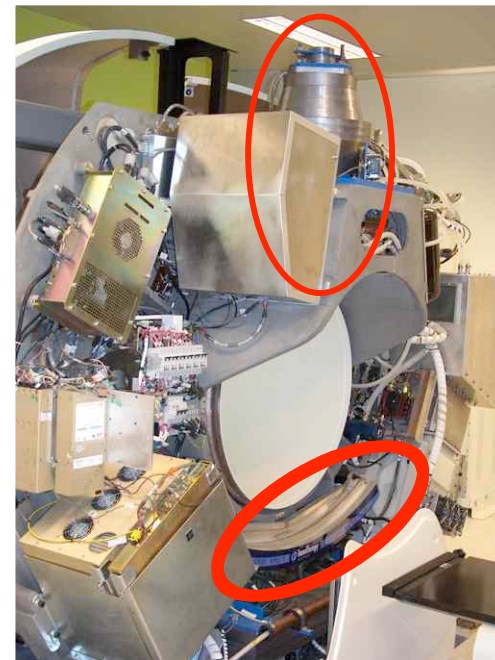# The place of TomoDose in the tomotherapy QA schedule

Koen Tournel, Medical Physics Radiotherapy
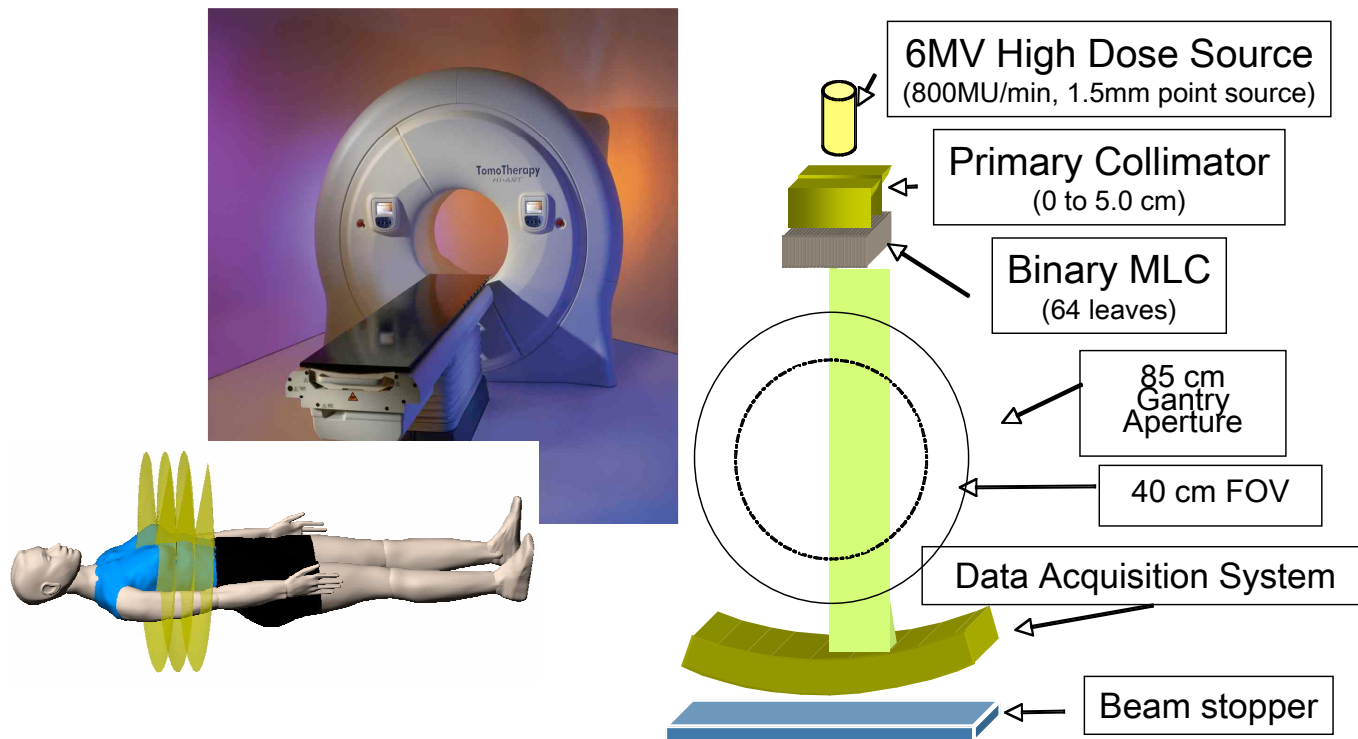UZ Brussel

# Introduction

- Tomotherapy and QA

- Importance of beam geometry QA

- Importance of constancy and statistics

- TomoDose

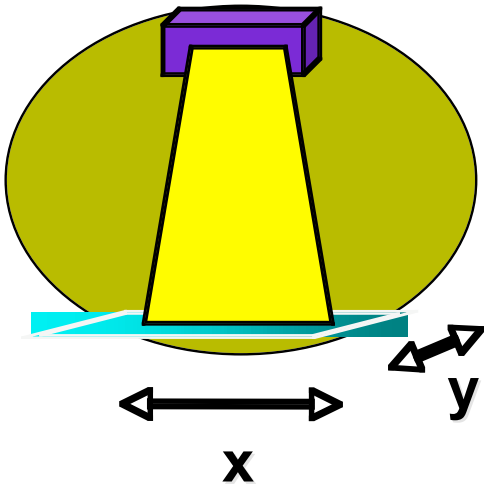- Advantages of TomoDose in the QA schedule

