



# Shaping the future of liquid crystals

Information Day 2013 – A Deep Dive into the LC&OLED Business

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Darmstadt · Germany

*Darmstadt, Germany – June 26, 2013*



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# Agenda

## **The R&D engine in display materials**

Drivers of liquid crystal display development

The role of liquid crystals in display development

Liquid crystals beyond flat panel displays

Summary

# We have a strong R&D platform for display materials

## A strong platform for R&D leadership in display materials

### Strong organizational setup



- ~500 people in R&D
- Highest number of research facilities and laboratories
- Powerful budget of more than ~€100 m

### Broad focus and know-how



- Broad R&D approach across the display value chain
- State-of-the-art application know-how
- Broadest range of display materials

### Global reach

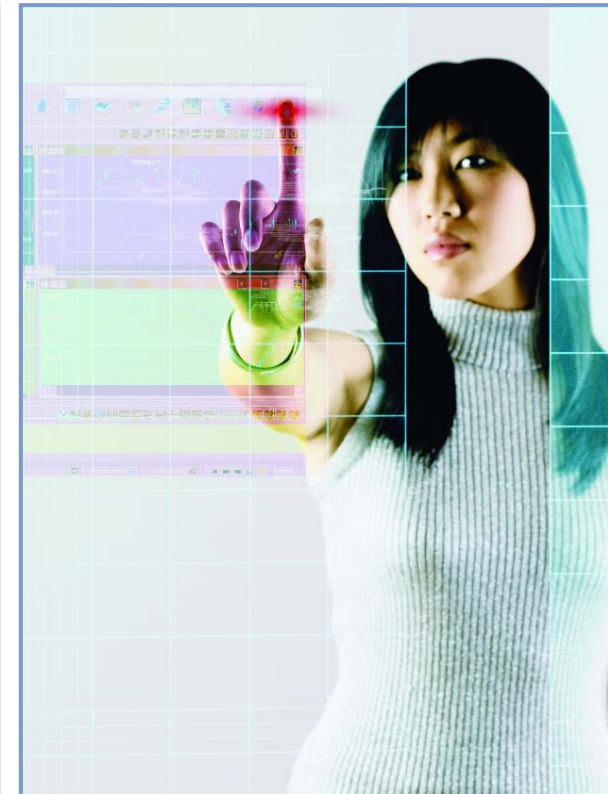
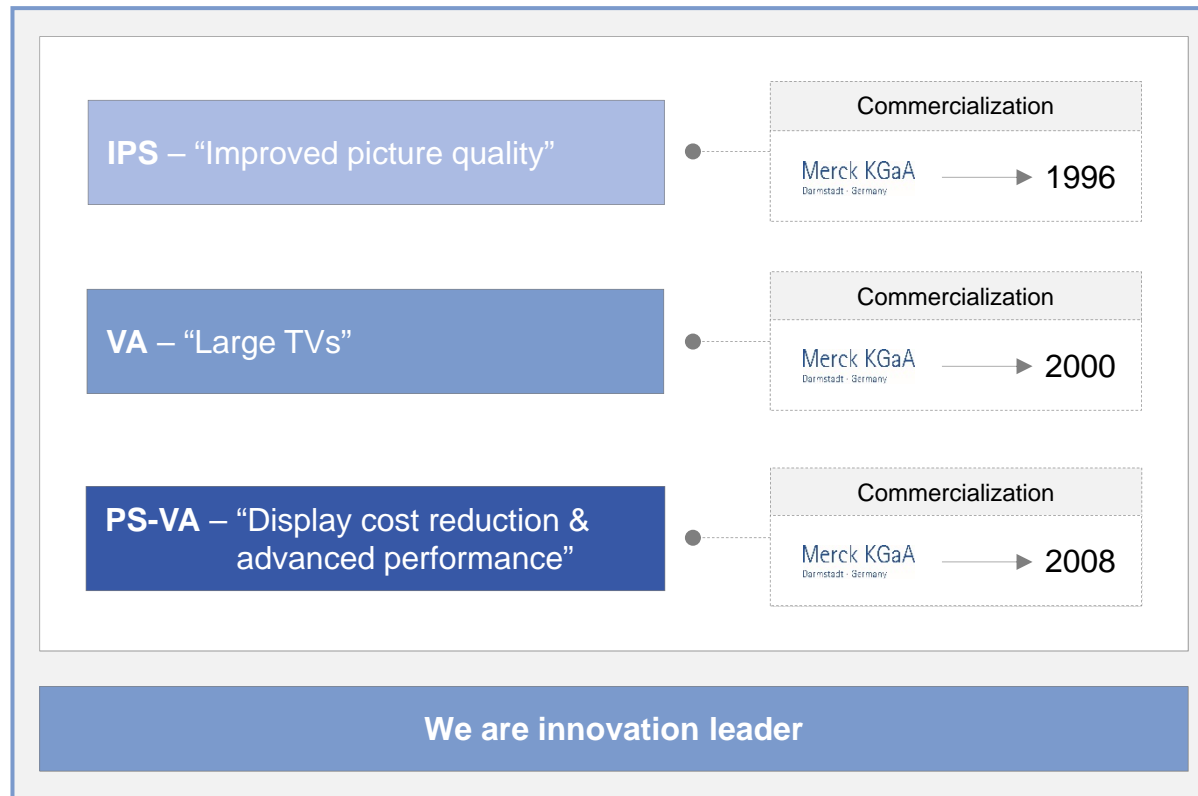


- Research centers in key innovation regions
- Development hubs close to customers

