

Homology-mediated end-capping as a primary step of sister chromatid fusion in the Breakage-Fusion-Bridge cycles

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A flowchart for defining the repeated (duplicated) sequence contents in GAPP-seq reads

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Genomic locations of breakpoints and repetitive elements

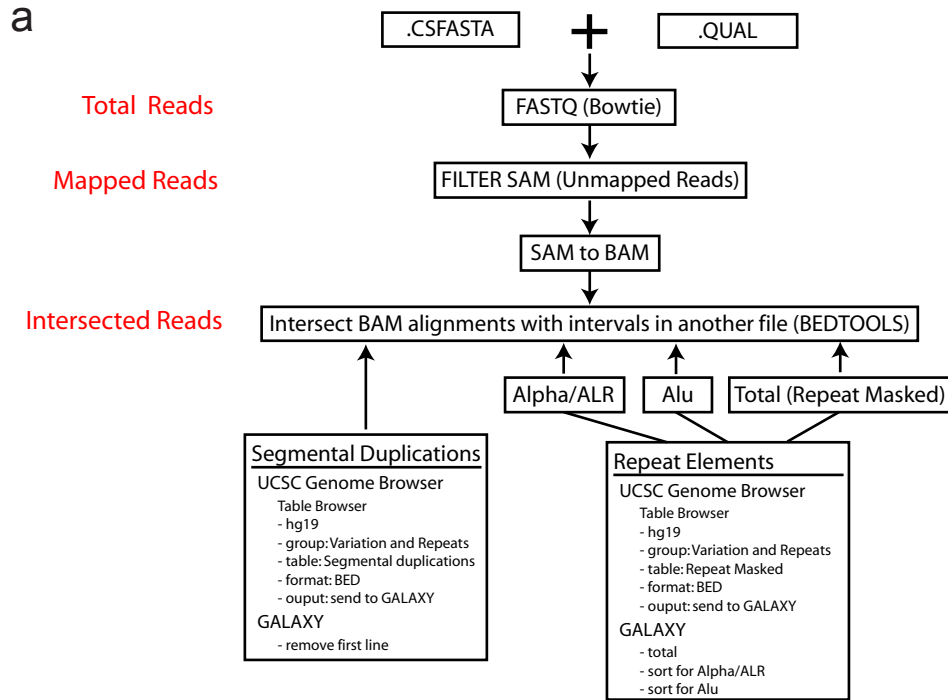
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Read Depth analyses of GAPP-seq reads (the numbers of reads/kb for chr1: 149,701,000 - 150,800,000)

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PCR primers

## Supplementary figure 1- Marotta et al.



**b**

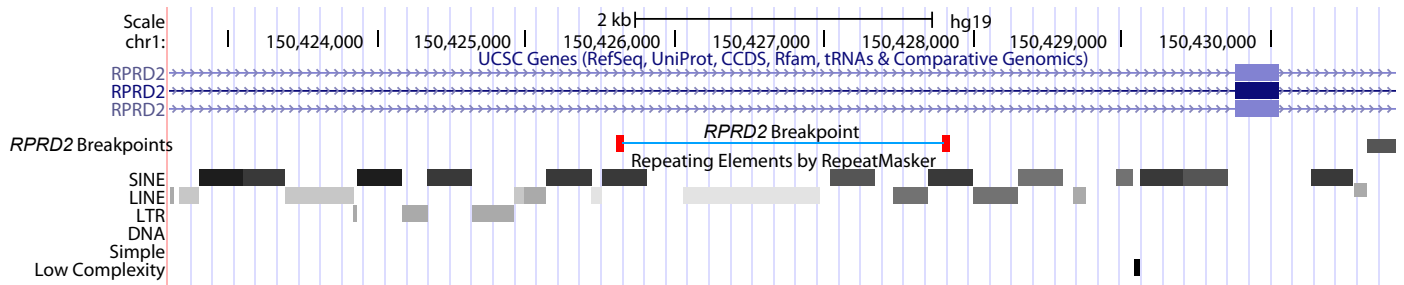
	Size (bp)	% of hg19	Source
hg19	3137161264	100.00	<a href="http://humanparalogy.gs.washington.edu/build37/nr_chr.htm">http://humanparalogy.gs.washington.edu/build37/nr_chr.htm</a>
Segmental Duplications	153622428	4.90	<a href="http://humanparalogy.gs.washington.edu/build37/nr_chr.htm">http://humanparalogy.gs.washington.edu/build37/nr_chr.htm</a>
Repeat Masked Total	1588344748	50.63	<a href="http://genomewiki.ucsc.edu/index.php/Hg19_Genome_size_statistics">http://genomewiki.ucsc.edu/index.php/Hg19_Genome_size_statistics</a>
Alu elements	305076148	9.72	Sum of size for 1142278 Alu sorted from hg19 repeat masker
Alpha satellite in hg19	7446336	0.24	Sum of size for 1301 alpha satellites sorted from hg19 repeat masker

