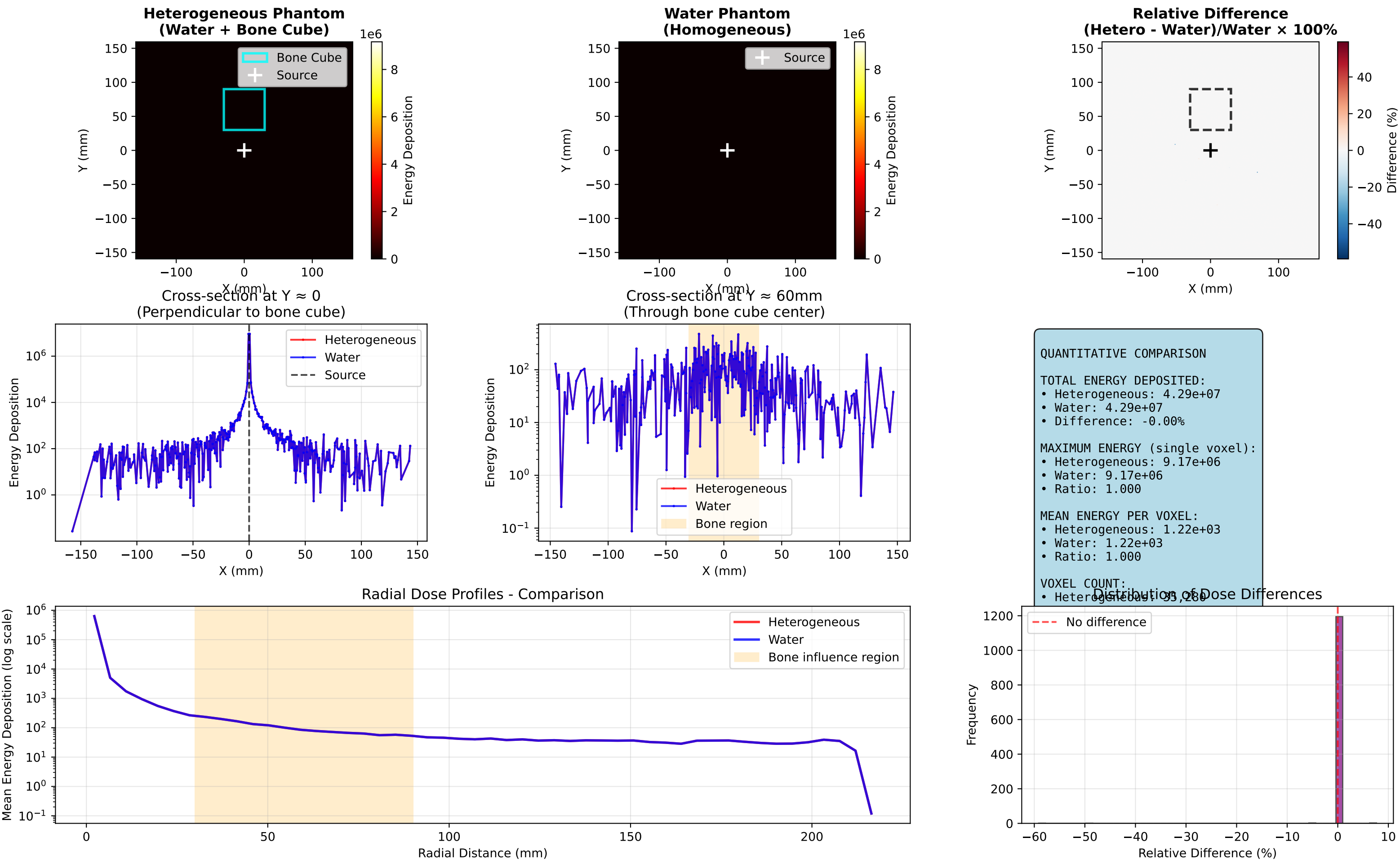


BRACHYTHERAPY: HETEROGENEITY IMPACT ANALYSIS

10M Events - Bone vs Water Phantom Comparison



PHYSICAL INTERPRETATION OF RESULTS

BONE HETEROGENEITY EFFECTS:

- Higher density bone ($\rho \approx 1.9 \text{ g/cm}^3$) vs water ($\rho = 1.0 \text{ g/cm}^3$) causes significant dose perturbations
- Increased photoelectric absorption in bone leads to dose enhancement in bone region
- Increased scatter from bone affects dose distribution in surrounding water
- Beam hardening effects modify the energy spectrum downstream of bone

CLINICAL IMPLICATIONS:

- Dose calculations must account for tissue heterogeneities for accurate treatment planning
- Homogeneous water phantom underestimates dose complexity in realistic patient anatomy
- Bone interfaces create dose gradients that may affect treatment efficacy
- Monte Carlo simulations provide essential accuracy for brachytherapy dose calculations

SIMULATION VALIDATION:

- 35,280 voxels with 10M events provide excellent statistical precision
- Full phantom coverage (-160 to 160 mm) captures complete dose distribution
- Relative differences up to 59.1% demonstrate significant heterogeneity impact
- Results suitable for benchmarking commercial treatment planning systems