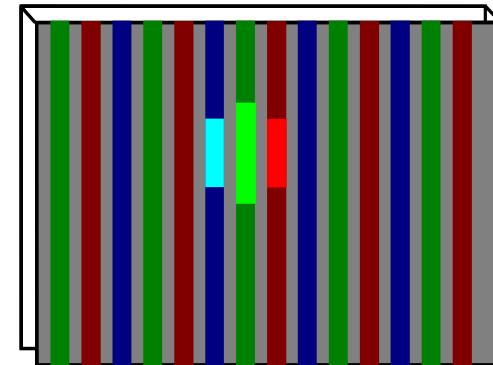
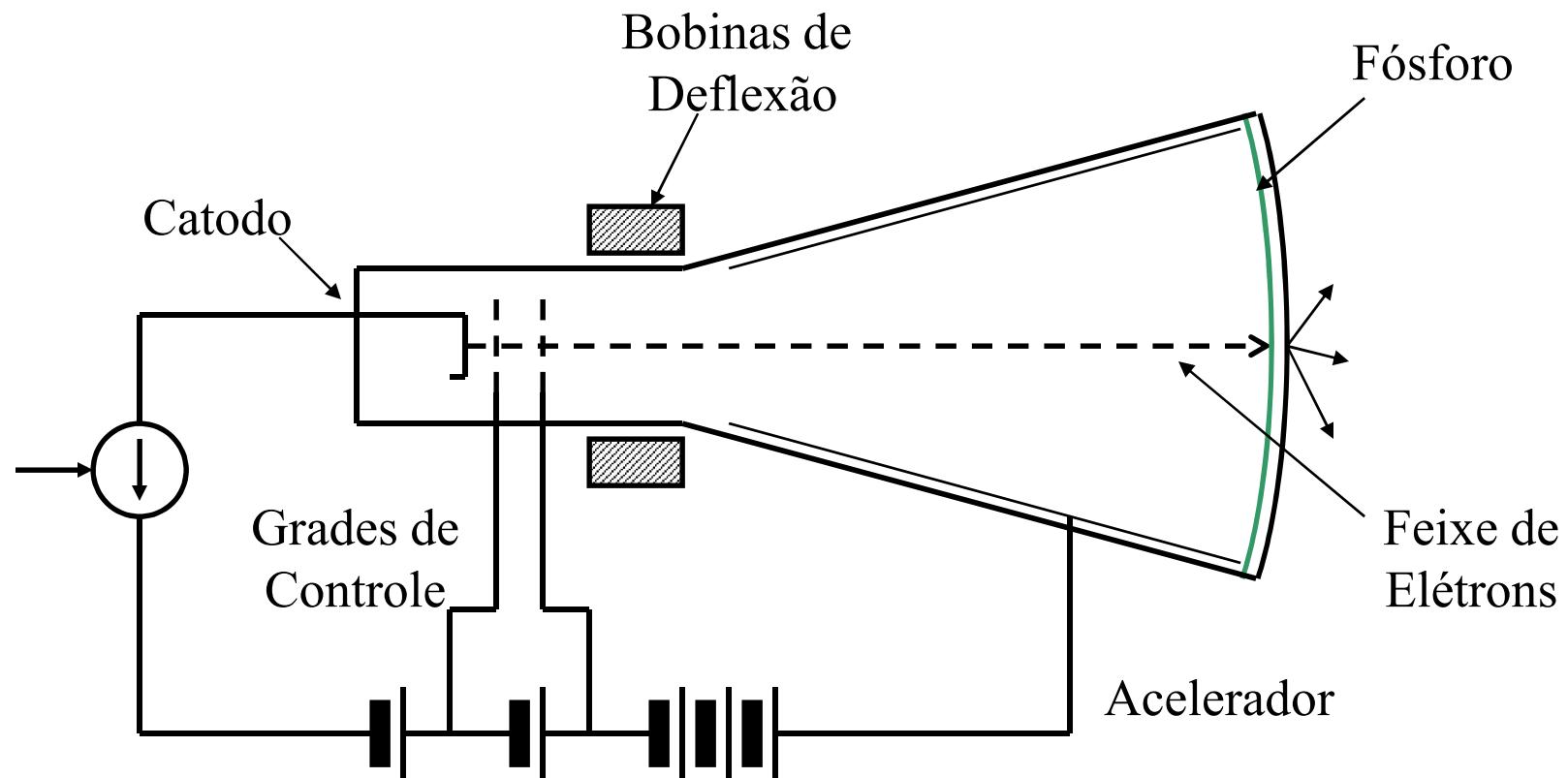


Dispositivos de Visualização de Imagem para TV



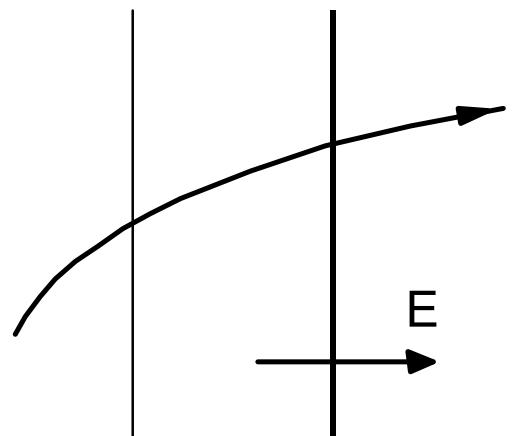
O Tubo de Raios Catódicos



Velocidade do Elétron em um Campo Elétrico

$$\Delta v = \left(\frac{2e}{m} E \Delta x \right)^{\frac{1}{2}}$$

$$\Delta v = 5.93 \times 10^5 \Delta V^{\frac{1}{2}}$$

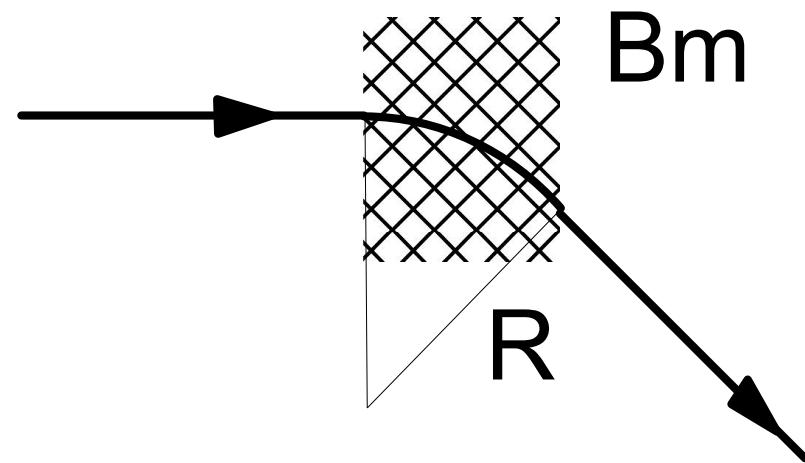


$$e = 1.6 \times 10^{-19} \text{ C}$$

$$m = 9.1 \times 10^{-31} \text{ g}$$

Movimento do Elétron em um Campo Magnético

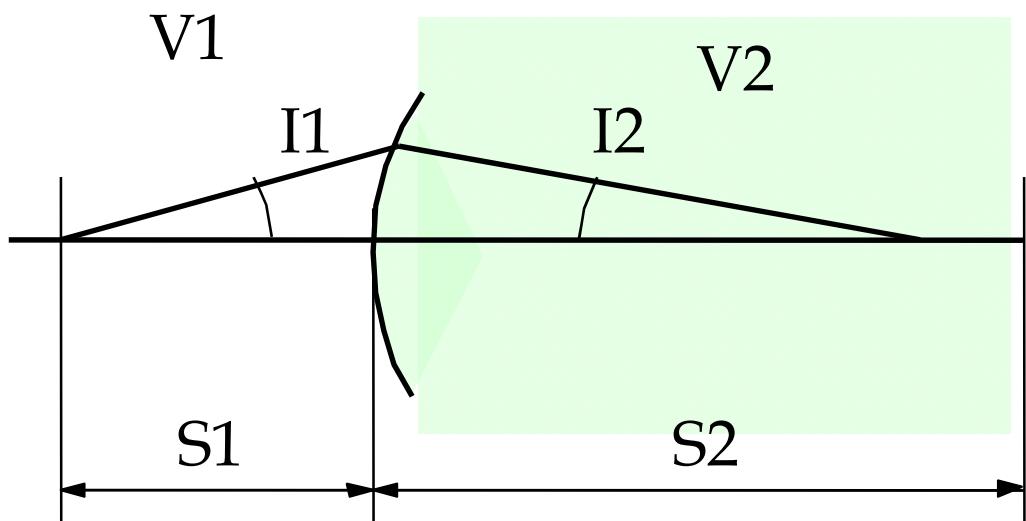
$$R = \frac{3.38 \times 10^{-6} V^{\frac{1}{2}}}{B_m}$$



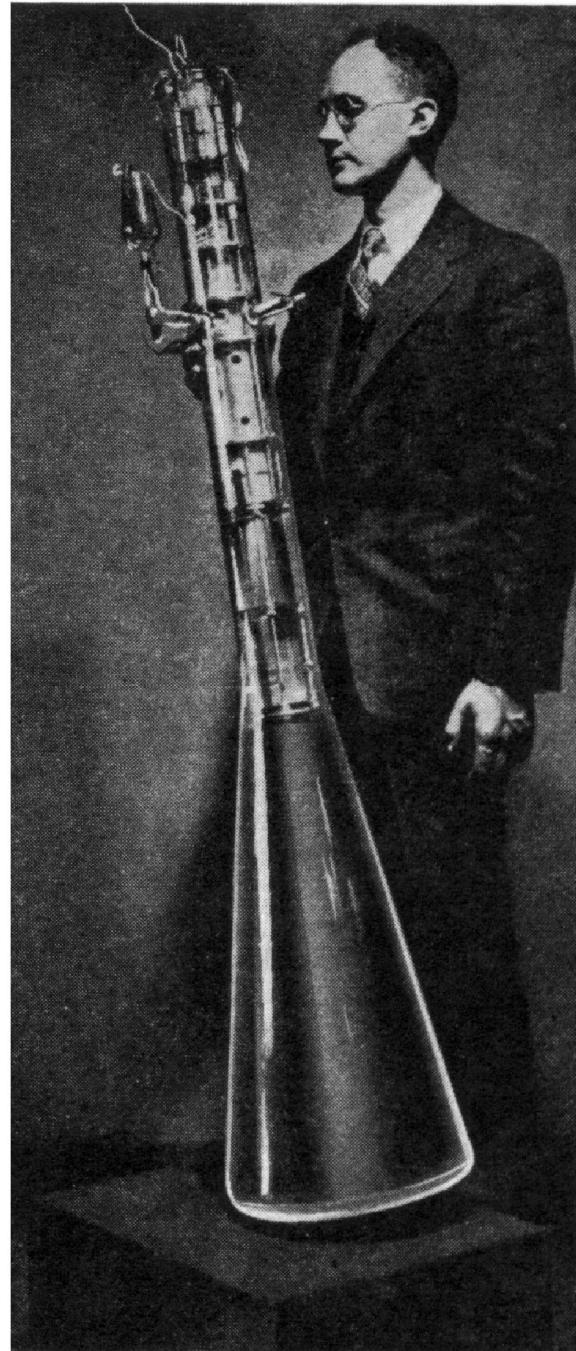
Lente Eletrostática

$$V_1 \operatorname{sen} I_1 = V_2 \operatorname{sen} I_2$$

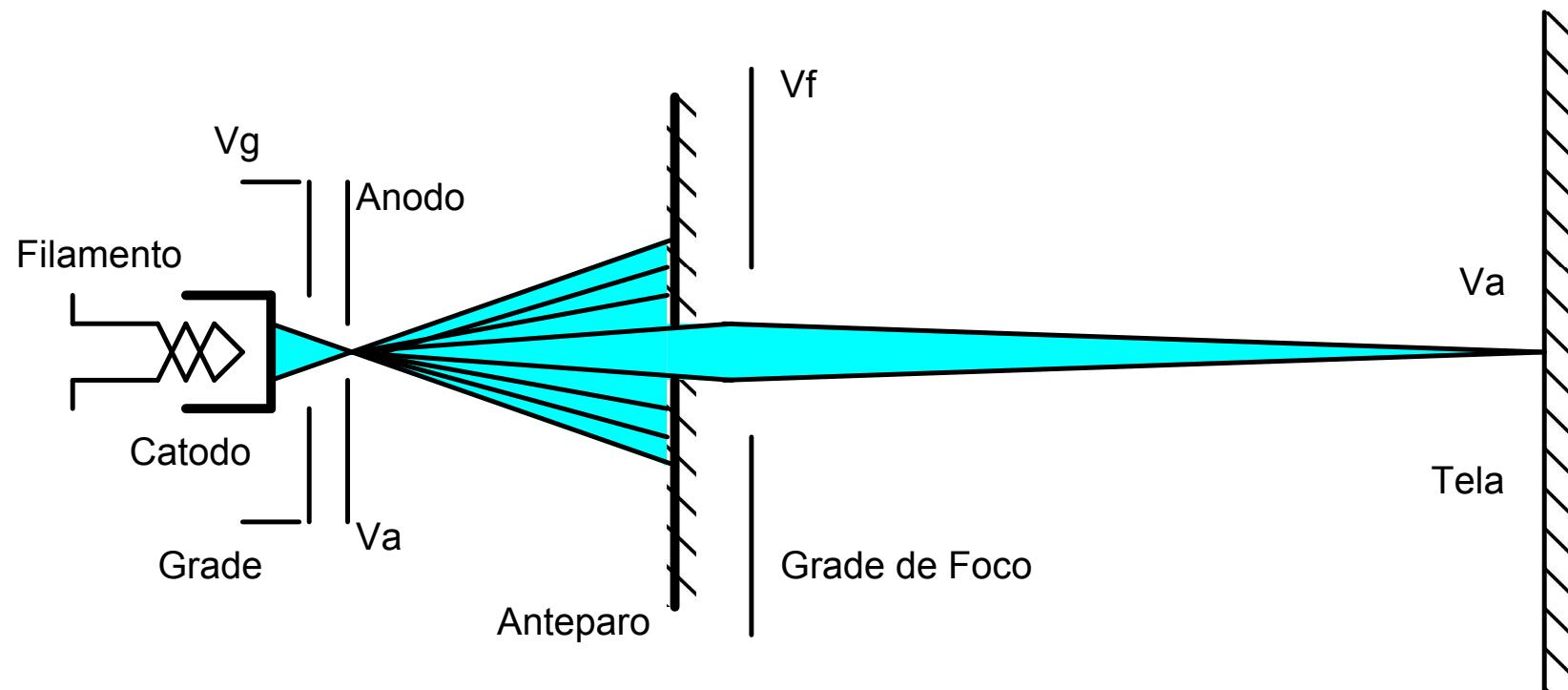
$$m = \left(\frac{V_1}{V_2} \right)^{\frac{1}{2}} \frac{S_2}{S_1} \quad (\text{magnificação})$$



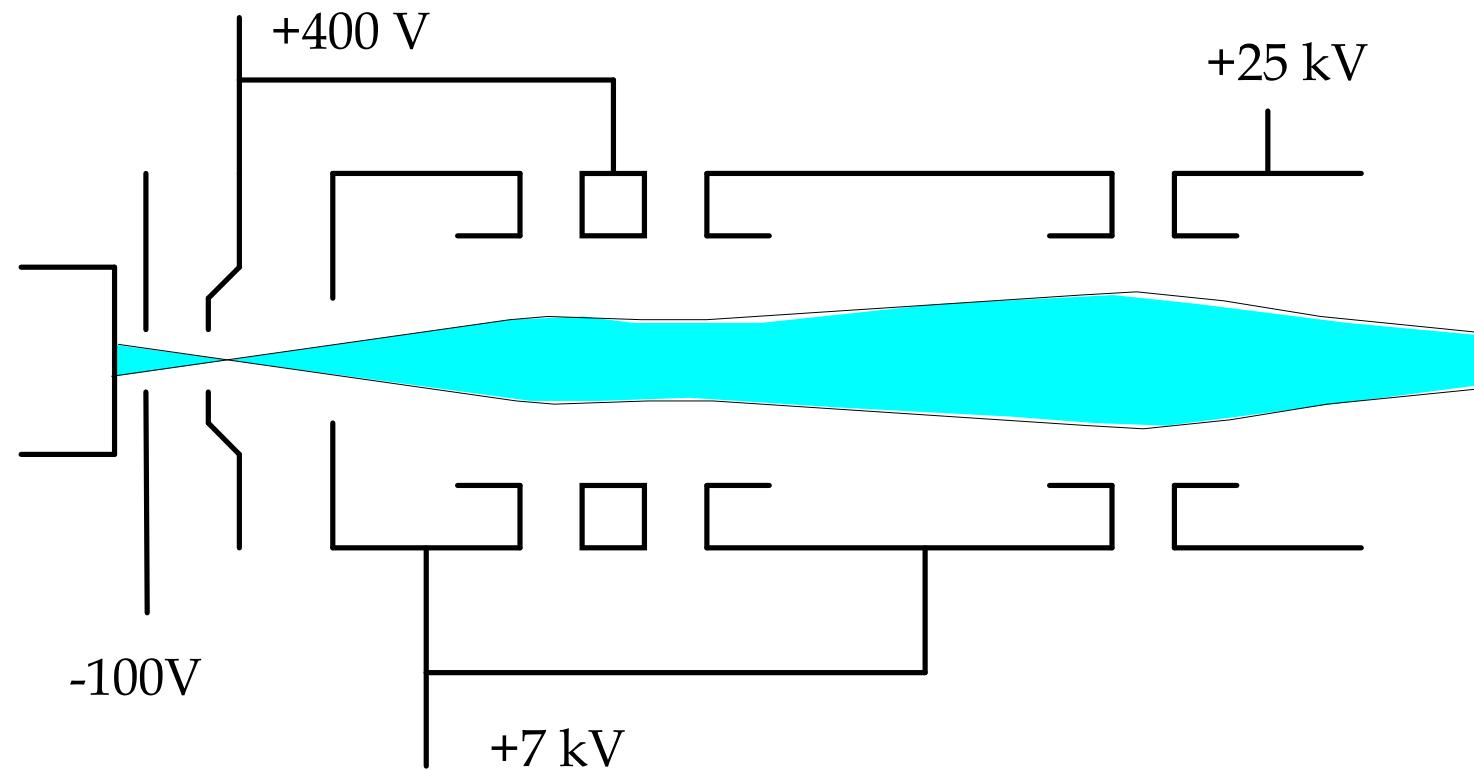
Tubo de raios Catódicos (C. J. Davisson, 1937)



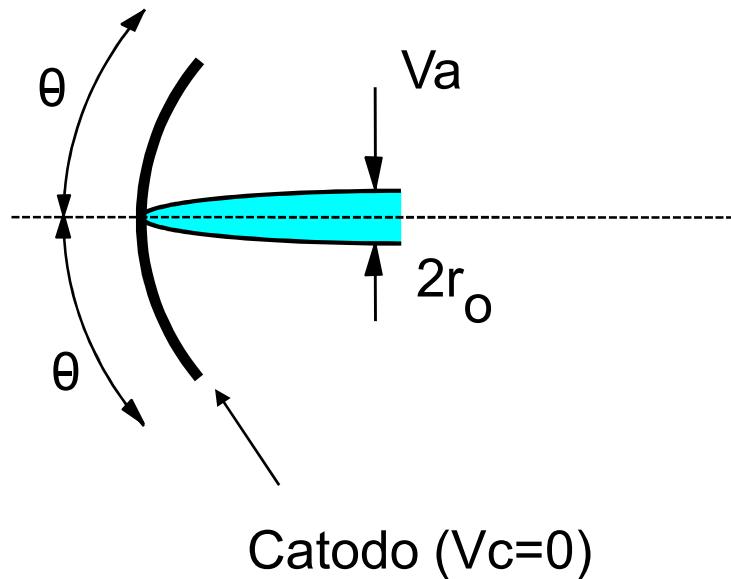
Canhão Eletrônico Unipotencial



Canhão Eletrônico Tripotencial



Colimação do Feixe de Elétrons



$$r_0 = \frac{2r_c}{\sin 2\Theta} \sqrt{\frac{V_e}{V_a}}$$

r_o = raio do feixe colimado

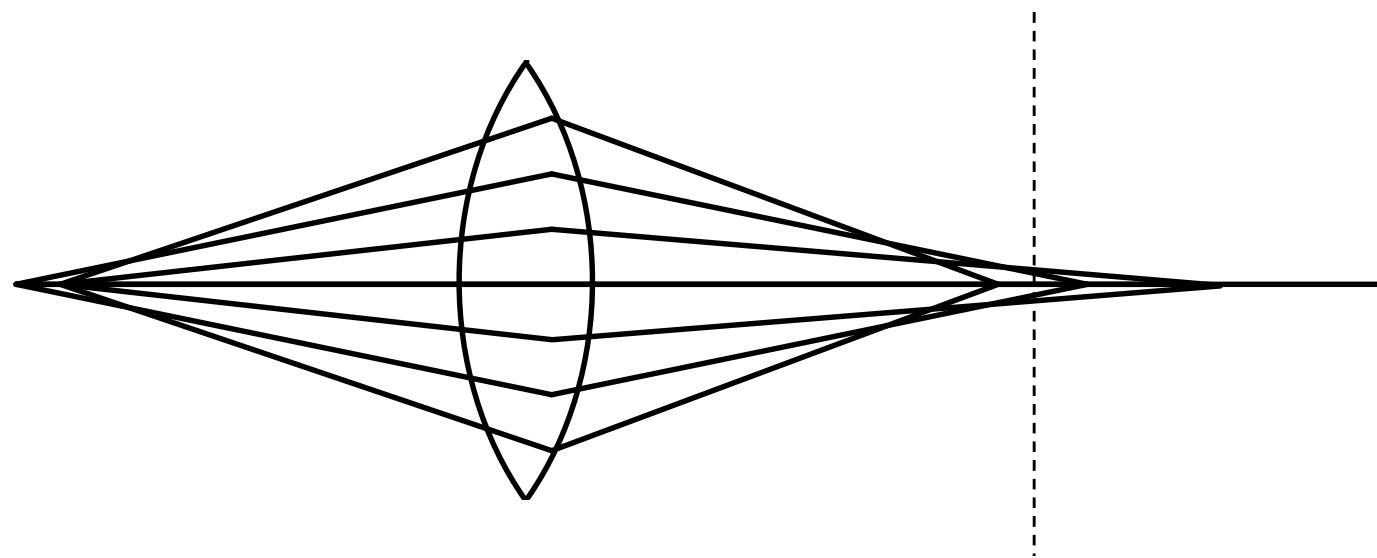
r_c = raio do catodo

V_a = tensão do anodo

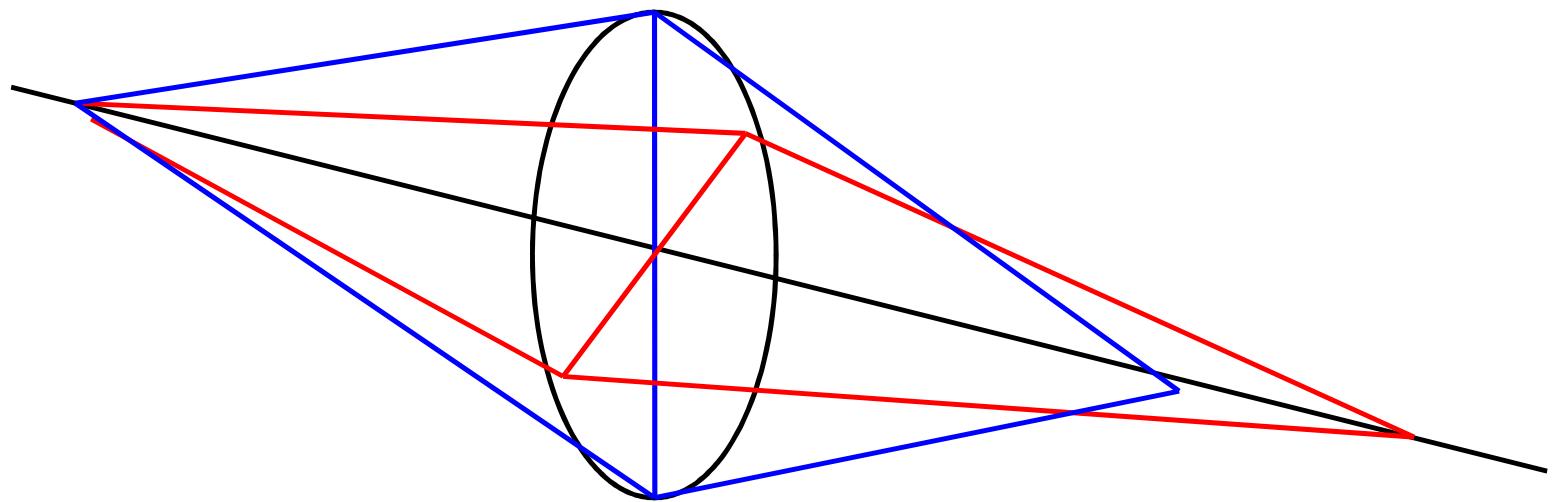
V_e = tensão equivalente da velocidade de emissão

