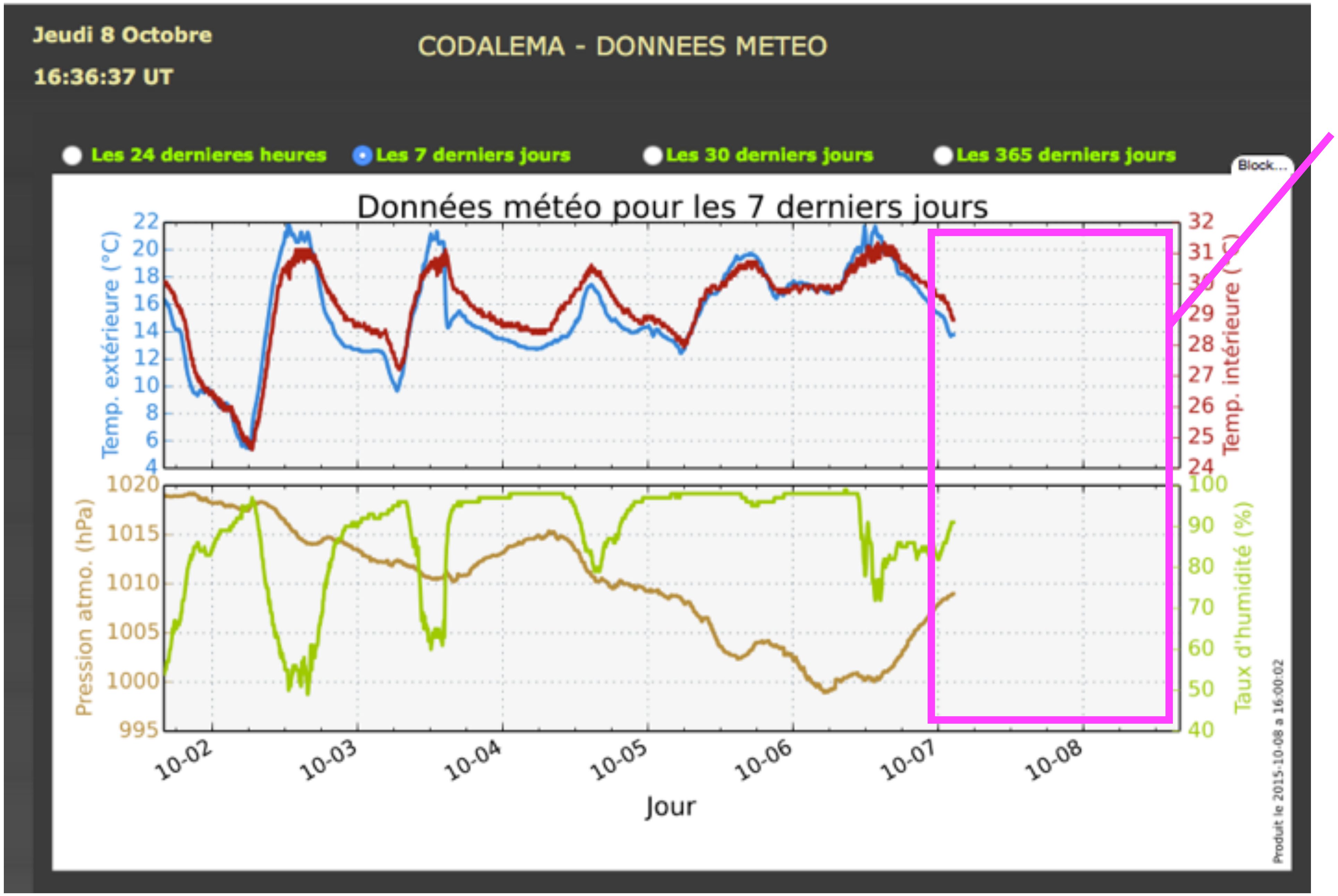
Station météo

- Surveillance de la température, de la pression atmosphérique et du taux d'hygrométrie au niveau du toit du conteneur CODALEMA
- Acquisition des données pilotée (Labview) par le PC d'acquisition des données scintillateurs (CodaDaqSC)
- Graphes évolutifs sur la page web de monitoring de CODALEMA



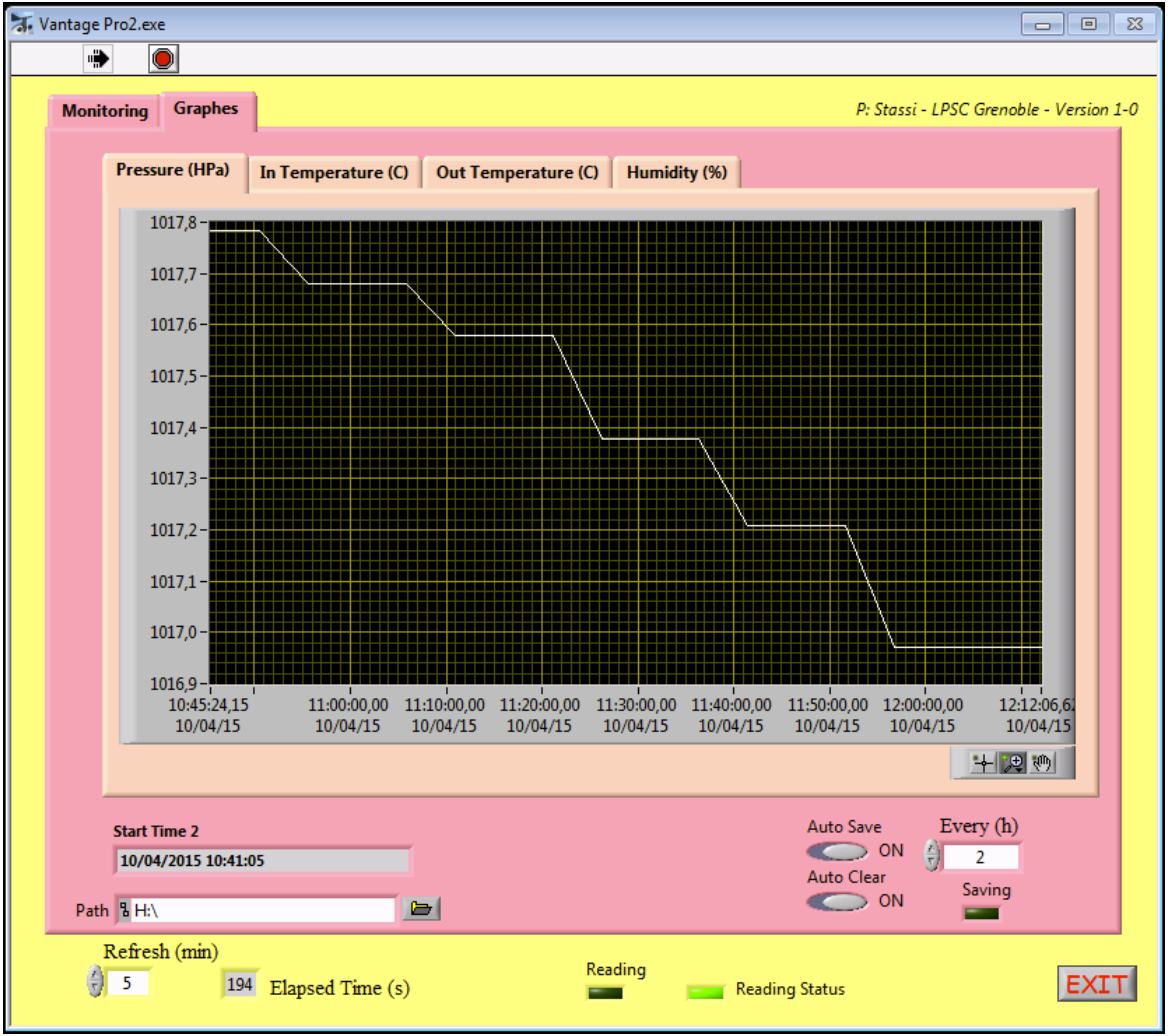
Jeudi 8 Octobre
16:36:37 UT

CODALEMA - DONNEES METEO

○ Les 24 dernieres heures ● Les 7 derniers jours ○ Les 30 derniers jours ○ Les 365 derniers jours

Elle a tendance à se "planter" ! ici, elle était en panne…

Comment la mettre à contribution dans LICORNE ? Que peut-elle apporter ?



P: Stassi - LPSC Grenoble - Version 1-0

Start Time 2: 10/04/2015 10:41:05

Path: H:\

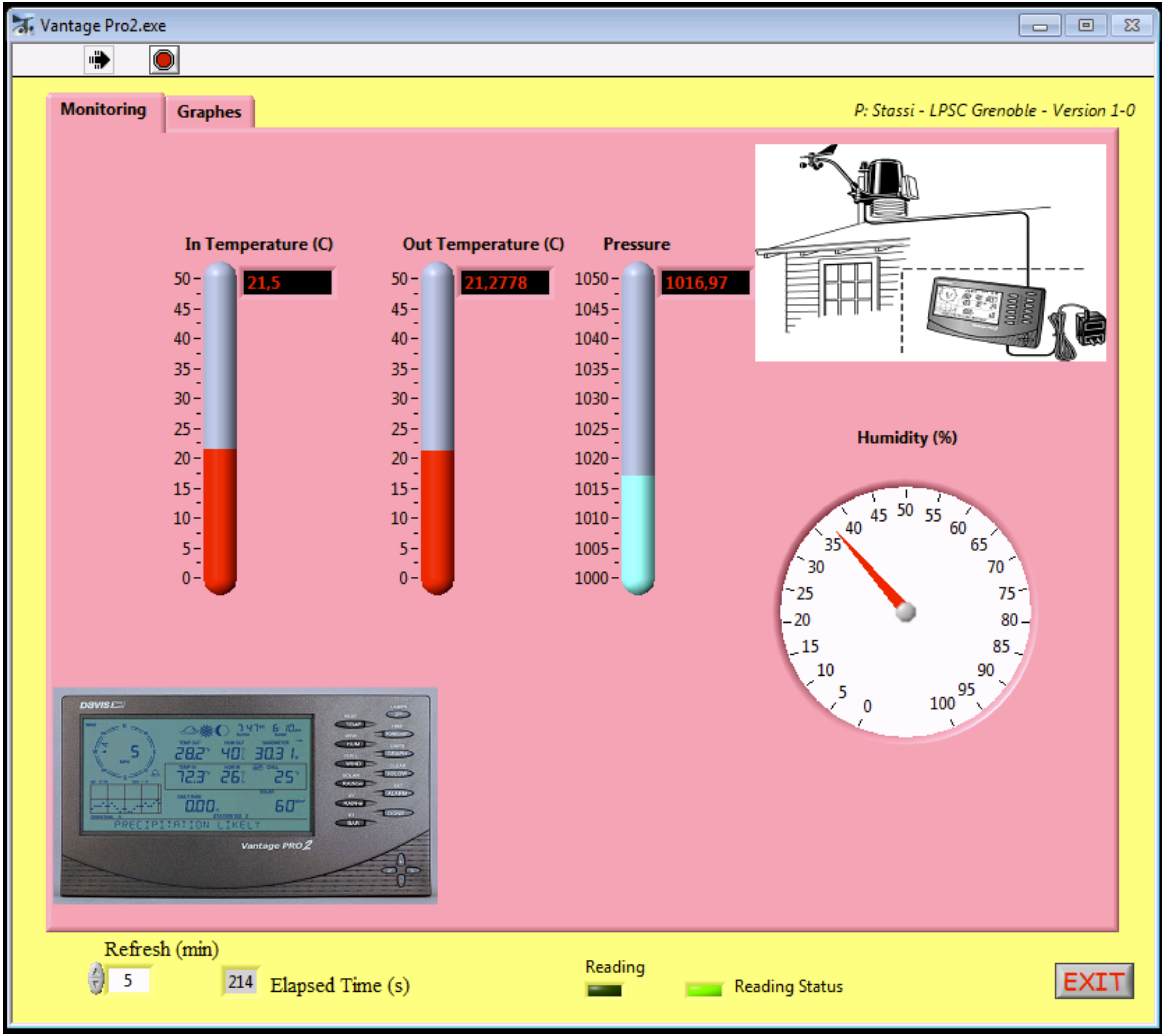
Auto Save: ON

Auto Clear: ON

Every (h): 2

Refresh (min): 5

Elapsed Time (s): 194



Vantage Pro2.exe

P: Stassi - LPSC Grenoble - Version 1-0

In Temperature (C): 21,5

Out Temperature (C): 21,2778

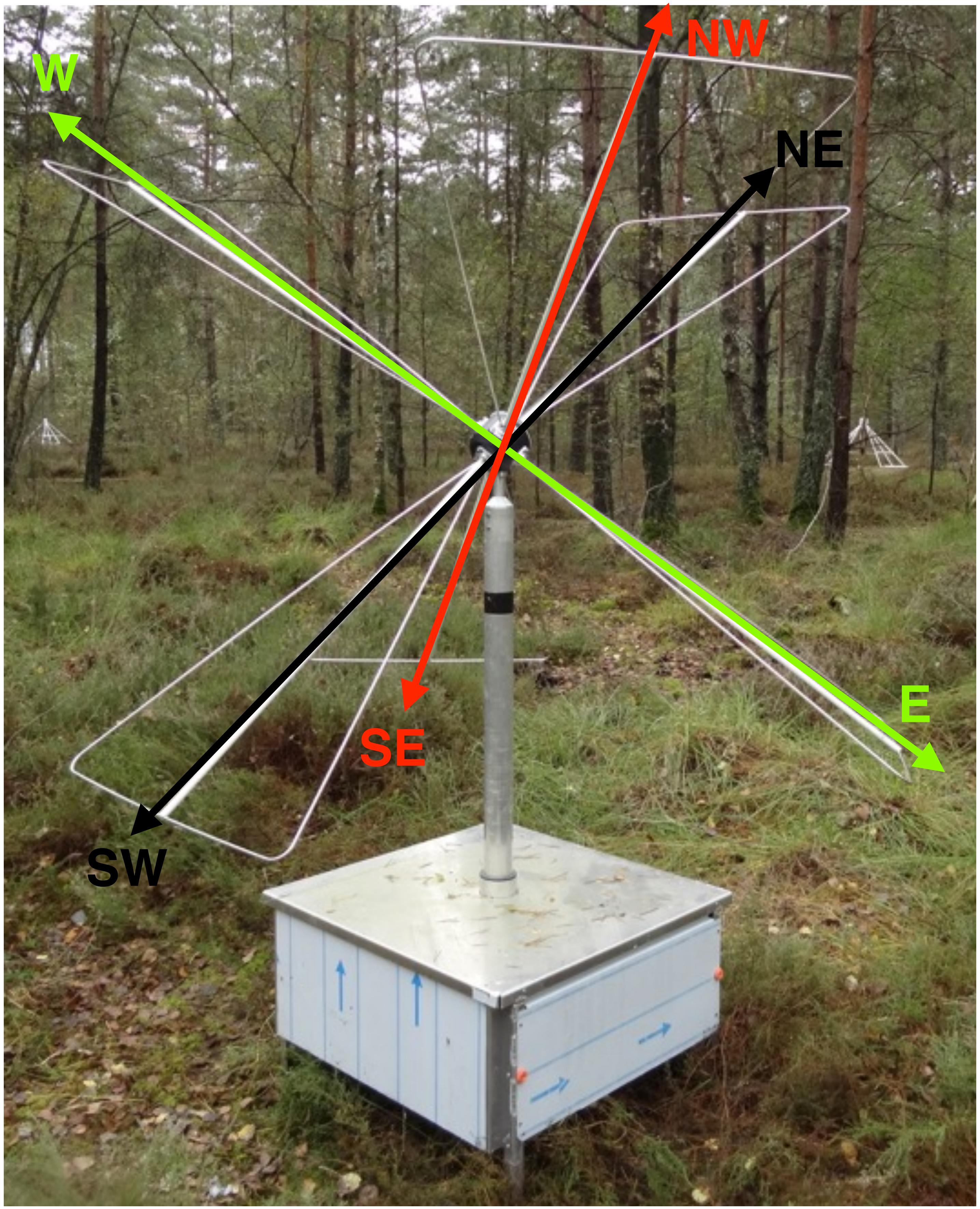
Pressure: 1016,97

Humidity (%)

