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THE CONSEQUENCES OF CELL GEOMETRY AND GAS MIXTURES
ON PLASMA DISPLAY PANEL PERFORMANCE*

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AGENDA

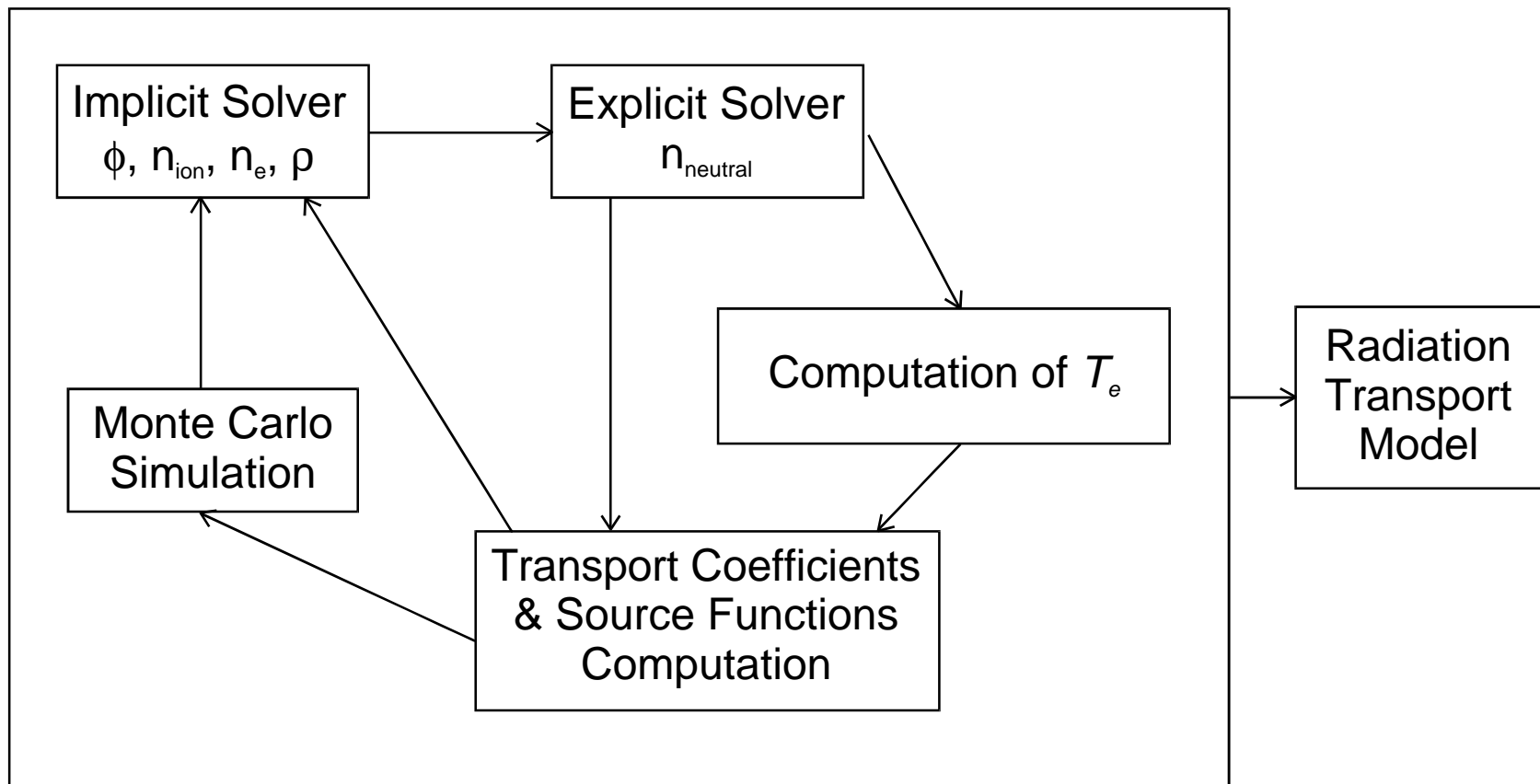
- Introduction
- Description of the Plasma Display Panel (PDP) model
- Simulation of a coplanar-electrode PDP cell
- Effect of He/Ne ratio and dielectric spacing
- Conclusions

