"Photon and electron beam penumbra determination using different measuring systems"

Pantelis Kalavrezos[1,2], Ioannis Seimenis[2], George Patatoukas[1], Maria Dilvoi[1], Elena Vlastou[1], Vasileios Kouloulias[1], Efstathios Efstathopoulos[1], Kalliopi Platoni[1]

[1] 2nd Department of Radiology, University General Hospital 'Attikon', School of Medicine, National and Kapodistrian University of Athens. Athens, Greece

[2] Medical School, Demokritus University of Thrace, Alexandroupolis, Greece

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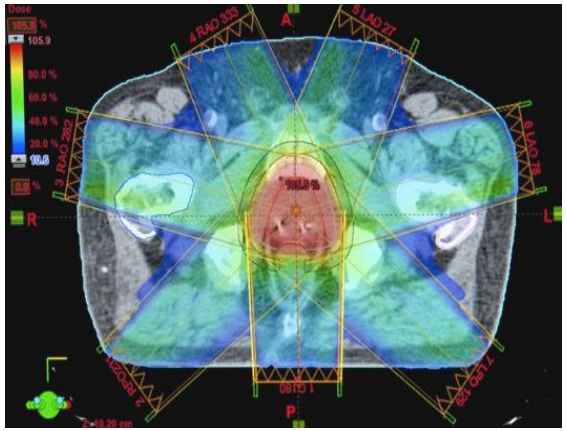
Purpose/Introduction

Penumbra: a fundamental characteristic of all photon and electron beams.

Its determination affects: field sizes -> healthy tissues irradiated.



Important variation of penumbra width results depending upon the detector used.

We compare results obtained using six different detectors.

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Methods

Detectors compared:

1. "Semiflex" Ionization Chamber (PTW 31002, 0.125cm^3)
2. "Roos" Ionization Chamber (PTW 34001, 0.35cm^3)
3. "Markus" Ionization Chamber (PTW 23343, 0.055 cm^3)
4. PTW LA48: Array of 47 iso-octane chambers (4×4 mm^2)
5. 60017 E type Dosimetry Diode (unshielded, 0.03 mm^3)
6. 60008 P type Dosimetry Diode (shielded, 1 mm^{2}x2.5 μm)





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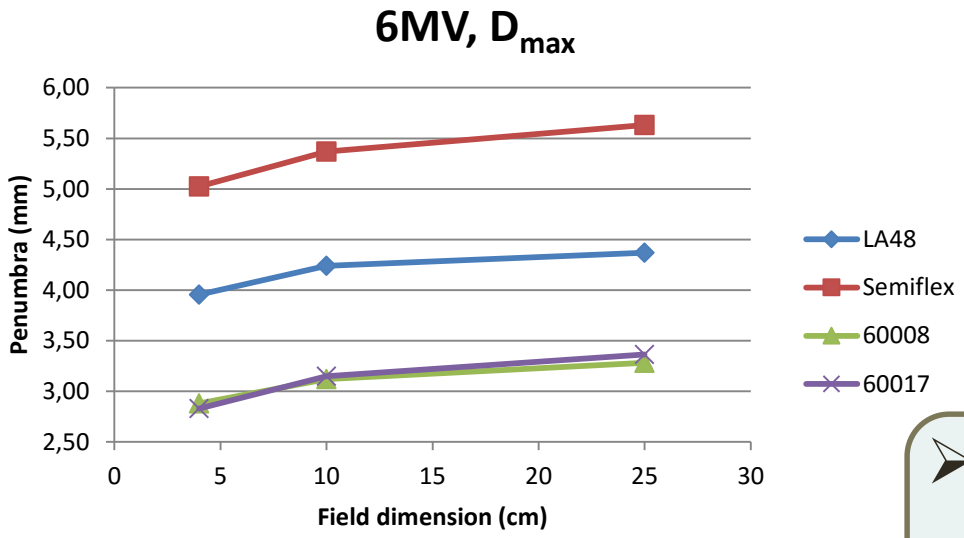
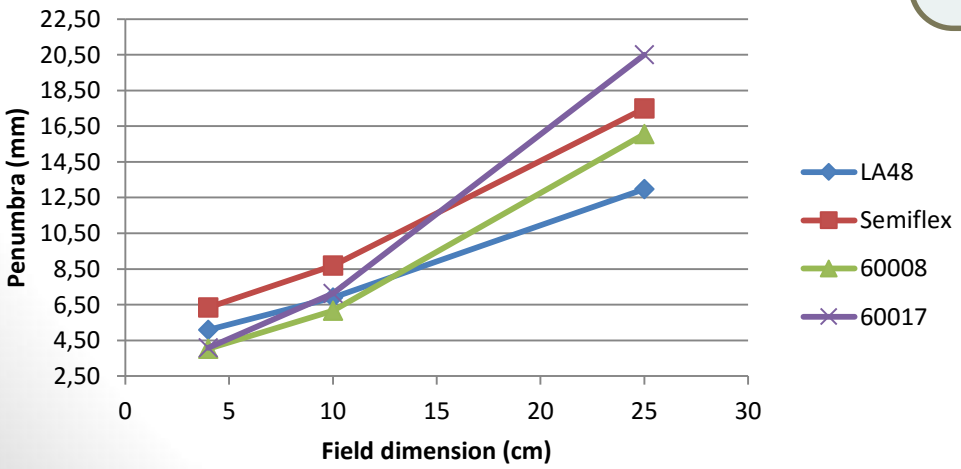
Results (6MV photons)





