Open Source Software for loudness measurement

Manuel Naudin

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Welcome !

Manuel Naudin

- Projects Manager at France Télévisions, the french public television broadcaster.
- Working on loudness since 2011 (E.B.U PLOUD, French Working Group on Delivery Specs, tools specifications, employees training).

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What is loudness measurement ?

- A standardized way to measure perceived loudness of audio content.
- Defined by I.T.U and E.B.U in open standards.
- Uses filtering, weighting and integration to produce the results.
- Produces 2 dynamic meters and 3 program descriptors.

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Momentary & Short-Term Loudness

- Dynamic indicators.
- **momentary loudness** is measured on a 400 ms sliding window.
- **short-term loudness** is measured on a 3 s sliding window.
- Mostly used in production.

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Integrated Loudness

- **integrated loudness** is the average loudness of a complete program.
- It is expressed in LUFS.
- E.B.U R128 target level : -23 LUFS

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Loudness Range

- **loudness range** is a statistical measure of the loudness levels distribution in a program. (Evaluation of the dynamic of the program).
- It is expressed in LU.
- 20 LU is considered as the maximum loudness range fit for TV broadcasting.

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True-Peaks

- **true-peaks** are the intersample audio peaks.
- It is expressed in dBTP.
- true-peaks $\neq$ sample peaks.
- To be taken into account at D/A stage and lossy encoding.

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Why should you measure loudness ?

- Because of delivery specs or legal constraints.
- To offer a smooth audio experience to your audience.
- To check maximum true-peaks before encoding or broadcasting.

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Software usage context

- Realtime or file-based measure.
- Production metering or conformance checking.
- D.A.W plugin or standalone.
- Demux audio data from container.
- Automated workflow.

Software functionalities

- Integrated loudness, loudness range, max true-peaks.
- Logging, plotting, metadata edition/insertion.
- Audio processing (loudness alignment).

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libebur128

- Homepage : https://github.com/jiixyj/libebur128
- Licence : Expat (see http://directory.fsf.org/wiki/License:Expat).
- CMake build system.

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libebur128, the library

- It's a C library.
- Easy portability.
- Simple API
- Requires libspeexdsp to measure true-peaks.

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libebur128, the loudness scanner

- *The scanner needs Glib, GTK and taglib. There is input support for gstreamer, libsndfile, libmpg123, FFmpeg and libmpcdec.*
- Measure of various multimedia file formats/codecs.
- Integrated loudness, loudness range and max true-peak descriptors.
- Logging of momentary or short-term loudness.
- ReplayGain tagging.