Refresh (min): 5

Elapsed Time (s): 214

Antenne “Tripole”



Trièdre [X,Y,Z] avec:
- → rotation de 45° autour du centre de la noix
- → rotation de 45° autour de l’axe EW
- → rotation de chaque brin de 45°

Axes **EW**, **NWSE**, **SWNE**

Amplis LONAMOS “classiques” 20 - 200 MHz

Numérisation 1 GS/s sur 2.56 μs

Signaux ± 500 mV

Acquisition déclenchée par chaque trigger “scintillateurs”, soit environ toutes les 2 minutes (de l’ordre de 800 à 900 événements par jour)

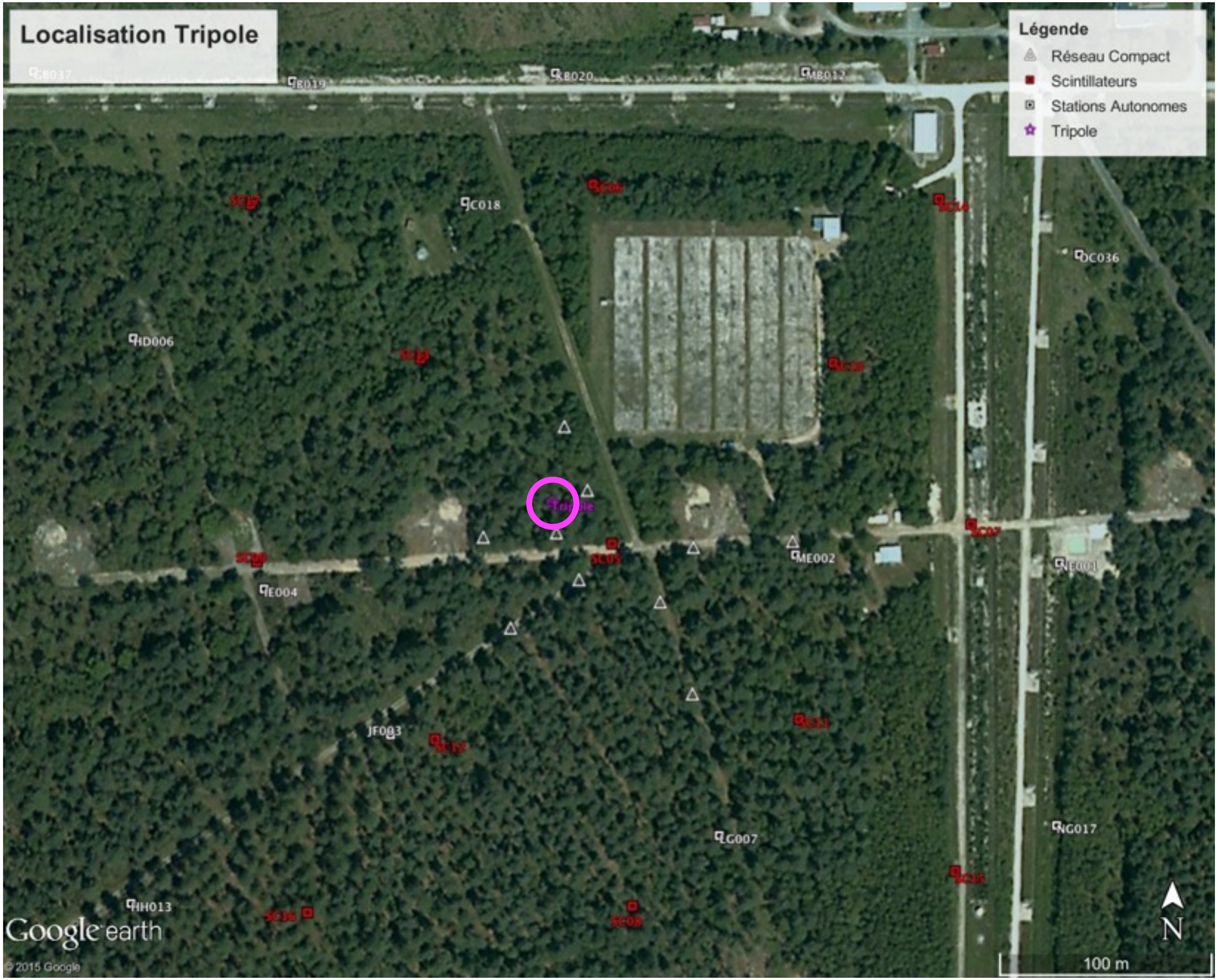
Antenne “Tripole”

- Seule antenne permettant de mesurer les 3 composantes du champ électrique en une seule fois

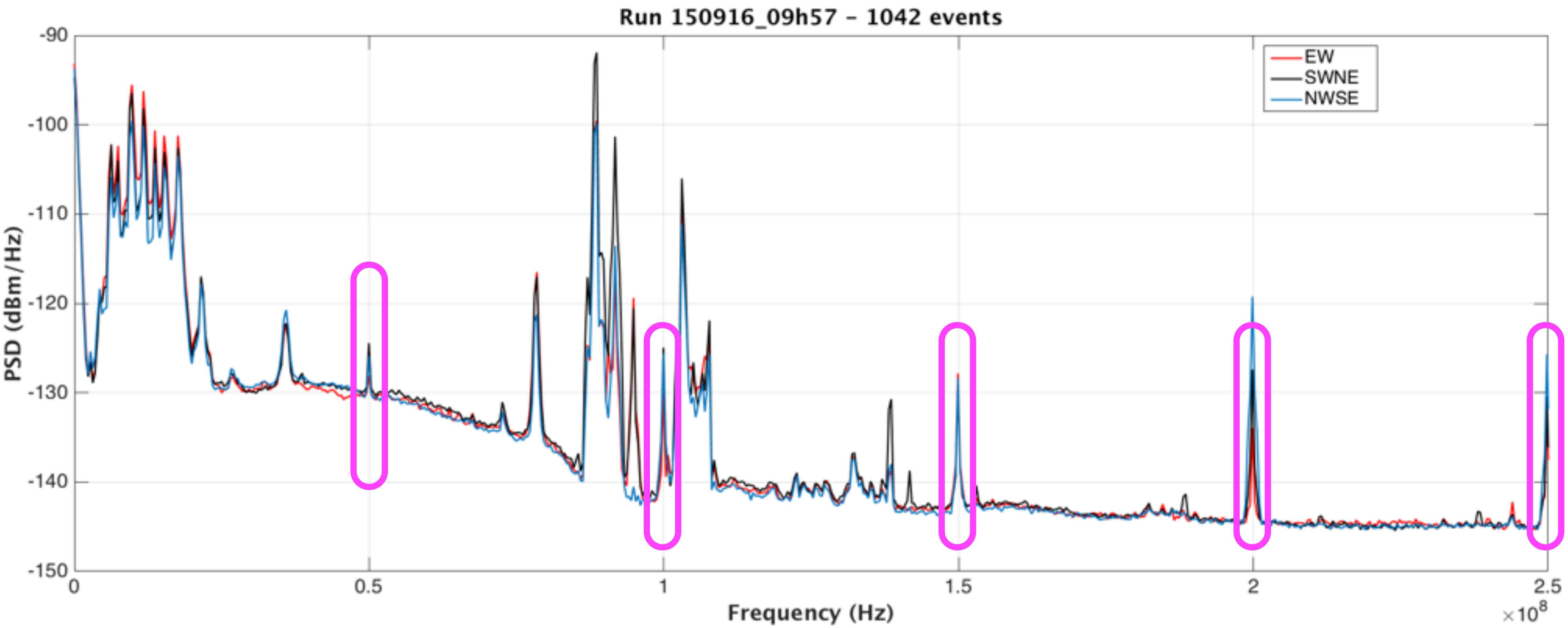
  Procédure de déconvolution encore à écrire pour retrouver E_{Total}
- Avec le réseau compact, seule antenne [20-200 MHz] dont l’acquisition est déclenchée à chaque événement scintillateurs, donc “rayon cosmique”
- Objectifs : vérifier (ou pas) l’hypothèse “champ lointain”. Cette hypothèse que la source du champ électrique mesuré dans les gerbes est lointaine (vs longueur d’onde) entraîne qu’il n’y a pas de composante longitudinale au champ électrique (le long de l’axe de la gerbe). Si elle est vraie, la connaissance de E_{NS} et E_{EW} suffit pour retrouver E_{Vertical}. Dans le cas contraire, le champ total mesuré par l’antenne 3D ne sera pas égal au champ reconstruit par une antenne “plane”.

Comment la mettre à contribution dans LICORNE ? Que peut-elle apporter ?

Antenne “Tripole”



Antenne “Tripole”



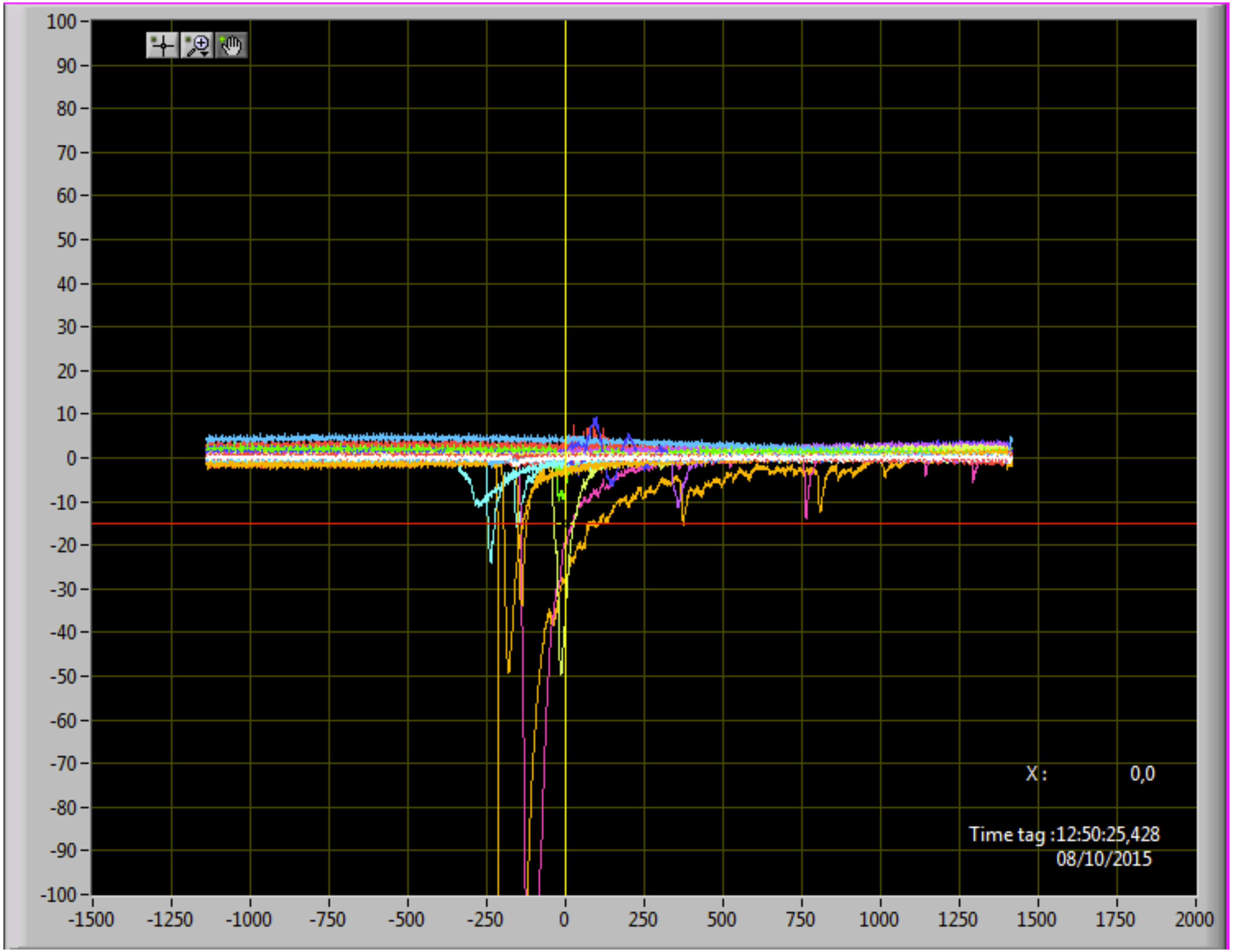
Réplication d’une raie tous les 50 MHz due
à la carte Matacq de numérisation (artefact)

Antenne “Tripole”

