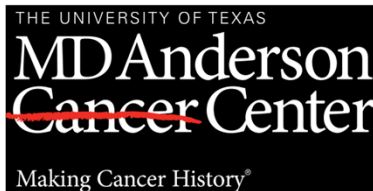# Update from the Radiation Physics Center

A report from the Childhood Cancer Survivor Study

Rebecca M. Howell, Susan A. Smith, Ying Qiao, Irene Harris, Rita Weathers, Tara Henderson, Samantha Murray, and Debbie Tanner

THE UNIVERSITY OF TEXAS
MD Anderson
Cancer Center

Making Cancer History®

Department of Radiation Physics ♦ Section of Outreach Physics ♦ Late Effects Group

CCSS
Childhood Cancer
Survivor Study

Our Team

- Susan Smith, MPH, QA Dosimetry Supervisor
- Ying Qiao, MS, Computational Scientist
- Irene Harris, CMD, Research Dosimetrist
- Rita Weathers, MS, Data Integration Developer
- Tera Jones, CMD, Dosimetrist
- Samantha Murray, Sr. Coordinator Research Data
- Debbie Tanner, Operations Manager

Medical Physics Graduate Students
- Aashish Gupta BS, MS student
- Suman Shrestha MS, PhD Student
- Constance Owens BS, PhD Student

Roles of the Radiation Physics Center

CCSS

- Provide input during the development of proposals regarding level of dosimetry detail needed and/or achievable for planned analyses

- Maintain secure databases with scanned indexed copies of the complete radiation therapy records from CCSS institutions

- Calculate organ and/or body-region doses from radiation therapy for study participants

- Assist the investigators in understanding and using the radiation data in analyses and manuscripts

- **Completed Dosimetry**

  - Pituitary dosimetry

  - Kidney dosimetry

  - Detailed chest field dosimetry

  - Body region dosimetry for ~ 350 individuals (new institutions included since last data freeze)

- **Methods Manuscript, *in press***

Adaptations to a Generalized Radiation Dose Reconstruction Methodology for Use in Epidemiologic Studies: An Update from the MD Anderson Late Effect Group

Rebecca M. Howell,[1] Susan A. Smith, Rita E. Weathers, Stephen F. Kry and Marilyn Stovall

Department of Radiation Physics, The University of Texas at MD Anderson Cancer Center, Houston, Texas

Radiation Dosimetry Process

ccss

1. Abstract patients' RT record

2. Reconstruct RT fields on age-specific phantom

3. Calculate dose to region or organ of interest

4. Quality assurance of computed doses

5. Create output files and documentation

6. Provide data to FH statistics center for distribution to individual investigators (w/ approved concept proposals)

Record Abstraction

- Pertinent data coded
  - Treatment Dates
  - Date of Birth
  - Prescription(s)
  - Field Data: orientation, energy, weighting, blocking, modifiers, etc.

CCSS II - Radiation Therapy - Ver. 4
designed 11/25/08 - mod 9/18/09 - mod 6/21/10 - mod 9/13/10

DOB (mm/dd/yyyy): ___ / ___ / ____ page ___ of ___ CCSS ID: ___ - _____ - _

Reason
Primary/Recurrence = 1
Metastatic disease = 3
Second Cancer (SMN) = 2
Other = 8   Unknown = 9

Dates of Therapy
Begin Date (mm/dd/yyyy)
End Date (mm/dd/yyyy)

Special Technique
☐ SRS (1)   ☐ None (0)
☐ IMRT (2)
☐ Other (8) _____

Beam Type:
☐ Co60 (02)
☐ Cs137 (03)
☐ Photons (04)   MV: __
☐ Electrons (07)   MeV: __
☐ Ortho (01)   KVP __
   HVL (mm) __ . __   ☐ AL ☐ CU ☐ Unk
☐ Betatron (05)   MV: __
☐ Brachy/Nuclear Scans (77)
☐ Other (88) (Note in Comment)
☐ Unknown (99)

