

# Holographic Image Guided Radiation Therapy (HIGRT) Treatment Planning: a Multi-Institutional Study

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**Purpose:** To determine the feasibility and potential of a novel 3D display for radiation treatment planning

### Why do we need a new display technology in treatment planning?

1. Many of the planning tasks, such as volume delineation, beam placement, plan evaluation etc., are 3D in nature
2. Current planning displays, showing 2D cross-sections or 3D renderings on 2D computer screens, are 2D in nature
3. We hypothesize that these 3D tasks can be performed more effectively with a 3D display tool

### The 3D Display Device:

- 24" dome
- 50/50 diffuser screen rotating at 900 rpm
- 3 relay mirrors
- 198 slices/180°
- 3,500 MVPS
- > 3 GB/sec bandwidth

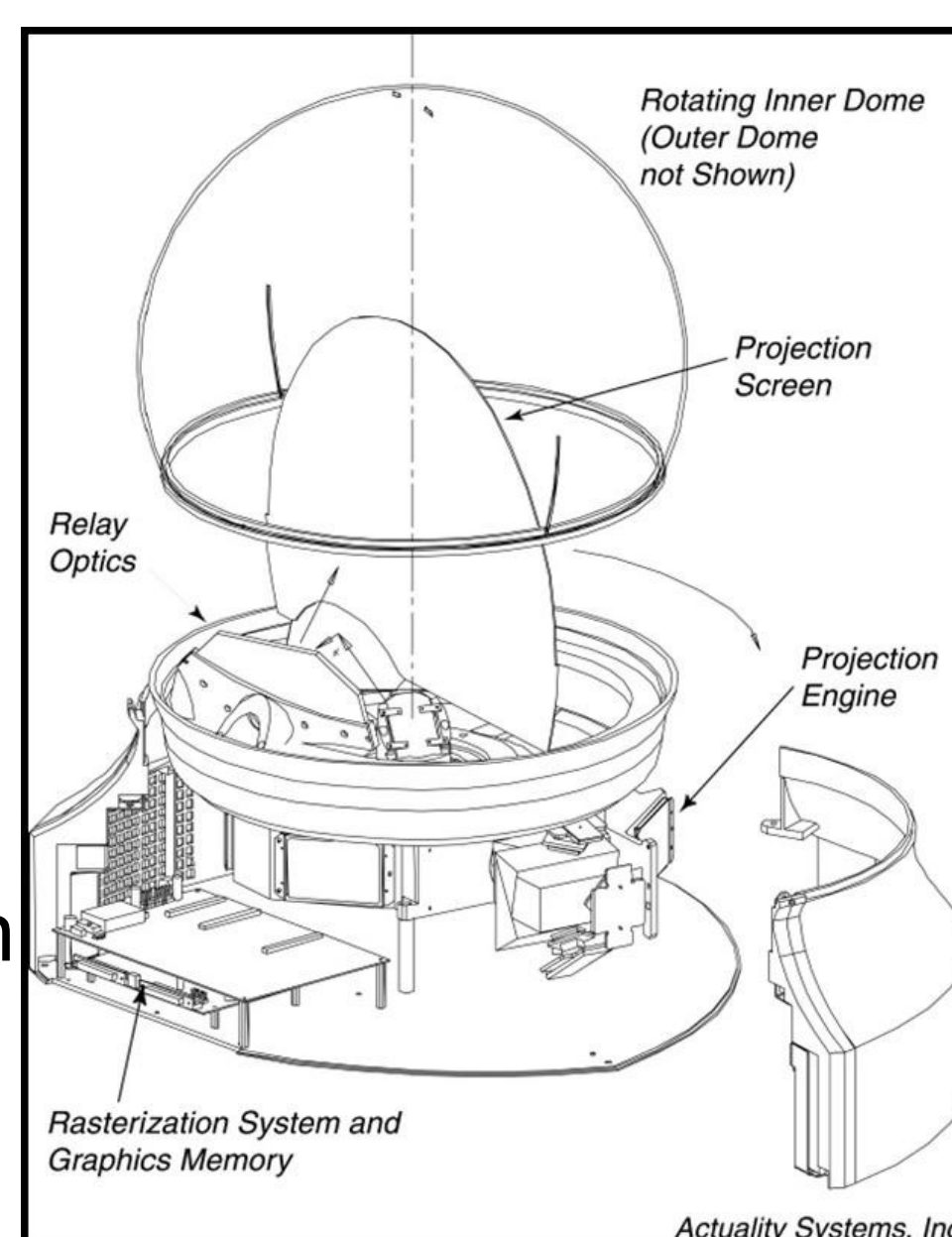


Fig 1. Perspecta Spatial 3D Display. The system generates volume-filling imagery with a full 360-degree field of view. The system projects 198 2D patterns onto an optimized diffuser for every half rotation through a relay mirror system. The screen rotates at or above 900 rpm and sweeps the entire volume twice for every complete revolution, resulting in a visual refresh rate of 30 Hz. The bandwidth is more than 3GB/sec.

