# New automatic detection method : description and some results

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Annual METRO meeting

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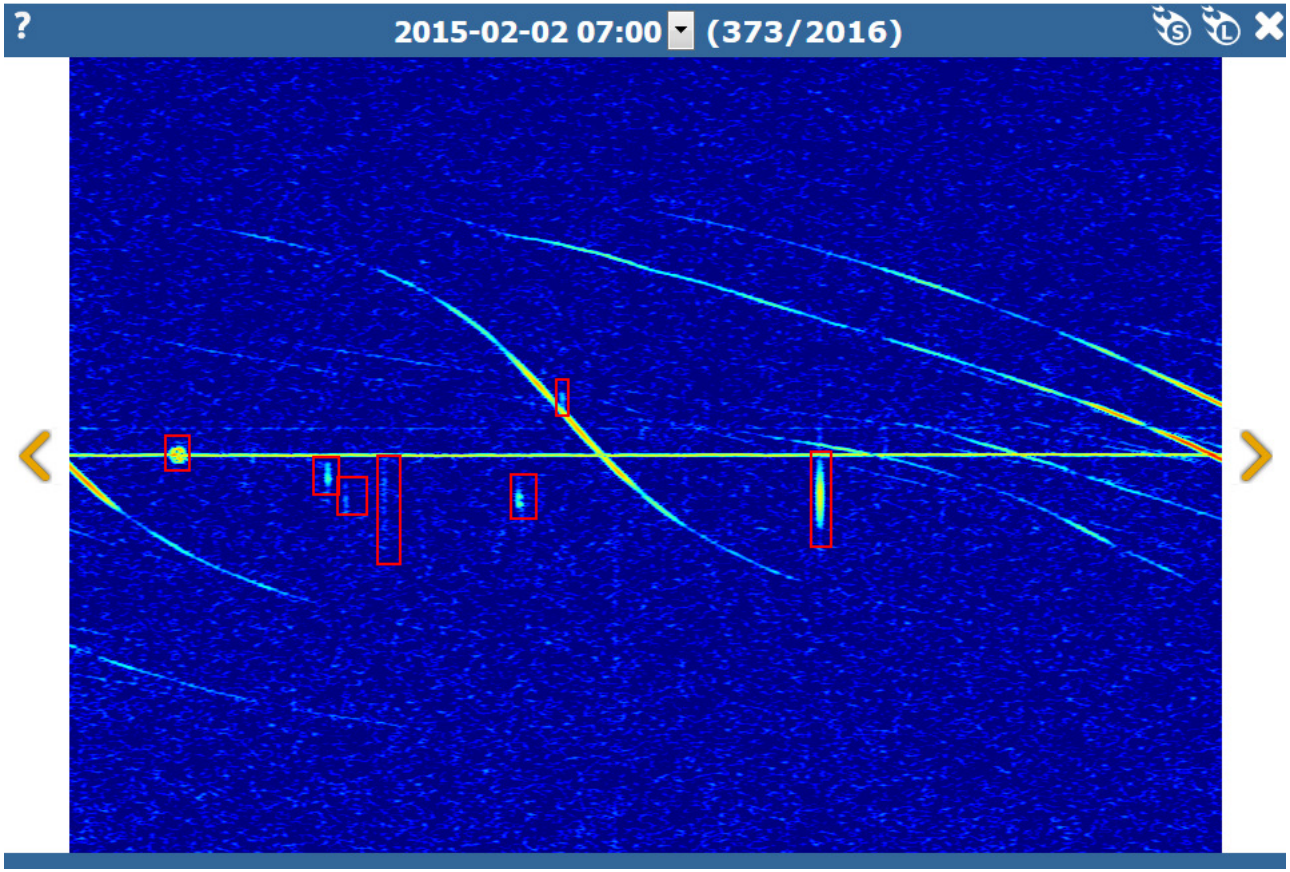
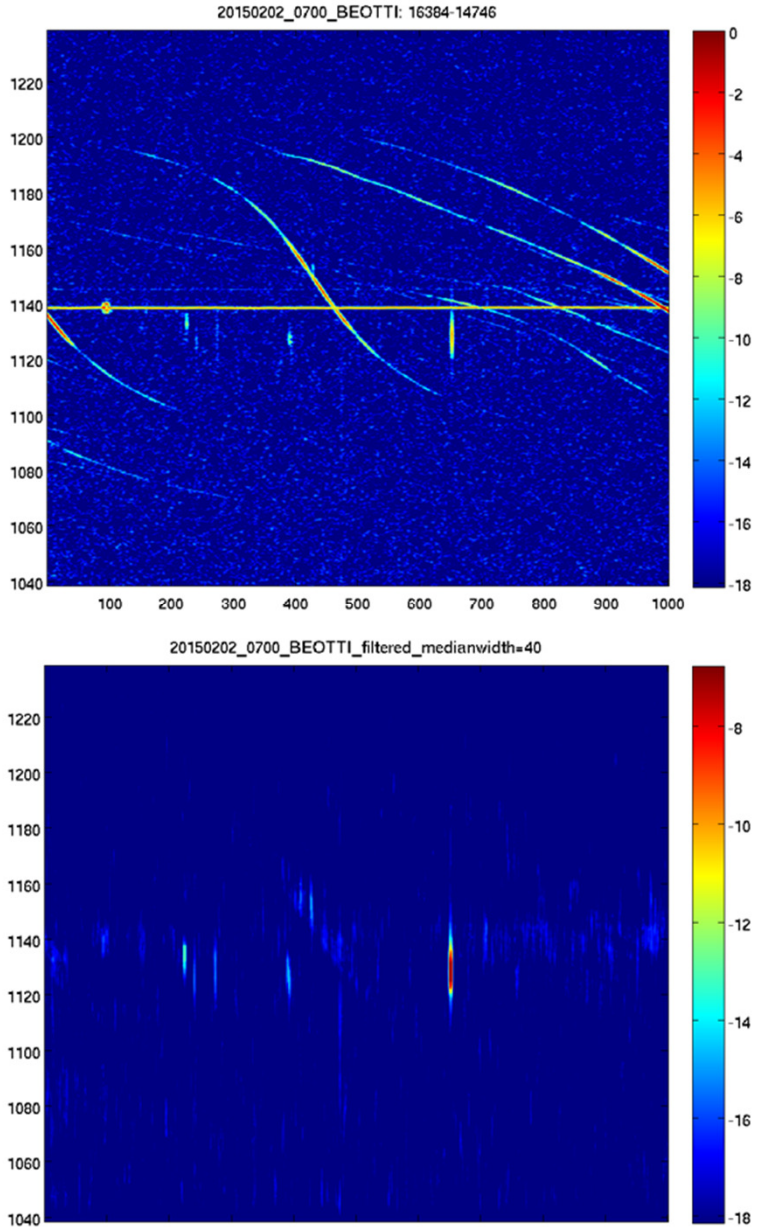
Thanks to Maxence Draguet, student from ULB, who did an internship to test this method

# Example 1




Manual counts : 7

# Step 1 : moving median filter




**Median width** = 40 pixels

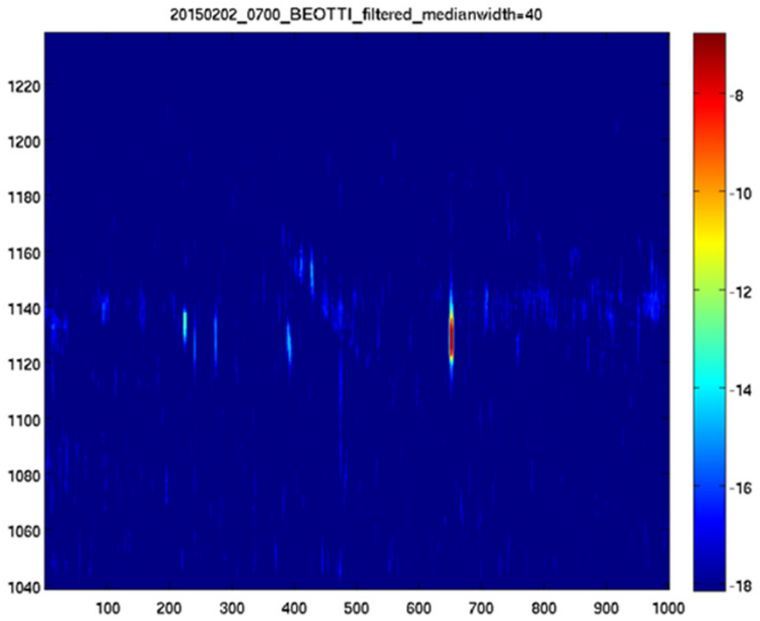
# Step 2 : binarisation of the image

- Every pixel > threshold → 1
- Every pixel ≤ threshold → 0

- Second parameter : **threshold**
  - Examples below : mean + 3 std of the whole spectrogram
  - Student tests : median + **nb_mad** * MAD per column of the spectrogram

# Step 3 : labelisation of the spectrogram

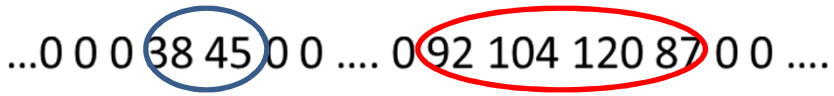
- For each column, a set of objects is created with various lengths (contiguous 1s)
- If length of the object > **min_length_value** → we keep this length value for this column, otherwise 0. A 1-D vector is created with these length values.




…0 0 0 38 45 0 0 …. 0 92 104 120 87 0 0 ….

# Step 4 : labelisation of the 1-D vector

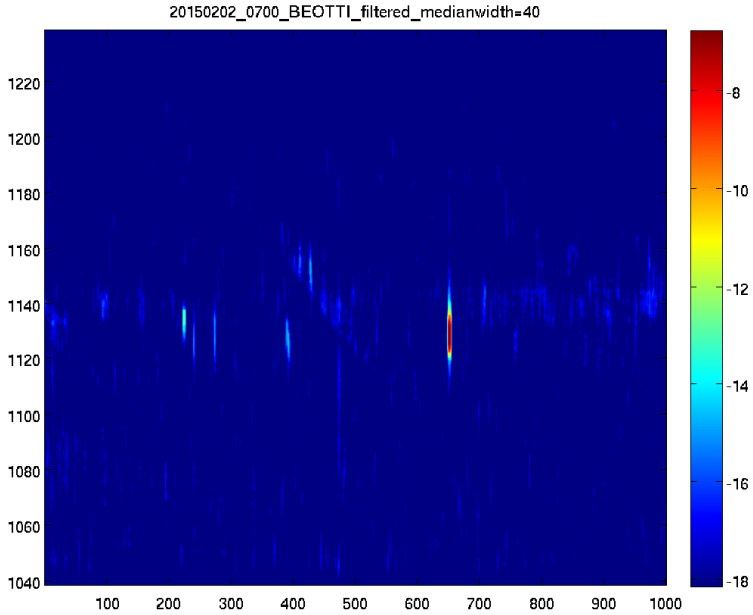
The 1-D vector with the length values of the labeled objects is also labeled. We keep only those « new objects » that have a width > **min_width_value**

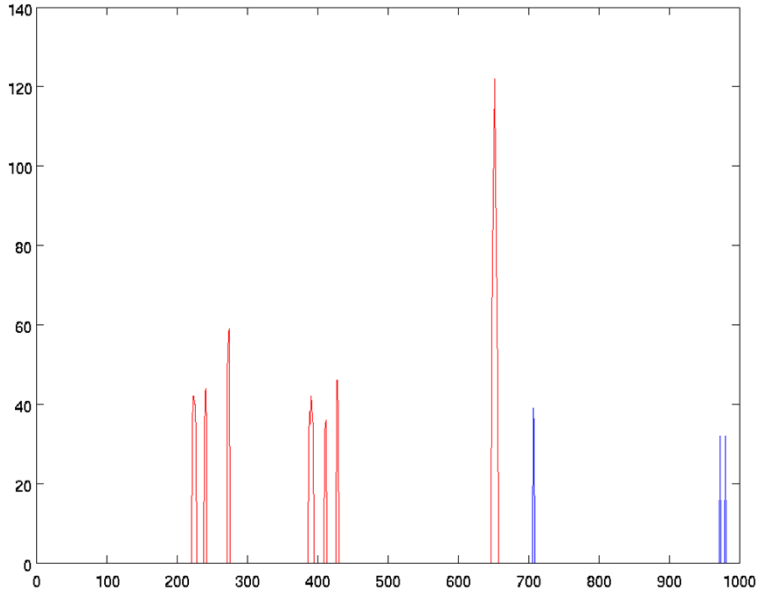


# In summary

4 parameters :

