Multiple RNA-RNA tertiary interactions are dispensable for formation of a functional U2/U6 RNA catalytic core in the spliceosome

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Supplementary Materials

Comprising five supplementary figures and five supplementary tables.

Supplementary Figures

Figure S1

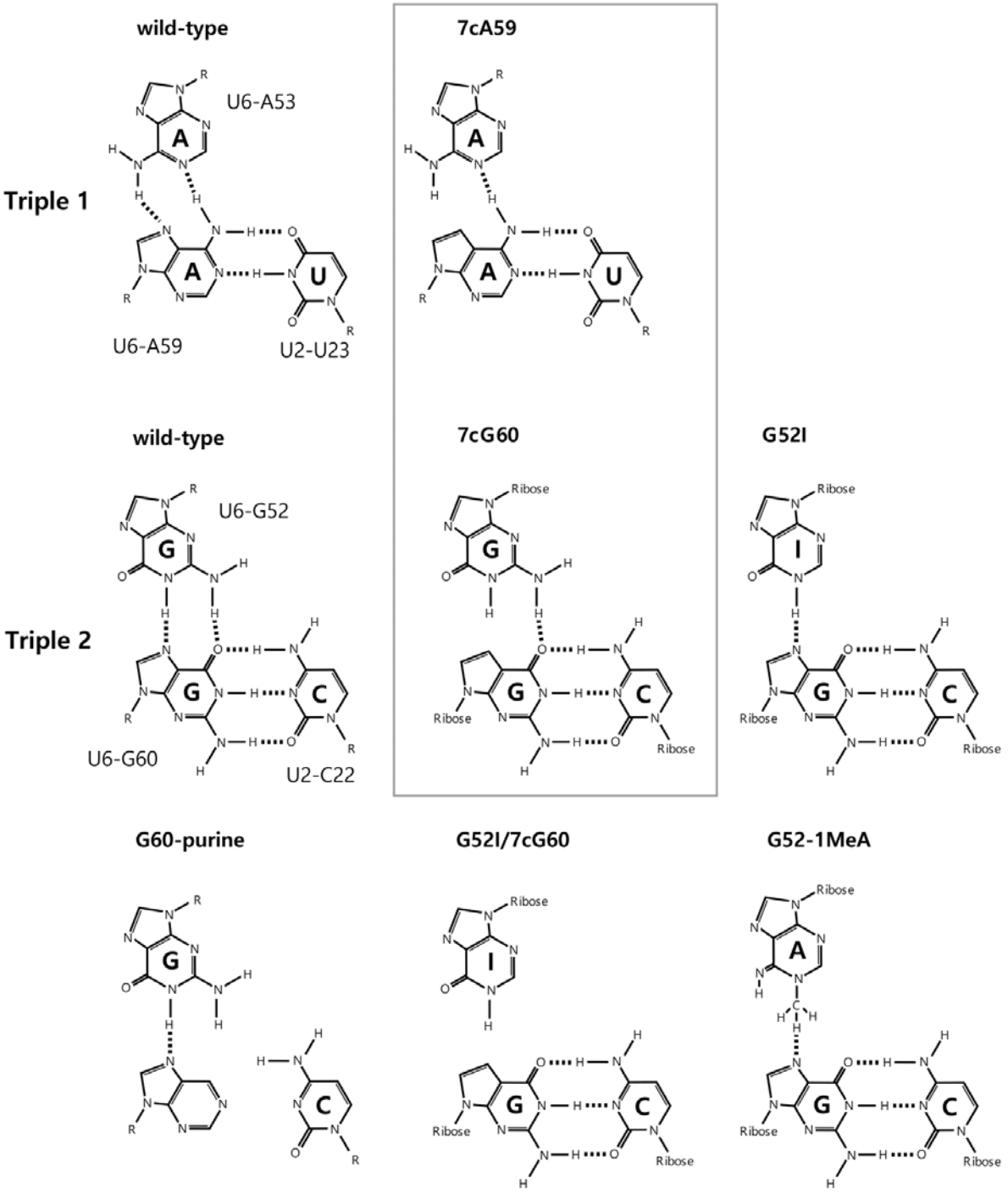

Figure S1. Chemical structure diagrams of the atomic mutations in U6 snRNA nucleotides involved in the catalytic triplex.

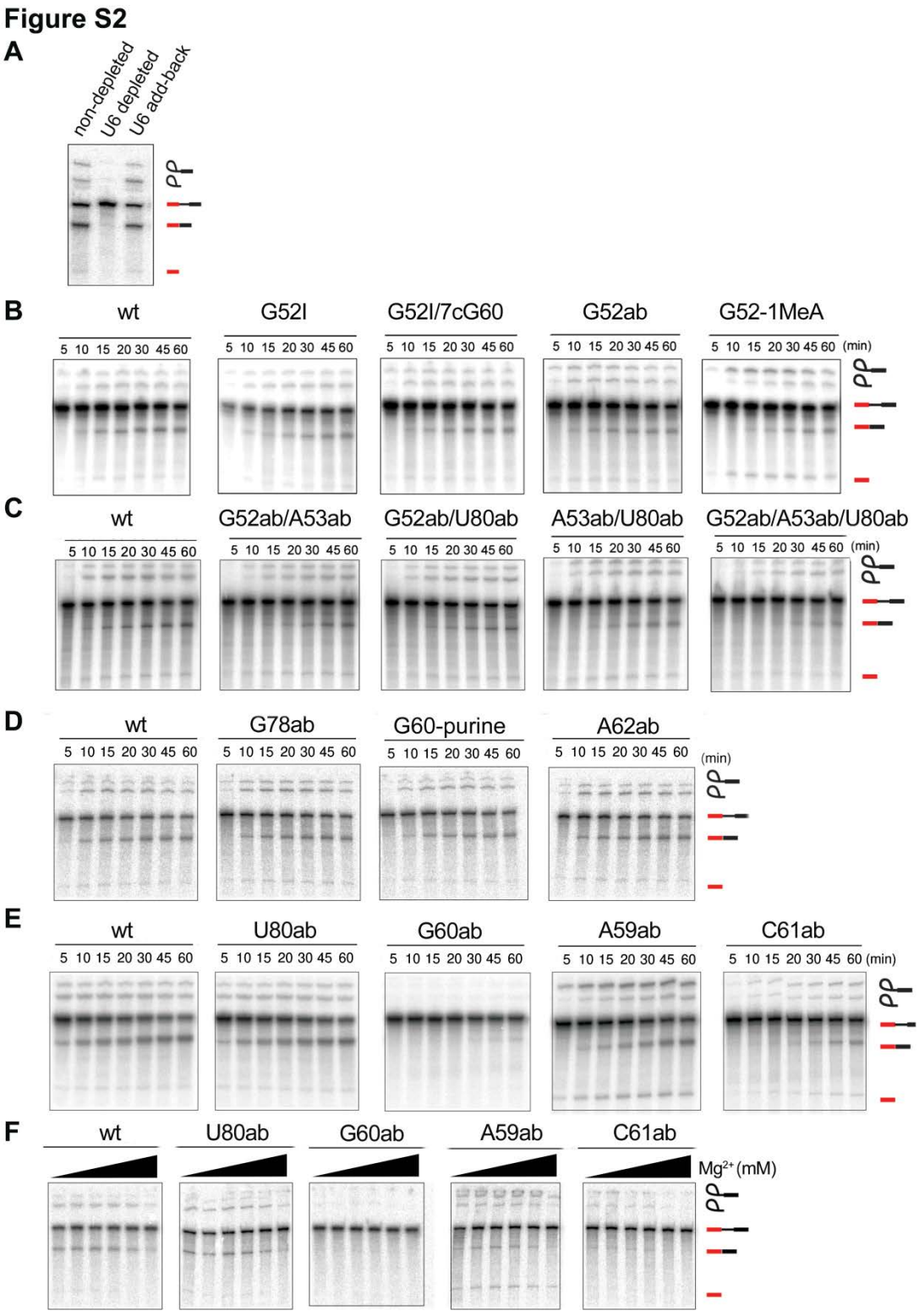

Figure S2. Representative examples of the kinetics of in vitro splicing with various mutated U6 RNAs. (**A**) Splicing of ^{32}P-labeled actin pre-mRNA in wt yeast extract (non-depleted), extract depleted of U6 snRNA by RNAse H digestion (U6 depleted) or U6-depleted extract complemented with wt U6 snRNA (U6 add-back). (**B**) - (**F**) Splicing complementation with

the indicated U6 snRNA mutants. For each series of mutants analysed, a wt U6 snRNA control was run in parallel. In (**F**) splicing was analysed after 20 min at increasing magnesium concentrations of 1, 1.5, 2.5, 5, and 10 mM. The positions of the pre-mRNA, and of the splicing intermediates and products are indicated on the right.

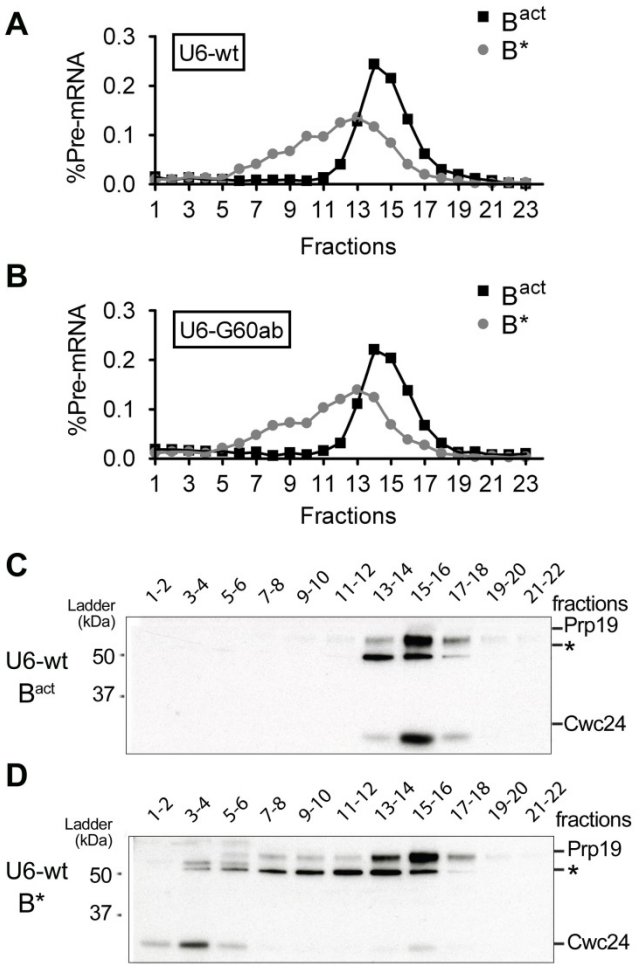

Figure S3. Gradient sedimentation profiles of B^{act} and B* spliceosomes containing wt U6 snRNA (**A**) or the U6-G60ab mutant RNA (**B**). Spliceosomes were affinity purified via the MS2 tag before the gradient analysis. The relative distribution of radioactivity from the pre-mRNA is plotted against the gradient fraction number, with top to bottom from left to right. B* formation was analysed by incubating the affinity purified B^{act} complexes with Prp2, Spp2 and ATP and then subjecting them to gradient centrifugation. (**C, D**) B^{act} complexes containing the wt U6 were assembled in prp2-1 yeast extract and purified B^{act} complexes were analysed on a gradient directly (**C**) or (**D**) after incubation with Prp2 and Spp2 to form B*. Gradient fractions (indicated above) of B^{act} (**C**) and B* (**D**) complex preparations were probed simultaneously with anti-Prp19 and anti-Cwc24 antibodies.

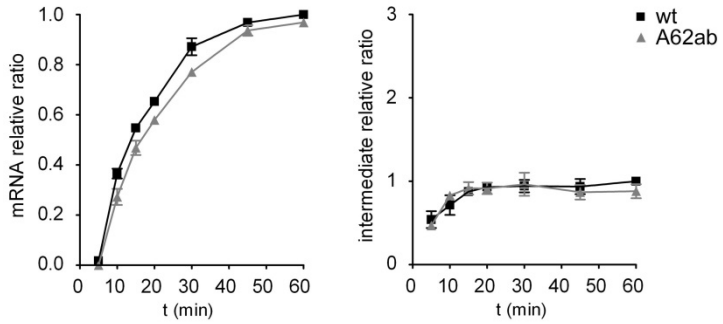

Figure S4. Efficiencies of the production of mRNA and splicing intermediate with the U6-A46ab and U6-A62-insert mutations at 5-60 min. Quantification was as described in the legend to Figure 2.