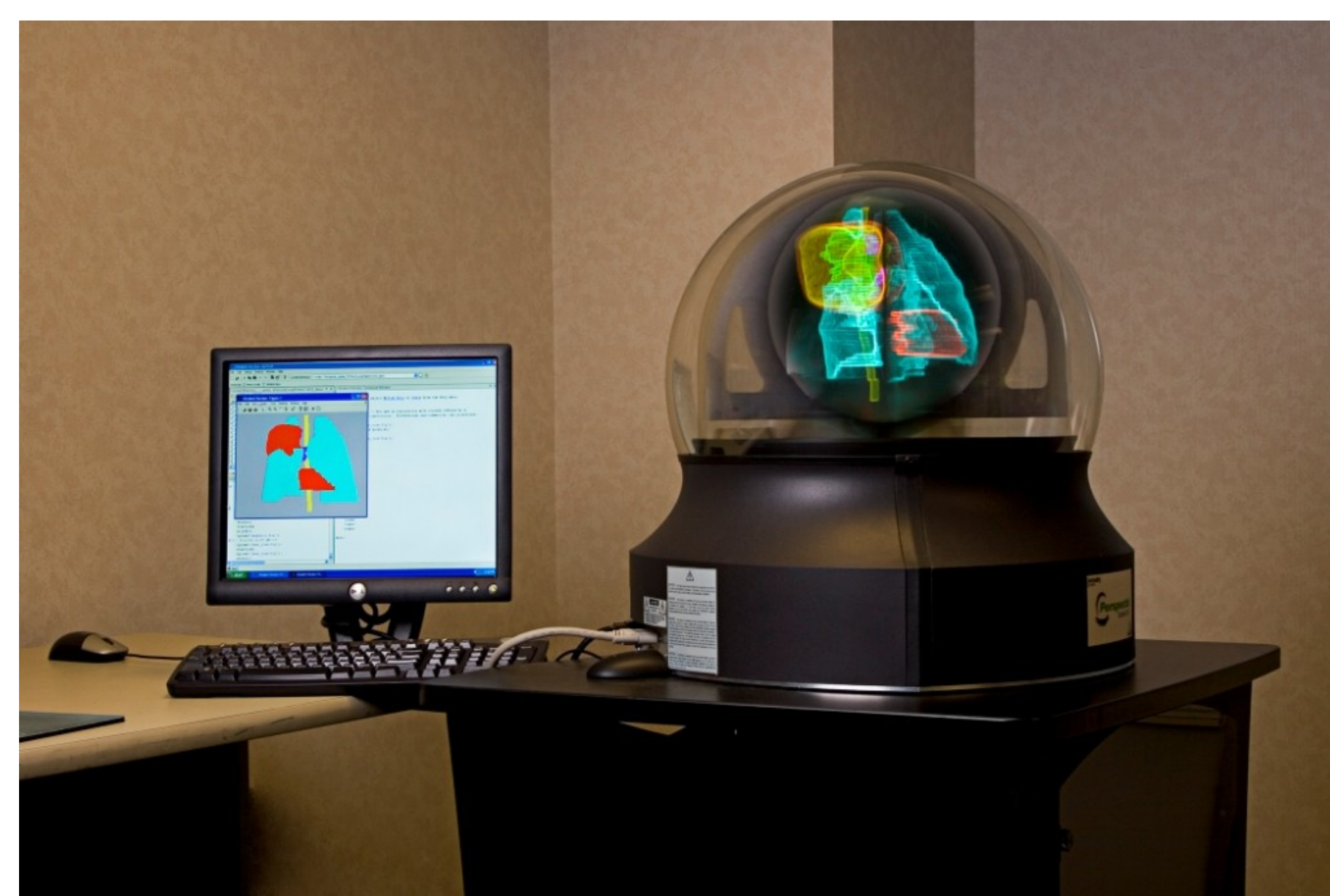


Fig. 2 Corresponding images displayed on a flat surface computer screen (left) and on the Perspecta system (right). The images are processed using an in-house software before transferred to Perspecta. Images from Pinnacle treatment planning system (Philips Medical Systems) can also be synchronized and displayed on Perspecta.

### Are Perspecta images just pretty pictures or are they clinically useful?

We performed the following to answer this question:

4. Conduct planning exercise to compare plans produced by Pinnacle or Perspect
5. Fourteen previously treated plans were replanned (12 brain, 1 lung, 1 breast) at 3 institutions
6. Each patient was planned by two different people, one used only Pinnacle and the other used Perspecta in addition.
7. Plan quality was then reviewed by 4 physicians who were blinded to the planning device used
8. Dose cloud, DVH, EUD were available during physician review