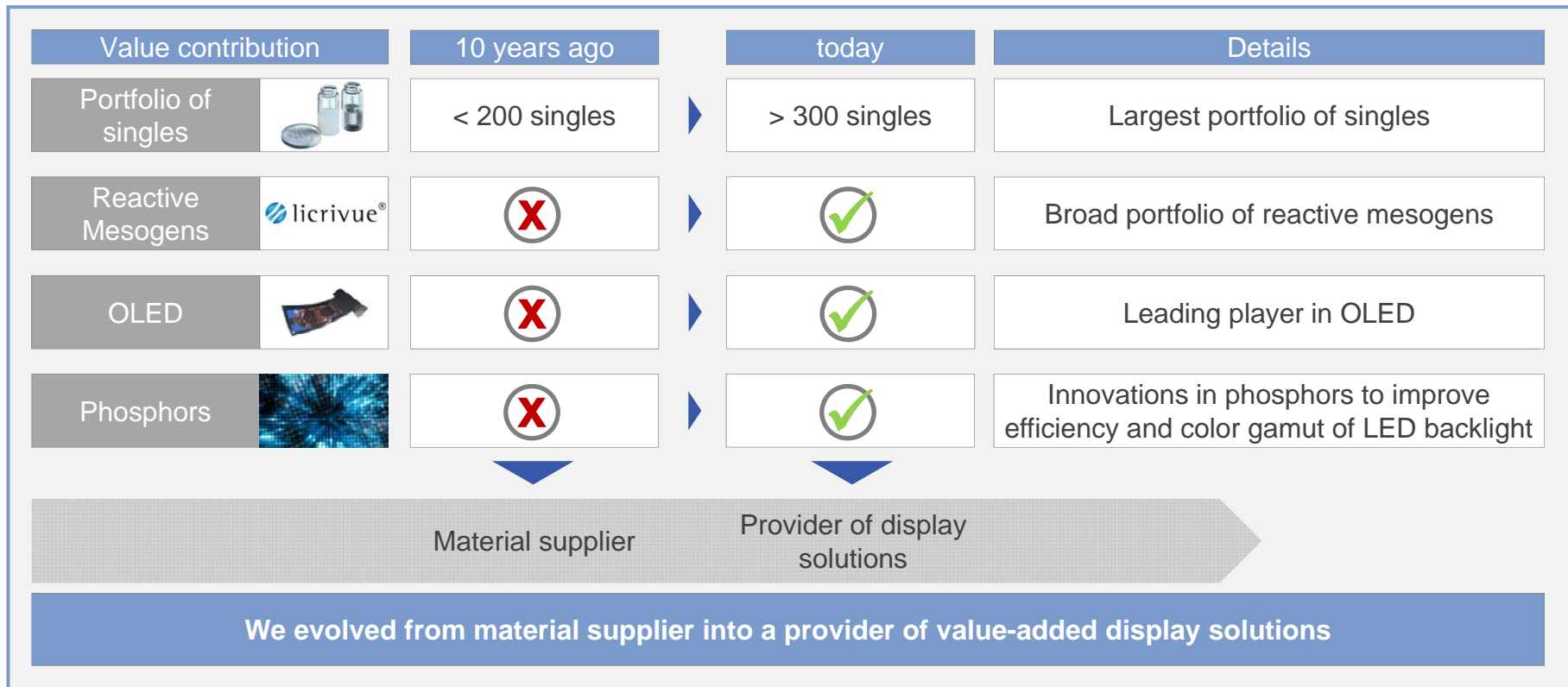
## R&D leadership is key in display market

- Fast-moving market
- Short innovation cycles
- High versatility of displays creates opportunity for new applications
- Display manufacturers seeking differentiation

# For this reason, we were first to introduce new liquid crystal technologies for large displays



# We continuously broadened our position to become a provider of commercial display solutions



# Agenda

The R&D engine in display materials

## **Drivers of liquid crystal display development**

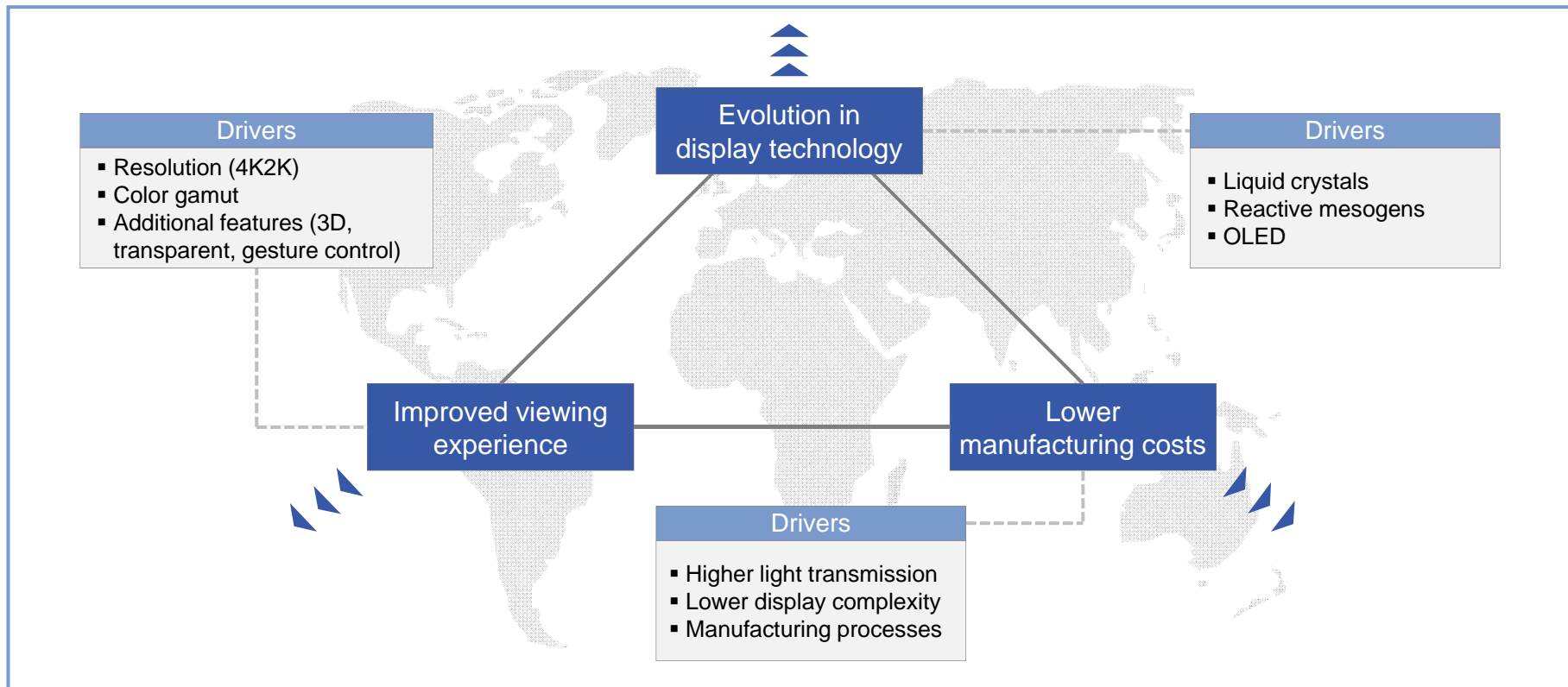
The role of liquid crystals in display development