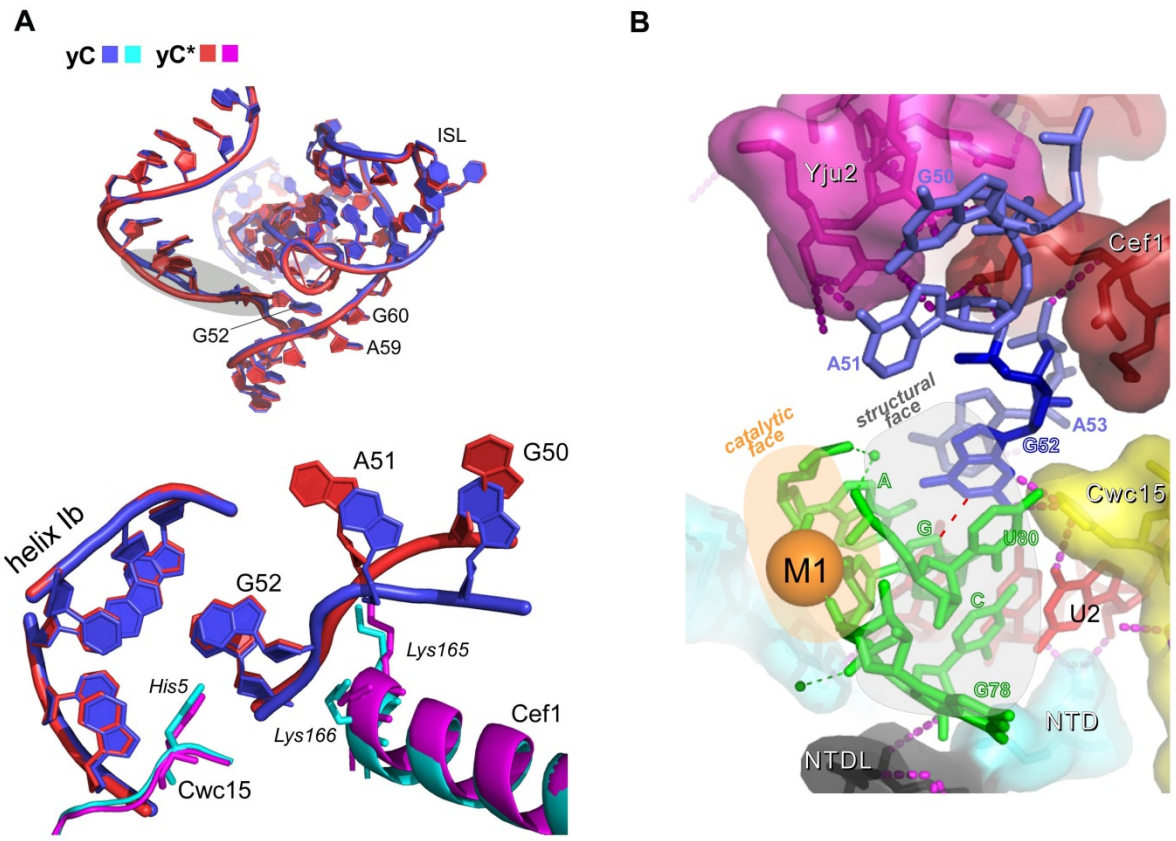

Figure S5. (**A**) Comparison of the conformation of the U2/U6 RNA core in the S. cerevisiae C (blue, 5GMK) and C* complex (red, 5WSG). Close-up of the yeast U6 backbone movement from the C (blue; 5GMK) to the C* complex (red; 5WSG) and contacts by Cwc15 and Cef1. U6 nucleotides G50 to G52 are shown, as well as U2/U6 helix Ib.. The Cef1 helix (aa 164-177) containing lysine 165 and lysine 166 that contacts the RNA backbone around U6-G52 is shown, as well as histidine 5 of Cwc15 that contacts the N2 and N3 positions of U6-G52 on its sugar edge. (**B**) Proteins and Prp8 protein domains (NTD and NTDL) shown as space filling models that cradle U6 nucleotides G50 to G52 and U2/U6 helix Ib in the yeast C complex. Red dashes: the N7-G60/N1-G52 Hoogsteen interaction of triple T2.

Supplementary Tables

Table S1. DNA oligonucleotides used in this study.

Name	Sequence 5'-3'
U6-d1	ATCTCTGTATTGTTTCAAATTGACCAA
U6-α-d1	TTGGTCAATTTGAAACAATACAGAGAT
U6(19-108) DNA splint	CGAAATAAATCTCTTTTGTAAAACGGTTCATCCTTATGCAGGGGAACTGCTG ATCATCTCTGTATTGTTTCAAATTGACCAAATGTCCACG

Table S2. U6 RNA oligonucleotides used in this study.

	Middle U6 oligonucelotides with mutations	
Name	Sequence 5'-3'	Purity (%)
wt	GAGAUGAUCAGCAGUUCCCCUGCAUAAGGAU	96.9
G52I	GAIAUGAUCAGCAGUUCCCCUGCAUAAGGAU	90.8
G52I/7cG60	GAIAUGAUCA(7cG)CAGUUCCCCUGCAUAAGGAU	90.4
G52ab	GA(rib)AUGAUCAGCAGUUCCCCUGCAUAAGGAU	93.0
G52-1MeA	GA(1MeA)AUGAUCAGCAGUUCCCCUGCAUAAGGAU	85.5
7cA59	GAGAUGAUC(7cA)GCAGUUCCCCUGCAUAAGGAU	90.5
7cA59/7cG60	GAGAUGAUC(7cA)(7cG)CAGUUCCCCUGCAUAAGGAU	95.9
A59ab	GAGAUGAUC(rib)GCAGUUCCCCUGCAUAAGGAU	96.7
7cG60	GAGAUGAUCA(7cG)CAGUUCCCCUGCAUAAGGAU	96.2
G60-purine	GAGAUGAUCA(purine)CAGUUCCCCUGCAUAAGGAU	86.6
G60ab	GAGAUGAUCA(rib)CAGUUCCCCUGCAUAAGGAU	92.6
C61ab	GAGAUGAUCAG(rib)AGUUCCCCUGCAUAAGGAU	95.8
A62ab	GAGAUGAUCAGC(rib)GUUCCCCUGCAUAAGGAU	87.2
G78ab	GAGAUGAUCAGCAGUUCCCCUGCAUAAG(rib)AU	91.6
U80ab	GAGAUGAUCAGCAGUUCCCCUGCAUAAGGA(rib)GAA	95.2
G52ab/A53ab	GA(rib)(rib)UGAUCAGCAGUUCCCCUGCAUAAGGAUGAA	89.5
G52ab/U80ab	GA(rib)AUGAUCAGCAGUUCCCCUGCAUAAGGA(rib)GAA	90.4
A53ab/U80ab	GAG(rib)UGAUCAGCAGUUCCCCUGCAUAAGGA(rib)GAA	91.1
G52ab/A53ab/U80ab	GA(rib)(rib)UGAUCAGCAGUUCCCCUGCAUAAGGA(rib)GAA	91.6
Flanking U6 oligonucleotides		
Name	Sequence 5'-3'	
1-49	GUUCGCGAAGUAACCCUUCGUGGACAUUUGGUCAAUUUGAAACAAUACA	96.0
81-112	pGAACCGUUUUACAAAGAGAUUUAUUUCGUUUU	96.2
84-112	pCCGUUUUACAAAGAGAUUUAUUUCGUUUU	92.7

Table S3. Protein contacts with U2 and U6 snRNA in the yeast Bact, C, and C* complexes.

Distances between amino acid side chains and U6 or U2 nucleotides were determined using the contact program from the CCP4 suite and the indicated PDB structures. In the angle column, "***" indicates the strong possibly of a hydrogen bond at this contact (distance < 3.3 A), " *" indicates a weak possibility (distance > 3.3 A), and blank indicates that the program considers there is no possibility of a hydrogen bond. The table summarizes only protein contacts for U2 nucleotides 19-32 and U6 nucleotides 41-87.

```
protein - U2 (nt 19-32) and U6 (41-87) snRNA core contacts in
yB-act ; pdb: 5gm6

chains analysed:

   protein chain

    Bud31   T
    Cef1    c
    Clf1    d
    Cus1    H
    Cwc15   S
    Cwc2    R
    Prp11   I
    Prp45   P
    Prp46   O
    Prp8    A
    Slt11   Q
    Syf2    f

   RNA     chain

    U2      L
    U6      E
```

source atoms				target atoms				distance	angle
Gln	784A	CD	...	U	19L	C5	...	3.54	
Gln	784A	CD	...	U	19L	C6	...	3.47	
Gln	784A	NE2	...	U	19L	C6	...	3.29	
Gln	784A	OE1	...	U	19L	C5	...	3.13	
Gln	784A	OE1	...	U	19L	C6	...	3.27	
Gln	784A	OE1	...	U	19L	OP1	...	3.49	*
Ala	168P	C	...	U	19L	O4	...	3.37	
Ala	168P	O	...	U	19L	C4	...	3.12	

Ala	168P	O	...	U	19L	C5	...	3.06	
Ala	168P	O	...	U	19L	O4	...	2.74	***
Val	169P	CA	...	U	19L	O4	...	3.15	
Val	169P	C	...	U	19L	O4	...	3.50	
Val	169P	N	...	U	19L	O4	...	3.58	*
Ser	170P	N	...	U	19L	O4	...	2.99	***
Asn	174P	C	...	U	19L	O2	...	3.52	
Pro	175P	CD	...	U	19L	C2	...	3.24	
Pro	175P	CD	...	U	19L	O2	...	2.55	
Pro	175P	CG	...	U	19L	C2	...	3.55	
Pro	175P	CG	...	U	19L	O2'	...	2.76	
Pro	175P	CG	...	U	19L	O2	...	2.93	
Pro	175P	N	...	U	19L	O2	...	3.00	***
Pro	175P	O	...	U	19L	O2	...	2.88	***
Thr	3S	CG2	...	G	20L	O2'	...	3.18	
Thr	3S	OG1	...	G	20L	N3	...	3.59	*
Asp	755A	CG	...	G	21L	O2'	...	3.32	
Asp	755A	OD1	...	G	21L	O2'	...	3.59	*
Asp	755A	OD2	...	G	21L	C2'	...	3.33	
Asp	755A	OD2	...	G	21L	O2'	...	2.36	***
Arg	759A	CD	...	G	21L	O2'	...	3.55	
Asp	755A	CG	...	C	22L	C4'	...	3.41	
Asp	755A	CG	...	C	22L	C5'	...	3.42	
Asp	755A	OD2	...	C	22L	C4'	...	3.11	
Asp	755A	OD2	...	C	22L	C5'	...	3.15	
Asp	755A	OD2	...	C	22L	O4'	...	2.93	***
Ser	787A	CB	...	C	22L	OP1	...	3.30	
Ser	787A	OG	...	C	22L	OP1	...	2.66	***
Lys	819A	NZ	...	U	23L	OP1	...	3.03	***
Trp	823A	NE1	...	U	24L	OP2	...	3.36	*
Lys	847A	CA	...	U	24L	O4'	...	3.44	
Lys	847A	CD	...	U	24L	OP1	...	3.50	
Lys	847A	CG	...	U	24L	OP1	...	3.03	
Lys	847A	O	...	U	24L	O4'	...	3.44	*
Arg	851A	CZ	...	U	24L	OP1	...	3.21	
Arg	851A	NE	...	U	24L	OP1	...	2.66	***
Arg	851A	NH2	...	U	24L	OP1	...	2.98	***
His	31c	O	...	A	25L	C2	...	3.34	
Lys	794A	NZ	...	A	25L	OP2	...	3.27	***
Arg	854A	CD	...	A	25L	OP1	...	3.10	
Arg	854A	CZ	...	A	25L	OP1	...	3.02	
Arg	854A	NE	...	A	25L	OP1	...	2.22	***
Arg	854A	NH1	...	A	25L	OP1	...	3.18	***
Lys	1093A	C	...	A	25L	N1	...	3.48	
Lys	1093A	O	...	A	25L	N1	...	3.58	*
Asp	1094A	CG	...	A	25L	N3	...	3.58	
Asp	1094A	N	...	A	25L	C2	...	3.59	
Asp	1094A	OD1	...	A	25L	C2	...	2.92	
Asp	1094A	OD1	...	A	25L	C4	...	3.33	
Asp	1094A	OD1	...	A	25L	N3	...	2.39	***
Lys	1093A	NZ	...	A	27L	OP1	...	2.19	***
Asn	930A	CG	...	C	29L	OP1	...	3.45	
Asn	930A	OD1	...	C	29L	OP1	...	3.41	*
Ser	34c	O	...	A	30L	N6	...	2.93	***
Asn	930A	C	...	A	30L	OP1	...	3.45	
Asn	930A	OD1	...	A	30L	OP2	...	3.52	*

