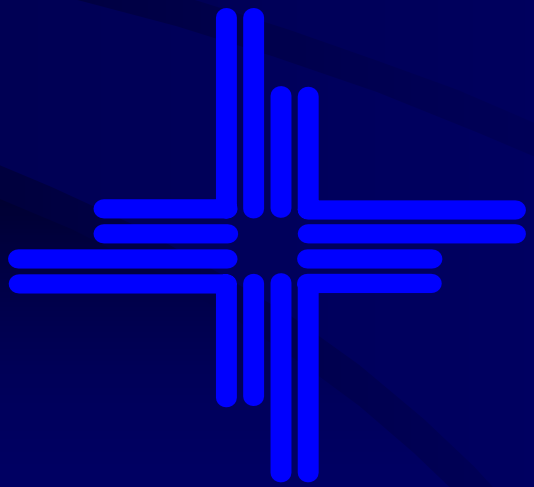
Microdisplays: Development and Applications

James Anderson

Lead Scientist

Hana Microdisplay Technologies, Inc.



Outline

- Microdisplay Applications
  - Near to Eye
  - Projection
- Microdisplay Technologies
  - Emissive devices
  - Micro-Electro-Mechanical System (MEMS) devices
  - Liquid Crystal devices

Microdisplay Applications

Near to Eye

- Camcorder Viewfinder
- Digital Camera Viewfinder
- Video Phones
- Head Mounted Displays

Near to Eye



Near to Eye





Images from MicroOptical

Near to Eye

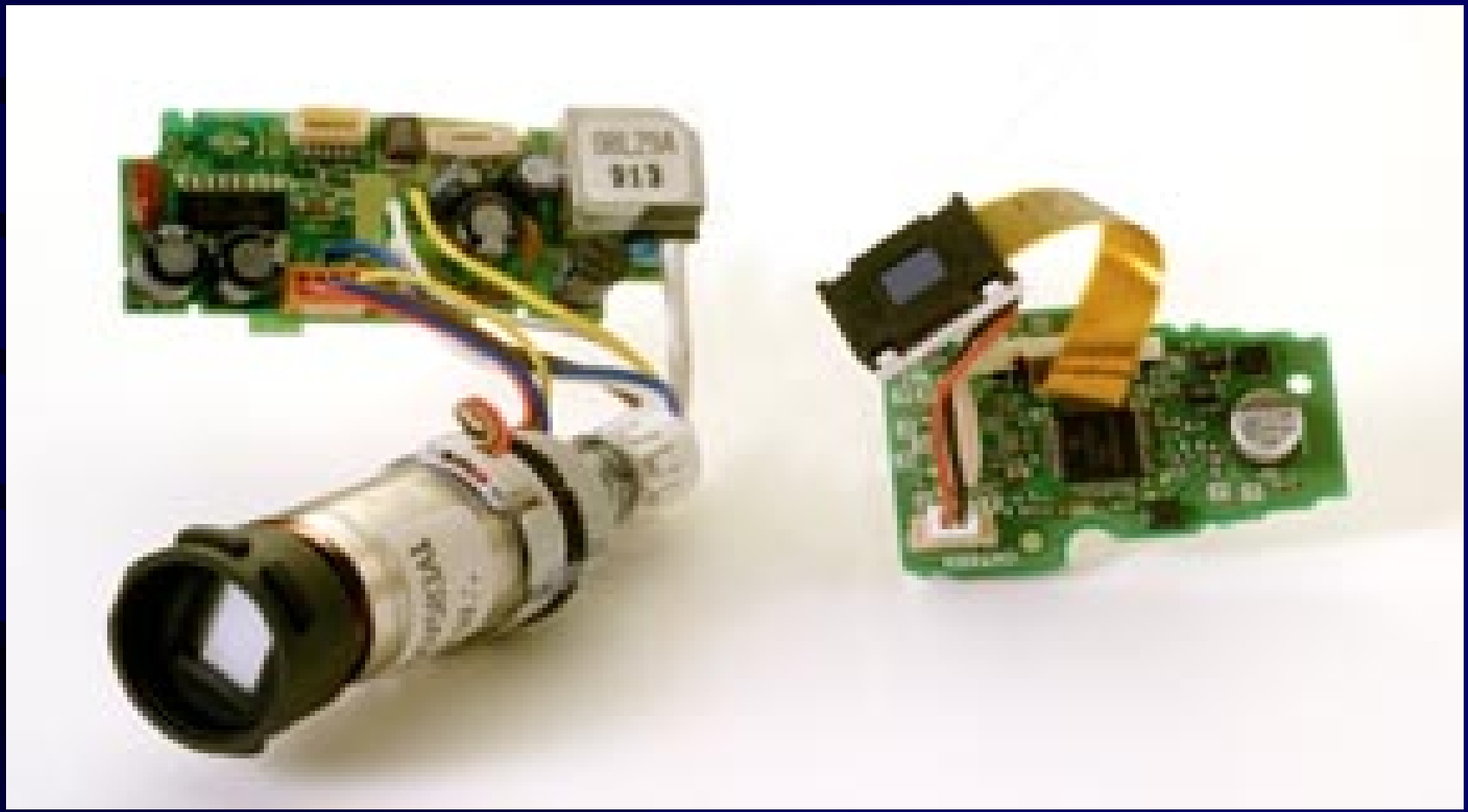


Image from Kopin

Primary Players in NTE

- Kopin
- Brillian (Formerly 3-5 Systems)
- DisplayTech
- MicroOptical
- eMagin (OLED)
- Olympus

Projection

- Conference Projector
  - Such as the one being used here
- Digital Cinema
- Rear Projection Television

Projection




D-Cine Premiere

CRT Rear Projection TVs

- Advantage
  - Good picture for least money
- Disadvantages
  - Big and Heavy
  - High Definition is difficult
  - Already pushing technology, can’t be pushed much further

- Todays 90% market share is expected to fall to <15% by 2007.

Microdisplay Rear Projection TVs

- Advantage
  - Excellent picture quality
  - High resolution
  - Light
  - Small form factor
  - Lots of room for future improvement
- Disadvantages
  - **Expensive**
  - Availability

Primary Players in Microdisplay RPTV

- Commercially Available Now
  - Philips (LCoS)
  - Hitachi (LCoS, HTPS)
  - Sony (LCoS, HTPS)
  - Samsung (DLP)
  - RCA (DLP)
  - Gateway (DLP)
  - Optiva (DLP)
- Future
  - Intel (LCoS)
  - Every TV Manufacturer

Microdisplay RPTV



KOLIN



SAMSUNG

Microdisplay RPTV



Philips 55” CINEOS LCoS TV

Microdisplay RPTV





Philips 55” CINEOS LCoS TV

Microdisplay RPTV



Gateway 56” DLP TV

Microdisplay RPTV





RCA / Thomson 61” DLP TV

Microdisplay RPTV



RCA / Thomson 70” DLP TV

Mitsubishi WL-82913 LCoS TV specs



- 82-inch diagonal
- 29 3/8 inches deep
- Resolution: 1920 x 1080
- 16:9 Aspect Ratio
- 500 lbs
- 1000:1 dark room, 250:1 bright ambient
- $16,500

Sony Grand WEGA HTPS TV specs



- 70-inch diagonal
- 25 1/2 inches deep
- Resolution: 1386 x 788
- 16:9 Aspect Ratio
- 222 lbs (100kg)
- $5,500

Philips 55PL9773 LCoS TV specs

- 55-inch diagonal
- 17.4 inches deep
- Resolution: 1280 x 720
- 16:9 Aspect Ratio
- 84 lbs
- 450 nits
- >400:1
- $3,500 - $4,500

RCA Scenium DLP TV specs

- 50-inch diagonal (also a 60-inch model)
- 15.5-inches deep
- Resolution: 1280 x 720
- 16:9 Aspect Ratio
- 90 lbs
- $3,000

Gateway 56-inch DLP TV specs

- 56-inch diagonal
- 19 inches deep
- Resolution: 1280 x 720
- 16:9 Aspect Ratio
- 130 lbs
- 400 nits
- 1000:1
- $3,500

Intel

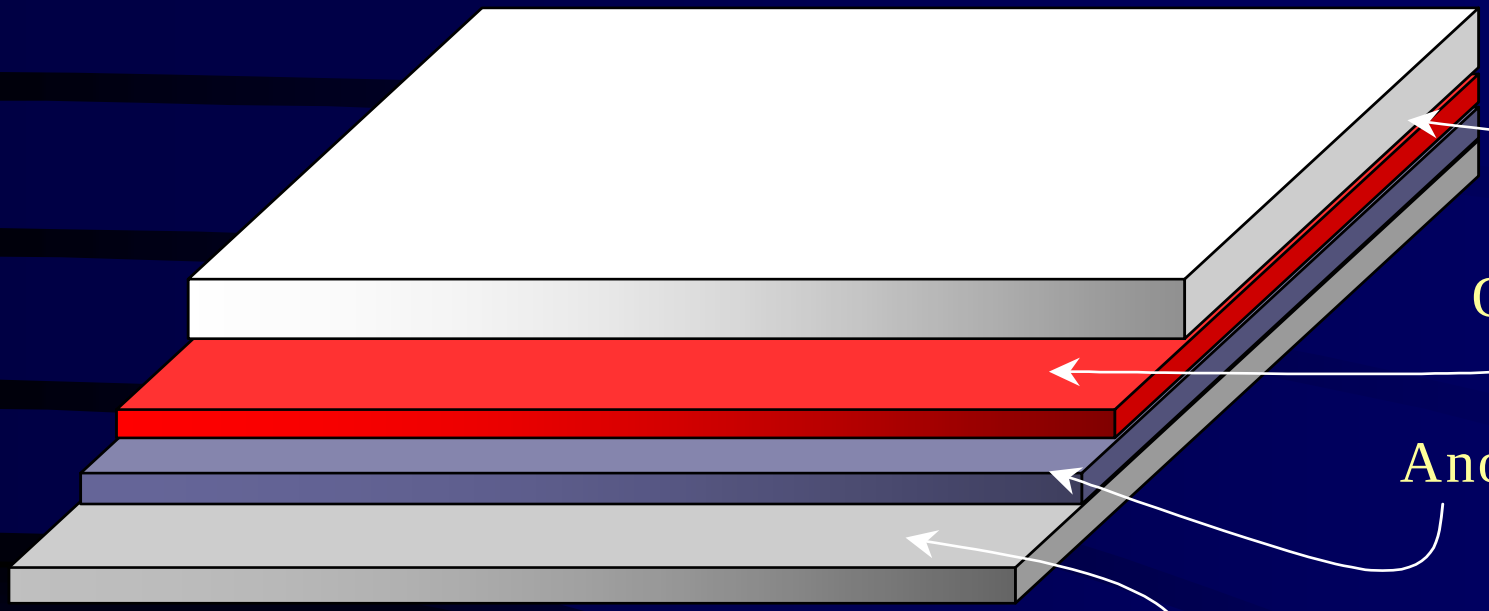
- Announced at CES in January that they are working on LCoS
- “High definition, large screen TVs, with clearer pictures than current systems for less than $2,000”
- Expect to ship LCoS displays by 2nd half of 2004.
- OEMS:
  - InFocus, TCL, Skyworth, Primax PDC . . .

