

# Portal Dosimetry of FFF beams using Epiqa software

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# Intro

- Epiqa
- Portal Imagers
- Epiqa Configuration
- VPD vs Epiqa
- Commissioning and QA of FFF Beams
- Studies
  - Comparison of VPD and Epiqa
  - Effect of Different Grid Sizes on the Analysis
  - Gaussian Convolution
- Conclusion

# Epiqa

- Epiqa is a comprehensive portal dosimetry QA tool
- Gamma Analysis
  - Measured and calculated with clinical algorithm
- Converts **image** to **dose** with GLAaS algorithm
- Using EPID for Varian Linacs
  - All models are supported by Epiqa
  - aS1000 and aS1200 in the study
- FFF beams are supported
  - Portal dosimetry of high dose rate photon energies



# Differences of Portal Imagers

## aS1000 (TrueBeam v1)

IDU20

40 x 30 cm<sup>2</sup> active area

1024 x 768 pixels

Pixel size ~0.39 mm

### Max dose rate without saturation

1000 MU/min @SID:100 cm

## aS1200 (TrueBeam v2)

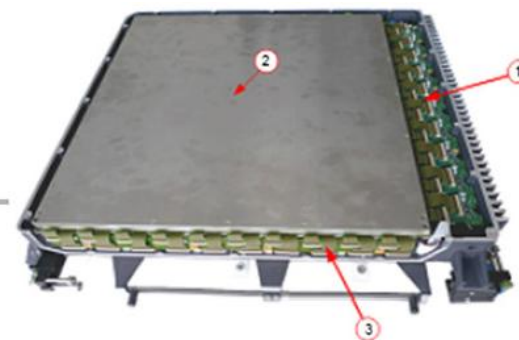
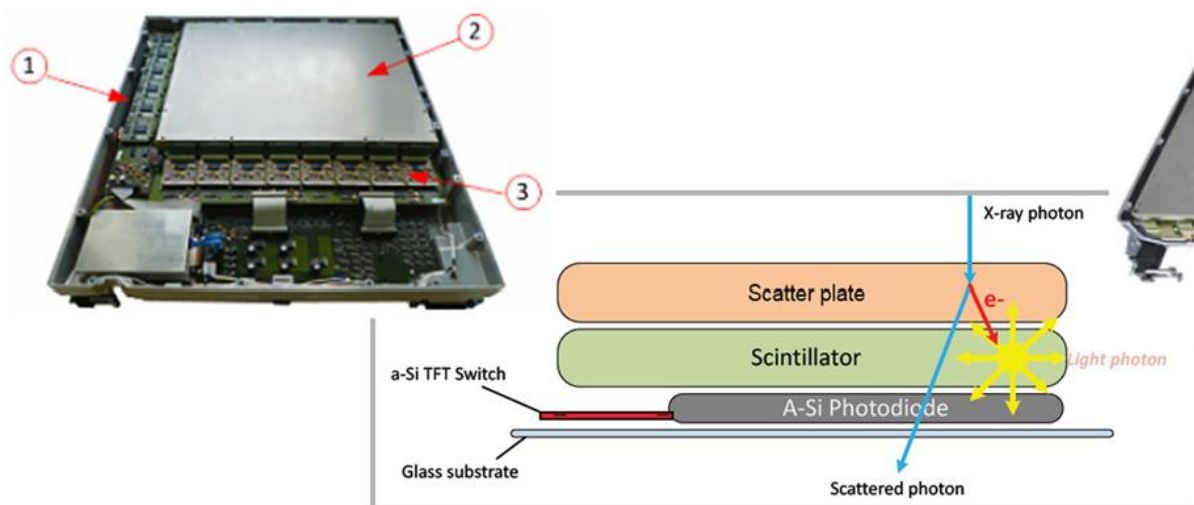
DMI (Digital Megavolt Imager)

43 x 43 cm<sup>2</sup> active area

1280 x 1280 pixels

Pixel size ~0.34 mm

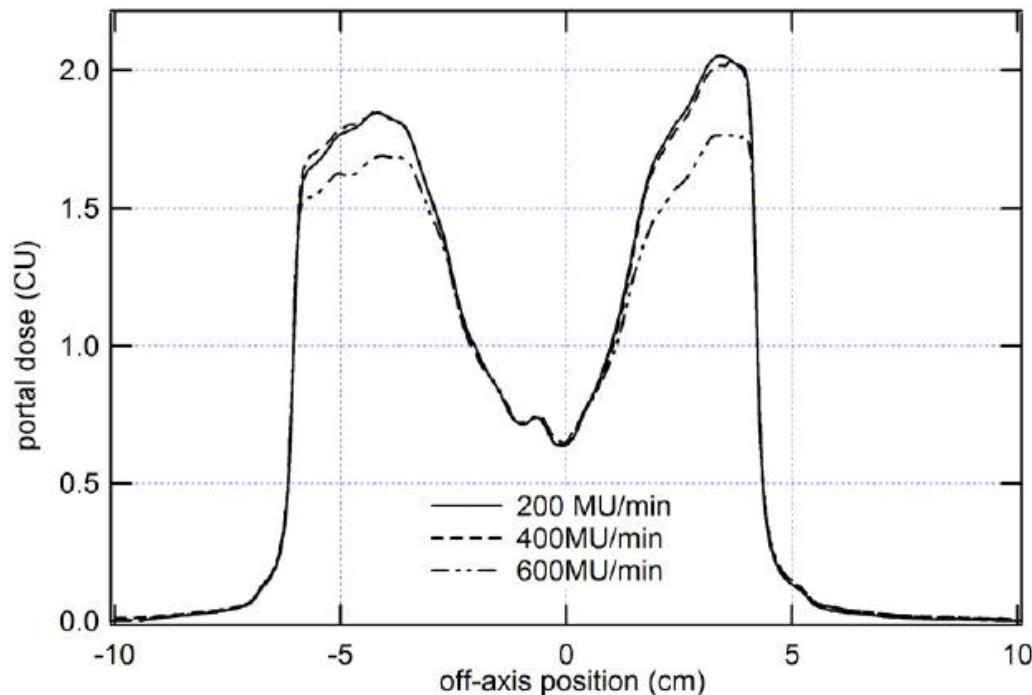
>2400 MU/min @SID:100 cm



The DMI imaging panel also has a backscatter shield (Pb - 3mm thick) to improve quantitative portal dosimetry measurements.

# Differences of Portal Imagers

- The signal of too many pulses sum up to the same frame, thereby exceeding the upper limit for AD conversion.



