MEteors **TR**ajectories and **O**rigins

FRIPON radio status

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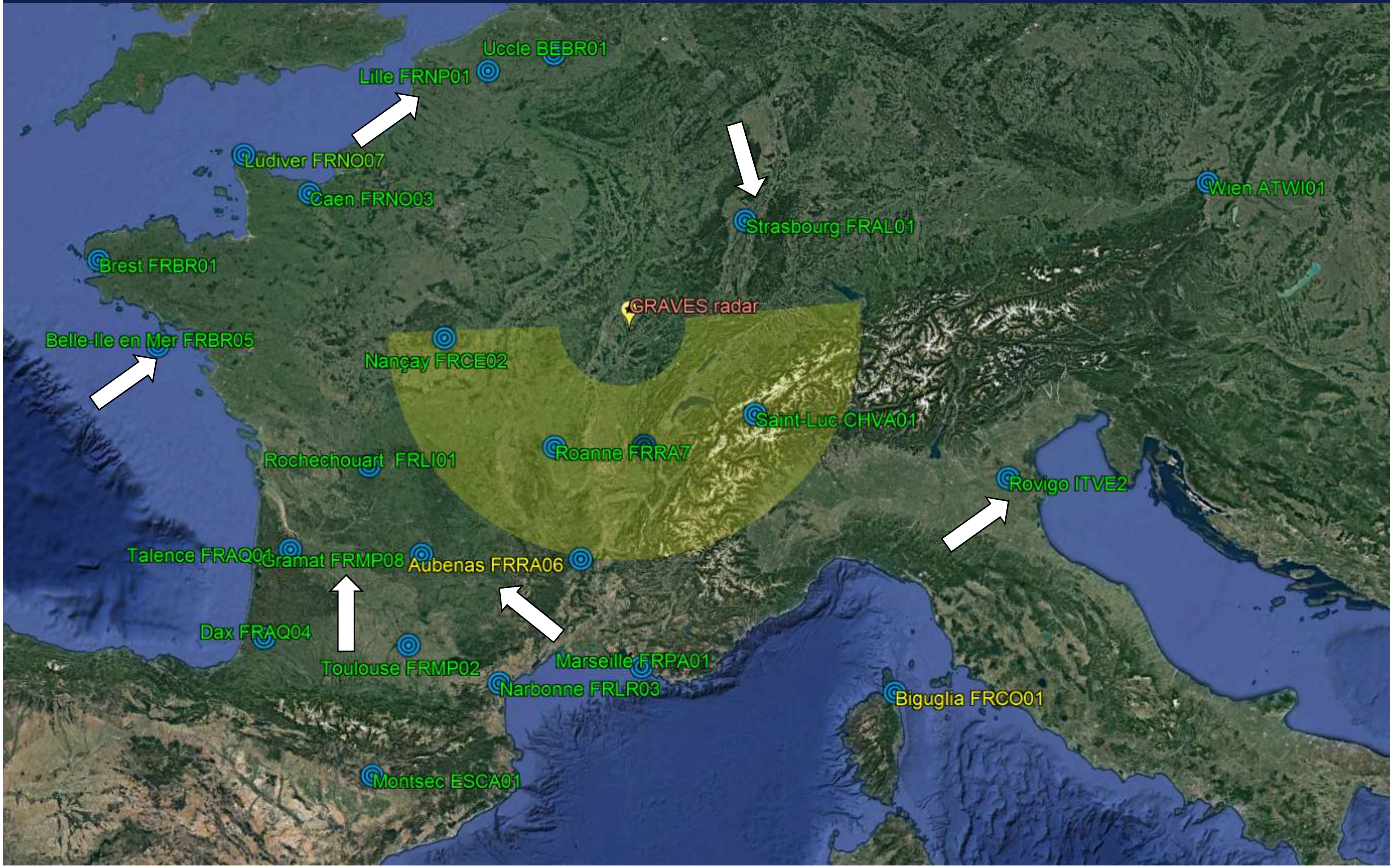
Uccle, Belgium

FRIPON radio network presentation

Status of the radio network (December 2018)



FRIPON radio network presentation

Status of the radio network (December 2018)

