ULTRA-FAST PULSED LED-ILLUMINATION OPENS NEW DIMENSION FOR OPTICAL SURFACE INSPECTION

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Stuttgart, Germany, 07.11.2018

ULTRA-SCHNELL GEPULSTE LED-BELEUCHTUNG ÖFFNET NEUE DIMENSION FÜR OPTISCHE OBERFLÄCHENINSPEKTION

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MOTIVATION – ADVANCED INLINE INSPECTION REQUIRES …

- … advanced illumination technology for:

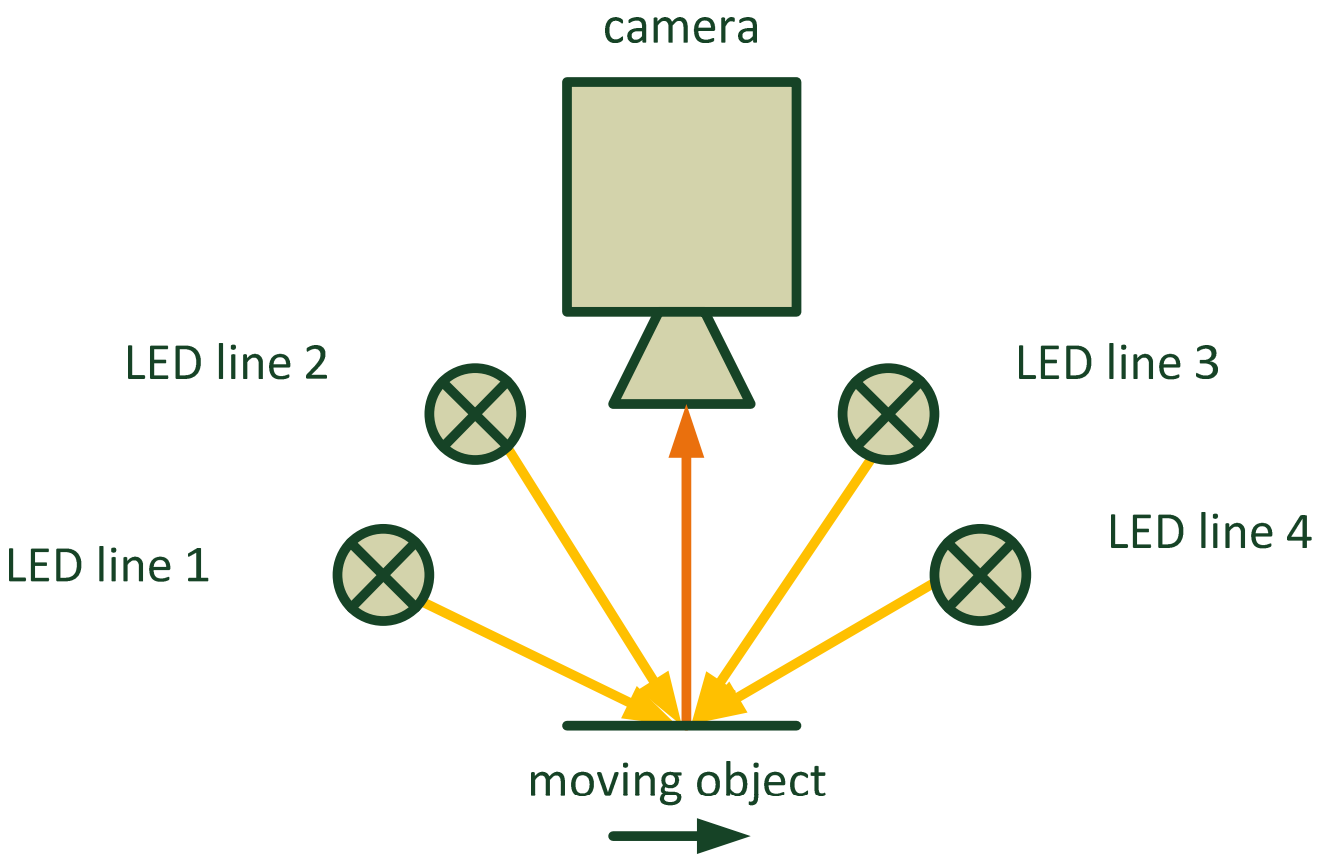
- Robust material classification
- Inspection of glossy material
- Multi-spectral imaging
- Photometric stereo
- Inline computational imaging techniques

FAST STROBING OF LED‘S IS KEY TECHNOLOGY

- Multi-channel acqusition by time-multiplexing of …
  - multiple illumination wavelengths
  - multiple illumination directions
  - multiple polarization directions
- Multi-channel with single camera
- More flexible than on-chip filters on image sensor

