Total Skin Electron Therapy Treatment Optimization:

MONTE CARLO SIMULATION OF LARGE SCATTERED ELECTRON BEAMS AT EXTENDED DISTANCES

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Total Skin Electron Therapy

- Total skin electron therapy (TSET) (AAPM 1987) is an external beam therapy indicated for the Treatment of mycosis fungoides (t-cell lymphoma) of the skin and lymph nodes

- It is a complex technique for which special irradiation and dosimetry conditions have been studied based on the particular methods implemented (AAPM 1987, Arrans *et al* 1999, Chen *et al* 1998)

Irradiation Techniques

- Beam scatterers are used
- Placed in the treatment head or externally:
  - near treatment plane, or
  - near the treatment unit head located several meters from the patient

Problem

- Broad treatment field are required for TSET
- In a confined treatment room little divergence of electron beam occurs (Lamba, 1988)
- Therefore an efficient scatterer is required to be placed at the treatment head

Problem

Selecting properties of the optimal TSET scatterer in order to achieve the optimal treatment field characteristics

Parameters

Treatment unit parameters influencing treatment field characteristics for a given electron beam and angle:

Type and thickness of TSET scatterer

Treatment Field Characteristics

- Depth dose curves
- Dose rate
- Field uniformity
- Bremsstrahlung contamination

Solution

- Experimental methods
- Monte CARLO methods

Materials and Methods

- Phillips SL-20 linear accelerator
- 0.025 cm copper scatterer
- PRM parallel plate ionization chamber (Ngas= 2.33×10^{10})
- Victoreen 500 electrometer
- Polystyrene phantom

Materials and Methods

- EGS4 Monte Carlo code system (nelson and Hirayama *et al*., 1985), on a VAX 11/780