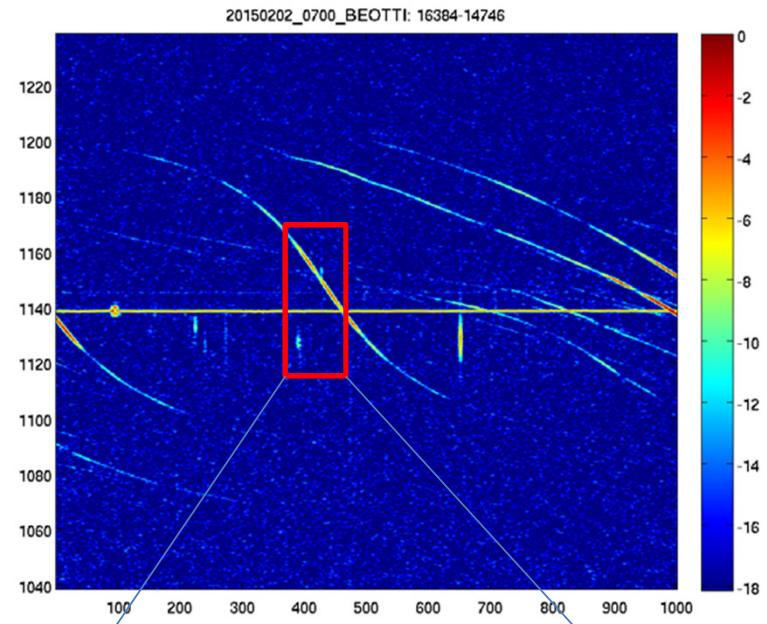
- Median width : 40
- Threshold or nb_mad
- Min_length_value (in frequency) : 30 pixels
- Min_width_value (in time) :  3 columns

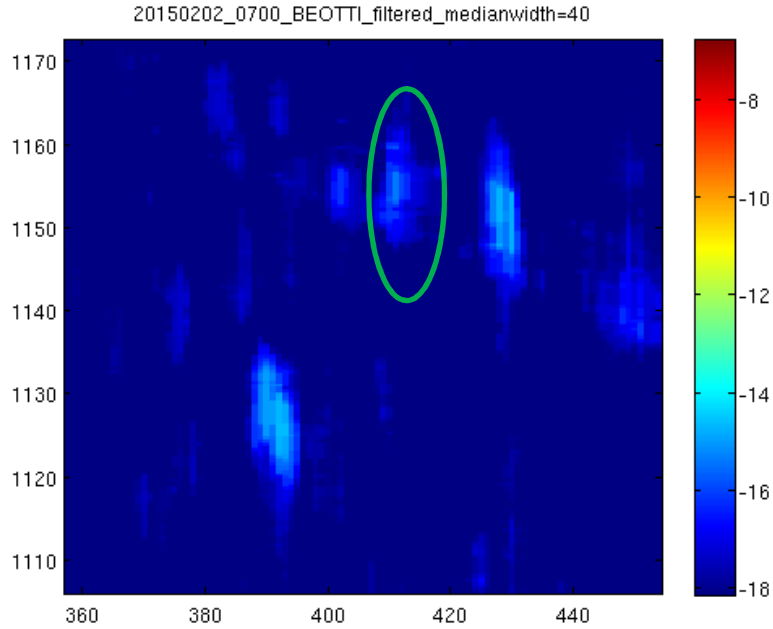


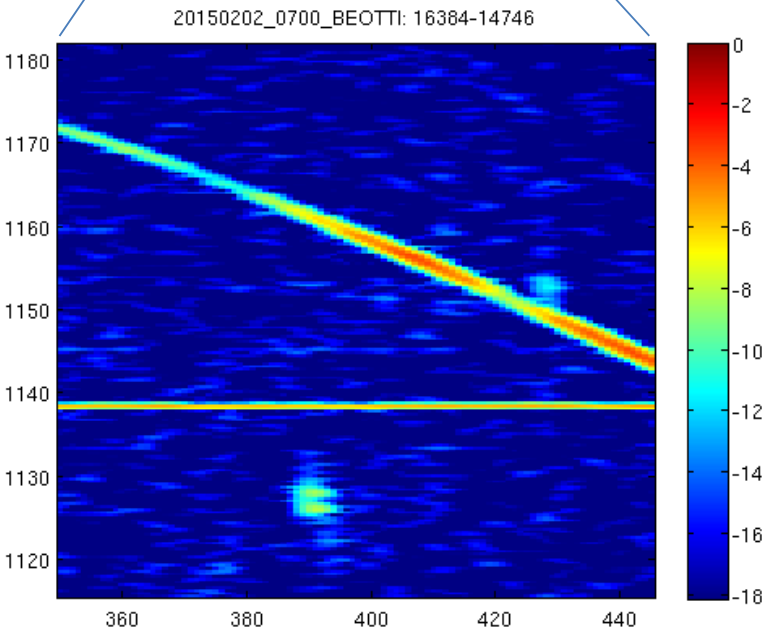



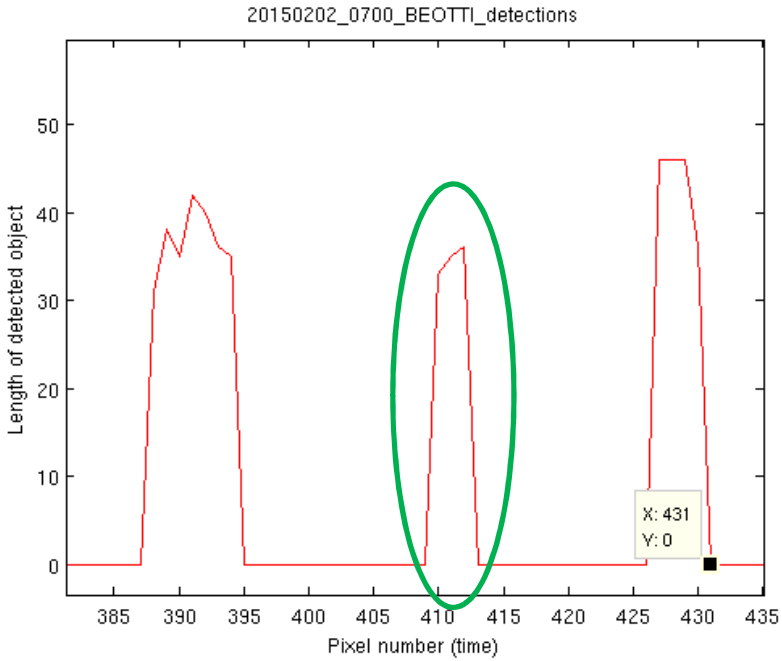

Objects with enough length in frequency but not enough width in time

Objects with enough length in frequency AND enough width in time

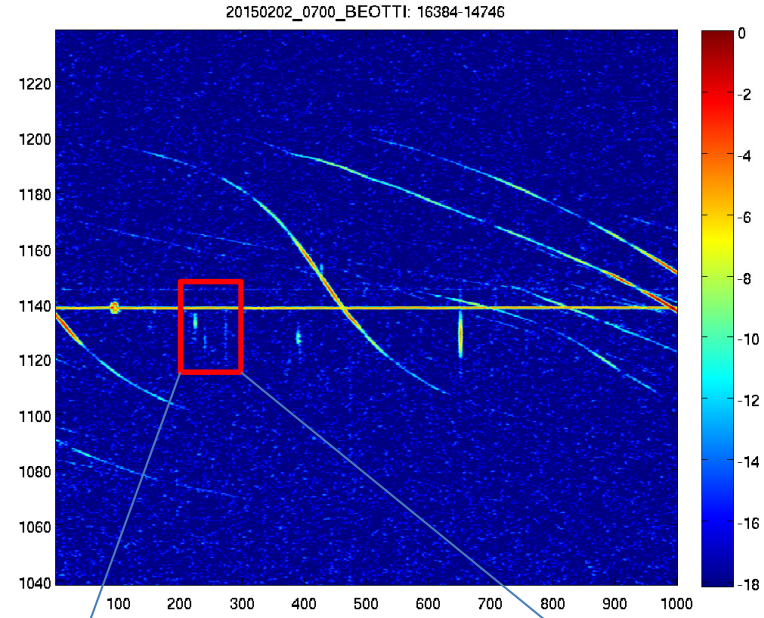

20150202_0700_BEOTTI: 16384-14746
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
0
-2
-4
-6
-8
-10
-12
-14
-16
-18

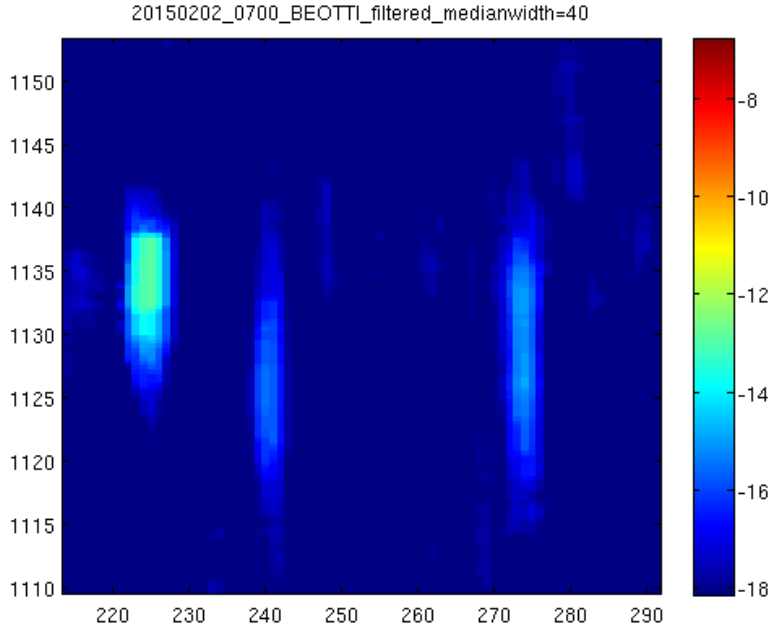

20150202_0700_BEOTTI_filtered_medianwidth=40
1170
1160
1150
1140
1130
1120
1110
360
380
400
420
440
-8
-10
-12
-14
-16
-18

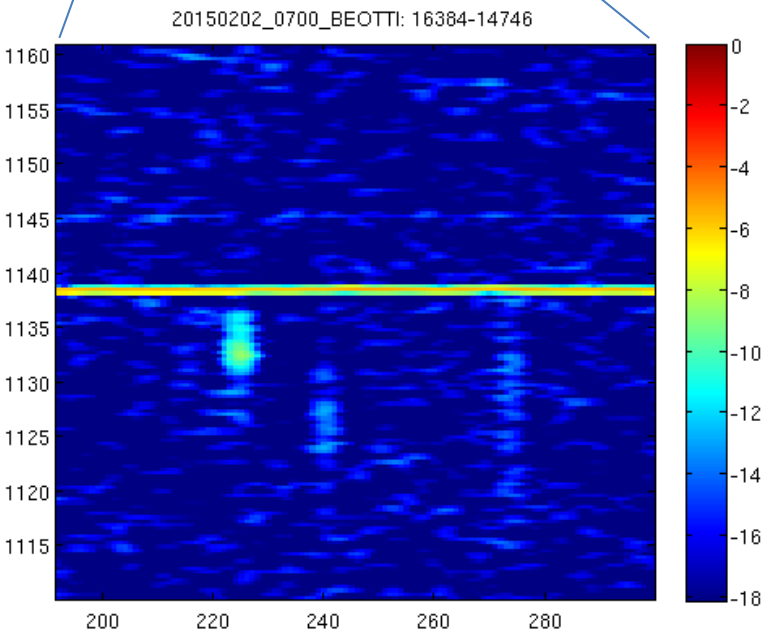

20150202_0700_BEOTTI: 16384-14746
1180
1170
1160
1150
1140
1130
1120
360
380
400
420
440
0
-2
-4
-6
-8
-10
-12
-14
-16
-18

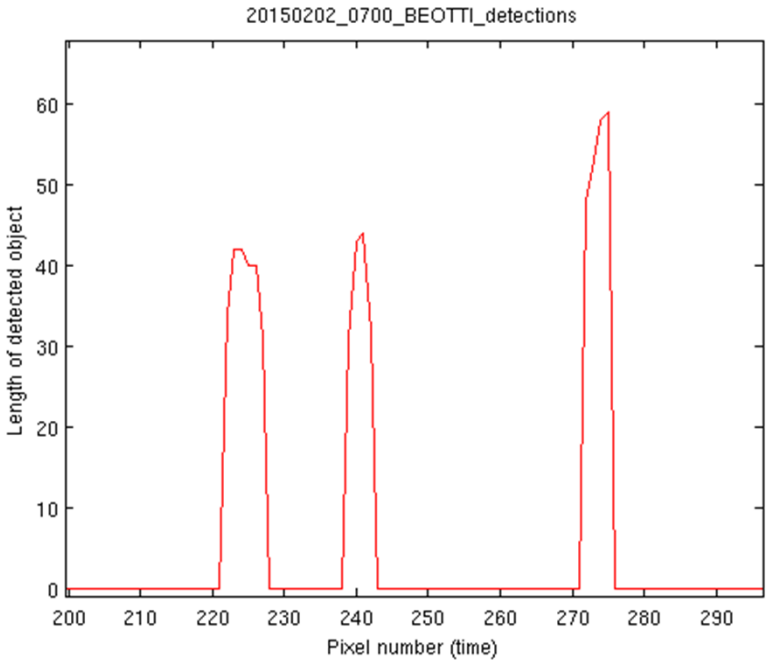

20150202_0700_BEOTTI_detections
Length of detected object
50
40
30
20
10
0
385
390
395
400
405
410
415
420
425
430
435
Pixel number (time)
X: 431
Y: 0

- Positive : faint meteor superimposed on bright plane is detected
- Negative : 1 FP → solution : width ≥ 4  instead of width ≥ 3 ?

