

A Novel Approach to Low Energy Dosimetry

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Low-voltage Concerns

Loss of beam in air and window

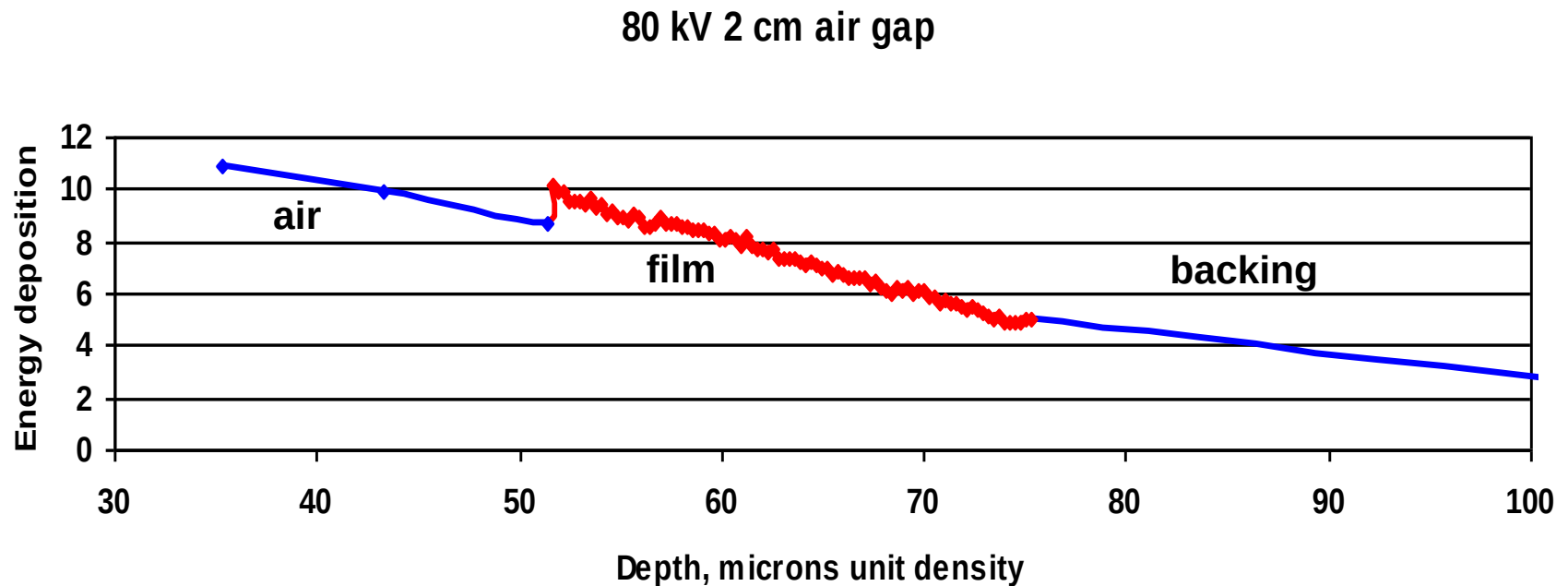
Dose gradient in dosimeters

Problems with polyethylene

Low-voltage Concerns

Loss of beam in air and window

Monte Carlo Energy Deposition in 25 μm HDPE Film



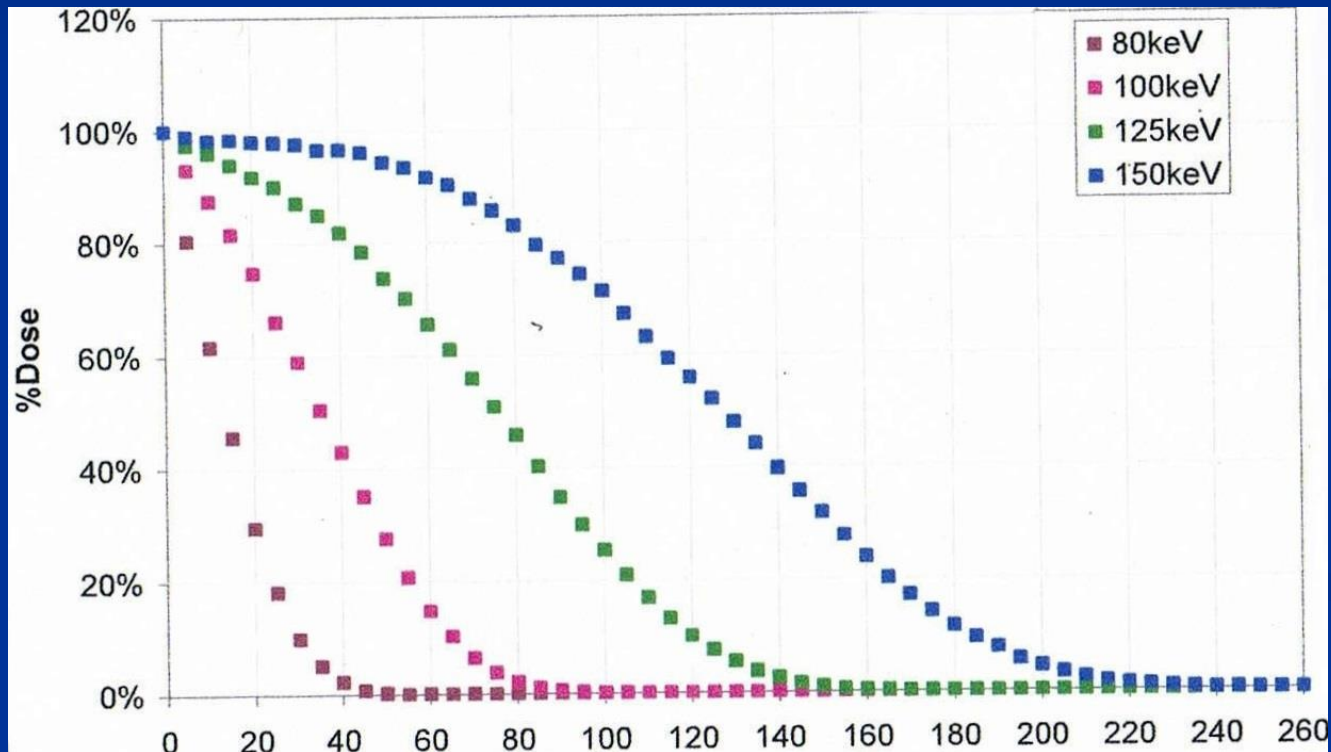
6 μm Ti window
80 kV dose gradient in film

