Low-cost Meteor Radiometer

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Croatian Meteor Network

Introduction – radiometric observations?

- First mention in 2001 (Spurný, et al.)

COMMON GROUND-BASED OPTICAL AND RADIOMETRIC DETECTIONS WITHIN CZECH FIREBALL NETWORK.

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ABSTRACT

This paper describes first results of common detections of fireballs by photographic cameras in Czech Fireball Network (CFN) and the new radiometric systems equipped with sensors with very high time and intensity resolutions placed at two stations of this network, Ondřejov Observatory and Kunžak. Since August 1999, when we started regular operation of two radiometric systems, we have detected 17 different fireballs. Eleven of them were recorded simultaneously by photographic cameras, another six were only single radiometric detections as radiometers can detect meteoric events also under cloudy conditions. From two most suitable common events we performed calibration of radiometers and we determined their sensitivity. We found significant differences between lightcurves of slow and fast meteors recorded by these techniques, and finally, we found substantial differences in shapes of lightcurves for fireballs belonging to the same meteor

consist of the visible wavelength sensors unit, a 30m cable that transfers data from the sensor assembly to the interface box, 68 pin interface cable that transfers data from an interface box to the acquisition board inside the PC and a PC for the actual data acquisition, archiving, viewing data files and searching for events. This

Source: Spurný, P., Spalding, R. E., Jacobs, C. (2001). "Common ground-based optical and radiometric detections within Czech fireball network".

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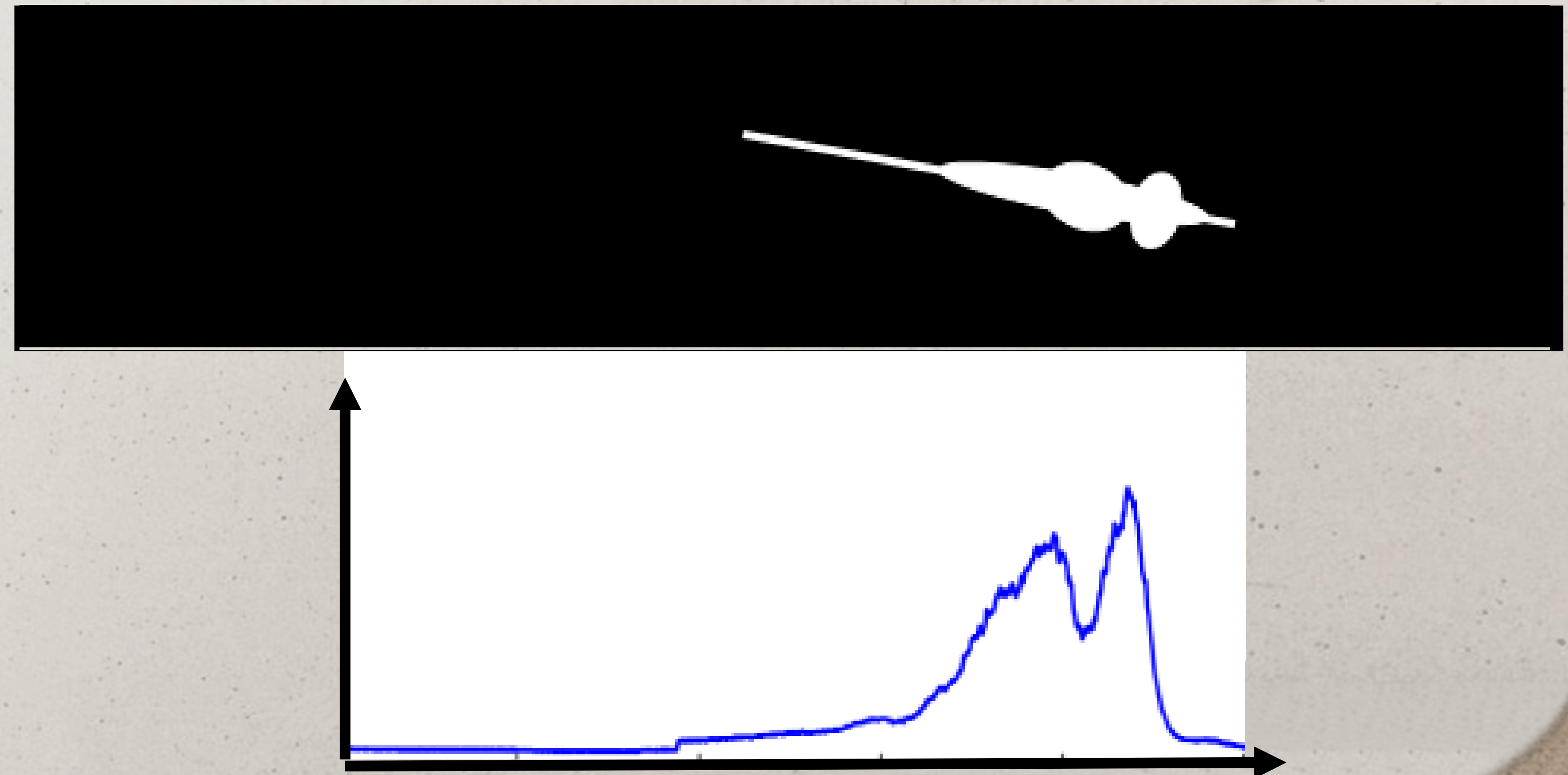
„... radiometric systems equipped with sensors with very high time and intensity resolutions..."

„ ... Record total brightness of the sky with sample rate 1200 s^{-1}... "

What is a radiometer?

- High time-resolution photometer which measures the sky brightness



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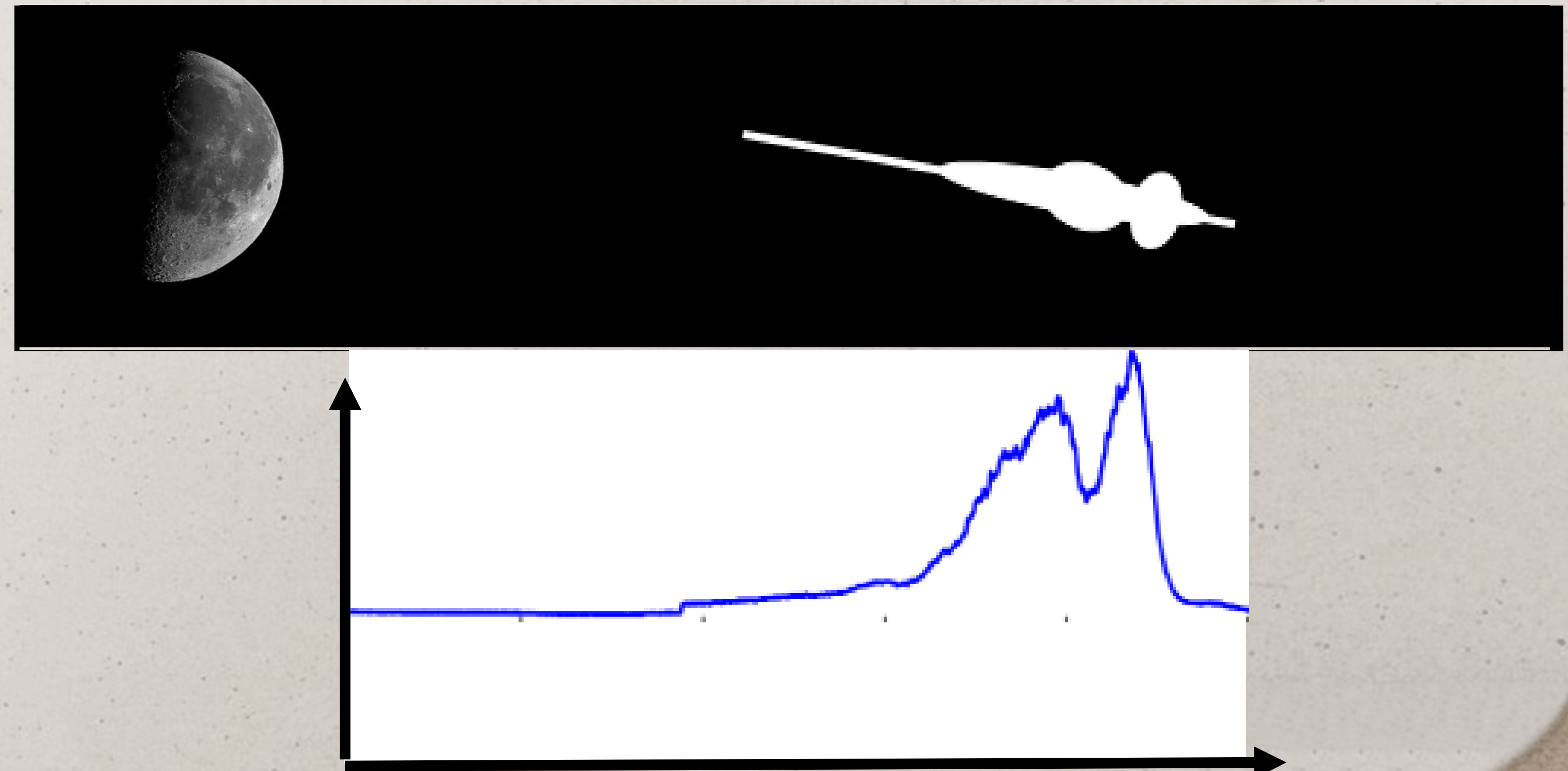
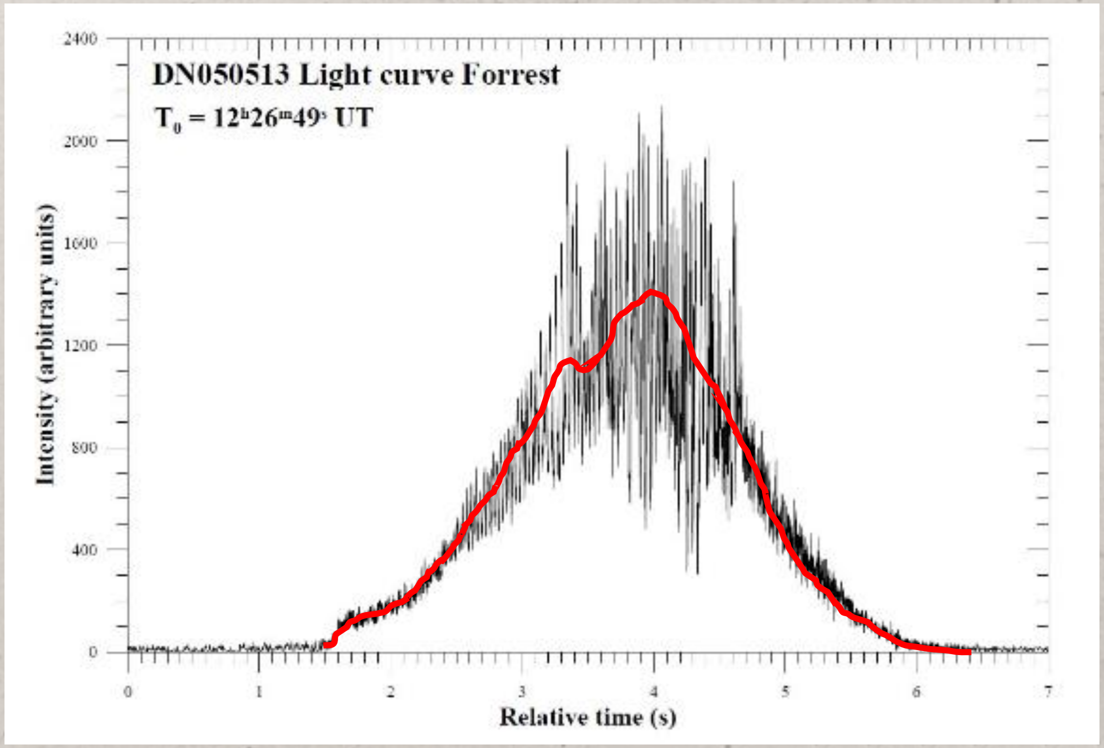


Why apply them to meteor research?

- Very fine time resolution
  - Ultimate fireball fragmentation modelling data!
- Unknown high frequency phenomena



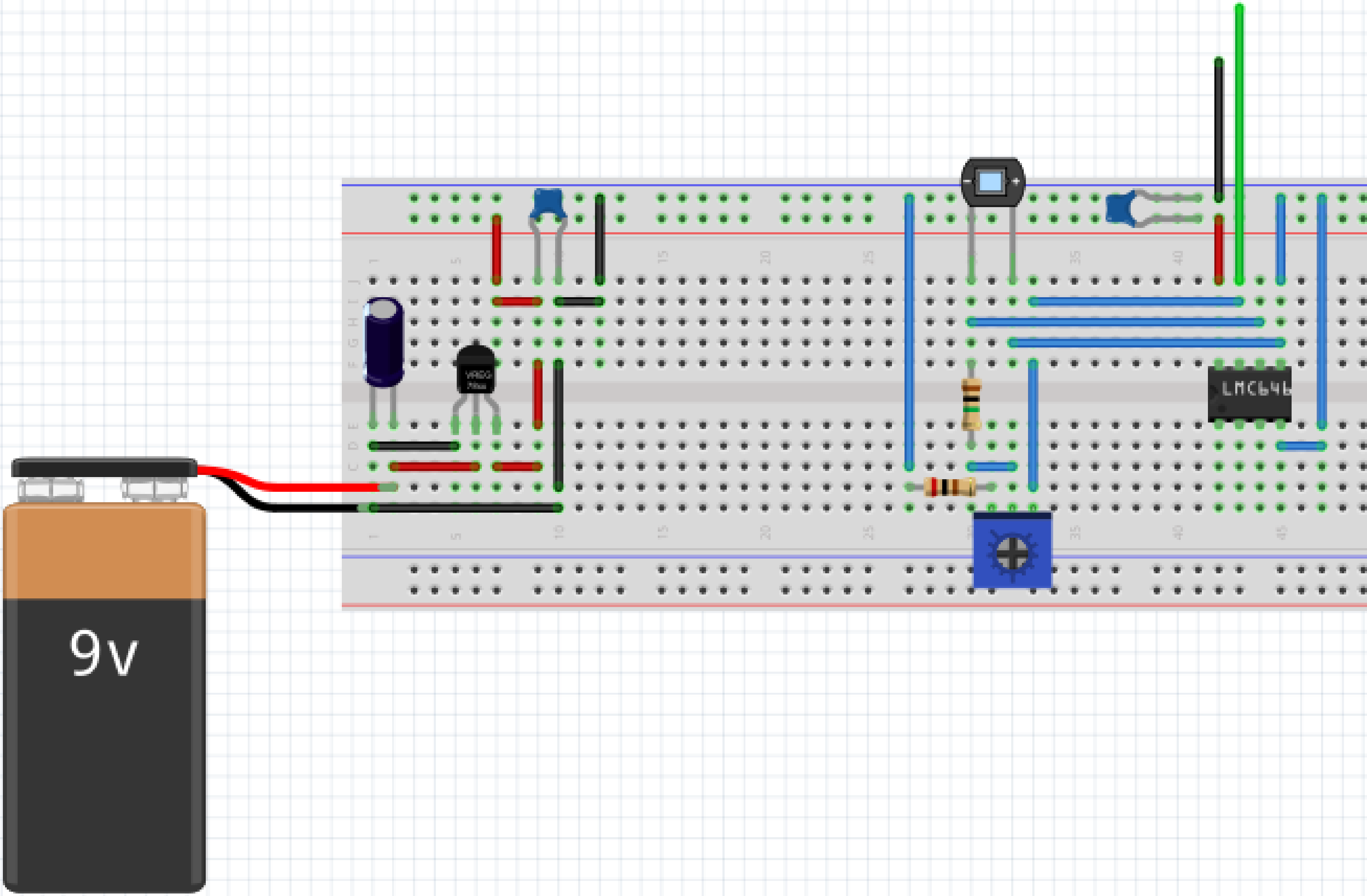
Source: Borovička J., Spurný P., Brown P. (2015). "Small Near-Earth Asteroids as a Source of Meteorites".

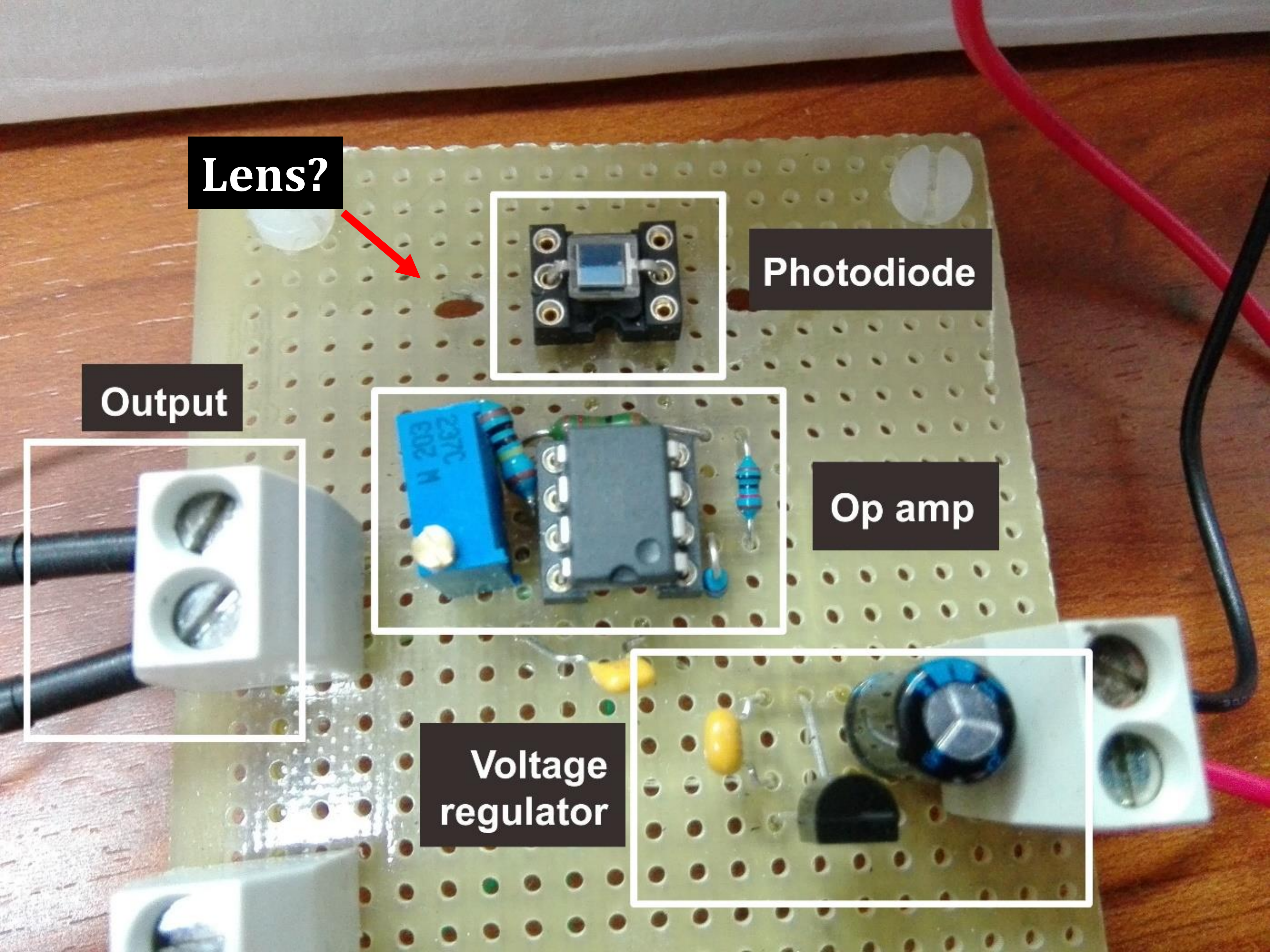
Building from scratch

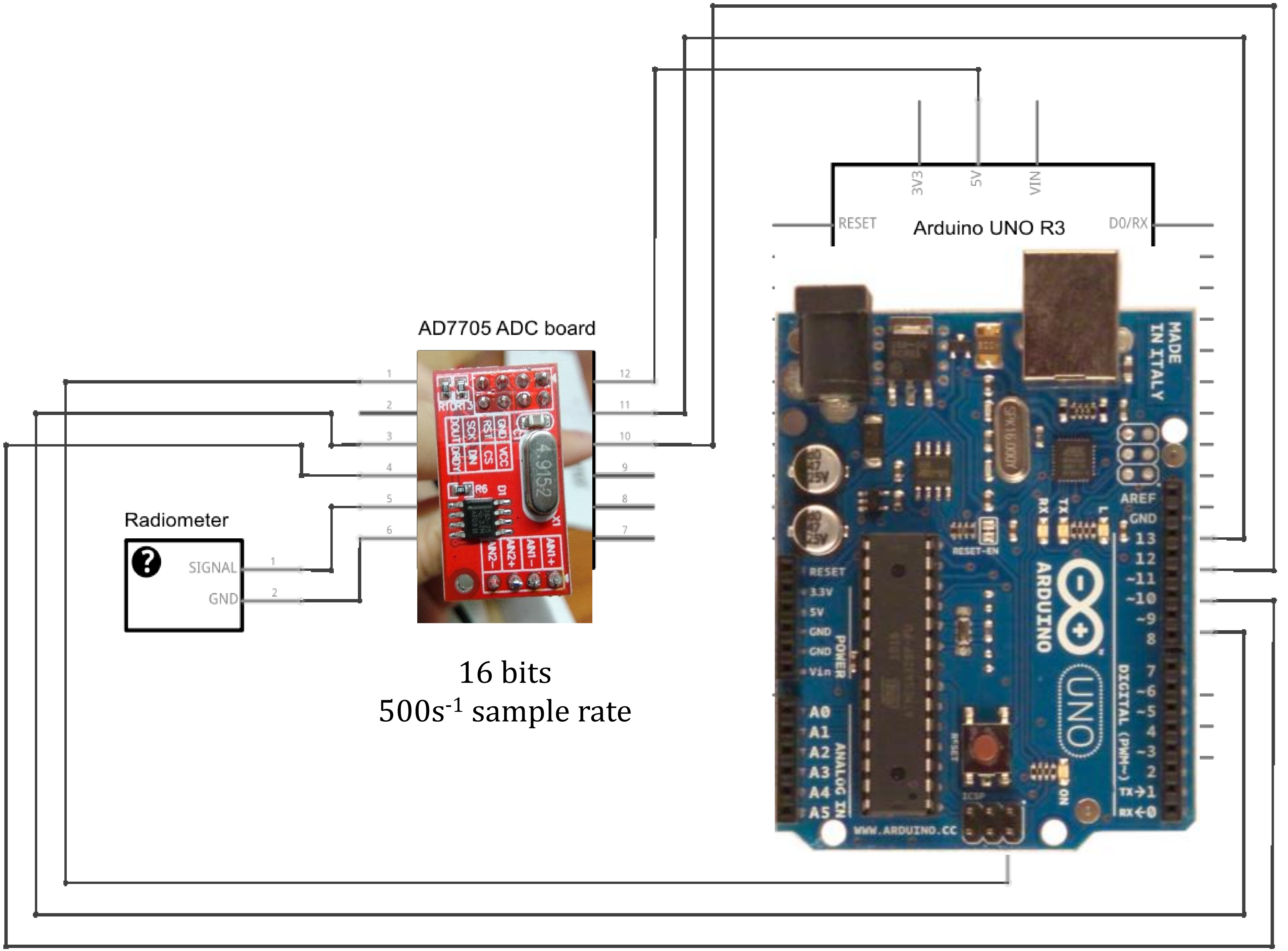
- Sensor
  - Choice of sensor (photodiode type and choice)
  - Sensitivity (10^{-5} lux)
  - Noise

- Data acquisition
  - Sampling frequency (500 Hz, several kilohertz?)
  - Precision (16-bit, 24-bit?)
  - Acquisition device throughput?

- Cost!

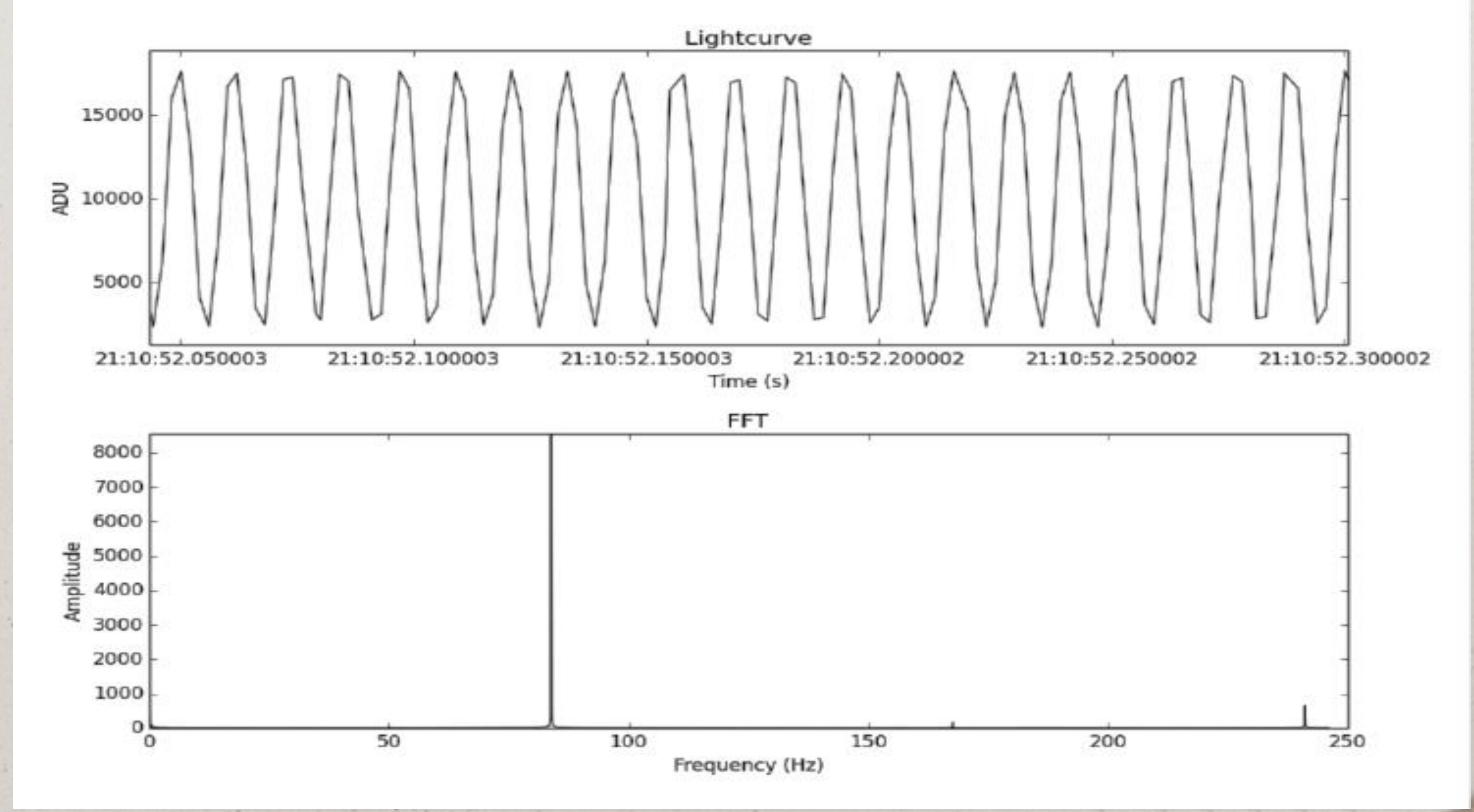

9v
LMC64


Lens?
Photodiode
Output
Op amp
Voltage
regulator


AD7705 ADC board
Radiometer
SIGNAL
GND
Arduino UNO R3
3V3
5V
VIN
RESET
D0/RX
16 bits
500s-1 sample rate

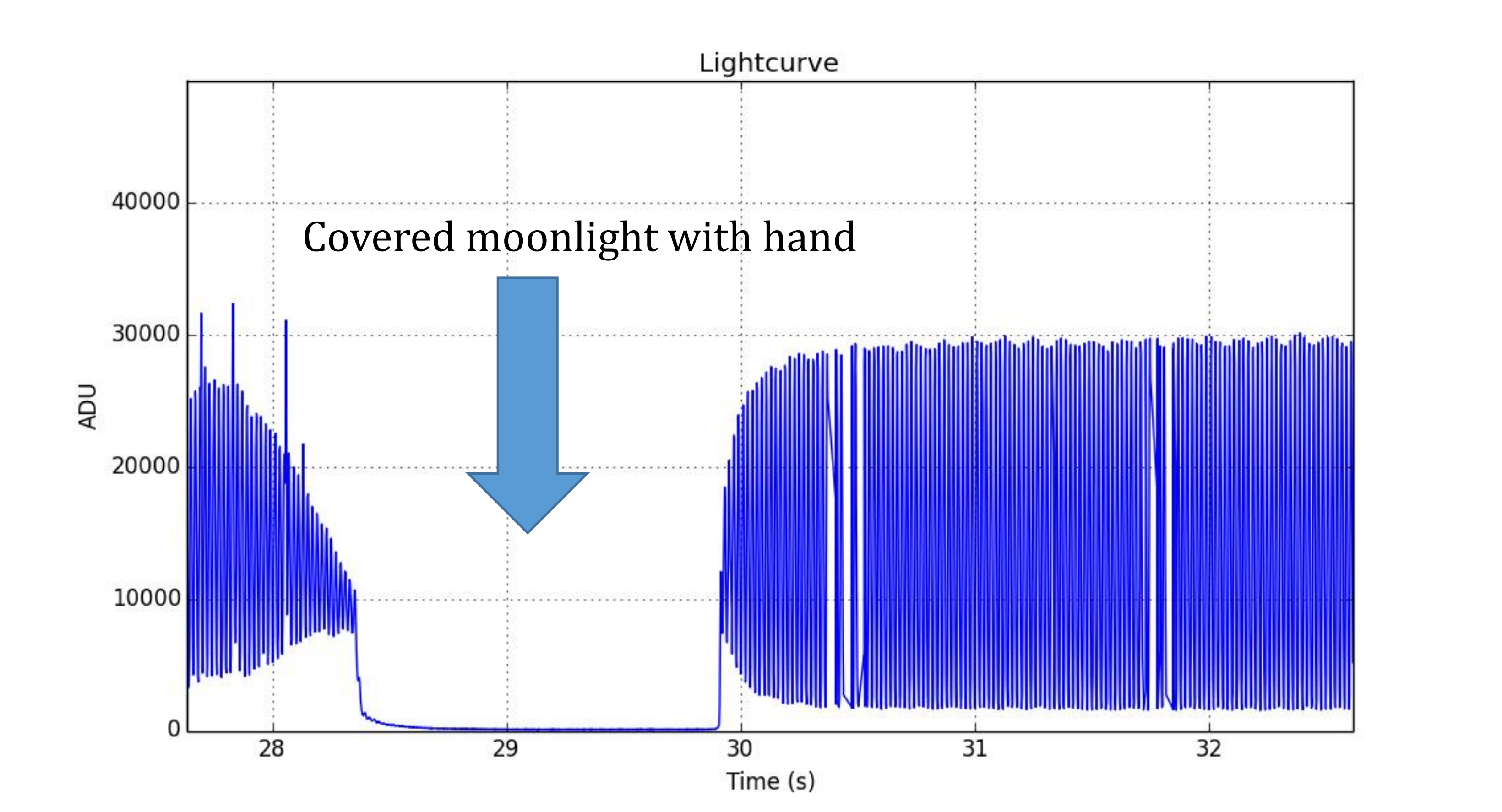
Testing - Frequency characteristics

- Tested with f = 83Hz square wave signal
  - 3nd harmonic at 3*f = 249 Hz



Testing - Sensitivity

- New Moon, 6° above horizon, -8 magnitude
- Light pollution



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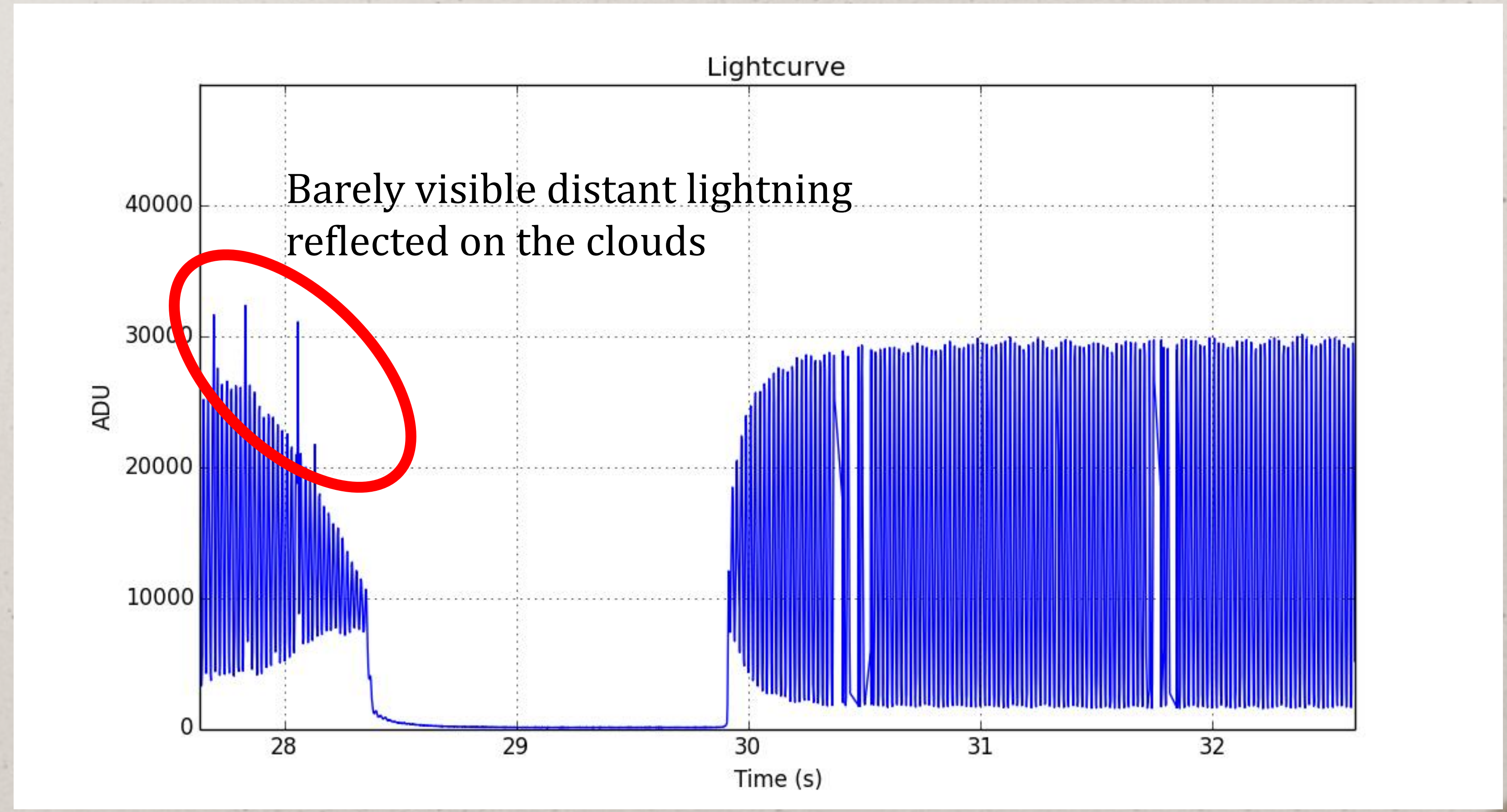
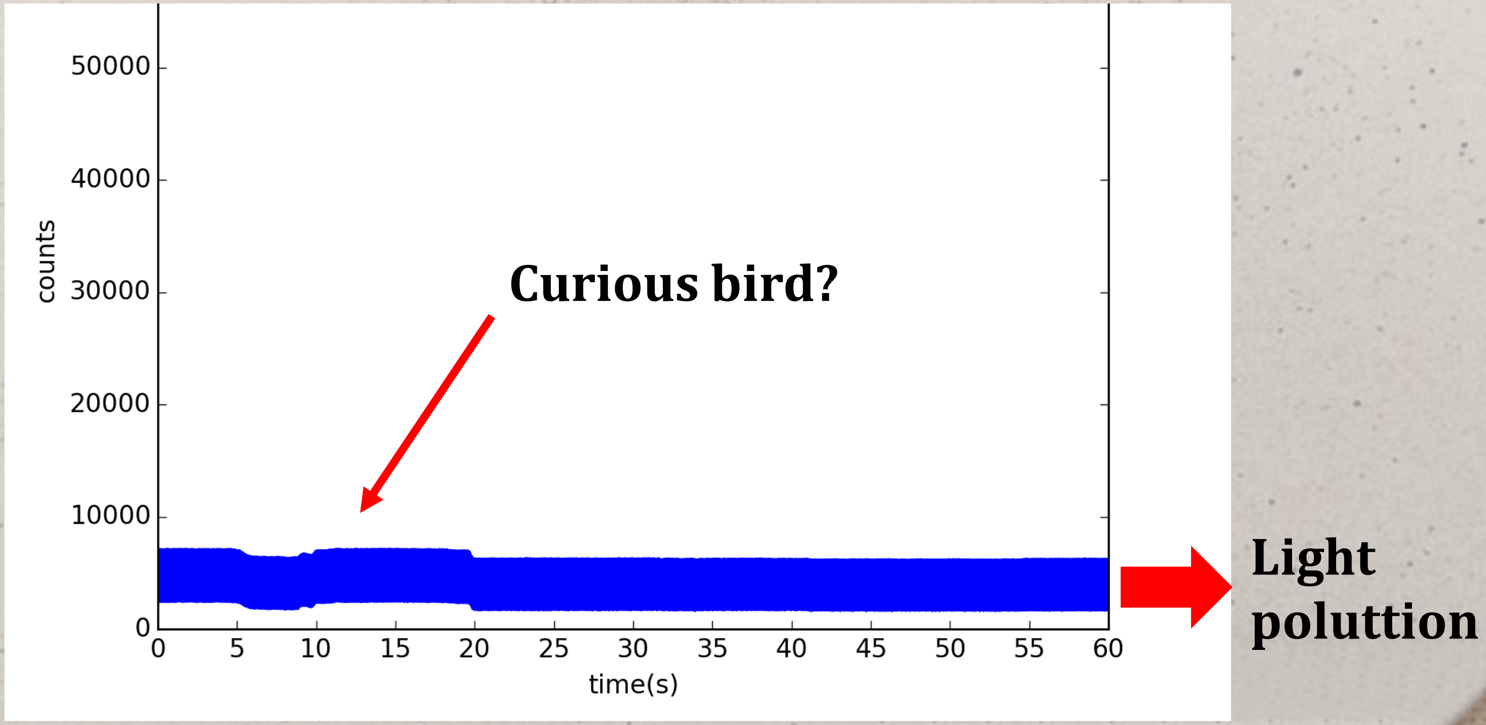


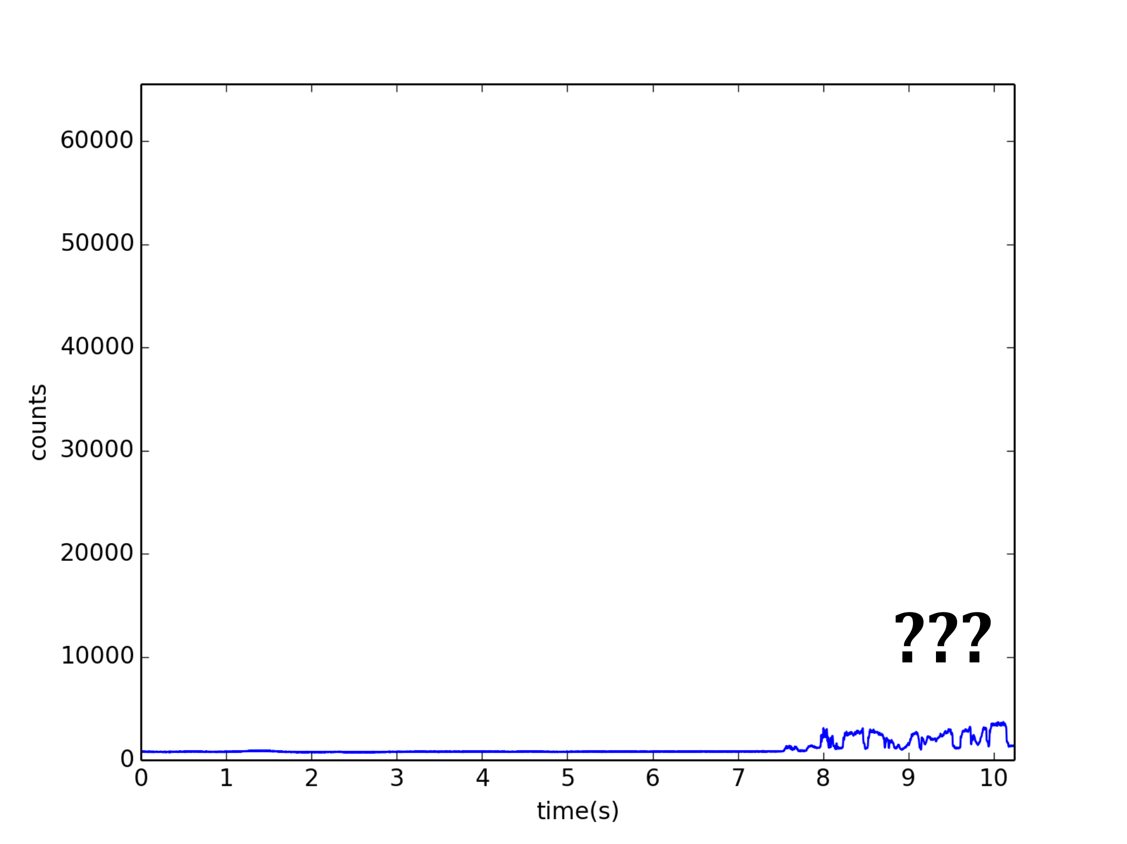
Observations

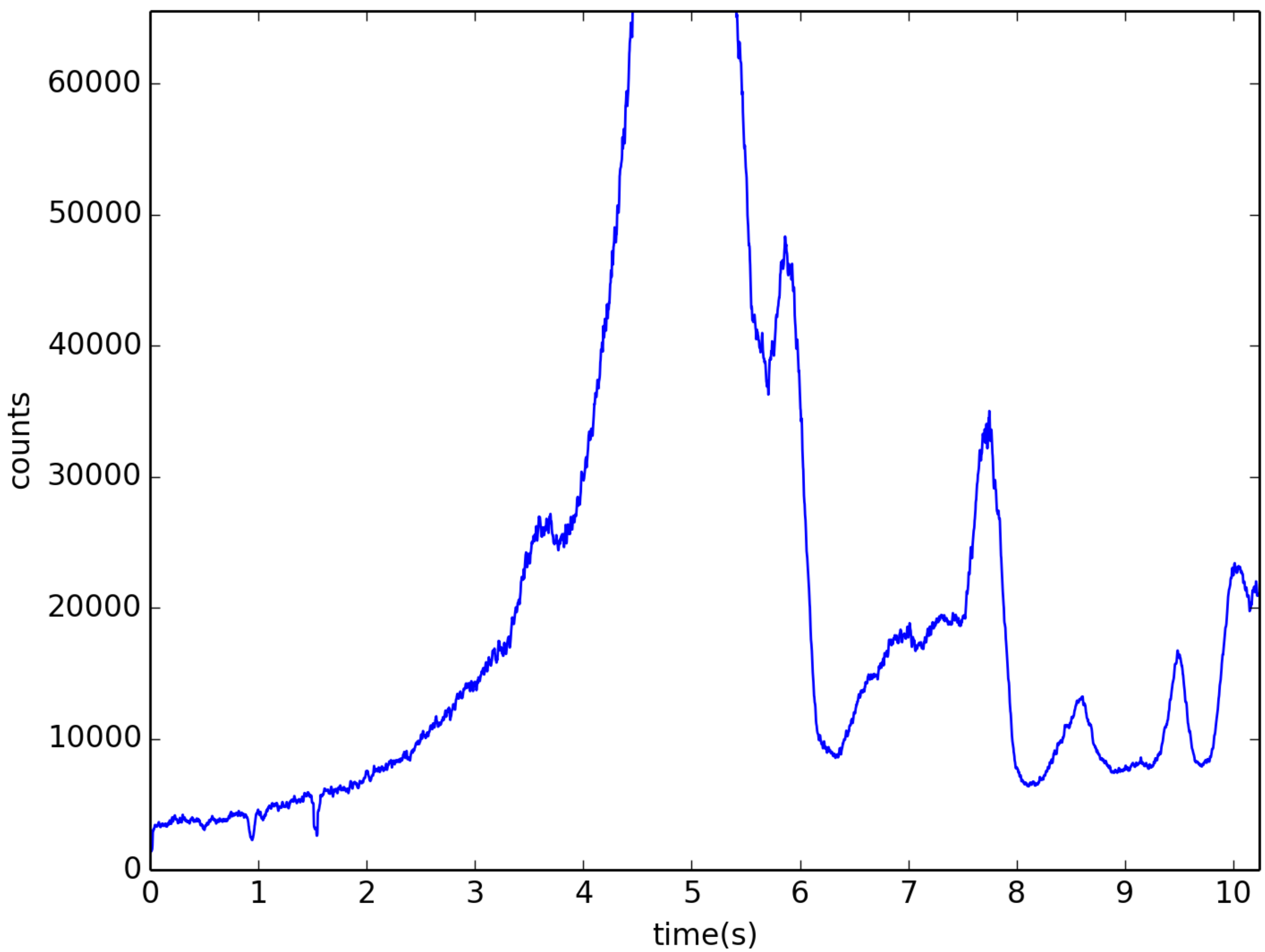
- Višnjan – August 3
  - No fireballs
- Pula – August 8
  - Light pollution, no fireballs



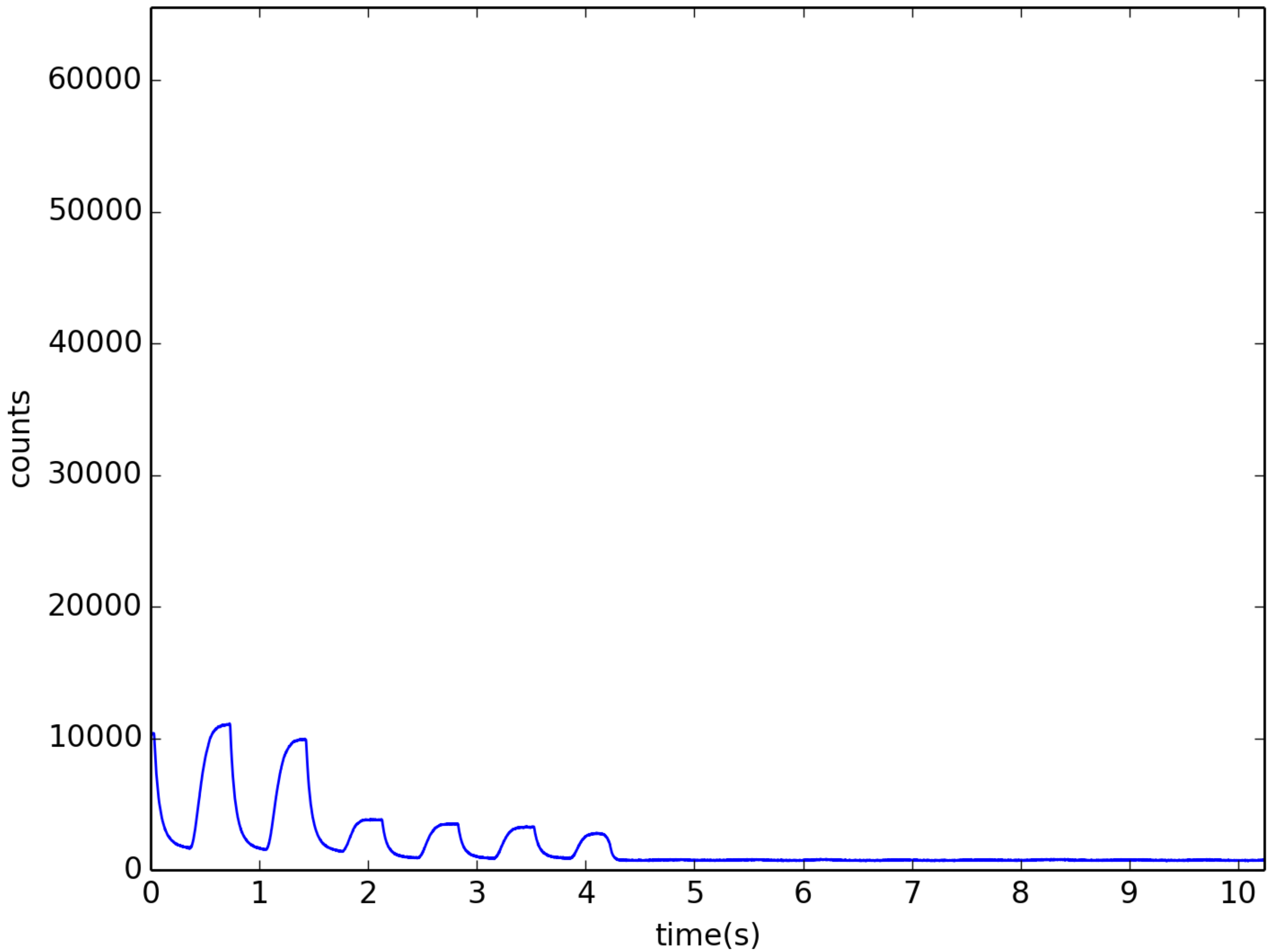
Observations

- Platak – August 12
  - No light pollution, ideal conditions
  - Recording only 1 hour on notebook battery





counts
60000
50000
40000
30000
20000
10000
0
0
1
2
3
4
5
6
7
8
9
10
time(s)



counts
60000
50000
40000
30000
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10000
0
0
1
2
3
4
5
6
7
8
9
10
time(s)

Conclusion

- No results so far – More testing!
- Need better observing conditions
- All-sky camera next to the radiometer
- Improve sampling frequency - several kHz
- Improve bit precision – 24-bits
- Improve sensitivity?

- Waiting for a big fireball!

Highlights

What I want you to remember:

- We need radiometers – unknown high frequency phenomena
- They help at fireball modelling

What I want you to do:

- Build your own radiometer (details in the proceedings), test it!
- Improve and share!

Thank you for your attention!

Questions?