Ala	931A	N	...	A	30L	OP1	...	3.34	*
Arg	934A	NH1	...	A	30L	OP1	...	3.44	*
Gln	41c	NE2	...	A	31L	O2'	...	3.59	*
Phe	1587A	CE2	...	A	31L	OP2	...	3.00	
Phe	1587A	CZ	...	A	31L	OP2	...	3.08	
Lys	1588A	CE	...	A	31L	OP1	...	2.98	
Lys	1588A	NZ	...	A	31L	OP1	...	3.51	*
Tyr	34R	CD2	...	A	41E	C8	...	3.01	
Tyr	34R	CD2	...	A	41E	N7	...	3.42	
Tyr	34R	CD2	...	A	41E	N9	...	3.23	
Tyr	34R	CE2	...	A	41E	C1'	...	3.47	
Tyr	34R	CE2	...	A	41E	C8	...	3.01	
Tyr	34R	CE2	...	A	41E	N9	...	3.32	
Tyr	34R	CZ	...	A	41E	C1'	...	3.56	
Lys	36R	NZ	...	A	41E	OP2	...	3.48	*
Ser	38R	C	...	A	42E	N1	...	2.86	
Ser	38R	CA	...	A	42E	N1	...	3.38	
Ser	38R	O	...	A	42E	C2	...	3.27	
Ser	38R	O	...	A	42E	C6	...	2.80	
Ser	38R	O	...	A	42E	N1	...	2.17	***
Ser	38R	O	...	A	42E	N6	...	2.67	***
Gln	39R	CA	...	C	43E	O2	...	3.53	
Gln	39R	CB	...	C	43E	O2	...	3.57	
Glu	609A	CD	...	C	43E	O2'	...	3.02	
Glu	609A	CD	...	C	43E	O3'	...	3.52	
Glu	609A	OE1	...	C	43E	O2'	...	3.42	*
Glu	609A	OE2	...	C	43E	C2'	...	3.00	
Glu	609A	OE2	...	C	43E	C3'	...	3.08	
Glu	609A	OE2	...	C	43E	C4'	...	3.45	
Glu	609A	OE2	...	C	43E	O2'	...	2.09	***
Glu	609A	OE2	...	C	43E	O3'	...	2.40	***
Gly	40R	C	...	A	44E	C2	...	3.33	
Gly	40R	O	...	A	44E	C2	...	3.21	
Thr	606A	OG1	...	A	44E	OP1	...	2.69	***
Glu	609A	OE2	...	A	44E	C5'	...	3.11	
Glu	609A	OE2	...	A	44E	OP1	...	3.54	*
Glu	609A	OE2	...	A	44E	P	...	3.42	
Lys	236H	CD	...	A	49E	OP1	...	3.41	
Lys	236H	CE	...	A	49E	OP1	...	3.02	
Lys	236H	NZ	...	A	49E	OP1	...	2.65	***
Glu	227H	OE2	...	G	50E	OP1	...	3.44	*
Arg	230H	NH1	...	G	50E	C3'	...	3.46	
Lys	11I	CB	...	A	51E	C2	...	3.52	
Arg	169c	CZ	...	A	51E	OP1	...	3.09	
Arg	169c	CZ	...	A	51E	OP2	...	3.30	
Arg	169c	NE	...	A	51E	OP2	...	3.09	***
Arg	169c	NH2	...	A	51E	OP1	...	2.27	***
Arg	169c	NH2	...	A	51E	OP2	...	3.24	***
Arg	169c	NH2	...	A	51E	P	...	3.14	
Arg	230H	NH1	...	A	51E	OP2	...	3.39	*
Lys	10I	CE	...	G	52E	N7	...	3.53	
Lys	10I	NZ	...	G	52E	N7	...	3.16	***
Lys	226H	NZ	...	A	53E	OP2	...	3.11	***
Lys	35c	CE	...	U	54E	O3'	...	3.11	
Lys	35c	NZ	...	U	54E	O3'	...	3.42	*

Lys	226H	CE	...	U	54E	O4	...	3.47	
Lys	226H	NZ	...	U	54E	O4	...	3.20	***
Gln	25I	NE2	...	G	55E	O2'	...	2.67	***
Gln	25I	NE2	...	G	55E	O3'	...	2.91	***
Lys	35c	CE	...	G	55E	OP1	...	3.46	
Ile	16I	CD1	...	A	56E	O2'	...	3.55	
Lys	226H	CD	...	U	57E	OP1	...	3.60	
Thr	1591A	CG2	...	U	57E	O2'	...	3.18	
His	1592A	CA	...	U	57E	O2'	...	3.45	
His	1592A	CB	...	U	57E	O2'	...	3.15	
His	1592A	CB	...	U	57E	O2	...	3.59	
His	1592A	N	...	U	57E	O2'	...	2.70	***
Gly	8I	C	...	C	58E	O3'	...	3.47	
Gly	8I	N	...	C	58E	O2'	...	3.48	*
Gly	8I	O	...	C	58E	C4'	...	3.27	
Ser	9I	OG	...	C	58E	OP1	...	3.01	***
Lys	10I	N	...	C	58E	OP1	...	3.25	***
Gly	6I	O	...	A	59E	C4'	...	3.37	
Gly	6I	O	...	A	59E	O4'	...	3.48	*
Lys	10I	NZ	...	A	59E	OP2	...	2.69	***
Gln	748A	O	...	C	61E	O2'	...	3.45	*
Arg	749A	CA	...	C	61E	O2'	...	3.48	
Arg	749A	CB	...	C	61E	O2'	...	3.53	
Gln	748A	NE2	...	A	62E	OP1	...	3.22	***
Arg	749A	CB	...	A	62E	O5'	...	3.37	
Arg	749A	CZ	...	A	62E	OP1	...	3.48	
Arg	749A	NE	...	A	62E	OP1	...	2.75	***
Arg	749A	NH1	...	A	62E	OP1	...	3.47	*
Ser	4S	CA	...	G	63E	O2'	...	3.17	
Ser	4S	CB	...	G	63E	O2'	...	3.07	
Tyr	753A	OH	...	G	63E	OP1	...	3.39	*
Leu	756A	CD1	...	G	63E	C4'	...	3.59	
Arg	6S	O	...	U	64E	C5'	...	3.42	
Pro	7S	CA	...	U	64E	OP1	...	3.38	
Pro	7S	C	...	U	64E	OP1	...	3.19	
Pro	7S	O	...	U	64E	C5'	...	3.27	
Gln	8S	N	...	U	64E	OP1	...	3.20	***
Arg	60d	O	...	U	64E	O2'	...	3.32	*
Gln	8S	OE1	...	U	65E	OP2	...	2.80	***
Arg	12S	CZ	...	U	65E	OP1	...	3.37	
Arg	12S	NH1	...	U	65E	OP1	...	2.54	***
Lys	59d	CE	...	U	65E	O2'	...	2.91	
Lys	59d	CG	...	U	65E	O2'	...	3.45	
Arg	12S	CZ	...	C	66E	OP1	...	3.58	
Arg	12S	NH1	...	C	66E	OP1	...	2.55	***
Met	108Q	CE	...	C	66E	O2'	...	2.90	
Val	135P	CG1	...	C	66E	C6	...	3.43	
Val	135P	CG1	...	C	66E	O4'	...	3.50	
Lys	59d	CE	...	C	67E	OP1	...	2.79	
Lys	59d	NZ	...	C	67E	OP1	...	3.10	***
Tyr	207c	CE2	...	C	67E	OP2	...	3.54	
Tyr	207c	CZ	...	C	67E	OP2	...	3.32	
Tyr	207c	OH	...	C	67E	OP2	...	3.36	*
Lys	133P	CD	...	C	68E	OP2	...	3.22	
Lys	133P	CE	...	C	68E	OP2	...	3.51	
Arg	737A	CG	...	C	69E	OP2	...	3.58	

Arg	614A	CB	...	U	70E	O2'	...	3.28	
Arg	614A	O	...	U	70E	O2'	...	3.49	*
Arg	737A	CZ	...	U	70E	OP2	...	3.50	
Arg	737A	NH1	...	U	70E	OP2	...	2.69	***
Arg	737A	NH2	...	U	70E	C5	...	3.28	
Arg	737A	NH2	...	U	70E	OP2	...	3.48	*
Lys	586A	NZ	...	G	71E	OP1	...	3.53	*
Lys	586A	NZ	...	G	71E	OP2	...	3.16	***
Gly	616A	CA	...	G	71E	O3'	...	3.49	
Arg	732A	CZ	...	G	71E	N7	...	3.54	
Arg	732A	NH1	...	G	71E	C8	...	3.31	
Arg	732A	NH1	...	G	71E	N7	...	2.98	***
Arg	732A	NH2	...	G	71E	O5'	...	3.31	*
Arg	732A	NH2	...	G	71E	OP2	...	2.75	***
Arg	732A	NH2	...	G	71E	P	...	3.53	
Arg	737A	CZ	...	G	71E	O6	...	3.48	
Arg	737A	NE	...	G	71E	O6	...	2.73	***
Arg	737A	NH2	...	G	71E	C5	...	3.47	
Arg	737A	NH2	...	G	71E	N7	...	2.62	***
Arg	737A	NH2	...	G	71E	O6	...	3.29	***
Gly	616A	CA	...	C	72E	OP1	...	3.46	
Gly	616A	C	...	C	72E	OP1	...	3.47	
Asn	617A	N	...	C	72E	OP1	...	3.01	***
Ser	618A	CB	...	C	72E	OP1	...	3.24	
Ser	618A	N	...	C	72E	OP1	...	2.80	***
Ser	618A	OG	...	C	72E	C5'	...	3.13	
Ser	618A	OG	...	C	72E	O4'	...	3.59	*
Ser	618A	OG	...	C	72E	O5'	...	3.48	*
Ser	618A	OG	...	C	72E	OP1	...	2.72	***
Ser	618A	OG	...	C	72E	P	...	3.57	
Tyr	725A	CA	...	C	72E	O4'	...	3.43	
Tyr	725A	CB	...	C	72E	O4'	...	3.44	
Tyr	725A	CD1	...	C	72E	C1'	...	2.98	
Tyr	725A	CD1	...	C	72E	N1	...	3.49	
Tyr	725A	CD1	...	C	72E	O4'	...	3.02	
Tyr	725A	CE1	...	C	72E	C1'	...	3.29	
Tyr	725A	CE1	...	C	72E	C2	...	3.38	
Tyr	725A	CE1	...	C	72E	N1	...	3.33	
Tyr	725A	CE1	...	C	72E	O2	...	3.45	
Tyr	725A	CG	...	C	72E	O4'	...	3.31	
Tyr	725A	O	...	C	72E	C4'	...	3.57	
Asn	728A	CB	...	C	72E	O3'	...	3.32	
Asn	728A	CG	...	C	72E	O2'	...	3.56	
Asn	728A	ND2	...	C	72E	O2'	...	2.54	***
Arg	732A	NH1	...	A	73E	OP1	...	2.93	***
Arg	732A	NH1	...	A	73E	OP2	...	2.45	***
Arg	732A	NH1	...	A	73E	P	...	3.13	
Arg	29S	CB	...	U	74E	O4	...	3.53	
Arg	29S	CD	...	U	74E	N3	...	3.29	
Arg	29S	NH1	...	U	74E	C2	...	3.38	
Arg	29S	NH1	...	U	74E	O2	...	2.58	***
Tyr	221O	CB	...	U	74E	O4	...	3.59	
Tyr	221O	CD1	...	U	74E	C2	...	3.43	
Tyr	221O	CD1	...	U	74E	N3	...	3.42	
Tyr	221O	CD2	...	U	74E	C4	...	3.57	
Tyr	221O	CD2	...	U	74E	C5	...	3.45	