Θ = semi-ângulo de abertura do catodo

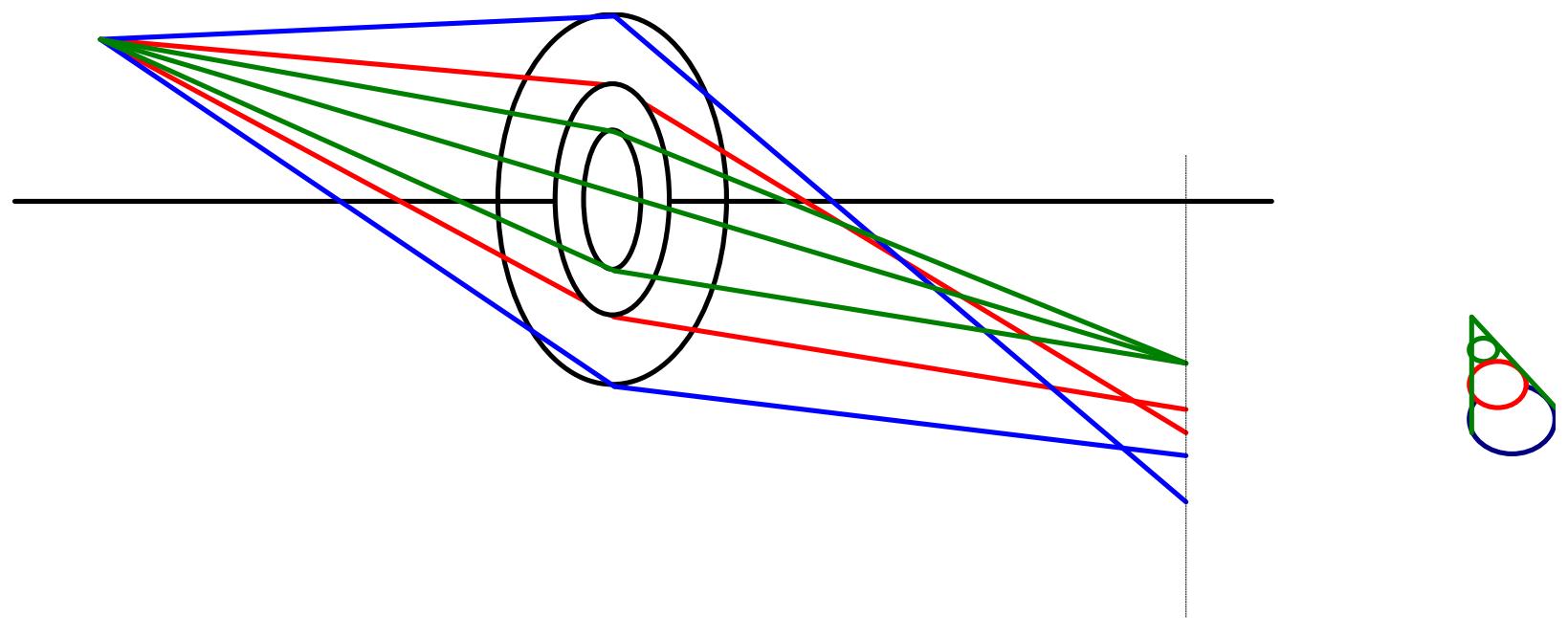
Aberraçāo de Esfericidade



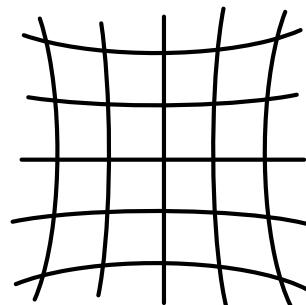
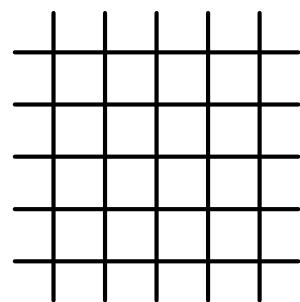
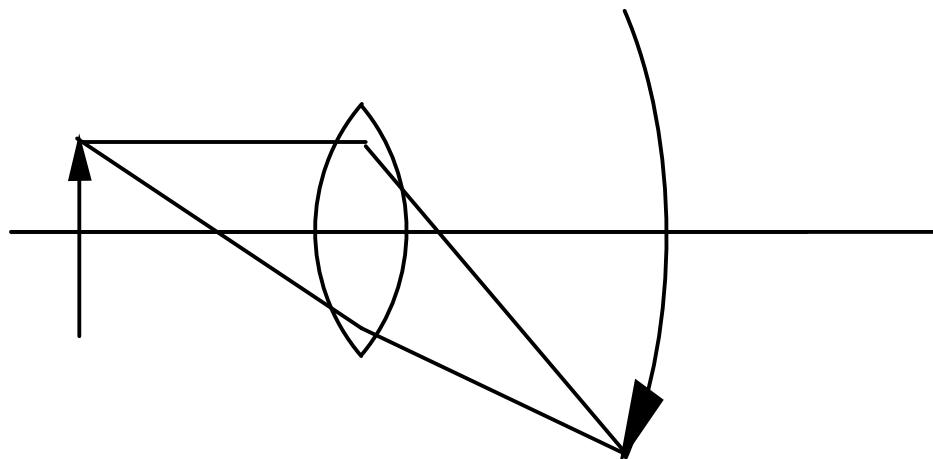
Astigmatismo



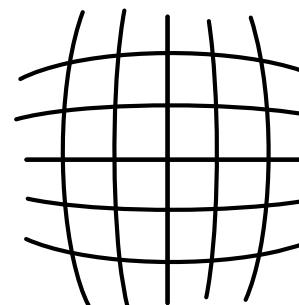
Distorção de Coma



Curvatura de Campo

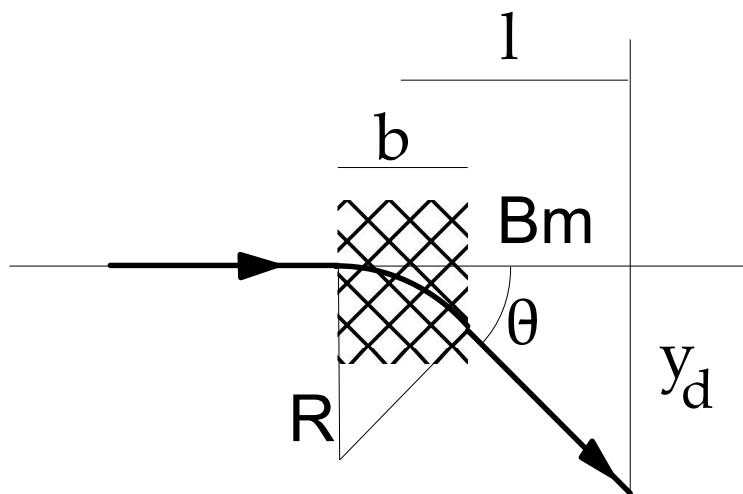


Almofada



Barilete

Deflexão Magnética



$$y_b = \frac{b \times l \times B_m}{3.38 \times 10^{-6} V^{\frac{1}{2}}}$$

$$\text{sen } \Theta = \left(\frac{k_m L}{2V} \right)^{\frac{1}{2}} \times I$$

$$\text{sen } \Theta = 2.97 \times 10^5 \frac{l B_m}{V^{\frac{1}{2}}}$$

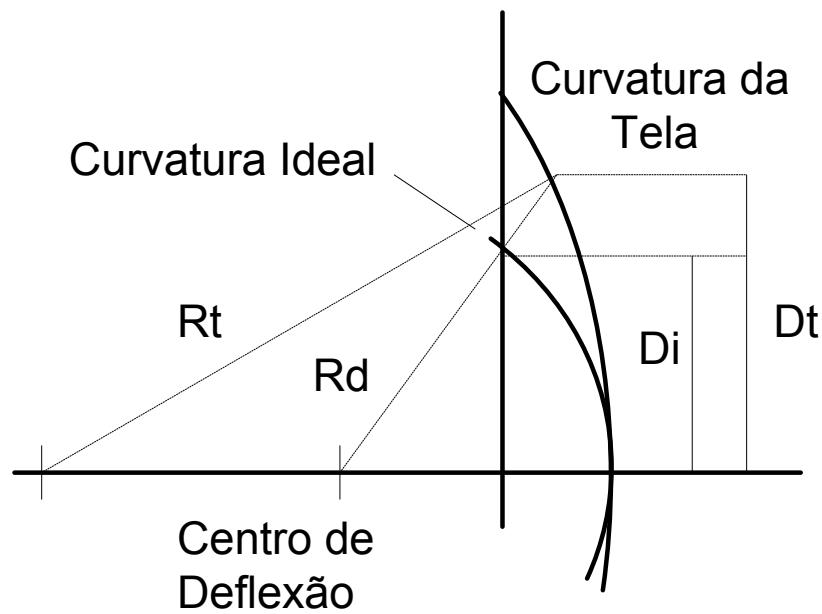
$$y_d = l \times \tan \Theta = 2.97 \times 10^5 \frac{l^2 B_m}{V^{\frac{1}{2}}}$$

L = Indutância do Yoke

I = Corrente no Yoke

k_m = Fator de Sensibilidade

Distorção de Curvatura na Deflexão



$$\frac{D_t}{D_i} = \frac{R_a \tan \Theta}{R_a \sin \Theta} = \frac{1}{\cos \Theta}$$

$$\frac{D_t}{D_i} \cong 1 + \frac{k_m L}{4V} I^2$$

Corrente de Emissão do Catodo

$$I_k = KV_D^{3.0} V_C^{-1.5} \quad (V_D < 0.5V_C)$$

$$I_k = KV_D^{3.5} V_C^{-2} \quad (V_D > 0.5V_C)$$

$$(V_{grade1} = -V_C + V_D)$$

onde V_C = Tensão de corte da grade 1

V_D = Tensão de Sinal na grade 1

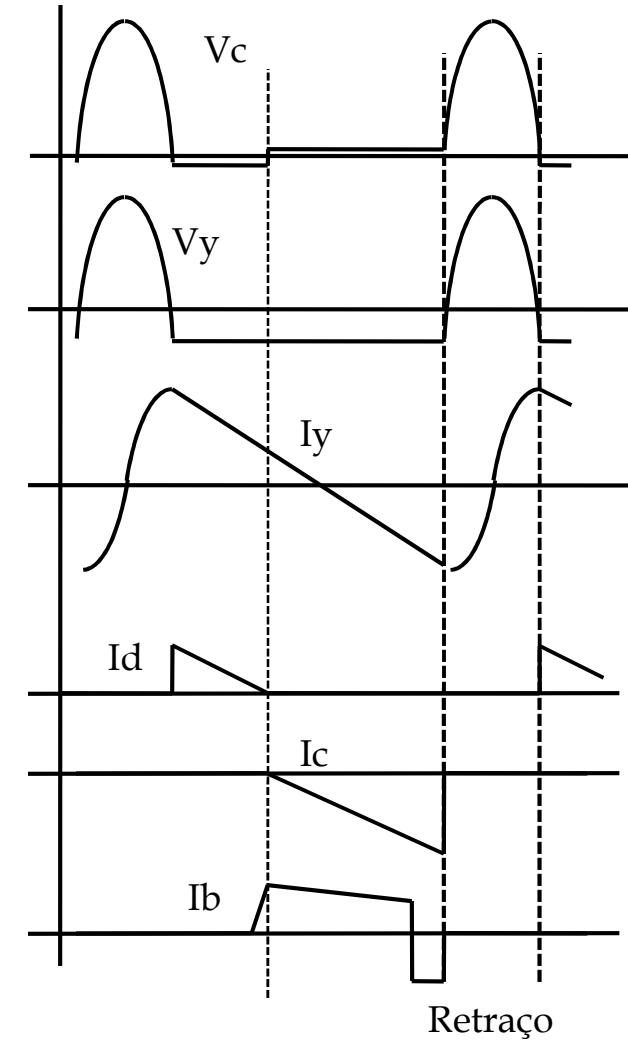
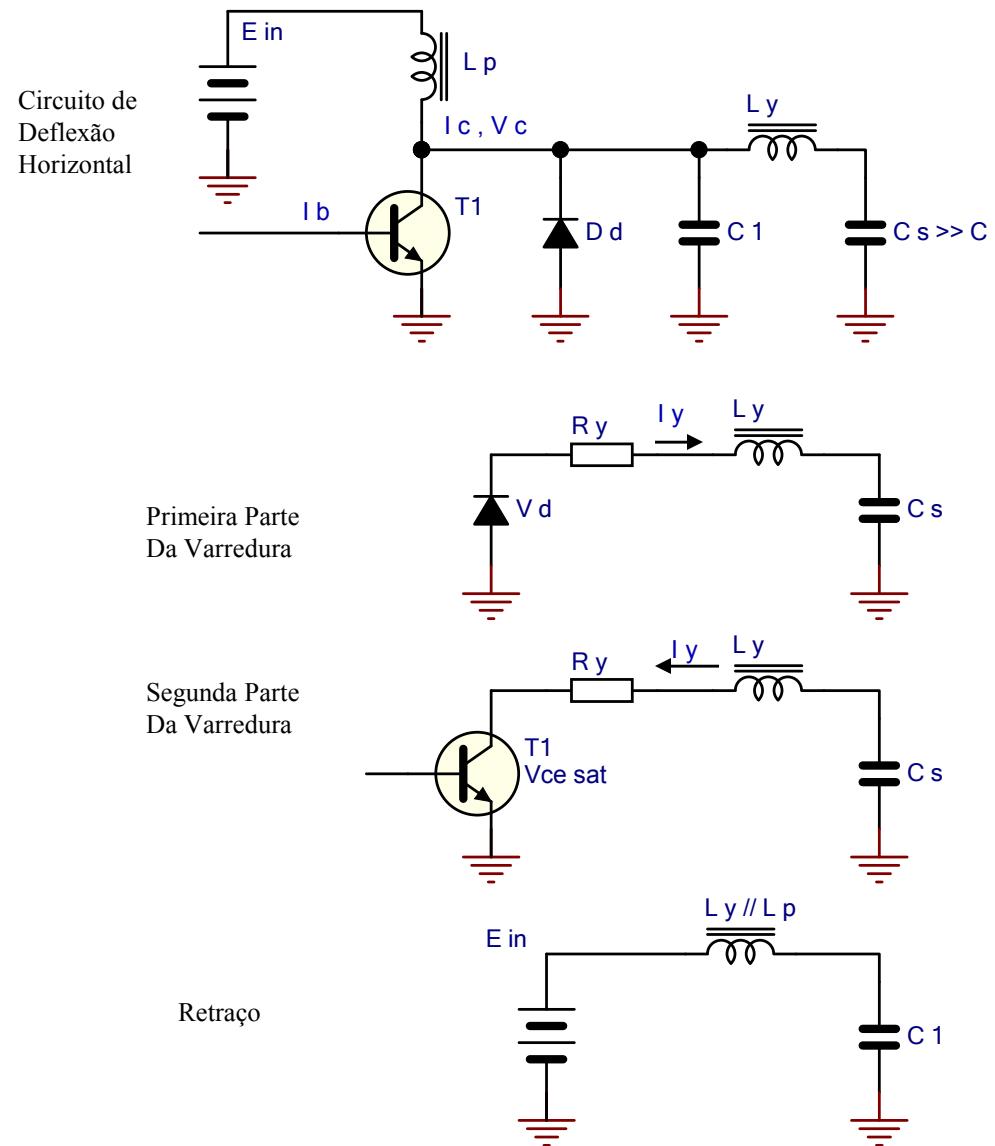
K = Constante de Modulação

Características de Bobinas Defletoras

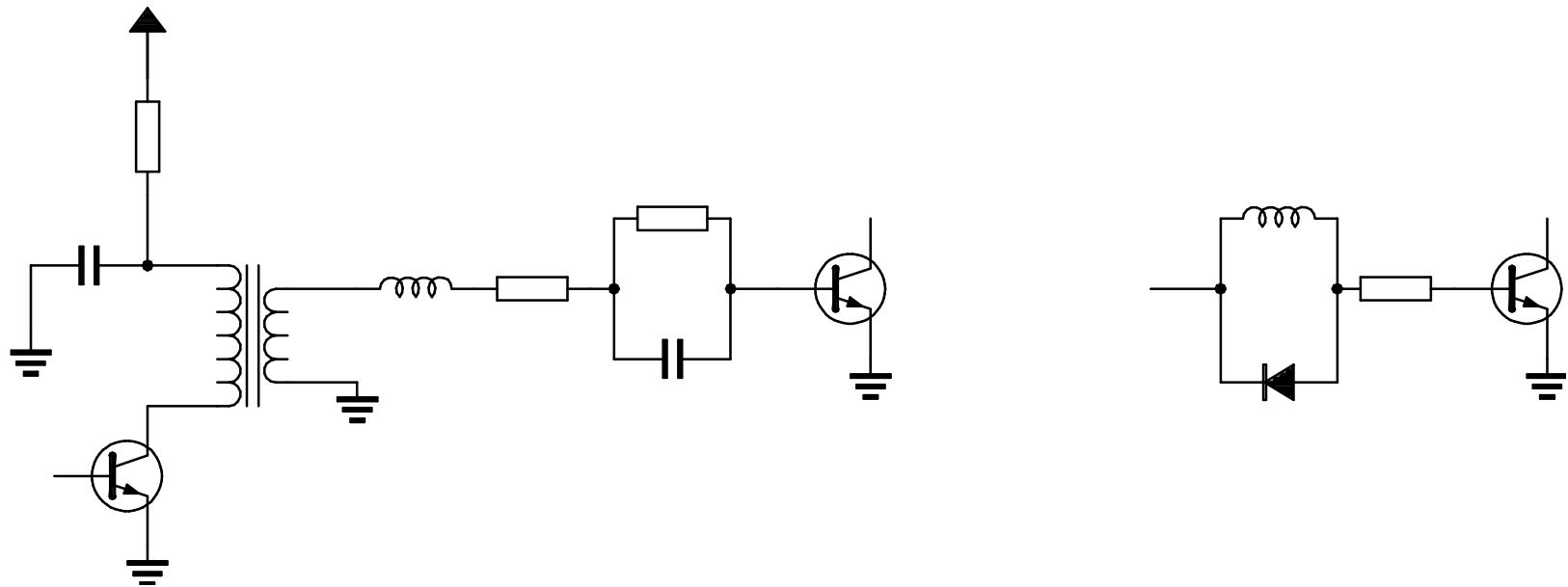
Bobina Defletora para 110°, "in-line", $\varnothing=36.5$ mm

	Horizontal	Vertical
Indutância	1.5 mH	9.7 mH
Resistência Série	1.3 Ω	5.8 Ω
Fluxo Magnético	7.6 mWb	
Corrente p/ Deflexão Plena	2.55 A	1.0 A

Circuito de Deflexão Horizontal a Transistor



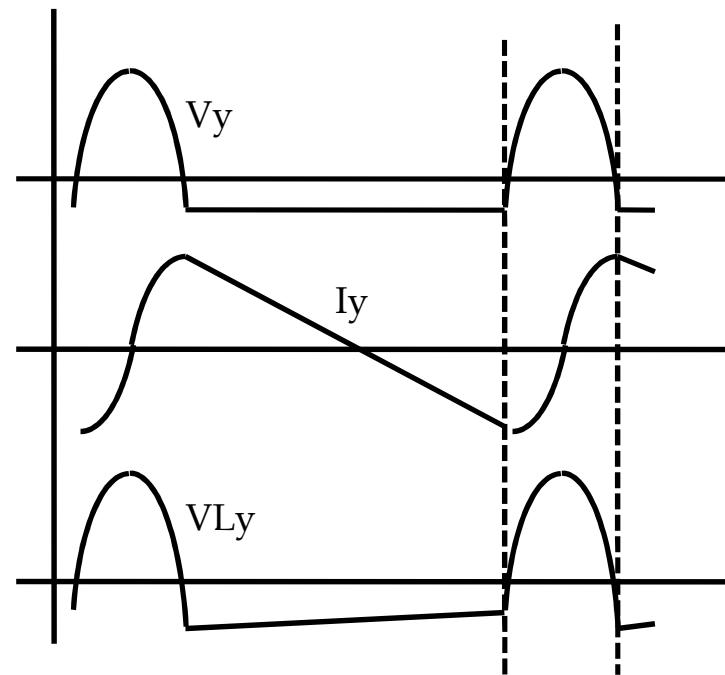
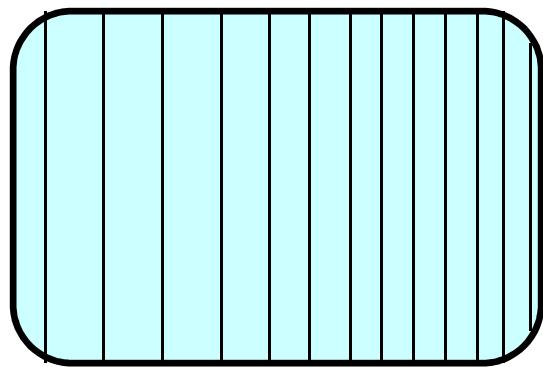
Excitação do Transistor de Saída Horizontal



