IMC 2019

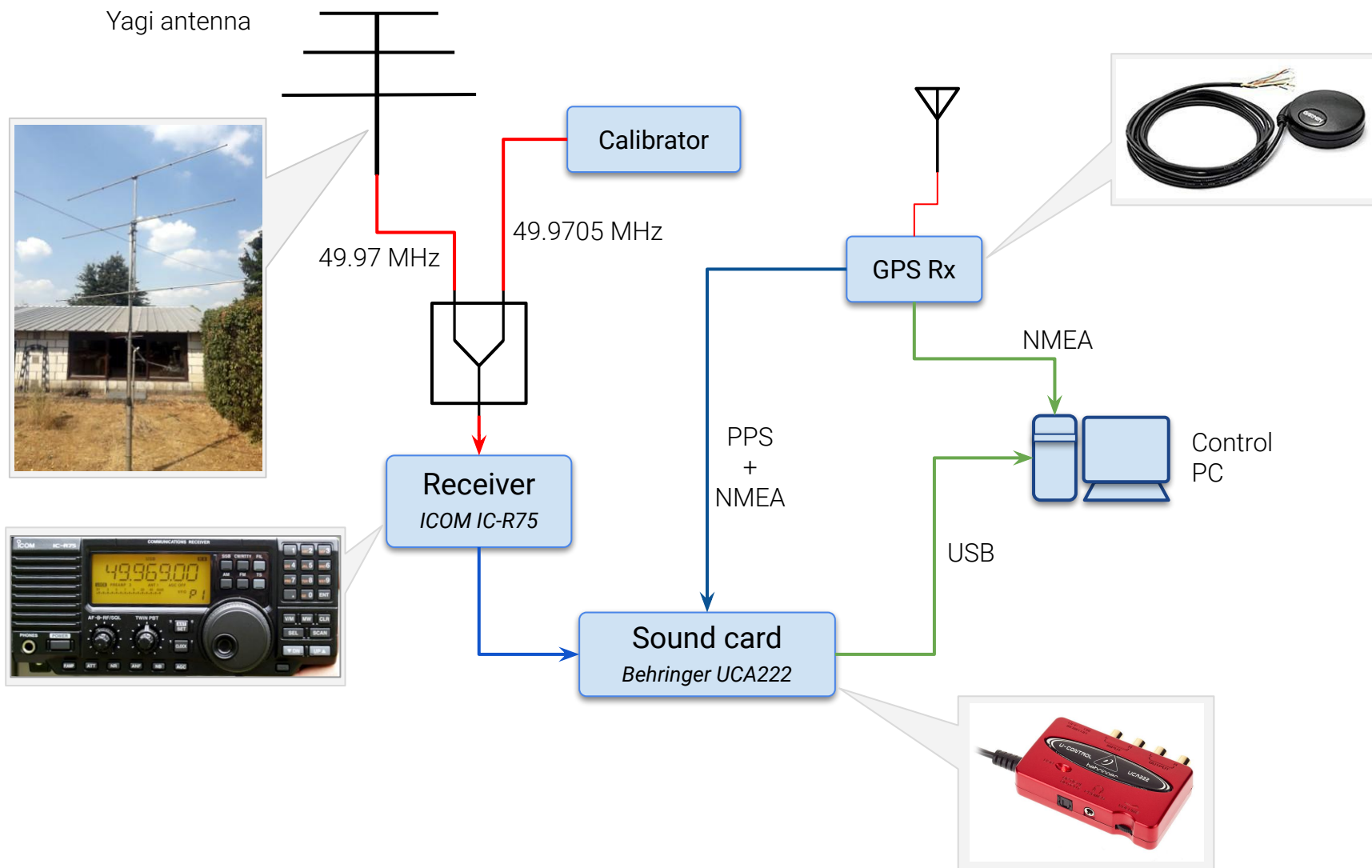# The BRAMS receiving station V2.0

Michel Anciaux, Hervé Lamy, Antoine Calegaro,
Antonio Martínez Picar, Sylvain Ranvier, Stijn Calders,
and Cis Verbeeck

BIRA·IASB

Solar-Terrestrial
Centre of Excellence

Current BRAMS basic station

Yagi antenna

Calibrator

49.9705 MHz

49.97 MHz

GPS Rx

NMEA

Receiver
ICOM IC-R75

PPS
+
NMEA

Control
PC

USB

Sound card
Behringer UCA222

IMC 2019

Current BRAMS station – Rx Issues

Reliability

- <u>Ageing</u>: several years of continuous operation
- Many have already failed!
- New types of degradation already observed
- This can only get worse!

