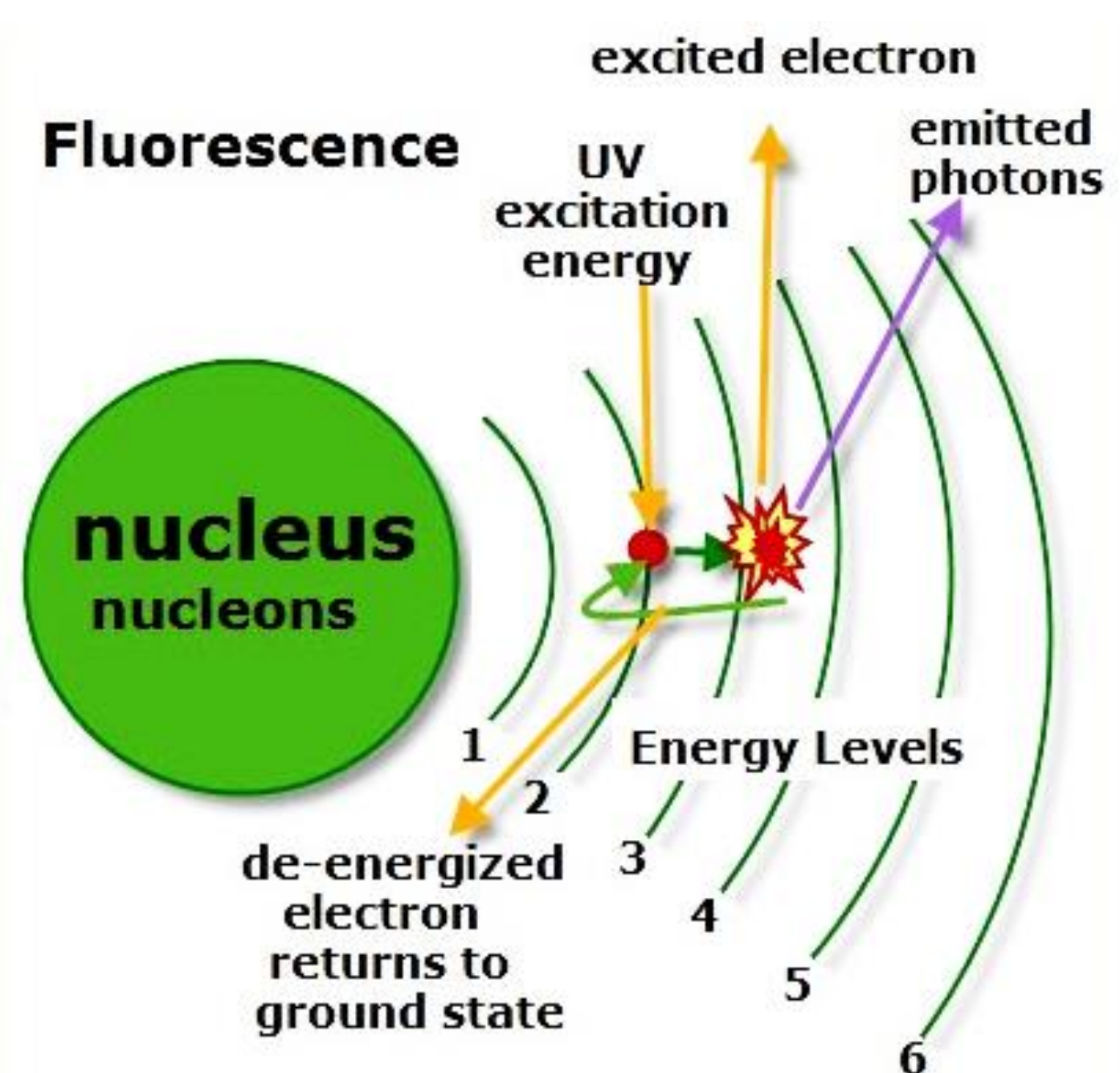


## Abstract

- A light field microscope is capable of capturing 3D information within a single shot, but it loses lateral resolution. [1]
- A combination of a fluorescence microscope with a diffuser is a proposed solution with the goal of obtaining better 3D resolution than a light field microscope equipped with a microlens array. [2]
- To demonstrate this idea, Zemax, Python, and Matlab are combined to compare the simulation results of different diffusers and microlens arrays.
- With this research, fluorescence beads are investigated, then experiments on living organisms, such as zebrafish are conducted.
- The goal is to eventually utilize this technique in improving the diagnosis and treatment of human diseases

## Why Fluorescence?



- Fluorescent materials absorb light and UV radiation (i.e. x-rays, UV light)
- Emits a longer wavelength than the originally absorbed one.
- A longer wavelength causes less scattering, allowing deeper penetration inside the brain.

