Apex™
Reagents and Chemicals
A Genesee Scientific Brand

APEX HIGH FIDELITY DNA POLYMERASE

Apex High Fidelity DNA Polymerase is composed of a novel chimeric DNA polymerase with Archaeal ancestry, fused to a processivity-enhancing DNA binding domain. Alongside very fast and robust amplification of complex and long targets, Apex High Fidelity DNA Polymerase displays a high fidelity ensuring accurate amplification.

Apex High Fidelity DNA Polymerase is well suited for PCR experiments that require amplification with very low error rates, such as cloning/sub-cloning, NGS applications, SNP analysis and mutagenesis.

Features:

- High Fidelity: > 60x Taq fidelity
- High elongation rate: 10 sec/kb
- Long range amplification: 18 kb for human gDNA and 25 kb for λ DNA
- 3' to 5' proofreading exonuclease activity

High fidelity

Fidelity values for Apex High Fidelity DNA Polymerase, a Pfu like DNA Polymerase, two well-recognized high fidelity DNA polymerases P and Q and Taq DNA Polymerase were determined through a novel NGS-based analysis of nucleotide misincorporation during PCR.

Initially, PCR amplification was performed on a ~ 200 bp synthetic DNA target, generating PCR products for each of the tested polymerases (using recommended setup conditions).

Each product was purified and NGS-prepped, followed by sequencing using the MiSeq sequencing platform. In total, over 100 million reads were generated, with an average dataset size of 6 million reads. The substitution rate (error rate) was determined at each position within the DNA target (Figure 2) and subsequently summarized to determine an error rate of the entire target (Figure 1).

The error rates found for Apex High Fidelity DNA Polymerase and the high fidelity DNA polymerases P and Q were below the detection limit of this method, indicating that these polymerases generated very few substitution errors. The detection limit is estimated to be 8.4 x 10^{-6} errors per base per doubling, which corresponds to around 60x the fidelity of Taq DNA Polymerase.

Applications:

- Cloning/sub-cloning
- Long range amplification
- NGS applications
- Mutagenesis
- Gene expression
- Construction of libraries
- SNP analysis

A

	Error rate[a]
Taq	5 x 10^{-4} (± 4.3 x 10^{-6})
AccuPOL	1.1 x 10^{-4} (± 2.9 x 10^{-5})
Apex HiFi	Below detection limit[b]
P	Below detection limit[b]
Q	Below detection limit[b]

B

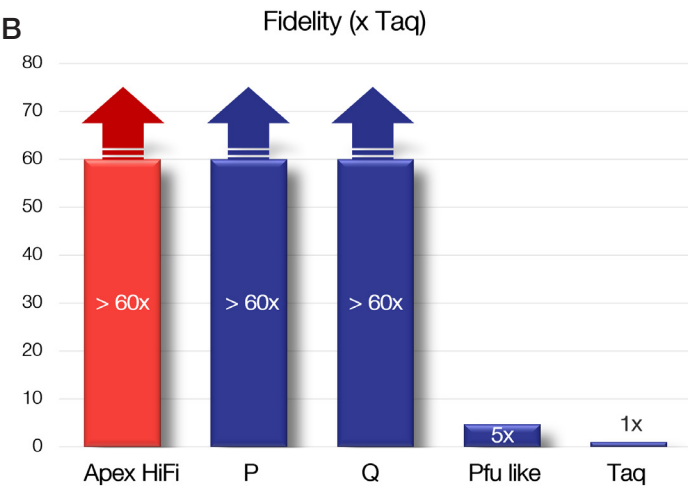

Figure 1. Error rates and corresponding fidelity values.
A: Errors per base per doubling. Standard deviations are given in brackets. B: Fidelity values for Apex High Fidelity DNA Polymerase, a Pfu like DNA Polymerase and high fidelity DNA polymerases P and Q were compared to the fidelity values of Taq DNA Polymerase (1x).
[a] The presented error rates may not be comparable to those presented in other literature due to technical and methodical differences.
[b] Error rates were below the detection limit for the method. This limit is estimated to be 8.4 x 10^{-6}.