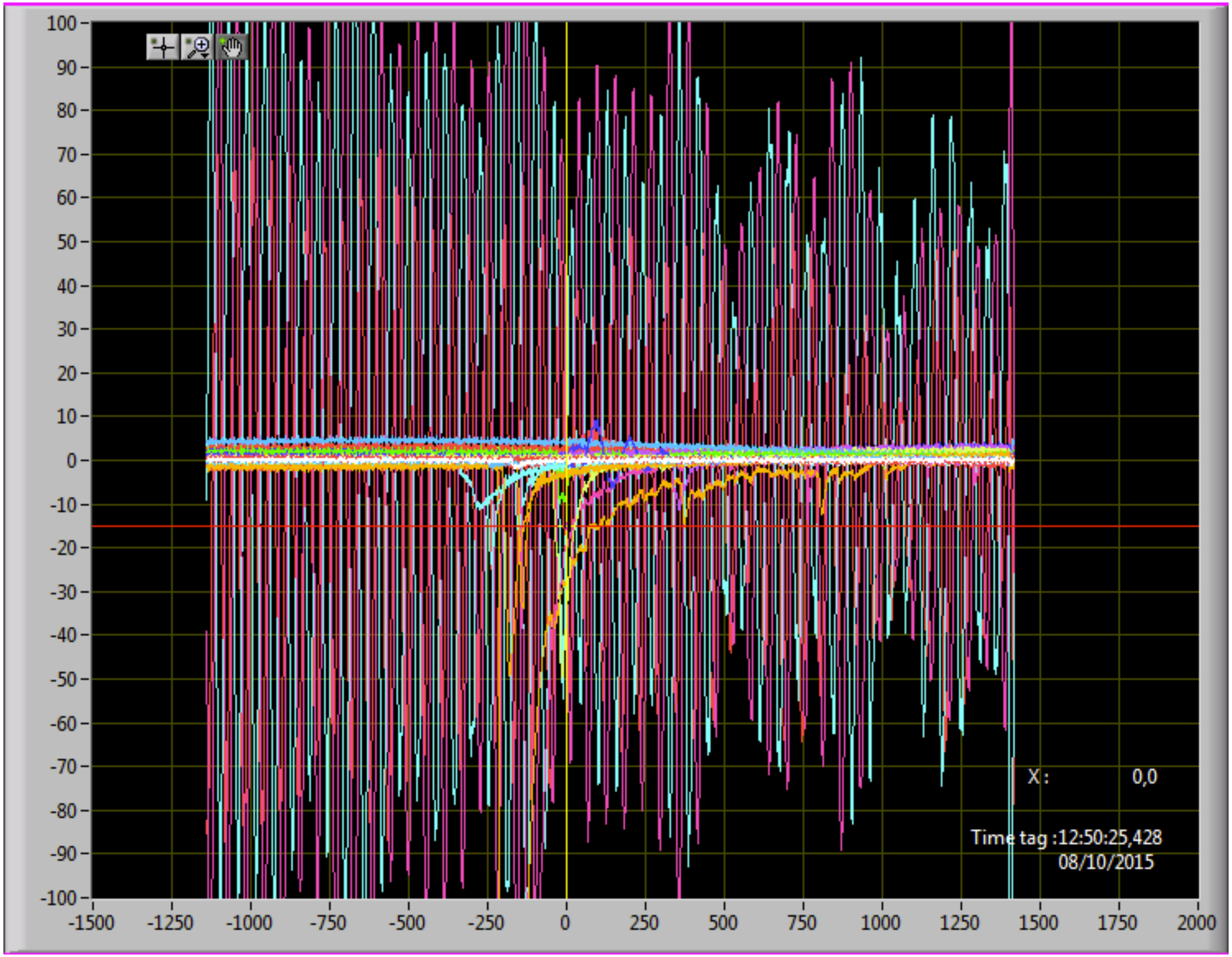
- Données en base, présentes dans chaque fichier d’événement scintillateurs, au format texte (colonnes 58, 60 et 64 du fichier)

```matlab
function [time,yellow,white,green]=read3Dfile(fileName);

% read3Dfile - Syntax: [timeBin,yellow,white,green]=read3Dfile(fileName);
%
% Reads the text files of the 3 polarisations of the 3D antenna. Returns
% the time vector for the 3 polarisations (time), and the yellow, white and
% green polarisation respectively. An automatic detection of the voltage
% unit (either mV or V) is made, so as the results are in volts.

% Last update: 23/02/2015 - R. Dallier

fid=fopen(fileName);
C=textscan(fid,'%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f
%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f%f');
fclose(fid);
time=C{57}*1e-9;  % The column containing the time bin for the first antenna pole recorded (s)
yellow=((max(C{58})>1)*1e-3+(max(C{58})<1))*C{58};
white=((max(C{60})>1)*1e-3+(max(C{60})<1))*C{60};
green=((max(C{64})>1)*1e-3+(max(C{64})<1))*C{64};
clear('C');

% End of read3Dfile.m
```

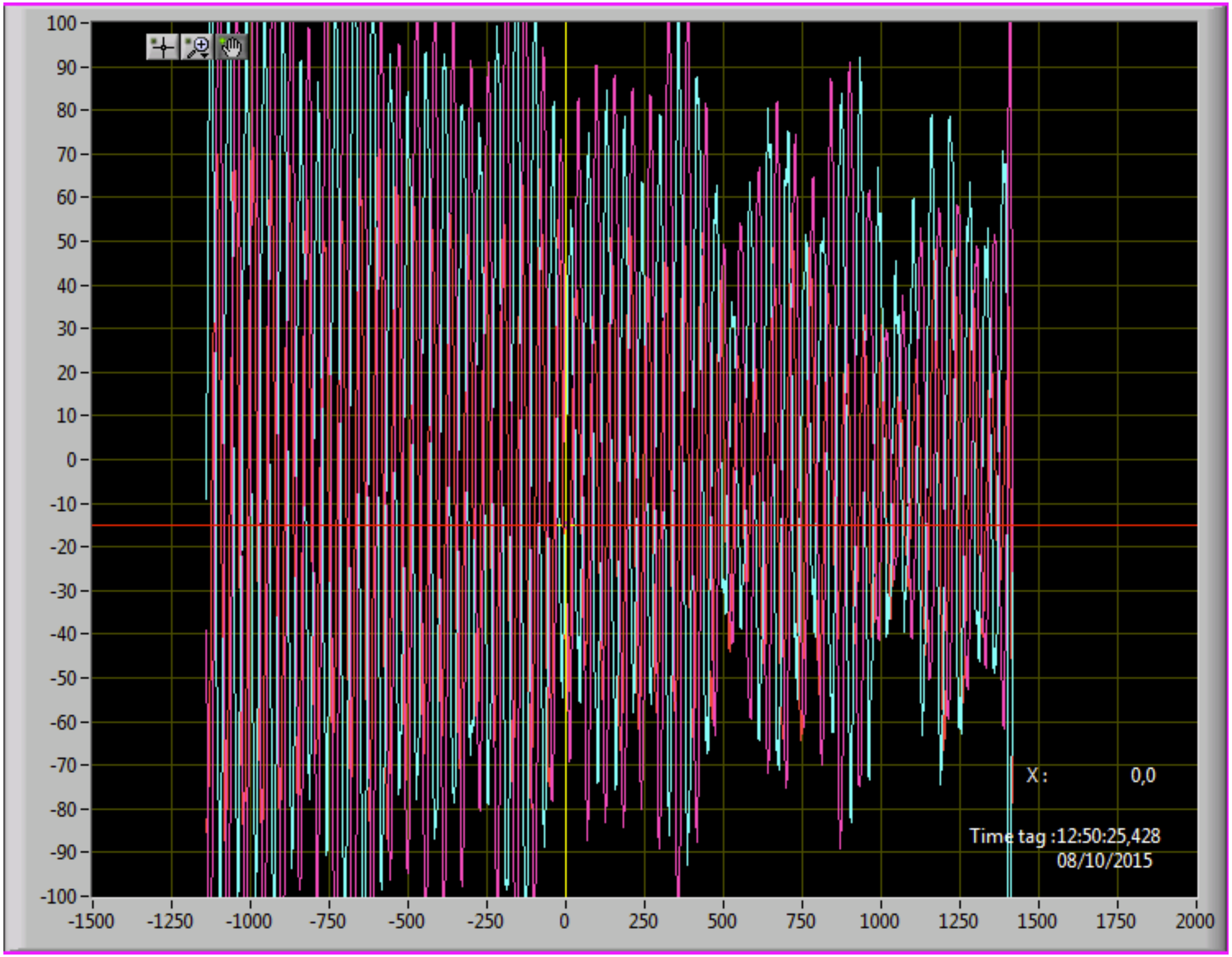
Antenne “Tripole”

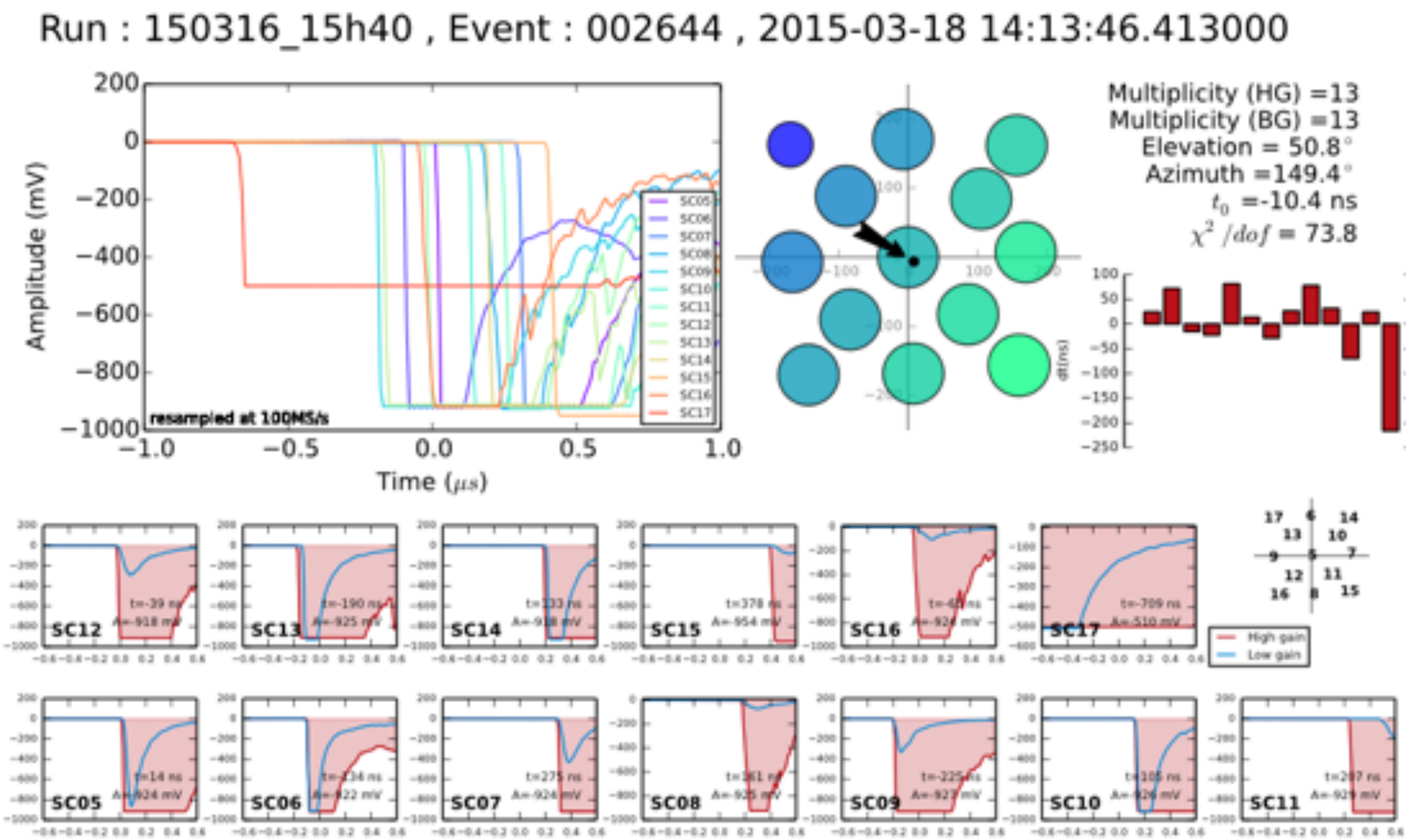


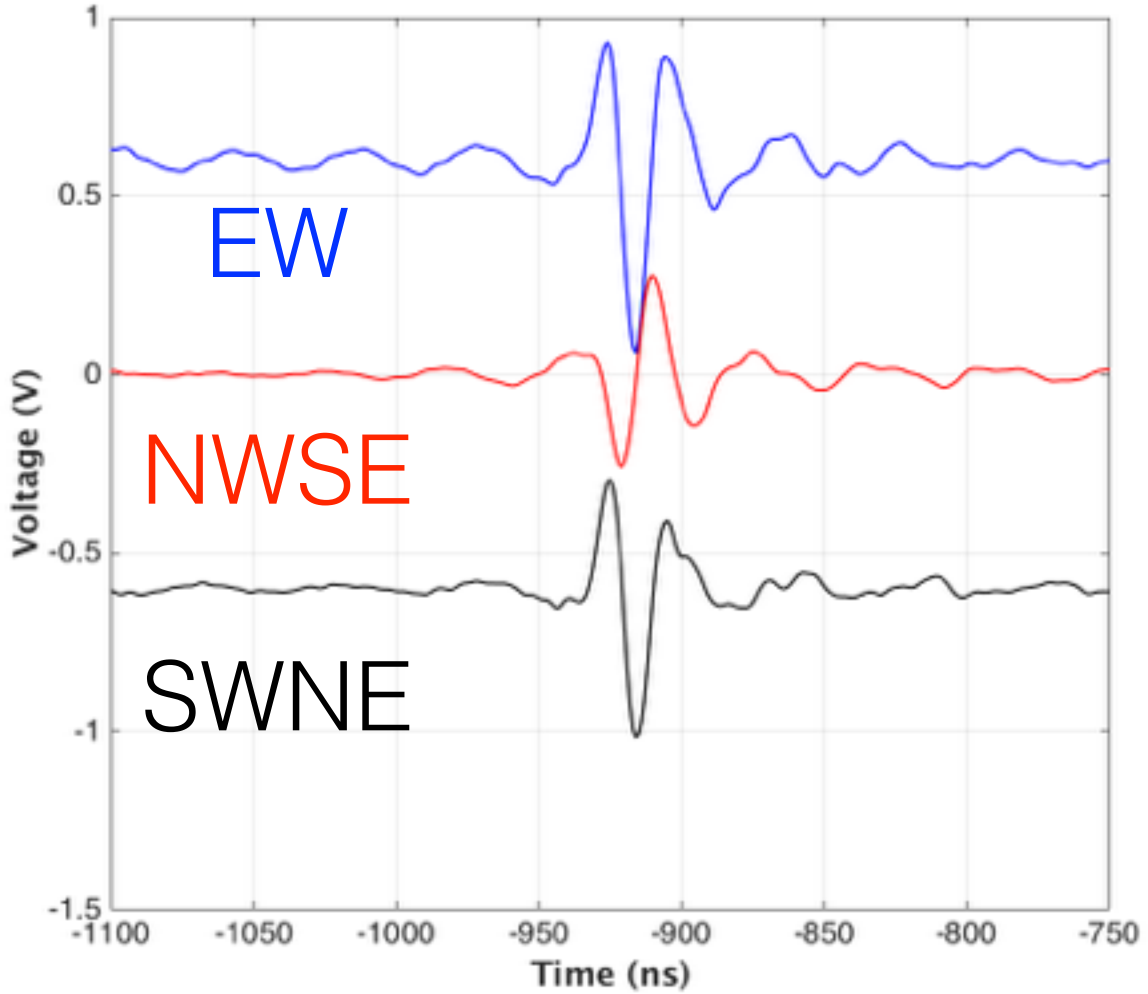
Antenne “Tripole”