Figure 1: The excited electrons jump from level 2 to level 3. The higher the electron goes more energy is needed. Later, the electrons on level 3 loses photons of energy and reverts back to its original ground state. [3]

## Comparison using Zemax

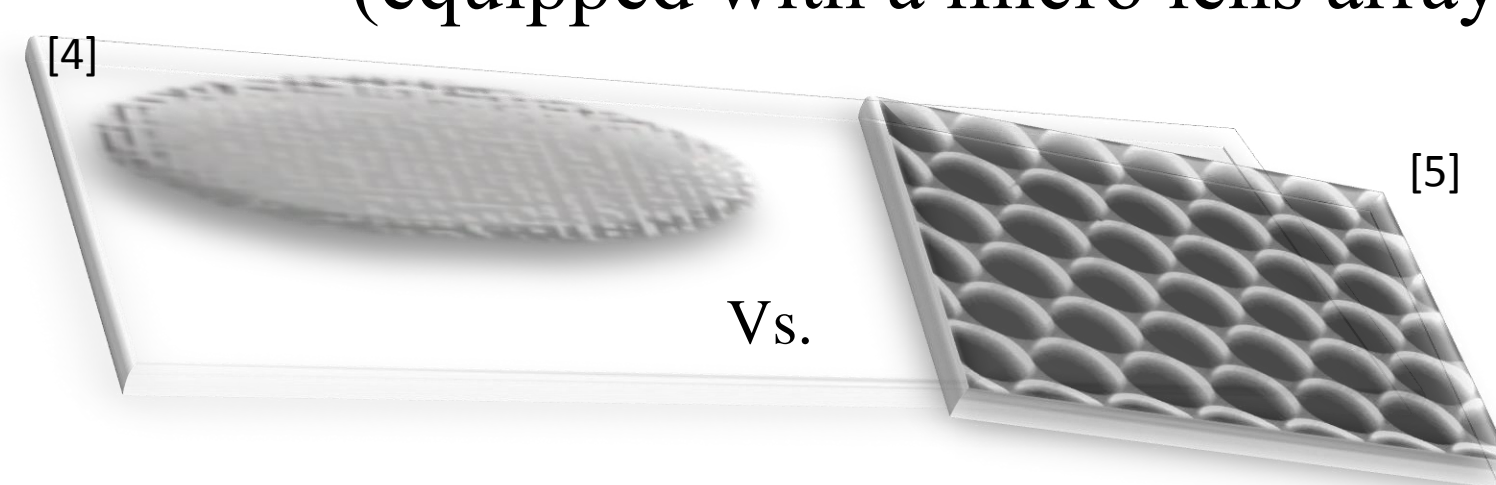
Software to replicate a live scenario optical design simulation

