Searching for meteor ELF /VLF radiations

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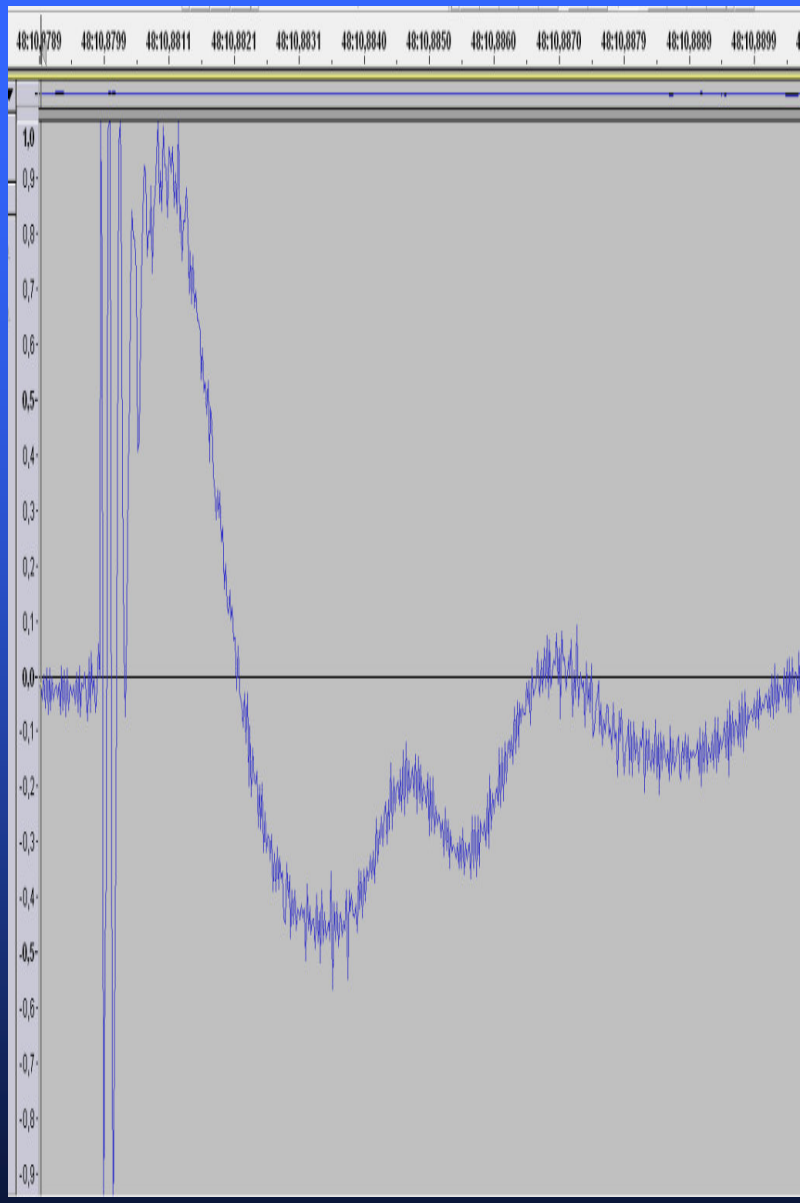


Société Astronomique de France

Commission Radioastronomie

International Meteor Organization

Radio Commission

IMC, Poreč , Croatia, September 2009

For more than 300 years, observers have been reporting audible sounds appearing simultaneouly with visible fireballs.

➔An approx. 4 minutes delay should be observed, instead of a coincidence …

A VLF radio wave vector has been proposed as an explanation (Keay, 1980).

Both the potential VLF wave generation and the hypothetic radio to acoustic wave transduction are not still well understood …

➢ 1993: Beech, Brown et al.

« 80 hours of simultaneous visual/video and VLF recordings made during the Lyrids, Perseids, Orionids, Leonids and Geminids (…) All meteor magnitudes from –11 to +4 have been sampled at least once during these observations.

The **only positive VLF** fireball detection was made at 19:57:32 UT on August 11, 1993 from the South of France (…) Our present observations suggest a **lower limit of M_v –10** ± 1 for a fireball to produce a VLF signal.

➢ 1998: Garaj, Zgrablic et al.

• « (…) **a positive signal** which consists of a sequence of sharp, short VLF bursts, coincident with the appearance of meteor that was recorded by the video camera. »

• « (…) first instrumental detection of electrophonic sounds obtained during the observation of 1998 Leonids from Mongolia. Two Leonid fireballs of brightness -6.5^m and -12^m produced short, low-frequency sounds, which were simultaneously recorded by microphones in a special setup and heard by different observers. Simultaneous measurements of electromagnetic ELF/VLF radiation above 500 Hz did not reveal any signal correlated to the electrophonic event »

- 1998: D. Vinkovic, S. Garaj et al.

Global Electrophonic Fireball Survey

« The GEFS reports show that such low brightness electrophonic meteors (dimmer than -7m) really exist and represent a large fraction of the electrophonic sound events; moreover, they can produce sustained sounds instead of only transient sounds »

➢ 2000: C.Price, M. Blum

• Continuous measurements of low frequency EM waves were performed during the 1999 Leonids in the Neguev desert.

• Up to 15000 pulses per hour during the 1999 Leonids peak, centered on 300 Hz, 10 mS duration

➢ 2001: R. Trautner, D. Koschny et al.

- ULF monitoring (in the Schuman resonance frequency range) in Australia during the ESA 2001 Leonids campaign
- « Remarkable increase of the electrical field on 14,8, 21,5, 59,2 and 140 Hz close to the shower peak »
- May be also two other peaks 4h before and after the main shower

The present work consists in detecting and analysing any low frequency radio events occuring during meteor events

Global Electrophonic Fireball Survey
(D. Vinkovic et al. 1998)

sound type	rate	sound description
		classification according to Keay (1993b)
smooth	40.5%	hissing, buzzing, whuss, whoosh, fizzing, bottle rocket, sjhh, pchiu, steam escaping from cooker, sss, swishing, voom, high-pitched whistle, whispering, sheewu
staccato	47.0%	rustling, crackling, wood burning, phtt - like electric arc, sizzling, white noise, shaking bulb with broken filament, zzz, firework, frying bacon, tzz, foam being ripped, like static, lit match, thrumming, small single engine 'Cesna' airplane, butter in hot pan, hot metal in water, cards being shuffled, ice breaking up, electric flutter
sharp	12.5%	pop, thwuck, tic, boom, whump, clap, kweik
		classification according to our study
vibration	51.3%	hissing, buzzing, fizzing, whuss, pop, thwuck, sjhh, tzz, bottle rocket, shaking bulb with broken filament, sss, tic, steam escaping from cooker high-pitched whistle, swishing, small single engine 'Cesna' airplane, whispering, thrumming, boom, whump, voom, sheewu, clap, kweik
discharge	48.7%	rustling, sizzling, whoosh, crackling, white noise, 'htt - like electric arc wood burning, firework, frying bacon, zzz, pchiu, foam being ripped, lit match, butter in hot pan, like static, hot metal in water, cards being shuffled, ice breaking up, electric flutter

Trying to find correlations between meteor optical observations and VLF records is a solution …

...but a VHF bistatic radar system is a more sensitive tool for detecting meteors than visual or video observations.

And such a system is able to work 24h a day, with no disturbances from the rain, from the Sun, from the Moon, from the clouds, etc …

The more VHF pings and the more VLF noises :

➔the more chances to detect a possible correlation

Principle:

