Efficacy of VARSKIN for Eye Dosimetry

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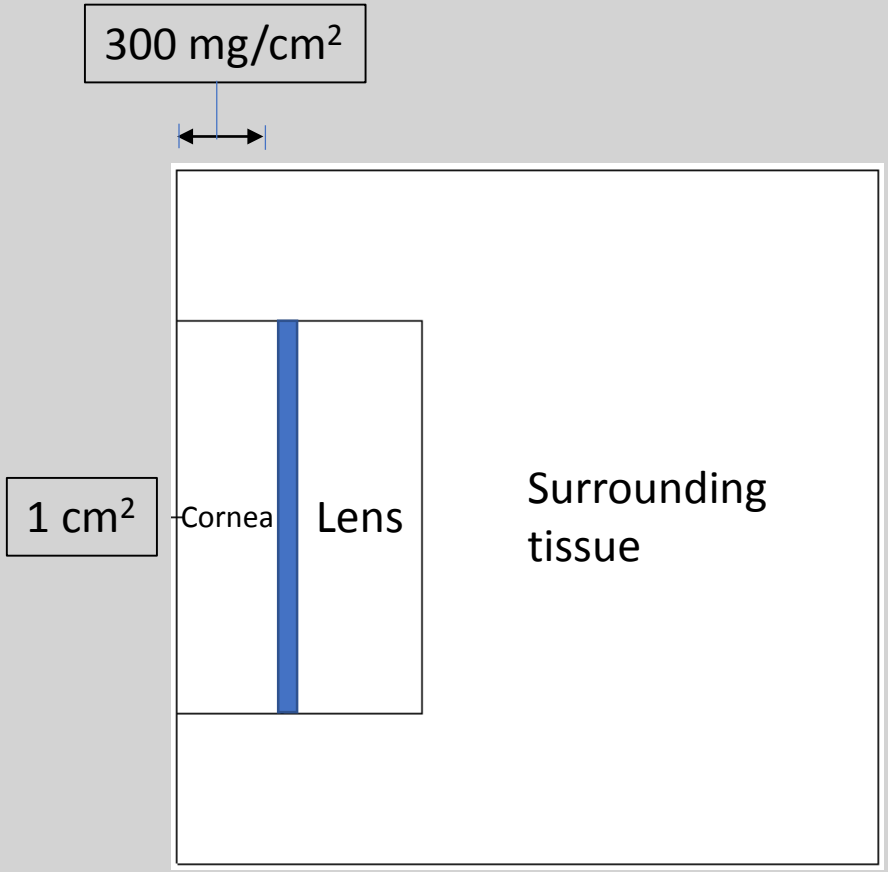
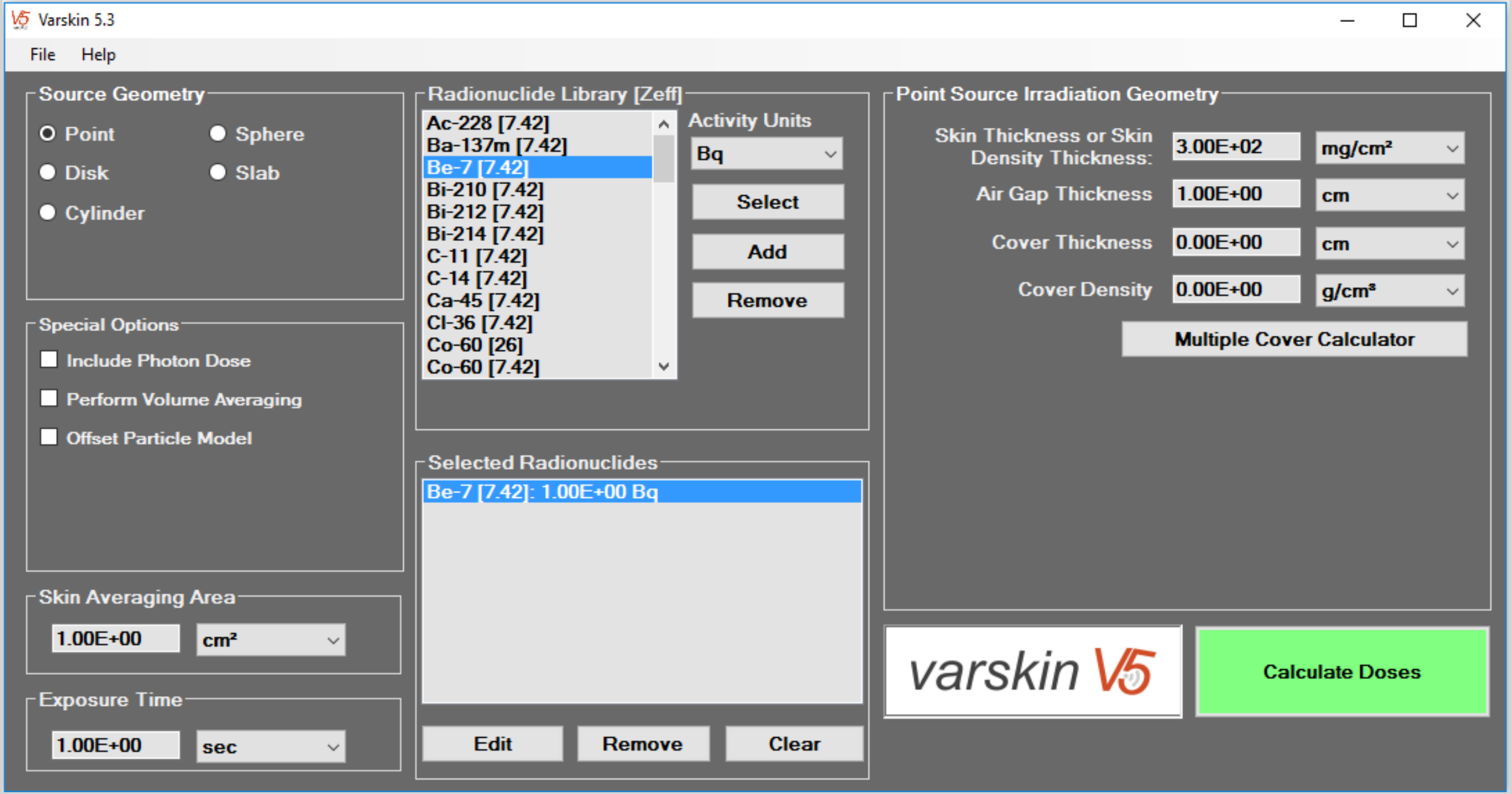
Introduction

- VARSKIN originally intended for estimating shallow dose from skin contamination
    - to show compliance with 10 CFR 20.1201
- April 2011, new dose limit guidance from ICRP
    - 20 mSv/yr, averaged over 5 yrs, < 50 mSv in any one year
- Users ask about VARSKIN for eye dosimetry
- Therefore, in its current state, how well does VARSKIN estimate eye dose?

