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## APPENDIX 1: ETHICS CLEARANCE - CSIR

Clearance granted by the CSIR for the *in vivo* diffuse reflectance probe measurements on 30 volunteers.



**CSIR Research Ethics Committee**  
PO Box 395 Pretoria 0001 South Africa  
Tel: +27 12 841 4080  
Fax: +27 12 841 2476  
Email: R&DEthics@csir.co.za

Date: 10 August 2011

Dear: Ms Aletta Karsten

Approval of Protocol: **Influence of Skin Type on Photonics Based Diagnostic Techniques for Cancer Detection**

This is to confirm that your Protocol reviewed by the CSIR REC has been approved. The reference number of this research project is **Ref 17/2011**.

This approval is granted under the condition that:

1. The researcher remains within the procedures and protocols indicated in the proposal, as well as the additions made to the procedures and protocols as indicated in the responses submitted to the questions of the REC, particularly in terms of any undertakings made and guarantees given.
2. The researcher notes that his research must be submitted again for ethical clearance if there is substantial departure from the existing proposal.
3. The researcher remains within the parameters of any applicable national legislation, institutional guidelines and scientific standards relevant to the specific field of research.
4. This approval is valid for one calendar year from the date of this letter.
5. The researcher submit bi-annual progress reports to the REC
6. The researcher immediately alert the REC of any adverse events that have occurred during the course of the study, as well as the actions that were taken to immediately respond to these events.
7. The researcher alert the REC of any new or unexpected ethical issues that emerged during the course of the study, and how these ethical issues were addressed. If unsure how to respond to these unexpected or new ethical issues as they emerge, the researcher should immediately consult with the REC for advice.
8. The researcher submit a short report to the REC on completion of the research in which it is indicated (i) that the research has been completed; (ii) if any new or unexpected ethical issues emerged during the course of the study; and if so, (iii) how these ethical issues were addressed.

We wish you all of the best with your research project.

Kind regards

Prof Johan Hattingh

Dr Sandile Ncanana



(CSIR REC Chair)



(CSIR REC Secretariat)

## APPENDIX II: ETHICS CLEARANCE - UNIVERSITY OF PRETORIA

Clearance granted by the University of Pretoria for the *in vivo* diffuse reflectance probe measurements on 30 volunteers.



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

ETHICS COMMITTEE  
Faculty of Natural and Agricultural Sciences

12 September 2011  
Prof M Braun  
Building 46, CSIR  
Scientia  
Pretoria  
0002

Dear Prof Braun

Re: EC110830-060 Determination of the reflectance of different skin types with a non-invasive reflectance probe

The project conforms to the requirements of the Ethics Committee.

Kind regards



Prof NH Casey  
Chairman: Ethics Committee

## APPENDIX III: SOURCE CODE FOR THE ASAP COMPUTER MODEL

```

!!++
!! Tumor with macros.INR
!!
!! Description: A skin model is illuminated with a 676nm light source.
!!           The energy absorbed in the slab volume is tracked using the
!!           VOXELS command. Model consists of epidermis, dermis and
!!           tumor embedded in dermis. SCC tumour data is used. The optical
!!           properties used is data published by Solamatmina, Journal of
!!           Biomedical Optics 11(6), 064026 November/December 2006
!!           Note!!!!
!!           The units use by Solamatmina is in mm-1, but
!!           when Tuchin reference it, they mistakenly used
!!           the same values but with units of cm-1.
!!
!!
!!           MACRO OUTPUT ANALYSIS CALCULATES THE ABS AND TRANS THROUGH THE LAYERS
!!
!!MACRO: OUTPUT_ANALYSIS
!! Functions: 1. Output analysis result to .txt file for post processing
!!
OUTPUT_ANALYSIS { 1
$ECHO NONE
$IO OUTPUT #1.TXT -FILE(10)
    $SCR 10
FILENAME = #1.TXT
NUMBER OF RAYS =\NRAYS.\
EPIDERMIS THICKNESS (MM) = \EPIDERMISTHICKNESS.\
TOTAL FLUX REFLECTED = \REFLECTED.\
TOTAL FLUX TRANSMITTED= \TRANSMITTED.\
SLICE THICKNESS=\SLICE_THICKNESS.\
EPIDERMIS MU_A=\E_MUA.\
EPIDERMIS MU_S=\E_MUS.\

SLICE DEPTH (MM) FLUX ABSORBED IN SLICE (mW) FLUX TRANSMITTED IN SLICE (mW)
$IO OUTPUT CLOSE
$ECHO ALL

FTRANS_SLICE=1-REFLECTED          !! VARIABLE DEFINED
$DO 1 (EVAL_ZSLICE)
{
    DISPLAY VOXEL_ABS ?          !!DO ANALYSIS FOR EACH SLICE
    RETURN

$GRAB 'File header:' 2 1 D_SLICE  !!D_SLICE is the variable/register to
!!store the depth of each slice
$GRAB 'Average' 0 1 VOX_FLUX_AVE
$GRAB 'Integral =' 0 1 VOX_FLUX_INT
FLUX_SLICE1=VOX_FLUX_AVE*SLICE_THICKNESS*SLICE_AREA