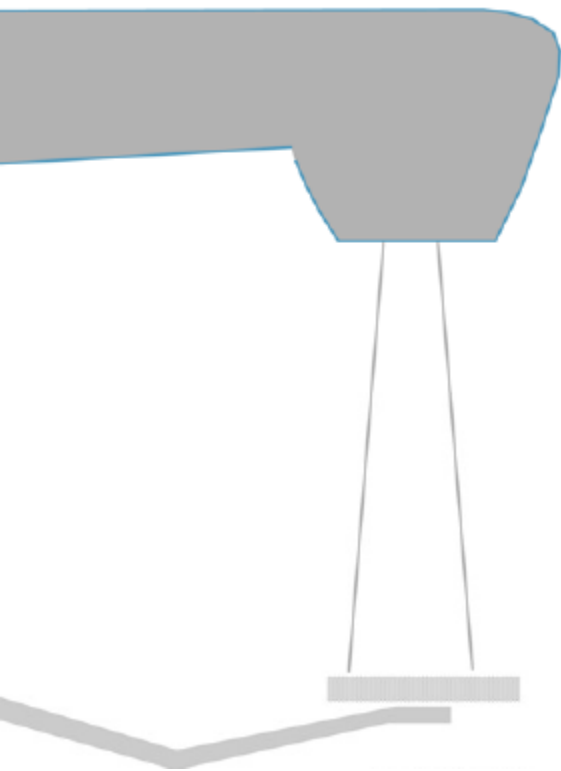
**Saturation  
with Dose Rate**

IAS2, SID:105 cm

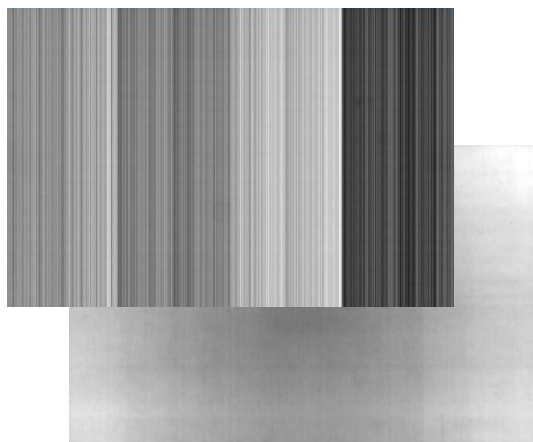
Van Esch A, *Radiotherapy and Oncology*  
2004; 71(2)

# Calibration Before the Configuration

- EPID image calibration on the linac



**Dark field**



**Flood field**

**Dark field image** provides information about background noise, and is obtained by reading out each pixel in the absence of radiation. The resulting image is a series of narrow vertical stripes, which result from the photodiode leakage current and varying electrometer offsets.

**Flood field image** is taken with the entire matrix exposed to a uniform dose. This allows the PortalVision software to internally correct for individual pixel sensitivities.

# Configuration of Epiqa for FFF Beams

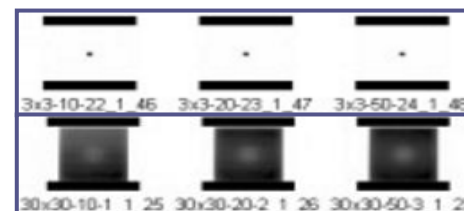
TB v1 - aS1000

Configured at  
SID: 150 cm

TB v2 - aS1200

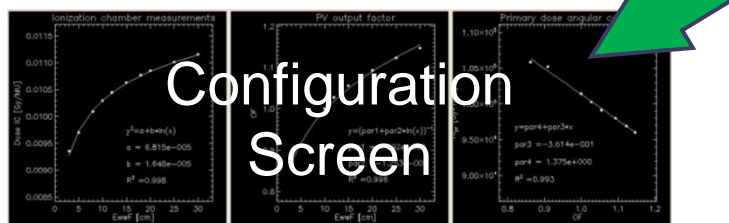
Configured at  
SID: 100 cm

- Open field plans
- Transmission plans



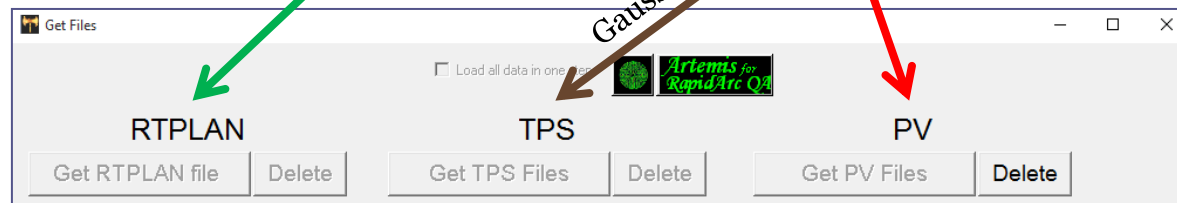
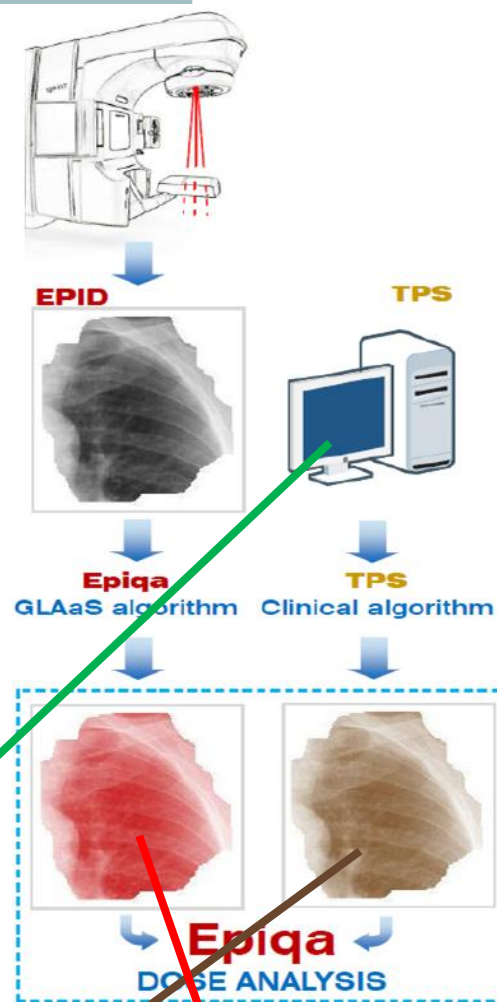
- Output factor table

```
IC MEASUREMENTS
[TreatmentmachineName:]
TruebeamSTX2055
[Energy:Low/High]
6
[Data MU/Gy]
[XY],3,5,8,10,12,15,18,20,25,30
3,95.99,95.08,94.21,93.95,93.79,93.56,93.49,93.45,93.29,93.12
5,95.15,93.86,92.66,92.22,92.03,91.82,91.64,91.53,91.36,91.21
8,94.44,92.90,91.45,90.90,90.61,90.30,90.09,89.99,89.75,89.56
10,94.18,92.59,91.00,90.36,90.01,89.62,89.41,89.32,89.07,88.88
12,94.07,92.40,90.77,90.12,89.72,89.28,89.02,88.90,88.62,88.41
15,93.98,92.24,90.56,89.89,89.44,88.93,88.61,88.44,88.14,87.91
18,93.90,92.10,90.36,89.63,89.18,88.66,88.29,88.10,87.73,87.44
20,93.87,92.04,90.27,89.50,89.04,88.53,88.14,87.92,87.51,87.19
25,93.78,91.90,90.12,89.34,88.84,88.26,87.85,87.64,87.22,86.89
30,93.72,91.80,90.02,89.23,88.70,88.08,87.66,87.44,87.01,86.68
[ENDDATA]
```