RCA / Thomson

- Ultra-thin DLP based HDTV
- Demo shown at CES in January
- Cabinets less than 7 inches deep
- Light weight so they can be easily mounted on a wall
- 50-inch and 61-inch models available in 2004
- 70-inch widescreen available in early 2005

Microdisplay Technologies

Organic Light Emitting Diode



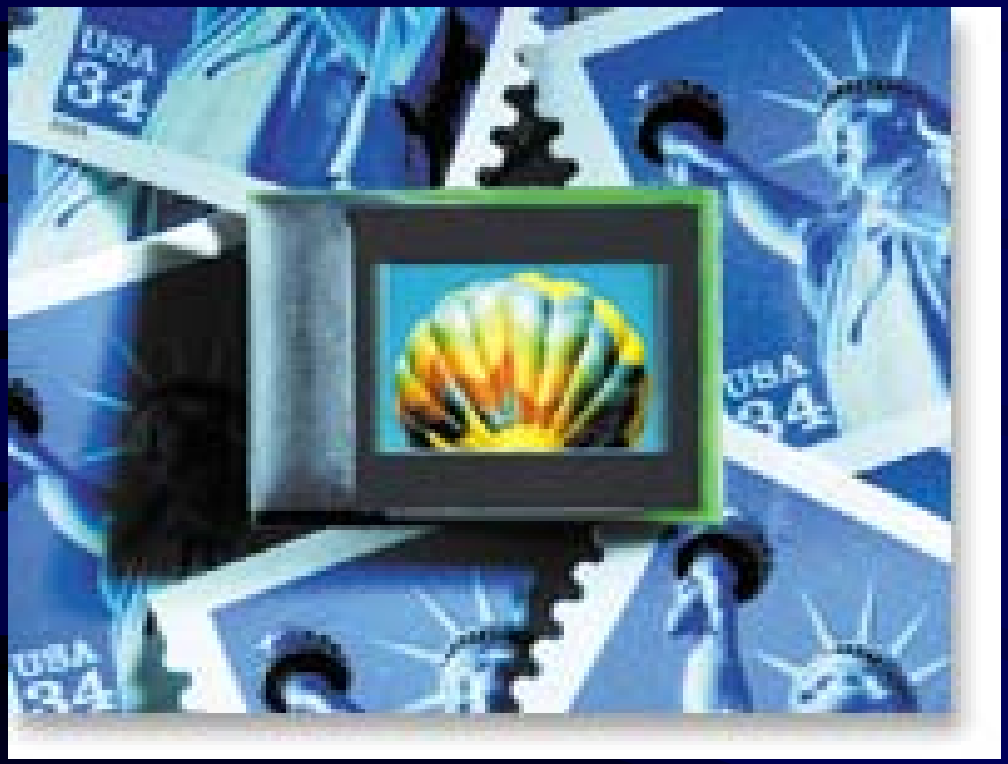
Transparent Cathode

Organic Layers

Anode

Silicon IC Substrate

OLED





Images from eMagin

OLED

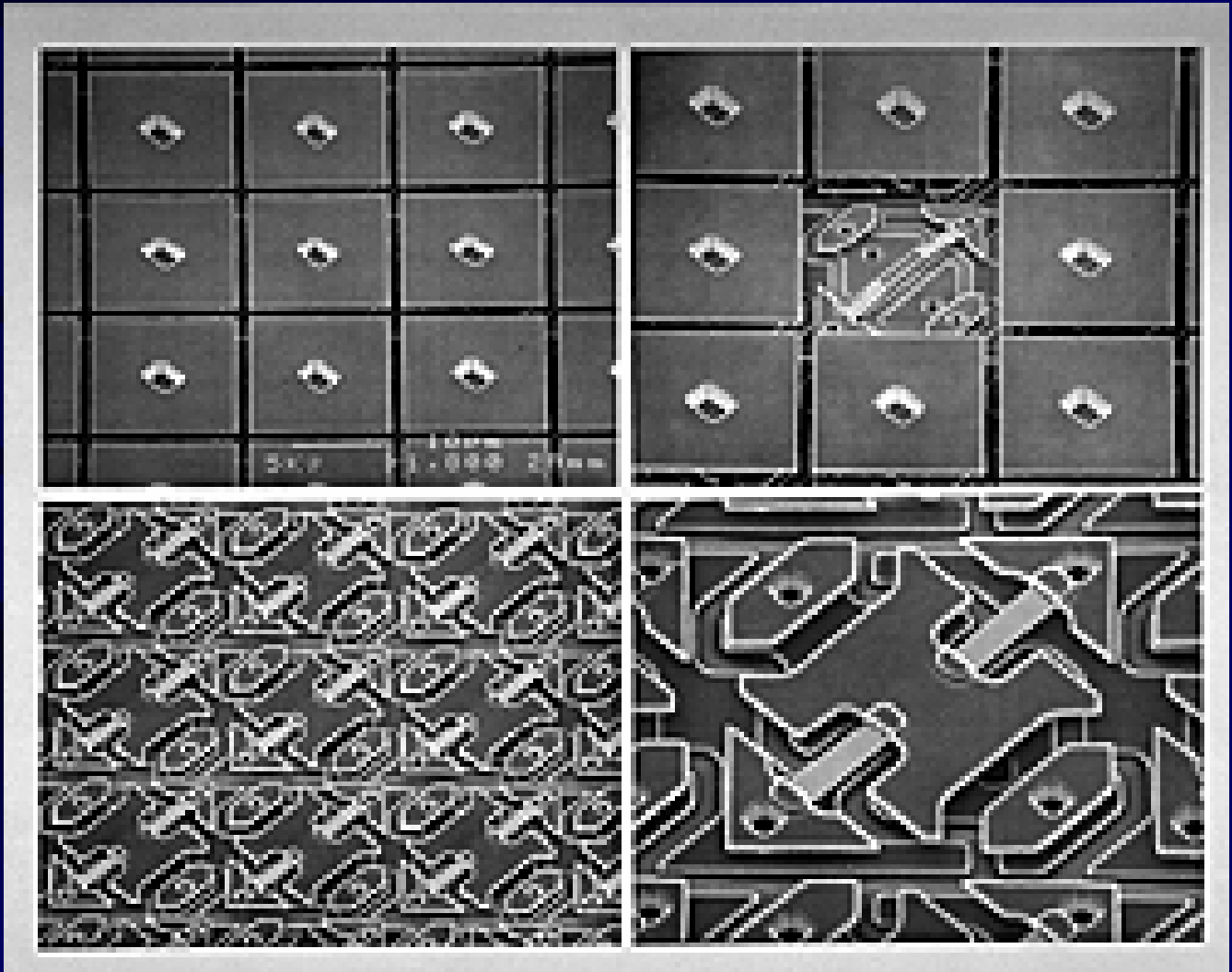
- Advantages
  - Emissive
  - Sensitivity to vibration
  - Low power
- Disadvantages
  - Lifetime
  - Cost
  - High volume manufacturability is unproven

Micro-Electro-Mechanical Systems (MEMS)

- Based on Micromachined devices
- Tilting mirrors (Texas Instruments' Digital Light Processing, DLP)
- Selective Diffraction (Silicon Light Machines)

