

Methods for Time Stamping Analog and Digital Video

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Outline

- Why accuracy?
- General needs of video timing
- Simple ways to do it
- Challenges of USB/Firewire video cameras
- Benefits of modular components
- PIC-based timestamper: AllTimer
- Examples

Why accuracy

- Two types of timing:
 - Absolute point-in-time
 - Duration
- For asteroid occultations:
 - Absolute timing provides shape and location relative to the star
 - Relative provides the chord length
- Many applications do not need absolute time
- This talk focuses on absolute timing

Two aspects of video timing

- Which second did an event take place?
- What was the fraction of a second?
 - It's not too hard to do one or the other, but doing both at the same time is more challenging
 - Manual methods may establish the nearest second...
 - ... But something automatic is preferred given all the things that can go wrong when doing realtime measurement
 - Could be accurate to a millisecond, but seconds off

Simplest timing

- Radio time signals have merits, but GPS modules with nanosecond-accurate Pulse-Per-Second (PPS) output are common and relatively inexpensive (\$40)
- Simplest video timestamp: Blinking LED attached to PPS output
- Dangle LED in front of telescope before and after event while recording video
- Mark the minute using a manual flash, or get time to nearest second (which-second) from accurately set clock on the pc or video recorder
- Low cost, reliable, some manual effort, works with analog and usb video cameras, all scopes

Two main types of video cameras

- Analog (NTSC/PAL)
 - Analog output at fixed frame rate
 - Analog stream can be electronically timestamped
 - On-Screen Display modules allow text overlay
- Digital (USB/Firewire/Ethernet)
 - Digital output at arbitrary frame rate
 - Buffered data stream, difficult to access and timestamp digitally without unknown delays

Simple options for analog cameras

- Don't need human-readable text to do timing – can superimpose simple lines and marks to embed timing info in the video
- Just have bar at bottom of screen indicating fraction of second, and another indicating “which” second
- Just needs GPS and microcontroller to insert bar
- Software will be extracting light curve from recorded video anyway, so can do automatic read of timing also
- Much better than times only readable by human and hard to read by computer

AllTimer PIC-based timestamper

- Main target is digital video cameras, e.g. USB
- But analog also supported
- Also accurately sets PC clock in the field using USB and GPS
- Includes “Occultation” LED for self-checks of timing accuracy
- Marks time on USB cameras with projected spot that ramps up and down each second
- “Which Second” shown by notches in the curve
- Continuous reading of GPS NMEA stream
- Venus GPS has internal clock and battery backup

Modular construction

PIC18F4550 mcontroller

Venus 634 GPS module

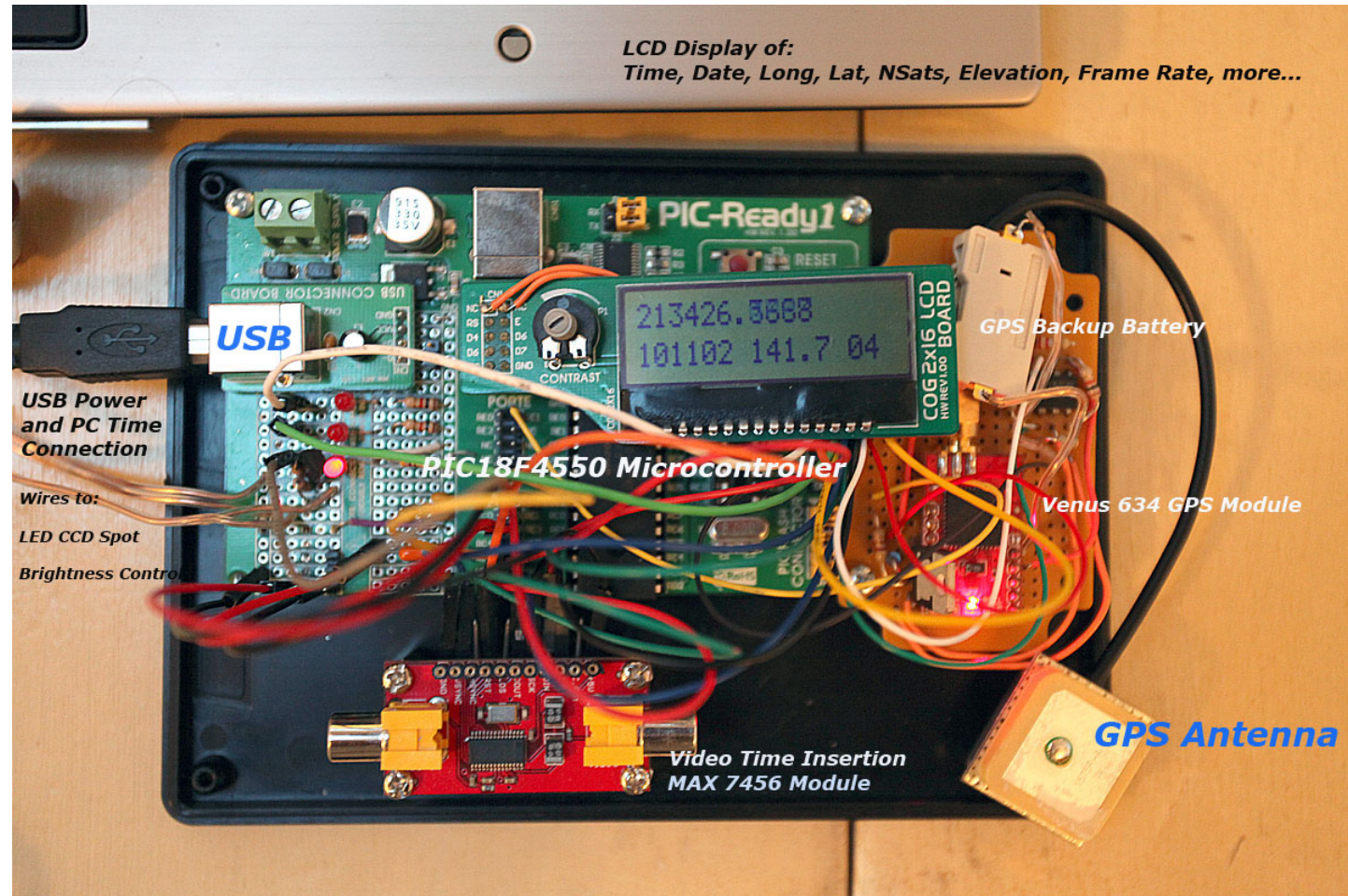
MAX 7456 Text insertion

PIC Ready1 board

GPS Antenna

LCD display

Power from USB



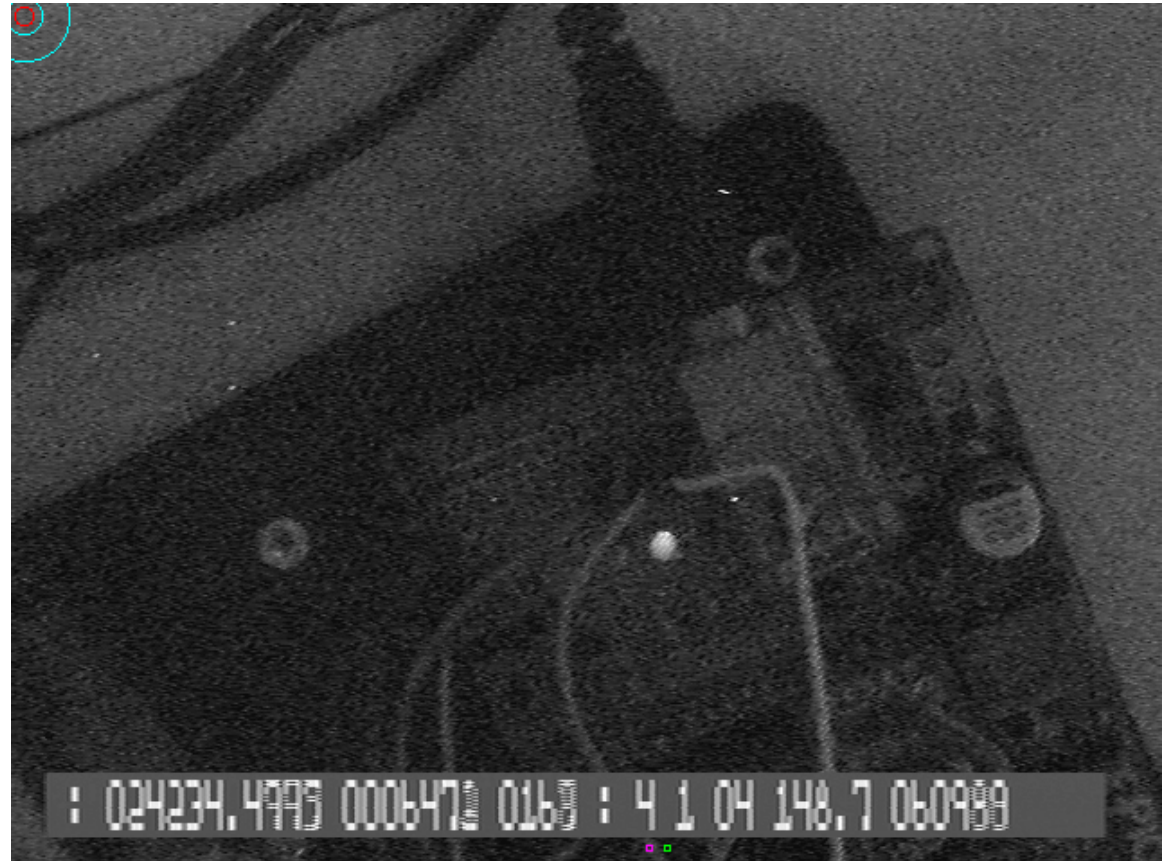
Ugly but effective. Simple parts strung together with wires under the control of the PIC

Analog output, frame view

Text shows standard items such as time and field count

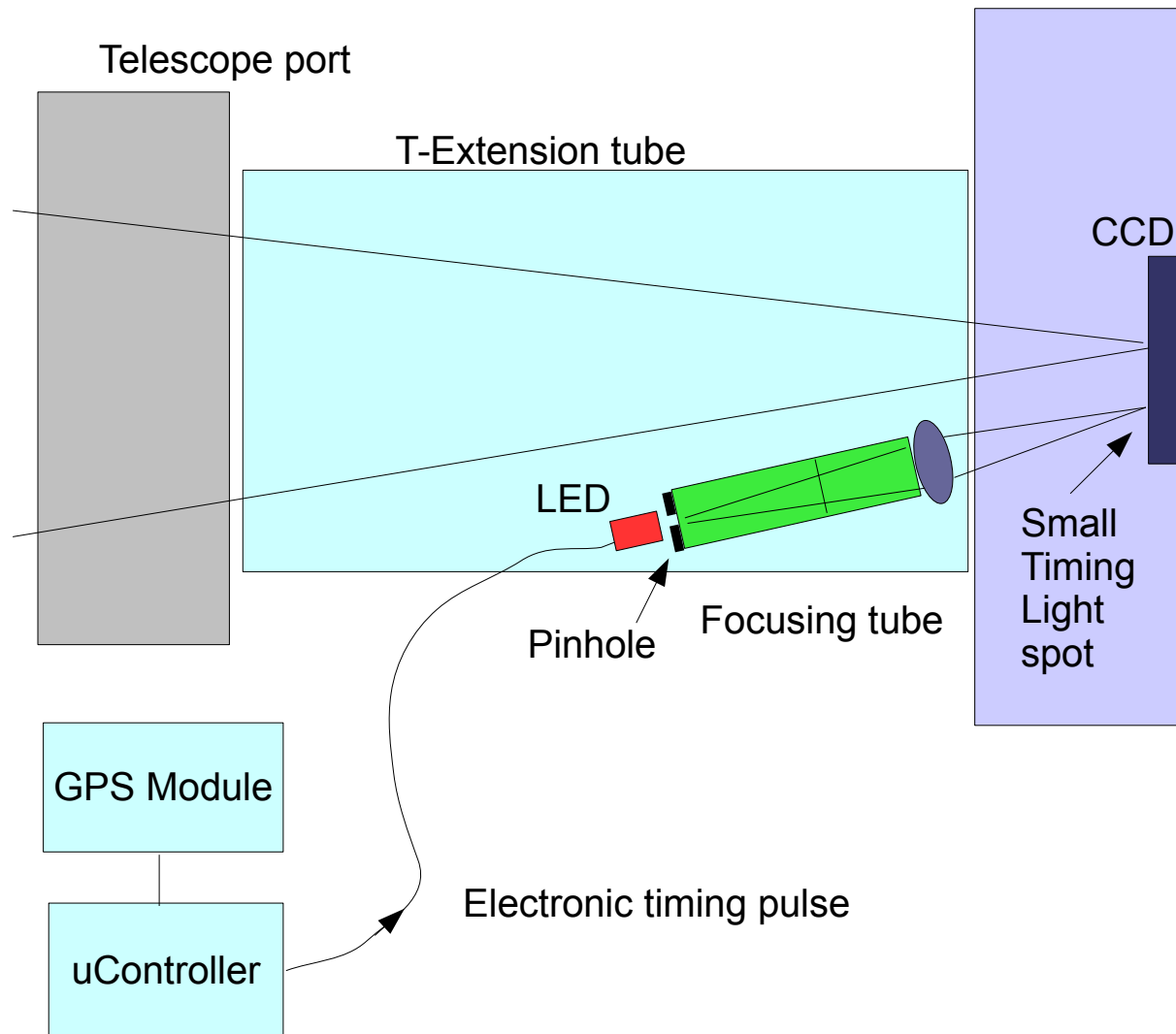
Also cycles through items such as:
Nsatellites
Lat/Long
Elevation
... and more

Characters at half normal size using special character set since MAX text is large



How to timestamp digital video?

LED Optical Time Inserter



Optical time inserter for USB cameras

Pinhole projected onto
CCD through small lens

Small and robust –
easily attached

Screw allows tilt adusment

Lens is focusable



Front view with Lumenera USB video camera

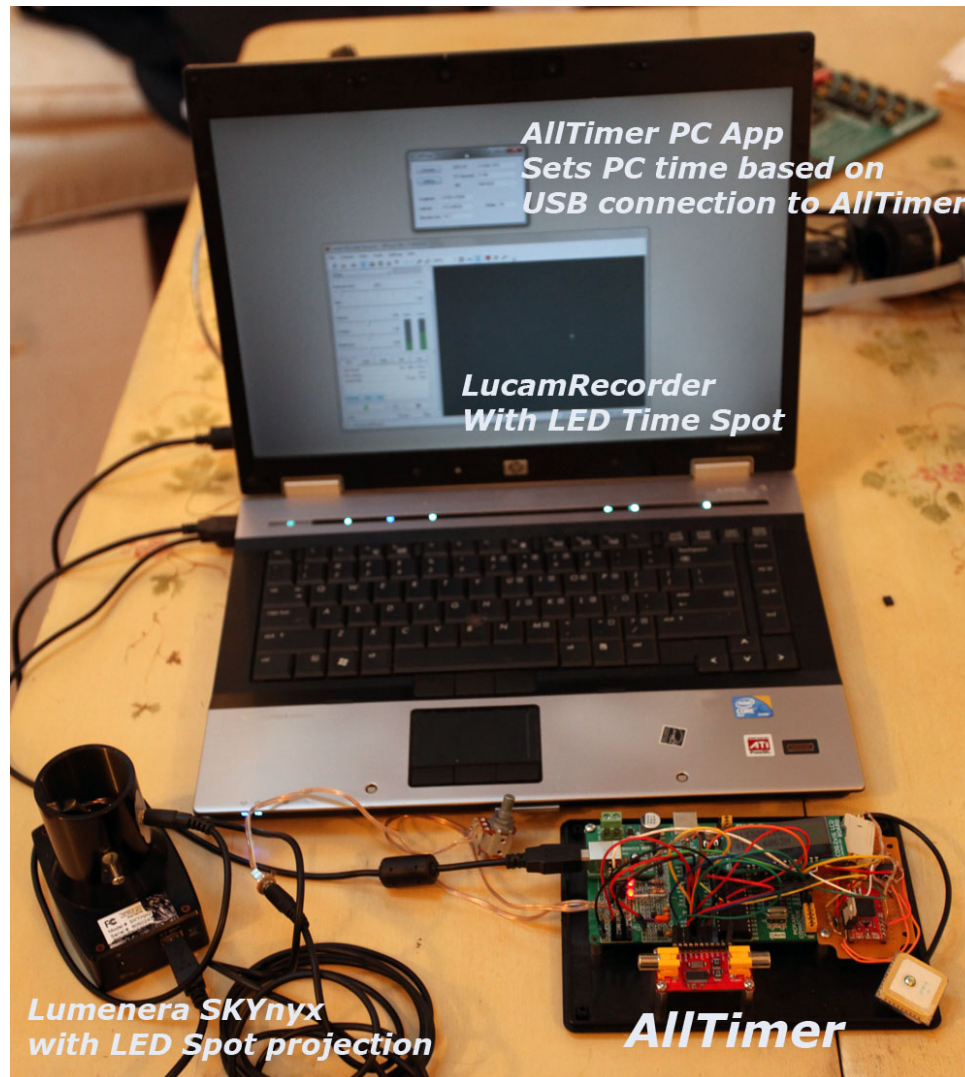


View of LED spot in frame

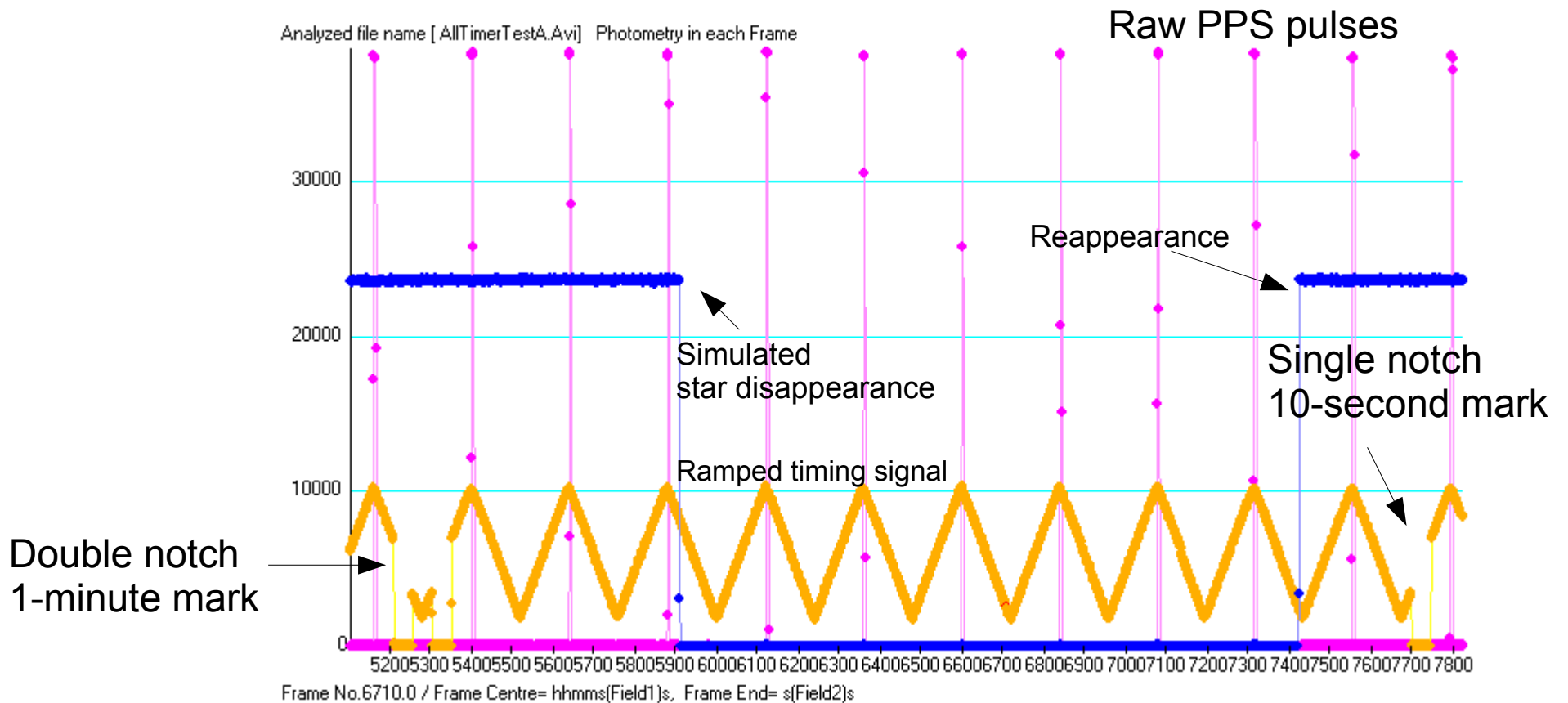
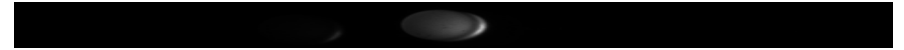
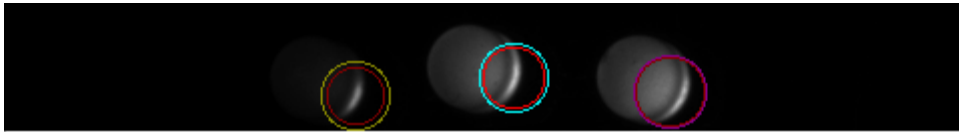
Spot is small and unobtrusive



Complete setup

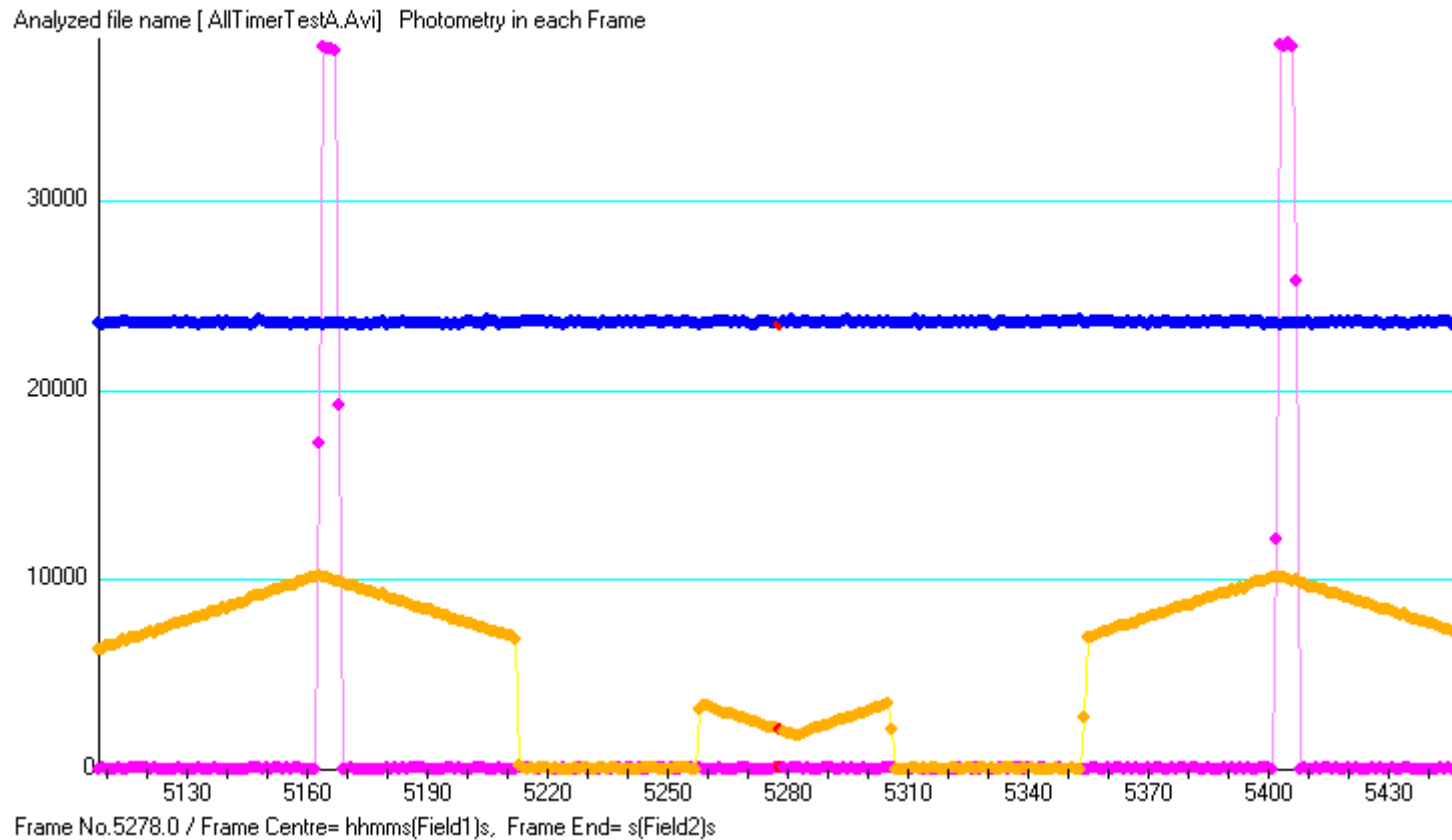


LED outputs: ramp with minute, 10s notches, and simulated occultation

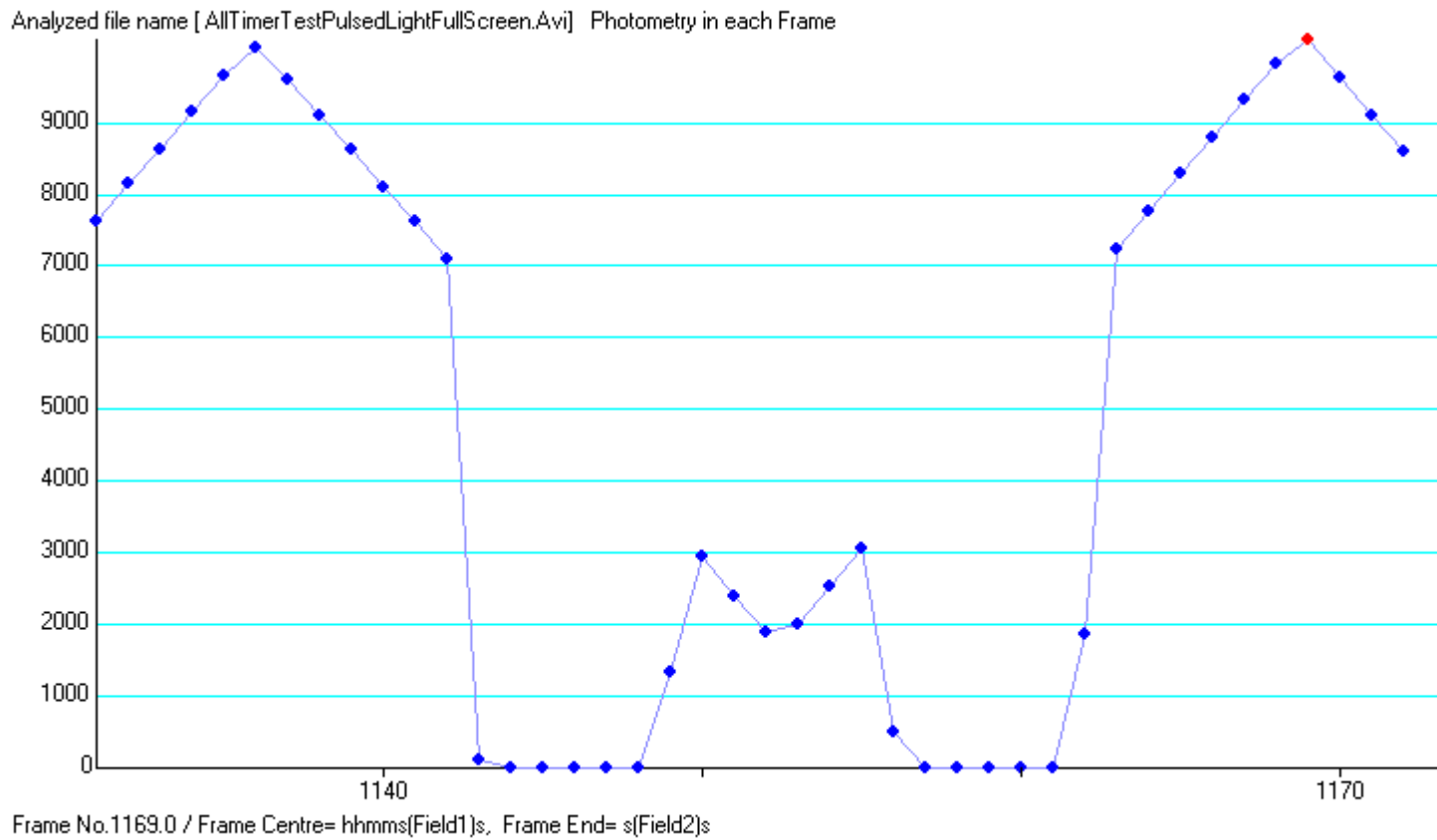


LED ramp generated by PIC using pulse width modulation (PWM)

Close up of minute notch at 245 fps

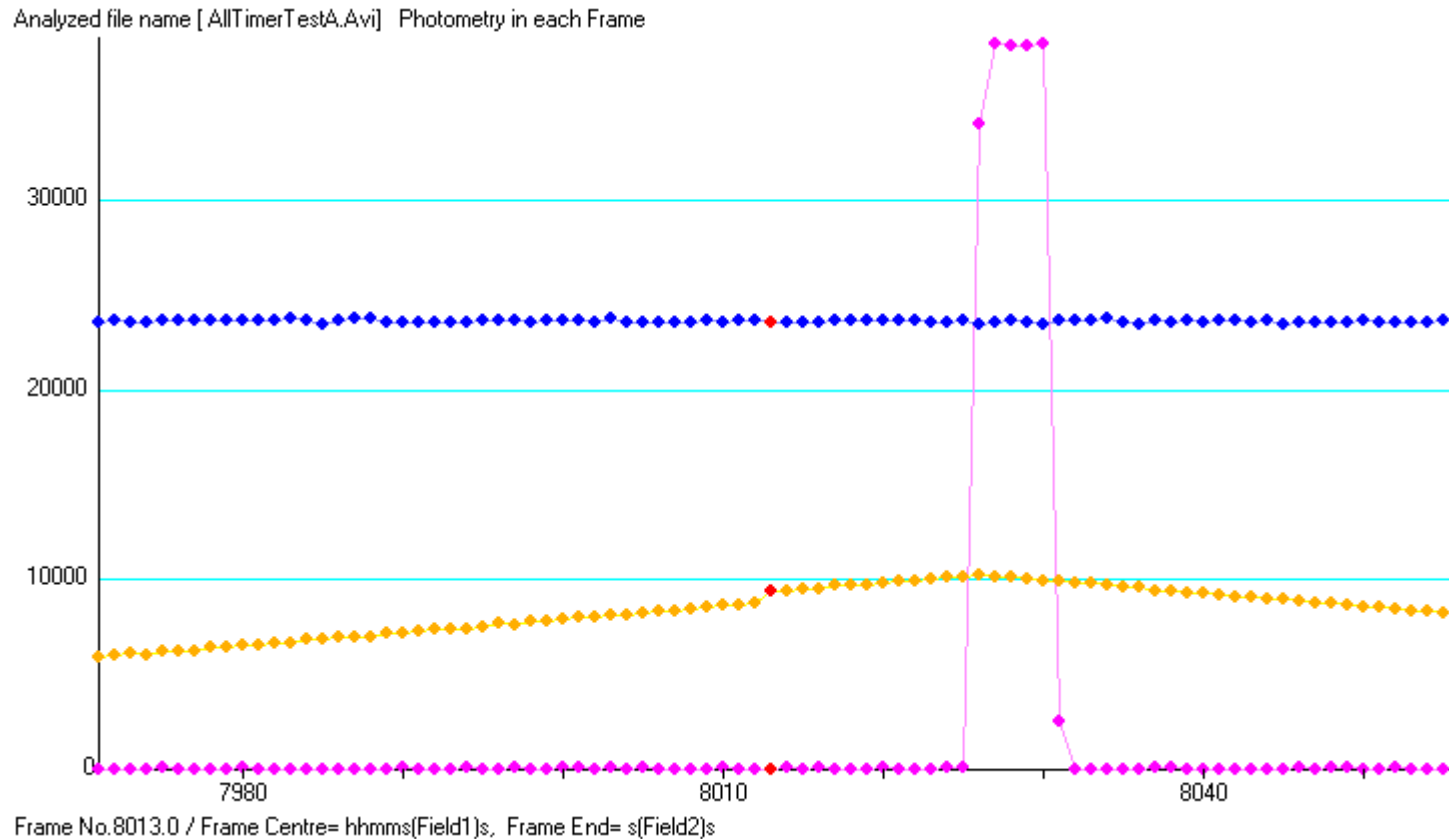


Minute notch at 30 fps



Ramp reveals dropped frames

Dropped frames can be detected and corrected with no impact on timing



If a dropped frame happens during an event and is not corrected, it could result in an error in duration even if absolute time is not needed

USB PC clock setting via GPS/PPS

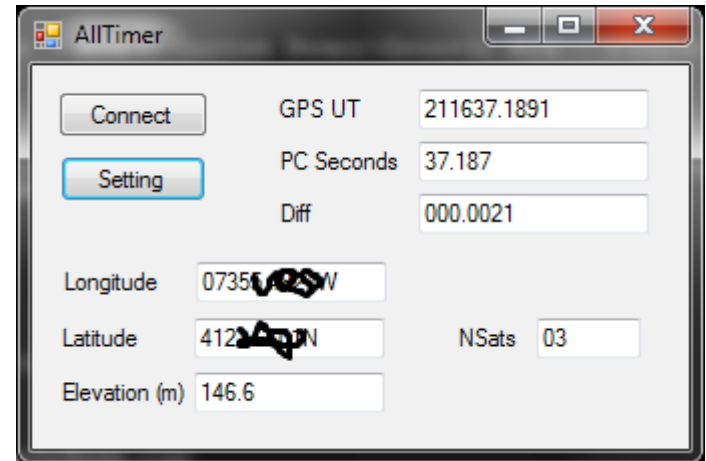
AllTimer sends exact time as text every 2 seconds

Lightweight utility waits for this message and immediately sets time

Accurate to 5-10ms with no cpu burden

Useful for many applications outside of occultations

Adequate accuracy for many events without need for the LED spot



AllTimer timing app running on PC
Reading time and satellite info over USB

Although NTP may be accurate, this is directly linked to local GPS module and works in the field where internet may not be available

Conclusion

- GPS modules and microcontrollers provide many ways to timestamp video
- Analog video can be timestamped with text overlay
- Both digital and analog can be optically stamped
- Two very different parts of a timestamp are the millisecond value, and the “which second” value
- AllTimer is a modular, PIC-based device for timestamping analog and digital video
- Also accurately sets the pc-clock via USB in the field

Extra slides

Remarks

Main microcontroller options are PIC and Arduino

Very similar, but PIC has advantage for direct USB connection

Next version will be much smaller

Could be extremely small with discrete components and custom circuit board

Could mix and match each of the features:

- On screen display for analog cameras not needed if main usage is for USB cameras

- Don't need LED or text if just setting PC time in the field

But if you just want to time occultations with analog video – could just have bars on screen telling you the time, with no text



Field view

Character set designed to be easily read by software in each field