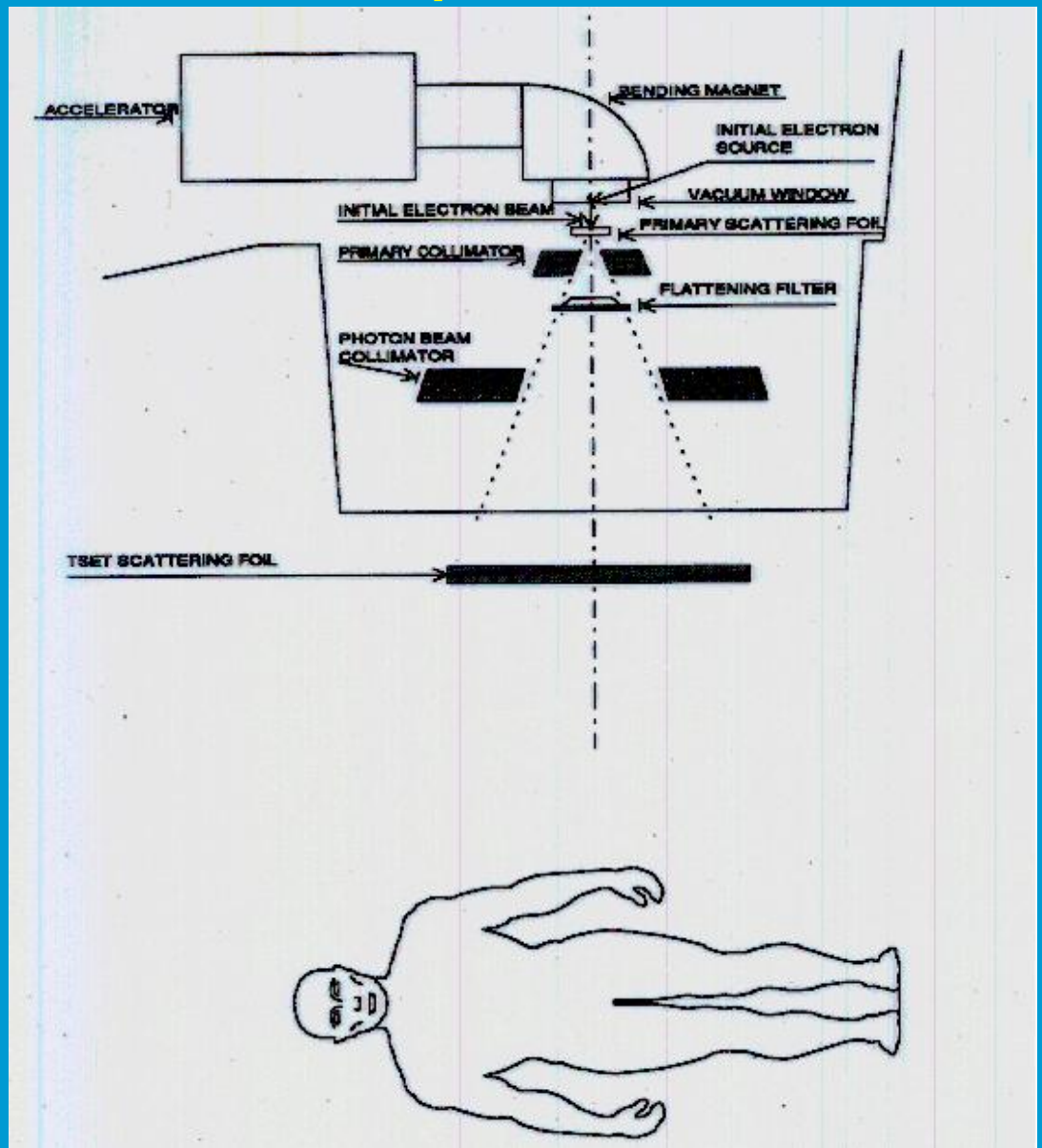
- ECUT=560 KeV, PCUT=100 keV

Variance Reduction Techniques

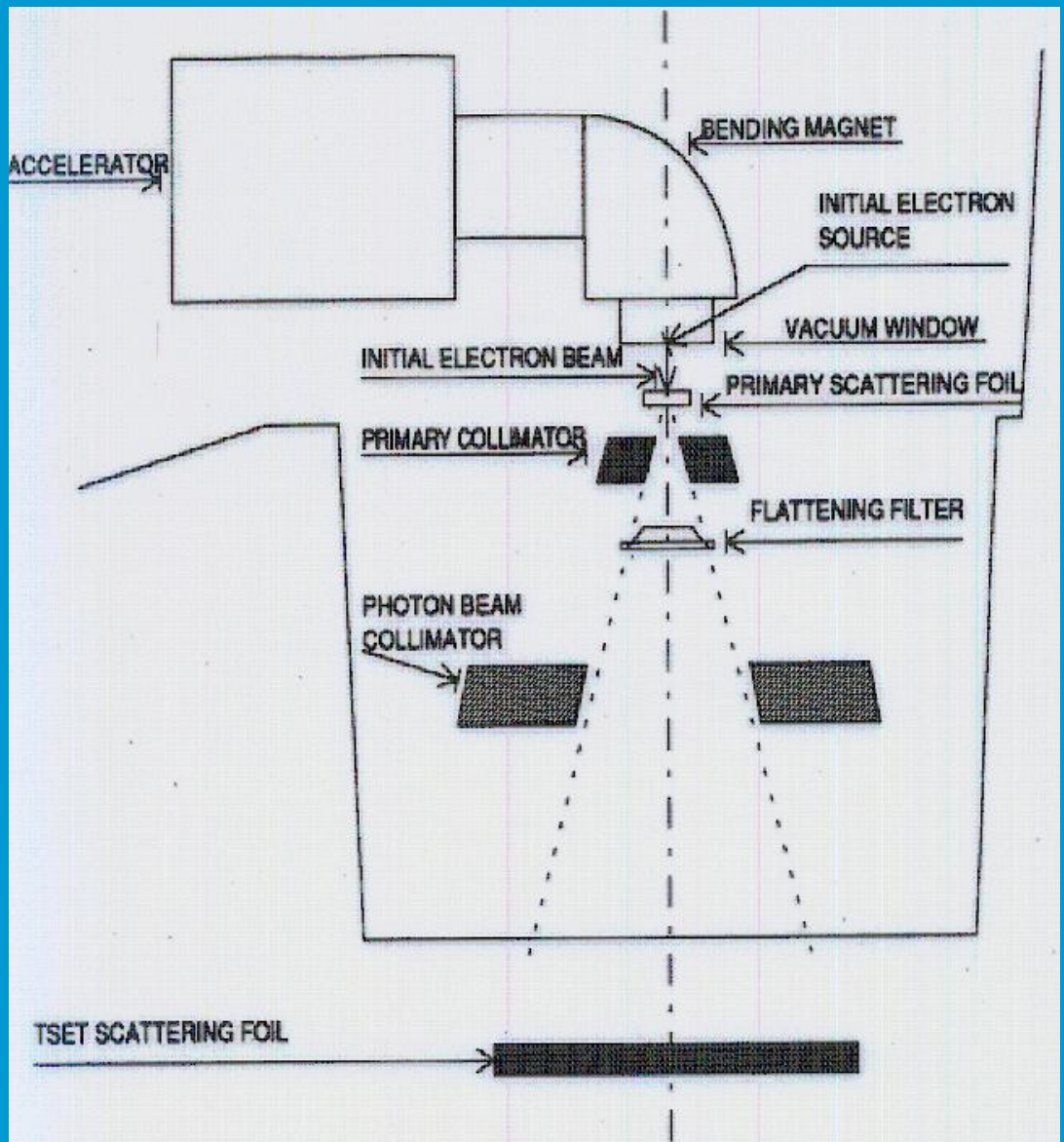
DNEAR variable

- PRESTA algorithm
- Sectioned problems

GEOMETRY for a Single Field TSET Set up SSD=300



GEOMETRY for a Single Field TSET Set up SSD=300

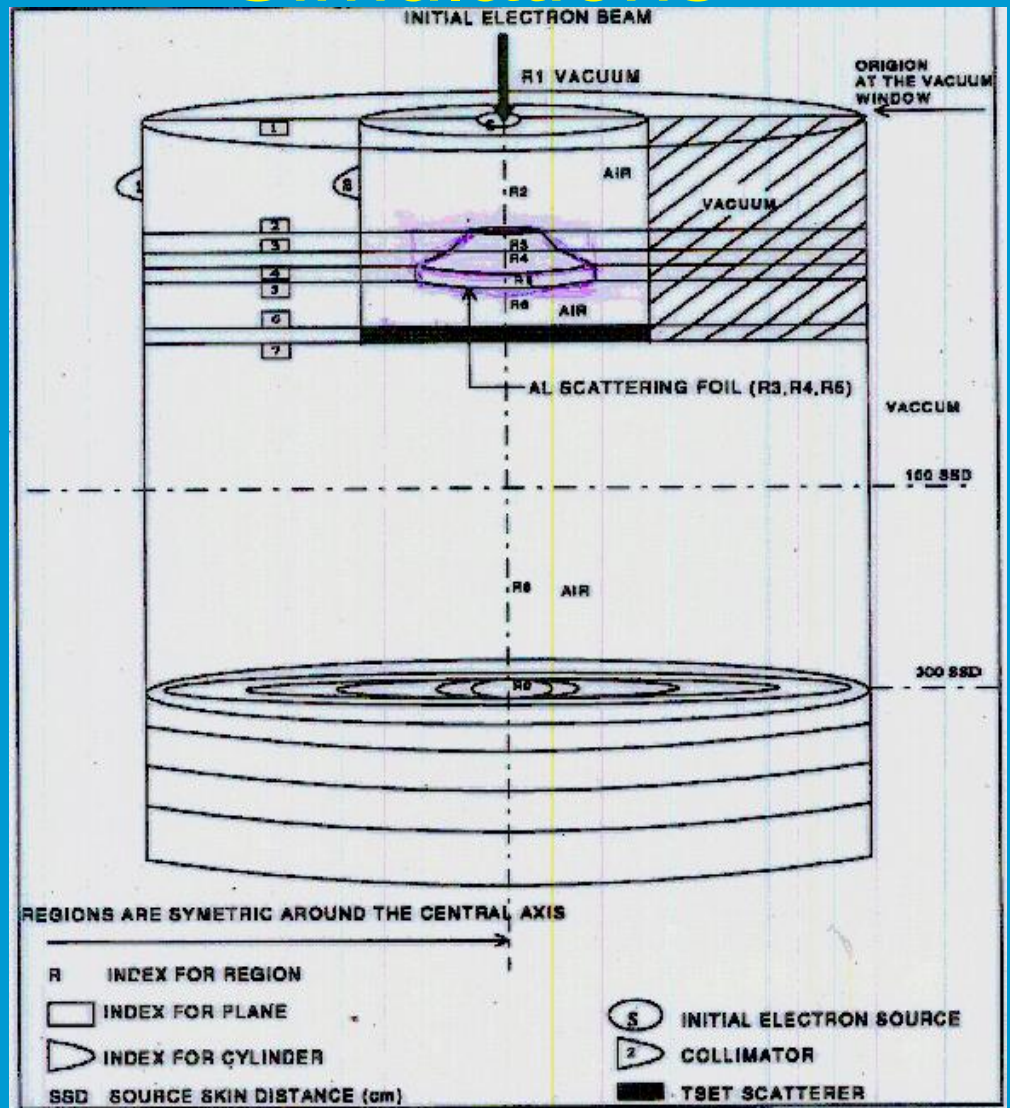


HOWFAR Subprogram

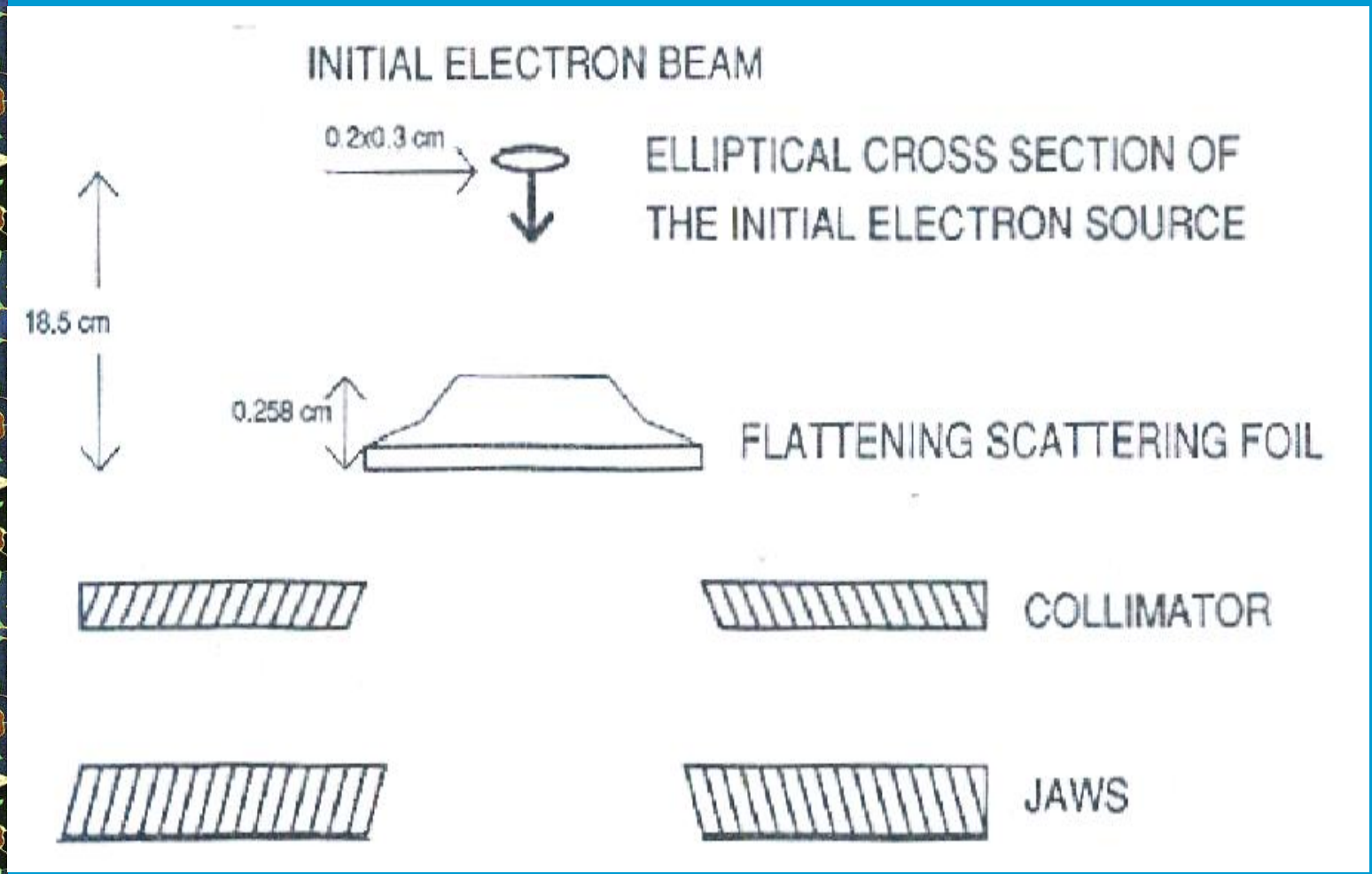
Consisted of subroutines:

- Cylinder
- Cone
- Plane2p
- Plane1

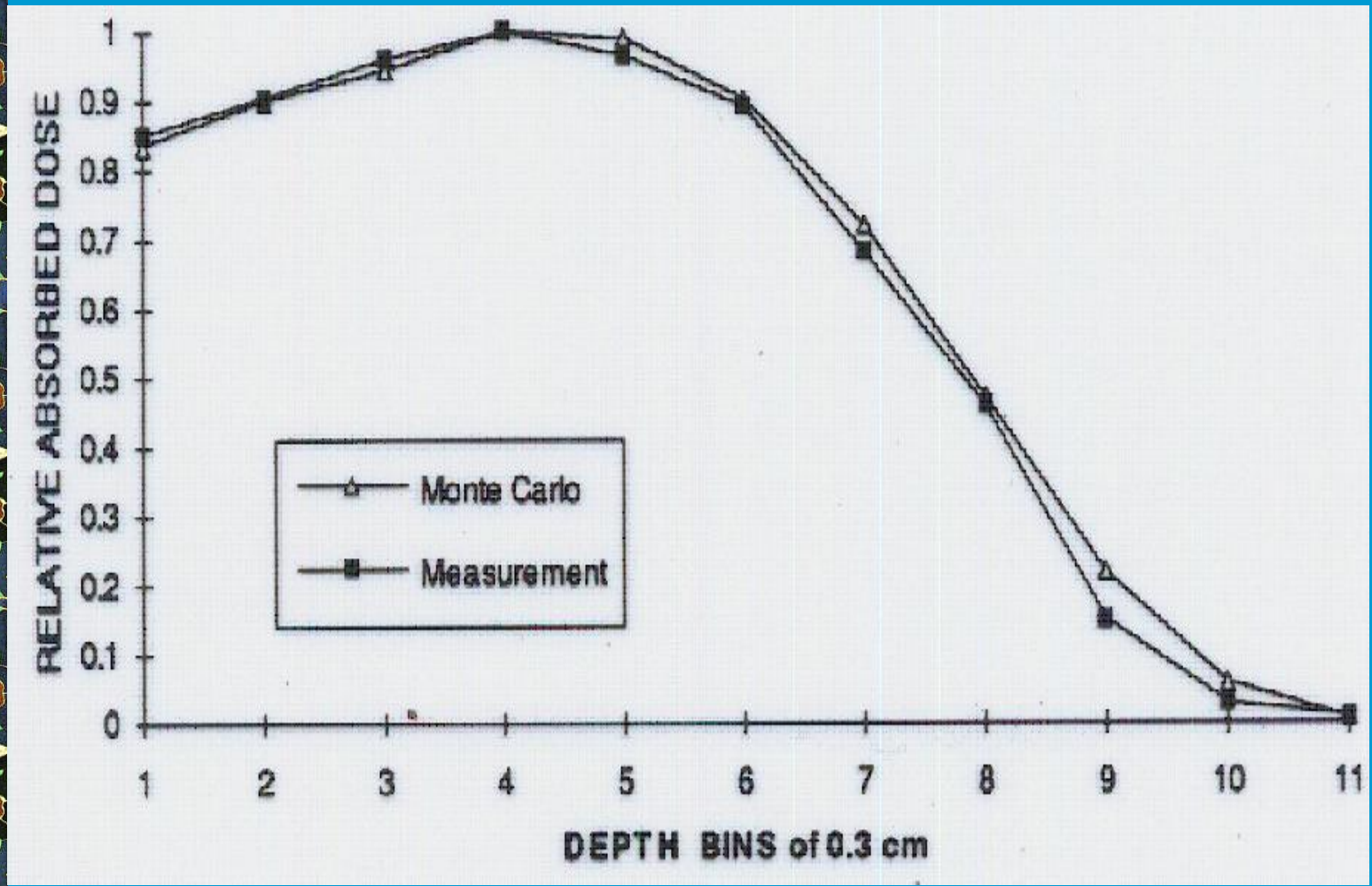
SL-20 Treatment Head: Components Used In The Simulations