Comments: ☐ Yes ☐ No

3051241488

Field
☐ MANTLE (330):
   ☐ T-Shaped (221)
☐ ABDOMEN [not kidney] (400):
   ☐ Para-Aortic (410)
   Spleen/Pedicle Treated: ☐ Yes ☐ No ☐ UNK
   Liver Treated: ☐ Yes ☐ No ☐ UNK
☐ KIDNEY (401)
☐ ABDOMEN & PELVIS (700):
   ☐ Whole (706)
   ☐ Inv. Y (710)
   ☐ Dogleg (730)
   ☐ Spade (720)
   Spleen/Pedicle Treated: ☐ Yes ☐ No ☐ UNK
   Liver Treated: ☐ Yes ☐ No ☐ UNK
☐ PELVIS (500):
   ☐ V Pelvis (520)
   ☐ Inguinal (530)
   ☐ Testicular (540)
   ☐ Perineal (550)
☐ OTHER (888)   Body Site ___
   Description _____

Lt/Rt Border for Any Field in the Trunk:
☐ To Midline (1) ☐ Over Midline (2) ☐ Unk (9)
☐ Whole (3) ☐ NOT to Midline (4)

Field Top/Bottom Borders

	Top:	Bottom:
Top of Head	☐	☐ (00)
Ear/Jaw	☐	☐ (01)
Mid neck	☐	☐ (02)
SSN	☐	☐ (03)
Mid chest	☐	☐ (04)
Nipple	☐	☐ (05)
Diaphragm	☐	☐ (06)
L2	☐	☐ (12)
Umbilicus	☐	☐ (07)
L5	☐	☐ (08)
L5/S1 Junction	☐	☐ (14)
Mid pelvis	☐	☐ (09)
Top of Femur	☐	☐ (13)
Pelvic Floor	☐	☐ (10)
Upper Leg	☐	☐ (11)
Other	☐	☐ (88)
Unk	☐	☐ (99)
N/A	☐	☐ (77) ==>

If N/A (77) is chosen answer the default center question below - code a center if no is marked
==> Default Center: ☐ Yes ☐ No

X ____ Y ____ Z ____

Size (mm) : (w x h) ____ X ____

Any Blocking? ☐ No (0) ☐ Unk (9) ☐ Yes (1)

Field Wedged? ☐ No ☐ Yes - Wedge Angle: ___ ☐ Unsure/UNK

Laterality
☐ Right (1)
☐ Left (2)
☐ Rt & Lt (3)
☐ Central (4)
☐ Unk (9)

Dose
____ . ____
Unit: ☐ cGy/Rad (1) ☐ Other (8) ☐ Gy (3) ☐ Unk (9) ☐ Roentgen (4)
Dose Def: ☐ Tumor (3) ☐ Given (2) ☐ Air (1) ☐ Other (8) ☐ Unk (9)
If Tumor dose code depth. Depth (cm) __ . __

Config
☐ A & P (01) ☐ Lat(s) (04) ☐ Inf & Sup (07)
☐ A & P Oblique (12) ☐ Lat Oblique Pair (64) ☐ Inferior (17)
☐ A only (02) ☐ Lat Oblique One (65) ☐ Superior (27)
☐ Ant Oblique (62) ☐ Tang (06) ☐ Other (88)
☐ P only (03) ☐ Direct (10) (Note in comment)
☐ Post Oblique (63) ☐ Arc/Rotational (11) ☐ Unk (99)

