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2. Crystal Data and Experimental 4d’ minor diastereomer obtained with (R)-catalyst

![Crystal Structure Image]

Figure 1. Thermal ellipsoids drawn at the 50 percent probability level.

**Experimental.** Single clear colourless fragment-shaped crystals of (2014sot0046) were recrystallised from a mixture of TCM and hexane by slow evaporation. A suitable crystal (0.09 × 0.08 × 0.05 mm$^3$) was selected and mounted on a MITIGEN holder in perfluoroether oil on a Rigaku AFC12 FRE-HF diffractometer. The crystal was kept at $T = 100(2)$ K during data collection. Using Olex2 (Dolomanov et al., 2009), the structure was solved with the ShelXT (Sheldrick, 2008) structure solution program, using the Direct Methods solution method. The model was refined with version of ShelXL (Sheldrick, 2008) using Least Squares minimisation.

**Crystal Data.** $C_{17}H_{11}N_3O_6$, $M_r = 353.29$, monoclinic, $P2_1/c$ (No. 14), $a = 9.9877(5)$ Å, $b = 15.1541(7)$ Å, $c = 10.2131(6)$ Å, $\beta = 103.161(5)^\circ$, $\alpha = \gamma = 90^\circ$, $V = 1505.20(14)$ Å$^3$, $T = 100(2)$ K, $Z = 4$, $Z' = 1$, $\mu$ (MoK$\alpha$) = 0.121, 14536 reflections measured, 3884 unique ($R_{int} = 0.0709$) which were used in all calculations. The final $wR_2$ was 0.3428 (all data) and $R_1$ was 0.1503 ($I > 2(I))$.

<table>
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<tbody>
<tr>
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<td>$D_{calc}$/ g cm$^{-3}$</td>
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<tr>
<td>$\mu$/mm$^{-1}$</td>
<td>0.121</td>
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<td>Formula Weight</td>
<td>353.29</td>
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<td>Colour</td>
<td>clear colourless</td>
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<td>Shape</td>
<td>fragment</td>
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<tr>
<td>Min Size/mm</td>
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<tr>
<td>$T$/K</td>
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<td>$P2_1/c$</td>
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<td>9.9877(5)</td>
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<td>$c$/Å</td>
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<td>90</td>
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<tr>
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<td>$\gamma$/</td>
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<td>$\Theta_{min}$/</td>
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<td>$\Theta_{max}$/</td>
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<td>Independent Refl.</td>
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<td>Largest Peak</td>
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<td>Deepest Hole</td>
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<td>GooF</td>
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<td>$wR_2$ (all data)</td>
<td>0.3428</td>
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<tr>
<td>$wR_2$</td>
<td>0.3307</td>
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<tr>
<td>$R_1$ (all data)</td>
<td>0.1725</td>
</tr>
<tr>
<td>$R_1$</td>
<td>0.1503</td>
</tr>
</tbody>
</table>
**Experimental Extended.** A clear colourless fragment-shaped crystal with dimensions $0.09 \times 0.08 \times 0.05 \text{ mm}^3$ was mounted on a MITIGEN holder in perfluoroether oil. Data were collected using a Rigaku AFC12 FRE-HF diffractometer equipped with an Oxford Cryostream low-temperature apparatus operating at $T = 100(2) \text{ K}$. Data were measured using profile data from $\omega$-scans of $1.0^\circ \text{ per frame for 15.0 s using MoK}_{\alpha}$ radiation (Rotating Anode, 45.0 kV, 55.0 mA). The total number of runs and images was based on the strategy calculation from the program **CrystalClear** (Rigaku). The actually achieve resolution was $\Theta = 28.699$.

Cell parameters were retrieved using the **CrysAlisPro** (Agilent, V1.171.37.31, 2014) software and refined using **CrysAlisPro** (Agilent, V1.171.37.31, 2014) on 6234 reflections, 43 of the observed reflections.

Data reduction was performed using the **CrysAlisPro** (Agilent, V1.171.37.31, 2014) software which corrects for Lorentz polarisation. The final completeness is 99.60 out to 28.699 in $\Theta$. The absorption coefficient (MU) of this material is 0.121 and the minimum and maximum transmissions are 0.56971 and 1.00000.

The structure was solved by Direct Methods using the ShelXT (Sheldrick, 2008) structure solution program and refined by Least Squares using version of **ShelXL** (Sheldrick, 2008). The structure was solved in the space group $P2_1/c$ (# 14). All non-hydrogen atoms were refined anisotropically. Hydrogens positions were calculated geometrically and refined using the riding model.

There is no entry for the cif item _refine_special_details.

**Citations**


CrystalClear, Rigaku.


3. Conformational analysis and absolute configuration

All the attempts to obtain good enantiopure crystals of the prepared compounds were not successful. For this reason the relative and absolute configuration was determined by a combination of conformational analysis and theoretical simulations of chiro-optical spectra. Compound 4d was selected as representative compound because good racemic crystals were obtained for the minor diastereomer (4d-minor). X-ray data allowed the determination of the relative configuration of the three stereogenic centres of the cyclopropane ring as R*,R*,R*.

![Figure S1. X-ray structure of racemic 4d-minor.](image)

Although the rigidity of the cyclopropane core reduces the number of conformations to be considered,\(^1\) two conformational degrees of freedom due to the rotation of the aldehyde and of the benzoxazole moiety must be considered for the conformational analysis step.

The whole conformational space was explored by means of Monte Carlo searching together with the MMFF94 molecular mechanics force field as implemented in Titan 1.0.5 (Wavefunction inc.)

All the conformations found by MM search within a 10 kcal/mol window were then optimized using DFT at the B3LYP/6-31+G(d,p) level using the Gaussian 09 suite of

---

programs\textsuperscript{2}. The harmonic vibrational frequencies of each optimized conformation were calculated at the same level to confirm their stability (no imaginary frequencies were observed) and to evaluate the ZPE corrected enthalpy and free energy of each conformation. After DFT minimization, four conformations were found to be enclosed in a 1 kcal/mol window as shown in Figure S2 and marked as a-d in Table S1 and Table S2.

Table S1. Relative energies of the four conformations of 4d-minor evaluated using ZPE-corrected enthalpies and different optimization levels: B3LYP/6-31+G(d,p) and M06-2X/6-31+G(d,p). Populations are calculated using Boltzmann distribution at 298°K.

<table>
<thead>
<tr>
<th>Conformation</th>
<th>$H^\circ$ (B3LYP)</th>
<th>$H^\circ$ (M06-2X)</th>
<th>Pop. (B3LYP)</th>
<th>Pop. (M06-2X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>0.74</td>
<td>1.25</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>b</td>
<td>0.48</td>
<td>0.88</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>c</td>
<td>0.63</td>
<td>0.89</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>d</td>
<td>0.00</td>
<td>0.00</td>
<td>48</td>
<td>64</td>
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</tbody>
</table>

Table S2. Relative energies of the four conformations of 4d-minor evaluated using ZPE-corrected Gibbs free energies and different optimization levels: B3LYP/6-31+G(d,p) and M06-2X/6-31+G(d,p). Populations are calculated using Boltzmann distribution at 298°K.

<table>
<thead>
<tr>
<th>Conformation</th>
<th>$G^\circ$ (B3LYP)</th>
<th>$G^\circ$ (M06-2X)</th>
<th>Pop. (B3LYP)</th>
<th>Pop. (M06-2X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>0.47</td>
<td>0.61</td>
<td>18</td>
<td>16</td>
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<tr>
<td>b</td>
<td>0.08</td>
<td>0.28</td>
<td>35</td>
<td>29</td>
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<tr>
<td>c</td>
<td>0.94</td>
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<td>d</td>
<td>0.00</td>
<td>0.00</td>
<td>39</td>
<td>46</td>
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</table>

As predictable, the four conformations correspond to the four different relative dispositions of the CHO and benzoxazole group, and the relative energies (both as ZPE-corrected enthalpies or Gibbs free energies) suggested that all these conformations should be appreciably populated. To check whether a different theoretical level provided different results, the four ground states were optimized again at the M06-2X/6-31+G(d,p) level with similar results in terms of relative energies. Conformation d was always the most stable, albeit it does not correspond to that observed in the solid state, that is conformation c. In addition to that, the dihedral angle between the plane of the p-nitrophenyl ring and the cyclopropane plane calculated for conformations c and d is rather different with respect to that observed in the solid state. However, both the calculation levels yield the same results and the different dihedral angle observed in the X-ray structure could be the result of crystal lattice stabilization. Indeed, when the geometry read from X-ray data was used as input to DFT optimization, the p-nitrophenyl ring was rotated to provide again conformation c.

Figure S2. 3D view of the four conformations of the model compound 4d-minor.
Absolute configuration

The determination of the absolute configuration (AC) of chiral molecules using chiroptical techniques like optical rotation (OR), electronic circular dichroism (ECD), and vibrational circular dichroism (VCD) has gained feasibility and reliability because of the development of methods for the prediction of these properties based on density functional theory (DFT) and on its Time-Dependent formalism (TD-DFT).\textsuperscript{3} In the present case the theoretical calculation of the electronic circular dichroism spectra (ECD) was selected for the absolute configuration assignment because of the presence of good UV chromophores. The ECD spectrum of 4d-minor (obtained with (R)-catalyst) was acquired in HPLC-grade acetonitrile solution (6·10\textsuperscript{-5} M) with a cell path of 0.5 cm in the 190-400 nm region by the sum of 16 scans at 50 nm/min scan rate (Figure S3). Albeit rather weak, the experimental ECD spectrum exhibits three negative Cotton effects at 321, 238 and 206 nm, a broad positive branch at 265-290 nm, as well as two weak positive branches at 222 and 194 nm.

![Figure S3](image)

**Figure S3:** ECD (blue trace) and UV (red trace) spectra of 4d-minor (R)-catalyst. Spectra were recorded in acetonitrile, 6·10\textsuperscript{-5}M, 0.5 cm cell path.

The electronic excitation energies and rotational strengths have been calculated for the isolated molecule in the gas phase for the four conformations a-d using TD-DFT. In a preliminary test, two different basis sets (6-311++G(2d,p) and def2-TZVPP) were employed to calculate the ECD spectrum of conformation d using the CAM-B3LYP functional and the two geometries provided by the B3LYP and M06-2X optimization steps. The results are reported in Figure S4, showing that the basis sets and input geometries did not influence the calculated ECD spectrum at a great extent.

Figure S4. TD-DFT simulated spectra calculated for conformation d of 4d-minor using the same CAM-B3LYP functional, two different basis sets (6-311++G(2d,p) and def2TZVPP) and two different input geometries form B3LYP/6-31+G(d,p) and M06-2X/6-31+G(d,p) optimization. For each calculation the first 60 excited states were calculated, and the spectrum was obtained using a 0.30 eV line width at half height.

The ECD spectra of the four conformations were calculated with four different methods (functionals), to ascertain if different computational approaches provide different shapes of the simulated spectra (Figure S5).  

---

Figure S5. TD-DFT simulated spectra calculated for the four conformations of 4d-minor using four different functionals (CAM-B3LYP, BH&HLYP, M06-2X, ωB97-XD) and the same 6-311++G(2d,p) basis set. For each conformation the first 60 excited states were calculated, and the spectrum was obtained using a 0.30 eV line width at half height.

Simulations were performed using the B3LYP-optimized geometries with the hybrid functionals BH&HLYP and M06-2X, ωB97XD that includes empirical dispersion, and CAM-B3LYP that includes long range correction using the Coulomb Attenuating Method. Given the result of the preliminary tests, the calculations employed the B3LYP-optimized geometries and the 6-311++G(2d,p) basis set, that is computationally cheaper than def2TZVPP, still providing good accuracy. The rotational strengths were calculated in both

---

6 In Gaussian 09 the BH&HLYP functional has the form: 0.5*E_X^HF + 0.5*E_X^LSDA + 0.5*ΔE_X^Becke88 + E_C^LYP
length and velocity representation, the resulting values being very similar (RMS difference < 5%). Errors due to basis set incompleteness should be therefore very small.\textsuperscript{10}

Although the spectra simulated within the same functional for the four conformation are quite different, they are nevertheless consistent with the simulation of the positive Cotton effect in the 245-270 nm region(Figure S5). This part of the UV spectrum is dominated by the two UV transitions of the \textit{p}-nitrophenyl moiety (oriented on the long axis) and of the 5-nitrobenzoxazole moiety. The almost coincidence of the simulated spectra for the same conformation on varying the functional represent a good proof of the simulations consistency.

The population-weighted spectra to be compared with the experimental spectrum were obtained using the percentages derived from ZPE corrected enthalpies (Table S1). As shown in Figure S6, the spectra simulated assuming 1\textit{R},2\textit{R},3\textit{R} absolute configuration match well the Cotton effects at 321, 283 nm. The best simulation was obtained by the \textit{ω}B97-XD functional, but all the simulated spectra show a good agreement with the experimental one.


Figure S6: Simulations of the experimental ECD spectrum of 4d-minor (obtained with (R)-catalyst). For each quadrant, the black line correspond to the experimental spectrum. The colored lines correspond to the simulations obtained using the populations derived from B3LYP/6-31+G(d,p) optimization. The simulated spectra were vertically scaled and red-shifted by 7-14 nm to get the best match with the experimental spectrum. All the simulations are for the 1R,2R,3R absolute configuration.
Major diastereomer

Good single crystals of the major diastereomer could not be obtained and the assignment of the relative configuration was determined by NMR. The $^1$H and $^{13}$C signals were assigned by means of 2D-NMR experiments (COSY, HSQC and HMBC), and NOE spectra were acquired using the DPFGSE sequence. In the case of the major isomer of 4d (obtained with (S)-catalyst) (4d-major), the $^1$H signals of the hydrogens of cyclopropane were heavily overlapped in a variety of solvent (CDCl$_3$, DMSO, CD$_3$CN), and the compound was not chemically stable in CD$_3$OD. More resolved spectra were obtained for the parent compound 4a, that exhibited a resolved $^1$H spectrum in CD$_3$CN (Figure S7). A close inspection of the $^1$H spectrum provided useful information about the relative disposition of the three hydrogens of the cyclopropane ring (named as H1, H2 and H3 in Figure S7).

