Physics Group Activities – 2001

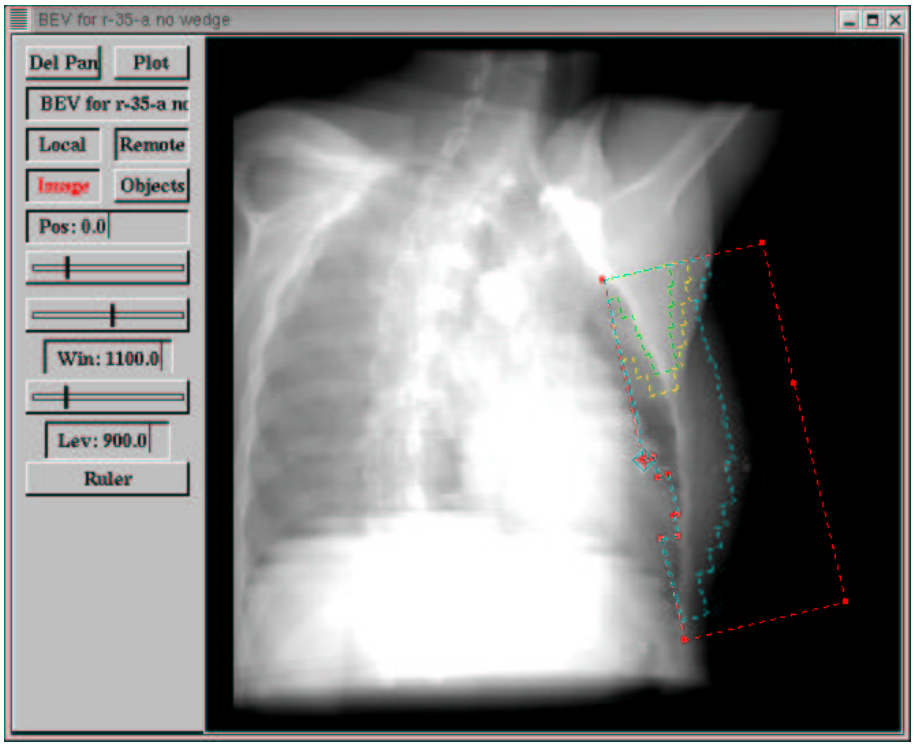

Figure 1: Prism image of a virtual compensator for a breast tangent field.

Group Members

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Robert Giansiracusa, M.S.
Jon Jacky, Ph.D.
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Juergen Meyer, Ph.D.
Dalong Pang, Ph.D.
Homayon Parsai, Ph.D.
Mark Phillips, Ph.D.
Alina Popescu, Ph.D.
Ruedi Risler, Ph.D.
Karen Singer, M.S.
Mark Wagner, B.S.
Peter Wootton, B.Sc.
Lori Young, Ph.D.

Transitions
Hired: Mark Wagner
Promoted: Homayon Parsai, Ph.D.
Arrived: Juergen Meyer, post-doctoral fellow

Clinical Program

- Seattle Cancer Care Alliance: The radiation equipment at the SCCA was commissioned and routine physics support of the clinic was implemented.
- RTOG: Provided physics support for RTOG application, which was accepted.
- Virtual Compensators: Multiple beam segments designed to produce uniform target doses were implemented. The primary application has been in treatment of breast cancer. This work required a number of new algorithms be implemented, new QA procedures, and the implementation of DICOM-RT (see below).
- Intravascular Brachytherapy: Working with the Cardiology Department, we started performing IVB for coronary restonosis.
- Pediatric TBI: The joint agreement between Children's Hospital, FHCRC, and UWMC means that we are now responsible for a certain number of pediatric TBI cases. A patient positioning stand was designed and built, and the dosimetry was commissioned.
- Total Skin Electrons: Total skin irradiations with electrons had been performed on the Cl 2500. This technique was re-commissioned on the SL20C using a re-designed patient positioning stand.
- In Vivo Dosimetry: Direct measurement of the dose delivered to the surface of the patient for each field was instituted by means of a multiple diode dosimetry system. This replaces a manual inspection of data entered into the SL20 computer to verify that the correct machine parameters have been set up for each different field.
- Direct Treatment Data Transfer: The DICOM-RT protocol for transferring data from Prism to the Elekta linacs was implemented in Prism. The software made use of the programming innovations that arose from our earlier development of the DICOM image transfer protocol that was implemented in Prism. In addition to increasing the quality of data transfer, it also paved the way for the introduction of more complex treatment techniques, such as compensated fields and IMRT.
- Prism: During this past year, a number of enhancements were included in Prism. In addition to many small improvements designed to make dosimetrists' life easier, major innovations included:
  - implementation of planning tools to calculate "virtual" compensators by means of multiple segmented beams (implemented for treatment of breast cancer);
  - inclusion of OpenGL support for enhanced image manipulation and display;
  - development and implementation of DICOM-RT code for direct Prism to linac plan setup;
  - inclusion of electron dose calculations (currently, the data are being inspected before clinical release).
- Computer Security/Administration: Mark Wagner was hired (jointly with Radiology Dept.) to improve computer security and administration.
- Provided clinical support. As part of our routine work, we provided clinical support for the following programs at UWMC and at the Seattle Cancer Care Alliance.
  - External beam therapy (x-rays, electrons, neutrons)
  - Intra-operative radiation therapy with electrons
  - Total body irradiation
  - Total skin electron irradiation
  - Intravascular brachytherapy

