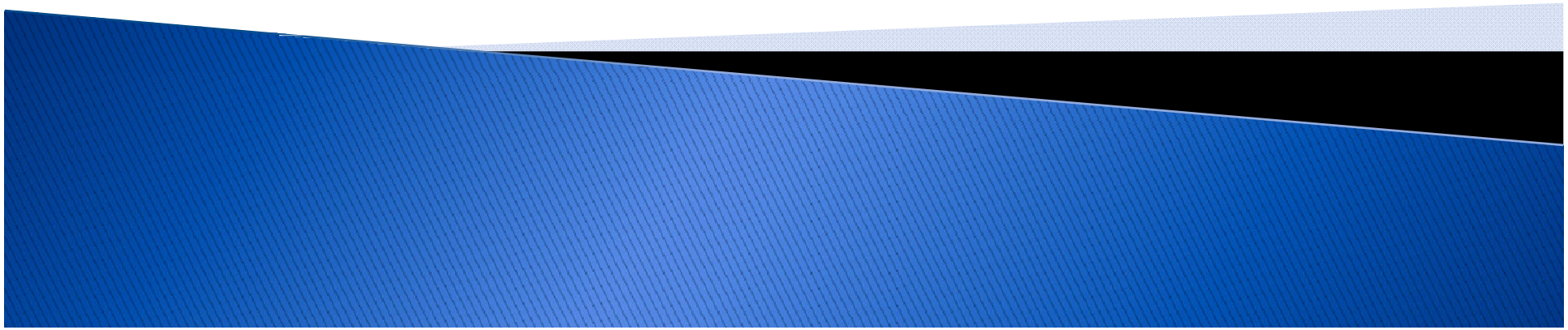
EBT2/EBT3 with FilmQA Pro

St Luke's Radiation Oncology Network



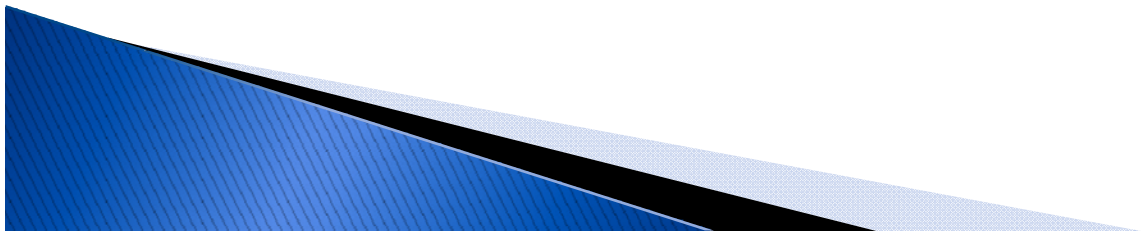
Overview

1. Rapidarc plan verification
   - Prostate
   - Head & Neck
2. Commissioning
   - Treatment plan verification
   - Algorithm tests – inhomogeneities
   - Measurement of interleaf leakage
3. Research
   - Cell survival study
4. Future work
   - Commissioning of stereotactic system
   - Investigation into out-of-field doses
   - A study on small field dosimetry

1.Rapidarc plan verification

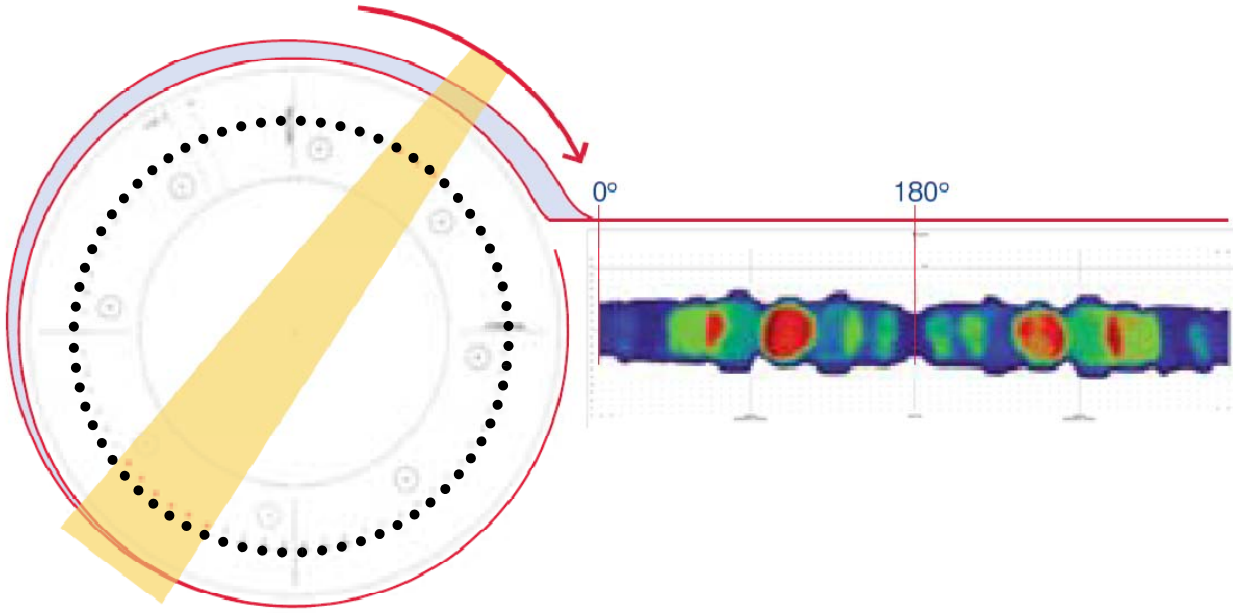
- Increased degrees of modulation present in RapidArc delivery:
  - MLC are continuously moving
  - Gantry speed & dose rate are variably modulated

- New methods and tools are required for patient specific QA
  1. ArcCHECK
  2. Gafchromic film measurements for validation and as a backup for arcCHECK.



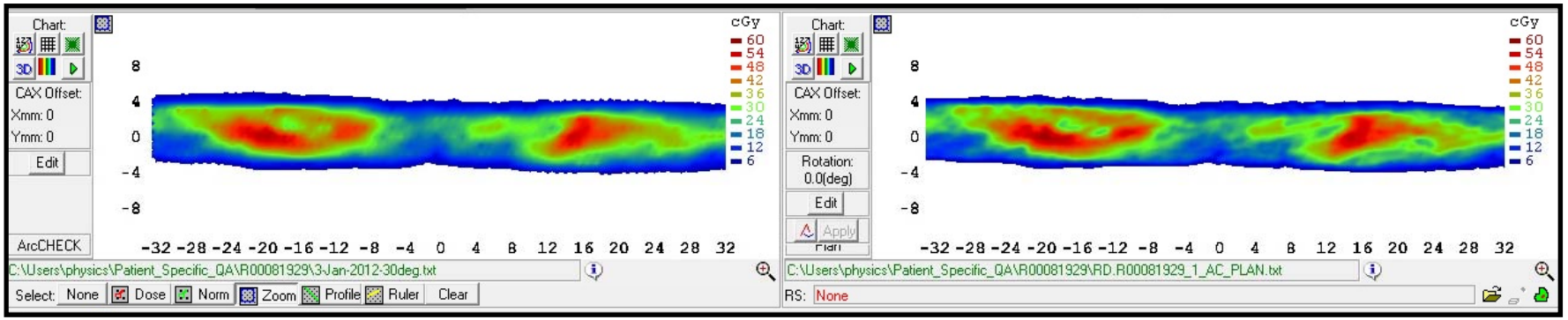
1.Rapidarc plan verification

- ArcCHECK is a commercial diode array designed specifically for rotational measurements.
  - 1386 diodes, depth = 3.3cm, 10mm spacing, spiral design



