

# Comparison of different dosimetric systems for VMAT pre treatment quality assurance in SBRT

A. Bruschi<sup>1</sup>, S. Russo<sup>2</sup>, M. Esposito<sup>2</sup>, S. Pini<sup>2</sup>, A. Ghirelli<sup>2</sup>, G. Zatelli<sup>2</sup>



<sup>1</sup> Medical Physics Specialization School, University of Florence, Florence, Italy; <sup>2</sup> Medical Physics Unit, Azienda Sanitaria di Firenze, Florence, Italy

## INTRODUCTION

The dosimetric implementation of stereotactic treatment with VMAT represent a challenge because of the small fields involved, the variation of dose rate, gantry speed rotation and leafs movements during the irradiation. Due to the high complexity and uniqueness of VMAT treatment plans, patient-specific pre-treatment quality assurance (QA) is considered a necessary prerequisite to patient treatment. An ideal dosimeter for VMAT SBRT QA must be independent by the energy, the dose rate, the irradiation angle, and must have a high spatial and temporal resolution, in order to fit the calculated dose map in three dimensions. Aim of this work is to compare the capability of two ionization chamber systems (PTW Octavius 4D 729 and PTW Octavius 4D 1000 SRS) and an electronic portal imaging dosimeter (Dosimetry Check) to correctly measure the dose on a homogeneous phantom.

## MATERIALS & METHODS

PTW Octavius 4D 729 is a gas filled ionization chamber 2D array equally distributed on a 27x27 cm<sup>2</sup> area. The detector size is 5 mm x 5 mm x 5 mm and the spacing (center-center) is 10 mm.

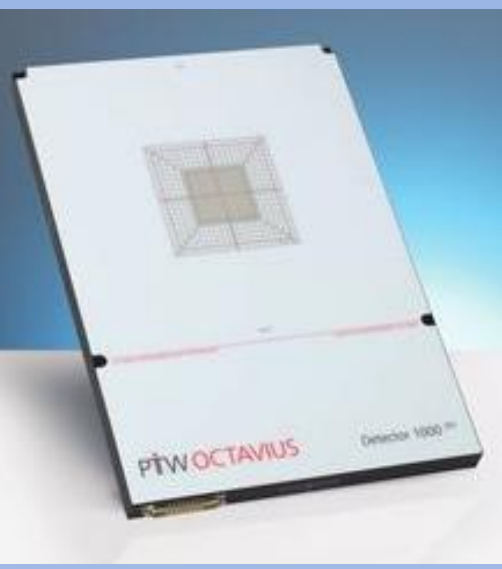
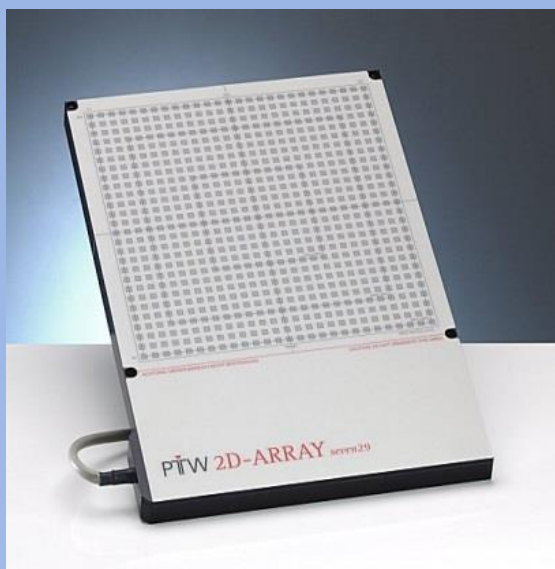
PTW Octavius 4D 1000 SRS consists of two-dimensional detector array based on 977 liquid-filled ionization chamber, on a 10x10 cm field. The detector size is 2.3 mm x 2.3 mm x 0.5 mm. In the inner 5.5 × 5.5 cm<sup>2</sup> area of the array, the spacing is 2.5 mm, while in the rest of the active area is 5 mm.