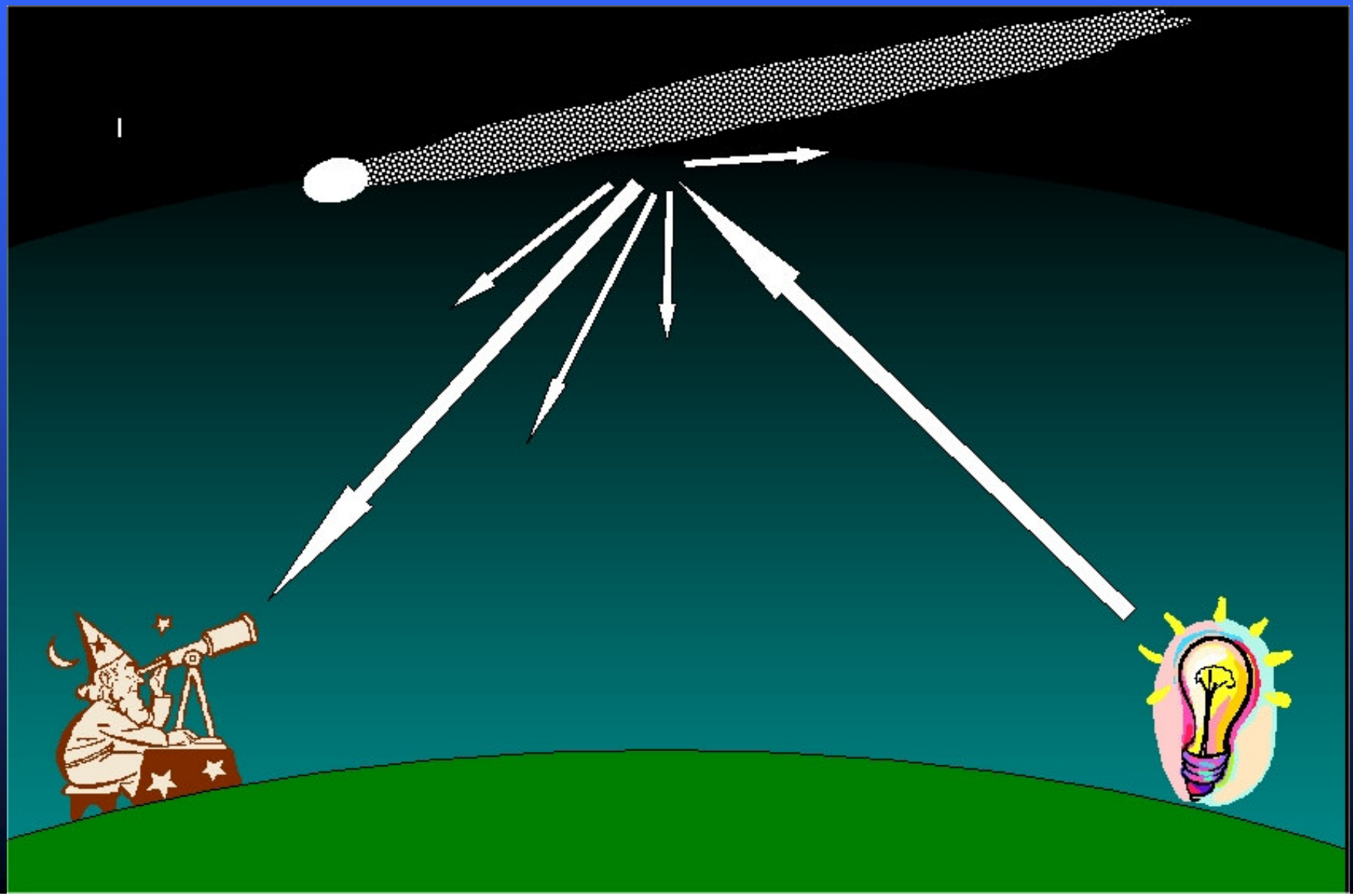
Simultaneous observation

of forward-scatter meteor echoes

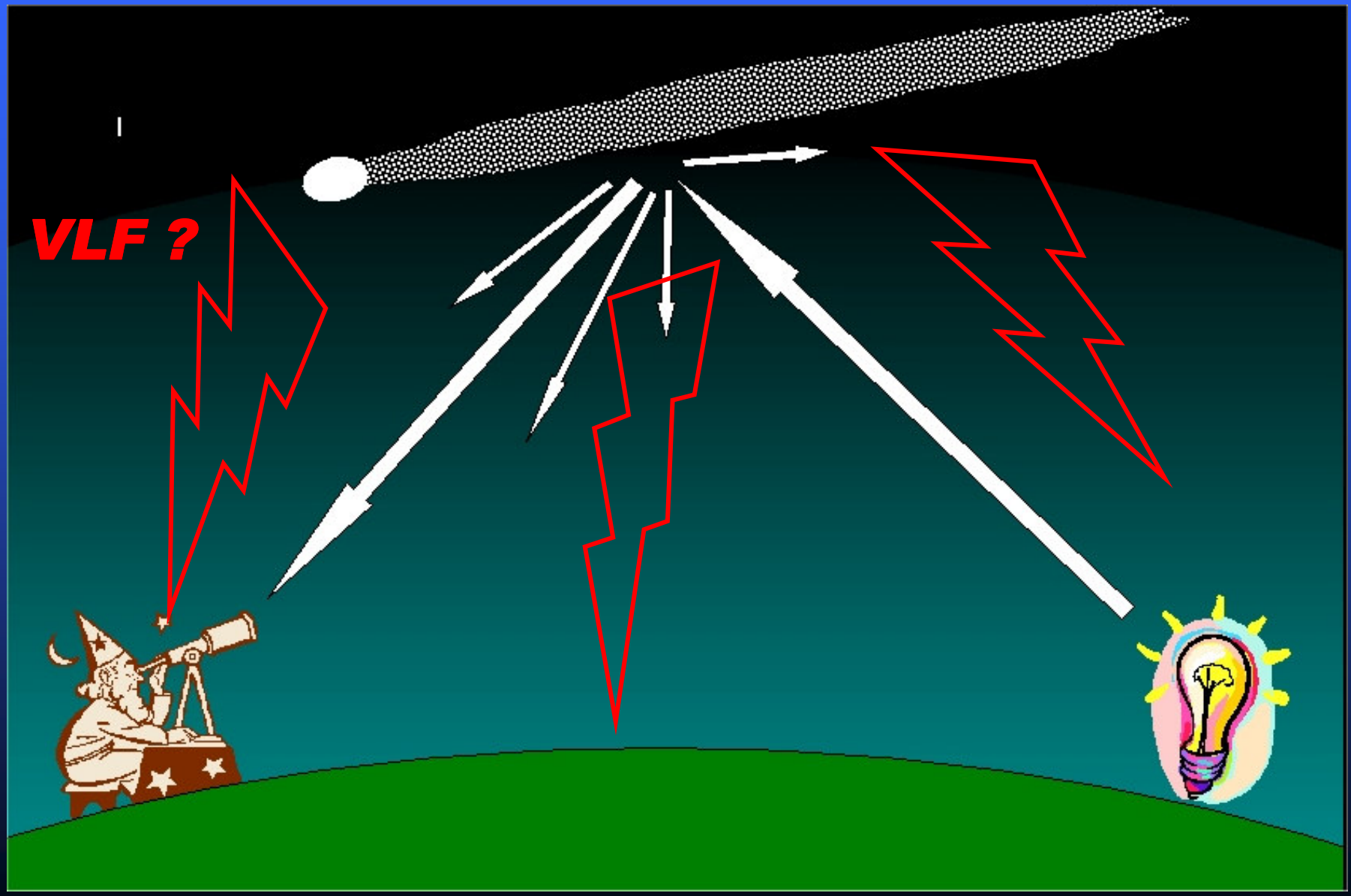
AND

of potential meteors VLF radiation

Forward scatter (bistatic) mode



Radiated VLF by trail and/or meteor head ?