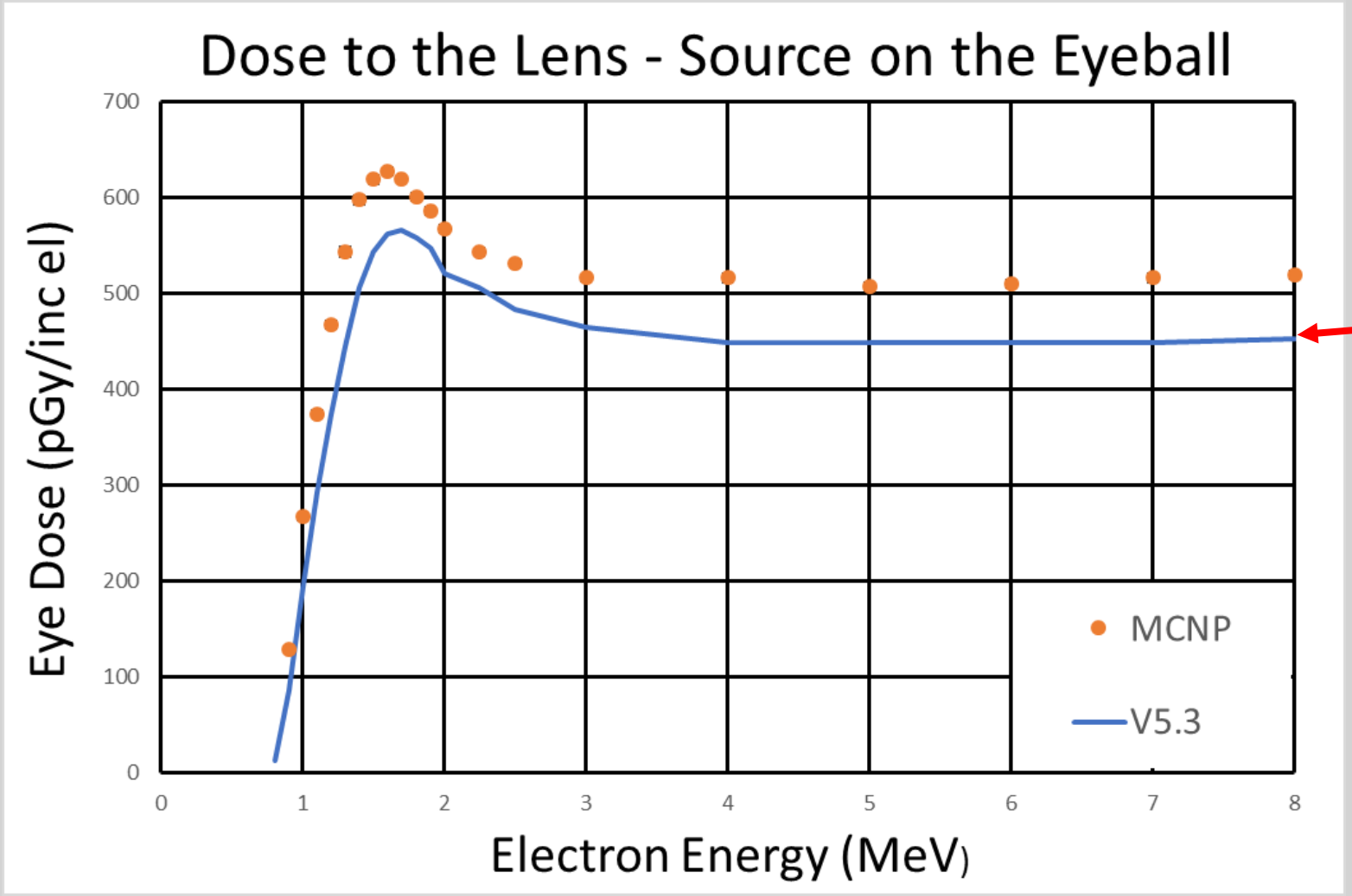
Eye Diagram



VARSKIN 5.3 (setup with 1 cm air gap)



