸ EX1006, 3053; EX1001, 13:34-14:16.

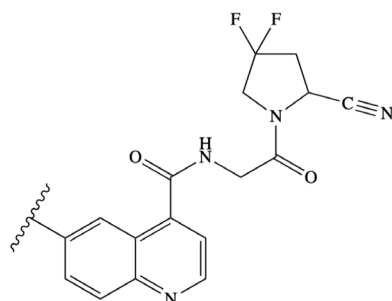
(10) Patent No.: US 11,938,201 B2

(45) Date of Patent: *Mar. 26, 2024

Jansen (EX1006)

EX1006, 3053

In more particular embodiments, A is selected from the group consisting of:



EX1001, 13:34-14:15

Moreover, the grounds rely on illustrative compounds that are obvious from the prior art that have molecular weights below or near 1500 Da,³⁹ the (arbitrary) upper weight limit chosen by Dr. Pomper (an inventor) in a declaration submitted during examination.⁴⁰ The Board thus need not determine the precise meaning of the “low molecular weight” term, as the grounds involve compounds that meet even Patentee’s arbitrary boundary.

3. Low Molecular Weight Refers to a Magnitude of Weight

If the Board finds it necessary to construe “low molecular weight,” Petitioner submits the intrinsic evidence demonstrates it means “*having a*

³⁹ See §§ V.G, VI.D.

⁴⁰ EX1002, 358-360.

molecular weight at least an order of magnitude less than an antibody-based radiopharmaceutical.”

Only one phrase in the specification informs the meaning of “low molecular weight.”⁴¹ In it, “low molecular weight (LMW) agents” are distinguished from anti-FAP antibodies based on their behavior *in vivo*, ease of synthesis and ability to get approved by the FDA (below).⁴²

man, et al., 2015). The use of antibodies as molecular imaging agents, however, suffers from pharmacokinetic limitations, including slow blood and non-target tissue clearance (normally 2-5 days or longer) and non-specific organ uptake. Low molecular weight (LMW) agents demonstrate faster pharmacokinetics and a higher specific signal within clinically convenient times after administration. They also can be synthesized in radiolabeled form more easily and may offer a shorter path to regulatory approval. (Coenen, et al., 2010; Coenen, et al., 2012; Reilly, et al., 2015). To date,

Named inventor Dr. Pomper cited some of these factors when he distinguished “low molecular weight” compounds from antibodies (~150,000 Da) and an anti-FAP “iBody”-HMPA compound of comparable size (~149,000 Da) (below):⁴³

⁴¹ The second passage (EX1001, 7:46-53) observes that “low-molecular-weight ligands of FAP- α ” can be conjugated to other components of radiopharmaceuticals and used for *in vivo* imaging.

⁴² EX1001, 1:54-67.

⁴³ EX1002, 358 (¶ 10).

10. Claim 29 is amended and further defines the compound of formula (I) as being “low molecular weight” (“LMW”). I distinguish the LMW compound of the pending claims from large molecule imaging agents containing anti-FAP moieties. In particular, I characterize large molecule imaging agents as having numerous disadvantages, including pharmacokinetic limitations, including slow blood and non-target tissue clearance and non-specific organ uptake. Page 1, lines 28-34; page 2, lines 1-7. In contrast, the LMW imaging agents of the instant application possess numerous advantages compared with the large molecule imaging agents. *Id.* Specifically, LMW imaging agents demonstrate faster pharmacokinetics and a higher specific signal within clinically convenient times after administration. *Id.* They also can be synthesized in radiolabeled form more easily and may offer a shorter path to regulatory approval.

11. I distinguish between the LMW compounds of the pending claims and larger biologic compounds such as antibodies and high relative molecule mass polymers, as cited below.

The specification and file history thus distinguish “low molecular weight” compounds from antibodies and similarly-sized compounds by their attributes associated with their pronounced size compared to small molecule agents, not with a precise molecular weight boundary.

Despite this, Dr. Pomper contended the meaning of “low molecular weight compound” was “well accepted in the chemical arts” and was “a molecular weight from about 50 Daltons to about 1,500 Daltons.”⁴⁴ But the basis of this opinion was *not* the specification—it was *extrinsic* evidence (*i.e.*, scientific publications).⁴⁵

⁴⁴ EX1002, 360 (¶ 17)

⁴⁵ *Id.*

Other literature attributes the same benefits the specification associates with “low molecular weight” compounds to peptide-based radiotracers up to **3500** Da.⁴⁶ A precise molecular weight boundary also was unnecessary to overcome rejections—it was the selectivity of targeting moiety, which the Examiner did not appreciate was already known in the prior art.⁴⁷

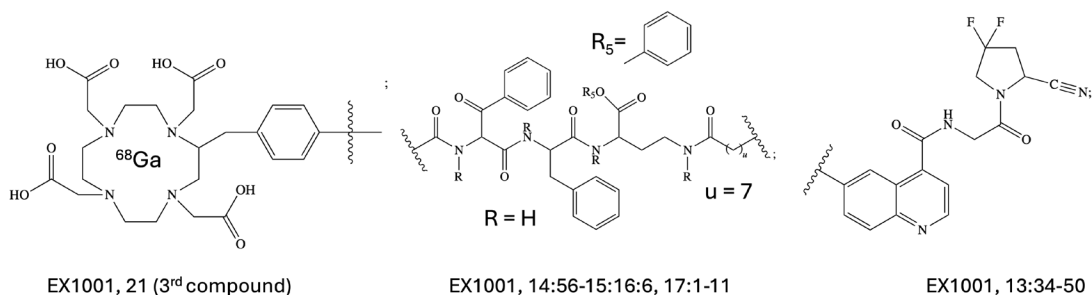
Under established principles of claim construction, extrinsic evidence cannot displace the meaning of a term conveyed by the specification. Here, nothing in the specification supports construing “low molecular weight” to mean *only* compounds weighing between 50 Da and 1500 Da. In fact, picking allowed components per the parameters of the disclosure yields “B-L-A” compounds above 1500 Da.⁴⁸

⁴⁶ EX1052, 59-60; EX1003, ¶ 172.

⁴⁷ EX1002, 442 (suggesting “quinolinyl compounds of the instant claims” have much higher selectivity than “other small molecule FAP inhibitors found in the prior art.”).

⁴⁸ EX1001, 13:34-50, 14:56-15:16:6, 17:1-11.

561.464	+	653.756	+	344	=	1559.22
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Likewise, small molecule compounds with molecular weights above 1500 Da (*e.g.*, 1,700 Da) can “demonstrate faster pharmacokinetics and a higher specific signal within clinically convenient times after administration” and “can be synthesized in radiolabeled form more easily.”⁴⁹

The intrinsic evidence thus does nothing more than distinguish the *magnitude* of the molecular weight of “low-molecular-weight” compounds relative to antibody-sized compounds that are orders of magnitude larger.

V. Ground 1: Claims 1-3 Are Obvious Based on US-633, Meletta and Jansen

Claims 1 to 3 of the '201 Patent differ from US-633 in only one respect: the identity of the targeting moiety (“A”). The other two components of the claimed compounds—“B” and “L”—are defined functionally, and as such, capture prior art targeting moieties and linkers, including those that US-633 teaches use of in FAP-targeting radiopharmaceuticals.

⁴⁹ EX1001, 1:60-65; EX1003, ¶¶ 130, 174.

A finding of obviousness under § 103 requires an articulated reasoning with a rational underpinning as to why the claimed invention would have been obvious.⁵⁰ Here that reason would not only be evident to a skilled artisan—it is documented in the literature, and concerns the sole distinction between the claims and US-633 (*i.e.*, the targeting moiety of the US-633 FAP-targeting radiopharmaceuticals). Specifically, Meletta (EX1008) reported that the boronic acid pyrrolidine targeting moiety in compounds disclosed in US-633 was insufficiently selective for FAP and identified a need for more selective targeting moieties for FAP-targeting radiopharmaceuticals.⁵¹

Prompted by Meletta and a general motivation to discover and use more selective FAP inhibitors in radiotracers than those used in US-633, a skilled artisan would have found Jansen (EX1006). The collective teachings of US-633, Meletta and Jansen, in turn, would have made it obvious to improve the radiopharmaceuticals taught in US-633 by incorporating Jansen’s highly selective FAP inhibitor (compound 60) as the targeting moiety, thus solving the problem

⁵⁰ *KSR Intern. Co. v. Teleflex Inc.*, 550 U.S. 398, 418.

⁵¹ EX1008, 2089, 2090 (“For future studies more selective inhibitors are needed to reduce non-specific tissue accumulation.”)

Meletta identified. Before October of 2017, claims 1 to 3 would have been obvious over US-633, Jansen and Meletta, and are unpatentable.

A. Teachings of the Prior Art

1. US-633

US-633 is a published U.S. application dated April 22, 2010. It describes a class of small molecule radiopharmaceuticals that target “seprase” (FAP), and explains they can be used in diagnostic imaging and radiotherapy of tumors and tissues that express FAP.⁵²

[0002] This invention relates in general to small molecule inhibitors of seprase that can be used as therapeutic agents through inhibition of seprase’s enzymatic activity, or as radiopharmaceuticals that bind to seprase and therefore enable imaging of tissues that express seprase or for delivering radiotherapy to tumor tissues that express seprase.

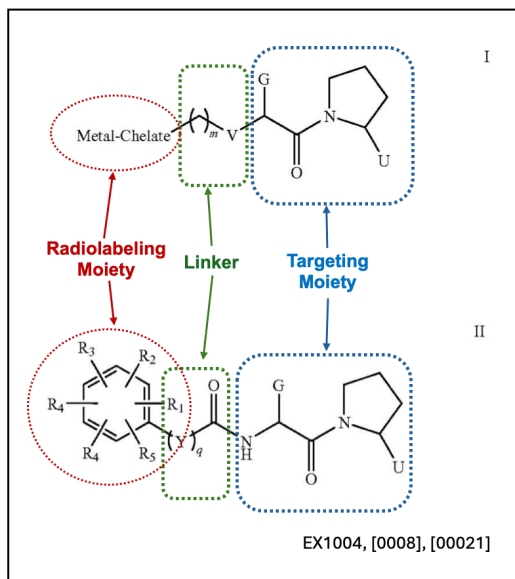
[0007] Small molecule inhibitors of seprase are provided for use as therapeutic medicines or as radiopharmaceuticals useful in diagnostic imaging and in the therapeutic treatment of diseases characterized by overexpression of seprase. The radiopharmaceuticals include complexes or compounds that

(a) Modular Three-Component Radiopharmaceuticals

US-633 describes two types of FAP-targeting radiopharmaceuticals, each employing the same modular, three-component design as the claimed compounds:

⁵² EX1004, [0002], [0007].

(i) a targeting moiety connected via (ii) a “tether” (a linker) to (iii) a radiolabeling moiety (below).⁵³ One uses a chelator as the radiolabeling group (Formula I), while the other uses a prosthetic group (Formula II).



The skilled artisan would have recognized that because Formulas I and II employ a modular design, different linker, targeting and radiolabeling moieties could be used in the compounds.⁵⁴ US-633 also illustrates several options for the radiolabeling moiety and linker components in each of Formulas I and II.

(b) *Imaging Platforms and Radionuclides*

US-633 indicates that the radionuclides that can be used with its radiotracers

⁵³ EX1004, [0008], [0021]; EX1003, ¶¶ 71-72.

⁵⁴ EX1003, ¶ 28.

are “capable of generating a detectable image that can be detected either by the naked eye or using an appropriate instrument, *e.g.* positron emission tomography (PET) and single photon emission computed tomography (SPECT).”⁵⁵ It lists several radiometals (*e.g.*, ⁶⁸Ga, ^{99m}Tc) and radiohalogens (*e.g.*, ¹⁸F, ¹²³I).⁵⁶ A skilled artisan would have known that PET scanners require a positron-emitting radionuclide (*e.g.*, ⁶⁸Ga or ¹⁸F), while SPECT scanners require a gamma-emitting radionuclide (*e.g.*, ^{99m}Tc, ¹²³I).⁵⁷

(c) Chelator and Prosthetic Group Radiolabeling Moieties

US-633 describes using radiolabeling moieties with two alternative chemical structures with radionuclides suitable for either PET or SPECT imaging (below).⁵⁸ Formula I compounds use chelators while Formula II compounds use prosthetic groups.⁵⁹

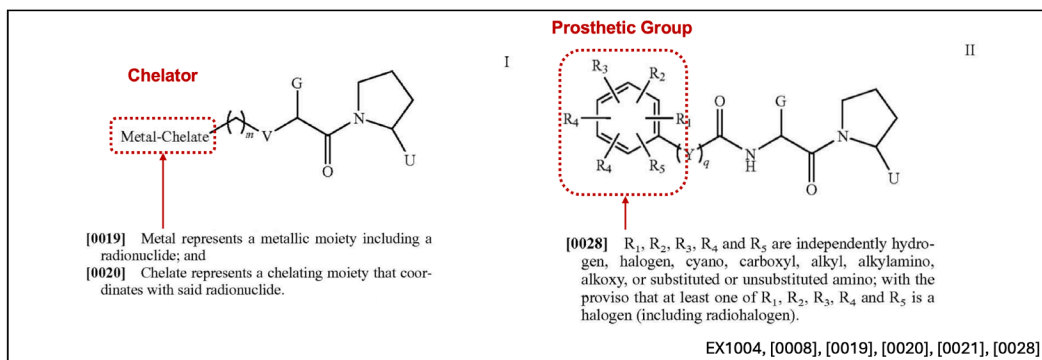
⁵⁵ EX1004, [0049].

⁵⁶ EX1004, [0049].

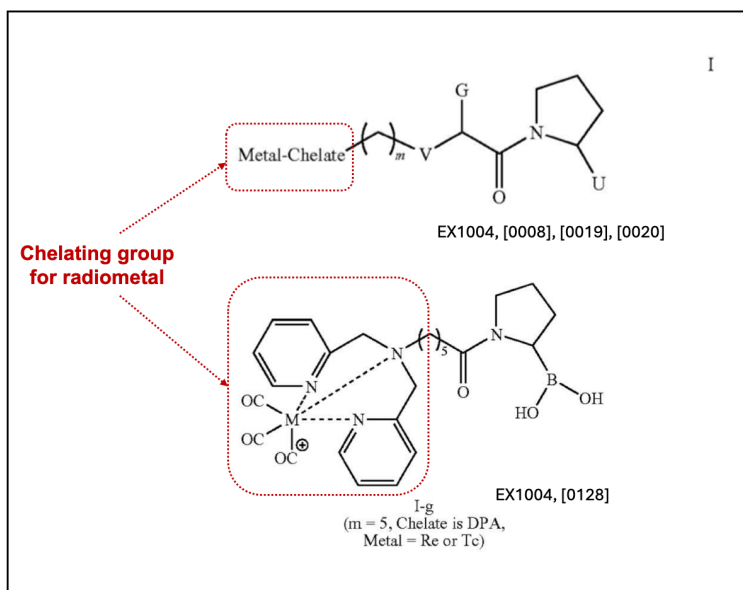
⁵⁷ EX1003, ¶¶ 39, 129; EX1010, 1, 4; EX1012, 2859; EX1013, 260.

⁵⁸ EX1004, [0008], [0019]-[0020] (chelator), [0021],[0028] (prosthetic group), [0049].

⁵⁹ EX1003, ¶¶ 77, 83; EX1004, [0008], [0019], [0020], [0021], [0111], [0128], [0175].



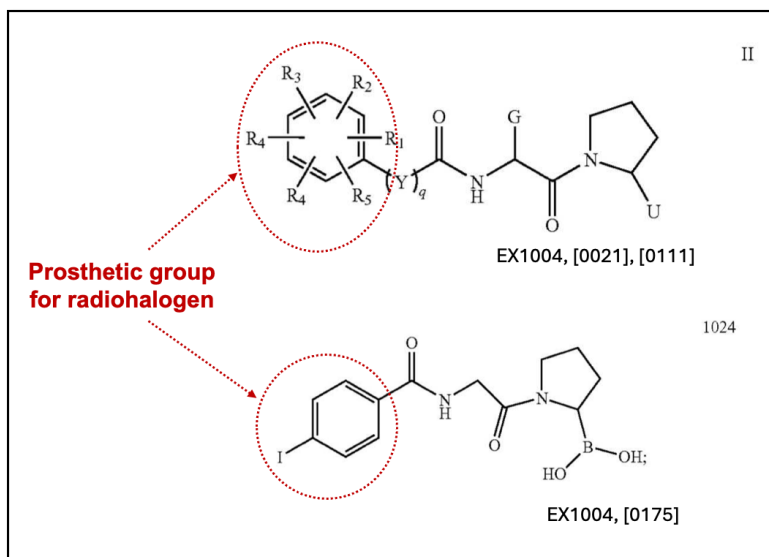
US-633 describes examples of chelators (illustrated below), which form stable coordinated complexes with a radiometal.⁶⁰



US-633 also describes prosthetic groups to which are covalently attached a

⁶⁰ EX1004, [0008], [0019], [0020], [0128]; *also id.*, [0087], [0097], [0098], [0101]-[0110]; EX1003, ¶¶ 55, 77-78.

radiohalogen (*e.g.*, at the para position of the phenyl group below).⁶¹ The radiolabeled prosthetic group is then covalently attached to the targeting moiety.⁶²



A skilled artisan would have known to select a chelating structure that is suitable for the particular radiometal (*e.g.*, ⁶⁸Ga or ^{99m}Tc), or to use a prosthetic group that can be labeled with a radiohalogen (*e.g.*, ¹⁸F or ¹²³I).⁶³

Numerous examples of each type of radiolabeling moiety are taught by US-633. For example, US-633 lists several classes and examples of metal chelators, including DOTA, DPA, DTPA, PAMA.⁶⁴ US-633 also explains that “[a]ny

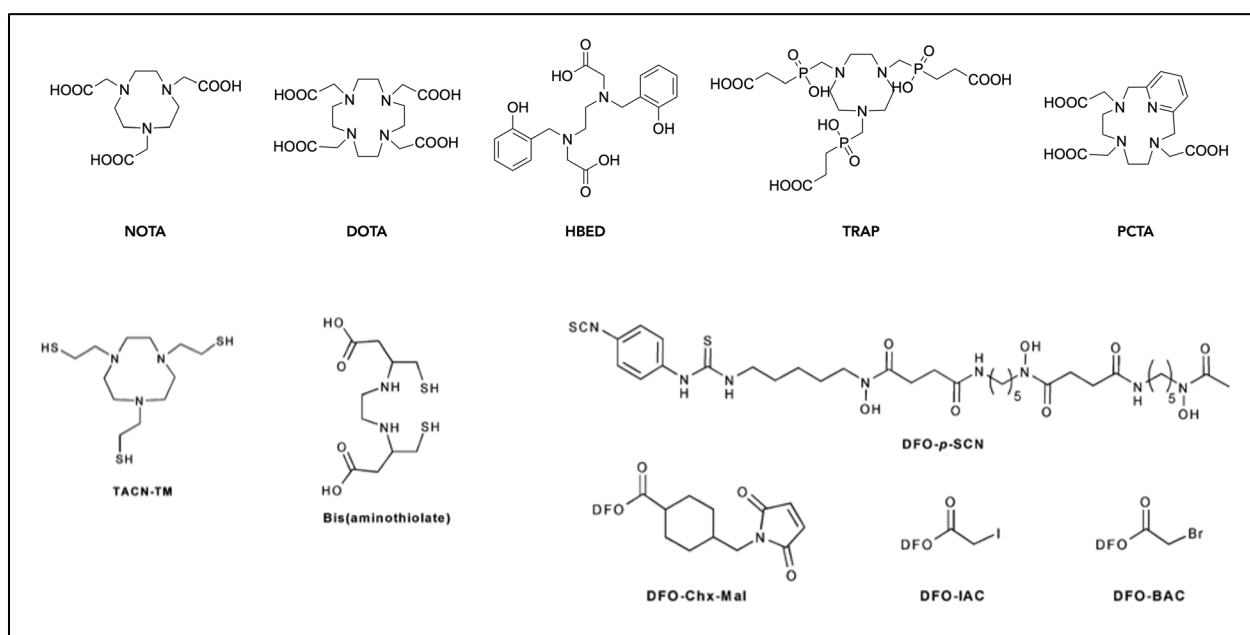
⁶¹ EX1004, [0021]-[0028], [0111]-[0122]; EX1003, ¶ 83.

⁶² EX1003, ¶ 84; EX1004 (US-633), [0134]-[0135].

⁶³ EX1003, ¶¶ 33-34.

⁶⁴ EX1004, [0048], [0100]-[0110], Table 4.

suitable chelating moiety may be used to provide a covalent or other association with a radionuclide.”⁶⁵ A skilled artisan would have understood this to mean that any known chelator could be used if it was suitable for the particular radionuclide being used with the radiotracer.⁶⁶ By 2017, a skilled artisan would have known that DOTA, NOTA, HBED, TRAP, PCTA, TACN-TM and DFO (below) had been successfully used to form stable coordination complexes with ⁶⁸Ga.⁶⁷



For prosthetic groups, US-633 describes covalently attaching radiohalogens

⁶⁵ EX1004, [0100], Tables 3, 4.

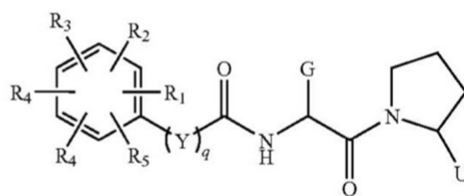
⁶⁶ EX1003, ¶ 81.

⁶⁷ EX1003, ¶¶ 32, 82; EX1011, 1882-83, 1887-88; EX1013, 267, 272, 275, 276.

at various positions on a phenyl ring included in the radiotracer.⁶⁸

[0021] In another aspect, a compound of general Formula II, its enantiomer, stereoisomer, racemate or pharmaceutically acceptable salt is provided:

[0028] R_1 , R_2 , R_3 , R_4 and R_5 are independently hydrogen, halogen, cyano, carboxyl, alkyl, alkylamino, alkoxy, or substituted or unsubstituted amino; with the proviso that at least one of R_1 , R_2 , R_3 , R_4 and R_5 is a halogen (including radiohalogen).



