Electron Treatment Planning

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Topics for Review

- Choosing an energy
- Deciding if bolus is needed
- Choosing a prescription point
- Choosing the correct beam angle
- Mixing energies
- Mixing modalities
- Air Gaps
- Hand calculations
- Blocking considerations

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Choosing an Energy

- The energy needed is dependent on
  - The depth of the target
  - The critical structures surrounding or beyond the treatment
  - The therapeutic range, R_{90}, of the energy, E/4
- The chosen energy should have a therapeutic range that encompasses the entire tumor

Choosing an Energy

- Energy range: 6 MeV-20 MeV
- Energy loss: 2 MeV/cm of water or soft tissue
- Most useful treatment depth of electrons is 90% (energy/4 cm) to the 80% (E/3)
- Bremsstrahlung tail: generated in scattering foil

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Deciding if bolus is needed

- Determine if the skin should be treated
  - If the skin is to be treated, get out your curves and look at them
  - Depending on the energy chosen, look at the dose to the surface
  - If the surface dose is not high enough, add bolus
- How much bolus is required?
  - Enough to give the surface adequate dose

Deciding if bolus is needed

- Surface irregularities
  - Produce localized hot and cold spots
  - Scattered outward by steep projections, i.e. nose
  - Inward by steep depressions, i.e. cavities
  - Can be corrected with bolus

