!"#$%&#%())%$*+#,+#-%"#.%+$/0&1#."(+)/% !

!"#$%"&'()!"#$%"*"&
!"#$"%&'()*+),-.+/&01*+)",*2&3/#/*4$5&6,)(/4#)-7&8/;*4+</,+&"=&>5)2"#";57&9?&
@"2"A"2*<#A"/&#5"#B&CDEEF&"%9&3.##)*&

!"#$%&'$!&G5/&$",$/;+&"=&H=4//&+5),A),IJ&),&+5/&$",+/K+&"=&L*,+M#&
;5)2"#";57&;4/#/,+#&*&+5/"4/+)$*2&*,N&;4*$+)$*2&;4"O2/<P&L*,+&*;;2)/#&+5/&
$",$/;+&"=&=4//N"<&;4)<*4)27&+"&;4*$+)$*2&4/*#",&*,N&<"4*2&;5)2"#";579&O.+&
/2/</,+#&"=&=4//N"<&0),&+5),A),I8&$*,&O/&)N&},&")+5/4&#/$+)",#&"=&5)#&
+/*$5),IP&Q4//&+5),A),I9&*$$"4N),I&+"&L*,+9&$*,&O/&),+/4;4/+/N&*#&+5),A),I&
$+)()+7&$",N.$+/N&),&+5/&*O#/,$/&"=&,7&;4/4/R.)#)+/#9&.+<"#+&
.,O"..,N/N,/##&*,N&),N/;/,N/,$/9&O.+&5*(),I&N/=),)+/&O"..,N*4)/#&),&(*4)".#&
4/#P&G5/&*,*2/#&"=&+5)#&*<O)(*2/,$/&"=&=4//&+5),A),I&)#&$*44)/N&".+&),&#.$5&
#/$+)",#&"=&L*,+M#&+/*$5),I&*#&+5/"4/+)$*2&A,"%2/NI/9&+5/&*4/*&"=&/(/47N*7&
+5),A),I9&+5/&#"$)*2&=)/2N&*,N&+5/&%"4A&"=&*4+)#+)$&I/,).#P&S,/&"=&+5/&
+/,N/,$)/#&4/(/*2/N&*#&*&4/#.2+&"=&+5)#&)#&2/7#)+M#&N/#)4/&+"&;"#+.2*+/&
+5/&.,$",N)+)",*2)+7&"=&+5/&=4//N"<&"=&+5".I5+&),&N)==/4/,+&*4/*#9&*,N&+5/,&+"&
="4<.2*+/&<),)<.<&$",#+4*),+#&",&)+P&G5.#9&%5)2/&;4"$2*)<),I&.,2)<)+/N&
=4//N"<&H+"&.#/&5)#&<),N&*,N&#;/*A&",&5)#&"%,&O/5*2=J&),&+5)#&"$)*2&#;5/4/
L*,+&*N<)+#&",27&+%"&4/#+4)$+)(/&;4),$);2/#T&+5/&4/R.)4/</,+&"=&#$)/,+)=)$&
A,"%2/NI/&*,N&+5/&;4/#/,$/&"=&I""N%)22P&G5/&<"#+&)<;"4+*,+&$"<;",/,+&"=&
=4//&+5),A),I&),&+5/&+/*$5),I#&"=&L*,+&)#&+5/&;4/#/,$/&"=&#$)/,+)=)$&
$+#&#&+5/&+4/I$5*,)#<&,N&+5/&=".,N*+)",&"=&=4//&+5),A),I9&*#&%/22&*#&
+5/&/()N/,$/&="4&)+#&#"$)*2)+7&I$5*,)#+)$&,*+.4/P&3/#/*4$5&#5"%#&
+5*+9&+54".I5&+5/&$",$/;)#&$*+,-.,9&L*,+&)<;2)$)+27&="4<.2*+/#&+5/&
)N/*2&"=&=4//&+5),A),I9&%5)$5&<*,)=/#+#&5)#+"4)$)*2,&N&5*#&2*#+),I&
(*2./P&

