

Development of super-specific epigenome editing by targeted allele-specific DNA methylation

Additional file 1

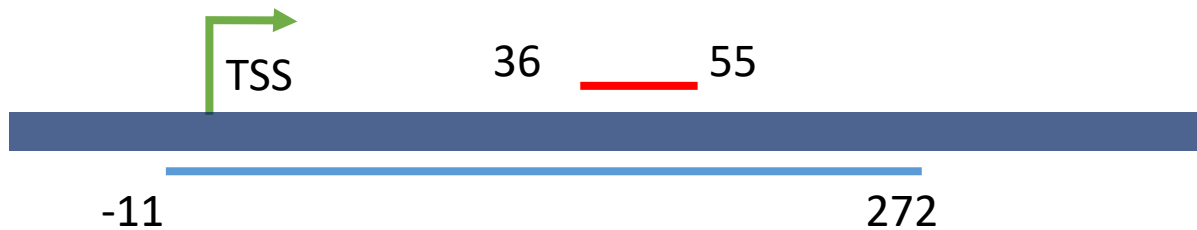
Schematic images showing the target loci and allele discrimination strategy.

The images in the top panel represent the positions of the sgRNA binding site (red bar), the genomic region analyzed by NGS (blue bar) and the TSS of the associated gene starting at position +1 (green arrow). The numbers indicate the distance in bps from the TSS. Some of the features are not drawn to scale.

The image in the lower panel indicate the strategy for discrimination of alleles with SNP in the PAM site or sgRNA seed region. The sequence of sgRNA for each target region and the binding site of the sgRNA in the targeted allele is highlighted. The regions are color coded with the sgRNA sequence in red, the binding site of the sgRNA in violet, PAM site in green, and the SNP is indicated with a red arrow and written in bold text. The designed sgRNA binds to the targeted allele mentioned in each figure. In the untargeted allele, the presence of the SNP in the PAM or sgRNA seed region, disfavors the binding of the sgRNA/dCas9 complex.

On the last page of this file, the sgRNA binding sites within the analyzed target regions and the corresponding CpG site numbers are provided.

DAP3-PAM3



Region	Genome coordinates (hg19)
SNP	chr1:155658940-155658940
sgRNA	chr1:155658918-155658937 (+)
NGS analysis region	chr1:155658871-155659154

DAP3-PAM3 sgRNA designed to target Allele 1

sgRNA

CCGCGGTTGTCTCCAGGCCA

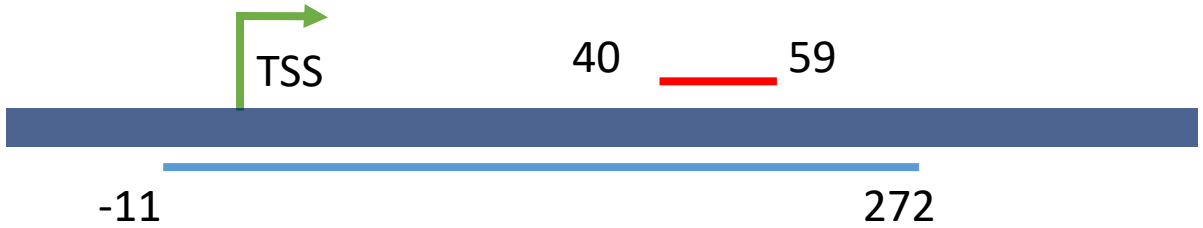
Allele 1

5' CGCTTTGGAGCCGGCCCCAG **CCGCGGTTGTCTCCAGGCCA** GCAGCGTGTGTGCGGTCGCCTAGGCTGGAGAACTAGTCCTCGAC3'
 3' GCGAAACCTCGGCCGGGGTCCGTCGCACACAGCCAGCGGATCCGACCTCTTGATCAGGAGCTG5'

Allele 2

5 'CGCTTTGGAGCCGGCCCCAGGCAGCGTGTGTCGGTCGCCTAG**T**CTGGAGAACTAGTCCTCGAC3 '
|||||
3 'GCGAAACCTCGGCCGGGGTCCGTCGCACACAGCCAGCGGATCAGACCTCTTGATCAGGAGCTG5 '

DAP3-Seed1



Region	Genome coordinates (hg19)
SNP	chr1:155658940-155658940
sgRNA	chr1:155658922-155658941 (+)
NGS analysis region	chr1:155658871-155659154

DAP3-Seed1 sgRNA designed to target Allele 1

sgRNA

CGTGTGTCGGTCGCCTAGTC

Allele 1

5' TTGAGCCGGCCCCAGGCAGCGTGTGTCTGGTTCGCCTAGGC **CTG**GAGAACTAGTCCTCGACTCAC3'
 3' AACCTCGGCCGGGGTCCGTCGCACACAGCCAGCGGATCCG **ACG**TCTTGATCAGGAGCTGAGTG5'

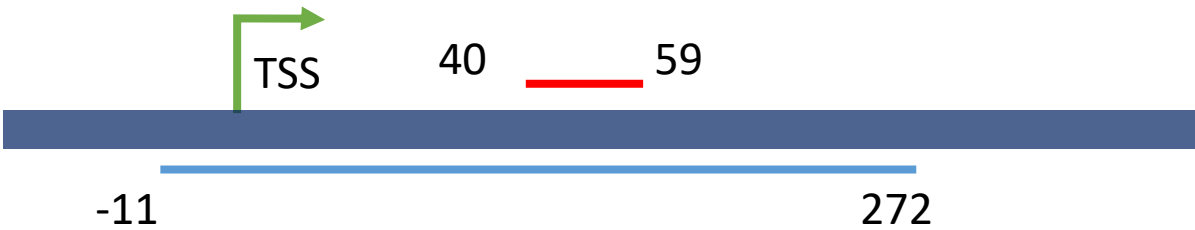
Allele 2

Allele 2

5' TTGGAGCCGGCCCCAGGCAGCGTGTGTCGGTCGCCTAG**TC**GGAGAAGTAGTCCTCGACTCAC '