*a.* A flowchart for the analyses of repeated (duplicated) sequence contents in GAPF-seq reads

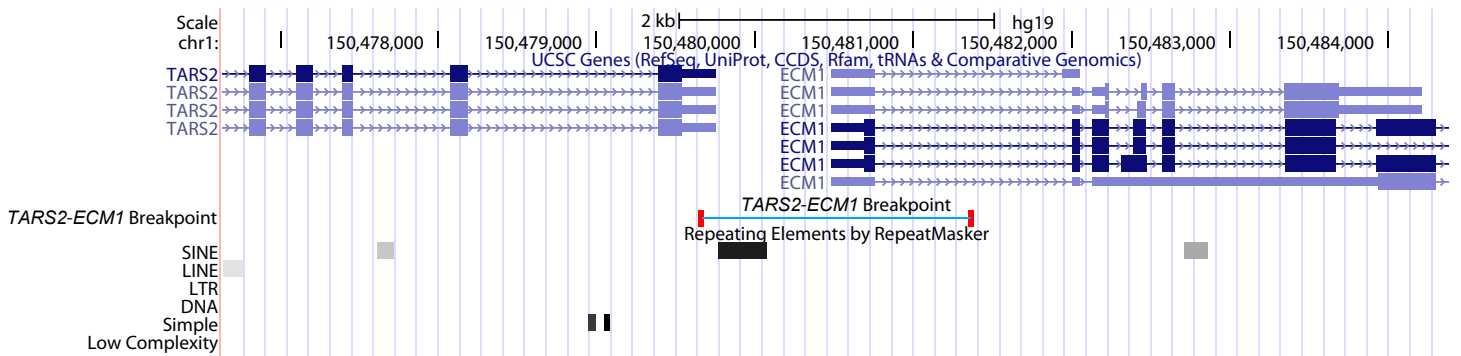
*b.* Repeated (duplicated) sequence contents in hg19