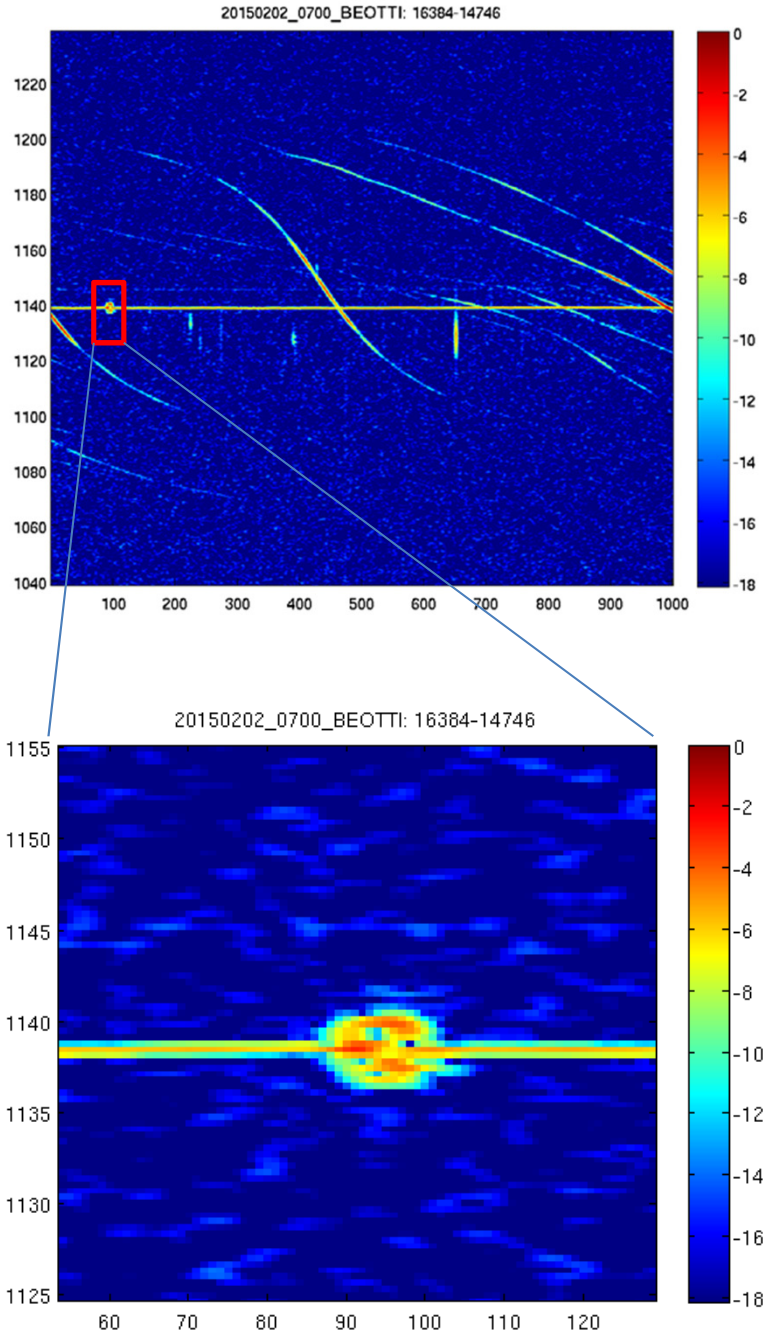

20150202_0700_BEOTTI: 16384-14746
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
0
-2
-4
-6
-8
-10
-12
-14
-16
-18


20150202_0700_BEOTTI_filtered_medianwidth=40
1150
1145
1140
1135
1130
1125
1120
1115
1110
220
230
240
250
260
270
280
290
-8
-10
-12
-14
-16
-18


20150202_0700_BEOTTI: 16384-14746
1160
1155
1150
1145
1140
1135
1130
1125
1120
1115
200
220
240
260
280
0
-2
-4
-6
-8
-10
-12
-14
-16
-18


20150202_0700_BEOTTI_detections
Length of detected object
60
50
40
30
20
10
0
200
210
220
230
240
250
260
270
280
290
Pixel number (time)

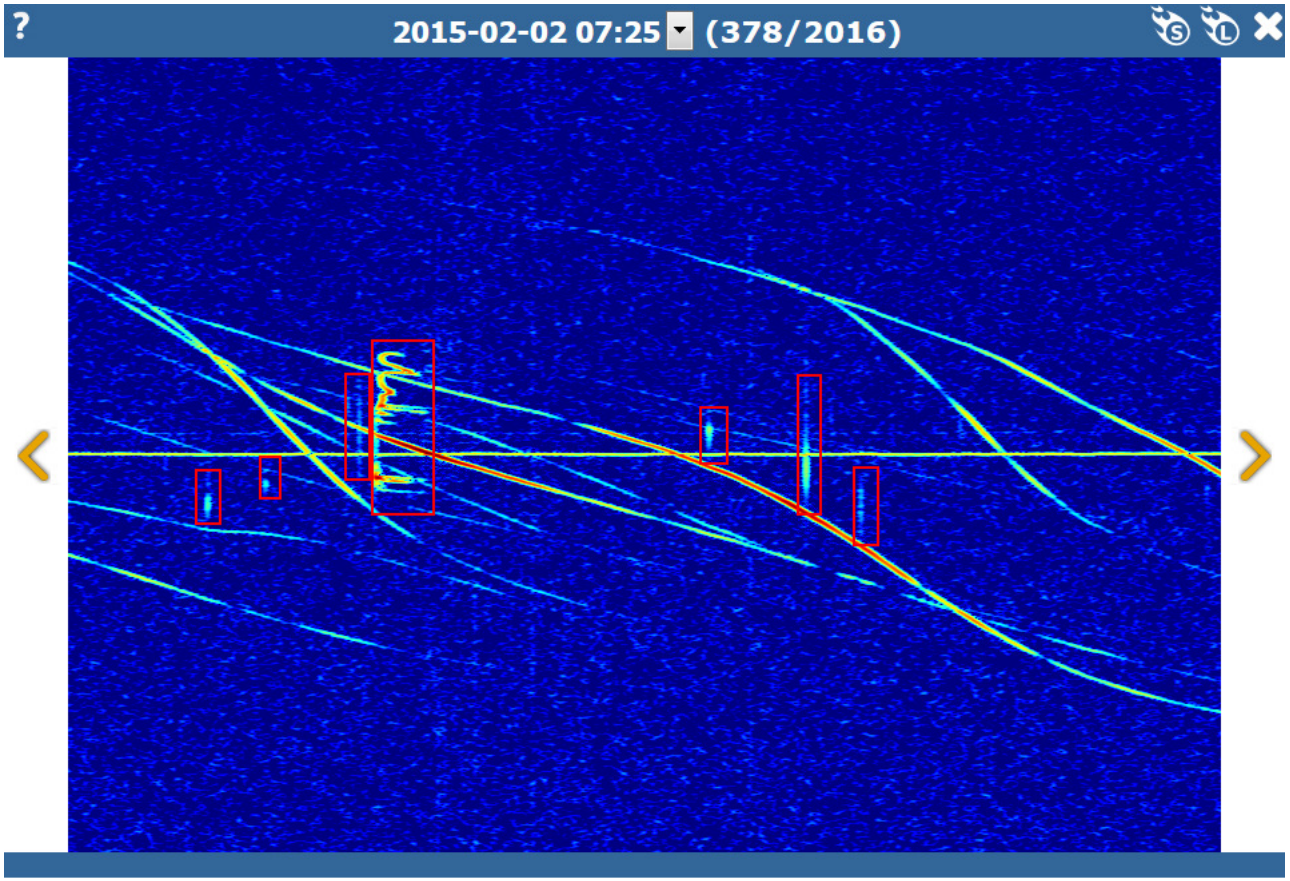
- Positive : all faint meteors are detected
- Negative : -




Summary :

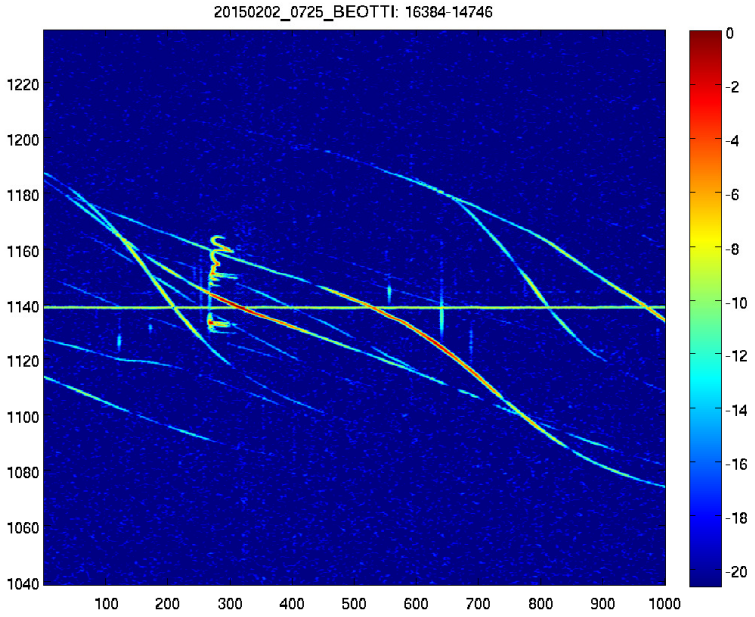
1. TP : 6/7
2. FP : 1 (can be avoided?)
3. FN : 1/7

# Example 2




Manual counts : 7

07H25


20150202_0725_BEOTTI: 16384-14746
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
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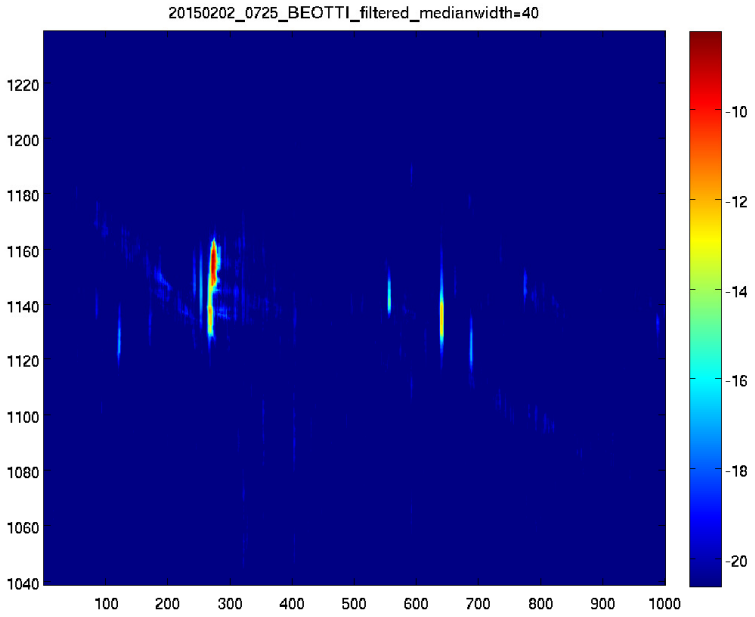
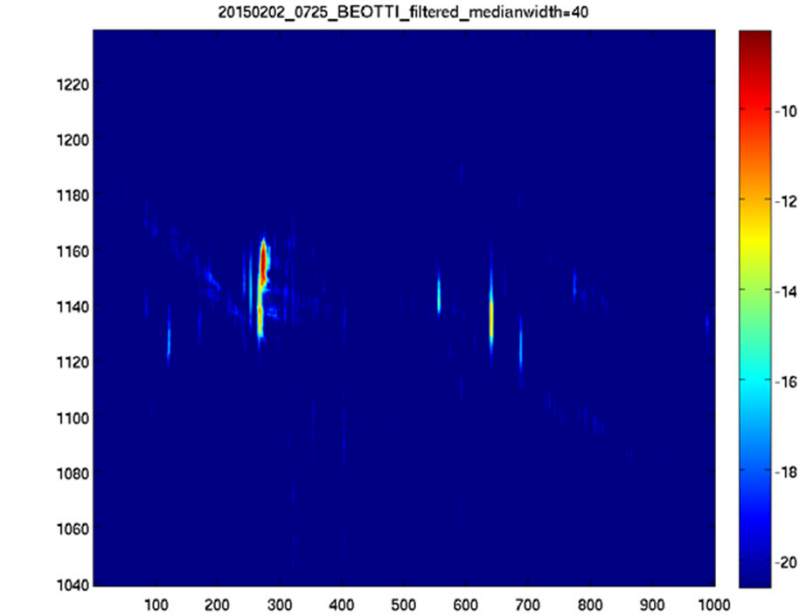
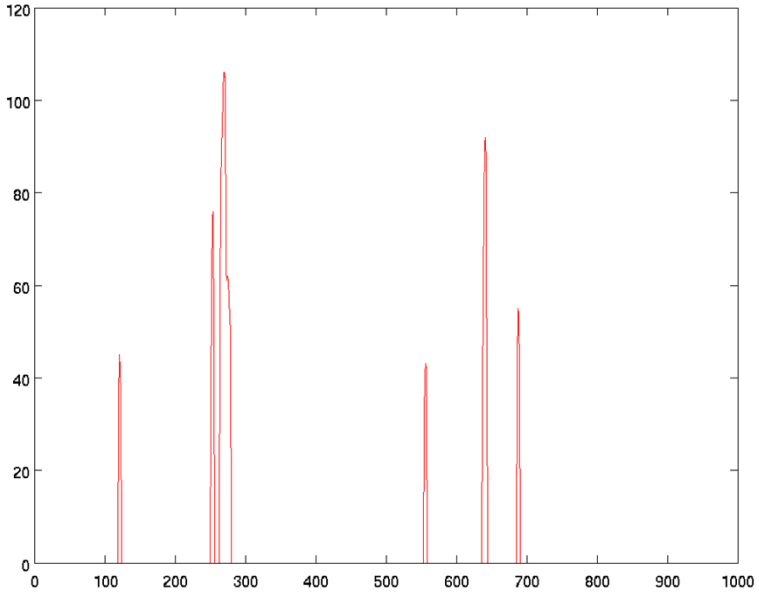
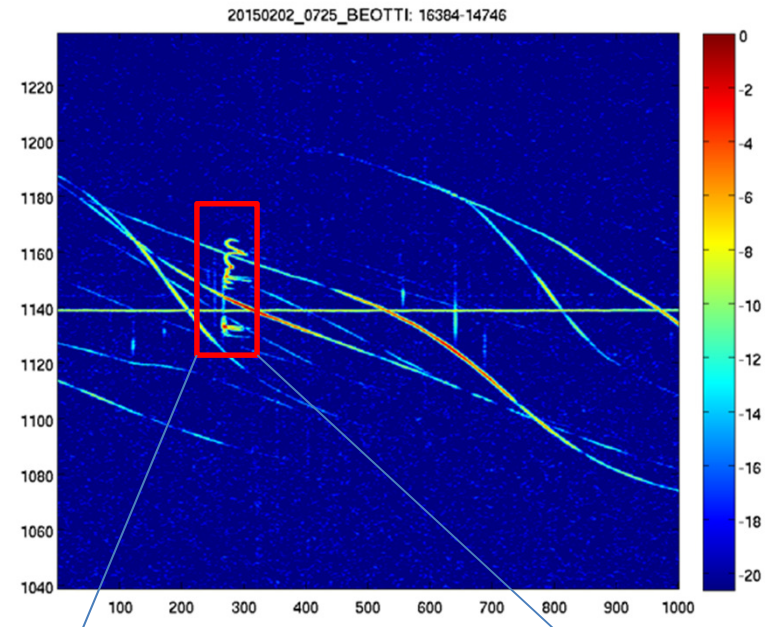
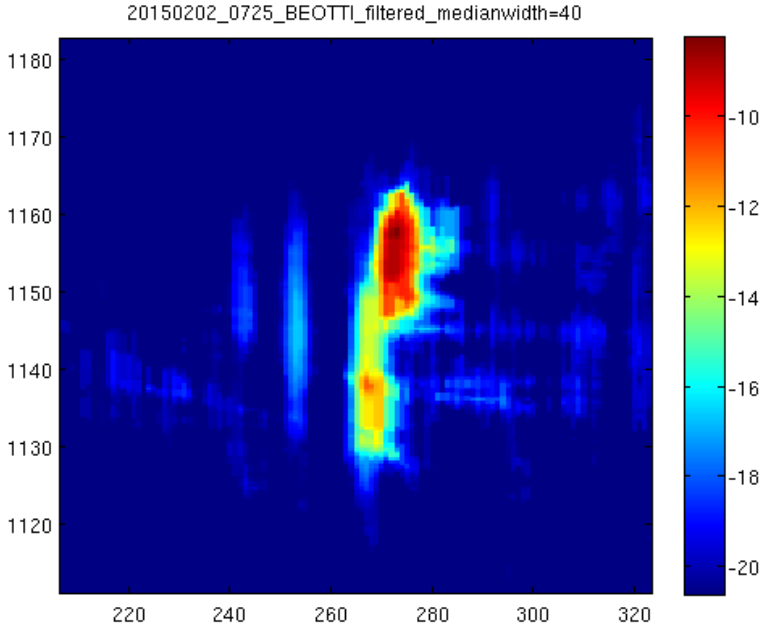
400
500
600
700
800
900
1000
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20

