Report from Medical Domain

Joseph Perl
SLAC National Accelerator Laboratory
Scientific Computing Applications Group

Geant4 Collaboration Meeting
Chartres, 10 September 2012

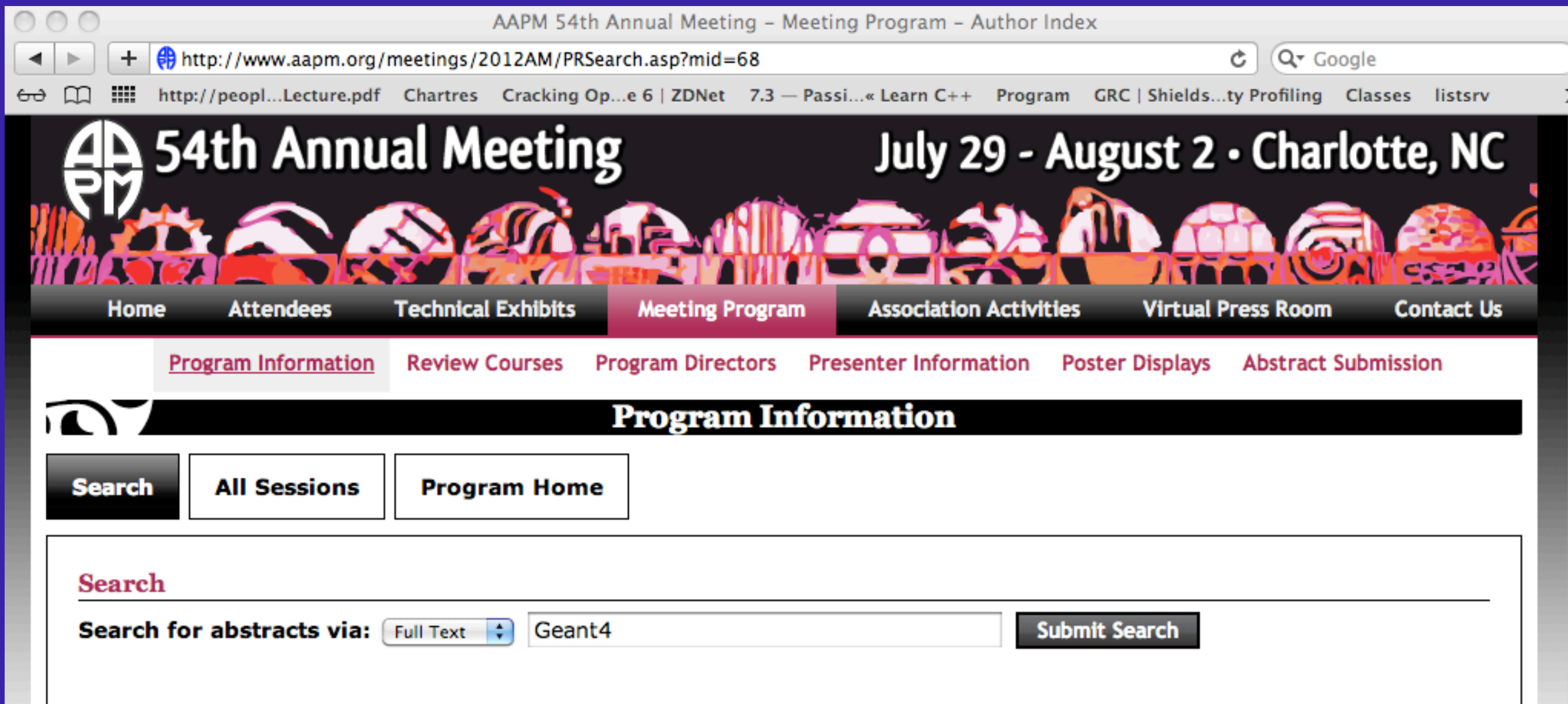
Work supported in part by the U.S. Department of Energy under contract number DE-AC02-76SF00515
and by the U.S National Institutes of Health under contract number 1R01CA140735-01

Not New !!!

- Geant4 is well established in the medical physics.
- Please do not refer to it as a new or emerging area for Geant4.

AAPM 2012

- Largest medical physics meeting world wide
- 59 Abstracts mention Geant4 (using it, benchmarking other tools against it, etc.)
  - http://www.aapm.org/meetings/2012AM/PRSearch.asp?mid=68



54th Annual Meeting July 29 - August 2 • Charlotte, NC

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Full Text Search Results for 'Geant4'

WE-C-BRB-8	**A GPU/CUDA Based Monte Carlo Code for Proton Transport: Preliminary Results of Proton Depth Dose in Water** - L Su*, T Liu, A Ding, X Xu, Rensselaer Polytechnic Inst., Troy, NY
WE-C-BRB-2	**A Monte Carlo Feasibility Study for Calculating Dose Perturbations in Patient Geometries Due to Homogenous Magnetic Fields From MRIgRT** - Y Yang*, B Bednarz, University of Wisconsin, MADISON, WI
TU-C-BRB-4	**A Monte Carlo-Based Small Animal Dosimetry Platform for Pre-Clinical Trials: Proof of Concept** - B Bednarz*, A Besemer, Y Yang, University of Wisconsin, MADISON, WI
SU-E-T-498	**A Preliminary Monte Carlo Simulation Study of the Varian TrueBeam Linear Accelerator** - D Johnson*, Y Chen, E Schnell, S Ahmad, University of Oklahoma Health Sciences Center, Oklahoma City, OK
SU-E-T-302	**A Simulation Study with Geant4 Investigating the Secondary Prompt Gamma Emissions From Incident 40 MeV Protons Onto Various Materials** - A Iau*, Y Chen, S Ahmad, Oklahoma Univ. Health Science Ctr., Oklahoma City, OK
SU-E-J-80	**A Simulation Study with Geant4 On the Yields of Positron-Emitting Nuclei (10C, 11C, and 15O) Induced by Protons and Carbon Ions** - A Iau*, Y Chen, S Ahmad, University of Oklahoma Health Sciences Center, Oklahoma City, OK
WE-C-BRB-7	**Benchmarking of the TOPAS Monte Carlo System Against Phantom Dose Measurements in Proton Therapy** - M Testa*, J Schuemann, H Paganetti, Massachusetts General Hospital, Boston, MA
MO-F-213AB-4	**Biological Effect of Dose Shadowing by Fiducial Markers in Spot Scanning Proton Therapy with a Limited Number of Fields** - T Matsuura[1]*, K Maeda[1], K Sutherland[1], T Takayanagi[2], S Shimizu[3], S Takao[1], H Nihongi[1], C Toramatsu[1], N Miyamoto[1], Y Nagamine[4], R Fujimoto[2], K Umegaki[3], H Shirato[3], (1)Department of Medical Physics, Hokkaido University Graduate School of Medicine, Japan, (2)Hitachi, Ltd., Hitachi Research Laboratory, Japan, (3) Department of Radiation Medicine, Hokkaido University Graduate School of Medicine, Japan, (4)Hitachi, Ltd., Hitachi Works, Japan

Benchmarking against Geant4

MRIgRT

Dosimetry

Linac

Prompt Gamma

Hadron Induced therapy

Proton Therapy

Scanning Proton

SU-E-T-472	**Characterization of the Very High Energy Electrons, 150 - 250 MeV (VHEE) Beam Generated by ALPHA-X Laser Wakefield Accelerator Beam Line for Utilization in Monte Carlo Simulation for Biomedical Experiment Planning** - V Moskvin[1]*, A Subiel[2], C Desrosiers[1], M Wiggins[2], M Maryanski[3], M Mendonca[1], M Boyd[4], A Sorensen[4], S Cipiccia[2], R Issac[2], G Welsh[2], E Brunetti[2], C Aniculaesei[2], D A Jaroszynski[2], (1) Department of Radaition Oncology, Indiana University- School of Medicine, Indianapolis, IN, (2) SILIS, Department of Physics, University of Strathclyde, Glasgow, UK,(3) MGS Research, Inc., Madison, CT, (4) SIPBS, University of Strathclyde, Glasgow, (5) Cyclotron Operations, IU Health Protons Therapy Center, Bloomington, IN
SU-E-I-97	**Characterizing the Modulation Transfer Function (MTF) of Proton Radiography** - J Seco[1]*, M Oumano[2], N Depauw[3], M Dias[4], R Teixeira[4], (1) Mass General Hospital; Harvard Medical, Boston , MA, (2) University of Massachusetts at Boston, Boston, MA, (3) Massachusetts General Hospital, Boston, MA, (4) University of Lisbon, Lisbon, Portugal
WE-C-BRB-6	**Clinical Impact of Uncertainties in the Mean Excitation Energy of Human Tissues During Proton Therapy** - A Besemer[1]*, H Paganetti[2], B Bednarz[1], (1) Department of Medical Physics, Wisconsin Institutes for Medical Research, University of Wisconsin, Madison, WI, (2) Department of Radiation Oncology, Massachusetts General Hospital and Harvard Medical School, Boston, MA
SU-E-T-5	**Comparing DNA Strand Break Yields for Photons Under Different Irradiation Conditions with Geant4-DNA** - P Pater[1]*, M Bernal[2], I El Naqa[1], J Seuntjens[1], (1) McGill University, Montreal, QC, (2) Instituto de Física Gleb Wataghin, Campinas, Brasil
WE-C-217BCD-11	**Coupled Radiative and Optical Geant4 Simulation of MV EPIDs Based On Thick Pixelated Scintillating Crystals** - D Constantin[1]*, M Sun[2], E Abel[2], J Star-Lack[2], R Fahrig[1], (1) Stanford University, Stanford, CA, (2) Varian Medical Systems, Palo Alto, CA
SU-E-T-60	**Development and Validation of a TOPAS Model of a Spot Scanning Proton Therapy Nozzle** - D Granville[1]*, M H Chequers[1], K Suzuki[2], G O Sawakuchi[1], (1) Carleton University, Ottawa, ON, (2) The University of Texas MD Anderson Cancer Center, Houston, TX
WE-C-BRB-9	**Development of a GPU-Based Monte Carlo Dose Calculation Package for Proton Radiotherapy** - X Jia[1]*, J Schuemann[2], H Paganetti[2], S Jiang[1], (1) University of California, San Diego, La Jolla, CA, (2) Massachusetts General Hospital, Boston, MA
TU-C-BRB-12	**Dose Enhancement Effect of Golden Nanoparticles in a Realistic Voxellized Cell Phantom for Proton Radiation: A Simulation Study with GEANT4** - Y Chen*, S Ahmad, University of Oklahoma Health Sciences Center, Oklahoma City, OK
SU-E-T-506	**Dosimetric Study for Shallow-Seated Tumor Using Passive/active Scanning Proton Beam** - C Toramatsu*, T Matsuura, H Nihongi, S Takao, N Miyamoto, S Shimizu, R Kinoshita, K Umegaki, H Shirato,
TU-G-BRA-4	**Emission Guided Radiation Therapy: A Simulation Study of Lung Cancer Treatment with Automatic Tumor Tracking Using a 4D Digital Patient Model** - Q Fan[1]*, A Nanduri[2], L Zhu[1], S Mazin[2],(1) Nuclear & Radiological Engineering and Medical Physics Programs, Georgia Institute of Technology, Atlanta, GA, (2) RefleXion Medical, Burlingame, CA

TU-A-BRA-6	**EPID Operation in a Bi-Directional MRI-Linac System: A Monte Carlo Study** - B. M. Oborn[1,2*], P Metcalfe[2], S Crozier[3], ,M. Bailey[1,2], P Keall[4], (1) Illawarra Cancer Care Centre, Wollongong, NSW Australia,(2) University of Wollongong, Wollongong, NSW Australia,(3) University of Queensland, Brisbane, QLD Australia, (4) University of Sydney, Sydney, NSW Australia.
SU-E-J-66	**Evaluation of Proton Induced X-Ray Fluorescence From Gold Fiducial Markers for In-Vivo Determination of Proton Range and Energy** - Brian Tonner[1*], Zuofeng Li[2], Derek Tishler[3], (1) Moffitt Cancer Center, Tampa, FL, (2) University of Florida, Jacksonville, FL, (3) University of Central Florida, Orlando, FL
SU-E-I-111	**Evaluation of the Analytical Scattering Models of 1) Lynch-Dahl 2) Highland and 3) Rossi for Proton Beams and Comparison with GEANT4 Monte Carlo Simulations as a Prerequisite for Proton Radiography Applications for Patients** - M Raytchev[1*], S Safai[2], J Seco[1], (1) Mass General Hospital; Harvard Medical, Boston, MA, (2) Paul Scherrer Institute, Villigen - PSI, Switzerland
SU-E-I-93	**External Beam Radiation Cherenkov Emission in Tissue Used for Tissue Oxygen Sensing** - R Zhang[1*], S Kanick[2], S Vinogradov[3], T Esipova[4], B Pogue[5], (1) ,,,(2) Dartmouth College, Hanover, NH, (3) University of Pennsylvania, ,,(4) University of Pennsylvania, ,,(5) Dartmouth College, Hanover, NH
SU-E-I-94	**External Beam Radiation Cherenkov Emission in Tissue Used for Tissue Oxygen Sensing** - R Zhang[1*], S Kanick[2], S Vinogradov[3], T Esipova[4], B Pogue[5], (1) ,,,(2) Dartmouth College, Hanover, NH, (3) University of Pennsylvania, ,,(4) University of Pennsylvania, ,,(5) Dartmouth College, Hanover, NH
MO-F-BRB-4	**Fast Estimation of Secondary Particle Therapy Dose Using a Modified Track Repeating Method** - R Keyes[1,2*], D Maes[2], S Luan[2], (1) New Mexico Cancer Center, Albuquerque, NM, (2) University of New Mexico, Albuquerque, NM
TH-C-BRB-8	**Four-Dimensional Monte Carlo Simulations of Lung Cancer Patients Treated with Proton Beam Scanning to Assess Interplay Effects** - C Grassberger[1 2*], J Shackleford[1], G Sharp[1], H Paganetti[1], (1) Massachusetts General Hospital, Boston, MA, (2) Centre for Proton Radiotherapy, Paul Scherrer Institute, Villigen-PSI, Switzerland
SU-E-T-478	**Geometrical Splitting Technique to Improve the Computational Efficiency in Monte Carlo Calculations for Proton Therapy** - J Ramos-Mendez[1*], J Perl[2], B Faddegon[3], H Paganetti[4], (1) Benérita Universidad Autónoma de Puebla, Puebla, México, (2) Stanford Linear Accelerator Center, Menlo Park, CA, (3) UC San Francisco, San Francisco, CA, (4) Massachusetts General Hospital, Boston, MA
SU-E-T-610	**Impact of Variable Beam Spot Size On Treatment Time in Particle Therapy** - D Riofrio[1*], S Sellner[2], G Cabal[2], R Keyes[3], M Holzscheiter[1], O Jaekel[4], S Luan[1], (1) University of New Mexico, Albuquerque, New Mexico, (2) The German Cancer Research Center (DKFZ), Heidelberg, Germany,(3) New Mexico Cancer Center, ALBUQUERQUE, NM, (4) Heidelberg University Hospital, Heidelberg, Germany
SU-E-T-22	**Is the Residual Range a Universal Quantity to Specify the Quality of Modulated Proton Beams?** - D Granville*, M Chequers, G Sawakuchi, Carleton University, Ottawa, ON
SU-E-T-234	**LET Measurement Using Nuclear Emulsion and Monte Carlo Simulation for Proton Beam** - J Shin[1*], S Cho[2], S Park[3], S Lee[4], J Kwak[5], S Kim[6], K Morishima[7], (1) National Cancer Center, Goyang, Gyeonggi-do, (2) National Cancer Center, Seoul, ,(3) National Cancer Center, Goyang, Gyeonggi-do, (4) National Cancer Center, GOYANG-SI, ,(5) Asan Medical Center, ,,(6) Pusan National University, ,,(7) Nagoya University,

SU-E-T-11	**LINAC Dose Profiling Using Cherenkov Emission Imaging** - A Glaser[1*], D McClatchy[1], S Davis[1], D Gladstone[2], B Pogue[1,2,3], (1) Thayer School of Engineering, Dartmouth College, Hanover, NH, (2) Norris Cotton Cancer Center, Dartmouth-Hitchcock Medical Center, Lebanon, NH, (3) Department of Physics and Astronomy, Dartmouth College, Hanover, NH
MO-F-BRB-2	**Macro Monte Carlo for Proton Dose Calculation in Different Materials** - MK Fix*, D Frei, W Volken, EJ Born, D Aebersold, P Manser, Division of Medical Radiation Physics and Department of Radiation Oncology, Inselspital, Bern University Hospital, and University of Bern, Switzerland
SU-E-T-467	**Monte Carlo Dosimetric Study of the New Flexisource Co-60 High Dose Rate Source** - J Vijande[1*], D Granero[2], J Perez-Calatayud[3], F Ballester[1], (1) University of Valencia, Valencia,Spain,(2) ERESA-Hospital General Universitario, Valencia, Spain,(3) Hospital La Fe, Valencia, Spain
SU-E-T-300	**Monte Carlo Simulation of Single-Plane Magnetically Focused Narrow Proton Beams** - G McAuley*, S Barnes, A Wroe, J Slater, Loma Linda University, Loma Linda, CA
SU-E-T-10	**Monte Carlo Study of the Dose Enhancement Factor (DEF) for Gold Nano-Particle (GNP) On the Cellular Level** - M Zhang[1*], S Qin[2], B Haffty[1], N Yue[1], (1) The Cancer Institute of New Jersey, New Brunswick, NJ, (2) The First Affiliated Hospital of Soochow University, Suzhou, Jiangsu, China
SU-E-T-475	**Nano-Dosimetric Track Structure Scoring Including Biological Modeling with TOPAS-NBio** - J Schuemann[1*], (1) Massachusetts General Hospital, Boston, MA
SU-E-T-316	**New Design of the Valencia Applicators to Reduce Radiation Leakage** - D Granero[1*], J Vijande[2], J Perez-Calatayud[3,4], J Richart[4], F Ballester[2], (1) ERESA-Hospital General Universitario, Valencia, Spain, (2) University of Valencia, Burjassot, Spain, (3) Hospital La Fe, Valencia, Spain, (4) Hosptal Clinica Benidorm, Benidorm, Spain
TH-C-213AB-12	**On the Importance of Heterogeneous Calculation in Brachytherapy: A Radiobiological Point of View** - H Afsharpour[1*], F Verhaegen[2], L Beaulieu[3], (1) Centre Hospitalier Univ de Quebec, Quebec, QC (2) Maastro clinic, Maastricht
SU-E-T-296	**Optimization of the Energy Selection System with Varying Magnetic Field for Laser-Accelerated Proton Beams** - D Kim[1*], S Yoo[2], W Cho[1], M Kim[1], J Jung[1], S Lee[3], T Suh[1] (1) Department of Biomedical Engineering and Research Institute of Biomedical Engineering, The Catholic University of Korea, Seoul,(2) CHA Bundang Medical Center, CHA Unicersity, Seongnam,(3) Proton Therapy Center, National Cancer Center, Gyeonggi-do
SU-E-T-500	**Pencil-Beam Versus Monte Carlo Based Dose Calculation for Proton Therapy Patients with Complex Geometries. Clinical Use of the TOPAS Monte Carlo System** - J Schuemann[1*], J Shin[2], J Perl[3], C Grassberger[1], J Verburg[1], B Faddegon[2], H Paganetti[1], (1) Massachusetts General Hospital, Boston, MA, (2) UC San Francisco, San Francisco, CA, (3) Stanford Linear Accelerator Center, Menlo Park, CA
SU-E-T-473	**Performance Assessment of the TOPAS Tool for Particle Simulation for Proton Therapy Applications** - J Perl[1*], J Shin[2], J Schuemann[3], B Faddegon[4], H Paganetti[5], (1) SLAC National Accelerator Laboratory, Menlo Park, CA, (2) UCSF, San Francisco, CA, (3) MGH, BOSTON, MA, (4) UC San Francisco, San Francisco, CA, (5) Massachusetts General Hospital, Boston, MA

