

## INTRODUCTION

- Previous in-vitro evaluation of the effect of pulse duration on popcorn laser lithotripsy has demonstrated that short pulse (SP) mode results in better sub-millimeter fragmentation when compared to long pulse (LP) mode.
- However, the efficacy of Moses Technology, especially Moses Distance (MD) mode which is optimized for lithotripsy at distance from stone, has not been studied.

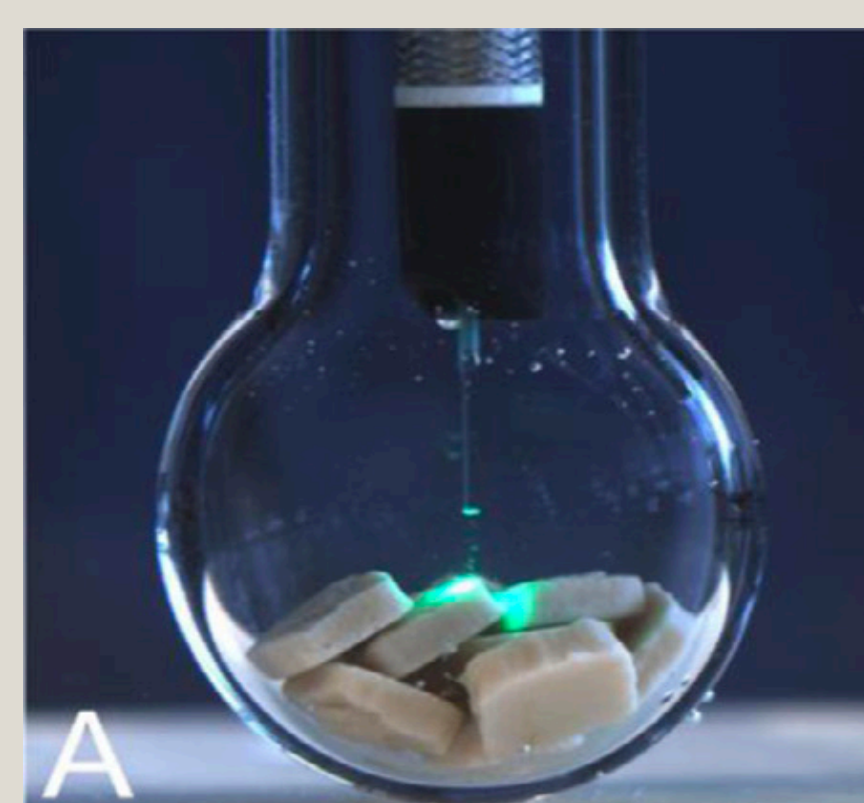
## OBJECTIVES

Assess the effect of pulse modulation with Moses Technology™ on popcorn laser lithotripsy outcomes in an *in vitro* model based on:

- Fragment size distribution.
- Amount of stone mass lost in fluid (initial mass - final dry mass of all sievable fragments).
- Laser-to-stone strike rate using high speed imaging.

## METHODS

- Experiments were conducted using 10 (3x3x1mm) pre-hydrated BegoStones (15:3) in a 11 mm glass test tube (Figure A). A 230 µm core (Moses) laser fiber was introduced through a digital ureteroscope and held in place 2mm above the stones with a 3D automated positioner.
- 20W (1Jx20Hz; 0.5Jx40Hz) and 40W (1Jx40Hz; 0.5Jx80Hz) settings using SP and MD modes were tested (P120 Moses, Lumenis). The laser was fired in 15 seconds intervals. Total energy delivered was 4.8kJ, equivalent to 2 and 4 minutes for the 40W and 20W settings, respectively.
- Post experiment fragment size distribution was determined using micro sieves (0.25, 0.5, 1.0, and 2.0 mm). Five trials were performed for each experiment. Two sample t-test was used to compare cohort means.
- For 1Jx20Hz and 0.5Jx80Hz settings, laser to stone strike rate was captured at 10,000 FPS (frames per second) by positioning a high-speed camera in front of the model (Figure B). Strike rate was calculated, by dividing the number of strikes occurring during a 1 second video clip by the frequency of that setting.
- Strikes were categorized as: (1) Direct - a visual plume of dust ejected from stone while in contact with the fiber-tip; (2) Indirect - a visual plume of dust ejected from stone with distance between stone and fiber-tip



## RESULTS

- The greatest difference in fragment size distribution was observed when comparing SP and MD mode at 1Jx20Hz, where MD mode produced 29% of fragments that were ≥2mm vs. SP which resulted in 55% of fragments ≥ 2mm in size (p=0.003) (Fig. 1A).
- For the 20W popcorn setting, using MD mode with 1Jx20Hz, resulted in the most mass lost in fluid compared to all other 20W settings and modes (Fig. 1A).
- Video analysis (Fig. 1B) demonstrated that most laser-to-stone strikes were indirect strikes rather than direct strikes. Specifically, for the 20W setting of 1Jx20Hz nearly all strikes (96% of total strikes) were indirect when using MD mode, compared to 61% indirect strikes when using SP (p=0.059).