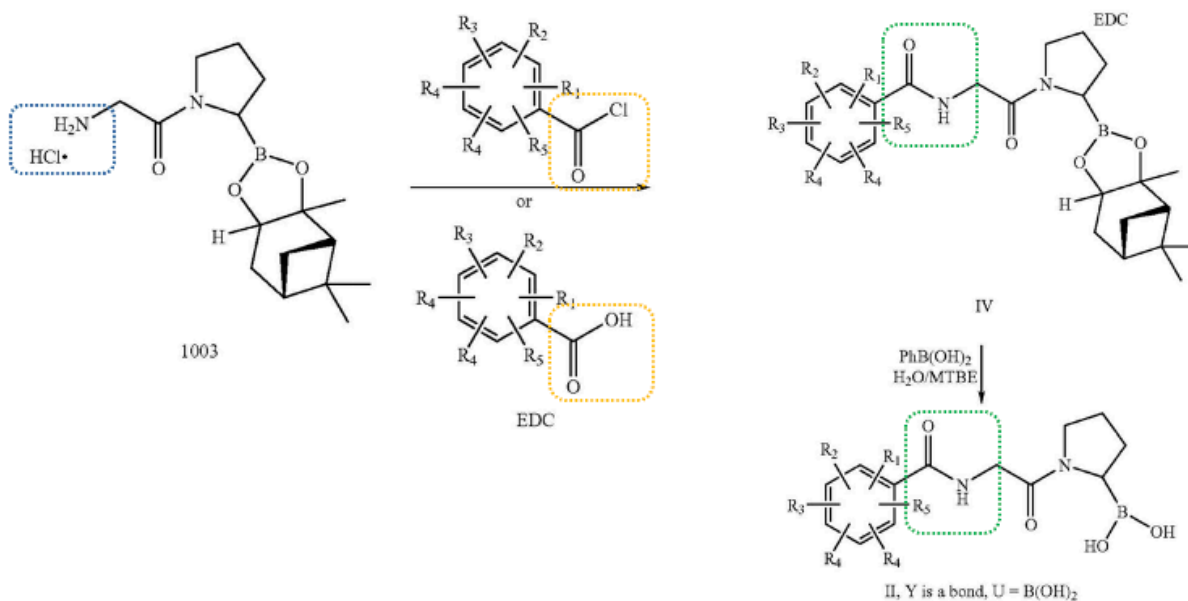
II

EX1004, [0021]-[0028]

US-633 also illustrates conventional synthetic schemes for attaching a radiolabeled prosthetic group to the remainder of the radiotracer. In it, a radiolabeled benzoic acid is reacted with a functionalized targeting moiety structure to form an amide bond (below).⁶⁹

⁶⁸ EX1004, [0021]-[0028], [0111]-[0123], [0173]-[0176].

⁶⁹ EX1004, [0134]-[0135]; EX1003, ¶ 84.



By 2017, a skilled artisan would have known of other prosthetic groups suitable for ^{18}F or ^{123}I that could be radiolabeled and included in the radiotracers being described in US-633.⁷⁰ That person also would have been familiar with efficient techniques for incorporating the radionuclide into the prosthetic group (e.g., “click chemistry” techniques).⁷¹

Any of the chelator or prosthetic groups described in US-633, when complexed with or covalently attached to a suitable radiometal or radionuclide, respectively, meets the “radiolabeled functional group...” element (“B”) of the claims. Likewise, any of the chelators or prosthetic groups known by 2017, when

⁷⁰ EX1003, ¶ 85; EX1034, 2792-95; EX1019, 475-476.

⁷¹ EX1003, ¶¶ 53-54; EX1015, 202-3; EX1021, 1-2, 6-12.

combined with a particular radionuclide for which it was known to be suitable, would meet the “B” element of the claims.

(d) *Linkers (“Tethers”)*

US-633 describes using a “tether” (a linker) to connect the “functionalized proline” targeting moiety to a radiolabeling moiety.⁷² It explains that attributes of “tethers” can be altered to vary the distance between the targeting moiety and the radiolabeling moiety and/or alter the pharmacokinetic characteristics of the radiopharmaceutical:⁷³ For example it teaches incorporation of heteroatoms to influence the pharmacokinetics of the overall compound.

[0101] The distance between the Metal-Chelate moiety and the pyrrolidine moiety of the complex represented by Formula I can be varied by altering the tether and/or expanding the length of the tether between them to modify the affinity and selectivity of the complex for seprase. The pharmacokinetic properties of the complex may also be modified by incorporating heteroatoms into the tethers. The following structures represented by Formulas I-a to I-k are some exemplary embodiments with different tethers and/or the length of tethers. To facilitate description, the complexes are described below with embodiments where the Metal-Chelate moiety has the following structure:

US-633 also describes use of a variety of examples of tethers, or components of tethers. It lists, for example, representative chemical moieties, including simple

⁷² EX1004, [0005], [0051]; EX1003, ¶¶ 86-88.

⁷³ EX1004, [0101]. *Also, id.* at [0133]; EX1003, ¶ 87.

alkyl chains, and polyethylene glycol (“PEG”) and polyethylamine oligomers, terminal alkanolic acids, including amino-PEG and carboxylic acid PEG moieties, and amino acids (*e.g.*, glycine and lysine), being used in tethers.⁷⁴

[0130] Scheme 3 can be utilized to synthesize functionalized proline- $M^+(CO)_3$ complexes to explore the effect of more significant variations of the distance of the metal chelator from the proline moiety by incorporating a tether into these structures. The tether may comprise a simple alkyl chain as shown, a PEG $(CH_2CH_2O)_n$, a polyethylene amine $((CH_2CH_2NH)_n)$, or the like. Terminal aminoalkanoic acids (such as β -alanine, 4-aminobutanoic acid, 5-aminopentanoic acid, 6-aminohexanoic acid and the 8-aminooctanoic acid) or amino-PEG-acids $(NH_2-(CH_2CH_2O)_n-CH_2-COOH)$, *e.g.* 2-(2-(3-aminopropoxy)ethoxy)acetic acid) may be utilized as tethers, according to some embodiments.

US-633 explains that commercially available polyethylene glycol compounds (*e.g.*, PEG-diamines) “can be readily incorporated” into radiotracer compounds.⁷⁵ It identifies practical benefits of using PEG compounds, which were commercially available in varying lengths and characteristics (*e.g.*, different functionalization of the termini of the PEG oligomer).⁷⁶

⁷⁴ EX1004, [0130], [0131].

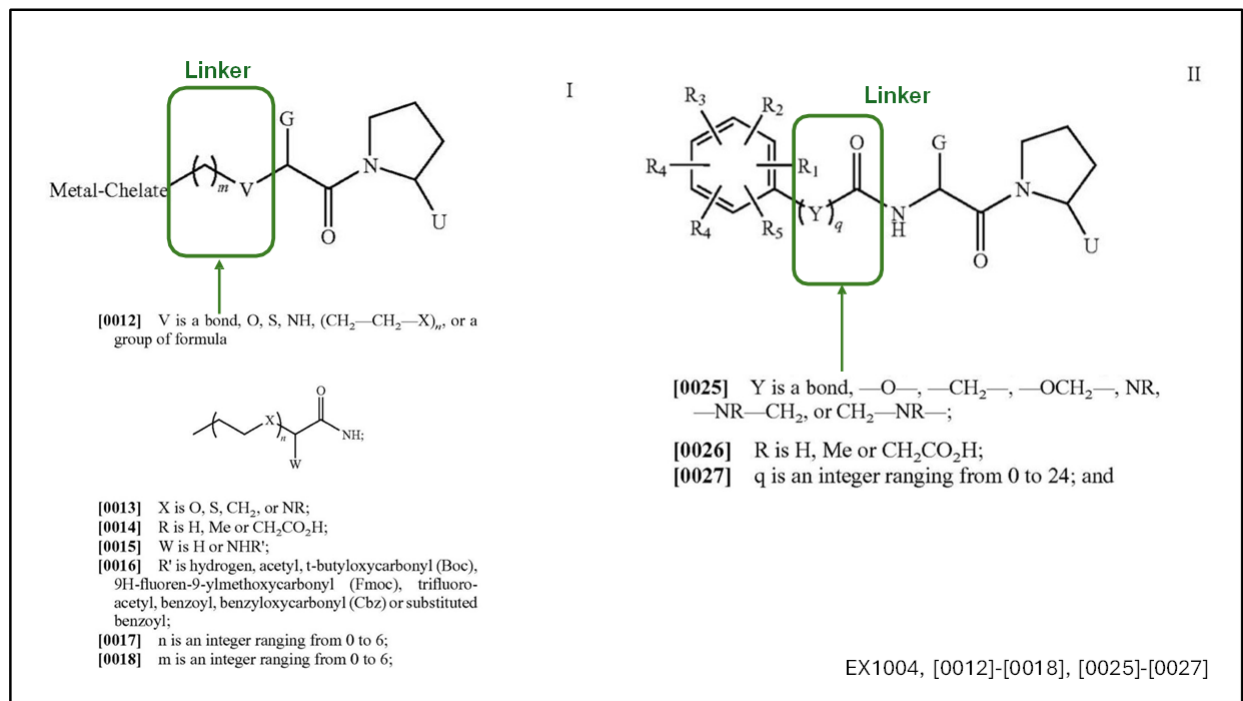
⁷⁵ EX1004, [0133].

⁷⁶ EX1003, ¶ 88.

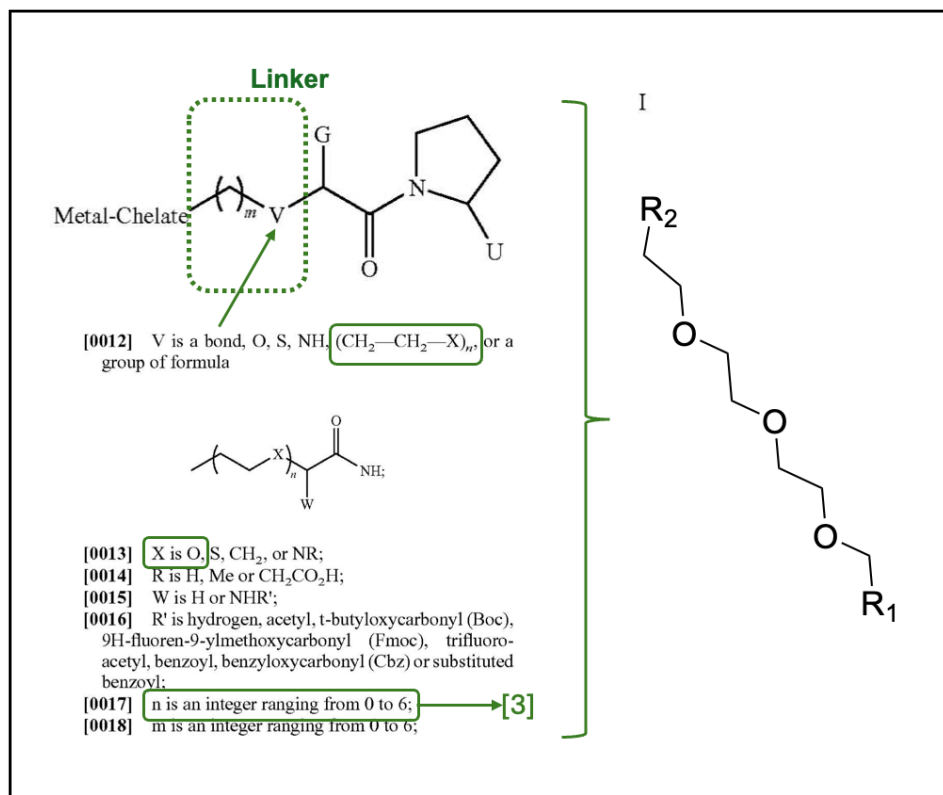
[0133] The above reaction scheme is applicable to any modification of the tether by incorporation of heteroatoms into the tether chain. This may have additional benefits on the affinity as well as the selectivity for seprase. Incorporation of heteroatoms into the tether such as oxygen can take advantage of the commercial availability of a variety of short polyethylene glycol (PEG) diamines that can be readily incorporated into the complexes. One of ordinary skilled in the art would also readily apply other chelates to prepare functionalized proline- $M^+(CO)_3$ complexes.

US-633 also describes via its two formulas for radiopharmaceuticals that tethers are positioned between the chelator/prosthetic and targeting moieties, and then describes varying chemical characteristics of tethers pursuant to the parameters for these formulae (below):⁷⁷

⁷⁷ EX1003, ¶ 149.



For example, one of the tethers taught by formula I is a 3-monomer PEG linker (*i.e.*, “V”=“CH₂—CH₂—X), X=“O” and “n”=3). (below, with R₁ and R₂ representing functional groups):



US-633 also describes tethers that have formed one chemical bond with a radiolabeling moiety and a second chemical bond with a targeting moiety.⁷⁸ Such tethers have “bi-functionalization,” as both of their termini had groups (*e.g.*, -OH, -CO₂H, -NH₂, -SH) that enabled formation of covalent bonds with each of two different moieties.⁷⁹

Before 2017, a skilled artisan would have understood from the guidance in US-633 about tethers, and from their own knowledge and experience, that there are

⁷⁸ EX1004, [0157].

⁷⁹ EX1004, [0157]; EX1003, ¶ 88.

practical benefits of using PEG-based “tethers” in radiotracers, such as that many different PEG compounds of varying length and having different types of functionalization at their termini could be purchased.⁸⁰ That person likewise would have been familiar with the chemical attributes, selection and use of “tethers” (linkers) that are illustrated and exemplified throughout US-633 and would know how to use different linkers to form the types of radiotracer compounds being described in US-633.⁸¹

The linkers described and suggested by US-633 are examples of “L” components in the claimed compounds.

(e) Boronic Acid Pyrrolidine Targeting Moiety

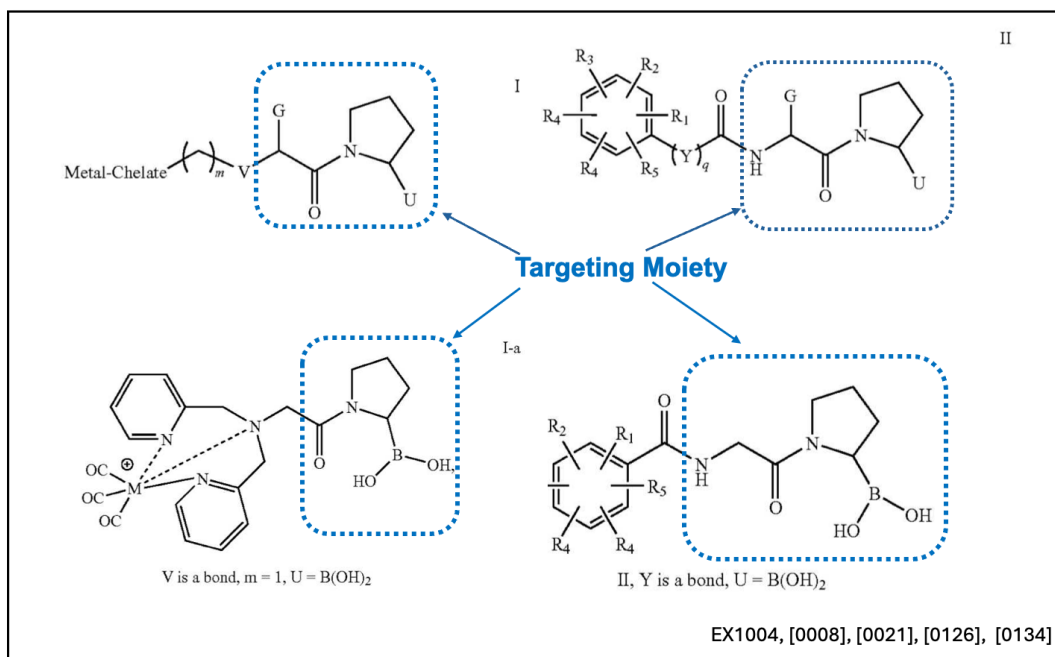
Both Formulas in US-633 use as their targeting moiety a “functionalized proline moiety capable of selectively inhibiting seprase” (*i.e.*, FAP).⁸² US-633 illustrates use of a particular boronic acid pyrrolidine moiety as the FAP-targeting moiety in most of its examples (*i.e.*, where “U” is boronic acid (below)).⁸³

⁸⁰ EX1003, ¶¶ 88, 150.

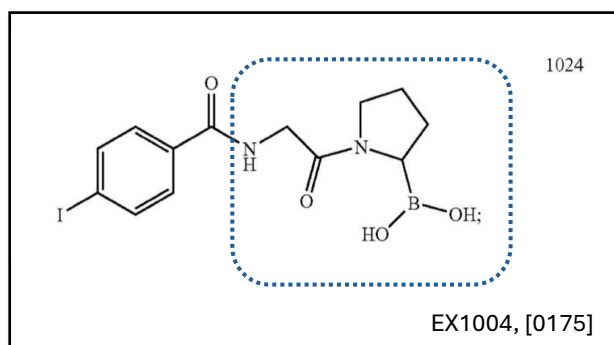
⁸¹ EX1003, ¶¶ 35-37, 89.

⁸² EX1004, [0007].

⁸³ EX1004, [0134]. Scheme 5.



This targeting moiety is also used in compound 1024 (below).



While the targeting moieties used in US-633 are “a targeting moiety for FAP- α ,” they do not meet the structural requirements for the “A” component of the claimed compounds.

(f) US-633 Identifies Examples of Compounds Based on its Targeting Moieties

US-633 describes examples of compounds that combine a boronic acid pyrrolidine FAP-targeting moiety with different combinations of linkers and

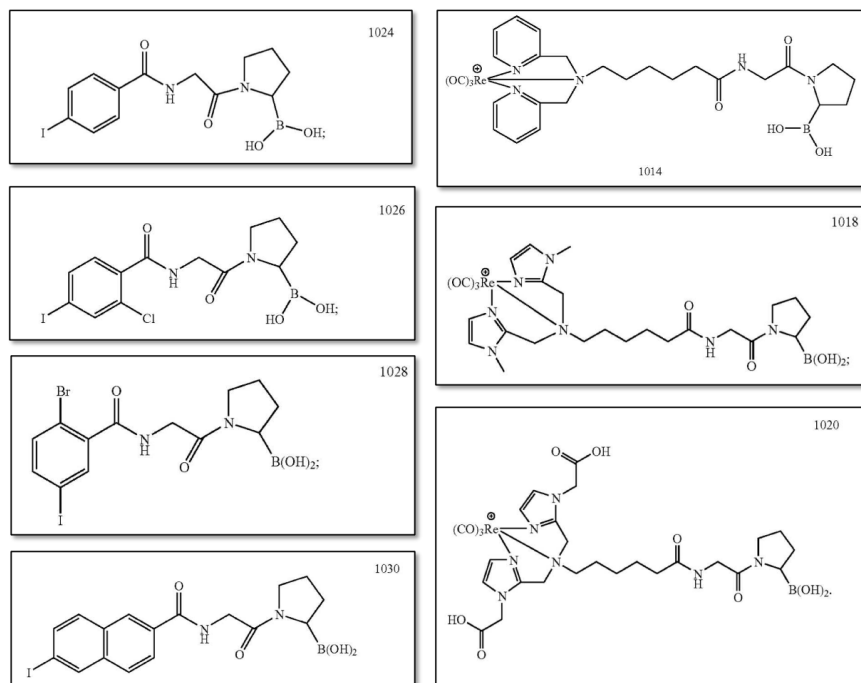
radiolabeling groups.⁸⁴ The various combinations of linkers and radiolabeling groups in these examples are illustrative of what a skilled artisan would have contemplated as possible radiopharmaceutical structures that could be developed once a suitable targeting moiety had been identified.⁸⁵

US-633 reports in Table 2 the potency of each example compound's inhibition of FAP (*i.e.*, “*in vitro* data of exemplary compounds against seprase (fibroblast activation protein, FAP)...”), with an IC₅₀ value for each (*i.e.*, “how much of a particular compound is needed to inhibit seprase by half.”).⁸⁶ Compounds 1018, 1020, 1024, 1025, 1026, 1027, 1028, 1030 and 1040 had IC₅₀ values between 2 and 5 nM, with compound 1014 at 21 nM (some compounds shown below).

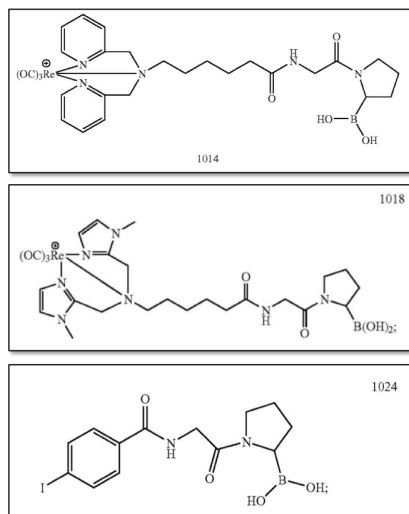
⁸⁴ EX1004, [0151](1006), [0157] (1010), [0159] (1011), [0160] (1014), [0161] (1016), [0162] (1016), [0164] (1020), [0175] (1023-1036), [0176] (1039), [0179] (1039), [0180] (1040-1050).

⁸⁵ EX1003, ¶¶ 49, 71, 74, 90.

⁸⁶ EX1004, [0185], Table 2.



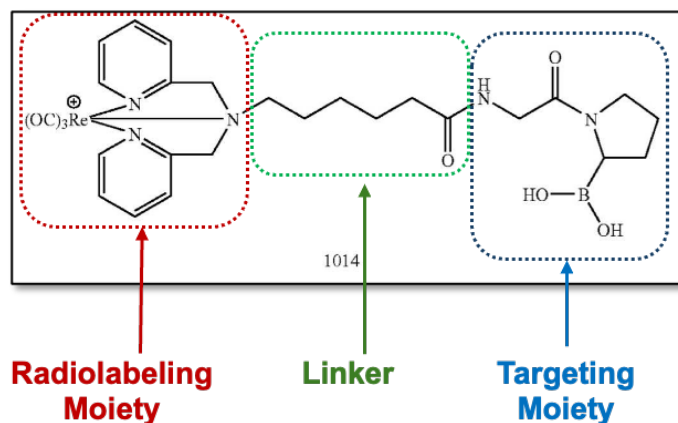
US-633 reported results from additional testing of compounds 1014/1109, 1018/1110 and 1024 (below).⁸⁷



A skilled artisan would have viewed any of these compounds to be a FAP-

⁸⁷ EX1004, [0189]-[0192].

targeting radiotracer with a three-component (“B-L-A”) design specified in the patent claims (compound 1014 illustrated below).⁸⁸ These examples, however, have a targeting moiety that does not satisfy the requirements of component A.



