IMRT QA Comparison Using MapCheck and Portal Dosimetry

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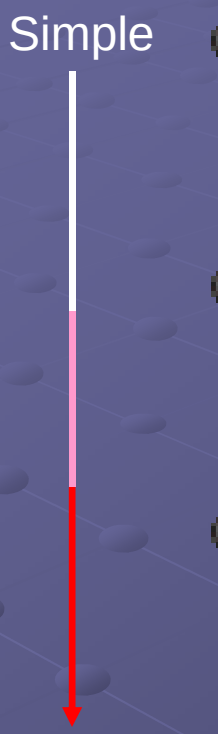
Research Performed at Edward Cancer Center

Purpose

- Research conducted to compare IMRT QA process of Sun Nuclear's MapCheck and Varian's Portal Dosimetry
- Compare absolute dose measurements of both systems to ion chamber results
- Compare dose/fluence map measurements of both systems
- Provide general advantages for each system (compared to the other)

Patient Selection



- 5 Field Brain (GBM)
- 7 Field Prostate Boost
- 11 Field Paraaortic Lymph Nodes
- 18 Field Head and Neck (9 Field Split)

Data Collection Methods and Procedures

MapCheck Process

- Create verification plan for each field
- Export calculated dose map (Frontal) to MapCheck for each field
- Calibrated diode array prior to collecting data

MapCheck Process Cont.

- Use 5 cm solid water block + 2 cm equivalent buildup included in MapCheck array (total of 7 cm buildup)
- SDD = 100 cm
- Chose normalization point in plateau region (ion chamber measurement will be performed at the same point)

Ion Chamber Process

- Used Standard Imaging Exradin A1 Mini Chamber w/ 0.056 cc collecting volume
- Solid water buildup = 7 cm
- SDD = 100 cm
- 5 cm solid water placed under ion chamber to provide back scatter
- Calibrated ion chamber readings with open field (10x10) prior to collecting data

Portal Dosimetry Process

- Created verification plan for each patient (all fields included in one plan per patient)
- Inherent buildup in panel = 1.2 cm (Aluminum and Foam)
- No additional build up used
- Calibrated panel prior to collecting data

Portal Dosimetry Process Cont.

- SDD = 100 cm
- Used same normalization point from MapCheck analysis for consistency
- Data measured in units of CU

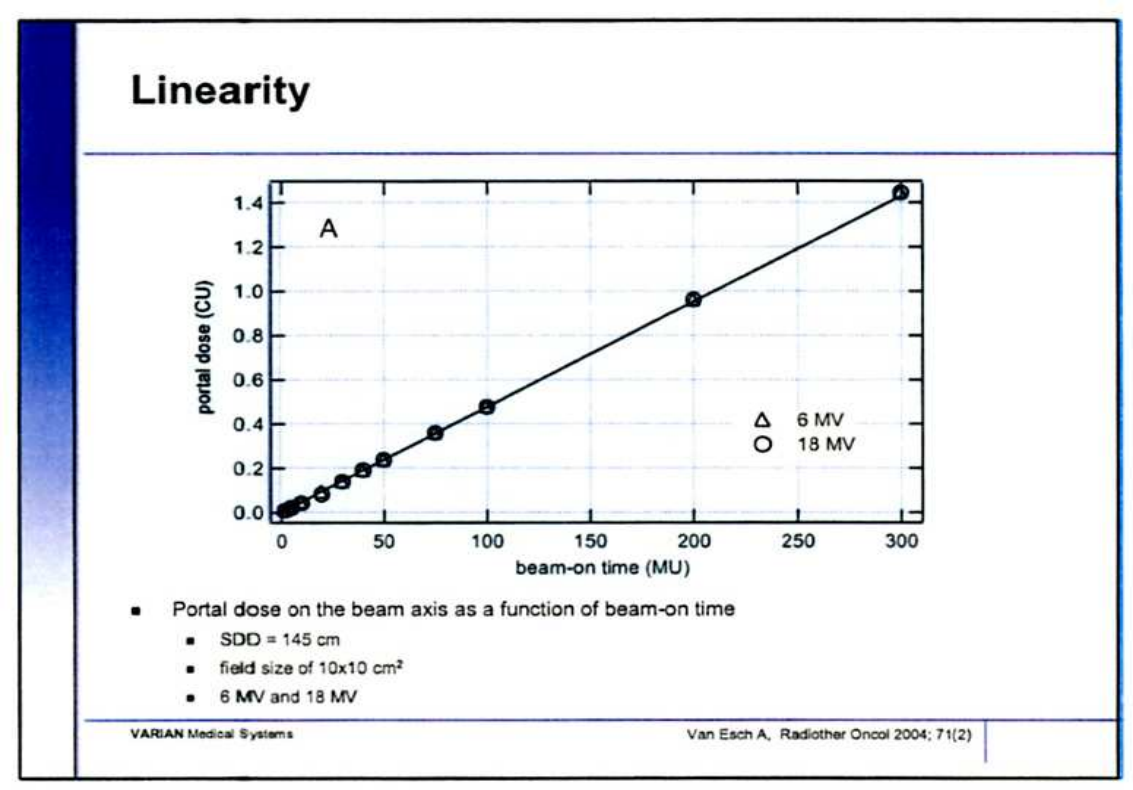
Definition of Calibrated Unit (CU)