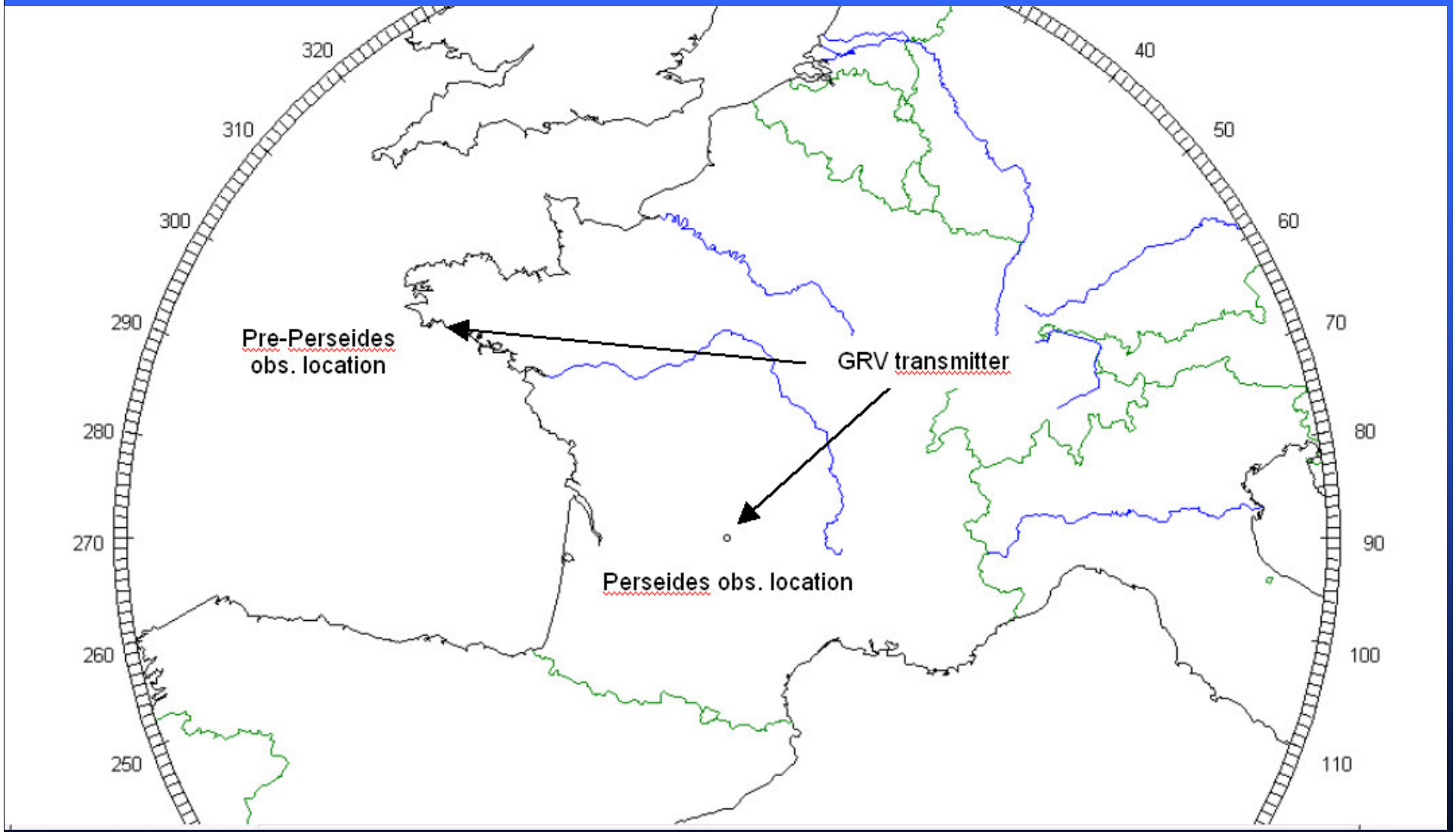


Meteors/VLF experiment

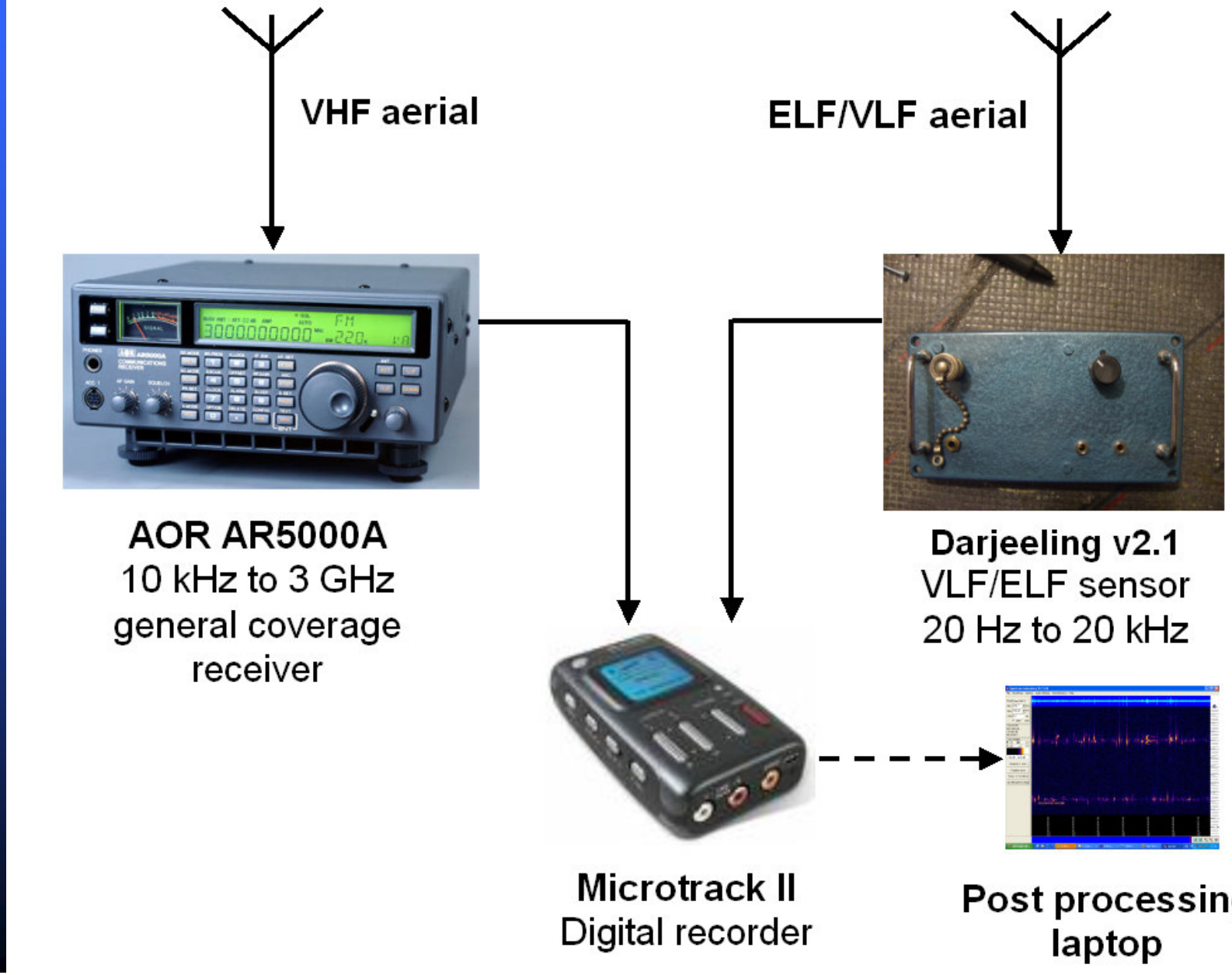
Perseids 2009

Britanny & Auvergne

Perseids 2009 observation locations