# Gamma Analysis

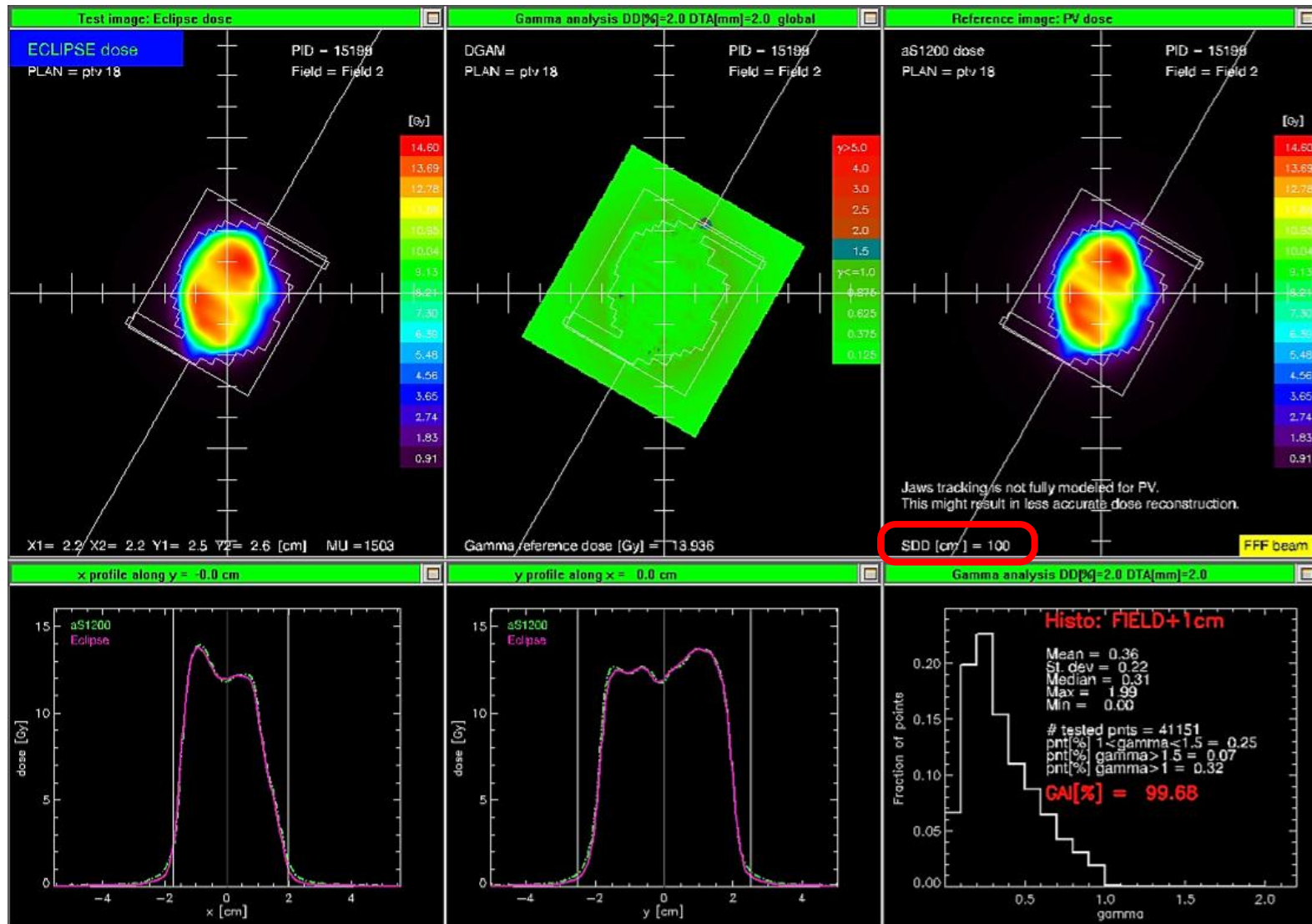
- Calculated Dose distribution  
VS  
Image
- Exported dose distributions  
calculated with AAA
- **6X FFF RapidArc** patients
- Criterias: DTA, DD





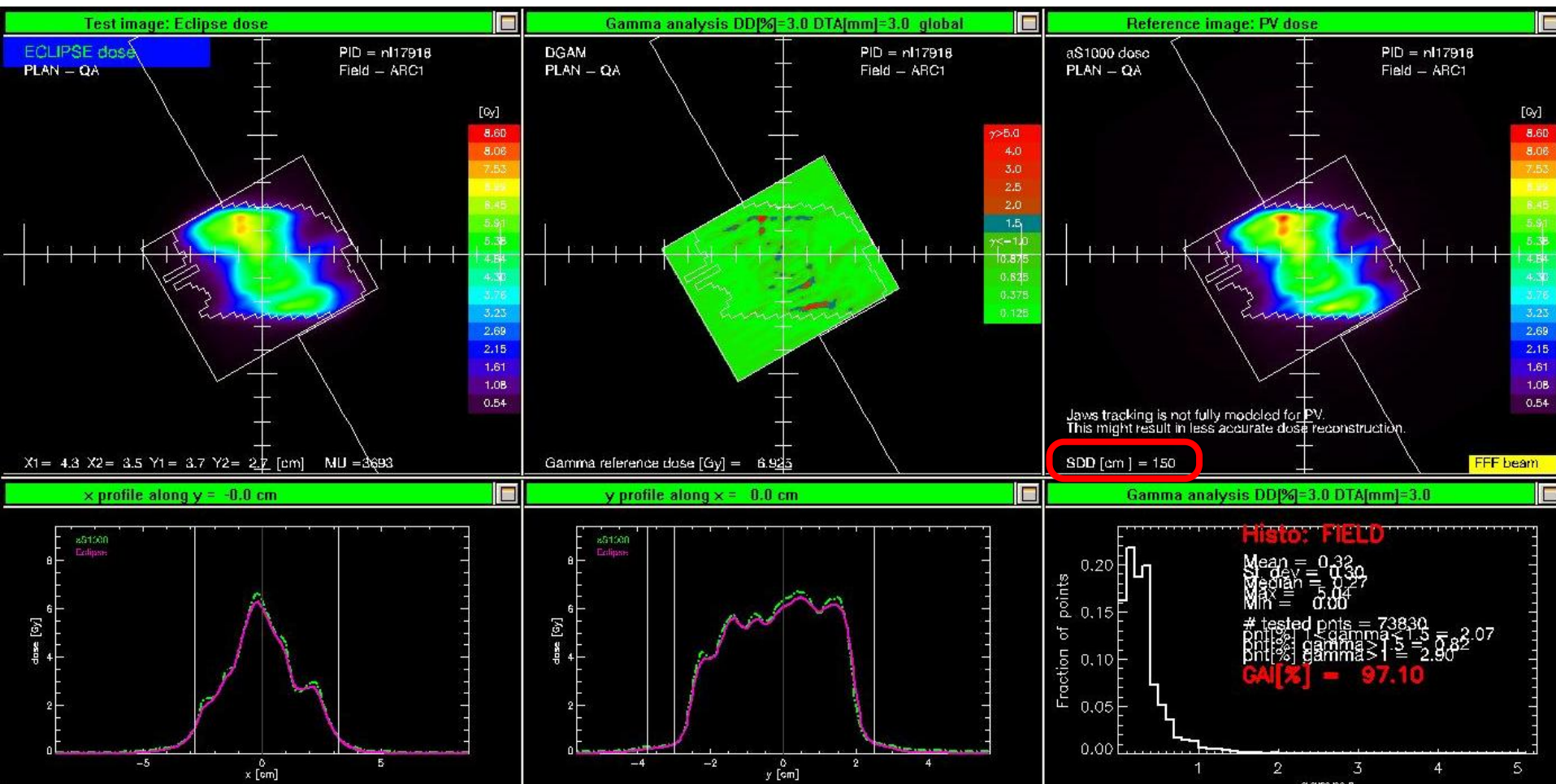
# Analysis

# aS1200



# Analysis

# aS1000



# VPD vs Epiqa

## Varian Portal Dosimetry

- Portal image vs PDIP calculation
- Absolute value unit is CU
- No correction for linac daily output and detector response
- Integrated in Aria