Current BRAMS station − Rx Issues

Availability

- <u>No longer produced</u>
- Alternative analogue Rx are <u>more expensive</u>
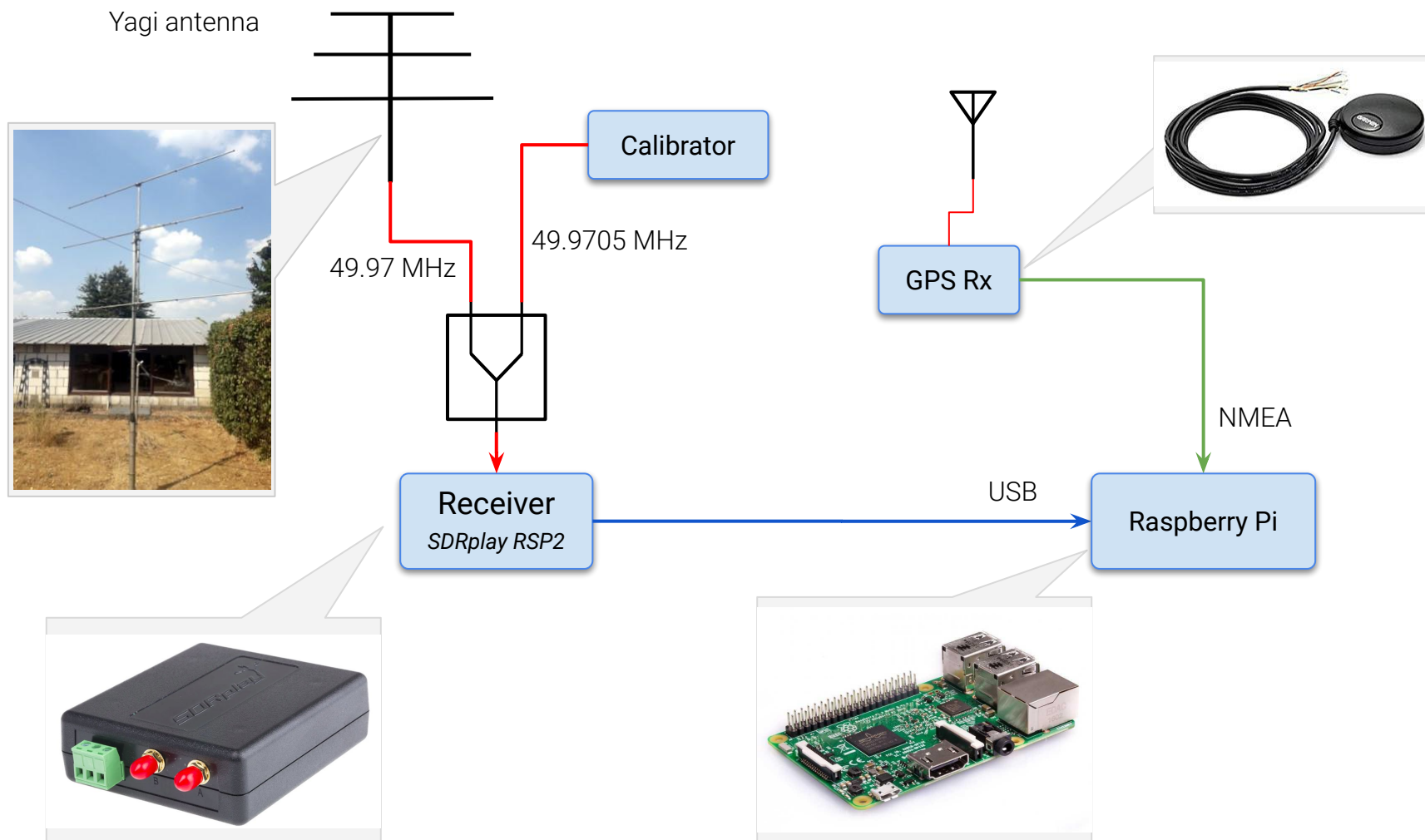- Market trend → software defined radio (SDR)