Low-voltage Concerns

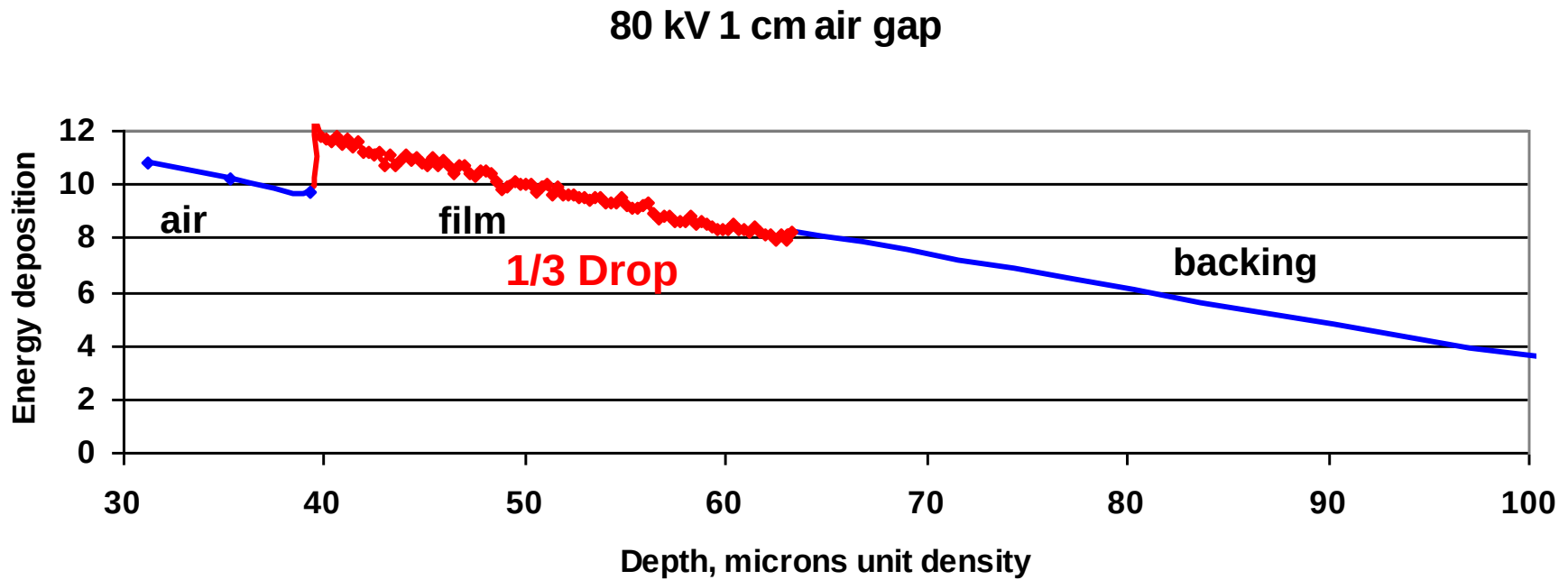
Dose gradient in dosimeters

Monte Carlo Energy Deposition

Depth μm (unit density)

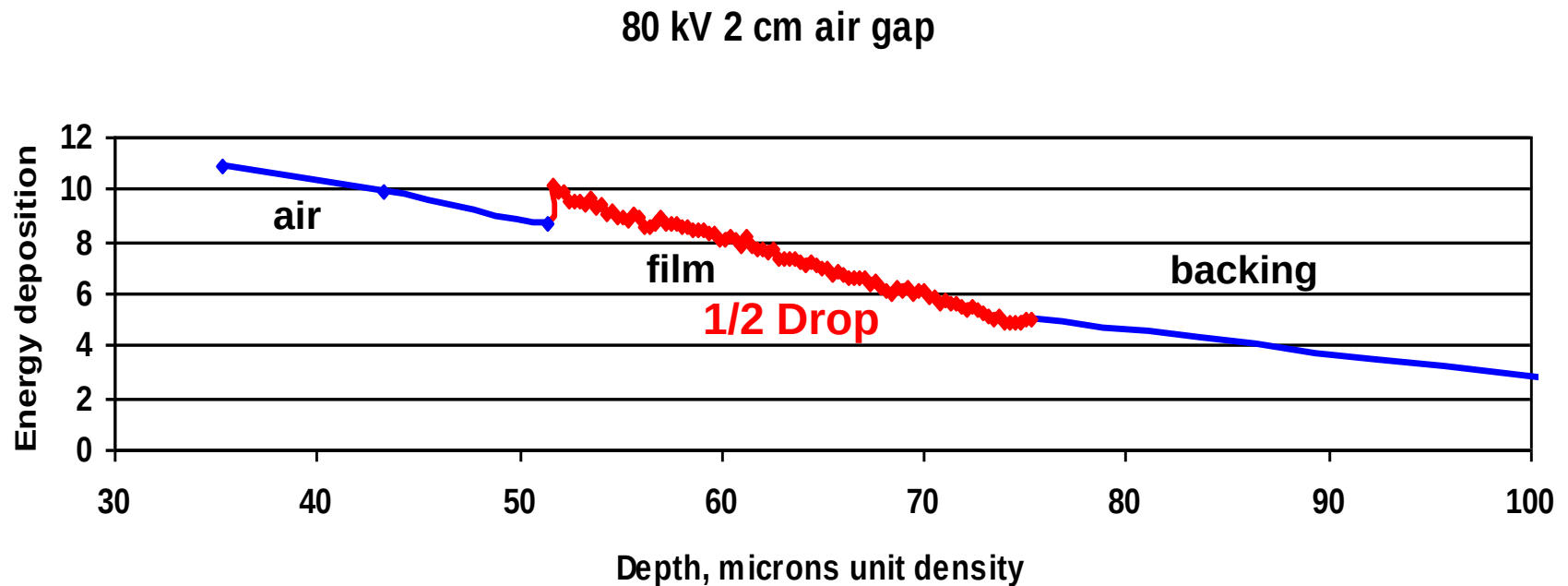


Monte Carlo Energy Deposition in 25 μm HDPE Film



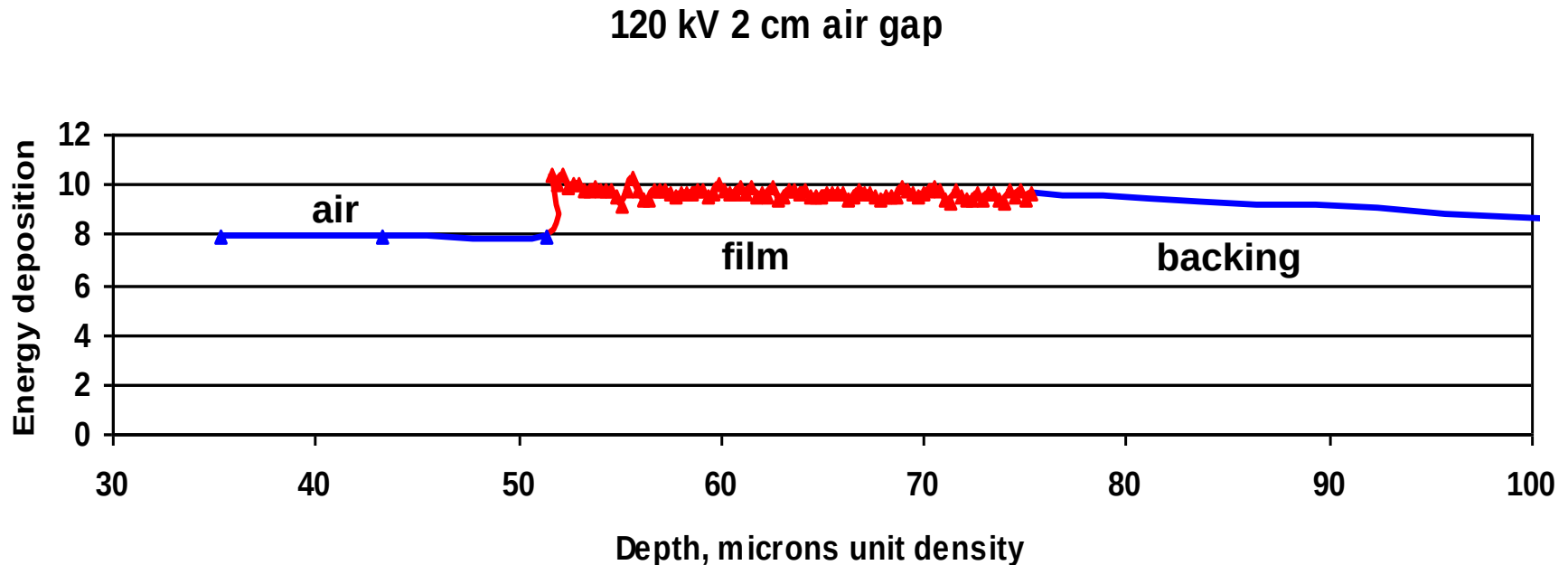
6 μm Ti window
80 kV dose gradient in film at 1 cm air gap