MEMS

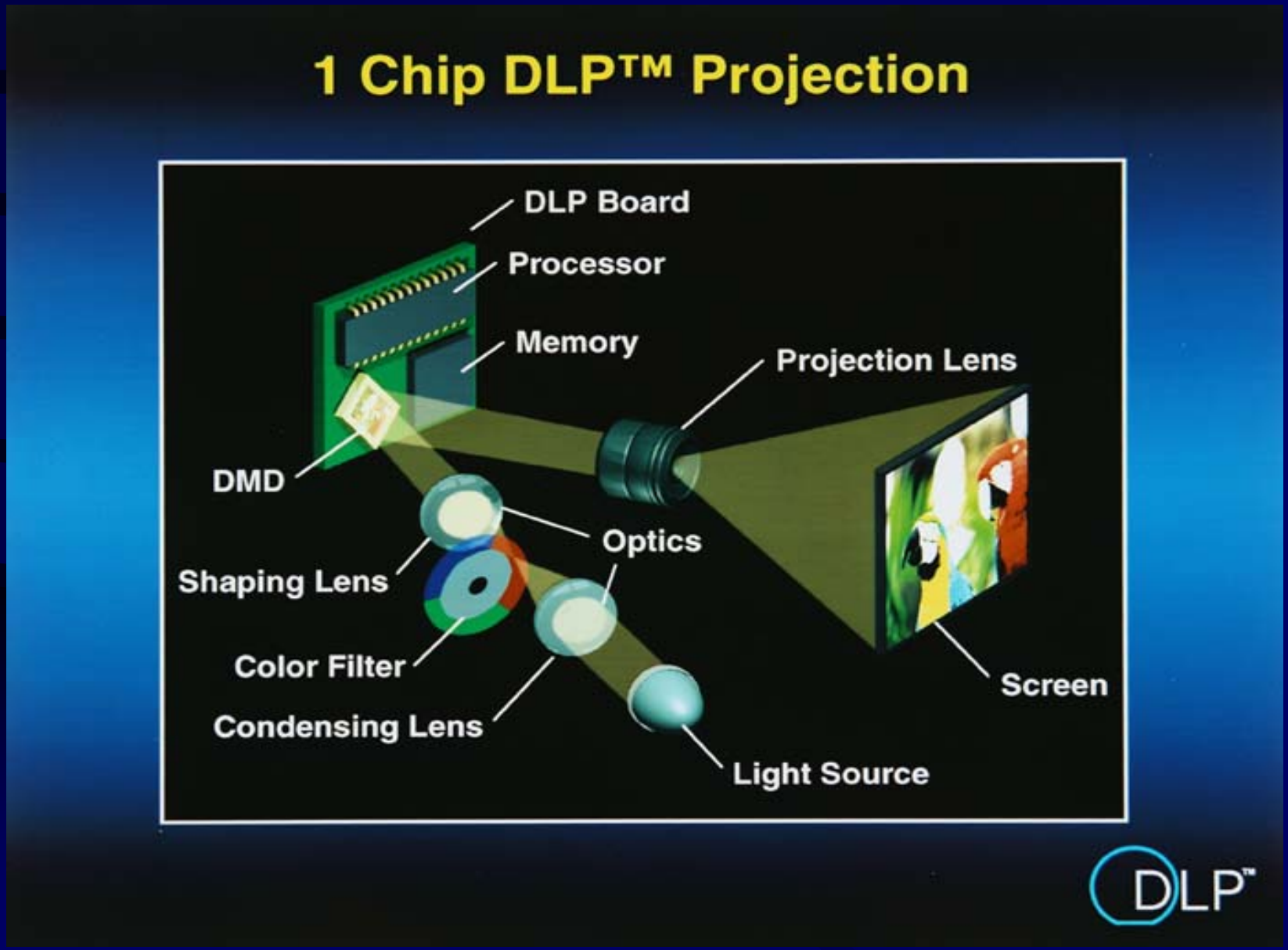
Texas Instruments' DLP



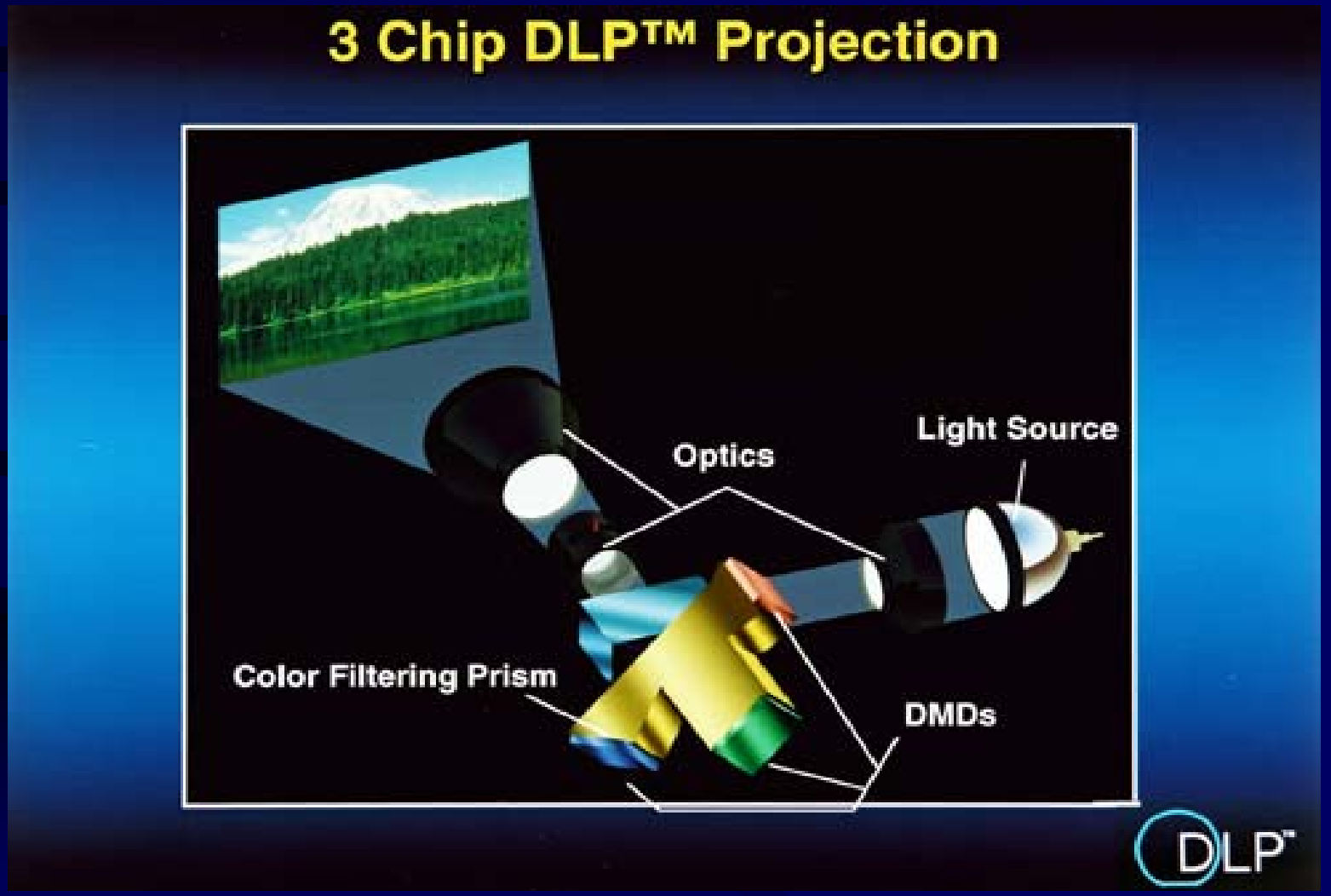
MEMS

Link to TI movie

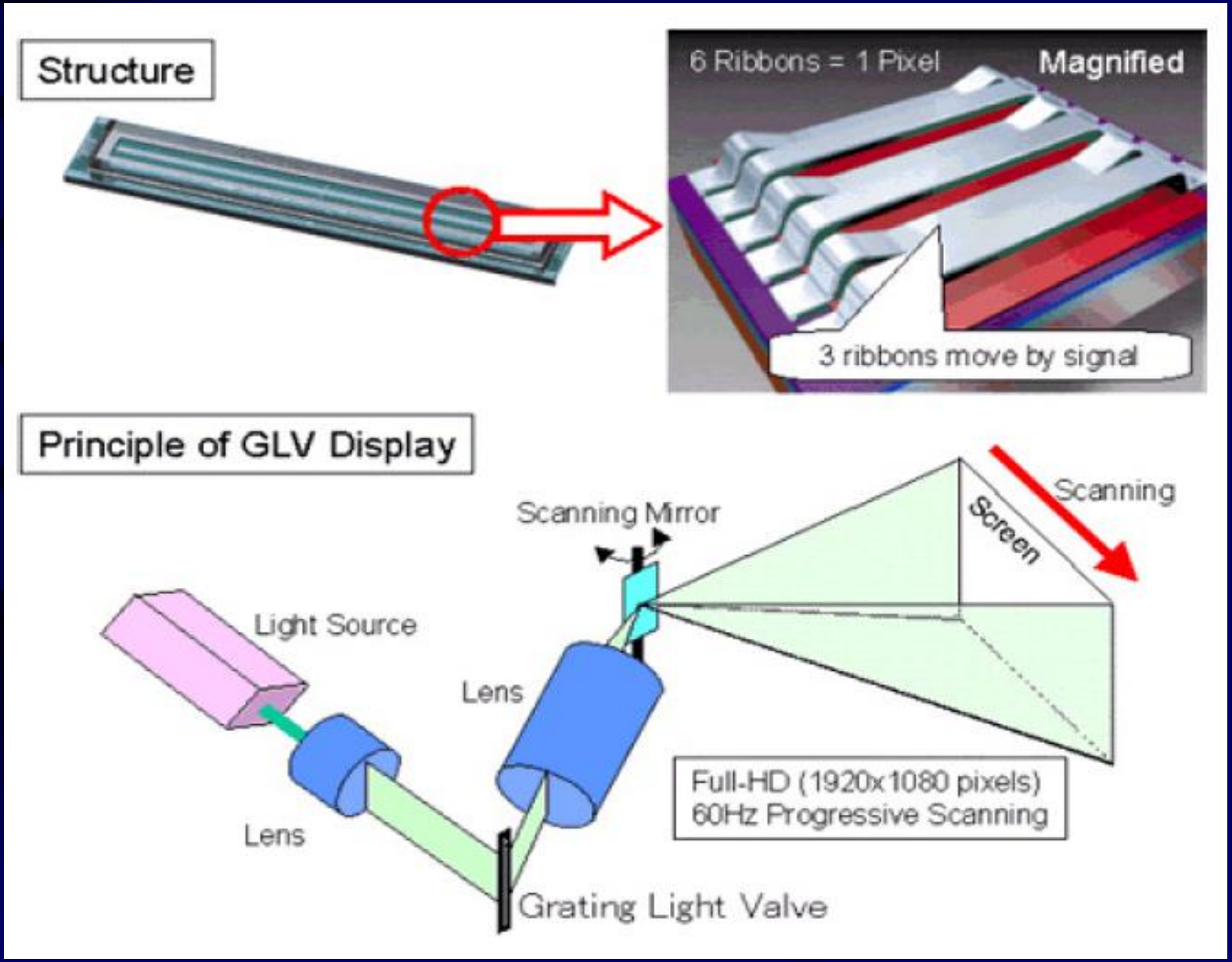
MEMS


1 Chip DLP™ Projection
DLP Board
Processor
Memory
Projection Lens
DMD
Optics
Shaping Lens
Color Filter
Condensing Lens
Screen
Light Source
DLP™

MEMS


3 Chip DLP™ Projection
Optics
Light Source
Color Filtering Prism
DMDs
DLP

MEMS


Structure
6 Ribbons = 1 Pixel
Magnified
3 ribbons move by signal
Principle of GLV Display
Scanning Mirror
Screen
Scanning
Light Source
Lens
Lens
Grating Light Valve
Full-HD (1920x1080 pixels)
60Hz Progressive Scanning

MEMS

- Advantages
  - Single chip design
  - Brightness (no polarizing optics)
  - High contrast
  - Thin
  - Light
  - Small form factor

MEMS

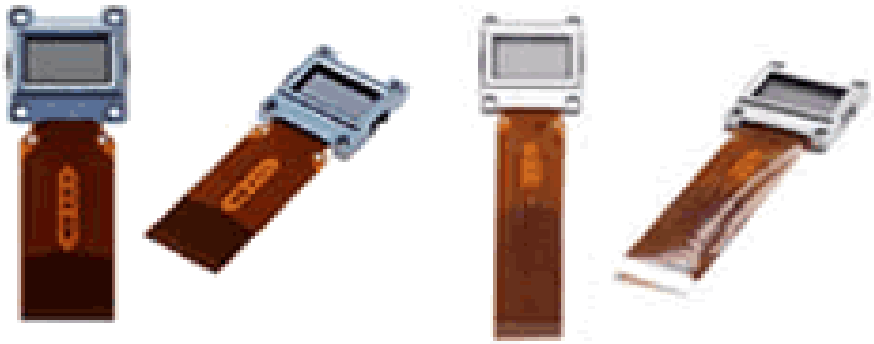
- Disadvantages
  - Slight “shimmer” artifact noticeable
  - Expensive to produce
  - Color depth lacking in some versions
  - Only one major supplier (TI)

Liquid Crystal Devices

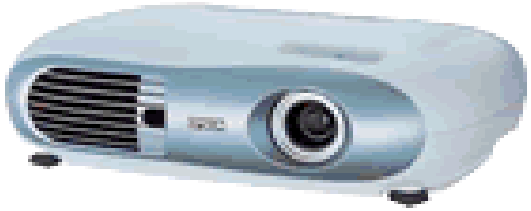
- Transmissive
  - High Temperature Poly-Silicon (HTPS)
- Reflective
  - Liquid Crystal on Silicon (LCoS)