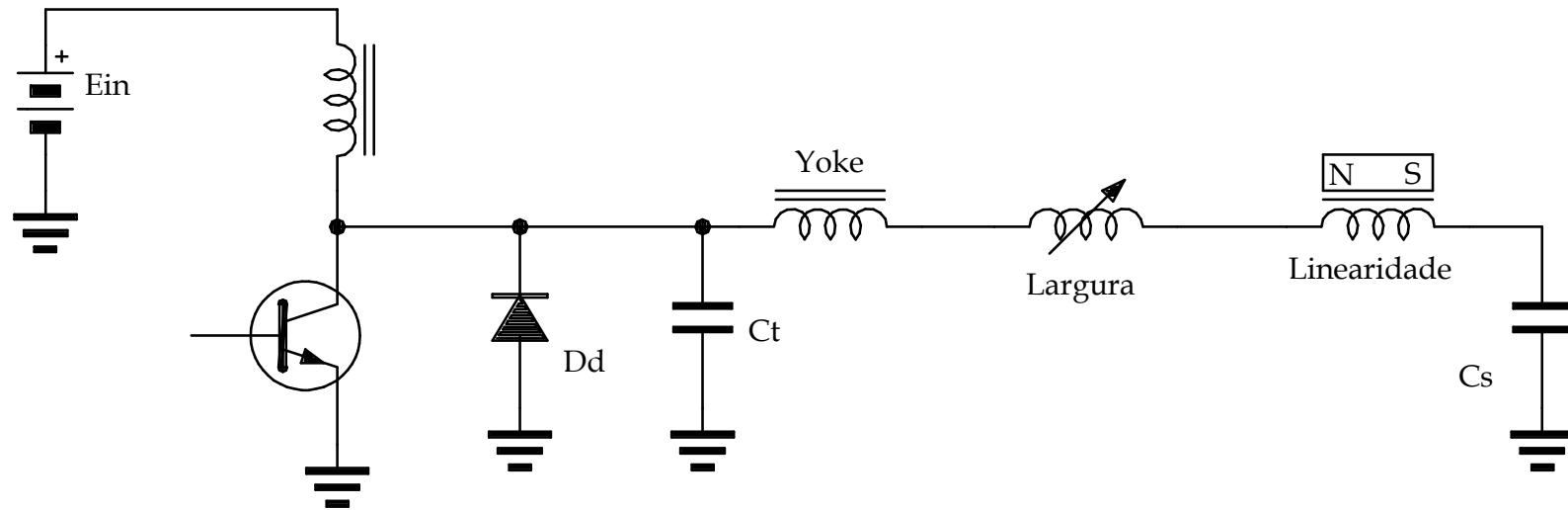
Correção de Linearidade Horizontal

$$V_{LY}(\text{esq.}) = E_{in} + R_Y I_{Yp} + V_D$$

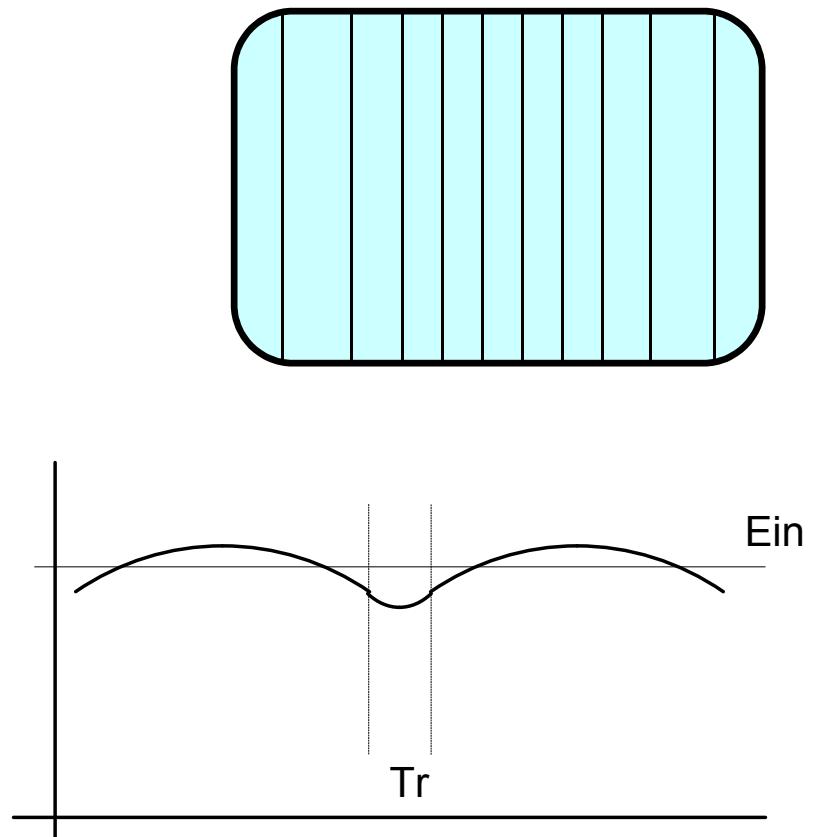
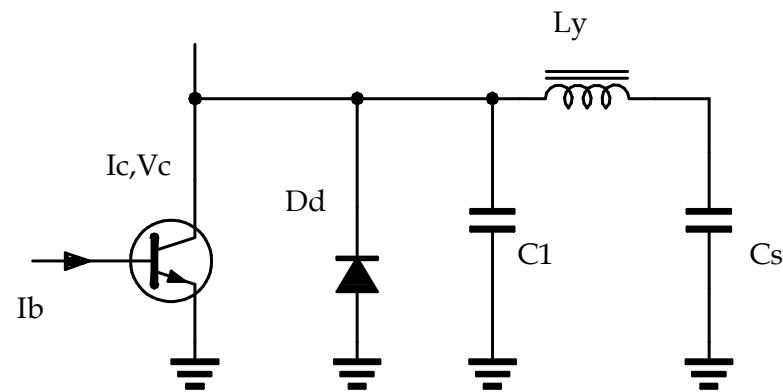
$$V_{LY}(\text{dir.}) = E_{in} - R_Y I_{Yp} - V_{CESat}$$



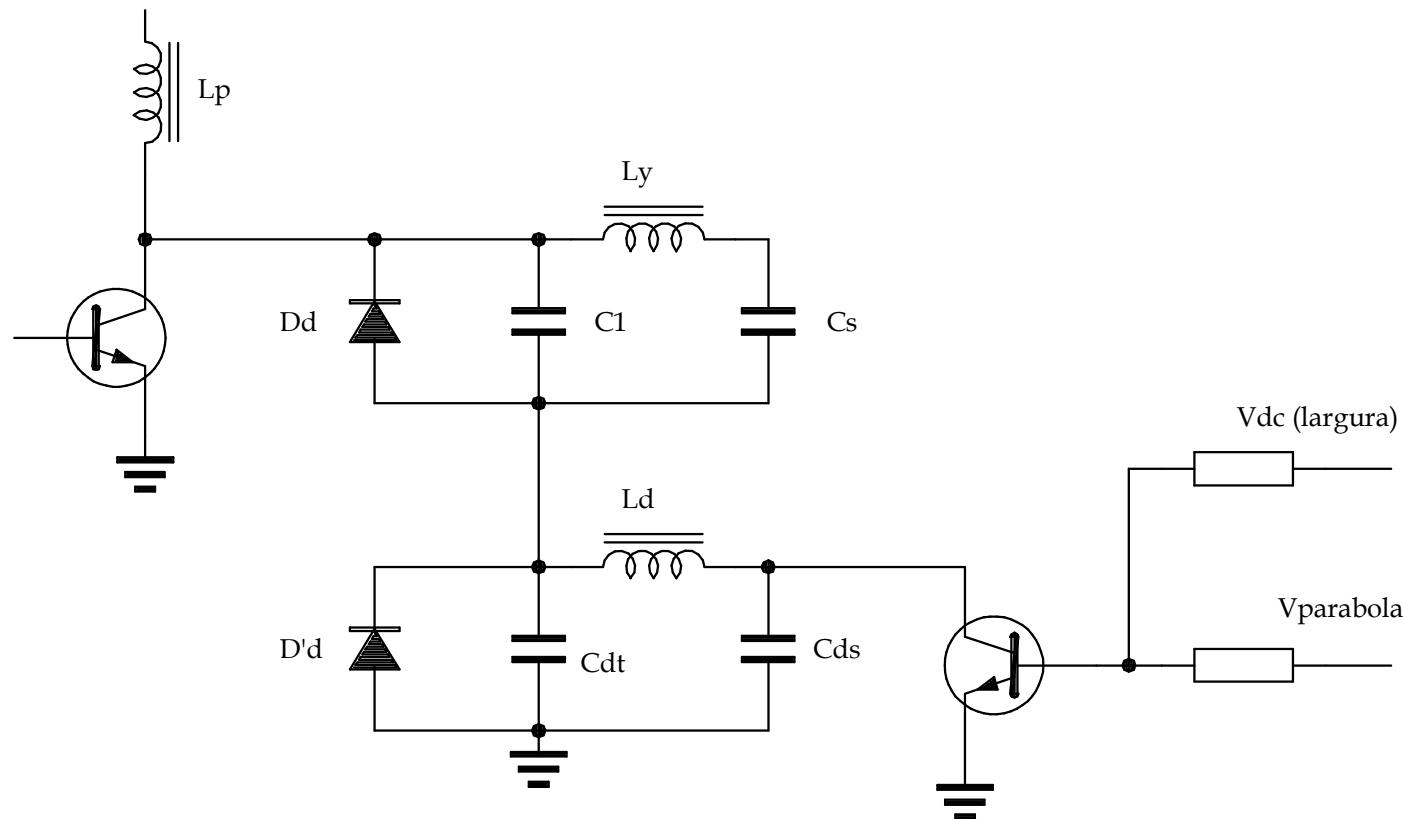
Círcuito de Correção de Linearidade



Correção “S”

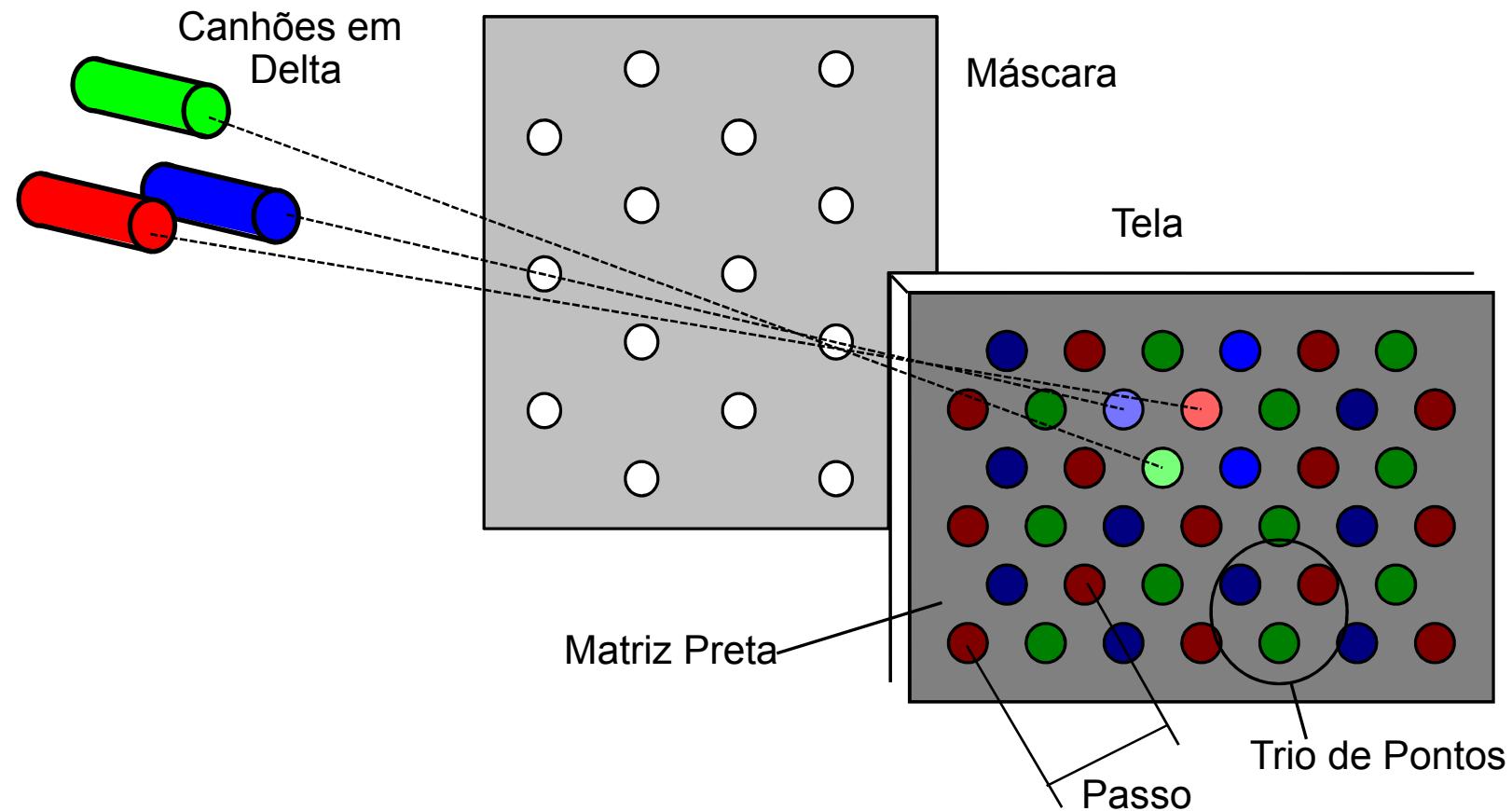


Modulador a Diodo para Correção “S” e Controle de Largura

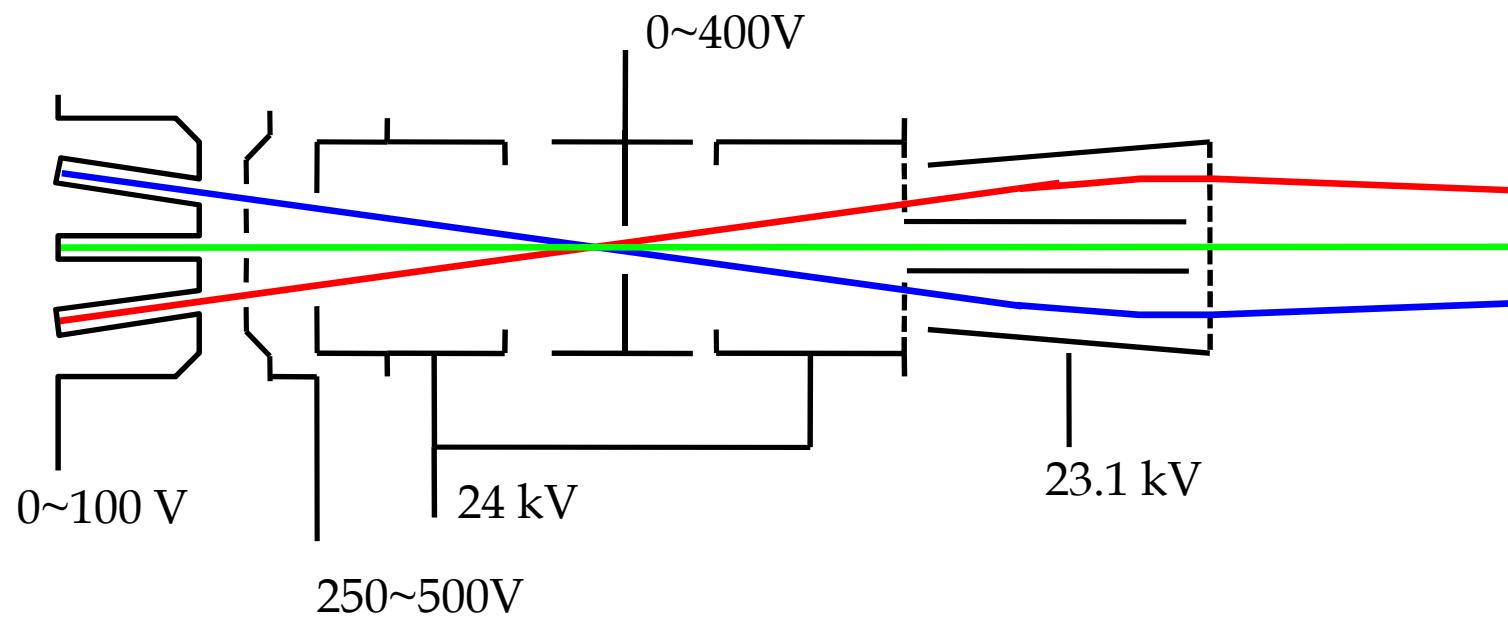


Cinescópios para TV a Cores

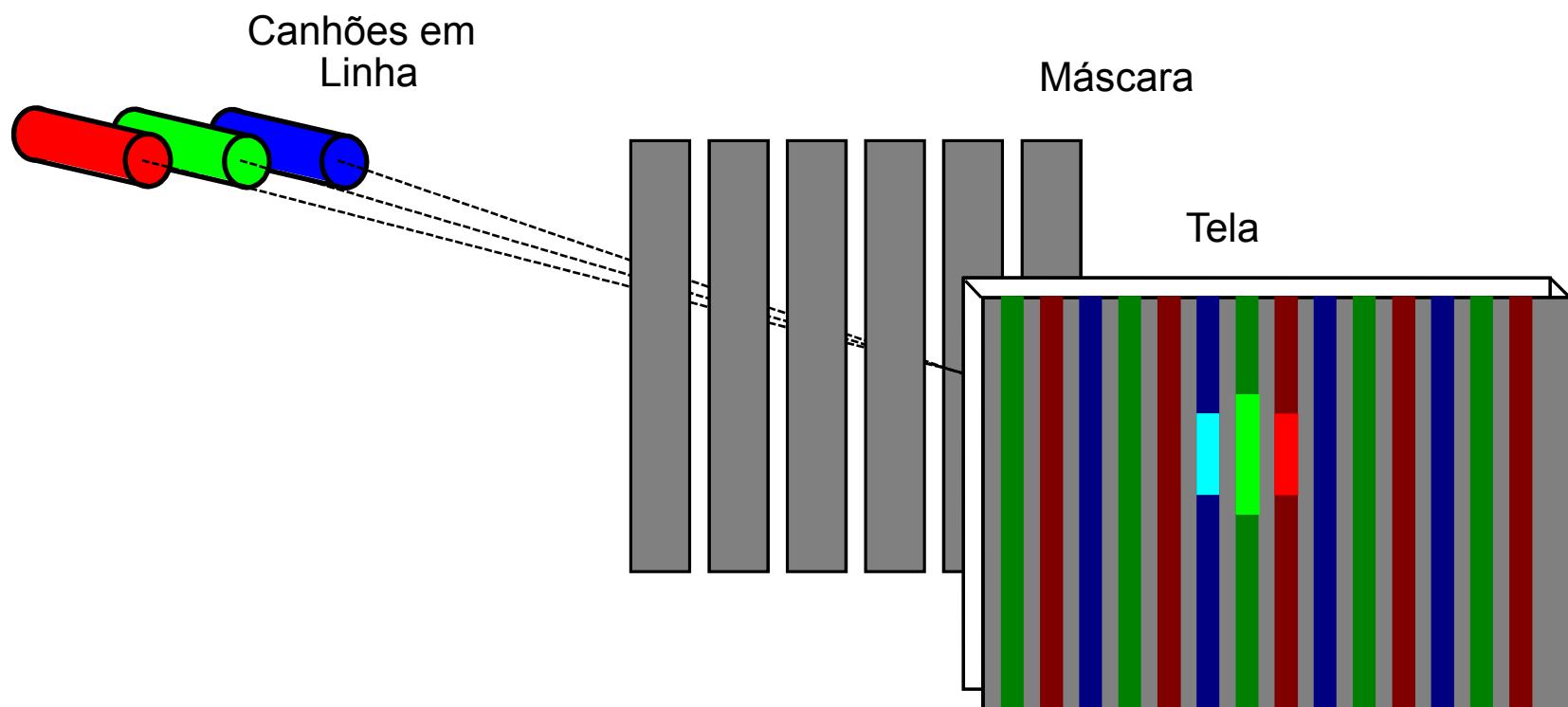
Cinescópio a Cores com Máscara de Sombra



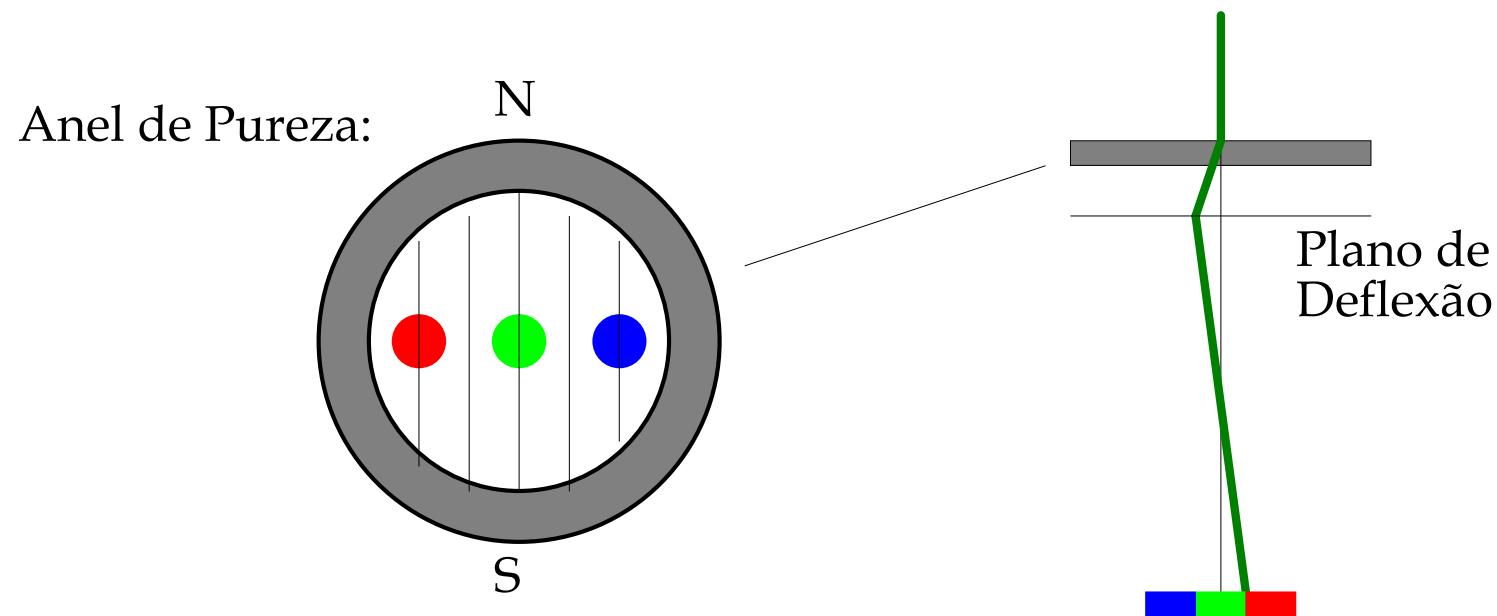
Canhão “Trinitron” (In-line)



Máscara “Trinitron”

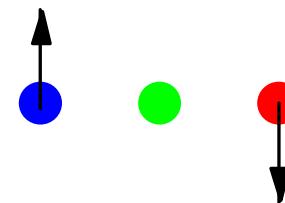
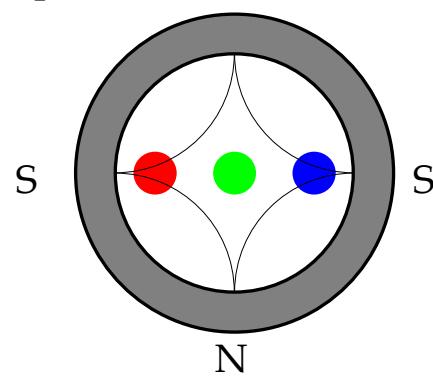


Convergência Estática

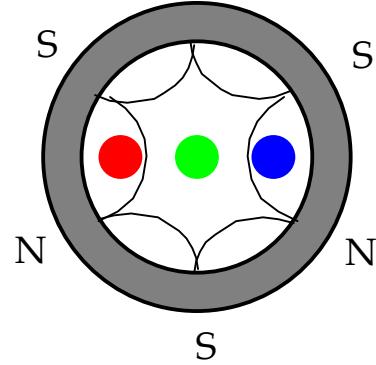


Convergência Estática

Anel de 4 polos:

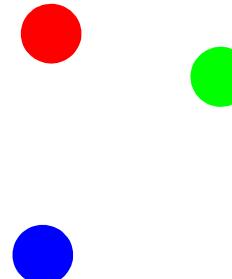


6 polos:

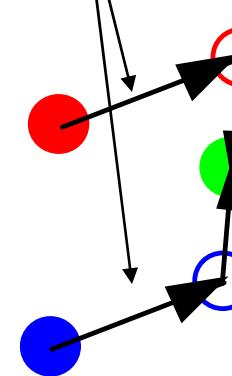


Ajuste de Convergência Estática

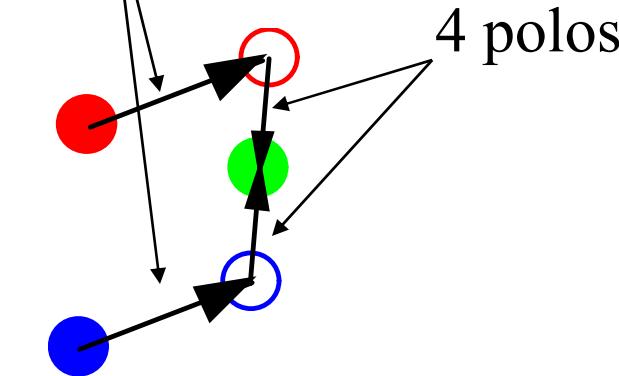
Desajustado



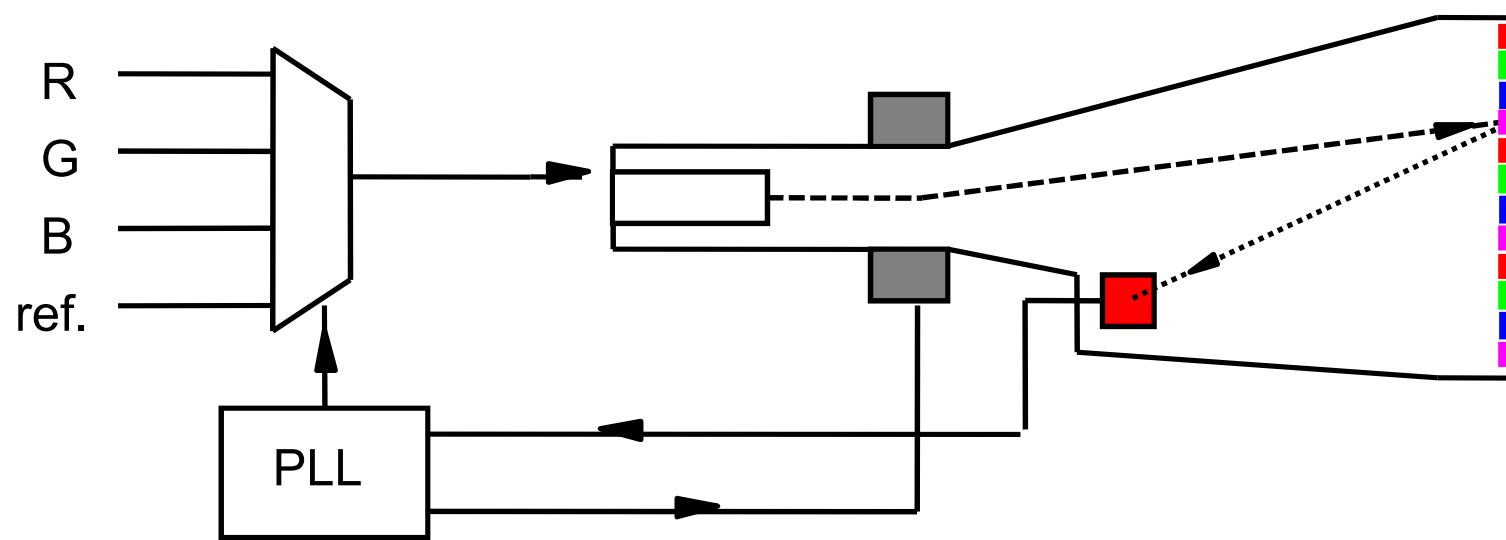
6 polos



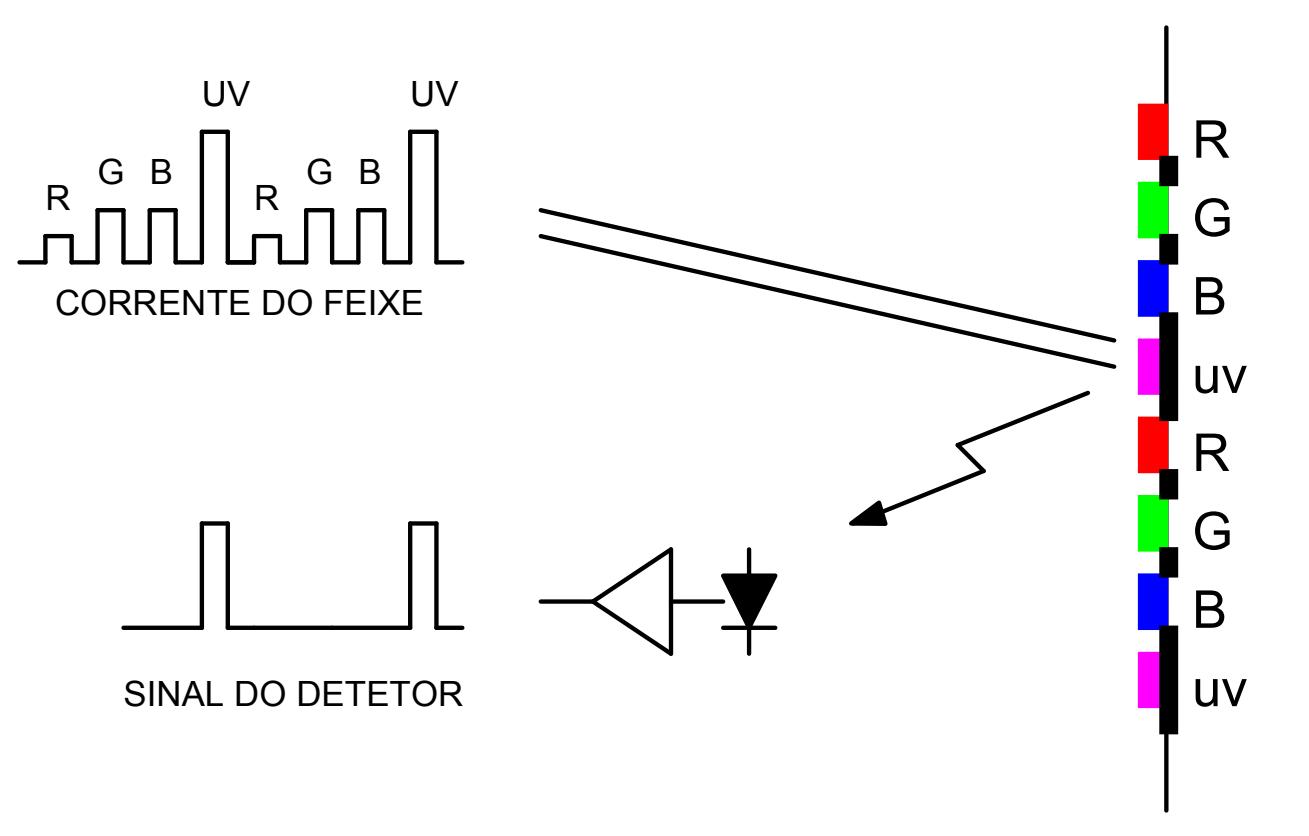
4 polos



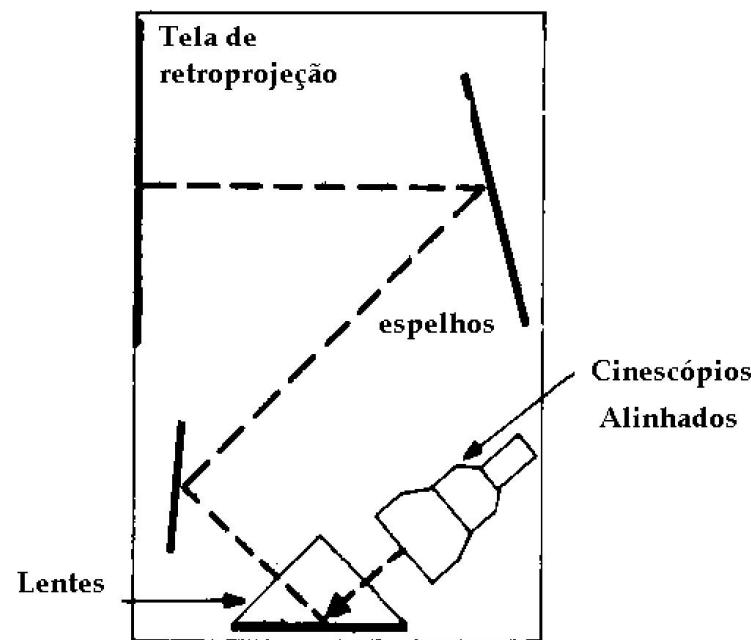
Cinescópio Indexado



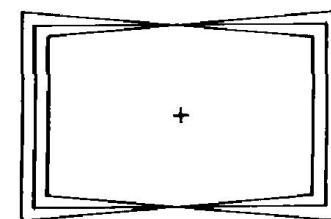
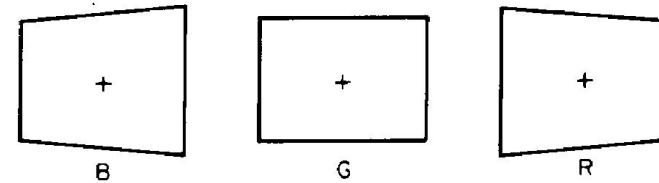
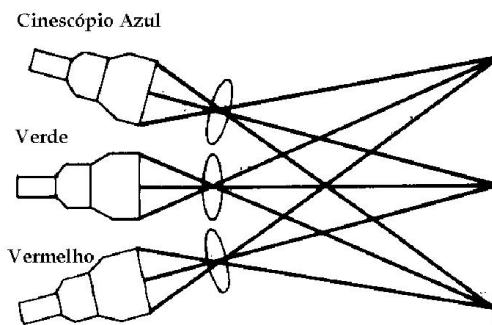
Excitação do Cinescópio Indexado



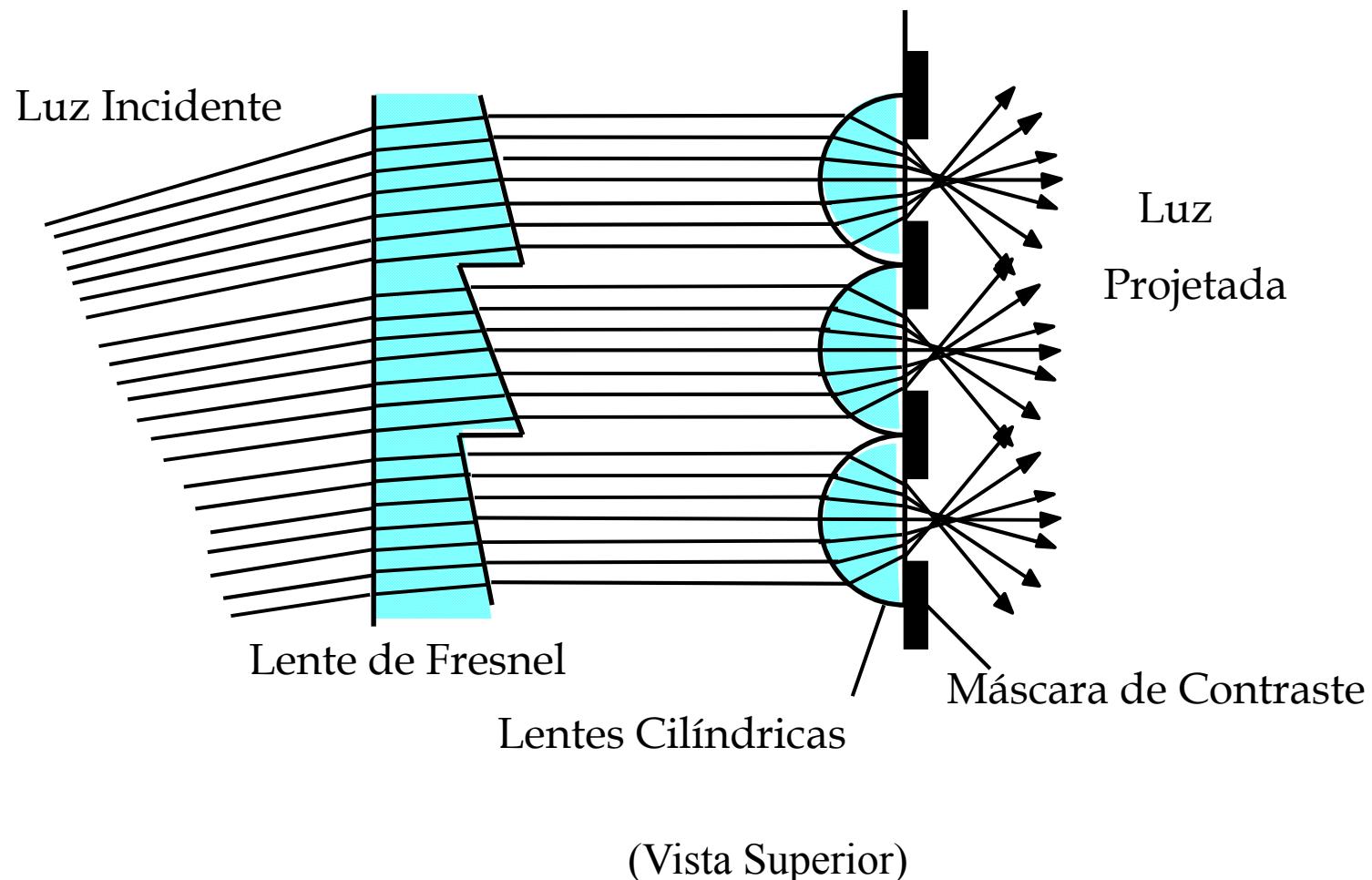
Monitor de Retroprojeção



Retroprojetor com
espelhos

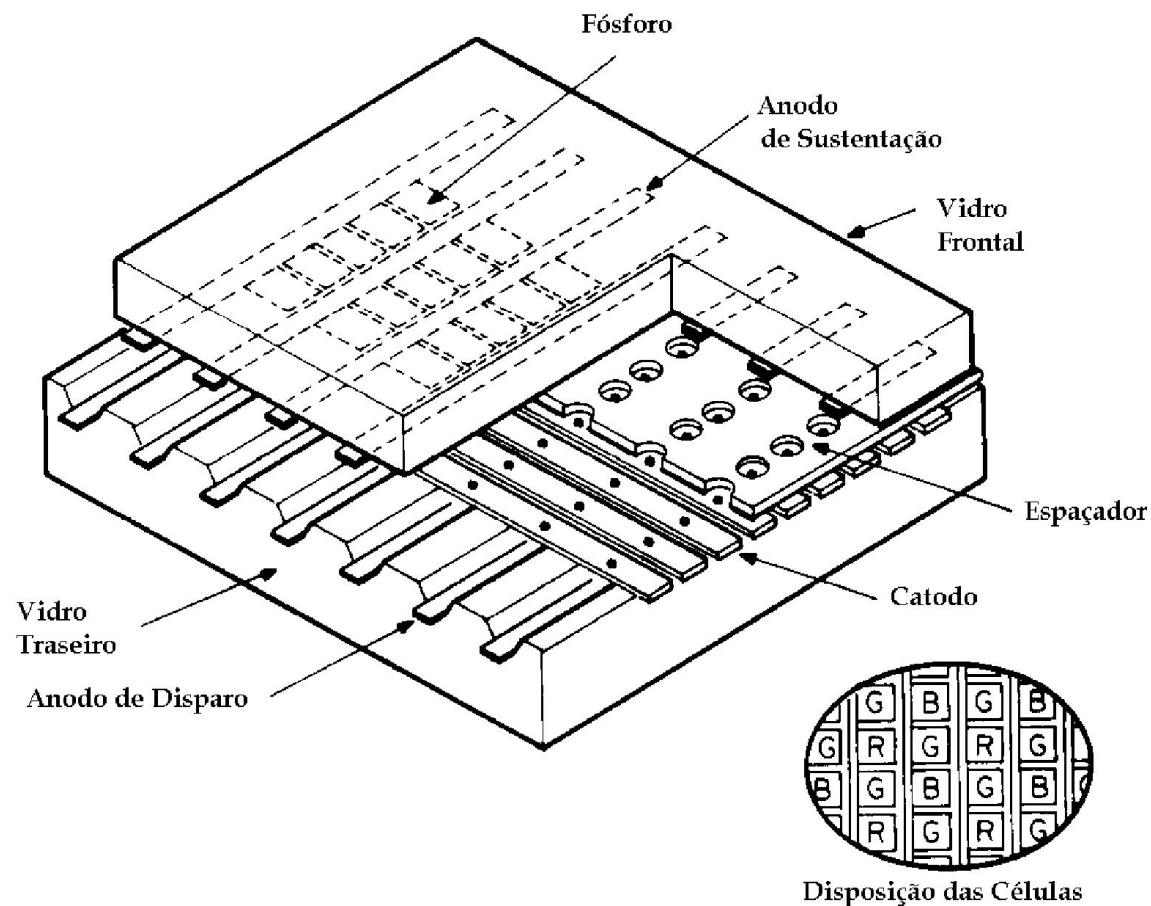


Tela de Retroprojeção de Alto Contraste



Visor de Plasma

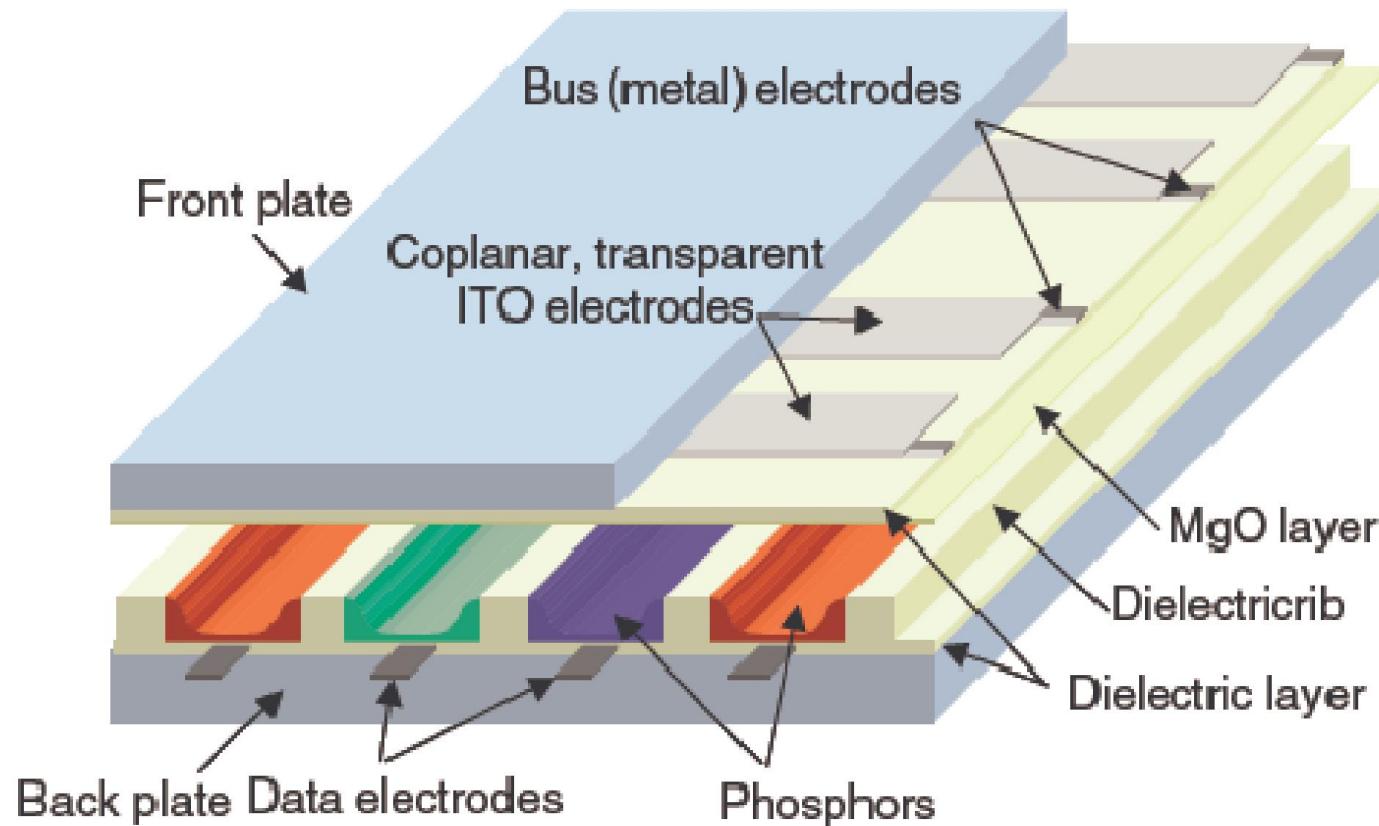
Visor de Plasma



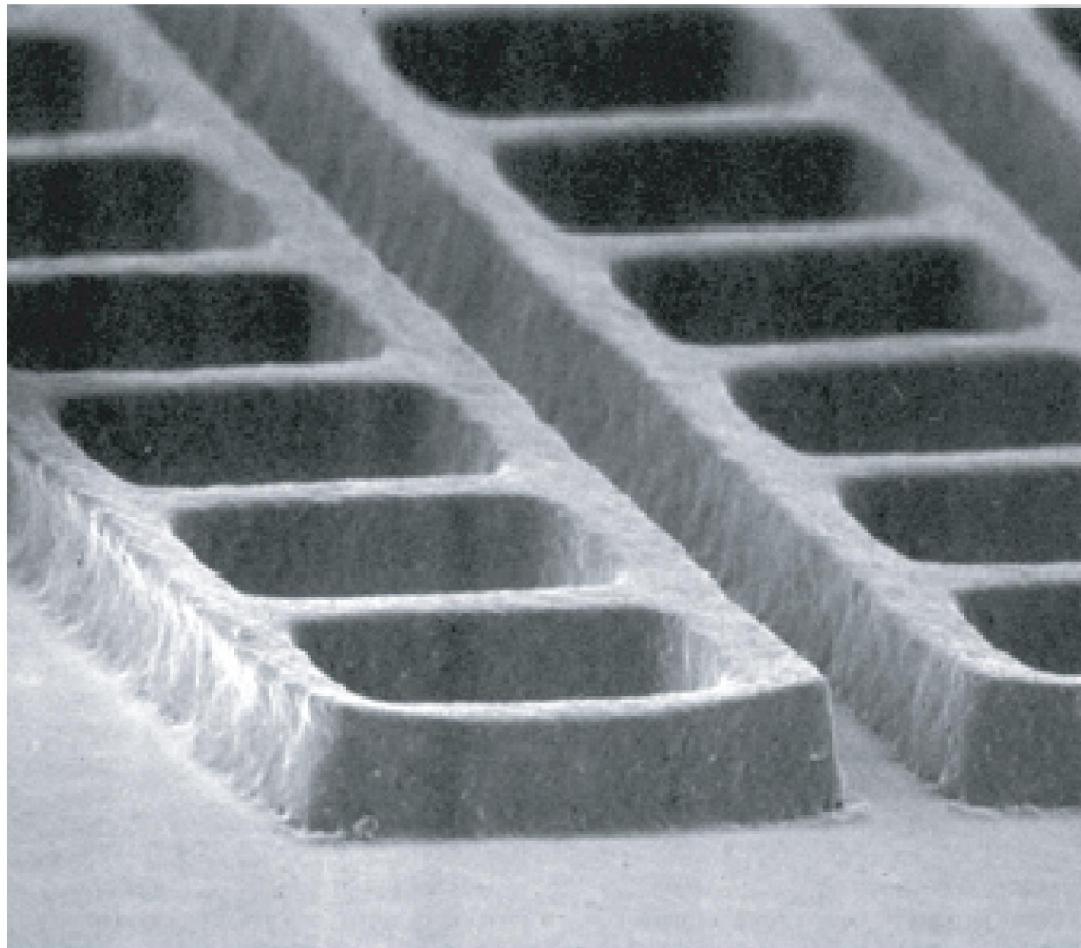
Visor de Plasma

- Universidade de Illinois, ~1964
- Emissão UV: Xe-Ne ou Xe-Ne-He
- Contraste: 3000:1 (no escuro); 120:1 (ambiente)
- Rendimento Luminoso: ~1 a 2 lumens/W
- Luminância máxima: 500 ~700 nits
- Meia vida: ~30.000 horas (-10% em 5000 horas)
- Controle de intensidade pela duração da descarga (PWM)
- Visor com excitação AC: maior vida útil

Visor de Plasma (AC Coplanar – 3 Eletrodos)