```

```

FTRANS_SLICE=FTRANS_SLICE-FLUX_SLICE1      !!FLUX TRANSMITTED THROUGH SLICE
$ECHO NONE

$SIO OUTPUT #1.TXT +FILE(10)      !! ALL SUCCESSIVE ITERATIONS '+' ADD DATA
!!TO EXISTING DATA IN FILE

$SCR 1
\D_SLICE. \          \FLUX_SLICE1^ \          \FTRANS_SLICE^ \
$SIO OUTPUT CLOSE
}
}
Skin model file name>

!!-----
!!MAIN
!!-----
SYSTEM NEW                      !!COMMANDS TO REINITIALIZE DATA
STORAGE
RESET
BEAMS INCOHERENT GEOMETRIC

!!DEFINE RAY SPLIT AND SCATTER CHARACTERISTICS
    SPLIT 100 MONTECARLO          !!DETERMINES THE NUMBER OF TIMES A
!!SINGLE RAY CAN BE SPLIT AND HOW
    LEVEL 100 ALL                 !!DETERMINES THE NUMBER OF TIMES A
!!RAY CAN SCATTER FROM A SINGLE SURFACE

FRESNEL AVE

!!SET SYSTEM UNITS
    UNITS MM 'mW'                 !!SETS DISTANCE MEASUREMENT UNITS
!!TO MM AND CREATES THE mW LABEL FOR ENERGY VALUES

!!SET SOURCE WAVELENGTH
    WAVELENGTH 676 NM             !!SETS WAVELENGTH TO 676NM FOR
TRACE

!!DEFINE COATINGS
    COATING
        0 0 'ABSORB'              !!ABSORBING COATING
        0 1 'TRANSMIT'           !!CREATES A COMPLETELY TRANSMITTING
!!(ZERO LOSS) COATING FOR SURFACES
!! DEFINE VARIABLES THAT MAY CHANGE
NRAYS=2001
ZSLICE=309
E_MUA=5.000
EPIDERMISTHICKNESS=0.09
EVAL_ZSLICE=ZSLICE
E_MUS=22.4      !!G=0.8

!!CREATE SCATTER AND ABSORPTION MODELS FOR TISSUE AND TUMOR
!! USE DATA FROM ARTICLE AND RSM @676 NM from Solamatmina
    MODEL !! g      us      ua      F

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VOLUM .80 E_MUS`E_MUA 1 !!EPIDERMIS SCATTER AND ABSORPTION MODEL
VOLUM .80 13.9`0.15 1 !!DERMIS SCATTER AND ABSORPTION MODEL
VOLUME .80 8.55`0.11 1 !!TUMOR SCATTER AND ABSORPTION MODEL USE SCC

!!CREATE MEDIA FOR TISSUE AND TUMOR USE n FROM RSM
MEDIA
    1.50 SCATTER 1 'EPIDERMIS' !!APPLIES TISSUE CATTER AND
!!ABSORPTION MODEL TO MEDIA WITH INDEX OF REFRACTION OF 1.50
    1.40 SCATTER 2 'DERMIS' !!APPLIES TISSUE SCATTER AND
!!ABSORPTION MODEL TO MEDIA WITH INDEX OF REFRACTION OF 1.40
    1.40 SCATTER 3 'TUMOR' !!APPLIES TUMOR SCATTER AND
!!ABSORPTION MODEL TO MEDIA WITH INDEX OF REFRACTION OF 1.40

!!VARIABLES FOR BUILDING GEOMETRY
!!THICKNESSES OF LAYERS AS IN RSM ASSUME SIMMILAR OPTICAL PROPERTIES FOR
!!DERMIS AND HYPODERMIS