Gramat

Nançay

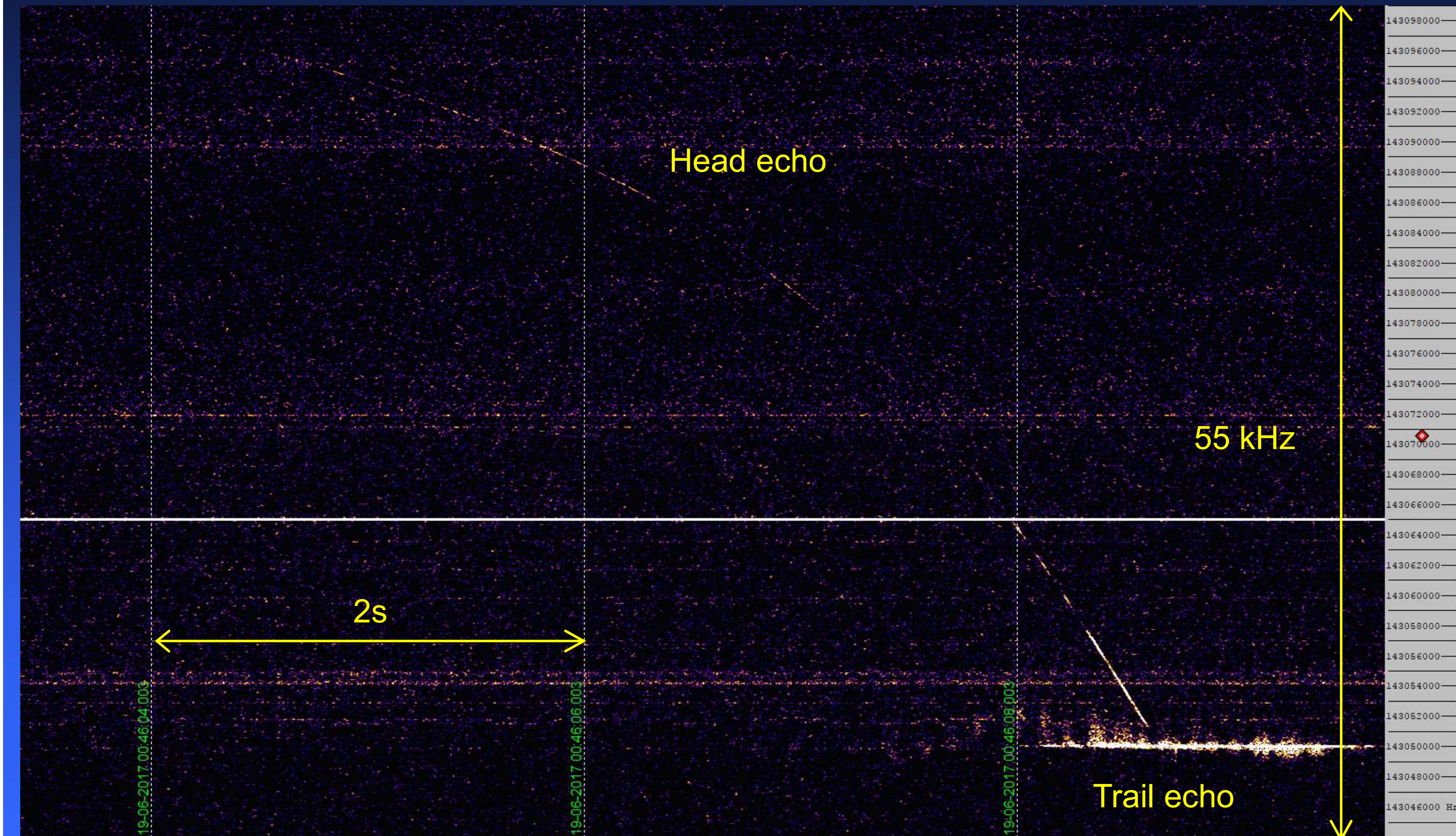
Biguglia (Corsica)

How does it work ?

- 23 radios running (25 are planned)
- I/Q SDR radio data are recorded 24/7 and stored after lossless compression (flac format) for one week on each FRIPON local computer (one 2 mn long flac file sampled @ 96 kHz → 15 Mo)
- In case of a meteor video multidetection (by two or more cameras), the corresponding radio data (before, during and after the event) are uploaded with the video data via VPN on a main data base located at Laboratoire d'Astrophysique de Marseille
- Spectrograms are automatically made available with the video data. Further data processing is performed manually
- In the absence of any video detection, radio data can be downloaded manually via VPN from any selected station for further study

How does it work ?

Example of a long meteor radio head echo recorded by the FRIPON network



Toulouse FRMP02_R_20170619T004448,471_UT

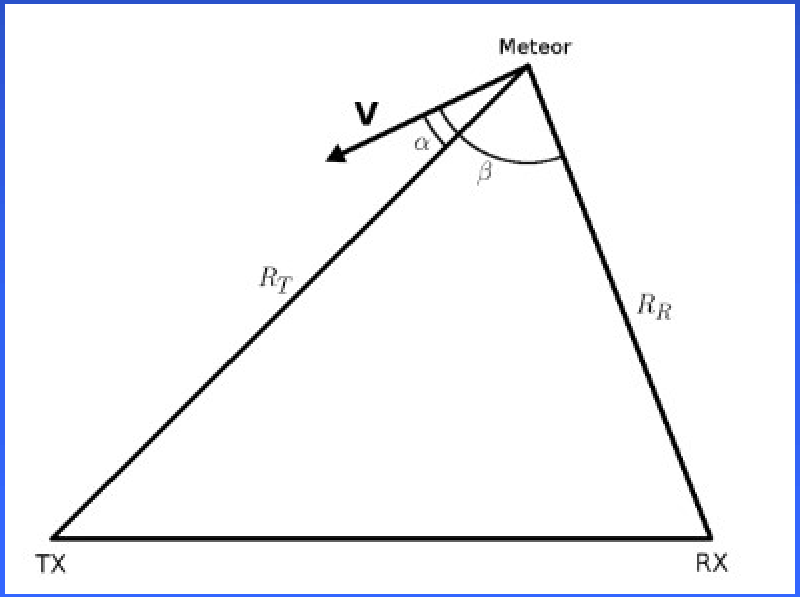
First purpose of the FRIPON radio set-up:

Determining accurate velocities of the bolides

FRIPON uses cameras to compute the trajectories of the fireballs, and the radio set-up is used to obtain accurate target velocity measurement.

