

## **Thursday March 9<sup>th</sup>**

10h00 – 12h00	Registration at the conference center The Strip at the High Tech Campus Eindhoven
12h00 – 13h00	Lunch
<b>13h00</b>	<b><u>Welcome</u></b> Opening by Dr. P.E. Wierenga Senior Vice President Philips Research Europe - Eindhoven
<b>13h15</b>	<b>Start session 1 “Electronic Paper”</b>
13h15 – 13h35	<b><u>“Development of 5.1-inch High Speed SVGA Bistable BiNem<sup>®</sup> LCD for Electronic Paper Applications”</u></b> Jacques Angelé, Nemoptic
13h35 – 13h55	<b><u>“Experience the brighter world of visual DNA<sup>™</sup>”</u></b> Michael Ryan, Ntera
13h55 – 14h15	<b><u>“Video-speed electronic paper based on electrowetting”</u></b> Rob Hayes, Liquavista
14h15 – 14h35	<b><u>“A new generation of e-readers takes off”</u></b> Alex Henzen, Irex
14h35 – 14h55	<b><u>“A Computer Simulation and material for Electrophoretic Displays”</u></b> Kimiya Takeshita, Mitsubishi Chemical
14h55 – 15h25	Coffee break
<b>15h25</b>	<b>Start session 2 “3D Displays”</b>
15h25 – 15h45	<b><u>“Novel autostereoscopic displays with user interaction”</u></b> Klaus Hopf, Fraunhofer Institute for Telecommunications (HHI)
15h45 – 16h05	<b><u>“Optimization of wavelength selective parallax barrier displays”</u></b> William Hopewell, NewSight Corporation
16h05 – 16h25	<b><u>“Design of wide viewing freedom flat panel 2D/3D displays”</u></b> Paul May, Ocuity Limited
16h25 – 16h45	<b><u>“Uniformity improvement through fractional view systems”</u></b> Oscar Willemsen, Philips Research Europe
16h45 – 17h05	<b><u>“True 3D displaying with the Holovizio System”</u></b> Tibor Balogh, Holografika Kft.
<b>17h05</b>	<b>Start session 3 “Student Award”</b>
17h05 – 17h35	<b><u>“Student award presentation”</u></b> <b><u>Model for the properties and behaviour of electronic paper</u></b> Tom Bert, TFCG Microsystems – Elintec, Ghent University
17h35	Informal drinks
18h30	Dinner
Estimated time: 21h00	Busses to Eindhoven

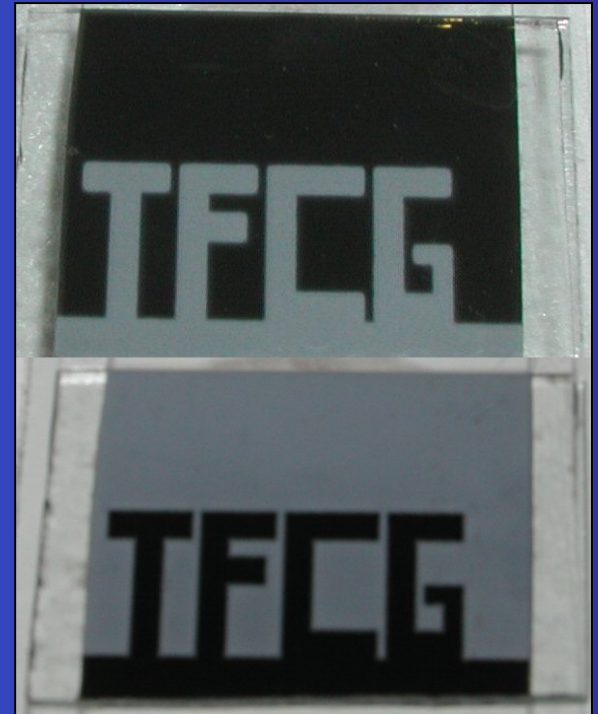
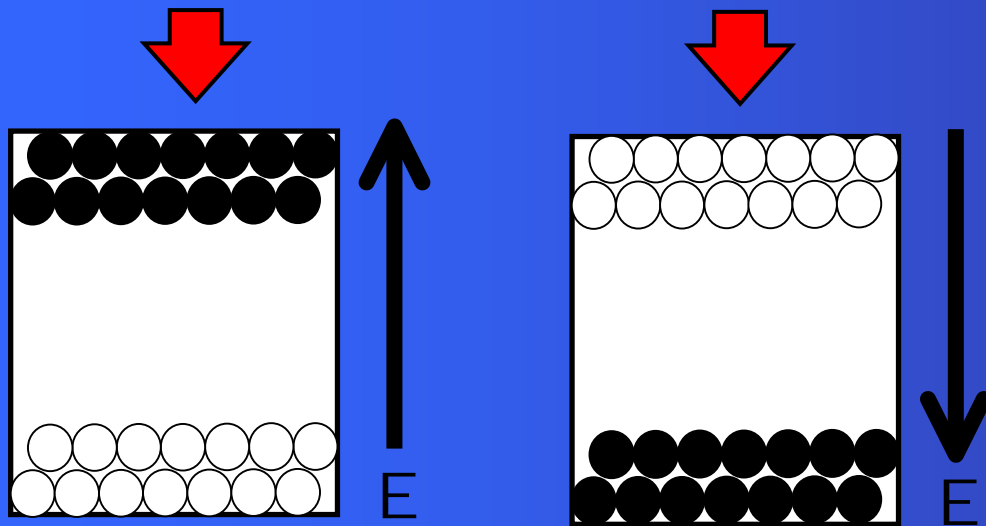
## **Friday March 10<sup>th</sup>**