HTPS

1.2"HDTV, 1.3" XGA, 0.9" XGA, 0.7" XGA



Ultrahigh resolution small LCD panel



Audio/Visual Projector



Rear Projection TV

HTPS

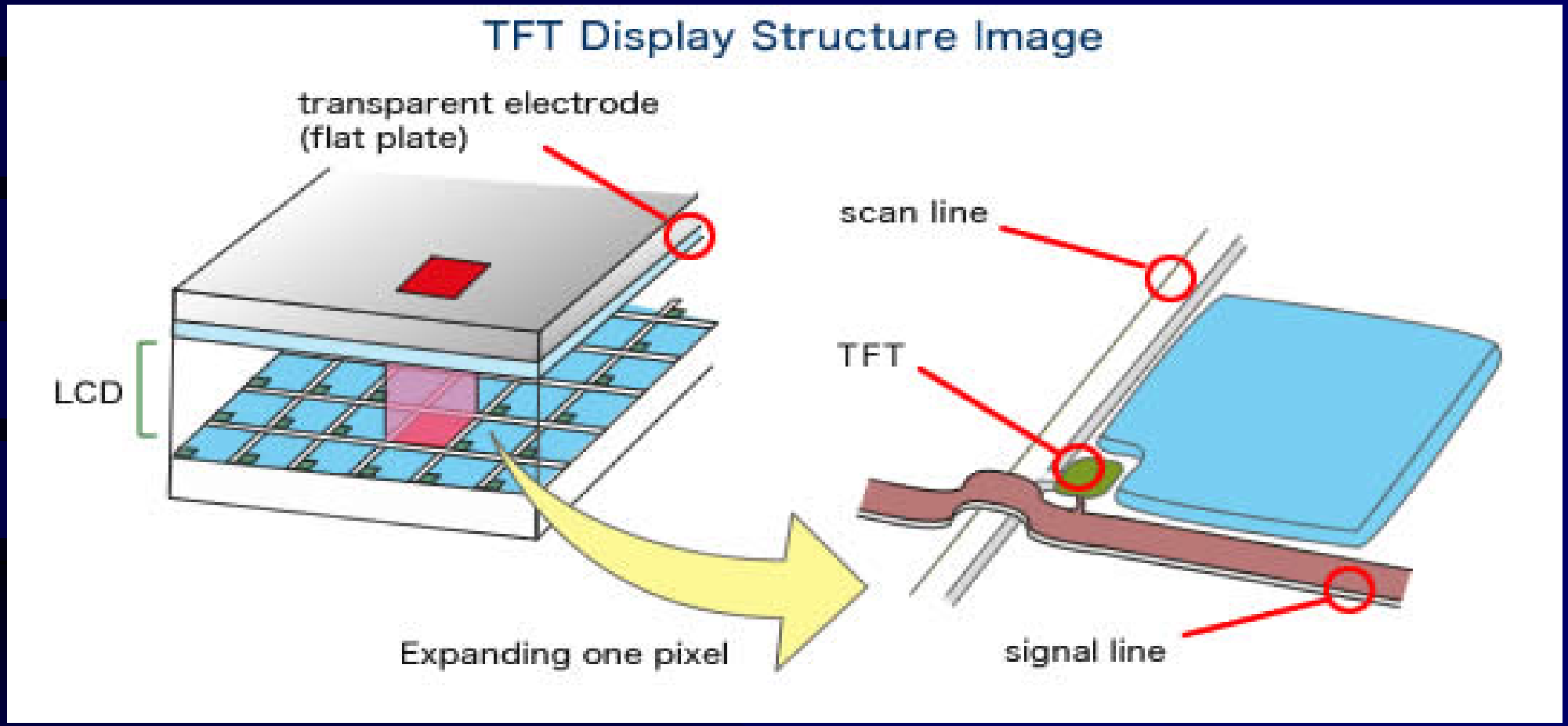


Image from Seiko-Epson

HTPS

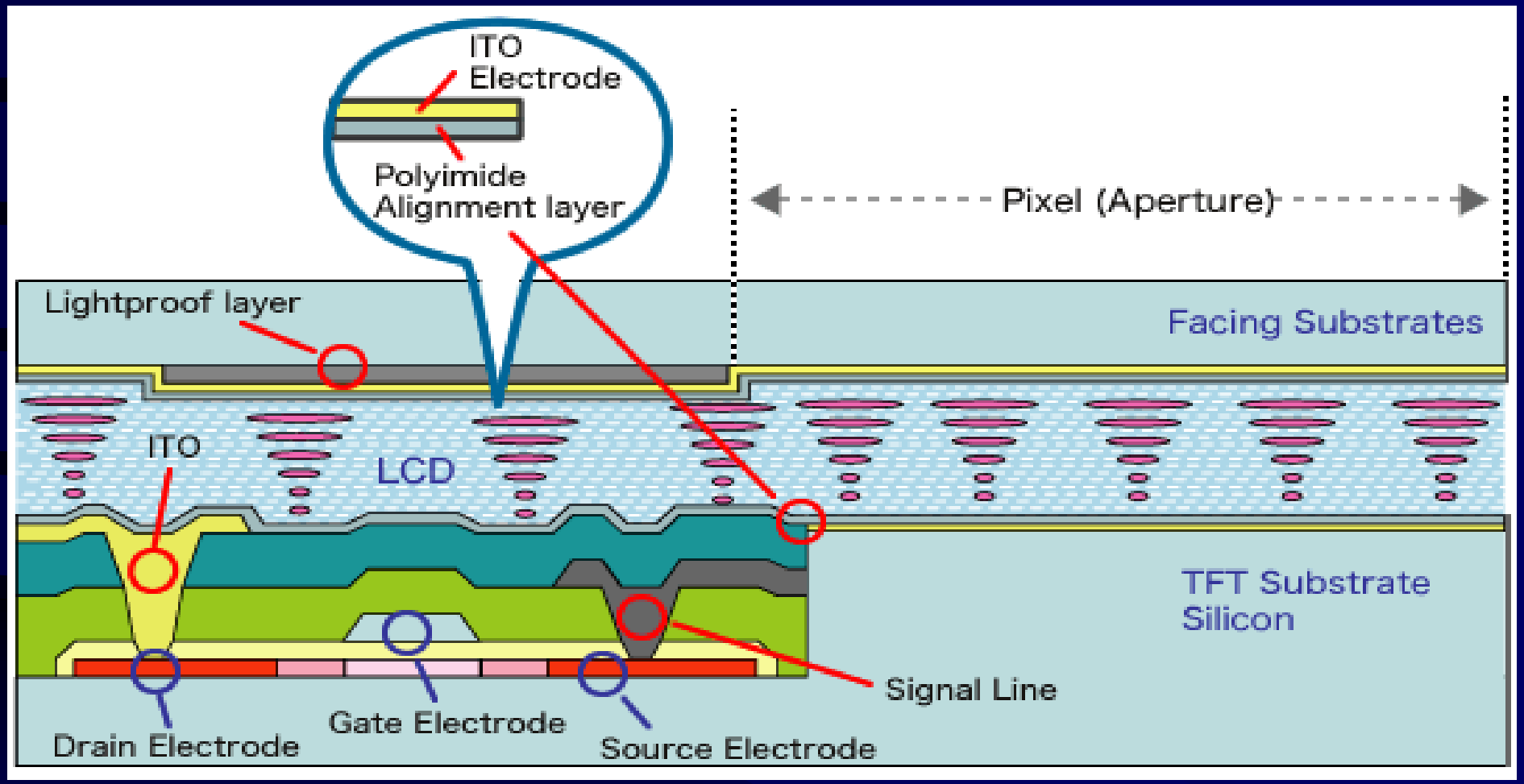


Image from Seiko-Epson

HTPS

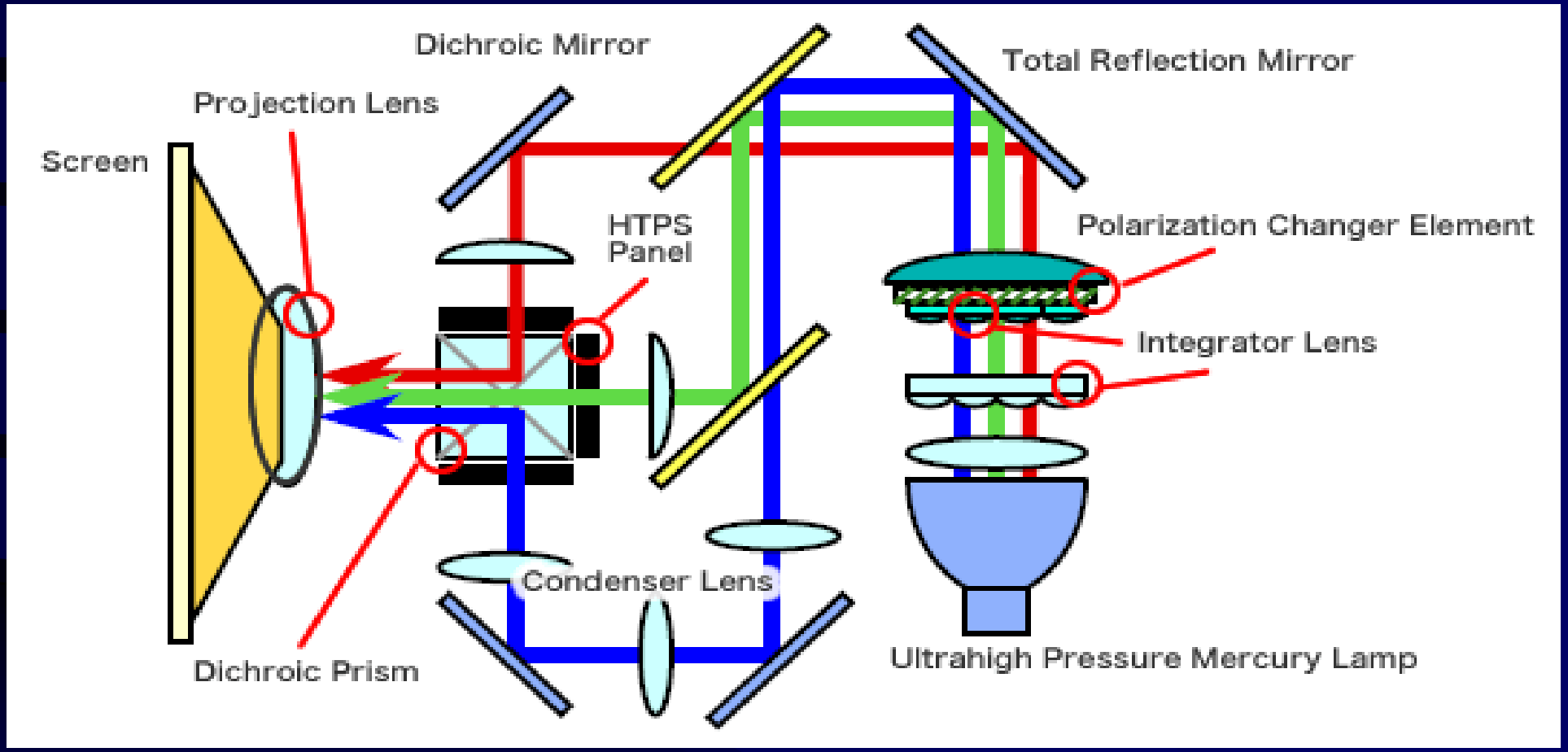


Image from Seiko-Epson

HTPS

- Advantages
  - Thin
  - Light
  - Small Form Factor
  - Good value vs Plasma or Direct View LCD

HTPS

- Disadvantages
  - Pixelization from TFTs, signal line line and scan line
  - Must use microlens array to increase effective aperture ratio
  - Low Contrast
  - Must use 3 panel design
    - Panel alignment
    - More complex engine
    - More displays = More expensive