- Field Size =10 x 10 cm^2
- SDD = 100 cm
- Deliver 100 MU to panel
- Set reading = 1 CU

- 1 CU is numerically approximate to 1 Gy

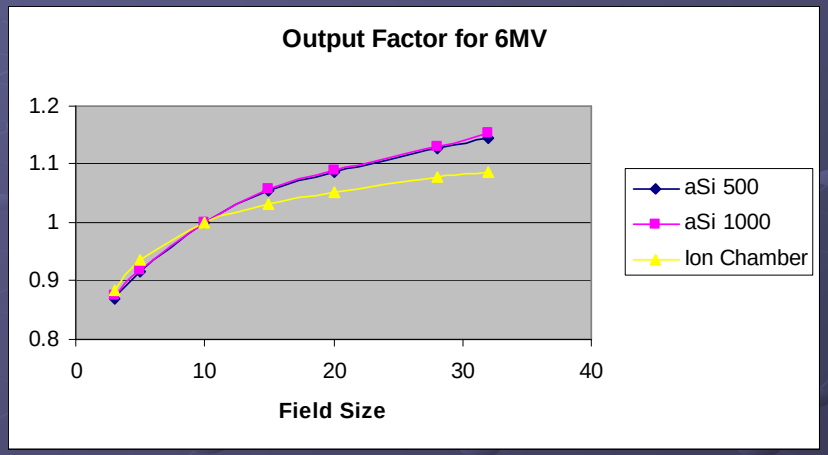
Dosimetric Characteristics of Portal Imager

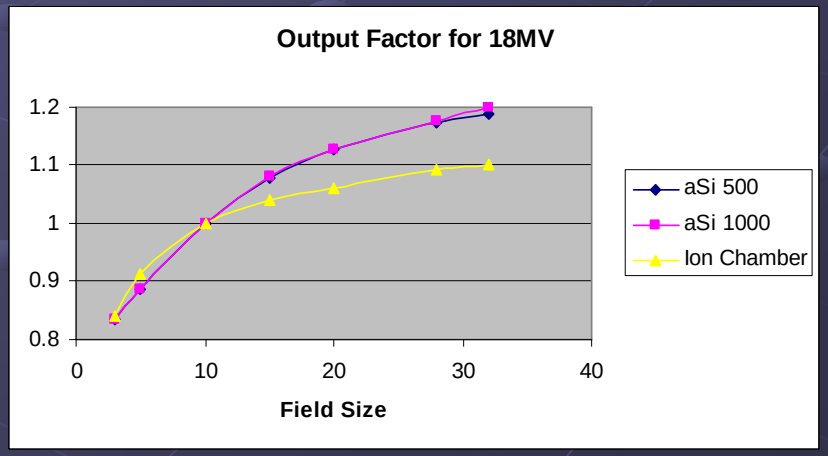
- CU has linear relationship with delivered monitor units for both energies



