An All Optical Touch and Gesture Interface

Tim Large, Neil Emerton, Liying Chen

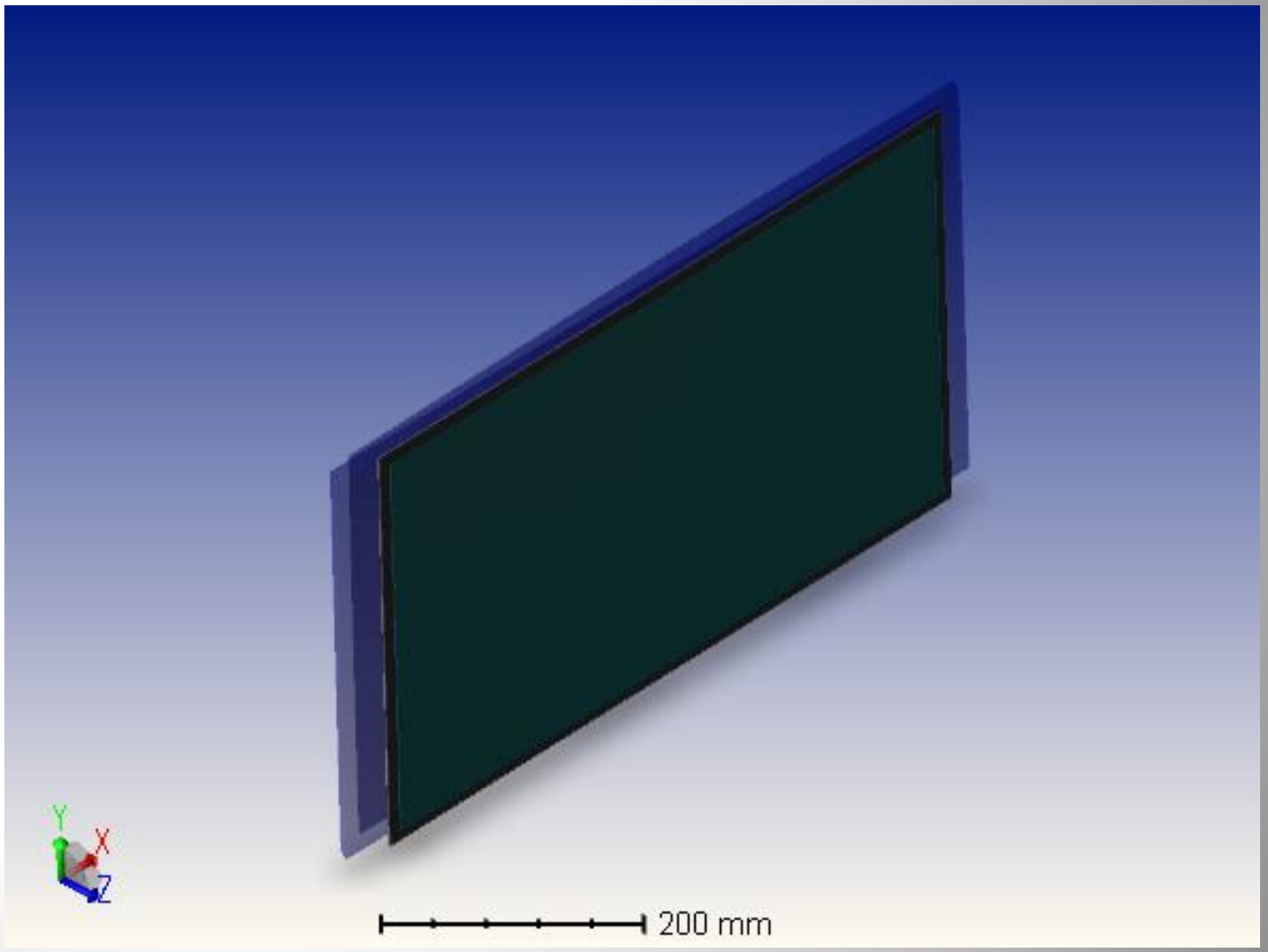
Project completed March 2011

Project Aim

- Create a thin, all-optical interface for touch and gesture .
- Display and sensing for on-screen and off-screen gestures.

