Development of a new Camera with Digital Video Time Insertion

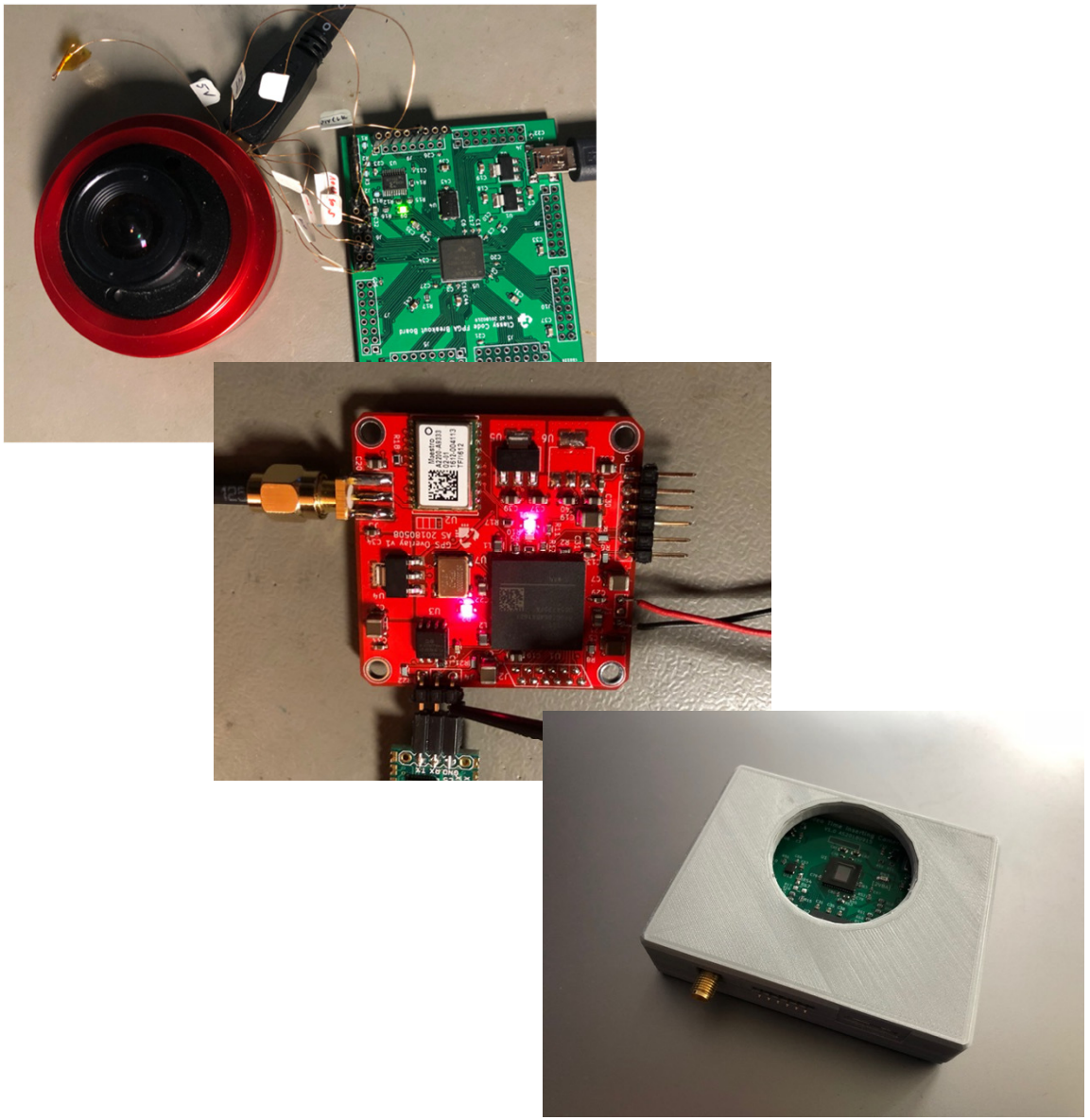
Andreas Schweizer, 27.10.2018

Agenda

- Who am I?
- Motivation

- Proof-of-Concept
  - System Architecture
  - Firmware
  - Hardware
  - Testing, Test Results

- Prototype
- Next Steps
- Demo, Discussion



Who am I?

- Born in Bülach ZH, now living in Wettswil ZH
- Married since 2003, 1 Girl (2 ½ years old)

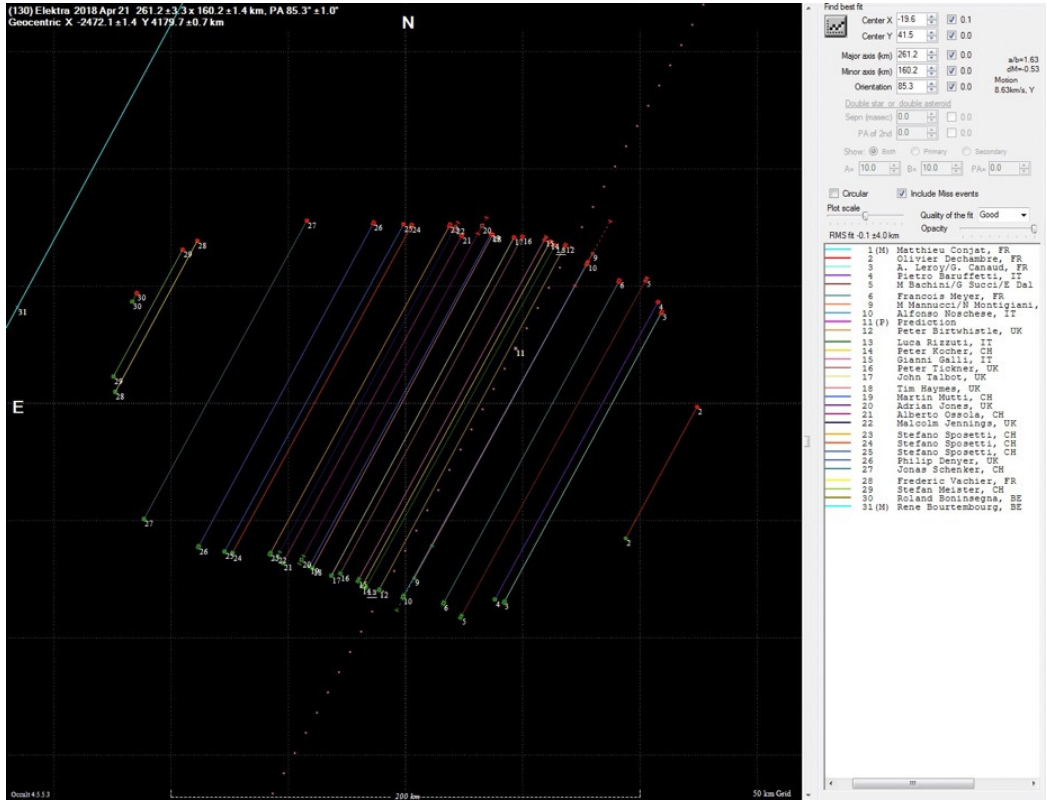
- Dipl. Software Engineer ETH 2003
- Worked in Software Company as SW Architect 2003-2016
- Company with a friend since 2016 (Classy Code GmbH)