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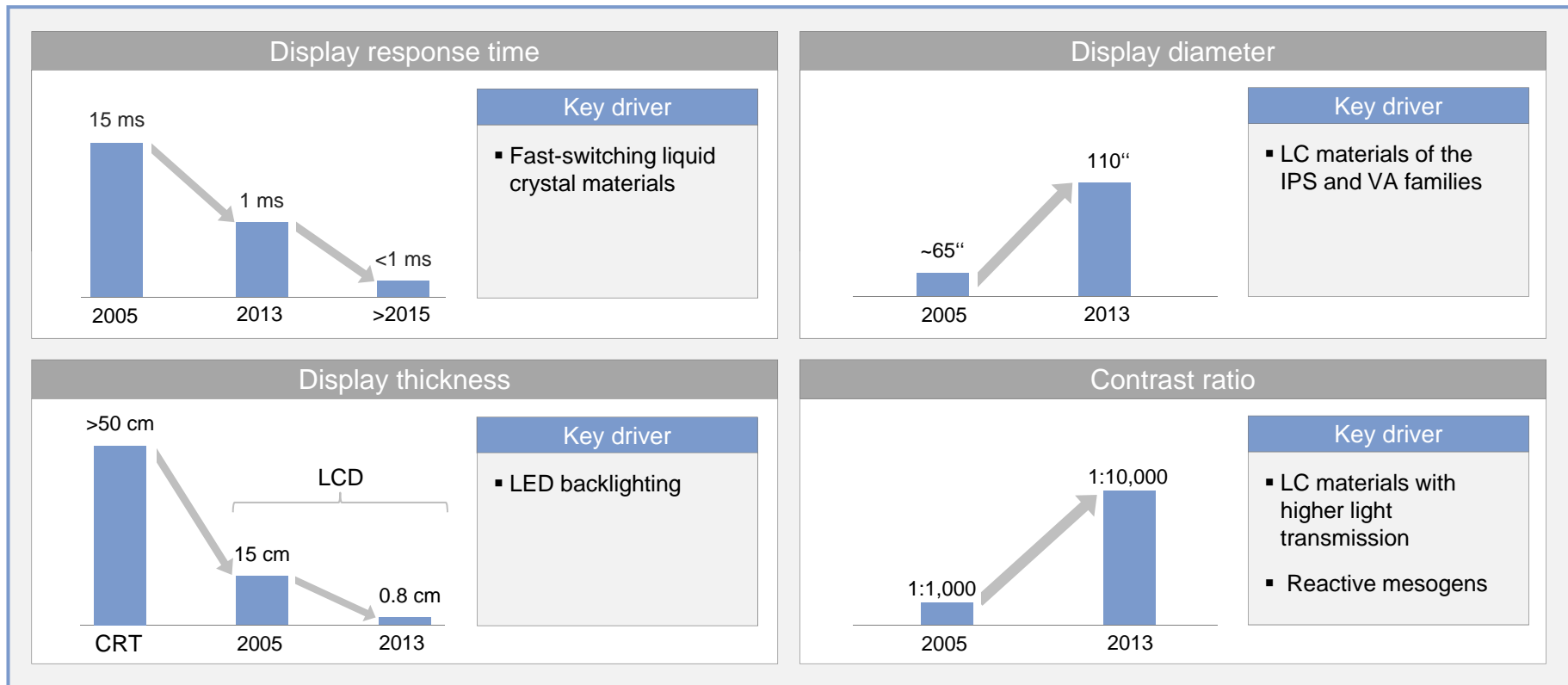
Summary






# Viewing experience, production costs and changing display technologies are key development trends



# LCD viewing experience has tremendously improved over the past years



# Despite the revolutionary progress in flat-panel displays, there is still much more to innovate (1/2)

Picture quality	Size	Thickness
		
Focus areas	Focus areas	Focus areas
<ul style="list-style-type: none"><li>▪ Contrast ratio</li><li>▪ Resolution, e. g. "4K2K"</li><li>▪ Color gamut</li><li>▪ Switching time</li><li>▪ New liquid crystal modes, e. g. FFS</li></ul>	<ul style="list-style-type: none"><li>▪ Jumbo TVs &gt; 120 inches</li><li>▪ Consumers buy larger screens</li><li>▪ Liquid crystals only technology to scale size cost-efficiently</li><li>▪ Higher resolution like "4K2K"</li></ul>	<ul style="list-style-type: none"><li>▪ Tablets</li><li>▪ Liquid crystal mixtures for LED backlit displays</li><li>▪ Phosphors for LED backlighting</li></ul>

# Despite the revolutionary progress in flat-panel displays, there is still much more to innovate (2/2)

## Reduction of manufacturing costs



### Focus areas

- Fewer display components
- Higher light transmission of liquid crystals
- Shorter processing time of displays

## New features



### Focus areas

- 3D without glasses
- Flexible/unbreakable displays
- Internet connectivity
- Transparent displays
- New controls (gesture, swiping remote)

## Energy efficiency



### Focus areas

- Higher light transmission of liquid crystals
- Backlighting with higher efficiency

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The R&D engine in display materials

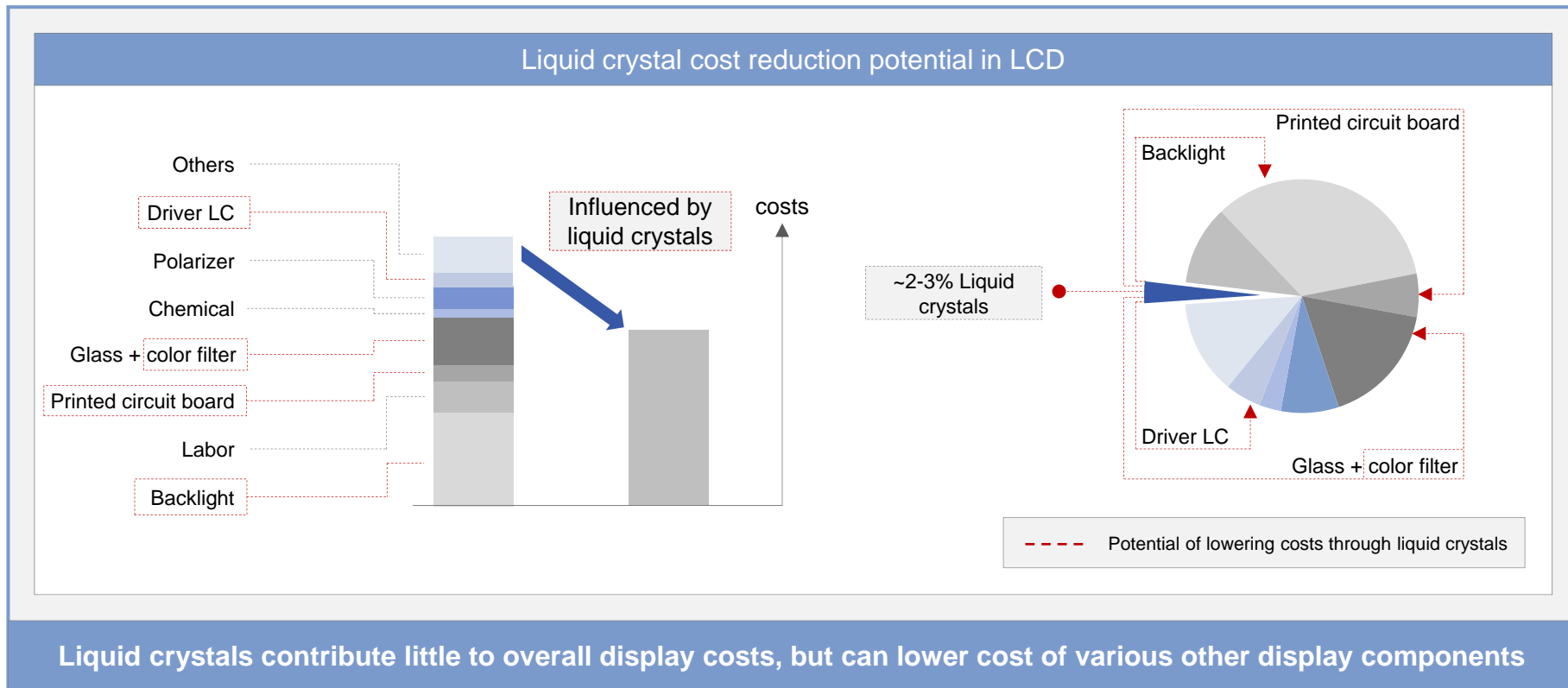
Drivers of liquid crystal display development