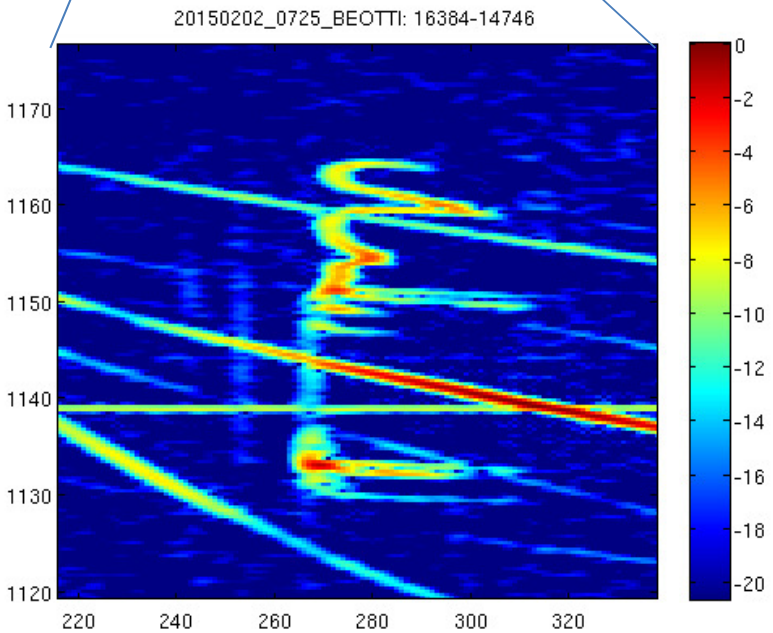

20150202_0725_BEOTTI_filtered_medianwidth=40
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
-10
-12
-14
-16
-18
-20

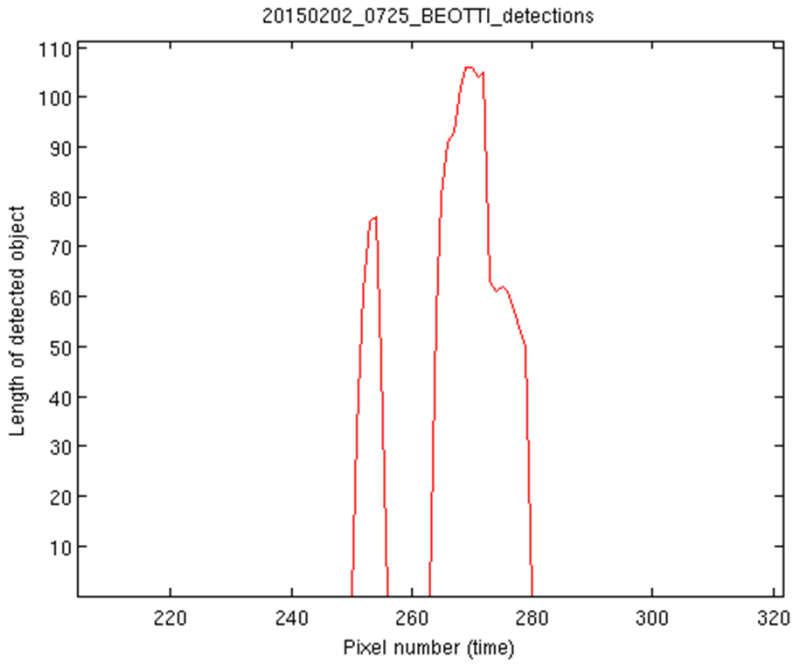

20150202_0725_BEOTTI_filtered_medianwidth=40
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
-10
-12
-14
-16
-18
-20


120
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000


20150202_0725_BEOTTI: 16384-14746
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20

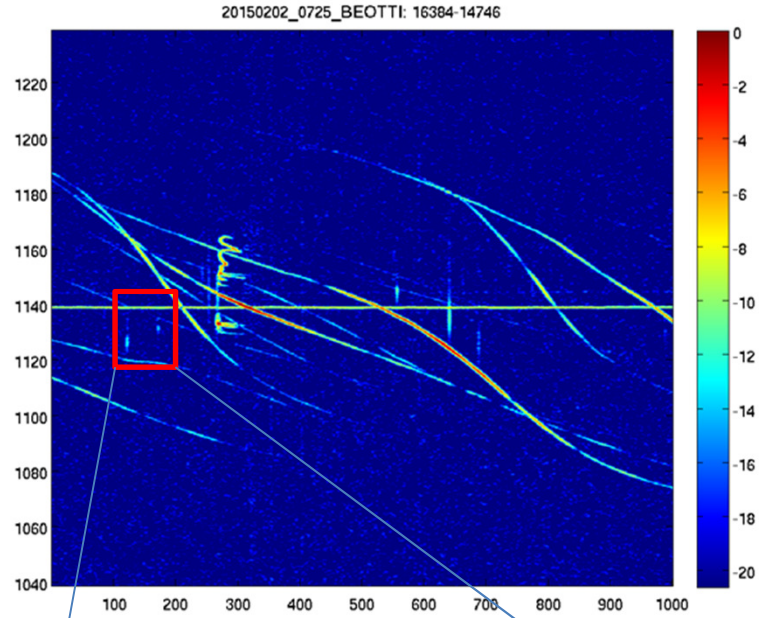

20150202_0725_BEOTTI_filtered_medianwidth=40
1180
1170
1160
1150
1140
1130
1120
220
240
260
280
300
320
-10
-12
-14
-16
-18
-20

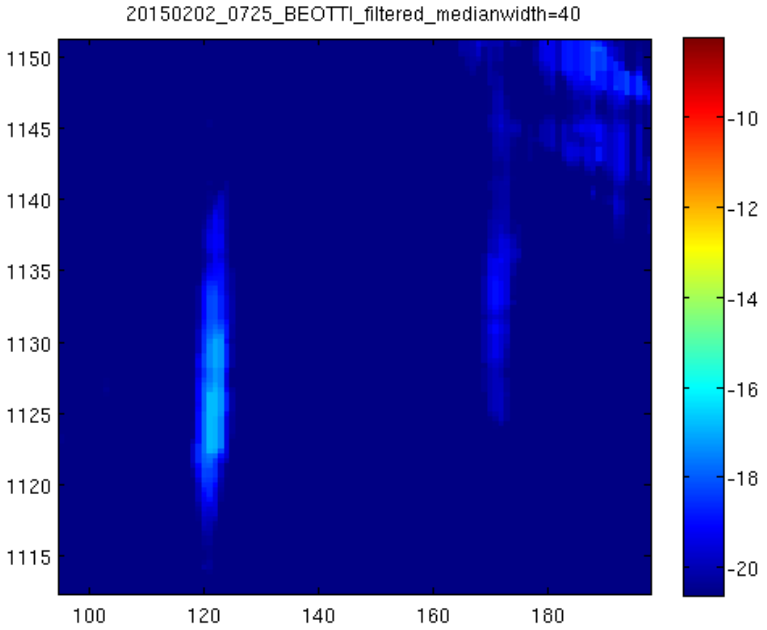

20150202_0725_BEOTTI: 16384-14746
1170
1160
1150
1140
1130
1120
220
240
260
280
300
320
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20

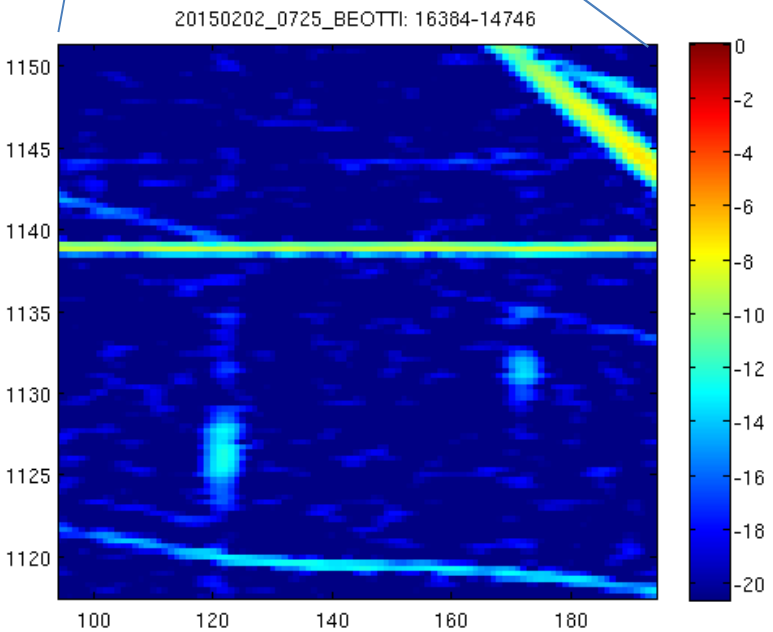

20150202_0725_BEOTTI_detections
Length of detected object
110
100
90
80
70
60
50
40
30
20
10
220
240
260
280
300
320
Pixel number (time)

