Secondary doses in proton therapy and IMRT

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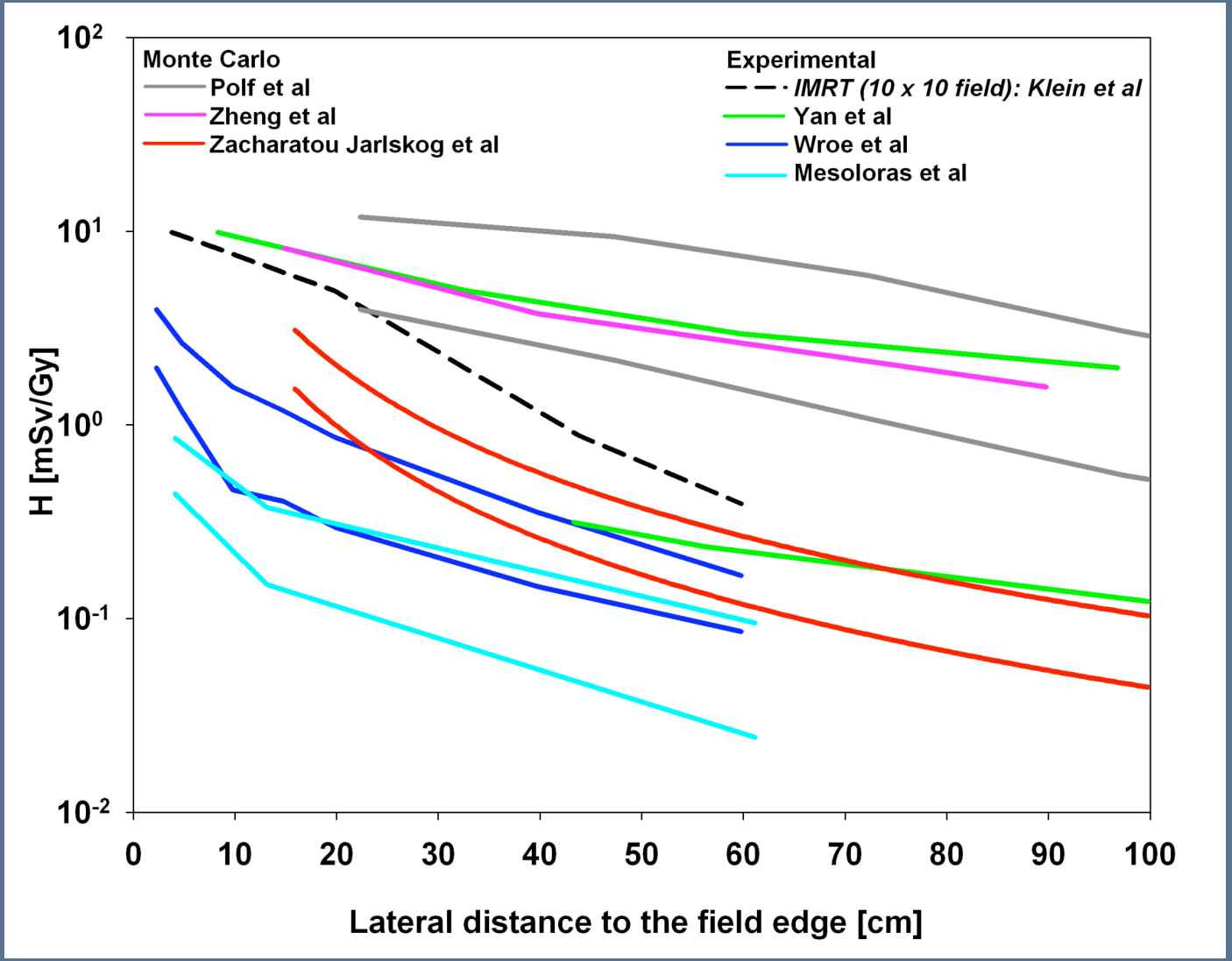
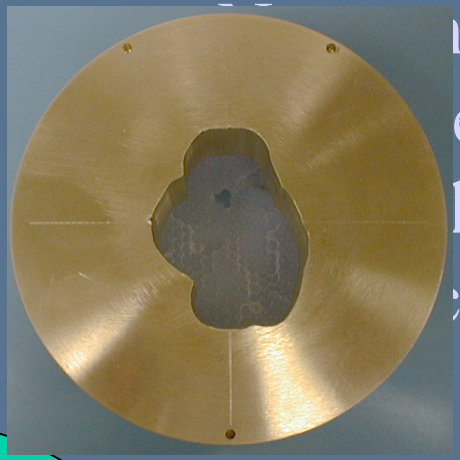


