PDP의 고효율화를 위한 구동 기술

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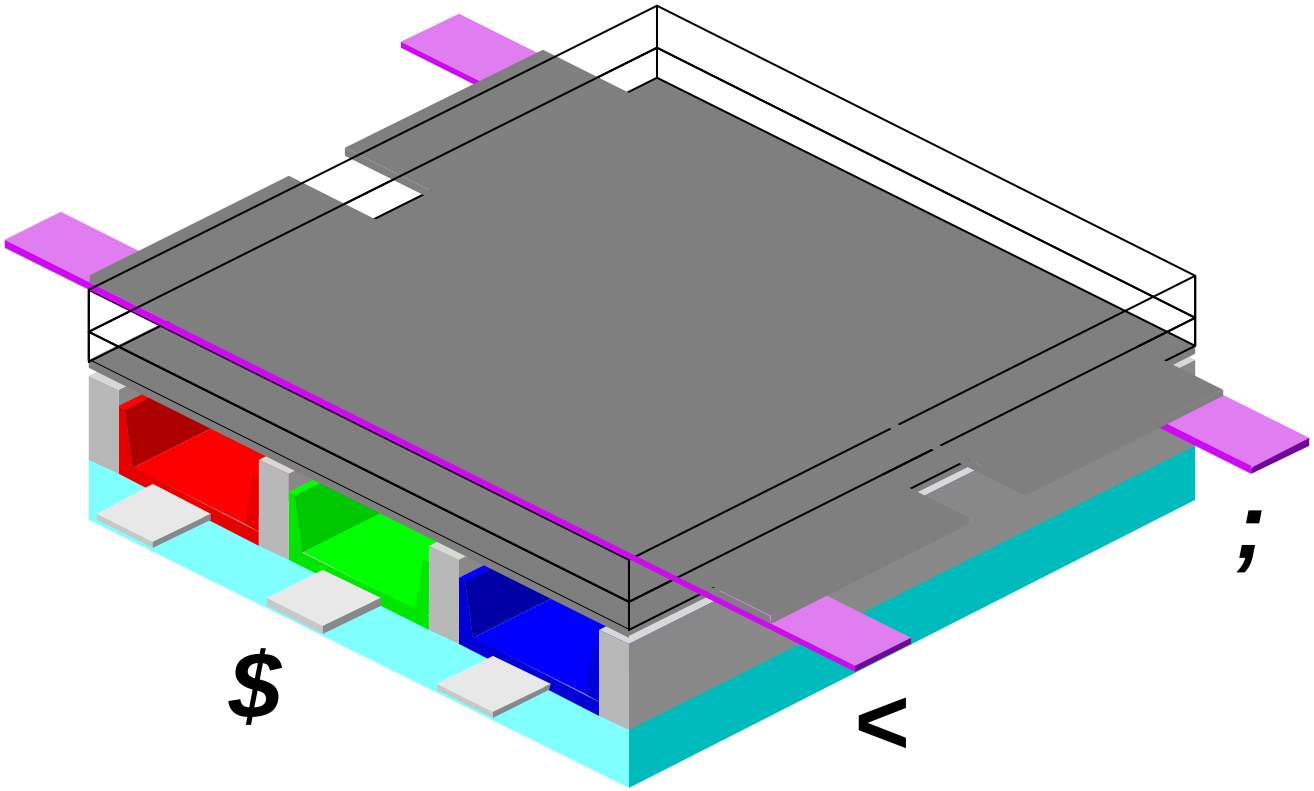
Contents

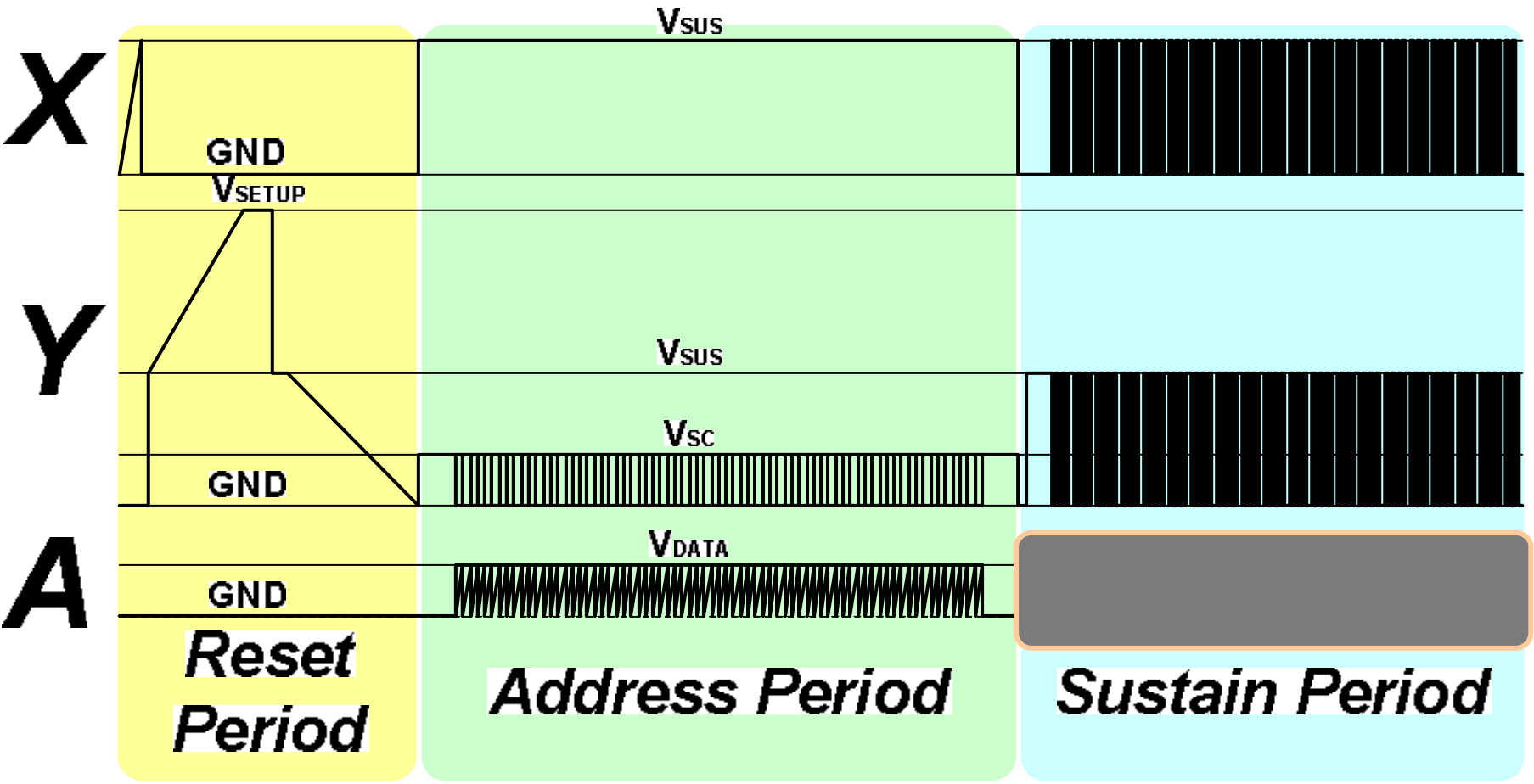
- *Introduction*
- *Improvement of Luminous Efficiency using Ramped-Square Sustain Waveform*
- *Improvement of Luminous Efficiency using Auxiliary Address Pulse During Sustain Period*
  - *Cross Sectional Observation of IR Emission using ICCD Camera*
  - *Self-Erasing Discharge*
- *Improvement of Luminous Efficiency using Long Gap Discharge*
- *New Cross-Shape Cell Structure for High Luminous Efficiency*

Panel Structure

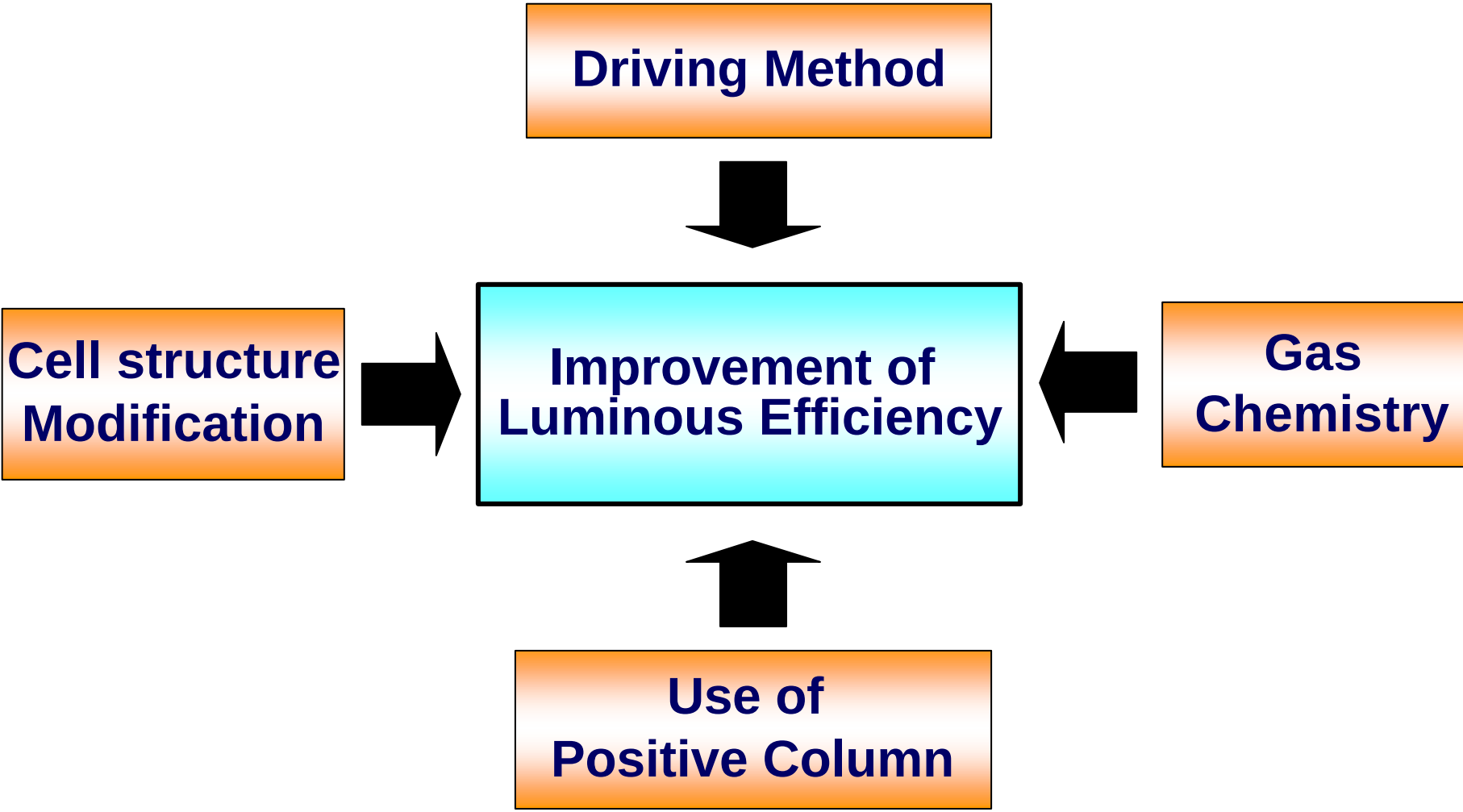


X: Common Sustain Electrode
Y: Scan & Sustain Electrode
A: Address Electrode

Conventional Driving Waveforms



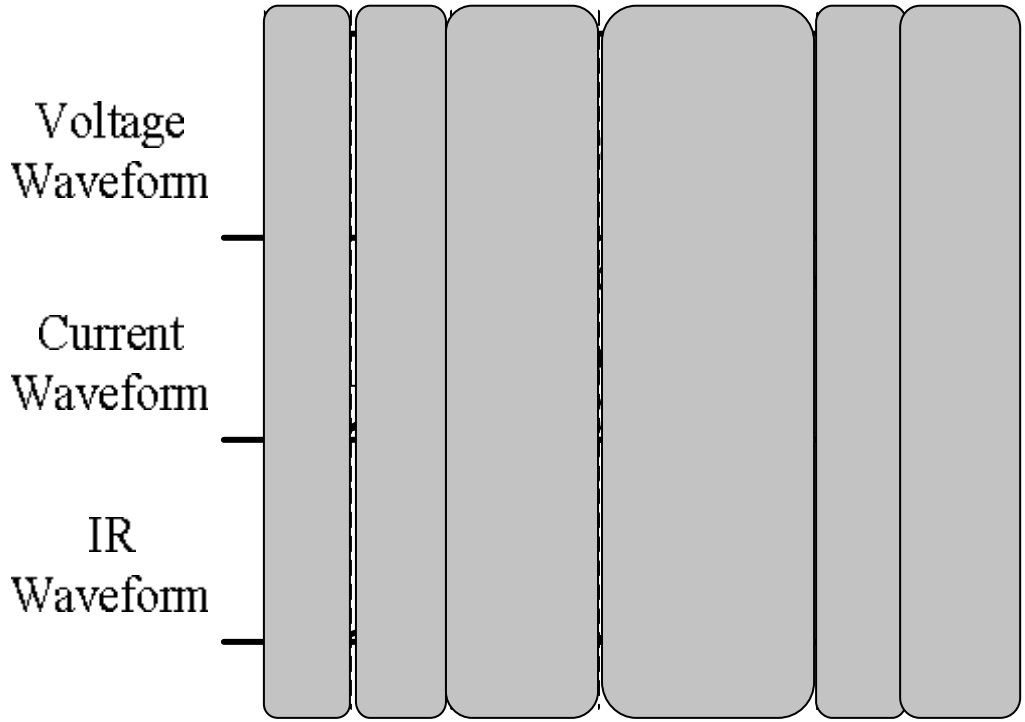
High Luminous Efficiency

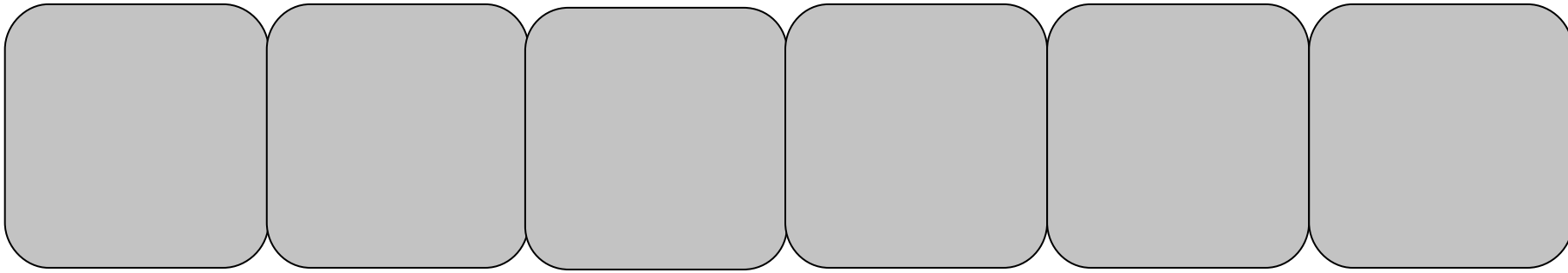


Part I

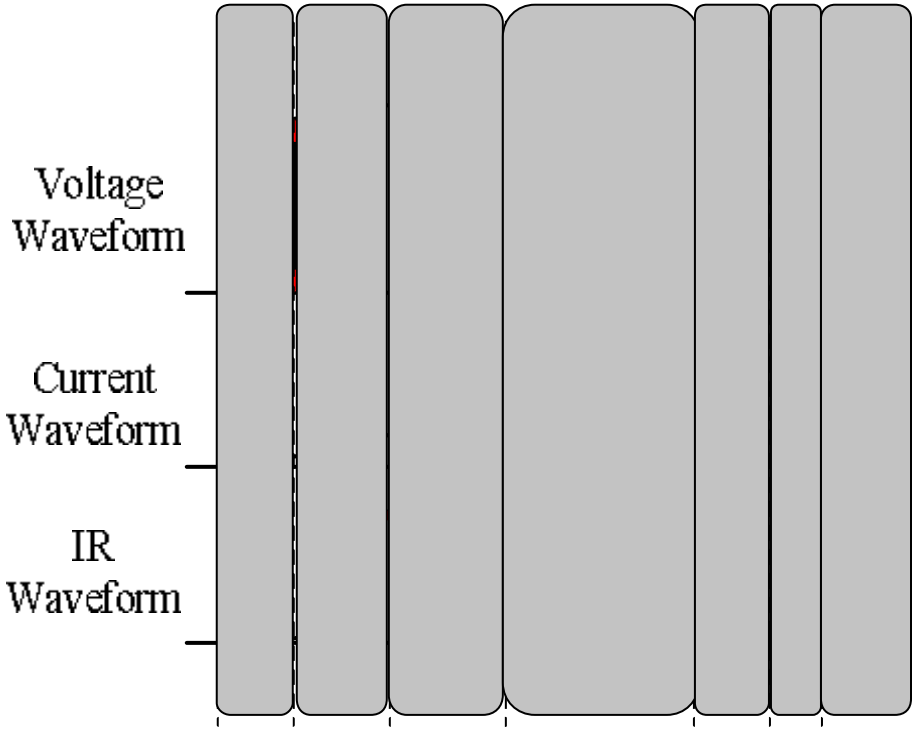
Improvement of Luminous Efficiency using Ramped-Square Sustain Waveform