CLASSY CODE

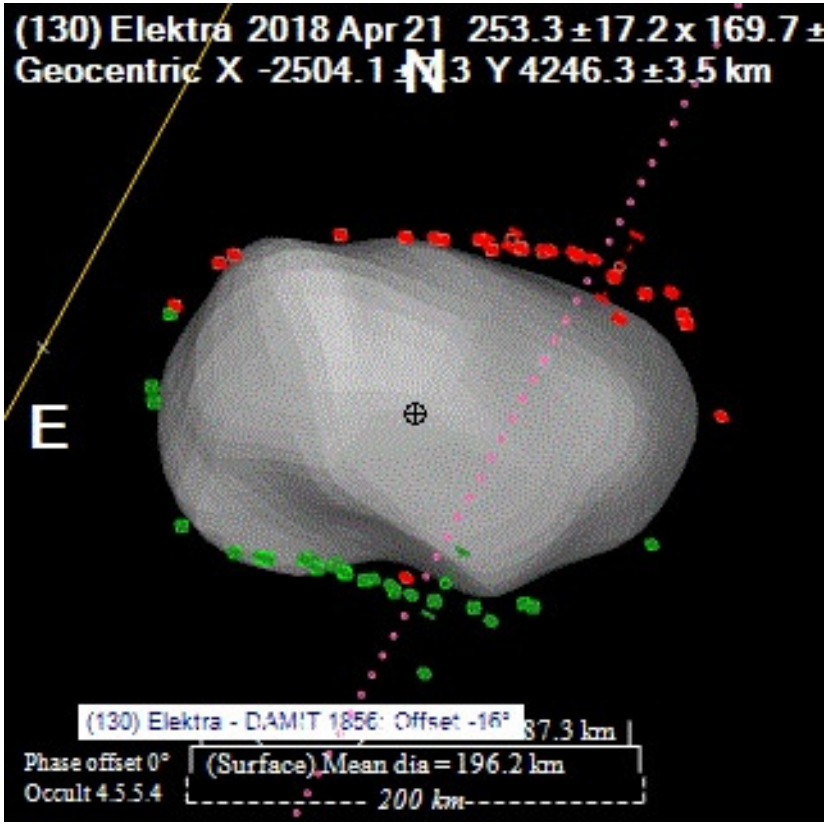
- AGZU since ~ 1993
- Technical Support Team Sternwarte Bülach
  - Guided Tours calendar
  - Telescope control system, motor drivers, ...
  - Support for technical projects

- Other hobbies: Amateur radio (HB9DPA), Squash

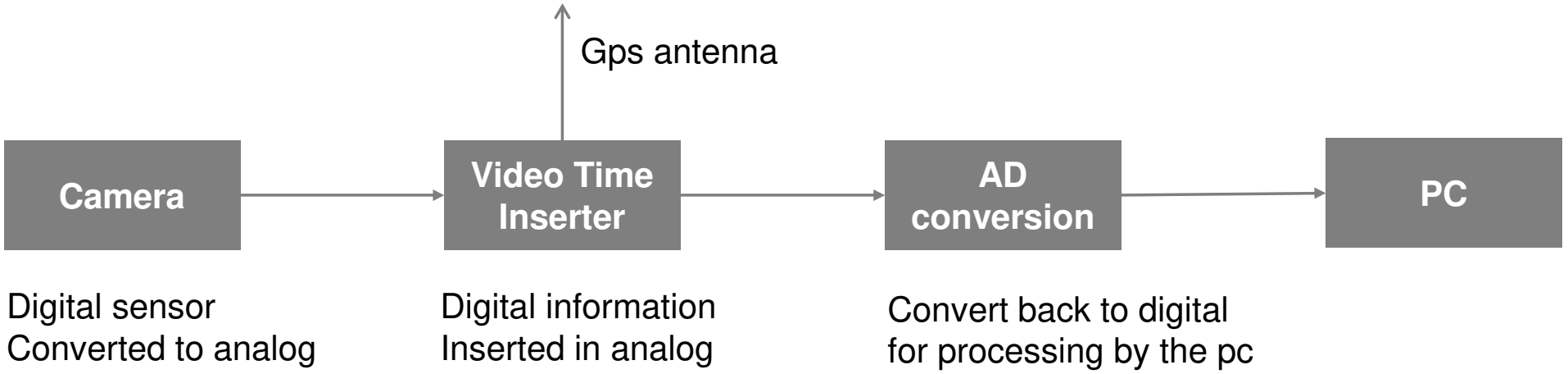
Motivation



(130) Elektra, 21.04.2018



Motivation



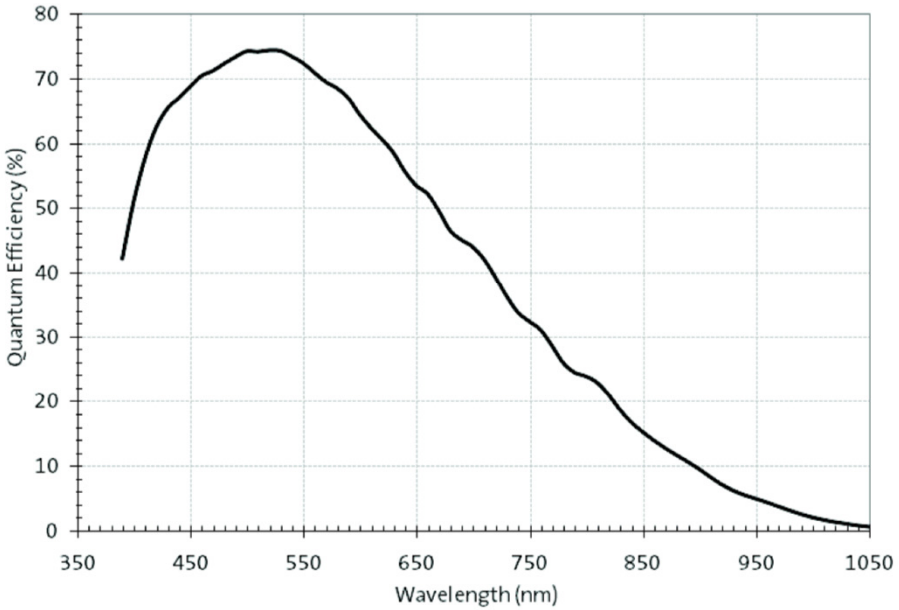
«Why not insert the time information directly into the pixel stream?»

Motivation

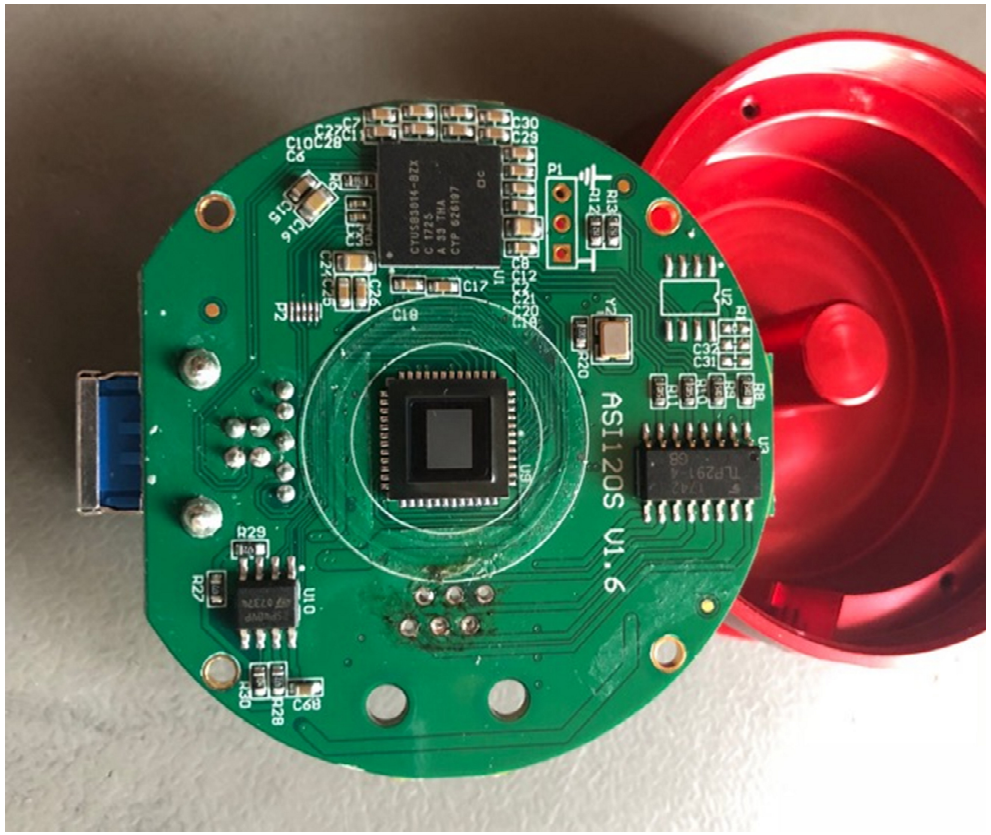
Cheap camera to modify for a POC?

