SCANDITRONIX WELLHÖFER

Der Neue Ionisationskammer-Flächendetektor MatriXX

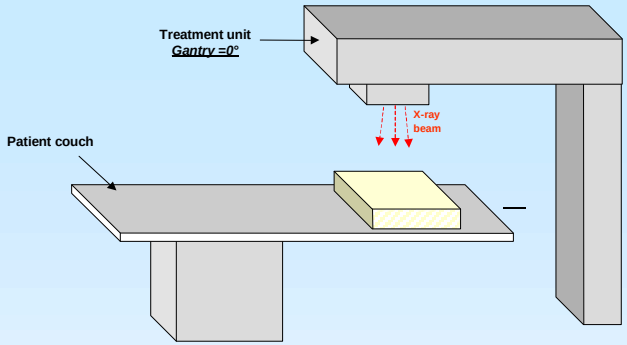
DGMP AK IMRT

Würzburg 17/18. März 2005

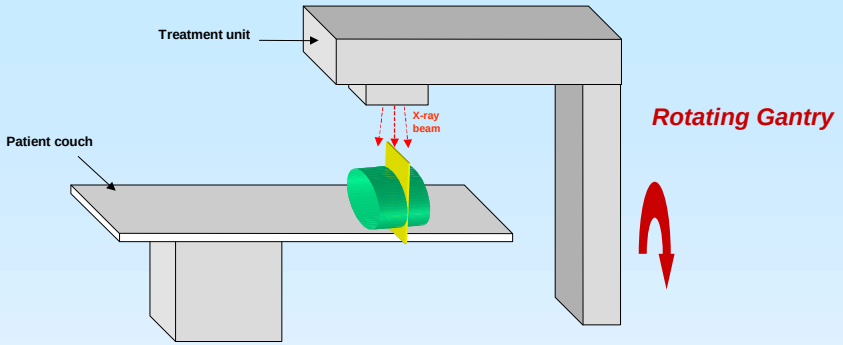
Dr. Lutz Müller

IMRT pre-treatment verification

Field oriented



Plan oriented



Workflow of Film Verification

CT scan of phantom

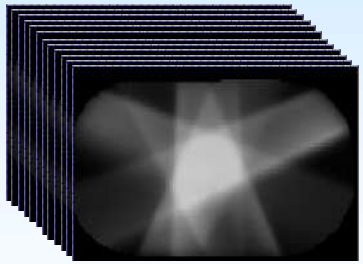
Irradiate patient‘s plan to phantom

Apply patient‘s plan to phantom

Calculate dose distribution in Phantom

Process film

OmniPro - IMRT

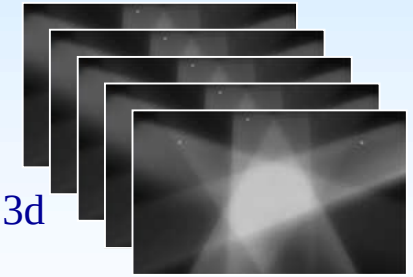


read in 3D data

COMPARE AND EVALUATE DATA:

isodoses, + - * /, γ

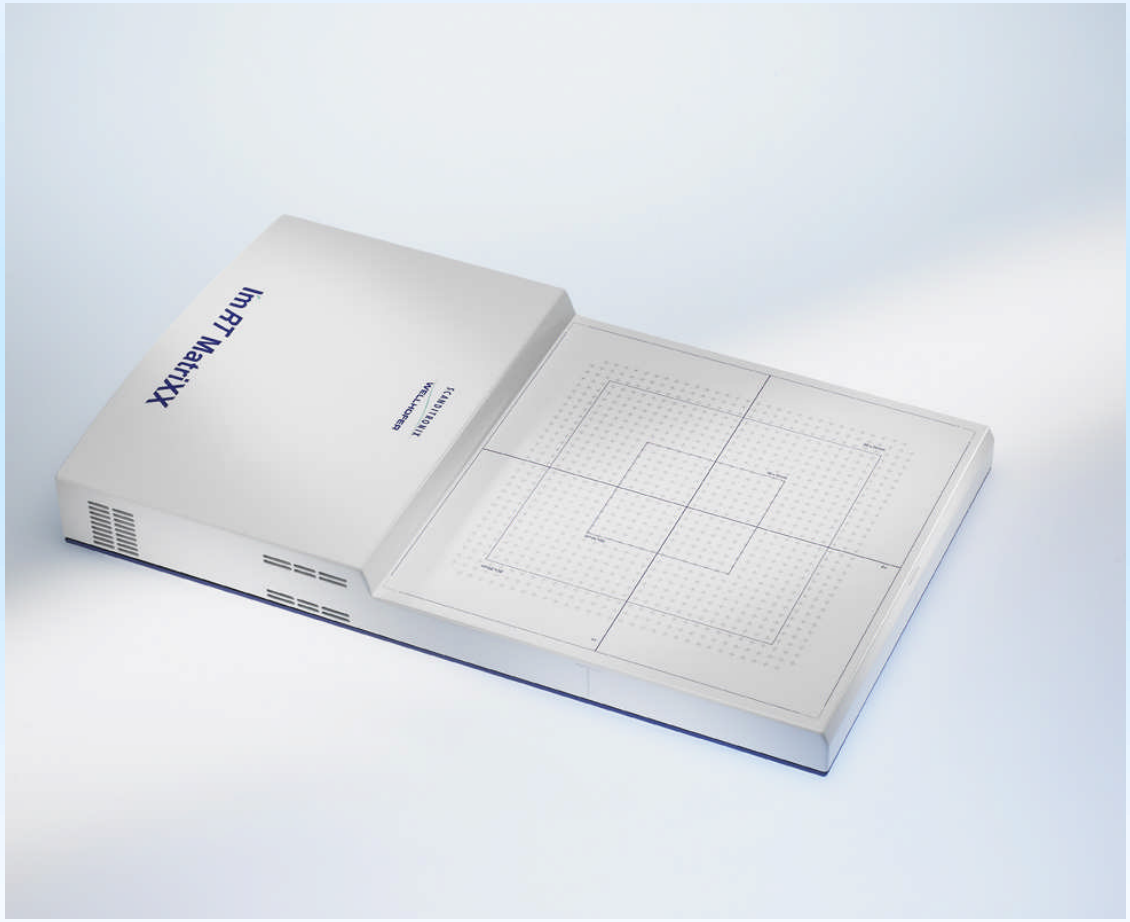
Scan Film
calibrate
register
reconstruct 3d



Requirements for ‚ideal' 2D device

- Good dosimetric properties — Air – vented Ion chambers
- High granularity — 1020 chambers, 7.62 mm spacing
- High dose linearity — TERA recycling integrator
- Short sampling intervals — TERA recycling integrator
- No deadtime — OmniPro ImRT Software
- Advanced analysis tools — OmniPro ImRT Software

MatriXX Key Features



Pixel Ion chamber technology (air vented)

1020 (MXX) detectors in 24x24 cm matrix

Single detector Φ = 4.5 mm (height 5mm), 0.07 cc

Parallel reading w/o dead time

Real time measurements

Software (OmniPro ImRT, Accept)

Calibration

- Normalization of detector responses
  - Factory calibration to ^{60}Co
- Absolute dose calibration
- Customer recalibration
  - Global and local calibration factors
- K_{PT} Correction
  - Build-in temperature and pressure sensors (or manual correction

Intended use

- IMRT
  - Pre-treatment verification of the 2D dose distribution delivered by IMRT beams
- QA of high energy photon and electron beams
  - Homogeneity
  - Symmetry
  - Dynamic and static wedge angle
  - Start up behaviour
  - Real time measurement
  - In-line & cross-line profiles (flatness, symmetry)

MatriXX– Basic dosimetry properties

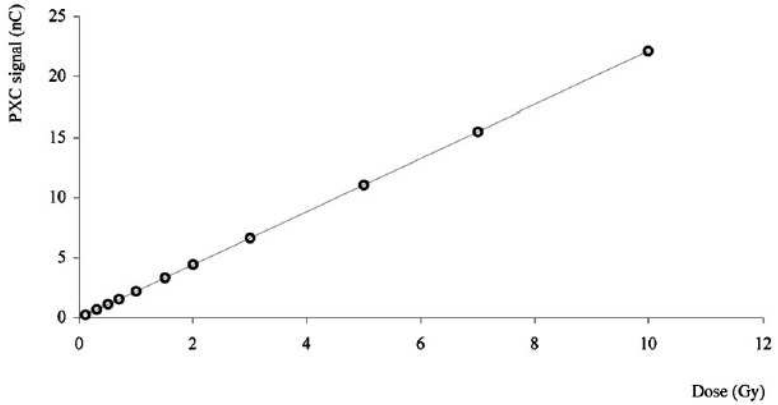


FIG. 6. Average reading of the four central pixels of the PXC as a function of the absorbed dose to water determined at d_{max}.

