

IBO & Sun Nuclear

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Neuruppin 27.- 28.03.08



>> Florida's Space Coast

- Private, founded 1984
- Experience since 1972
- Medical Physics, Nuclear Medicine, Radon Monitoring

Sun Nuclear Corporation

Core Tools → MapCHECK™

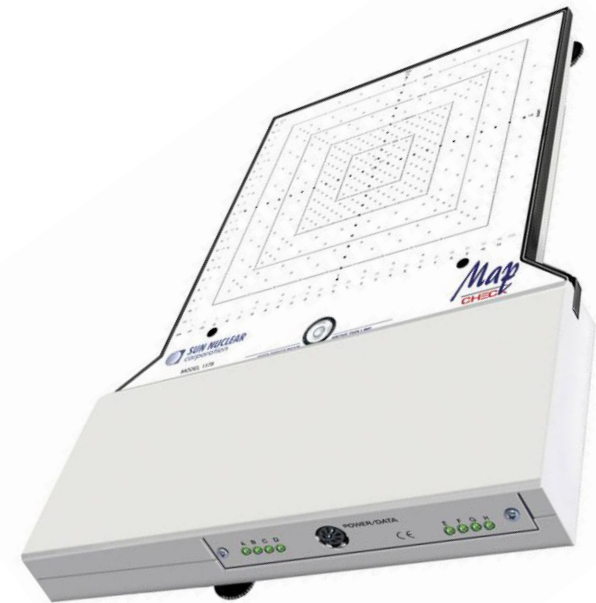
#1 Requirement: Built for IMRT QA

- Small detectors do not hide errors
- No warmup time, no waiting
- Calibration stable > 1 year
- User calibrated

#2 Requirement: Advanced features

- Beam QA
- Film support: EBT & EDR2
- Anatomical structure filter
- MLC QA
- Respiratory Motion/Gating QA (XY/4D)
- EPID based analysis
- Combine feature to increase field size and data density

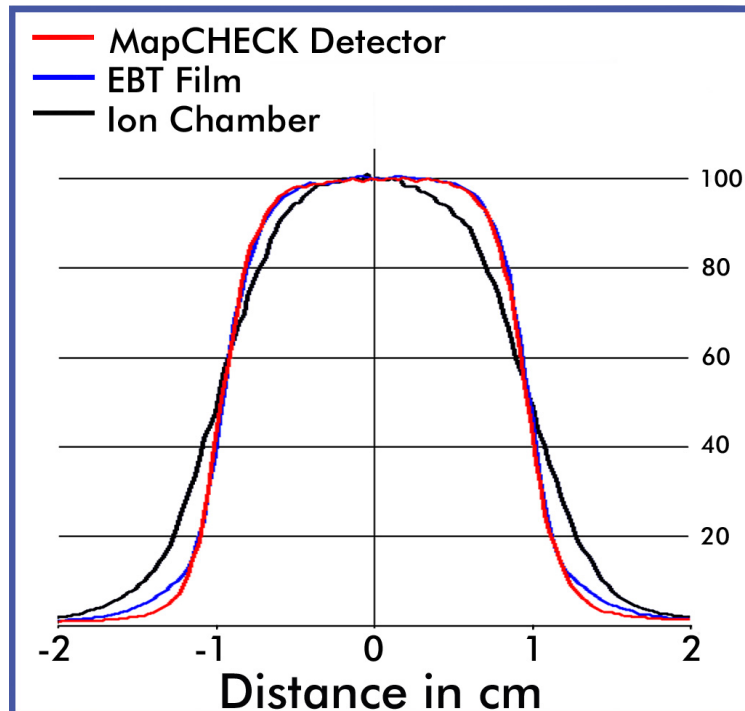
>> Over 50 publications, 5 years of clinical use



Why Diodes?

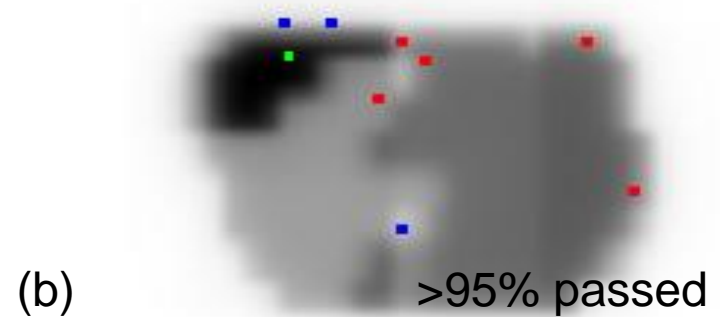
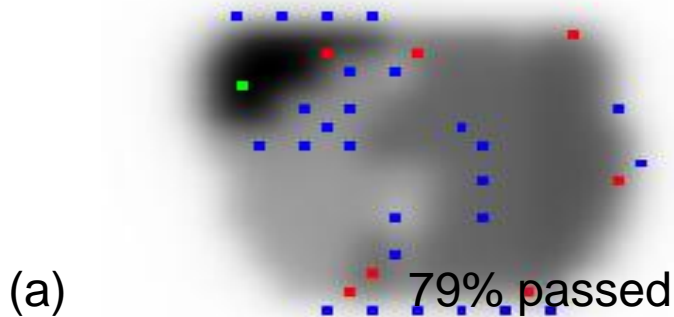
- IMRT fields are collections of small fields with steep dose gradients
 - Small field beam scanning results are best with a diode
 - › The same is logically true with IMRT fields

Detector response for a 2cm x 2cm field



Dose Volume Averaging

Case Study: Beam modeling error detected by MapCHECK



- The small diodes in MapCHECK detected the beam modeling error in (a), where the data was collected by a large volume ion chamber.

MapCHECK: Current Version

The screenshot displays the MapCHECK software interface, which is used for comparing measured dose distributions with Treatment Planning System (TPS) calculations. The interface is divided into several panels:

- Top Panel:** Contains menu options (File, Edit, Setup, Tools, Help) and control buttons (Start, Stop, Background, Dose, Calibration).
- Left Panel (Measures):** Labeled "Measured", it shows a color-coded dose distribution map with a grid of measurement points. The color scale ranges from 23 cGy (blue) to 230 cGy (red).
- Right Panel (TPS):** Labeled "TPS", it shows a color-coded dose distribution map from the Treatment Planning System. The color scale is identical to the Measured panel.
- Bottom-Left Panel (Comparison):** Labeled "Comparison", it displays a grid-based difference map between the Measured and TPS distributions. The color scale ranges from -8 cGy (dark blue) to 10 cGy (dark red).
- Bottom-Right Panel (Structure Summary):** Titled "Profile / Histogram / Structure", it provides a detailed summary of the dose distribution across various anatomical structures. The table below shows the results for the comparison between Set1 and Set2.