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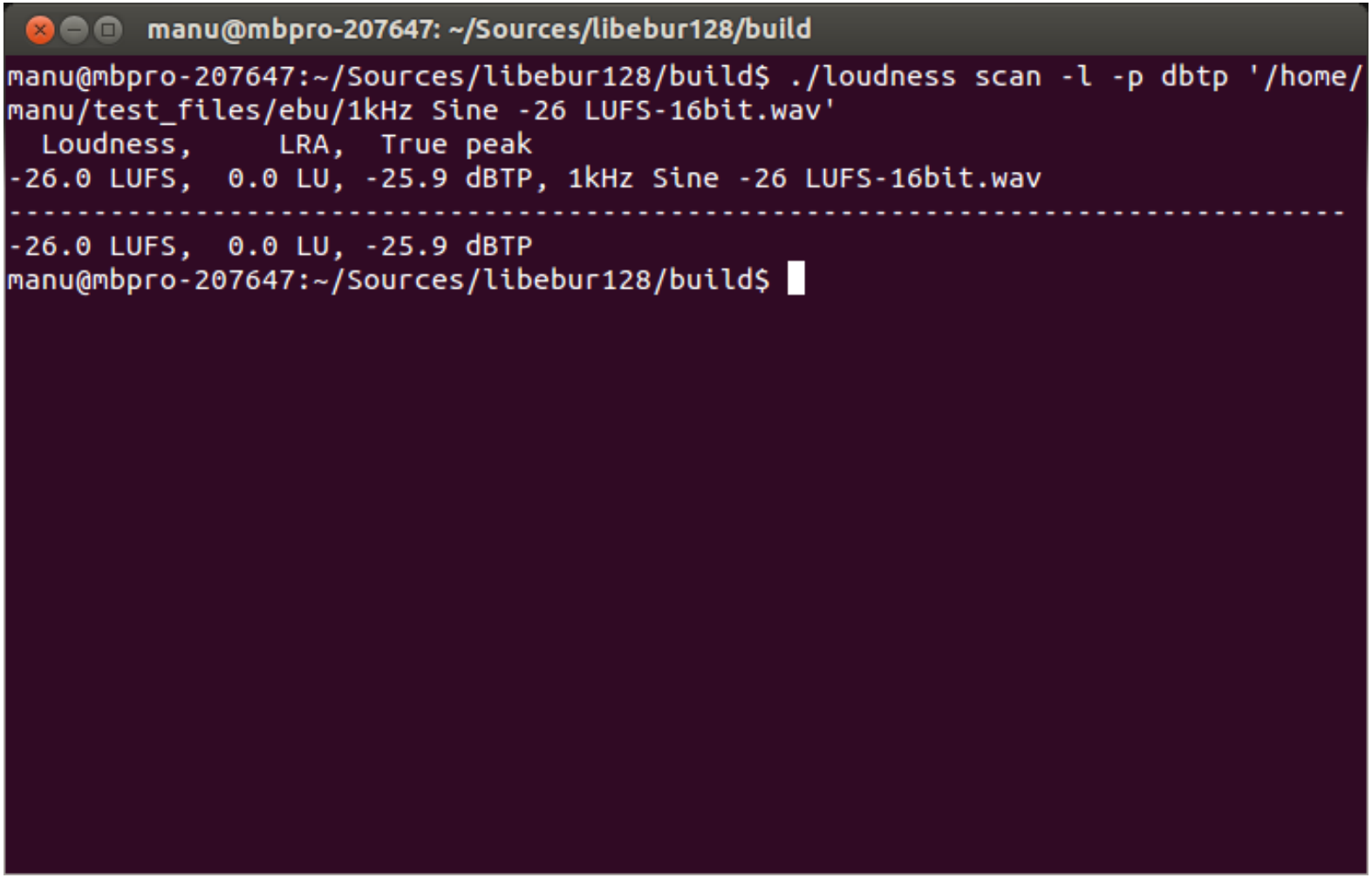