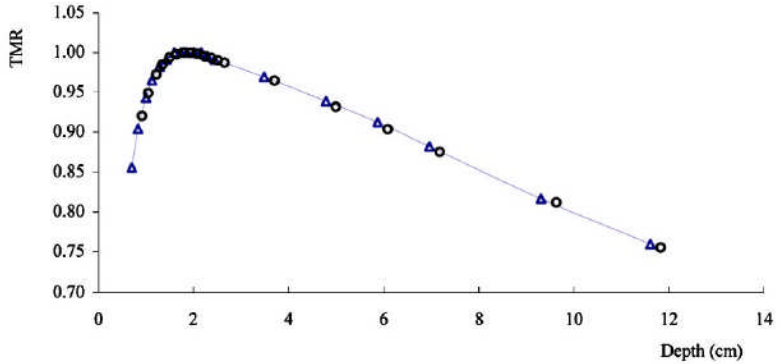


FIG. 8. TMR data obtained with a 12×12 cm^2 field of a 6 MV x-ray beam, using a Farmer chamber (△) and the PXC (○).

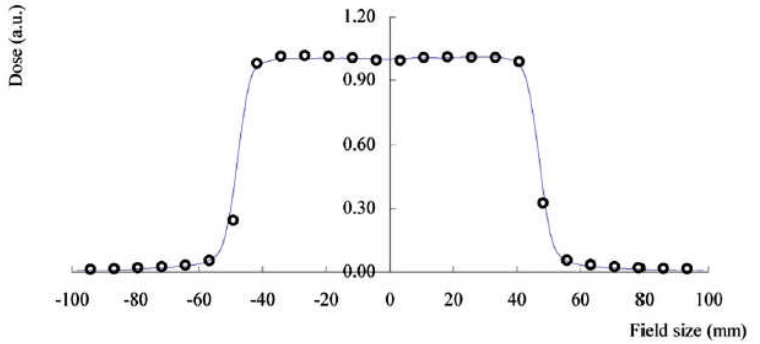
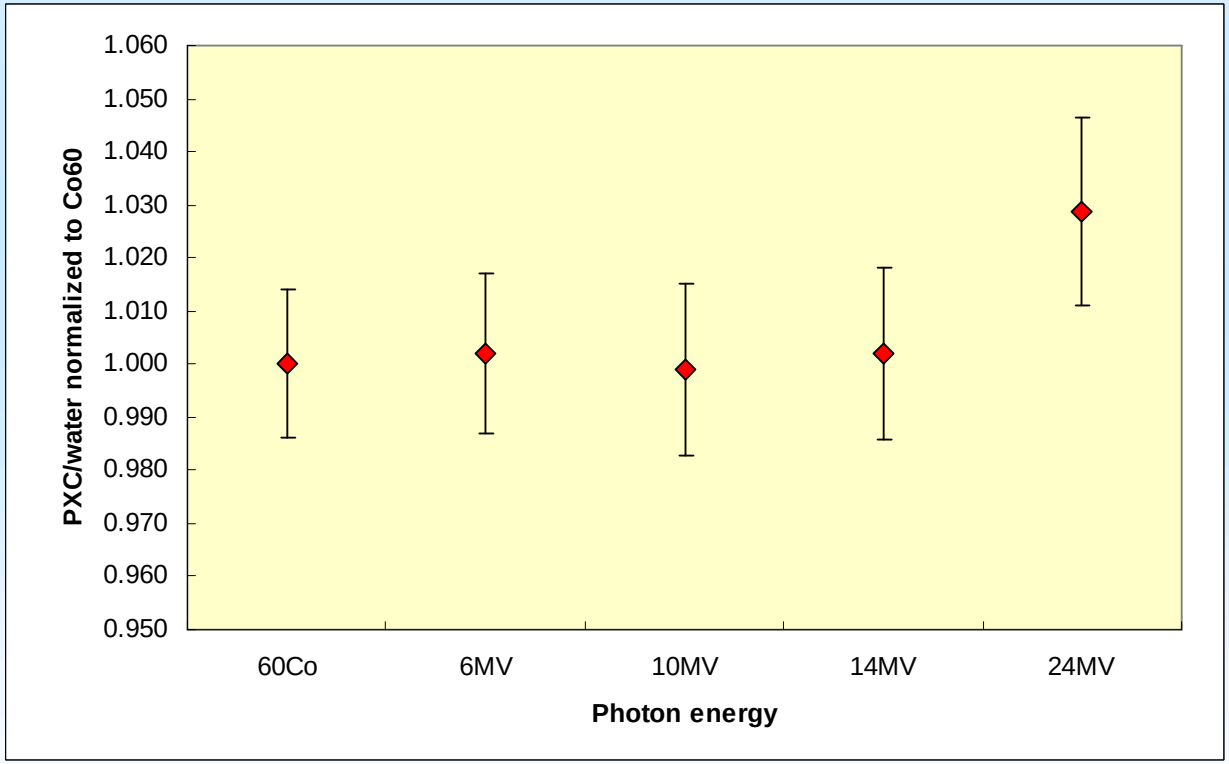


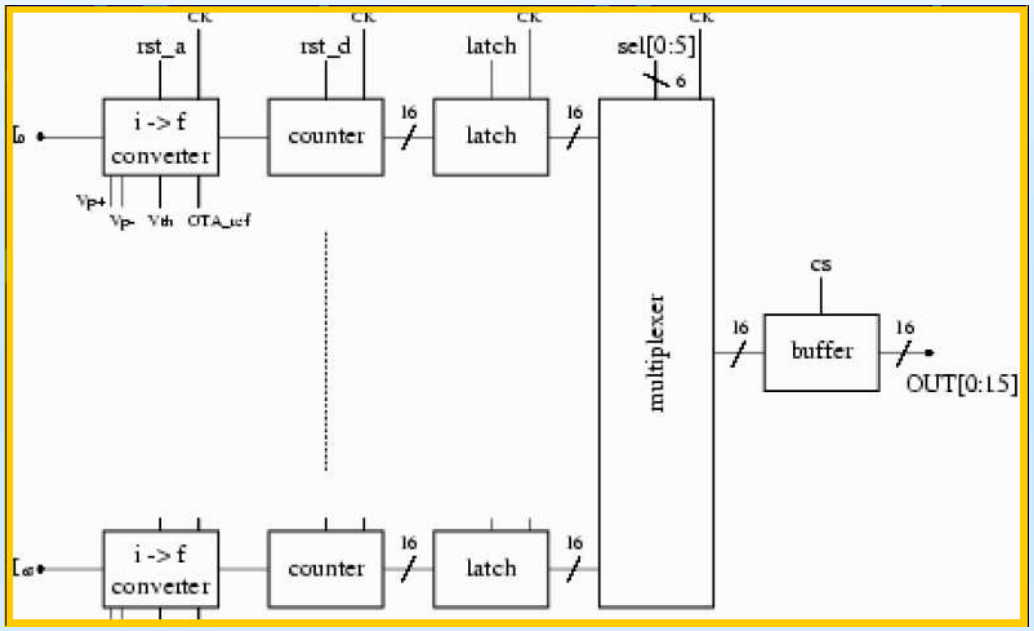
FIG. 10. Comparison of beam profiles measured with an ionization chamber in a water phantom (—) and with the PXC (○). The irradiations were performed in a MV x-ray beam at d_{max} and 10×10 cm^2 field size. The results are normalized to the central beam axis.

