Neutron Measurements around the Varian TrueBeam Linac

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Objectives

Measure neutron spectra around a Varian TrueBeam linac

1. Compare measured neutron spectra of flattened and un-flattened treatment beams

2. Measure the total fluence rates, ambient dose equivalents and neutron source strengths

A New Neutron Spectrometer

Nested Neutron Spectrometer

- Thermal neutron He-3 detector with HDPE shells
- Current mode (possible due to Kr mixed with He-3)
- Similar but more practical than Bonner sphere system

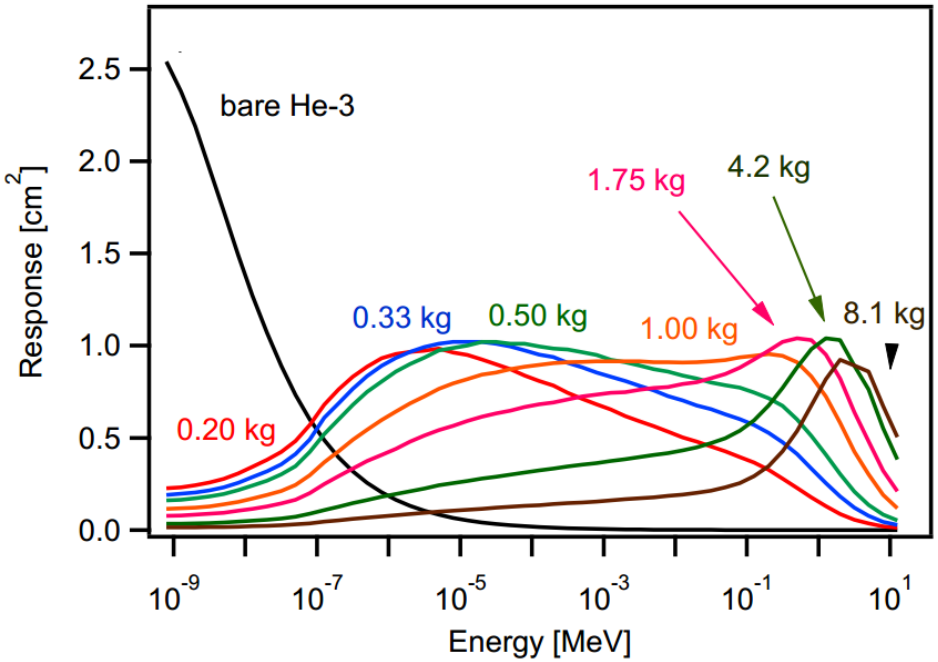
Dubeau, J., et al. "A neutron spectrometer using nested moderators." Radiation protection dosimetry 150.2 (2012): 217-222.

Methods

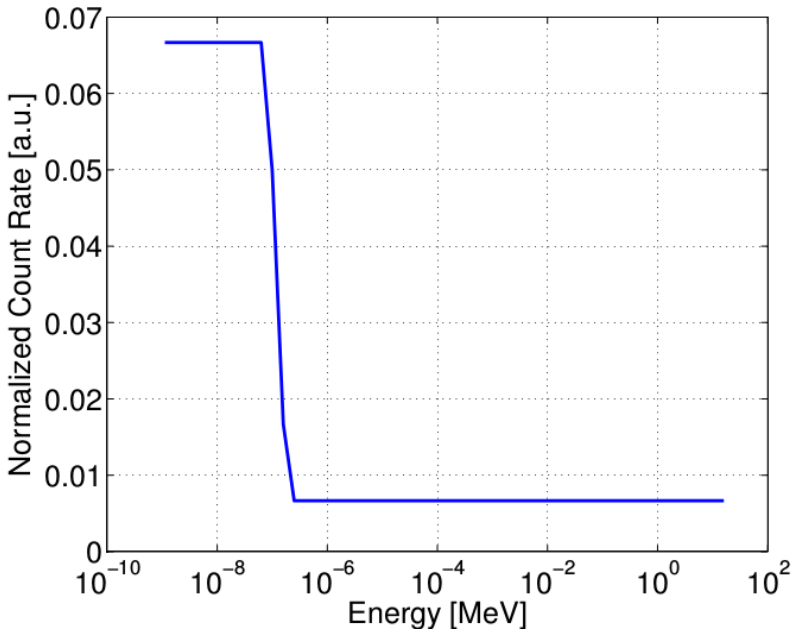
Unfolding

- Custom unfolding based on MLEM algorithm
- Response functions provided by manufacturer
- Unique input spectrum for radiotherapy