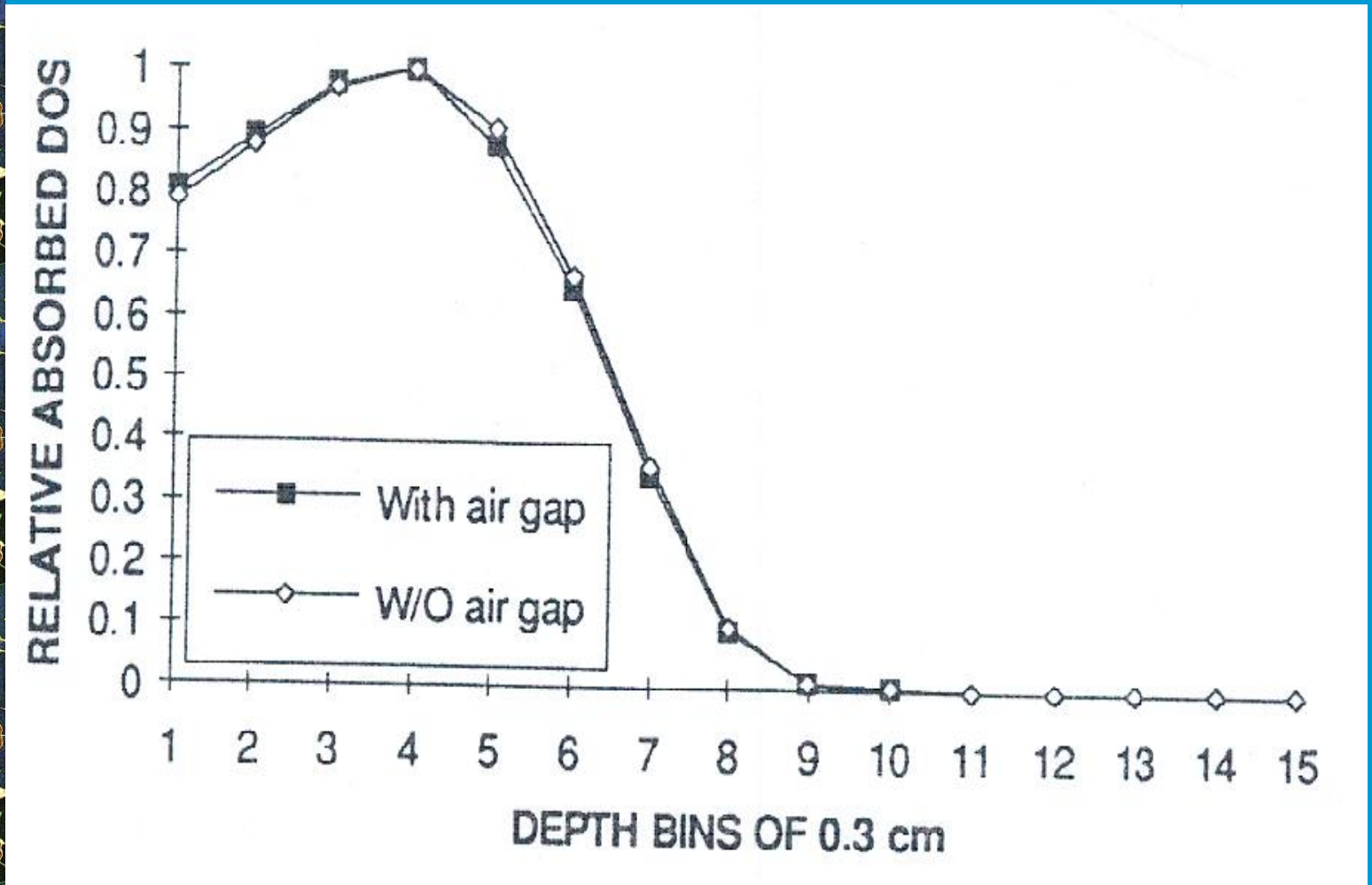
Central Axis PDD IN Water: 6 MeV Open Beam, SSD=95



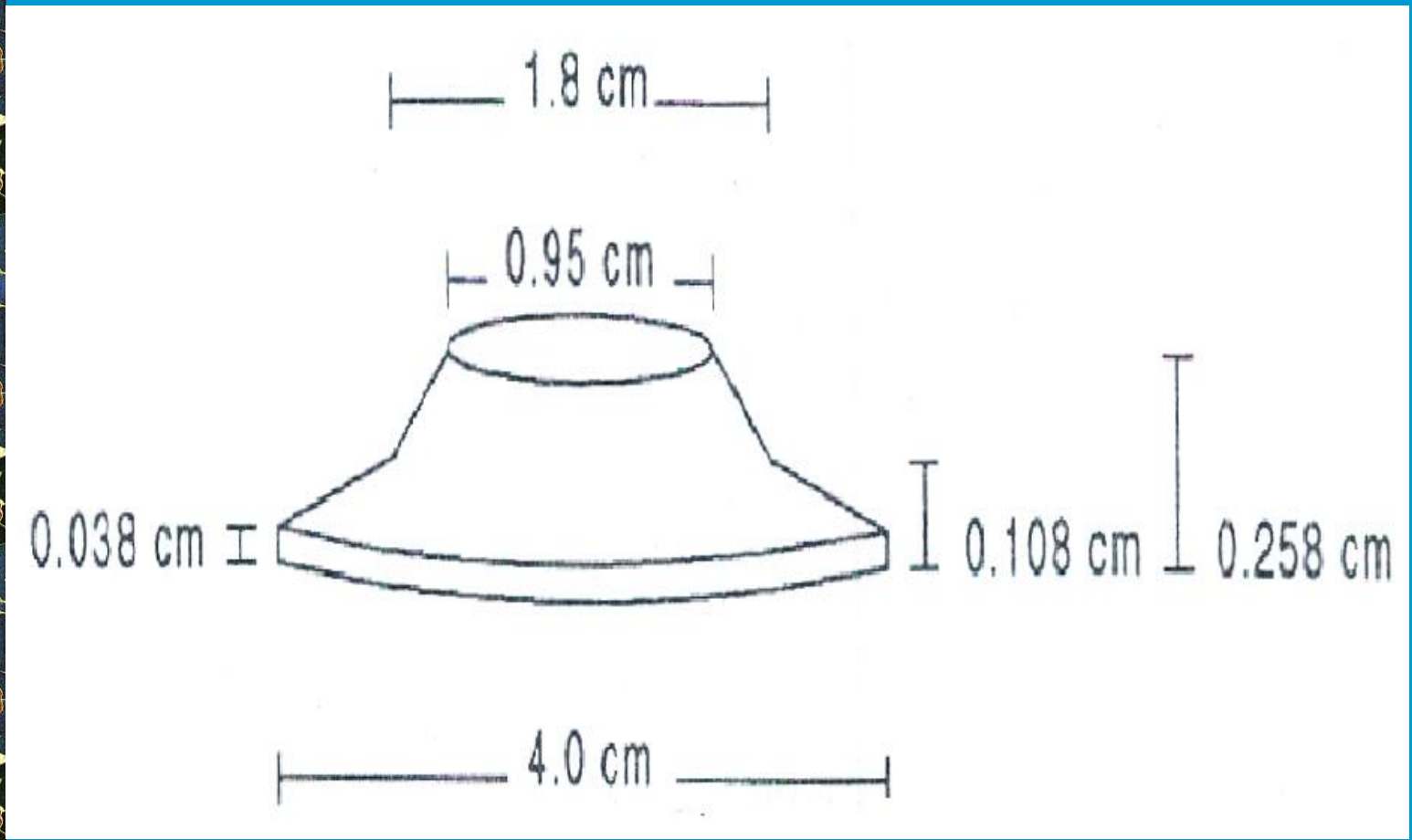
CENTRAL AXIS PDD: MEASURED 6 MeV and CALCULATED 7 MeV SSD=95