MatriXX - Energy dependence

MC study

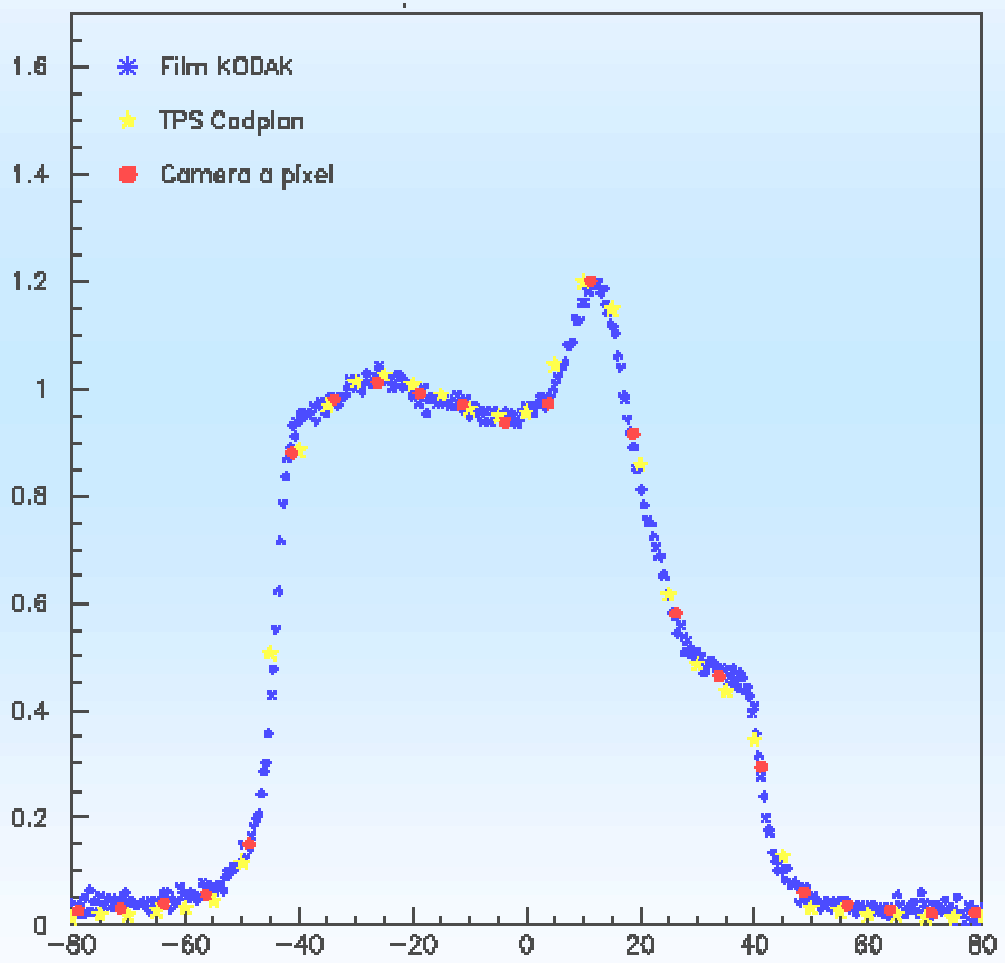


TERA Asic scheme



MatriXX- clinical tests

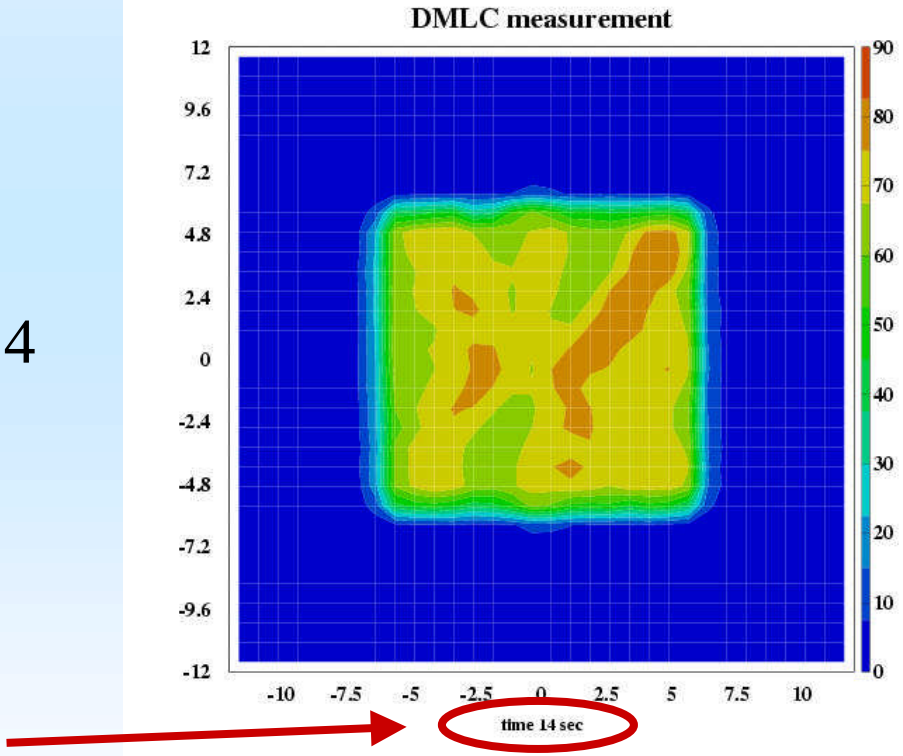
- IMRT field verification



Clinical tests

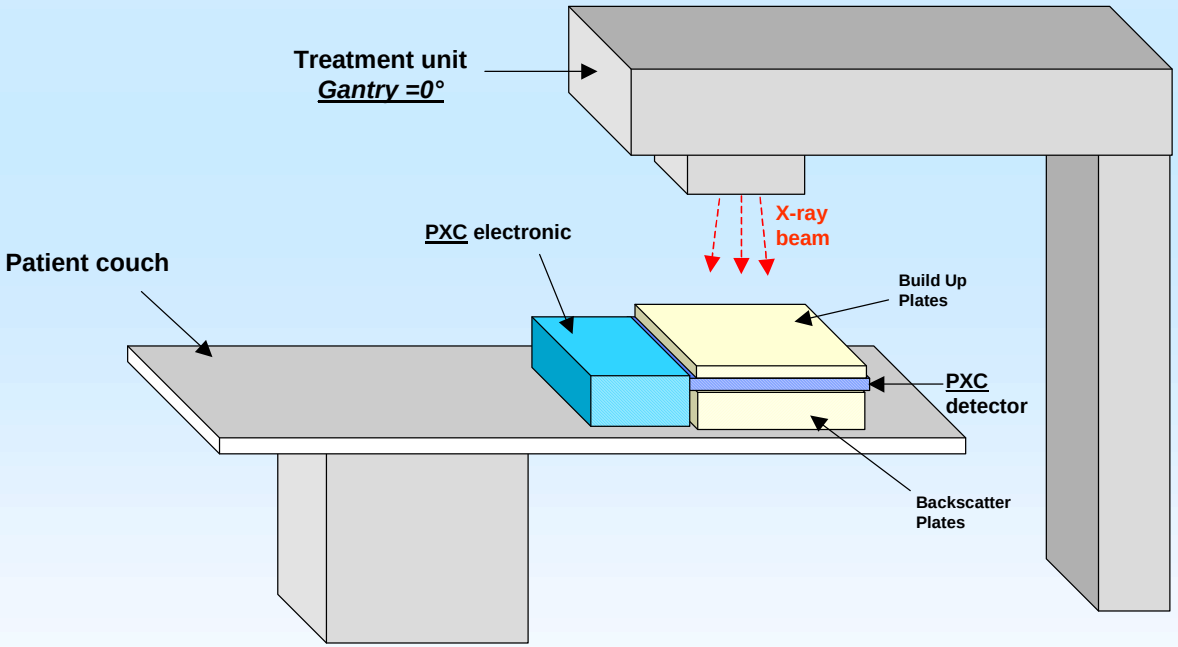
- S.Anna Hospital (Torino) – test with DMLC Varian

