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*

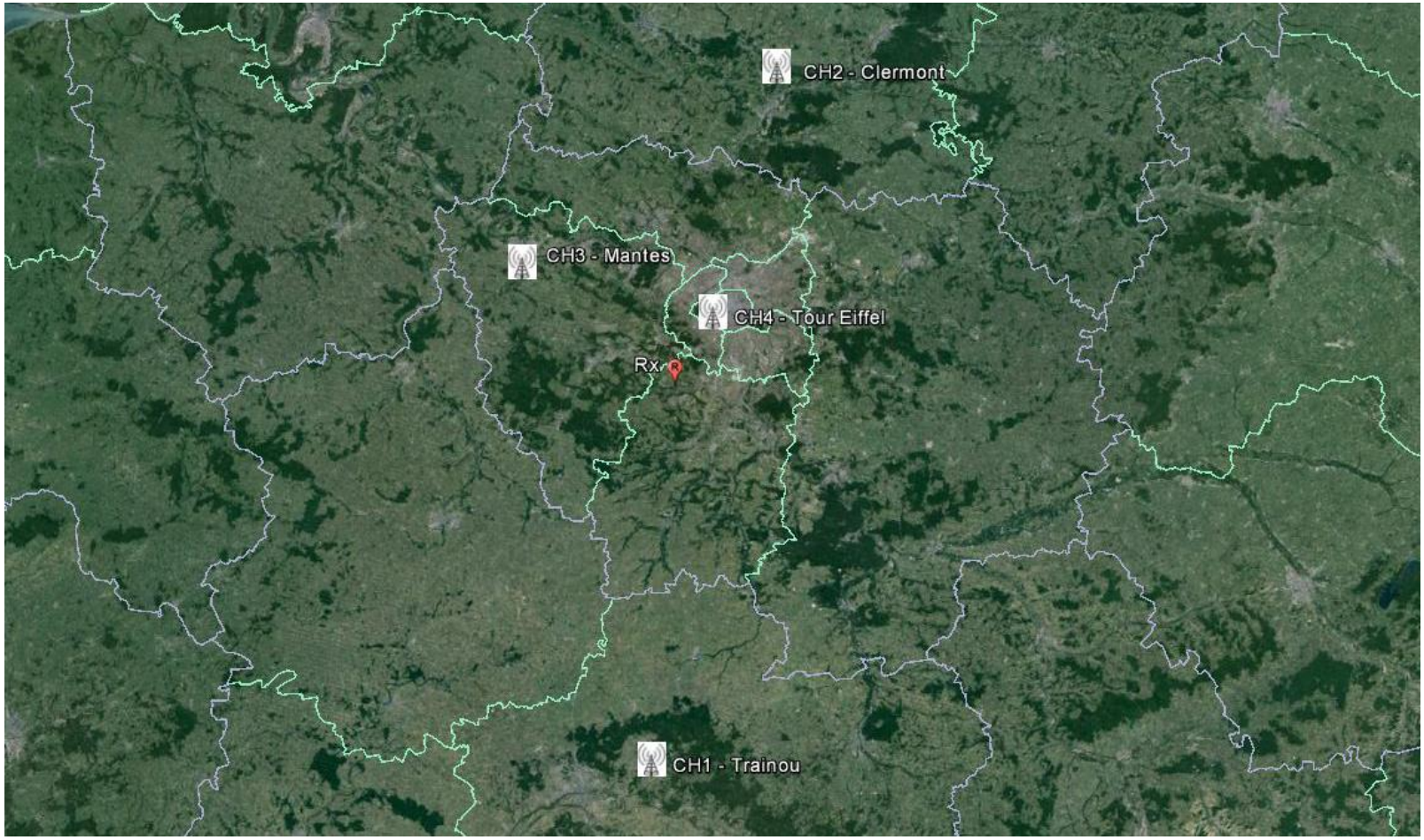
  http://www.retram.org
  http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/209_LINEAR/2014/index.php
  Time is UTC format
  Velocities are in m/s
  Bistatic delay and distance are in km
  RCS (Radar Cross Section) are in m²
  Map from Google-Earth

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 *gives a brief description of the station and processing.*

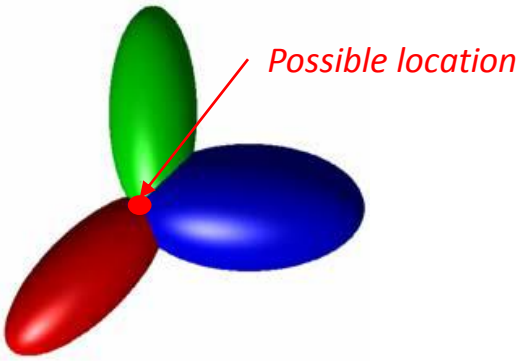
REMINDER

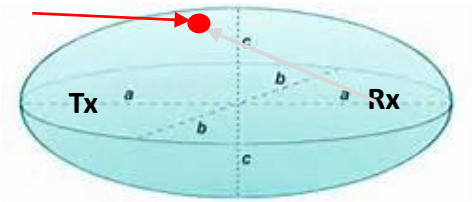
- Tx FM (Broadcast transmitter)
  - To collect enough information, the digital receiver (Rx) processed 4 FM channels.
  - CH1-100,9MHz, CH2-102,1MHz, CH3-101,7MHz and CH4-101,9MHz



REMINDER

- Bi-static data
  - Processing displays Range/Doppler maps
  - Doppler (velocity) is in m/s
  - Range (Db) is the delay between transmitted signal and reflected then received signal is in km
  - Distance from receiver to transmitter is Drt
  - The true bi-static distance is calculated by : Drt + Db 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.