Monte Carlo Energy Deposition in 25 μm HDPE Film



6 μm Ti window
80 kV dose gradient in film

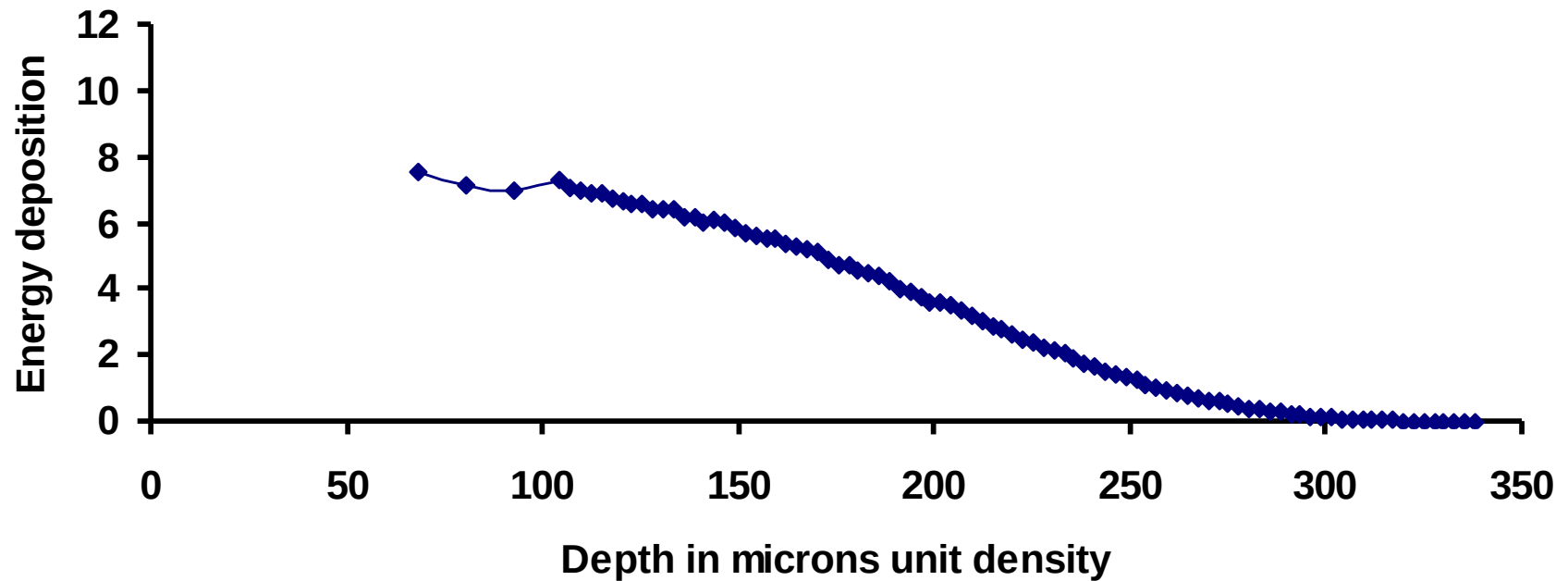
Monte Carlo Energy Deposition in 25 μm HDPE Film



6 μm Ti window
120 kV

Monte Carlo Energy Deposition

150 kV, 15 μm Ti window
3 cm air gap in 144 μm alanine



Low-voltage Concerns

- Dose gradient in dosimeters
 - Thin film FWT and B3 dosimeters should work at 125 kV and above, but alanine will show a gradient even above 200 kV
 - There are some temperature and humidity issues with FWT and B3