## Epiqa

- Portal image vs clinical algorithm
- Absolute value unit is Gy (Dose)
- Correction for linac daily output and detector response with a 10x10 open field irradiation
- Not integrated
- Machine QA for FFF beam parameters, RapidArc tests, open field, wedge, EDW, TPS vs TPS
- FFF QA with aS1000 imager
- More precise gamma result

# Commissioning and QA of FFF Beams

- Unflatness
- Slope
- Peak position



## Definition of parameters for quality assurance of flattening filter free (FFF) photon beams in radiation therapy

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	Field size [cm]	Left pen [mm]	Right pen [mm]	Dmax [%]	Dmin [%]	Homogeneity [%]	Symmetry [%]
X PV	20.02	3.5	3.2	164.2	110.3	19.6	100.2
X TPS	20.06	4.0	3.4	164.2	109.9	19.8	100.3
X DIFF	0.04	0.5	0.2	-0.0	-0.4	0.2	0.1
Y PV	19.89	4.4	4.4	164.2	110.1	19.7	100.8
Y TPS	20.06	4.8	5.3	164.2	109.4	20.0	100.6
Y DIFF	0.17	0.4	1.0	-0.0	-0.7	0.3	-0.2



# Commissioning and QA of FFF Beams



# Comparison of VPD and Epiqa

- Comparison:
  - 6X FFF RapidArc patients
  - Gamma Analysis
  - Varian Portal Dosimetry vs Epiqa

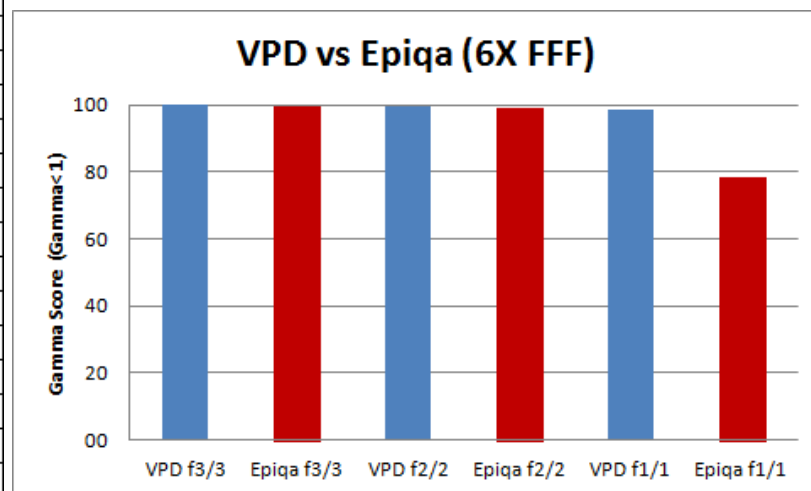
Area : CIAO  
Criteria : DTA=3, 2, 1 cm  
DD=3, 2, 1 %

Area : Field  
Criteria : DTA=3, 2, 1 cm  
DD=3, 2, 1 %

# Comparison of VPD and Epiqa

6X FFF	VPD f3/3	Epiqa f3/3	VPD f2/2	Epiqa f2/2	VPD f1/1	Epiqa f1/1
Field 1	100	100	100	99	100	84
Field 2	100	100	100	99	99	91
Field 3	100	100	100	100	100	74
Field 4	100	100	100	99	100	78
Field 5	100	100	100	99	98	83
Field 6	100	100	100	99	98	83
Field 7	100	100	100	99	99	83
Field 8	100	100	100	99	99	78
Field 9	100	99	99	98	98	80
Field 10	100	100	100	99	99	81
Field 11	100	99	100	99	98	85
Field 12	100	100	99	99	98	90
Field 13	100	99	99	98	97	81
Field 14	100	100	100	97	98	62
Field 15	100	100	100	99	98	73
Field 16	100	100	100	99	99	72
Field 17	100	100	100	98	98	66
Field 18	100	100	100	99	99	74
Field 19	100	100	100	99	100	69
Field 20	100	99	100	98	99	84
Field 21	100	100	100	99	99	90
Field 22	100	100	100	98	99	72
Field 23	100	100	100	99	99	80
Field 24	100	100	100	99	99	80
Field 25	100	100	99	99	97	75
Field 26	100	100	100	100	100	75
Average	100	100	100	99	99	79

\* f: Field, DTA/DD

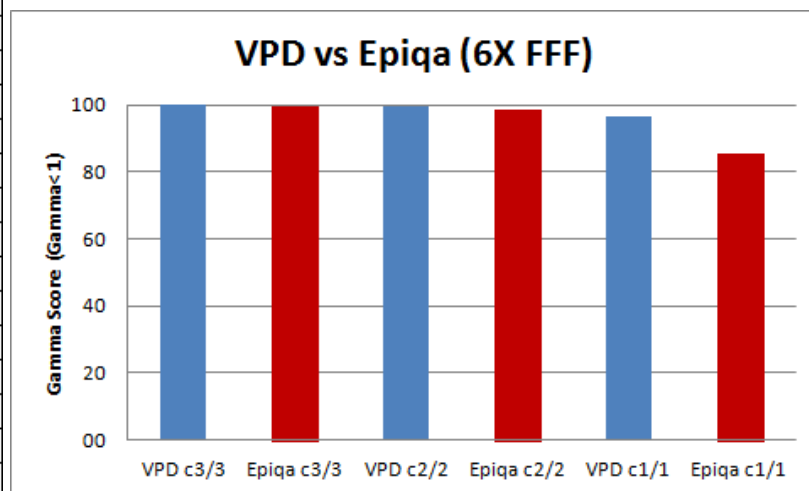


Area : Field  
 Criteria : DTA=3, 2, 1 cm  
 DD=3, 2, 1 %

# Comparison of VPD and Epiqa

6X FFF	VPD c3/3	Epiqa c3/3	VPD c2/2	Epiqa c2/2	VPD c1/1	Epiqa c1/1
Field 1	100	100	100	98	99	79
Field 2	100	99	99	97	96	77
Field 3	100	100	100	100	99	90
Field 4	100	100	100	100	99	94
Field 5	100	99	99	99	96	87
Field 6	100	100	99	98	93	88
Field 7	100	100	100	99	98	90
Field 8	100	100	100	99	99	82
Field 9	99	99	99	96	94	77
Field 10	100	100	100	99	99	89
Field 11	100	100	99	98	95	84
Field 12	99	100	99	99	94	87
Field 13	99	99	98	96	91	78
Field 14	100	100	99	97	94	74
Field 15	100	100	99	98	94	80
Field 16	99	100	100	99	98	87
Field 17	100	99	99	97	95	80
Field 18	100	100	100	99	96	87
Field 19	100	100	100	100	99	89
Field 20	100	99	99	97	95	83
Field 21	100	100	100	99	97	86
Field 22	100	100	100	100	99	90
Field 23	100	100	99	100	97	92
Field 24	100	100	100	100	97	94
Field 25	100	100	100	98	99	80
Field 26	100	100	100	100	100	88
Average	100	100	99	99	97	85