ZWO ASI120MM

Sensor: 1/3" CMOS AR0130CS(Mono)
Resolution: 1.2Mega Pixels 1280×960
Pixel Size: 3.75μm
Exposure Range: 64μs-2000s
ROI: Supported
Interface: USB2.0
Bit rate: 12bit output
Adaptor: 2" / 1.25" / M42X0.75
Dimension: ϕ62mm X 28mm
Weight: 100g
Working Temperature: -5°C—45°C
Storage Temperature: -20°C—60°C
Working Relative Humidity: 20%—80%
Storage Relative Humidity: 20%—95%



ASI120MM Sytem Architecture



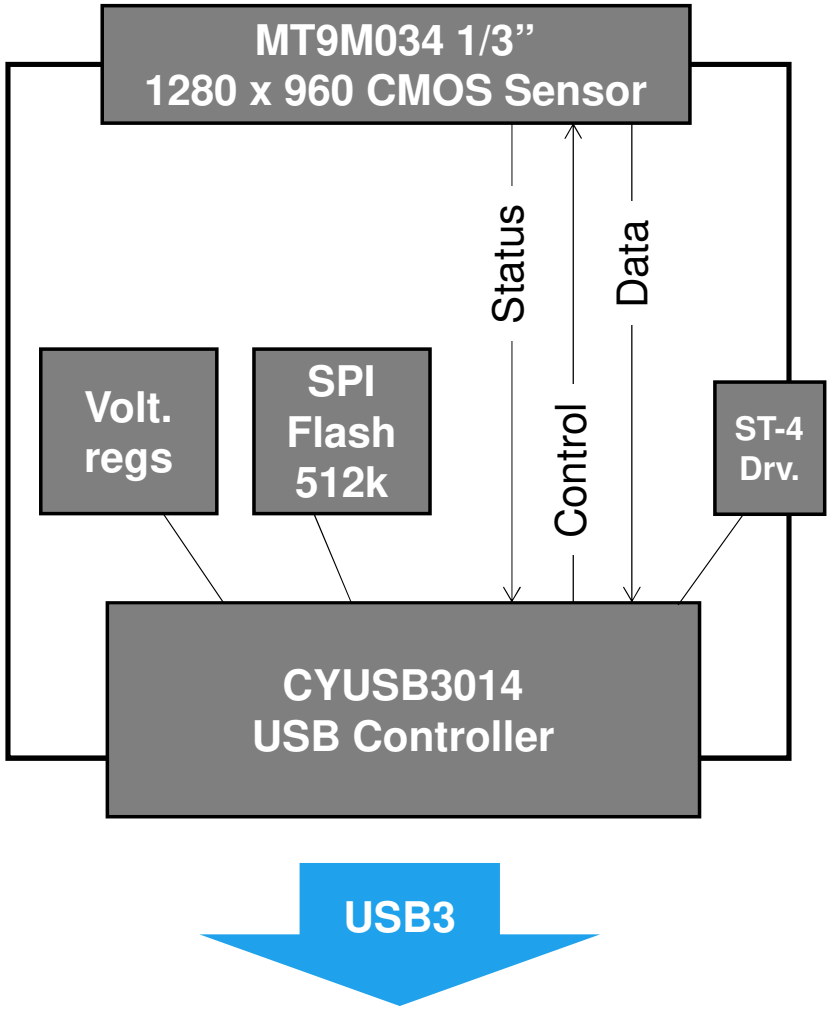


Image Sensor MT9M034

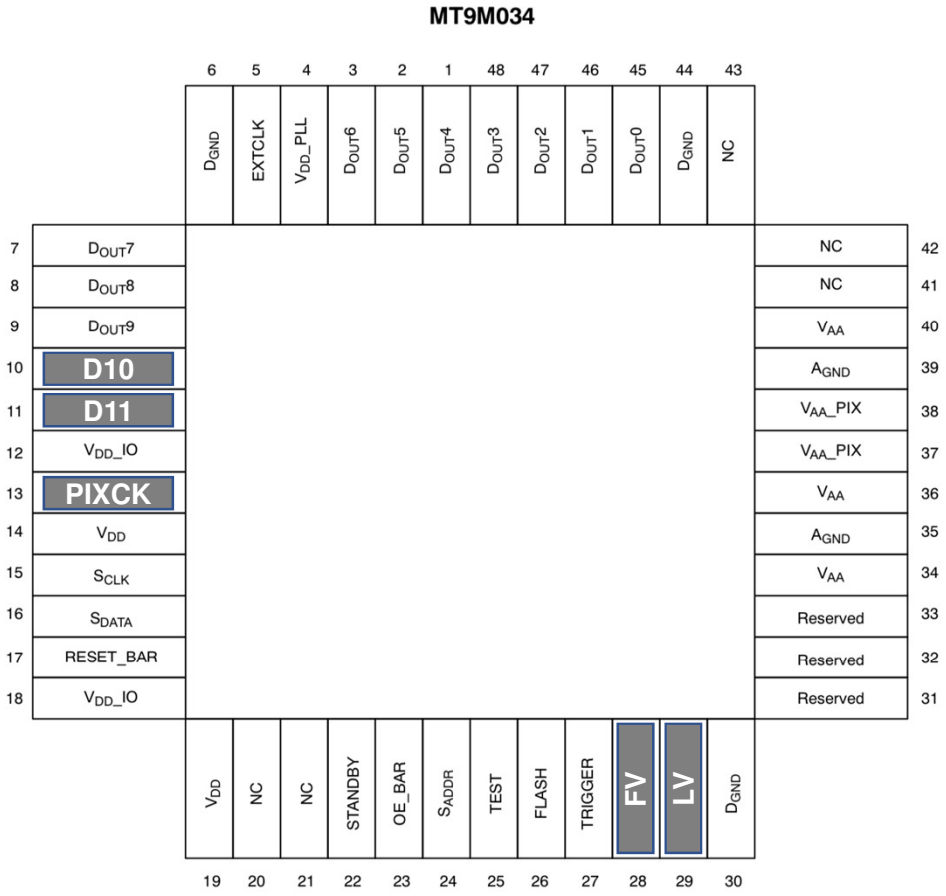


Figure 3. 48 iLCC Package, Parallel Output

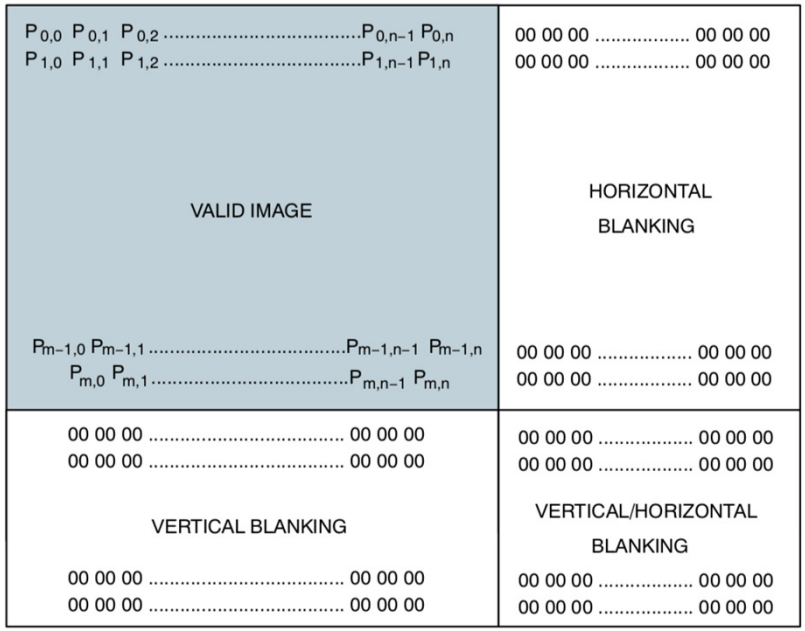


Figure 7. Spatial Illustration of Image Readout

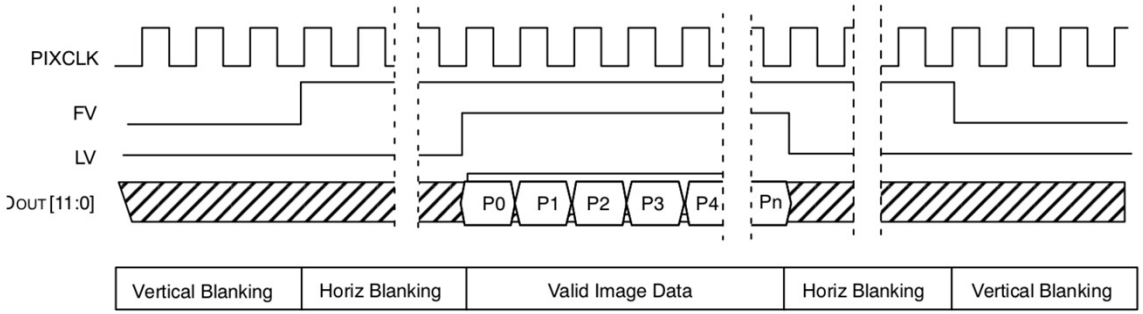
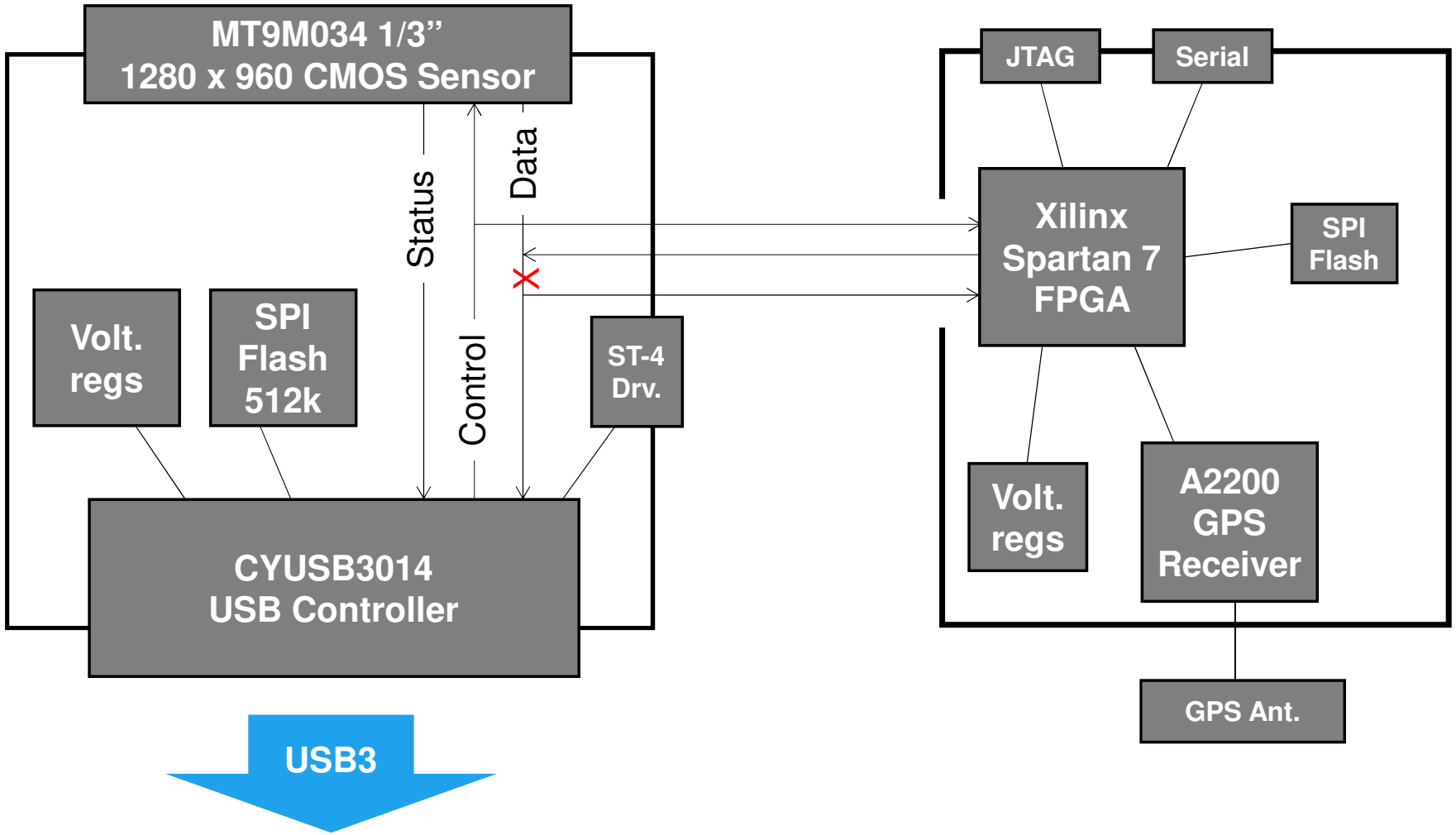
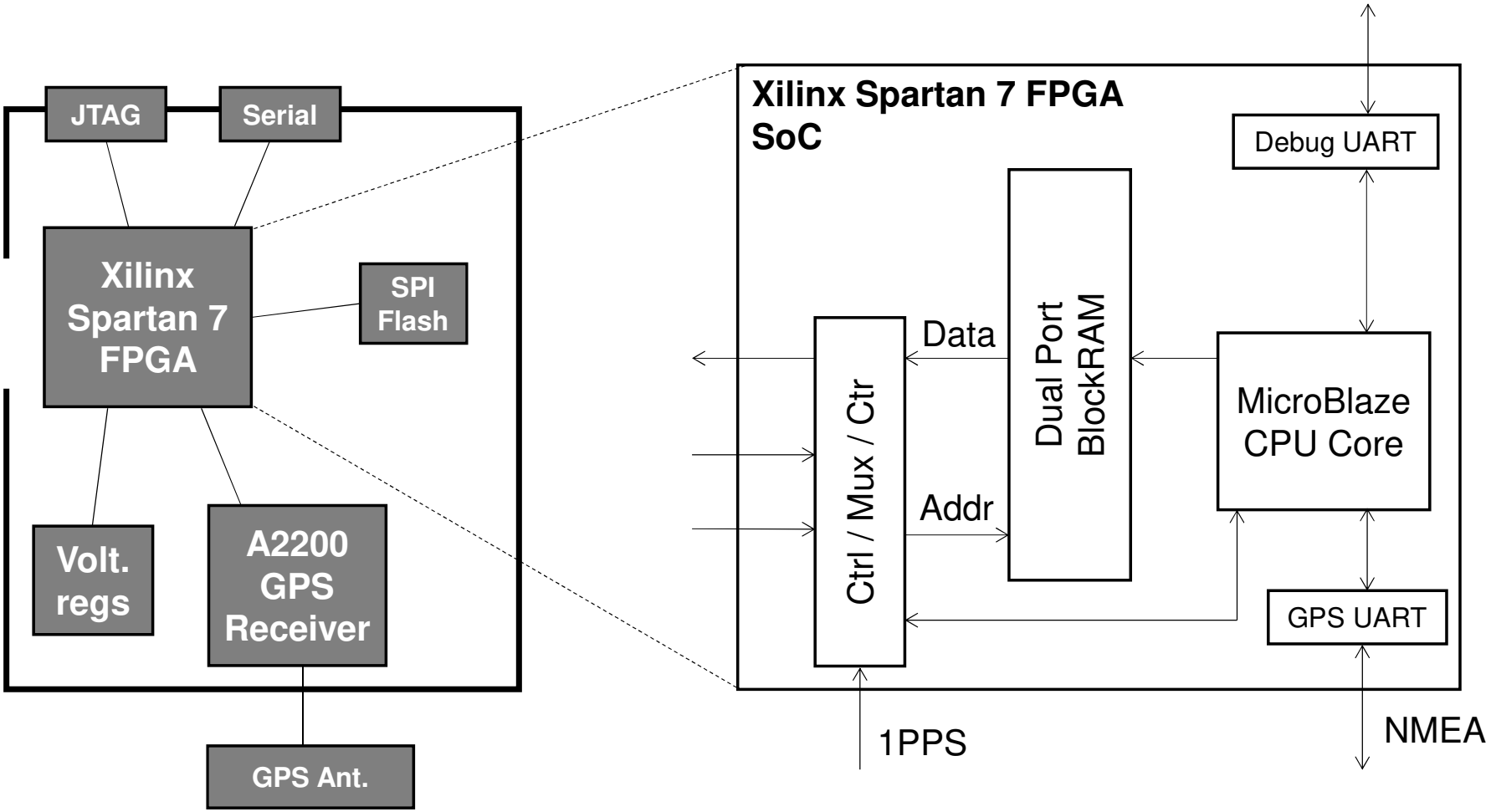