### Holographic Image Guided Beam Placement (HIGBP)

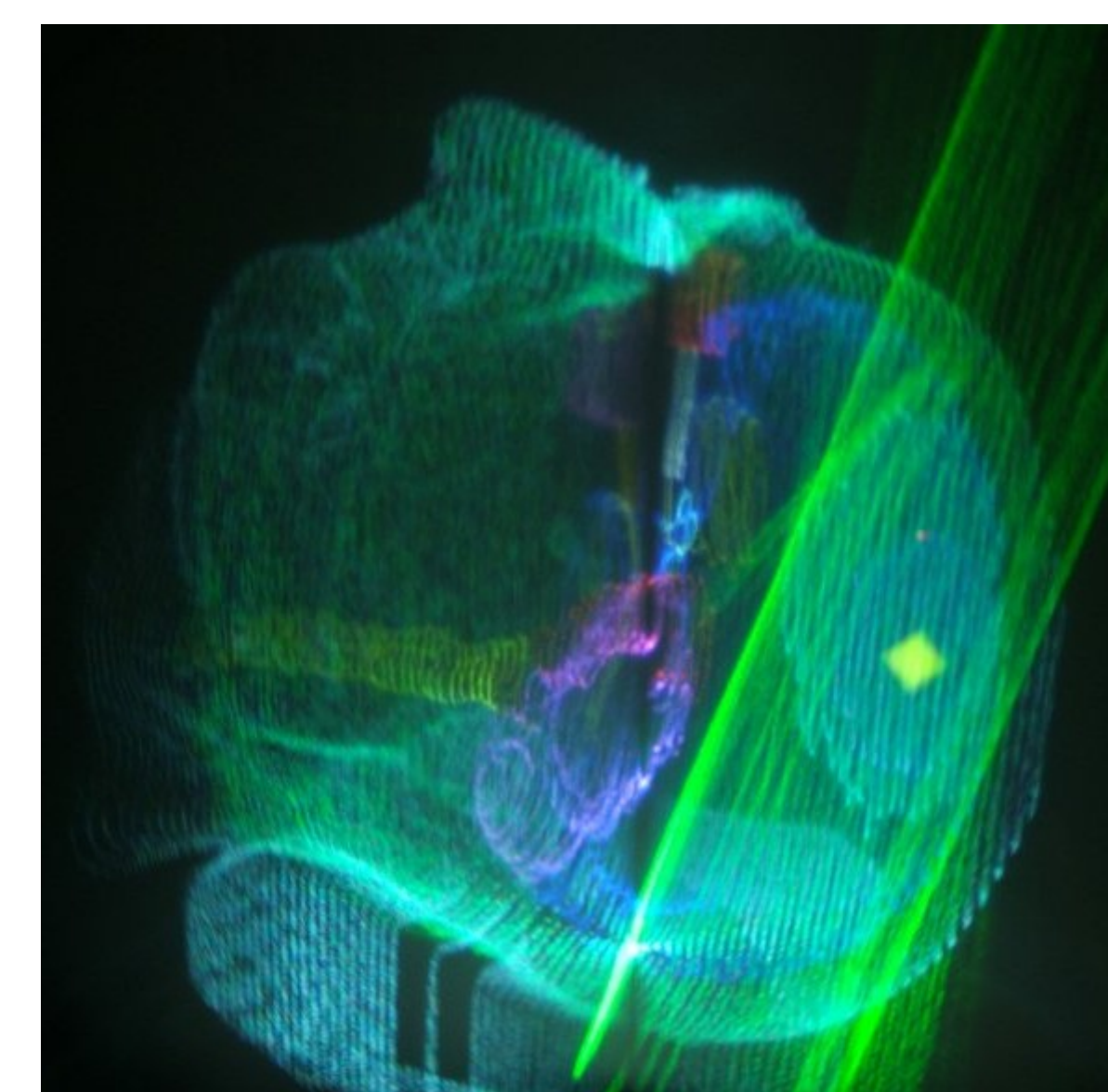


Fig. 3. Holographic image guided beam placement for a brain cancer patient. Internal structures are visible in this patient. Isocenter (yellow cube) can be placed with a 3D mouse. The figure shows an posterior oblique field being placed; the beam orientation can be adjusted interactively using the same 3D mouse.

