

## Purpose:

- The gold standard method for generating internal target volumes (ITVs) requires contouring of gross tumor volumes (GTVs) in up to 10 phases of a respiratory cycle follow-up with Boolean-OR operation.
- Different clinics have chosen several different methods to improve work-flow efficiency
- In this study, we attempt to see whether standard ITV to PTV margins are comparable to the gold standard 10 phase SBRT benchmark.

## Materials and Methods:

- In this retrospective study, 4DCT data from 17 lower lobe lung SBRT patients were analyzed.
- A single physician contoured GTVs on all the 10 phases of a 4DCT scan, free breathing (FB) scan and ITVs on an average intensity projection (AIP), and maximum intensity projection (MIP) scan.
- A gold standard ITV was created by performing Boolean-OR operation on 10 GTVs from the phased binned image set.
- We also considered an augmented phase FB (Aug-FB) set where the ITV was generated by using Boolean-OR operation among the contoured FB GTV scan, the maximum inhale [0%] and minimum phase [50%] of the breathing cycle.
- While the gold standard 10 phase, MIP, AIP, Aug-FB ITVs used a 5-mm isotropic margin in 3D space, FB-GTV used a 10-mm margin in the superior-inferior direction and 5-mm radially.
- A Dice statistical analysis was performed to see how the four alternate PTV's compared to the standard 10 phase technique.

## Statistical methods:

**PTV ratio:**  $R_x = \frac{PTV_x}{PTV_{10\ phase}}$

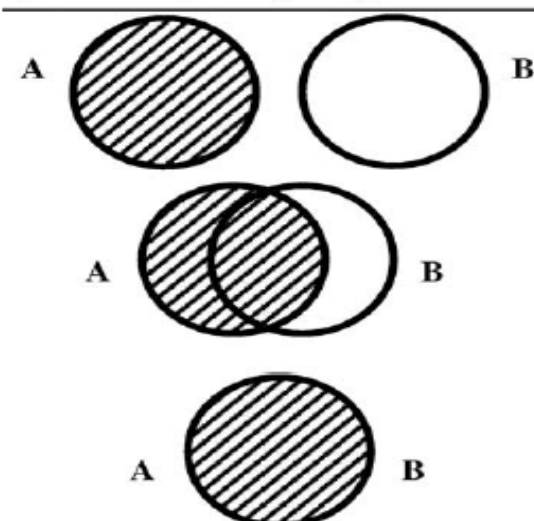
-Where x represents either FB, FB-Aug, AIP or MIP target delineation.