INTRODUCTION

- Computational models can be very useful for optimizing PDP performance as a function of gas composition, operating conditions, materials and cell design.
- We have developed a 2-dimensional hybrid PDP simulation for this purpose.
- The model has been used to investigate the operation of a coplanar-electrode PDP cell with He/Ne/Xe gas mixture.
- Results indicate that gas mixtures with higher Ne concentrations produce more visible light photons with similar efficiency.
- PDP characteristics are very sensitive to dielectric spacing, and there is an optimum spacing where light emission and light generation efficiency are both high.
- In this talk, I will describe the model, use computational results to explain the operation of the PDP cell and present results from parametric studies.

THE PLASMA DISPLAY PANEL MODEL

- The PDP simulation code consists of a number of modules in which different physical quantities are computed using the appropriate computational techniques.

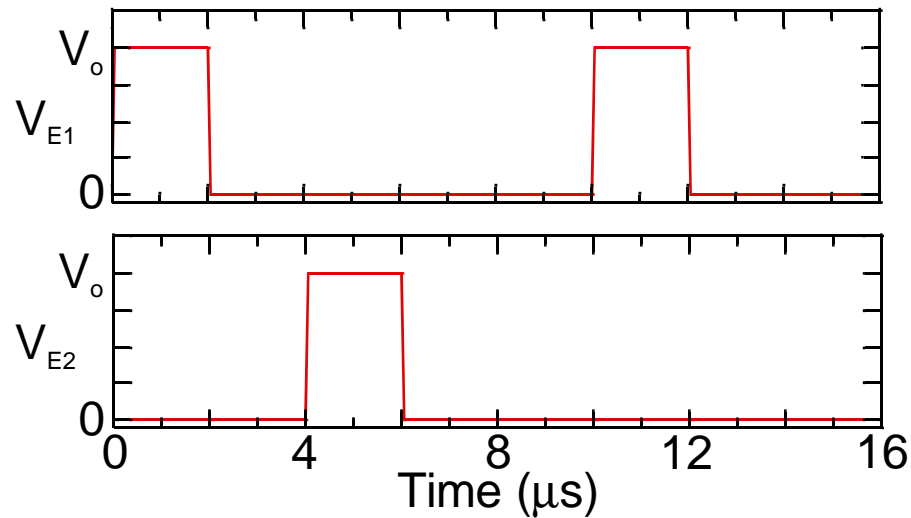
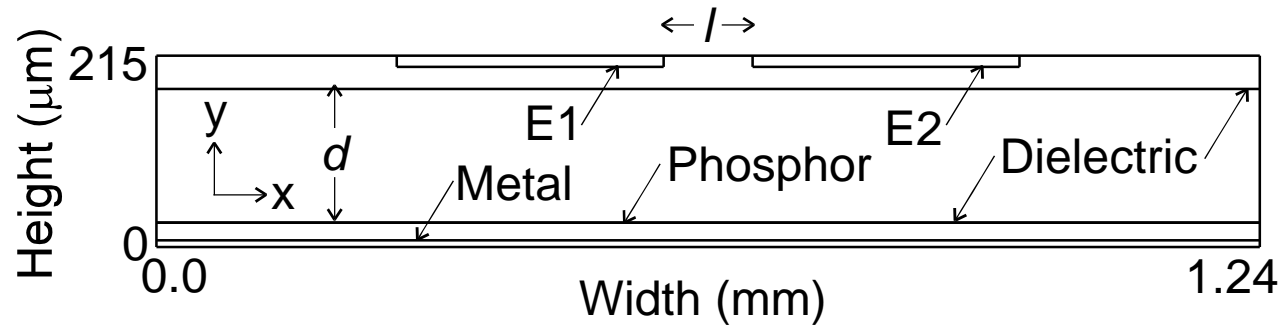