Field Proximity Sex: ☐ MALE ☐ FEMALE ☐ UNK

	Out > 3cm (0)	In Beam (1)	Edge (2)	Near <3cm (3)	Blocked (4)	Testes Shield / Pinned Ovary (5)	TE Shld & Blk (7)	Moved Away (6)	UNK (9)	Review (R)
Pituitary:	☐ (0)	☐ (1)	☐ (2)	☐ (3)	☐ (4)				☐ (9)	☐ (R)
Thyroid:	☐ (0)	☐ (1)	☐ (2)	☐ (3)	☐ (4)				☐ (9)	☐ (R)
Heart:	☐ (0)	☐ (1)	☐ (2)	☐ (3)	☐ (4)				☐ (9)	☐ (R)
Testes:	☐ (0)	☐ (1)	☐ (2)	☐ (3)	☐ (4)	☐ (5)	☐ (7)	☐ (6)	☐ (9)	☐ (R)
Left Ovary:	☐ (0)	☐ (1)	☐ (2)	☐ (3)	☐ (4)	☐ (5)			☐ (9)	☐ (R)
Right Ovary:	☐ (0)	☐ (1)	☐ (2)	☐ (3)	☐ (4)	☐ (5)			☐ (9)	☐ (R)
Uterus:	☐ (0)	☐ (1)	☐ (2)	☐ (3)	☐ (4)				☐ (9)	☐ (R)

Information Received:
☐ Complete record (1)
☐ Partial record (2)
☐ Notes &/or Summary (3)
☐ Abstract information only (4)

Quality Score:
☐ Good (1)
☐ Item(s) missing/not important (2)
☐ Item(s) missing/important (3)
☐ Inadequate for dosimetry (4)
☐ Part inadequate (5)

Sim Film Available: ☐ yes ☐ no
Photo Available: ☐ yes ☐ no
Diagram: ☐ yes ☐ no

Abstracted By: ___ on ___ / ___ / 2013 Minutes to abstract: ___
QC By: ___ on ___ / ___ / 2013 Minutes required to QC: ___

Wilm's Tumor Example Case

Translation of patient chart data to reconstructed fields on age specific phantom:

a. Photo of RT field outlined on patient's abdomen

b. RT field diagram

c. Frontal view of phantom showing reconstructed AP field

d. Sagittal view of phantom showing reconstructed AP and PA fields.
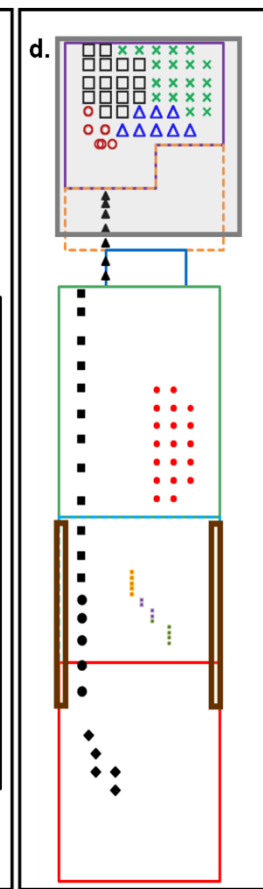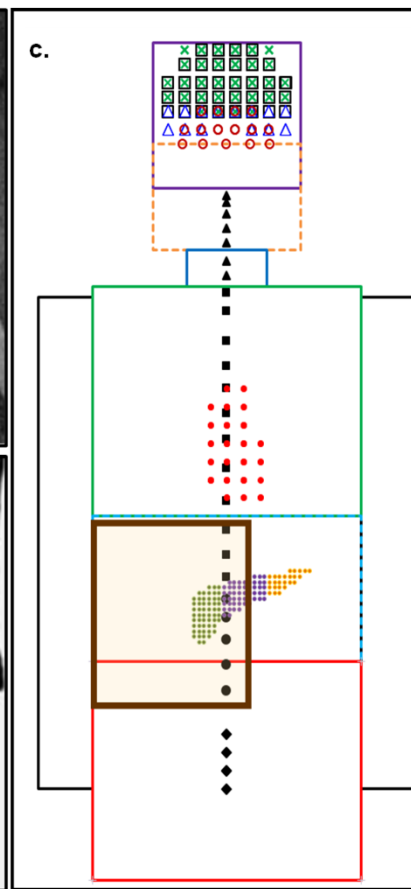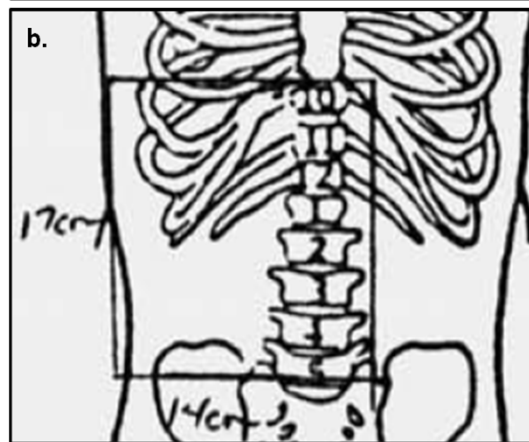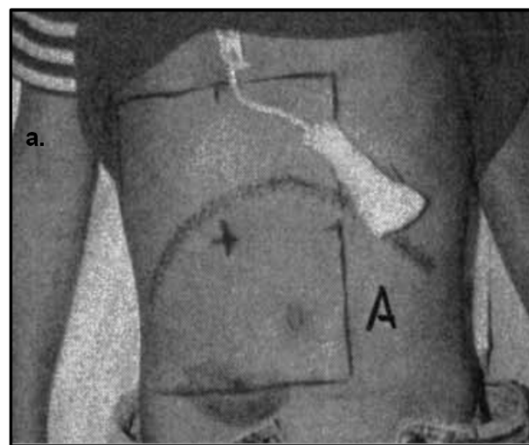
Translation of patient chart data to reconstructed fields on age specific phantom
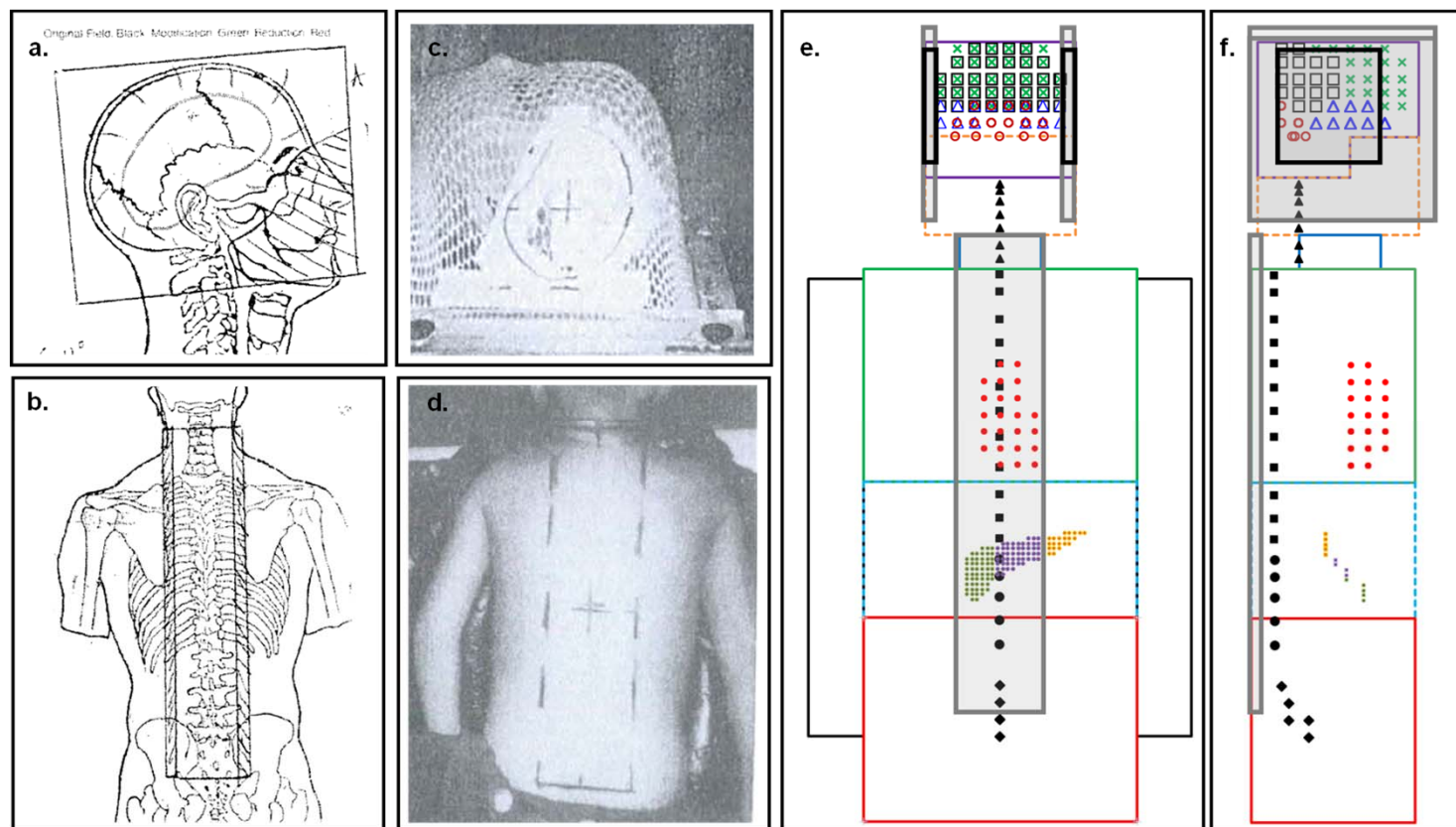
- **<u>Study Specific Dosimetry</u>**

