

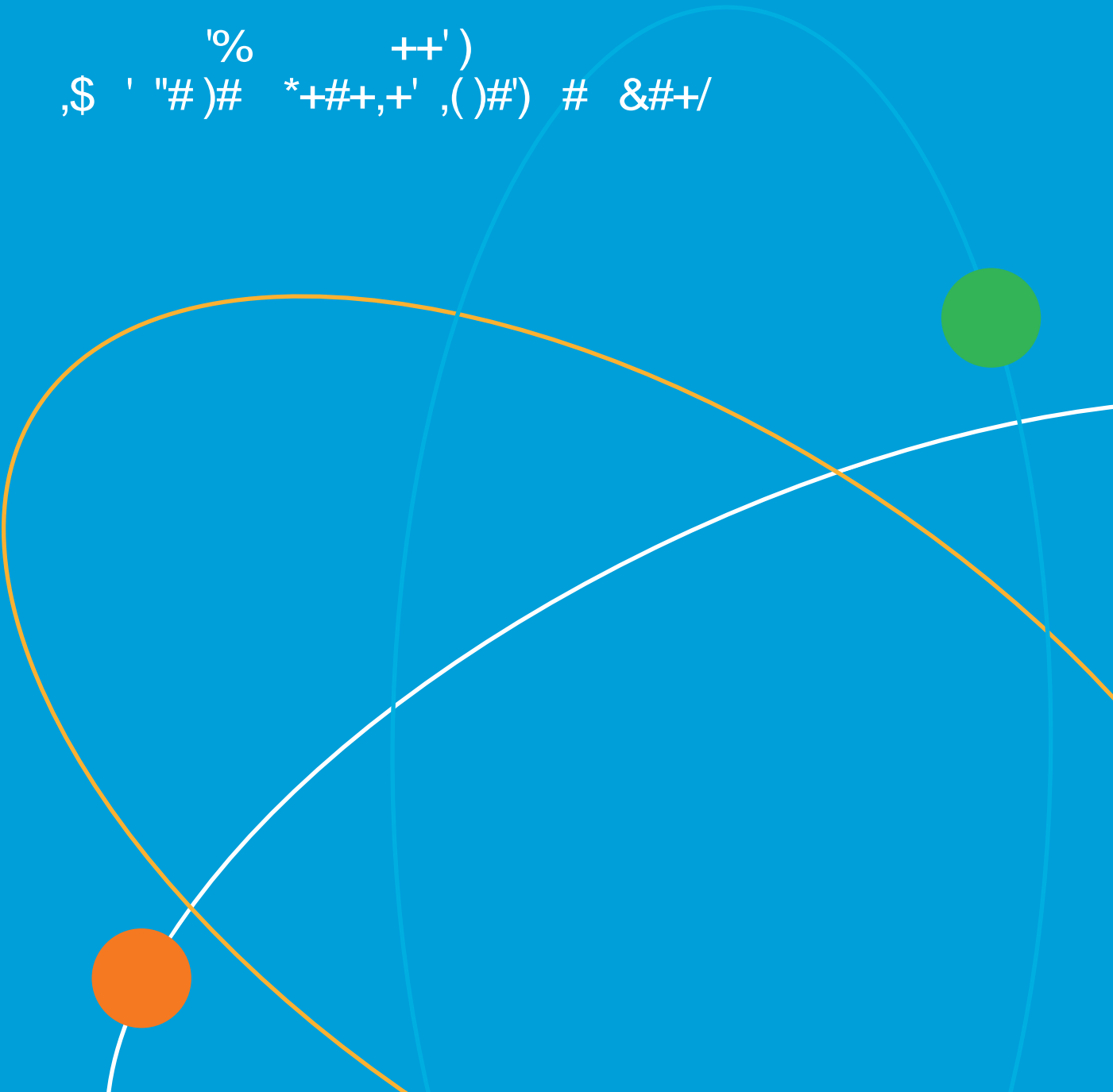
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()#\$!*+'

) # -#'&#
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'% ++')
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#+.3+C3873 #3-;/+ / 9953+ C3873
!;/38.3-8 ./55+ \$8-3/=D =+53+7+
9;/ 5/ #3-;/-2/ <>55/ #+.3+C3873
!>,53+C387/ !;/38.3+
">+.;36/<=;+5/
9;35/ 18<=8 \$>995/6/7=8 +5
'85 (7

3;/=8;/ #/<987<+,35/
;+7-/<-+ +55+;373
?F7HJ?C;DJE :? ?I?97 (K9B;7H; ; ;EH?97
/D?L;HI?JS :? *7L?7
; C7?B <H7D9;I97 87BB7H?D? FL ?D<D ?J

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#+00+/5/ / '3=+
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(;DJHE ;?9;H9>; 71799?7 ,EC7
; C7?B ;L?J7 ;D;7 ?J

+98 #/.+==8;/
8;/7C8 +7=3
?F7HJ?C;DJE :? ?I?97
/D?L;HI?JS ;H?9E ## (7FEB?
; C7?B BEH;DPE C7DJ? D7 ?D<D ?J

863=+=8 .3 #/.+C387/
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?F7HJ?C;DJE :? ;9DEBE=?7 ; -7BKJ;
#IJ?JKJE -KF;H?EH; :? -7D?JS ,EC7
; C7?B <H7D9;I97 7DJED;BB? ?II ?J

+>;8 87+; ;3
/D?L;HI?JS ;=B? -JK: ? ?'B7DE
; C7?B C7KHE 8ED7H: ? C? ?D<D ?J

+; -8 \$-2@+; C
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.H;DJE
; C7?B I9>M7HP 7JH; F ?J


;3<=3+7+ '3.+53
- :? ;?EJ;H7F?7
=;DP?7)IF; ;7B?;HE /D?L;HI?J7H?7
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!;/ 708;6+C3873 / 8;;3<987./7C+
;+7-/<-+ +55+;373
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-J7CF7 digiprintland

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&% 385813+ ./55/ #+.3+C3873 / \$+5>=/ ./55F&868

/7=;8 #3-;/-2/ +<+--3+ < 9
'3+ 71>355+;/</ #
+A
/ 6+35 ./73== /7/+ 3=
2==9 ,38=-/ -+<+--3+ /7/+ 3= <3;;

\$/1;/=;/3+ \$ # #
&% 385813+ ./55/ #+.3+C3873 / \$+5>=/ ./55F&868
/7=;8 #3-;/-2/ +<+--3+ < 9

'3+ 71>355+;/</ #
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'% ++')
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863=+=8 \$-3/7=303-8

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& '7DJ? *Università Federico II, Napoli* ' .78E99>?D? *ISS, Roma*
*799>?;HEJJ? *ENEA, Roma* ;IJ7 *ENEA, Roma*
' *K=B?;I; *Università Federico II, Napoli* .EHH;==?7D? *CNR, Bologna*

863=+=8 ;1+73CC+=8;/

7CF7 *ISS, Roma* ,EI? *ISS, Roma*
, ;0?J7 *ENEA, Roma*) -7FEH7 *ISS, Roma*
- !H7D;:; *ISS, Roma* ' .78E99>?D? *ISS, Roma*
*799>?;HEJJ? *ENEA, Roma* ;IJ7 *ENEA, Roma*
*7JHEDE *ENEA, Roma* 0?:7B? *A.O.U., Trieste*


\$/1;!/;/;3+ / \$>998;=8 %/-73-8

- EB?BB? #-- ,EC7
!H?I7DJ? #-- ,EC7
' -787J?D? #-- ,EC7



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#((#IJ?JKJE (7P?ED7B; :? ?I?97 (K9B;7H;

#-- #IJ?JKJE -KF;H?EH; :? -7D?JS

#, , ;;H7P?ED; #J7B?7D7 ,?9;H9>; IKBB; ,7:~7P?ED?

#' IIE9?7P?ED; #J7B?7D7 :? ?I?97 ?D ';;?9?D7

#'(IIE9?7P?ED; #J7B?7D7 :? ';;?9?D7 (K9B;7H;

#, IIE9?7P?ED; #J7B?7D7 :? ,7:~E8?EBE=?7

#,' IIE9?7P?ED; #J7B?7D7 :? ,7:~EFHEJ;P?ED; ';;?97

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#,* IIE9?7P?ED; #J7B?7D7 :? ,7:~EFHEJ;P?ED;

-#,' IIE9?7P?ED; #J7B?7D7 :? ,7:~EBE=?7 ';;?97

ECKD; :? ,EC7

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87 35 <>998;=8 .3



#((#IJ?JKJE (7P?ED7B; :? ?I?97 (K9B;7H;



#-- #IJ?JKJE -KF;H?EH; :? -7D?JS



#DIJHKC;DJ7J?ED &78EH7JEHO



' ';;?97B ;L;BEFC;DJ

**XV CONVEGNO NAZIONALE DELLA SOCIETÀ ITALIANA PER LE RICERCHE
SULLE RADIAZIONI (SIRR)**

**Roma, Aula Pocchiari, Istituto Superiore di Sanità
27-29 ottobre 2010**

PROGRAMMA DEL CONVEGNO

Mercoledì 27 ottobre 2010

- 8.30-9.00 *Registrazione partecipanti*
- 9.00-9.30 **Inaugurazione del Convegno**
V. Macellari (Direttore Dipartimento di Tecnologie e Salute, Istituto Superiore di Sanità, Roma),
M.A. Tabocchini (Presidente SIRR, Istituto Superiore di Sanità, Roma)
- 9.30-13.00 **SESSIONE CONGIUNTA FIRR-SIRR**
**LA CONSAPEVOLEZZA DEL RISCHIO RADIOLOGICO IN AMBITO MEDICO,
AMBIENTALE, OCCUPAZIONALE**
Moderatori: D. Tirindelli Danesi (Presidente FIRR), M.A. Tabocchini (Presidente SIRR)
- 9.30-10.00 **Assicurazione di qualità in radiodiagnostica**
A. Rotondo (Seconda Università, Napoli)
- 10.00-10.30 **Risk management in radioterapia**
V. Tombolini (Università dell'Aquila)
- 10.30-11.00 *Coffee break*
- 11.00-11.30 **Rischio da radiazioni in diagnostica medico nucleare**
M. Salvatori (Università Cattolica del Sacro Cuore, Policlinico A. Gemelli, Roma)
- 11.30-12.00 **Dosimetria delle estremità e del cristallino in radiologia e cardiologia
interventistica: il progetto EU-ORAMED**
P. Ferrari (ENEA, Bologna)
- 12.00-12.30 **Aggiornamento ICRP**
R. Moccaldi (CNR, Roma)
- 12.30-13.00 **Discussione**
- 13.00-14.00 *Intervallo pranzo*
- SESSIONE I: LE RADIAZIONI IN MEDICINA: SFIDE ED OPPORTUNITA'**
Moderatori: M. Amichetti, V. Donato
- 14.00-14.35 **La moderna radioterapia tra l'integrazione dei saperi e l'innovazione tecnologica**
V. Valentini (Università Cattolica del Sacro Cuore, Policlinico A. Gemelli, Roma)
- 14.35-15.10 **Radioterapia adattiva multi-dimensionale: ottimizzazione radiobiologica
e modelli predittivi**
C. Fiorino (Ospedale San Raffaele, Milano)

Comunicazioni

- 15.10-15.25 **Associazione di brachiterapia (BRT) e radioterapia esterna (EBRT) come terapia adiuvante nel controllo locale dei sarcomi delle parti molli (SPM)**
A. Galuppi (Ospedale S. Orsola-Malpighi, Bologna)
- 15.25-15.40 **Polimorfismi in geni della riparazione del danno al DNA e suscettibilità individuale al tumore mammario**
C. Patrono (ENEA Casaccia, Roma)
- 15.40-15.55 **Applicazione del codice Monte Carlo GEANT4 in radioterapia**
S. Chauvie (Ospedale Santa Croce e Carle, Cuneo)
- 15.55-16.20 *Coffee break*

Comunicazioni

- 16.20-16.35 **Range e Robustezza: il bello o il brutto dei protoni?**
F. Albertini (Paul Scherrer Institute, Switzerland)
- 16.35-16.50 **Il programma di protonterapia TOP-IMPLART**
L. Strigari (IFO- IRE, Roma)

LETTURA MAGISTRALE "MARCELLO QUINTILIANI"

Moderatore: O. Sapura

- 16.50-17.30 ***Interdisciplinarietà e radiobiologia***
G. Simone (Istituto Superiore di Sanità, Roma)
- 17.30-18.30 **Assemblea dei soci**

Giovedì 28 ottobre 2010

SESSIONE II: CHIMICA E RADIAZIONI: RICERCA E NUOVE APPLICAZIONI

Moderatori: S. Emmi, A. Torreggiani

- 8.30-8.40 ***Ricordo di Giuliano Mulazzani***
S. Emmi (ISOF, CNR, Bologna)
- 8.40-9.15 ***Modelli biomimetici di stress radicalico e biomarcatori correlati***
C. Chatgililoglu (ISOF, CNR, Bologna)
- 9.15-9.30 **Comunicazioni**
Danno radicalico in stato di crioconservazione, studio EPR di intrappolamento, rilascio e reazioni dei radicali durante il riscaldamento
D. Dondi (Università di Pavia)
- 9.30- 9.45 **Effetti dell'esposizione della sostanza P a stress radicalico: selettività del danno e suo trasferimento ad altri target biologici**
Z. Jurasekova (ISOF, CNR, Bologna)

- 9.45-10.15 *Coffee break*
- 10.15-10.50 **Applicazioni delle radiazioni alla sintesi di materiali cellulosici innovativi e alla preparazione di eparine a basso peso molecolare**
E. Vismara (Politecnico di Milano)
- Comunicazioni**
- 10.50-11.05 **Nanoparticelle luminescenti di silice per l'imaging e la diagnostica**
N. Zaccheroni (Università di Bologna)
- 11.05-11.20 **Preparazione di sorgenti alfa e caratterizzazione di radionuclidi mediante spettrometria alfa in matrici ambientali ed alimentari**
G. Palumbo (Università Federico II, Napoli)

SESSIONE POSTER

Coordinatori: L. Manti, A. Rosi, A. Testa, A. Torreggiani, C. Vidali

- 11.20-12.30 **Presentazione poster**
- 12.30-13.15 *Intervallo pranzo*
- 13.15-14.40 **Visita ai Poster**

SESSIONE III: EFFETTI BIOLOGICI DELLE RADIAZIONI: APPROCCI MODELLISTICI E SPERIMENTALI

Moderatori: L. Manti, A. Testa

- 14.40-15.15 **Systems Radiation Biology: un possibile strumento per l'indagine dei meccanismi dell'effetto bystander?**
L. Mariotti (Università di Pavia)
- Comunicazioni**
- 15.15-15.30 **I segnali di ¹H MRS del glutathione sono correlati alla radiosensibilità cellulare nei gliomi e nei carcinomi**
A. Palma (Istituto Superiore di Sanità, Roma)
- 15.30-15.45 **Effetto bystander in vivo: nuovi aspetti del meccanismo di trasmissione del danno**
M. Mancuso (ENEA Casaccia, Roma)
- 15.45-16.00 **Alterazioni strutturali e funzionali della DNA glicosilasi OGG1 dopo stress ossidativo**
V. Simonelli (Istituto Superiore di Sanità, Roma)
- 16.00-16.30 *Coffee break*
- 16.30-17.05 **Ruolo dei polimorfismi genetici nella riparazione del danno al DNA radio-indotto**
S. Sterpone (Università degli Studi Roma Tre)

Comunicazioni

- 17.05-17.20 **Studio della modulazione della lunghezza telomerica in fibroblasti umani esposti a raggi X**
A. Sgura (Università degli Studi Roma Tre)
- 17.20-17.35 **Modellizzazione matematica e studio sperimentale della risposta adattativa**
G. Esposito (Istituto Superiore di Sanità, Roma)
- 17.35-17.50 **Influenza del segnale UMTS (1.95 GHz) su danno citogenetico acuto ed instabilità genomica indotti in vitro da radiazione ionizzante ad alto LET**
A. D'Arco (Università di Napoli Federico II)

LETTURA MAGISTRALE "PIETRO METALLI"

Moderatore: F. Pacchierotti

- 17.50-18.30 ***Ruolo del danno ossidativo al DNA nell'instabilità del genoma, nelle malattie neurodegenerative e nell'invecchiamento***
M. Bignami (Istituto Superiore di Sanità, Roma)
- 20.45 **Cena sociale**

Venerdì 29 ottobre 2010

SESSIONE IV: FISICA DELLE RADIAZIONI: ASPETTI DOSIMETRICI E RADIOPROTEZIONISTICI

Moderatori: A. Campa, P. De Felice

- 9.00-9.35 ***Tecniche fisiche e biologiche di dosimetria retrospettiva nelle emergenze radiologiche***
P. Fattibene (Istituto Superiore di Sanità, Roma)

Comunicazioni

- 9.35-9.50 **Sviluppo e caratterizzazione dosimetrica di rivelatori a diamante sintetico monocristallino SSCD (Synthetic Single Crystal Diamond) per impiego in radioterapia con fasci di fotoni di piccola dimensione e di intensità modulata**
R. Consorti (A.C.O. San Filippo Neri, Roma)
- 9.50-10.05 **Dosimetria in vivo su pazienti con tumore pelvico con una camera a ionizzazione**
S. Imbimbo (Università degli Studi di Napoli Federico II)
- 10.05-10.35 *Coffee break*
- 10.35-11.10 ***Il principio di ottimizzazione e la dose collettiva***
M. Pugliese (Università Federico II, Napoli)

Comunicazioni

- 11.10-11.25 **Uso della Spettroscopia ESR per l'identificazione di alimenti ad uso Zootecnico irradiati a scopo conservativo e valutazione dell'effetto sanitizzante attraverso analisi microbiologiche**
M. C. D'Oca (Università di Palermo)

- 11.25-11.40 **Confronto tra due diversi metodi per la determinazione del ksat per camere a ionizzazione ad elettrodi piani e paralleli in fasci di elettroni ad alta dose per impulso (fasci IORT)**
L. Cella (IBB, CNR, Napoli)
- 11.40-11.55 **Nuovi dati relativi alla concentrazione di radon nelle scuole della Campania**
F. De Cicco (Seconda Università degli studi di Napoli)
- CONSEGNA DEI 2 PREMI SIRR PER TESI DI LAUREA E PRESENTAZIONI DEI LAVORI SCIENTIFICI**
- 11.55-12.10 **Valutazione della dose assorbita dal paziente in radiologia digitale: sviluppo di un modello fisico**
D. Ravanelli (Università degli Studi di Trento)
- 12.10-12.25 **I processi di ossidazione avanzata nel trattamento delle acque: la degradazione di un disorganizzatore endocrino, l'octilfenolo**
M. Saracino (Università di Bologna)
- 12.25-12.45 **Premiazione Poster**
- 12.45-13.00 **Verifica con questionario e compilazione della scheda di valutazione ECM**
- 13.00 *Chiusura dei lavori*

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V. Valentini

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C. Fiorino

<<8-3+C387/ .3 ,;+23=;/+93+ #% / ;+.38=;/+93+ /<=;/7+ #% -86/ =;/+93+ +.3>?+7=/
7/5 -87=;8558 58-+5/ ./3 <+; -863 ./55/ 9+;=3 68553 \$!
A. Galuppi., S. Medoro, M. La Macchia, L. Bordonaro, E. Barbieri

!85368;03<63 37 1/73 ./55+ ;39+;+C387/ ./5 .+778 +5 / <><-/=3,353=D 37.3?3.>+5/ +5
=>68;/ 6+66+;38
C. Patrono, S. Sterpone, A. Testa, T. Cornetta, F. Novelli, V. Donato, D. Giammarino, R. Cozzi

9953-+C387/ ./5 -8.3- / 87= / +;58 % 37 ;+.38=;/+93+
C. Andenna, B. Caccia, S. Chauvie, G. A. P. Cirrone, A. Occhigrossi, E. Petetti, S. Valentini

#+71/ / #8,><= /CC+ 35 ./558 8 35 ,;>==8 ./3 9;8=873
F. Albertini, A. Bolsi, C. Algranati, K. Haller, M. Hartmann, A. J. Lomax

5 9;81;+66+ .3 9;8=87=;/+93+ % ! ! #%
G. Arcangeli, M. Benassi, E. Cisbani, S. Frullani, C. Marino, L. Picardi, C. Ronsivalle, L. Strigari,
D. Tirindelli

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G. Simone

8./553 ,38636/=3-3 .3 <=;/<< ;+.3-+53-8 / ,386+;-+=8;3 -8;;/5+=3
C. Chatgialloglu

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;/+C3873 ./3 ;+.3-+53 .>;+7=/ 35 ;3<-+5.+6/7=8
D. Dondi, A. Buttafava, A. Faucitano, R. Cherubini, V. De Nadal, S. Gerardi

00/=3 ./55F/<98<3C387/ ./55+ <8<+=7C+ ! + <=;/<< ;+.3-+53-8 </5/=3?3=D ./5 .+778 / <>8
=;+<0;/36/7=8 +. +5=;3 =+;1/= ,385813-3
Z. Jurasekova, A. Torreggiani, F. Genovese, M. Cantù, C. Ferreri, C. Chatgialloglu

9953-+C3873 ./55/ ;+.3+C3873 +55+ <37= /<3 .3 6+="/;3+53 -/55>58<3-3 3778?+=3?3 / +55+ 9;/9+;+
.3 /9+;37/ + ,+<<8 9/<8 685/-85+;/
E. Vismara

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S. Bonacchi, D. Genovese, R. Juris, M. Montalti, L. Prodi, E. Rampazzo, N. Zaccheroni

!;/9+;+C387/ .3 <8;1/7=3 +50+ / -+;+==;/3CC+C387/ .3 ;+.387>-53.3 6/.3+7=/ <9/==;86/=;3+ +50+
37 6+;=;3-3 +6,3/7=+53 / .+536/7=+;3
V. Roca, M. G. Pugliese, F. De Cicco, G. Palumbo

\$B<=/6< #+.3+=387 38581B >7 98<<3,35/ <=;>6/7=8 9/; 5F37.+137/ ./3
6/--+7<63 ./55F/00/=8 ,B<=+7./;
L. Mariotti, D. Alloni, D. Cappelletti, D. Scannicchio, A. Ottolenghi

</17+53 .3 #\$. /5 15>+=387/ <878 -8;/5+=3 +55+ ;+.38</7<3,353=D -/55>5+;/ 7/3 153863 / 7/3
-+;-37863

A. Palma, S. Grande, A. Rosi, A. M. Luciani, C. Giovannini, O. Sapora, L. Guidoni, V. Viti

00/==8 ,B<=+7./; 37 ?3?8 7>8?3 +<9/==3 ./5 6/--+73<68 .3 =;+<63<<387/ ./5 .+778
M. Mancuso, S. Leonardi, E. Pasquali, S. Rebessi, M. Tanori, P. Giardullo, F. Borra, V. Di Majo,
S. Pazzaglia, A. Saran

5=;/+C3873 <=;>==>;+53 / 0>7C387+53 ./55+ 153-8<35+<3 .898 <=;/<< 8<<3.+<3?8
V. Simonelli, S. Camerini, F. Mazzei, A. Minoprio, M. D'Errico, M. Crescenzi, M. Bjoras, E. Dogliotti

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S. Sterpone

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R. Buonsante, D. Nieri, F. Berardinelli, A. Antoccia, C. Tanzarella, A. Sgura

8./553CC+C387/ 6+=/6+=3-+ / <=>.38 <9;/36/7=+5/ ./55+ ;3<98<=+ +.+=+=3?+
G. Esposito, M. Pinto, S. Grande, G. Simone, M. A. Tabocchini, M. Belli, G. Patel, R. Ugenskiene,
G. Schettino, K. M. Prise, A. Campa

705>/7C+ ./5 </17+5/ & %\$ C <> .+778 -3=81/7/=3-8 +->=8 /. 37<=+,353=D 1/7863-+
37.8==3 37 ?3=;8 .+ ;+.3+C387/ 3873CC+7=/ +. +5=8 %