()*+,%-# T&=4//N"<9&V,2)I5+/,</,+9&$%$&"'(9&)N/*2&"=&=4//&+5),A),I

!" #$%&'()*%+'$

!$&'#$()*&(+#,-.$/&(-+&,%$,+0(&%1&12++3%4&,%22+5#(+*&6.(-&(-+&*0-+2+&%1&4%2#5.(78&
.*&#$&#,(&0+21%24+3&*%5+57&%$&(-&%1&#3&.$&#,,%23#$,+&6.(-&(&(-+&(#$+(*&%1
02#,(.,#5&2+#*%$8&;-+&4%(."+&%1&*<,-&#$&#,(&.*&,%$$+,(+3&6.(-&#&4#$.1+*(#(.%$&
,#<*#5.(7>8&9,(*&%2&4%(."+*&:#*+3&%$&#$7&%(-+2&,#<*#5.(7&?,%/$.(."+@&*+$*.:5+@&+
4%2#5&.$&(-+&,%$(+B(&#$&%$(%*%0-78&C%$*+D<+$(57@&12++3%4&.*&.40%**.:5+&.$&#$
%1&#,(."(7&.$&6-.,-&(-+2+&.*&$%&12++&4%2#5&,#<*#5.(7&#,,%23.$/&(%&'#$(8&9$3&7+(&'#
,%$,+0(&%1&=12++3%4>&6.(-&2+/#23&(%&(-+&*0-+2+&%1&,%/$.(."$@&*%,.+(7@&#2(.*(

"&W"44/#;",N),I&*.+5"4T(&,"(<)A5*)25XI<*)2P$"<&
S3W-: T&YYW&YYYC&BZEPB[F&

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (http://creativecommons.org/licenses/by/4.0/).

#*&.(&6+2+@&12%4&(-+&02%0+2(.+*&%1&(-+&1./<2+K&:<(&2#(-+2&(-#(&-+&-#3&(%&02%3<
6-# (&-+&-.4*+51&(-%</-(&.$(%&(-+&%:]+,(&#$3&02+*+$(+3&?(-2%</-&,%$*(2<,(.%$A&#,,%23
02.%2.&,%$,+0(*@&#$3&(-#(&.$&%23+2&(%&E$%6&*%4+(-.$/&*+,<2+57&#&02.%2.&-+&-#3&
(-.$/& $%(-.$/& +B,+0(& 6-#(& 1%55%6+3& $+,+**#2.57& 12%4& 6-#(&&0&(&4$(%2&(&3$&
#,,%23#$,+&6.(-&.(*&,%$,&@(+&^&FSK&#$(S&@NFGA&+2+&6+&#5*%&*+++&(-+&<$.(7&%1&
12++3%4&#$3&,%$3.(.%$.$/H&(-+&1./<2+&.*&,%$*(2<,(+3@&:<(&=#,,%23.$/&(%&,%$*(#$(&
(-#(&:+.$/&#*,2.:+3&(%&(-.$/*& 6-.,-&$+,+**#2.57& 12%4& 6-#(&.*& +$,%40#**+3&:7&(-+&
2+*+#2,-+2&.$&#,,%23#$,+&6.(-&-.*&<$3+2&W#23.$/&(-+&3+0+$3+$,+&%1&,%/$(.%$&%$&
:+"5+&1%24*@&'#$(&0%.$(*&(%&(-+&#,(."(7&%1&(-+&,%/$.*.$/&0+2*%$H&-.*&#:.5.(7&(%&<$3
0+,.1.,.(.+& #$3& 0%**.:.5.(.+*&+%2&<*+K& *<,-& 4+$(#5& %0+2#(.%$*& #2+& .40%**.:5+&
#,,%405.*-& 4+,-#$.,#557@& ,#55.$/& #*& (-+7& 3%& 1%2& ,%$*,.%<*& +11%2(*& %1& (-+& 6.5
12++3%4&
;-+&#,(."(7&%1&(-+&,%/$.*.$/&*<:]+,(&0%.$(+3&%<(&:7&'#$(&-#*&:++$&,%$1.24+3&:7&
/2%6.$/& 2%5+& %1&(,#5&2,%/$.(.%$& .$& 4%3+2$& *,.+$,+@& (-+& 2+5#("+& .$3+0+$3+$,+
(-+%2+(.,#5&.$D<.27&12%4&+40.2.,#5&3#(#@&#$3&,%$*(2.,("+$+**&#*&#&4+(-%3%5%/.,#
;6+$(.+(- R+$(<27&*,.+$,+&*#7*&(-#(&=Z-7*.,#5&,%$,+0(*&#2+&12++&,2+#(.%$*&%1&(-+&-<4#
#$3&#2&$%(@&-%6+"+2&.(&4#7&*++4@&<$.D<+57&3+(+24.$+3&:7&(-+&+B(+2$#5&6%253>&
!$1+5@LFFG@&A@& (-#(& (-+& 6%253& .*& %2.+$(+3& (%6#23& 2+"%5<(.%$#27& (2#$*1%24
E$%65+3/+@&=,2#c7>&.3+#*&#$3&,%$*(#$(&*,.+$(.1.&2+"%5<(.%$*8&
'#$()*&,%$,+0(&3%+*&$%(&%$57&+B-.:.(&+5+4+$(*&%1&12++3%4&.$&+0.*(+4%5%/.,#5&
;-+%2+(.,#557@&#*&-#*&:++$&$%(+3@&.(&#55%6*&%1&4%2#5&12++3%48&'#$(&:+5.+"+*&(
,%$*+D<+$(57&#5*%&:+&#:5+&(%&:+&,%$,+."+3&.$&*<,-&#&6#7&(-#(&4%&5&1*5&**&%1&
5+#*(&.$&#/2++4+$(&6.(-&(-+&0%**.:.5.(7&%1&(-+&+$3*&(-#(&#2&(%&$&#,2+3#$3&
6.(-&(-+&5#6*&%1&12++@&A&&FJH&NDOMK&'#$(FFF:@&&IA8&;-.*&#002%#,-&0#"+*&
(-+&6#7&1%2&12++3%4&.$&(+24*&%1&+(-.,#5&.$15<+$,+&%$&*,.+$(.1.,&#,(."(7@&#$3&$%
+B(+2$#5& +(-.,#5& 2+/<5#(%2*@& :<(& #5*%& (-2%</-& .$(+2$#5& %$+*8& b(-.,#5& 1#,(%2*&
,%/$.("+&02%,+**K&(-+7&#2+&1%<$3&$%2&(+*&#1&%2/#$.*+3&*,+0(.,.*4@&*,.+$(.1.,&.$(+/2.(7&
+(,8&?Q+2@&$SOI@&&MLGFA8&;-+*+&+(-.,#5&2+/<5#(%2*&3%&$%(&-&2.*(.,&,-#2#
?!"#$%&FNG@&&JRLOA@&.8+8&(-+.2&.40#,(&.*&$%(&,%$*(2<,("+&:<(&2+/<5#("+@&(%&<
(+24.$%5%/&8&