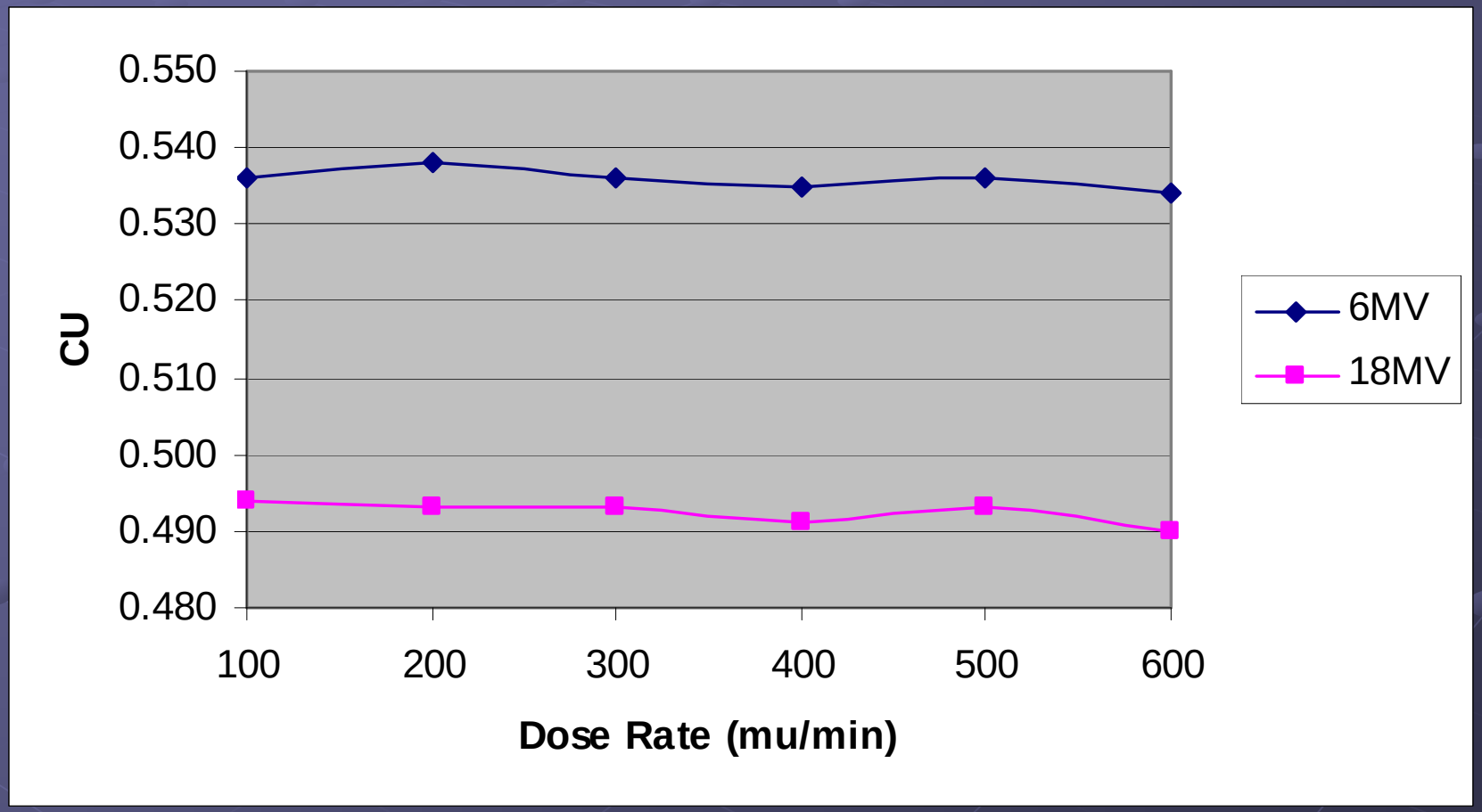
Field Size Dependence

- Portal imager has different field size dependence than ion chamber
- Need to measure output factors during commissioning process
- Field Size dependence is same for both panel types