Tyr	221O	CE1	...	U	74E	C2	...	3.47	
Tyr	221O	CE1	...	U	74E	C6	...	3.60	
Tyr	221O	CE1	...	U	74E	N1	...	3.31	
Tyr	221O	CE1	...	U	74E	O4'	...	3.42	
Tyr	221O	CE2	...	U	74E	C5	...	3.47	
Tyr	221O	CE2	...	U	74E	C6	...	3.53	
Tyr	221O	CG	...	U	74E	C4	...	3.42	
Tyr	221O	CG	...	U	74E	N3	...	3.54	
Tyr	221O	CZ	...	U	74E	C6	...	3.32	
Tyr	221O	CZ	...	U	74E	N1	...	3.51	
Tyr	221O	CZ	...	U	74E	O4'	...	3.26	
Tyr	221O	OH	...	U	74E	O4'	...	2.77	***
Thr	744A	CG2	...	A	75E	OP1	...	3.13	
Thr	744A	N	...	A	75E	OP1	...	3.29	***
Thr	746A	OG1	...	A	76E	OP1	...	3.01	***
Gln	748A	NE2	...	A	76E	OP1	...	3.43	*
Arg	749A	CZ	...	A	76E	OP2	...	3.59	
Arg	749A	NH1	...	A	76E	OP1	...	3.02	***
Arg	749A	NH1	...	A	76E	OP2	...	2.44	***
Arg	749A	NH1	...	A	76E	P	...	3.12	
Gln	748A	OE1	...	G	77E	OP1	...	3.24	***
Lys	611A	CD	...	G	78E	O2'	...	3.39	
Lys	611A	CE	...	G	78E	O2'	...	3.19	
Lys	10I	NZ	...	U	80E	OP1	...	3.24	***
Arg	60d	NH2	...	A	83E	O2'	...	3.33	*
Arg	60d	NH1	...	C	84E	C1'	...	3.27	
Arg	60d	NH1	...	C	84E	C2'	...	3.55	
Arg	60d	NH1	...	C	84E	O2'	...	2.67	***
Arg	60d	NH1	...	C	84E	O4'	...	3.59	*
Tyr	57d	CD1	...	G	86E	C6	...	3.13	
Tyr	57d	CD1	...	G	86E	O6	...	2.72	
Tyr	57d	CD2	...	G	86E	O6	...	3.19	
Tyr	57d	CE1	...	G	86E	C6	...	3.35	
Tyr	57d	CE1	...	G	86E	O6	...	2.56	
Tyr	57d	CE2	...	G	86E	O6	...	3.06	
Tyr	57d	CG	...	G	86E	C6	...	3.47	
Tyr	57d	CG	...	G	86E	O6	...	3.04	
Tyr	57d	CZ	...	G	86E	O6	...	2.74	
Tyr	57d	OH	...	G	86E	O6	...	3.49	*
Gln	67d	OE1	...	G	86E	N1	...	3.41	*
Gln	67d	OE1	...	G	86E	O6	...	3.35	*
Gln	67d	OE1	...	U	87E	O2	...	3.10	***
Arg	70d	CZ	...	U	87E	C2	...	3.54	
Arg	70d	CZ	...	U	87E	O2	...	2.63	
Arg	70d	NH1	...	U	87E	C2	...	2.89	
Arg	70d	NH1	...	U	87E	C2'	...	3.43	
Arg	70d	NH1	...	U	87E	N3	...	3.57	*
Arg	70d	NH1	...	U	87E	O2	...	2.13	***
Arg	70d	NH2	...	U	87E	C2	...	3.44	
Arg	70d	NH2	...	U	87E	N3	...	3.42	*
Arg	70d	NH2	...	U	87E	O2	...	2.76	***

protein - U2 (nts 19-32) and U6 (nts 41-87) core contacts in yC ; pdb: 5gmk

chains analysed:

protein	chain
Bud31	T
Cef1	c
Clf1	d
Cwc15	S
Cwc16	F
Cwc25	G
Cwc2	R
Isy1	H
Prp17	n
Prp45	P
Prp46	O
Prp8	A
Slt11	Q
Syf2	I

RNA	chain
U2	L
U6	E

source atoms				target atoms				distance	angle
Phe	203I	CD1	...	U	19L	O5'	...	3.30	
Phe	203I	CE1	...	U	19L	O5'	...	2.83	
Gln	784A	NE2	...	U	19L	C3'	...	3.51	
Asn	174P	CA	...	U	19L	N3	...	3.24	
Asn	174P	CA	...	U	19L	O4	...	3.40	
Asn	174P	CB	...	U	19L	N3	...	3.49	
Asn	174P	CB	...	U	19L	O4	...	2.96	
Asn	174P	CG	...	U	19L	C4	...	3.35	
Asn	174P	CG	...	U	19L	N3	...	3.00	
Asn	174P	CG	...	U	19L	O4	...	2.89	
Asn	174P	C	...	U	19L	N3	...	3.58	
Asn	174P	OD1	...	U	19L	C2	...	3.42	
Asn	174P	OD1	...	U	19L	C4	...	2.44	
Asn	174P	OD1	...	U	19L	N3	...	2.27	***
Asn	174P	OD1	...	U	19L	O4	...	2.17	***
Pro	175P	CG	...	U	19L	O2	...	3.60	
Asn	176P	CA	...	U	19L	O2	...	3.22	
Asn	176P	CB	...	U	19L	O2	...	2.70	
Asn	176P	CG	...	U	19L	O2	...	3.40	
Asn	176P	N	...	U	19L	O2	...	2.70	***
Tyr	178P	CD2	...	U	19L	C1'	...	3.03	
Tyr	178P	CD2	...	U	19L	C2	...	3.10	
Tyr	178P	CD2	...	U	19L	C6	...	3.23	
Tyr	178P	CD2	...	U	19L	N1	...	2.78	
Tyr	178P	CD2	...	U	19L	O2	...	3.50	
Tyr	178P	CD2	...	U	19L	O4'	...	2.95	
Tyr	178P	CE2	...	U	19L	C1'	...	2.83	
Tyr	178P	CE2	...	U	19L	N1	...	3.26	
Tyr	178P	CE2	...	U	19L	O4'	...	2.59	
Arg	185P	NH1	...	U	19L	O4	...	3.11	***

Arg	185P	NH2	...	U	19L	O4	...	3.57	*
His	5S	O	...	G	20L	O2'	...	3.54	*
Arg	6S	CB	...	G	20L	C2	...	3.08	
Arg	6S	CB	...	G	20L	N2	...	2.38	
Arg	6S	CB	...	G	20L	N3	...	3.09	
Arg	6S	CG	...	G	20L	C2	...	3.54	
Arg	6S	CG	...	G	20L	N2	...	2.87	
Pro	7S	CD	...	G	20L	N3	...	3.57	
Leu	9S	CD2	...	G	20L	C2	...	3.58	
Arg	780A	CZ	...	G	20L	C4	...	3.48	
Arg	780A	CZ	...	G	20L	C5	...	3.22	
Arg	780A	CZ	...	G	20L	C8	...	3.40	
Arg	780A	CZ	...	G	20L	N7	...	3.21	
Arg	780A	CZ	...	G	20L	N9	...	3.59	
Arg	780A	NE	...	G	20L	C8	...	3.54	
Arg	780A	NE	...	G	20L	N7	...	3.47	*
Arg	780A	NH1	...	G	20L	C5	...	3.24	
Arg	780A	NH1	...	G	20L	C6	...	3.29	
Arg	780A	NH1	...	G	20L	N7	...	3.52	*
Arg	780A	NH1	...	G	20L	O6	...	3.55	*
Arg	780A	NH2	...	G	20L	C1'	...	3.55	
Arg	780A	NH2	...	G	20L	C4	...	2.89	
Arg	780A	NH2	...	G	20L	C5	...	3.18	
Arg	780A	NH2	...	G	20L	C8	...	3.24	
Arg	780A	NH2	...	G	20L	N3	...	3.40	*
Arg	780A	NH2	...	G	20L	N7	...	3.42	*
Arg	780A	NH2	...	G	20L	N9	...	2.93	***
Arg	780A	NH2	...	G	20L	O4'	...	3.40	*
Gln	784A	NE2	...	G	20L	C5'	...	3.14	
His	5S	CB	...	G	21L	C5	...	3.40	
His	5S	CB	...	G	21L	N7	...	2.69	
His	5S	CB	...	G	21L	O6	...	3.23	
His	5S	CG	...	G	21L	O6	...	3.12	
His	5S	ND1	...	G	21L	O6	...	3.32	*
Asp	755A	OD2	...	G	21L	O2'	...	2.79	***
Ser	787A	OG	...	G	21L	O3'	...	3.53	*
Asp	755A	CG	...	C	22L	C4'	...	3.52	
Asp	755A	CG	...	C	22L	O4'	...	3.45	
Asp	755A	OD2	...	C	22L	C4'	...	3.12	
Asp	755A	OD2	...	C	22L	C5'	...	3.45	
Asp	755A	OD2	...	C	22L	O4'	...	2.64	***
Ser	787A	CB	...	C	22L	OP1	...	3.20	
Ser	787A	OG	...	C	22L	OP1	...	2.71	***
Arg	791A	NH2	...	C	22L	OP2	...	3.37	*
Trp	790A	NE1	...	U	23L	OP1	...	3.09	***
Lys	794A	NZ	...	U	23L	OP1	...	3.24	***
Lys	847A	CE	...	U	23L	O2'	...	3.38	
Lys	847A	NZ	...	U	23L	O2'	...	3.50	*
Lys	846A	CD	...	U	24L	C2	...	3.50	
Lys	846A	CD	...	U	24L	O2	...	2.78	
Lys	846A	CG	...	U	24L	O2	...	3.11	
Lys	847A	CA	...	U	24L	O4'	...	3.44	
Lys	847A	CG	...	U	24L	C5	...	3.53	
Lys	847A	CG	...	U	24L	C6	...	3.43	
Arg	851A	CZ	...	U	24L	OP1	...	3.17	
Arg	851A	NE	...	U	24L	OP1	...	2.57	***

Arg	851A	NH2	...	U	24L	OP1	...	2.98	***
Lys	1093A	NZ	...	U	24L	O2'	...	2.84	***
Arg	854A	CZ	...	A	25L	OP1	...	3.40	
Arg	854A	NE	...	A	25L	OP1	...	3.54	*
Arg	854A	NH2	...	A	25L	C5'	...	3.07	
Arg	854A	NH2	...	A	25L	OP1	...	3.26	***
Lys	1093A	C	...	A	25L	C2	...	3.14	
Lys	1093A	C	...	A	25L	N1	...	3.24	
Lys	1093A	CA	...	A	25L	C2	...	3.45	
Lys	1093A	CA	...	A	25L	C6	...	3.49	
Lys	1093A	CA	...	A	25L	N1	...	3.18	
Lys	1093A	O	...	A	25L	C2	...	3.56	
Lys	1093A	O	...	A	25L	N1	...	3.46	*
Asp	1094A	N	...	A	25L	C2	...	3.26	
Asp	1094A	OD1	...	A	25L	C2	...	3.01	
Asp	1094A	OD1	...	A	25L	N3	...	2.87	***
Lys	173P	NZ	...	G	26L	OP1	...	3.19	***
Lys	1093A	CE	...	A	27L	OP1	...	3.43	
Lys	1093A	NZ	...	A	27L	OP1	...	2.76	***
Ser	34c	CB	...	C	29L	N4	...	3.29	
Ser	34c	OG	...	C	29L	N4	...	2.91	***
Arg	928A	CG	...	A	30L	C2	...	3.13	
Arg	928A	CG	...	A	30L	N3	...	2.64	
Arg	928A	CZ	...	A	30L	O2'	...	2.99	
Arg	928A	CZ	...	A	30L	O3'	...	3.16	
Arg	928A	NE	...	A	30L	N3	...	3.45	*
Arg	928A	NH1	...	A	30L	C3'	...	3.59	
Arg	928A	NH1	...	A	30L	O2'	...	3.43	*
Arg	928A	NH1	...	A	30L	O3'	...	2.40	***
Arg	928A	NH2	...	A	30L	C2'	...	3.56	
Arg	928A	NH2	...	A	30L	O2'	...	2.42	***
Arg	928A	NH2	...	A	30L	O3'	...	3.36	*
Asn	930A	OD1	...	A	30L	OP1	...	2.94	***
Ala	931A	CB	...	A	30L	OP1	...	3.49	
Arg	928A	NH1	...	A	31L	O5'	...	2.63	***
Arg	928A	NH1	...	A	31L	P	...	3.14	
Arg	934A	CZ	...	A	31L	OP1	...	3.04	
Arg	934A	NH1	...	A	31L	OP1	...	2.56	***
Arg	934A	NH2	...	A	31L	OP1	...	3.49	*
Arg	928A	CZ	...	G	32L	C8	...	2.81	
Arg	928A	CZ	...	G	32L	N7	...	3.39	
Arg	928A	CZ	...	G	32L	N9	...	3.26	
Arg	928A	CZ	...	G	32L	O4'	...	3.32	
Arg	928A	CZ	...	G	32L	OP2	...	3.49	
Arg	928A	NE	...	G	32L	C1'	...	3.15	
Arg	928A	NE	...	G	32L	C4	...	3.22	
Arg	928A	NE	...	G	32L	C5	...	3.50	
Arg	928A	NE	...	G	32L	C8	...	2.77	
Arg	928A	NE	...	G	32L	N7	...	3.29	***
Arg	928A	NE	...	G	32L	N9	...	2.71	***
Arg	928A	NE	...	G	32L	O4'	...	3.29	***
Arg	928A	NH1	...	G	32L	OP2	...	3.53	*
Arg	928A	NH2	...	G	32L	C8	...	2.18	
Arg	928A	NH2	...	G	32L	N7	...	2.66	***
Arg	928A	NH2	...	G	32L	N9	...	3.16	***
Arg	928A	NH2	...	G	32L	O4'	...	3.42	*