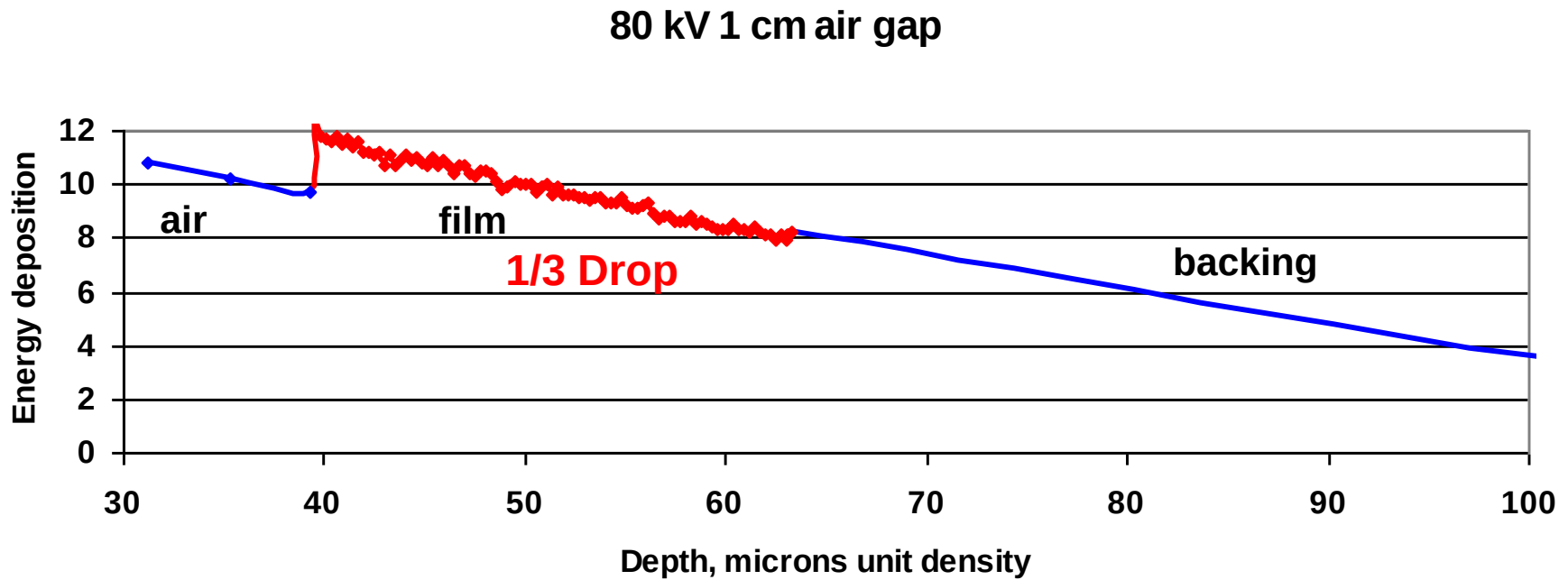
Low-voltage Concerns

Problems with polyethylene

Low-voltage Concerns

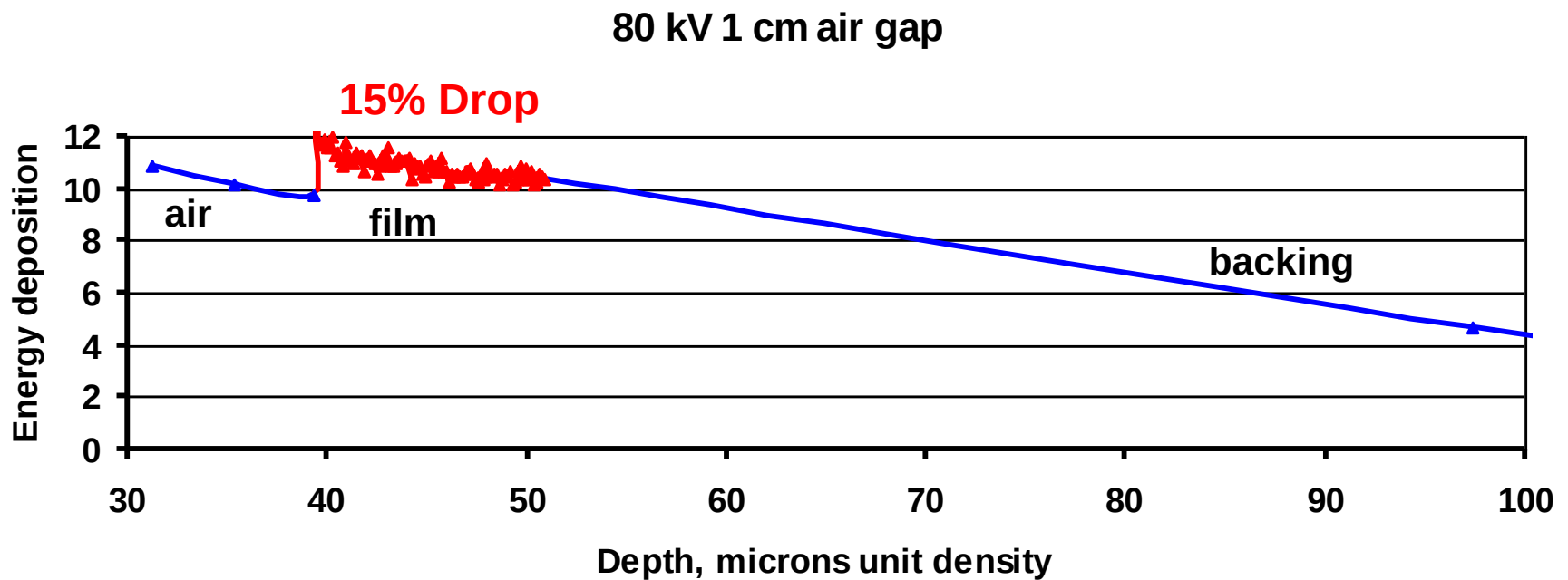
- Problems with polyethylene
 - Transmission IR

Monte Carlo Energy Deposition in 25 μm HDPE Film



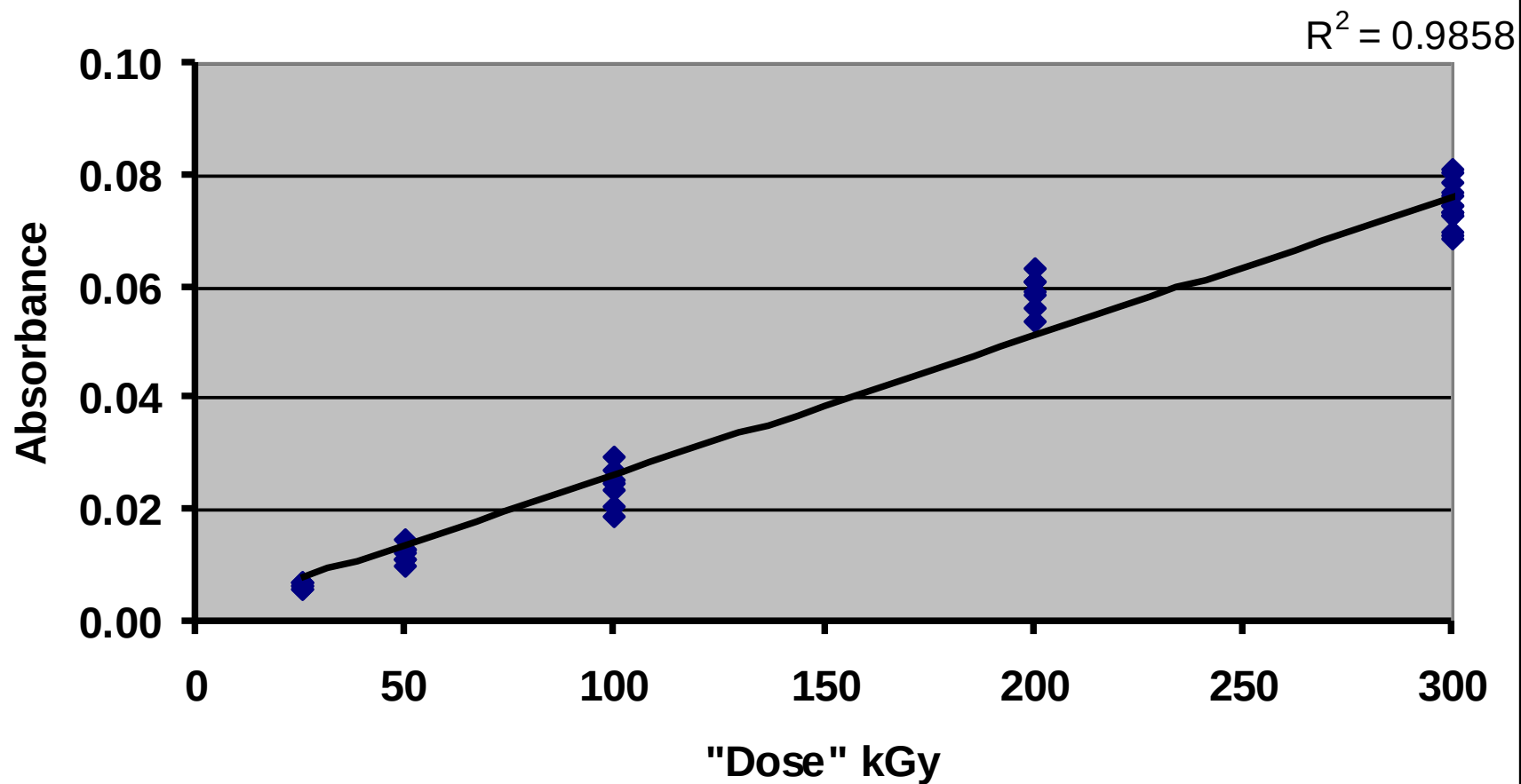
6 μm Ti window
80 kV dose gradient in film at 1 cm air gap

