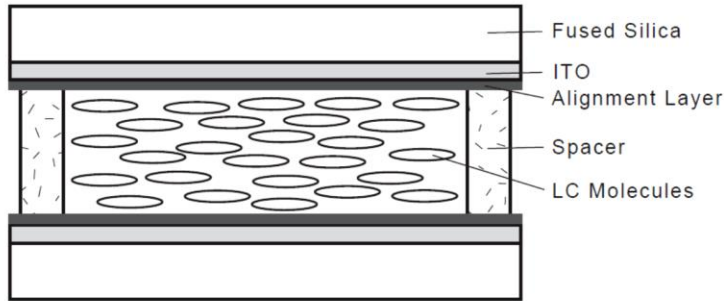


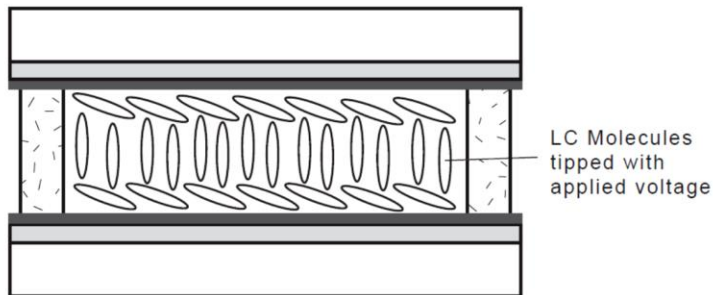
Development of the Liquid Crystal Polarization Analyzer

Andrey Alexandrov

Liquid Crystals

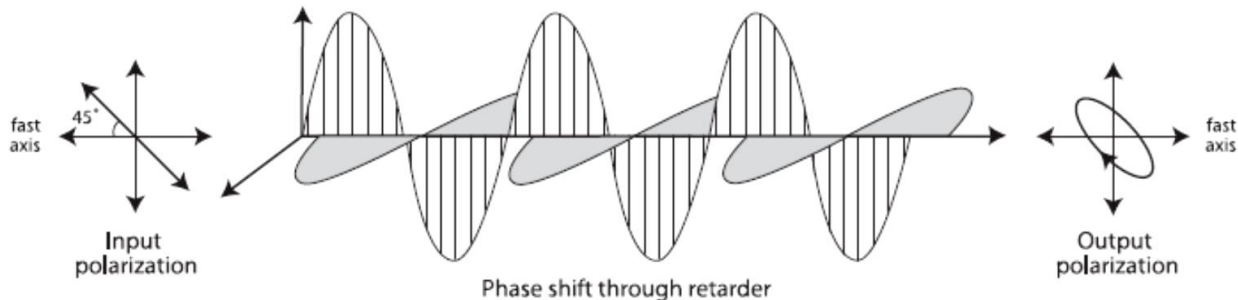


(a) Maximum Retardance ($V = 0$)