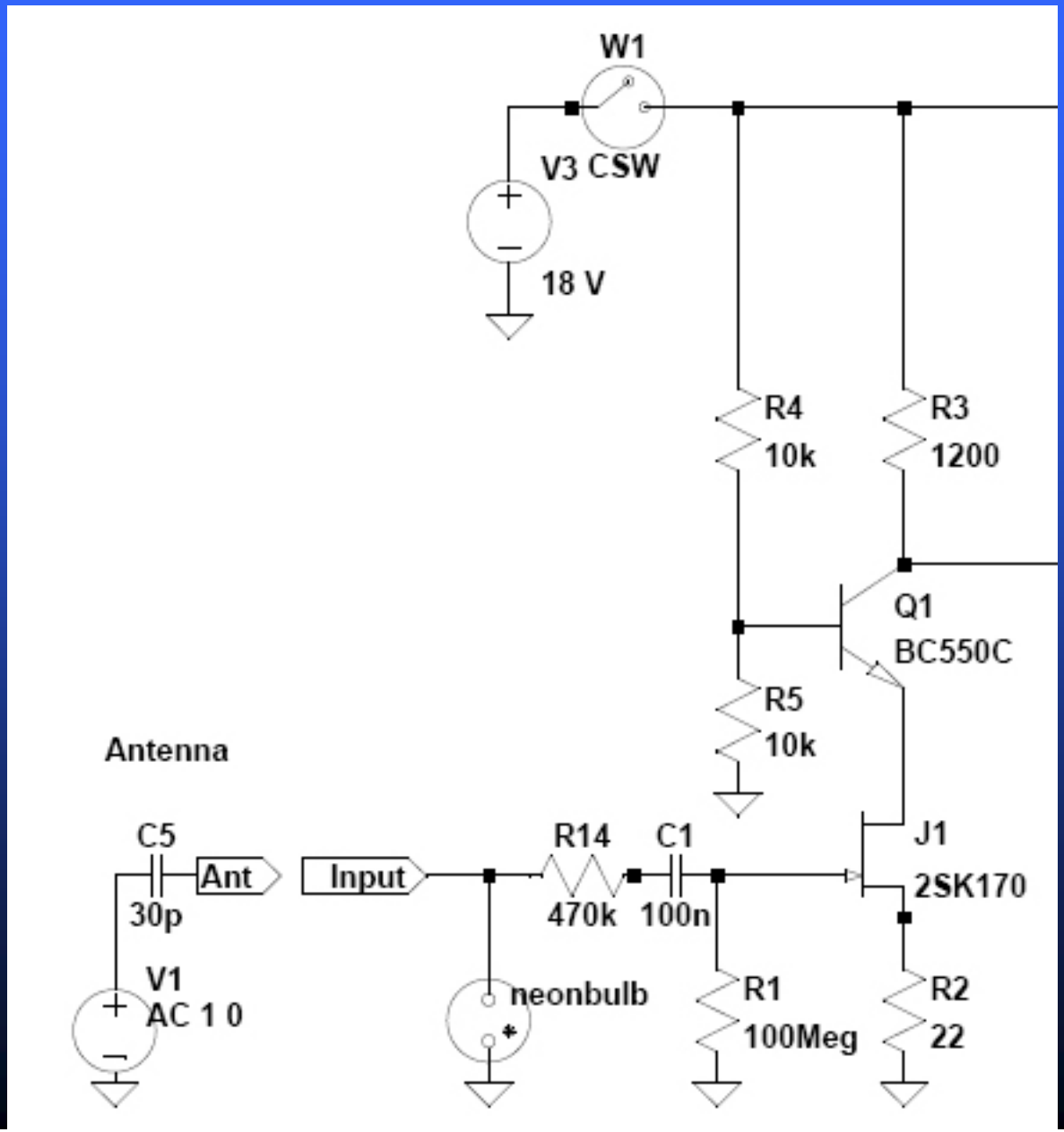


Experimental set-up for the 2009 campaigns



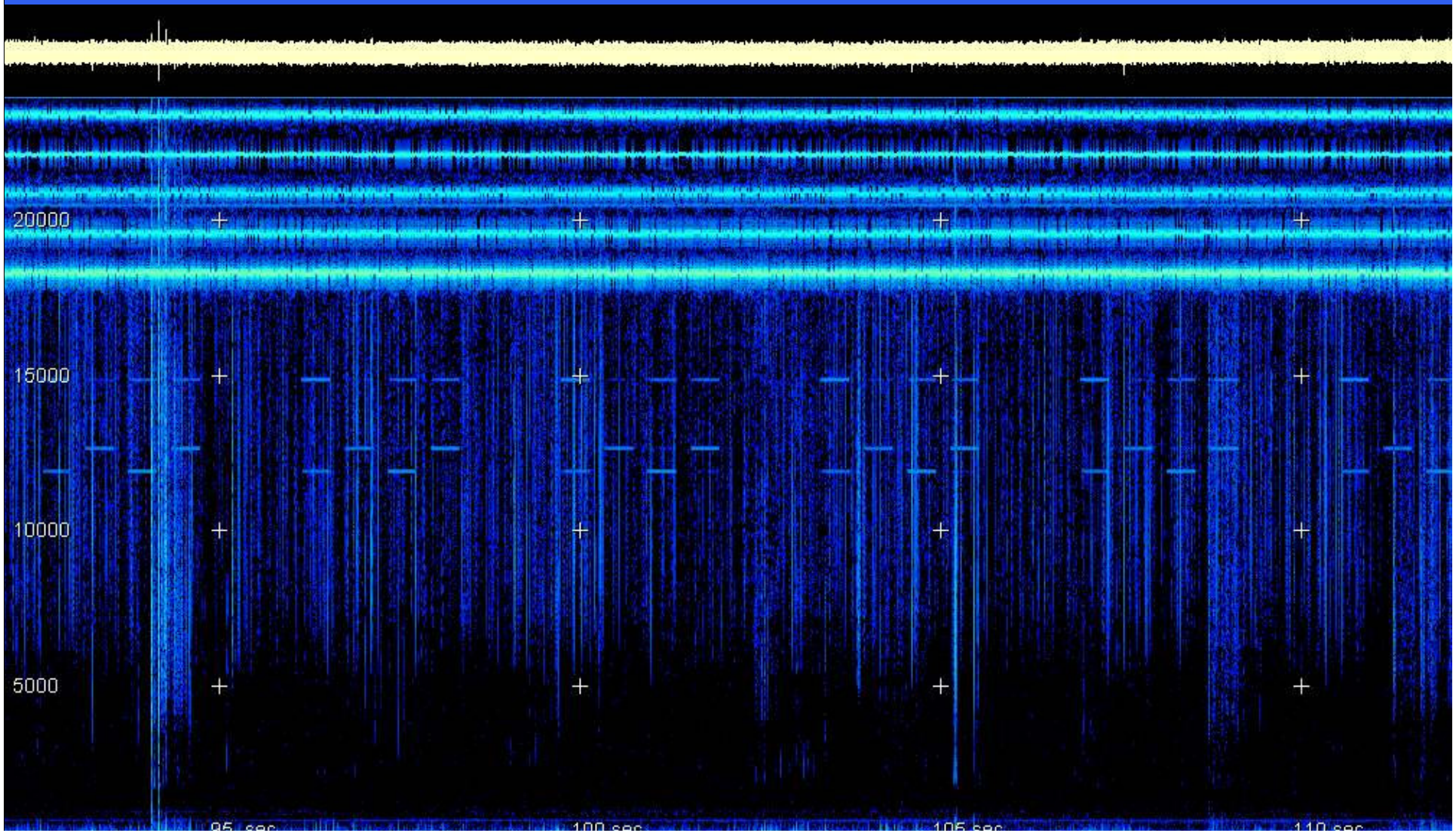
Experimental set-up for the 2009 campaigns