A. D'Arco, L. Manti, L. Campajola, G. Gialanella, R. Massa, P. Scampoli, G. Grossi

#>858 ./5 .+778 8<<3.+<3?8 +5 7/55F37<=+,353=D ./5 1/786+ 7/55/ 6+5+==3/
7/>;8./1/7;+=3?/ / 7/55F37?/--23+6/7=8

M. Bignami

%d-73-2/ 03<3-2/ / ,385813-2/ .3 .8<36/=;3+ ;/=;8<9/==3?+ 7/55/ /6;/1/7C/ ;+.385813-2/
P. Fattibene

\$?35>998 / -+;+==;/3CC+C387/ .8<36/=;3-+ .3 ;3?/5+=8;3 + .3+6+7=/ <37=/=3-8 6878-;3<=+5537
\$\$ **Synthetic Single Crystal Diamond** 9/; 3693/18 37 ;+.38=/;+93+ -87 0+<-3 .3 08=873 .3 93--85+
.36/7<387/ / .3 37=/7<3=D 68.>5+==+

R. Consorti, A. Petrucci, I. Ciancaglioni, M. Marinelli, E. Milani, G. Prestopino, C. Verona,
G. Verona-Rinati, F. De Notaristefani

8<36/=;3+ 37 ?3?8 <> 9+C3/7=3 -87 =>68;/ 9/5?3-8 -87 >7+ -+6;/+ + 3873CC+C387/
L. Iadanza, S. Imbimbo, S. Maffei, M. Mormile, V. Cerciello

5 9;37-3938 .3 8==363CC+C387/ / 5+ .8</ -855/==3?+
M. G. Pugliese

&<8 ./55+ \$9/==;8<-893+ \$# 9/; 5F3./7=303-+C387/ .3 +536/7=3 +. ><8 *88=-/73-8
3;;+.3+=3 + <-898 -87</;?+=3?8 / ?+5>=+C387/ ./55F/00/==8 <+73=3CC+7=/ +=;+?/;<8 +7+53<3
63-;8,385813-2/

M. C. D'Oca , A. Bartolotta, P. Fuochi, A. M. Di Noto, C. Cardamone

870;87=8 =;+ .>/ .3?/;<3 6/=8.3 9/; 5+ ./=/;637+C387/ ./5 k_{sat} 9/; -+6;/+ 3873CC+C387/ +.
/5/==;8.3 93+73 / 9+;+55/53 37 0+<-3 .3 /5/==;873 +. +5=+ .8</ 9/; 369>5<8 0+<-3 #%

L. Cella, R. Liuzzi

>8?3 .+=3 ;/5+=3?3 +55+ -87-/7=;+C387/ .3 ;+.87 7/55/ <->85/ ./55+ +69+73+
F. De Cicco, M. G. Pugliese, V. Roca, C. Sabbarese

'+5>=+C387/ ./55+ .8</ +<<8;,3=+ .+5 9+C3/7=/ 37 ;+.385813+ .313=+5/ <?35>998 .3 >7 68./558
03<3-8
D. Ravanelli, A. Valentini

O32- I processi di ossidazione avanzata nel trattamento delle acque: la degradazione di un disorganizzatore endocrino, l'octilfenolo

M. Saracino, S. Caminati, S. S. Emmi, B. Esposito, E. Ferri, E. Gattavecchia

! \$% #

! 8<36/=;3+ 37 ?3?8 -87 >7 0+<-38 .3 9;8=873 ./0373C387/ ./5 -87-/==8 +7+53<3 / 63<> ;/
C. Algranati, M. L. Belli, M. Mumot, S. Koenig, M. Hartmann, E. Hug, A. J. Lomax

! '+5>=+C387/ ./55+ 9;81; /<<387/ 9; /-8- / .3 6+5+==3+ 37=/;-8; /7=/ =;+ -23;>;13+ / =/;+93/
+.3>?+7=3 7/5 1538,5+<=86+ -87 ;3<87+7C+ 6+17/=3-+ 6>5=3 9+;+6/=;3-+ + %
D. Amelio, P. Farace, G. K. Ricciardi, A. Beltramello, M. Amichetti

! /3+=8;3 9; /-8-3 / =+;.3?3 .3 /00/==3 ,B<=+7./;
F. Antonelli, S. Grande, L. Mariotti, A. Rosi, G. Esposito, G. Simone, A. Campa, M. Belli, A. Ottolenghi,
D. Cappelletti, A. Bertolotti, E. Ranza, A. Facchetti, M. A. Tabocchini

! '+5>=+C387/ ;+.38=8<<3-85813-+ + </1>3=8 .3 =;+003-8 37=/;7+C387+5/ .3 6+=/;3+5/ 7>-5+;/
G. Capannesi, C. Vicini, A. Rosada, P. Avino

! \$=>.38 !# ./3 9;8- /<<3 ;+.3-+53-3 7/55+ 6/---+7853<3 / ;+.3853<3 .3 6+=/;3+53 3693/1+=3 7/55+
.8<36/=;3+ ;/=;8<9/==3?+
A. Buttafava, D. Dondi, A. Faucitano

! 00/==3 ./55/ ;+.3+C3873 3873CC+7=3 <>55+ -86>73-+C387/ -/55>5+;/ >78 <=>.38 -869+;+=3?8 0;
9+;=3-/55/ G 9;8=873 / ;+113 H =;+63=/ 5+ =/-73-+ ./5 !+=-2 5+69
G. Castellani, R. Cherubini, V. De Nadal, S. Gerardi, M. Marengo, D. Remondini, I. Zironi

! ' /;<8 <85>C3873 .3 5+?+1138 <8<=/73,353 +<<3<=3=/ .+ ;+.3+C3873
S. S. Emmi, C. Castro, B. Esposito, M. Saracino, E. Ferri, L. Bossi, L. Arteconi, A. Ciarletta

! 5 -871/5+6/7=8 373,3<-/ 5+ 68;=/ -/55>5+;/ 37.8==+ .+ ;+.3+C3873 3873CC+7=3
G. Cugia, A. Lucarini, F. Centis, G. Del Zotto, E. Argazzi, M. Bono, G. Zini, M. Valentini, F. Picardi, W. Cesarini,
E. Fusco, L. Zamai

! 9953-+C387/ ./5 7>8?8 08;6+53<68 9/; 5+ ./=/;637+C387/ .3 .8</ 37 0+<-3 9/; =868=/;+93+
M. C. Pressello, C. De Angelis, R. Rauco, D. Aragno, M. Betti, D. Viscomi, E. Santini

! /=8.3 03<3-3 .3 -870/;6+ 9/; 5F3./7=303-+C387/ .3 8<=;3-2/ 3;;+.3+=/
S. Della Monaca, C. Boniglia, P. Fattibene, R. Gargiulo, E. Bortolin

! 00/==8 9;8=/==3?8 ./55+ -;38 -87</;?+C387/ <>55+ ;3<98<=+ .3 <3<=/63 ,385813-3 + ;+113 H
R. Cherubini, V. De Nadal, S. Gerardi

! '+5>=+C387/ .3 >7+ ;3<98<=+ +.+=+=3?+ 37 53708-3=3 .3 9+C3/7=3 39/;=3;83./3 <8==898<=3 + 6/=+,853-+ -87 38.38

V. Dini, M. Belli, G. Simone, L. Lo Conte, D. Dambra, M. Salvatori, A. Giordano

! #/+C3873 .3 -;8<<5374371 / 1;+0=371 <> 63<-/5/ <353-/ / <353-/ /5+<=86/;3 37.8==/ .+ ;+.3+C3873 3873CC+7=3

D. Dondi, C. Palamini, A. Buttafava, A. Faucitano

! !8<<3,353 /00/==3 ./55F/<98<3C387/ + -+698 /5/==;86+17/=3-8 \$ <>55+ 68;085813+ =3;83./+ 37 ;+=3 \$9;+1>/ +@5/B

P. Galloni, M. Bossola, A. Lanzoni, G. A. Lovisolo , M. Piscitelli, R. Pinto, C. Marino

! ;+23=;/+93+ +. +5=8 ;+=/8 .3 .8</ #% # / ;+.38=;/+93+ /<=;/;7+ #% +<<8-3+=+ + -2/638=;/+93+ 7/5 =;+==+6/7=8 ./5 -85+7138-+;-3786+

A. Galuppi, S. Medoro, M. La Macchia, C. Blasi, E. Barbieri

! 00/==3 787 537/+;3 37.8==3 .+ ,+<</ .8<3 .3 ;+.3+C3873 3873CC+7=3 .3 .3?/;<+ :>+53=D 37 <3<=63 37 ?3=;8

R. Cherubini, V. De Nadal, S. Gerardi

! ;+113+6/7=8 -87 0+<-3 .3 9;8=873 =;/+9/>=3-3 /00/==3 <>5 6/=+,853<68 -/55>5+;/ /<+637+=3 6/.3+7=/ <9/==;8<-893+ #

S. Grande, A. Palma, A. M. Luciani, A. Rosi, C. Giovannini, O. Sapora, G. A. P.Cirrone, G. Cuttone, F. Di Rosa, V. Viti, L. Guidoni

! !% % 7/55+ ./0373C387/ ./3 ?85>6/ .3 =;+==+6/7=8 9/; 35 ,88<= 5370878.+5/ 7/3 =>68;3 ./55+ -/;?3-/ >=;/;37+ 37 <=+.38 58-+56/7=/ +?+7C+=8 % &\$

M. La Macchia, A. Galuppi, S. Medoro, E. Barbieri

! 870;87=8 =;+ ;+.38=;/+93+ +. 37=/7<3=D 68.>5+=+ -87 08=873 #% / ;+.38=;/+93+ +. 37=/7<3=D 68.>5+=+ -87 9;8=873 !%

S. Lorentini, A. J. Olch, B. Rombi, M. Amichetti, M. Schwarz

! 00/==3 ./55F/<98<3C387/ 37 ?3=;8 + -+693 /5/==;86+17/=3-3 \$ <> 03;,8,5+<=3 >6+73

P. Galloni, E. Bennici, L. Bocchio Chiavetto, A. M. Cattaneo, R. Lodato, G. A. Lovisolo, C. Marino

! 693/18 ./55+ =/-73-+ \$!# 9/; 5+ 63<>;+ ./55F+==3?3=D 153-8<35+<3-+ 37 /<=;+==3 -/55>5+;3

P. Torreri, E. Turco, T. C. Petrucci, A. Minoprio, V. Ruggieri, P. Pichierri, M. Bignami, F. Mazzei

! 7<=+,353=D -;868<863-+ 37.8==+ 37 03;,8,5+<=3 >6+73 .+ ,+<</ .8<3 .3 ;+.3+C3873 .3 .3?/;<+ :>+53=D

D. Nieri, F. Berardinelli, A. Sgura, R. Cherubini, V. De Nadal, S. Gerardi, C. Tanzarella, A. Antoccia

! 00/==8 ,B<=+7./; 37 03;,8,5+<=3 >6+73 37 0>7C387/ ./55+ :>+53=D ./55+ ;+.3+C387/

L. Mariotti, F. Antonelli, G. Esposito, G. Simone, A. Campa, M. Belli, D. Cappelletti, A. Bertolotti, E. Ranza, M. A. Tabocchini, A. Ottolenghi

! /58-3=D / 0/./5=D ./55+ ;39+;+C387/ ./55/ ;8==>:/ + .8993+ /53-+ 37.8==/ .+ ;+.3+C3873 3873CC+7=3 37 -/55>5/ .3 63.8558 8<</8 / <9/;6+=8-3=3 9;36+;3 .3 ~~Rad54B~~ **Rad54B**

T. Salvitti, E. Cordelli, P. Eleuteri, M. G. Grollino, L. Paris, F. Pacchierotti

! <</7C+ .3 /00/==3 **bystander** 37 9;863/58-3=3 >6+73 37.>-3,353 + .300/;7C3+6/7 ~~#~~ **in vitro**

I. Pecchia, V. Dini, O. Sapora, M. A. Tabocchini

! #+.38=;/+93+ \$=;/8=+<3-+ 7/5 --7-;8 985687+;/ 9>E 5+ ?/7=35+C387/ -87 8<<31/78 -87</7=3;/ 5F3;+;+3+C387/ 37 +97/+ 631538;+7.8 5F+-->;+=/CC+ .3 =;+==+6/7=8 .3 >7 <3<=/6+ .3 +=371 #/<93;+=8;38 #!

M. Romano, S. Maluta, C. Cavedon, M. G. Giri, G. Meliador

! 5 9;81/==8 \$35/7C38 8<63-8 *in vivo*

G. Simone, M. A. Tabocchini, G. Esposito, E. Fratini, A. Tessitore, R. Amendola, E. Alesse, F. Zazzeroni, L. Fruci, M. Balata, L. Ioannucci, P. Sykes, R. Ormsby, B. Blyth, L. Satta

! +5-858 138;7+53;/8 ./55+ .8</ +<<8;,3=+ .3 ;+3+C3873 3873CC+7=3 / 63<>;+C387/ 37.3?3.>+5/ ./55F/7/;13+ ;35+<-3+=+ .+ >7 -+698 6+17/=3-8 7>-5+;/

M. Stroili

! 00/==8 .3 +5=;/+C3873 -86,37+=/ .3 !+=-2/ . / .3 1/73 ./5 ;39+;8 ./5 37 =>68;3 -;/;+53

M. Tanori, M. Mancuso, E. Pasquali, S. Leonardi, P. Giardullo, S. Rebessi, V. Di Majo, A. Saran, S. Pazzaglia

P30- Alterazioni di struttura di oligopeptidi auto-assemblanti per superfici biomimetiche causate da stress radicalico

A. Torreggiani, M. Di Foggia, P. Taddei, M. Dettin, A. Tinti

! 2363-+ ./55/ ;+3+C3873 +9953-+=+ +558 <=>.38 ./153 /00/==3 ./558 <=;/<< ;+3-+53-8 <> ,38685/-85/

S. Barata Vallej, Z. Jurasekova, F. Boussicault, M. Terzidis, A. Torreggiani, C. Ferreri, C. Chatgialiloglu

! +;+==;/3CC+C387/ ./55+ ?+;3+7=/ ./55+ 153-8<35+<3 >6+7+ &%) 35 ;>858 ./55/ 37=;/+C3873 9;8=/37+ 9;8=/37+

E. Turco, P. Torreri, T. C. Petrucci, A. Minoprio, V. Ruggieri, P. Pichierri, G. N. Ranzani, M. Bignami, F. Mazzei

! '5>=+C387/ ./153 /00/==3 + ,;/?/ / 5>718 =;/637/ 37.8==3 .+55/ ;+3+C3873 3873CC+7=3 <>55+ <9/;6+=81/7/<3 6>;37+

E. Di Caprio, P. Eleuteri, M. G. Grollino, F. Pacchierotti, E. Cordelli, P. Villani

! \$878 3 93+73 8==/7>=3 -87 9;8=873 +. 37=/7<3=D 68.>5+=+ !% <>003-3/7=/6/7=/ +003.,353 ;3<9/==8 +55/ 37-;/=CC/ 9/; 5F3;+;+3+C387/ .3 5/<3873 9;8<+=+3-2/ -87 -837?85136/7=8 5370878.+5

L. Widesott, F. Albertini, A. Bolsi, D. Amelio, R. Schneider, E. Hug, M. Schwarz, A. Lomax

! #+.38</7<3,353CC+C387/ .3 153863 9/; +.;8=;/+93+

I. Improta, D. Bettega, P. Calzolari, V. de Franciscis, G. Gialanella, M. Lupi, L. Manti, R. Marchesini, R. Massa, E. Pignoli, P. Scampoli, P. Ubezio, G. Grossi

ABSTRACT

+ 68./;7+ #+.38=;/+93+ =;+ 5F37=/1;+C387/ .J3 <+9;/3 / 5F3778?+C387/ /=785813-+

I?7 ?D J;HC?D? :? 9EDJHEBBE :? C7B7JJ?7 E :? ?DIEH=;DP7 :? ;<< ;!?:;H7J?

V. Valentini

/D?L;HI?JS 7JJE?97 :;B -79HE KEH; *EB?9B?D?9E !;C;BB?

-EFH7JKKJE F;H GK7DJE H?=-K7H:7 Bc?DIEH=;DP7 :? ;<<;JJ? 9EB B7 CE;;BB?IJ?97 FH;L?I?ED7B; L7 L?7 L?7 7<<<?D7D:E B7 FEII?8?B

&7 CE;;HD7 H7?:EJ;H7F?? E<<H; 7? F7P?;DJ? 7<<<;JJ? :7 JKCEH;H7F?? ;<<<D; DEC;DEBE=?9E &cKJ?B?PPE ;;BB7 / >7 C7==?EH? EFFEJHKD?JS :? =K7H?=?ED; ; :? FH;I;HL7P?ED; ;;BB7 BEHE <KDP?ED; +K;IJE C?=-B?EH7C;DJE U EJJ;DDE H7B?E =?9E 9EC; IJHKC;DJE :? L7BKJ7P?ED; ;; EJJ?C? C7B7J? ; ;BB7 BEHE <KDP?ED; +K;IJE C?=-B?EH7C;DJE U EJJ;DDE H7B?E =?9E 9EC; IJHKC;DJE :? L7BKJ7P?ED; ;; EJJ?C? ?DJ;=H7P?ED; :? I7F;H? :?L;HI? &7 CE;;HD7 H7?:EJ;H7F?? I? 7LL7P?ED; ;<<<D; DEC;DEBE=?9E &cKJ?B?PPE ;;BB7 / >7 ;;BBc7FFHE<ED?7C;DJE ;;BB; 9EDEI9;DP; IKBb?DJ;H7P?ED; :?H7F??D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7

FB7I?97 ; ;B C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E CEB;9EB;D;B FEJ;DP?7H; B7 IK7 7P?ED; IKBB; 9;BBKB; D;EFB7I?7?H?=?ED; :? F7HJ?9;BB; ;?<<<H;DJ? :7=B?C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E J?L?I?7?F;H (* 9>; F;H . * CEBJ?I?CE H;IJ7 7D9EH7 :7 <7H; F;H (KEL; CE:7B?JS :? 799;B;H7P?ED; ;? F7HJ?9;BB; ;?<<<H;DJ? :7=B?C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E H;D:EDE :?IFED?8?B? H7:??P?ED? :7BB; 97H7JJ;H?IJ?9>; KJ?9EB?C; ;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E C;DJ; F;H;<P?ED7H; Bc?HH7:??P?ED; :? 8;HI7=-B? 9ECFB;I? ; ;J;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E D;BB7 BEHE I;DI?8?B?JS &7 H7FFH;I;DJ?7P?ED; C:;?7DJ; KD <?7C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E ?;DJ?<?97H; C;=-B?E ? LEBKC? 7 H?I9>?E :? FH;I;DP7 :? C7B7JJ?7 E :? ?DIEH=;DP7 :? ;<< ;!?:;H7J? J?L?I?7?F;H (* 9>; F;H . * CEBJ?I?CE H;IJ7 7D9EH7 :7 <7H; F;H =DEIJ?97 <7LEH?I9; ?B CED?JEH7==?E ;;BB7 9EHH;JJ7 =;EC;JH?7 :? B?C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E J7C;DJE H7:??7DJ; :KH7J; JKJJ7 B7 IK7 :KH7J7 ; ?B =EL;HDE =;BB7 #?% -86/ =;/+93+ +.3>?+7=/ 7/5 -87=-;8558 58-+5/ ?HH7:??P?ED; :? EH=7D? ?D CEL?C;DJE /3 <+;-863 ./55/ 9+;=3 68553 \$!

&c;I;D; ;HI? ;;BB; FEII?8?B?JS ;;BB; 7BJH; J;H7F?; ED9EBE=?9>; <7LEH?I9; B7 :;<<?D?P?ED; :? 7FFHE99? J;H7F;KJ?9? F;HIED7B?PP7J? ?D =H7E; ;? =H7D

G. Gullotti¹, S. Medoro, M. La Macchia, L. Bordonaro, E. Barbieri

J?H; DED IEBE B7 =K7H?=?ED; ;? F7P?;DJ? C7 7D9>; KD7 BEHE I;DI?8?B?JS &7 H7FFH;I;DJ?7P?ED; C:;?7DJ; KD <?7C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E GK7B?JS :? L?J7 &7 F;H9;P?ED; :7 F7HJ; ;;BB7 <ED:7C;DJ7B; ?CFEHJ7DP7 :? ?;DJ?<?97H; D;BBc;GK?F; J;H7F;KJ?9? ;? I7D?J7H?L?9?D? 7BB; 9ECFB;I; :?D7C?9>; ;CEJ?L; ;;EH=7D?PP7J?L; D;BB; GK7B? ;? IJHEI?7E 7 ?9;C8H; F7P?;DJ? FP 7<<<;JJ? :7 7 L?L;H; H?9>; ;;Bc;I;H9?P?E :? KD I7F;H; H;B7P?ED7B; 7JJ;DJE ;;BB7 BEHE I;DI?8?B?JS &7 H7FFH;I;DJ?7P?ED; C:;?7DJ; KD <?7C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E F;J;DJ; (;BB7 CE;;HD7 H7?:EJ;H7F?? 7 DKEL; FHE<?B? FHE<?;I?ED7B? B?9B?D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 I;DJ;D:E B; D;9;I?H?; EJJ?C?PP7P?ED? &7 FEII?8?B?JS :? H;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E C799>?D; ?8H?; 9ED :?7=DEIJ?9>; :?IFED?8?B? D;BBc7FF7H;9>?D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 JH7JJ7C;DJE E :? CEDJ7H; KD?JS :? J;H7F?? ?D 7FF7H;99>?7JKH; :? :? =DEIJ?97 <7LEH?I9; ?B CED?JEH7==?E ;;BB7 9EHH;JJ7 =;EC;JH?7 :? B?C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E J7C;DJE H7:??7DJ; :KH7J; JKJJ7 B7 IK7 :KH7J7 ; ?B =EL;HDE =;BB7 #?% -86/ =;/+93+ +.3>?+7=/ 7/5 -87=-;8558 58-+5/ ?HH7:??P?ED; :? EH=7D? ?D CEL?C;DJE /3 <+;-863 ./55/ 9+;=3 68553 \$!