Importantly, US-633 provides no information on selectivity of any of its compounds for FAP relative to PREP or other prolyl oligopeptidases. Such data is important to differentiate compounds that merely exhibit high affinity for FAP from compounds that can *selectively* bind cells in tissues that express elevated levels of FAP but not prolyl oligopeptidases.⁸⁹ A skilled artisan, thus, would have considered publications further characterizing the boronic acid pyrrolidone compounds described in US-633 to assess their feasibility for being used as the

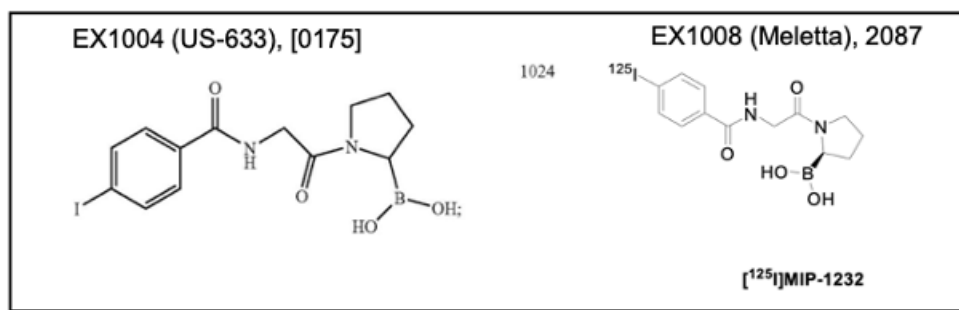
⁸⁸ EX1003, ¶¶ 90, 93.

⁸⁹ EX1003, ¶¶ 45, 47-48, 60; EX1004, [0003], [0005].

targeting moiety of a FAP-targeting radiotracer.⁹⁰

2. Meletta (EX1008)

Meletta is a 2015 publication. It reports experimental results from testing an ¹²⁵I-labeled form of compound 1024 (designated MIP-1232) in US-633. Meletta specifically cites to US-633.⁹¹



Meletta investigated the ability of compound 1024/MIP-1232 to be used as a radiotracer for atherosclerosis imaging.⁹² It explains that studies had shown that FAP expression is elevated in atherosclerotic plaques, and that a FAP-selective radiotracer could be useful in non-invasive atherosclerotic plaque imaging.⁹³

Meletta reports that compound 1024/MIP-1232 was 32-fold more potent in

⁹⁰ EX1003, ¶ 91.

⁹¹ EX1008, 2087, 2098 (FN31). *See* § V.C.

⁹² EX1008, 2083.

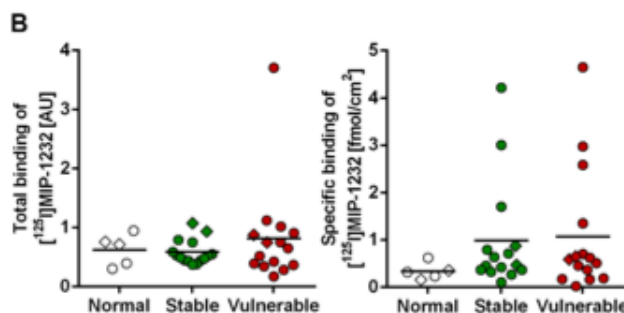
⁹³ EX1008, 2083; *also id.* 2081-2, 2089.

inhibiting FAP than PREP, citing an abstract that reported measured IC₅₀ values for compound 1024/MIP-1232 for FAP and PREP.⁹⁴ Meletta thus provides information on the selectivity of compound 1024 that was not in US-633.

Meletta reported that while compound 1024/MIP-1232 exhibited binding that “was higher in atherosclerotic plaques than normal arteries,” “after correction for the size of the tissue samples, average total binding was similar for the three categories,” citing Figure 3B (below).⁹⁵

⁹⁴ EX1008, 2083; EX1035 (“The IC₅₀ values of ... MIP-1232...for POP [PREP] were ... 19... nM, respectively, with POP[PREP]/FAP ratios of ... 32 ..., respectively.”) EX1003, ¶ 97.

⁹⁵ EX1008, 2084-85 (reporting FAP expression levels in Figs. 1, 2), 2087-88 (in vitro imaging of three types of tissue with compound 1024/MIP-1232); 2089 (... we found a pronounced binding to carotid plaques, however with *no difference in average specific binding between stable and vulnerable plaques and between plaques and normal arteries*, after correction for the size of the tissue samples”)(*emphasis added*).



Based on its experimental results, Meletta portrayed compound 1024/MIP-1232 as *not being sufficiently selective for FAP*:

Based on our data *we cannot conclude on the selectivity of [125I]MIP-1232 for FAP*. In the absence of a known selective inhibitor, we investigated specificity by blocking with the unlabeled compound itself. The relatively high amount of remaining radiotracer after blocking *must, therefore, accumulate with low affinity*. ... The *non-specific accumulation* may result from interactions with highly abundant hydrolases or other proteins with affinities in the high micromolar range, considering that our blocker concentration was 100 μ M. ... A conclusive evaluation of the binding affinity to dipeptidyl peptidases such as DPP-2, DPP-4, DPP-8 and DPP-9 would be required, irrespective of the fact that DPPs display in general low affinities for N blocked peptides []. As [125I]MIP-1232 did not selectively accumulate in the atherosclerotic tissue and *as its low FAP/PREP affinity ratio is already known we did not further investigate its selectivity profile*.⁹⁶

⁹⁶ EX1008, 2089-90 (*emphases added*); EX1003, ¶¶ 99-100.

Due to the insufficient selectivity of compound 1024/MIP-1232 for FAP, Meletta explained that new, more FAP-selective targeting moieties were needed:

For future studies more selective inhibitors are needed to reduce non-specific tissue accumulation. *To overcome limitations in specificity, novel lead structures* and the use of antibodies and fusion proteins was proposed *to minimize off-target effects* [].⁹⁷

Despite the failure of compound 1024/MIP-1232, Meletta indicated that there was continuing interest in targeting FAP for diagnostic imaging, explaining that its "...findings with the tumor xenografts are of interest in oncology" and explained that "FAP imaging with a selective ligand would enable the identification of FAP-positive tumors sensitive to a FAP-targeted radiotherapy with existing antibodies."⁹⁸

Patentee and Dr. Pomper reached the same conclusion from Meletta. Dr. Pomper, for example, portrayed Meletta as demonstrating that MIP-1232/compound 1024 was "determined as not suitable for the [radiotracer] application" and that was because of the "low selectivity" of the compound for

⁹⁷ EX1008, 2089-90 (*emphases added*); EX1003, ¶¶ 100-101.

⁹⁸ EX1008, 2090; EX1003, ¶ 101.

FAP.⁹⁹

A skilled artisan would have read Meletta as indicating there was a need for new compounds exhibiting greater selectivity for FAP and would have been motivated by it to search for other, more FAP-selective small molecule FAP-inhibitor compounds to use in FAP-targeting radiotracers.¹⁰⁰

3. Jansen (EX1006)

Jansen (EX1006) was published in 2014. It reports on the development and characterization of a number of FAP inhibitors based on an “N-4-quinolinoyl-Gly-(2S)-cyanoPro scaffold.”¹⁰¹ It showcases one compound in particular—“compound 60”—as being a highly selective FAP-inhibitor with characteristics that make it a desirable candidate to use as a FAP-targeting moiety in a radiotracer.

A skilled artisan interested in developing FAP-targeting small molecule radiopharmaceuticals would have found and evaluated Jansen, as it describes not only important considerations for developing highly selective small molecule FAP-

⁹⁹ EX1002, 363-365 (¶¶ 32-37); EX1003, ¶ 102.

¹⁰⁰ EX1003, ¶¶ 101, 103-104.

¹⁰¹ EX1006, 3053.

targeting moieties but provides numerous examples and experimental data on particular compounds.¹⁰²

(a) Jansen Highlights Interest in FAP as a Drug Target

Jansen explains why FAP was recognized as an appealing target for pharmaceutical development, including its selective expression on human epithelial tumors and role in promoting tumor growth:

These appealing characteristics of FAP account for its ongoing evaluation as a drug target. Both immunotherapy and small-molecule based approaches have so far been reported, most of them focusing on applications in the oncology domain ...¹⁰³

That perspective was widely shared in the field before 2017, as explained in §IV.A.3.¹⁰⁴

(b) Jansen Described a Need for Improved FAP-Targeting Moieties that It Solved with Compound 60

Jansen recounts challenges of finding small molecules that exhibit sufficient FAP-selectivity to serve as a drug targeting moiety, particularly the selectivity of each compound for FAP over PREP (below).¹⁰⁵

¹⁰² EX1003, ¶ 128.

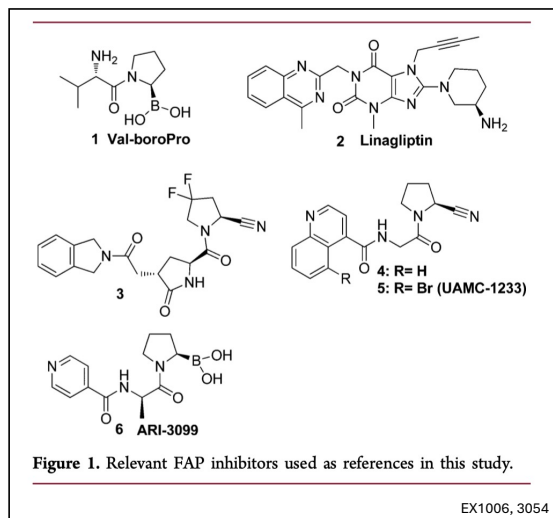
¹⁰³ EX1006, 3053 (*emphasis added*).

¹⁰⁴ EX1003, ¶¶ 58-59, 61-62, 128.

¹⁰⁵ EX1006, 3053; EX1003, ¶¶ 107, 109 (*emphasis added*).

While designing out DPP affinity in FAP inhibitors is relatively straightforward, *obtaining inhibitors possessing selectivity for FAP over PREP is considered to be far more challenging*. This is, among others, illustrated by the significant overlap between in vitro processable substrate sequences for FAP and PREP and the fact that numerous reported FAP inhibitors have limited or no selectivity with respect to PREP.[¹⁰⁶]

Jansen surveyed six, pre-2014 compounds as potential FAP inhibitors (below), and identified shortcomings for each compound.¹⁰⁶



- Val-boroPro (1) was a “non-selective boronic acid inhibitor” that was withdrawn after initial clinical testing, while linagliptin (2) was not selective for FAP—it also inhibited DPPIV.¹⁰⁷

¹⁰⁶ EX1006, 3054, Fig. 1; EX1003, ¶¶ 108-109.

¹⁰⁷ EX1003, ¶ 109(a)-(b).

- Compound #3 had good FAP/PREP selectivity but exhibited poor pharmacokinetics, while compounds 4 and 5 exhibited overall properties that were not as favorable as compound 60 (discussed *infra*).¹⁰⁸
- Compound #6 shared a pyrrolidine-2-boronic acid structure with compound 1024 in US-633, and while Jansen reports it showing high selectivity for FAP over PREP, it also noted a lack of pharmacokinetic data for it.¹⁰⁹

Jansen explains that it explored modifications to positions on the quinolinyl-ring structures shared by compounds 4 and 5 to deduce structure-activity relationships (SAR), described around sixty such inhibitors and provided data from testing them for affinity and selectivity to FAP and other prolyl-specific peptidases.¹¹⁰

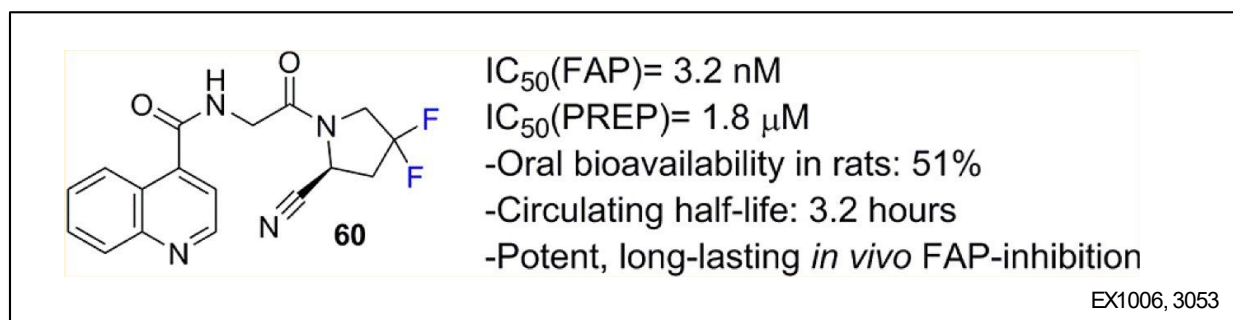
¹⁰⁸ EX1003, ¶ 109(c).

¹⁰⁹ EX1003, ¶ 109(d).

¹¹⁰ EX1006, 3054, Tables 1-6.

(c) *Jansen Identifies Compound 60 as Its Most Promising FAP Inhibitor*

Jansen showcases compound 60 as its most promising FAP inhibitor. In fact, it included the structure of compound 60 in its abstract, along with an array of properties that a skilled artisan would have recognized to be favorable characteristics of a targeting moiety for a FAP-targeting radiotracer.¹¹¹



The data reported by Jansen reinforces this conclusion about Compound 60. Tables 1 to 6 show potency values of each compound for inhibition of the activity of FAP and other prolyl-specific peptidases (*i.e.*, an IC₅₀ concentration). Jansen also reports a “selectivity index” for each compound calculated by dividing its IC₅₀ value for PREP by its IC₅₀ value for FAP.¹¹² After assessing the compounds for potency and FAP/PREP selectivity, Jansen reported that compound 60 was one of the “four most promising compounds” selected for additional testing based on

¹¹¹ EX1006, 3053; EX1003, ¶¶ 110-111.

¹¹² *E.g.*, EX1006, 3054, Table 1.

selectivity/affinity (*i.e.*, compounds 4, 5, 60 and 61):

Taking into account the number of low nanomolar FAP inhibitors with high FAP/PREP selectivity that we had discovered as part of this and the foregoing study, ***four of the most promising compounds were then selected*** for which in vitro pharmacokinetic parameters were determined (log D_{7.4}, kinetic solubility, stabilities in mouse, rat, and/or human plasma) (Table 7).¹¹³

Jansen reported IC₅₀ and selectivity values for the four compounds (below).¹¹⁴

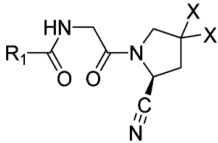
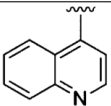
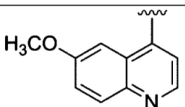
Table 1. IC ₅₀ of Reference FAP Inhibitors						
compd	IC ₅₀ (μM) ^a					SI (FAP/PREP) ^b
	FAP	PREP	DPPIV	DPP9	DPP2	
1	0.066 ± 0.011	0.98 ± 0.06	0.022 ± 0.001	ND ^c	0.086 ± 0.007	14.8
2	0.37 ± 0.002	>100	0.0020 ± 0.0002	>100	>100	>250
3	0.017 ± 0.001	>100	>100	>100	>100	5882.4
4	0.0103 ± 0.0004	0.86 ± 0.07	>100	>100	>100	83.5
5	0.011 ± 0.0004	>50	>100	>100	>100	>4500
6	0.025 ± 0.001	0.99 ± 0.04	>100	>50	>100	39.6

^aDetermined under our own assay conditions. ^bSI stands for "selectivity Index" (calculated as [IC₅₀(PREP)/IC₅₀(FAP)]). ^cND stands for "not determined".

EX1006, 3054

¹¹³ EX1006, 3063 (*emphasis added*).

¹¹⁴ EX1006, Table 1 (compounds 4, 5), Table 5 (compounds 60, 61). Compound 60 is identical to Compound 1 in Example 1 of US-650. EX1044, [0317], Table 4.

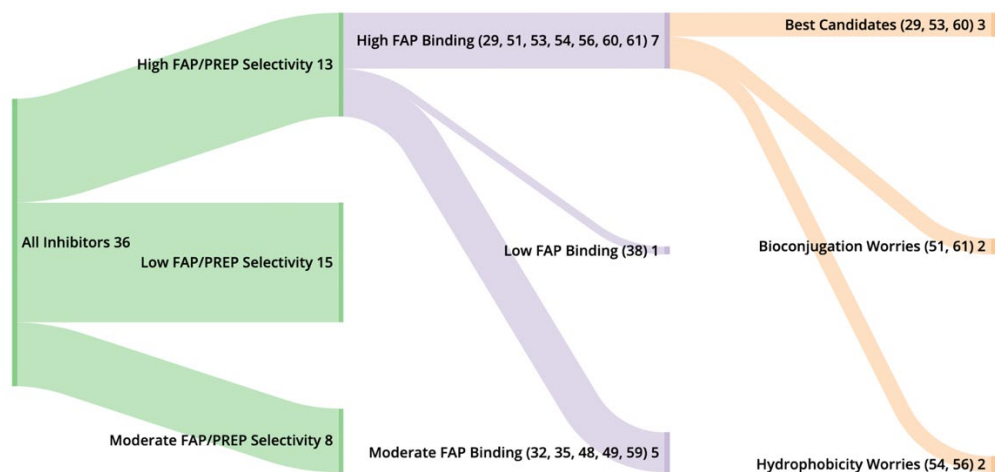
								
Nr	R ₁	X	IC ₅₀ (μM)					SI (FAP/PREP) ^a
			FAP	PREP	DPPIV	DPP9	DPP2	
60		F,F	0.0032± 0.0004	>1.8 ± 0.2	>100	>12.5	>100	562.5
61		F,F	0.0085± 0.0009	8.3 ± 0.7	19±1.3	27.2±0.8	>100	976.4

EX1006, 3062 (60, 61)

A skilled artisan also would have concluded that compound 60 was one of the most promising FAP inhibitors in Jansen based on the selectivity/affinity data in the paper. As Dr. Zeglis explains, a skilled artisan would have ranked the Jansen compounds using a sequence of classification steps. The first and most important characteristic is high selectivity for FAP over PREP.¹¹⁵ Next, compounds exhibiting high FAP-vs-PREP selectivity would be ranked based on potency (*i.e.*, lower IC₅₀ values better). Finally, the compounds would be classified based on their susceptibility to degradation, hydrophobic character

¹¹⁵ EX1003, ¶ 117; EX1006, 3053 (“FAP over PREP selectivity could nonetheless be an important feature for inhibitors.”)

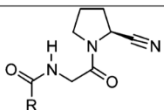
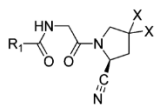
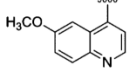
(which can influence pharmacokinetics), and ability to be incorporated into a radiopharmaceutical. Using this methodology, Dr. Zeglis identified compounds 29, 53 and 60 as the most promising FAP inhibitors in Jansen.¹¹⁶



The binding characteristics and structures of compounds 29, 53 and 60 are shown below. As can be seen, compound 60 had the highest affinity for FAP (lowest IC_{50}), and the second highest selectivity rating relative to PREP.¹¹⁷

¹¹⁶ EX1003, ¶¶ 119-121.

¹¹⁷ EX1006, 3059-60 (29,53), 3062 (60, 61).

								
Nr	R =	IC ₅₀ (μM)					SI (FAP/PREP) ^a	
		FAP	PREP	DPPIV	DPP9	DPII		
29		0.063± 0.003	11.3 ± 1.2	>100	>100	>100	179.4	
53		0.0043± 0.0001	9.1 ± 0.6	>100	>50	>100	2116.3	
								
Nr	R ₁	X	IC ₅₀ (μM)					SI (FAP/PREP) ^a
			FAP	PREP	DPPIV	DPP9	DPP2	
60		F,F	0.0032± 0.0004	>1.8 ± 0.2	>100	>12.5	>100	562.5
61		F,F	0.0085± 0.0009	8.3 ± 0.7	19±1.3	27.2±0.8	>100	976.4
EX1006, 3059-60 (29,53), 3062 (60, 61)								

Compound 60, thus, was not only portrayed by Jansen as being one of its most promising FAP inhibitors, it would have been recognized as such by a skilled artisan based on its affinity and selectivity characteristics before 2017.¹¹⁸

(d) *Additional In Vitro and In Vivo Testing Identifies Appealing Attributes of Compound 60*

Jansen subjected four compounds (4, 5, 60 and 61) to a series of *in vitro* tests, including stability of the compounds in plasma. The results of those experiments are reported in Table 7 (below).

¹¹⁸ EX1006, 3064; EX1003, ¶¶ 111-113, 115-116.

Table 7. In Vitro Pharmacokinetic Properties of Selected FAP Inhibitors ^a					
parameter	4	5	68	60	61
kinetic solubility (μ M)	>200	>200	>200	>200	>200
log <i>D</i>	0.5	0.7	0.8	1	nd
plasma stability (% unchanged at 6 h) (mouse/rat/human)	100/90/nd	90/nd/100	nd/100/80	85/95/nd	nd
microsomal stability (% unchanged at 6 h) (mouse/rat)	nd	75/nd	90/nd	90/94/nd	nd
cytotoxicity (MRC-5 cells) (μ M)	>64	>64	>64	>64	>64

^and stands for “not determined”.

Jansen reported no significant differences between the compounds from these *in vitro* tests, observing that compound 60, like the other tested compounds, was stable in human, mouse and rat plasma, showed an acceptable *in vitro* half-life (> 6 hours), and none of the compounds showed cytotoxicity in a cellular assay.¹¹⁹

Jansen subjected three of the compounds (5, 60 and 61) to *in vivo* testing in rats.¹²⁰ It reported that while compounds 5, 60 and 61 each “displayed significant, roughly comparable oral bioavailabilities (50-79%) and reasonable elimination

¹¹⁹ EX1006, 3063 (“In general, no large differences between individual inhibitors were observed for the evaluated parameters.”) Table 7 appears to contain a typographical error in referencing a “compound 68.”