Dosimetry Check (DC) is a software that uses EPID measured fluences of the treatment fields/arcs to reconstruct the dose distribution on a CT study. The EPID acquisitions, correlated with the corresponding gantry inclination, were converted in fluence in air.

SBRT VMAT plans have been generated by Monaco with energies of 6 MV and 10 MV. Seven treatment plans have been used in this comparison (5 lung tumours and 2 pelvic nodes). The QA maps were computed on the synthetic Octavius 4D phantom. Portal imaging QA was performed both in air and in transit and the fluence obtained from the analysis of the acquired QA was used for computing dose on the phantom. 2D isodose distributions in the principal planes through the isocentre, 3D dose distributions and 3D  $\gamma$  metric at 2 % 2 mm have been used to compare measured and computed maps.

## RESULTS

The SRS array shows the best agreement with the computed maps (98.5 % point with  $\gamma < 1$ , obtained as the mean of  $\gamma$  passing rates for the seven plan). Despite the 729 array has a good agreement in term of 3D  $\gamma$  metric at 2% 2 mm (96.7% point with  $\gamma < 1$ ), along the gun-target (G-T) direction, in the high gradients region, we found a trend to underestimate the dose. The Dosimetry Check shows a good agreement with the computed maps (95.2 % in air and 97.6 % in transit) and also in the high gradient regions correctly fit the computed dose distribution.