# Tomotherapy

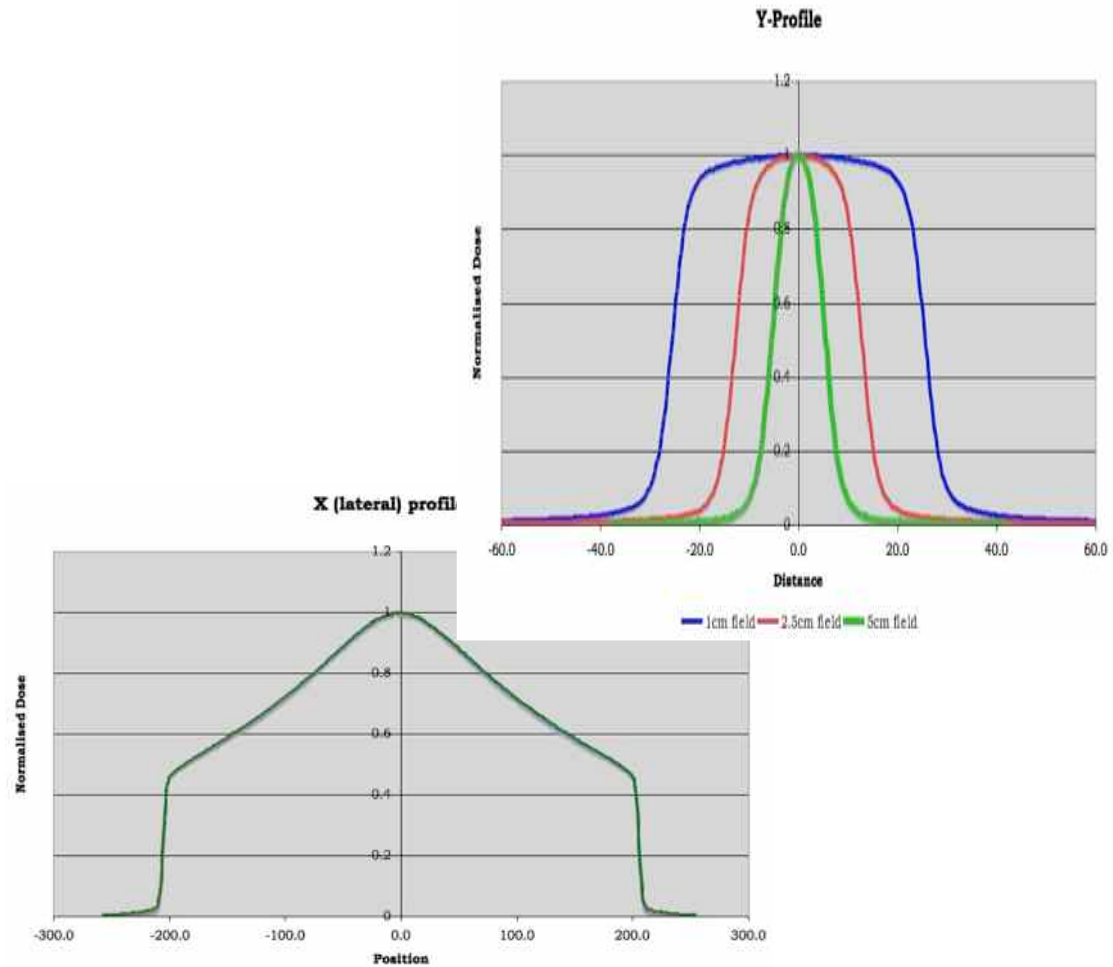Integration of IMRT and Image Guidance

# Tomotherapy@a glance



**6MV High Dose Source**
(800MU/min, 1.5mm point source)

**Primary Collimator**
(0 to 5.0 cm)

**Binary MLC**
(64 leaves)

85 cm Gantry Aperture

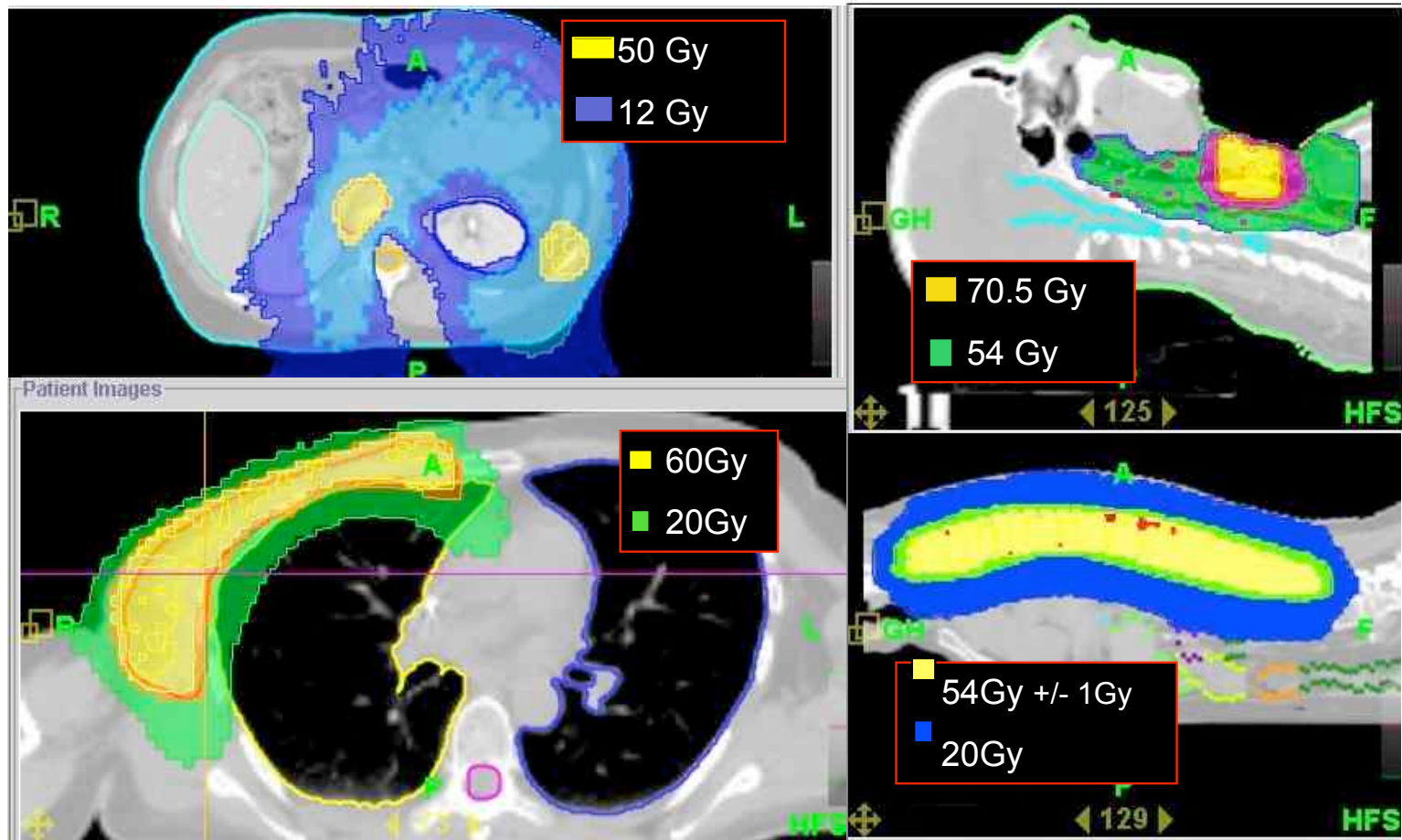40 cm FOV

Data Acquisition System

Beam stopper

# Tomo beam profiles



40cm x (1,2.5,5)cm

# Planning

# Very nice, but dosimetry is pure and utter hell...

- SSD 85cm

- 40x5cm field

- Dose rate based, not MU based

- Calibration is static, treatment rotational

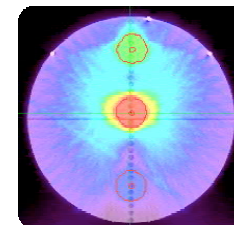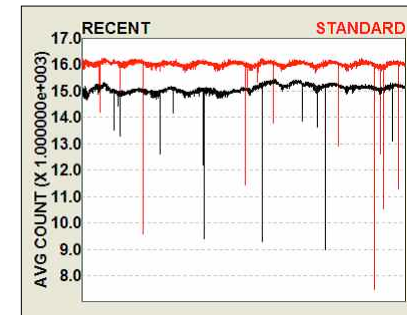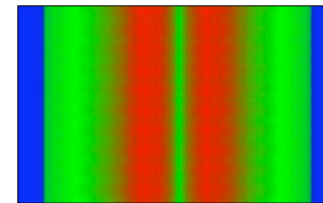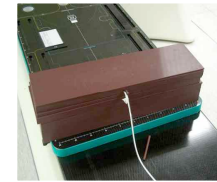- Beam is modeled in TPS, shape has to be very stable.

# ..., is mainly 'relative",...

- Company comparison : detector

- TLD, mosfet, film...has to be calibrated on the machine itself.

- Beam shape is one thing, IMRT treatments are something else.