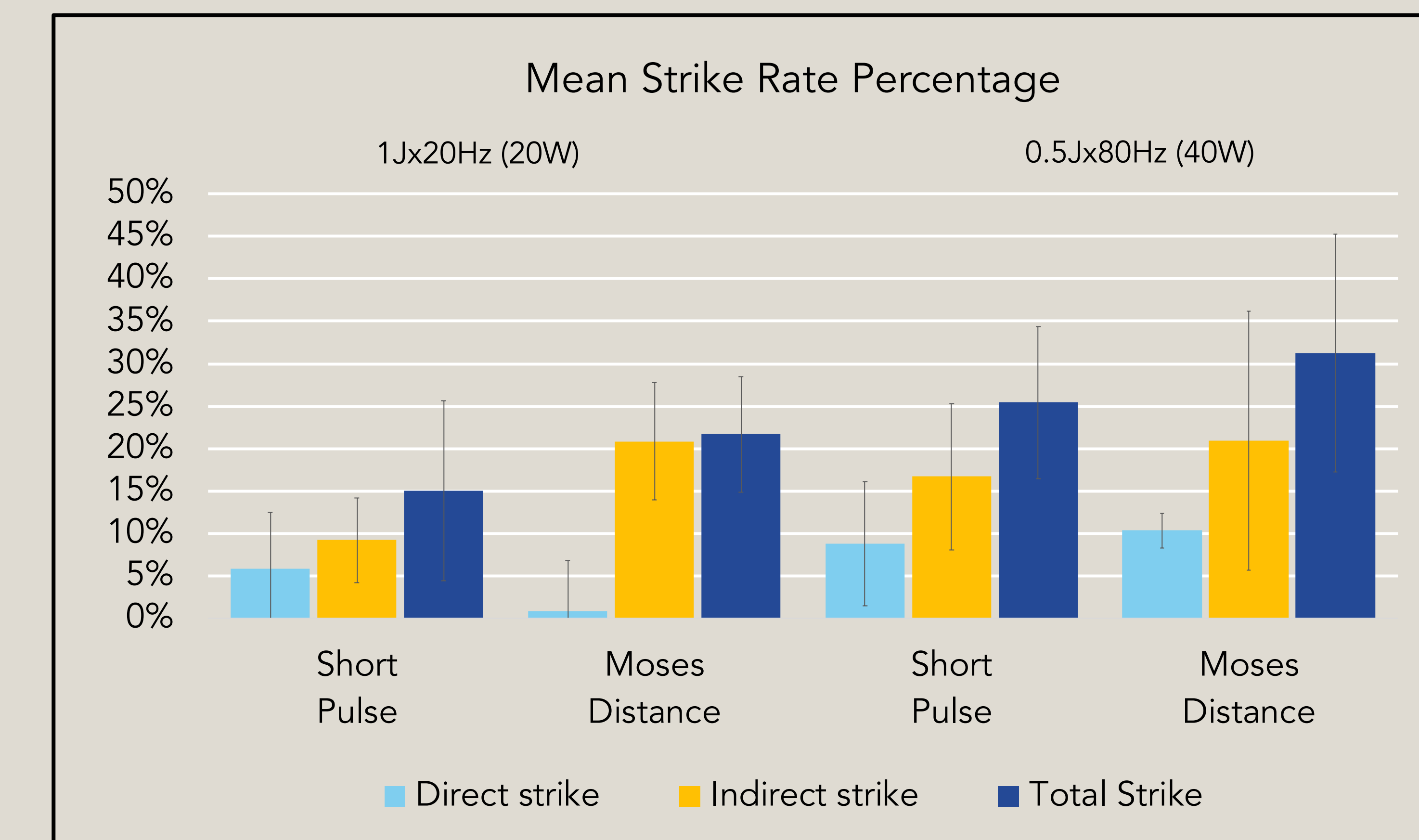
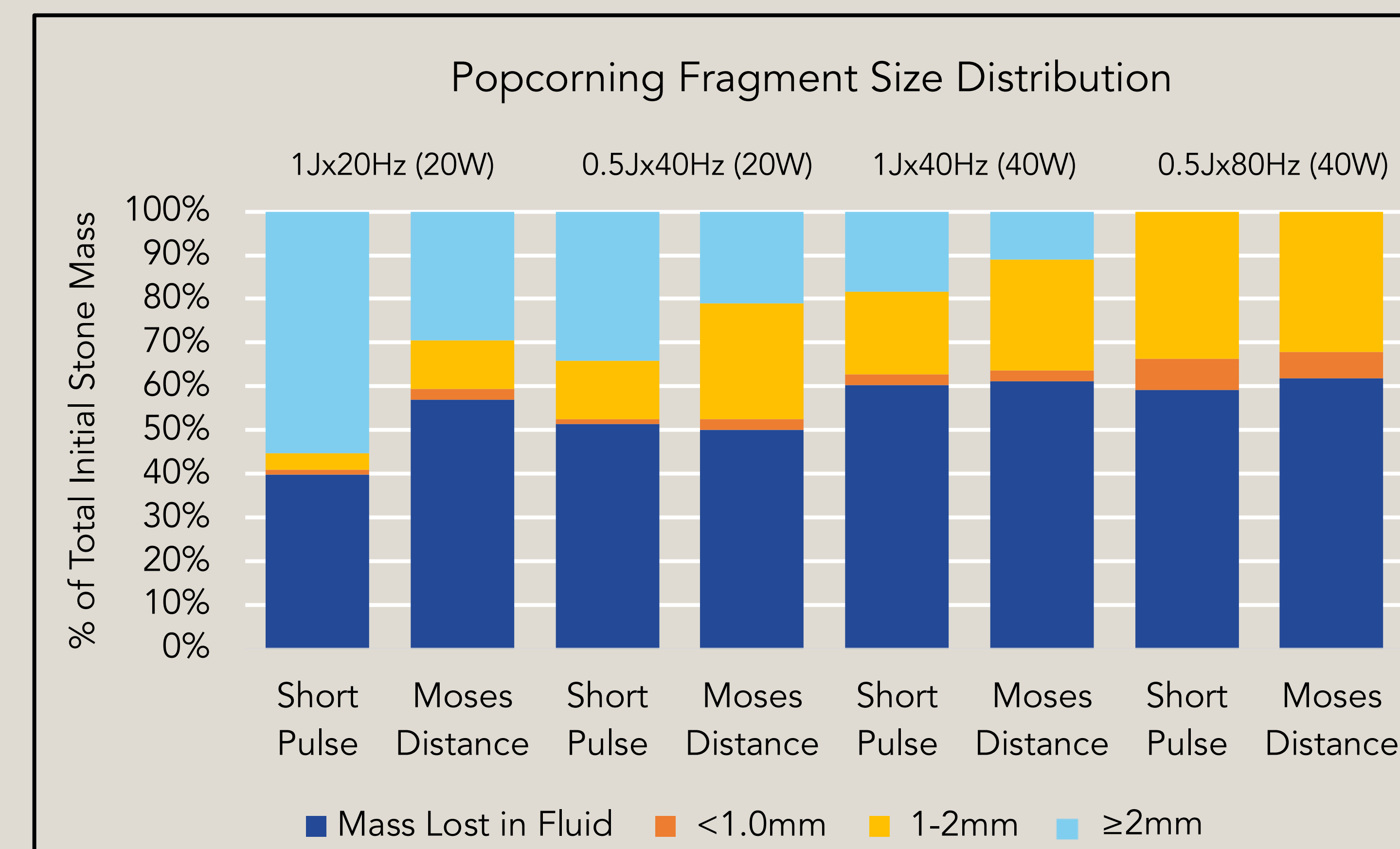


Figure 1: (A) Fragment size distribution for 20W and 40W settings following popcorn laser lithotripsy in an 11mm in-vitro calyceal model. (B) Laser fragmentation strike percentage during popcorn laser lithotripsy for 20W and 40W settings using SP and MD mode.

## CONCLUSIONS

MD mode was better than SP in creating less fragments ≥2 mm for popcorn laser lithotripsy.



MD 1Jx20Hz is an attractive lower power setting, with good efficacy for popcorn laser lithotripsy.



The indirect strike pattern of MD mode could be a protective factor for fiber tip degradation and needs further study.