**The role of liquid crystals in display development**

Liquid crystals beyond flat panel displays

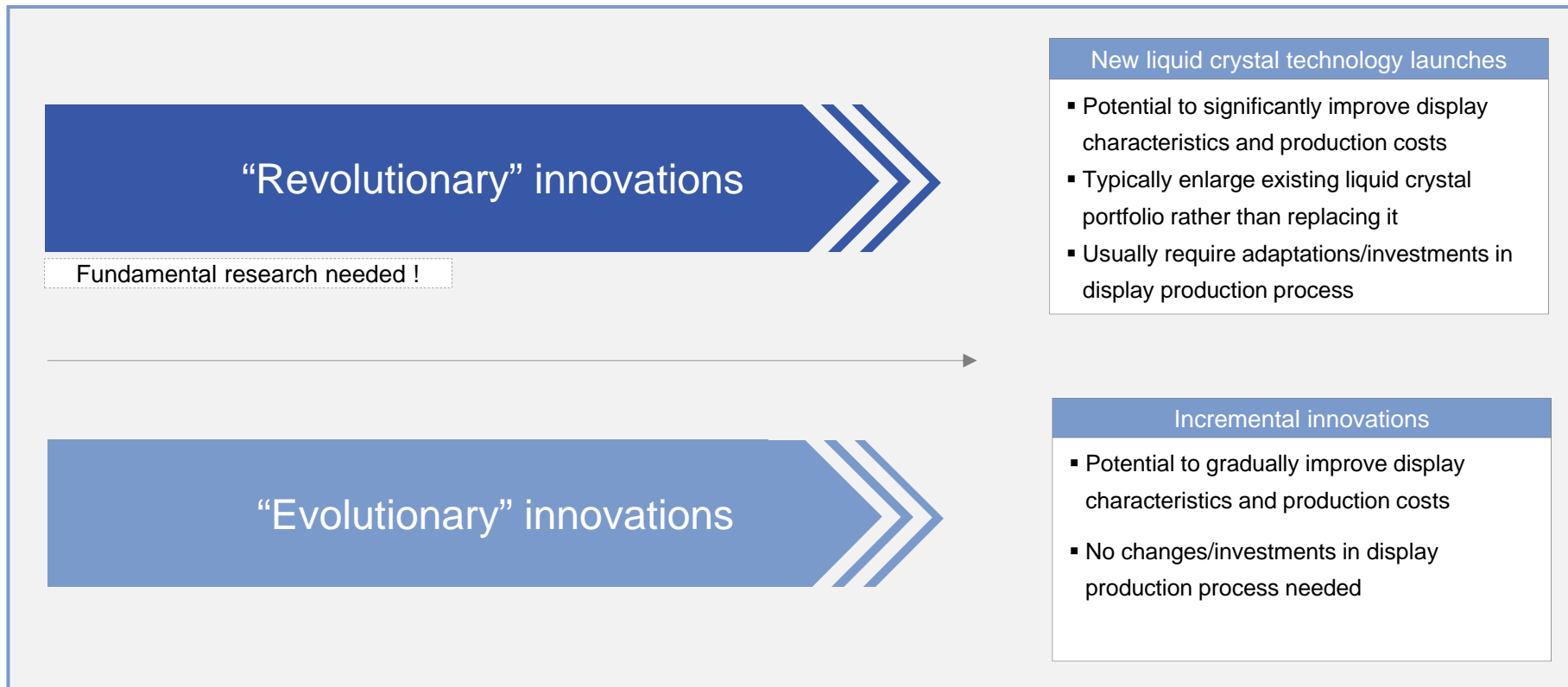
Summary

# We innovate to contribute to both overall display cost reduction and display performance



Source: DS Cost Report Q4 2012 (40" FHD 120 Hz TV module)

# We are active in both fundamental research and continuous technology improvements



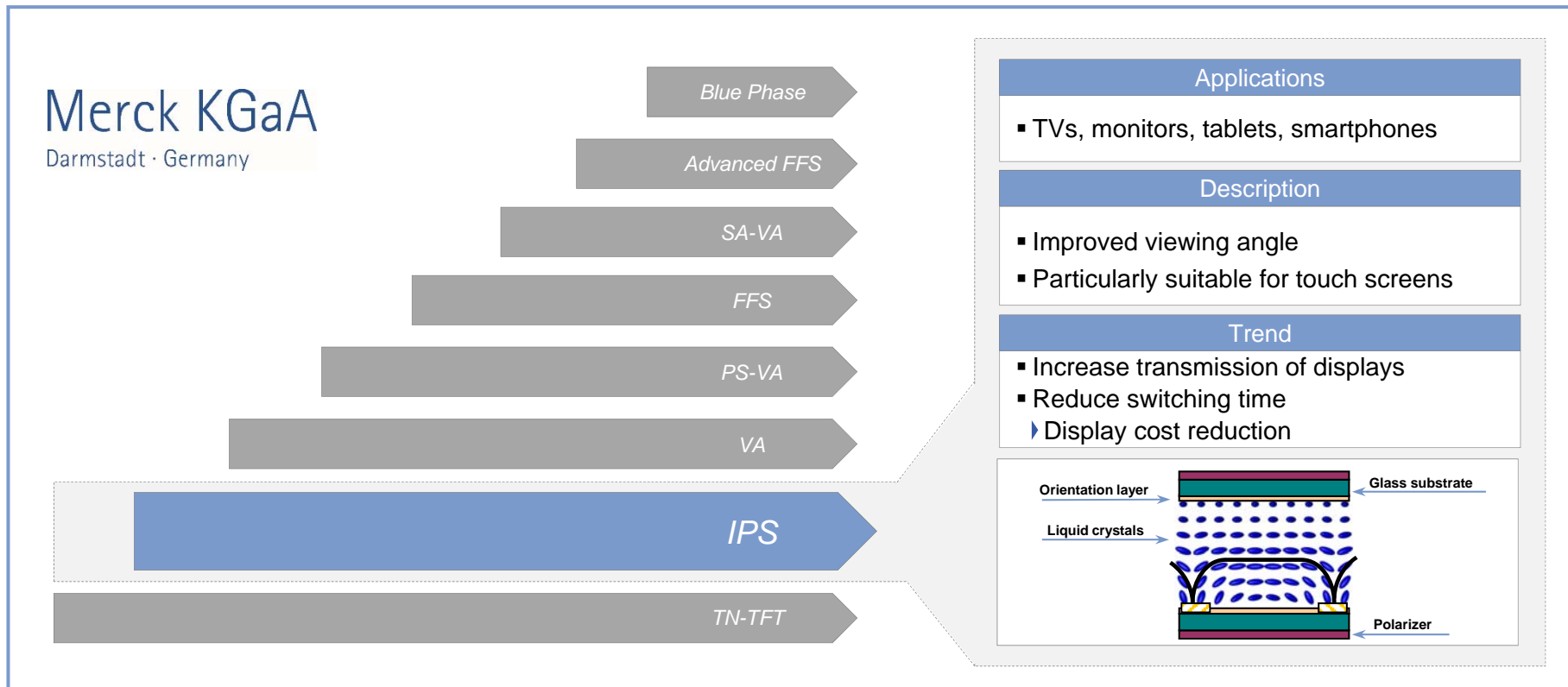
# Innovation and differentiation in existing as well as in new liquid crystal technologies