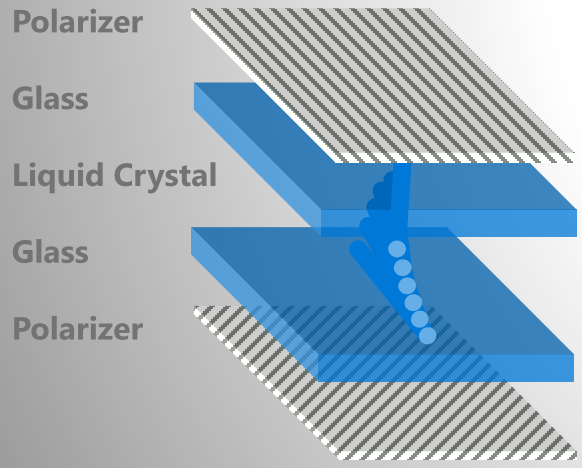
Structure of the device

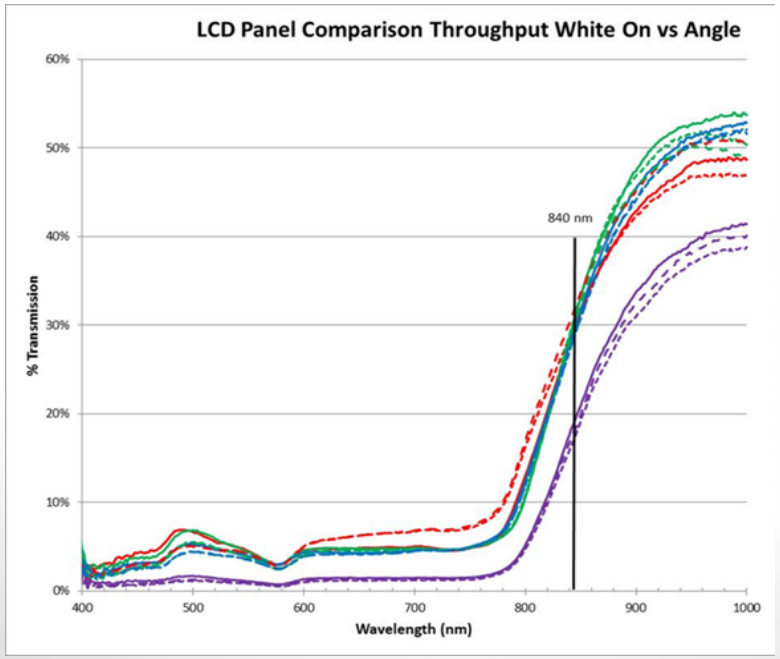
- The device structure consists of Wedge, PDLC, LCD, Elastomer and IR Mirror layers.
- The function of each is explained in the following slides.

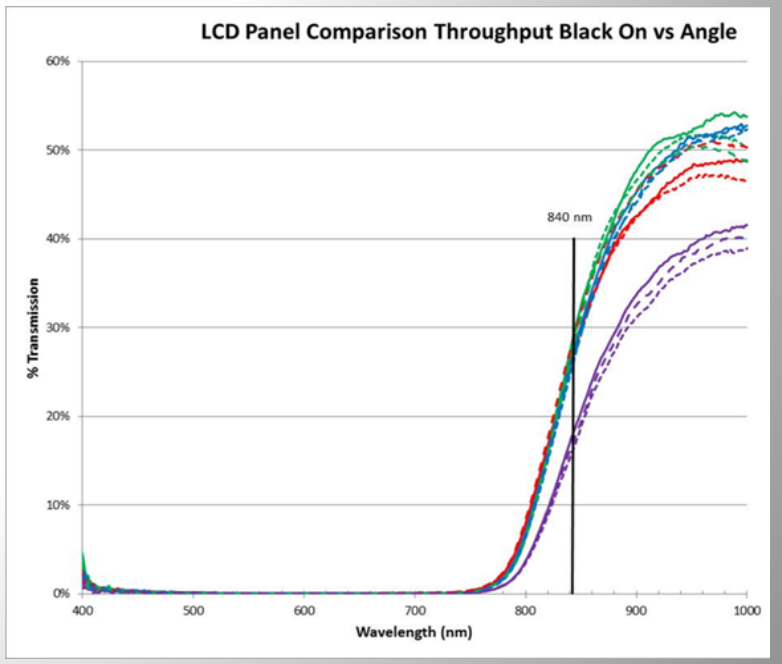


Vision through an LCD

- A liquid crystal display consists of a cell and backlight unit (BLU).
- The cell has input and output polarizer, with liquid crystal and color filters between them, modulating the light from the backlight.
- The cell is transparent in the infra-red, which can be used for sensing.