LCoS

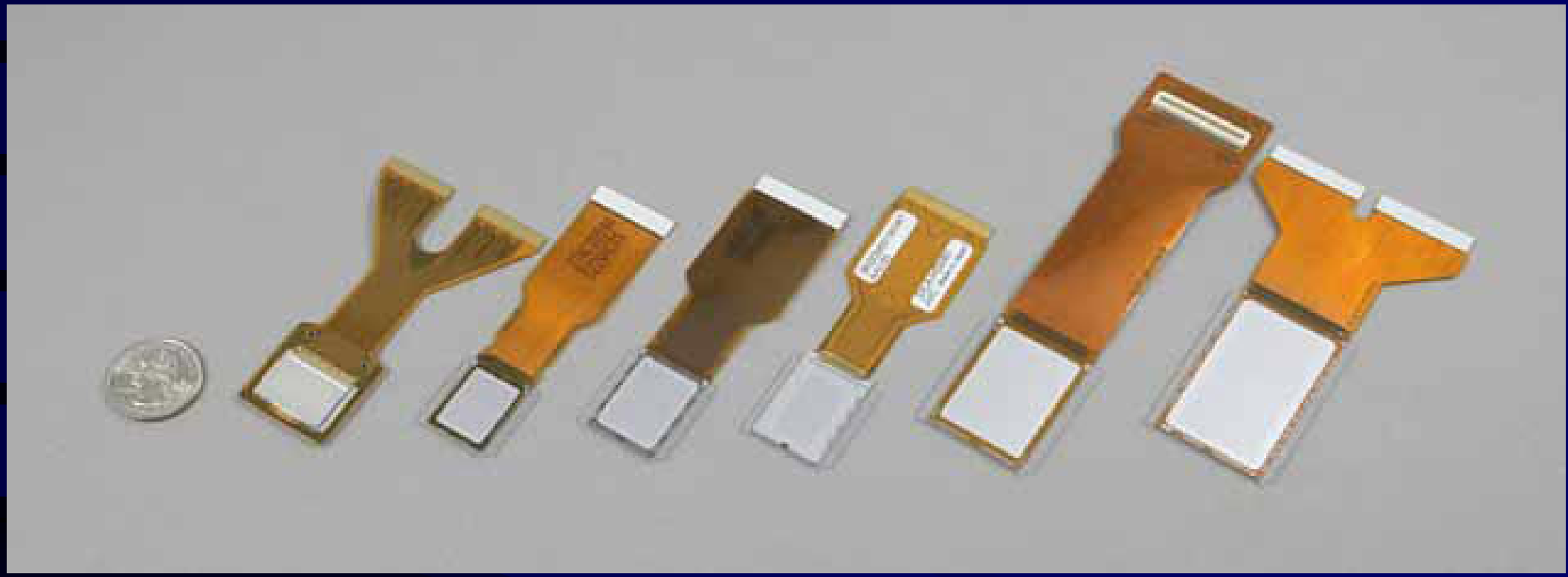


Image from JVC

LCoS

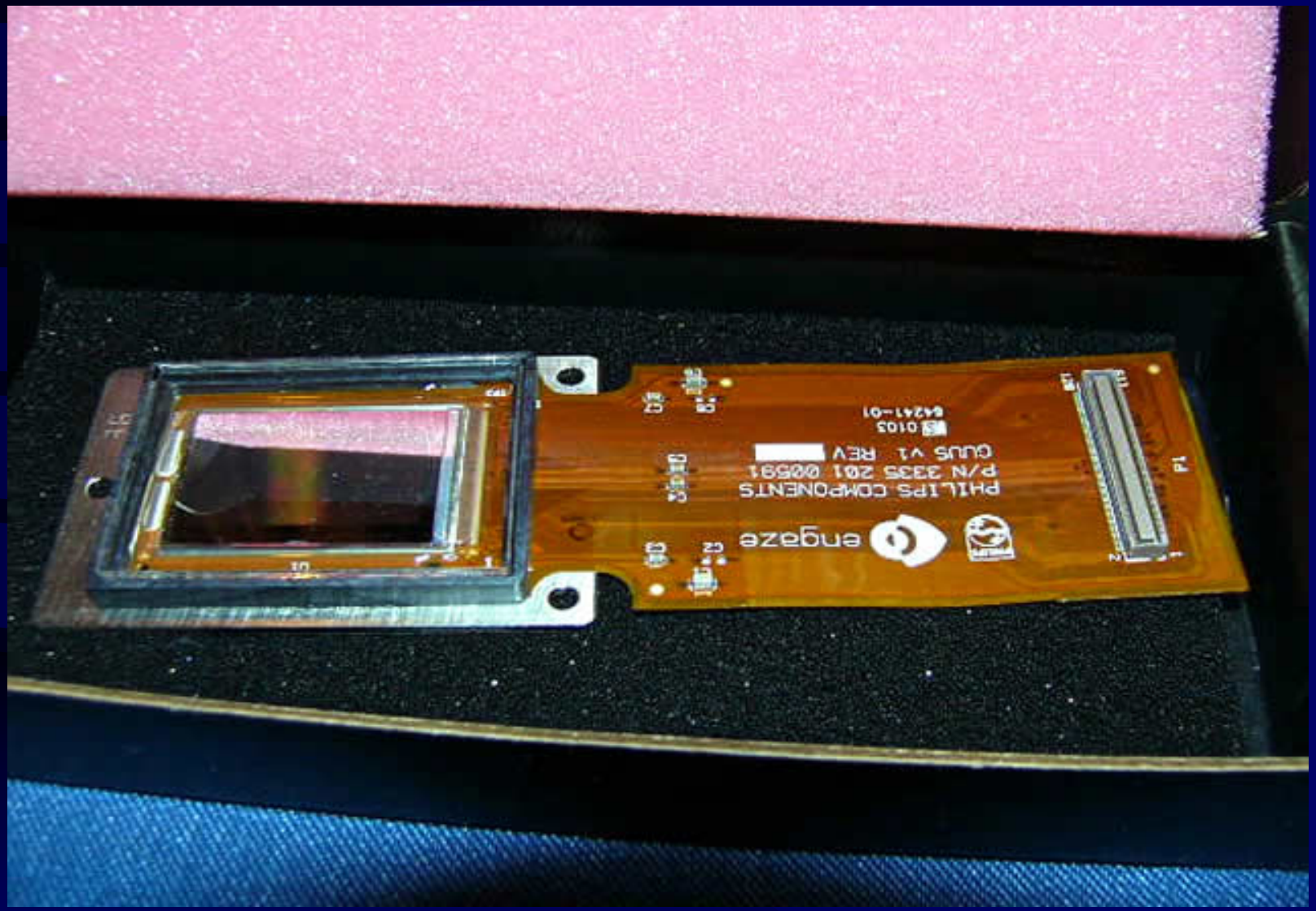


Image from Philips

LCoS



Image from MicroDisplay Corporation

LCoS

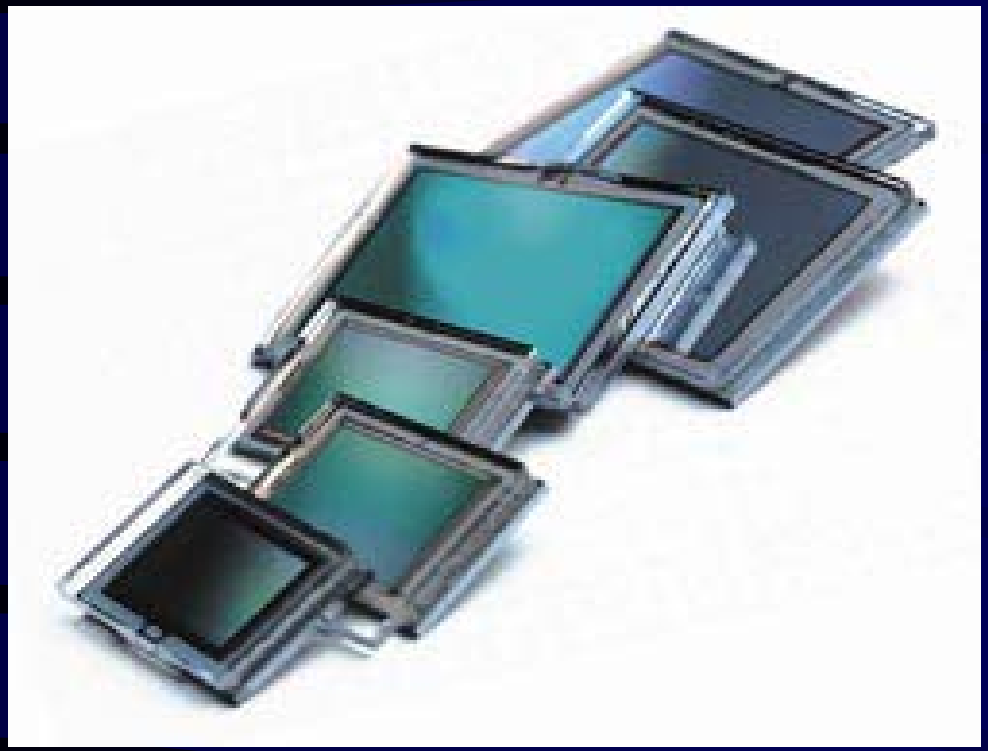




Image from Brillian Corporation

LCoS

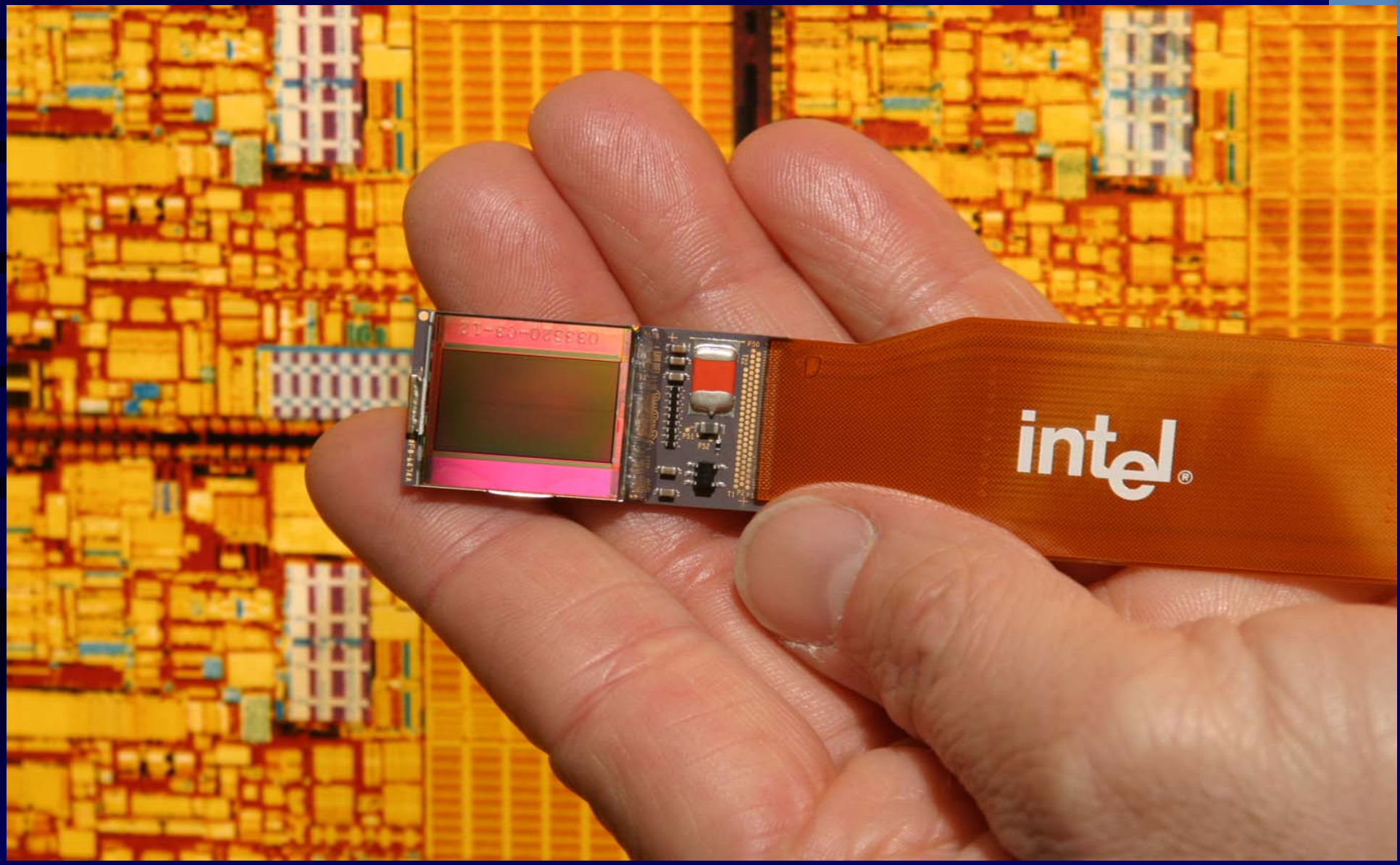


Image from Intel Corporation

LCoS

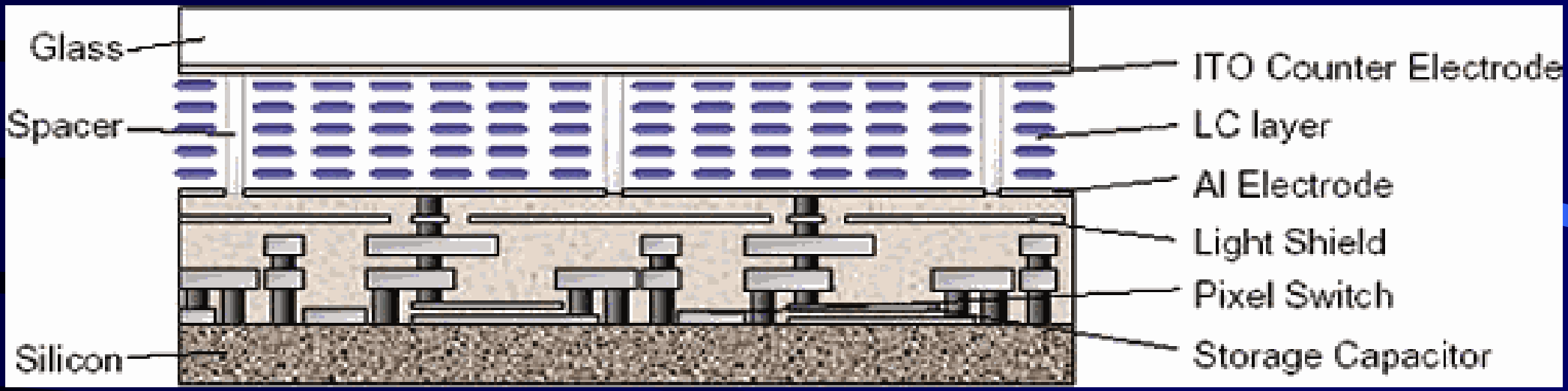
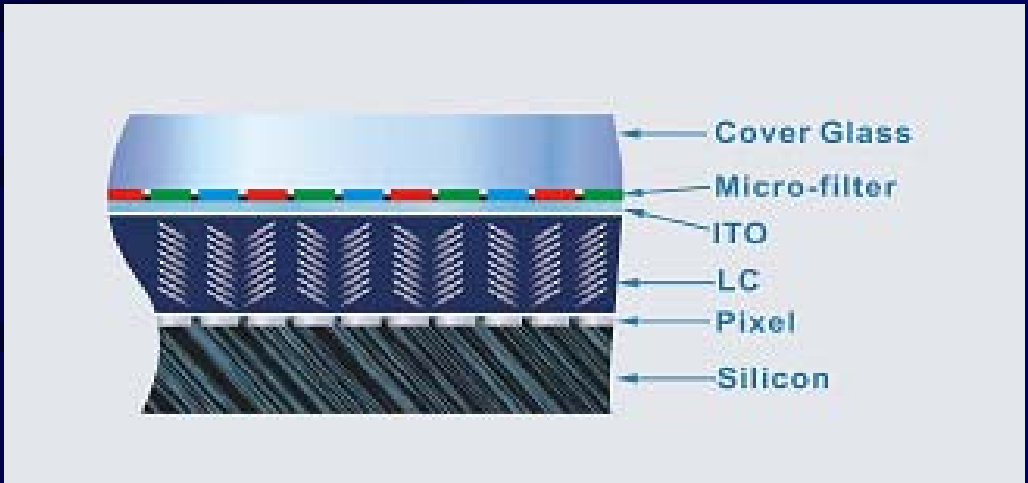


