



RETRAM

RECOGNITION AND TRAJECTORY OF METEORS

# Meteors Detection & Localization using FM transmitters

First 3D localization results

RETRAM - May 2014

Update of August 2014





# FM Detection & localization

## 1st 3D localization results

- Reminder
  - Station
  - TX FM
  - Bistatic delays and distance
- Camelopardalis (Comet 209P / Linear)
  - Meteors crossing at
    - ❖ 07:54:18
    - ❖ 08:30:10
- Remarks – Synthesis about this pas period
- Perseids (August 2014)
  - Optic correlation and 3D Radio localization

### ❖ *references*

<http://www.retram.org>

[http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/209\\_LINEAR/2014/index.php](http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/209_LINEAR/2014/index.php)

*Time is UTC format*

*Velocities are in m/s*

*Bistatic delay and distance are in km*

*RCS (Radar Cross Section) are in m<sup>2</sup>*

*Map from Google-Earth*



# REMINDER

## ❑ STATION (Receiver)

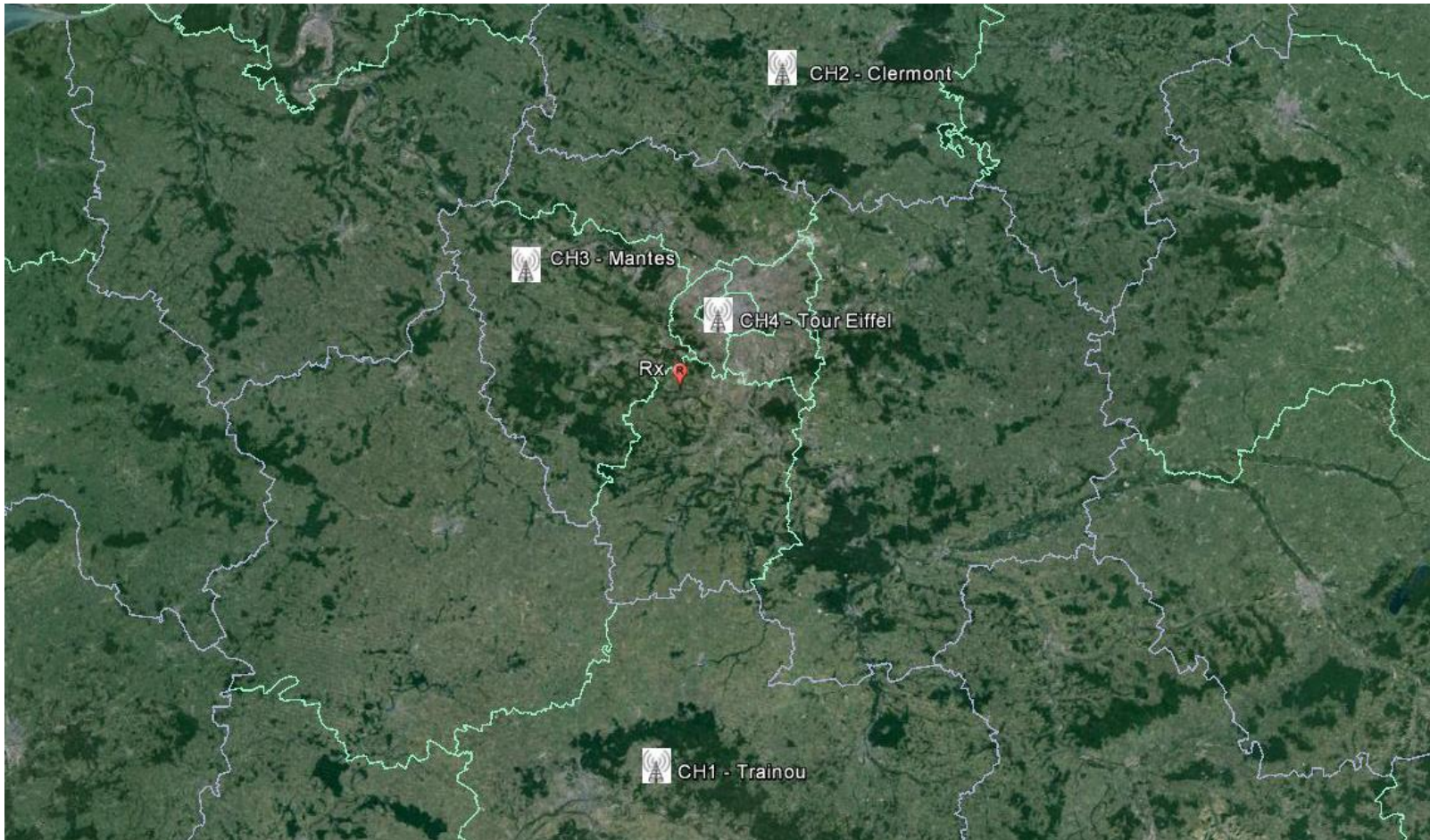
- ❑ For these tests, RETRAM used a single receiver station with recorded and post-processed data.
- ❑ This document [http://www.retram.org/wp-content/uploads/2014/02/RETRAM\\_nenufar.pdf](http://www.retram.org/wp-content/uploads/2014/02/RETRAM_nenufar.pdf) gives a brief description of the station and processing.



# REMINDER

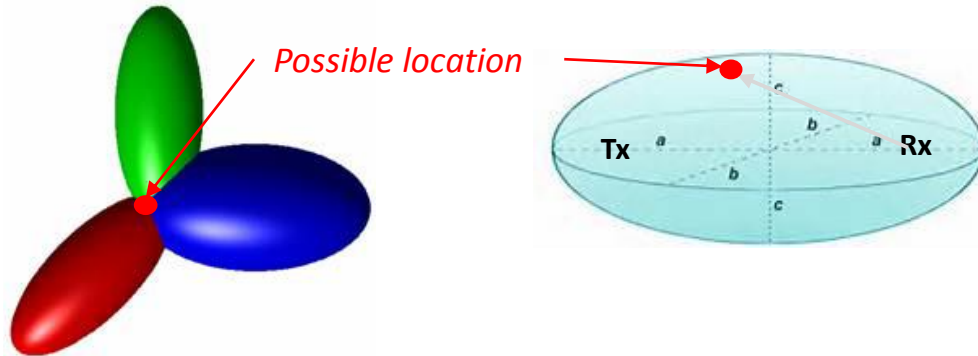
## ❑ Tx FM (Broadcast transmitter)

- ❑ To collect enough information, the digital receiver (Rx) processed 4 FM channels.
- ❑ CH1-100,9MHz, CH2-102,1MHz, CH3-101,7MHz and CH4-101,9MHz



# REMINDER

- ❑ Bi-static data
  - ❑ Processing displays Range/Doppler maps
  - ❑ Doppler (velocity) is in m/s
  - ❑ Range ( $D_b$ ) is the delay between transmitted signal and reflected then received signal is in km
  - ❑ Distance from receiver to transmitter is  $D_{rt}$
  - ❑ The true bi-static distance is calculated by :  $D_{rt} + D_b$  where is the possible location. This calculation is done for each couple Rx/Tx.
  - ❑ So, we can expect up to 4 true bi-static distances for 1 object.