The radio set-up is based on a multistatic radar configuration and consists in:

- one VHF HPLA (High Power Large Aperture) transmitter scanning a large volume of sky
- Twenty five SDR (software defined radios) located with some of the 100 video cameras



$$F_{rec} = F_{tr}\frac{1 - \frac{dR_T}{c \cdot dt}}{1 + \frac{dR_R}{c \cdot dt}} = F_{tr}\frac{1 + \frac{V \cdot \cos\alpha}{c}}{1 - \frac{V \cdot \cos\beta}{c}}$$

First purpose of the radio set-up:

Determining accurate velocities of the bolides

The equation above can’t be used directly as the radio data timestamping for each FRIPON station is not accurate enough (a few tens ms, because of Debian Linux OS delays and NTP jitter)

So we use a deceleration model fitted by a least squares method.

The model is fitted with five parameters:

- the time shift between receivers and cameras
- the initial velocity of the bolide V,
- a deceleration coefficient A,
- an ablation coefficient B,
- a chape change coefficient μ

First purpose of the FRIPON radio set-up:

Determining accurate velocities of the bolides

An example

Fig. 5. The bolide of 22 June 2016 as seen by the FRIPON camera in Lyon-France.

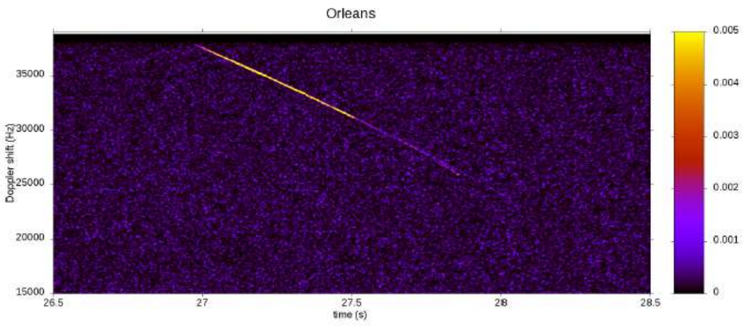


Fig. 6. Head echo of the bolide of 22 June 2016 as seen by the receiver located in Orléans. Time is counted from the start of the record. The color scale represents the energy of the signal (arbitrary unit).

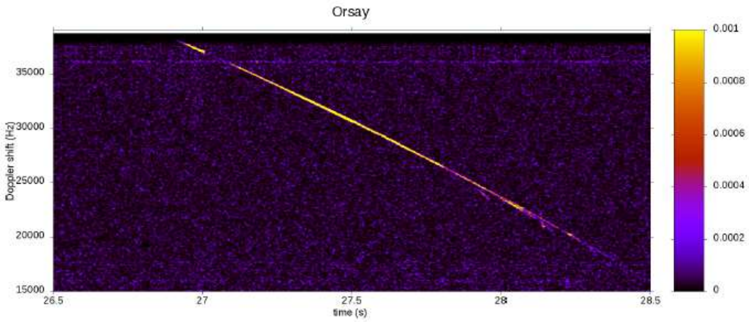


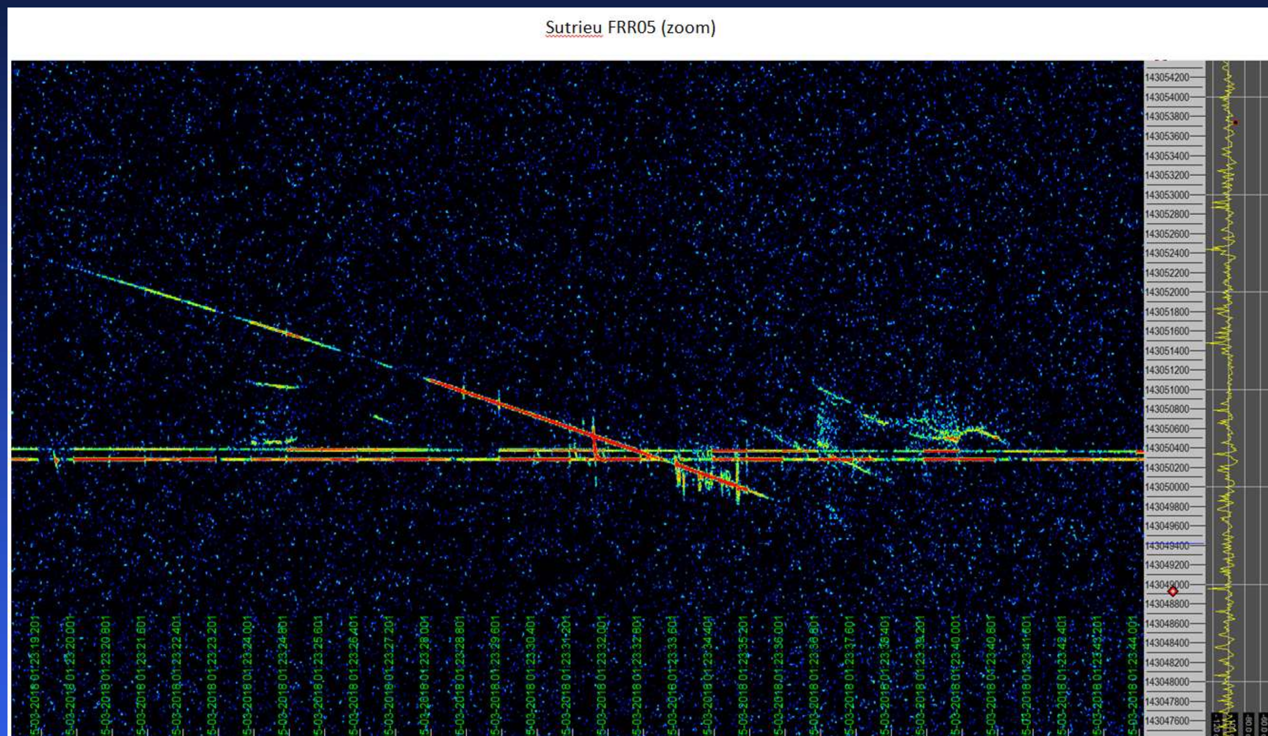
Fig. 7. Head echo of the bolide of 22 June 2016 as seen by the receiver located in Orsay. Time is counted from the start of the record. The color scale represents the energy of the signal (arbitrary unit).