ELF/VLF receiver front end

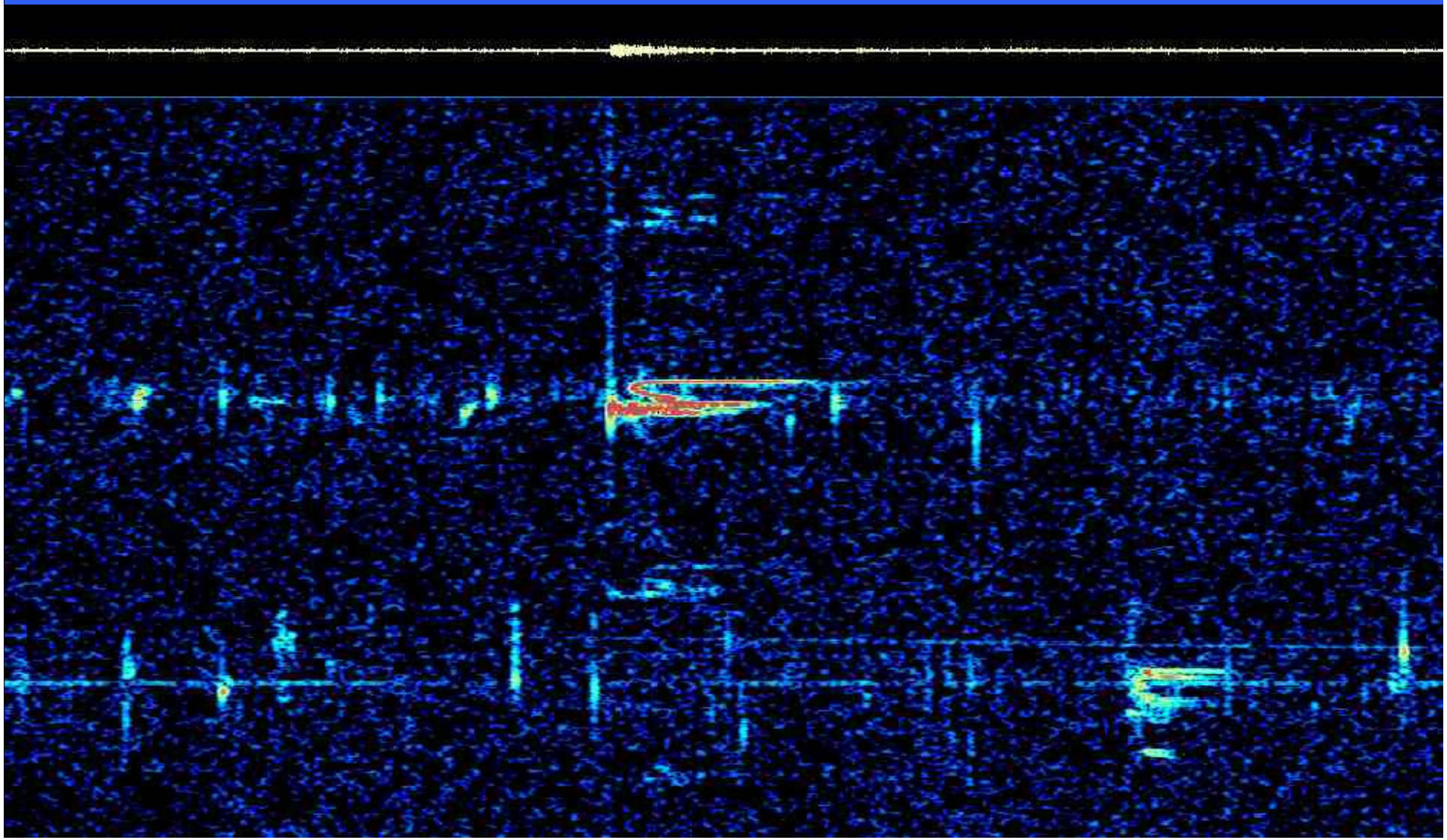


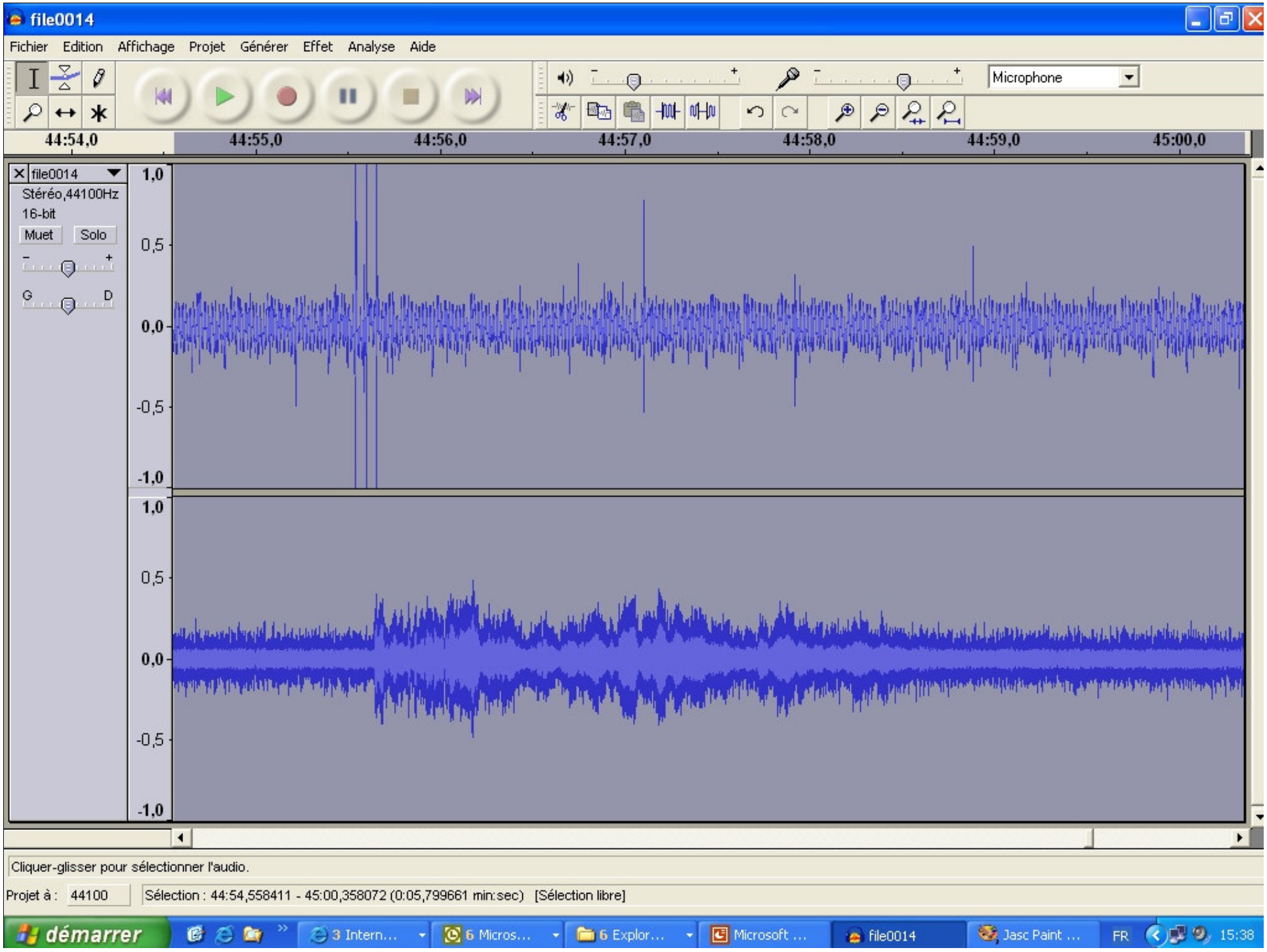
Yelc’h hill, Menez-Hom, 6 august 2009

Overview of the 5 Hz to 24 kHz low frequency band



Typical forward scatter meteor echoes

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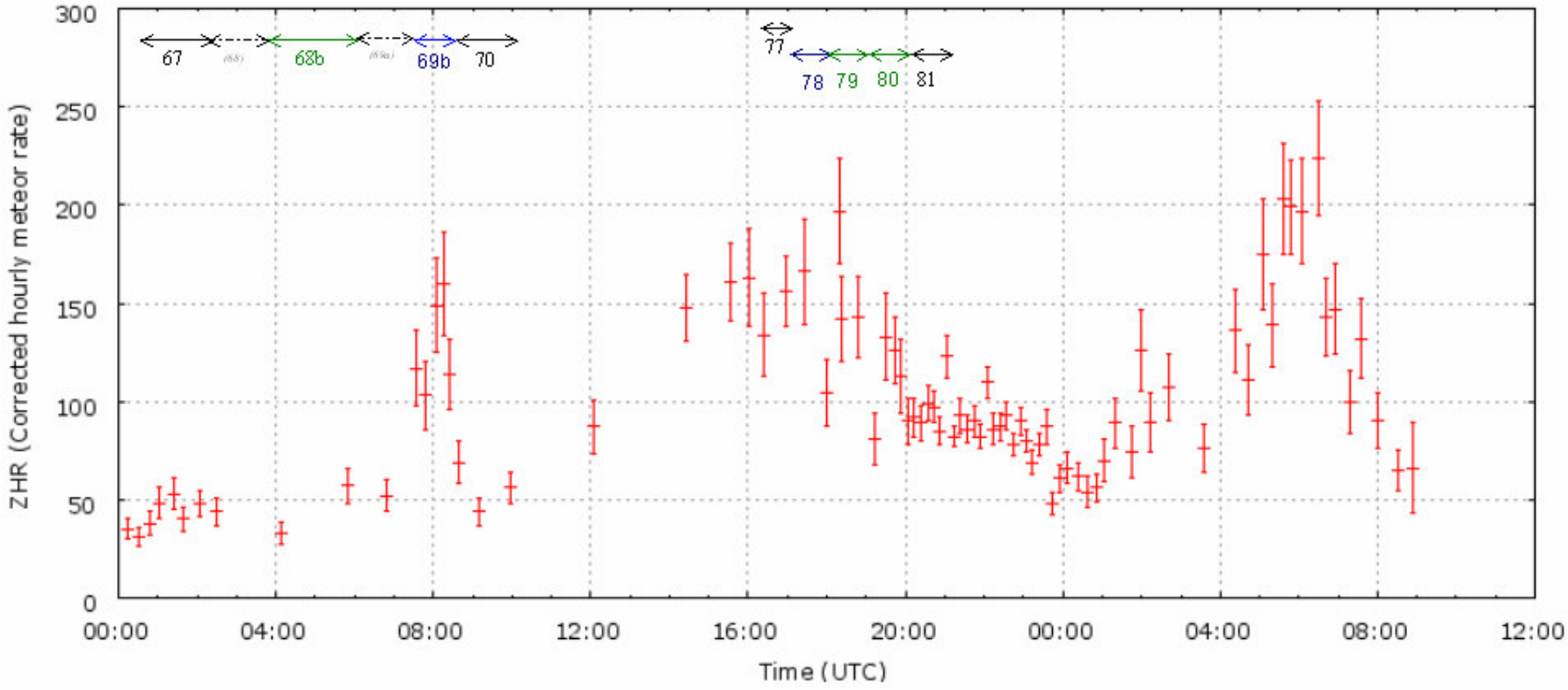
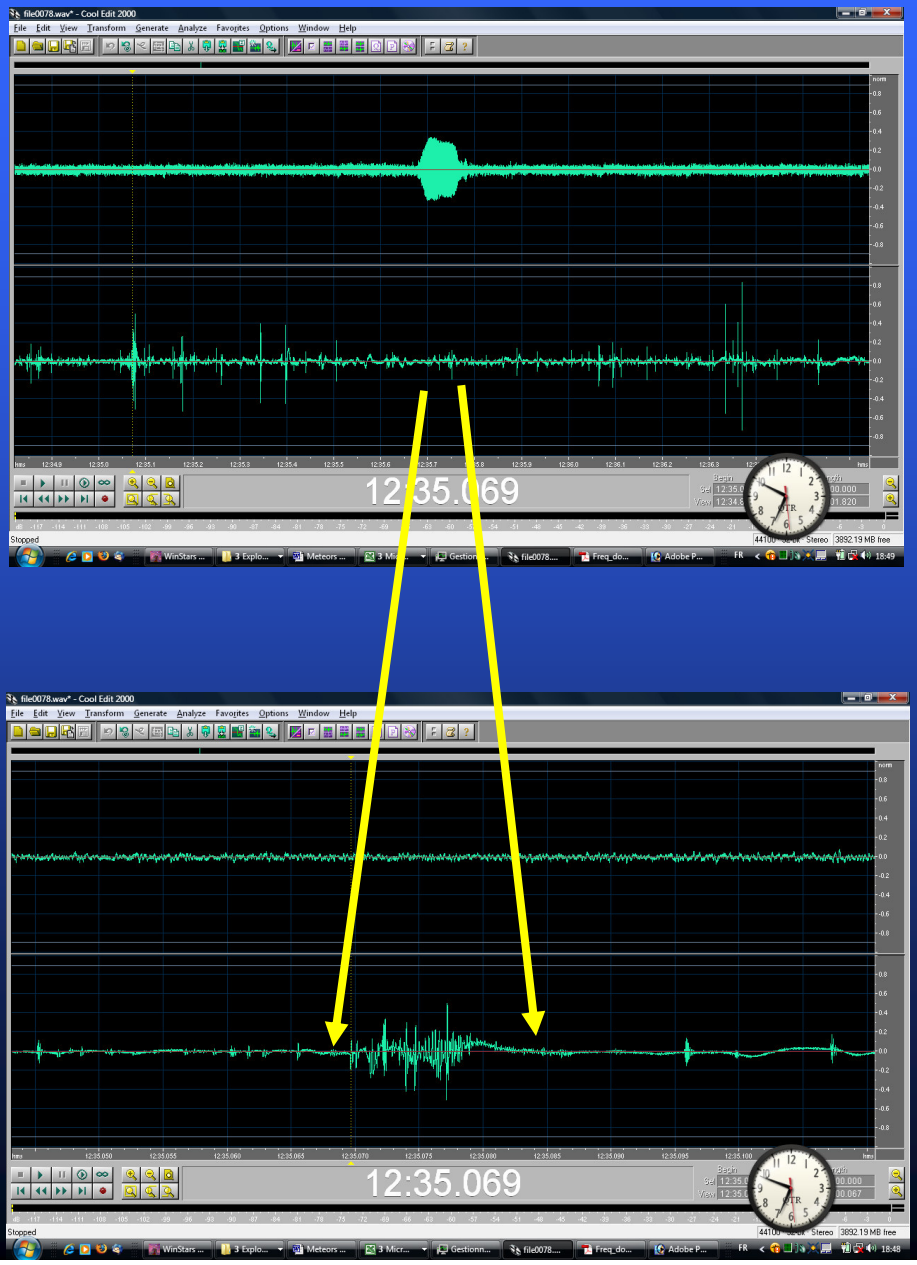
Preliminary results