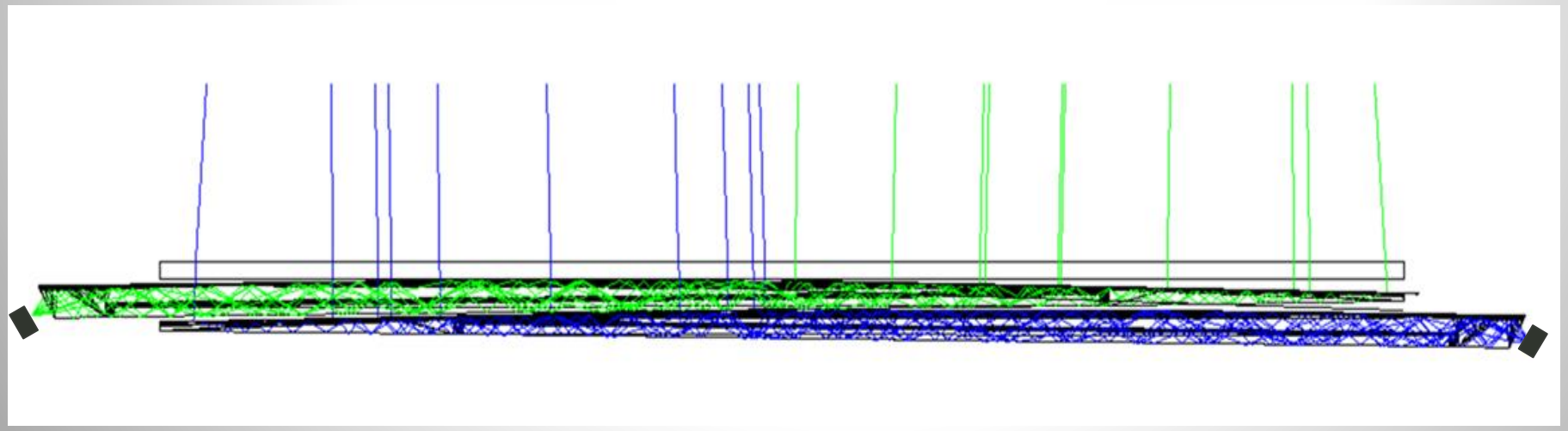






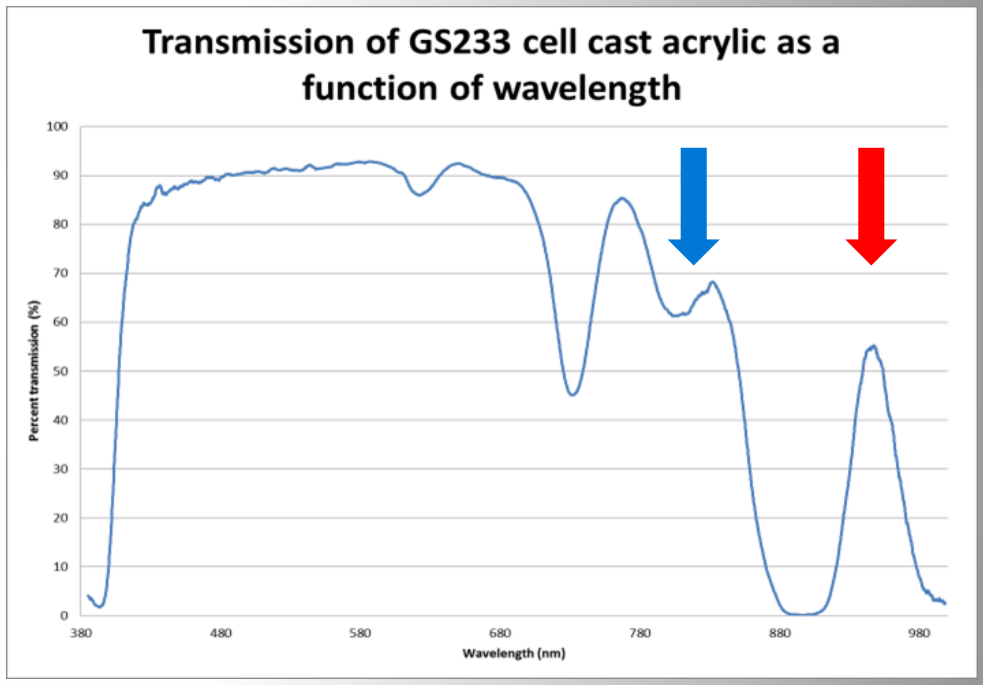
Wedge Technology

- Wedge technology allows an imaging volume to be flat.
- Wedge panels are substantially achromatic, one design works through the visible and infra-red.
- They are also bidirectional.