Name	Color	% Pass	Pass Pts	Fail Pts	Total Pts
<input checked="" type="checkbox"/> Custom	Green	0 pts	0	0	0
<input checked="" type="checkbox"/> BODY	Light Green	84.96	209	37	246
<input checked="" type="checkbox"/> L LUNG	Light Green	88.14	171	23	194
<input checked="" type="checkbox"/> L LUNG AVOID	Dark Green	90.80	158	16	174
<input checked="" type="checkbox"/> OPT PTV	Red	88.17	149	20	169
<input checked="" type="checkbox"/> R LUNG	Dark Blue	93.55	29	2	31
<input checked="" type="checkbox"/> SPINAL CORD	Magenta	100.00	5	0	5
<input checked="" type="checkbox"/> esophagus	Light Green	88.89	24	3	27
<input checked="" type="checkbox"/> heart	Orange	87.91	80	11	91
<input checked="" type="checkbox"/> ptv-mass	Cyan	88.10	148	20	168
<input checked="" type="checkbox"/> tumor volume	Red	95.77	68	3	71

Additional data from the Structure Summary table:

SEL	195.45	198.67	-3.22	-1.56	0.00	0/0	0/0
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Anatomical Structure Filter

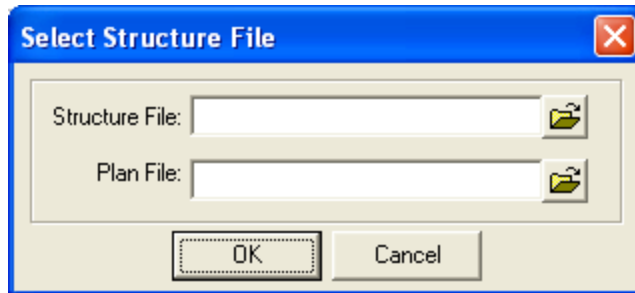
- There is a need for more intuitive and clinically relevant tools for IMRT QA
 - Relate QA “failures” to contoured BEV patient anatomy

- Benefits
 - See if there are any ‘cold’ spots in your PTV mass
 - See if there are any ‘hot’ spots in the patient’s critical structures

- Must account for patient isocenter, couch angle, gantry angle when projecting structures

How it Works

1
STEP

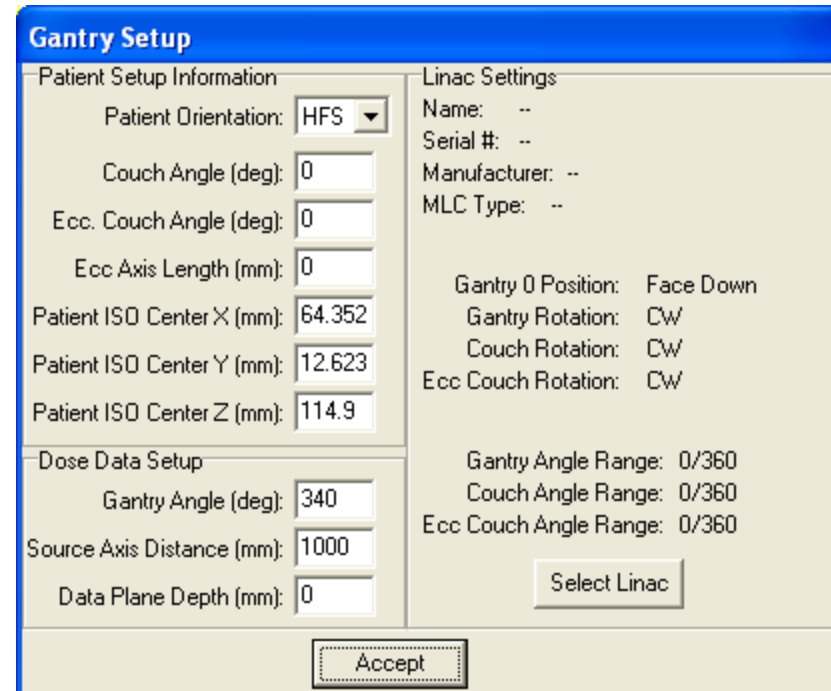
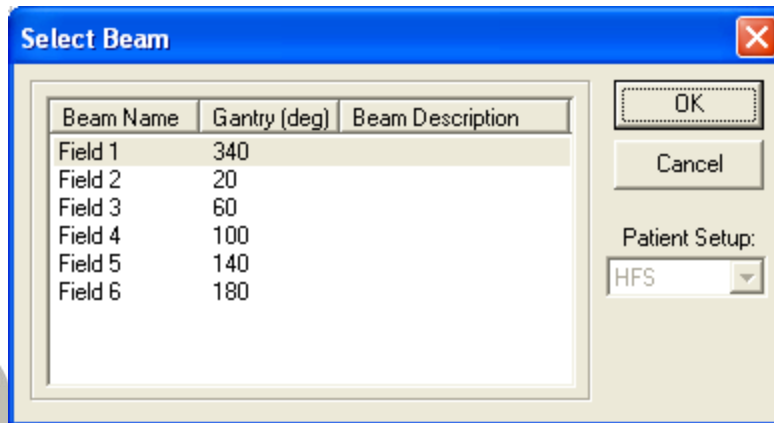