of the Perseids 2009 campaign

Observation periods



Some examples of ELF/VLF meteor candidates



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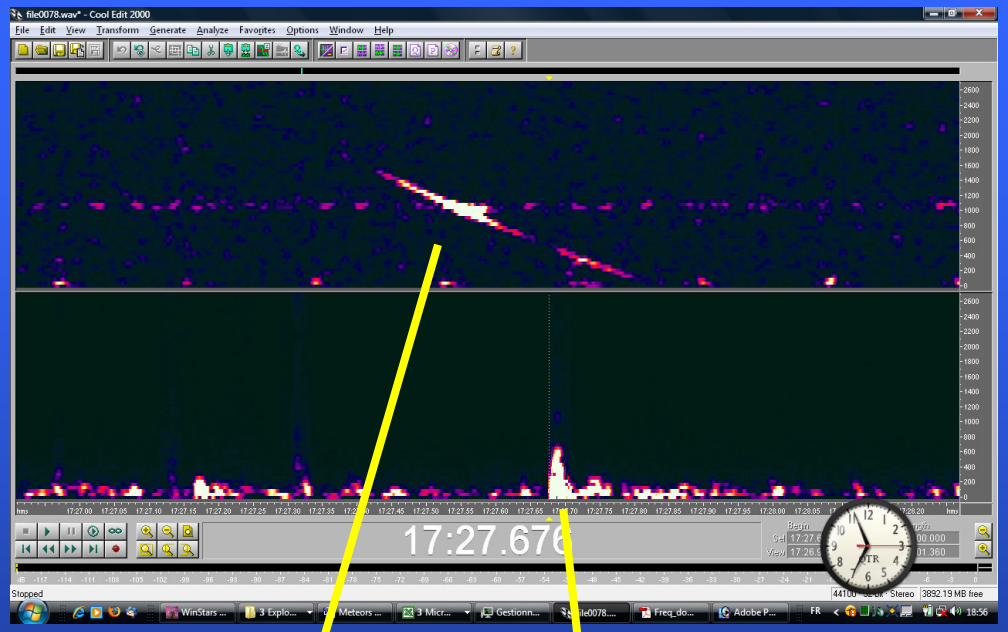

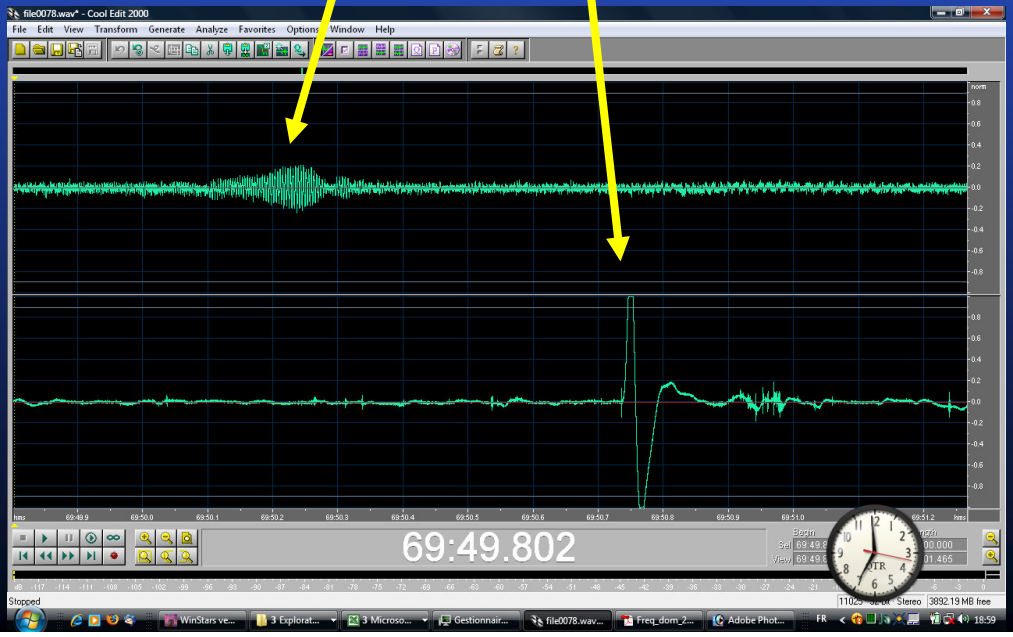

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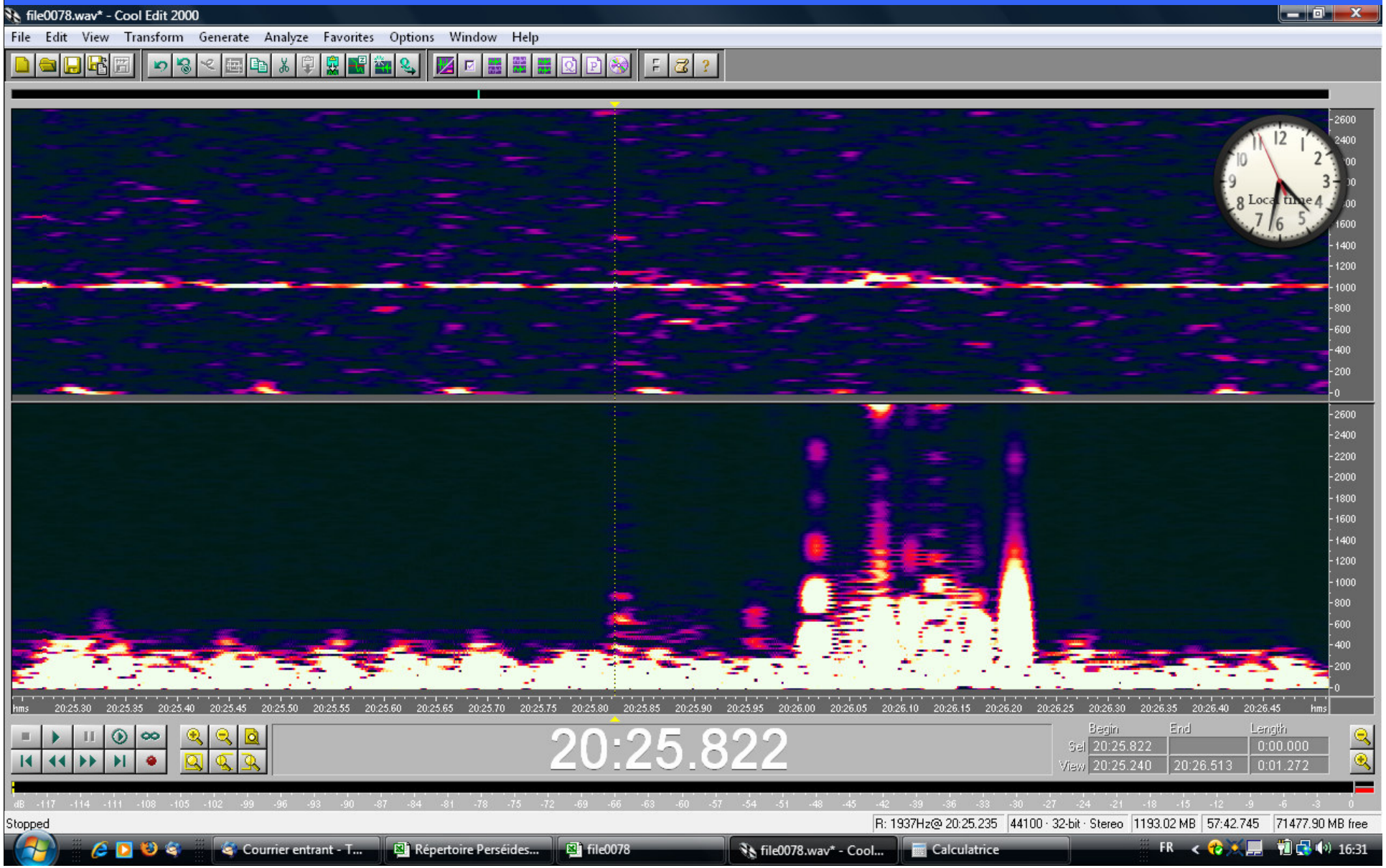

