

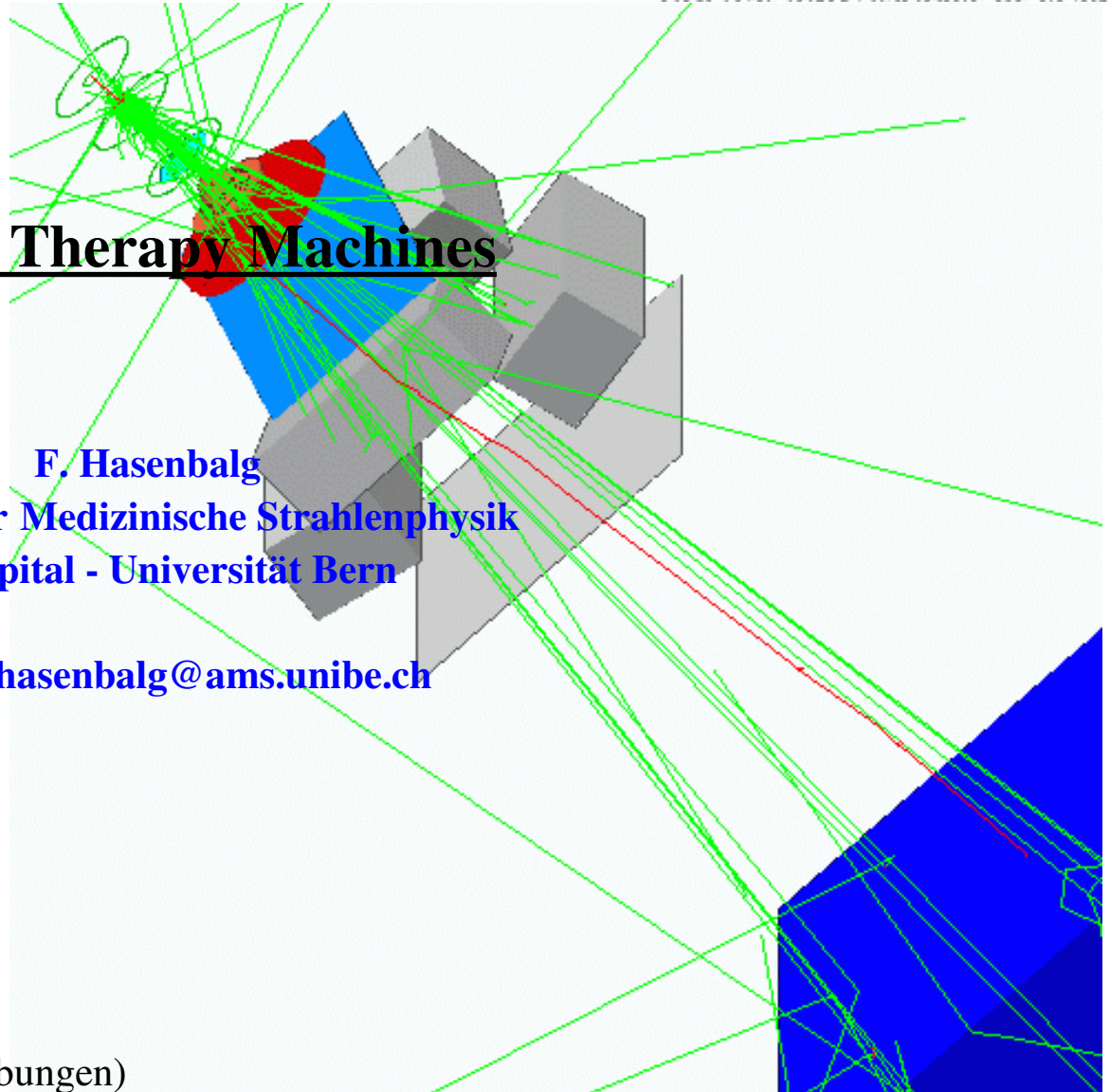


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Photon Therapy Machines

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EGSRay: Simplified linear accelerator in vacuum or air

' Linac electron beam
' simplified model of an electron field
' in vacuum or air
' and a water phantom
,

Daten

D:\...\700icru.dat

Randomseed

1802 9373

Histories

1000000

Punktquelle

0. 0. -1.

Richtung

0. 0. 1.

Elektronen

Energie

10.511

Rechenraum

-10 -10 -2 10 10 110.