Arg	928A	NH2	...	G	32L	O5'	...	3.01	***
Arg	928A	NH2	...	G	32L	OP2	...	2.66	***
Arg	928A	NH2	...	G	32L	P	...	3.44	
Leu	8G	CD1	...	G	32L	N7	...	3.40	
Tyr	34R	CD2	...	A	41E	C8	...	3.28	
Tyr	34R	CD2	...	A	41E	N7	...	3.54	
Tyr	34R	CD2	...	A	41E	N9	...	3.43	
Tyr	34R	CE2	...	A	41E	C1'	...	3.40	
Tyr	34R	CE2	...	A	41E	C8	...	3.11	
Tyr	34R	CE2	...	A	41E	N9	...	3.27	
Lys	36R	CB	...	A	41E	N1	...	3.33	
Lys	36R	CG	...	A	41E	C2	...	3.58	
Lys	36R	CG	...	A	41E	N1	...	3.32	
Lys	36R	NZ	...	A	41E	OP2	...	2.77	***
Trp	37R	O	...	A	41E	N6	...	2.95	***
Ser	38R	O	...	A	42E	C2	...	2.72	
Ser	38R	O	...	A	42E	N1	...	2.75	***
Gln	39R	CA	...	C	43E	O2	...	3.33	
Gly	40R	N	...	C	43E	N3	...	3.36	*
Glu	609A	CD	...	C	43E	O2'	...	3.18	
Glu	609A	OE1	...	C	43E	O2'	...	3.47	*
Glu	609A	OE2	...	C	43E	C2'	...	3.37	
Glu	609A	OE2	...	C	43E	O2'	...	2.26	***
Glu	609A	OE2	...	C	43E	O3'	...	2.99	***
Lys	612A	NZ	...	C	43E	OP1	...	3.60	*
Gly	40R	CA	...	A	44E	C2	...	3.54	
Gly	40R	CA	...	A	44E	N3	...	3.32	
Thr	606A	OG1	...	A	44E	OP1	...	3.38	*
Lys	608A	NZ	...	A	44E	OP2	...	3.55	*
Glu	609A	OE2	...	A	44E	C5'	...	3.55	
Ala	8H	CB	...	A	45E	OP1	...	3.21	
Ser	30H	OG	...	A	45E	O2'	...	3.31	*
Arg	31H	CD	...	A	45E	O2'	...	3.27	
Arg	31H	NE	...	A	45E	C4'	...	3.39	
Arg	31H	NE	...	A	45E	O2'	...	3.13	***
Arg	31H	NE	...	A	45E	O3'	...	3.58	*
Arg	31H	NH2	...	A	45E	C4'	...	3.51	
Ser	30H	O	...	U	46E	C4'	...	3.45	
Ser	30H	O	...	U	46E	O4'	...	3.42	*
Lys	32F	CD	...	U	46E	O3'	...	3.34	
Lys	32F	NZ	...	U	46E	O2'	...	3.55	*
Thr	33F	CB	...	U	46E	OP1	...	3.30	
Thr	33F	OG1	...	U	46E	OP1	...	2.12	***
Thr	33F	OG1	...	U	46E	P	...	3.49	
Lys	32F	CD	...	A	47E	OP1	...	3.38	
Arg	64H	NH2	...	A	47E	O2'	...	3.54	*
Asn	65F	CB	...	G	50E	O2'	...	3.17	
Asn	65F	CG	...	G	50E	C4	...	3.58	
Asn	65F	CG	...	G	50E	N3	...	3.24	
Asn	65F	CG	...	G	50E	O2'	...	2.95	
Asn	65F	ND2	...	G	50E	C1'	...	3.06	
Asn	65F	ND2	...	G	50E	C2	...	3.03	
Asn	65F	ND2	...	G	50E	C2'	...	3.18	
Asn	65F	ND2	...	G	50E	C4	...	2.66	
Asn	65F	ND2	...	G	50E	N2	...	3.60	*

Asn	65F	ND2	...	G	50E	N3	...	2.24	***
Asn	65F	ND2	...	G	50E	N9	...	2.99	***
Asn	65F	ND2	...	G	50E	O2'	...	2.34	***
Arg	42F	CZ	...	A	51E	C5	...	3.50	
Arg	42F	CZ	...	A	51E	N7	...	3.37	
Arg	42F	NH2	...	A	51E	C4	...	3.54	
Arg	42F	NH2	...	A	51E	C5	...	3.35	
Arg	42F	NH2	...	A	51E	C8	...	2.91	
Arg	42F	NH2	...	A	51E	N7	...	2.98	***
Arg	42F	NH2	...	A	51E	N9	...	3.27	***
Lys	165c	NZ	...	A	51E	C3'	...	3.57	
Lys	165c	NZ	...	A	51E	O2'	...	3.18	***
Lys	165c	NZ	...	A	51E	O3'	...	3.25	***
Arg	169c	NE	...	A	51E	C5'	...	3.37	
His	5S	CE1	...	G	52E	C2	...	3.41	
His	5S	CE1	...	G	52E	N2	...	2.62	
His	5S	CE1	...	G	52E	N3	...	3.34	
His	5S	NE2	...	G	52E	C2	...	3.43	
His	5S	NE2	...	G	52E	N2	...	2.87	***
His	5S	NE2	...	G	52E	N3	...	3.17	***
Lys	165c	CB	...	A	53E	OP1	...	3.24	
Lys	165c	CE	...	A	53E	OP1	...	3.30	
Lys	165c	CG	...	A	53E	OP1	...	3.55	
Lys	165c	N	...	A	53E	OP1	...	3.46	*
Lys	35c	NZ	...	U	54E	C4'	...	3.55	
Lys	165c	CD	...	U	54E	O4	...	3.34	
Lys	165c	CE	...	U	54E	O4	...	2.75	
Lys	165c	CG	...	U	54E	O4	...	3.37	
Tyr	28c	OH	...	G	55E	OP1	...	3.49	*
Lys	35c	CG	...	G	55E	N7	...	3.16	
Lys	35c	CG	...	G	55E	O6	...	3.39	
Ser	38c	CB	...	G	55E	C4	...	3.53	
Pro	59F	CB	...	G	55E	O2'	...	2.97	
Pro	59F	CG	...	G	55E	O2'	...	2.94	
Arg	158c	CD	...	G	55E	O4'	...	3.14	
Arg	158c	NE	...	G	55E	O4'	...	3.36	*
Ser	61F	O	...	A	56E	O2'	...	2.77	***
Ser	61F	C	...	U	57E	OP1	...	3.52	
Ser	61F	O	...	U	57E	OP1	...	2.77	***
Arg	62F	CA	...	U	57E	OP1	...	2.72	
Arg	62F	CB	...	U	57E	OP1	...	3.30	
Arg	62F	CG	...	U	57E	OP1	...	2.89	
Arg	62F	N	...	U	57E	OP1	...	3.55	*
Lys	63F	CE	...	U	57E	O3'	...	3.35	
Lys	63F	N	...	U	57E	OP1	...	3.51	*
Lys	63F	NZ	...	U	57E	O3'	...	2.82	***
Lys	63F	NZ	...	C	58E	O5'	...	3.44	*
Lys	63F	NZ	...	C	58E	OP1	...	2.45	***
Lys	63F	NZ	...	C	58E	P	...	3.07	
Gly	2G	CA	...	C	58E	O2'	...	3.48	
Gly	2G	C	...	C	58E	O2'	...	3.48	
Gly	2G	N	...	C	58E	O2'	...	3.46	*
Gly	2G	O	...	C	58E	C1'	...	2.92	
Gly	2G	O	...	C	58E	C2'	...	3.41	
Gly	2G	O	...	C	58E	O2'	...	2.73	***
Gly	2G	O	...	C	58E	O4'	...	3.17	***

Gln	748A	O	...	C	61E	O2'	...	3.38	*
Arg	749A	CA	...	C	61E	O2'	...	3.35	
Arg	749A	CB	...	C	61E	O3'	...	3.49	
His	5S	CB	...	A	62E	N6	...	3.53	
Arg	6S	O	...	A	62E	C2	...	3.18	
Arg	6S	O	...	A	62E	N1	...	3.10	***
Gln	748A	NE2	...	A	62E	OP1	...	2.81	***
Arg	749A	CZ	...	A	62E	OP1	...	3.33	
Arg	749A	NE	...	A	62E	OP1	...	2.95	***
Arg	749A	NH1	...	A	62E	OP1	...	3.02	***
Ala	752A	CB	...	A	62E	O2'	...	3.55	
Arg	6S	CB	...	G	63E	N2	...	3.13	
Arg	6S	CG	...	G	63E	N2	...	2.60	
Arg	6S	N	...	G	63E	N2	...	3.58	*
Arg	6S	O	...	G	63E	N3	...	3.59	*
Gln	8S	CA	...	G	63E	O2'	...	3.07	
Gln	8S	CB	...	G	63E	O2'	...	2.39	
Gln	8S	CD	...	G	63E	O2'	...	2.95	
Gln	8S	CG	...	G	63E	O2'	...	2.28	
Gln	8S	NE2	...	G	63E	O2'	...	3.30	***
Arg	12S	N	...	U	64E	OP1	...	3.56	*
Arg	60d	O	...	U	64E	O2'	...	3.34	*
Arg	12S	NE	...	U	65E	OP2	...	3.56	*
Lys	16S	NZ	...	U	65E	OP2	...	2.52	***
Lys	16S	NZ	...	U	65E	P	...	3.60	
Lys	59d	CE	...	U	65E	O2'	...	2.86	
Lys	59d	CG	...	U	65E	O2'	...	3.56	
Lys	59d	O	...	U	65E	C4'	...	3.45	
Arg	12S	NH2	...	C	66E	OP2	...	3.17	***
Lys	16S	NZ	...	C	66E	OP1	...	3.50	*
Tyr	20S	OH	...	C	66E	O5'	...	3.44	*
Met	108Q	CE	...	C	66E	O2'	...	3.58	
Met	108Q	SD	...	C	66E	C1'	...	3.43	
Met	108Q	SD	...	C	66E	O2	...	3.46	
Tyr	219c	CZ	...	C	66E	O2	...	3.56	
Tyr	219c	OH	...	C	66E	C2	...	3.27	
Tyr	219c	OH	...	C	66E	O2	...	2.44	***
Lys	133P	CD	...	C	66E	C4'	...	3.59	
Lys	59d	CE	...	C	67E	OP2	...	2.82	
Lys	59d	NZ	...	C	67E	OP2	...	3.40	*
Tyr	207c	CB	...	C	67E	O2'	...	3.55	
Arg	737A	CD	...	C	69E	OP2	...	3.28	
Arg	737A	CG	...	C	69E	OP2	...	3.14	
Arg	614A	CB	...	U	70E	O2'	...	3.43	
Arg	614A	O	...	U	70E	O2'	...	2.87	***
Arg	614A	O	...	U	70E	O3'	...	3.22	***
Arg	737A	CZ	...	U	70E	OP2	...	3.08	
Arg	737A	NH1	...	U	70E	OP2	...	2.34	***
Arg	737A	NH2	...	U	70E	C5	...	3.04	
Arg	737A	NH2	...	U	70E	C6	...	3.33	
Arg	737A	NH2	...	U	70E	OP2	...	3.12	***
Lys	586A	NZ	...	G	71E	OP1	...	3.48	*
Lys	586A	NZ	...	G	71E	OP2	...	3.23	***
Arg	614A	O	...	G	71E	OP1	...	3.56	*
Gly	616A	CA	...	G	71E	O3'	...	3.55	
Arg	732A	CZ	...	G	71E	C8	...	3.57	