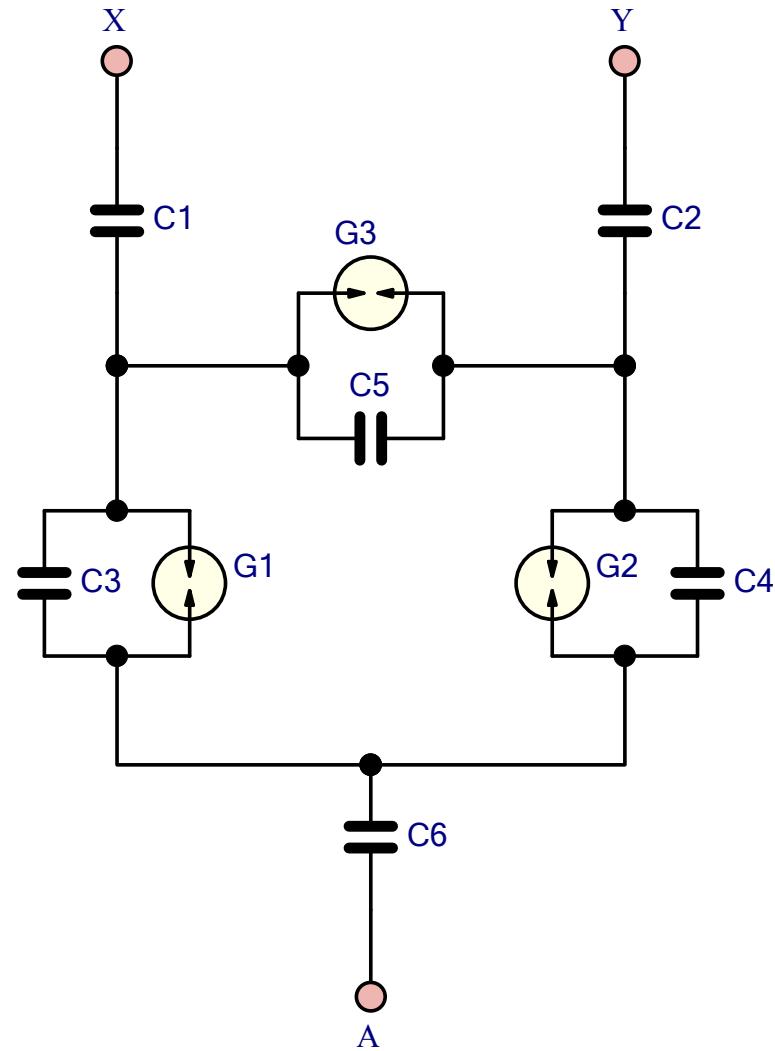
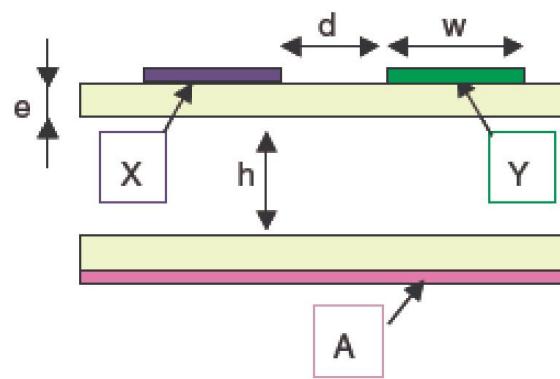
Estrutura das Células de Descarga



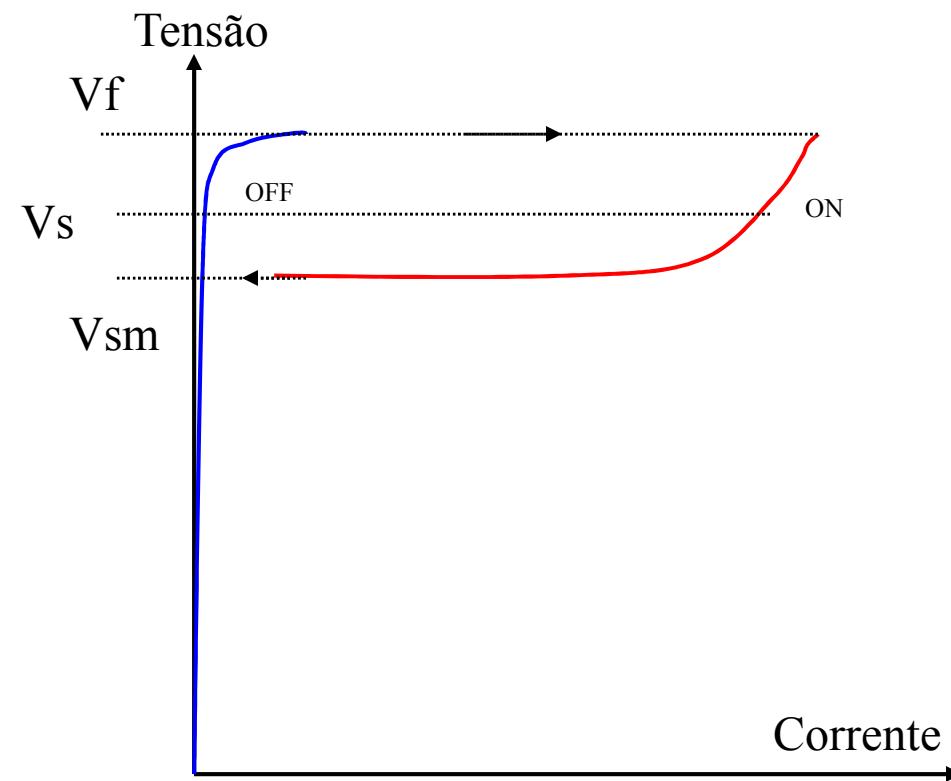
Visor de Plasma ACC

- Camada de MgO : proteção do dielétrico e emissão secundária de elétrons
- Espessura da camada MgO: $\sim 0.5 \mu\text{m}$
- Espessura das camadas dielétricas: $\sim 20 \mu\text{m}$
- Espessura da célula: $\sim 0,1 \text{ mm}$
- Largura dos eletrodos transparentes: $\sim 0,2 \text{ a } 0,3 \text{ mm}$
 - ITO (Óxidos de Estanho e Índio)
- Pressão do gás: $\sim 500 \text{ Torr}$
- Freqüência de excitação: até $\sim 100 \text{ kHz}$

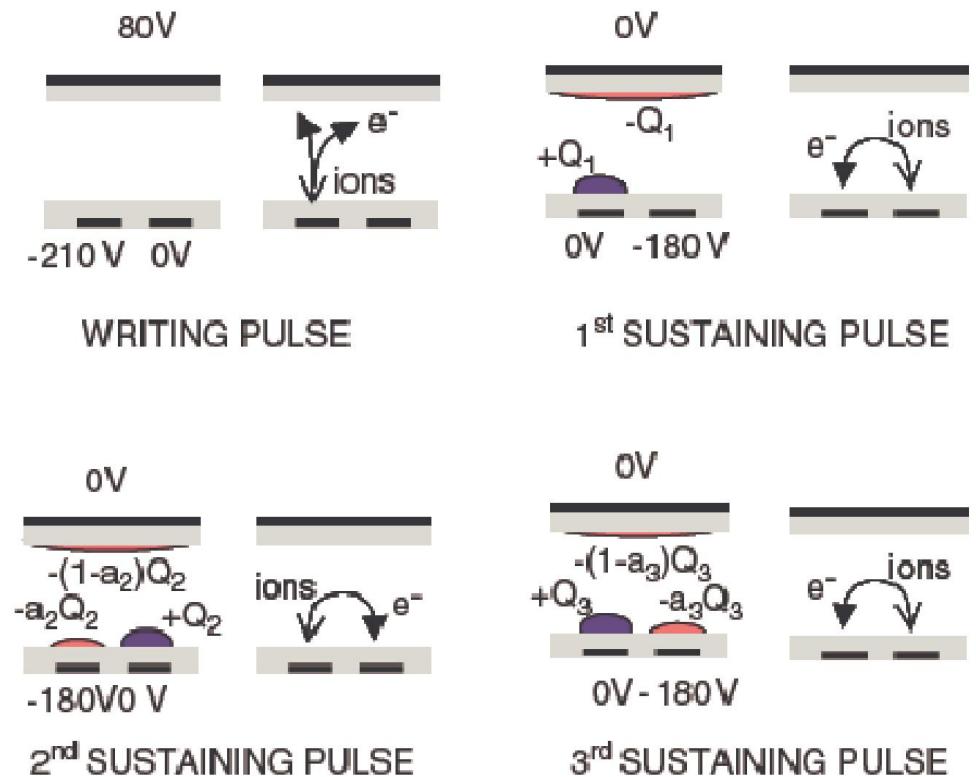
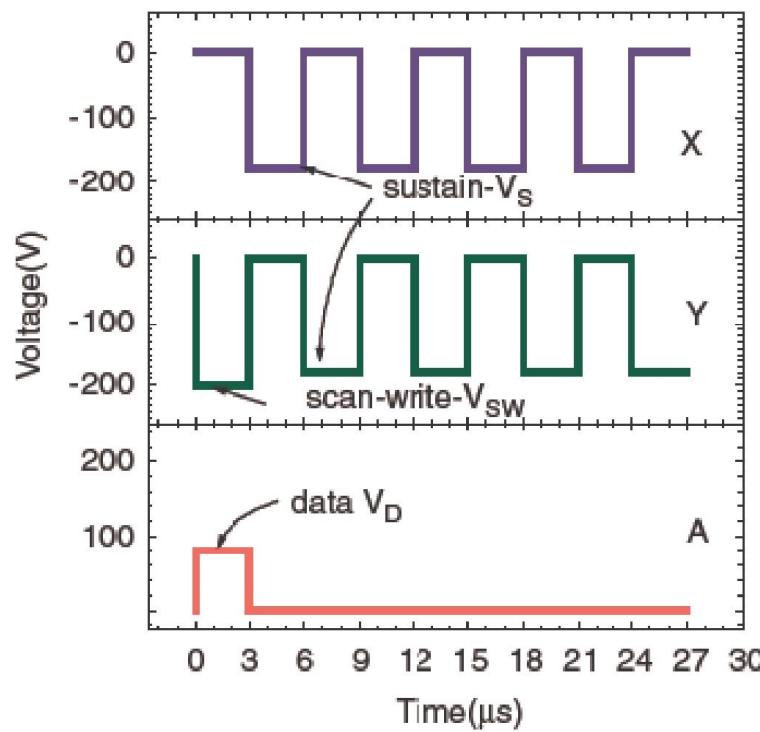
Célula ACC



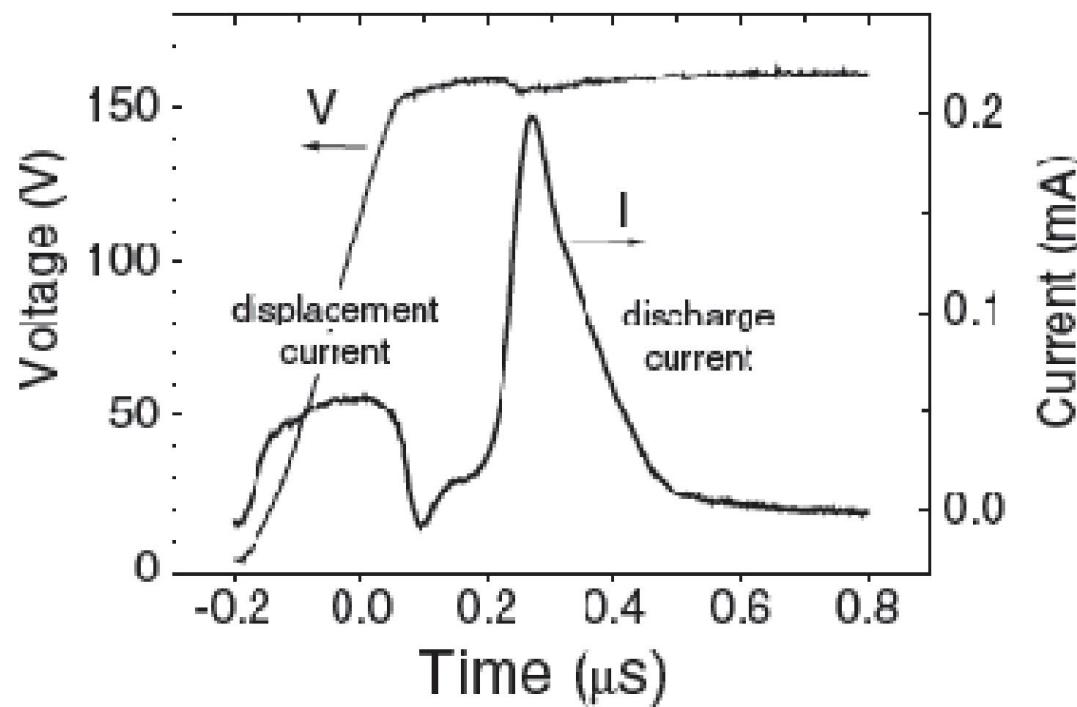
Curva Característica da Descarga em Gás



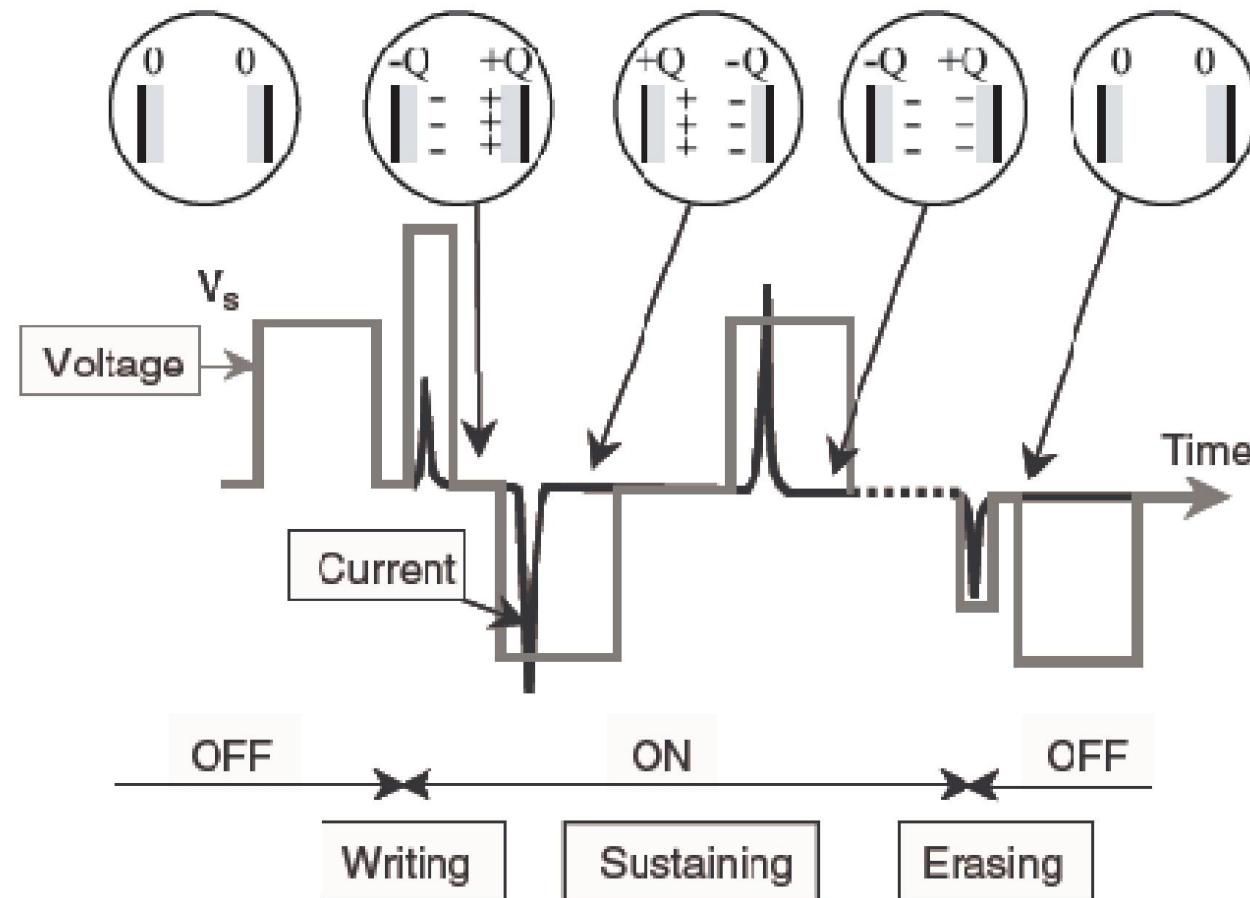
Formas de Onda para Visor de Plasma ACC



Corrente em uma Célula de Plasma ACC



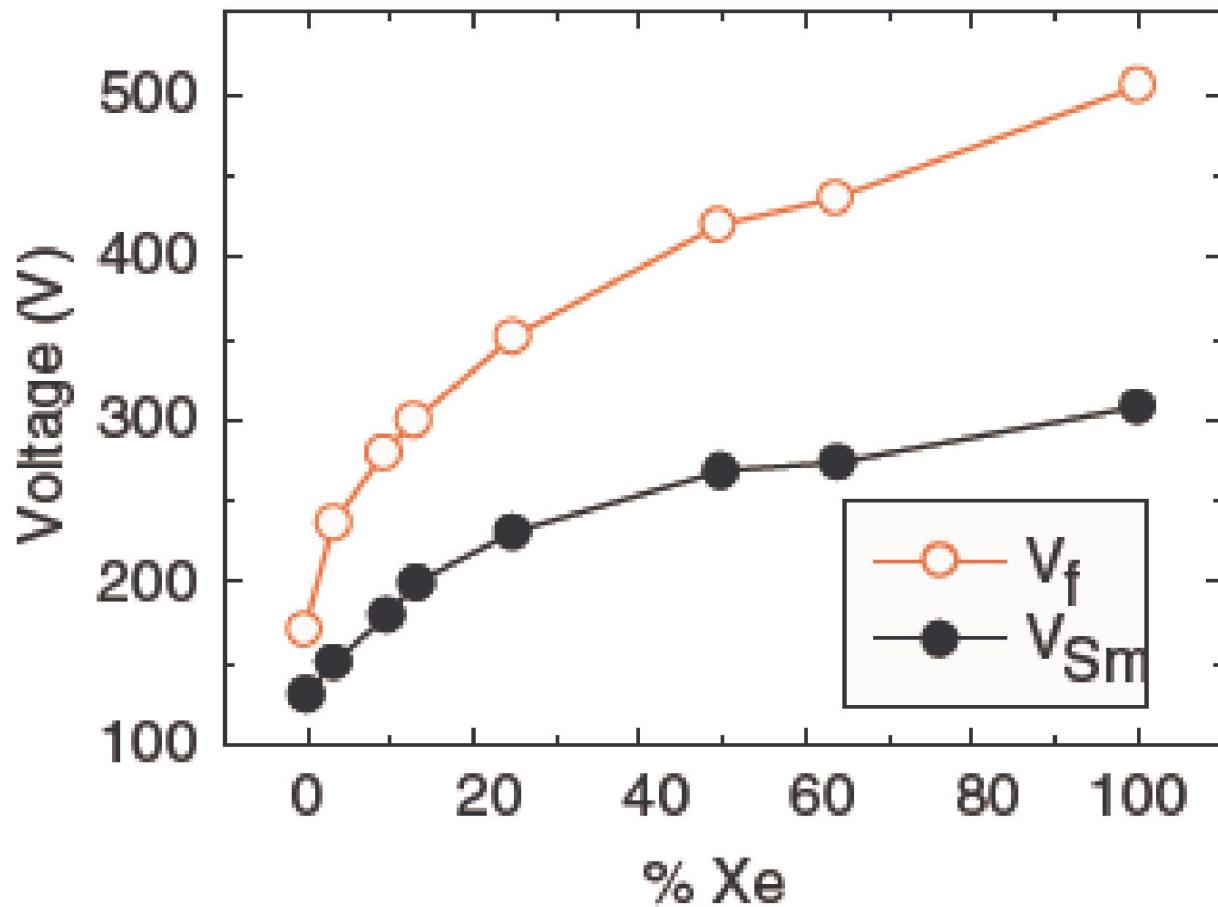
Corrente em uma Célula de Plasma ACC



Descarga Gasosa

- Xenônio
 - Concentração: 3 a 10%
 - Função: Emissão de fótons UV (~ 150 nm)
- Neônio
 - Função: Reduzir a tensão de ionização do gás
 - Alto coeficiente de emissão secundária na camada de MgO
 - Inconveniente: emissão de luz visível (alaranjada)

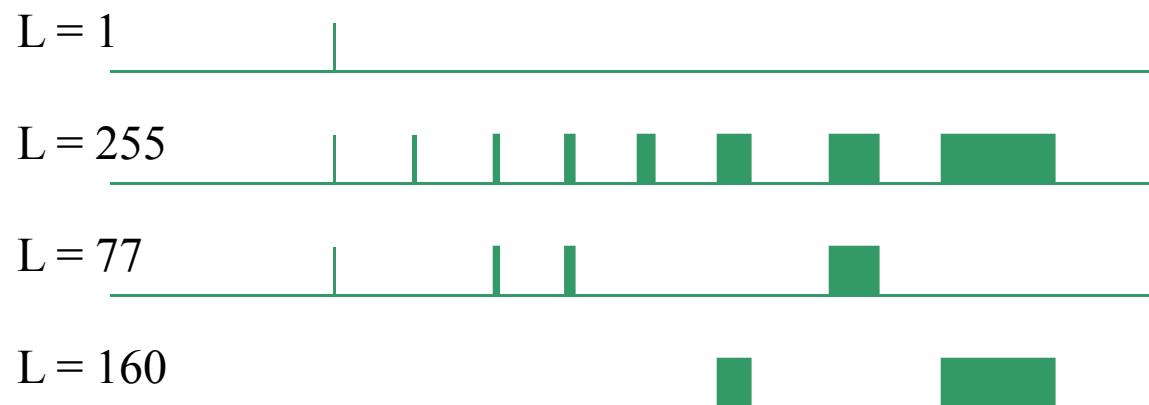
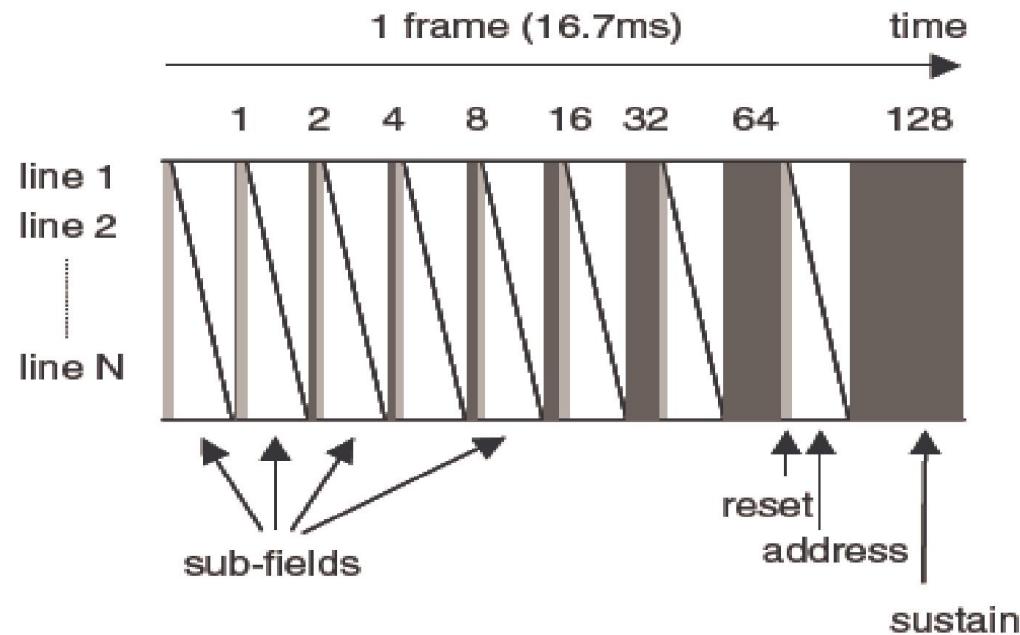
Margens ON / OFF x Relação Xe / Ne



