Poor man's space program – High altitude balloons

ERAU Winter day 2015
14.02.2015.

People.lv
NEAR SPACE

People.lv
LAASE-2
Nekaitīgs zinātnisks eksperiments
Atrodot to, lūdzu sazināties ar +371 26229224 vai
space@people.lv
$ atlīdzība atgriešanas gadījumā $
Harmless scientific experiment
If found, please contact +371 26229224 or
space@people.lv
$ reward offered $

Idea

- *First Rickroll in Space* @ Youtube
- Yes, ok, but can **we** do that?
- FOR SCIENCE!

2010
\+ 3.5

2013

History etc.

First amateur balloon launches happened in 1980s in the USA by Bill Brown WB8ELK.

He's still doing it!

European centre for ballooners is Great Britain.

UK High Altitude Society – actually worldwide.

UKHAS.org.uk

Where is space?

space starts above the Kármán line at 100 km

"near space"
from 20 to 100 km

balloons don't leave the Earth's atmosphere!

Balloons in spaaace!

NASA Echo I & Echo II

Required components
(in a large scale)

- Idea ← that's how all starts
- Balloon
- Parachute
- Payload
- Lifting gas
  - Helium
  - Hydrogen
- Suitable weather
- Helpful heads and hands

Safety

- ICAO Convention on International Civil Aviation, Annex 2
- EU regulation No 923/2012, Annex 2
- Local laws and rules
- Permission from the Civil aviation authority

In short:

- String breaking force <230 N
- Density less than 13 g/cm^2
- Weight less than 2 kg

- Rules
- Safety and common sense
- Still durable enough

LATVIJAS REPUBLIKAS SATIKSMES MINISTRIJA
Valsts aģentūra „CIVILĀS AVIĀCIJAS AĢENTŪRA"

CIVIL AVIATION AGENCY

Mārupes novadā

_____. Nr._____
Uz_____. Nr._____

AERONAVIGĀCIJAS DAĻA

Kristapam Menģelim
Pers. k. [redacted]
Adrese: [redacted]

VAS „Latvijas gaisa satiksme"

Par lidojumu atļauju

Izvērtējot Jūsu pieprasījumu, valsts aģentūra „ Civilās aviācijas aģentūra" atļauj veikt bezpilota brīvā gaisa balona lidojumu līdz 2013.gada 31.jūlijam ar palaišanas vietu koordinātās 570767N 0245082E (Siguldas apkārtne). Lidojumu veikt, ievērojot Starptautiskās civilās aviācijas konvencijas (ICAO), 2.pielikuma (Rules of the Air), 4. pielikuma (Unmanned free balloons) prasības.

Pirms lidojuma iesniegt valsts aģentūrai „Civilās aviācijas aģentūra" uz Latvijas kartes vizualizētu prognozēto lidojuma trajektoriju. Pēc lidojuma izpildes 1 darba dienas laikā iesniegt valsts aģentūrai „Civilās aviācijas aģentūra" uz Latvijas kartes vizualizētu faktisko lidojuma trajektoriju ar informācija par augstumu pēdās (ft) virs vidējā jūras līmeņa (AMSL) ik pēc 2 minūtēm.

Pārtraukt bezpilota brīvā gaisa balona lidojumu gaisa telpā, kas atrodas mazāk nekā 10 km rādiusā no Rīgas lidlauka.

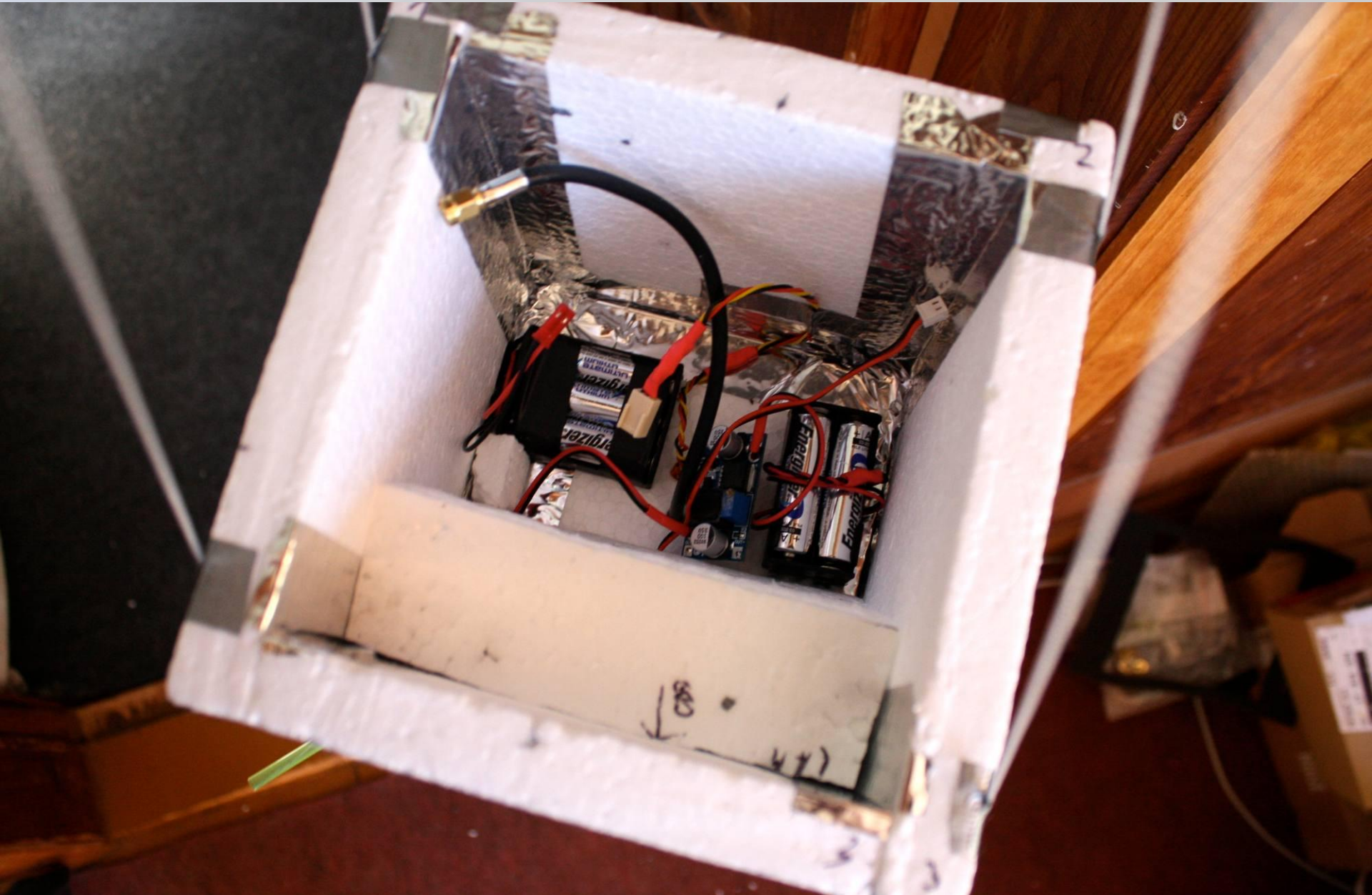
Lidojumiem ārpus Latvijas Republikas teritorijas, pirms lidojumu izpildes lūdzam jūs saņemt atļauju no valsts, virs kuras teritorijas plānots veikt lidojumus, un nosūtīt atļaujas kopiju valsts aģentūrai „Civilās aviācijas aģentūra" uz e-pastu latcaa@latcaa.gov.lv.

Ar cieņu,

daļas vadītājs
M.Čerņonoks
Jēkabsons 67507913

Payload

Payload



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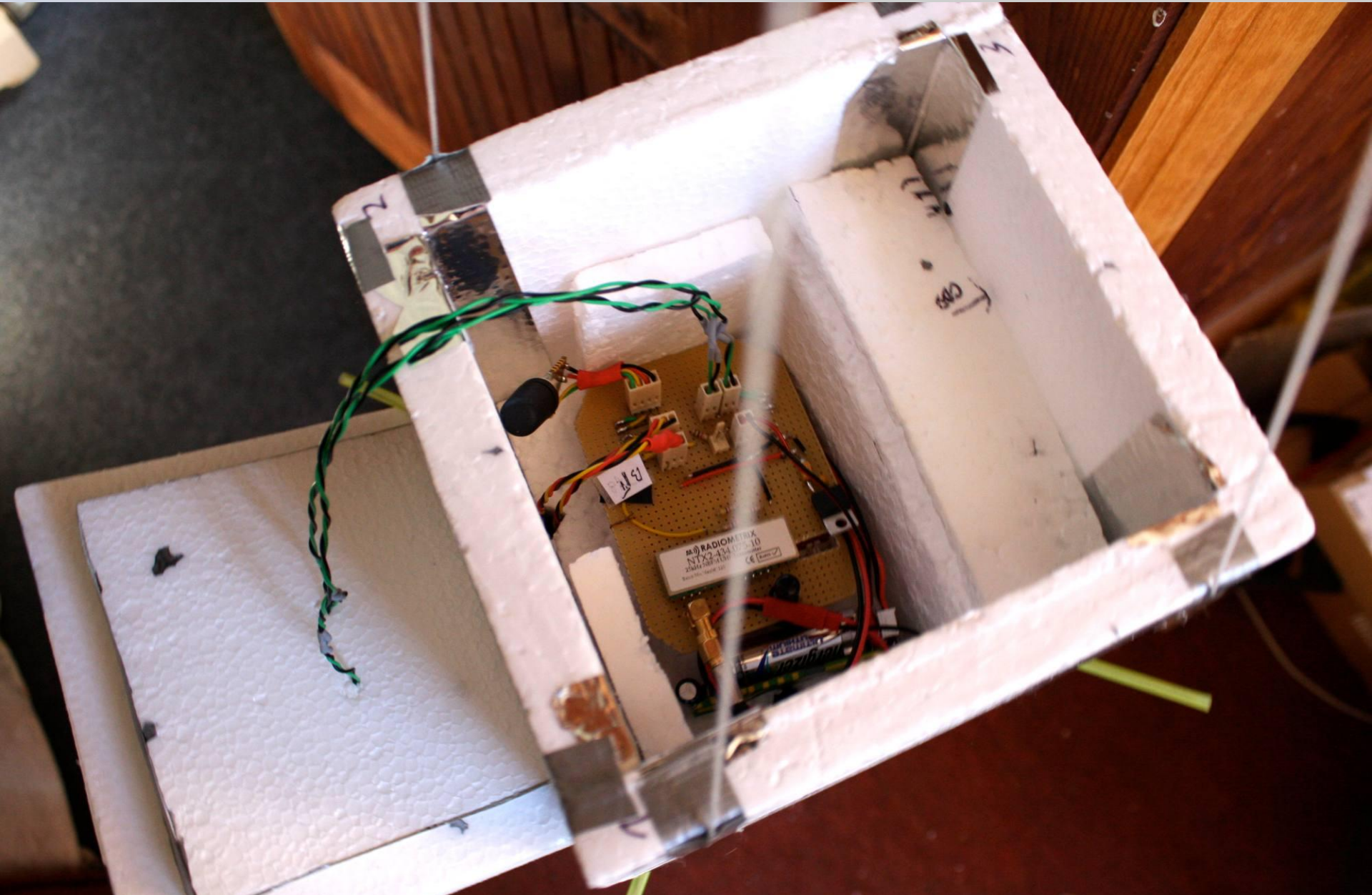