Reliability

- <u>Ageing</u>: several years of continuous operation
- Many have already failed!
- New types of degradation already observed
- This can only get worse!

Current BRAMS station – Rx Issues

Availability

- <u>No longer produced</u>
- Alternative analogue Rx are <u>more expensive</u>
- Market trend → software defined radio (SDR)

Reliability

- <u>Ageing</u>: several years of continuous operation
- Many have already failed!
- New types of degradation already observed
- This can only get worse!

Performance Limitations

- Limited dynamic range ~36 dB
- Noise temperature ≈1000 K
- Frequency instability:
  - LO dependent on temperature (10 Hz/°C)
  - LO cannot be locked to a reference

BRAMS station V2.0

Yagi antenna

Calibrator

49.9705 MHz

49.97 MHz

GPS Rx

NMEA

Receiver
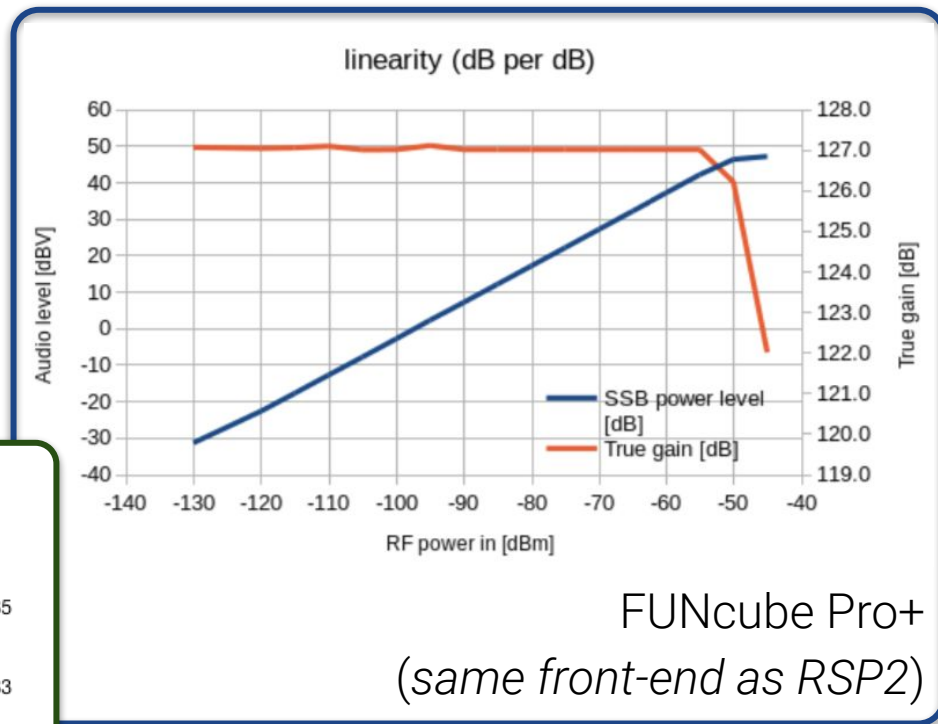*SDRplay RSP2*

USB

Raspberry Pi

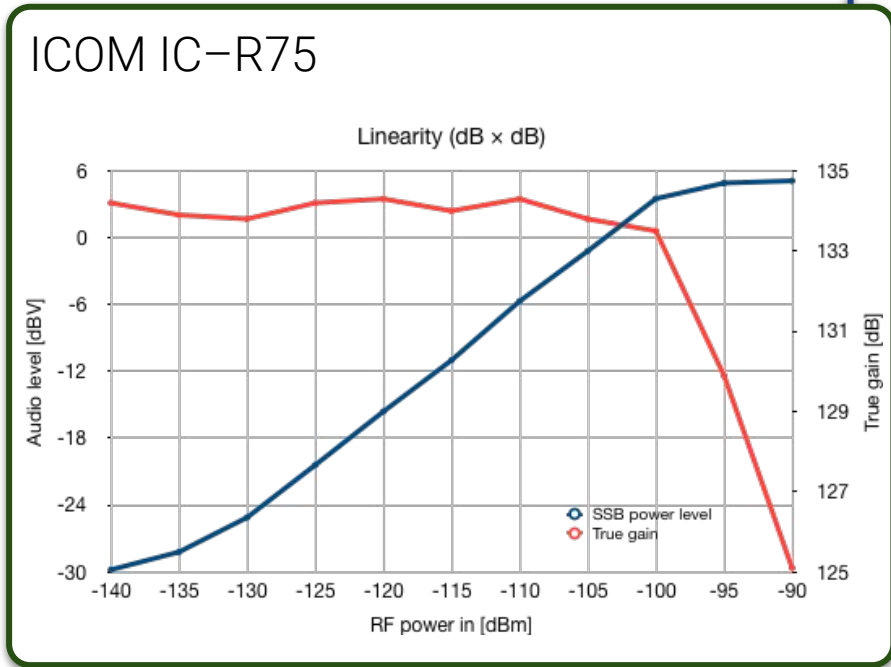# New Receiver: SDRplay RSP2

- Range: 1 kHz − 2 GHz

- Bandwidth: 10 MHz

- 3 inputs (2 × 50 Ω + 1 × High-Z)

- Cost < 200€

- Reference Clock I/O

- Noise temperature 320 K

- Same front-end as FUNcube Pro+

Linearity & Dynamic Range

ICOM IC–R75

FUNcube Pro+
(*same front-end as RSP2*)

New Acquisition/Control : Raspberry Pi 3B

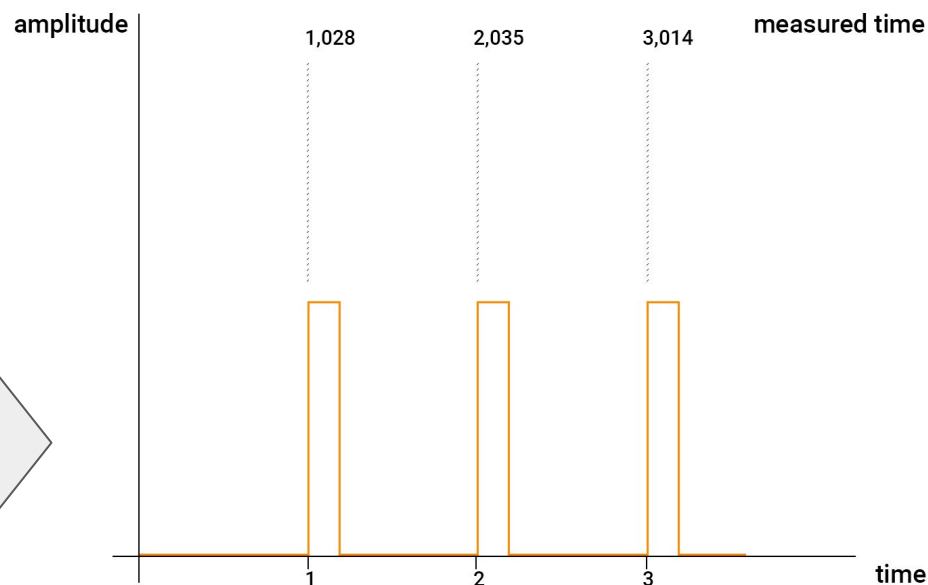The software has the following characteristics:

- Acquisition program written in **C**

- Decimates the data – resulting sampling rate: 6048 Samples/s

- WAV files of 300-second + time stamps : current BRAMS format

- Maintenance via Hamachi VPN

- Data transfer via HTTP

- NTPD configured to synchronize the system clock to the GPS signal

Time stamp management
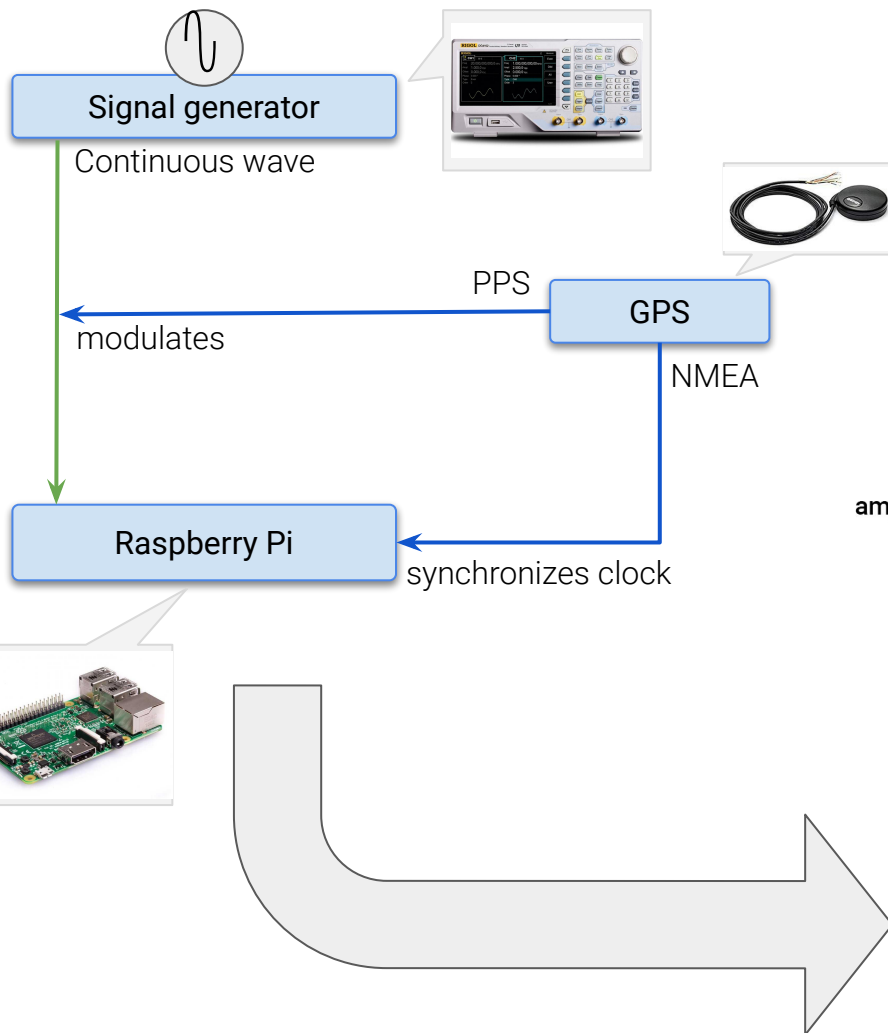
Signal generator

Continuous wave

modulates

PPS

GPS

NMEA

Raspberry Pi

synchronizes clock

- Raspbian is multitask optimized → jitter

- Packets of 1008 samples (I+Q)