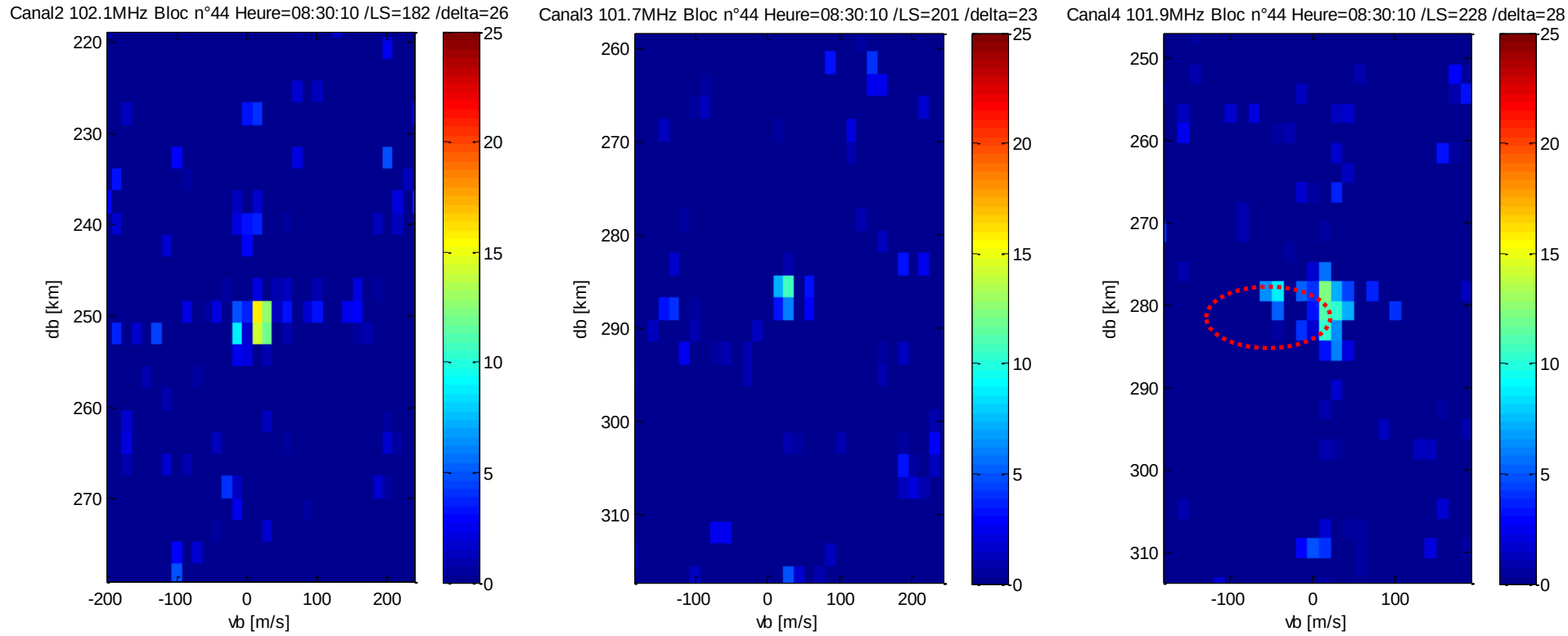




  - With a minimum of 3 information, we are able to locate the object in 3D (X,Y,Z or Lat, Lon,Altitude) with doing the interception of the ellipsoids.

Comet 209P / Linear

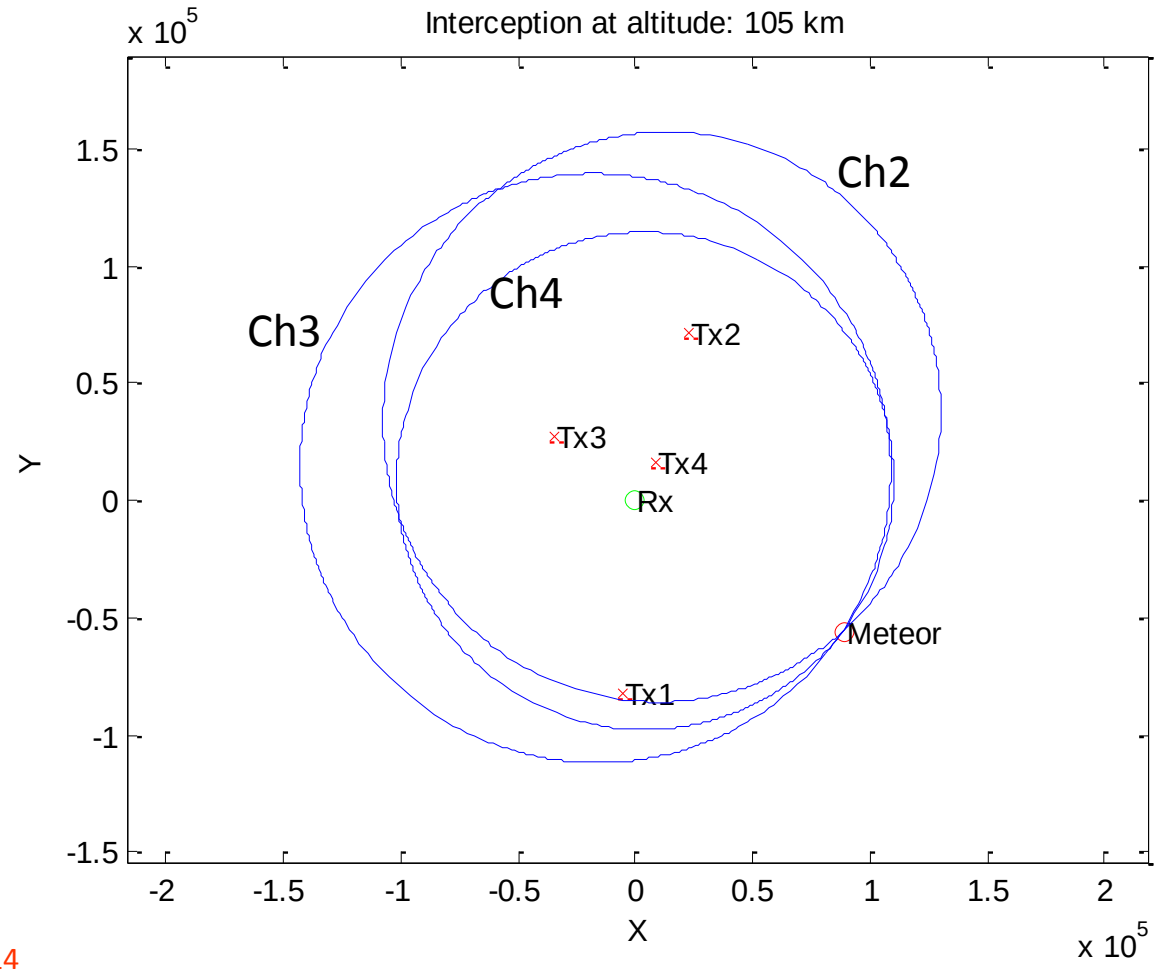
- 24 May 2014 Meteor Shower
  - The radiant is located in the Camelopardalis constellation
  - Prediction was given by IMCCE (see reference)
  - 08:30:10 detections on Channels 2, 3 and 4. Signals simultaneously appears on 3 of the 4 channels. The end of head echo is visible on channel 4 (red circled). Head echo will be processed using a dedicated processing SW.



