# wwPDB X-ray Structure Validation Summary Report (i)

Jun 14, 2020 – 06:42 am BST

| | | |
|---|---|---|
| PDB ID | : | 1QRQ |
| Title | : | STRUCTURE OF A VOLTAGE-DEPENDENT K+ CHANNEL BETA SUB-UNIT |
| Authors | : | Gulbis, J.M.; Mann, S.; MacKinnon, R. |
| Deposited on | : | 1999-06-15 |
| Resolution | : | 2.80 Å(reported) |

The following versions of software and data (see references (1)) were used in the production of this report:

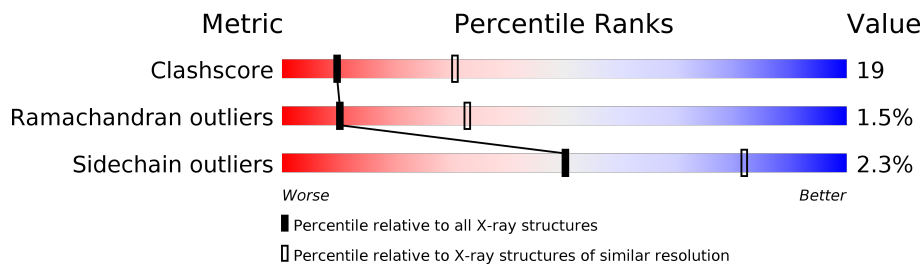| | | |
|---|---|---|
| MolProbity | : | 4.02b-467 |
| Mogul | : | 1.8.5 (274361), CSD as541be (2020) |
| Xtriage (Phenix) | : | NOT EXECUTED |
| EDS | : | NOT EXECUTED |
| buster-report | : | 1.1.7 (2018) |
| Percentile statistics | : | 20191225.v01 (using entries in the PDB archive December 25th 2019) |
| Ideal geometry (proteins) | : | Engh & Huber (2001) |
| Ideal geometry (DNA, RNA) | : | Parkinson et al. (1996) |
| Validation Pipeline (wwPDB-VP) | : | 2.11 |

# 1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.80 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.

| Metric | Percentile Ranks | Value |
|---|---|---|
| Clashscore | | 19 |
| Ramachandran outliers | | 1.5% |
| Sidechain outliers | | 2.3% |

*Worse*                                                                                    *Better*

■ Percentile relative to all X-ray structures
▯ Percentile relative to X-ray structures of similar resolution

| Metric | Whole archive (#Entries) | Similar resolution (#Entries, resolution range(Å)) |
|---|---|---|
| Clashscore | 141614 | 3569 (2.80-2.80) |
| Ramachandran outliers | 138981 | 3498 (2.80-2.80) |
| Sidechain outliers | 138945 | 3500 (2.80-2.80) |

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments on the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5%

Note EDS was not executed.

| Mol | Chain | Length | Quality of chain |
|---|---|---|---|
| 1 | A | 325 | 66%          32%          • |
| 1 | B | 325 | 65%          34%          • |
| 1 | C | 325 | 66%          32%          • |
| 1 | D | 325 | 66%          32%          • |

# 2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 10348 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called PROTEIN (KV BETA2 PROTEIN).

| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf | Trace |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 325 | Total | C | N | O | S | 0 | 0 | 0 |
| | | | 2501 | 1591 | 436 | 458 | 16 | | | |
| 1 | B | 325 | Total | C | N | O | S | 0 | 0 | 0 |
| | | | 2501 | 1591 | 436 | 458 | 16 | | | |
| 1 | C | 325 | Total | C | N | O | S | 0 | 0 | 0 |
| | | | 2501 | 1591 | 436 | 458 | 16 | | | |
| 1 | D | 325 | Total | C | N | O | S | 0 | 0 | 0 |
| | | | 2501 | 1591 | 436 | 458 | 16 | | | |

- Molecule 2 is NADPH DIHYDRO-NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (three-letter code: NDP) (formula: $C_{21}H_{30}N_7O_{17}P_3$).
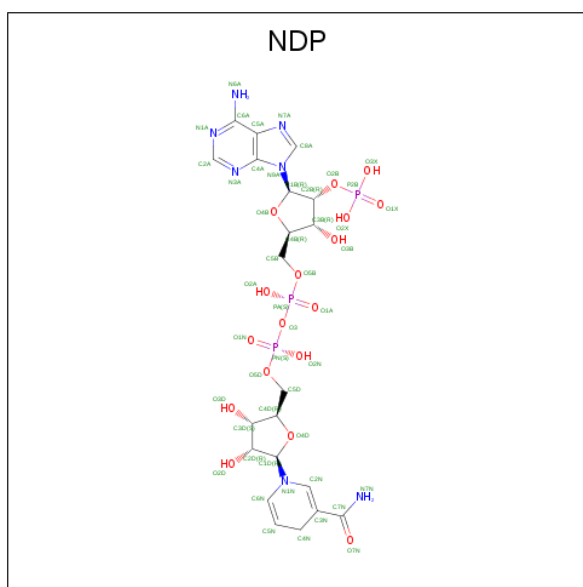


| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf |
|---|---|---|---|---|---|---|---|---|---|
| 2 | A | 1 | Total | C | N | O | P | 0 | 0 |
| | | | 48 | 21 | 7 | 17 | 3 | | |
| 2 | B | 1 | Total | C | N | O | P | 0 | 0 |
| | | | 48 | 21 | 7 | 17 | 3 | | |