DESCRIPTION OF THE MODEL

- The main model consists of:
 - (1) Poisson's equation,
 - (2) continuity equations for charged species,
 - (3) equation for dielectric charging,
 - (4) continuity equations for neutral species.
- Equations (1)-(3) are solved using implicit time integration.
- The electron transport models include:
 - implicit solution of the electron energy conservation equation for T_e ,
 - local field approximation,
 - a Monte Carlo simulation for secondary electrons.
- The plasma model is coupled to a radiation transport model for computing visible light emission.

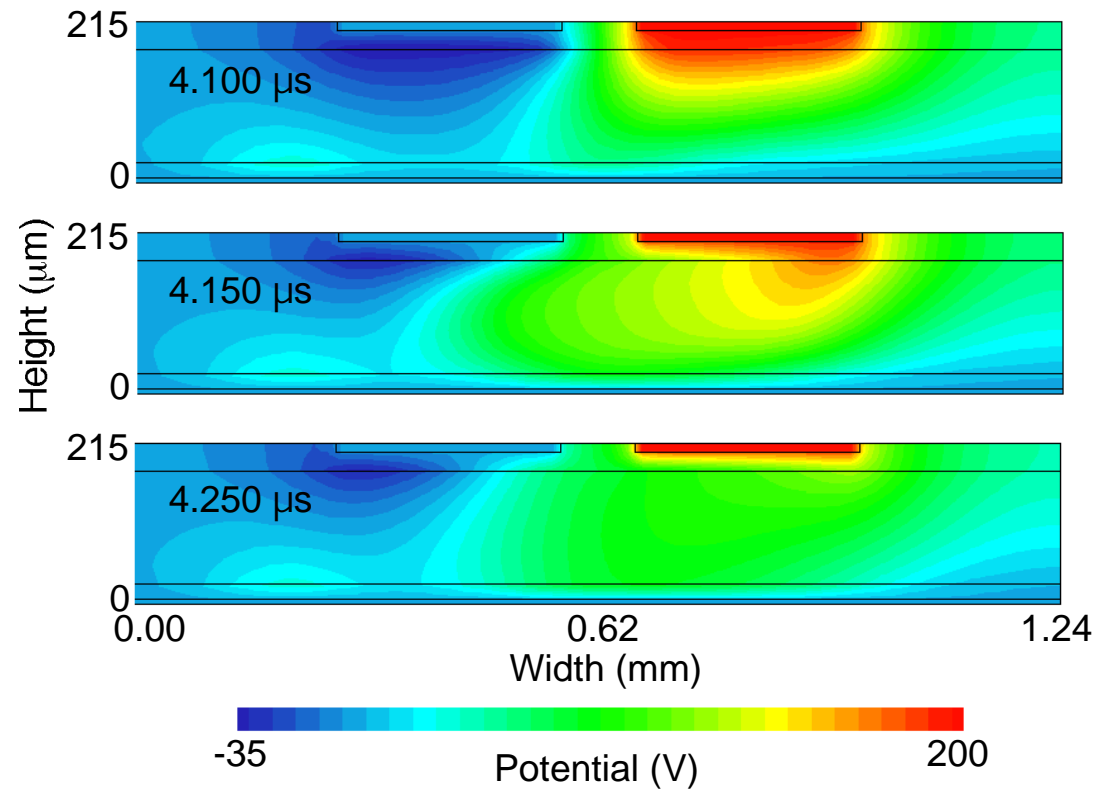
BASE CASE OPERATING CONDITIONS

- The base case has been studied for He/Ne/Xe = 70/26/4, 400 Torr, $\gamma = 0.4$ and $V_o = 200$ V.