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

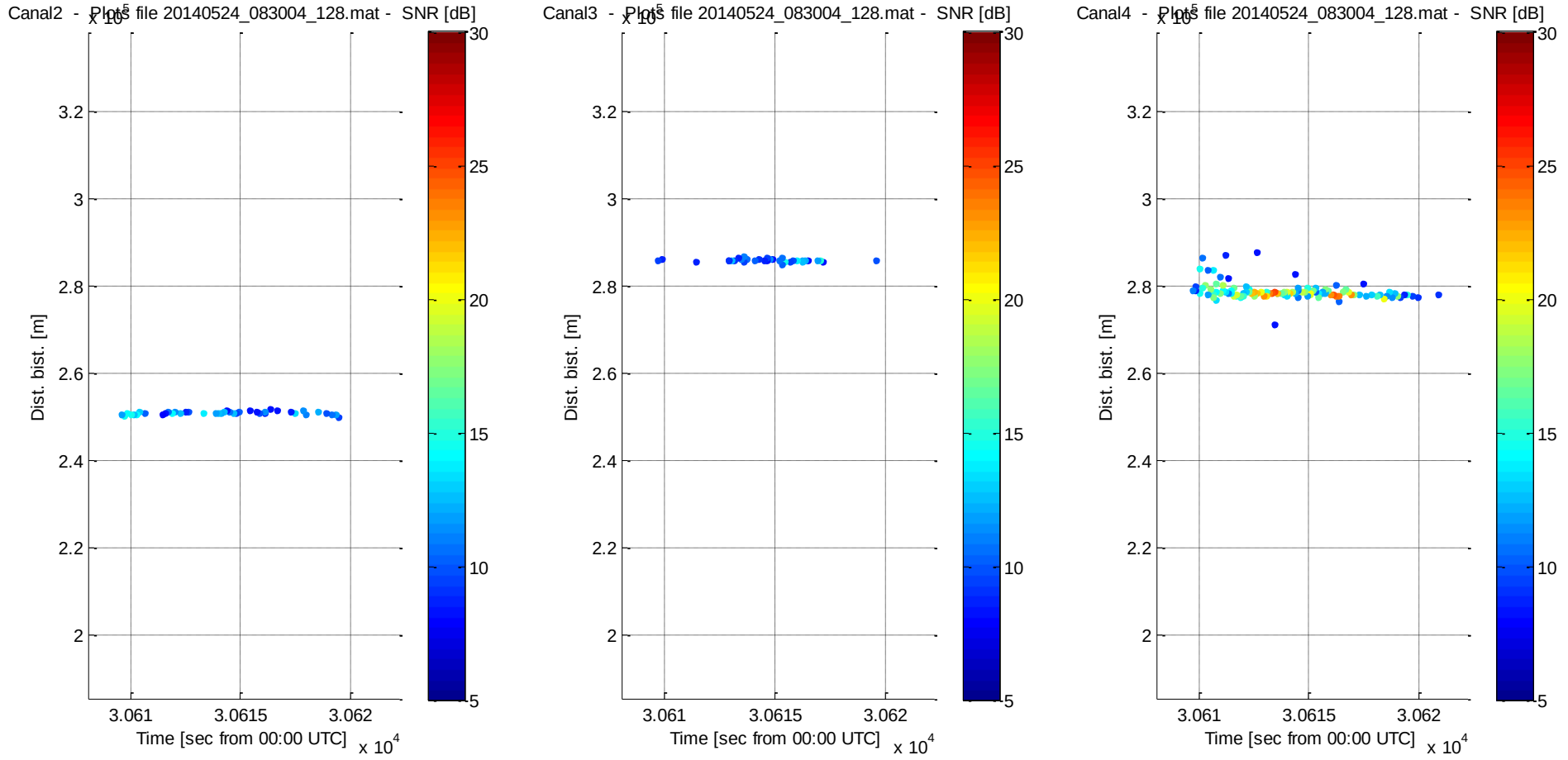
Comet 209P / Linear

- 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

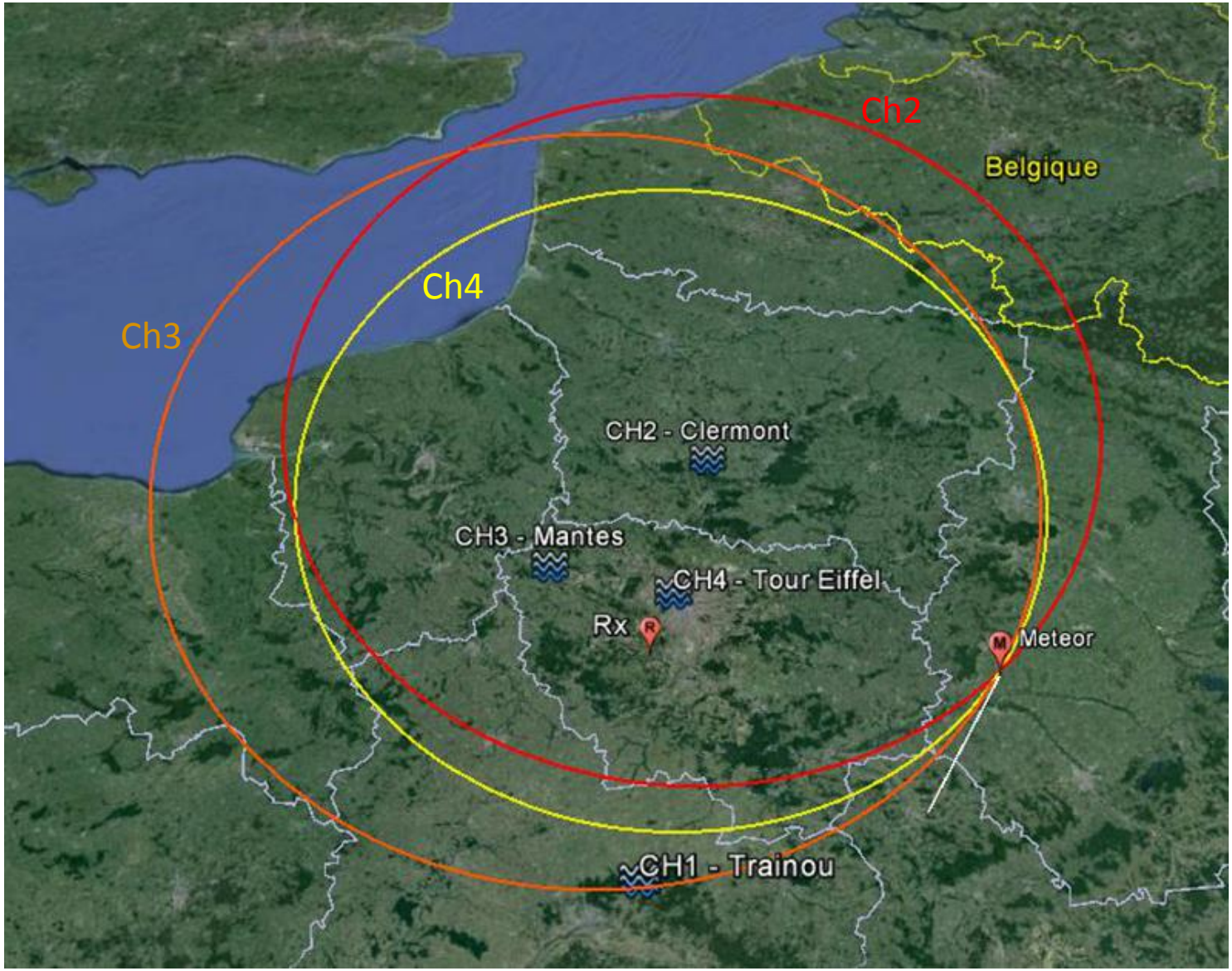
- 24 May 2014 Meteor Shower @ 08:30:10



This figure shows the tracking oh 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.