- Result : users trying to pry open the black box and use whatever they can find
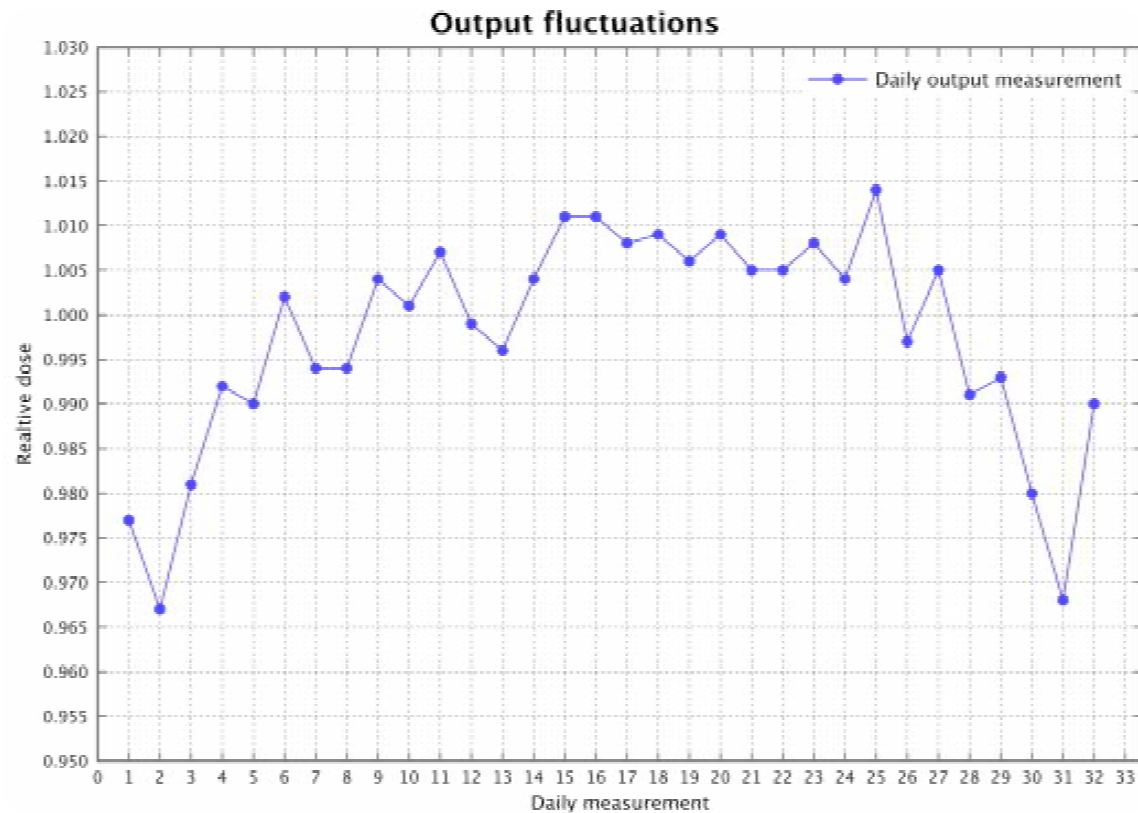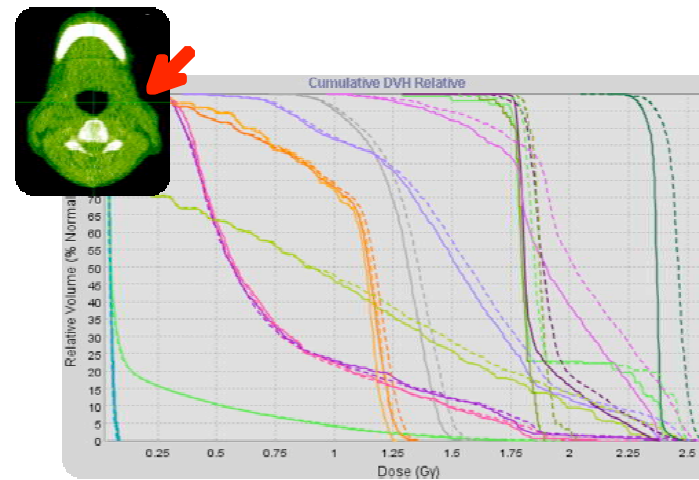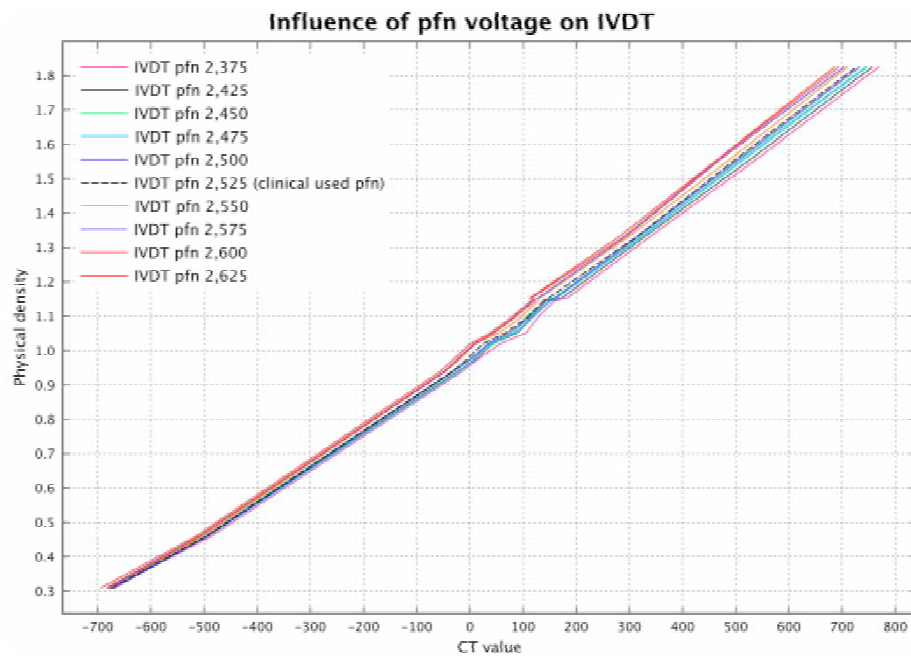
# ...and has to be performed a lot

- Daily output variation

- Weekly beam checks

- 6months/magnetron

- 12 months/target

- various other parts...

- Film calibration for patient QA

# Stability and constancy
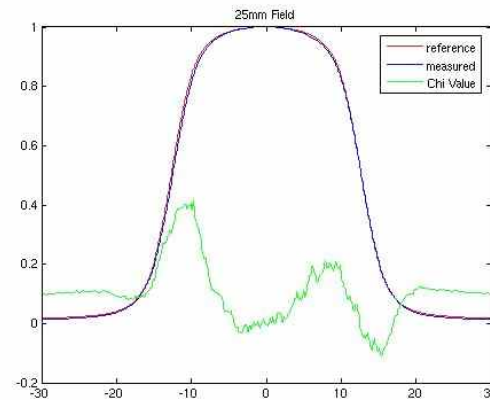
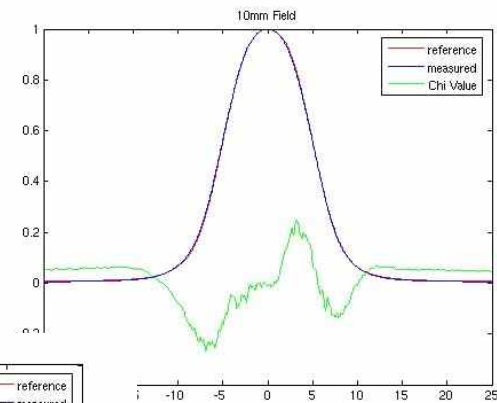# An example : imaging



Influence of pfn voltage on IVDT

IVDT pfn 2,375
IVDT pfn 2,425
IVDT pfn 2,450
IVDT pfn 2,475
IVDT pfn 2,500
IVDT pfn 2,525 (clinical used pfn)
IVDT pfn 2,550
IVDT pfn 2,575
IVDT pfn 2,600
IVDT pfn 2,625
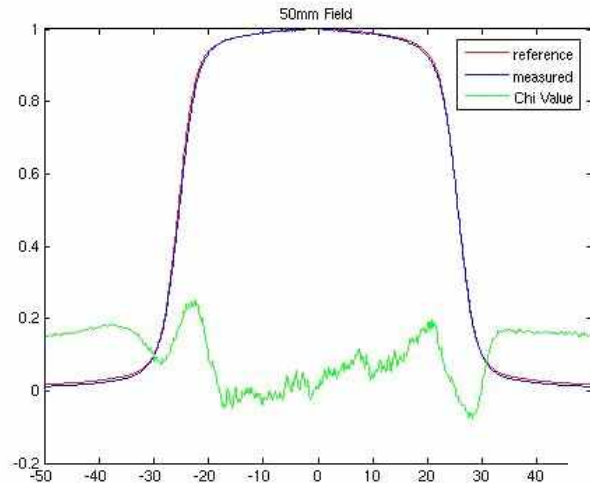
Cumulative DVH Relative