![Figure S7](image)

**Figure S7.** $^1$H spectrum of the aliphatic region of 4a-major (600 MHz, CD$_3$CN).

---

The two vicinal $^3J$ coupling constants $H_2-H_1$ and $H_2-H_3$ have similar values (4.9 and 6.3 Hz, respectively), while the $H_1-H_3$ coupling constant between the two CH bearing the aromatic rings is rather large (10.0 Hz). The large value of the latter suggests that the dihedral angle between the two hydrogens is close to $0^\circ$ (thus a *syn* relationship of the aromatic rings), while the smaller coupling constants of $H_1$ and $H_3$ with $H_2$ are a clear indication of a gauche disposition of $H_2$ with respect to $H_1$ and $H_3$ (thus a *trans* relationship of the hydrogens).

As a confirm, the $^1H$ spectrum of 4d-*minor* showed a similar set of rate constants, but the large one (9.9 Hz) took place between $H_2$ and $H_3$ (see Table S3).

To have further support to the assignment based on coupling constant, DFT calculations were run to calculate the coupling constants values of the major isomer supposing the 1R*,2R*,3S* relative configuration. Due to the rigidity of cyclopropane, the relative disposition of the key hydrogens of the stereogenic centres are fixed independently from the different conformations of the CHO and benzoxazole, and the values of the coupling constants can elucidate the relative stereochemistry. Before to run the NMR simulations, a conformational search was run by means of Monte Carlo searching together with the MMFF94 molecular mechanics force field. All the conformations found by MM search were then optimized using DFT at the B3LYP/6-31+G(d,p) level and their stability was checked by vibrational analysis. As for 4d-*minor*, four conformations were found to be enclosed in a 2 kcal/mol window as shown in Figure S8 and marked as a-d in Table S3. Again, the four conformations correspond to the four different relative dispositions of the CHO and benzoxazole group.

---

Table S3. Relative energies of the four conformations of 4a-major evaluated using ZPE-corrected enthalpies and different optimization levels: B3LYP/6-31+G(d,p) and M06-2X/6-31+G(d,p). Populations are calculated using Boltzmann distribution at 298°K.

<table>
<thead>
<tr>
<th>Conformation</th>
<th>H° (B3LYP)</th>
<th>H° (M06-2X)</th>
<th>Pop. (B3LYP)</th>
<th>Pop. (M06-2X)</th>
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</thead>
<tbody>
<tr>
<td>a</td>
<td>0.58</td>
<td>0.97</td>
<td>15</td>
<td>9</td>
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<tr>
<td>b</td>
<td>0.73</td>
<td>1.37</td>
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<tr>
<td>c</td>
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<td>0.00</td>
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<td>44</td>
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<tr>
<td>d</td>
<td>0.17</td>
<td>0.01</td>
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The simulations of the coupling constants were run at the at the B3LYP/6-311++G(2d,p) level using the GIAO method and including the Fermi contact term (Gaussian 09 keyword: spinspin, mixed). The calculated coupling constants for the 1R*, 2R*, 3S* relative
configuration (Table S4) are in a very good agreement with the experimental values of 4a-major.

**Table S4.** Calculated and experimental coupling constants for the four diastereoisomers of 4d. Calculations were run at the GIAO-B3LYP/6-311++G(2d,p)//B3LYP/6-31+G(d,p) level. In parenthesis are reported the calculated $J$-couplings of the conformations in which the H2-C-(CO)-H dihedral is close to 180°. In italics are reported the calculated values for those conformations in which the H1-C1-Cq-O ≈ 180°. Plain text values are relative to values for those conformations in which the H1-C1-Cq-O ≈ 0°.

<table>
<thead>
<tr>
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<th>Calcd. for $3^J$ (1R*,2S*,3S*)</th>
<th>Calcd. for $3^J$ (1R*,2S*,3R*)</th>
<th>Calcd. for $3^J$ (1R*,2R*,3S*)</th>
<th>Calcd. for $3^J$ (1R*,2S*,3R*)</th>
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<th>Expl. 4d-minor</th>
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<tbody>
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<td>H2-CHO</td>
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<td>1.8 (6.7)</td>
<td>1.7 (6.9)</td>
<td>1.5 (7.6)</td>
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<td>1.7 (6.9)</td>
<td>1.7 (6.9)</td>
<td>1.5 (7.3)</td>
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<tr>
<td>H2-H1</td>
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<td>9.9 (10.4)</td>
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<tr>
<td>H2-H3</td>
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<td>5.4 (7.2)</td>
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<td>11.1 (11.2)</td>
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<tr>
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<td>7.2 (6.7)</td>
<td>11.2 (11.3)</td>
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<td>11.2 (11.3)</td>
<td>7.9 (6.9)</td>
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<td></td>
</tr>
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</table>

*relative configuration from X-Ray data

As a check of the calculation reliability, the coupling constants were calculated also for 4d-minor, which relative configuration was known from X-ray data. Also in this case the calculated values fully matched the experimental values. It should be noted that in both compounds the experimental value of the H2-CHO coupling constant clearly results from the weighted average of two conformations where the dihedral angle H2-C-(CO)-H is close to 0° or 180° (see below). The resulting experimental value seems to suggest that both the two conformations are populated roughly at the same extent. The full set of coupling constants were calculated also for the remaining two diastereomers due to inversion at C2 carbon
(Table S4, columns 2 and 3). For both cases the set of calculated couplings does not match the experimental data, thus confirming the previous assignment of the \((1R^*,2R^*,3S^*)\) relative configuration to \textbf{4a-major}.

\textbf{Figure S9}. DPFGSE NOE spectra of \textbf{4a-major} (600 MHz in CD\textsubscript{3}CN). Bottom: control spectrum. Middle trace: NOE obtained on saturation of the \textit{ortho}-phenyl signal. Top trace: NOE obtained on saturation of the CHO signal.

NOE spectra were recorded to further confirm the relative configuration of the major diastereomer of \textbf{4a}. These spectra, however, were thwarted by the distance constraints imposed by the cyclopropanic ring and by the partial overlapping of the key signals (H1, H2 and H3). On saturation of the CHO signal (Figure S9), comparable NOEs were observed for
H1 and H3, while on saturation of the ortho hydrogens of the phenyl ring the NOE on H2 is larger than that on H3 and H1. These results again confirm the relative configuration previously assigned by the coupling constants analysis.
Absolute configuration of 4d-major

For coherence with the first assignment, the absolute configuration of the major diastereomer was performed on compound 4d-Major (obtained with (S)-catalyst). The ECD spectrum was acquired in HPLC-grade acetonitrile solution (1·10^{-4} M) with a cell path of 0.2 cm in the 195-400 nm region by the sum of 16 scans at 50 nm/min scan rate (Figure S10). The spectrum of 4d-major is similar to the of the minor isomer, but the relative intensities of the Cotton effects are different. In this case the two branches at 310 and 270 nm seem to generate a weak exciton coupling and that at 245 nm is much more weaker that the corresponding one of the minor isomer.

![Figure S10. ECD (blue trace) and UV (red trace) spectra of 4d-major (obtained with (S)-catalyst). Spectra were recorded in acetonitrile, 1·10^{-4}M, 0.2 cm cell path.](image)

The four stable conformations of 4d-major were again optimized at the B3LYP/6-31+G(d,p) level starting from the geometries obtained for 4a-major. Calculations were run in the gas-phase and including two different solvents (chloroform and acetonitrile) using the PCM method. The relative energies and corresponding populations derived from Boltzmann statistics are reported in Table S5.

The electronic excitation energies and rotational strengths have been calculated for the

---

isolated molecule in the gas phase with the four different methods (functionals) already employed for the simulation of the ECD spectrum of the minor diastereomer (CAM-B3LYP, BH&HLYP, M06-2X, and ωB97XD). In analogy with 4d-minor, TD-DFT calculations employed the 6-311++G(2d,p) basis set, yielding the results reported in Figure S11.

**Table S5.** Relative energies of the four conformations of 4d-major evaluated using ZPE-corrected enthalpies obtained from B3LYP/6-31+G(d,p) optimizations in gas phase and including two different solvents (CHCl₃ and CH₃CN) with the PCM method. Populations are calculated using Boltzmann distribution at 298°K.

<table>
<thead>
<tr>
<th>Conf.</th>
<th>gas phase</th>
<th>PCM(CHCl₃)</th>
<th>PCM(CH₃CN)</th>
<th>Pop%</th>
<th>Pop%</th>
<th>Pop%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1.46</td>
<td>0.20</td>
<td>0.00</td>
<td>5</td>
<td>23</td>
<td>33</td>
</tr>
<tr>
<td>b</td>
<td>1.12</td>
<td>0.18</td>
<td>0.08</td>
<td>11</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>c</td>
<td>0.79</td>
<td>0.21</td>
<td>0.25</td>
<td>17</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>d</td>
<td>0.00</td>
<td>0.00</td>
<td>0.37</td>
<td>67</td>
<td>32</td>
<td>17</td>
</tr>
</tbody>
</table>

Within the same conformation, the four kind of calculations provide very similar traces. However, at a variance with the minor isomer, the simulated spectra for conformations a and d are nearly opposite to that simulated for b and c. The two pairs of conformations showing opposite spectra are different because of the ≈ 180° rotation of the benzoxazole ring. A rationale of the opposite calculated traces can be found in a close analysis of the different disposition of the p-nitrophenyl ring and benzoxazole in the two conformations. (Figure S12).
Figure S11. Calculated ECD for each conformation of 4d-major with different functionals and the same 6-311++G(2d,p) basis set.

Figure S12: View of the dipoles of 4d-major acting in the generation of the UV spectrum in the 250-350 nm region. In both conformations the p-nitrophenyl ring is far away from the observer and the benzoxazole is close. The dotted arrows correspond to the UV transition of the p-nitrophenyl ring oriented along the long axis, while the full arrow are that of benzoxazole.
The dihedral angles generated by the two dipoles of along the long axes of $p$-nitrophenyl and benzoxazole in the two conformations yield opposite sign, thus explaining the opposite exciton coupling in the simulations.

Being the ECD spectrum the weighted average of the spectra of the four conformations, the correct ratio to be used is crucial to the success of the ECD simulation (in the following discussion only conformations $c$ and $d$ will be considered since the spectrum of the second conformation of each pair due to CHO rotation is identical). In similar cases\textsuperscript{14,15} the conformational ratio could be evaluated by Dynamic NMR or NOE experiments, but in the present situation this approach is thwarted by the absence of any benzoxazole hydrogen in the closeness of the cyclopropane ring. To overcome this difficulties, a carefully degassed CDCl$_3$ NMR sample was prepared in order to extend the effective radius of the NOE effect. CDCl$_3$ was selected as solvent because of its low viscosity that allows longer T1 relaxation times. In CDCl$_3$ the two signals of the two CH of cyclopropane bearing the aromatic rings (H1 and H3) are exactly overlapped and yield a doublet, whereas the CH(CHO) signal is a triplet of doublets due to the coupling with the two isochronous CH of cyclopropane and with the CHO. DPFGSE NOE spectra were acquired using long mixing times (4-6 s) corresponding to the T1 relaxation time of the cyclopropane hydrogens measured at ambient temperature by the inversion-recovery sequence (Figure S13).


Figure S13. DPFGSE-NOE of 4d-major recorded on saturation of the CH(CHO) signal and using 4 s mixing time. The negative NOE at 8.08 ppm is due to transferred NOE from the NOE signal at 7.44 ppm.

On saturating the CH(CHO) signal, weak but comparable NOEs were observed on the two aromatic signals in position 4 (ortho to the oxygen of benzoxazole) and in position 7 (ortho to the nitrogen) of benzoxazole. If only one conformation were populated, NOE should be visible mainly on one signal of the benzoxazole. Taking into account only conformation c, the theoretical NOE ratio should be 88:12 in favour of the NOE on H-4. If only conformation d were populated, the observed NOE ratio should be reversed to 14:86 (ratio were calculated using the distances of the optimized structures, and using the r^-6 rule). The experimental evidence of a 60:40 H-4:H-7 ratio suggests that both conformations are appreciably populated. When considering the distances extracted from calculations, the experimental NOE ratio corresponds to a 56:44 ratio in favour of the c conformation. Unfortunately the same NOE spectrum taken in acetonitrile did not allow to see any long-range enhancement, most probably because of faster relaxation times that did not allow to develop measurable NOEs for H-4 and H-7. As from Table S5, conformation d was calculated.
to be the more stable in the gas phase and in chloroform, whereas conformation a is the more stable in acetonitrile. Nevertheless, the energy differences are very small and well support the NOE results obtained in chloroform. To evaluate the variations caused by the different conformational ratios, the simulations of the experimental ECD spectrum were obtained using the three different sets of relative energies reported in Table S5. From the simulations reported in Figure S14 it is evident that the simulations obtained using the relative ratio suggested by PCM calculations provide better results than that obtained using the gas-phase conformational ratio. Nevertheless, each simulation well reproduces the experimental trace, and the 1R, 2R, 3S absolute configuration can be reliably assigned to the major isomer of 4d.
Figure S14. Simulations of the experimental ECD spectrum of 4d-major. For each graph, the black line correspond to the experimental spectrum. The colored lines correspond to the simulations obtained using the populations derived from B3LYP/6-31+G(d,p) geometry optimizations. Left column: gas-phase optimization; middle column: PCM optimization with chloroform; right column: PCM optimization with acetonitrile. The simulated spectra were vertically scaled and red-shifted by 12-18 nm to get the best match with the experimental spectrum. All the simulations are for the 1R,2R,3S absolute configuration.
4. Screening of Solvents

![Chemical Reaction Diagram](image-url)

Table S6. Screening of solvents

<table>
<thead>
<tr>
<th>Entry</th>
<th>Solvent</th>
<th>conversion % (24h)</th>
<th>dr (crude)</th>
<th>ee major dia (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EtOAc</td>
<td>52</td>
<td>2.1:1.7:1:1</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>CH₃CN</td>
<td>59</td>
<td>4:3.2:1</td>
<td>99</td>
</tr>
<tr>
<td>3</td>
<td>DMF</td>
<td>33</td>
<td>3.5:2.4:1</td>
<td>---</td>
</tr>
<tr>
<td>4</td>
<td>MeOH</td>
<td>97</td>
<td>2:1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>5</td>
<td>DCM</td>
<td>57</td>
<td>2:1:2:1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>6</td>
<td>CHCl₃</td>
<td>29</td>
<td>2.4:1.6:1</td>
<td>&gt; 70</td>
</tr>
</tbody>
</table>
5. Screening of Organic Catalyst

![Chemical Reaction Diagram]