  - Stereotactic radiotherapy
  - Stereotactic radiosurgery
  - General brachytherapy
  - Eye Plaques
  - High Dose Rate brachytherapy
  - Permanent prostate implant brachytherapy
  - Permament implant brachytherapy for other sites

- Provided quality assurance and maintanence support. As part of our routine work, we provided quality assurance and maintanence support for the following UWMC and/or SCCA systems:
  - Linear accelerators
  - Cyclotron
  - Gamma Knife
  - Radiocamera system
  - High dose rate afterloader
  - Intravascular brachytherapy device
  - Brachytherapy systems (high and low dose rate)
  - Treatment planning systems:
    * External beam therapy with x-rays and neutrons (Prism)
    * Stereotactic radiosurgery
    * Stereotactic radiotherapy
    * High dose rate brachytherapy
    * Permanent prostate implant brachytherapy
  - Departmental computers for research and treatment planning

- Operations and upgrades of the neutron therapy system (with Ruedi Risler, David Reid, Robert Emery James Kuan, Eric Dorman, Jon Jacky):
  - Provided neutron beam for ongoing neutron therapy
  - Provided proton beam for PET radionuclide production
  - Provided alpha beam once a month for 211-Astatine production
  - Operated and maintained the clinical cyclotron with less than 1% of the scheduled patient sessions cancelled for technical reasons
  - Upgraded both Modicon programmable logic controllers to the latest Quantum processors
  - Changed the connection from the therapy control computer to the two Modicon controllers to Ethernet using our private network
  - Continued changing therapy motion controls from the original relay controls to a new combination of Modicon and relay control.
  - Replaced two thirds of the original 500 series I/O modules of Modicon 1 by Quantum type modules.
  - Continued preparations for a major seismic upgrade by re-routing control area cabling, getting equipment stabilization brackets manufactured and getting holes drilled into the equipment for the installation of hold-down anchors.
  - Increased the alpha beam output to 60 uA on the first Faraday cup
  - Replaced several quadrupole power supplies by new units which can be digitally controlled in the future

- Continued preparation work for a future move of the cyclotron and beam line controls away from the PDP 11/23
- Continued the investigation of neutron production targets for a therapy beam with enhanced boron neutron capture capabilities by building and characterizing 6 more target assemblies

Journal Articles

1. Cho, P.S. and Phillips, M.H. Reduction of computational dimensionality in inverse radiotherapy planning using sparse matrix operations. *Physics in Medicine and Biology* 46:N117–N125, 2001.
2. Kuterdem, H.G. and Cho, P.S. Leaf Sequencing with secondary beam blocking under leaf positioning constraints for continuously modulated radiotherapy beams. *Medical Physics* 28 (6): 894-902, 2001.
3. Meyer J, Mills J A, Haas O C L, Burnham K J, Parvin E M. 'Accommodation of Couch Constraints for Coplanar Intensity Modulated Radiation Therapy', Radiotherapy and Oncology, Vol. 61 (1): 23-32, 2001.
4. Meyer J, Burnham K J, Haas O C C, Mills J A, Parvin E M. 'Application of a Least-Squares Parameter Estimation Approach for 2D Spatial Modelling of Compensators for Intensity-Modulated Radiotherapy', *Transactions of the Institute of Measurement and Control*, accepted for publication.
5. Parsaei, H., Phillips, M.H., Cho, P.S., Kippenes, H., Gavin, P., and Axen, D. Verification of dynamic intensity-modulated beam deliveries in canine subjects. *Medical Physics*, 28: 2198-2208, 2001.
6. Parsaei, H., Cho, P.S., Phillips, M. H., Giansiracusa, R.S., and Axen, D. Influence of systematic and random errors in delivery of dynamic intensity-modulated fields. Physics in Medicine and Biology (submitted).
7. Kippenes, H., Gavin, P.R., Parsaei, H., Leathers, C.L., Phillips, M.H., Cho, P.S., Silver, G.M., and Sanders, S. Spatial accuracy of fractionated IMRT delivery: Studies in canine paraspinal irradiation. *Int. J. Radiat. Oncolo. Biol. Phys.* (submitted).