Supplemental figure 2 - Genomic locations of breakpoints and repetitive elements

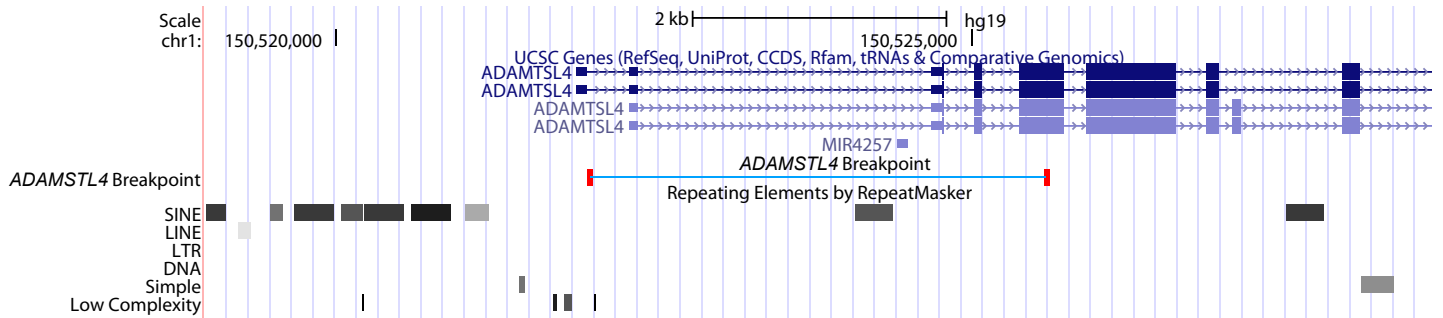
*RPRD2* Breakpoint



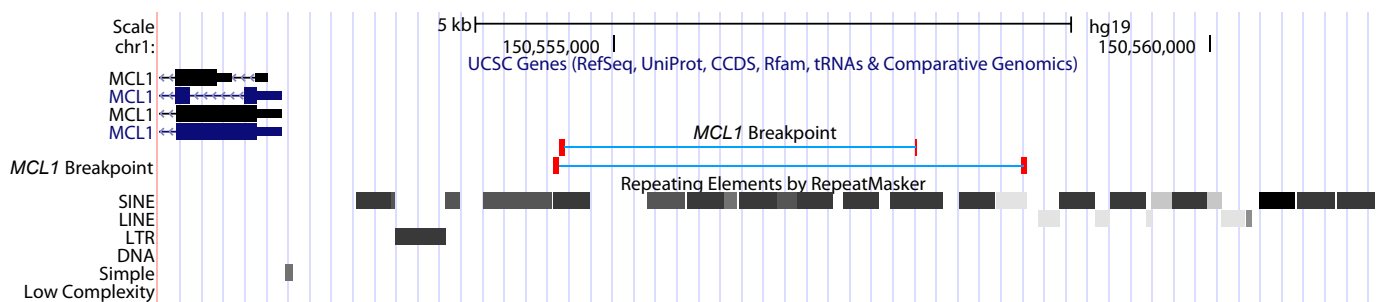
*TARS2-ECM1* Breakpoint



*ADAMSTL4* Breakpoint



*MCL1* Breakpoints



**Supplementary Table 1**

Read depth Analysis of GAPF reads (the # of reads/kb)

chr1: 149,701,000 - 150,800,000

chr1	Colo320DM	IMR90
149701000	14	0
149702000	17	0
149703000	9	3
149704000	2	0
149705000	5	0
149706000	11	0
149707000	3	0
149708000	3	0
149709000	3	0
149710000	13	0
149711000	1	2
149712000	4	1
149713000	6	1
149714000	6	13
149715000	17	0
149716000	1	8
149717000	1	0
149718000	1	5
149719000	1	0
149720000	8	0
149721000	8	2
149722000	1	0
149723000	4	0
149724000	3	1
149725000	2	5
149726000	8	1
149727000	4	25
149728000	3	0
149729000	11	0
149730000	13	0
149731000	1	2
149732000	3	2
149733000	1	2
149734000	5	0
149735000	6	0
149736000	3	0
149737000	2	6
149738000	10	0
149739000	5	0
149740000	4	2
149741000	3	0
149742000	15	0
149743000	0	0
149744000	3	0
149745000	0	5
149746000	12	0
149747000	3	16
149748000	3	5
149749000	10	5
149750000	10	5
149751000	14	0
149752000	25	9
149753000	1	1
149754000	3	3

149755000	0	0
149756000	2	0
149757000	3	0
149758000	2	0
149759000	4	7
149760000	2	1
149761000	3	10
149762000	14	1
149763000	4	2
149764000	14	0
149765000	5	2
149766000	9	0
149767000	1	9
149768000	5	0
149769000	0	0
149770000	2	0
149771000	2	0
149772000	4	0
149773000	2	0
149774000	0	0
149775000	8	0
149776000	2	0
149777000	2	0
149778000	6	0
149779000	2	0
149780000	5	0
149781000	0	0
149782000	4	4
149783000	10	13
149784000	1	0
149785000	6	1
149786000	1	5
149787000	3	0
149788000	0	4
149789000	1	8
149790000	9	1
149791000	6	5
149792000	6	2
149793000	11	8
149794000	26	12
149795000	11	0
149796000	2	5
149797000	1	3
149798000	6	0
149799000	5	0
149800000	14	1
149801000	3	2
149802000	9	0
149803000	1	1
149804000	9	0
149805000	21	8
149806000	13	0
149807000	39	5
149808000	9	5
149809000	12	0
149810000	12	0
149811000	15	4
149812000	16	0
149813000	21	11