C. Fiorino

IF:;7B; -7D ,7<<<7;B; 'B7DE

IEDE IJ7? IEJJEFEIJ? 7 JH7JJ7C;DJE 9>?HKH=?9E FH;IIE Bc#IJ? JH;F? :?9E ;?PPEB? 7 .. FH;IIE Bc#IJ?JKJE :? ;?EJ;H7F?? ;;B *E B?9B?D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 IED7B? ;;BB7 BEHE <KDP?ED; +K;IJE C?=-B?EH7C;DJE U EJJ;DDE H7B?E =?9E 9EC; IJHKC;DJE :? L7BKJ7P?ED; ;; EJJ?C? ?DJ;=H7P?ED; :? I7F;H? :?L;HI? &7 CE;;HD7 H7?:EJ;H7F?? I? 7LL7P?ED; ;<<<D; DEC;DEBE=?9E &cKJ?B?PPE ;;BB7 / >7 ;;BBc7FFHE<ED?7C;DJE ;;BB; 9EDEI9;DP; IKBb?DJ;H7P?ED; :?H7F??D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 I;DJ;D:E B; D;9;I?H?; EJJ?C?PP7P?ED? &7 FEII?8?B?JS :? H;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E C799>?D; ?8H?; 9ED :?7=DEIJ?9>; :?IFED?8?B? D;BBc7FF7H;9>?D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 JH7JJ7C;DJE E :? CEDJ7H; KD?JS :? J;H7F?? ?D 7FF7H;99>?7JKH; :? :? =DEIJ?97 <7LEH?I9; ?B CED?JEH7==?E ;;BB7 9EHH;JJ7 =;EC;JH?7 :? B?C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E J7C;DJE H7:??7DJ; :KH7J; JKJJ7 B7 IK7 :KH7J7 ; ?B =EL;HDE =;BB7 #?% -86/ =;/+93+ +.3>?+7=/ 7/5 -87=-;8558 58-+5/ ?HH7:??P?ED; :? EH=7D? ?D CEL?C;DJE /3 <+;-863 ./55/ 9+;=3 68553 \$! ;? 97I? 7 B?L;BBE :;= 7HJ? ?D<;H?EH? D;B 7 B?L;BBE :;=B? 7HJ? IKF;H?EH? ;;D;B 7B; &; ;?IJEBE=?; F?X <H;GK;DJ? IEDE IJ7J; I7H9EC7 7 9;BBKB; <KI I7H9EC7 I?DEL?7B; I7H9EC7 7 9;BBKB; <KI7J; ; FEB? CEH<; -EDE IJ7J? IEJJEFEIJ? 7 .. ;; FP :EFE FH?C7 ;N;H;I? # =HKFFE FP :EFE ;I9?II?ED; :? 9?97JH?9; ## =HKFFE FP :EFE ;I9?II?ED; :? H;9?L7 ### =HKFFE #D<?D; FP IEDE IJ7J? H;?HH7:??J? C:;?7DJ; ; :EFE ;N;H;I? :? H;9?L7 #O =HKFFE -EDE IJ7J? FEI?P?ED7J? IKB B;JJE 9>?HKH=?9E 97J;J;H? ;;BB7 BEHE <KDP?ED; +K;IJE C?=-B?EH7C;DJE U EJJ;DDE H7B?E =?9E 9EC; IJHKC;DJE :? L7BKJ7P?ED; ;; EJJ?C? ?DJ;=H7P?ED; :? I7F;H? :?L;HI? &7 CE;;HD7 H7?:EJ;H7F?? I? 7LL7P?ED; ;<<<D; DEC;DEBE=?9E &cKJ?B?PPE ;;BB7 / >7 ;;BBc7FFHE<ED?7C;DJE ;;BB; 9EDEI9;DP; IKBb?DJ;H7P?ED; :?H7F??D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 I;DJ;D:E B; D;9;I?H?; EJJ?C?PP7P?ED? &7 FEII?8?B?JS :? H;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E C799>?D; ?8H?; 9ED :?7=DEIJ?9>; :?IFED?8?B? D;BBc7FF7H;9>?D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 JH7JJ7C;DJE E :? CEDJ7H; KD?JS :? J;H7F?? ?D 7FF7H;99>?7JKH; :? :? =DEIJ?97 <7LEH?I9; ?B CED?JEH7==?E ;;BB7 9EHH;JJ7 =;EC;JH?7 :? B?C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E J7C;DJE H7:??7DJ; :KH7J; JKJJ7 B7 IK7 :KH7J7 ; ?B =EL;HDE =;BB7 #?% -86/ =;/+93+ +.3>?+7=/ 7/5 -87=-;8558 58-+5/ ?HH7:??P?ED; :? EH=7D? ?D CEL?C;DJE /3 <+;-863 ./55/ 9+;=3 68553 \$! #5368;03<63 37 1/73 ./55+ ;39+;+C387/ .I5 .+778 +5 C;DJ; KJ?B?PP7J? >7DDE =;D;H7BC;DJ; `FE9Ea :? 8?EBE=?9E C7 E<<<?7D?=<?7D?=?9E 3,353=D 37.3?3.>+5/ +5 =68;/ 6+66+;38 <HEDE JKJJ7L?7 B7 FEII?8?B?JS :? EF;H7H; ?D CEBJ; I?JK7P?ED? IJ?C; 7887IJ7DP7 9EHH;JJ; ;;BBcEKJ9EC; :? KD JH7JJ7C;DJE H7:??EJ;H7F?? 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 I;DJ;D:E B; D;9;I?H?; EJJ?C?PP7P?ED? &7 FEII?8?B?JS :? H;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E C799>?D; ?8H?; 9ED :?7=DEIJ?9>; :?IFED?8?B? D;BBc7FF7H;9>?D?9E ; =;D;J?9E CEB;9EB7H; 9EDJH?8K?HS 7: 7<<<D7H; C :?H;JJ7 JH7 B; H7:??P?ED? ; :?L;HI? FHE9;I? C;J78EB? ;;BB7 9EB?DE; ;;BB? E==? ;!?:;H7J?9E 9ED BcE8?;JJ?LE :? F;HIED7B?PP7 JH7JJ7C;DJE E :? CEDJ7H; KD?JS :? J;H7F?? ?D 7FF7H;99>?7JKH; :? :? =DEIJ?97 <7LEH?I9; ?B CED?JEH7==?E ;;BB7 9EHH;JJ7 =;EC;JH?7 :? B?C?9HE7C8?;DJ; 9>; B7 9?H9ED:7 ; IKB HKEBE ;;BB;H7F?? 7D9>; :7B FKDJJE :? L?IJ7 H7?E8?EBE=?9E J7C;DJE H7:??7DJ; :KH7J; JKJJ7 B7 IK7 :KH7J7 ; ?B =EL;HDE =;BB7 #?% -86/ =;/+93+ +.3>?+7=/ 7/5 -87=-;8558 58-+5/ ?HH7:??P?ED; :? EH=7D? ?D CEL?C;DJE /3 <+;-863 ./55/ 9+;=3 68553 \$!

C. Fiorino¹, S. Sterpone², A. Testa¹, T. Cornetta², F. Novelli¹, V. Bortone³, D. Giammarino³, R. Cozzi²

20 EDL;=DE (7P?ED7B; ,EC7 EJJE8H;

&c7KC;DJE ;B !- ' ?D J;CF? 8H;L? :EFE Bc?HH7==?7C;DJE :? =B...
U IJ7JE C;IIE ?D H;B7P?ED; 7BBc7JJ?L7P?ED; ;B I?IJ;C7 :? 79D9HE #DEBJH; ?D KDE IJK;?E :? 9EHH;B7P?
;B =BKJ7CC7JE 9ED B7 9?IJ?D7 ?D:EJJE :7BB; H7:??P?ED? J;CF?;BKJ?I9>?E :? 97D9HE #DEBJH; ?D KDE IJK;?E :? 9EHH;B7P?
=>? :7BBc?HH7==?7C;DJE B7 :?C?DKP?ED; ;B B?L;BBE :? !-="UEJ?FE <;DEJ?FE <;JJK7JE IK LEBEDJ7H? I7D? U IJ7J7 C?IK
?DL;9; C;IIE ?D H;B7P?ED; 7B HKEBE :? ;JEI?<?97P?ED; ;B !-KD? H?;KP?ED; I?=D?<?97J?L7 ;BBc7JJ?L?JS)!! ?D IE==;JJ? ECE
9ED<HEDJ? ;? ;)- =EJ? F;H Bc7BB;B; OI H?IF;JJE 7 GK;BB7 EJJ;DKJ7 :7 ECEP?=EJ? F;
B;B; -;H *;H 9ECFH;D;;H; C;=B?E J7B; <;DEC;DE B7 FHEJ;?D7
M?B; JOF; ; B7 L7H?7DJ; FEB?CEH<?97 IEDE IJ7J; FKH?<?97J; ; U
:??J?ED 7I ;L?;;D9; 8O " , IF;9JH7 E< 9KBJKH; JKCEKH 9;BBc7D7B?I? ;B;JJE<EH;J?97 ;BB; FHEJ;?D; >7 CEIJH7JE 9EC; ;DJH
I?7DE I;DI?8?B? 7 L7H?7P?ED? 9ED<EHC7P?ED7B? :EFE JH7JJ7C
7=;DJ? EII?7DJ? #DEBJH; B7 L7H?7DJ; - <EHC7 :?C;H? 9>; FEI
IEDE ;II;H; <79?BC;DJ; :?IIIE9?7J? :7 7=;DJ? H?;K9;DJ? &7 IF;JJHE
C;JH?7 :? C7I17 >7 9EDI;DJ?JE :? 97H7JJ;H?PP7H; :?L;HI? FED
:?IEB<KHE B7 9K? <EHC7P?ED; :?F;D;; 7BB7 I;GK;DP7 :?)!! ; 7BB;
9ED:??ED? EII?7J?L; +K;IJE IJK;?E ;L?;;DP?7 KD7 H;B7P?ED; DE
7D9EH7 ;9H?JJ7 JH7 IJKKJJKH7 ; <KDP?ED; :?)!! ; B7 IK7 CE:KB7
P?ED; ?D I?JK7P?ED? :? IJH;II EII?7J?LE
!B? 7KJEH? >7DDE 9EDJH?8K?JE ?D K=K7B C?IKH7

5 6,EI? IH7D;; - &K9?7D? ' *7BC7 !?EL7DD?D? !K?
:ED? & -7FEH7) 0?J? 0 ,EB; E< =BKJ7J>?ED; ?D 7FEFJEI? 8O?7H7;H?PP7J7 B7 BEHE I;DI?8?B?JS 7: 7=;DJ? H?;K9;DJ? ; EII?
:??J?ED 7I ;L?;;D9; 8O " , IF;9JH7 E< 9KBJKH; JKCEKH 9;BBc7D7B?I? ;B;JJE<EH;J?97 ;BB; FHEJ;?D; >7 CEIJH7JE 9EC; ;DJH
Radiat. Res. I?7DE I;DI?8?B? 7 L7H?7P?ED? 9ED<EHC7P?ED7B? :EFE JH7JJ7C

00/==8 ,B<=+7.; 37 ??38 7>8?3 +<9/==3 .I5 6/---73<68
.3 =+<63<<387/ .I5 .+778

M. Mancuso¹, S. Leonardi¹, E. Pasquali², S. Rebessi¹, M. Tanori¹,
P. Giardullo³, F. Borra¹, V. Di Majo¹, S. Pazzaglia¹, A. Saran¹
&78EH7JEH?E :? ?EBE=?7 ;BB; ;7:??P?ED? ; ?EC;?9?D7
7I799?7 ,EC7
/D?L;HI?JS ;=B? -JK: ? !K=B?;BCE '7H9ED? ,EC7

#>858 .I3 985368;03<63 1/7/=3-3 7/55+ ;39+;+C387/ .I5
.+778 +5 ;+.38 37.8==8

,?IKBJ7J? EJJ;DKJ? H;9;DJ;C;DJ; D;B DEIJHE B78EH7JEH?E >7DDE :?CE
IJH7JE ?D KD CE;BBE CKH?DE H7:??E;DI?8?B; ;J;HEP?E=EJ; F;H ?B =;D;
Patched *J9> 9>; :?7DD? 97KI7J? :7BBc?;7DDE ;?EJ ;BB;
H7:??P?ED? FEIIEDE 97KI7H; BE IL?BKFFE :? JKCEH? ?D J;IJK? ?EJ;
H;JJ7C;DJ; ?HH7==?7J? 9ED KD C;997D?ICE 9>; I;C8H7 9E?DLEB=E;H;
B;=?KDP?ED? I;HH7J; E gap juh\$#i6
#D GK;IJE IJK;?E ?B HKEBE ;BB; !\$# D;BBc;<;JJE 8OIJ7D;H?H?H?
7FFHE<ED?JE C;;?7DJ; BcKJ?B?PPE :? JEF? ;J;HEP?E=EJ; F;H?H?
sina N B7 FHEJ;?D7 FH;EC?D7DJ; :? GK;IJ; =?KDP?ED? ;#B
:7DDE =;D;J?9E D;B 9;HL;BB;JJE :? JEF? N ; N ?HH7==?7J?
7 =?EHD? :? ;JS 9ED !O :? H7==? 2 I9>;HC7D:E B7 J;IJ7 9ED KD
97FFK99?E :? F?EC8E U H?IKBJ7JE I?=D?<?97J?L7C;DJ; H?EJJE D;=B? ;
7D?C7B? N H?IF;JJE ?? N *;H L7BKJ7H; ?B HKEBE ;BB; !\$#
D;BBcED9E=D;I? JEF? :EFF? ADE9AEKN *J9>; *J9>
N IEDE IJ7J? ?HH7==?7J? 9ED B; CE:7B?JS IEFH7 ;?I9H?JJ; # H?
IKBJ7J? >7DDE ?D:??97JE 9>; Bc7I;DP7 :? KD7 9EF?7 ; ;B =;D;
EBJH; 7 B?C?J7H; B7 JH7IC?II?ED; ;B :7DDE =;D;J?9E H?;K9;
97J?L7C;DJ; BE IL?BKFFE :? JKCEH? D;? J;IJK? :?IJ7DJ? :7B 97C?E
H7==?7JE ;J;HC?D7H; GK?D? KD <;DEJ?FE F?X E C;DE H7:??E;DI?8?B;
&; !\$# FEIIEDE ;II;H; 7JJH7L;HI7J; IEBE :7 F?99EB; CEB;9EB;
A 7 ;9;DJ;C;DJ; U IJ7JE :?CEIJH7JE 9>; 9;BBKB; ;IFEIJ; 7 H7=
Y H?B7I9?7DE D;B C;PPE :? 9EBJKH7 . * ; FE?9>T GK;IJE DK9B;EJ;
>7 KD HKEBE 9?7L; 9EC; C;I17==;HE D;B -(I?7 ?D 9ED:??ED;?
I?EBE=?9>; 9>; F7JEBE=?9>; H7FFH;I;DJ7 KD EDJ?CE 97D:??7I9E9C
<7JJEH; H;IFEDI78?B; ;BB7 JH7IC?II?ED; ;B :7DDE ?D:??H;JJE
:??P?ED? 5 6 # H?IKBJ7J? EJJ;DKJ? :EFE IECC?D?IJH7P?ED; ?D
.* ; E IKE? ?D?8?JEH? I7H7DDE FH;I;DJ7J? ; :?I9KI?

5 6 '7D9KIE ' et al
5 6 .IKA?CEJE ' et al
5 6 .K \$ et al

5=;/+C3873 <=>;=>;+53 / 0>7C387+53 .I55+ 153-8<35+<3
.898 <=;/<< 8<<3.+=3?8

V. Simonelli (a) *, S. Camerini (b) *, F. Mazzei (a) *, A. Minoprio (a),
M. D'Errico(a), M. Crescenzi (b), M. Bjoras (c), E. Dogliotti (a)
7 ?F7HJ?C;DJE C8?;DJ; ; 9EDD;I17 FH;L;DP?ED; FH?C7H?7
#IJ?JKJE -KF;H?EH; :? -7D?JS ,EC7 #J7B?7
8 ?F7HJ?C;DJE :? ?EBE=?7 ;BBKB7H; ; ;(KHEI9?;DP;
#IJ?JKJE -KF;H?EH; :? -7D?JS ,EC7 #J7B?7
9)IBE /D?L;HI?JO "EIF?J7B /D?L;HI?JS :?)IBE)IBE (EHL;=?C.
)!! U B7 FH?D9?F7B; =B?9EI?B7I? KC7D7 9>; H?CKEL; B7 B;I?ED;CK? ?EBE=?7 /D?L;HI?JS `EC7 .H;a ,EC7 #J7B?7
J7=;D7 ENE=K7D?D7 FHE:EJJ7 D;B (:7BB; IF;9?; H;7JJ?L; ;B
BcEII?;DE .) - &7 IJ;I17 FHEJ;?D7 FKW ;II;H; CE:??97J7 :7
7=;DJ? EII?7DJ? #D :?L;HI? IJK;? ;F?;;C?EBE=?9? U IJ7J7 JH7H7
JH7H7?9>; B; H7:??P?ED? ?ED?PP7DJ? ?D:K9EDE 78;HH7P?ED?

R. Buonsante*, D. Nieri*o, F. Berardinelli*o, A. Antoccia*o,
C. Tanzarella*o e A. Sgura*o
\$=>.38 .I55+ 68.>5+C387/ .I55+ 5>712/CC+ =/586;3+- 37
03;8,5+<=3 >6+73 /<98<=3 + ;+113 (

I?7DE I;DI?8?B? 7 L7H?7P?ED? 9ED<EHC7P?ED7B? :EFE JH7JJ7C
7=;DJ? EII?7DJ? #DEBJH; B7 L7H?7DJ; - <EHC7 :?C;H? 9>; FEI
IEDE ;II;H; <79?BC;DJ; :?IIIE9?7J? :7 7=;DJ? H?;K9;DJ? &7 IF;JJHE
C;JH?7 :? C7I17 >7 9EDI;DJ?JE :? 97H7JJ;H?PP7H; :?L;HI? FED
:?IEB<KHE B7 9K? <EHC7P?ED; :?F;D;; 7BB7 I;GK;DP7 :?)!! ; 7BB;
9ED:??ED? EII?7J?L; +K;IJE IJK;?E ;L?;;DP?7 KD7 H;B7P?ED; DE
7D9EH7 ;9H?JJ7 JH7 IJKKJJKH7 ; <KDP?ED; :?)!! ; B7 IK7 CE:KB7
P?ED; ?D I?JK7P?ED? :? IJH;II EII?7J?LE
!B? 7KJEH? >7DDE 9EDJH?8K?JE ?D K=K7B C?IKH7

20 EDL;=DE (7P?ED7B; ,EC7 EJJ8H;

HE;=:D;H7J?L; #B HKEBE ;BBc;DP?C7 >." KD7 ?;HEB7I? 9>9ED ;B;L7J H?IEBK?ED; :EI?C;JH?97 ;;9;DJ? FK88B?97P?ED? >7
C?D7 ? FH;9KHIEH? EII?:7J? ;;BB7 I?DJ;I? ;;B (;;B ;(F;H ?C ;L?;;DP?7JE 7B9KD; 9H?J?9?JS D;BBcKIE ? C?9HE 97C;H; 7 ?ED?PP
F;?:HD; B7 BEHE ?D9EHFEH7P?ED; D;=B? 79??: DK9B;?9? U 9ZDEL8K7C;JEDI?8?B; \ 9CF;H B7 :EI?C;JH?7 ? H?<;H?C;DJE
9ED =H7D;; 7JJ;DP?ED; I?7 ?D 0E7BB>; in vivo F;H B7 9EH;7 ; IK==;H?JE <7JJEH? 9EHH;JJ?L? :?<<?9?B? :7 KI7H; FF7H; GK?D:
:?"KDJ?=-JED ; F;H B7 C7B7JJ?7 ? *7HA?DIED # H?IKBJJ7? :7 DED782;B;KBE IL?BKFFE :? DKEL? I?IJ;C? :EI?C;JH?9? 9>; EFFEJJKI
?D KD CE;;BBE JH7DI=;D?9E 9>; IELH7 ;IFH?C; Bc;DP?C7 >." CDJ; J7H7J? ?D J;HC?D? :? :EI; 7IIEH8?J7 ?D 790KD<HEDJE
L7H? EH=7D? ?D9BKIE ?B 9;HL;BBE ?D:97DE 9>; B7 FHEJ;P?ED; 9ED; 9ED;9E ?ED; FH?C7H?E E I;9ED:7H?E D;B 97CFE IJ7D:7H: N
:7DDE EII?:7J?LE <EHD?JE :7 GK;IJ7 ?;HEB7I? >7 ?CFEH7J7D?C 9EDDE ?D =H7:E :? C?IKH7H; 799KH7J7C;DJ; B7 :EI; 7IIEH8?J7 ?
=K;DP; I?7 IK? C;997D?IC? :? D;KHE;=:D;H7P?ED; 9>; IKB FHE9;9BK7 ?D 97CF? `DED IJ7D:7H:a
: ? ?DL;99>?7C;DJE

%/-73-2/ 03<3-2/ / ,385813-2/ .3 .8<36/=;+3 ;/=-;8<9/=3?+
7/55/ /6;/17C/ ;+.385813-2/

P. Fattibene

?F7HJ?C;DJE ;9DEBE=?: ; -7BKJ; #IJ?JKJE -KF;H?EH; :? -7D?JS
IHKFFE EBB;=7JE -7D?JS #IJ?JKJE (7P?ED7B; :? ?I?97 (K9B;7H;
0?7B; ;=?D7 B;D7 ,EC7

&cKIE I;CFH; F?X :?<<KIE ;;BB; H7:??P?ED? ?ED?PP7DJ? ?D DKC;HEI?P
I;JJEH? ?CFB?97 KD H?I9>?E I;CFH; 9H;I9;DJ; :? KDC;IFEI?P?ED? DED
9EDJHEBB7J7 ;;B FK88B?9E ;;H?L7DJ; :7 FEJ;DP?7B? ?D9?;;DJ? 9ED;7J?
7BBcKIE ?D:KIJH?7B; ; C;:9E ;;BB; H? 7B JH7IFEHJE ; ;;DP?9EDP?ED; F;H 97CF? \ N 9E;H 97CF? #; . H;7B?PP7J? F;H
C7J;H?7B; H7:??E7JJ?LE E 7BBcKIE ?CFHEFH?E :? IEH=;DJ? 9ED; 4H7J?C?9E
?BB;9?J? ?B BEHE 7887D:EDE E KIE ;;B?8;H7J7C;DJ; EIJ?B; F;88D? ; # H?IKBJJ7? IEDE IJ7J? 9ED<HEDJ7J? 9ED GK;BB? :? :?L;H
97I? H;7BC;DJ; 7997:KJ? I?7DE IJ7J? <?DEH7 <EHJKD7J7C;DJ; H7H?
Bc;L;DJE ;c9ECKDGK; H?B;L7DJ; F;H B; 9EDI;=K;DP; DED IEBE I7D?
J7H?; 9>; FKW FEHJ7H;

&7 FH?C7 I;B;P?ED; ;;BB; L?JJ?C(=H7J?H?9>?;; B7 :?IFED?
8?B?JS :? C;JE: ? F;H 7II;=D7H; H7F?:7C;DJ; B7 :EI; ?D?:L?:K7B; 9EIV
:7 :?IJ?D=K;H; =B? ?D?:L?:K? DED ;IFEI? ; ?D?:H?PP7H; GK;BB? ;IFEI?
7 KDC?;=K7J7 IEHL;=B?7DP7 C;:97)BJH; 7 C;JE: ? 9EDL;DP?ED7B?
8717J? IKBBcEII;HL7P?ED; ;? I?DJEC? 9B?D?9? 7 8H;L; J;HC?D; IKB
C?IKH7 ;;BB7 H7:??E7JJ?L?JS ; IKBB7 :EI?C;JH?7 <?I?97 GK7D:E :?IFE
D?8?B; I? FEIIEDE KJ?B?PP7H; C;JE: ? :? :EI?C;JH?7 H;JHEIF;JJ?L?
#D GK;IJE B7LEHE I? FH;I;DJ;HS KD7 F7DEH7C?97 ;;BBE IJ7JE 9EHH;DJ;
;BBc7CF?E IF;JJHE ;;BB; J;9D?9>; :? :EI?C;JH?7 H;JHEIF;JJ?L7 7JJK7B
C;DJ; :?IFED?8?B? 9>; FEIIEDE ;II;H; KI7J; F;H <EHD?H; KD7 IJ?C?
;BB7 :EI; :? H7:??P?ED; ;IJ;HD7 ;;=B? ?D?:L?:K? *7HJ?9EB7H; 7JJ;D
P?ED; I7HS :7J7 7BB7 9EI?;;JJ7 :EI?C;JH?7 <EHJK?J7a EII?7 ?C;JE ;
9>; <EHD?I9EDE KD7 IJ?C7 ;;BB7 :EI; ?D?:L?:K7B; C?IKH7D:E ? 7DD?
<?I?9? ?D:EJJ? :7BB7 H7:??P?ED; D;=B? E==;JJ? F;HIED7B? ?D;I? ; 9>
I?IJ;C? 8?EBE=?9? -? ?BBKIJH;H7DDE GK?D? ? 7D7BE=?; ; ?<<;H;D;L? ;H7
B; J;9D?9>; 8717J; IK C;JE: ? <?I?9? E 8?EBE=?9? #D<?D; I? ;;I9H?L;HS
?B F?X 7JJK7B; 7FFH9E?E CKB?F7H7C;JH?9E 9>; F;HC;JJ; ?;I?IKBJJ7?
B7 9ECFB;C;DJ7H?;JS ;? C;JE: ? ?D :?L;HI? I9;D7H? :? ;IFEI?P?ED?
?D9BK? GK;BB? ?D 9K? KD =H7D DKC;HE :? L?JJ?C; FKW ;I;H?FB;J?
P?7BC;DJ; ;IFEIJE 7 ?DJ;HL7BB? :? :EI; 7D9>; CEBJE 7CF?