- CW modulated by 1 PPS from GPS

amplitude

measured time

1,028   2,035   3,014

time

1   2   3

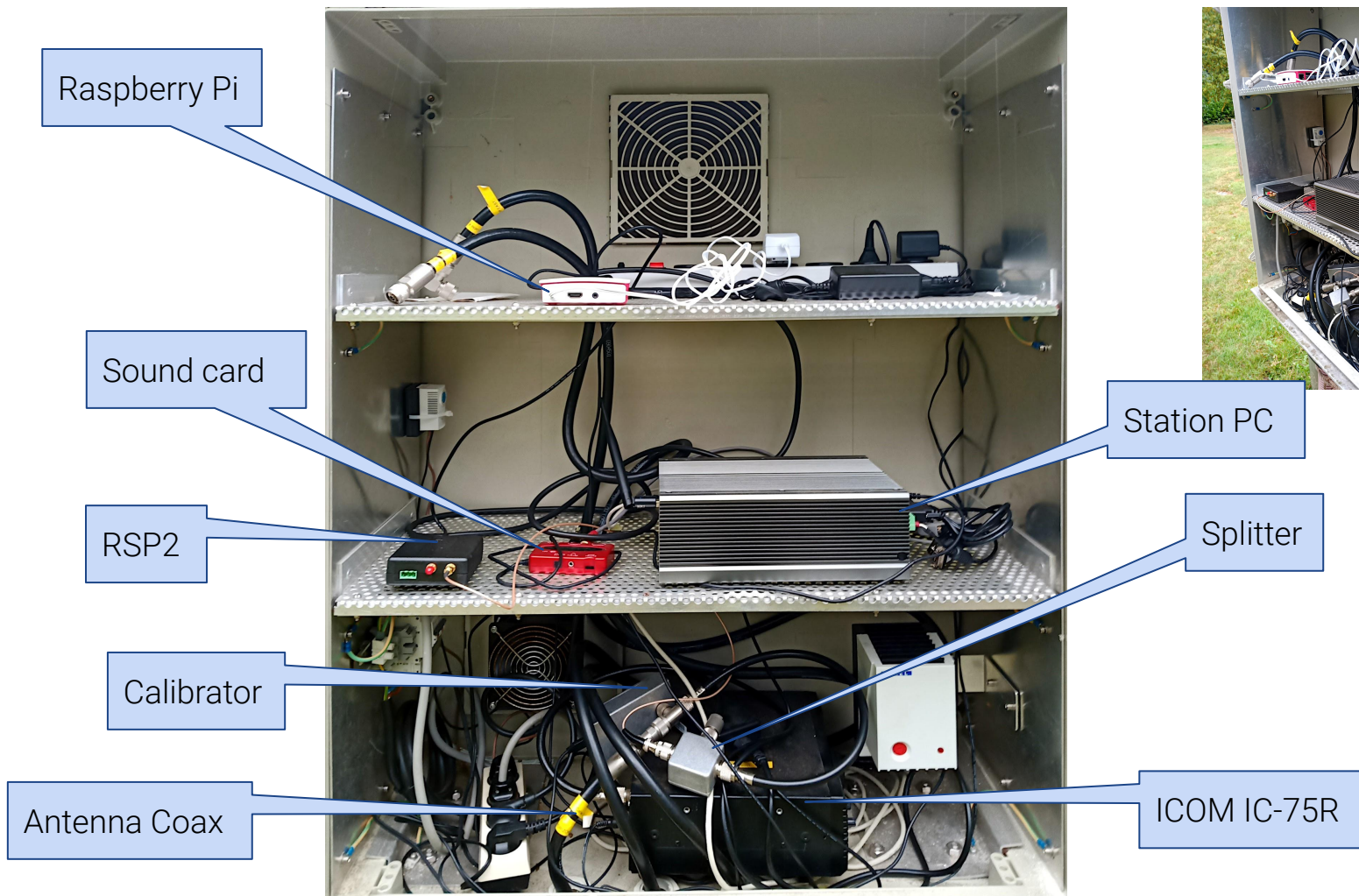# Time stamp management

- Raspbian is multitask optimized → jitter

- Packets of 1008 samples (I+Q)