Time-varying field: 1.2x1.2 cm^2 square field going to 12.4x12.4 cm^2 square field

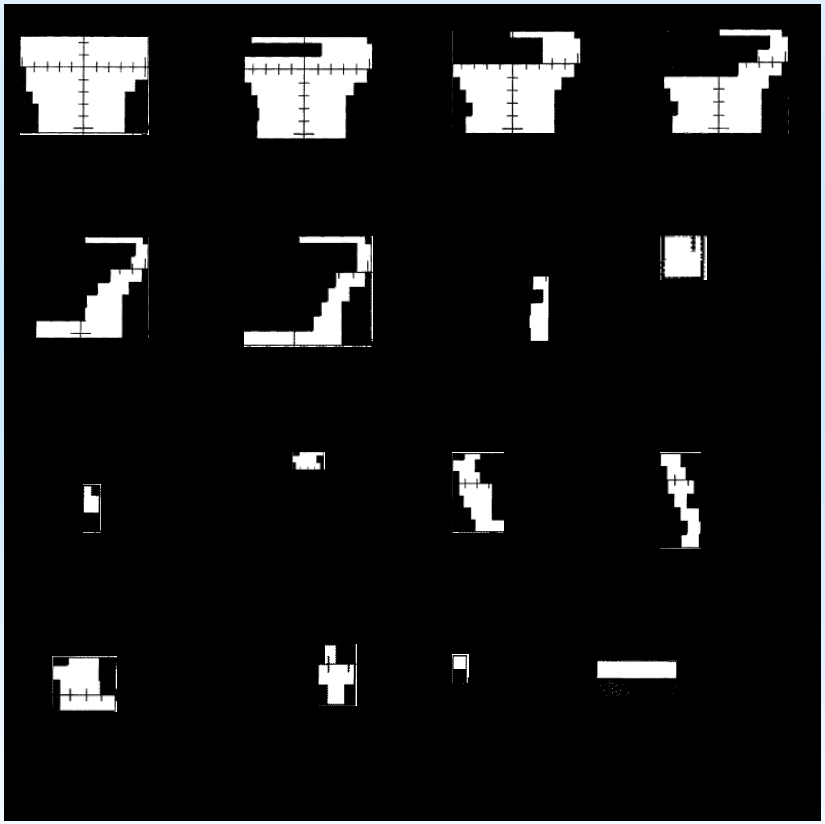


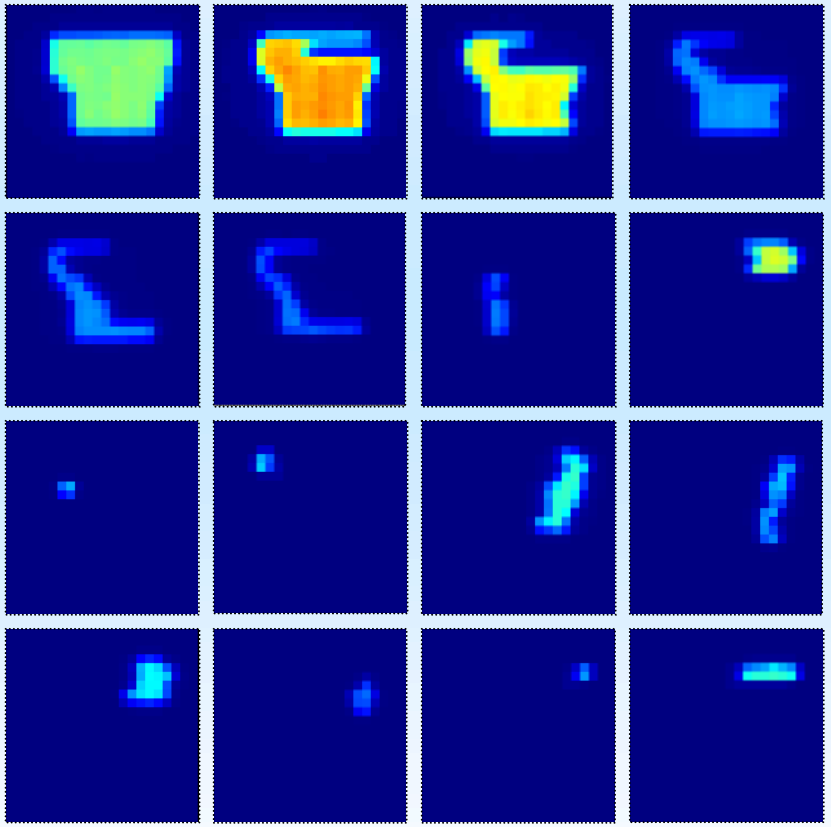
IMRT Measurements 6MV

Set-up

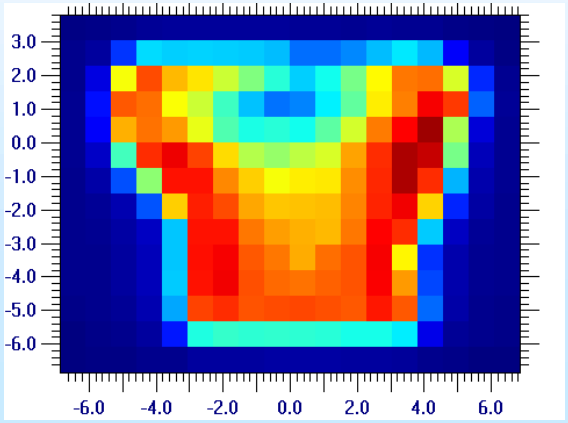


Prostate field – 16 segments

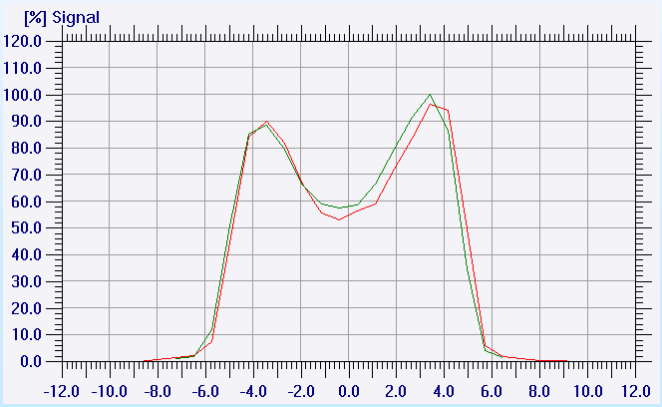




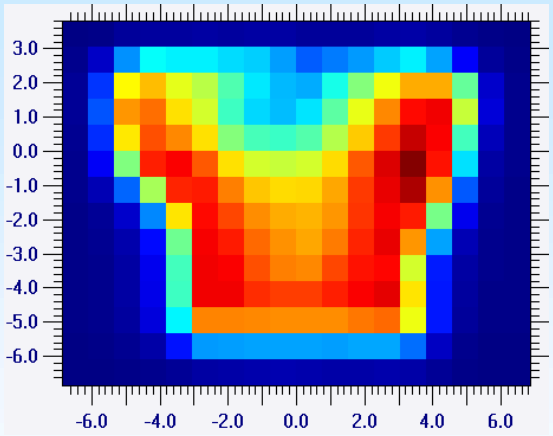
Direct comparison



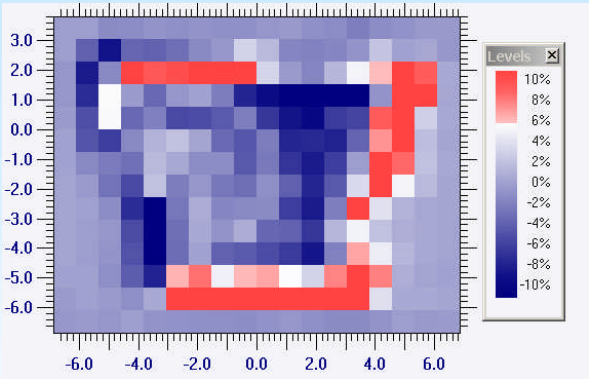
MatriXX measurement



Profiles comparison

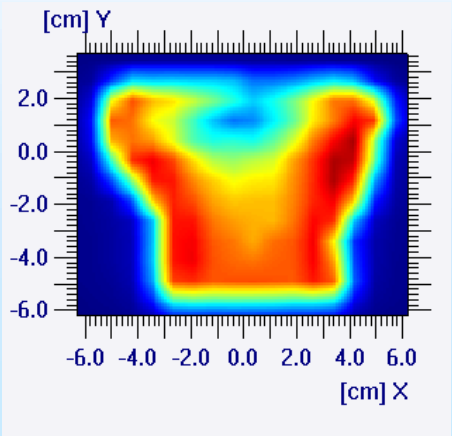


Plan data

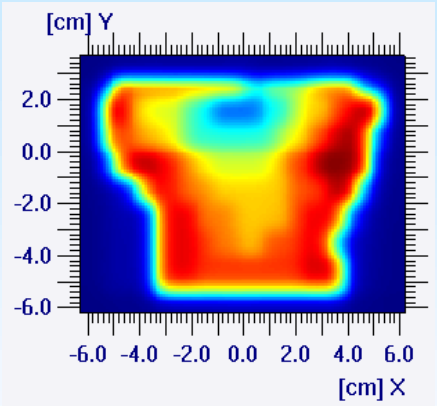