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| Mol | Chain | Residues | Atoms | | | | | ZeroOcc | AltConf |
|-----|-------|----------|-------|----|----|----|----|---------|---------|
| 2 | C | 1 | Total | C | N | O | P | 0 | 0 |
| | | | 48 | 21 | 7 | 17 | 3 | | |
| 2 | D | 1 | Total | C | N | O | P | 0 | 0 |
| | | | 48 | 21 | 7 | 17 | 3 | | |

- Molecule 3 is water.

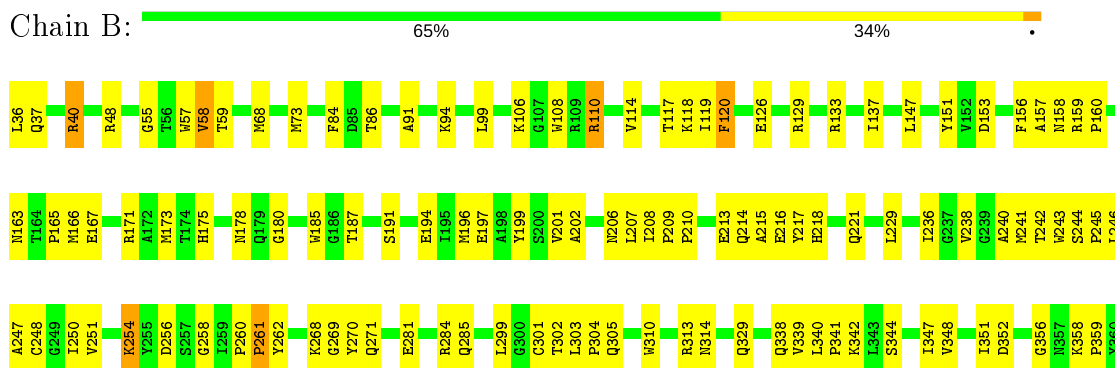| Mol | Chain | Residues | Atoms | | ZeroOcc | AltConf |
|-----|-------|----------|-------|----|---------|---------|
| 3 | A | 38 | Total | O | 0 | 0 |
| | | | 38 | 38 | | |
| 3 | B | 38 | Total | O | 0 | 0 |
| | | | 38 | 38 | | |
| 3 | C | 38 | Total | O | 0 | 0 |
| | | | 38 | 38 | | |
| 3 | D | 38 | Total | O | 0 | 0 |
| | | | 38 | 38 | | |

# 3 Residue-property plots (i)

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.
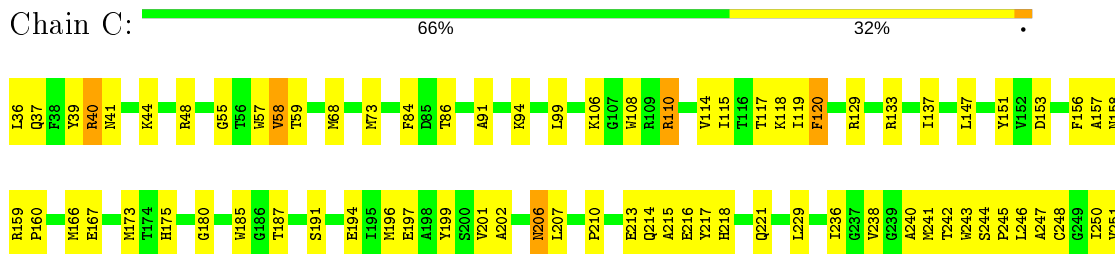
Note EDS was not executed.