149814000	16	30
149815000	37	13
149816000	7	0
149817000	8	0
149818000	8	1
149819000	11	0
149820000	0	0
149821000	0	0
149822000	8	0
149823000	42	8
149824000	47	14
149825000	10	4
149826000	21	7
149827000	3	0
149828000	19	6
149829000	14	0
149830000	10	0
149831000	17	1
149832000	3	0
149833000	8	0
149834000	10	0
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149836000	7	4
149837000	29	0
149838000	5	2
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149841000	11	0
149842000	4	0
149843000	6	0
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149845000	11	6
149846000	3	3
149847000	5	3
149848000	1	3
149849000	10	0
149850000	1	0
149851000	2	0
149852000	4	0
149853000	5	2
149854000	0	0
149855000	1	0
149856000	0	0
149857000	5	0
149858000	2	0
149859000	25	13
149860000	24	15
149861000	0	0
149862000	2	14
149863000	5	0
149864000	21	0
149865000	0	1
149866000	13	1
149867000	6	0
149868000	5	0
149869000	0	0
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149872000	1	0

149873000	1	0
149874000	6	0
149875000	9	0
149876000	7	0
149877000	1	0
149878000	7	0
149879000	8	0
149880000	8	0
149881000	9	0
149882000	4	0
149883000	2	0
149884000	2	0
149885000	7	0
149886000	7	0
149887000	2	0
149888000	2	0
149889000	12	0
149890000	4	0
149891000	4	0
149892000	6	0
149893000	1	0
149894000	4	0
149895000	8	2
149896000	2	11
149897000	4	8
149898000	4	0
149899000	0	0
149900000	2	6
149901000	0	0
149902000	6	10
149903000	0	0
149904000	1	0
149905000	5	0
149906000	0	0
149907000	3	0
149908000	7	0
149909000	7	1
149910000	15	5
149911000	0	5
149912000	1	2
149913000	3	0
149914000	0	0
149915000	4	0
149916000	4	0
149917000	3	0
149918000	0	0
149919000	4	0
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149921000	0	11
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149925000	2	0
149926000	1	0
149927000	0	0
149928000	3	0
149929000	1	0
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149931000	0	0

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149933000	0	9
149934000	7	3
149935000	0	0
149936000	2	0
149937000	5	0
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149939000	0	0
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149943000	3	7
149944000	13	0
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149946000	14	10
149947000	4	0
149948000	3	0
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149959000	4	0
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150005000	1	0
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150014000	5	0
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150036000	2	4
150037000	2	0
150038000	0	1
150039000	7	0
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150042000	0	0
150043000	0	0
150044000	1	0
150045000	2	0
150046000	4	0
150047000	4	0
150048000	2	0
150049000	0	0

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150051000	9	3
150052000	6	8
150053000	4	6
150054000	0	1
150055000	4	0
150056000	3	0
150057000	3	0
150058000	2	0
150059000	0	0
150060000	0	0
150061000	2	0
150062000	0	0
150063000	0	0
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150093000	1	0
150094000	8	0
150095000	6	0
150096000	4	0
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150098000	4	0
150099000	4	0
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150101000	4	0
150102000	6	1
150103000	4	0
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150106000	3	0
150107000	2	0
150108000	14	2

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150111000	8	2
150112000	2	8
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150114000	7	0
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150208000	1	0
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150210000	1	1
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150214000	23	0
150215000	30	4
150216000	1	1
150217000	6	1
150218000	1	2
150219000	14	8
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150222000	10	1
150223000	7	10
150224000	3	8
150225000	12	2
150226000	9	0