Figure 8. Default Pixel Output Timing

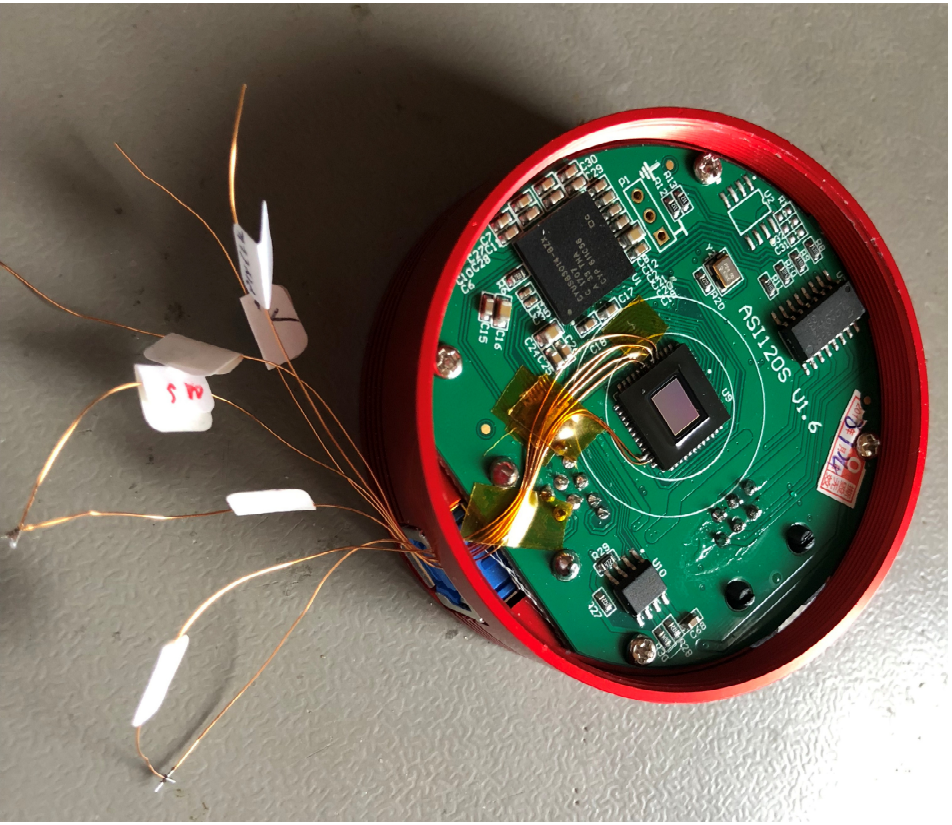
PoC Sytem Architecture

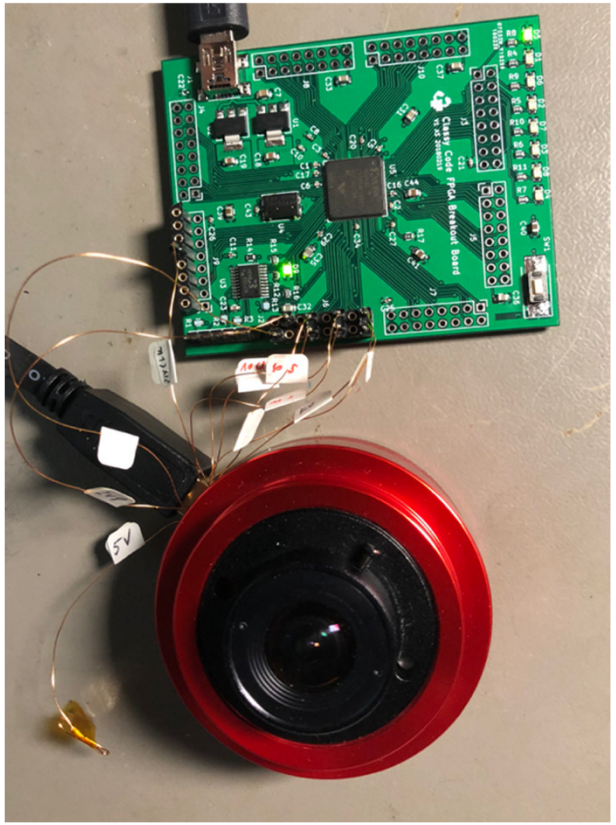


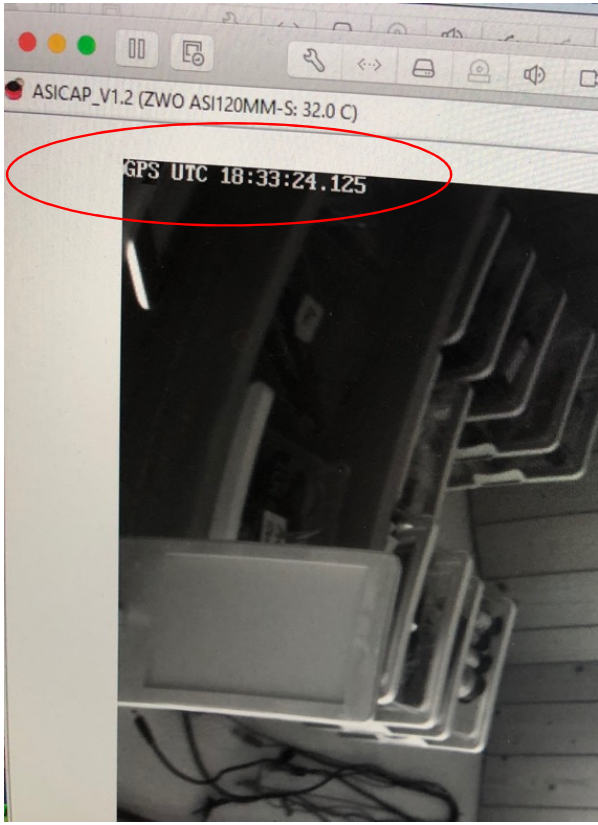
PoC Sytem Architecture



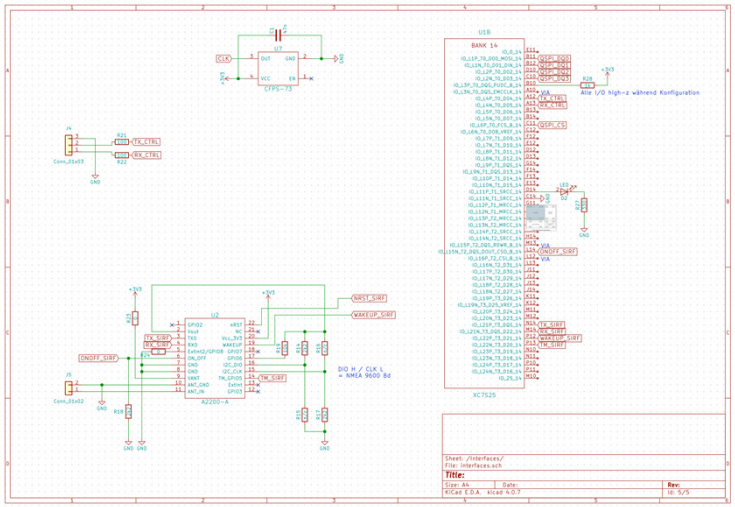
PoC Quick Test



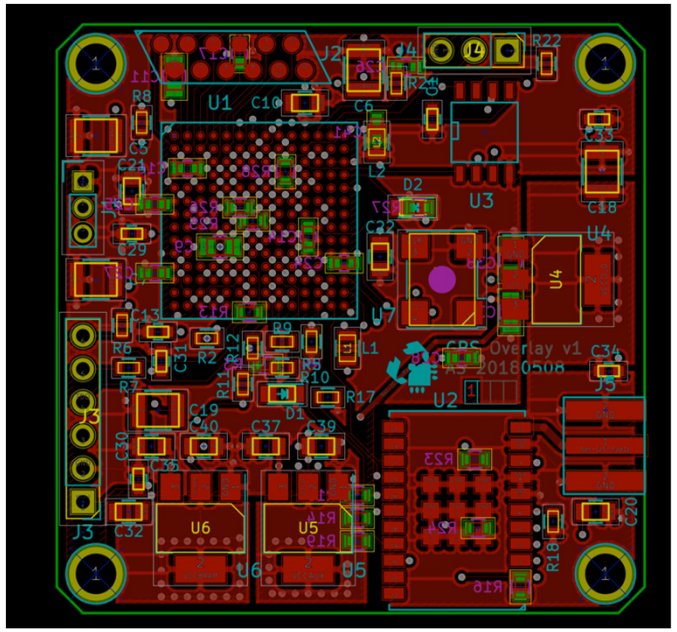




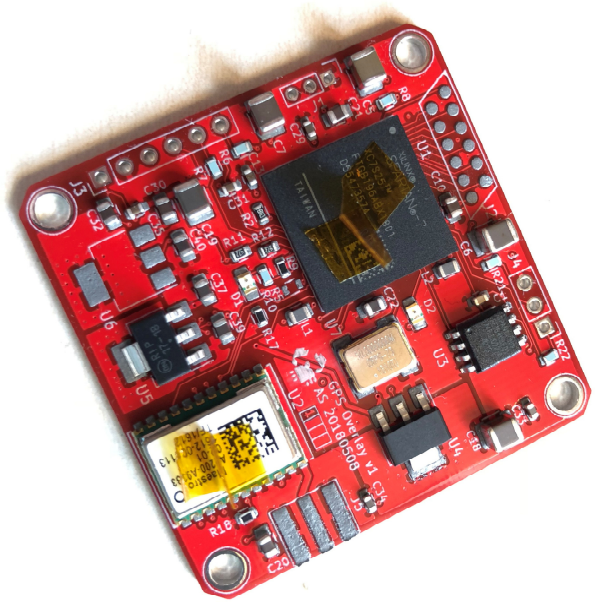
PoC PCB Design



Schematics



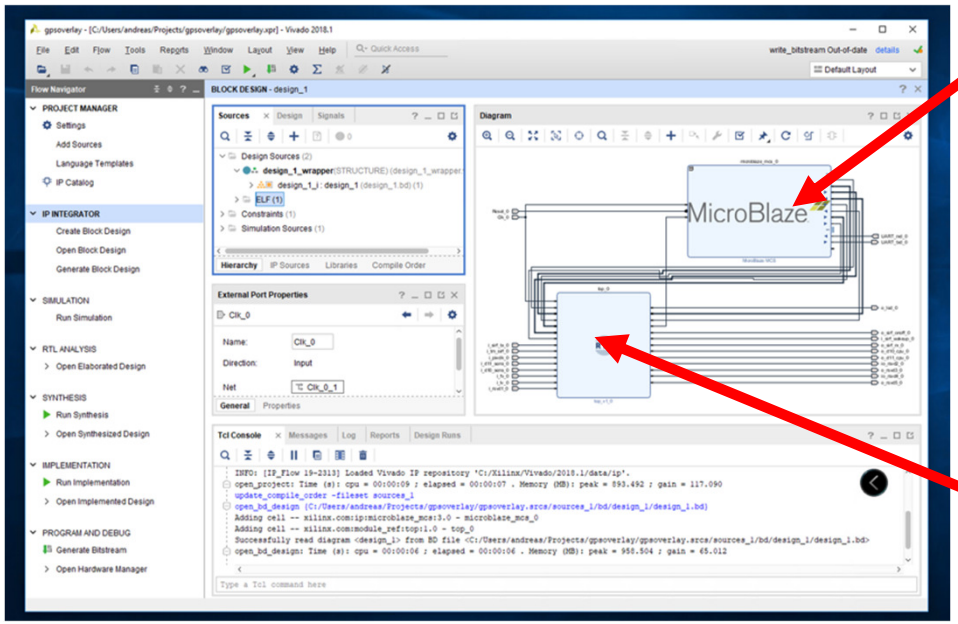
→ Layout

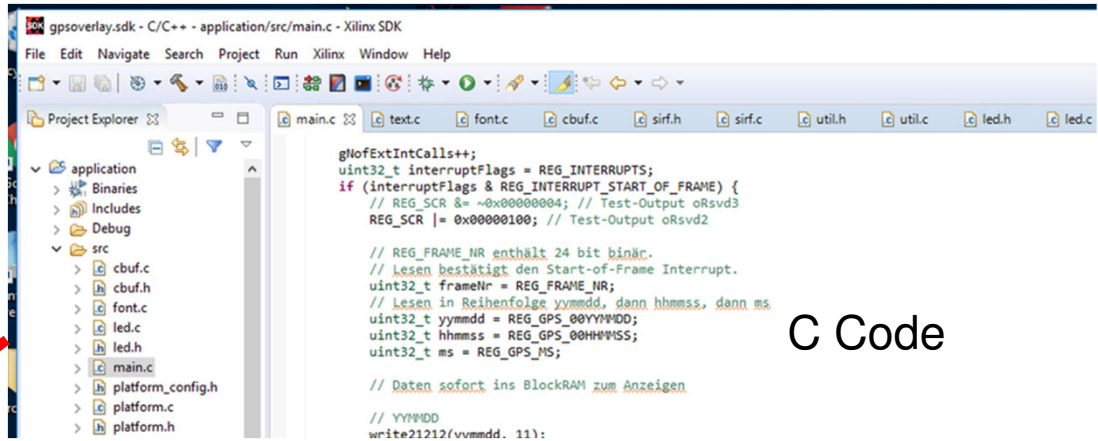


→ Board

