“Absorbed Fractions for Multi-Region Models of the Kidneys in ICRP/ICRU Voxel Phantoms”

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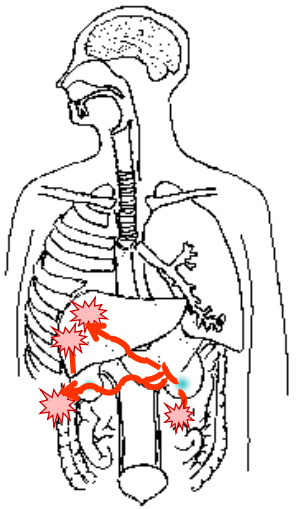


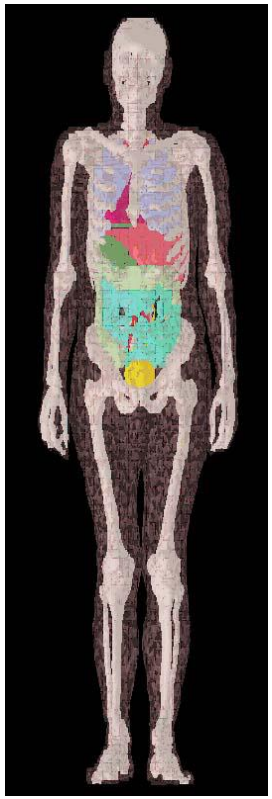
Motivation

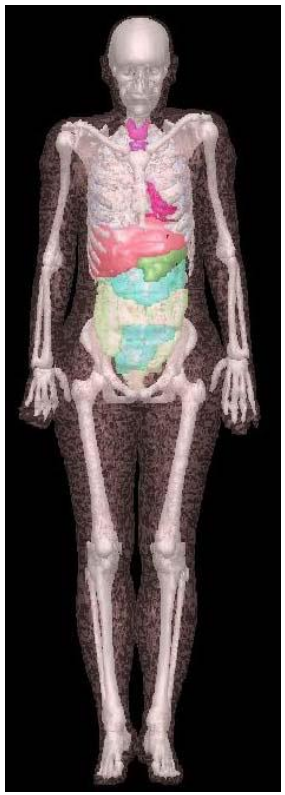
1. Our projects
   To update kidney dosimetry in internal dose evaluations
2. Technical issues
   The ICRP 2007 recommendations
   ⇒ The evolution of dose quantities using human models
3. Improvements in this study
   The ICRP/ICRU voxel phantoms + Monte Carlo simulations
   ⇒ Evaluation of absorbed fractions (AFs) for the Kidneys

ICRP/ICRU voxel phantoms

Presented in ICRP Publ.110（2009)