High fidelity (continued)

Diagram A in Figure 2 displays the distribution profile of the substitution rate across the amplification target for Taq DNA Polymerase, Apex High Fidelity DNA Polymerase and the two well-recognized high fidelity DNA polymerases Q and P. The diagram shows that the number of substitutions at each target position are much higher for Taq DNA Polymerase than for Apex High Fidelity DNA Polymerase and the two high fidelity DNA polymerases P and Q. Furthermore, the number of substitutions at each target position for Apex High Fidelity DNA Polymerase and the two high fidelity DNA polymerases P and Q is close to the detection limit of the method. Diagram B magnifies the area near the detection limit, displaying more information about the number of substitutions for Apex High Fidelity DNA Polymerase and the high fidelity DNA polymerases; P and Q.

Collectively, these diagrams show that Apex High Fidelity DNA Polymerase displays an extremely low numbers of substitutions. Furthermore, there is an indication that the substitution pattern of Apex High Fidelity DNA Polymerase is very similar to both high fidelity DNA polymerase P and Q.

Long range amplification

Apex High Fidelity DNA Polymerase provides the user with the ability to amplify a broad range of DNA targets from short and up to 18 kb for human genomic DNA (Figure 5).

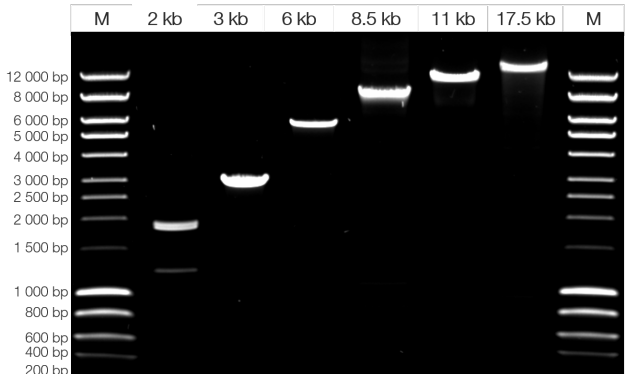

Figure 5: Apex High Fidelity DNA Polymerase enables long range amplification. Six different targets of human genomic DNA ranging from 2 kb and up to 17.5 kb was used in this study. Amplicon sizes are indicated at the top of the gel.