Discharge Mechanism –
(Conventional Sustain Waveform)



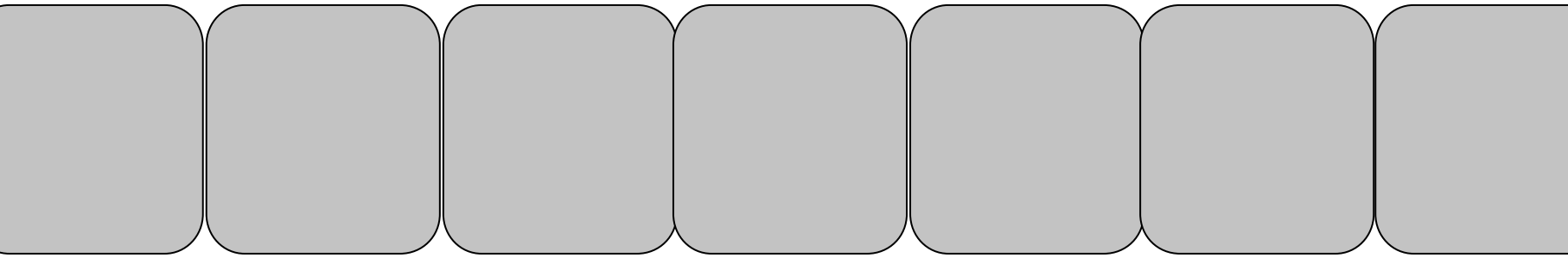


Discharge Mechanism –
(New Ramped-Square Sustain Waveform)



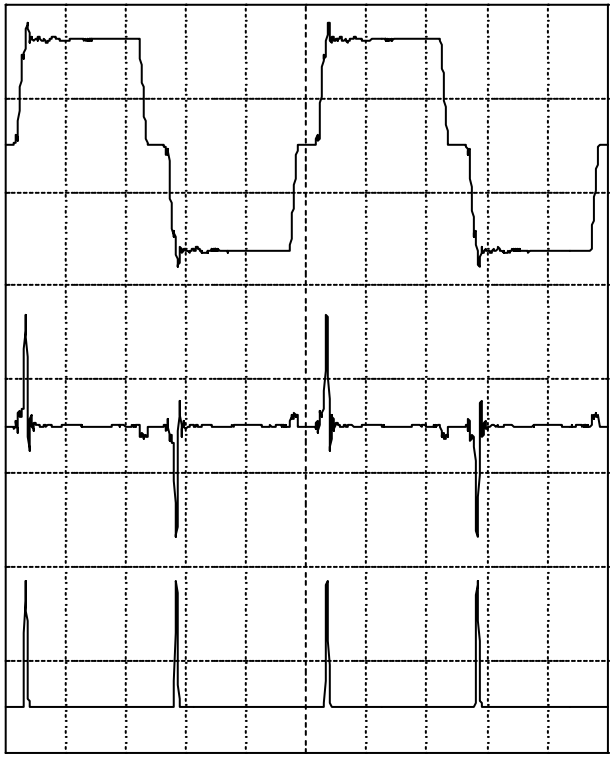
The **Ramped-Squared sustain waveform** with an increased voltage slope can induce **the longer-sustaining discharge** with **low power consumption**.

After the flow of displacement current, the **self-erasing discharge** is produced by the excess wall charges with **no power consumption**.



Measured waveforms

- **Conv. Waveform**

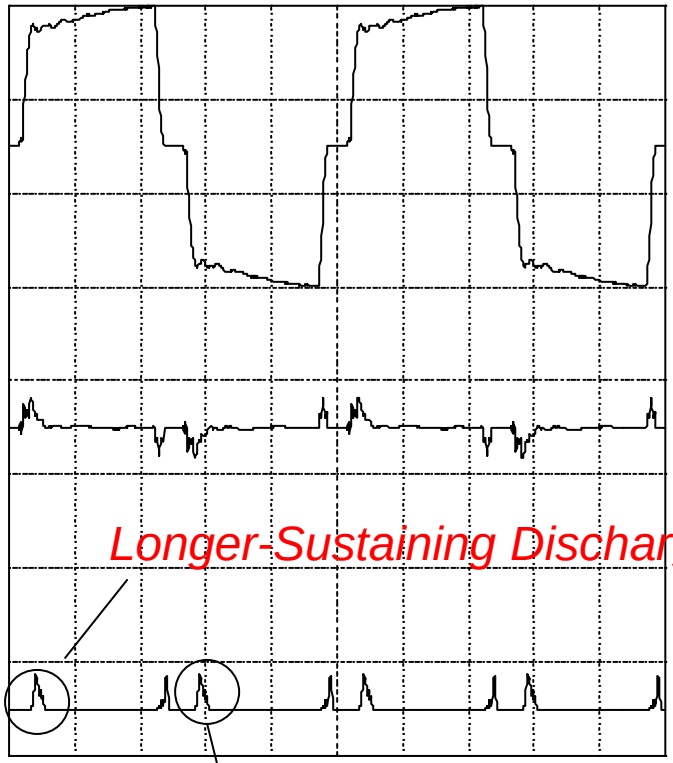


Voltage

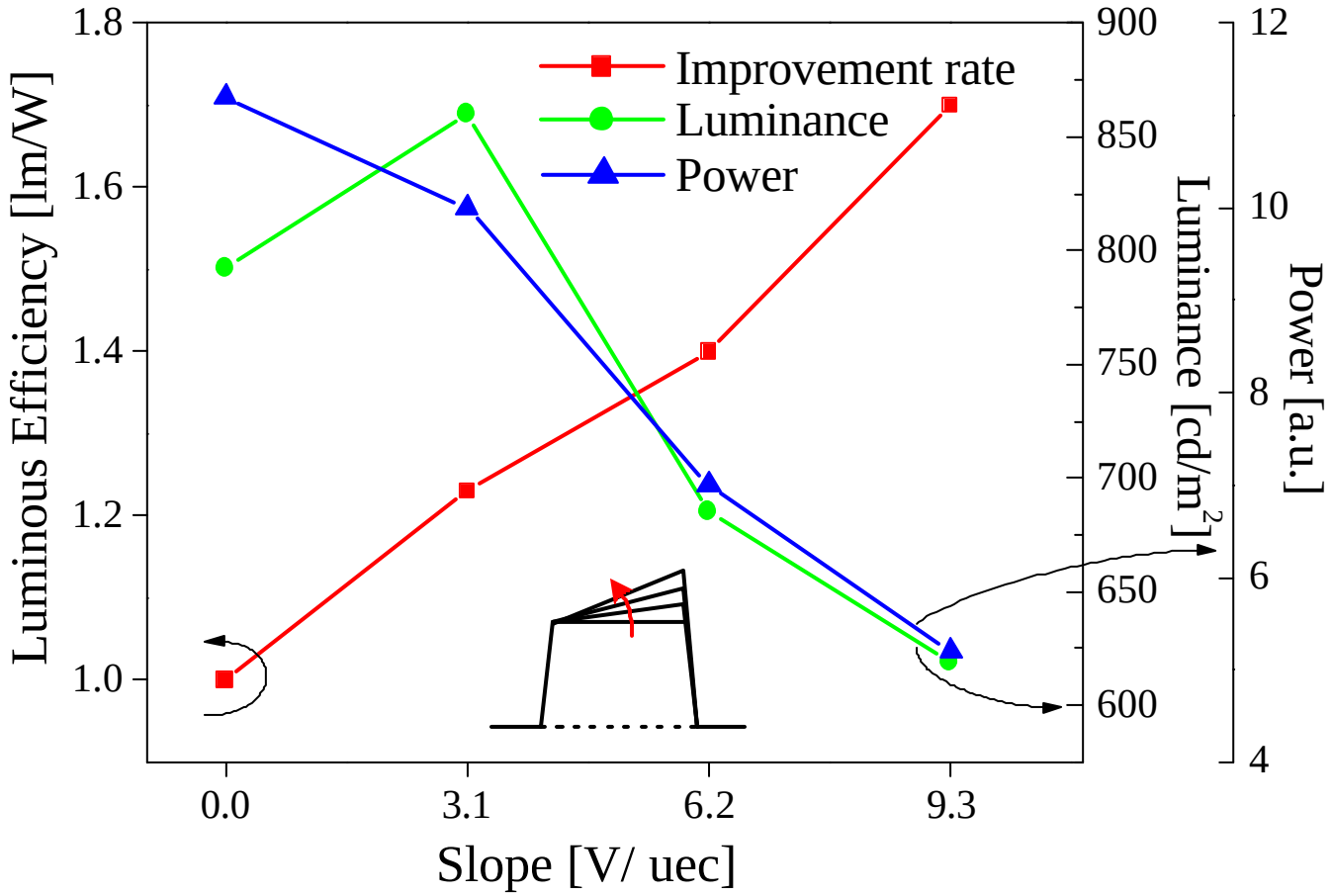
Current

IR

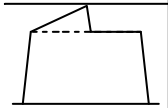
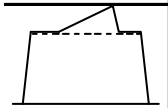
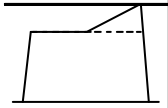
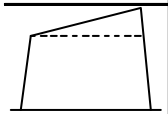
- **New Waveform**



Results – Luminance & Luminous Efficiency



Results – Modification of Ramp Shape

		Luminance	Luminous Efficiency	*Longer-Sustaining Discharge*	*Self-Erasing Discharge*
		246 (-)	9.62 (-)	X	X
(a)		304 (23%)	11.64 (35%)	O	X
(b)		292 (18%)	11.56 (34%)	O	X
(c)		292 (18%)	11.82 (37%)	X	O
(d)		300 (22%)	11.75 (36%)	O	O

Summary

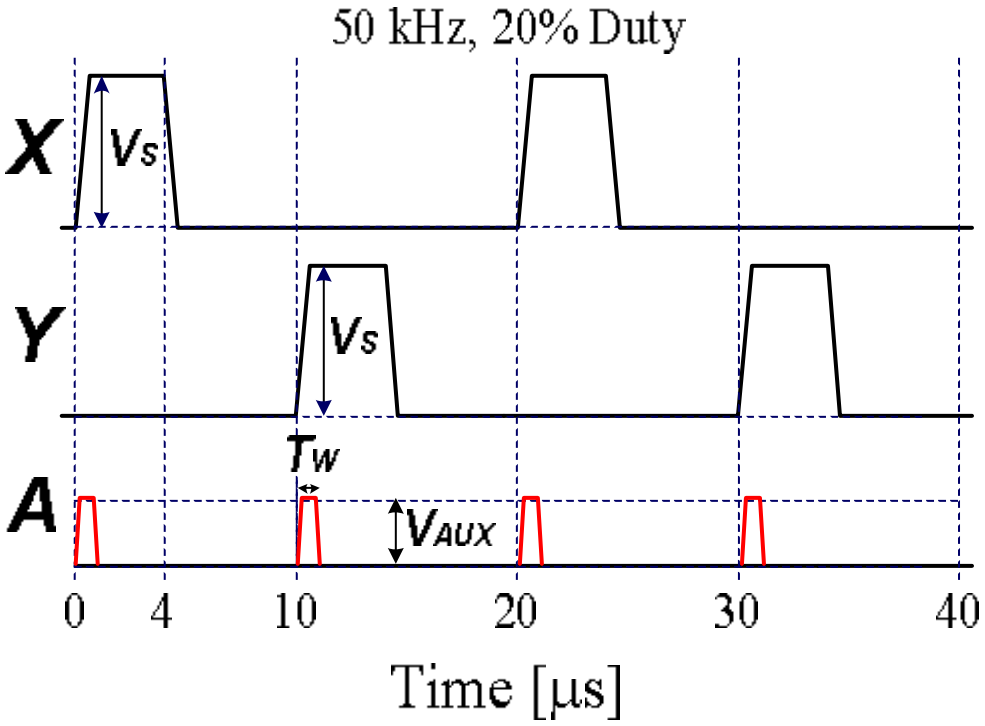
- *New Ramped-Square sustain waveform were proposed to improve the luminous efficiency of an ac-PDP.*
- *This waveform can induce the longer-sustaining discharge and self-erasing discharge, thereby resulting in improvement of luminous efficiency.*
- *In various ramp shape condition, this waveform achieved about 20% higher luminance and about 35% higher luminous efficiency, simultaneously.*

- IDW '00, pp.655-658, 2000.
- IEEE Transactions on Electron Devices. Vol.48, No.7, 2001

Part II

Improvement of Luminous Efficiency Using Auxiliary Address Pulse During Sustain Period

Basic Concept



Driving Waveforms

Applying Auxiliary Address Pulse During Sustain Period

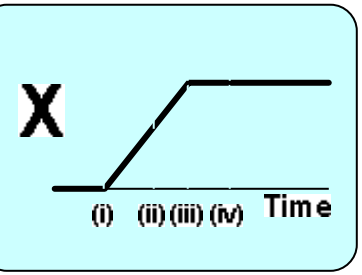
Attract Electrons toward Address Electrodes

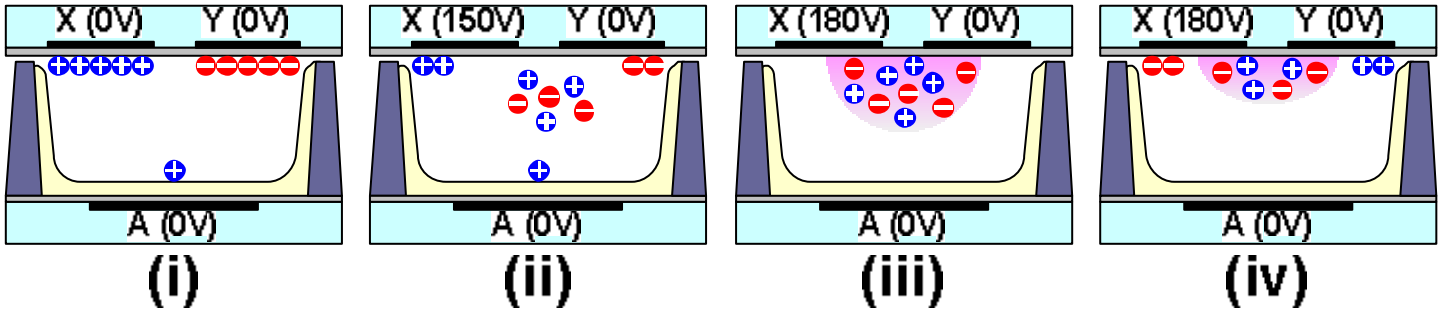
Large Volume and Fast Sustain Discharge

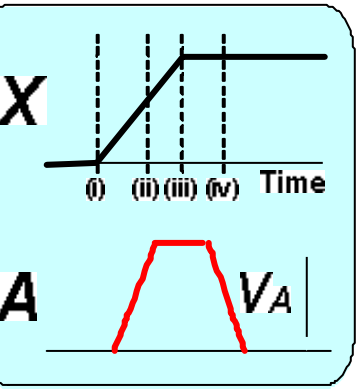
Improvement of Luminance and Luminous Efficiency

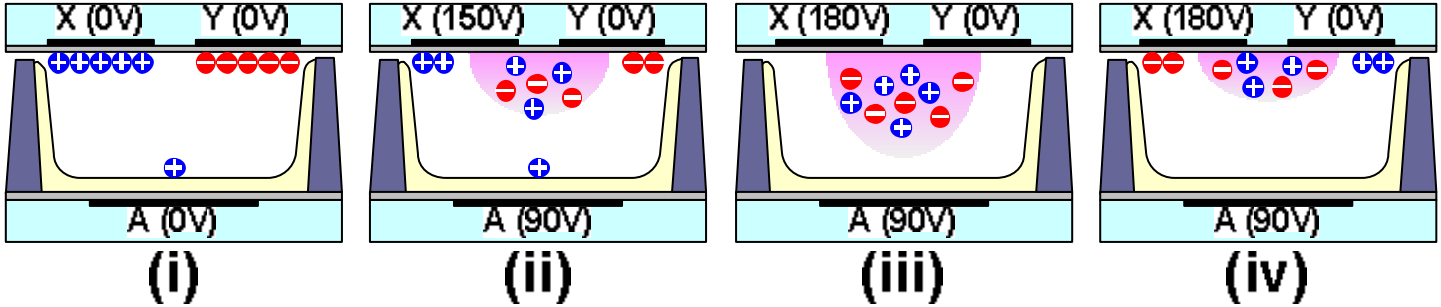
Space / Wall Charge Distribution Model

Conv.