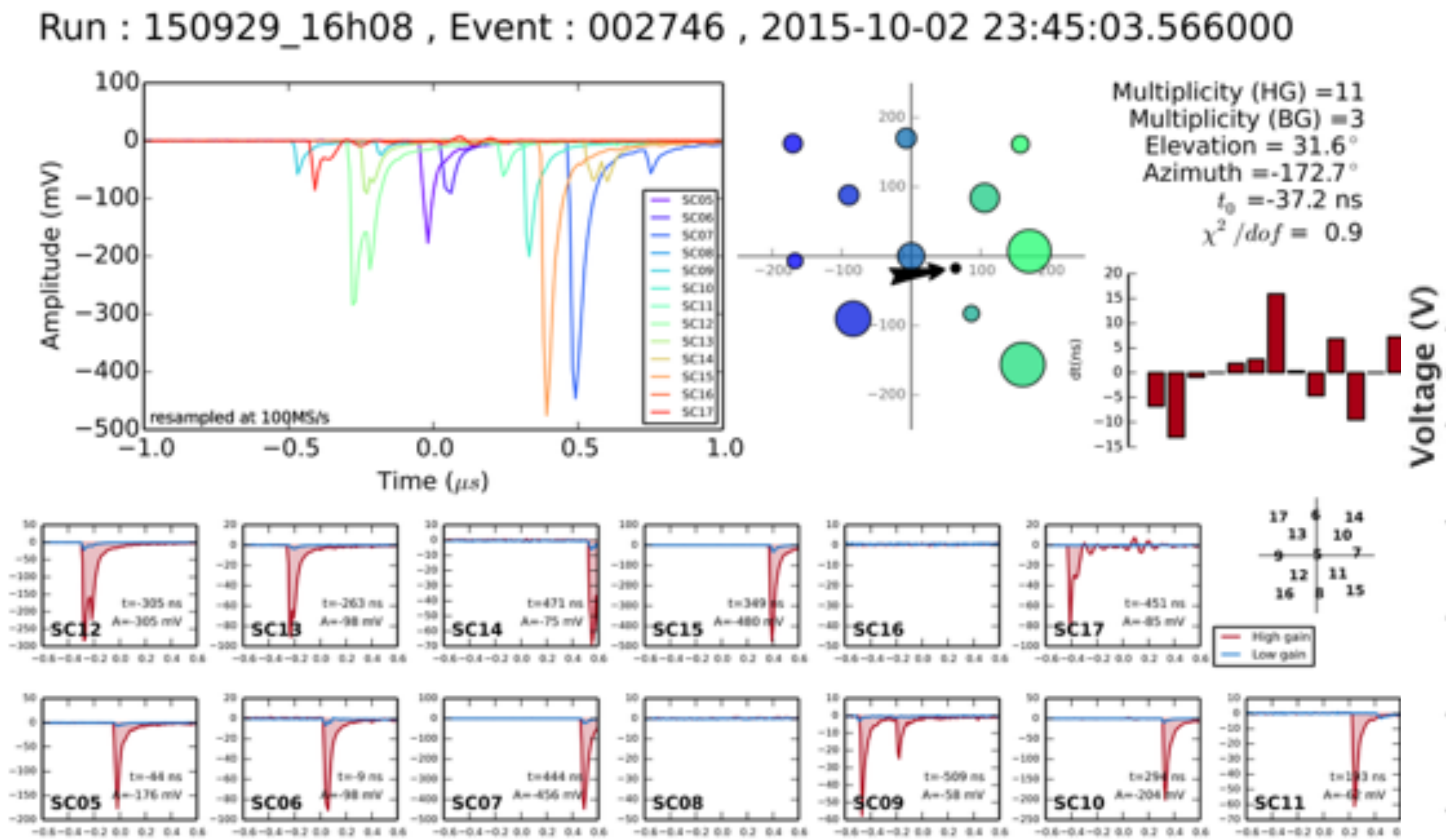


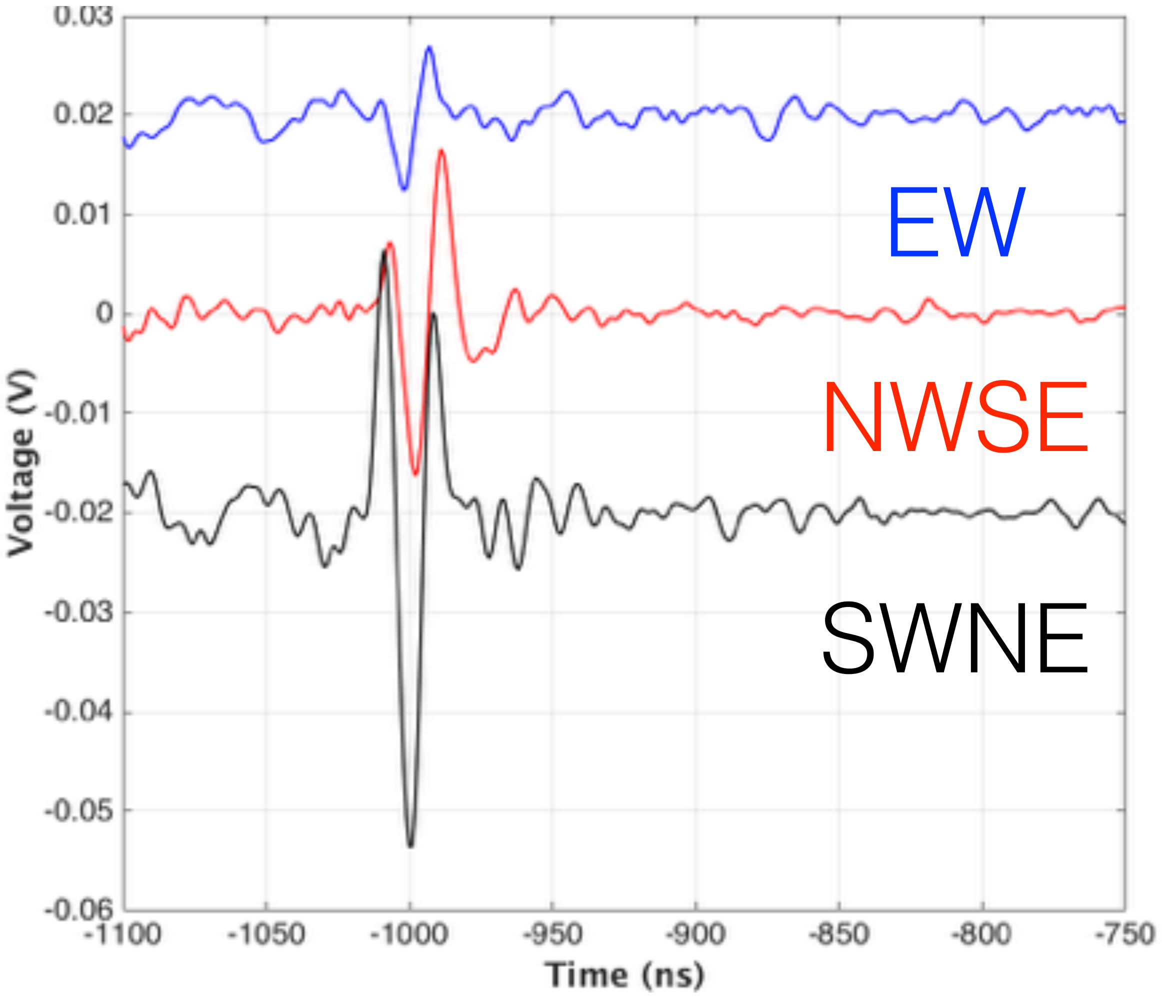
Antenne “Tripole”




Run : 150316_15h40 , Event : 002644 , 2015-03-18 14:13:46.413000
Amplitude (mV)
Time (μs)
resampled at 100MS/s
SC05 SC06 SC07 SC08 SC09 SC10 SC11 SC12 SC13 SC14 SC15 SC16 SC17
Multiplicity (HG) =13
Multiplicity (BG) =13
Elevation = 50.8°
Azimuth =149.4°
t_0 =-10.4 ns
χ^2/dof = 73.8
dt(ns)
High gain
Low gain
17 6 14 13 10 9 5 7 12 11 16 8 15


EW
NWSE
SWNE
Voltage (V)
Time (ns)
1
0.5
0
-0.5
-1
-1.5
-1100
-1050
-1000
-950
-900
-850
-800
-750


Run : 150929_16h08 , Event : 002746 , 2015-10-02 23:45:03.566000
Amplitude (mV)
Time (μs)
resampled at 100MS/s
SC05 SC06 SC07 SC08 SC09 SC10 SC11 SC12 SC13 SC14 SC15 SC16 SC17
Multiplicity (HG) =11
Multiplicity (BG) =3
Elevation = 31.6°
Azimuth =-172.7°
t_0 =-37.2 ns
χ^2/dof = 0.9
dt(ns)
High gain
Low gain
17 6 14 13 10 9 5 7 12 11 16 8 15

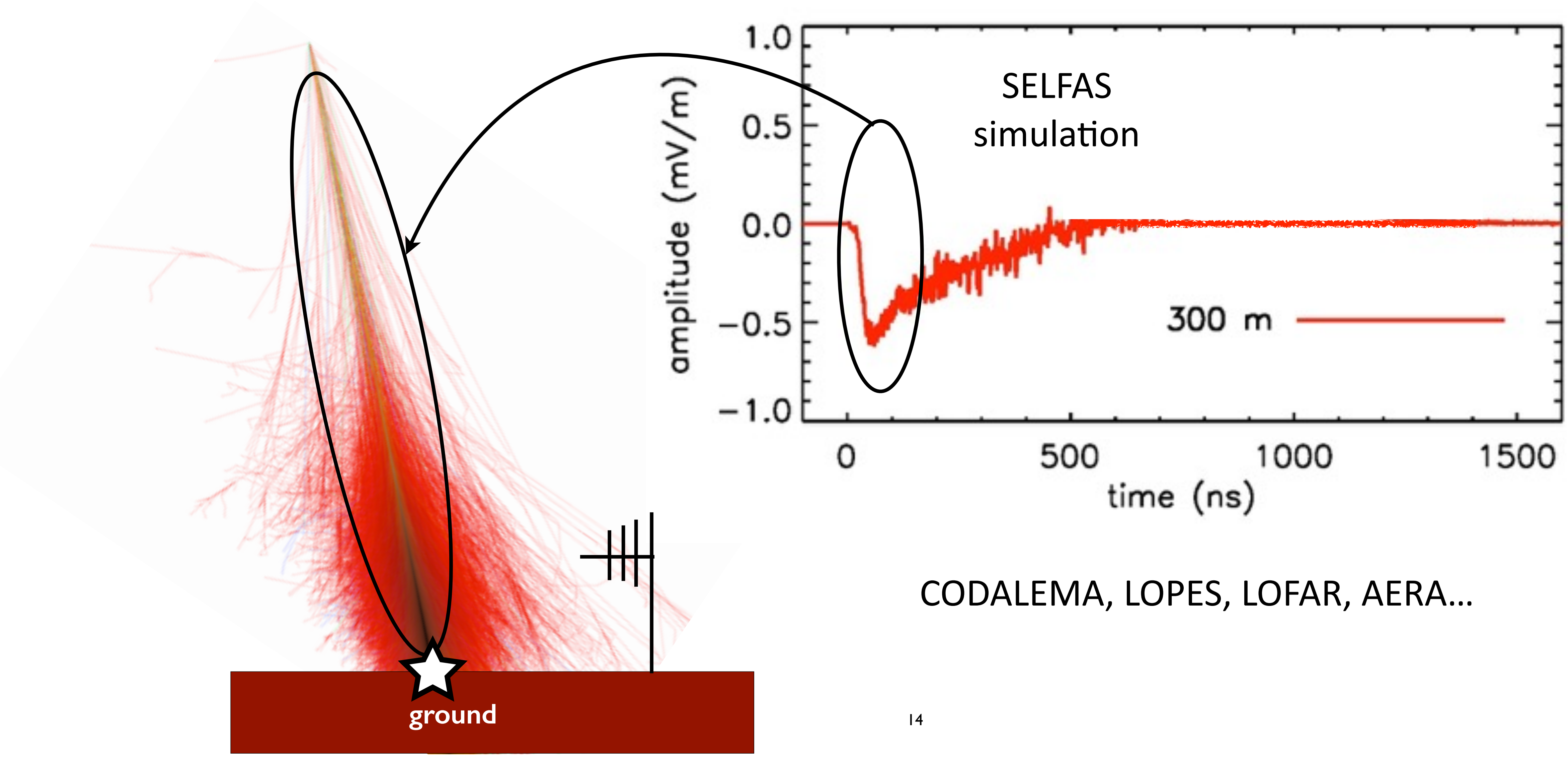

EW
NWSE
SWNE
Voltage (V)
Time (ns)
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-1100
-1050
-1000
-950
-900
-850
-800
-750

Antennes “BF”

- Actuellement 2 antennes basses fréquences installées, environ 300 m à l’ouest (BFO et à l’est (BFE) du scintillateur central SC05
- Installation de 5 autres antennes prévue en 2016
- Etudes et simulations NEC4 montrent que la hauteur optimale (minimale) est de l’ordre de 9 m (aussi dans les limites de l’accessible)
- Acquisitions déclenchées par le trigger scintillateur, soit environ toutes les 2 minutes (de l’ordre de 800 à 900 événements par jour)
- Objectifs : détecter (ou pas) le signal de “mort subite” des gerbes, prévu pour être visible < 10 MHz. Ne pas exclure la détection de la contrepartie basse fréquence du signal “normal”, d’origine géomagnétique

EXTASIS: the low-frequency components

The “classical” signal (here vertical polarization, full band)