**Dice similarity coefficient:**

$$DSC = \frac{2 |V_A \cap V_B|}{|V_A \cup V_B|}$$

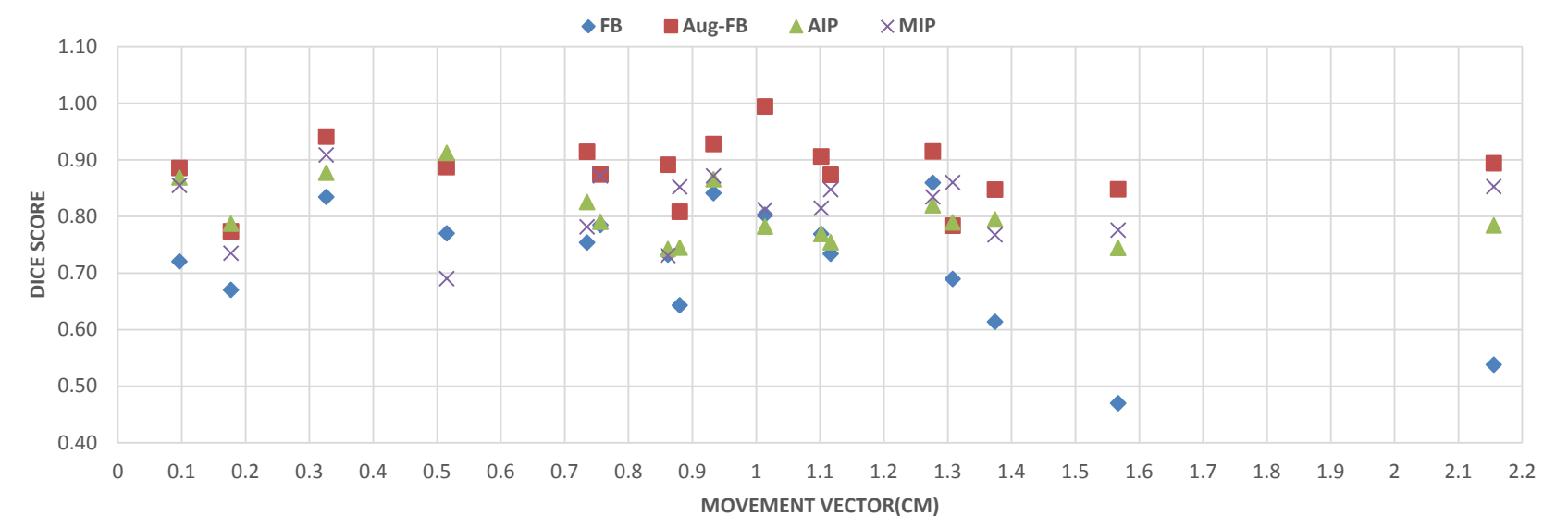
-Where  $V_A = PTV_{10\ phase}$  and  $V_B = PTV_x$ .