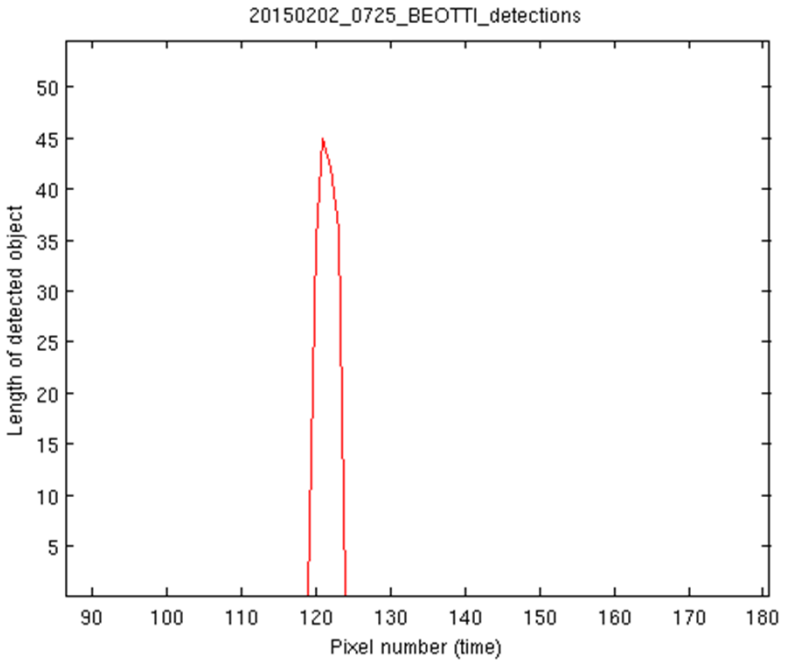
- Positive : the very faint but « long » meteor echo is clearly detected even though it is superimposed on bright planes

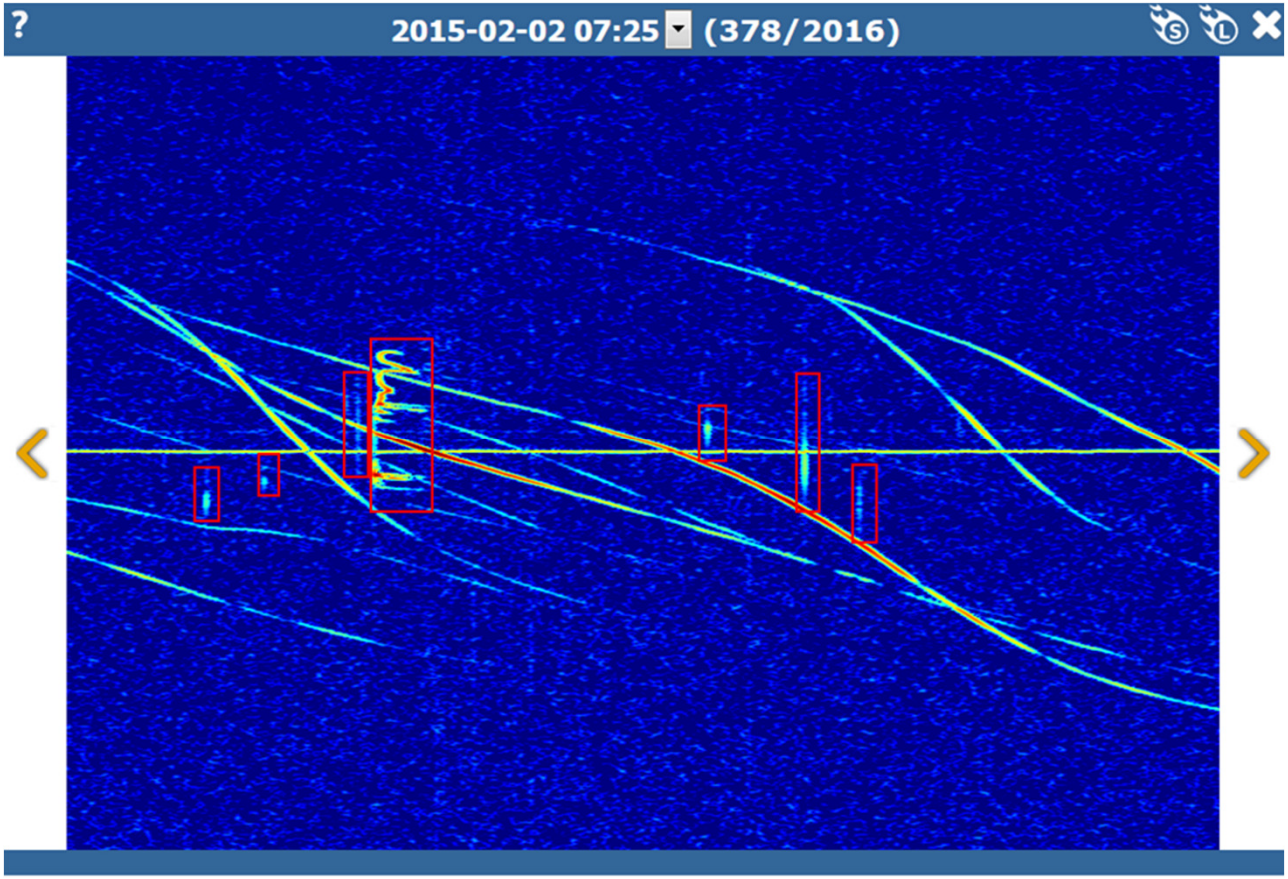
- Positive : the epsilon echo is detected, at least part of it. The long branches disappear due to the median filter.


20150202_0725_BEOTTI: 16384-14746
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20


20150202_0725_BEOTTI_filtered_medianwidth=40
1150
1145
1140
1135
1130
1125
1120
1115
100
120
140
160
180
-10
-12
-14
-16
-18
-20


20150202_0725_BEOTTI: 16384-14746
1150
1145
1140
1135
1130
1125
1120
100
120
140
160
180
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20

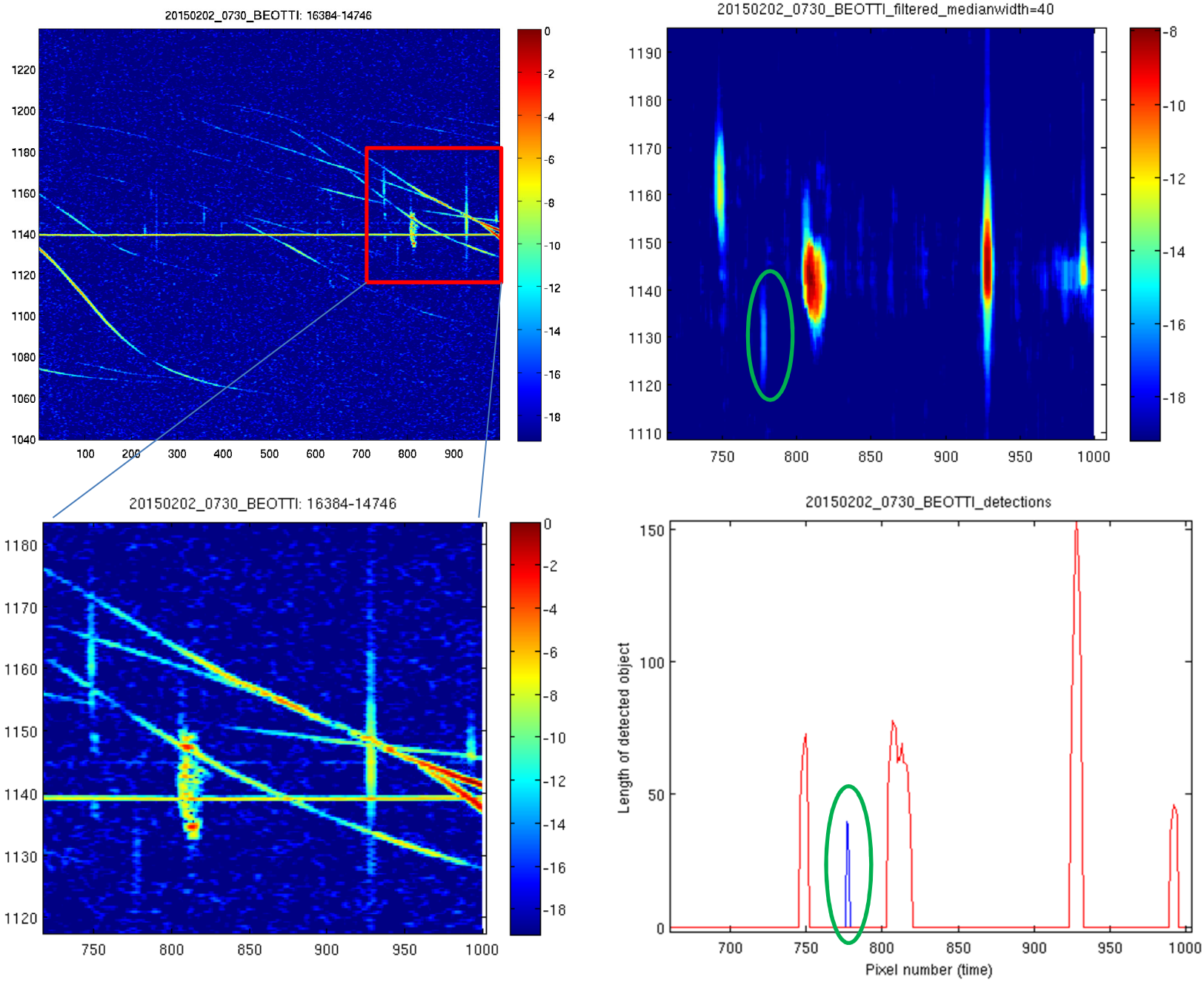

20150202_0725_BEOTTI_detections
Length of detected object
50
45
40
35
30
25
20
15
10
5
90
100
110
120
130
140
150
160
170
180
Pixel number (time)



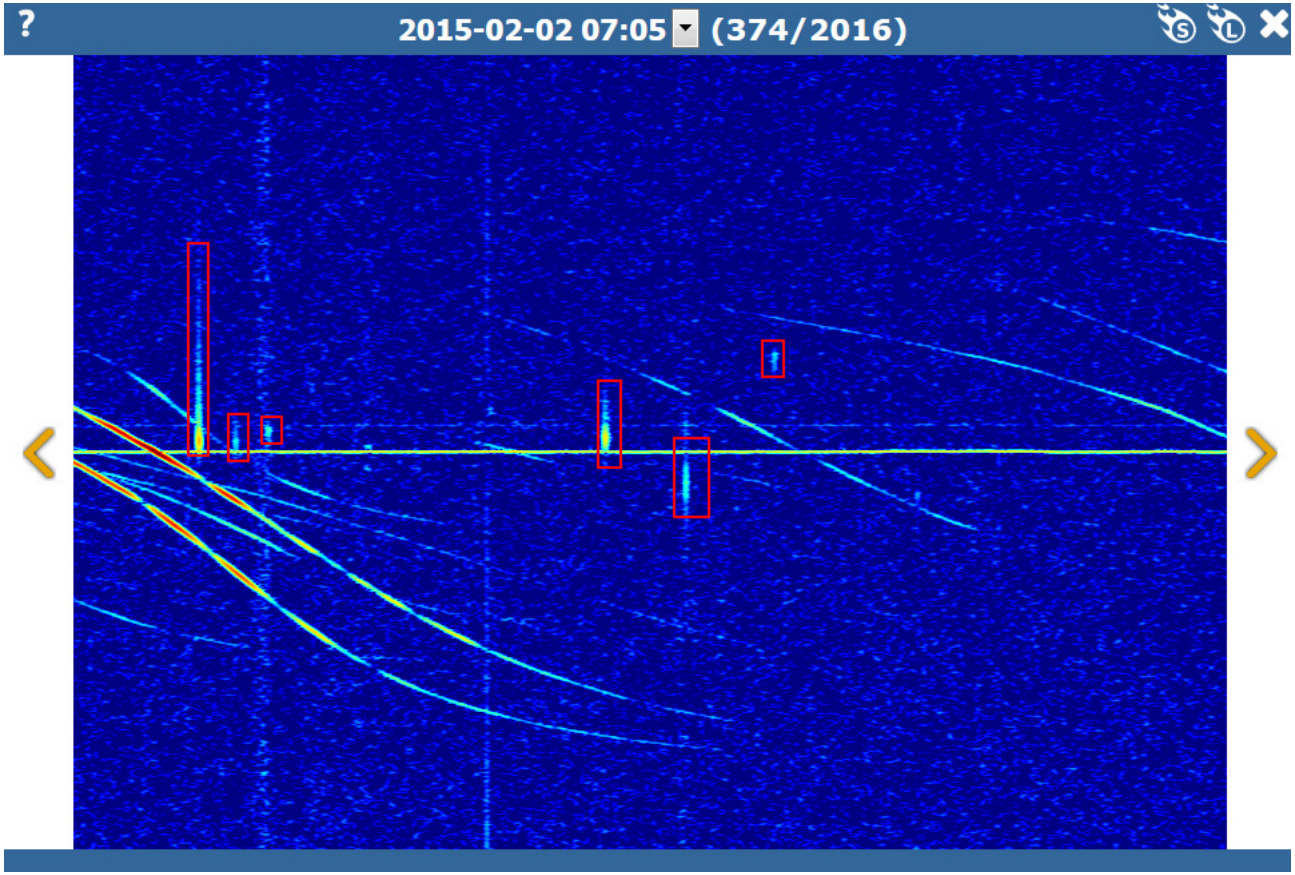

Summary :