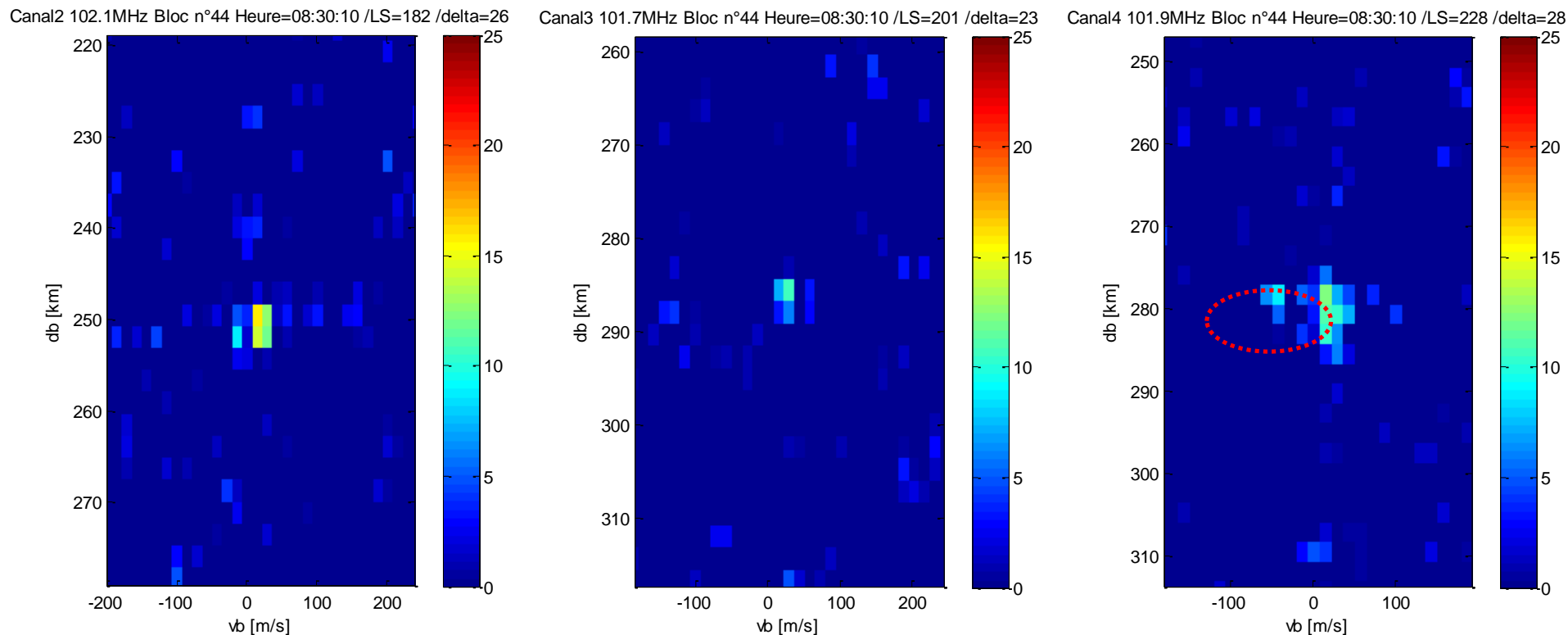


- ❑ With a minimum of 3 information, we are able to locate the object in 3D (X,Y,Z or Lat, Lon,Altitude) with doing the interception of the ellipsoids.

# Comet 209P / Linear

## ☐ 24 May 2014 Meteor Shower

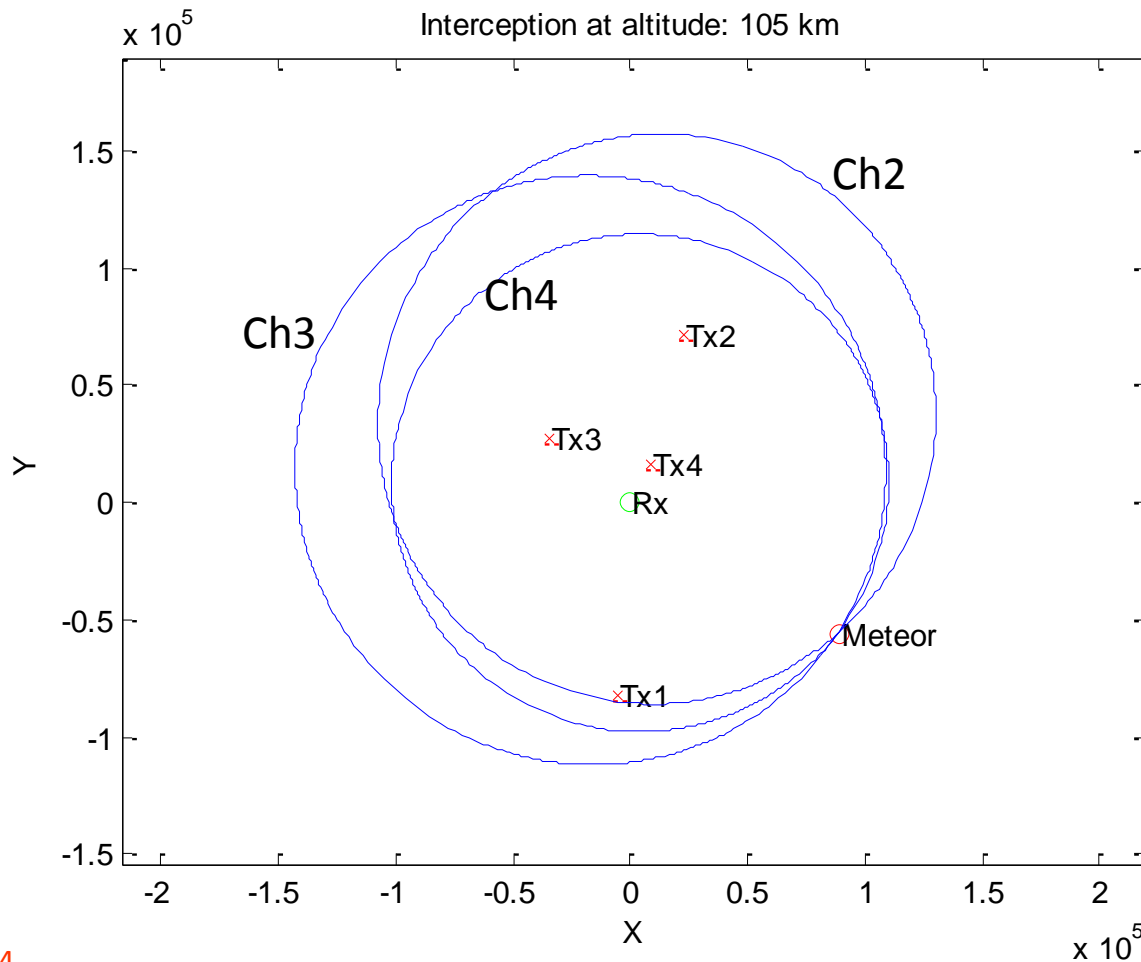
- ☐ The radiant is located in the Camelopardalis constellation
- ☐ Prediction was given by IMCCE (see reference)
- ☐ 08:30:10 detections on Channels 2, 3 and 4. Signals simultaneously appears on 3 of the 4 channels. The end of head echo is visible on channel 4 (red circled). Head echo will be processed using a dedicated processing SW.