¹²⁰ EX1006, 3064. Jansen omitted compound 4 after questions were raised due to its toxicity in rats: “all rats treated with this compound died within 6 hours” while rats given compounds 5, 60 and 61 “did not show signs of toxicity.” EX1003, ¶¶ 114, 125.

half-lives (1.5–3 h),” compound 60 exhibited superior *in vivo* characteristics.¹²¹

Specifically, Jansen reported that when administered intravenously (as opposed to orally), compound 60 caused a more extensive inhibition of FAP activity (>85% at all time points) for a longer period than compounds 5 and 61 (~50% after 24 hours) (below), which Jansen attributed the compound 60’s longer *in vivo* half-life.¹²²

A skilled artisan would have concluded that compound 60’s favorable FAP to PREP selectivity, high affinity, stability, pharmacokinetics, long half-life and *in vivo* potency of inhibition of FAP, a skilled artisan would have found that it was one of the best small-molecule FAP inhibitors available before 2017.¹²³ Jansen likewise reports:

We believe that our selective, *in vivo* active inhibitors are currently best placed among all published compounds to help elucidate the function of FAP in different animal models of disease and to allow its continuing validation as a drug target.¹²⁴

A skilled artisan thus would have seen compound 60 as an excellent targeting

¹²¹ EX1006, 3064; EX1003, ¶¶ 125-126.

¹²² EX1006, 3064; EX1003, ¶ 126.

¹²³ EX1003, ¶¶ 111-112, 115-116, 127.

¹²⁴ EX1006, 3065.

moiety for a FAP-targeting radiopharmaceutical to be used in nuclear imaging or therapy of cancer.¹²⁵

B. Differences Between the Claims and the Prior Art

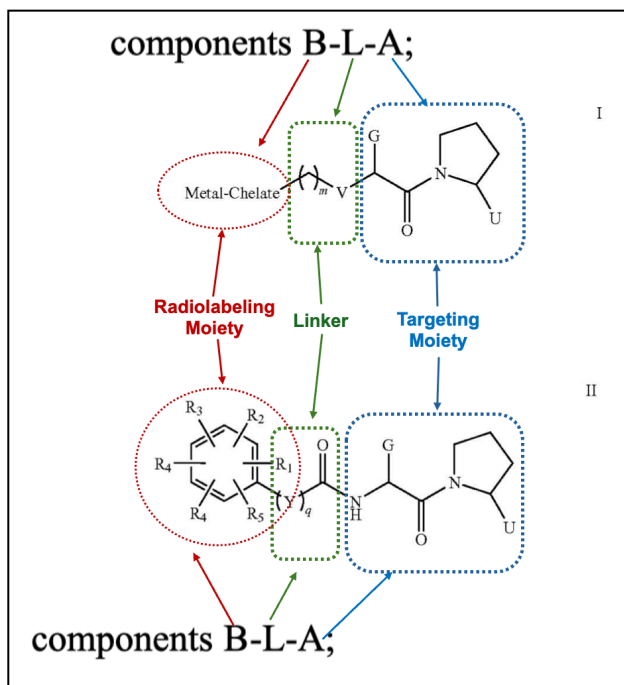
As explained in § V.A.1(a), US-633 describes radiopharmaceutical compounds having a modular design with three components:

- (i) a radiolabeling moiety containing a radionuclide (*e.g.*, a radiometal such as ⁶⁸Ga or ^{99m}Tc complexed with a chelator, or a radiohalogen such as ¹⁸F or ¹²³I attached to a prosthetic group),
- (ii) a “tether” (linker) and
- (iii) a FAP- α targeting moiety.

These three components are components “B”, “L” and “A” within the meaning of the '201 Patent claims (below).¹²⁶

¹²⁵ EX1003, ¶ 127.

¹²⁶ EX1003, ¶ 71.



As explained above (§ V.A.1(b)-V.A.1(b)), US-633 describes compounds comprising radiolabeling moieties and a radionuclide that together meet the requirements of “B” as each is a “... radiolabeled functional group suitable for ... positron-emission tomography (PET), single-photon emission computed tomography (SPECT) or radiotherapy.”¹²⁷

As explained above (§ V.A.1(d)), US-633 describes compounds that contain “tethers” (linkers) that meet the requirements of “L” as each has “bi-functionalization adapted to form a chemical bond with B and A.”¹²⁸ In particular, each of the molecules contains chemical bonds between a linker and each of the

¹²⁷ EX1001, 2:8-10.

¹²⁸ EX1004, [0051], [0101].

radiolabeling group and the targeting moiety.

While the targeting moiety in the US-633 molecules is “a targeting moiety for FAP- α ,” its structure does not meet the parameters of “A.” This is *the only difference* between the claimed compounds and the FAP-targeting radiopharmaceuticals described in US-633.

C. A Skilled Artisan Would Have Considered US-633 with Both Meletta and Jansen

A skilled artisan would have considered US-633 together with each of Meletta and Jansen.

First, all three concern scientific developments in the same field—targeting FAP in cancer diagnosis and treatment due to its prevalent and selective expression in tumors.¹²⁹

Second, all three discuss small molecule FAP inhibitors that can be used in

¹²⁹ EX1004, [0004] (“The expression of seprase [FAP] on tumors makes it an attractive target to exploit for noninvasive imaging as well as targeted radiotherapy.”); EX1006, 3053 (“These appealing characteristics of FAP account for its ongoing evaluation as a drug target.”); EX1008, 2082 (FAP expression pattern and role in tumor environment indicated it “may serve as a therapy target in oncology [].”); EX1003, ¶ 128(a).

radiotracers and other radiopharmaceuticals. More directly, each describes FAP inhibitor compounds within the same structural class (*i.e.*, each contains a substituted pyrrolidine structure) and provides similar types of data characterizing the affinity of such compounds for FAP and other prolyl oligopeptidases.¹³⁰ For example, Jansen discusses work on boronic acid pyrrolidine FAP inhibitors that were the subject of US-633 and Meletta,¹³¹ while US-633 reports on 2-cyano-pyrrolidine structures that are the focus of Jansen.¹³²

Third, Meletta cites US-633 (below) and describes experimental investigations of one of the US-633 compounds (*i.e.*, compound 1024). This demonstrates that skilled artisans actually did consider the collective teachings of these two publications before 2017.

FAP [29]. MIP-1232 was 32-fold more potent in inhibiting FAP than PREP. The corresponding K_d value of [^{123} I]MIP-1232 in stably FAP-transfected human embryonic kidney cells (HEK-293) was 30 nM and different FAP-positive cell lines showed a markedly reduced enzymatic activity under MIP-1232 treatment compared to baseline conditions [29,31]. The high binding affinity to FAP and the selectivity

31. Zimmerman, C.; Babich, J.W.; Joyal, J.; Marquis, J.; Wang, J. Selective Seprase Inhibitors. Patent US 2010/0098633 A1, 22 April 2010.

A skilled artisan thus would have considered the collective teachings of US-

¹³⁰ EX1003, ¶ 128(b).

¹³¹ EX1006, 3054, 3055, 3063.

¹³² EX1004, [0169]-[0170], [0178]-[0180], [0185].

633, Meletta and Jansen.¹³³

D. A Skilled Artisan Would Have Been Motivated to Use Compound 60 as the Targeting Moiety of FAP-Targeting Radiotracers

Before 2027, the prior art indicated, and a skilled artisan would have believed, that FAP was an appealing drug target for therapeutic and diagnostic radiopharmaceuticals.¹³⁴ One reason was its elevated expression on >90% of human epithelial tumors and its effective absence of expression in normal adult tissues and non-malignant tumors. A second was that small molecule compounds existed that were selective inhibitors of FAP. For example, US-633 states:¹³⁵

The expression of seprase [FAP] on tumors makes it *an attractive target* to exploit *for noninvasive imaging* as well as *targeted radiotherapy*.

Small molecule inhibitors of seprase [FAP] are provided for use as therapeutic medicines or as *radiopharmaceuticals useful in diagnostic imaging* and in the therapeutic treatment of diseases characterized by overexpression of seprase.

Jansen similarly identified the appeal of selectively targeting FAP as a drug target with small molecule compounds:

¹³³ EX1003, ¶ 128.

¹³⁴ EX1003, ¶¶ 58-59, 61-62, 67, 69-70, 106.

¹³⁵ EX1004, [0005], [0007] (*emphases added*).

These appealing characteristics of FAP account for its *ongoing evaluation as a drug target*. Both immunotherapy and *small-molecule based approaches* have so far been reported, most of them *focusing on applications in the oncology domain* (vide infra).¹³⁶

Other publications from before 2017 reinforce this conclusion.¹³⁷

US-633 attempted to realize the goal of producing small-molecule FAP-targeting radiotracers, and described modular, three-component FAP-targeting radiotracers which enable the facile replacement of one or more of its components.¹³⁸ US-633 also provided extensive guidance on varying the chelating and linker components of its radiotracers, listing many options and variables for each that were well known to those skilled in the art.¹³⁹

Before 2017, however, the boronic acid pyrrolidine targeting moiety used in the radiotracers described in US-633 was shown to be insufficiently selective for

¹³⁶ EX1006, 3053 (*emphases added*).

¹³⁷ See § IV.A.3; EX1003, ¶ 59; EX1046, 26; EX1026, 1, 8; EX1022, 123, 125; EX1024, 454, 455.

¹³⁸ See §§ V.A.1(a); EX1003, ¶¶ 71, 27-28.

¹³⁹ See §§ V.A.1(c), V.A.1(d); EX1003, §§ III.A.4, III.A.5.

FAP, effectively terminating interest in developing radiotracers based on the boronic acid pyrrolidine targeting moiety used in the US-633 radiotracers.¹⁴⁰

Consistent with the view of skilled artisans, Meletta did not propose giving up on FAP as a target for radiotracers—it instead identified a need for *more selective* FAP targeting moieties (including small molecules) (below).¹⁴¹

For *future studies more selective inhibitors are needed to reduce non-specific tissue accumulation*. To overcome limitations in specificity, *novel lead structures* and the use of antibodies and fusion proteins was proposed to minimize off-target effects [].

Prompted by the failure of the boronic acid pyrrolidine-based radiotracers in US-633 and following the recommendation in Meletta, skilled artisans would have looked for alternative small molecule compounds that were highly selective for

¹⁴⁰ EX1008, 2089-90 (“As [125I]MIP-1232 did not selectively accumulate in the atherosclerotic tissue and as its low FAP/PREP affinity ratio is already known we *did not further investigate its selectivity profile*.”); EX1002, 363-365 (¶¶ 32-37); EX1003, ¶¶ 99-100, 102.

¹⁴¹ EX1008, 2090 (*emphases added*); EX1003, ¶¶ 101, 103-104; *also id.* ¶¶ 59, 61-62.

FAP and could serve as a targeting moiety for a FAP-targeting radiotracer, which would have led such artisans to Jansen and compound 60.¹⁴²

Initially, a skilled artisan would have read Jansen as identifying compound 60 as its most promising FAP inhibitor—it showcases that compound in its abstract, and portrays it as having the best combination of selectivity, affinity, in vitro and in vivo characteristics of the compounds tested.¹⁴³

A skilled artisan would have found compound 60 to be an excellent candidate for the targeting moiety of a small molecule FAP-targeting radiotracer, as it has an array of attributes that make it ideal for that role:

- it is highly selective for FAP relative to PREP (*i.e.*, a FAP IC₅₀ more than 562 times more potent than its IC₅₀ for PREP), and has very high affinity for FAP (*i.e.*, IC₅₀ of 3.2 nanomolar (0.0032 μM));¹⁴⁴
- it is stable in human plasma, was not subject to oxidative metabolism, exhibits *in vitro* half-life exceeding 6 hours and exhibited no signs of cellular toxicity;¹⁴⁵

¹⁴² EX1003, ¶¶ 133-134.

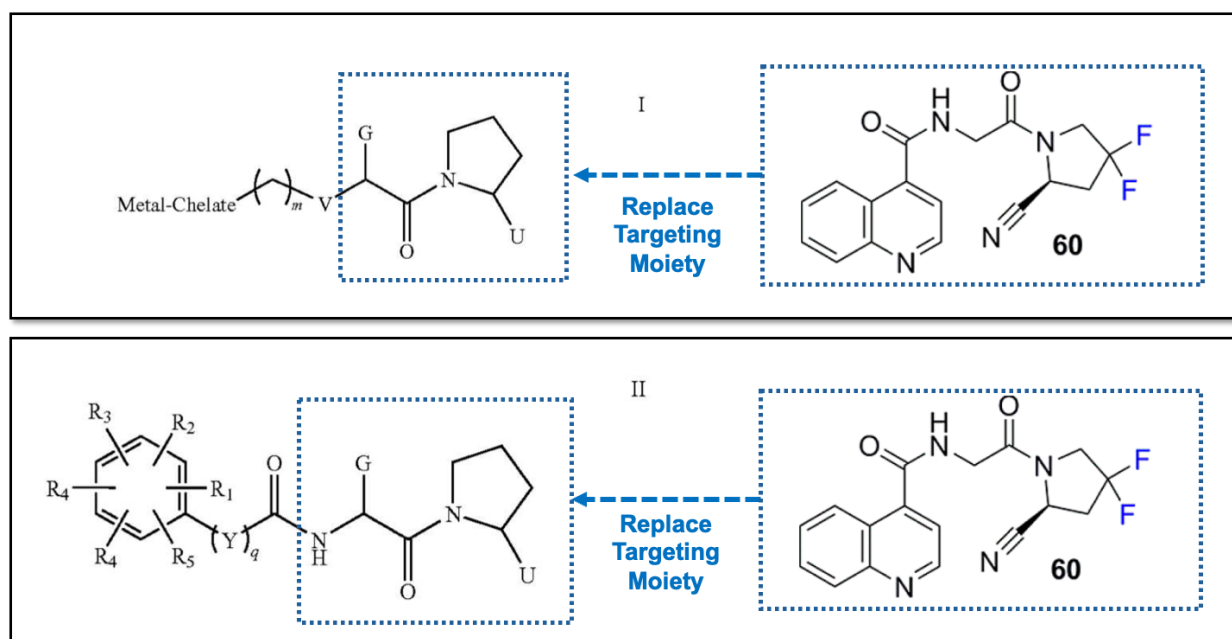
¹⁴³ EX1006, 3053, 3064, 3065; EX1003, ¶¶ 134-135, *also* ¶¶ 110-115, 120-127.

¹⁴⁴ EX1006, 3062 (Table 5); EX1003, ¶¶ 112, 115, 122.

¹⁴⁵ EX1006, 3063; EX1003, ¶¶ 112, 114, 123-124.

- *in vivo*, it showed good oral bioavailability and elimination half-lives;¹⁴⁶ and
- it caused “the most extensive and prolonged inhibition of FAP in the pK studies” due to its “longer in vivo half-life” relative to other tested compounds.¹⁴⁷

Consequently, a skilled artisan would have been motivated to replace the boronic acid pyrrolidine targeting moiety of the radiotracers described in US-633 with more selective compound 60 of Jansen (below).¹⁴⁸

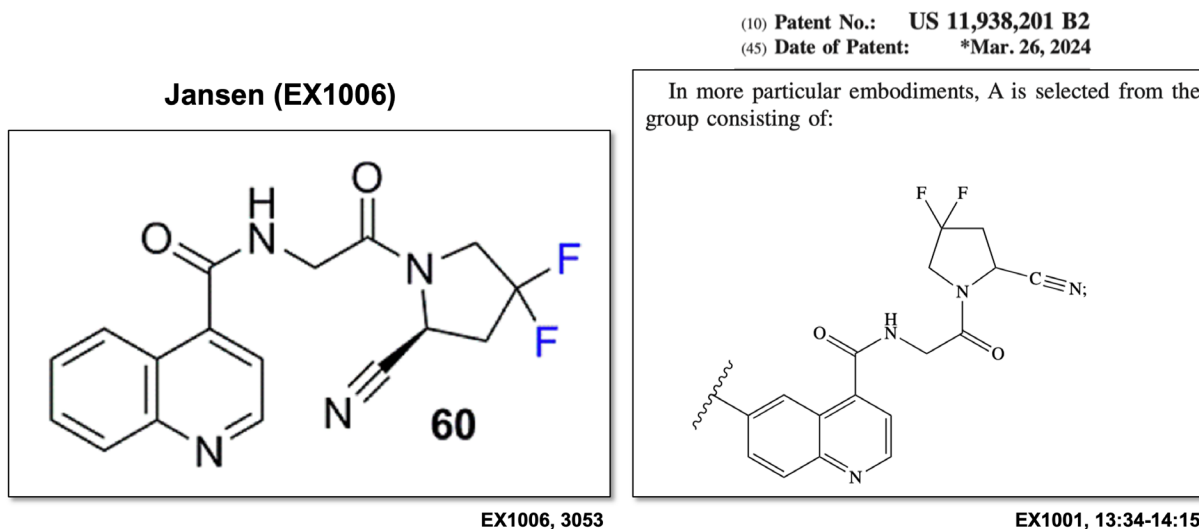


¹⁴⁶ EX1006, 3064; EX1003, ¶¶ 113, 125.

¹⁴⁷ EX1006, 3064; EX1003, ¶¶ 125-126.

¹⁴⁸ EX1003, ¶¶ 134-135, 146.

Notably, in late 2017, the '201 Patent itself portrayed compound 60—a compound that was published in the scientific literature before then—as a small molecule targeting moiety suitable for a FAP-targeting radiotracer, labeling it a “particular embodiment” of its “A” component (below right).¹⁴⁹



E. Compound 60 Meets Every Requirement of the “A” Moiety of the Claimed Compounds

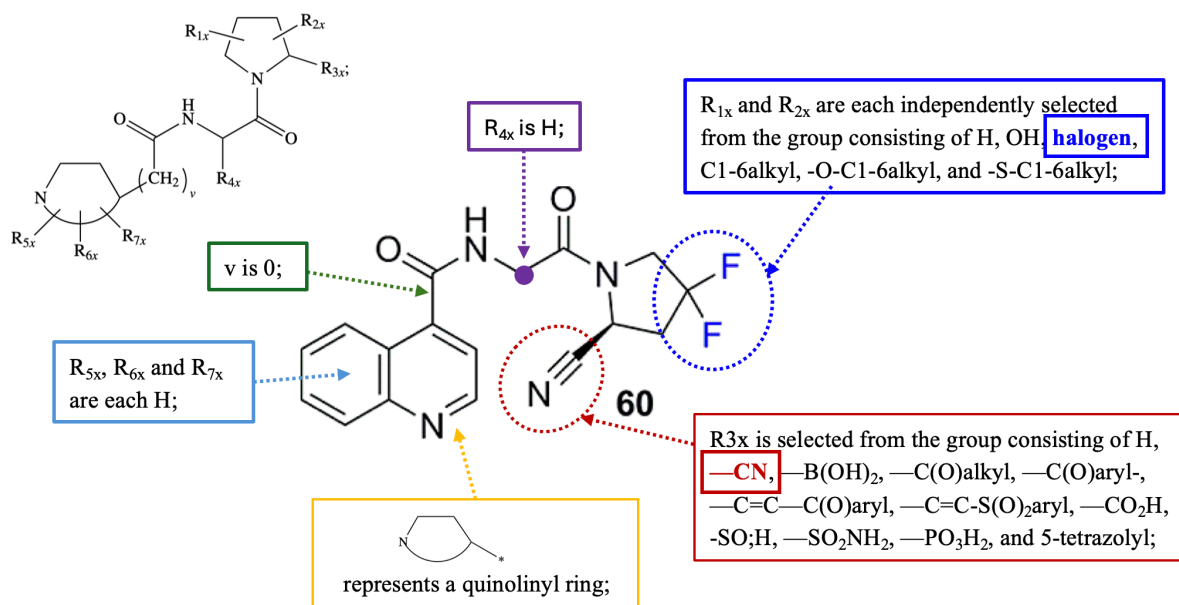
In addition to matching a structure that the '201 Patent portrays as a “particular embodiment” of an “A” moiety in its claimed compounds, compound 60 unquestionably meets every requirement of that “A” component in the claims.

First, Jansen describes compound 60 as a highly selective FAP inhibitor (*e.g.*, it has a selectivity index of >560 for binding to FAP relative to PREP, and a

¹⁴⁹ EX1001, 13:34-14:15; Jansen, 3053.

high affinity (*i.e.*, an IC_{50} of 3.2 nM)).¹⁵⁰ A skilled artisan would conclude that, when incorporated in a radiotracer, compound 60 is “a targeting moiety for FAP- α ” within the meaning of the claims.¹⁵¹

Second, compound 60 meets the structural requirements of the “A” component in the claimed “Formula (I)” of “B-L-A” based on its structure. As shown below, compound 60 has attributes at positions in the “A” generic structure that match parameters in the claims for those positions:¹⁵²



Also, the claims’ options for the left side of the quinolinyl ring require 3 of

¹⁵⁰ EX1006, 3053.

¹⁵¹ EX1003, ¶ 168.

¹⁵² EX1001, Claim 1 (corrected).

the 4 available positions to be hydrogen, which allows one (*e.g.*, position C⁶ or C⁷) to be functionalized to be the site of the linker attachment.

F. A Skilled Artisan Would Have Found It Obvious to Combine Compound 60 with Conventional Radiolabeling Groups and Linkers Suggested by US-633 to Yield Specific Radiotracers

To integrate compound 60 into radiotracer structures suggested by US-633, a skilled artisan would have made decisions regarding the radionuclide to use, the type and identity of the radiolabeling moiety and linkers to use in the compounds. In making these choices, the skilled artisan would draw on the guidance in US-633 as well as their own education, training and experience as of early 2017.

1. A Modular Three Component Design Would Be Used

Initially, a skilled artisan would have used the modular three-component design for a radiotracer based on the guidance in US-633, the structure of compound 60 and guidance in Jansen and related literature regarding modifications to compound 60 that can influence its selectivity and affinity.¹⁵³

2. Choices for the Radiolabeling Moiety

As Dr. Zeglis explains, a skilled artisan would select a radionuclide based on the imaging platform to be used (*i.e.*, PET or SPECT) and by matching its radioactive half-life to the pharmacokinetic half-life of the radiotracer carrying

¹⁵³ EX1003, ¶¶ 71, 139, 142; EX1006, 3062 (Table 5); EX1007, 493.

it.¹⁵⁴ A skilled artisan would have believed a radiotracer based on compound 60 would have a short pharmacokinetic half-life, and as such, would have considered certain radionuclides appropriate: (i) ^{68}Ga and ^{18}F for PET imaging, and (ii) $^{99\text{m}}\text{Tc}$ and ^{123}I for SPECT imaging.¹⁵⁵

As US-633 explains, “[a]ny suitable chelating moiety may be used to provide a covalent or other association with a radionuclide.”¹⁵⁶ Skilled artisans would have known how to select a chelator that was suitable for a particular chosen radiometal.¹⁵⁷ US-633 lists DOTA as one chelator option, which was known to be suitable for ^{68}Ga .¹⁵⁸ US-633 also describes several chelators that were known to be suitable for $^{99\text{m}}\text{Tc}$ (below), including DPA (“1-a”).¹⁵⁹ US-633 thus suggested particular chelators for ^{68}Ga and $^{99\text{m}}\text{Tc}$ radionuclides used in PET or SPECT imaging.