\$?35>998 / +;+==/;3CC+C387/ .8<36/=;+3 .3 ;3?/5+=8;3 +
.3+6+7=/ <37=/=3-8 monocrystalline (Synthetic Single
Crystal Diamond) 9/; 3693/18 37 ;+.38=/;+93+ -87 0+<-3 .3
08=873 .3 93--85+ .367/<387/ / .3 37=/7<3=D 68.>5+==

R. Consorti¹, A. Petrucci¹, I. Ciancaglion², M. Marinelli²,
E. Milani², G. Prestopino², C. Verona², G. Verona-Rinati²,
F. De Notaristefani³

1) ?I?97 -7D?J7H?7) -7D ?B?FFE (H? 0?7 ! '7HJ?DEJJ?
,EC7

?F7HJ?C;DJE :? #D=;=D;H?7 ;997D?97 /D?L;HI?JS :? ,EC7
0;H=7J7a 0?7 ;;B *EB?J;9D?9E # ,EC7
#((-;P?ED; ,EC7 0?7 ;;BB7 07197 (7L7B; ,EC7

&c?DJHE:KP?ED; :? J;9D?9>; :? H7:??EJ;H7F?7 DED 9EDL;DP?ED7B; 9EC
B7 H7:??E9>?HKH=?7 IJ;H;EJ7II?97 -; B7 H7:??EJ;H7F?7 ? ?DJ;DI?JS
CE:KB7J7 #. ; B7 JECEJ;H7F?7 97H7J7;H?PP7J; :7BBcKIE :? 97C?C;FI 97B9EB7J7 :7B *- #D GK;IJE CE:E U GK?D: ? FEII?8?B;
CKBJ?FB? :? F?99EB; :?C;DI?ED? <?DE 7 ;NB?CFH;I;DP7 9ED<HEDJ7H; B7 ;E; EJJ;DKJ7 :7B *- 9ED B7 :E; C?IK
: ? 7BJ? =H7:??DJ? :? :EI; >7 FEIJE Bc;I?=-;DP7 :? :?IFEHH; :? H?L;B7JEH?
#D GK;IJE B7LEHE L?;D; FH;I;DJ;HS KD7 F7DEH7C?97 ;;BBE IJ7JE 9EHH;DJ;
I?DJ;J?9E CEDE9H?IJ7BB?DE - -ODJ>;J?9 -?D=B; HOIJ7B ?7C
CED: 9EIJ?JK?JE :7 KD7 IJHKJJKH7 7 <?BC IEJJ?B; ;;B J?FE :?7C
:HE=7JE F :?7C7DJ; ?DJH?DI;9E C;J7BBE LEBKC; I;DI?8?B;
CC H;7B?PP7JE FH;IIE Bc/D?L;HI?JS :? ,EC7.EH 0;H=7J7 5 6 &7
97H7JJ;H?PP7P?ED; :EI?C;JH?97 9ED:EJJ7 9ED <7I9? :? <EJED?
?FHE:EJJ? :7 KD 799;B;H7JEH; 07H?7D "2 >7 <EHD?JE 8KED? H?
IKBJJ7? IEFH7JJKJJE ?D J;HC?D? :? H?IFEIJ7 B?D;7H; 9ED B7 :EI;
F;D;DP7 :7B H7J;E :? :EI; ;;7BBc;D;H=?7 #DEBJH; ? H?L;B7JEH? --
DED D;9;II?J7DE :? FH; ?HH7==?7C;DJE ; =H7P?; 7BBc;I?IJ;DP7 :?
FEI;DP?7B; ?DJH?DI;9E FEIIEDE EF;H7H; 7 J;DI?ED; :? B7LEHE 08
0 F?H?9EB7H?JS CEBJE ?CFEH7DJ; F;H 7FFB?97P?ED? :? :EI?C
I?L;E 87 H?IFEIJ7 :? H?L;B7JEH? -- U IJ7J7 IJK:??J7 9ED F7HJ?9EB
?D;H?9EDP?ED; F;H 97CF? \ N 9E;H 97CF? #; . H;7B?PP7J? F;H
?D; 4H7J?C?9E :? KD JKCEH; ;;BB7 FHEIJ7J7 ; ;? H;B7J?L? B?D-
F;88D? ; # H?IKBJJ7? IEDE IJ7J? 9ED<HEDJ7J? 9ED GK;BB? :? :?L;H
7?ED?PP7P?ED; *1 7JJK7BC;DJ; ?D 9ECC;H9?E
5 6 - BC7L?L7 ;J 7B -ODJ>;J?9 -?D=B; HOIJ7B ?7CED: ?E;I <EH
7:??EJ>;H7FO EI?C;JHO (K9B #DIJH D: ;J>
5 6 - BC7L?L7 ;J 7B -ODJ>;J?9 -?D=B; HOIJ7B ?7CED: EI?C;J;HI
45H #D;DI?JO 'E:KB7J; ; :?7?7?ED .>;H7FO FFB?97J?EDI (K9B
#DIJH D: ;J>
8 -36/=;+3 37 ?3?8 <> 9+C3/7=3 -87 =>68; /9/5?3-8 -87
>7+ -+6/;+ + 3873CC+C387/
Ladanza¹, S. Imbimbo², S. Maffei¹, M. Mormile¹, V. Cerciello¹
D?3JS)F;H7J?L7 :? ?I?97 -7D?J7H?7 #IJ?JKJE (7P?ED7B; ;; .KCEH
ED;7P?ED; ! *7197B;a (7FEB?
9K?B7 :? F;9?7B?PP7P?ED; ?D ?I?97 -7D?J7H?7 /D?L;HI?JS ;;
JK;B?7FEB? ;;H?9E ##
K;IJE B7LEHE H?FEH7J KD C;JE:E FH7J?9E F;H B7 ;;J;HC?D7P?ED
L7BEH; ;;BB7 :EI; C IKBBc7II; 9;DJH7B; ;;B <7I9?E KJ?B?PP7D:E K
I;H?FB;J? EJJ;DKJE :7 KD7 97C;H7 :? ?ED?PP7P?ED; FEI?P?ED7J7
9;DJHE ;B I?IJ;C7 :? ?CC7=?D? FEHJ7B? *# ;?HH7:??J7 :7BB7 EI;
?D KI9?J7 :7B F7P?;DJ; :KH7DJ; ?B JH7JJ7C;DJE &cKIE :? KD7 97C;
?ED?PP7P?ED; H?K9; DEJ;LEBC;DJ; =B? ?D9EDL;D?;DJ? 9?EU H?
P?ED; F;H?E:97 ;J;CFE :? FEI?P?ED7C;DJE BKD=>? 7IIE9?7J? 7BB
: ? 7BJH? H?L;B7JEH? .& :?E: ? ; =7-9>HEC?9
& C?IKH; IEDE IJ7J; ;<<;JJK7J; 9ED KD <7I9?E :? <EJED? :7
'0 9ED KD 07H?7D 9 &?D79 KJ?B?PP7D:E KD <7DJE99?E ECE=;
D;E "" #B <7DJE99?E U <7JJE :? B7IJH; :? N 9E 9ED
I;DJEDE :? ?DI;H?H; KD7 97C;H7 ?ED?PP7P?ED; 7B 9;DJHE ;;B <7DJ
9ED :?L;HI? IF;IIEH? &7 97C;H7 U IJ7J7 KJ?B?PP7J7 F;H ;;J;HC?D7
B7 :EI; C ;D;B <7DJE99?E ;;<?D?J7 IKBBc7II; 9;DJH7B; ;;B <7I9?E ;
C;JS JH7 ? FKDJ? :? ?D=H;IIE ; KI9?J7 ;;B <7I9?E D;BBE ;;B <7DJE9
/D?C7BJH7 97C;H7 :?ED?PP7P?ED; U FEI?P?ED7J7 7B 9;DJHE ;;BB
F;H C?IKH7H; ?B I;=D7B; JH7IC;IIE :7B F7P?;DJ; #B C;JE:E I? 7LL7B
: ? KD7 I;H? :? <KDP?ED? :? 9EHH;B7P?ED; EJJ;DKJ; :7B H7FFEHJE
C F;H ;;J;HC?D7H; ?B L7BEH; ;;BB7 :EI; D;B F7P?;DJ; &7 :EI;
?;D? ; 297J7 BKD=E Bc7II; 9;DJH7B; ;;B <7I9?E :EL; BE IF;IIEH; :? C7
JH?7B; ?D J;HC?D? :? ;;DI?JS U BE IJ;IIE U IJ7J7 9ED<HEDJ7J7 9
97C?C;FI 97B9EB7J7 :7B *- #D GK;IJE CE:E U GK?D: ? FEII?8?B;
9ED<HEDJ7H; B7 ;E; EJJ;DKJ7 :7B *- 9ED B7 :E; C?IK
H7J7 2D?L?LE ;DJH7C8; ;;<?D?J; D;BBE IJ;IIE FDKJE
L7B7JEH?

#B C;JE:E U IJ7JE 7FFB?97JE F;H B7 :EI?C;JH?? ?D L?LE :? ... JH7JJ7J? 9ED <7I9? 9ED<EHC7J? F;H JKCEH? F;BL?9? ?B 9EDJ...
;<<;JJK7JE IKB 97CFE * * ;H E=D? 97CFE IEDE IJ7J? ;<<;JJK7J...
IKH; FFB?97D:E KD 9EHH;JJE FHE=H7CC7 :? 7II?9KH7P?ED; :D...
? H?IKBJ7J? >7DDE :?CEIJH7JE 9>; ?B C;JE:E U ?D =H7:E :? L;...
=B? 799EH: ? JH7 B7 ;EI; 97B9EB7J7 ; GK;BB7 C?IKH7J7 ?D 97LE...
c ;DJHE F;H ? C?IKH7P?ED? ;<<;JJK7J; ?D L?LE

5 9;37-3938 .3 8==363CC+C387/ / 5+ .8</ -855/==3?+

M. Pugliese

/D?L;HI?JS :;=B? -JK: ? :? (7FEB? ;;;H?9E ##

&c?CFEIJ7P?ED; 7JJK7B; ;;BB7 ;?EFHEJ;P?ED; D;BB7 H;9;DJ;...
97P?ED; ;;BB7 # * 9EDIEB? ? ? FH?D9?F? ;;BB7 EJJ?C?P...
P?ED; =?KIJ?<?97P?ED; ; B?C?J7P?ED; ;;BB; :EI? H?7D7B?PP...
; H?FHEFED; ? L7BEH? ;;BB7 B?C?J7P?ED; ;;BB7 :EI; ?D 87I; 9ED...
P?ED? IE9?E I7D?J7H?; & # * 9EDJ?DK7 7 IEIJ;D;H; Bc?D:9...
=:D;H7B; 9>; F;H =B? I9EF? FH7J?9? ;;BB7 ;?EFHEJ;P?ED; ;I...
H;B7P?ED; B?D;7H; I;DP7 IE=B? ? ?B CE::BBE &?D;7H (E .>H...
&(JH7 Bc;IFEI?P?ED; 7 H7:??P?ED? ?ED?PP7DJ? ; H?I9>?E ...
F7H; KD7 F7JEBE=?D ;EFB7I?97 F;H :EI? 79KJ; E H?9;LKJ; ?D K...
I?DE 7?H97 C-L EC; 9EDI:=K;DP7 DED ;I?I; `H?I9>?E P;Hea

;B7J?L7C;DJ; 7BB7 D;9;I?JS :? ;JH7FEB7H; 7? L7BEH? :? :EI; 87I...
CEBJE 87II? B; IJ?C; :? H?I9>?E ?D:2L?:K7J; F;H :EI? C: ?E 7B...
J?DK7 7 :;I;H; KJ?B?PP7JE ?B <7JJEH; :? ;<<?979?7 ;;BB7 :EI; ;...
: ? :EI; ; #D FH7J?97 IKBB7 87I; :? KD7 9EC8?D7P?ED; ;? ...
:J7? ;F?;C?EBE=?9? 7D?C7B? ; 9;BBKB7H? I? H?J?;D; 9>; ?B H...
D;EFB7I?; 7 87I; :EI? ;? 7 87IIE H7J;E :? :EI; ;887 ;I;H; H?EJJE

;B <7JJEH; 7JJH?8K?JE 7B ; .7B; L7BEH; 9EDJ?DK7 7 :;I;H; ...
BKJ7JE F7H? 7 :7BB7 # *
L?;DJ;C;DJ; 7 GK;IJ7 FHE8B;C7J?97 U IJH;JJ7C;DJ; 9EHH;B7J...
9ED9;JJE :? :EI; 9EBB;JJ?L7 9>; H?K7H:7 =H7D F7HJ; ;;BB; ;IFEI?P...
7BB; H7:??P?ED? :ELKJ; I?7 7 :;IFEI?P?ED? ?D 7C8?JE B7LEH7...
:9>; ?D:KIJH?7B? C?B?J7H? 9>; 7C8?;DJ7B? B7 9K? CE: ? 97...
*K88B?97P?ED; # * U <EHI; B7 F?X ?DJ;H;I?7DJ; F;H9>T ?B...
9;JJE :? :EI; 9EBB;JJ?L7 U H?C7IJE 9EC; =H7D;PP7 ? H7:??E...
P?ED; C7 9ED Bc7LL;HJ;DP7 9>; FKW ;I;H; KJ?B?PP7J7 F;H...
BcEJJ?C?PP7P?ED; F;H H7<<HEDJ7H; J;9D?9>; ; EFP?ED? :? ;...
P?ED; C7 DED F;H L7BKJ7H; ?B H?I9>?E ?D IJK: ? ;F?;C?EBE=?...
J7DJE C;DE F;H FH;?H; ?B DKC;HE :; CEHJ? F;H 97D9HE 7 I;...
F?99EB; :EI? 7 ;I;I? =HKFF? :? FEFEB7P?ED;

&<8 /55+ \$9/==:8<-893+ \$# 9/; 5F3./7=303+C387/ .3
+536/7=3 +. ><8 *88=-/73-83; .+3+=3 + <-898 -87<;?+=3?8 /
?+5>+=C387/ /55F/00/=8 <+73=3CC+7/+==;+?/<8 +7+53...
63-;8,385813-2/

M. C. D'Oca (1), A. Bartolotta (1), P. Fuochi (2), A. M. Di Noto (3),
C. Cardamone (3)

?F7HJ?C;DJE 7HC79E9>?C?9E .EI?9EBE=?9E ; ?EBE=?9E...
?FEBB7 : *7B;HCE

#IJ?JKJE F;H B7 -?DJ;I?)H=7D?97 ; B7 EJEH;7J?L?JS ` (a
EBE=D7

#IJ?JKJE 4EEFHE<?B7JJ?9E -F;H?C;DJ7B; ;;BB7 -?9?B7? ?
*7B;HCE

>8?3 .+=3 /5+=3?3 +55+ -87-7=;+C387/ .3 ;+.87 7/55/
<->85/ .55+ +69+73+

ED ?B J;HC?D; ^-?9KH;PP7 B?C;DJ7H;a I? ?DJ;D; I?7 GK;BB7 H;B7J?L7
7=B? 7B?C;DJ? F;H KIE KC7DE C7 7D9>; GK;BB7 H;B7J?L7 7=B? 7B?C;DJ?
F;H KIE PEEJ;9D?9E /D7 ;;BB; FH?D9?F7B? 9EDJ7C?D7P?ED...
=?C? U :ELKJ7 7 C?9HEH=7D?IC? F7JE=:D? .H7 ? C;JE: ? DDEL...
I7D?J?PP7P?ED; ;;=B? 7B?C;DJ? F;H KIE KC7DE ; PEEJ;9D?9E...
L;H7 BcKIE :? H7:??P?ED? ?ED?PP7DJ? ;? (7FEB? ;;BB...
-;88;D; ;I?IJ7DE DEHC; 9ECKD?J7H?; 9>; D; H;=EB7C;DJ7DE B...
; I?7DE IJ7J? L7B?:?J? C;JE: ? F;H Bc?;DJ?<?97P?ED; :? 7B?C...
:??J? F;H KIE KC7DE D;I?KD7 H;=EB7C;DJ7P?ED; U IJ7J? ?DL;9...
D7J7 DT F;H BcKIE DT F;H Bc?;DJ?<?97P?ED; :? 7B?C;DJ? H...
KIE PEEJ;9D?9E

20 EDL;=DE (7P?ED7B; ,EC7 EJJ8H;

=K?JE :7 7B9KD7 97CF7=D7 D;? BKE=>? :? B7LEHE DT D;BB; I9KEB;JJC MMM PCF8CJ C;:KD?M?;D 79 7J
8?:DJ? GK;IJ? KBJ?C? CEBJE ?DJ;H;II?DJ? F;H9>T E99KF7J?;F;H9>T E99KF7J?;F;H9>T E99KF7J?
FEB7P?ED; F7HJ?9EB7HC;DJ; I;DI?8?B; 7BBc;IFEI?P?ED; 7BB; H7:??P?ED? ;F;H9>T E99KF7J?
?ED?PP7DJ? 9;8- / << 3.3 8 << 3. +C387/ +?+7C+==+ 7/5 =;+==+6/7=8 ./55/
*;H 9EBC7H; GK;IJ7 B79KD7 U D7JE ?B FHE=;JJE (0#, H;7B?PP7J? 5+ /1;+. +C387/ .3 >7 .3<8;1+73CC+=8; /7.8-;378
=H7P?; 7: KD7 9EBB78EH7P?ED; JH7 Bc#((Bc/D?L;HI?JS :? (7FEB? 5F8=350/7858
;;H?9E ## B7 -;9ED:7 /D?L;HI?JS :? (7FEB? ; I9KEB; I;9ED:7H?;
;;BB7 7CF7D?7 -7H79?DE - 7C?D7J?- - CC? ? IFEI?JE? ;HH?
FH?C? H?IKBJ7J? :? J7B; IJK:?E IEDE =S :?IFED?8?B? ; CEI;H7DE;F;H 17JJ7L-99>?7
B; I9KEB; 7D7BE=7C;DJ; 7: ?D:7=?D? I?C?B? ;<<;JJK7J; ?D 7BJH;B;=0?D? ;FJ /(#) 0?7 - ED7JE
?J7B?7D; B?L;BB? :? H7:ED F?X ;B;L7J? H?IF;JJE 7 GK;BB? H?IF;JJE 7 GK;BB? H?IF;JJE 7 GK;BB?
78?J7P?ED? I9KEB;JJC MMM PCF8CJ C;:KD?M?;D 79 7J ;GK;IJ;B; I? ? B7KH;7 ILEB=; KDC?D:7=?D; IF;H?C;DJ7B; IKBB7 ;:=H7
/D7 :?<<H;DP7 CEBJE ?CFEH7DJ; JH7 GK;IJ7 ?D:7=?D; ; GK;IJ;B; I? ? B7KH;7 ILEB=; KDC?D:7=?D; IF;H?C;DJ7B; IKBB7 ;:=H7
7BJH; H;=?ED? U IJ7J7 B7 I9;BJ7 :? CED?JEH7H; KD 9EIF?9KE?DKE;HE?D; 79GK7 :? KD 9ECFEIJE ?DGK?D7DJ; BcE9J?B<;DEBE
BE97B? F;H E=D? ;?<?9?E ?D C;:7 BE97B? F;H 9?H97 :?<?9?E ?D C;:7 BE97B? F;H 9?H97 :?<?9?E ?D C;:7 BE97B?
:IF;JJE :? FE9>? CED?JEH7J? D;=B? 7BJH? IJK:? ?W >7 F;H9>T E99KF7J?;F;H9>T E99KF7J?
;L?;DP?7H; 9ED9;DJH7P?ED? ;9?I7C;DJ; F?X ;B;L7J; D;=B? K?<?9?E ?D C;:7 BE97B?
D;? B78EH7JEH? H?IF;JJE 7BB; 7KB; e IJ7JE :?CEI;H7JE JH7C?J;H7?#? ; in vivo 9>; Bc)* C?C7
#B FHE=;JJE 9EDJ?DK7 JKJJEH7 ;9?W 9ECFEH7 B7 :?IFED?8?B? ;JJK7J; :? F;H9>T E99KF7J?
:7J? Bc?P?ED; ;=B? EHCED? I;IK7B? ; F;H GK;IJE U 9B7II?<?97JE 9EC;
IEH=7D?PP7JEH; ;B I?IJ;C7 ;D:E9H?DE
& C?IKH; :? 9ED9;DJH7P?ED; :? H7:ED IEDE ;<<;JJK7J; KJ?B?7P?ED; E 7H7?P?ED; 7L7DP7J7) * ?D F7HJ?9EB7H; B; H7:??P?ED? g B;
H?L;B7JEH? 7 JH799; :? J?FE & ;H EJJ?C?PP7H; B7 FHE9;KH?;? * ?D F7HJ?9EB7H; B; H7:??P?ED? g B;
7D7B?I? I? IJ7 FHE9;:D:E C;:7DJ; 97CF7=D; :? J7H7JKH7 ;:??P?ED? /0; =B? KBJH7IKED? 9ED Bc?DJ;DJE :? 9ECF7H7H; B7 B
J;H9ED<HEDJE 7: KD7 F?X 7J7;DJ7 L;H?<?97 :? F7H7C;JH? <?9?E ?D C;:7 BE97B?) * FEIIEDE 9ED:KHH; 7BB7 9ECFB;J7 C?D;H7B?PP7P?
P?ED; :? J7B? :?IFEI?J?L? :?=B? ?DGK?D7DJ? =H7P?; 7B FEJ;H; EII?:7DJ; ; 7BB7 H;7JJ?L?JS
:97B; ?;HEII?B; ;J"
#DEBJH; IEDE IJ7J? IF;H?C;DJ7J? 7=;DJ? 9>; FEJ;DP?7DE B7 FHE:K
: ? H7:97B?) ?B 8?EII?:E ? J?J7D?E ?B)F;HEII?:E :? :?HE
=;DE ")
& ;JH7<EHC7P?ED? FHELE97J; D;BB; IEBKP?ED? :?) * 9ED B; L7H?
D?9>; :? EII?:7P?ED; IEDE IJ7J; CED?JEH7J; JH7C?J; 7D7B?I? IF;JJ
<EJEC;JH?9>; D;B L?I?8?B; ; D;B L?9?DE /0 7D7B?I? :?
-? U IL?BKFF7JE KD CE;;BBE <?I?9E 9ED 7FFHE99?E ;;J;HC?D? ;B)F;HEII?:E :? :?HE
B7 I?CKB7P?ED; :? KD <719?E :? H7==? 2 :?7=DEIJ?9E 7B <?D; F;H9>T E99KF7J?
?B ;:FEI?JE :? ;D;H=?7 D;B F7P?;DJ;
&c7B=EH?JCE I? 87I7 IKBBc;IF7DI?ED; ?D I;H?; :? ;(KC7DD ;:BBc;GK7
P?ED; ;:B JH7IFEHJE ?DJ;=H7B; ;? EBJPC7DD ?D:?F;D;DJ; :7B J;CFE ./.5 -87- /==8 +7+53<3 / 63<> ;/
;:B <719?E :? <EJED? .KJJ7L?7 :7JE Bc;B;L7JE J;CFE :? 97B9EBE D;9;I
I7H?E I? U 7:EJJ7J7 GK;IJ7 J;9D?97 D;BB7 I?CKB7P?ED; ;:BB7 I?CKB7P?ED; ;:BB7 I?CKB7P?ED;
FH?C7H?7 ; :?<<K17 7B FH?CE EH:?D; C;DJH; F;H ?B 9EDJH?8;D;J?E?HEJED.;;H7FO *# 0?BB?;D;D;JJE
H7:??P?ED; :?<<K17 CKB?FB7 I? U KJ?B?PP7JE KD CE;;BBE 7H7C;JH9E
7 F7HJ?H; :7BBc?CC7=?D; H7:?EBE=?97 :?=?J7B;
&7 IEH=;DJ; U IJ7J7 CE;;BB?PP7J7 F;H B7 I?CKB7P?ED; ;:BBE;IF;JJE
;HE=7JE 9ED ?B FHE=H7CC7 2 ECF H 5 6 C;DJH; F;H B7 C?IKH;H7?7?FEJ?PP?7CE :? KJ?B?PP7H; KD <719?E IED:7 :? FHEJED?
H;D?;C;DJE ;:B JK8E I? IEDE ;<<;JJK7J; C?IKH7P?ED? 9ED :EIF;H9>T E99KF7J?
&7 I?CKB7P?ED; ;:BB7 H7:??P?ED; :?<<K17 U IJ7J7 ;<<;JJK7J; IJK:?E 'EDJ; 7HBE ' ; ;:BB; C?IKH; ;<<;JJK7J; IKBB7
P7D:E B; I;P?ED? :cKHJE :?<<H;DP?7B? H?97L7J; :7B :7J787L;
:;BBc# 5 6 C;DJH; ? F7H7C;JH? :? ?DJ;H7P?ED; H7:??P?ED; C?I?H?
IEDE IJ7J? EJJ;DKJ? :7B :7J787L; 2) ;:B (#-.5 6
#B F7P?;DJ; ;: ?B H?L;B7JEH; IEDE IJ7J? 7FFHEII?C7J? 7: E==;H7D?;C7;I9EF; ; FEIJE 7BBcK19?J7 &7 I?CKB7P?ED; ;:c IJ7J7 H?F;
J;H?7B; ECE=;D;E ;I9H?JJ? :7 KD7 IKF;H<?9?; =;EC;JH?97 JKJ7 L7H?7D:E B7 FEI?P?ED; ;:B * ; U IJ7JE L7BKJ7JE Bc?DJ;=H7B
#B CE;;BBE U IJ7JE L7B?7JE 9ED :7J? ;:BB7 B;JJ;H7JKH7 ; 9ED I?CKB7P?ED; ;:BB7 I?CKB7P?ED; ;:BB7 I?CKB7P?ED;
P?ED? :? 7FF7H;99>? .9ED <7DJE99? 9?B?D:H?9? EJJ;D;D;E I?CKB7P?ED; ;:BB7 I?CKB7P?ED; ;:BB7 I?CKB7P?ED;
I9H;F7DP7 C7II?C7 ?D<;H?EH; 7B F;H B7 H7:??P?ED; FH?C7H?7? ;:BB?CC7=?D; ;
: ?D<;H?EH; 7B F;H B7 H7:??P?ED; :?<<K17
#B IE<JM7H; U IJ7JE IL?BKFF7JE ?D 0?IK7B 7I?9 ;: 7FFB?97JE I? ;<<;JJK7J; C?IKH; 9ED KD <7DJE99?E ECE=;D;E ; KD7 97
B7 I?CKB7P?ED; :? 7FF7H;99>? H7:EBE=?9? ?D KIE 9B?D?9E C;H7? ?ED?PP7P?ED; CKB?IJH7JE 7 F?7D? F7H7B;B?
7BBc7D7B?I? ;: ?J? H?IKBJ7 9>; F;H H;=?ED? ECE=;D; ;:B <7DJE9
U FEII?8?B; EJJ;D;H; KD7 H?IEBKP?ED; :? CC 9ED KDE IF;IIEH; ;:B