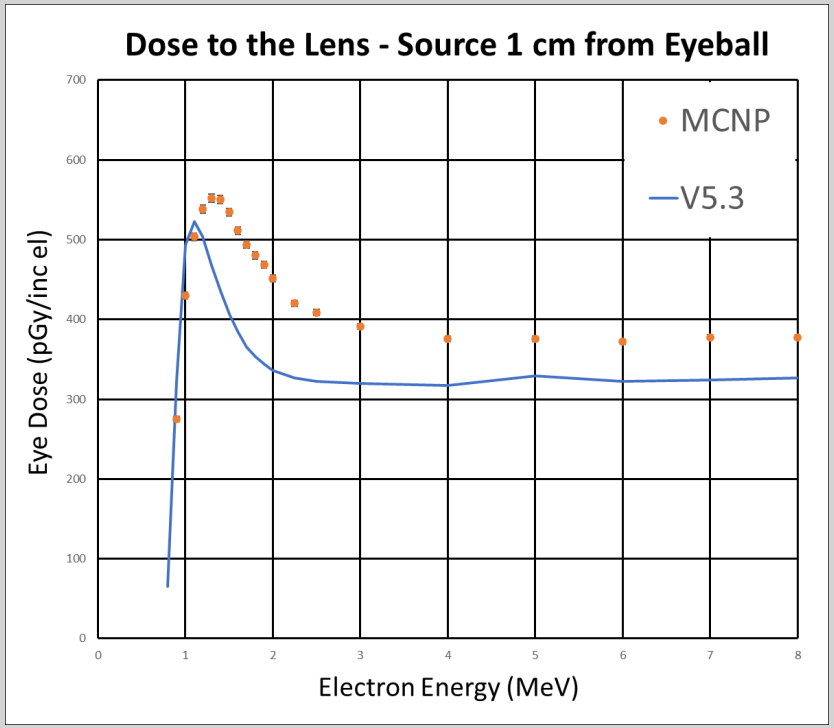
No Air Gap

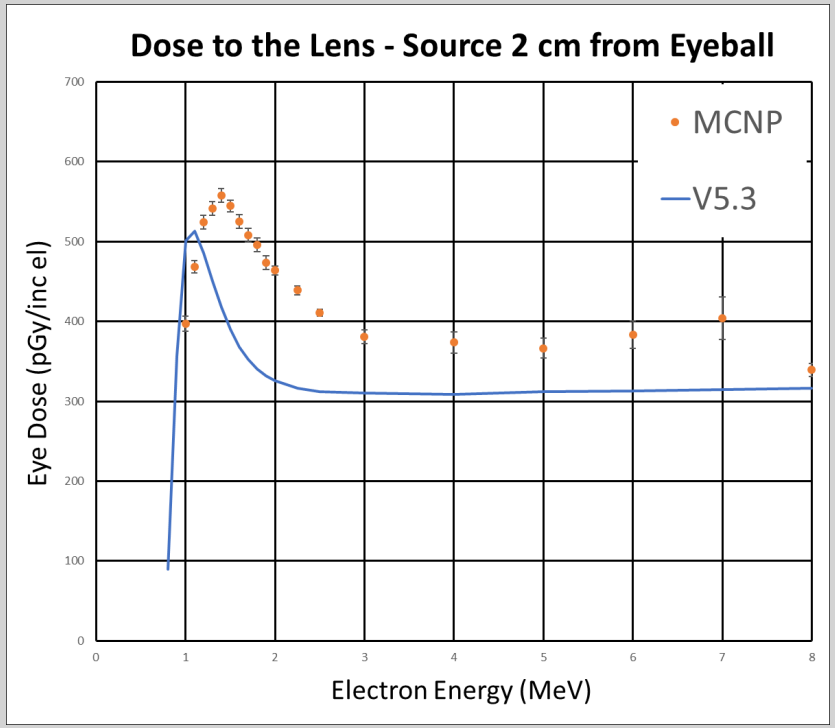


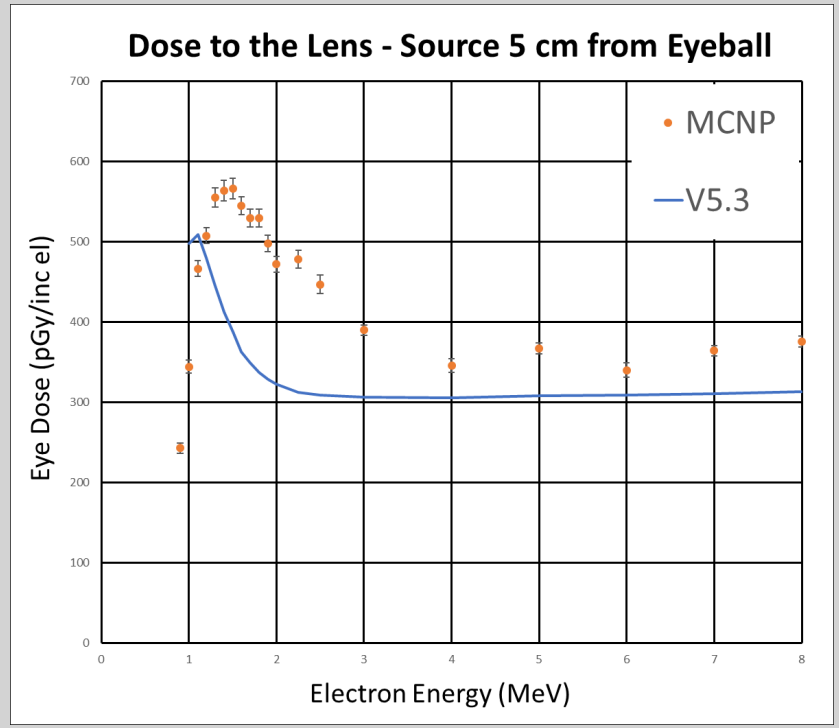
VARSKIN underestimates by roughly 10%

- Equal Scales
- Normalized for incident energy by solid angle
- MCNP standard error expected to increase with distance