• Molecule 1: PROTEIN (KV BETA2 PROTEIN)
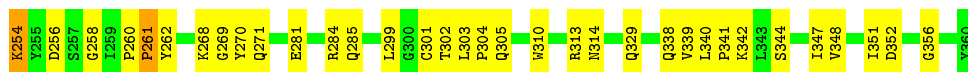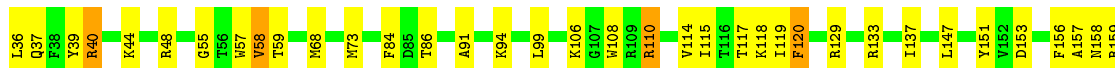
Chain A:



• Molecule 1: PROTEIN (KV BETA2 PROTEIN)

Chain B:



• Molecule 1: PROTEIN (KV BETA2 PROTEIN)

Chain C:

K254 Y255 D256 S257 G258 I259 P260 P261 K268 G269 Y270 Q271 E281 R284 Q285 L299 G300 C301 T302 L303 P304 Q305 W310 R313 N314 Q329 Q338 V339 L340 P341 K342 L343 S344 I347 V348 I351 D352 G356 N357 K358 P359 Y360

• Molecule 1: PROTEIN (KV BETA2 PROTEIN)

Chain D:

66%                                              32%                        •

L36 Q37 F38 Y39 R40 K44 R48 G55 T56 W57 V58 T59 M68 M73 F84 D85 T86 A91 K94 L99 K106 G107 W108 R109 R110 V114 I115 T116 T117 K118 I119 F120 R129 R133 I137 L147 Y151 V152 D153 F156 A157 N158 R159

P160 M166 E167 M173 T174 H175 G180 W185 G186 T187 S191 E194 I195 M196 E197 A198 Y199 S200 V201 A202 N206 L207 P210 E213 Q214 A215 E216 Y217 H218 Q221 L229 I236 G237 V238 G239 A240 M241 T242 W243 S244 P245 L246 A247 C248 G249 I250 V251

K254 Y255 D256 S257 G258 I259 P260 P261 Y262 K268 G269 Y270 Q271 E281 R284 Q285 L299 G300 C301 T302 L303 P304 Q305 W310 R313 N314 Q329 Q338 V339 L340 P341 K342 L343 S344 I347 V348 I351 D352 G356 Y360

# 4 Data and refinement statistics (i)

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

| Property | Value | Source |
|----------|-------|--------|
| Space group | P 21 21 2 | Depositor |
| Cell constants a, b, c, $\alpha$, $\beta$, $\gamma$ | 156.75Å    114.35Å    93.05Å<br>90.00°       90.00°       90.00° | Depositor |
| Resolution (Å) | 40.00    –    2.80 | Depositor |
| % Data completeness (in resolution range) | 97.7 (40.00-2.80) | Depositor |
| $R_{merge}$ | 0.07 | Depositor |
| $R_{sym}$ | (Not available) | Depositor |
| Refinement program | CNS | Depositor |
| R, $R_{free}$ | 0.236   ,   0.242 | Depositor |
| Estimated twinning fraction | No twinning to report. | Xtriage |
| Total number of atoms | 10348 | wwPDB-VP |
| Average B, all atoms (Å$^2$) | 59.0 | wwPDB-VP |

# 5   Model quality (i)

## 5.1   Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: NDP

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

| Mol | Chain | Bond lengths | | Bond angles | |
|-----|-------|------|--------|------|--------|
|     |       | RMSZ | #$|Z|$>5 | RMSZ | #$|Z|$>5 |
| 1   | A     | 0.36 | 0/2550 | 0.63 | 2/3451 (0.1%) |
| 1   | B     | 0.36 | 0/2550 | 0.63 | 2/3451 (0.1%) |
| 1   | C     | 0.36 | 0/2550 | 0.63 | 2/3451 (0.1%) |
| 1   | D     | 0.36 | 0/2550 | 0.63 | 2/3451 (0.1%) |
| All | All   | 0.36 | 0/10200 | 0.63 | 8/13804 (0.1%) |

There are no bond length outliers.

The worst 5 of 8 bond angle outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed($^o$) | Ideal($^o$) |
|-----|-------|-----|------|-------|-----|-----------|--------|
| 1 | D | 157 | ALA | N-CA-C | -5.39 | 96.46 | 111.00 |
| 1 | C | 157 | ALA | N-CA-C | -5.38 | 96.48 | 111.00 |
| 1 | A | 157 | ALA | N-CA-C | -5.38 | 96.48 | 111.00 |
| 1 | B | 157 | ALA | N-CA-C | -5.38 | 96.48 | 111.00 |
| 1 | B | 260 | PRO | N-CA-CB | 5.26 | 109.61 | 103.30 |

There are no chirality outliers.

There are no planarity outliers.

## 5.2   Too-close contacts (i)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry related clashes.

| Mol | Chain | Non-H | H(model) | H(added) | Clashes | Symm-Clashes |
|-----|-------|-------|----------|----------|---------|--------------|
| 1 | A | 2501 | 0 | 2477 | 93 | 0 |
| 1 | B | 2501 | 0 | 2477 | 98 | 0 |

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| Mol | Chain | Non-H | H(model) | H(added) | Clashes | Symm-Clashes |
|-----|-------|-------|----------|----------|---------|--------------|
| 1 | C | 2501 | 0 | 2477 | 97 | 0 |
| 1 | D | 2501 | 0 | 2477 | 96 | 0 |
| 2 | A | 48 | 0 | 26 | 9 | 0 |
| 2 | B | 48 | 0 | 26 | 9 | 0 |
| 2 | C | 48 | 0 | 26 | 10 | 0 |
| 2 | D | 48 | 0 | 26 | 10 | 0 |
| 3 | A | 38 | 0 | 0 | 0 | 0 |
| 3 | B | 38 | 0 | 0 | 0 | 0 |
| 3 | C | 38 | 0 | 0 | 0 | 0 |
| 3 | D | 38 | 0 | 0 | 0 | 0 |
| All | All | 10348 | 0 | 10012 | 390 | 0 |

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 19.

