Purpose: To commission and benchmark a 3D dosimetry system for clinical use, in particular, for verification and commissioning of complex radiation treatments like VMAT, IMRT and gated treatments. The system is composed of two parts: a radiochromic plastic dosimeter Presage, which responds to absorbed dose with a linear change in optical-density; and the Duke Large field of view Optical-CT Scanner (DLOS).

Methods: DLOS commissioning involved creating stray light and spectral corrections, determining the dynamic range, spatial resolution, and noise, and characteristics of source and imaging components. The benchmarking tests were performed on the combined DLOS/Presage system to establish baseline capabilities. These tests consisted of delivering 6 treatments of gradually increasing complexity, and comparing the measured distributions with a gold standard (e.g. machine beam-data). All studies used standard-procedures to ensure consistency.

Results: Commissioning: isotropic spatial resolution was sub-mm (MTF >0.5 for frequencies of 1.5lp/mm) and the dynamic range was ~ 60dB . Flood field uniformity was 10% and stable after 45minutes. Stray light is small, due to telecentricity, but even the residual can be removed through deconvolution. Benchmarking: the mean 3D passing gamma rate (3%, 3mm, 5% dose threshold) over the 6 benchmark data sets was 97.3% ± 0.6% (range 96%-98%), indicating excellent ability to perform 3D dosimetry. Noise was low at ~2% for 2mm reconstructions.

Conclusions: The DLOS/Presage benchmark tests show consistently excellent performance, with very good agreement to simple known distributions. The telecentric design was critical to enabling fast (~15mins) imaging with minimal stray light artifacts. The system produces accurate isotropic 2mm3 dose data over clinical volumes (e.g. 16cm diameter phantoms, 12 cm height), and represents a uniquely useful and versatile new tool for commissioning complex therapy techniques. The system also has wide versatility, and has successfully been used in preliminary tests with protons, and kV irradiations.