1. TP : 6/7
2. FP : 0
3. FN : 1/7

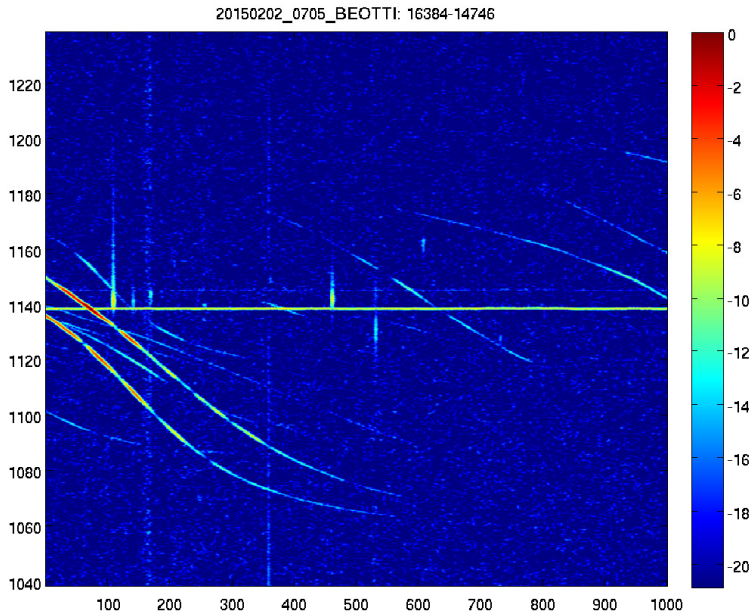
# Example 3

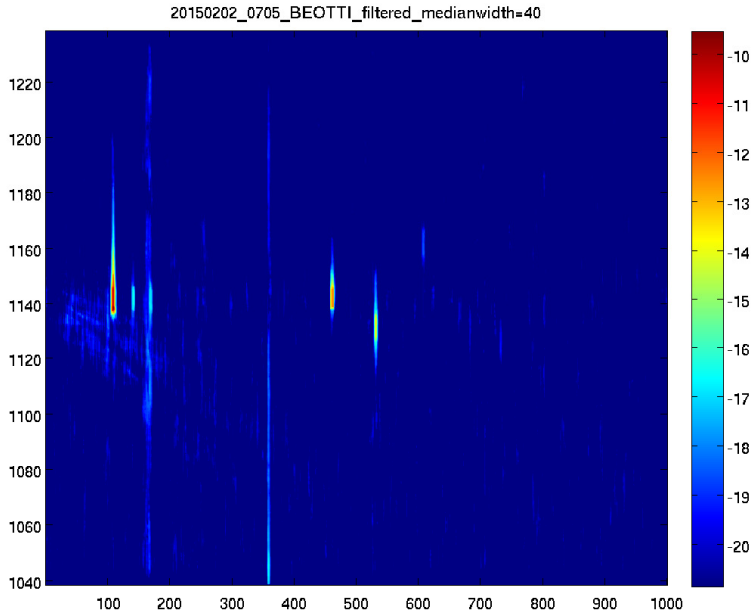

20150202_0730_BEOTTI: 16384-14746
20150202_0730_BEOTTI_filtered_medianwidth=40
20150202_0730_BEOTTI: 16384-14746
20150202_0730_BEOTTI_detections
Length of detected object
Pixel number (time)

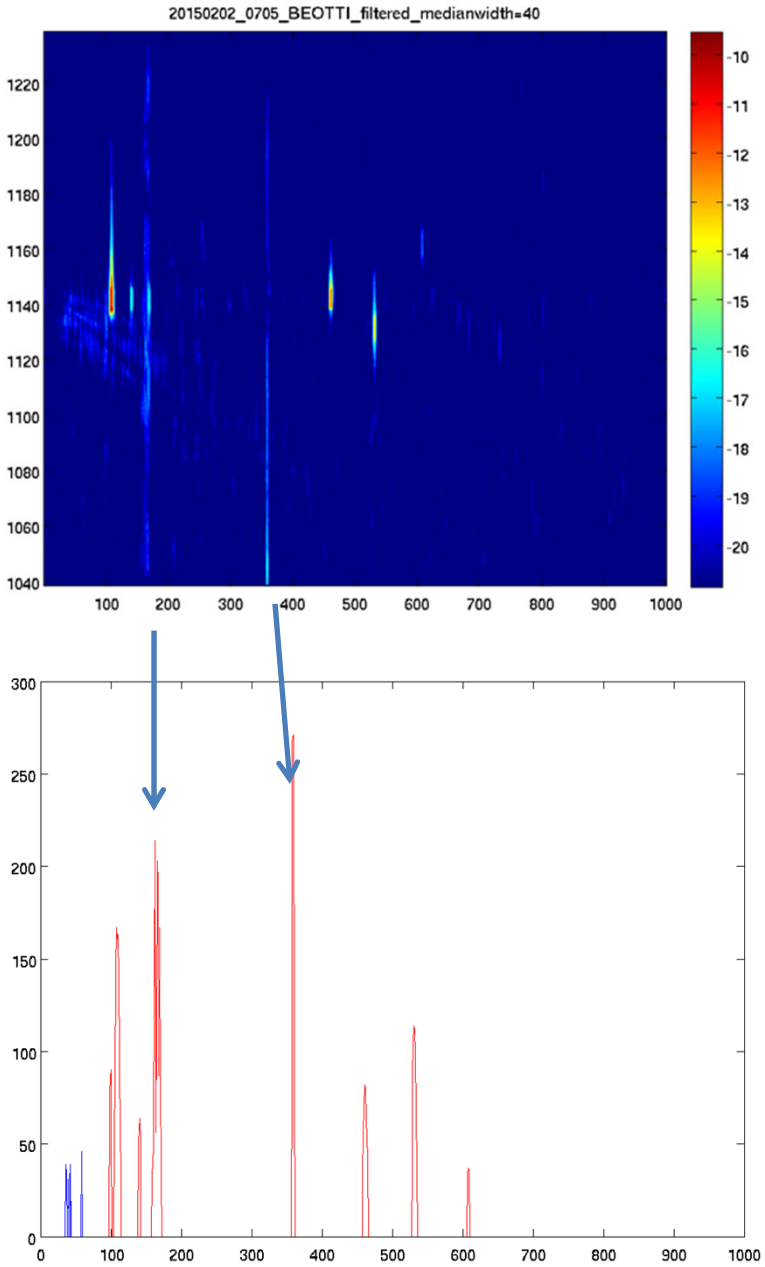
# Example 4

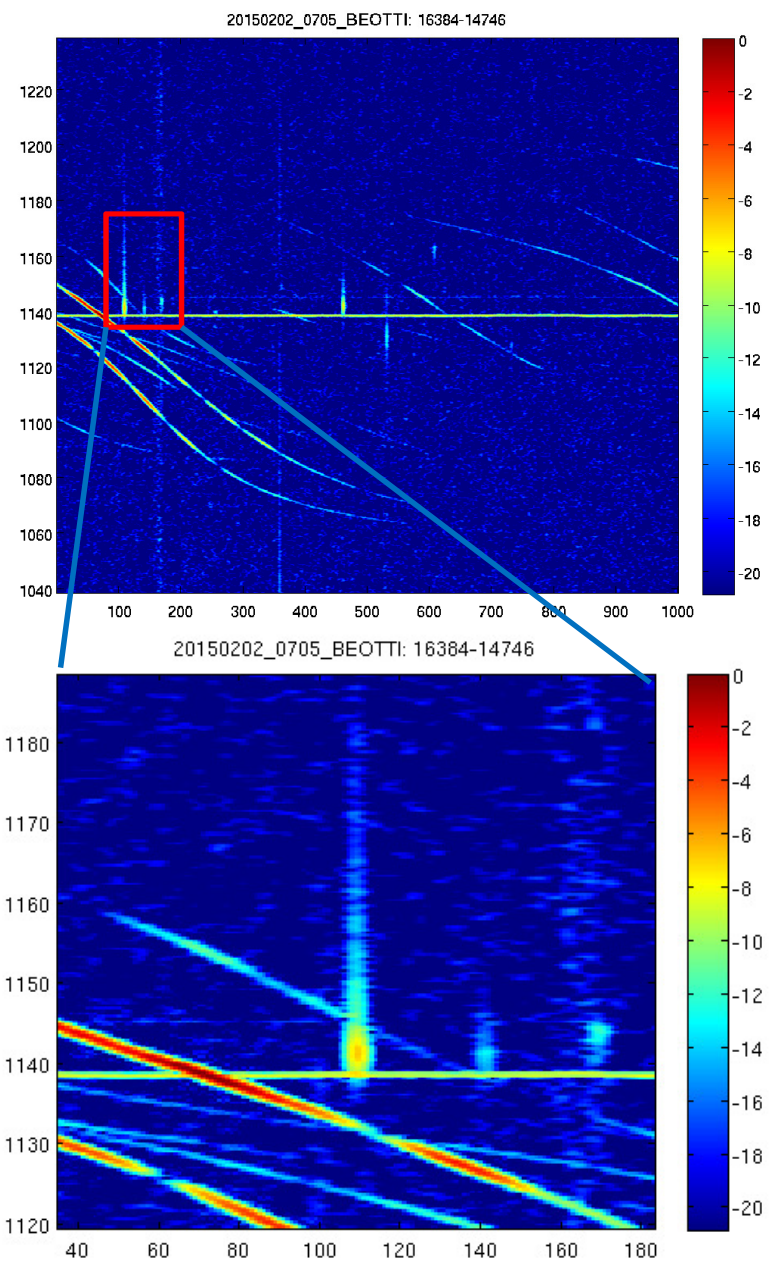


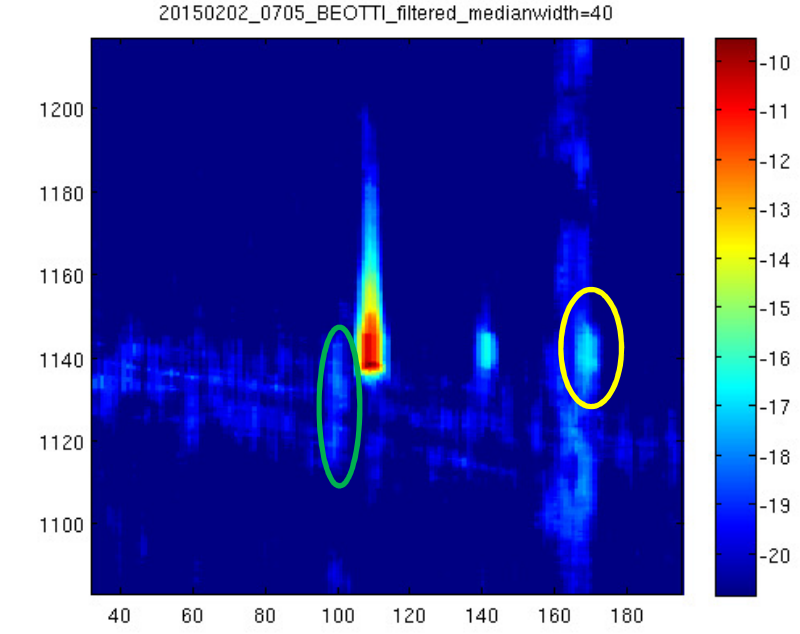

Manual count: 6

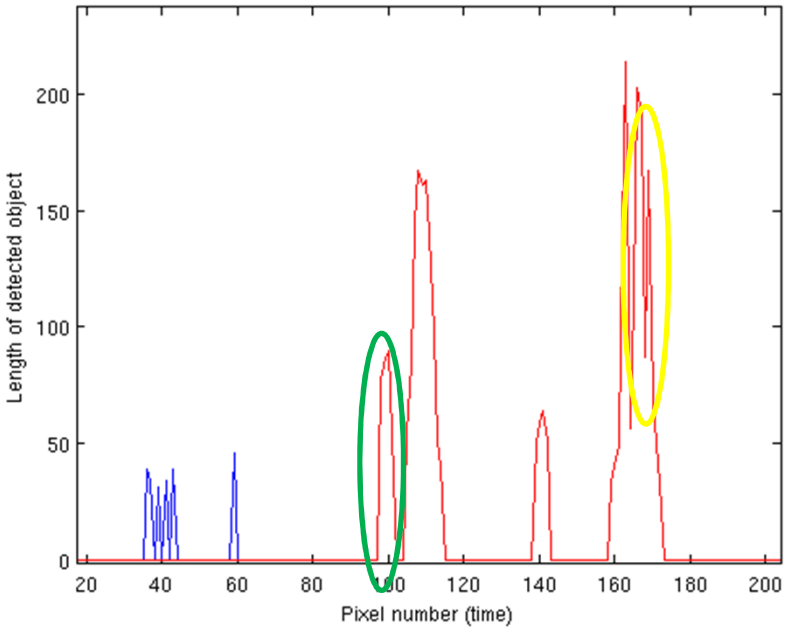

20150202_0705_BEOTTI: 16384-14746
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20


20150202_0705_BEOTTI_filtered_medianwidth=40
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
-10
-11
-12
-13
-14
-15
-16
-17
-18
-19
-20


20150202_0705_BEOTTI_filtered_medianwidth=40
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100
200
300
400
500
600
700
800
900
1000
-10
-11
-12
-13
-14
-15
-16
-17
-18
-19
-20
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
800
900
1000

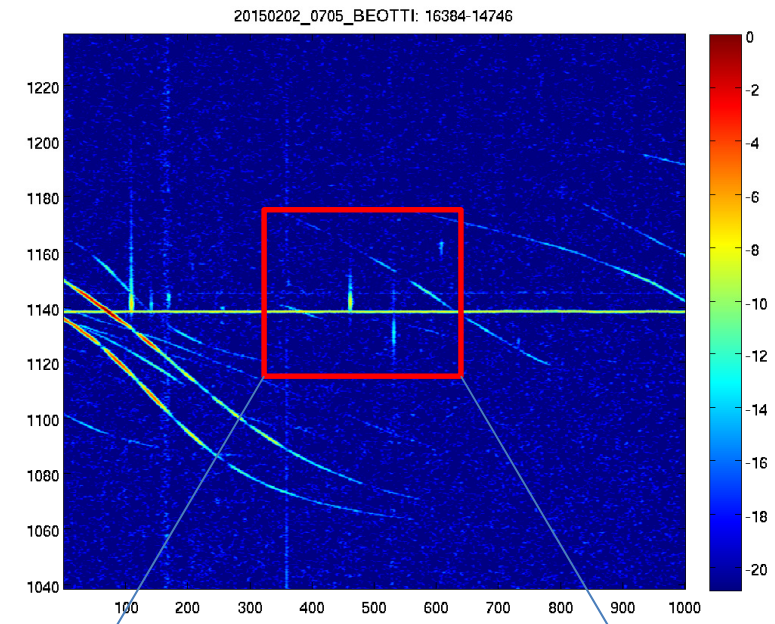

20150202_0705_BEOTTI: 16384-14746
20150202_0705_BEOTTI: 16384-14746


20150202_0705_BEOTTI_filtered_medianwidth=40


Length of detected object
Pixel number (time)

- Positive : meteor maybe detected even though it’s very close to the interference?