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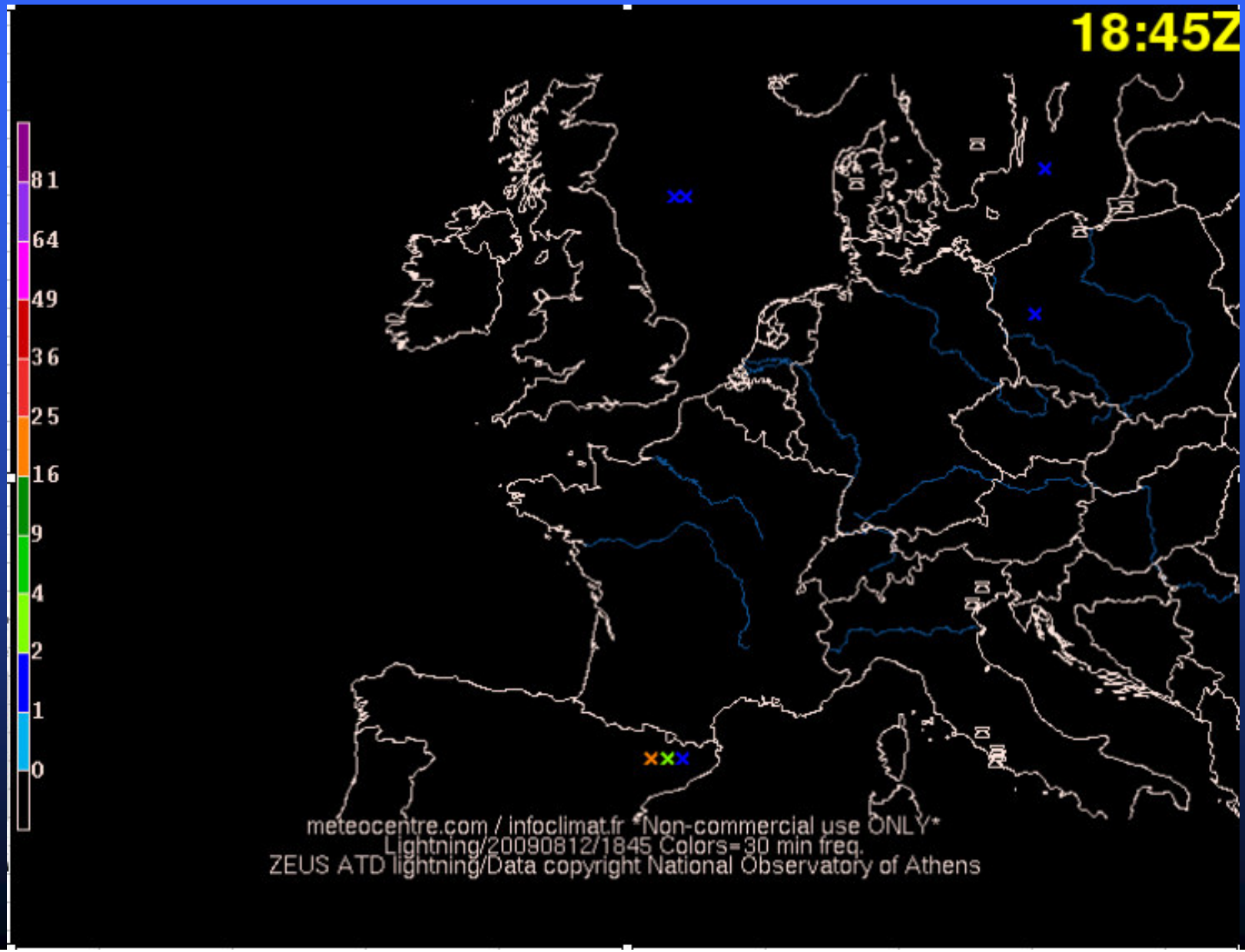

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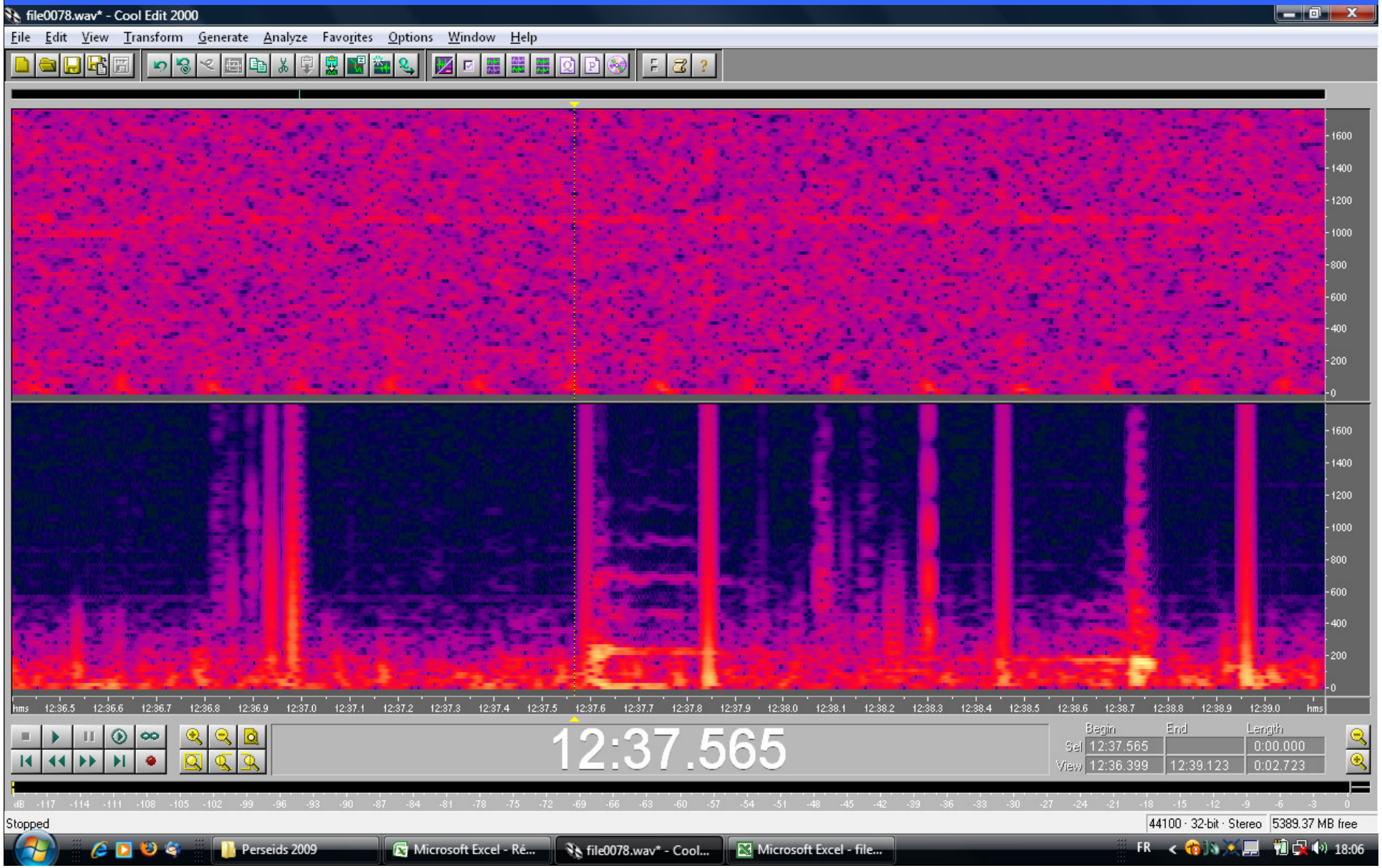