	Velocity ($km.s^{-1}$)	A ($m^2.Kg^{-1}$)	B ($m^2.J^{-1}$)	μ
Orsay	71.937 ± 0.053	≤ 0.035	-	-
Orleans	71.638 ± 0.194	≤ 0.44	-	-
Both	71.916 ± 0.051	≤ 0.035	-	-
Cameras	73.871±??	-	-	-

Table 1. Velocity measured by Doppler shift and by cameras.

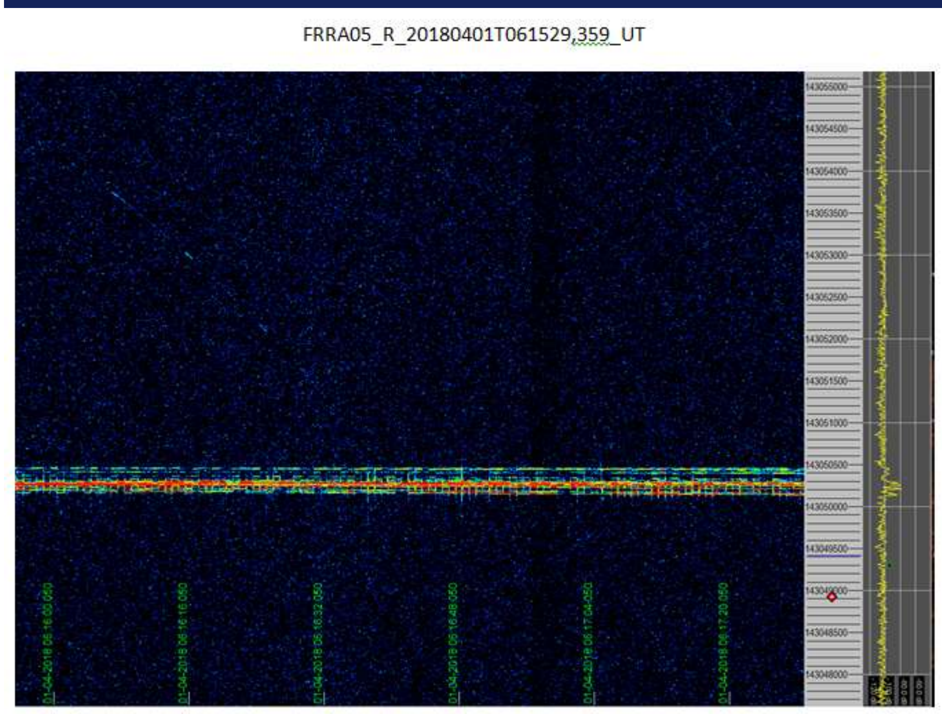
Other possibilities of the FRIPON radio set-up:

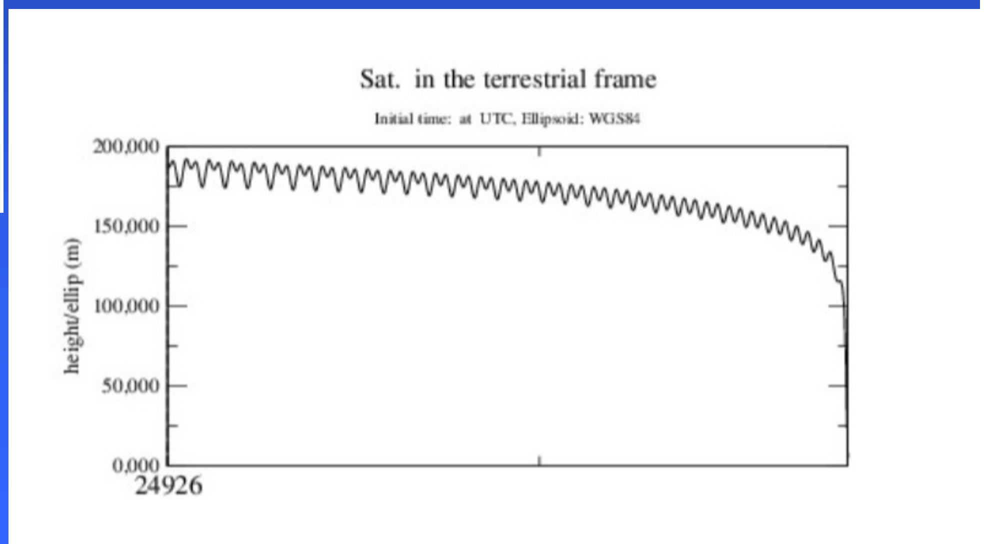
Observation of space debris: Soyuz 25 march 2018