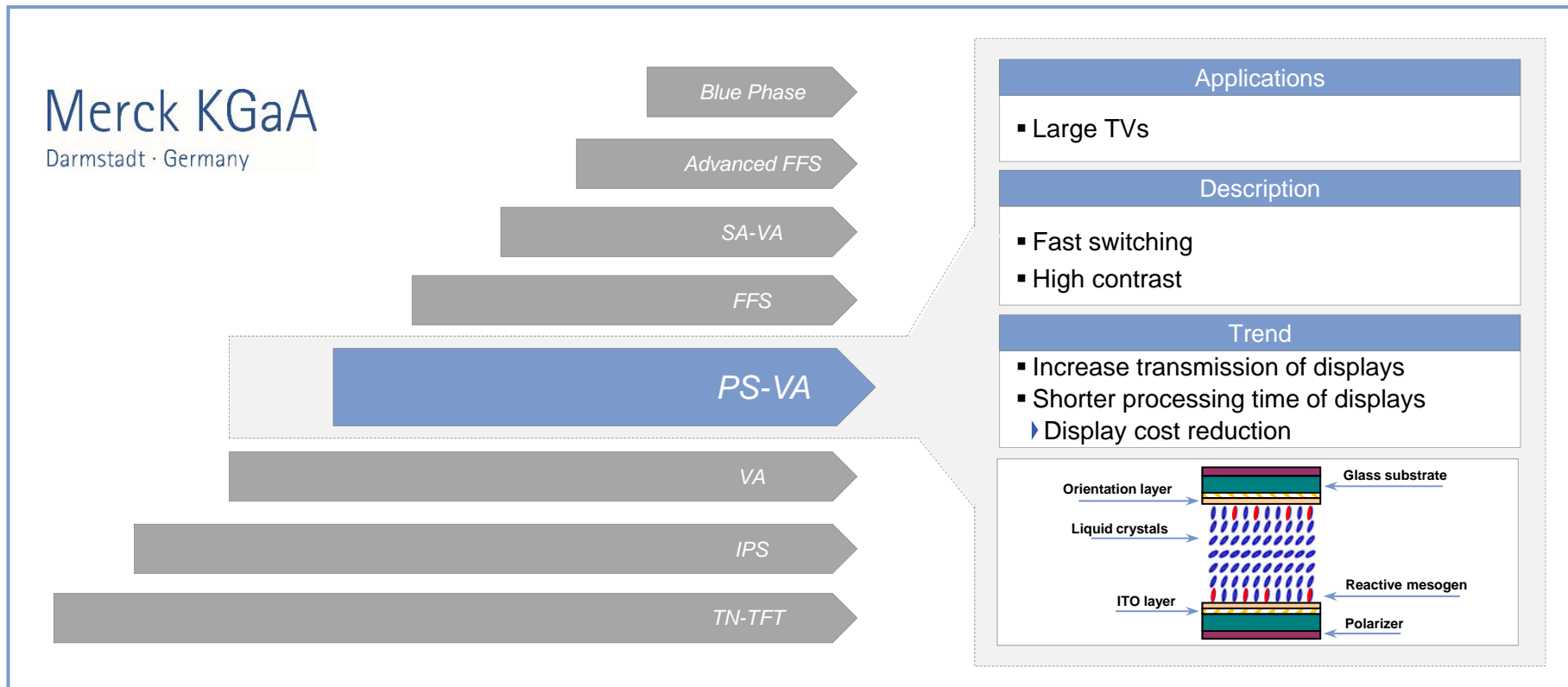
Acronyms: TN = Twisted Nematic; IPS = In-Plane Switching; FFS = Fringe-Field Switching; VA = Vertical Alignment; PS-VA = Polymer-Stabilized Vertical Alignment; SA-VA = Self-Aligned Vertical Alignment



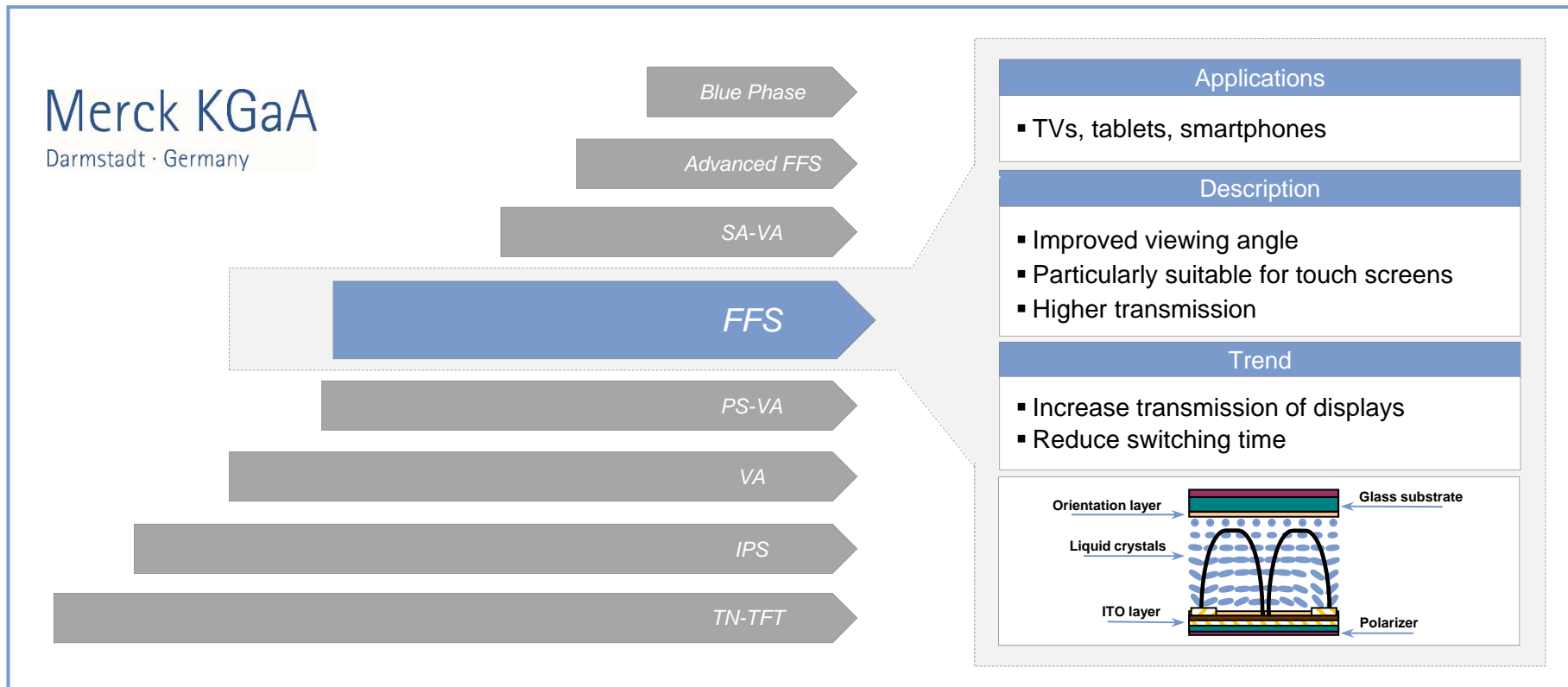
# Liquid crystals of the IPS type are primarily used in TVs and touch screen displays