Table S7: Screening of organic catalyst

<table>
<thead>
<tr>
<th>Entry</th>
<th>Catalyst</th>
<th>Conversion % (24h)</th>
<th>dr (crude)</th>
<th>ee %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1" alt="Catalyst 1" /></td>
<td>59</td>
<td>4:3.2:1</td>
<td>99</td>
</tr>
<tr>
<td>2</td>
<td><img src="image2" alt="Catalyst 2" /></td>
<td>82</td>
<td>2.5:1.1:1</td>
<td>99</td>
</tr>
<tr>
<td>3</td>
<td><img src="image3" alt="Catalyst 3" /></td>
<td>traces</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4</td>
<td><img src="image4" alt="Catalyst 4" /></td>
<td>traces</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td><img src="image5" alt="Catalyst 5" /></td>
<td>--</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td><img src="image6" alt="Catalyst 6" /></td>
<td>traces</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td>No organic catalyst</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

a) maybe 4 diastereomers total.
6. Screening of Bases

![Chemical Reaction]

Table S8: Screening of bases

<table>
<thead>
<tr>
<th>Entry</th>
<th>Base</th>
<th>Conversion % (24h)</th>
<th>dr (crude)</th>
<th>ee %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TEA</td>
<td>59</td>
<td>4:3:2:1</td>
<td>99</td>
</tr>
<tr>
<td>2</td>
<td>DIPEA</td>
<td>full</td>
<td>1.6:0.8:1</td>
<td>99</td>
</tr>
<tr>
<td>3</td>
<td>2,6-lutidine</td>
<td>93</td>
<td>4.1:2.4:1</td>
<td>99</td>
</tr>
<tr>
<td>4</td>
<td>Cs$_2$O$_3$</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>DABCO</td>
<td>34</td>
<td>2.5:1:1:1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>6</td>
<td>No base</td>
<td>29</td>
<td>2.4:1:1</td>
<td>---</td>
</tr>
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</table>
### 7. Screening of Lewis Acid

![Chemical Reaction](attachment:image.png)

**Table S9**: Screening of Lewis acid

<table>
<thead>
<tr>
<th>Entry</th>
<th>Lewis Acid</th>
<th>Conversion % (24h)</th>
<th>dr (crude)</th>
<th>ee %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pd(OAc)$_2$</td>
<td>full</td>
<td>1.6:0.8:1</td>
<td>99</td>
</tr>
<tr>
<td>2</td>
<td>AgOBz</td>
<td>92</td>
<td>2:1:1</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>AgOAc</td>
<td>79</td>
<td>2.7:1.3:1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>4</td>
<td>Cu(OAc)$_2$</td>
<td>61</td>
<td>1.7:0.6:1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>5</td>
<td>Yb(SO$_3$CF$_3$)$_2$</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>Cu(SO$_3$CF$_3$)$_2$</td>
<td>50</td>
<td>2.5:2.2:1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>7</td>
<td>PdCl$_2$</td>
<td>29</td>
<td>1:0.6:1</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>8</td>
<td>No Lewis Acid</td>
<td>traces</td>
<td>---</td>
<td>---</td>
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</table>
8. Screening of Temperatures

![Chemical reaction diagram]

**Table S10:** Screening of temperatures

<table>
<thead>
<tr>
<th>Entry</th>
<th>Temperature (°C)</th>
<th>Conversion %</th>
<th>dr (crude)</th>
<th>ee %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>63 (24 h)</td>
<td>1.7:1.1:1</td>
<td>&gt; 95</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>61 (60 h)</td>
<td>2:0.8:1</td>
<td>&gt; 95</td>
</tr>
<tr>
<td>3</td>
<td>rt</td>
<td>full (24h)</td>
<td>1.6:0.8:1</td>
<td>&gt; 95</td>
</tr>
</tbody>
</table>

9. Screening of Metals with 2,6-lutidine

![Chemical reaction diagram]

**Table S11:** Screening of metals with lutidine

<table>
<thead>
<tr>
<th>Entry</th>
<th>Metal</th>
<th>Conversion % (24h)</th>
<th>dr (crude)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pd(OAc)₂</td>
<td>full</td>
<td>5.2:2.6:1</td>
</tr>
<tr>
<td>2</td>
<td>Cu(OAc)₂</td>
<td>traces-degradation</td>
<td>---</td>
</tr>
<tr>
<td>3</td>
<td>AgOAc</td>
<td>Full (NMR less clean than Pd)</td>
<td>2.2:1.4:1</td>
</tr>
</tbody>
</table>
10. Scope of the reaction - aldehydes

![Chemical Reaction](image)

Table S12. Scope of the reaction - aldehydes

<table>
<thead>
<tr>
<th>Product</th>
<th>Aldehyde</th>
<th>Yield %</th>
<th>d.r.</th>
<th>ee major</th>
<th>ee minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a</td>
<td>H</td>
<td>89</td>
<td>4.5 : 1.2 : 1</td>
<td>96 % R / 99 % S</td>
<td>not determined</td>
</tr>
<tr>
<td>4b</td>
<td>4-Br</td>
<td>70</td>
<td>7 : 2.2 : 1</td>
<td>97 % R / 98 % S</td>
<td>not determined</td>
</tr>
<tr>
<td>4c</td>
<td>4-Cl</td>
<td>74</td>
<td>2:1</td>
<td>98 % R / 97 % S</td>
<td>not determined</td>
</tr>
<tr>
<td>4d</td>
<td>4-NO₂</td>
<td>79</td>
<td>14 : 5.6 : 1</td>
<td>&gt;99 % R / &gt;99 % S</td>
<td>89 % S / 81 % R</td>
</tr>
<tr>
<td>4f</td>
<td>4-CN</td>
<td>89</td>
<td>4.8 : 3 : 1</td>
<td>&gt;99 % R / &gt;99 % S</td>
<td>not determined</td>
</tr>
<tr>
<td>4e</td>
<td>4-F</td>
<td>86</td>
<td>6.6 : 2.6 : 1</td>
<td>98 % R / 98 % S</td>
<td>not determined</td>
</tr>
<tr>
<td>4g</td>
<td>4-CH₃</td>
<td>66</td>
<td>5.3 : 1.6 : 1</td>
<td>99 % R / 99 % S</td>
<td>not determined</td>
</tr>
<tr>
<td>4h</td>
<td>2-Br</td>
<td>81</td>
<td>13.4 : 2.3 : 1</td>
<td>&gt;99 % R / &gt;99 % S</td>
<td>not determined</td>
</tr>
<tr>
<td>4i</td>
<td>OHC-CH₂-COOE</td>
<td>85</td>
<td>&gt; 15:1</td>
<td>81 % R / 87 % S</td>
<td>-----</td>
</tr>
<tr>
<td>4j</td>
<td>OHC-CH₂-Me</td>
<td>---</td>
<td>---</td>
<td>---</td>
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</tr>
</tbody>
</table>
11. Scope of the reaction – benzoxazoles

Table S13. Scope of the reaction – benzoxazoles

<table>
<thead>
<tr>
<th>Product</th>
<th>Benzoxazole</th>
<th>Ar</th>
<th>Yield</th>
<th>dr</th>
<th>ee major</th>
<th>ee minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a</td>
<td><img src="image1" alt="Structure" /></td>
<td>Ph</td>
<td>89%</td>
<td>4.5 : 1.2 : 1</td>
<td>96% R / 99% S</td>
<td>Not determined</td>
</tr>
<tr>
<td>5a</td>
<td><img src="image2" alt="Structure" /></td>
<td>Ph</td>
<td>68%</td>
<td>10.5 : 3.3 : 1</td>
<td>&gt;99% R / &gt;99% S</td>
<td>90% R</td>
</tr>
<tr>
<td>5g</td>
<td><img src="image3" alt="Structure" /></td>
<td>Ph</td>
<td>traces</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5c</td>
<td><img src="image4" alt="Structure" /></td>
<td>Ph</td>
<td>78%</td>
<td>4.5 : 1.9 : 1</td>
<td>98% R / 98% S</td>
<td>Not determined</td>
</tr>
<tr>
<td>5b</td>
<td><img src="image5" alt="Structure" /></td>
<td>Ph</td>
<td>55%</td>
<td>6.2 : 1.3 : 1</td>
<td>99% R / 98% S</td>
<td>Not determined</td>
</tr>
<tr>
<td>5d</td>
<td><img src="image6" alt="Structure" /></td>
<td>Ph</td>
<td>51%</td>
<td>2.3 : 1.6 : 1</td>
<td>&gt;99% R / &gt;99% S</td>
<td>Not determined</td>
</tr>
<tr>
<td>5e</td>
<td><img src="image7" alt="Structure" /></td>
<td>pBrC₆H₄</td>
<td>85%</td>
<td>8.1 : 4.8 : 1</td>
<td>98% R / 97% S</td>
<td>Not determined</td>
</tr>
<tr>
<td>5f</td>
<td><img src="image8" alt="Structure" /></td>
<td>mBrC₆H₄</td>
<td>66%</td>
<td>17.4 : 6.3 : 1</td>
<td>91% R / 97% S</td>
<td>Not determined</td>
</tr>
</tbody>
</table>
12. Synthesis of the starting material – benzoxazoles

General procedure:
In a round bottom flask, equipped with a condenser, were added 1 equivalent of aminophenol followed by 1,1 equivalents of 2-chloro-1,1,1-triethoxyethane or 2-chloro-1,1,1-trimethoxyethane. The reaction mixture is stirred and heated. The reaction is followed by TLC. After the reaction is completed, the crude is purified by recrystallization or by flash column chromatography (n-hexane/EtOAc) to obtain the desired benzoxazole.

2-(chloromethyl)-6-nitrobenzoxazole (1a)

The reaction was performed following the general procedure adding 2-amino-5-nitrophenol (712 mg, 4.623 mmol, 1 equiv) and 2-chloro-1,1,1-triethoxyethane (1 g, 5.085 mmol, 1.1 equiv). The reaction mixture was stirred at 100°C for 4 hours. The crude was purified by recrystallization with EtOH/H₂O to obtain 584 mg of the desired product as dark orange solid. Yield: 59%.

\(^1\)H NMR (400 MHz, CDCl₃) δ 8.49 (s, 1H), 8.35 (d, \(J = 8.6\) Hz, 1H), 7.87 (d, \(J = 8.7\) Hz, 1H), 4.81 (s, 2H).

\(^{13}\)C NMR (101 MHz, CDCl₃) δ 165.4 (Cq), 150.3 (Cq), 145.9 (Cq), 145.9 (Cq), 120.9 (CH), 120.7 (CH), 107.7 (CH), 35.9 (CH₂).

HRMS m/z (ESI⁺) Exact mass calculated for C₈H₆ClN₂O₃ [M+H]⁺: 213.0061, found: 213.0062.

5-chloro-2-(chloromethyl)-6-nitrobenzoxazole (1b)

The reaction was performed following the general procedure adding 2-amino-4-chloro-5-nitrophenol (1.66 g, 8.801 mmol, 1 equiv) and 2-chloro-1,1,1-trimethoxyethane (1.3 mL, 9.681 mmol, 1.1 equiv). The reaction mixture was stirred at 100°C for 19 hours. The crude was purified by recrystallization with EtOH/H₂O to obtain 1.715 g of the desired product as dark brown solid. Yield: 79%.

\(^1\)H NMR (400 MHz, CDCl₃) δ 8.15 (s, 1H), 7.94 (s, 1H), 4.80 (s, 2H).
$^{13}$C NMR (101 MHz, CDCl$_3$) δ 165.9 (Cq), 148.5 (Cq), 145.6 (Cq), 144.3 (Cq), 124.0 (Cq), 123.2 (CH), 109.0 (CH), 35.7 (CH$_2$).

HRMS m/z (ESI+) Exact mass calculated for C$_9$H$_3$ClN$_2$O$_3$ [M+H]$^+$: 246.9672, found: 246.9671.

**methyl 2-(chloromethyl)benzoxazole-6-carboxylate (1d)**

![Methyl 2-(chloromethyl)benzoxazole-6-carboxylate (1d)](image)

The reaction was performed following the general procedure adding methyl 4-amino-3-hydroxybenzoate (980 mg, 5.862 mmol, 1 equiv) and 2-chloro-1,1,1-trimethoxyethane (0.87 mL, 6.448 mmol, 1.1 equiv). The reaction mixture was stirred at 100°C for 19 hours. The crude was purified by recrystallization with EtOH/H$_2$O to obtain 1.250 g of the desired product as light brown solid. Yield: 95%.

$^1$H NMR (400 MHz, CDCl$_3$) δ 8.24 (d, J = 1.0 Hz, 1H), 8.09 (dd, J = 8.4, 1.4 Hz, 1H), 7.77 (d, J = 8.4 Hz, 1H), 4.78 (s, 2H), 3.96 (s, 3H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 166.3 (Cq), 163.5 (Cq), 150.8 (Cq), 144.6 (Cq), 128.1 (Cq), 126.5 (CH), 120.2 (CH), 112.6 (CH), 52.5 (CH$_3$), 36.2 (CH$_2$).

HRMS m/z (ESI+) Exact mass calculated for C$_{10}$H$_9$ClNO$_3$ [M+H]$^+$: 226.0265, found: 226.0269.

**2-(chloromethyl)-5-nitrobenzoxazole (1c)**

![2-(chloromethyl)-5-nitrobenzoxazole (1c)](image)

The reaction was performed following the general procedure adding 2-amino-4-nitrophenol (712 mg, 4.623 mmol, 1 equiv) and 2-chloro-1,1,1-trimethoxyethane (1 g, 5.085 mmol, 1.1 equiv). The reaction mixture was stirred at 80°C for 12 hours. The residual solvent was evaporated under vacuum to obtain 686 mg of the desired product as brown solid. Yield: 70%.

$^1$H NMR (400 MHz, CDCl$_3$) δ 8.65 (d, J = 1.9 Hz, 1H), 8.37 (dd, J = 9.0, 2.1 Hz, 1H), 7.69 (d, J = 9.0 Hz, 1H), 4.80 (s, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 164.0 (Cq), 154.5 (Cq), 145.6 (Cq), 141.2 (Cq), 122.0 (CH), 117.1 (CH), 111.3 (CH), 35.9 (CH$_2$).