1.Rapidarc plan verification

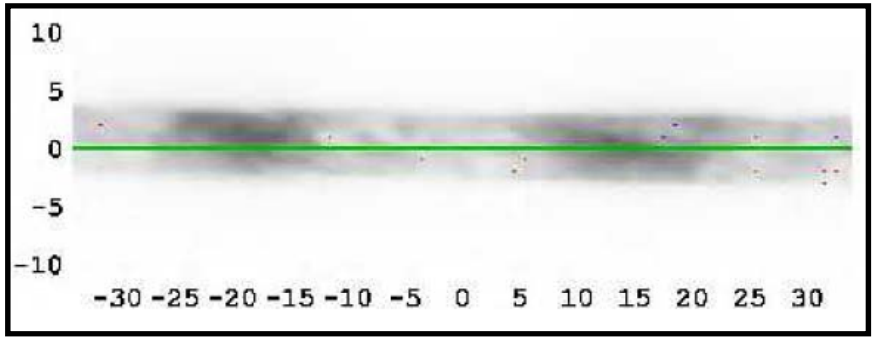
ArcCHECK – plan assessment

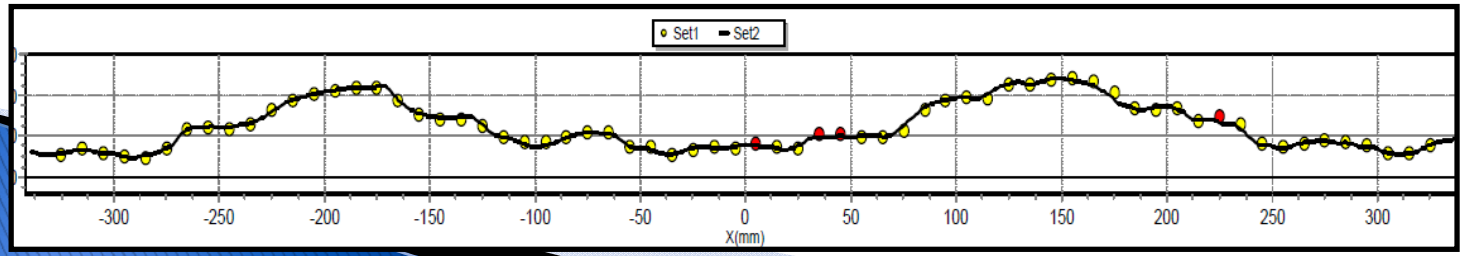


Summary (Gamma Analysis)

Total Points	: 448
Passed	: 431
Failed	: 17
% Passed	: 96.2

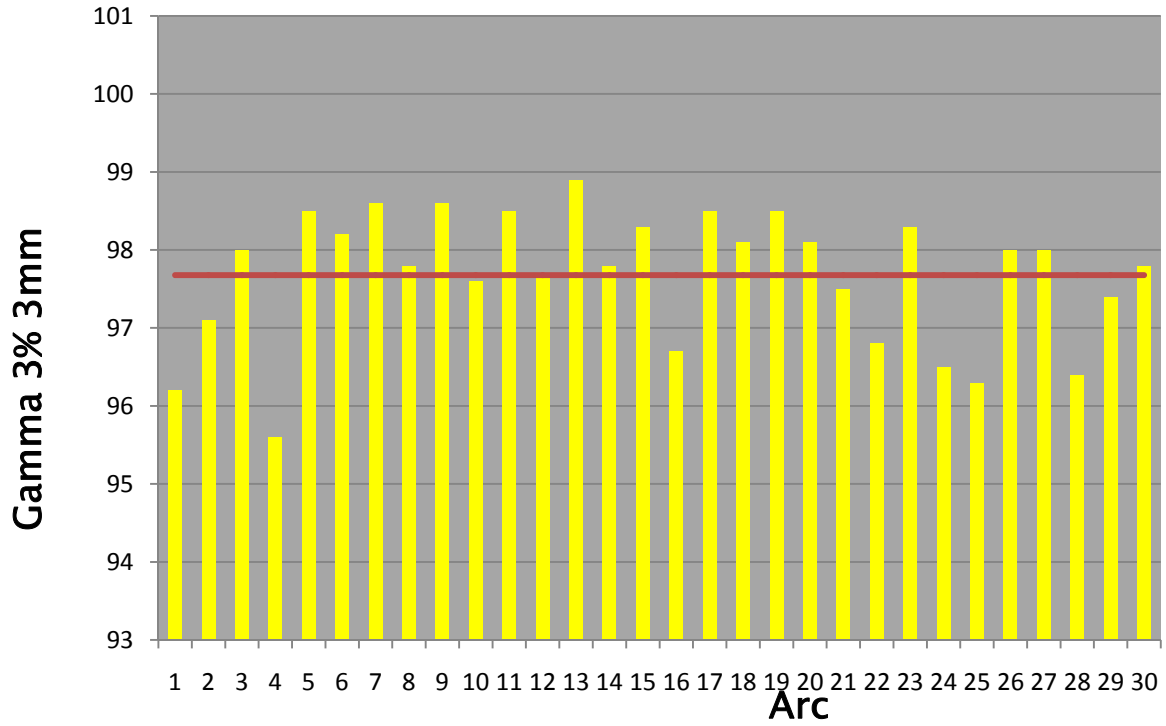
*DTA/Gamma is using 3D Mode





1.Rapidarc plan verification

- ArcCHECK – confidence limit
- From the commissioning plans the confidence limit is 96.2%. (for gamma criteria of 3% 3mm, Threshold =10%)



Average = 97.7%

- Pass rate should equal 96.2%, for 95% of the measurements.

Ezzell et al., 2009

1.Rapidarc plan verification

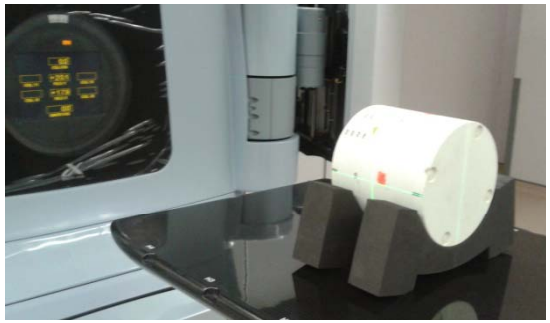
- Gafchromic film
- Advantages:
  - High spatial resolution
  - Weak energy dependence
  - Near-tissue equivalence

- Disadvantages:
  - Images suffer from a ‘lateral’ artifact and other problems related to scanning
  - Other non dose-dependent artifacts including variations in thickness of film active layer

Solution: Use triple channel dosimetry to separate dose-dependent and dose-independent parts of scanned film