1"-&..('/" '2" %3+$4+$0" +$" %3"*+67" 583.&." 6$(" +$" (69:%:(69"
. ;8.&+.$*. "

T2++3%4& %1& (-%</-(&.$&(-+& *%,.#5& *0-+2+& #$3& .$& 3#.57& 5.1+& ,#$& :+& .55<*(2#(+3&
(.76,+"./-$,'E4,7-"5.F'0$%-'G7'H.&"/$-,.2,.-I &$&&#$(&.3+$(.1.+*&(6%&5+"+5*&%1&12++3%4H&
(-+&"+7.*&(-+&0<:5.,&<*+&%1&%$+)*&2+#(*%$:+$&.*&*+++$&#*&#&*%,.#5&*<:]+,(&2+/#235+**&
%1&-.*&,.".5&0%*.(.%$&#$3&%11.,+8&9(&(-.*&5+"+5@&#&0+2*%$&4<*(&-#"+&<$5.4.(+3&12+
#$3& 0<:5.,& +B02+$8&4&J+2+& -+& *0+#E*& %$& -.*& %6$& :+-#518& ;-+& %$57& 2+*(2.,(.%$*&
12++3%4&#2+&#&/2%<$3+3&%0.$.%$&?(-+&*,.+$(.1.,&#002%#,-A&#3&2+<5#&#*0+,(&
+B#4.$+3&#$3&6$5$(.%$+3&(-%</-(&>A8 55%6.$/&+"+27&,(&+&12++3%4&(%&
,%44+$(&0:5.,57@&(-#(&.*@&(-2%</-&62.($/*@&.$&-.*&,#0#,.(7&#*&#&*,-%5#2@&%$&(-#
15#6+3&.$&(-+&02+*+$(&#22#$0+&3&&&GH&RSK&'#$(FFM@&&IA8
;-+&7,85.1&5+"+5&%1&12++3%4&(%&6.(-&#&0+2*%$)*&0+21%24#$,+&%1&,.".5&%2&%
3<(78&'$(&,#55*&(-.*&5+"+&2."#(+&<*+&%1&%$+)*&2+#(*%$&.*&*+++$&#*&#&*%,.#5&*<:]+,(&2+/#235+**&
#33.(.%$#5& 2+*(2.,(.%$*&%1& 12++3%4& %1& (-%</-(8& ;-<*@&#& 4.5.(#27& %11.,+2& -#*&(
.$*(+#3&%1&2+#*%$.$/&%$&(-+&1+#*.::.5.(7&%2&<*+1<5$+**&%1&(-*&2+3+&2&U2&"+2@&
%1&-.*&%11.,.#5&3<(.+*@&#,(.$&#*&U#&,.#$$%@&&-%6+"+2@&]<*(.1.#:57&:+&:#22+3&12%
4#E.$/&,%44+$(*@&#*&#*,-%5#2@&%$&(-+&4.*(#E+*&.$&(-+&0(5.@&2&2+2&+2C.H&KO
'#$(@&FFM@&&IA8&+&*#4+&#005.+*&(%&0%5+&%1#(.%$*8&