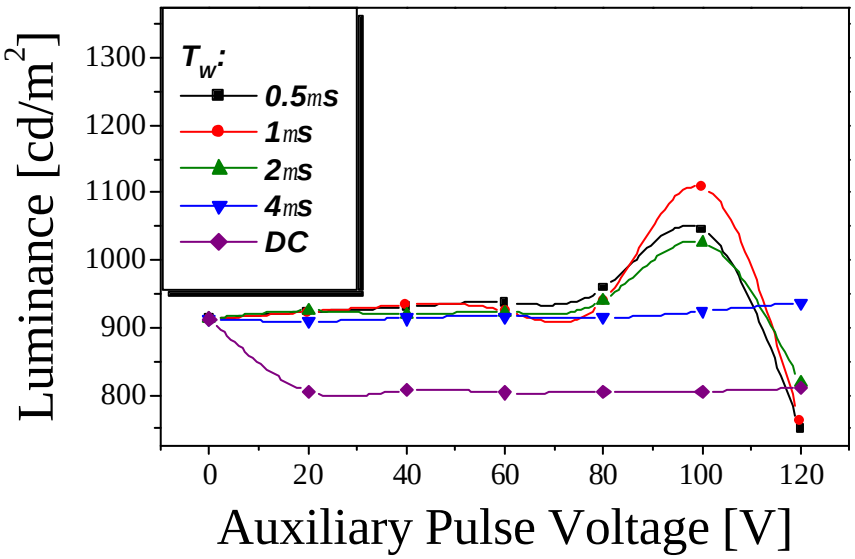




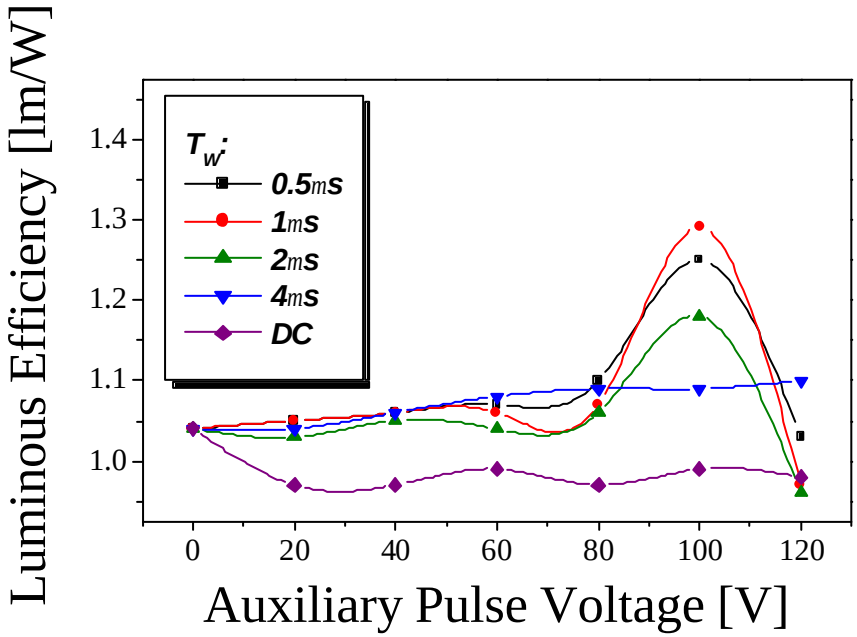
New

Results – Luminance & Luminous Efficiency

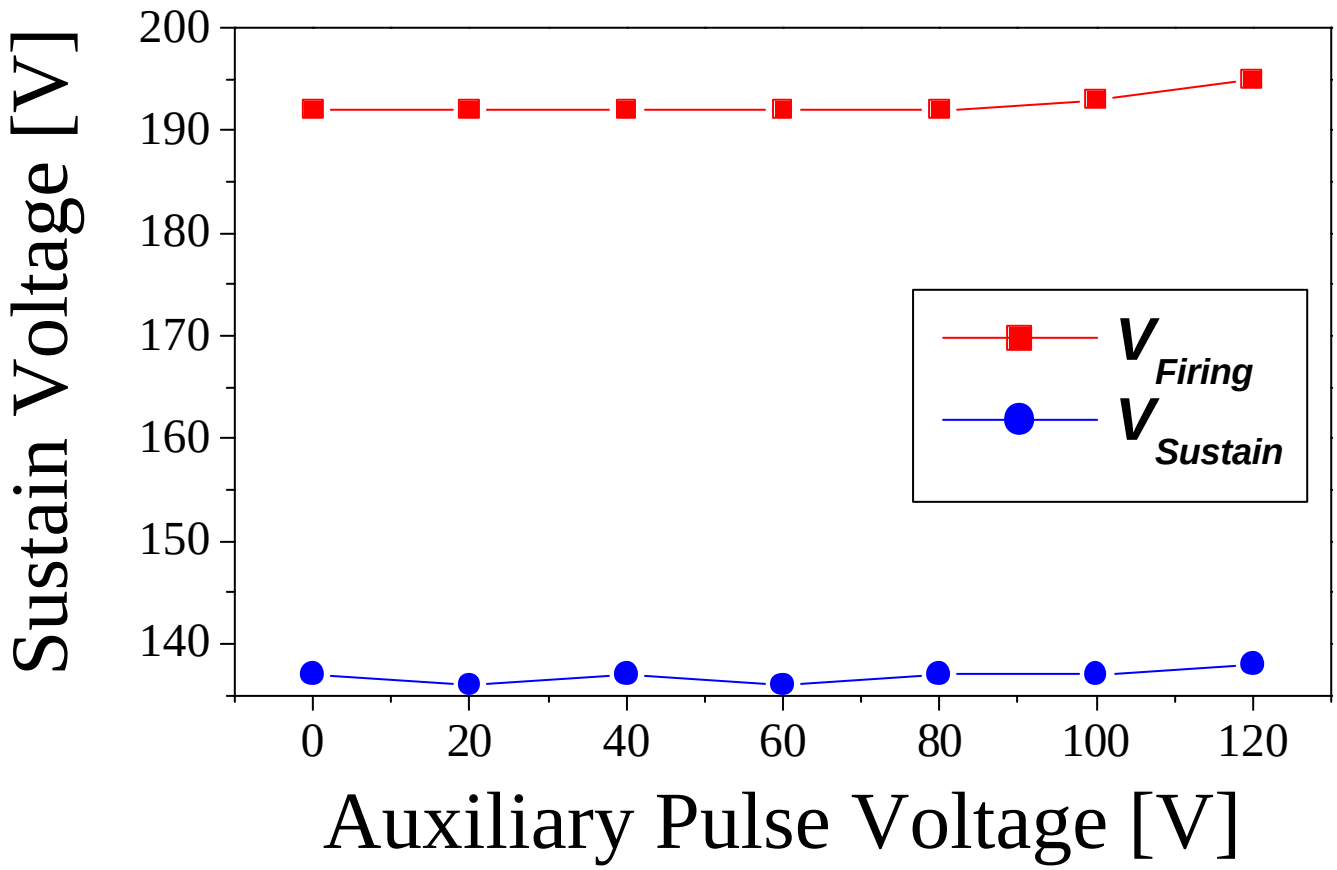
Luminance



Luminous Efficiency



Results – Static Voltage Margin



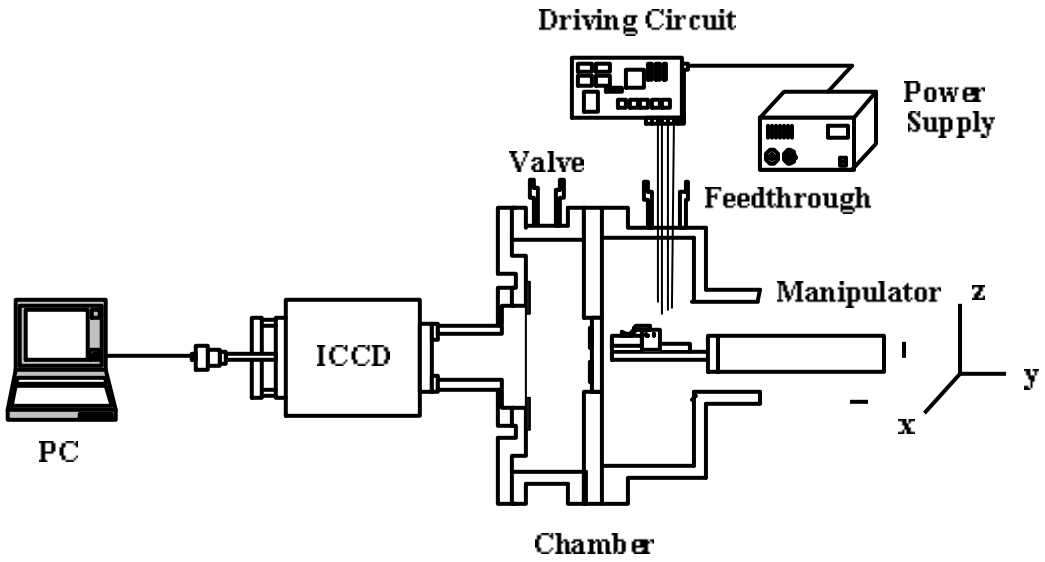
Summary

- *To improve the luminance and luminous efficiency, auxiliary voltage pulses were applied to the address electrode during a sustain-period.*
- *The luminance and luminous efficiency exhibited maximum values at an address voltage of 100V and pulse width of 1us.*
- *An improved luminance of 21.4% and luminous efficiency of 24% were simultaneously obtained.*

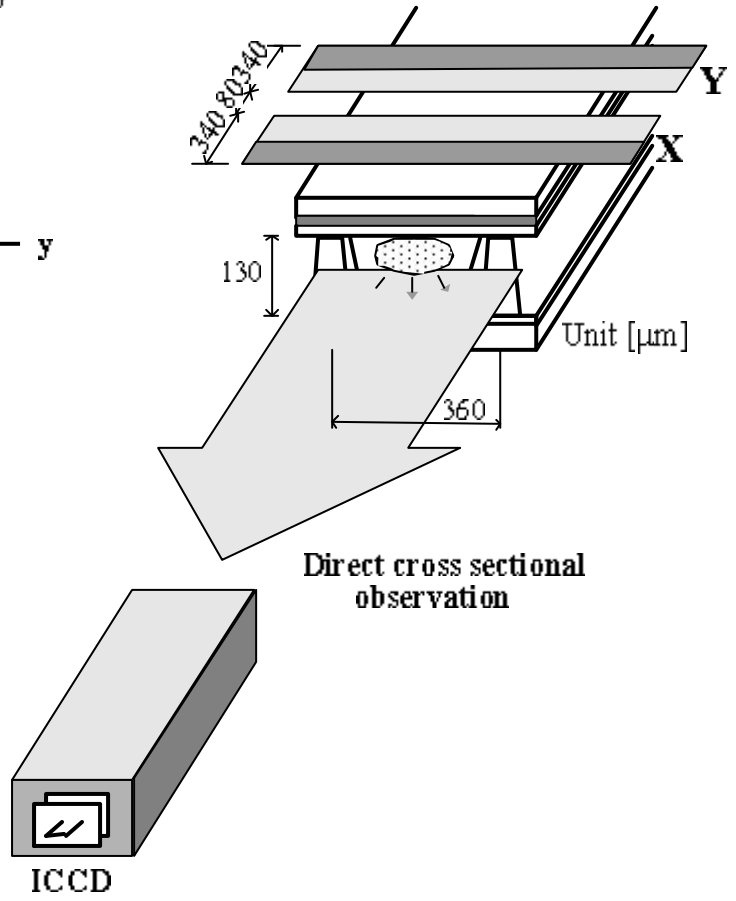
- **IDW '00, pp. 771-774, 2000.**
- **IEEE Trans. Electron Devices, vol.48, no.9, pp.1903-1910, 2001.**

Cross Sectional Observation of IR Emission Using ICCD Camera

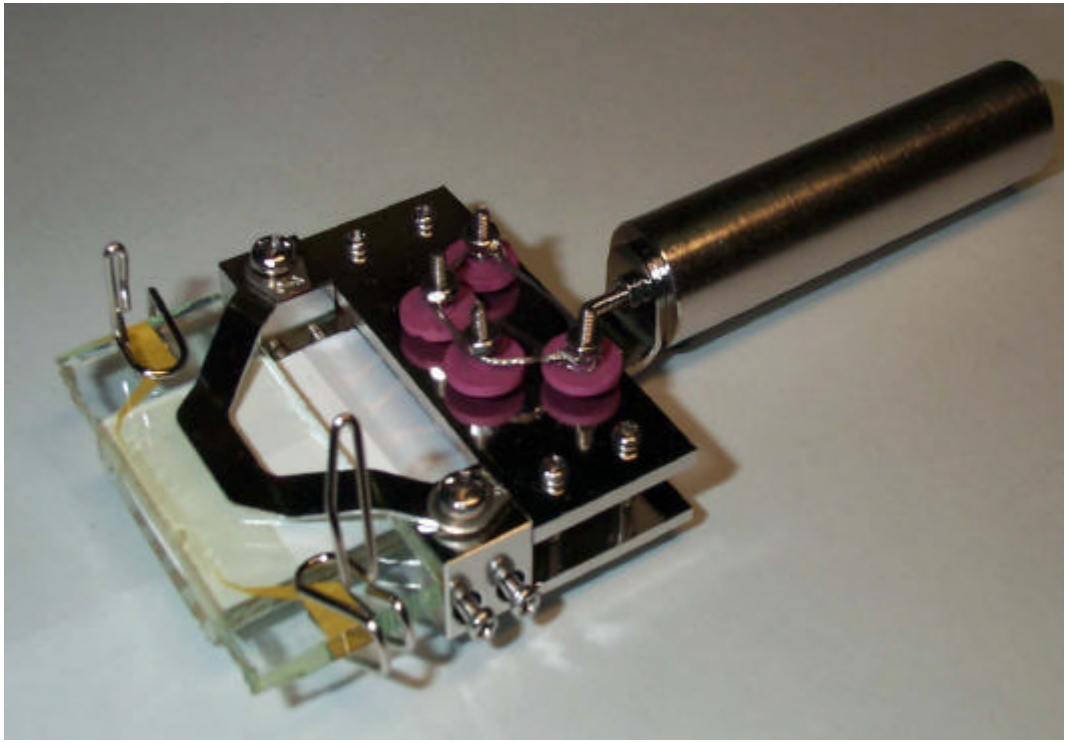
Experimental Setup



- ICCD-576EM, Princeton Instrument, Inc.
- Optical Filter: Center Freq.: 821nm FWHM: about 10nm
- Pressure: 300 Torr Gas Mixture: Ne-Xe(4%)