Bistatic delays (db) are are respectively 251, 286 and 280 km

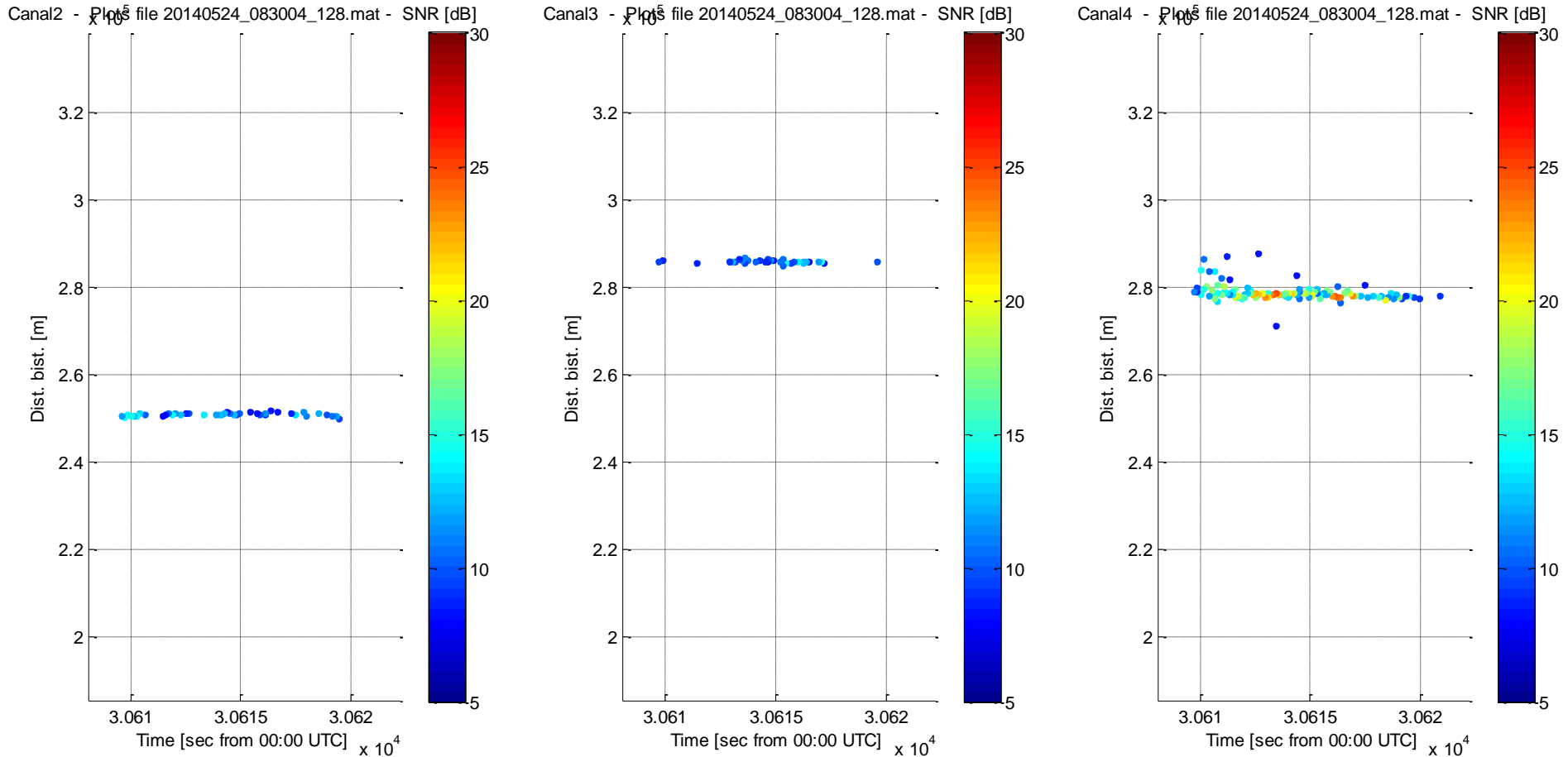
# Comet 209P / Linear

- 24 May 2014 Meteor Shower @ 08:30:10
- The 3D computation gives an interception point at **48.204 N, 3.359 E and 105 km high**
- A cut at 105 km of the 3 ellipsoids shows the interception point and of course the meteor location at the beginning of its train..