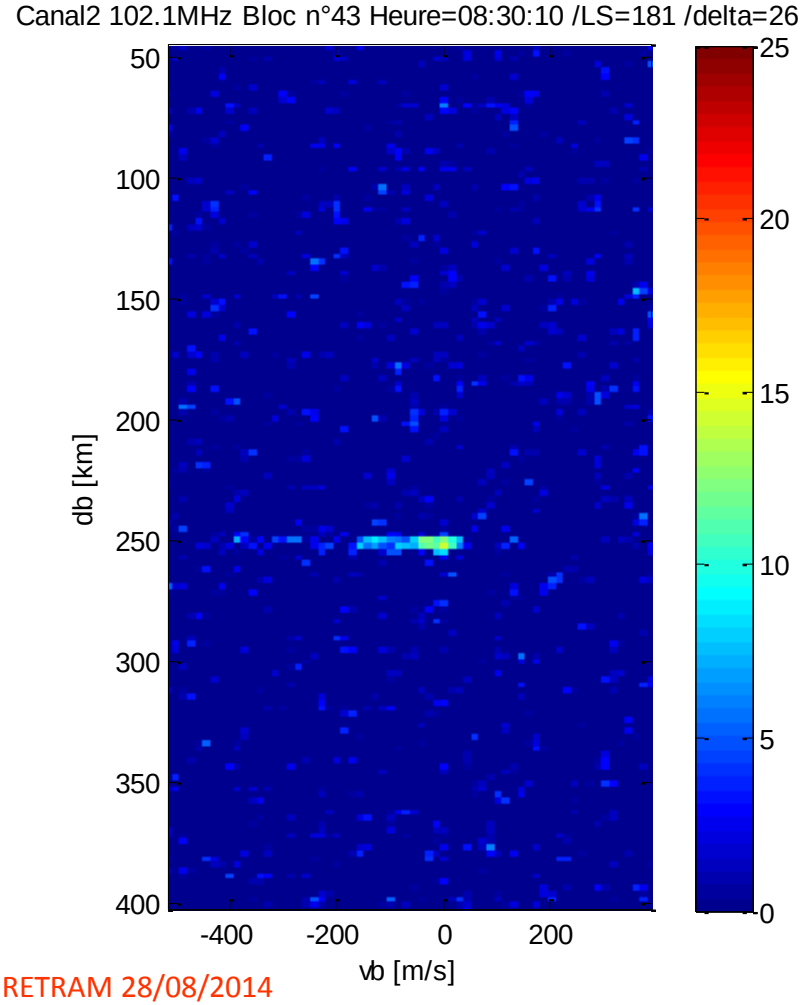
Comet 209P / Linear

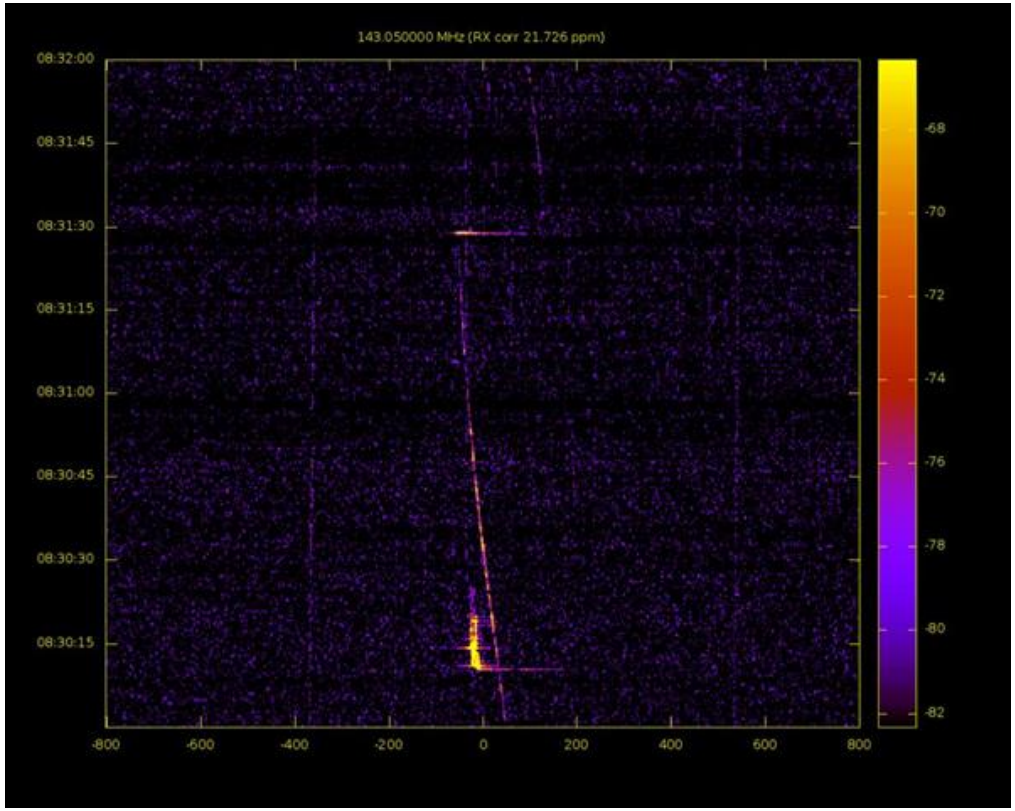
- 24 May 2014 Meteor Shower @ 08:30:10 – 3D view with a cut @ 105km



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.





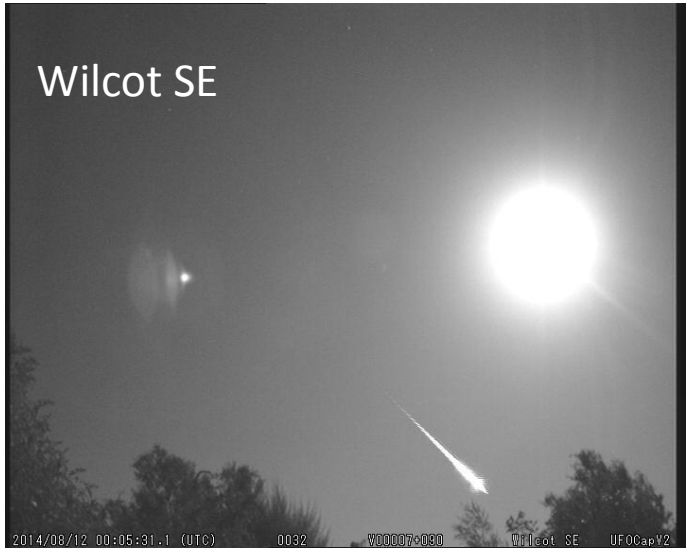