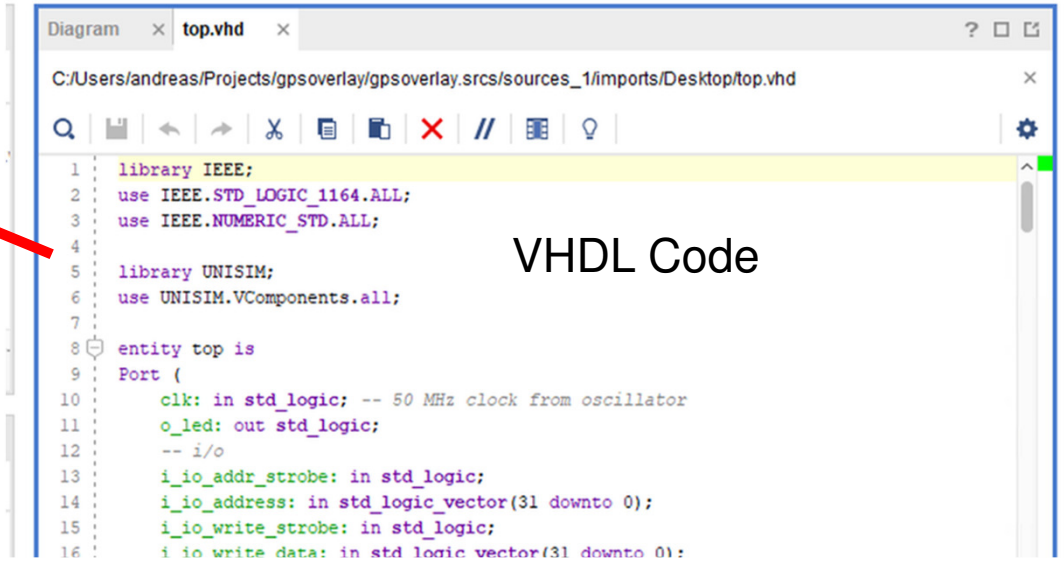
PoC Firmware + HDL Code

Vivado



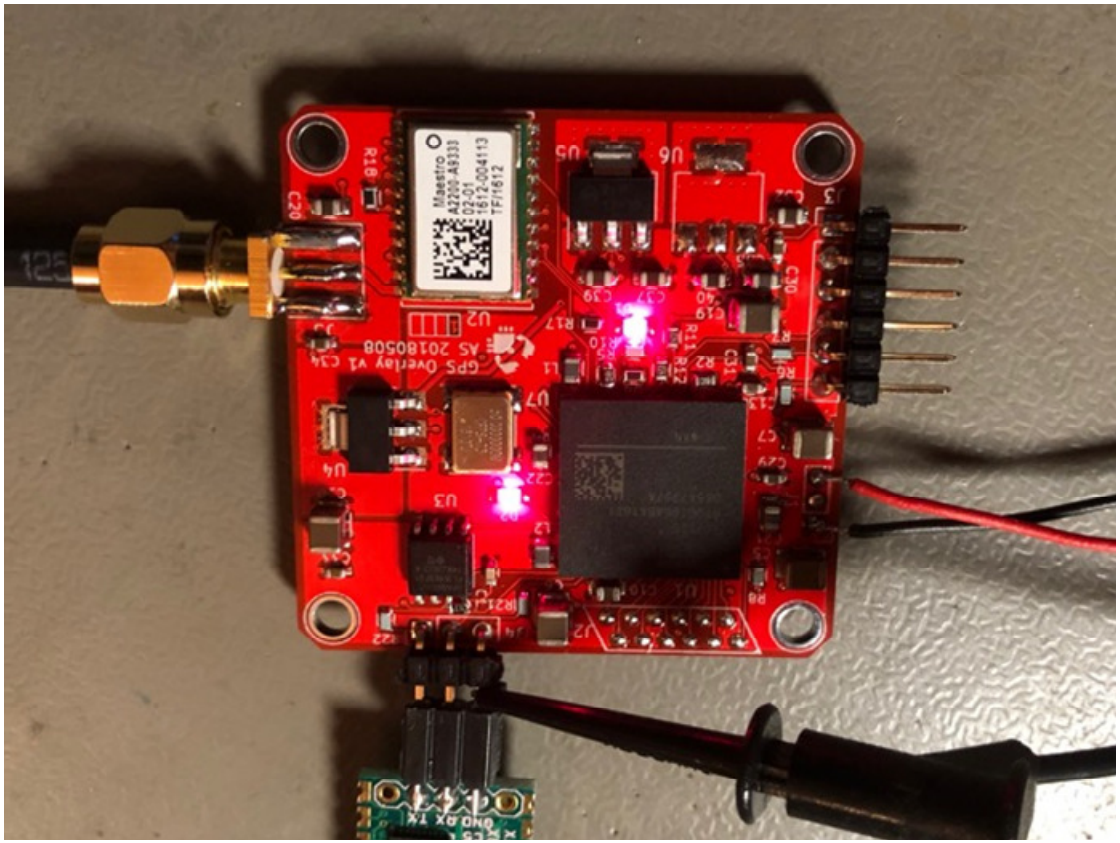


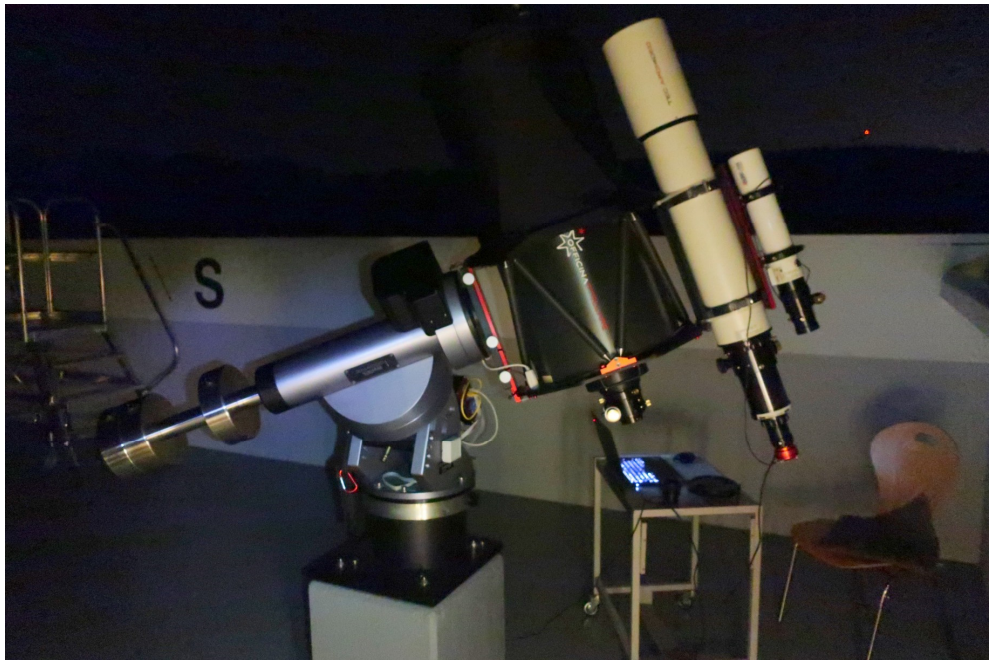
C Code

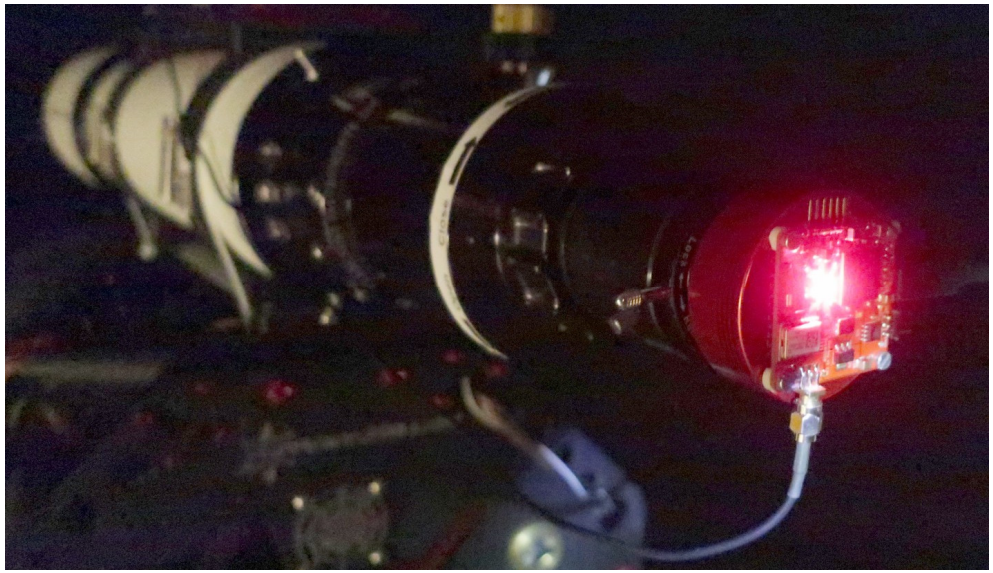


VHDL Code

PoC Testing







PoC Timestamp Format

GPS: GPS-Empfänger empfängt Daten
XXX: Schaltsekunden noch nicht empfangen
UTC: Schaltsekunden empfangen, GPS-Zeit korrekt
YYYY-MM-DD HH:MM:SS.millisec: Start der Integration
-SS.millisec: Ende der Integration
Frame-Nummer
Genauigkeit des GPS-Fixes
GPS-Koordinaten
Empfangene Satelliten inkl. SNR - - - - - - - - - - >


PoC Testing
ORION

PoC Testing

Accurate to ~ 20ms with the FV signal

Could be improved by using the FLASH signal

PoC Test Results + Feedback

- Start time accurate to ~20ms
- End time based on frame rate instead of exposure time!
- Timestamp not readable if binning is active
- Loss of GPS almanach, GPS-UTC difference on shutdown

- Accuracy: Use FLASH signal instead of FV
- GPS: Use buffer battery, include GLONASS
- Include digital timestamp in SER file?

