

Evaluation of the PTW Octavius 1600SRS high resolution detector array for CyberKnife treatment plan verification

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Purpose

To evaluate the performance of the Octavius 1600 SRS (PTW, Freiburg, Germany) high resolution liquid-filled ion-chamber for plan delivery quality assurance (DQA) for CyberKnife M6 treatments (Accuray, Sunnyvale, USA).

Materials & Methods

- Octavius 1600SRS (PTW, Freiburg, Germany)
- CyberKnife M6® (Accuray, Sunnyvale, USA)
- TPS Precision V3.0 (Accuray)
- Verisoft V8.0.1 (PTW)
- Diode 60017 & MicroDiamond 60019 (PTW)
- EBT3 films (Ashland) with BluePhantom (Standard Imaging)
- RW3 slabs with fiducials (PTW)

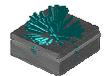
1. Small fields aperture response

Comparison of the 1600 SRS field output measurements with those determined with PTW Diode and microdiamond, using fixed collimator apertures ranging from 5 to 60 mm



2. Beam incidence angle response

Evaluation of the relative dose difference between 1600SRS central chamber response and the calculated dose for each of the 173 nodes using a 60 mm fixed collimator aperture beam



3. 1600SRS vs EBT3 film DQA performance

- 30 clinical MLC treatment plans
 Comparison of DQA results in terms of:
- Gamma index (3% (local) / 1.5 mm / Threshold 30%)
 - Geometric accuracy
 - Dosimetric accuracy



Results

1. Small fields aperture response

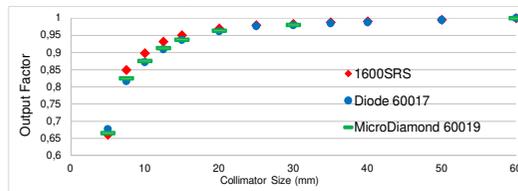


Figure 1. Comparison of the output factors (OF) between the Octavius 1600SRS (uncorrected) with diode 60017 & microdiamond 60019 (corrected with AIEA TRS 483 output correction factors), normalized with respect to the value obtained for 60mm

Compared to well-established OF, 1600SRS field aperture response accuracy was:

- within +/- 2% for field size > 10mm
- up to +3.9% for field size ≤ 10mm

2. Beam incidence angle response

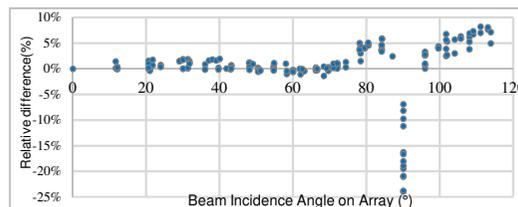


Figure 2. Relative dose difference (%) between measured and calculated dose (ref) (normalized to a 0° perpendicular incidence beam) for all the beam incidence

The 1600SRS beam incidence angle response was:

- ≤ 2% for beam incidence ≤ 78°
- ≥ 5% for beam incidence > 78°
- Up to -23.5% for 90° beam incidence

3. 1600SRS vs EBT3 film DQA performance

Table 1. Summary of DQA results (Mean value +/- 1 sd) obtained for 30 similar MLC treatment plans

	1600SRS	EBT3 film
Gamma passing rate (%)	98.5 +/- 2.4	94.5 +/- 4.7
Mean gamma value	0.48 +/- 0.21	0.48 +/- 0.08
Geometric deviation between calculated and measured dose map (2D vector) (mm)	0.7 +/- 0.3	0.8 +/- 0.3
Relative dose difference deviation between calculated and measured dose map (%)	1.7 +/- 1.1	0.9 +/- 2.2

Compared to a EBT3 film-based DQA protocol, a 1600SRS-based DQA protocol showed:

- Higher γ passing rate / Similar mean γ value
- Better dose reproducibility / Same geometric accuracy
- Slightly higher systematic dose deviation (probably due to the 1600 SRS beam incidence response)

Conclusions

The Octavius 1600SRS detector array is a reliable tool for performing CyberKnife treatment plan verifications when using fields apertures larger than 10mm

This study shows that the beam incidence angular response dependence of the 1600SRS has no significant dosimetric impact for CyberKnife plan delivery quality assurance.