<b>09h00</b>	<b>Start session 4 “Flexible Displays”</b>
9h00 – 9h20	<a href="#"><b>“TFT Backplanes on Flexible Foils: A Status Report”</b></a> Nicholas Colaneri, Flexible Display Center, Arizona State University
9h20 – 9h40	<a href="#"><b>“Inorganic LTPS TFTs on metal for flexible AM-OLED displays”</b></a> François Templier, CEA-LETI
9h40 – 10h00	<a href="#"><b>“Organic transistors and their application in active-matrix displays”</b></a> Gerwin Gelinck, Polymer Vision
10h00 – 10h20	<a href="#"><b>“Polymers behind the scenes: on how structured polymers enhance your displays”</b></a> Dirk J. Broer, Technical University Eindhoven, Dept. Polymer Technology (SKT)
10h20 – 10h50	Coffee break (including 10h30 the SID-MEC General meeting)
<b>10h50</b>	<b>Start session 5 “Signal Processing”</b>
10h50 – 11h10	<a href="#"><b>“The impact of new display technologies on HDTV broadcasting in Europe”</b></a> Richard Salmon, HDTV Systems Project
11h10 – 11h30	<a href="#"><b>“Mobile Display Signal Processing”</b></a> Petri Nenonen, Nokia Research Center
11h30 – 11h50	<a href="#"><b>“Design consideration of field sequential display”</b></a> Erno Langendijk, Philips Research Europe
11h50 – 12h10	<b>“Display System Architecture for LCD-TV”</b> Gerben Hekstra, Philips Research Europe
12h10 – 12h30	<a href="#"><b>“Precise measurement of the light emission temporal behaviour of flat panel displays”</b></a> Pierre Boher, Eldim
12h30 – 13h30	Lunch
13h30 – 14h00	<a href="#"><b>Introduction MiPlaza and open innovation</b></a> Gerjan van de Walle and Hans Naus, High Tech Campus Eindhoven
14h00 – 14h05	Announcements
14h05 – 15h30	Visit MiPlaza, demonstrations and sponsor booths in sub-groups
15h30 – 16h30	Visit to the OTB company: OLED manufacturing line near Eindhoven airport