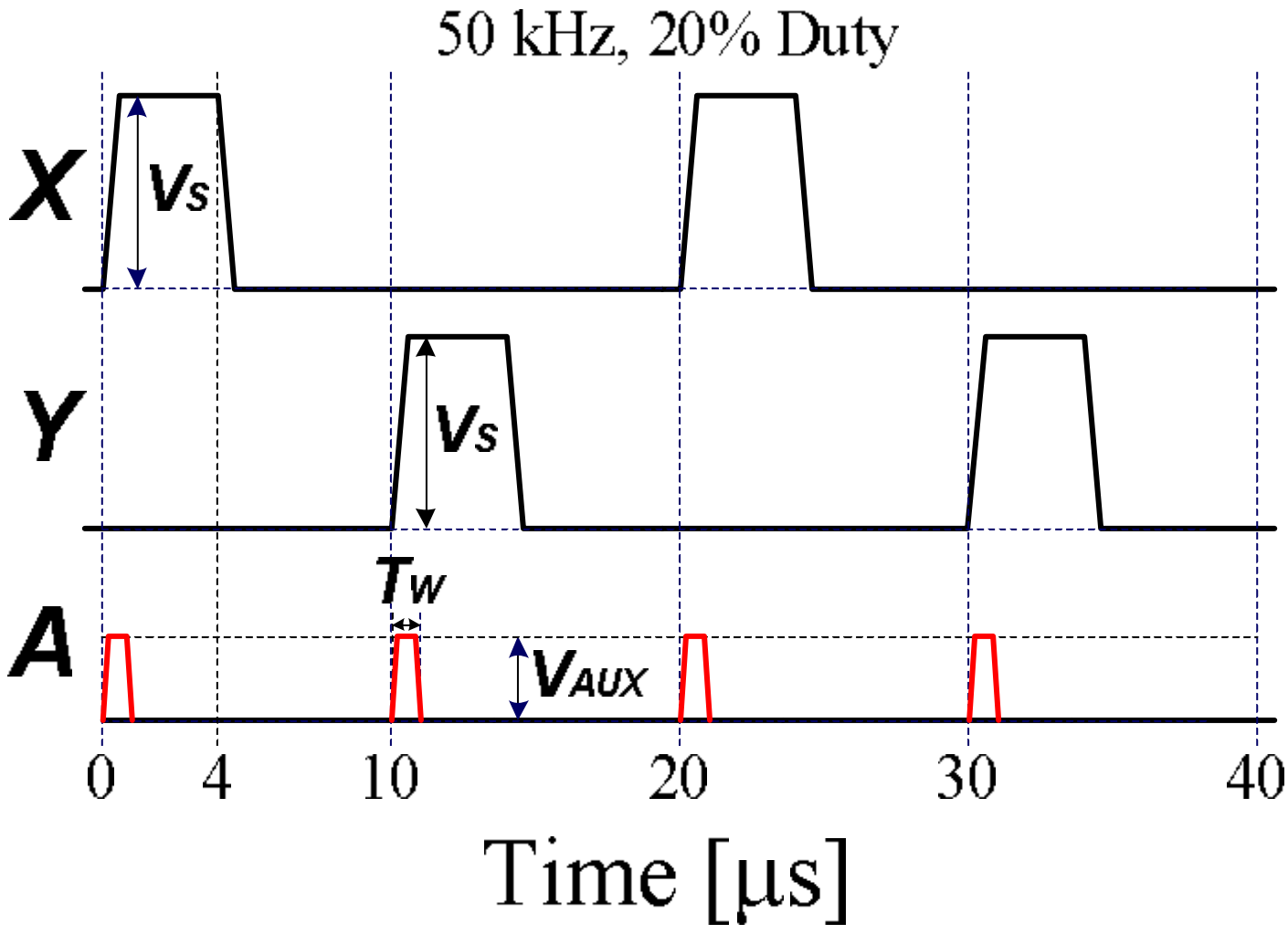


Experimental Setup – Test Panel



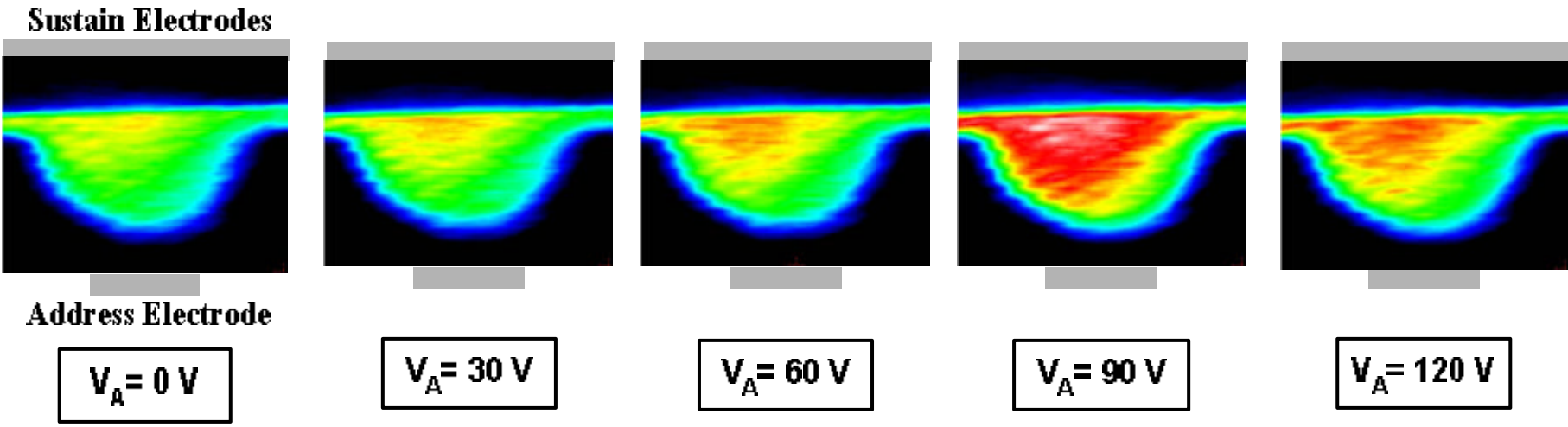
- **Front Substrate**
  - a width of ITO: 340 μm
  - a gap between ITO: 80 μm
  - a with of bus: 120 μm
- **Rear substrate**
  - a cell pitch: 360 μm
  - a width of address: 150 μm
  - a height of barrier rib: 130 μm

Driving Waveforms



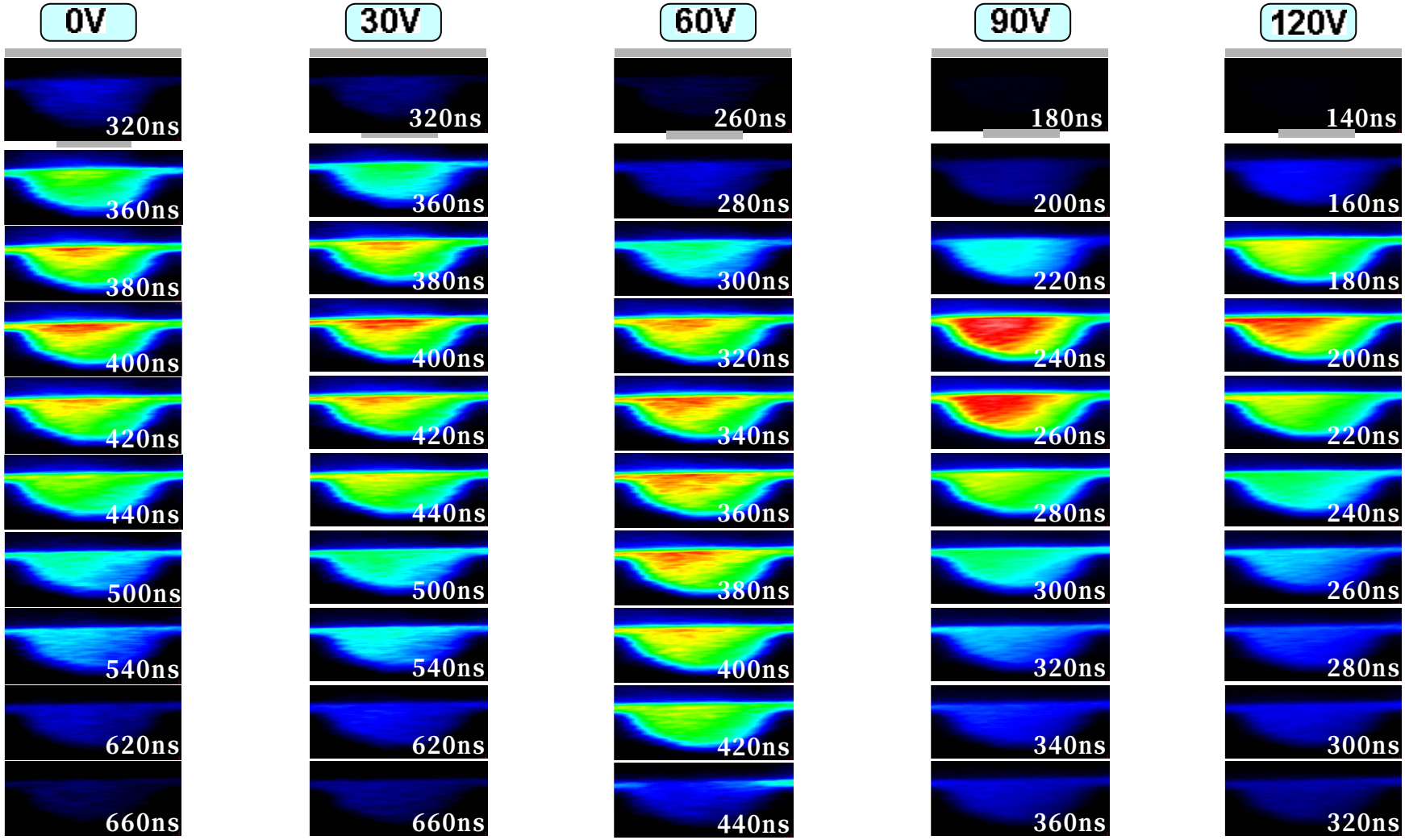
IR Emission Image – Shutter Mode

Various Auxiliary Pulse Voltage
(T_W = 400ns)



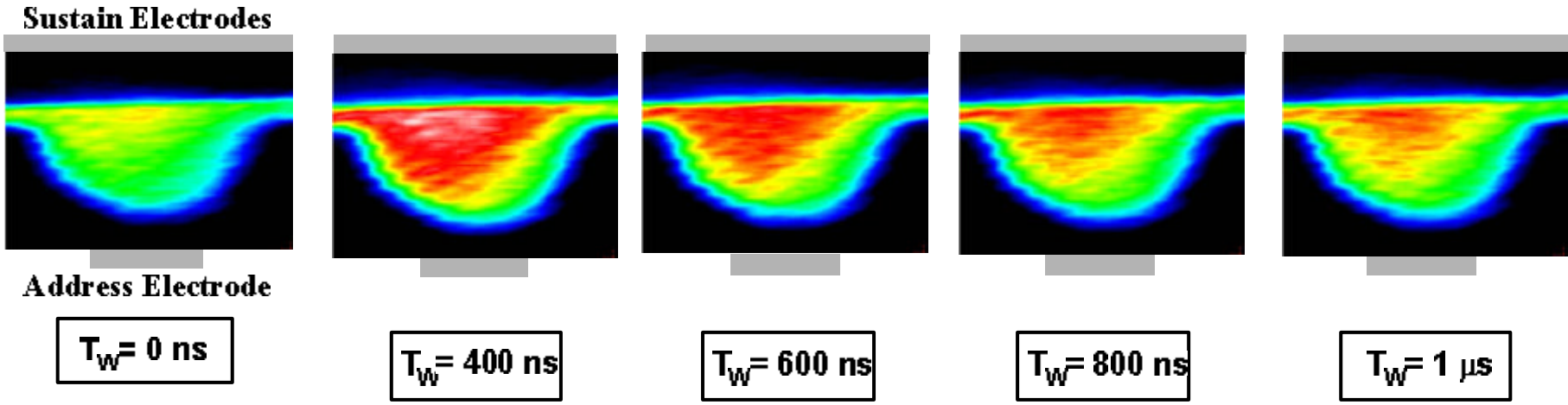
IR Emission Image – Gate Mode

Various Auxiliary Pulse Voltage (T_W = 400ns)



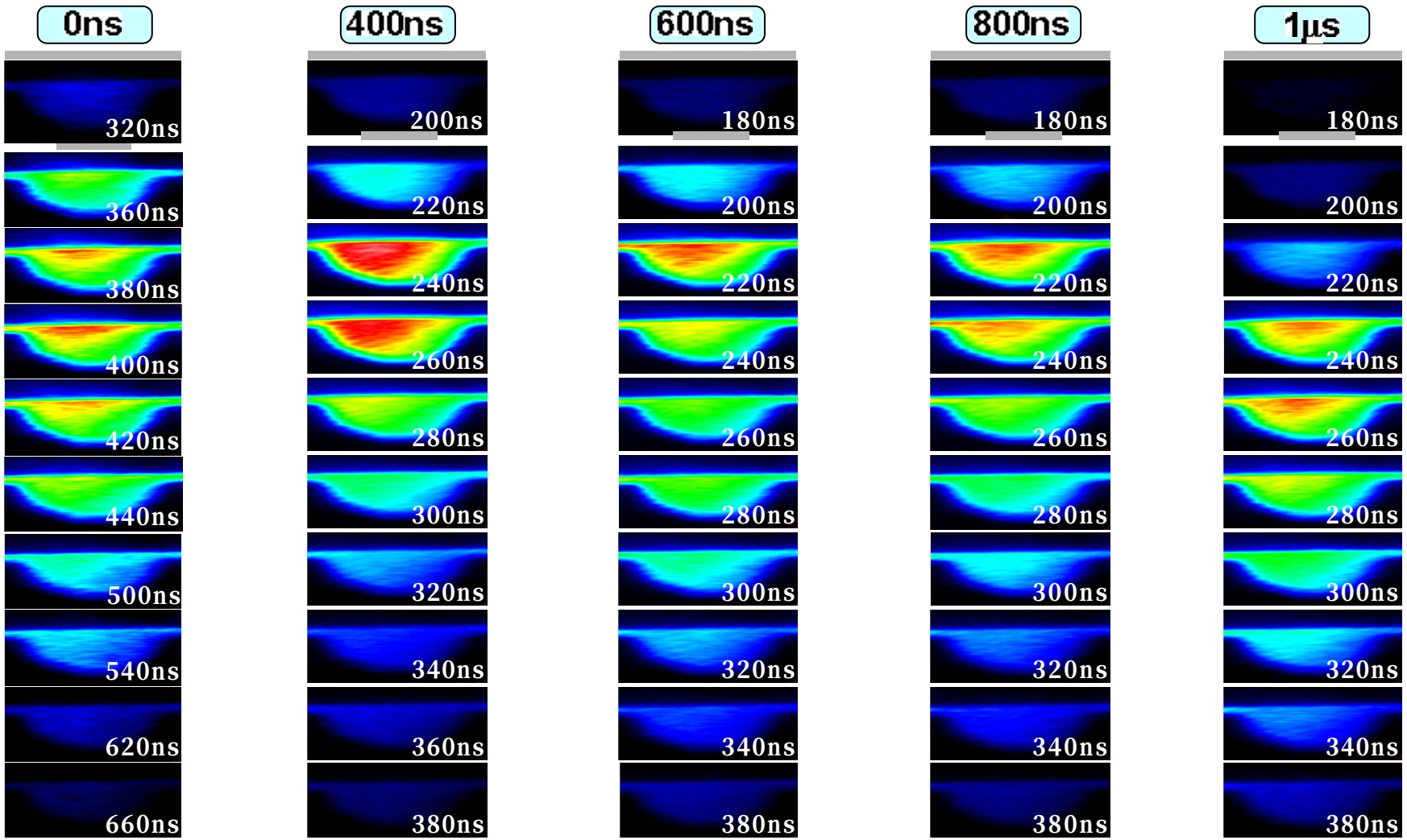
IR Emission Image – Shutter Mode

Various Auxiliary Pulse Width
(V_{AUX} = 90V)

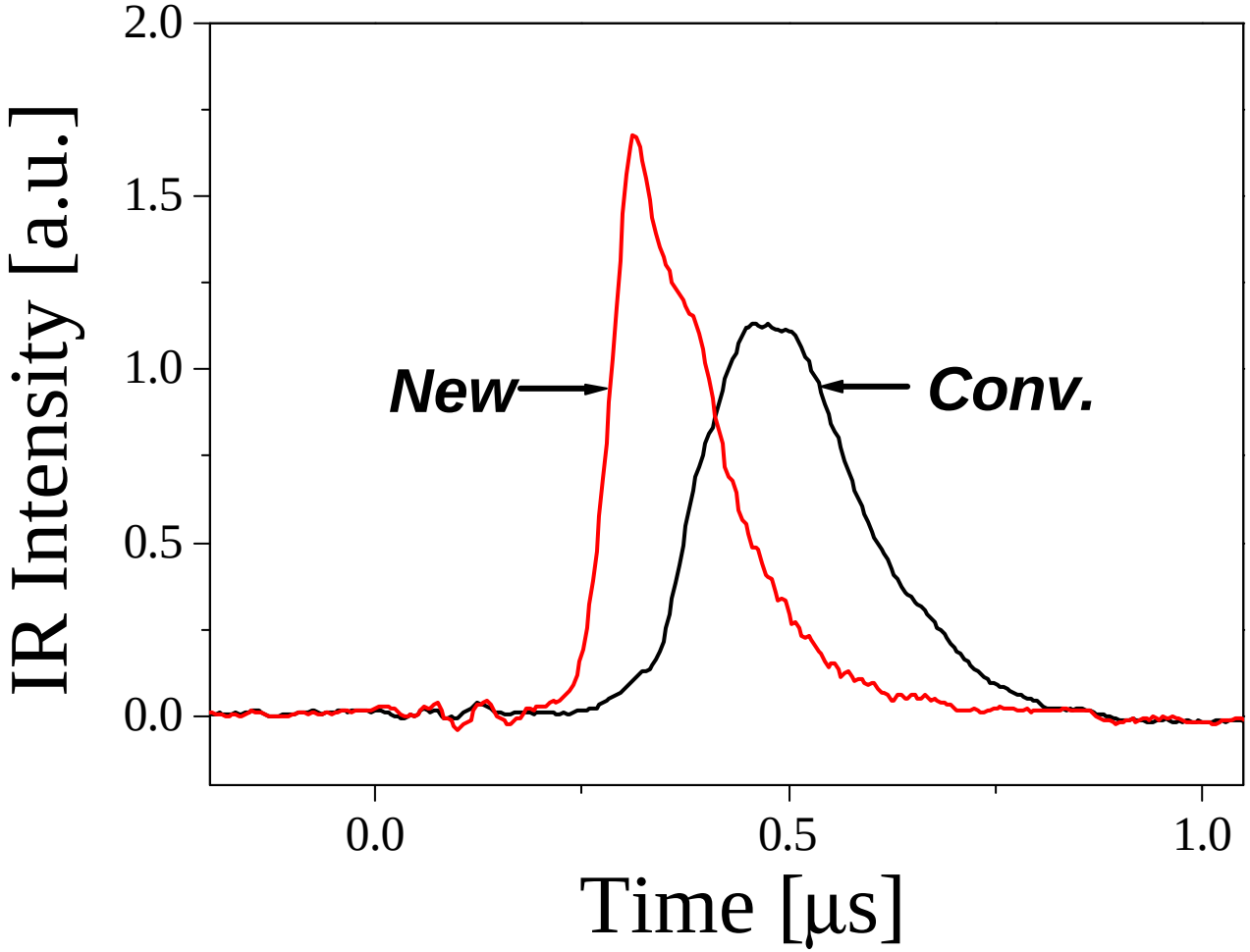


IR Emission Image – Gate Mode

Various Auxiliary Pulse Width (V_{AUX} = 90V)



Changes in Time-Resolved IR Emission



Summary

- *IR emission in a cell is observed from the cross sectional view with ICCD camera.*