3' AACCTCGGCCGGGGTCCGTCGCACACAGCCAGCGGATC**AG**AGCTCTTGATCAGGAGCTGAGTG5'

DAP3-Seed2



Region	Genome coordinates (hg19)
SNP	chr1:155658940-155658940
sgRNA	chr1:155658922-155658941 (+)
NGS analysis region	chr1:155658871-155659154

DAP3-Seed2 sgRNA designed to target Allele 2

sgRNA

CGTGTGTCGGTCGCCTAGGC

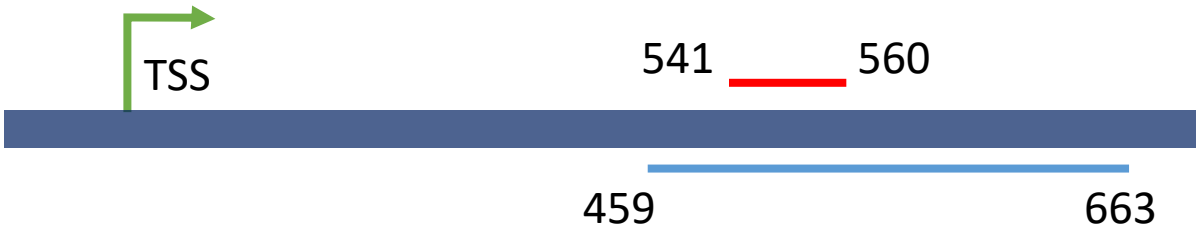
Allele 1

5 `TTGGAGCCGGCCCCAGGCAGCGTGTGTCGGTCGCCTAGGCTGGAGAACTAGTCCTCGACTCAC3`
|||||
3 `AACCTCGGCCGGGGTCCGTCGCACACAGCCAGCGGATCCGACCTCTTGATCAGGAGCTGAGTG5`

Allele 2

5 `TTGGAGCCGGCCCCAGGCAGCGTGTGTCGGTCGCCTAGTCGGAGAACTAGTCCTCGACTCAC`
|||||
3 `AACCTCGGCCGGGGTCCGTCGCACACAGCCAGCGGATCCGAGCTCTTGATCAGGAGCTGAGTG5`

GPD1L-PAM3



Region	Genome coordinates (hg19)
SNP	chr3:32148716-32148716
sgRNA	chr3:32148694-32148713 (+)
NGS analysis region	chr3:32148612-32148816

GPD1L-PAM3 sgRNA designed to target Allele 1

sgRNA

CTTGCTGCCCAGGTCACGGG

Allele 1

CTTGCTGCCCAGGTCACGGG

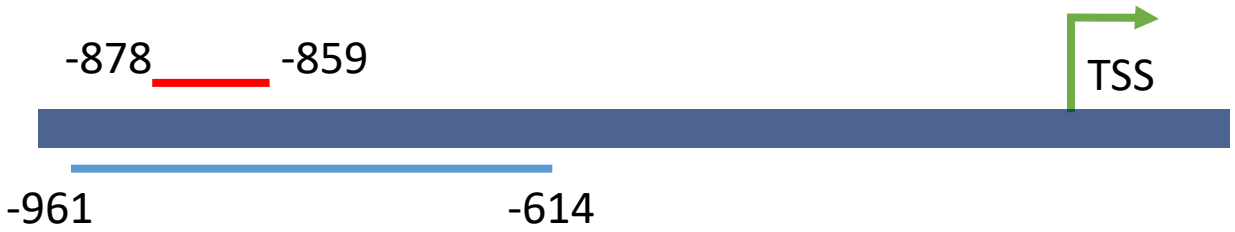
5 `GCGGAGAGGGCTAAAGGGCTCTTGCTGCCCAGGTCACGGGCGGGGCATGCTCTGCCCTTCAAG3`
|||||
3 `CGCCTCTCCCGATTTCGAGAACGACGGGTCCAGTGCCCGCCCGTACGAGACGGGAAGTTC5`

Allele 2

↓

5 `GCGGAGAGGGCTAAAGGGCTCTTGCTGCCCAGGTCACGGGCGTGGGCATGCTCTGCCCTTCAAG3`
|||||
3 `CGCCTCTCCCGATTTCGAGAACGACGGGTCCAGTGCCCGCAACGTACGAGACGGGAAGTTC5`

GSPT1-PAM3



Region	Genome coordinates (hg19)
SNP	chr16:12008941-12008941
sgRNA	chr16:12008919-12008938 (+)
NGS analysis region	chr16:12008836-12009183

GSPT1-PAM3 sgRNA designed to target Allele 1

sgRNA

TCCATACGGTTC CATCTCA

Allele 1

5' CGCCGCGGCCCCCACTCCGT **TCCATACGGTTCCCATCTCA** AGGGGTAAGTGCAGACTCCAGA3'
 |||||
 3' GCGGCGCCGGGGGTGAGGCAAGGTATGCCAAGGGTAGAGT **TCCCCCAT** TGACGCCTGAGGTCT5'