MO-F-213AB-3	**Potential Reduction in Out-Of-Field Dose in Pencil Beam Scanning Proton Therapy Through Use of a Patient-Specific Aperture** - S Dowdell[1,2]*, B Clasie[1], N Depauw[1,2], P Metcalfe[2], A Rosenfeld[2], H Kooy[1], J Flanz[1], H Paganetti[1], (1) Massachusetts General Hospital & Harvard Medical School, Boston, MA (2) University of Wollongong, Wollongong, NSW, Australia
SU-E-T-282	**Preliminary Simulation Study for 3 Dimensional Dose Delivery in Carbon Beam Active Scanning System of KHIMA** - C Kim*, H Kim, T Yang, G Han, H Lee, H Jang, J Kim, D Park, S Hong, Korea Institute of Radiological & Medical Science, Seoul, 75 Nowon-gu
SU-E-T-232	**Proton Source Modeling for Geant4 Monte Carlo Simulations** - S Barnes[1]*, G McAuley[1], A Wroe[2], J Slater[1], (1) Loma Linda University, Loma Linda, CA, (2) Loma Linda University Medical Center, Loma Linda, CA
WE-C-217BCD-8	**Rapid Monte Carlo Simulations of DQE(f) of Scintillator-Based Detectors** - J Star-Lack[1]*, E Abel[1], D Constantin[2], R Fahrig[2], M Sun[1], (1) Varian Medical Systems, Palo Alto, CA, (2) Stanford University, Stanford, CA.
SU-E-T-146	**Reference Dosimetry for Protons and Light-Ion Beams Based On Graphite Calorimetry** - S. Rossomme[1,2]*, H. Palmans[2], R. Thomas[2], N. Lee[2], M. Bailey[2], D. Shipley[2], L. Al-Sulaiti[2,3], P. Cirrone[4], F. Romano[4,5], A. Kacperek[6], D. Bertrand[7], S. Vynckier[1,8], (1) Molecular Imaging and Experimental Radiotherapy Department, Catholic University of Louvain, Brussels, Belgium (2) Division of Acoustics and Ionising Radiation, National Physical Laboratory, Teddington, UK (3) University of Surrey, Guildford, UK (4) Laboratori Nazionali del Sud, Istituto Nazionale di Fisica Nucleare, Catania, Italy (5) Centro Studi e Ricerche e Museo Storico della Fisica "E. Fermi", Roma, Italy (6) Douglas Cyclotron, Clatterbridge Centre of Oncology, Wirral, UK (7) Ion Beam Application s.a., Louvain-la-Neuve , Belgium,(8) Cliniques Universitaires Saint-Luc, Brussels, Belgium
TU-E-BRA-5	**Reverse Geometry Imaging with MV Detector for Improved Image Resolution** - A Ganguly[1]*, E Abel[2], M Sun[3], R Fahrig[4], G Virshup[5], J Star-Lack[6], (1) Varian Medical Systems Inc., Palo Alto, CA, (2) Varian Medical Systems Inc., Palo Alto, CA,(3) Varian Medical Systems Inc., Palo Alto, CA, (4) Stanford University, Stanford, CA, (5) Varian Medical Systems Inc., Palo Alto, CA, (6) Varian Medical Systems Inc., Palo Alto, CA,
MO-A-213AB-10	**Scattering System Optimization for Proton Therapy** - A Wroe[1]*, R Schulte[1], S Barnes[2], G McAuley[2], J D Slater[1], J M Slater[2], (1) Loma Linda University Medical Center, Loma Linda, CA, (2) Loma Linda University, Loma Linda, CA
SU-E-T-281	**Secondary Light-Ions in Carbon-Ion Therapy: A GEANT4 Simulation of LET and Dose Contributions** - D Johnson*, Y Chen, S Ahmad, University of Oklahoma Health Sciences Center, Oklahoma City, OK
SU-E-I-109	**Sensitivity Analysis of An Electronic Portal Imaging Device Monte Carlo Model to Variations in Optical Transport Parameters** - S Blake[1], P Vial[2]*, L Holloway[2], A McNamara[1], P Greer[3,4], Z Kuncic[1], (1) The University of Sydney, Sydney, NSW, Australia (2) Liverpool and Macarthur Cancer Therapy Centres, NSW, Australia (3) Newcastle Mater Hospital, Newcastle, NSW, Australia, (4) University of Newcastle, Newcastle, NSW, Australia

SU-E-T-161	**SOBP Beam Analysis Using Light Output of Scintillation Plate Acquired by CCD Camera** - S Cho[1], S Lee[1]*, J Shin[1], B Min[1], K Chung[1], D Shin[1], Y Lim[1], S Park[2], (1) Proton Therapy Center, National Cancer Center, ,Gyeonggi-do, (2) McLaren Regional Medical Center, FLINT, MI
MO-G-BRA-6	**Three-Stage Compton Camera Image Resolution Losses Due Detector Effects** - D Mackin[1]*, J Polf[2], S Peterson[3], S Beddar[1], (1) MD Anderson Cancer Center, Houston, TX, (2) Oklahoma State University, Stillwater, OK, (3) University of Cape Town, Capetown, ZA, South Africa
SU-E-T-91	**Validation of Geant4 Physics for Ionization Chamber Calculations in Radiotherapy Photon Beams** - M H Chequers*, G O Sawakuchi, Carleton University, Ottawa, ON
MO-A-213AB-6	**Validation of Nuclear Reaction Models to Simulate Proton Therapy Range Verification Using Prompt Gamma-Rays** - J Verburg*, H Shih, J Seco, Massachusetts General Hospital and Harvard Medical School, Boston, MA
SU-E-I-77	**X-Ray Coherent Scatter Diffraction Pattern Modeling in GEANT4** - A Kapadia[1]*, E Samei[1], B Harrawood[1], P Sahbaee[2], A Chawla[3], Z Tan[3], D Brady[3], (1) Duke University Medical Center, Durham, NC, (2) N.C. State University, Raleigh, NC,(3) Duke University, Durham, NC.

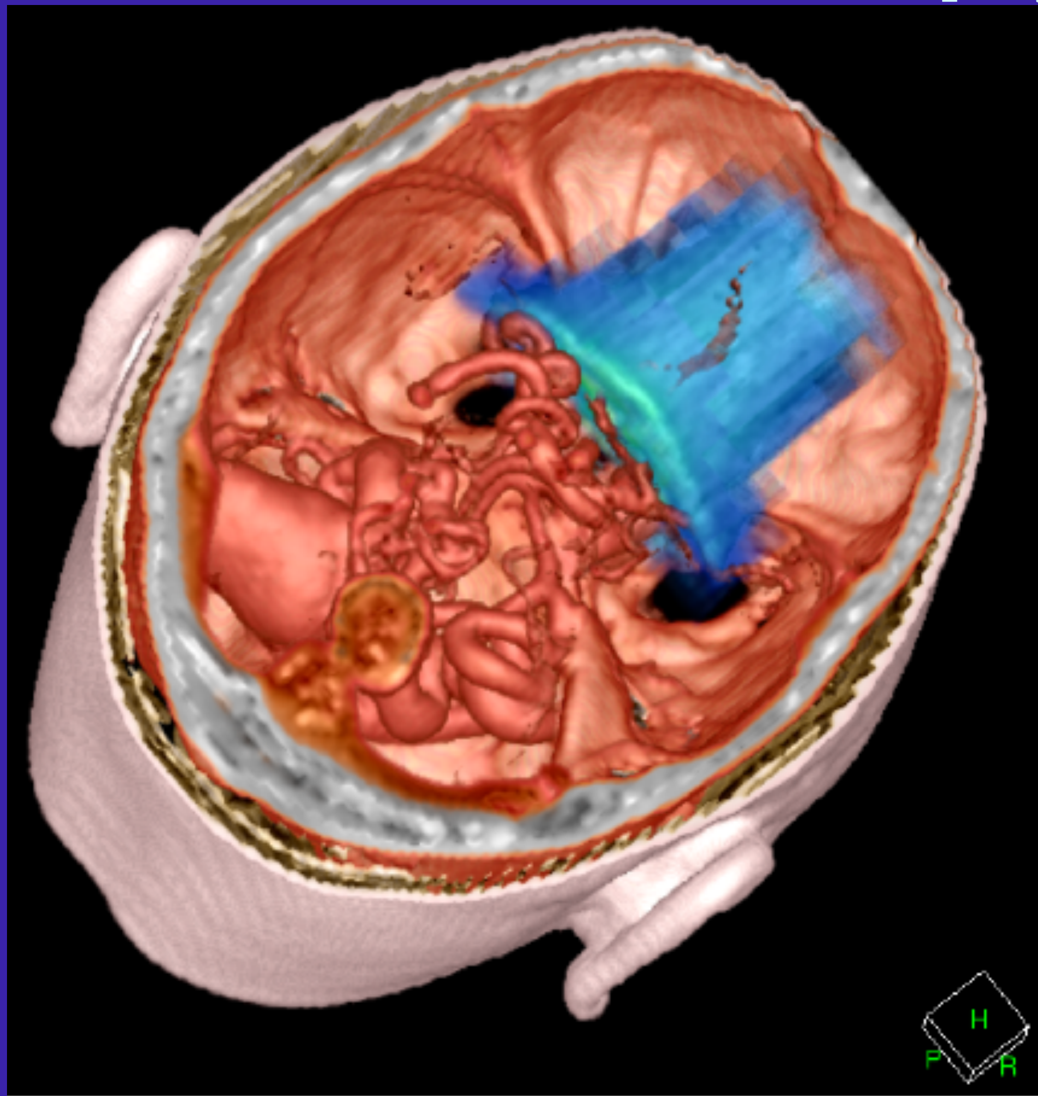
- And all of this is just one medical conference

There is no One Medical Physics Use Case

- physics list?
- requirements?

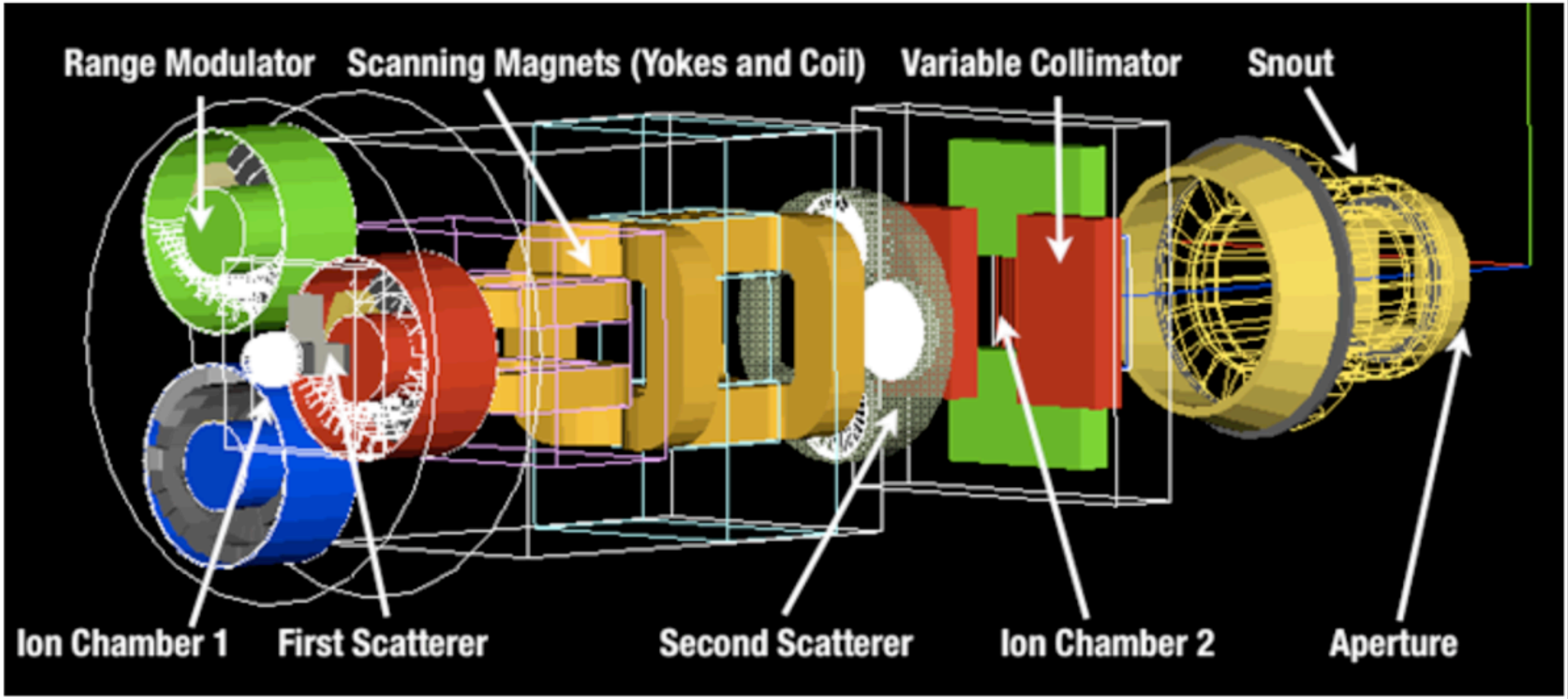
Proton Therapy

70 - 230 MeV



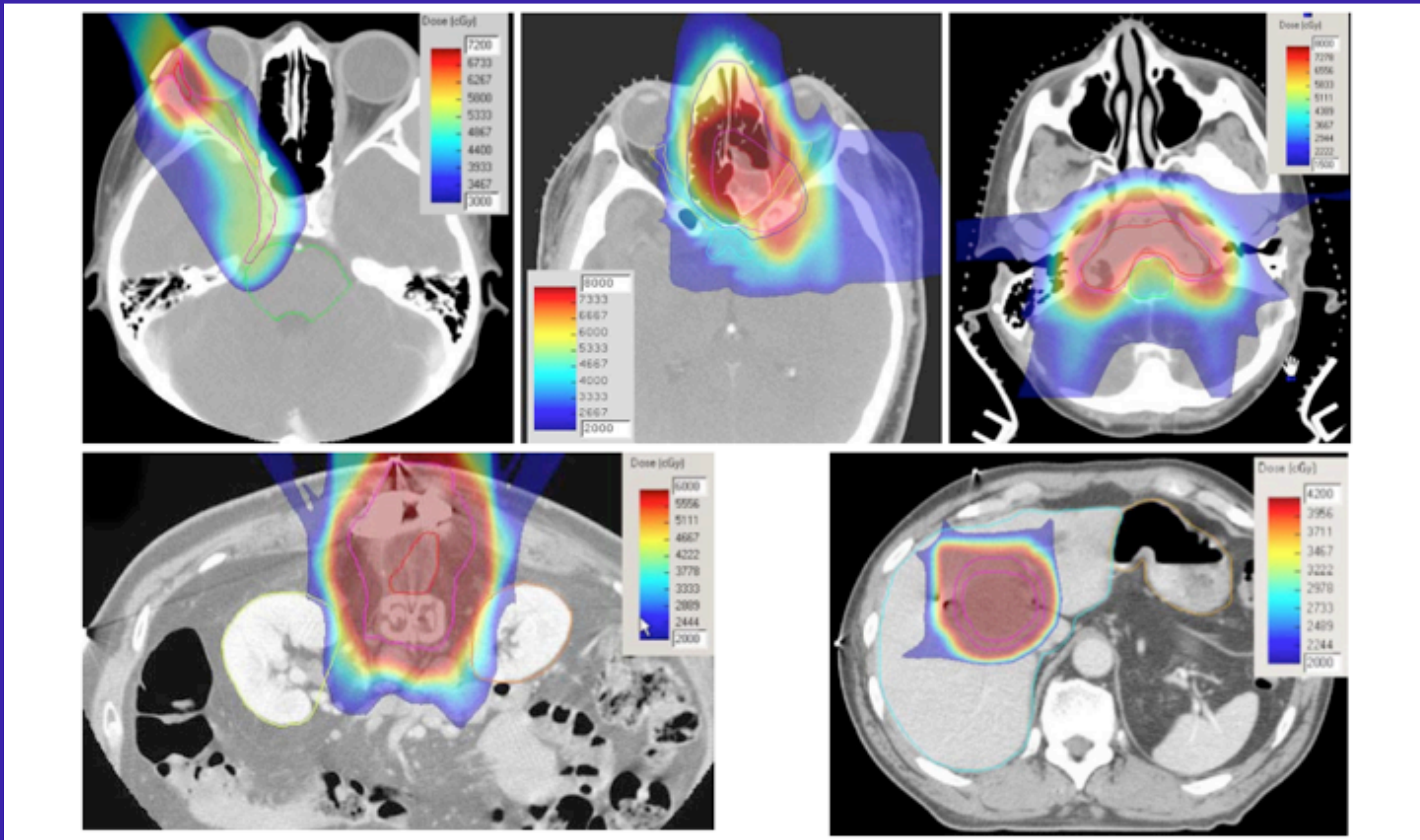
courtesy of Akinori Kimura, gMocren group, JST/CREST project, Japan

Treatment Head Simulation

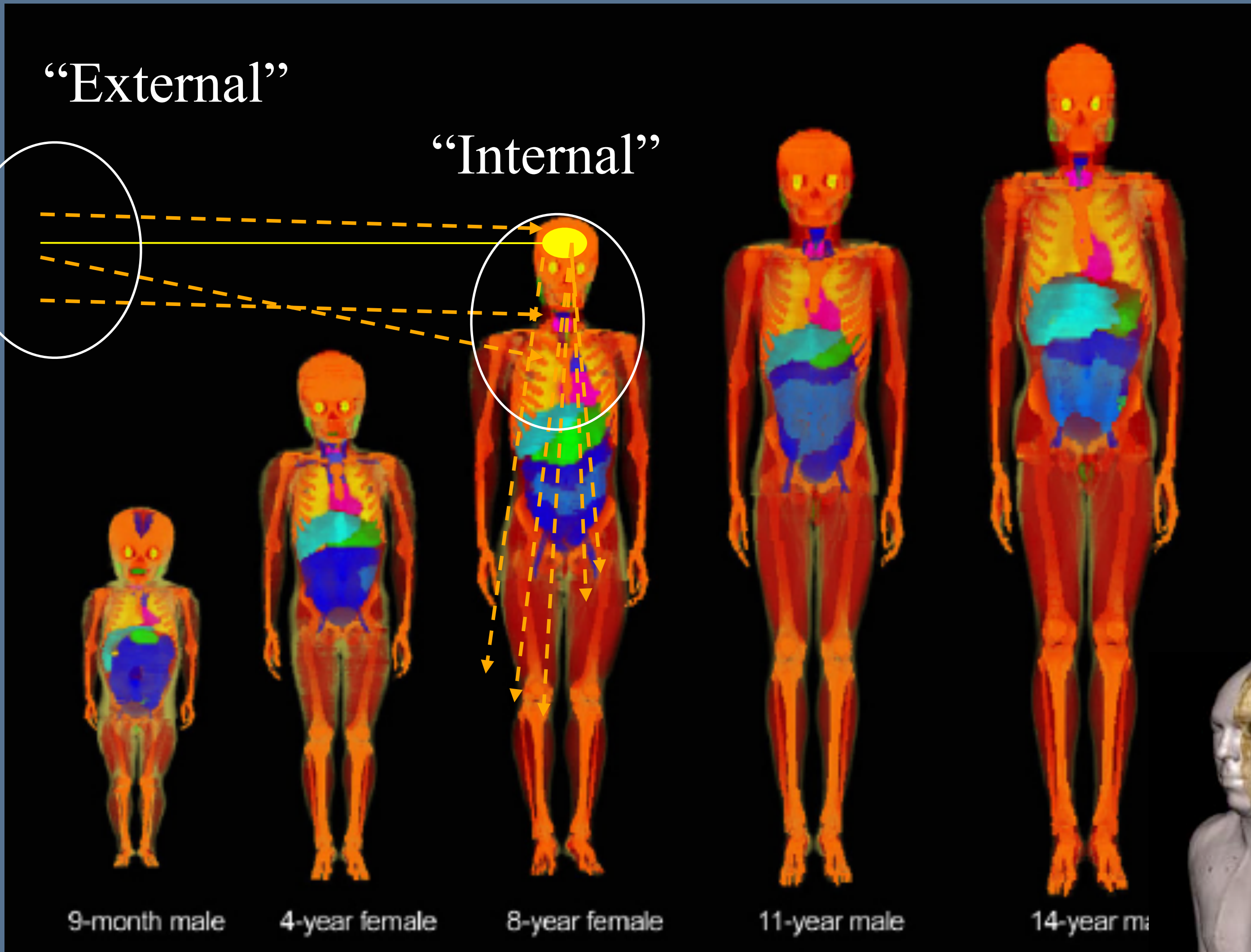


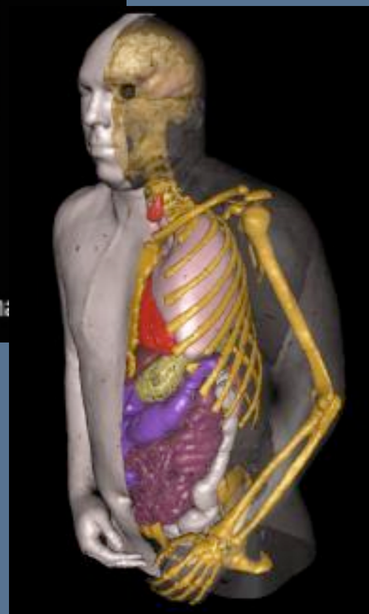
Jungwook Shin et al, Proton Therapy Center, National Cancer Center, Korea

Conformal Treatment Plans



Bussiere and Adams, 2003





Phantoms implemented into the Geant4 Monte Carlo dose calculation environment at Mass. Gen. Hosp.