Penumbra, 6MV, 10x10 cm², D_{max}

Semiflex: 26,7% wider than LA48
72,1% wider than 60008
70,5% wider than 60017

- **The detector with the biggest volume displays the widest penumbras**

Penumbra, 6MV 10x10 cm², 200mm

Semiflex: 25,7% wider than LA48
42.1% wider than 60008
21.7% wider than 60017

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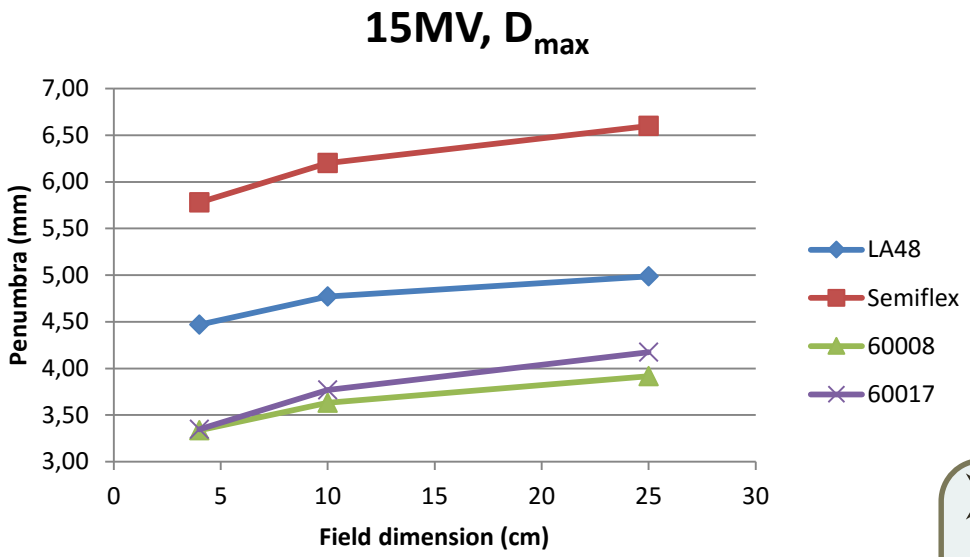
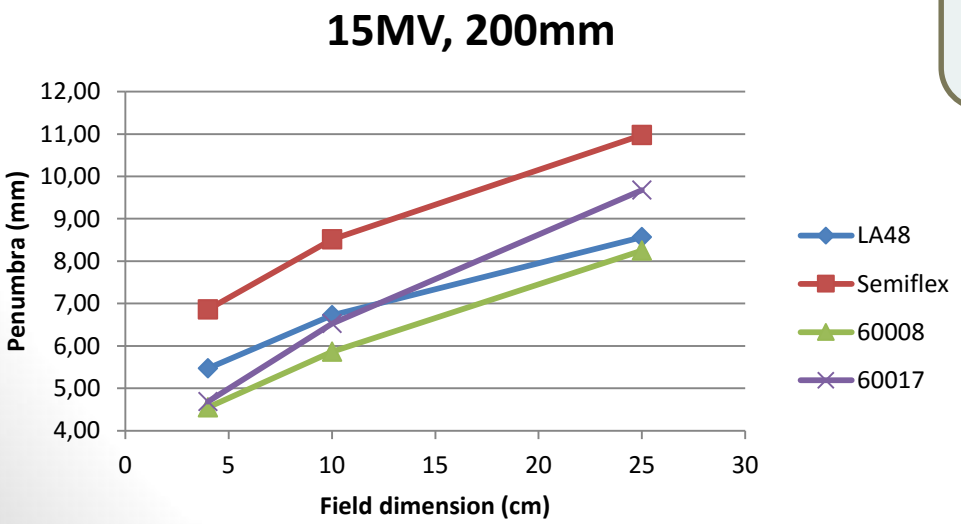
Results (15MV photons)