# **Model for the properties and behavior of electronic paper**

T. Bert, V. Degezelle, G. Van Steenberge, S. Van Put, P. Geerinck & H. De Smet

TFCG Microsystems – Elintec  
Ghent University

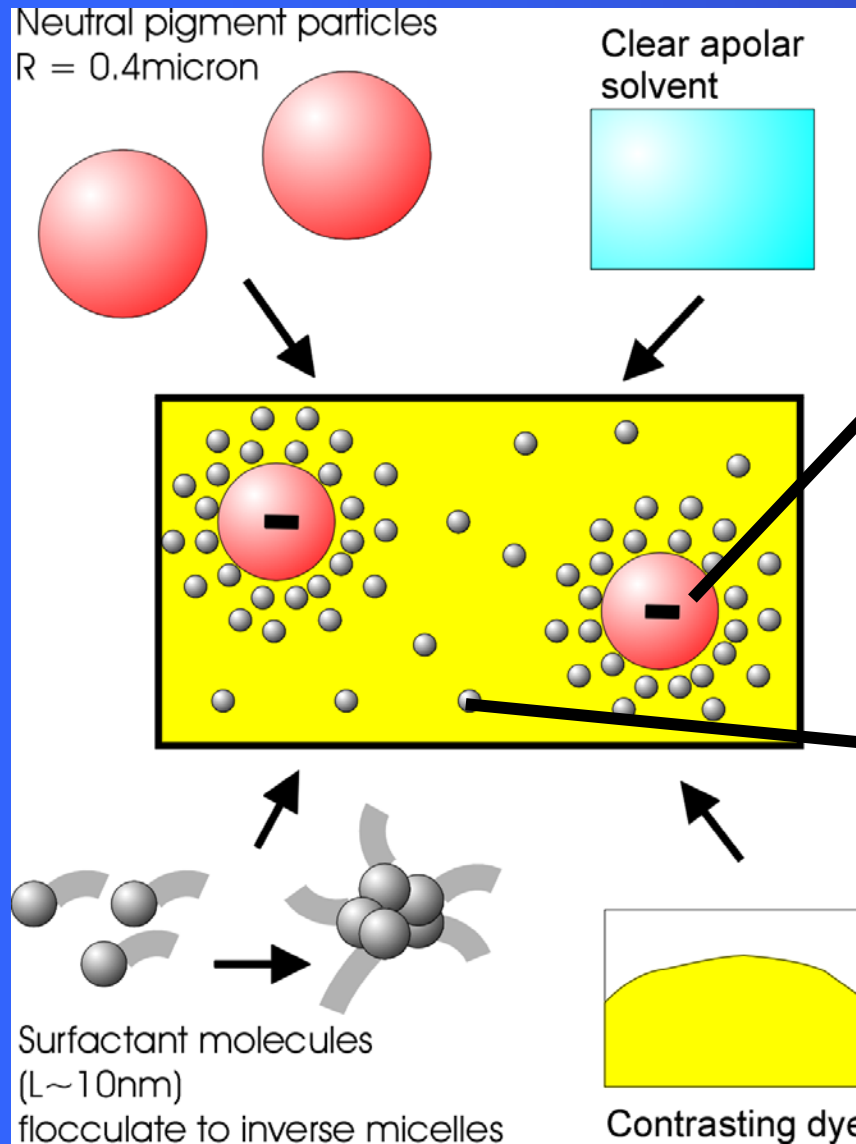




- bistability
- lightweight
- readability
- flexibility