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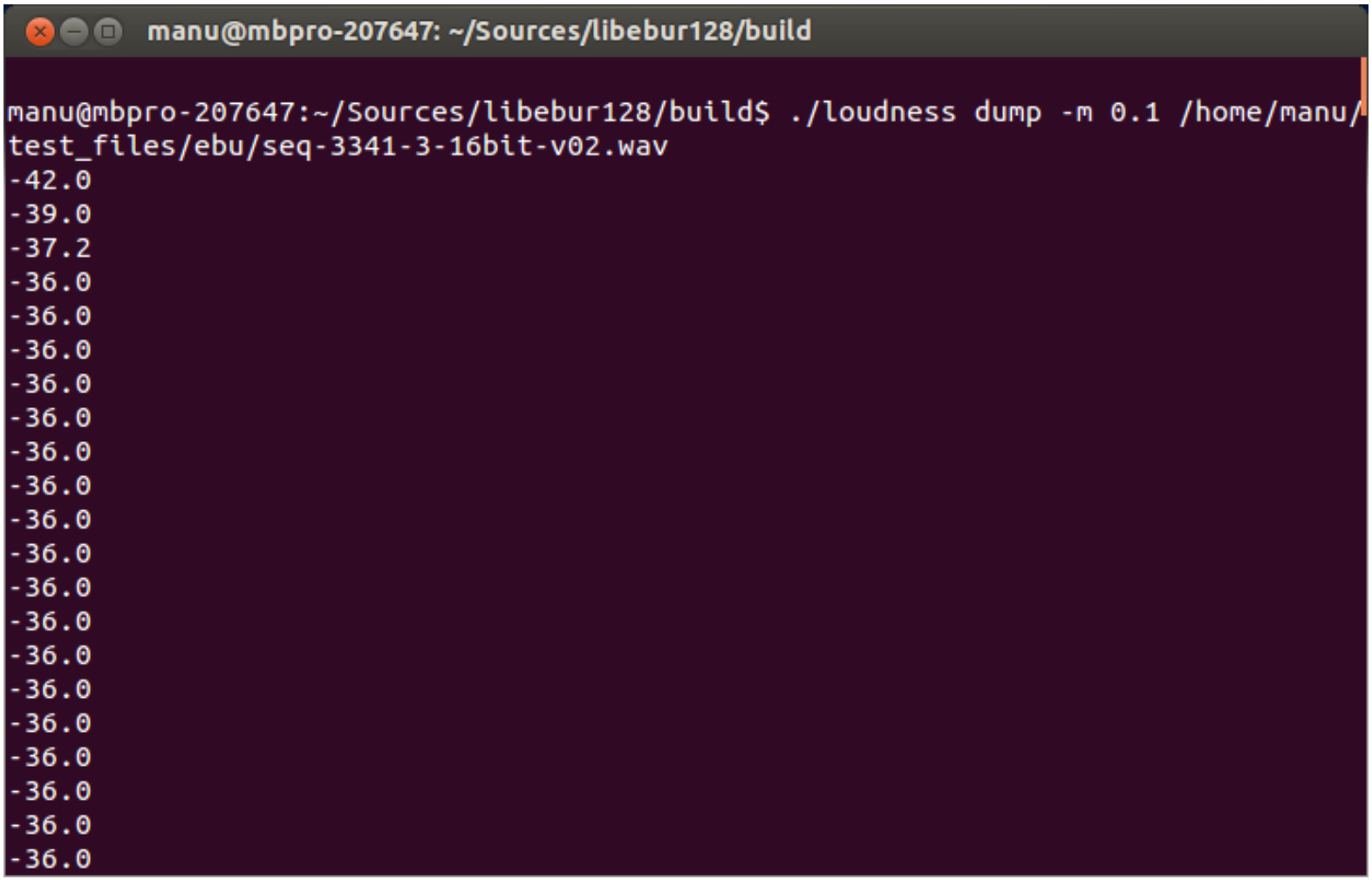

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FFmpeg

- Homepage : http://www.ffmpeg.org/
- Licence : GPL/LGPL (see http://www.ffmpeg.org/legal.html).
- Autotools build system, or thru packages.

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FFmpeg, the libavfilter library

- The ebur128 filter is part of libavfilter.
- Part of the libav* libraries.
- Complex API.
- Implemented only for 48 kHz sampling rate. Other input sampling rates must be resampled.

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FFmpeg, the ffmpeg executable