Next Steps

- PoC → works!

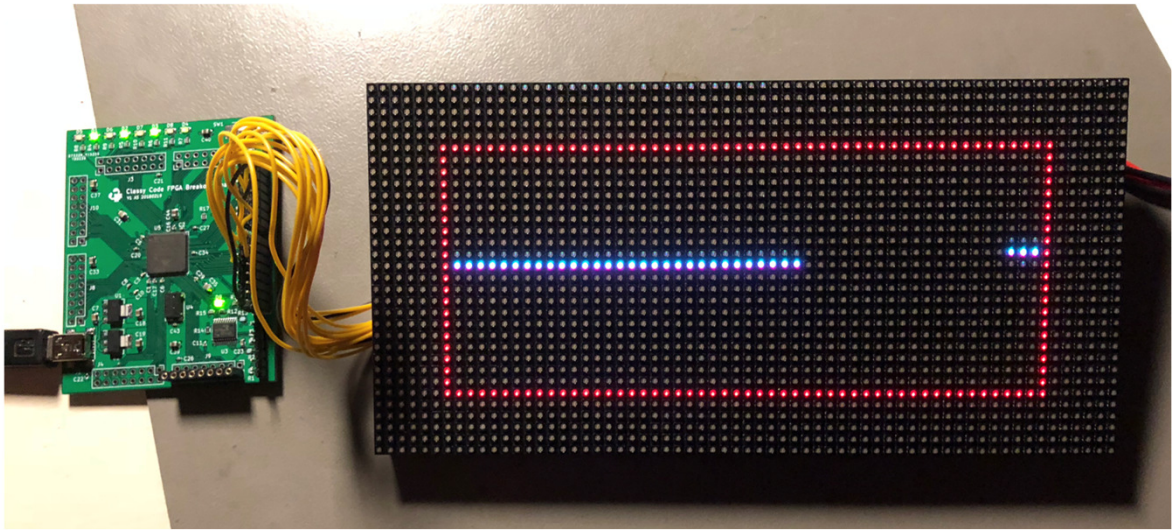
- **Camera Prototype**
  - Software + Hardware Development
  - More testing
  - Detail decisions (filter glass, M42 mount, alternative sensors, ...)

- **Kickstarter Project**

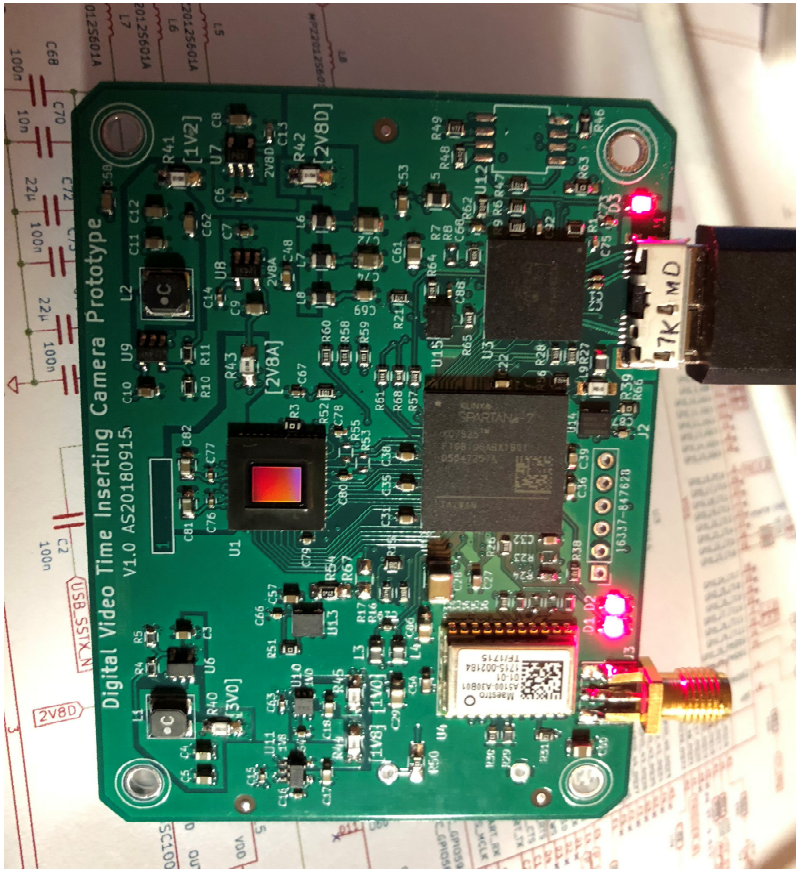
Next Steps – Testing

More tests planned with the **camera prototype**:

- Gerhard Dangl (EXTA)
- GPS LED Panel (side project ;-)
- Peter Schlatter (Uni Bern) if possible
- Christoph Bittner (QHYCCD174 GPS) if possible
- ...



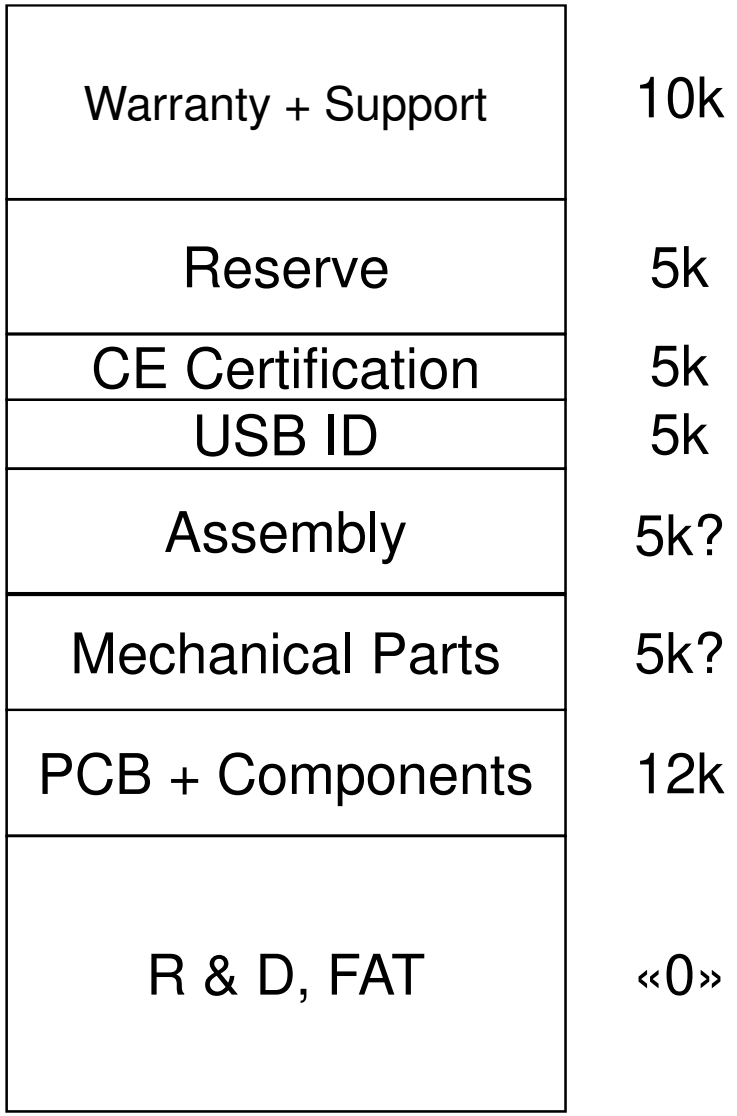
Next Steps – Camera Prototype



Next Steps – Kickstarter Project

- Design Decisions
- Cost Calculations
- Supplier Evaluation
- Project Plan
- Prototype V2
- KickStarter Campain

~ **400...500 CHF**
per Camera
@ 100 PCS ?



Demo + Discussion