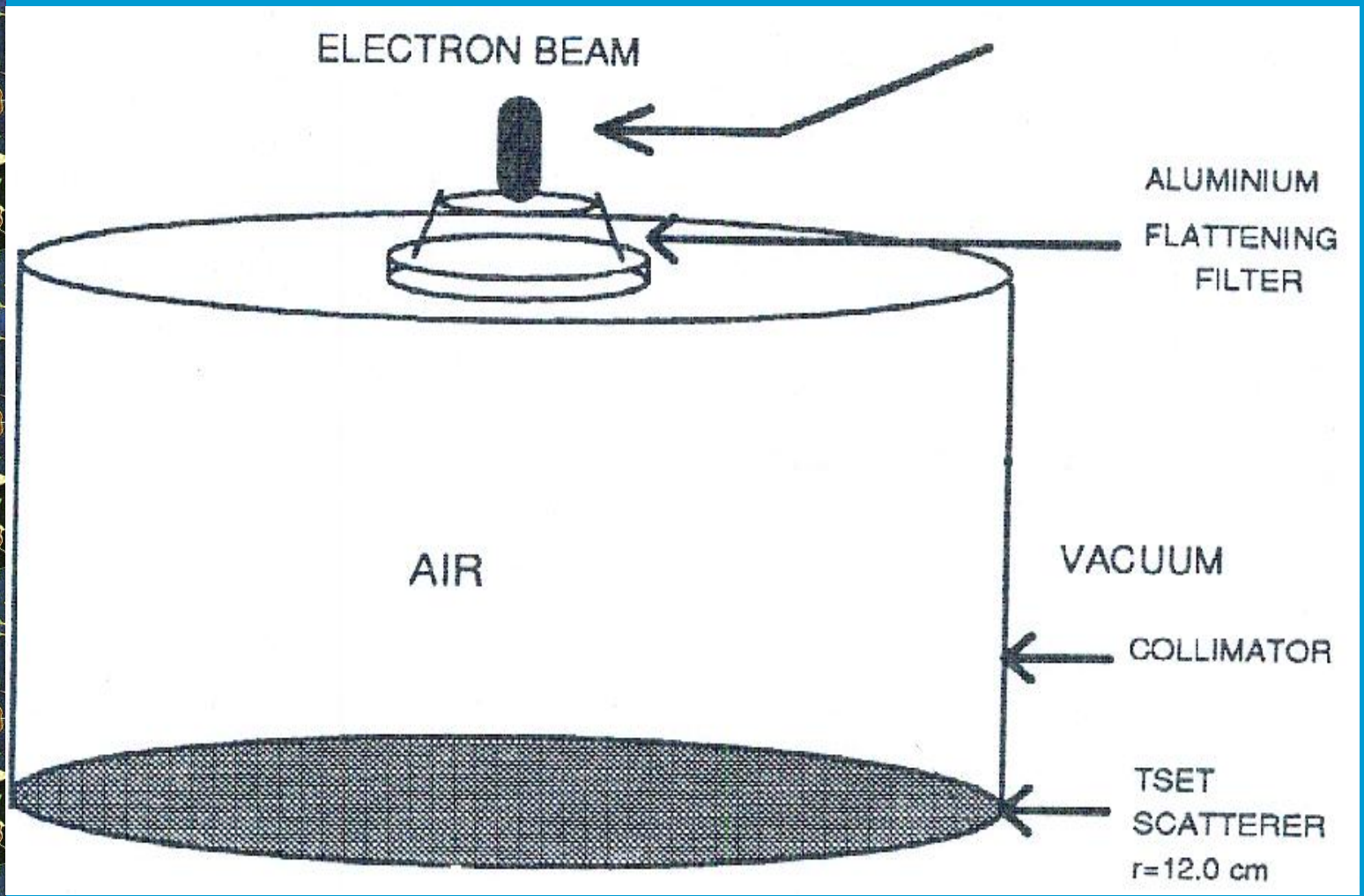
Simulation Of Air Gap Between VACCUM Window And The Flattening Scattering Foil: Effect On CA PDD



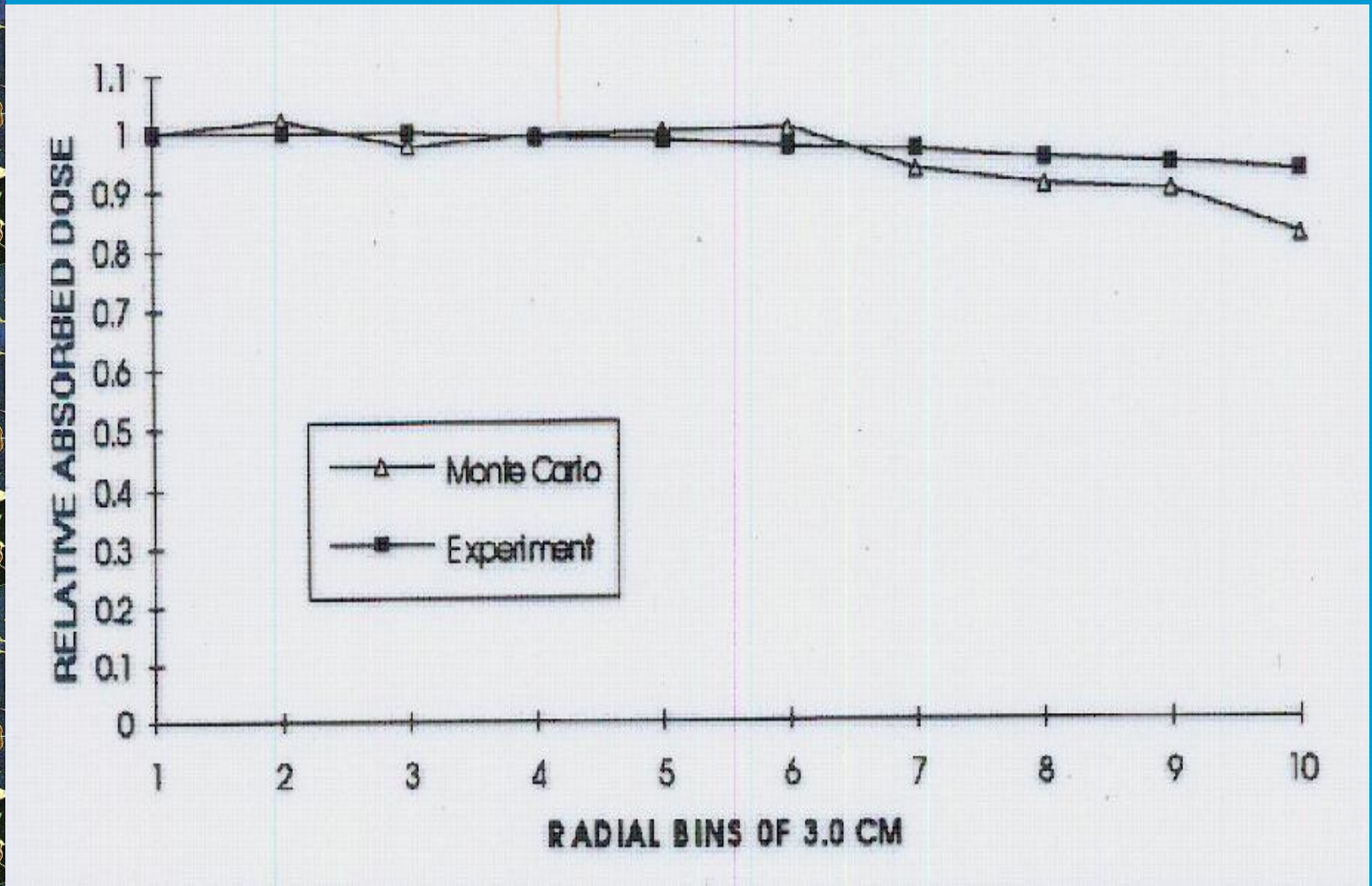
PHYLLIPS SL-20 Flattening Scattering Foil: Dimensions



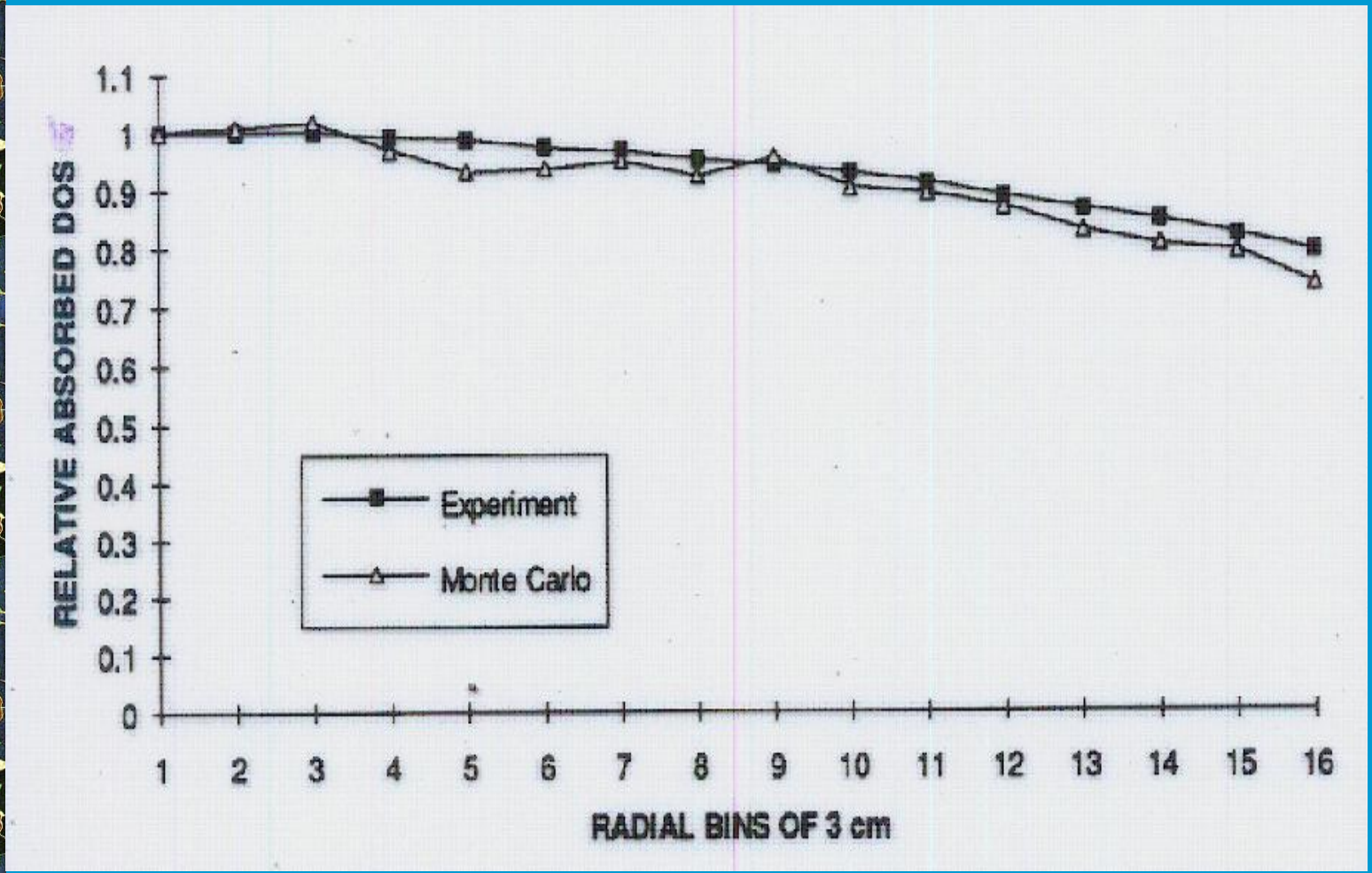
Geometry Used In HOWFAR To Simulate The Treatment Machine Head