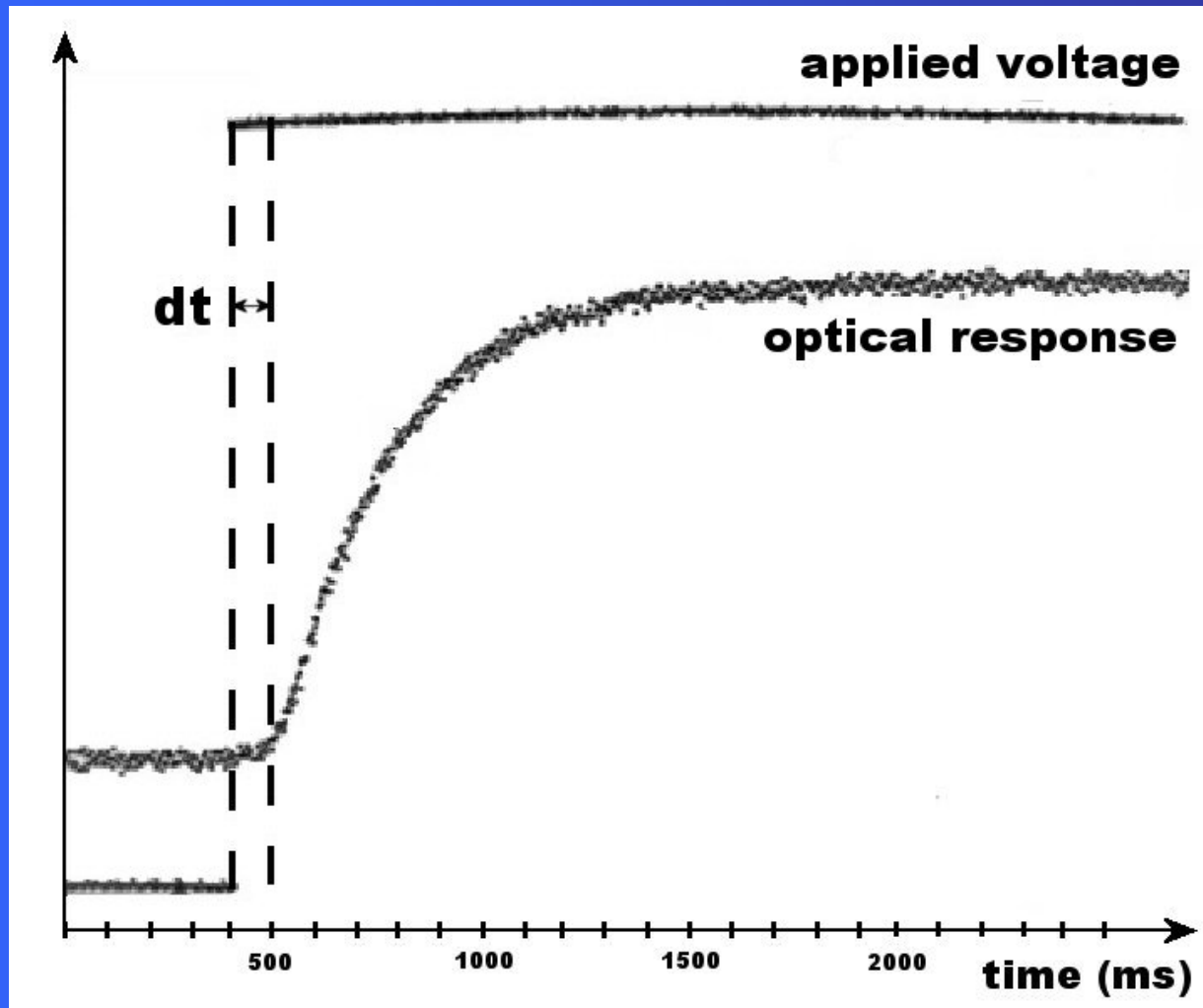


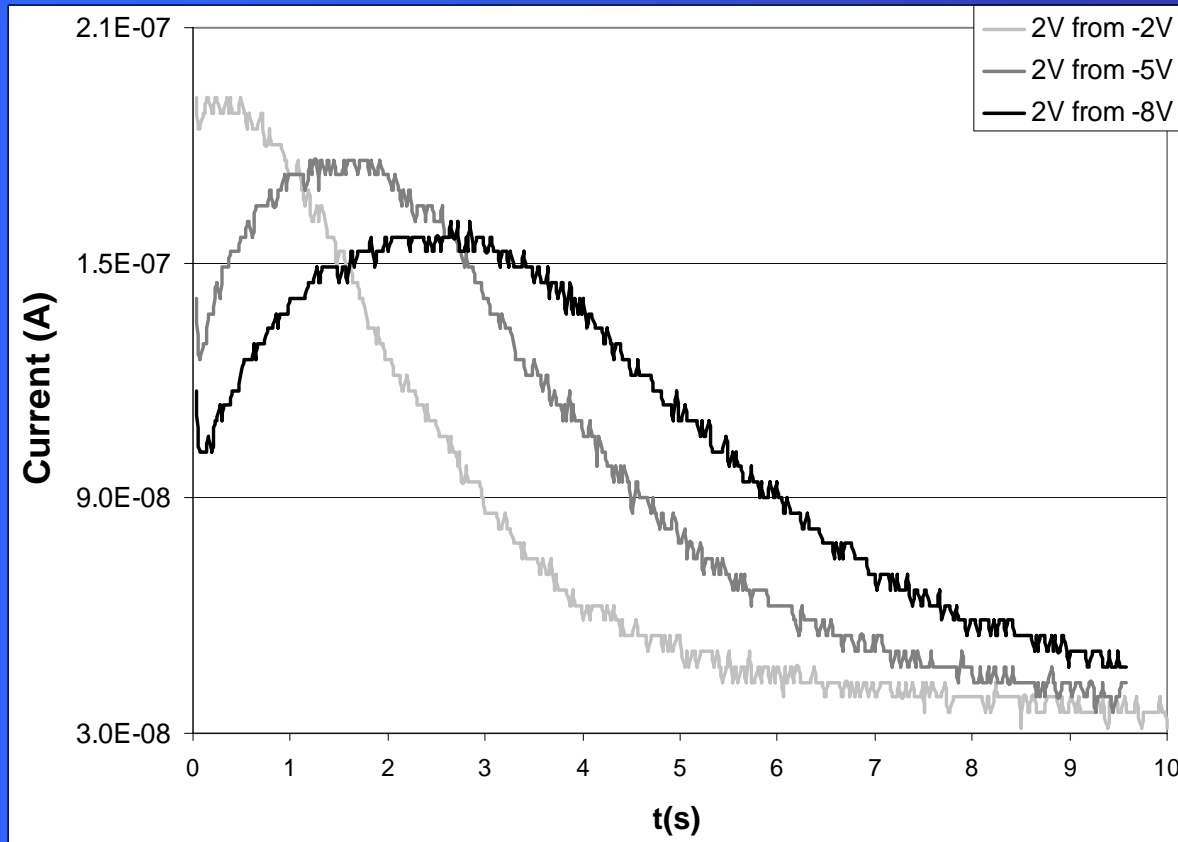
- switching speed
- no threshold
- no colour
- electrochemical complexity



Pigments:  
optical response

Micelles:  
electrical response  
and ...





Current peak broadens, becomes lower, later and more pronounced.