Allele 2

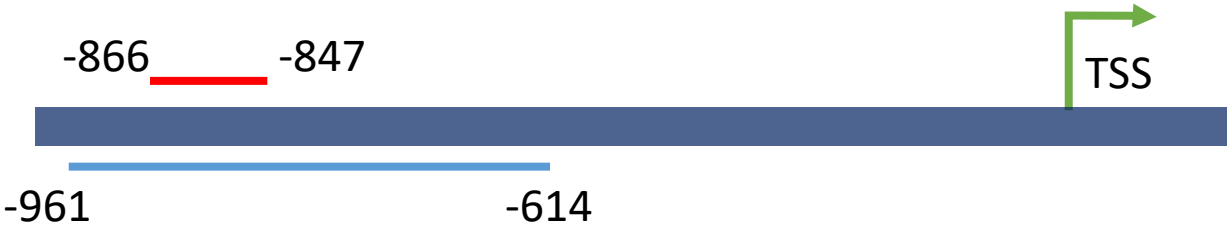
Allele 2

5' CGCCGCGGCCCCCACTCCGT TCCATACGGTTCCCATCTCAAG TGGGTA ACTGCGGACTCCAGA 3'

|||||

3' GCGGCGCCGGGGGTGAGGCAAGGTATGCCAAGGGTAGAGTTC ACCCATTGACGCCTGAGGTCT 5'

GSPT1-Seed1



Region	Genome coordinates (hg19)
SNP	chr16:12008941-12008941
sgRNA	chr16:12008931-12008950 (+)
NGS analysis region	chr16:12008836-12009183

GSPT1-Seed1 sgRNA designed to target Allele 1

sgRNA

CCATCTCAAGGGGGTAACTG

Allele 1

CCATCTCAAGGGGGTAACTG

5 `CACTCCGTTCCATACGGTTCCCATCTCAAGGGGGTAACTGCGGACTCCAGAGCAGGGCAGGGG3 `

|||||

3 `GTGAGGCAAGGTATGCCAAGGGTAGAGTTCCCCATTGACGCGTGAGGTCTCGTCCCGTCCCC5 `

Allele 2

↓

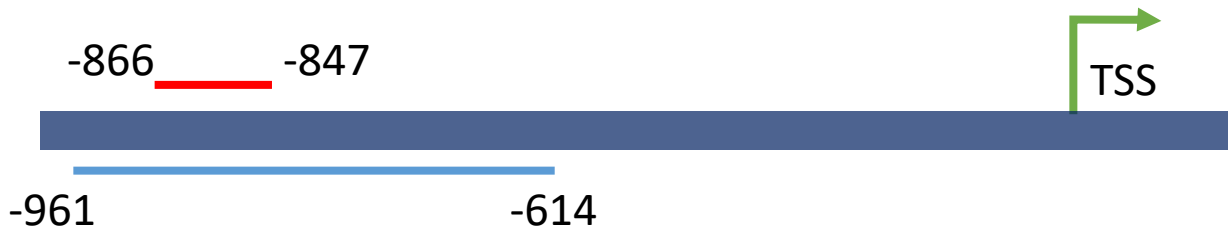
5 `CACTCCGTTCCATACGGTTCCCATCTCAAGTGGGTAACTGCGGACTCCAGAGCAGGGCAGGGG3 `

|||||

3 `GTGAGGCAAGGTATGCCAAGGGTAGAGTTCA~~ACC~~CATTGACGCGTGAGGTCTCGTCCCGTCCCC5 `

ACC

GSPT1-Seed2



Region	Genome coordinates (hg19)
SNP	chr16:12008941-12008941
sgRNA	chr16:12008931-12008950 (+)
NGS analysis region	chr16:12008836-12009183

GSPT1-Seed2 sgRNA designed to target Allele 2

sgRNA

CCATCTCAAGTGGGTAAGT

Allele 1



Allele 2



ISG15-PAM2



Region	Genome coordinates (hg19)
SNP	chr1:948878-948878
sgRNA	chr1:948872-948891 (-)
NGS analysis region	chr1:948633-948924

ISG15-PAM2 sgRNA designed to target Allele 1

sgRNA

TGCCTCTCAGCCGCCGGCTT

Allele 1

5 'ACTGGCAAAGATGAGTTCGCTGCCTCTCAGCCGCCGGCTT**TGCCTCTCAGCCGCCGGCTT**CGGCAGGCAGCACCGGCCCTATT3 '
3 'TGACCGTTTCTACTCAAGCGACGGAGAGTCGGCGGCCGAA**GC**GTCCGTCGTGGCCGGGATAA5 '

Allele 2

5 'ACTGGCAAAGATGAGTTCGCTGCCTCTCAGCCGCCGGCTT**C**GCAGGCAGCACCGGCCCTATT3 '
3 'TGACCGTTTCTACTCAAGCGACGGAGAGTCGGCGGCCGAAAGGCGTCCGTCGTGGCCGGGATAA5 '

ISG15-Seed1



Region	Genome coordinates (hg19)
SNP	chr1:948878-948878
sgRNA	chr1:948868-948887 (-)
NGS analysis region	chr1:948633-948924

ISG15-Seed1 sgRNA designed to target Allele 1

sgRNA

TCTCAGCCGCCGGCTTCGGC

Allele 1

5' GCAAAGATGAGTTCGCTGCC**TCTCAGCCGCCGGCTTCGGC**AGGCAGCACCGGCCCTATTATTA3'
|||||
3' CGTTTCTACTCAAGCGACGGAGAGTCGGCGGCCGAAGCCG**TCC**GTCTGTGGCCGGGATAATAAT'

Allele 2

5' GCAAAGATGAGTTCGCTGCC**TCTCAGCCGCCGGCTTC****CGC**AGGCAGCACCGGCCCTATTATTA3'
|||||
3' CGTTTCTACTCAAGCGACGGAGAGTCGGCGGCCGAAG**GCG****TCC**GTCTGTGGCCGGGATAATAAT'

ISG15-Seed2



Region	Genome coordinates (hg19)
SNP	chr1:948878-948878
sgRNA	chr1:948868-948887 (-)
NGS analysis region	chr1:948633-948924