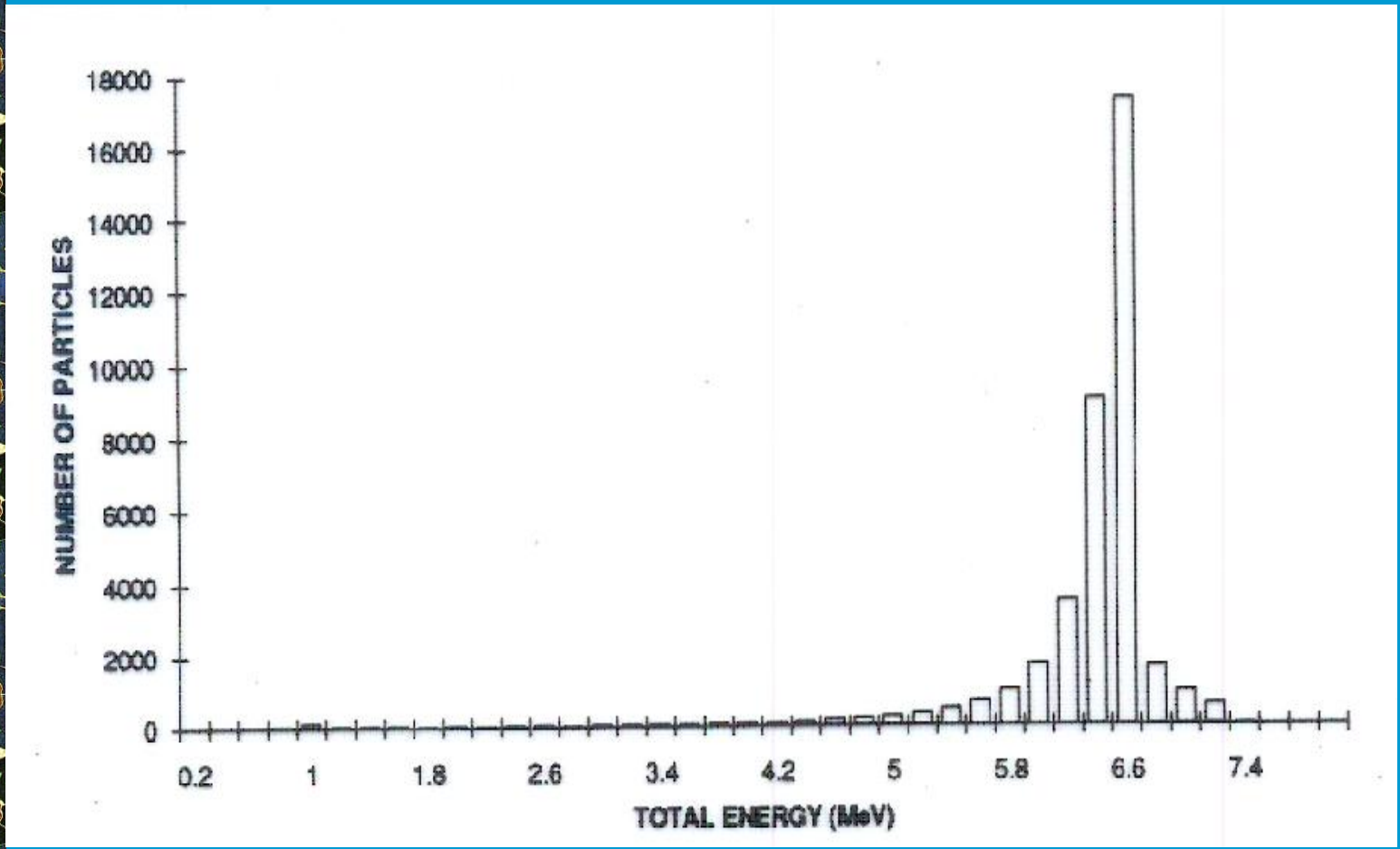
Field Uniformity (dmax)
Scattering Foil Simulated As a Flat Base and One Conic Section, SSD=95



Field Uniformity at dmax: Scattering Foil As a Flat Base and Two Conic Sections, SSD=95



