**Supporting Information.**

# Synthesis and Evaluation of Radioligands for Imaging Brain Nociceptin/Orphanin FQ Peptide (NOP) Receptors with Positron Emission Tomography

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## X-ray crystallographic determination of the absolute configuration of the biologically more active enantiomer of 9c

### Sample Preparation

Single crystals were grown by slow evaporation of a solution of the biologically more active enantiomer of **9c** in ethanol/water (50/50, v/v).

### Description of Crystal Structure

A single crystal was mounted on a thin fiber at −173 °C. Data were collected using a $CuK_\alpha$ radiation source (λ = 1.54178 Å) and a Bruker D8 based 3-circle goniometer diffractometer equipped with a SMART 6000CCD area detector[1]. Cell refinement and data reduction were performed using the *SAINT* program V7.68A[2]. The unit cell was indexed, having orthorhombic parameters of a = 7.4629(2) Å, b = 9.80302(2) Å, and c = 27.7482(5) Å. The cell volume of crystal structure was 2030.03(8) $Å^3$. The calculated density of the structure is 1.330 $g/cm^3$ at −173 °C. The structure was solved by direct methods[2]. All atomic parameters were independently refined. The space group choice, that is $P2_12_12_1$, was confirmed by successful convergence of the full-matrix least-squares refinement on $F^2$ (refernce 3) with a final goodness of fit of 1.035. The final residual factor, $R_1$, was = 0.0390 and the largest difference peak and hole after the final refinement cycle were 0.174 and −0.258 ($e.A^{-3}$), respectively. The absolute stereochemistry was determined by refinement of the absolute structure parameter to 0.01(2), indicating the stereochemistry of the molecule depicted[4].

### Conclusion

A single crystal structure was obtained and showed the stereocenter to possess the *S* configuration by using the anomalous scattering contribution of the heavy atom (sulfur). A thermal ellipsoid representation of **9c** is shown at −173 °C in Figure S1. A photomicrograph shows that the morphology of the single crystals was bladed (Figure S2).

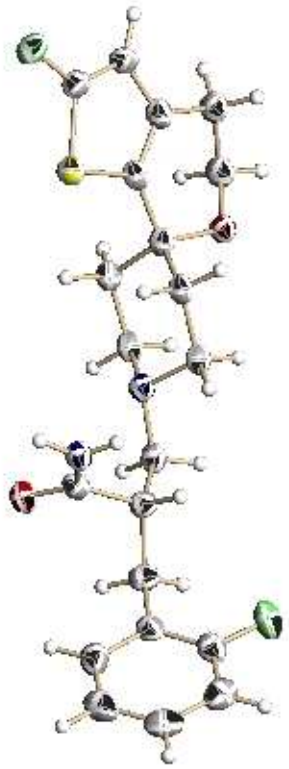


**Figure S1**. Thermal ellipsoid representation of biologically active enantiomer of **9c**, showing *S*-configuration.

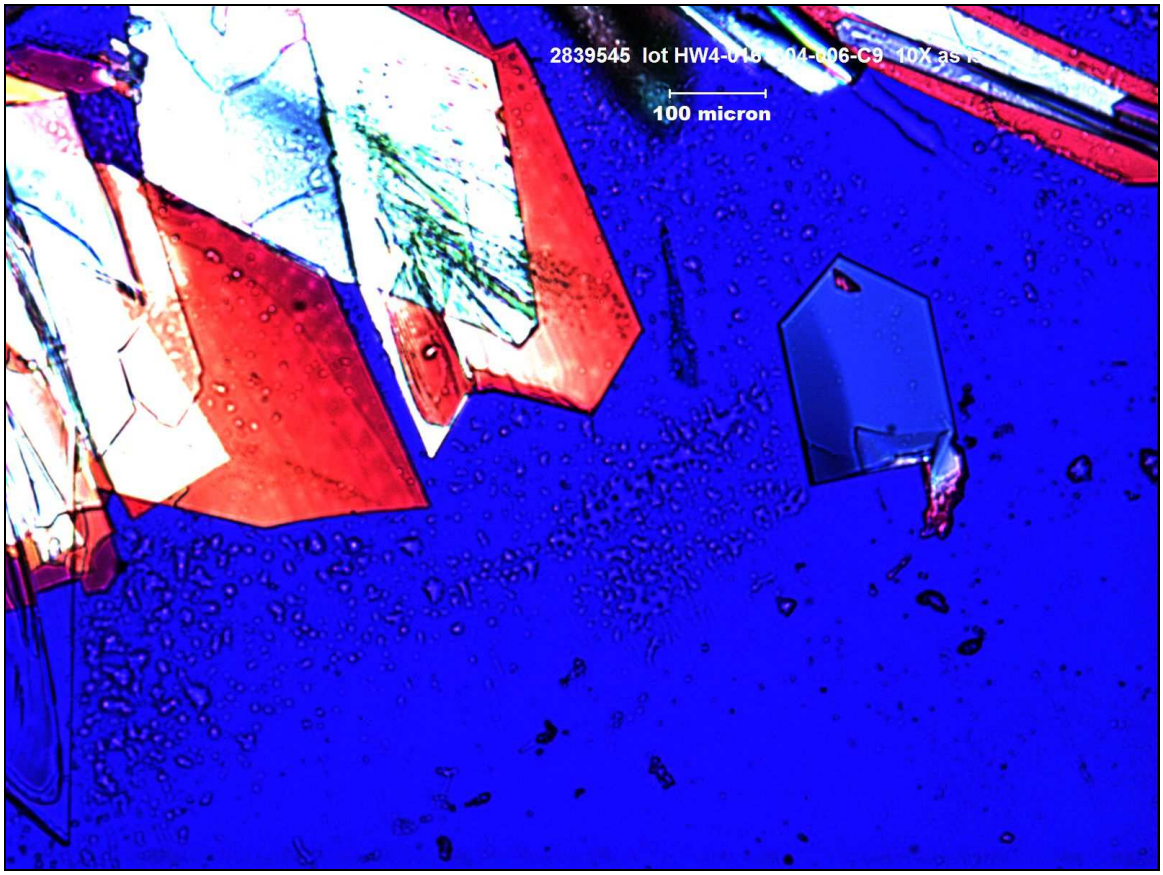



**Figure S2**. Photomicrograph of crystals of **(*S*)-9c**.

**Table S1.** Crystal data and structure refinement for (***S***)**-9c.**

| | | |
|---|---|---|
| Identification code | 10022_0m | |
| Empirical formula | $C_{21}H_{24}F_2N_2O_2S$ | |
| Formula weight | 406.48 | |
| Temperature | 100(2) K | |
| Wavelength | 1.54178 Å | |
| Crystal system | Orthorhombic | |
| Space group | P2(1)2(1)2(1) | |
| Unit cell dimensions | a = 7.4629(2) Å | α= 90°. |
| | b = 9.8030(2) Å | β= 90°. |
| | c = 27.7482(5) Å | γ = 90°. |
| Volume | 2030.03(8) $Å^3$ | |
| Z | 4 | |
| Density (calculated) | 1.330 $Mg/m^3$ | |
| Absorption coefficient | 1.739 $mm^{-1}$ | |
| F(000) | 856 | |
| Crystal size | 0.15 x 0.08 x 0.01 $mm^3$ | |
| Theta range for data collection | 3.19 to 71.99°. | |
| Index ranges | -8<=h<=5, -10<=k<=11, -33<=l<=30 | |
| Reflections collected | 8471 | |
| Independent reflections | 3589 [R(int) = 0.0333] | |
| Completeness to theta = 71.99° | 92.8 % | |
| Absorption correction | None | |
| Max. and min. transmission | 0.9828 and 0.7805 | |
| Refinement method | Full-matrix least-squares on $F^2$ | |
| Data / restraints / parameters | 3589 / 0 / 262 | |
| Goodness-of-fit on $F^2$ | 1.035 | |
| Final R indices [I>2sigma(I)] | R1 = 0.0390, wR2 = 0.0974 | |
| R indices (all data) | R1 = 0.0467, wR2 = 0.1031 | |
| Absolute structure parameter | 0.01(2) | |
| Largest diff. peak and hole | 0.174 and -0.258 $e.Å^{-3}$ | |

**Table S2.** Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($Å^2 \times 10^3$) for 10022_0m. U(eq) is defined as one third of the trace of the orthogonalized $U^{ij}$ tensor.

| | x | y | z | U(eq) |
|---|---|---|---|---|
| S(1) | 7684(1) | 702(1) | 593(1) | 34(1) |
| C(2) | 9774(3) | 576(3) | 863(1) | 31(1) |
| O(4) | 11841(2) | 482(2) | 1520(1) | 32(1) |
| C(7) | 11126(3) | 779(3) | 543(1) | 34(1) |
| C(3) | 9984(3) | 263(3) | 1390(1) | 30(1) |
| C(9) | 8704(4) | 1016(3) | 45(1) | 34(1) |
| C(8) | 10491(4) | 1038(3) | 66(1) | 34(1) |
| C(5) | 13107(4) | -84(3) | 1180(1) | 36(1) |
| C(6) | 13035(4) | 665(3) | 705(1) | 37(1) |
| F(9) | 7659(2) | 1176(2) | -345(1) | 40(1) |
| N(12) | 8196(3) | -516(2) | 2290(1) | 30(1) |
| C(13) | 8915(3) | 858(2) | 2232(1) | 31(1) |
| C(10) | 9397(4) | -1198(2) | 1507(1) | 32(1) |
| C(14) | 8927(3) | 1261(3) | 1704(1) | 30(1) |
| C(11) | 9359(4) | -1492(2) | 2044(1) | 31(1) |
| C(16) | 6291(4) | -169(3) | 3012(1) | 32(1) |
| C(15) | 7950(3) | -859(3) | 2798(1) | 33(1) |
| C(17) | 4726(4) | -429(2) | 2671(1) | 31(1) |
| O(17) | 4126(2) | -1586(2) | 2619(1) | 36(1) |
| N(18) | 4103(3) | 655(2) | 2429(1) | 33(1) |
| C(19) | 5928(4) | -766(3) | 3514(1) | 36(1) |
| C(20) | 4589(4) | 42(3) | 3807(1) | 32(1) |
| C(23) | 2190(4) | 1543(3) | 4373(1) | 46(1) |
| C(24) | 1587(4) | 466(3) | 4101(1) | 46(1) |
| C(21) | 5125(4) | 1132(3) | 4087(1) | 37(1) |
| C(22) | 3981(4) | 1893(3) | 4370(1) | 44(1) |
| C(25) | 2773(4) | -276(3) | 3821(1) | 41(1) |
| F(21) | 6901(2) | 1470(2) | 4093(1) | 49(1) |

