

Mychaela Coyne (IUSM)

Title: Updating SRS/SBRT procedures (workflow, immobilization, tolerance tables, and Special Physics Consults)

Genre: Radiation Therapy

Title: New methods in electron therapy treatment utilizing 3D scanners and 3D printers.

Genre: Radiation Therapy

Ulrike Dydak (Purdue)

Title: Neuroimaging of Manganese Toxicology

Genre: Brain Imaging

Occupational exposure to manganese and other heavy metals can be toxic leading to cognitive and motor deficits, but neither diagnostic methods exist nor is the full mechanism understood.

- Topics:
- Develop and validate MRI techniques to *quantify* Mn and Fe deposits in the human brain
 - Study the dynamics and dose-response relationships of *uptake and elimination* of Mn into specific brain regions in welders in new welder recruits and retired welders (longitudinal study)
 - Evaluate whether Mn toxicity results in oxidative stress and neurotransmitter imbalance by measuring glutathione, a marker of oxidative stress, and GABA, an inhibitory neurotransmitter, in several brain regions
 - Analyze the effects of Mn exposure on the cerebellum (Glutathione MRS – oxidative stress, volume changes, quant. MRI for Mn & Fe deposition) and test for a relationship to changes in mood or motor deficits

Title: Oxidative stress and excitatory/inhibitory imbalance in Mental Health

Genre: Brain Imaging

Oxidative stress as well as excitatory/inhibitory imbalance play important roles in addiction as well as neurodevelopmental (e.g. autism) and neurodegenerative diseases (e.g. Alzheimer's, Parkinson's Disease). MRS allows to measure glutathione, a marker of oxidative stress, as well as Glutamate and GABA, excitatory and inhibitory neurotransmitters, respectively.

- Topics:
- Establish optimal protocols for the measurement of *GABA, glutamate and glutathione* and determine their variability in healthy subjects
 - develop a fast Glutathione spectroscopic imaging technique
 - help with MRS data analysis in several collaborative studies on addiction to alcohol, addiction to opioids, postpartum depression and post-traumatic stress disorder
 - study sex differences in oxidative stress and EI-imbalance in these datasets

Title: Imaging Biomarkers of Risk for Liver Cancer

Genre: Liver Imaging, Cancer, Multi-Nuclei MRI

The prevalence of liver disease is increasing with rising obesity, resulting in elevated risk for liver cancer. While it is crucial to detect liver cancer at its earliest stages, imaging screening of all people with liver disease is not feasible. MRS may yield a more specific biomarker to identify patients at risk to develop liver cancer.

- Establish a reproducible study protocol that incorporates 1H MRS (lipids) and 31P MRS (energy metabolism) of the liver
- Develop and validate a fast 31P MR Spectroscopic Imaging sequence of the liver (Collab. with Dr. Emir)

- Study and differentiate the ^1H and ^{31}P MRS signatures of different types of liver disease and liver cancer in 30 patients (Collab. with IUSM)

Uzay Emir (Purdue)

Title: Kidney Fat-Water Imaging

Genre: Renal Cell Carcinoma Imaging

MRS could be useful for characterization of the renal cell carcinoma by detecting lipid content. However, single-voxel MRS cannot show the distribution of lipids for heterogeneous tumors. We propose a fast MRSI sequence to map the distribution of lipid metabolites within a clinically acceptable time frame at 3T.

Title: Ultra-short echo time (30 microsecond) and very-high resolution FAST Sodium Imaging

Genre: Cancer Imaging

Compare the novel sodium imaging method against gold standard method. To implement an accelerated MR-acquisition method allowing to map T^*2 relaxation and absolute concentration of sodium within skeletal muscles at 3T.

Leia Fanelli (IUSM)

Title: Bolus Classification for Eclipse TPS using mobile MOSFET Dosimetry System

Genre: Radiation Therapy Physics

Install mobileMOSFET system via wireless connection for use in TBNorth1 vault. Determine water equivalent thicknesses of different types of materials to be used for clinical bolus and classified in Eclipse for planning using mobile MOSFET dosimetry system. Photon and electron beams are to be considered. The student will obtain experience with the Best Medical Canada mobileMOSFET Dosimetry system, Calibration Jig, bolus design (brass, superflab, 3D printed), and Ecoflex30/PLA/Ninjaflex Varian TrueBeam 2.7 system, and Varian Eclipse treatment planning system v15.6.

K. Colin Huang (IUSM)

Title: Evaluation Of Dosimetric Changes Induced by Setup Uncertainties in VMAT TBI Treatment

Genre: Radiation Therapy Physics

Introduction. Total body irradiation (TBI) is frequently used as part of the preparation for a stem cell or bone marrow transplant. Most TBI treatment requires the treatment at extended distance in a large shielded room, the cost of which is high. Patients are treated in uncomfortable positions. Dose distribution of the treatment not optimal. Lung blocks and additional shielding for certain body parts might be needed, which are cumbersome. Implementing VMAT can be used to optimize dose distribution, ergonomically more comfortable for the patient, eliminates the need for physical shielding, and can spare dose to the lungs.