Energy Distribution of Electron Beam Before Entering the TSET Scatterer



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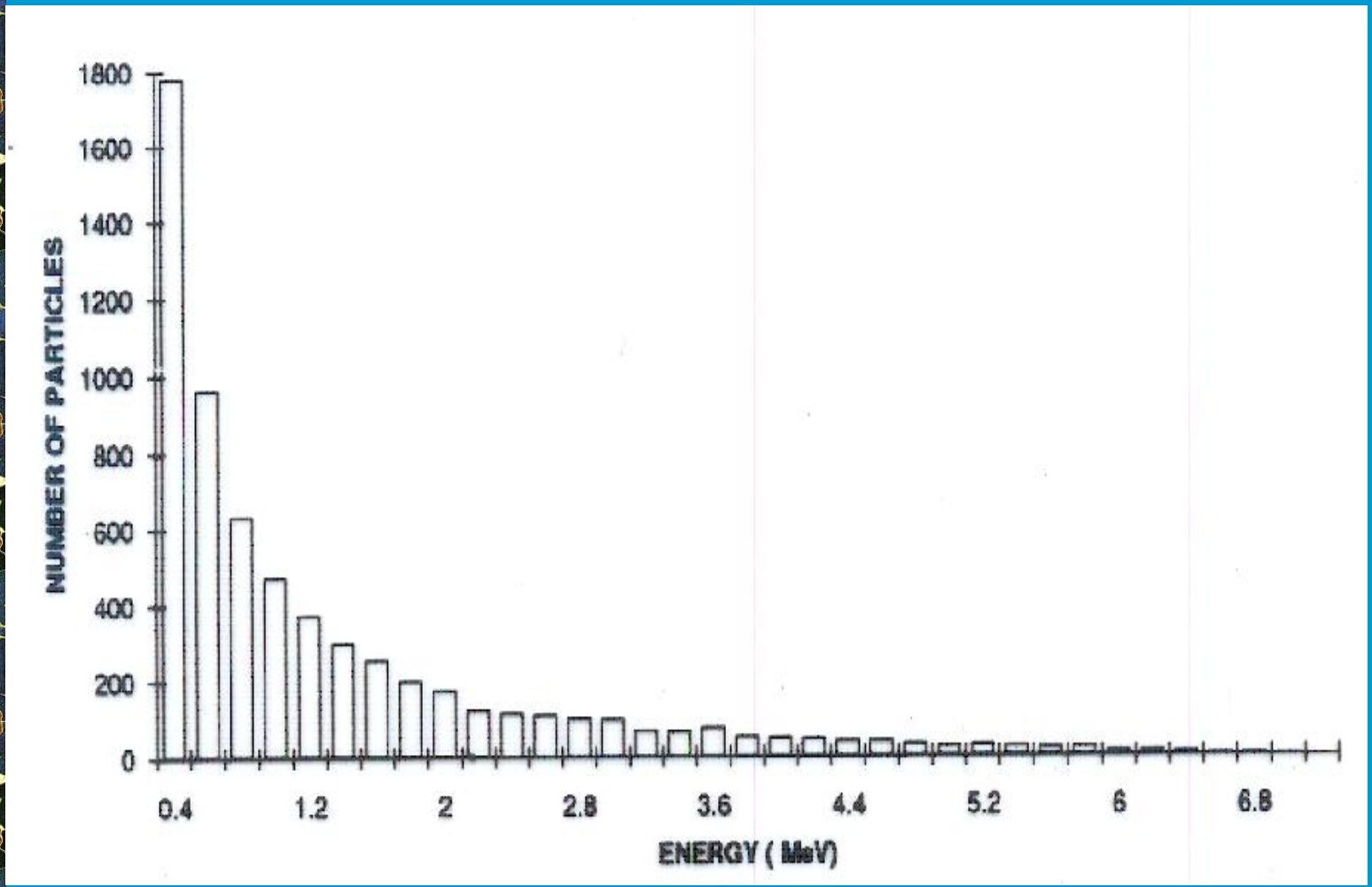
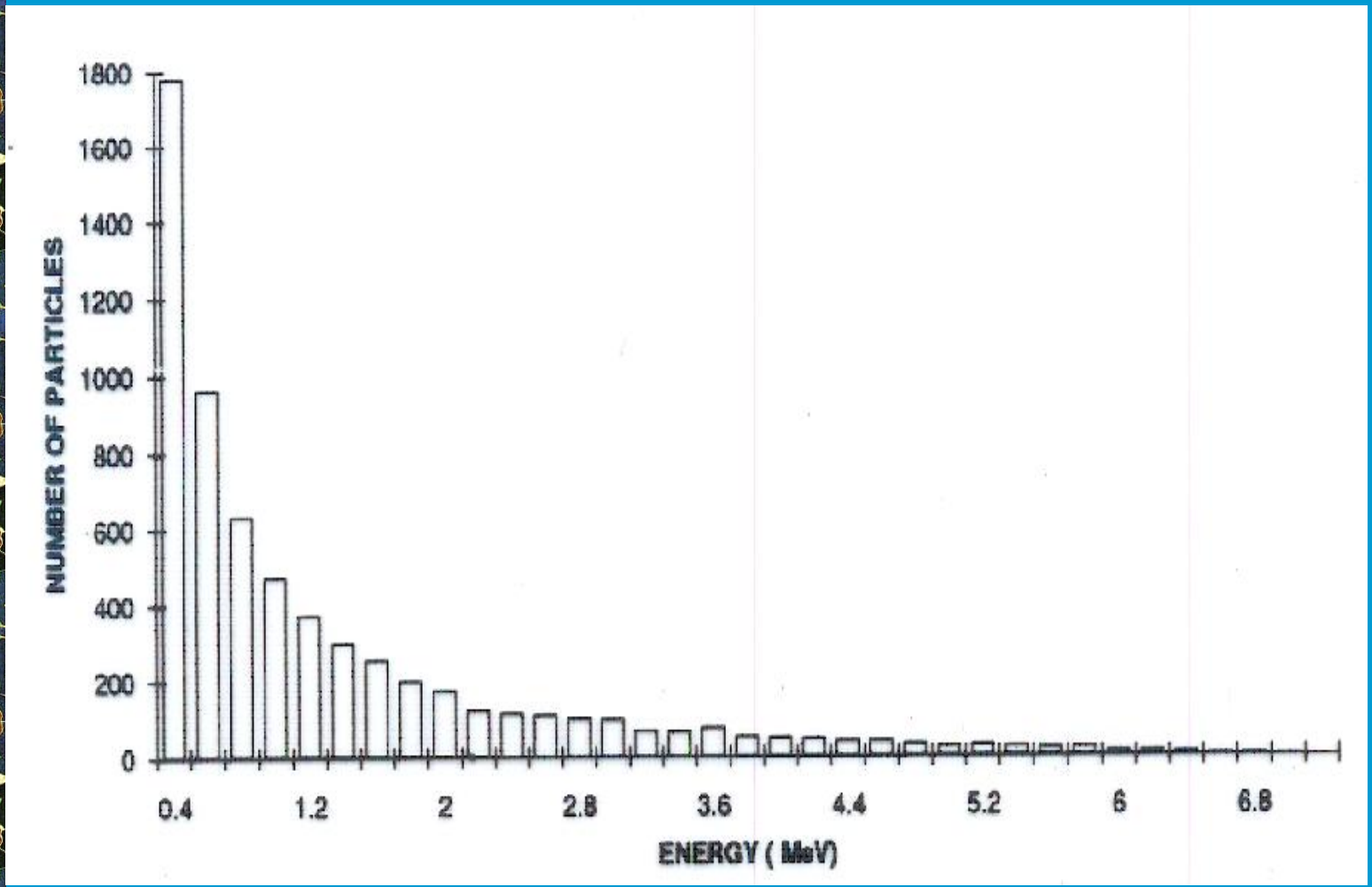
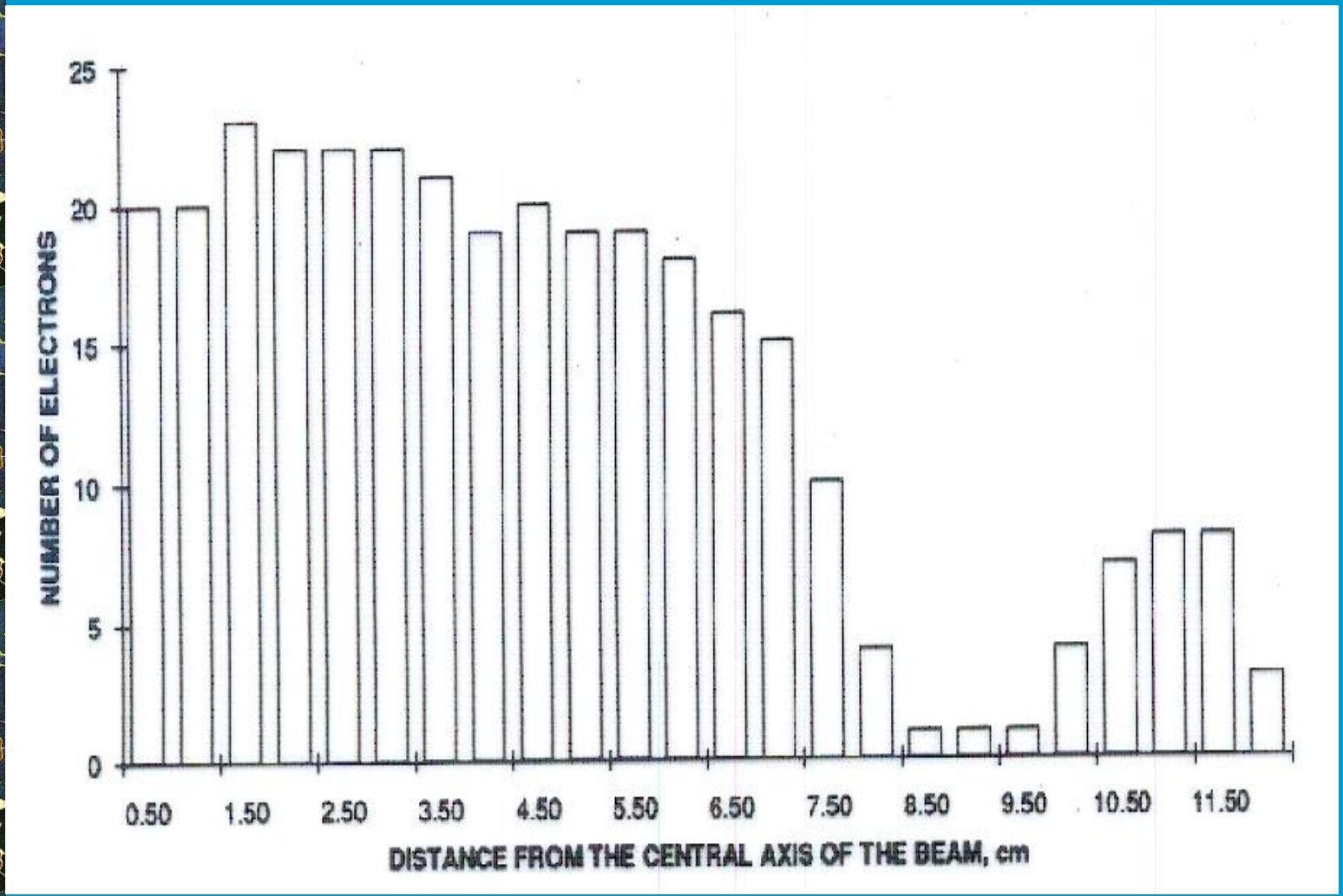


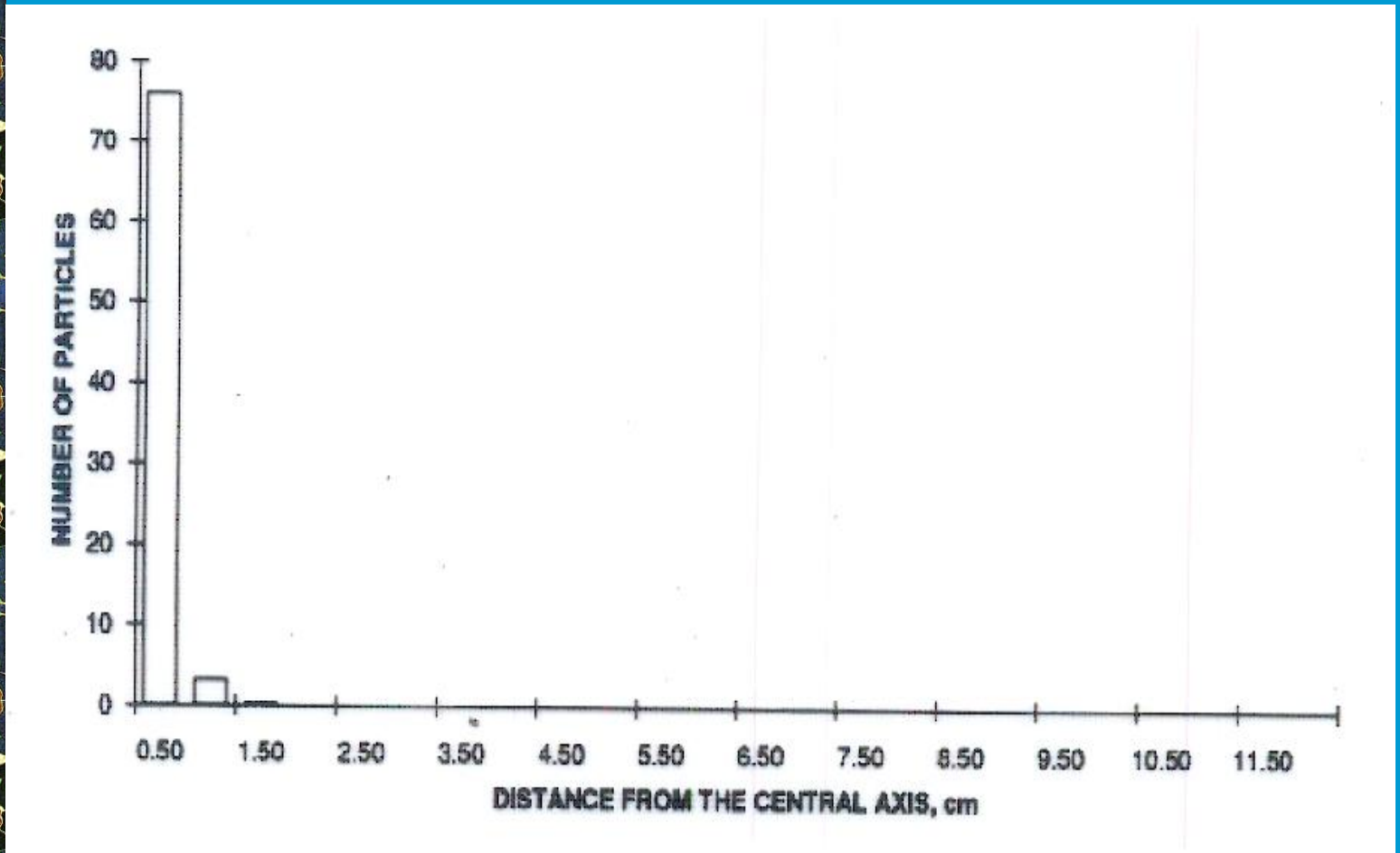
Energy Distribution Of Bremsstrahlung Contamination At The Level Of Scatterer