5 2 1

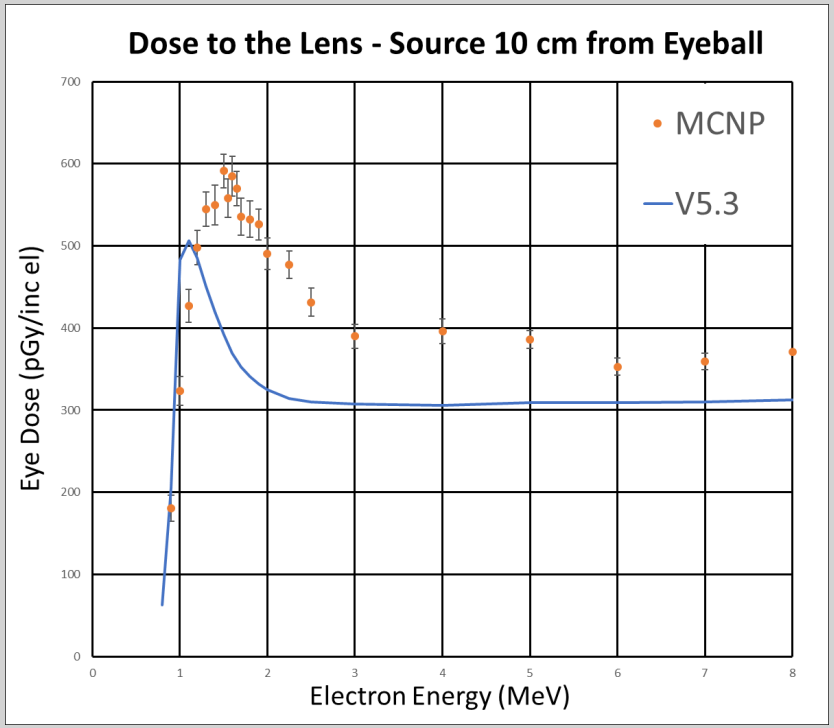


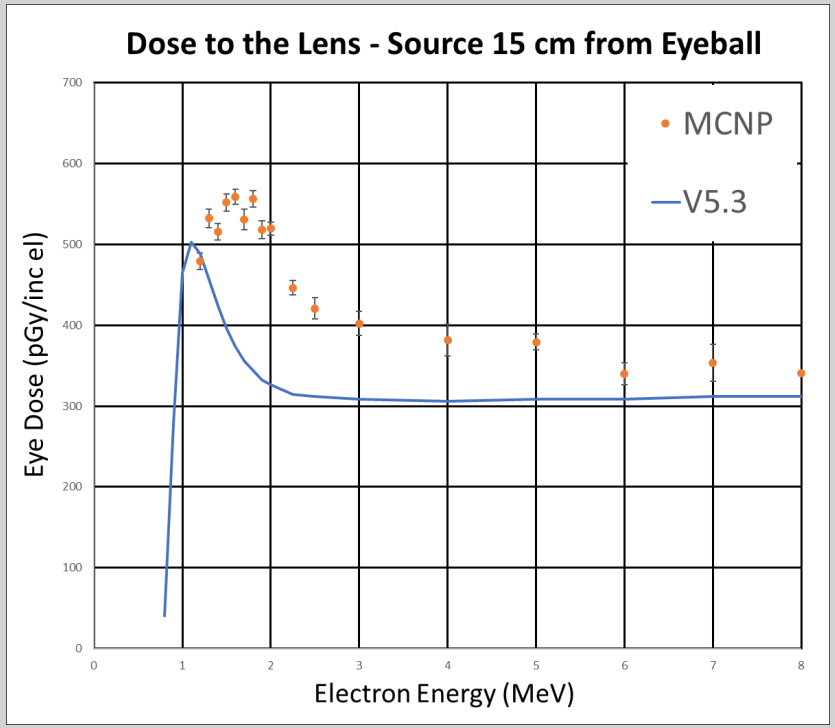


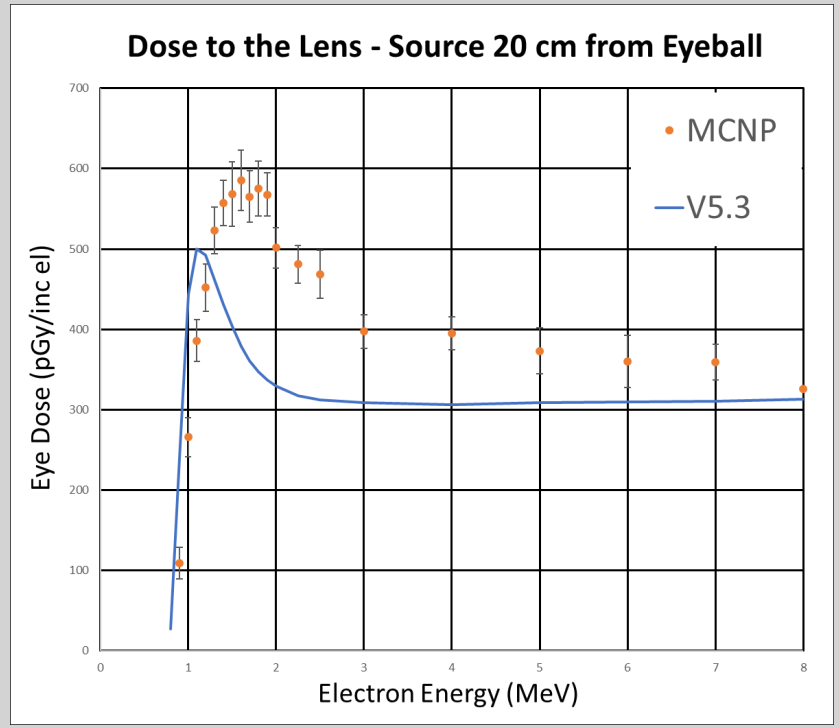


20 15 10

- MCNP accounts for scattered path, VARSKIN does not



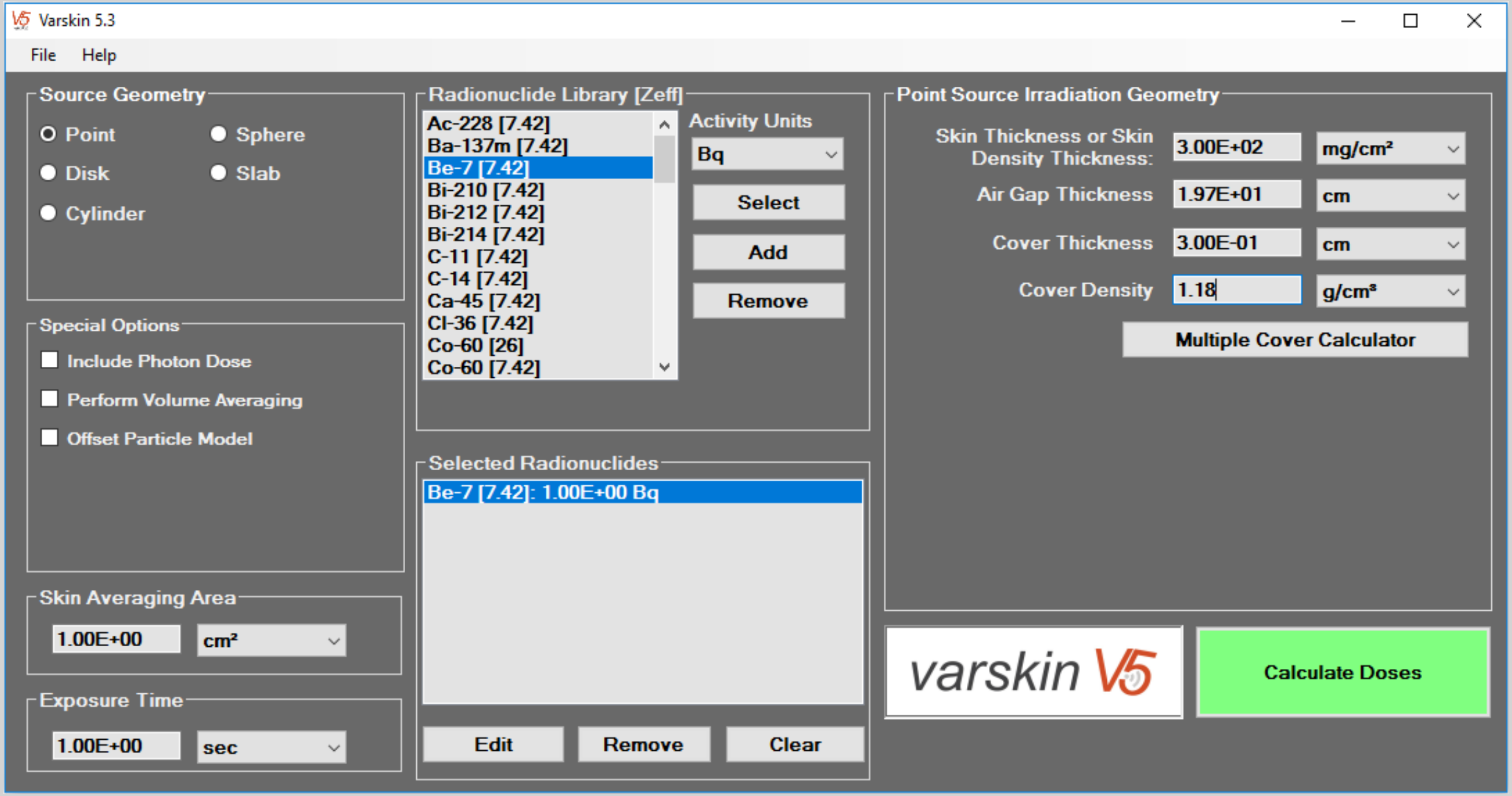




Eye Shields

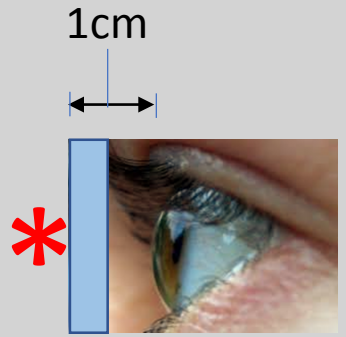
- Now consider exposure geometry with plastic between source and eye
- Contamination of the face shield leading to eye exposure
- Potentially the worker also wears glasses
- Protection is cumulative (i.e. total thickness)