difference

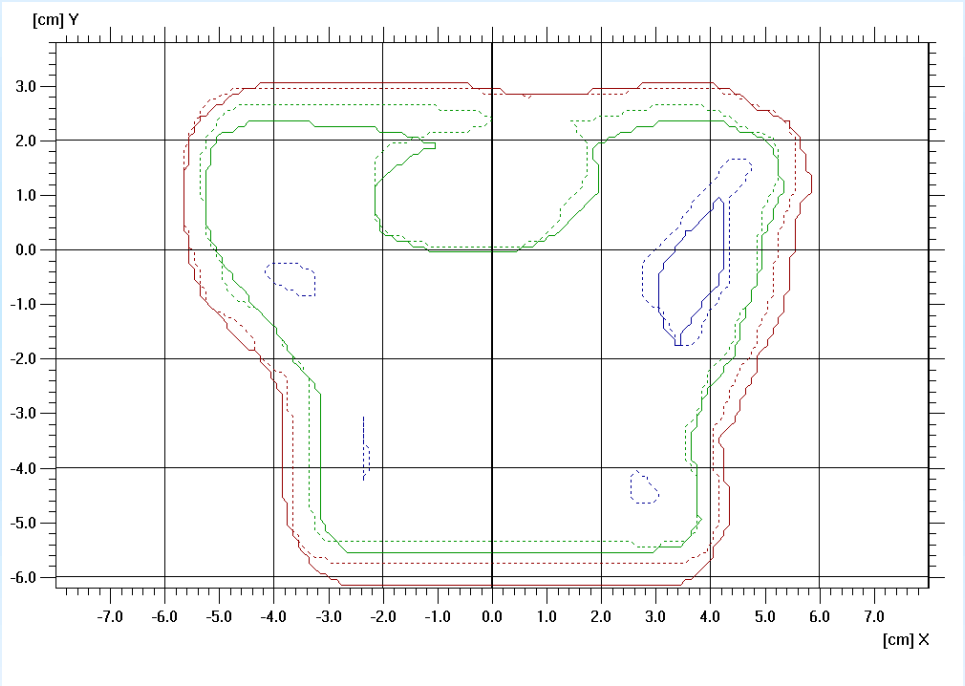
Interpolation to 1mm grid



MatriXX measurement

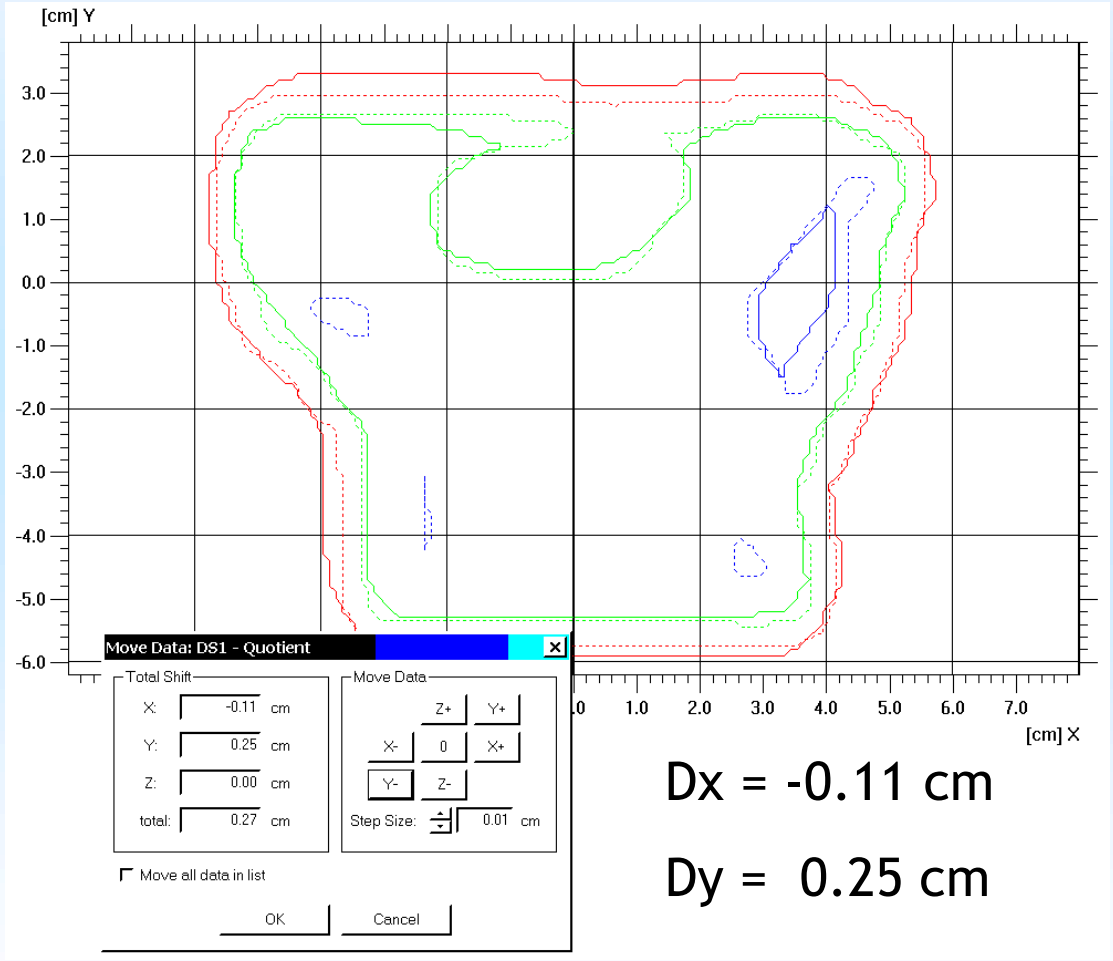


Plan data



Isodoses ___MXX .....Plan

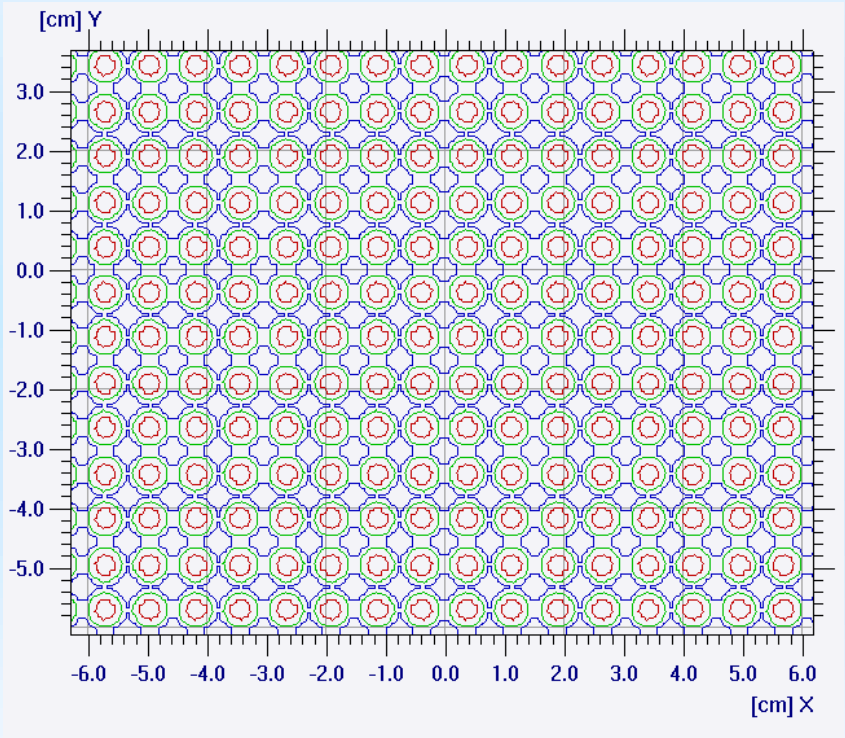
Position adjustment



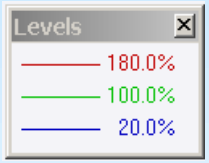
Dx = -0.11 cm

Dy = 0.25 cm

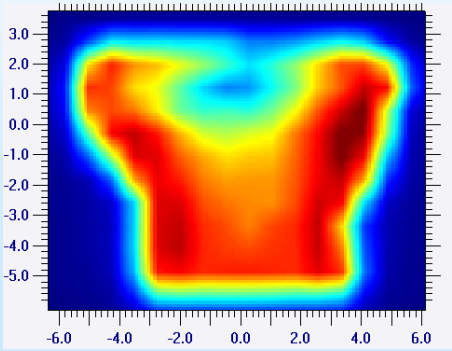
Detector response fuction



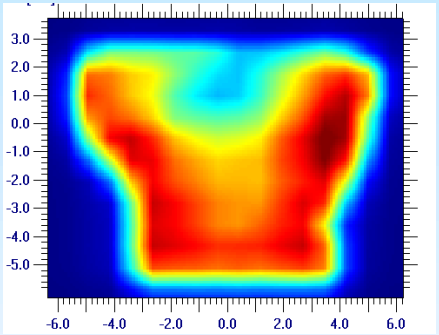
$$a(r) \propto \frac{1}{1+e^{(r-r_0)/\sigma}}$$



Folding with response function