“Fósforos” para Visor de Plasma

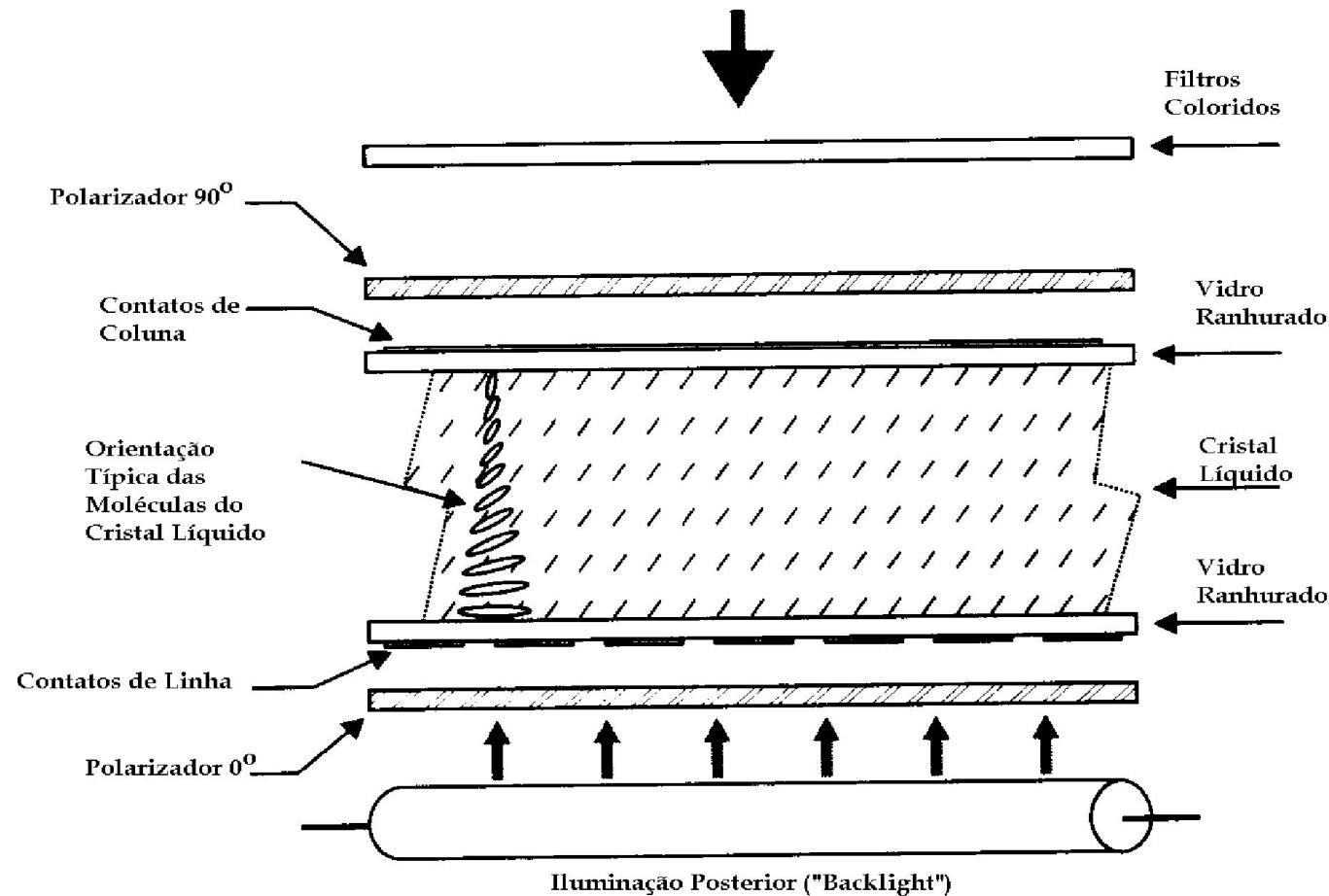
- Requisitos:
 - Alta eficiência quântica (80% a 95%)
 - Alta refletância para luz visível
 - Baixa refletância para UV
- Azul: $\text{Ba Mg Al}_{10}\text{O}_{17} : \text{Eu}^{2+}$
- Verde: $\text{Zn}_2\text{SiO}_4 : \text{Mn}^{2+}$
- Vermelho: $(\text{Y, Gd})\text{B O}_3 : \text{Eu}^{3+}$ e $\text{Y}_2\text{O}_3 : \text{Eu}^{3+}$

Controle de Intensidade



Visor de Cristal Líquido (LCD)

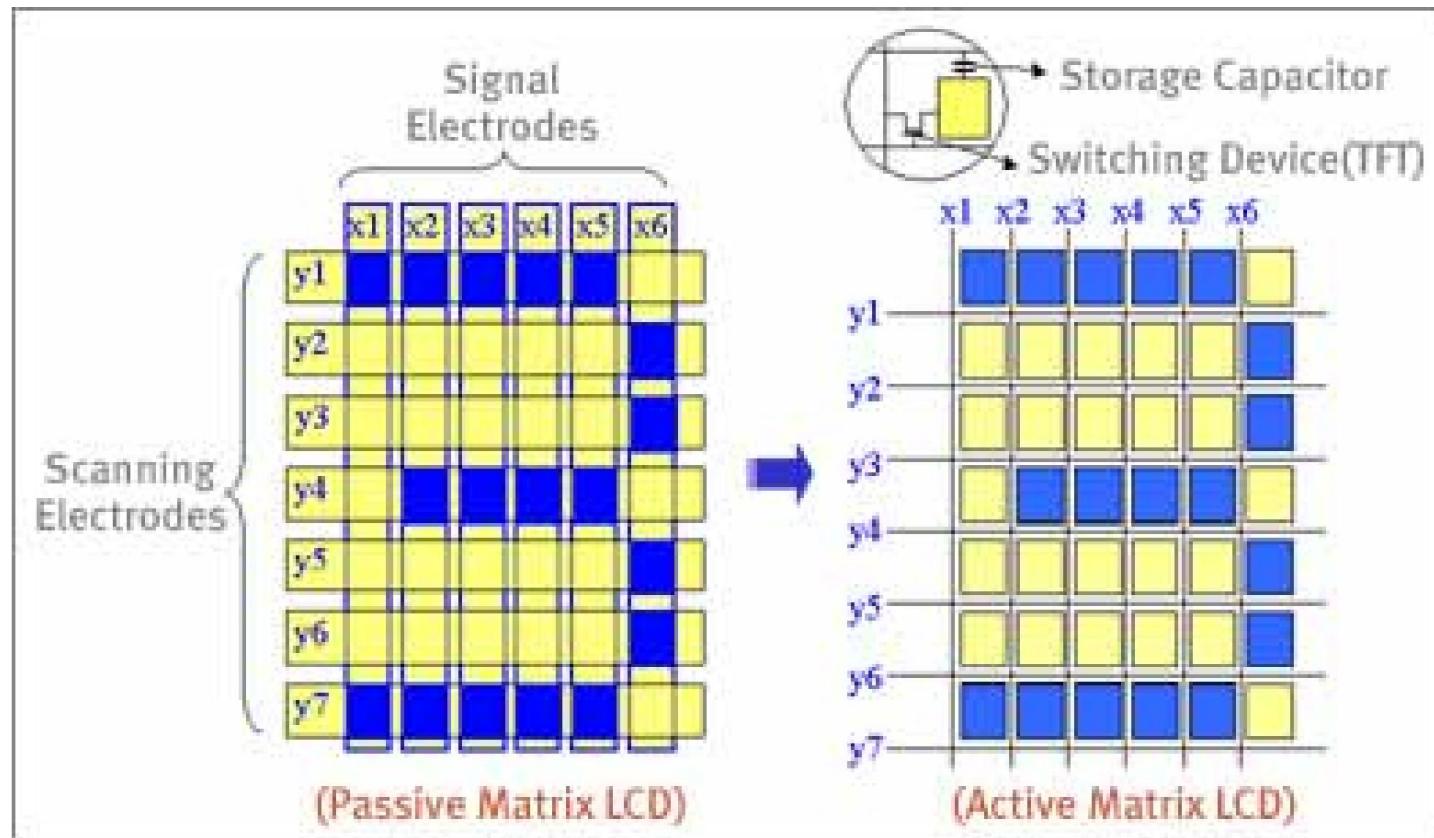
Visor de Cristal Líquido



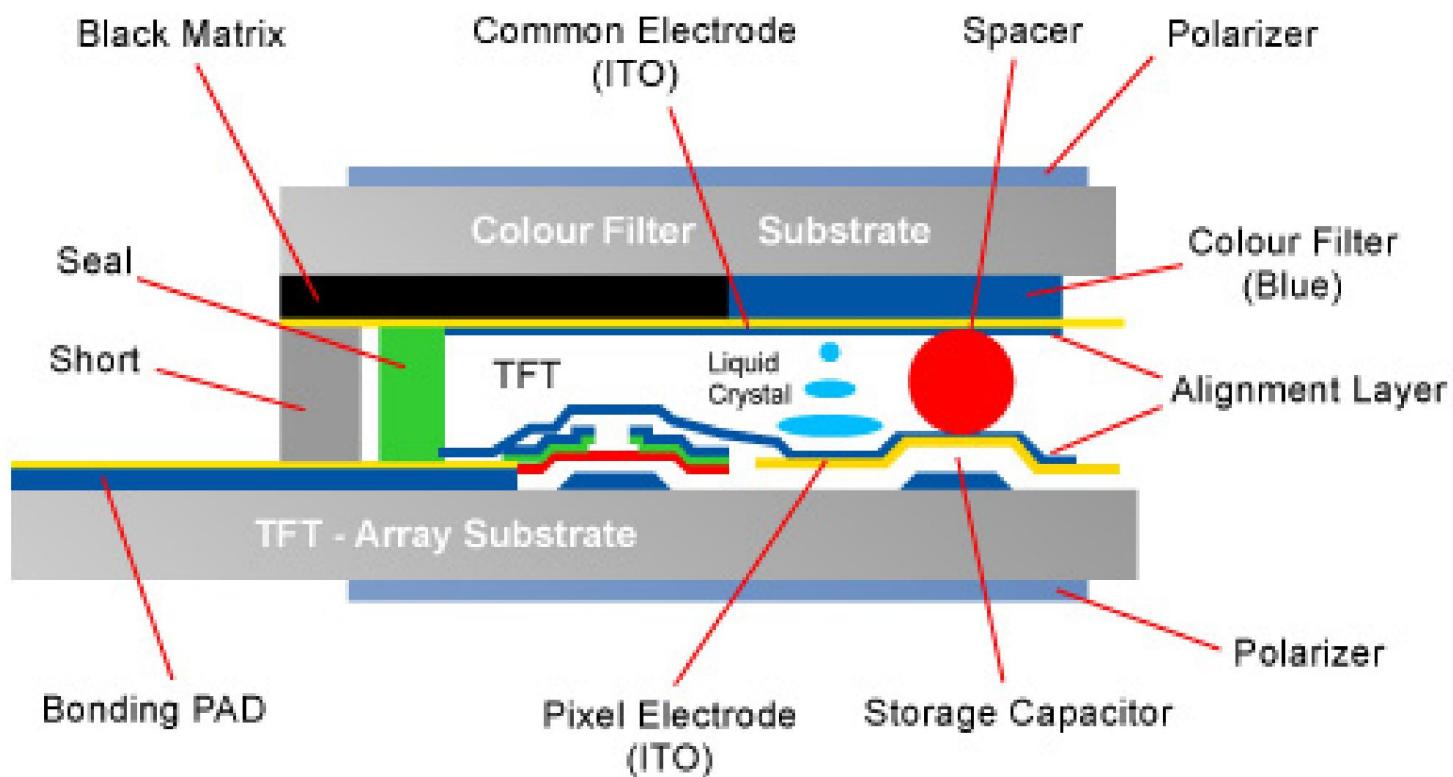
Visor de Cristal Líquido (LCD)

- Visor LCD: RCA, 1968
- Cristal Líquido: F. Reinitzer, 1888
- Moléculas orgânicas com propriedade de auto-alinhamento
- Intensidade do Campo Elétrico controla a transmitância da célula
- Excitação AC para evitar degradação do material
- Inconvenientes: tempo de resposta, ângulo de visualização