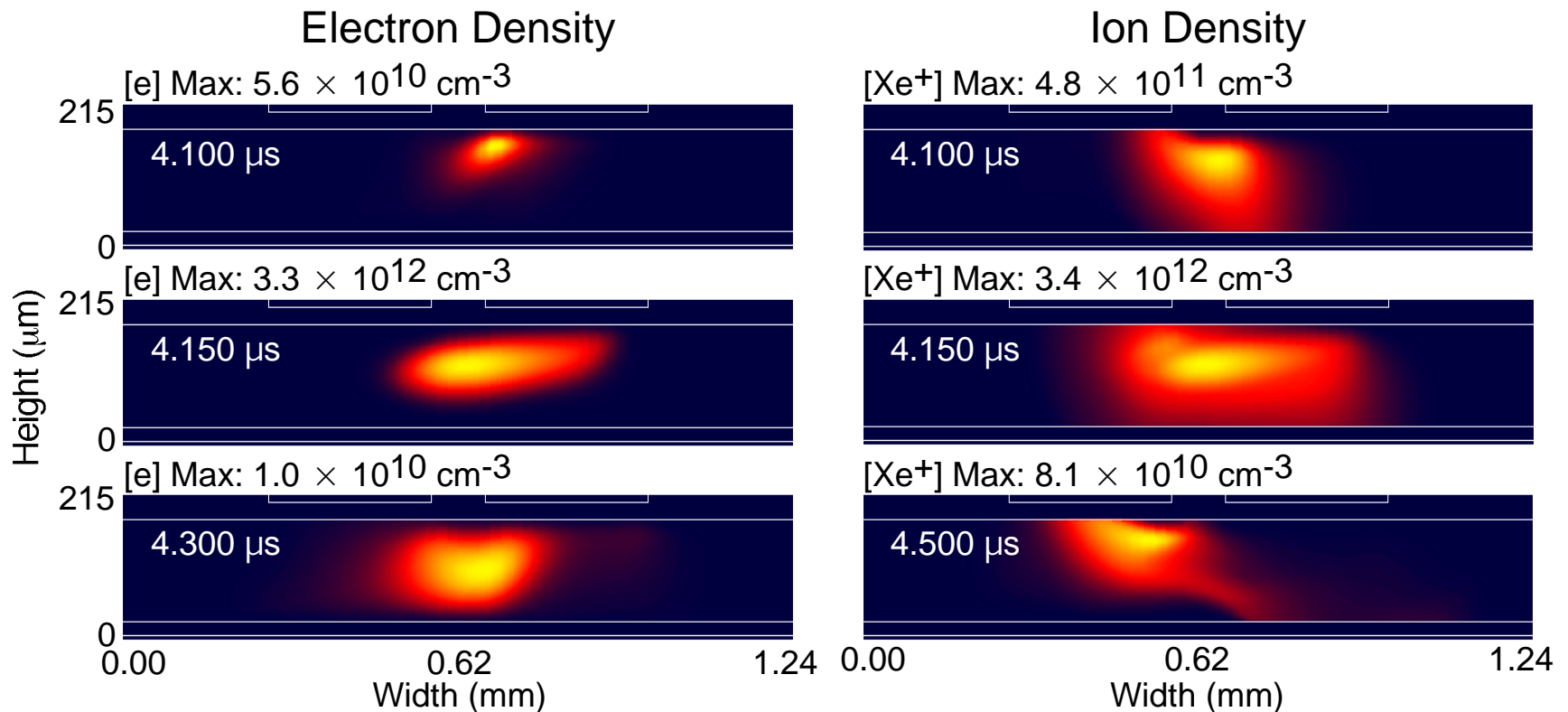
ELECTRICAL POTENTIAL (SECOND PULSE)

- The applied voltage on E2 initiates a discharge in the gas.
- Electrons and ions charge the dielectric surfaces under E1 and E2, which reduces the gap voltage and extinguishes the discharge.