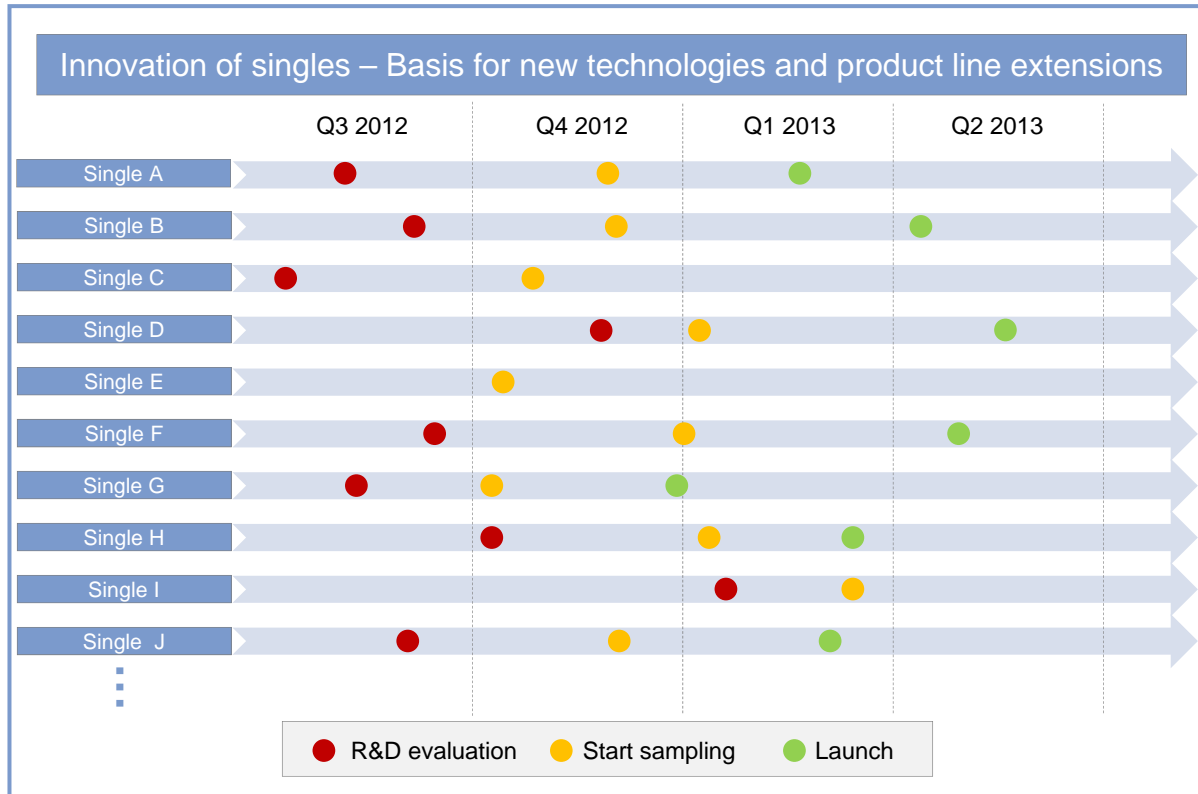
# PS-VA is a premium liquid crystals technology that is mainly used in large TVs



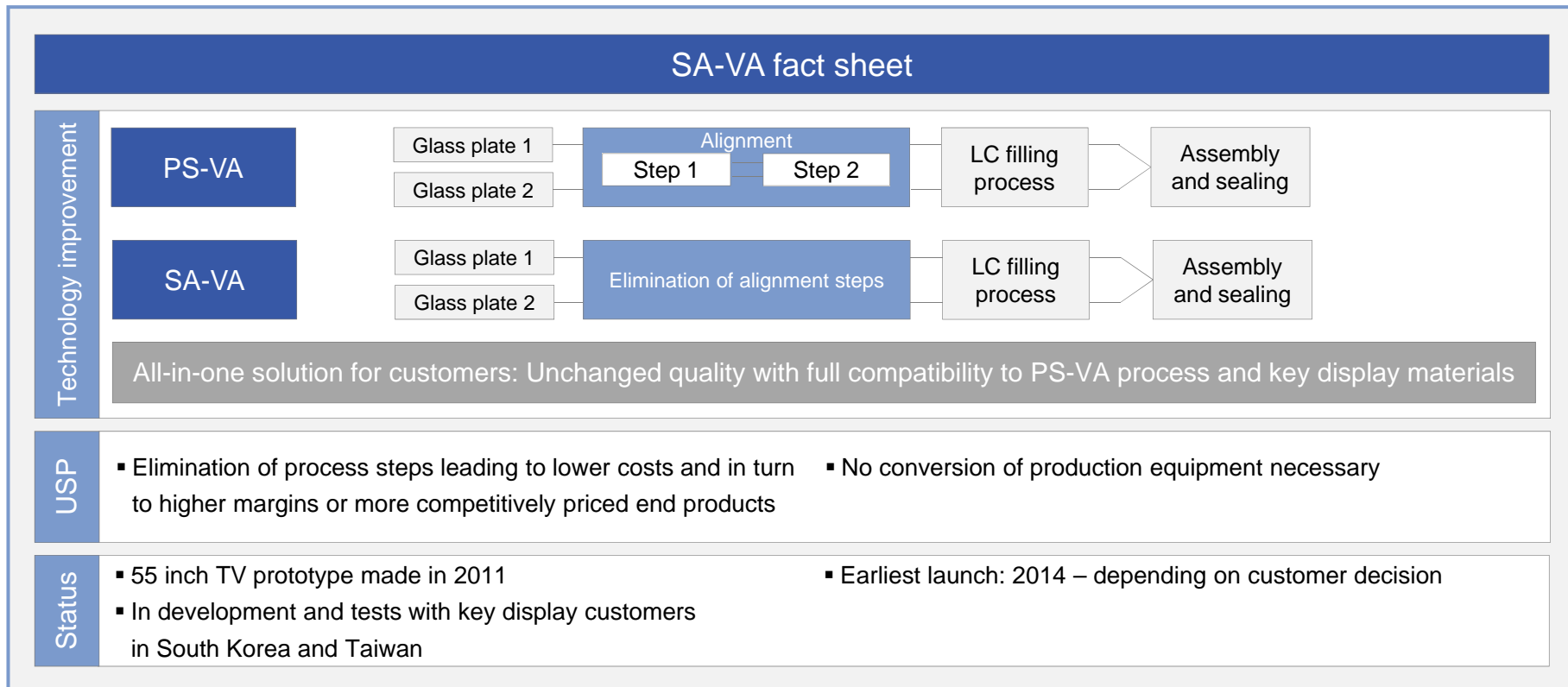
# FFS – The key new liquid crystals technology to be used in touch screen displays