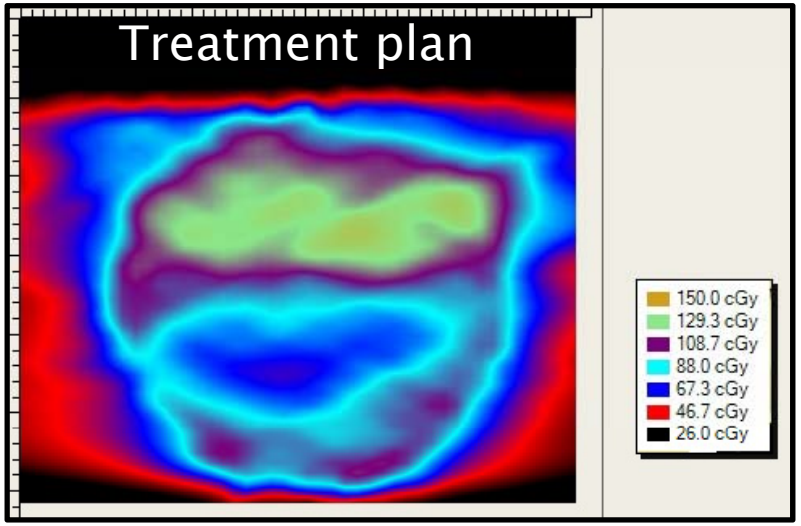
1.Rapidarc plan verification

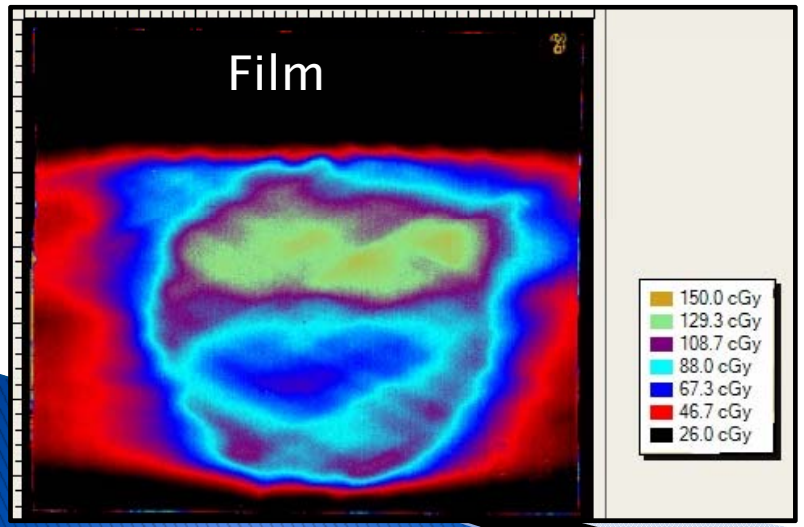
- Axial dose planes



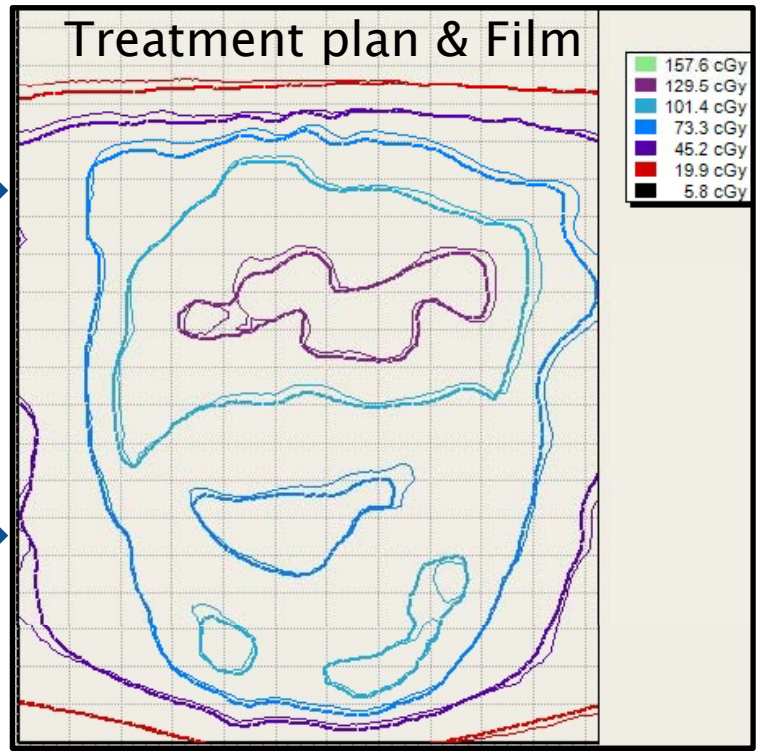
- Coronal dose planes

1.Rapidarc plan verification



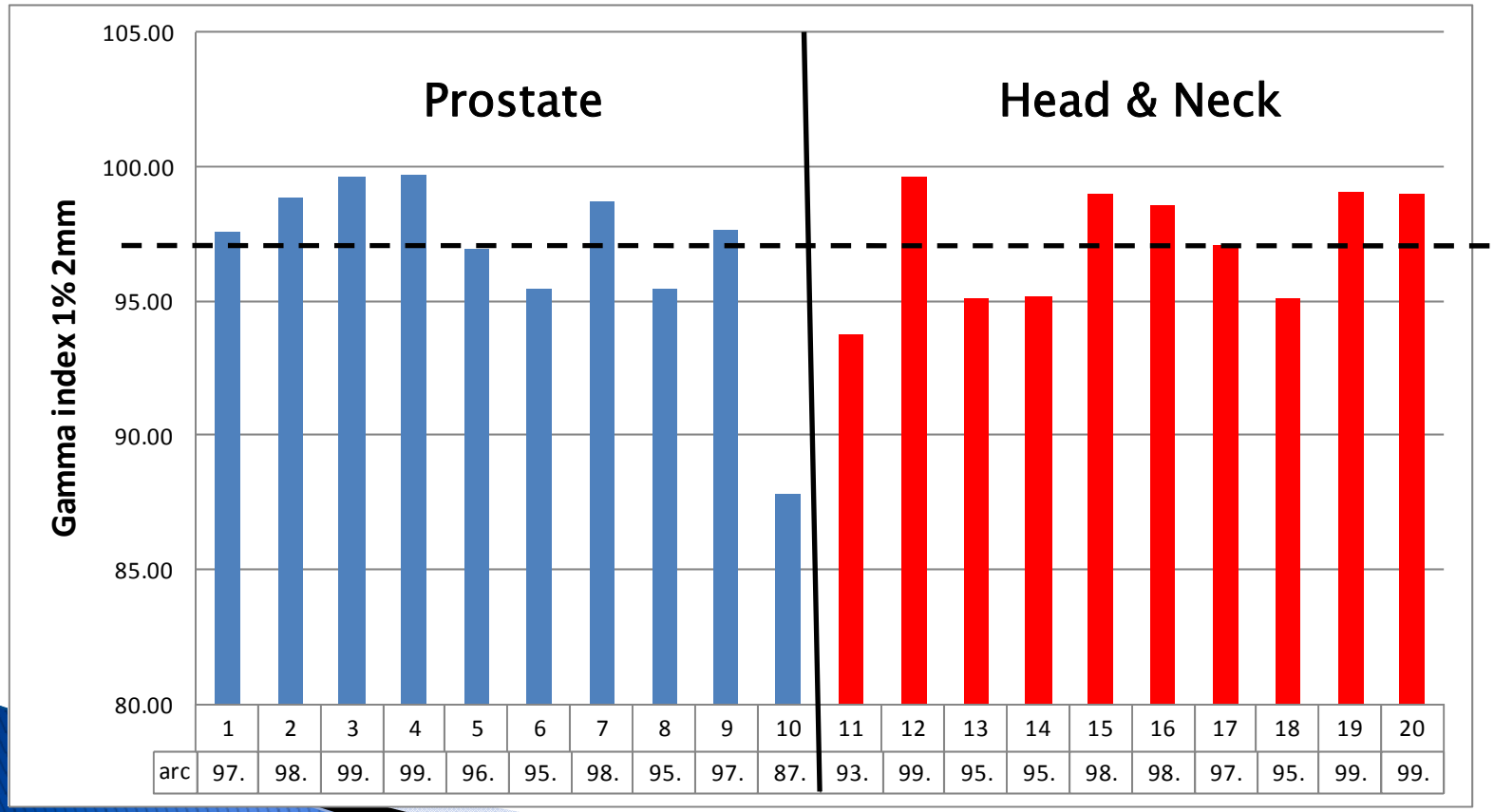


Assessment using FilmQA Pro software



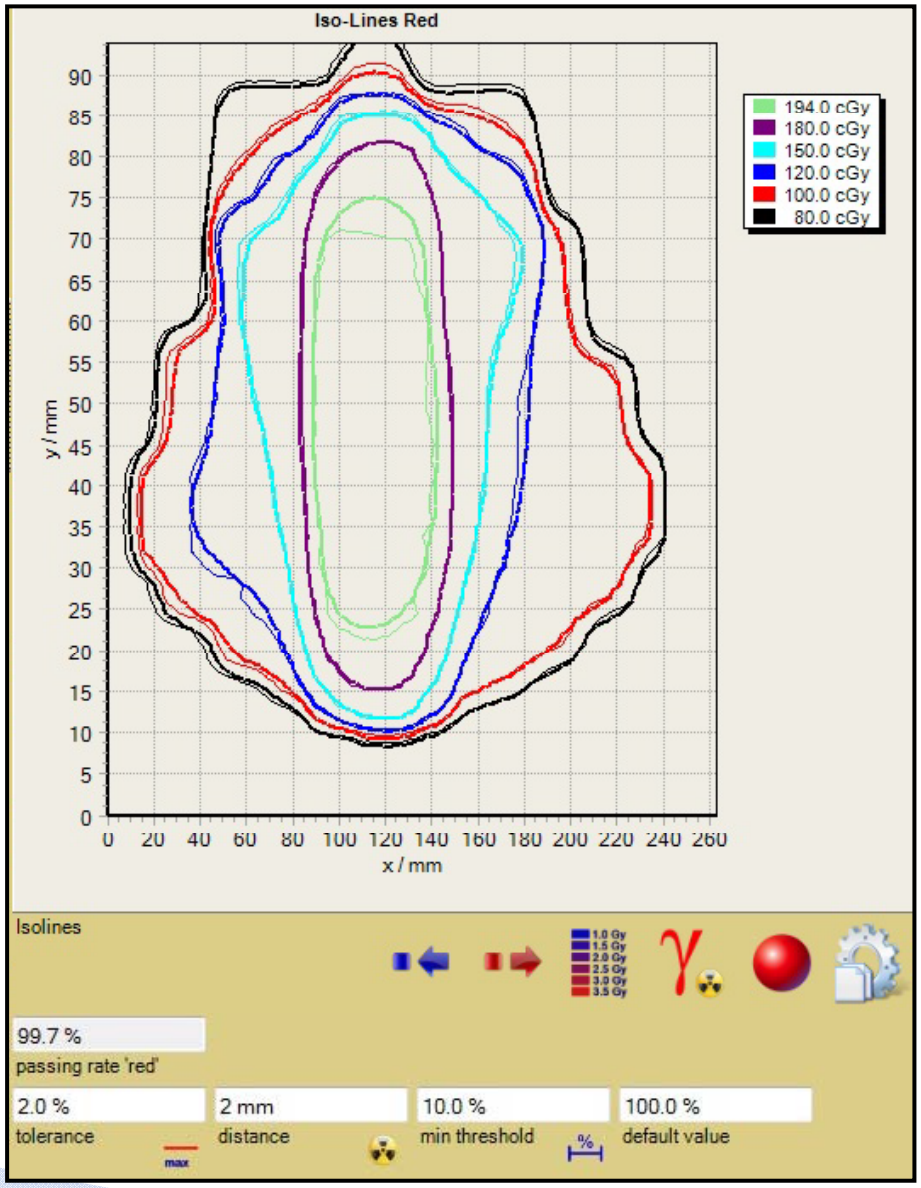
1.Rapidarc plan verification

Gafchromic results



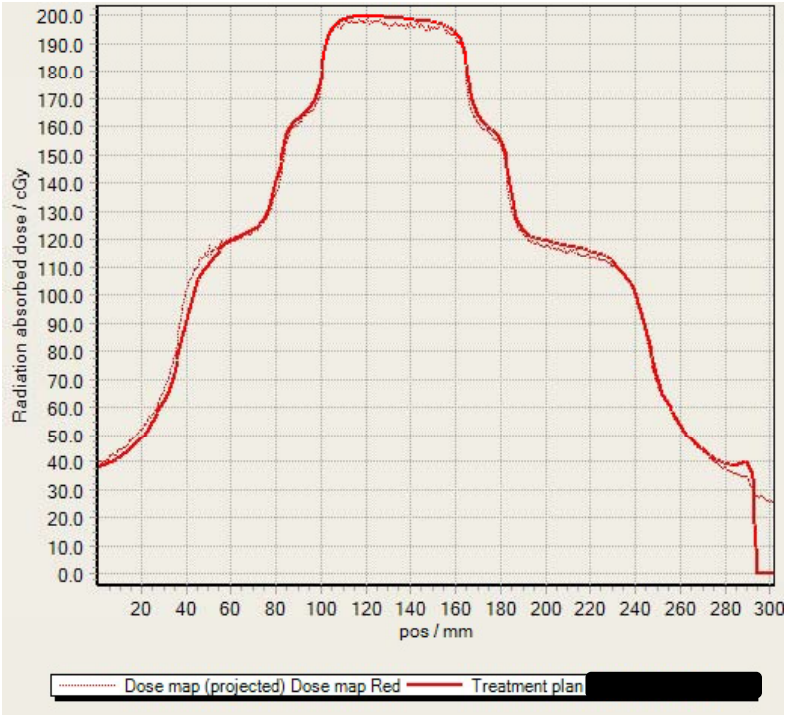