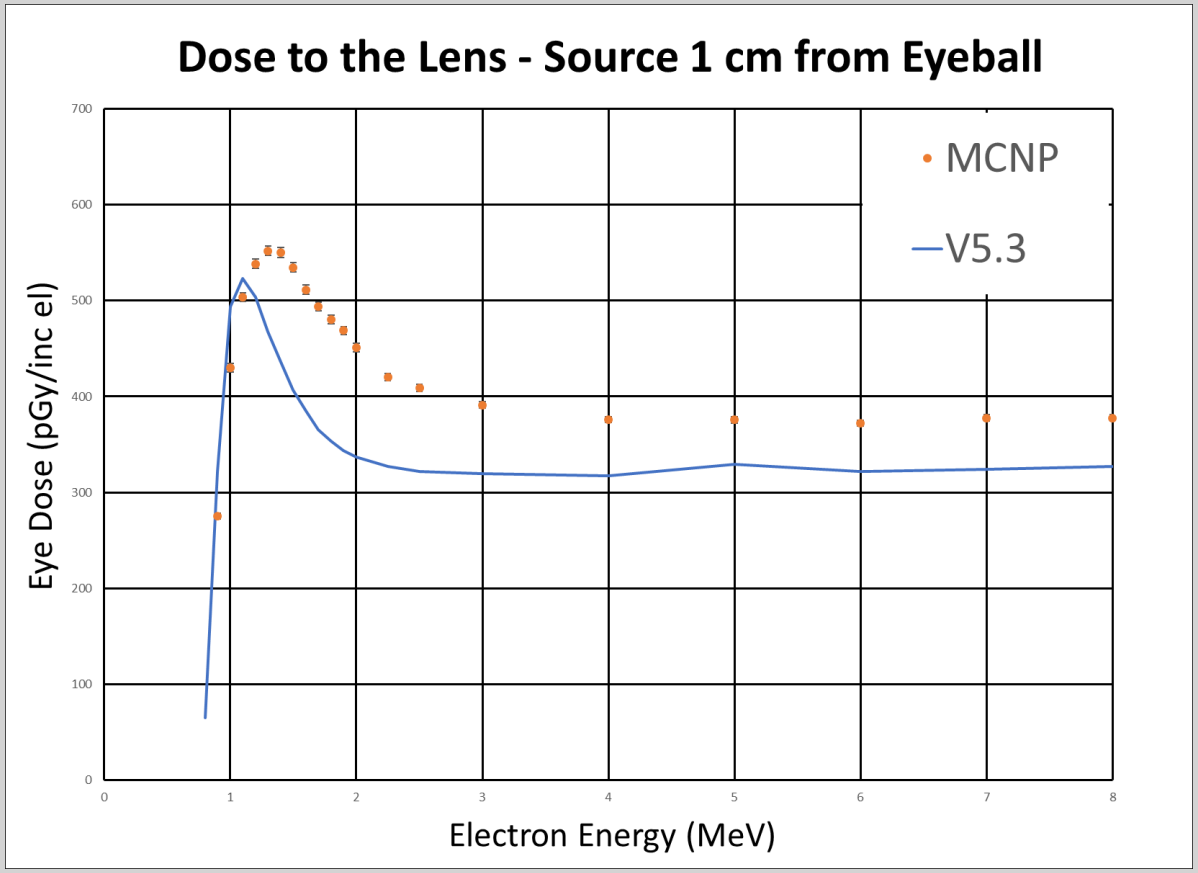
VARSKIN 5.3 (setup with air gap and acrylic - 20 cm)