ISG15-Seed2 sgRNA designed to target Allele 2

sgRNA

TCTCAGCCGCCGGCTTCCGC

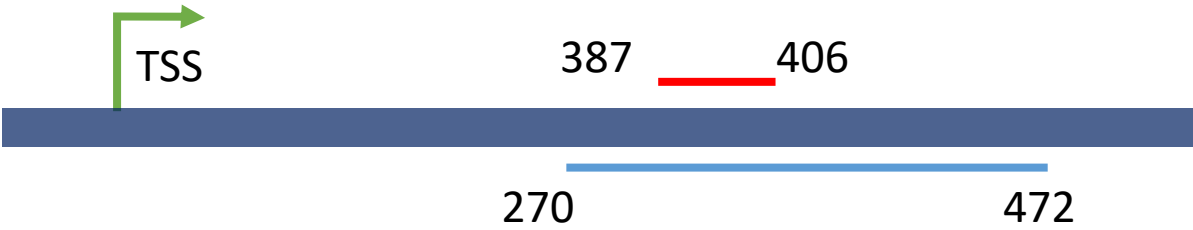
Allele 1



Allele 2



MAPK1-Seed1



Region	Genome coordinates (hg19)
SNP	chr22:22222320-22222320
sgRNA	chr22:22222318-22222337 (-)
NGS analysis region	chr22:22222201-22222403

MAPK1-Seed1 sgRNA designed to target Allele 1

sgRNA

GCTGCGGCGCTGCCGGGATA

Allele 1

5 `ACAGATTTCGAGAGGCCTGAGCTGCGGCGCTGCCGGGATAGCTGCGGCGCTGCCGGGATATGGCGCGTCGTCGGGCCTCAAGC3 `

|||||

3 `TGTCTAAGCGTCTCCGGACTCGACGCCGCGACGGCCCTATACCGCGCAGCAGCCCGGAGTTCG5 `

Allele 2

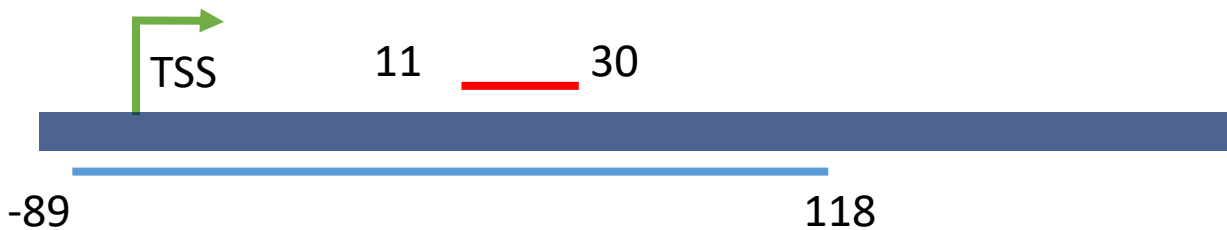
5 `ACAGATTTCGAGAGGCCTGAGCTGCGGCGCTGCCGGGCTATGGCGCGTCGTCGGGCCTCAAGC3 `

|||||

3 `TGTCTAAGCGTCTCCGGACTCGACGCCGCGACGGCCCGATACCGCGCAGCAGCCCGGAGTTCG5 `

↓

MRPL52-PAM3



Region	Genome coordinates (hg19)
SNP	chr14:23299135-23299135
sgRNA	chr14:23299113-23299132 (+)
NGS analysis region	chr14:23299013-23299220

MRPL52-PAM3 sgRNA designed to target Allele 1

sgRNA

CTGCTCAGCATGGCTGCTTT

Allele 1

5' TCCGGCTACCCCGGCTACTCCTGCTCAGCATGGCTGCTTTAGGGAAGTGTCTCTTCAGTGAGT3'
 3' AGGCCGATGGGGCCGATGAGGACGAGTCGTACCGACGAAATCCCTGACAAGAGAAGTCACTCA5'

Allele 2

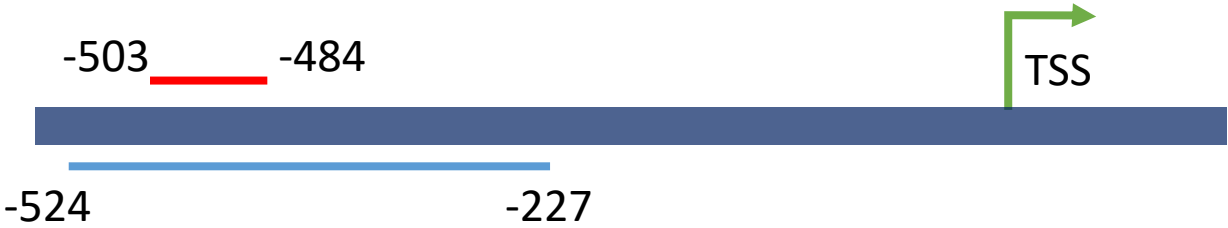
Allele 2

5' TCCGGCTACCCCGGCTACTCCTGCTCAGCATGGCTGCTTTAG**T**GACTGTTCTCTTCAGTGAGT3'

|||||

3' AGGCCGATGGGGCCGATGAGGACGAGTCGTACCGACGAAAT**C**ACTGACAAGAGAAGTCACTCA5'

MSH6-PAM3



Region	Genome coordinates (hg19)
SNP	chr2:48009816-48009816
sgRNA	chr2:48009794-48009813 (+)
NGS analysis region	chr2:48009773-48010070