HRMS m/z (ESI+) Exact mass calculated for C$_8$H$_6$ClN$_2$O$_3$ [M+H]$^+$: 213.0061, found: 213.0062.
2-{(chloromethyl)}-4-nitrobenzoxazole[1] (1e)

The reaction was performed following the general procedure adding 2-amino-3-nitrophenol (1.355 g, 8.791 mmol, 1 equiv) and 2-chloro-1,1,1-trimethoxyethane (1.305 mL, 9.670 mmol, 1.1 equiv). The reaction mixture was stirred at 100°C for 12 hours. The crude was purified by recrystallization with EtOH/H$_2$O to obtain 720 mg of the desired product as light brown solid. Yield: 93%.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.25 (d, $J$ = 8.2 Hz, 1H), 7.94 (d, $J$ = 8.2 Hz, 1H), 7.59 (t, $J$ = 8.2 Hz, 1H), 4.88 (s, 2H).

2-{(chloromethyl)}benzoxazole[2] (1f)

The reaction was performed following the general procedure adding 2-aminophenol (640 mg, 5.865 mmol, 1 equiv) and 2-chloro-1,1,1-trimethoxyethane (0.87 mL, 6.451 mmol, 1.1 equiv). The reaction mixture was stirred at 80°C for 20 hours. The crude was purified by flash column chromatography ($n$-hexane/EtOAc 5:1) to obtain 490 mg of the desired product as light orange oil. Yield: 54%.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.75 (dd, $J$ = 6.7, 2.4 Hz, 1H), 7.56 (dd, $J$ = 6.9, 2.2 Hz, 1H), 7.43 – 7.32 (m, 2H), 4.76 (s, 2H).
13. Synthesis of the starting material – α,β-unsaturated aldehydes

\[
\text{R'}\begin{array}{c}
\text{CHO} \\
\end{array} + \text{Ph}_3\text{P} = = \text{CHO} \quad \text{toluene, 50°C} \quad \rightarrow \quad \text{R'}\begin{array}{c}
\text{CHO} \\
\end{array} + \text{Ph}_3\text{P} = \text{O}
\]

The starting aldehydes were synthesized through a Wittig reaction, following the procedure described in literature. In a round bottom flask a substituted benzaldehyde derivative (2 equiv) and (triphenylphosphoranyldiene)acetaldehyde (1 equiv) were stirred in anhydrous toluene under reflux at 50°C under argon. The crude mixture was purified by a flash column chromatography.

Literature’s references for the aldehydes synthesized:

- (E)-3-(4-bromophenyl)acrylaldehyde (2b), (E)-3-(p-tolyl)acrylaldehyde (2g) and (E)-3-(4-chlorophenyl)acrylaldehyde (2c)[3]
- (E)-3-(4-nitrophenyl)acrylaldehyde (2d) and (E)-3-(2-bromophenyl)acrylaldehyde (2h)[4]
- (E)-3-(4-fluorophenyl)acrylaldehyde (2e)[5]
- (E)-4-(3-oxoprop-1-en-1-yl)benzonitrile (2f)[6]
- Ethyl (E)-4-oxobut-2-enoate (2i)[7]
- (E)-3-(3-bromophenyl)acrylaldehyde (2k)[8]
14. General procedure for the synthesis of cyclopropanes

In a closed vial were added in this sequence: the organic catalyst 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (20 mol% equiv), α,β-unsaturated aldehyde (2 equiv), azaarene (1 equiv), Pd(OAc)$_2$ (5 mol% equiv) and CH$_3$CN (1 mL). To the reaction mixture, was finally added 2,6-lutidine (1 equiv). The reaction mixture was stirred at room temperature and then concentrated in vacuo. The crude was purified by flash column chromatography (n-hexane/EtOAc) to obtain the desired product.

15. Final products characterisation

**Compound 4a**

![Chemical structure of compound 4a]

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (306 mg, 0.941 mmol, 20 mol% equiv), cinnamaldehyde (1.243 g, 9.408 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (1 g, 4.704 mmol, 1 equiv), Pd(OAc)$_2$ (53 mg, 0.235 mmol, 5 mol% equiv), CH$_3$CN (10 mL) and 2,6-lutidine (504 mg, 4.704 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 10:1) to obtain 1.289 g of the desired products as dark yellow oil. Yield: 89%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 4.5:1.2:1

(1R,2R,3S)-2-(6-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

![Chemical structure of compound 1R,2R,3S-2-(6-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde]

IR (liquid film): 2922, 2851, 1709 (CHO), 1570 (aromatic NO$_2$), 1525, 1345 (aromatic NO$_2$), 758 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.89 (d, $J = 2.8$ Hz, 1H), 8.24 – 8.18 (m, 2H), 7.64 (d, $J = 8.6$ Hz, 1H), 7.24 – 7.16 (m, 5H), 3.57 (ddd, $J = 5.6$, 5.6, 2.8 Hz, 1H), 3.41 (bd, $J = 5.5$ Hz, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 197.4 (CH), 166.7 (Cq), 150.0 (Cq), 146.3 (Cq), 145.2 (Cq), 133.0 (Cq), 128.8 (CH), 128.7 (CH), 128.0 (CH), 120.7 (CH), 119.7 (CH), 107.0 (CH), 34.9 (CH), 34.5 (CH), 26.24 (CH).
The enantiomeric excess was determined by HPLC using a Chiralpak IA column (hexane/iPrOH = 85:15, flow rate 1.0 mL/min, λ = 210 nm): tᵣ (S) = 16.1, tᵣ (R) = 17.0, 96% (R) and 99% (S) ee.

[α]₀²² = -107.6° (c = 0.1, CHCl₃) (S catalyst)

HRMS m/z (ESI+) Exact mass calculated for C₁₇H₁₃N₂O₄ [M+H]⁺: 309.0870, found: 309.0872.

(1R,2R,3R)-2-(6-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

1H NMR (400 MHz, CDCl₃) δ 9.16 (d, J = 5.0 Hz, 1H, CHO), 8.43 (d, J = 2.1 Hz, 1H, H²), 8.32 (dd, J = 8.8, 2.1 Hz, 1H, H¹), 7.77 (d, J = 8.8 Hz, 1H, H⁶), 7.38 (m, J = 4.4 Hz, 5H, Ph), 3.66 (m, 2H, H₁₂, H₁₁). Proton and carbon were assigned using the COSY and HMBC NMR analysis.

[α]₀²¹ = +21.4° (c = 0.4, CHCl₃) (R catalyst)

Mixture of minor and minor’:

1H NMR (400 MHz, CDCl₃) δ 9.69 (d, J = 5.7 Hz, 1H‘), 9.16 (d, J = 5.0 Hz, 1H), 8.41 (d, J = 2.1 Hz, 2H), 8.30 (dd, J = 8.8, 2.0 Hz, 1H + 1H‘), 7.77 (dd, J = 8.8, 4.7 Hz, 1H + 1H‘), 7.43 – 7.23 (m, 11H Ar), 3.77 (t, J = 6.3 Hz, 1H‘), 3.72 – 3.63 (m, 2H), 3.20 (dd, J = 8.9, 6.5 Hz, 1H‘), 3.09 (dt, J = 9.7, 5.0 Hz, 1H), 2.80 (dt, J = 8.9, 5.9 Hz, 1H‘).

13C NMR (101 MHz, CDCl₃) δ 197.2 (C¹⁶), 166.5 (Cq), 149.8 (Cq), 146.1 (Cq), 145.0 (Cq), 132.8 (Cq), 128.7 (CH), 128.5 (CH), 127.9 (CH), 120.6 (C¹), 119.5 (C⁶), 106.9 (C³), 34.8 (C¹¹), 34.3 (C¹²), 26.1 (C¹⁰).
HRMS m/z (ESI+) Exact mass calculated for C\textsubscript{17}H\textsubscript{13}N\textsubscript{2}O\textsubscript{4} [M+H]\textsuperscript{+}: 309.0870, found: 309.0868.

**Compound 4b**

![Chemical structure of compound 4b]

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol\% equiv), (\textit{E})-3-(4-bromophenyl)acrylaldehyde (198 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)\textsubscript{2} (5 mg, 0.024 mmol, 5 mol\% equiv), CH\textsubscript{3}CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 5:1) to obtain 127 mg of the desired products as light yellow solid. Yield: 70%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 7:2:2:1

**(1S,2R,3S)-2-(4-bromophenyl)-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde**

![Chemical structure of (1S,2R,3S)-2-(4-bromophenyl)-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde]

IR (liquid film): 2926, 1714 (CHO), 1571 (aromatic NO\textsubscript{2}), 1570, 1523, 1344 (aromatic NO\textsubscript{2}), 760 cm\textsuperscript{-1}.

\textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \(\delta\) 9.88 (d, \(J = 2.7\) Hz, 1H), 8.24 (d, \(J = 2.1\) Hz, 1H), 8.19 (dd, \(J = 8.8, 2.1\) Hz, 1H), 7.64 (d, \(J = 8.7\) Hz, 1H), 7.33 – 7.27 (m, 2H), 7.12 – 7.05 (m, 2H), 3.53 (ddd, \(J = 5.9, 5.3, 2.7\) Hz, 1H), 3.38 (dd, \(J = 9.8, 5.2\) Hz, 1H), 3.32 (dd, \(J = 9.8, 6.0\) Hz, 1H).

\textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) \(\delta\) 197.1 (CH), 166.2 (Cq), 149.9 (Cq), 146.1 (Cq), 145.2 (Cq), 132.0 (Cq), 131.7 (Cq), 130.5 (CH), 122.1 (CH), 120.8 (CH), 119.7 (CH), 107.1 (CH), 34.4 (CH), 34.2 (CH), 26.2 (CH).
The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/iPrOH = 85:15, flow rate 1.0 mL/min, λ = 210 nm): \( t_r (S) = 56.6, t_r (R) = 43.5 \), 97% (R) and 98% (S) ee.

\[ [\alpha]_D^{22} = +168.0^\circ \text{ (c = 0.5, CHCl}_3 \text{)} \] (R catalyst)

mp: 116-117 °C

HRMS \( m/z \) (ESI+) Exact mass calculated for \( \text{C}_{17}\text{H}_{12}\text{BrN}_2\text{O}_4 \) [M+H]^+: 386.9975, found: 386.9984.

(1\textit{R},2\textit{R},3\textit{R})-2-(4-bromophenyl)-3-(6-nitrobenzooxazol-2-yl)cyclopropane-1-carbaldehyde

\[ \begin{align*}
\text{O}_2\text{N} & \quad \text{CHO} \\
\text{Br} & \quad \text{minor}
\end{align*} \]

\( ^1\text{H} \text{ NMR (400 MHz, CDCl}_3 \delta 9.26 \) (d, \( J = 4.3 \text{ Hz, 1H} \)), 8.42 (d, \( J = 2.1 \text{ Hz, 1H} \)), 8.32 (dd, \( J = 8.8, 2.1 \text{ Hz, 1H} \)), 7.76 (d, \( J = 8.8 \text{ Hz, 1H} \)), 7.51 – 7.48 (m, 2H), 7.26 – 7.22 (m, 2H), 3.60 (d, \( J = 6.8 \text{ Hz, 2H} \)), 3.13 (ddd, \( J = 7.7, 6.8, 4.3 \text{ Hz, 1H} \)).

\( ^{13}\text{C} \text{ NMR (101 MHz, CDCl}_3 \delta 195.5 \) (CH), 168.9 (Cq), 150.0 (Cq), 146.6 (Cq), 145.4 (Cq), 132.2 (CH), 131.9 (Cq), 130.8 (CH), 122.4 (Cq), 121.1 (CH), 119.7 (CH), 107.3 (CH), 38.6 (CH), 35.1 (CH), 22.3 (CH).

Mixture of minor and minor’:

\( ^1\text{H} \text{ NMR (400 MHz, CDCl}_3 \delta 9.66 \) (d, \( J = 5.5 \text{ Hz, 1H} \)), 9.25 (d, \( J = 4.3 \text{ Hz, 1H} \)), 8.40 (d, \( J = 1.9 \text{ Hz, 1H + 1H} \)), 8.30 (dd, \( J = 8.8, 2.1 \text{ Hz, 1H + 1H} \)), 7.76 (dd, \( J = 8.7, 6.1 \text{ Hz, 1H + 1H} \)), 7.49 (t, \( J = 7.0 \text{ Hz, 2H + 2H} \)), 7.24 (d, \( J = 8.4 \text{ Hz, 2H} \)), 7.13 (d, \( J = 8.4 \text{ Hz, 2H} \)), 3.71 (t, \( J = 6.2 \text{ Hz, 1H} \)), 3.60 (d, \( J = 6.1 \text{ Hz, 2H} \)), 3.12 (ddd, \( J = 8.7, 6.0, 4.3 \text{ Hz, 1H + m, 1H} \)), 2.75 (dt, \( J = 9.0, 5.9 \text{ Hz, 1H} \)).

mp: 119-120°C

HRMS minor \( m/z \) (ESI+) Exact mass calculated for \( \text{C}_{17}\text{H}_{12}\text{BrN}_2\text{O}_4 \) [M+H]^+: 386.9975, found: 386.9982.

HRMS minor’ \( m/z \) (ESI+) Exact mass calculated for \( \text{C}_{17}\text{H}_{12}\text{BrN}_2\text{O}_4 \) [M+H]^+: 386.9975, found: 386.9977.
**Compound 4c**

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol% equiv), (E)-3-(4-chlorophenyl)acrylaldehyde (157 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 4:1) to obtain 120 mg of the desired products as orange solid (major dia) and yellow oil (minor dia). Yield: 74%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 43:22:1

**IR (liquid film):** 3107, 2927, 2924, 2853, 1714 (CHO), 1570 (aromatic NO$_2$), 1523, 1344 (aromatic NO$_2$), 751 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.89 (d, $J = 4.5$ Hz, 1H), 8.25 (d, $J = 2.1$ Hz, 1H), 8.21 (dd, $J = 8.7$, 2.1 Hz, 1H), 7.64 (d, $J = 8.7$ Hz, 1H), 7.16 (s, 4H), 3.56 – 3.52 (m, 1H), 3.41 – 3.33 (m, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 197.2 (CH), 166.3 (Cq), 149.9 (Cq), 146.1 (Cq), 145.3 (Cq), 134.0 (Cq), 131.5, 130.2 (CH), 128.9 (CH), 120.8 (CH), 119.8 (CH), 107.1 (CH), 34.4 (CH), 34.2 (CH), 26.3 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/iPrOH = 80:20, flow rate 1.0 mL/min, $\lambda = 250$ nm): $t_r$ (S) = 41.0, $t_r$ (R) = 28.2, 98% (R) and 97% (S) ee.