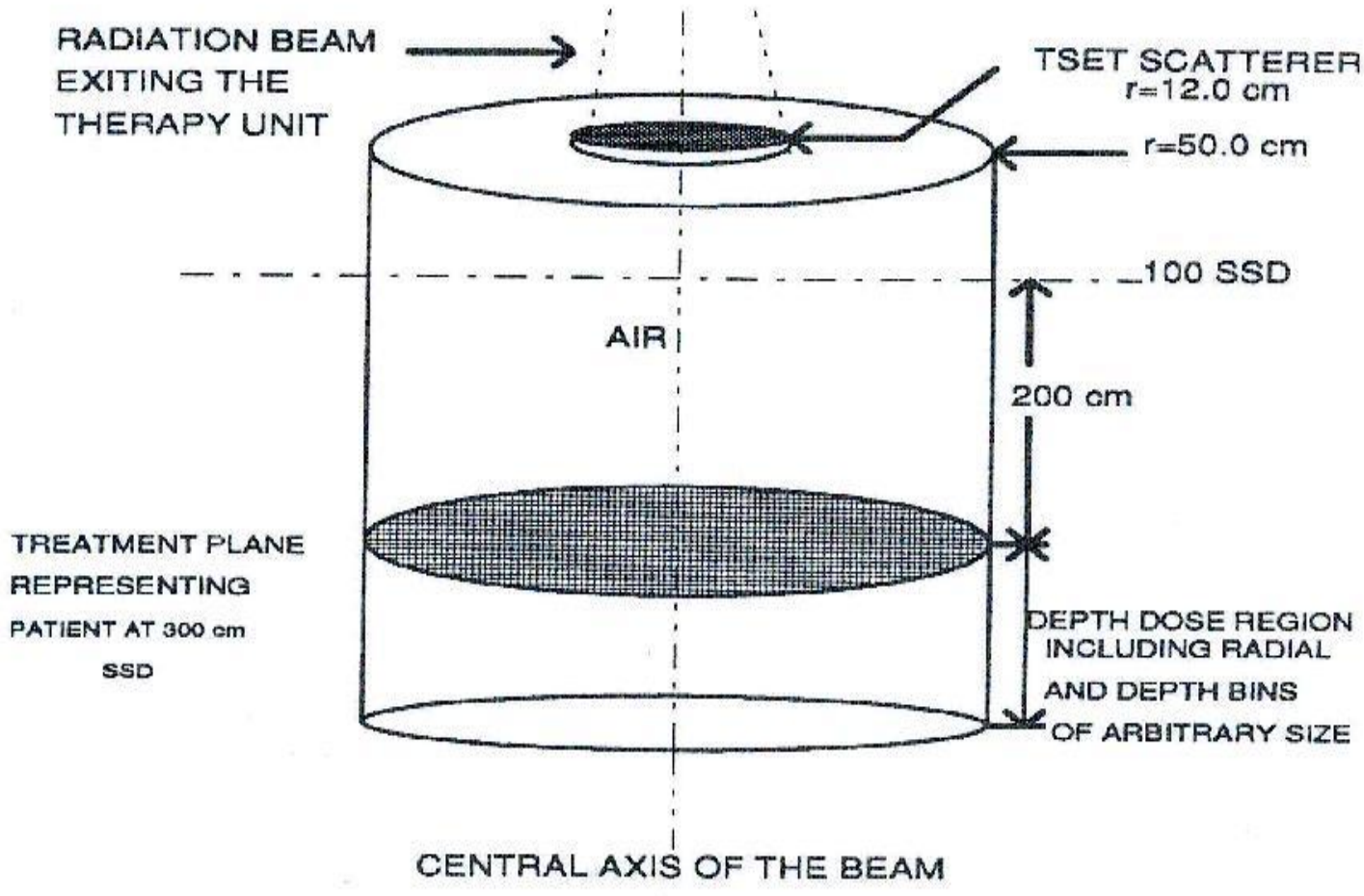
Radial Distribution of Electrons Reaching TSET Scatterer



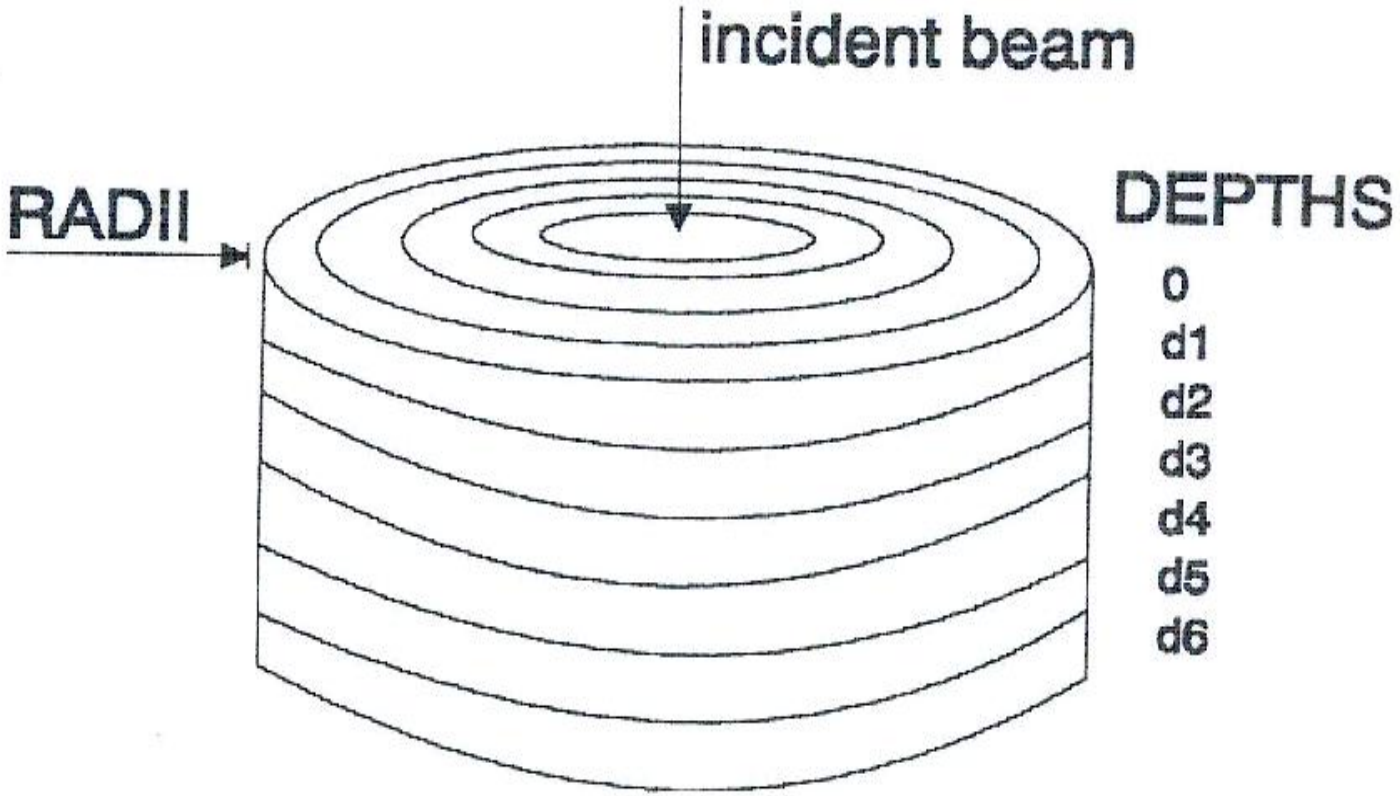
Radial Distribution of Bremsstrahlung Radiation Reaching TSET Scatterer



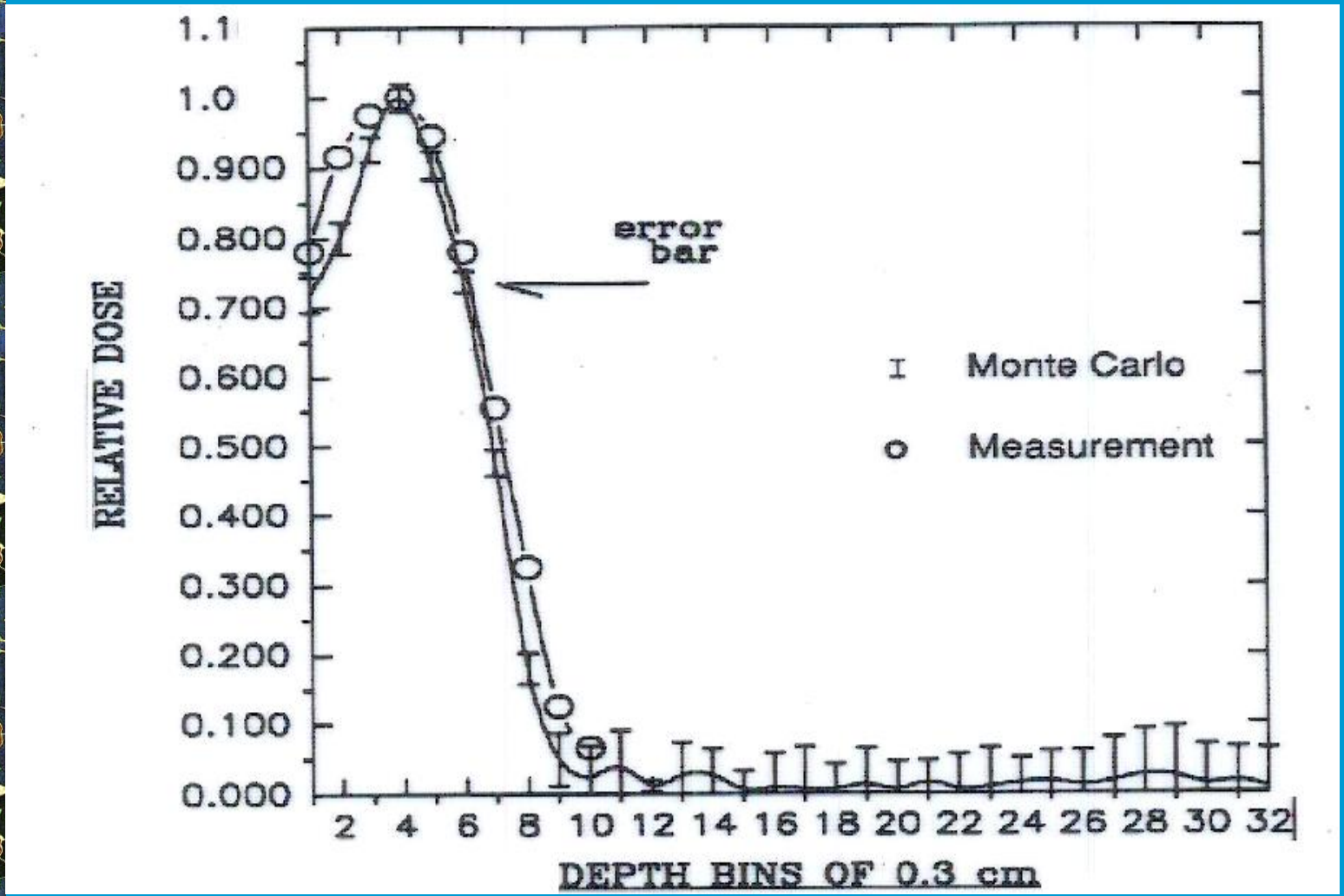
Geometry Used To Simulate Scattered Electron Field At Extended SSD