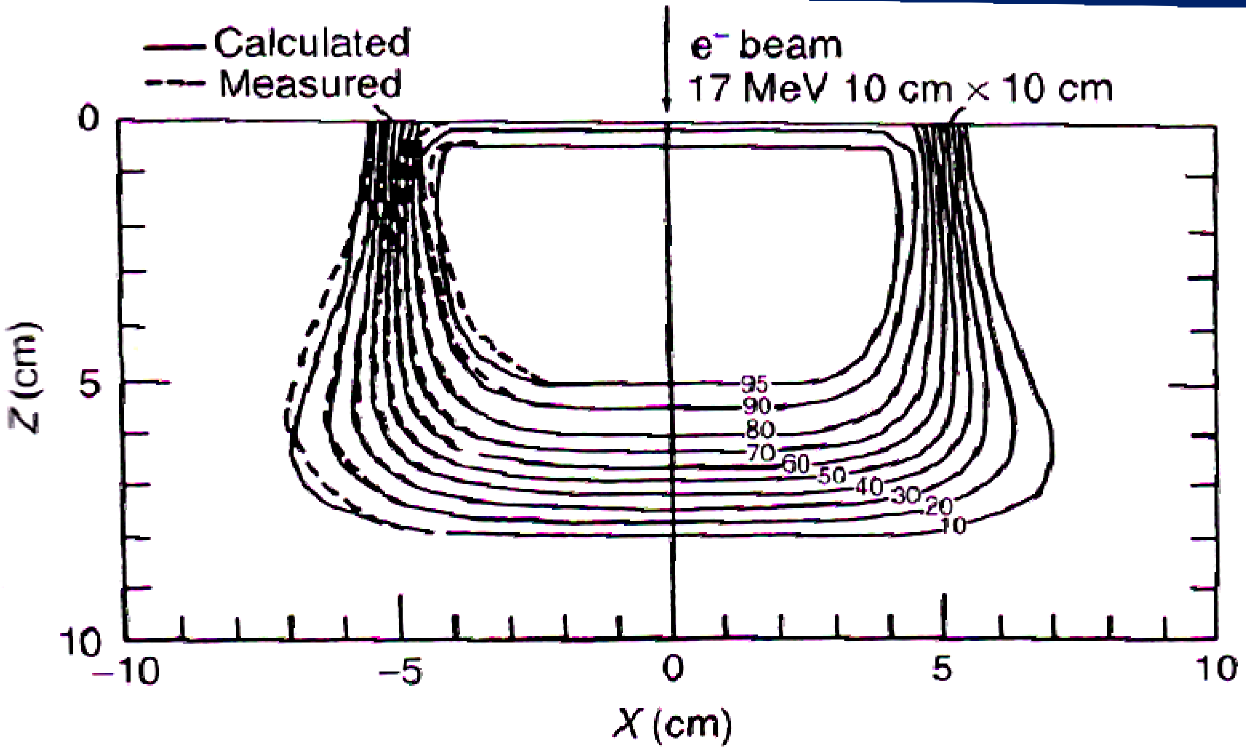
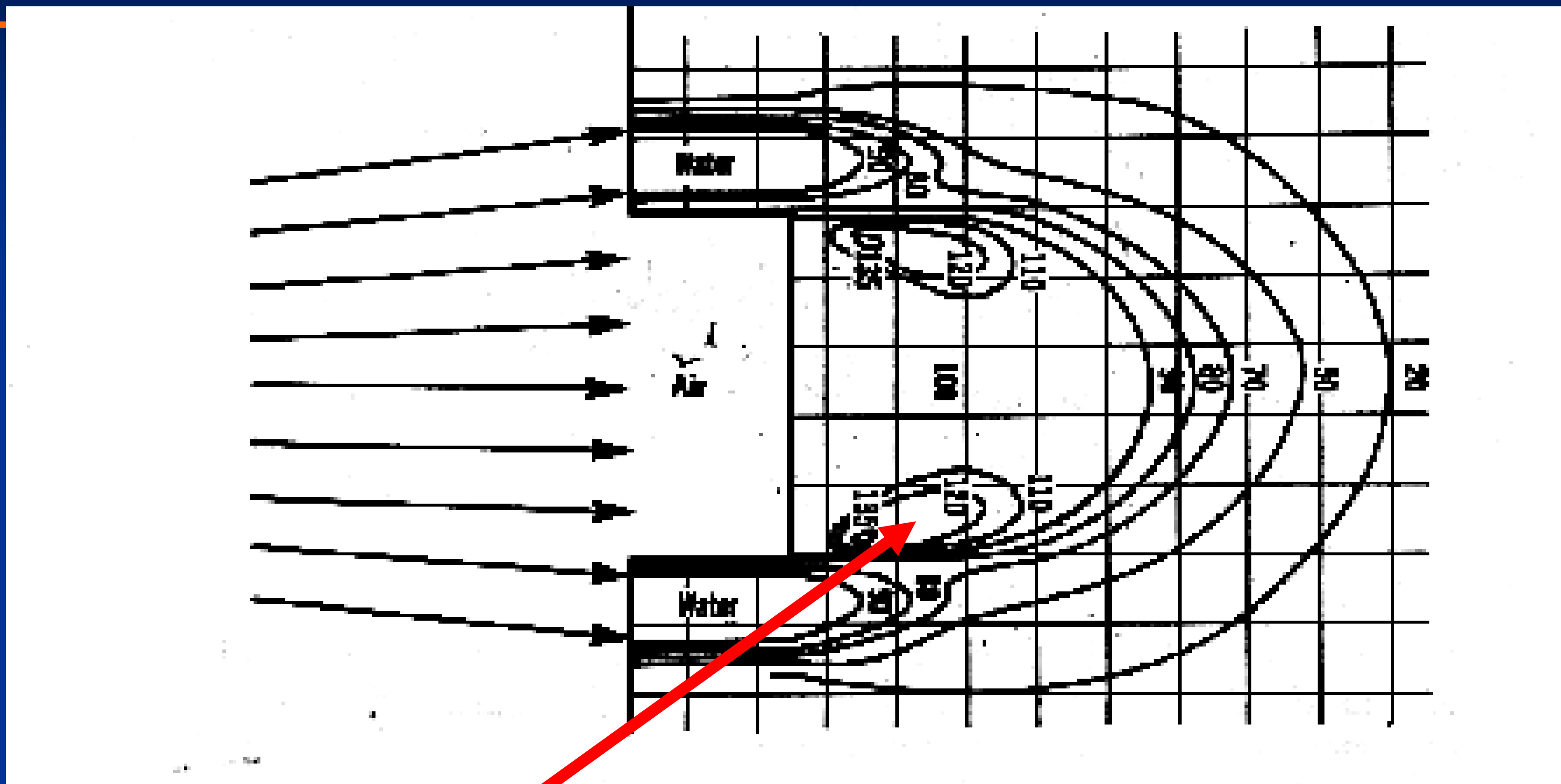