MSH6-PAM3 sgRNA designed to target Allele 1

sgRNA

AAGTTTGGTCCCTTTCGCTC

Allele 1

5 `TGAAGGTGAACTGCTGACTAAAGTTTGGTCCCTTTCGCTCCTCCTTGCGAAAATGCTCTA5 `

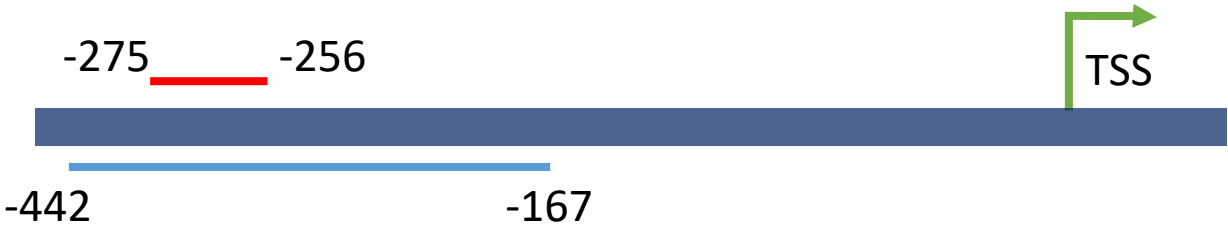
3 `ACTTCCACTTGACGACTGATTTCAAACCAGGGAAAGCGAGGCGAGGAGGAACGCTTTTACGAGAT3 `

Allele 2

5 `TGAAGGTGAACTGCTGACTAAAGTTTGGTCCCTTTCGCTCCGTCTCCTTGCGAAAATGCTCTA5 `

3 `ACTTCCACTTGACGACTGATTTCAAACCAGGGAAAGCGAGGCAAGAGGAACGCTTTTACGAGAT3 `

MYH10-Seed1



Region	Genome coordinates (hg19)
SNP	chr17:8533798-8533798
sgRNA	chr17:8533796-8533815 (-)
NGS analysis region	chr17:8533629-8533904

MYH10-Seed1 sgRNA designed to target Allele 1

sgRNA

GAGCTGTAGGGTTTGTGCTG

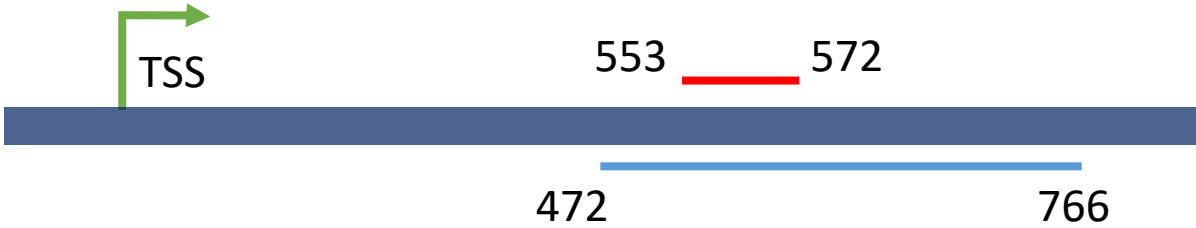
Allele 1

5`GGGAAGACAGAGGGGCTTCTGAGCTGTAGGGTTTGTGCTGGGGACCTTAGGTTAGTTTGAG3`
|||||
3`CCCTTCTGTCTCCCCGAAGACTCGACATCCCAAACACGACGCCCTGGAATCCAATCAAATC5`

Allele 2

5`GGGAAGACAGAGGGGCTTCTGAGCTGTAGGGTTTGTGTTGGGGACCTTAGGTTAGTTTGAG3`
|||||
3`CCCTTCTGTCTCCCCGAAGACTCGACATCCCAAACACAACGCCCTGGAATCCAATCAAATC5`

NARF-PAM2



Region	Genome coordinates (hg19)
SNP	chr17:80417150-80417150
sgRNA	chr17:80417129-80417148 (+)
NGS analysis region	chr17:80417054-80417348

NARF-PAM2 sgRNA designed to target Allele 1

sgRNA

CGCCTTCCGCGGTTGTCTCC

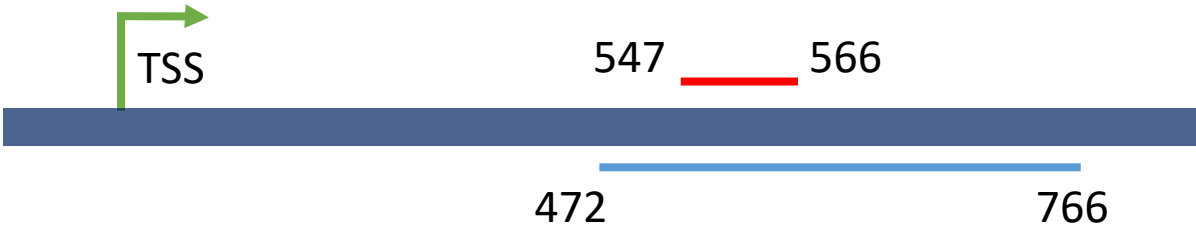
Allele 1

5'GGGTGACGGCTGCTGACCGGCGCCTTCCGCGGTTGTCTCCAGGCCATGGCAACAACCGCGCAG3'
3'CCCACTGCCGACGACTGGCCGCGGAAGGCGCCAACAGAGGTCCGGTACCGTTGTTGGCGCGTC5'

Allele 2

5'GGGTGACGGCTGCTGACCGGCGCCTTCCGCGGTTGTCTCCATGGCCATGGCAACAACCGCGCAG3'
3'CCCACTGCCGACGACTGGCCGCGGAAGGCGCCAACAGAGGTACGGTACCGTTGTTGGCGCGTC5'

NARF-Seed1



Region	Genome coordinates (hg19)
SNP	chr17:80417150-80417150
sgRNA	chr17:80417135-80417154 (+)
NGS analysis region	chr17:80417054-80417348