.$&#&/+$.<*@&#$3&#&h,H2(#&$&+B02+**.%$&#$3&.$&/+$+2#5&*%4+&3+".#(.%$&12%4&
,%44%$&2<5+&.*&6+55&*<.(+3&(@&499&FJH&RNG&'#@FFF:@8&NSJRNSM&8
C-#2#,(+2.*(.,#557@&'#$(&#5*%&<*+*&(-2(#=,%&#*&#&,%$3.(.%$&%1&12++&(-%</-(&.$
-.*&6%2E&%$&+$5./-(+@(&99&FGK&@#FMA8
9$&.40%2(#$(&2+/<5#(."+&02.$,.05+&.$&(-+&6%2E&%1&#&/+$.<*&?%2./.$#5.(7@&12++3%4&12%4&(2#3.(.%
,2+#(.%$&%1&#&6%2E&%1&#2(&.*&2+/<5#(+3&$%(&%1&$5(7@&2+/<5#&%3&2&(%&.(*&
02#,(.,#:.5.(7A@&:<(&:7&%2.+$(#(.%$&(%6#23&#&,+2(#.$&(70+&%1&:+#<(78&95(-%</-&'#$
,%$*.3+2&(-+&.3+#5&%1&:+#<(7&(%&:+&#&4#$.1+*(#(.%$&%1&=0<2+>&:+#<(7@&-+&*+++*&
<02+4+&"#5<+&%1&-.&0-.5%*%0(-7&,#$&3&2&'#$(&(-+&.3+#5&%1&:+#<(7&.*&.$&1#,(&%$5
12++&-<4#$&:+.$/@&.8+8&#&4%2#5&0+2*%$&6-%&-.4*+51&?12++57A&3+(+24.$+*&-.*&/%#
0+2*%$&6-%&$&7&(-#(&6-.,-&-#*&(-+&+$3&%1&.(*&+B.*(+$,P@&&(9&1>&LIIK&#$(
LFFF:@8&NJ&8
;-<*@&-#".$/&02%,5#.4+3&*<02+4+&12++3%4&.$&#2(&?,2+#(.%$&(-2%</-&12++3%4A&#
.(*&4#$.1+*(#(.%$&.$&(-+&6%2E&%1&#&/+$.<*&?%2./.$#5.(7@&12++3%4&12%4&(2#3.(.%
4%3+5*@&(-+&1<$,(.%$.$/&%1&.4#/.$#(.%$A&'#$(&4#2E*&.(*&:%<$3#2(#(*(%&&14)05+4+
(-+&02.$,.05+&%1&6.*3%4@&(-+&4#$.1+*(#(.%$&%1&2+#*%$&?(#*(+@&,#0#,.(7&%1&]<3/4
%2.+$(#(.%$&(%6&#23&#&3+#5&%1&:+&<(78

>'?'$*7)5+'$ "