Diffuser – Random distribution of concave and convex regions

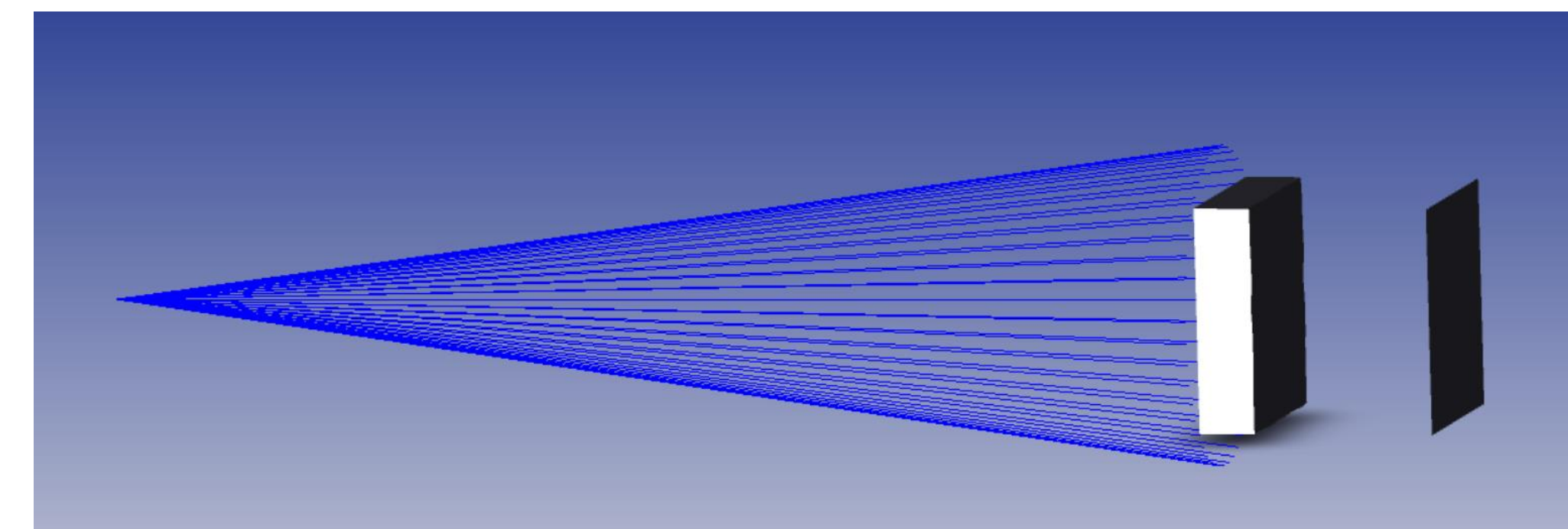
Micro Lens Array – Multiple small lenses

Fluorescence Microscope with a Diffuser  
Vs.

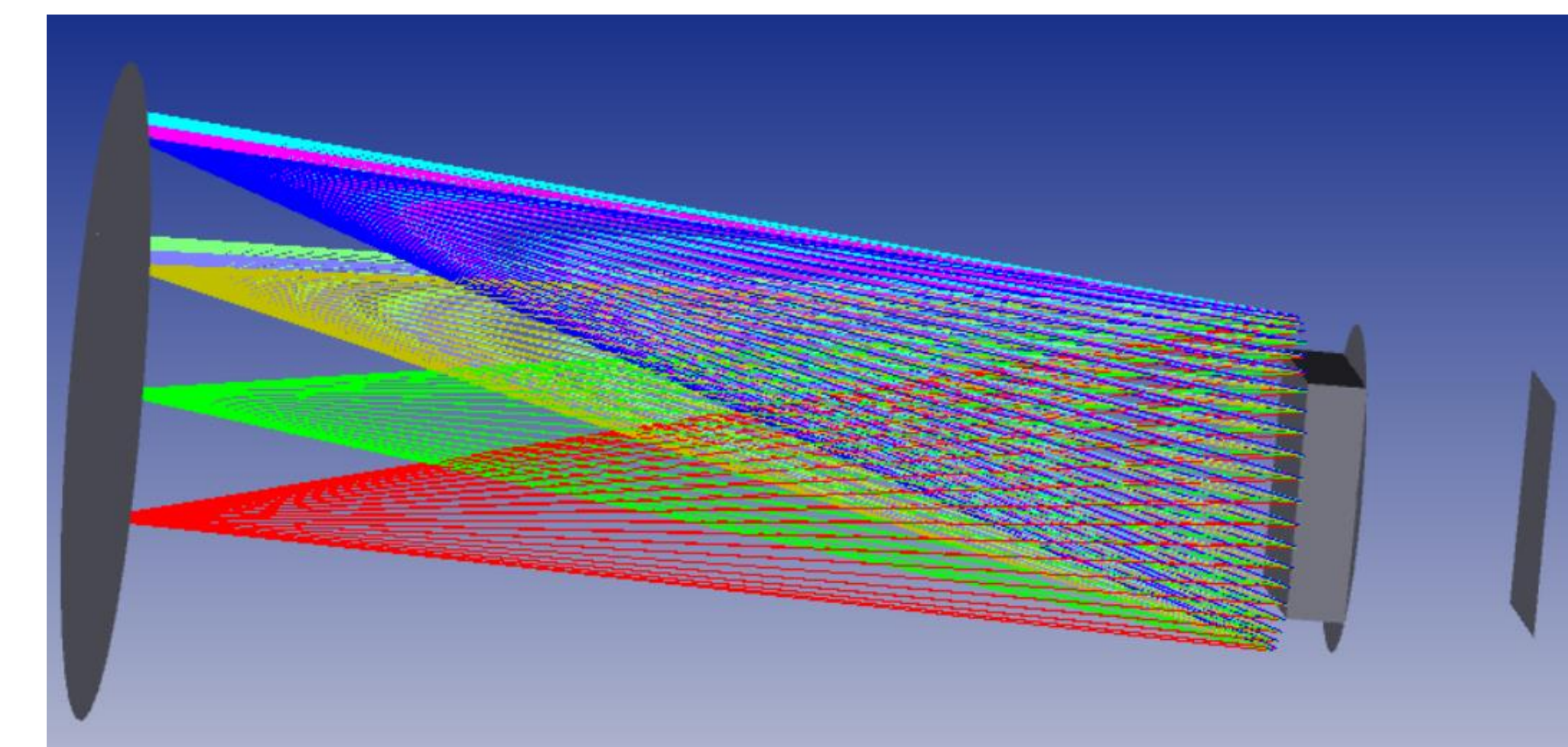
Fluorescence Light Field Microscope  
(equipped with a micro lens array)