Arg	732A	CZ	...	G	71E	N7	...	3.31	
Arg	732A	CZ	...	G	71E	OP2	...	3.50	
Arg	732A	NH1	...	G	71E	C5	...	3.45	
Arg	732A	NH1	...	G	71E	C8	...	3.04	
Arg	732A	NH1	...	G	71E	N7	...	2.79	***
Arg	732A	NH2	...	G	71E	O5'	...	3.26	***
Arg	732A	NH2	...	G	71E	OP2	...	2.43	***
Arg	732A	NH2	...	G	71E	P	...	3.32	
Arg	737A	CD	...	G	71E	O6	...	3.52	
Arg	737A	CZ	...	G	71E	N7	...	3.51	
Arg	737A	CZ	...	G	71E	O6	...	3.38	
Arg	737A	NE	...	G	71E	C6	...	3.55	
Arg	737A	NE	...	G	71E	O6	...	2.68	***
Arg	737A	NH2	...	G	71E	C5	...	3.33	
Arg	737A	NH2	...	G	71E	C8	...	3.37	
Arg	737A	NH2	...	G	71E	N7	...	2.45	***
Arg	737A	NH2	...	G	71E	O6	...	3.43	*
Asn	617A	N	...	C	72E	OP1	...	3.36	*
Ser	618A	CB	...	C	72E	OP1	...	3.39	
Ser	618A	N	...	C	72E	OP1	...	3.10	***
Ser	618A	OG	...	C	72E	C5'	...	3.26	
Ser	618A	OG	...	C	72E	O4'	...	3.26	***
Ser	618A	OG	...	C	72E	OP1	...	2.84	***
Tyr	725A	CA	...	C	72E	O4'	...	3.24	
Tyr	725A	CB	...	C	72E	O4'	...	3.19	
Tyr	725A	CD1	...	C	72E	C1'	...	3.35	
Tyr	725A	CD1	...	C	72E	C2	...	3.34	
Tyr	725A	CD1	...	C	72E	N1	...	3.27	
Tyr	725A	CD1	...	C	72E	O2	...	3.44	
Tyr	725A	CE1	...	C	72E	C2	...	3.15	
Tyr	725A	CE1	...	C	72E	N1	...	3.54	
Tyr	725A	CE1	...	C	72E	N3	...	3.41	
Tyr	725A	CE1	...	C	72E	O2	...	3.32	
Tyr	725A	CG	...	C	72E	O4'	...	3.57	
Tyr	725A	O	...	C	72E	C4'	...	3.53	
Asn	728A	CB	...	C	72E	O2'	...	2.96	
Asn	728A	CB	...	C	72E	O3'	...	3.27	
Asn	728A	CG	...	C	72E	O2'	...	2.94	
Asn	728A	ND2	...	C	72E	C2'	...	3.55	
Asn	728A	ND2	...	C	72E	O2'	...	2.15	***
Arg	732A	NH1	...	C	72E	O3'	...	3.55	*
Arg	732A	CD	...	A	73E	OP1	...	3.38	
Arg	732A	NH1	...	A	73E	OP1	...	3.01	***
Arg	732A	NH1	...	A	73E	OP2	...	3.54	*
Arg	732A	NH1	...	A	73E	P	...	3.46	
His	27S	CB	...	U	74E	C5	...	3.35	
His	27S	CD2	...	U	74E	C5	...	3.30	
His	27S	CG	...	U	74E	C5	...	3.11	
His	27S	ND1	...	U	74E	C5	...	3.56	
Arg	29S	NH1	...	U	74E	O2	...	3.53	*
Leu	30S	CD1	...	U	74E	O4	...	3.27	
Leu	30S	CD2	...	U	74E	O4	...	3.24	
Leu	30S	CG	...	U	74E	O4	...	2.92	
Tyr	221O	CD1	...	U	74E	C2	...	3.34	
Tyr	221O	CD1	...	U	74E	N3	...	3.38	
Tyr	221O	CD1	...	U	74E	O2	...	3.57	

Tyr	221O	CE1	...	U	74E	C2	...	3.53	
Tyr	221O	CE1	...	U	74E	N1	...	3.50	
Tyr	221O	CE1	...	U	74E	O4'	...	3.33	
Tyr	221O	CG	...	U	74E	N3	...	3.45	
Tyr	221O	OH	...	U	74E	O4'	...	3.40	*
Thr	744A	CG2	...	A	75E	OP1	...	3.26	
Thr	744A	N	...	A	75E	OP1	...	3.10	***
Thr	746A	OG1	...	A	76E	OP1	...	3.05	***
Arg	749A	NH1	...	A	76E	OP2	...	2.83	***
Lys	611A	CD	...	G	78E	O2'	...	3.06	
Lys	611A	CE	...	G	78E	O2'	...	3.15	
Lys	611A	CE	...	G	78E	O3'	...	3.45	
Ser	4S	CB	...	C	84E	O2'	...	3.24	
Ser	4S	O	...	C	84E	O2	...	3.31	*
Ser	4S	OG	...	C	84E	C2'	...	3.35	
Ser	4S	OG	...	C	84E	O2'	...	2.09	***
Arg	6S	NH1	...	C	84E	O2	...	2.57	***
Arg	6S	NH2	...	C	84E	O2'	...	3.59	*
Arg	60d	NH1	...	C	84E	C4'	...	3.05	
Arg	60d	NH1	...	C	84E	C5'	...	3.54	
Ser	4S	OG	...	C	85E	OP1	...	3.15	***
Arg	6S	NH2	...	C	85E	OP1	...	3.17	***
Arg	6S	NH2	...	C	85E	OP2	...	2.76	***
Arg	6S	NH2	...	C	85E	P	...	3.31	
Lys	166c	CE	...	C	85E	C4	...	3.54	
Lys	166c	CE	...	C	85E	N3	...	3.57	
Lys	166c	CE	...	C	85E	N4	...	3.12	
Tyr	57d	CD1	...	G	86E	C2	...	3.40	
Tyr	57d	CD1	...	G	86E	N1	...	3.55	
Tyr	57d	CD1	...	G	86E	N2	...	3.10	
Tyr	57d	CD2	...	G	86E	C6	...	3.56	
Tyr	57d	CD2	...	G	86E	N1	...	3.42	
Tyr	57d	CE1	...	G	86E	C2	...	2.87	
Tyr	57d	CE1	...	G	86E	N1	...	3.49	
Tyr	57d	CE1	...	G	86E	N2	...	2.65	
Tyr	57d	CE1	...	G	86E	N3	...	3.29	
Tyr	57d	CE2	...	G	86E	C2	...	3.33	
Tyr	57d	CE2	...	G	86E	C4	...	3.39	
Tyr	57d	CE2	...	G	86E	C5	...	3.46	
Tyr	57d	CE2	...	G	86E	C6	...	3.48	
Tyr	57d	CE2	...	G	86E	N1	...	3.36	
Tyr	57d	CE2	...	G	86E	N3	...	3.39	
Tyr	57d	CG	...	G	86E	N1	...	3.53	
Tyr	57d	CZ	...	G	86E	C2	...	2.83	
Tyr	57d	CZ	...	G	86E	C4	...	3.29	
Tyr	57d	CZ	...	G	86E	N1	...	3.40	
Tyr	57d	CZ	...	G	86E	N2	...	3.20	
Tyr	57d	CZ	...	G	86E	N3	...	2.80	
Tyr	57d	OH	...	G	86E	C2	...	3.22	
Tyr	57d	OH	...	G	86E	C4	...	3.08	
Tyr	57d	OH	...	G	86E	N3	...	2.60	***
Tyr	57d	OH	...	G	86E	N9	...	3.51	*
Gln	67d	OE1	...	G	86E	O6	...	3.22	***
Arg	174c	CZ	...	G	86E	O2'	...	3.47	
Arg	174c	NH1	...	G	86E	O2'	...	3.57	*
Gln	67d	OE1	...	U	87E	N3	...	3.53	*

Arg	70d	NH1	...	U	87E	C2	...	3.49	
Arg	70d	NH1	...	U	87E	N3	...	3.10	***
Arg	70d	NH1	...	U	87E	O2	...	3.58	*
Arg	70d	NH2	...	U	87E	N3	...	3.48	*

protein - U2 (nts 19-32) and U6 (41-87) core contacts in yC* ;
pdb: 5wsg

chains analysed:

protein	chain
Bud31	T
Cef1	c
Clf1	d
Cwc15	S
Cwc2	R
Prp17	n
Prp45	P
Prp46	O
Prp8	A
Slt11	Q
Syf2	I

RNA	chain
U2	L
U6	E

source atoms				target atoms				distance	angle
Phe	203I	CD1	...	U	19L	O5'	...	3.29	
Phe	203I	CE1	...	U	19L	O5'	...	3.24	
Phe	203I	CZ	...	U	19L	C5	...	3.57	
Lys	206I	NZ	...	U	19L	OP2	...	2.75	***
Gln	784A	NE2	...	U	19L	C2'	...	3.14	
Gln	784A	NE2	...	U	19L	C3'	...	3.35	
Gln	784A	NE2	...	U	19L	O2'	...	2.84	***
Asn	174P	OD1	...	U	19L	C4	...	3.28	
Asn	174P	OD1	...	U	19L	N3	...	3.15	***
Asn	174P	OD1	...	U	19L	O4	...	2.63	***
Pro	175P	CD	...	U	19L	O2	...	2.78	
Pro	175P	CG	...	U	19L	O2	...	2.83	
Pro	175P	CG	...	U	19L	O2'	...	3.52	
Pro	175P	N	...	U	19L	O2	...	3.13	***
Asn	176P	ND2	...	U	19L	O2	...	3.35	*
Asn	176P	N	...	U	19L	O2	...	3.33	*
Tyr	178P	CD2	...	U	19L	N1	...	3.47	
Tyr	178P	CE2	...	U	19L	O4'	...	3.37	
Arg	185P	NH1	...	U	19L	O4	...	2.88	***
His	5S	O	...	G	20L	O2'	...	3.31	*
Arg	6S	CB	...	G	20L	N2	...	3.40	
Pro	7S	CD	...	G	20L	N3	...	3.06	
Leu	9S	CD2	...	G	20L	N2	...	3.52	
Gln	784A	NE2	...	G	20L	C4'	...	3.21	