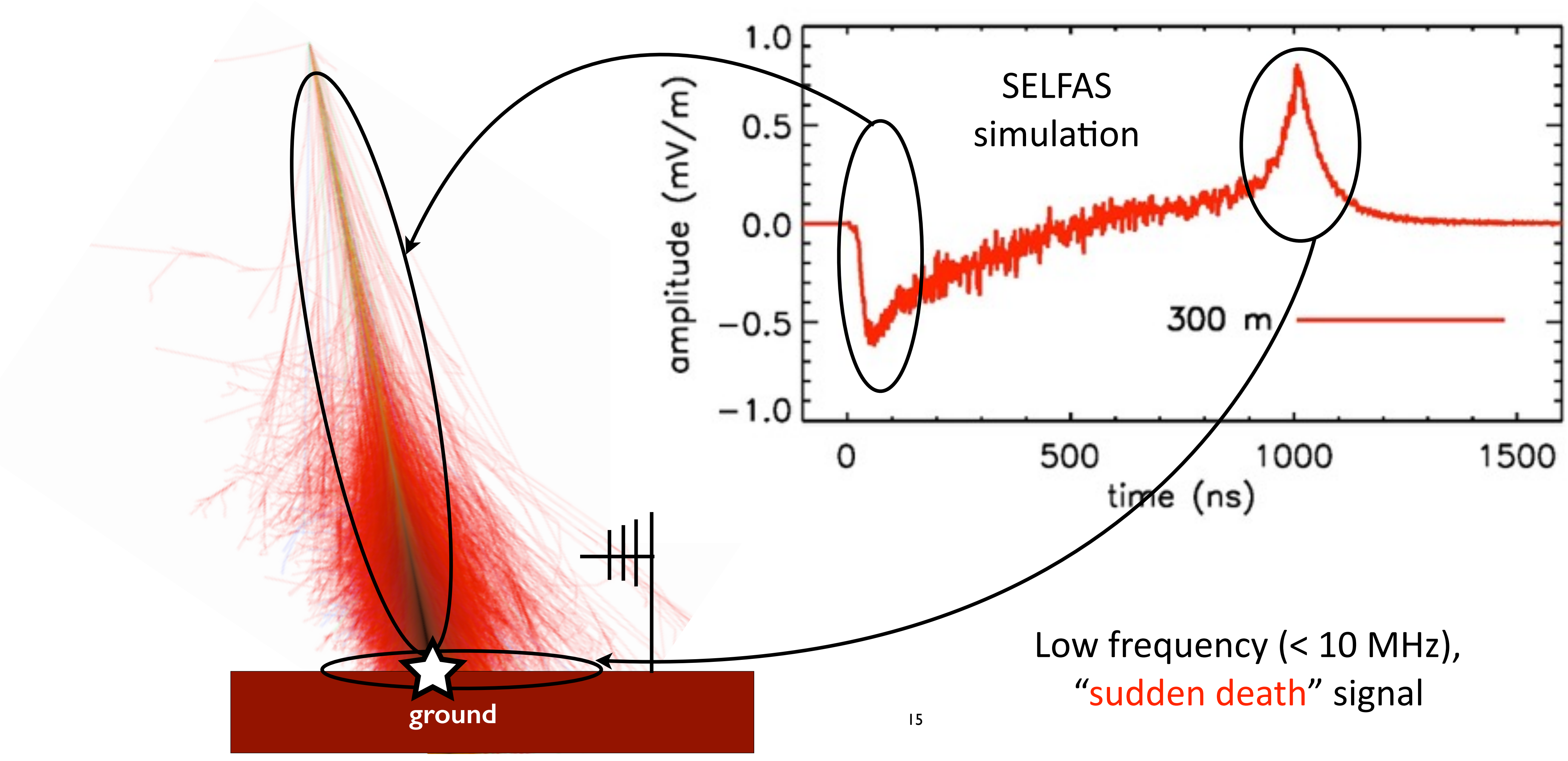


SELFAS simulation

CODALEMA, LOPES, LOFAR, AERA…

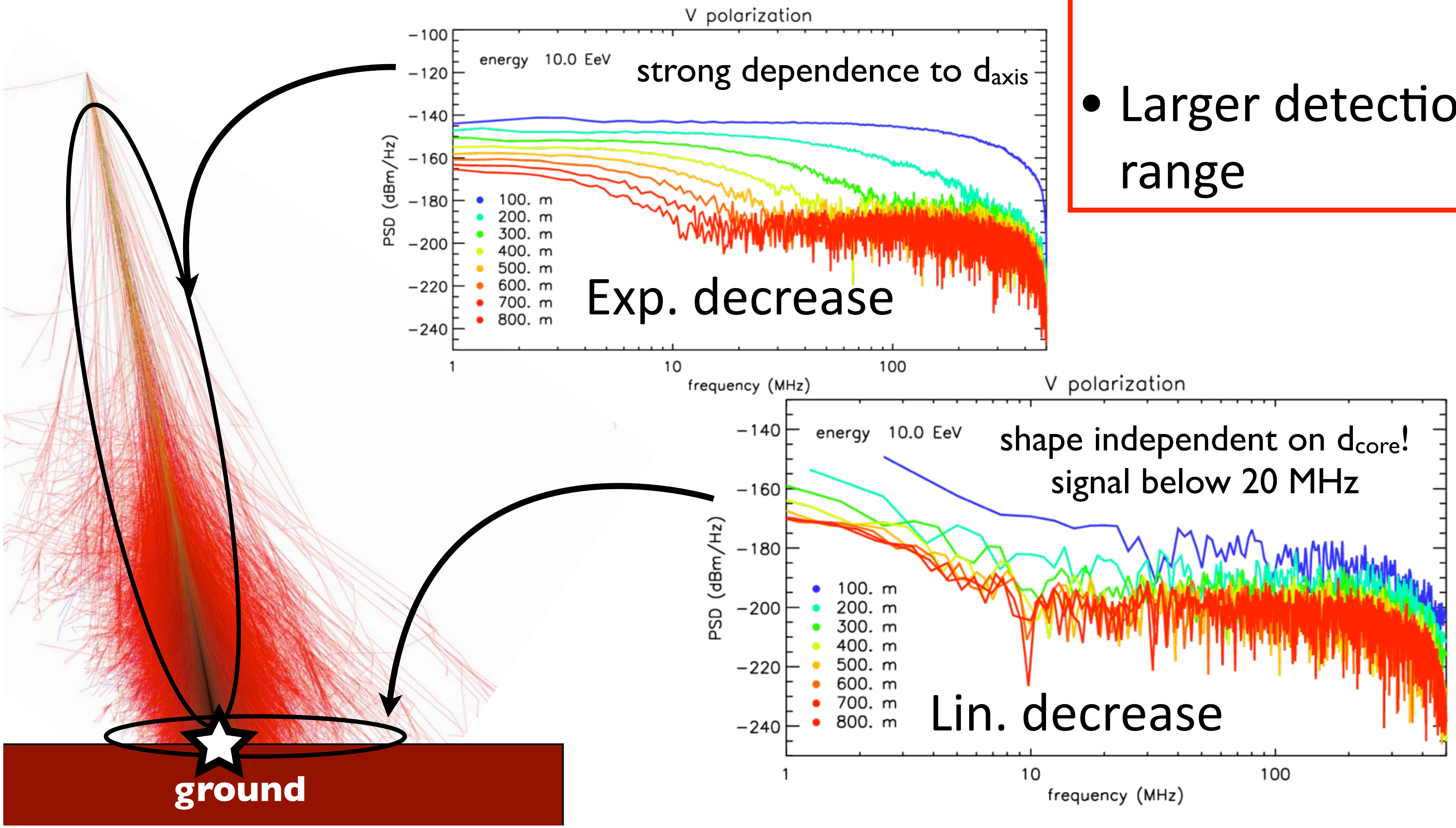
EXTASIS: the low-frequency components

And the expected “new one” (still vertical polarization, full band)



Low frequency (< 10 MHz),
“sudden death” signal

- Absolute timing
- Shower core position
- Larger detection range



strong dependence to d_{axis}

Exp. decrease

shape independent on d_{core}!
signal below 20 MHz

Lin. decrease

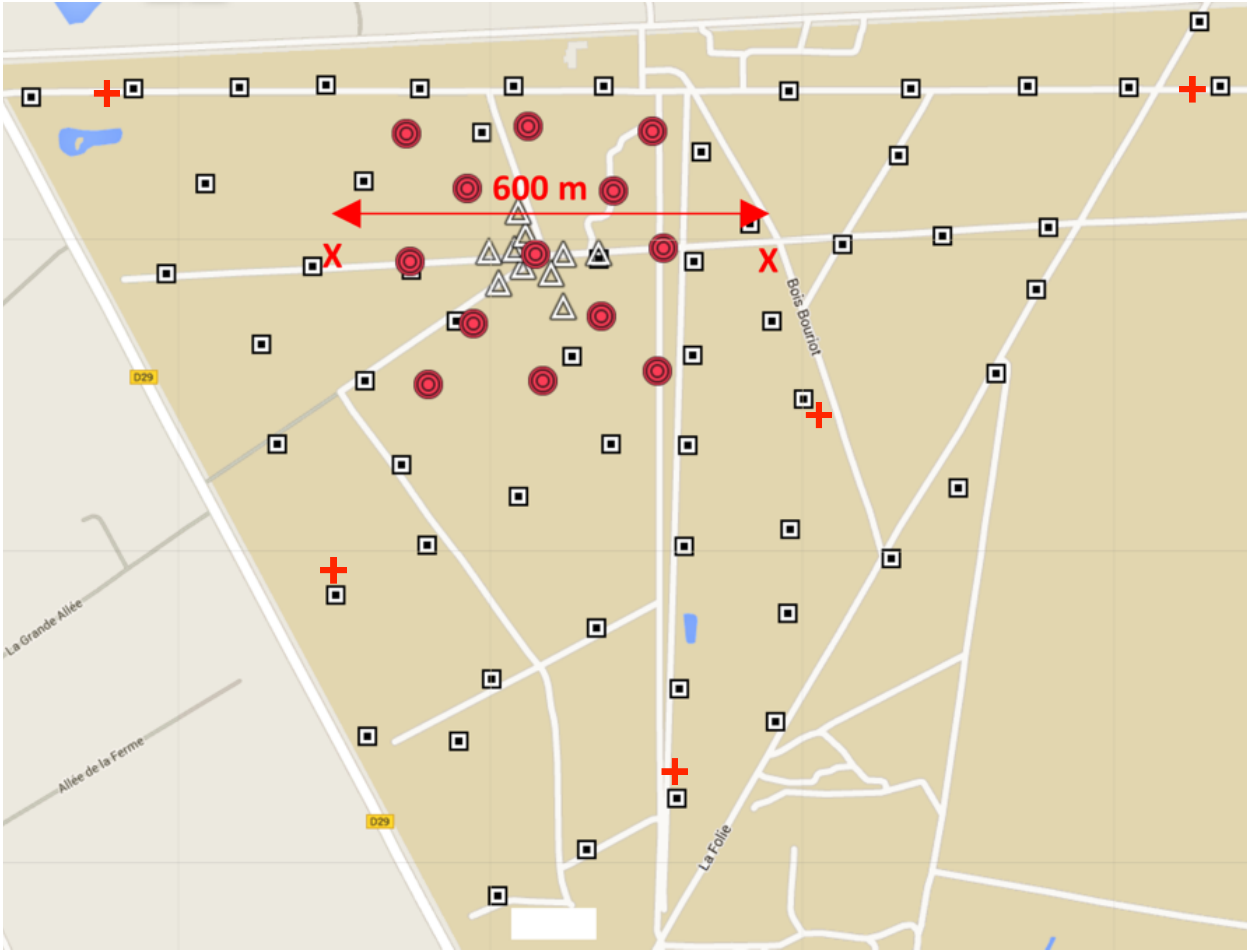
B. Revenu, ICRC 2013

Antennes “BF”

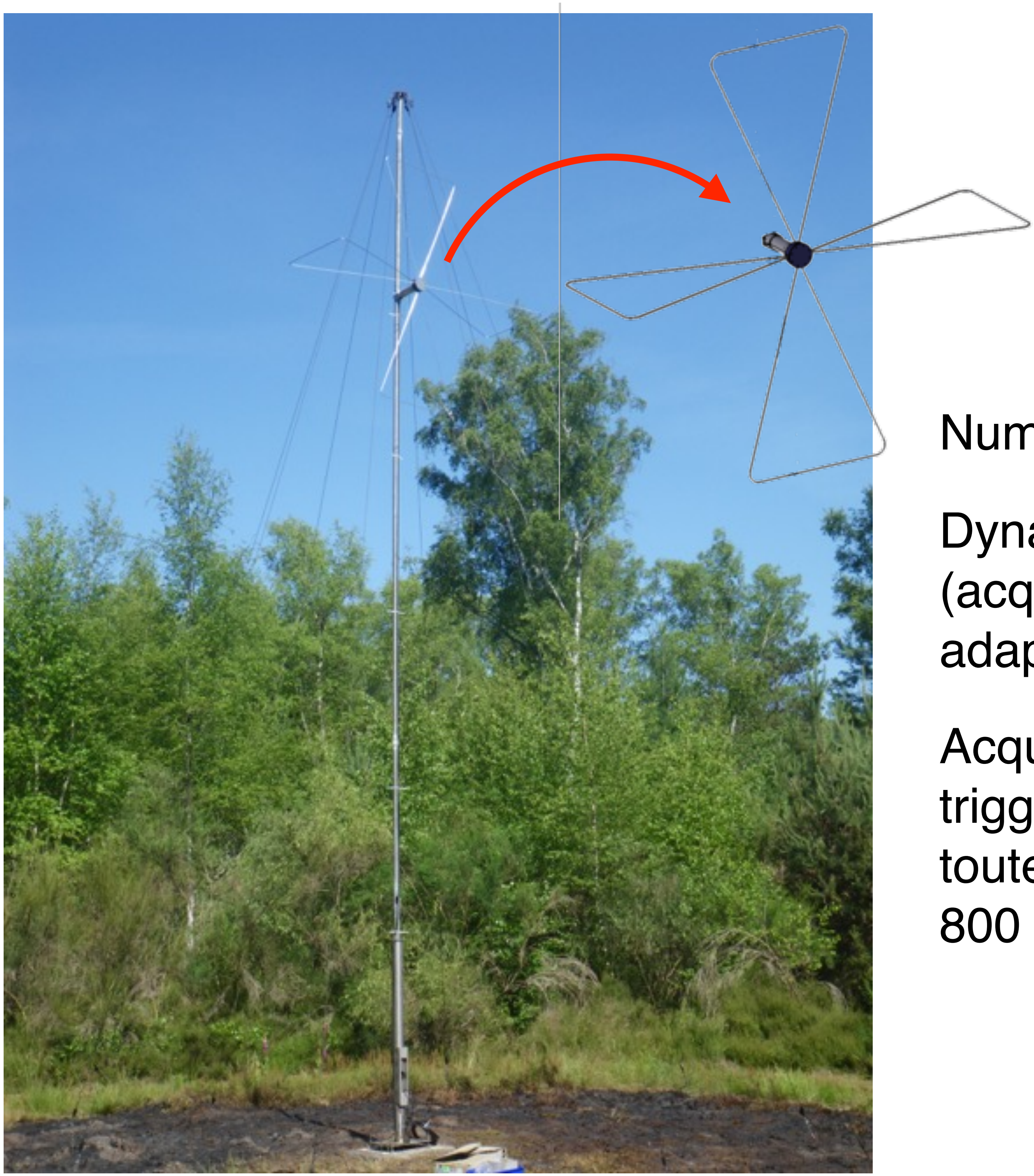
- Actuellement 2 antennes basses fréquences installées, environ 300 m à l’ouest (BFO et à l’est (BFE) du scintillateur central SC05
- Installation de 5 autres antennes prévue en 2016
- Etudes et simulations NEC4 montrent que la hauteur optimale (minimale) est de l’ordre de 9 m (aussi dans les limites de l’accessible)
- Acquisitions déclenchées par le trigger scintillateur, soit environ toutes les 2 minutes (de l’ordre de 800 à 900 événements par jour)
- Objectifs : détecter (ou pas) le signal de “mort subite” des gerbes, prévu pour être visible < 10 MHz. Ne pas exclure la détection de la contrepartie basse fréquence du signal “normal”, d’origine géomagnétique

Comment les mettre à contribution dans LICORNE ?
Que peuvent-elles apporter ?