- Measure of various multimedia file formats/codecs.
- Integrated loudness and loudness range descriptors.
- Logging of momentary and short-term loudness.
- Real-time short-term loudness plotting and momentary loudness bargraph.

```
manu@mbpro-207647: ~
manu@mbpro-207647:~$ ffmpeg -nostats -i /home/manu/test_files/ebu/seq-3341-3-16b
it-v02.wav -filter_complex ebur128 -f null -
ffmpeg version git-2013-06-21-5d509fb Copyright (c) 2000-2013 the FFmpeg develop
ers
  built on Jun 21 2013 11:12:07 with gcc 4.6 (Ubuntu/Linaro 4.6.3-1ubuntu5)
  configuration: --prefix=/home/manu/ffmpeg_build --extra-cflags=-I/home/manu/ff
mpeg_build/include --extra-ldflags=-L/home/manu/ffmpeg_build/lib --bindir=/home/
manu/bin --extra-libs=-ldl --enable-gpl --enable-nonfree --enable-x11grab
  libavutil      52. 37.101 / 52. 37.101
  libavcodec     55. 16.100 / 55. 16.100
  libavformat    55.  9.100 / 55.  9.100
  libavdevice    55.  2.100 / 55.  2.100
  libavfilter     3. 77.101 /  3. 77.101
  libswscale      2.  3.100 /  2.  3.100
  libswresample   0. 17.102 /  0. 17.102
  libpostproc    52.  3.100 / 52.  3.100
[wav @ 0x1a86960] max_analyze_duration 5000000 reached at 5013333 microseconds
Guessed Channel Layout for  Input Stream #0.0 : stereo
Input #0, wav, from '/home/manu/test_files/ebu/seq-3341-3-16bit-v02.wav':
  Duration: 00:01:20.00, bitrate: 1536 kb/s
    Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 48000 Hz, stereo, s16
, 1536 kb/s
Output #0, null, to 'pipe:':
  Metadata:
```

```
manu@mbpro-207647: ~
     LRA:   13.0 LU
[Parsed_ebur128_0 @ 0x1a97740] t: 79.7       M: -36.0 S: -36.0     I: -23.0 LUFS
     LRA:   13.0 LU
[Parsed_ebur128_0 @ 0x1a97740] t: 79.8       M: -36.0 S: -36.0     I: -23.0 LUFS
     LRA:   13.0 LU
[Parsed_ebur128_0 @ 0x1a97740] t: 79.9       M: -36.0 S: -36.0     I: -23.0 LUFS
     LRA:   13.0 LU
[Parsed_ebur128_0 @ 0x1a97740] t: 80         M: -36.0 S: -36.0     I: -23.0 LUFS
     LRA:   13.0 LU
size=N/A time=00:01:20.00 bitrate=N/A
video:0kB audio:15000kB subtitle:0 global headers:0kB muxing overhead -100.00014
3%
[Parsed_ebur128_0 @ 0x1a97740] Summary:

  Integrated loudness:
    I:         -23.0 LUFS
    Threshold: -34.2 LUFS

  Loudness range:
    LRA:        13.0 LU
    Threshold: -44.0 LUFS
    LRA low:   -36.0 LUFS
    LRA high:  -23.0 LUFS
manu@mbpro-207647:~$
```