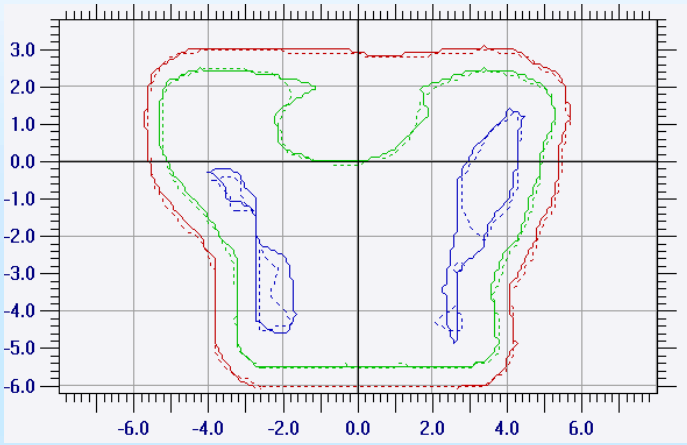


MatriXX measurement

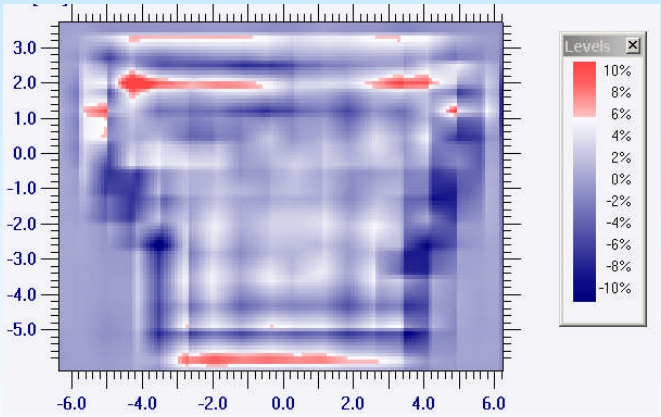


Plan data folded with Matrixx

Response function



Isodose comparison



difference

Pixel spacing

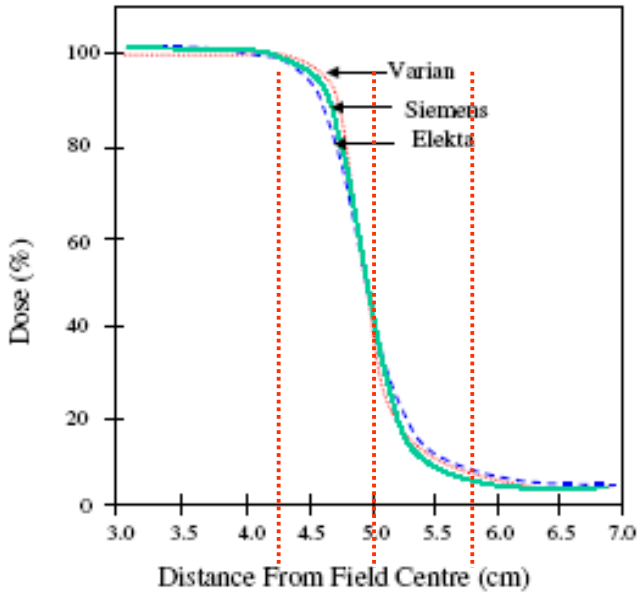


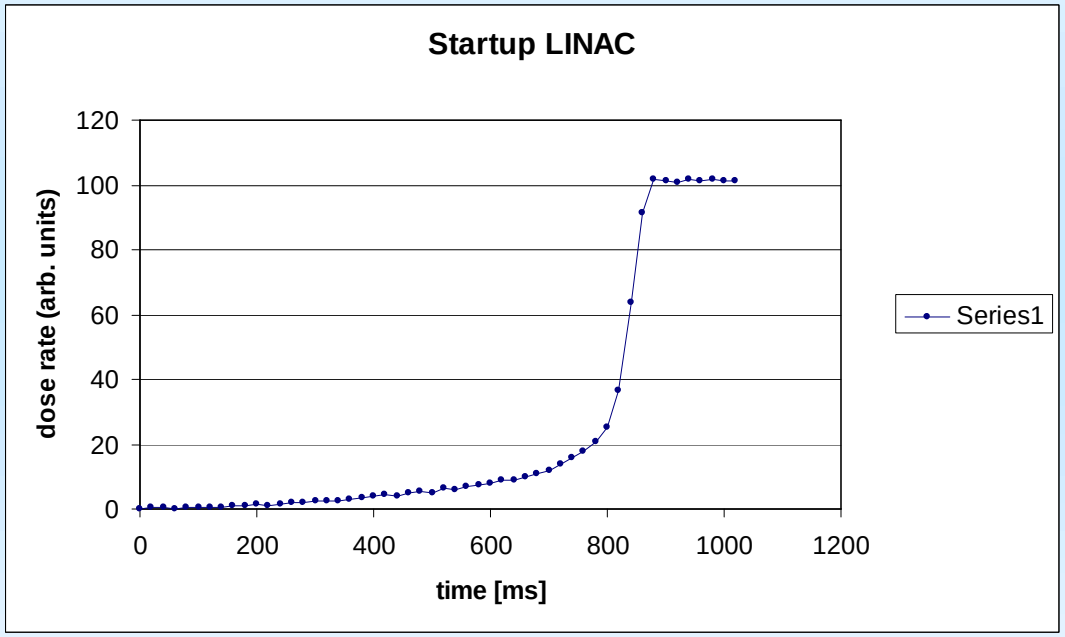
Figure 3. Comparison of the penumbra for the three collimators when the leaves are positioned at the edge of a centred 10 × 10 cm^2 field for 6 MV beams. Note that there is no appreciable difference between all three systems though designs are different.