Antennes “BF”


600 m
X
X
Bois Bouriot
D29
La Grande Allée
Allée de la Ferme
D29
La Folie

Antennes “BF”



Butterfly “classique”
Axes **NS** et **vertical**

Amplis LONAMOS
modifiés 1-10 MHz

Numérisation 17.86 MS/s sur 1 ms

Dynamique signaux variable (acquisition “Picoscope”, calibre adapté au bruit toutes les heures)

Acquisition déclenchée par chaque trigger “scintillateurs”, soit environ toutes les 2 minutes (de l’ordre de 800 à 900 événements par jour)

Antennes “BF”

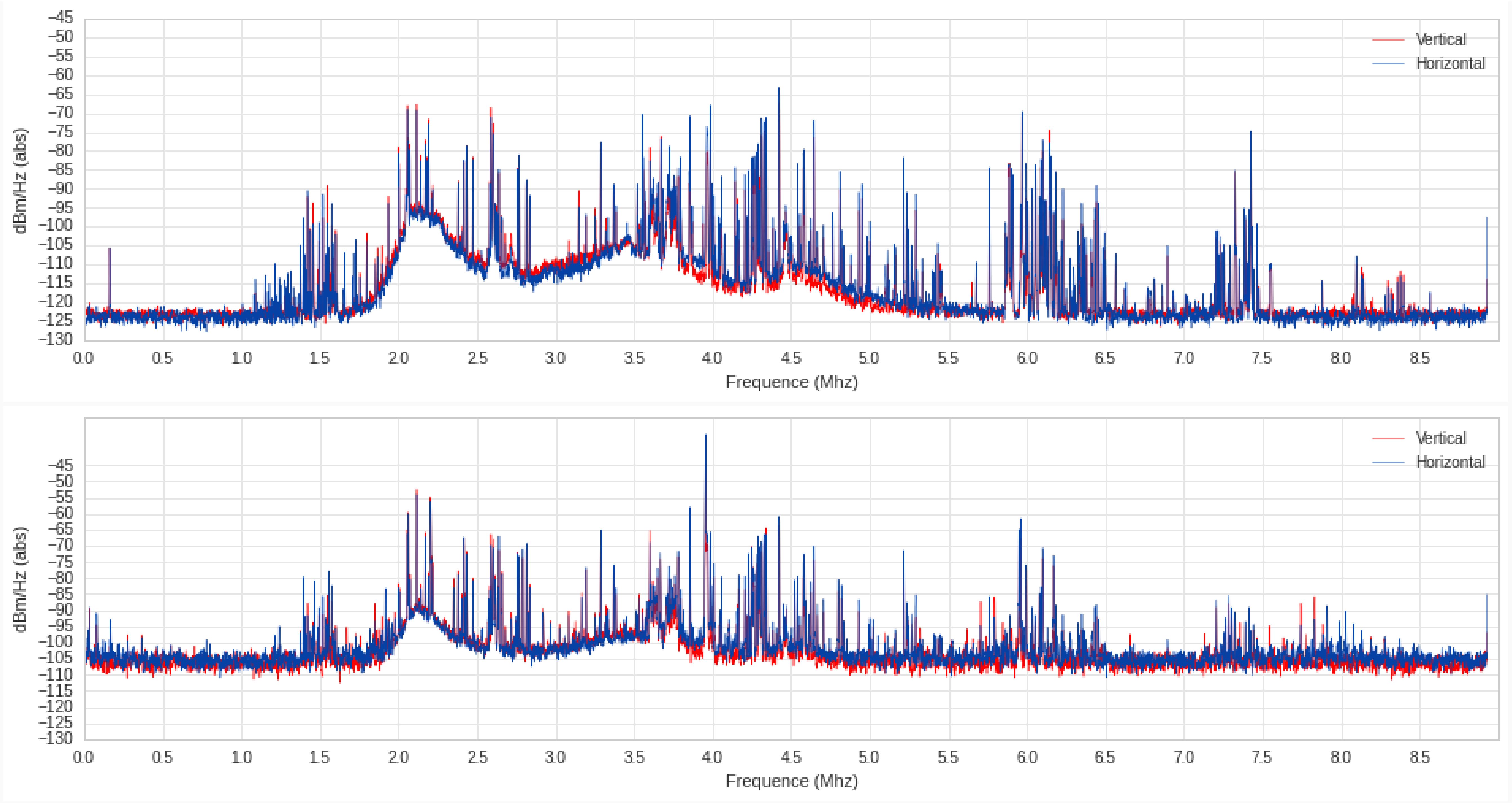


Figure 1: PSD des deux voies de BFE le 18 juin vers 19h (en haut) et 20h (en bas)

Antennes “BF”

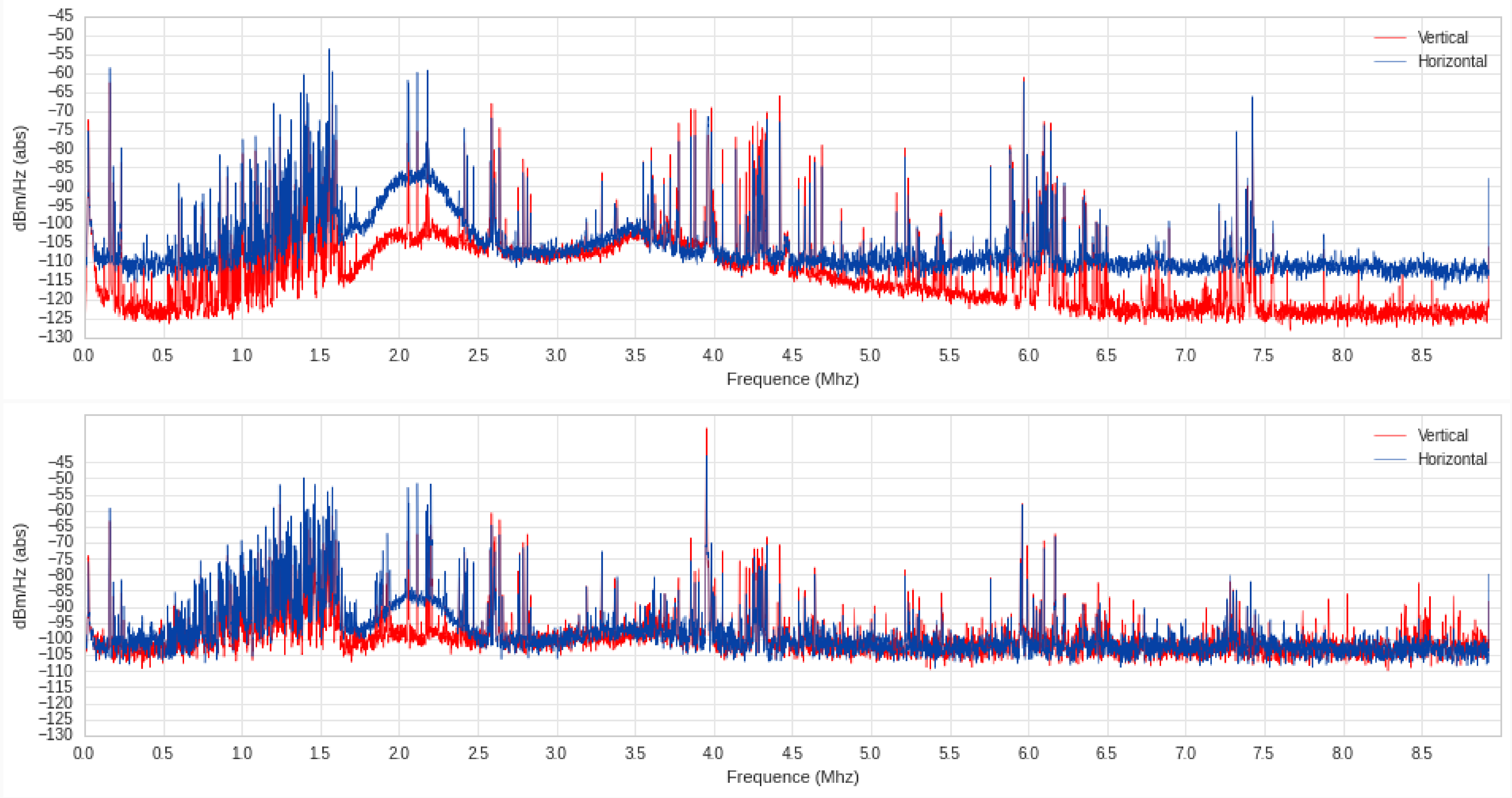


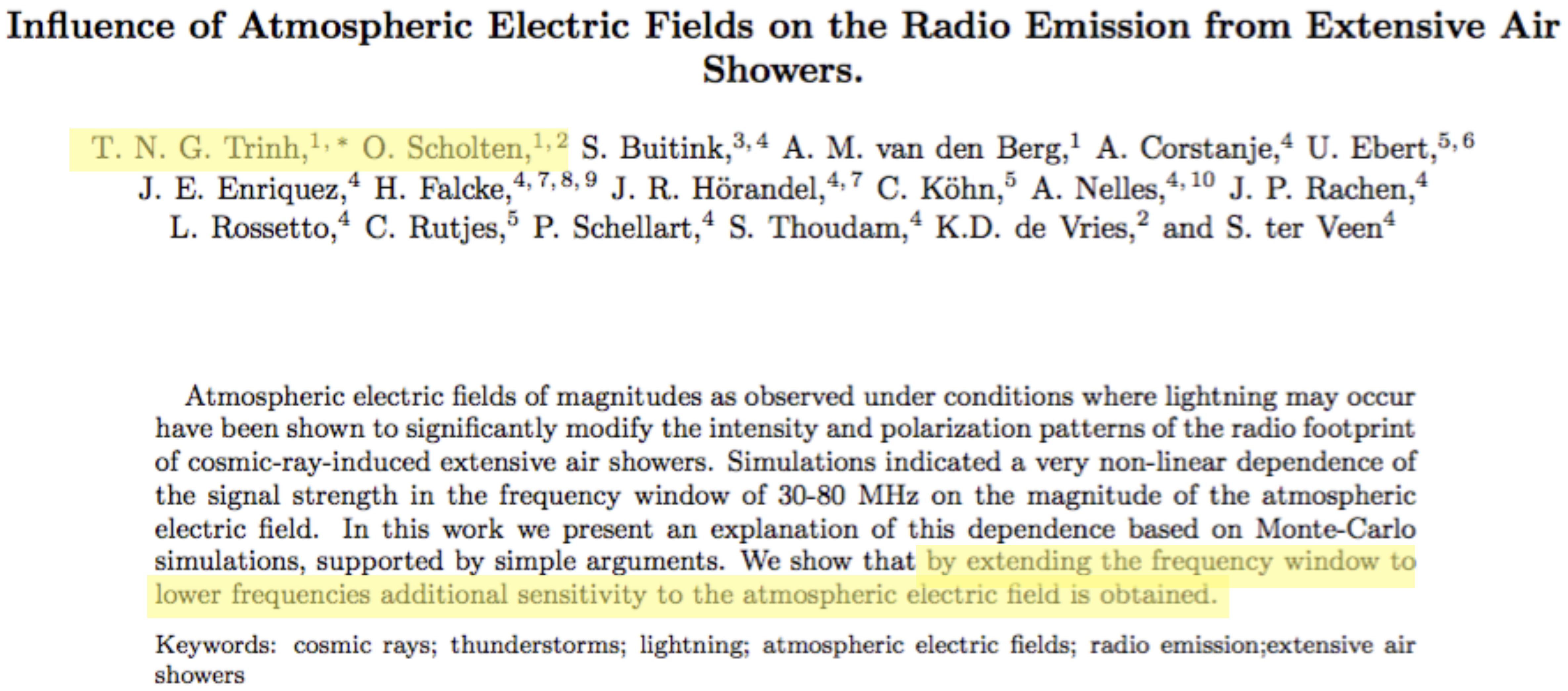
Figure 2: PSD des deux voies de BFO le 19 juin vers 19h (en haut) et 20h (en bas)

Antennes “BF”

- Données en fichiers CSV, présentes avec chaque fichier d’événement scintillateurs

```
function [t,bfV,bfH]=readBFdata(fileName);
% readBFdata
% Reads the data of any LF antenna (BF in french) recorded on .csv format
% by the PicoTop DAQ. We assume that the vertical polarization is on
% channel A (1) of the PicoScope, the horizontal one on channel B (2).
% t contains the time in microseconds
% bfV and bfH contain the voltage of both A and B channels, directly
% converted in volts regardless the real contents of the .csv file header
% which may state "mv" of "V".
%
% Remark: a typical file begins as
% Time  Channel A   Channel B
% (us)  (mV)    (mV)
% -500.08000107 8.26771600  -0.39370070
% -500.02400108 5.90551100  0.00000000
% ...
% and the values are comma-separated.

calV=1;calH=1;
fid=fopen(fileName);
header=textscan(fid,'%s %s %s',2,'delimiter',',');
unitA=cell2mat(header{2}(2));
unitB=cell2mat(header{3}(2));
if unitA(2)=='m', calV=1e-3; end;
if unitB(2)=='m', calH=1e-3; end;
data=textscan(fid,'%f %f %f','delimiter',',','TreatAsEmpty',{'Infinity','-Infinity'});
t=data{1};
bfV=calV*data{2};
bfH=calH*data{3};
fclose(fid);
```

Antennes “BF”



Influence of Atmospheric Electric Fields on the Radio Emission from Extensive Air Showers.

T. N. G. Trinh,[1,*] O. Scholten,[1,2] S. Buitink,[3,4] A. M. van den Berg,[1] A. Corstanje,[4] U. Ebert,[5,6]
J. E. Enriquez,[4] H. Falcke,[4,7,8,9] J. R. Hörandel,[4,7] C. Köhn,[5] A. Nelles,[4,10] J. P. Rachen,[4]
L. Rossetto,[4] C. Rutjes,[5] P. Schellart,[4] S. Thoudam,[4] K.D. de Vries,[2] and S. ter Veen[4]

Atmospheric electric fields of magnitudes as observed under conditions where lightning may occur have been shown to significantly modify the intensity and polarization patterns of the radio footprint of cosmic-ray-induced extensive air showers. Simulations indicated a very non-linear dependence of the signal strength in the frequency window of 30-80 MHz on the magnitude of the atmospheric electric field. In this work we present an explanation of this dependence based on Monte-Carlo simulations, supported by simple arguments. We show that by extending the frequency window to lower frequencies additional sensitivity to the atmospheric electric field is obtained.

Keywords: cosmic rays; thunderstorms; lightning; atmospheric electric fields; radio emission;extensive air showers

Antennes “BF”

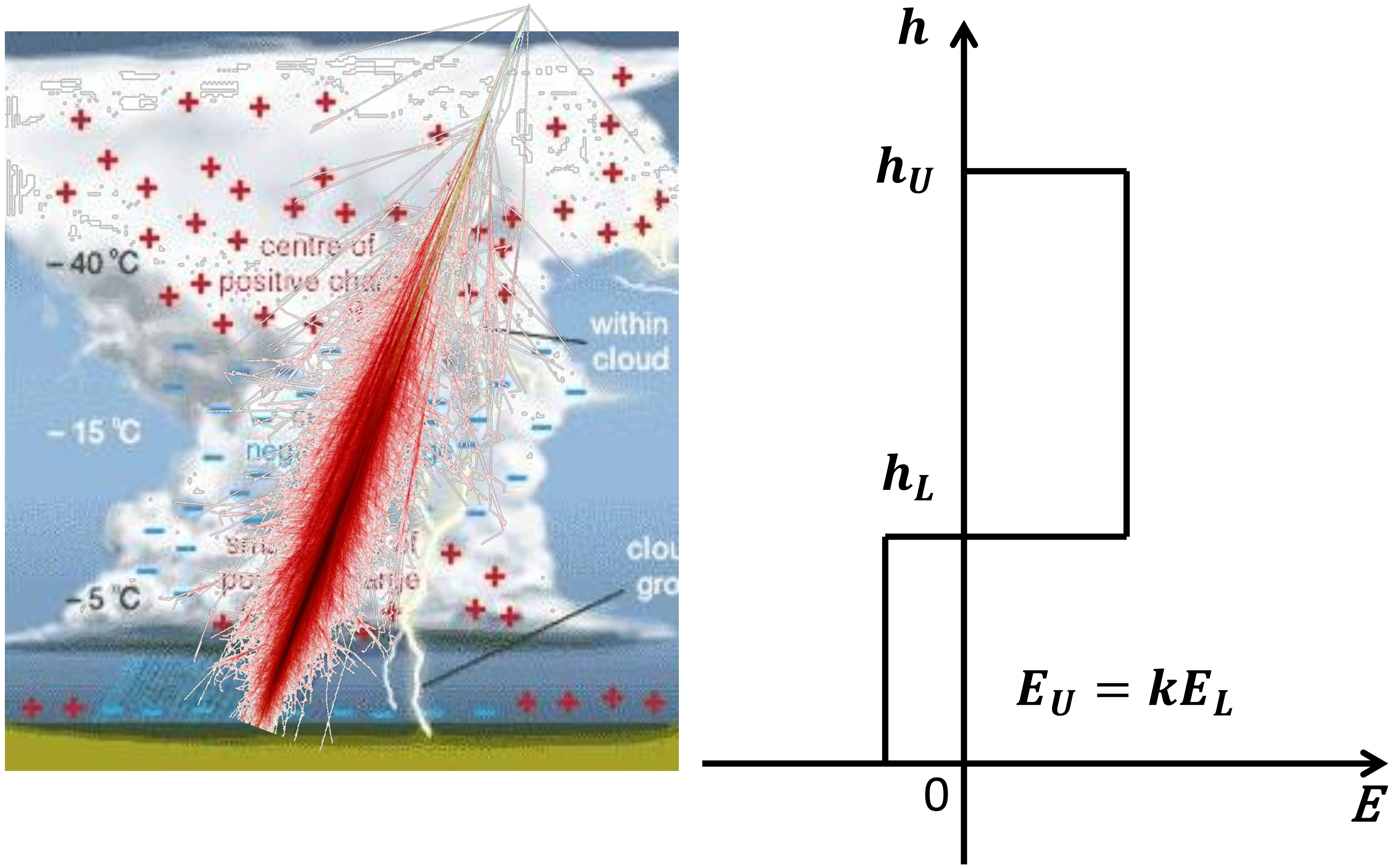


FIG. 1: A schematic structure of a thundercloud is given where charge is accumulated at the bottom and the top layer. The structure of the induced electric field is given schematically on the right hand side.