HWEPIDERMIS=20 !!HALF-WIDTH OF EPIDERMIS SURFACE IN MM
HWDERMIS=20 !!HALF-WIDTH OF TISSUE SURFACE IN MM
DERMISTHICKNESS=3 !!TISSUE THICKNESS IN MM
HWTUMOR=5 !!HALF-WIDTH OF TUMOR SURFACE IN MM
TUMORTHICKNESS=2 !!TUMOR THICKNESS IN MM
EPIDERMISLOCATION=0 !!LOCATION OF EPIDERMIS SURFACE ALONG THE Z AXIS
DERMISLOCATION=EPIDERMISTHICKNESS !! DERMIS BEGINS WHERE EPIDERMIS ENDS
TUMORLOCATION=0.2 !!LOCATION OF TUMOR SURFACE ALONG THE Z AXIS

!!EPIDERMIS SLAB GEOMETRY
ENT OBJ
PLANE Z (EPIDERMISLOCATION) RECT (HWEPIDERMIS) 'EPIDERMIS.SURFACE'
INTERFACE COATING BARE AIR EPIDERMIS
REDEFINE COLOR 10
PLANE X (HWEPIDERMIS) RECT (HWEPIDERMIS) (EPIDERMISTHICKNESS/2)
'EPIDERMIS.EDGE1'
INTERFACE COATING ABSORB AIR EPIDERMIS
SHIFT Z (EPIDERMISTHICKNESS/2)
REDEFINE COLOR 10
PLANE X -(HWEPIDERMIS) RECT (HWEPIDERMIS) (EPIDERMISTHICKNESS/2)
'EPIDERMIS.EDGE2'
INTERFACE COATING ABSORB AIR EPIDERMIS
SHIFT Z (EPIDERMISTHICKNESS/2)
REDEFINE COLOR 10
PLANE Y (HWEPIDERMIS) RECT (EPIDERMISTHICKNESS/2) (HWEPIDERMIS)
'EPIDERMIS.EDGE3'
INTERFACE COATING ABSORB AIR EPIDERMIS
SHIFT Z (EPIDERMISTHICKNESS/2)
REDEFINE COLOR 10
PLANE Y -(HWEPIDERMIS) RECT (EPIDERMISTHICKNESS/2) (HWEPIDERMIS)
'EPIDERMIS.EDGE4'
INTERFACE COATING ABSORB AIR EPIDERMIS
SHIFT Z (EPIDERMISTHICKNESS/2)
REDEFINE COLOR 10
PLANE Z (EPIDERMISTHICKNESS) RECT (HWEPIDERMIS) 'EPIDERMIS.BACK'
INTERFACE COATING BARE EPIDERMIS DERMIS
REDEFINE COLOR 10

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RETURN
!!DERMIS SLAB GEOMETRY
ENT OBJ
PLANE Z (DERMISLOCATION) RECT (HWDERMIS) 'DERMIS.SURFACE'
INTERFACE COATING BARE EPIDERMIS DERMIS
REDEFINE COLOR 14
PLANE X (HWDERMIS) RECT (HWDERMIS)
((DERMISLOCATION+DERMISTHICKNESS)/2) 'DERMIS.EDGE1'
INTERFACE COATING ABSORB AIR DERMIS
SHIFT Z ((DERMISLOCATION+DERMISTHICKNESS)/2)
REDEFINE COLOR 14
PLANE X -(HWDERMIS) RECT (HWDERMIS)
((DERMISLOCATION+DERMISTHICKNESS)/2) 'DERMIS.EDGE2'
INTERFACE COATING ABSORB AIR DERMIS
SHIFT Z ((DERMISLOCATION+DERMISTHICKNESS)/2)
REDEFINE COLOR 14
PLANE Y (HWDERMIS) RECT ((DERMISLOCATION+DERMISTHICKNESS)/2)
(HWDERMIS) 'DERMIS.EDGE3'
INTERFACE COATING ABSORB AIR DERMIS
SHIFT Z ((DERMISLOCATION+DERMISTHICKNESS)/2)
REDEFINE COLOR 14
PLANE Y -(HWDERMIS) RECT ((DERMISLOCATION+DERMISTHICKNESS)/2)