150227000	21	4
150228000	13	0
150229000	1	0
150230000	6	13
150231000	1	0
150232000	8	3
150233000	6	8
150234000	5	3
150235000	0	0
150236000	9	0
150237000	13	0
150238000	5	0
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150261000	21	14
150262000	4	0
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150268000	23	11
150269000	5	2
150270000	3	1
150271000	7	0
150272000	7	2
150273000	2	5
150274000	8	1
150275000	6	15
150276000	7	0
150277000	12	2
150278000	12	1
150279000	14	1
150280000	6	1
150281000	8	0
150282000	12	3
150283000	5	0
150284000	18	10
150285000	0	0

150286000	3	3
150287000	6	5
150288000	1	0
150289000	4	0
150290000	18	0
150291000	6	3
150292000	16	5
150293000	24	15
150294000	4	1
150295000	1	0
150296000	5	2
150297000	0	0
150298000	8	0
150299000	4	0
150300000	1	0
150301000	2	0
150302000	7	5
150303000	4	0
150304000	3	0
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150306000	0	0
150307000	0	0
150308000	8	0
150309000	9	1
150310000	11	4
150311000	14	1
150312000	1	0
150313000	0	0
150314000	9	0
150315000	10	1
150316000	14	2
150317000	0	0
150318000	15	0
150319000	3	0
150320000	3	0
150321000	30	2
150322000	5	0
150323000	13	10
150324000	12	7
150325000	0	18
150326000	0	0
150327000	0	0
150328000	15	0
150329000	2	0
150330000	2	0
150331000	9	0
150332000	15	1
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150336000	3	0
150337000	4	0
150338000	0	8
150339000	13	3
150340000	6	0
150341000	6	0
150342000	1	0
150343000	0	0
150344000	4	0

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150347000	2	0
150348000	3	0
150349000	4	0
150350000	5	0
150351000	0	0
150352000	9	1
150353000	3	5
150354000	0	1
150355000	0	0
150356000	1	0
150357000	0	0
150358000	0	0
150359000	0	0
150360000	2	0
150361000	0	0
150362000	5	0
150363000	5	0
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150368000	1	0
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150372000	19	2
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150409000	3	13
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150417000	4	0
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150421000	3	0
150422000	4	0
150423000	3	0
150424000	4	6
150425000	6	1
150426000	6	4
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150428000	60	0
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150430000	44	10
150431000	56	0
150432000	38	0
150433000	26	0
150434000	0	0
150435000	11	0
150436000	9	1
150437000	2	0
150438000	6	0
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150442000	2	0
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150449000	0	0
150450000	4	0
150451000	5	0
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150453000	16	0
150454000	16	3
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150456000	14	0
150457000	15	1
150458000	4	0
150459000	38	11
150460000	4	0
150461000	7	0
150462000	3	0



150463000	55	8
150464000	1	3
150465000	19	0
150466000	12	0
150467000	24	6
150468000	15	0
150469000	10	0
150470000	14	4
150471000	2	4
150472000	12	3
150473000	4	9
150474000	4	0
150475000	4	0
150476000	8	0
150477000	5	0
150478000	12	0
150479000	7	0
150480000	10	0
150481000	3	0
150482000	43	23
150483000	66	3
150484000	23	0
150485000	22	0
150486000	31	0
150487000	23	0
150488000	31	0
150489000	8	2
150490000	12	0
150491000	14	0
150492000	37	2
150493000	16	0
150494000	10	1
150495000	10	5
150496000	19	2
150497000	3	0
150498000	10	14
150499000	3	0
150500000	9	0
150501000	55	0
150502000	17	3
150503000	7	0
150504000	21	6
150505000	12	0
150506000	5	3
150507000	3	8
150508000	17	5
150509000	8	0
150510000	7	0
150511000	22	0
150512000	9	0
150513000	12	0
150514000	10	0
150515000	17	0
150516000	4	0
150517000	3	0
150518000	10	0
150519000	14	0
150520000	8	0
150521000	6	1