Pediatrics

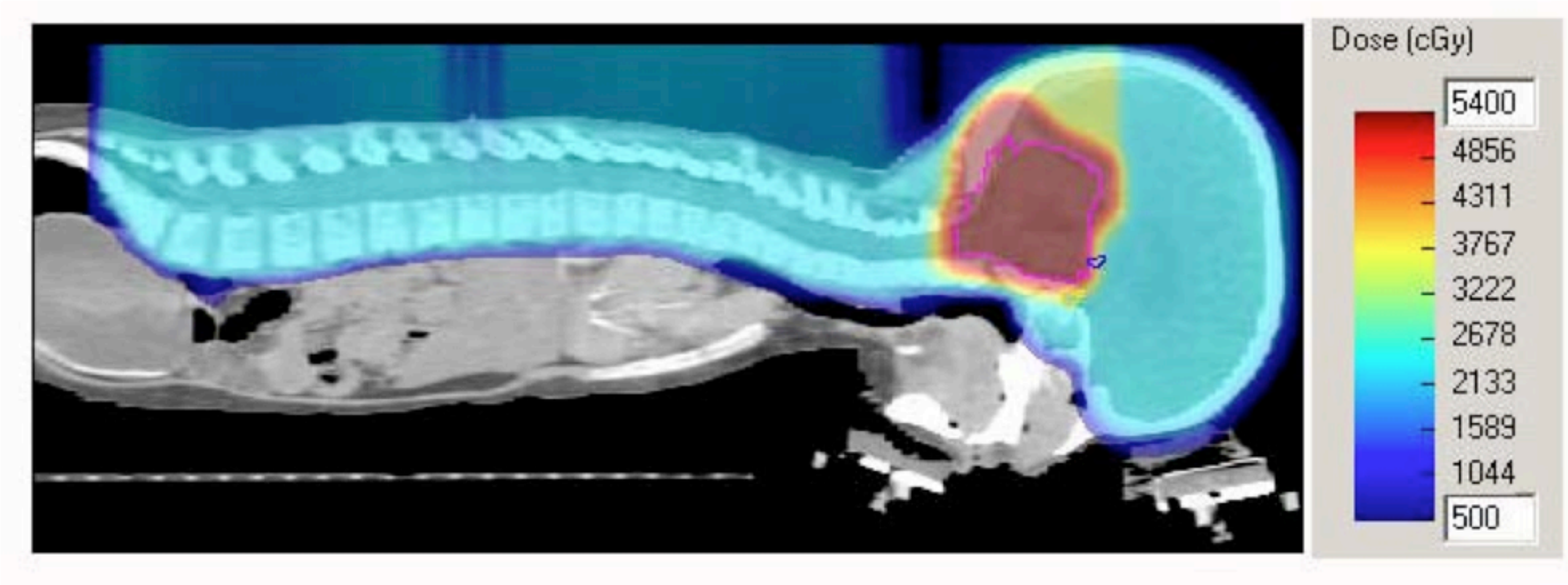
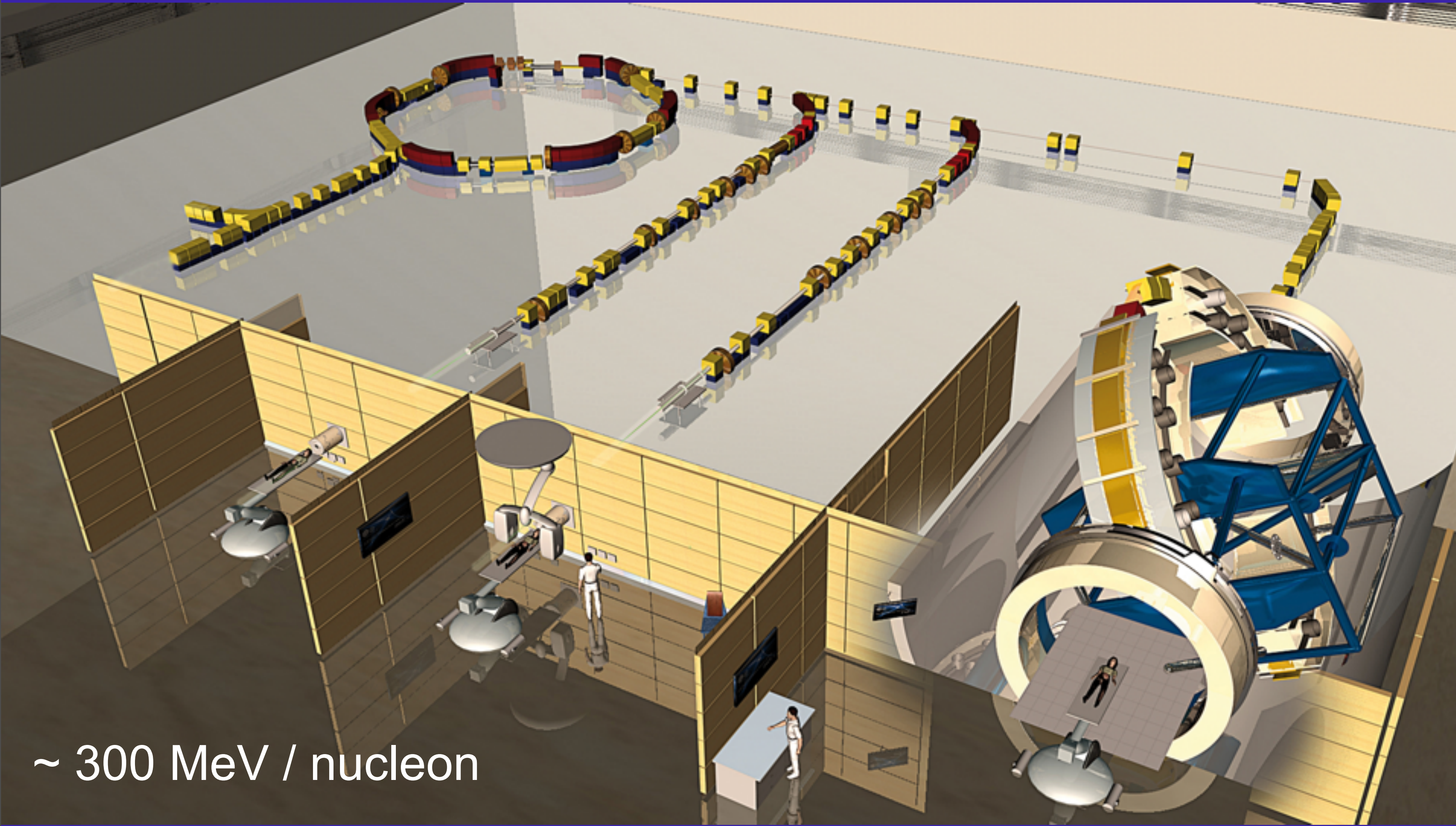


Figure 3: Sagital color-wash dose display for the treatment of meduloblastoma including the CSI to 23.4 CGE as well as the posterior fossa boost to 54 CGE. (Bussiere and Adams, 2003)

Heavy Ion Therapy



~ 300 MeV / nucleon

Heidelberg Ion Therapy Centre, Courtesy by Stern, Gruner+Jahr AG & Co KG, Germany | © dkfz.de

Linac Therapy

5-21 MeV

Varian TrueBeam

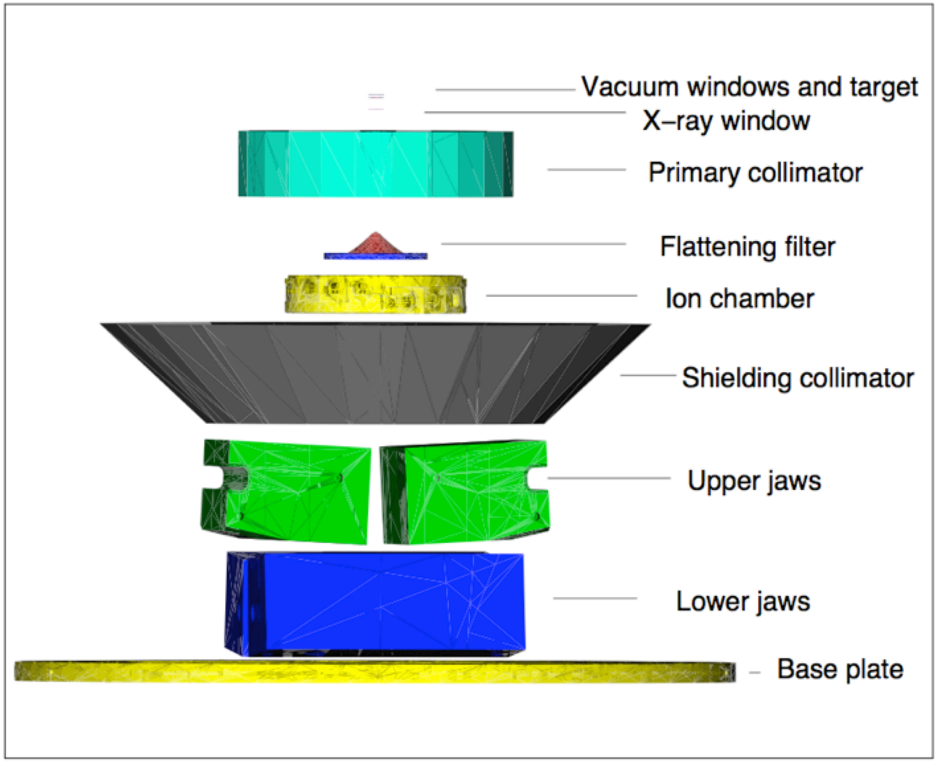


FIG. 3: Visualization of the treatment head components using OpenInventor in Geant4. All the components have been imported in Geant4 as GDML input files.

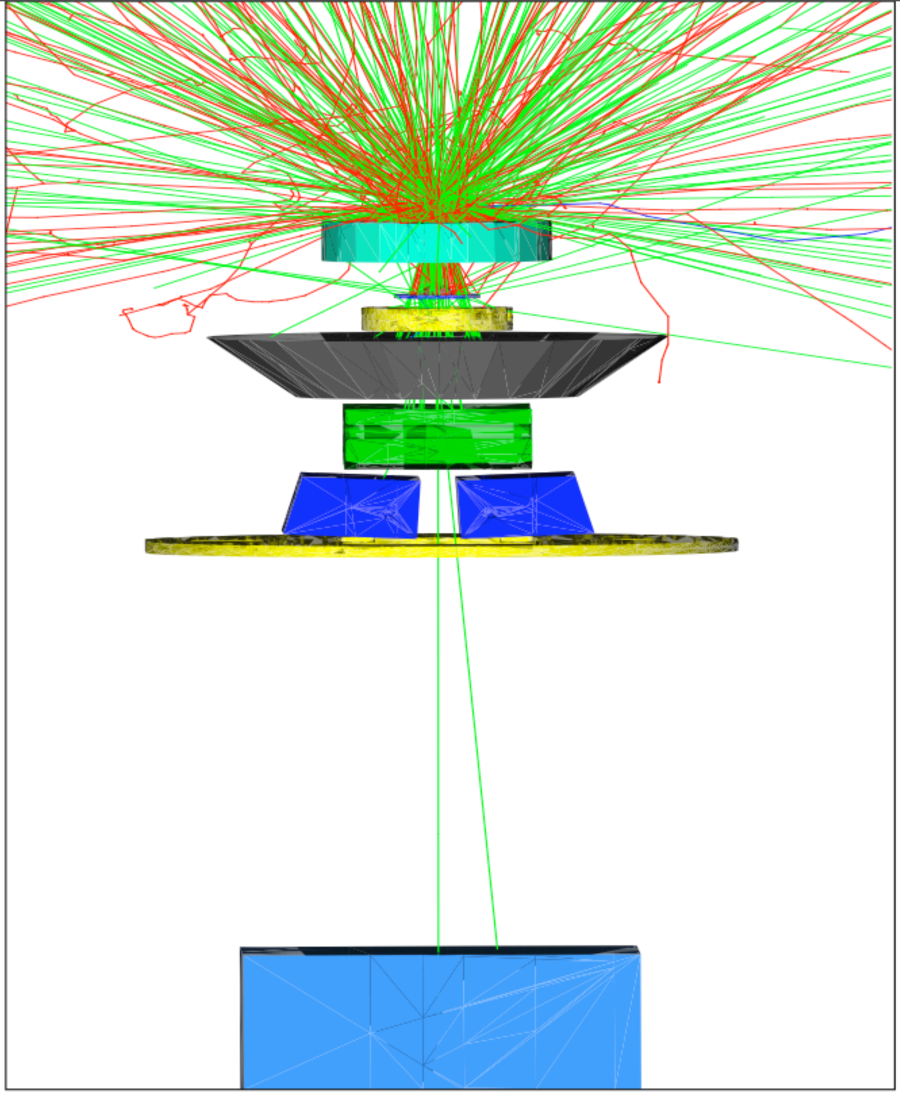


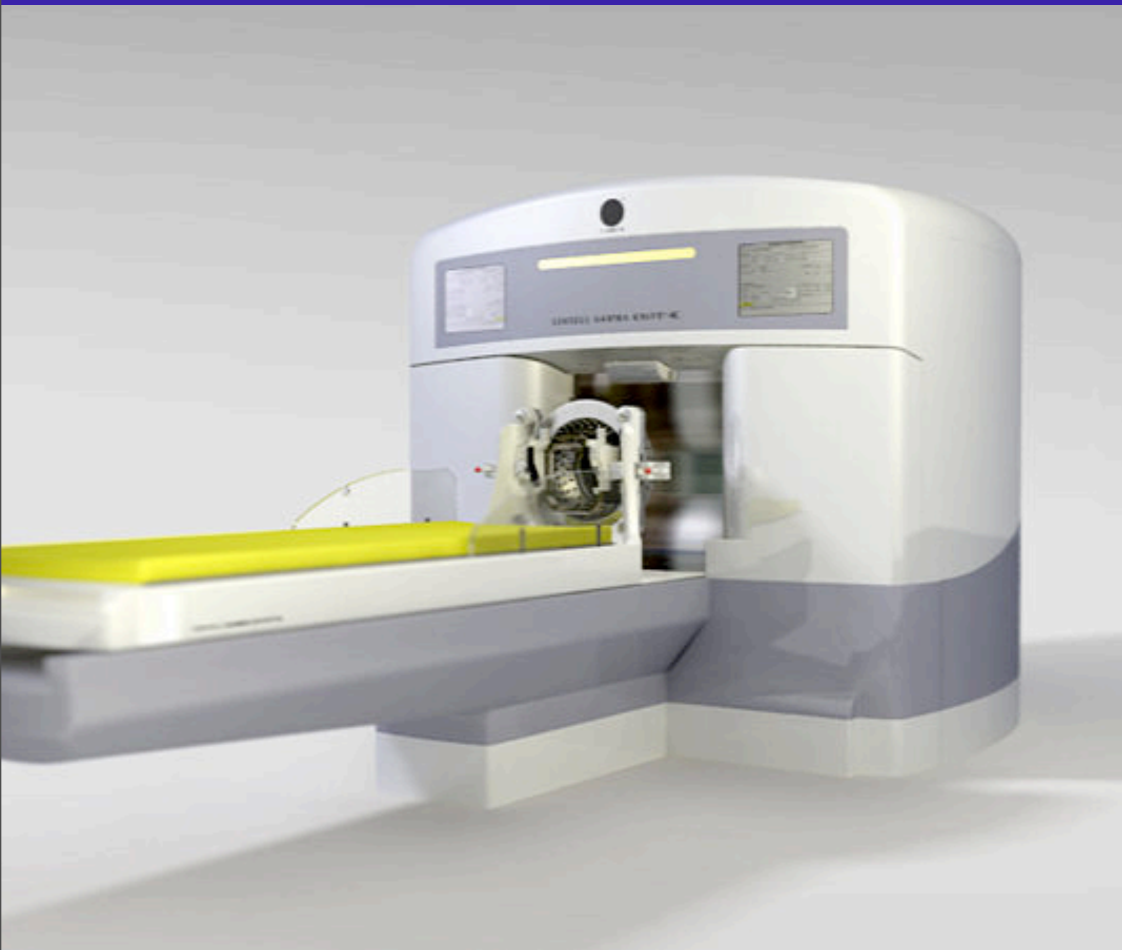
FIG. 4: Visualization of Geant4 particle trajectories along the treatment head components using OpenInventor. Electrons are photons shown in red and green, respectively. Field size was set to $10 \times 10 \mathrm{cm}^2$ and SSD to 100 cm. Note that for proprietary reasons, the appearance of some of the components in this figure has been modified.