1) Select DICOM Structure & Patient Plan File

2) Select Beam

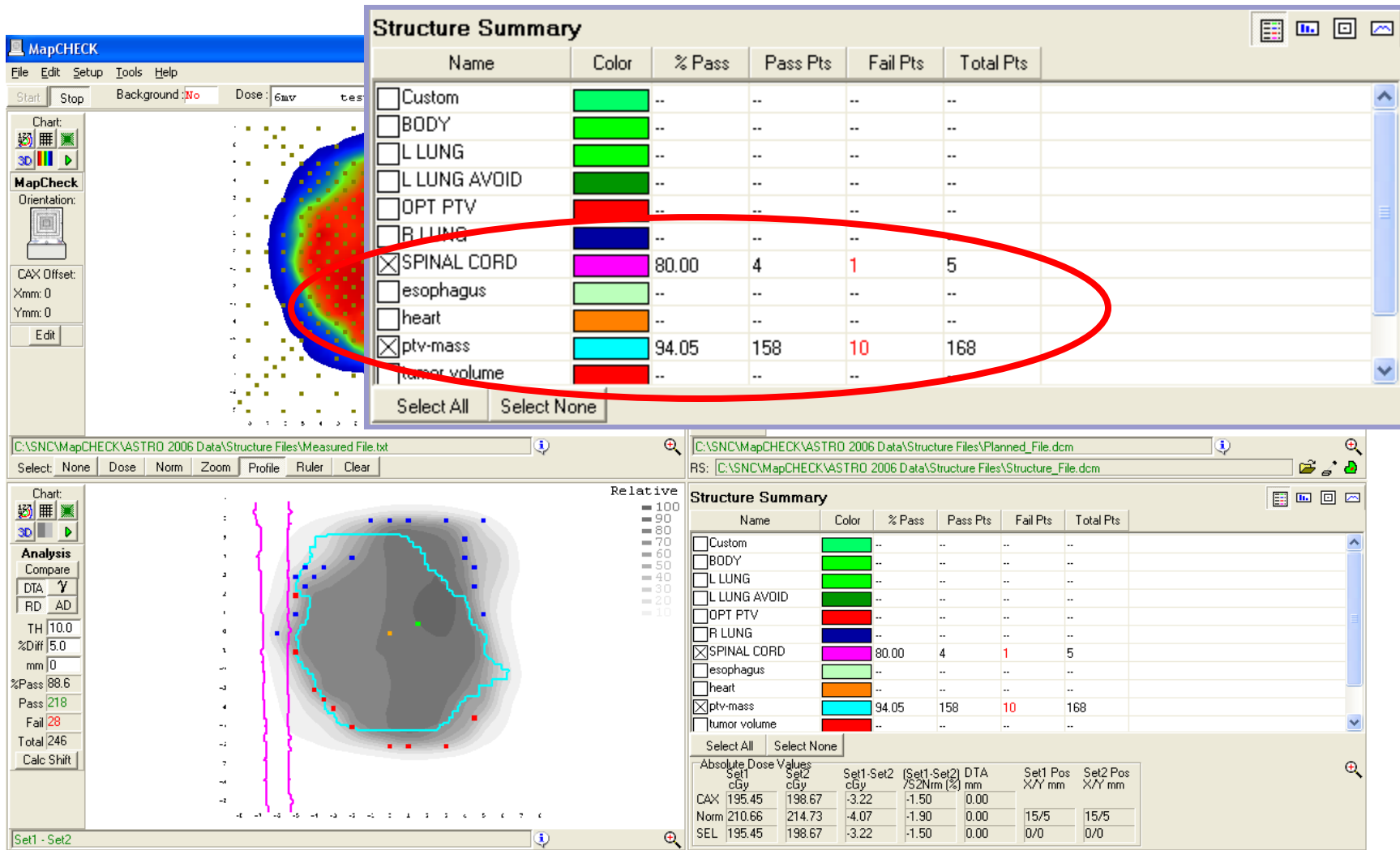
3) Accept Gantry Setup

3
STEP



2
STEP

Structure Results



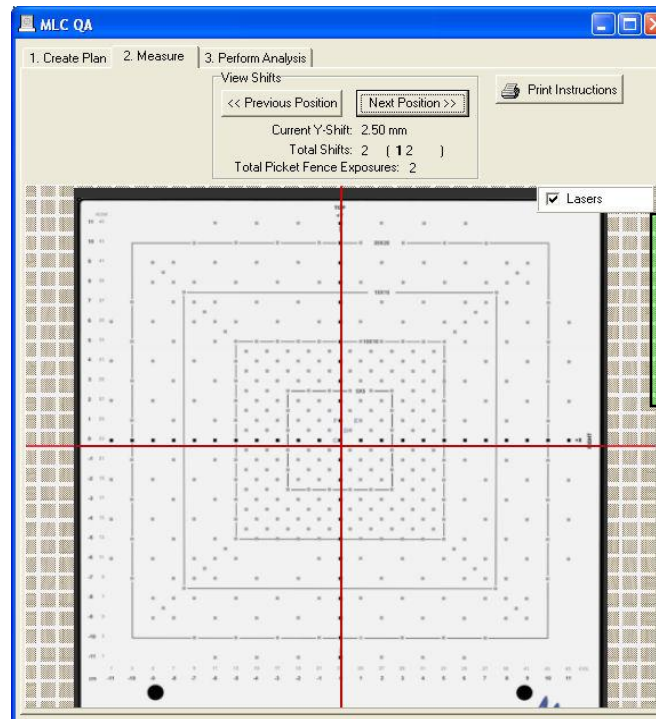
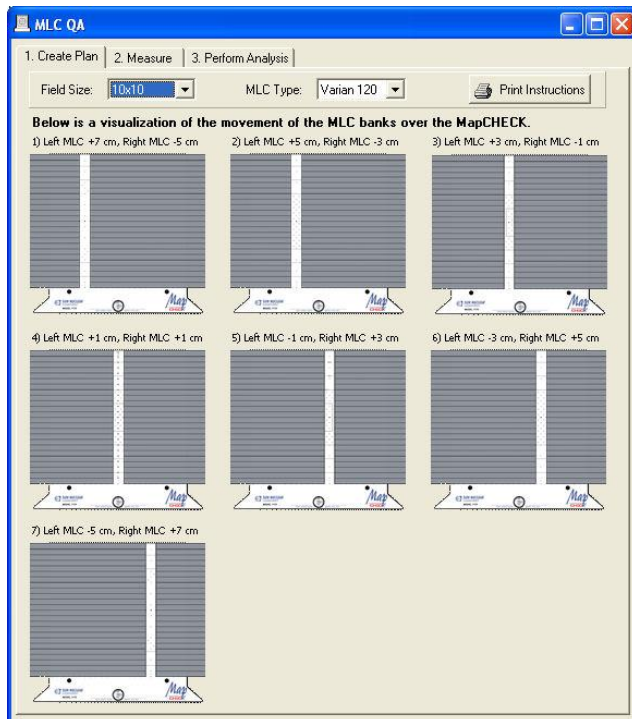
MLC QA