Other possibilities of the FRIPON radio set-up:

Observation of space debris: Tiangong 1 2 april 2018





Other possibilities of the FRIPON radio set-up:

Interactions between meteors and upper atmosphere

An example of bolide fragmentation

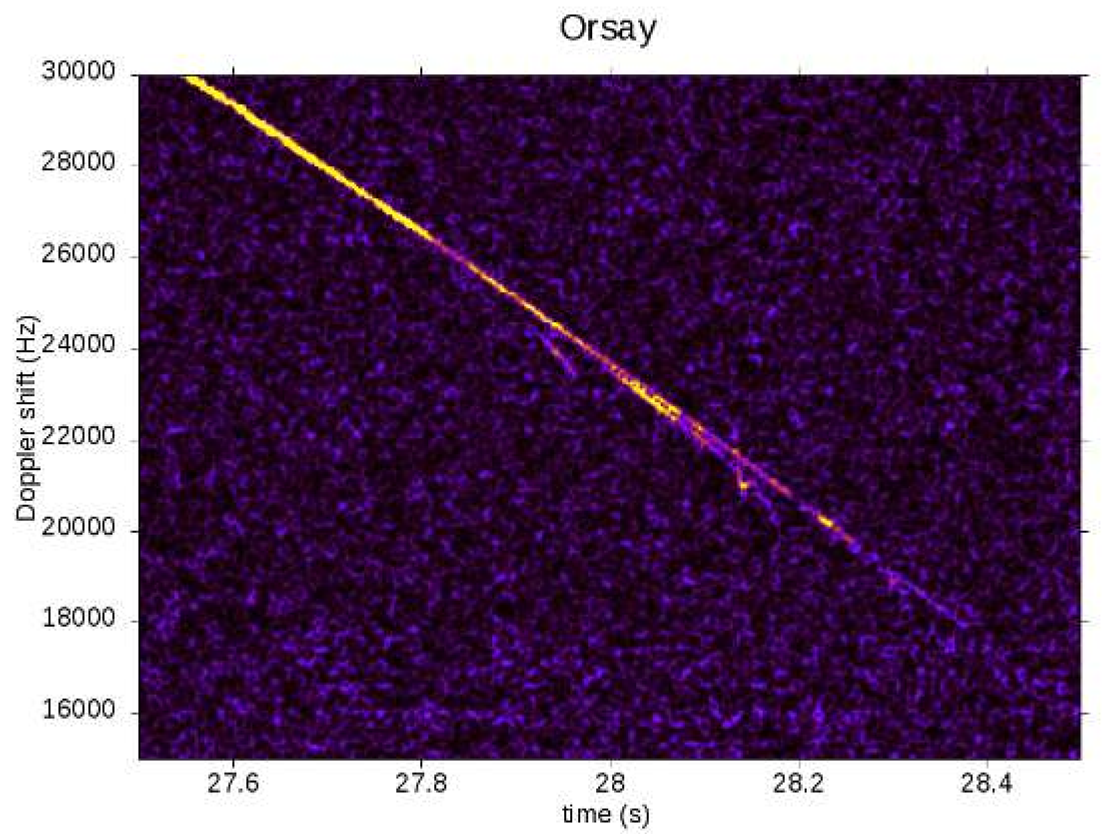


Fig. 9. Zoom on the head echoes produced by the fragmentation of bolide in 22 June 2016.