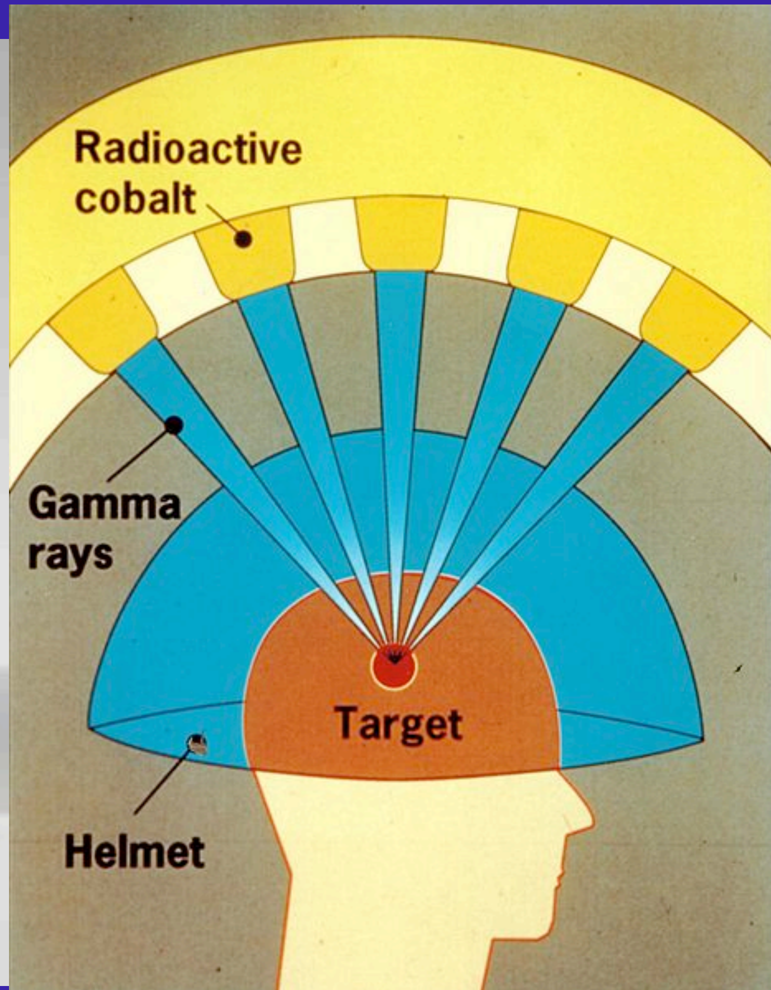
Linking Computer-Aided Design (CAD) to Geant4-based Monte Carlo Simulations for Precise Implementation of Complex Treatment Head Geometries
Magdalena Constantin, Dragos E. Constantin, Paul J. Keall - Stanford Univ
Anisha Narula, Michelle Svatos - Varian Medical Systems
Joseph Perl - SLAC
Phys. Med. Biol. 55 N211 doi: 10.1088/0031-9155/55/8/N03