Quantitative Results

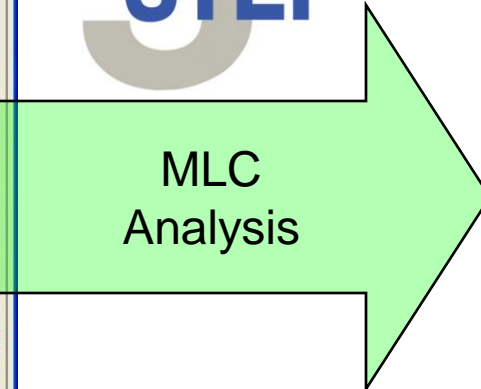
1
STEP

2
STEP

- 1) Picket Fence Plan
- 2) Measure Picket Fence
- 3) View Results

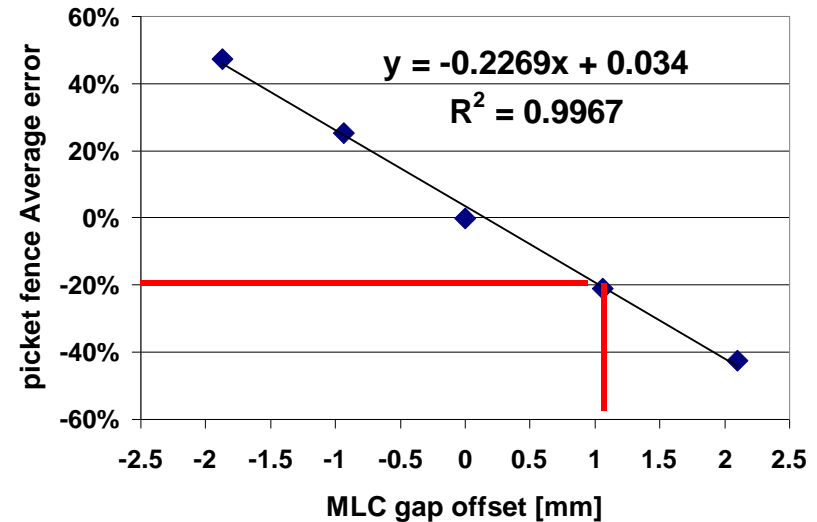
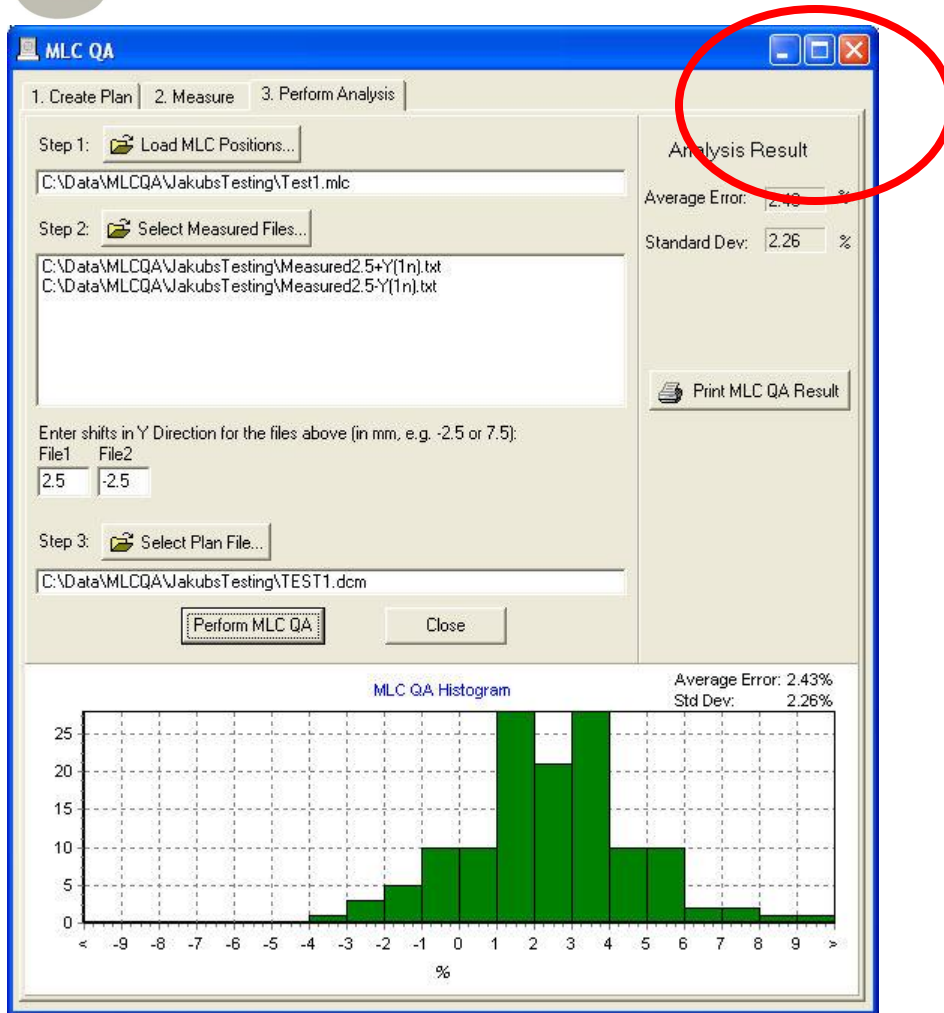


3
STEP



MLC Analysis

3 STEP



“A 1mm MLC error equates to a MapCHECK measured error of 20%”

MLC: Leaf by Leaf

Analysis data
for each leaf
pair

Print Preview

Print... Print To PDF... Page 1 of 2 100% Close Current Printer: Brother HL-1440

MLC QA Analysis Result

Field Size : 10x10
Linac Type : Varian 120
Average Error : -2.38%
Standard Deviation : 2.23%

Date : 5/27/2007
Institution : (null)
Sign Off : _____

Measured % difference from plan

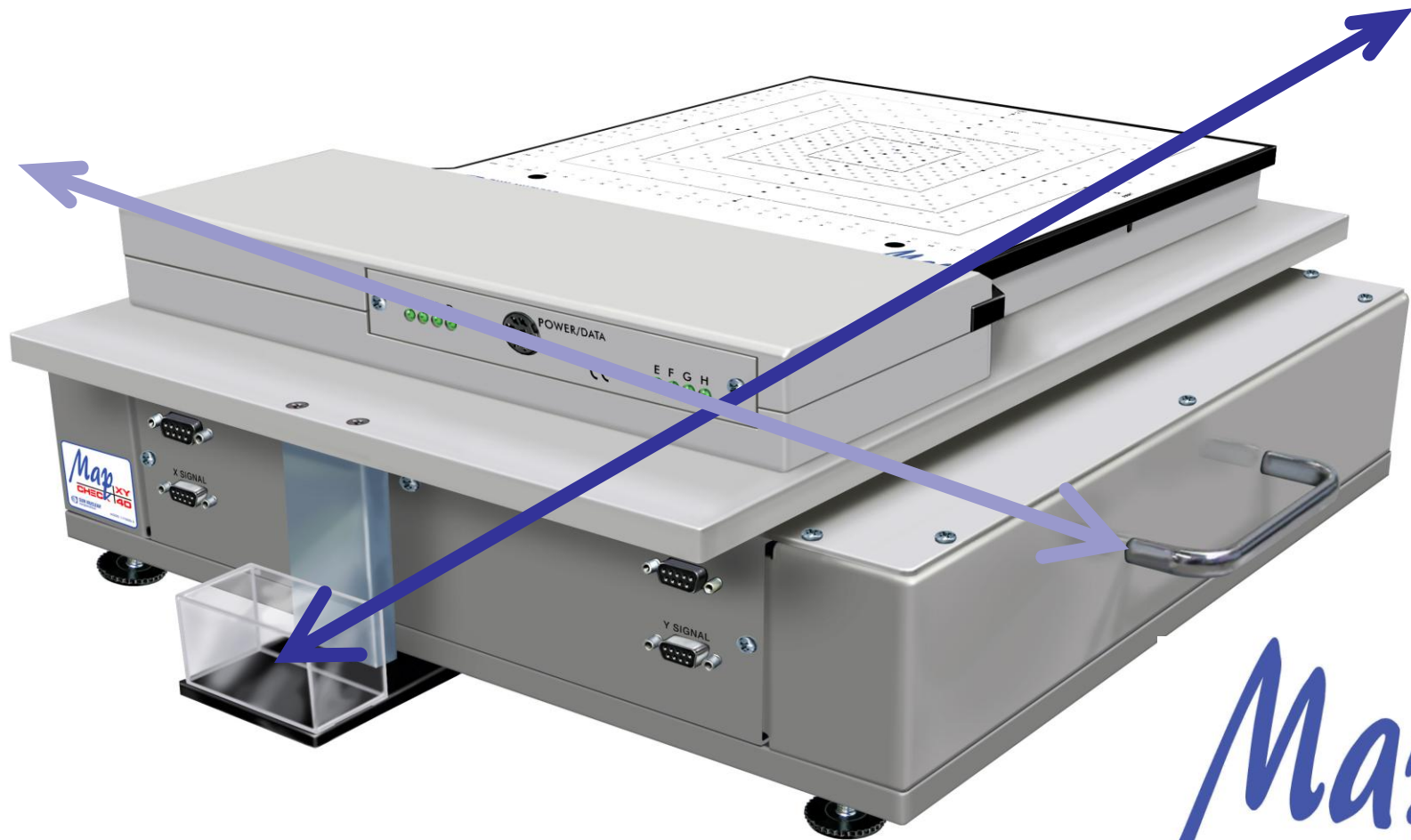
	X(mm)					
	-50	-30	-10	10	30	50
52.5	-9.1	-7.0	-4.8	-6.5	-7.1	-3.7
47.5	-3.5	-2.5	-1.4	-1.4	-1.4	-2.3
42.5	-0.8	-2.7	-2.1	-1.0	-1.2	-1.6
37.5	-0.6	-2.5	-2.5	-1.3	-1.3	-3.7
32.5	-5.4	-5.9	0.0	-0.1	-1.5	-3.1
27.5	-5.0	-4.8	-1.3	-1.5	-4.0	-4.3
22.5	-6.0	-3.6	-2.9	0.5	-1.7	-3.2
17.5	-2.9	-2.5	-1.1	-0.4	-1.0	-2.2
12.5	-4.0	-3.7	-1.2	-0.5	-2.2	-1.9
7.5	-4.4	-4.2	-3.5	-2.7	-3.5	-3.7
2.5	-1.8	-2.3	-1.5	-3.0	-2.5	-1.7
-2.5	-4.0	-5.4	-3.4	-2.1	-2.6	-3.9
-7.5	-5.1	-3.5	-0.1	1.2	0.7	0.4
-12.5	-3.4	-4.1	-4.1	-2.0	-3.6	-3.6
-17.5	-1.7	-2.0	-1.8	0.6	-1.6	-2.5
-22.5	-3.9	-3.9	-3.5	-1.8	-3.3	-3.0
-27.5	-1.9	-1.0	0.7	3.3	1.0	-0.8
-32.5	-4.0	-4.6	-4.0	-1.9	-3.1	-3.5
-37.5	-0.7	-1.2	0.7	1.2	0.4	-1.6
-42.5	-2.3	-2.4	-3.0	-3.8	-2.4	-2.5
-47.5	-1.7	-1.8	2.8	0.4	0.9	1.2
-52.5	-4.9	-7.9	-5.1	-5.0	-5.4	-4.1