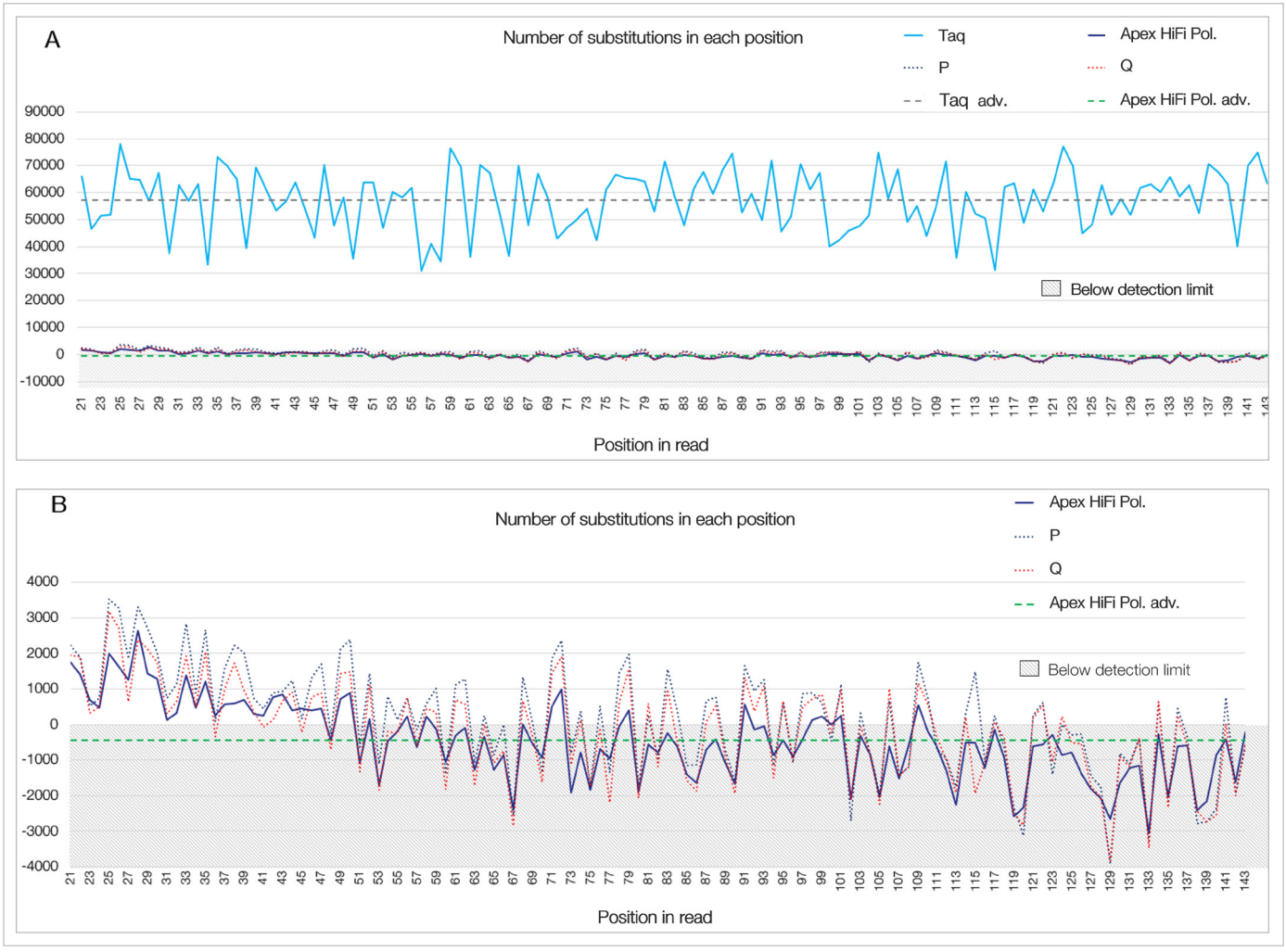

Figure 2. Distribution of substitutions. PCR was performed on a synthetic DNA target, using Taq DNA Polymerase, Apex High Fidelity DNA Polymerase and the two well-recognized high fidelity DNA polymerase P and Q. The amplified products were purified, NGS-prepped and sequenced. The number of substitutions at each target position was calculated and plotted in diagrams A and B. Diagram B magnifies the area near the detection limit. Substitutions include misincorporated nucleotides and deletions. Non-polymerase errors are subtracted from the total number of errors to reveal true polymerase errors. Non-polymerase errors include mutations caused by thermocycling-induced DNA-damage, pre-NGS sample preparation and sequencing errors. In these diagrams the average number of substitutions for Taq DNA Polymerase (Taq average) and for Apex High Fidelity DNA Polymerase (High Fidelity average) is also plotted.

APEX HIGH FIDELITY DNA POLYMERASE

Robust amplification on AT-rich to GC-rich DNA targets

Apex High Fidelity DNA Polymerase provides the user with robust and specific amplification of a variety of DNA targets with GC content ranging from ~ 30 – 80 % GC. The 5x High Fidelity Buffer provided with the enzyme is recommended for highest fidelity and specificity. For DNA targets with a high GC content, more complex secondary structure or longer DNA targets, the addition of 1-2 M Betaine Enhancer Solution is recommended.

The PCR performance of Apex High Fidelity DNA Polymerase was compared to that of high fidelity DNA polymerases from three well-recognized competitors Q, S and P (Figure 3). PCR was performed on eight different human genomic targets, 400 – 800 bp in length and with GC content ranging from 29 – 78 % (Table 1). Robust amplification was observed for all targets using Apex High Fidelity DNA Polymerase. High fidelity DNA polymerase Q and S provided results very similar to Apex High Fidelity DNA Polymerase, except on the last target with the highest GC content of 78%. In contrary, high fidelity DNA polymerase P were not able to provide the same level of robust amplification on the DNA targets with higher GC content, under the conditions tested here.

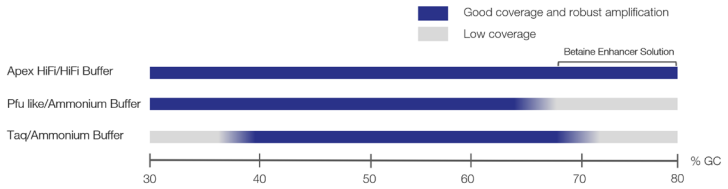

Figure 4. Illustration of the coverage of Apex High Fidelity DNA Polymerase. 5x High Fidelity Buffer supports robust amplification of DNA targets with a GC content ranging from ~ 30 – 80 %. The addition of 2M Betaine Enhancer solution supports amplification of DNA targets with high GC content. The coverage of Apex High Fidelity DNA Polymerase is illustrated against the coverage of a Pfu like DNA polymerase and Taq DNA Polymerase when using the 10x Ammonium Buffer.