150522000	5	0
150523000	10	0
150524000	6	3
150525000	33	0
150526000	27	0
150527000	22	1
150528000	8	7
150529000	9	0
150530000	18	0
150531000	9	0
150532000	14	0
150533000	6	0
150534000	5	0
150535000	10	0
150536000	5	1
150537000	7	5
150538000	0	0
150539000	9	0
150540000	6	0
150541000	1	0
150542000	11	12
150543000	2	0
150544000	11	0
150545000	3	0
150546000	6	0
150547000	17	8
150548000	10	1
150549000	0	0
150550000	9	0
150551000	5	0
150552000	0	6
150553000	8	6
150554000	7	0
150555000	9	0
150556000	9	0
150557000	31	3
150558000	45	5
150559000	27	12
150560000	24	8
150561000	7	0
150562000	5	0
150563000	13	2
150564000	9	0
150565000	19	4
150566000	32	7
150567000	17	2
150568000	23	0
150569000	39	3
150570000	13	0
150571000	14	0
150572000	30	0
150573000	24	1
150574000	9	0
150575000	4	1
150576000	7	8
150577000	4	0
150578000	4	0
150579000	13	2
150580000	7	3

150581000	3	7
150582000	11	0
150583000	9	0
150584000	12	2
150585000	1	0
150586000	32	0
150587000	3	0
150588000	0	0
150589000	5	1
150590000	8	9
150591000	9	0
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150593000	0	0
150594000	1	0
150595000	8	0
150596000	0	0
150597000	2	0
150598000	2	0
150599000	3	0
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150601000	7	0
150602000	6	0
150603000	9	3
150604000	6	0
150605000	13	11
150606000	1	3
150607000	1	0
150608000	0	0
150609000	8	0
150610000	5	4
150611000	1	6
150612000	19	6
150613000	5	7
150614000	15	0
150615000	4	0
150616000	17	2
150617000	18	4
150618000	9	0
150619000	5	0
150620000	3	0
150621000	1	0
150622000	6	0
150623000	0	0
150624000	6	0
150625000	3	0
150626000	5	0
150627000	38	0
150628000	0	0
150629000	2	0
150630000	3	0
150631000	1	12
150632000	1	0
150633000	2	0
150634000	0	9
150635000	4	7
150636000	2	0
150637000	4	0
150638000	4	5
150639000	15	4

150640000	9	0
150641000	4	0
150642000	6	8
150643000	8	2
150644000	11	0
150645000	9	0
150646000	16	0
150647000	9	0
150648000	8	0
150649000	4	0
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150652000	0	0
150653000	0	0
150654000	0	0
150655000	2	2
150656000	5	0
150657000	2	0
150658000	10	0
150659000	5	1
150660000	3	0
150661000	4	0
150662000	11	0
150663000	2	0
150664000	7	0
150665000	4	3
150666000	2	0
150667000	11	0
150668000	1	0
150669000	2	0
150670000	0	5
150671000	3	0
150672000	1	0
150673000	9	0
150674000	1	0
150675000	3	0
150676000	0	0
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150678000	14	0
150679000	2	0
150680000	1	0
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150682000	1	0
150683000	0	0
150684000	6	0
150685000	4	0
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150687000	4	0
150688000	6	0
150689000	4	0
150690000	7	0
150691000	17	0
150692000	10	4
150693000	5	2
150694000	12	0
150695000	11	5
150696000	6	0
150697000	15	0
150698000	17	0

150699000	4	1
150700000	9	0
150701000	2	0
150702000	8	0
150703000	16	2
150704000	9	4
150705000	5	4
150706000	11	0
150707000	10	1
150708000	11	0
150709000	5	0
150710000	9	0
150711000	5	0
150712000	16	3
150713000	6	0
150714000	8	0
150715000	4	0
150716000	2	0
150717000	0	0
150718000	7	0
150719000	10	0
150720000	5	0
150721000	4	6
150722000	13	0
150723000	11	2
150724000	8	0
150725000	3	0
150726000	6	0
150727000	22	15
150728000	38	4
150729000	5	0
150730000	10	0
150731000	8	0
150732000	6	8
150733000	8	10
150734000	8	1
150735000	5	0
150736000	13	7
150737000	2	0
150738000	4	0
150739000	2	0
150740000	7	2
150741000	5	0
150742000	7	4
150743000	7	4
150744000	14	0
150745000	8	0
150746000	6	0
150747000	12	0
150748000	22	0
150749000	8	0
150750000	9	0
150751000	16	4
150752000	10	0
150753000	16	1
150754000	8	0
150755000	1	0
150756000	27	0
150757000	28	2