!&-#"+&(2.+3&(%&2+"+#5&(-+&1+#(<2+*&%1&12++&(-.$E.$/&#$3&.(*&:%<$3#2.+*&.$&'#$()*&
,%/$.(.%$@&.$&*%,.#5&#$3&3#.57&5.1+@&#$3&.$&(-+&#,(."(7&%1&#$&#2(.*(.,&/+$.<*8&Q7&
(-#(& (-+& ,%$,+0(& %1& =12++& (-.$E.$/>& .*& :#*+3& %$& (-+& <$.(7& %1& .$(+55+,(<#5&
.$*(2<4+$(#5A&#$3&#%,.,%5&+5+4+$&8&
!$&(-+&*0-+2+&%1&E$%&5+3&(-&E.$/&4#$.1+*(*&.(*+51&.$&(-+&1<$,(.%$.$/&%1&,%/$.("
#:.5.(.+*&.$&*-#0.$/&*+$*.:5+&3#(#&#$3&+B0+2.+$,+@&.$&4+(-%3%5%/.,#5&#$3&,%$*(2<,(."+
%1&(-+&,%/$.*.$/&*<:]+,(&#$3&.$&(-+&0%(+$(.#5&%1&+(-.,*(%&.$15<+$,+&(&+&,%/$.("+&02
!$&(-&%,.#5&#$3&#%&#7&*0-+2+&12++&(-.$E.$/&4#$.1+*(*&.(*+51&.$&0+%05+&6-%&#2+
(%&(-.$E&6.(-%<(&,%$*(2#.$(*&#$3&0<:5.,57&+B02+**&(-+.2&%0.$.%$&6-.5+&#3-+2.$/&(%&
%1&*,.+$(.1.,.(7&#$3&/%%&6.558&
!$&(-+&#,(."(7&%1&#$&#2(.*(.,&/+$%&12+43$.1+*(+3&(-2%</-&%2./.$#5.(7&#$3&(-+&
1<$,(.%$.$/&%1&.4#/.$#(.%$&#*&0#2(&%1&+*(-+(.,&0%6+2&%1&]<3/4+$(&#$3&(#*(+@&6
4.$31<5&%1&02#,(.,#:.5.(7&#$3&(-+&.3+#&%1&:+#<(78
;-+&%"+2#55&(+$3+$,7&.$&'#$()*&3+1.$.$/&%1&12++&(-.$E.$/&.*(&&4%44.(+$&&
<$(2#44+5+3&(-.$E.$/&#$3&4.$.4.*.$/&.(*&:%<$3#2.+*&6-,-@&,%<05+3&6.(-&+(-.,#5&1#,(%
2+02+*+$%&"1,%&'5*'*+,,'-$".#".[&%(&1<557&2+#5.*#:5+@&:<(&(%&"#27.$/&3+/2++*&0%**.:
"#2.%<*&*0-+2+*&#$3&<$3+2&"#27.$/&-.*(%2.,#5&,%$3.(.%$*8&
Q7&*(<37&-#*&*-%6$&(-+&2+5+"#$,+&%1&(-+&,%$,+0(&%1&=12++&(-.$E.$/>&#$3&.(*&
"#5<+8&;-+&+(-.,#5&#$3&.$(+55+,(<#5&,%40%$+$(*&%1&12++&(-.$E.$/@&(-+&:#5#$,+&%
,2.(.,.*4&#$3&*%,P#54#$.(#2.#$&,%$,+2$*@&02%".3+@&.$&47&%0.$&%$@&4&2E%&2(#$(
1%2&(-+&4%3+2$&6%253&#$3&.(*&-.*(%2.,#5&0+2*0+,(."+8

@.2.&.$*.5 "

Y2++$:+2/@&h8@&Q1F,N5&47'5*'M+,,152F'@%.-R7'S%47%&'Q$,5+>'58&8"+25.$&i&
X+6&j%2EH&_+&Y2<&7(+28
b.$*(+.$@& 98& #$3& !$1+53@& k8@&#15&4-5& 5*' D$>7&8&7#4:2.3/+H& C#4:2.3/+&
l$."+2*.(7&Z2+*&8
U+/+5@&Y8\8T8@&Q$S1S&8&5:%,1"%T5/&8&%+-'G'5*'-$,'H.8>8&5:%,1"%'5*'D$"&575:$"8%&'
98",.8,7'6"-$'-$,'U47%-&,&9&$+6&(2#$*5#(.%$&6.(-&!$(2%3<,(.%$&#$3&X%(+*&:7&;8T8&Y+2