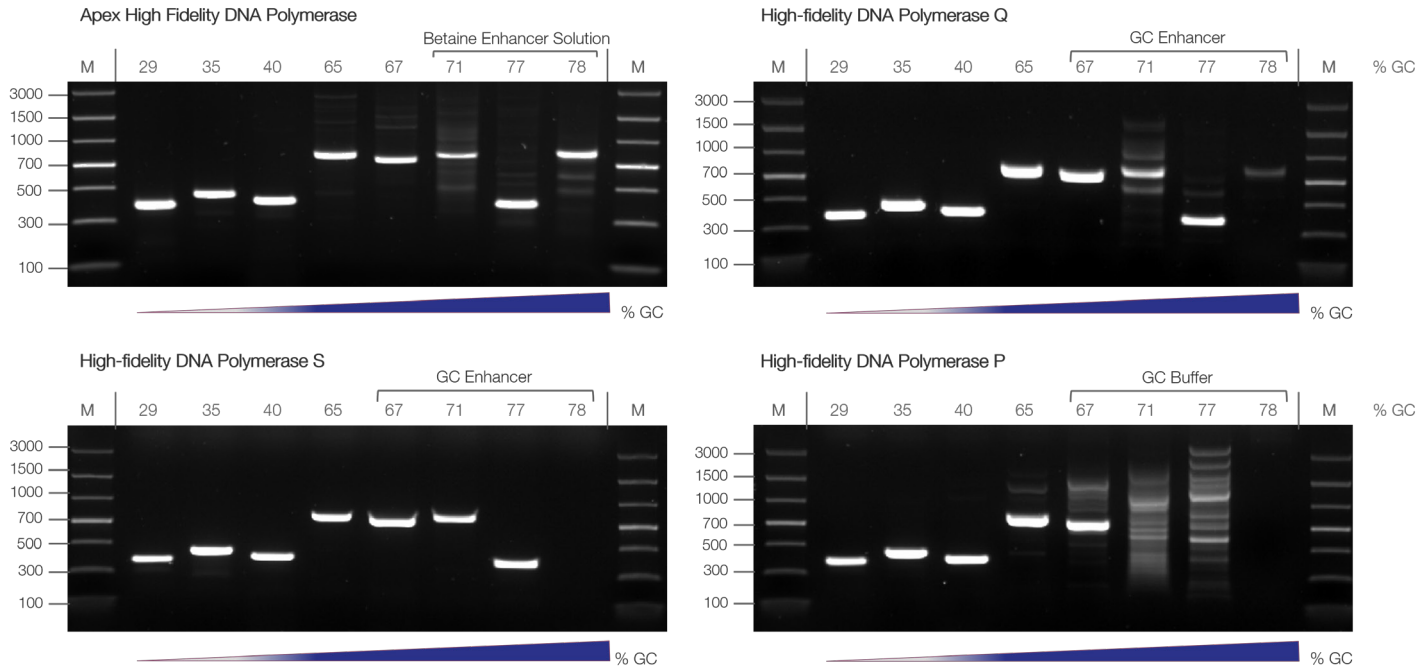

Figure 3. Robust amplification of Apex High Fidelity DNA Polymerase. Performance of Apex High Fidelity DNA Polymerase was compared to three leading high fidelity DNA Polymerase (Q, S and P). Eight different human genomic DNA targets, 400 – 800 bp in length and with GC content ranging from 29 – 78 %, were amplified. Amplification studies have been set up, as recommended by the manufactures. Tm Calculators of the respective competitors were used to calculate optimal annealing temperature for primers. When amplifying GC-rich targets, 2 M Betaine Enhancer Solution (Apex High Fidelity DNA Polymerase), GC enhancer (Competitor Q and S) or GC-rich specific PCR Buffer (competitor P) were included in the reaction mix.

% GC	Target	bp
29	CFTR-EX21	396
35	DMD19	459
40	DMD17	416
65	BAIP3	788
67	CEND	737
71	KLF14	777
77	FECH1	381
78	PO3F3	790

Table 1. DNA targets. Overview of the eight genomic DNA targets used for the amplification study in figure 3. This table shows the GC content (% GC), target names and the respective target lenghts (bp).

Ordering information

Product	Size	Cat #
Apex High Fidelity DNA Polymerase	100 Units	42-500
	500 Units	42-500B
	1000 Units	42-500C
Apex High Fidelity 2X Master Mix	100 RXN	42-501
	500 RXN	42-501B
	2500 RXN	42-501C
Betaine Enhancer Solution, 5 M	5 x 1 ml	42-504

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