A 200Hz change is visible on Graves and it is equivalent to the -400m/s on FM

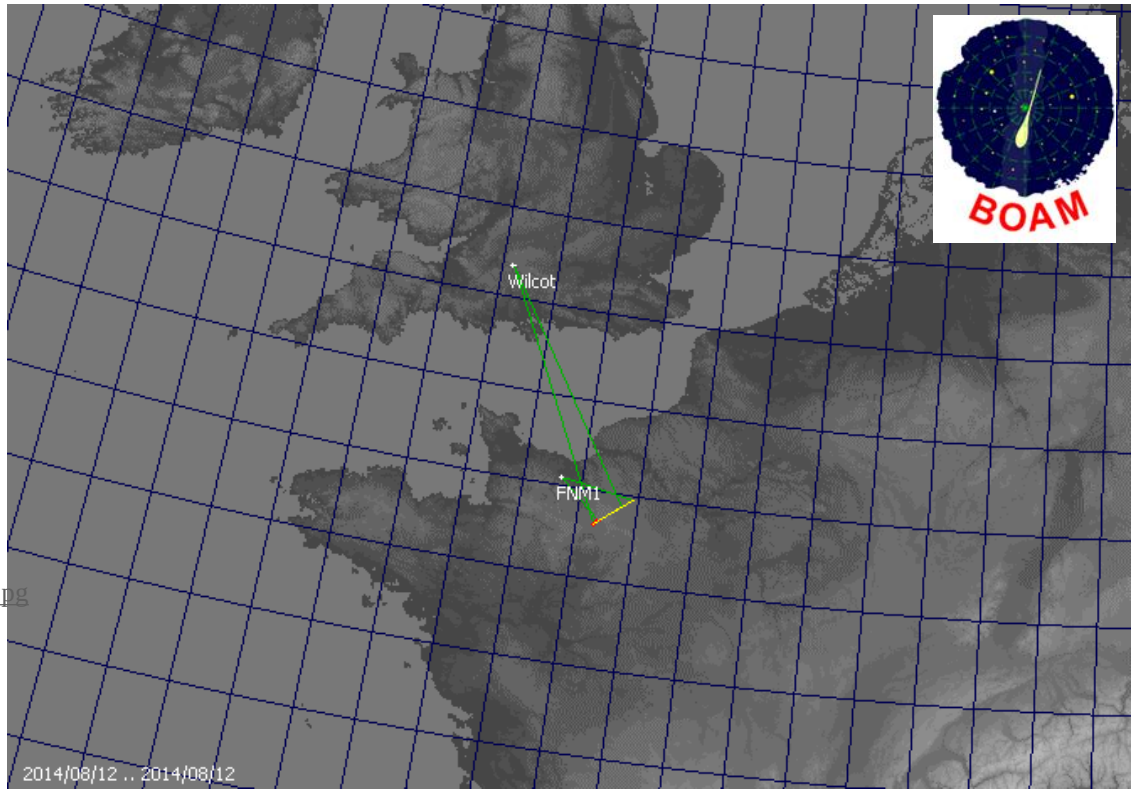
Remarks – Synthesis

- ✓ 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* .
- ✓ 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