- Negative : 1 FP


20150202_0705_BEOTTI: 16384-14746
1220
1200
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1060
1040
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200
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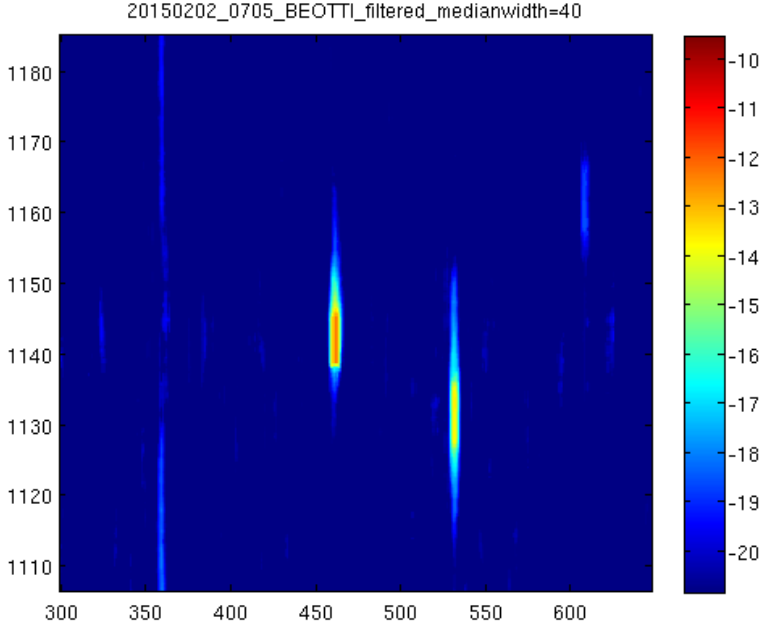
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1110
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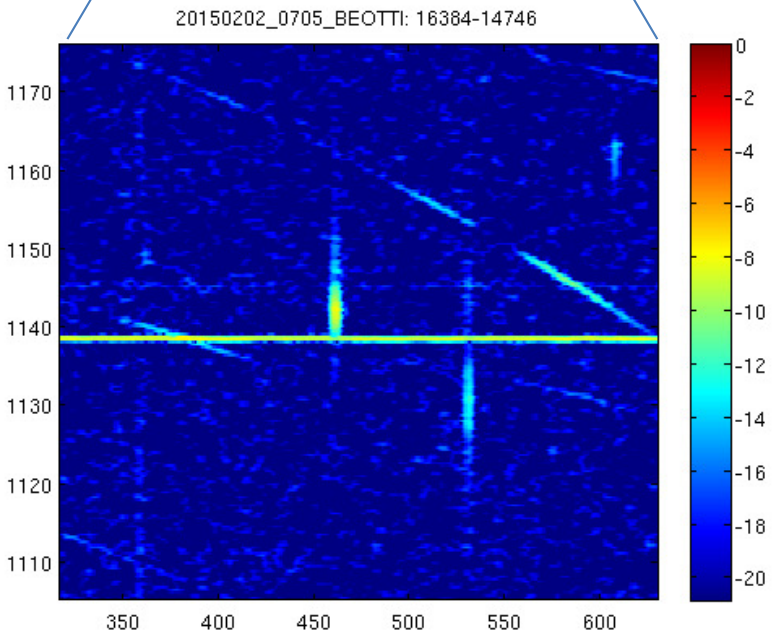
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-18
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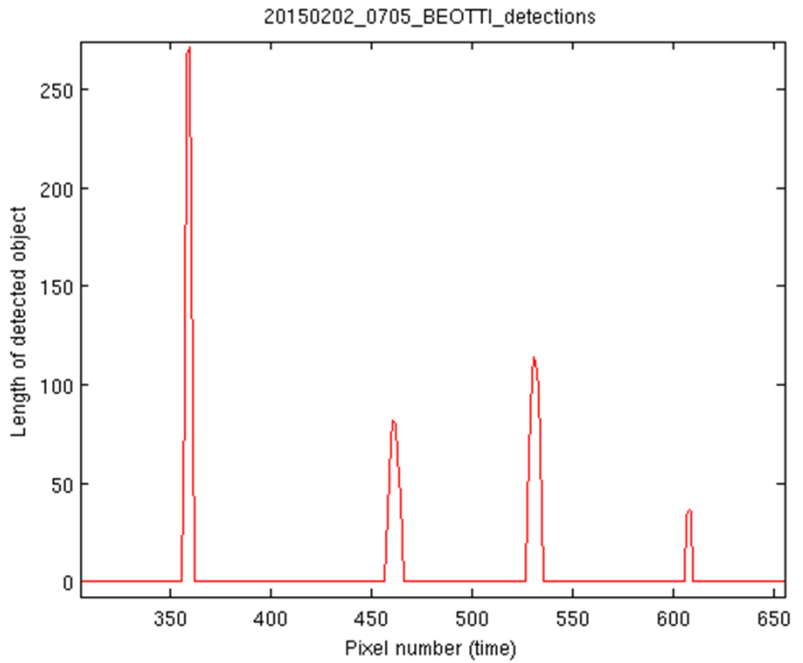
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50
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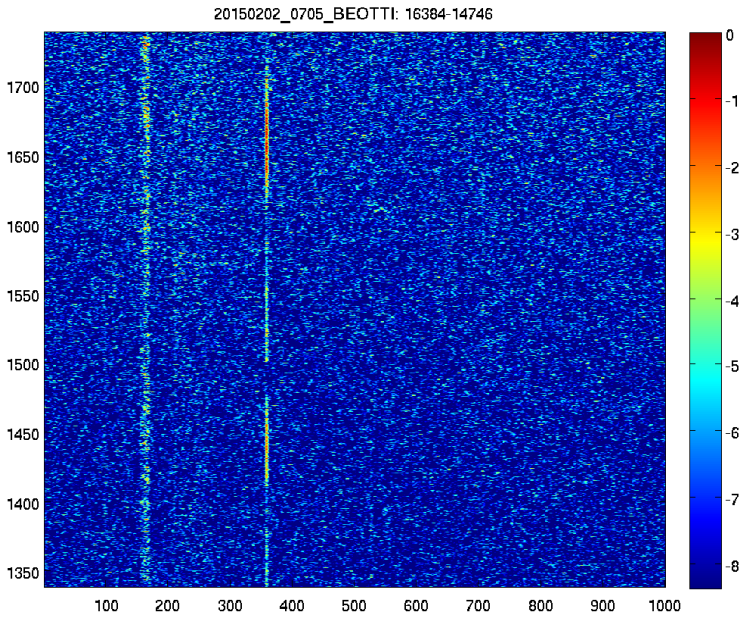
400
450
500
550
600
650
Pixel number (time)

# Detection of interferences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600
700
800
900
1000
0
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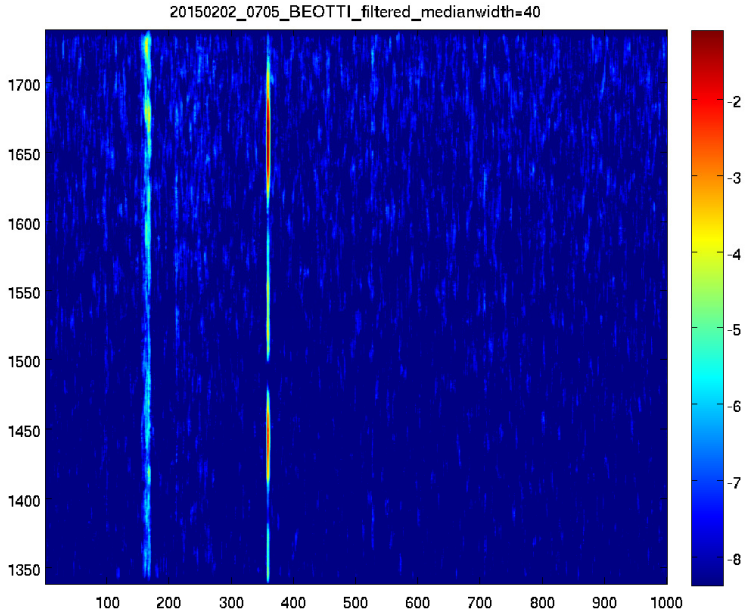
-2
-3
-4
-5
-6
-7
-8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-2
-3
-4
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-6
-7
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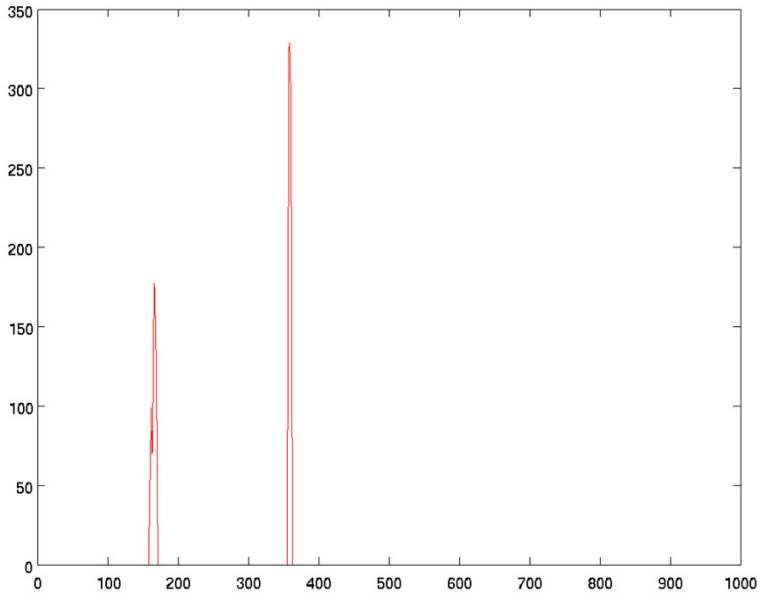
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200
150
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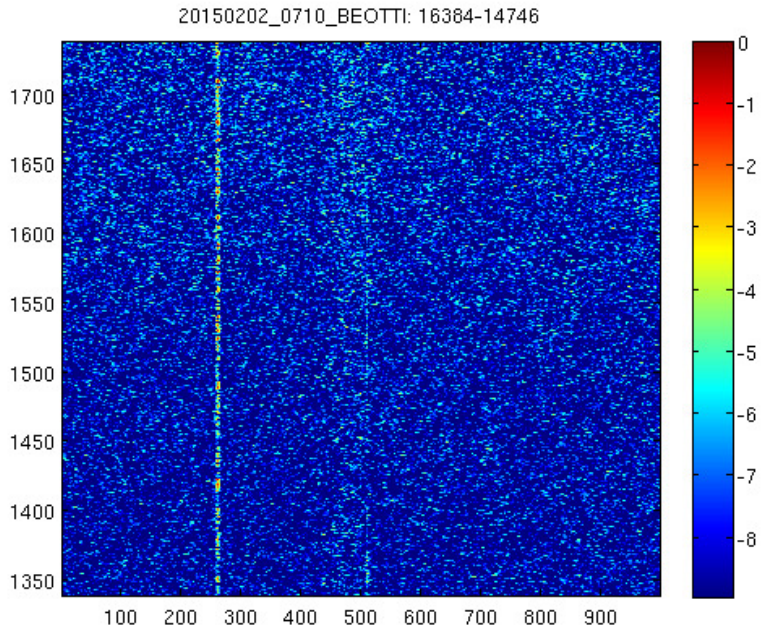
50
0
0
100
200
300
400
500
600
700
800
900
1000