Spatial Overlap of Target Segments A and B

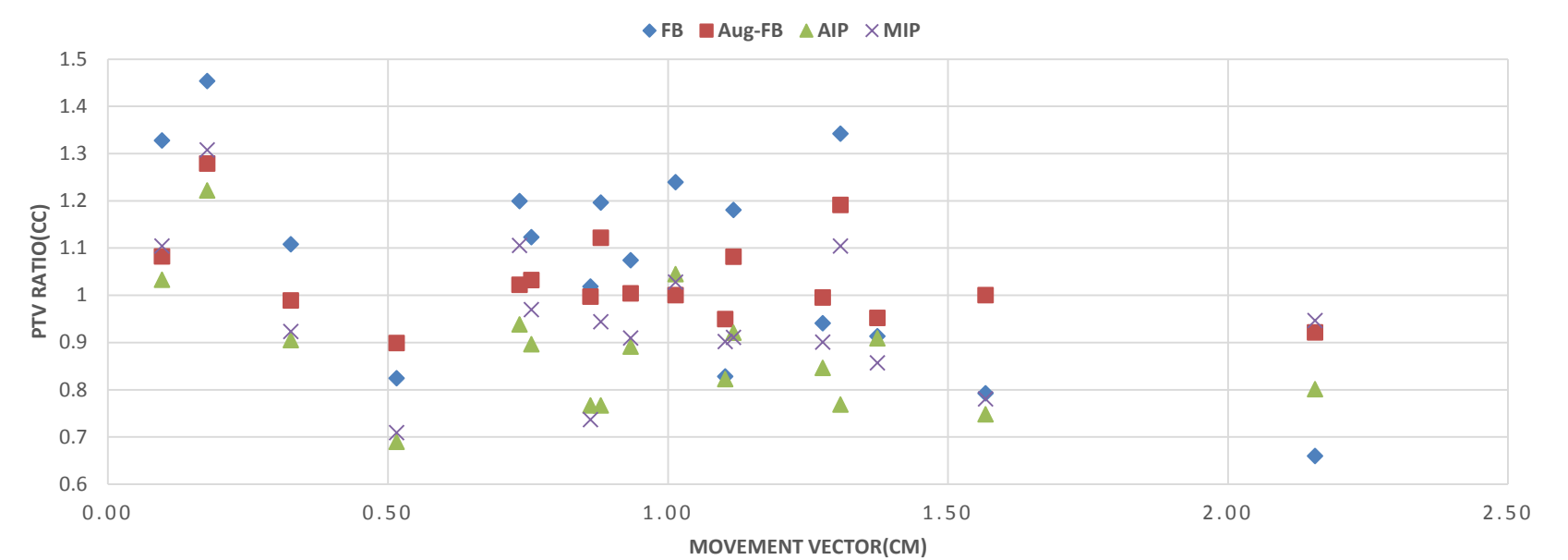


## Results:

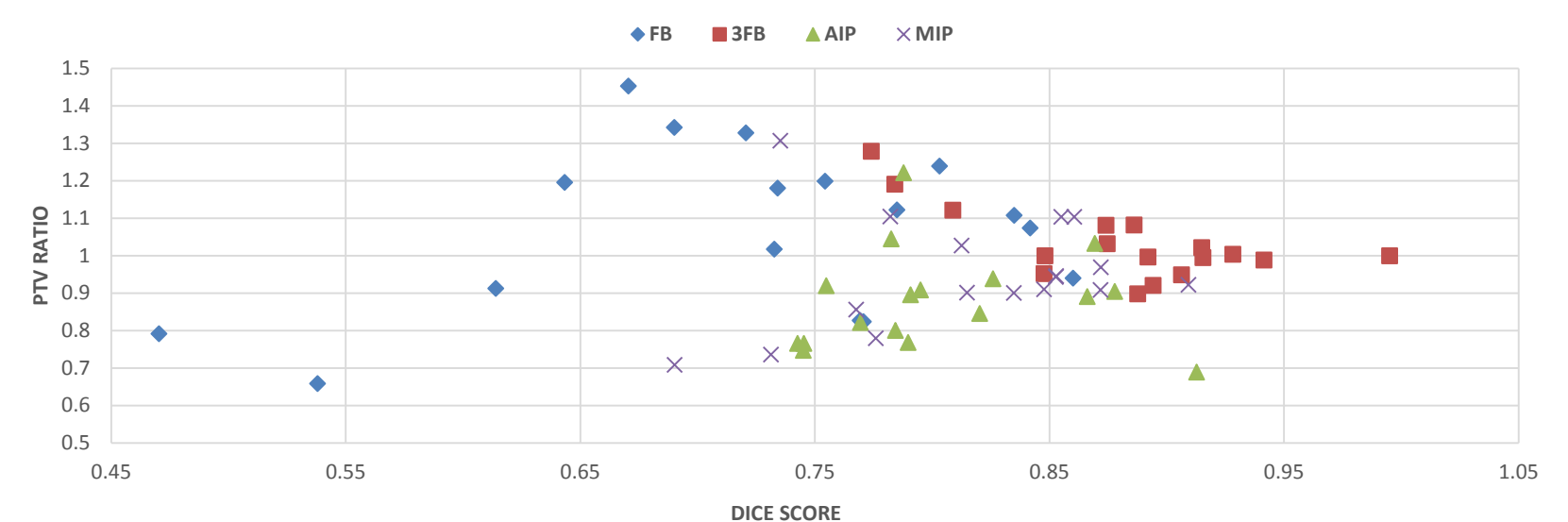
**Figure I.** The relationship between Dice score and movement vector where the Aug-FB PTV has the highest Dice score for 13 of 17 patients.



**Figure II.** Relationship between the PTV ratio and three-dimensional movement vector where Aug-FB PTV is most consistently aligned close to a 1:1 ratio regardless of motion



**Figure III.** Relationship between PTV ratio and Dice score showing the Aug-FB PTV stays within the PTV ratio 82% of the time



## Conclusions:

- The range of tumor motion determines the accuracy of the defined PTV, for all 4 methods.
- Compared to the gold standard PTV, the Augmented phase free breathing produced the best spatial conformity, followed by the MIP
- A standard margin around a free breathing GTV is not adequate for accurate tumor dose delivery