$[\alpha]_D^{22} = +132.4^\circ$ (c = 1.3, CHCl$_3$) (R catalyst)
mp: 86-87°C

HRMS m/z (ESI+) Exact mass calculated for C$_{17}$H$_{12}$ClN$_2$O$_4$ [M+H]$^+$: 343.0480, found: 343.0480.

(1R,2R,3R)-2-(4-chlorophenyl)-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde

NMR minor diastereomer with traces of the minor’:
$^1$H NMR (400 MHz, CDCl$_3$) δ 9.26 (d, J = 4.3 Hz, 1H), 8.42 (d, J = 2.1 Hz, 1H), 8.32 (dd, J = 8.8, 2.1 Hz, 1H), 7.76 (d, J = 8.8 Hz, 1H), 7.36 – 7.28 (m, 4H), 3.65 – 3.58 (m, 2H), 3.13 (ddd, J = 8.7, 5.7, 4.4 Hz, 1H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 195.4 (CH), 169.0 (Cq), 150.0 (Cq), 146.6 (Cq), 145.4 (Cq), 134.3 (Cq), 131.4 (Cq), 130.5 (CH), 129.3 (CH), 121.1 (CH), 119.8 (CH), 107.3 (CH), 38.7 (CH), 35.0 (CH), 22.4 (CH).

[α]$^D_{21}$ = +36.7° (c = 0.2, CHCl$_3$) (R catalyst)

**Compound 4d**

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol% equiv), (E)-3-(4-nitrophenyl)acrylaldehyde (166 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 5:1) to obtain 151 mg of the desired products as orange oil (major dia) and yellow solid (minor dia). Yield: 79%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 14:5.6:1
(1R,2R,3S)-2-(6-nitrobenzoxazol-2-yl)-3-(4-nitrophenyl)cyclopropane-1-carbaldehyde

IR (liquid film): 3109, 2924, 2852, 1714 (CHO), 1571 (aromatic NO$_2$), 1518, 1344 (aromatic NO$_2$), 735 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.96 (d, $J = 2.4$ Hz, 1H), 8.25 (d, $J = 2.1$ Hz, 1H), 8.21 (dd, $J = 8.8$, 2.1 Hz, 1H), 8.06 (bd, $J = 8.7$ Hz, 2H), 7.64 (d, $J = 8.8$ Hz, 1H), 7.44 (bd, $J = 8.7$ Hz, 2H), 3.66 (ddd, $J = 5.7$, 5.6, 2.4 Hz, 1H), 3.46 (bd, $J = 5.7$ Hz, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 196.6 (CH), 165.6 (Cq), 149.9 (Cq), 147.6 (Cq), 145.9 (Cq), 145.4 (Cq), 140.5 (Cq), 129.9 (CH), 123.8 (CH), 121.0 (CH), 119.9 (CH), 107.2 (CH), 34.4 (CH), 34.1 (CH), 26.6 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/iPrOH = 55:45, flow rate 0.8 mL/min, $\lambda = 210$ nm): $t_r$ (S) = 44.5, $t_r$ (R) = 36.0, $>99\%$ (R and S) ee.

$[\alpha]_D^{21} = -50.1^\circ$ (c = 1.0, CHCl$_3$) ([S] catalyst)

HRMS m/z (ESI$^+$) Exact mass calculated for C$_{17}$H$_{12}$N$_3$O$_6$ [M+H]$^+$: 354.0721, found: 354.0726.

(1R,2R,3R)-2-(6-nitrobenzoxazol-2-yl)-3-(4-nitrophenyl)cyclopropane-1-carbaldehyde

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.44 (d, $J = 3.2$ Hz, 1H), 8.43 (d, $J = 2.0$ Hz, 1H), 8.32 (d, $J = 8.8$ Hz, 1H), 8.22 (d, $J = 8.7$ Hz, 2H), 7.77 (d, $J = 8.8$ Hz, 1H), 7.54 (d, $J = 8.6$ Hz, 2H), 3.71 (bd, $J = 6.8$ Hz, 2H), 3.30 (ddd, $J = 7.9$, 6.7, 3.2 Hz, 1H).
$^{13}$C NMR (101 MHz, CDCl$_3$) δ 194.7 (CH), 168.4 (Cq), 150.0 (Cq), 147.8 (Cq), 146.5 (Cq), 145.5 (Cq), 140.2 (Cq), 130.2 (CH), 124.1 (CH), 121.2 (CH), 119.9 (CH), 107.3 (CH), 38.6 (CH), 35.5 (CH), 22.7 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak IB column (hexane/iPrOH = 70:30, flow rate 1.0 mL/min, λ = 210 nm): t$_r$ (S) = 40.3, t$_r$ (R) = 38.7, 81% (R) and 89% (S) ee.

$[\alpha]_{D}^{22} = +26.9^\circ$ (c = 0.5, CHCl$_3$) \textbf{(R catalyst)}

mp: 190°C decomposition

HRMS m/z (ESI+) Exact mass calculated for C$_{17}$H$_{12}$N$_3$O$_6$ [M+H]$^+$: 354.0721, found: 354.0718.

**Compound 4f**

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol% equiv), (E)-4-(3-oxoprop-1-en-1-yl)benzonitrile (148 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 5:1) to obtain 139 mg of the desired products as orange solid (major dia) and yellow oil (minor dia). Yield: 89%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 4.8:3:1

**4-((1S,2R,3R)-2-formyl-3-(6-nitrobenzoxazol-2-yl)cyclopropyl)benzonitrile**

IR (liquid film): 2923, 2838, 2229 (CN), 1714 (CHO), 1571 (aromatic NO$_2$), 1523, 1345 (aromatic NO$_2$), 759 cm$^{-1}$. 

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$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.95 (d, $J = 2.4$ Hz, 1H), 8.27 (d, $J = 2.0$ Hz, 1H), 8.23 (dd, $J = 8.7$, 2.1 Hz, 1H), 7.65 (d, $J = 8.7$ Hz, 1H), 7.51 (bd, $J = 8.4$ Hz, 2H), 7.37 (bd, $J = 8.3$ Hz, 2H), 3.62 (ddd, $J = 5.7$, 5.6, 2.4 Hz, 1H), 3.47 – 3.39 (m, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 196.6 (CH), 165.7 (Cq), 149.9 (Cq), 145.9 (Cq), 145.4 (Cq), 138.5 (Cq), 132.4 (CH), 129.7 (CH), 120.9 (CH), 119.9 (CH), 118.4 (Cq), 112.0 (Cq), 107.1 (CH), 34.4 (CH), 34.2 (CH), 26.5 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak AY-H column (hexane/iPrOH = 60:40, flow rate 0.8 mL/min, $\lambda = 210$ nm): $t_r$ (S) = 33.8, $t_r$ (R) = 28.8, >99% (R and S) ee.

$[\alpha]_D^{22} = -169.2^\circ$ (c = 0.7, CHCl$_3$) (S catalyst)

mp: 65°C decomposition

HRMS $m/z$ (ESI+) Exact mass calculated for C$_{16}$H$_{12}$N$_3$O$_4$ [M+H]$^+$: 334.0822, found: 334.0814.

4-((1R,2R,3R)-2-formyl-3-(6-nitrobenzoxazol-2-yl)cyclopropyl)benzonitrile

Mixture of minor and minor':

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.69 (d, $J = 5.3$ Hz, 1H'), 9.40 (d, $J = 3.4$ Hz, 1H), 8.42 (bs, 1H + 1H'), 8.32 (bd, $J = 8.8$ Hz, 1H + 1H'), 7.79 – 7.75 (m, 1H + 1H'), 7.69 – 7.65 (m, 2H + 2H'), 7.48 (d, $J = 8.2$ Hz, 2H), 7.38 (d, $J = 8.3$ Hz, 2H'), 3.79 (dd, $J = 6.3$, 6.2 Hz, 1H'), 3.63 (bd, $J = 7.1$ Hz, 2H), 3.30 – 3.19 (m, 1H + 1H'), 2.86 – 2.81 (m, 1H').

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 196.0 (CH'), 194.8 (CH), 168.5 (Cq), 166.5 (Cq'), 150.1 (Cq'), 150.0 (Cq), 146.5 (Cq), 146.2 (Cq'), 145.4 (Cq), 141.5 (Cq'), 138.2 (Cq), 133.0 (CH'), 132.7 (CH), 130.0 (CH), 127.6 (CH'), 121.2 (CH), 121.1 (CH'), 120.1 (CH'), 119.8 (CH), 118.39 (Cq), 118.38 (Cq'), 112.3 (Cq), 112.2 (Cq'), 107.4 (CH'), 107.3 (CH), 39.2 (CH'), 38.6(CH), 35.6(CH), 31.6 (CH'), 26.9 (CH'), 22.5 (CH).

HRMS $m/z$ (ESI+) Exact mass calculated for C$_{16}$H$_{12}$N$_3$O$_4$ [M+H]$^+$: 334.0822, found: 334.0828.
Compound 4e

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol% equiv), (E)-3-(4-fluorophenyl)acrylaldehyde (141 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 4:1) to obtain 132 mg of the desired products as yellow oil. Yield: 86%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 6.6:2.6:1

(1R,2S,3R)-2-(4-fluorophenyl)-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde

IR (liquid film): 3109, 2924, 2850, 1721 (CHO), 1571 (aromatic NO$_2$), 1513, 1343 (aromatic NO$_2$), 1232 (aromatic F), 1154 (aromatic F), 757 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.89 (d, $J = 2.7$ Hz, 1H), 8.24 (d, $J = 1.4$ Hz, 1H), 8.23 – 8.18 (m, 1H), 7.64 (d, $J = 8.7$ Hz, 1H), 7.24 – 7.15 (m, 2H), 6.88 (t, $J = 8.6$ Hz, 2H), 3.53 (ddd, $J = 5.5$, 5.5, 2.8 Hz, 1H), 3.37 (d, $J = 5.5$ Hz, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 197.2 (CH), 166.4 (Cq), 163.6 (Cq), 161.1 (Cq), 149.9 (Cq), 146.1 (Cq), 145.2 (Cq), 130.6 (CH), 130.5 (CH), 128.74 (Cq), 128.71 (Cq), 120.8 (CH), 119.7 (CH), 115.8 (CH), 115.6 (CH), 107.1 (CH), 34.6 (CH), 34.1 (CH), 26.2 (CH).

$^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -113.79.

The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/iPrOH = 80:20, flow rate 1.0 mL/min, $\lambda = 210$ nm): t$_r$ (S) = 24.8, t$_r$ (R) = 18.7, 98% (R and S) ee.
[α]D
\[\text{21} = -136.6^\circ \quad (c = 1.4, \text{CHCl}_3) \quad (S \text{ catalyst})\]

HRMS \text{m/z (ESI+)} Exact mass calculated for C_{17}H_{12}F_{2}N_{2}O_{4} [M+H]^+: 327.0776, found: 327.0771.

(1R,2R,3R)-2-(4-fluorophenyl)-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde

Mixture of minor and minor':

\(^1\text{H NMR (400 MHz, CDCl}_3\) δ 9.67 (d, \(J = 5.6 \text{ Hz, 1H'}\), 9.24 (d, \(J = 4.4 \text{ Hz, 1H}\), 8.43 – 8.42 (m, 1H + 1H'), 8.32 (d, \(J = 8.8 \text{ Hz, 1H }+ \text{ d, } J = 2.1 \text{ Hz, 1H'}\), 7.78 (d, \(J = 8.7 \text{ Hz, 1H}\), 7.76 (d, \(J = 6.2 \text{ Hz, 1H'}\), 7.34 (dd, \(J = 8.5 \text{, 5.3 Hz, 2H}\), 7.23 (dd, \(J = 5.9 \text{, 2.8 Hz, 2H'}\), 7.10 – 7.03 (m, 2H + 2H'), 3.75 (dd, \(J = 6.3 \text{, 6.1 Hz, 1H'}\), 3.62 (m, 2H), 3.16 – 3.07 (m, 1H + 1H'), 2.77 – 2.72 (m, Hz, 1H').

\(^{13}\text{C NMR (101 MHz, CDCl}_3\) δ 196.9 (CH'), 195.7 (CH), 169.1 (Cq), 167.3 (Cq'), 163.79 (Cq'), 163.76 (Cq), 161.33 (Cq'), 161.30 (Cq), 150.1 (Cq'), 150.0 (Cq), 146.6 (Cq), 146.4 (Cq'), 145.5 (Cq'), 145.4 (Cq), 131.74 (Cq'), 131.71 (Cq'), 130.9 (CH), 130.8 (CH), 128.7 (Cq), 128.63 (CH'), 128.61 (Cq), 128.5 (CH'), 121.09 (CH), 121.06 (CH'), 120.0 (CH'), 119.7 (CH), 116.3 (CH'), 116.2 (CH), 116.1 (CH'), 115.9 (CH), 107.3 (CH'), 107.2 (CH), 39.4 (CH'), 38.7 (CH), 34.9 (CH), 31.6 (CH'), 26.7 (CH'), 22.5 (CH).

\(^{19}\text{F NMR (376 MHz, CDCl}_3\) δ -113.43, -113.65'.

HRMS \text{m/z (ESI+)} Exact mass calculated for C_{17}H_{12}F_{2}N_{2}O_{4} [M+H]^+: 327.0776, found: 327.0769.