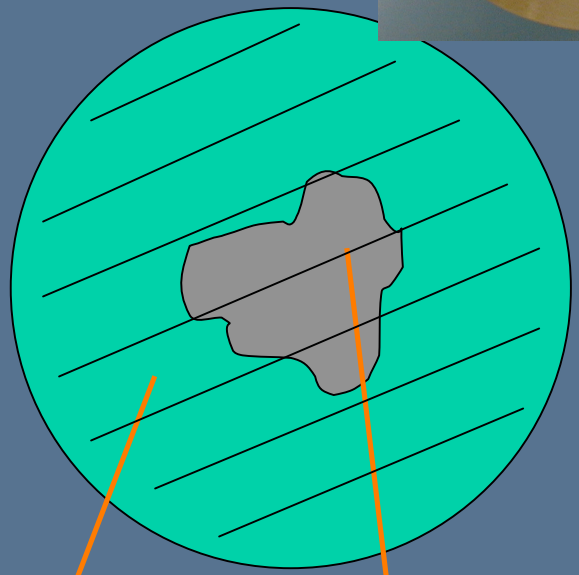
Zacharatou Jarlskog C and Paganetti H: The risk of developing second cancer due to neutron dose in proton therapy as a function of field characteristics, organ, and patient age. *International Journal of Radiation Oncology, Biology, Physics* in press

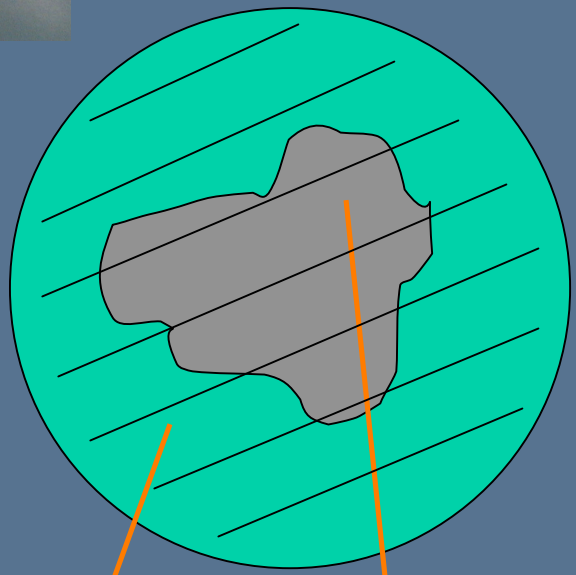
Where are the neutrons coming from in passive scattered proton therapy ?