(HWDERMIS) 'DERMIS.EDGE4'
INTERFACE COATING ABSORB AIR DERMIS
SHIFT Z ((DERMISLOCATION+DERMISTHICKNESS)/2)
REDEFINE COLOR 14
PLANE Z ((DERMISLOCATION+DERMISTHICKNESS)) RECT (HWDERMIS)
'DERMIS.BACK'
INTERFACE COATING BARE DERMIS AIR
REDEFINE COLOR 14
RETURN

!!TUMOR SLAB GEOMETRY CYLINDRICAL
ENT OBJ
PLANE Z (TUMORLOCATION) ELLIPSE (HWTUMOR) 'TUMOR.SURFACE'
INTERFACE COATING BARE TUMOR DERMIS
REDEFINE COLOR 14
TUBE Z (TUMORLOCATION) (HWTUMOR) (HWTUMOR)
(TUMORTHICKNESS+TUMORLOCATION) (HWTUMOR) (HWTUMOR) 0 0 'TUMOR.RING'
INTERFACE COATING BARE TUMOR DERMIS
REDEFINE COLOR 14
PLANE Z (TUMORLOCATION+TUMORTHICKNESS) ELLIPSE (HWTUMOR) 'TUMOR.BACK'
INTERFACE COATING BARE DERMIS TUMOR
REDEFINE COLOR 14
RETURN

!! SET UP A DETECTOR PLANE TO EVALUATE THE FLUENCE THROUGH THE LAST PLANE
ENT OBJECT
PLANE Z (DERMISTHICKNESS+EPIDERMISTHICKNESS+0.2) ELLIPSE 20 20
'DETECTOR'
INTERFACE 0 0 !!DEFINE INTERFACE TO BE 100% ABSORPTIVE
REDEFINE COLOR 50
RETURN

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!! SET UP ELLIPSOID DETECTOR TO MEASURE ALL THE BACSCATTERED LIGHT LEAVING
!!THE SAMPLE IN -Z
SURFACE; ELLIPSOID 3@20 3@0 -Z
OBJECT 'DETECTOR.REFLECT'; INTERFACE 0 0 AIR AIR

!! VIEW GEOMETRY
WINDOW Y Z
PLOT FACETS 5 5 0
$VIEW

!! DEFINE LIGHT SOURCE
GRID ELLIP Z -3.734 -4@6 2@(NRAYS) RANDOM 1
SOURCE DIRECTION 0 0 1
FLUX TOTAL 1

!!DEFINE VOXEL EVALUATION SYSTEM
!!ZSLICE=22  !! ALREADY DEFINIED EARLIER
VOX_X1=-(HWDERMIS)
VOX_X2=(HWDERMIS)
VOX_Y1=-(HWDERMIS)
VOX_Y2=(HWDERMIS)
VOX_Z1=0
VOX_Z2=(DERMISTHICKNESS+EPIDERMISTHICKNESS)

SLICE_AREA=(VOX_X2-VOX_X1)*(VOX_Y2-VOX_Y1)
SLICE_THICKNESS=(VOX_Z2-VOX_Z1)/ZSLICE

!! ABSORPTION EVALUATIONS
VOXELS ABSORB (VOX_X1) (VOX_X2) (VOX_Y1) (VOX_Y2) (VOX_Z1) (VOX_Z2) 2@200
(ZSLICE)

PLOT FACETS 5 5 0 OVERLAY  !!OVERLAY OVER GEOMETRY PLOT
TRACE
STATS
$COPY 9 VOXEL_ABS.DIS
$VIEW
&VIEW VOXEL_ABS.DIS

!!ANALYSIS
STATS
CONSIDER ONLY DETECTOR.REFLECT  !!ONLY EVALUATE RAYS REACHING REFLECTION
!!DETECTOR
STATS
$GRAB 'TOTAL' 0 2 REFLECTED

CONSIDER ALL  !!ONLY EVALUATE RAYS REACHING !!TRANSMISSION DETECTOR
CONSIDER ONLY DETECTOR
STATS
$GRAB 'TOTAL' 0 2 TRANSMITTED
$REG REFLECTED
$REG TRANSMITTED
$OUTPUT_ANALYSIS A1"

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