- Optimization of switching speed is pure chemical and physical process
- Intelligent display design
- Investigation of other display materials

There is a need for better understanding of display properties and a means to model behavior

- Gaussian distribution: average value measures drift, standard deviation measures diffusion.
- one-dimensional simulation: pixel dimension parallel to the field is much smaller than perpendicular.

$$n(x, t) = \frac{N}{\sqrt{2\pi} v_{diffusion} t} e^{-\frac{1}{2} \frac{(x - v_{drift} t)^2}{(v_{diffusion} t)^2}}$$

From charged particle distribution:  
transient currents, voltage dependence, ...

$$v(x, t, V_1, V_2) = \frac{dx}{dt} = \frac{\frac{dn(x, t, V_1, V_2)}{dt}}{\frac{dn(x, t, V_1, V_2)}{dx}}$$

$$J(t, V_1, V_2) = \int_0^d v(x, t, V_1, V_2) n(x, t, V_1, V_2) dx$$

From pigment distribution: delay time, switching speed,...

$$I(t, V_1, V_2) = I_0 s \int_0^t R(t_d) \left[ \int_0^d n(x, t - t_d, V_1, V_2) e^{-\alpha a(d-x)} dx + \int_d^\infty n(x, t - t_d, V_1, V_2) dx \right] dt_d$$

$$\varepsilon_0 \varepsilon_r \nabla E = \varepsilon_0 \varepsilon_r \frac{dE}{dx} = \rho(x) = n(x)e$$

$$\Delta E(t) \approx \frac{NQ}{\varepsilon} \frac{1}{\sqrt{2D}} \frac{1}{\left( t + \frac{Q^* cst}{8\pi\varepsilon DV_1} \right)^{1/2}}$$

Reduce charge to increase field strength: centrifugation

$$R(t_d) = \frac{1}{\sqrt{2\pi}\sigma_{delay}} e^{-\frac{1}{2} \frac{(t_d - T_{delay})^2}{(\sigma_{delay})^2}}$$

$$T_{delay} = \frac{\Delta s}{\mu} \frac{1}{\frac{V_2}{d} - N \sqrt{\frac{4\pi Q}{\epsilon^* c s t}} \sqrt{V_1}}$$

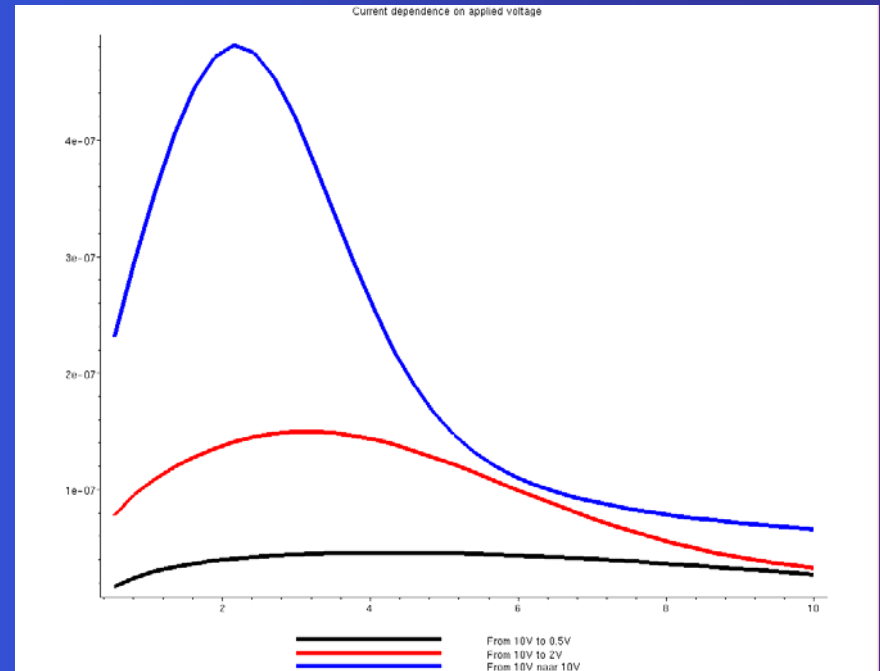
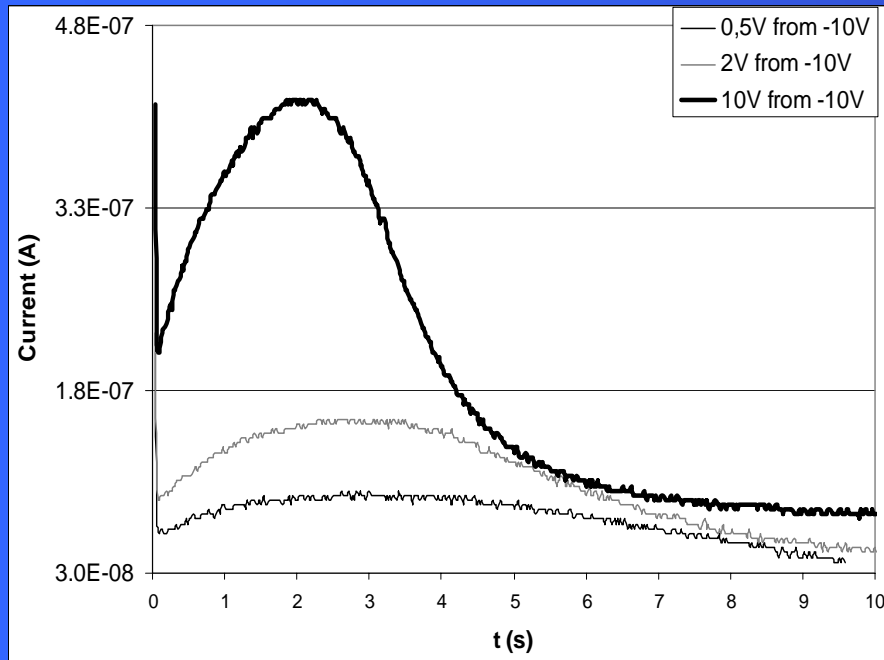
$$D = \frac{kT}{q} \mu$$