# Comet 209P / Linear

## ☐ 24 May 2014 Meteor Shower @ 08:30:10



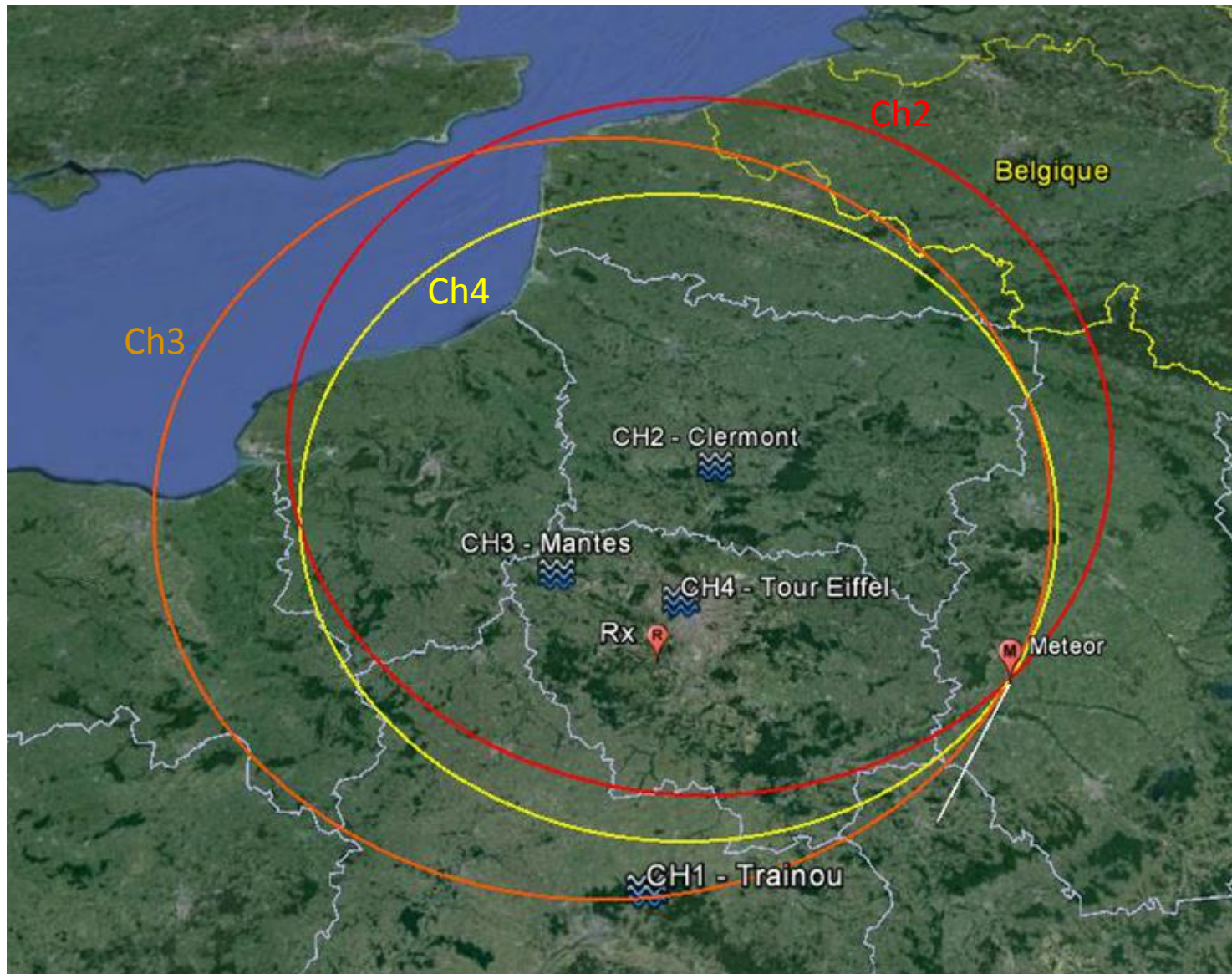
This figure shows the tracking of the meteor train from its beginning at 08:30:10 (30610 sec after 00:00 UTC) up to its end 10 sec later. We are able to observe the dispersion of the train and here it is very weak.





# Comet 209P / Linear

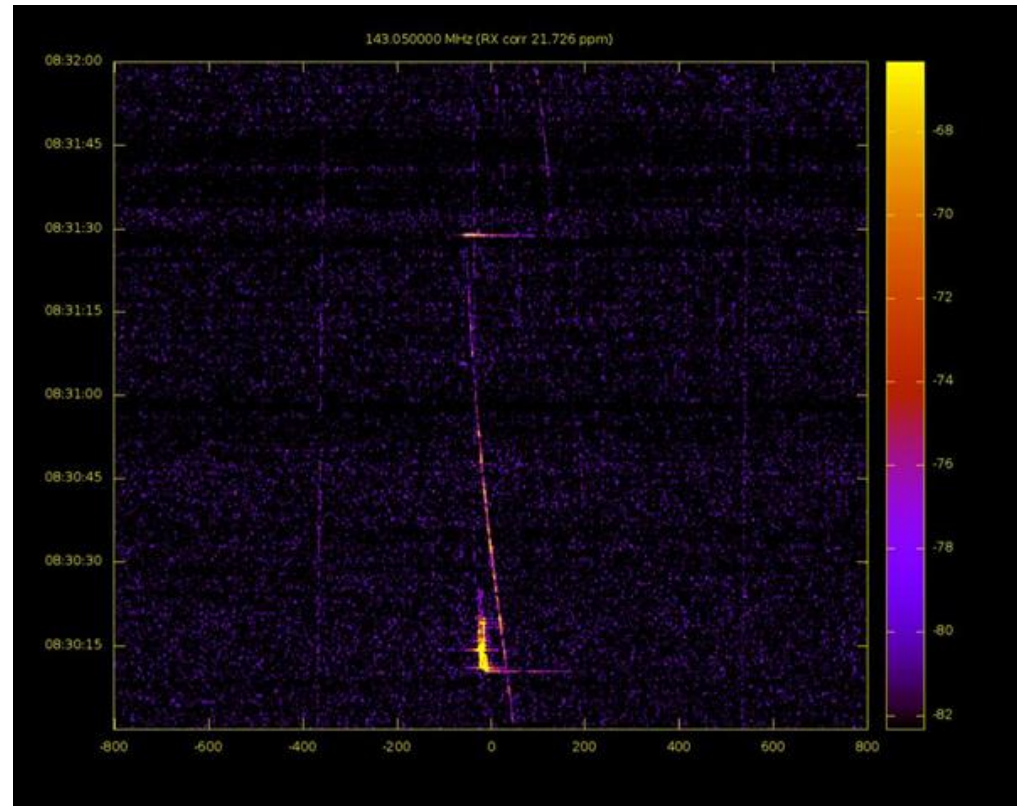
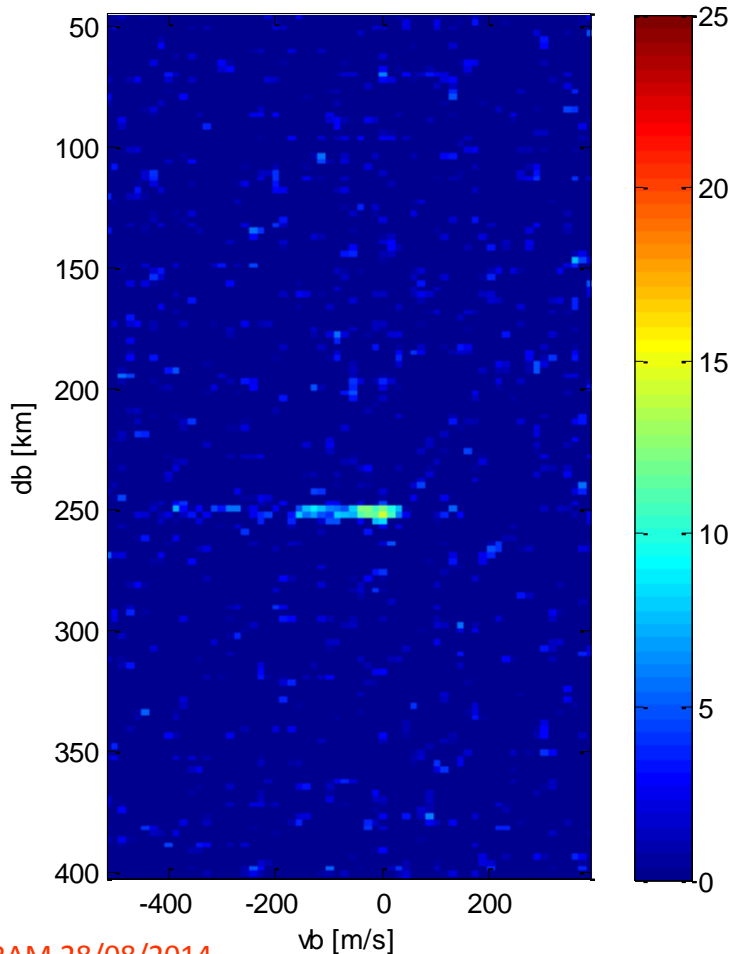
- 24 May 2014 Meteor Shower @ 08:30:10 – 3D view with a cut @ 105km