TomoTherapy

CyberKnife

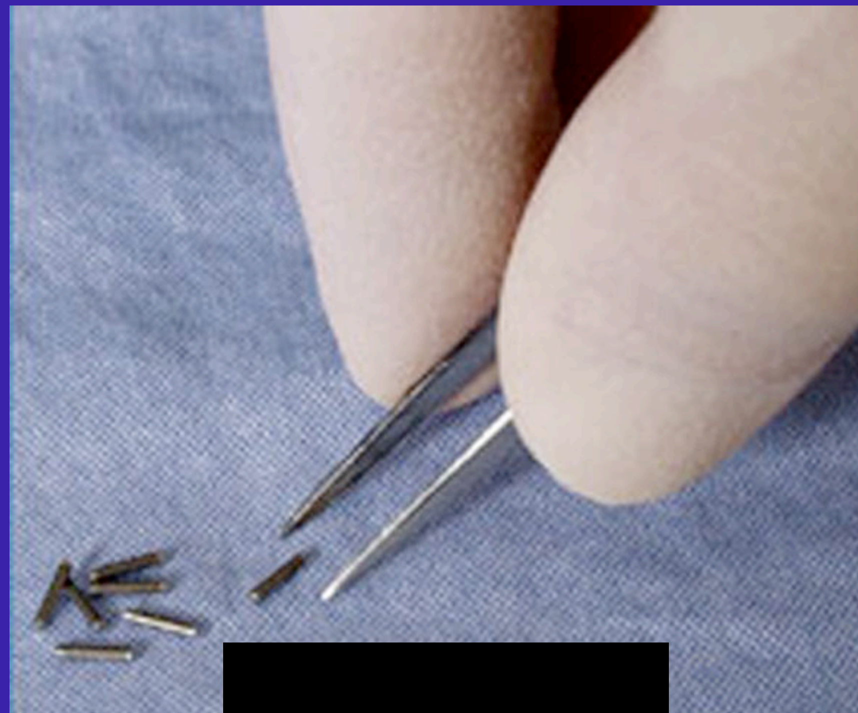
Gamma Knife

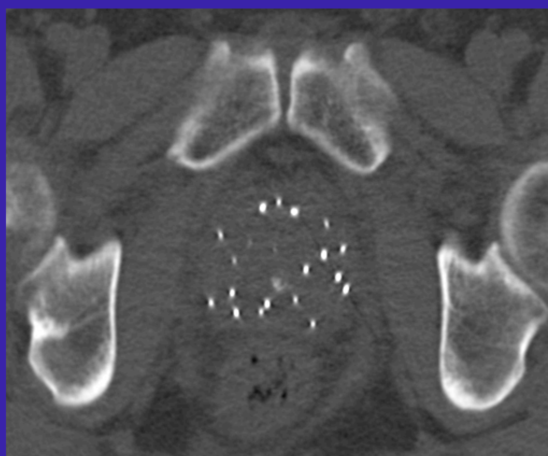




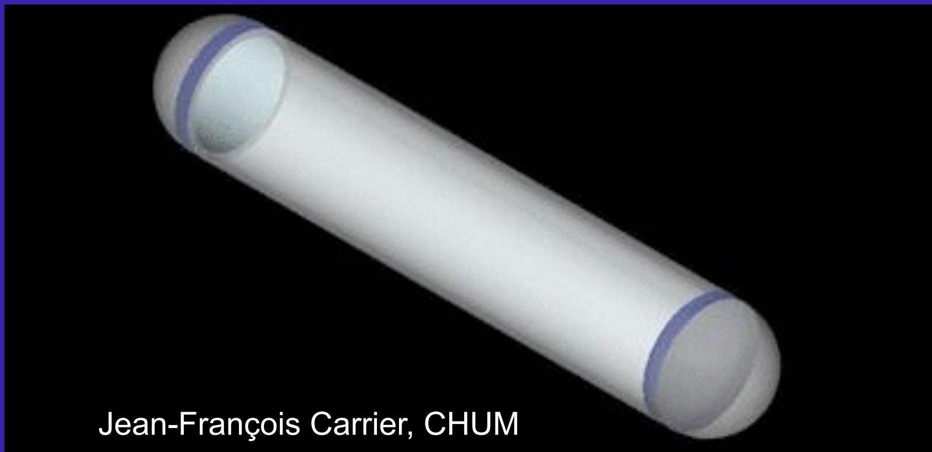
LDR Brachytherapy

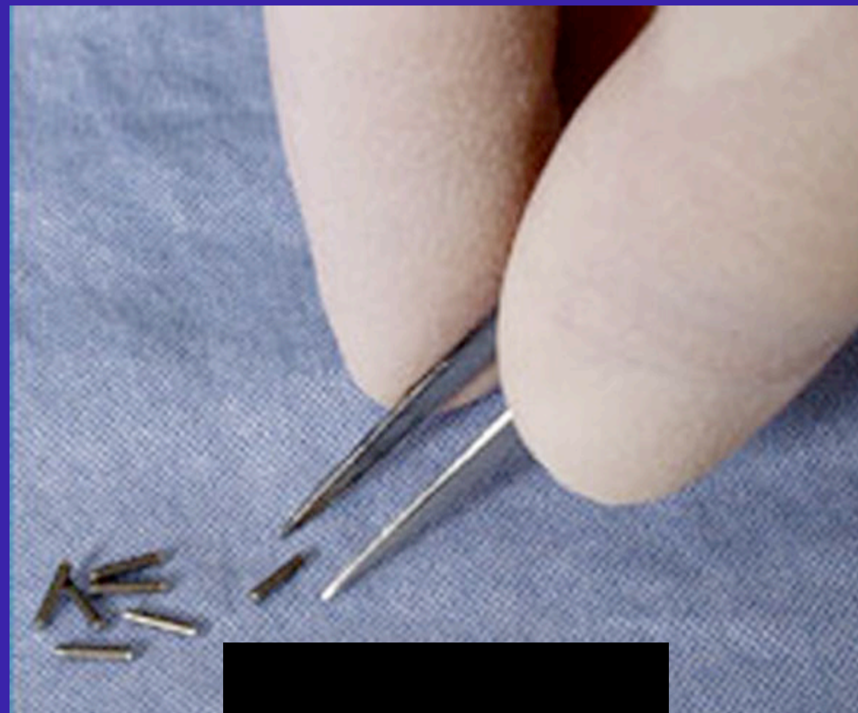
Jean-François Carrier, CHUM

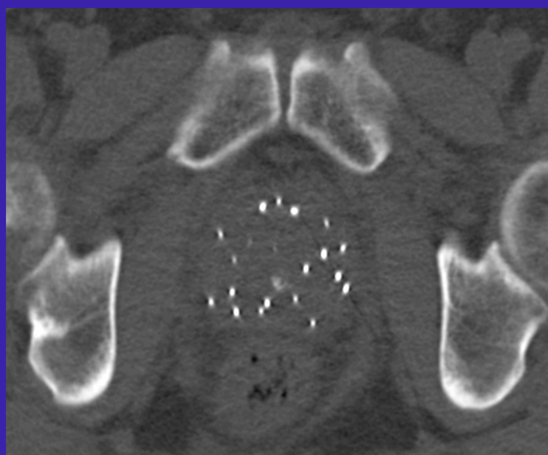




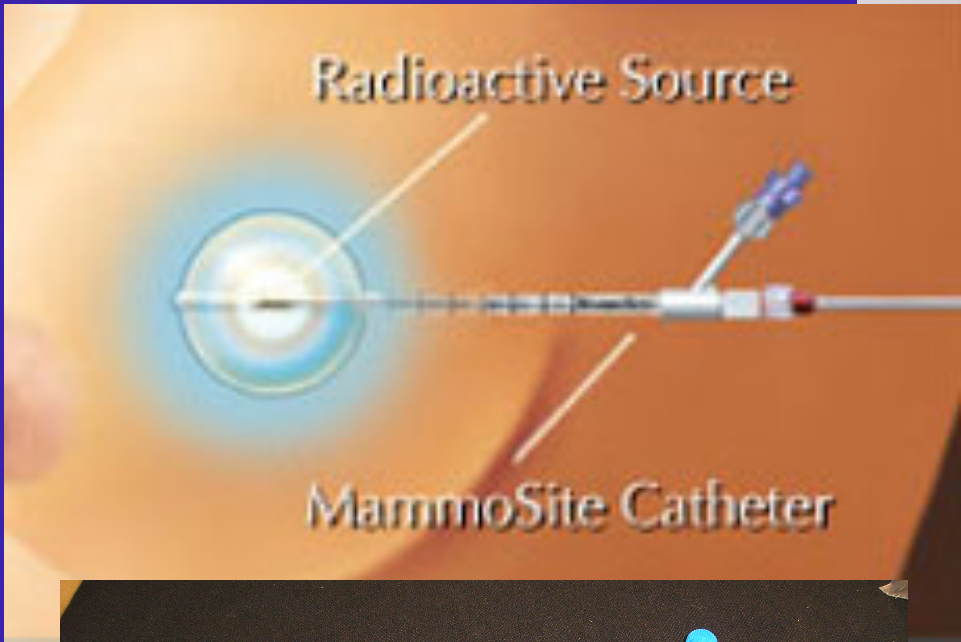
LDR Brachytherapy

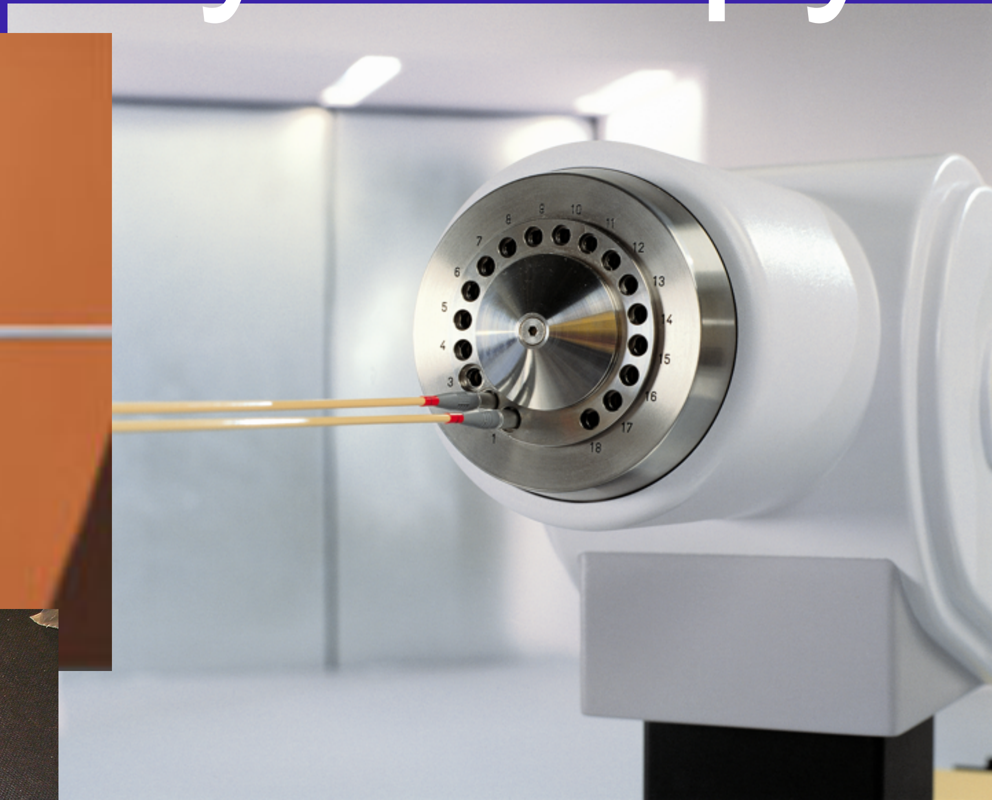


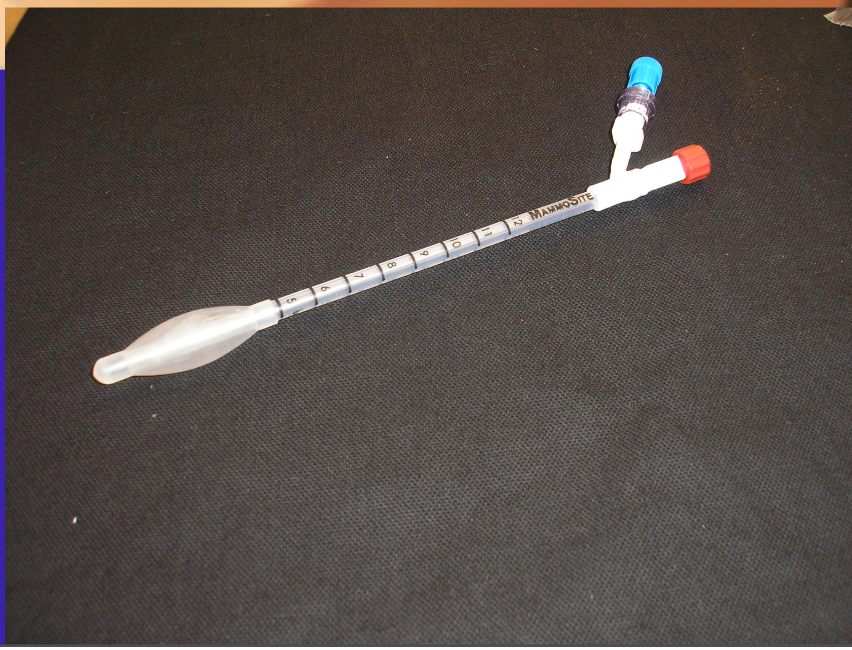




HDR Brachytherapy





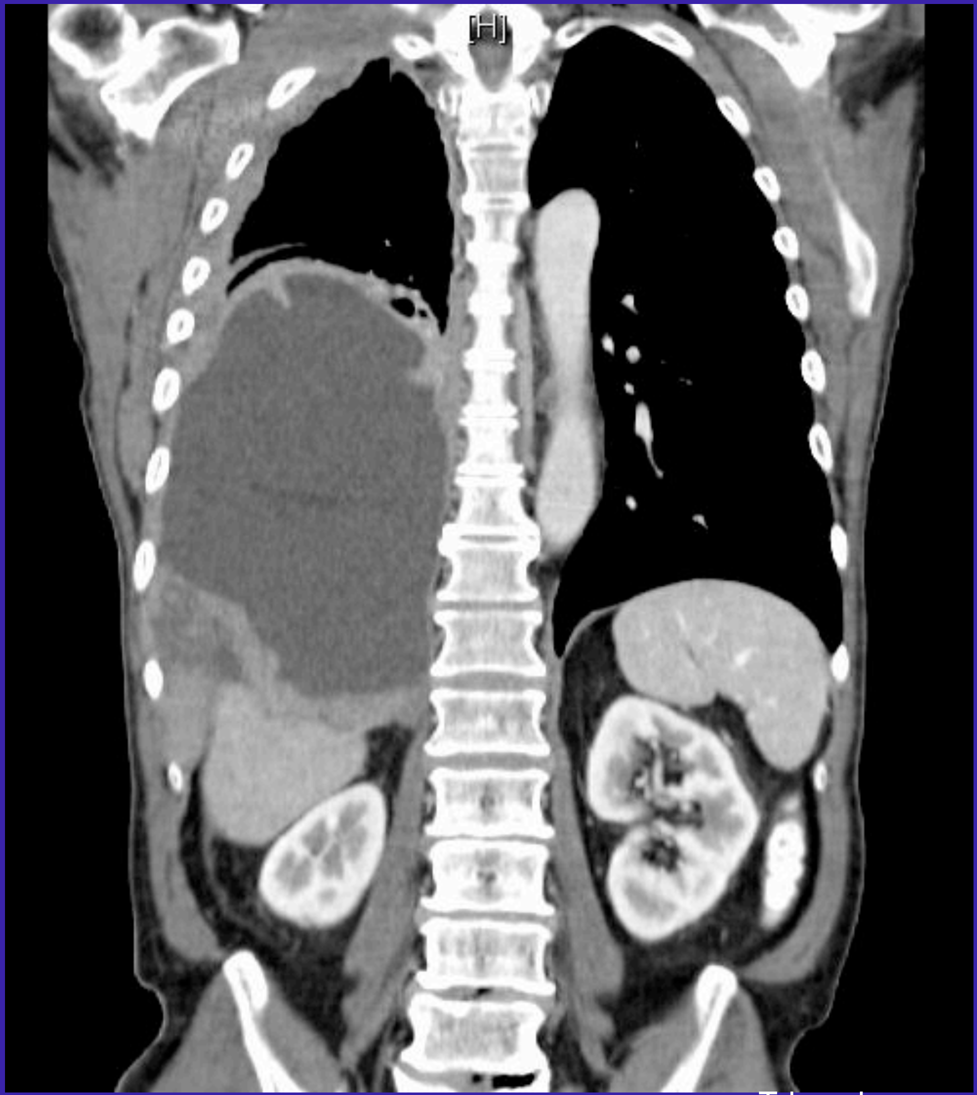


Paul Gueye, Hampton University

X-Ray Based Imaging

CT,
Mammography,
Radiagraphy

Tens of keV



Tdvorak

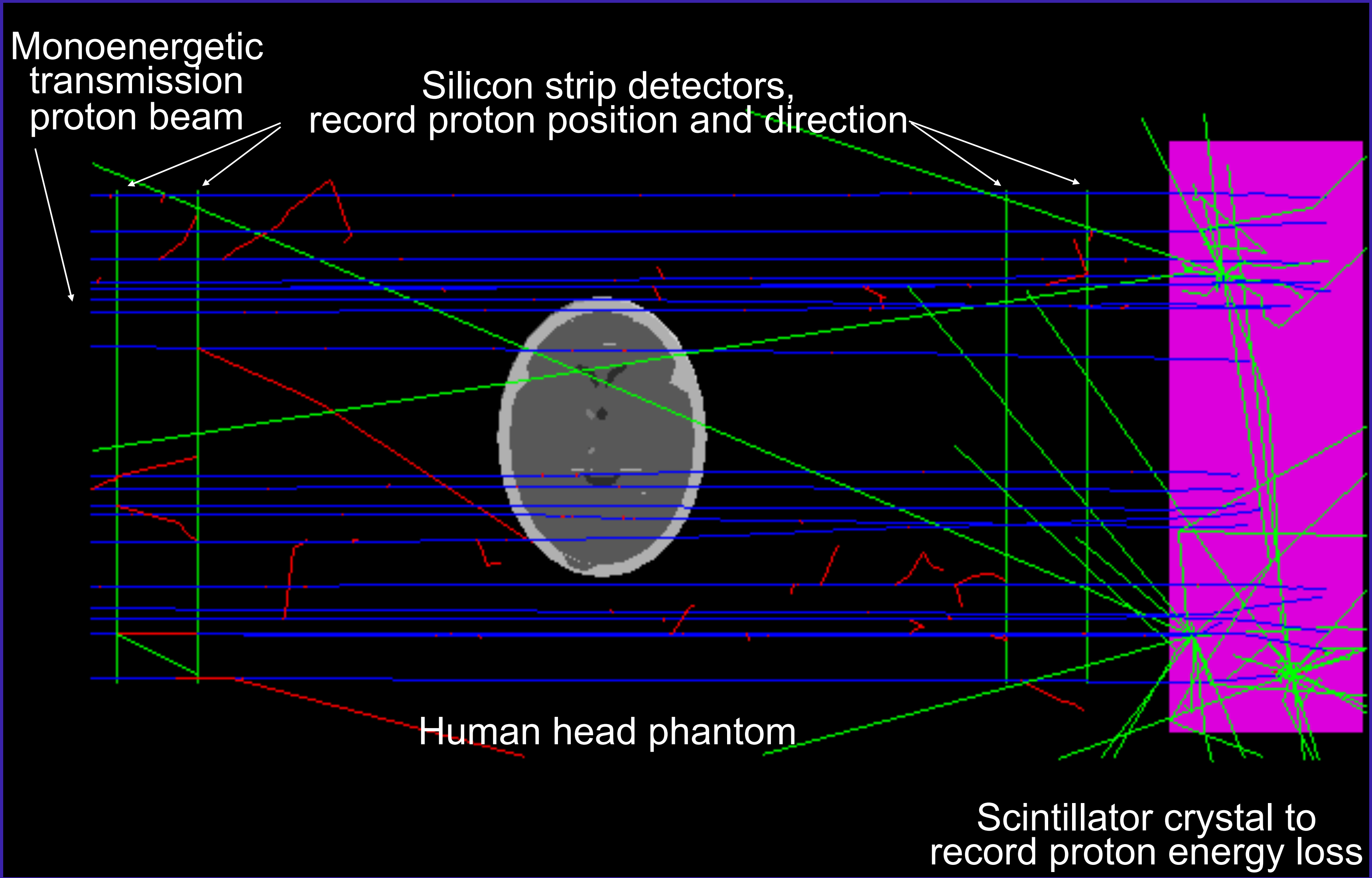
MV Imaging

Siemens Oncology Care Systems

Low-dose megavoltage cone-beam CT for radiation therapy, Jean Pouliot et. al.,

Int Journal Rad Onc*Bio*Phys, Volume 61, Issue 2, 1 February 2005, Pages 552–560

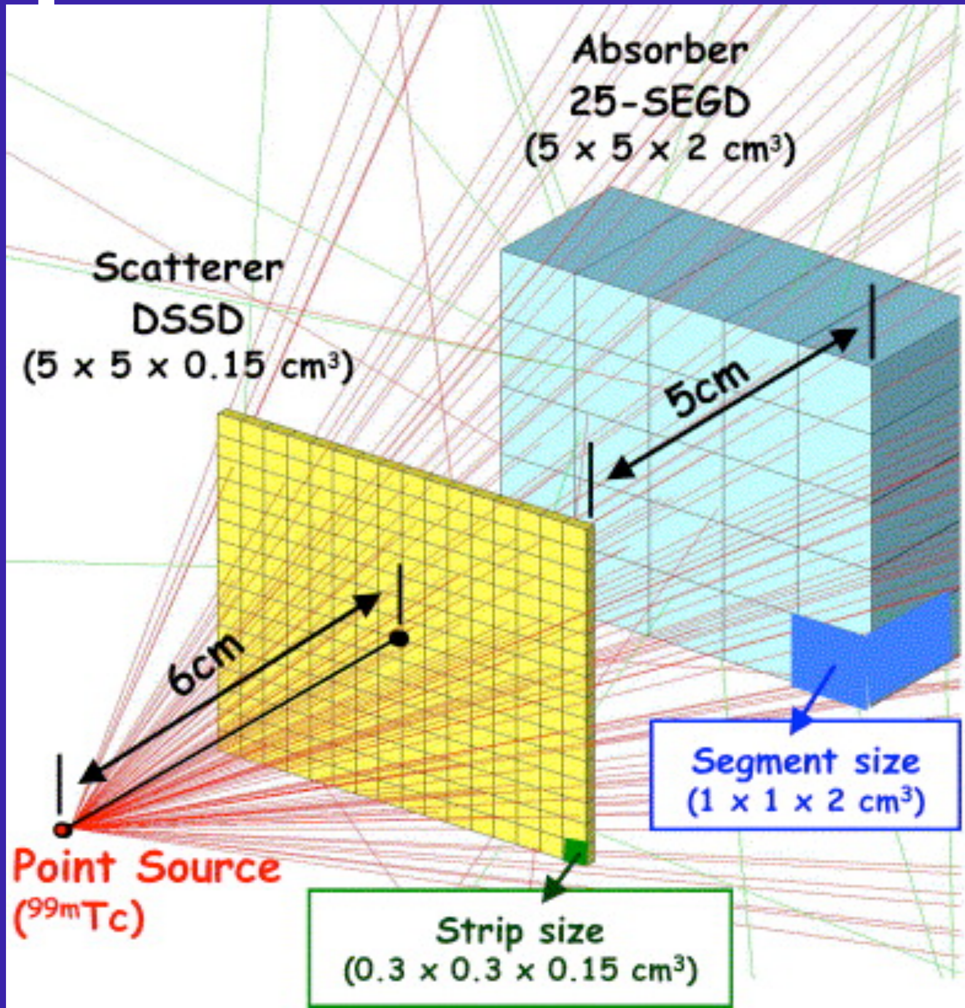
Proton Computed Tomography



anatoly@uow.edu.au

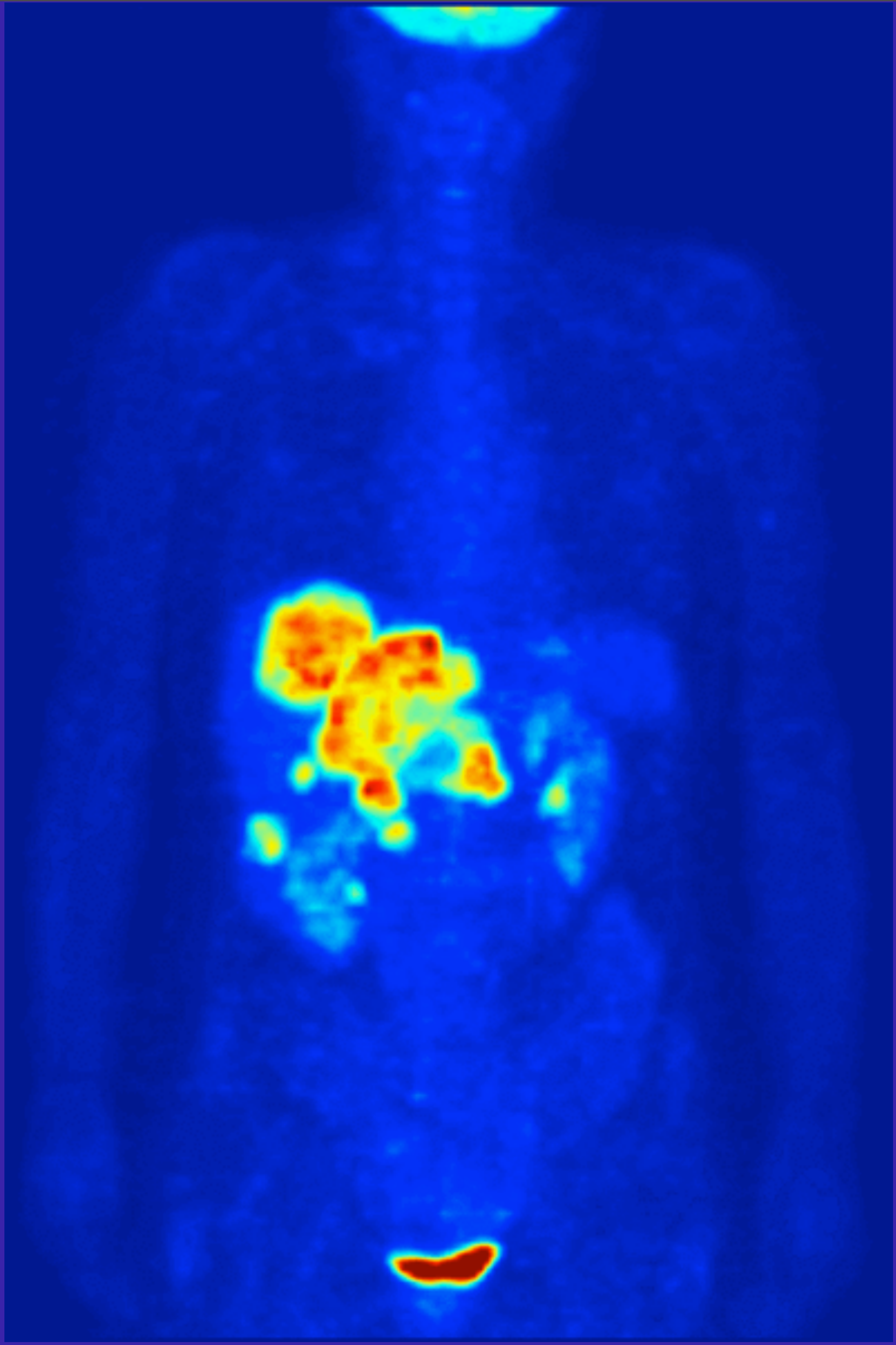
Prompt Gamma

- Compton Camera



Effect of detector parameters on the image quality of Compton camera for 99mTc
S.H. Ana, H. Seoa, J.H. Leeb, C.S. Leeb, J.S. Leec, C.H. Kima
NIM, Volume 571, Issues 1–2, 1 February 2007, Pages 251–254

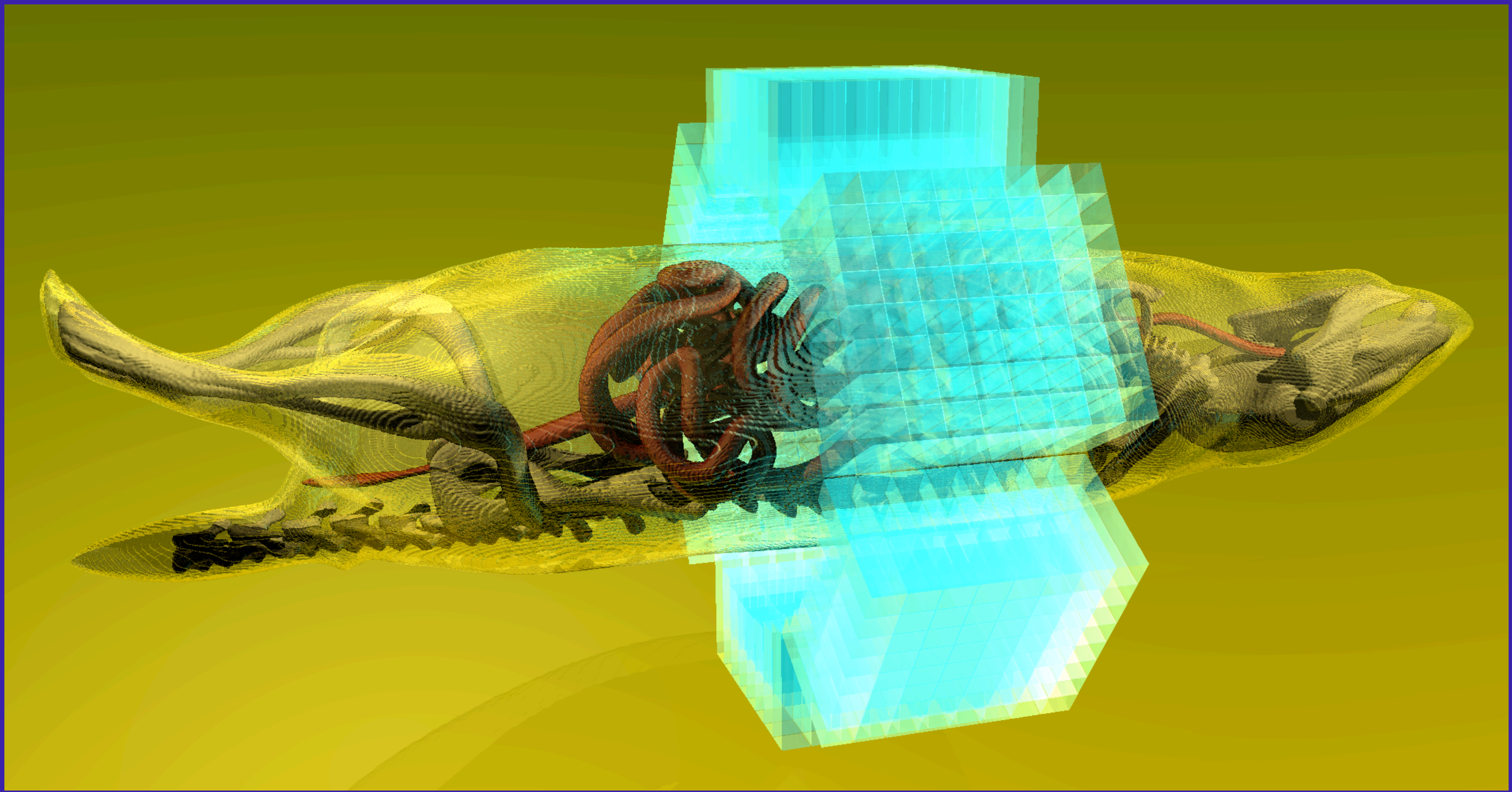
PET



Jens Langner - http://www.jens-langner.de/

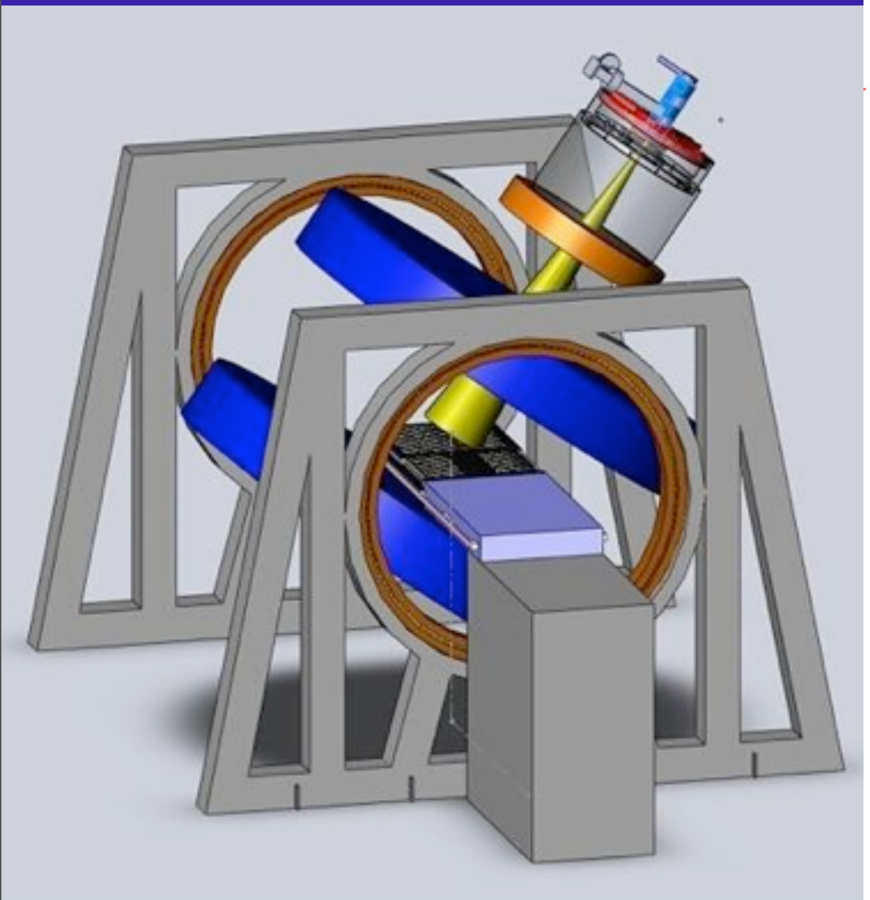
Optical Imaging

- OPET = Optical tomography + Positron emission tomography

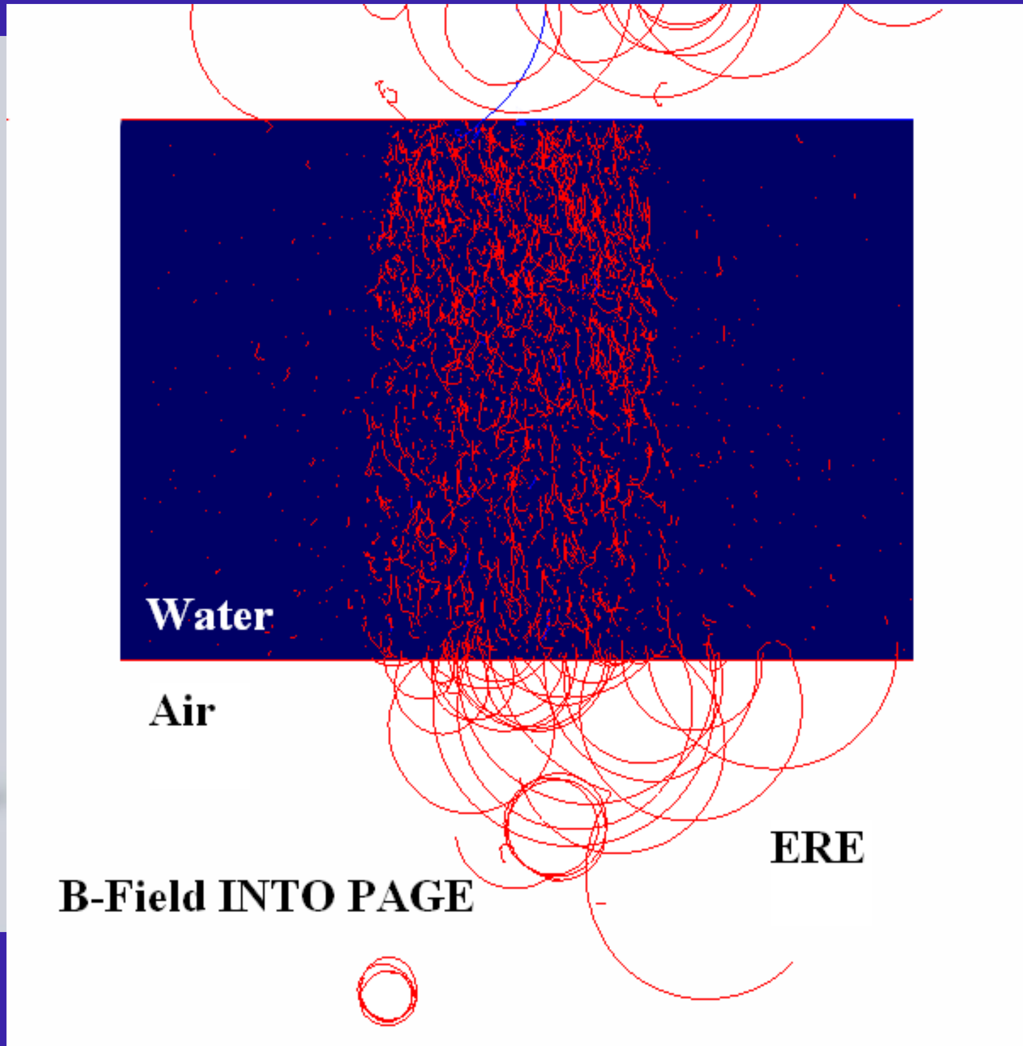


A Douraghy, F Rannou, G Alexandrakis, RW Silverman and AF Chatziioannou, FPGA Electronics for OPET: A dual-modallity optical & PET imaging tomography,AMI-SMI conference, Providence RI, 2007