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H?L;B7JEH; ? CC #DEBJH; F;H H;=?ED? ;J;HE=;D;; B7 L7H?7P?ED;3+=8;3 9;/-8-3 / =+;.3?3 .3 /00/=3 ,B<=+7./;
::BB7 <EHC7=:B F?99E :? H7== 7 97KI7 ::BB7 JH7IB7P?ED; IF7P?7B;
::Bbc?CC7=?D; . FEJH;88; H?IKBJ7H; KD7 C?IKH7 IK<<?9?;DJ;C;DJ;
I;DI?8?B; F;H B7 L;H?<?97 ::Bbc;HHEH; :? FEI?P?ED7C;DJE ::B F?7P?D;J;
FH?C7 ::B JH7JJ7C;DJE

Antonelli¹, S. Grande¹, L. Mariotti², A. Rosi¹, G. Esposito¹,
G. Simone¹, A. Campa¹, M. Belli¹, A. Ottolenghi², D. Cappelletti²,
A. Bertolotti², E. Ranza², A. Facioetti², M. A. Tabocchini¹

*;H B; C?IKH; U IJ7J7 KJ?B?PP7J7 KD7 97C;H7 7 ?ED?PP7P?ED;CKB?;
IJH7JE '&# 9ED KDC7H;7 ::BB; IKF;H<?9? ::? F?7D? F7H7BB;B? :?
N 9C ;KDE IF;IIEH; ;GK?L7B;DJ; 7BBc79GK7 :? CC # H?IKB
J7J? ::B 9ED<HEDJE JH7 ? 97B9EB? ' ; B; C?IKH; CEIJH7DE 9>; B7
'&# U KDE IJHKC;DJE 7:7JJE F;H GK;IJE J?FE :? C?IKH7 ?D H?B?E
ECE=;D;; F;H L;H?<?97H; B7 9EH;JJ;PP7 ::BB; KD?J7c"EKDI<B?;B; H?L;IJEDE 9EC; C;?7JEH? D;BB7 97J;D7 :? I;=D7B? 9>; ;J;H
D;BB; ?CC7=?D? . KI7J; F;H B7 F?7D<?97P?ED; C?D7 B7 H?IFEIJ7 8OIJ7D;;H U IJ7JE IJK?:7JE KJ?B?PP7D:E I97L;
#B 9ED9;JJE ::B bH7D=; FHE8;c:? FHEJED? I;C8H7 KJ?B?PP7J7F?7P?D;K7B? H?IF;JJ?L7C;DJ; ?B 9 *.#); ?B '-') J7B;I9EFE
L;H<?97 ?D L?LE 9ED H?IEBKP?ED; :? 97 CC &; C?IKH; ?D:97?D;H;
B7 '&# FKEc;II;H; KJ?B?PP7J7 9EC; ;.

! '+5>=+C387/ .J55+ 9;81;/<<387/ 9;/-8- / .3 6+5+==3+ 37=/;
-8; ;7=/ =+; -23; ;13+ / =/+93/ +.3>?+7=3 7/5 1538,5+<=86+
-87 ;3<87+7C+ 6+17/=3-+ 6>5=3 9+;+6/=;3-+ + %

D. Amelio*, P. Farace*, G. K. Ricciardi, A. Beltramello,
M. Amichetti*.

.H;* _ =;DP?7 *HEL?D9?7B; F;H B7 *HEJEDJ;H7F?7 .H;DJE
Y ?F7HJ?C;DJE :? -9?;DP; 'EH<EBE=?9E ?EC;:9>; /D?L;HI?J
0;HED7
d ?F7HJ?C;DJE :? (;KHEH7:?EBE=?7)IF;:7B; '7==?EH; 0;HED7

&cKJ?B?PPE ::BB7 H?IED7DP7 C7=D;J?97 ' 9ED CE:7B?JS CKBJ?F?7?8?B? C;?7JEH? 7 CEDJ; ::BB7 97J;D7 :? ;L;DJ? 9>; FEHJ7
H7C;JH?97 >7 :?CEIJH7JE D;? =B?E8B7IJECC? ! ' :? FEJ;H C;B?B?B7I9?E :? ?9?JE9>?D; # H?IKBJ7J? EJJ;DKJ? >7DDE CEIJH7JE
::<?D?H; ? <;DEC;D? 9EHH;B7J? 7? FHE9;II? D;EFB7IJ?9E ; J;H?IKBJ7J? EJJ;DKJ? >7DDE CEIJH7JE
&cKJ?B?PPE :? KD ?C7=?D= ?D9BK::DJ; IF;JJHEI9EF?7 ?<<KI?ED; ;H?IKBJ7J? EJJ;DKJ? >7DDE CEIJH7JE
<KI?ED; EB;H; 9>; CEH<EBE=?9E F;HC;JJ; Bc?D?:L?:K7P?ED; ;H?IKBJ7J? EJJ;DKJ? >7DDE CEIJH7JE
=H;II?ED; JKCEH7B; FH;9E9; ?DJ;H9EHH;DJ; JH7 9>?HKH=?9E IED?H7J; ?DEB;H; 7D7B?PP7J; L7H?7P?ED? C;J78EB?9>; ?D 9
7:7?KL7DJ? <;DEC;DE 9>; 9EHH;B78?B; 9ED KD7 FHE=DEI? F;=H?7; ?HH7?:7J; 9ED :EI? :? E !O :? H7==? =7CC7 9>;
.H;DJ7I;JJ; F7P?;DJ? 7<<;JJ? :7 !' IEDE IJ7J? 7D7B?PP7J? H;JH?IKBJ7J? EJJ;DKJ? >7DDE CEIJH7JE
J?L7C;DJ; &7 ;' ;DJHE EH; :7BBc?DJ;HL;DJE ;* U IJ7J7 9EC E ?HH7?:7J; 9ED !O :? H7==? =7CC7 #H?IKBJ7J? :? GK;IJ7 7D7B
F7H7J7 9ED KD7 ' ;I;=K?J7 FH?C7 ::Bbc?D?P?E ;<<JJK7J7 C;?7DJ; -F;JJHEI9EF?7 7 ?IED7DP7 '7=D;J?97 ' -
H7:7?E 9>;C?EJ;H7F?7 ;. F;H L7BKJ7H; B7 H;I;P?ED; 9>?HKH=?9E IED?H7J; ?DEB;H; 7D7B?PP7J; L7H?7P?ED? C;J78EB?9E ?D H;B7
Bc;L;DKJ7B; 9ECF7HI7 :? DKEL; 7H;; :? FH;I7 :? 9EDJH7IJE ;BBE IJH; II EII?:7J?LE I?7 ?D 9;BBKB; :?H;JJ7C;DJ; ?HH7==?7J; 9>
97H7JJ;H?PP7H; GK;IJ; 7H;; 9EC; FHE=H;II?ED; D;EFB7IJ?97 9EBK; 8OIJ7D;;H
9>?HKH=?9E IEDE IJ7J; 9ECF7H7J; C;JE:9>; :?<<KI?ED; ;'K;IJE B7LEHE U IJ7JE ?D F7HJ; <?D7DP?7JE :7BB7 ECC?II?ED; K
?CC7=?D? . ;. F;H<KI?ED; * ;. IF;JJHEI9EF?7 - ;. F;7 EDJH79J * `). a

&c7D7B?I? ::BB7 ;* >7 ;L?;DP?7JE 9>; ?B ::? 97I? 7L;L7 IK8?JE
KD7 H;I;P?ED; ?D9ECFB;J7 F7P?;DJ? >7DDE CEIJH7JE B7
9ECF7HI7 :? DKEL; 7H;; :? ED B7 ;* I? U ;L?;DP?7JE 9>;
?D B; 7H;; :? 9EHH?IFED::L7DE 7 PED; :? H?:EJJ7 :?<<KI?L?JS
; GK?D? ?D:97J?L; :? IEB7 ?I9>;C?7 FEIJ 9>?HKH=?97 (;? H?C7D;DJ?
97I? ;H7DE IK==;IJ?L; :? FHE=H;II?ED; D;EFB7IJ?97 E :? FHE=H;I;
I?ED; ?I9>;C?7 9ED9EC?J7DJ? ED<HEDJ7D:E B; ?CC7=?D? .
LI ;' IEBE >7DDE CEIJH7JE KD 7KC;DJE ::Bbc;;C7 IK==;
IJ?LE :? FHE=H;II?ED;
&7 ;' ;>7 ;L?;DP?7JE 9>; IEBE CEIJH7L7DE 7H;; :? H?:EJJ7
:?'<<KI?L?JS 9ECF7J?8?B? 9ED 7KC;DJ7J7 9;BBKB7H?JS ; GK?D? ? FHE=H;I
I?ED; &7 * ;' >7 CEIJH7JE ?F;HF;H<KI?ED; IK==;IJ?L7 :? FHE=H;I
I?ED; ?D &7 - ;' >7 ?D<?D; ;L?;DP?7JE 9>; 7H;;
;H7DE 9ECF7J?8?B? 9ED FHE=H;II?ED; JKCEH7B; &; C7==?H?IKBJ7J? EJJ;DKJ? >7DDE CEIJH7JE
IFED::DP; IEDE ;C;HI; JH7 B7 ;* * ; - ;' &c;IJ;DI?ED;
DKJE 7 I;=K?JE :? EF;H7P?ED; :? 9EDJHEBBE IKB JH7<<?9E ?DJ;HD
::BB7 H;I;P?ED; DED >7 ?D<BK;DP7JE ?B J7IIE :? FHE=H;II?ED; :? C7J;H?7B; <?II?B;
97I? H;I;97J? H7:97BC;DJ; >7 CEIJH7JE FHE=H;II?ED; 9EDJHEBBE
? ?GK;BB? H;I;97J? F7HP?7BC;DJ;
&c7FFB?97P?ED; ::BB7 ;' CKBJ? F7H7C;JH?97 U KDE IJHKC;DJE
979; F;H B7 97H7JJ;H?PP7P?ED; ::BB; 7H;; :? 9>; I? IL?BKFF?7
F;H?E:E ?DJ;H9EHH;DJ; JH7 ?DJ;HL;DJE 9>?HKH=?9E ; H7:7?E
F?7

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97I? ;H7DE IK==;IJ?L; :? FHE=H;II?ED; D;EFB7IJ?97 E :? FHE=H;I;
I?ED; ?I9>;C?7 9ED9EC?J7DJ? ED<HEDJ7D:E B; ?CC7=?D? .
LI ;' IEBE >7DDE CEIJH7JE KD 7KC;DJE ::Bbc;;C7 IK==;
IJ?LE :? FHE=H;II?ED;
&7 ;' ;>7 ;L?;DP?7JE 9>; IEBE CEIJH7L7DE 7H;; :? H?:EJJ7
:?'<<KI?L?JS 9ECF7J?8?B? 9ED 7KC;DJ7J7 9;BBKB7H?JS ; GK?D? ? FHE=H;I
I?ED; &7 * ;' >7 CEIJH7JE ?F;HF;H<KI?ED; IK==;IJ?L7 :? FHE=H;I
I?ED; ?D &7 - ;' >7 ?D<?D; ;L?;DP?7JE 9>; 7H;;
;H7DE 9ECF7J?8?B? 9ED FHE=H;II?ED; JKCEH7B; &; C7==?H?IKBJ7J? EJJ;DKJ? >7DDE CEIJH7JE
IFED::DP; IEDE ;C;HI; JH7 B7 ;* * ; - ;' &c;IJ;DI?ED;
DKJE 7 I;=K?JE :? EF;H7P?ED; :? 9EDJHEBBE IKB JH7<<?9E ?DJ;HD
::BB7 H;I;P?ED; DED >7 ?D<BK;DP7JE ?B J7IIE :? FHE=H;II?ED; :? C7J;H?7B; <?II?B;
97I? H;I;97J? H7:97BC;DJ; >7 CEIJH7JE FHE=H;II?ED; 9EDJHEBBE
? ?GK;BB? H;I;97J? F7HP?7BC;DJ;
&c7FFB?97P?ED; ::BB7 ;' CKBJ? F7H7C;JH?97 U KDE IJHKC;DJE
979; F;H B7 97H7JJ;H?PP7P?ED; ::BB; 7H;; :? 9>; I? IL?BKFF?7
F;H?E:E ?DJ;H9EHH;DJ; JH7 ?DJ;HL;DJE 9>?HKH=?9E ; H7:7?E
F?7

20 EDL;=DE (7P?ED7B; ,EC7 EJJ8H;

KH7JEC ; ?D C7J;H7? :? H7:??P?ED? ?E ! 00/==3 ./55/ ;+.3+C3873 3873CC+7=3 <>55+ -86>73+C387/ D?PP7DJ? -/55>5+ / >78 <=>.38 -869+;+=3?8 0;+ 9+;=-3/59/8x873 / 7Bbc7D7B?I? :? :?7J? F;H FH?C7 9E17 U IJ7JE IJ78?B?JE 9>; :I?I; KD7;+113 Y=;+63=/ 5+ =/-73+ .5 !+=-2 5+69 I?C?B7H?JS JEJ7B; JH7 Bc;B;C;DJE H;F;HJ7JE :: KD ;B;C;DJE :? H?<;H?

C;DJE J?FE .,#! ;B ;DJHE ,?9;H9>; 7I799?7 ((EDE G. Castellani¹, R. Cherubini², V. de Nadal³, S. Gerardi², IJ7DJ; L?I?8?B? 78H7I?ED? 7CC7997JKH; ;? ?D9?I?ED? F.H.M.D. Jago², D. Remondini¹, I. Zironi¹ IKBBc;B;C;DJE I?7 B; C?IKH; FH;B?C?D7H? :? :EI; I?7 B; IK99;II?E7HJ?C;DJE :? ?I?97 EBE=D7 ;#((EBE=D7 &78EH7JEH? C?IKH; :? H7:??E7JJ?L?JS >7DDE ;I9BKIE 7IFEHJ7P?ED; E <K?P?ED? ;&=D7HE #((-;P?ED; :? ?I?97 -7D?J7H?7 *EB?9B?D?99 F;H:??J7 :? C7J;H?7B; <?I?B; /B;H?EH? C?IKH; >7DDE F;HC;IIE)HIEB7 EBE=D7 8?B?H; 9>; Bc7HH?99>?C;DJE ?IEJEFFB9H;F;DJE U F7H? 7B

K=K7B; 7 GK;BBE :? #D ;B;C;DJE :? 9EC8KIJ?8?B; DED ?HH7?79E?K?D?97P?ED; 9;BBKB7H; U ?CFEHJ7DJ; ?D L7H? <;DEC;D? F;H H;7JJEH? ;B J?FE .,#! ; 9>; Bc?HH7==?7C;DJE U 7LL;DKJE =D9?B? : U IJ7J7 ?DLE97J7 9EC; KDE ;? FEII?8?B? C;997D?IC? ;B 7DD? c 7 87II7 FEJ;DP7 9EC; ;L?;;DP?7JE :7BB7 FH;I;DP7 ;;B ` OI7D;:H <<;9Ja 9>; 9EDI?IJ; D;BB7 FHEF7=7P?ED; ;B :7DDE 7 ;;B E 9;BBKB; DED :?H;JJ7C;DJ; 9EBF?J; :7BB; H7:??P?ED? H7 B; L7H?; :? 9ECKD?97P?ED; 9;BBKB7H; KD7 ?CFEHJ7DJ; U GK;BB7 C;:??J 97D7B? ?ED?9? 9>; IEJJ;D:EDE 9EHH;DJ? ?ED?9>; :? L7H?E J?FE

! \$=>.38 !# ./3 9;8/<<3 ;+.3+-53-3 7/55+ 6/---+7853<3 / 97D7B? ?ED?9? 9>; IEJJ;D:EDE 9EHH;DJ? ?ED?9>; :? L7H?E J?FE ;+.3853<3 .3 6+=/;3+53 3693/1+=3 7/55+ .8<36/=;3+ ;/;8<9/=3?7 B ;J9 &; 9EHH;DJ? ?ED?9>; FEIIEDE ;II;H; C?IKH7J; 9ED B7 J;9 D?97 :B *7J9> B7CF 5 6 9>; 9EDI;DJ; B7 H;=?IJH7P?ED; :? 9EHH;D :7 I?D=EB; 9;BBKB; ; :7 I?D=EBE 97D7B; ?ED?9E EH:??D; ;? F

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?F7HJ?C;DJE :? >?C?97 I;D;H7B; /D?L;HI?JS :? *7L?7 ; #IJ?JK?C?7C8?JE ;B FHE=;JJE 2 &# / ; ;BBc#((9;BBKB; 0 :? (7P?ED7B; :? ?I?97 (K9B;7H; -;P?ED; :? *7L?7 0B; .7H7C;BB? HE:??JEH; IEDE IJ7J; ?HH7==?7J; 9ED F;H;H9;BB? ?FH;IIE ? &(& 7 L7H?; :EI? ; ;D;H=?; ; 9ED H7==? = FH;IIE ?B FEB?9B?D?9E -)H IEB7 :? EBE=D7

/DE ;? FH?D9?F7B? E8?;JJ?L? ;BB; H?9;H9>; IKBB7 :EI?C;JH?D?H?E?L?I?J7 ;B;JJHE<?I?EBE=?9E ; >7DDE ;L?;;DP?7JE Bc;I?IJ;D IF;JJ?L7 9EDI?IJ; D;BBc?D?L?:K7P?ED; :? C7J;H?7B? :? EH=?3P;H;5?F FEJ7II?E &; IK99;II?L; H;=?IJH7P?ED? :? GK;IJ; 9EHH;DJ? =?97 ; DED 9>; IEJJEFEIJ? 7 H7:??P?ED? ?ED?PP7DJ? 9EDI;HL?D?E;F;BB C;J;D;E;F;P;K?D? IJ?CEB? :? LEBJ7==?E D; >7DDE ;L?;;DP?7JE KD BEHE 97H7JJ;H?IJ?9>; GK7B9>; FHEFH?;JS 9>; FEI17 ;II;H; KI7 ;J79E; H?7?9?ED; 9>; H?I;DJ; I?7 ;BB7 :EI; 9>; ;B J?FE :? H7:??P?ED; `C7HA;Ha GK7DJ?J7?LE ;:BBc7LL;DKJE ?HH7==?7C;DJE & 7 ;9;B;J7 ?#D?E?HJ?9EB7H; 788?7CE ;L?;;DP?7JE :?<<;H;DP; <H7 :EI? ?D KD H J;H?IJ?9>; 7C8?;DJ7B? J;CF;H7JKH7 KC?:?JS FH;I;DP7 :? EI? =DE 9ECF;H;IE <H7 ; !O ;: 7D9>; F;H :EI? C?DEH? :? IO F?X E >7DDE IKBB7 FHEFH?;JS C?IKH7J7 ?L;IJ; GK?D? :? KD7 F7HJ?9EB7H; ?C?97J?7?9? ;B ;?<<;H;DP; D;B FH?CE H7D=; IEDE IJ7J?IJ?97C;D B;=7J? 7BB7 <EHC7P?ED; ;BB7 IF;9?; B7 9K? C?IKH7 IF;H?C;DJ?7?9?7?L; C;DJH; D;B I;9ED:E H7D=; H?IKBJ7DE ;II;H; 7B B?C KI7J7 9EC; C7HA;H :? ?HH7==?7C;DJE & 7 9EDEI9;DP7 :? GK;IJ;BB? I?D?<?97J?L?JS IJ7J?IJ?97 97D?IC? FKW ;II;H; ?D<7JJ? KJ?B; D;BBc?D?L?:K7P?ED; ;? <7JJEH? 7C