  - Y/N RT (per FH stats/data center)
  - Y/N for specific types of RT, e.g., CSI, TBI, etc.
  - Body region maximum tumor dose (maxTD, SH, SL)
  - Organ specific doses, e.g., heart, thyroid, gonads, pancreas, etc.
  - Average dose (most common parameter)
  - Average dose to organ parts, e.g., pancreas head, body, tail
  - Percent volume that received $\geq$ X Gy, e.g., PV_5, PV_{10}, PV_{20}

MDA

Completed Cohort Dosimetry to Date

CCSS

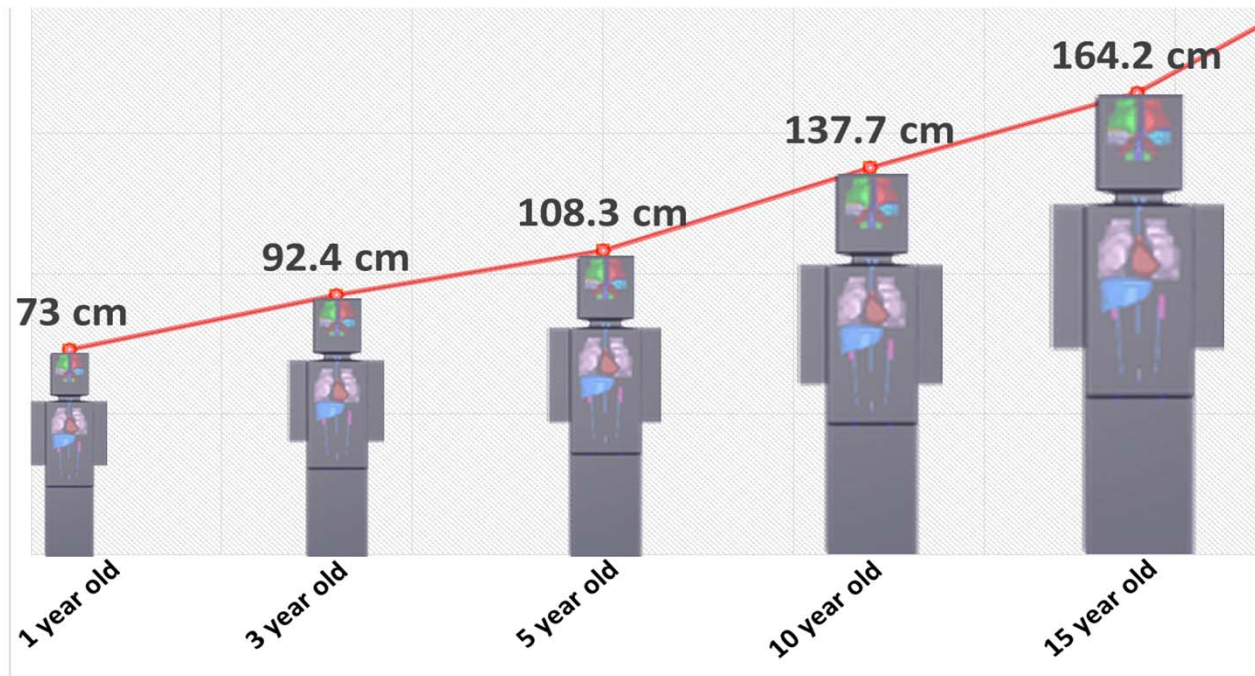| Organ/Region	Data Reported	Cohort
Body Regions + brain 4 seg	MaxTD, SH, SL	Overall
Eyes/lenses	Average Dose	Original
Heart	Avg. V_5, V_{10}, V_{15}, V_{20}	Overall
Kidneys (right and left)	Average dose	Original, Expansion
Lungs	Average	Overall (*12,846 patients)
Ovaries	Average dose	Overall (female)
Uterus	Average dose	Overall (female)
Pancreas	Average dose for whole, head, body, tail V_{20} and V_{30} for whole pancreas	Overall
Pituitary	Average dose	Original, Expansion
Salivary Glands	Average dose	Original
Spleen (Abdomen LUQ as surrogate)	Average dose	Overall
Testes	Average dose	Original
Thyroid	Average dose	Original
Teeth	Average dose	Original