# Another example: target replacement

- Alignment (long. and lateral)

- Beam profiles

- Beam output/energy

- IMRT treatments

# and since we are working with partially overlapping beams, profiles are really important!

# QA schedule

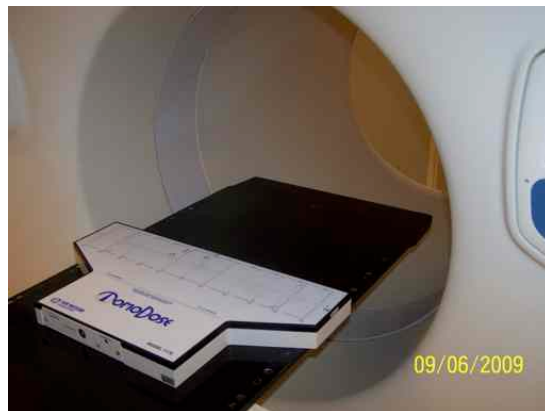|  | Daily | Weekly | (x)Monthly |
|---|---|---|---|
| **What?** | output<br>output constancy<br>lat. beam profile<br>patient | image beam<br>table<br>(laser) | magnetron<br>target<br>jaws<br>MLC,... |
| **Using?** | ~~detector~~<br>IC<br>film | ~~detector~~<br>IC<br>film | ~~detector~~<br>IC<br>watertank<br>film |

Request for Independence

# QA : conclusion

- QA is plenty and consumes a lot of time and resources.

- QA is mainly company dependent, or will need a lot of calibration time (TLD fields, film fields...)

- Set-up of the tomo watertank is ~~crap~~ not really efficient.

- There is a need for a company independent system allowing for a fast procedure replacing watertank or topographic measurements, and if it would give us an absolute dose, that would be nice as well.

# Possible solution : TomoDose



2D diode array "shaped" to
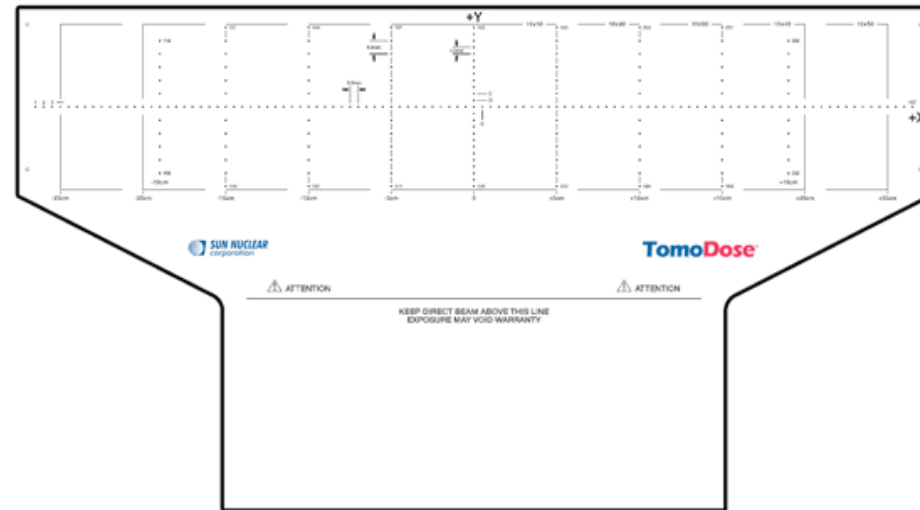fit the tomotherapy field



Possibility of adding "build up"

- Depth measurements

- Replacement of water tank

- Coupled to a laptop for read-out
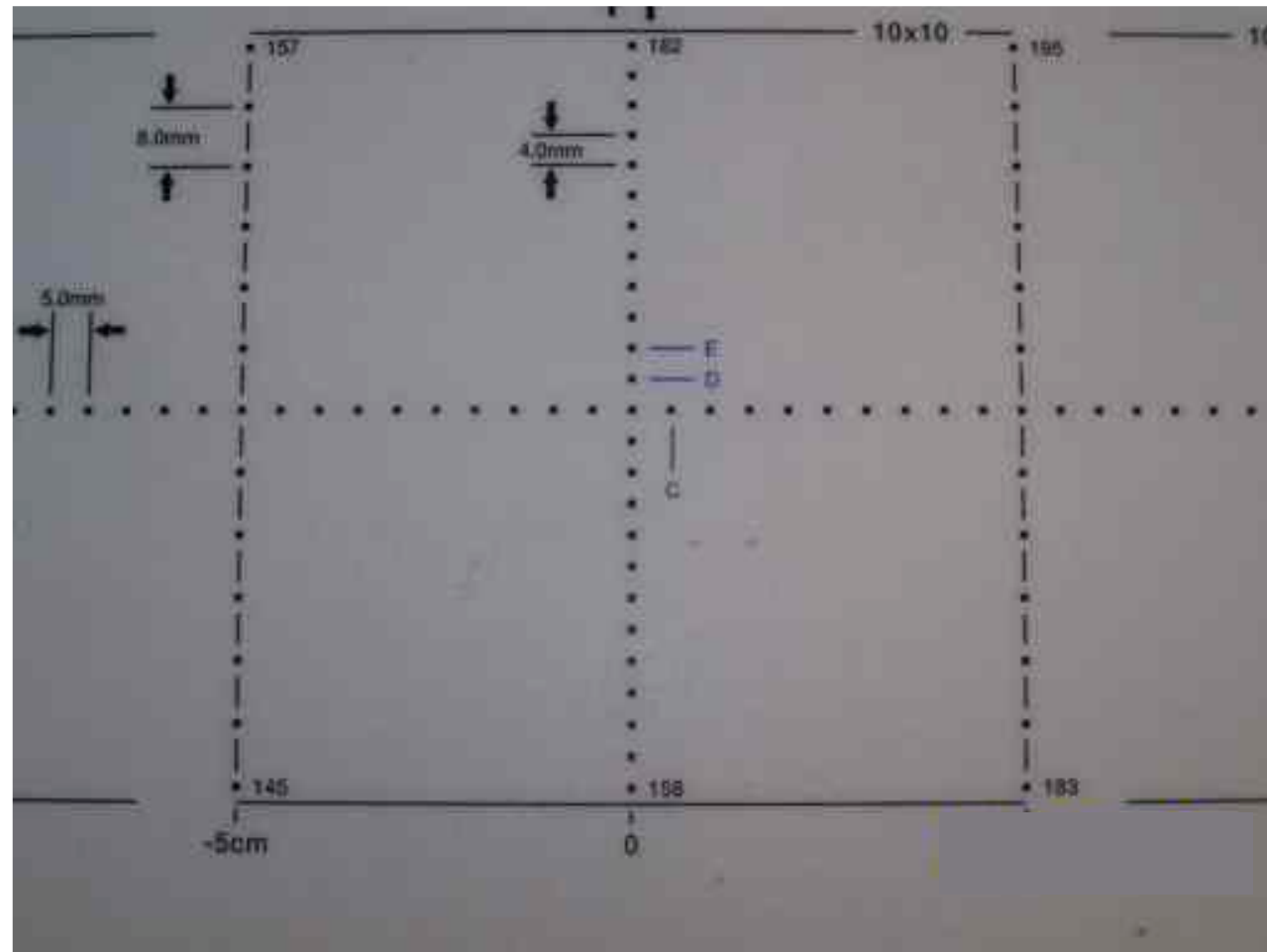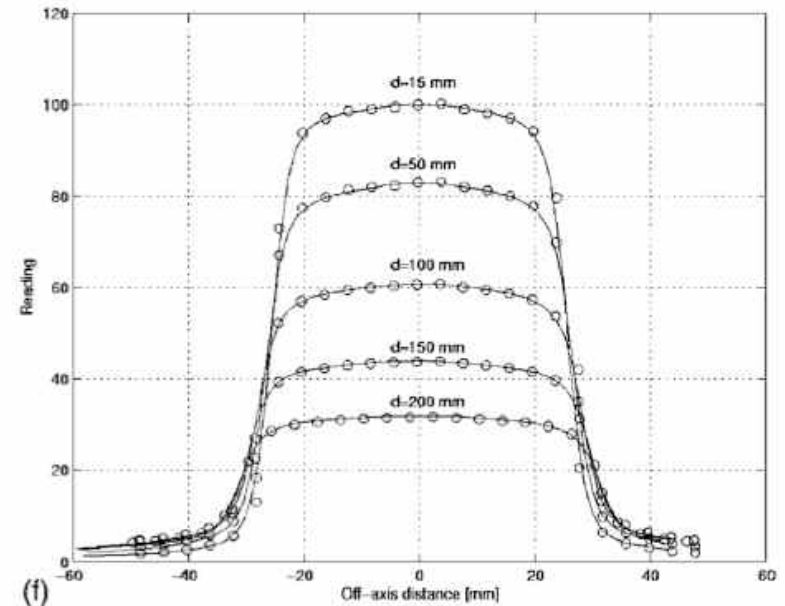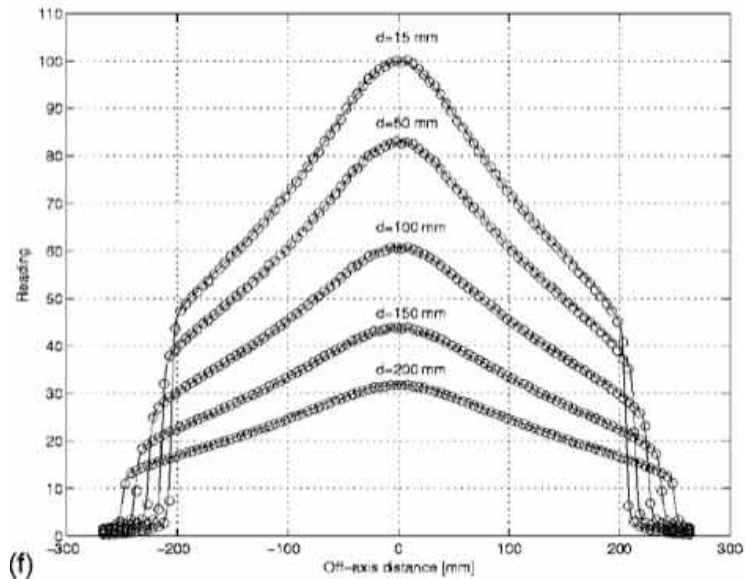
- low-resource software