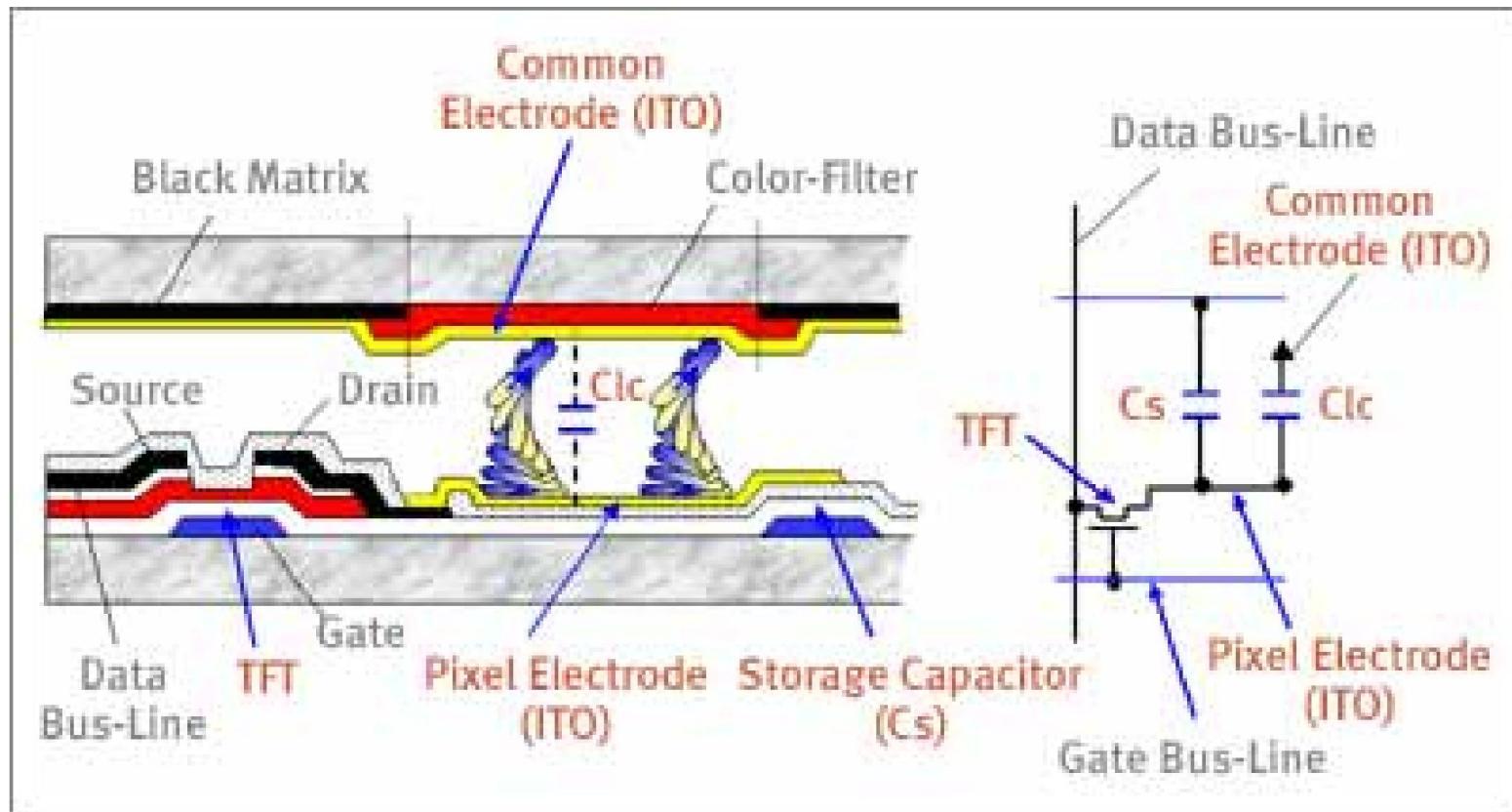
Matriz Passiva e Ativa



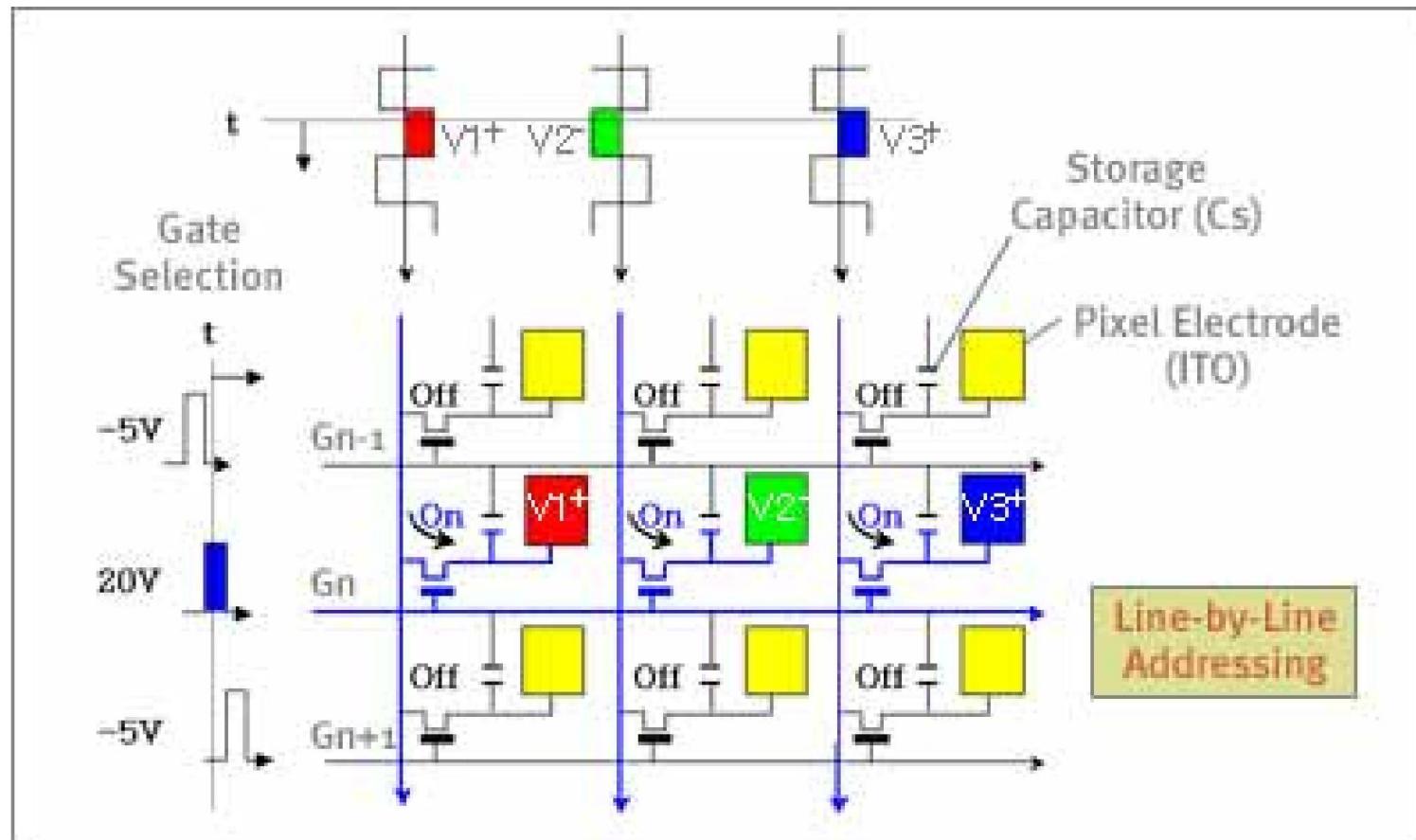
Célula de Matriz Ativa



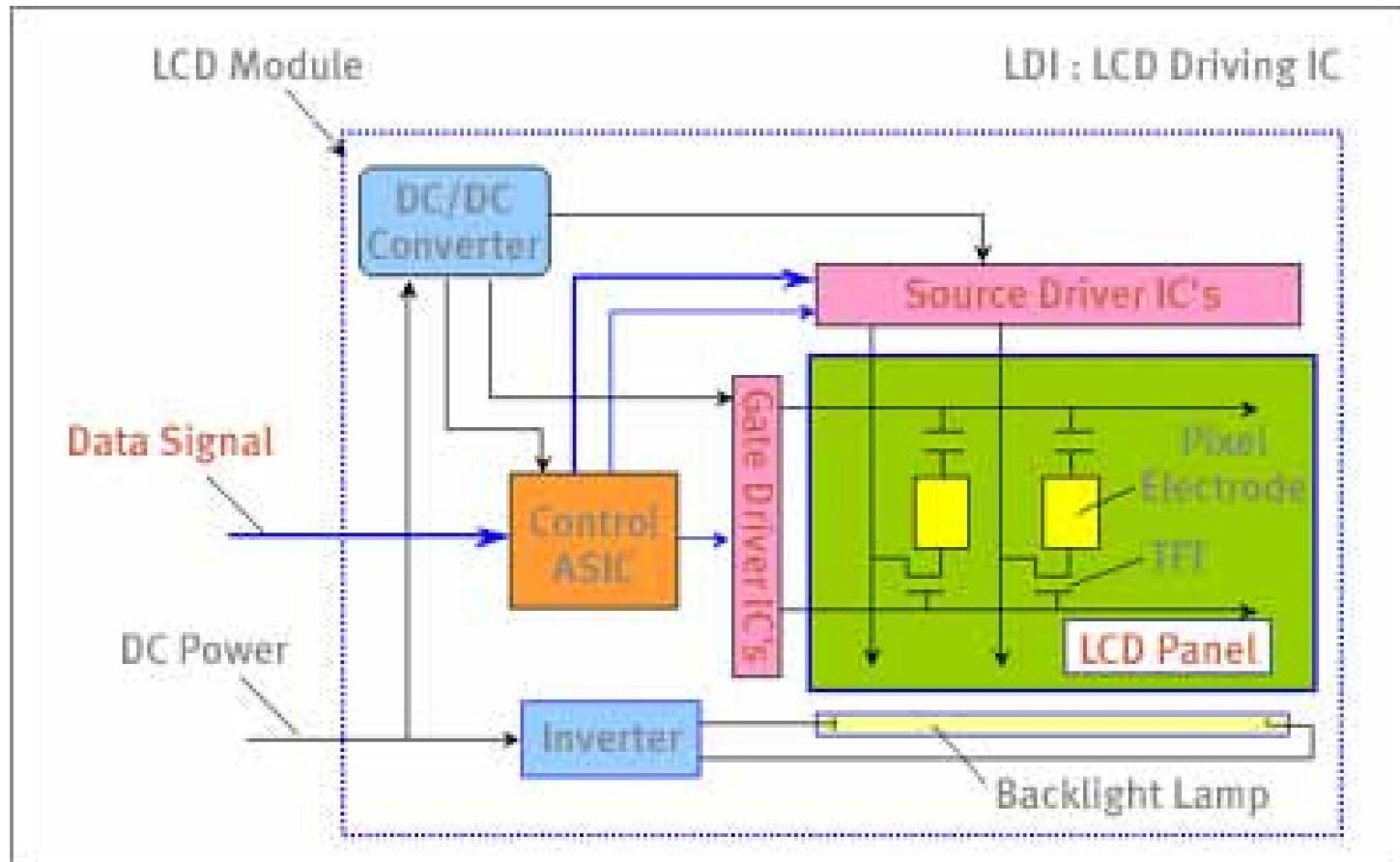
Célula de Matriz Ativa



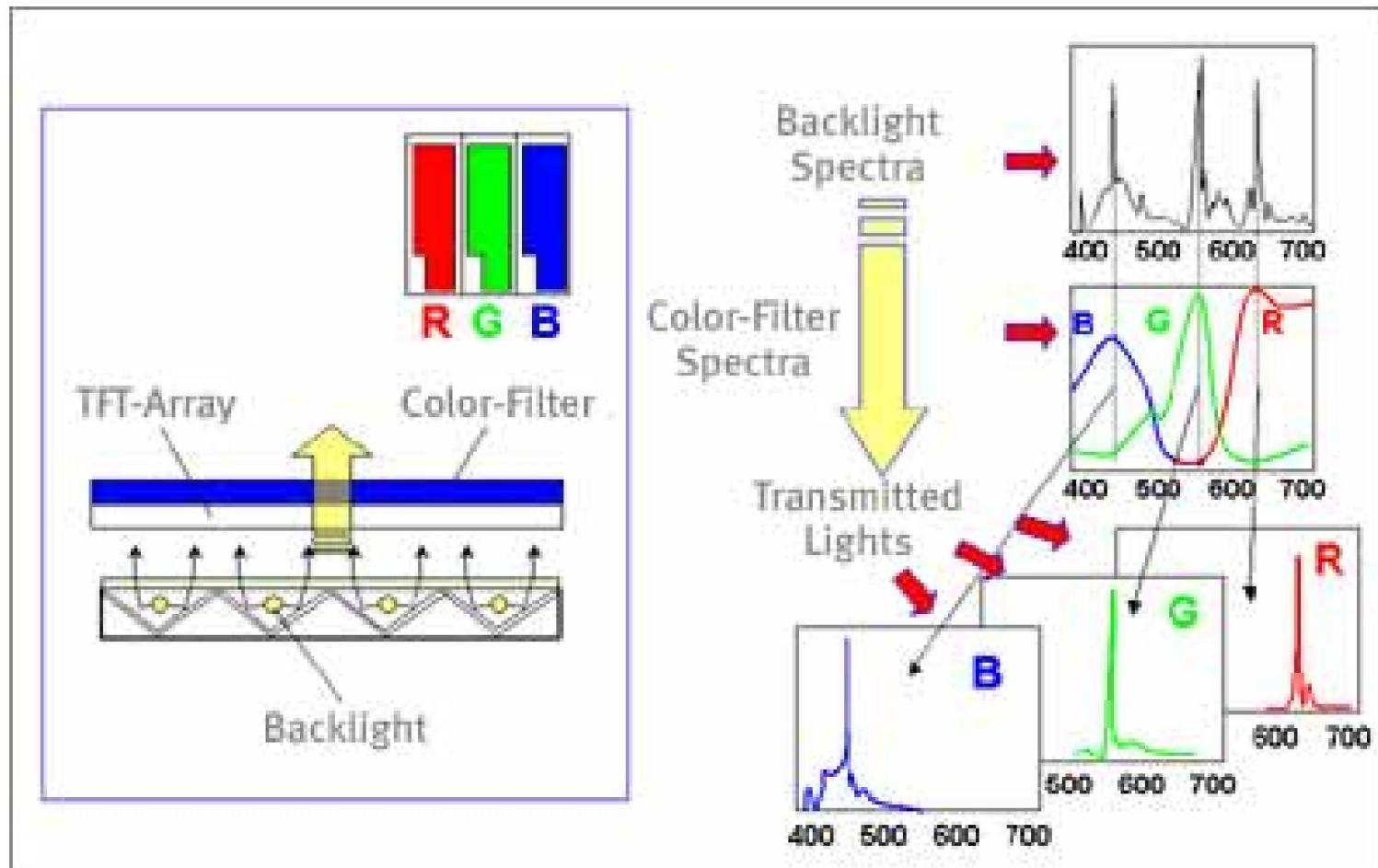
Endereçamento das Células



Circuito de Acionamento do Visor LCD

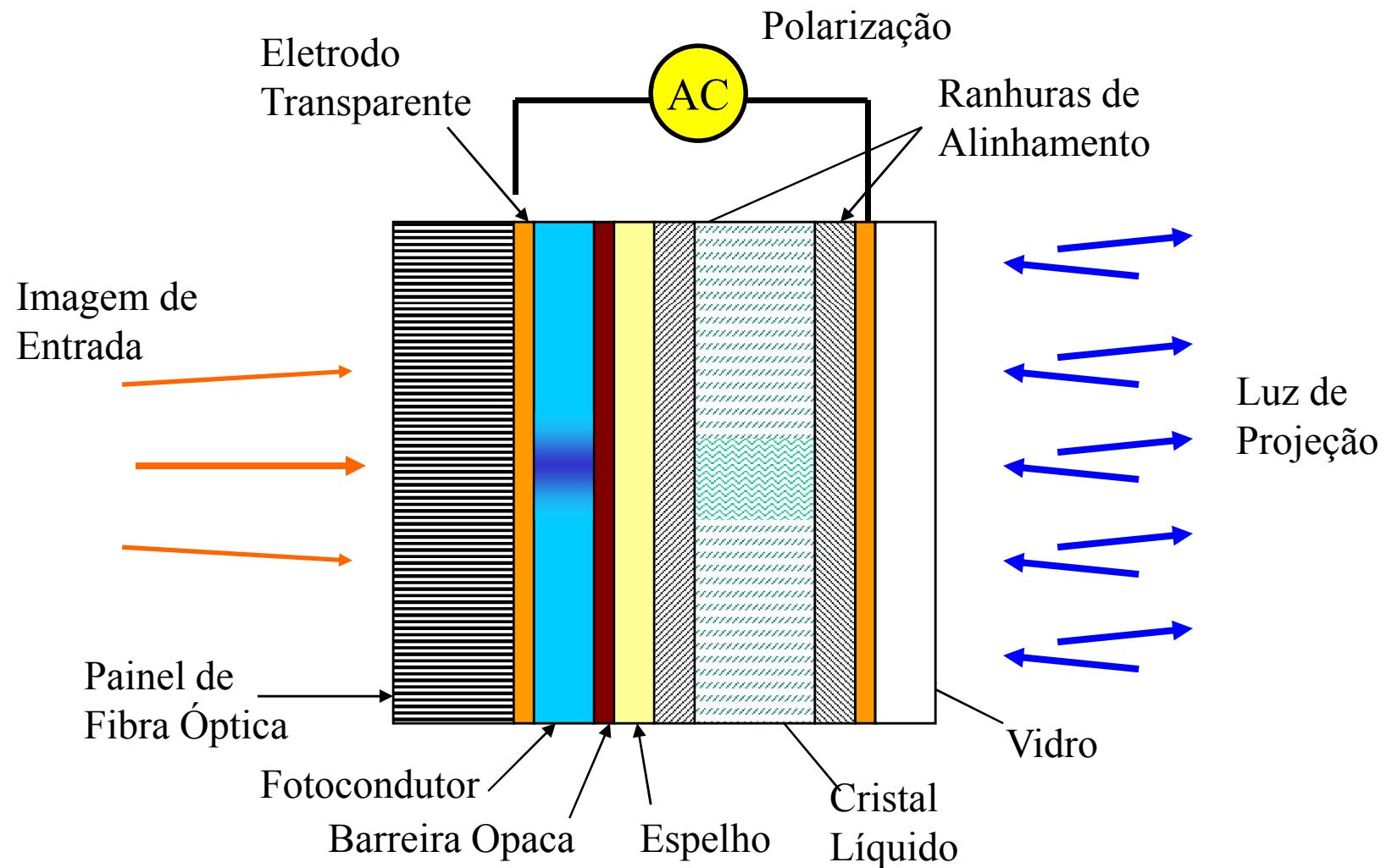


Filtros para Visor a Cores

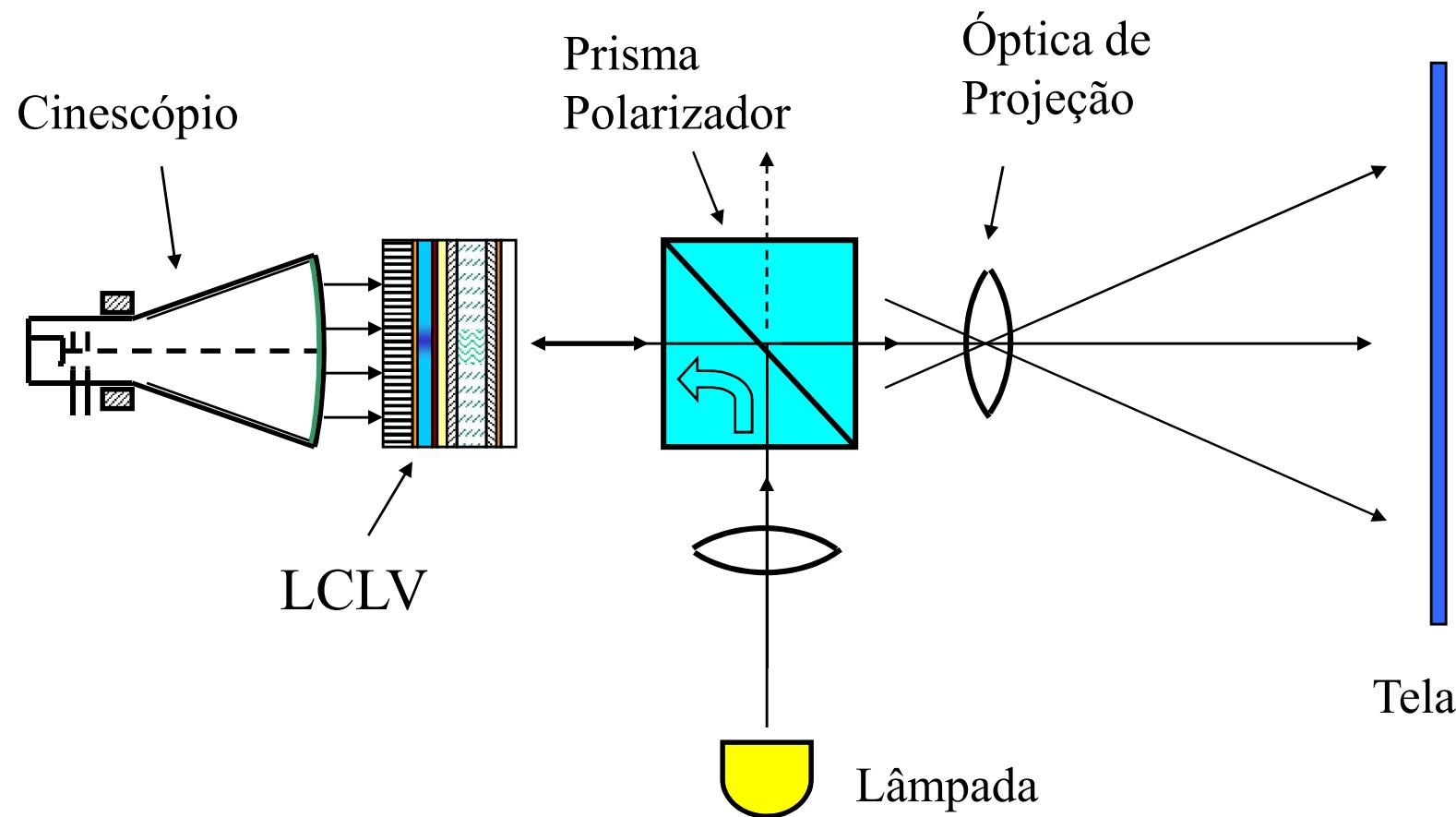


Amplificador Óptico

(LCLV – Liquid Crystal Light Valve)

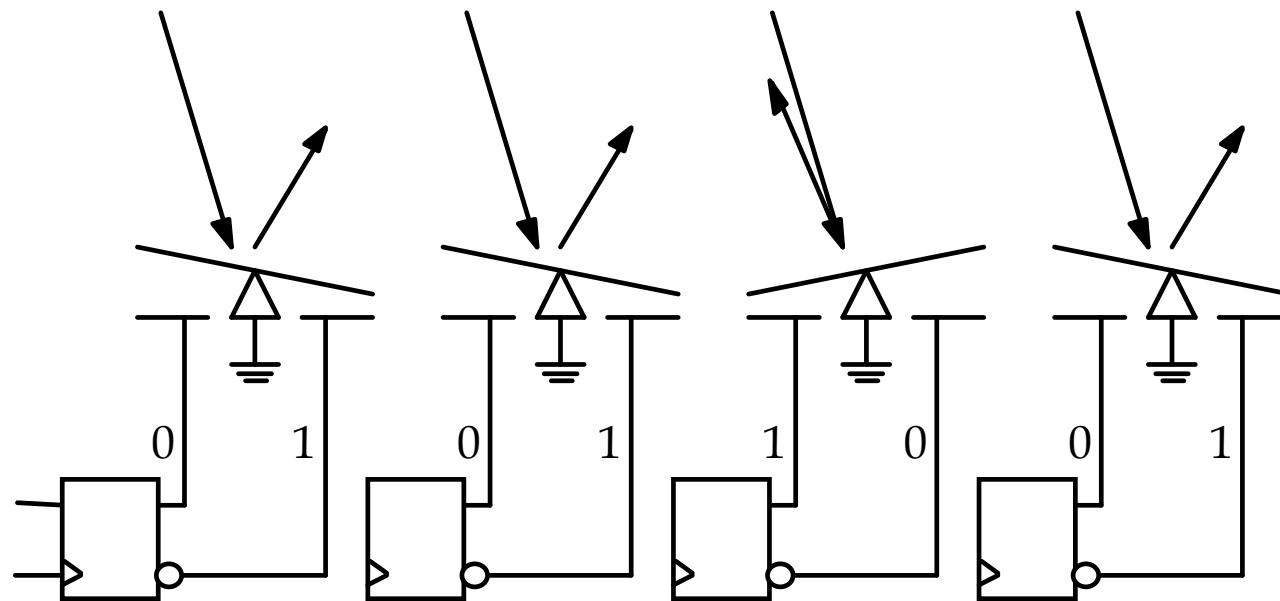


Sistema de Projeção com Amplificador Óptico



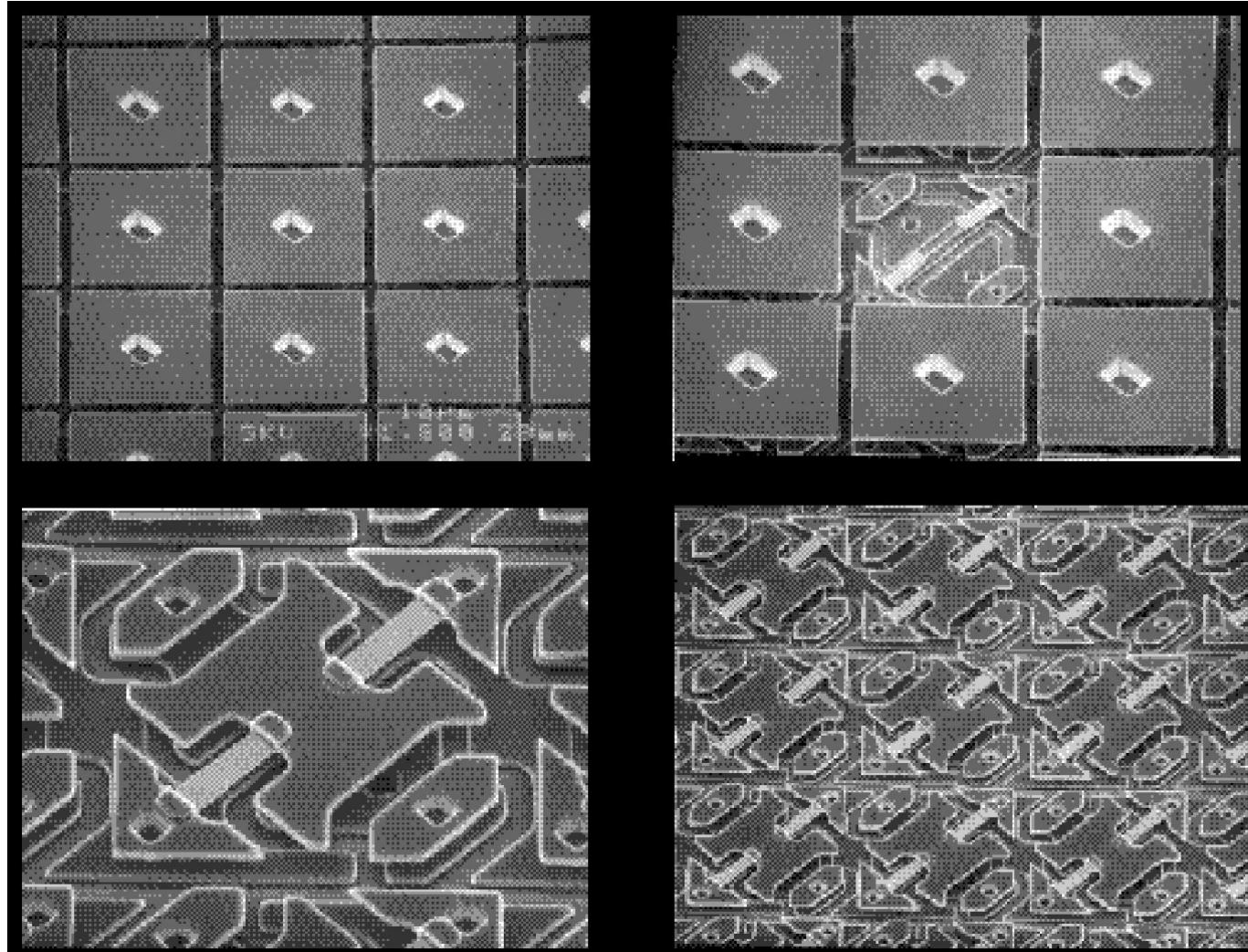
Outros Sistemas

Visor de Micro-Espelhos (DMD)

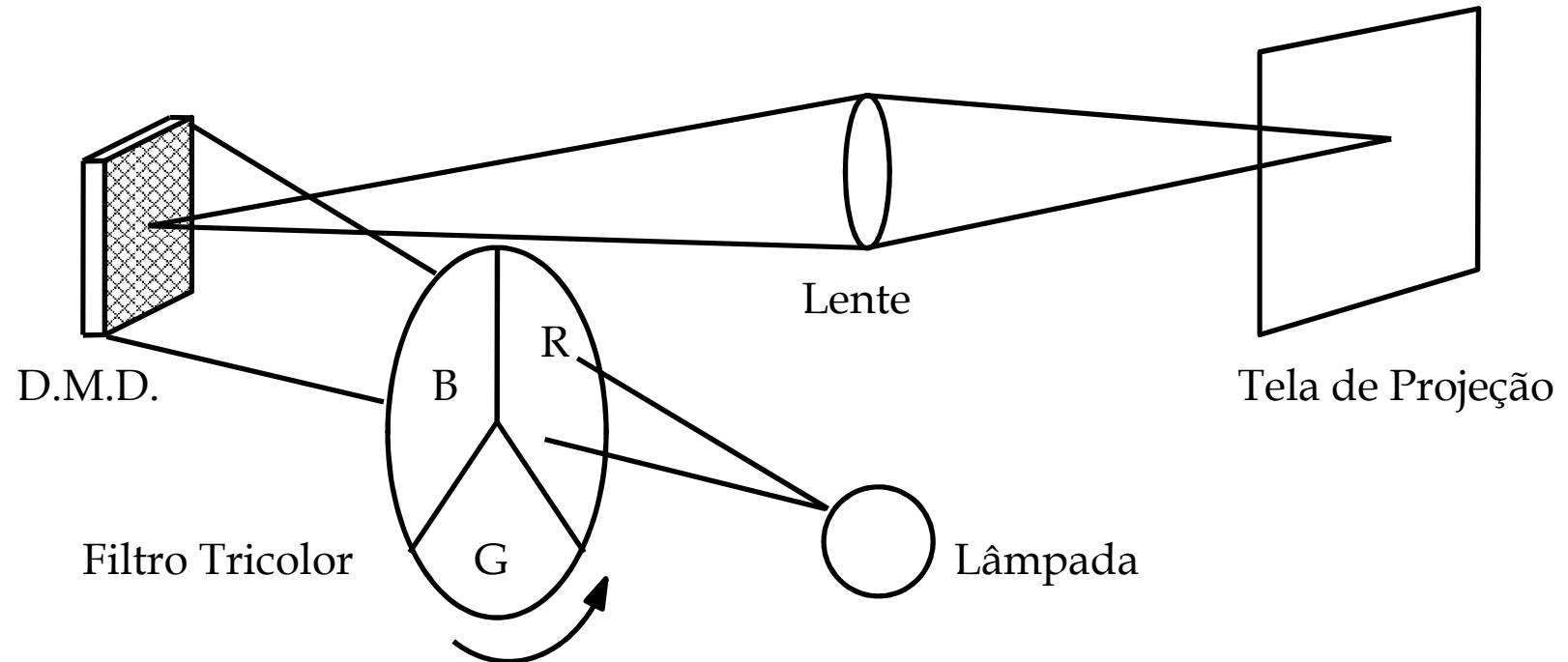


“Digital Micro-mirror Device”

Estrutura do Micro-Espelho



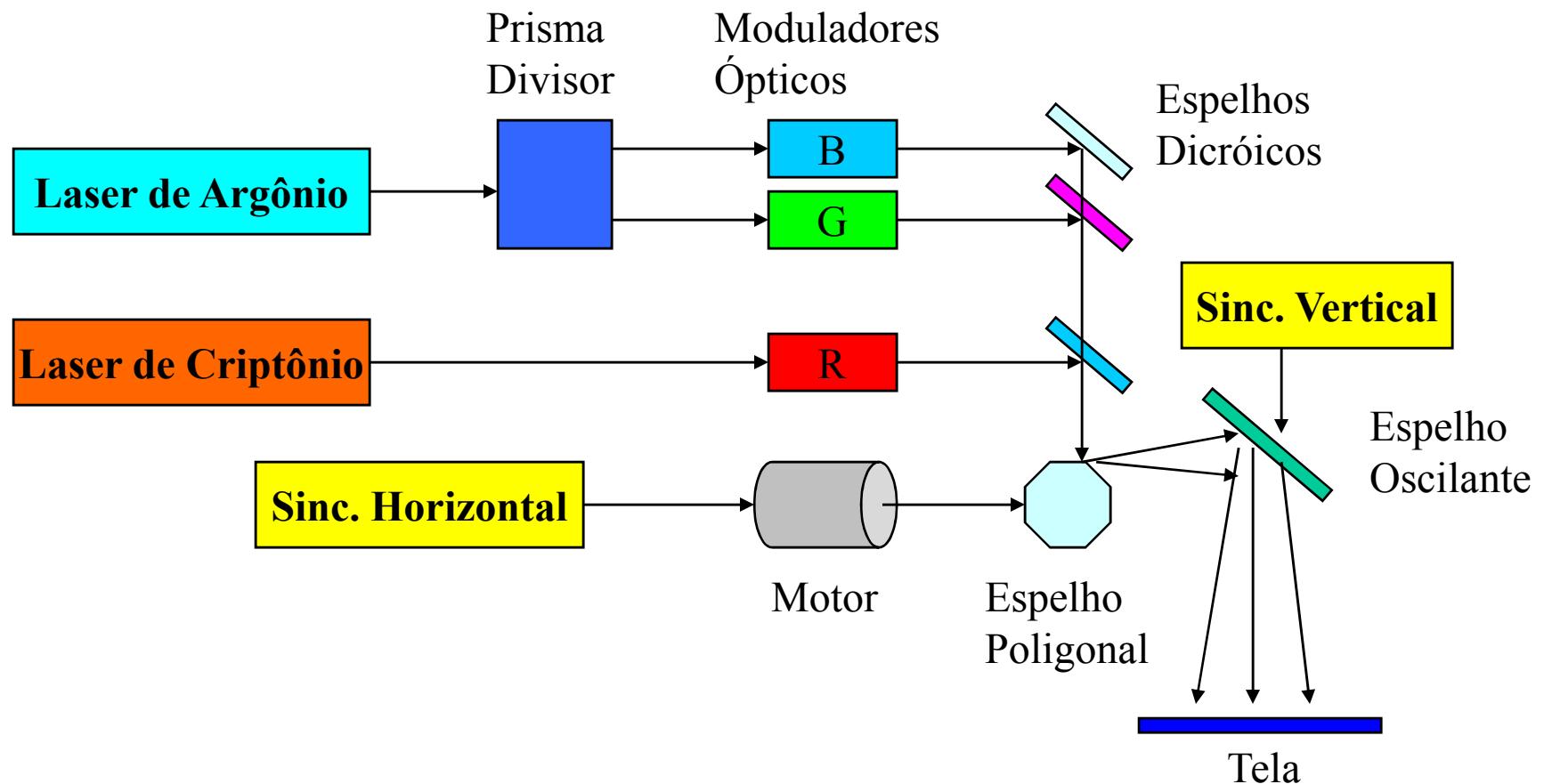
Projetor Seqüencial com Micro-Espelhos



Visor de Micro-Espelhos (DMD)

- Texas Instruments, 1995
- Para uso em projetores
- Alta luminosidade possível (Fluxo luminoso)
- Baixo contraste em ambientes iluminados
- Consumo elevado
- Vida útil da lâmpada : ~ 1000 horas