¹⁵⁴ EX1003, ¶¶ 39-41, 129-130.

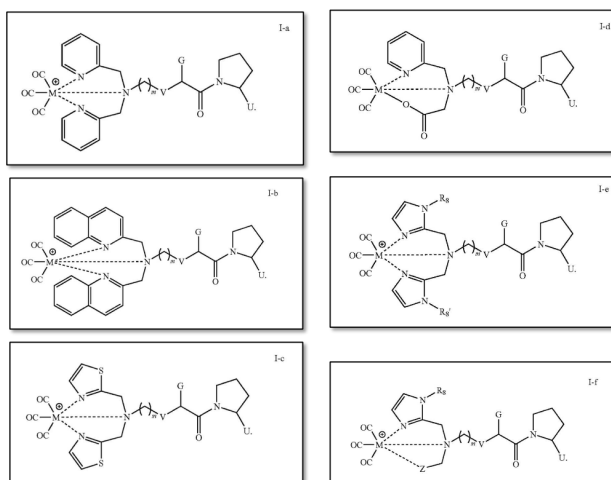
¹⁵⁵ EX1004, [0049]; EX1003, ¶¶ 39, 42, 43, 132.

¹⁵⁶ EX1004, [0100].

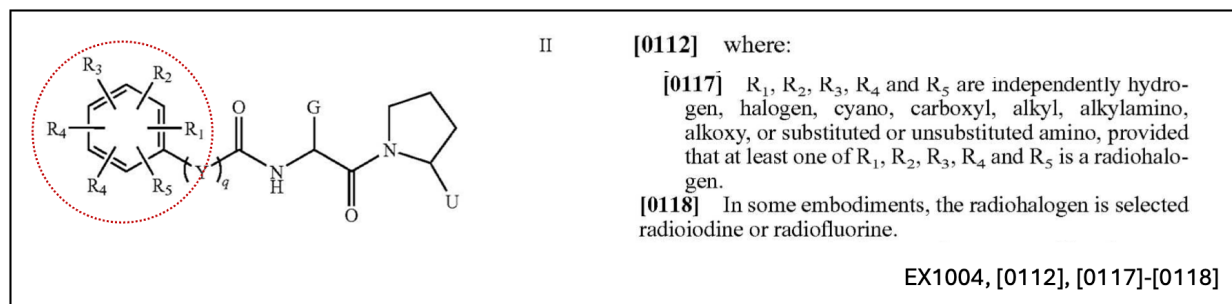
¹⁵⁷ EX1003, ¶¶ 32-33, 81, 147.

¹⁵⁸ EX1004, [0100] (DOTA); EX1003, ¶¶ 78, 82; *also id.* ¶ 33.

¹⁵⁹ EX1003, ¶¶ 78-80, 148.



US-633 teaches use of prosthetic groups in radiotracers based on radiohalogens (*i.e.*, ^{18}F , ^{123}I). It illustrates use of a prosthetic group in Formula II, teaching covalently attaching radioiodine (^{123}I) or radiofluorine (^{18}F) to a position on the phenyl ring (below):¹⁶⁰



A skilled artisan would have considered the prosthetic groups illustrated in US-633 to be suitable options for a compound 60-based radiotracer based on ^{18}F or ^{123}I .¹⁶¹

¹⁶⁰ EX1004, [0117]-[0118].

¹⁶¹ EX1003, ¶¶ 83-85, 157, 161; *also id.* ¶ 34.

3. Choices for the Linker

A skilled artisan would have been familiar with linkers used commonly in the construction of radiotracers.¹⁶² US-633 also provides guidance regarding linkers (“tethers”) suitable to use in the modular radiotracer compounds it describes. *See* § V.A.1(d). For example, US-633 proposes use of linkers that are, *inter alia*, simple alkyl chains or PEG.¹⁶³ US-633 also explains (as would be known by the skilled artisan) that the size of the linker can be adjusted to ensure the radiolabeling moiety is sufficiently far from the targeting moiety.¹⁶⁴

US-633 also explains that PEG-based linkers can be readily incorporated into radiotracers by skilled artisans:

¹⁶² EX1003, ¶¶ 35-36, 88-89.

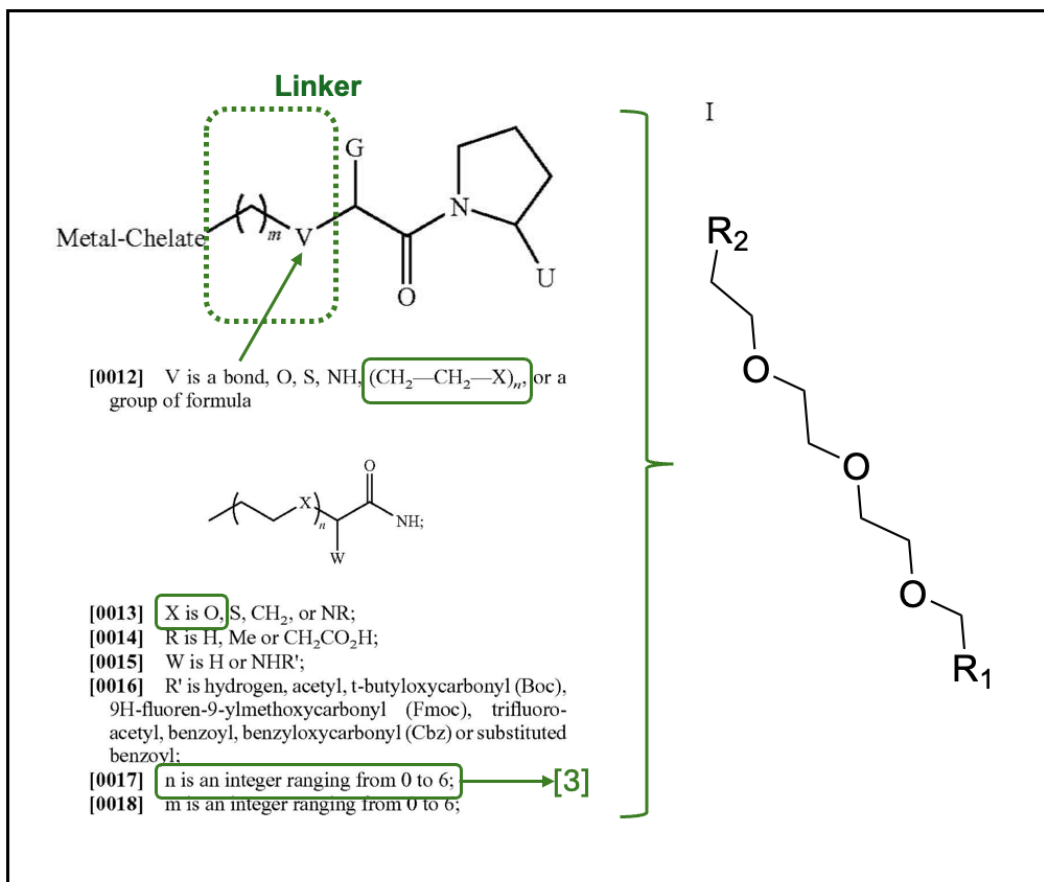
¹⁶³ EX1004, [0130] (“The tether may comprise a simple alkyl chain as shown, a PEG (CH₂CH₂O)_n, a polyethylene amine ((CH₂CH₂NH)_n), or the like.”)

¹⁶⁴ EX1003, ¶ 151.

[0133] The above reaction scheme is applicable to any modification of the tether by incorporation of heteroatoms into the tether chain. This may have additional benefits on the affinity as well as the selectivity for seprase. Incorporation of heteroatoms into the tether such as oxygen can take advantage of the commercially availability of a variety of short polyethylene glycol (PEG) diamines that can be readily incorporated into the complexes. One of ordinary skilled in the art would also readily apply other chelates to prepare functionalized proline- $M^+(CO)_3$ complexes.

US-633 also teaches, via options it sets forth in its structural description of its radiotracers, use of short PEG oligomers (*e.g.*, 3 units). As shown below, in Formula I, selecting “V” as “ $(CH_2—CH_2—X)_n$,” X as “O” and “n” as 3 yields a 3 monomer unit PEG oligomer (below).¹⁶⁵

¹⁶⁵ EX1004, [0012]-[0018].

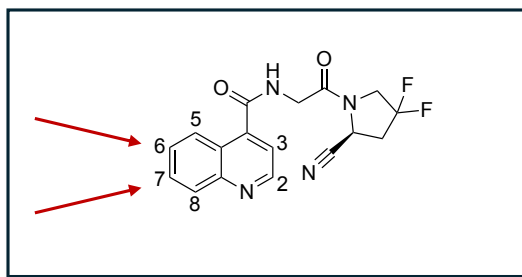


While the “tether” is illustrated with a chelator group, a skilled artisan would have found this guidance useful for compounds incorporating prosthetic groups. Specifically, the skilled artisan would recognize that the compound 60 moiety should be separated by a sufficient distance (*e.g.*, 10 to 20 bonds) to avoid interacting with the prosthetic group, which would be achieved by using a 3-monomer PEG linker.¹⁶⁶

¹⁶⁶ EX1003, ¶¶ 35, 151; EX1004, [0101], [0130].

4. Construction of Compound 60- Linker-Radiolabeling Moiety Compounds

Compound 60 has a structure amenable to being integrated into a radiotracer. As Dr. Zeglis explains, a skilled artisan would have used a linker to connect compound 60 to a radiolabeling moiety in order to avoid causing steric or chemical interference between the radiolabeling and targeting moieties.¹⁶⁷ He also explained that, after determining which part of compound 60 is responsible for its binding to FAP¹⁶⁸ and studying the effects on selectivity and affinity from substitutions at various positions in quinolinyl-glycyl(2-cyanopyrrolidine) FAP inhibitors, a skilled artisan would have considered positions C⁶ or C⁷ on the quinolinyl ring of compound 60 to be the most suitable positions to attach a linker (below), as modifications to those positions did not affect the selectivity or affinity of the compound.¹⁶⁹

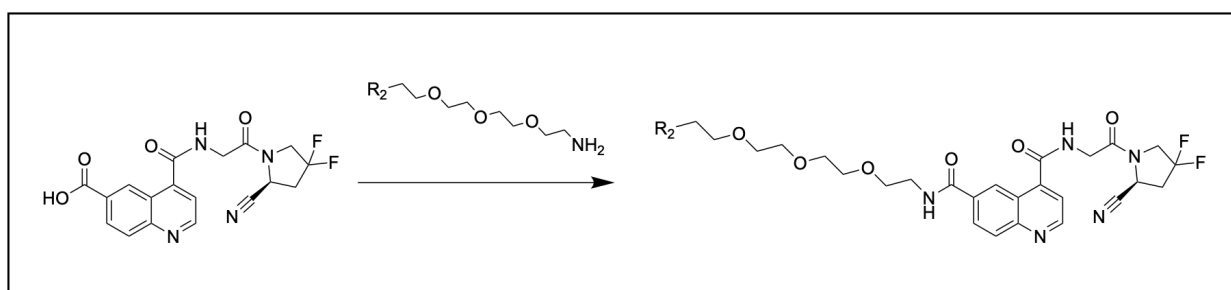


¹⁶⁷ EX1003, ¶ 139.

¹⁶⁸ EX1003, ¶ 140.

¹⁶⁹ EX1003, ¶ 142.

A skilled artisan would have recognized that positions C⁶ or C⁷ would need to be functionalized to enable formation of a covalent bond to the linker. The skilled artisan, for example, would have found it obvious to incorporate a carboxyl group at positions C⁶ (illustrated) or C⁷ that could be exploited to form an amide bond with an amine-terminated PEG oligomer (such as the one discussed above), thereby yielding the following linker-compound 60 construct (below).¹⁷⁰



A skilled artisan would also have functionalized the R₂ terminus in the above exemplary PEG linker to enable formation of a second covalent bond with either a chelating or prosthetic structure. For example, if the R₂ group were also an amine (*e.g.*, a “diamine PEG” linker discussed in US-633),¹⁷¹ it would enable formation of an amide bond with a free carboxylic acid on a DOTA chelator.¹⁷² Of course, other synthetic routes could be taken (*e.g.*, forming the DOTA-linker

¹⁷⁰ EX1003, ¶¶ 143, 151.

¹⁷¹ EX1004, [0133].

¹⁷² EX1003, ¶ 152.

construct first, and then attaching it to a functionalized compound 60). These are routine synthetic chemistry steps that would be familiar to a skilled artisan in 2007.¹⁷³

G. Examples of Compounds Suggested by US-633, Meletta and Jansen Satisfy Claims 1-3

A skilled artisan would have found particular compounds to have been an obvious application of the teachings of US-633, Meletta and Jansen, in view of their training and experience as of early 2017. In particular, the skilled artisan would have found it obvious from those teachings to:

- (i) use the modular, three-component design for radiotracers described in US-633 (*see* § V.F.1);
- (i) replace the boronic acid pyrrolidine targeting moiety of the radiotracers in US-633 with compound 60 from Jansen (*see* § V.D);
- (ii) select a radionuclide and its suitable chelator or prosthetic group for a desired imaging platform (PET or SPECT) pursuant to US-633 and knowledge they possessed in 2017 (*see* § V.F.2);
- (iii) select a linker pursuant to the guidance in US-633 to connect compound 60 to the radiolabeling moiety (*e.g.*, a 3-monomer functionalized PEG) (*see* § V.F.3); and

¹⁷³ EX1003, ¶ 154.

- (iv) construct the compound by conventional synthetic steps (*e.g.*, functionalize compound 60 at position C⁶ with a carboxylic group, attach PEG linker via amide bond, attach chelator/prosthetic group via amide bond) (*see* § V.F.4).

Compounds reflecting these choices suggested by the prior art are illustrated below and meet every requirement of claims 1-3 of the '201 Patent.

1. A PET Radiotracer Based on ⁶⁸Ga, DOTA and PEG Satisfies Claims 1-3 (Compound A1)

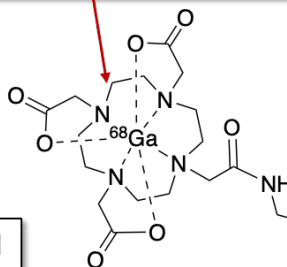
Below is illustrated Compound A1 that incorporates (i) Jansen's compound 60 functionalized to contain a carboxylic group at position C⁶, (ii) a DOTA chelator suitable for ⁶⁸Ga, and (iii) a 3-monomer PEG functionalized to contain terminal amine groups. Some of the support within US-633 and Jansen for these component selections is also shown.¹⁷⁴

¹⁷⁴ EX1003, ¶¶ 149-153; EX1004, [0008], [0019], [0020], [0048], [0049], [0100], [0130]; EX1006, 3053, 3062.

stituted or unsubstituted cyclopentadienyl. By way of example, suitable chelating agents include tetra-azacyclododecanetetra-acetic acid (DOTA), diethylenetriamine-pentaacetic acid (DTPA), bis(pyridin-2-ylmethyl)amine (DPA), quinolinemethylamino acetic acid, 2,2'-azanediyl-di-

EX1004, [0100]

Compound A1

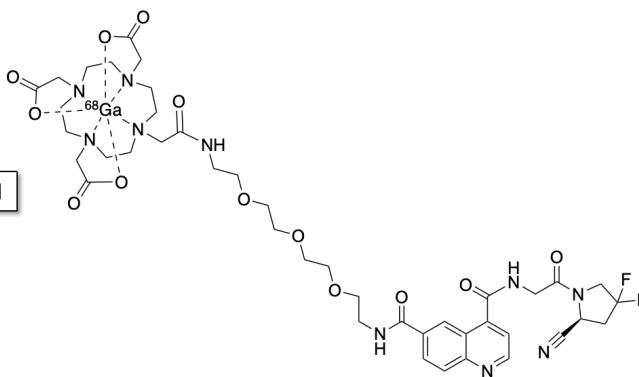


these structures. The tether may comprise a simple alkyl chain as shown, a PEG (CH₂CH₂O)_n, a polyethylene amine ((CH₂CH₂NH)_n), or the like. Terminal aminoalkanoic acids

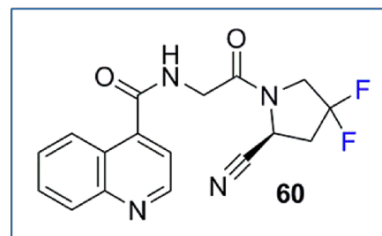
EX1004, [0130]

Chemical Formula: C₄₂H₅₅F₂⁶⁸GaN₁₀O₁₃
Molecular Weight: 1013.88

Compound A1



Chemical Formula: C₄₂H₅₅F₂⁶⁸GaN₁₀O₁₃
Molecular Weight: 1013.88



EX1006, 3053, 3062

Compound A1 is a “low molecular weight” compound in the meaning of the claims as it has a molecular weight of ~1014 Da, which is orders of magnitude

smaller than an antibody, and below 1500 Da.¹⁷⁵ With its stably coordinated complex with ⁶⁸Ga, the Compound A1 compound would be suitable for use as a radiotracer for PET imaging.¹⁷⁶ Compound A1 renders claims 1-3 obvious.

2. A SPECT Radiotracer Based on ⁶⁸Ga, DPA and PEG Satisfies Claims 1-3 (Compound A2)

Below is illustrated Compound A2 incorporating (i) compound 60 functionalized to contain a carboxylic group at position C⁶, (ii) a DPA chelator suitable for ^{99m}Tc, and (iii) a 3-monomer PEG functionalized to contain terminal groups that enable formation of the compound. Because the DPA chelator has an accessible nitrogen, a skilled artisan could use a PEG where one end is a protected amine (*e.g.*, NH-Boc), and the other terminates with a chlorine group. The first step would create the DPA-PEG-NH-Boc, and then in a second step, it would be attached to the carboxyl group functionalized compound 60, yielding Compound A2 below.¹⁷⁷ Some of the support within US-633 and Jansen for these component selections being included is also shown.¹⁷⁸

¹⁷⁵ EX1003, ¶ 176.

¹⁷⁶ EX1003, ¶ 177.

¹⁷⁷ EX1003, ¶ 154.

¹⁷⁸ EX1004, [0008], [0019], [0020], [0048], [0049], [0100], [0130]; EX1006, 3053, 3062.

stituted or unsubstituted cyclopentadienyl. By way of example, suitable chelating agents include tetra-azacyclododecanetetra-acetic acid (DOTA), diethylenetriamine-pentaacetic acid (DTPA), bis(pyridin-2-ylmethyl)amine (DPA), quinolinemethylamino acetic acid, 2,2'-azanediyldi-

EX1004, [0100]

Compound A2

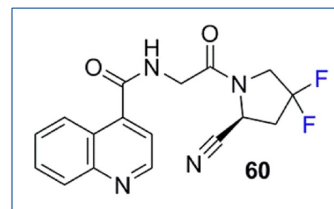
these structures. The tether may comprise a simple alkyl chain as shown, a PEG $(\text{CH}_2\text{CH}_2\text{O})_n$, a polyethylene amine $((\text{CH}_2\text{CH}_2\text{NH})_n)$, or the like. Terminal aminoalkanoic acids

EX1004, [0130]

Chemical Formula: $\text{C}_{41}\text{H}_{42}\text{F}_2\text{N}_8\text{O}_9^{99}\text{Tc}$
Molecular Weight: 927.74

Compound A2

Chemical Formula: $\text{C}_{41}\text{H}_{42}\text{F}_2\text{N}_8\text{O}_9^{99}\text{Tc}$
Molecular Weight: 927.74



EX1006, 3053, 3062

Compound A2 is a “low molecular weight” compound in the meaning of the claims as it has a molecular weight of ~928 Da, which is orders of magnitude

smaller than an antibody, and below 1500 Da.¹⁷⁹ With its stably coordinated complex with ^{99m}Tc, the Compound A2 radiotracer would be suitable for use in SPECT imaging.¹⁸⁰ Compound A2 renders claims 1-3 obvious.