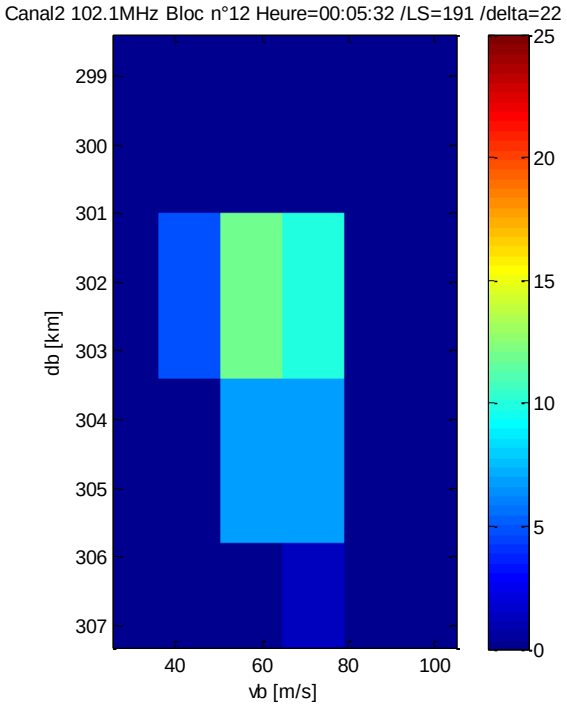
http://boam.fr/detection/image/M20140812_000531_FNM1_JB2P.jpg

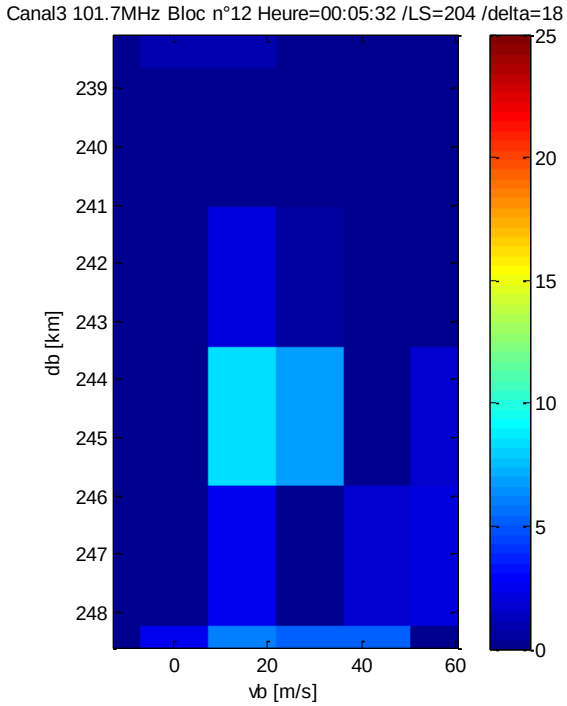
_localtime	_mjd	_sol	_amag	_ra_o	_dc_o	_ra_t	_dc_t	_elng	_elat	_vo	_vg	_vs	_stream
20140812_000531	56881,004	139,04	-6,4	39,25	55,41	39,66	55,48	56,52	37,74	68,8	67,7	48,2	_J5_Per

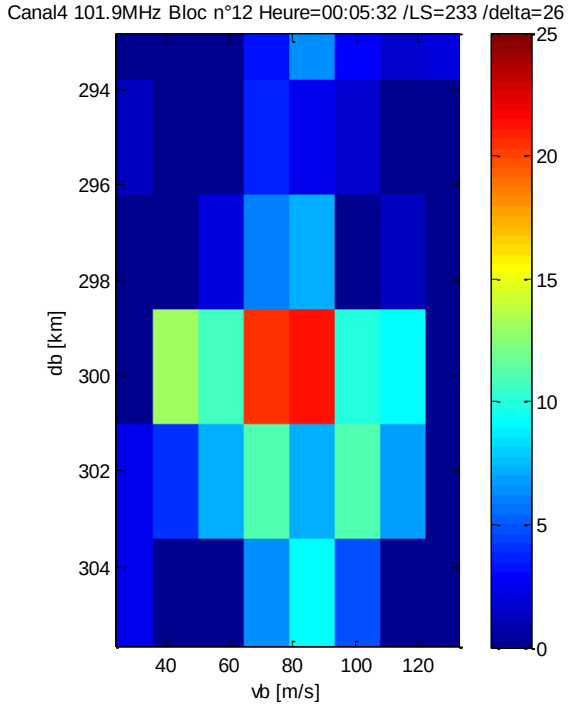
_mag	_dur	_lng1	_lat1	_H1	_lng2	_lat2	_H2	_dt	_Qo	_Qc	_QA
-4,7	0,940	0,91	48,96	133,2	0,37	48,67	82,2	0,040	20,6	16	0,440

