Mary Bird Perkins Cancer Center's CAMD Cancer Therapy Research Program

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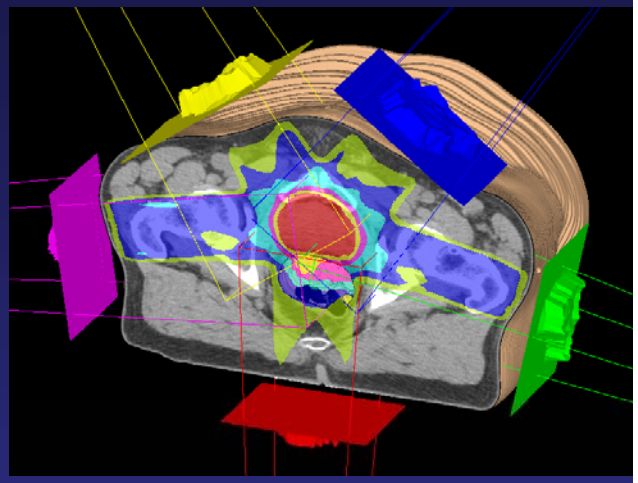
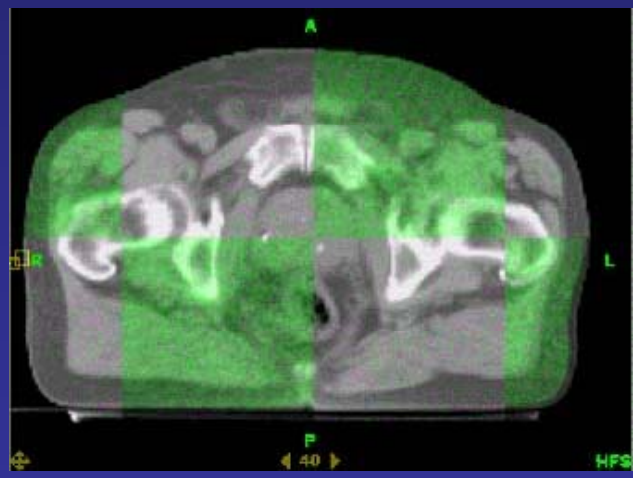
Why High-Z Enhanced Radiation Therapy?

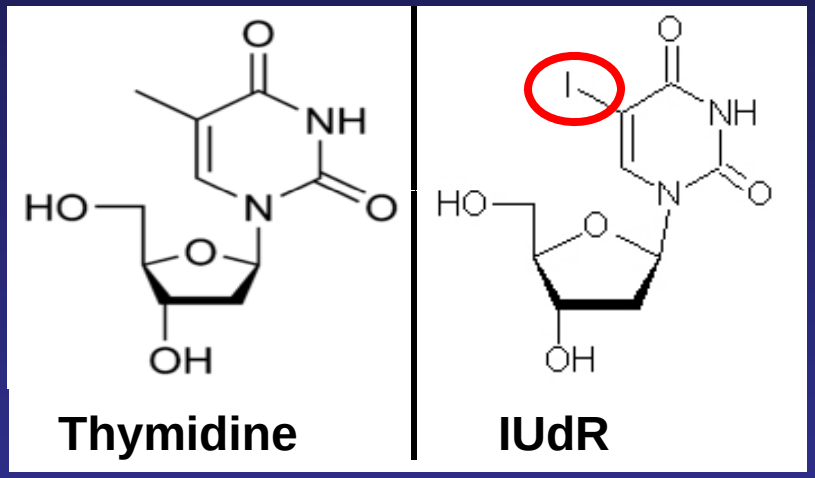




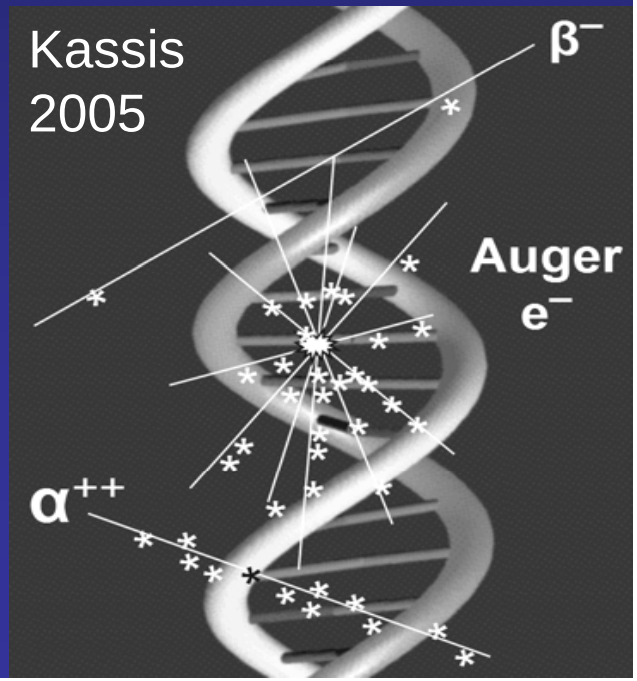
- Current radiation therapy practice targets a volume of tissue (PTV) quite accurately:
  - Intensity modulated radiation therapy (IMRT)
  - Proton therapy & heavy ion therapy
  - Image guided radiation therapy (IGRT)
  - Respiratory gated radiotherapy
  - Adaptive radiotherapy (Intrafraction and interfraction changes)
- Can we improve radiation therapy by targeting cancer at the cellular level?