NARF-Seed1 sgRNA designed to target Allele 1

sgRNA

CCGCGGTTGTCTCCAGGCCA

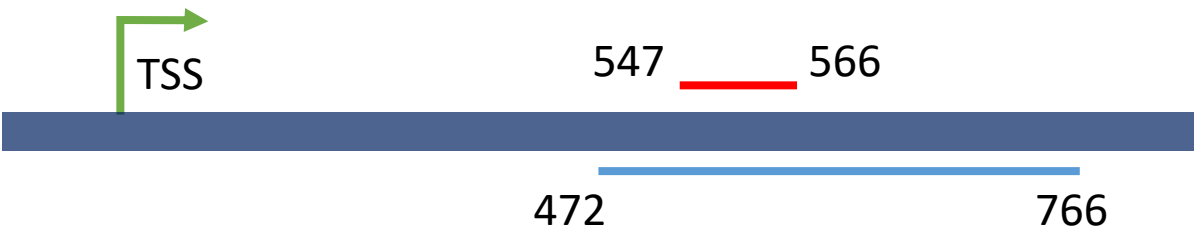
Allele 1

CCGCGGTTGTCTCCAGGCCA
5 `CGGCTGCTGACCGGCGCCTTCCGCGGTTGTCTCCAGGCCATGGCAACAACCGCGCAGCGCACG5`
|||||
3 `GCCGACGACTGGCCGCGGAAGGCGCCAACAGAGGTCGGTACCGTTGTTGGCGCGTCGCGTGC3`

Allele 2

↓
5 `CGGCTGCTGACCGGCGCCTTCCGCGGTTGTCTCCA**T**GCCATGGCAACAACCGCGCAGCGCACG5`
|||||
3 `GCCGACGACTGGCCGCGGAAGGCGCCAACAGAGGT**A**CGGTACCGTTGTTGGCGCGTCGCGTGC3`

NARF-Seed2



Region	Genome coordinates (hg19)
SNP	chr17:80417150-80417150
sgRNA	chr17:80417135-80417154 (+)
NGS analysis region	chr17:80417054-80417348

NARF-Seed2 sgRNA designed to target Allele 2

sgRNA

CCGCGGTTGTCTCCATGCCA

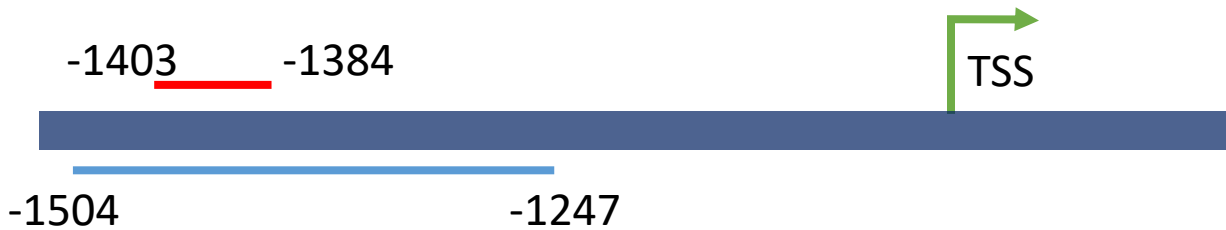
Allele 1



Allele 2



PDE8A-PAM2



Region	Genome coordinates (hg19)
SNP	chr15:85523678-85523678
sgRNA	chr15:85523657-85523676 (+)
NGS analysis region	chr15:85523556-85523813

PDE8A-PAM2 sgRNA designed to target Allele 1

sgRNA

CTCCGGGTCTTTGCAGTAGC

Allele 1

Allele 1
 5' GAATCCAGCCCGCAGCACGCCTCCGGGTCTTTGCAGTAGCCGGCCAAGGCGGGAGCGGCTGC3'
 3' CTTAGGTCGGGCGTCGTGCGGAGGCCAGAAACGTCATCGGCCCGGTTCCGCCCTCGCCGACG5'

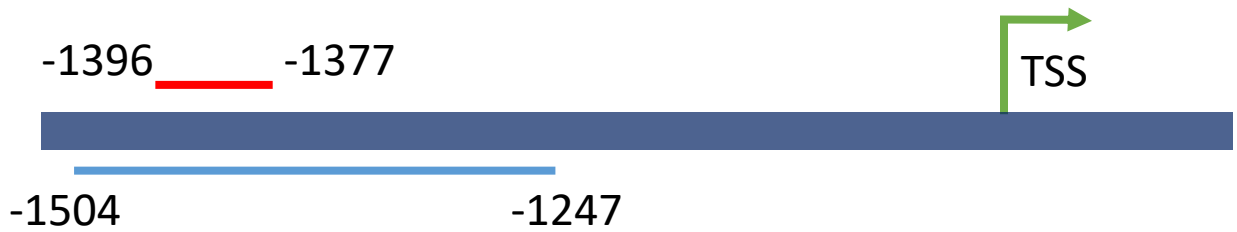
Allele 2

Allele 2

5' GAAATCCAGCCCGCAGCACGCCTCCGGGTCTTTGCAGTAGCC**T**GGCCAAGGCGGGAGCGGCTGC 3'

3' CTTAGGTCGGGCGTCGTGCGGAGGCCCAGAAACGTCATCGGA**A**CCGGTTCGCCCTCGCCGACG 5'

PDE8A-Seed1



Region	Genome coordinates (hg19)
SNP	chr15:85523678-85523678
sgRNA	chr15:85523664-85523683 (+)
NGS analysis region	chr15:85523556-85523813

PDE8A-Seed1 sgRNA designed to target Allele 1

sgRNA

TCTTTGCAGTAGCCGGGCCA

Allele 1

5' GCCCGCAGCACGCCTCCGGG TCTTTGCAGTAGCCGGGCCA AGCGGGAGCGGCTGCCTCTCAG3'
 3' CGGGCGTCGTGCGGAGGCCCAGAAACGTCATCGGCCCGGT TCGGCCCTCGCCGACGGAGAGTC5'