- CW modulated by 1 PPS from GPS

decimal part of time stamp at trailing edge
found 55913 edges

55913 overlaid pulses (1 PPS)
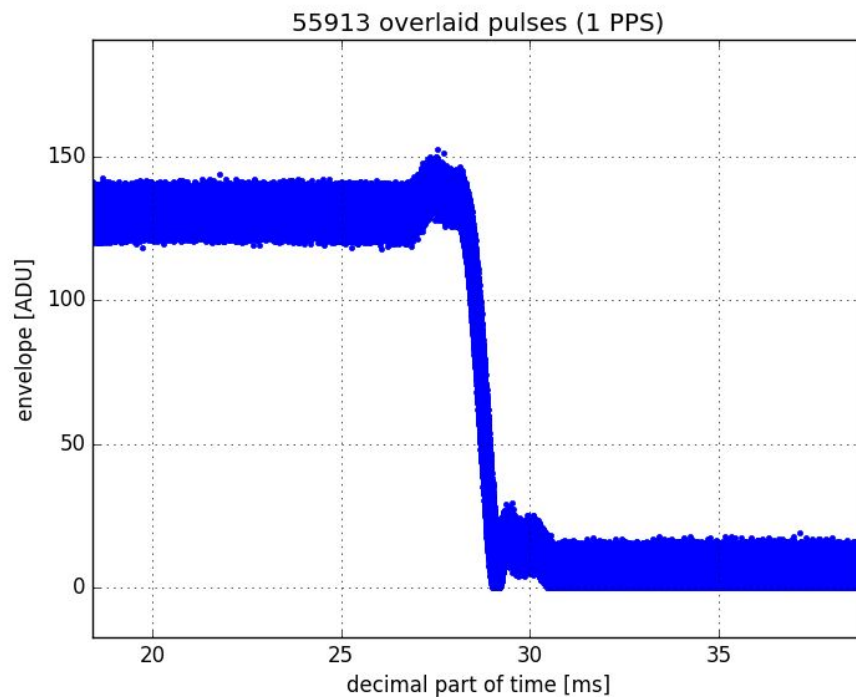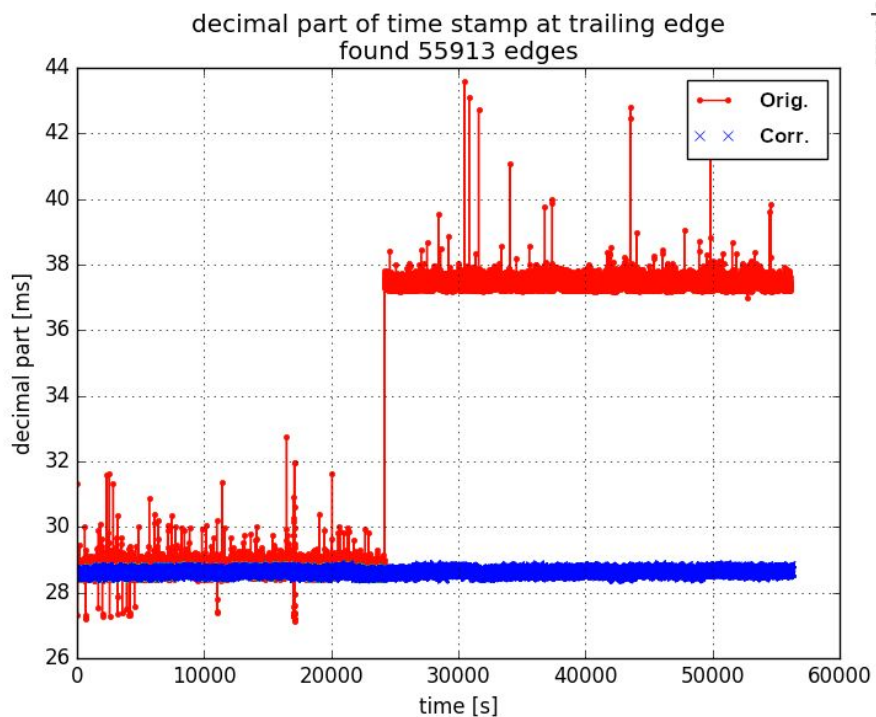
- Jitter corrected in post-processing