\* c: CIAO (Complete Irradiation Area Outline), DTA/DD



Area : CIAO

Criteria : DTA=3, 2, 1 cm

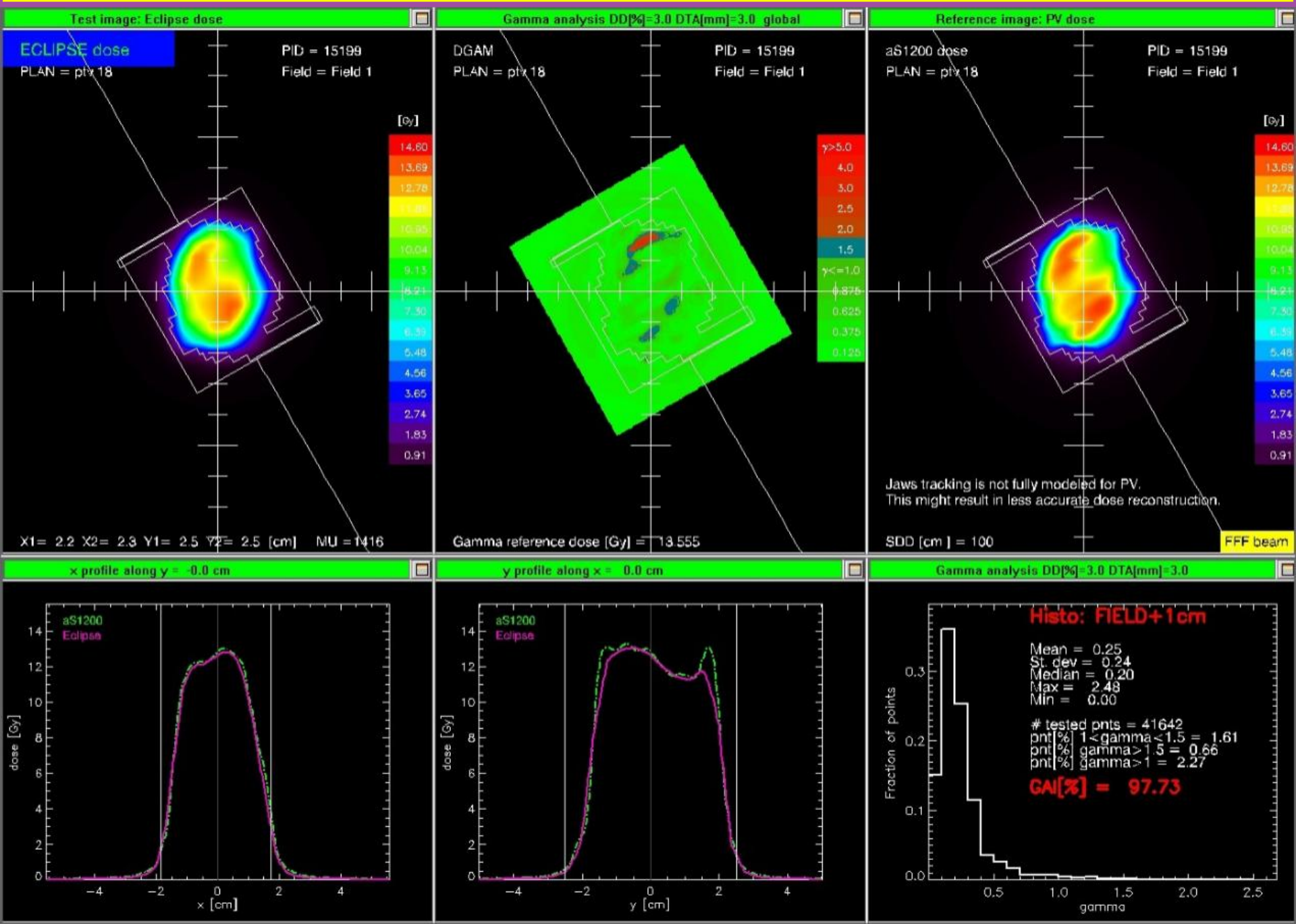
DD=3, 2, 1 %



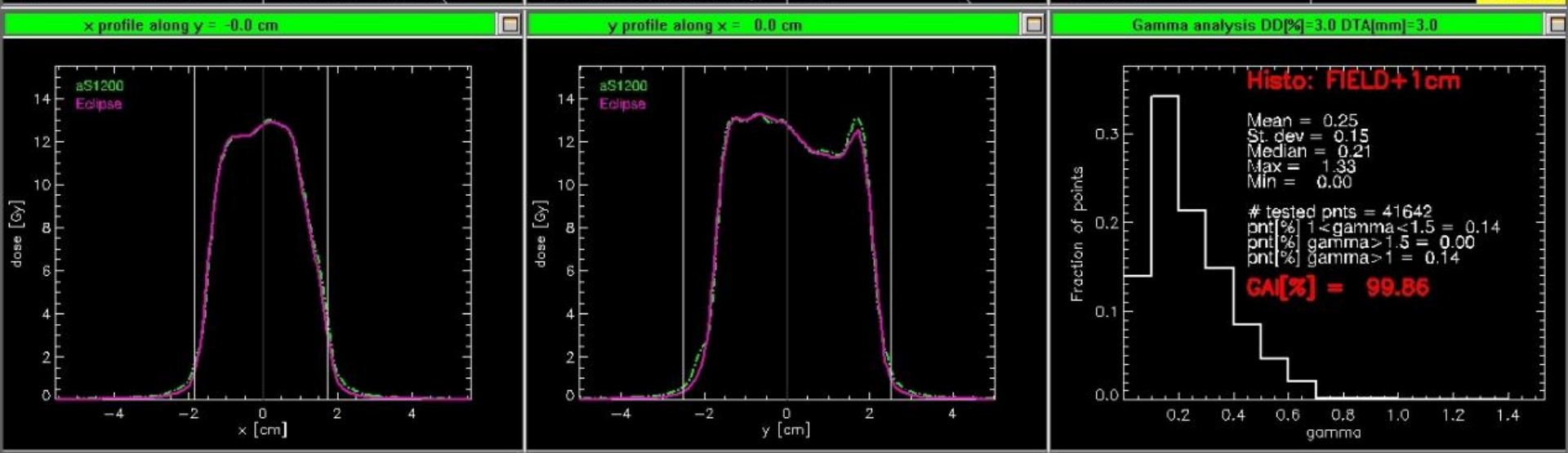
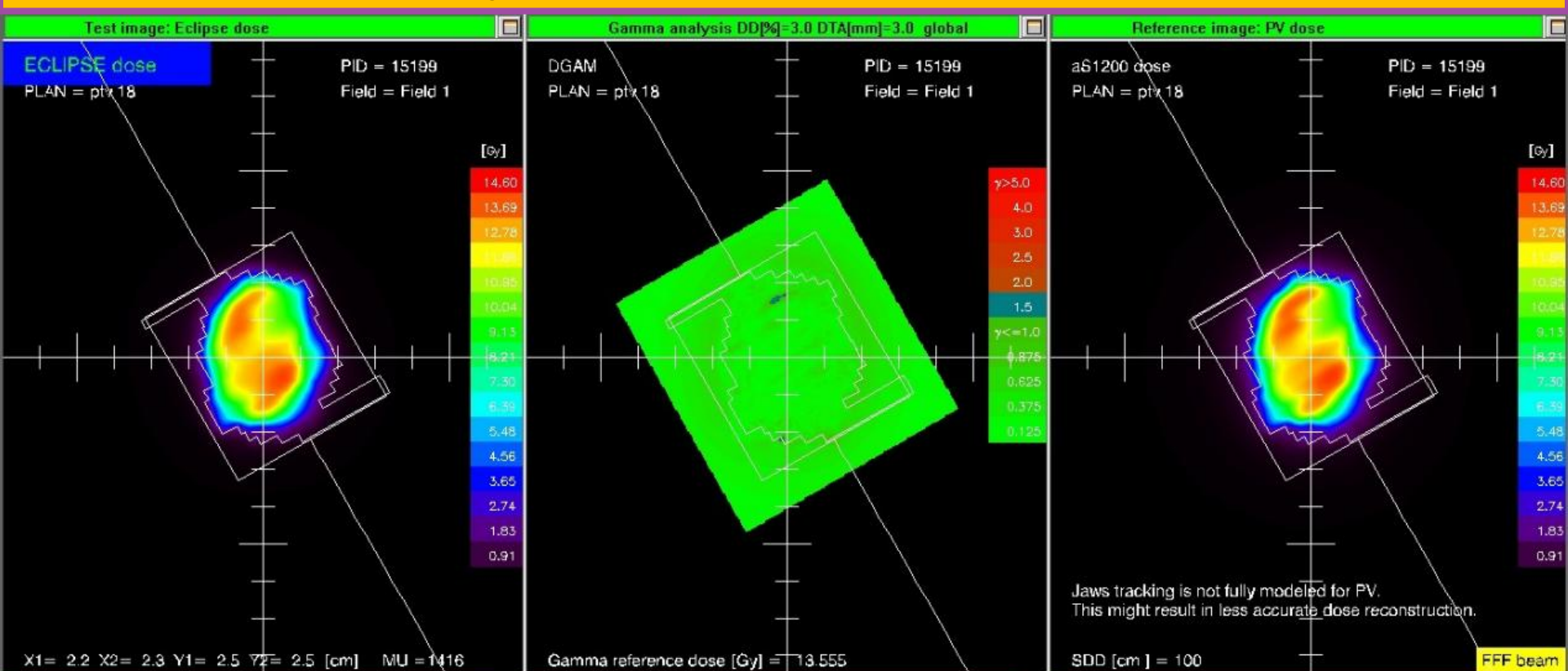
# Comparison of Different Grid Sizes

- Grid Size of the Clinical Algorithm
  - More realistic
  - Eclipse allows GS: 0.1 – 0.5 cm
  - Decrease grid size in Eclipse dose calc. algorithms
  - High modulated small fields
- Comparison:
  - 6X FFF RapidArc patients
  - GS: 1.5, 2.5, 3.5, 5 mm
  - Epiqa, DTA: 3mm, DD: 3%