Penumbra, 15MV, 10x10 cm², D_{max}

Semiflex: 30.0% wider than LA48
70.8% wider than 60008
64.5% wider than 60017

- **Overresponse of the diodes for large fields and big depths**



Penumbra, 15MV, 10x10 cm², 200mm

Semiflex: 26.6% wider than LA48
45.1% wider than 60008
35.5% wider than 60017

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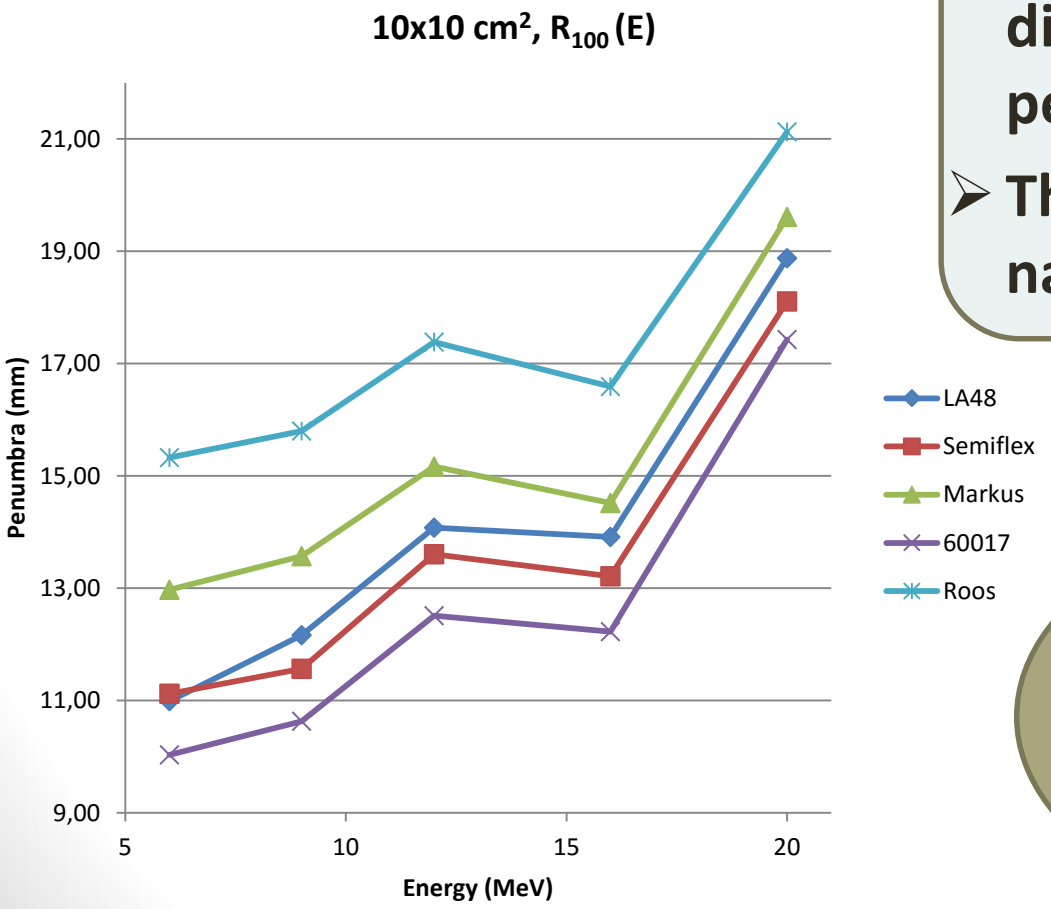
Results (electrons at R_{100})