Image from Philips

LCoS



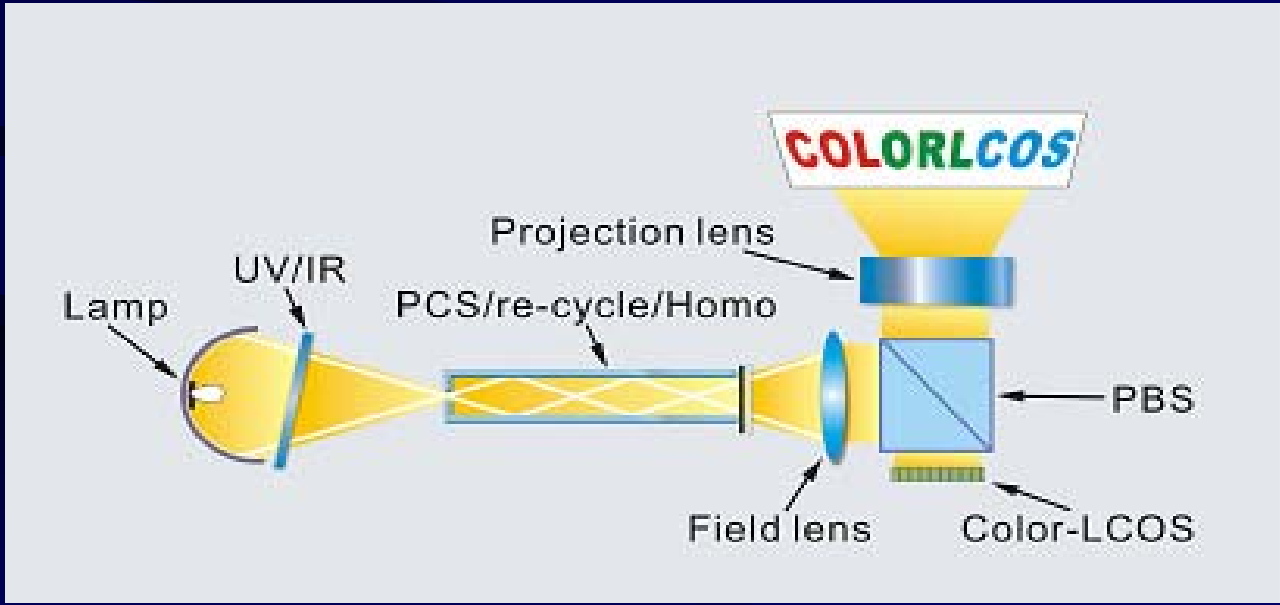


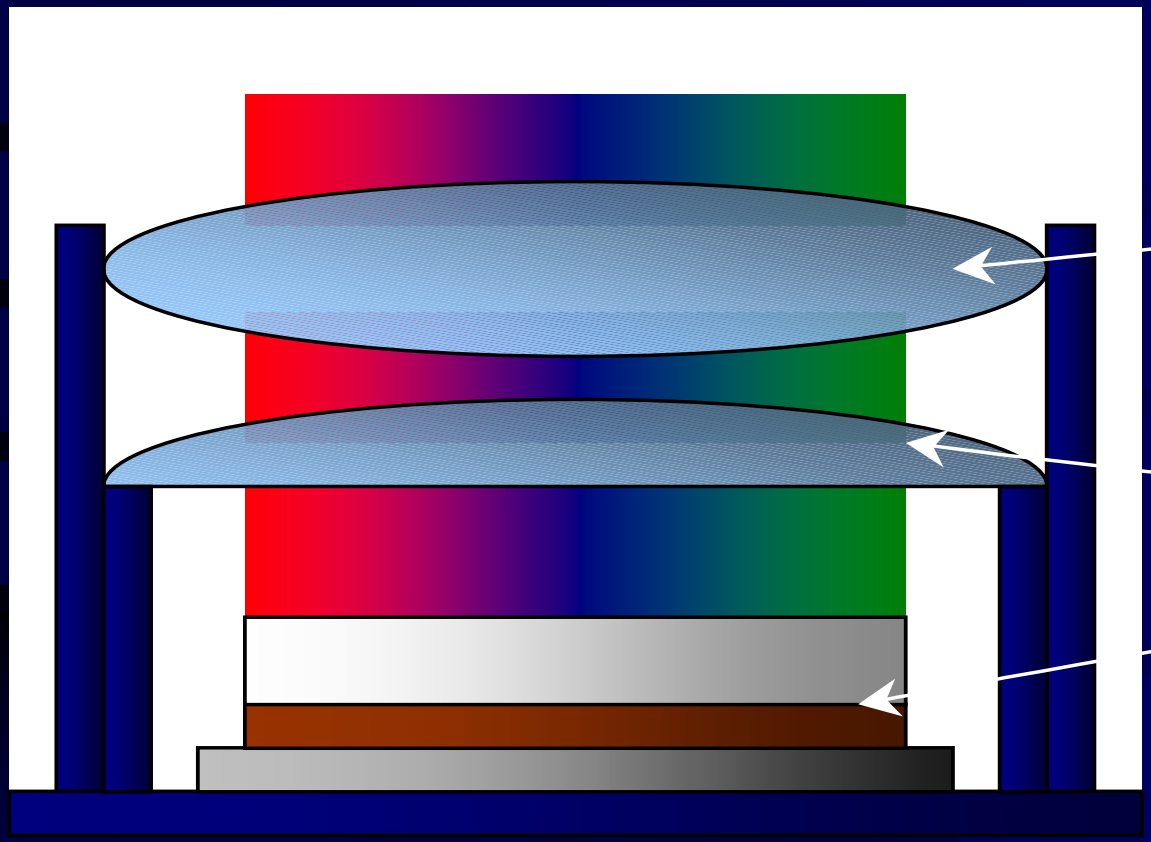
Image from KinOptics

LCoS

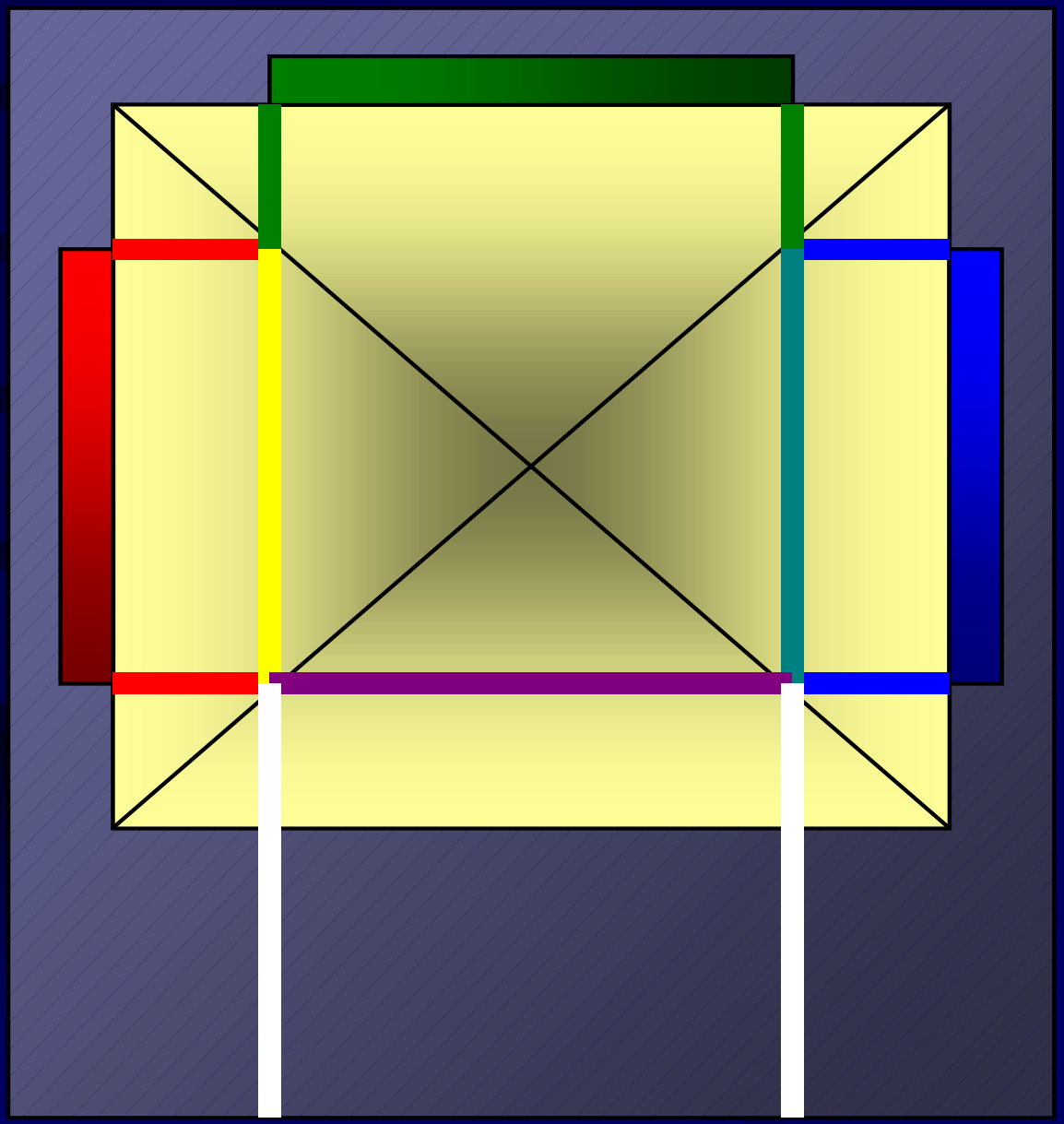
- Advantages
  - High resolution
  - Excellent fill factor
  - High Speed (enabling 1 panel designs)
  - Potentially low cost (based on standard CMOS)
- Disadvantages
  - Manufacturability is unproven
    - TVs now on market, this will be proven/disproven soon