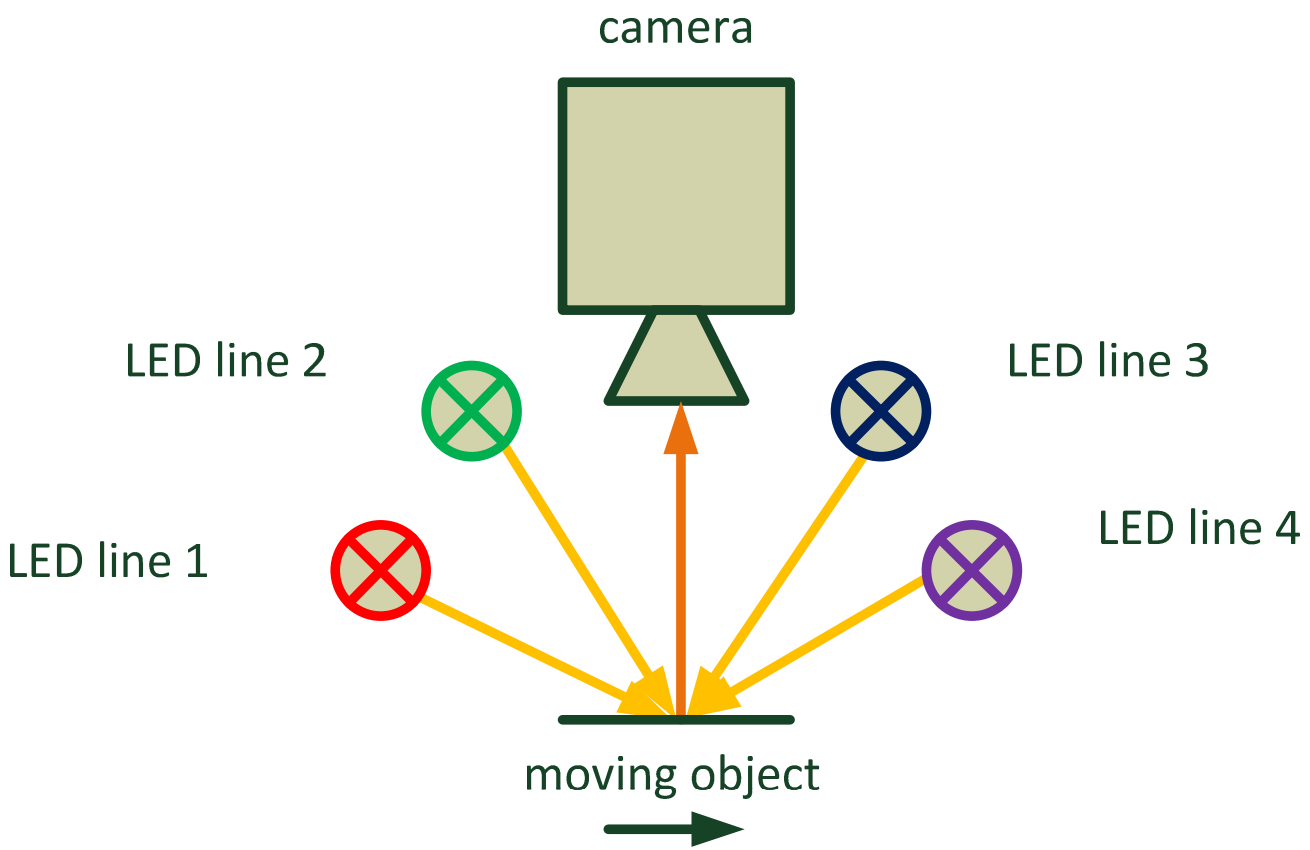
INLINE PHOTOMETRIC STEREO

- AIT‘s xposure camera with up to 600 kHz line-rate
- 4 strobed LED lines illuminating four different directions
- -> inline photometric stereo with 150 kHz line-rate



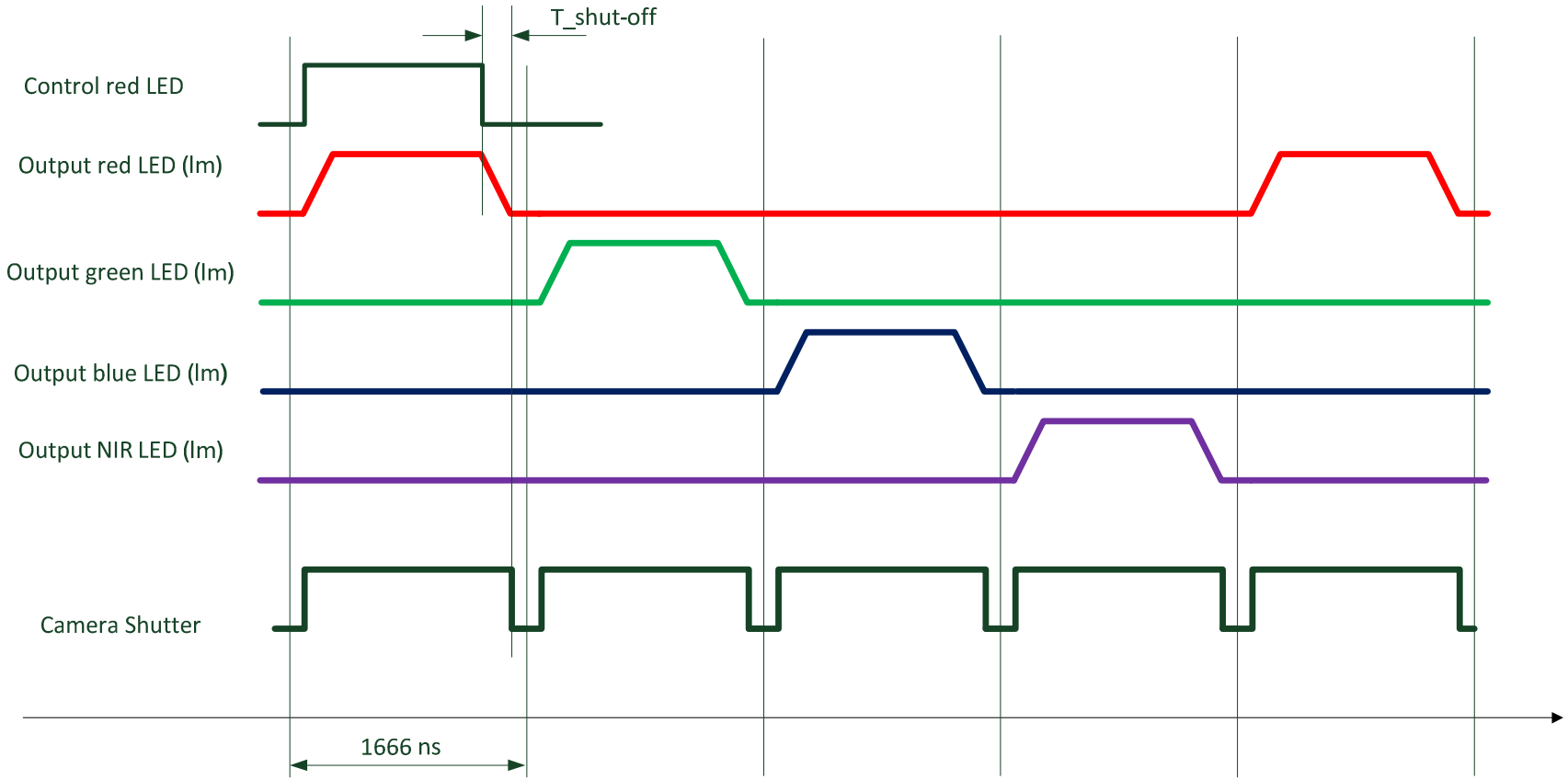
INLINE MULTI-SPECTRAL IMAGING

- AIT‘s xposure camera with up to 600 kHz line-rate
- 4 strobed LED lines with different colors
- -> inline multi-spectral with 150 kHz line-rate