\898 &W<,-(.$/& #$3& U8W8& U#22.*$&0%5.*& i& C#4:2.3/+H& U#,E+((& Z<:5.*-.$/&
C%40#$7@&l$,8&
U+.3+//+2@&Q8@&NSSM'7$&%&&,1'Q$".#"&7NSJVA8&9&;2#$*5#(0%$&%'1&N,.#,.I &
:7&T8_8&\.+,E&#$3&m8Y8&Y2#7&6.(-&#$&!$(2%3<,(.%$&:7&m8Y8&Y2#78&X+6&j%2E@&
k%$3%$H&U#20+2&i&h%68&
!"#$%'@& Q898@& LFNG8& f$& (-+& T<$,(.%$#5& W0+,.1.,.(7& %1& W,.+$(.1.,& C%/$.(.%$& r
!8;&#*#".$@&;8_8&W%E%5%&#@&$E_8@&b8Y8&Y2+:+$*-,-.E%"#&#$3&!$E%"@&
+3*8& LFNG8&7&5+>'%.1'D$"&575:$>'5*'98",.8,'%-'-$,'Q"2,'5*'S$%./,)'G.'X'B5&42,7
B5&42,'X8&Q%*,%6H&h<**.#$&W%,.+(7&%1&U.*(%27&#$3&Z-.5%*%0&&W,.+$,+@
`%$5.$&a 9"#.5#:5+& #(H& p-((0Hgg2*-0*82<g:%%E*g,%$/2+**LFNG(M8031q& `9,,+*
NF8NF8LFLFa8&?!$&h<*8A
'#$(@&!8@&NSSM'8&7'G-'!,%.'-5'O+",.-'O.,7,&*"'.'Q$".#"./I &$H&!8&'#$(@&NSSM&"/"5.'
%.1'Y%-"5.%&'Q$,5&&/,2#$*5#(+3&:7&Y8&3.&Y.%"#$$.@&+3.(+3&:7&98\8&\%%3&#$3&Y
Y.%"#$$.8&C#4:2.3/+H&C#4:2.3/+&l$."+2*.(7&Z2+**8
'#$(@&!8@&NSSM'!,-%:$>7"875*!5+%&8$H&!8&$(@&NSSM'8&-"8D&'575:$&3.(+3&
:7& Q8m8& Y2+/%2@& (2#$*5#(+3& :7& 98\8& \%%38& C#4:2.3/+H& C#4:2.3/+& l$."+2*.(7&Z
008&JI RMFV&8
'#$(@&!8@&NSSM'8&'5*'D4+,'Y,%78&b3.(+3&#$3&(2#$*5#(+3&:7&Z8&Y<7+2&#$3&98&\%%
C#4:2.3/+H&C#4:2.3/+&l$."+2*.(7&Z2+**8&&
'#$(&!8@&LFFM8&/52,.%'-5'(.>'M4-4+,'!,-%:$>7"87'Q$%-'0"&&'J,'(C&,'-5'S52,'M5+6%+1'
%7'98",.8&?NOGIA8&C#4:2.3/+H&C#4:2.3/+&l$."+2*.(7&Z2+**8
'#$(&!8@&LFFM8&Z4,'5*'-$,'D56,+'5*'[41/,2,.- 8;2#$*5#(+3&:7&Z8&Y<7+2&#$3&b8&Q#((-+6*8&
b3.(+3&:7&Z8&Y<7+28&C#4:2.3/+H&C#4:2.3/+&l$."+2*.(7&Z2+**8
'#$(@&!8&LFFM8&+'-5'-$,'E4,7-"5.F'0$%-'G7'H.&"/$-,.2,.-I &$H&!8&'#$(@&LFFM8&;%6#23&
Z+20+(<#5& Z+#,+& #$3& f(-+2& \2.(.$/*& %$& Z%5.(.,*@& Z+#,+@& #$3& U.*(%278& X+6&
k%$3%$H&j#5+&l$."+2*.(7&Z2+**8&&
Q+2(%$@& h8'8@&NSSM'8&5/>'5*'98",.8,F'Q$,5+,-"8%&'%.1'H2:"+"8%&'G.?,7&%-"5.7
C-.,#/%&i&k%$3%$H&l$."+2*.(7&%1&C-.,#/%&Z2+**8
Q%(2%*-.5%@&X8n8@&LFFJ8&Z#2#3%B+*&%1&T2++3%4&.$&'#$()*&Z-.5%*%0-7H&;-+.2&h+
W"7-5+>'5*'D$"&575:$>'\,%+C55#&Q%*,%6H&X#&LFO8&?!$&h<*8A8
X#2*E..@& !8W8@& NSSI8& '#$()*& C#(+/%27&%1&'T2-[5+%&N?NOAGS&?!$&
h<*8A8
Z%2,-+3<@& h8@& LFNG8& '#$(*& T2+.-+.(*#2/<4+$(8& _.*E<**.%$& "%$& U+.E%& Z<5*H&
^+6<**(*+.$&<$3&'#(+/%2.*,-+2&!40+2#(."&.$&'#$(*&Y2<$35+/<$/8&b.$&'%44+$(#2&c<4&
32.((+$&9:*,-$.((8&_+&Y2<7(+2@&LFNG8&'#$(&!8@&IO?LAGS&