Scoringraum

-10.1 -10.1 100 10.1 10.1 110

Voxelgröße

0.2 0.2 0.2

Halbraum

AIR700ICRU

2 0 1

Halbraum

H2O700ICRU

2 100 1

Presta

electron
source

To have vacuum
comment these lines

Water
phantom
at SSD 100 cm

Histogramm

2 1

Histogramm

2 10

Histogramm

2 20

Histogramm

2 50

Histogramm

2 87.5

Histogramm

2 100

Histogramm

2 101

Histogramm

2 102

Histogramm

2 103

Histogramm

2 104

Histogramm

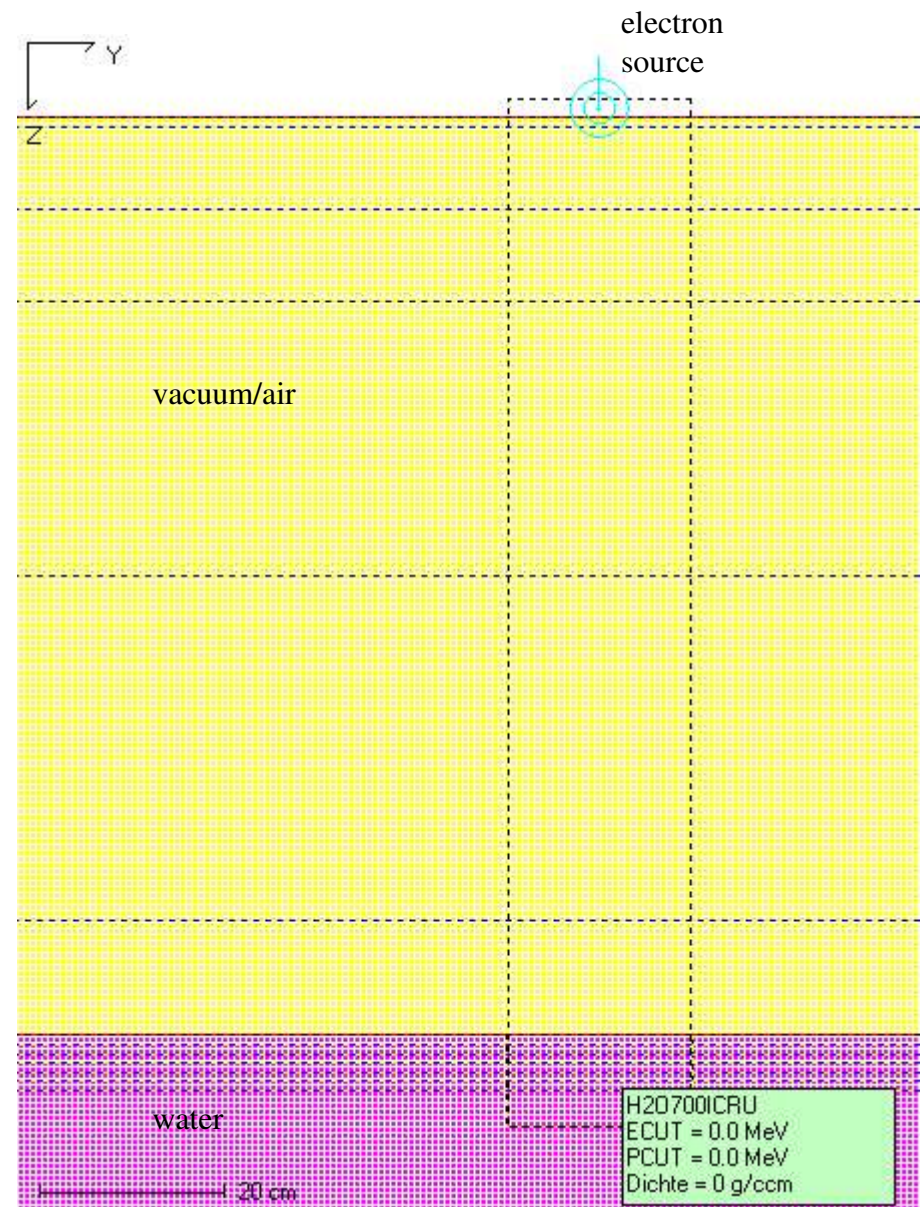
2 105

Histogramm

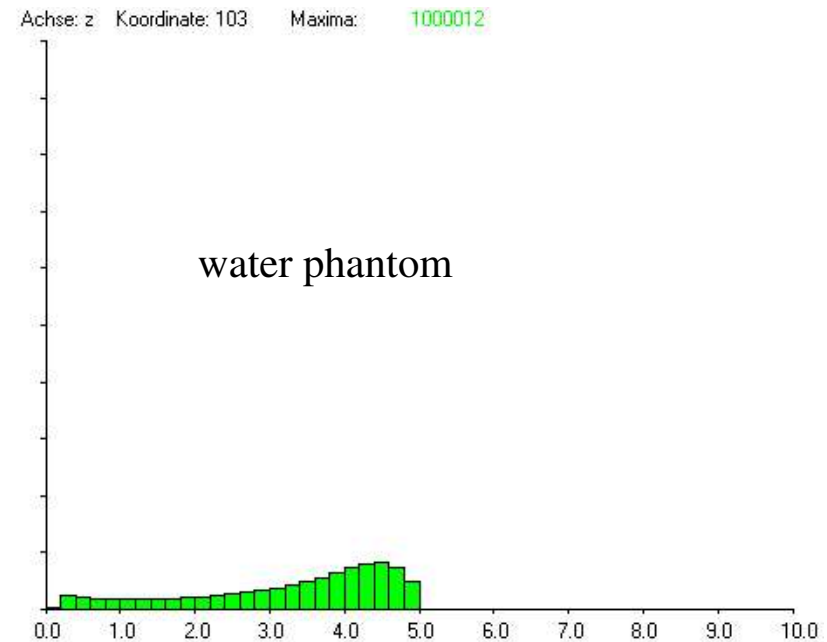
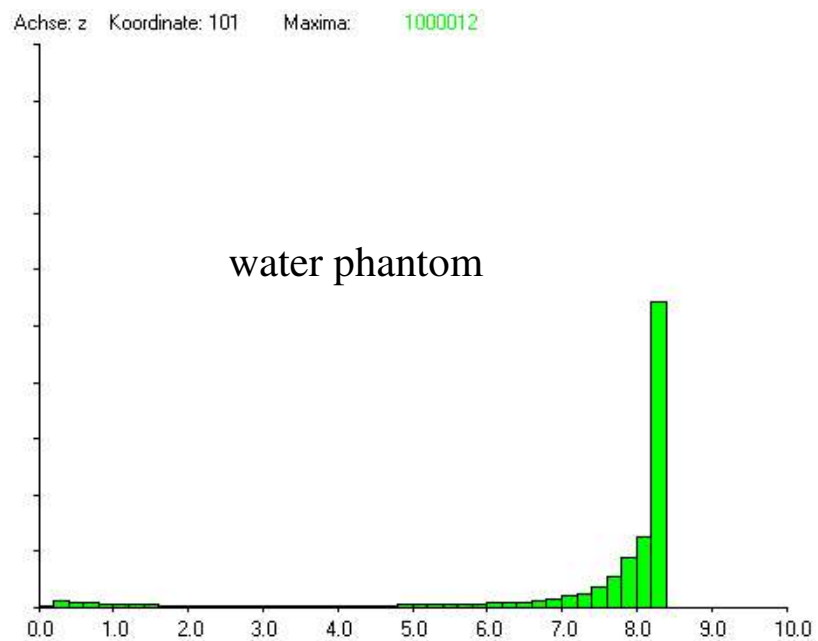
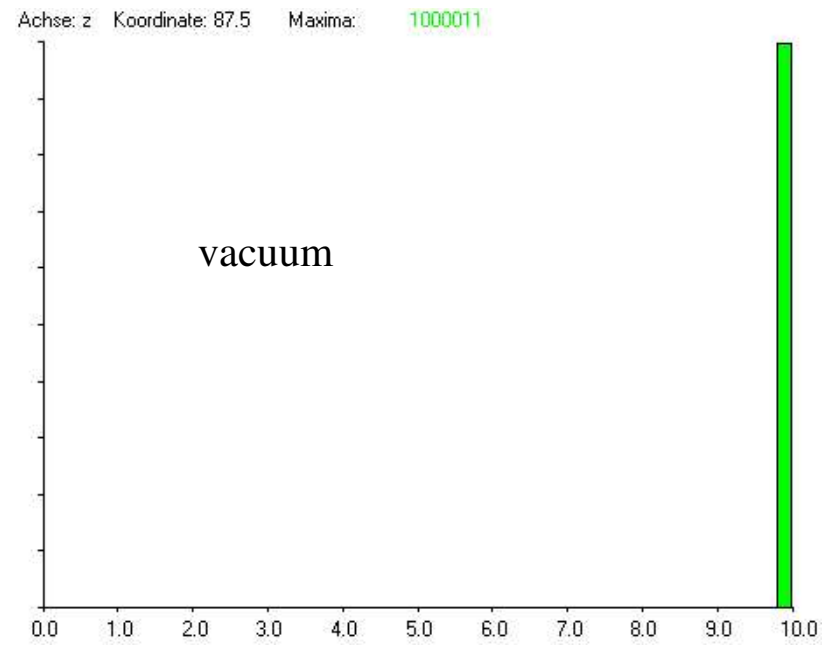
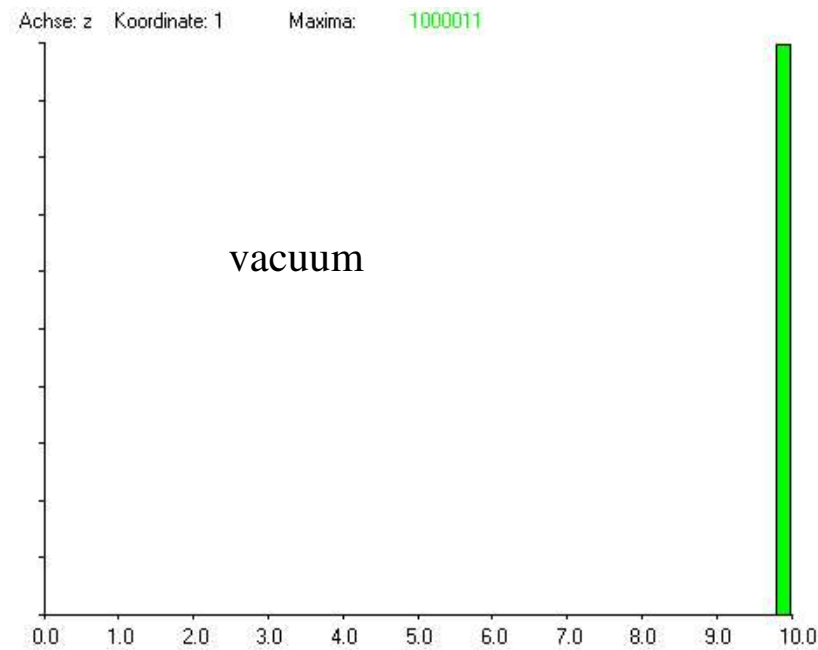
2 106

Histograms
along the beam

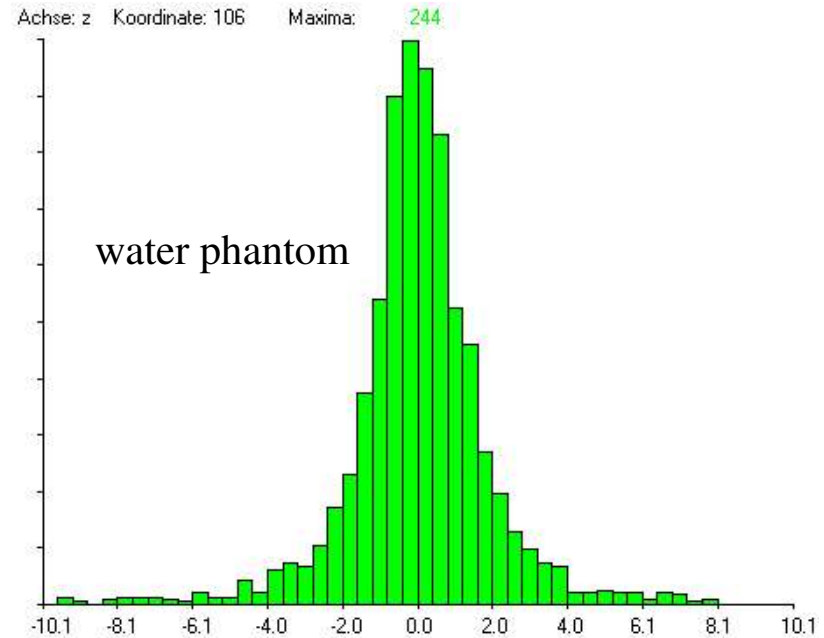
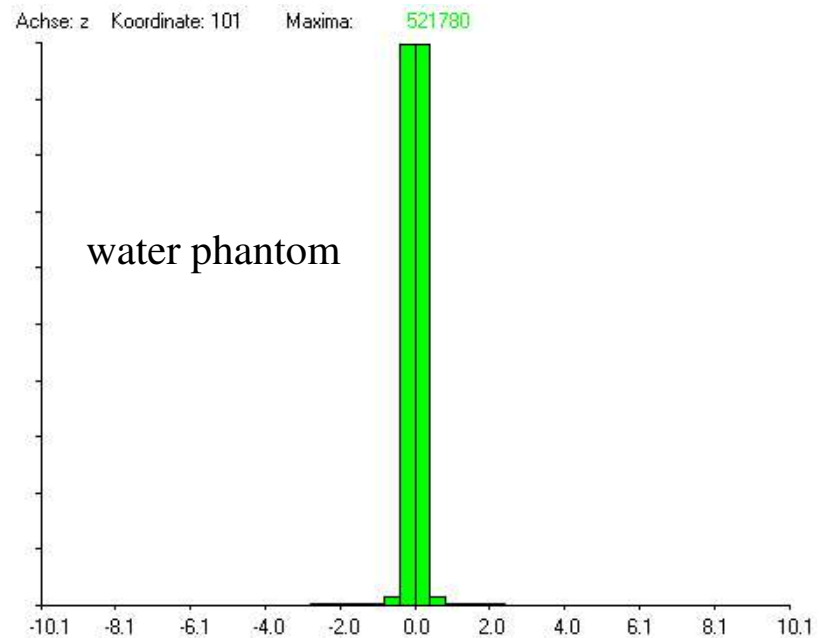
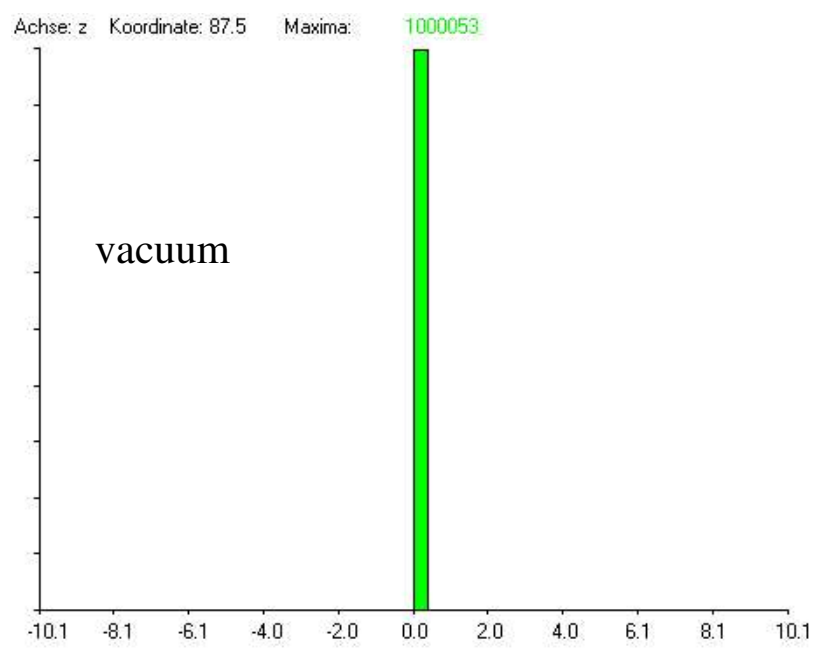
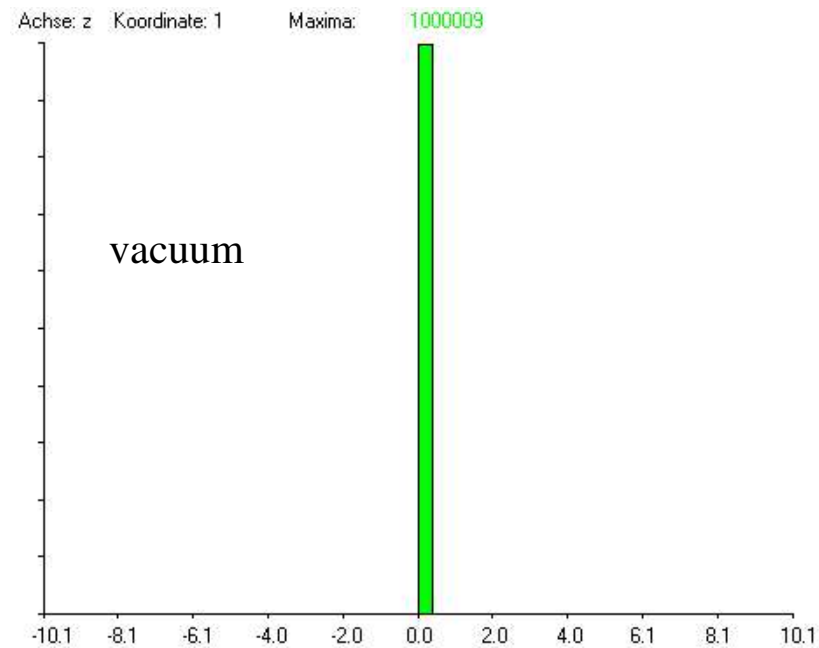
Histograms
in the water
phantom