Monte Carlo Energy Deposition in 12 μm HDPE Film



6 μm Ti window
80 kV dose gradient in film at 1 cm air gap

Transmission FTIR Absorbance at 965 cm^{-1} in 25 μm HDPE Film

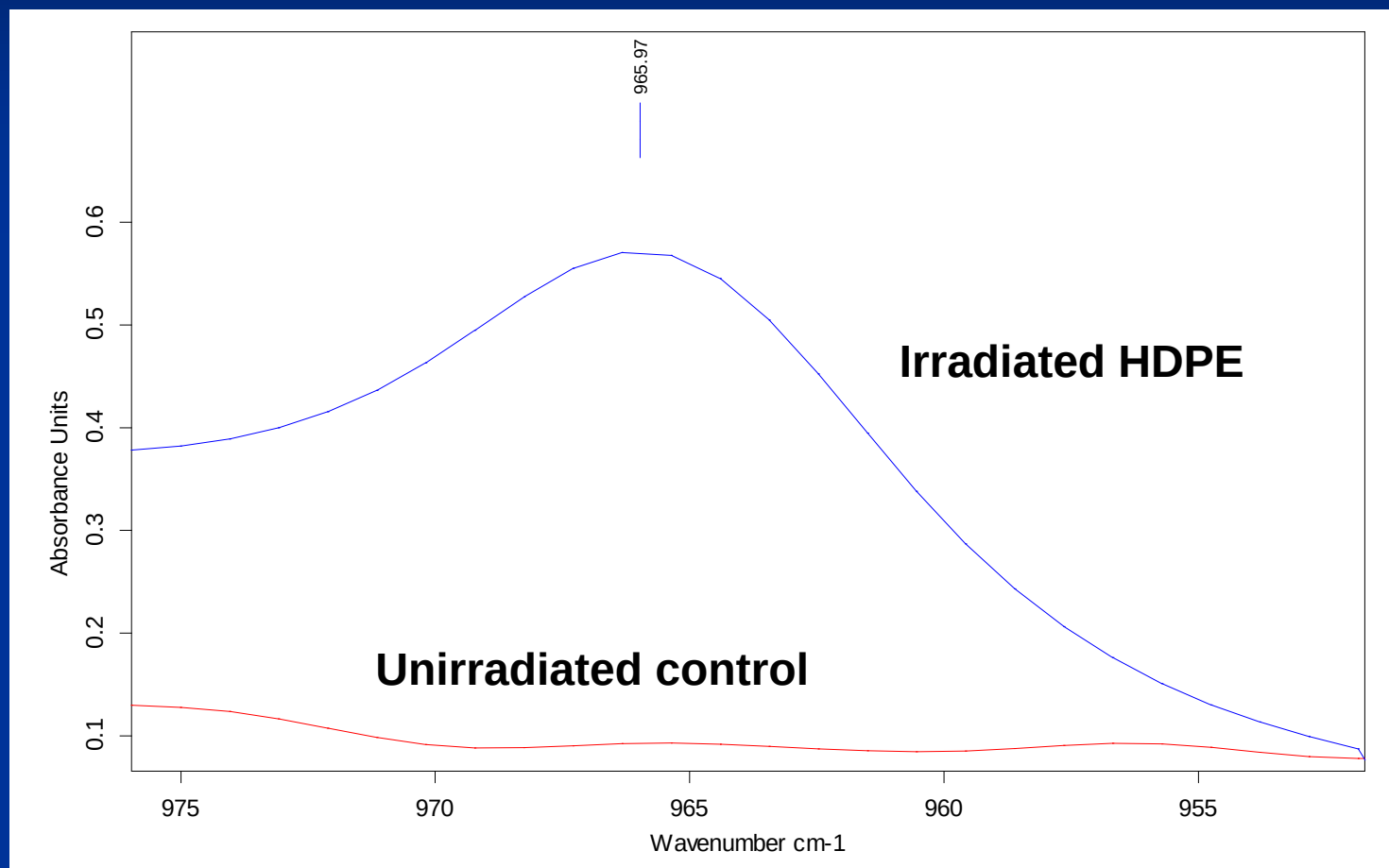


125 kV, 6 μm Ti window, 2 cm air gap

Low-voltage Concerns

- Problems with polyethylene
 - Transmission IR
 - ATR

ATR FTIR Absorbance at 965 cm^{-1} in 890 μm HDPE Sheet



~30 kGy at 3.0 MV

FTIR Spectrometer



Monte Carlo

- As you can see from the earlier slides Monte Carlo simulation can be used to determine the energy deposition of electrons into matter.
- **BUT!**

Monte Carlo

- To use Monte Carlo simulation we need to know a few things.
 - Window thickness and makeup
 - Air gap
 - Beam voltage
 - Beam amperage

Monte Carlo

- Thus if you set up a number of identical accelerators with the same window thickness, air gap and set the voltage and amperage the same; you should get the same dose (energy deposition) reading on all the instruments.

Monte Carlo

- To use Monte Carlo simulation we need to know a few things.
 - Window thickness and makeup
 - Air gap
 - **Beam voltage**
 - **Beam amperage**

The Big Question

- How do we determine the beam voltage and amperage?