Portal Imager Dose Rate Dependence (aSi 1000)



(Dose Rate Independent within +/- 0.5%)

Absolute Dose Measurement Results

Simple

Complex

ABSOLUTE DOSE vs ION CHAMBER				
	MapCheck		Portal Dosimetry	
	Average Dose	σ	Average Dose	σ
5 Field Brain	0.36%	0.6%	1.27%	1.0%
7 Field Prostate Boost	0.48%	0.2%	-0.31%	0.6%
11 Field Paraaortic	-0.16%	1.6%	0.00%	0.9%
18 Field Split H&N	0.43%	4.9%	-0.49%	5.5%

- MapCheck & Portal Dosimetry are consistent w/ ion chamber results
- Standard Deviation increases (Less Consistent) with plan complexity
- Average measured dose is independent of plan complexity

Simple

Complex

ABSOLUTE DOSE vs PLANNED DOSE						
	MapCheck		Portal Dosimetry		Ion Chamber	
	Average Dose	σ	Average Dose	σ	Average Dose	σ
5 Field Brain	0.14%	0.8%	1.02%	0.5%	-0.22%	1.1%
7 Field Prostate Boost	2.27%	0.8%	1.51%	0.8%	1.79%	0.8%
11 Field Paraaortic	2.06%	2.4%	2.21%	1.8%	2.21%	1.6%
18 Field Split H&N	0.85%	1.9%	0.13%	2.2%	0.47%	4.7%

- Both are adequate for measuring absolute dose in IMRT QA
- Ion chamber volume averaging

Simple

Complex

GAMMA COMPARISON (3% & 3mm)				
	MapCheck		Portal Dosimetry	
	Gamma	σ	Gamma	σ
5 Field Brain	100.0%	0.0%	96.9%	1.1%
7 Field Prostate Boost	100.0%	0.0%	98.2%	1.3%
11 Field Paraaortic	95.4%	5.2%	98.6%	1.3%
18 Field Split H&N	92.7%	4.7%	97.6%	1.7%

- Portal Dosimetry Gamma Pass % is independent of plan complexity
- MapCheck Gamma Pass % decreases w/ plan complexity

Simple

Complex

GAMMA COMPARISON (3% & 3mm)				
	MapCheck		Portal Dosimetry	
	Gamma	σ	Gamma	σ
5 Field Brain	100.0%	**0.0%**	96.9%	**1.1%**
7 Field Prostate Boost	100.0%	**0.0%**	98.2%	**1.3%**
11 Field Paraaortic	95.4%	**5.2%**	98.6%	**1.3%**
18 Field Split H&N	92.7%	**4.7%**	97.6%	**1.7%**

- Portal Dosimetry Standard Deviation/inconsistency independent of plan complexity
- MapCheck Standard Deviation/inconsistency increases w/ plan complexity

Possible Reasons for MapCheck's Gamma Inconsistency

- Few sampling points within field especially for small fields.
- Non-uniform distribution of detectors (spacing varies from 7mm to 14mm) makes central area more "important" than outer area in gamma passing percentage.
- Distance to agreement criteria (3mm) is smaller than detector spacing. MapCheck has to interpolate measured data between diodes.