150758000	18	0
150759000	29	15
150760000	24	0
150761000	70	0
150762000	37	21
150763000	35	2
150764000	35	0
150765000	31	0
150766000	24	3
150767000	47	0
150768000	49	5
150769000	48	5
150770000	94	0
150771000	106	1
150772000	244	0
150773000	182	0
150774000	187	11
150775000	10	0
150776000	3	0
150777000	2	0
150778000	6	4
150779000	7	0
150780000	4	1
150781000	0	7
150782000	1	4
150783000	4	0
150784000	3	0
150785000	2	3
150786000	0	19
150787000	3	3
150788000	4	0
150789000	0	6
150790000	2	1
150791000	0	0
150792000	0	2
150793000	0	3
150794000	0	0
150795000	0	0
150796000	2	0
150797000	3	0
150798000	2	0
150799000	0	0

**Supplemental table 2: Primers**

Name	Sequence	Location(hg19)	Application
150429870	ATGCTTGGGAAGGAAGTGGTG	150429849 150429870	RPRD2 Breakpoint
150425835	AGAGATGGAAGTGCTGGGAGACTG	150425835 150425858	RPRD2 Breakpoint
150428618	CTGGGAGGTCAGATGCTATTGTTT	150428618 150428641	RPRD2 Breakpoint Confirmation
150425953	CAGTGGCTTAGAGAGAATGGACCC	150425953 150425976	RPRD2 Breakpoint Confirmation
150558521	AAACTTTGCCCCACCACTC	150558502 150558521	MCL1 Breakpoint
150554876	CGCCGTATCACCTTACTAACTGTG	150554852 150554876	MCL1 Breakpoint
150558550	AAGCCCTTCACAATCTGTC	150558532 150558550	MCL1 Breakpoint Confirmation (External)
150554906	CCTGCCAAAACATAAATGG	150554887 150554906	MCL1 Breakpoint Confirmation (External)
150558521	AAACTTTGCCCCACCACTC	150558502 150558521	MCL1 Breakpoint Confirmation (Nested)
150554875	GCCGTATCACCTTACTAACTG	150554854 150554875	MCL1 Breakpoint Confirmation (Nested)
150483170	CTGAAAGGAAAAGAGAAGCGAGG	150483170 150483192	TARS2_ECM1 Breakpoint
150480220	GGGAGCAGGAAACCTATCCAAG	150480220 150480241	TARS2_ECM1 Breakpoint
150482233	TGGGATGGTGACCTTACCTTGAC	150482233 150482255	TARS2_ECM1 Breakpoint Confirmation
150480263	AACTGGGGTTGGGGAAACAG	150480263 150480282	TARS2_ECM1 Breakpoint Confirmation
150526529	GAATAGGGCTACTGGGAGCAAAG	150526529 150526551	ADAMTSL4 Breakpoint
150523062	GGGAAGAAGAAATGGGGTGATAGTC	150523062 150523086	ADAMTSL4 Breakpoint
150526063	TTGCGGAGAATGGCTCTGCTCTTG	150526063 150526086	ADAMTSL4 Breakpoint Confirmation (External)
150522489	ATGGAGAATCCCTGTCTGAGTCC	150522489 150522512	ADAMTSL4 Breakpoint Confirmation (External)
150526045	TCTTGGAGTAGGGACGGAATAG	150526045 150526067	ADAMTSL4 Breakpoint Confirmation (Nested)
150522397	TGTCAACCTCTTCTGCCATCGG	150522397 150522418	ADAMTSL4 Breakpoint Confirmation (Nested)