The worst 5 of 390 close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

| Atom-1 | Atom-2 | Interatomic distance (Å) | Clash overlap (Å) |
|--------|--------|--------------------------|-------------------|
| 1:A:254:LYS:HA | 1:A:258:GLY:HA3 | 1.40 | 1.04 |
| 1:B:254:LYS:HA | 1:B:258:GLY:HA3 | 1.40 | 1.03 |
| 1:C:254:LYS:HA | 1:C:258:GLY:HA3 | 1.40 | 1.01 |
| 1:D:254:LYS:HA | 1:D:258:GLY:HA3 | 1.40 | 1.00 |
| 2:B:1001:NDP:H52N | 2:B:1001:NDP:H6N | 1.53 | 0.90 |

There are no symmetry-related clashes.

## 5.3 Torsion angles (i)

### 5.3.1 Protein backbone (i)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

| Mol | Chain | Analysed | Favoured | Allowed | Outliers | Percentiles | |
|-----|-------|----------|----------|---------|----------|-------------|---|
| 1 | A | 323/325 (99%) | 312 (97%) | 6 (2%) | 5 (2%) | 10 | 33 |
| 1 | B | 323/325 (99%) | 312 (97%) | 6 (2%) | 5 (2%) | 10 | 33 |

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| Mol | Chain | Analysed | Favoured | Allowed | Outliers | Percentiles | |
|-----|-------|----------|----------|---------|----------|:---:|:---:|
| 1 | C | 323/325 (99%) | 312 (97%) | 6 (2%) | 5 (2%) | 10 | 33 |
| 1 | D | 323/325 (99%) | 312 (97%) | 6 (2%) | 5 (2%) | 10 | 33 |
| All | All | 1292/1300 (99%) | 1248 (97%) | 24 (2%) | 20 (2%) | 10 | 33 |

5 of 20 Ramachandran outliers are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 1 | A | 261 | PRO |
| 1 | B | 261 | PRO |
| 1 | C | 261 | PRO |
| 1 | D | 261 | PRO |
| 1 | A | 58 | VAL |

### 5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

| Mol | Chain | Analysed | Rotameric | Outliers | Percentiles | |
|-----|-------|----------|-----------|----------|:---:|:---:|
| 1 | A | 257/272 (94%) | 251 (98%) | 6 (2%) | 50 | 82 |
| 1 | B | 257/272 (94%) | 251 (98%) | 6 (2%) | 50 | 82 |
| 1 | C | 257/272 (94%) | 251 (98%) | 6 (2%) | 50 | 82 |
| 1 | D | 257/272 (94%) | 251 (98%) | 6 (2%) | 50 | 82 |
| All | All | 1028/1088 (94%) | 1004 (98%) | 24 (2%) | 50 | 82 |

5 of 24 residues with a non-rotameric sidechain are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 1 | B | 206 | ASN |
| 1 | C | 48 | ARG |
| 1 | D | 206 | ASN |
| 1 | B | 268 | LYS |
| 1 | C | 40 | ARG |

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 36 such sidechains are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 1 | B | 285 | GLN |
| 1 | C | 148 | GLN |
| 1 | D | 271 | GLN |
| 1 | C | 71 | HIS |
| 1 | C | 158 | ASN |

### 5.3.3   RNA (i)

There are no RNA molecules in this entry.

## 5.4   Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

## 5.5   Carbohydrates (i)

There are no carbohydrates in this entry.

## 5.6   Ligand geometry (i)

4 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

| Mol | Type | Chain | Res | Link | Bond lengths | | | Bond angles | | |
|-----|------|-------|-----|------|--------|------|-----------|--------|------|-----------|
| | | | | | Counts | RMSZ | #$|Z| > 2$ | Counts | RMSZ | #$|Z| > 2$ |
| 2 | NDP | B | 1001 | - | 45,52,52 | 1.83 | 11 (24%) | 53,80,80 | 2.15 | 13 (24%) |
| 2 | NDP | A | 1000 | - | 45,52,52 | 1.83 | 12 (26%) | 53,80,80 | 2.15 | 13 (24%) |
| 2 | NDP | C | 1002 | - | 45,52,52 | 1.84 | 11 (24%) | 53,80,80 | 2.15 | 13 (24%) |
| 2 | NDP | D | 1003 | - | 45,52,52 | 1.84 | 11 (24%) | 53,80,80 | 2.15 | 13 (24%) |