# Comet 209P / Linear

- ❑ 24 May 2014 Meteor Shower @ 08:30:10
  - ❑ CH2 (on left) shows a quick variation of speed during the observation (it could be the sign of head echo)
  - ❑ At the same time (on right) a small head echo is visible on a Graves detection.

Canal2 102.1MHz Bloc n°43 Heure=08:30:10 /LS=181 /delta=26



A 200Hz change is visible on Graves and it is equivalent to the -400m/s on FM

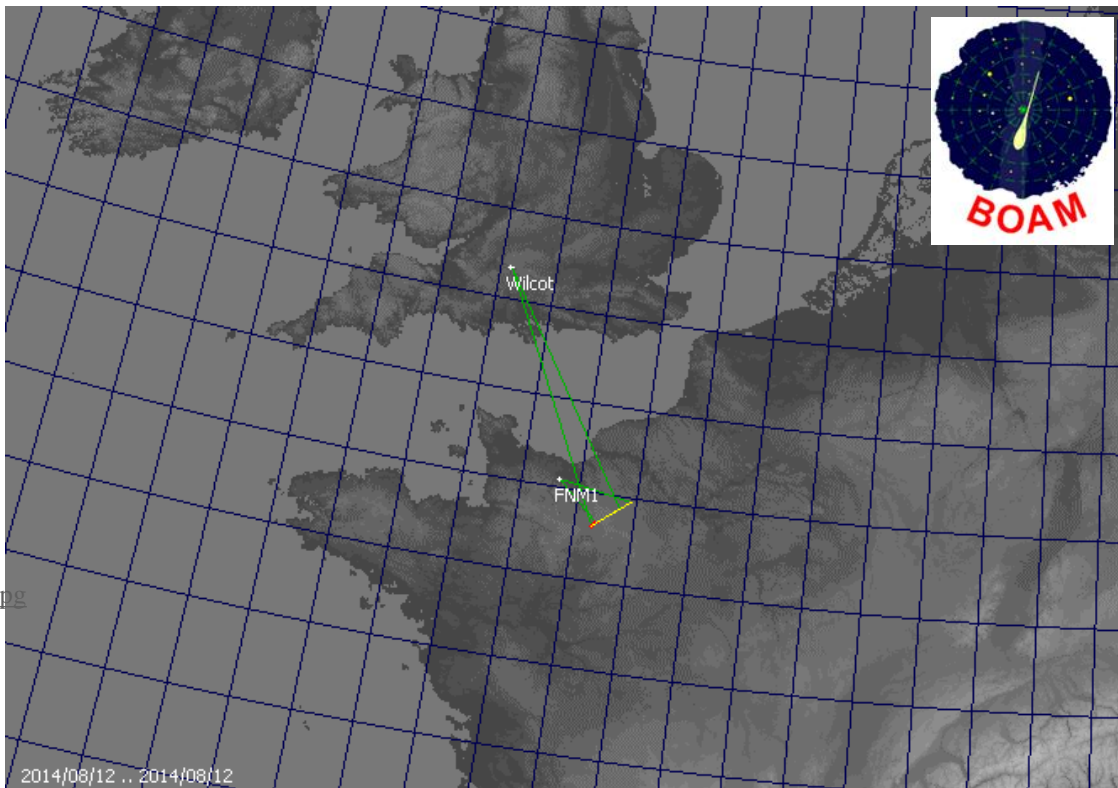
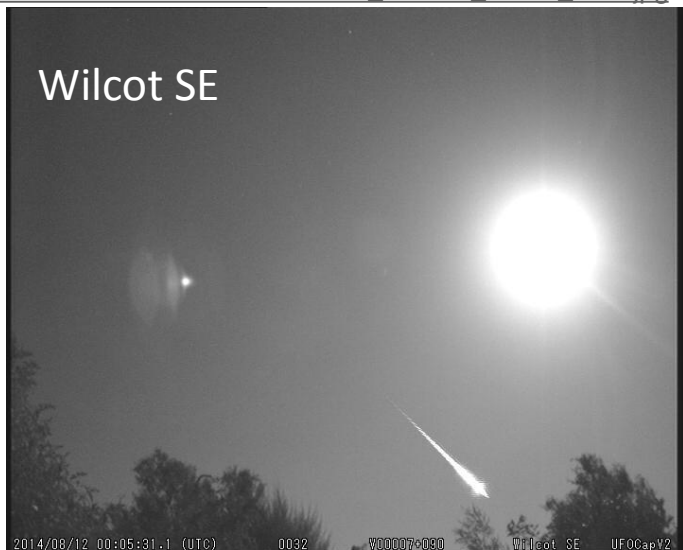
# Remarks – Synthesis