Gln	784A	NE2	...	G	20L	C5'	...	2.61	
His	5S	CB	...	G	21L	N7	...	2.94	
Pro	7S	CB	...	G	21L	O4'	...	3.47	
Asp	755A	OD2	...	G	21L	O2'	...	3.06	***
Ser	787A	OG	...	G	21L	O3'	...	3.34	*
Asp	755A	OD2	...	C	22L	C4'	...	3.06	
Asp	755A	OD2	...	C	22L	C5'	...	3.45	
Asp	755A	OD2	...	C	22L	O4'	...	3.02	***
Ser	787A	CB	...	C	22L	OP1	...	3.01	
Ser	787A	OG	...	C	22L	OP1	...	2.45	***
Ser	787A	OG	...	C	22L	P	...	3.46	
Arg	791A	NH2	...	C	22L	OP1	...	3.27	***
Arg	791A	NH2	...	C	22L	OP2	...	3.13	***
Trp	790A	NE1	...	U	23L	OP1	...	3.07	***
Lys	794A	NZ	...	U	23L	OP1	...	3.55	*
Lys	847A	CE	...	U	23L	O2'	...	3.36	
Lys	847A	NZ	...	U	23L	O2'	...	3.42	*
Lys	794A	NZ	...	U	24L	OP2	...	3.32	*
Lys	847A	CG	...	U	24L	C5	...	3.31	
Lys	847A	CG	...	U	24L	C6	...	3.18	
Arg	851A	CG	...	U	24L	OP1	...	3.60	
Arg	851A	NE	...	U	24L	OP1	...	3.13	***
Lys	1093A	NZ	...	U	24L	O2'	...	3.14	***
His	31c	C	...	A	25L	C2	...	3.45	
His	31c	CB	...	A	25L	C2	...	3.08	
His	31c	O	...	A	25L	C2	...	2.54	
His	31c	O	...	A	25L	N1	...	2.68	***
His	31c	O	...	A	25L	N3	...	3.49	*
Lys	794A	NZ	...	A	25L	OP2	...	3.29	***
Arg	854A	CZ	...	A	25L	OP1	...	2.17	
Arg	854A	NE	...	A	25L	OP1	...	3.19	***
Arg	854A	NH1	...	A	25L	OP1	...	2.39	***
Arg	854A	NH2	...	A	25L	C5'	...	2.74	
Arg	854A	NH2	...	A	25L	O5'	...	3.27	***
Arg	854A	NH2	...	A	25L	OP1	...	1.84	***
Arg	854A	NH2	...	A	25L	P	...	3.02	
Lys	1093A	CD	...	A	25L	C8	...	3.52	
Lys	1093A	CD	...	A	25L	N7	...	3.47	
Lys	1093A	CG	...	A	25L	N7	...	3.38	
Asp	1094A	CG	...	A	25L	C4	...	3.53	
Asp	1094A	CG	...	A	25L	N3	...	3.31	
Asp	1094A	OD1	...	A	25L	C2	...	2.64	
Asp	1094A	OD1	...	A	25L	C4	...	2.67	
Asp	1094A	OD1	...	A	25L	C5	...	3.01	
Asp	1094A	OD1	...	A	25L	C6	...	3.15	
Asp	1094A	OD1	...	A	25L	N1	...	2.97	***
Asp	1094A	OD1	...	A	25L	N3	...	2.55	***
Asp	1094A	OD1	...	A	25L	N9	...	3.47	*
Asp	1094A	OD2	...	A	25L	N3	...	3.51	*
Asp	1094A	OD2	...	A	25L	O4'	...	2.76	***
Lys	1093A	NZ	...	A	27L	OP1	...	2.49	***
Ser	34c	OG	...	C	29L	N4	...	3.18	***
Asn	930A	ND2	...	C	29L	OP1	...	3.36	*
Asn	930A	CG	...	A	30L	OP1	...	3.35	
Asn	930A	CG	...	A	30L	OP2	...	3.23	
Asn	930A	ND2	...	A	30L	OP2	...	3.02	***

Asn	930A	OD1	...	A	30L	OP1	...	2.27	***
Asn	930A	OD1	...	A	30L	OP2	...	3.00	***
Asn	930A	OD1	...	A	30L	P	...	3.02	
Ala	931A	CB	...	A	30L	C5'	...	3.56	
Ala	931A	CB	...	A	30L	O5'	...	3.55	
Arg	934A	NH2	...	A	30L	C3'	...	3.14	
Arg	934A	NH2	...	A	30L	C4'	...	3.27	
Arg	934A	NH2	...	A	30L	C5'	...	2.75	
Arg	934A	NH2	...	A	30L	O3'	...	3.55	*
Lys	1588A	CD	...	A	30L	C2	...	2.38	
Lys	1588A	CD	...	A	30L	N1	...	3.43	
Lys	1588A	CD	...	A	30L	N3	...	2.51	
Lys	1588A	CE	...	A	30L	C2	...	3.29	
Lys	1588A	CE	...	A	30L	N3	...	3.51	
Lys	1588A	CG	...	A	30L	N3	...	3.52	
Lys	1588A	NZ	...	A	30L	C2	...	3.23	
Lys	1588A	NZ	...	A	30L	N1	...	3.44	*
Lys	1588A	NZ	...	A	30L	N3	...	3.52	*
Leu	929A	O	...	A	31L	OP2	...	3.19	***
Arg	934A	CD	...	A	31L	C5	...	3.17	
Arg	934A	CD	...	A	31L	C8	...	3.39	
Arg	934A	CD	...	A	31L	N7	...	2.93	
Arg	934A	CZ	...	A	31L	OP2	...	3.58	
Arg	934A	NH1	...	A	31L	OP2	...	2.82	***
Phe	1587A	CD2	...	A	31L	C5'	...	3.22	
Phe	1587A	CD2	...	A	31L	O5'	...	3.57	
Phe	1587A	CE2	...	A	31L	C4'	...	3.29	
Phe	1587A	CE2	...	A	31L	C5'	...	2.11	
Phe	1587A	CE2	...	A	31L	O5'	...	2.40	
Phe	1587A	CZ	...	A	31L	C5'	...	2.47	
Phe	1587A	CZ	...	A	31L	O5'	...	2.89	
Lys	1588A	CD	...	G	32L	OP2	...	3.50	
Lys	1588A	CE	...	G	32L	OP2	...	2.91	
Lys	1588A	NZ	...	G	32L	OP2	...	3.47	*
Tyr	34R	CE2	...	A	41E	C1'	...	3.19	
Tyr	34R	CE2	...	A	41E	C8	...	3.45	
Tyr	34R	CE2	...	A	41E	N9	...	3.17	
Tyr	34R	CZ	...	A	41E	C1'	...	3.27	
Tyr	34R	CZ	...	A	41E	O4'	...	3.56	
Tyr	34R	OH	...	A	41E	C1'	...	3.18	
Tyr	34R	OH	...	A	41E	O2'	...	3.59	*
Lys	36R	CG	...	A	41E	C2	...	3.49	
Lys	36R	CG	...	A	41E	N1	...	3.36	
Lys	36R	NZ	...	A	41E	C2	...	2.82	
Lys	36R	NZ	...	A	41E	N3	...	3.43	*
Lys	36R	NZ	...	A	41E	OP1	...	3.17	***
Lys	36R	NZ	...	A	41E	OP2	...	2.97	***
Lys	36R	NZ	...	A	41E	P	...	3.42	
Trp	37R	O	...	A	41E	N6	...	3.27	***
Ser	38R	O	...	A	42E	N1	...	3.10	***
Gln	39R	CG	...	C	43E	O2	...	3.53	
Lys	608A	CE	...	C	43E	C5'	...	3.56	
Lys	608A	CE	...	C	43E	O3'	...	2.93	
Lys	608A	NZ	...	C	43E	C5'	...	2.93	
Lys	608A	NZ	...	C	43E	O3'	...	3.13	***

Glu	609A	CD	...	C	43E	O2'	...	3.05	
Glu	609A	CG	...	C	43E	O2'	...	3.12	
Glu	609A	OE2	...	C	43E	C2'	...	3.54	
Glu	609A	OE2	...	C	43E	C4'	...	3.46	
Glu	609A	OE2	...	C	43E	O2'	...	2.45	***
Phe	41R	CB	...	A	44E	C2	...	3.43	
Phe	41R	CB	...	A	44E	N1	...	3.04	
Phe	41R	N	...	A	44E	C2	...	3.36	
Lys	608A	CE	...	A	44E	OP1	...	3.54	
Lys	608A	CE	...	A	44E	P	...	3.53	
Lys	608A	NZ	...	A	44E	OP2	...	3.12	***
Lys	608A	NZ	...	A	44E	P	...	3.53	
Phe	1866A	CD2	...	C	48E	O2'	...	3.22	
Phe	1866A	CD2	...	C	48E	O3'	...	3.37	
Phe	1866A	CE2	...	C	48E	O2'	...	2.82	
Asn	1869A	ND2	...	G	50E	OP1	...	3.10	***
His	5S	CE1	...	G	52E	N2	...	3.53	
Lys	165c	CE	...	G	52E	OP2	...	3.59	
Lys	165c	N	...	A	53E	OP1	...	2.99	***
Lys	165c	CE	...	U	54E	O4	...	2.87	
Lys	165c	CG	...	U	54E	O4	...	3.54	
Tyr	28c	CE1	...	G	55E	OP1	...	3.25	
Tyr	28c	CZ	...	G	55E	OP1	...	3.48	
Tyr	28c	OH	...	G	55E	OP1	...	2.84	***
Lys	35c	CG	...	G	55E	N7	...	3.23	
Lys	35c	CG	...	G	55E	O6	...	3.07	
Arg	158c	CD	...	G	55E	O4'	...	3.07	
Arg	158c	CZ	...	G	55E	C1'	...	3.29	
Arg	158c	CZ	...	G	55E	O4'	...	3.07	
Arg	158c	NE	...	G	55E	O4'	...	2.96	***
Arg	158c	NH1	...	G	55E	C1'	...	3.35	
Arg	158c	NH1	...	G	55E	O4'	...	3.21	***
Lys	165c	NZ	...	U	57E	OP2	...	3.41	*
Arg	749A	CA	...	C	61E	O2'	...	3.23	
Arg	749A	CB	...	C	61E	O3'	...	3.28	
Lys	743A	NZ	...	A	62E	OP1	...	3.37	*
Arg	749A	NE	...	A	62E	OP1	...	2.91	***
Ala	752A	CB	...	A	62E	O2'	...	2.88	
Arg	6S	O	...	G	63E	N3	...	3.47	*
Gln	8S	CA	...	G	63E	O2'	...	2.89	
Gln	8S	CB	...	G	63E	O2'	...	2.54	
Gln	8S	CG	...	G	63E	O2'	...	2.91	
Arg	60d	O	...	U	64E	O2'	...	3.38	*
Arg	12S	CG	...	U	65E	OP2	...	3.57	
Lys	16S	CD	...	U	65E	OP2	...	3.51	
Lys	16S	CE	...	U	65E	OP2	...	2.92	
Lys	59d	CE	...	U	65E	O2'	...	3.15	
Arg	12S	CZ	...	C	66E	OP2	...	3.30	
Arg	12S	NH1	...	C	66E	OP2	...	3.34	*
Arg	12S	NH2	...	C	66E	OP2	...	3.17	***
Lys	16S	CD	...	C	66E	OP1	...	3.38	
Met	108Q	CE	...	C	66E	O2'	...	3.25	
Met	108Q	SD	...	C	66E	C1'	...	3.29	
Met	108Q	SD	...	C	66E	O2'	...	3.37	
Met	108Q	SD	...	C	66E	O4'	...	3.50	
Ile	211c	CD1	...	C	66E	O2	...	2.76	