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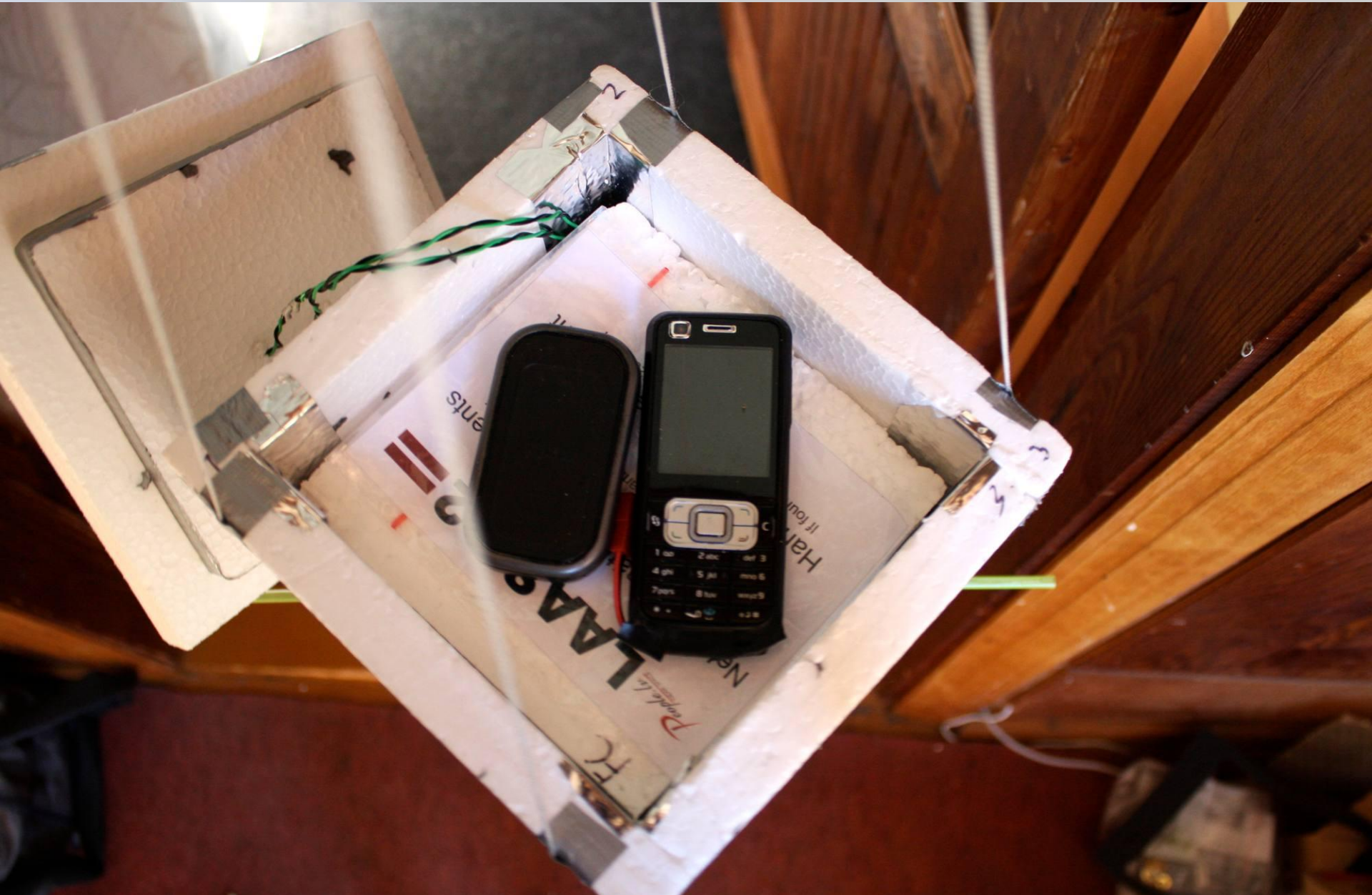
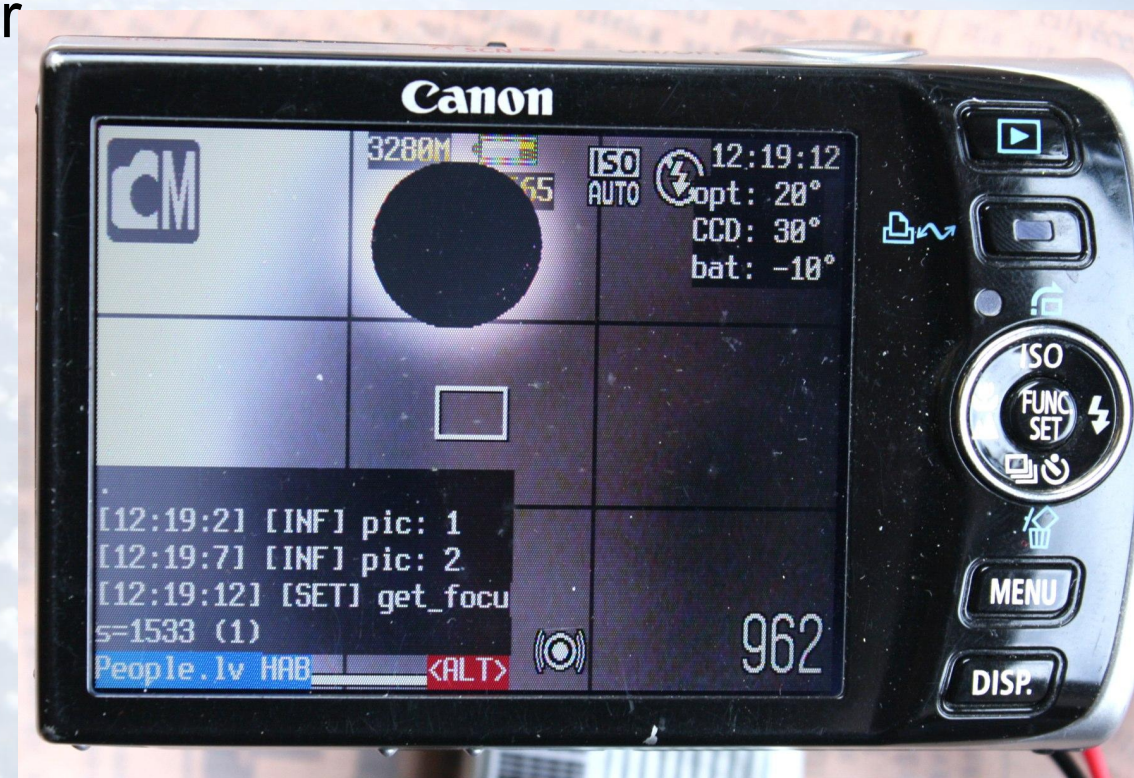


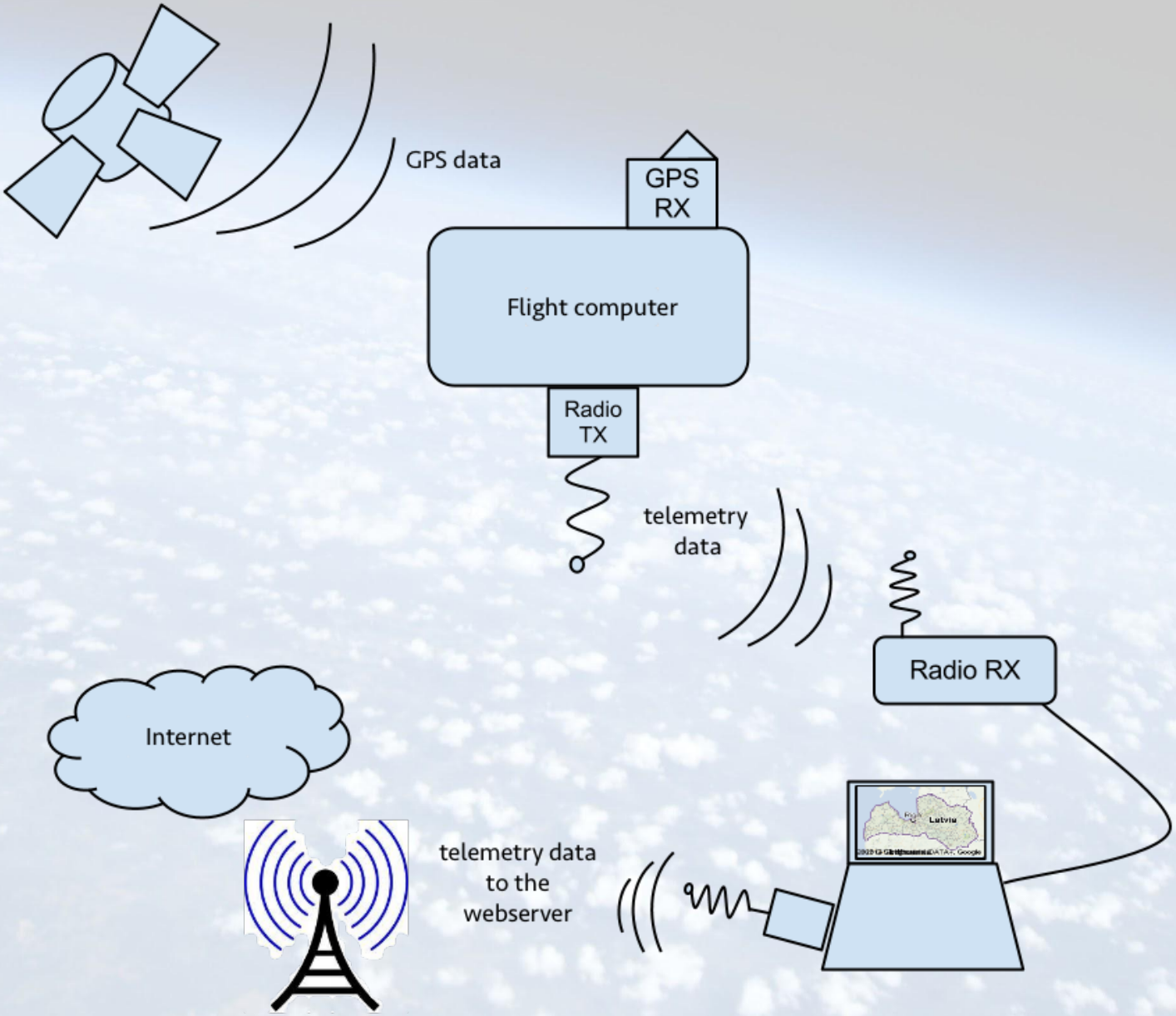
Electronics – video, photo, phono

Everybody likes pretty pictures!!