MapCheck vs Portal Dosimetry

Resolution Comparison

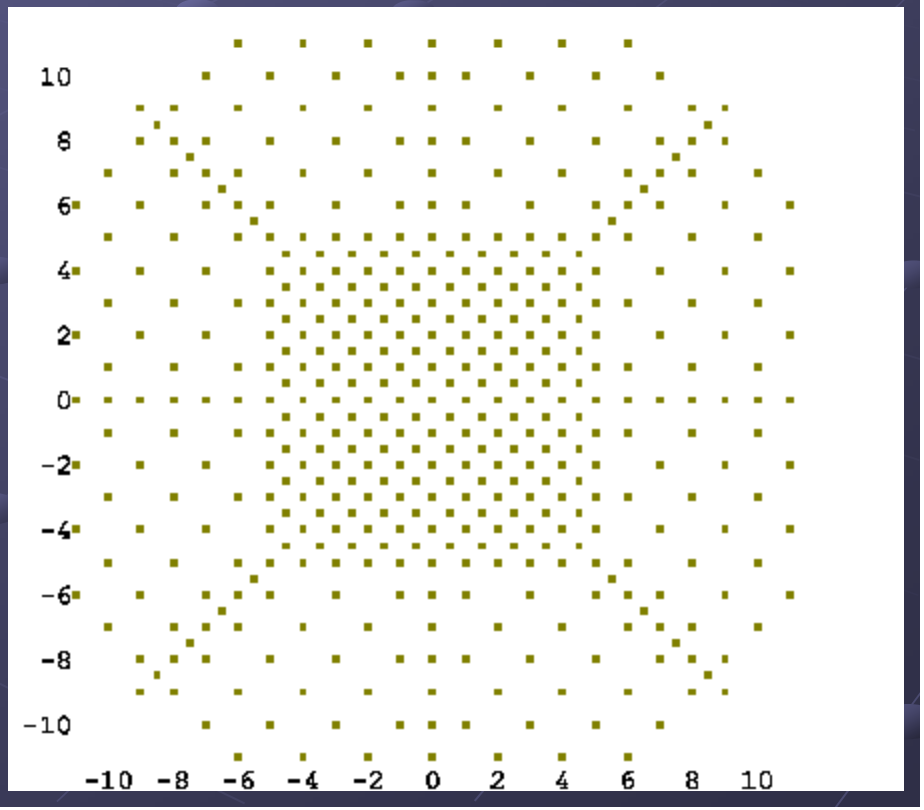
- Portal imaging panel capable of 0.39 mm resolution
- MapCheck capable of only 7 – 14 mm resolution