2. Commissioning – plan delivery

- Prostate plan
  - 4 field 3D conformal plan with MLC and EDWs.
- Measurement set-up
  - A 20cm block of WEP was set to SSD = 90cm.
  - EBT3 Gafchromic film was placed at isocentre (10cm depth). Plan delivered at planned gantry angles.
  - Analysis was performed using FilmQA Pro software.

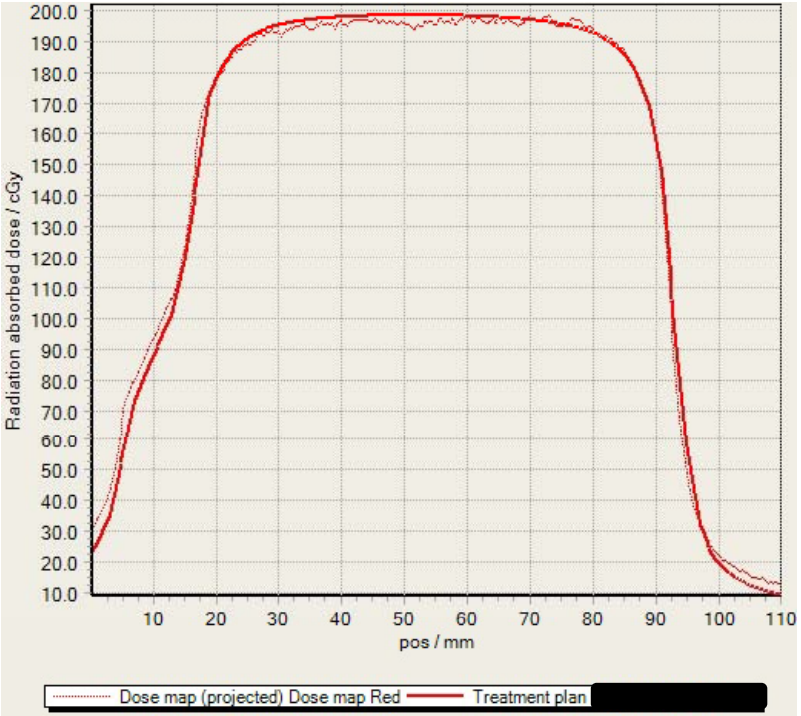


2. Commissioning – plan delivery

- Profiles through the central axis.