- Canon point&shoot camera
  - CHDK
    - intervalometer
    - Lua program
  - external battery
- video camera



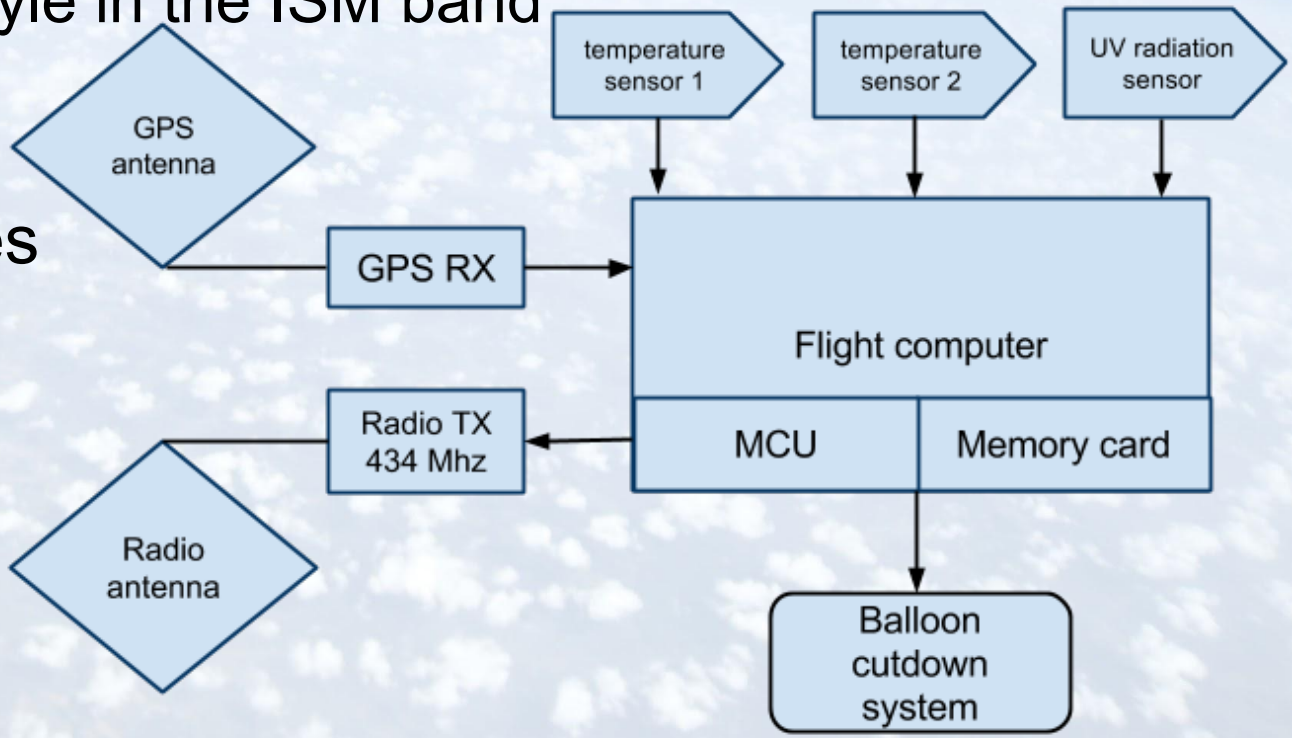
Electronics – tracker



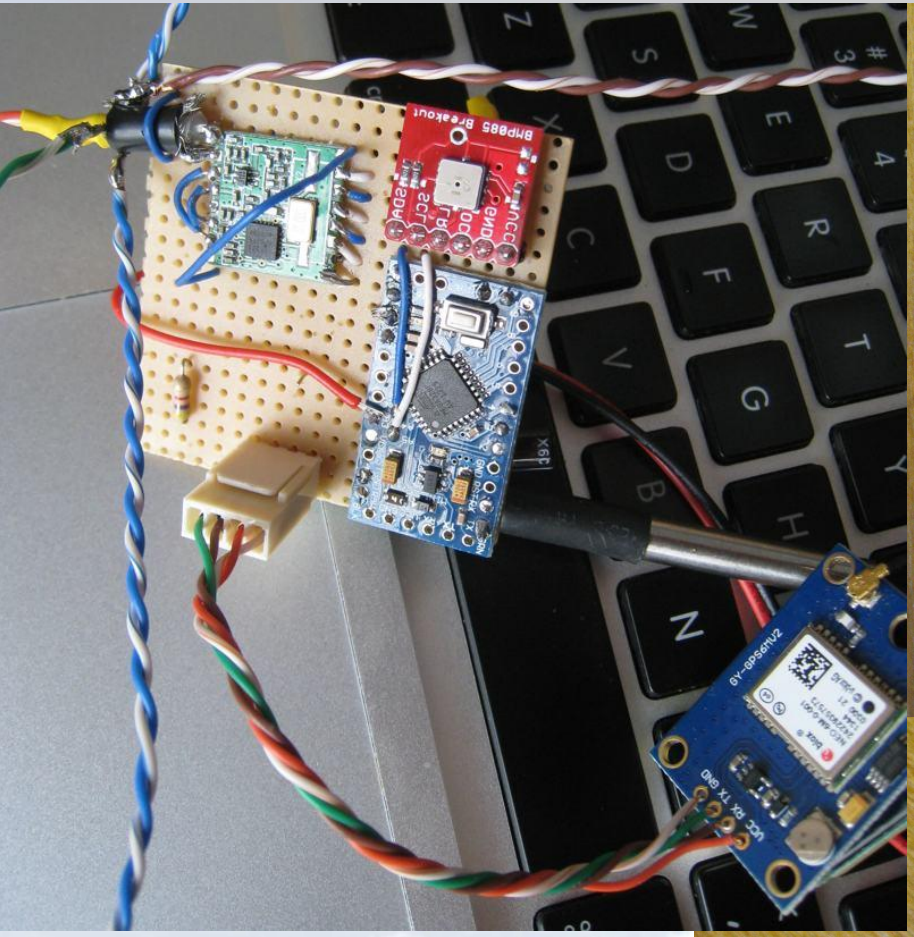
Electronics – tracker

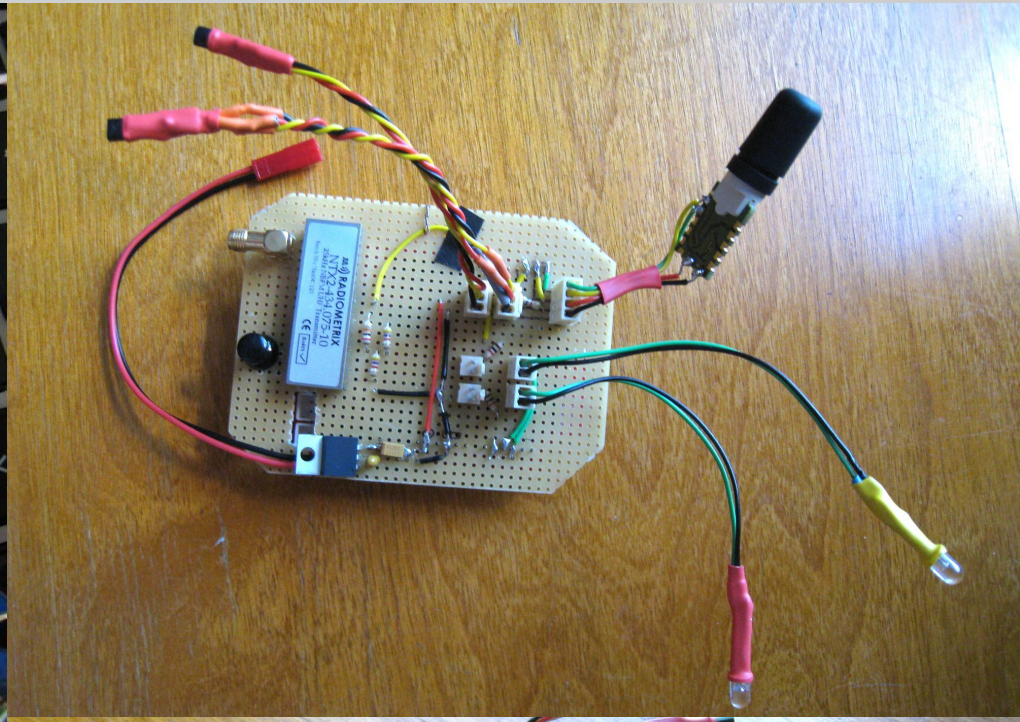
Responsible for the position reporting and data sampling.

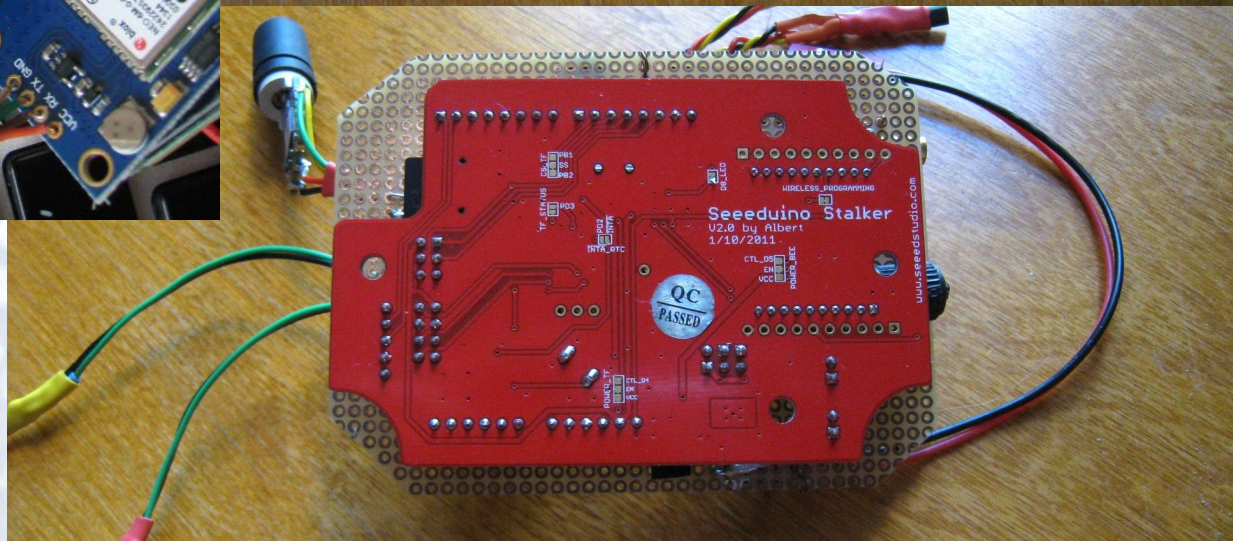
- AVR (“Arduino”) or other microcontroller
- GPS receiver
  - has to work above the 18 km CoCom limit
- Radio transmitter
  - UKHAS-style in the ISM band
  - or APRS
- Sensors
- Other thingies



Electronics – tracker







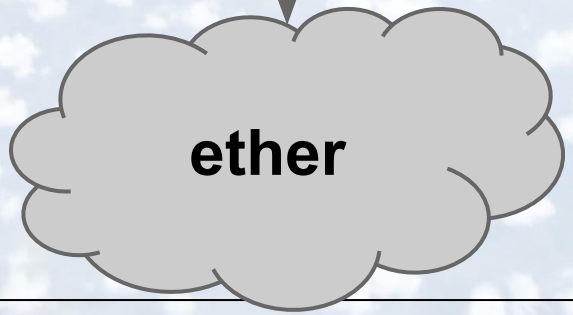
Electronics – tracker

- GPS data

```
$PUBX,00,183041.00,5709.81424,N,
02434.19748,E,137.086,G3,
17,15,65.396,19.40,-0.812,,
1.63,2.17,1.62,7,0,0*41
```

- sensor data
- telemetry sentence

```
$$LAASE,454,11:05:
29,57.07664,25.21273,22725,21,9,86,
-160,52,21,2*13BD
```



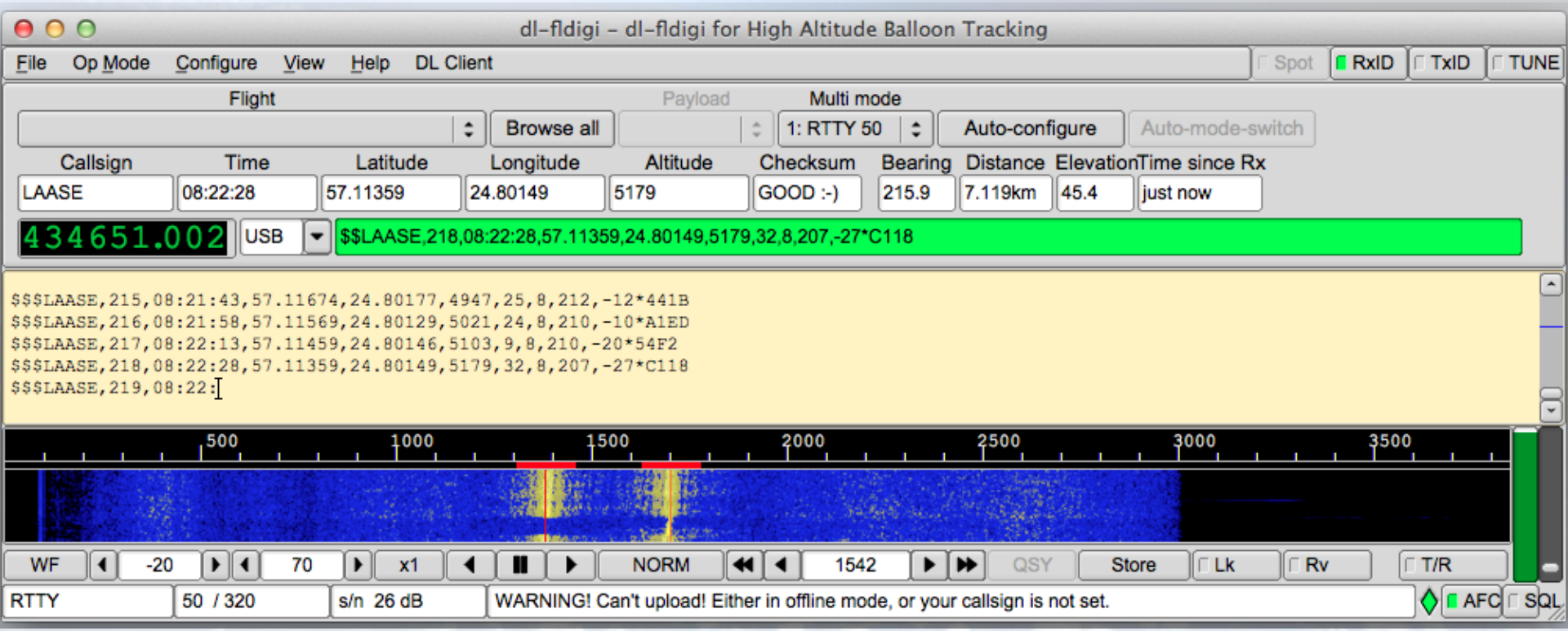
Closer look on the radio comms

- Radio transmitter
  - 70cm ISM band (434 MHz) @ 10mW
  - RTTY or other data mode @ 50-600 baud

- Radio receiver – SDR, scanner or a proper ham rig
- dl-fldigi program – HAB-enabled *FLdigi* version
  DL – *distributed listener*

- Habhub.org server – receives data from all listeners
- SpaceNear.us – flight path on the map

Decoding with dl-fldigi



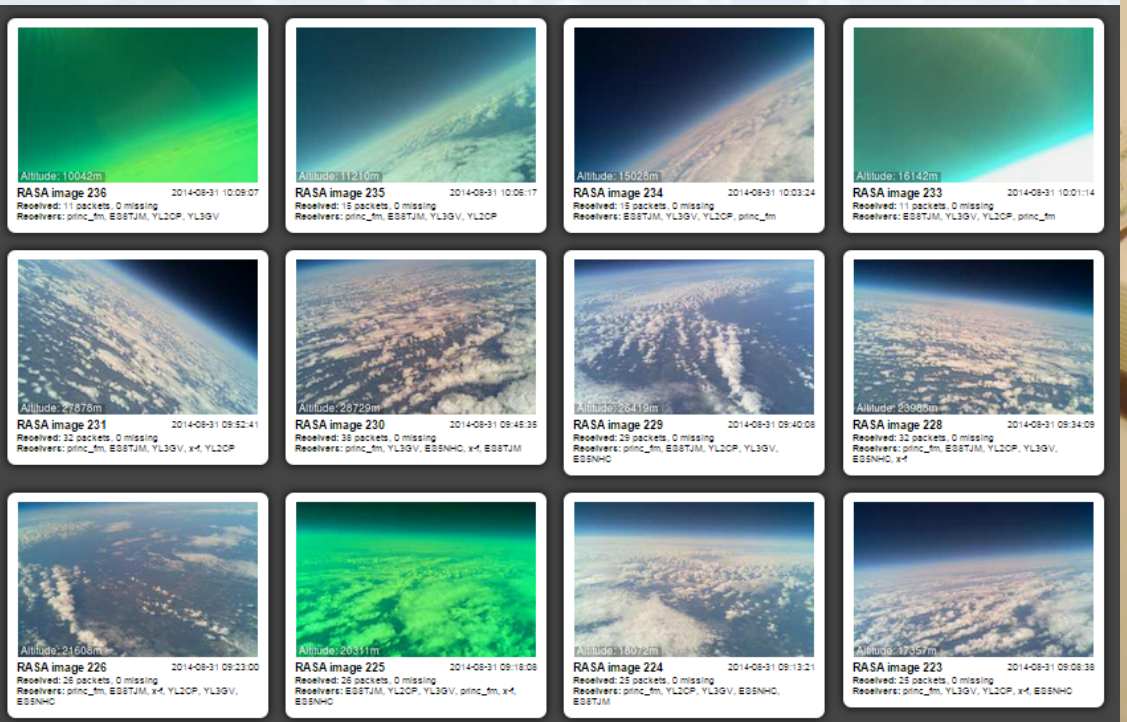
Radio horizon

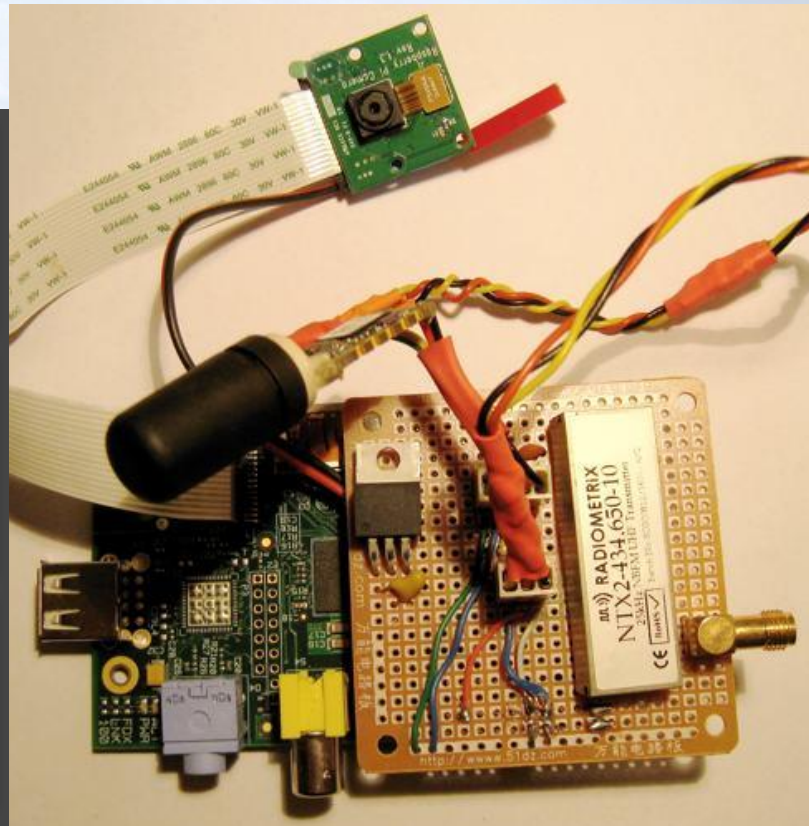
Electronics – tracker++

Live pictures with SSDV

Image packets interleaved with the telemetry

- ATmega328 + UART camera or..
- RaspberyPi + PiCam





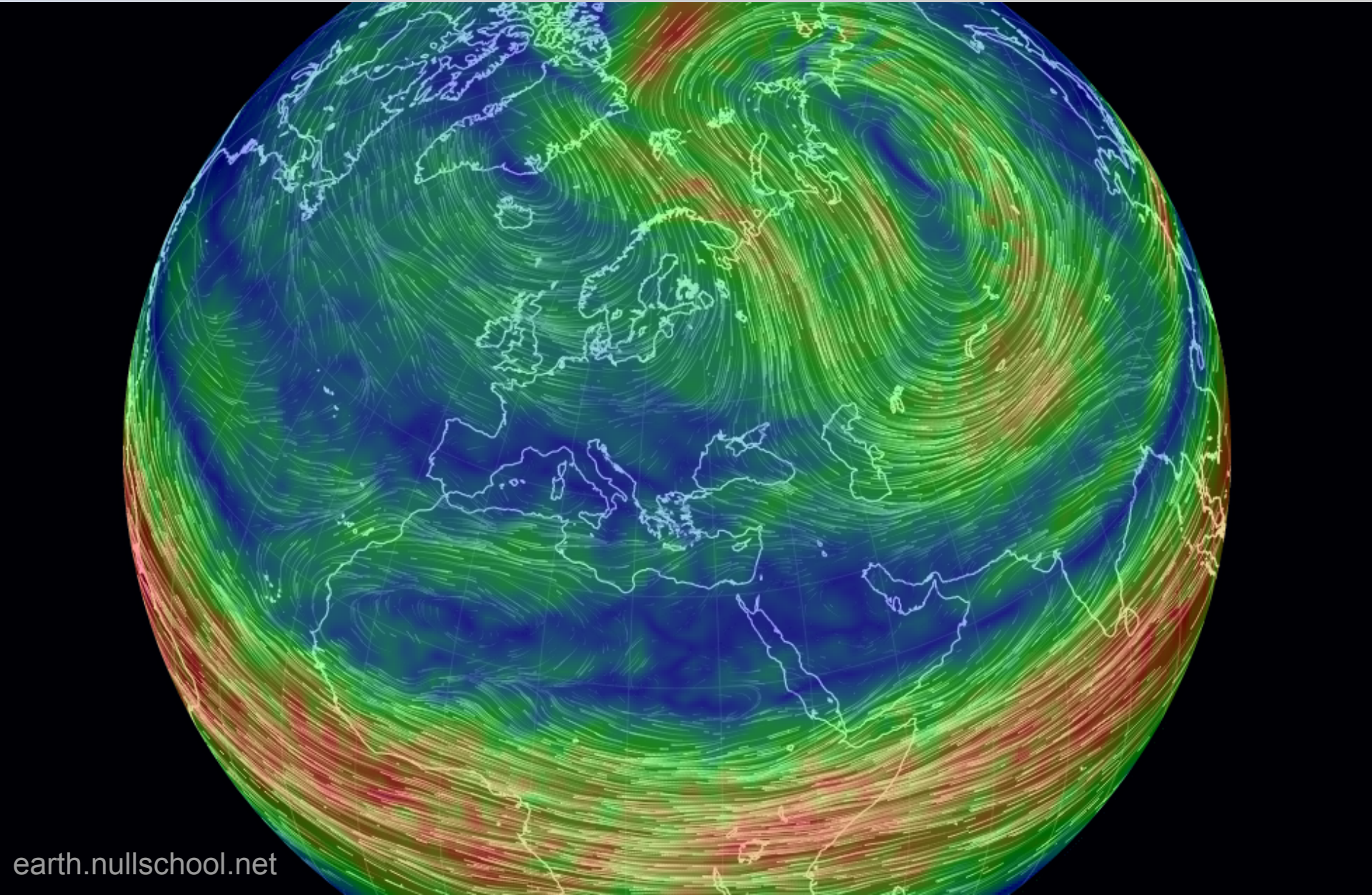
Electronics – backup comms

Relying on one untested system might be unwise, let's use another untested system as a backup..

- Nokia 6120c with GPS
- sends position reports via SMS
- of course, works only near the ground

A separate radio tracker would be a lot more useful!

Guess the balloon's flight path



earth.nullschool.net

Guess the balloon’s flight path

- NOAA GFS forecasts
  - available worldwide
  - available for free
  - updated four times each day
- **predict.habhub.org** – balloon trajectory prediction tool

Avoid if possible

- crossing the border
- flying over big cities
- landing near big cities (and waters)

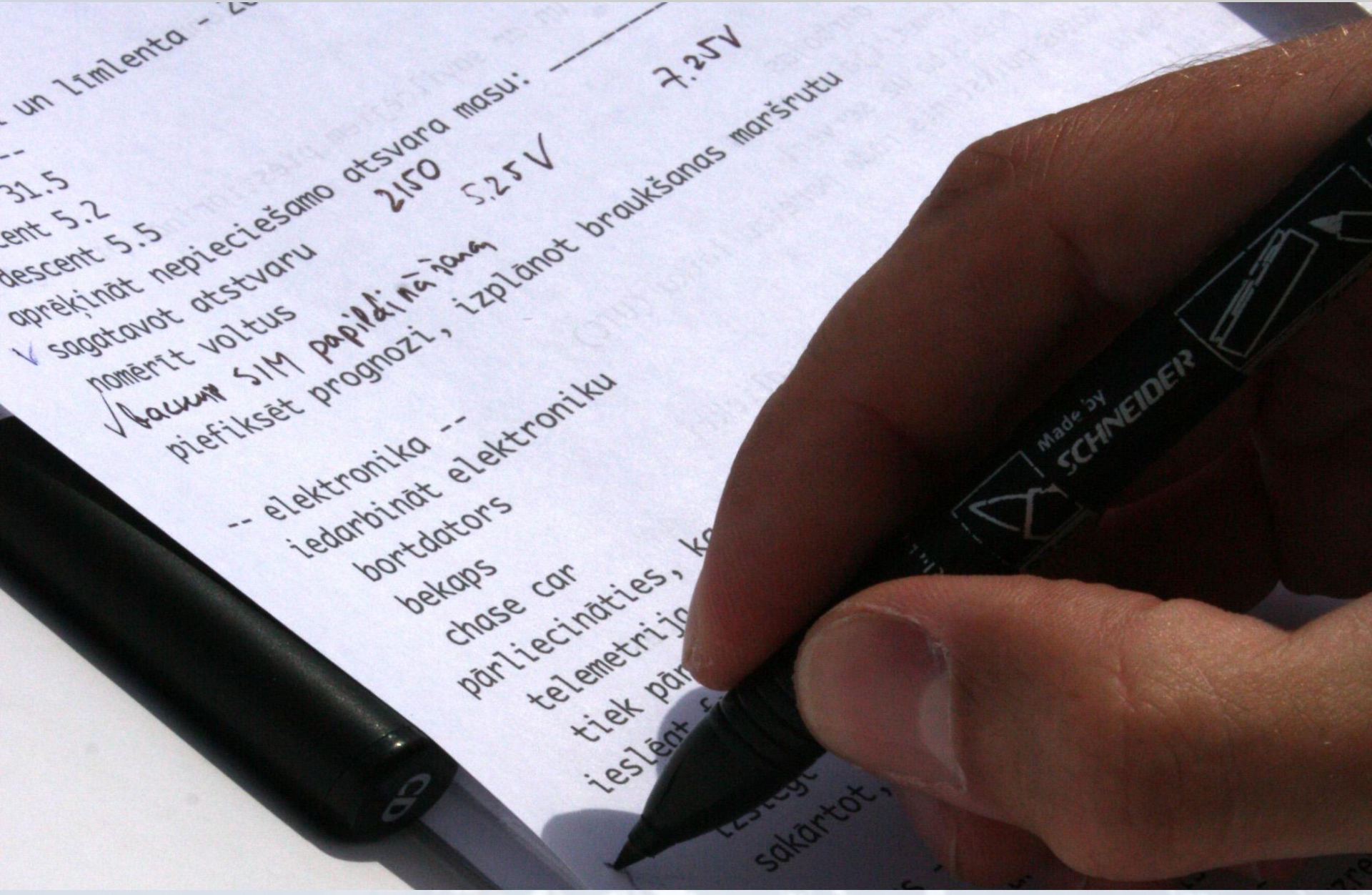
Guess the balloon's flight path

Launch day!

- Everything is ready and has been tested, tested, tested
- Permission received
- Checklist compiled
- Weather forecast confirmed
- All weighted and required lift calculated

Go!

Launch day!


un līmlenta
31.5
ent 5.2
descent 5.5
aprēķināt nepieciešamo atsvara masu:
sagatavot atstvaru
nomērīt voltus
piefiksēt prognozi, izplānot braukšanas maršrutu
-- elektronika --
iedarbināt elektroniku
bortdators
bekaps
chase car
pārliecināties,
telemetrij
tiek pār
ieslēgt
sakārtot,
Made by SCHNEIDER

Launch day!

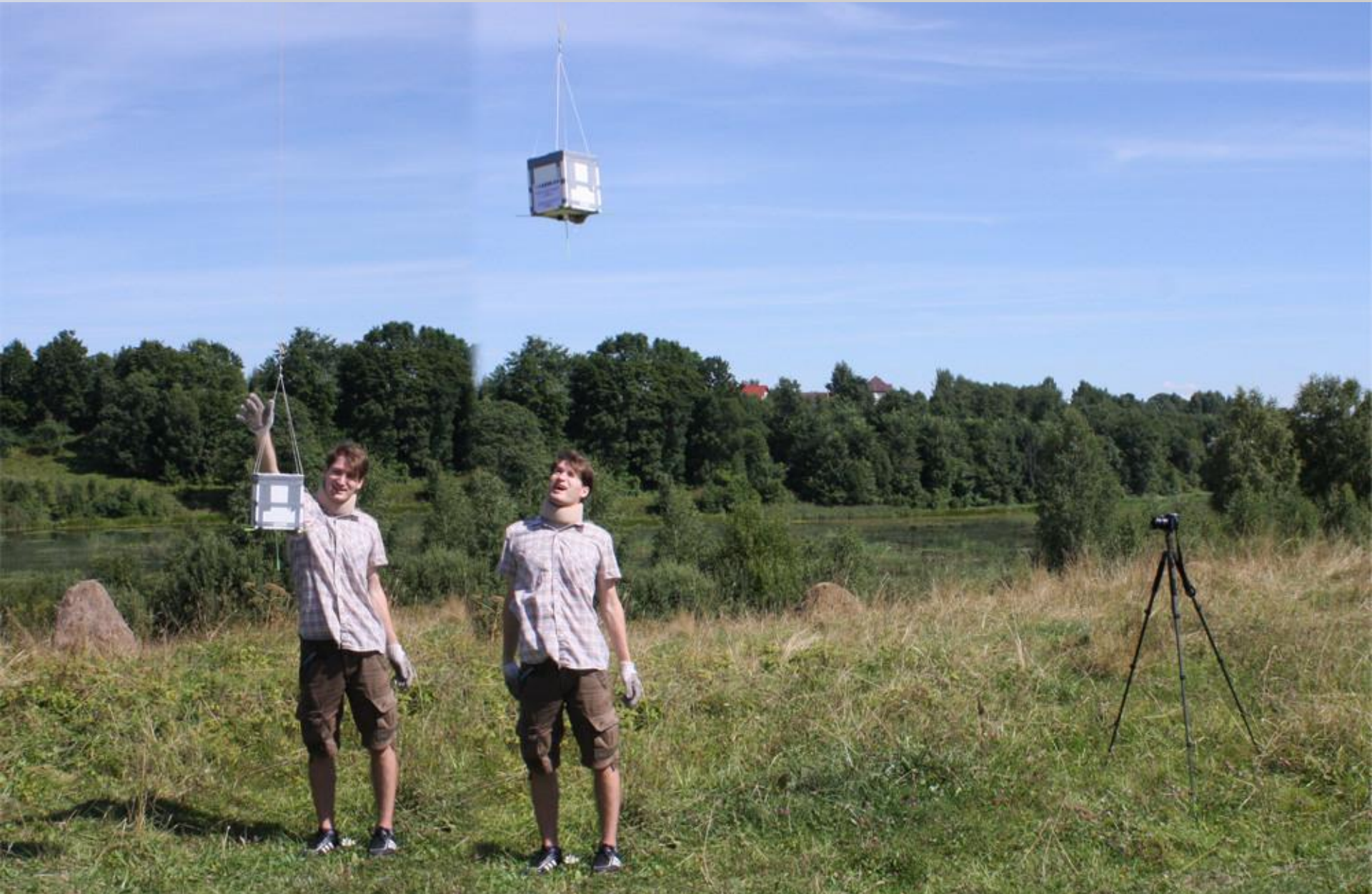
Launch day!

Launch day!

Launch day!

Launch day!

Launch day!

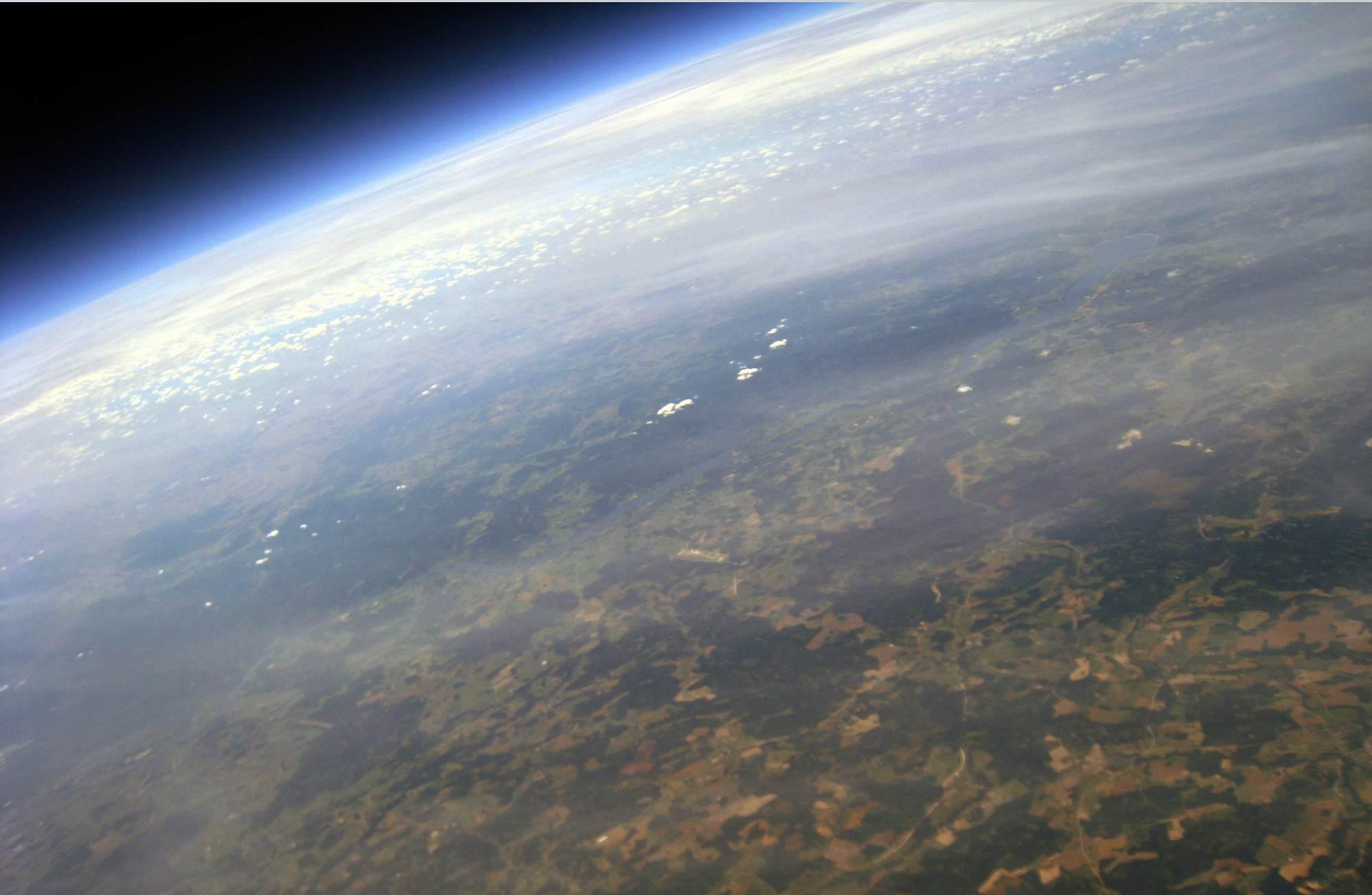


Launch day!

Launch day!

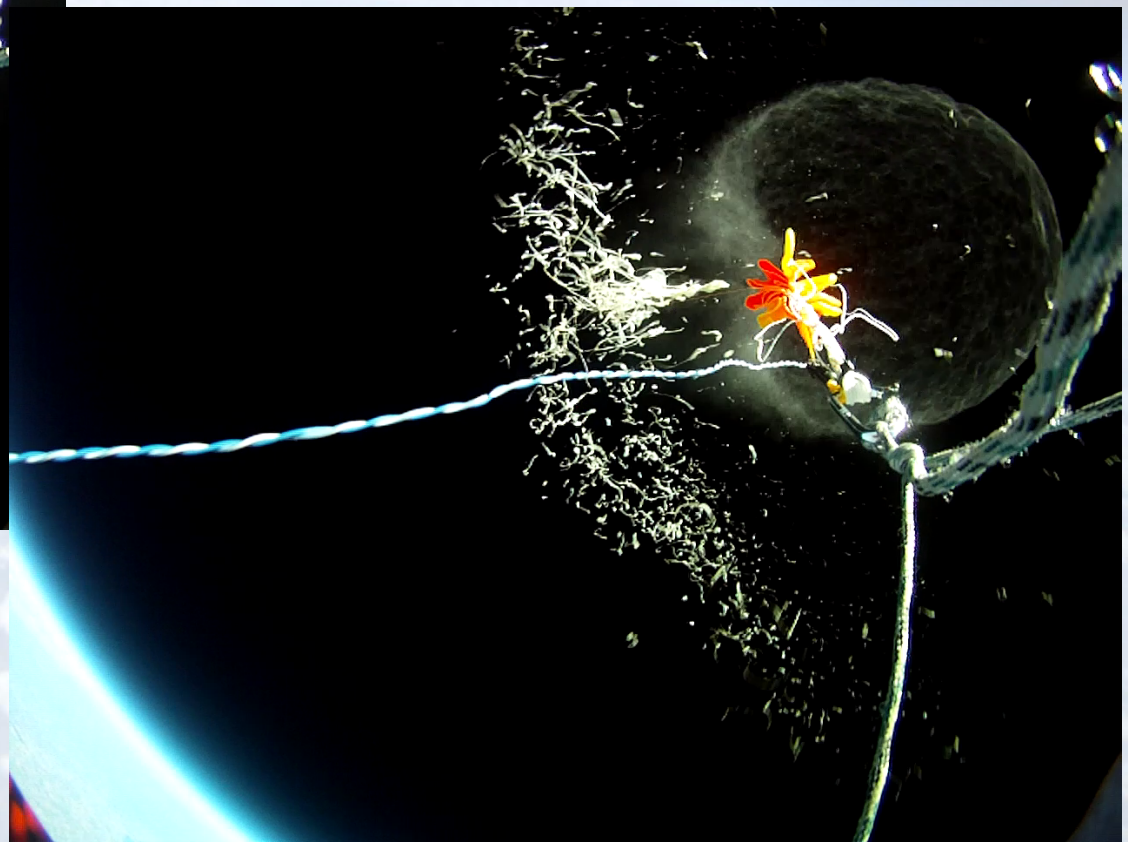
Launch day!

Launch day!



Launch day!

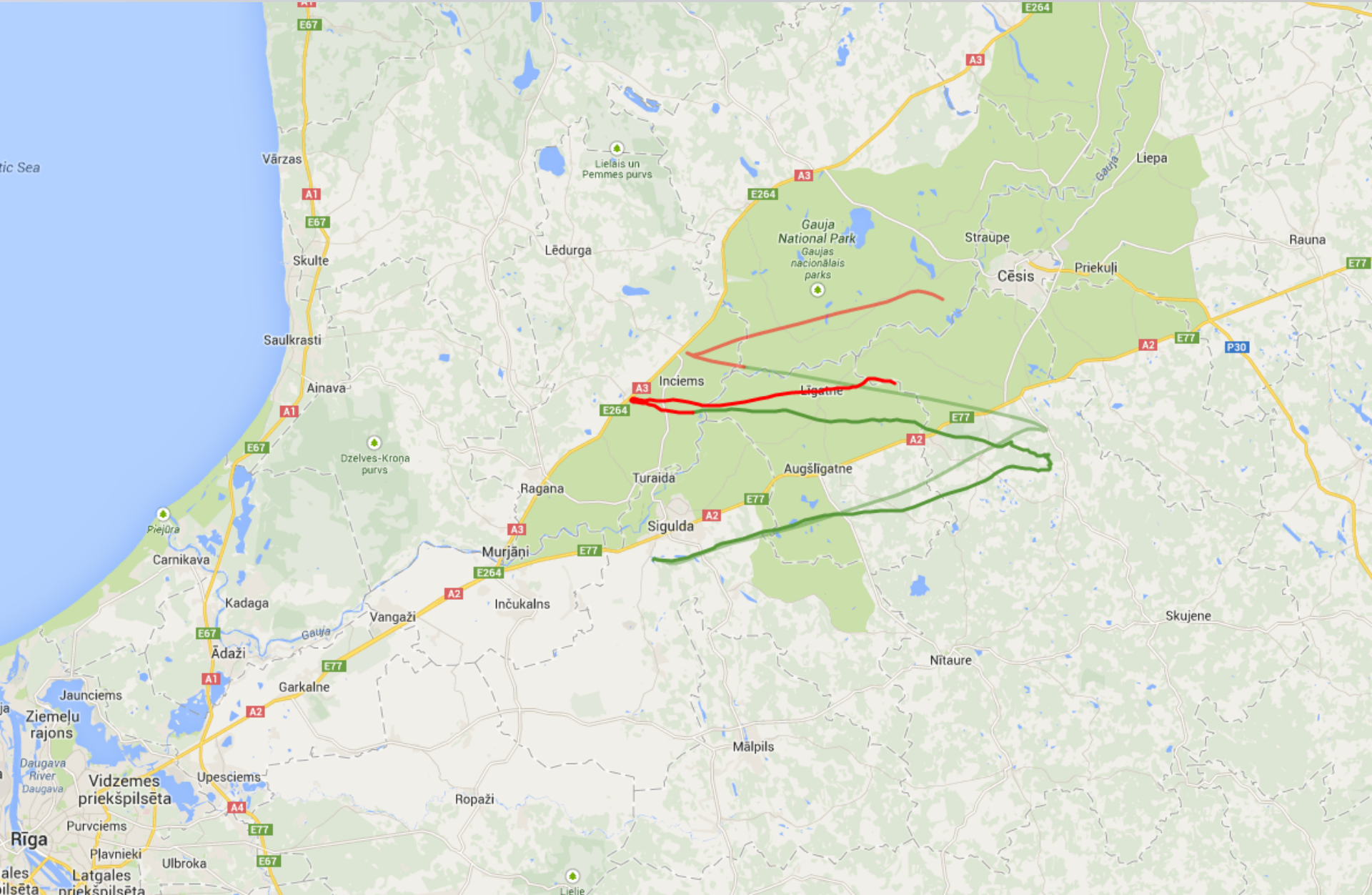
Launch day!



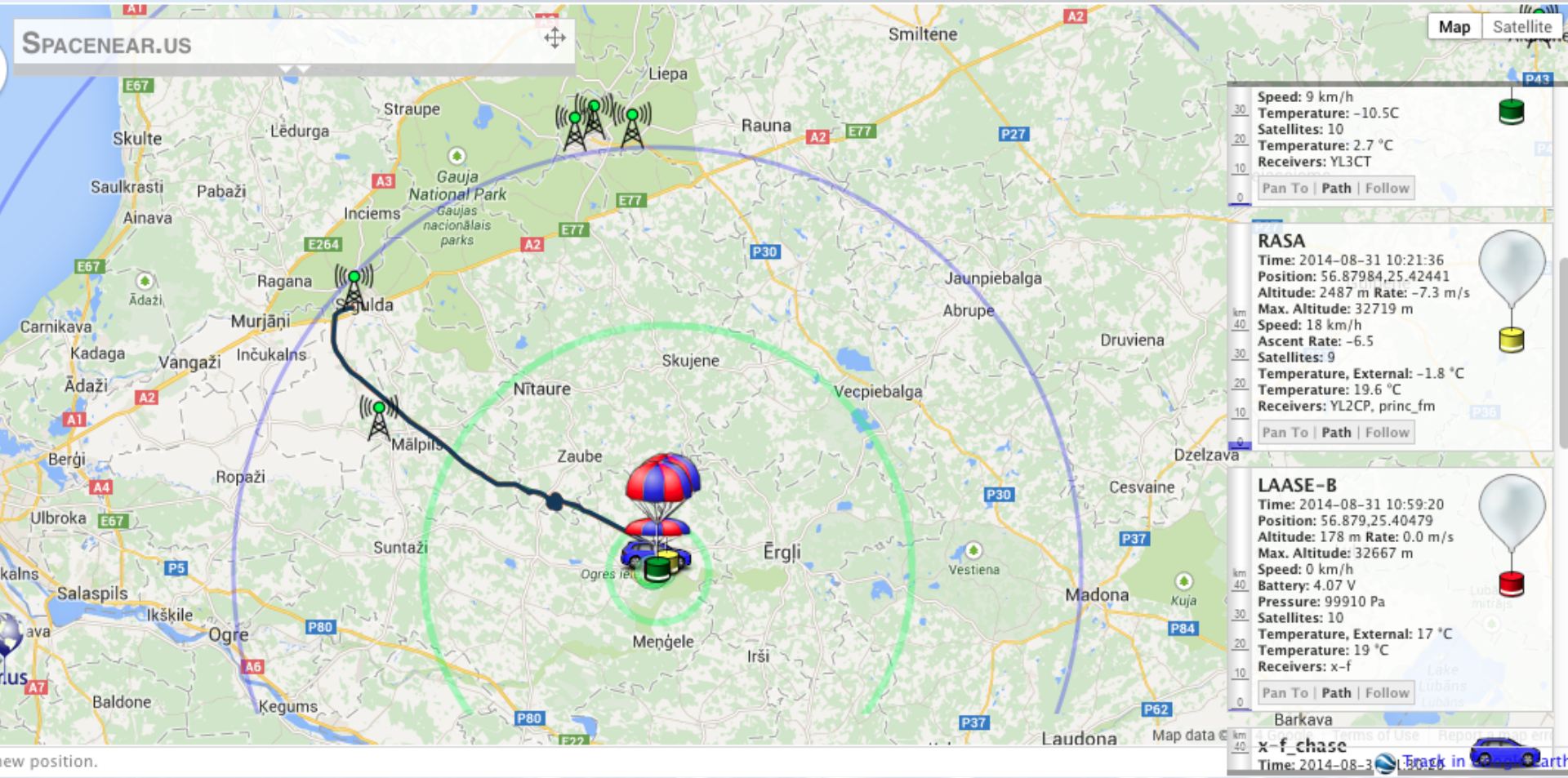
arawr.ca

Launch day!

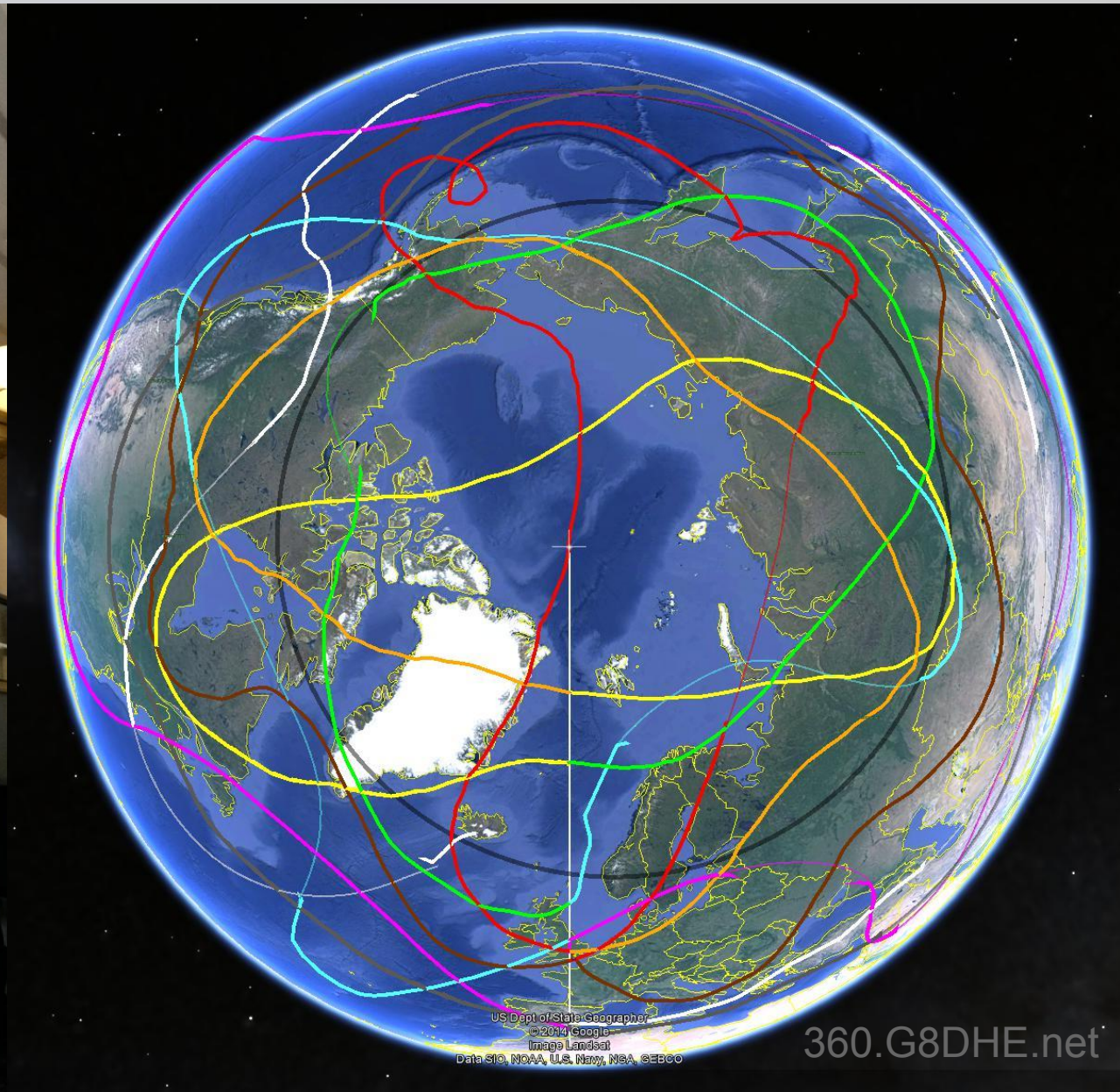
Post flight review



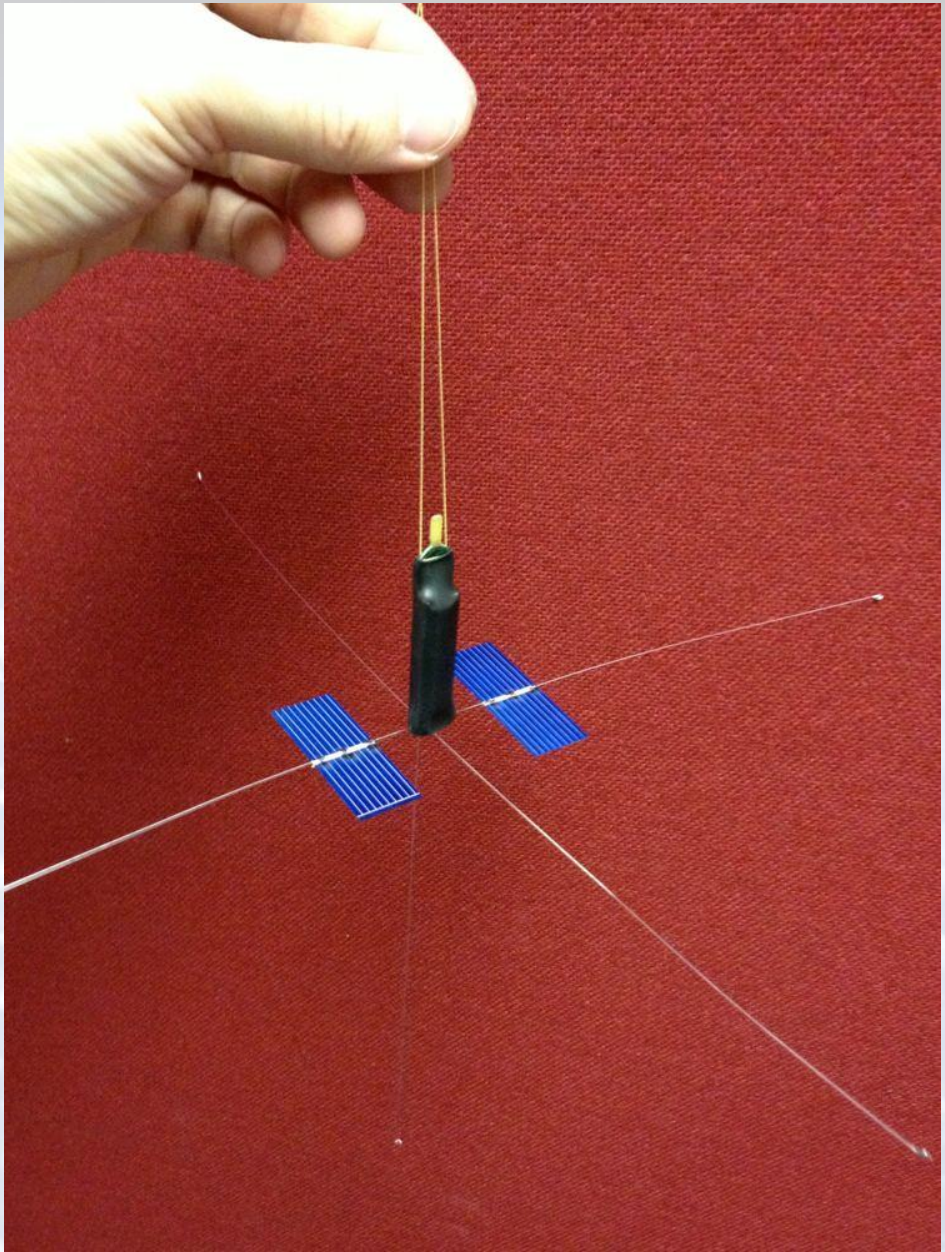
Post flight review



Trends in the world



Trends in the world



What else can be done with balloons?

various experiments

- environment measurements
- radio experiments – repeaters, SSTV, ..
- microgravity experiments
- telescopes

photo / video

stabilised platform

Solar eclipse challenge in 2017

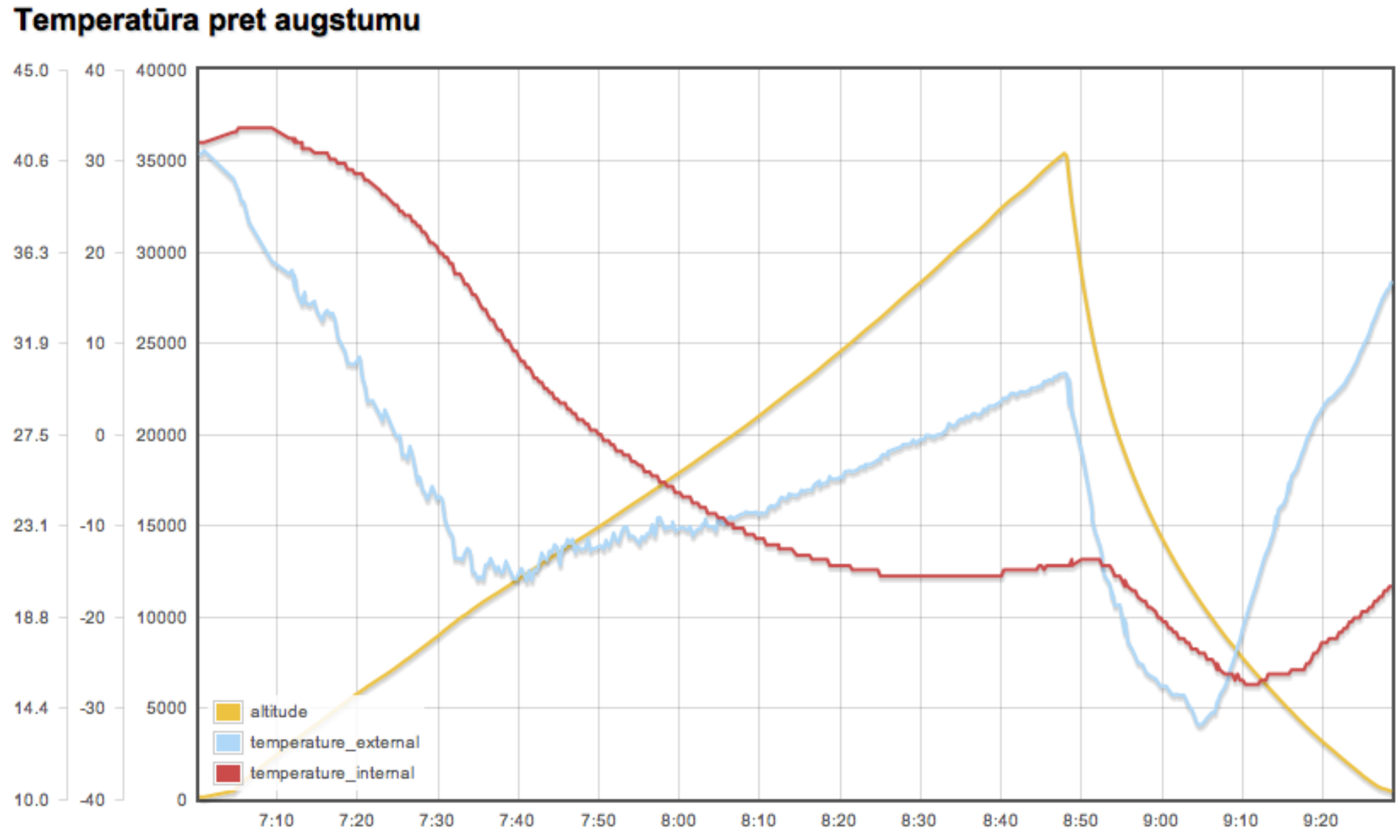
Useful resources

UKHAS.org.uk
#highaltitude @ Freenode IRC
groups.google.com/group/ukhas

SpaceNear.us
predict.habhub.org
habhub.org

FreeFM.lv
space.people.lv
space@people.lv

used materials, photos and illustrations:

Kristaps Meņģelis
Andrejs Tarans
Filips Palejs
Andris Jenerts
NASA.gov
Buzzle.com
earth.nullschool.net
CU Spaceflight
UKHAS
Leo Bodnar
Geoff G8DHE
Bill Watterson

Post flight review – graphs