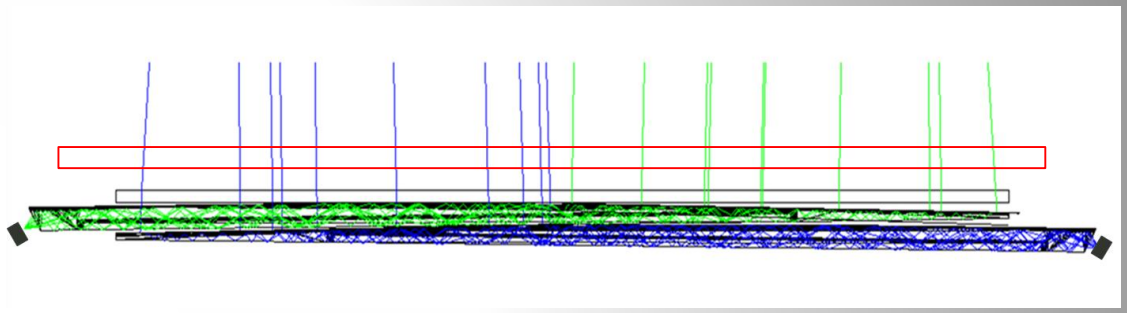
Detecting Gestures and Objects

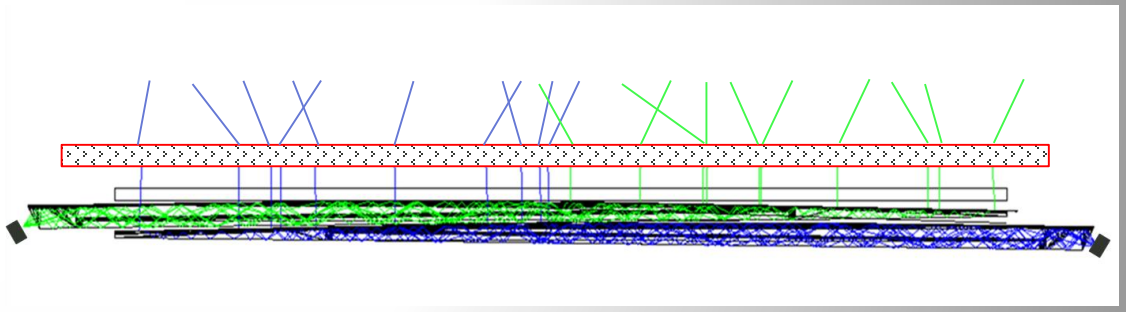
- Acrylic and LCD have useful transmission at 830nm (blue arrow) and 940 (red arrow).
- Camera at the edge of Wedge panels can be used to detect touch and gesture.
- LEDs at the edge of Wedge panels provide backlighting for the LCD.



Making the system one-way

- Using Wedge panels to both illuminate an LCD, and see out, we have the start of an interactive display.
- Since the illumination LEDs are very bright, they must be turned off when the camera is on.
- To stop the user from seeing into the internal structure, a high-speed polymer disperse liquid crystal (PDLC) sheet was designed.
- The PDLC is diffuse when the backlight LEDs are on.