Neutron yield depends on aperture size

dose generated
eatment head
ly) decreases
reasing treatment







Brass aperture

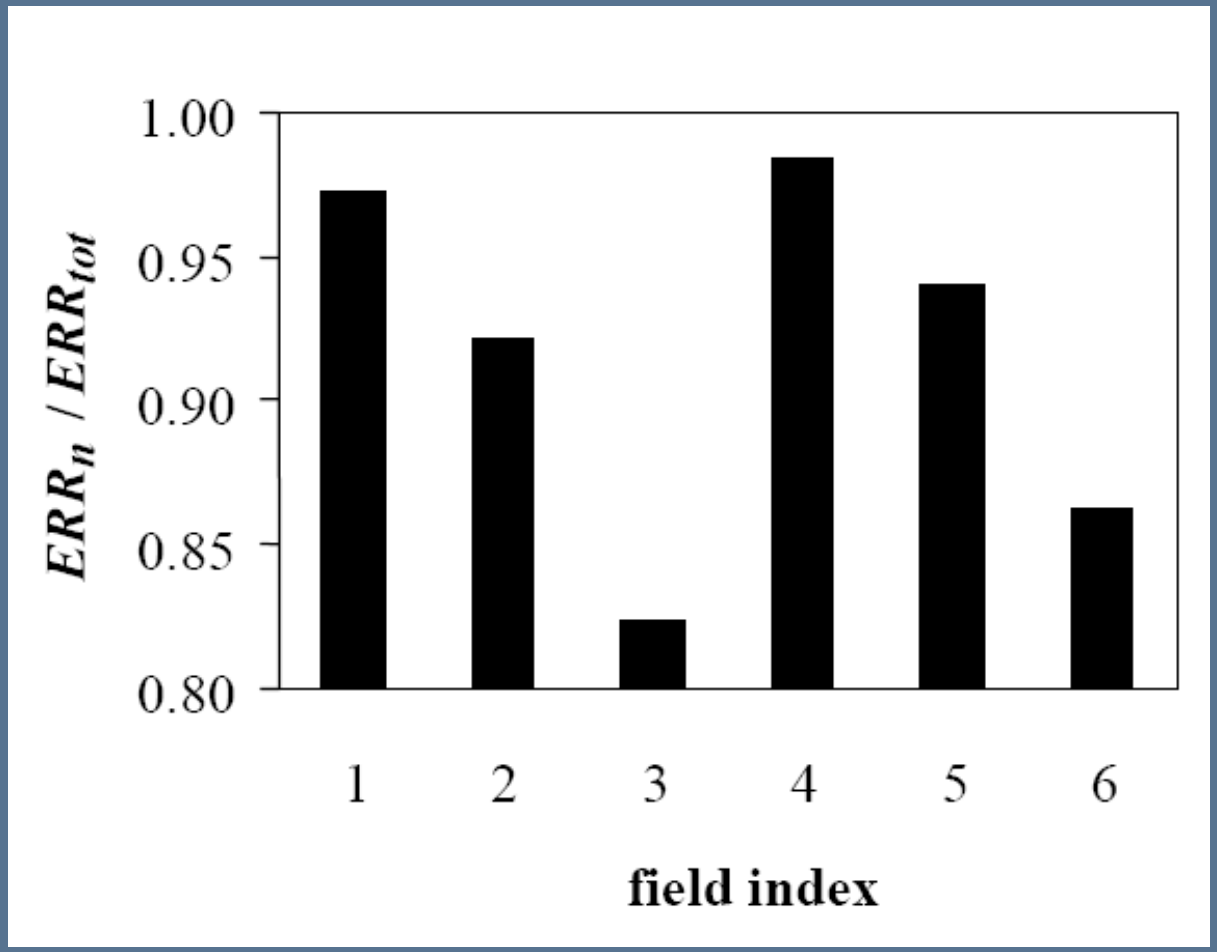
Opening (target)

~20% of the beam treats
~80% of the beam produces neutr.

Brass aperture

Opening (target)

~60% of the beam treats
~40% of the beam produces neutr.



Relative contribution of external neutrons to thyroid cancer risk as a function of field index

Zacharatou Jarlskog C and Paganetti H: The risk of developing second cancer due to neutron dose in proton therapy as a function of field characteristics, organ, and patient age. *International Journal of Radiation Oncology, Biology, Physics* in press

How do neutron equivalent doses in proton therapy compare to doses from CT imaging ?