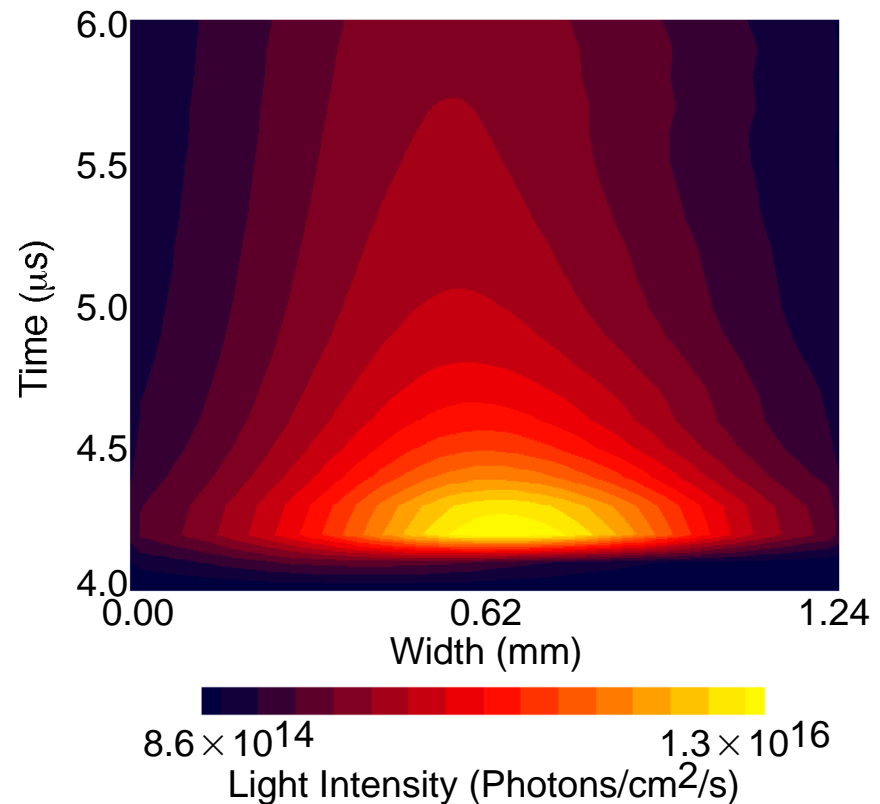
ELECTRON AND Xe⁺ DENSITY (SECOND PULSE)

- The electrons drift to E2, the positively biased electrode, and the ions drift towards E1.
- The ion density decays much slower after the discharge than electron density because of smaller ion mobility.