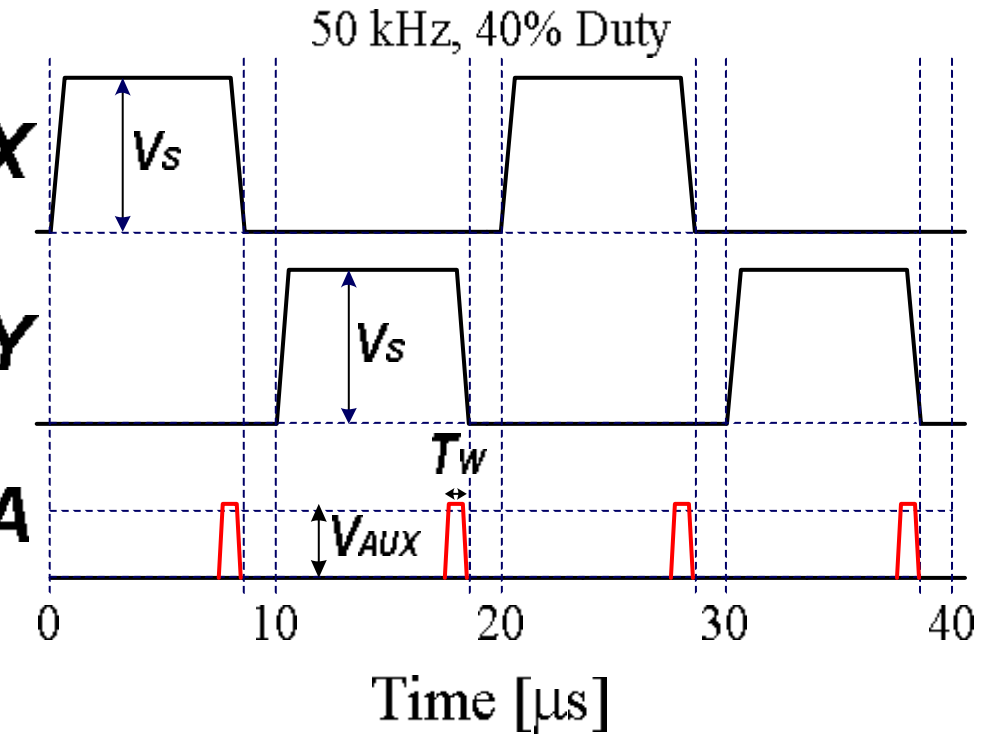
- *These Images clarify that this driving scheme contributes to improving the intensity of IR Emission and extending the area of discharge distribution toward the address electrode.*

- *This direct measurement of discharge phenomena will be helpful to understand the discharge physics, moreover, to achieve high performance in an AC-PDP.*

• IDW ’02, pp.813-816, 2002.

Self-Erasing Discharge Using Auxiliary Address Pulse

Basic Concept



Driving Waveforms

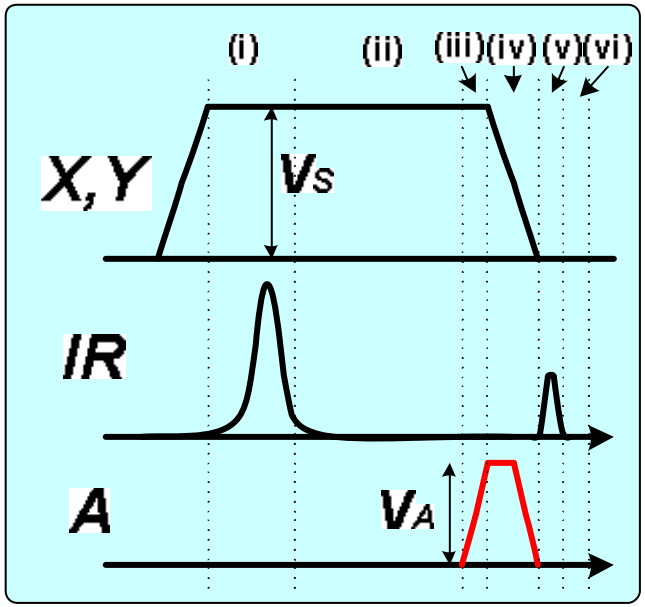
Applying Auxiliary Address Pulse at Falling Edge of Sustain Pulse

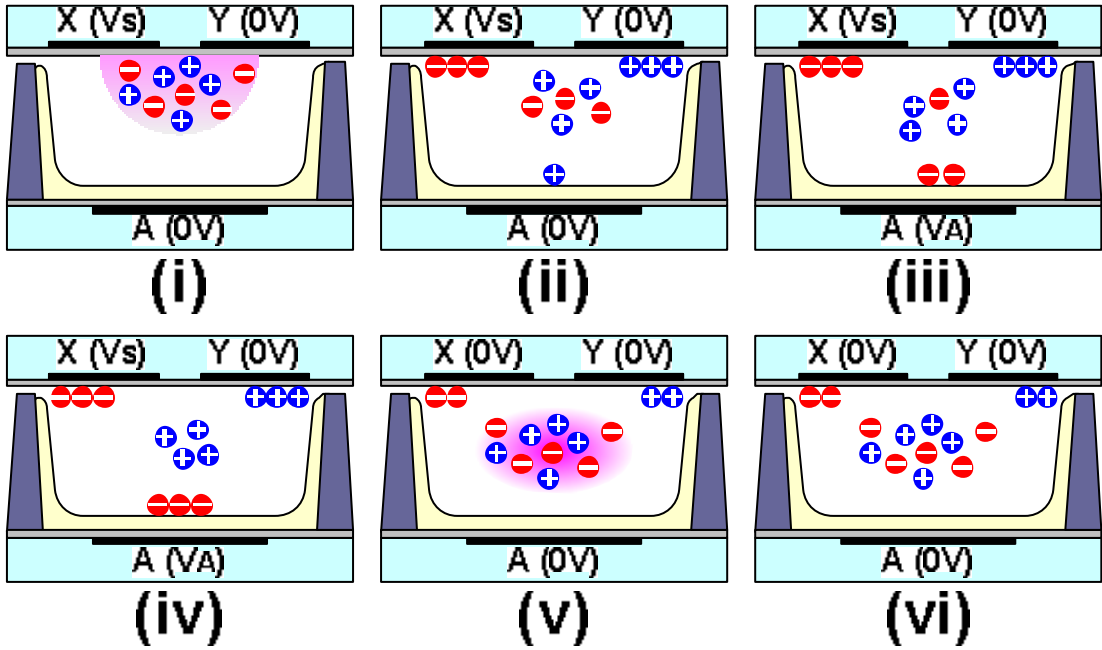
Triggering Effect by Auxiliary Address Pulse

Self-Erasing Discharge

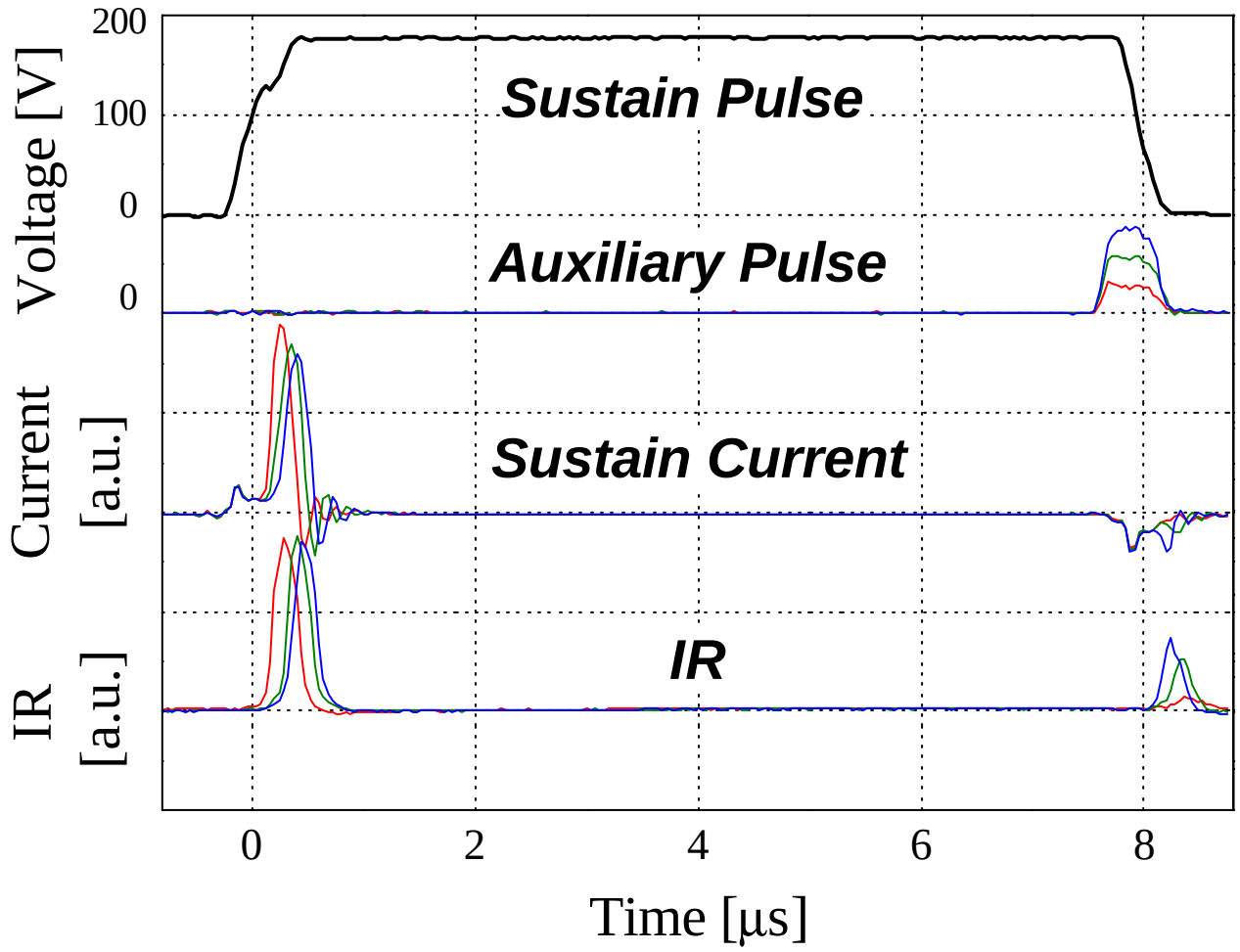
Improvement of Luminance and Luminous Efficiency