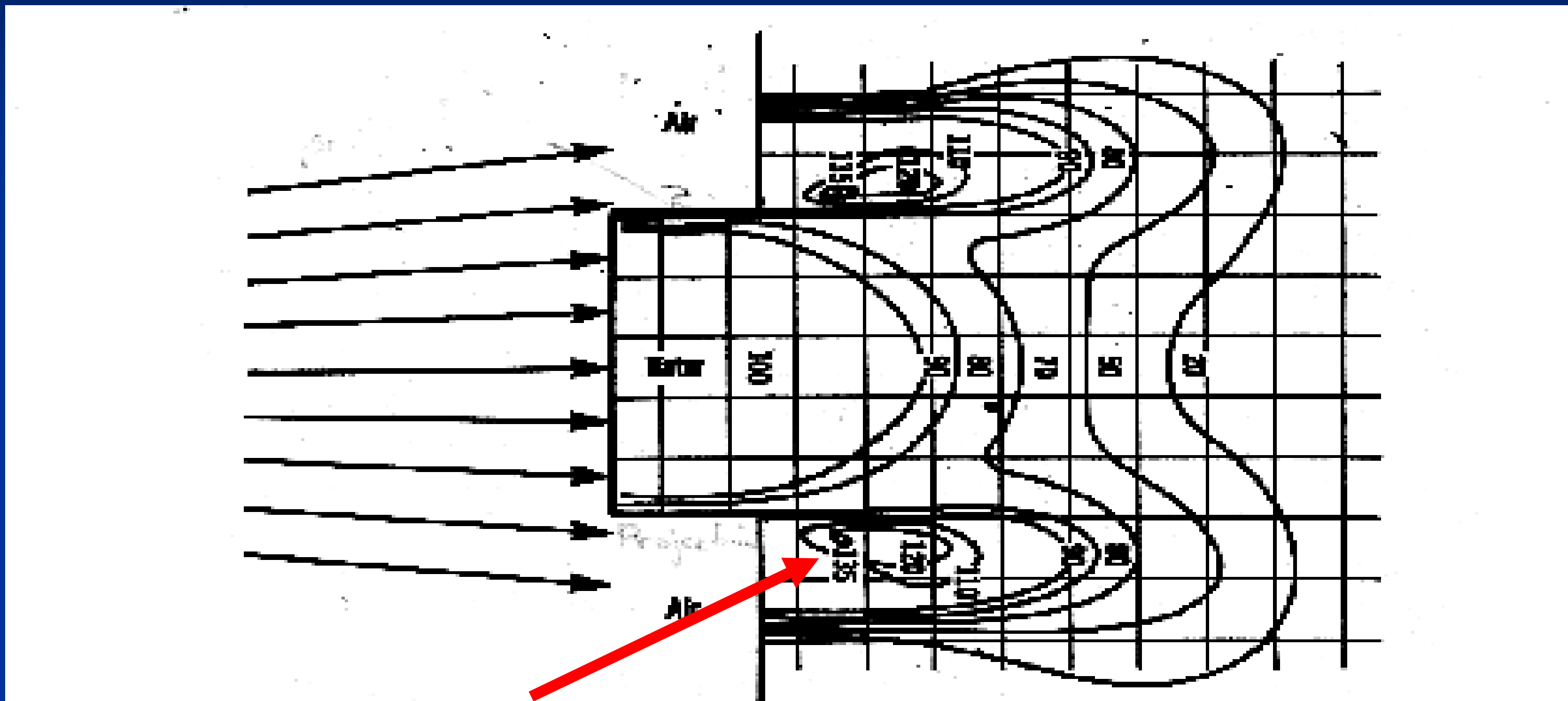
FIGURE 7.6. Comparison of calculated and measured isodose distribution. (Reprinted with permission from Hogstrom KR, Mills, MD, Almond PR. Electron beam dose calculations. Phys Med Biol 1981;26:445.)