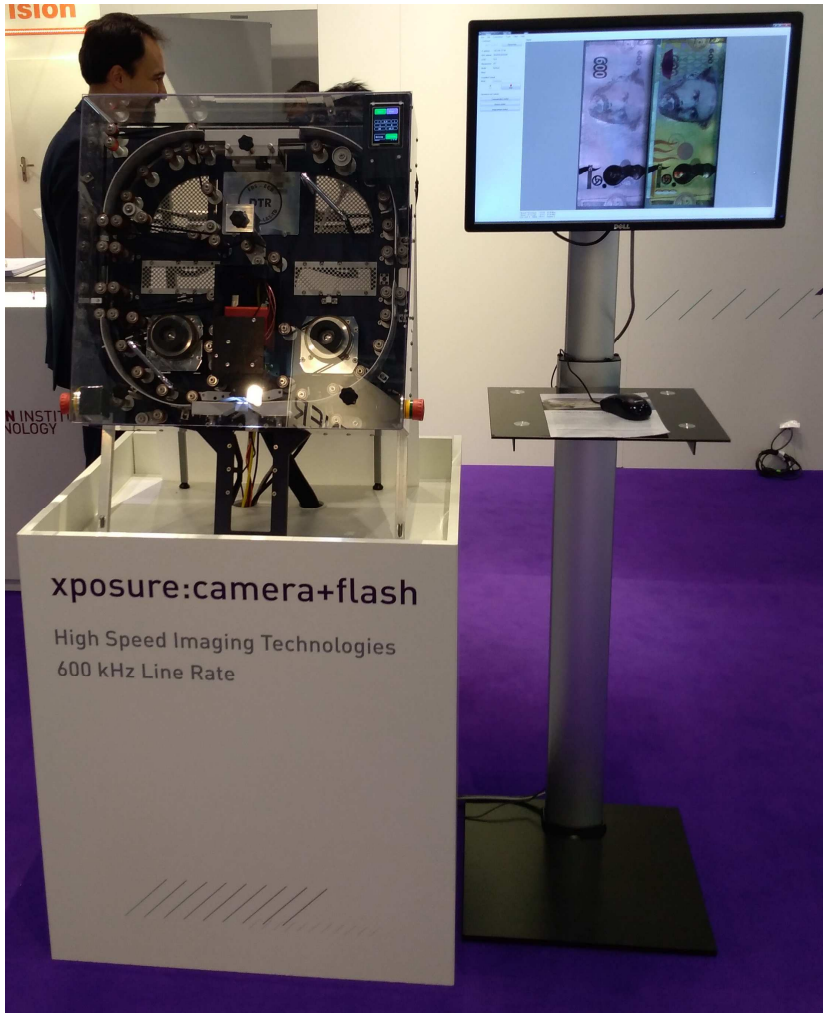
LED- AND CAMERA TIMING

- LED‘s synchronized with camera shutter



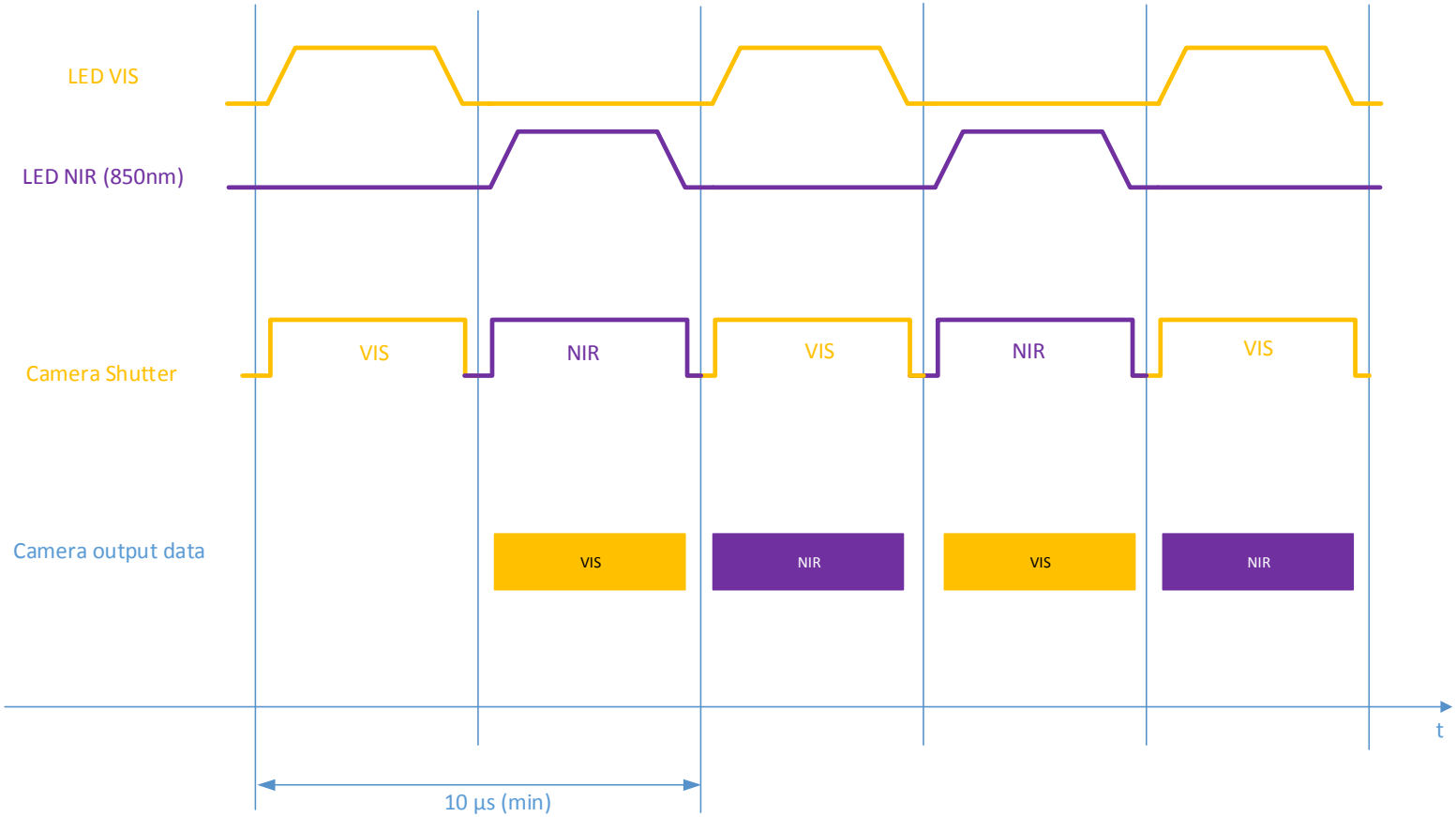
WE DEMONSTRATE

- Ultra-fast LED-strobing
- 2 spectral ranges: VIS + NIR
- High illuminance
- Homogeneous illumination
- Fast line-scan technology
- Industrial application context
- Transport 10 m/s
- Resolution 0,1 mm