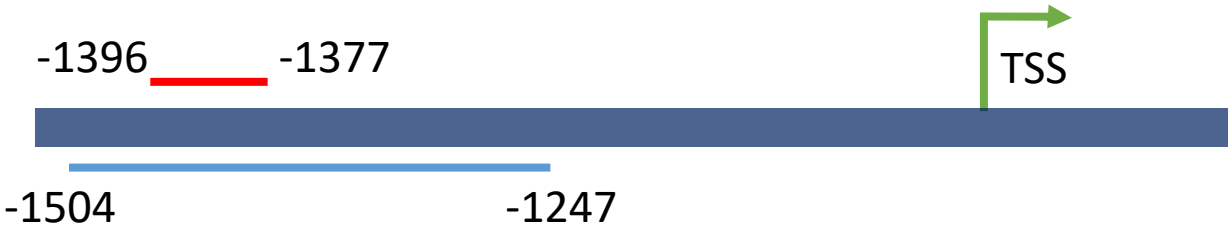
Allele 2

Allele 2

5' G C C C G C A G C A C G C C T C C G G G T C T T T G C A G T A G C C T **T** G G C C A A G G C G G G A G C G G C T G C C T C T C A G 3'

3' C G G G C G T C G T G C G G A G G C C C A G A A A C G T C A T C G G A C C G G T T C G C C C T C G C C G A C G G A G A G T C 5'

PDE8A-Seed2



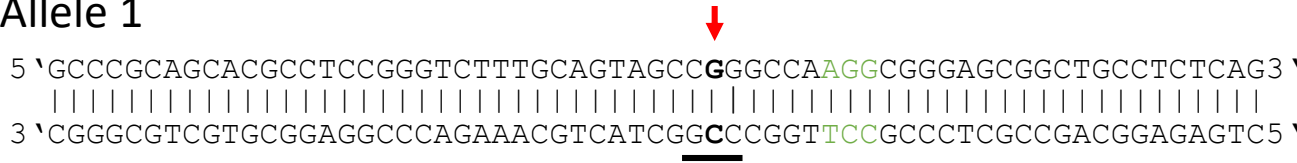
Region	Genome coordinates (hg19)
SNP	chr15:85523678-85523678
sgRNA	chr15:85523664-85523683 (+)
NGS analysis region	chr15:85523556-85523813

PDE8A-Seed2 sgRNA designed to target Allele 2

sgRNA

TCTTTGCAGTAGCCGGGCCA

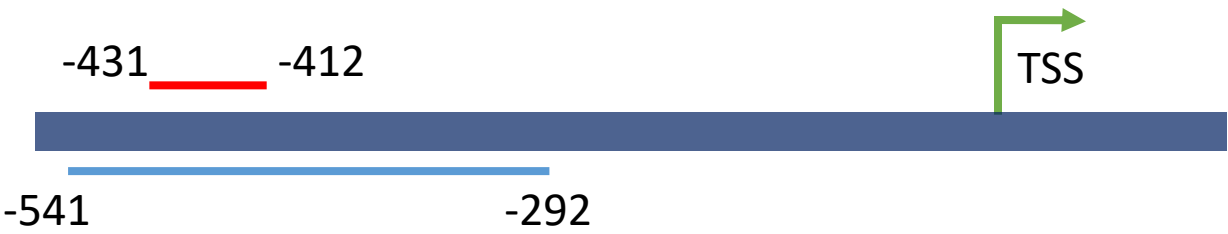
Allele 1



Allele 2



RAF1-PAM3



Region	Genome coordinates (hg19)
SNP	chr3:12705208-12705208
sgRNA	chr3:12705186-12705205 (+)
NGS analysis region	chr3:12705076-12705325

RAF1-PAM3 sgRNA designed to target Allele 1

sgRNA

AGCCCTCTGCCCGGCAGCCG

Allele 1

AGCCCTCTGCCCGGCAGCCG

5 `GGTGACAACGGCCTGGCCCAAGCCCTCTGCCCGGCAGCCGCGGGGCGCTCCATCAGCGCCAC3 `

|||||

3 `CCACTGTTGCCGGACCGGGTTCGGGAGACGGGCCGTCGGCGCCCGGCGAGGTAGTCGCGGTG5 `

Allele 2

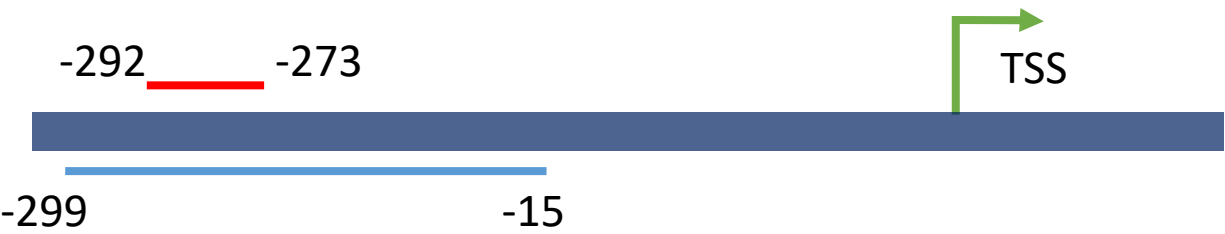
↓

5 `GGTGACAACGGCCTGGCCCAAGCCCTCTGCCCGGCAGCCGCGAGGCGCTCCATCAGCGCCAC3 `

|||||

3 `CCACTGTTGCCGGACCGGGTTCGGGAGACGGGCCGTCGGCGCTCCCGGCGAGGTAGTCGCGGTG5 `

RALB-PAM2



Region	Genome coordinates (hg19)
SNP	chr2:121010211-121010211
sgRNA	chr2:121010190-121010209 (+)
NGS analysis region	chr2:121010183-121010467