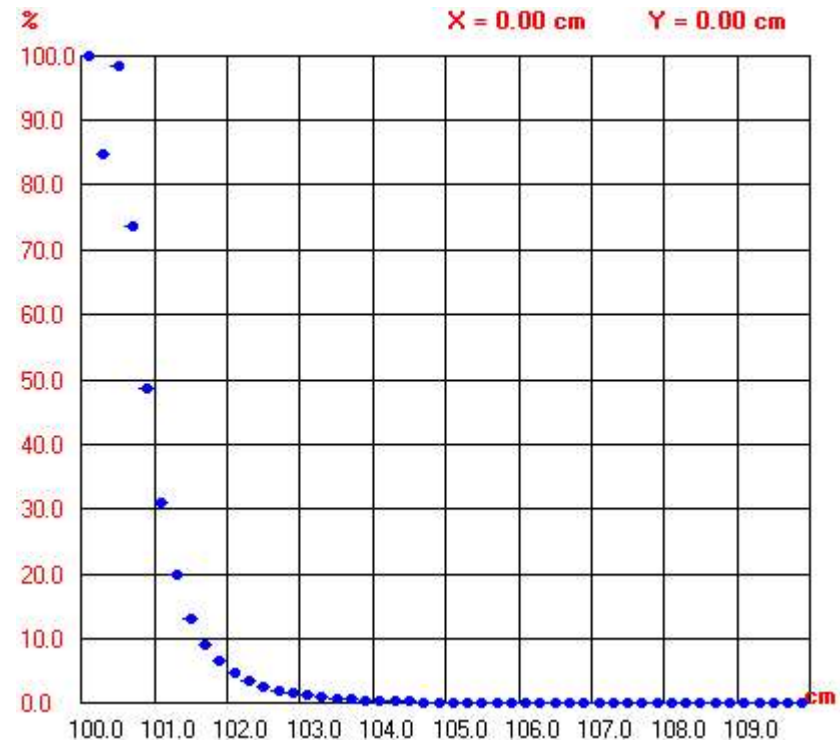
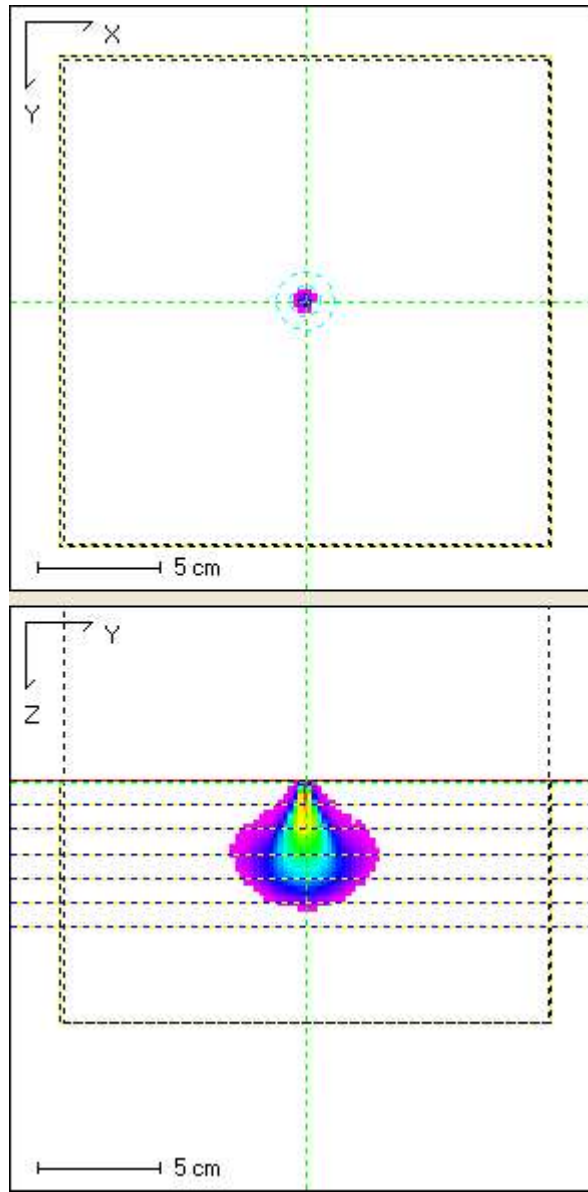
EGSRay: Simplified linear accelerator in vacuum (spectra)



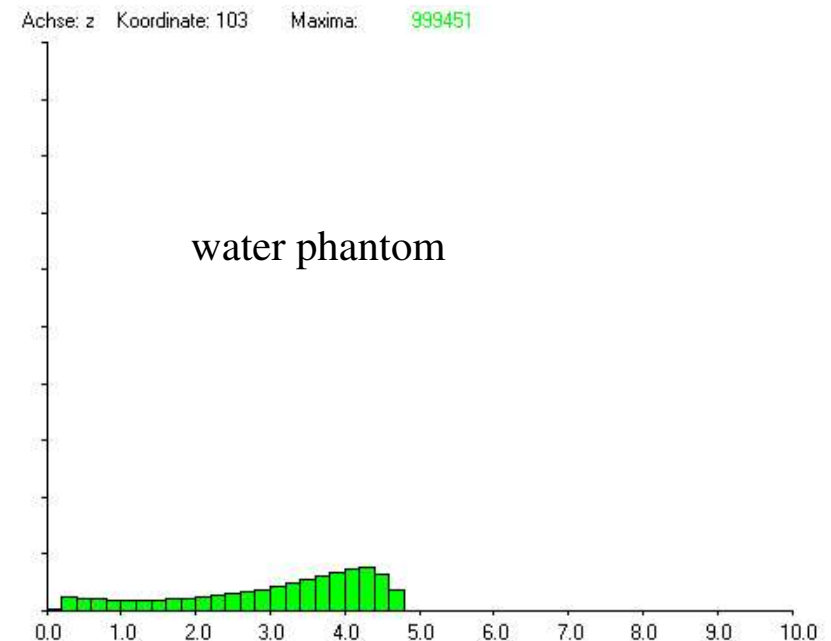
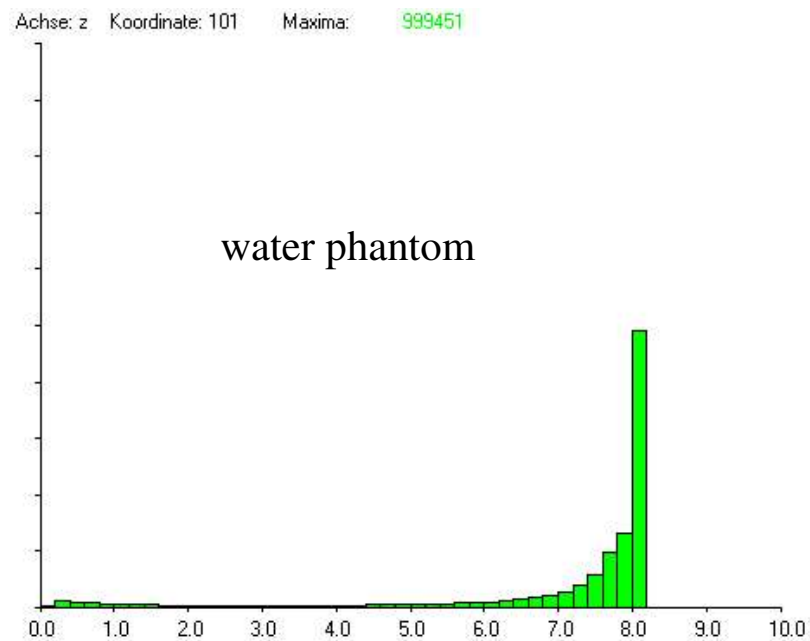
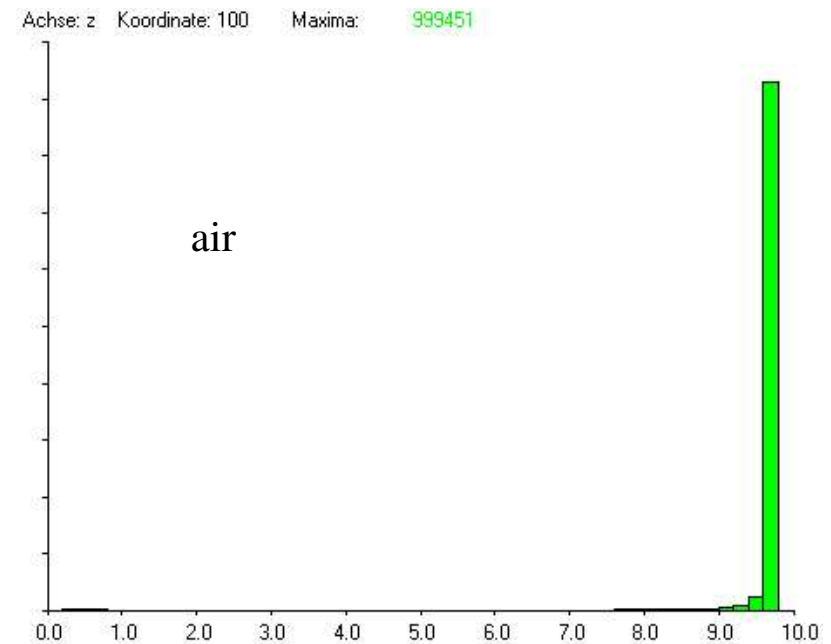
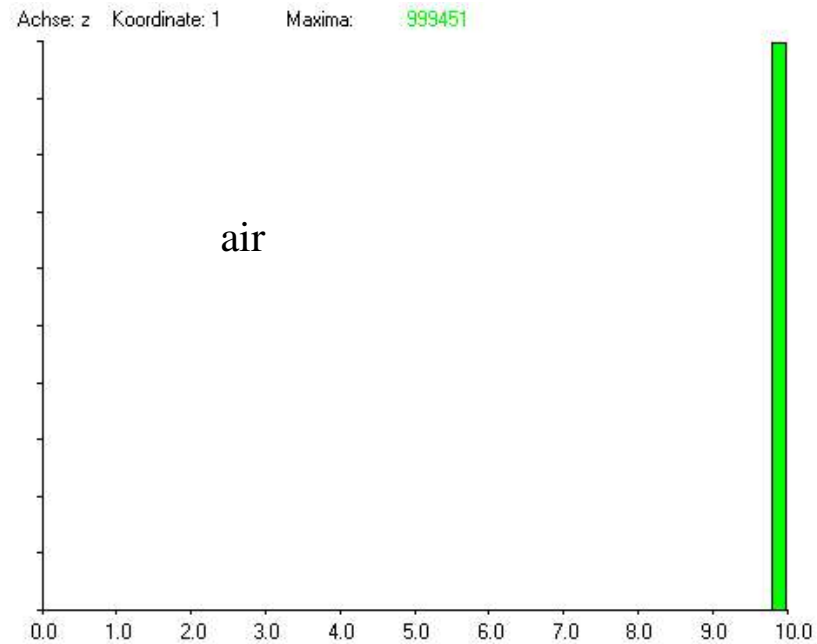
EGSRay: Simplified linear accelerator in vacuum (profiles)