Linac / MRI



Univ. Alberta Linac-MR Project



anatoly@uow.edu.au

Molecular Imaging

54th Annual Meeting July 29 - August 2 • Charlotte, NC

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Program Information

The Future of Physics Research in Cancer Therapy and Imaging | **All President's Symposium** | **All Sessions** | **Program Home**

Towards Personalized Medicine: Integration of Imaging Into Therapy

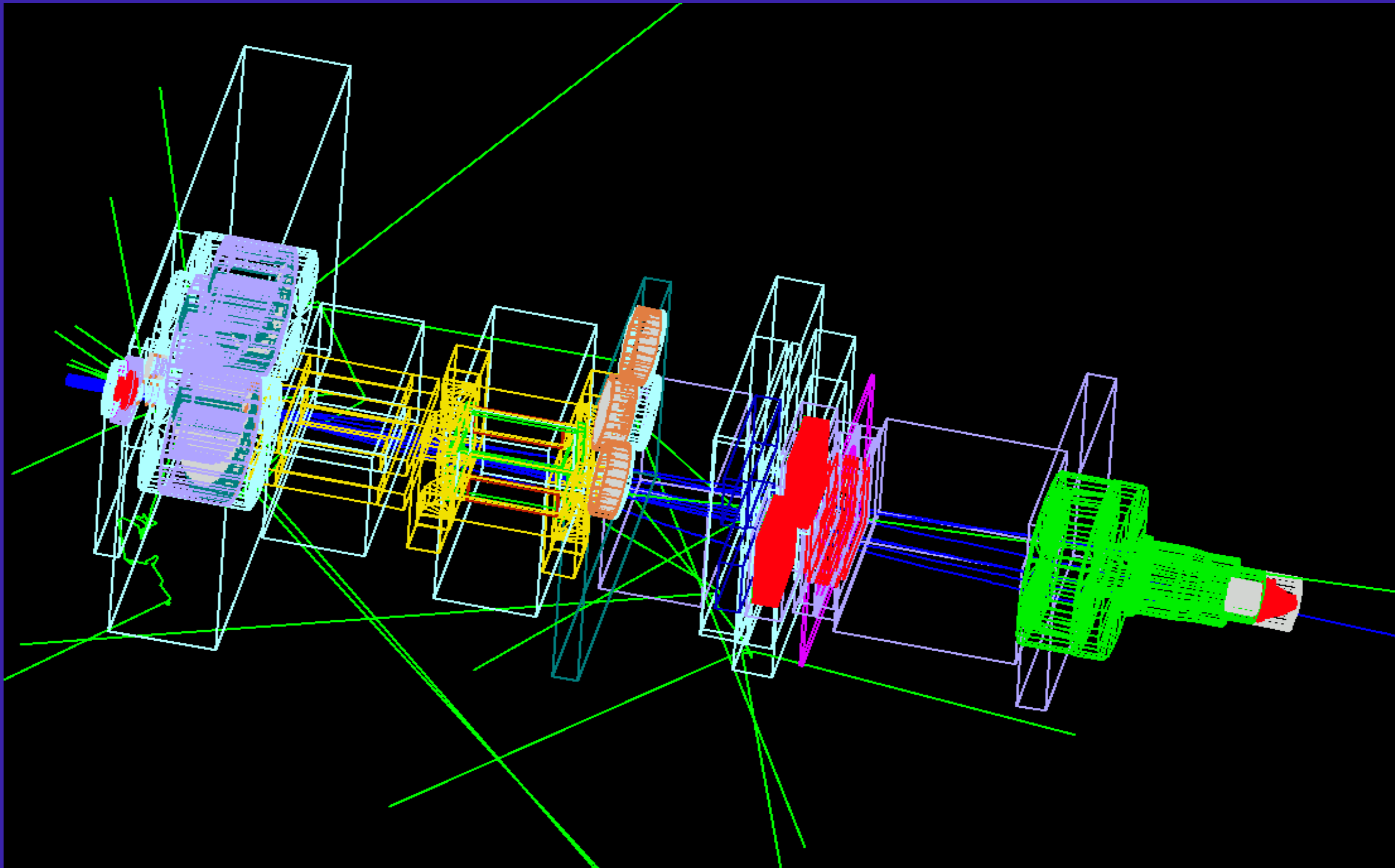
R Jeraj[1], (1) University of Wisconsin, Madison, WI

MO-C-BRCD-1 Monday 10:30:00 AM - 12:30:00 PM Room: Ballroom CD

Robert Jeraj

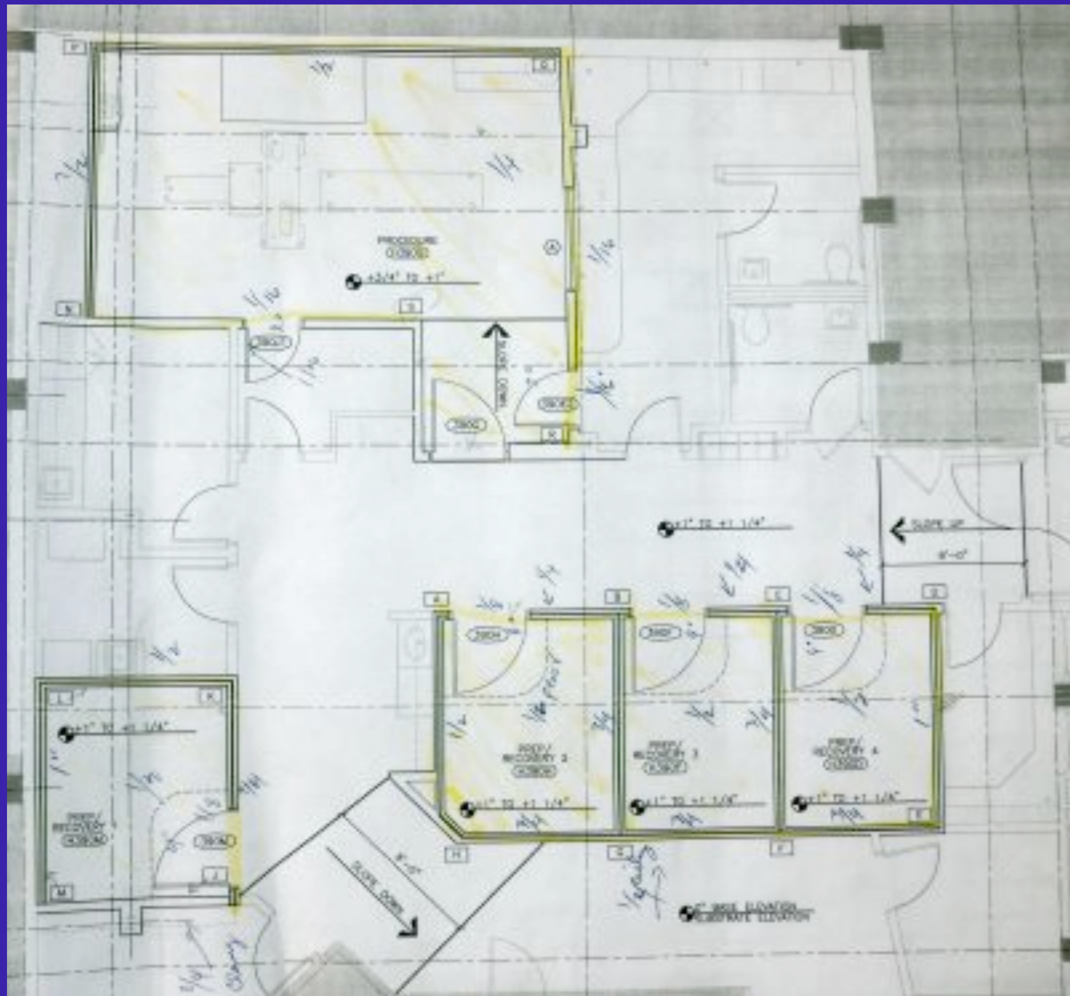
A significant advance in cancer therapy is currently underway with the evolution from a population-based to a personalized patient-based prescription. Rapid developments in imaging, particularly adoption of molecular imaging, offer unprecedented opportunities for accurate characterization of tumor biology, as well as early assessment of treatment response. Accurate characterization of tumor biology enables effective selection of appropriate therapy or even a design of purposefully non-uniform tumor-specific treatment plans, tailored to the spatial distribution of biological properties of each patient's tumor. Early assessment of treatment response enables treatment adaptation, potentially intensifying or reducing the treatment dose to provide more efficacious and less toxic therapies. However, integration of imaging into therapeutic applications requires a high level of image quantification, well beyond what is currently required in diagnostic imaging applications.

Radiation Protection

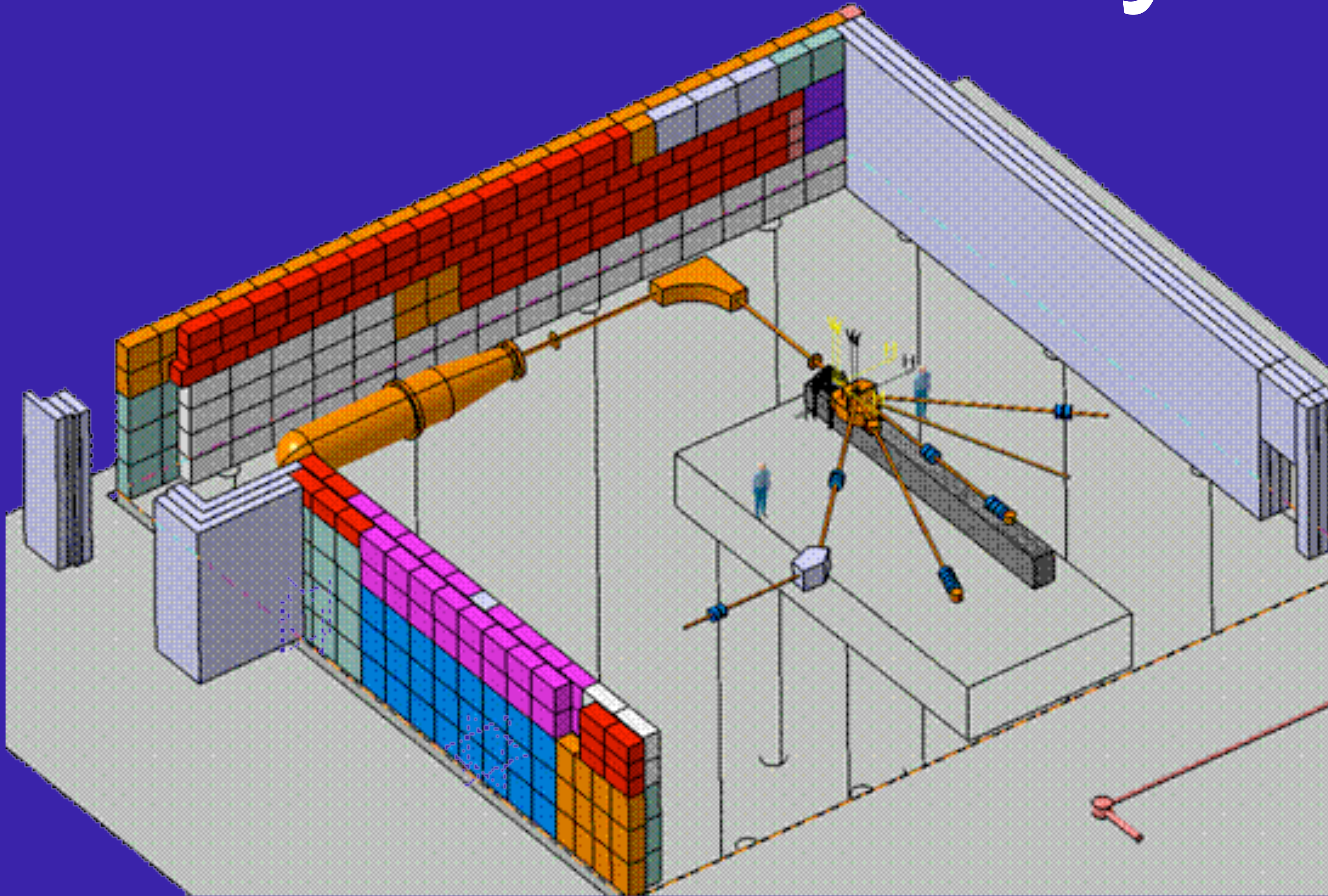


Harald Paganetti, Harvard / MGH

Shielding

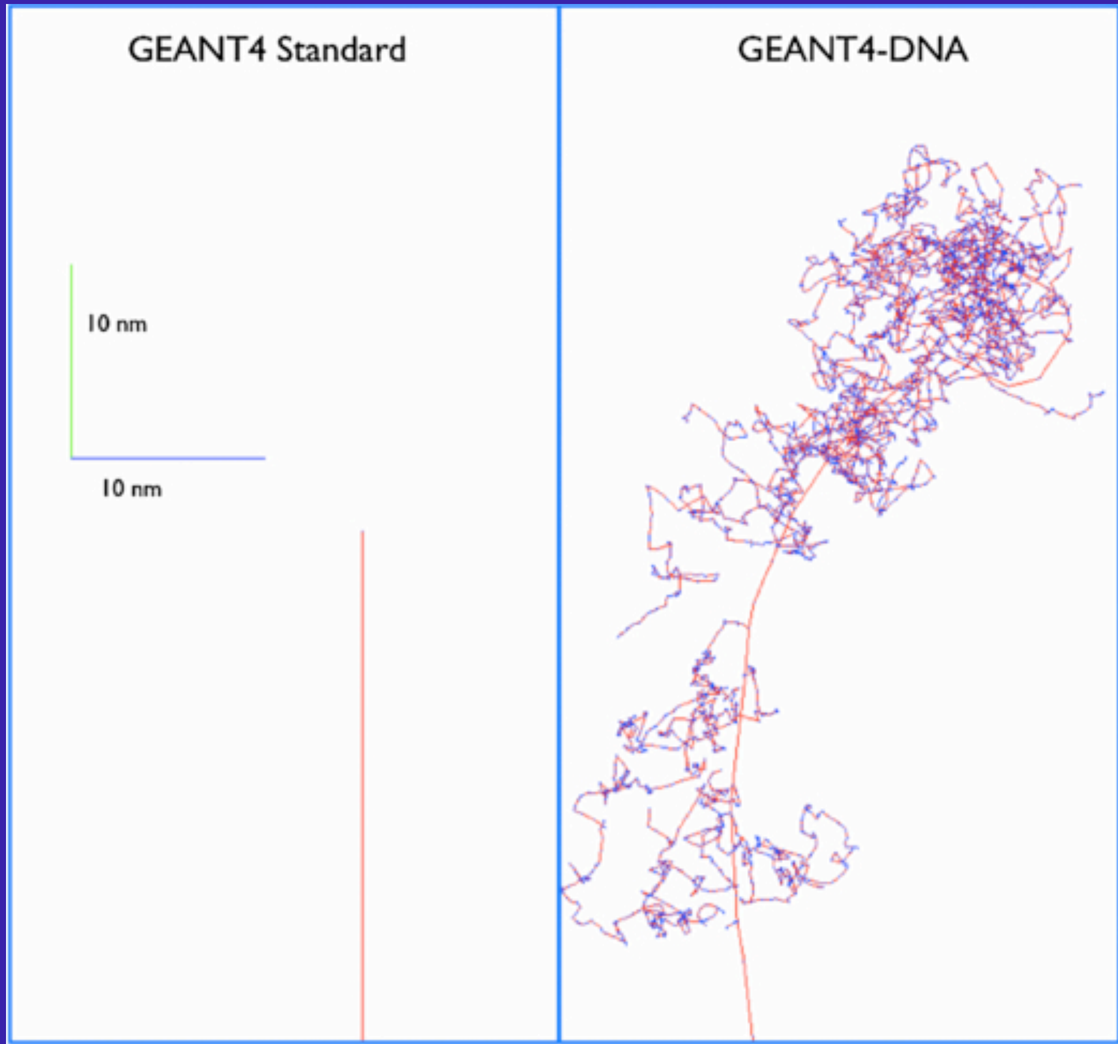


Microdosimetry



Sebastien Incerti, CENBG

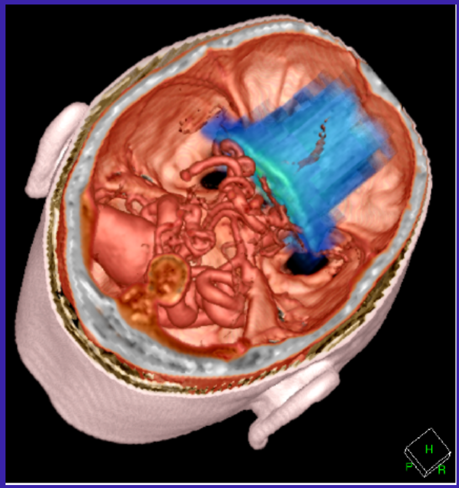
Nanodosimetry



GEANT4-DNA project

Future of Medical Physics

- Again from Robert Jeraj's AAPM talk:
  - The future of medical physics is biology
- Enthusiasm for Geant4-DNA project



Why do So Many Medical Physicists Choose Geant4?