Perseids – 20140812 00:05:31

- FM detection
- Bistatic raw data



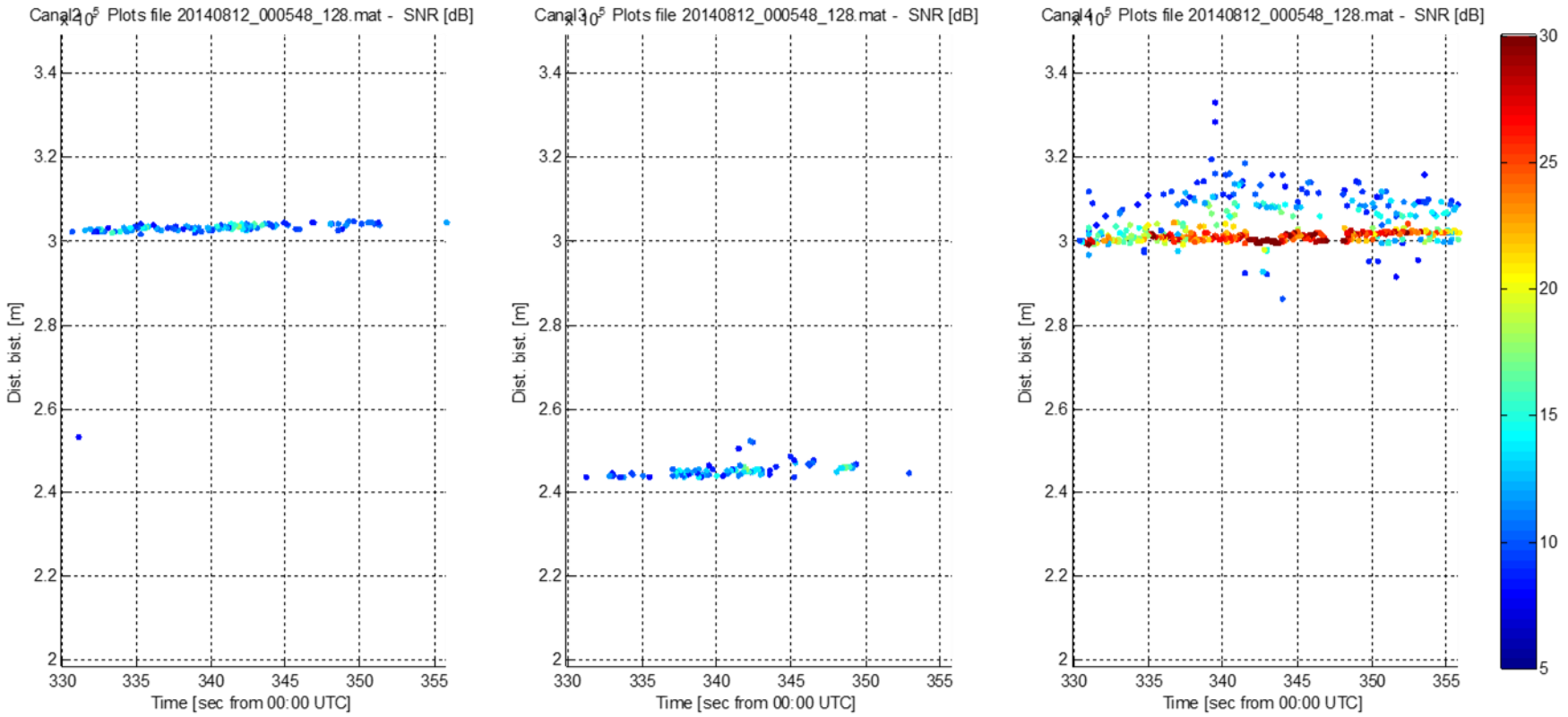




3 bistatic ranges are estimated from 3 channels : 302, 245 et 300 km

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

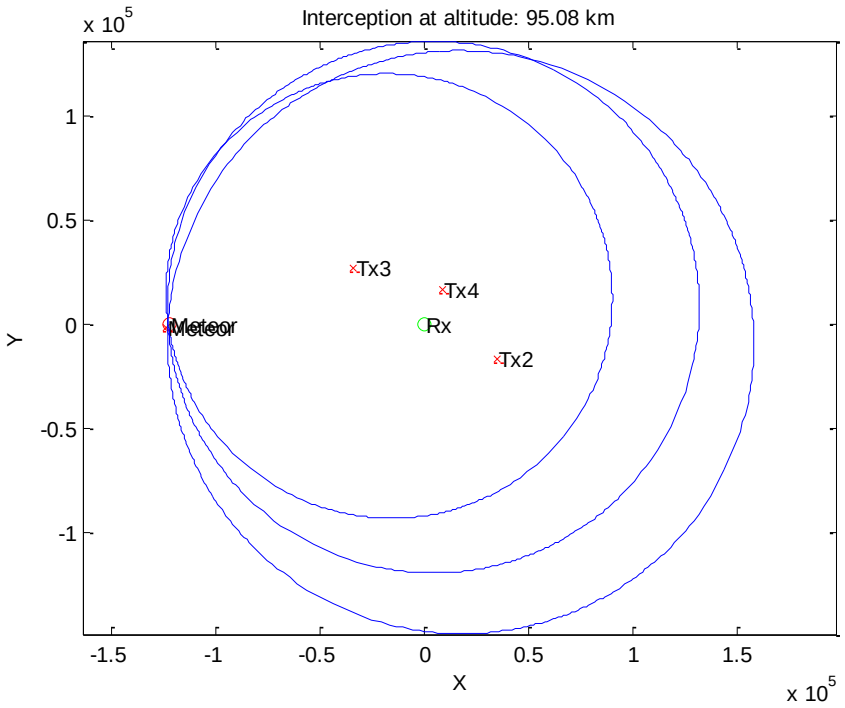


3 bistatic ranges are estimated from 3 channels : 302, 245 et 300 km