A. Parallel electric field

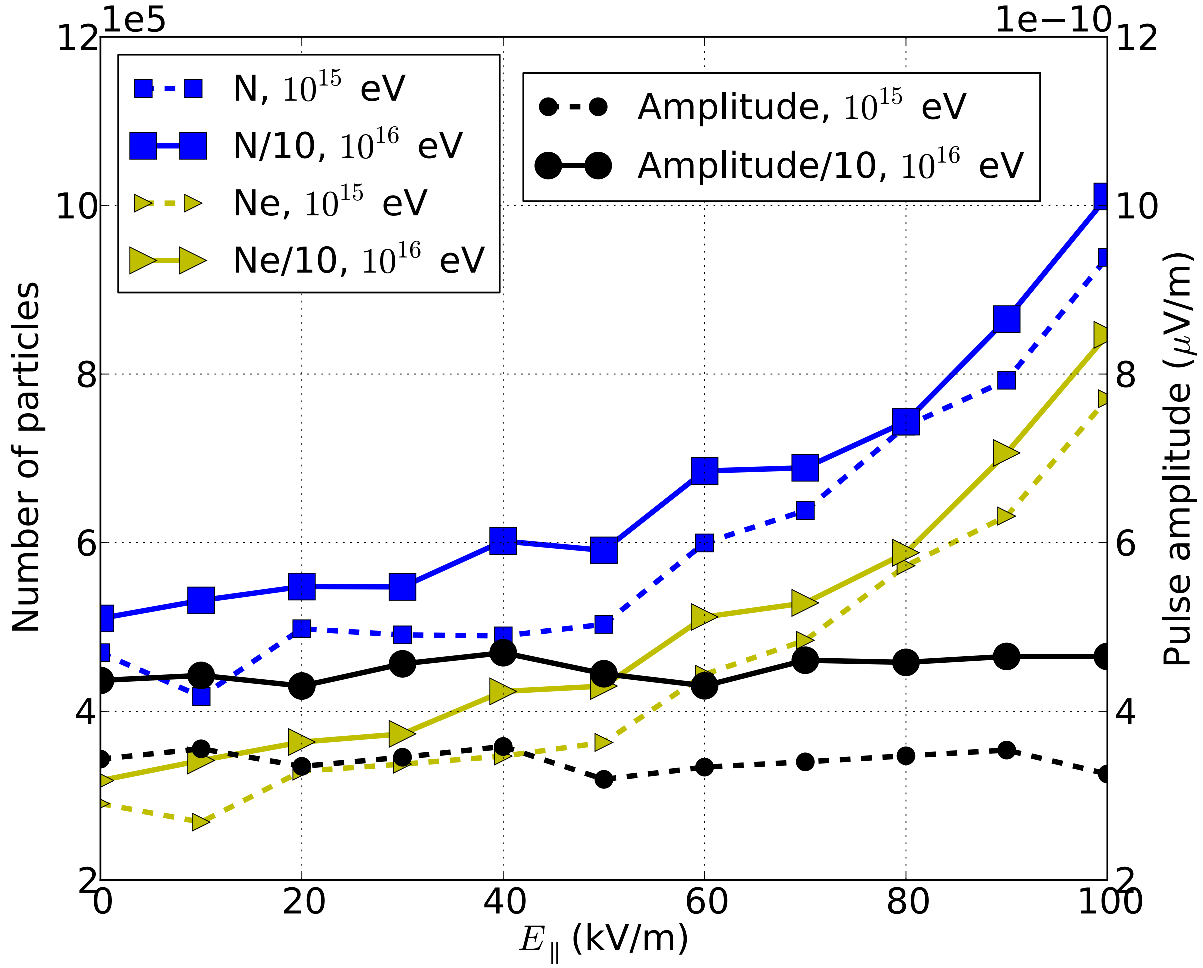
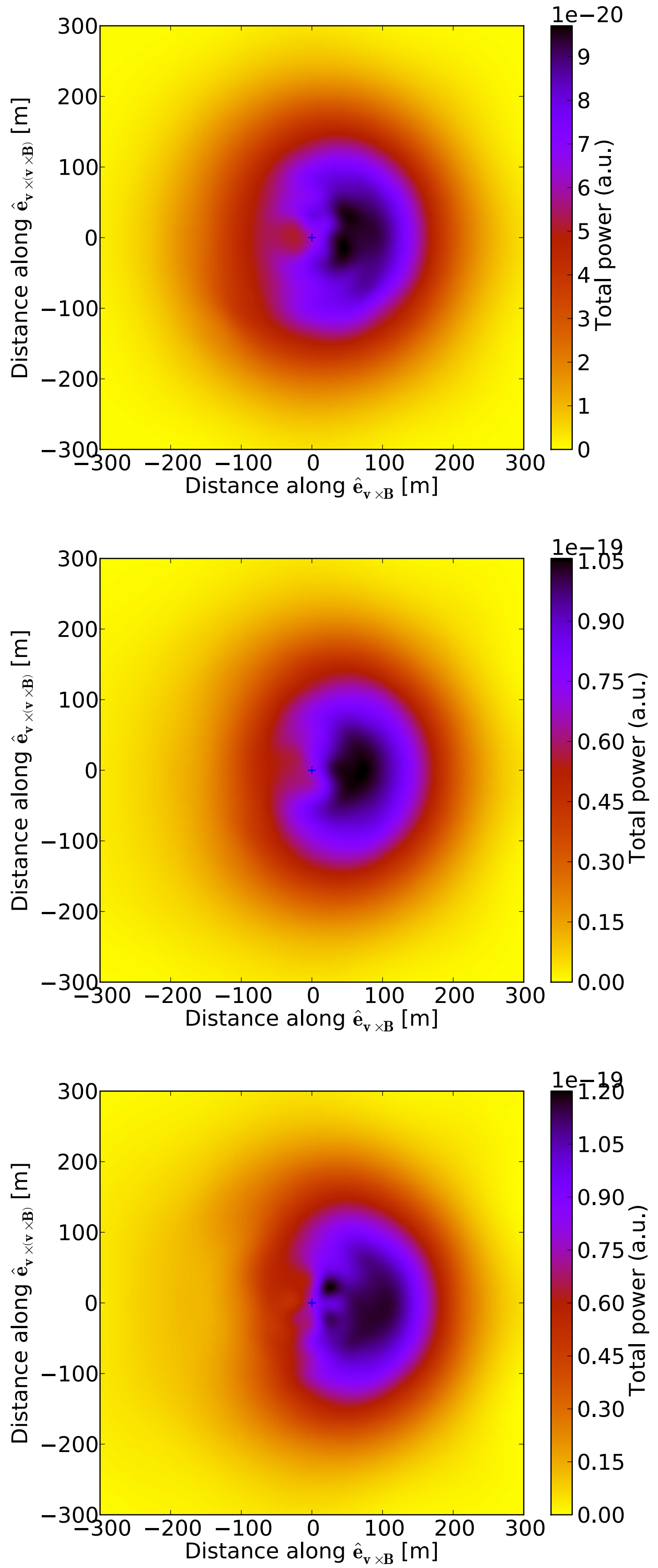


FIG. 2: The number of leptons at the shower maximum (blue left axis), the number of electrons at the shower maximum (yellow left axis) and the maximum pulse-amplitude (black right axis) for vertical 10^{15} eV showers (dashed lines) and for vertical 10^{16} eV showers (right solid lines) as a function of the parallel electric fields. For the 10^{16} eV showers the number of particles and the pulse-amplitude are scaled down by a factor 10.



30-80 MHz

FIG. 3: Intensity footprints of 10^{15} eV vertical showers for the 30 - 80 MHz band for the case of no electric field (top), $E_\parallel = 50$ kV/m (middle), and $E_\parallel = 100$ kV/m (bottom).

As explained in Section III C the observed limited dependence is due to the fact that the additional low-energy electrons in the shower trail behind the shower front at a relatively large distance and thus do not contribute to coherent emission at the observed frequencies. The trailing behind the shower front of the low-energy electrons was also shown in Ref. [28], but for the breakdown region.

Not only the strength of the signal, but also the structure of the radio footprints for the LOFAR LBA frequency range, as shown in Fig. 3, does not really depend on the strength of the parallel electric field. Furthermore, the bean shape, typically observed in air showers in fair-weather condition, is also present in these footprints because the parallel electric fields have small effects on both the transverse-current and the charge-excess components.

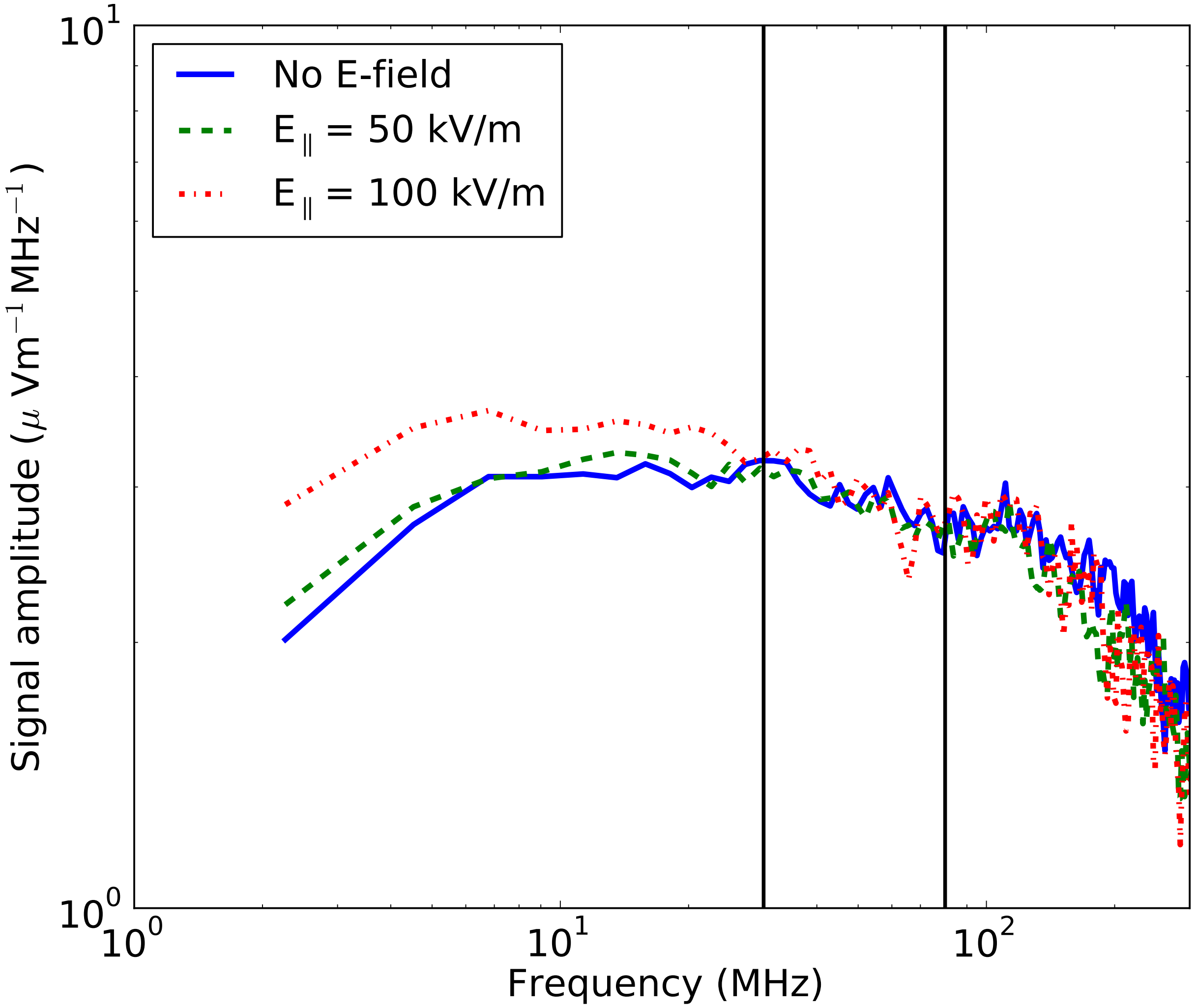


FIG. 12: The square-root of the power in the pulse, as obtained from CoREAS simulations, as function of frequency for a vertical shower of 10^{15} eV at 50 m from the core in the absence and in the presence of parallel electric fields. The black vertical lines represents the LOFAR LBA frequency window.

D. Influence of $E_\perp$

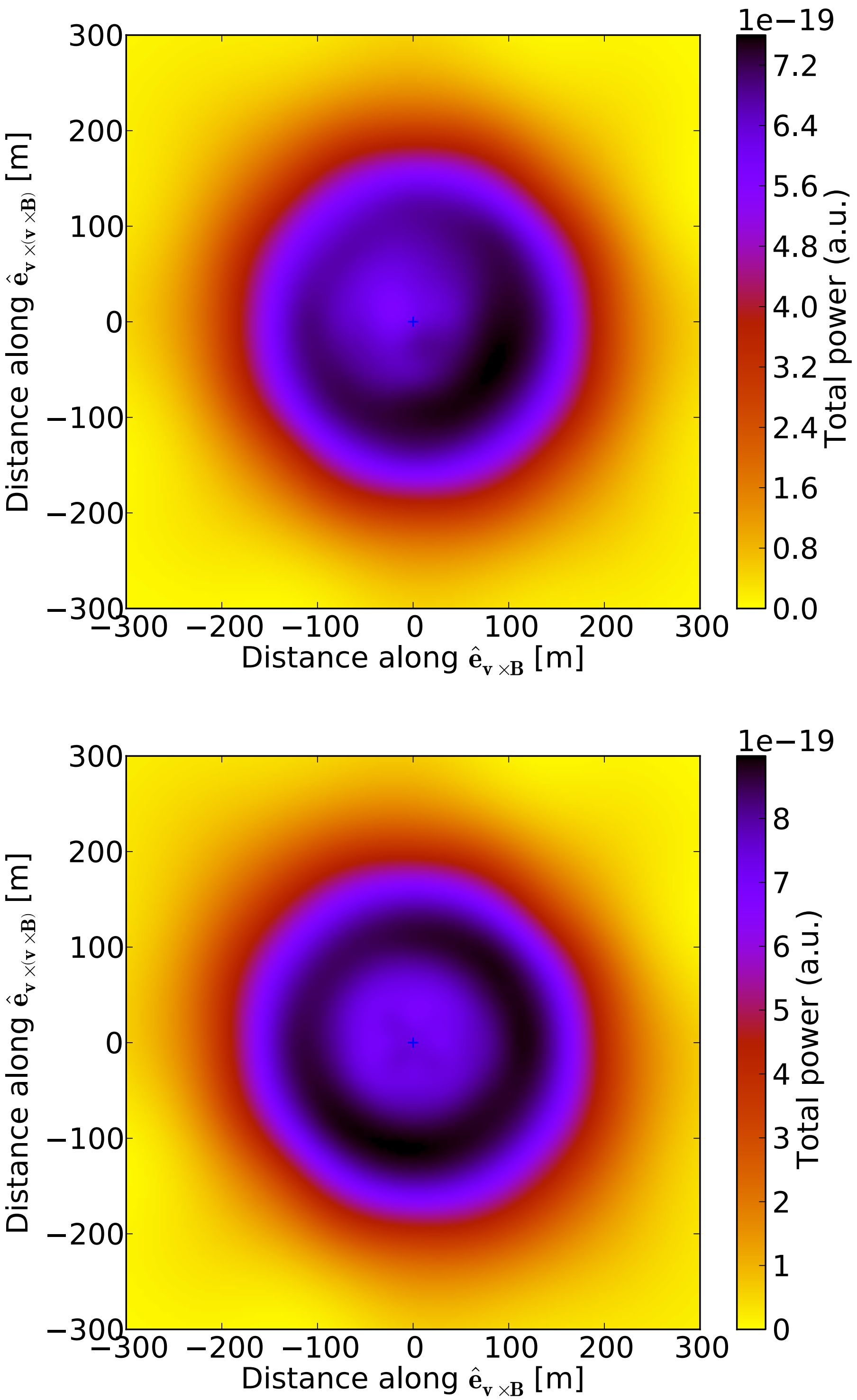


FIG. 5: Intensity footprints of 10^{15} eV vertical showers for the 30 - 80 MHz band for the case of $F_\perp =$ 50 keV/m (top) and $F_\perp =$ 100 keV/m (bottom).