M Saiful Huq, Indra J Das, Todd Steinberg and James M Galvin

A dosimetric comparison of various multileaf collimators

Phys. Med. Biol. **47** (2002) N159–N170

Linac startup



Key benefits

- Fast (increased throughput)
- Accurate
- Reliable

2D Array – References

Dosimetric characterization of a large area pixel-segmented ionization chamber

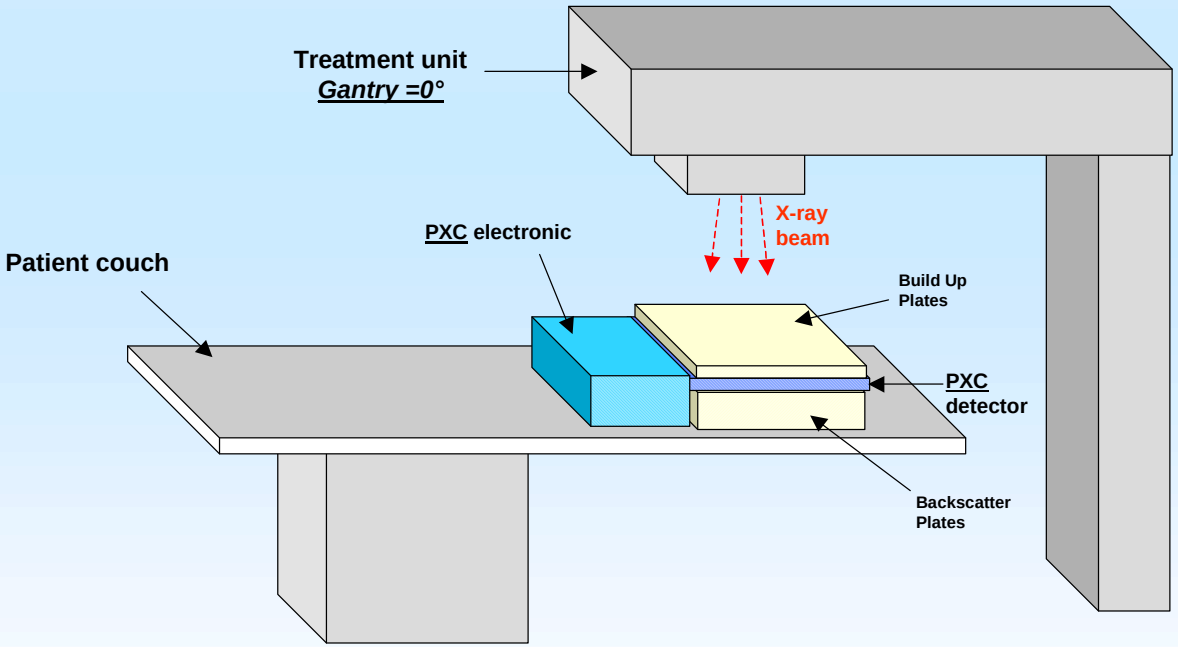
414 Med. Phys. 31 (2), February 2004 0094-2405/2004/31(2)/414/7/$22.00

D-IMRT VERIFICATION WITH A 2D PIXEL IONIZATION CHAMBER: DOSIMETRIC AND CLINICAL RESULTS IN HEAD AND NECK CANCER

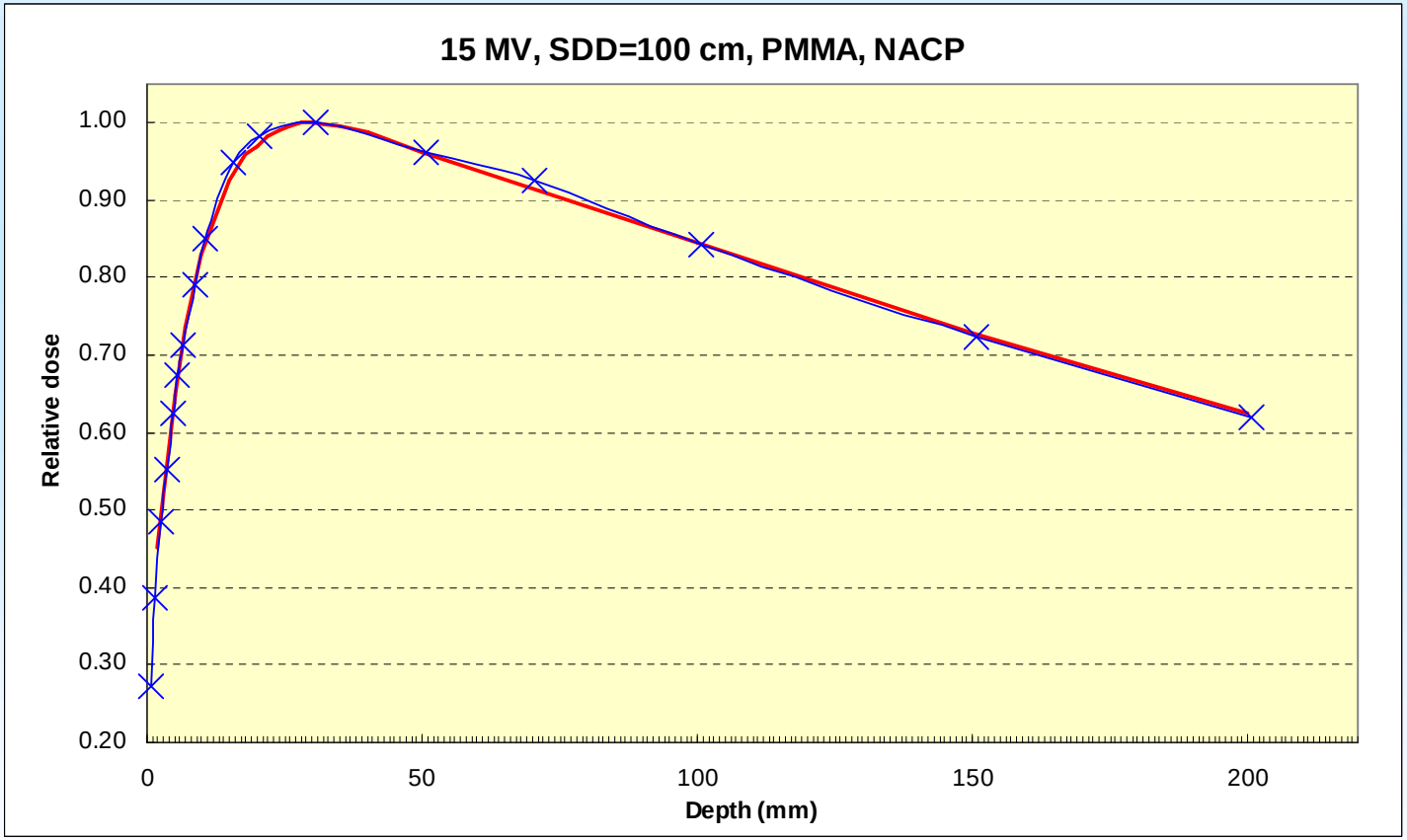
M.Stasi[g^], S. Giordanengo[a#], R. Cirio[a], A. Boriano[a], F. Bourhaleb[a,b], M. Donetti[a,c], E. Garelli[a,d], I. Gomola[e], F. Marchetto[a], C. Peroni[a], A. Sardo[a,f], G. Scielzo[g]