# TomoDose



- 223 diodes (0.8x0.8)
- every 5mm y-direction, 4 and 8mm y axis
- 530mm x 98mm
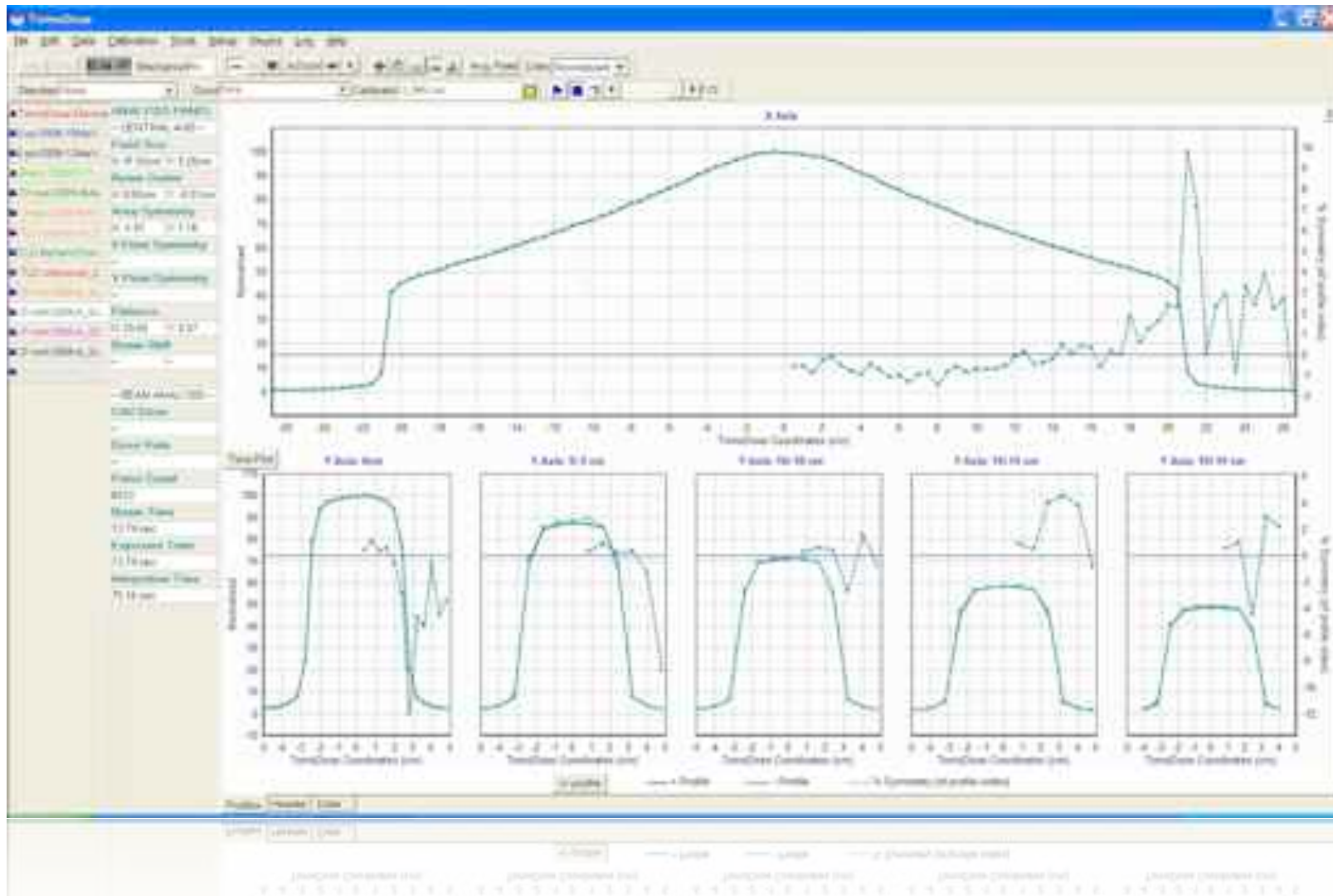- User calibration (detector response and dose)