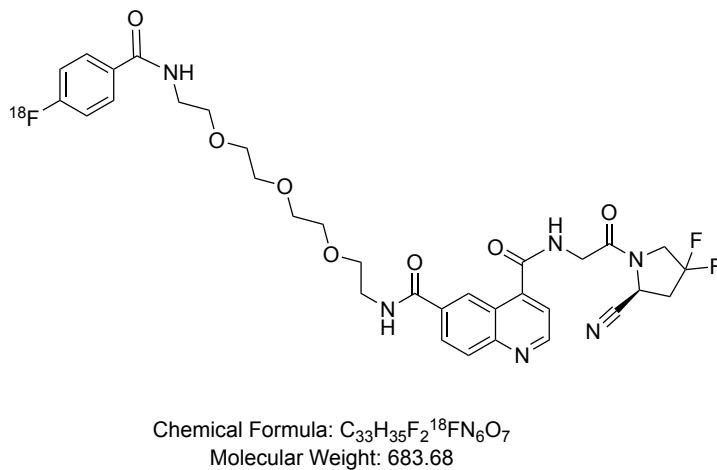
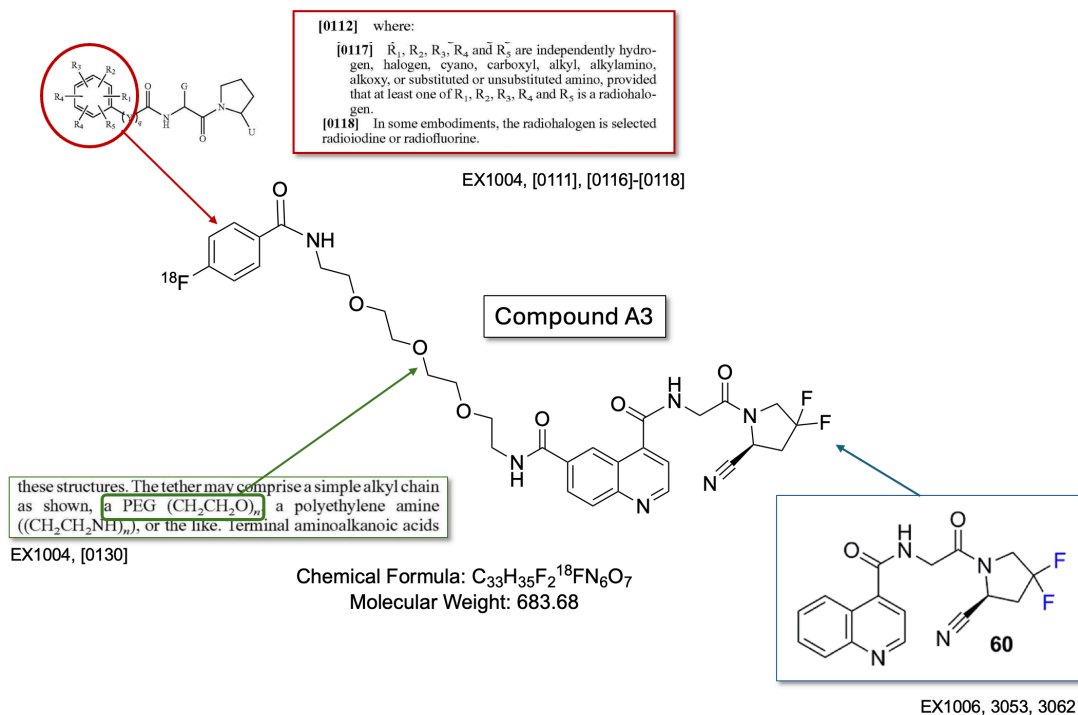
3. A PET Radiotracer Based on ¹⁸F, a Prosthetic Group and PEG Satisfies Claims 1-3 (Compound A3)

Below is illustrated Compound A3 incorporating (i) compound 60 functionalized to contain a carboxylic group at position C⁶, (ii) a prosthetic group labeled with ¹⁸F at the para position of the phenyl group, and (iii) a 3-monomer PEG functionalized to contain terminal amine groups. Some of the support within US-633 and Jansen for these component selections being included is also shown.¹⁸¹

¹⁷⁹ EX1003, ¶ 176.

¹⁸⁰ EX1003, ¶ 177.

¹⁸¹ EX1003, ¶¶ 156-161; EX1004, [0021], [0028], [0049], [0111], [0116]-[0118], [0133]; EX1006, 3053, 3061, 3062.



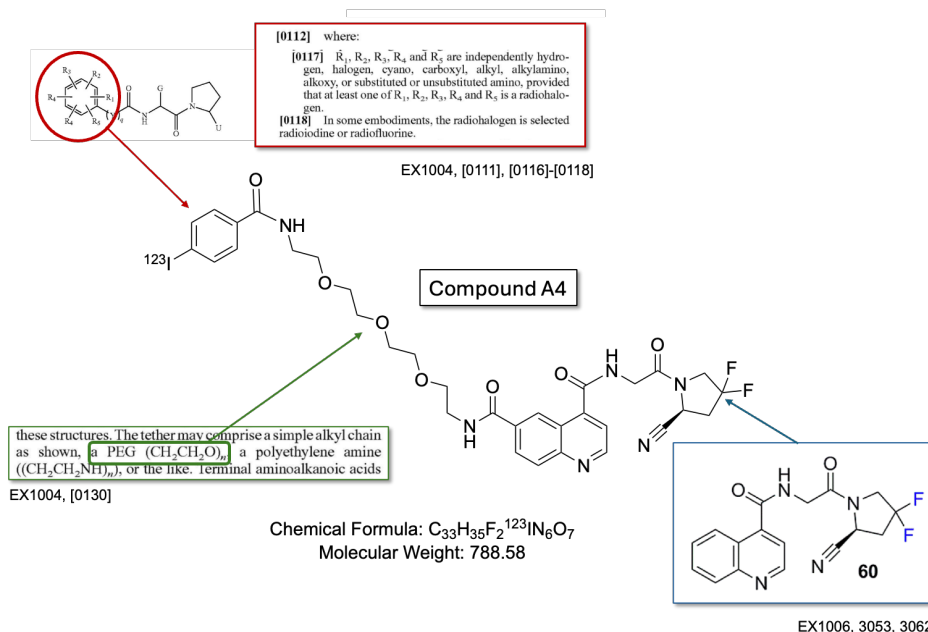
Compound A3 is a “low molecular weight” compound in the meaning of the claims as it has a molecular weight of ~683 Da, which is orders of magnitude smaller than an antibody, and below 1500 Da.¹⁸² With its covalently attached ^{18}F

¹⁸² EX1003, ¶ 176.

radionuclide, the Compound A3 radiotracer would be suitable for use in PET imaging.¹⁸³ Compound A3 renders claims 1-3 obvious.

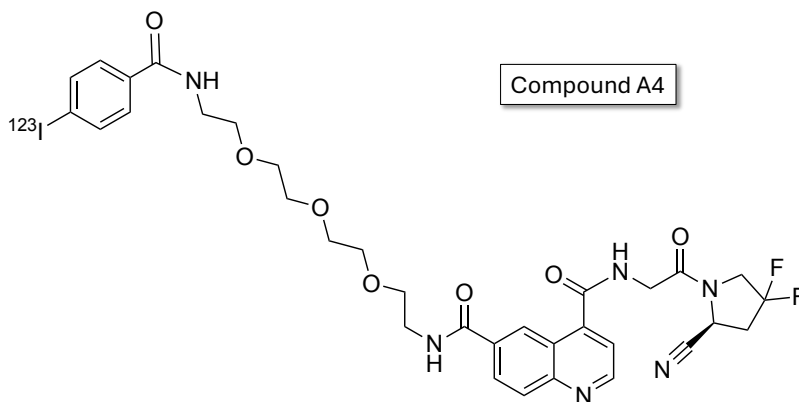
4. A SPECT Radiotracer Based on ¹²³I, a Prosthetic Group and PEG Satisfies Claims 1-3 (Compound A4)

Below is illustrated Compound A4 incorporating (i) compound 60 functionalized to contain a carboxylic group at position C⁶, (ii) a prosthetic group labeled with ¹²³I at the para position of the phenyl group, and (iii) a 3-monomer PEG functionalized to contain terminal amine groups. Some of the support within US-633 and Jansen for these component selections is also shown.¹⁸⁴



¹⁸³ EX1003, ¶ 177.

¹⁸⁴ EX1003, ¶¶ 156-161; EX1004, [0021], [0028], [0049], [0111], [0116]-[0118], [0133]; EX1006, 3053, 3061, 3062.



Chemical Formula: $C_{33}H_{35}F_2^{123}IN_6O_7$
Molecular Weight: 788.58

Compound A4 is a “low molecular weight” compound in the meaning of the claims as it has a molecular weight of ~791 Da, which is orders of magnitude smaller than an antibody, and below 1500 Da.¹⁸⁵ With its covalently attached ^{123}I radionuclide, the Compound A4 radiotracer would be suitable for use in SPECT imaging.¹⁸⁶ Compound A4 renders claims 1-3 obvious.

H. Claims 1-3 Would Have Been Obvious

As explained in § V.G, a skilled artisan would have compounds A1-A4 to have been obvious from US-633, Meletta and Jansen before 2017.

A skilled artisan also would have reasonably expected compounds A1-A4 to be viable nuclear imaging agents, as they would be expected to retain the

¹⁸⁵ EX1003, ¶ 176.

¹⁸⁶ EX1003, ¶ 177.

selectivity and affinity of compound 60, and thus render them viable radiotracers.¹⁸⁷ The illustrated PEG linker included in these compounds separates the radiolabeling moiety in each compound from the compound 60 targeting moiety by 12+ bonds.¹⁸⁸ In addition, a skilled artisan would expect that attaching the linker at position C⁶ of the quinolinyl ring of compound 60 would not disturb its selectivity and affinity for FAP.¹⁸⁹

Because compounds A1-A4 meet every requirement of claims 1-4 and would have been obvious, claims 1-4 are unpatentable.

VI. Ground 2: Claims 1-3 Are Obvious Based on US-121 (EX1005) and Jansen (EX1006)

Claims 1-3 also would have been obvious from the combined teachings of US-121 and Jansen.

The teachings of Jansen (EX1006) are summarized in § V.A.3.

A. Teachings of US-121

US-121 published in 2012 and is owned by the assignee of the '201 Patent that also names Dr. Pomper as an inventor.

¹⁸⁷ EX1003, ¶ 177.

¹⁸⁸ EX1003, ¶¶ 151, 165; EX1004, [0101], [0130], [0131].

¹⁸⁹ EX1003, ¶ 177.

US-121 describes “low molecular weight” compounds used as radiotracers and therapeutic radiopharmaceuticals.¹⁹⁰ It identifies several advantages of such agents over antibody-based imaging agents, including that they (i) “offer better contrast between target tissues and non-target tissues,”¹⁹¹ and (ii) provide better tumor penetration.¹⁹² These advantages are similar to the ones identified in the ’201 Patent (below).¹⁹³

US-121 provides examples of radiotracer designs that target a protein called prostate-specific membrane antigen (PSMA), which US-121 describes as “an excellent target for imaging ...” of tumors and prostate cancer because it is an enzyme with an extracellular site (below).¹⁹⁴

¹⁹⁰ EX1005, [0012].

¹⁹¹ EX1005, [0012].

¹⁹² EX1005, [0012] (“greater cellular retention”), [0008]-[0009], [0188] (longer tumor residence).

¹⁹³ *Compare* EX1005, [0008]-[0009]; EX1001, 1:49-67. *See* EX1003, ¶ 183.

¹⁹⁴ EX1005, [0007].

renal lesion, did not express PSMA. As an enzyme with an extracellular active site, PSMA represents an excellent target for imaging and therapy directed toward solid tumor neovasculature in addition to prostate cancer itself. PSMA-based agents can report on the presence of this marker, which is increasingly recognized as an important prognostic determinate in PCa (Murphy et al., *Urology*, vol. 51, pp. 89-97, 1998). It is also the target for a variety of new PCa therapies (Galsky et al., *J Clin Oncol*, vol. 26, pp. 2147-2154, 2008).

EX1005, [0007]

Like PSMA, FAP is a transmembrane (cell-surface) enzyme with an extracellular active site that is selectively expressed in epithelial cancers.¹⁹⁵

US-121 describes its compounds as responding to “the long standing and unmet need for new imaging and therapeutic compounds for targeting prostate cancer and cancer angiogenesis.”¹⁹⁶ That need certainly persisted past 2012 and was not limited to PSMA-targeting radiotracers.

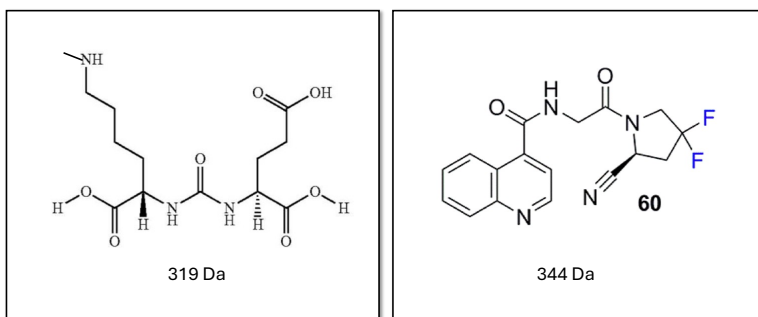
The radiotracers described in US-121 use as their targeting moiety a small molecule lysine-urea-glutamic acid moiety (below, left).¹⁹⁷ It has a comparable

¹⁹⁵ See § IV.A.3; EX1004, [0003].

¹⁹⁶ EX1005, [0012].

¹⁹⁷ EX1005, [0166], [0169]; EX1003, ¶¶ 183, 205.

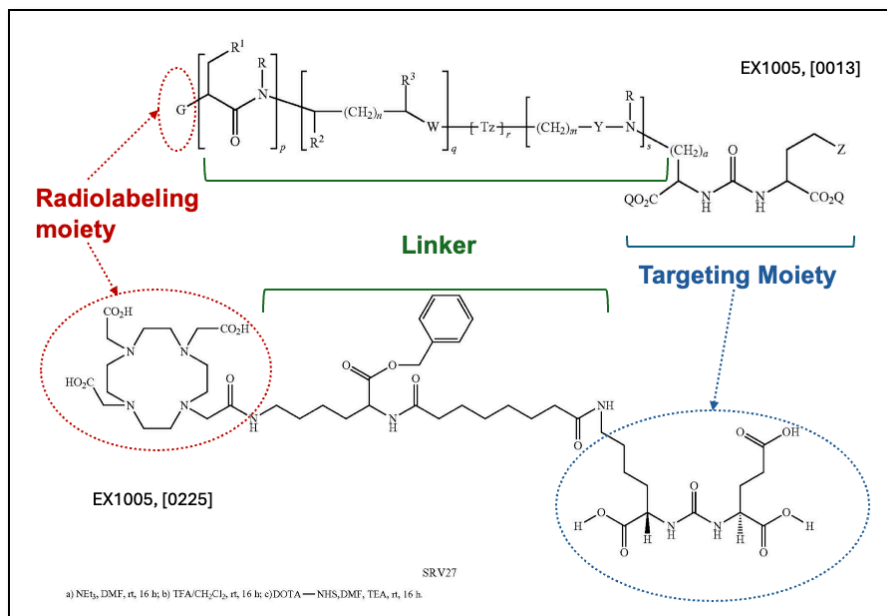
molecular weight to Jansen's compound 60 (*i.e.*, 319 Da vs. 344 Da) (below right).¹⁹⁸



The radiotracers described in US-121 join a urea-based targeting moiety to a chelator using a variety of linkers. These radiotracers share the same modular, three-component design as the claimed radiotracers (illustrated below using generic structure and exemplified compound SRV27)(below).¹⁹⁹

¹⁹⁸ EX1003, ¶ 205.

¹⁹⁹ EX1003, ¶ 183.



US-121 identifies advantages of this modular design, including that it allows one to easily optimize the pharmacokinetics of the radiotracer.²⁰⁰ US-121 provides several other examples of radiotracer compounds that embody this modular three-component structure of the '201 Patent claims.²⁰¹

US-121 explains that its radiotracers can be used with both PET and SPECT devices.²⁰² It identifies advantages of using PET with ⁶⁸Ga-labeled radiotracers,²⁰³ but also describes examples of ^{99m}Tc-based radiotracers being used with SPECT

²⁰⁰ EX1003, ¶ 184; EX1005, [0279](YC27 pharmacokinetics).

²⁰¹ EX1005, [0103], [0207], [0214], [0225], [0244], [0249]-[0250].

²⁰² EX1005, [0184]; EX1003, ¶ 184.

²⁰³ EX1005, [0242], [0011]; EX1003, ¶ 188.

imaging.²⁰⁴ It also explains that “[n]umerous metal chelating moieties are known in the art” and lists several pages of them (*e.g.*, DOTA, DTPA, NOTA),²⁰⁵ and explains that “[a]ny acceptable chelator can be used with the present invention as long as compatible and capable of chelating a desired metal.”²⁰⁶

US-121 explains that linkers “attach the metal chelating moiety to the rest of the compound” and that the linker group may comprise “alkyl, aryl, combination of alkyl and aryl, or alkyl and aryl groups having heteroatoms....”²⁰⁷ US-121 also explains that linkers (or their constituents) can be selected to make a radiotracer compound more hydrophobic, and that such radiotracers “may have longer circulation times, thereby providing more prolonged supply of tracer to bind to cells.”²⁰⁸ For example, US-121 compares two examples of radiotracers (SRV27, SRV100)(below), explaining that one is more lipophilic “which is reasonable in

²⁰⁴ EX1005, [0027], [0214]; EX1003, ¶¶ 189, 197.

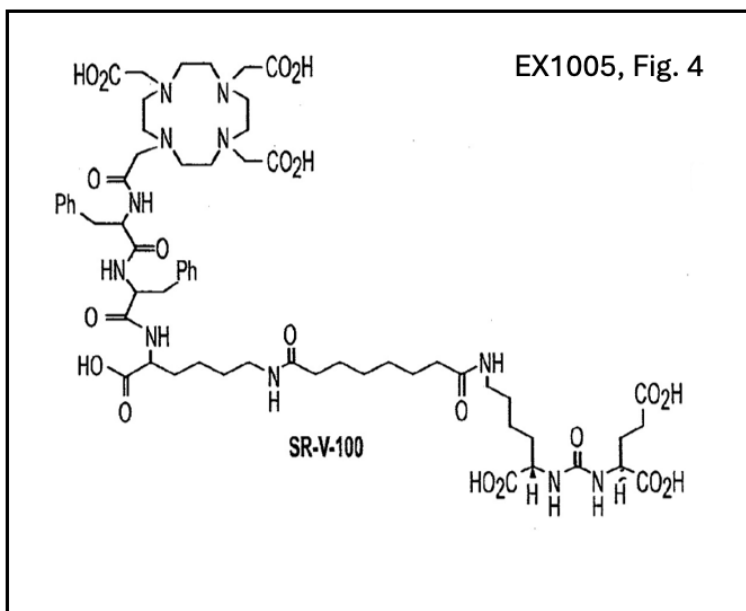
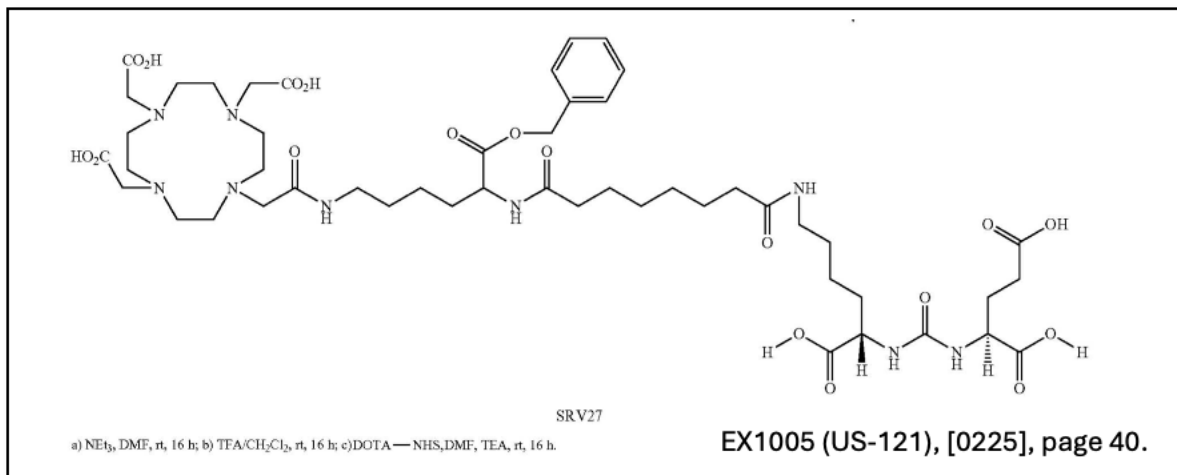
²⁰⁵ EX1005, [0102].

²⁰⁶ EX1005, [0102].

²⁰⁷ EX1005, [0102].

²⁰⁸ EX1005, [0187], [0012]; EX1003, ¶¶ 193, 207.

light of the presence of two phenylalanine residues in the long linker of SRV100, while SRV27 has only one lysine residue protected as the benzyl ester.”²⁰⁹



B. A Skilled Artisan Would Have Considered US-121 with Jansen

US-121 and Jansen would have been considered together by a skilled artisan

²⁰⁹ EX1005, [0231]; Fig. 4.

before 2017.

First, both report developments in the same scientific field—small-molecule inhibitors of enzymes (*i.e.*, PSMA and FAP) that are selectively expressed on the surface of epithelial cells and that were recognized as being appealing targets for imaging and therapy.²¹⁰ For example, US-121 reports that PSMA is “expressed in prostate tumor epithelium” and “in the neovasculature of many solid tumors.”²¹¹ Similarly, Jansen explains that “FAP is highly expressed on activated fibroblasts in over 90% of common human epithelial tumors” and that is one of “appealing characteristics of FAP ... for its ongoing evaluation as a drug target.”²¹²

Second, both publications highlight the importance of selectivity of the small molecule for its targeted cell-surface enzyme.²¹³

Third, a skilled artisan would have recognized that the compounds identified in US-121 and Jansen are not only both small molecule inhibitors of their enzyme targets (PSMA and FAP, respectively), but that they have approximately the same

²¹⁰ EX1003, ¶¶ 179, 199, 201; EX1036, 226-27; § IV.A.3.

²¹¹ EX1005, [0007].

²¹² EX1006, 3053.

²¹³ EX1005, [0240] (selectivity key to accurate imaging); EX1006, 3053 (FAP-PREP selectivity), 3065 (selectivity key attribute).

size (*i.e.*, 319 Da vs. 344 Da).²¹⁴

Finally, a skilled artisan would be prompted to consider development of compound 60-based radiopharmaceuticals based on Jansen's observations about the potential of its compounds to selectively target FAP as a drug target.²¹⁵ Such persons would have found the guidance in US-121 helpful, as it provides examples of particular radiotracer designs useful for tumor imaging to accelerate development of radiotracers adapted to use compound 60 as the targeting moiety.²¹⁶

C. A Skilled Artisan Would Have Modified the US-121 Radiotracers to Use Compound 60 to Target FAP

A skilled artisan, starting with the exemplified radiotracers described in US-121, would have found it obvious to replace the urea-based targeting moiety in them with Compound 60 of Jansen.

First, a skilled artisan would have recognized that a compound 60-based radiotracer could be used for imaging a wider range of tumors than the PSMA-targeting radiotracers, given that FAP was expressed at elevated levels in over 90%

²¹⁴ EX1003, ¶ 205.

²¹⁵ EX1006, 3053, 3065; EX1003, ¶¶ 200, 202-203.

²¹⁶ EX1003, ¶¶ 199, 204, 206.

of epithelial tumors.²¹⁷ More generally, FAP was seen as a particularly promising target for nuclear imaging, which would have encouraged skilled artisans to find radiotracer designs that had proven successful in tumor imaging, such as those in US-121.²¹⁸ This would have motivated the skilled artisan to adapt the PSMA-targeting radiotracers in US-121 to use a FAP targeting moiety, particularly compound 60.²¹⁹

Second, a skilled artisan would have understood from the guidance in US-121 that *any* individual components of the modular, three-component radiotracers being described in US-121 could be altered—including the targeting moiety.²²⁰ Indeed, US-121 invites skilled artisans to modify those individual components of its exemplified radiotracers, stating:

A person skilled in the relevant art will recognize that *other equivalent components can be employed* and other methods developed without departing from the broad concepts of the current invention.²²¹

²¹⁷ EX1003, ¶¶ 202-203, 58.