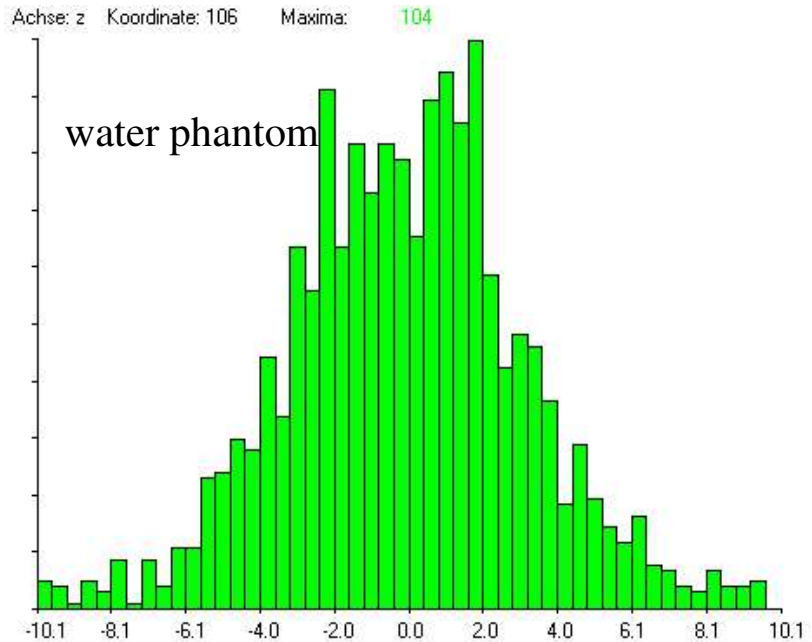
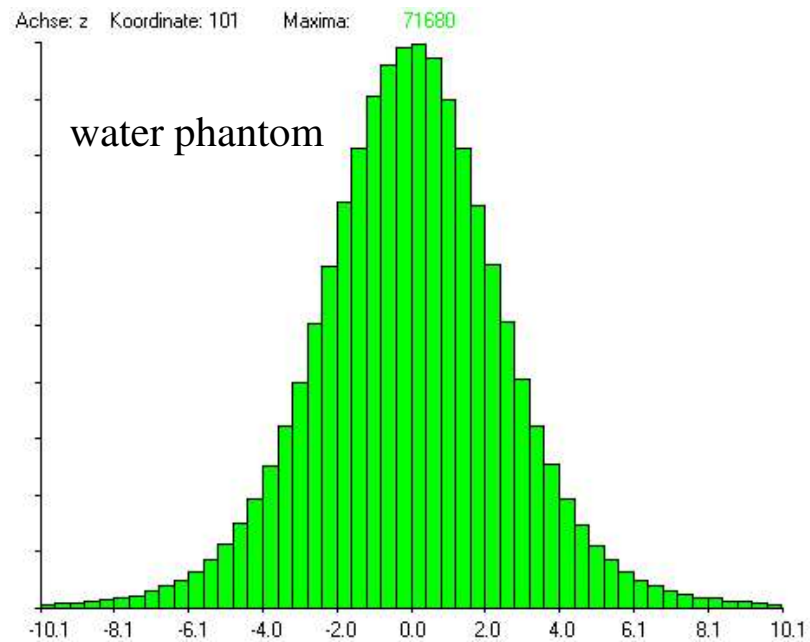
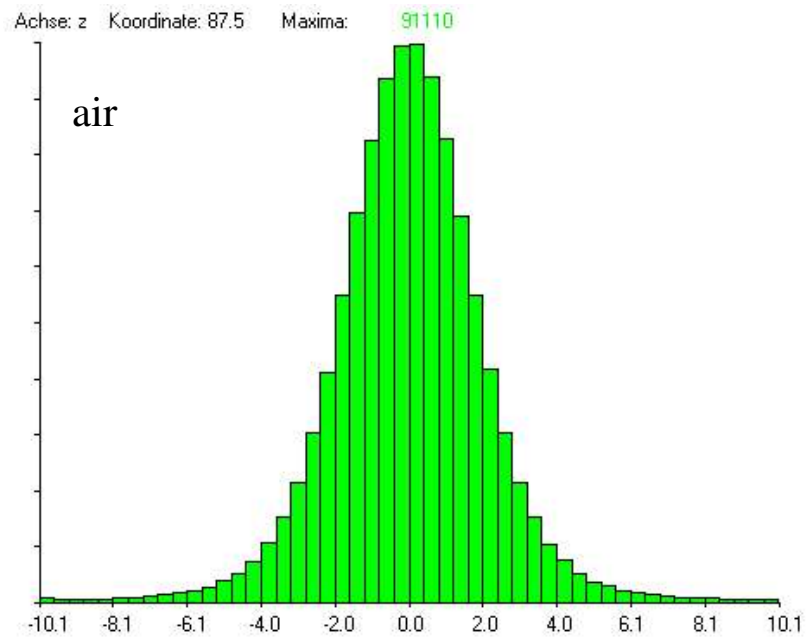
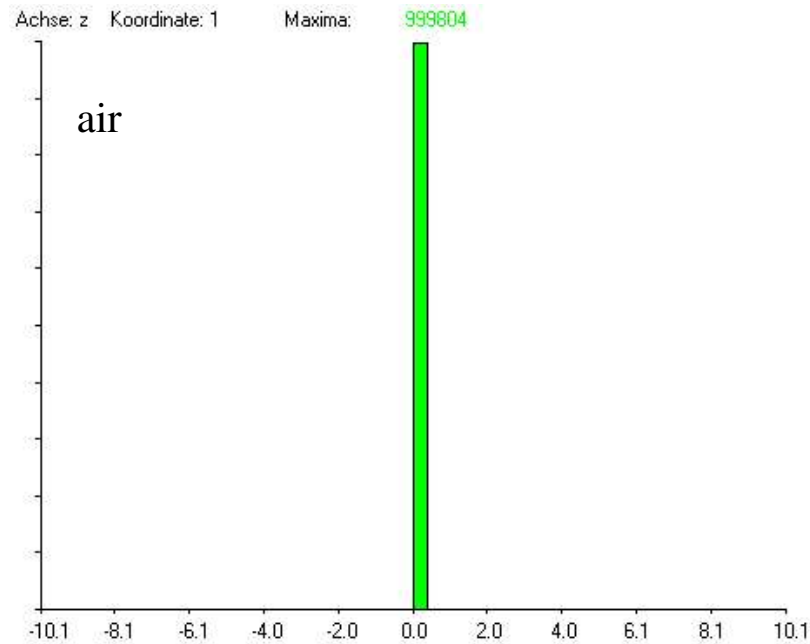
EGSRay: Simplified linear accelerator in vacuum



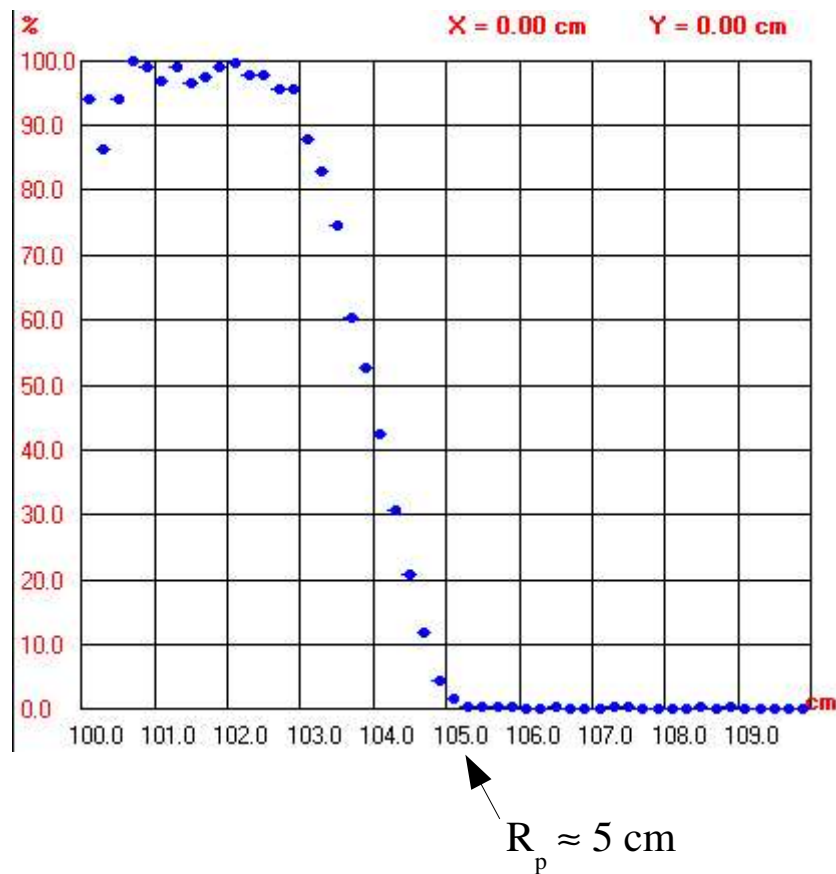
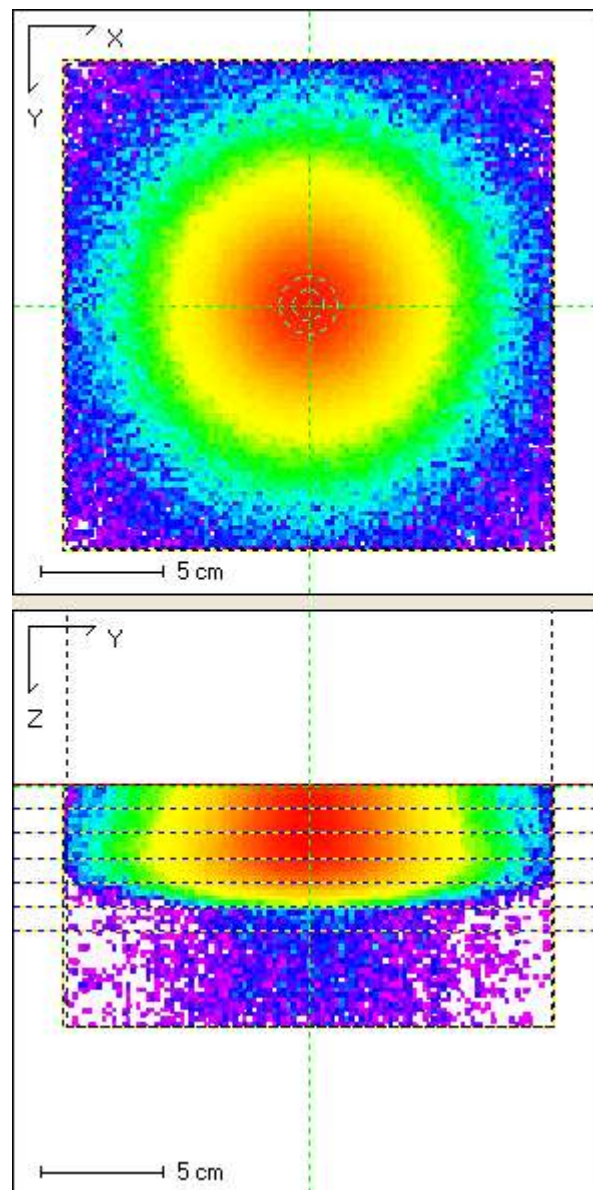
EGSRay: Simplified linear accelerator in air (spectra)



EGSRay: Simplified linear accelerator in air (profiles)



EGSRay: Simplified linear accelerator in air



EGSRay: Simplified linear accelerator with scattering foil

' Linac electron beam
' simplified model of an electron field
' with scattering foil, air
' and water phantom
'