**Table S3.** Bond lengths [Å] and angles [°] for 10022_0m.

| **Bond lengths** | | **Angles** | |
|---|---|---|---|
| S(1)-C(9) | 1.727(3) | C(9)-S(1)-C(2) | 89.79(12) |
| S(1)-C(2) | 1.735(3) | C(7)-C(2)-C(3) | 126.1(2) |
| C(2)-C(7) | 1.359(4) | C(7)-C(2)-S(1) | 112.02(19) |
| C(2)-C(3) | 1.504(4) | C(3)-C(2)-S(1) | 121.91(19) |
| O(4)-C(5) | 1.446(3) | C(5)-O(4)-C(3) | 114.03(18) |
| O(4)-C(3) | 1.447(3) | C(2)-C(7)-C(8) | 112.7(2) |
| C(7)-C(8) | 1.428(4) | C(2)-C(7)-C(6) | 119.9(2) |
| C(7)-C(6) | 1.499(4) | C(8)-C(7)-C(6) | 127.4(2) |
| C(3)-C(14) | 1.528(3) | O(4)-C(3)-C(2) | 108.1(2) |
| C(3)-C(10) | 1.533(3) | O(4)-C(3)-C(14) | 104.97(19) |
| C(9)-C(8) | 1.335(4) | C(2)-C(3)-C(14) | 111.7(2) |
| C(9)-F(9) | 1.343(3) | O(4)-C(3)-C(10) | 111.1(2) |
| C(5)-C(6) | 1.509(4) | C(2)-C(3)-C(10) | 111.5(2) |
| N(12)-C(13) | 1.458(3) | C(14)-C(3)-C(10) | 109.3(2) |
| N(12)-C(11) | 1.461(3) | C(8)-C(9)-F(9) | 127.8(2) |
| N(12)-C(15) | 1.460(3) | C(8)-C(9)-S(1) | 113.9(2) |
| C(13)-C(14) | 1.518(3) | F(9)-C(9)-S(1) | 118.24(19) |
| C(10)-C(11) | 1.518(3) | C(9)-C(8)-C(7) | 111.6(2) |
| C(16)-C(17) | 1.524(4) | O(4)-C(5)-C(6) | 111.0(2) |
| C(16)-C(15) | 1.531(4) | C(7)-C(6)-C(5) | 109.4(2) |
| C(16)-C(19) | 1.535(3) | C(13)-N(12)-C(11) | 109.58(19) |
| C(17)-O(17) | 1.228(3) | C(13)-N(12)-C(15) | 111.40(19) |
| C(17)-N(18) | 1.340(3) | C(11)-N(12)-C(15) | 111.97(19) |
| C(19)-C(20) | 1.512(4) | N(12)-C(13)-C(14) | 110.4(2) |
| C(20)-C(21) | 1.380(4) | C(11)-C(10)-C(3) | 112.9(2) |
| C(20)-C(25) | 1.391(4) | C(13)-C(14)-C(3) | 112.7(2) |
| C(23)-C(24) | 1.375(5) | N(12)-C(11)-C(10) | 110.2(2) |
| C(23)-C(22) | 1.379(5) | C(17)-C(16)-C(15) | 107.8(2) |
| C(24)-C(25) | 1.383(4) | C(17)-C(16)-C(19) | 111.3(2) |
| C(21)-F(21) | 1.366(3) | C(15)-C(16)-C(19) | 109.1(2) |
| C(21)-C(22) | 1.380(4) | N(12)-C(15)-C(16) | 112.0(2) |
| | | O(17)-C(17)-N(18) | 123.2(2) |
| | | O(17)-C(17)-C(16) | 120.4(2) |
| | | N(18)-C(17)-C(16) | 116.4(2) |
| | | C(20)-C(19)-C(16) | 113.9(2) |
| | | C(21)-C(20)-C(25) | 116.1(3) |
| | | C(21)-C(20)-C(19) | 121.1(2) |
| | | C(25)-C(20)-C(19) | 122.8(2) |
| | | C(24)-C(23)-C(22) | 120.3(3) |
| | | C(23)-C(24)-C(25) | 120.2(3) |
| | | F(21)-C(21)-C(20) | 118.4(2) |
| | | F(21)-C(21)-C(22) | 117.5(3) |
| | | C(20)-C(21)-C(22) | 124.1(3) |
| | | C(23)-C(22)-C(21) | 117.9(3) |
| | | C(24)-C(25)-C(20) | 121.4(3) |

Symmetry transformations used to generate equivalent atoms:

**Table S4.** Anisotropic displacement parameters ($Å^2 \times 10^3$) for 10022_0m. The anisotropic displacement factor exponent takes the form: $-2\pi^2[ h^2 a^{*2} U^{11} + ... + 2 h k a^* b^* U^{12} ]$.

| | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{23}$ | $U^{13}$ | $U^{12}$ |
|---|---|---|---|---|---|---|
| S(1) | 27(1) | 42(1) | 33(1) | 2(1) | -2(1) | 1(1) |
| C(2) | 23(1) | 31(1) | 39(1) | 0(1) | 0(1) | 1(1) |
| O(4) | 25(1) | 37(1) | 34(1) | -2(1) | -2(1) | 0(1) |
| C(7) | 28(1) | 35(1) | 38(1) | -2(1) | 0(1) | 0(1) |
| C(3) | 23(2) | 32(1) | 34(1) | -2(1) | -4(1) | 2(1) |
| C(9) | 36(2) | 34(1) | 31(1) | 0(1) | -2(1) | -1(1) |
| C(8) | 30(2) | 40(1) | 33(1) | -3(1) | 5(1) | 1(1) |
| C(5) | 25(2) | 40(1) | 41(1) | -3(1) | 0(1) | 3(1) |
| C(6) | 27(2) | 44(2) | 40(1) | -4(1) | -1(1) | 1(1) |
| F(9) | 40(1) | 49(1) | 33(1) | 0(1) | -8(1) | 4(1) |
| N(12) | 29(1) | 30(1) | 31(1) | 1(1) | -2(1) | 0(1) |
| C(13) | 31(2) | 26(1) | 36(1) | -2(1) | -3(1) | 0(1) |
| C(10) | 28(2) | 30(1) | 37(1) | -4(1) | -1(1) | 2(1) |
| C(14) | 25(1) | 30(1) | 37(1) | -1(1) | -2(1) | 0(1) |
| C(11) | 28(2) | 28(1) | 38(1) | 0(1) | -3(1) | 1(1) |
| C(16) | 32(2) | 33(1) | 30(1) | 2(1) | -1(1) | 1(1) |
| C(15) | 30(2) | 33(1) | 36(1) | 1(1) | -6(1) | -1(1) |
| C(17) | 28(2) | 31(1) | 33(1) | 1(1) | 3(1) | 0(1) |
| O(17) | 34(1) | 31(1) | 44(1) | 1(1) | -4(1) | -2(1) |
| N(18) | 30(1) | 31(1) | 37(1) | 2(1) | -4(1) | -1(1) |
| C(19) | 38(2) | 40(1) | 31(1) | 4(1) | 0(1) | 4(1) |
| C(20) | 32(2) | 36(1) | 29(1) | 6(1) | -2(1) | -1(1) |
| C(23) | 50(2) | 48(2) | 38(1) | 7(1) | 8(1) | 16(1) |
| C(24) | 32(2) | 59(2) | 48(2) | 13(1) | 0(1) | 5(1) |
| C(21) | 37(2) | 34(1) | 40(1) | 9(1) | -1(1) | -2(1) |
| C(22) | 56(2) | 36(1) | 39(1) | -1(1) | -3(1) | 5(1) |
| C(25) | 41(2) | 42(2) | 40(1) | 2(1) | -7(1) | -4(1) |
| F(21) | 39(1) | 43(1) | 64(1) | 3(1) | -6(1) | -10(1) |

**Table S5**. Hydrogen coordinates ($\times 10^4$) and isotropic displacement parameters ($Å^2 \times 10^3$) for 10022_0m.

| | x | y | z | U(eq) |
|---|---|---|---|---|
| H(8) | 11247 | 1204 | -204 | 41 |
| H(5A) | 12831 | -1060 | 1126 | 43 |
| H(5B) | 14332 | -21 | 1315 | 43 |
| H(6A) | 13558 | 1587 | 743 | 45 |
| H(6B) | 13744 | 166 | 461 | 45 |
| H(13A) | 10151 | 893 | 2362 | 37 |
| H(13B) | 8173 | 1511 | 2417 | 37 |
| H(10A) | 8187 | -1354 | 1372 | 38 |
| H(10B) | 10229 | -1845 | 1349 | 38 |
| H(14A) | 9457 | 2182 | 1672 | 37 |
| H(14B) | 7677 | 1306 | 1586 | 37 |
| H(11A) | 8914 | -2430 | 2100 | 38 |
| H(11B) | 10588 | -1428 | 2176 | 38 |
| H(16) | 6506 | 834 | 3039 | 38 |
| H(15A) | 9023 | -573 | 2981 | 39 |
| H(15B) | 7829 | -1861 | 2830 | 39 |
| H(19A) | 5478 | -1710 | 3477 | 43 |
| H(19B) | 7072 | -811 | 3694 | 43 |
| H(23) | 1370 | 2049 | 4565 | 55 |
| H(24) | 353 | 230 | 4104 | 56 |
| H(22) | 4412 | 2636 | 4557 | 52 |
| H(25) | 2338 | -1019 | 3635 | 49 |
| H(18A) | 3260(30) | 480(20) | 2200(8) | 13(6) |
| H(18B) | 4610(40) | 1470(30) | 2434(10) | 29(7) |

**Table S6.** Torsion angles [°] for 10022_0m.

| | |
|---|---|
| C(9)-S(1)-C(2)-C(7) | 0.5(2) |
| C(9)-S(1)-C(2)-C(3) | -179.0(2) |
| C(3)-C(2)-C(7)-C(8) | 179.2(2) |
| S(1)-C(2)-C(7)-C(8) | -0.3(3) |
| C(3)-C(2)-C(7)-C(6) | 1.5(4) |
| S(1)-C(2)-C(7)-C(6) | -178.02(19) |
| C(5)-O(4)-C(3)-C(2) | -44.9(3) |
| C(5)-O(4)-C(3)-C(14) | -164.3(2) |
| C(5)-O(4)-C(3)-C(10) | 77.7(2) |
| C(7)-C(2)-C(3)-O(4) | 11.2(3) |
| S(1)-C(2)-C(3)-O(4) | -169.35(16) |
| C(7)-C(2)-C(3)-C(14) | 126.2(3) |
| S(1)-C(2)-C(3)-C(14) | -54.3(3) |
| C(7)-C(2)-C(3)-C(10) | -111.2(3) |
| S(1)-C(2)-C(3)-C(10) | 68.3(3) |
| C(2)-S(1)-C(9)-C(8) | -0.6(2) |
| C(2)-S(1)-C(9)-F(9) | 177.9(2) |
| F(9)-C(9)-C(8)-C(7) | -177.8(2) |
| S(1)-C(9)-C(8)-C(7) | 0.5(3) |
| C(2)-C(7)-C(8)-C(9) | -0.1(3) |
| C(6)-C(7)-C(8)-C(9) | 177.4(3) |
| C(3)-O(4)-C(5)-C(6) | 67.7(3) |
| C(2)-C(7)-C(6)-C(5) | 17.2(3) |
| C(8)-C(7)-C(6)-C(5) | -160.1(3) |
| O(4)-C(5)-C(6)-C(7) | -49.4(3) |
| C(11)-N(12)-C(13)-C(14) | 63.0(3) |
| C(15)-N(12)-C(13)-C(14) | -172.5(2) |
| O(4)-C(3)-C(10)-C(11) | 66.9(3) |
| C(2)-C(3)-C(10)-C(11) | -172.5(2) |
| C(14)-C(3)-C(10)-C(11) | -48.5(3) |
| N(12)-C(13)-C(14)-C(3) | -56.8(3) |
| O(4)-C(3)-C(14)-C(13) | -70.7(2) |
| C(2)-C(3)-C(14)-C(13) | 172.4(2) |
| C(10)-C(3)-C(14)-C(13) | 48.6(3) |
| C(13)-N(12)-C(11)-C(10) | -62.8(3) |
| C(15)-N(12)-C(11)-C(10) | 173.1(2) |
| C(3)-C(10)-C(11)-N(12) | 56.4(3) |
| C(13)-N(12)-C(15)-C(16) | 76.3(3) |
| C(11)-N(12)-C(15)-C(16) | -160.6(2) |
| C(17)-C(16)-C(15)-N(12) | 49.2(3) |
| C(19)-C(16)-C(15)-N(12) | 170.1(2) |
| C(15)-C(16)-C(17)-O(17) | 67.5(3) |
| C(19)-C(16)-C(17)-O(17) | -52.1(3) |

| | |
|---|---|
| C(15)-C(16)-C(17)-N(18) | -110.6(2) |
| C(19)-C(16)-C(17)-N(18) | 129.8(2) |
| C(17)-C(16)-C(19)-C(20) | -74.1(3) |
| C(15)-C(16)-C(19)-C(20) | 167.1(2) |
| C(16)-C(19)-C(20)-C(21) | -86.7(3) |
| C(16)-C(19)-C(20)-C(25) | 94.8(3) |
| C(22)-C(23)-C(24)-C(25) | 0.0(4) |
| C(25)-C(20)-C(21)-F(21) | 178.8(2) |
| C(19)-C(20)-C(21)-F(21) | 0.1(4) |
| C(25)-C(20)-C(21)-C(22) | 0.0(4) |
| C(19)-C(20)-C(21)-C(22) | -178.6(2) |
| C(24)-C(23)-C(22)-C(21) | 0.0(4) |
| F(21)-C(21)-C(22)-C(23) | -178.8(2) |
| C(20)-C(21)-C(22)-C(23) | 0.0(4) |
| C(23)-C(24)-C(25)-C(20) | -0.1(4) |
| C(21)-C(20)-C(25)-C(24) | 0.1(4) |
| C(19)-C(20)-C(25)-C(24) | 178.7(3) |

Symmetry transformations used to generate equivalent atoms:

## X-Ray crystallographic determination of the absolute configuration of the biologically less active enantiomer of 9a

### Sample Preparation

Single crystals were grown by adding approximately 50 mg of the biologically less active enantiomer of **9a** to a small vial. To the vial, approximately of water-saturated ethyl acetate (0.75mL) was added to dissolve the compound. The sample was set aside to evaporate. Large single crystals grew on the side of the vial as the sample evaporated to dryness. The single crystals were isolated and a sample was isolated for single crystal analysis.