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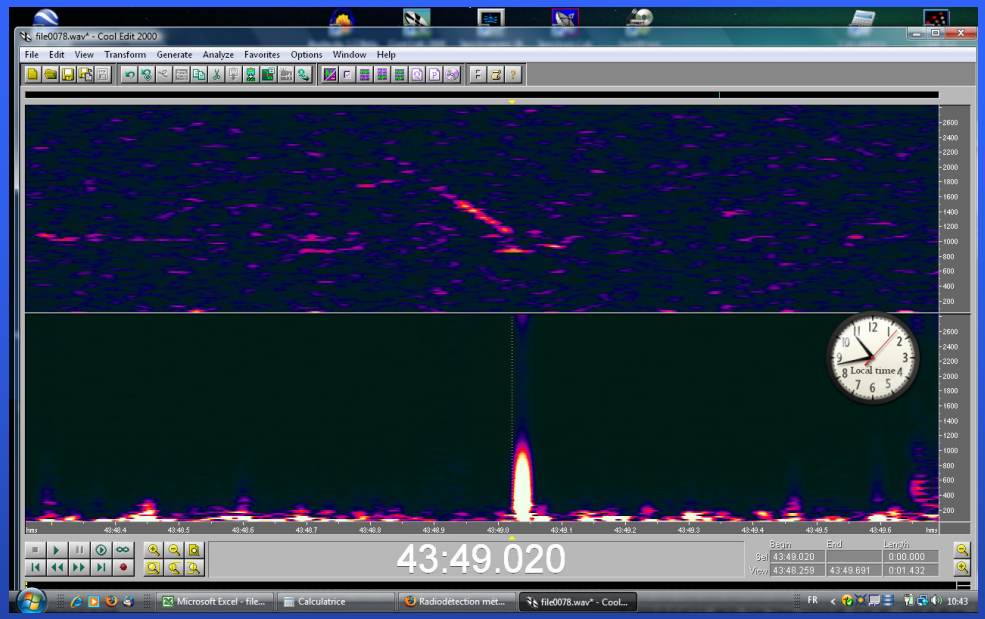

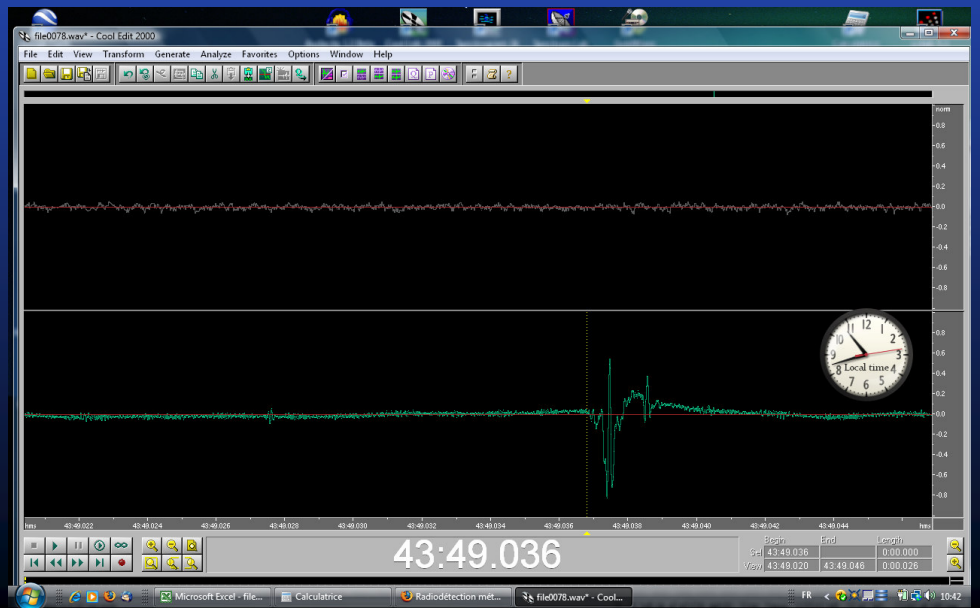

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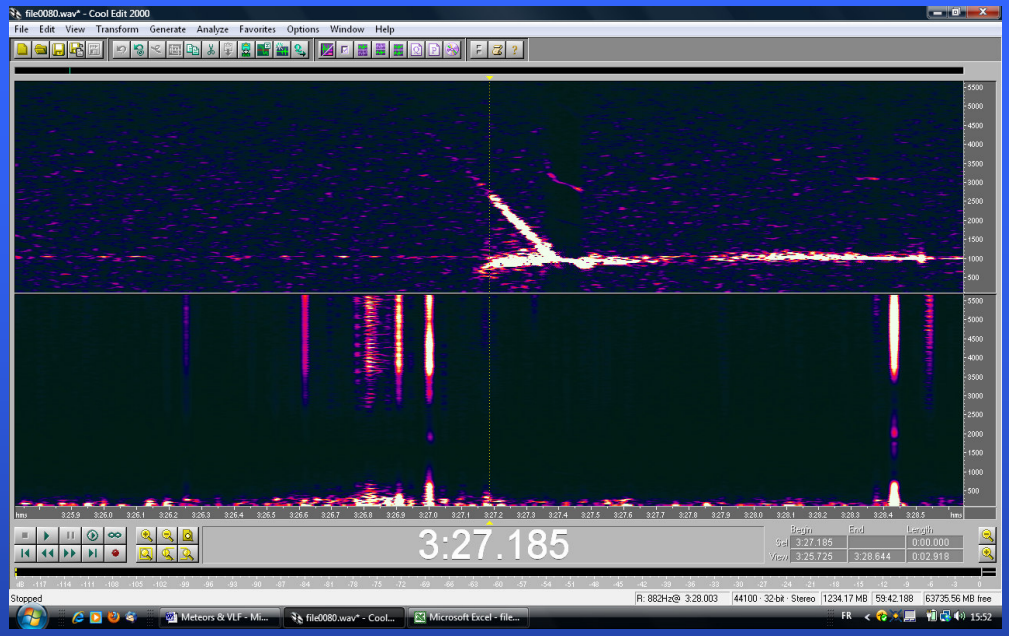

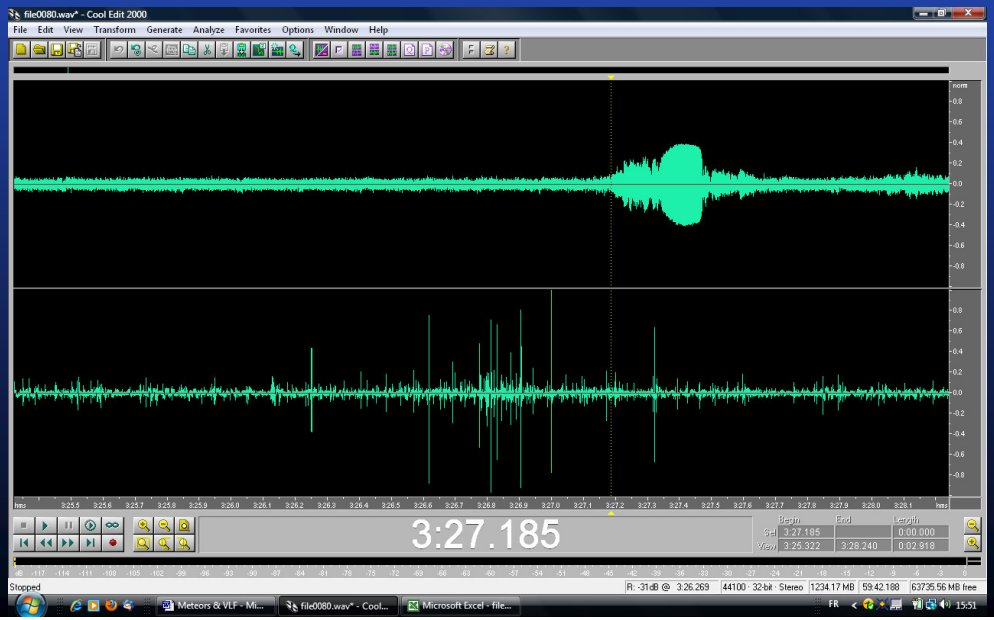

Meteor VHF echoes sorted by type

File	\	__	=__	-----	====	Misc	Total
40	6	15	0	13	2	2	38
42	4	14	0	9	7	3	37
68b	8	12	0	10	3	5	38
69b	131	37	0	21	5	28	222
78	34	4	2	26	1	33	100
79	4	1	1	2	2	5	15
80	5	3	7	1	2	5	23
81	10	2	2	2	5	6	27
Total	202	88	12	84	27	87	500

Low frequency events sorted by type

File	ELF	VLF	Spikes	Tweek	Misc	Total
40	7	1	12	1	1	22
42	7	3	11	0	3	24
68b	2	0	11	2	7	22
69b	9	5	24	0	11	49
78	5	2	4	0	13	24
79	1	0	6	0	2	9
80	1	0	6	0	4	11
81	2	0	8	0	3	13
Total	34	11	82	3	44	174

Any questions ?

Thanks for your attention