Adult male　Adult female



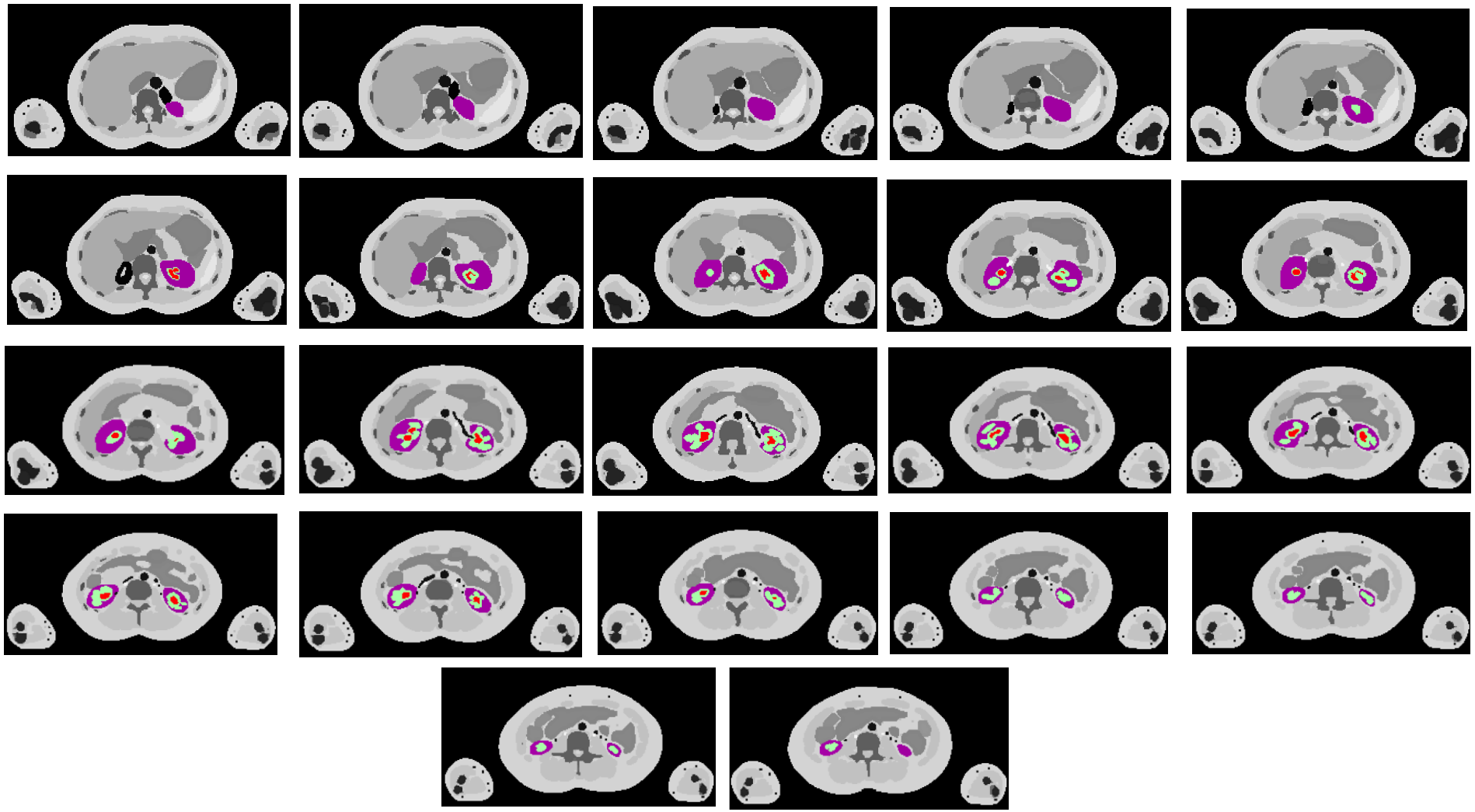


- Adult Reference Male
  height:1.76m　mass:73.0kg
  voxel size:
  $2.137 \times 2.137 \times 8.0\ mm^3$
- Adult Refernce Female
  height:1.63m　mass:60.0kg
  voxel size:
  $1.775 \times 1.775 \times 4.84\ mm^3$

Application of the kidneys of ICRP/ICRU voxel phantoms

Kidney model montage

ICRP/ICRU adult female voxel phantom



Violet: Cortex, Red: Pelvis, Yellowish green: Medulla

Absorbed fraction (AF)

AF: the fraction of energy emitted as a specified radiation type in a source region, which is absorbed in a target tissue

AFs are essential for internal effective dose evaluations

$AF = \phi_i (r_T \leftarrow r_S)$ $\quad 0 \le \phi_i (r_T \leftarrow r_S) \le 1$

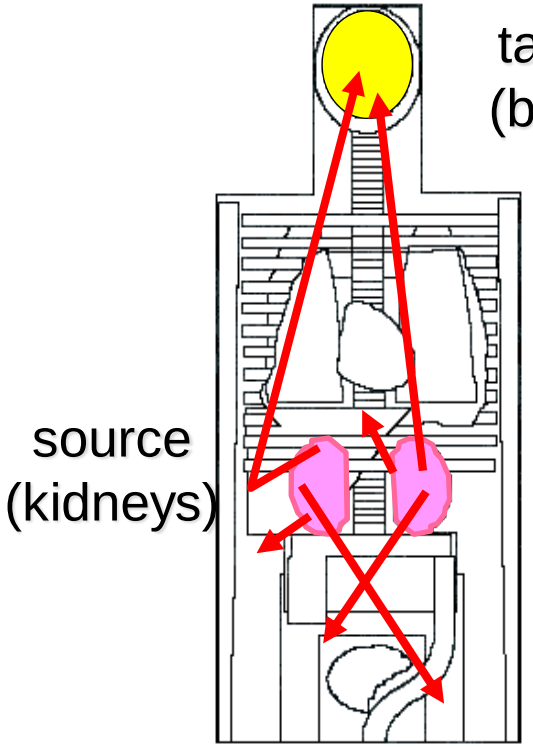
$\phi_i (r_T \leftarrow r_S)$ depend on

the type and energy of the radiation,
the size, shape, composition of tissue,
the distance between r_T and r_S,
and the composition of the intervening tissue.