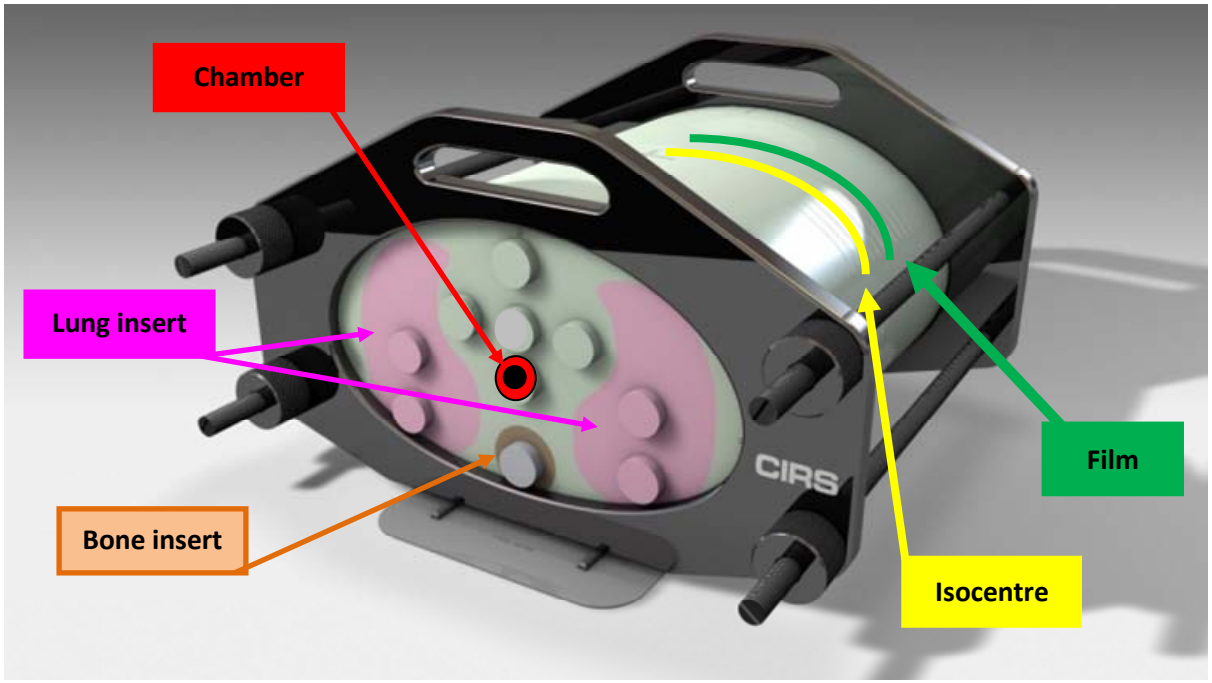
Horizontal



Vertical

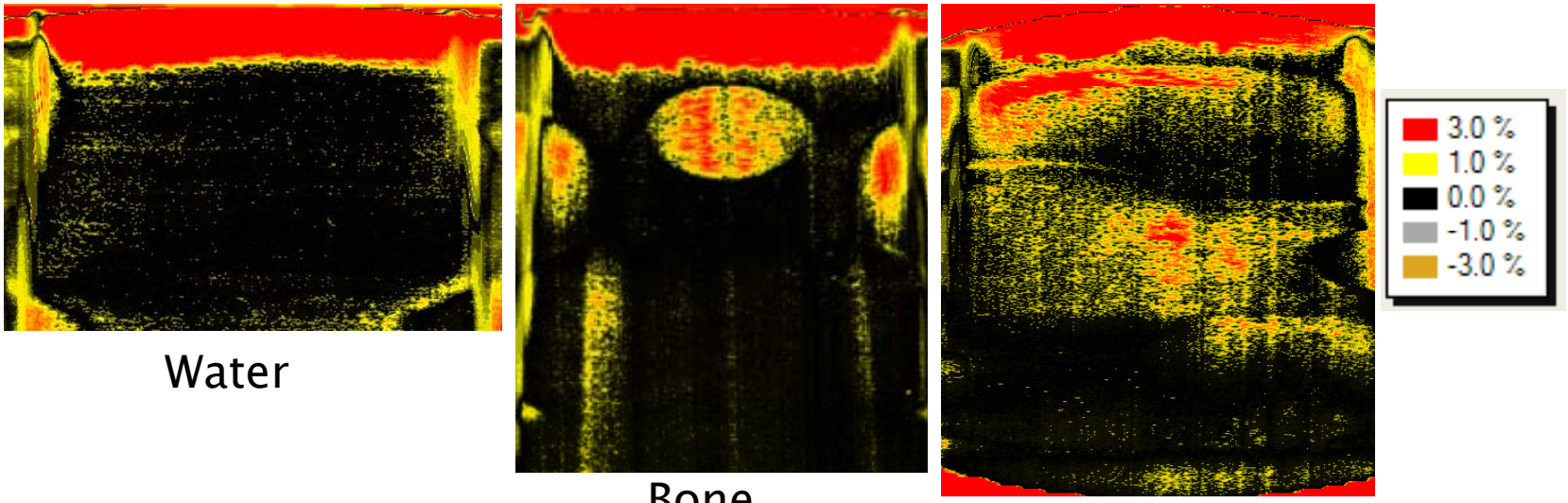
2. Commissioning - Algorithm tests

- The ability of the AAA algorithm to account for inhomogeneities was tested using Gafchromic EBT3 film in the CIRS phantom.



2. Commissioning - Algorithm tests

- Gamma analysis was used in order to ensure film was aligned with dose plane from TPS.



Water

Bone

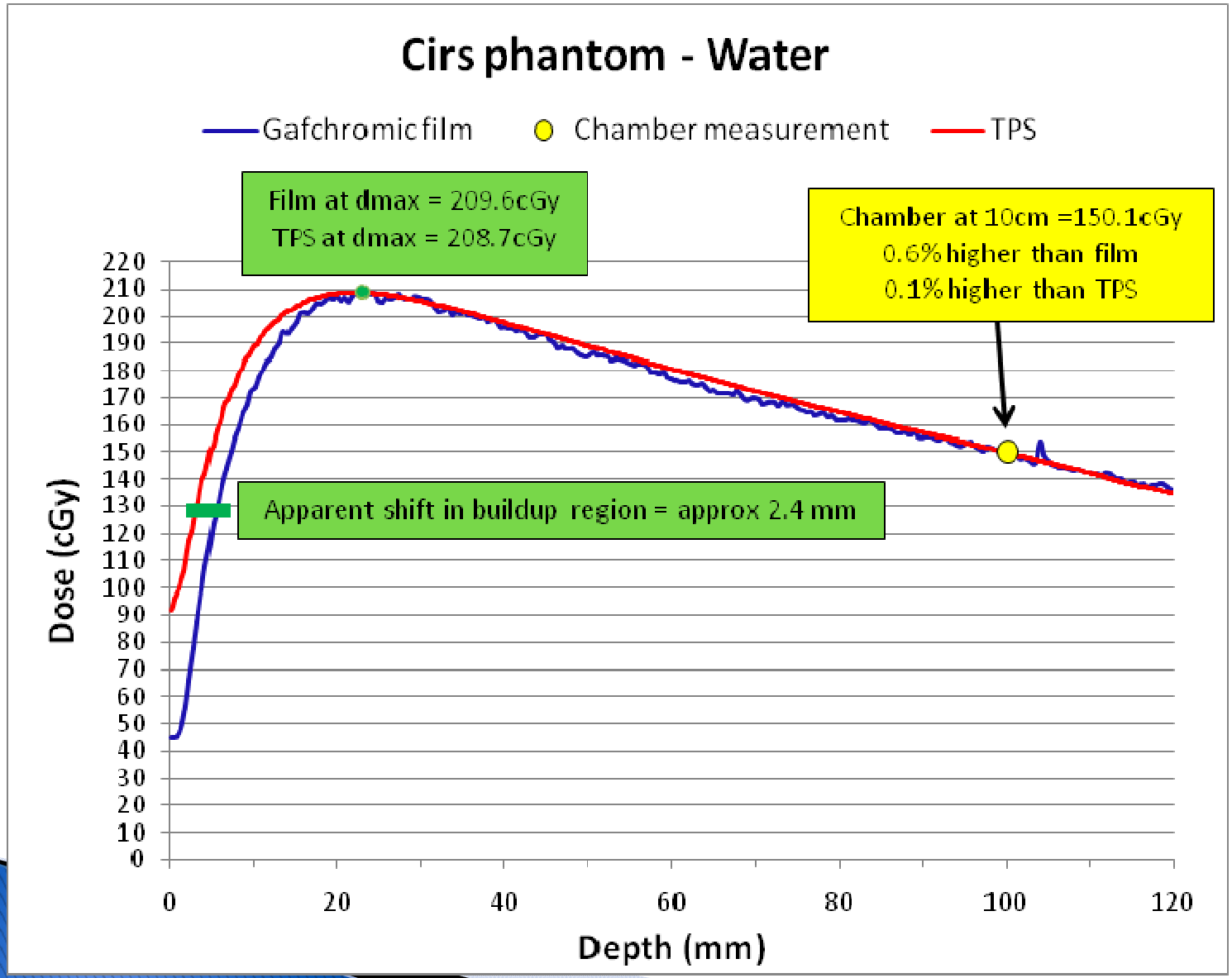
Lung

- Disagreement is evident in build-up region and at inhomogeneity interfaces.