Other MC codes in medicine:

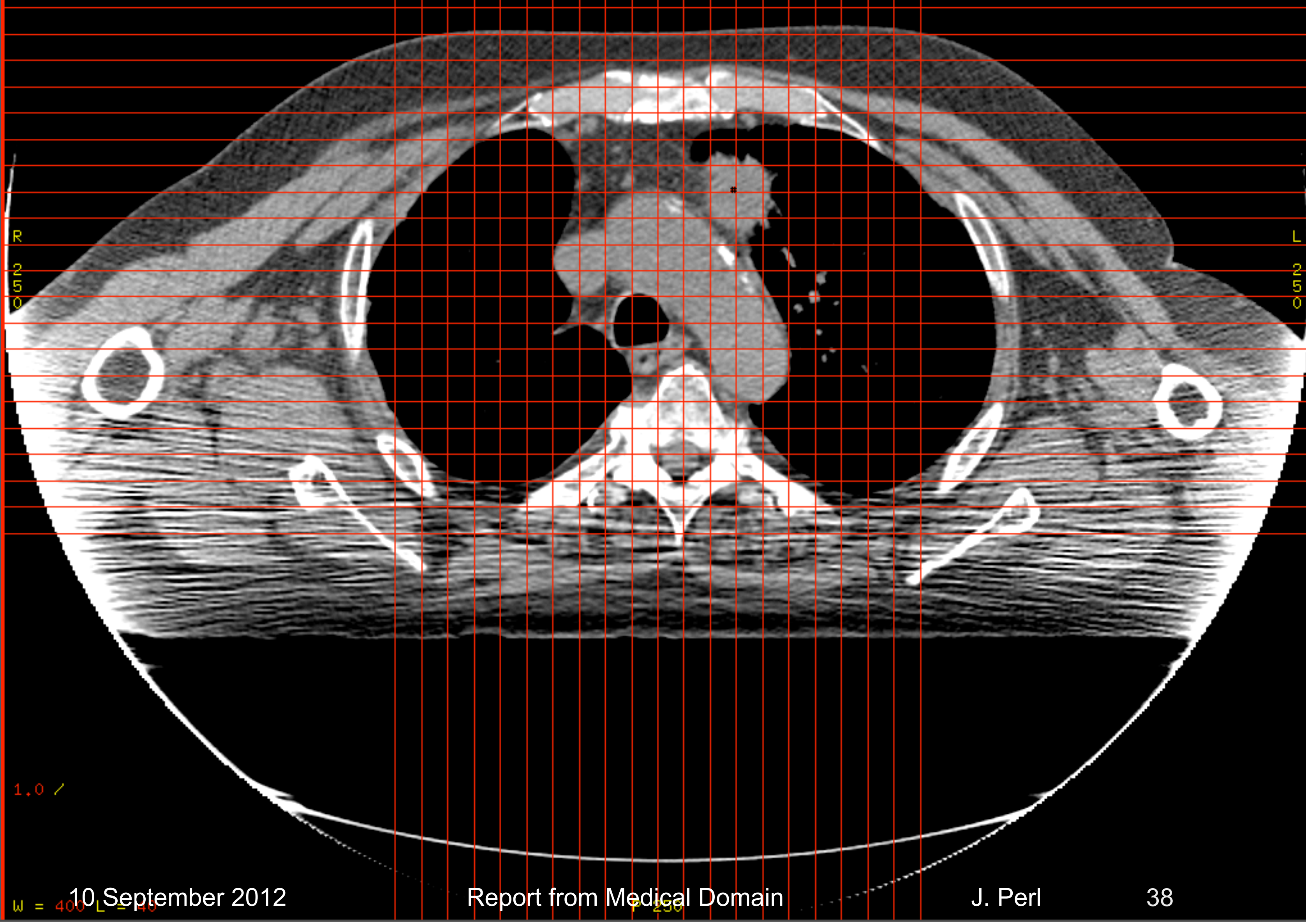
- EGSnrc, MCNPX, PENELOPE, FLUKA, XVMC, VMC++

Geant4 is the only code that offers all of:

- All Particle Code
- Complex Geometry
- Motion
- Fields
- Modern Programming Language
- Open and Free

Lateral Motion of Lung Tumor

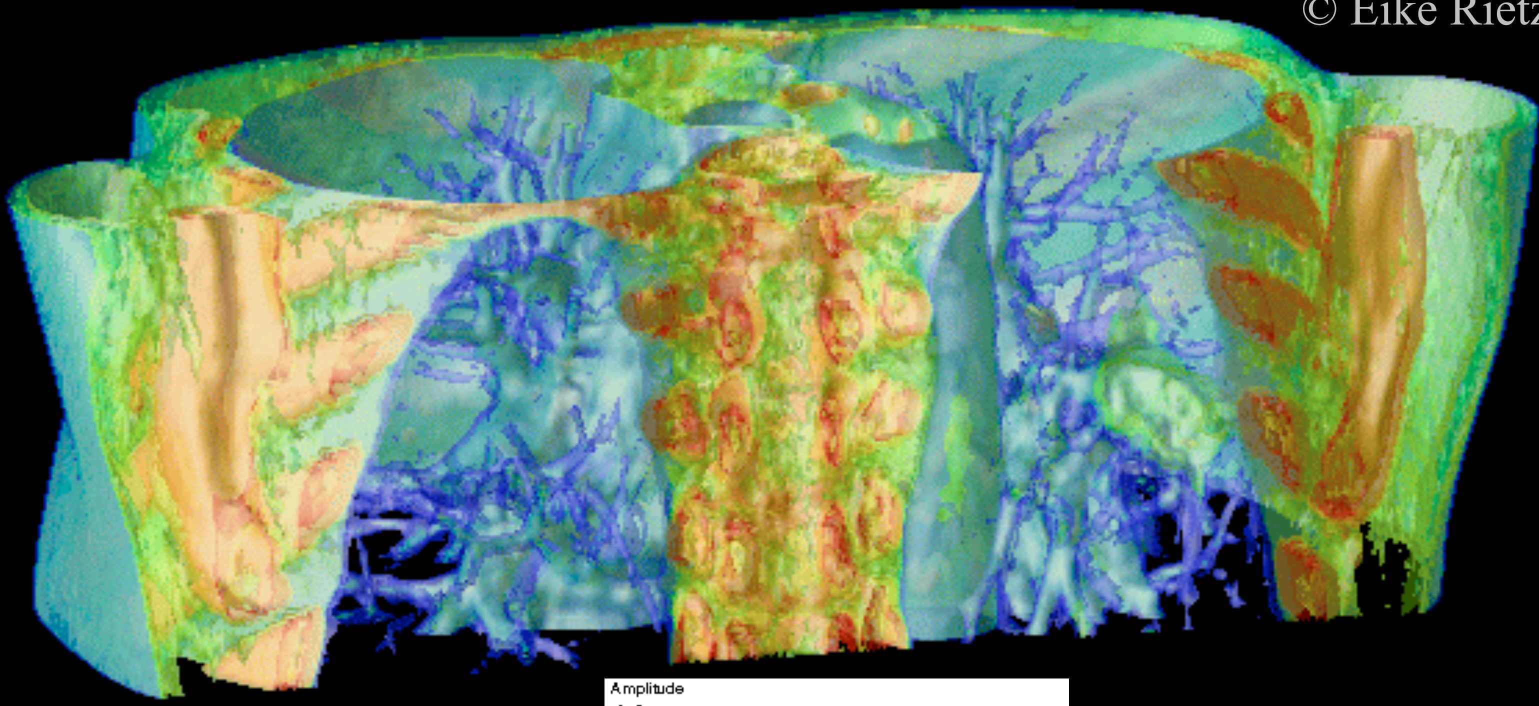
4D Patient

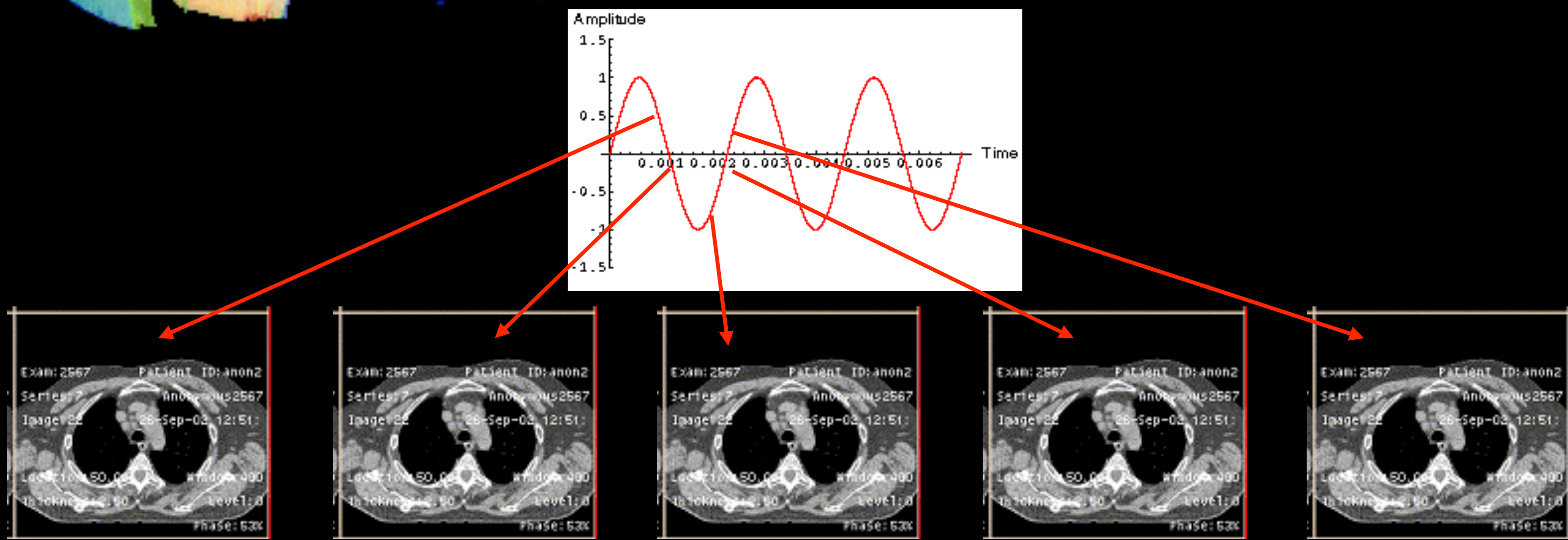


Monday, September 10, 2012

- Breathing Patient -

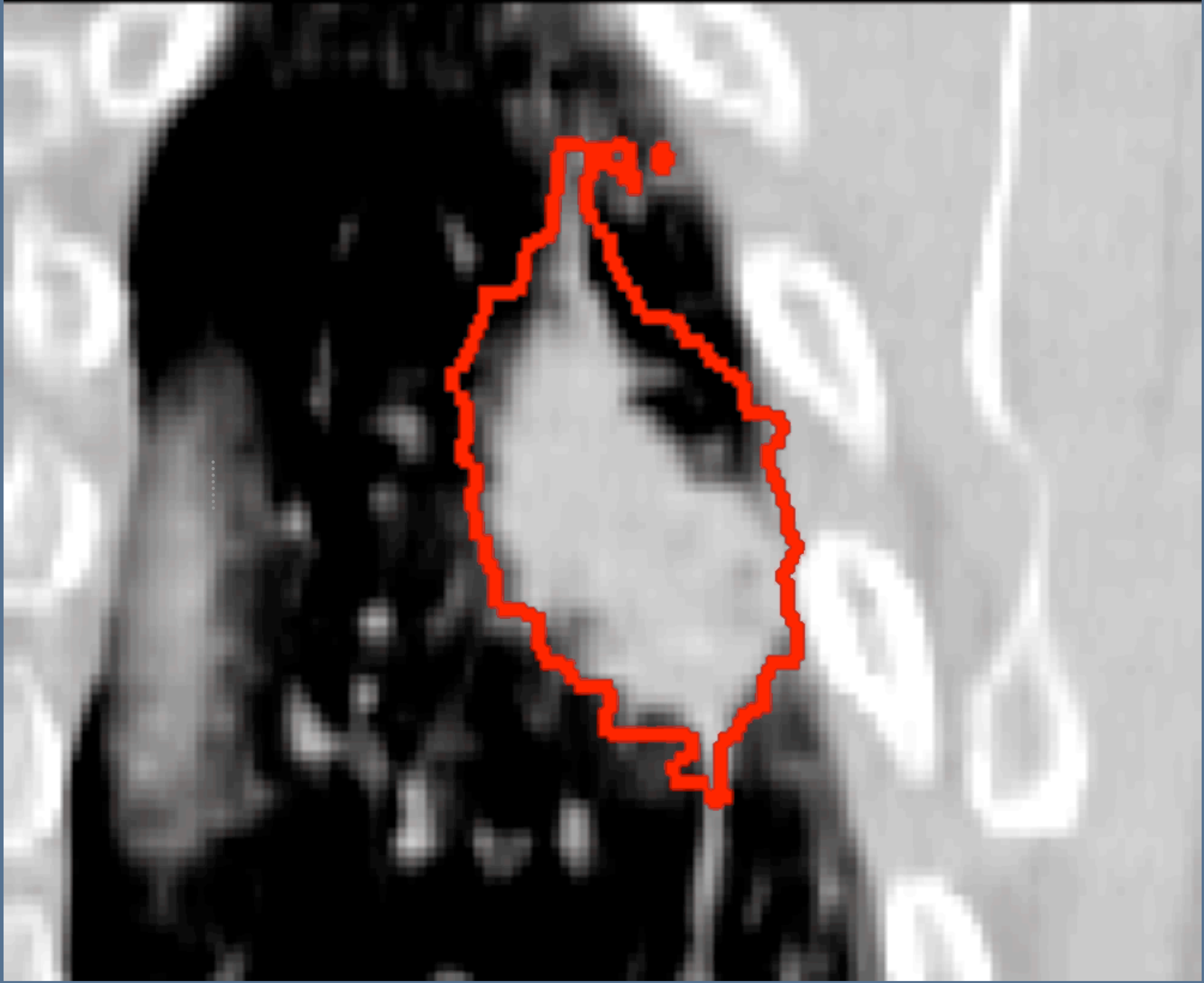
4D Patient



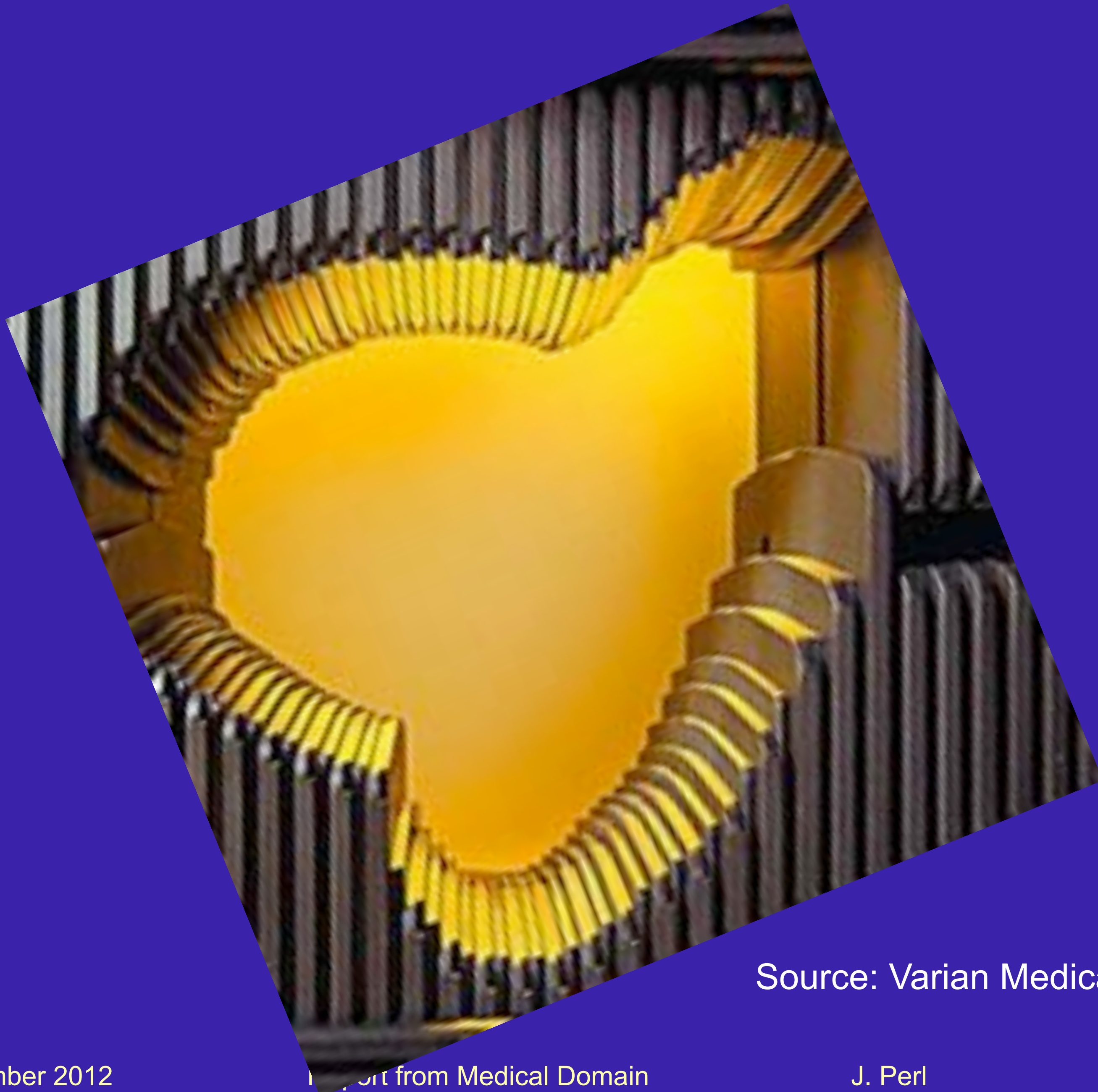


Characterize Tumor Motion

4D Patient

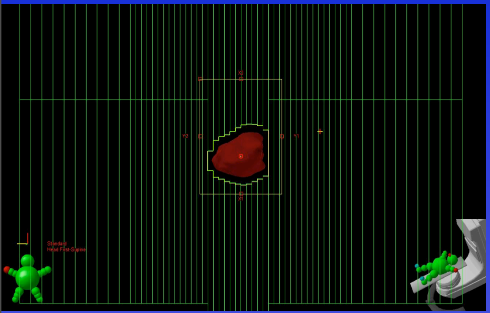


Multileaf Collimator

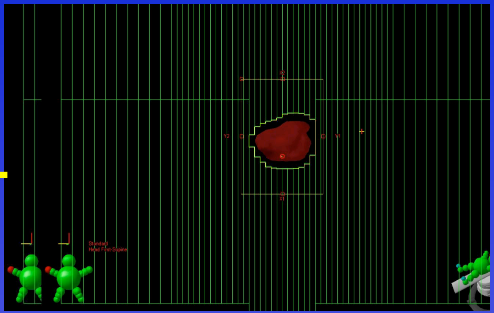


Source: Varian Medical Systems

4D RT Treatment Plan



+



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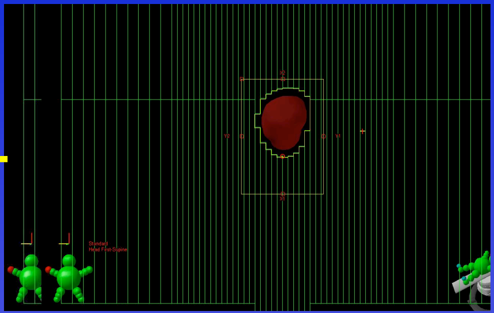
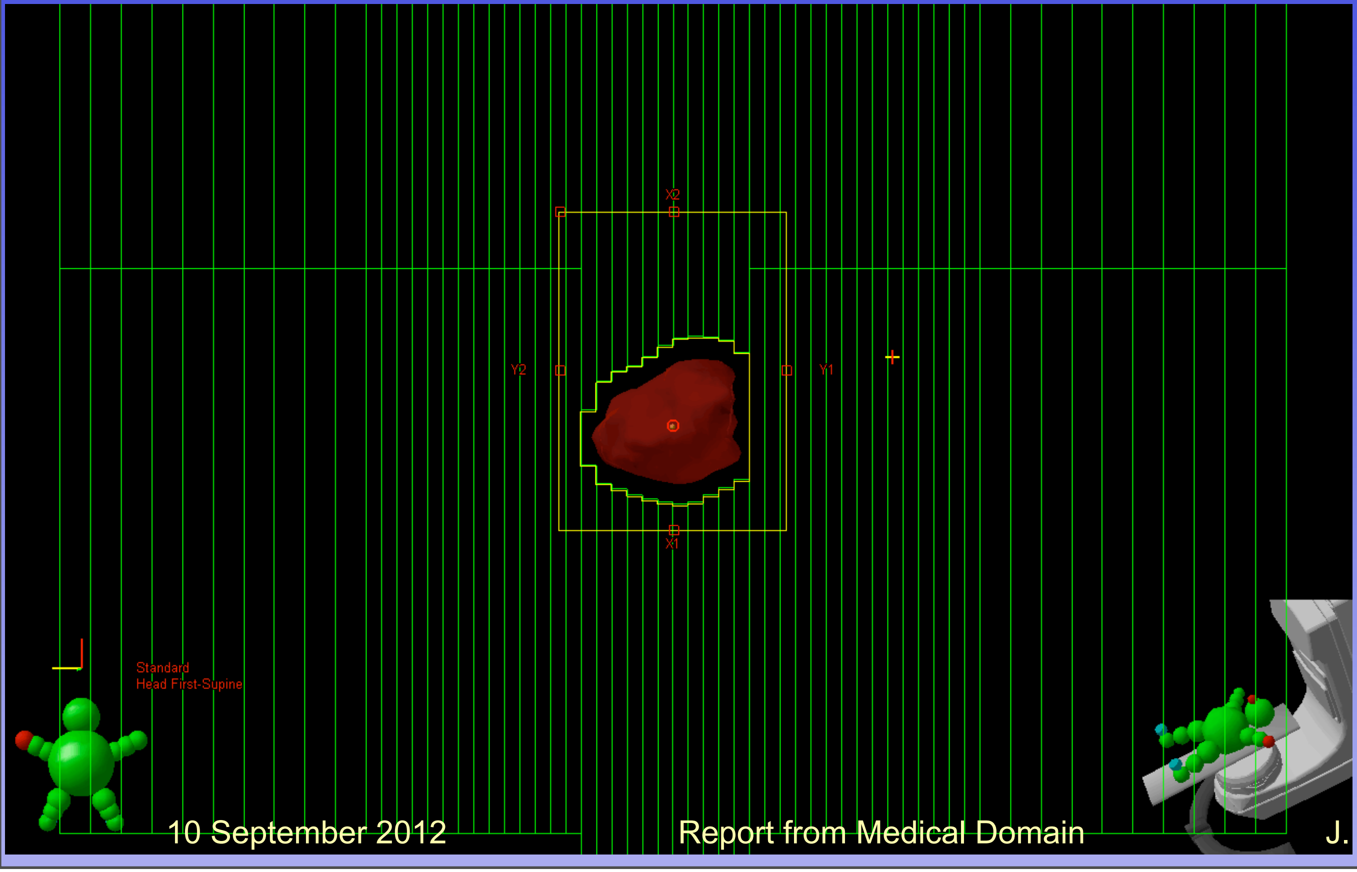