8?;DJ7? 9>; C7==?EHC;DJ; FEJH;88;HE ?D<BK;DP7H; B7 5?E7F?9?B ;J 7B *<BK=;HI H9> K= :EI?C;JH?97 ; D;BB7 ;J;HC?D7P?ED; ;? FHEJE9EBB? :? H799EBJ7 ; 9ED I;HL7P?ED; ;B C7J;H?7B; &; KD=>?; 9EIJ?JK?I9EDE KDE :? C7J;H?7B? >85>C3873 .3 5+?+1138 <8<=/73,353 +<<3<=3/ .+ ;+.3+C3873 F?X 7JJ?L7C;DJ; IJK:??J? F7HJ?9EB7HC;DJ; 7JJH7L;HIE B7 IF;JJHEI9EF?7 F7H7C7=D;J?97 ;B;JJHED?97 * , '7D97 JKJJ7L?7 KDC7D7B?I? 9ECFB; J7 5 ; S. Emmi^a, C. Castro^a, B. Esposito^a, M. Saracino^a, E. Ferri^b, :B C;997D?ICE :? H7:??EB?I? ; ;BB; 97H7JJ;H?IJ?9>; ;BB7 IF;9? ; L. Bossi^c, L. Arteconi^c, A. Ciarletta^c IFEDI78?B; ;B I;=D7B; * , KI7JE 9EC; C7HA;H :? ?HH7==?7C;DJE (0?7 * !E8;JJ? H;7 ;BB7 ;9;H97 (, (ED 9>?7H? IEDE ?DEBJH; ? C;997D?IC? :? <EHC7P?ED; ;B I=-D7B; . ;FJ /(#) 0?7 - ED7JE * , EH=?D7JE :7BBc7P?ED; C;997D?97 :? J7=B?E EBE=D7#D:;I?J ECF7DO -F 0?7B; ;HBED? #D GK;IJE B7LEHE U IJ7JE ?D?P?7JE KDE IJK:??E C?H7JE 7BB?97H?E;H?P P7P?ED; ;? H7:??97B? FHE:EJJ :?7BBc?HH7==?7C;DJE =7CC7 :? 7B Bc7P?ED; C;997D?97 ?D KD=>?; 7 :?L;HIE =H7:E :? :?H7J7P?ED; &7D7B?I? ;BB; IF;9?; FHE:EJJ; :7BBc?HH7==?7C;DJE E :7BB7 C?97D? P?ED; ?D 7JCEI<;H7 ?D;HJ; 7 % ; ? FHE9;II? 9>?C?9? ;L?;;DP?7JE ?9GK;FH;=?7J; ; H?;K9;D:E Bc?DGK?D7C;DJE #B L7DJ7==?EIE 8?D? 97CF?ED? D;BB; <7I? :? H?I97B:7C;DJE 7 J;CF;H7JKH7 7C8?;DJ;H7D?H=?7 ; 7887JJ?C;DJE ;=B? ?DGK?D7DJ? EH=7D?9? H7FFH; F;HC;IIE :? ?D:??L?:K7H; 7B9KD? F7II7==? I7B?;DJ? ;? FHE9;II? :? H7 :? FHE9;II? :?)II?:7P?ED; L7DP7J7) * >7 ?D;EJJE :?L;HI; :?EB?I? ; C;997DEB?I? &; IF;9?; FH?C7H?; FHE:EJJ; :7BBc?HH7==?7C;DJE :? ?DL;IJ?H; D;B I;JJEH; C;DJE IEDE H?9ED:K9?8?B? 7 H7:??97B? J?B?9? , [- ; H7:??97B? ?D?ED? ;? K;IJE B7LEHE >7 9EC; I9EFE Bc7FFB?97P?ED; ;BB; J;9DEBE=?;) * FEDJ? 7 PEB<E , - , 97H7JJ;H?IJ?9? ;BB7 9>;H7J?D7 &c7KC;DJE B7 L78?7D9>;H?7 FHE=;JJE #D:KI7H?7 7B <?D; :? H?KJ?B? J;CF;H7JKH7 FHELE97 ?B ;:97?C;DJE :? GK;IJ; IF;9?; ; B7 9EDI ;? B7L7==?E D;? 9?9B? IK99;II?L? # FHE9;II? ?CF?;=7J? I? I?ED; FH;L7B;DJ; ?D H7:??97B? F;HJ?B?9? , - [D? ?97CF?ED? ?;H?I? ?D I?DE K I?J;C? /0 ") /0) /097J7B?I? IEDEB?I? H7:??EB?I? KD7 DKEL7 IF;9?; ?D GK;BB? 7D?:H? &c;IFEI?P?ED; 7BBc7H?7-9H?7 IEDE :? C?97B; B;9JHED 8;7C II? C?H7DE 7BB7 C?D;H7B?PP7P?ED; F7I ?D GK;IJ? KBJ?C? KD ?DJ;DIE I;=D7B; 7D7BE=E 7 GK;BBE K?F;9EC C7HA;H :EI?C;JH?9E & 7 C79?D7P?ED; 7 87II7 J;CF;H7JKH7 I;C8H? H7 H?GK;IJ? JHEL?7CE 7: ;IE ?B IE:??E HECF;H; ?D CE:E 7I?CC;JH?9E ?B FEDJ; 7 PEB<E 9H;7D:E H7:??97B? H?97B;DIEB<ED7JE &- - (?B IE:??E J?B?9? ; H7:??97B? 7B 97H8ED?E -? FHEFED; KDE I9>;C7 :? H7:??97B? ?D?ED?9? ;? B;BB?<7JE -- - (;?B IE:??E B7KH?B ;J;H; IEB<7JE H;DJ; 9ED Bc;LEBKP?ED; 9ED B7 J;CF;H7JKH7 ;BB; L7H?; IF;9?; ?B

BEHE 9ECFEHJ7C;DJE ?D FH;I;DP7 ;:BBcEII?;=;DE # 97CF?ED? I?IJ;C? CE;;BBE E 79GK; :? B7L7==?E DEHC7J?L; ;L;D =EDE ;FEIJ? <ED:7C;DJ7BC;DJ; 7 JH; J?F? :? ;D;H=?7 BK9; /0 KB JH7IKED? H7:??P?ED? ?ED?PP7DJ? ;H;B;9?HED8;7C (EHC7BC;DJ; L;D=EDE ;<<;JJK7J? JH7JJ7C;DJ? 7 :EI? 9H;I9;DJ? ; 97C 8?7D:E 7B9KD? F7H7C;JH? 9EC; <H;GK;DP7 J?FE :? =7I :?I9?EBJE

EII?=:DE FHEJEII?:E ? 7PEJE 9EDJ;DKJE ;?D".?) & ; IJ7D:7H: 5 6 9>; <EHD?I9; KDC;IJ;DI?ED; 9ECFB;J7 ; ;<<?979; ;B
CE:??<?9>; IEFH7LL;DKJ; D;? 97CF?ED? IEDE CED?JEH7J; 7JHHE;IEEBBE # 5 6 F;H B7 ;;J;HC?D7P?ED; ;BB7 :EI;
IF;JJHE<EJEC;JH?7 /0L?I ; #, .)) ; C;:??7DJ; 87JJ;H? #D GK;IJE B7LEHE I? H?FEHJ7 Bc7FFB?97P?ED; ;B DKELE <EHC
BKC?D;I9;DJ? JEII?9?JS 0;D=EDE FE? 9ED<HEDJ7J? ? H?IKBJ7J;K;L97C;H; 7 ?ED?PP7P?ED; 7HC;H ; -& NH7:??D ?D
C;JE:?? ? JH7JJ7C;DJE F;H H?97L7H; ?D<EHC7P?ED? 9?H979CF?F?XIJ7J?9? N 9C ;:??D7C?9? N 9C N 9C
;<<?9?;DJ;

! 5 -871/5+6/7=8 373,3<-/ 5+ 68;=/ -/55>5+;/ 37.8==+ .+
;+.3+C3873 3873CC+7=3

G. Cugia^{1,2}, A. Lucarini^{1,3}, F. Centis⁴, G. Del Zotto¹, E. Argazzi⁵,
M. Bono⁵, G. Zini⁵, M. Valentini⁴, F. Picardi⁶, W. Cesarini^{2,5},
E. Fusco , L. Zamai^{1,2}

?F7HJ?C;DJE -/ (/D?L;HI?JS ;=B? IJK:?? ? /H8?DE ` 7HBE Ea
#((&78EH7JEH? (7P?ED7B? ;B !H7D -7IIE II;H=? +
-&' -7D '7H?DE
&78EH7JEH?E ? ? *7JEBE=?7 B?D?97) -7D -7BL7JEH; :? *;I7HE
-) ?I?97 ';;?97) -7D -7BL7JEH; :? *;I7HE
-;HL?P?E ? C;:??9?D7 JH7I<KI?ED7B;) -7D -7BL7JEH; :? *;I7HE
/) :? !?D;9EBE=?7 4ED7 ;HH?JEH?7B; /H8?DE

5 6 * D;H;E et al 8IEH8;: :EI; ;J;HC?D7J?ED ?D ;NJ;HD7B 8;7C
H7:??EJ>;H7FO # ;.9>D?97B ;;FEHJ (E
5 6 * , BCED: et al *cl ! FHEJE9EB <EH 9B?D?97B H;<;
H;D9; :EI?C;JHO E<>?=> ;D;H=O F>EJED 7D: ;B;9JHED 8;7CI ';;
>OI (E
5 6 , \$;H7@ et al ; 97B?8H7J?ED E< DED 9EDL;DJ?ED7B JH;7J;DJ
H;D;?E?;JE >;B?97B .ECEJ>;H7FO ';; >OI
5 6 * , BCED: et al *cl ! FHEJE9EB <EH 9B?D?97B H;<;
H;D9; :EI?C;JHO E<>?=> ;D;H=O F>EJED 7D: ;B;9JHED 8;7CI ';;
>OI (E
5 6 , \$;H7@ et al ; 97B?8H7J?ED E< DED 9EDL;DJ?ED7B JH;7J;DJ
H;D;?E?;JE >;B?97B .ECEJ>;H7FO ';; >OI
5 6 * , BCED: et al *cl ! FHEJE9EB <EH 9B?D?97B H;<;
H;D9; :EI?C;JHO E<>?=> ;D;H=O F>EJED 7D: ;B;9JHED 8;7CI ';;
>OI (E
5 6 , \$;H7@ et al ; 97B?8H7J?ED E< DED 9EDL;DJ?ED7B JH;7J;DJ
H;D;?E?;JE >;B?97B .ECEJ>;H7FO ';; >OI

.KJJ? ? I?IJ;C? 8?EBE=?9? L?L;DJ? 9ECFH;I? GK;BB? 9H?EFH;I;L7C?I?E?; JE >;B?97B .ECEJ>;H7FO ';; >OI
9EDJ?DK7C;DJ; ;IFEIJ? 7 87II? B?L;BB? :? H7:??P?ED? ?ED?PP7DJ? ;EC7I et al 'EDJ; 7HBE ;H?L;: ! ;GK?L7B;DJ
;H?L7DJ? :7B <ED:E D7JKH7B; ;88;D; B7 9H?E9EDI;HL7P?ED? 97B?8H7J?ED <EH >;B?97B .ECEJ>;H7FO ';; >OI
C;JE:E ;B;JJ?LE :? FH;I;HL7P?ED; ;B C7J;H?7B; 8?EBE=?9E GRUCKB7D; et al EI?C;JHO 7K:??J <EH .ECEJ>;H7FO KI?D= 7B7
J?CE 799KCKB7 ? :DD? FHE:EJJ? :7BBc;IFEI?P?ED; 7BB; H7:??P?ED? ;>OI
<ED:E 9ED BE IL7DJ7==?E :? DED FEJ;HB? H?F7H7H; 7 97KI7 ;B;B;EDIE et al D;M <EHC7B?IC <EH H;<;H;D9; :EI?C;JHO E<
C;J7EB?9E ?D:EJJE :7BB; 87II; J;CF;H7JKH; e DEJE 9>; B; #; FEI
IC?BB 7D: DEDIJ7D:7H: <?;B:I ';; >OI

IEDE ?D:KHH; I?7 CEHJ; 9;BBKB7H; I;9ED:E KD7 9EHH;B7P?ED; :EI; :? /=.8.3 03<3-3 .3 -870;/6+ 9/; 5F3./7=303-+C387/ .3
F;D;:DP7 DED B?D;7H; ?F;HI;DI?8?B?JS 7BB; 87II; :EI? I?7 CKJ7P?ED? 8<=;3-2/ 3;+;3+=
=;D?9>; C7 FE9>; IEDE B; ?D<EHC7P?ED? :?IFED?8?B? H?K7H:E 7B C7
J;H?7B; 8?EBE=?9E 9H?EFH;I;HL7JE *;H L7BKJ7H; =B? ;<<JJ;:BB;H7?7
P?ED? ?ED?PP7DJ? IK? I?IJ;C? 8?EBE=?9? 9EDI;HL7J? ?D 7PEJE ;B?GK?:E

IEDE IJ7J; KJ?B?PP7J; 9;BBKB; CEDEDK9B;7J; ?IEB7J; :7 I7D=K;J;KJE -KF;H?EH; :? -7D?JS 0?7B; ;=?D7 B;D7
<;H?9E ; ?HH7:??J; 7 :?L;HI; :EI? I?7 7 J;CF;H7JKH7 7C8?;DJ; 9EC7
#JH7J7C;DJE 9ED H7:??P?ED? ?ED?PP7DJ? 7; 7BJ; :EI? ?E IJH?9
Y EFE I9ED=;B7C;DJE IEDE IJ7J; L7BKJ7J; B7 IEFH7LL?L;D?78EH7JEH?E ? ? I?97 ';;?97 ; -?IJ;C? IF;HJ? #IJ?JKJE ;=?D7
9;BBKB7H; ; B7 <H;GK;DP7 :? CKJ7P?ED; BE9KI "., ; #! ?B;D7_#) L?7 B?E >?7D;I? _ ,EC7
:7J? EJJ;DKJ? ;C;H=; 9>; ?B 9ED=;B7C;DJE >7 KD ;<<;JJE FHEJ;JJ?LE
IKBB7 CEHJ7B?JS 9;BBKB7H; ; ?D<BK;DP7 ?B <;DEC;DE ;BB?F;H;DI
#B;H7J7C;DJE 9ED H7:??P?ED? ?ED?PP7DJ? 7; 7BJ; :EI? ?E IJH?9
8?B?JS 7BB; 87II; :EI?

! 9953-+C387/ .5 7>8?8 08;6+53<68 9/; 5+
./=;/637+C387/ .3 .8</ 37 0+<-3 9/; =868=;/+93+

M.C. Pressello⁽¹⁾, C. De Angelis⁽²⁾, R. Rauco⁽¹⁾, D. Aragno⁽¹⁾,
M. Betti⁽¹⁾, D. Viscomi⁽²⁾, E. Santini⁽¹⁾

?F7HJ?C;DJE :? ?I?97 ';;?97 P?;D:7)IF;:7B?;H7 -7D 7C?BBE
EHB7D?D? ,EC7
&7 "TomoTherapy Hi-Art System" .." U KDCkD?JS ;:;?97J7 F;H
JH7JJ7C;DJ? :? ?HH7:??P?ED; 9ED <7I9? CE:KB7J? D;? GK7B? B7E;I?P?D? #D F7HJ?9EB7H; IEDE IJ7J; 9ED:EJJ; B; I;=K;DJ? 7J
H?B7I9?77J ?D CE:7B?JS ;B?9E?7B;
&7 :EI?C;JH?7 ? ? GK;IJE I?IJ;C7 U F7HJ?9EB7HC;DJ; 9ECFB;IJ7
97KI7 ;;BBc?D7FFB?978?B?JS ;? FHEJE9EBB? ?DJ;HD7P?ED7B? ? ?EI?C;JH?7
5 6 DED FEJ;D:E H;7B?PP7H; B; 9ED:??P?ED? IF;H?C;DJ7B? ? ?H?<H?
C;DJE :?C;DI?ED? ;B 97CFE N -- 9C #DEBJH; Bc7I
I;DP7 :? K?attening filter 7BBc?DJ;HDE ;;BBc799;B;H7JEH; CE:??97
BE IF;JJHE :? ;D;H=?7 ;B <7I9?E ?D<?9?7D:E ? <7JJEH? :? 9EHH;P?ED ;? ;C;JE:?? ;B;D97J? U IJ7JE ;<<;JJK7JE BE IJK?E :? ; I;
B?J7C;DJ; 7FFB?97J? 7BB; 97C;H; 7 ?ED?PP7P?ED; F;H B7 ;;J;HC?D7P?ED; ;BB7 :EI;
;BB7 :EI;
*;H IKF;H7H; GK;IJ7 B?C?J7P?ED; IEDE IJ7J? FHEFEIJ? ?D B;J;H7JKH7?<?97H; B7 IF;9?<?9?JS ;;B C;JE:E B7 H?F;J?8?B?JS ;;BB; C
L;HI? 7FFHE99? 5 6 ;;9;DJ;C;DJ; U IJ7JE FHEFEIJE KD DKELE B7H78?B?JS ;;B I;=D7B; ?D :?L;HI; 9ED:??P?ED? :? 9EDI;HL7P?EI
C7B?ICE F;H B7 ;;J;HC?D7P?ED; ;BB7 :EI; 7IIEBKJ7 ?D 97CF?D;DED
7HJ?9EB7H; 7JJ;DP?ED; U IJ7J7 H?LEBJ7 7BB7 FH;F7H7P?ED; ;B 9

=EB; ; 7BJH? 9HEIJ79;? U IJ7JE H;9;DJ;C;DJ; 7KJEH?PP7JE :7E
Bc CC?D?IJH7P?ED; B?C;DJ7H; C;H?97D7 EE: 7D: HK=
:C?D?IJH7J?ED 7BBE I9EFE :? H?:KHH; ?B H?I9>?E ? JEII?D<
P?ED? 97KI7J; :7 87JJ;H? F7JE=;D?9EC7I et al Enteriditis ;
?B'ibrio parahaemolyticus B <?D; :? =H7DJ?H; KD 9EDJHEBBE ;;B
BcEII;HL7DP7 ;;BB; DEHC; ;I?IJ;DJ? ?D C7J;H?7 :? 7B?C;DJ? ?HH7;
7BBc?DJ;HDE ;? *7;I? ;;BBc/D?ED; KHEF; 7 ?D F7HJ?9EB7H; B7 9EH
;J?9>;JJ7JKH7 ;? FHE:EJJ? JH7JJ7J? U ;C;HI7 Bc;I?;=DP7 7BBc?DJ;
7;?S?ECKD?J7H? :? :EJ7H? :? C;JE:?? 7<<?78?B? F;H Bc?;DJ?<?97
? ? ?;DJ?<?97P?ED; :? EIJH?9>; IEJFEFEIJ; 7 JH7JJ7C;DJE 9ED H7:??
#B FH;I;DJ; B7LEHE >7 BE I9EFE :? ?D:7=7H; ? FEII?8?B? C;JE:?? <?
: ? ?;DJ?<?97P?ED; :? EIJH?9>; IEJFEFEIJ; 7 JH7JJ7C;DJE 9ED H7:??
B7E;I?P?D? #D F7HJ?9EB7H; IEDE IJ7J; 9ED:EJJ; B; I;=K;DJ? 7J
IF;H?C;DJ7B? C?IKH; :? J;HCEBKC?D;I9;DP7 IK I?B?97J? GK;IJ? KB
IJH7JJ? F;H C;PPE :? ?;HEB?I? 79?:7 IKBBc?D?C7B; ?DJ;HE B7L7=
=KI9?E :?I?P?ED; ;;BBc;F7JEF7D9H;7I ;;BBc?D?C7B; C?IKH; :? J;H
CEBKC?D;I9;DP7 ;? ;?IED7DP7 *7H7C7=D;J?97 B;JJHED?97 *
IK?9=KI9? C79?D7J?

&7 "TomoTherapy Hi-Art System" .." U KDCkD?JS ;:;?97J7 F;H
JH7JJ7C;DJ? :? ?HH7:??P?ED; 9ED <7I9? CE:KB7J? D;? GK7B? B7E;I?P?D? #D F7HJ?9EB7H; IEDE IJ7J; 9ED:EJJ; B; I;=K;DJ? 7J
H?B7I9?77J ?D CE:7B?JS ;B?9E?7B;
&7 :EI?C;JH?7 ? ? GK;IJE I?IJ;C7 U F7HJ?9EB7HC;DJ; 9ECFB;IJ7
97KI7 ;;BBc?D7FFB?978?B?JS ;? FHEJE9EBB? ?DJ;HD7P?ED7B? ? ?EI?C;JH?7
5 6 DED FEJ;D:E H;7B?PP7H; B; 9ED:??P?ED? IF;H?C;DJ7B? ? ?H?<H?
C;DJE :?C;DI?ED? ;B 97CFE N -- 9C #DEBJH; Bc7I
I;DP7 :? K?attening filter 7BBc?DJ;HDE ;;BBc799;B;H7JEH; CE:??97
BE IF;JJHE :? ;D;H=?7 ;B <7I9?E ?D<?9?7D:E ? <7JJEH? :? 9EHH;P?ED ;? ;C;JE:?? ;B;D97J? U IJ7JE ;<<;JJK7JE BE IJK?E :? ; I;
B?J7C;DJ; 7FFB?97J? 7BB; 97C;H; 7 ?ED?PP7P?ED; F;H B7 ;;J;HC?D7P?ED; ;BB7 :EI;
;BB7 :EI;
*;H IKF;H7H; GK;IJ7 B?C?J7P?ED; IEDE IJ7J? FHEFEIJ? ?D B;J;H7JKH7?<?97H; B7 IF;9?<?9?JS ;;B C;JE:E B7 H?F;J?8?B?JS ;;BB; C
L;HI? 7FFHE99? 5 6 ;;9;DJ;C;DJ; U IJ7JE FHEFEIJE KD DKELE B7H78?B?JS ;;B I;=D7B; ?D :?L;HI; 9ED:??P?ED? :? 9EDI;HL7P?EI
C7B?ICE F;H B7 ;;J;HC?D7P?ED; ;BB7 :EI; 7IIEBKJ7 ?D 97CF?D;DED
7HJ?9EB7H; 7JJ;DP?ED; U IJ7J7 H?LEBJ7 7BB7 FH;F7H7P?ED; ;B 9

20 EDL;=DE (7P?ED7B; ,EC7 EJJJE8H;

; 7BB7 IK7 ?D<BK;DP7 IK? H?IKBJ7J? ;;BB; C?IKH;
*;H E=DKDE ;? C;JE:? U IJ7J7 ?DEBJH; FH;F7H7J7 KD7 L;HI?E
C?D7H; :? FHEJE9EBBE :? FHE9;KH7 F;H Bc?;DJ?<?97P?ED;
?HH7:77J; ?D:~H?PP7J; ?? B78EH7JEH? 7:;;JJ? 7 9EDJHEBB?
7B?C;DJ7H;

! 00/==8 9;8/=378 ./55+ -;38 -87<;?+C387/ <>55+ ;3<98<=
.3 <3<=/63 ,385813-3 + ;+113 Y

R. Cherubini, V. De Nadal, S. Gerardi

#((&78EH7JEH? (7P?ED7B? :? &:=D7HE &:=D7HE *7:EL7

<HEDJ; ;B <7JJE 9>; B7 9H?E9EDI;HL7P?ED; ?D 7PEJE B?GK?E L7F7H
:c7PEJE I?7 KD7 J;9D?97 8;D 9EDIEB?:7J7 ; B7H=7C;DJ; KJ?B?F7H
C7DJ;D;H; F;H BKD=E J;CFE 9;BBKB; J;IJK? EH=7D?IC? ?D K?E L7J7E
L?7J7B; ?D 9ED:~P?ED? :? GK?;I9;DP7 KD7 ;;BB; FHE8B;C7J?9;
I? FED; U I; Bc;IFEI?P?ED; FHEJH7JJ7 ;? I?IJ;C? 9H?E 9EDI;HL7
:7P?ED? ;;B <ED:E 7C8?;DJ7B; FEI17 9ECFEHJ7H; ;;BB; 7B;J;
D;BB; C79HECEB;9EB; ;;B (9ED KD 799KCKBE :? :7DDE :ELK;H
7B <7JJE 9>; ? I?IJ;C? :? H?F7H7P?ED; ;DP?C7J?9? DED I?7DE 7J?
J;CF;H7JKH; 9H?E=;D?9>; EDJH7H?7C;DJ; 7BBc?FEJ;I? :? 7
P?7B; ;IF;H?C;DJ? ;<<;JJK7J? D;=B? KB?C? 7DD? D;BBc7C8?;H;B
=;JJE #); #((>7DDE CEIJH7JE ?DL;9; KD ;<<;JJE FHEJ;JJ?LE # J Nucl Med
;BB7 9H?E9EDI;HL7P?ED; D;? 9ED<HEDJ? ;;B :7DDE ?D:EJJE 7 B?L;BBE
9;BBKB7H; ; CEB;9EB7H; 7 I;=K?JE :? ;IFEI?P?ED;D;H7C?
8?EBE=?9? 9ED :?L;HI7 H7?EI;DI?8?B?JS 87JJ;H? I9>;H?9>?7 9EB?<353-
BKB; 0 :?>7CIJ;H 9?D;I; B?D<E9?J? KC7D? ?D J;HC?D? :? L7H?;D:
FE?DJ 8?EBE=?9? 5 6 *;H IJK:77H; B7 D7JKH7 :? J7B; ;<<;JJE FHEJ;J
IJ7J7 7LL?7J7 KD7 I?IJ;C7J?97 :? C?IKH; IK 9;BBKB; 0 :?>7C
9?D;I; ?HH7==?7J; 9ED;H7C 7CF?E ?DJ;HL7BBE :? :EI? 7J?
?DL;IJ?7H; ?B HKEBE :? L7H? F7H7C;JH? ?D =?E9E B7 J;CF;H7JKH7 9>;
B?C?J7 B7 :?<<KI?ED; ;? H7:~97B? B?8;H? B7 FH;I;DP7 :? 7
FHEJ;JJ?L? ?D GK;IJE B7LEHE '-') 9ED 97F79?JS :? `H7:~97B?9;
L7D=;Ha B7 C7JH?9; IJ7JE IEB?:E (;B FH;I;DJ; B7LEHE I7H7C?J;
H?FEHJ7J? ;?I9KII? ? H?IKBJ7J? FH;B?C?D7H? :? J7B? C?IKH; I
:? IEFH7LL?L;DP7 9;BBKB7H; ;?D:KP?ED; :? CKJ7P?ED? 7B BEGKI
L7H?7H; ;;BB7 J;CF;H7JKH7 ; ;;BB7 FH;I;DP7 :? '-')
*HE=;JJE <?D7DP?7JE :7BBc#((- ;IF;H?C;DJE 2 #&I/;