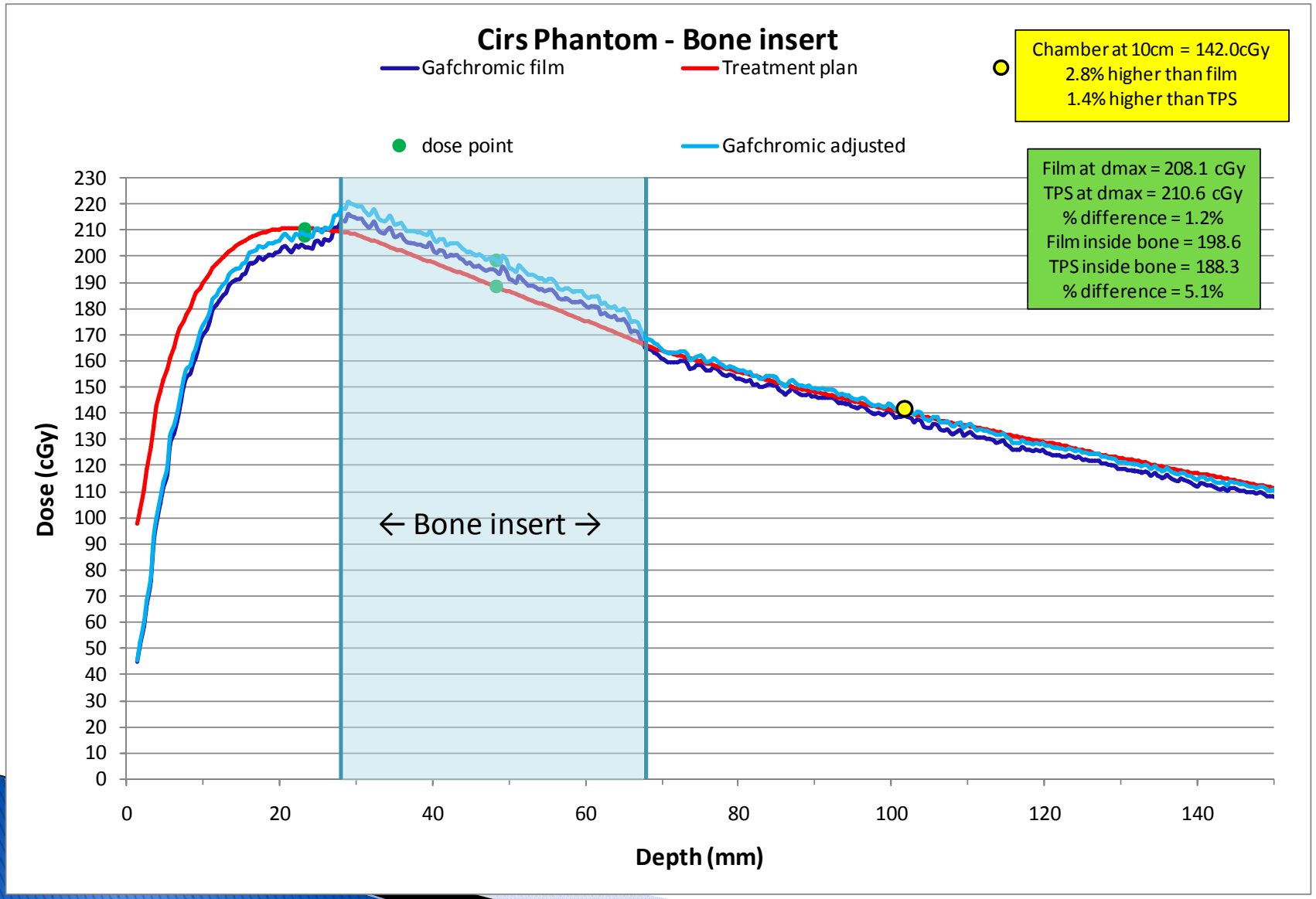
2. Commissioning - Algorithm tests

- ***Validation of absolute dose***
  - To validate the calibration of the film, a 0.125cc semiflex chamber was used.
    - Dose of 150.1cGy was measured at 10cm deep in water equivalent part of phantom.
    - Dose values of 142.0cGy and 133.2cGy were calculated for the beams which traversed the bone and lung inserts respectively.