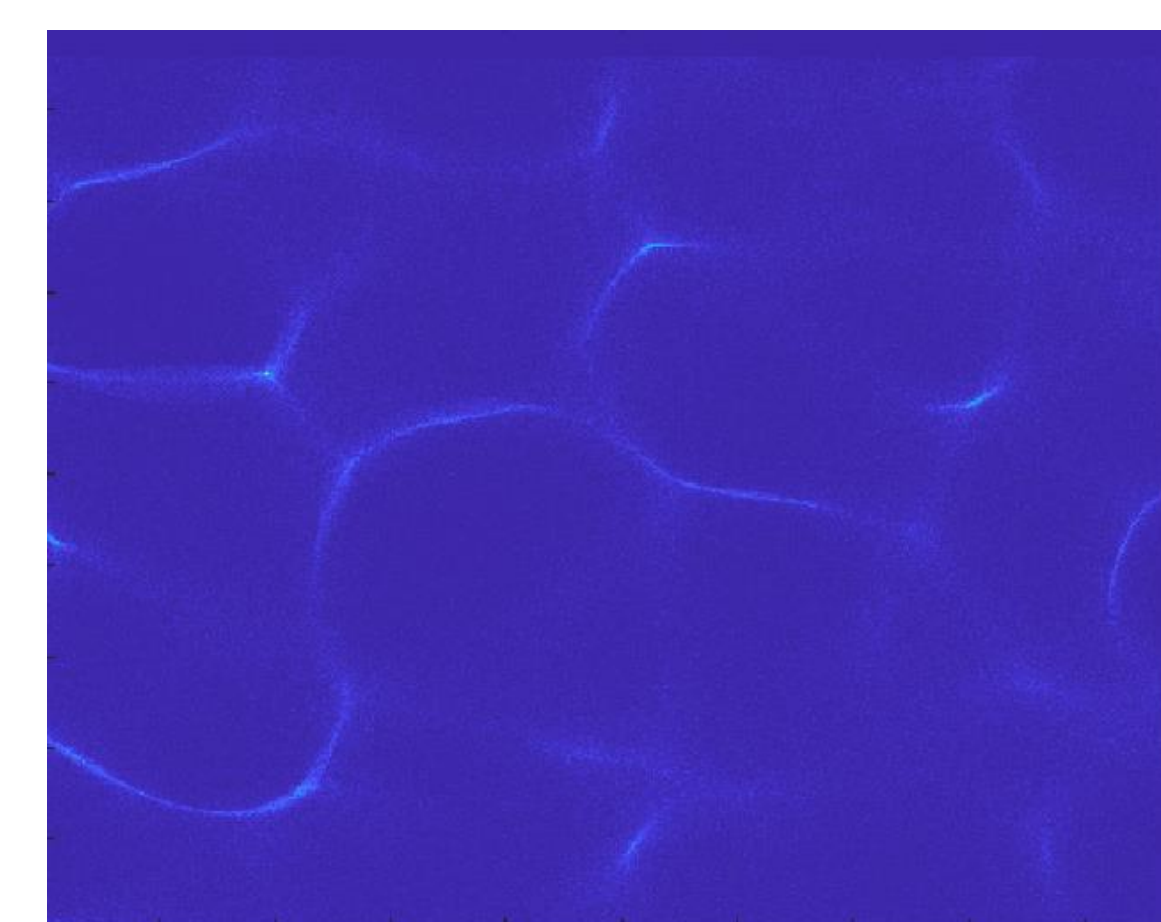
## Diffuser



1 point source  
A diffuser  
A sensor



8 point source  
(only difference from previous setup)