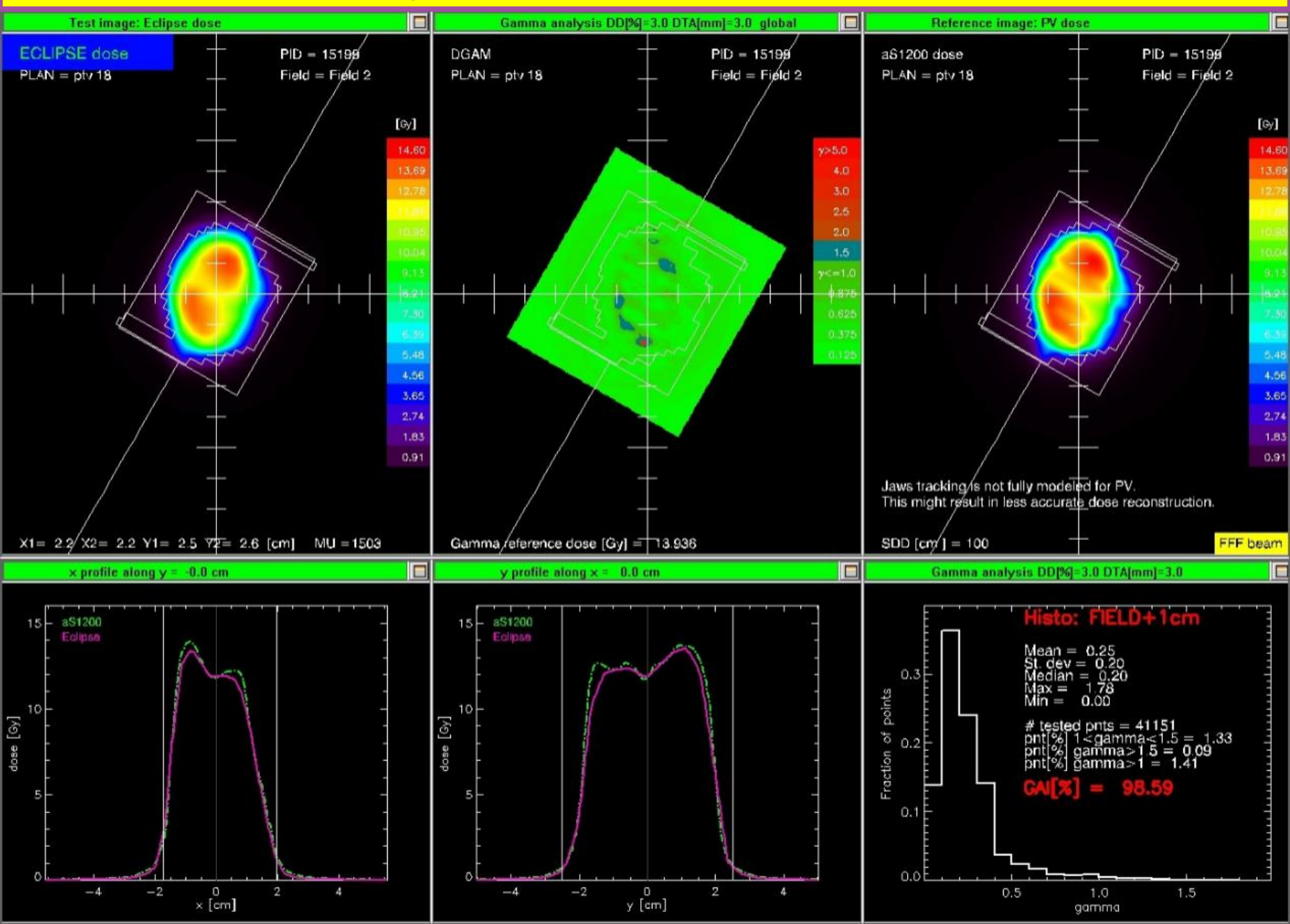
Field 1 - AAA - Grid Size: 2.5 mm



# Field 1 - AAA - Grid Size: 1.5 mm

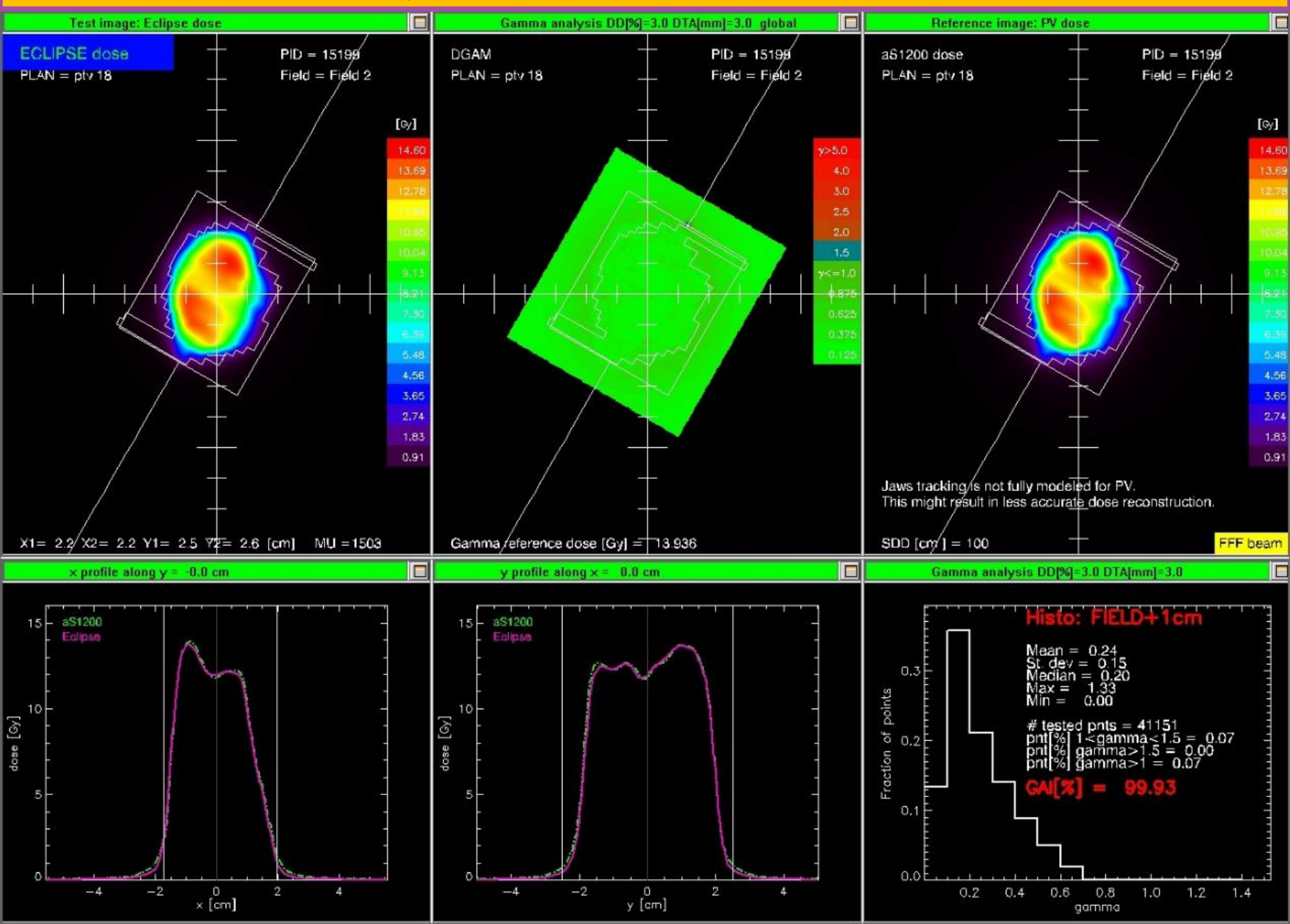