What needs to be done. Based on the current clinical treated plans, new plans with shift on ISO centers for VMAT plans need to be generated in Eclipse at 0.5cm and 1cm (maybe also 0.7cm) for each test patient. Dose need to be recalculated for these plans. Dicom dose files for these plans need to be exported and compared with the original plans in Matlab.

Shuang Liu (Purdue)

Title: New Radiotracers for Myocardial Perfusion Imaging

Genre: Heart Imaging

Discovery and development of new radiopharmaceuticals for heart imaging. The key for success is to establish the linear relationship between the radiotracer heart uptake and the regional blood flow rate.

Title: New Radiotracers for Molecular Imaging of Tumors

Genre: Tumor Imaging

Discovery and development of new target-specific radiopharmaceuticals for tumor imaging. The successful radiotracers are those which have the potential not only for early diagnosis of tumors of different origin, but also for noninvasive monitoring of cancer treatment.

QiuHong He (Purdue)

Title: Fast pi-MRSI for early and prognostic detection of cancer treatment responses

Genre: MR biomarker imaging of human cancer

Topics - We are developing fast MRI methods for biomarker imaging to provide high specificity for cancer detection. Our recent pi-MRSI methods (patent-pending) enables early detection of treatment responses in days rather than several months and differentiate pseudo-progression from true tumor progression. By detecting biomarkers of tumor immune microenvironment, pi-MRSI may provide clinical prognostic biomarkers for immunotherapy of solid tumors.

1. Fast biomarker imaging for early detection of neoadjuvant chemotherapy response in triple negative breast cancer (TNBC)
2. MR spectroscopic imaging of prognostic biomarkers for combinational immunotherapy-chemotherapy treatment of TNBC
3. In vivo pi-MRSI imaging of glioma metabolic markers 2-hydroxyglutarate, lactate and choline for in vivo IDH1 mutation genotyping in glioma and differentiation of pseudo-progression from true tumor progression after therapy

Title: Bacteria based cancer therapy and imaging

Genre: Anti-cancer bacteria and immunotherapy

Topics – We have genetically engineered anti-cancer bacteria inducing rapid tumor tissue destruction in immune competent murine tumor models. Diffusion weighted MRI (DWI) and Diffusion Tensor MRI (DTI) are begin employed in longitudinal monitoring of bacteria based cancer treatment responses. The anti-cancer bacteria carry magnetic resonance imaging markers.

1. Investigate innate and adaptive immune response induced by the anti-cancer bacteria in mouse tumor models and develop MRI techniques to image immune cell infiltration in solid tumors.

Linda Nie (Purdue)

Title: Neutron Activation Analysis to Quantify Metals and Trace Elements in Human Body In Vivo

Genre: Human Body Composition Study, Metal Exposure Assessment and Health Effects, Nutrition Study, Metal Toxicology Study

Development and application of novel in vivo neutron activation analysis (IVNAA) technologies to quantify metals and trace elements such as manganese, aluminum, sodium, potassium, etc. in human bone and soft tissue and to study how the exposure to and intake of these elements affect human health.

Title: X-ray Fluorescence Technology to Quantify Metals and Trace Elements in Human Body In Vivo

Genre: Human Body Composition Study, Metal Exposure Assessment and Health Effects, Bone Health, Nutrition Study, Metal Toxicology Study

Development and application of novel in vivo x-ray fluorescence (IVXRF) technologies to quantify metals and trace elements such as lead, strontium, manganese, mercury, gadolinium, zinc, etc. in human bone and toenail and to study how the exposure to and intake of these elements affect human health.

Title: Lead Exposure, Metal Interactions, and ADRD Neuropathology

Genre: Metal Exposure, Neurodegeneration, and Aging

To study the involvement of metals, especially toxic metals including lead and mercury, in the etiology of neurodegeneration and neurodegenerative diseases such as Alzheimer's disease and related dementias (ADRD). Advance synchrotron X-ray technologies and pathological imaging techniques will be used to map the metal distribution and pathology structure in brain samples at resolution down to nms.

Seyi Oderinde (Purdue)

Title: Application of molecular Imaging in radiation oncology

Genre: radiotherapy physics

Topics:

1. Re-designing patient's specific radiotherapy based tumor response assessment using positron emission tomography
2. Evaluating radiation-induced cardiotoxicity of biology-guided radiotherapy for breast cancer: Treatment planning study

Title: Monte Carlo simulations in radiation dosimetry

Genre: radiotherapy physics

Topics:

1. Investigating 3 megavolt linear accelerator for deep seated tumor treatment using Monte Carlo simulation
2. Simulation of novel radiotherapy systems and nanoparticle enhancement for radiotherapy
3. Artificial intelligence/Machine Learning for Monte Carlo simulation in radiation dosimetry

Jason Parker (IUSM)

Title: Mapping tumor genomics from in vivo imaging

Genre: Multimodal tumor imaging, genomics, statistics

Topics: Develop statistical models to predict spatial distributions of tumor mutations using multimodal and multiparametric in vivo methods including MR (diffusion, perfusion) and PET (^{18}F -FET, ^{15}O -water)

Matthew Scarpelli (Purdue)