As has been concluded in the previous two sections, the pulse-amplitude as can be measured in the LOFAR frequency window of 30-80 MHz is strongly determined by the strength of the transverse electric field up to values of about 40 kV/m. In addition, parallel electric fields have small effects on the pulse-amplitude in the frequency window 30-80 MHz. It was shown that at lower frequencies, the pulse amplitude keeps growing with increasing field strength up to at least 100 keV/m. In this section we in-

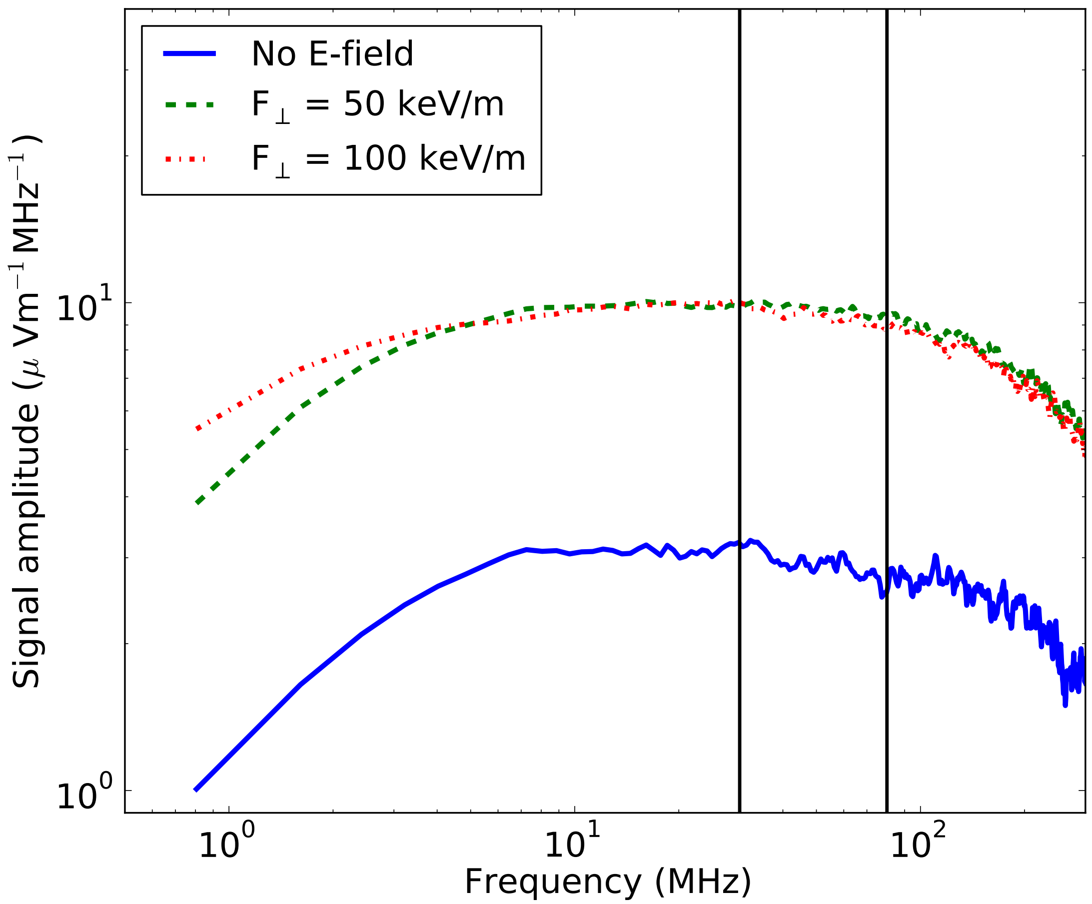


FIG. 17: The same as displayed in Fig. 12 for different strength of the net-transverse force.

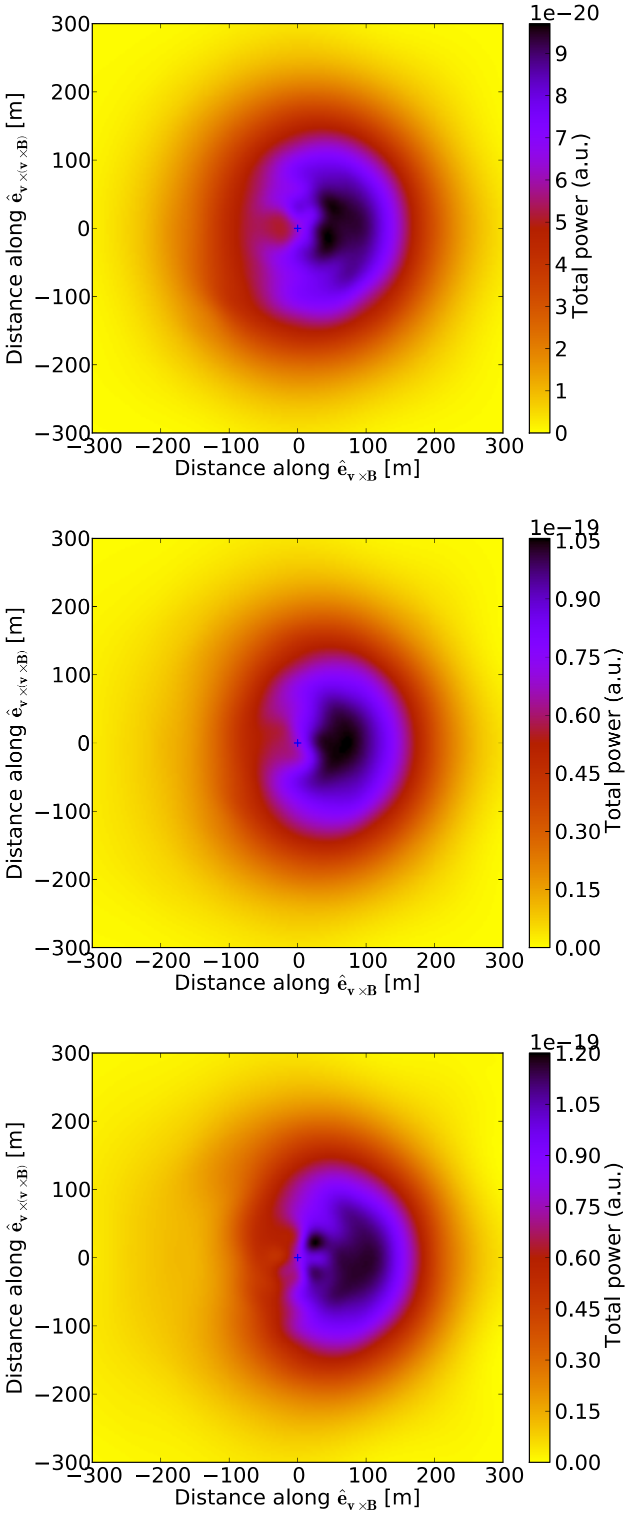


FIG. 3: Intensity footprints of 10^{15} eV vertical showers for the 30 - 80 MHz band for the case of no electric field (top), $E_{\parallel} = 50$ kV/m (middle), and $E_{\parallel} = 100$ kV/m (bottom).

30-80 MHz

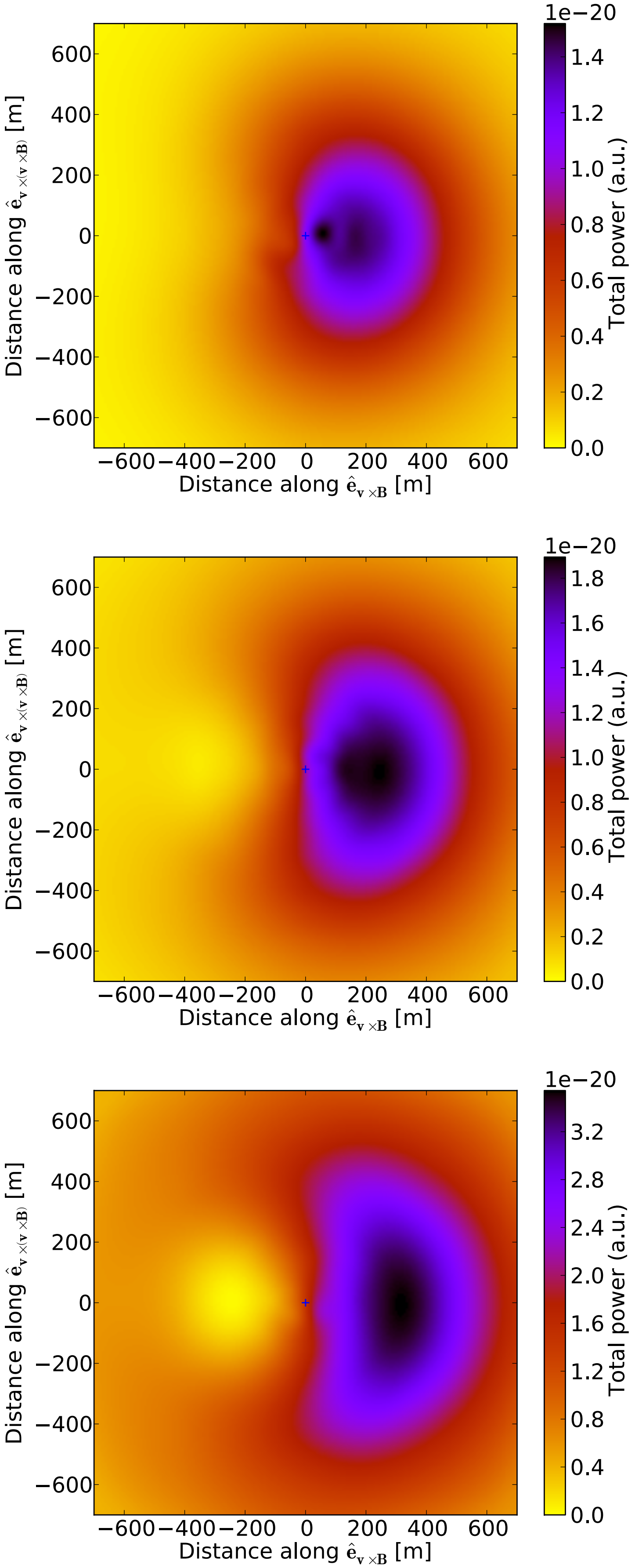


FIG. 18: Intensity footprints of 10^{15} eV vertical showers for the 2 - 9 MHz band for the cases of no electric field (top), $E_{\parallel} = 50$ kV/m (middle), and $E_{\parallel} = 100$ kV/m (bottom).

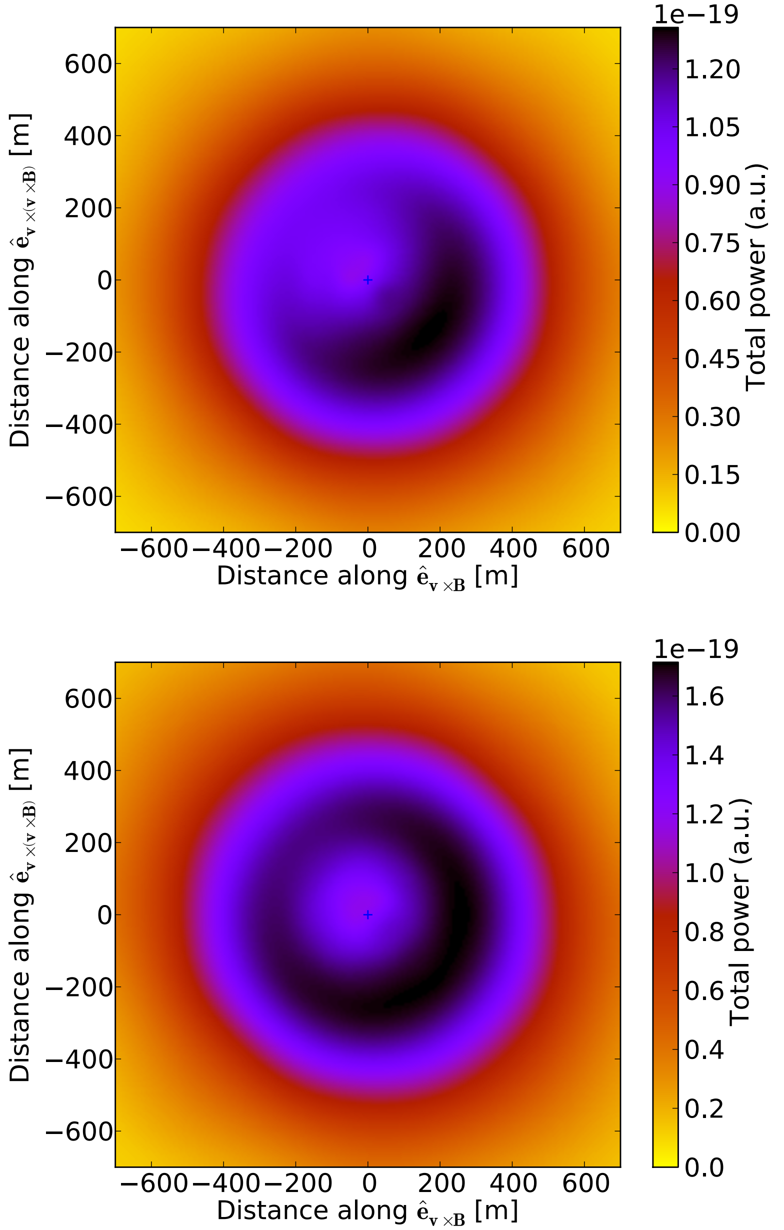


FIG. 19: Intensity footprints of 10^{15} eV vertical showers for the 2 - 9 MHz band for the cases of $F_{\perp} = 50$ keV/m (top) and $F_{\perp} = 100$ keV/m (bottom).

2-9 MHz