### Description of Crystal Structure

A single crystal was mounted on a thin fiber at −173 °C. Data were collected using a $CuK_\alpha$ radiation source ($\lambda$ = 1.54178 Å) and a Bruker D8 based 3-circle goniometer diffractometer equipped with a SMART 6000CCD area detector[1]. Cell refinement and data reduction were performed using the *SAINT* program V7.68°.[2] The unit cell was indexed, having monoclinic parameters of a = 9.9155(8) Å, b = 19.9332(16) Å, and c = 11.6883(10) Å and $\beta$ = 95.439(3)°. The cell volume of crystal structure was 2299.8(3) $Å^3$. The calculated density of the structure is 1.293 $g/cm^3$ at −173 °C. The structure was solved by direct methods.[2] All atomic parameters were independently refined. The chiral space group choice, that is $P2_1$, was confirmed by successful convergence of the full-matrix least-squares refinement on $F^2$ (reference 3) with a final goodness of fit of 1.027. The final residual factor, $R_1$, was = 0.0534 and the largest difference peak and hole after the final refinement cycle were 0.381 and -0.265 ($e.A^{-3}$), respectively. The absolute stereochemistry was determined by refinement of the absolute structure parameter to -0.02(3), indicating the stereochemistry of the molecule depicted.[4]

### Conclusion

A single crystal structure has been obtained and shows the stereocenter to possess the *R* configuration by using the anomalous scattering contribution of the heavy atom (sulfur) and

refinement of its absolute structure parameter that resulted in a value of -0.02(2). A thermal ellipsoid representation of **9a** is shown at – 173 °C in Figure S3.

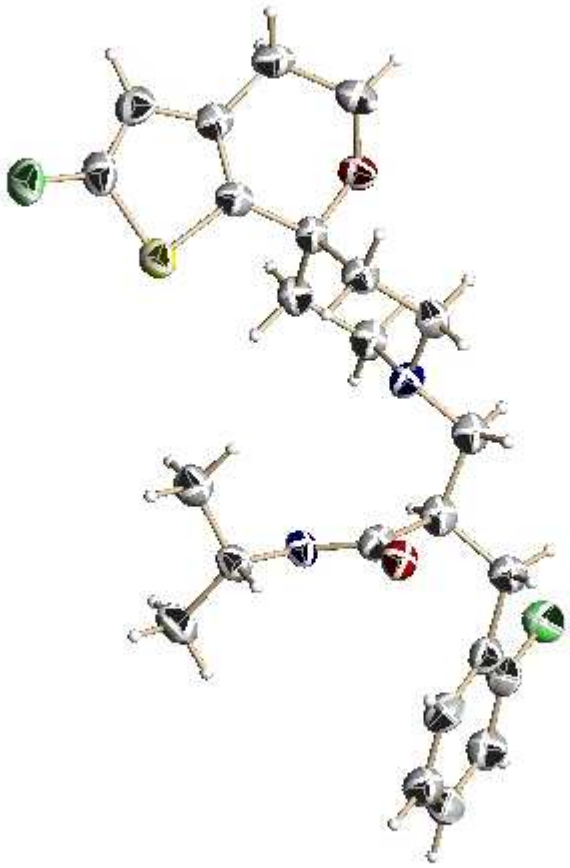


**Figure S3.** Thermal ellipsoid representation of biologically less active enantiomer of **9a**, showing *R*-configuration

**Table S7.** Crystal data and structure refinement for 09061_0m (lot V19E0077172-027).

| | | |
|---|---|---|
| Identification code | 09061_0m | |
| Empirical formula | $C_{24}H_{30}F_2N_2O_2S$ | |
| Formula weight | 448.56 | |
| Temperature | 100(2) K | |
| Wavelength | 1.54178 Å | |
| Crystal system | Monoclinic | |
| Space group | P2(1) | |
| Unit cell dimensions | a = 9.9155(8) Å | α = 90°. |
| | b = 19.9332(16) Å | β = 95.439(3)°. |
| | c = 11.6883(10) Å | γ = 90°. |
| Volume | 2299.8(3) $Å^3$ | |
| Z | 4 | |
| Density (calculated) | 1.296 $Mg/m^3$ | |
| Absorption coefficient | 1.582 $mm^{-1}$ | |
| F(000) | 952 | |
| Crystal size | 0.20 x 0.05 x 0.05 $mm^3$ | |
| Theta range for data collection | 10.54 to 58.63°. | |
| Index ranges | -10<=h<=10, -21<=k<=21, -12<=l<=12 | |
| Reflections collected | 9779 | |
| Independent reflections | 5642 [R(int) = 0.0763] | |
| Completeness to theta = 58.63° | 95.9 % | |
| Absorption correction | None | |
| Max. and min. transmission | 0.9251 and 0.7426 | |
| Refinement method | Full-matrix least-squares on $F^2$ | |
| Data / restraints / parameters | 5642 / 1 / 564 | |
| Goodness-of-fit on $F^2$ | 1.036 | |
| Final R indices [I>2sigma(I)] | R1 = 0.0525, wR2 = 0.1246 | |
| R indices (all data) | R1 = 0.0710, wR2 = 0.1365 | |
| Absolute structure parameter | -0.02(2) | |
| Largest diff. peak and hole | 0.381 and -0.265 e.$Å^{-3}$ | |

**Table S8.** Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($Å^2 \times 10^3$) for 09061_0m. U(eq) is defined as one third of the trace of the orthogonalized $U^{ij}$ tensor.

| | x | y | z | U(eq) |
|---|---|---|---|---|
| S(1A) | 4363(1) | 6453(1) | 3837(1) | 41(1) |
| S(1B) | -155(1) | 5020(1) | 5688(1) | 45(1) |
| F(19B) | 1562(3) | 9438(2) | 10111(3) | 50(1) |
| O(7B) | -790(3) | 6833(2) | 4172(3) | 40(1) |
| F(2A) | 4016(3) | 7620(2) | 4850(3) | 53(1) |
| F(2B) | 258(4) | 3842(2) | 4754(3) | 63(1) |
| O(24B) | -1337(3) | 7034(2) | 9802(3) | 41(1) |
| F(19A) | 3106(3) | 4393(2) | -374(3) | 58(1) |
| N(25A) | 4241(4) | 1980(2) | 683(3) | 33(1) |
| N(12A) | 5309(4) | 4053(2) | 2566(3) | 35(1) |
| N(12B) | -851(4) | 7288(2) | 7111(4) | 36(1) |
| C(13A) | 6240(4) | 4229(3) | 3587(5) | 38(1) |
| O(7A) | 4255(3) | 4578(2) | 5146(3) | 41(1) |
| O(24A) | 6465(3) | 2234(2) | 997(3) | 44(1) |
| N(25B) | 829(4) | 6766(2) | 9550(4) | 34(1) |
| C(2B) | -28(5) | 4491(3) | 4539(5) | 48(1) |
| C(24B) | -225(4) | 7181(3) | 9462(4) | 36(1) |
| C(19B) | 1448(5) | 8996(3) | 10991(5) | 39(1) |
| C(5A) | 3997(5) | 5364(3) | 6673(5) | 44(1) |
| C(23A) | 4677(5) | 3067(3) | -1843(5) | 42(1) |
| C(2A) | 4098(4) | 6951(3) | 5000(5) | 39(1) |
| C(15A) | 5563(5) | 3361(3) | 2259(5) | 37(1) |
| C(27B) | 620(5) | 5616(3) | 8847(5) | 47(1) |
| C(17A) | 5395(5) | 3580(3) | 114(5) | 41(1) |
| C(3A) | 3980(4) | 6614(3) | 5970(5) | 40(1) |
| C(16B) | -42(5) | 7864(3) | 8932(5) | 39(1) |
| C(6B) | -1564(5) | 6570(3) | 3160(4) | 44(1) |
| C(11B) | 346(4) | 7307(3) | 6447(5) | 39(1) |
| C(8A) | 4556(4) | 5052(3) | 4280(4) | 35(1) |
| C(18A) | 4474(5) | 3525(3) | -993(5) | 40(1) |
| C(10B) | 542(5) | 6626(3) | 5912(5) | 38(1) |
| C(10A) | 3628(5) | 4855(3) | 3212(4) | 38(1) |
| C(4A) | 4091(4) | 5905(3) | 5779(5) | 39(1) |
| C(13B) | -2062(4) | 7152(3) | 6319(5) | 38(1) |

| | | | | |
|---|---|---|---|---|
| C(21B) | 2173(5) | 8636(3) | 12875(5) | 46(1) |
| C(11A) | 3885(5) | 4143(3) | 2830(5) | 37(1) |
| C(22A) | 3771(5) | 3008(3) | -2831(5) | 44(1) |
| C(20A) | 2431(5) | 3886(3) | -2141(5) | 44(1) |
| C(9A) | 4314(4) | 5740(3) | 4709(4) | 35(1) |
| C(19A) | 3331(5) | 3932(3) | -1186(4) | 40(1) |
| C(14A) | 6027(4) | 4944(3) | 3966(4) | 39(1) |
| C(28A) | 3419(5) | 846(3) | 1004(6) | 56(2) |
| C(21A) | 2648(5) | 3418(3) | -2971(5) | 46(1) |
| C(24A) | 5261(5) | 2413(3) | 909(4) | 35(1) |
| C(9B) | -501(4) | 5686(3) | 4734(4) | 36(1) |
| C(26A) | 4443(5) | 1269(3) | 454(5) | 39(1) |
| C(6A) | 4765(5) | 4768(3) | 6285(4) | 42(1) |
| C(26B) | 745(5) | 6060(3) | 9884(4) | 38(1) |
| C(16A) | 4912(5) | 3147(3) | 1064(5) | 38(1) |
| C(3B) | -234(5) | 4785(3) | 3517(5) | 46(1) |
| C(14B) | -1970(4) | 6465(3) | 5799(4) | 37(1) |
| C(20B) | 2261(5) | 9082(3) | 11985(5) | 47(1) |
| C(5B) | -833(5) | 5982(3) | 2693(5) | 45(1) |
| C(8B) | -702(4) | 6392(3) | 5143(4) | 35(1) |
| C(15B) | -965(5) | 7888(3) | 7791(5) | 41(1) |
| C(27A) | 4365(6) | 1154(3) | -832(6) | 59(2) |
| C(18B) | 478(5) | 8493(3) | 10826(5) | 40(1) |
| C(17B) | -421(5) | 8427(3) | 9715(5) | 40(1) |
| C(23B) | 419(5) | 8052(3) | 11732(5) | 46(1) |
| C(22B) | 1263(6) | 8115(3) | 12749(5) | 51(1) |
| C(28B) | 1952(5) | 5881(4) | 10726(5) | 55(2) |
| C(4B) | -514(4) | 5488(3) | 3636(4) | 38(1) |