# Calibration

# Validation



- In-field <0.5% correspondance with watertank
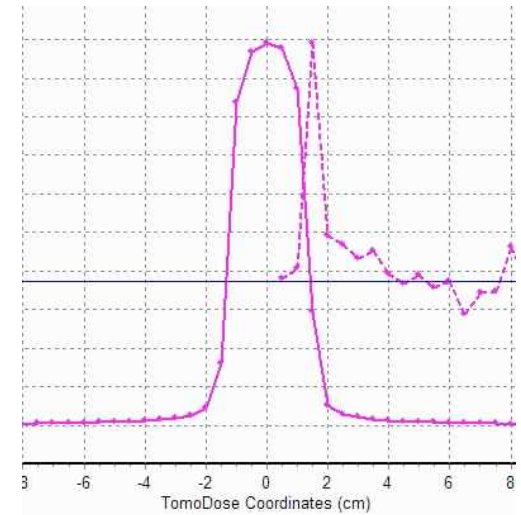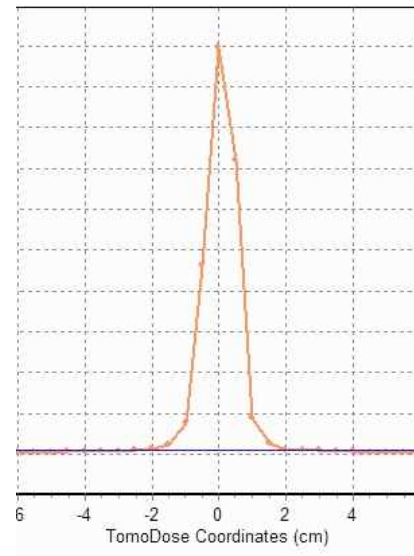- Penumbra < DTA 1mm (lat) or 2mm(long)
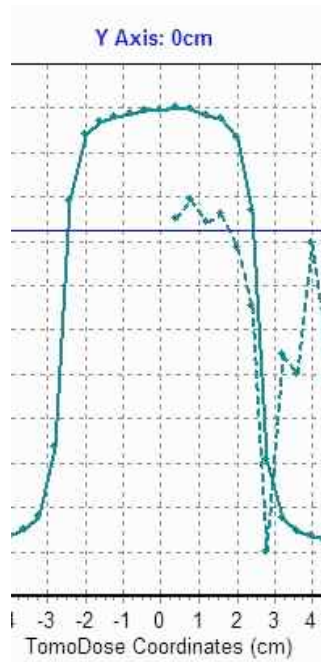
Langen et al. Med Phys 32(11)

# Software

- Developed and growing 'on the go'

- Added features of import, 'integrated' view and 'frame-per-frame' view

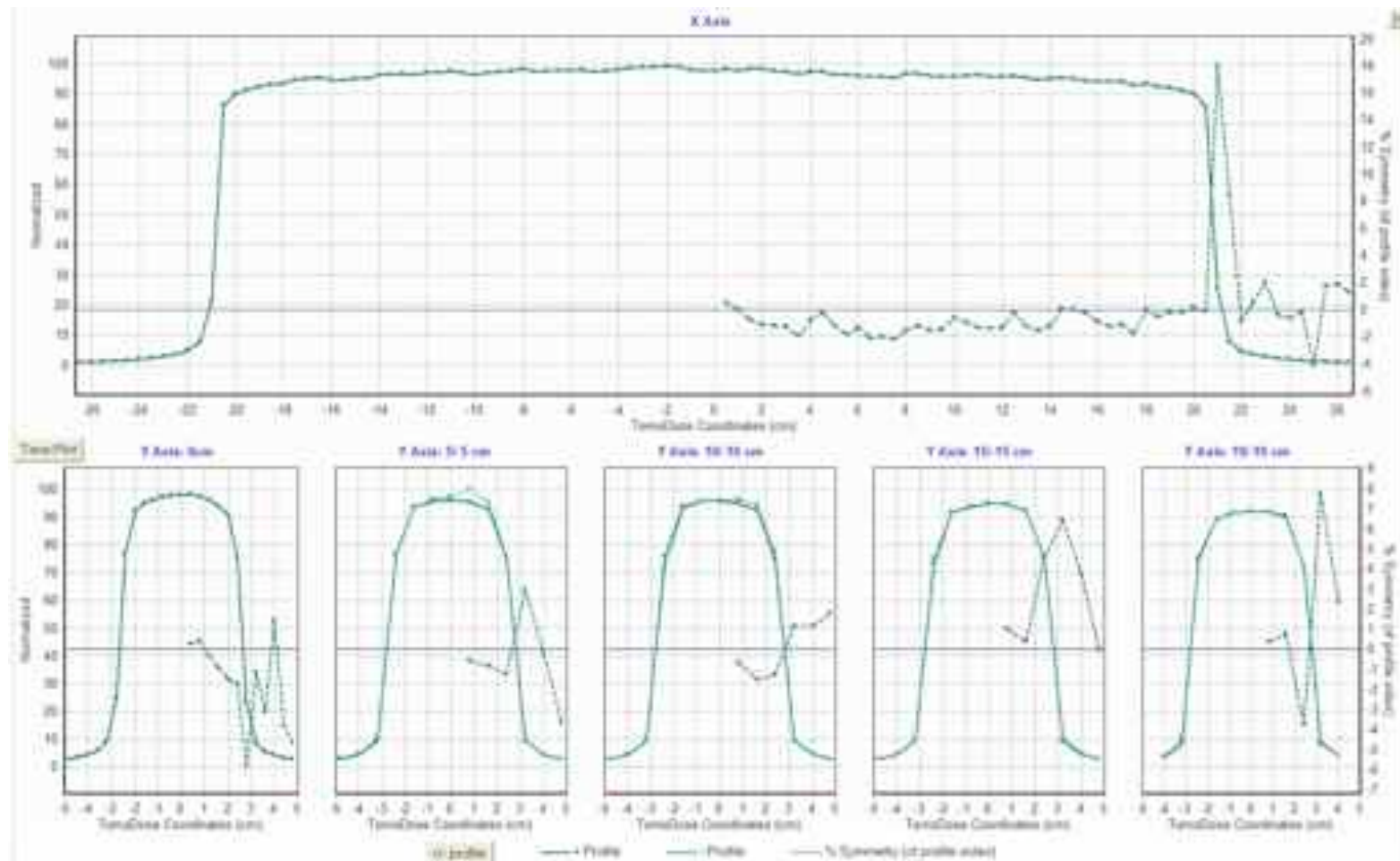- Added coupling to database for trending (Atlas)
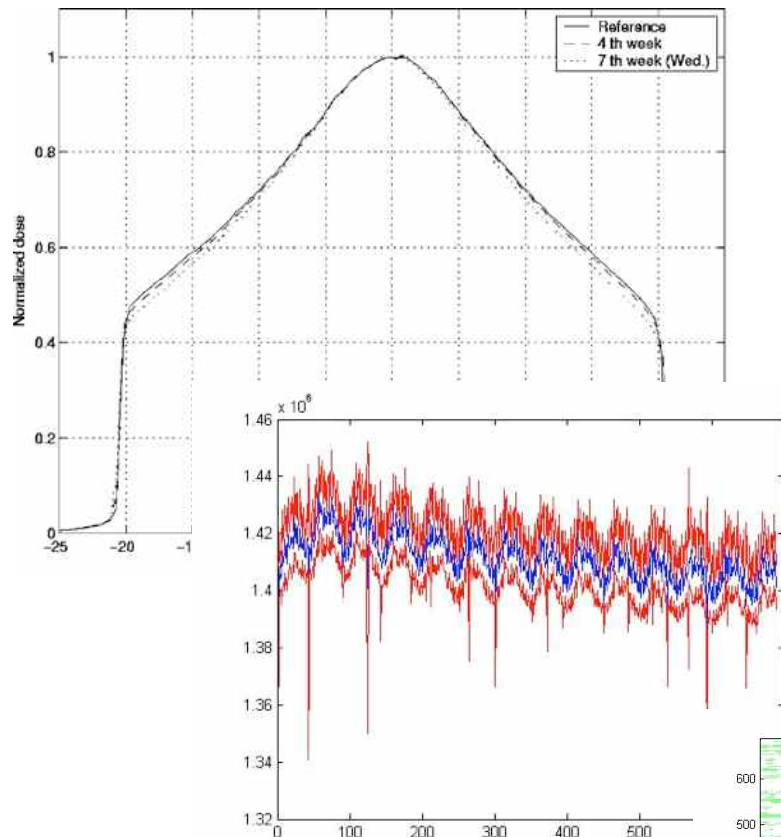
# Software