Deciding if bolus is needed



Dose scattered inward

Deciding if bolus is needed



Dose scattered outward

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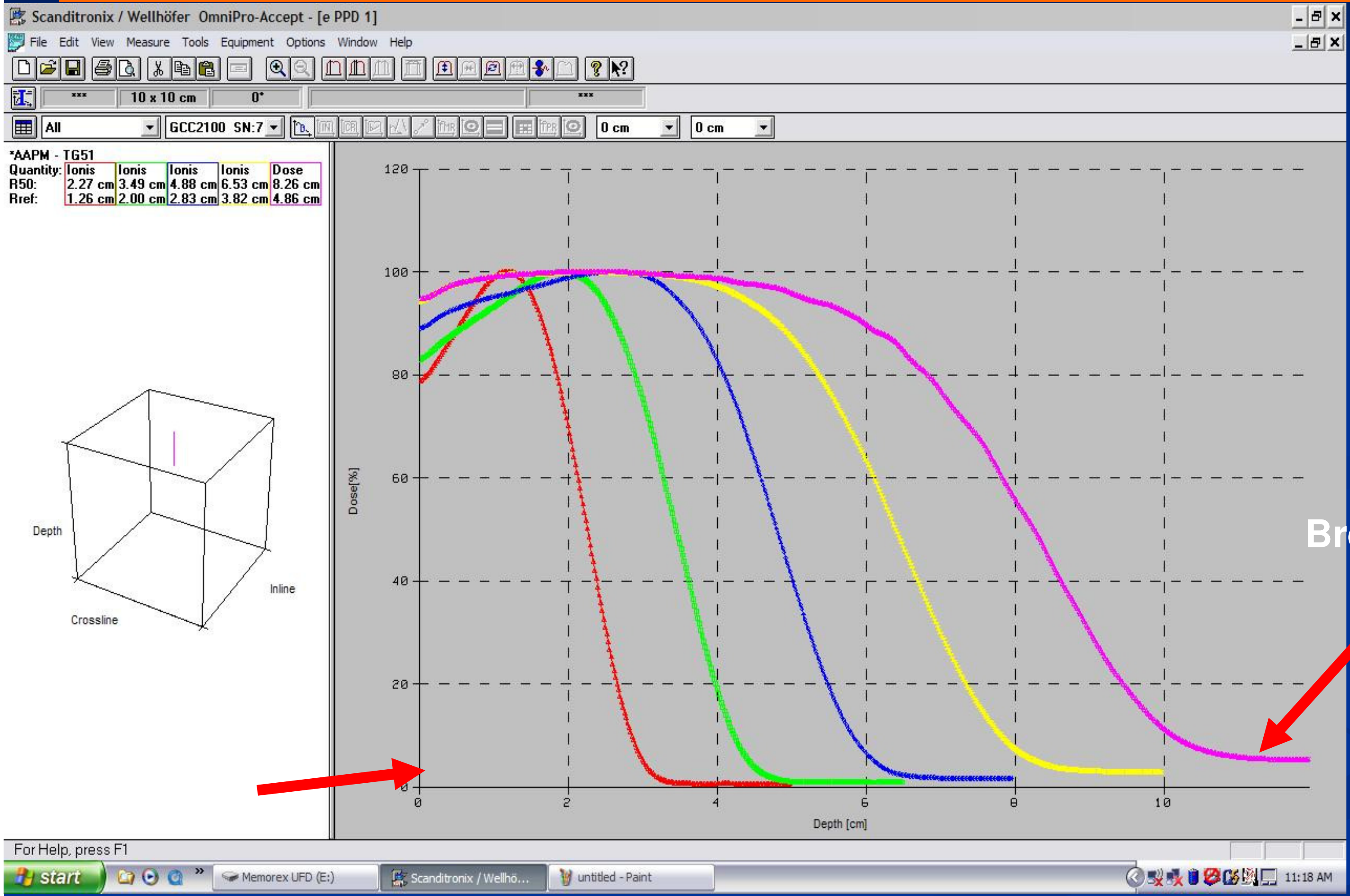
Deciding if bolus is needed

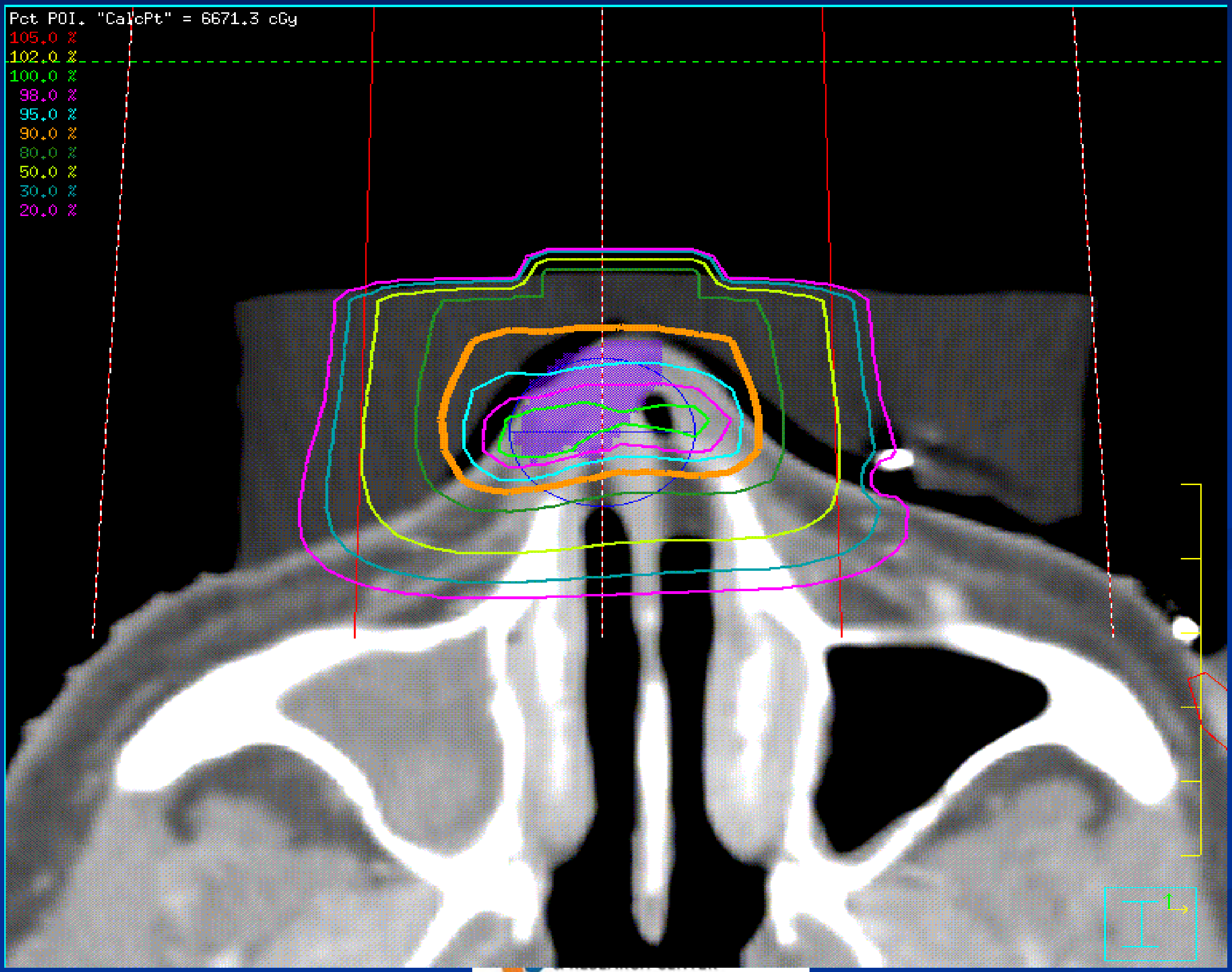
- When deciding if bolus is to be used to reduce beam penetration in a selected part of the field, the edges of the bolus should be tapered to minimize the effect demonstrated in the previous two slides.