- ✓ Trials using several bi-static bases (here 4 couples Rx/Tx) show we are able to locate the penetration of the meteor into the terrestrial atmosphere. These first results are very hopeful.
- ✓ In a previous report, we showed it was possible to track the meteor train. This feature could help to measure wind at high altitude.
- ✓ These results are a great step and confirm our project of building / extending the RETRAM network [http://www.retram.org/wp-content/uploads/2014/02/RETRAM\\_nenufar.pdf](http://www.retram.org/wp-content/uploads/2014/02/RETRAM_nenufar.pdf) .
- ✓ So, with a multi-receivers and multi-transmitters system (network), we will improve :
  - The capacity of detection (more information available for the same meteor)
  - The accuracy of location (by averaging the information)
  - The covered area
  - The reliability (redundancy)
- ✓ During these trials we did not find any optical information because the maximum of this shower was during the day, but our measurements proved to be reliable (see former reports). Moreover it is a great advantage to detect and track at any hour or with any weather.
- ✓ Next work in the coming weeks will be around :
  - Assess performance and comparison to optic detection and correlation
  - Analyzing the “head echoes”
  - Extending the network with a new receiver at Rambouillet



# Perseids – 20140812 00:05:31

[http://www.ukmeteorwatch.co.uk/data/wilcot/camera4/2014/201408/20140811/M20140812\\_000531\\_Wilcot\\_SEP.jpg](http://www.ukmeteorwatch.co.uk/data/wilcot/camera4/2014/201408/20140811/M20140812_000531_Wilcot_SEP.jpg)



[http://boam.fr/detection/image/M20140812\\_000531\\_FNM1\\_JB2P.jpg](http://boam.fr/detection/image/M20140812_000531_FNM1_JB2P.jpg)



| _localtime      | _mjd      | _sol   | _amag | _ra_o | _dc_o | _ra_t | _dc_t | _elng | _elat | _vo  | _vg  | _vs  | _stream |
|-----------------|-----------|--------|-------|-------|-------|-------|-------|-------|-------|------|------|------|---------|
| 20140812_000531 | 56881,004 | 139,04 | -6,4  | 39,25 | 55,41 | 39,66 | 55,48 | 56,52 | 37,74 | 68,8 | 67,7 | 48,2 | _J5_Per |

| _mag | _dur  | _lng1 | _lat1 | _H1   | _lng2 | _lat2 | _H2  | _dt   | _Qo  | _Qc | _QA   |
|------|-------|-------|-------|-------|-------|-------|------|-------|------|-----|-------|
| -4,7 | 0,940 | 0,91  | 48,96 | 133,2 | 0,37  | 48,67 | 82,2 | 0,040 | 20,6 | 16  | 0,440 |

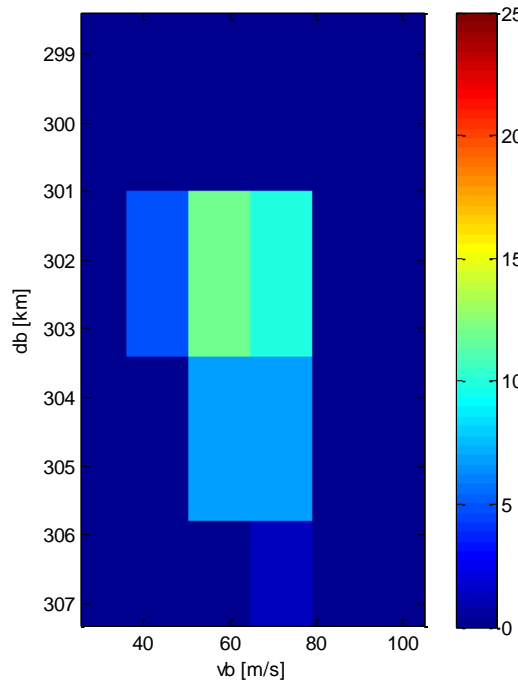
RETRAM 28/08/2014



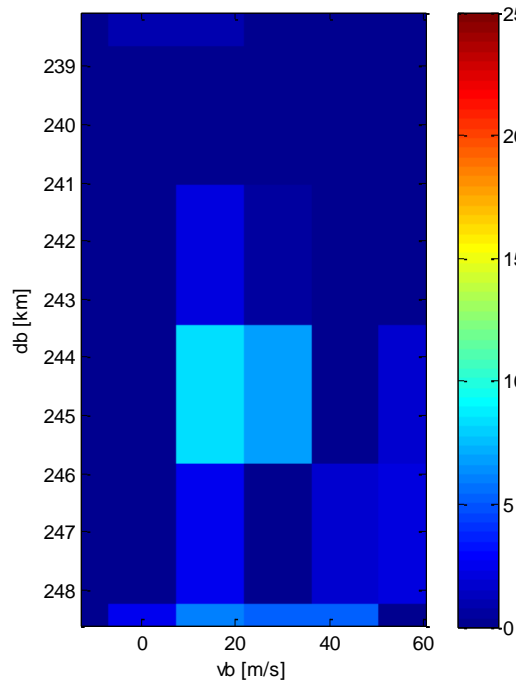
# Perseids – 20140812 00:05:31

- ☐ FM detection
- ☐ Bistatic raw data

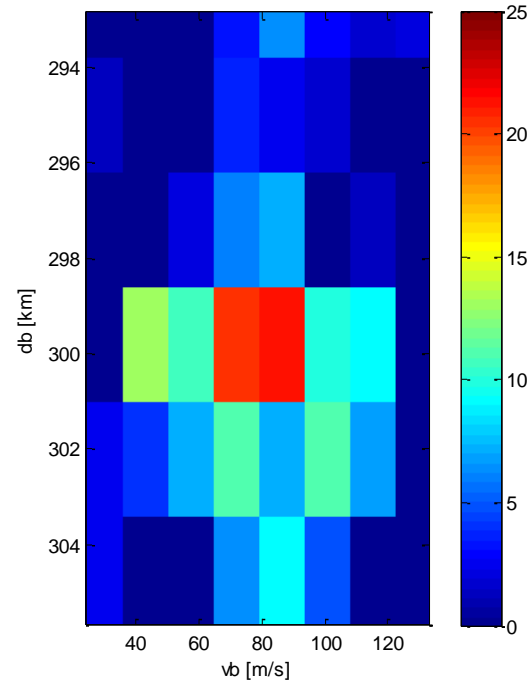
Canal2 102.1MHz Bloc n°12 Heure=00:05:32 /LS=191 /delta=22