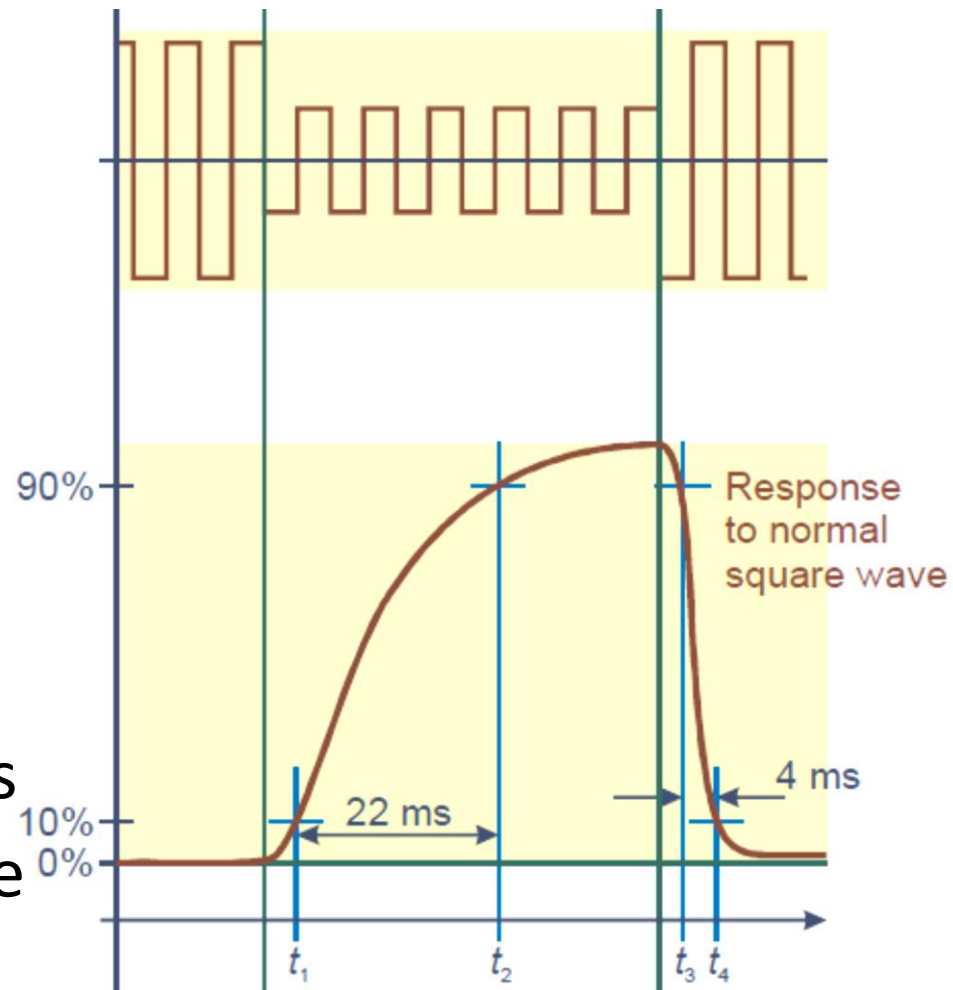
(b) Minimum Retardance ($V \gg 0$)

- Nematic LCs are birefringent materials
- Birefringence can be changed by varying an applied voltage
- Birefringence (B) = $|n_e - n_o|$
- Retardation (Γ) = Thickness (t) * $B = t * |n_e - n_o|$



Liquid Crystal – Time Response

- Response time is complicated and asymmetric
- ~20 ms on high-low V change
- ~5 ms on low-high V change
- Anyway is slow compared with the camera frame duration = $1/563 = 1.76$ ms
- Dynamic characteristics are to be tested



LC Polarization Rotator

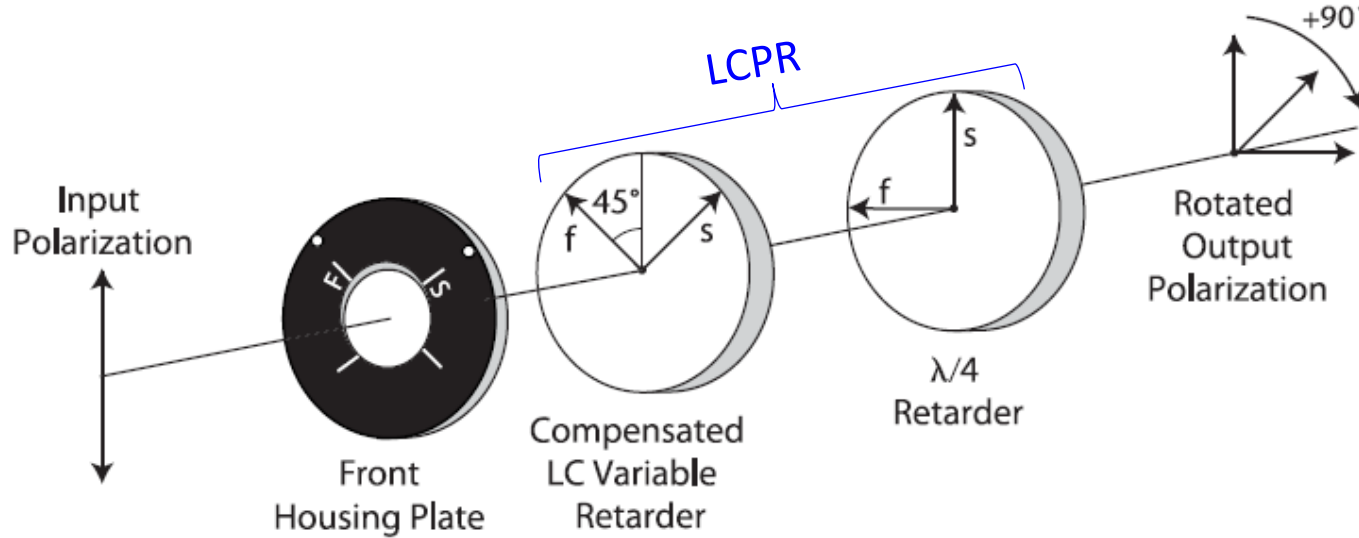


- LPR-200-0405 -C
 - Operating $\lambda = 405 \text{ nm}$
 - Average contrast 342:1
 - Continuous rotation 180°
- D5020 LC Controller
 - Generates 2kHz drive voltage
 - Handles up to 2 LCs
 - 2 trigger input/output
 - A number of predefined waveforms
 - USB interface