+ ……

Source: Lei Xing, Stanford University

Y. Yang, S. Huq, L Xing, Med. Phys, 2006



Optimize dose distribution in spatial and temporal domains

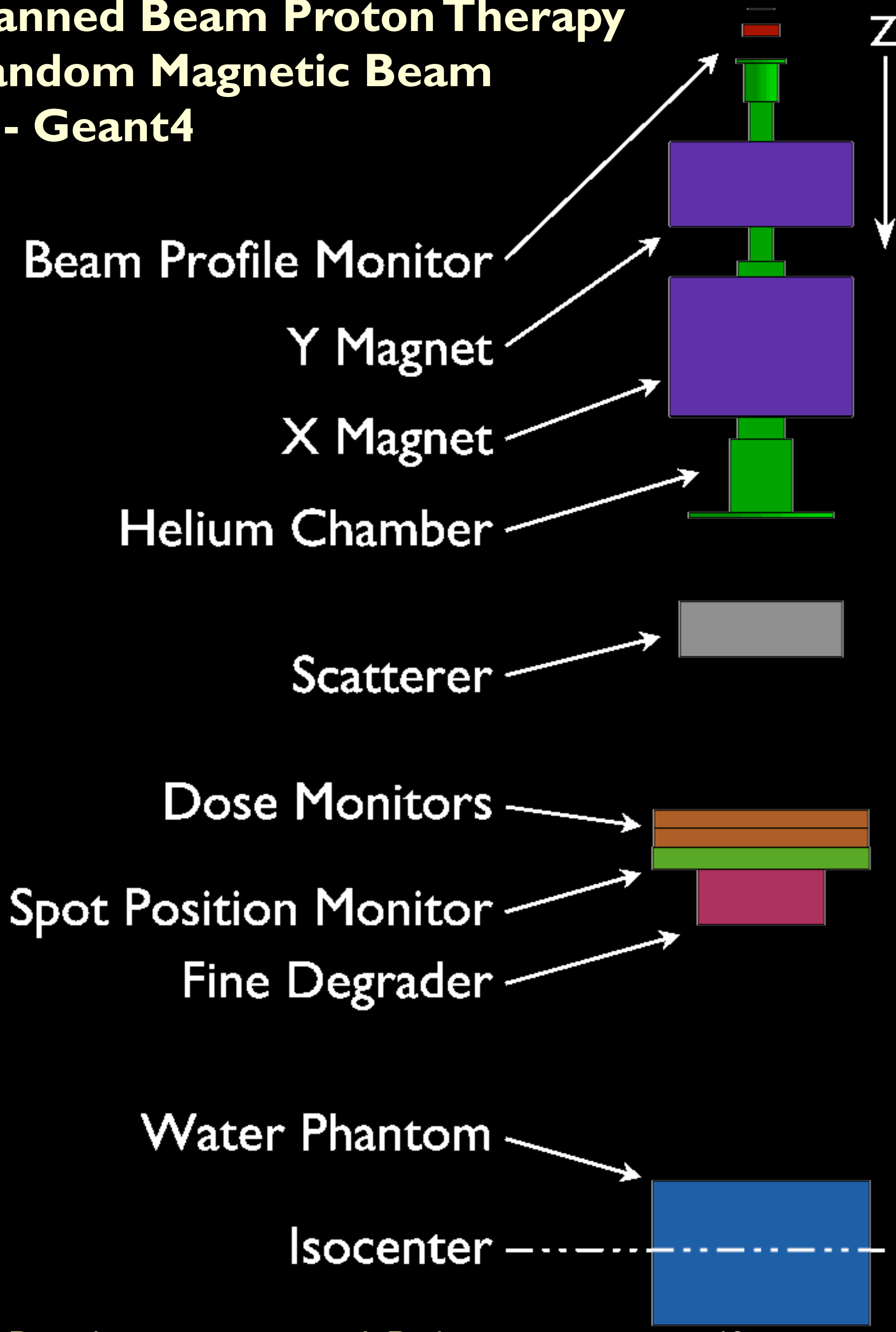
This slide is just to explain patient motion, but the work shown here is not using Geant4

Variations in Scanned Beam Proton Therapy Doses due to Random Magnetic Beam Steering Errors - Geant4

Stephen Peterson, Jerimy Polf,
Steven Frank, Martin Bues, Alfred Smith

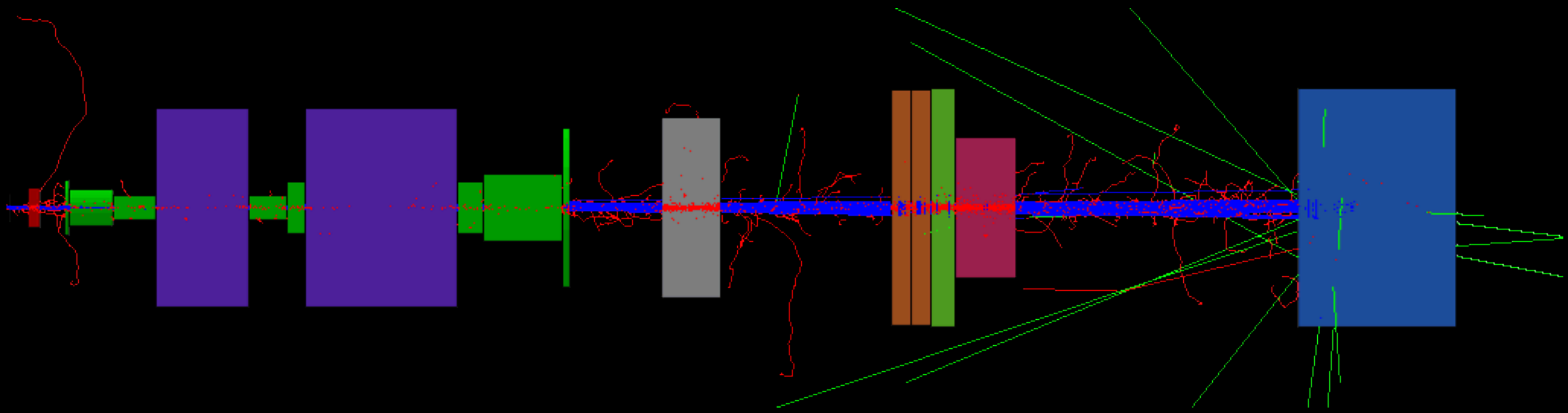
Scanned Beam Nozzle

- Beam scanning achieved by magnetic fields (X,Y) and changing incident beam energy (Z)
- Magnetic field values
  - Y magnet: 0.72 T (max)
  - X magnet: 0.39 T (max)
- Purpose: Determine magnetic field uncertainty that produces significant dose impact



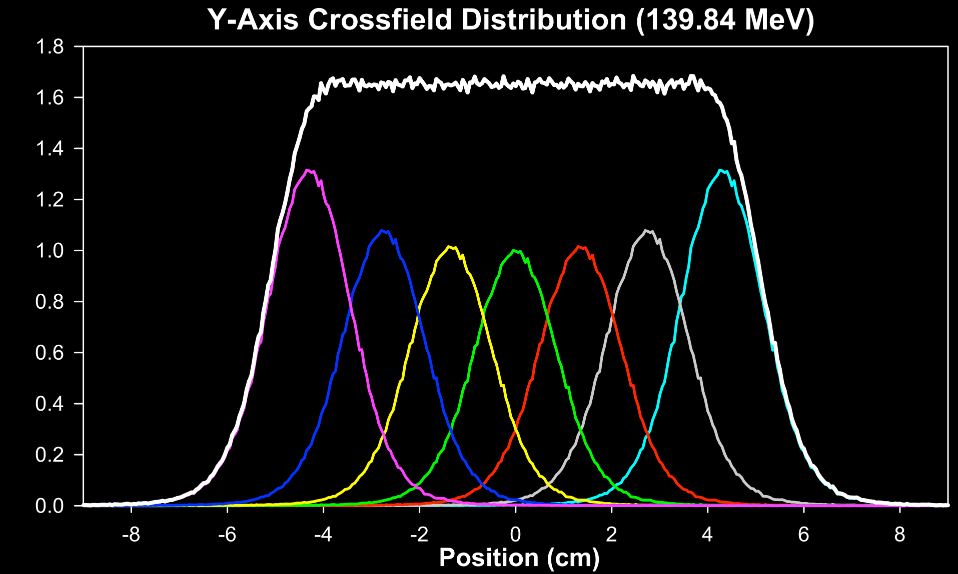
Monday, September 10, 2012

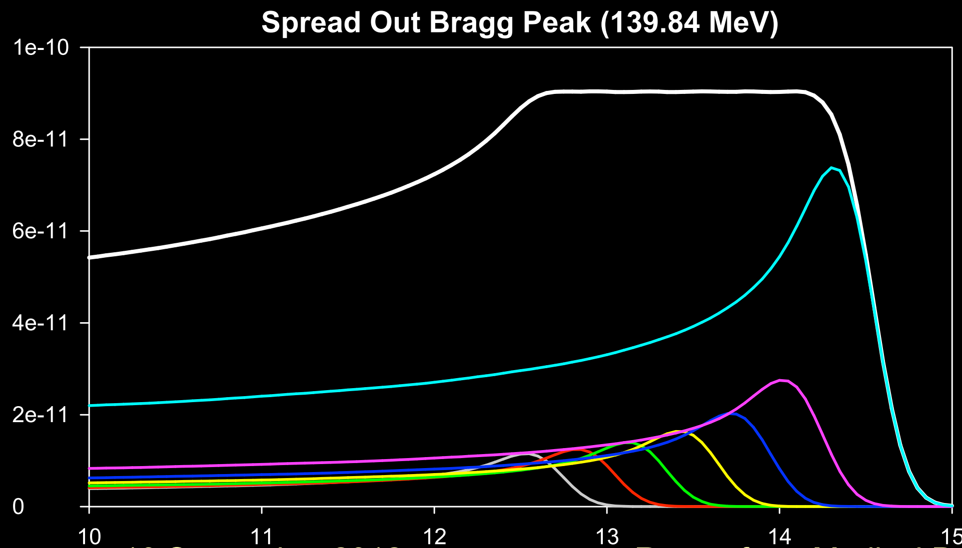
Monte Carlo Simulation



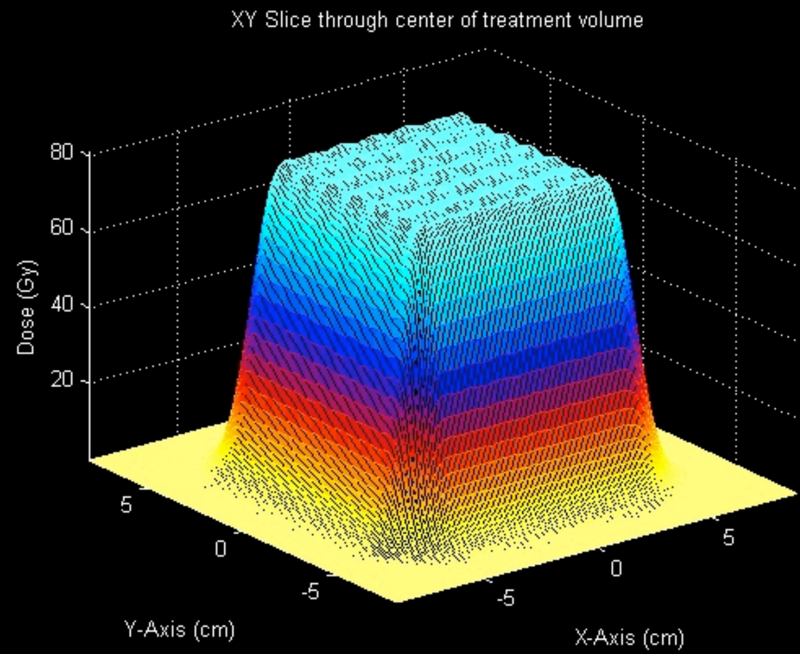
- Monte Carlo simulations performed using the Geant4 software toolkit version 8.1.p01
- Geant4 chosen for ability to model the beam steering magnetic fields

Creating 3D Dose Distribution





- The dose distribution is assembled during simulation by adjusting the spot energy and steering magnetic fields



Challenges

- Ease of Use
  - collaborations tend to have only a few people
- Physics
  - therapeutic ratio means tight margins
    (few percent, few mm)
- Speed
  - enthusiastic about our move towards MT and our exploration of GPU

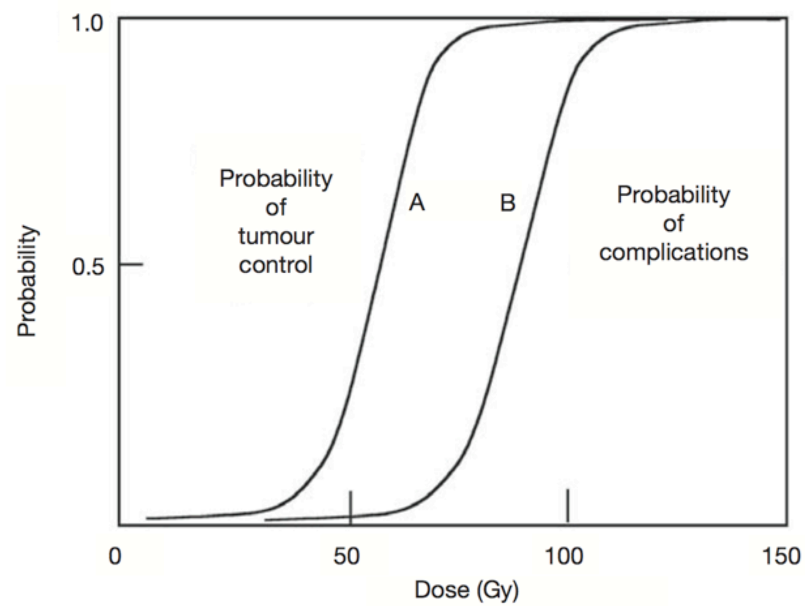


FIG. 14.4. The principle of therapeutic ratio. Curve A represents the TCP, curve B the probability of complications. The total clinical dose is usually delivered in 2 Gy fractions.

Podgorsak et al, Radiation Oncology Physics Handbook, IAEA 2005

Feedback

- Our open and friendly attitude is working
- Understanding of our limitations
- Increasing engagement
  - more joining as collaborators

23,000,000

number of times a patient receives radiation therapy treatment per year in the US alone

1.5 million new cancer diagnoses per year
2/3 of these receive radiation as part of their treatment
treatment delivered as on average 23 fractions

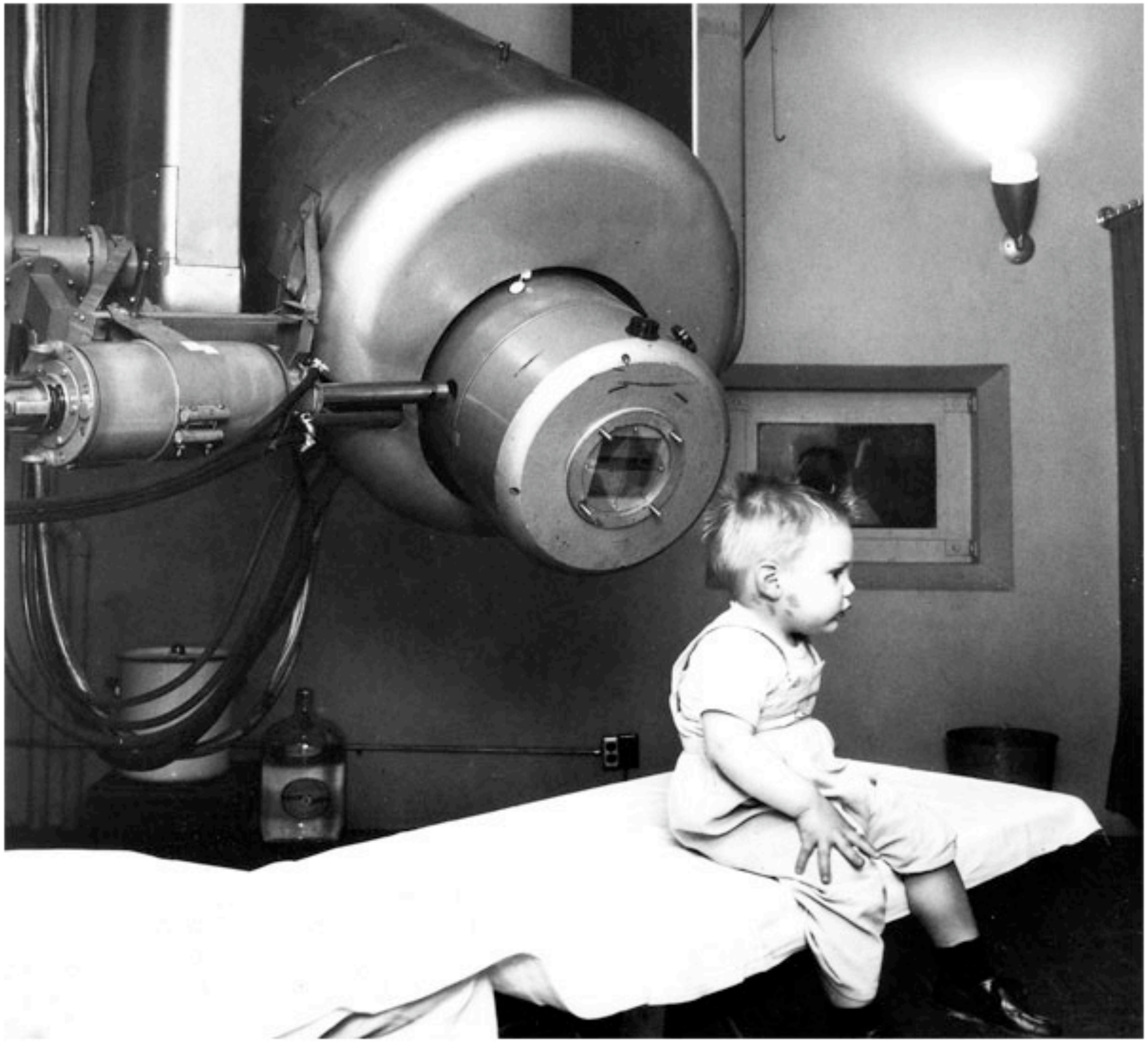
230,000,000

for whole world

230,000,000

+

all the other benefits from improved imaging



The first patient to receive radiation therapy from the medical linear accelerator at Stanford was a 2-year-old boy.

Stanford University Dept of Radiation Oncology