**Table S9.** Bond lengths [Å] and angles [°] for 09061_0m. (Symmetry transformations used to generate equivalent atoms)

| **Bond lengths** | | **Bond angles** | |
|---|---|---|---|
| S(1A)-C(2A) | 1.722(6) | C(2A)-S(1A)-C(9A) | 89.6(3) |
| S(1A)-C(9A) | 1.753(5) | C(2B)-S(1B)-C(9B) | 89.5(3) |
| S(1B)-C(2B) | 1.721(6) | C(8B)-O(7B)-C(6B) | 114.4(4) |
| S(1B)-C(9B) | 1.746(5) | C(24A)-N(25A)-C(26A) | 123.2(4) |
| F(19B)-C(19B) | 1.367(6) | C(15A)-N(12A)-C(13A) | 108.3(4) |
| O(7B)-C(8B) | 1.432(6) | C(15A)-N(12A)-C(11A) | 110.9(4) |
| O(7B)-C(6B) | 1.446(7) | C(13A)-N(12A)-C(11A) | 109.7(4) |
| F(2A)-C(2A) | 1.348(6) | C(15B)-N(12B)-C(13B) | 113.3(4) |
| F(2B)-C(2B) | 1.342(7) | C(15B)-N(12B)-C(11B) | 112.0(4) |
| O(24B)-C(24B) | 1.242(6) | C(13B)-N(12B)-C(11B) | 108.8(4) |
| F(19A)-C(19A) | 1.354(7) | N(12A)-C(13A)-C(14A) | 111.4(4) |
| N(25A)-C(24A) | 1.336(7) | C(6A)-O(7A)-C(8A) | 113.8(4) |
| N(25A)-C(26A) | 1.459(7) | C(24B)-N(25B)-C(26B) | 123.7(4) |
| N(12A)-C(15A) | 1.455(7) | C(3B)-C(2B)-F(2B) | 127.2(6) |
| N(12A)-C(13A) | 1.481(7) | C(3B)-C(2B)-S(1B) | 114.5(4) |
| N(12A)-C(11A) | 1.484(6) | F(2B)-C(2B)-S(1B) | 118.3(4) |
| N(12B)-C(15B) | 1.448(7) | O(24B)-C(24B)-N(25B) | 122.9(5) |
| N(12B)-C(13B) | 1.470(7) | O(24B)-C(24B)-C(16B) | 119.2(4) |
| N(12B)-C(11B) | 1.478(6) | N(25B)-C(24B)-C(16B) | 117.9(4) |
| C(13A)-C(14A) | 1.512(8) | C(20B)-C(19B)-F(19B) | 118.5(4) |
| O(7A)-C(6A) | 1.430(7) | C(20B)-C(19B)-C(18B) | 123.8(5) |
| O(7A)-C(8A) | 1.435(6) | F(19B)-C(19B)-C(18B) | 117.7(4) |
| O(24A)-C(24A) | 1.241(6) | C(6A)-C(5A)-C(4A) | 106.8(4) |
| N(25B)-C(24B) | 1.329(6) | C(18A)-C(23A)-C(22A) | 121.7(5) |
| N(25B)-C(26B) | 1.465(7) | C(3A)-C(2A)-F(2A) | 126.9(5) |
| C(2B)-C(3B) | 1.329(9) | C(3A)-C(2A)-S(1A) | 114.4(4) |
| C(24B)-C(16B) | 1.514(8) | F(2A)-C(2A)-S(1A) | 118.7(4) |
| C(19B)-C(20B) | 1.361(8) | N(12A)-C(15A)-C(16A) | 114.7(4) |
| C(19B)-C(18B) | 1.389(7) | C(18A)-C(17A)-C(16A) | 112.1(4) |
| C(5A)-C(6A) | 1.504(8) | C(2A)-C(3A)-C(4A) | 110.4(5) |
| C(5A)-C(4A) | 1.510(8) | C(24B)-C(16B)-C(17B) | 111.8(4) |
| C(23A)-C(18A) | 1.378(8) | C(24B)-C(16B)-C(15B) | 107.3(4) |
| C(23A)-C(22A) | 1.399(8) | C(17B)-C(16B)-C(15B) | 109.7(4) |
| C(2A)-C(3A) | 1.332(8) | O(7B)-C(6B)-C(5B) | 110.0(4) |
| C(15A)-C(16A) | 1.542(8) | N(12B)-C(11B)-C(10B) | 109.5(4) |
| C(27B)-C(26B) | 1.497(8) | O(7A)-C(8A)-C(9A) | 108.5(4) |
| C(17A)-C(18A) | 1.515(8) | O(7A)-C(8A)-C(10A) | 104.9(4) |
| C(17A)-C(16A) | 1.520(8) | C(9A)-C(8A)-C(10A) | 114.0(4) |
| C(3A)-C(4A) | 1.437(8) | O(7A)-C(8A)-C(14A) | 109.8(4) |
| C(16B)-C(17B) | 1.517(8) | C(9A)-C(8A)-C(14A) | 113.1(4) |
| C(16B)-C(15B) | 1.545(8) | C(10A)-C(8A)-C(14A) | 106.1(4) |
| C(6B)-C(5B) | 1.507(8) | C(23A)-C(18A)-C(19A) | 116.2(5) |
| C(11B)-C(10B) | 1.516(8) | C(23A)-C(18A)-C(17A) | 123.1(5) |
| C(8A)-C(9A) | 1.488(8) | C(19A)-C(18A)-C(17A) | 120.6(5) |
| C(8A)-C(10A) | 1.530(7) | C(11B)-C(10B)-C(8B) | 112.9(4) |
| C(8A)-C(14A) | 1.552(7) | C(11A)-C(10A)-C(8A) | 112.0(4) |
| C(18A)-C(19A) | 1.395(7) | C(9A)-C(4A)-C(3A) | 114.3(5) |

| | | | |
|---|---|---|---|
| C(10B)-C(8B) | 1.529(7) | C(9A)-C(4A)-C(5A) | 120.0(5) |
| C(10A)-C(11A) | 1.516(7) | C(3A)-C(4A)-C(5A) | 125.7(5) |
| C(4A)-C(9A) | 1.332(7) | N(12B)-C(13B)-C(14B) | 110.1(4) |
| C(13B)-C(14B) | 1.506(8) | C(22B)-C(21B)-C(20B) | 119.7(5) |
| C(21B)-C(22B) | 1.374(8) | N(12A)-C(11A)-C(10A) | 111.4(4) |
| C(21B)-C(20B) | 1.377(8) | C(21A)-C(22A)-C(23A) | 119.7(5) |
| C(22A)-C(21A) | 1.379(8) | C(19A)-C(20A)-C(21A) | 119.2(5) |
| C(20A)-C(19A) | 1.365(8) | C(4A)-C(9A)-C(8A) | 126.2(5) |
| C(20A)-C(21A) | 1.378(8) | C(4A)-C(9A)-S(1A) | 111.2(4) |
| C(28A)-C(26A) | 1.511(8) | C(8A)-C(9A)-S(1A) | 122.5(4) |
| C(24A)-C(16A) | 1.519(8) | F(19A)-C(19A)-C(20A) | 118.7(4) |
| C(9B)-C(4B) | 1.341(7) | F(19A)-C(19A)-C(18A) | 117.9(5) |
| C(9B)-C(8B) | 1.506(8) | C(20A)-C(19A)-C(18A) | 123.4(5) |
| C(26A)-C(27A) | 1.516(9) | C(13A)-C(14A)-C(8A) | 111.1(4) |
| C(26B)-C(28B) | 1.518(7) | C(20A)-C(21A)-C(22A) | 119.8(5) |
| C(3B)-C(4B) | 1.438(8) | O(24A)-C(24A)-N(25A) | 122.4(5) |
| C(14B)-C(8B) | 1.541(7) | O(24A)-C(24A)-C(16A) | 119.7(4) |
| C(5B)-C(4B) | 1.489(8) | N(25A)-C(24A)-C(16A) | 117.9(4) |
| C(18B)-C(23B) | 1.382(8) | C(4B)-C(9B)-C(8B) | 126.0(5) |
| C(18B)-C(17B) | 1.510(8) | C(4B)-C(9B)-S(1B) | 111.8(4) |
| C(23B)-C(22B) | 1.393(8) | C(8B)-C(9B)-S(1B) | 122.1(4) |
| | | N(25A)-C(26A)-C(28A) | 110.8(4) |
| | | N(25A)-C(26A)-C(27A) | 109.5(4) |
| | | C(28A)-C(26A)-C(27A) | 111.3(5) |
| | | O(7A)-C(6A)-C(5A) | 110.2(4) |
| | | N(25B)-C(26B)-C(27B) | 110.8(4) |
| | | N(25B)-C(26B)-C(28B) | 109.7(5) |
| | | C(27B)-C(26B)-C(28B) | 112.7(5) |
| | | C(17A)-C(16A)-C(24A) | 111.6(4) |
| | | C(17A)-C(16A)-C(15A) | 111.8(4) |
| | | C(24A)-C(16A)-C(15A) | 107.1(4) |
| | | C(2B)-C(3B)-C(4B) | 111.0(5) |
| | | C(13B)-C(14B)-C(8B) | 111.7(4) |
| | | C(19B)-C(20B)-C(21B) | 119.2(5) |
| | | C(4B)-C(5B)-C(6B) | 108.8(4) |
| | | O(7B)-C(8B)-C(9B) | 108.8(4) |
| | | O(7B)-C(8B)-C(10B) | 105.3(4) |
| | | C(9B)-C(8B)-C(10B) | 110.4(4) |
| | | O(7B)-C(8B)-C(14B) | 110.2(4) |
| | | C(9B)-C(8B)-C(14B) | 112.6(4) |
| | | C(10B)-C(8B)-C(14B) | 109.2(4) |
| | | N(12B)-C(15B)-C(16B) | 112.2(4) |
| | | C(23B)-C(18B)-C(19B) | 115.5(5) |
| | | C(23B)-C(18B)-C(17B) | 122.7(5) |
| | | C(19B)-C(18B)-C(17B) | 121.8(5) |
| | | C(18B)-C(17B)-C(16B) | 115.1(4) |
| | | C(18B)-C(23B)-C(22B) | 122.1(5) |
| | | C(21B)-C(22B)-C(23B) | 119.7(6) |
| | | C(9B)-C(4B)-C(3B) | 113.2(5) |
| | | C(9B)-C(4B)-C(5B) | 119.7(5) |
| | | C(3B)-C(4B)-C(5B) | 127.0(5) |