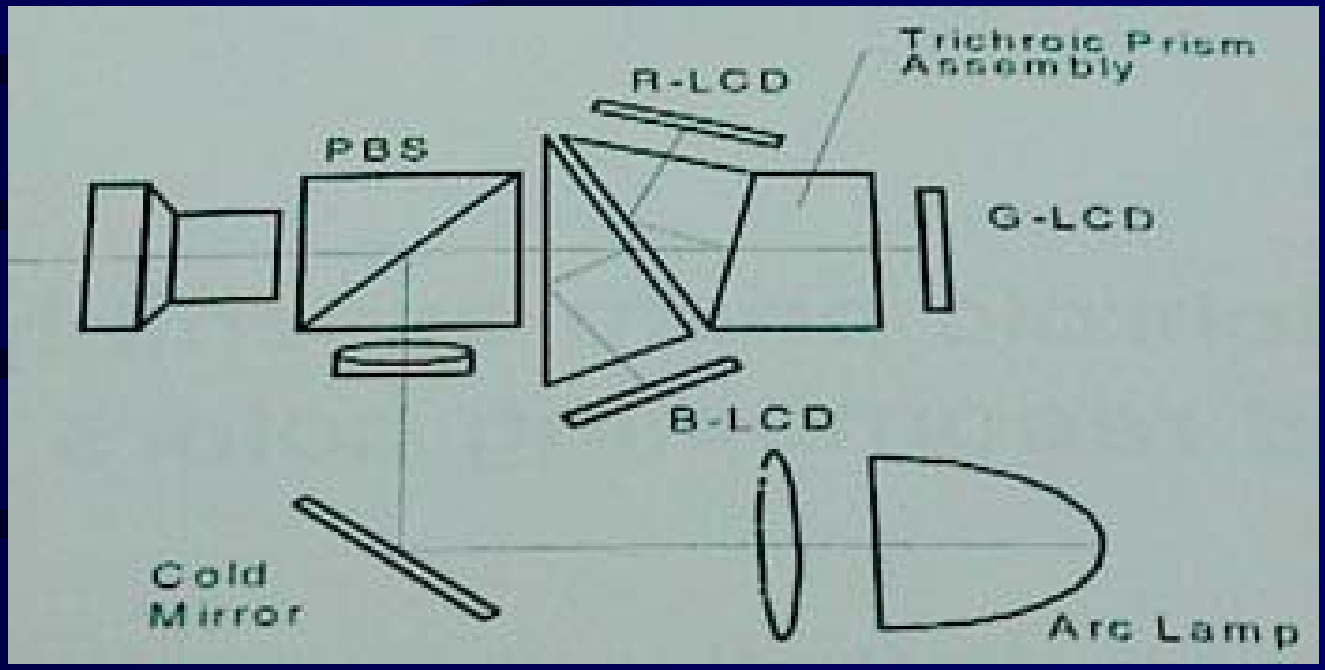
Microdisplay Light Engines

Emissive



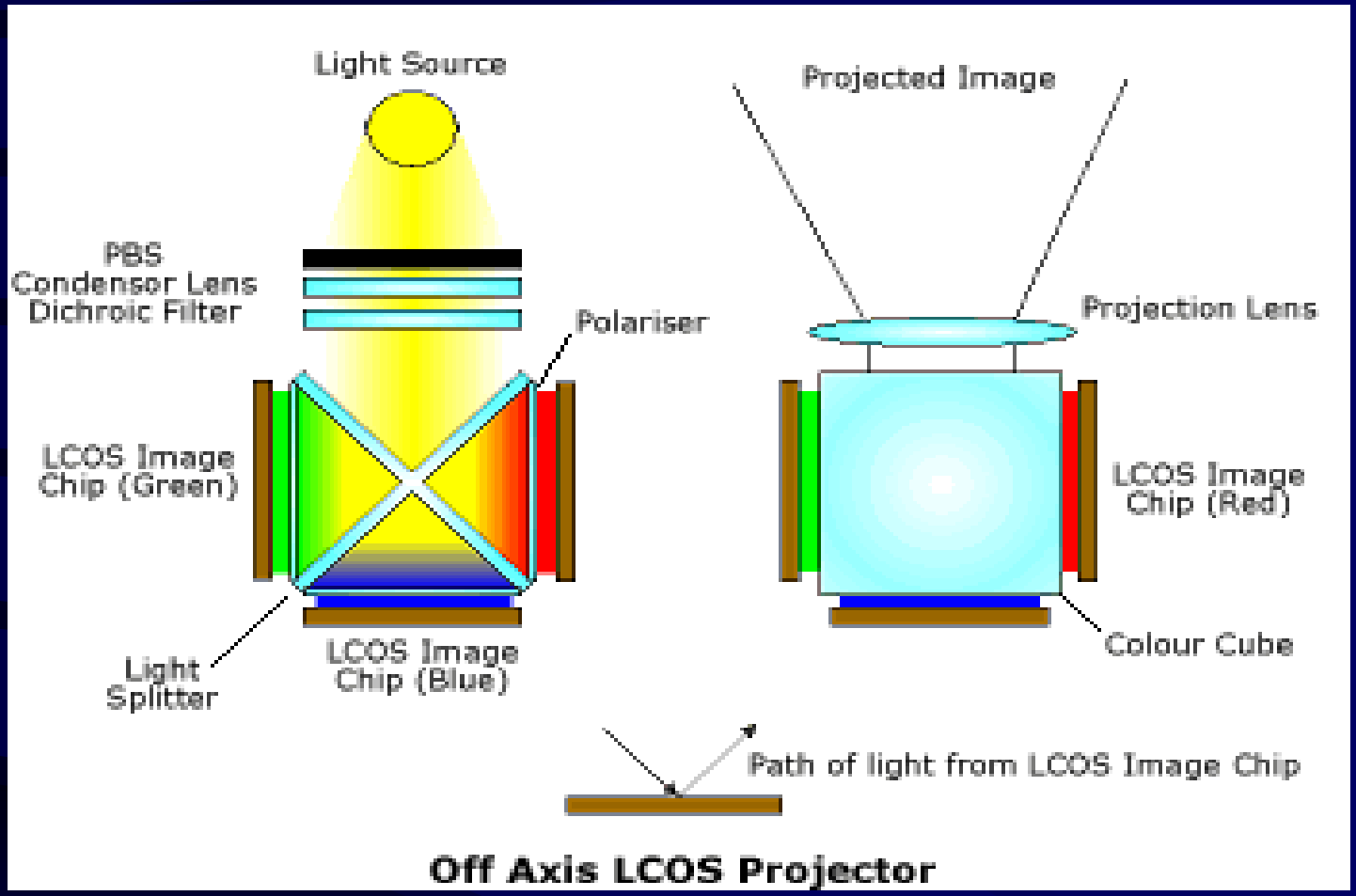
3-Panel Projection Engine

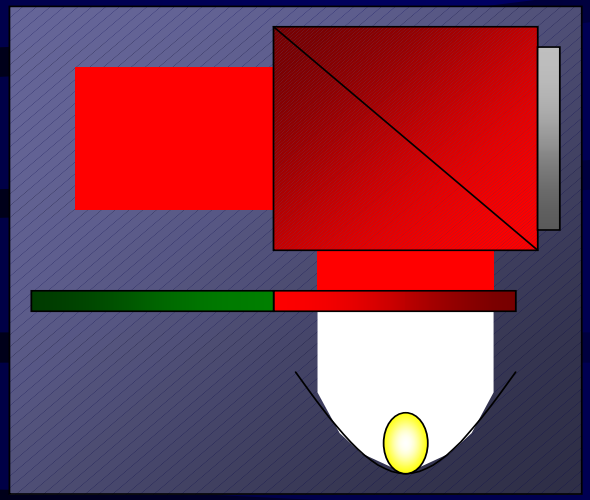


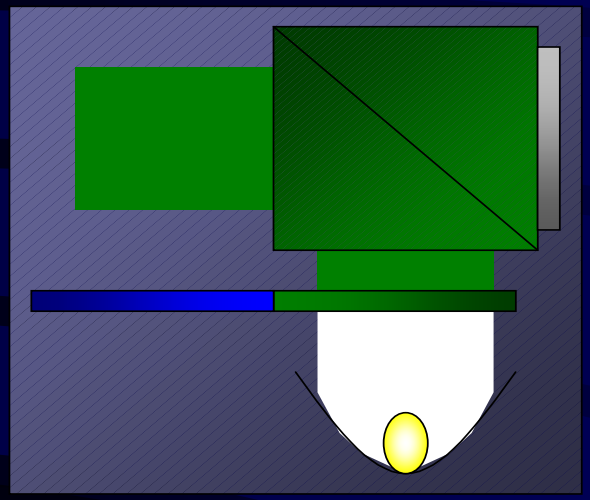


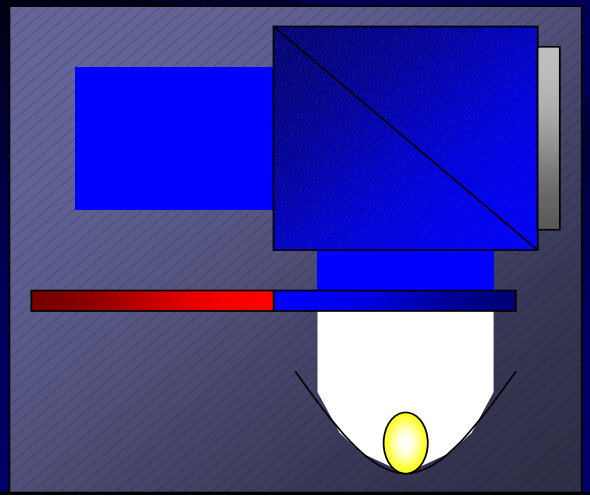


Images from Varitronix

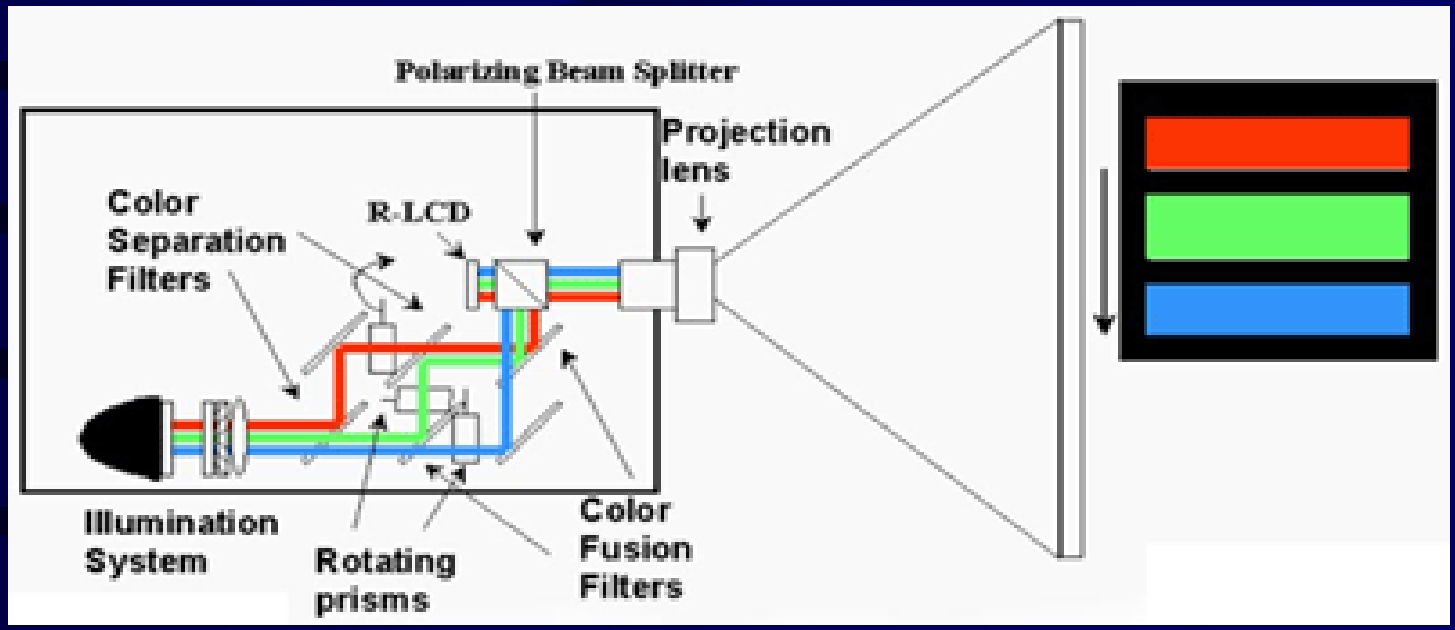

Light Source
Projected Image
PBS
Condensor Lens
Dichroic Filter
Polariser
Projection Lens
LCOS Image
Chip (Green)
LCOS Image
Chip (Red)
Light
Splitter
LCOS Image
Chip (Blue)
Colour Cube
Path of light from LCOS Image Chip
Off Axis LCOS Projector

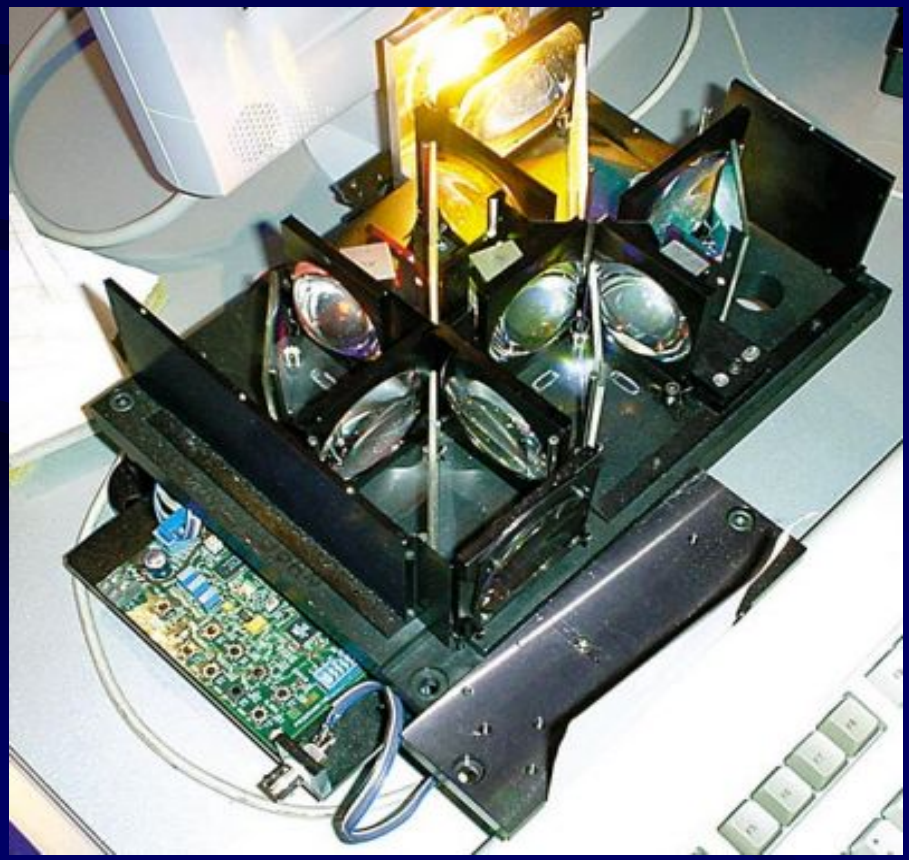









Polarizing Beam Splitter
Projection lens
Color Separation Filters
R-LCD
Illumination System
Rotating prisms
Color Fusion Filters




PHILIPS

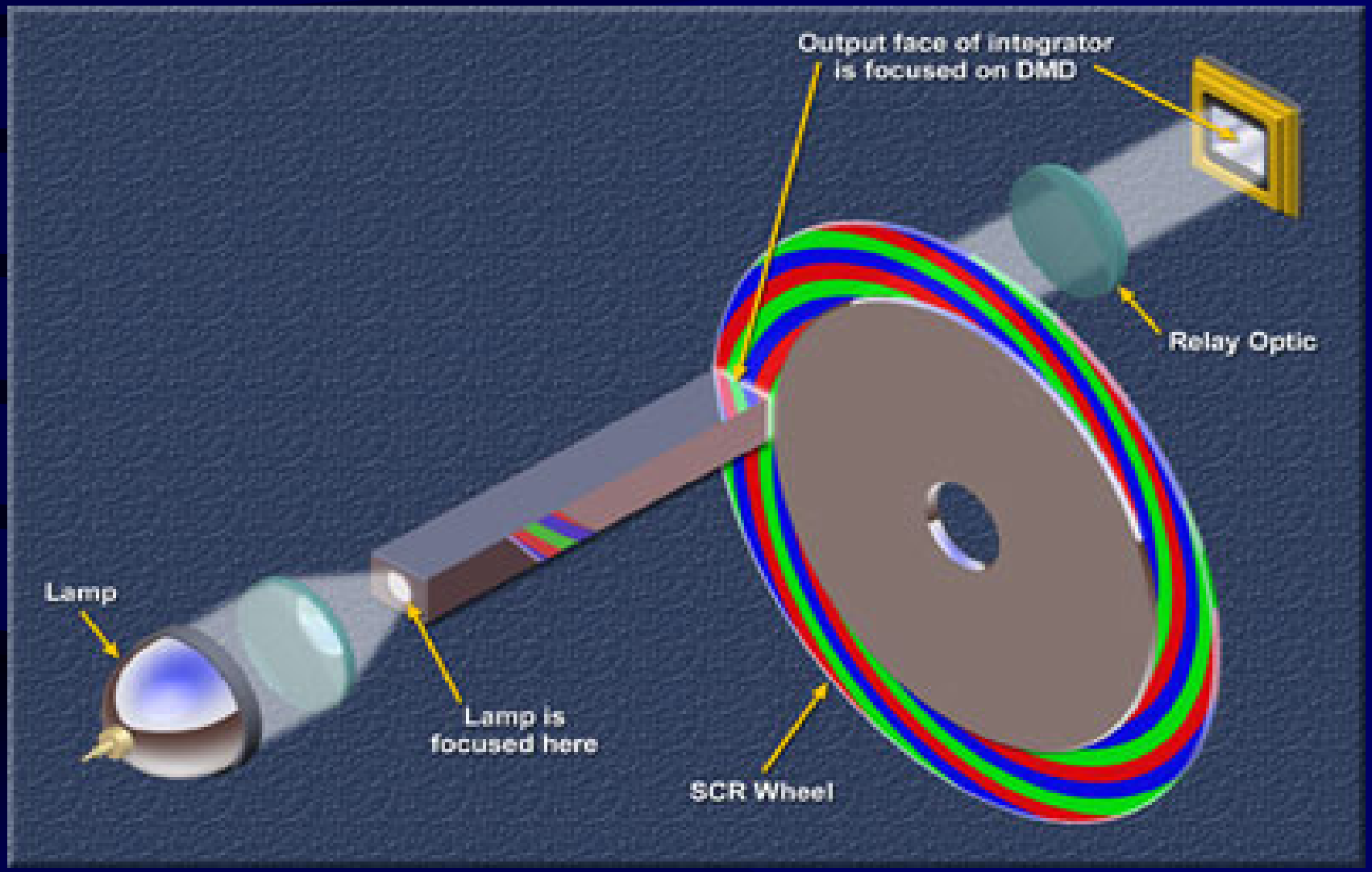


Image from www.hcinema.de

Hana Microdisplay

Pure Contract Manufacturing Service Provider for Microdisplays

- Experience manufacturing most microdisplay technologies
  - LCoS, HTPS, MEMS
- Interested in getting into OLED microdisplays also

Focused on microdisplay manufacturing and technology solutions

- Formed in August of 1999 in Ohio
- Missing link between fab-less product design companies and systems integrators
- Experienced and Knowledgeable Microdisplay Manufacturing Team
- Automated processing of 6-inch and 8-inch wafers

Located in Twinsburg, Ohio, USA

- 20 miles from the Liquid Crystal Institute at Kent State University
- 24,000 square foot facility
- Technical Staff of 40 people



End Markets for our Customers

- Personal Viewers / Head sets
- Large Screen Monitors
- Digital Television
- Multimedia Projectors
- Fiber-optic switches and routers

Microdisplay Future

- Enable new technologies
  - Head Mounted Displays
  - Projection of Computer Images
- Create higher quality monitors and TVs
  - Higher resolution
  - Brighter
  - Lighter
  - Thinner

Microdisplay Future

- CRT monitors and TVs have limited lifetime
- Direct View LCD and Plasma will take most of market for screen sizes <40 inches
- Microdisplay-based projection will rule:
  - Large screen TV (40-inch - 50-inch +)
  - Conference projection
  - Near to Eye displays