# Longitudinal

# Software

- Acquiring profiles
    - Lateral and longitudinal (resolution!)
    - In "real" time (frame/frame)
    - integrated
- Dose measurements (TLD profile)
- Comparing with previous profiles
- Data analysis
    - symmetry
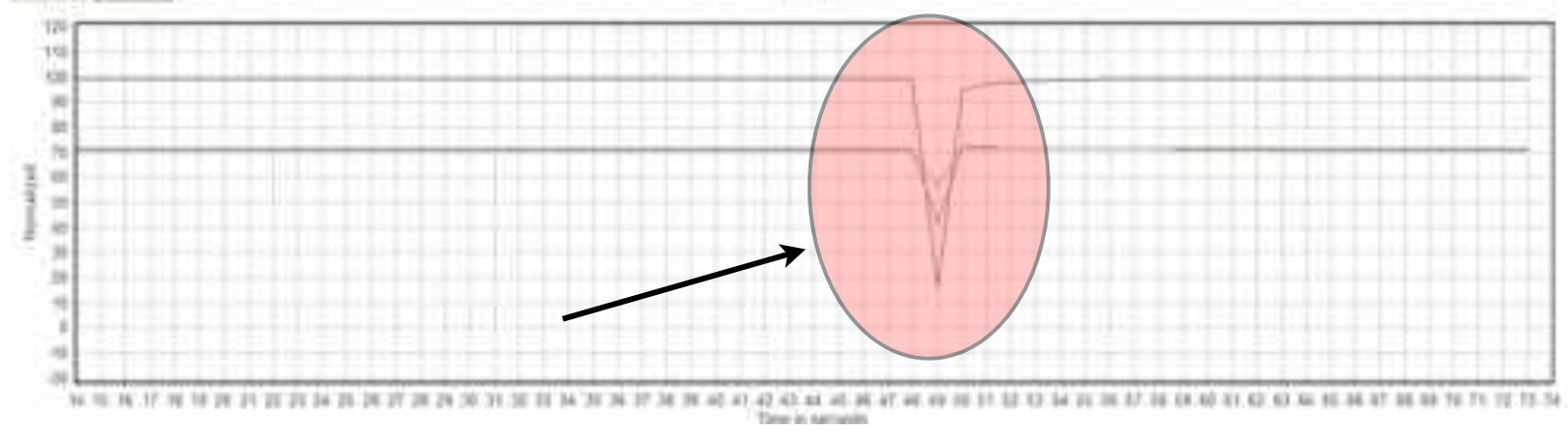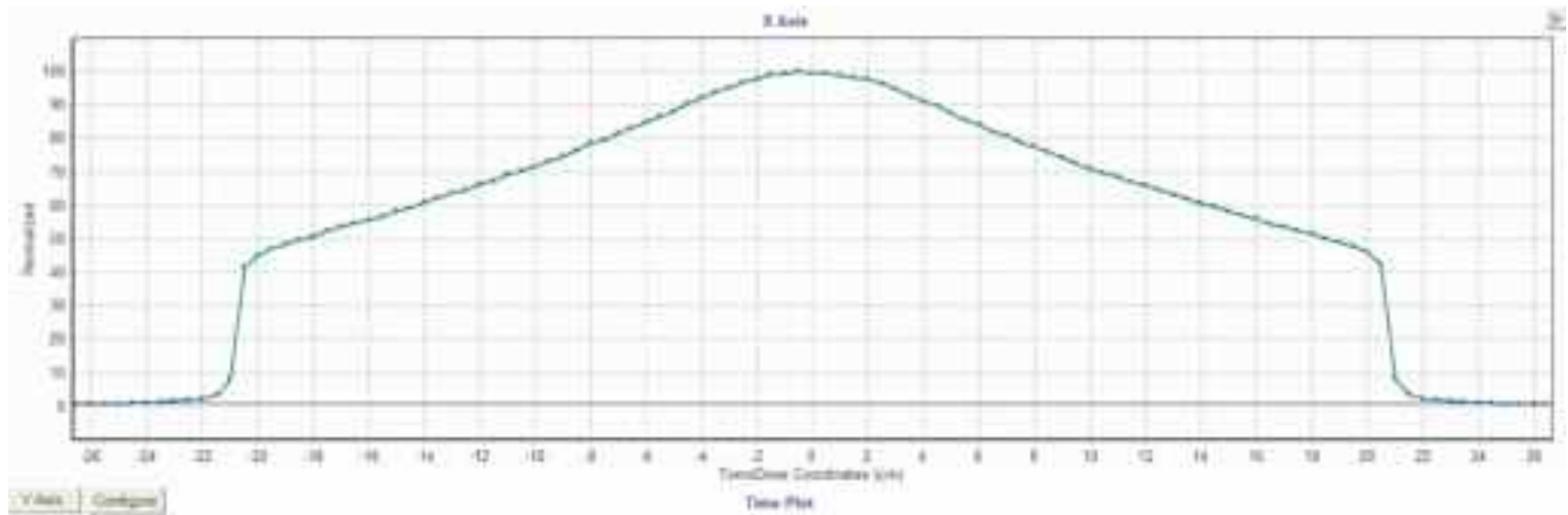    - Difference

# TLD fields

# Time evolution



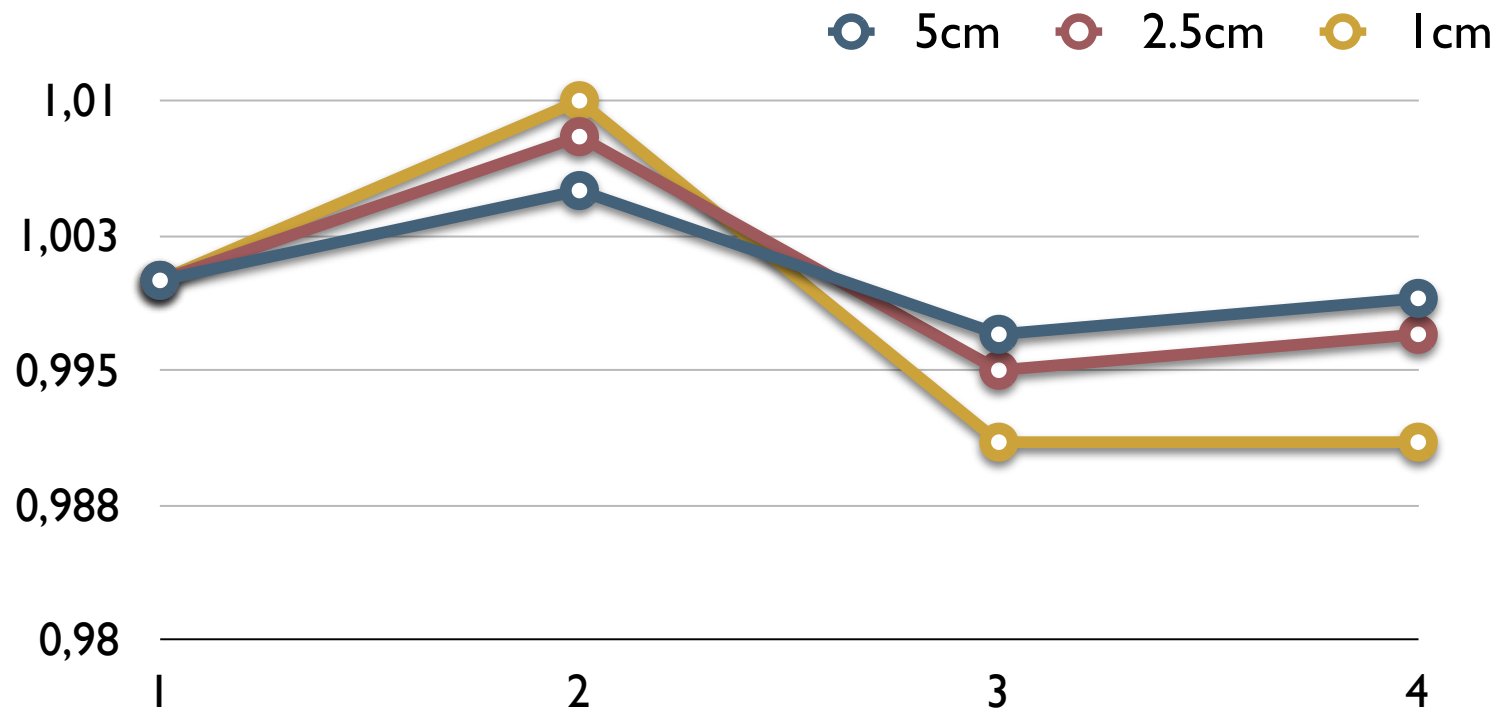'Deterioration of the beam'

...in months...
...in days...
...in minutes...