Response Functions



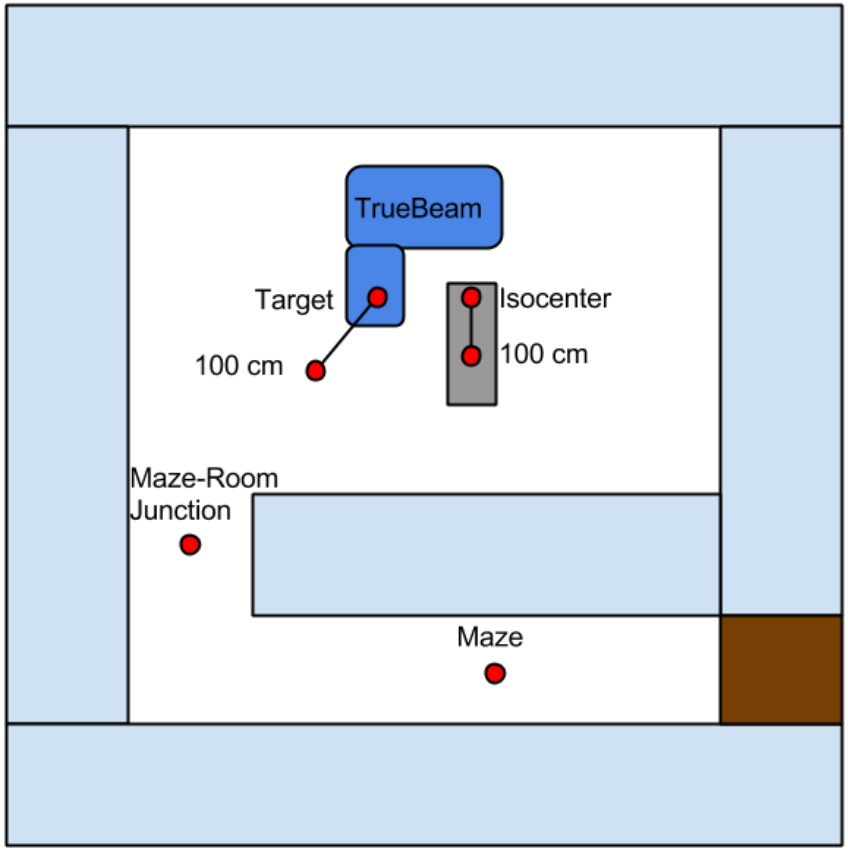
Input Spectrum



Methods

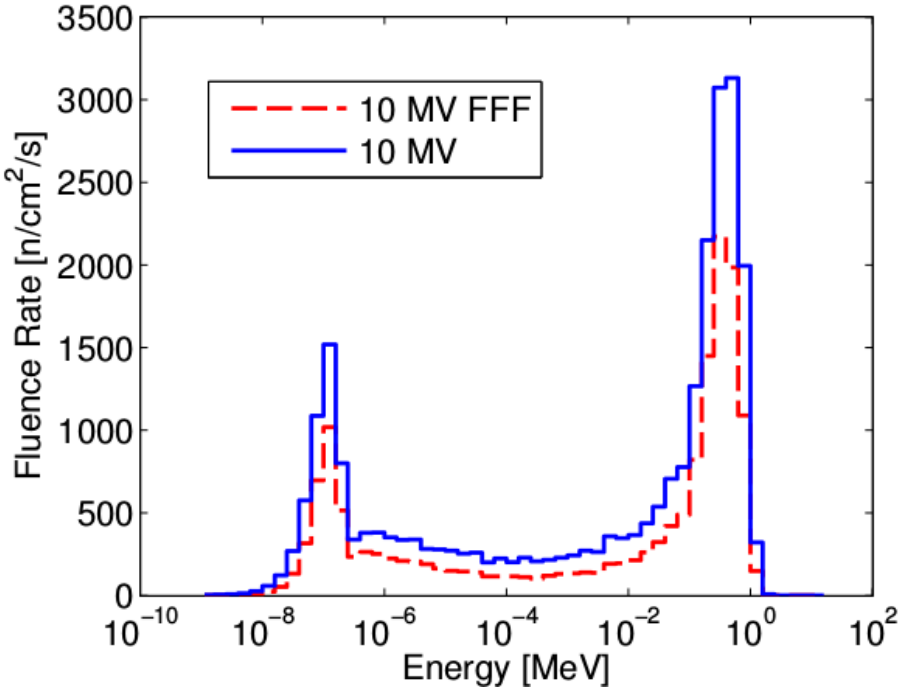
Experimental Setup

- Varian TrueBeam at JGH
- Energies:
  - 10 MV, 10 MV FFF
  - 15 MV
- Dose rate: 400 MU/min
- Gantry: 270°
- Positions:
  - 100 cm from the isocenter
  - 100 cm from target
  - Maze-room junction
  - Maze



Results

Neutron production from flattened and unflattened beams at 100 cm from isocenter



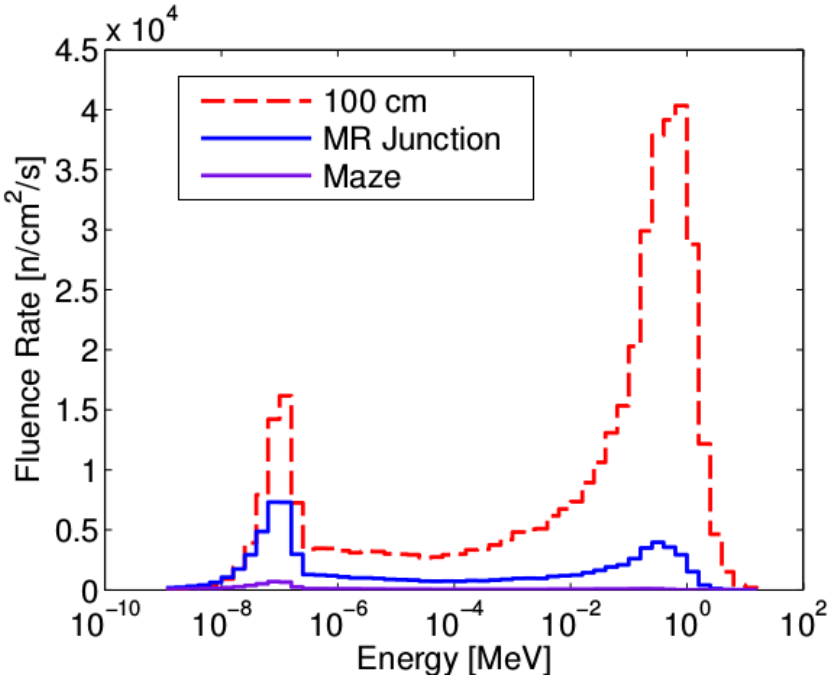
Neutron flux, dose equivalent and source strengths reduced by **38 %**

Energy	Flux ($\times 10^4 \frac{n}{cm^2 s}$)	H*(10) (mSv/hr)	Qn ($\times 10^{12}$ n/Gy)
10 MV	2.57	10.6	0.060
10 MV FFF	1.59	6.6	0.037

Neutrons produced by the linac per Gy of photon dose at isocenter

Results

Neutron production from 15 MV treatment beams



Ambient dose equivalent is **~500** less in maze than at 100 cm

Position	Flux ($\times 10^4$ $\frac{n}{cm^2 s}$)	H*(10) (mSv/hr)	Qn ($\times 10^{12}$ n/Gy)
100 cm	40.96	218.0	0.59
MR Junction	7.85	18.8	-
Maze	0.56	0.4	-

Conclusions

FFF mode reduces the production of neutrons

- Fluence rates, ambient dose equivalent and source strength decrease by 35-40%

Measured new shielding quantities for 15 MV beam

- Ambient dose equivalent in the maze is ~500 times less than in the treatment room

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