# Field 2 - AAA - Grid Size: 2.5 mm



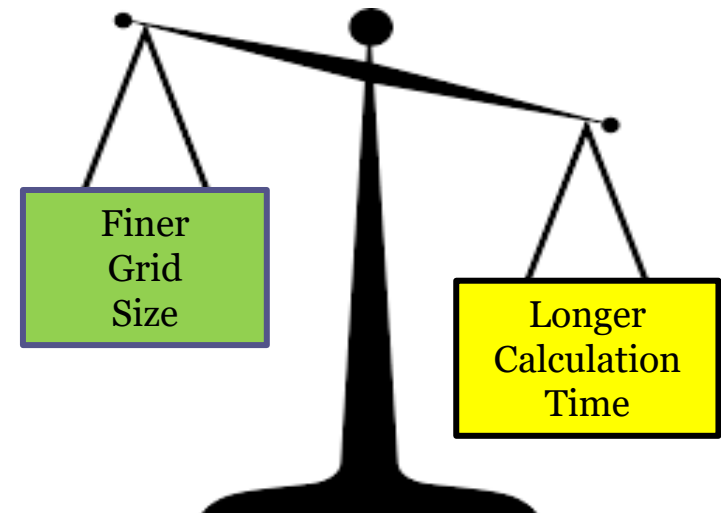
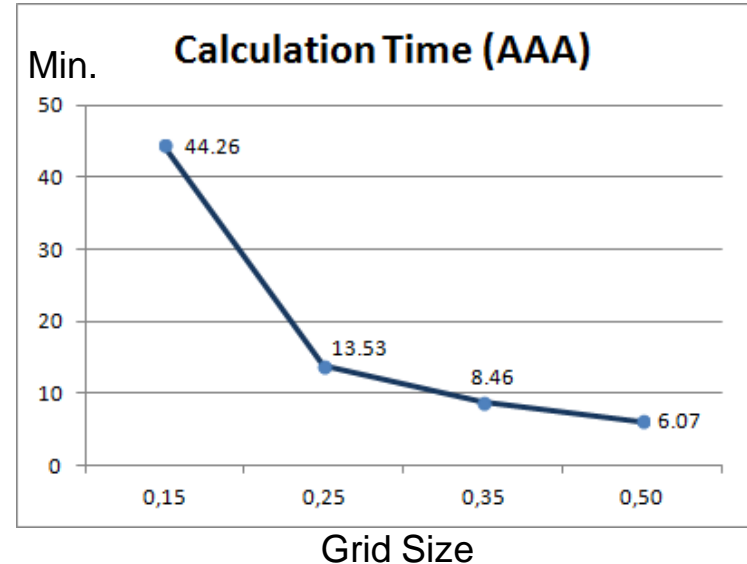
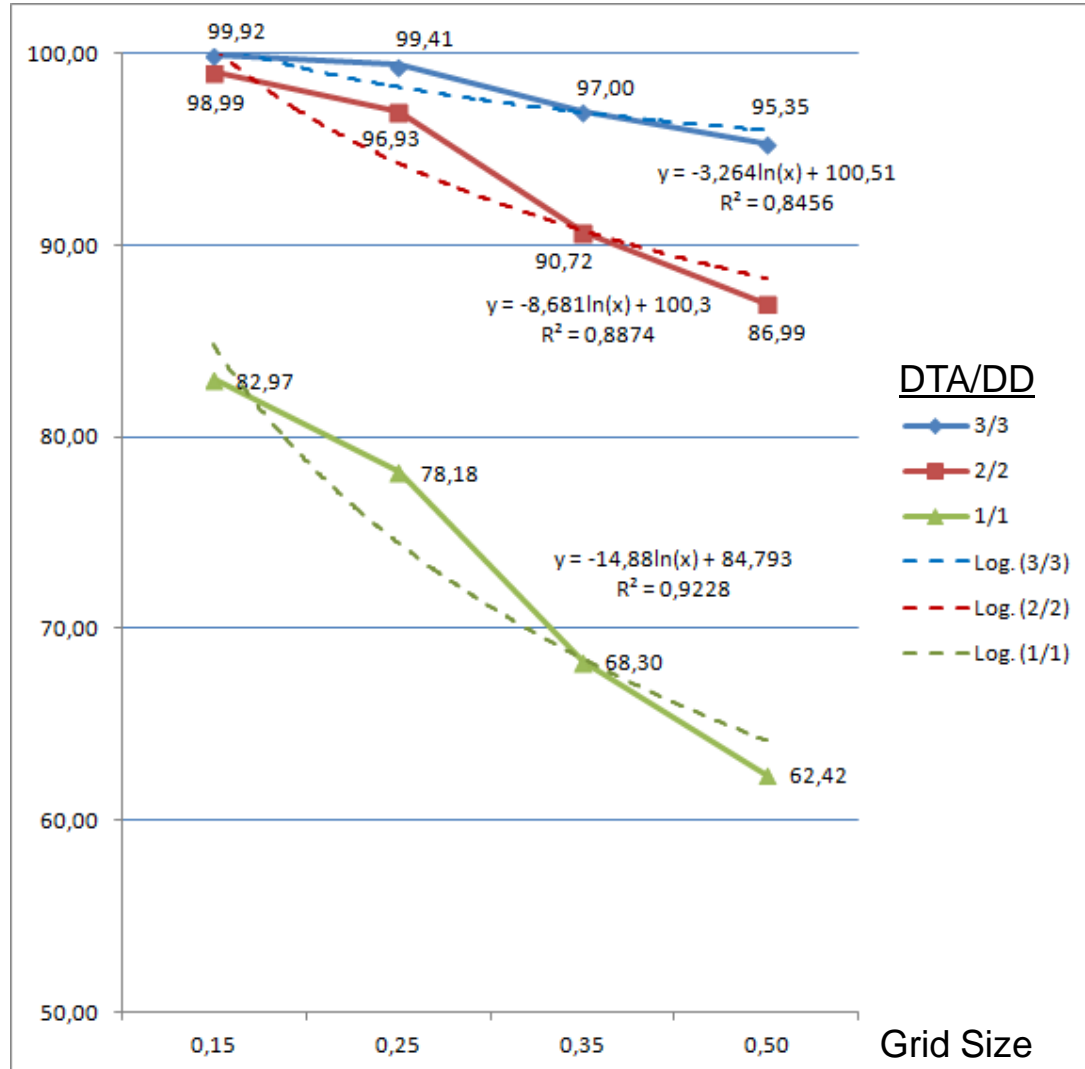