The Big Question

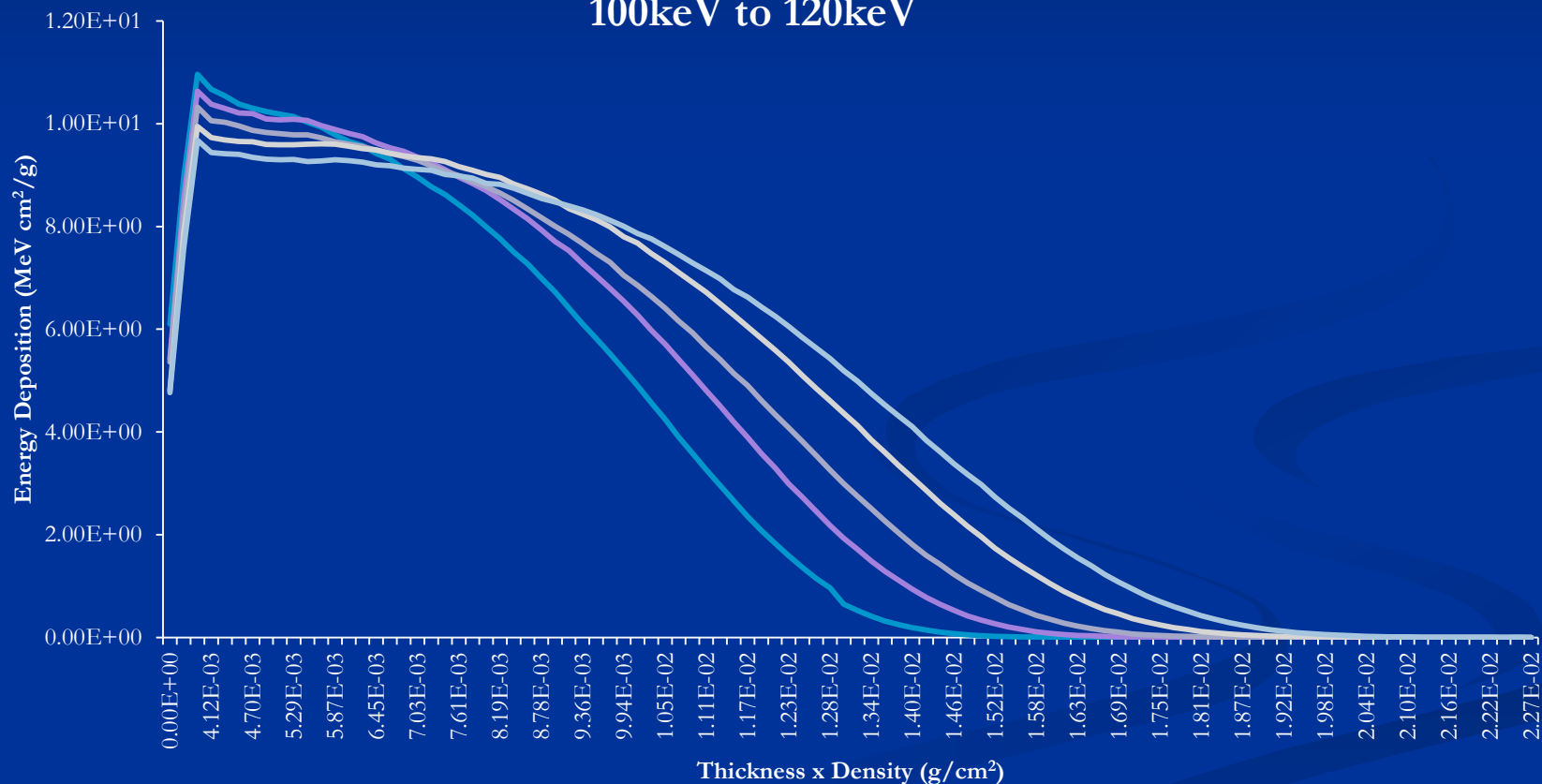
- How do we determine the beam voltage and amperage?
- The amperage is not important with this method.

How to Determine Beam Voltage

- Use area ratios.