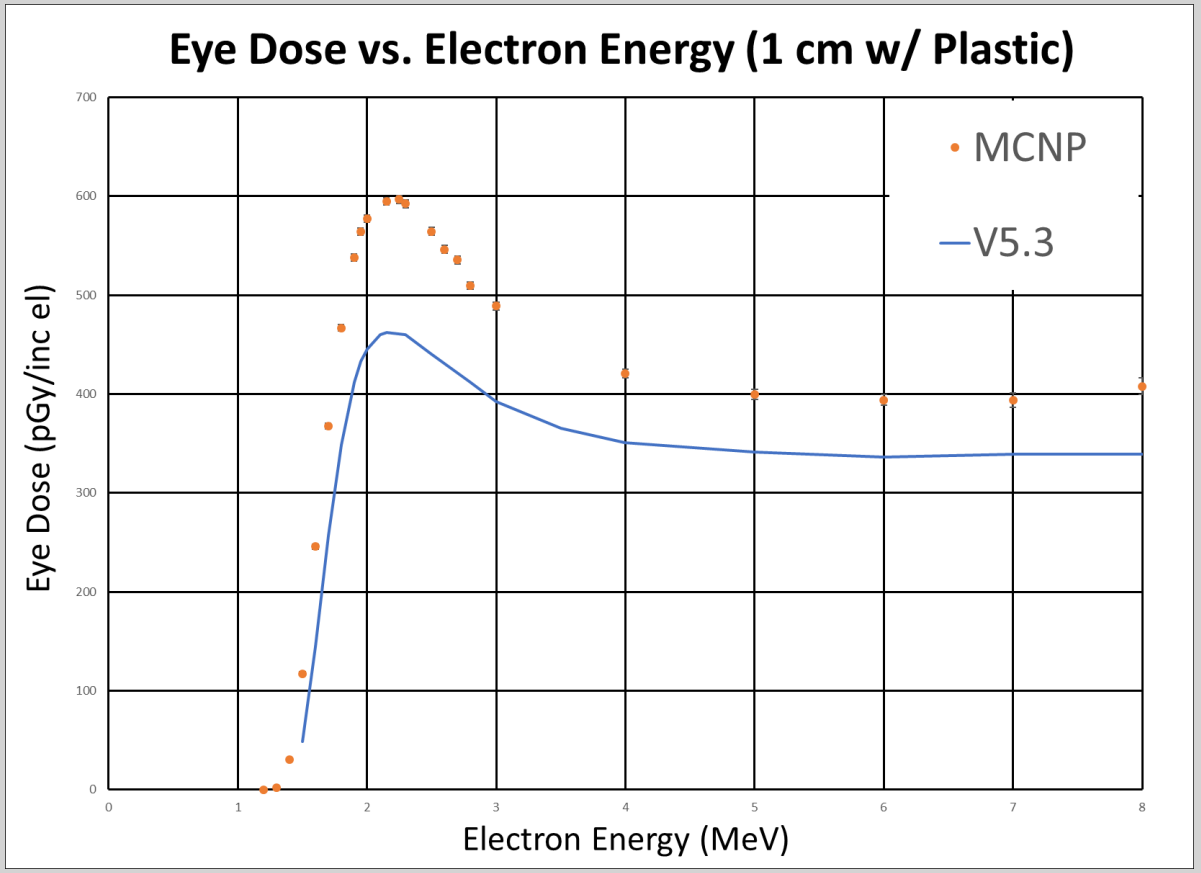


1 cm Gap with Plastic

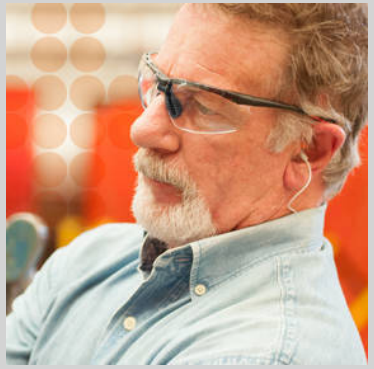
- Broader VARSKIN peak
- Delayed peak formation