# Field 2 - AAA - Grid Size: 1.5 mm



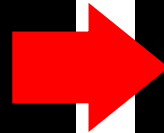
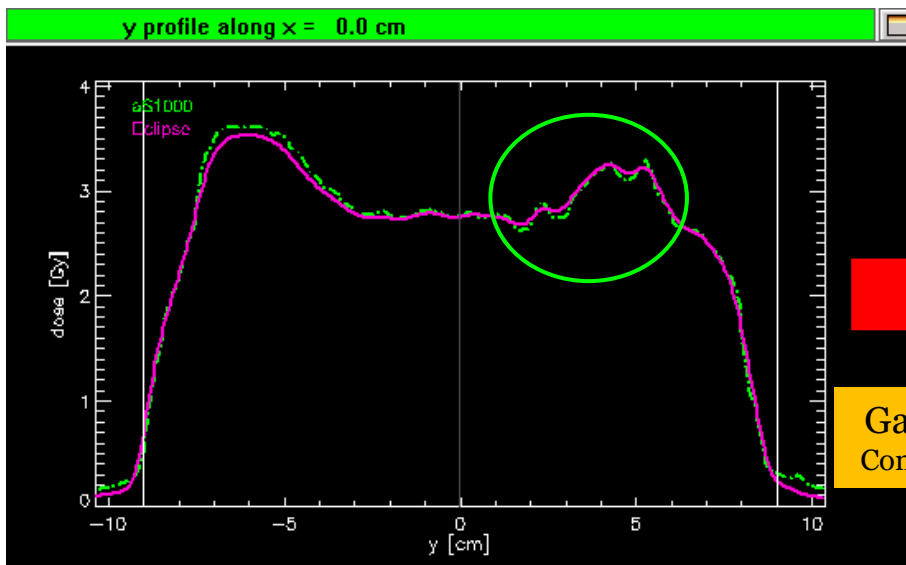
# Power of the Change and Trade Off

Gamma Score

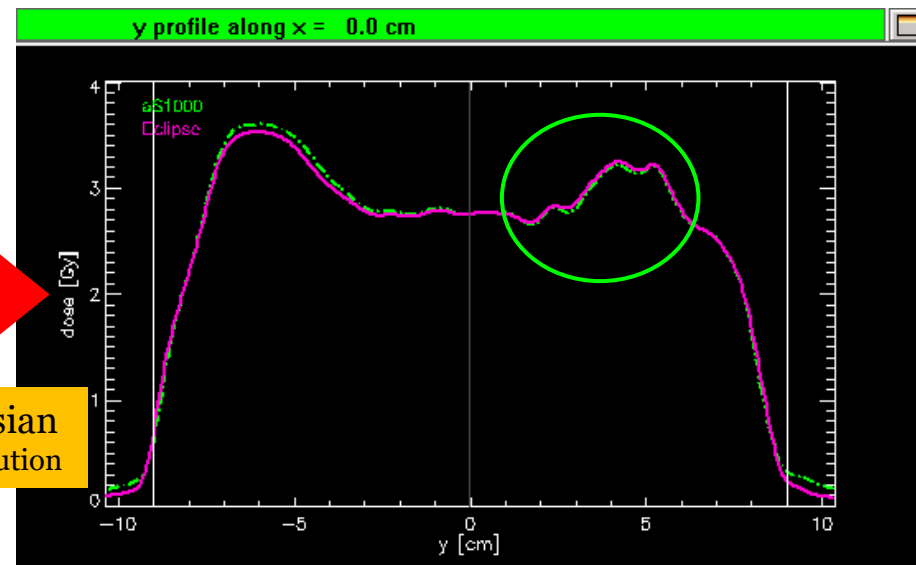


# For a Better Analysis

- Gaussian Convolution
  - Smoothing on the image
  - Calculated dose distribution is in water
  - PV is not water based
  - Has different reflections



Gaussian  
Convolution



# Conclusion

- Both calibrations of Epiqa have similar results for QA's of FFF RapidArc patients
- Gamma analysis results going better with decreasing grid size
- We got better results with gaussian convolution option for some cases
- Epiqa is precise and reliable



# Ďakujem...



*Istanbul*