Deciding if bolus is needed



Bremsstrahlung tail

Deciding if bolus is needed



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Choosing a prescription point

- The placement of the prescription point when planning is dependent on:
  - The anatomy: no interfaces, air, or bone please
  - If other energies or modalities are being used
- If the prescription point is dmax, the hand calculation becomes easy. Most clinics use the hand calc MU's

Choosing a prescription point

- If the calc point is not placed at dmax how do you account for the depth in the hand calc?
- Where do you put the calc point if you are mixing electron energies? Refer back to the electron curves for your answer.
- Placing points in the build-up region is not recommended.

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Choosing the correct beam angle

- En Face (appositional)- the beam axis is perpendicular to the slope of the irradiated surface
- With two electron beams adjacent to each other, angle one beam 2 °-3° from the other

Choosing the correct beam angle

- To eliminate hotspot caused by two adjacent fields:
  1. Use no gap between fields
  2. Treat fields on alternate days
  3. Use multiple junction shifts
  4. Leave a gap between fields
  5. Angle one beam away from the other with no gap on the skin surface
  6. All the above?

Choosing the correct beam angle

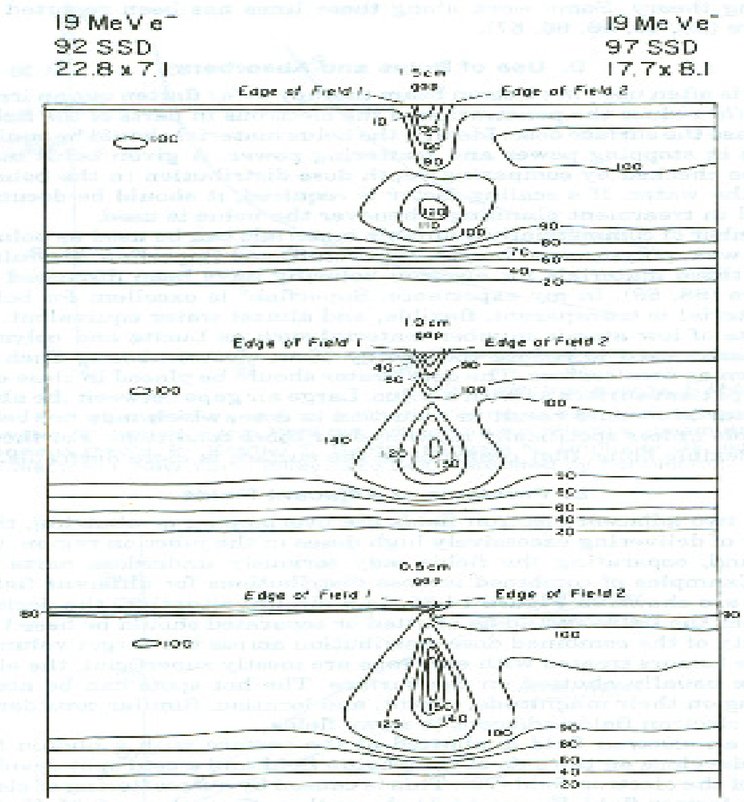

Figure 14.30. Isodose distributions for adjacent electron fields with different gap widths. From Almond PR. Radiation physics of electron beams. In: Tapley N, ed. Clinical applications of the electron beam. New York: Wiley, 1976. Reprinted by permission.