# Continuous improvement in line with our customers' roadmaps – a snapshot of our line extensions

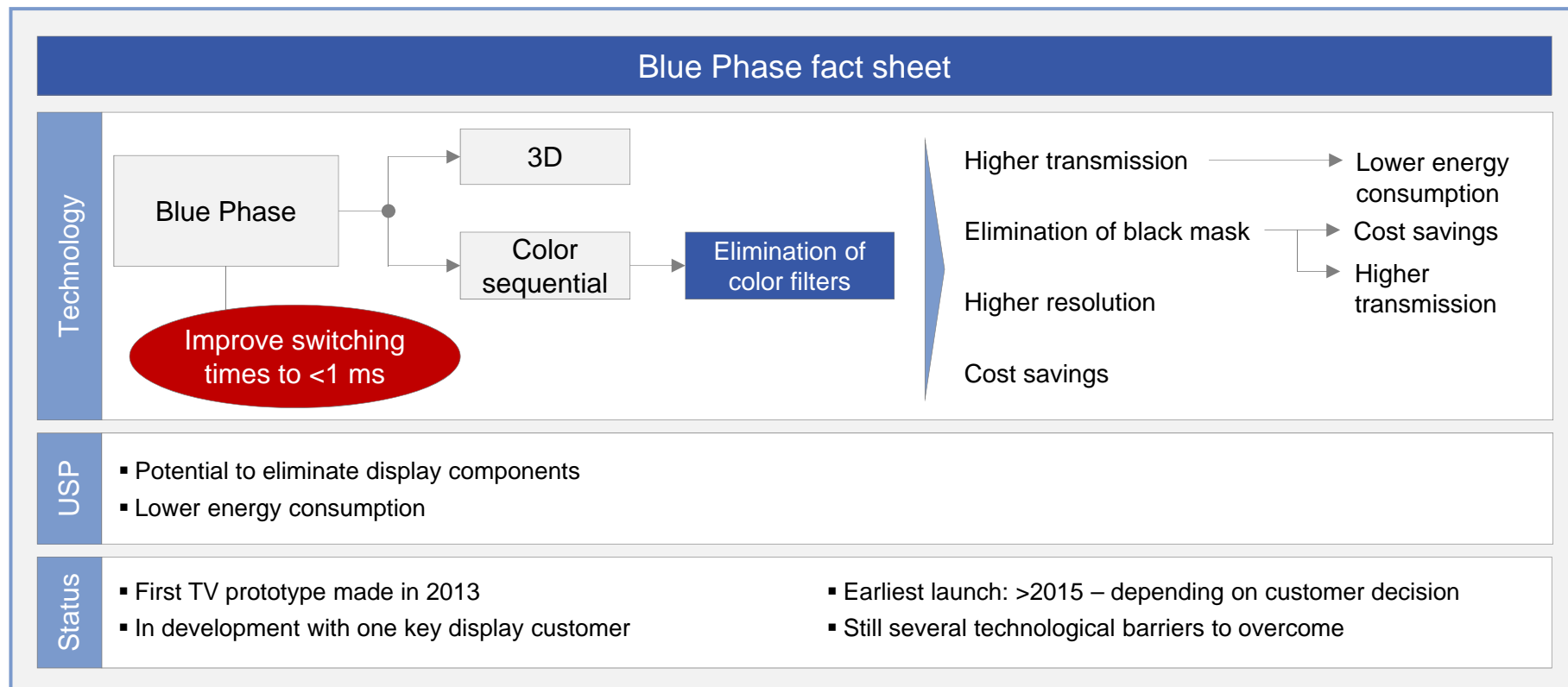


# Liquid crystals of the SA-VA\* type simplify panel manufacturing

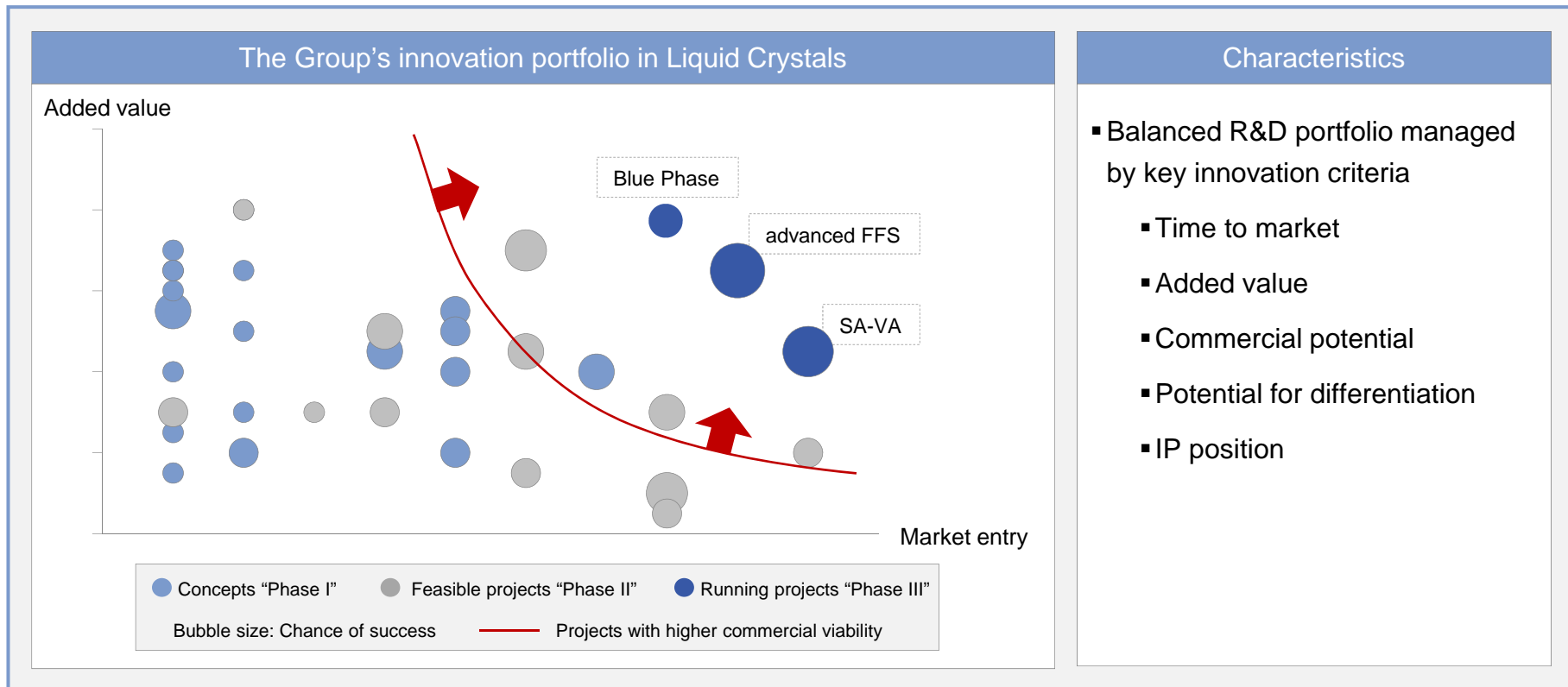


\*SA-VA = Self Aligned Vertical Alignment

# Blue Phase technology can significantly reduce display costs while improving picture quality



# A strong and balanced R&D portfolio, addressing future needs of the display industry



## Characteristics

- Balanced R&D portfolio managed by key innovation criteria
  - Time to market
  - Added value
  - Commercial potential
  - Potential for differentiation
  - IP position

# 4K2K: The trend for larger displays drives the need for higher resolutions, stimulating demand for PS-VA

Full HD TV		Ultra High Definition TV (UHD)	Impact on the company				
<p>Full HD 1,920 x 1,080 pixel</p> <p>13 pixel per inch</p>	<p>x 4</p>	<table border="1"><tr><td>Full HD 1,920 x 1,080 pixel</td><td>Full HD 1,920 x 1,080 pixel</td></tr><tr><td>Full HD 1,920 x 1,080 pixel</td><td>Full HD 1,920 x 1,080 pixel</td></tr></table> <p>52 pixel per inch</p>	Full HD 1,920 x 1,080 pixel	Full HD 1,920 x 1,080 pixel	Full HD 1,920 x 1,080 pixel	Full HD 1,920 x 1,080 pixel	<ul style="list-style-type: none"><li>Major trend towards larger display sizes (&gt;50 inch)</li><li>Customers focus on exploiting potential of current liquid crystal technologies<ul style="list-style-type: none"><li>Shifts commercial adaption of new liquid crystal technologies</li><li>Creates opportunities for reactive mesogens</li></ul></li></ul>
Full HD 1,920 x 1,080 pixel	Full HD 1,920 x 1,080 pixel						
Full HD 1,920 x 1,080 pixel	Full HD 1,920 x 1,080 pixel						
<p>1,920 x 1,080 HD</p>		<p>3,840 x 2,160 4K</p>					