$$\mu = \frac{Q}{6\pi\eta R}$$

Link between model parameters (diffusion velocity, drift velocity,...) and real parameters (viscosity, temperature, charge, pigment radius,...)

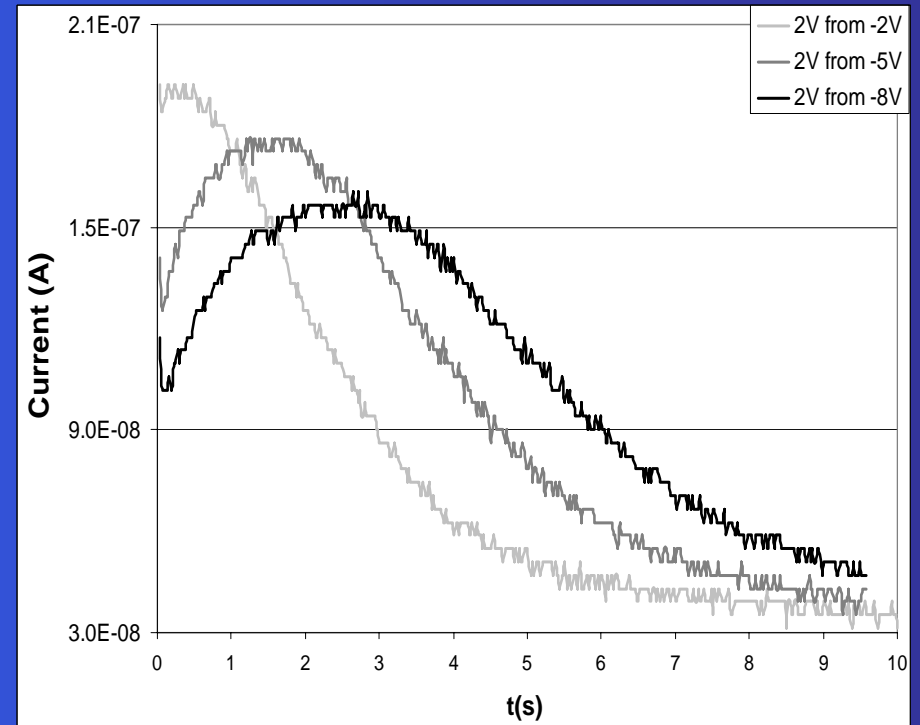
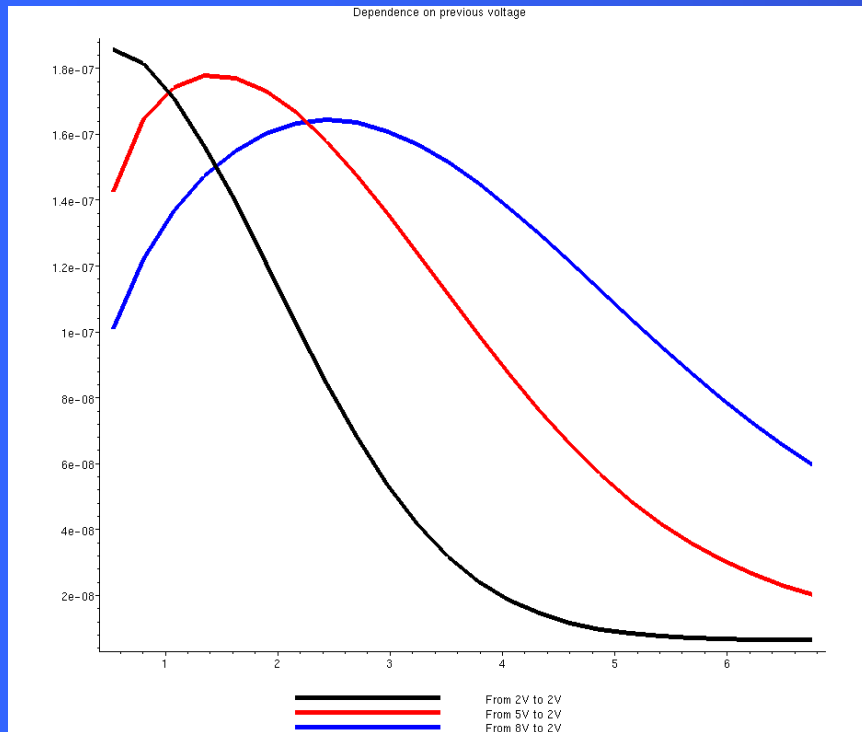
# Results