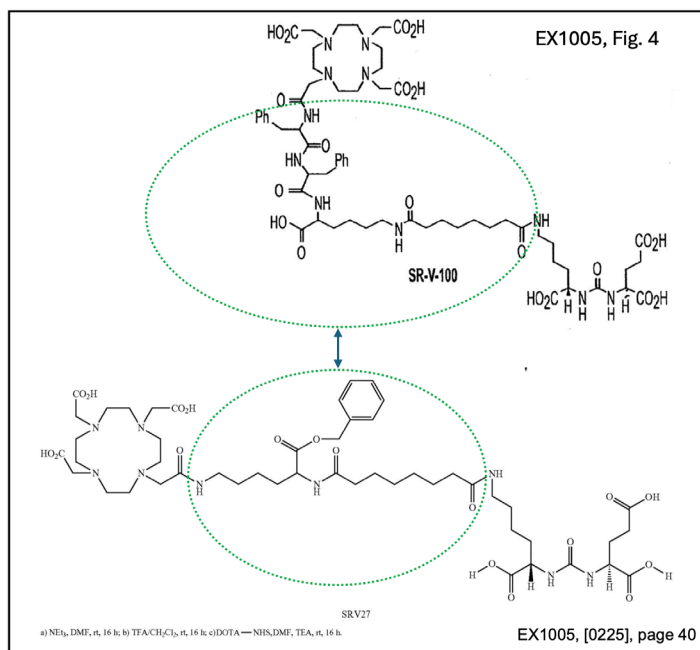
²¹⁸ EX1003, ¶¶ 58-59, 208.

²¹⁹ EX1003, ¶¶ 205-206.

²²⁰ EX1003, ¶¶ 184, 203.

²²¹ EX1005, [0060] (*emphasis added*).

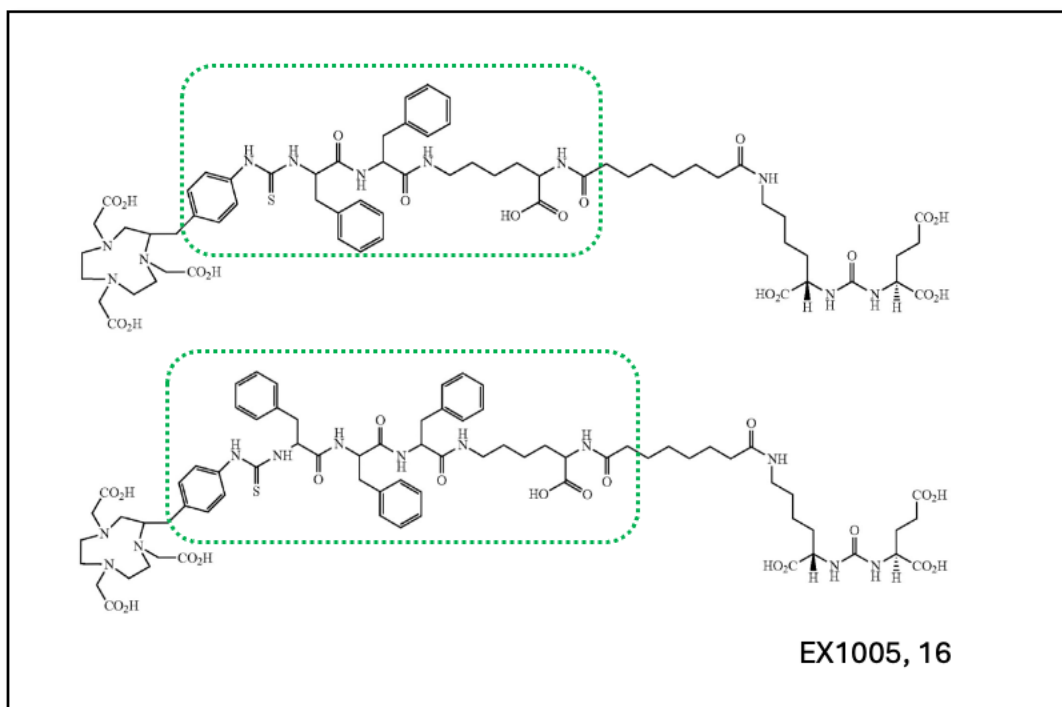
For example, US-121 shows compounds SR-V-100 and SRV27, which share the same targeting and radiolabeling moieties, but use different linkers (below).



Third, US-121 credits the use of particular linkers in radiotracers that had proven successful in imaging tumors: “compounds with increased hydrophobicity, such as compounds having hydrophobic linkers, may have longer circulation times, thereby providing more prolonged supply of tracer to bind to cells.”²²² US-121 also describes series of linkers having varying numbers of pendent benzyl groups to influence their hydrophobic character (below).²²³

²²² EX1005, [0187]; EX1003, ¶¶ 193, 207.

²²³ EX1005, [0103], page 16, *also* 14, 47; EX1003, ¶¶ 206, 36.



The emphasis in US-121 of using particular linkers within radiotracers to achieve benefits in tumor imaging would have motivated a skilled artisan to use the particular combinations of linkers and chelators found in examples of radiotracers in US-121 to produce FAP-targeting radiotracers that use compound 60 as their targeting moiety.²²⁴

Fourth, the skilled artisan would have viewed the substitution of compound 60 for the urea-based PSMA targeting moiety to be straightforward due to their comparable size (*i.e.*, 344 Da vs. 319 Da) and because compound 60 could be functionalized to enable its attachment to particular linker-chelator structures

²²⁴ EX1003, ¶¶ 206-208.

described in US-121 via an amide bond with the same orientation with which the PSMA targeting moiety is attached.²²⁵

Fifth, a skilled artisan would have recognized that small molecule radiotracers have relatively short pharmacokinetic half-lives.²²⁶ Following the established design principle that the radiotracer's half-life should match the half-life of the radionuclide, a skilled artisan would have selected ⁶⁸Ga and ^{99m}Tc as the radionuclide to use in a compound 60-based radiotracer based on examples in US-121.²²⁷ US-121 also highlights the use of ⁶⁸Ga and ^{99m}Tc in its radiotracers.²²⁸ The skilled artisan consequently would have focused on radiotracers in US-121 that include chelators suitable to use with ⁶⁸Ga or ^{99m}Tc.²²⁹ Dr. Zeglis illustrates modifications to four examples of such radiotracers that use compound 60 as the targeting moiety (below).²³⁰

²²⁵ EX1003, ¶ 209.

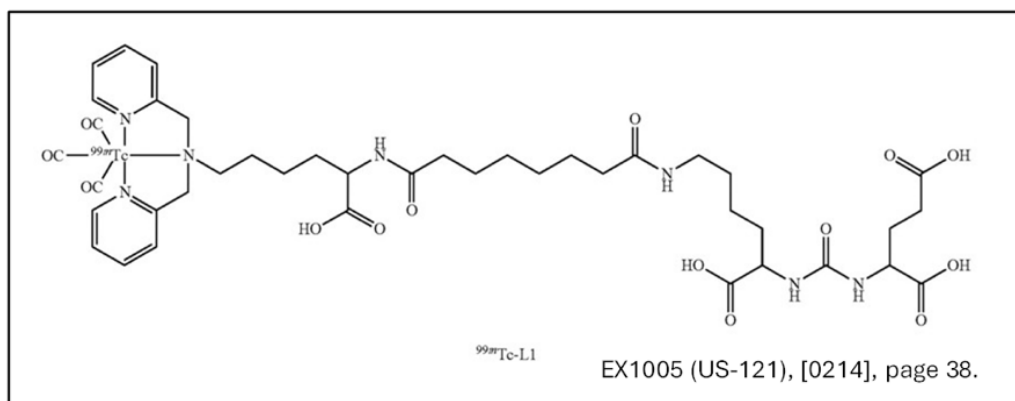
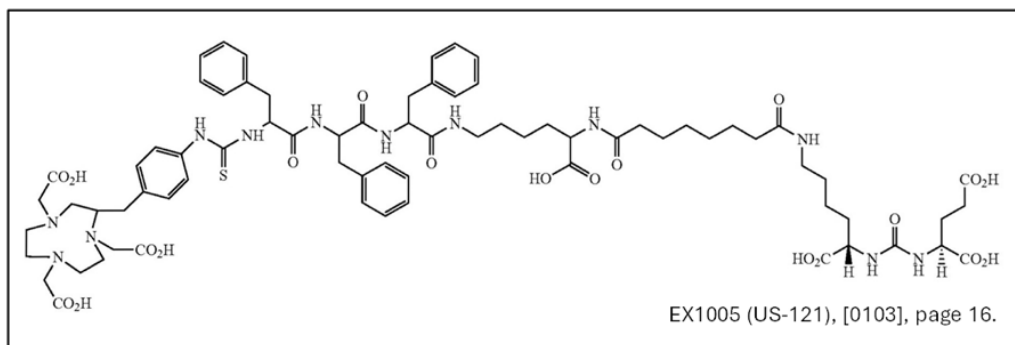
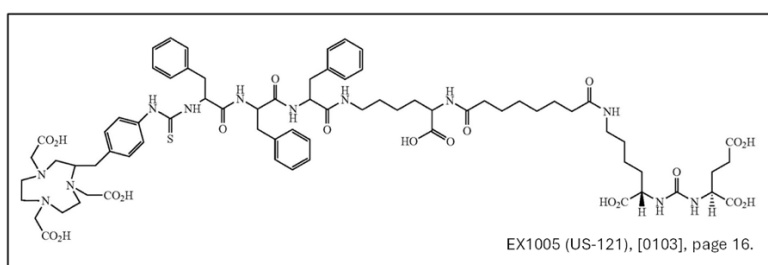
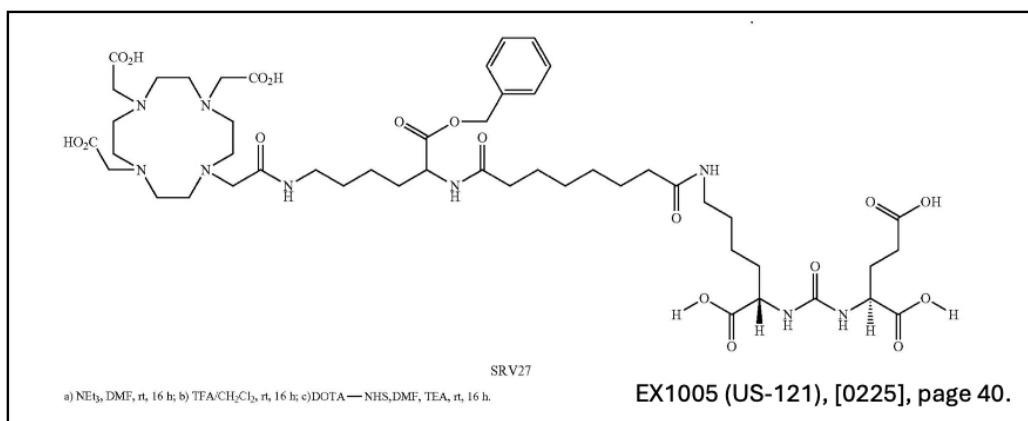
²²⁶ EX1003, ¶ 30.

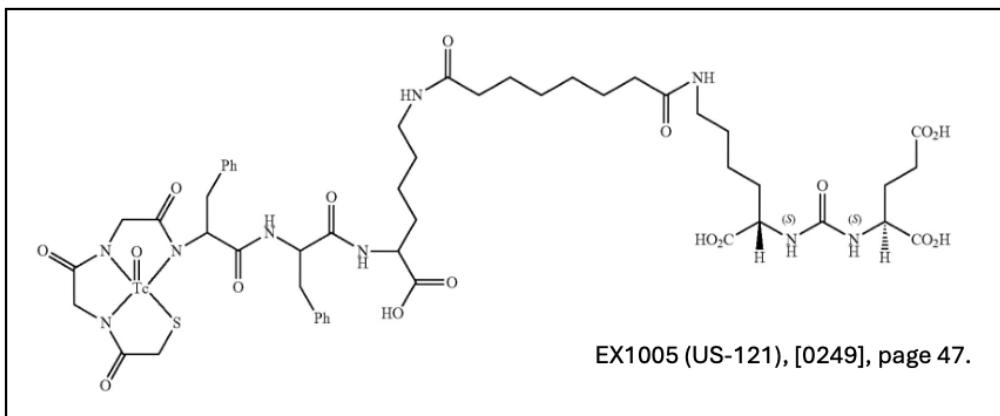
²²⁷ EX1003, ¶¶ 40-41, 188(c).

²²⁸ EX1005, [0011], [0242]; EX1003, ¶¶ 187-188, 197, 204.

²²⁹ EX1003, ¶¶ 189, 195-199.

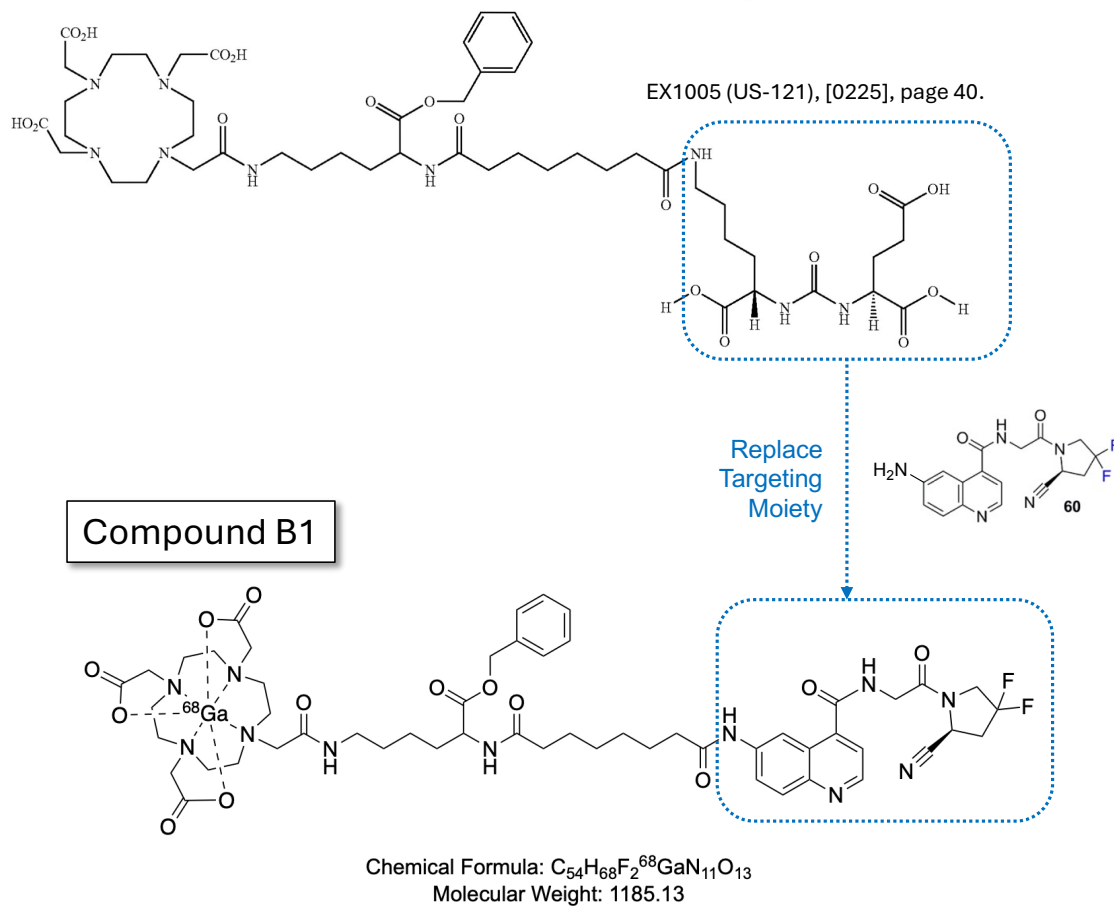
²³⁰ EX1003, ¶¶ 210-211.

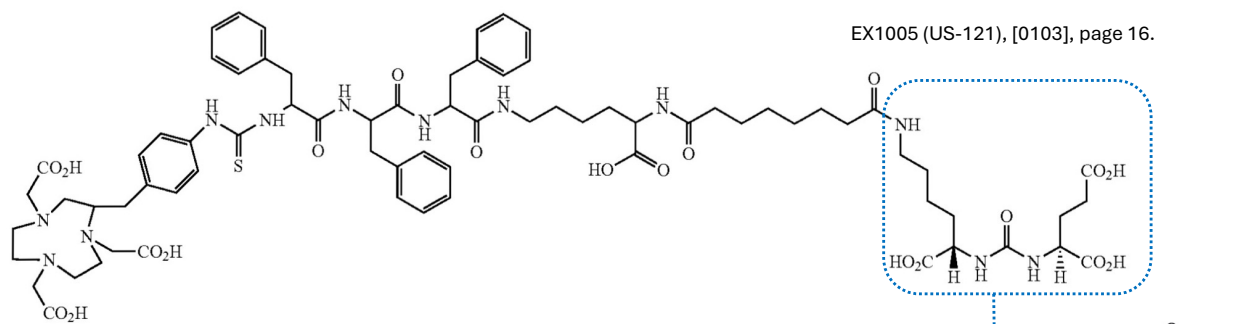




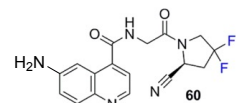
For the reasons provided above, a skilled artisan would have considered it obvious before 2017 to modify the four radiotracers described above (which are depicted in US-121) by replacing the urea-based targeting moiety with compound 60 of Jansen. This could be achieved using a functionalized form of compound 60 having an amine group at position C⁶ (illustrated) or C⁷ which would preserve the orientation of the amide bond in the starting compounds relative to the urea-based targeting moiety.²³¹

²³¹ EX1003, ¶ 209.

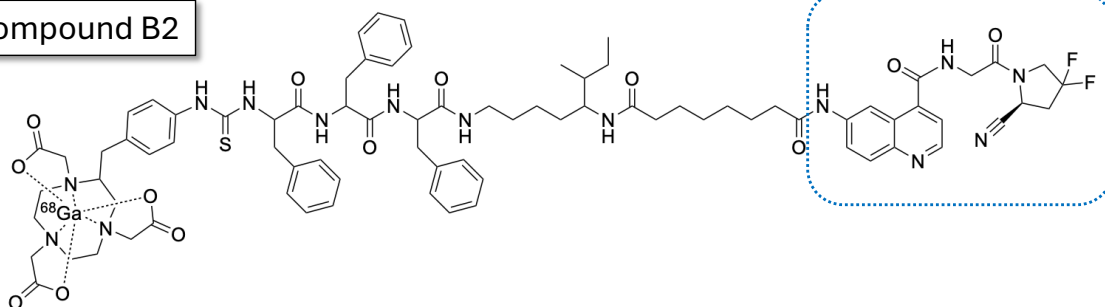




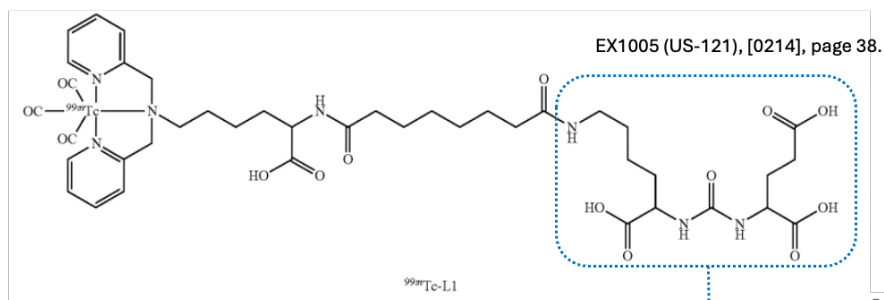
Replace
Targeting
Moiety



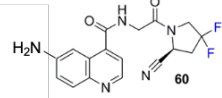
Compound B2



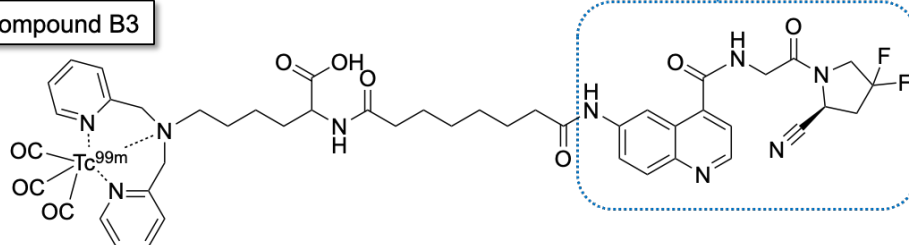
Chemical Formula: $C_{81}H_{97}F_2^{68}GaN_{14}O_{13}S$
Molecular Weight: 1612.74