RALB-PAM2 sgRNA designed targeting Allele 1

sgRNA

GAGAGAGAAACAGAGGGGGA

Allele 1

5 `AGCTGCGTGTCCGAGGGGCA GAGAGAGAAACAGAGGGGGA CGGGCAGGCGCGCTGGGCCCCGC3 `

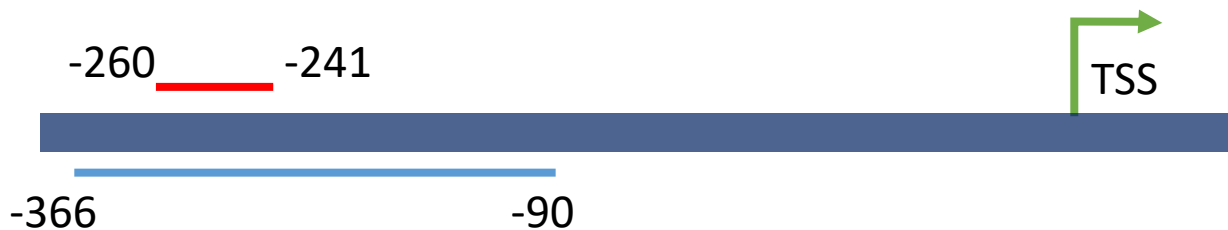
3 `TCGACGCACAGGCTCCCCGTCTCTCTCTTTGTCTCCCCCT GCGCCGTCCGCGCGACCCGGGCG5 `

Allele 2

5 `AGCTGCGTGTCCGAGGGGCAGAGAGAGAAACAGAGGGGGAC CGGGCAGGCGCGCTGGGCCCCGC3 `

3 `ACTTCCACTTGACGACTGATTTCAAACCAGGGAAAGCGAGG GAGAGGAACGCTTTTACGAGAT3 `

TTC41P-PAM3



Region	Genome coordinates (hg19)
SNP	chr12:104323950-104323950
sgRNA	chr12:104323928-104323947 (+)
NGS analysis region	chr12:104323822-104324098

TTC41P-PAM3 sgRNA designed to target Allele 1

sgRNA

AAGGGGCGGTCCACGTGTG

Allele 1

5' AGGCCAAGGCCGCCAGGCA **AAGGGGCGGTCCCACGTGTG** AGGGCCCGCGGAGCCATTTGAT3'
 3' TCCGGTTCCGGCGGGTCCGTTTCCCGGCCAGGGTGCACAC **TCCCCGGGCGCCTCGGTAAACTA**5'

Allele 2

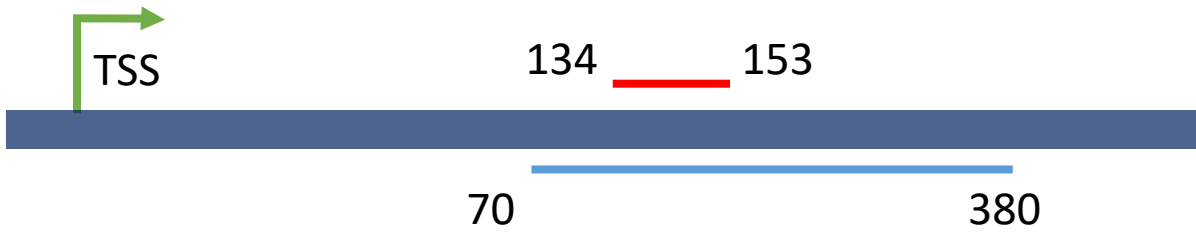
Allele 2

5' AGGCCAAGGCCGCCAGGCAAAGGGGCGGTCCCACGTGTGAG**T**GGCCCGCGGAGCCATTTGAT3'

|||||

3' TCCGGTTCCGGCGGGTCCGTTTCCCCGCCAGGTGCACACT**A**CCGGGCGCCTCGGTAAACTA5'

TYK2-PAM2



Region	Genome coordinates (hg19)
SNP	chr19:10491382-10491382
sgRNA	chr19:10491361-10491380 (+)
NGS analysis region	chr19:10491297-10491607

TYK2-PAM2 sgRNA designed to target Allele 1

sgRNA

GGCGGCCTCTCATTGGTCC

Allele 1

Alice 1

5' TTTT TTTT TTTT TTTT GCCATGGT GGC GGC ACTCTC ATTGGTCC GG GGT CATTCG TCACTC AGCC 3'

3' AAAAAAAAAA AC GGTACC ACCGCC GTGAGAGTA ACCAGG ACC CCGAGTAAGC AGTGAGT CGG 5'

Allele 2

Allele 2

5' TTTT'TTTTTTTGCCATGGTGGCGGCACTCTCATTGGTCCT**C**GGGCTCATTCGTCACTCAGCC3'
|||||
3' AAAAAAAAAAACGGTACCACCGCCGTGAGAGTAACCAGGA**G**CCCCGAGTAAGCAGTGAGTCGG5'

sgRNA binding sites within the analyzed target regions and corresponding CpG site numbers

Category	Experiment	CpG site numbers
Category 1	DAP3-Seed1	3, 4, 5
	DAP3-Seed2	3, 4, 5
	GSPT1-Seed1	7
	GSPT1-Seed2	7
	ISG15-Seed1	16, 17, 18
	ISG15-Seed2	16, 17, 18
	MAPK1-Seed1	11, 12, 13
	MYH10-Seed1	6
	NARF-Seed1	8, 9
	NARF-Seed2	8, 9
	PDE8A-Seed1	9, 10
	PDE8A-Seed2	9, 10
Category 2	ISG15-PAM2	16, 17, 18
	NARF-PAM2	7, 8, 9
	PDE8A-PAM2	8, 9
	RALB-PAM2	1
	TYK2-PAM2	2
Category 3	DAP3-PAM3	3, 4, 5
	GPD1L-PAM3	5, 6
	GSPT1-PAM3	6
	MRPL52-PAM3	between 5 and 6
	MSH6-PAM3	in front of 1
	RAF1-PAM3	9, 10, 11
	TTC41P-PAM3	7, 8