Daten

D:\..\700icru.dat

Randomseed

1802 9373

Histories

4000000

Punktquelle

0 0 -1

Richtung electron

0 0 1 source

Elektronen

Energie

10.511

Rechenraum

-30.1 -30.1 -2 30.1 30.1 110

Scoringraum

-30.1 -30.1 100 30.1 30.1 110

Voxelgröße

0.2 0.2 0.2

Halbraum

AIR700ICRU

2 0 1

Halbraum

H2O700ICRU Water

2 100 1 phantom

at SSD 100 cm

rem

rem scattering foil definition

rem

Platte

TA700ICRU

2 0 0.0035

scattering foil

at z =0

Presta

Histogramm

2 1

Histogramm

2 10

Histogramm

2 20

Histogramm

2 50

Histogramm

2 87.5

Histogramm

2 100

Histogramm

2 101

Histogramm

2 102

Histogramm

2 103

Histogramm

2 104

Histogramm

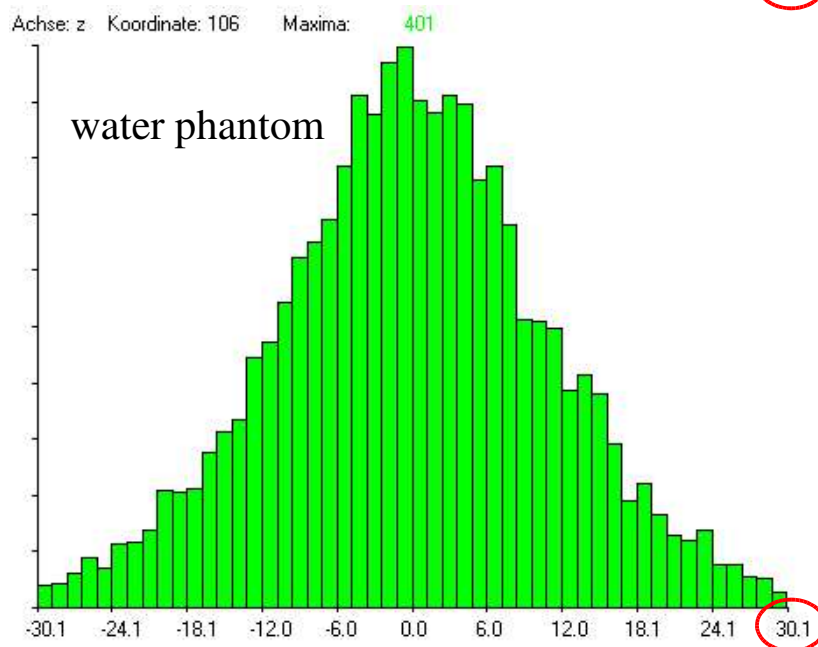
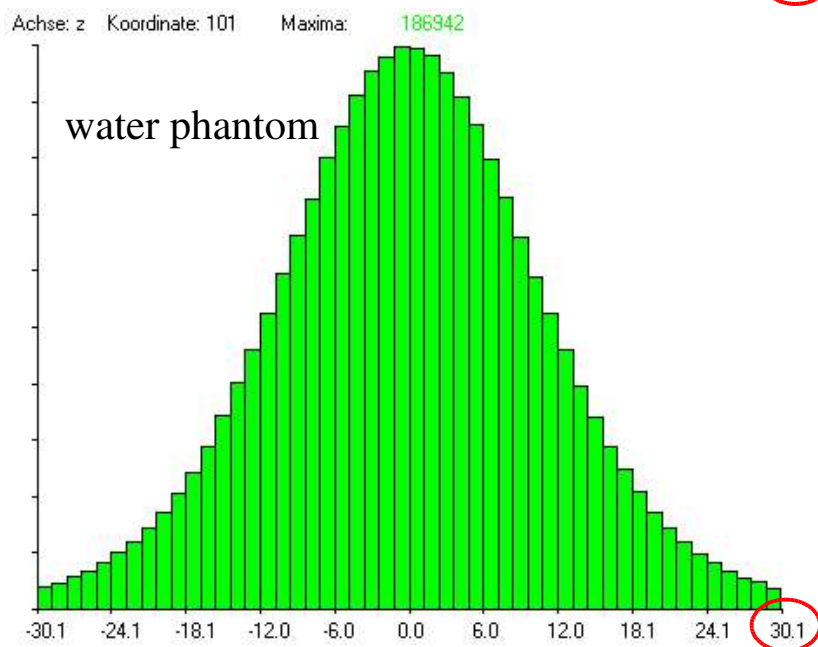
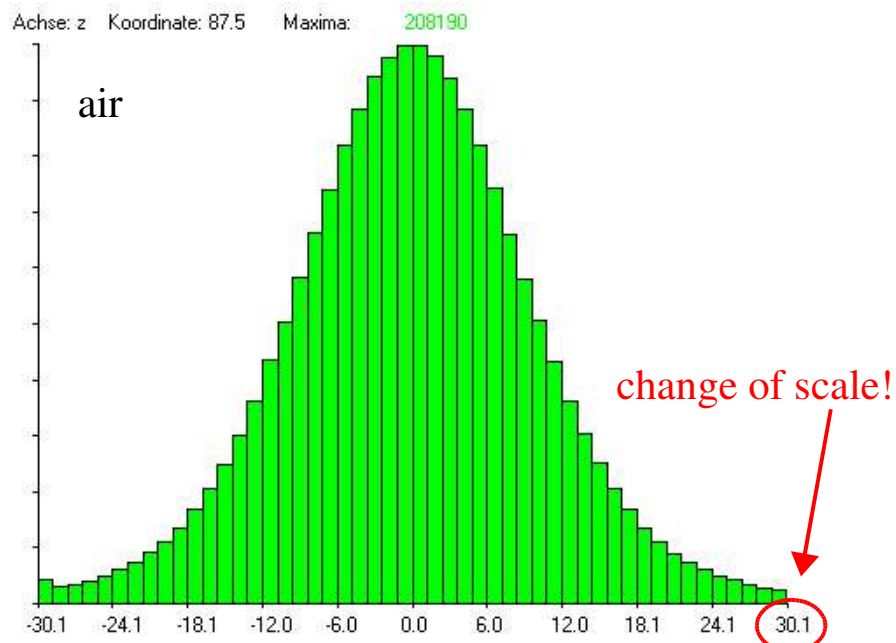
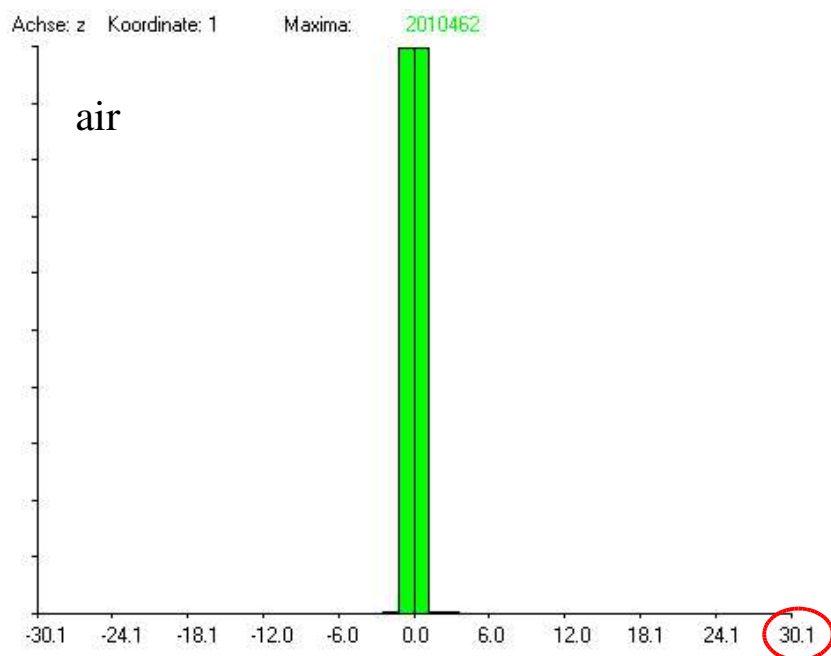
2 105

Histogramm

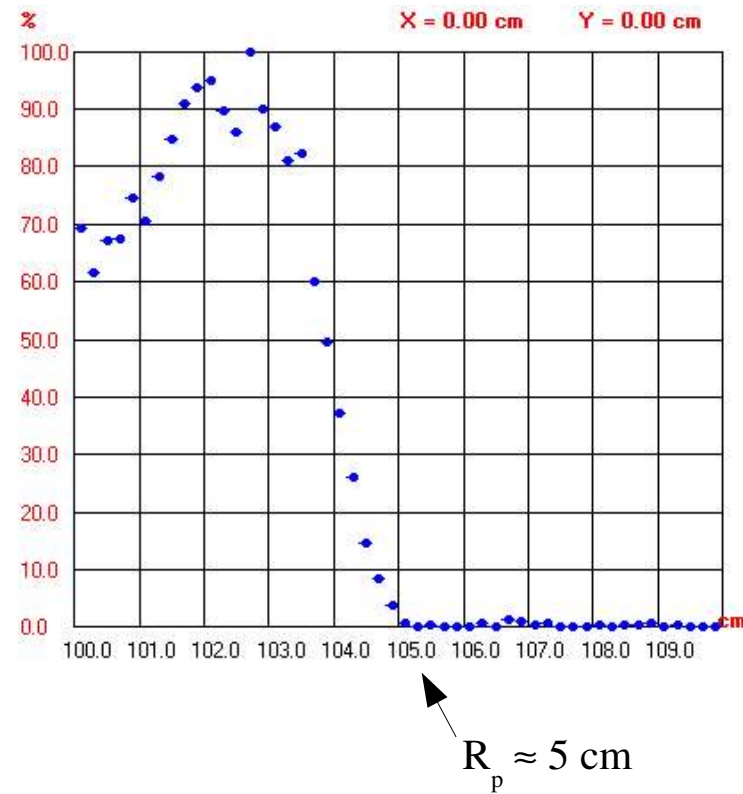
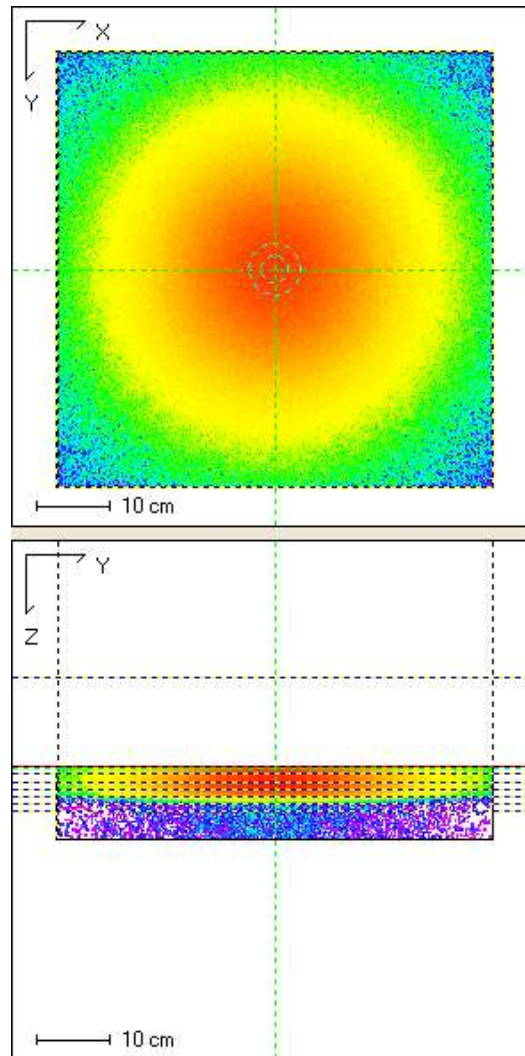
2 106



EGSRay: Simplified linear accelerator with scattering foil (profiles)