Canal3 101.7MHz Bloc n°12 Heure=00:05:32 /LS=204 /delta=18



Canal4 101.9MHz Bloc n°12 Heure=00:05:32 /LS=233 /delta=26

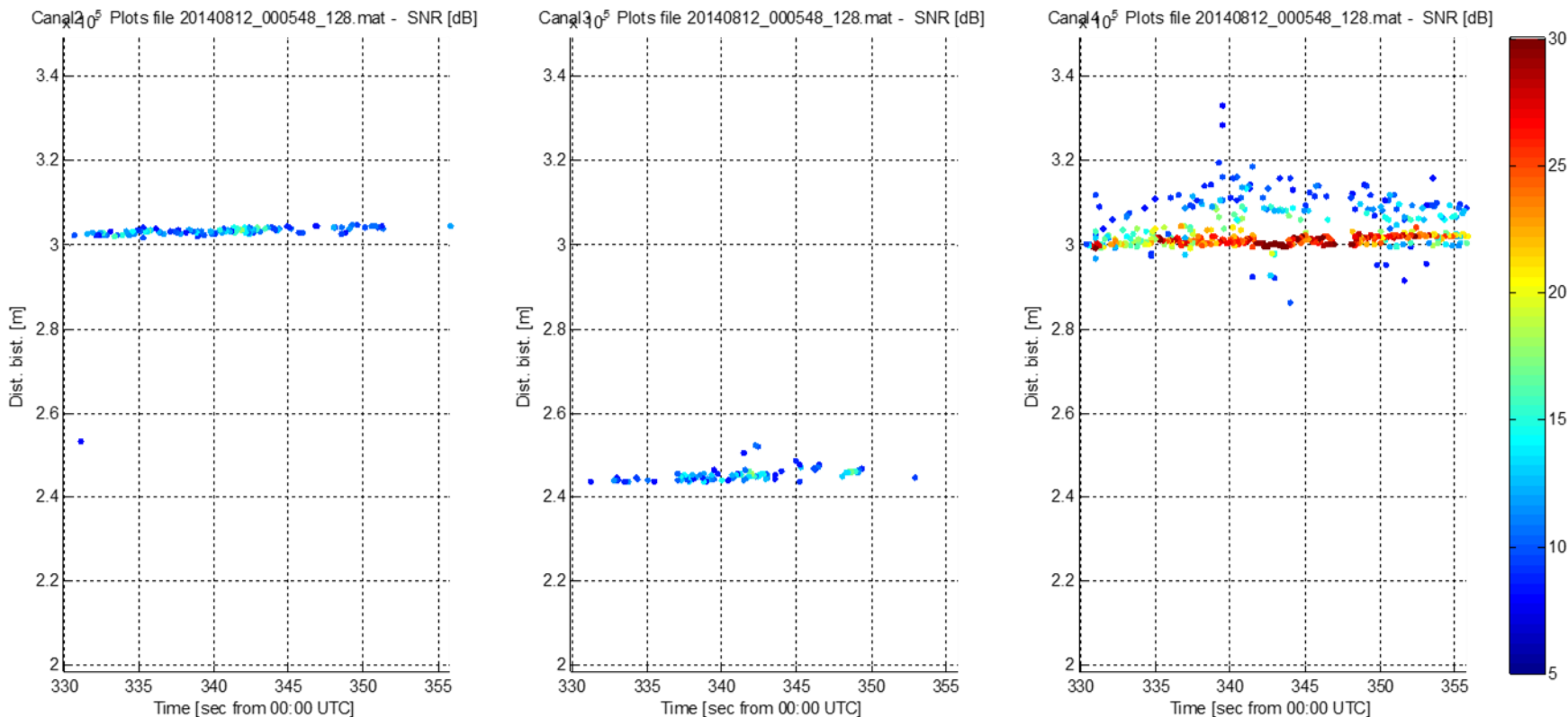


3 bistatic ranges are estimated from 3 channels : 302, 245 et 300 km



# Perseids – 20140812 00:05:31

- ❑ Detection : started 331s after 00:00 UTC => 00:05:31 UTC
- ❑ Meteor train detection during more than 20 seconds
- ❑ Bistatic range evolution over the detection