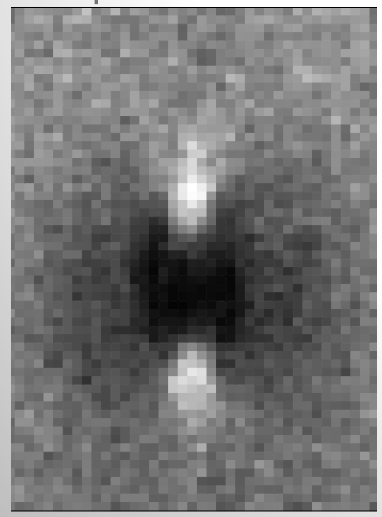




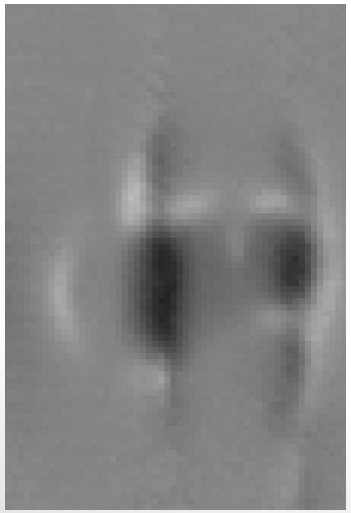
Detecting touch by pressure

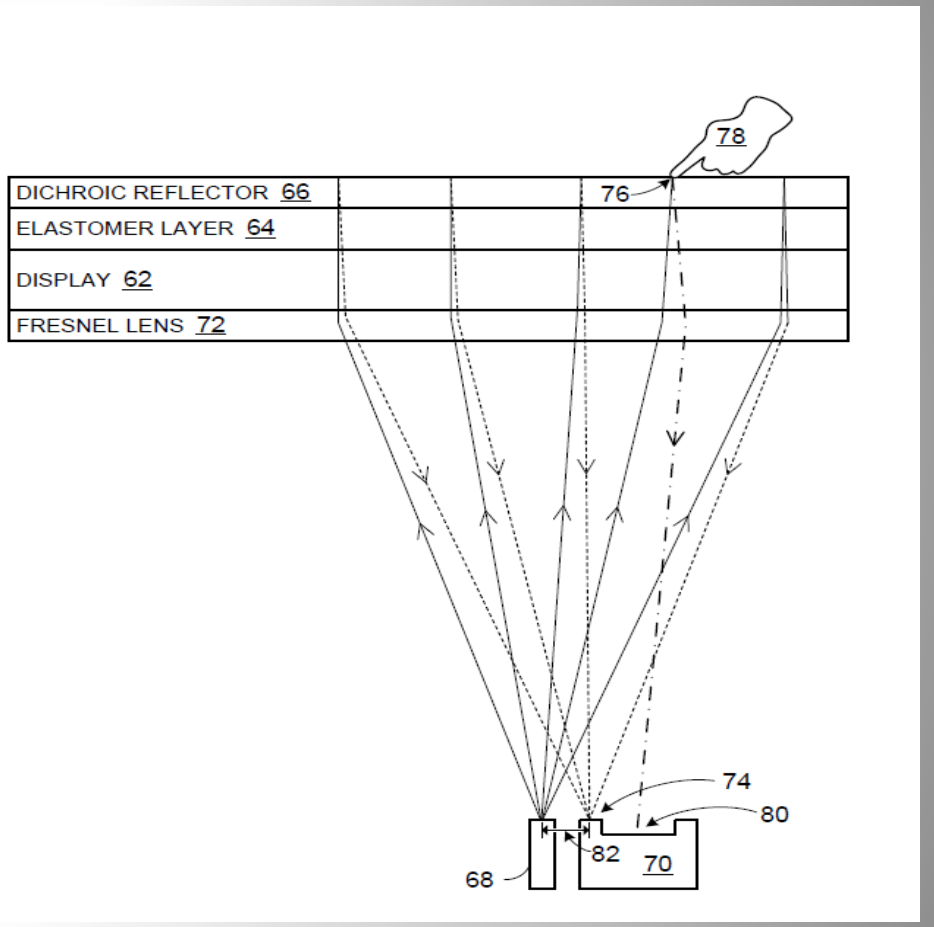
- Light reflected from a mirror returns to the focus.
- Off-setting the source and detector makes a Schlieren interferometer, that is extremely sensitive to surface deflection.
- A soft surface allows detection of pressure on the surface.