Langen et al. Med Phys 32(11)
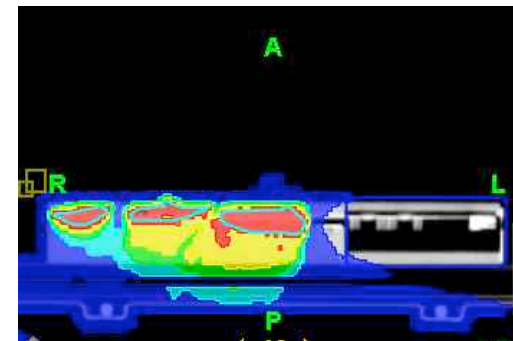
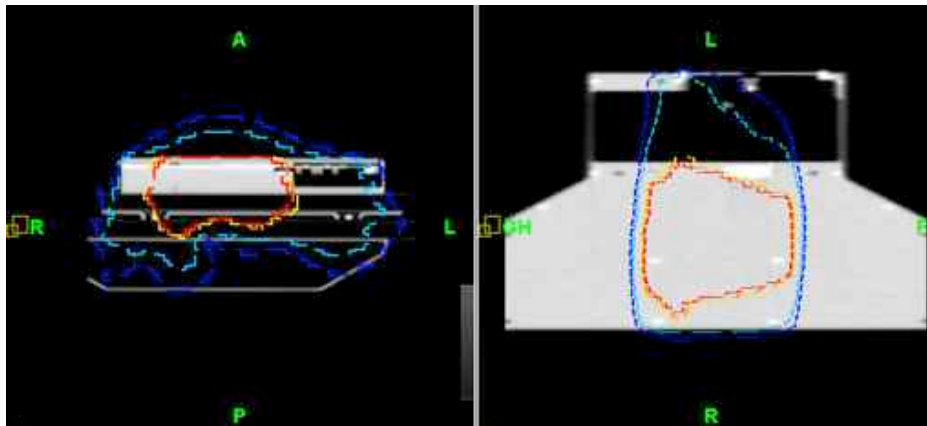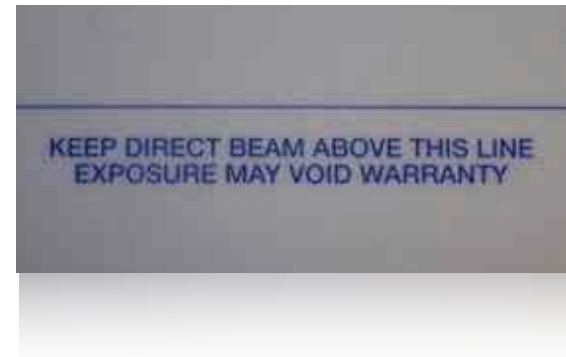# Measuring Time evolution

# Software

Used for fast comparing of beam width and profile.

# Limitation

## Can we use it for patient QA? Yes but...

- PRO :
  - No more film
  - Long field (40cm)
- CON :
  - Lateral : field too short
  - Longitudinal : electronics in beam



KEEP DIRECT BEAM ABOVE THIS LINE
EXPOSURE MAY VOID WARRANTY

# Reducing QA time...

| | |
|---|---|
| film + calibration | 45-60min* |
| water tank | 2h* |
| topoprocedure | 30min* |
| TLD calibration | 20min* |

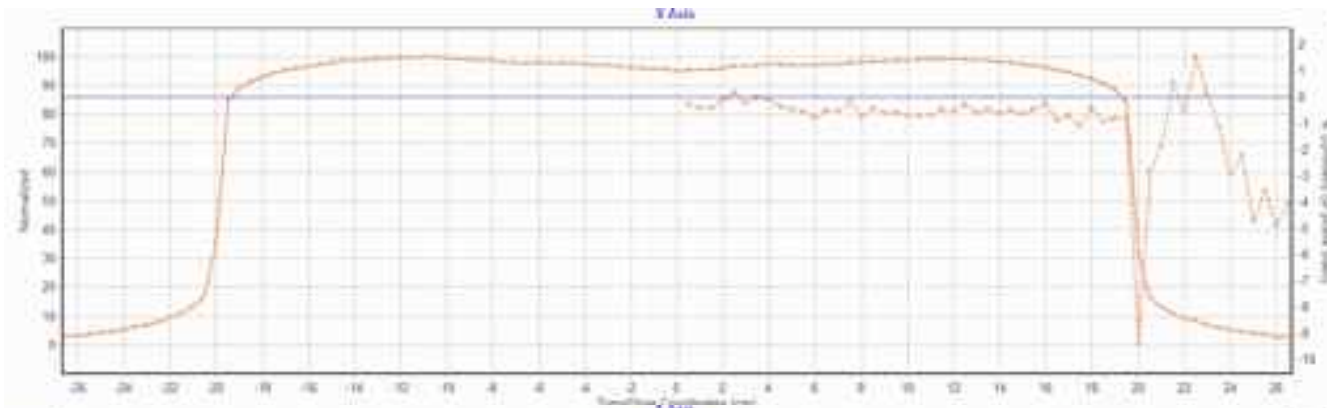| | |
|---|---|
| Tomodose | 15 min |

* including restarting the machine because of machine interruptions, redoing the setup, cursing again and again, kicking the machine and making mistakes because it's already pretty late on a friday night
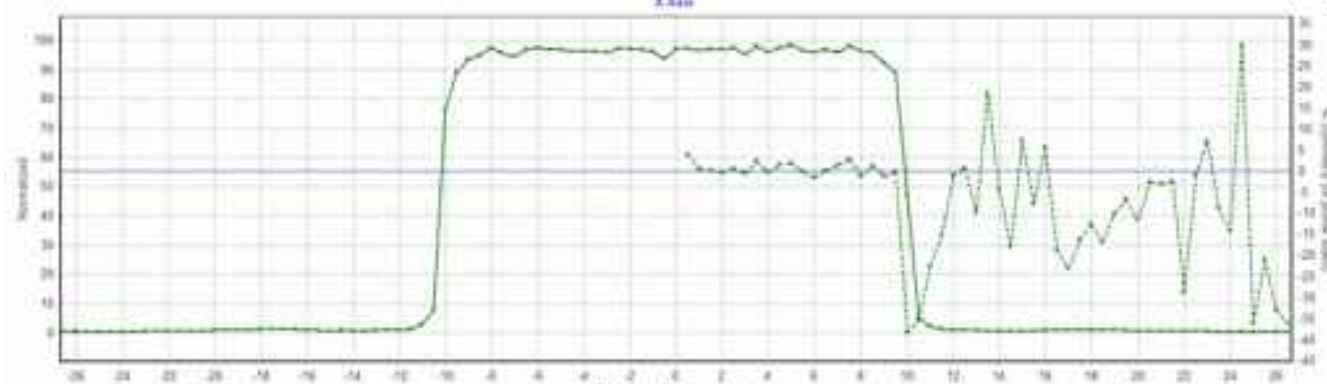
# Bonus : conventional linacs

Best and one of the only devices capable of measuring a 40cm field for flatness and symmetry in realtime, and within 10min

fotons

electrons

# Conclusion

- TomoDose is able to acquire and monitor trends in the geometric beam profiles, independent of tomotherapy soft- or hardware.

- ...able to perform (semi)independent output checks (absolute dosimetry).

- Software is easy to use, and was adapted to the needs of the user.

- Is a time-saving alternative to the cumber- (and loathsome) tomotherapy watertank.