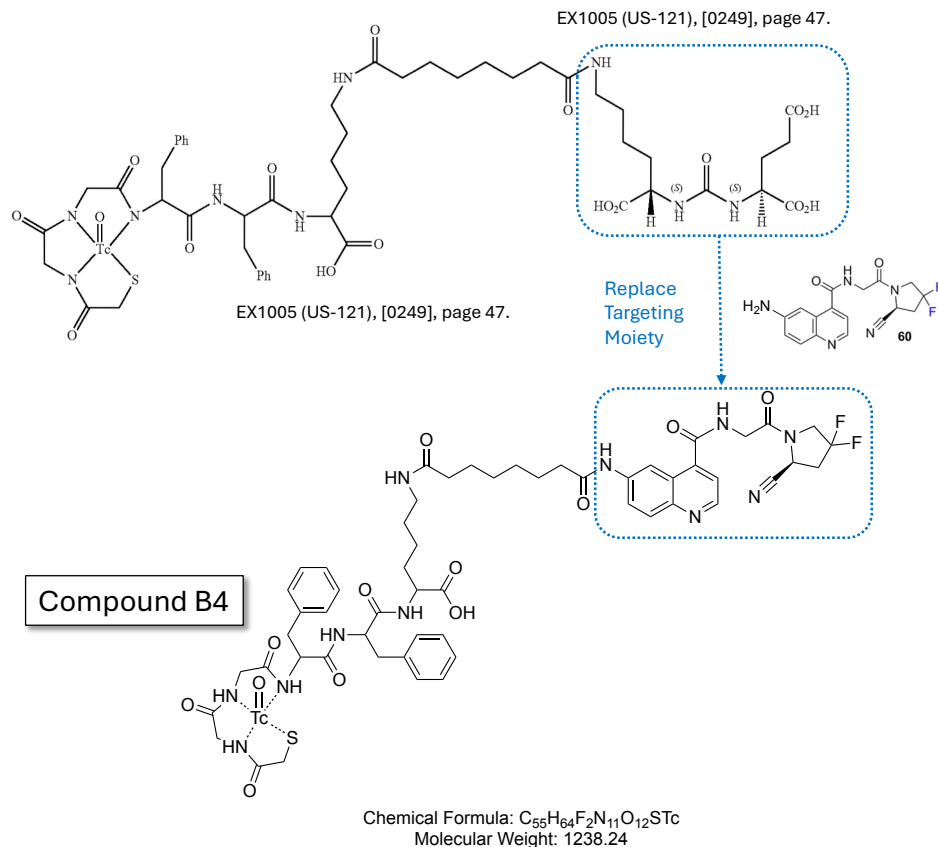
Replace
Targeting
Moiety



Compound B3

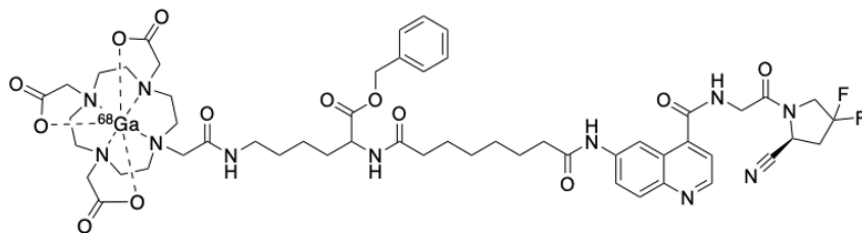


Chemical Formula: $C_{46}H_{49}F_2N_9O_9^{99m}Tc$
Molecular Weight: 1008.86

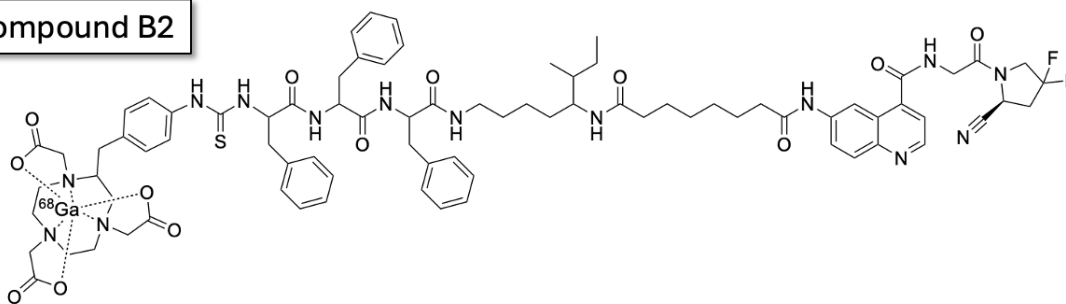


D. Compounds Made Obvious by US-121 and Jansen Meet All Requirements of the Claims

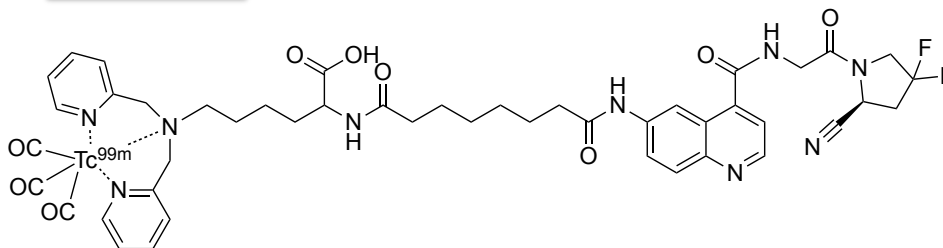
Following the straightforward logic and methodology described in § VI.C, a skilled artisan would have arrived at particular radiotracer compounds that incorporate compound 60 into radiotracer compounds having particular chelator and linker combinations shown in examples of US-121 (*i.e.*, compounds B1 to B4, below).

Compound B1

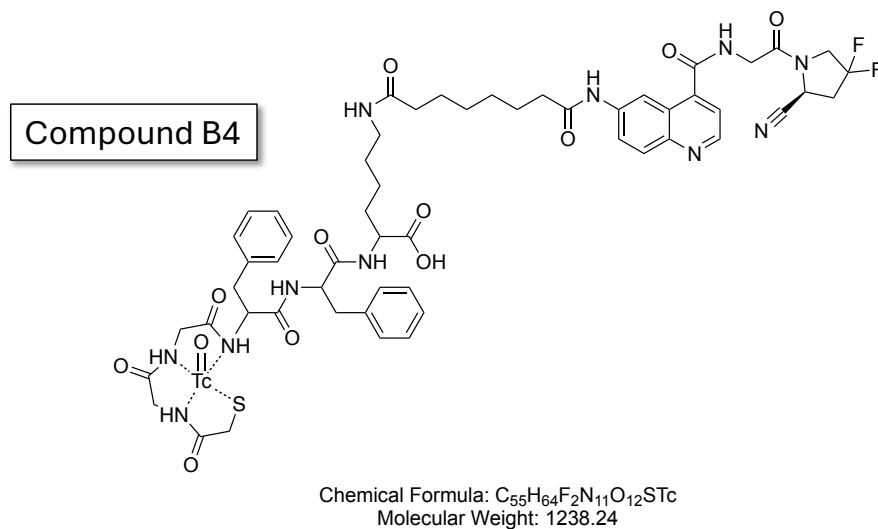
Chemical Formula: $C_{54}H_{68}F_2^{68}GaN_{11}O_{13}$
Molecular Weight: 1185.13

Compound B2

Chemical Formula: $C_{81}H_{97}F_2^{68}GaN_{14}O_{13}S$
Molecular Weight: 1612.74

Compound B3

Chemical Formula: $C_{46}H_{49}F_2N_9O_9^{99}Tc$
Molecular Weight: 1008.86



Each of compounds B1 to B4 falls within the scope of claims 1 to 3 of the '201 Patent.

First, each is a “low molecular weight compound” as each has a molecular weight near or below 1500 Da, which is orders of magnitude smaller than an antibody.²³²

Second, each contains a chelator complexed with either ^{68}Ga or $^{99\text{m}}\text{Tc}$, which is in each instance a “radiolabeled functional group suitable for ...” PET or SPECT imaging that satisfies the “B” component.²³³

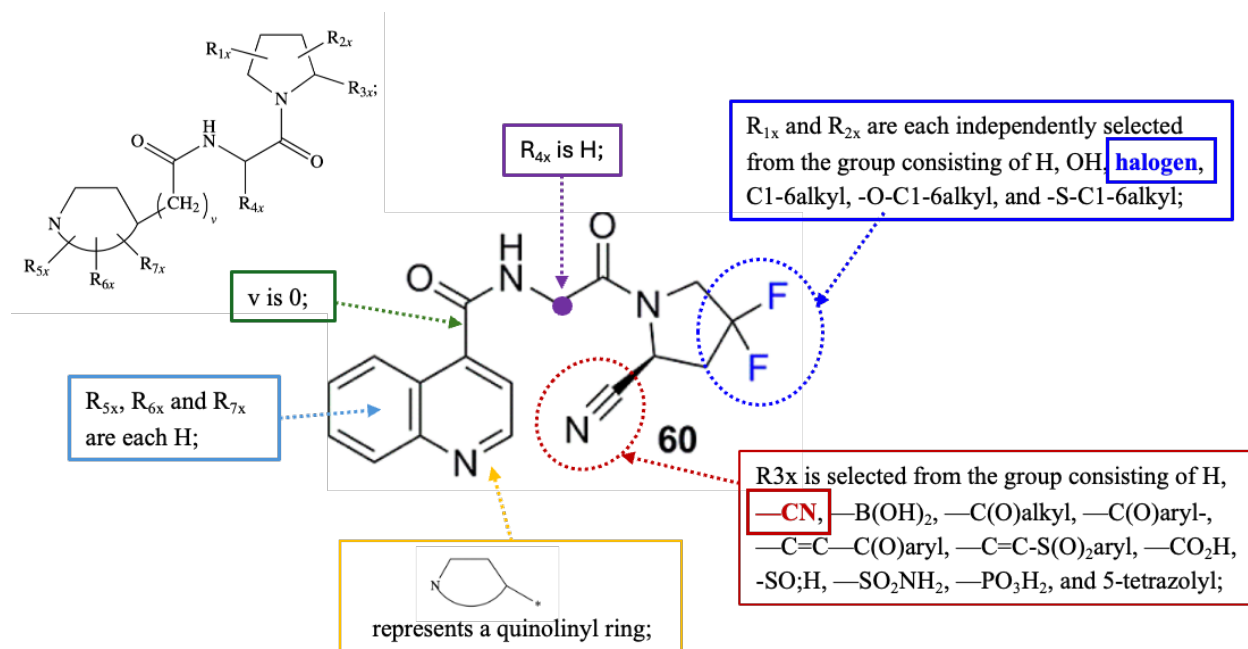
Third, each contains chemical structure that forms distinct chemical bonds with each the radiolabeling moiety (“B”) and compound 60 FAP-targeting moiety

232 EX1003, ¶ 217.

233 EX1003, ¶ 214.

(“A”) components of the compound, and as such, is a “linker having bi-functionalization adapted to form a chemical bond with B and A.”²³⁴

Finally, each contains compound 60, which is a “targeting moiety for FAP- α ” because of its high selectivity and binding affinity for FAP, and which thus meets the requirements of the “A” element of the claims (below).



Skilled artisans would have reasonably expected that compounds B1-B4 would retain the selectivity and affinity of compound 60 because they would have believed: (i) the size of the linker used would position the radiolabeling moiety so as to avoid it affecting the characteristics of the targeting moiety²³⁵ and (ii) based

²³⁴ See § V.E.

²³⁵ EX1003, ¶ 218.

on experimentation by Jansen, attaching the linker at position C⁶ of the quinoliny ring would not alter the characteristics of compound 60 in a way that would affect its selectivity and affinity for FAP.²³⁶

Finally, each of compounds B1 to B4 could be synthesized using straightforward synthetic procedures based on the descriptions in US-121.

Because compounds B1 to B4 each are obvious and within the scope of claims 1-3, each of those claims is unpatentable.

VII. No Secondary Indicia Exist or Are Relevant

Patentee may contend that compounds within the scope of claims 1-3 possess unexpected benefits or other secondary indicia of non-obviousness. Such an assertion has no legal merit. For claims to benefit from secondary considerations evidence, there must be a nexus between the evidence and the claims. Here, the claims capture any possible “B” and “L” component while the “A” component captures prior art compound 60 (along with its attributes). Any secondary considerations thus would be associated with prior art elements, not the claims. To the extent Patentee alleges secondary considerations exist, Petitioner respectfully submits such issues should be addressed after institution.

²³⁶ EX1003, ¶ 142.

VIII. Discretionary Denial Is Not Warranted

Petitioner reserves its right to oppose a request from Patent Owner that the Director exercise his discretion to not institute trial in this proceeding, should such a request be made. Petitioner notes, for example, that there is no litigation involving the '201 Patent pending, making discretionary denial unwarranted under *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11, 5-6 (P.T.A.B. Mar. 20, 2020). In addition, Petitioner promptly sought *inter partes* review after the expiration of the 9-month period following grant of the '201 Patent. Pursuant to the agreement between the parties in connection with that proceeding (IPR2025-00808), Petitioner promptly submitted this petition for *inter partes* review after termination of a third party proceeding involving the "'201 Patent (PGR2025-00012). See § II.B.2 and cited papers therein. For reasons Petitioner can elaborate as necessary, there are no settled expectations regarding the '201 Patent, and Petitioner has acted promptly in seeking *inter parties* review of this patent.

Finally, Patent Owner may contend that discretionary denial is warranted under 35 U.S.C. § 325(d). Petitioner reserves its right to dispute such a contention. For example, the present grounds rely on prior art not used during examination of the '201 Patent in any rejection, and the Examiner made foundational errors about the teachings of the prior art that was used in rejections that resulted in the Examiner's erroneous determination that the claims were patentable over that prior

art. Moreover, the present petition relies on expert testimony not available to the Examiner during examination of the '201 Patent.

As Petitioner can further establish in additional briefing, discretionary denial of this petition is not warranted.

IX. CONCLUSION

For the foregoing reasons, the Board should institute trial in this proceeding and cancel the challenged claims.

Dated: October 21, 2025

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EXHIBIT LIST

No.	Exhibit Description	Short Name
1001	U.S. Patent No. 11,938,201	US-201
1002	File History of U.S. Patent No. 11,938,201	US-201 FW
1003	Declaration of Dr. Brian Zeglis	Zeglis Dec.
1004	U.S. Patent Publication 2010/0098633	US-633
1005	U.S. Patent Publication 2012/0009121	US-121
1006	Jansen et al., “Extended Structure–Activity Relationship and Pharmacokinetic Investigation of (4-Quinolinoyl)glycyl-2-cyanopyrrolidine Inhibitors of Fibroblast Activation Protein (FAP),” J. Med. Chem, 57:3053–3074 (2014)	Jansen
1007	Jansen et al., “Selective Inhibitors of Fibroblast Activation Protein (FAP) with a (4-Quinolinoyl)-glycyl-2-cyanopyrrolidine Scaffold,” ACS Med. Chem. Lett., 4:491–496 (2013)	Jansen 2013
1008	Meletta et al., “Evaluation of the Radiolabeled Boronic Acid-Based FAP Inhibitor MIP-1232 for Atherosclerotic Plaque Imaging,” Molecules, 20:2081–2099 (2015)	Meletta
1009	Jamous et al., “Synthesis of Peptide Radiopharmaceuticals for the Therapy and Diagnosis of Tumor Diseases,” Molecules, 18:3379–3409 (2013)	Jamous
1010	Zeglis et al., “A practical guide to the construction of radiometallated bioconjugates for positron emission tomography,” Dalton Trans., 40(23):6168–6195 (2011)	Zeglis 2011
1011	Zeglis et al., “Underscoring the Influence of Inorganic Chemistry on Nuclear Imaging with Radiometals,” Inorg. Chem., 53:1880–1889 (2013)	Zeglis 2013
1012	Wadas et al., “Coordinating Radiometals of Copper, Gallium, Indium, Yttrium, and	Wadas

No.	Exhibit Description	Short Name
	Zirconium for PET and SPECT Imaging of Disease,” Chem. Rev., 110(5):2858–2902 (2010)	
1013	Price et al., “Matching chelators to radiometals for radiopharmaceuticals,” Chem. Soc. Rev., 43:260–290 (2014)	Price
1014	Riondato et al., “Chapter 4: Radiopharmaceuticals,” Springer International Publishing, (2016)	Riondato
1015	Ross, “The Click Chemistry Approach Applied to Fluorine-18,” Current Radiopharmaceuticals, 3:202–223 (2010)	Ross
1016	Brennen et al., “Rationale Behind Targeting Fibroblast Activation Protein–Expressing Carcinoma-Associated Fibroblasts as a Novel Chemotherapeutic Strategy,” Mol. Cancer Ther., 11(2):257–266 (2012)	Brennen
1017	Sarko et al., “Bifunctional Chelators in the Design and Application of Radiopharmaceuticals for Oncological Diseases,” Current Medicinal Chem., 19:2667–2688 (2012)	Sarko
1018	Fichna et al., “Synthesis of Target-Specific Radiolabeled Peptides for Diagnostic Imaging,” Bioconjugate Chem., 14:3–17 (2003)	Fichna
1019	Schirmacher et al., “Small Prosthetic Groups in ¹⁸ F-Radiochemistry: Useful Auxiliaries for the Design of ¹⁸ F-PET Tracers,” Semin. Nucl. Med., 47(5):474–492 (August 2017)	Schirmacher
1020	Saha et al., “Chapter 8: Synthesis of PET Radiopharmaceuticals,” Springer International Publishing, (2016)	Saha
1021	Kettenbach et al., “ ¹⁸ F-Labeling Using Click Cycloadditions,” BioMed Research International, 2014:1–16 (2014)	Kettenbach

No.	Exhibit Description	Short Name
1022	Liu et al., “Fibroblast activation protein, A potential therapeutic target in cancer,” <i>Cancer Biology & Ther.</i> , 13(3):123–129 (2012)	Liu
1023	DiMagno et al., “Advanced Fibroblast Activation Protein-Ligand Developments, FAP Imaging Agents: A Review of the Structural Requirements,” <i>PET Clin.</i> , 18:287–294 (2023)	DiMagno
1024	Hamson et al., “Understanding fibroblast activation protein (FAP): Substrates, activities, expression and targeting for cancer therapy,” <i>Proteomics Clin. Appl.</i> , 8:454–463 (2014)	Hamson
1025	O’Brien et al., “Seprase: An overview of an important matrix serine protease,” <i>Biochimica et Biophysica Acta</i> , 1784:1130–1145 (2008)	O’Brien
1026	Jia et al., “FAP- α (Fibroblast activation protein- α) is involved in the control of human breast cancer cell line growth and motility via the FAK pathway,” <i>BMC Cell Biology</i> , 15(16): 1–14 (2014)	Jia
1027	Agdeppa et al., “A Review of Imaging Agent Development,” <i>The American Association of Pharmaceutical Scientists (AAPS) J.</i> , 11(2):286–299 (2009)	Agdeppa
1028	Mankoff et al., “Tumor Receptor Imaging,” <i>J. Nucl. Med.</i> , 49:149S–163S (2008)	Mankoff
1029	Ryabtsova et al., “Acylated Gly-(2-cyano)pyrrolidines as inhibitors of fibroblast activation protein (FAP) and the issue of FAP/prolyl oligopeptidase (PREP)-selectivity,” <i>Bioorganic & Medicinal Chemistry Letters</i> , 22(10):3412–3417 (2012)	Ryabtsova
1030	Eder et al., “ ^{68}Ga -Complex Lipophilicity and the Targeting Property of a Urea-Based PSMA Inhibitor for PET Imaging,” <i>Bioconjugate Chem.</i> , 23:688–697 (2012)	Eder

No.	Exhibit Description	Short Name
1032	Fani et al., “Radiolabeled Peptides: Valuable Tools for the Detection and Treatment of Cancer,” <i>Theranostics</i> , 2(5):481–501 (2012)	Fani
1033	Mach et al., “Challenges for Developing PET Tracers: Isotopes, Chemistry, and Regulatory Aspects,” 5(2): 131–153 (2010)	Mach
1034	Meyer et al., “Click Chemistry and Radiochemistry: The First 10 Years,” <i>Bioconjugate Chem.</i> , 27:2791–2807 (2016)	Meyer
1035	Marquis et al., “Abstract #4467: Targeting tumor microenvironment with radiolabeled inhibitors of seprase (FAP\#945;),” <i>Cancer Chem.</i> , 69:4467 (2009)	Marquis
1036	Maurer et al., “Current use of PSMA-PET in prostate cancer management,” <i>Nature Reviews: Urology</i> , 13:226–235 (2016)	Maurer
1037	Karakatsanis et al., “Dosage optimization in positron emission tomography: state-of-the-art methods and future prospects,” <i>Am. J. Nucl. Med. Mol. Imaging</i> , 5(5):527–547 (2015)	Karakatsanis
1038	LeBeau et al., “Targeting the cancer stroma with a fibroblast activation protein-activated promelittin protoxin,” <i>Mol. Cancer Ther.</i> 8(5):1378–1386 (2009)	LeBeau
1039	Nelson et al., “Good practices for ⁶⁸ Ga radiopharmaceutical production,” <i>EJNMMI Radiopharmacy and Chem.</i> , 7(1):1–26 (2022)	Nelson
1040	Meyer et al., “Exploring Structural Parameters for Pretargeting Radioligand Optimization,” <i>J. Med. Chem.</i> , 60:8201–8217 (2017)	Meyer 2017
1041	Gorrell, “Dipeptidyl peptidase IV and related enzymes in cell biology and liver disorders,” <i>Clinical Science</i> , 108:1–16 (2005)	Gorrell

No.	Exhibit Description	Short Name
1042	Kiesewetter et al., “Automated radiochemical synthesis of [^{18}F]FBEM: A thiol reactive synthon for radiofluorination of peptides and proteins,” Appl. Radiation and Isotopes, 69(2): 410–414 (2011)	Kiesewetter
1043	Chansaenpak et al., “[^{18}F]-NHC- BF_3 adducts as water stable radio-prosthetic groups for PET imaging,” Chem. Commun., 51(62):12439–12442 (2015)	Chansaenpak
1044	U.S. Patent Publication 2014/0357650	US-650
1045	Ji et al., “Tumor fibroblast specific activation of a hybrid ferritin nanocage-based optical probe for tumor microenvironment imaging,” Small J., 9(14):2427–2431 (2013)	Ji
1046	Wilson et al., “Chapter 1, Dipeptidyl Peptidases: Substrates and Therapeutic Targeting in Human Health and Disease,” Royal Society of Chemistry, (2012)	Wilson
1047	Tsai et al., “Substituted 4-carboxymethylpyroglutamic Acid Diamides as Potent and Selective Inhibitors of Fibroblast Activation Protein,” J. Med. Chem. 53(18):6572–6583 (2010)	Tsai
1048	International Publication 2010/108125	US-121 PCT
1051	Harris et al., “Impact of 2-Deoxy-2[^{18}F]Fluoro-D-Glucose Positron Emission Tomography on the Management of Patients with Advanced Melanoma,” Mol. Imaging Biol., 7(4):304–308 (2005)	Harris
1052	Zhou et al., “Radiolabeled Cyclic RGD Peptides as Radiotracers for Imaging Tumors and Thrombosis by SPECT,” Theranostics, 1:58-82 (2011)	Zhou

CERTIFICATE OF COMPLIANCE

I hereby certify that this brief complies with the type-volume limitations of 37 C.F.R. § 42.24, because it contains 12,987 words (as determined by the Microsoft Word word-processing system used to prepare the brief), excluding the parts of the brief exempted by 37 C.F.R. § 42.24.

Dated: October 21, 2025

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), I hereby certify that on this 21st day of October, 2025, I caused to be served a true and correct copy of the foregoing and any accompanying exhibits by FedEx on the following counsel:

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Respectfully Submitted,
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