DEMO TIMING (THEORY)

- Spectral separation VIS and NIR by strobing
- Separation of color channels R,G,B by on-chip color filters
- xposure-camera: 2016x3 Pixel (tri-linear), 200 kHz color line-rate

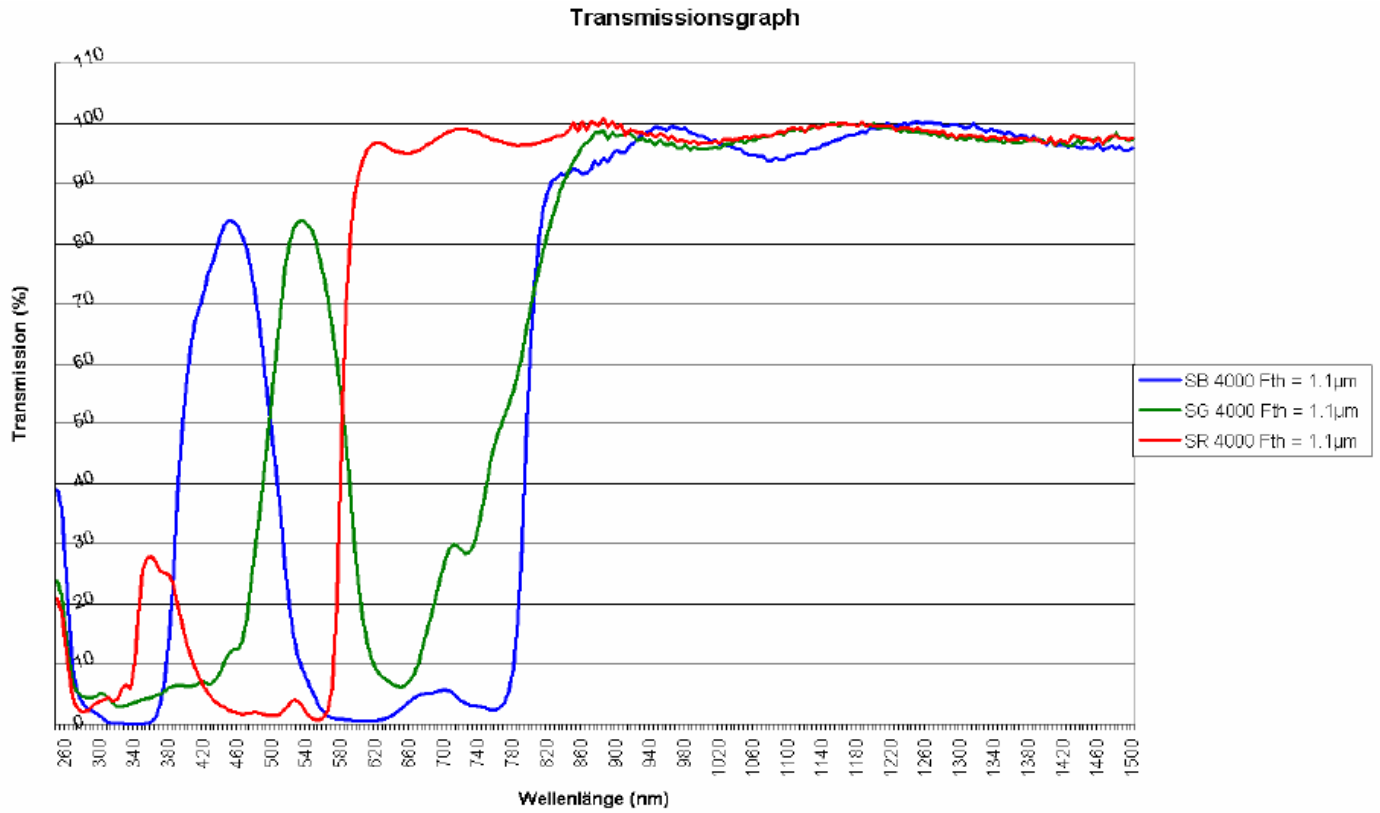


DEMO TIMING (PRACTICE)

- Oscillogram @ transport 6 m/s (60% full speed)
- VIS-LED trigger = yellow, NIR-LED trigger = green, camera frame-trigger = blue, camera line-trigger = red