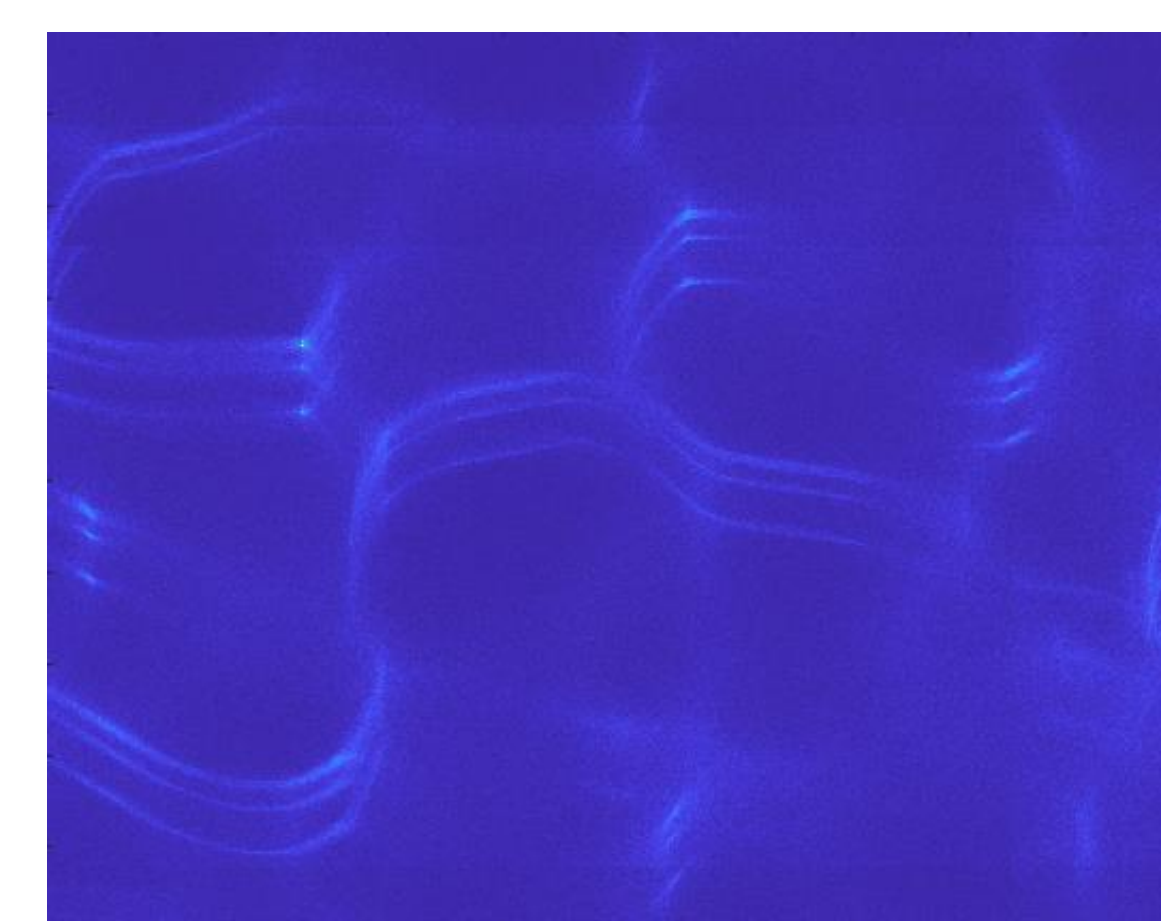
### Caustic

- Each point represents a pixel on a camera
- Brighter the light, the more intensity the pixel has
- One point source = Caustic (PSF)