EGSRay: Simplified linear accelerator with scattering foil

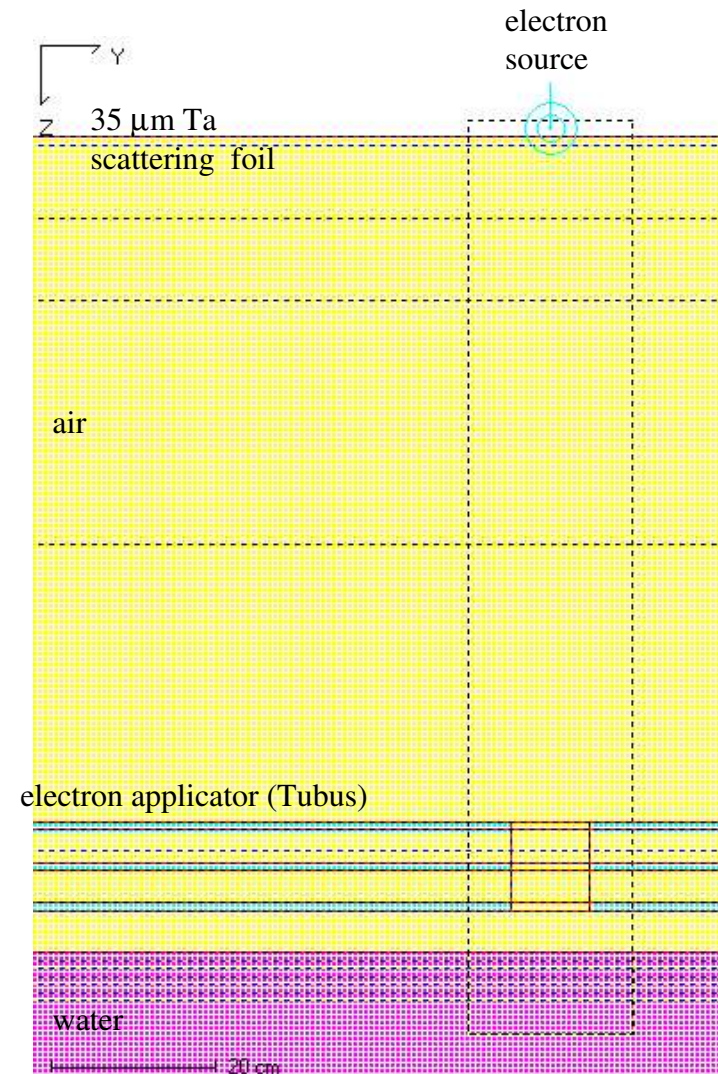


EGSRay: linear accelerator with scattering foil and electron applicator

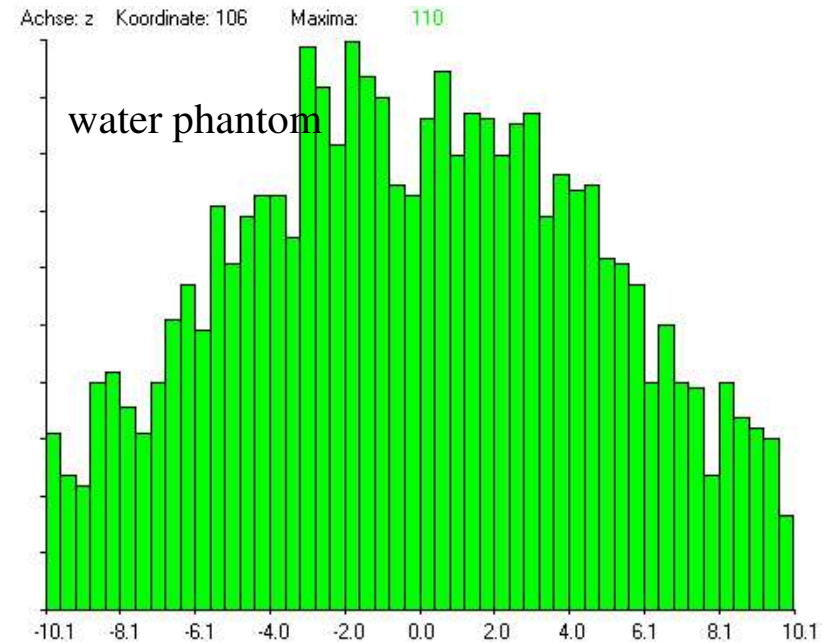
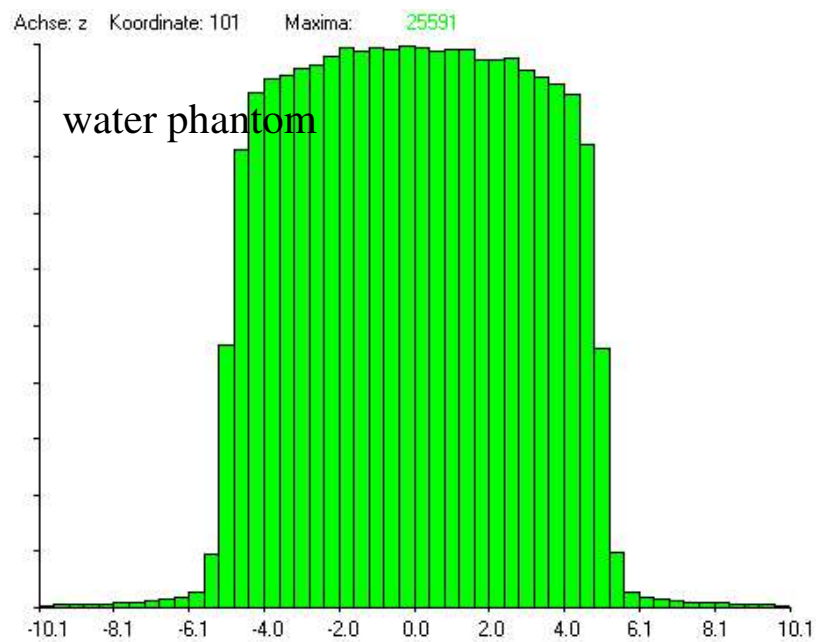
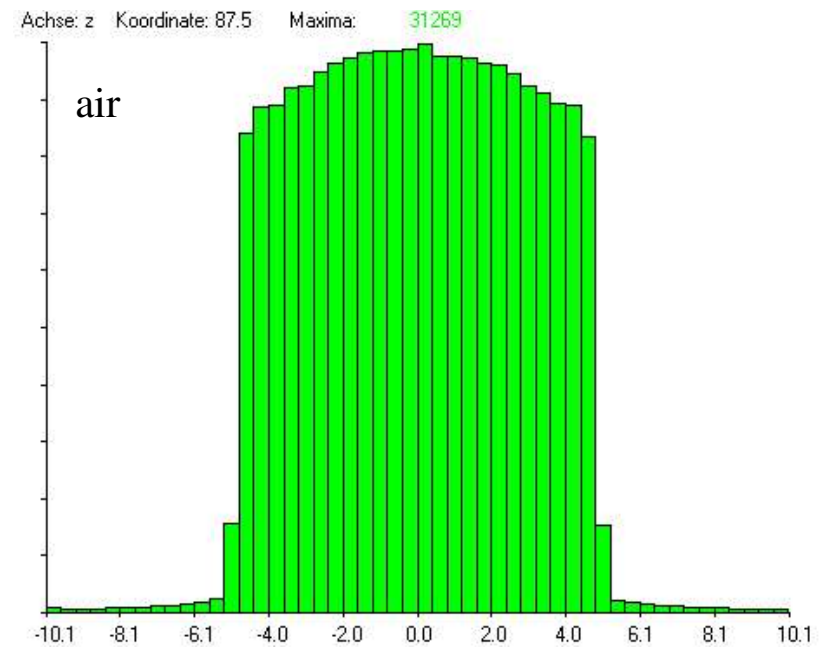
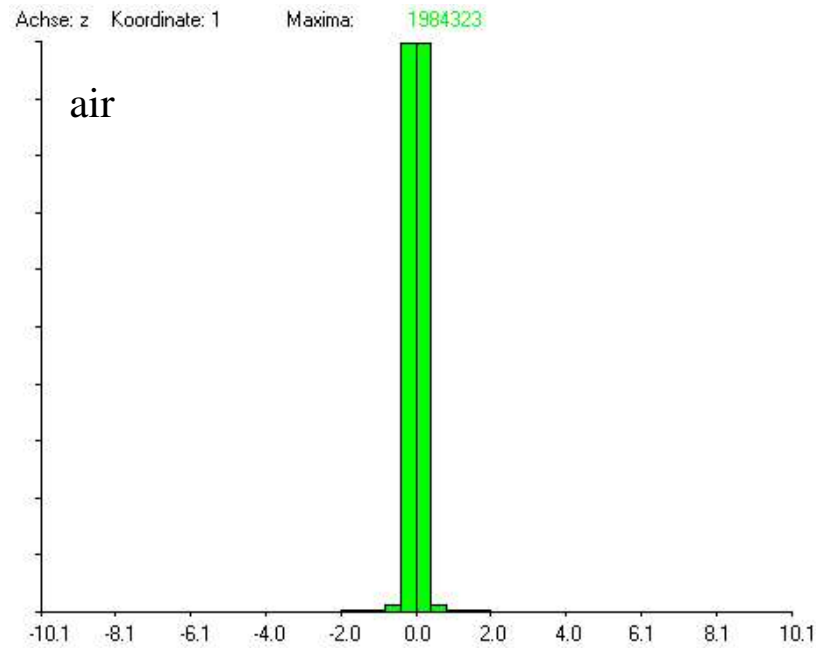
' Linac electron beam
' simplified model of a 10x10 cm² electron field
' with scattering foil, e- applicator, air
' and water phantom
,

Daten
D:\...\700icru.dat
Randomseed
1802 9373
Histories
4000000
Punktquelle
0 0 -1
Richtung
0 0 1
Elektronen
Energie
10.511
Rechenraum
-10.1 -10.1 -2 10.1 10.1 110
Scoringraum
-10.1 -10.1 100 10.1 10.1 110
Voxelgröße
0.2 0.2 0.2
Halbraum
AIR700ICRU
2 0 1
Halbraum
H2O700ICRU
2 100 1
Water
phantom
at SSD 100 cm

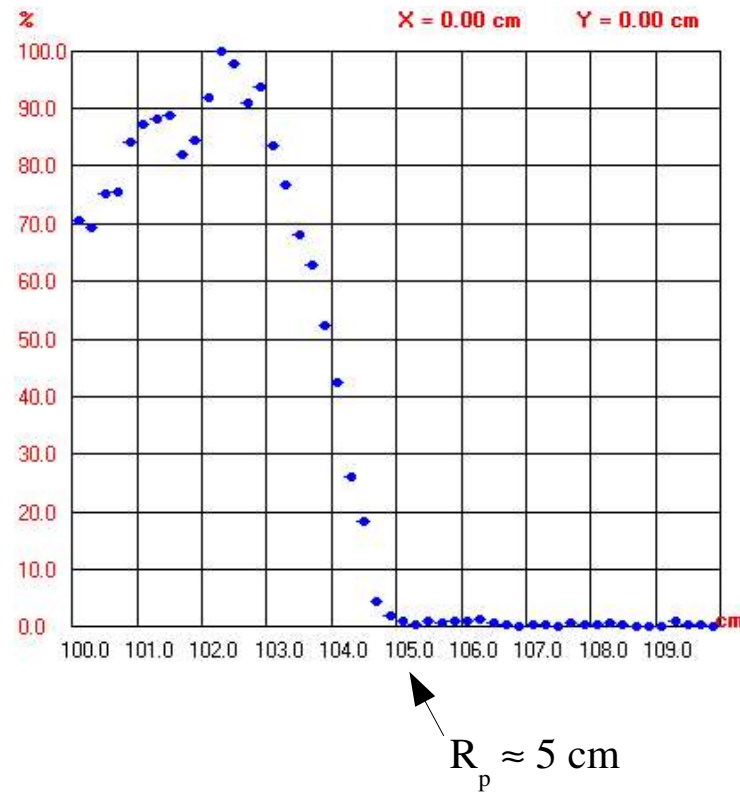
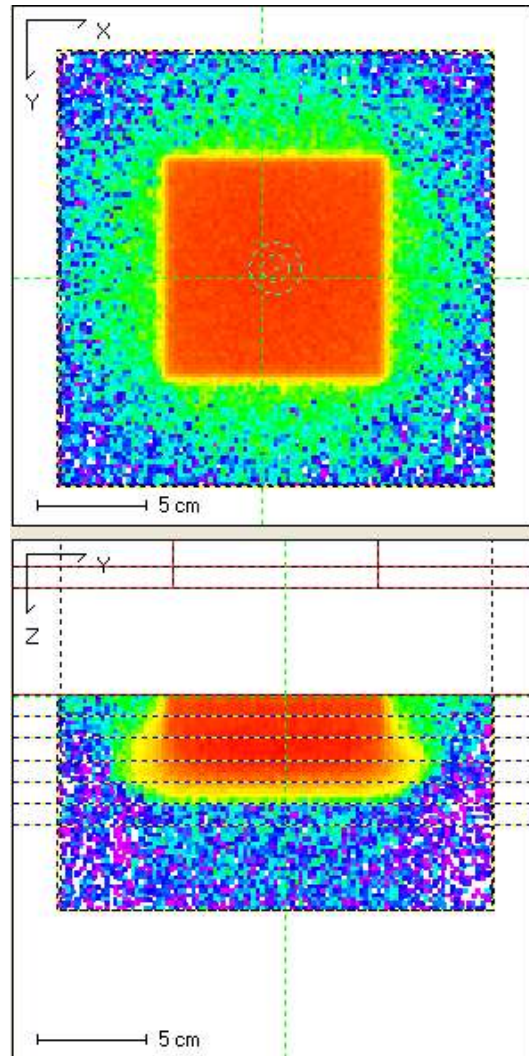
rem scattering foil definition
Platte
TA700ICRU
2 0 0.0035
scattering foil
at z =0
rem e- applicator definition
Platte
STEEL700ICRU
2 84 85
electron applicator
(Tubus)
ECUT
1.
Platte
STEEL700ICRU
2 89 90
ECUT
1.
Platte
STEEL700ICRU
2 94 95
ECUT
1.
Box
AIR700ICRU
-4.75 -4.75 84 4.75 4.75 95
Presta
Histogramm
2 1
Histogramm
2 10
.....
Histogramm
2 106