**Compound 4g**

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol% equiv), (E)-3-(p-tolyl)acrylaldehyde (137 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL)
and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 5:1) to obtain 100 mg of the desired products as yellow oil. Yield: 66%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 5.3:1.6:1

\[(1S,2S,3R)-2-(6-nitrobenzoxazol-2-yl)-3-(p-tolyl)cyclopropane-1-carbaldehyde\]

\[
\text{IR (liquid film): } 3106, 2922, 2853, 1714 (\text{CHO}), 1571 (\text{aromatic NO}_2), 1522, 1344 (\text{aromatic NO}_2), 751, 735 \text{ cm}^{-1}.
\]

\[
\text{\textsuperscript{1}H NMR (400 MHz, CDCl}_3\text{) \delta 9.87 (d, } J = 2.9 \text{ Hz, 1H), 8.24 (d, } J = 1.9 \text{ Hz, 1H), 8.21 (dd, } J = 8.7, 2.1 \text{ Hz, 1H), 7.65 (d, } J = 8.7 \text{ Hz, 1H), 7.10 (d, } J = 8.0 \text{ Hz, 2H), 6.99 (d, } J = 7.9 \text{ Hz, 2H), 3.54 (ddd, } J = 5.6, 5.5, 2.9 \text{ Hz, 1H), 3.42 – 3.31 (m, 2H), 2.23 (s, 3H).}
\]

\[
\text{\textsuperscript{13}C NMR (101 MHz, CDCl}_3\text{) \delta 197.5 (CH), 166.8 (Cq), 150.0 (Cq), 146.3 (Cq), 145.2 (Cq), 137.8 (Cq), 129.9 (Cq), 129.4 (CH), 128.6 (CH), 120.7 (CH), 119.7 (CH), 107.1 (CH), 34.8 (CH), 34.6 (CH), 26.3 (CH), 21.2 (CH}_3\text{).}
\]

The enantiomeric excess was determined by HPLC using a Chiralpak AY-H column (hexane/iPrOH = 80:20, flow rate 1.0 mL/min, \( \lambda = 210 \text{ nm} \)): \( t_r (S) = 22.7, t_r (R) = 21.3, 99\% \) (R and S) ee.

\[ \alpha_D^{22} = +131.3^\circ \text{ (c = 0.5, CHCl}_3\text{) (R catalyst)} \]

HRMS \( m/z \) (ESI+) Exact mass calculated for C\(_{18}\)H\(_{15}\)N\(_2\)O\(_4\) \([\text{M+H}]^+\): 323.1026, found: 323.1024.

\[(1R,2R,3R)-2-(6-nitrobenzoxazol-2-yl)-3-(p-tolyl)cyclopropane-1-carbaldehyde\]

Mixture of minor and minor’:

Purity: 62 \%, the starting benzoxazole was also present in the NMR
$^1$H NMR (400 MHz, CDCl$_3$) δ 9.66 (d, $J = 5.8$ Hz, 1H'), 9.14 (d, $J = 5.0$ Hz, 1H), 8.41 (m, 1H + 1H'), 8.31 (m, 1H + 1H'), 7.76 (d, $J = 8.8$ Hz, 1H'), 7.75 (d, $J = 8.8$ Hz, 1H'), 7.26-7.24 (m, 2H), 7.19 – 7.11 (m, 2H + 4H'), 3.72 (dd, $J = 6.3$, 6.2 Hz, 1H'), 3.61 (m, $J = 6.3$ Hz, 2H), 3.13 (dd, $J = 8.9$, 6.5 Hz, 1H'), 3.04 (ddd, $J = 9.3$, 9.3, 5.0 Hz, 1H), 2.77 – 2.72 (m, 1H'), 2.35 (s, 3H'), 2.34 (s, 3H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 197.3 (CH'), 196.2 (CH), 171.9 (Cq), 169.4 (Cq), 152.4 (Cq), 150.0 (Cq), 146.7 (Cq), 138.2 (Cq), 132.9 (Cq), 129.9 (CH'), 129.8 (CH), 129.0 (CH), 126.7 (CH'), 121.1 (CH), 120.9 (CH'), 119.9 (CH'), 119.7 (CH), 107.3 (CH'), 107.2 (CH), 39.6 (CH'), 38.9 (CH), 35.2 (CH), 32.2 (CH'), 26.8 (CH'), 22.3 (CH), 21.30 (CH), 21.29 (CH').

HRMS m/z (ESI+) Exact mass calculated for C$_{18}$H$_{15}$N$_2$O$_4$ [M+H]$^+$: 323.1026, found: 323.1033.

**Compound 4h**

![Compound 4h](image)

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol% equiv), (E)-3-(2-bromophenyl)acrylaldehyde (198 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 4:1) to obtain 147 mg of the desired products as yellow oil. Yield: 81%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 13.4:2.3:1

**{(1R,2S,3R)-2-(2-bromophenyl)-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde**

![Compound 4h](image)

IR (liquid film): 3107, 2922, 2850, 1713 (CHO), 1570 (aromatic NO$_2$), 1513, 1342 (aromatic NO$_2$), 757 cm$^{-1}$. 

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$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.87 (d, $J$ = 2.8 Hz, 1H), 8.22 (d, $J$ = 2.0 Hz, 1H), 8.19 (dd, $J$ = 8.7, 2.1 Hz, 1H), 7.59 (d, $J$ = 8.7 Hz, 1H), 7.44 (d, $J$ = 7.8 Hz, 1H), 7.24 – 7.20 (m, 2H), 7.13 – 7.07 (m, 1H), 3.54 – 3.47 (m, 2H), 3.40 (dd, $J$ = 8.9, 6.9 Hz, 1H).

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 196.9, 166.8, 149.8, 146.3, 145.1, 132.9, 130.7, 129.7, 127.4, 126.0, 120.7, 119.6, 107.0, 35.8, 35.6, 26.0.

The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/iPrOH = 70:30, flow rate 0.8 mL/min, $\lambda$ = 210 nm): t, (S) = 52.2, t, (R) = 34.0, >99% (R and S) ee.

$[\alpha]_D^{20}$ = -62.3° (c = 1.0, CHCl$_3$) (S catalyst)

$[\alpha]_D^{20}$ = +58.7° (c = 1.3, CHCl$_3$) (R catalyst)

HRMS m/z (ESI+) Exact mass calculated for C$_{17}$H$_{12}$BrN$_2$O$_4$ [M+H]$^+$: 386.9975, found: 386.9964.

(1R,2R,3R)-2-(2-bromophenyl)-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde

![Chemical structure](image)

Mainly minor diastereomer present in the NMR with traces of major diastereomer, minor’ and starting aldehyde.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.38 (d, $J$ = 3.7 Hz, 1H), 8.44 (d, $J$ = 2.1 Hz, 1H), 8.32 (dd, $J$ = 8.7, 2.1 Hz, 1H), 7.78 (d, $J$ = 8.8 Hz, 1H), 7.60 (dd, $J$ = 7.9, 0.8 Hz, 1H), 7.41 (d, $J$ = 7.2 Hz, 1H), 7.37 – 7.33 (m, 1H), 7.24 – 7.20 (m, 1H), 3.61 (dd, $J$ = 6.5, 4.9 Hz, 1H), 3.55 (dd, $J$ = 9.4, 6.7 Hz, 1H), 3.30 (ddd, $J$ = 9.4, 4.6, 3.9 Hz, 1H).

HRMS m/z (ESI+) Exact mass calculated for C$_{17}$H$_{12}$BrN$_2$O$_4$ [M+H]$^+$: 386.9975, found: 386.9978.

**Compound 4i**

![Chemical structure](image)

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31 mg, 0.094 mmol, 20 mol% equiv), ethyl...
(E)-4-oxobut-2-enoate (198 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 4:1) to obtain 147 mg of the desired products as yellow oil. Yield: 81%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: >15

**ethyl (15,2R,3R)-2-formyl-3-(6-nitrobenzoxazol-2-yl)cyclopropane-1-carboxylate**

![Chemical structure](image)

IR (liquid film): 3019, 2920, 2851, 1730 (CHO), 1577 (aromatic NO$_2$), 1528, 1346 (aromatic NO$_2$), 1214 (ester), 746 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.87 (d, $J = 2.0$ Hz, 1H), 8.41 (d, $J = 2.0$ Hz, 1H), 8.29 (dd, $J = 8.8$, 2.1 Hz, 1H), 7.78 (d, $J = 8.8$ Hz, 1H), 4.06 (dq, $J = 7.1$, 2.8 Hz, 2H), 3.53 (ddd, $J = 5.9$, 5.4, 2.1 Hz, 1H), 3.27 (dd, $J = 9.5$, 5.9 Hz, 1H), 2.82 (dd, $J = 9.5$, 5.4 Hz, 1H), 1.12 (t, $J = 7.1$ Hz, 3H).

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 195.9 (CH), 167.4 (Cq), 165.4 (Cq), 150.1 (Cq), 146.3 (Cq), 145.6 (Cq), 120.9 (CH), 120.2 (CH), 107.4 (CH), 62.1 (CH$_2$), 33.2 (CH), 29.6 (CH), 24.4 (CH), 14.1 (CH$_3$).

The enantiomeric excess was determined by HPLC using a Chiralpak AY-H column (hexane/iPrOH = 50:50, flow rate 1.0 mL/min, $\lambda$ = 210 nm): $t_r$ (S) = 31.8, $t_r$ (R) = 35.2, 81% (R) / 87% (S) ee.

$[\alpha]_D^{22} = -45.8^\circ$ (c = 0.4, CHCl$_3$) *(S catalyst)*

HRMS m/z (ESI+) Exact mass calculated for C$_{14}$H$_{13}$N$_2$O$_6$ [M+H]$^+$: 305.0768, found: 305.0763.

**Compound 5a**

![Chemical structure](image)

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (26 mg, 0.081 mmol, 20 mol% equiv), cinnamaldehyde (107 mg, 0.810 mmol, 2 equiv), 5-chloro-2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.405 mmol, 1 equiv), Pd(OAc)$_2$ (4.5 mg, 0.020 mmol, 5 mol%
equiv), CH$_3$CN (1 mL) and 2,6-lutidine (43 mg, 0.405 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 10:1) to obtain 106 mg of the desired products as yellow oil. Yield: 68%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 10.5:3.3:1

(1S,2S,3R)-2-(5-chloro-6-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

IR (liquid film): 3101, 2922, 2849, 1713 (CHO), 1564 (aromatic NO$_2$), 1531, 1344 (aromatic NO$_2$), 752 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.89 (d, $J = 2.7$ Hz, 1H), 7.89 (s, 1H), 7.69 (s, 1H), 7.22 – 7.17 (m, 5H), 3.56 (ddd, $J = 6.1$, 5.1, 2.8 Hz, 1H), 3.44 – 3.33 (m, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 197.2 (CH), 167.3 (Cq), 148.2 (Cq), 144.71 (Cq), 144.67 (Cq), 132.8 (Cq), 128.8 (CH), 128.7 (CH), 128.1 (CH), 123.8 (Cq), 122.2 (CH), 108.4 (CH), 35.0 (CH), 34.5 (CH), 26.1 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak IC column (hexane/iPrOH = 85:15, flow rate 1.0 mL/min, $\lambda = 210$ nm): $t_r$ (S) = 30.7, $t_r$ (R) = 33.9, >99% (R and S) ee.

$\lbrack$α$\rbrack_{D}^{21} = +99.6^\circ$ (c = 0.4, CHCl$_3$) (R catalyst)

HRMS m/z (ESI+) Exact mass calculated for C$_{17}$H$_{12}$ClN$_2$O$_4$ [M+H]$^+$: 343.0480, found: 343.0472.

(1S,2S,3R)-2-(5-chloro-6-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

Mixture of minor and minor':

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.57 (d, $J = 5.5$ Hz, 1H'), 9.06 (d, $J = 4.9$ Hz, 1H), 7.99 (s, 1H + 1H'), 7.73 (s, 1H'), 7.71 (s, 1H), 7.29 – 7.13 (m, 5H + 5H'), 3.63 (dd, $J = 6.3$, 6.3 Hz, 1H'), 3.59 – 3.48 (m, 2H), 3.05 (dd, $J = 8.9$, 6.5 Hz, 1H'), 2.97 (dt, $J = 9.7$, 4.9 Hz, 1H), 2.70 (ddd, $J = 8.9$, 6.2, 5.7 Hz, 1H').

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**Compound 5c**

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (29 mg, 0.089 mmol, 20 mol% equiv), cinnamaldehyde (117 mg, 0.886 mmol, 2 equiv), methyl 2-(chloromethyl)benzoxazole-6-carboxylate (100 mg, 0.443 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.022 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (48 mg, 0.443 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 5:1) to obtain 111 mg of the desired products as yellow oil. Yield: 78%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 4.5:1.9:1

**methyl 2-((1R,2R,3S)-2-formyl-3-phenylcyclopropyl)benzoxazole-6-carboxylate**

IR (liquid film): 3061, 2952, 2847, 1717 (CHO, CO ester), 1434, 1287 (ester), 1269 (ester), 746 cm$^{-1}$.
$^1$H NMR (400 MHz, CDCl$_3$) δ 9.87 (d, $J = 2.9$ Hz, 1H), 8.00 (d, $J = 0.9$ Hz, 1H), 7.98 (dd, $J = 5.5$, 5.5, 2.9 Hz, 1H), 7.34 – 7.14 (m, 5H), 3.91 (s, 3H), 3.54 (ddd, $J = 5.5$, 5.5, 2.9 Hz, 1H), 3.41 – 3.33 (m, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 197.6 (CH), 166.5 (Cq), 164.3 (Cq), 150.4 (Cq), 144.8 (Cq), 133.2 (Cq), 128.7 (CH), 128.4 (CH), 127.7 (CH), 126.9 (Cq), 126.1 (CH), 119.2 (CH), 111.9 (CH), 52.4 (CH$_3$), 34.4 (CH), 34.3 (CH), 26.2 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak AY-H column (hexane/iPrOH = 80:20, flow rate 1.0 mL/min, λ = 230 nm): $t_r$ (S) = 21.1, $t_r$ (R) = 20.0, 98% (R) / 98% (S) ee.

$[\alpha]_D^{22} = -104.6^\circ$ (c = 0.8, CHCl$_3$) (S catalyst)

$[\alpha]_D^{22} = +105.8^\circ$ (c = 0.4, CHCl$_3$) (R catalyst)

HRMS m/z (ESI+) Exact mass calculated for C$_{19}$H$_{16}$NO$_4$ [M+H]$^+$: 322.1074, found: 322.1079.

methyl 2-((1R,2R,3S)-2-formyl-3-phenylcyclopropyl)benzoxazole-6-carboxylate

Mixture of minor and minor’ (inverted compared to the previous products as in this case the minor’ is prevalent):

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.64 (d, $J = 6.0$ Hz, 1H’), 9.13 (d, $J = 5.2$ Hz, 1H), 8.22 – 8.18 (m, 1H + 1H’), 8.09 (d, $J = 8.4$ Hz, 1H + d, $J = 8.4$ Hz, 1H’), 7.71 (d, $J = 8.3, 1H'$), 7.70 (d, $J = 8.3$, Hz, 1H), 7.41 – 7.22 (m, 5H + 5H’), 3.97 (s, 3H + 3H’), 3.04 (ddd, $J = 9.7$, 5.0 Hz, 1H), 2.73 (ddd, $J = 8.9, 6.0, 6.0$ Hz, 1H’).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 197.3 (CH’), 196.3 (CH), 166.9 (Cq), 166.53 (Cq’), 166.50 (Cq), 165.2 (Cq’), 150.4 (Cq’), 150.3 (Cq), 145.1 (Cq), 144.9 (Cq’), 136.1 (Cq’), 133.1, 129.0 (CH’), 129.0 (CH + CH’), 128.9 (CH), 128.0 (CH), 127.9 (CH’), 127.3 (Cq), 127.1 (Cq’), 126.6 (CH’), 126.5 (CH), 119.4 (CH’), 119.1 (CH), 112.14 (CH’), 112.07 (CH), 52.4 (CH$_3$ + CH$_3$’), 39.5 (CH’), 38.5 (CH), 34.8 (CH), 31.7 (CH’), 26.6 (CH’), 22.1 (CH).