Current Study
Properties of Iododeoxyuridine (IUdR)

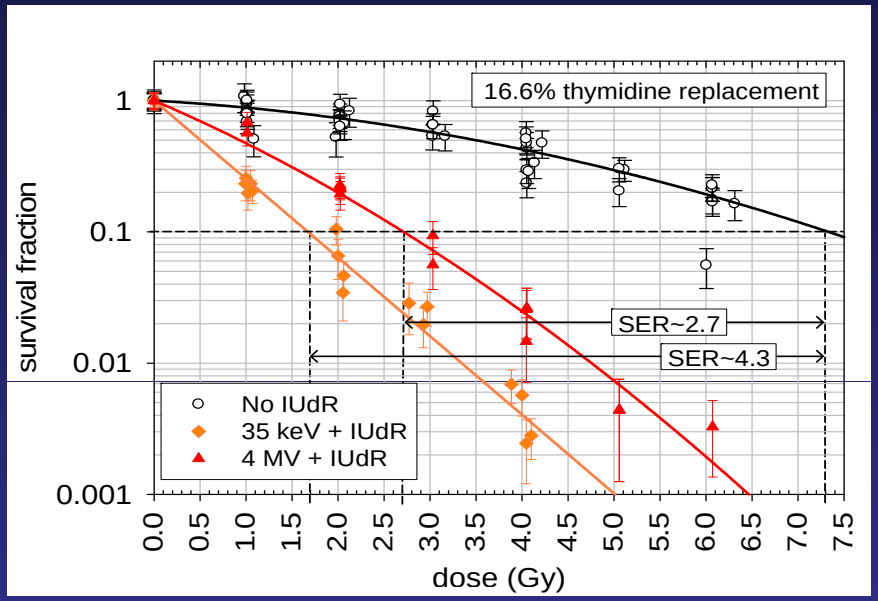
- IUdR replaces thymidine in DNA during cell division.