3 bistatic ranges are estimated from 3 channels : 302, 245 et 300 km

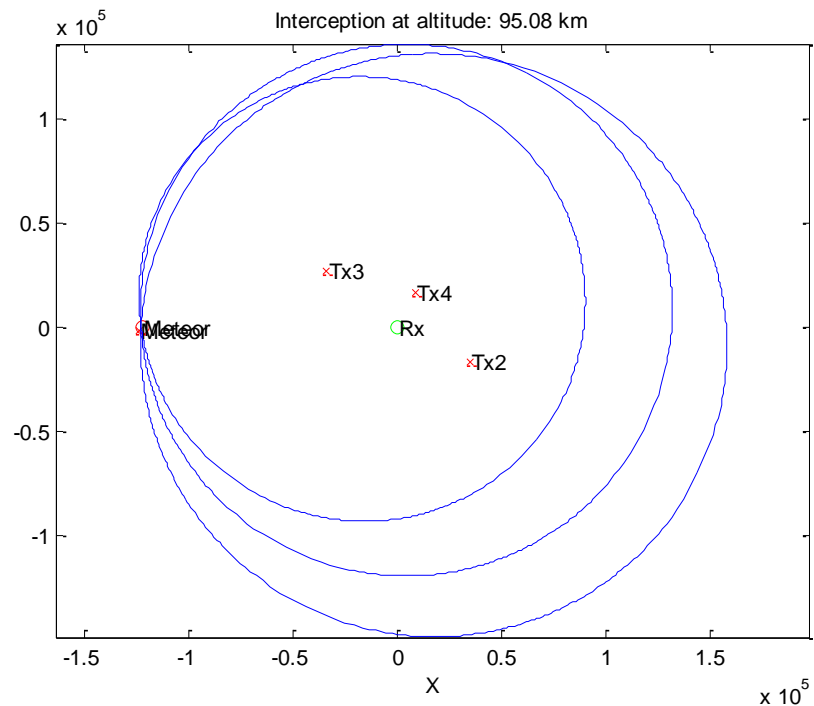


# Perseids – 20140812 00:05:31

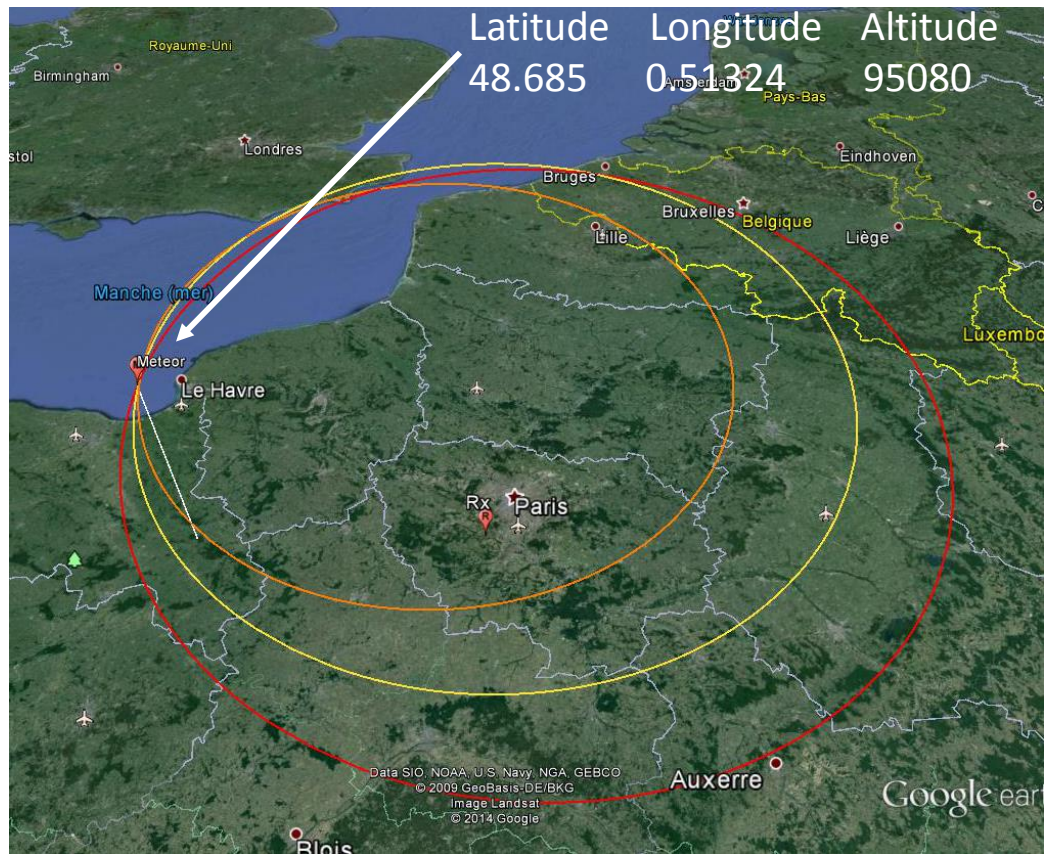
## 3D ellipsoids interception

### Receiver and transmitters locations

Receiver = [48.708286; 2.179563; 150] - Orsay - Rx  
 Eiffel Tower = [48.858301; 2.294220; 335] - 101.9 Tx4  
 Mantes = [48.954722; 1.715000; 133] - 101.7 Tx3  
 Melun = [48.555556; 2.650278; 160] - 102.1 Tx2

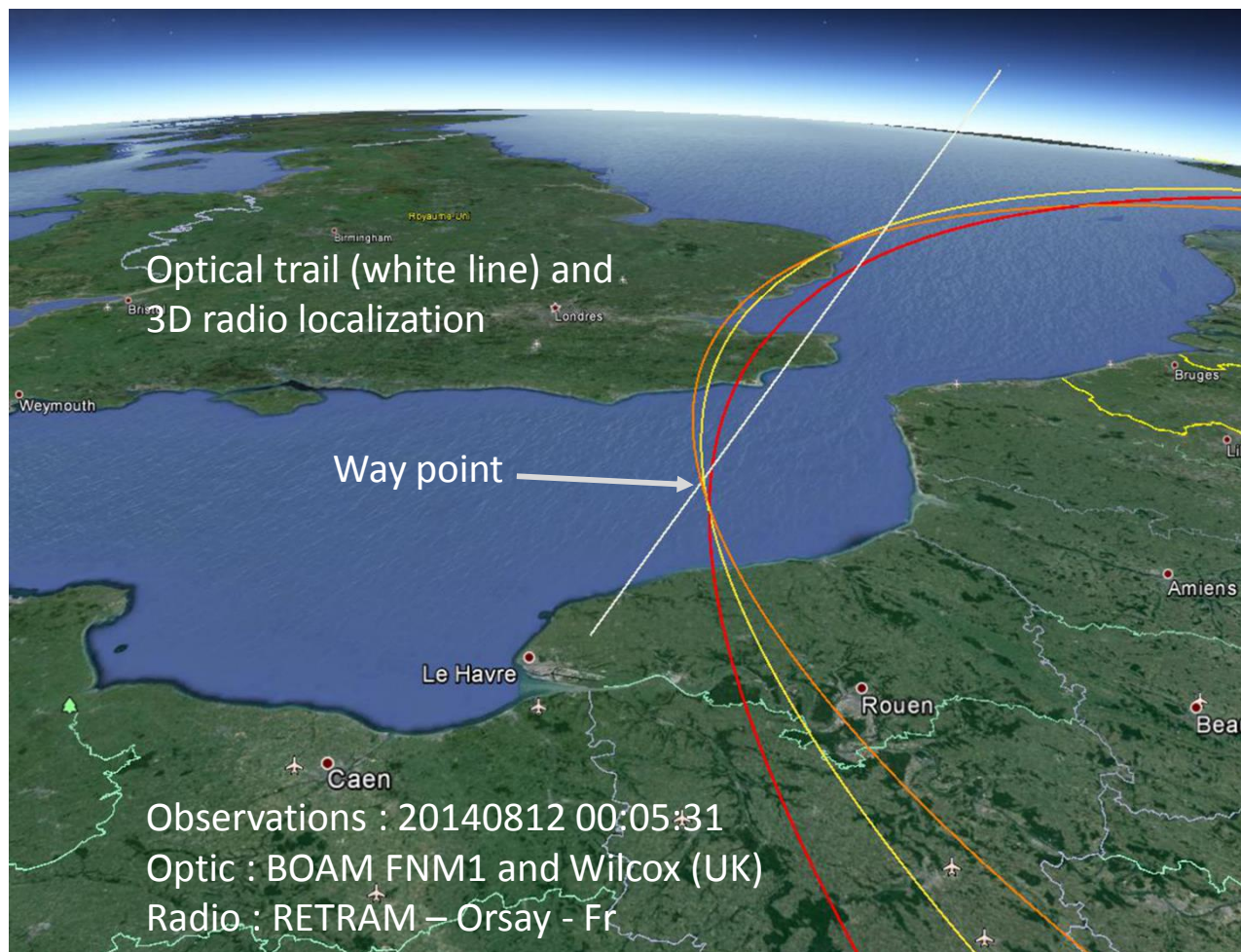


2D cut of ellipsoids at calculated altitude of 95,08km.



# Perseids – 20140812 00:05:31

- ❑ First comparison optic / radio



First result gives an hopeful performance of the system. Head echo was detected. We have to continue to assess performance and work to process automatically the head echo Doppler shift