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```
manu@mbpro-207647: ~
manu@mbpro-207647:~$ ffplay -f lavfi -i "amovie=/home/manu/test_files/ebu/seq-33
41-3-16bit-v02.wav,ebur128=video=1:meter=9 [out0][out1]"
ffplay version git-2013-06-21-5d509fb Copyright (c) 2003-2013 the FFmpeg develop
ers
  built on Jun 21 2013 11:12:07 with gcc 4.6 (Ubuntu/Linaro 4.6.3-1ubuntu5)
  configuration: --prefix=/home/manu/ffmpeg_build --extra-cflags=-I/home/manu/ff
mpeg_build/include --extra-ldflags=-L/home/manu/ffmpeg_build/lib --bindir=/home/
manu/bin --extra-libs=-ldl --enable-gpl --enable-nonfree --enable-x11grab
  libavutil      52. 37.101 / 52. 37.101
  libavcodec     55. 16.100 / 55. 16.100
  libavformat    55.  9.100 / 55.  9.100
  libavdevice    55.  2.100 / 55.  2.100
  libavfilter     3. 77.101 /  3. 77.101
  libswscale      2.  3.100 /  2.  3.100
  libswresample   0. 17.102 /  0. 17.102
  libpostproc    52.  3.100 / 52.  3.100
max_analyze_duration 5000000 reached at 5013333 microsecondsf=0/0
[Parsed_amovie_0 @ 0x7f4140003260] Channel layout is not set in output stream 0,
 guessed channel layout is 'stereo'
Input #0, lavfi, from 'amovie=/home/manu/test_files/ebu/seq-3341-3-16bit-v02.wav