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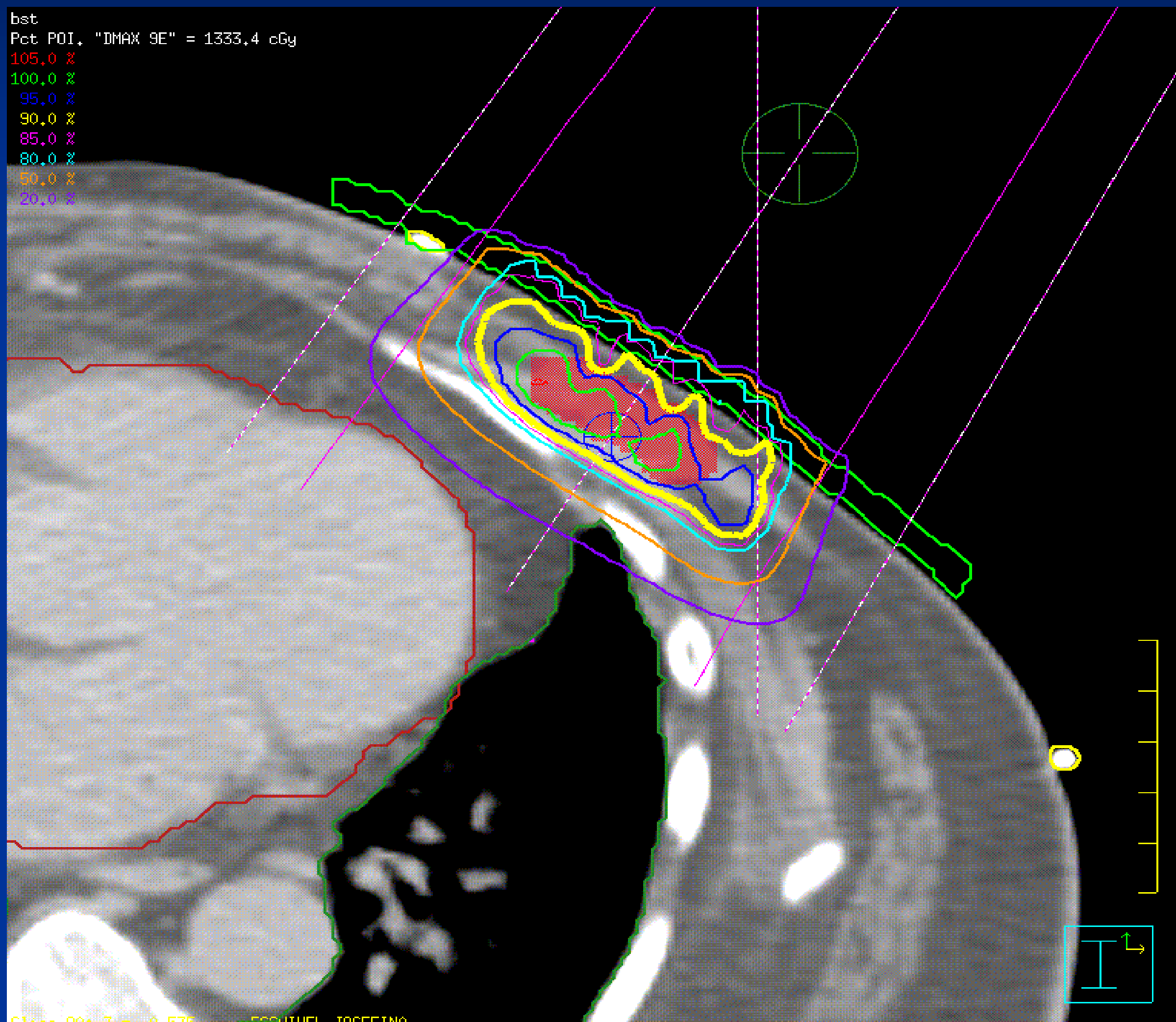
Choosing the correct beam angle



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Mixing energies

- Why do we mix electron energies when planning?
  - Ans. To give the effect of the energy we don't have
  - This is applied mostly during isodose planning when one energy does not adequately cover the target and the next higher energy covers too deep.
  - Treat all fields on the same day