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

| Mol | Type | Chain | Res | Link | Chirals | Torsions | Rings |
|-----|------|-------|-----|------|---------|----------|-------|
| 2 | NDP | B | 1001 | - | - | 4/30/77/77 | 0/5/5/5 |
| 2 | NDP | A | 1000 | - | - | 4/30/77/77 | 0/5/5/5 |
| 2 | NDP | C | 1002 | - | - | 4/30/77/77 | 0/5/5/5 |
| 2 | NDP | D | 1003 | - | - | 4/30/77/77 | 0/5/5/5 |

The worst 5 of 45 bond length outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(Å) | Ideal(Å) |
|-----|-------|-----|------|-------|---|-------------|----------|
| 2 | C | 1002 | NDP | P2B-O2B | 5.81 | 1.70 | 1.59 |
| 2 | B | 1001 | NDP | P2B-O2B | 5.77 | 1.70 | 1.59 |
| 2 | A | 1000 | NDP | P2B-O2B | 5.77 | 1.70 | 1.59 |
| 2 | D | 1003 | NDP | P2B-O2B | 5.77 | 1.70 | 1.59 |
| 2 | D | 1003 | NDP | C7N-C3N | 4.47 | 1.58 | 1.48 |

The worst 5 of 52 bond angle outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(°) | Ideal(°) |
|-----|-------|-----|------|-------|---|-------------|----------|
| 2 | B | 1001 | NDP | PN-O3-PA | 7.54 | 158.71 | 132.83 |
| 2 | A | 1000 | NDP | PN-O3-PA | 7.54 | 158.71 | 132.83 |
| 2 | D | 1003 | NDP | PN-O3-PA | 7.54 | 158.71 | 132.83 |
| 2 | C | 1002 | NDP | PN-O3-PA | 7.53 | 158.68 | 132.83 |
| 2 | B | 1001 | NDP | O2N-PN-O5D | -5.13 | 83.92 | 107.75 |

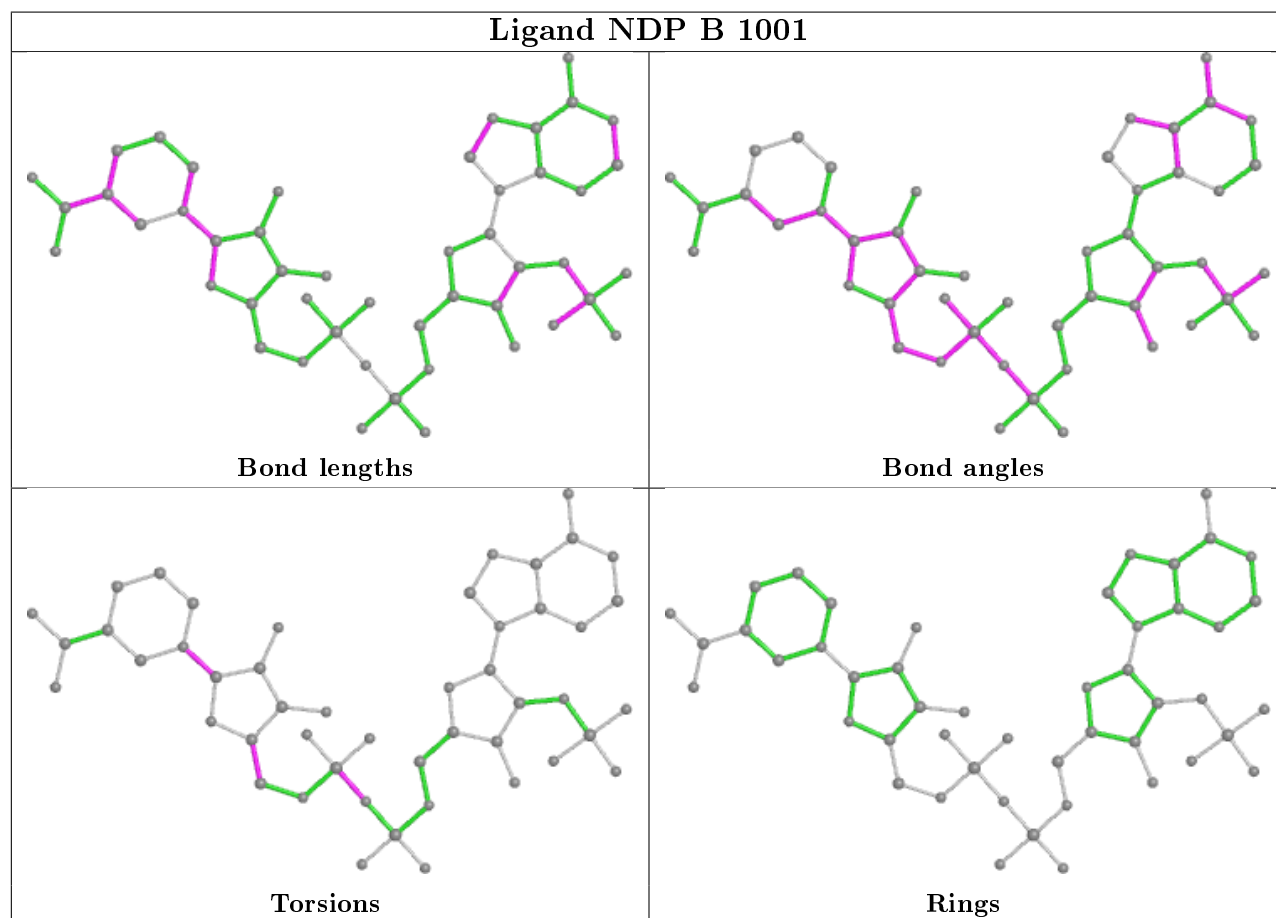There are no chirality outliers.