Space / Wall Charge Distribution Model

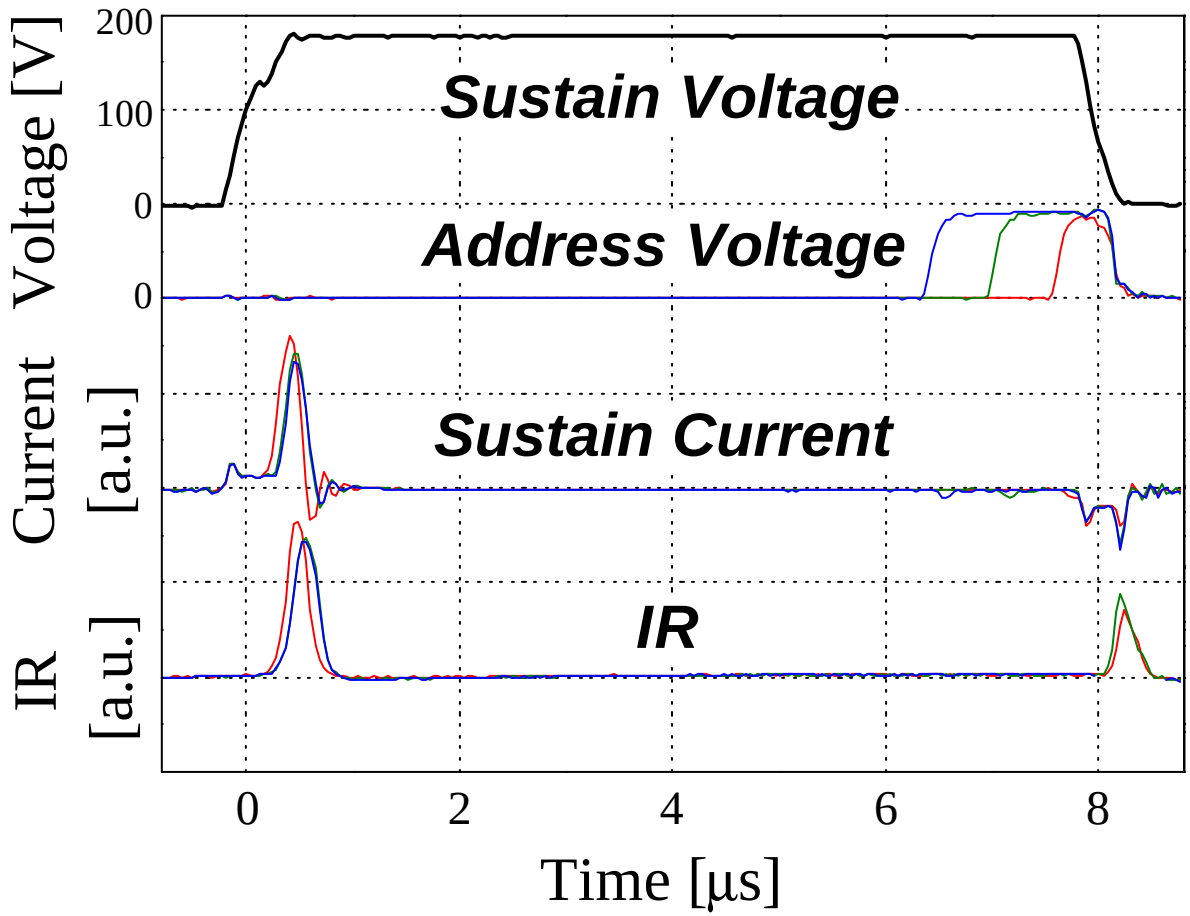




Results – Variation of V_A

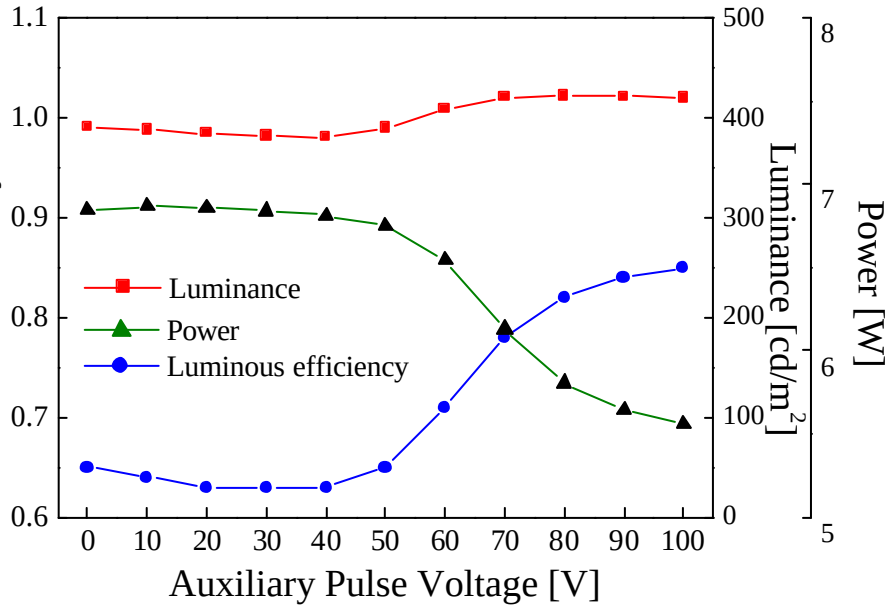


Results – Variation of T_w

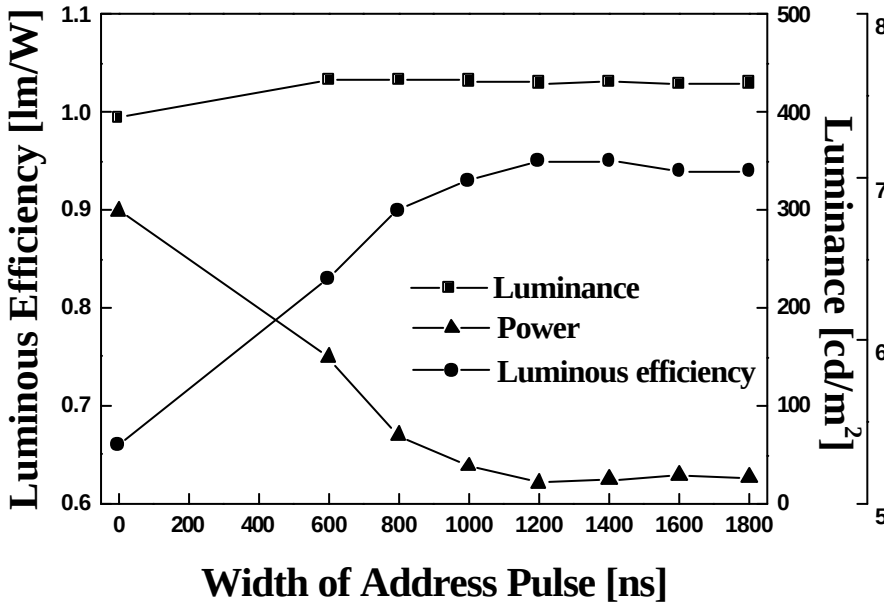


Results - Luminance & Luminous Efficiency

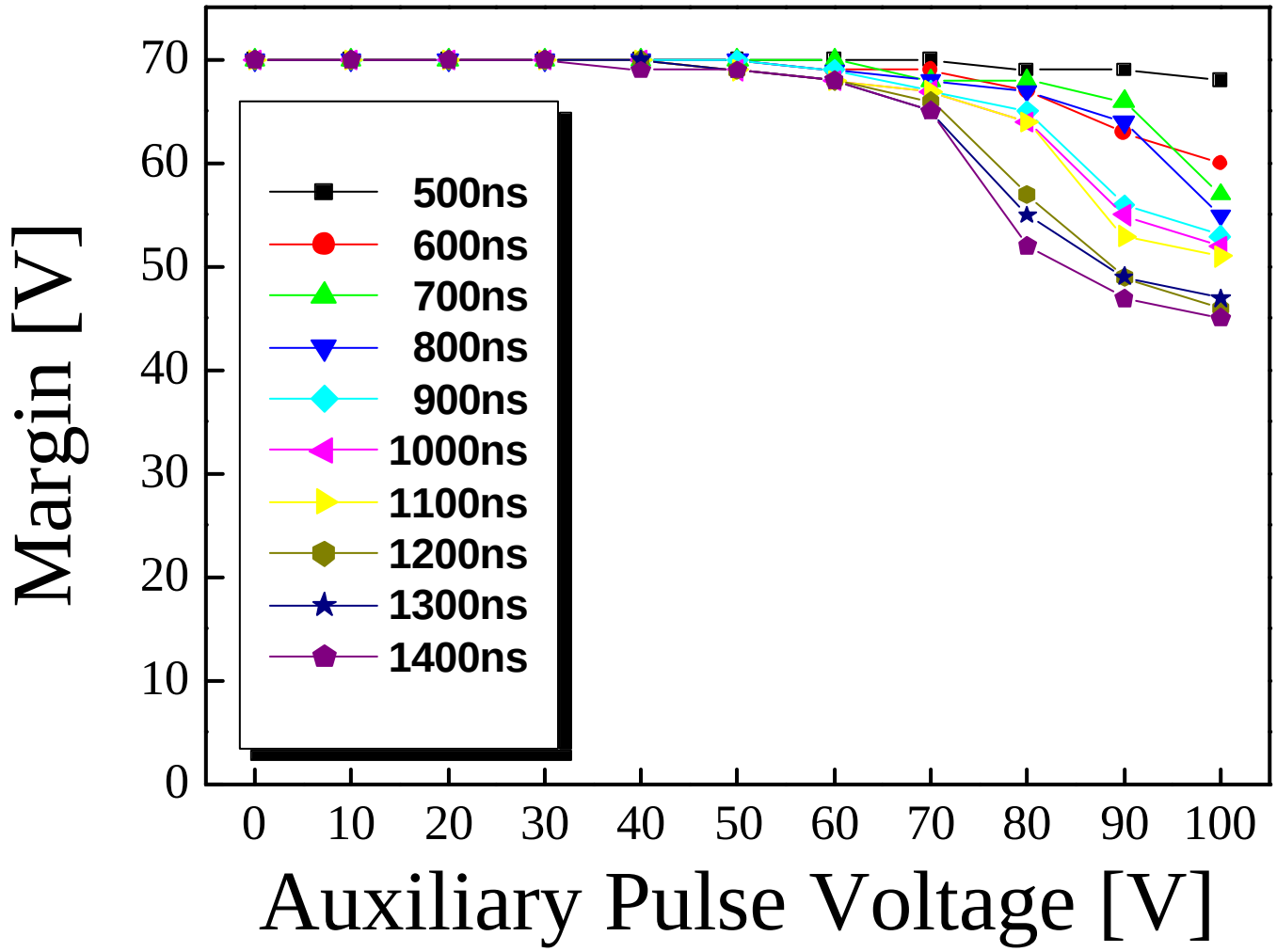
Variation of Auxiliary Pulse Voltage



Variation of Auxiliary Pulse Width



Results - Static Margin



Summary

- *New auxiliary short address pulses for triggering the self-erasing discharge were proposed to improve the luminous efficiency of an ac-PDP.*

- *The effects of the amplitude and width in the proposed auxiliary pulse on the luminance efficiency, luminance, and voltage margin of an ac-PDP were investigated.*

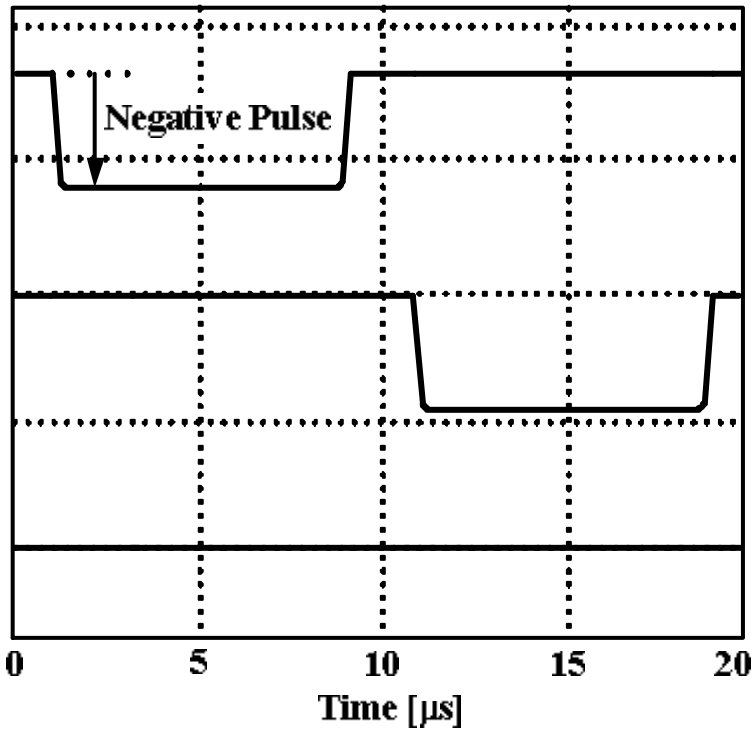
- *By proper adjusting of the amplitude and width of the auxiliary short pulse, an improved luminous efficiency of 26 % and luminance of 8 % were simultaneously obtained under the stable driving voltage margin condition (> 60 V).*

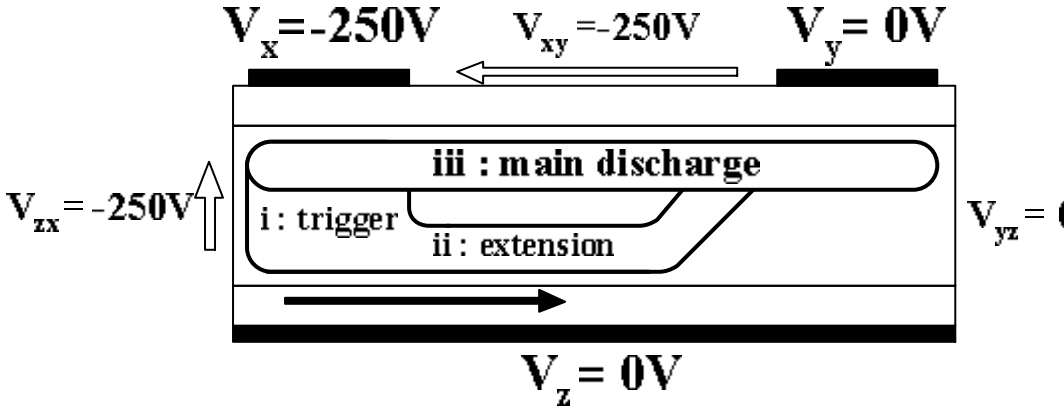
- **SID '02, pp.440-443, 2002.**
- **IEEE Trans. Electron Devices, vol.50, no.2, 2003.**

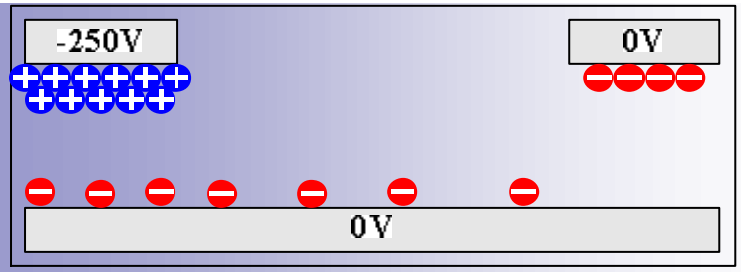
Part III

Improvement of Luminous Efficiency using Long gap Discharge

Positive Column Discharge by Weber(2001)







Discharge process by Weber's negative sustain pulse

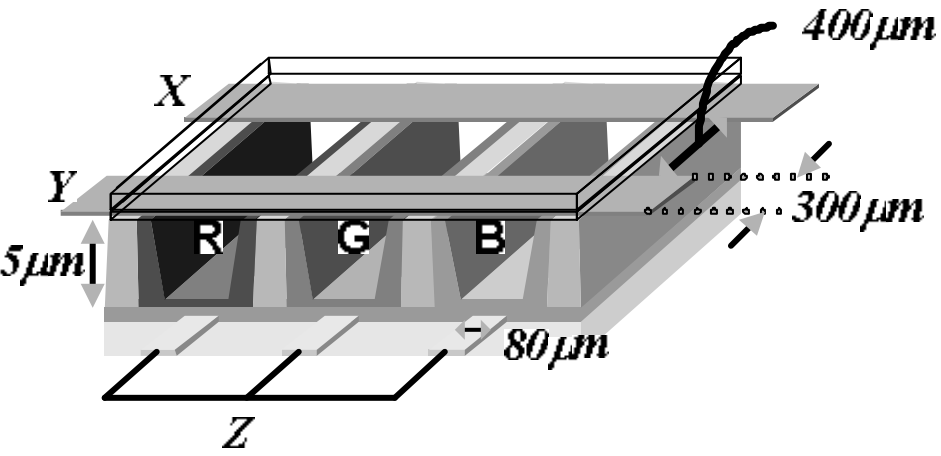
(i) ignition, (ii) extension, (iii) main discharge

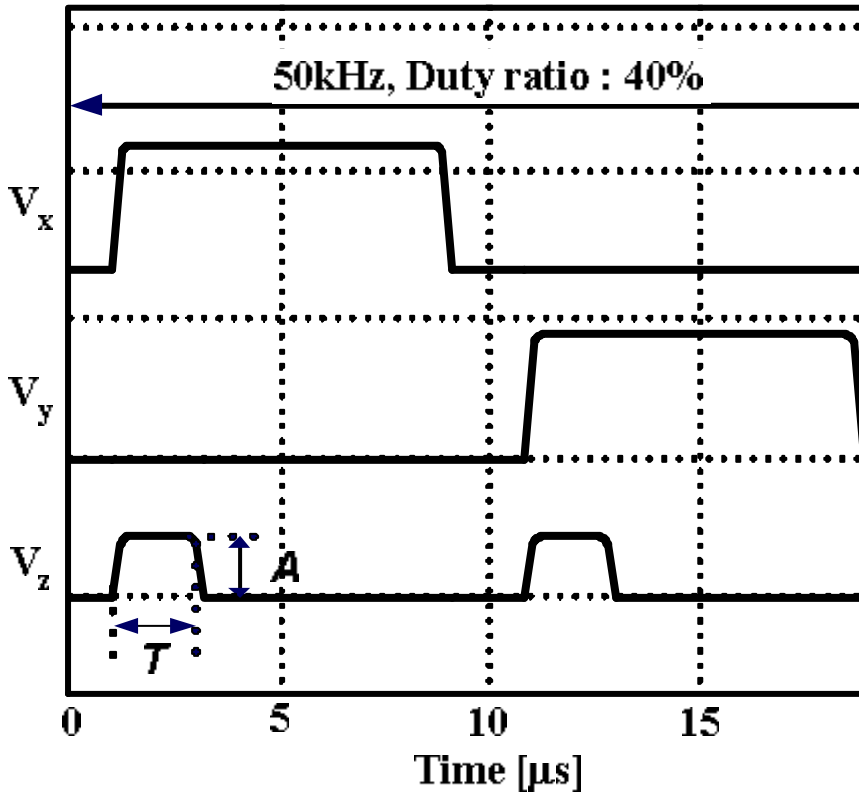
Lower firing/sustaining voltage than X-Y direct discharge

- high secondary emission coefficient of ions
- channel

- **Our experimental result (gap=400 μm)**
  - Luminous efficiency = 0.83 lm/W (V_s=250V)
- ***Problems***
  - *High sustaining voltage : Charged Channel*
  - *Strong triggering discharge below the electrode*
    : fixed XZ voltage

New Long Gap Discharge Mode

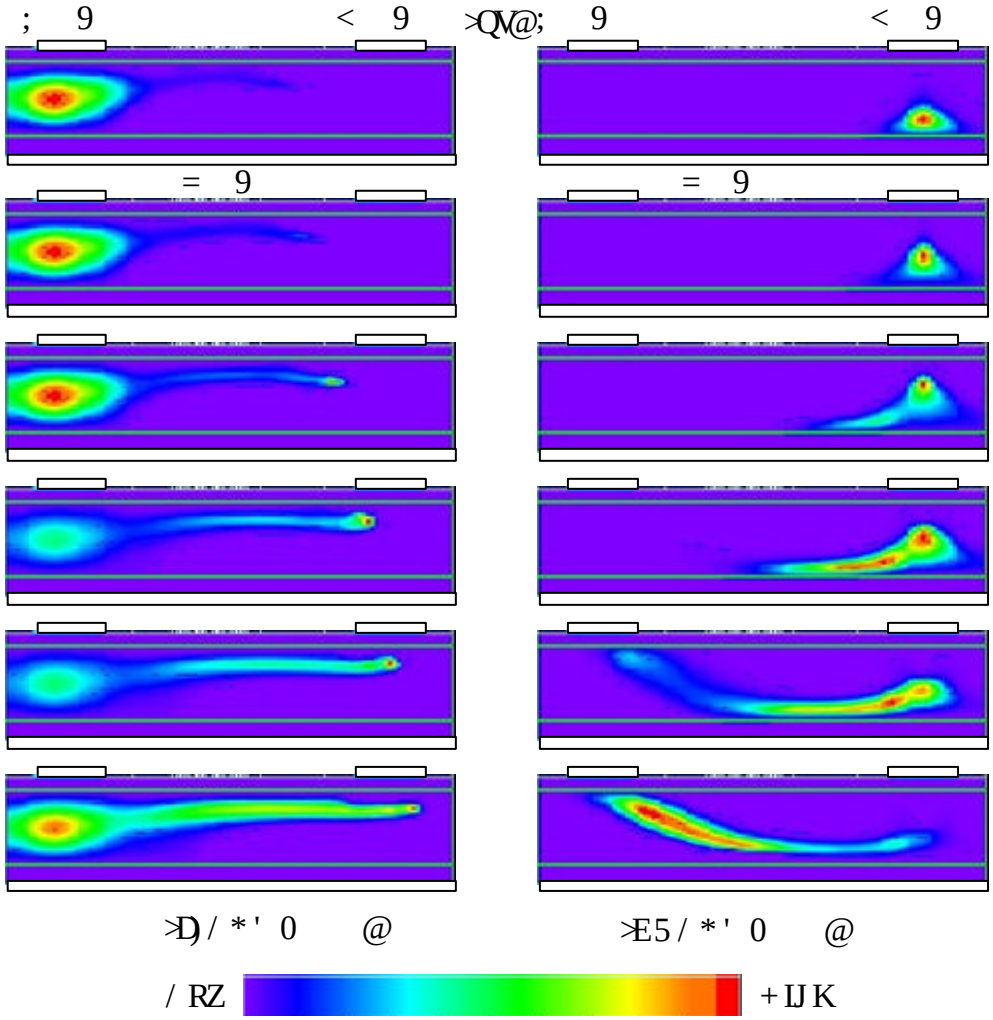




- 7 inch test panel
- Pressure : 500 Torr
- Gas mixture : Ne-Xe(5%)
- Discharge gap : 400 μm
- X, Y width : 300 μm
- Z width 80 μm
- Rib height : 125 μm

- Active Control of voltage distribution among three electrodes
- Using Auxiliary pulse on the address electrode.