- **Developing/advancing dosimetry methods**

  - Implementation of 3D computational phantoms in commercial radiotherapy treatment planning software (TPS)

  - Development of an enhanced heart model with substructures for cardiac dosimetry

    Concept proposal (aim 1): Influence of Radiotherapy Dose to Cardiac Substructures on Cardiac Risk in Long-Term Survivors of Childhood Cancer

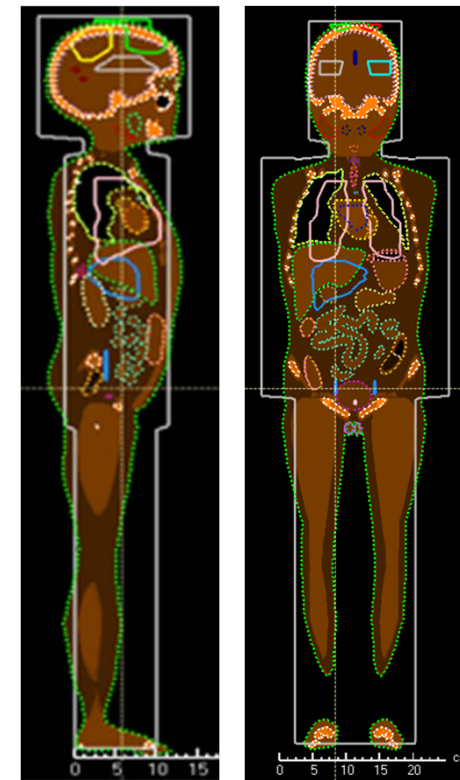# Implementation of 3D computational phantoms in in commercial TPS

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Age-scaled phantoms generated in TPS