**Table S9.** Anisotropic displacement parameters ($Å^2 x\ 10^3$) for 09061_0m. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

| | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{23}$ | $U^{13}$ | $U^{12}$ |
|---|---|---|---|---|---|---|
| S(1A) | 45(1) | 34(1) | 44(1) | 1(1) | 3(1) | -1(1) |
| S(1B) | 52(1) | 35(1) | 47(1) | 1(1) | -4(1) | -1(1) |
| F(19B) | 52(2) | 44(2) | 52(2) | 2(2) | 0(1) | -10(1) |
| O(7B) | 44(2) | 38(2) | 36(2) | 2(2) | 1(2) | -5(2) |
| F(2A) | 61(2) | 33(2) | 65(2) | -4(2) | 2(2) | 4(1) |
| F(2B) | 80(2) | 36(2) | 70(2) | -9(2) | -9(2) | 7(2) |
| O(24B) | 30(2) | 43(2) | 50(2) | -3(2) | 1(1) | -1(1) |
| F(19A) | 64(2) | 53(2) | 59(2) | -7(2) | 9(2) | 9(2) |
| N(25A) | 28(2) | 30(2) | 42(2) | 3(2) | 0(2) | 5(2) |
| N(12A) | 32(2) | 35(2) | 38(2) | -2(2) | 0(2) | 1(2) |
| N(12B) | 31(2) | 37(2) | 39(2) | -8(2) | 5(2) | -2(2) |
| C(13A) | 28(2) | 38(3) | 47(3) | -5(2) | -4(2) | 1(2) |
| O(7A) | 46(2) | 40(2) | 38(2) | 2(2) | 4(2) | -4(2) |
| O(24A) | 29(2) | 41(2) | 61(2) | -8(2) | 0(1) | 2(2) |
| N(25B) | 24(2) | 36(2) | 42(2) | 1(2) | -1(2) | -2(2) |
| C(2B) | 45(3) | 34(3) | 62(4) | -1(3) | -2(3) | 1(2) |
| C(24B) | 26(2) | 40(3) | 40(3) | -8(2) | -1(2) | -6(2) |
| C(19B) | 36(3) | 36(3) | 46(3) | -1(3) | 7(2) | -1(2) |
| C(5A) | 51(3) | 45(3) | 38(3) | 1(2) | 6(2) | -4(2) |
| C(23A) | 46(3) | 35(3) | 48(3) | 2(3) | 13(2) | 7(2) |
| C(2A) | 31(2) | 36(3) | 48(3) | 1(3) | -4(2) | -1(2) |
| C(15A) | 29(2) | 37(3) | 45(3) | -2(2) | -4(2) | 1(2) |
| C(27B) | 45(3) | 46(3) | 49(3) | 4(3) | 5(2) | 0(2) |
| C(17A) | 43(3) | 37(3) | 43(3) | -5(2) | 3(2) | -2(2) |
| C(3A) | 34(2) | 46(3) | 42(3) | -8(3) | 2(2) | -2(2) |
| C(16B) | 31(2) | 36(3) | 50(3) | 0(2) | -2(2) | -4(2) |
| C(6B) | 46(3) | 51(4) | 36(3) | 6(3) | 0(2) | -4(2) |
| C(11B) | 29(2) | 40(3) | 49(3) | -3(2) | 2(2) | -3(2) |
| C(8A) | 35(2) | 31(3) | 39(3) | 2(2) | 5(2) | 1(2) |
| C(18A) | 41(3) | 40(3) | 42(3) | 3(2) | 12(2) | -3(2) |
| C(10B) | 36(2) | 35(3) | 44(3) | 1(2) | 2(2) | -2(2) |
| C(10A) | 31(2) | 42(3) | 40(3) | 0(2) | 1(2) | 2(2) |
| C(4A) | 27(2) | 43(3) | 46(3) | 0(3) | -2(2) | -1(2) |
| C(13B) | 29(2) | 42(3) | 44(3) | 1(2) | 1(2) | 2(2) |

| | | | | | | |
|---|---|---|---|---|---|---|
| C(21B) | 43(3) | 49(3) | 45(3) | -5(3) | -6(2) | 2(3) |
| C(11A) | 34(2) | 37(3) | 40(3) | -4(2) | -4(2) | -1(2) |
| C(22A) | 54(3) | 37(3) | 41(3) | -4(2) | 7(2) | -3(3) |
| C(20A) | 43(3) | 48(3) | 40(3) | 7(3) | 3(2) | 6(2) |
| C(9A) | 27(2) | 35(3) | 42(3) | 2(2) | -1(2) | -1(2) |
| C(19A) | 46(3) | 36(3) | 41(3) | 1(2) | 11(2) | 3(2) |
| C(14A) | 33(2) | 39(3) | 43(3) | -1(2) | -4(2) | 0(2) |
| C(28A) | 38(3) | 37(3) | 93(5) | 11(3) | 2(3) | -1(2) |
| C(21A) | 50(3) | 48(3) | 39(3) | 7(3) | 0(2) | -5(3) |
| C(24A) | 41(3) | 38(3) | 27(3) | -3(2) | 4(2) | -1(2) |
| C(9B) | 28(2) | 43(3) | 35(3) | 2(2) | 1(2) | -4(2) |
| C(26A) | 31(2) | 39(3) | 46(3) | 1(2) | -2(2) | 2(2) |
| C(6A) | 47(3) | 42(3) | 36(3) | 5(2) | -2(2) | -4(2) |
| C(26B) | 30(2) | 45(3) | 39(3) | 6(2) | 3(2) | 4(2) |
| C(16A) | 34(2) | 39(3) | 41(3) | 2(2) | 2(2) | -2(2) |
| C(3B) | 44(3) | 44(3) | 48(3) | -13(3) | -3(2) | -3(2) |
| C(14B) | 30(2) | 42(3) | 39(3) | -2(3) | -1(2) | -4(2) |
| C(20B) | 41(3) | 44(3) | 54(3) | -6(3) | 0(2) | -5(2) |
| C(5B) | 41(3) | 62(4) | 32(3) | -3(3) | 3(2) | -1(3) |
| C(8B) | 33(2) | 32(3) | 40(3) | 1(2) | 1(2) | 0(2) |
| C(15B) | 31(2) | 43(3) | 48(3) | 0(3) | 3(2) | -2(2) |
| C(27A) | 66(4) | 52(4) | 56(4) | -6(3) | -11(3) | 8(3) |
| C(18B) | 36(2) | 40(3) | 45(3) | -6(3) | 5(2) | 5(2) |
| C(17B) | 36(2) | 42(3) | 43(3) | -1(2) | 1(2) | -2(2) |
| C(23B) | 44(3) | 43(3) | 51(3) | -11(3) | 7(2) | -10(2) |
| C(22B) | 55(3) | 51(4) | 47(3) | 0(3) | 8(3) | 2(3) |
| C(28B) | 44(3) | 75(4) | 46(3) | 18(3) | 3(2) | 15(3) |
| C(4B) | 30(2) | 46(3) | 38(3) | -4(3) | 3(2) | -2(2) |

**Table S10.** Hydrogen coordinates ( x $10^4$) and isotropic displacement parameters ($Å^2$x $10^3$) for 09061_0m.

| | x | y | z | U(eq) |
|---|---|---|---|---|
| H(25A) | 3406 | 2131 | 671 | 40 |
| H(13A) | 7188 | 4174 | 3404 | 46 |
| H(13B) | 6088 | 3920 | 4225 | 46 |
| H(25B) | 1621 | 6925 | 9400 | 41 |
| H(5A1) | 4400 | 5522 | 7433 | 53 |
| H(5A2) | 3038 | 5244 | 6736 | 53 |
| H(23A) | 5451 | 2784 | -1756 | 51 |
| H(15A) | 5220 | 3063 | 2845 | 45 |
| H(15B) | 6555 | 3292 | 2285 | 45 |
| H(27A) | -172 | 5752 | 8333 | 70 |
| H(27B) | 510 | 5149 | 9086 | 70 |
| H(27C) | 1438 | 5656 | 8443 | 70 |
| H(17A) | 5433 | 4054 | 368 | 49 |
| H(17B) | 6323 | 3442 | -31 | 49 |
| H(3A) | 3843 | 6815 | 6687 | 48 |
| H(16B) | 924 | 7919 | 8768 | 47 |
| H(6B1) | -1693 | 6924 | 2567 | 53 |
| H(6B2) | -2469 | 6426 | 3358 | 53 |
| H(11A) | 1161 | 7428 | 6961 | 47 |
| H(11B) | 214 | 7652 | 5838 | 47 |
| H(10A) | 750 | 6293 | 6531 | 46 |
| H(10B) | 1328 | 6647 | 5451 | 46 |
| H(10C) | 2672 | 4897 | 3382 | 45 |
| H(10D) | 3774 | 5168 | 2579 | 45 |
| H(13C) | -2141 | 7494 | 5702 | 46 |
| H(13D) | -2881 | 7180 | 6740 | 46 |
| H(21B) | 2738 | 8689 | 13572 | 55 |
| H(11C) | 3689 | 3827 | 3446 | 45 |
| H(11D) | 3267 | 4037 | 2138 | 45 |
| H(22A) | 3929 | 2686 | -3403 | 52 |
| H(20A) | 1665 | 4174 | -2233 | 53 |
| H(14A) | 6211 | 5255 | 3339 | 47 |
| H(14B) | 6671 | 5047 | 4642 | 47 |

| | | | | |
|---|---|---|---|---|
| H(28A) | 3494 | 930 | 1833 | 85 |
| H(28B) | 3593 | 370 | 864 | 85 |
| H(28C) | 2504 | 962 | 671 | 85 |
| H(21A) | 2025 | 3377 | -3637 | 55 |
| H(26A) | 5370 | 1140 | 795 | 47 |
| H(6A1) | 5739 | 4881 | 6302 | 50 |
| H(6A2) | 4671 | 4388 | 6816 | 50 |
| H(26B) | -92 | 6003 | 10288 | 46 |
| H(16A) | 3906 | 3191 | 1051 | 46 |
| H(3B) | -200 | 4561 | 2803 | 55 |
| H(14C) | -2789 | 6381 | 5265 | 45 |
| H(14D) | -1942 | 6123 | 6416 | 45 |
| H(20B) | 2883 | 9446 | 12064 | 56 |
| H(5B1) | -1411 | 5769 | 2057 | 54 |
| H(5B2) | 13 | 6136 | 2391 | 54 |
| H(15C) | -1918 | 7944 | 7961 | 49 |
| H(15D) | -719 | 8283 | 7339 | 49 |
| H(27D) | 3459 | 1276 | -1180 | 88 |
| H(27E) | 4539 | 680 | -985 | 88 |
| H(27F) | 5044 | 1432 | -1163 | 88 |
| H(17C) | -400 | 8856 | 9290 | 49 |
| H(17D) | -1364 | 8355 | 9900 | 49 |
| H(23B) | -216 | 7694 | 11659 | 55 |
| H(22B) | 1210 | 7800 | 13353 | 61 |
| H(28D) | 2787 | 5923 | 10345 | 83 |
| H(28E) | 1859 | 5418 | 10989 | 83 |
| H(28F) | 1990 | 6185 | 11386 | 83 |