J7B; I9EFE 788?7CE ?DJH7FH;IE KDE IJK:~E JKJJEH7 ?D 9EHIE
DDE;B? :EJJE 7 97H?9E ;;B (;? 9HECEIEC? D;? B?D<E9?J? ;;B
I?D?F7H?<;H?9E :? F7P?;DJ? 7<<;JJ? :7 CEH8E :? 7I;EM IEJJEFE
IKBB7;I9K?;C;78EB?97 FH;IE ?B ?F7HJ?C;DJE :? ;?9?D7 (K
9B;7H; ;;B *EB?9B?D?9E !;C;BB? ,EC7 &E IJK:~E FH;L;; 7
FH;B?;LE :? B?D<E9?J? ?CC;~?7J7C;DJ; FH?C7 ; KD7 I;JJ?C7D7 :EF
Bc?D?P?E ;;BB7 J;H7F?7 9ED # 8 ?H7?77P?EB;#IJ?JKJE
-KF;H?EH; :? -7D?JS 9ED :EI? 79KJ; :? H7==? =7CC7 9 C?IKH7 ;;B
:7DDE H7?E?D:EJJE ?D J;HC?D? :? :EFF?; HEJJKH; IKB (<EI<EH
B7P?ED; ;;BBc?IJED; " 2 ;? :?D:KP?ED; :? C?9HEDK9B;? C?:7DJ;
8BE99E ;;BB7 9?JE9>?D;I? : L7BKJ7P?ED; F;H 9?7I9K 7F7P?;DJ; :
Bc?DIEH=;DP7 ? KD7 ,D;? B?D<E9?J? C;~?7D; 9ED<HEDJE ;;BBc;<
;BBc;IFEI?P?ED; 79KJ7 IK? 97CF?ED? FH;B;L7J? FH?C7 ; :EFE ?B ?
J7C?DJE #H?IKBJ7J? FH;B?C?D7H? EJJ;DKJ? IK KD =HKFFE B?C?J?
I?7DDE ?D:~97JE ?D J;HC?D? :? :D:KP?ED; :? C?9HEDK9
KD7 ?D 9?H9? ?B ;? F7P?;DJ? # :7J? IKB :7DDE 7B (DED
I;C8H?DE 7B CEC;DJE 9EHH;B7H; 9ED GK;BB? IKBBc?D:KP?ED; ;;
9HEDK9B;? ECFB;I?L7C;DJ; ? H?IKBJ7J? I?DEH7 EJJ;DKJ? 9ED<;H
KD7 =H7D; L7H?78?B?JS ?DJ;H?D:~L?:K7B; ;;BB7 H?IFEIJ7 7B JH7J
L7BKJ7P?ED; +K;IJ? :7J? I7H7DDE :?I9KII? 7D9>; 7BB7 BK9; :? KB
I?7DDE :ELK;H?EH? 7D7B?I? 7JJK7BC;DJ; ?D 9EHIE IK 7BJH? F7P?;DJ?

! #+C3873 .3 -;8<<5374371 / 1 ;+0=371 <> 63<-/5/ <353-/
-353- / 5+<=86/; 3 37.8==/ . + ;+3+C3873 3873CC+7=3
BKB; 0 :?>7CIJ;H 9?D;I; B?D<E9?J? KC7D? ?D J;HC?D? :? L7H?;D:
FE?DJ 8?EBE=?9? 5 6 *;H IJK:77H; B7 D7JKH7 :? J7B; ;<<;JJE FHEJ;J
IJ7J7 7LL?7J7 KD7 I?IJ;C7J?97 :? C?IKH; IK 9;BBKB; 0 :?>7C
9?D;I; ?HH7==?7J; 9ED;H7C 7CF?E ?DJ;HL7BBE :? :EI? 7J?
?DL;IJ?7H; ?B HKEBE :? L7H? F7H7C;JH? ?D =?E9E B7 J;CF;H7JKH7 9>;

B?C?J7 B7 :?<<KI?ED; ;? H7:~97B? B?8;H? B7 FH;I;DP7 :? 7
FHEJ;JJ?L? ?D GK;IJE B7LEHE '-') 9ED 97F79?JS :? `H7:~97B?9;
L7D=;Ha B7 C7JH?9; IJ7JE IEB?:E (;B FH;I;DJ; B7LEHE I7H7C?J;
H?FEHJ7J? ;?I9KII? ? H?IKBJ7J? FH;B?C?D7H? :? J7B? C?IKH; I
:? IEFH7LL?L;DP7 9;BBKB7H; ;?D:KP?ED; :? CKJ7P?ED? 7B BEGKI
L7H?7H; ;;BB7 J;CF;H7JKH7 ; ;;BB7 FH;I;DP7 :? '-')
*HE=;JJE <?D7DP?7JE :7BBc#((- ;IF;H?C;DJE 2 #&I/;

5 6 / EJJ?B?;J 7B (KELE ?C;DJE

! '+5>=+C387/ .3 >7+ ;3<98<=+ +.+=+3?+ 37 53708-3=3.3
9+C3/7=3 39/;=3;83/3 <8==898<=3 + =/;+93+ 6/=+;853+
-87 38.38

V. Dini^{1,2}, M. Belli^{1,2}, G. Simone^{1,2}, L. Lo Conte³, D. Dambra³,
M. Salvatori³, A. Giordano³

?F7HJ?C;DJE :? ;9DEBE=?; ; -7BKJ; #IJ?JKJE -KF;H?EH; :? -7D?JS
,EC7 #((-;P ,EC7 !H 9EBB -7D?JS ,EC7 ?F7HJ?C;DJE
:~?~?9?D7 (K9B;7H; *EB?9B?D?9E !;C;BB? ,EC7

&c7FFB?97P?ED; J;H7F;KJ?97 :? ?E:~E H7FFH;I;DJ7 KD7 FH?
D?97 <ED:7C;DJ7B; ;?<<KI7 D;B JH7JJ7C;DJE ;;B 97D9HE 7B
; ;BBc?F;HJ?HE?:ICE -;88;D; J7B; FH7J?97 I?7 9EDI?;H7J?
I;DP7 ;<<;JJ? 9EBB7J;H7B? D;=B? 7:KB? E99EHH; EJJ?C?PP7F;B?;E; 7C
F?;=7J7 ?D CE:E 9>; I?7 IK<<?9?;DJ; F;H BcE8?;JJ?LE J;H7F;KJ?9E C7
J7B; :7 DED 9EIJ?JK?H; H?I9>? 7FFH;PP78?B? F;H ? J;IJK? I7D? /DE IJK
:~E :? 'EDI?;KH ;J 7B 5 6 IKBBc?D:KP?ED; :? C?9HEDK9B;? ?D
B?D<E9?J? :? F7P?;DJ? JH7JJ7J? 9ED # >7 IK==;H?JE Bc?DIEH=;DP7 ?
KD7 H?IFEIJ7 7:7JJ7J?L7 , ?D I;=K?JE 7B JH7JJ7C;DJE 9ED #
KD7 <H7P?ED; 9EDI?;H;LEB; :? F7P?;DJ? H?FHEFED;D:E B7 GK;IJE
:~? GK7DJE B7 H7?EI;DI?8?B?JS ?D:~L?:K7B; FEI17 ?D<BK?H; IKBB7
7B JH7JJ7C;DJE ; 9EC; ;I? FEI17 ;I;H; L7BKJ7J7 F;H ;<<;JJK7H;
J7C;DJ? F;HIED7B?PP7J?

=?:la ?7BEM?:9P7 *EB7D: -;FJ;C8;H 7FFHE99?E J;H7F;KJ?9E CKB;J?CE:7B; 8H79>?J;H7F?7 .. ,. 7I
ED:? KJJ7<7L7 7K9?J7DE *!7BB?D;JJE .KHJKHHEIE9?7J7 7 9>;C?EJ;H7F?7 I?I;C?97 9ED I;C9?J78?D7 C= C
*H?EB7 * -J7=D7HE - H799E '(7>C?7I & !?7DD?D? LEBJ; I;JJ?C7D7 JKJJ? ? FP IEDE IJ7J? FEI?P?ED7J? :H;D7==? F
&EIJH?JJE '79HECEB -OCFEI?7 799;FJ; <EH FK8B?97J?ED9KJ7D;? 8?B?7H? 8?B7J;H7B? 7JJH7L;HIE ? GK7B? IEDE IJ7J? ?DI;H
ED:? *7B7C?D? *;FEH? KJJ7<7L7 * !7B?D;JJE F;H , &7 , U IJ7J7 ;!;=K?J7 ?D I;KJ; 7 ?!IJ7DP7 ? ? =?EHD?
7K9?J7DE (%&)(#% ;: U IJ7J7 ;HE=7J7 KD7 :EI; :? IO F;H I;KJ7 KJ?B?PP7D:E KD FHE
?;JJEH; :? IEH=;DJ? :? #H?;?E " , #B JH7JJ7C;DJE U IJ7JE 9EC

! !8<<3,353 /00/==3 ./55F/<98<3C387/ + --698 /5/==;86+17/=3-8FB;J7JE 9ED ,. B7 :EI; ;HE=7J7 U IJ7J7 :? IO C;?:7DJ;
\$ <>55+ 68;085813+ =3;83./+ 37 ;+==3 \$9;+1>/ +@5/B <H7P?ED7C;DJE :? 9!O :?; &7 JEII?9?JS 79KJ7 U IJ7J7 L7BK
J7J7 I;9ED:E B7 I97B7 ,!)

P. Galloni¹, M. Bossola², A. Lanzoni³, G. A. Lovisolò¹,
M. Piscitelli¹, R. Pinto¹, C. Marino¹.

D;7 7I799?7 I.#), , ,EC7
#IJ?JKJE :? #JFE7JEBE=?7 ; ?JE:??=DEI? /D?L;HI?JS 7JJEB?97
EC7
?F7HJ?C;DJE :? *7JEBE=?7 !B7NE-C?J>%B?D; - F 0;HED7
&7 IEFH7LL?L;DP7 C;?:?7 :? FP 9>; >7DDE 9ECFB;J7JE ?B JH7JJ7C;DJE FP F;H B; 9ED:??
C;DJE U IJ7J7 :? C;I? C;DJH; D;B =HKFFE IEJFEFEIJE 7 ,.
;I9BK?L7 B7 IEFH7LL?L;DP7 C;?:?7 U IJ7J7 :? C;I? #D D;IHKDE :;?
JJE?97
7JJEB?97
&7 IEFH7LL?L;DP7 C;?:?7 :? FP 9>; >7DDE 9ECFB;J7JE ?B JH7JJ7C;DJE H7:??7D
C;DJE U IJ7J7 :? C;I? C;DJH; D;B =HKFFE IEJFEFEIJE 7 ,.
;I9BK?L7 B7 IEFH7LL?L;DP7 C;?:?7 U IJ7J7 :? C;I? #D D;IHKDE :;?
FP ? IEDE J;H?<?97J; 9ECFB?97DP; B;=7J; 7B JH7JJ7C;DJE H7:??7D
7JJEB?97
&7 IEFH7LL?L;DP7 C;?:?7 :? FP 9ED 9EB7D=?E97H9?DEC7 DED EF;H78?B; H7
C;DJ;H? ?D <7KIJ7 JKJJ7L?7 Bc7IIE9?7P?ED; ;:BB7 ,. 9ED B7 ,.
7IIE9?7L7 9>;C?EJ;H7F?7 FKW ;II;H; KJ?B?PP7J7 F;H 7KC;DJ7H; B7
FH7L?L;DP7 9ED KD =H7:E :? JEII?9?JS 799;JJ78?B;
KDE :;?
= B?
007==3 787 537/+;3 37.8==3 .+ ,+<</ .8<3 .3 ;+3+C3873
3873CC+7=3 .3 .3?/;<+ :>+53=D 37 <3<=/63 37 ?3=;8
-EDE
R. Cherubini, V. De Nadal, S. Gerardi

&c?DJ;H7P?ED; JH7 97CF? ;B;JJHEC7=D;J?9? 7 H7?:E<H;GK;D 7JJEB?97
7BB; J;B;<ED?7 CE8?B; ;? ?B I?IJ;C7 ;D:E9H?DE U KD 7H=EC;B;JJEH?7
C7H?E :? H?9;H97 :7JE ?B 9HK9?7B; HKEBE :? J7B; I?IJ;C7 D;B;JJEH?7
IJ7I? ;:BBcEH=7D?ICE KC7DE &7 J?HE?; :?J7 B7 IK7 FHEI?C;JS 7B
J;B;<EDE 9;BBKB7H; :KH7DJ; ?B DEHC7B; KIE FEJH;88; ;II;H; KDE :;?
FH?C? EH=7D? 9E?DLEBJ? -9EFE :;B B7LEHE U B7 L7BKJ7P?ED; :;=B?
;L;DJK7B? ;<<;JJ? ;:BBc;IFEI?P?ED; BE97B?PP7J7 7 97CFE ;B;JJHEC7
=D;J?9E !' IKBB7 IJHKJKH7 ; B7 <KDP?ED; J?HE?;? 7 D;B H7JJE -EDE
IJ7J? KJ?B?PP7J? H7JJ? -FH7=K; 7MB;O <C;C?D7 :? = :?L?I? ?D
=HKFF? ;IFEI? 7 "P ;IFEI? 7 "P I>7C ;IFEI?
;IFEI?P?ED; I?CKB7J7 ;=HKFFE :? 9EDJHEBBE DED JH7JJ7C;DJE
;IFEI? BE97BC;DJ; ?D 9EHH?IFED;:DP7 ;:BBcEH;99>?E JH7C?J; I;J
:? 7DJ;DD; 7 BEEF 9?7I9KDE 5 6 EH;=?EHDE =?EHD? I;JJEH?7
F;H I;JJ?C7D; 7: KD L7BEH; :? - , -F;9?<?9 8IEHFJ?ED ,7J; IO U IJ7JE 7H=EC;DJE :? 799;IE ?DJ;H;II; D;=B? KBJ?C?
:?
1 A= #B F;IE :? H7JJ? U IJ7JE 9EDJHEBB7JE F;H?E 97?
C;DJ; ; Bc;IFEI?P?ED; U IJ7J7 ;<<;JJK7J7 ?D 9?;9E !B? 7D?C7B? IEDE
IJ7J? I79H?<?97J? 7B J;HC?D; ;:BB; I;JJ?C7D; B; =>?7D;EB; ;IF?7DJ7J;
<?I?IJ; ?D <EHC7B?D7 7B FHE9;I?J; J7=B?7J; ?D I;P?ED? 9EBEH?J;
?D ;C7JEII?B?D7 ;EI?D7 ; L7BKJ7J; 9ED 7D7B?I? ?IJE7JEBE=?7
IJ7J? H799EBJ? 7D9>; 97CF?ED? :? <=;7JE ; :? I?;HE FE? 9ED;B;JJEH?
KDC;L;DJK7B; 7D7B?I? IK99;I?L7
BBc;I7C; ?IJE7JEBE=?9E B; =>?7D;EB; >7DDE CEI
?F;HJHE<?7 ?F;HFB7I?7 ;:BB; 9;BBKB; <EBB?9EB7H? " 9>; J7F;97C;D;9EH7 JKJJc7BJHE 9>; DEJ? 9>; D;9;I?IJ7DE KBJ;H?EH? 7
799ECF7=D7 Bc7JJ?L7P?ED; ;:BB7 =>?7D;EB7 /D7 9B7II?<?97
7 U IJ7JE 7II;=D7J7 ?7 97CF?ED? ?D :?F;D;:DP7 :7BBc7IF;JJE B? 9EFE :? 9EDJH?8K?H; 7BB7 9ECFH;DI?ED; :? J7B? 7IF;JJ? U
<EBB?9EB? ;:7BBc7BJ;PP7 ;:BBc;F?J;B?E /D B?L;BBE DED I? -D?<?97I?L7
C;DJ; :?<<;H;DJ; :? " U IJ7JE H?I9EDJH7JDE ;? =HKFF? ;IFEI? I77?
9>; 7 "P I9EH; ?D 9ECF7H7P?ED; 9ED ?B B?L;BBE :;=B?
7D?C7B? I>7C; DED JH7JJ7J? I9EH; ?FEJ?PP7D:E KD7 C7=FEI;
7JJ?L7P?ED; ;:BB7 =>?7D;EB7 ;:B? 7D?C7B? ;IFEI? D;BB; 9ED;I?ED?
IF;H?C;DJ7B? ;:I9H?JJ; C;DJH; DED I? U H?I9EDJH7J7 D;IHKD7P?C?D?
=?D; :? ?D<?7CC7P?ED; J?HE?;?J; /D7 H?F;J?P?ED; ;:B FHEJED?7J; 9ED <7I9? :? FHEJED? D;BBc?DJ;HL7BBE :? & .
IF;H?C;DJ7B; U 7JJK7BC;DJ; ?D 9EHIE ? 9K? H?IKBJ7J? I7H7AD?799ECB;H;88;HE :D:97H; 7II;DP7 :? ?F;HI;DI?8?B?JS ; H7:??E
F7=D7J? :7BBc7D7B?I? I?;HEBE=?97 ;=B? EHCED? J?HE?;?
H;I?IJ;DP7 ?D:EJJ7 DED9>T :? ;<<;JJE 80IJ7D;H ?D J;HC?D? :? IEFH
L?L;DP7 9;BBKB7H; ;(B FH;I;DJ; B7LEHE I7H7DDE H?FEHJ7J? ; :?I9
H?IKBJ7J? FH;B?C?D7H? EJJ;DKJ? ?D I;=K?JE 7 ?HH7=?7C;DJ? 9
FHEJED? ?ED? ;B?E ; ?ED? 97H8ED?E :? :?L;HIE & .
*HE JJE <?D7DP?7JE :7BBc#((- (;IF;H?C;DJE 2 &# /,
*HE JJE

5 6 0 &EFH;IJE , *?DJE ; 0?J7 - '7D9?D? * !7BBED?
'7H?DE * ,7L7PP7D? ! &EL?IEBE NFEIKH; I;JKF JE IJK:O
FEJ;DJ?7B 7:L;HI; ;<<;9J I 7J !' 7D: /.- <H;GK;D9?;I ED
J>; 7K: ?JEHO IOIJ;CI E< H7JI ,7:??J?ED *HEJ;9J?ED EI?C;JHO
DY FF

! ;+23=;/+93+ +. +5=8 ;+;/8 .3 .8</ # % # /
;+.38=;/+93+ /<=;/7+ # % +<<8-3+=+ + -2/638=;/+93+ 7/5
=;+==+6/7=8 ./5 -85+7138-+;-3786+

A. Galuppi, S. Medoro, M. La Macchia, C. Blasi, E. Barbieri.
I) ,7: ?EJ;H7F?7)IF;?7B; -)HIEB7 '7BF?=>? EBE=D7

7B 7B D;BBc #IJ?JKJE :? ,7: ?EJ;H7F?7 ;B *EB?9B?D?9
)HIEB7 '7BF?=>? F7P?;DJ? FP 7<<;JJ? :7 9EB7D=?E97H9?DEC7B;J7C;DJE :? -7D?JS *K88B?97 O;J;H?D7H?7 ; -?9KH;PP7 B?C;D
GK7B? U IJ7JE ;I9BKIE Bc?DJ;HL;DJE 9>?HKKH=?9E IEDE IJ7J7L?L;DP7 9ED KD =H7:E :? JEII?9?JS 799;JJ78?B;
JH7J7C;DJE H7:??7D
C;DJ;H? ?D <7KIJ7 JKJJ7L?7 Bc7IIE9?7P?ED; ;:BB7 ,. 9ED B7 ,.
7IIE9?7L7 9>;C?EJ;H7F?7 FKW ;II;H; KJ?B?PP7J7 F;H 7KC;DJ7H; B7
FH7L?L;DP7 9ED KD =H7:E :? JEII?9?JS 799;JJ78?B;
KDE :;?
= B?
007==3 787 537/+;3 37.8==3 .+ ,+<</ .8<3 .3 ;+3+C3873
3873CC+7=3 .3 .3?/;<+ :>+53=D 37 <3<=/63 37 ?3=;8
-EDE
R. Cherubini, V. De Nadal, S. Gerardi

! ;+113+6/7=8 -87 0+<-3 .3 9;8=873 =;/+9/>=3-3 /00/==3
<>5 6/+;853<68 -/55>5+;/ /<+637+=3 6/.3+7=/ <9/==;8<-893+
#

S. Grande¹, A. Palma¹, A.M. Luciani¹, A. Rosi¹, C. Giovannini²,
O. Saporà³, G. A. P. Cirrone⁴, G. Cuttone⁴, F. Di Rosa⁴, V. Viti¹,
L. Guidoni¹.

?F7HJ?C;DJE :? ;9DEBE=?; ; -7BKJ; ; # ((!BBB -7D?JS
#IJ?JKJE -KF;H?EH; :? -7D?JS ,EC7
JH7J7C;DJE :? -7D?JS *K88B?97 O;J;H?D7H?7 ; -?9KH;PP7 B?C;D
JH7J7C;DJE H7:??7D
C;DJ;H? ?D <7KIJ7 JKJJ7L?7 Bc7IIE9?7P?ED; ;:BB7 ,. 9ED B7 ,.
7IIE9?7L7 9>;C?EJ;H7F?7 FKW ;II;H; KJ?B?PP7J7 F;H 7KC;DJ7H; B7
FH7L?L;DP7 9ED KD =H7:E :? JEII?9?JS 799;JJ78?B;
KDE :;?
= B?
007==3 787 537/+;3 37.8==3 .+ ,+<</ .8<3 .3 ;+3+C3873
3873CC+7=3 .3 .3?/;<+ :>+53=D 37 <3<=/63 37 ?3=;8
-EDE
R. Cherubini, V. De Nadal, S. Gerardi

! ;+113+6/7=8 -87 0+<-3 .3 9;8=873 =;/+9/>=3-3 /00/==3
<>5 6/+;853<68 -/55>5+;/ /<+637+=3 6/.3+7=/ <9/==;8<-893+
#

S. Grande¹, A. Palma¹, A.M. Luciani¹, A. Rosi¹, C. Giovannini²,
O. Saporà³, G. A. P. Cirrone⁴, G. Cuttone⁴, F. Di Rosa⁴, V. Viti¹,
L. Guidoni¹.