- **Parallel plate chambers display the widest penumbras.**
- **The diode displays the narrowest penumbras.**

Penumbra, 12MeV, 10x10 cm², R_{100}

Roos: 14.6% wider than Markus
27.8% wider than Semiflex
23.5% wider than LA48
39.0% wider than 60017

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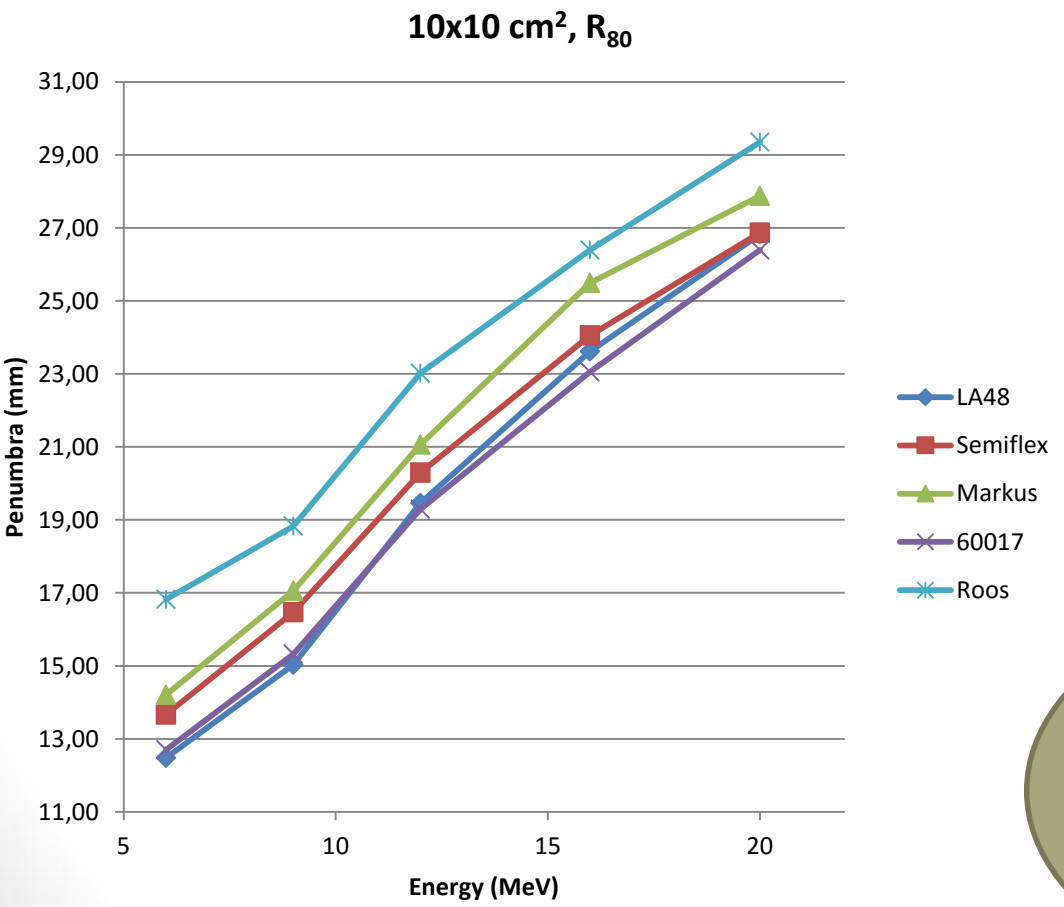
Results (electrons R_{80})