Geometry Used To Calculate Depth Dose Distributions



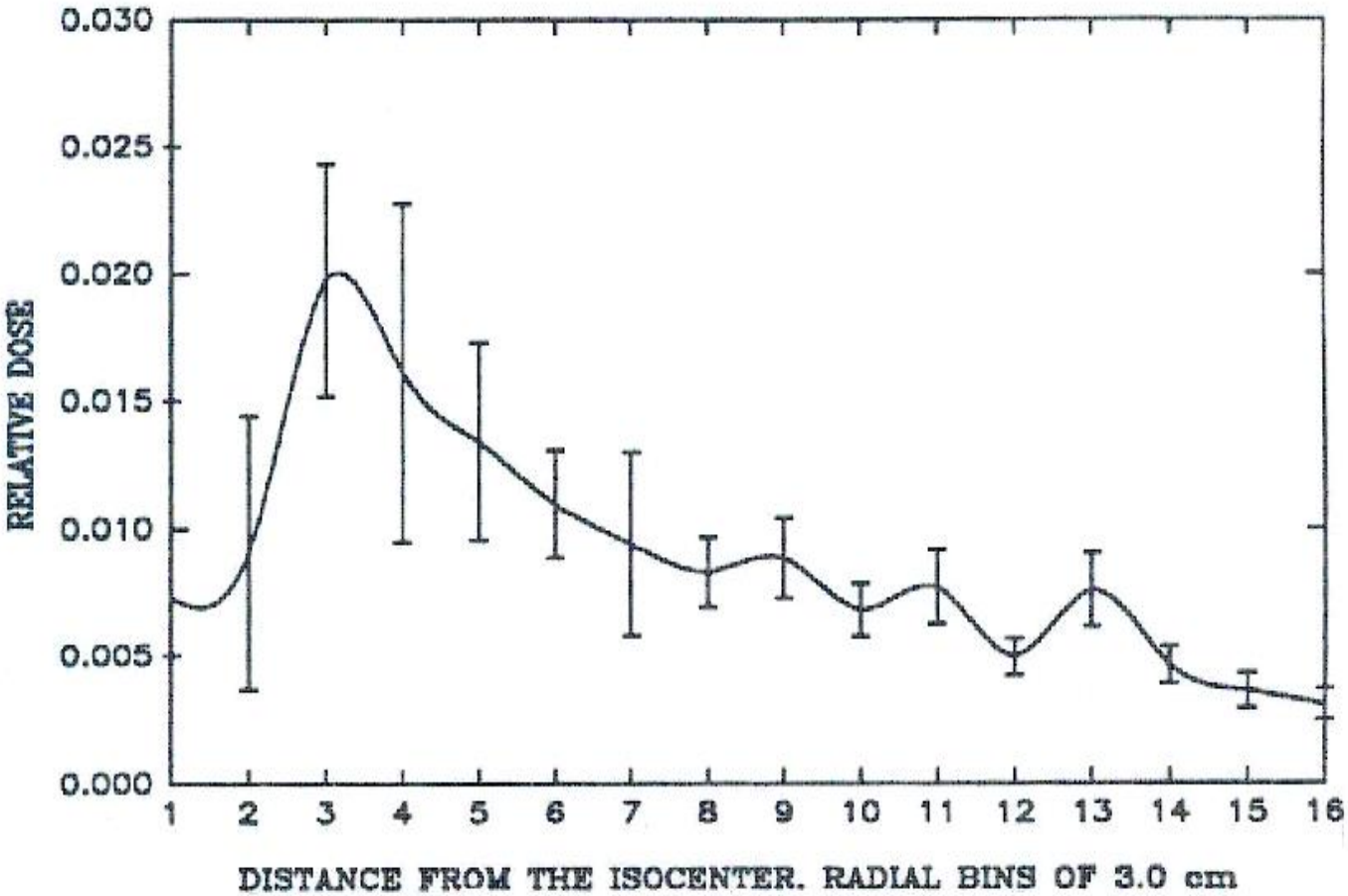
Depth Dose Curve At 300 SSD Scatterer: 0.025 Cm OF COPPER



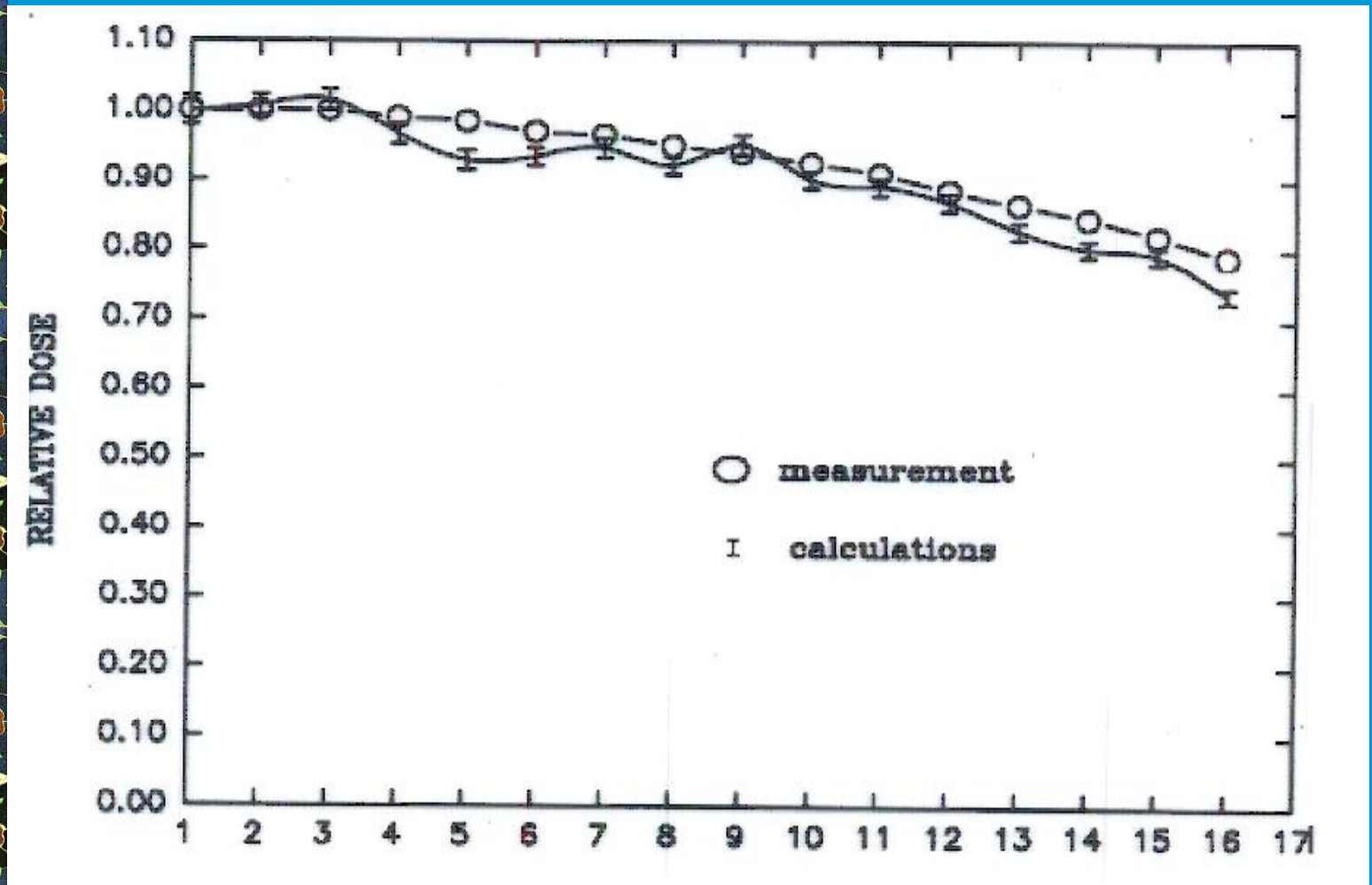
Values Used To Benchmark Monte Carlo Simulations

Depth dose parameters	Monte Carlo	Measurement
Surface dose	73%	78%
d_{max}	1.2 cm	1.2 cm
$d_{80\%}$	1.8 cm	1.76 cm
$d_{50\%}$	2.1 cm	2.2 cm

BREMSS CONTAMINATION
COPPER SCATTERER
RELATIVE TO DMAX, TREATMENT PLANE AT 300 SSD, D=10cm



Uniformity At DMAX
Copper SCATERER
300 SSD



Conclusions

- EGS4 Monte Carlo code together with the user code developed in this research, simulated a single field TSET technique accurately
- Problem areas:

1- central axis surface dose

2- distance dependency of x-ray contamination

Thank you for your time and attention

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