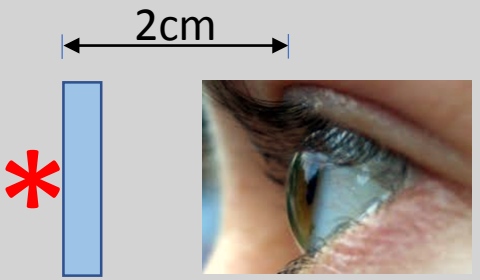


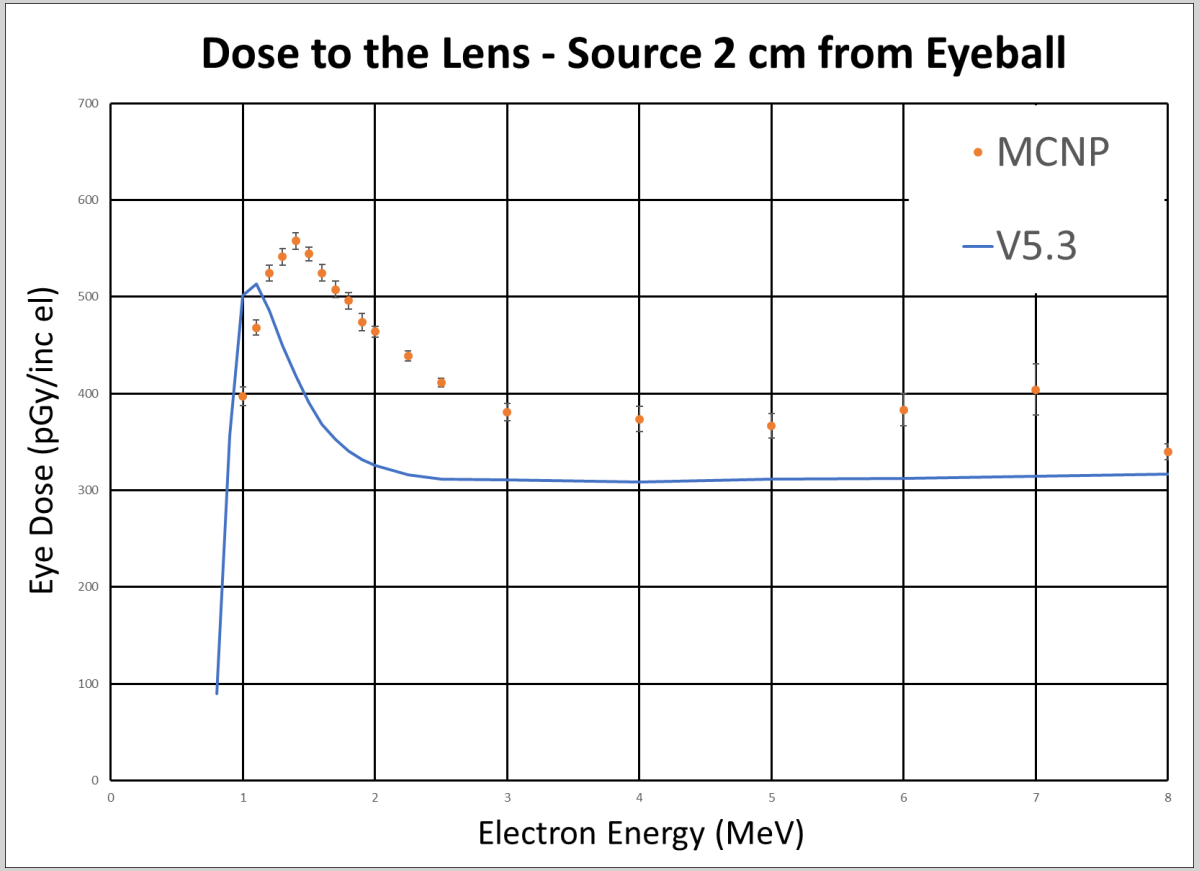


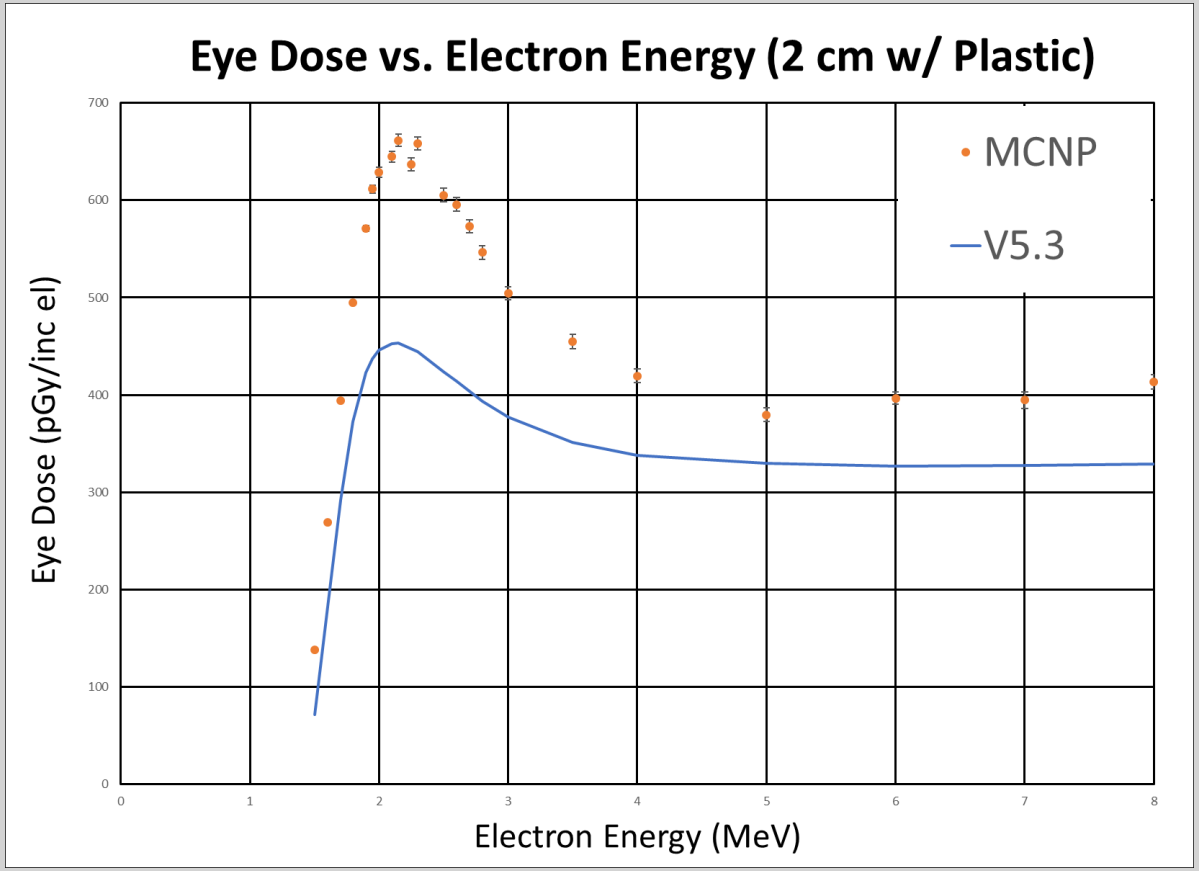


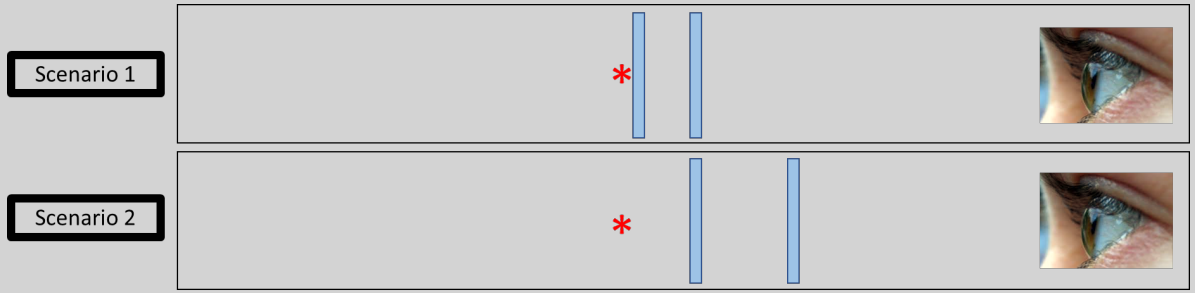
2 cm Gap with Plastic

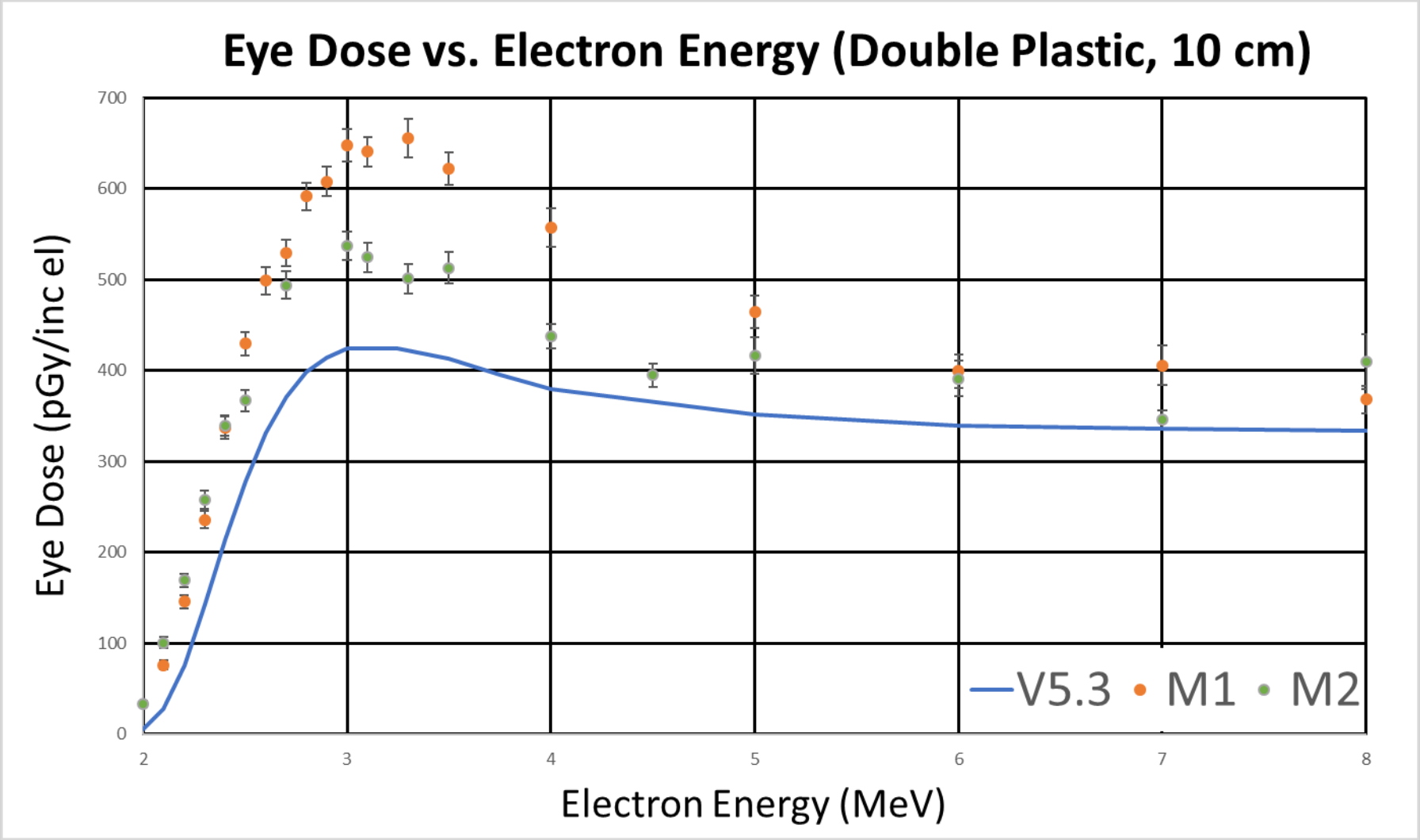








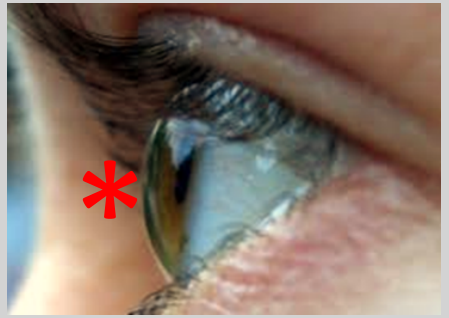

Scenario 1
Scenario 2


Eye Dose vs. Electron Energy (Double Plastic, 10 cm)
Eye Dose (pGy/inc el)
700
600
500
400
300
200
100
0
2
3
4
5
6
7
8
Electron Energy (MeV)
V5.3
M1
M2

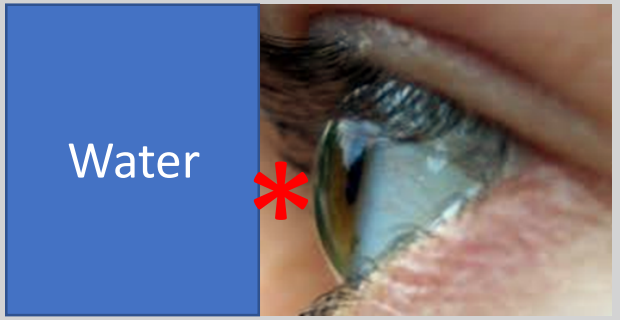
Influence of Eyelid

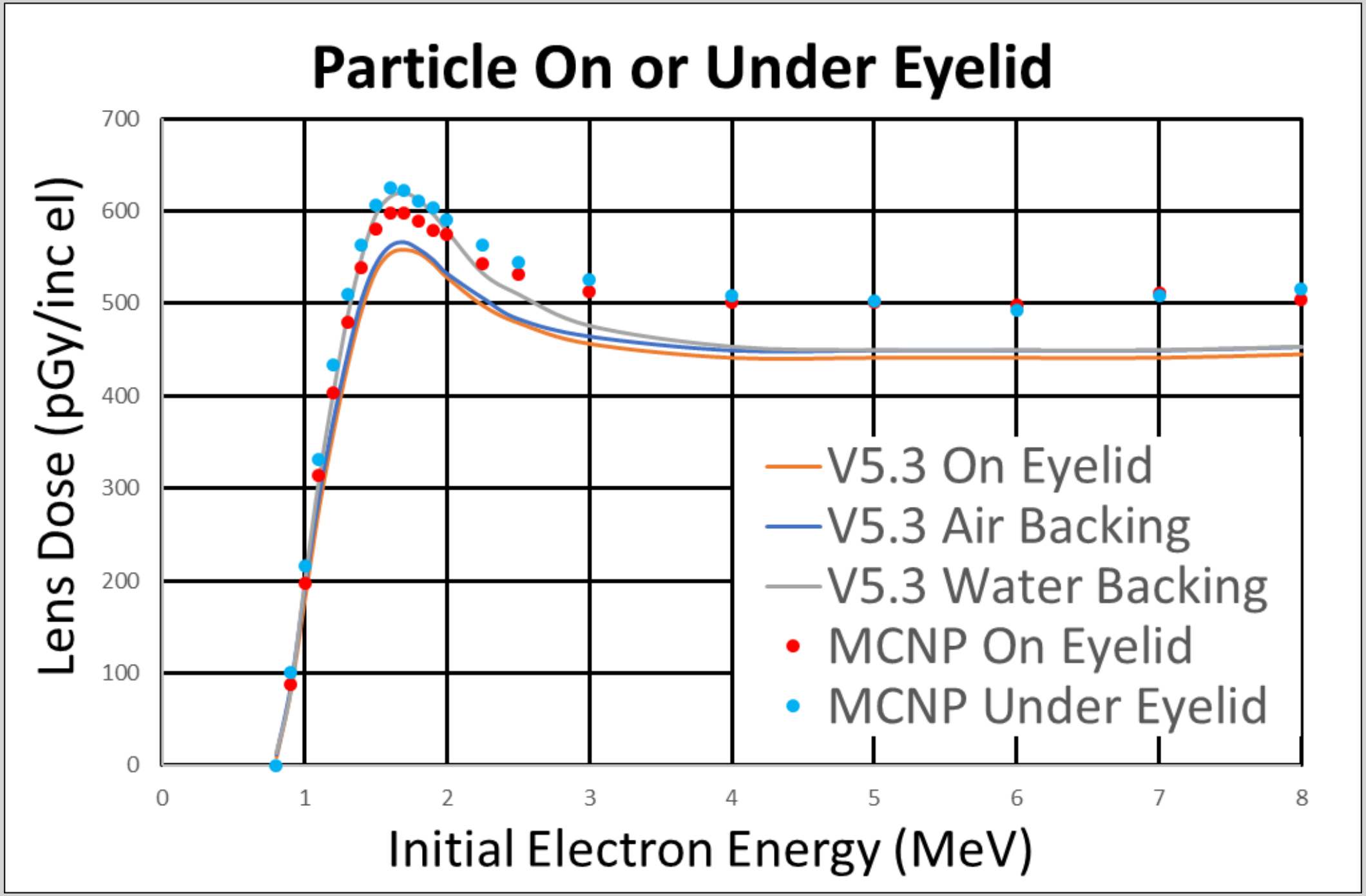
On top of eyelid

Under eyelid with
air backing



Under eyelid with
water backing




Particle On or Under Eyelid
Lens Dose (pGy/inc el)
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
Initial Electron Energy (MeV)
V5.3 On Eyelid
V5.3 Air Backing
V5.3 Water Backing
MCNP On Eyelid
MCNP Under Eyelid

Qualitative Assessment of VARSKIN for Eye Dosimetry

Particle Position	VARSKIN
Eyeball	✓
High electron energy	✓
Inside of Eyelid	~
Outside of Eyelid	~
Separation (with air/acrylic)	✗

Conclusion/Recommendations

- While accurate for shallow depth, VARSKIN in its current iteration is inadequate for most scenarios of eye dosimetry
- Corrections needed, but VARSKIN structure provides a good foundation for eye dosimetry implementation
- If given no other choice, VARSKIN is “okay”
  - Underestimates by 10-20%
  - Otherwise use Monte Carlo


OREGON STATE
OREGON STATE BEAVERS
pepsi
DAIMLER
-20
-30
-40
50