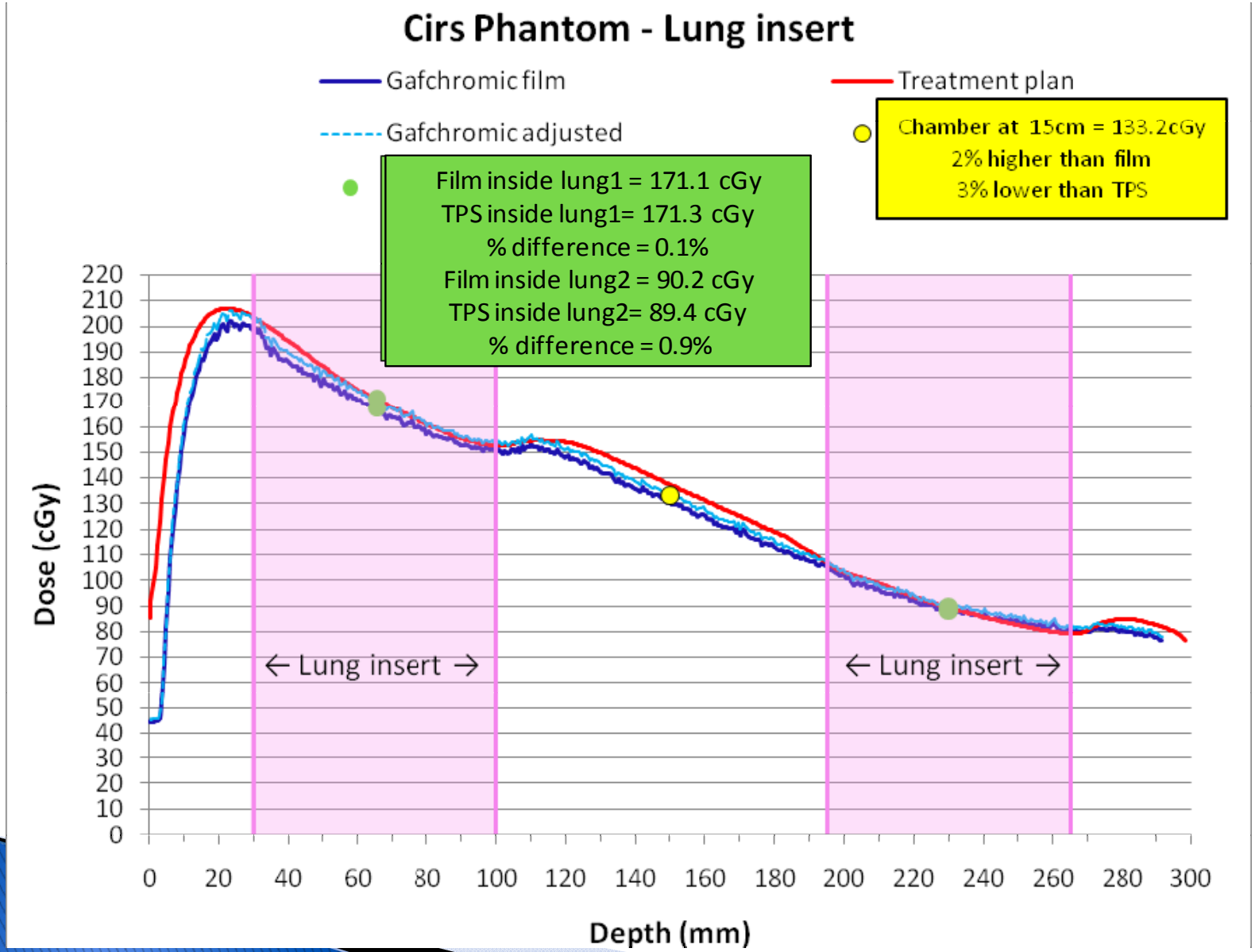
2. Commissioning - Algorithm tests



2. Commissioning - Algorithm tests



2. Commissioning - Algorithm tests



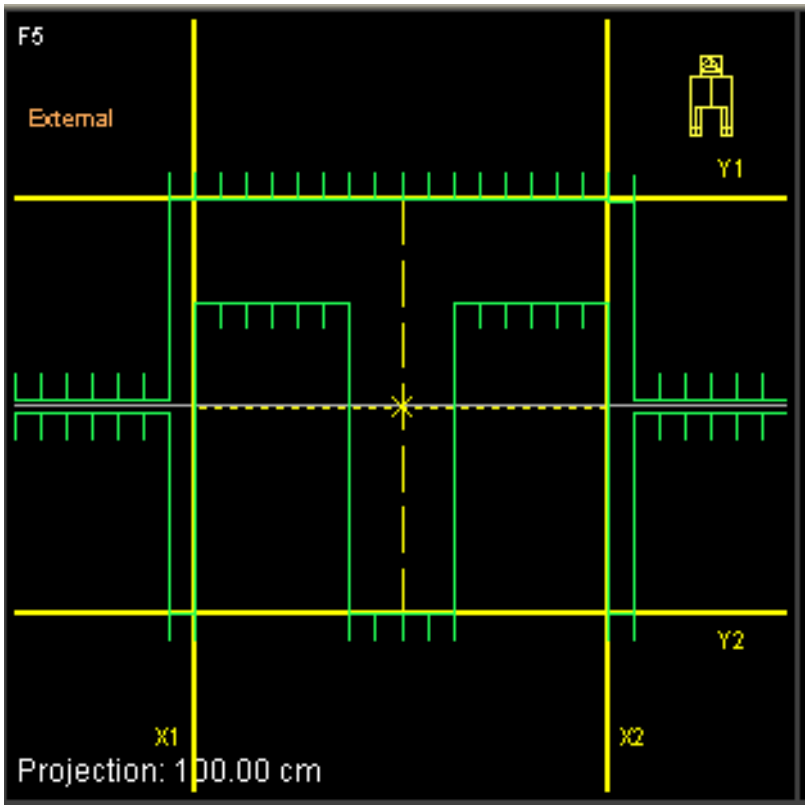
2. Commissioning - Algorithm tests

Summary

- We observed an overestimation of dose beyond inhomogeneities for 10MV:
  - Bone ~1%
  - Lung ~3%
- Previous commissioning work for 6MV gave similarly overestimated doses beyond inhomogeneities:
  - bone ~1.5%
  - Lung ~3.5%
- Van Esch et al., measured point doses beyond lung and cork:
  - Dose overestimated beyond lung by 4.7% and 3.4% for 6MV and 15MV
  - Dose overestimated beyond cork by 7% and 2.5% for 6MV and 18MV

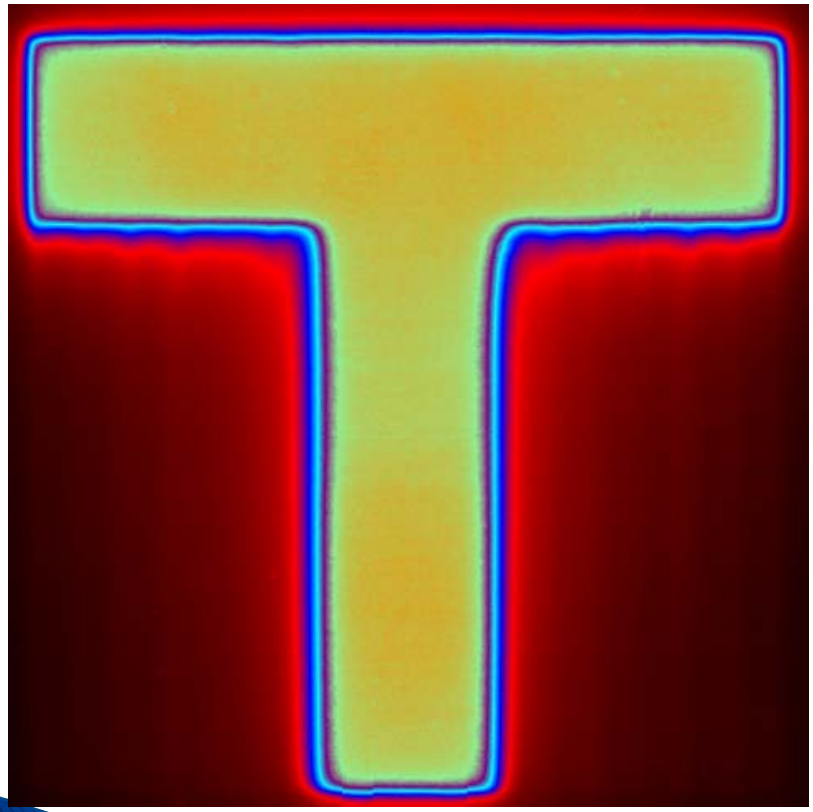
Van Esch et al., 2006. Testing of AAA for photon dose calculation. Med. Phys. 33 (11)

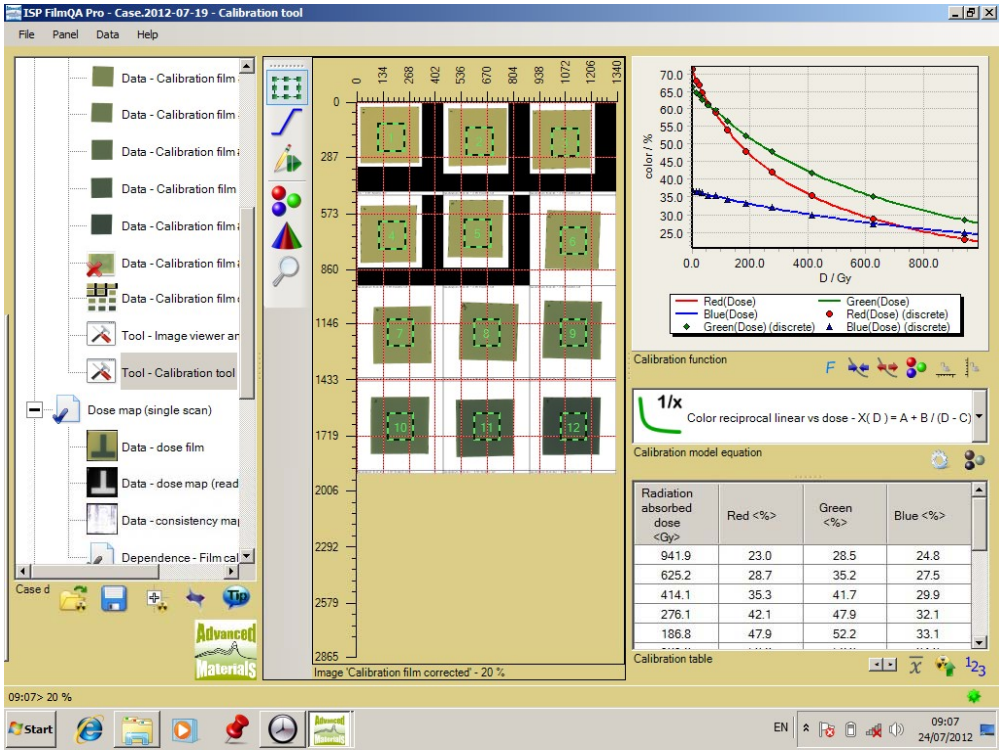
2. Commissioning – interleaf leakage



- Recommended measurement:
  - Central axis cross-plane profile for T-shaped field shown here
- Measurement conditions:
  - Gafchromic Film (EBT2)
  - 90 cm SSD, 10 cm deep
  - 1000 MU irradiation
  - Backscatter > 10 cm
  - Gantry 0°, Collimator 90°
- Analysis software:
  - FilmQA Pro