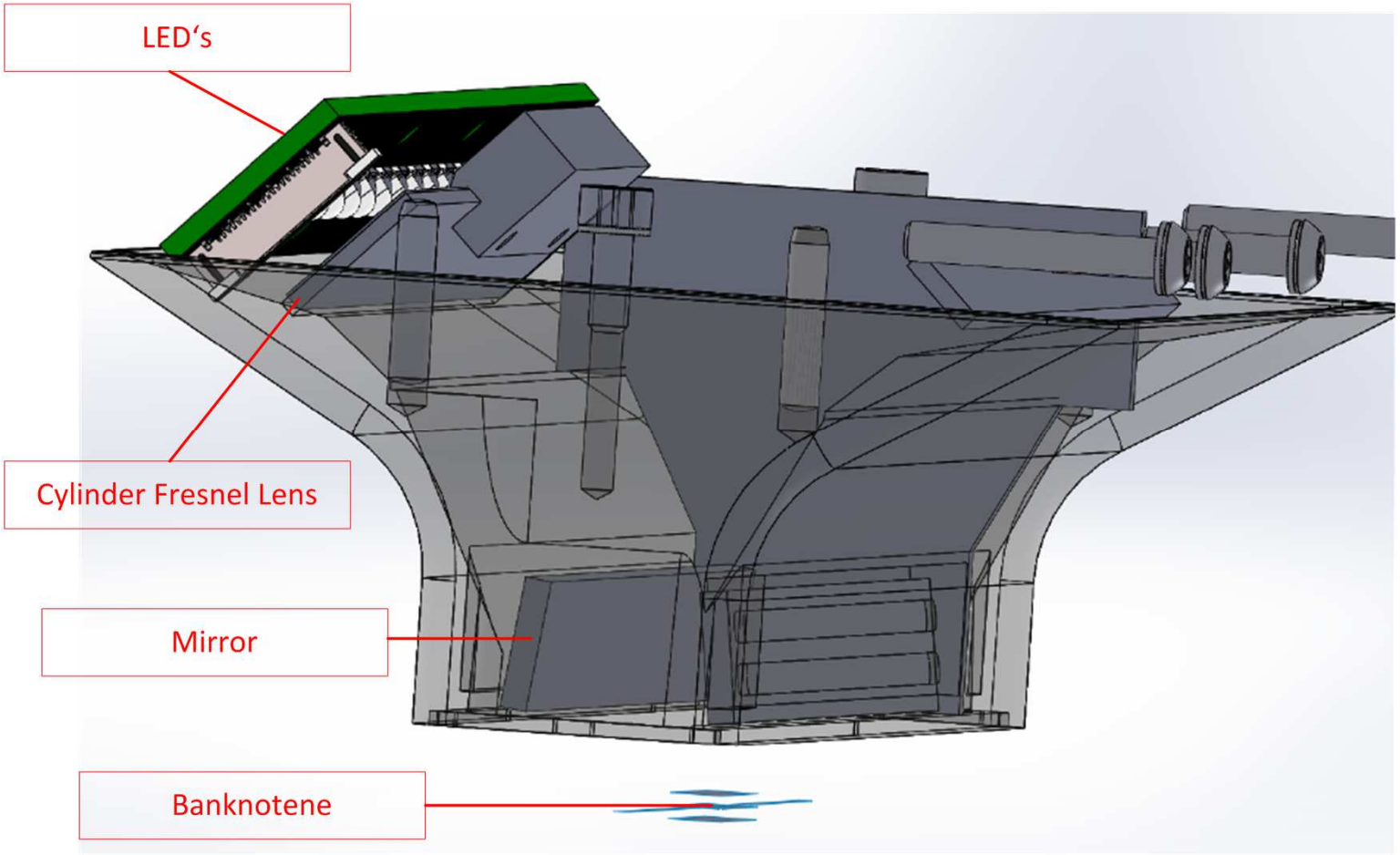
ON-CHIP FILTERS ON XPOSURE SENSOR

- Sensor rows coated with color filters
- Alternating red-, green-, blue-transmissive
- All filters transparent @ 850 nm (NIR illumination) !