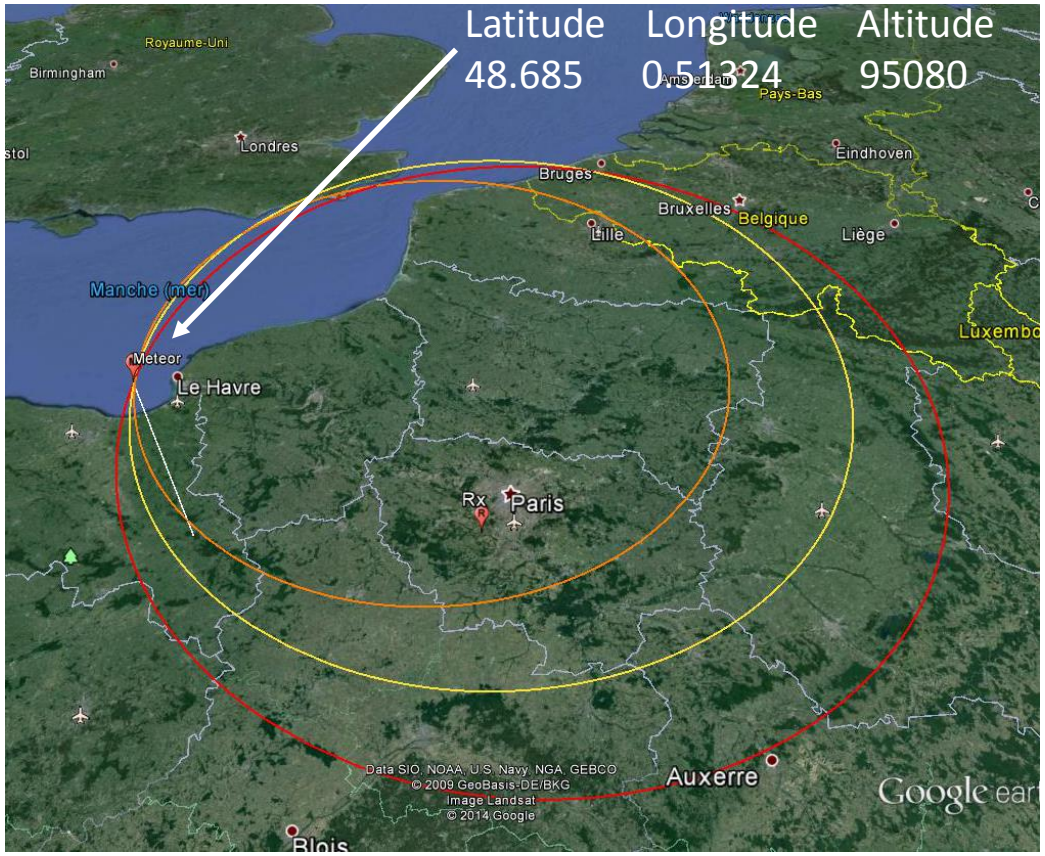
Perseids – 20140812 00:05:31

- 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

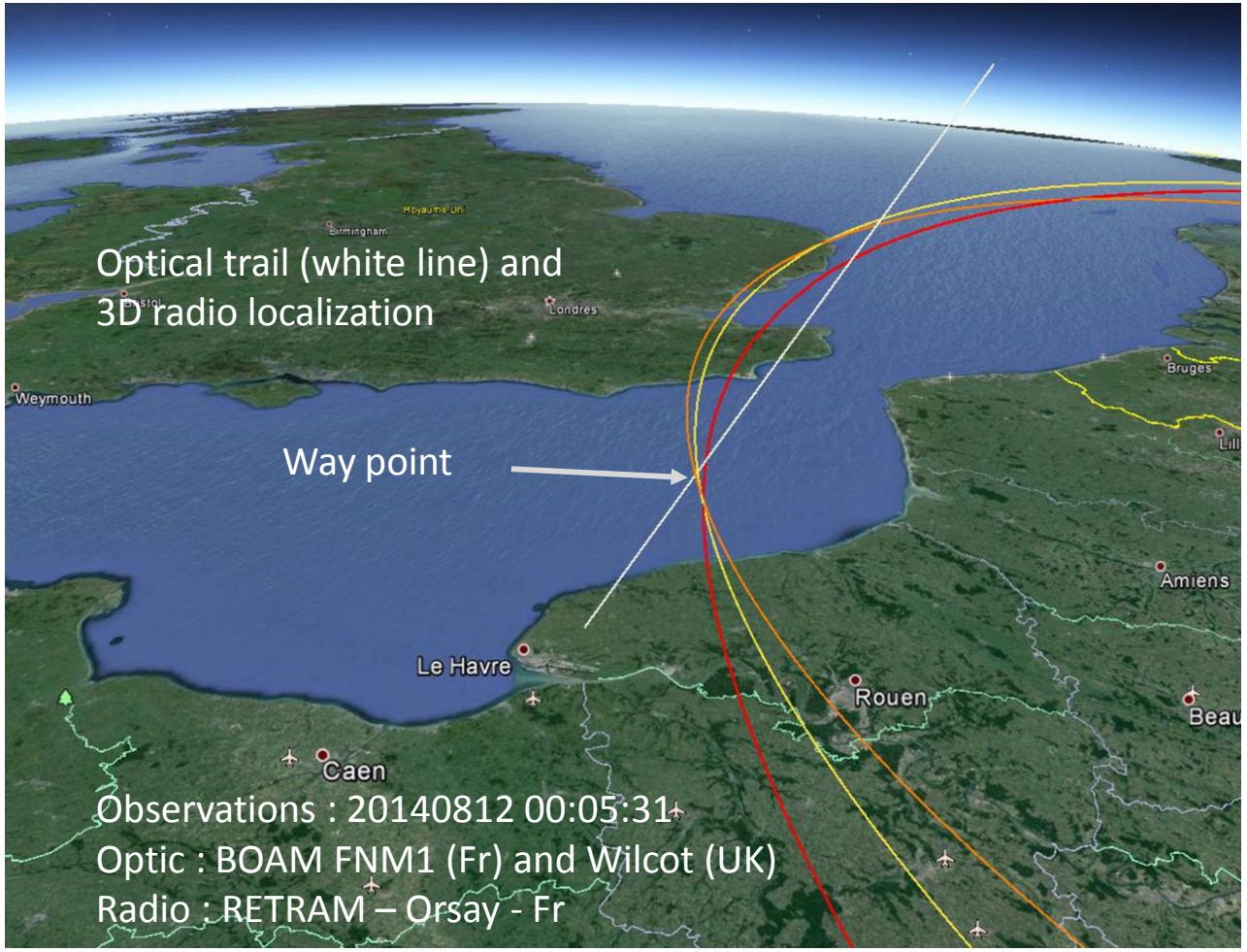


2D cut of ellipsoids at calculated altitude of 95,08km.



Perseids – 20140812 00:05:31

- First comparison optic / radio



First result gives an hopefull 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