SCANDITRONIX
WELLHÖFER

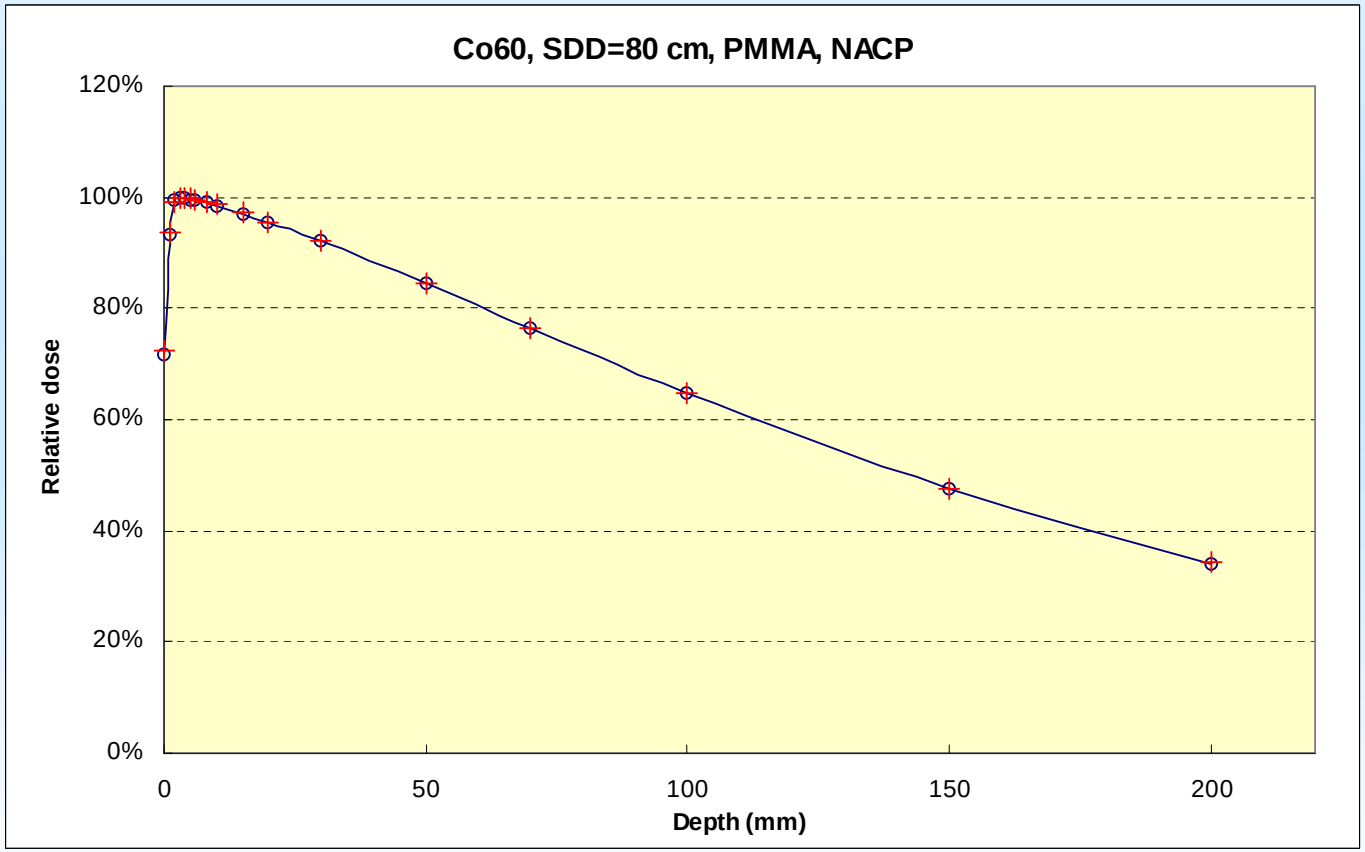
MatriXX- typical setup



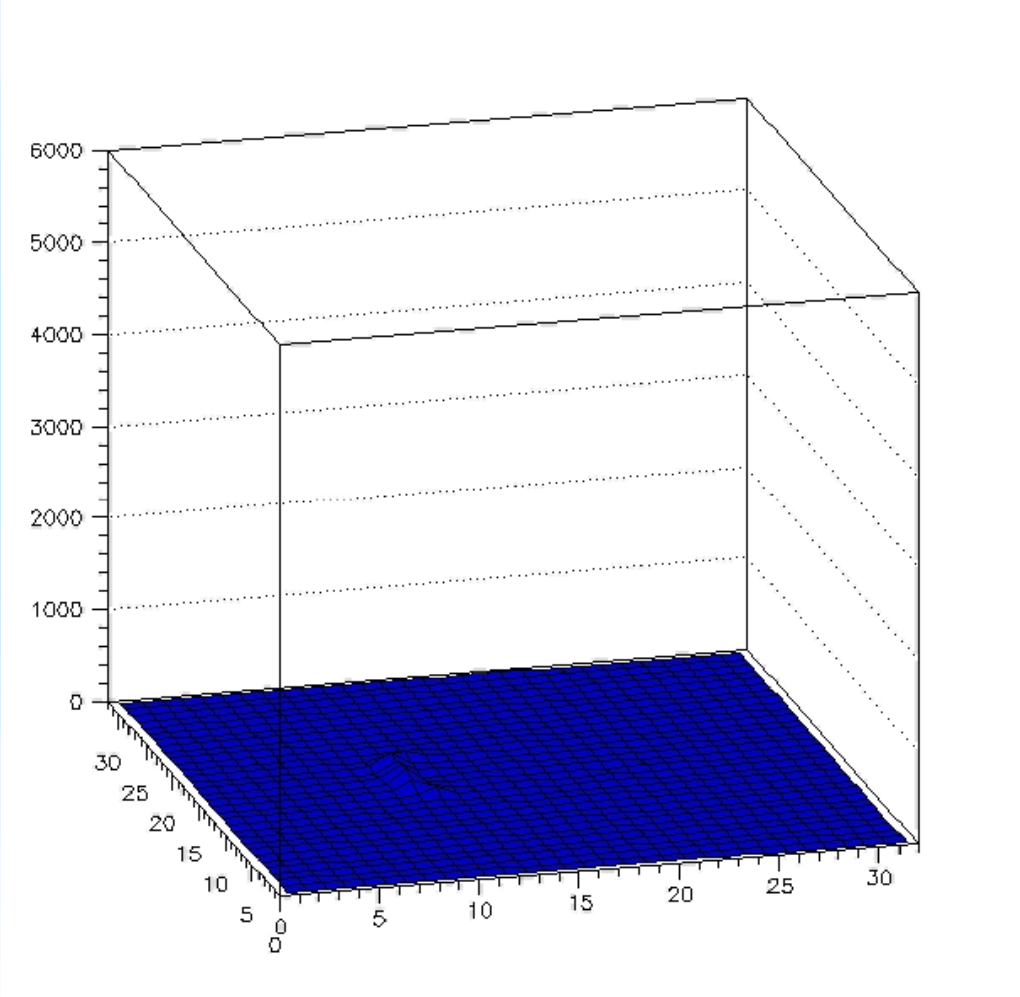
MatriXX - TMR


15 MV, SDD=100 cm, PMMA, NACP
Relative dose
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0
50
100
150
200
Depth (mm)

MatriXX - TMR


Co60, SDD=80 cm, PMMA, NACP
120%
100%
80%
60%
40%
20%
0%
Relative dose
0
50
100
150
200
Depth (mm)

MatriXX - dynamic read out



MatriXX features

- Pixel Ion chamber technology (air vented)
- 1020 (MXX) detectors in 24x24 cm matrix
- Single detector Φ = 4.5 mm (height 5mm), 0.07 cc
- Parallel reading w/o dead time
- Real time measurements
- Software (OmniPro ImRT, Accept)

SCANDITRONIX WELLHÖFER

Segments