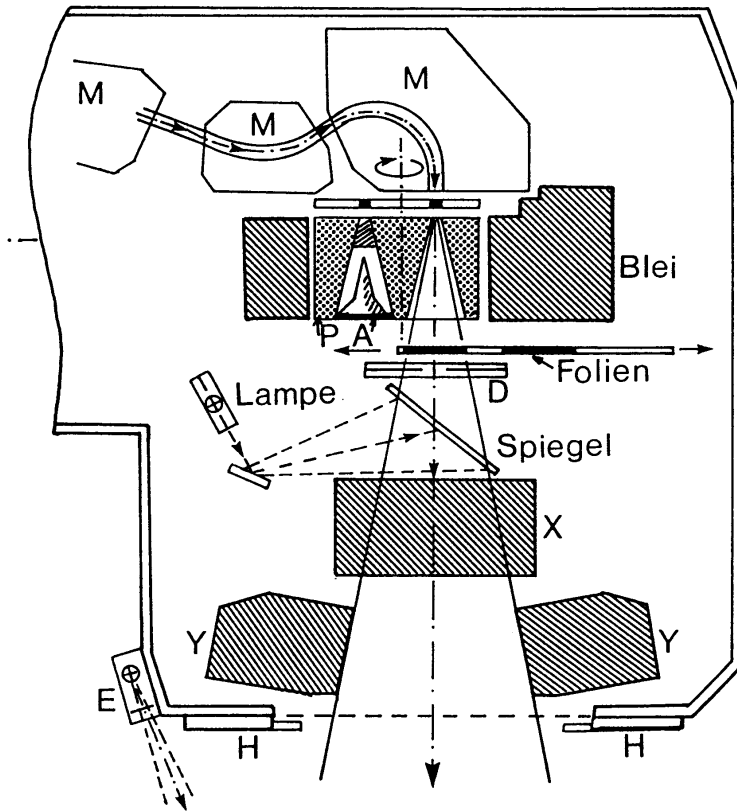
Linear accelerator with scattering foil and electron applicator (profiles)



EGSRay: linear accelerator with scattering foil and electron applicator

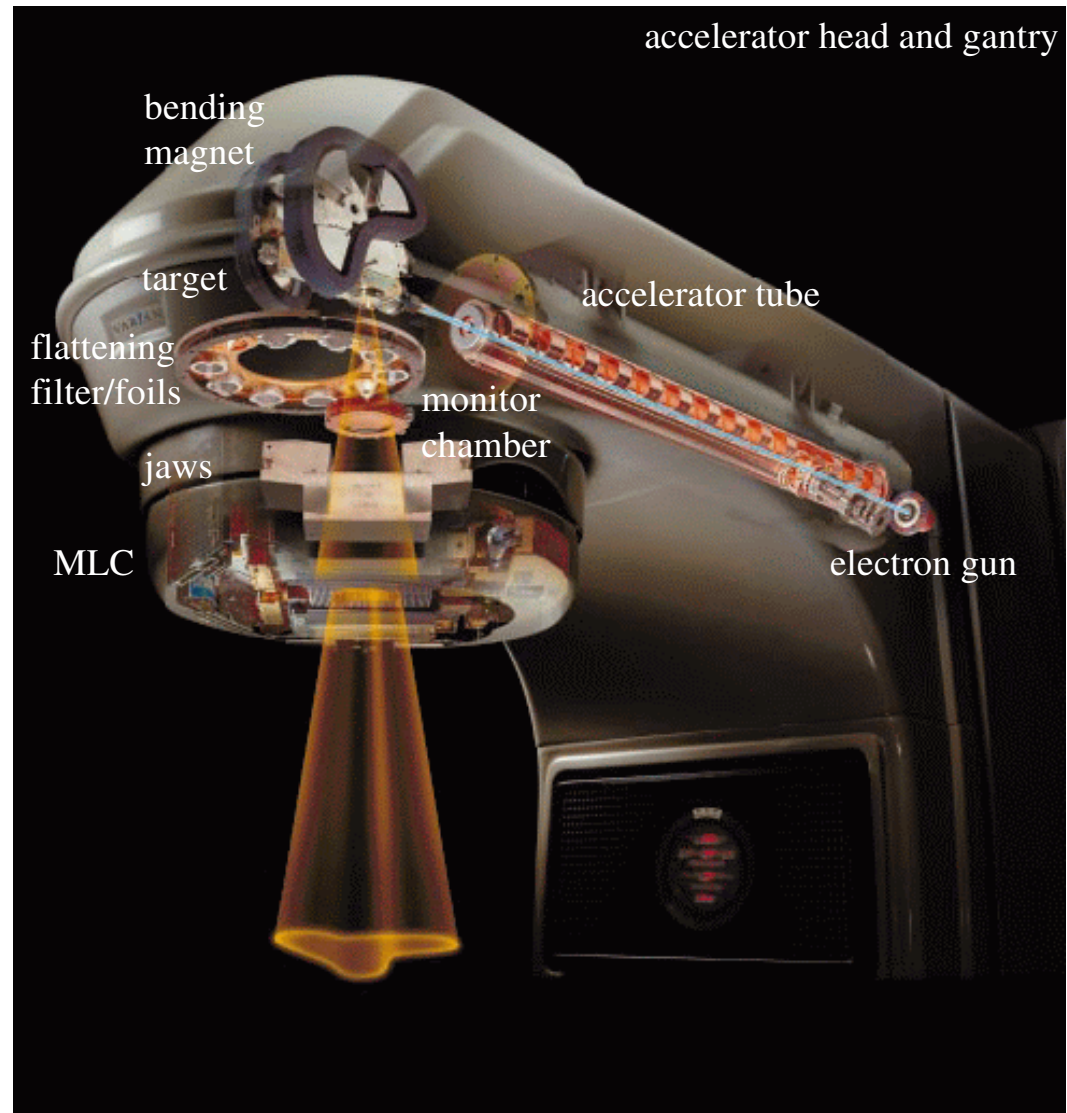


accelerator head



Typischer Strahlerkopf eines modernen medizinischen Elektronen-Linearbeschleunigers. (M: Slalom-Magnete für die Strahlumlenkung, D: Doppeldosismonitor, P: Primärkollimator, A: Photonenausgleichskörper mit vorgeschaltetem Beamhardener und Elektronenfänger, Folien: Ausgleichsfolien für Elektronen, E: Entfernungsmesser, H: Halter für Tubusse und Filter, X,Y: Kollimatorblenden, Lampe und Spiegel: Lichtvisier).

accelerator head and gantry



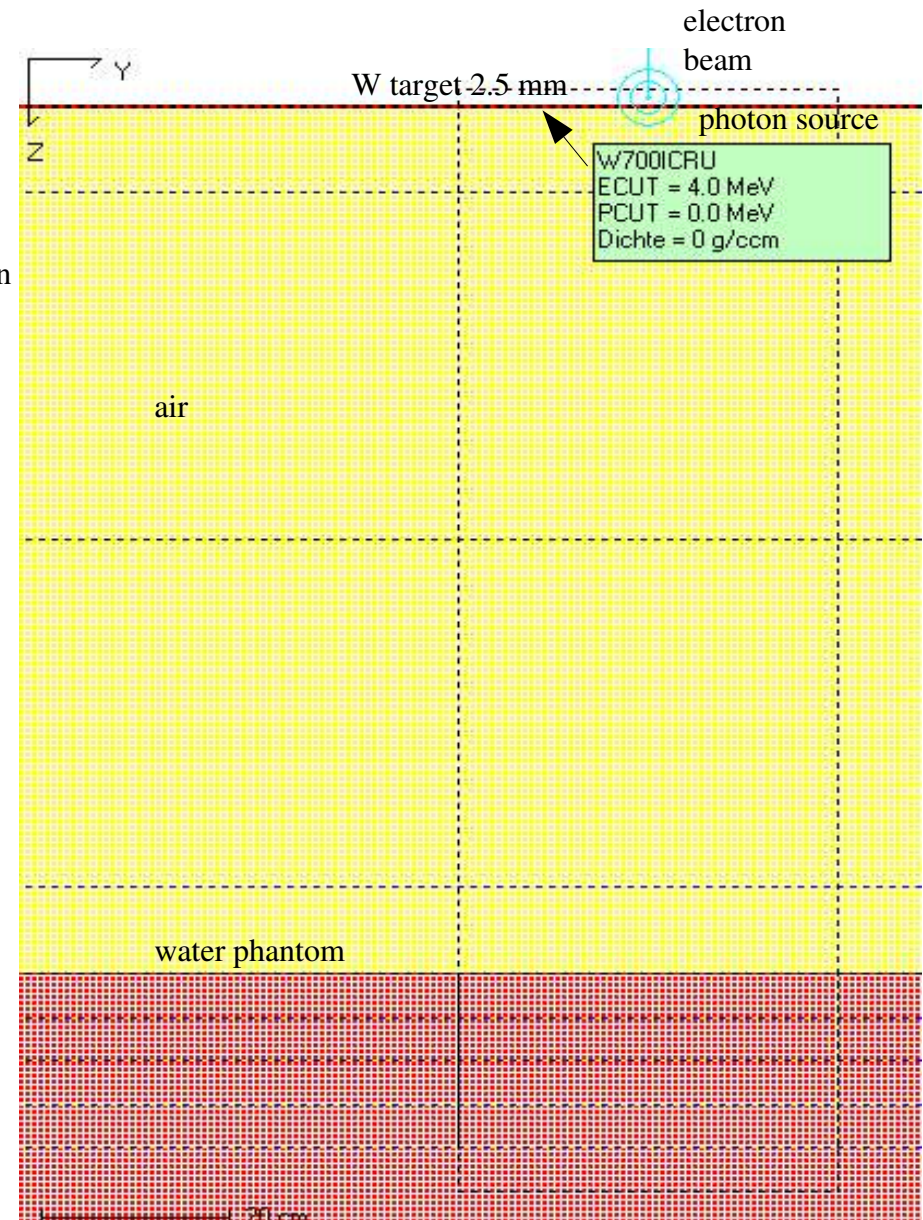
Simplified linac photon beam with W target

' Linac photon beam
' simplified model of a photon field
' with W target
'

Daten
D:\...\700icru.dat
Randomseed
1802 9373
Histories
8000000
Punktquelle
0. 0. -1.
Richtung
0. 0. 1.
Elektronen
Energie electron
10.511 beam
Rechenraum
-20.25 -20.25 -2 20.25 20.25 125
Scoringraum
-20.25 -20.25 100 20.25 20.25 120
Voxelgröße
0.5 0.5 0.5
Halbraum
AIR700ICRU
2 0 1
rem
rem W Target
Platte
W700ICRU W target
2 0 0.25 2.5 mm thick
ECUT
4

Halbraum
H2O700ICRU
2 100 1
particlesplitting Variance reduction
100 technique
Histogramm
2 10
Histogramm
2 50
Histogramm
2 90
Histogramm
2 100
Histogramm
2 105
Histogramm
2 110
Histogramm
2 115
Histogramm
2 120

Water phantom
at SSD = 100 cm
Histograms
along the beam
Histograms
in the water
phantom



Simplified linac photon beam with W target and flattening filter

' Linac photon beam
' simplified model of a photon field
' with W target and flattening filter
'

Daten

D:\...\700icru.dat

Randomseed

1802 9373

Histories

8000000

Punktquelle

0. 0. -1.