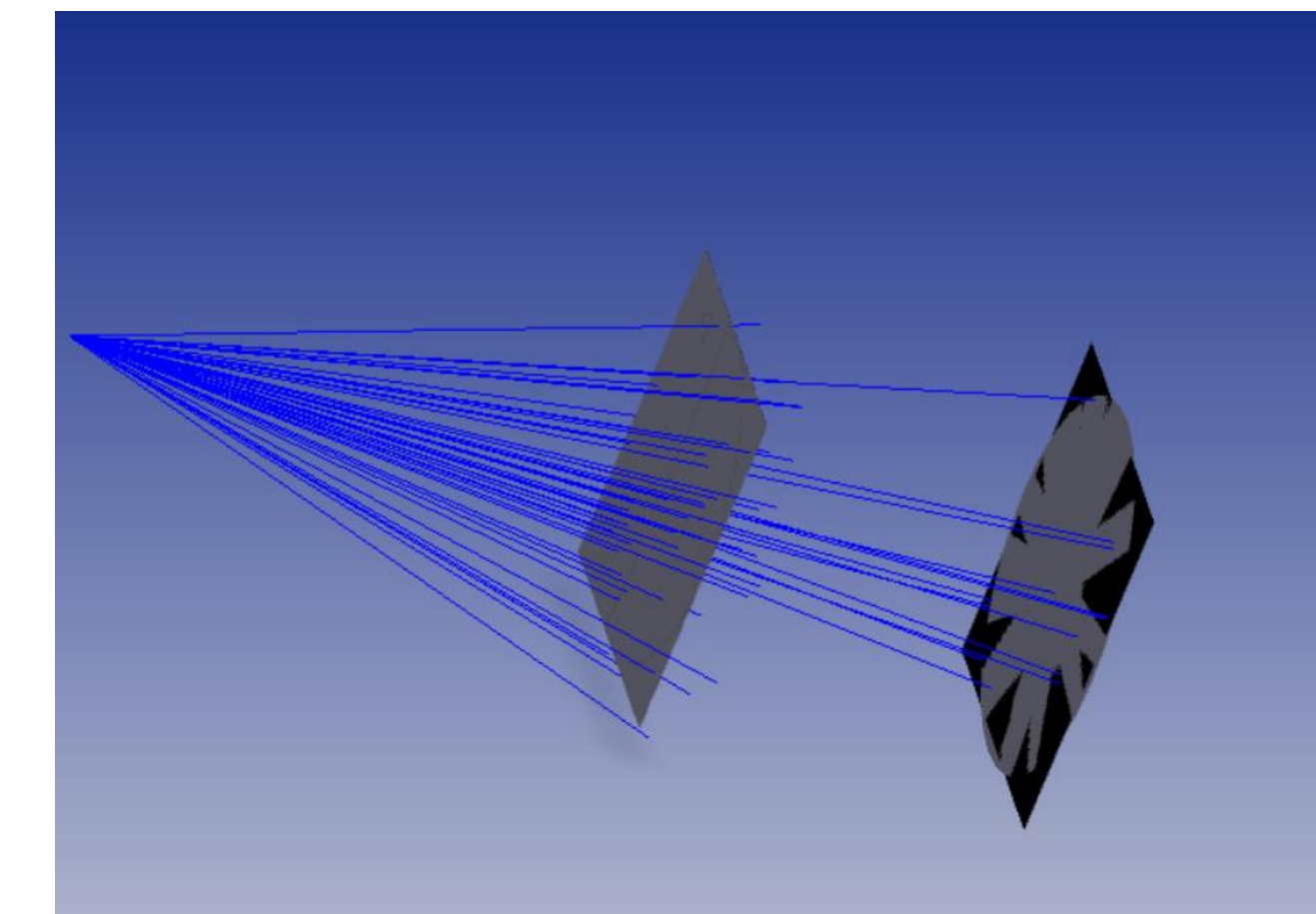


### Blur Data

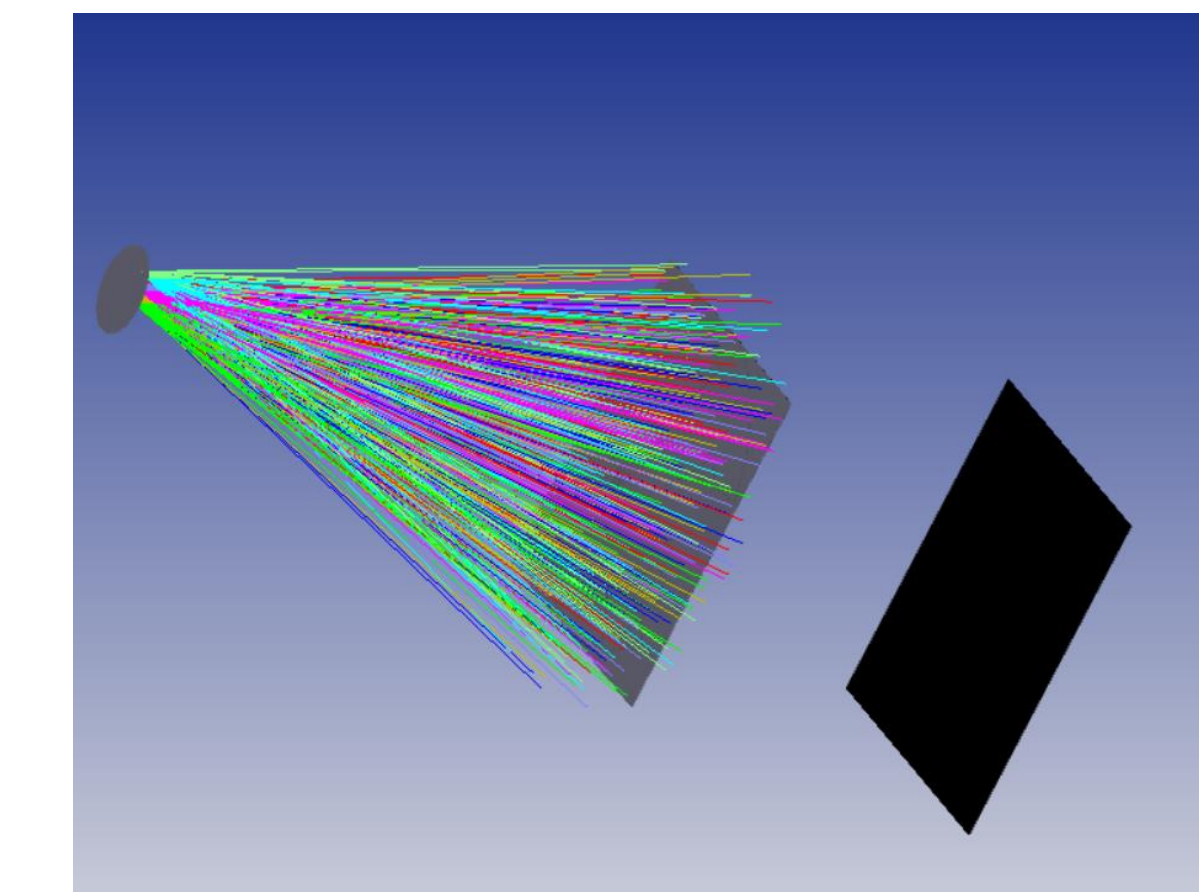
- Superimposed the Caustic
- Every caustic on the Blur corresponds to a light source on the scene
- More than 1 point source = Blur Image