Optical model



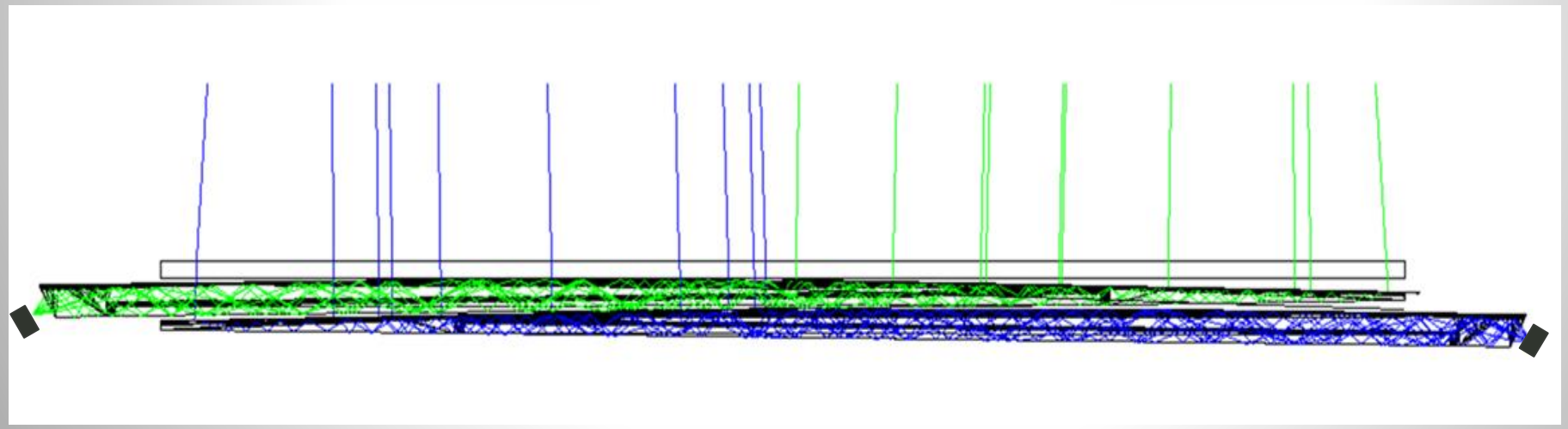
Photo





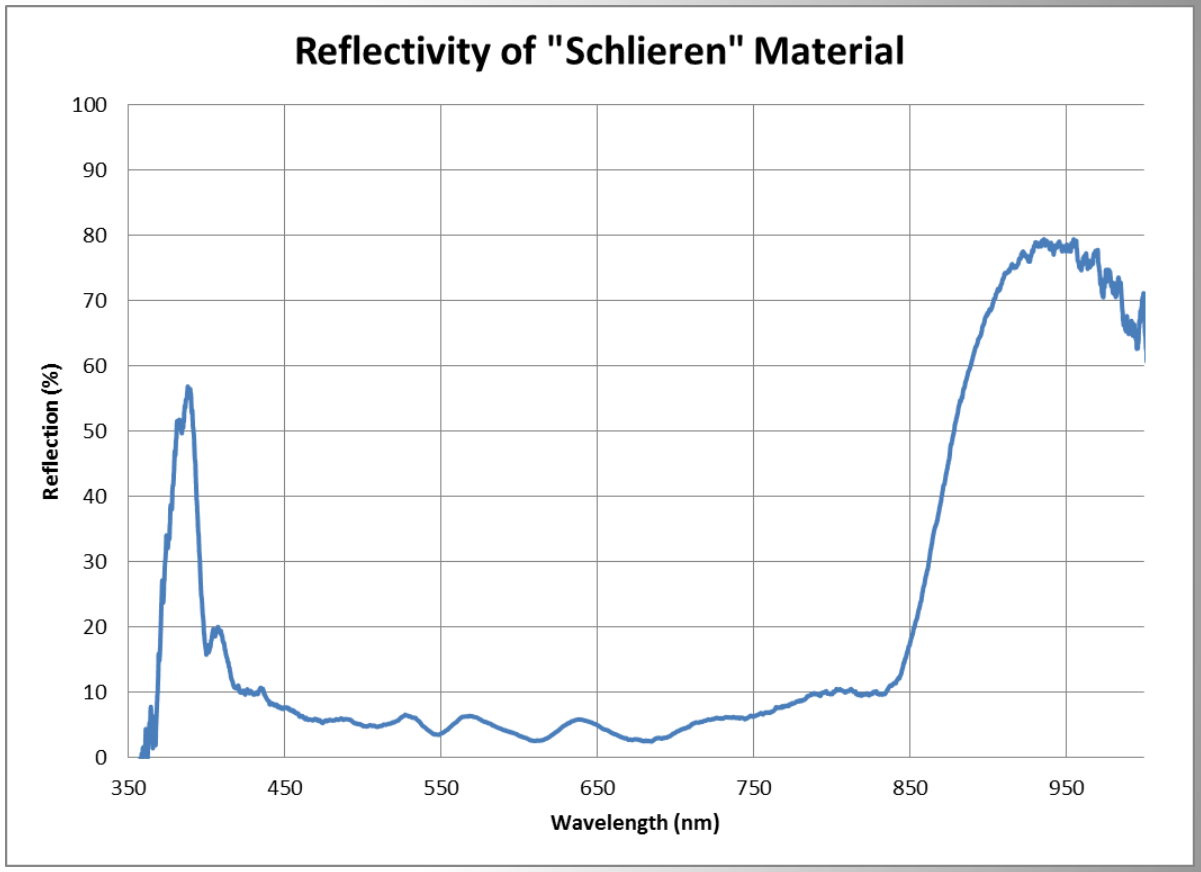
Telecentric Imager

- The Wedge is a telecentric imager – light emitted from the focus is collimated at the face.
- This allows the Schlieren system to be folded flat, integrated with the illumination and gesture sensing.