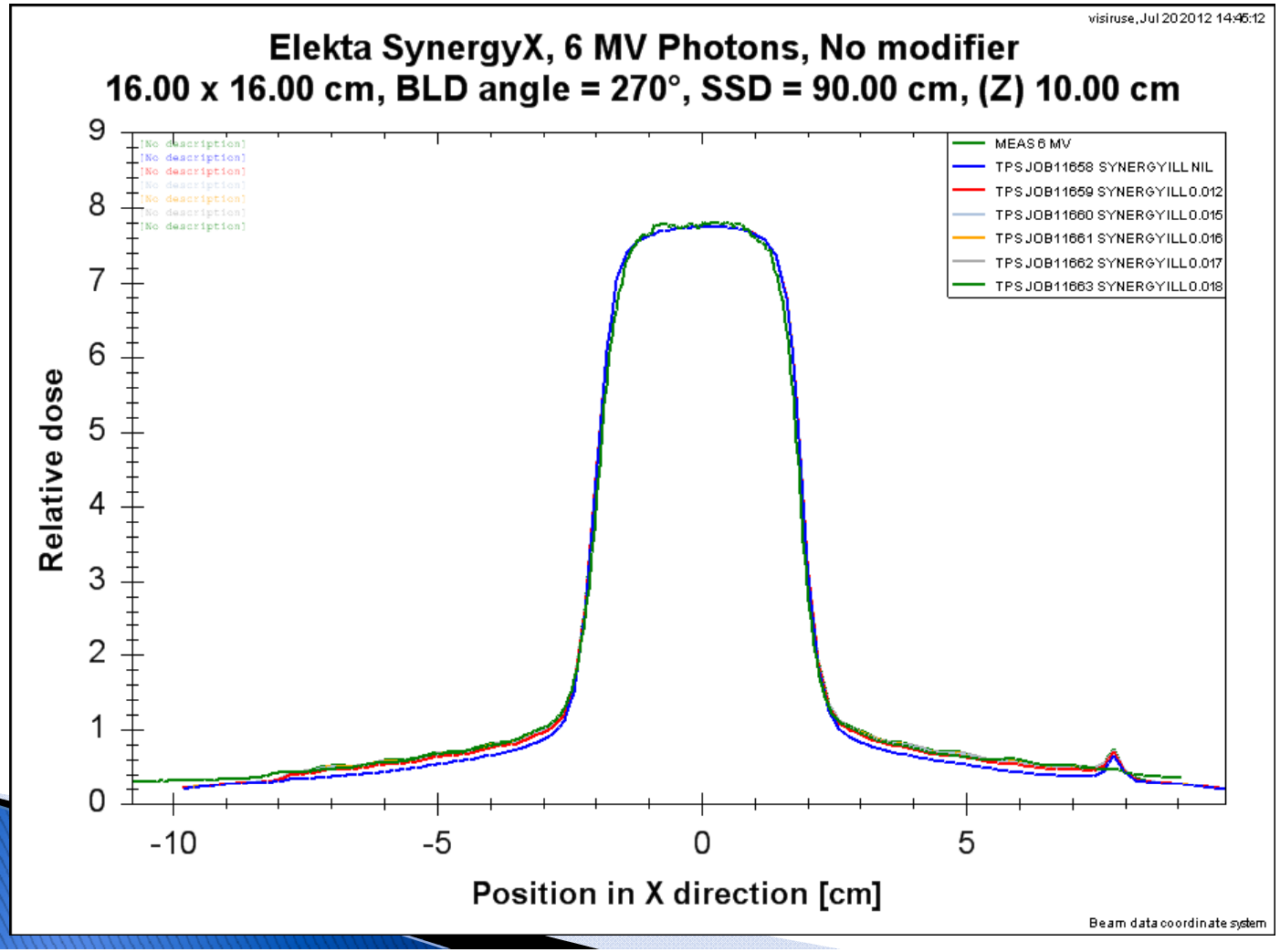
2. Commissioning – interleaf leakage





2. Commissioning – interleaf leakage

Values of ILL = 0, 0.012, 0.015, 0.016, 0.017, 0.018



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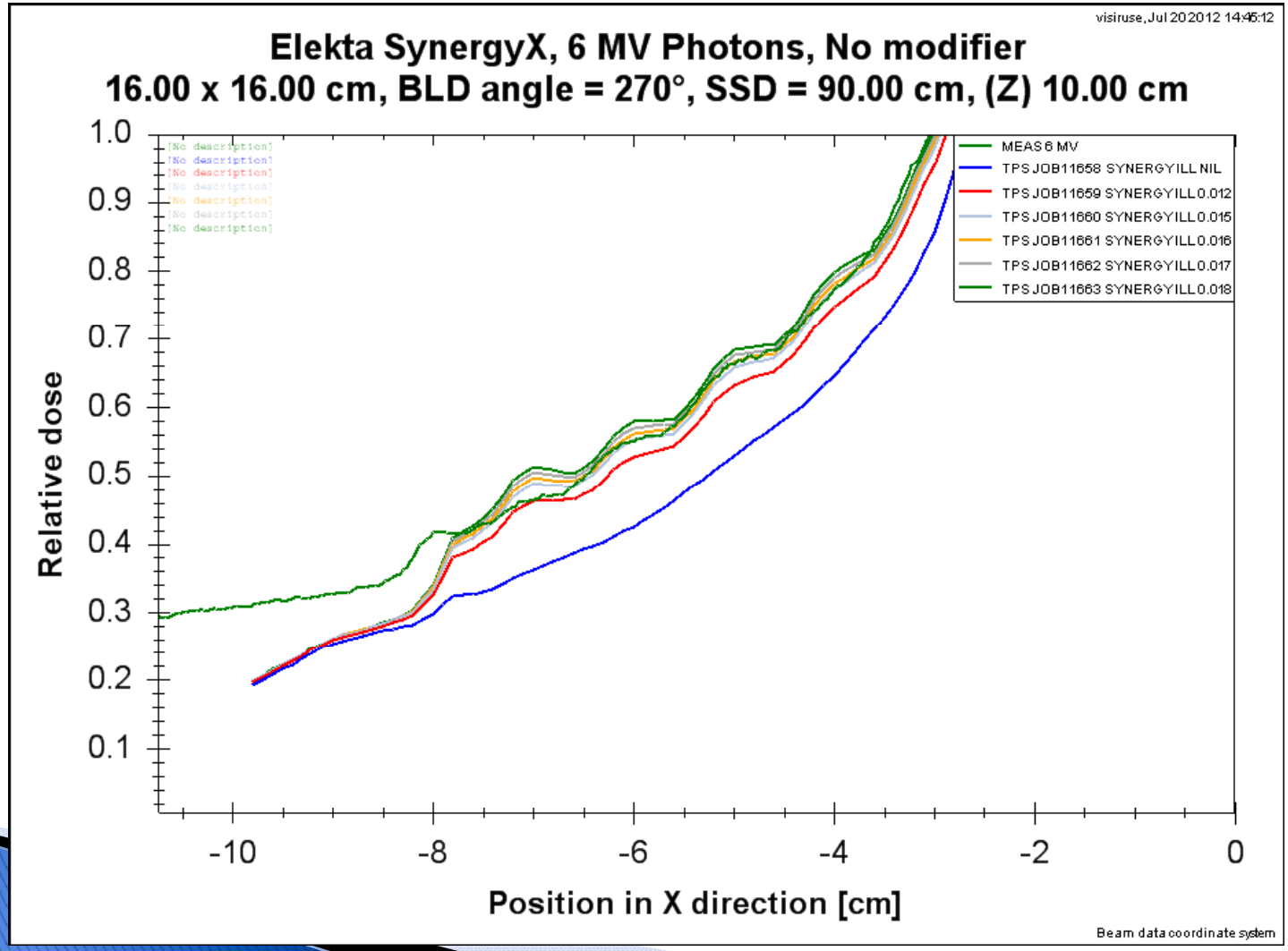


3. Research – Cell survival study

- A study focussing on the 'Bystander effect' led by DIT
  - Tissue and blood samples from treated cancer patients are irradiated to low dose levels (0.05Gy and 0.5Gy)
  - Individual patient radiosensitivity can be investigated
- Gafchromic film is used:
  - To help us design the experimental set up.
  - To determine the exact dose level being delivered to the cells.

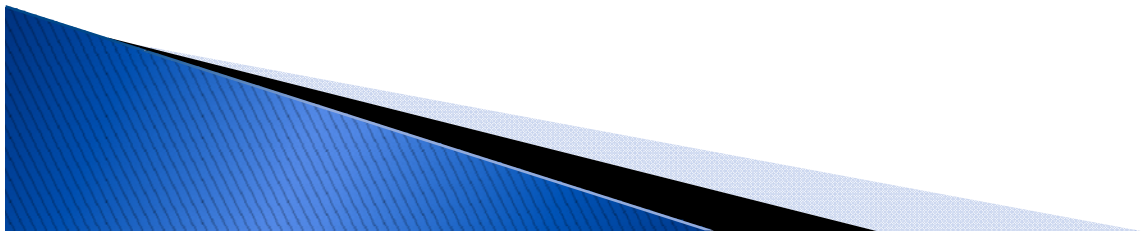
4. Future work: Stereotactic commissioning

- Varian Trilogy linac commissioning for stereotactic treatments
  - Accurate measurement of small fields (0.5cm x 0.5cm) is required
    - We propose to use gafchromic film in a water tank.
    - We will need a specialised holder in order to be able to accurately place the film within the tank.

4. Future work: Research

- Accurate measurement of out-of-field doses
  - Using Gafchromic to measure out-of-field doses (<2Gy) and compare to TPS and Monte Carlo

- Small field dosimetry
  - Using Gafchromic to measure small fields (<0.5cm) and compare to TPS and Monte Carlo



Acknowledgements

- All staff at St Luke's in Rathgar, Beaumont and James's.
- Andre Micke and David Lewis for all their work on gafchromic film and FilmQA Pro software.
- Ann Martindale from Perlamar for organising the workshop.

Thanks for listening !