## MicroLens Array



1 point source  
A microlens array  
A sensor

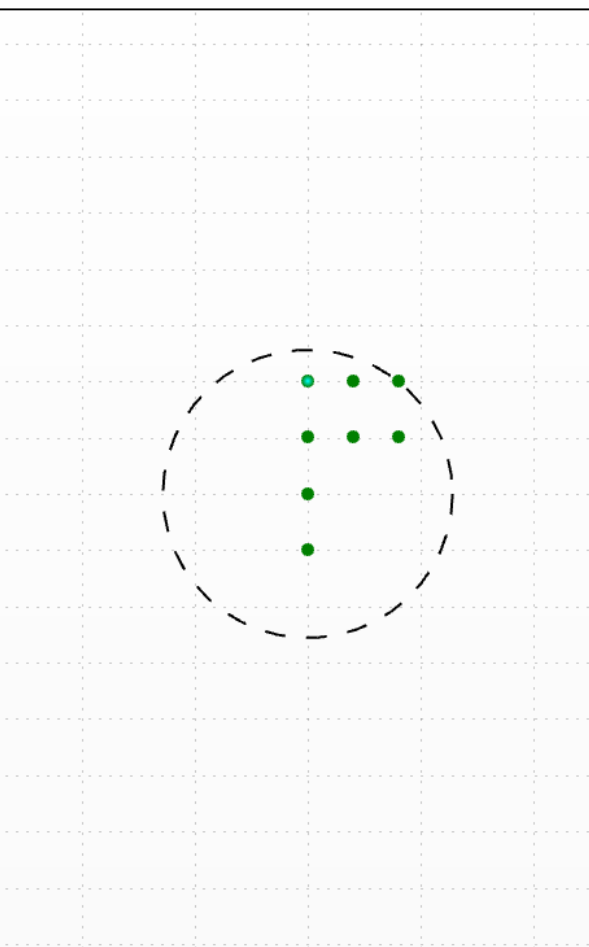


8 point source  
(only difference from previous setup)

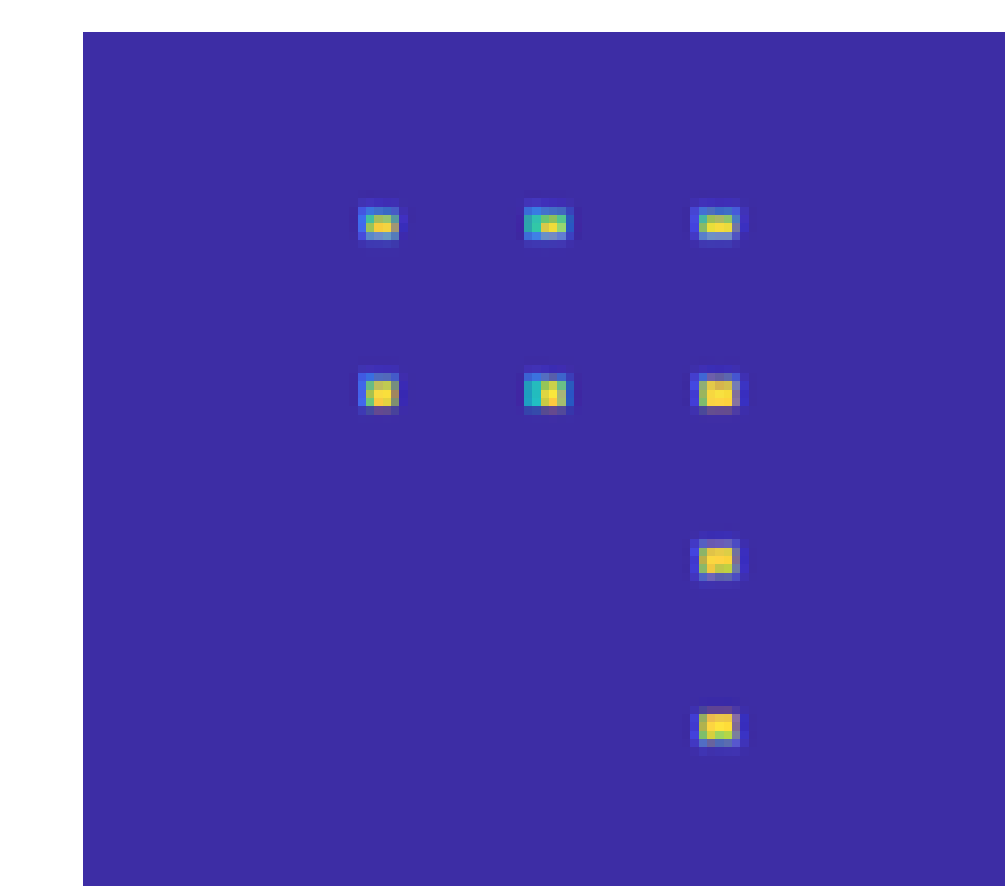
## Results



Diffuser Result



Sensor Data



Microlens Array Results

## Conclusion

From the above comparison, we conclude that using a diffuser relieves the field of view constraint on the optical system. In the situation of having a huge field of view the diffuser would give us a better reconstruction than a microlens array. Thus, concluding that a microlens array would work best for this instant.

## References

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- [3] VanCleave, Janice. "Fluorescence vs. Phosphorescence." *VanCleave's Science Fun*, 13 Mar. 2012, scienceprojectideasforkids.com/2011/fluorescence-vs-phosphorescence/
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### Contact Information

Shan Rafique  
shanRafique98@gmail.com  
(209) 224-1960

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