Corresponding to ICRP 2007 !

AF evaluations for ICRP/ICRU voxel phantoms

Cross-irradiation AFs

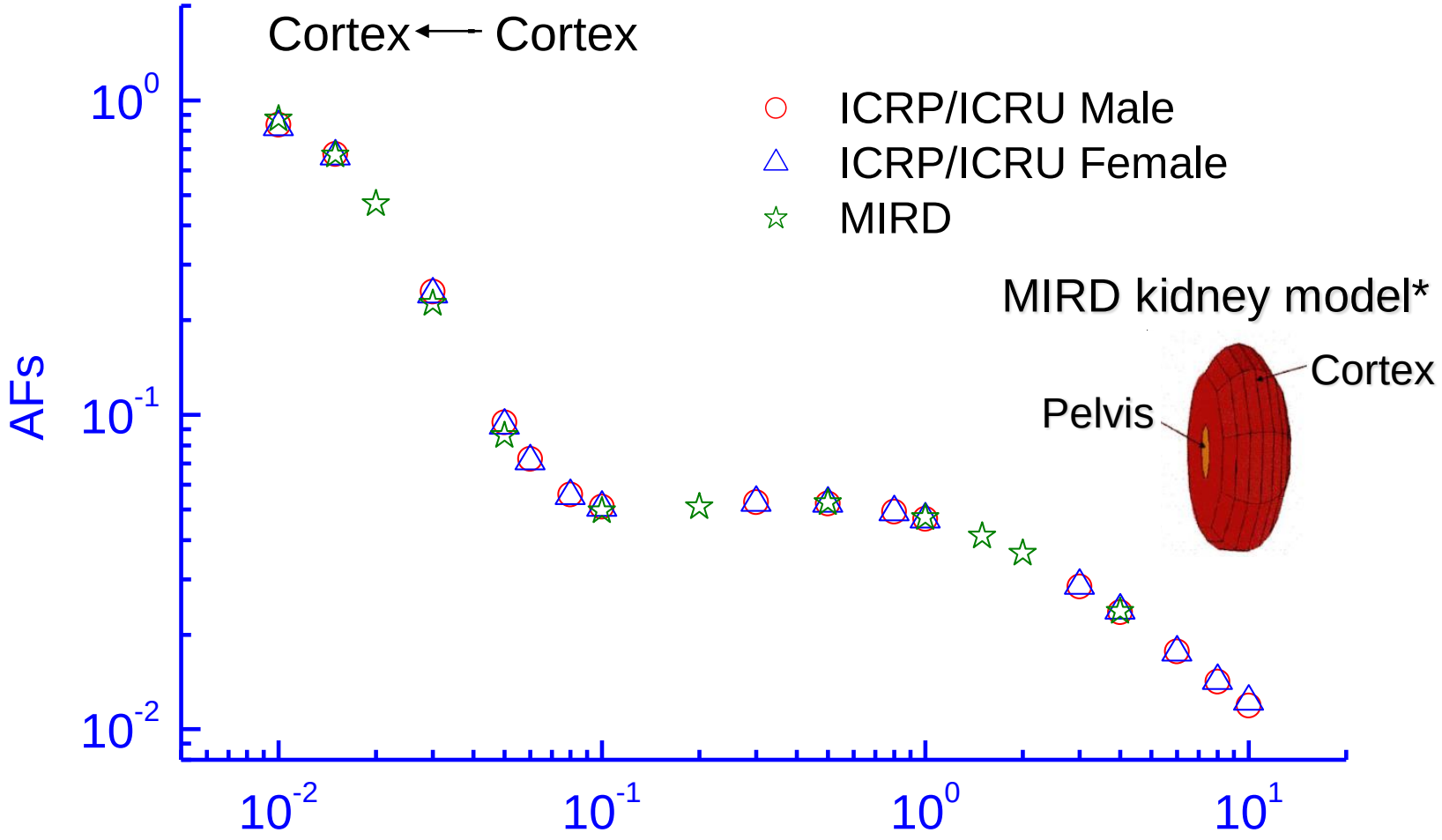


e.g. MIRD 5 type phantom

Monte Carlo simulations

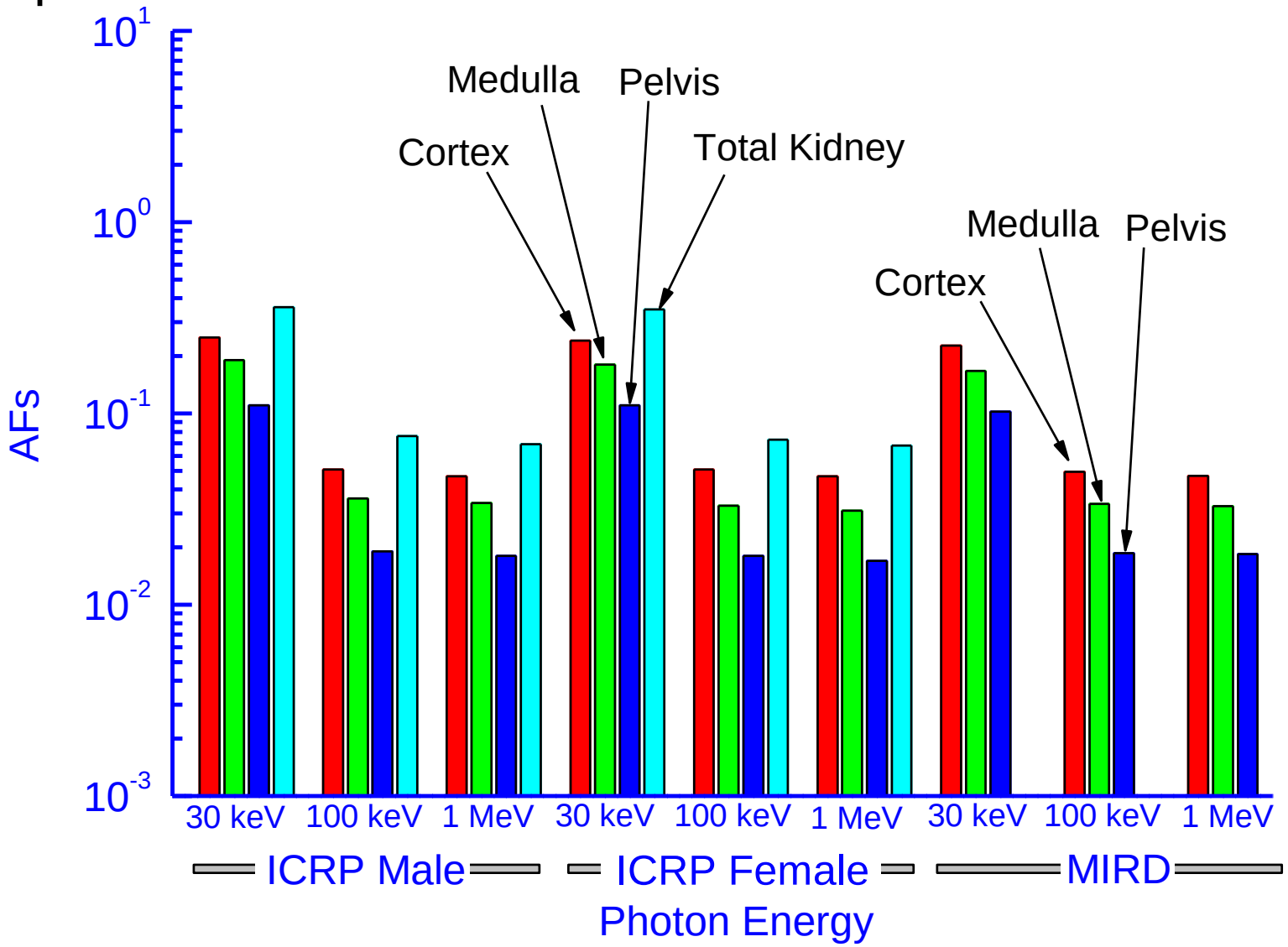
- Kidney models
  - ICRP/ICRU adult male and female voxel phantoms
- Source distribution
  - Uniformly distributed in the muti-region kidney
    -cortex, medulla and pelvis-
    (mono-energetic photons in 10keV-10MeV)
- Simulation code
  - EGS4-UCSAF
- Cross-section data
  - Electron:ICRU 37 Photon:PHOTX
- Statistical uncertainties
  - FSD within 5%

Self-irradiation AFs (1)