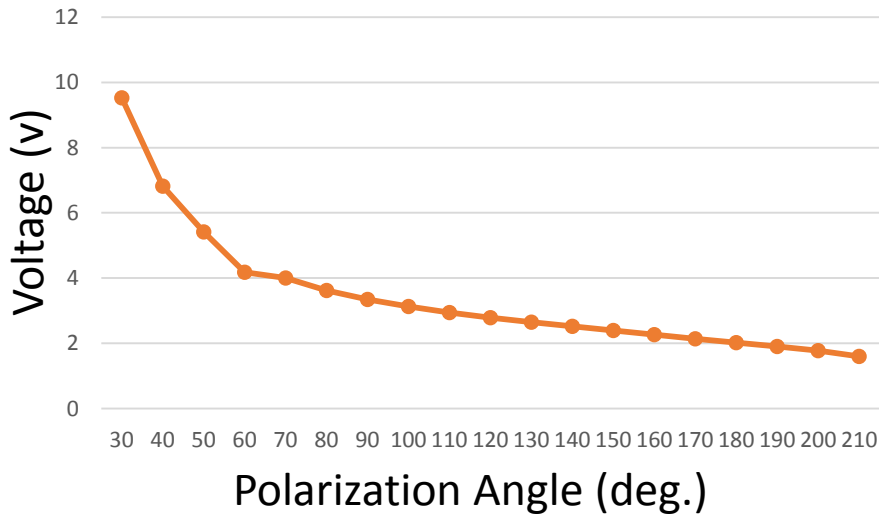
LCPR control options

- SW control
 - C++ program controls command flow
 - ASCII string sent to USB port
 - Slow operation – only step waveform is possible
- HW control
 - Preloaded waveforms are not suitable (linear V not retardance)
 - C++ program loads parameters into LC controller and runs it
 - LC controller generates waveform
 - Max 16 steps (independent voltage and duration)
 - Output HW trigger for each step
 - Can cycle on external HW trigger as well
- External waveform input
 - Any waveform type
 - Can be distorted by the LC response timing