07H05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100 200 300 400 500 600 700 800 900
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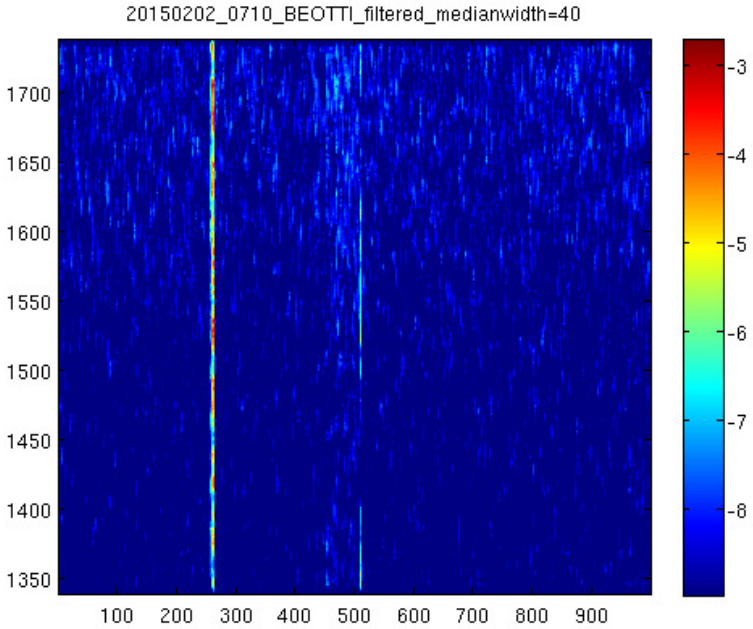
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1350
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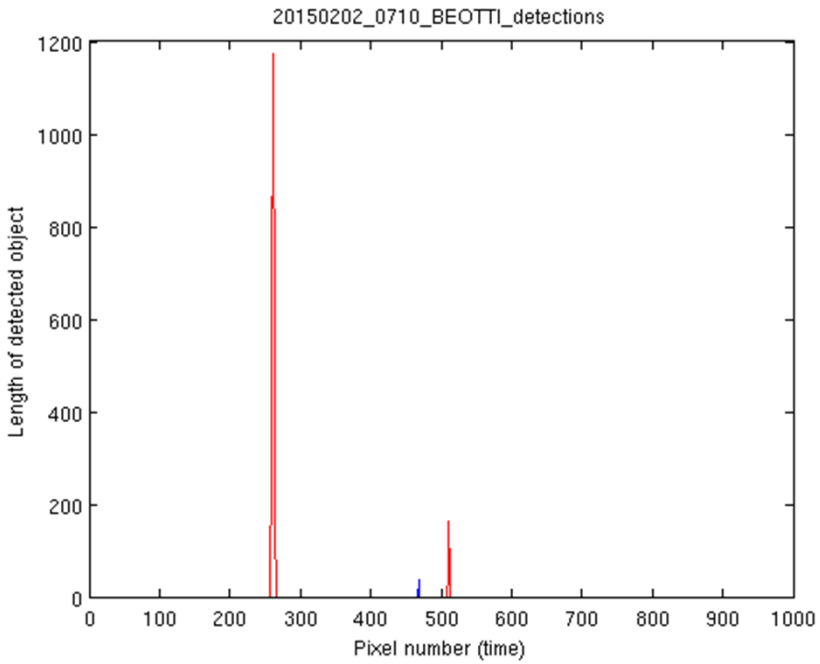
-3 -4 -5 -6 -7 -8


20150202_0710_BEOTTI_detections
Length of detected object
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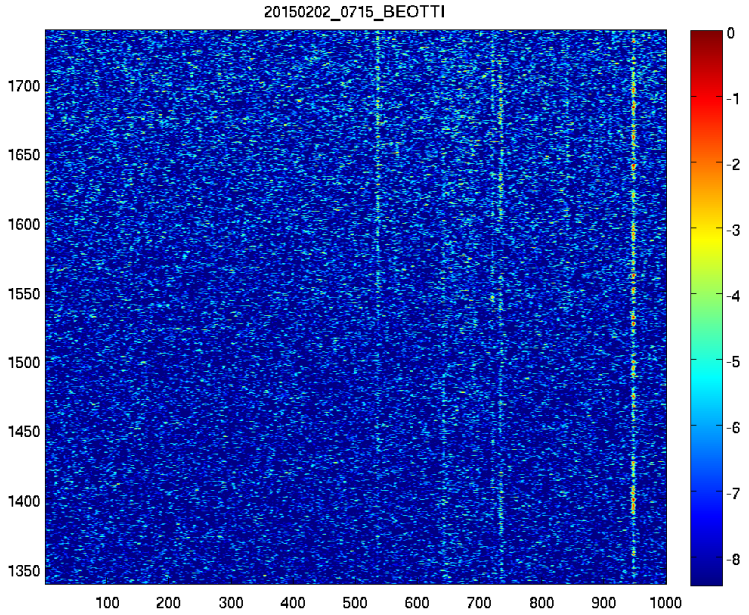
800
600
400
200
0
0 100 200 300 400 500 600 700 800 900 1000
Pixel number (time)

07H10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700
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900
1000
0
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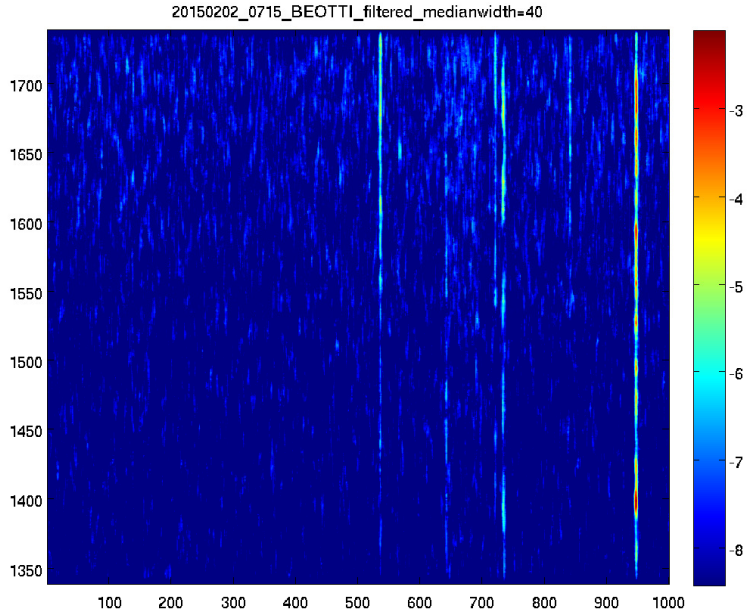
-2
-3
-4
-5
-6
-7
-8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1000
-3
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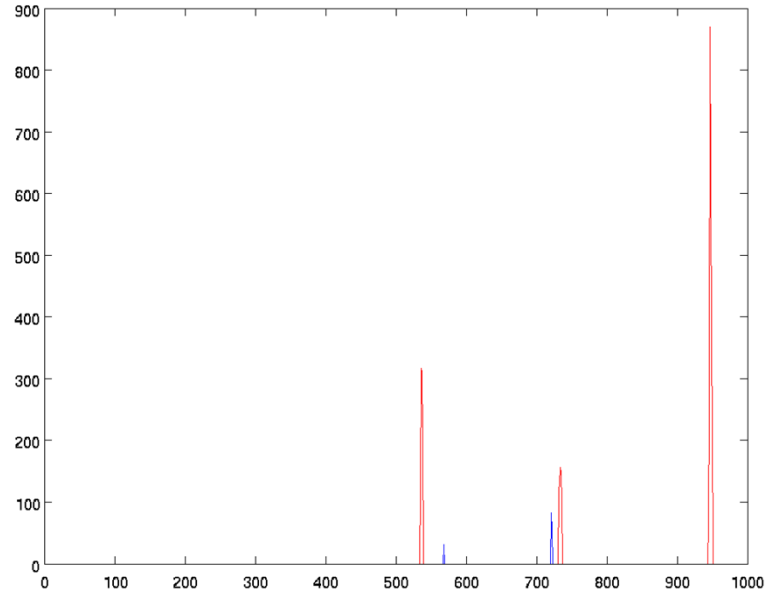
-6
-7
-8


900
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400
300
200
100
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700
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900
1000

07H15

# New algorithm

- Work by Maxence Draguet (ULB)
- Automated, comparison with manual database, computes TP, FP rates, removes interferences
- Threshold (nb_MAD) varies from column to column
- « Optimization » of 4 parameters : median_width, nb_MAD, length_min, width_min = [ 40, 25, 4, 5 ]

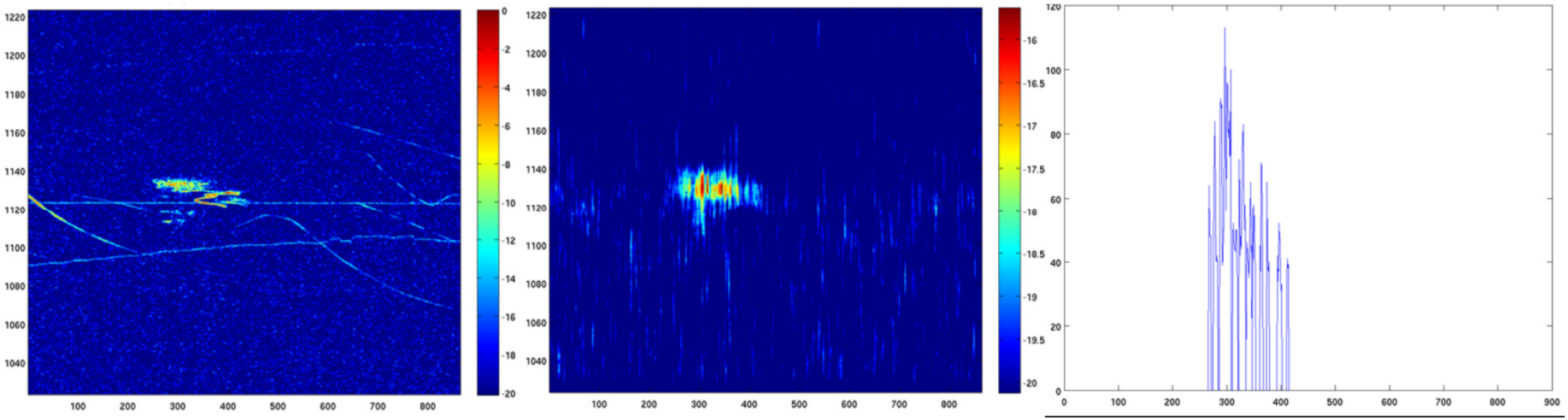
# Test for BEUCCL 01-02/01/2016

01/01/2016

- TP ~ 65 %
- FP ~ 10 %

02/01/2016

- TP ~ 68 %
- FP ~ 14 %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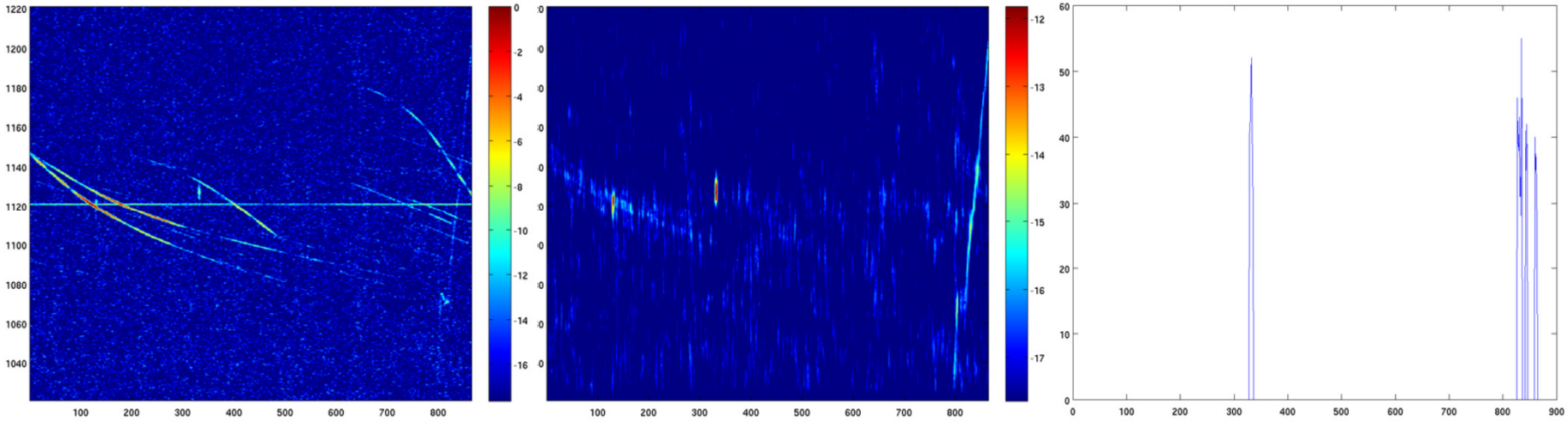
1200
1180
1160
1140
1120
1100
1080
1060
1040
100 200 300 400 500 600 700 800
0 -2 -4 -6 -8 -10 -12 -14 -16 -18 -20
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
100 200 300 400 500 600 700 800
-16 -16.5 -17 -17.5 -18 -18.5 -19 -19.5 -20
120
100
80
60
40
20
0
0 100 200 300 400 500 600 700 800 900


1220
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1040
100 200 300 400 500 600 700 800
0 -2 -4 -6 -8 -10 -12 -14 -16
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1200
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1160
1140
1120
1100
1080
1060
1040
100 200 300 400 500 600 700 800
-12 -13 -14 -15 -16 -17
60
50
40
30
20
10
0
0 100 200 300 400 500 600 700 800 900

# Conclusions & perspectives

- Moving median method is probably the simplest one and should provide acceptable results (TP ~ 70-75% and FP ≤ 10%)

- A few problems still to solve + doing a « real optimization » study on several sets of data from various BRAMS receiving stations

- Once new IT person is hired, plan to automatically analyze all incoming data before archiving them. Results to be available via an interface on the BRAMS website (e.g. to plot the daily variation)

- Not the most efficient method in terms of computing since it relies on the spectrogram and not the raw WAV audio file. We should keep an eye open to new techniques.