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Mixing Modalities

- The use of electrons and photons allows for the following:
  - The ability to treat to greater doses without overdosing underlying structures

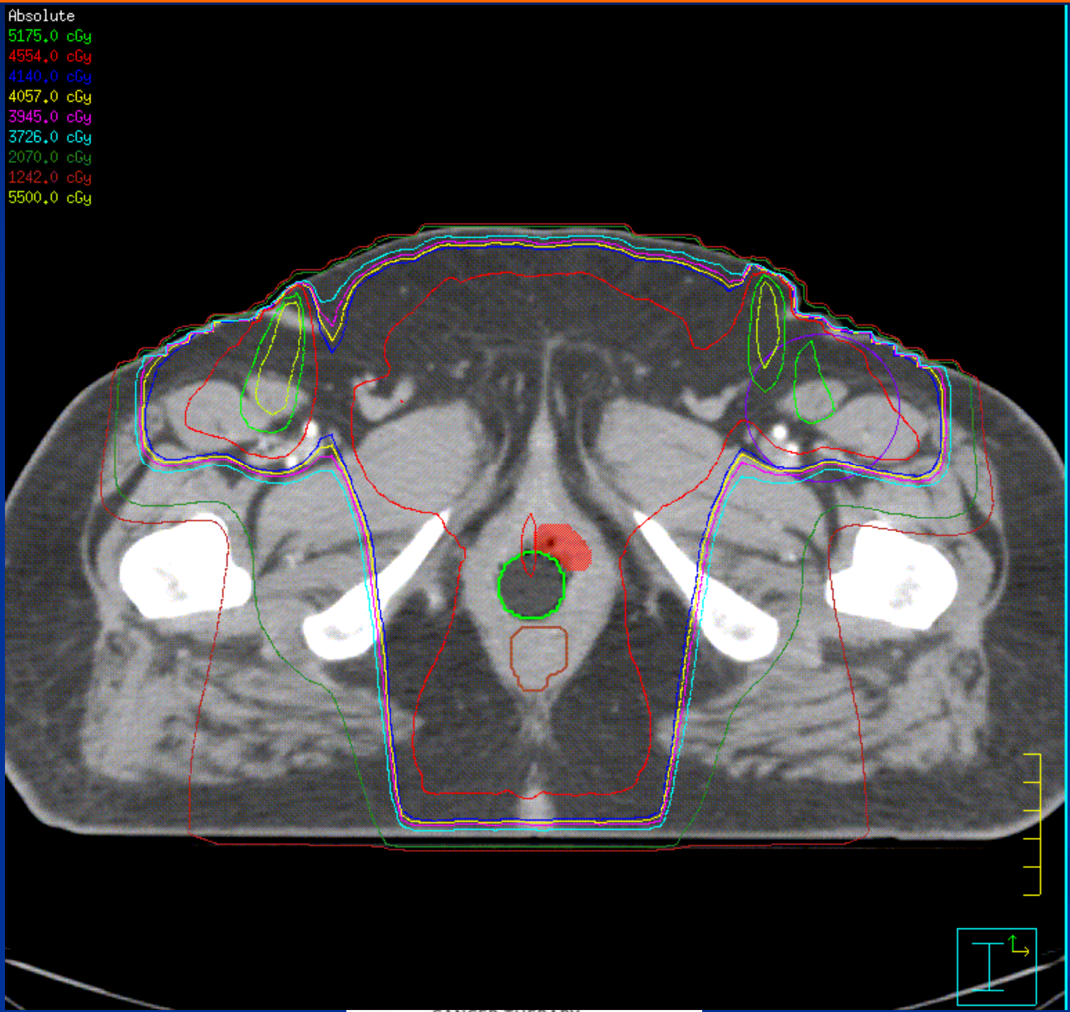
  --Treat with a photon beam and sprinkle electrons over the field or treat with electrons and sprinkle the field with photons

  i.e. Parotid tumors, facial tumors, internal mammary fields

Mixing Modalities

- The use of electrons and photons allows for the following:
  - The ability to treat adjacent fields with rapid fall off in one area while treating to midplane in the adjacent area
- Cold spot on side of electron field
- Hot spot on side of photon field
- Due to out-scattering of electrons

Electron with Photon field



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Air Gaps

- Increase side scatter at depth of maximum dose
- Shift dmax toward surface
- Decrease depth of penetration

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Hand Calculations

A physician uses 9 MeV to treat a boost field with a 6x6 cone (open) at an SSD of 105. The prescription is written to the 90% isodose line, 200cGy per fraction, and the machine is calibrated to 1.00 cGy/MU at 100 cm SSD at dmax for a 10x10 cone. How many mu's should be given? (The cone factor = 1.007 and SSD factor = 0.899)