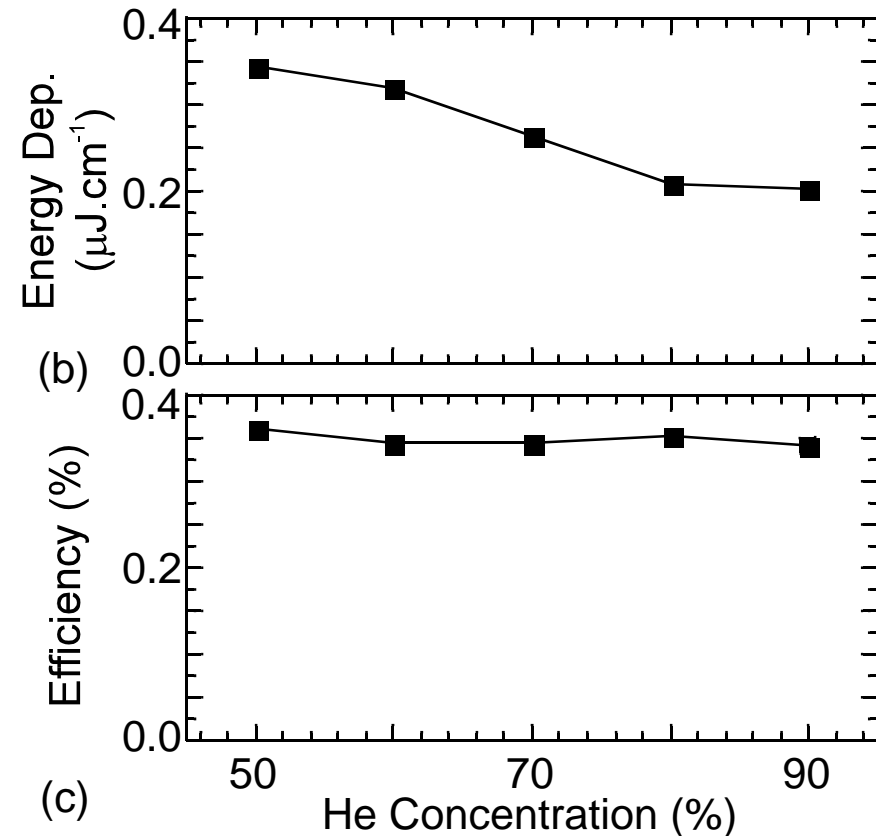
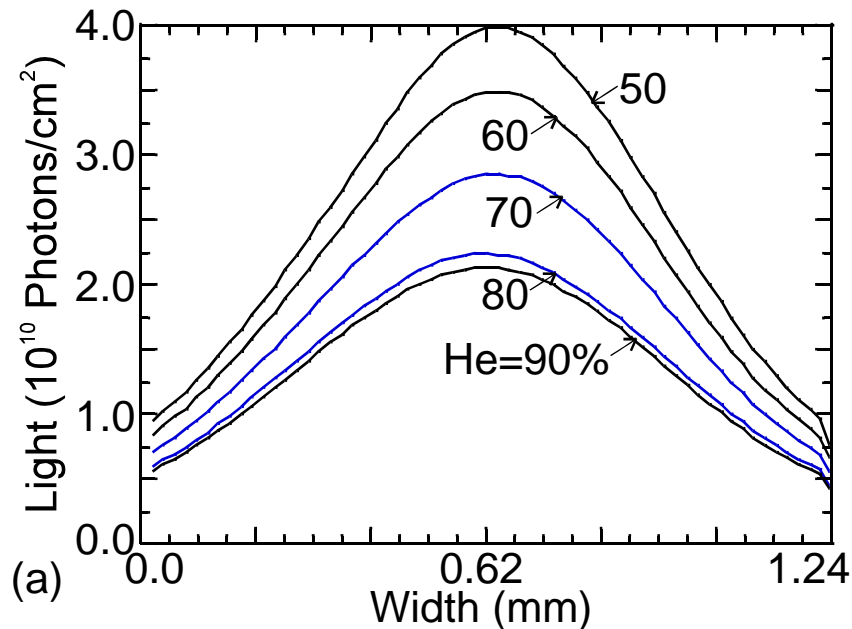
VISIBLE LIGHT EMISSION (SECOND PULSE)

- Visible light is produced when UV photons generated by Xe^* , Xe^{**} and Xe_2^* bombard the phosphor.
- The cell keeps on emitting visible light for many microseconds after the discharge because of long lived Xe excited states.
- UV emission from Xe^* and Xe^{**} is optically thick and UV photons from only a few absorption lengths of the phosphor contribute to visible light emission.
- Since radiation from Xe_2^* is optically thin, it contributes more strongly to visible light emission.