## Dependence on applied voltage



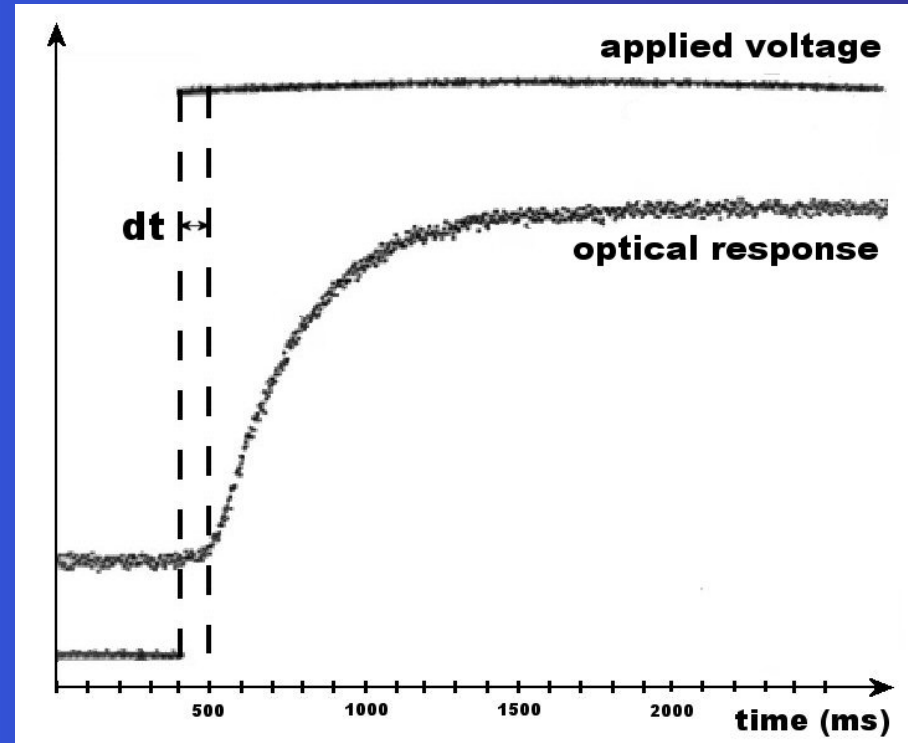
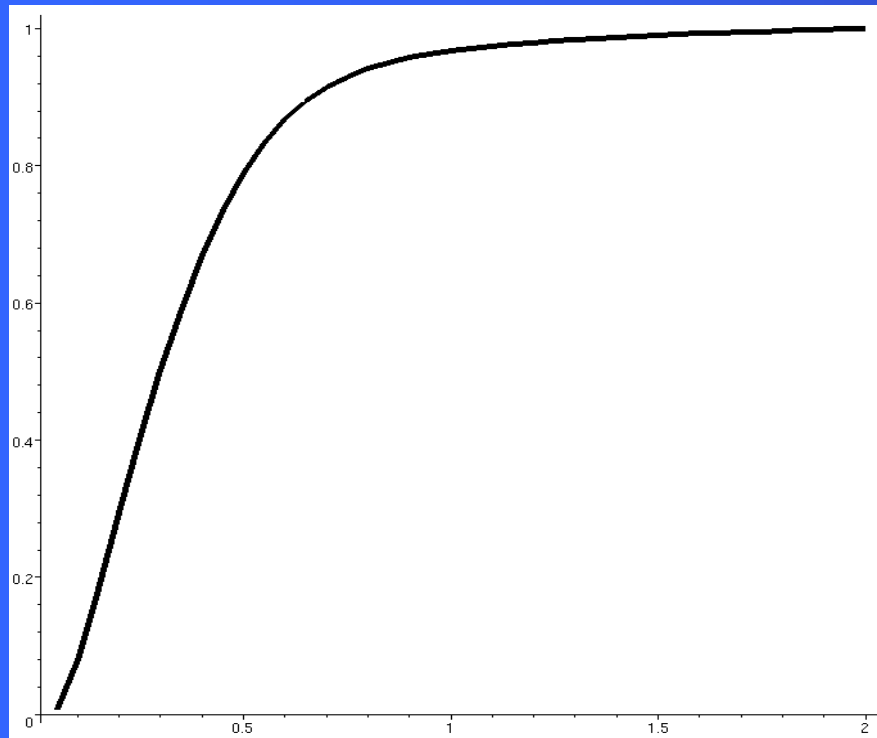
# Results