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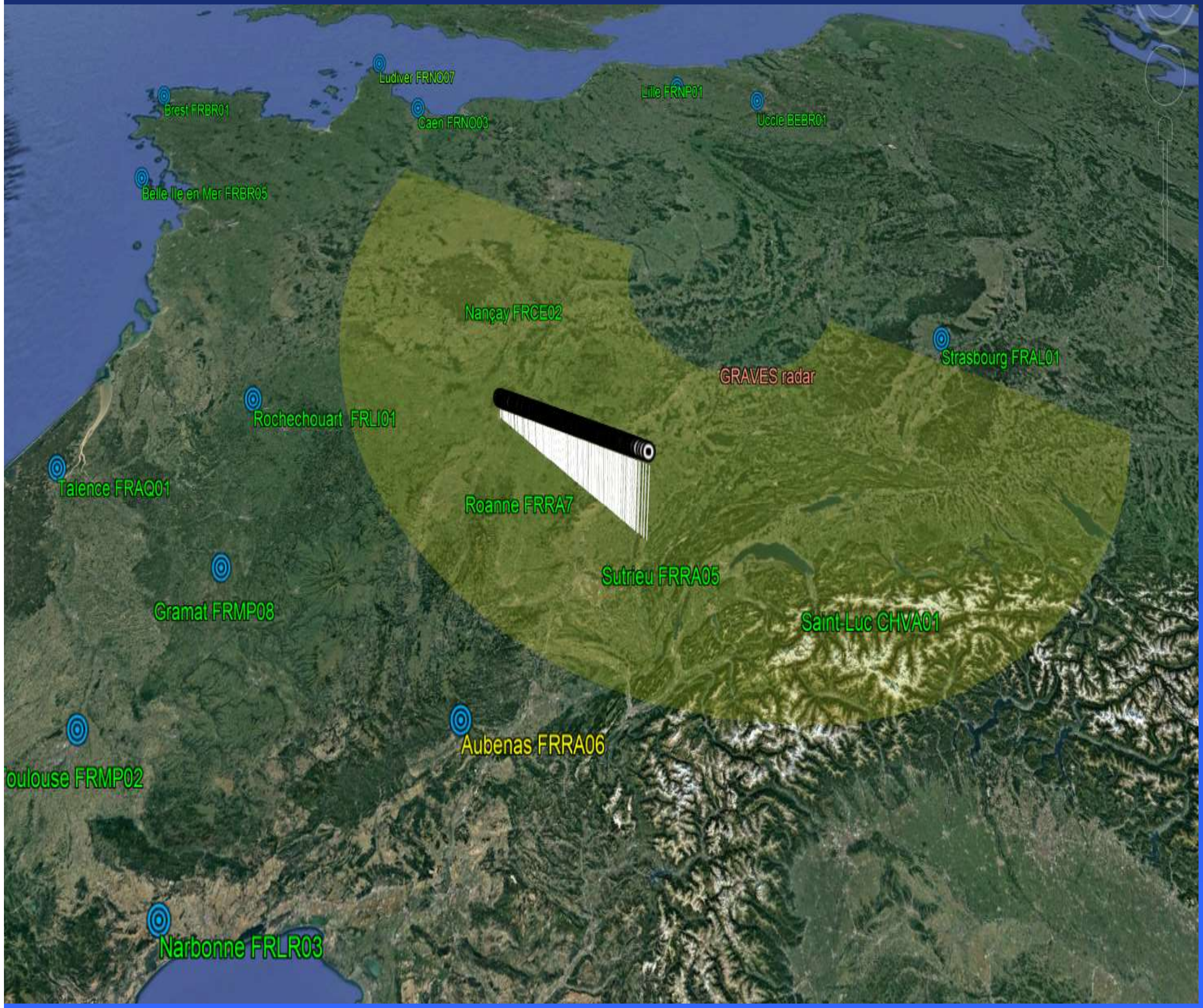

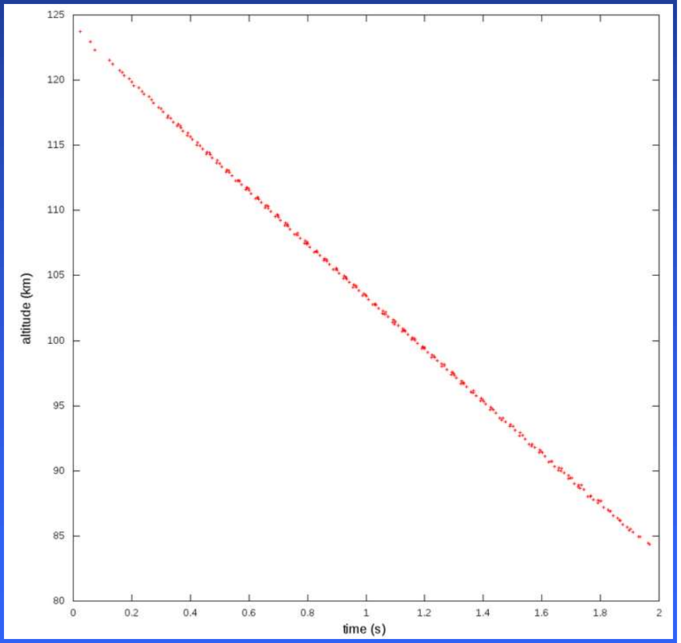

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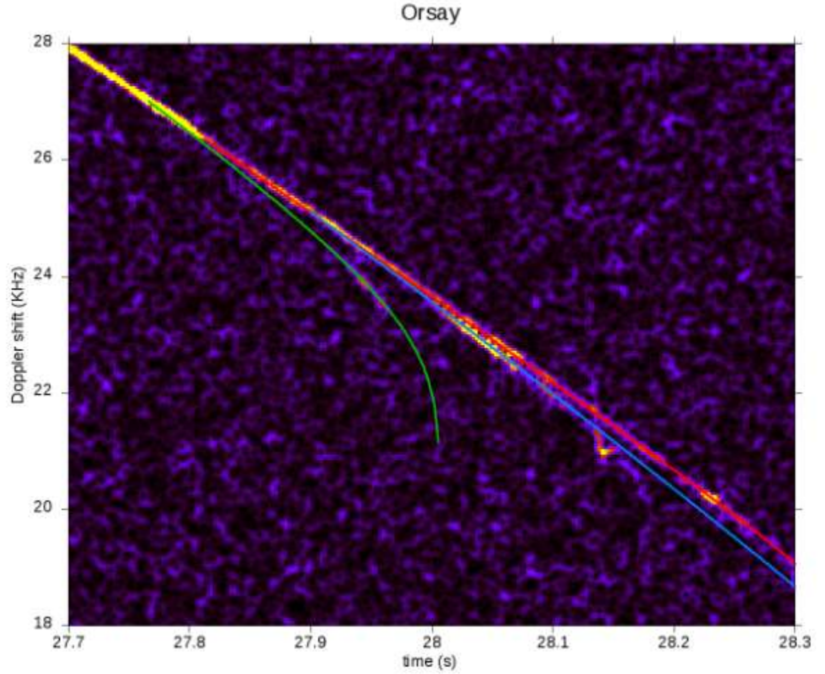


Fig. 11. Head echoes from modeled fragments which best fit the data points superposed to the spectrogram from Orsay. The fragment A is red, the fragment B is green and the fragment C is blue.