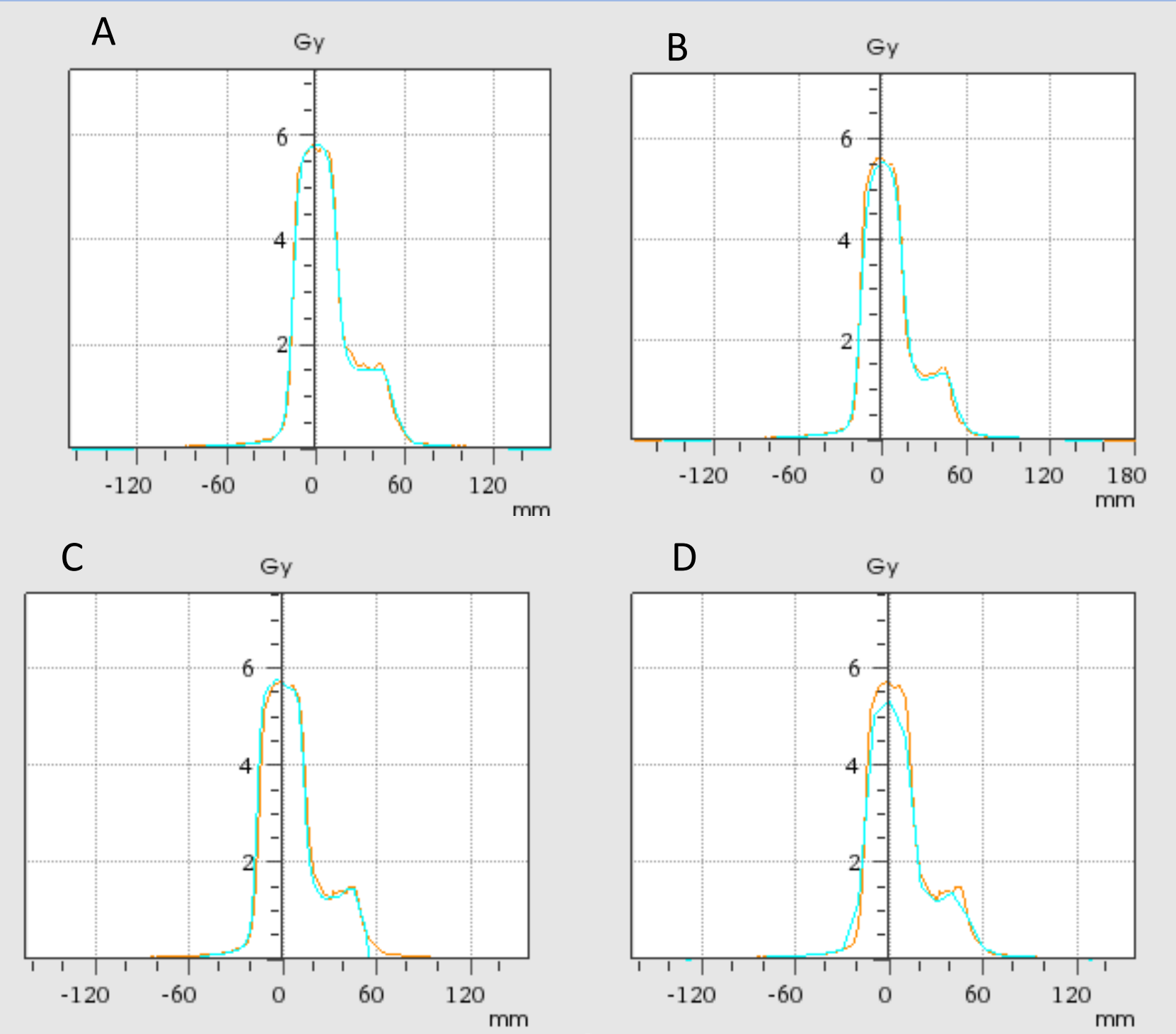
2D-Array Seven29 2D-Array 1000 SRS



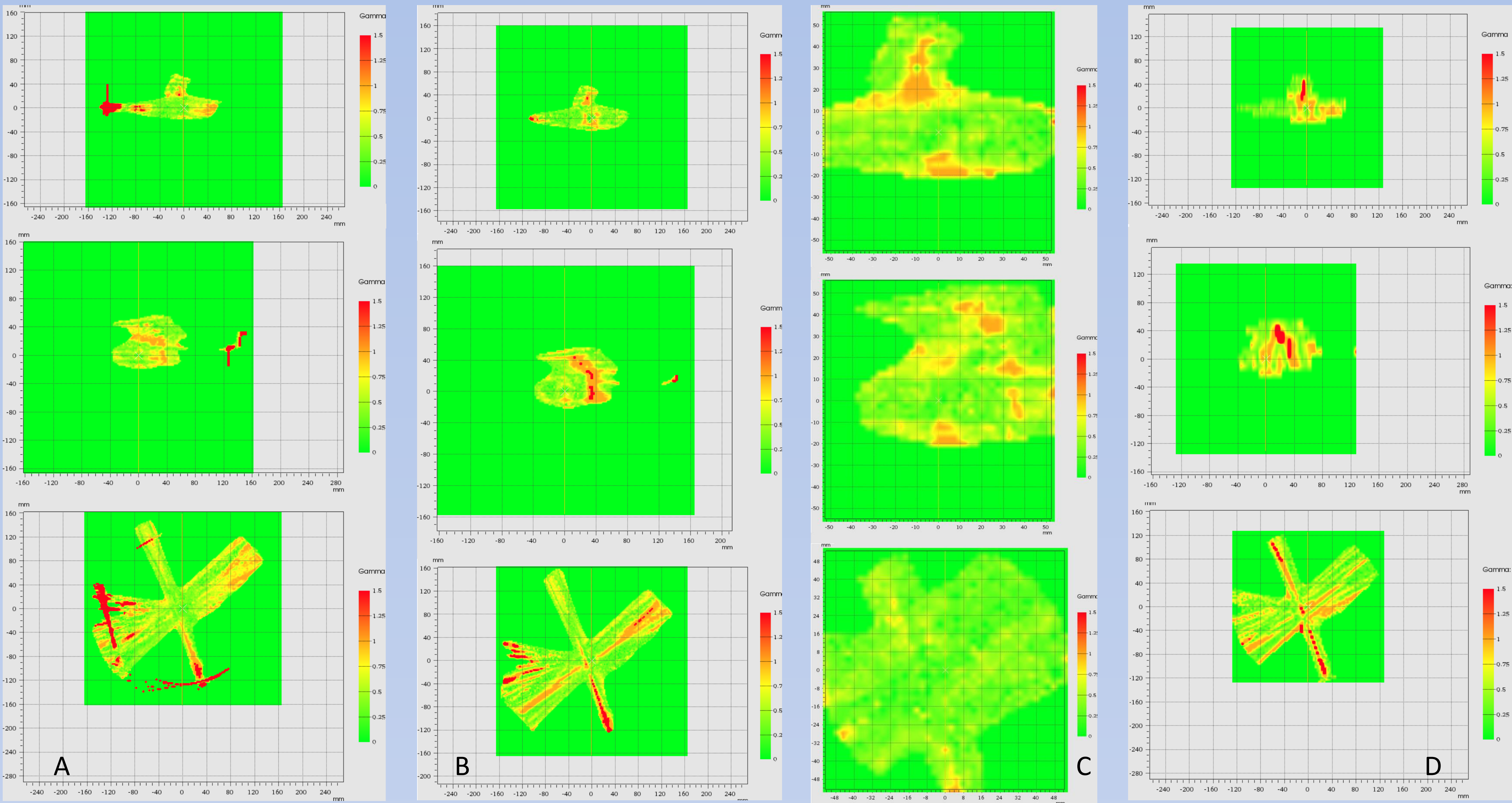
Octavius4D

	DC in air (%)	DC in transit (%)	SRS (%)	729 (%)
Plan1	91.1	96.4	99.9	97.9
Plan2	96.1	96.6	98.5	98.5
Plan3	98.1	99.8	98.3	96.4
Plan4	94.6	96.3	99.9	90.6
Plan5	96.1	97.4	99.9	95.8
Plan6	95.3	99.3	96.1	98.8
Plan7	95.1	99.8	96.7	99.1

Percentage of points with  $\gamma < 1$  in 3D for the Dosimetry Check (DC) in air and in transit , the PTW Octavius 4D 1000 SRS (SRS) and the PTW Octavius 4D 729.



The G-T profile at the isocenter for plan 5 is shown. Yellow line represent the calculated map, and the green line is the measure: A) Dosimetry Check (in air), B) Dosimetry Check (in transit), C) PTW Octavius 4D 1000 SRS (SRS), and D) PTW Octavius 4D 729.



The 2D  $\gamma$  distribution for plan 5 on the coronal (top), sagittal (middle) and transversal (bottom) plane passing through the isocenter is shown: A) Dosimetry Check (in air), B) Dosimetry Check (in transit), C) PTW Octavius 4D 1000 SRS (SRS) and D) PTW Octavius 4D 729.

## CONCLUSIONS

All dosimeters analysed showed a good agreement with the computed map in term of 3D  $\gamma$  metric at 2% 2mm. The DC and the SRS, have very high data density compared to the more discrete 729 measured points in the G-T direction and this results in a better resolution in the high gradient regions. These results show that DC is a suitable tool for patient-specific pre-treatment quality assurance in stereotactic treatment where a better resolution is recommended to correctly measure the dose map in high gradient region. The DC can be used also for QA check during treatment and this study is preliminary to DC use for in vivo dosimetry.

## REFERENCES

A. Mans et al , « 3D Dosimetric verification of volumetric-modulated arc therapy by portal dosimetry », Radiotherapy and Oncology 94 (2010) 181–187  
B. Poppe et al , « Performance parameters of a liquid filled ionization chamber array », Medical Physics 40, 082106 (2013); doi: 10.1118/1.4816298  
C. Fogliata et al , « Quality assurance of RapidArc in clinical practice using portal Dosimetry », The British Journal of Radiology, 84 (2011), 534–545