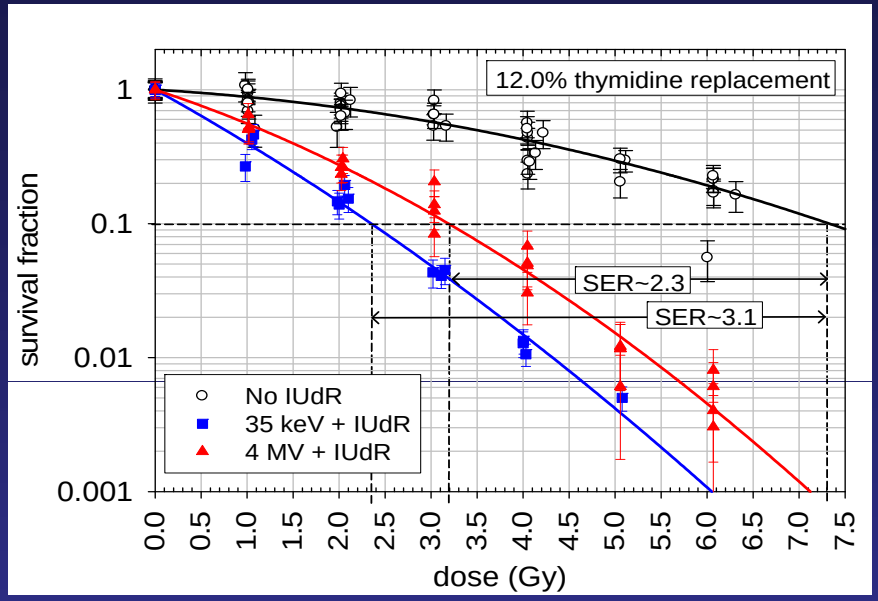


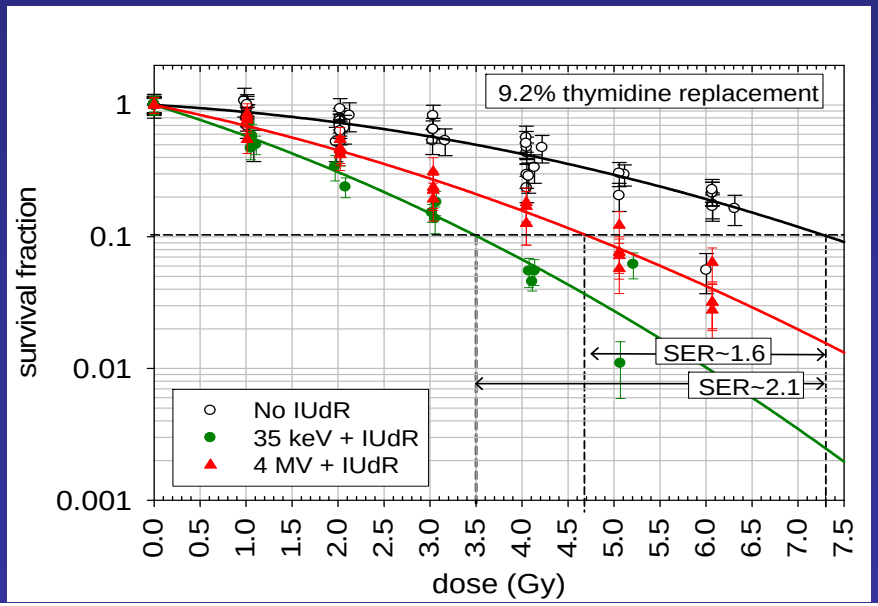
- X-ray capture by I in IUdR results in tremendous local energy deposition in the DNA, enhancing the effectiveness to radiation dose.

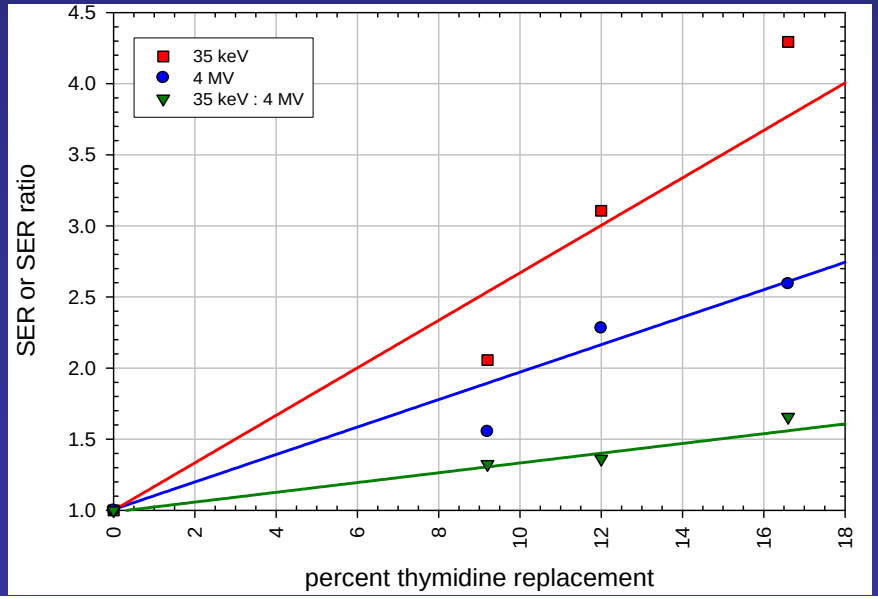


IUdR (LSU Group 2009)
CHO Cell Survival vs Dose to Water









High-Z Enhanced Radiation Therapy
Requisites

- Drug Properties
  - Contains high-Z atom(s)
  - Preferentially targets cancer cells
  - Adequate concentration achievable (non-toxic)
- Photoactivation
  - Monochromatic X-ray Source ($E_\gamma > E_{K\text{-}edge}$)
- Optimal Energy
  - Treatment site
  - Drug location with respect to cell
    - DNA (IUdR, cis-platinum)
    - Intra-nuclear (oxine)
    - Intra-cellular or cell wall (antibodies)
    - Inter-cellular (iodine contrast, Au nanoparticles)

MPBCC-LSU DOD Grant
High-Z Enhanced Radiation Therapy with Monochromatic X-rays: Project Goals

- Goal 1: Understand the Mechanism for IUdR Sensitization
  - Measure cell survival curves as a function of %IUdR (9% & 18%) and energy (25-70 keV and 6 MV).
  - Develop cell survival model(s) as a function of E and %IUdR.
- Goal 2: Predict cell survival in a patient-like phantom
  - Use a Monte Carlo (MC) model for calculating differential dose in a cylindrical phantom for rotational therapy.
  - Develop models for calculating dose equivalent using MC-calculated differential dose.
  - Determine and verify optimal energies for rotational therapy for various planning target volumes by comparing measured cell survival curves with models.

MPBCC-LSU DOD Grant
High-Z Enhanced Radiation Therapy with Monochromatic X-rays: Project Goals

- Goal 3: Construct User-Friendly Medical Radiology Beamline
  - Specify, acquire, and install biomedical beamline components, hutch, and experimental apparatus on new multi-pole wiggler beamline.
- Goal 4: Develop Treatment Planning System for High-Z Therapy
  - Develop a treatment planning model for high-Z enhanced rotational delivery.
  - Integrate the model with a commercial treatment planning system and validate.
- Goal 5: Develop Feedback for High-Z Drug Development
  - Investigate dose to DNA versus monochromatic energy and cellular location.
  - Determine minimal drug concentrations and optimal beam E required for sensitization ratio of 2 as a function of tumor site and cellular location.