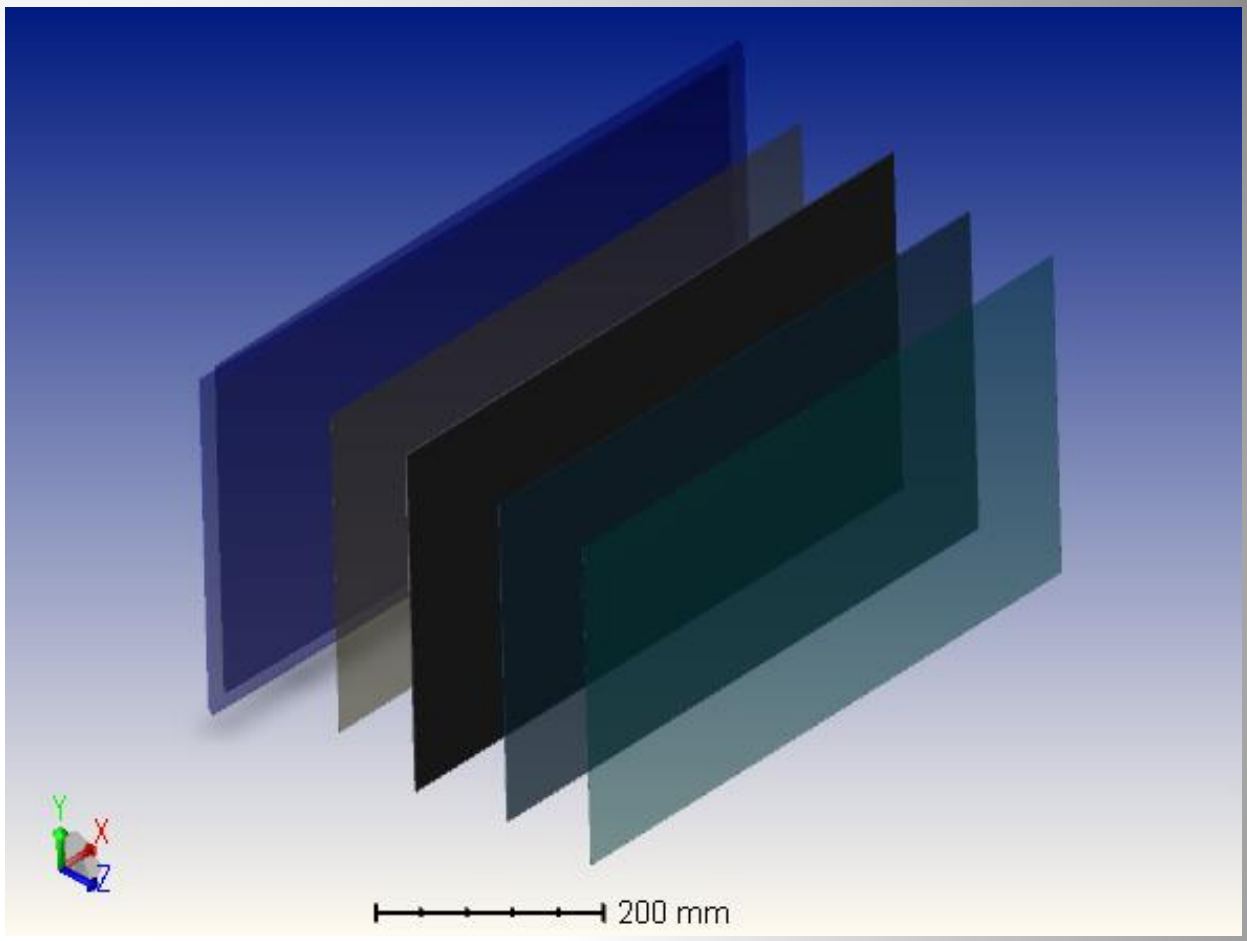
Schlieren Mirror

- To detect pressure using Schlieren interferometry, the imaging surface must be a mirror.
- But we want so see out in the visible and near IR.
- A film dichroic mirror was designed that reflects 940nm but passes visible and 830nm.