5 of 16 torsion outliers are listed below:

| Mol | Chain | Res | Type | Atoms |
|-----|-------|-----|------|-------|
| 2 | B | 1001 | NDP | C3D-C4D-C5D-O5D |
| 2 | A | 1000 | NDP | C3D-C4D-C5D-O5D |
| 2 | C | 1002 | NDP | C3D-C4D-C5D-O5D |
| 2 | D | 1003 | NDP | C3D-C4D-C5D-O5D |
| 2 | B | 1001 | NDP | O4D-C1D-N1N-C2N |

There are no ring outliers.
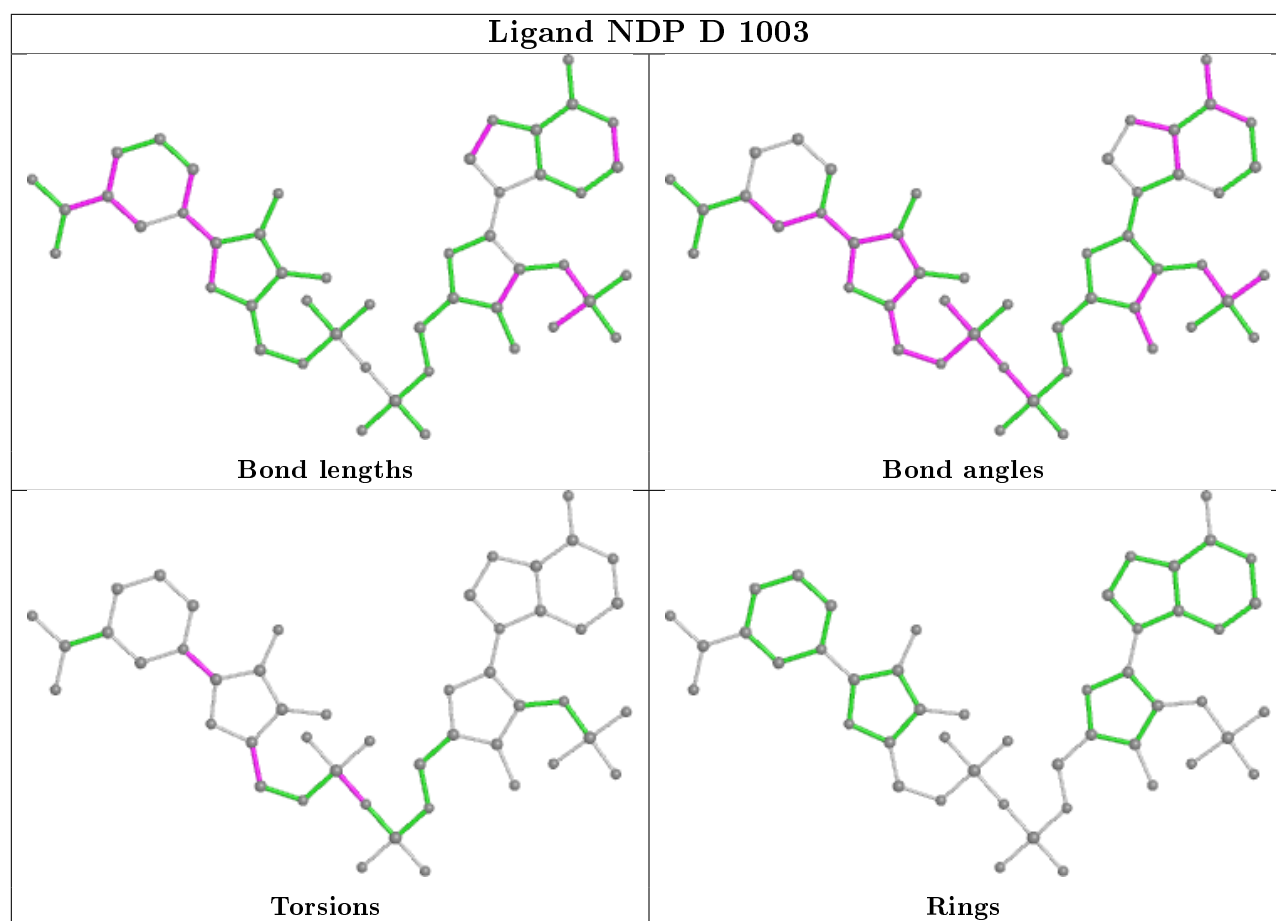
4 monomers are involved in 38 short contacts:

| Mol | Chain | Res | Type | Clashes | Symm-Clashes |
|-----|-------|-----|------|---------|--------------|
| 2 | B | 1001 | NDP | 9 | 0 |
| 2 | A | 1000 | NDP | 9 | 0 |
| 2 | C | 1002 | NDP | 10 | 0 |
| 2 | D | 1003 | NDP | 10 | 0 |

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.



Ligand NDP B 1001

Bond lengths

Bond angles

Torsions

Rings

## Ligand NDP A 1000


Bond lengths


Bond angles


Torsions


Rings

## Ligand NDP C 1002



Bond lengths



Bond angles



Torsions



Rings

**Ligand NDP D 1003**



Bond lengths



Bond angles



Torsions



Rings
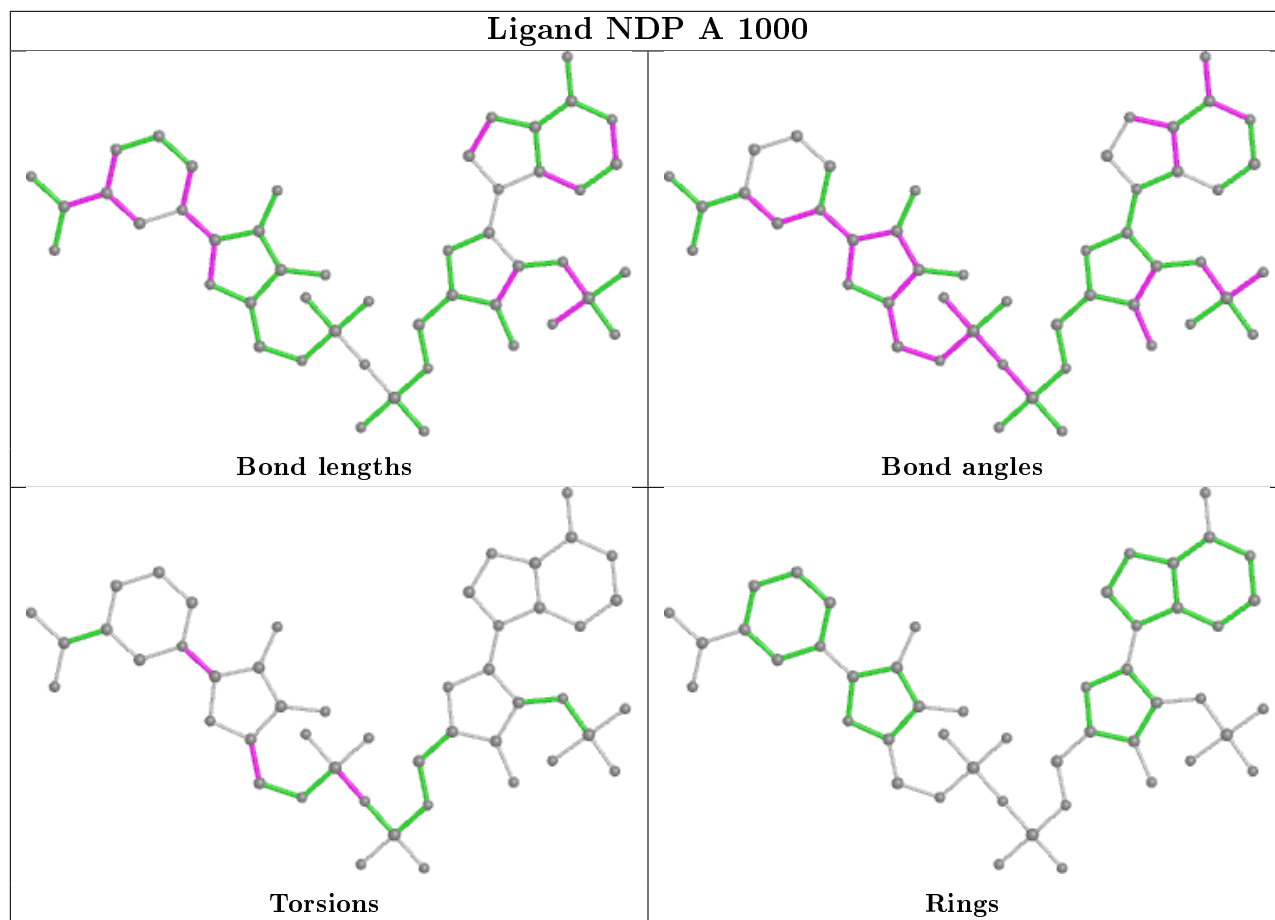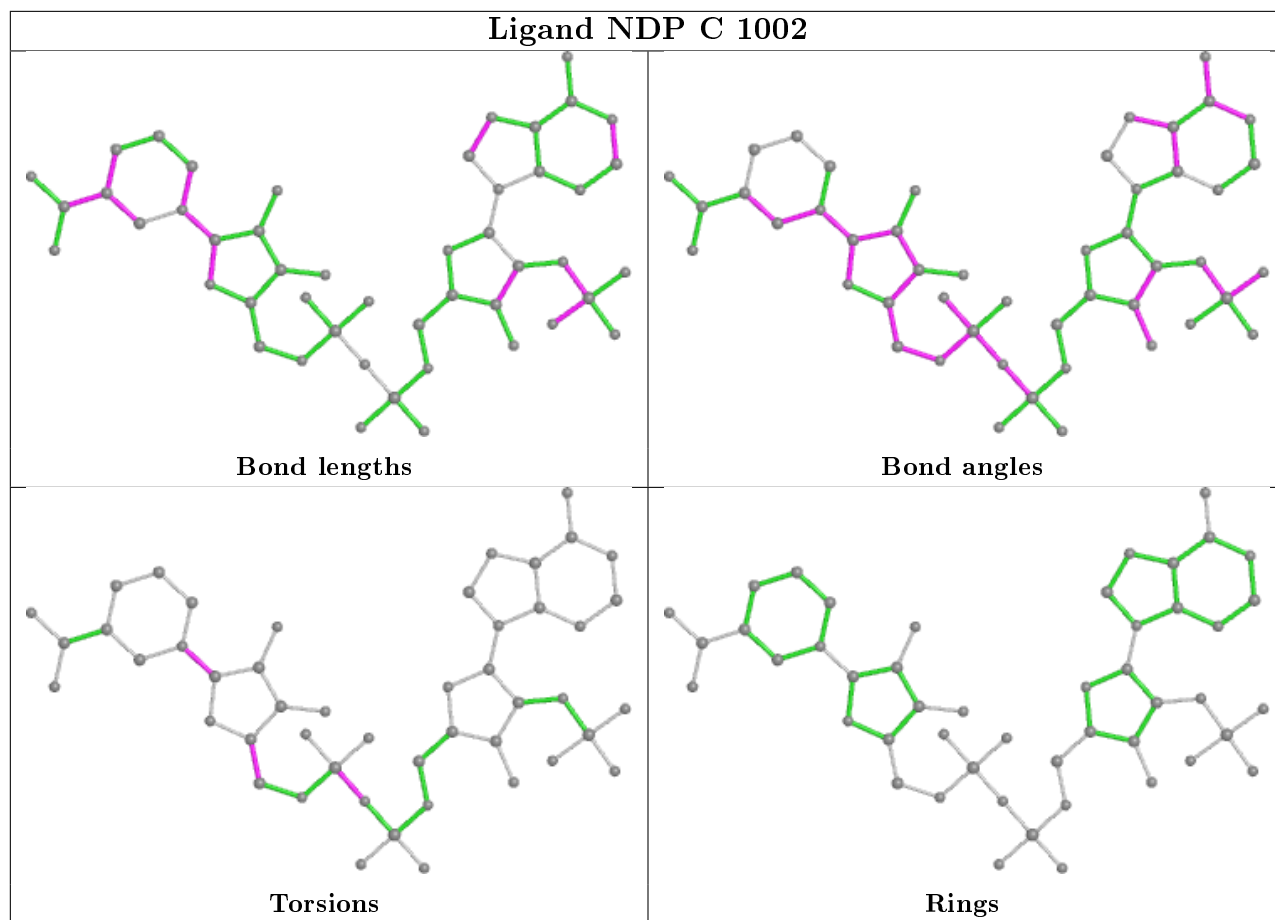
## 5.7 Other polymers (i)

There are no such residues in this entry.

## 5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

# 6 Fit of model and data (i)

## 6.1 Protein, DNA and RNA chains (i)

EDS was not executed - this section is therefore empty.

## 6.2 Non-standard residues in protein, DNA, RNA chains (i)

EDS was not executed - this section is therefore empty.

## 6.3 Carbohydrates (i)

EDS was not executed - this section is therefore empty.

## 6.4 Ligands (i)

EDS was not executed - this section is therefore empty.

## 6.5 Other polymers (i)

EDS was not executed - this section is therefore empty.