,ebur128=video=1:meter=9 [out0][out1]':
  Duration: N/A, start: 0.000000, bitrate: 6144 kb/s
    Stream #0:0: Video: rawvideo (RGB[24] / 0x18424752), rgb24, 640x480 [SAR 1:1
 DAR 4:3], 10 tbr, 48k tbn, 48k tbc
```

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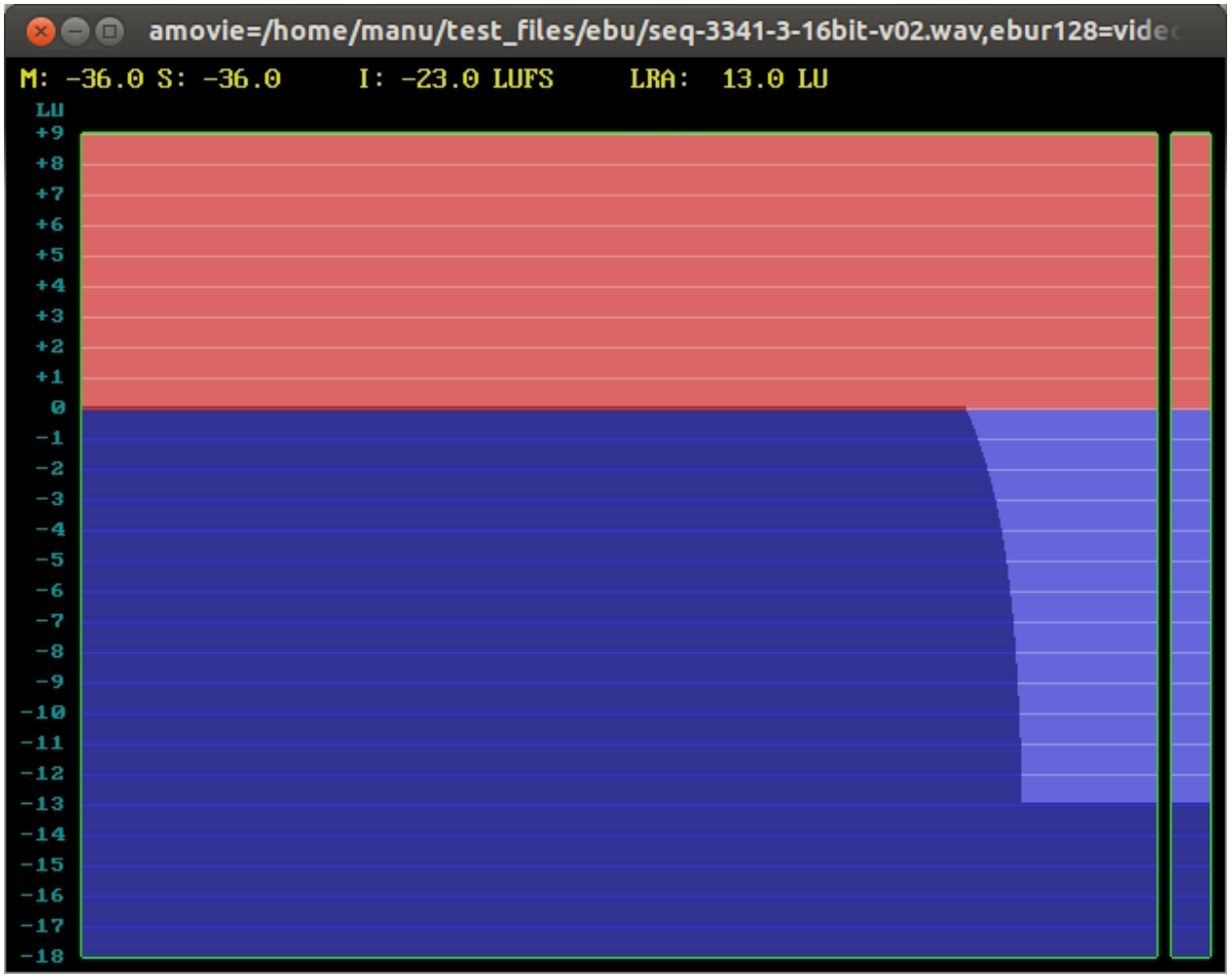

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freelcs

- Homepage : http://sourceforge.net/projects/freelcs/
- Licence : GPL.
- Python3 script to install on Ubuntu 12.04.

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freelcs

- *FreeLCS allows you to build a server that automatically measures and corrects audio loudness according to EBU R128 standard of audio files transferred to it.*
- freelcs uses libebur128, gnuplot, sox, media info and (optionally) FFmpeg.
- Drop your files in the HotFolder, freelcs will measure, create a graphic plot, and correct.
- The HotFolder can be shared on the network thru Samba.
- Status monitoring by e-mail and web browser.

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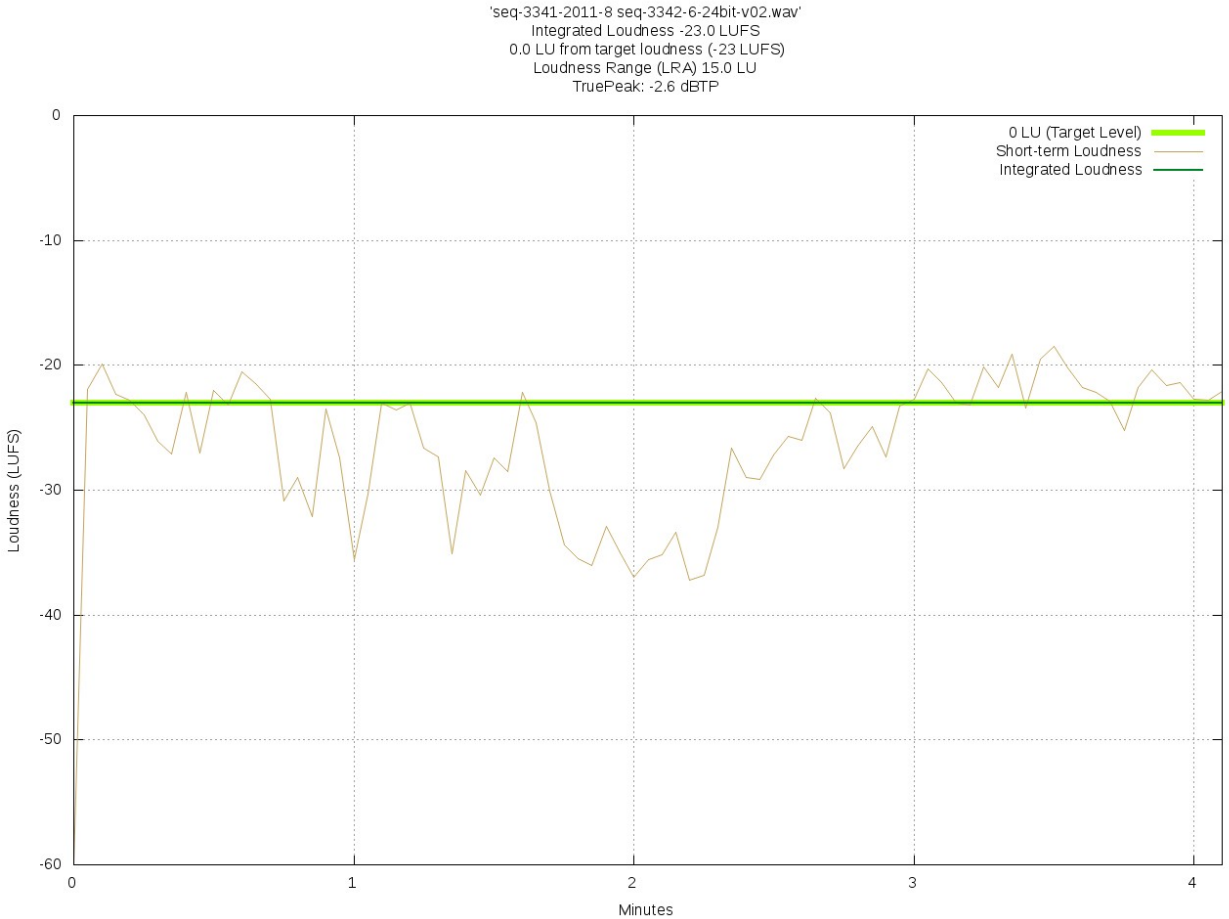

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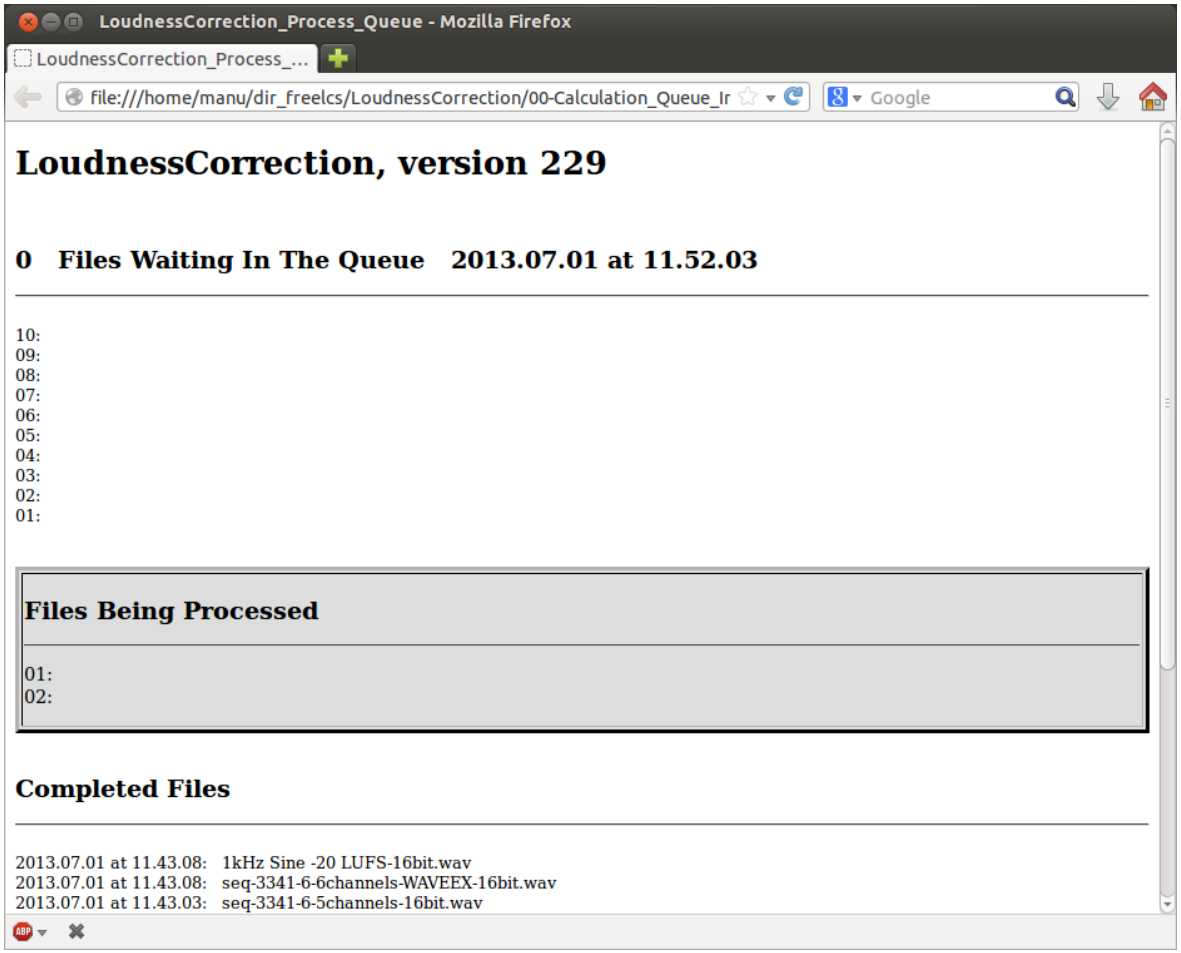

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Conformance Checking

- 2 sets of audio files for integrated loudness and loudness range conformance checking : *E.B.U loudness test set v3* and *Compliance material for Recommendation ITU-R BS.1770*.
- libebur128 and FFmpeg pass successfully !
- Unfortunately, there's no true-peak conformance test endorsed by I.T.U.

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Table

software	IL	LRA	MAX TP	MOM	SHORT	CORR.
libebur128	x	x	x	x	x	-
FFmpeg	x	x	-	x	x	-
freelcs	x	x	x	-	-	x

Performance on a 4'30" .mp4 file with AAC-LC 64 Kbps 48 kHz stereo audio stream.
libebur128 (with true-peak and loudness range) : $\simeq$ 10 s.
libebur128 (with loudness range) : $\simeq$ 4 4.
ffmpeg (with momentary and short-term dump) : $\simeq$ 5".

Wrap Up

- There are several open source solutions available for loudness measurement.
- They are mostly fit for file-based measurement.
- To use them in an automated workflow requires some development.
- Plugins ?

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Thank You

Questions ?

Contact : manuel.naudin@francetv.fr

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