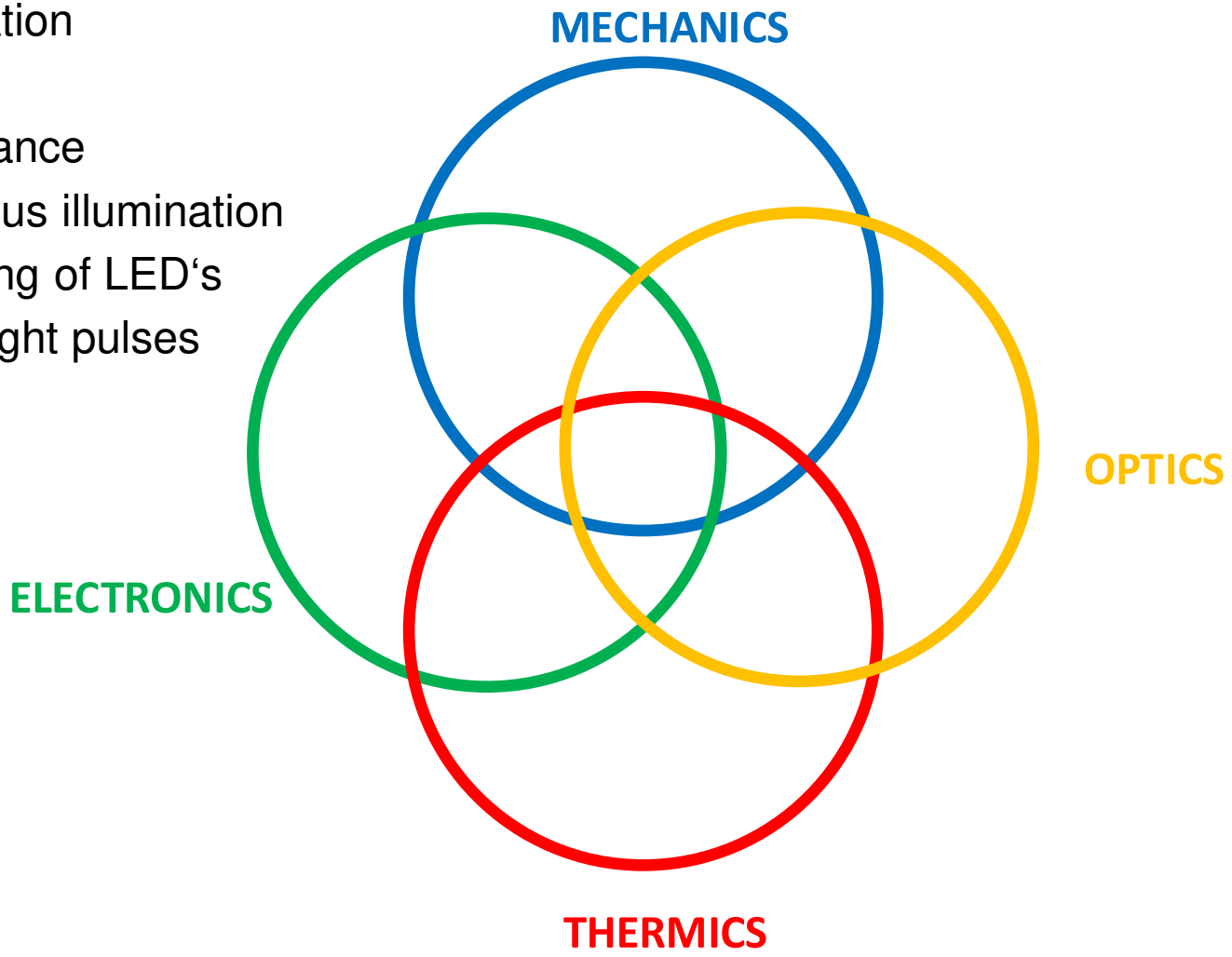
OPTO-MECHANIC

- Space limitation
- Passive cooling



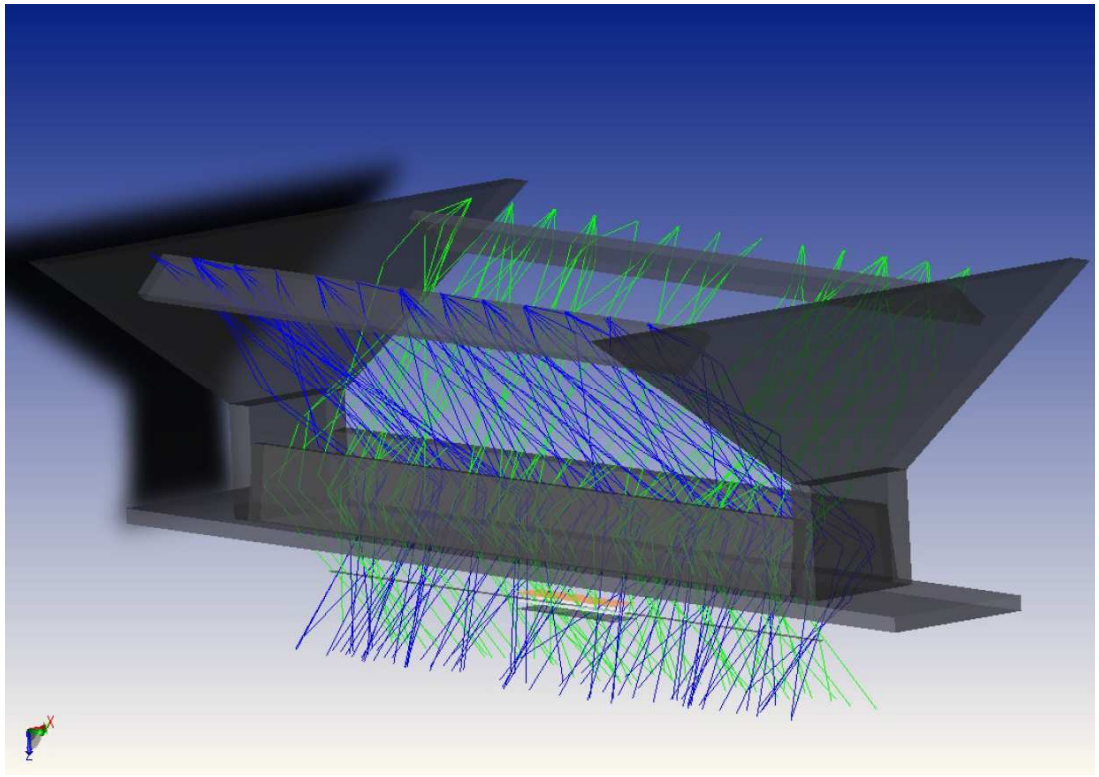
INTERDISCIPLINARY DESIGN

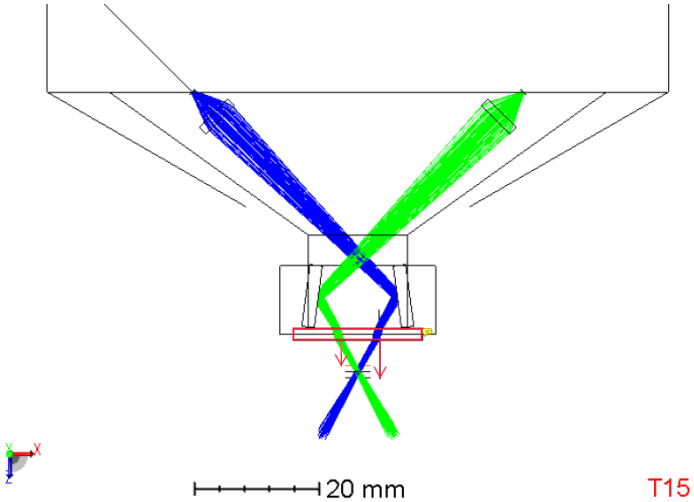
- Space limitation
- cooling
- High illuminance
- Homogeneous illumination
- Fast switching of LED‘s
- Stability of light pulses



OPTICS DESIGN

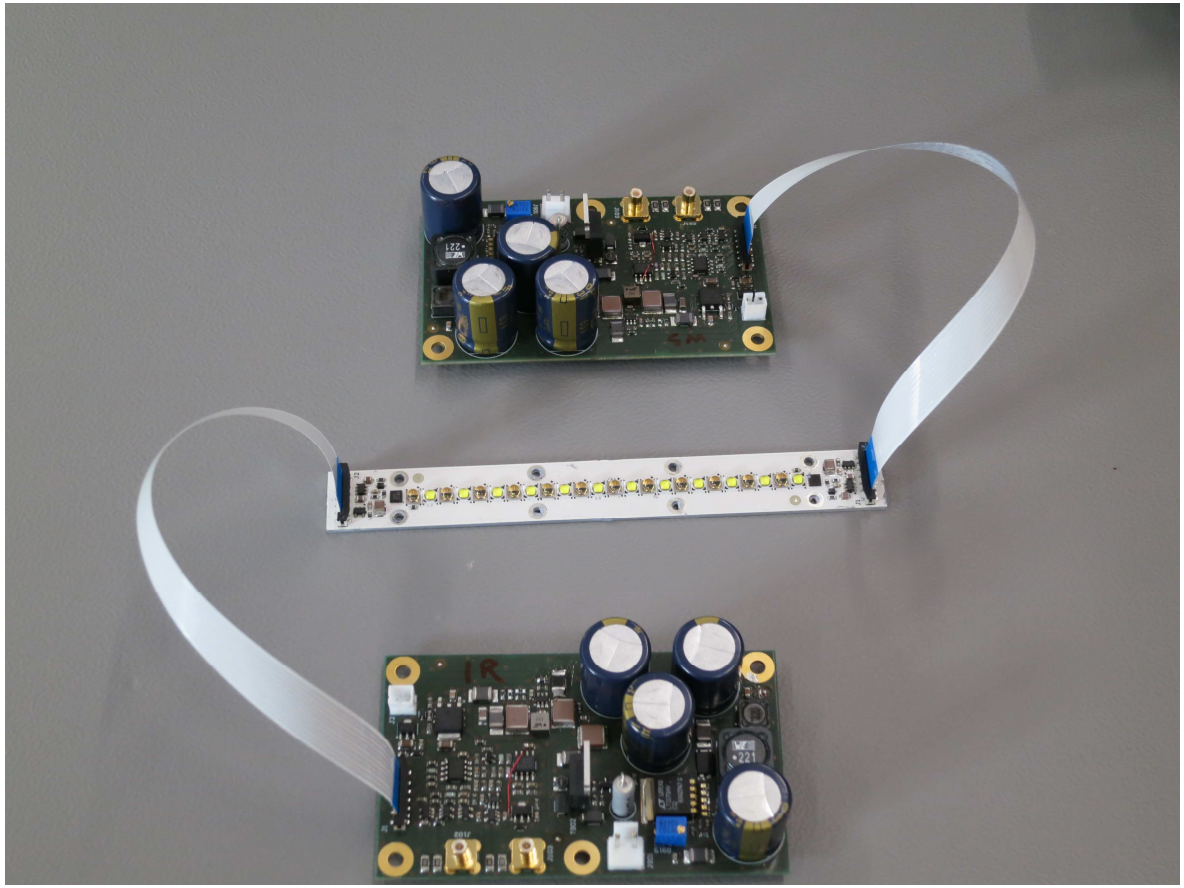
- Trade-Off between brightness and homogeneity
- homogeneity in a volume (banknote flutter)