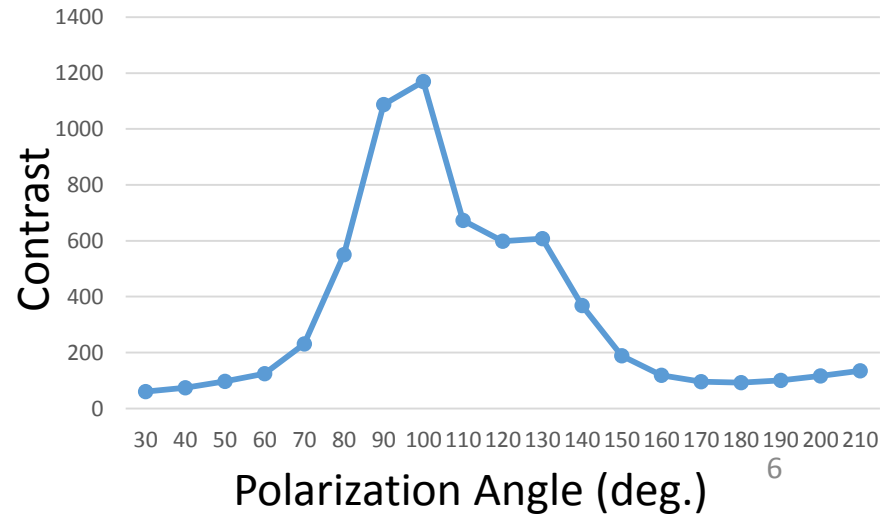
LC Polarization Rotator



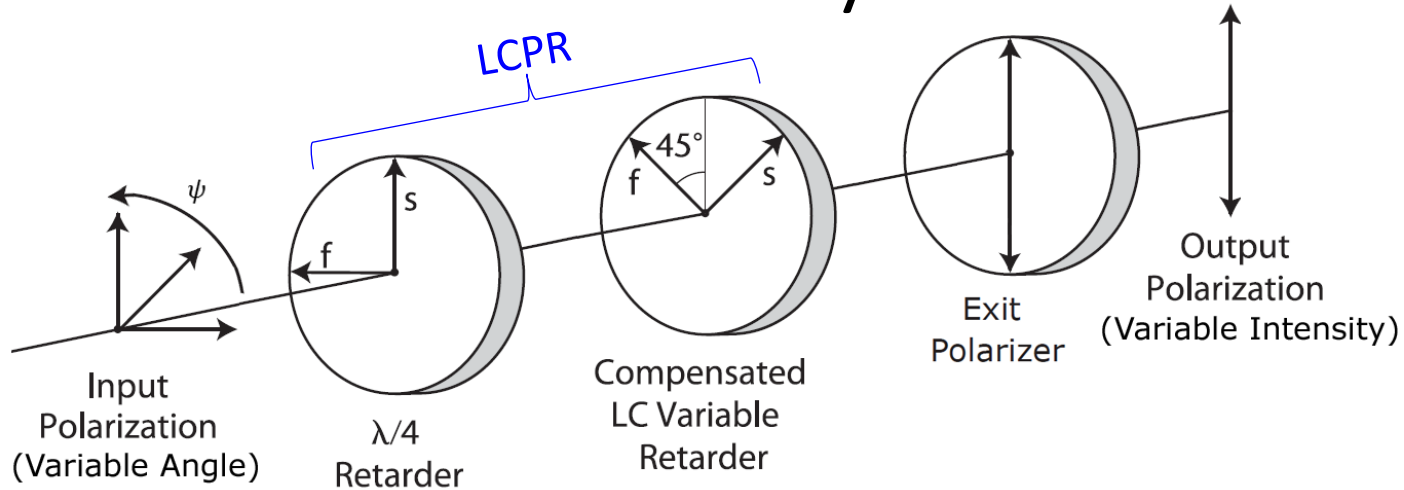
Voltage vs Polarization Angle



Contrast vs Polarization Angle

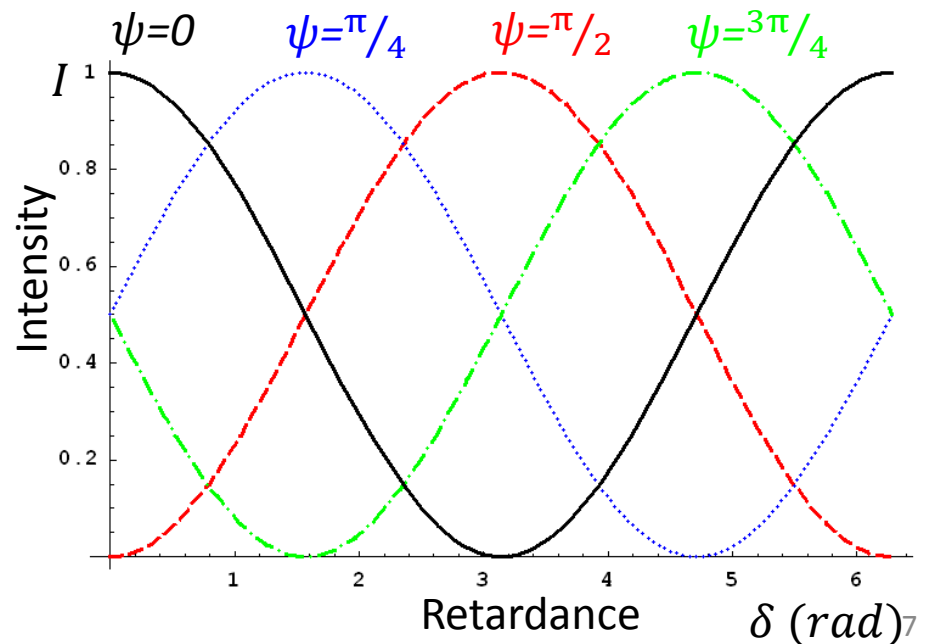


LC Polarization Analyzer for NEWS



Calculated intensity:

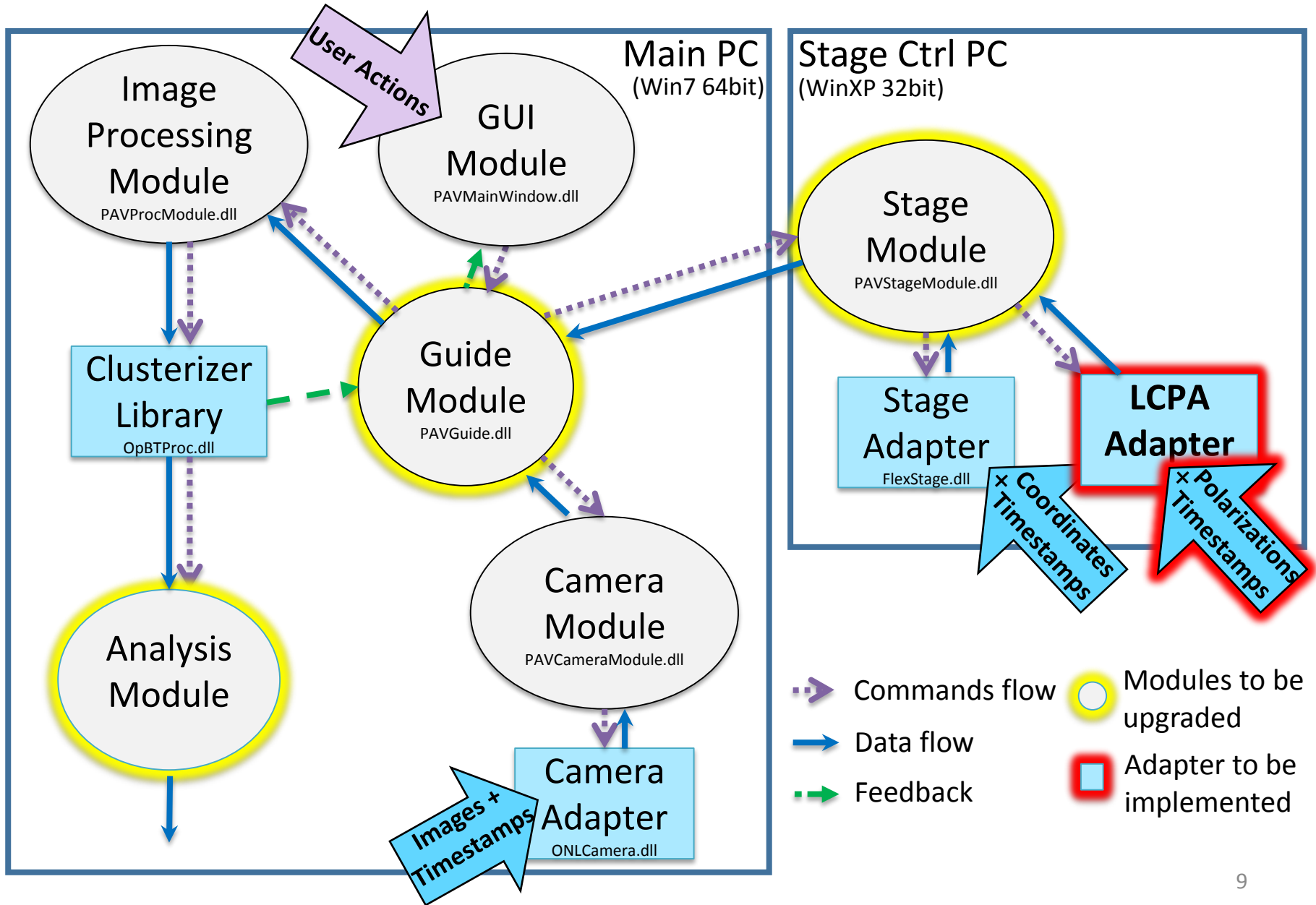
$$I = \cos^2\left(\frac{\delta}{2} - \psi\right)$$



Changes in LASSO

- LCPA adapter
 - Controls the LCPR device
 - Provides measured polarization angles and their timestamps
- Stage module
 - 3 axes/1 stage model -> Multi-axis/Multi-stage model
- Guide module
 - 4-axes scan trajectory
- Analysis module
 - Polarization analysis
 - Analysis of intensity profiles?

LASSO extension to use multiple axes



Summary

- Integration of the LCPA is ongoing
- First HW tests give positive results
- Timing performance seems to be worse than expected – to be tested more
- LASSO extension for use of multiple axes and stages is in progress
- First working prototype microscope by the end of December (save clusters without analysis)
- Analysis Module implementation starts soon after

Thank You!