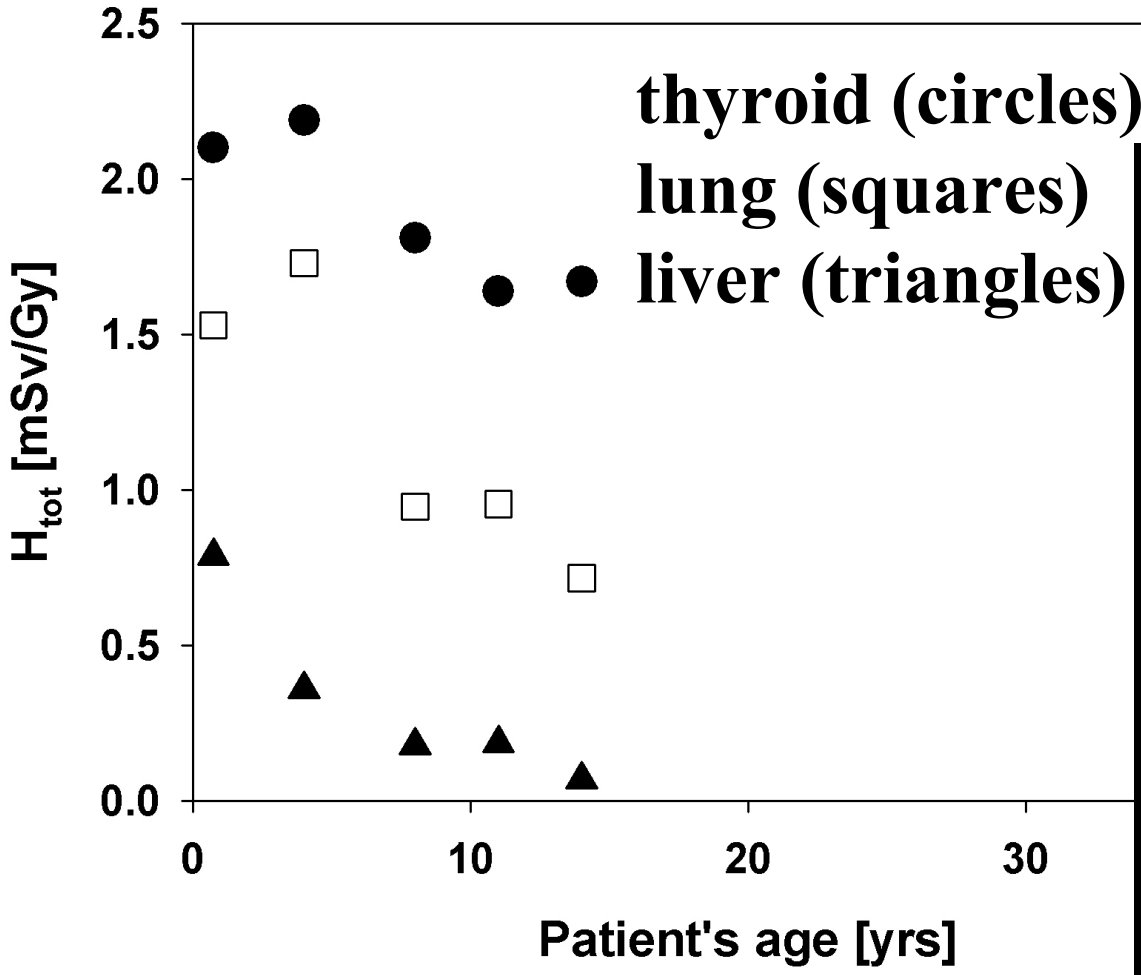
Putting it into perspective: protons vs. imaging

	4-yr old	11-yr old	14-yr old	average
H (thyroid) from therapy [mSv]	195.4	166.0	155.1	
H (thyroid) from chest CT [mSv]	9.0	5.2	6.9	
RATIO	21.6	31.8	22.4	22.7
H (stomach) from therapy [mSv]	28.5	13.5	3.8	
H (stomach) from chest CT [mSv]	4.9	5.9	5.0	
RATIO	5.8	2.3	0.7	4.0

Zacharatou Jarlskog et al. (2008). Assessment of organ-specific neutron equivalent doses in proton therapy using computational whole-body age-dependent voxel phantoms. Phys Med Biol, 53, 693-717

What is the risk for developing second malignancies ?