Portal Vision hardware

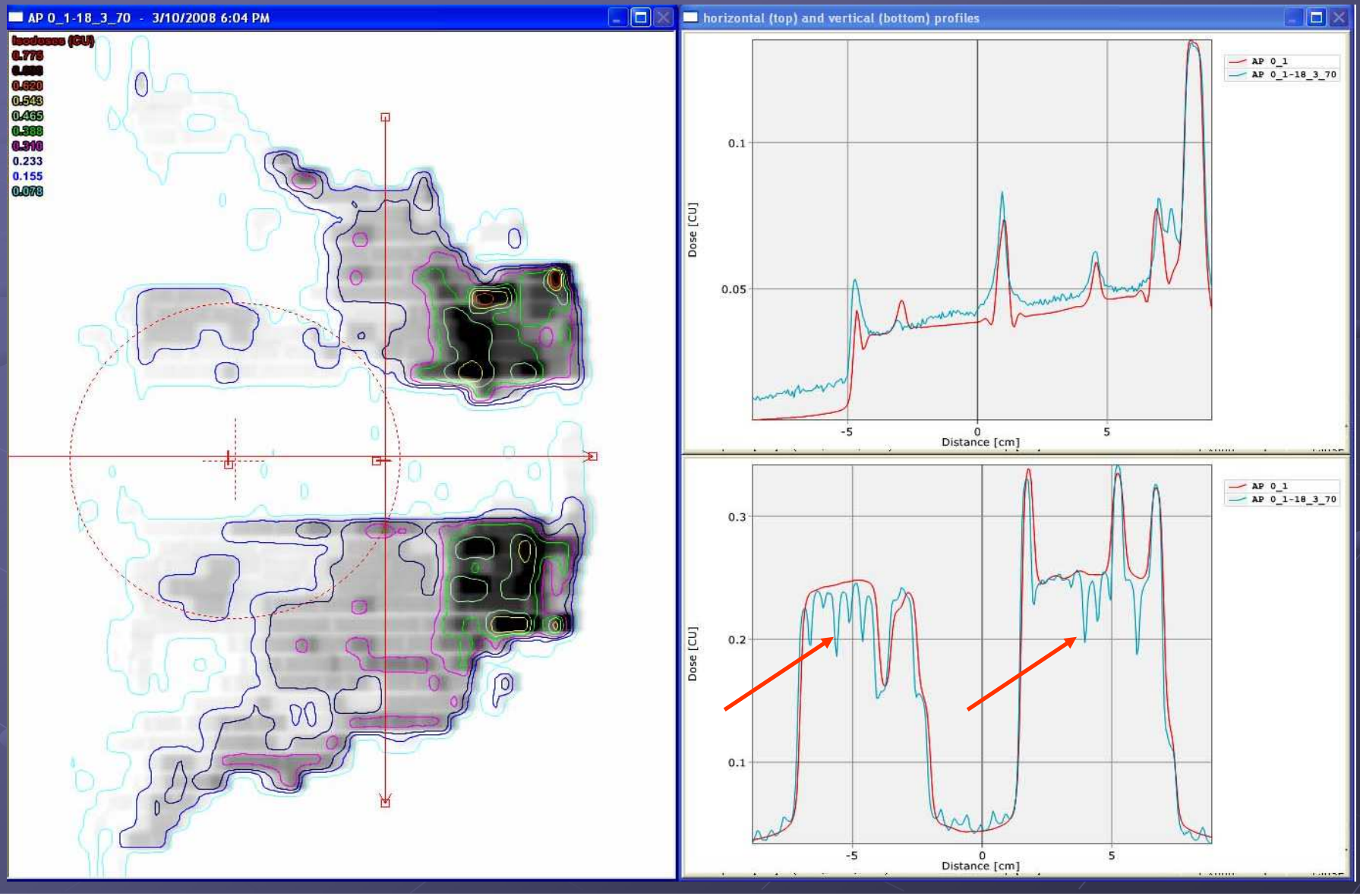
- Three aSi detector types

Name/ Type	Acq. Unit	Matrix	Resolution
aSi 500	IAS2	512 x 384	0.78mm
aSi 500-II	IAS3	512 x 384	0.78mm
aSi 1000	IAS3	1024 x 768	0.39mm