Two Discharge Modes (Forward/Reverse)

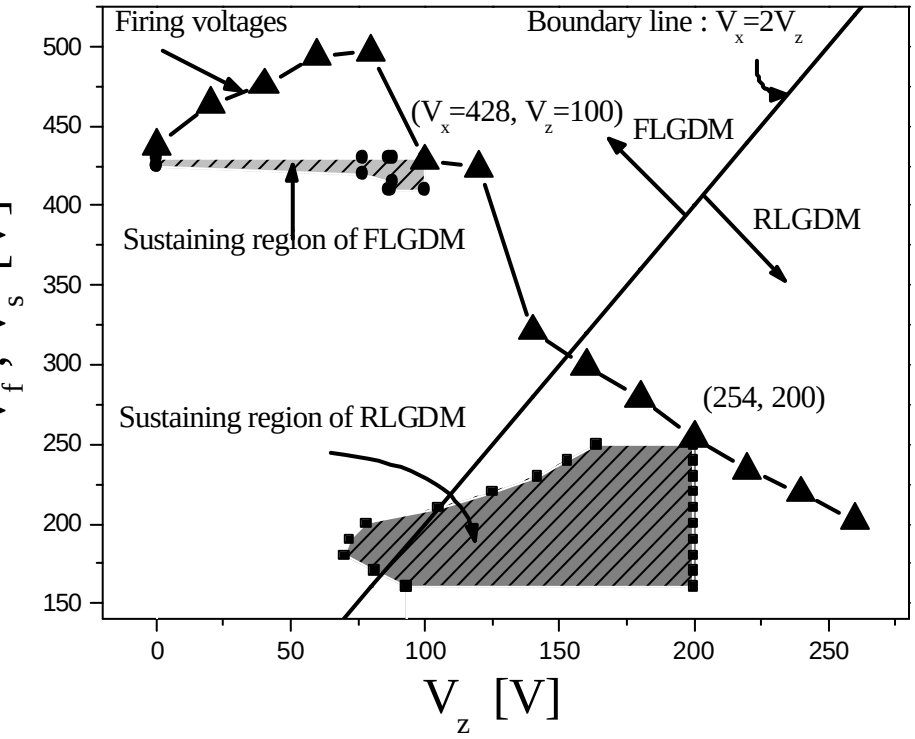


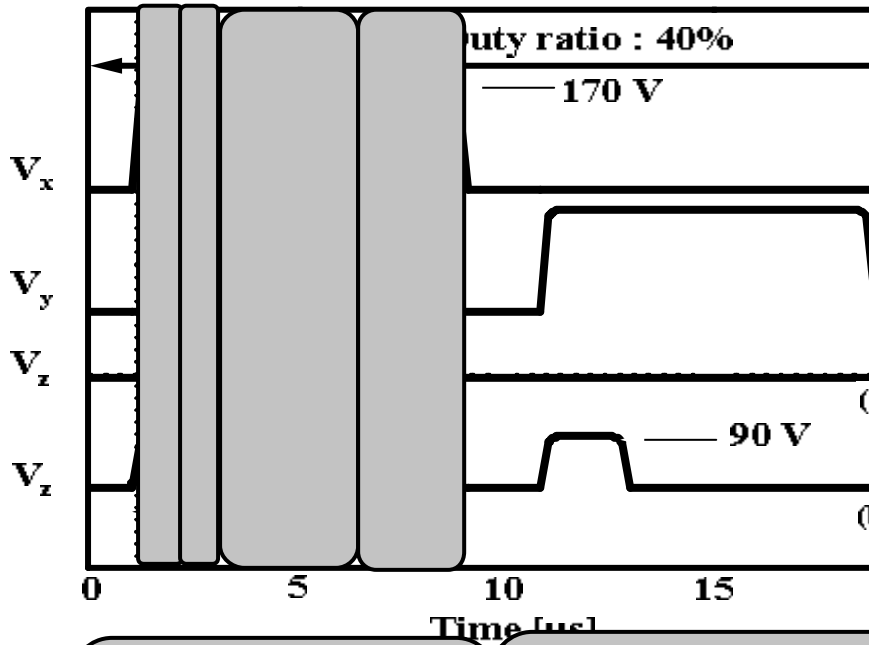
< Simulation Result >

- F.M : $V_x=V_y > 2V_z$
  ($|V_{yz}| < |V_{zx}|$)
- Discharge process
  (i) ignition & diffusion: X – Z
  (ii) main discharge

- R. M. : $V_x=V_y \leq 2V_z$
- ($|V_{yz}| \leq |V_{zx}|$)
- Discharge process
  (i) trigger : Y – Z
  (ii) main discharge

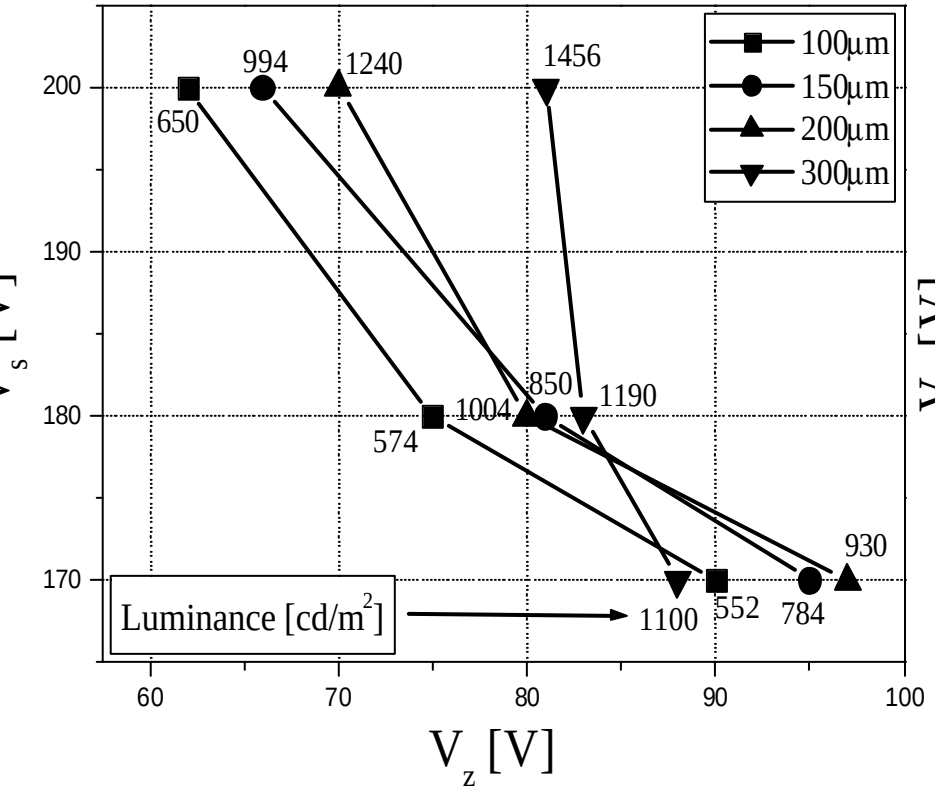
Operational Region

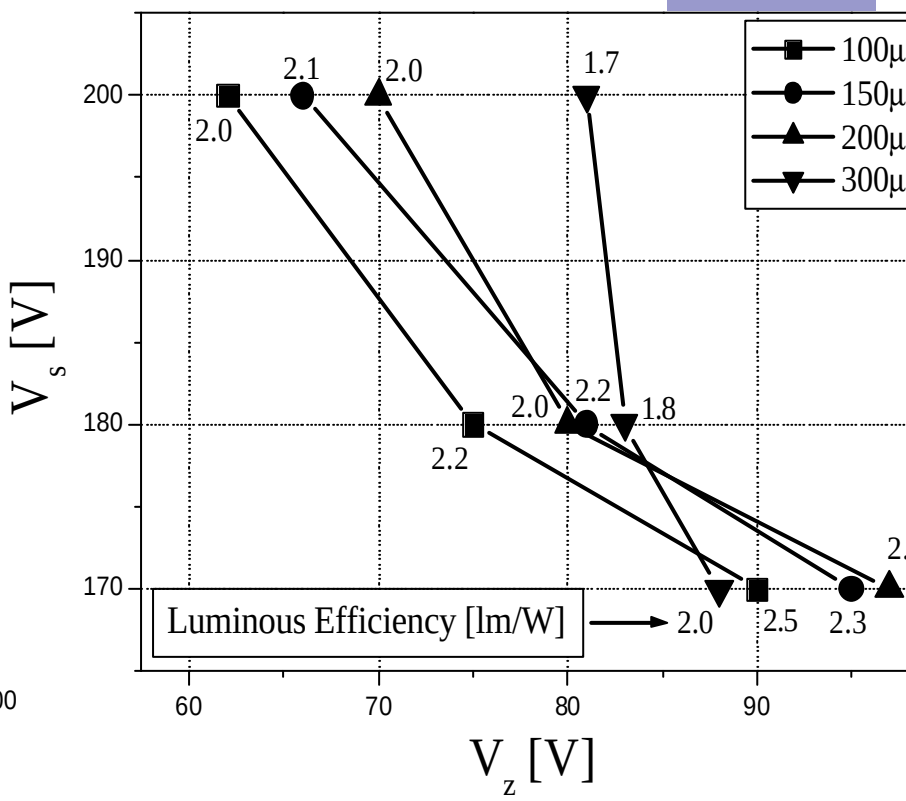




- *Sustainable at V_s=170V, V_z=90V*
  - *evacuation of the channel,*
- *Controllable triggering discharge intensity by V_z*

Luminance & Luminous Efficiency (Gap=400 μm)





- *Wider electrode shows a higher luminance.*
- *Narrower electrode shows a higher luminous efficiency.*
- *Maximum luminous efficiency of 2.5 lm/W (V_s=170V, V_z=90V).*
- *The luminance from 300 μm electrode with the discharge current from 100 μ electrode means 5 lm/W.*

Summary

- *Two different positive column discharge modes (F.M./R.M.) are evaluated based on the control of voltage distribution among three electrodes in ac-PDP.*
- *Low operating voltage (as conventional) is possible in the Reverse Mode.*
- *As a result, under the stable voltage margin condition, the firing and sustain voltages extremely decrease(<170V) and finally, the improved luminous efficiency of about 2.5 lm/W is obtained when the electrode width is 100 μm in R.M.*
- *Until now, it is observed that the discharge is successfully addres sed without misfiring or undesired firing by the suggested driving scheme.*

- SID '03, pp.40-43, 2003.
- IDW'03, pp.837-840,2003.

Part IV

New Cross-Shape Cell Structure for High Luminous Efficiency

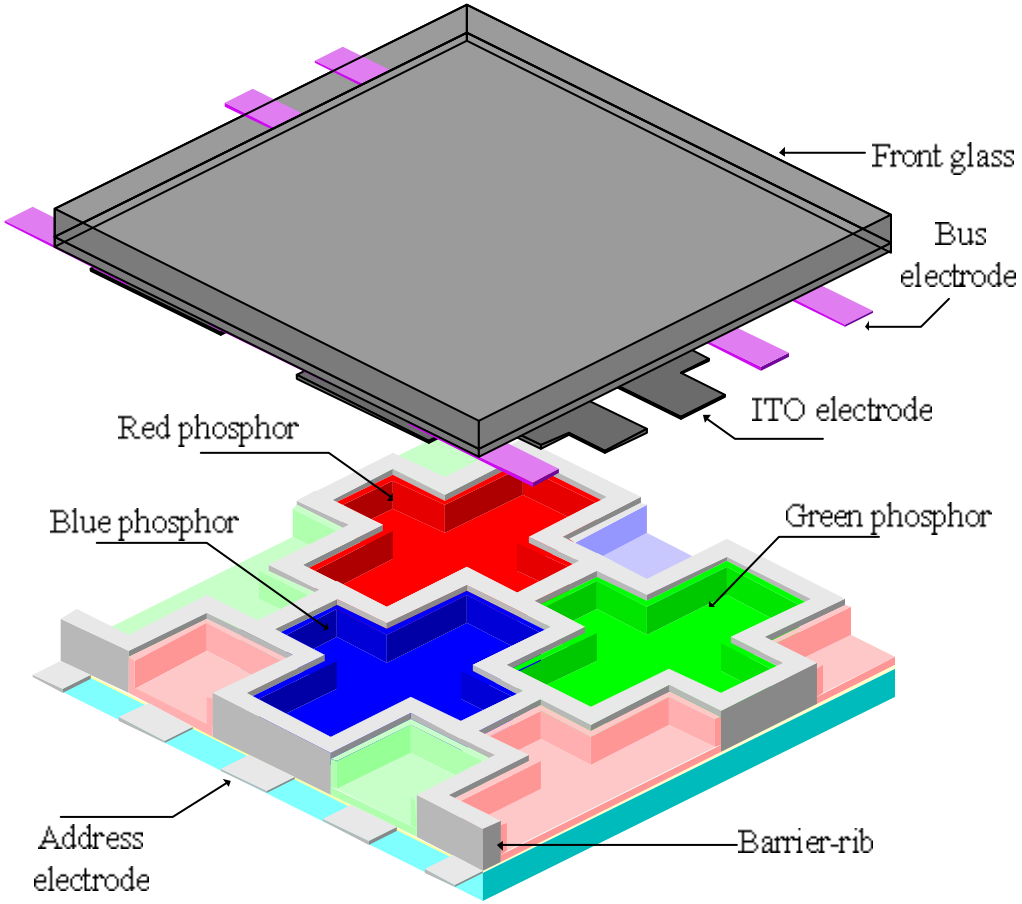
Introduction

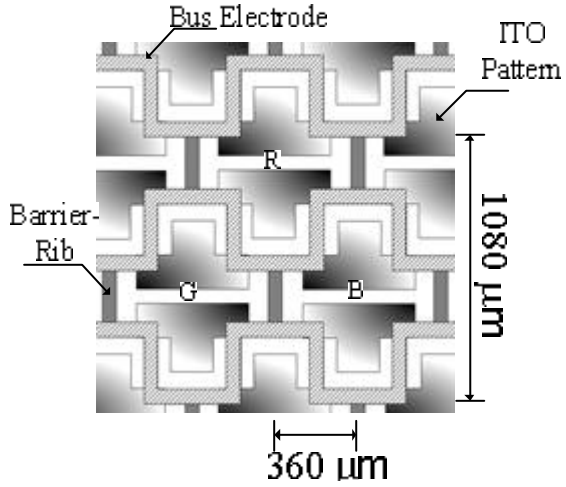
- ***High Efficient Delta Pixel Structures***
  - *– Meander, Rectangular, Hexagonal*
  - ***Maximal use of the discharge area***
  - ***Enlargement of the open area for the visible emission***

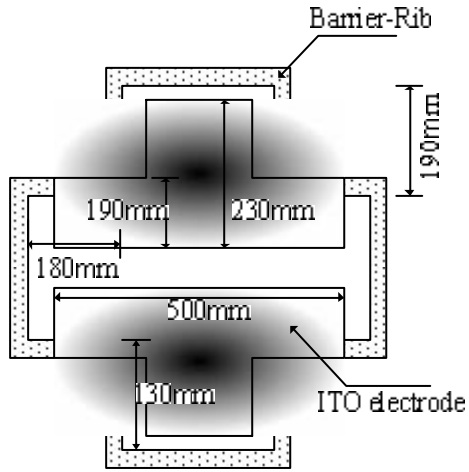
- ***High efficient cross-shaped cell structure having a delta pixel color array is proposed to improve the luminous efficiency of ac-PDP***

- ***The sustain voltage, the luminance, and the luminous efficiency of the new cross-shaped cell structure are examined under various Xe percents and partial pressure conditions***