HRMS m/z (ESI+) Exact mass calculated for C$_{19}$H$_{16}$NO$_4$ [M+H]$^+$: 322.1074, found: 322.1079.
Compound 5b

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31mg, 0.094 mmol, 20 mol% equiv), cinnamaldehyde (124 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-5-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 3:1) to obtain 80 mg of the desired products as dark yellow oil. Yield: 55%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 6.2:1.3:1

(1R,2R,3S)-2-(5-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

IR (liquid film): 3105, 2923, 2852, 1714 (CHO), 1526, 1347 (aromatic NO$_2$), 743 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.89 (d, $J = 2.8$ Hz, 1H), 8.44 (d, $J = 2.3$ Hz, 1H), 8.19 (dd, $J = 8.9$, 2.3 Hz, 1H), 7.42 (d, $J = 9.0$ Hz, 1H), 7.23 – 7.14 (m, 5H), 3.56 (ddd, $J = 5.5$, 5.4, 2.8 Hz, 1H), 3.38 (d, $J = 5.5$ Hz, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) δ 194.5 (CH), 162.0 (Cq), 151.3 (Cq), 142.4 (Cq), 138.4 (Cq), 130.1 (Cq), 125.8 (CH), 125.6 (CH), 125.0 (CH), 118.1 (CH), 113.2 (CH), 107.6 (CH), 31.8 (CH), 31.4 (CH), 23.1 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/iPrOH = 70:30, flow rate 1.0 mL/min, $\lambda = 210$ nm): t$_r$ (S) = 20.6, t$_r$ (R) = 19.8, 99% (R) / 98% (S) ee.

$[\alpha]_D^{22} = -41.6^\circ$ (c = 0.8, CHCl$_3$) (S catalyst)

$[\alpha]_D^{22} = +36.2^\circ$ (c = 0.5, CHCl$_3$) (R catalyst)

HRMS m/z (ESI+) Exact mass calculated for C$_{17}$H$_{13}$N$_2$O$_4$ [M+H]$^+$: 309.0870, found: 309.0868.
(1R,2R,3R)-2-(5-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

Mixture of minor and minor':

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.66 (d, $J = 5.7$ Hz, 1H'), 9.15 (d, $J = 5.0$ Hz, 1H), 8.57 (d, $J = 2.2$ Hz, 1H'), 8.55 (d, $J = 2.2$ Hz, 1H), 8.31 (dd, $J = 8.9$, 2.5 Hz, 1H + dd, $J = 8.9$, 2.5 Hz, 1H'), 7.62 (bd, $J = 8.9$ Hz, 1H + 1H'), 7.41 – 7.24 (m, 10H), 3.75 (dd, $J = 6.3$, 6.3 Hz, 1H'), 3.69 – 3.59 (m, 2H), 3.16 (dd, $J = 8.9$, 6.5 Hz, 1H'), 3.06 (ddd, $J = 9.7$, 5.0, 4.9 Hz, 1H), 2.77 (ddd, $J = 8.9$, 5.9, 5.9 Hz, 1H').

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 197.2 (CH), 196.1 (CH), 167.6 (Cq), 165.9 (Cq), 154.4 (Cq), 154.3 (Cq), 145.7 (Cq), 141.9 (Cq), 141.7 (Cq), 136.0 (Cq), 132.9 (Cq), 129.2 (CH), 129.1 (CH), 129.0 (CH), 128.3 (CH), 128.2 (CH), 126.8 (CH), 121.4 (CH), 121.2 (CH), 116.4 (CH), 116.1 (CH), 110.9 (CH), 110.8 (CH), 39.4 (CH), 38.6 (CH), 35.2 (CH), 32.1 (CH), 26.6 (CH), 22.0 (CH).

HRMS m/z (ESI+) Exact mass calculated for C$_{17}$H$_{13}$N$_2$O$_4$ [M+H]$^+$: 309.0870, found: 309.0877.

**Compound 5d**

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (31mg, 0.094 mmol, 20 mol% equiv), cinnamaldehyde (124 mg, 0.940 mmol, 2 equiv), 2-(chloromethyl)-4-nitrobenzoxazole (100 mg, 0.470 mmol, 1 equiv), Pd(OAc)$_2$ (5 mg, 0.024 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (50 mg, 0.470 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 3:1) to obtain 74 mg of the desired products as dark yellow oil. Yield: 51%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 2.3:1.6:1
(1R,2R,3S)-2-(4-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

Mixture of major (m) and minor:

IR (liquid film): 3020, 2852, 1713 (CHO), 1561 (aromatic NO₂), 1526, 1343 (aromatic NO₂), 1214, 747 cm⁻¹.

¹H NMR (400 MHz, CDCl₃) δ 9.88 (d, J = 2.8 Hz, 1Hm), 9.14 (d, J = 5.0 Hz, 1H), 8.20 (d, J = 8.3 Hz, 1H), 8.10 (d, J = 8.2 Hz, 1Hm), 7.85 (d, J = 8.1 Hz, 1H), 7.61 (d, J = 8.1 Hz, 1Hm), 7.49 (dd, J = 8.2 Hz, 1H), 7.39 – 7.15 (m, 6Hm + 5H), 3.77 – 3.72 (m, 2H), 3.64 (ddd, J = 5.6, 5.6, 2.9 Hz, 1Hm), 3.50 (ddd, J = 9.8, 5.1 Hz, 1Hm), 3.44 – 3.34 (m, 1Hm), 3.12 (ddd, J = 9.2, 5.2, 5.2 Hz, 1H).

¹³C NMR (101 MHz, CDCl₃) δ 197.3 (CHm), 195.9 (CH), 167.9 (Cq), 165.5 (Cqm), 152.3 (Cq), 152.2 (Cqm), 138.8 (Cq), 138.7 (Cqm), 136.1 (Cq), 135.7 (Cqm), 132.9 (Cqm), 132.8 (Cq), 129.0 (CH), 128.9 (CH), 128.7 (CHm), 128.4 (CHm), 128.1 (CH), 127.8 (CHm), 124.4 (CH), 124.2 (CHm), 121.1 (CH), 120.8 (CHm), 116.4 (CH), 116.2 (CHm), 38.6 (CH), 35.1 (CH), 34.7 (CHm), 34.5 (CHm), 26.2 (CHm), 22.1 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak AY-H column (hexane/IPrOH = 70:30, flow rate 1.0 mL/min, λ = 210 nm): t₁ (S) = 37.7, t₂ (R) = 21.7, >99% (R and S) ee.

[α]₀²² = -5.2° (c = 0.8, CHCl₃) (S catalyst)

[α]₀²² = +6.6° (c = 0.7, CHCl₃) (R catalyst)

HRMS m/z (ESI⁺) Exact mass calculated for C₁₇H₁₃N₂O₄ [M+H]⁺: 309.0870, found: 309.0871.

(1R,2R,3R)-2-(4-nitrobenzoxazol-2-yl)-3-phenylcyclopropane-1-carbaldehyde

Mixture of major′, minor, minor′ and traces of starting benzoxazole:

¹H NMR (400 MHz, CDCl₃) δ 9.88 (d, J = 2.8 Hz, 1Hm), 9.73 (d, J = 5.6 Hz, 1H′), 9.14 (d, J = 5.0 Hz, 1H), 8.20 (d, J = 8.3 Hz, 1H), 8.10 (d, J = 8.2 Hz, 4Hm), 7.85 (ddd, J = 8.1, 4.7, 0.8 Hz, 4H + ′), 7.64 – 7.57 (m, 4Hm), 7.50 (td, J = 8.2, 3.3 Hz, 5H + ′), 7.42 – 7.13 (m, 51H), 3.85 (dd, J = 6.3, 6.3 Hz, 1H′), 3.78 – 3.72 (m, 2H), 3.64 (ddd, J = 6.0, 5.2, 2.9 Hz, 1Hm), 3.51 (dd, J = 9.8,
5.1 Hz, 1H\textsuperscript{m}), 3.45 – 3.34 (m, 1H\textsuperscript{m}), 3.29 (dd, J = 8.9, 6.6 Hz, 1H\textsuperscript{r}), 3.12 (ddd, J = 9.2, 5.2, 5.2 Hz, 1H\textsuperscript{r}), 2.79 (ddd, J = 8.9, 5.9, 5.9 Hz, 1H\textsuperscript{r}).

\textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) δ 197.3 (CH\textsuperscript{m}), 197.1 (CH\textsuperscript{r}), 195.9 (CH), 167.9 (Cq), 166.4 (Cq\textsuperscript{r}), 165.5 (Cq\textsuperscript{m}), 152.3 (Cq\textsuperscript{r}), 152.3 (Cq), 152.2 (Cq\textsuperscript{m}), 138.8 (Cq), 138.6 (Cq\textsuperscript{m}), 136.1 (Cq), 135.9 (Cq\textsuperscript{r}), 135.8 (Cq\textsuperscript{r}), 135.7 (Cq\textsuperscript{m}), 132.9 (Cq\textsuperscript{m}), 132.8 (Cq), 129.0 (CH), 128.97 (CH\textsuperscript{r}), 128.90 (CH), 128.7 (CH\textsuperscript{m}), 128.4 (CH\textsuperscript{r}), 128.1 (CH), 128.0 (CH\textsuperscript{r}), 127.8 (CH\textsuperscript{m}), 126.6 (CH\textsuperscript{r}), 125.7 (CH\textsuperscript{r}), 124.6 (CH\textsuperscript{r}), 124.4 (CH), 124.2 (CH\textsuperscript{m}), 121.1 (CH), 120.8 (CH\textsuperscript{m}), 117.2 (CH\textsuperscript{r}), 116.5 (CH\textsuperscript{r}), 116.4 (CH), 116.2 (CH\textsuperscript{m}), 39.7 (CH\textsuperscript{r}), 38.6 (CH), 35.9 (CH\textsuperscript{r}), 35.1 (CH), 34.7 (CH\textsuperscript{m}), 34.5 (CH\textsuperscript{m}), 32.1 (CH\textsuperscript{r}), 26.6 (CH\textsuperscript{r}), 26.3 (CH\textsuperscript{m}), 22.1 (CH).

HRMS m/z (ESI+) Exact mass calculated for C\textsubscript{17}H\textsubscript{13}N\textsubscript{2}O\textsubscript{4} [M+H]\textsuperscript{+}: 309.0870, found: 309.0871.

**Compound 5e**

![Chemical structure of Compound 5e](image)

The reaction was performed following the general procedure adding: 2-(diphenyl(((trimethylsilyl)oxy)methyl)pyrrolidine (26 mg, 0.081 mmol, 20 mol% equiv), (E)-3-(4-bromophenyl)acrylaldehyde (171 mg, 0.810 mmol, 2 equiv), 5-chloro-2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.405 mmol, 1 equiv), Pd(OAc)\textsubscript{2} (4.5 mg, 0.020 mmol, 5 mol% equiv), CH\textsubscript{3}CN (1 mL) and 2,6-lutidine (43 mg, 0.405 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 4:1) to obtain 145 mg of the desired products as yellow oil. Yield: 85%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 8.1:4.8:1

**(1R,2S,3R)-2-(4-bromophenyl)-3-(5-chloro-6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde**

![Chemical structure of (1R,2S,3R)-2-(4-bromophenyl)-3-(5-chloro-6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde](image)
IR (liquid film): 3101, 2923, 2850, 1713 (CHO), 1565 (aromatic NO$_2$), 1531, 1446, 1345 (aromatic NO$_2$), 755 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.89 (d, $J$ = 2.6 Hz, 1H), 7.92 (s, 1H), 7.69 (s, 1H), 7.33 (d, $J$ = 8.4 Hz, 2H), 7.09 (d, $J$ = 8.4 Hz, 2H), 3.53 (dd, $J$ = 5.6, 5.6, 2.6 Hz, 1H), 3.35 (dd, $J$ = 9.8, 5.7 Hz, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 196.8 (CH), 166.7 (Cq), 148.1 (Cq), 144.6 (Cq), 144.4 (Cq), 131.7 (CH), 130.3 (CH), 123.8 (Cq), 122.2 (CH), 122.1 (Cq), 108.4 (CH), 34.2 (CH), 34.2 (CH), 25.9 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/iPrOH = 85:15, flow rate 1.0 mL/min, $\lambda$ = 210 nm): $t_r$ (S) = 39.2, $t_r$ (R) = 30.6, 98% (R) / 97% (S) ee.

$[\alpha]_D^{21}$ = -153.8° (c = 0.6, CHCl$_3$) (S catalyst)

HRMS $m/z$ (ESI+) Exact mass calculated for C$_{17}$H$_{11}$BrClN$_2$O$_4$ [M+H]$^+$: 420.9585, found: 420.9587.

(1R,2R,3R)-2-(4-bromophenyl)-3-(5-chloro-6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde

Mixture of minor and minor':

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.66 (d, $J$ = 5.3 Hz, 1H'), 9.26 (d, $J$ = 4.2 Hz, 1H), 8.09 (s, 1H + 1H'), 7.83 (s, 1H'), 7.81 (s, 1H), 7.51 (d, $J$ = 8.3 Hz, 2H'), 7.49 (d, $J$ = 8.3 Hz, 2H), 7.23 (d, $J$ = 8.4 Hz, 2H), 7.13 (d, $J$ = 8.4 Hz, 2H'), 3.69 (dd, $J$ = 6.3, 6.3 Hz, 1H'), 3.58 (bd, $J$ = 6.8 Hz, 2H), 3.15 – 3.08 (m, 1H + 1H'), 2.80 – 2.72 (m, 1H').

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 196.2, 195.1, 169.4, 167.6, 148.1, 144.9, 144.7, 144.7, 134.7, 132.2, 132.0, 131.6, 130.6, 128.3, 124.1, 122.4, 122.3, 122.1, 122.0, 108.6, 108.5, 39.0, 38.5, 35.0, 31.6, 26.4, 22.0.