- Linear fit in BRAMS file

Testing at Brussels

Raspberry Pi

Sound card

Station PC

RSP2

Splitter

Calibrator

Antenna Coax

ICOM IC-75R

Preliminary results

Original BRAMS station
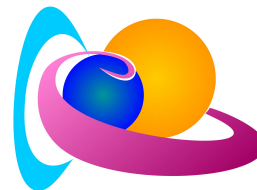*ICOM IC−R75 + Sound-Card + PC*
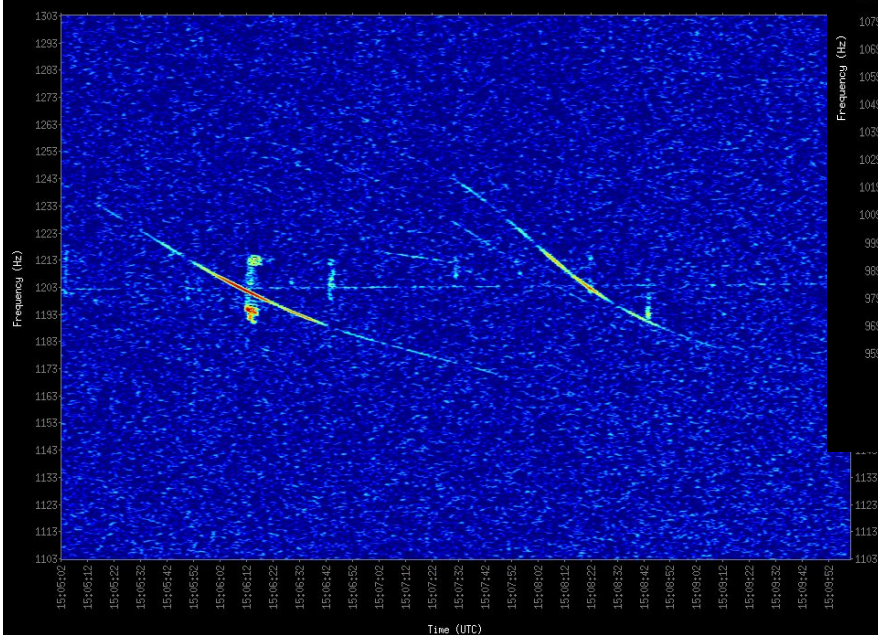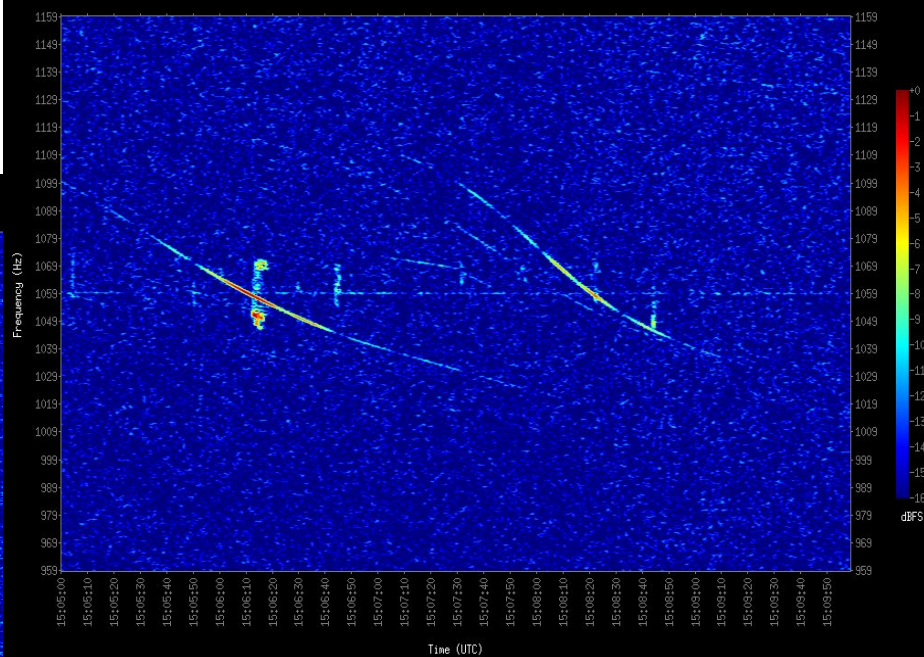
BRAMS station v2.0
RSP2 + Raspberry Pi 3⁺

Observations made in Brussels (Uccle) on 2019-07-02T15:05

On behalf of **Michel Anciaux** `(michel.anciaux@aeronomy.be)`

and the rest of the BRAMS team:

Many thanks!

http://brams.aeronomy.be/