Fragment	t_{frag}	$A\ (m^2/Kg)$	$B\ (m^2/J)$	μ
A	$27.82^{+0.08}_{-0.06}$	$0.21^{+0.07}_{-0.03}$	$1.3 \pm 0.6 \cdot 10^{-8}$	0.5 ± 0.3
B	$27.77^{+0.10}_{-0.05}$	$3.5^{+8.2}_{-0.7}$	$\leq 7.8 \cdot 10^{-8}$	-
C	27.90 ± 0.02	1.4 ± 0.1	$\leq 3.1 \cdot 10^{-9}$	-

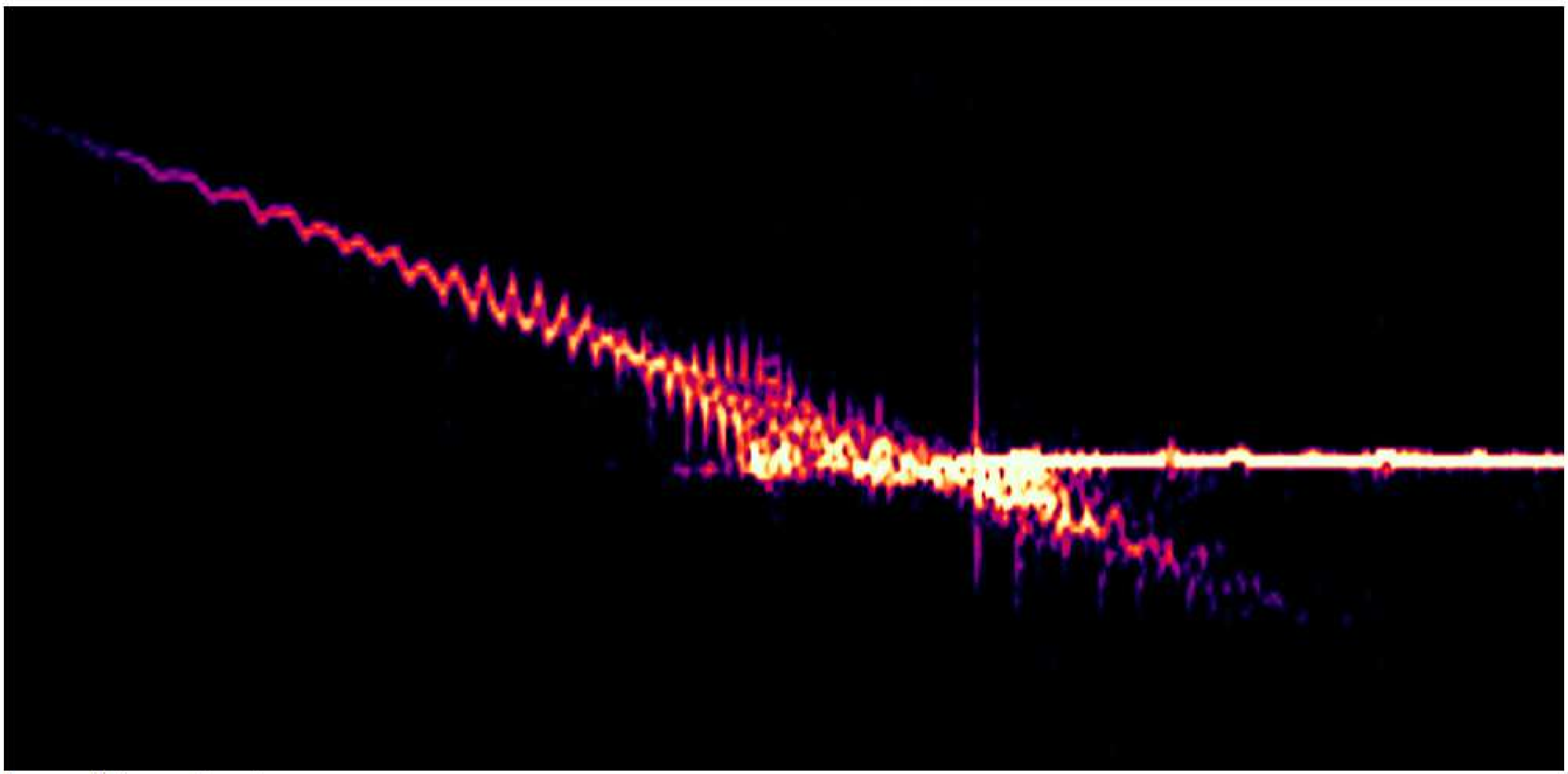
Other possibilities of the FRIPON radio set-up:

Interactions between meteors and upper atmosphere

Example of Doppler (radial speed) oscillations on head echoes

20180320T234650_UT

code	station	LExpCat	astro	FC
Chalon	FRBO05	OK	NO -> pas assez d'azel	OK
Glux	FRBO03	OK	OK	OK
Troyes	FRCA04	OK	OK	OK