Organ equivalent dose after H&N tx



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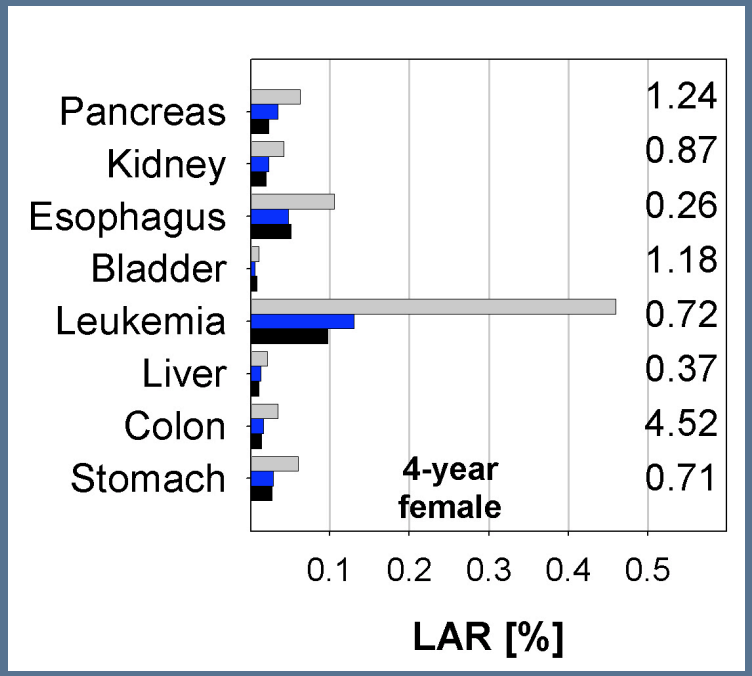

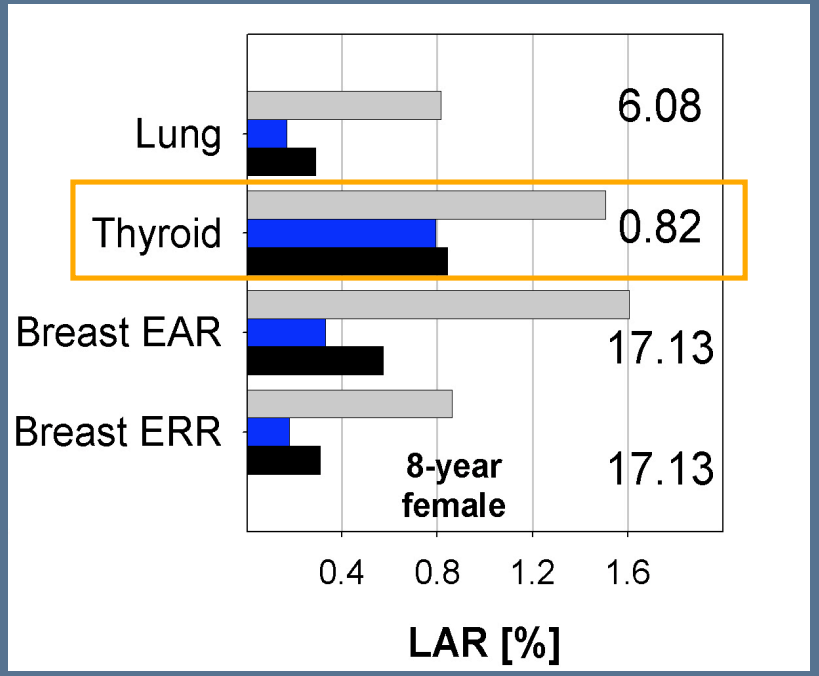

Field 1
Field 2
Field 3

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The risk associated with neutron doses in proton therapy is presumably smaller than the lifetime baseline risk for most fields

The risk associated with neutron doses in proton therapy is similar to the risk associated with scattered photon doses in IMRT or CT

The uncertainties when estimating neutron equivalent doses in proton therapy are bigger than for scattered IMRT and CT doses

The integral dose in proton therapy is roughly a factor of 2-3 lower than with any type of photon therapy

Research to be done:

What is the difference between IMRT, passive scattered proton therapy, and scanned beam proton therapy in terms of out-of-field organ specific absorbed dose and equivalent dose as a function of treatment field ?

How does this depend on patient's age?

Such studies can help to reduce our uncertainties in risk models in the long run !