MLC QA Result

Average Error: -2.38%

MapCHECK XY/4D

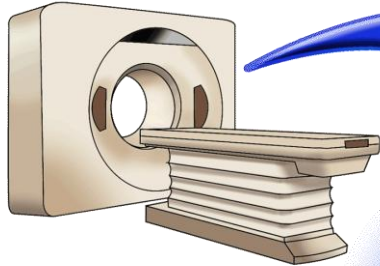
Respiratory Motion/Gating QA



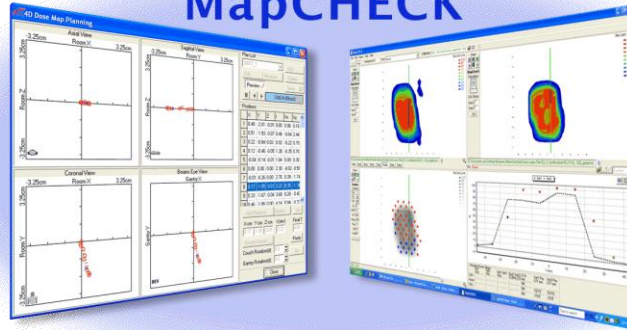
Map XY
CHECK 4D

XY/4D Workflow

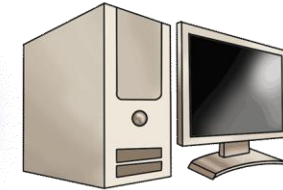
4D-CT ① TUMOR TRAJECTORY DATA



MapCHECK™

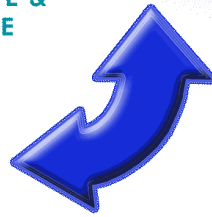
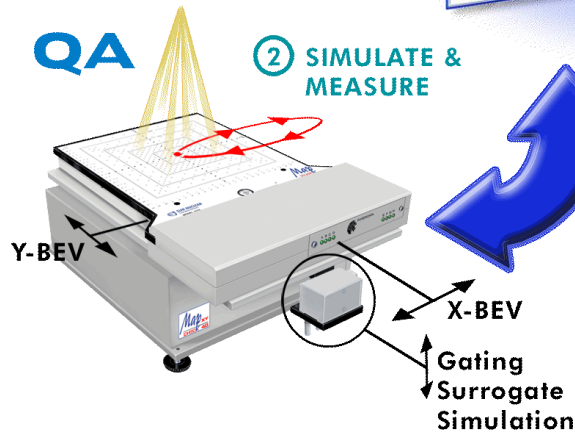