Title: Iron nanoparticles as dual imaging and therapy agents to enhance radiosensitivity of tumors

Genre: Radiotherapy, tumor cell culture, rodent tumors, MRI

Topics:

1. Evaluate iron nanoparticle induced radiosensitization in cell cultures using clonogenic assay and related assays

2. Evaluate iron nanoparticle induced radiosensitization in rodent tumors using various pathologic techniques, including immunohistochemistry and flow cytometry
3. Utilize imaging and pathologic techniques to quantify iron nanoparticle retention in tissue

Title: Imaging the effects of radiotherapy on the immune system

Genre: Develop imaging techniques (PET, MRI) for assessing immune cells

Topics:

1. Validate with histopathology various medical imaging techniques for assessing immune cells
2. Apply imaging techniques to measure the effects of radiotherapy on the immune system in rodents

Aaron Specht (Purdue)

Title: X-ray fluorescence: exposure assessment in environmental health studies

Genre: Environmental/Occupational Health, Imaging, Photon interactions with matter, radiation detection, spectroscopy

Topics: Calibration and validation of measurements of environmental chemicals using x-ray fluorescence. Understanding x-ray interactions with matter for calibration and how compositional changes in biologic tissues will impact x-ray signals. Interdisciplinary learning with environmental health and physiological measures from biomarkers.

Title: 2-Dimension x-ray fluorescence for mapping elemental exposures from a lab benchtop

Genre: Environmental/Occupational Health, Imaging, Photon interactions with matter, spectroscopy, imaging.

Topics: Utilization of a novel benchtop 2-dimensional x-ray fluorescence approach for imaging of biomaterials (such as teeth or brain sections) for elemental exposures. Identification of ultra-low energy photon interactions to determine elemental composition down to fluorine with part per million level detection limits. Advanced statistical methods in 2-dimensional data for exposure assessment in environmental health studies.

Title: Development and simulation of novel nuclear instruments for environmental health

Genre: Proton beams (PIGE), In-field ultra low energy XRF measurements, dosimetry studies of in vivo applications

Topics: Novel approaches to quantification of environmental pollutants using known interactions between radiation and charged particles in matter. Proton interactions create opportunities for quantification of fluorine and carbon isotopes, which can be utilized heavily in environmental health studies. Ultra low energy (<2kV) radiation detectors can be utilized for spectroscopy with x-ray fluorescence down to carbon with the intention of creating in-field screening technology for long-lived chemical pollutants such as PFAS.

Keith Stantz (Purdue)

Title: Investigate effects of LET and hypoxia on radiation on immune activation

Genre: Cancer-related and image-guided therapy

Topics: Investigate the effects of radiation in activation an anti-cancer immune response and determine its dependency on dose, fractionation, LET, FLASH and tumor microenvironment. Develop biophysics models to predict immune activation and leverage these models to develop a treatment planning system to locally activate such an immune response, testing in preclinical models.

Title: AI-based Image Fusion

Genre: Cancer-related and Imaging-focused

Topics: Develop methods to advance absolute quantification of tissue physiology and molecular expression in DCE and PCT imaging.

Develop models of tissue oxygen transport to determine cellular oxygen levels based on data from multiple image modalities

Multimodality image fusion based on AI and biophysical modeling

Title: Developing image-guided high-LET RT platform for small animal studies.

Genre: Cancer-based and Image-plus-therapy focused

Topics: Develop 3D thermoacoustic imaging to measure charge particle dosimetry

Investigate new particle beam designs with varying LET

Isabelle Vanhaezebrouck (Purdue)

Title: Concept of Radionuclide stent for urethral tumor in dog

Genre: Brachytherapy

Dogs with urethral TCC have a high risk of death relating to Tumor obstruction beside the risk of metastasis. Interventional Radiologists use Infinity medical stents as local treatment, however the tumor progress over the stent over 6-12 months.

Topics: - Conceive a radionuclide stent (starting from existing normal stent infinity medical)

Selection of the radionuclide Short half- life, low energy

Purpose a dosimetry scheme LDR alone or in conjunction with Bladder IMRT

- Collaborative work with the Vet school in the future Interventional Radiology, Medical

Oncology Dr Knapp 's field, Veterinary Radiation Oncology

With success a patent could be thought of for Purdue

Title: Molecular Imaging of the primary immune response: Natural disease

Genre: Dog oral Melonoma and RT-plus-immunotherapy

Dogs present natural Cancer and a potent immune system: Having a natural model for immune response follow- up with potential translation to human medicine

Topics: Combining Radiation therapy (Hypofraction -ICD) and Native immune stimulation in vivo monitoring of the immune response

Development of Nuclear imaging-biomoleculars probes in order to be able to predict the abscopal effect

Collaboration Dr. Keith Stanz, New Faculty RT-immuno? Nuclear imagers (Spect or Pet)

Purdue Drug development (M2 to M1 programming)-TLR , Intratumoral-nanoparticles

Purdue Immunology, Inflammation and infectiology Institute (Oncolytic virus)

Purdue Pharmacology (immune check points, IDO inhibitors)

VET School: radiation Oncology service both medical and radiation