## Dependence on previous voltage



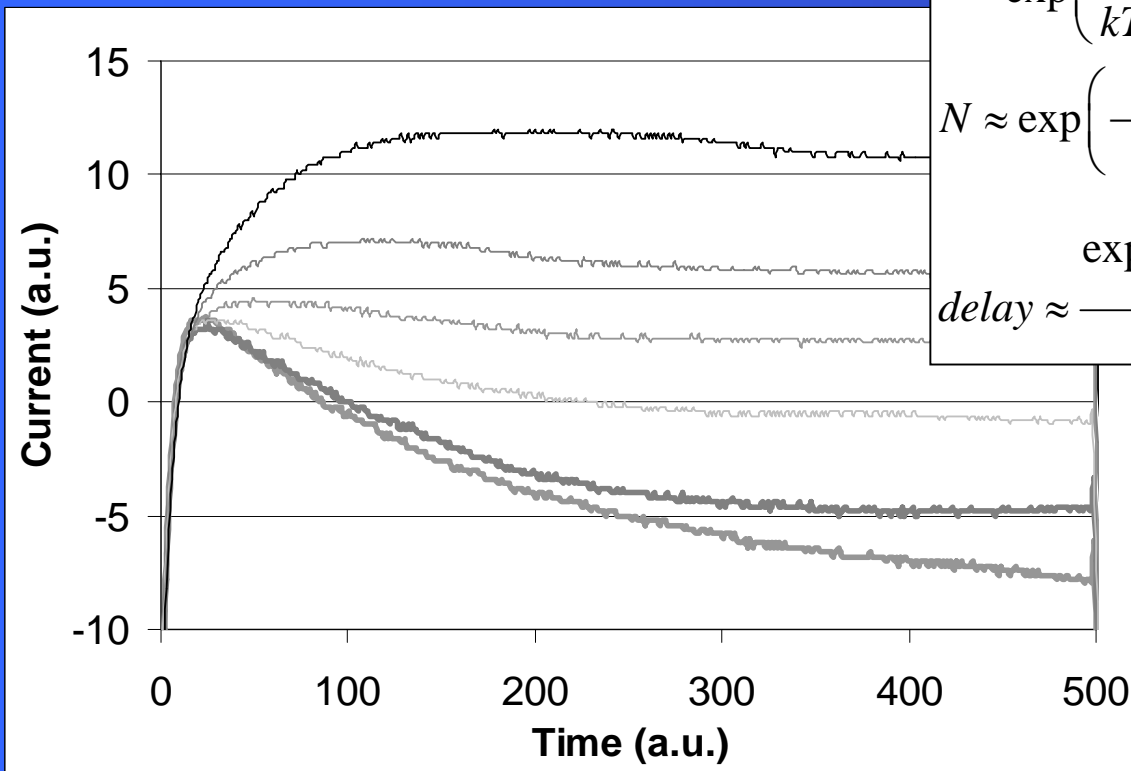
# Results

## Optical response



# Results

## Temperature dependence



$$\eta \approx \exp\left(\frac{E_1}{kT}\right)$$

$$\nu \approx \frac{T}{\exp\left(\frac{E_1}{kT}\right)} = T \exp\left(-\frac{E_1}{kT}\right)$$

$$N \approx \exp\left(-\frac{E_2}{kT}\right)$$

$$\text{delay} \approx \frac{\exp\left(\frac{E_1}{kT}\right) \exp\left(-\frac{E_2}{kT}\right)}{T} = \frac{\exp\left(-\frac{E_2 - E_1}{kT}\right)}{T}$$

# Conclusion

Electrical & Optical simulation of EPIDs

Physical, measurable parameters are used

Importance of field screening and centrifugation

→ Optimize displays production