③ IMPORT PLAN **TPS PLAN**



QA

② SIMULATE & MEASURE

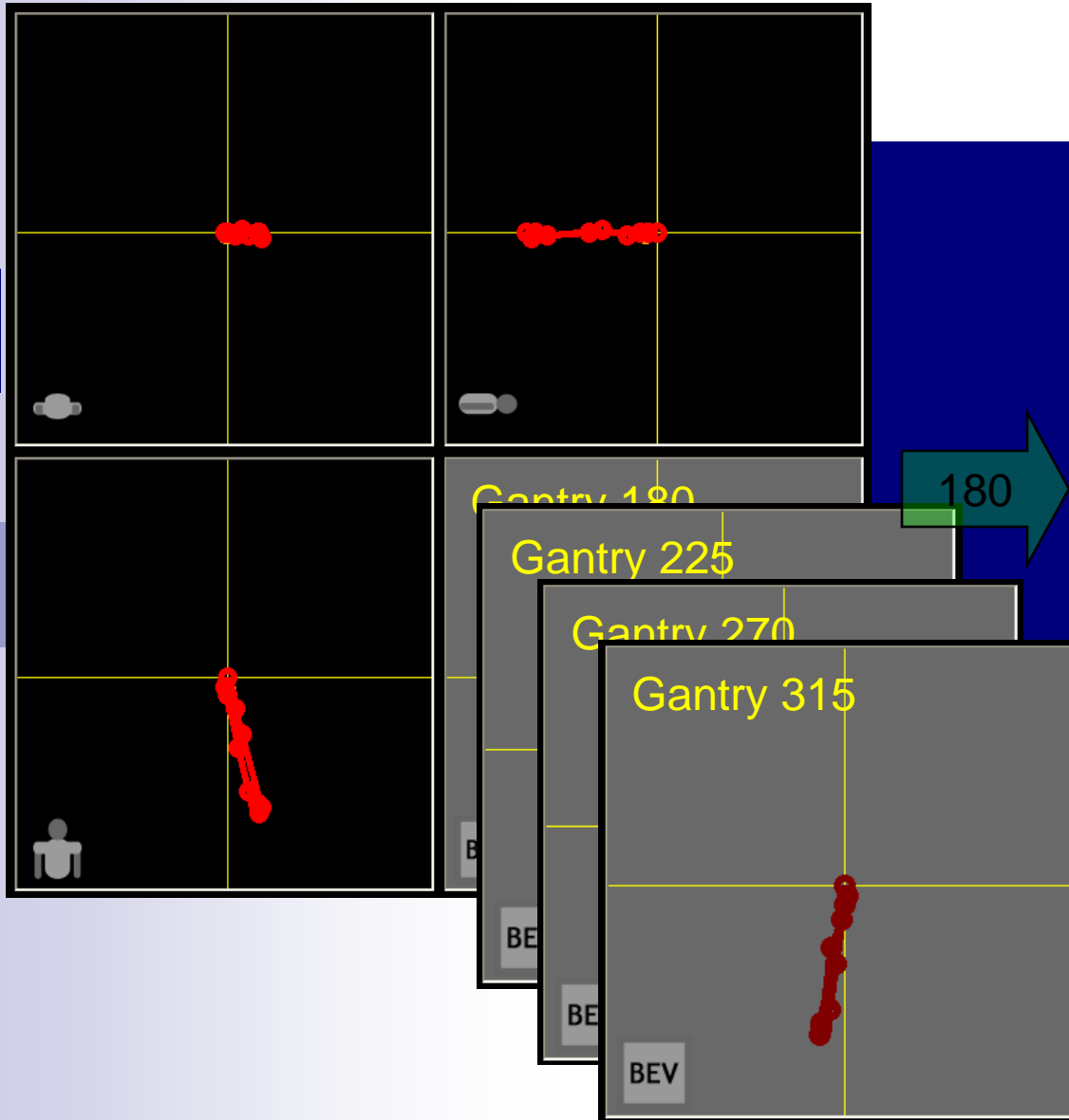


④ COMPARE DOSE & ANALYZE ITV &/OR GATING



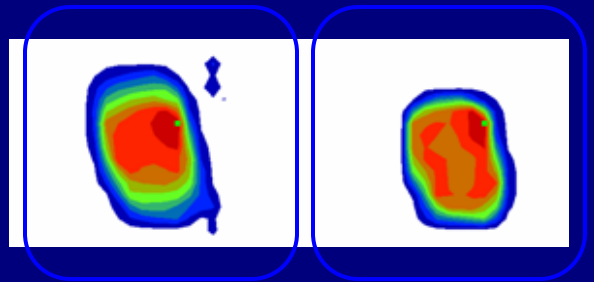
TPS STRUCTURES

BEV Motion



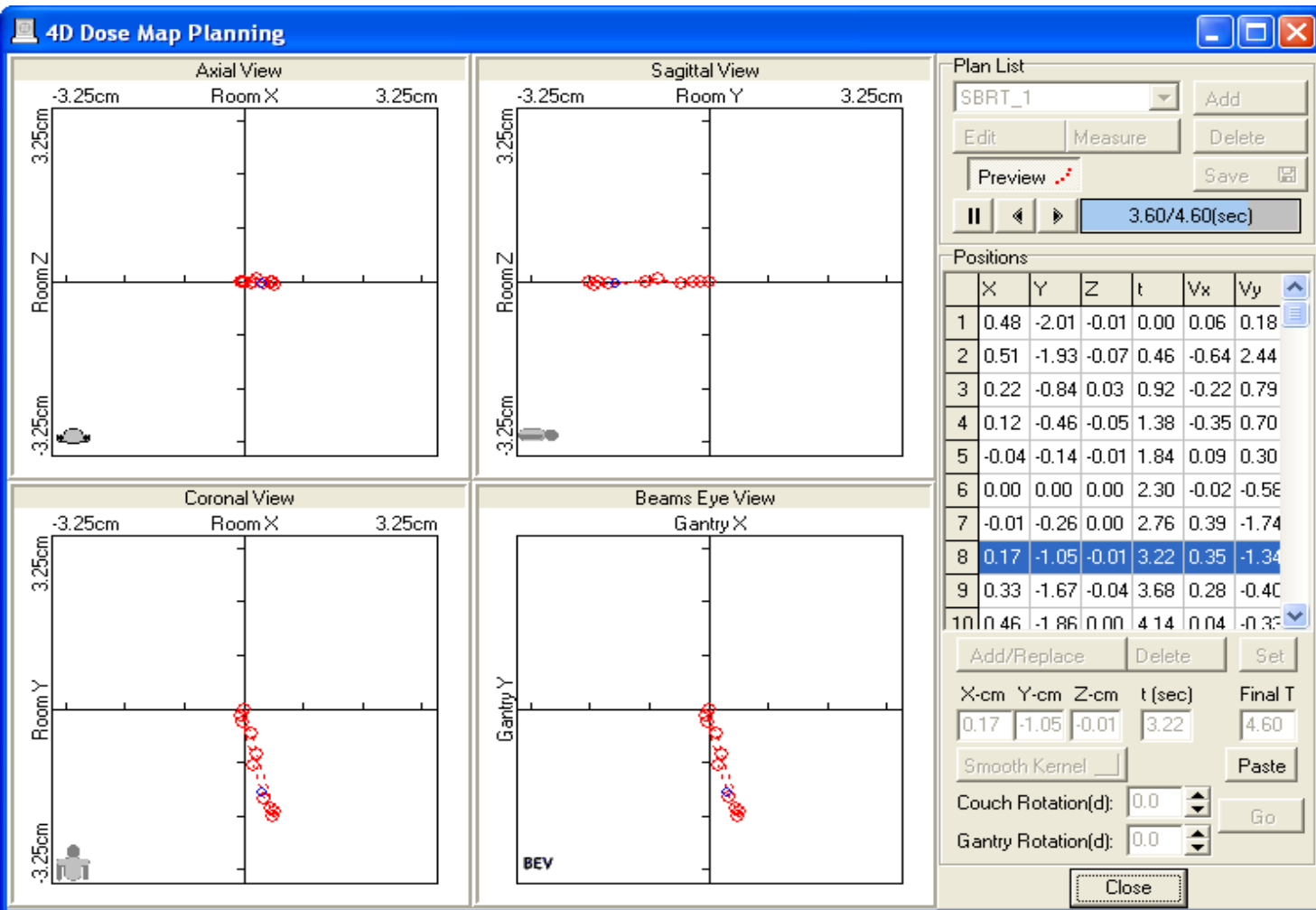
Non-Gated

Gated

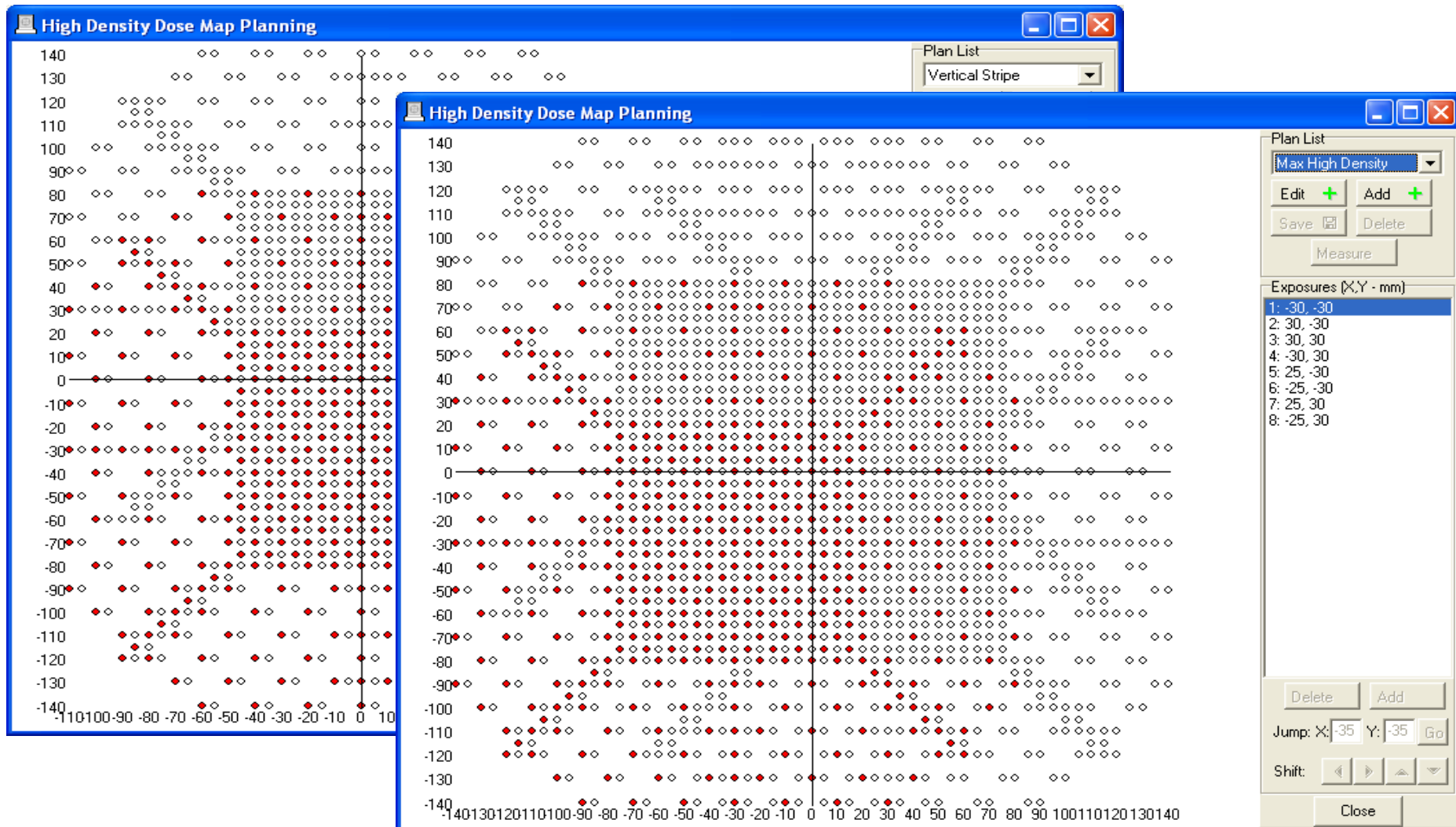