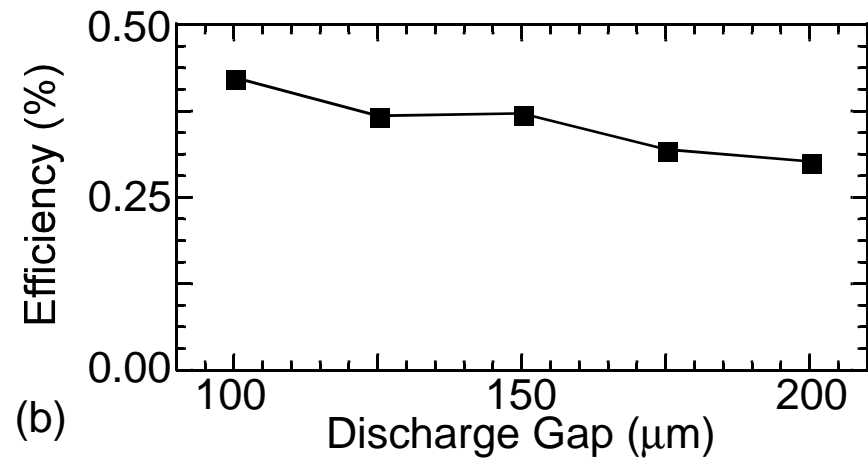
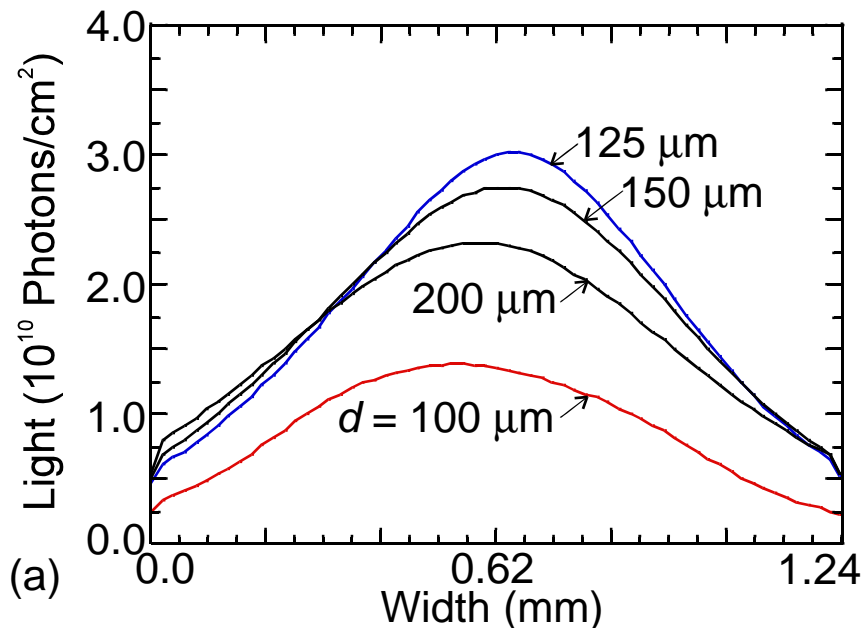
EFFECT OF He/Ne RATIO

- As He concentration is decreased, the PDP cell spends more time in the discharge phase because of a lower sustaining voltage, which increases light emission.
- Larger total current fluence at smaller He concentrations leads to more energy deposition.