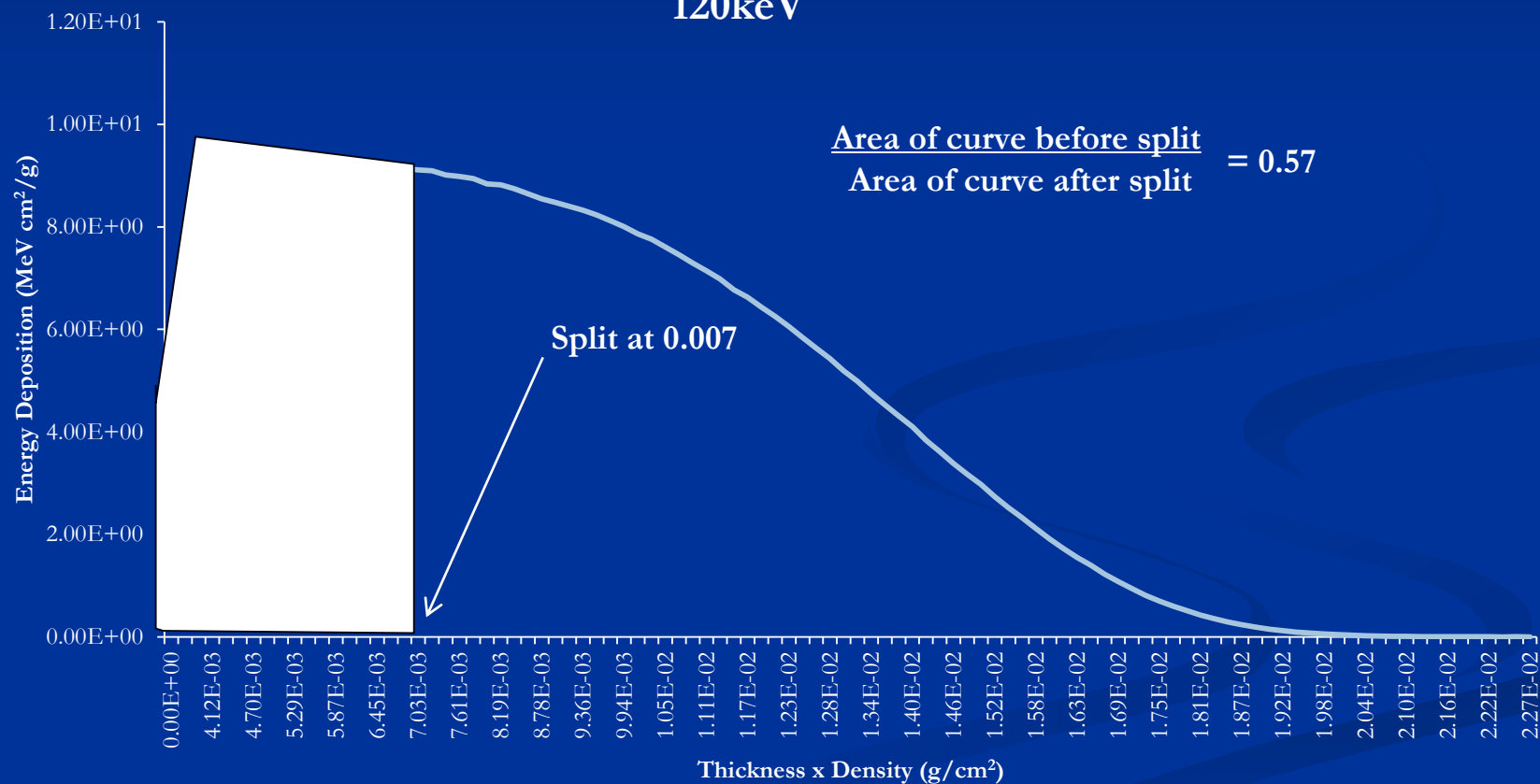
Area Ratios

Energy absorbed vs thickness
100keV to 120keV



Area Ratios

Energy absorbed vs thickness
120keV



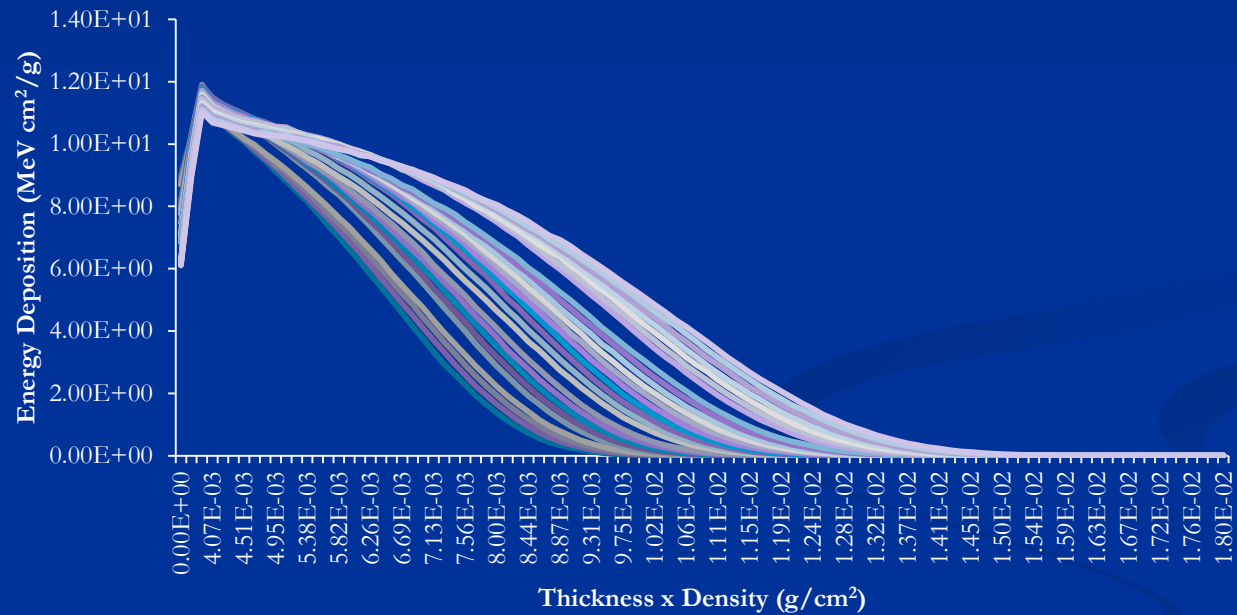
Area Ratios

Area ratios for 100-120keV curves

Energy (keV)	Area ratio	%Difference
100	1.22	23.00
105	0.94	14.97
110	0.80	18.16
115	0.65	12.56
120	0.57	

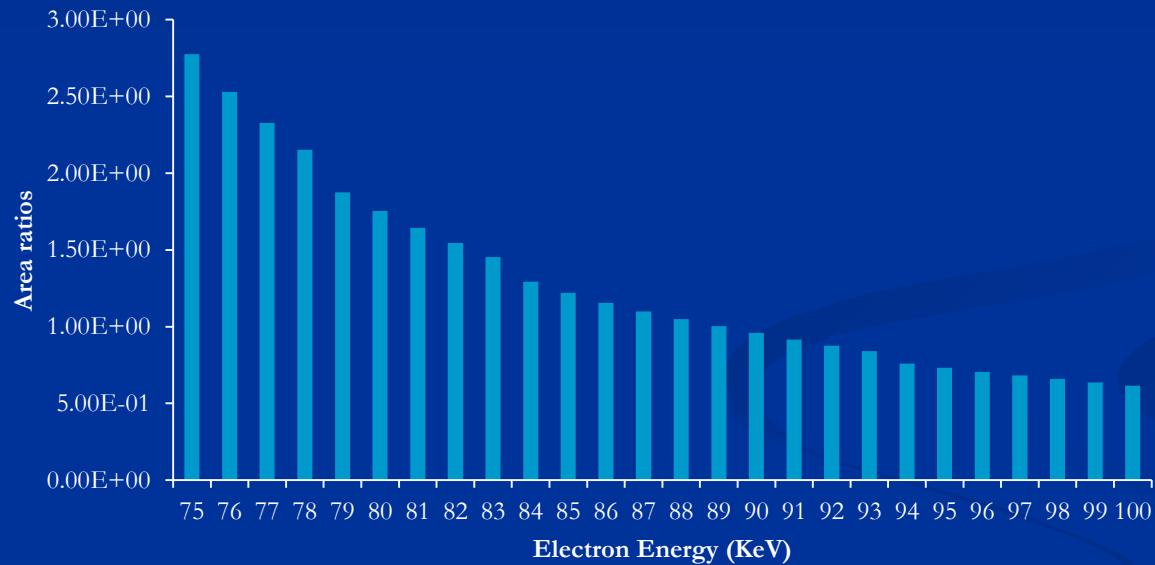
Area Ratios

Energy absorbed vs thickness
75 keV to 100 keV (0.15 PE)