Proceedings

1. Cho, P.S. "A new paradigm for designing the intensity modulated radiotherapy beams." 2001 Whitaker Foundation Biomedical Engineering Conference, La Jolla, CA, August 10, 2001.
2. Lam, S.T., Marks, R.J., and Cho, P.S. "Prostate brachytherapy seed segmentation using spoke transform." Medical Imaging 2001: Image Processing, M. Sonka and K.M. Hanson, Eds. Proceedings of SPIE Vol. 4322:1490-1500 (2001).
3. Phillips MH, Cho PS, Parsaei H. Validation of an IMRT Program from Beginning to End. ESTRO Physics Workshop on "Verification of IMRT from A to Z", Seville, Spain, Sept. 15-16, 2001.
4. R.Risler, A.Z.Diaz, R.Emery, J.Jacky, G.E.Laramore and D.Reid, "Status Report of the Clinical Cyclotron Facility in Seattle." Proceedings of the 16th International Conference on Cyclotrons and their Applications, East Lansing, MI.

Abstracts

1. Cho, P.S., Parsaei, H., and Phillips, M.H., Influence of random field perturbation on dynamic intensity modulated beams. 43rd Annual Meeting of the American Association of Physicists in Medicine, Salt Lake City (2001).

2. Meyer J, Harding P, Mills J A, Bonnett D E, Glendinning A G, Haas O C L. Design and Manufacture of a Head and Neck Phantom for Assessing IMRT Delivery with Gel Dosimetry, *Dosgel 01, 2nd International Conference on Radiotherapy Gel Dosimetry*, Queensland University of Technology, Brisbane, Australia, 18-21 November 2001

3. Meyer J, Mills J A, Haas O C C, Burnham K J, Parvin E M. An Assessment of the Suitability of Different Treatment Couch Systems for IMRT, *1st UK Radiation Oncology Conference (UKRO1)*, University College of Ripon and York, York, 23-25 April 2001

4. Parsaei, H., Phillips, M.H., and Cho, P.S., Delivery verification in dynamic fileds: An in-vivo study in canine subjects. 43rd Annual Meeting of the American Association of Physicists in Medicine, Salt Lake City (2001).

5. Phillips, M.H., Parsaei, H., and Cho, P.S., Modelling dynamic IMRT dose distributions. 43rd Annual Meeting of the American Association of Physicists in Medicine, Salt Lake City (2001).

Invited Talks

1. Mark Phillips. "Validation of an IMRT Program from A(lgorithm) to Z(ooRadiotherapy)", ESTRO Annual Meeting, Seville, Spain, Sept. 2001.

Technical Reports

1. J Jacky, Clinical Neutron Therapy System Implementation, 2001-03-01, Department of Radiation Oncology, University of Washington, March, 2001.

2. J Jacky, Clinical Neutron Therapy System Installation and Operations, 99-08-01, Department of Radiation Oncology, University of Washington, August, 1999, (Revised April 2001, 125 pages)

Academic Milestones

- Prostate Seed Grant: Paul Cho received an R21 from the National Cancer Institute for a project designed to develop improved methods of automatically sorting seeds from images.
- Homayon Parsaei received doctorate: Dr. Parsaei received his doctorate in Physics from University of British Columbia. He performed his graduate thesis project at UW in the area of IMRT under the guidance of Drs. Phillips and Cho.
- Hege Kippenes received doctorate: Dr. Kippenes received her doctorate in Radiological Veterinary Science from Washington State University. She worked with Drs. Phillips and Cho on a joint project designed to determine the spatial accuracy of IMRT delivery.
- Juergen Meyer received doctorate: Dr. Meyer received his doctorate in Mathematical and Information Sciences Coventry University, England. His thesis work was on the accommodation of practical constraints for IMRT by means of compensators.
- Grant Reviews: Mark Phillips served as an *ad hoc* reviewer for the NCI Radiation Study Section. Paul Cho served as a reviewer for the Congressionally- Directed Peer-Reviewed Medical Research Program, U.S.Army Research and Materiel Command.
- Program Reviews: Ruedi Risler served on a review committee for the Northeast Proton Therapy Center at MGH in Boston.