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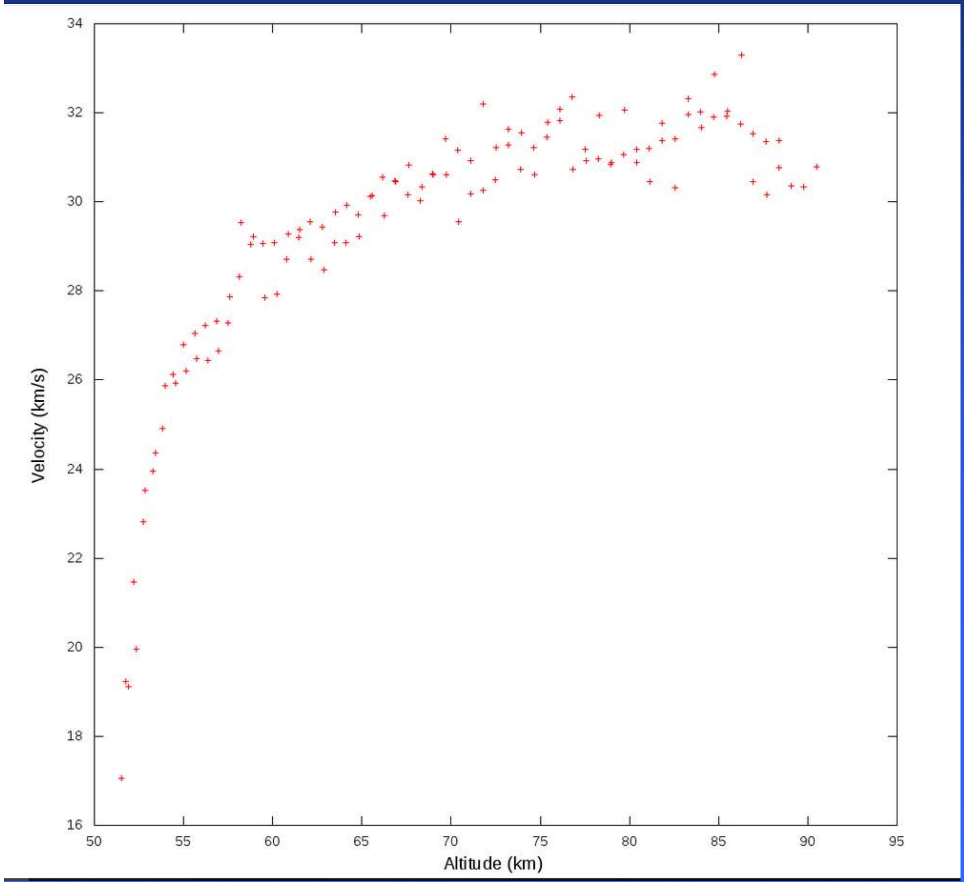

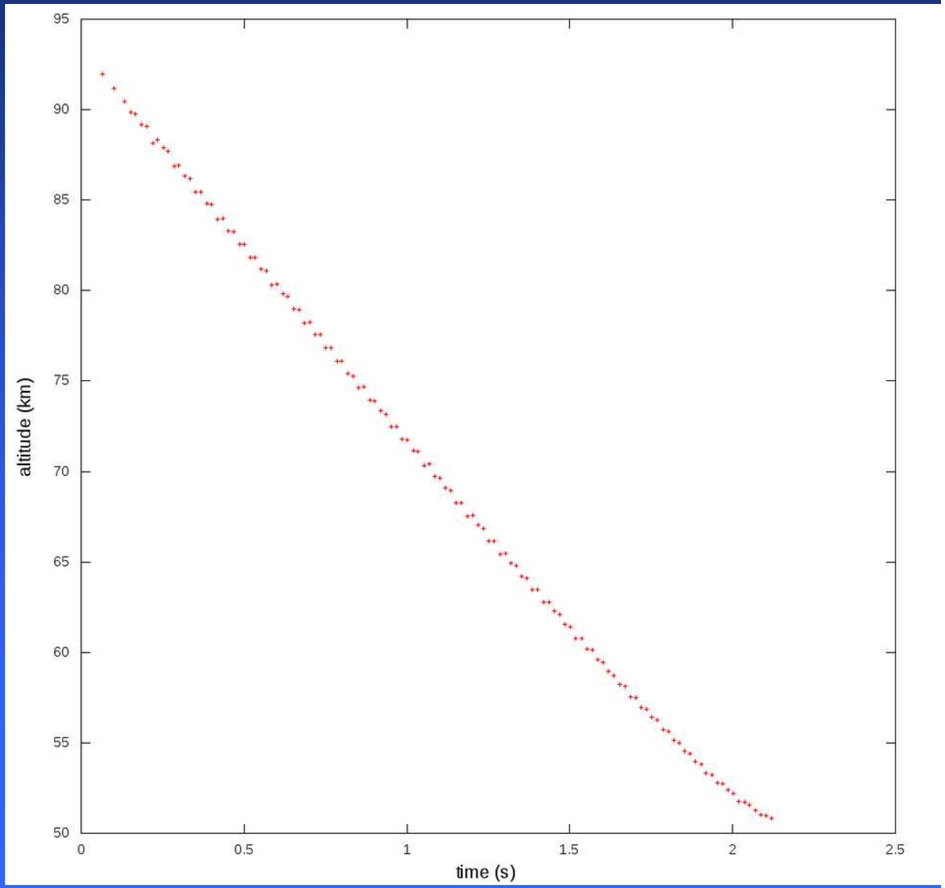

Thanks for your attention
Any questions ?