<p>Increasing end-user demand for 4K2K devices supports our technologies, fuels replacement cycle</p>							



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Summary

# The unique characteristics of liquid crystals could further increase the range of applications

## Liquid crystals beyond 2020



### Smart Windows

- Darkening of windows
- Smart energy glass



### New optical features

- Haptic displays
- Holography

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### Light and display

- New lighting concepts
- Convergence of light and display



### Smart Antennas

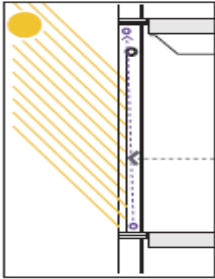
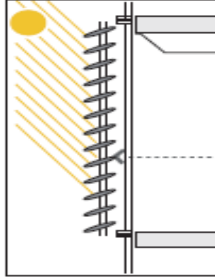
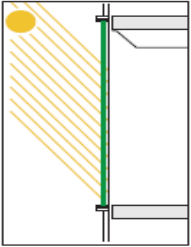

- Mobile data management



Chemistry evolves, tending to find its own applications

# Smart windows can offer significant added value to the operating cost of modern buildings

**Smart windows**

Challenges today		Our solution	
<p><b>Green performance</b></p>  <p>Double skin facade</p>	<p><b>Architectural design</b></p>  <p>Sun shades, take away real estate</p>	<p><b>Smart windows</b></p>  	<ul style="list-style-type: none"><li>▪ Single skin facade with liquid crystal shading:<ul style="list-style-type: none"><li>▪ Same performance</li></ul></li><li>▪ Less material and weight</li><li>▪ More floor area</li><li>▪ No maintenance</li></ul>

**Freedom of design for premium architecture**

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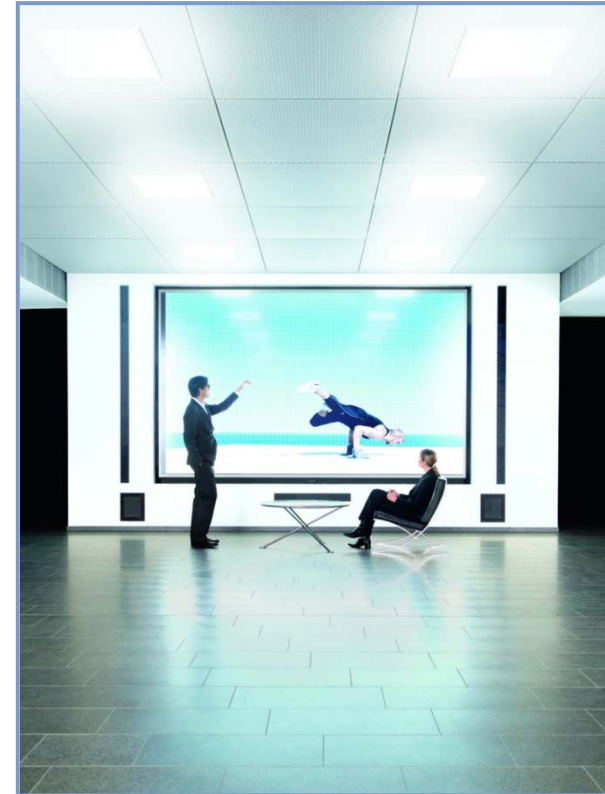
**Summary**

# We are well-positioned to meet current and future innovation needs

We have been the innovation leader

We continue to strive for innovation upgrades today and in the future

We are ongoingly seeking out new end-applications for liquid crystals in displays and beyond



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