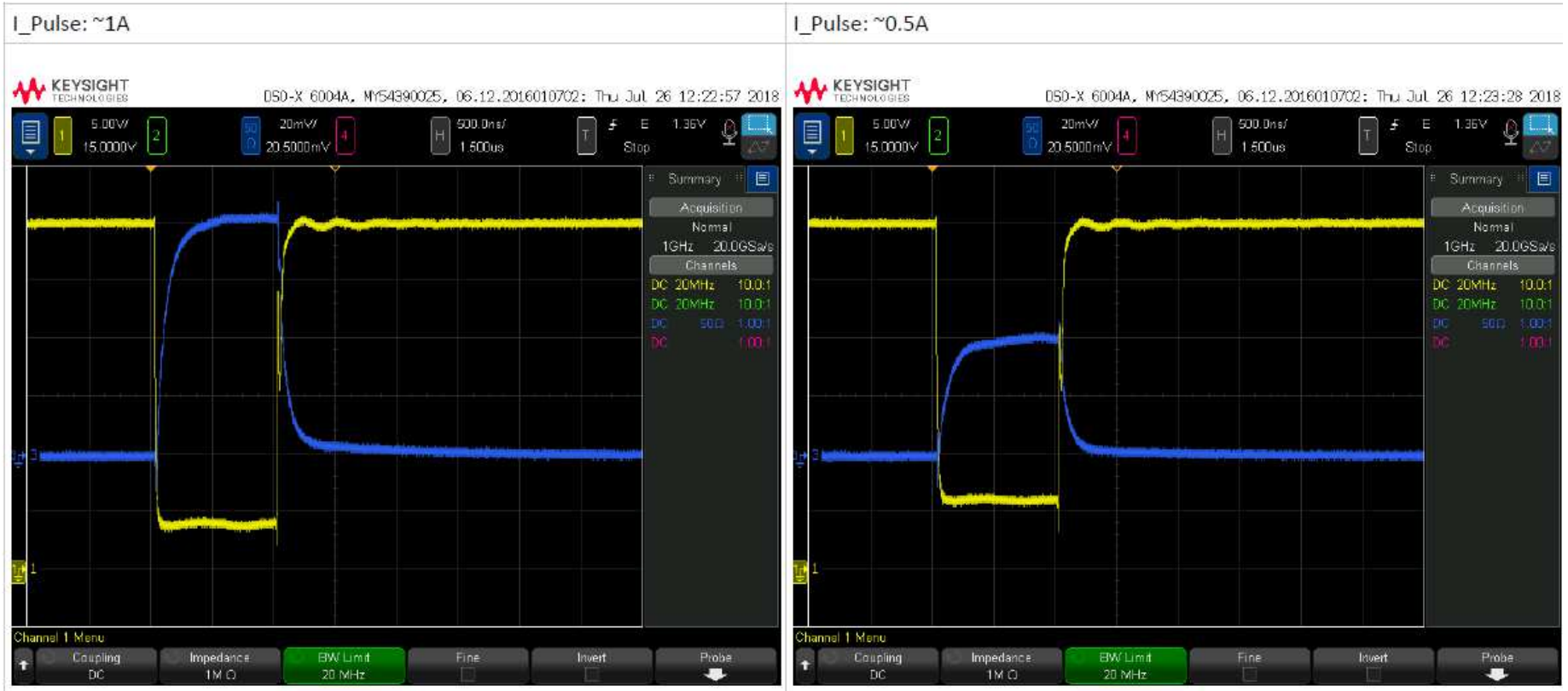
ELECTRONIC DESIGN

- 1 LED-line with VIS and NIR-LED‘s alternating
- 1 controller per channel
- Trigger input for timing, PWM input for LED-current