### Holographic Image Guided Plan Evaluation (HIGPE)

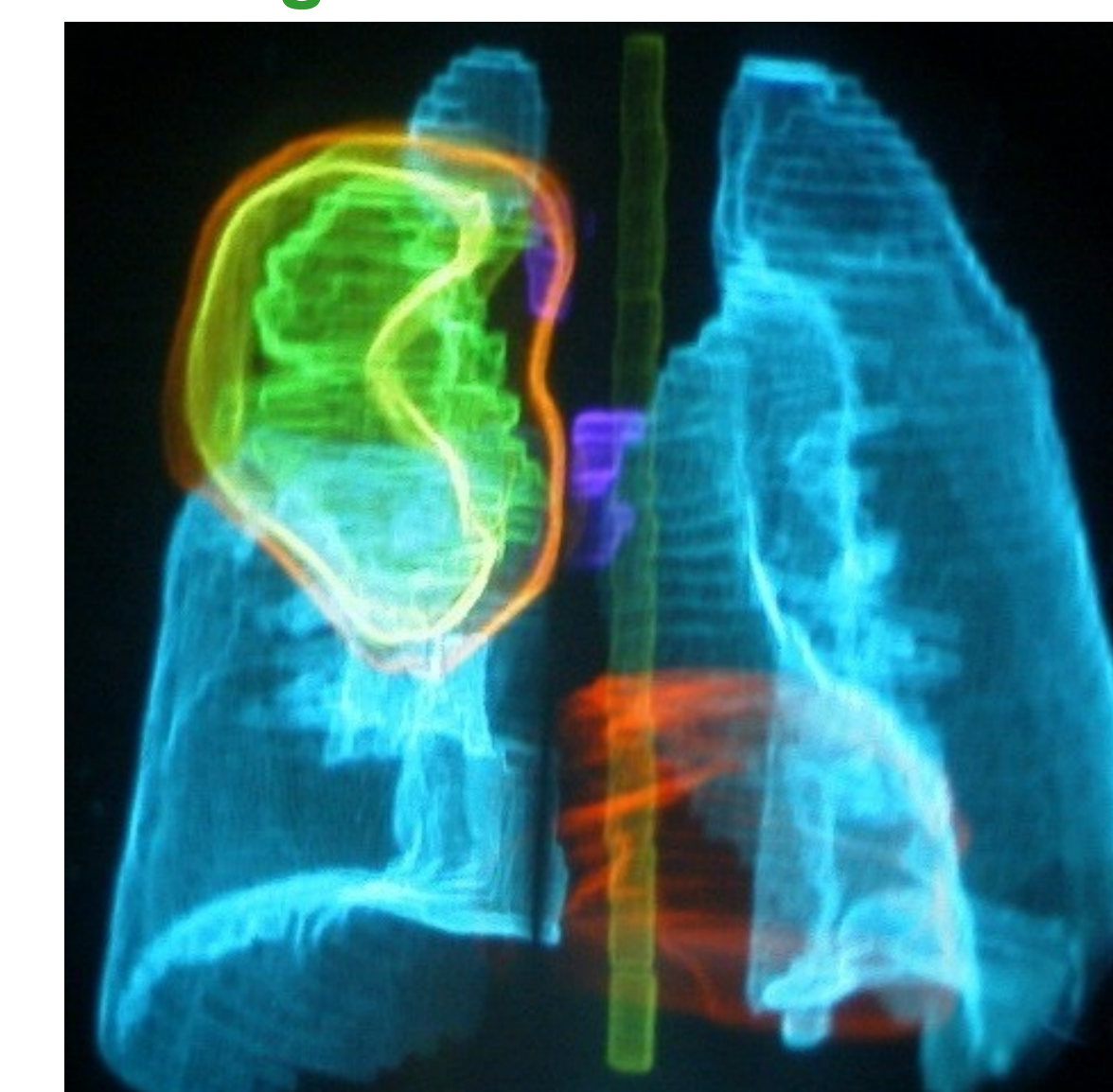


Fig. 4. Holographic image guided plan evaluation for a lung cancer patient. Isodose surface representing the prescription dose (orange) is encloses the target volume (green). A higher dose surface (yellow) only partially covers the target. This display allows easy visualization of the 3D relationships of dose distributions and critical structures.

**Results:** Four physicians evaluated treatment plans generated either with or without the use of Perspecta display. The table below shows that Perspecta produced better plans in 6 out of 12 brain cases. Perspecta also produced better lung and breast plans in 2 patients. All reviewers felt that the Perspecta device allowed better appreciation of 3D relationships of anatomical and dose data than images from a flat screen display. The location and size of over- or under-dosed regions were also easier to identify on Perspecta.

Tumor Site	Perspecta(+)	Pinnacle(+)	Equivalent
Brain	6	2	4
Lung	1	--	--
Breast	1	--	--
Total	8	2	4

Perspecta(+):  
Perspecta display produces better plan

Pinnacle(+):  
Pinnacle system produces better plan

Equivalent:  
Perspecta/Pinnacle produce similar quality plans

**Conclusions:** We have successfully completed a preliminary study to evaluate the usefulness of a holographic display device in radiotherapy treatment planning. The volumetric display provides users complex, 3D information in a more efficient and natural way. The preliminary data demonstrate that Perspecta has significant potential to achieve better plan quality in radiation therapy treatment planning. These preliminary results warrant an expanded study to include a larger number of patients for a variety of disease sites.

**Conflict of Interest Statement:** Actuality Systems Inc. provided the 3D display used in this study.