Structure of the device

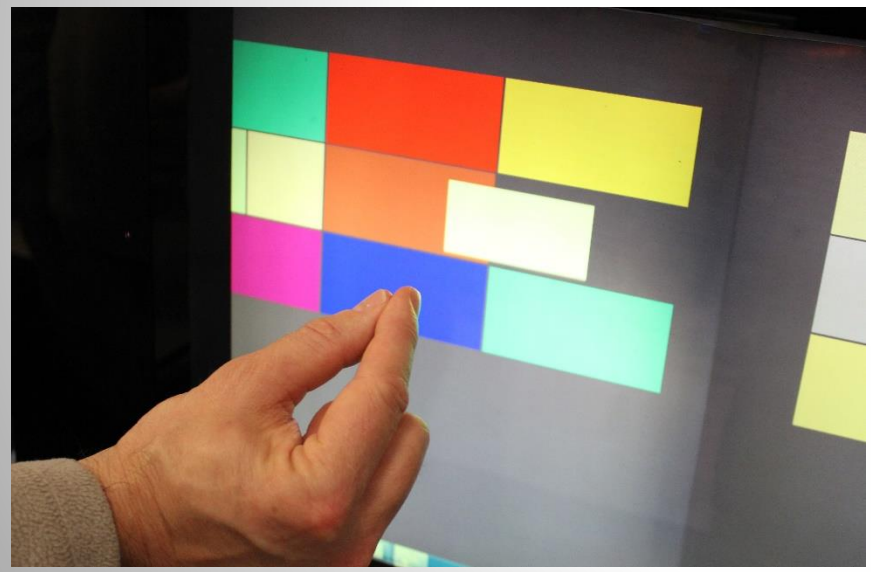
- Visible, 830nm, and 940nm layers are overlaid.
- Display, touch and gesture are cycled at 120Hz.



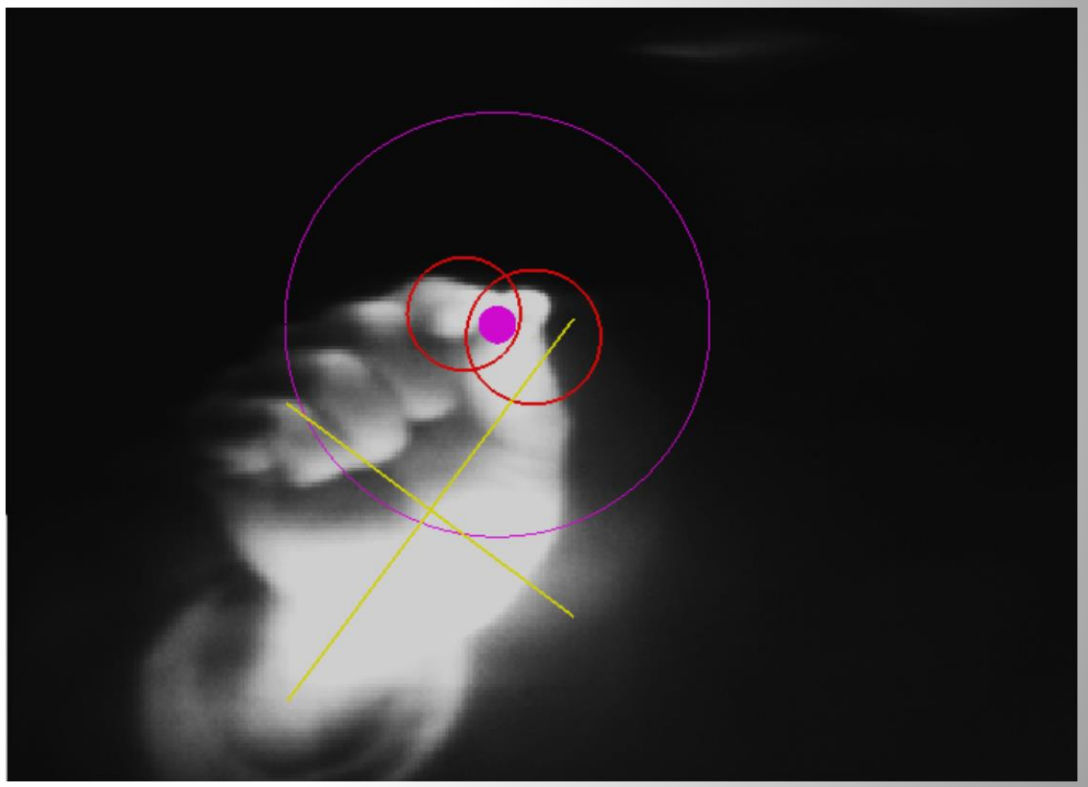
	Frame 1				Frame 2				Frame 3				Frame 4			
Display Illumination				■				■				■				■
830nm gesture sensing	■	■	■	■	■	■	■		■	■	■	■	■	■	■	
940nm pressure sensing	■	■	■		■	■	■	■	■	■	■		■	■	■	■

Putting it all together

- Visible illumination
- 940nm pressure sensing (right)
- 830nm gesture sensing (below)



Yellow cross = hand centroid
Red circles = finger pressure
Purple dot = pinch gesture



Finished demonstration

Clockwise from top left:

1. Compact optical system
2. Off-screen imaging
3. Arbitrary number of pressure sense points
4. Drawing on screen
5. Pinch and float 3D interaction