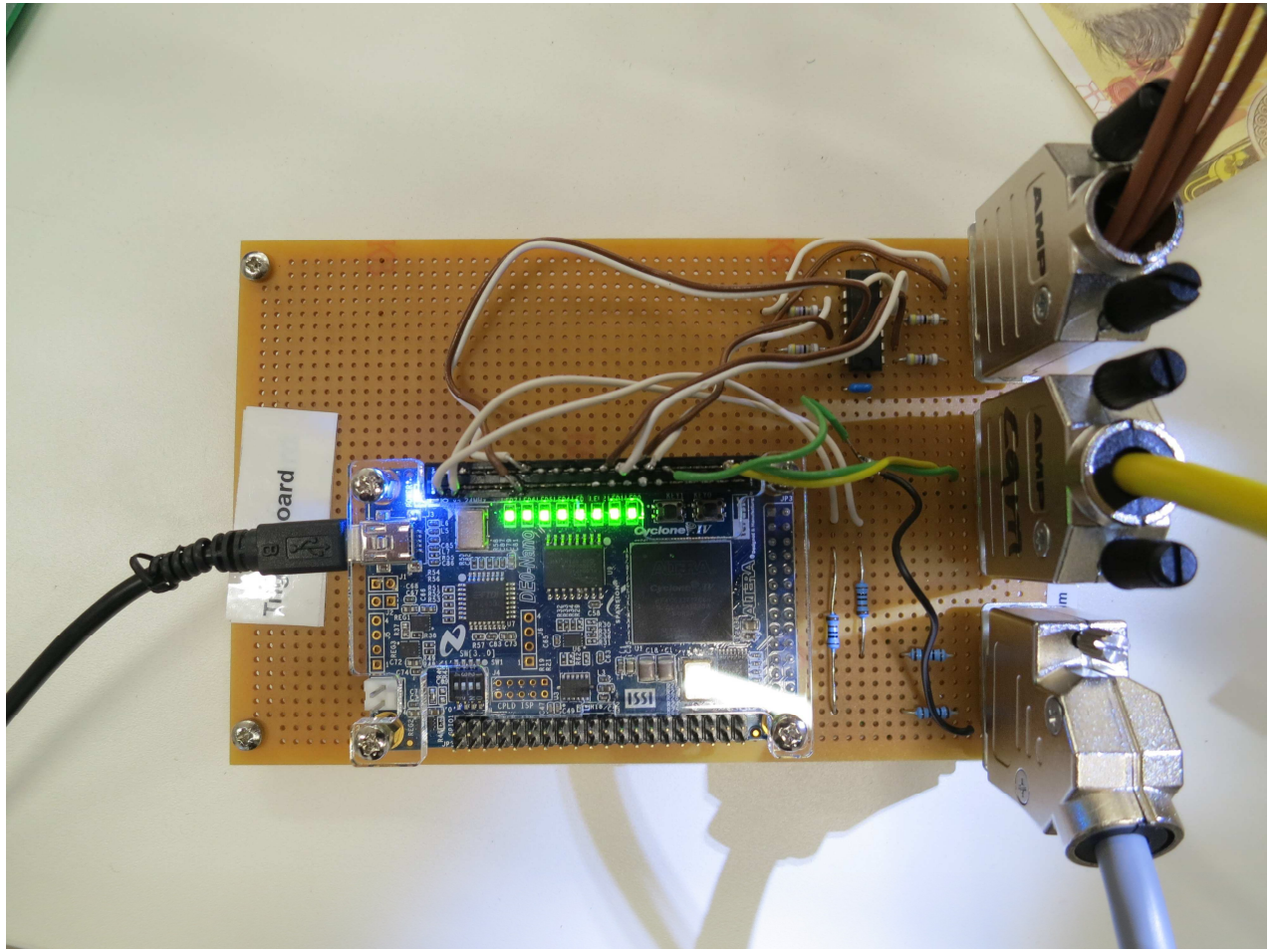
LIGHT PULSES

- Fast switching of LED‘s
- Oscillogram of light pulse of white LED
- LED-current (yellow), luminious flux (blue), time base 500ns/div



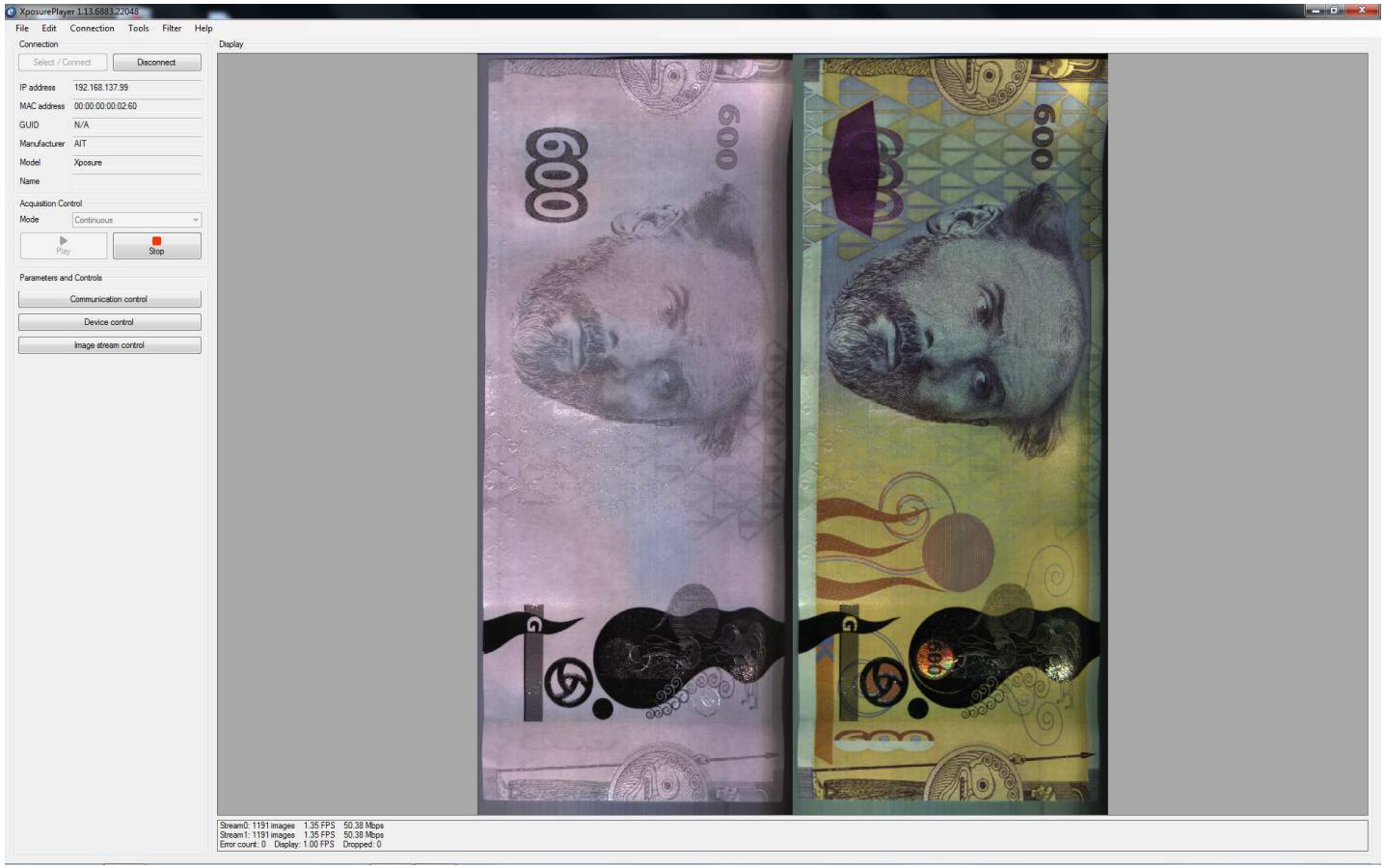
SIGNAL GENERATION WITH FPGA

- Signal generation with FPGA prototype board



DEMO LIVE IMAGE

- 100 kHz image NIR + RGB



CONCLUSION

- With a fast strobed LED technology you get more out of your camera
- You get multi-channel images with one camera and one lens
- Arranging LED‘s is more flexible than structuring on-chip filters on the image sensor
- Inspection of glossy material more robust
- Classification more disciminative due to
  - multiple illumination wavelengths
  - multiple illumination directions
  - multiple polarization directions