**Table S11**. Torsion angles [°] for 09061_0m.

| | |
|---|---|
| C(15A)-N(12A)-C(13A)-C(14A) | -179.5(4) |
| C(11A)-N(12A)-C(13A)-C(14A) | -58.4(5) |
| C(9B)-S(1B)-C(2B)-C(3B) | -0.3(4) |
| C(9B)-S(1B)-C(2B)-F(2B) | 179.8(4) |
| C(26B)-N(25B)-C(24B)-O(24B) | 10.0(7) |
| C(26B)-N(25B)-C(24B)-C(16B) | -170.6(5) |
| C(9A)-S(1A)-C(2A)-C(3A) | 0.0(4) |
| C(9A)-S(1A)-C(2A)-F(2A) | -179.3(4) |
| C(13A)-N(12A)-C(15A)-C(16A) | -166.9(4) |
| C(11A)-N(12A)-C(15A)-C(16A) | 72.7(5) |
| F(2A)-C(2A)-C(3A)-C(4A) | 178.5(4) |
| S(1A)-C(2A)-C(3A)-C(4A) | -0.8(5) |
| O(24B)-C(24B)-C(16B)-C(17B) | 53.8(6) |
| N(25B)-C(24B)-C(16B)-C(17B) | -125.5(5) |
| O(24B)-C(24B)-C(16B)-C(15B) | -66.5(6) |
| N(25B)-C(24B)-C(16B)-C(15B) | 114.1(5) |
| C(8B)-O(7B)-C(6B)-C(5B) | -67.5(5) |
| C(15B)-N(12B)-C(11B)-C(10B) | 170.8(4) |
| C(13B)-N(12B)-C(11B)-C(10B) | -63.1(5) |
| C(6A)-O(7A)-C(8A)-C(9A) | -43.2(5) |
| C(6A)-O(7A)-C(8A)-C(10A) | -165.5(4) |
| C(6A)-O(7A)-C(8A)-C(14A) | 80.9(5) |
| C(22A)-C(23A)-C(18A)-C(19A) | -1.1(7) |
| C(22A)-C(23A)-C(18A)-C(17A) | 176.9(5) |
| C(16A)-C(17A)-C(18A)-C(23A) | -91.6(6) |
| C(16A)-C(17A)-C(18A)-C(19A) | 86.3(6) |
| N(12B)-C(11B)-C(10B)-C(8B) | 57.1(6) |
| O(7A)-C(8A)-C(10A)-C(11A) | -59.7(5) |
| C(9A)-C(8A)-C(10A)-C(11A) | -178.3(4) |
| C(14A)-C(8A)-C(10A)-C(11A) | 56.5(5) |
| C(2A)-C(3A)-C(4A)-C(9A) | 1.4(6) |
| C(2A)-C(3A)-C(4A)-C(5A) | -179.4(4) |
| C(6A)-C(5A)-C(4A)-C(9A) | 24.2(6) |
| C(6A)-C(5A)-C(4A)-C(3A) | -154.9(4) |
| C(15B)-N(12B)-C(13B)-C(14B) | -170.1(4) |
| C(11B)-N(12B)-C(13B)-C(14B) | 64.6(5) |
| C(15A)-N(12A)-C(11A)-C(10A) | 177.0(4) |

| | |
|---|---|
| C(13A)-N(12A)-C(11A)-C(10A) | 57.4(5) |
| C(8A)-C(10A)-C(11A)-N(12A) | -58.9(6) |
| C(18A)-C(23A)-C(22A)-C(21A) | 0.4(8) |
| C(3A)-C(4A)-C(9A)-C(8A) | 176.0(4) |
| C(5A)-C(4A)-C(9A)-C(8A) | -3.2(7) |
| C(3A)-C(4A)-C(9A)-S(1A) | -1.4(5) |
| C(5A)-C(4A)-C(9A)-S(1A) | 179.4(3) |
| O(7A)-C(8A)-C(9A)-C(4A) | 11.0(6) |
| C(10A)-C(8A)-C(9A)-C(4A) | 127.5(5) |
| C(14A)-C(8A)-C(9A)-C(4A) | -111.1(5) |
| O(7A)-C(8A)-C(9A)-S(1A) | -171.9(3) |
| C(10A)-C(8A)-C(9A)-S(1A) | -55.4(5) |
| C(14A)-C(8A)-C(9A)-S(1A) | 66.0(5) |
| C(2A)-S(1A)-C(9A)-C(4A) | 0.8(4) |
| C(2A)-S(1A)-C(9A)-C(8A) | -176.7(4) |
| C(21A)-C(20A)-C(19A)-F(19A) | -179.7(5) |
| C(21A)-C(20A)-C(19A)-C(18A) | -0.2(8) |
| C(23A)-C(18A)-C(19A)-F(19A) | -179.4(4) |
| C(17A)-C(18A)-C(19A)-F(19A) | 2.5(7) |
| C(23A)-C(18A)-C(19A)-C(20A) | 1.1(7) |
| C(17A)-C(18A)-C(19A)-C(20A) | -177.0(5) |
| N(12A)-C(13A)-C(14A)-C(8A) | 59.8(6) |
| O(7A)-C(8A)-C(14A)-C(13A) | 56.0(5) |
| C(9A)-C(8A)-C(14A)-C(13A) | 177.4(4) |
| C(10A)-C(8A)-C(14A)-C(13A) | -56.8(5) |
| C(19A)-C(20A)-C(21A)-C(22A) | -0.6(8) |
| C(23A)-C(22A)-C(21A)-C(20A) | 0.5(8) |
| C(26A)-N(25A)-C(24A)-O(24A) | -3.7(7) |
| C(26A)-N(25A)-C(24A)-C(16A) | 176.6(4) |
| C(2B)-S(1B)-C(9B)-C(4B) | 0.4(4) |
| C(2B)-S(1B)-C(9B)-C(8B) | -177.6(4) |
| C(24A)-N(25A)-C(26A)-C(28A) | 141.2(5) |
| C(24A)-N(25A)-C(26A)-C(27A) | -95.7(5) |
| C(8A)-O(7A)-C(6A)-C(5A) | 69.4(5) |
| C(4A)-C(5A)-C(6A)-O(7A) | -55.0(5) |
| C(24B)-N(25B)-C(26B)-C(27B) | 97.6(5) |
| C(24B)-N(25B)-C(26B)-C(28B) | -137.3(5) |
| C(18A)-C(17A)-C(16A)-C(24A) | 77.5(5) |
| C(18A)-C(17A)-C(16A)-C(15A) | -162.5(4) |

| | |
|---|---|
| O(24A)-C(24A)-C(16A)-C(17A) | 66.2(6) |
| N(25A)-C(24A)-C(16A)-C(17A) | -114.0(5) |
| O(24A)-C(24A)-C(16A)-C(15A) | -56.5(6) |
| N(25A)-C(24A)-C(16A)-C(15A) | 123.3(4) |
| N(12A)-C(15A)-C(16A)-C(17A) | 58.6(6) |
| N(12A)-C(15A)-C(16A)-C(24A) | -178.9(4) |
| F(2B)-C(2B)-C(3B)-C(4B) | -180.0(5) |
| S(1B)-C(2B)-C(3B)-C(4B) | 0.1(6) |
| N(12B)-C(13B)-C(14B)-C(8B) | -58.7(5) |
| F(19B)-C(19B)-C(20B)-C(21B) | -179.1(5) |
| C(18B)-C(19B)-C(20B)-C(21B) | 2.6(8) |
| C(22B)-C(21B)-C(20B)-C(19B) | -0.4(8) |
| O(7B)-C(6B)-C(5B)-C(4B) | 53.0(5) |
| C(6B)-O(7B)-C(8B)-C(9B) | 40.4(5) |
| C(6B)-O(7B)-C(8B)-C(10B) | 158.8(4) |
| C(6B)-O(7B)-C(8B)-C(14B) | -83.5(5) |
| C(4B)-C(9B)-C(8B)-O(7B) | -5.1(6) |
| S(1B)-C(9B)-C(8B)-O(7B) | 172.5(3) |
| C(4B)-C(9B)-C(8B)-C(10B) | -120.2(5) |
| S(1B)-C(9B)-C(8B)-C(10B) | 57.4(5) |
| C(4B)-C(9B)-C(8B)-C(14B) | 117.4(5) |
| S(1B)-C(9B)-C(8B)-C(14B) | -65.0(5) |
| C(11B)-C(10B)-C(8B)-O(7B) | 68.5(5) |
| C(11B)-C(10B)-C(8B)-C(9B) | -174.2(4) |
| C(11B)-C(10B)-C(8B)-C(14B) | -49.9(6) |
| C(13B)-C(14B)-C(8B)-O(7B) | -65.0(5) |
| C(13B)-C(14B)-C(8B)-C(9B) | 173.3(4) |
| C(13B)-C(14B)-C(8B)-C(10B) | 50.2(5) |
| C(13B)-N(12B)-C(15B)-C(16B) | 154.9(4) |
| C(11B)-N(12B)-C(15B)-C(16B) | -81.5(5) |
| C(24B)-C(16B)-C(15B)-N(12B) | -46.1(5) |
| C(17B)-C(16B)-C(15B)-N(12B) | -167.8(4) |
| C(20B)-C(19B)-C(18B)-C(23B) | -2.9(7) |
| F(19B)-C(19B)-C(18B)-C(23B) | 178.9(4) |
| C(20B)-C(19B)-C(18B)-C(17B) | 178.7(5) |
| F(19B)-C(19B)-C(18B)-C(17B) | 0.4(7) |
| C(23B)-C(18B)-C(17B)-C(16B) | -74.3(6) |
| C(19B)-C(18B)-C(17B)-C(16B) | 104.0(6) |
| C(24B)-C(16B)-C(17B)-C(18B) | 65.6(6) |

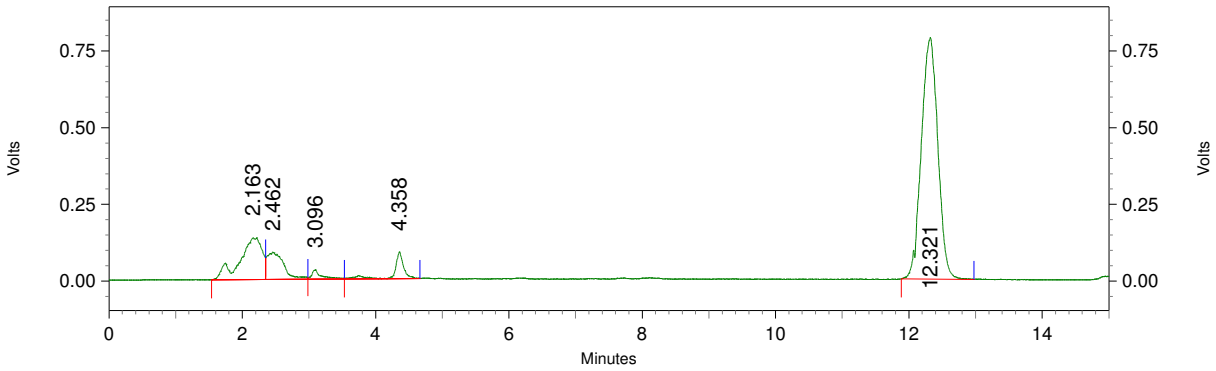
| | |
|---|---|
| C(15B)-C(16B)-C(17B)-C(18B) | -175.5(4) |
| C(19B)-C(18B)-C(23B)-C(22B) | 1.0(7) |
| C(17B)-C(18B)-C(23B)-C(22B) | 179.4(5) |
| C(20B)-C(21B)-C(22B)-C(23B) | -1.4(8) |
| C(18B)-C(23B)-C(22B)-C(21B) | 1.0(8) |
| C(8B)-C(9B)-C(4B)-C(3B) | 177.5(4) |
| S(1B)-C(9B)-C(4B)-C(3B) | -0.4(5) |
| C(8B)-C(9B)-C(4B)-C(5B) | -4.0(7) |
| S(1B)-C(9B)-C(4B)-C(5B) | 178.1(4) |
| C(2B)-C(3B)-C(4B)-C(9B) | 0.2(6) |
| C(2B)-C(3B)-C(4B)-C(5B) | -178.2(5) |
| C(6B)-C(5B)-C(4B)-C(9B) | -19.9(6) |
| C(6B)-C(5B)-C(4B)-C(3B) | 158.4(5) |

Symmetry transformations used to generate equivalent atoms.