Richtung

0. 0. 1.

Elektronen

Energie electron
10.511 beam

Rechenraum

-20.25 -20.25 -2 20.25 20.25 125

Scoringraum

-20.25 -20.25 100 20.25 20.25 120

Voxelgröße

0.5 0.5 0.5

Halbraum

AIR700ICRU

2 0 1

rem

rem W Target

Platte

W700ICRU

2 0 0.25 W target
2.5 mm thick

ECUT

4

rem

rem Pb Flattening Filter

Kegel

PB700ICRU

2 0 0 2

2 0 4 1

Halbraum

AIR700ICRU

2 4 1

Halbraum

H2O700ICRU

2 100 1

particlesplitting

100

Histogramm

2 10

Histogramm

2 50

Histogramm

2 90

Histogramm

2 100

Histogramm

2 105

Histogramm

2 110

...

Histogramm

2 120

z axis x,y,z
z1 r1 z2 r2

Pb Cone flattening
filter

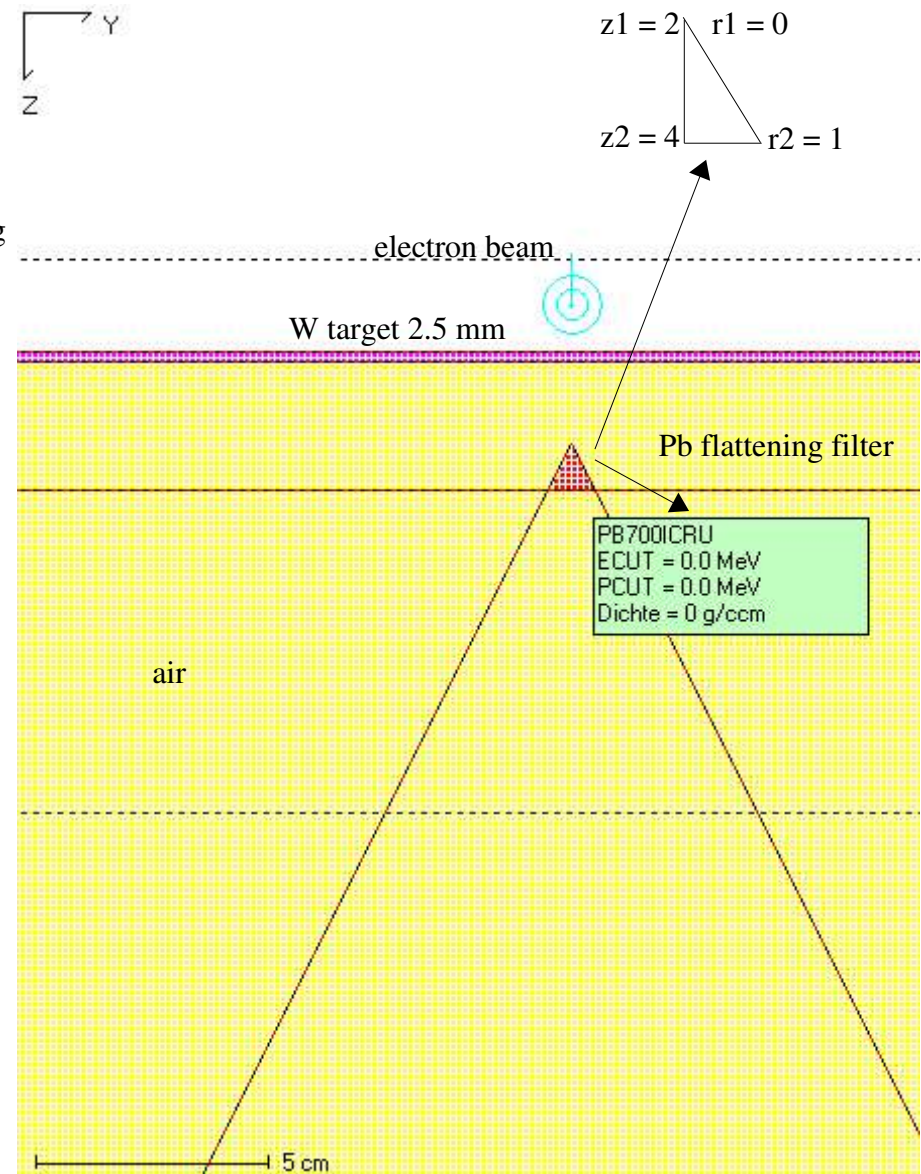
Air below fft

Water phantom
at SSD = 100 cm

photon source

W target

2.5 mm thick



Linac with W target, flattening filter and divergent collimator

' Linac photon beam
' simplified model of a photon field
' with W target, flattening filter
' and collimator

Daten

D:\...\700icru.dat

Randomseed

1802 9373

Histories

14000000

Punktquelle

0. 0. -1.

Richtung

0. 0. 1.

Elektronen

Energie

10.511

Rechenraum

-20.25 -20.25 -2 20.25 20.25 125

Scoringraum

-20.25 -20.25 100 20.25 20.25 120

Voxelgröße

0.5 0.5 0.5 80.5 05 0.5 (for pdd)

Halbraum

AIR700ICRU

2 0 1

rem

rem W Target

Platte

W700ICRU

2 0 0.25

ECUT

4

rem Pb Flattening Filter

Kegel

PB700ICRU Pb Cone flattening
2 0 0 2 filter

2 0 4 1

Halbraum

AIR700ICRU

2 4 1

rem Divergent Pb collimator

Platte

PB700ICRU

2 50 58

ECUT

4

rem Collimator opening

Flächenobjekt

AIR700ICRU

0 0 52

6

Wand

2 50 axis \perp wall coord

Wand

2 58

Fläche x1 y1 z1 x2 y2 z2 x3 y3 z3

0 0 0 2.5 2.5 50 2.5 -2.5 50

Fläche

0 0 0 2.5 -2.5 50 -2.5 -2.5 50

Fläche

0 0 0 -2.5 -2.5 50 -2.5 2.5 50

Fläche

0 0 0 -2.5 2.5 50 2.5 2.5 50

Halbraum

H2O700ICRU

2 100 1

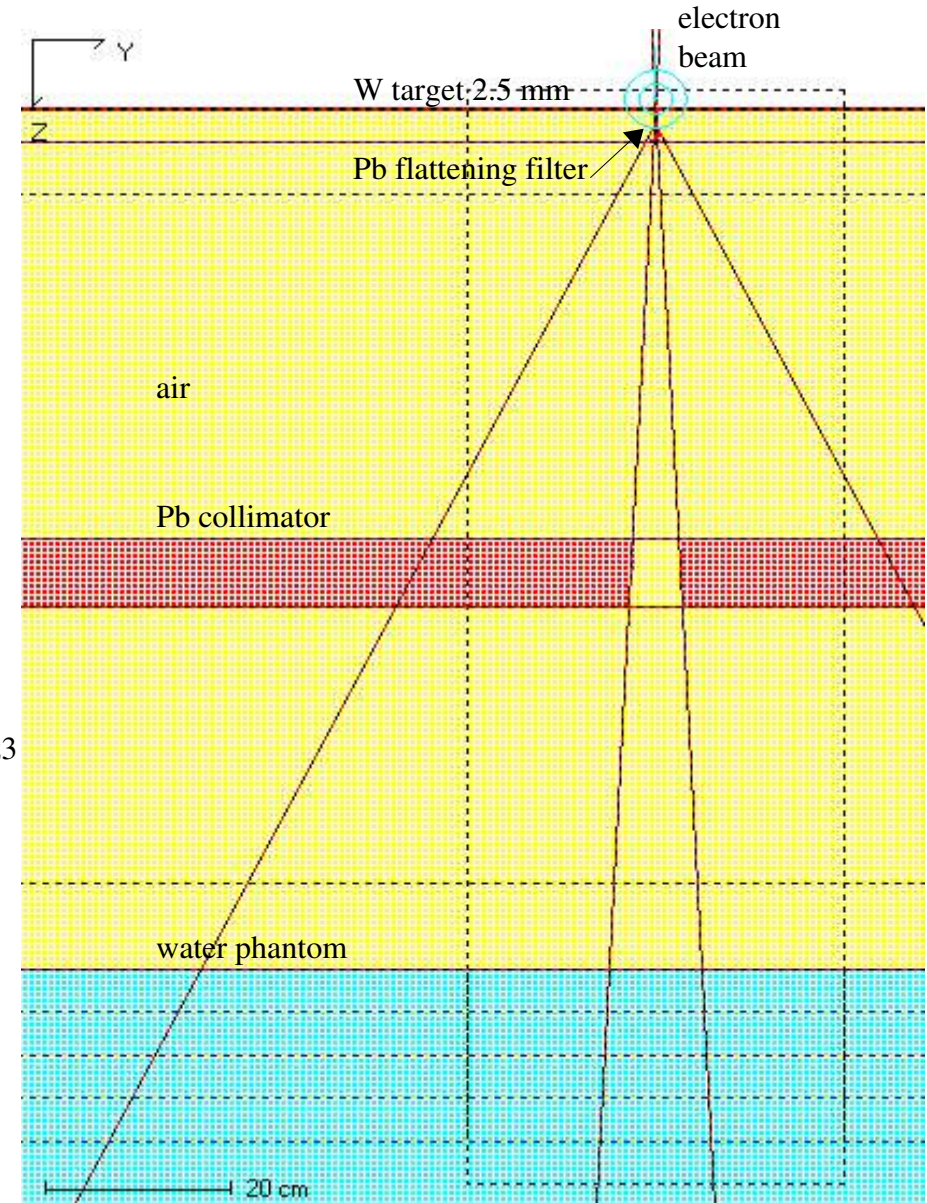
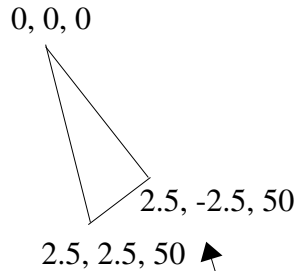
particlesplitting

100

...

Histogramm

2 120



Assignment 08: Photon therapy machines

Photon beams $E = 10 \text{ MV}$:

- 1) Simulate: a linac head to produce photon beams in air and impinging on a water phantom at $\text{SSD} = 100 \text{ cm}$. Consider first an electron beam hitting a **W target** 2.5 mm thick

Analysis: study the photon spectra and profiles at several depths and the depth dose curve. Discuss the results.

- 2) Simulate: photon therapy machine as before adding a **conical Pb flattening filter** 2 cm in height, radius = 1 cm and starting at $z = 2 \text{ cm}$

Analysis: study the photon spectra and profiles at several depths and the depth dose curve. Discuss the results.

- 3) Simulate: photon therapy machine as before adding a **divergent Pb collimator** at $z = 50 \text{ cm}$ and $5 \times 5 \text{ cm}^2$ opening

Analysis: study the photon spectra and profiles at several depths and the depth dose curve. Discuss the results.

Scoring dimensions and voxel size adapted to each case. Enough statistics.