Registered with NCI phantom

73 cm
92.4 cm
108.3 cm
137.7 cm
164.2 cm

1 year old
3 year old
5 year old
10 year old
15 year old

Aashish Gupta, BS (MS student)
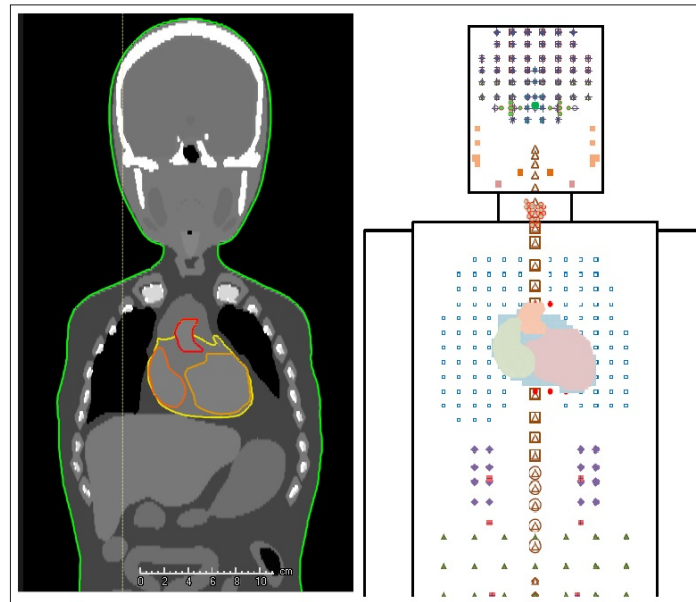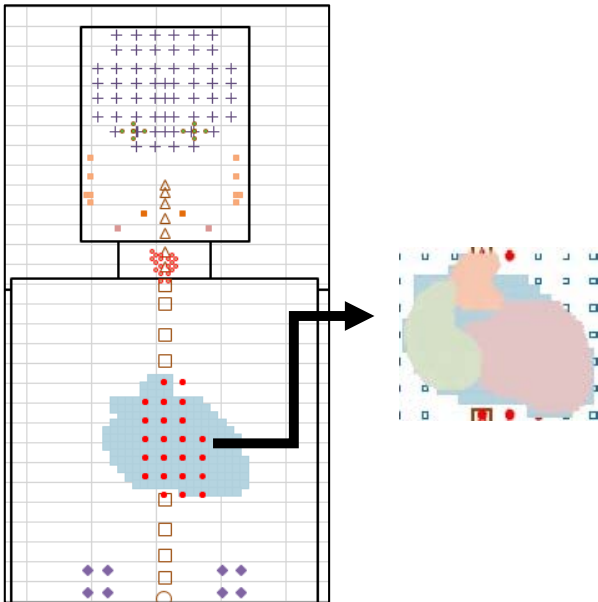*Choonsik Lee, PhD, (NCI-REB)*

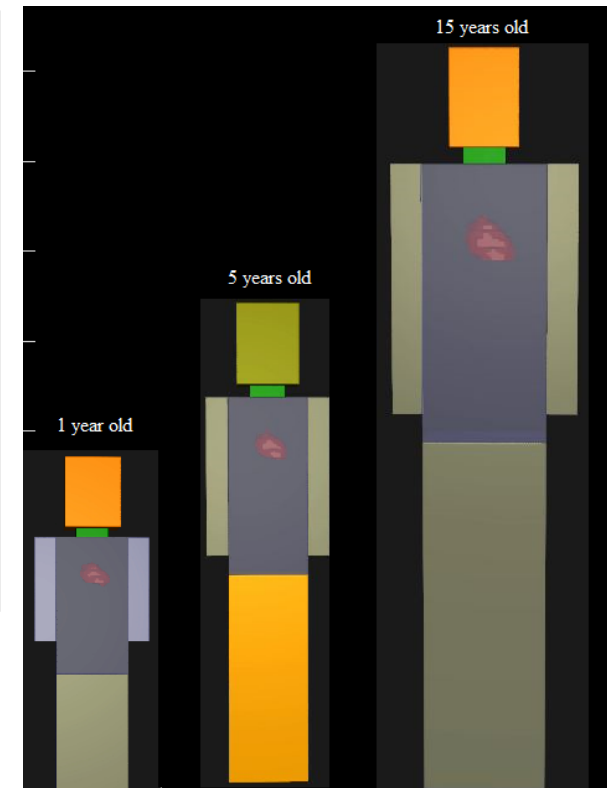# Development of an enhanced heart model with substructures for cardiac dosimetry

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New heart model

- Human anatomy based

- 20X higher resolution

- Includes substructures

NCI phantom (left) and in-house phantom (right) with whole heart and selective substructure contours

Age-scaled phantom/heart

Suman Shrestha (MS student), Choonsik Lee PhD (NCI-REB), and James Bates (UF)

Thank you