**Motion is Beam
Geometry Specific**

XY/4D Interface



XY: Increase Field Size, Density



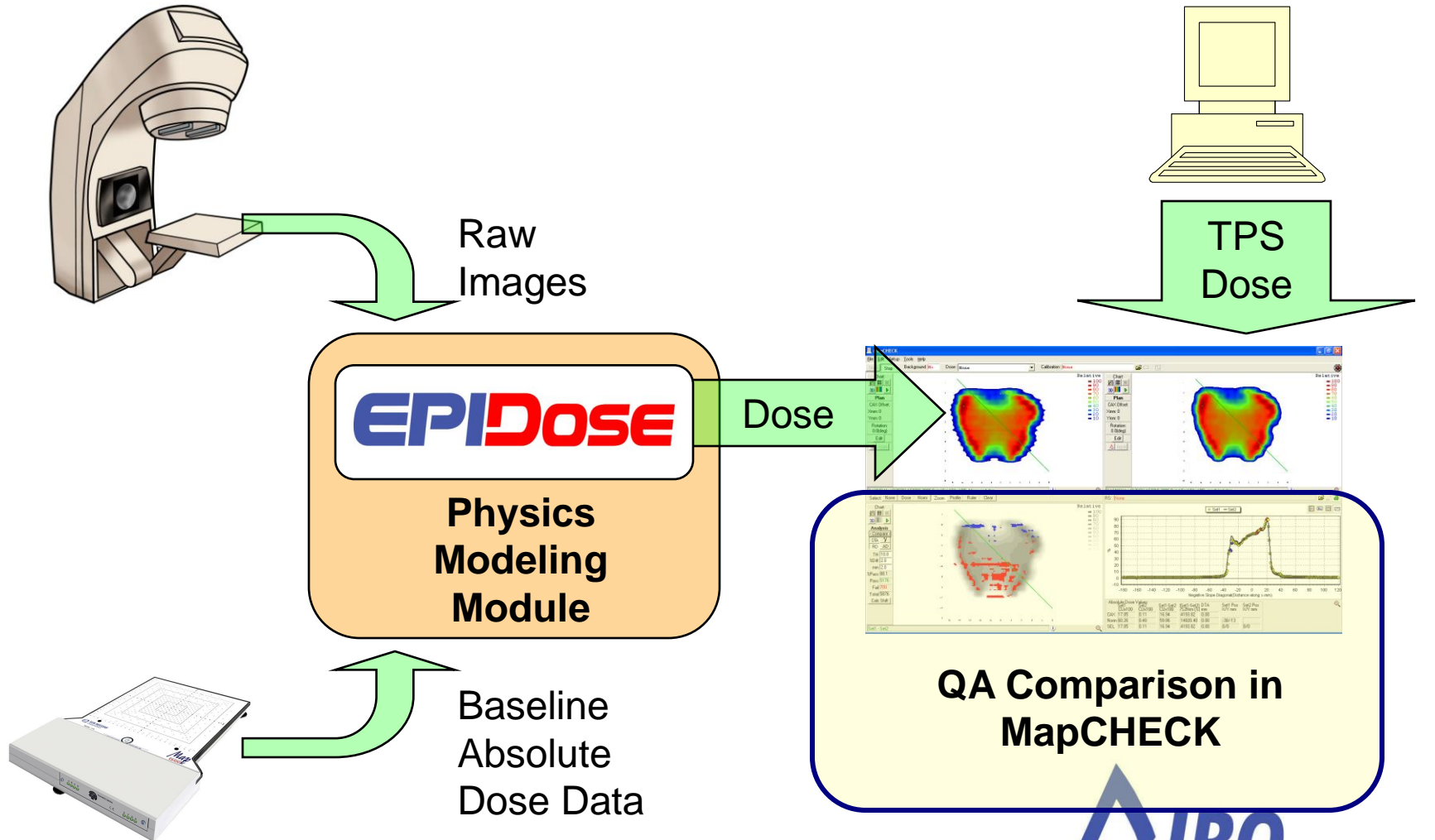
XY/4D Applications

- Beam gating qualification
- Study impact to moving targets (Structures, ITV, PTV)
- Increase data density, field size
- Supports:
 - Varian RPM
 - Siemens/Elekta Pressure Belt