?F7HJ?C;DJE :? ;9DEBE=?; ; -7BKJ; ; # ((!BBB -7D?JS
#IJ?JKJE -KF;H?EH; :? -7D?JS ,EC7
JH7J7C;DJE :? -7D?JS *K88B?97 O;J;H?D7H?7 ; -?9KH;PP7 B?C;D
JH7J7C;DJE H7:??7D
C;DJ;H? ?D <7KIJ7 JKJJ7L?7 Bc7IIE9?7P?ED; ;:BB7 ,. 9ED B7 ,.
7IIE9?7L7 9>;C?EJ;H7F?7 FKW ;II;H; KJ?B?PP7J7 F;H 7KC;DJ7H; B7
FH7L?L;DP7 9ED KD =H7:E :? JEII?9?JS 799;JJ78?B;
KDE :;?
= B?
007==3 787 537/+;3 37.8==3 .+ ,+<</ .8<3 .3 ;+3+C3873
3873CC+7=3 .3 .3?/;<+ :>+53=D 37 <3<=/63 37 ?3=;8
-EDE
R. Cherubini, V. De Nadal, S. Gerardi

I;DP7 E B7 H?:KP?ED; ;;BbC7JJ?L?JS ;;BB7 FHEJ;?D7 ;;J;HC?D7 KD57093 93+73 8==/7>=3 -87 9;8=873 +. 37=/7<3=D 68.>5+=+ CKBE :? JH7IL;HI?ED? IS. ;; U 7IIE9?7J7 7: KD7 <EHC7 H;9;II?L7% <>003-3/7=/6/7=/ +003.+353 ;3<9/==8 +55/ 37-/;=/CC/ ;:BB7 FEB?FEI? 7:;DEC7JIE17 9EBEH;JJ7B; '/.3" IIE9?7J: *EBO 9/; 5F3;+.3+C387/ .3 5/<3873 9;8<=+=3-2/ -87 -837?85136/7=8 FEI?I ' * -JK:? *in vivo* ;; *in vitro* >7DDE :?CEIJH7JE 9>; 5370878.+5/ '/.3" ?DJ;H7=?I9; :?H;JJ7C;DJ; 9ED :?L;HI; FHEJ;?D; 9E?DLEBJ; D;BB7 H?F7H7P?ED; ;:B (#D GK;IJE B7LEHE 788?7CE IJK:77JE B; Faddessott *°, F. Albertini°, A. Bolsi°, D. Amelio *, R. Schneider°, 97H7JJ;H?IJ?9>; <KDP?ED7B? :;BB7 L7H?7DJ;! ?;DJ?<?97J7 D;F7M. Schwarz*, A. J. Lomax° P?;DJ? ' * F;H B7 GK7B; IEDE H?FEHJ7J? ?D B;JJ;H7JKH7 H?IKB;J?;F;9E# #J7B?7 Y *# 0?BB?;D -L?PP;H7 :7DJ? &7 L7H?7DJ;! U IJ7J7 EL;H;IFH;I;7 D;B 9;FFE & :? *E.coli* 9EC; FHEJ;?D7 :? <KI?ED; 9ED B7e Binding Protein)8?;JJ?LE U :? L7BKJ7H; Bc7<<?:78?B?JS ;:BB7 9EF;HJKH7 :? :EI; :? (* ; FKH?<?97J7 JH7C?J; 9HEC7JE=H7<?7 F;H 7<<?D?JS IK <EED? :&(D;? F7P?;DJ? 9ED JKCEH; FHEIJ7J?9E 7: 7BJE H?I9?>?E 7C?BEI?E -EDE IJ7J? ;!;=K?J? I7==? :? 7JJ?L?JS =B?9EI?B7I?977K? 9ED I? * ;?L;HI? 7FFHE99? :? F?7D?<?97P?ED; IK8IJH7J? C;DJH; U IJ7J7 KJ?B?PP7J7 B7 ?IED7DP7 *B7ICED 9877C?KEJJ?C?PP7J? ?B F?7DE #*. IKBB7 FB7DD?D= . . 9ED F;H<?9?; *; F;H 7D7B?PP7H; :?<<;H;DP; D;BBc?DJ;H7P?ED; (: F;H 7CF? B;==;HC;DJ; FEIJ;H?EH; ; =H7?: :EI; :? FH; J;?D7 H?IF;JJE 7BB7 FHEJ;?D7 M?B; JOF; -EDE 7JK7BC;DJ;I?D?9E! IO , F;H :? &(KJ?B?PP7D:E :?L;HI? 7F KBJ;H?EH? IJK: ? F;H EJJ;D;H; KD7 FHEJ;?D7 F;H 7H?E? FHE99? F;H H?IF7HC?7H; B7 97L?JS ?DJ;IJ?D7B; IE<J 9EDIJH7? FH;D;H; C;=B?E ?B HKEBE ;:BB7 L7H?7DJ;! D;BB; ?DJ;H7P?ED;?D;J;IJ?D7B? # F;H EJJ;D;H; B7 C?=?B?EH; 9EF;HJKH7 J;?D7 FHEJ;?D7 #*. >7H: 9EDIJH7?DJ 7BB7 # #*. F;H 7KC;DJ7H; ?B H? IF7HC?E ;:BB7 # ; 9ED Bc?DJHE:KP?ED; :? b87HH?;H; L?HJK7B?C F7HJ; C;??7B; ;IKF;H?EH; ;:BB7 # 9ED 9EDIJH7?DJ =?S 7BB; 87II; :EI F;H ;L?J7H; 7B C7II?CE Bc7JJH7L;HI7C;DJE ;:BB7 # :? KD 97CFE #*. L;D:E EJJ;DKJE KD7 8KED7 9EF;HJKH7 :? &(9ED KJJJ? =B? 7FFHE99? :? EJJ?C?PP7P?ED; IKB . 788?7CE CE: ?<?97JE C DK7BC;DJ; B7 ;:DI?JS ;:BB7 97L?JS ?DJ;IJ?D7B; "/ ; "/ H?IF;JJ?L7C;DJ; F;H I?CKB7H; ? 97C8?7C;DJ? :? H?;CF?C;DJE ;:B Bc?DJ;IJ?DE ; H?97B9EB7JE B7 ?IJH?8KP?ED; :? :EI; :? FHEJED? #B I?IJ;C7 =;HC?D7B; C7I9>?B; U KD 8;HI7=B?E I;DI?8?B; F;H B;DJ;C?DJ; EJJ?C?PP7J? IKBB; . CE: ?<?97J; #D<?D; 788?7CE P?ED? ?ED?PP7DJ? 9>; FEIIEDE ?D:KHH; IJ;H?B?JS H;L;HI?8?9?B?H?7E ? F?7D? EJJ?C?PP7J? IK . IK :K; . H?F;JKJ; ;:BB D;DJ; B?L;BBE 9;BBKB7H; Bc;<<;JJE FH?D9?F7B; ;:BBc?HH7;HE7C?D?DU . ; . 9ED . 9>; CEIJH7 C7==?EH? 7BJ;H7 Bc?D:KP?ED; :? HEJJKH; ;:B (C;??7DJ; 9;II?ED; :?H;JJ7 :? ;D;H?P?ED? 7D7JEC?9>; :? . H?IF;JJE 7BB7 . E 7JJH7L;HIE B7 FHE:KP?ED; :? H7:97B? B?8;H? . KJJ7L?7 E?H?7 C?BMC ;? &(9EF;HJE :7 IO , 0 :EFE BbEJ ;<<;JJ? H;9;DJ;C;DJ; IEDE IJ7J; C;II; ?D ;L?;DP7 7BJ;H7P?ED;C?PP7P?ED; IK? . U IJ7JE ;:B #* . 9;BBKB; DED :?H;JJ7C;DJ; ?HH7==?7J; . 7B? H?IFEIJ; 9>; FH;H?ED#?B?H?IF;JJ?L7C;DJ; 0 ;0 H?9;LKJ? :7BB7 #IEDE DEC; :? <<;JJ? `DED J7H=;J;:a 9ECFH;D:EDE ;<<;JJ? IK 9;BBKB;I?7 ; F;H #*. ; F;H #*. ;:B P?7BC;DJ; ; E J;CFEH7BC;DJ; I;F7H7J; :7 GK;BB; ?HH7==?7J; (:B I? F;H #*. EFE ?B H? 97B9EBE IKBB7 . 9ED ?DJ;IJ?DE IJ;C7 =;HC?D7B; C7I9>?B; 7B9KD? IJK: ? >7DDE ;L?;DP?7JE F?B;I?7B 7BJ7 ;:DI?JS B7 9EF;HJKH7 :? &(DED I? U CE: ?<?97J7 I;D :7DDE ?CC:??7JE 7D9>; HEJJKH; ;:B (?D IF;HC7JEPE? C7JJK?BC;DJ; F;H ? JH;J?F? :? EJJ?C?PP7P?ED? #* . KJJ7L?7 ?B :?H?L7DJ? :? 9;BBKB; ?HH7==?7J; ?D IJ7: ? FH;9E9? :? :?<<;H;E?B?C?JBB; 7BJ; :EI? <KEH? :? &(U 7KC;DJ7JE F;H #* . ?D 97IE IK==;H;D:E KD ;<<;JJE ;:BB; H7:7P?ED? FHE9H7I?D7JE D;B J;O?D;J?DE I?CKB7JE 7 87II? ;:DI?JS # L7BEH? :? 0 ;0 F;H B7 9>T B7 F;HC7D;DP7 :? GK;IJ; HEJJKH; U 7FF7H;DJ;C;DJ; ?D9EDED IEDE 97C8?7J? F;H B; . 9ED ;:DI?JS ;:BBc?DJ;IJ?DE 8?B; 9ED B; :?L?I?ED? 9;BBKB7H? ;: ?B FHE9;IIE C7JKH7 7JE<?977 IF;HC7JE=;D;I? B7 D7JKH7 ? GK;IJE <;DEC;DE D;9;II?J7 :? KBJ;H?9EB7D:E ? F?7D? #* . IKBB7 . B7 9EF;HJKH7 :? &(U :?C? IJK: ? DK?J7 ;:B F;H #* ; #* . H?IF;JJE 7 . ;:B F;H -9EFE ;:B B7LEHE U L7BKJ7H; IKB JEFE ? :7DD? ?D:EJJ? :7BB#H?7?P?ED? ;HJKH7 :? &(IKBB7 . H?C7D; I?C?B; 7 GK;BB7 EJ ?ED?PP7DJ? IKB I?IJ;C7 =;HC?D7B; C7I9>?B; ; :? IJK:??HD; B?DKBK . ?DL7H?7J7 F;H #* . F;H #* ; F;H P?ED; D;B J;CFE J7B <?D; JEF? IEDE IJ7J? ?HH7==?7J? 9ED . IO ?;H # U :?C?DK?J7 ;:B ?D . H?IF;JJE 7 . 9ED H7==? 2 ; I79H?<?97J? 7 L7H? J;CF? :EFE ?B JH7JJ7C;DJE F?B;I?7B?PP7P?ED; #* . ;:U H?C7IJE IJ78?B; ?D . ; 9ED #* . Bc;LEBKP?ED; ;:B :7DDE :KH7DJ; Bc?DJ;HE 9?9BE IF;HC7JE=;D;I?9B?K?J ; B; I;H?; . 0 U :?C?DK?J7 ;:B ?D . F;H FH;I;DP7 :? :EFF?; HEJJKH; ;:B (- D;BB; 9;BBKB; J;IJ?9EB7H? . ; 7KC;DJ7J7 ;:B ?D . I?7 F;H #* . 9>; #* . ; D;=? IF;HC7JEPE? U IJ7J7 L7BKJ7?9EB7? J?FE D;K &cKIE :? :K; 97CF? B;==;HC;DJ; FEIJ;H?EH? F;H F?7D? #* . >7 =7 JHE B; 7BJ;H7P?ED? ;:BB7 IJHKJJKH7 ;:BB7 9HEC7J?D7 ;:B I?D?I?9ED ?P?ED? :? 8KED7 7<<?:78?B?JS H?=?K7H:E B7 9EF; IEDE IJ7J; IJK:??J; C;??7DJ; -F;HC >HEC7J?D -JHK9JKK ;: ?B H?IF7HC?E ;:BB7 # 7 ;:99;P?ED; :? #* . 9>; ;H7 97H7J I7Oa - - ; ?B B?L;BBE :? <EI<EH?B7P?ED; ;:BBc?IJED; " 2 JH?PP7J7 :7 ;:B;L7J? =H7:?.DJ? :? :EI; F?X I;DI?8?B? 7BB; 7BJ;H7P IJ7JE 7D7B?PP7JE 9ED J;9D?9>; ?CCKDE?IJE9>?C?9>; D;B J?D?9EB?9>; 9?JE<BKEH?C;JH?9>; D;=? IF;HC7JEPE? # H?IKBJ7J? >7DDE CEIJH7JE 9>; Bc?HH7==?7C;DJE ?D:K9; - D;BB; #. 38</7<3,353CC+C387/ .3 153863 9/; +.8=;+93+ 9;BBKB; J;IJ?9EB7H? C;DJH; D;I;KD ;<<;JJE U IJ7JE ;L?;DP??7JE IK=B? IF;HC7JEPE? &; HEJJKH; ?D:EJJ; DED IEDE F?X H?B;L78?B? =?EHD? :EFE Bc?HH7==?7C;DJE C;DJH; 7 J;CF? F?X BKD=>? I? EII;H7 B?H? 9ECF7H17 ;:B :7DDE 9ED KD7 9?D;J?97 9>; IK==;H?I9; KD7 H;B?P?ED; JH7 :?<<;H;DP?7C;DJE FEIJ C;?EJ?9E ; <EHC7P?ED; :? HEJJKH; ;:B B BKBK ;:H?L7DJ? :7=B? IF;HC7JE=ED? ?HH7==?7J? ?F7HJ?C;DJE :? -9?;DP; ?I?9>; /D?L;HI?JS ;:H?9E ## # ((- (7FEB? ?F7HJ?C;DJE :? ?I?97 /D?L;HI?JS # (('_?B7DE (, # ((- (7FEB? #IJ?JKJE '7H?E (=H? _ '?B7DE ;F7HJ?C;DJ E< ;?7?7J?ED)D9EBE=O _ /D?L;HI?JO E< ;HD

20 EDL;=DE (7P?ED7B; ,EC7 EJJ8H; -KFFB;C;DJE 7B 0EBKC; 2### D 7FH?B; 7=EIJE

D;EFB7I?7 FH?C7H?7 ;B 9;HL;BBE ; ?B F?X 7==H;II?LE ;? =B?EC? C7
B?=D? 9ED C;DE ;B :? F7P?;DJ? 9>; IEFH7LL?LEDE :EFE :K;
7DD? :7BB7 :?7=DEI? 7J; B; 97H7JJ;H?IJ?9>; H7:?E8?EBE=?9>; ;?
!' H7:?EH;I?IJ;DP7 BE97B?PP7P?ED; 7BJ7 F;H9;DJK7B; :? 9;BBKB;
?FEII?9>; BcKIE ;;BBc7;HEJ;H7F?7 FEJH;88; 7KC;DJ7HD; B7 9KH78?
B?JS IF;9?7BC;DJ; ?D 9EC8?D7P?ED; :? H7:?EI;DI?8?B?PP7DJ?
;9;DJ;C;DJ; U IJ7JE ?DJHE:EJJE D;BB7 9B?D?97 ?B ;CEPEBEC?;;
'4 KD 7=;DJ; 7B9>?B7DJ; 9>; 7=;D:E :?H;JJ7C;DJ; IKB (;BB;
9;BBKB; JKCEH7B? FKW 7KC;DJ7HD; B7 H7:?EI;DI?8?B?JS ?CF;;;D:E B7
IK7 H?F7H7P?ED;
)8?;JJ?LE :? GK;IJE B7LEHE U L7BKJ7B;L;DJK7B; ?D9H;C;DJE
:? H7:?EI;DI?8?B?JS :? =B?EC? H7:?EH;I?IJ;DJ? ;IFEIJ? 7 F7HJ?9;BB; 97
H?9>; ; 7D7B?PP7H; ?D F7H7BB;BE =B? ;<<;JJ? :? L7H? J?F? :? H7:?7P?ED? 7I
IE9?7J; 7B JH7JJ7C;DJE 9ED '4
&?D;; 9;BBKB7H? :? =B?EC? :? :?L;HI7 H7:?EI;DI?8?B?JS
. !/ '! & / IEDE IJ7J; ?HH7==?7J; 9ED <EJED? ;
<7I9? CEDE;D;H=;J?9? :? ?ED? A;0 KC :EFE ?B JH7J
J7C;DJE F;H KDCcEH7 9ED :?L;HI; 9ED9;DJH7P?ED? :? '4
&7 9?JEJEII?9?JS H7:?ED:EJJ7 U IJ7J7 C?IKH7J7 JH7C?J; I7==?E 9BEDE
=;D?9E ;;BB7 IEFH7LL?L;DP7 9;BBKB7H; -JK:? FH;B?C?D7H? >7DDE CE
IJH7JE 9>; =B? ?ED?7BJE & . IEDE CEBJE ;<<?979? D;BBc?D?8?H;
B7 97F79?JS FHEB?<;H7J?L7 ;? =B?EC? ; ?B FH;JH7JJ7C;DJE 9ED '4
I;C8H7 7KC;DJ7H; B7 CEHJ; 9;BBKB7H; ?D:EJJ7 :7? DEB? ?ED?
=B?EC? F?X H7:?EH;I?IJ;DJ?
#B FHE=;JJE :? H?9;H97 U <?D7DP?7JE :7BBc#((JH7C?J; Bc;IF;H?C;DJE
.*-

B8;HJ?D?) *
 B;ll; *
 B=H7D7J?) *
 BBED?)
 C;B?E * *
 C;D;EB7 , *
 C?9>;JJ? ' * *
 D::DD7)
 DJE99?7) *
 DJED;BB? * *
 H7=DE *
 H97D=;B? !)
 H=7PP? *
 HJ;9ED? & *
 L?DE * *
 7B7J7 ' *
 7H7J7 07BB;@ - *
 7H8?;H?) * *
 7HJEBEJJ7)
 ;BB? ') * * *
 ;BB? ' & *
 ;BJH7C;BBE *
 ;D7II? ')
 ;DD?9? *
 ;H7H?:D;BB?) *
 ;HJEBEJJ? * *
 ;JJ;=7 *
 ;JJ? ' *
 ?=D7C? ') * *
 @EH7I ')
 B7I? *
 BOJ> *
 E99>?E >?7L;JJE & *
 EBI?) *
 ED799>? -)
 ED?=B?7 *
 EDE ' *
 EH:ED7HE &)
 EHH7)
 EHJEB?D *
 EII? & *
 EIIEB7 ' *
 EKII?97KBJ *
 KEDI7DJ; ,)
 KJJ7<7L7) * *
 799?7)
 7BPEB7H? * *
 7C;H?D? -)
 7C?D7J? -)
 7CF7) * *
 7CF7@EB7 &)
 7DJX ')
 7F7DD;I? ! *
 7FF;BB;JJ?) * *
 7H:7CED;)
 7IJ;BB7D? ! *

7IJHE *
 7JJ7D;E ' *
 7L::ED *
 ;BB7 &)
 ;DJ?I *
 ;H9?;BBE 0)
 ;I7H?D? 1 *
 >7J=?B?7BE=BK)) *
 >7KL?; -)
 >;HK8?D? ,) * * * *
 ?7D97=B?ED? #)
 ?7HB;JJ7 *
 ?HHED; ! *) *
 ?I87D?)
 EDIEHJ? ,)
 EH::BB? * *
 EHD;JJ7 .)
 EPP? ,)
 H;I9;DP? ')
 K=?7 ! *
 KJJED; ! *
 c H9E)
 c HH?9E ')
 c)97 ')
 7C8H7 *
 ; D=;B?I *
 ; ?99E))
 ; H7D9?I9?I 0 *
 ;(7:7B 0) * * * *
 ;(EJ7H?IJ;<7D?)
 ;B 4EJJE ! *
 ;BB7 'ED797 - *
 ;JJ?D ' *
 ? 7FH?E *
 ? E==?7 ' *
 ? '7@E 0) *
 ? (EJE ')
 ? ,EI7 *
 ?D? 0 * *
 E=B?EJJ?)
 ED7JE 0)
 ED:?) * *
 B;KJ;H? * * *
 CC? -) *
 IFEI?JE) *
 IFEI?JE !) * * *
 79E;JJ? *
 7H79; * *
 7JJ?8;D; *) *
 7K9?J7DE) * *
 ;HH;H?) *
 ;HH?) *
 ?EH?DE)
 H7J?D? *
 HK9? & *
 HKBB7D? -)

KE9>? *)
 KI9E *
 !7BBED? * * *
 !7BKFF?) * *
 !7H=?KBE , *
 !7JJ7L;99>?7)
 !;DEL;I;)
 !;DEL;I;)
 !;H7H:?? -) * * * *
 !?7B7D;BB7 !) *
 !?7CC7H?DE)
 !?7H:KBBE *) *
 !?EH:7DE *
 !?EL7DD?D?) *
 !?H? ' ! *
 !H7D;; -)) * *
 !HEBB?DE ' ! * *
 !HEII? !) *
 !K?:ED? &) *
 "7BB;H %)
 "7HJC7DD ') *
 "K= * *
 #7:7DP7 &)
 #C8?C8E -)
 #CFHEJ7 # *
 #E7DDK99? & *
 \$KH7I;AEL7 4) *
 \$KH?I ,)
 %E;D?=- *
 &7 '799>?7 ') * *
 &7DPED? *
 &;ED7H:?? -) *
 &?KPP? ,)
 &E EDJ; & *
 &E:7JE , *
 &EC7N \$) * *
 &EH;DJ?D? - *
 &EL?IEBE ! * *
 &K97H?D? *
 &K9?7D? ') *
 &KF? ' *
 '7<<;? -)
 '7BKJ7 - *
 &KF? ' *
 '7<<;? -)
 '7BKJ7 - *
 '7D9KIE ') *
 '7DJ? &) *
 '7H9>;I?D? , *
 '7H;D=E ' *
 '7H?D;BB? ')
 '7H?DE) * *
 '7H?EJJ? &) * *
 '7II7 ,) *
 '7PP;?) * *
 !:EHE -) * *

20 EDL;=DE (7P?ED7B; ,EC7 EJJE8H;

';B?7:W! *	-7FEH7)) * *
'?B7D?)	-7H79?DE ') *
'?DEFH?E) * *	-7H7D) *
'EDJ7BJ? ')	-7JJ7 & *
'EHC?B; ')	-97CFEB? *) *
'KCEJ ' *	-97DD?99>?E)
(?;H?) *	-9>;JJ?DE !)
(EL;BB?)	-9>D;?;;H , *
)99>?=HEII?)	-9>M7HP ' * *
)B9> \$ *	-=KH7) *
)HCI8O , *	-?CED; !)) * * * *
)JJEB;D=>?) * *	-?CED;BB? 0)
*799>?;HEJJ? * *	-J;HFED; -))
*7B7C?D? *	-JH?=7H? &)
*7BC7) *	-JHE?B? ' *
*7BKC8E !)	-OA;I * *
*7H?I & *	.78E99>?D? ') * * *
*7IGK7B?) *	*
*7J;B !)	.7::;? * *
*7JHEDE)	.7DEH? ') *
*7PP7=B?7 -) *	.7DP7H;BB7) *
*;99>?7 # *	.;HP?:?I ' *
*;J;JJ?)	.;II?JEH; *
*;JHK99?)	.;IJ7)
*;JHK99? . * *	.?DJ? *
*?97H:? *	.?H?D;BB?)
*?97H:? &)	.EHH;==?7D?) * *
*?9>?;HH? * * *	.EHH;H? * * *
*?=DEB? *	.KH9E * *
*?DJE ')	/8;P?E * *
*?DJE , *	/=;DIA?;D; ,)
*?I9?J;BB? ' *	07B;DJ?D?)
*H;II;BBE ' *	07B;DJ?D? ' *
*H;IJEF?DE !)	07B;DJ?D? -)
*H?I; % ')	07B;DJ?D? 0)
*HE:? &)	0;HED7)
*K=B?;I; ')) *	0;HED7 ,?D7J? !)
,7CF7PPE)	0?9?D? *
,7DP7 * *	0?BB7D? * *
,7DP7D? ! (*	0?I9EC? *
,7K9E , *	0?IC7H7)
,7L7D;BB?)	0?J? 0) *
,;8;II? -) *	1?;;IEJJ & *
,;CED:?D? *	4799>;HED? ()
,?99?7H:?! % *	47C7? & *
,E97 0))	47PP;HED? *
,EC7DE ' *	4?D?! *
,EC8? *	4?HED? # *
,EDI?L7BB;)	
,EI7:7 *	
,EI?) * *	
,K==?;H? 0 * *	
-7887H;I;)	
-7BL7JEH? ' *	
-7BL?JJ? . *	
-7DJ?D? *	



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