- **Smaller relative differences between the detectors at R_{80}.**
- **Semiflex displays wider penumbras than the LA48.**

Penumbra, 12MeV, 10x10 cm², R_{80}

Roos: 9.3% wider than Markus
13.5% wider than Semiflex
18.3% wider than LA48
19.3% wider than 60017

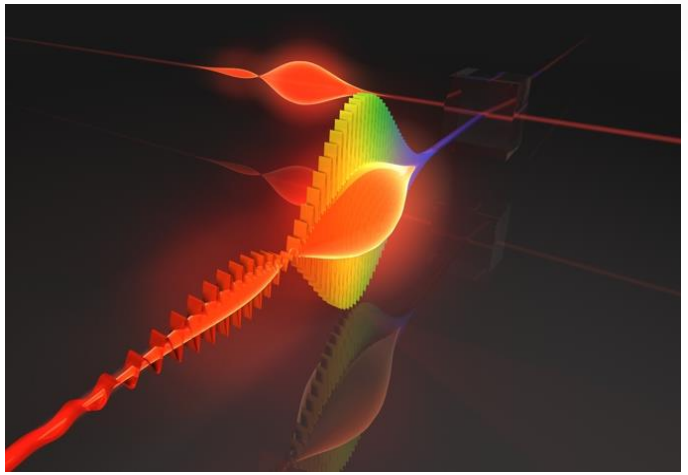
Conclusions

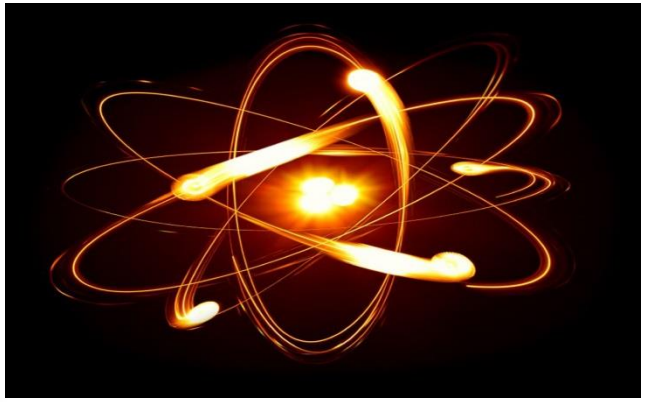
- ***"Volume averaging effect": detectors with large volumes/diameters display wider penumbras because of their poor spatial resolution***.
- Diodes (Z=14) over-respond in scattered radiation (high photoelectric effect cross section).
- Absorption of the obliquely scattered electrons by the side material of the LA48.

Conclusions

Photon measurements:

- Semiflex displays the widest penumbra although considered the gold standard.
- Diodes: not appropriate for measurements in large depths and fields.





Electron measurements:

- Parallel plate ionization chambers not appropriate for relative dosimetry.

Conclusions

The LA48:

- Time saving: 25 sec/profile no matter the field size.
  - Other detectors: 2,5 min/profile (10x10 cm^2 field).

- Requires rotation of the water phantom for measurements in both directions.

- Acceptable for relative dosimetry in photon and electron beams.