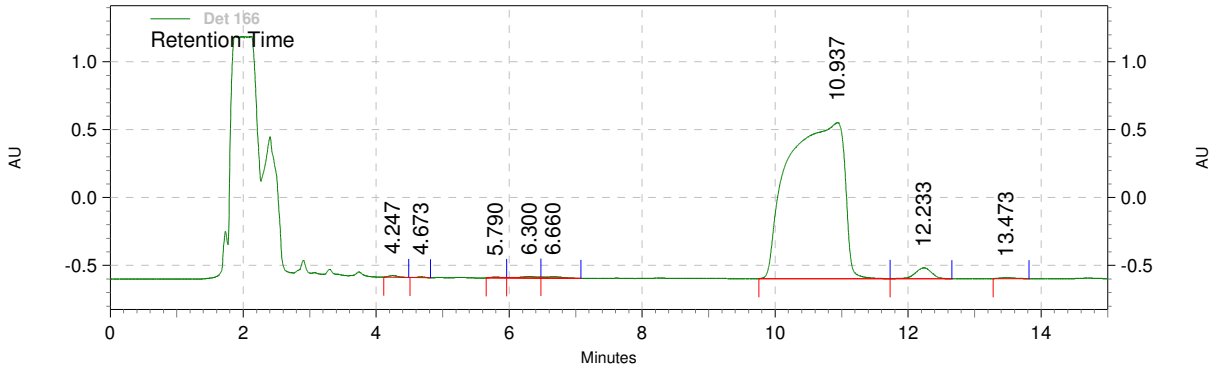
# Separation of [$^{11}$C](*S*)-10c with HPLC

**Conditions**: Luna C18 column (10 μm; 10 × 250 mm; Phenomenex) eluted at 8.0 mL/min for 5 min and then at 6.0 mL/min with MeCN-100 mM $HCOONH_4$ solution (50: 50 v/v), with eluate monitored for absorbance at 235 nm. $t_R$S: [$^{11}$C]**(*S*)-10c**, 12.32 min; precursor **(*S*)-9c**, 10.93 min.

**Radioactivity**




**Absorbance at 235 nm**



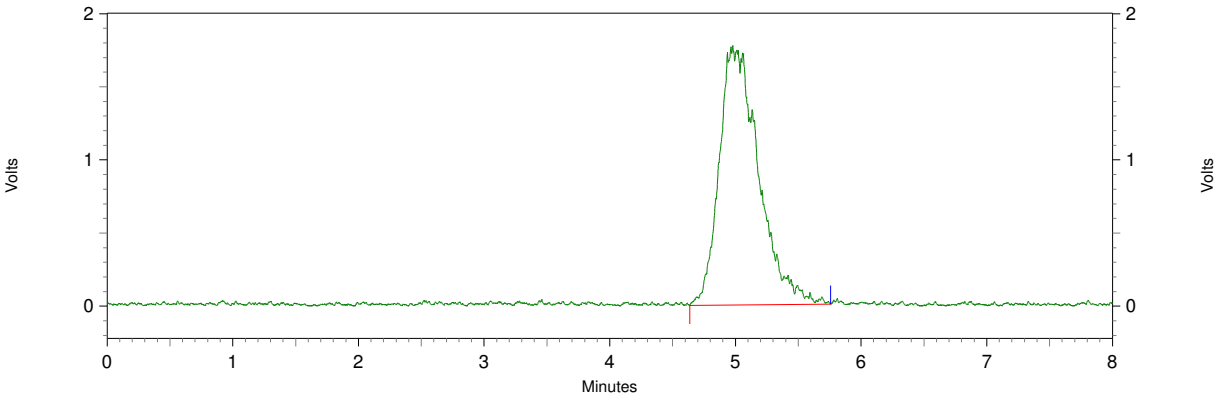

**Radioactivity distribution**

| Time (min) | Area | Area (%) |
|---|---|---|
| 2.163 | 3170566 | 16.41 |
| 2.462 | 1530971 | 7.92 |
| 3.096 | 307363 | 1.59 |
| 4.358 | 802248 | 4.15 |
| 12.321 | 13512019 | 69.93 |

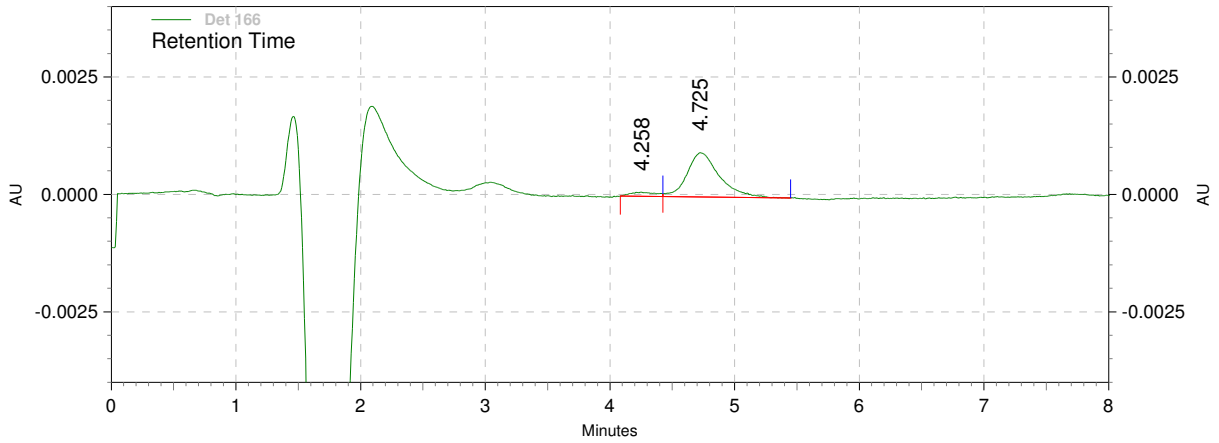
## Analysis of [$^{11}$C](*S*)-10a with radio-HPLC

**Conditions**: Luna C18 column (10 µm; 10 × 250 mm; Phenomenex) eluted at 3.0 mL/min with MeCN-10 mM $(NH_4)_2CO_3$ solution (55: 45 v/v) with eluate monitored for absorbance at 235 nm. $t_R$s: [$^{11}$C]**(*S*)-10a**, 4.98 min; **(*S*)-10a**, 5.75 min.

**Radioactivity**




**Absorbance at 235 nm**




**Radiochemical purity:**

| Time (min) | Area | Area (%) | Height | Height (%) |
|---|---|---|---|---|
| 4.98 | 38639759 | 100.00 | 1773523 | 100.00 |

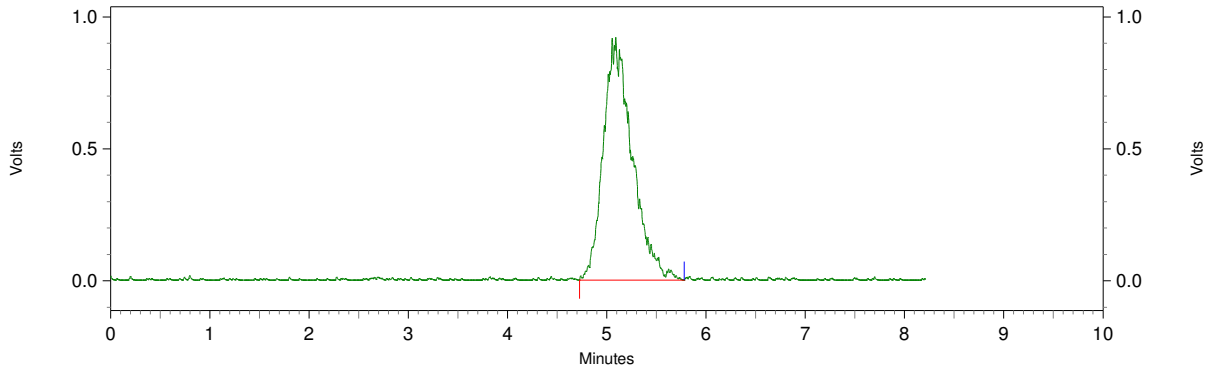
**% Chemical purity:**

| Time (min) | Area | Area (%) | Height | Height (%) |
|---|---|---|---|---|
| 4.258 | 1272 | 6.94 | 90 | 8.70 |
| 4.725 | 17050 | 93.06 | 945 | 91.30 |

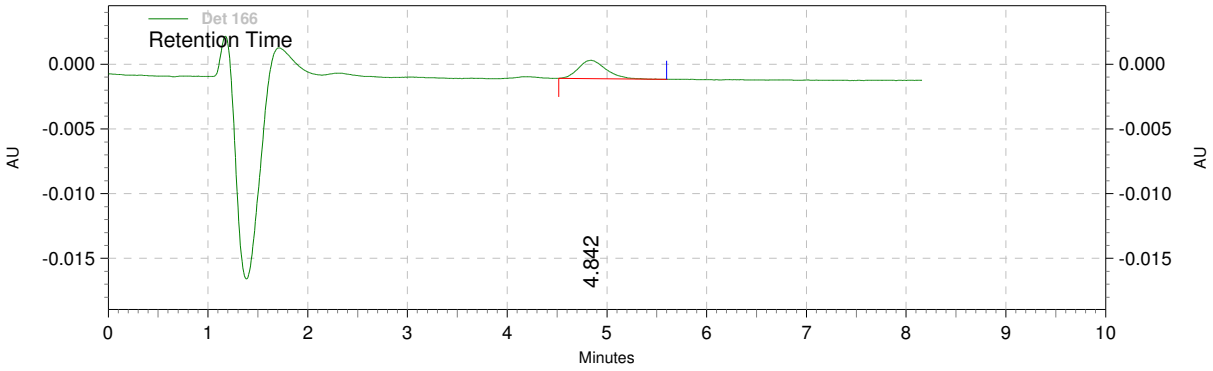
# Analysis of [$^{11}$C](*S*)-10b with radio-HPLC

**Conditions**: Luna C18 column (10 µm; 10 × 250 mm; Phenomenex) eluted at 3.0 mL/min with MeCN-100 mM $HCOONH_4$ solution (60: 40 v/v) with eluate monitored for absorbance at 235 nm. $t_R$s: [$^{11}$C]**(*S*)-10b**, 5.09 min; **(*S*)-10b**, 4.842 min.

**Radioactivity**




**Absorbance at 235 nm**




**Radiochemical purity:**

| Time (min) | Area | Area (%) | Height | Height (%) |
|---|---|---|---|---|
| 5.09 | 18601456 | 100 | 920395 | 100 |

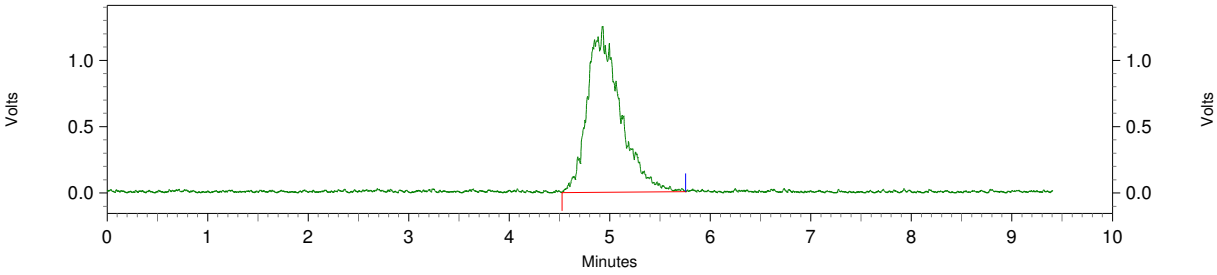
**Chemical purity:**

| Time (min) | Area | Area (%) | Height | Height (%) |
|---|---|---|---|---|
| 4.842 | 27480 | 100 | 1421 | 100 |

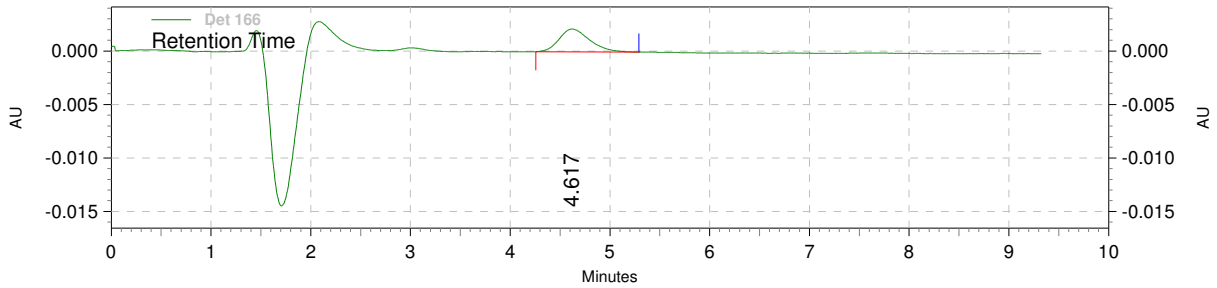
# Analysis of [$^{11}$C](*S*)-10c with radio-HPLC

**Conditions**: Gemini-NX C18 column (5 µm; 10 × 250 mm; Phenomenex) eluted at 2.0 mL/min with MeCN-100 mM $NH_4OH$ solution (60: 40 v/v) with eluate monitored for absorbance at 235 nm. $t_R$s: [$^{11}$C]**(*S*)-10c**, 4.926 min; **(*S*)-10c**, 4.617 min.