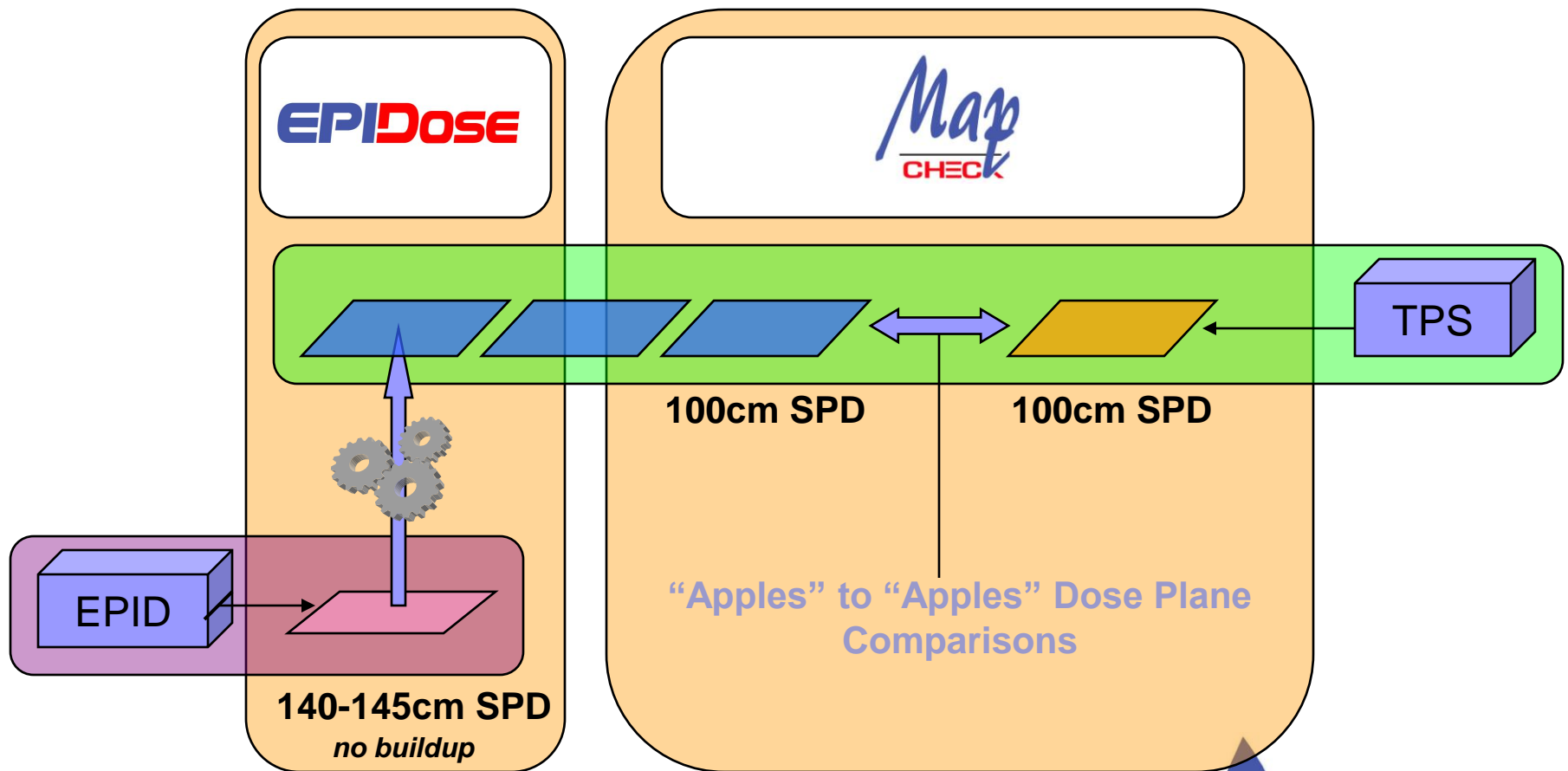
- Publications
 - **“On the dose to a moving target while employing different IMRT delivery mechanisms”**
 - Eric D. Ehler, Benjamin E. Nelms, Wolfgang A. Tomé
Radiotherapy & Oncology Journal of the ESTRO, Volume 83, Issue 1, pg. 49-56, April 2007

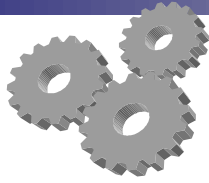
 - **“Quality assurance device for four dimensional intensity modulated or stereotactic body radiation therapy and respiratory gating using patient specific intrafraction motion kernels”**

EPIDose Workflow



From Image to Dose





EPID Physics Modeling

The screenshot displays three overlapping windows of the EpiDOSE Physics Modeling software. The foreground window is titled 'EpiDOSE Physics Modeling: VariantIX_6MV.spm' and is in the 'Calibration' tab. It features a '2D Wide Field Calibration' dialog box with the following components:

- Kernel Size (cm):** A list of kernel sizes from 0.0 to 5.0 in increments of 0.1.
- Color LUT: Slope:** A label for the color lookup table.
- Table:** A table with three columns: MU, EPID DICOM RT File, and MapCHECK Dose File. The rows correspond to MU values of 25, 50, 100, and 200.
- Buttons:** 'Calculate Dose Calibration Map', 'Save Model', and 'Cancel'.
- Y Position (cm):** A vertical axis label on the right side of the dialog.
- X Position (cm):** A horizontal axis label at the bottom of the dialog.

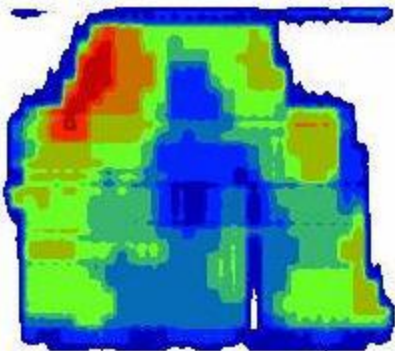
MU	EPID DICOM RT File	MapCHECK Dose File
25
50
100
200

EPID QA

The result?

EPIDose physics model smartly accounts for differences between EPID response and tissue dose

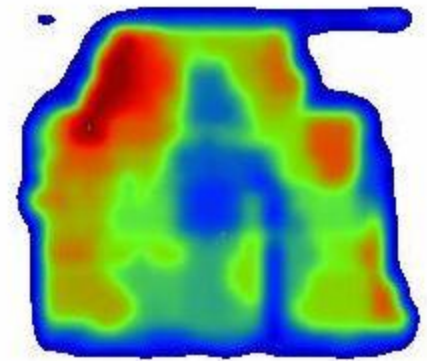
EPID image



EPIDose

EPID to Dose
Conversion Algorithms

EPID dose



New Arrays