Hand Calculations

Dose rate = 1.00 cGy/mu * 1.007 * 0.899* .90

Dose rate = 0.815 cGy/mu

200 cGy/0.815 cGy/mu = 245 mu

Shielding Considerations

- When adding shielding the dose rate as well as the dose distribution will change
- For energies less than 10MeV less than 5mm thickness of Pb is required
- Five percent transmission is acceptable
- If the thickness of the Pb chosen is too thin for the E being used, the transmitted dose may be enhanced behind the shield

Shielding Considerations

- Greater thickness than what is required can be used as long as weight is not an issue i.e. eyeshields
- Rule of thumb: The minimum thickness of lead required for blocking in mm is the electron energy,MeV, incident on the lead divided by 2 (then add 1mm for safety)
- Cerrobend thickness is approximately 20% greater than pure lead thickness

Shielding Considerations

- Distance from a field edge to any calc point should be $R_p/2$ for lateral scatter equilibrium to be maintained i.e. for a 12MeV beam $R_p/2$ = 6cm therefore a 6x6 cm field must be used
- For internal shielding watch out for back scattered electrons
- The dose at the tissue lead interface can increase from 30-70%

Shielding Considerations

- Add wax or bolus to the lead as an absorber

- Last question: How is the PDD affected by
  - 1. Adding a block?
  - 2. Changing SSD?
  - 3. Changing field size?

Shielding Considerations

- 1. When a block is added there is a decrease in output (less scatter). Blocks too small will alter your depth dose curves by eliminating their flatness, shallower %DD
- 2. Increased air gaps, (increased SSD's), cause the beam to loose its flatness, more scatter of electrons in air, deeper %DD curves
- 3. Dose is increased with f/s increase due to increased scatter from the collimator and phantom, deeper %DD curves

Shielding Considerations

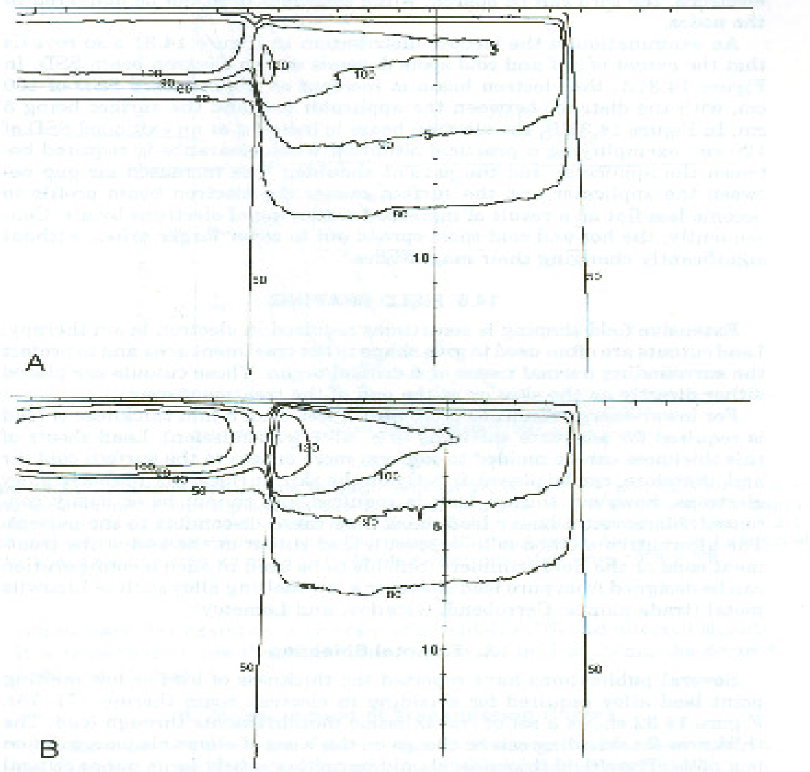

Figure 14.31. Isodose curves in a plane perpendicular to the junction line between abutting photon and electron fields. 9-MeV Electron beam: field size = 10 × 10 cm; 6-MV photon beam; SSD = 100 cm. **A.** Electron beam at standard SSD of 100 cm. **B.** Electron beam at extended SSD of 120 cm. From Johnson JM, Khan FM. Dosimetric effects of abutting extended SSD electron fields with photons in the treatment of head and neck cancers. Int J Radiat Oncol Biol Phys 1992;24(suppl 2):202.

SSD
HANGES

Shielding Considerations

- Remember: low energy, small field sizes, and increased SSD is a poor combination

GOOD LUCK