Val	135P	CG1	...	C	66E	O4'	...	3.60	
Lys	59d	CE	...	C	67E	OP2	...	2.76	
Lys	59d	NZ	...	C	67E	OP2	...	3.19	***
Tyr	207c	CB	...	C	67E	O2'	...	3.15	
Tyr	207c	CB	...	C	67E	O3'	...	3.26	
Tyr	207c	CG	...	C	67E	C4'	...	3.57	
Arg	737A	CG	...	C	69E	OP2	...	3.33	
Arg	737A	NH1	...	C	69E	OP2	...	3.55	*
Arg	737A	CZ	...	U	70E	OP2	...	3.31	
Arg	737A	NH1	...	U	70E	OP2	...	2.70	***
Arg	737A	NH2	...	U	70E	C5	...	3.53	
Arg	737A	NH2	...	U	70E	OP2	...	3.21	***
Lys	586A	NZ	...	G	71E	OP1	...	3.43	*
Lys	586A	NZ	...	G	71E	OP2	...	3.39	*
Arg	732A	CZ	...	G	71E	N7	...	3.49	
Arg	732A	CZ	...	G	71E	OP2	...	3.51	
Arg	732A	NH1	...	G	71E	C5	...	3.40	
Arg	732A	NH1	...	G	71E	C8	...	3.38	
Arg	732A	NH1	...	G	71E	N7	...	2.87	***
Arg	732A	NH2	...	G	71E	O5'	...	3.23	***
Arg	732A	NH2	...	G	71E	OP2	...	2.87	***
Arg	732A	NH2	...	G	71E	P	...	3.57	
Arg	737A	CD	...	G	71E	O6	...	3.33	
Arg	737A	CZ	...	G	71E	O6	...	3.36	
Arg	737A	NE	...	G	71E	O6	...	2.61	***
Arg	737A	NH2	...	G	71E	N7	...	2.70	***
Arg	737A	NH2	...	G	71E	O6	...	3.52	*
Gly	616A	CA	...	C	72E	OP1	...	3.18	
Gly	616A	CA	...	C	72E	OP2	...	3.37	
Gly	616A	CA	...	C	72E	P	...	3.55	
Gly	616A	C	...	C	72E	OP1	...	3.33	
Asn	617A	N	...	C	72E	OP1	...	2.99	***
Ser	618A	N	...	C	72E	OP1	...	3.04	***
Tyr	725A	CD1	...	C	72E	C1'	...	2.80	
Tyr	725A	CD1	...	C	72E	C6	...	3.56	
Tyr	725A	CD1	...	C	72E	N1	...	3.07	
Tyr	725A	CD1	...	C	72E	O4'	...	2.65	
Tyr	725A	CE1	...	C	72E	C1'	...	3.05	
Tyr	725A	CE1	...	C	72E	C2	...	2.92	
Tyr	725A	CE1	...	C	72E	C6	...	3.15	
Tyr	725A	CE1	...	C	72E	N1	...	2.69	
Tyr	725A	CE1	...	C	72E	N3	...	3.50	
Tyr	725A	CE1	...	C	72E	O2	...	3.32	
Tyr	725A	CE1	...	C	72E	O4'	...	3.31	
Tyr	725A	CZ	...	C	72E	C2	...	3.58	
Tyr	725A	O	...	C	72E	C4'	...	3.41	
Tyr	725A	OH	...	C	72E	N3	...	3.49	*
Asn	728A	CB	...	C	72E	O2'	...	3.54	
Asn	728A	CB	...	C	72E	O3'	...	3.35	
Asn	728A	CG	...	C	72E	O2'	...	3.31	
Asn	728A	ND2	...	C	72E	O2'	...	2.29	***
Arg	732A	NH2	...	C	72E	OP2	...	3.55	*
Arg	732A	NH1	...	A	73E	OP1	...	2.88	***
Arg	732A	NH1	...	A	73E	OP2	...	3.29	***
Arg	732A	NH1	...	A	73E	P	...	3.46	
His	27S	CD2	...	U	74E	C5	...	3.50	

Arg	29S	NH1	...	U	74E	O2	...	3.49	*
Leu	30S	CD2	...	U	74E	O4	...	3.42	
Leu	30S	CG	...	U	74E	O4	...	3.30	
Tyr	221O	CD2	...	U	74E	C4	...	3.35	
Tyr	221O	CD2	...	U	74E	N3	...	3.50	
Tyr	221O	CE2	...	U	74E	C4	...	3.55	
Tyr	221O	CE2	...	U	74E	C5	...	3.34	
Tyr	221O	CE2	...	U	74E	C6	...	3.43	
Tyr	221O	CZ	...	U	74E	N1	...	3.57	
Tyr	221O	CZ	...	U	74E	O4'	...	3.45	
Tyr	221O	OH	...	U	74E	O4'	...	2.86	***
Lys	743A	CB	...	A	75E	OP1	...	3.59	
Thr	744A	CG2	...	A	75E	OP1	...	2.95	
Thr	744A	N	...	A	75E	OP1	...	3.28	***
Thr	746A	OG1	...	A	76E	OP1	...	3.42	*
Arg	749A	CZ	...	A	76E	OP2	...	3.40	
Arg	749A	NH1	...	A	76E	OP1	...	3.41	*
Arg	749A	NH1	...	A	76E	OP2	...	2.26	***
Arg	749A	NH1	...	A	76E	P	...	3.25	
Lys	611A	CD	...	G	78E	O2'	...	3.49	
Arg	60d	CZ	...	A	83E	O2'	...	3.57	
Arg	60d	NH2	...	A	83E	O2'	...	2.61	***
Ser	4S	CB	...	C	84E	O2'	...	3.40	
Ser	4S	OG	...	C	84E	C2	...	3.04	
Ser	4S	OG	...	C	84E	C4	...	3.59	
Ser	4S	OG	...	C	84E	C6	...	3.59	
Ser	4S	OG	...	C	84E	N1	...	3.23	***
Ser	4S	OG	...	C	84E	N3	...	3.26	***
Ser	4S	OG	...	C	84E	O2'	...	3.04	***
Ser	4S	OG	...	C	84E	O2	...	3.45	*
Arg	6S	CZ	...	C	84E	O2'	...	2.74	
Arg	6S	NH1	...	C	84E	C2'	...	3.24	
Arg	6S	NH1	...	C	84E	O2'	...	1.96	***
Arg	6S	NH1	...	C	84E	O2	...	3.22	***
Arg	6S	NH2	...	C	84E	O2'	...	2.88	***
Lys	170c	CE	...	C	84E	OP1	...	3.52	
Lys	170c	NZ	...	C	84E	OP1	...	3.43	*
Arg	6S	CZ	...	C	85E	OP1	...	2.93	
Arg	6S	NH1	...	C	85E	OP1	...	3.23	***
Arg	6S	NH2	...	C	85E	O4'	...	3.49	*
Arg	6S	NH2	...	C	85E	OP1	...	2.36	***
Arg	6S	NH2	...	C	85E	P	...	3.59	
Lys	166c	CE	...	C	85E	N4	...	3.16	
Lys	166c	CG	...	C	85E	C4	...	3.60	
Lys	166c	CG	...	C	85E	N3	...	3.40	
Lys	166c	CG	...	C	85E	N4	...	3.37	
Ala	167c	CB	...	C	85E	O2'	...	3.39	
Tyr	57d	CD2	...	G	86E	C2	...	3.09	
Tyr	57d	CD2	...	G	86E	N1	...	3.28	
Tyr	57d	CD2	...	G	86E	N2	...	2.70	
Tyr	57d	CE1	...	G	86E	C2	...	3.54	
Tyr	57d	CE1	...	G	86E	N3	...	3.51	
Tyr	57d	CE2	...	G	86E	C2	...	2.91	
Tyr	57d	CE2	...	G	86E	N2	...	2.40	
Tyr	57d	CE2	...	G	86E	N3	...	3.42	
Tyr	57d	CG	...	G	86E	C2	...	3.51	

Tyr	57d	CG	...	G	86E	N1	...	3.28	
Tyr	57d	CZ	...	G	86E	C2	...	3.15	
Tyr	57d	CZ	...	G	86E	N2	...	3.14	
Tyr	57d	CZ	...	G	86E	N3	...	3.16	
Tyr	57d	OH	...	G	86E	N3	...	3.40	*
Gln	67d	OE1	...	G	86E	C6	...	3.58	
Gln	67d	OE1	...	G	86E	O6	...	2.75	***

Table S4. Splicing efficiency (mRNA production) of the mutant U6 RNAs compared to the wildtype (set to 100%) after 60 min.

Nucleotide	Mutation	Splicing efficiency	Note
G52	G52I	98±3%	
	G52I/7cG60	80±3%	
	G52ab	63±2%	
	G52-1MeA	65±3%	transition defect
A59	7cA59	93±7%	
	A59ab	67±4%	transition defect
	7cA59/7cG60	80±4%	transition defect
G60	7cG60	85±6%	
	G60-purine	79±6%	
	G60ab	3±1%	splicing blocked
C61	C61ab	31±4%	
A62	A62ab	96±1%	
G78	G78ab	90±4%	
U80	U80ab	92±3%	
Double/ Tripe deletions	G52ab/A53ab	62±3%	
	G52ab/U80ab	69±5%	
	A53ab/U80ab	68±5%	transition defect
	G52ab/A53ab/U80ab	47±4%	

Table S5. Protein composition of affinity purified *S. cerevisiae* B^{act} spliceosomes assembled with U6-wt or U6-G60ab snRNA as determined by mass spectrometry.

Yeast name protein	Systematic gene name	MW (kDa)	U6-G60ab	U6-wt
Sm proteins				
B	YER029C	22.4	31	42
D1	YGR074W	16.3	20	16
D2	YLR275W	12.8	37	35
D3	YLR147C	11.2	36	49
E	YOR159C	10.4	3	6
F or X3	YPR182W	9.6	2	5
G or X2	YFL017W-A	8.5	7	8
U1 snRNP				
Prp39	YML046W	74.7	47	45
Snu71	YGR013W	71.4	86	74
Prp40	YKL012W	69	63	77
Prp42	YDR235W	65	79	101
Mud2	YKL074C	60.5	13	17
Nam8	YHR086W	56.9	27	32
Snu56	YDR240C	56.5	31	26
Snp1	YIL061C	34.4	33	27
Mud1	YBR119W	34.4	25	24
Luc7	YDL087C	30	28	22
Yhc1	YLR298C	27	8	4
U2 snRNP				
Rse1	YML049C	153.8	397	408
Hsh155	YMR288W	110	180	188
Prp9	YDL030W	63	134	126
Cus1	YMR240C	50.2	105	98
Prp21	YJL203W	33	82	59
Prp11	YDL043C	29.9	50	46
Lea1	YPL213W	27.2	86	74
Hsh49	YOR319W	24.5	15	16
Msl1	YIR009W	12.8	24	19
Rds3	YPR094W	12.3	11	16
Ysf3	YNL138W-A	10	7	7
U5 snRNP				
Prp8	YHR165C	279.5	416	369
Brr2	YER172C	246.2	522	496
Snu114	YKL173W	114	237	218

Prp6	YBR055C	104.2	110	90
Prp28	YDR243C	66.6	4	8
Lin1	YHR156C	40.4	0	0
Dib1	YPR082C	16.7	11	8
U4/U6 snRNP				
Prp31	YGR091W	56.3	43	32
Prp3	YDR473C	56	39	41
Prp4	YPR178W	52.4	47	39
Snu13	YEL026W	13.6	5	5
Snu66	YOR308C	66.4	96	61
Sad1	YFR005C	52.2	1	1
Spp381	YBR152W	34	7	12
Prp38	YGR075C	28	23	21
Snu23	YDL098C	23	14	13
Lsm proteins				
Lsm4	YER112W	21.3	13	11
Lsm7	YNL147W	13	7	5
Lsm8	YJR022W	12.4	6	4
Lsm2	YBL026W	11.2	13	16
Lsm5	YER146W	10.4	5	4
Lsm3	YLR438C	10	1	2
Lsm6	YDR378C	9.4	8	5
RES complex				
Bud13	YGL174W	30.5	56	54
Pml1	YLR016C	23.6	39	25
Snu17/Ist3	YIR005W	17	16	19
NTC/Prp19 complex				
Syf1	YDR416W	100	145	149
Clf1	YLR117C	82.4	83	66
Cef1	YMR213W	68	94	106
Prp19	YLL036C	56.6	256	280
Isy1	YJR050W	28	16	12
Syf2	YGR129W	25	27	30
Snt309	YPR101W	21	21	25
Ntc20	YBR188C	16	11	5
NTC-related protein				
Prp46	YPL151C	51	102	111
Prp45	YAL032C	42.5	79	101
Ecm2	YBR065C	41	0	0
Cwc2	YDL209C	38.4	58	74

Cwc15	YDR163W	20	43	47
Bud31	YCR063W	18.4	15	17
Early splicing factor				
Prp5	YBR237W	96.4	35	43
Urn1	YPR152C	54	41	24
Known splicing factor				
Prp2	YNR011C	100	0	0
Spp2	YOR148C	20.6	1	3
Yju2	YKL095W	32	16	17
Cwc21	YDR482C	15.7	24	19
Cwc22	YGR278W	67.3	46	51
Cwc24	YLR323C	28	24	19
Cwc27	YPL064C	35	42	36
Cwc23	YGL128C	33.2	1	1
Cwc25	YNL245C	20.4	0	0
Step 2 proteins				
Prp17	YDR364C	52	43	36
Prp22	YER013W	130	10	17
Prp16	YKR086W	121.6	0	1
Slu7	YDR088C	44.6	7	28
Prp18	YGR006W	28.4	14	9
Disassembly proteins				
Prp43	YGL120C	87.6	10	13
Ntr1	YLR424W	83	3	4
Ntr2	YKR022C	36.6	1	3
CBP protein				
Sto1	YMR125W	100	13	11
Cbc2	YPL178W	24	8	6