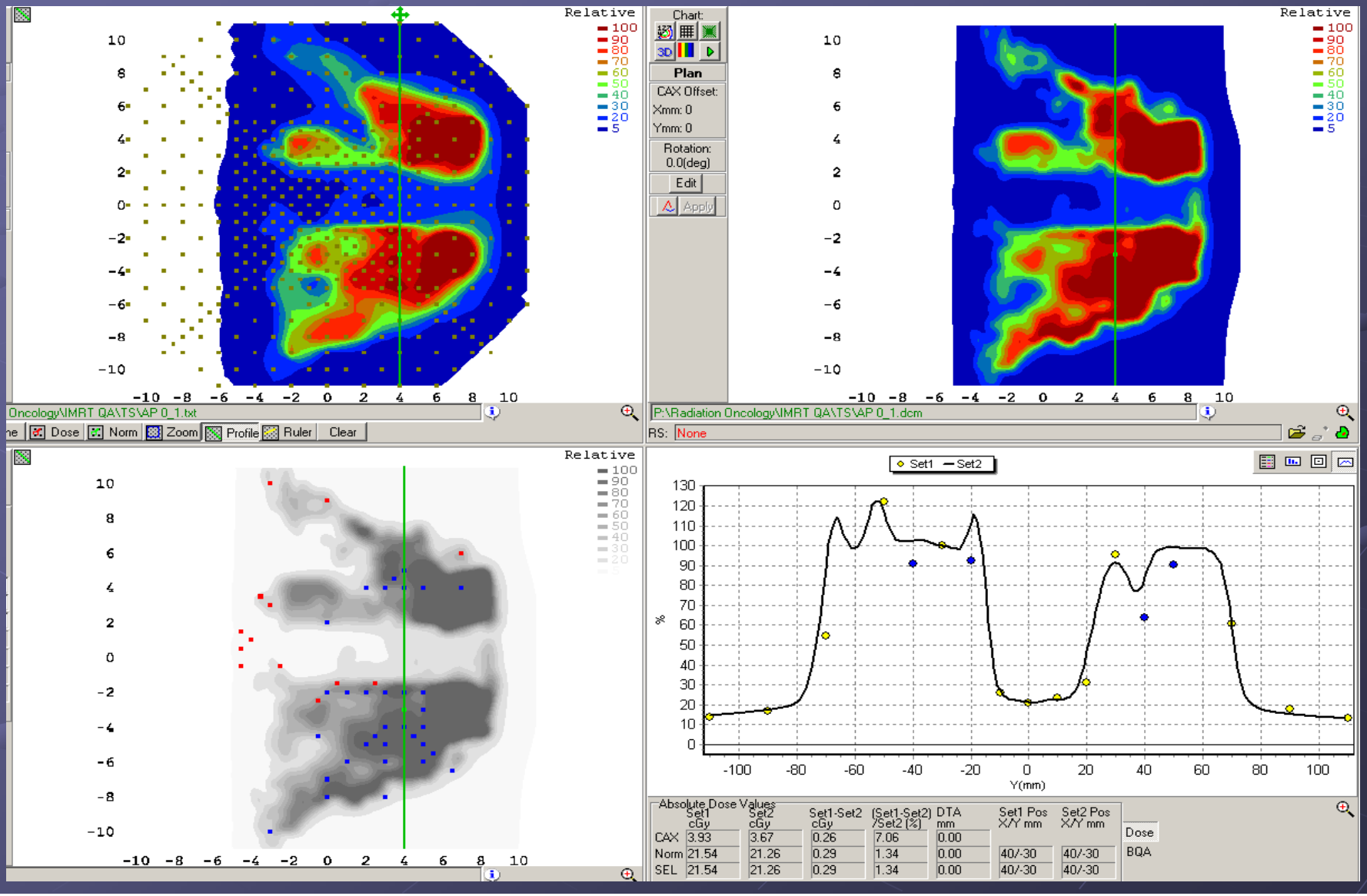
VARIAN Medical Systems



Higher Resolution Portal Image showing Tongue and Groove Effect



MapCheck does not show details as well due to detector spacing



MapCheck Advantages

- User friendly software for data analysis
- Easier commissioning process
- True 3rd party verification system in Sun Nuclear
- Generates comprehensive report

Portal Dosimetry Advantages

- Higher resolution and consistent Gamma analysis
- Easier verification plan creation
  - No extra data to export
- Easier setup – no additional equip & software
- Results integrated into patient database

Major Disadvantages of MapCheck

- Large detector spacing
- Non-uniform detector distribution

Major Disadvantages of Portal Dosimetry

- Does not test patient dose calculation algorithms (convolution, superposition, etc). Portal dosimetry prediction is calculated from fluence map, not dose map.
- Must not use portal dosimetry for IMRT commissioning. Beam modeling must be tested by some other methods.

Summary

- Both systems are capable of performing accurate IMRT QA
- Portal Dosimetry has advantage in resolution and system integration
- MapCheck has advantage in ease of commissioning and user friendliness of software
- Choice lies with user and what they are comfortable with

Acknowledgements

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