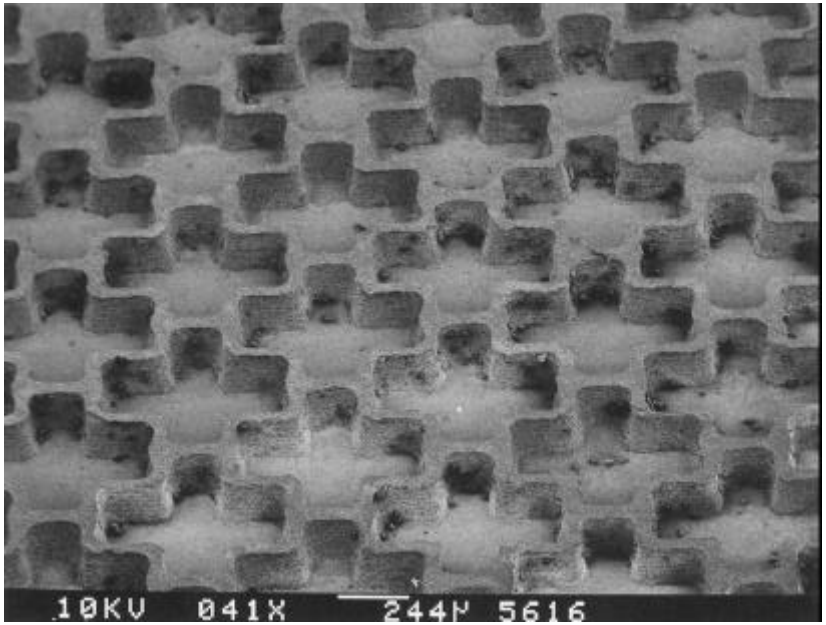
New Cross-shape Cell Structure

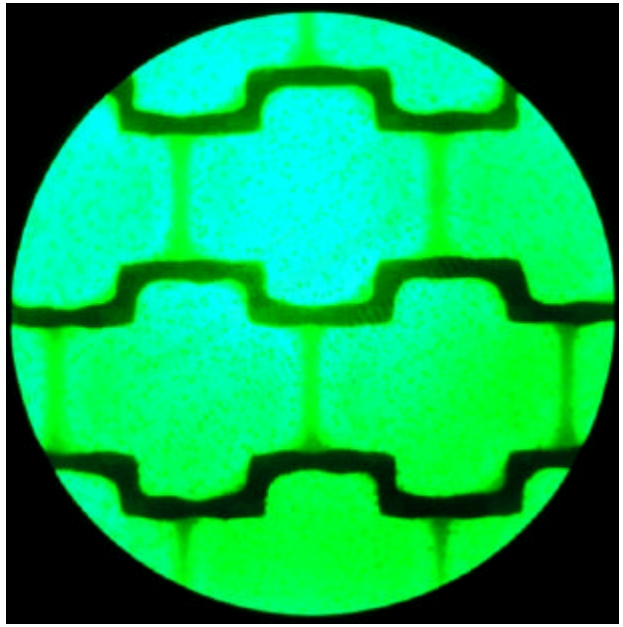






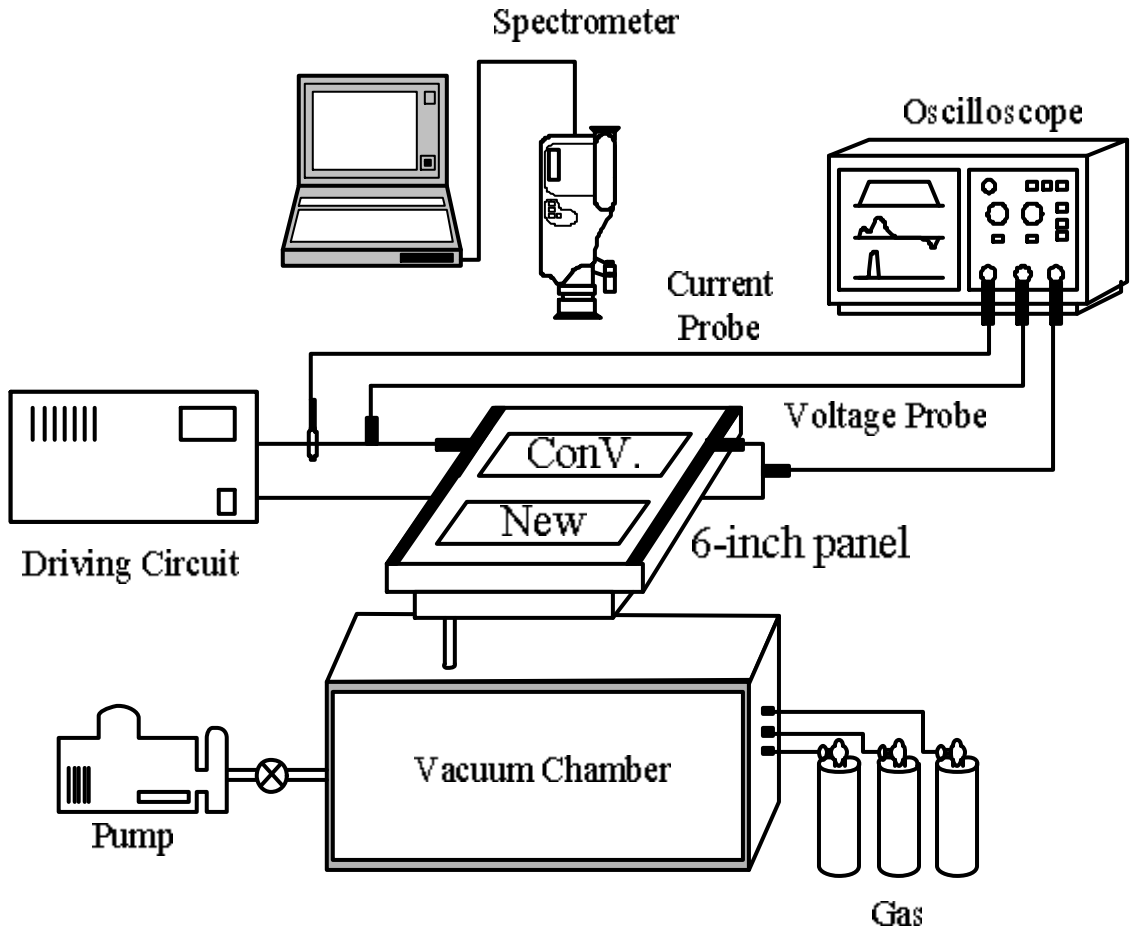
New Cross-shape Cell Structure





- ***SEM and test panel image of cross-shaped cell structure***
  - *Barrier ribs of the test panel are fabricated by sandblasting method*
  - *The height of barrier rib is 120㎛, and the width of the rib is 80㎛*

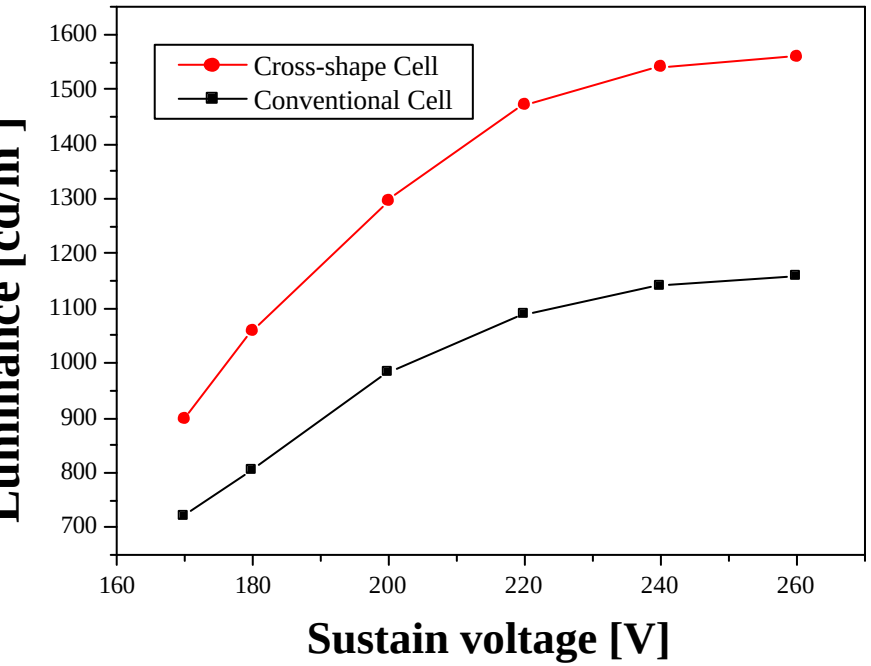
Experimental Setup



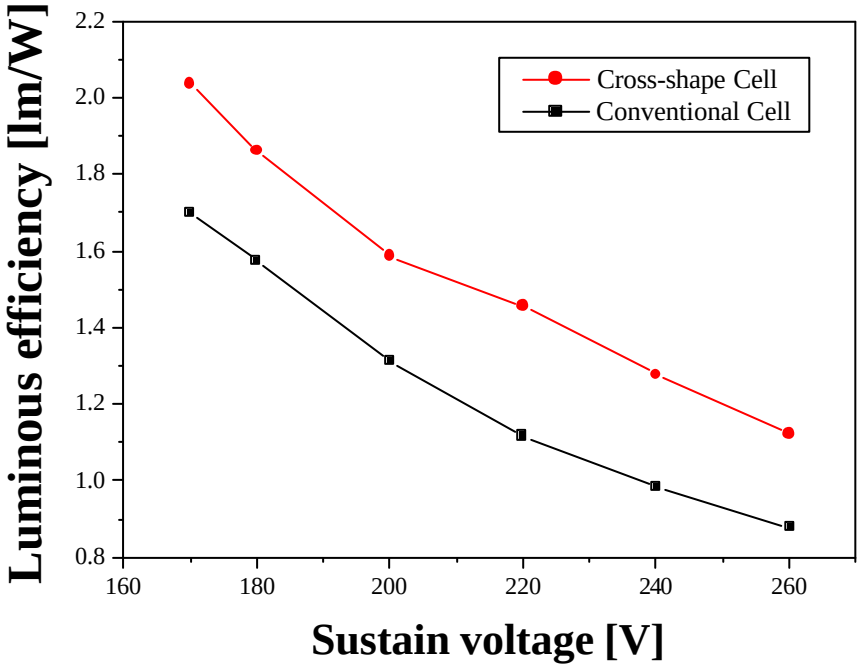
- ***Driving Conditions***
  Freq. : 30KHz
  Duty ratio : 30%
- ***Gas mixture :***
  Ne-Xe (4, 7, 10 %)
  Gas Pressure :
  (300, 400, 500, 600 torr)
- ***Only the green phosphor layers are deposited in the test panel***

Results – Luminance & Luminous efficiency

Luminance

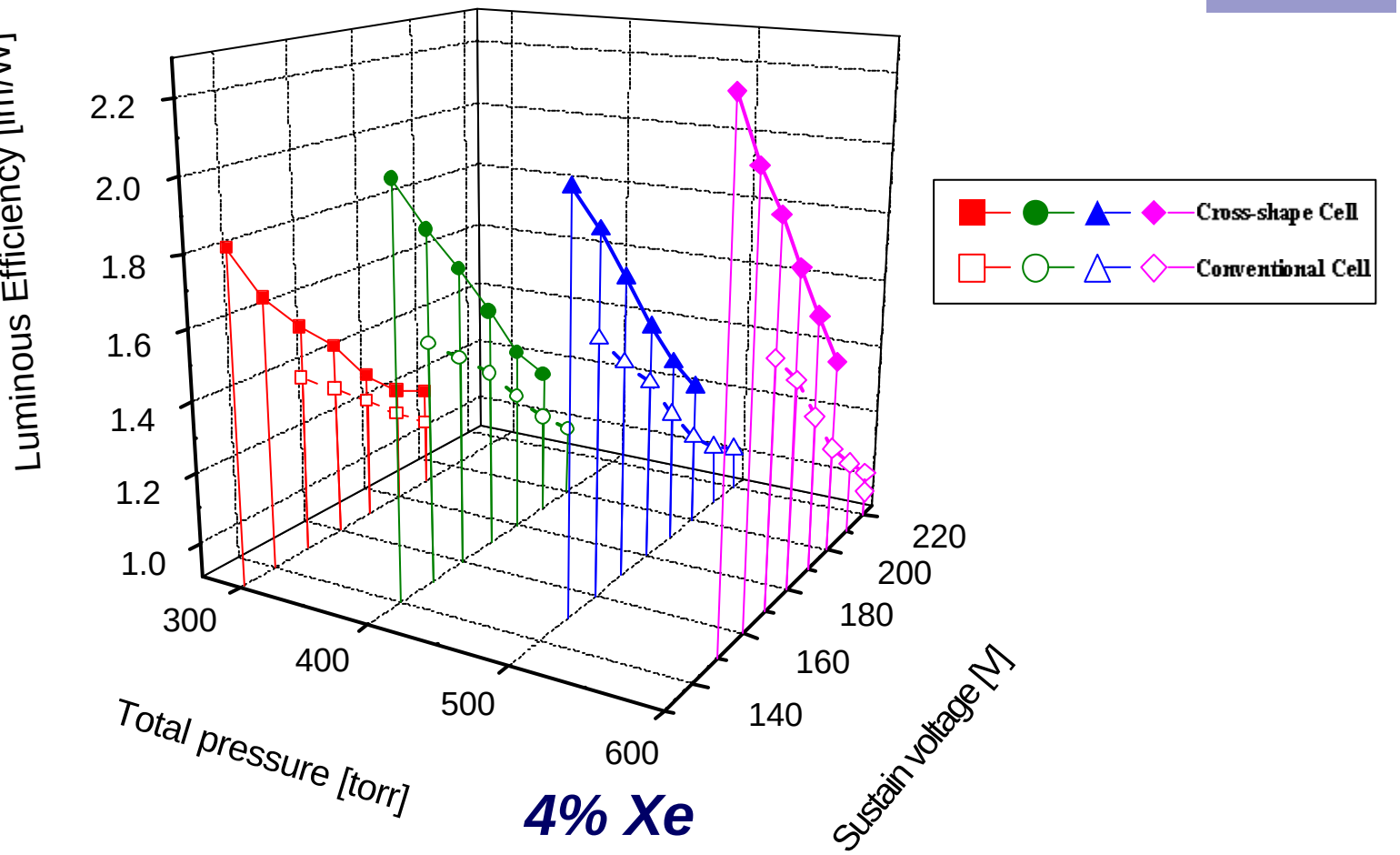


Luminous Efficiency



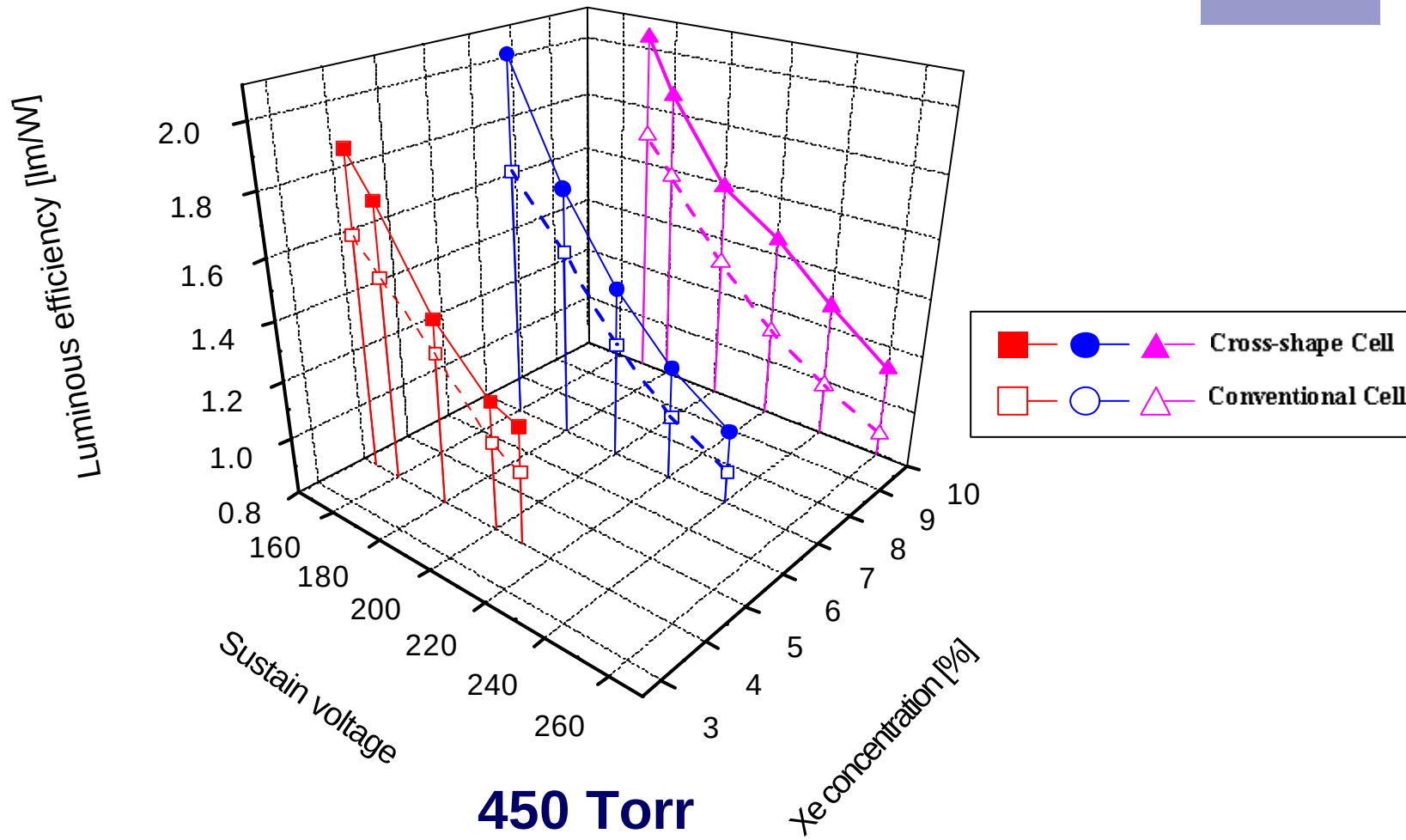
The luminous efficiency of the cross-shape cell with a high Xe percent (10%) is shown to be 2.0 lm/W at the sustain voltage of 170 V

Results – various total pressure



Compared with the conventional structure, the cross-shaped cell structure shows the higher pressure, the higher luminous efficiency

Results – various Xe percents



The luminous efficiencies of the cross-shape cell structure are improved by 20 % at Xe content of 4 %, 27 % at Xe content of 7 % and 30 % at Xe content of 10 %, respectively

Summary

- *A New Cross-Shaped AC PDP Cell with delta pixel array*
  - *Increase of the effective phosphor area*
  - *The luminous efficiency of cross-shape cell was increased much higher than conventional cell when Xe concentration and pressure increase*
  - *This result implies that the new cell structure is suitable for the high Xe discharge*

- *Result* :
  - *The new cross-shaped cell structure shows a higher luminous efficiency (2.2 lm/W at 180V, Xe10%, 600torr) than the conventional stripe-type cell structure (1.5 lm/W at 150V, Xe4%, 400torr)*
  - *The luminous efficiencies of the cross-shape cell structure are improved by 20 % at Xe content of 4 %, 27 % at Xe content of 7 % and 30 % at Xe content of 10 %, respectively*

- **IDW '03, pp.997-1000, 2003.**