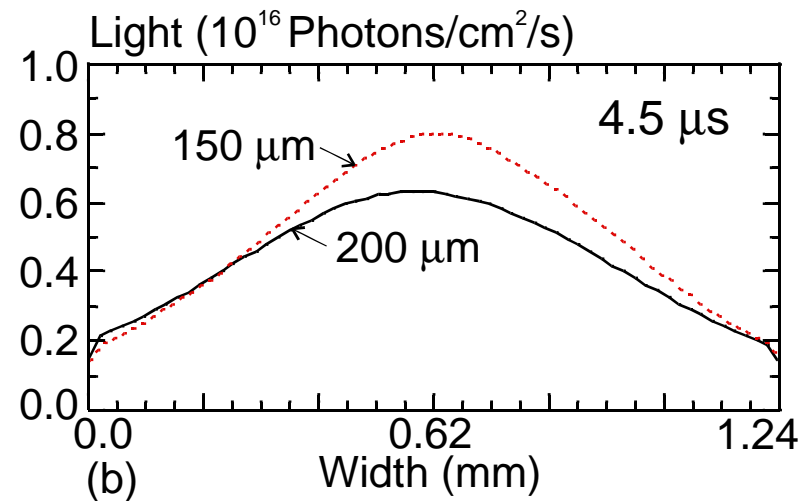
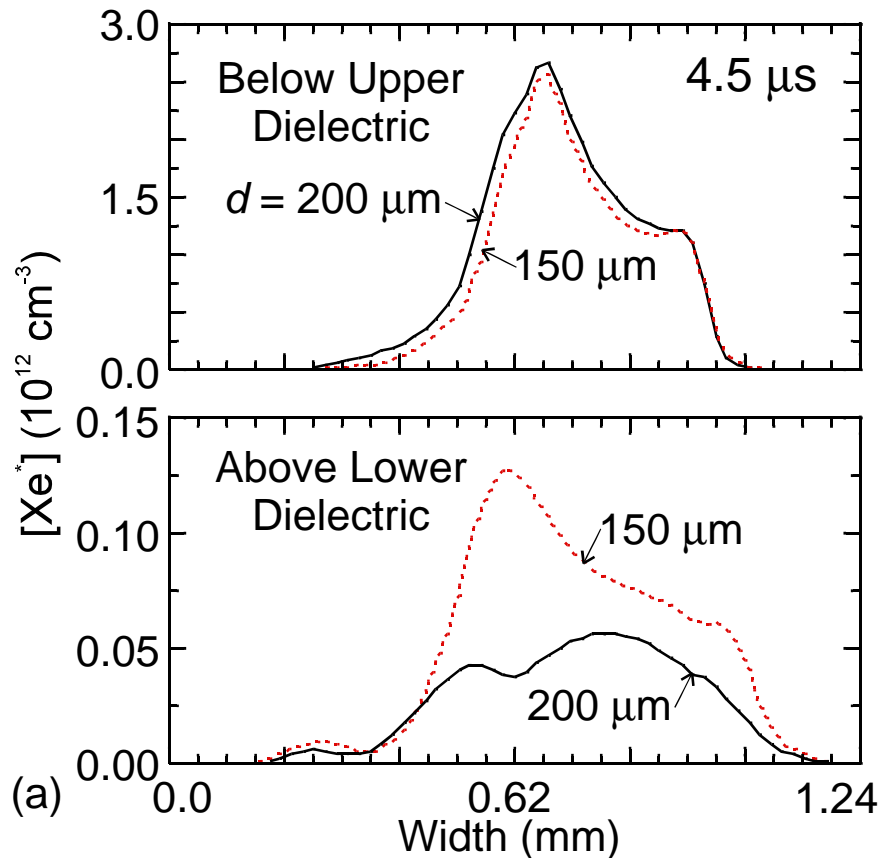
EFFECT OF DISCHARGE GAP - I

- At smaller discharge gaps, the bottom address electrode interferes with normal PDP operation.
- Once the PDP is operating normally, discharge gap does not have a significant influence on total energy deposition.
- There is an optimum value for the discharge gap at which efficiency and light intensity are both high.



EFFECT OF DISCHARGE GAP - II

- The reduction in light intensity at larger gap lengths is due to the fact that Xe^* density decays rapidly from the region of generation (near the top dielectric) to the phosphor (on the bottom dielectric) due to quenching.
- Since UV radiation from Xe^* is optically thick, it decreases considerably as gap length is increased.



CONCLUSIONS

- A 2-dimensional hybrid model has been developed for Plasma Display Panel (PDP) simulation.
- The model consists of an implicit solution of the Poisson's equation and continuity equations, a Monte Carlo simulation for the secondary electrons and a radiation transport model.
- The model was used to simulate a coplanar-electrode PDP cell with a He/Ne/Xe gas mixture.
- Results indicate that gas mixtures with higher Ne concentration produce more visible light because:
 - the discharge is sustained for a longer time,
 - three-body collisions (that generate Xe_2^*) are more efficient with Ne than He.
- PDP light emission characteristics are very sensitive to dielectric spacing, and there is an optimum spacing where visible light emission and light generation efficiency are both high.