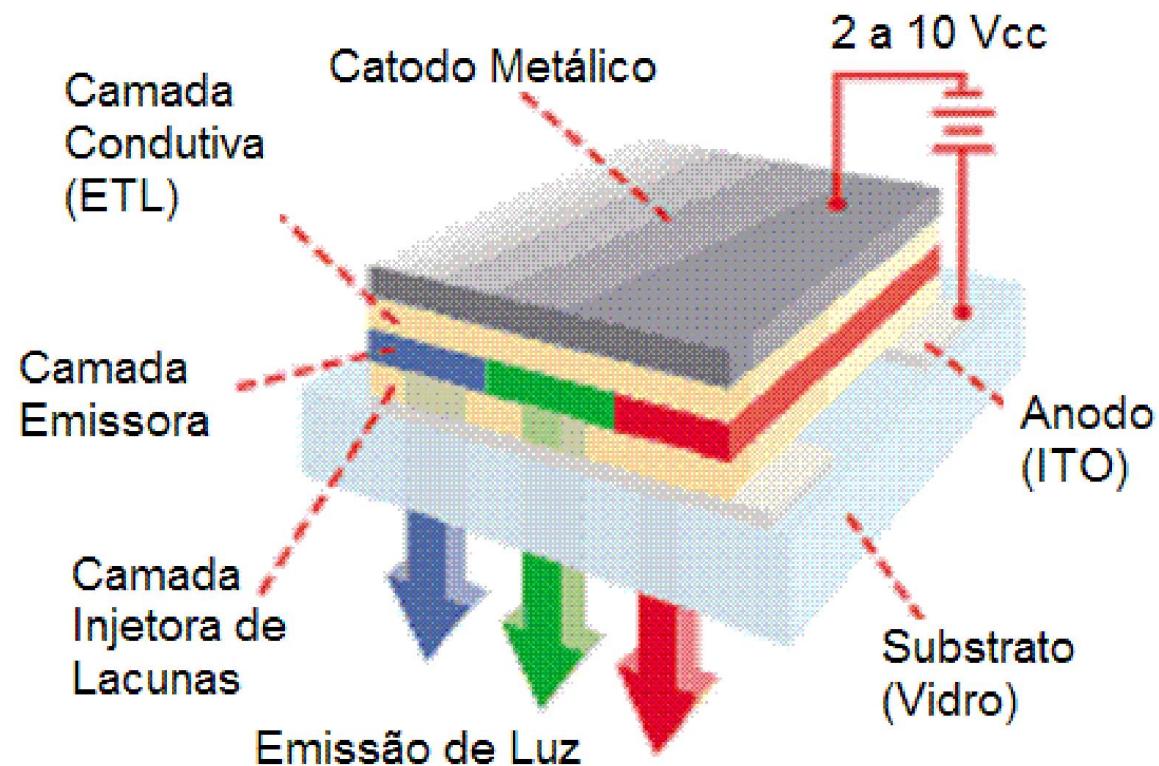
Sistema de Projeção a Laser



LED Orgânico (OLED)

- Eastman Kodak, 1987
- Display emissivo de baixa tensão
- Junção entre camadas de compostos orgânicos ou polímeros:
 - Camada condutora
 - Camada emissora
- Materiais: PPV (Poli p-Fenileno Vinileno) e Poli Fluoreno
- Matriz passiva (PMOLED) ou ativa (AMOLED)

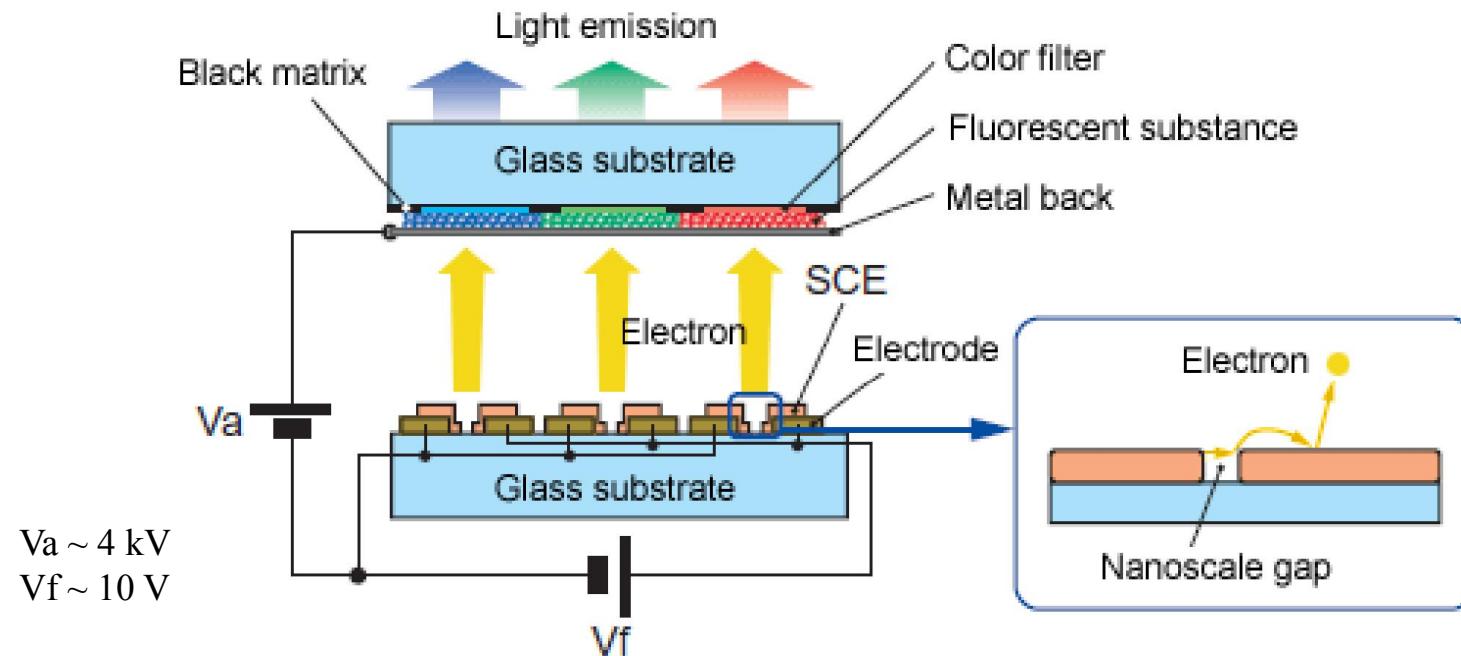
LED Orgânico (OLED)



Características do OLED

- Baixo peso, custo e consumo
 - Pode ser fabricado com técnicas de impressão (ink-jet)
 - Ângulo de visualização excelente
 - Boa colorimetria
 - Displays flexíveis e transparentes são possíveis
-
- Baixa durabilidade (~ 5000 horas p/ OLED azul)
 - Sensível a H_2O e O_2

SED (Surface-conduction Electron-emitter Display)



SED (Surface-conduction Electron-emitter Display)

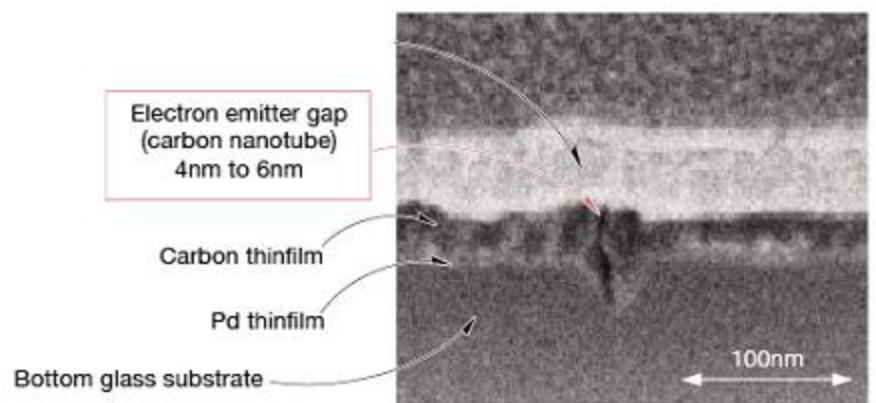
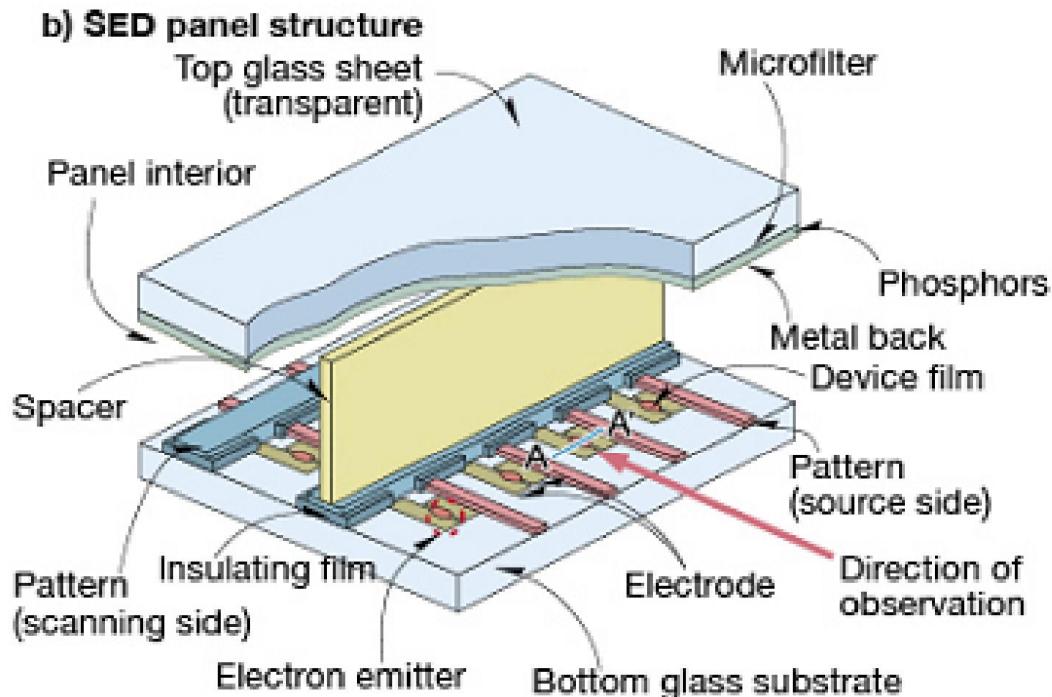
- Canon, Toshiba - 2004
- Protótipos p/ HDTV demonstrados em 2006
- Colorimetria, Ângulo de Visualização e tempo de resposta excelentes
- Baixo consumo, proporcional ao brilho da imagem
- Processo construtivo similar ao TRC

Protótipo SED 55" (2006)



Luminância: 450 nits;
Tempo de resposta: 1 ms
Contraste: 50.000:1

Detalhes Construtivos do SED

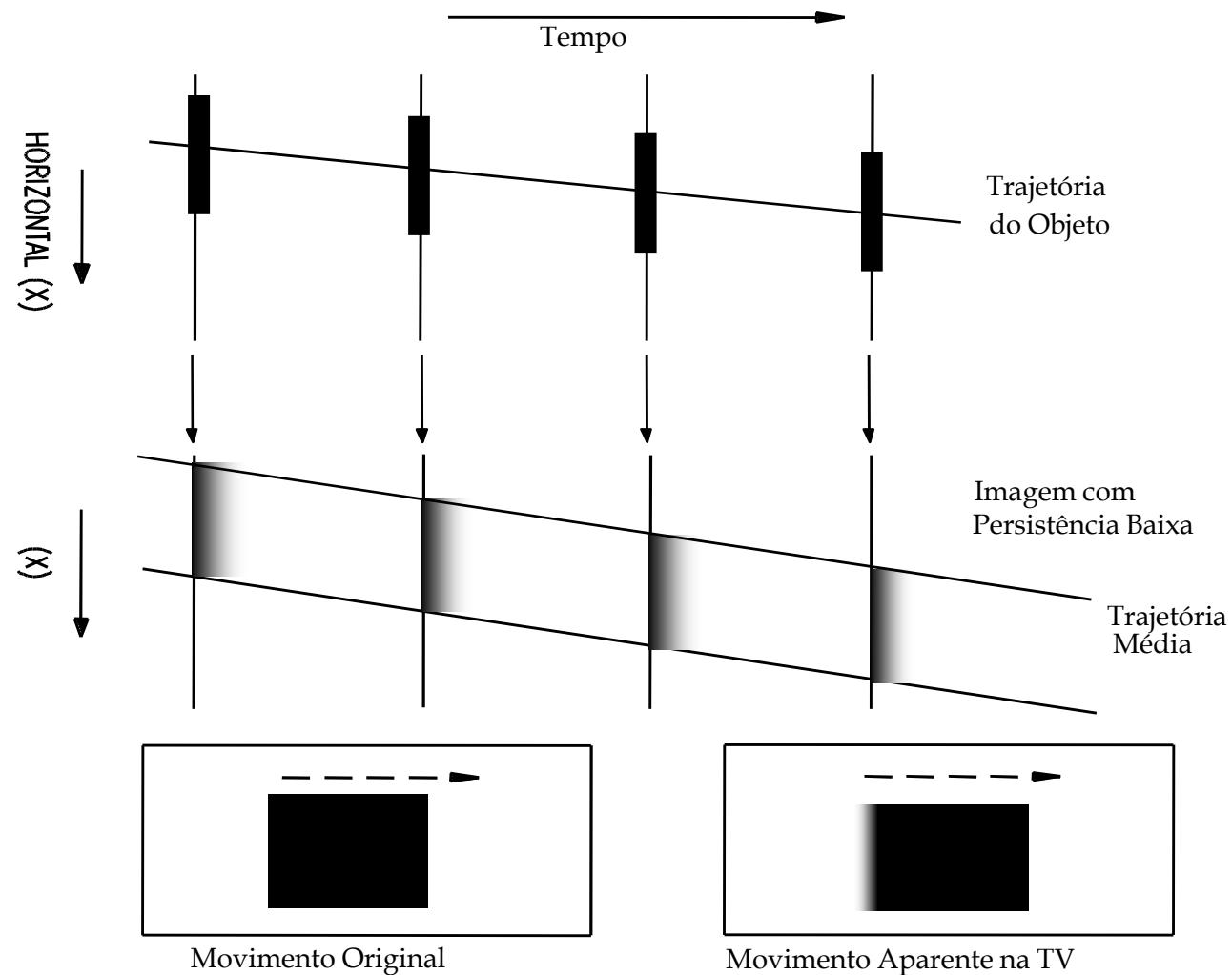


Considerações Comparativas

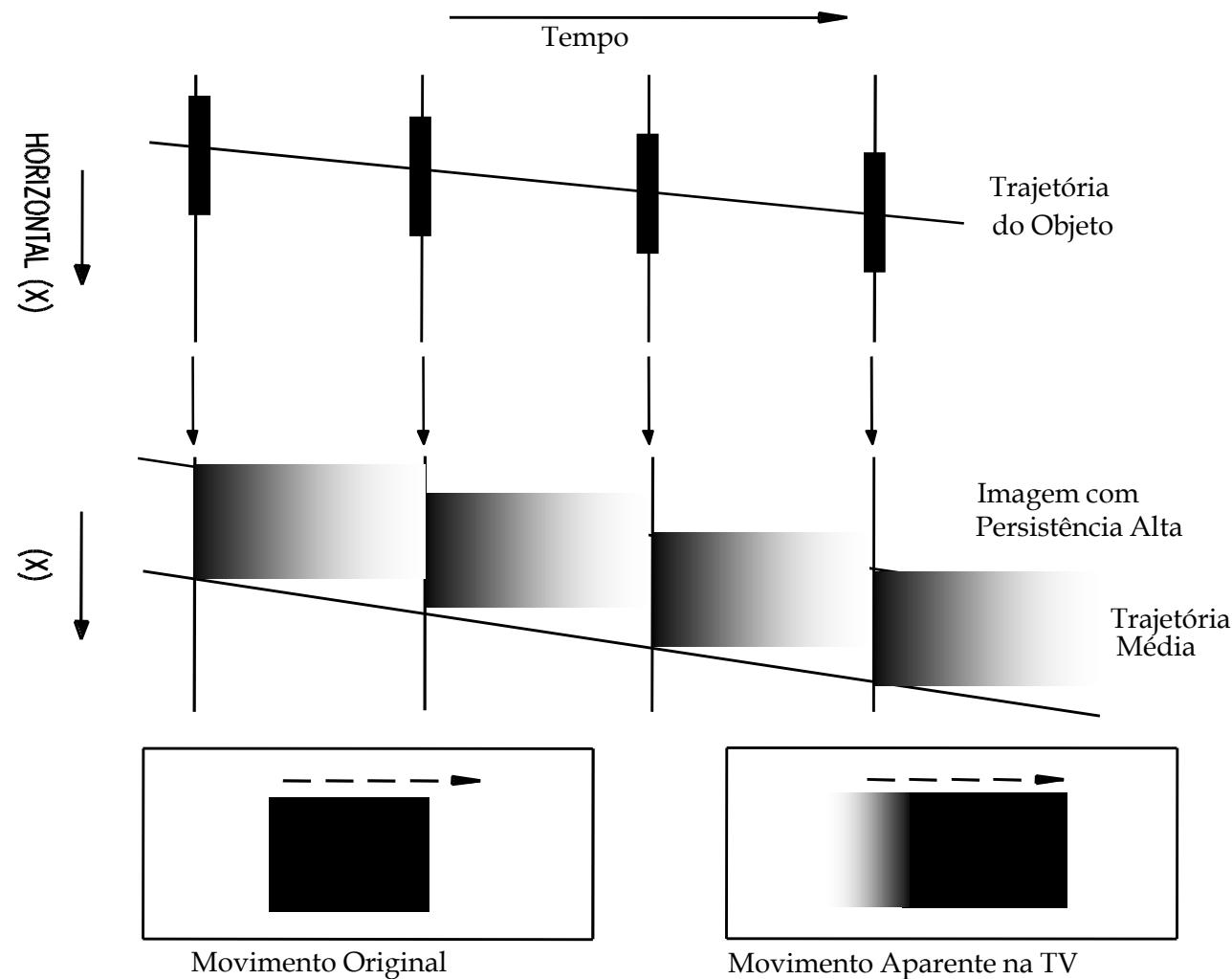
Aspectos a Serem Considerados Para as Tecnologias Competitivas em Relação ao TRC

- Persistência / Tempo de Resposta
- Contraste, Nível de Iluminação Ambiente
- Brilho Máximo (Luminância)
- Ângulo de Visualização
- Resolução Espacial
- Homogeneidade de Cor (Local e Global)
- Fidelidade de Reprodução de Cores
- Durabilidade
- Consumo
- Custo de Fabricação e Índice de Aproveitamento

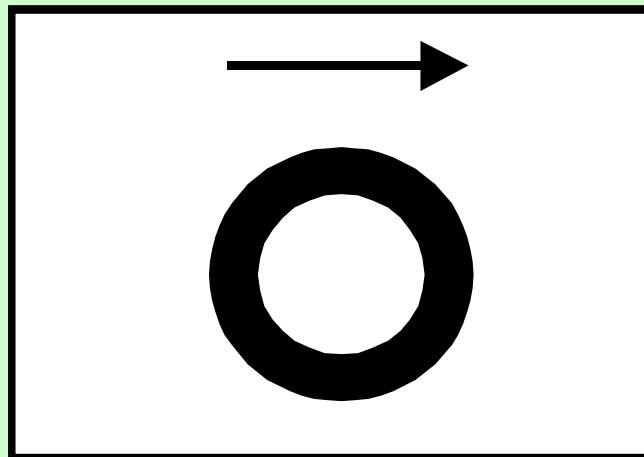
Persistência da Imagem em um TRC



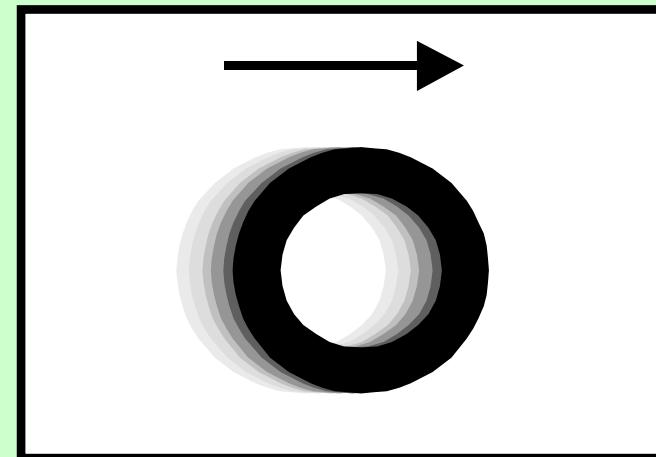
Persistência Exponencial da Imagem



Efeito Visual da Persistência

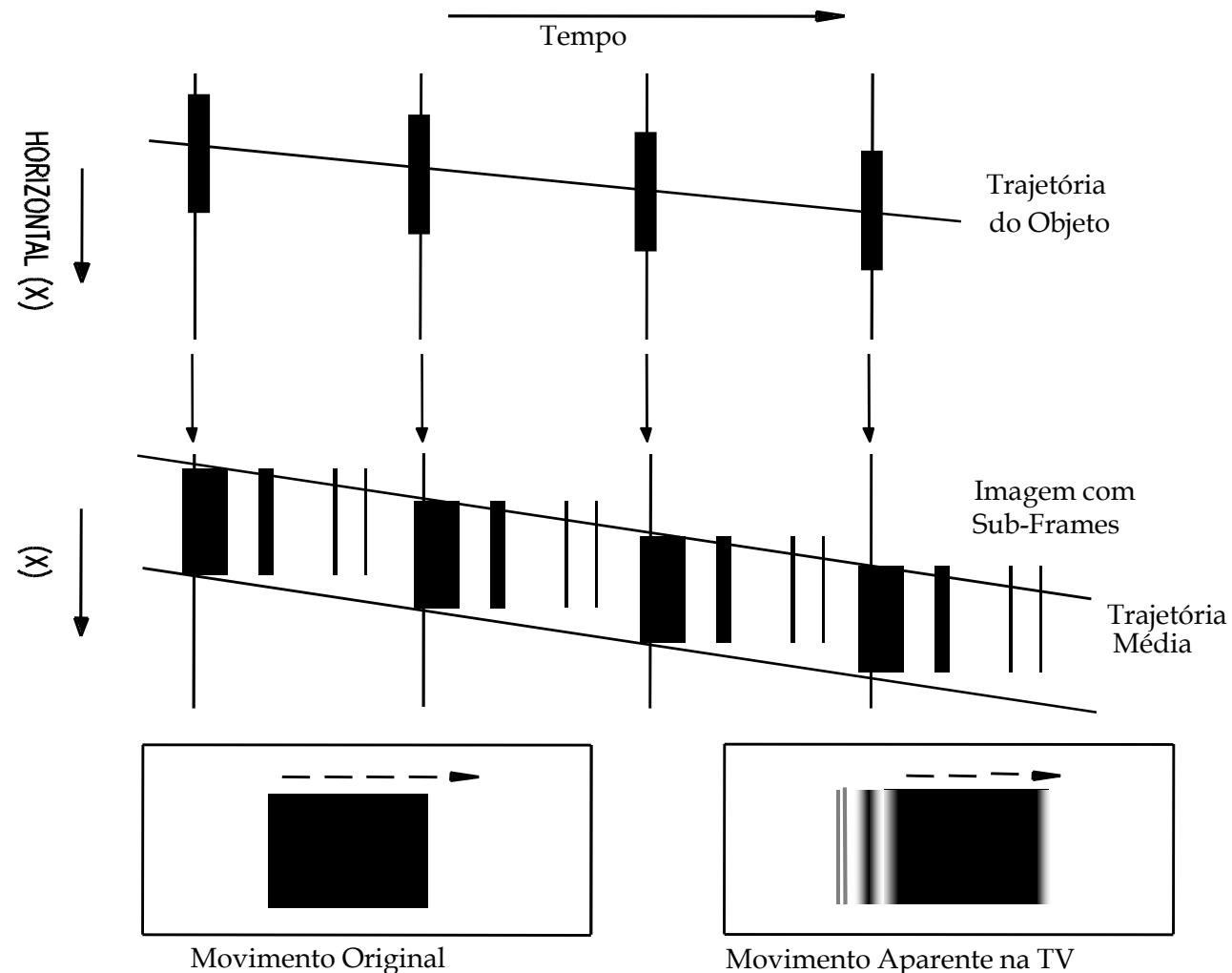


Movimento Original



Movimento Aparente na TV

Persistência no Visor de Plasma



Persistência no Visor LCD