HRMS $m/z$ (ESI+) Exact mass calculated for C$_{17}$H$_{11}$BrClN$_2$O$_4$ [M+H]$^+$: 420.9585, found: 420.9585.
**Compound 5f**

![Compound 5f](image)

The reaction was performed following the general procedure adding: 2-(diphenyl((trimethylsilyl)oxy)methyl)pyrrolidine (26 mg, 0.081 mmol, 20 mol% equiv), (E)-3-(3-bromophenyl)acrylaldehyde (171 mg, 0.810 mmol, 2 equiv), 5-chloro-2-(chloromethyl)-6-nitrobenzoxazole (100 mg, 0.405 mmol, 1 equiv), Pd(OAc)$_2$ (4.5 mg, 0.020 mmol, 5 mol% equiv), CH$_3$CN (1 mL) and 2,6-lutidine (43 mg, 0.405 mmol, 1 equiv). The crude was purified by flash column chromatography (hexane/EtOAc 4:1) to obtain 112 mg of the desired products as yellow oil. Yield: 66%. The diastereomeric ratio was calculated based on the isolated products after column chromatography. d.r.: 17.4:6.3:1

**{(1R,2S,3R)-2-(3-bromophenyl)-3-(5-chloro-6-nitrobenzoxazol-2-yl)cyclopropane-1-carbaldehyde}**

![Chemical Structure](image)

IR (liquid film): 3101, 2922, 2850, 1714 (CHO), 1564 (aromatic NO$_2$), 1531, 1446, 1344 (aromatic NO$_2$), 754 cm$^{-1}$.

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.92 (d, $J$ = 2.5 Hz, 1H), 7.94 (s, 1H), 7.72 (s, 1H), 7.44 (dd, $J$ = 1.7, 1.7 Hz, 1H), 7.33 (ddd, $J$ = 7.7, 1.6, 1.6 Hz, 1H), 7.14 – 7.05 (m, 2H), 3.56 (ddd, $J$ = 5.6, 5.6, 2.5 Hz, 1H), 3.41 – 3.34 (m, 2H).

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 196.7 (CH), 166.6 (Cq), 148.1 (Cq), 144.7 (Cq), 144.4 (Cq), 134.9 (Cq), 132.0 (CH), 131.2 (CH), 130.0 (CH), 127.2 (CH), 123.8, 122.5 (Cq), 122.2 (CH), 108.4 (CH), 34.2 (CH), 34.1 (CH), 26.0 (CH).

The enantiomeric excess was determined by HPLC using a Chiralpak OD-H column (hexane/PrOH = 70:30, flow rate 1.0 mL/min, $\lambda$ = 210 nm): $t_r$ (S) = 38.2, $t_r$ (R) = 32.9, 91% (R) / 97% (S) ee.

$[\alpha]_D^{21} = -107.2^\circ$ (c = 1.3, CHCl$_3$) **(S catalyst)**
$[\alpha]_D^{21} = +97.9^\circ \ (c = 2.0, \text{CHCl}_3) \ (R \text{ catalyst})$

HRMS $m/z$ (ESI+) Exact mass calculated for $\text{C}_{17}\text{H}_{11}\text{BrClN}_2\text{O}_4 \ [\text{M+H}]^+$: 420.9585, found: 420.9581.

$(1R,2R,3R)-2\text{-}(3\text{-bromophenyl})\text{-}3\text{-}(5\text{-chloro}-6\text{-nitrobenzoxazol}-2\text{-yl})\text{cyclopropane-1-carbaldehyde}$

![Chemical Structure](image)

Mixture of minor and minor$'$:

$^1H$ NMR (400 MHz, CDCl$_3$) $\delta$ 9.67 (d, $J = 5.3$ Hz, 1H$'$), 9.26 (d, $J = 4.3$ Hz, 1H), 8.10 (s, 1H + 1H$'$), 7.84 (s, 1H$'$), 7.82 (s, 1H), 7.54 (bs, 1H), 7.49 − 7.43 (m, 1H + 1H$'$), 7.41 (t, $J = 1.7$ Hz, 1H$'$), 7.32 − 7.17 (m, 2H + 2H$'$), 3.71 (dd, $J = 6.3$, 6.3 Hz, 1H$'$), 3.64 − 3.60 (m, 2H), 3.19 − 3.08 (m, 1H + 1H$'$), 2.84 − 2.76 (ddd, $J = 9.0$, 6.0, 5.4 Hz, 1H$'$).

$^{13}C$ NMR (101 MHz, CDCl$_3$) $\delta$ 196.2 (CH$'$), 195.0 (CH), 169.3 (Cq), 167.5 (Cq$'$), 148.1 (Cq$'$), 148.0 (Cq), 144.9 (Cq), 144.7 (Cq$'$), 138.0 (Cq$'$), 134.8 (Cq), 132.1 (CH), 131.4 (CH), 131.2 (CH$'$), 130.6 (CH$'$), 130.4 (CH), 129.8 (CH$'$), 127.6 (CH), 125.4 (CH$'$), 124.1 (Cq), 124.0 (Cq$'$), 123.1 (Cq$'$), 122.9 (Cq), 122.4 (CH$'$), 122.1 (CH), 108.6, 108.6, 38.9 (CH$'$), 38.5 (CH), 34.8 (CH), 31.5 (CH$'$), 26.4 (CH$'$), 21.9 (CH).

HRMS $m/z$ (ESI+) Exact mass calculated for $\text{C}_{17}\text{H}_{11}\text{BrClN}_2\text{O}_4 \ [\text{M+H}]^+$: 420.9585, found: 420.9589.
16. **Notes:**

Thin layer chromatography (TLC) was performed on Merck TLC Silicagel 60 F$_{254}$. Product spots were visualized by UV-light at 254nm, and developed with potassium permanganate. Column chromatography was effectuated using silica gel (Geduran Si60, 40-63µm). Infra-red spectra were recorded on a Nicolet 280 FT-IR; the IR analyses were performed as a liquid IR with the compounds dissolved in CHCl$_3$.

$^1$H-NMR, $^{13}$C-NMR, $^{19}$F-NMR were recorded with a Bruker DPX400 NMR.

High resolution mass spectra were recorded using a MaXis (Bruker Daltonics, Bremen, Germany) mass spectrometer equipped with a Time of Flight (TOF) analyser.

17. **References**


18. HPLC traces

The racemic mixtures used in the HPLC traces were prepared by mixing the product obtained using the organic catalyst with the R configuration and the product obtained using the organic catalyst with the S configuration.

Mixture of S and R: ([IA, 85.15, 210, 1ml/min])

Chiral S:
Chiral R:

Mixture of S and R: (OD-H, 85.15, 210 nm, 1ml/min)

Mixture of S and R: (OD-H, 85.15, 210 nm, 1ml/min)
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Chiral S:
Chiral R:

4d major

Mixture of S and R: (OD-H, 55.45, 210 nm, 0.8 ml/min)
Chiral S:

![Chiral S graph]

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Chiral S:
Chiral R:

![Chiral R Chart]

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Mixture of S and R: (AY-H, 60.40, 210 nm, 0.8 ml/min)

![Mixture of S and R Chart]

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Mixture of S and R: (OD-H, 80.20, 210 nm, 1 ml/min)

Chiral S:
Chiral R:

4g major

Mixture of S and R: (AY-H, 80.20, 210 nm, 1 ml/min)
Chiral S:

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<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width [min]</th>
<th>Area [mAU*s]</th>
<th>Height [mAU]</th>
<th>Area %</th>
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<td>983.27905</td>
<td>99.3777</td>
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</table>

Chiral R:

<table>
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<th>Width [min]</th>
<th>Area [mAU*s]</th>
<th>Height [mAU]</th>
<th>Area %</th>
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</thead>
<tbody>
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<td>347.60397</td>
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<td>0.4023</td>
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</table>
Mixture of S and R: (OD-H, 70.30, 210 nm, 0.8 ml/min)

Chiral S:
Chiral R:

Mixture of S and R: (AY-H, 50.50, 210 nm, 1 ml/min)
### Chiral S:

![Graph](image1)

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31.823</td>
<td>BB</td>
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### Chiral R:

![Graph](image2)

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<th>%</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>31.338</td>
<td>BB</td>
<td>0.7819</td>
<td>385.97067</td>
<td>5.87918</td>
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<tr>
<td>2</td>
<td>35.215</td>
<td>BB</td>
<td>1.1297</td>
<td>3736.24438</td>
<td>50.46899</td>
<td>90.6368</td>
<td></td>
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</tbody>
</table>
Mixture of S and R: (IC, 85.15, 210 nm, 1 ml/min)

Chiral S:
Chiral R:

![Graph](image)

<table>
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<tr>
<th>Peak</th>
<th>RetTime</th>
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<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33.869</td>
<td>BB</td>
<td>1.1023</td>
<td>1.04667e4</td>
<td>143.95297</td>
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</tbody>
</table>

5a minor

Mixture of S and R: (IC, 85.15, 210 nm, 1 ml/min)

![Graph](image)

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36.177</td>
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<td>1.1856</td>
<td>3.10209e4</td>
<td>396.98383</td>
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<tr>
<td>2</td>
<td>39.201</td>
<td>VB</td>
<td>1.5418</td>
<td>5.02063e4</td>
<td>462.02722</td>
<td>61.8098</td>
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</table>
Chiral R:

Peak RetTime Type Width Area Height Area %
# [min] [min] [mAU*s] [mAU] |
1 37.686 BB 0.8948 733.99097 11.75086 4.9646 |
2 40.064 BB 1.3182 1.40506e4 158.49655 95.0354 |

Mixture of S and R: (AY-H, 80.20, 230 nm, 1ml/min)
Chiral S:

<table>
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<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>19.963</td>
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Chiral R:

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<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19.967</td>
<td>MM</td>
<td>0.9136</td>
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<tr>
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</table>
Mixture of S and R: (OD-H, 70.30, 210 nm, 1 ml/min)

Chiral S:
Chiral R:

Mixture of S and R: (AY-H, 70.30, 210 nm, 1 ml/min)
### Chiral S:

![Chiral S Chromatogram]

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime [min]</th>
<th>Type</th>
<th>Width [min]</th>
<th>Area [mAU*s]</th>
<th>Height [mAU]</th>
<th>Area [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>BB</td>
<td>1.1013</td>
<td>6581.40137</td>
<td>89.35355</td>
<td>100.000</td>
</tr>
</tbody>
</table>

### Chiral R:

![Chiral R Chromatogram]

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime [min]</th>
<th>Type</th>
<th>Width [min]</th>
<th>Area [mAU*s]</th>
<th>Height [mAU]</th>
<th>Area [%]</th>
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</thead>
<tbody>
<tr>
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Mixture of S and R: (OD-H, 70.30, 230 nm, 1 ml/min)

Chiral S:
Chiral R:

![Chiral R Graph](image)

<table>
<thead>
<tr>
<th>#</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area %</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>1.1803</td>
<td>8144.36621</td>
<td>162.36057</td>
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Mixture of S and R: (OD-H, 70.30, 210 nm, 1 ml/min)

![Mixture Graph](image)

<table>
<thead>
<tr>
<th>#</th>
<th>RetTime</th>
<th>Type</th>
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<th>Height</th>
<th>Area %</th>
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<tbody>
<tr>
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<tr>
<td>2</td>
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5f major
Chiral S:

<table>
<thead>
<tr>
<th>Peak RetTime</th>
<th>Type</th>
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<th>Area</th>
<th>Height</th>
<th>Area</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>[mAU*s]</td>
<td>[mAU]</td>
<td>%</td>
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<tr>
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<tr>
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<td>1.2748</td>
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</table>

Chiral R:

<table>
<thead>
<tr>
<th>Peak RetTime</th>
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<th>Area</th>
<th>Height</th>
<th>Area</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>[mAU*s]</td>
<td>[mAU]</td>
<td>%</td>
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<tr>
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<td>2.9513</td>
<td>567.80548</td>
<td>3.20654</td>
<td>4.6485</td>
</tr>
</tbody>
</table>
19. **NMR starting materials**

- **1H-NMR**

![1H-NMR spectrum](image)

- **13C-NMR**

![13C-NMR spectrum](image)
20. **NMR cyclopropanes**

Product 4a major diastereomer:
Product 4a minor diastereomer:
Product 4a mixture of minor and minor'.
Product 4b major diastereomer:

**1H-NMR**

**DEPT-135**
Product 4b minor diastereomer:
Product 4b mixture of minor and minor' diastereomers:
Product 4c major diastereomer:
Product 4c minor diastereomer with traces of minor':
Product 4d major diastereomer:

**$^1$H-NMR**

**$^{13}$C-NMR**
Product 4d minor diastereomer:
$^{13}$C-NMR

DEPT-135
Product 4f major diastereomer:

$^1$H-NMR

$^{13}$C-NMR
Product 4f mixture of minor and minor' diastereomers:
Product 4e major diastereomer:

$^1$H-NMR

$^{13}$C-NMR
Product 4e mixture of minor and minor' diastereomers:

**$^{1}H$-NMR**

**$^{13}C$-NMR**
Product 4g major diastereomer:

$^1$H-NMR

$^{13}$C-NMR
Product 4g mixture of minor and minor' diastereomers:
Product 4h major diastereomer:
Product 4h minor diastereomer + traces of minor’ and major diastereomers and starting enals

Product 4i:
Product 5a major diastereomer:

$^1$H-NMR

$^{13}$C-NMR
Product 5a mixture of minor and minor' diastereomers:
Product 5c major diastereomer:

$^{1}H$-NMR

$^{13}C$-NMR
Product 5c mixture of minor and minor’ diastereomers:
Product 5b major diastereomer:

\[ \text{H-NMR} \]

\[ \text{C-NMR} \]
Product 5b mixture of minor and minor’ diastereomers:

1H-NMR
Product 5d mixture of major and minor diastereomers:

\[ ^{1}H\text{-NMR} \]

\[ ^{13}C\text{-NMR} \]
Product 5b mixture of major minor ad minor’ diastereomers:
Product 5e major diastereomer:

$^1$H-NMR

$^{13}$C-NMR
Product 5e mixture of minor and minor ‘ diastereomers:

![1H-NMR spectrum](image-url)

![DEPT-135 spectrum](image-url)
Product 5f major diastereomer:

$^1$H-NMR

$^{13}$C-NMR
Product 5f mixture of minor and minor' diastereomers: