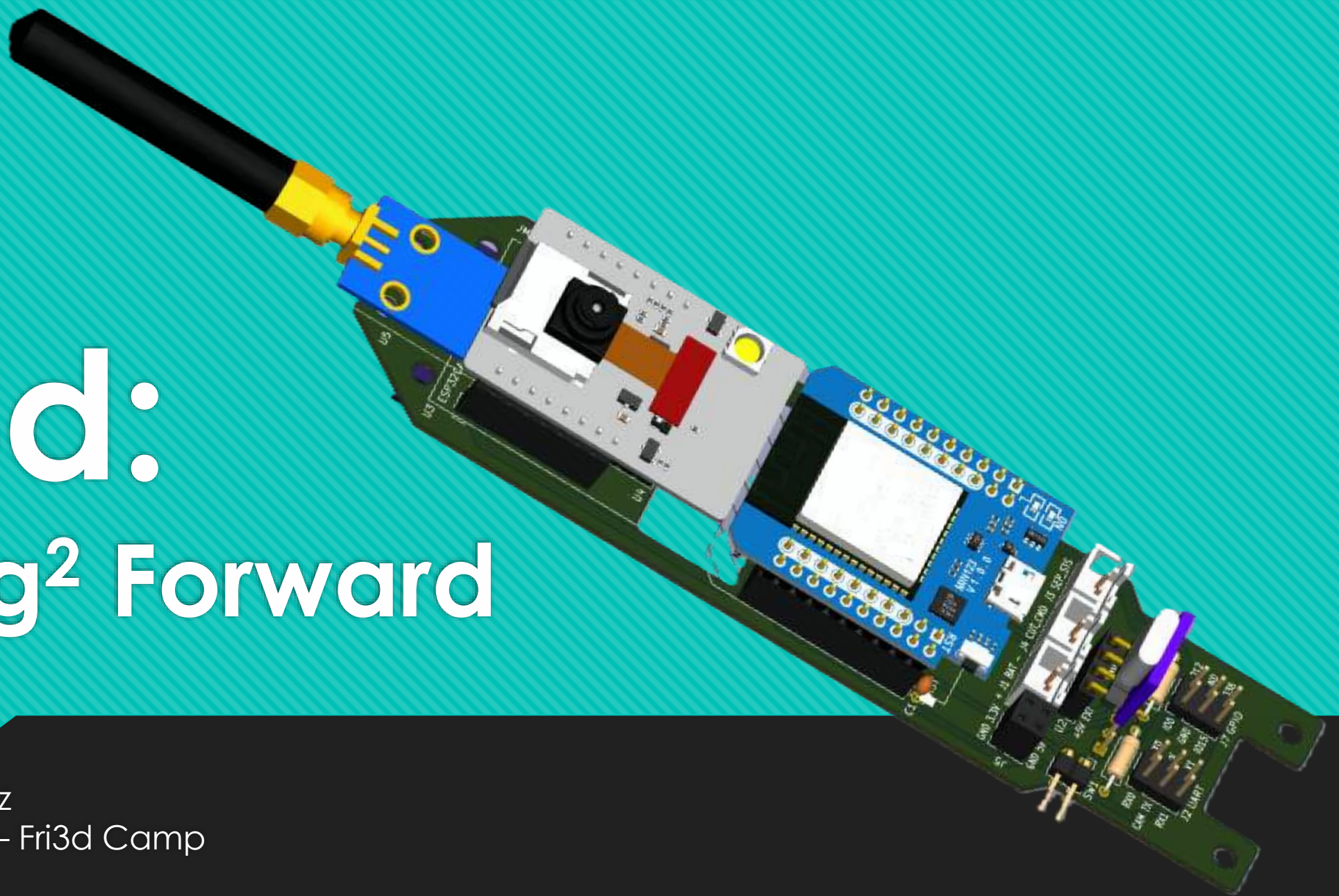


Fli3d: Failing² Forward

Jean-Marc Wislez
August 14, 2026 – Fri3d Camp



Who am I?

- Physicist from Universiteit Antwerpen / Universiteit Gent
- 25+ years of experience in Space Industry as Systems Engineer and Project Manager
- Currently working for Space Applications Services, Zaventem
- Worked on ISS Operations, Shuttle/ISS Payloads, Gateway Payload, now Moon Payloads
- Fri3d Camp 2018/2022/2024 participant

Fli3d is what happened when all this came together ...

Fli3d?

After Fri3d Camp 2018: the Fli3d idea

Design and build myself
a **payload** that can fly on top of a **micro-rocket**
that is as **cool** as possible
using my **space engineering experience**
and acquiring **hands-on experience**
to have **fun** and **improve** my PM/SE skills

2018-2024: Fli3d v1



Hardware

- ESP32 + ESP32CAM
- BMP280 (altitude) + MPU6050 (motion)
- NEO6MV2 (GPS)
- WL102-341 (433 MHz radio)
- 134N3P (charger) / 250 mAh Li-Ion battery
- 3-D printed structure + custom harness

Software

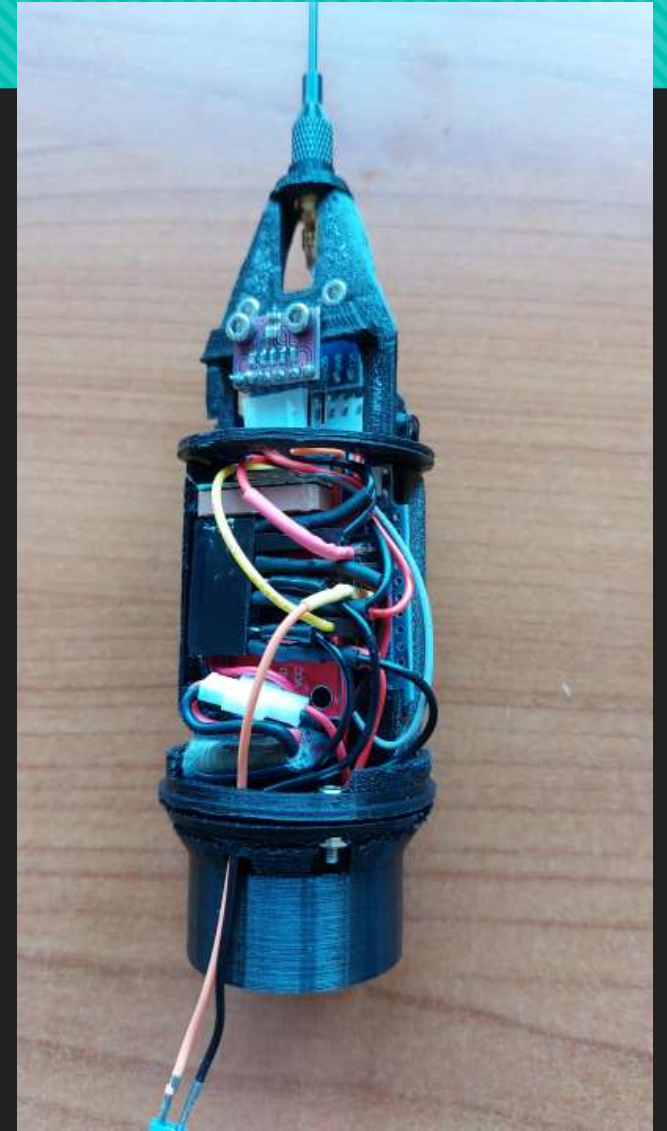
- Arduino IDE / ESP core 1.0.6
- 5000 lines of native code
- CCSDS communication over WiFi/radio + SD storage



Fli3d v1 development lessons learnt

Conceptually it all worked, but ...

- Hardware fragile and hard to assemble
- Poor physical access to hardware ports/pins
- Software too complex and configuration too opaque
- Software not stable and never finished
- ESP32 overloaded with all peripherals
- Regular SD-card corruptions
- 2.4 GHz WiFi connection unusable at Fri3d Camp





Failing ...

Fli3d Chicken

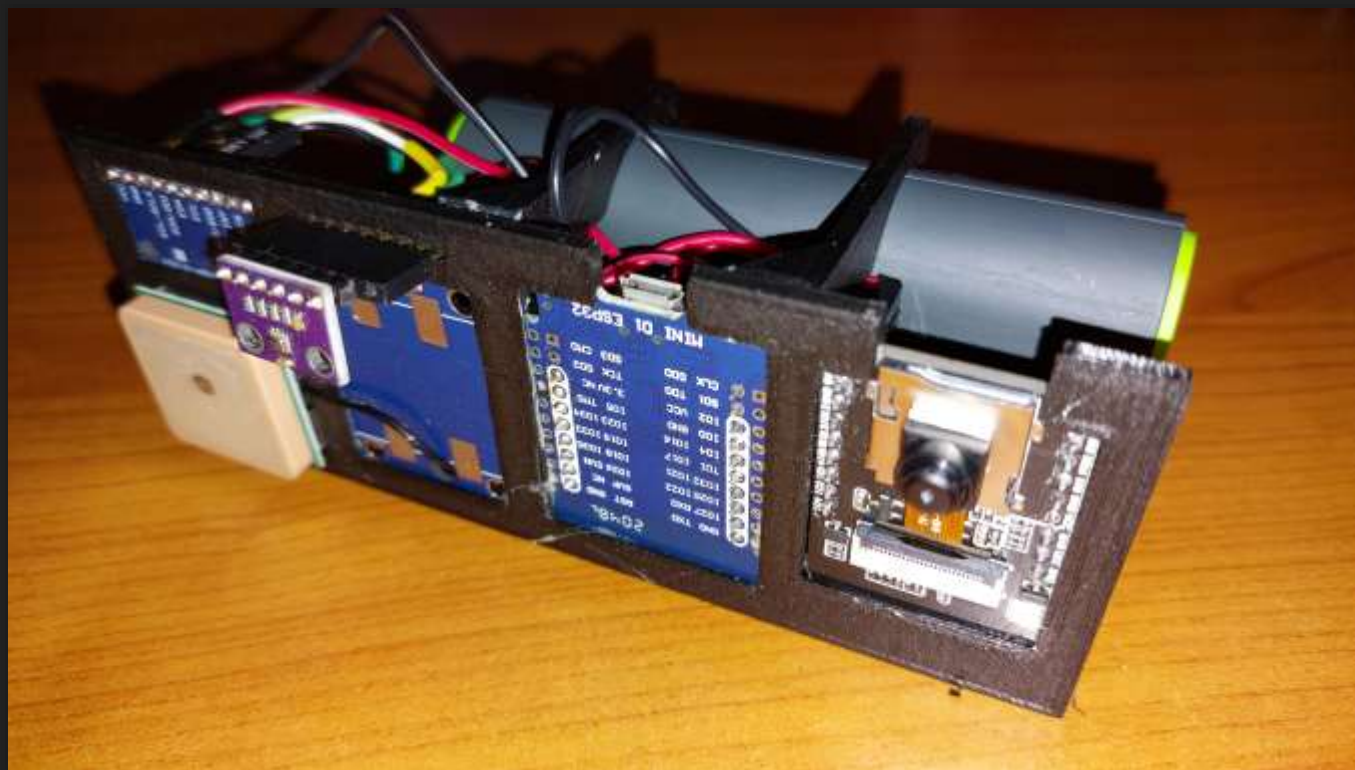
KMI weather balloon – 25 Sep 2022

Fli3d Chicken flew in 2022

- Special version for weather balloon
- Flight opportunity by KMI on September 25, 2022
- Differences:
 - Different housing
 - Larger battery
 - Internal temperature
 - MPU6050 replaced by MPU9250 (adds magnetometer)
 - Slower data sampling rate
 - No radio, and no wifi connection during flight



The hardware ...



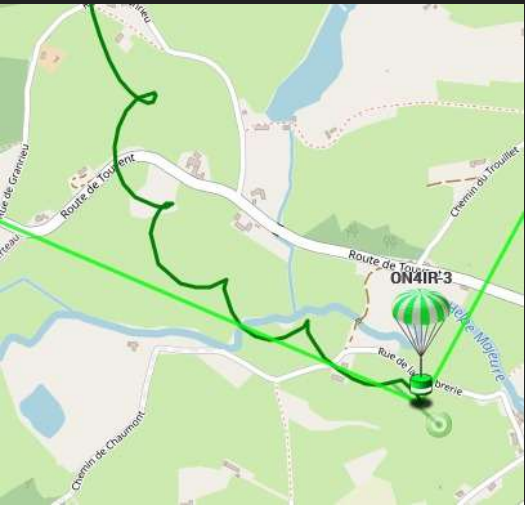
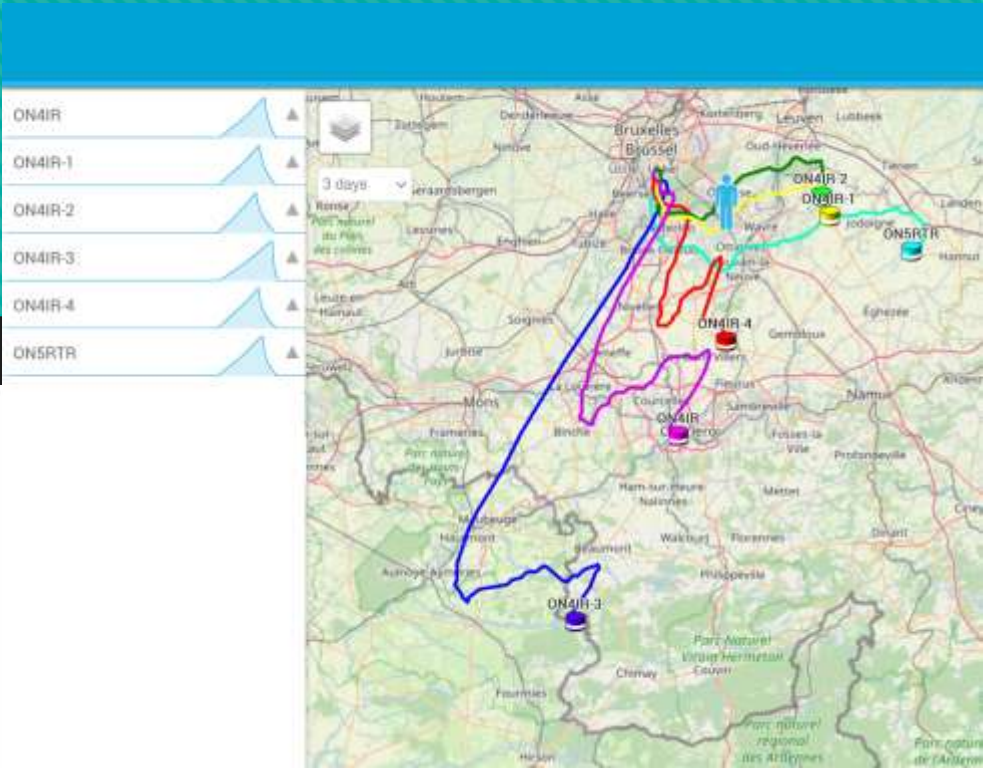
Flight preparations and launch ...

- Had prepared well with procedure and dry-run
- Flew jointly with a GPS tracker by radio amateurs
- But ...
 - Had to improvise parachute attachment
 - Software for configuration and check-out not working
 - Tried hack ... in the blind ...
 - SD card fried, and computer reboot needed
 - Extreme time pressure



Flight characteristics

Event	Details
Platform	IRM/KMI weather balloon ON4IR-3 tracker
Launch	25/09/2022 15:18:31 UTC IRM/KMI Uccle, Belgium
Burst	25/09/2022 17:26:35 UTC at 37085 m altitude Rupture from parachute line and start of freefall, with speeds up to 700 km/h
Crash	25/09/2022 17:39:58 UTC in a field near Eppe-Sauvage, France (76.86 km distance), at 65 km/h
Duration	Ascent: 2h08m03s Descent: 13m25s Total: 2h21m28s



Fli3d Chicken Results

- Hack did not work: no pictures ...
- Housing very performant thermally and mechanically
- Battery performed very well
- Several small issues with electronics, but all survived
- Good internal recording of telemetry

Full report on <https://github.com/jmwislez/fli3d/>



Fli3d Chicken Lessons learnt

The electronics survived and worked pretty well, but ...

- Means to activate camera without software communication
- Need better reboot handling with operations mode control
- Implement robust time synchronization
- Not depend on SD cards
- Stronger structural attachment to parachute
- Send live TM via radio amateur probe (modified RS41) via UART



Failing ...

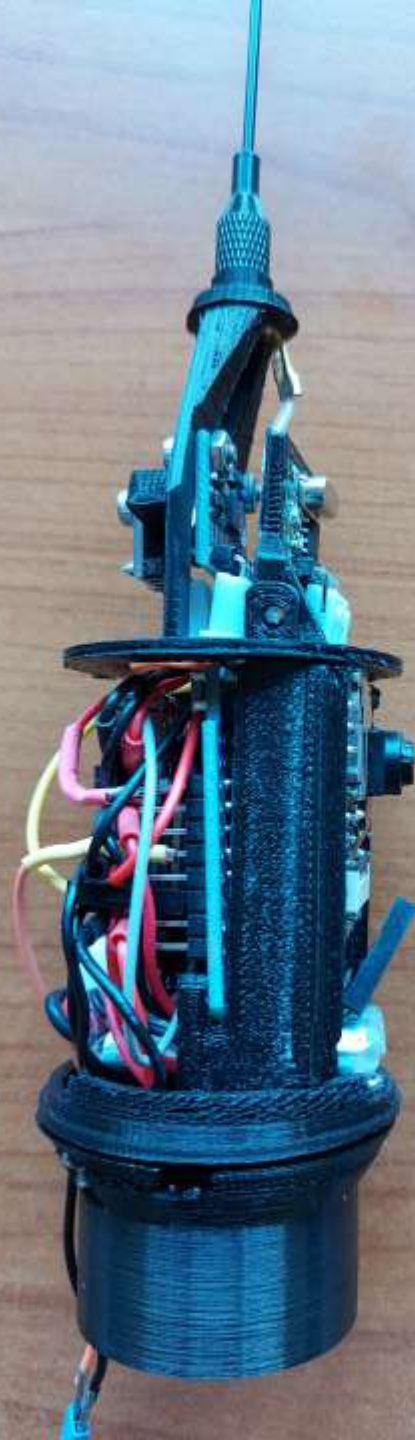
Fli3d Aubergine

Microrocket – Fri3d Camp 2024

Fli3d Aubergine microrocket flew at Fri3d Camp 2024

- Height (without antenna): 50 cm
- Height (with antenna): 65 cm
- Diameter: 35 mm
- Mass: 145 g
- Motor: C6-3
- Parachute: 45 cm by Klima
- Fins: 3D printed (3)
- Stability number: 4.94 calibre
(anything above 1.0 is considered stable)
- Significantly improved software stability

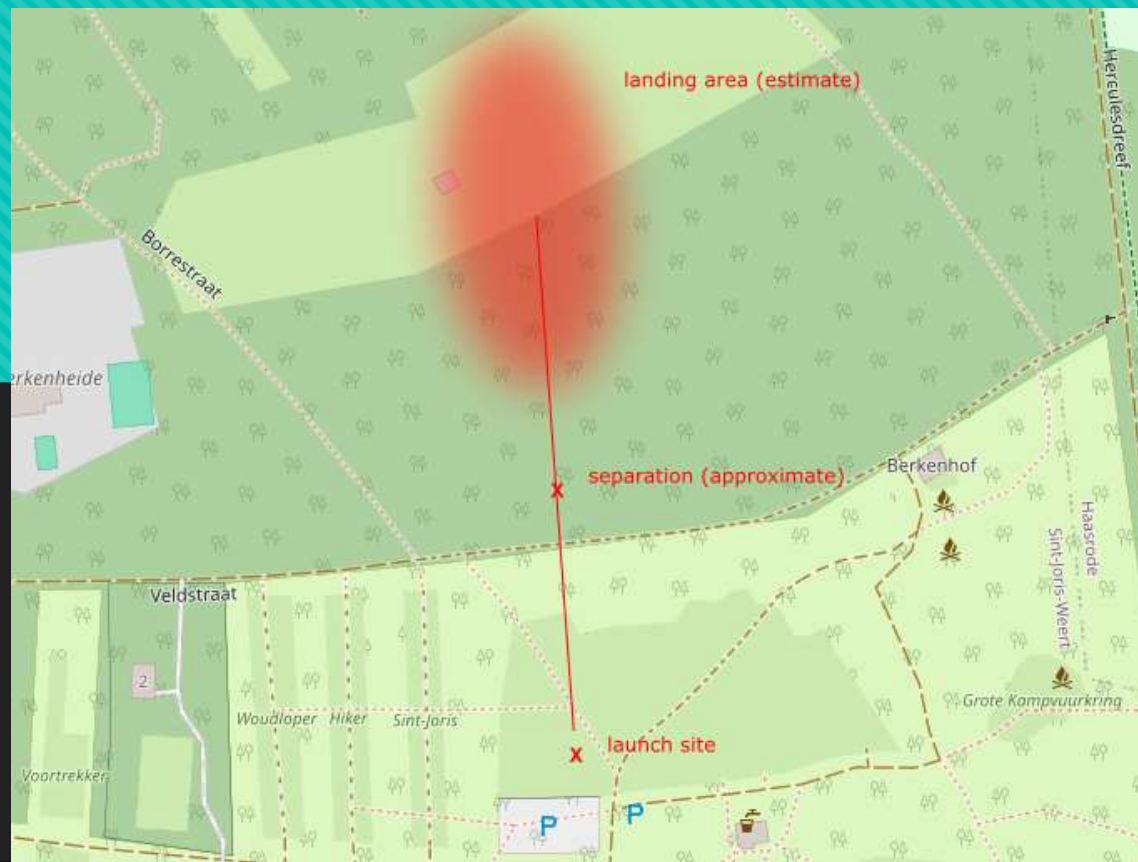




Fli3d Aubergine Flight report

- Checkout showed all systems except GPS working and activated
- Reboot after untethering before launch:
 - Loss of Wifi connection
 - Loss of time sync
 - Loss of opsmode
- Horizontal flight
- Messy separation
- Hardware lost in tree/bushes (thanks Sebastiaan and David!)
- One TM packet received after landing (over radio)



TM_RADIO (APID 50)

pkt ctr	215
millis	248538
mode	checkout
errors	0
warnings	0

	ESP32	CAM
FS / SD		
serial	 	 
wifi	  	 
data storage		 

pressure	
height	0 m
velocity_v	0 m/s
temperature	35 °C

motion	
tilt	112 °
g-level	1.0 G
a	-2 m/s ²
rpm	0 rpm

gps	
satellites	0
velocity	0 m/s
velocity_v	0 m/s
height	0 m

camera 
image ctr 0

sep / state static

215s = 3m35s after untethering

After untethering, the system rebooted properly

ESP32 has no data from ESP32CAM
(known problem)

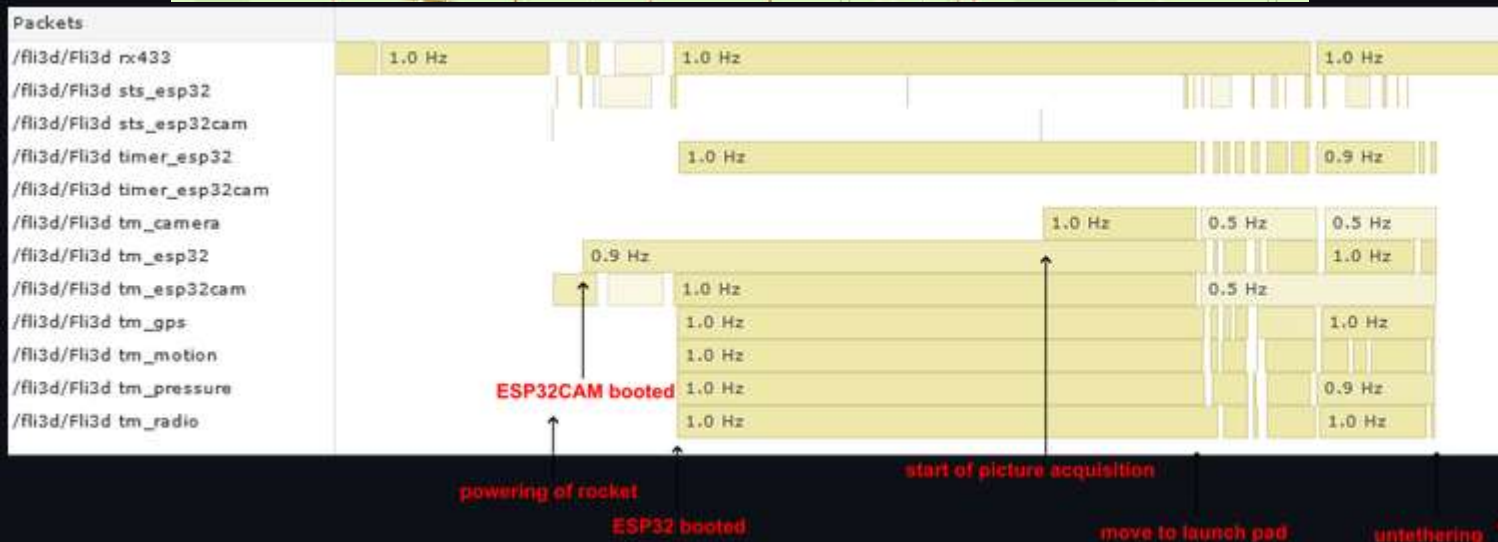
No Wi-Fi connection available
TM properly stored in internal memory drive

No valid height/velocity as in "checkout"
the pressure sensor is in calibration mode

The payload is almost horizontal
Normal gravity, so no acceleration (so flight is over)
Acceleration with gravity subtracted
(known to be inaccurate)

GPS did not lock (known problem)

No data from camera (known problem:
ESP32CAM is not talking to ESP32)
Separation from rocket detected, and rocket is static
(this is after landing)



Fli3d Aubergine Lessons learnt

It could have been almost perfect, but ...

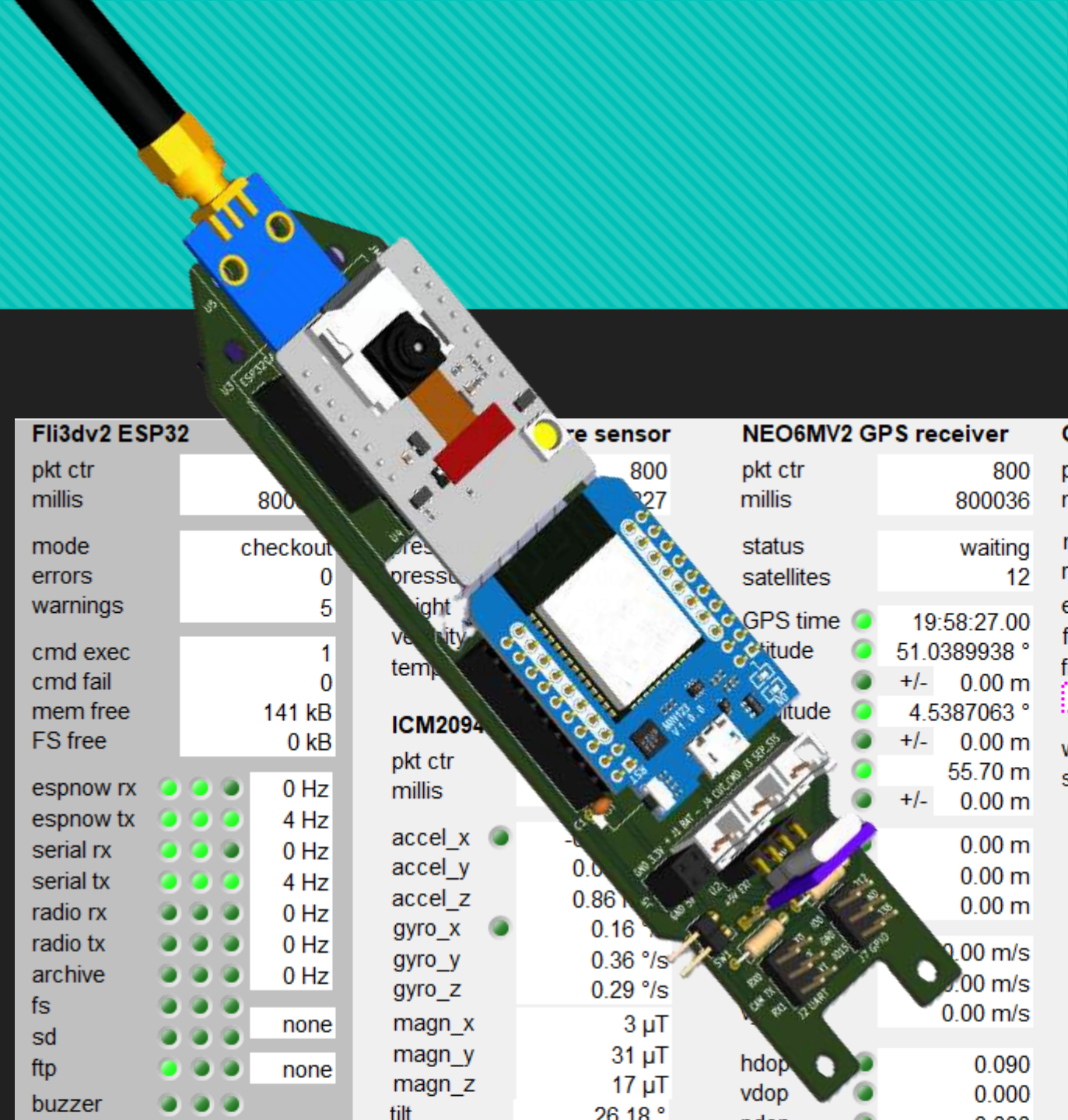
- PLA parts disforms with electronics heating and when stored in tent
- Don't launch alone in a rush
- Improve and permanently monitor communication
- Don't rely on WiFi
- Better reboot handling
- Lower stability number for rocket
- Better attachment to parachute
- Think of recovery means and strategy

Forward!

Fli3dv2

Fli3dv2

- Complete redesign of:
 - Hardware
 - Software
 - Communications
 - Operations
- Addressing the Fli3d lessons learnt

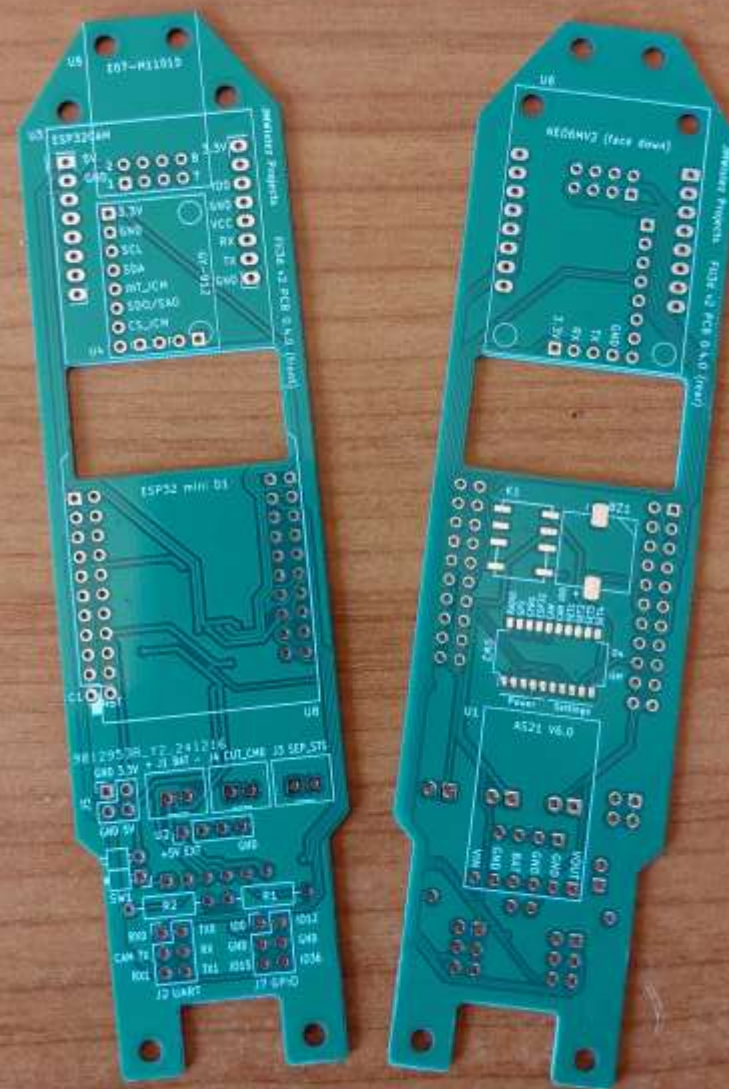


Distracting side project ...



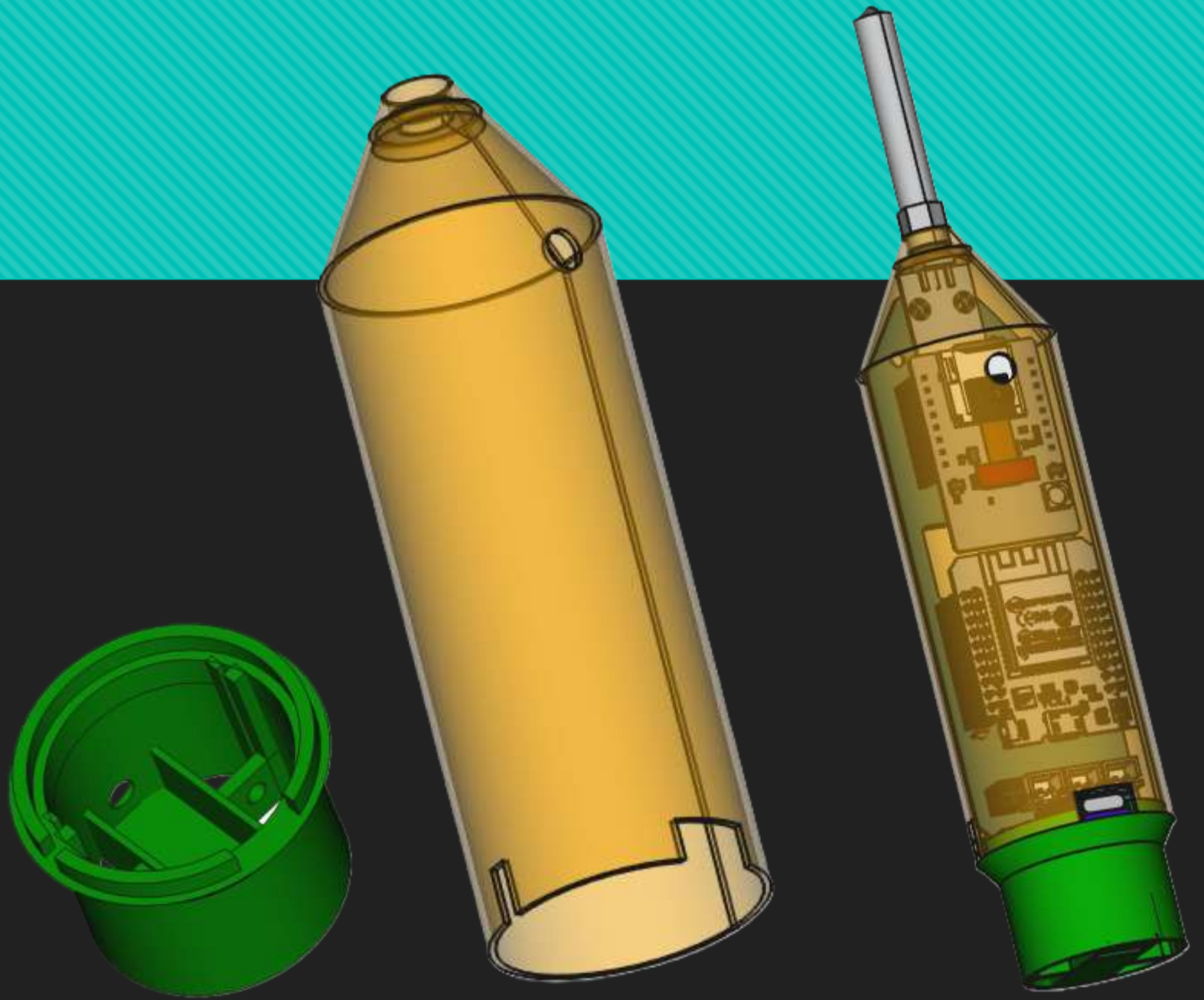
PCB

- Designed with KiCAD after Fri3d Camp 2024 intro (thanks xans!)
- 2 layers
- Easier assembly
- Sockets for temporary mount and test pins
- No harness needed
- Less mechanical structure needed



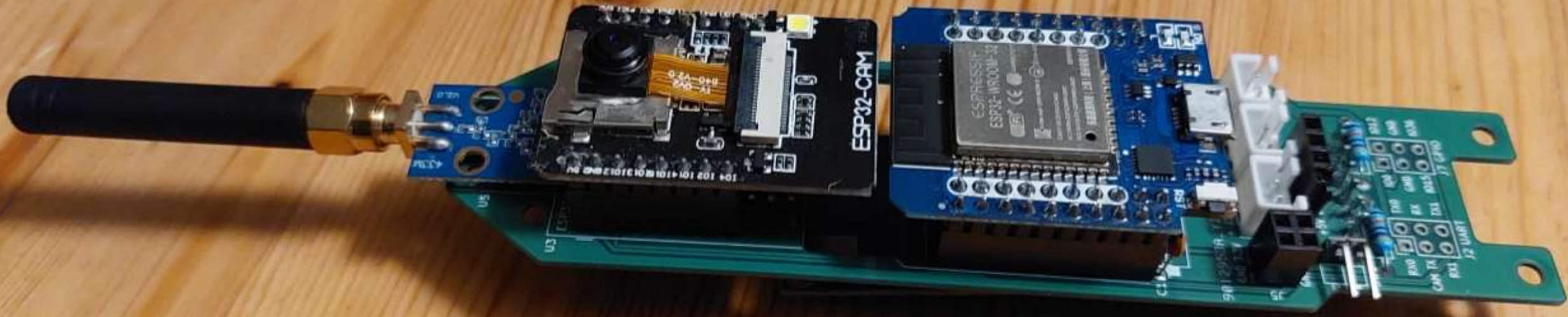
Structure

- Designed with FreeCAD
- 3D printed parts + PCB
- Simpler:
 - only 2 instead of 6 parts
 - easier to print
 - no screws or glue



Updated peripherals

- 433 MHz Radio: WL102-341 -> CC1101
- Motion + pressure: MPU6050 + BMP280 -> GY-912 (ICM20948 + BMP388)
- Added battery voltage measurement
- Added DIP switch bank
- Added active buzzer
- Added relay and electromagnet for parachute release
- Battery charger: 134N3P -> AS21
- Larger Li-ION battery (250 mAh -> 700 mAh)



Ground segment / Yamcs

- Same hardware as Fli3d payload
- Similar software with different software configuration
- ESP-NOW and radio communications
- USB over serial comms with Yamcs on laptop
- Yamcs and Yamcs Studio for:
 - TM/TC handling
 - Visualisation
 - TM archiving
- VLC for video display and recording

Fli3dv2 ESP32

pkt ctr

801

millis

800072

mode

checkout

errors

0

warnings

5

cmd exec

1

cmd fail

0

mem free

141 kB

FS free

0 kB

espnow rx

0 Hz

espnow tx

4 Hz

serial rx

0 Hz

serial tx

4 Hz

radio rx

0 Hz

radio tx

0 Hz

archive

0 Hz

fs

none

sd

none

ftp

none

buzzer

pressure

1 Hz

motion

1 Hz

gps

1 Hz

wifi ap

0 dB

wifi sta

time

ota

sep / state

static

BMP388 Pressure sensor

pkt ctr

800

millis

799827

pressure

1023.95 hPa

pressure_0

0.00 hPa

height

-92.88 m

velocity_v

0.00 m/s

temperature

28.6 °C

ICM20948 Motion sensor

pkt ctr

800

millis

799841

accel_x

-0.49 m/s²

accel_y

0.03 m/s²

accel_z

0.86 m/s²

gyro_x

0.16 °/s

gyro_y

0.36 °/s

gyro_z

0.29 °/s

magn_x

3 µT

magn_y

31 µT

magn_z

17 µT

tilt

26.18 °

g-level

0.00 G

a

0.00 m/s²

rpm

0.00 rpm

accel range

+/-16 g

gyro range

+/-2000 °/s

Event messages ESP32

pkt ctr

19

NEO6MV2 GPS receiver

pkt ctr

800

millis

800036

status

waiting

satellites

12

GPS time

19:58:27.00

latitude

51.0389938 °

+/- 0.00 m

longitude

4.5387063 °

+/- 0.00 m

altitude

55.70 m

+/- 0.00 m

x

0.00 m

y

0.00 m

z (height)

0.00 m

v_north

0.00 m/s

v_east

0.00 m/s

v_down

0.00 m/s

hdop

0.090

vdop

0.000

pdop

0.000

latitude_0

0.0000000 °

longitude_0

0.0000000 °

altitude_0

0.00 m

OV2640 camera

pkt ctr

#####

millis

#####

mode

#####

resolution

#####

exposure

#####

file size

#####

filename

#####

wifi xfer

#####

sd save

#####

Fli3dv2 ESP32CAM

pkt ctr

#####

millis

#####

mode

#####

errors

#####

warnings

#####

cmd exec

#####

cmd fail

#####

mem free

#####

FS free

#####

SD free

#####

espnow rx

#####

espnow tx

#####

serial rx

#####

serial tx

#####

archive

#####

fs

#####

sd

#####

ftp

#####

flashlight

Di Di Di

camera

#####

wifi ap

#####

wifi sta

#####

time

ota

#####

Set OpsMode

Reboot

Fli3dv2 GNDCTRL

pkt ctr

350

millis

353000

mode

nominal

errors

0

warnings

0

cmd exec

0

cmd fail

0

mem free

145 kB

FS free

0 kB

SD free

0 kB

espnow rx

4 Hz

espnow tx

0 Hz

serial rx

0 Hz

serial tx

5 Hz

radio rx

0 Hz

radio tx

0 Hz

archive

0 Hz

fs

none

sd

none

ftp

none

buzzer

wifi ap

wifi sta

0 dB

time

ota

Reboot

Set OpsMode

Set timestamp to 2026-08-11 19:41:45.003

subsystem esp32 type cmd_resp

Full software rewrite

- Arduino ESP Core 1.0.6 -> 3.3.11
- Arduino IDE -> Visual Studio Code + PlatformIO
- Different library choices
- Smarter functions and more readable code
- 5000 lines -> 4000 lines with strongly improved functionality
- OTA update

Operability

- Display to show/change configuration
- Memory banks to store configurations
- DIP switches for hardware overrides
- ESP-NOW not depending on WiFi
- Define and train operational roles:
 - Launch operator
 - TM watcher (launch procedure)
 - Visual watcher (binoculars)
 - Recovery team (trackers)

	ESP32 packet routing			
	espnow	serial	radio	archive
TC_ESP32	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TC_ESP32CAM	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TC_GNDCTRL	☒ on/off	☒ on/off	☒ on/off	☒ on/off
STS_ESP32	☒ on/off	☒ on/off	☒ on/off	☒ on/off
STS_ESP32CAM	☒ on/off	☒ on/off	☒ on/off	☒ on/off
STS_GNDCTRL	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_ESP32	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_GPS	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_MOTION	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_PRESSURE	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_RADIO	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_ESP32CAM	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_CAMERA	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TM_GNDCTRL	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TMR_ESP32	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TMR_ESP32CAM	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TMR_GNDCTRL	☒ on/off	☒ on/off	☒ on/off	☒ on/off
CFG_ESP32	☒ on/off	☒ on/off	☒ on/off	☒ on/off
CFG_ESP32CAM	☒ on/off	☒ on/off	☒ on/off	☒ on/off
CFG_GNDCTRL	☒ on/off	☒ on/off	☒ on/off	☒ on/off
Speed (baud)		115200	2000	
RX enable	☒ on/off	☒ on/off	☒ on/off	☒ on/off
TX enable	☒ on/off	☒ on/off	☒ on/off	
Buffer enable	☒ on/off	☒ on/off	☒ on/off	☒ on/off

Recoverability

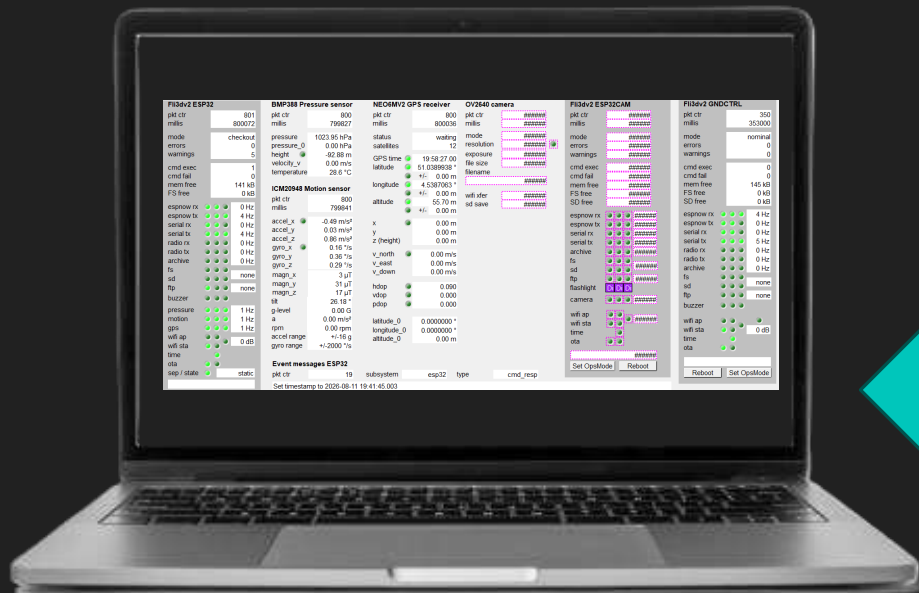
- Bright orange and reflective tape
- Add contact information
- Buzzer
- Stronger parachute attachment
- Parachute cutter
- WiFi AP broadcast
- Portable ESP-NOW receiver
- Maybe: Flashing light from ESP32CAM (transparent printing)

Fli3d v2 development lessons learnt

Feels like a tremendous improvement, but ...

- Aliexpress quality and configuration control poor
 - ESP32 brownout on good power supply
 - Change of pinouts (A21 battery loader)
 - Partial functionality (CC1101 interrupt pins)
- Aliexpress prices significantly increasing
- Minor update of PCB will be needed
- Again not ready for launch at Fri3d Camp 2026

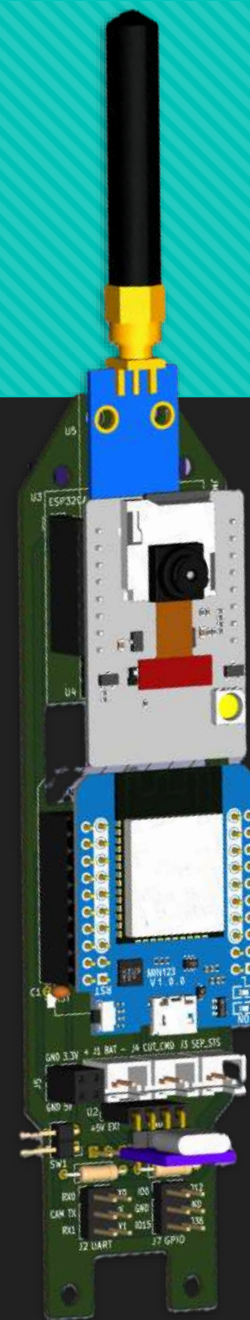
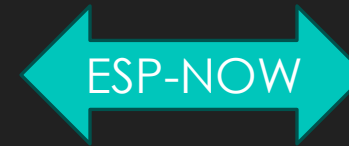
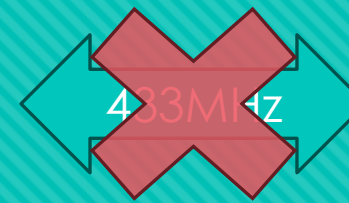
Demo



Yamcs

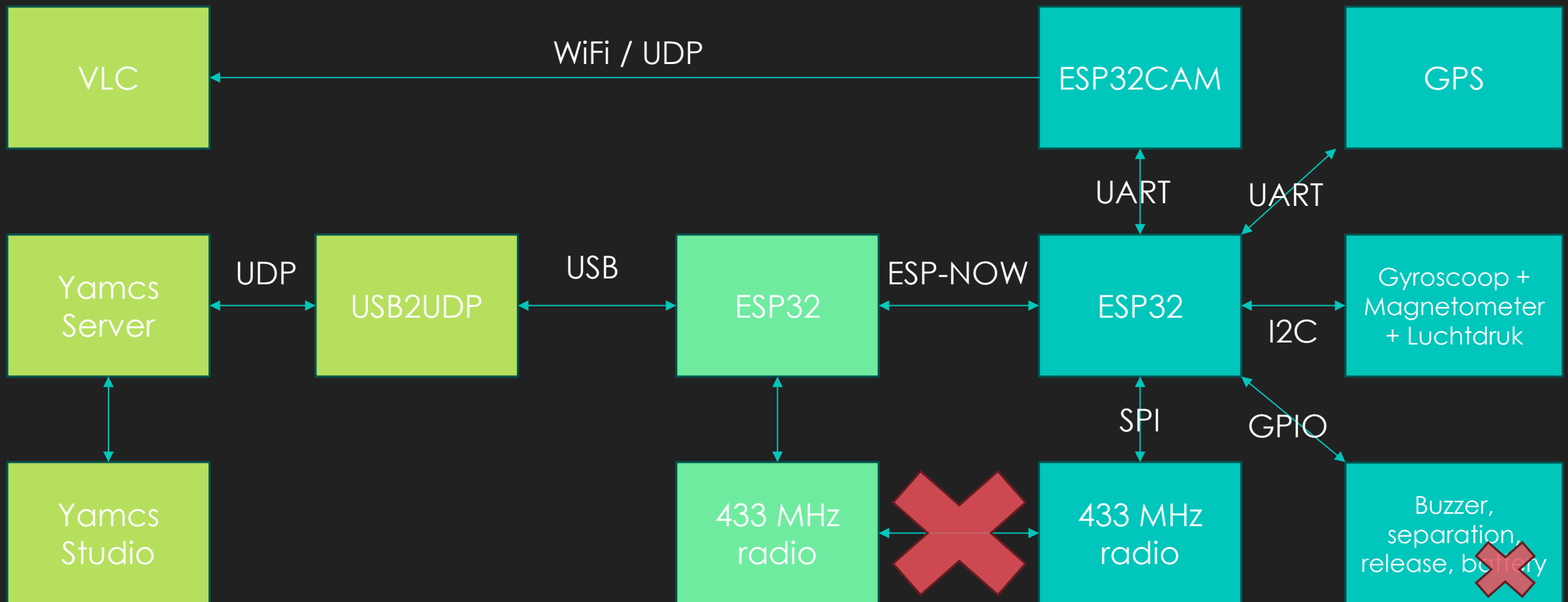


gndctrl



Fli3dv2

Behind the scenes



Roadmap to Fli3d Banana

- Debug/repair hardware (radio, charging, ESP32CAM comms)
- Debug software (catch crash reports)
- Improve handling of modules (derived data and higher data rates)
- Design rocket with correct stability
- Dry-run of launch with team
- Launch with team



More info

- <https://github.com/jmwislez/fli3d>
 - C code
 - Design descriptions
 - Fli3d Chicken and Fli3d Aubergine flight reports
- <https://github.com/jmwislez/fli3dv2>
 - C code
 - FreeCAD 3D design
 - KiCAD PCB design
 - Yamcs configuration
- jmwislez@gmail.com



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