**Radioactivity**




**Absorbance at 235 nm**




**Radiochemical purity:**

| Time (min) | Area | Area (%) | Height | Height (%) |
|---|---|---|---|---|
| 4.926 | 28192260 | 100 | 1251923 | 100 |

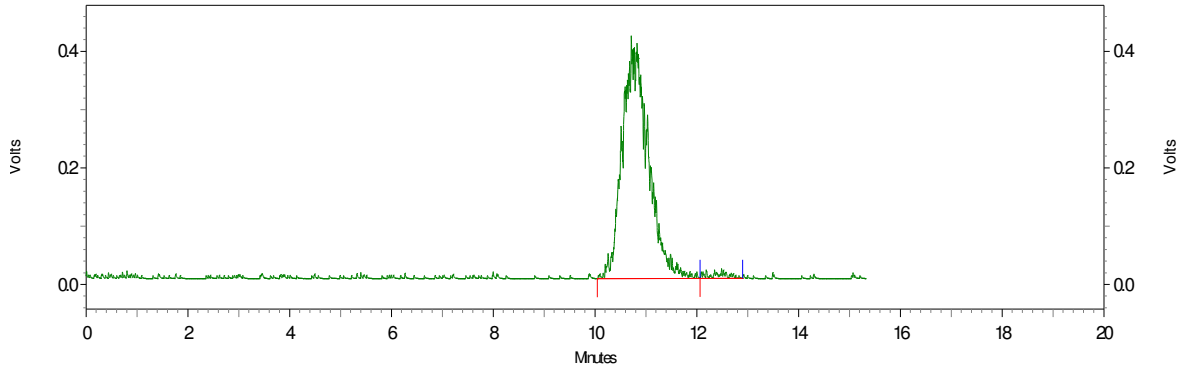
**Chemical purity:**

| Time (min) | Area | Area (%) | Height | Height (%) |
|---|---|---|---|---|
| 4.617 | 45380 | 100 | 2137 | 100 |

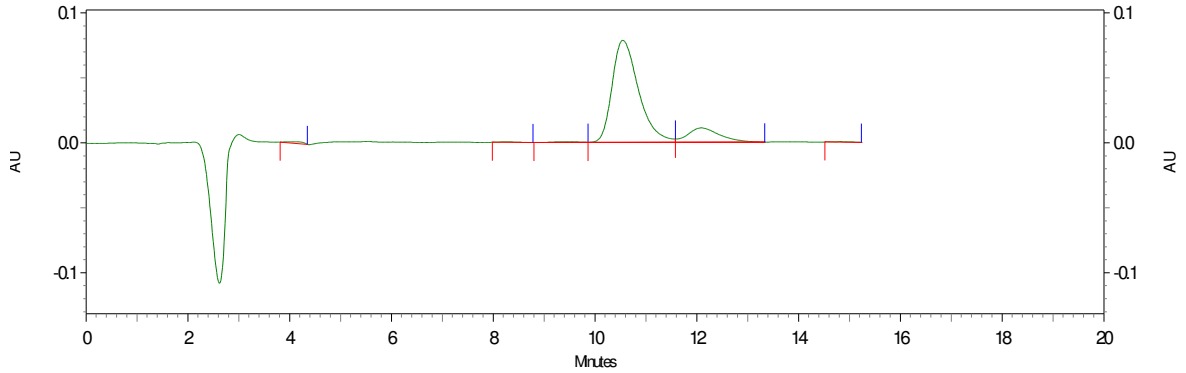
## Analysis of [$^{11}$C](*S*)-10c with chiral radio-HPLC

**Conditions**: Chiralpak AD column (4.6 × 250 mm) eluted at 2.0 mL/min with A: B (4: 96 v/v), with A = 0.1% TEA in hexane and B = 0.1% TEA in isopropyl alcohol, and with eluate monitored for absorbance at 254 nm. $t_R$s, [$^{11}$C]**(*S*)-10c/(*S*)-10c**, 10.71 min; **(*R*)-10c**, 12.35 min. [$^{11}$C]**(*S*)-10c** was spiked with an unequal mixture of **(*S*)-10c** and **(*R*)-10c** before injection onto the chiral column.

**Radioactivity**




**Absorbance at 254 nm**




**Radiochemical purity:**

| Time (min) | Area | Area (%) |
|---|---|---|
| 10.71 | 14318624 | 98.2 |
| 12.35 | 262038 | 1.80 |

**Displacement of [$^{11}$C](*S*)-10c from monkey brain with 1**

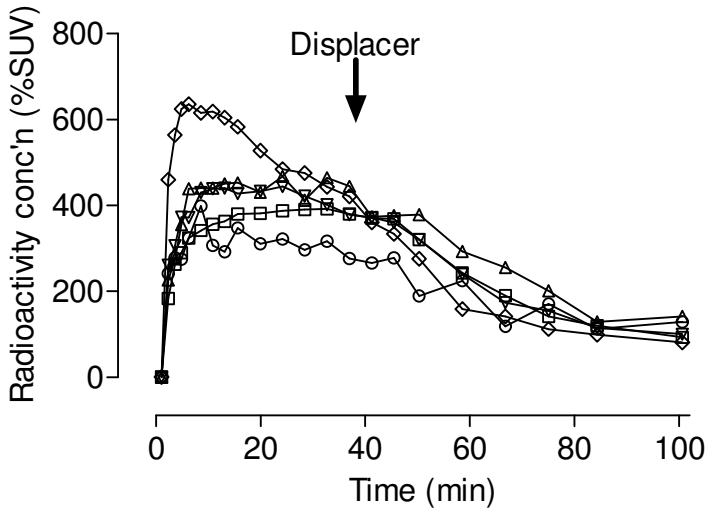



**Figure S4.** Brain region time–activity curves in monkey after injection of radioligand [$^{11}$C]**(*S*)-10c** in which NOP displacer **1** (2 mg/kg, i.v.) was given at 40 min after radioligand. Key: hypothalamus (○), cerebellum (◊), caudate (∇), amygdala (Δ), lateral temporal cortex (□). Time-activity curves for other examined regions as listed in the experimental were generally similar to the non-cerebellar curves. NOP displacer increased washout of radioactivity from brain.

**Attempted displacement of [$^{11}$C](*S*)-10c from monkey brain with naloxone**

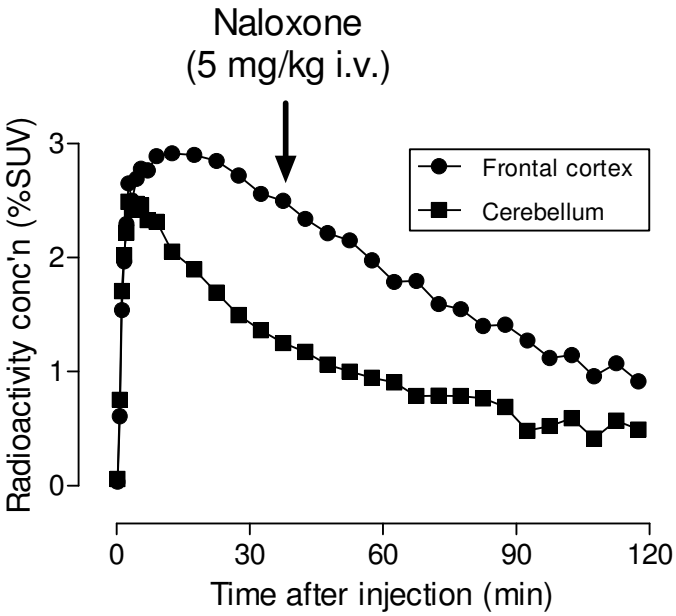



**Figure S5.** Brain region time–activity curves in monkey after injection of radioligand [$^{11}$C](***S***)**-10c** in which naloxone **1** (5 mg/kg, i.v.) was given at 37 min after radioligand. Naloxone did not increase washout of radioactivity from brain.

**Brain baseline and pre-block time-activity curves in monkey injected with [$^{11}$C](*R*)-10c**

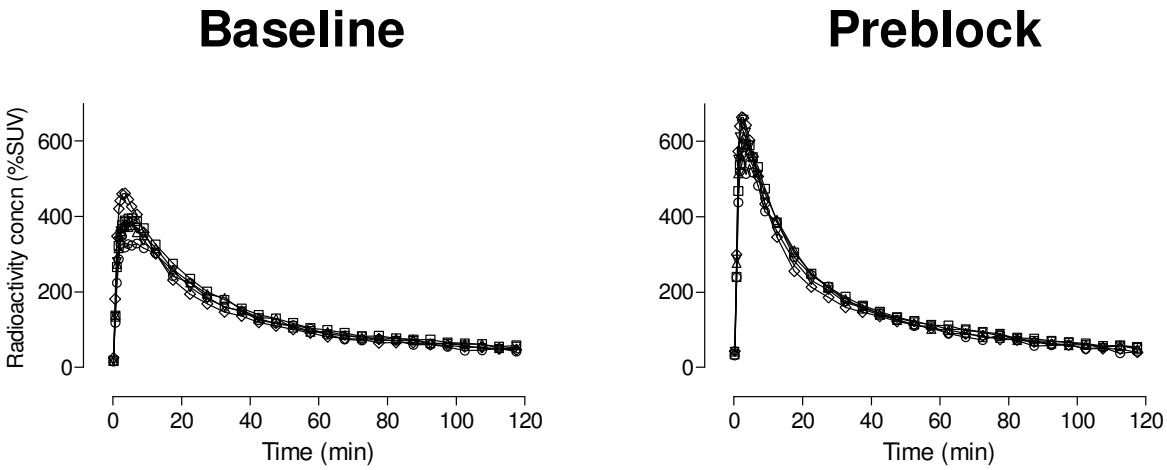



**Figure S6.** Brain region time–activity curves in monkey after injection of radioligand [$^{11}$C](***R***)-**10c**, the less active enantiomer of [$^{11}$C](***S***)-**10c**, in a baseline and pre-block experiment, in which NOP preblocker **1** (2 mg/kg, i.v.) was given at 10 min before radioligand. The baseline and pre-block experiments were conducted about 3 h apart in the same monkey. Key: hypothalamus (○), cerebellum (◊), caudate (∇), amygdala (Δ), lateral temporal cortex (□). Time-activity curves for other examined regions as listed in the experimental were generally similar.

**References**


1. Bruker-AXS. Madison, Wisconsin, USA
2. Sheldrick, G. M. (*SHELXS86*. *Acta Cryst*. **1990**, *A46*, 467-473
3. Sheldrick, G. M. *SHELXS93*. Program for crystal structure refinement. Institute fur Anorg Chemie, Göttingen, Germany, **1993**.
4. Filename: 10022_0m.ins