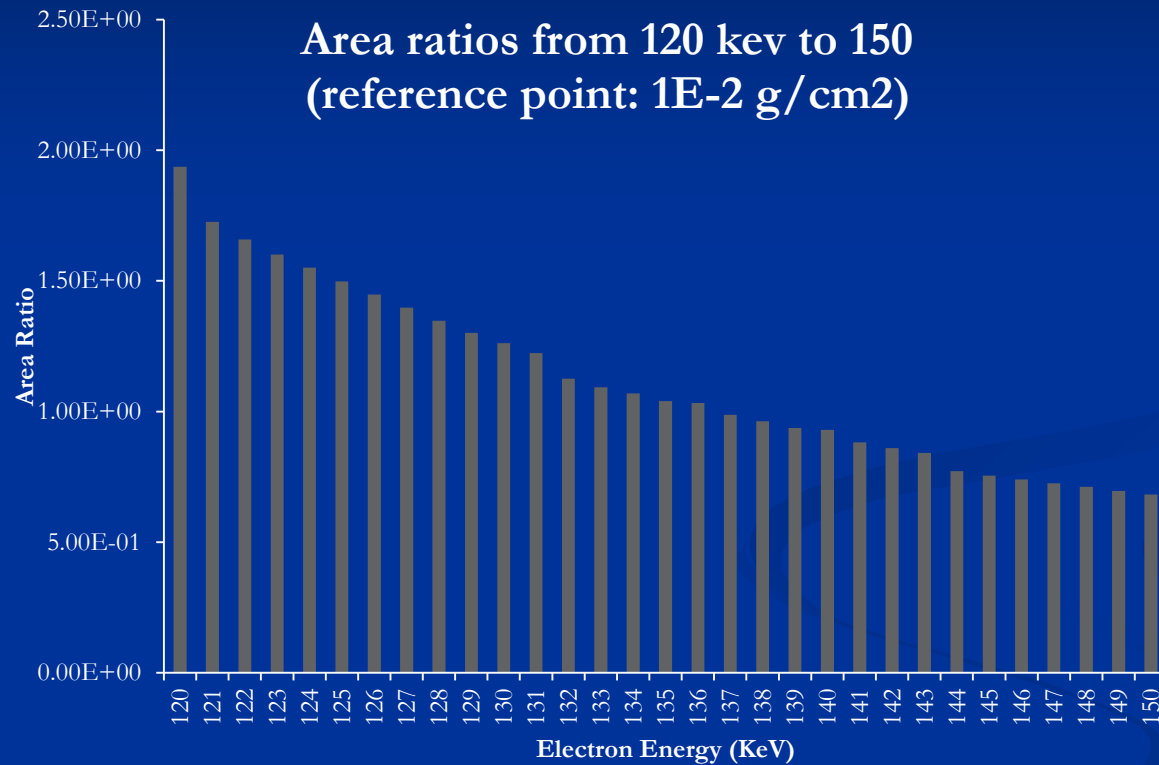


Area Ratios

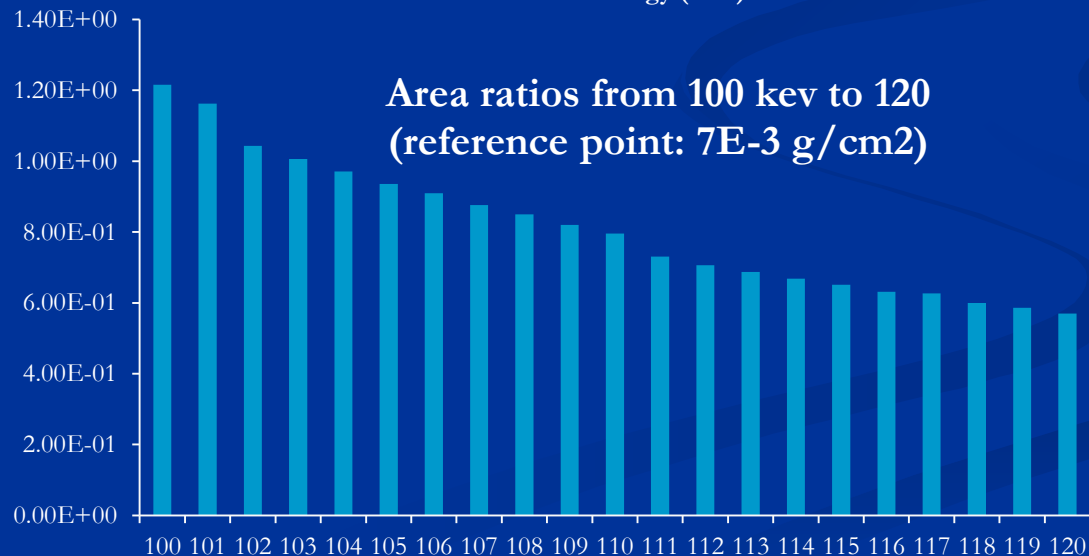
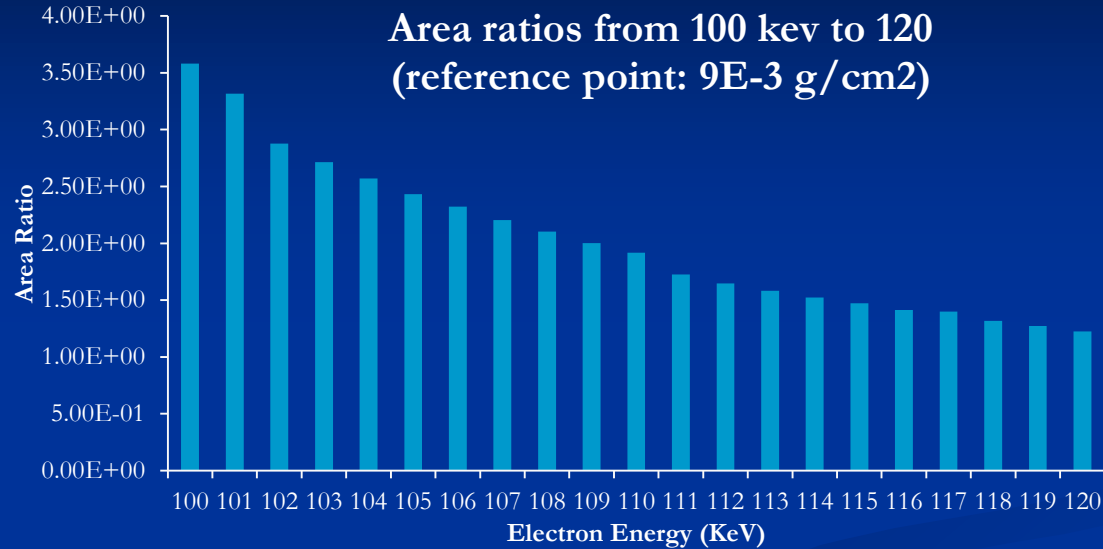
Area ratios from 75 kev to 100
(reference point: 6E-3 g/cm²)



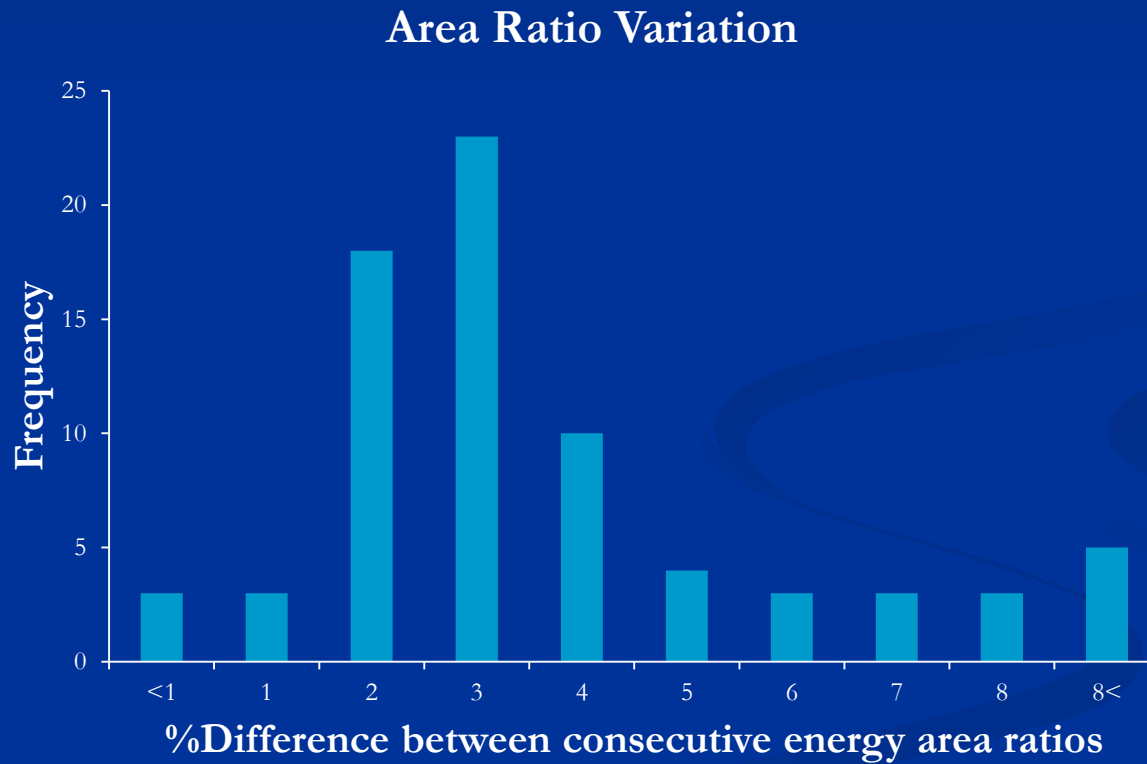
Area Ratios



Area Ratios



Area Ratios



How Would This be Used

- Use a thick dosimeter.
- Run one dosimeter without an absorber.
- Run one dosimeter with a standard thin PE absorber.

How Would This be Used

- From the ratio you can determine the energy of the beam.
- You do not need the amperage of the unit since your dose at any thickness will be a percentage of the total energy deposited.

Additional Work

- Conduct work with dosimeters and absorbers to determine the reproducibility of the ratios obtained.
- Determine the energy resolution that can be obtained with the dosimeters.
- Would using two or more ratios increase the reliability of this method.

Acknowledgements

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NYSERDA

Questions?