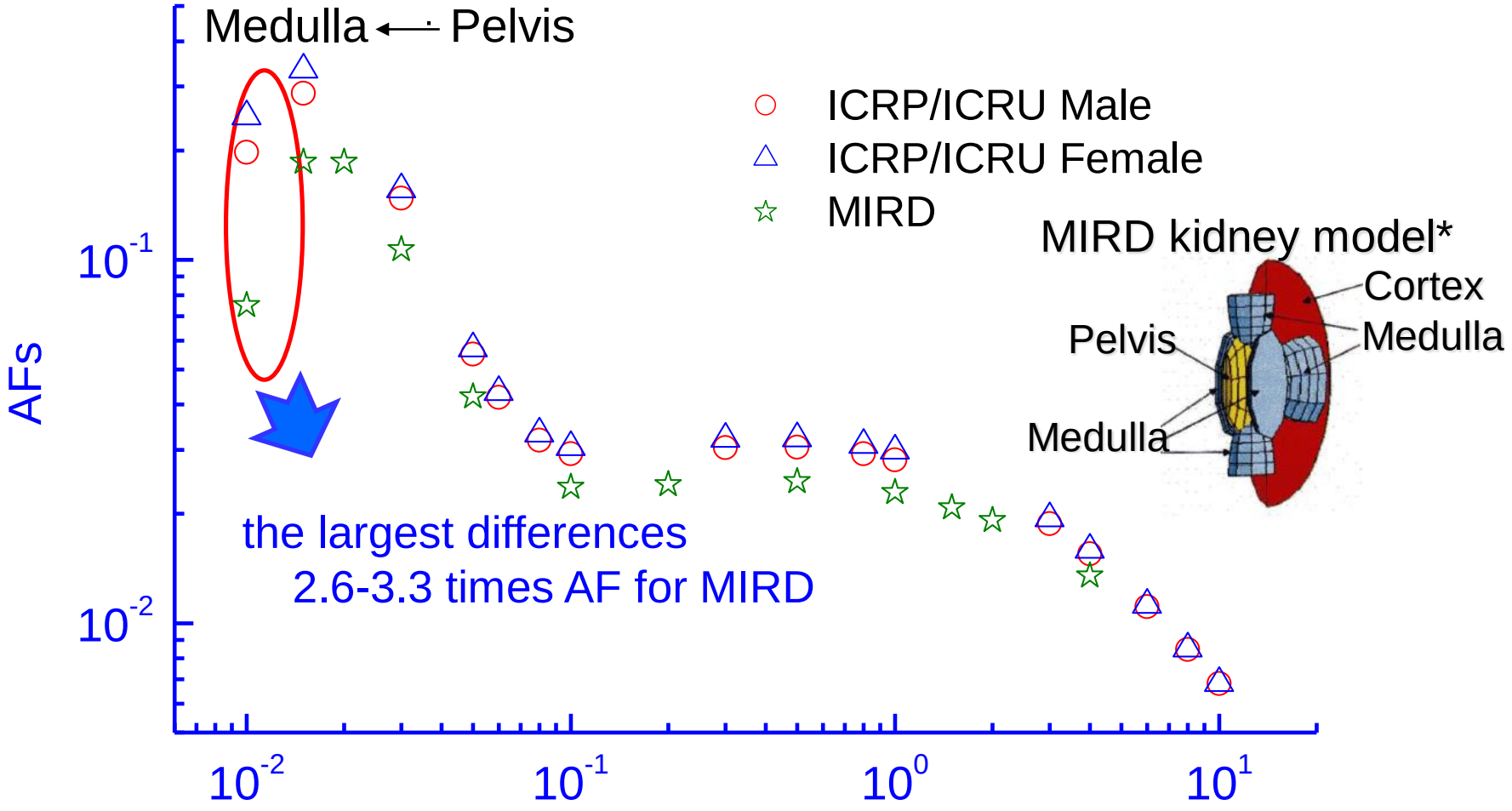


*From MIRD Pamphlet 19

Self-irradiation AFs (2)



Cross-irradiation AFs



*From MIRD Pamphlet 19

Conclusions

Photon absorbed fractions for the multi-region kidneys of the ICRP/ICRU voxel phantoms were evaluated using EGS4-UCSAF code.

- The self-irradiation AFs agree well with those evaluated with the MIRD kidney model.
- The self-irradiation AFs are smaller than those for single-region kidney models.
- The cross-irradiation AFs are different from those for the MIRD kidney model in the low-energy region.