Question(s):	2	**Meeting, date:**	VQEG meeting, Singapore, 10-14 Dec 2012
Study Group:	**Working Party:**	**Intended type of document** (R-C-TD): C	
Source:	Technicolor		
Title:	Certification analysis of VQEG 3D source video sequences		

Contact:	Quan Huynh-Thu Technicolor France	Tel: +33 (0)2 99 27 34 45 Fax: +33 (0)2 99 27 30 15 Email: quan.huynh-thu@technicolor.com
Contact:	Thierry Borel Technicolor France	Tel: +33 (0) 2 99 27 31 81 Fax: +33 (0)2 99 27 30 15 Email: thierry.borel@technicolor.com

Please don't change the structure of this table, just insert the necessary information.

Summary

1 Introduction

The VQEG 3DTV ad-hoc group has initiated three work items in parallel, with two items focusing on the subjective quality testing of stereoscopic 3D (S3D) video. This is summarized in Figure 1. Additionally, one test plan related to the evaluation of objective video quality metrics for S3D is being developed in parallel.

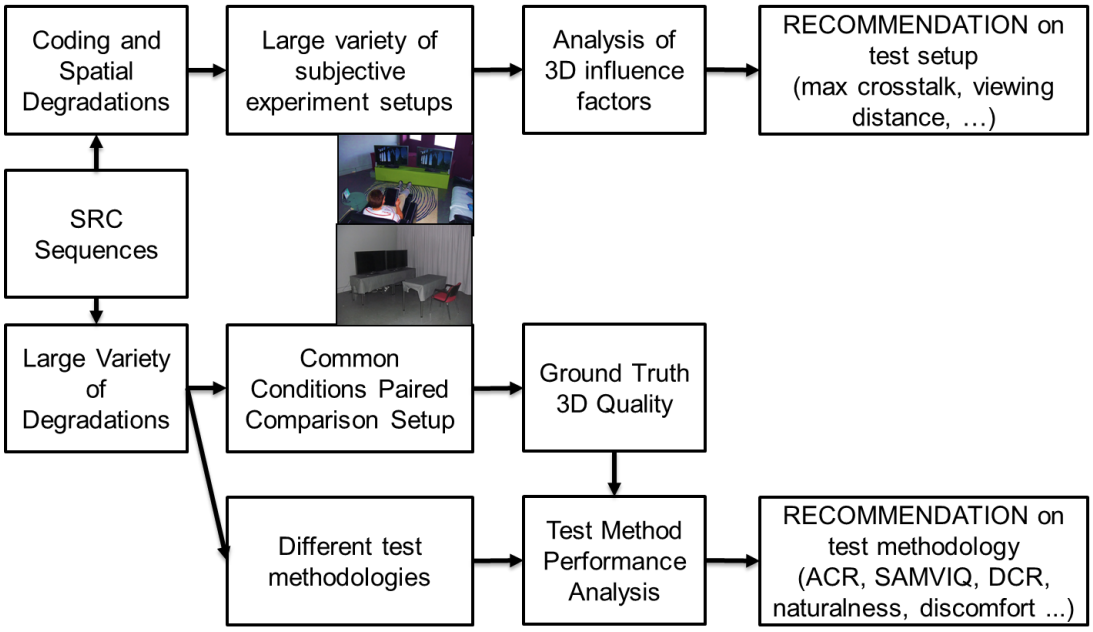


Figure 1. Overview of studies on S3D subjective quality assessment (from VQEG meeting, Rennes, June 2012).

As shown in Figure 1, a unique set of source sequences is being used for all work items related to subjective testing methodologies. VQEG has been facing the recurrent problem of getting access to freely available video content that can be distributed and used in the context of standards-related work. To overcome this

problem, a set of 10 stereoscopic video sequences (NAMA3DS1) has been provided by UMC and Polytech Nantes for free usage and distribution for research and standardization purposes. A brief overview of this video set is provided below and in Figure 2.

- Video capture with Panasonic camera AG-3DA1 (Integrated Twin-lens 3D Camera Recorder)
- Video format: 1920x1080p, 25fps
- Duration: 13 to 16 seconds
- Most of the content captured uncompressed, otherwise ~20Mbit/s per view
- Generated depth maps available

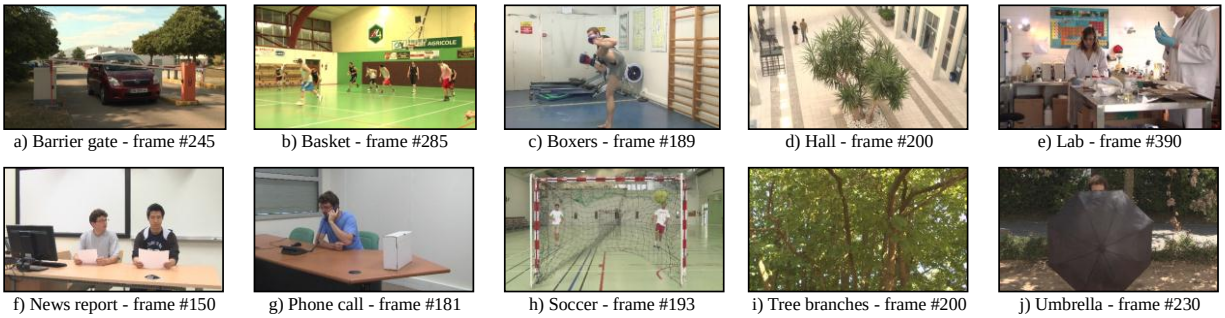


Figure 2. Snapshots of the NAMA3DS1 video set.

The availability of the NAMA3DS1 set has allowed to start the work of the 3DTV ad-hoc group by producing test sequences to be used in future subjective experiments. Because these source sequences were not professionally captured and produced, it is possible that the source content can present some defects. A pilot subjective quality experiment has indicated that the video quality of the NAMA3DS1 source sequences varies with MOS from 3.96 to 4.75, and with a standard deviation σ=0.3 [1]. The average quality of most source sequences could therefore be considered to be sufficient for those sequences to be used as reference content in future subjective experiments. However, some precautions must be taken as the presence of artifacts in these source sequences may influence the conclusions drawn from subjective results.

Precise characterization of this set of source sequences is important to fully understand future subjective tests results using these source sequences, for example to understand potentially unexpected ratings. Understanding clearly the characteristics of each sequence will help in the interpretation of the future subjective results.

The goal of this contribution is to provide complementary information to the one found in [1] in the characterization of the NAMA3DS1 source sequences. In order to achieve this, the source sequences were analyzed by Technicolor's Certifi3D tool and reviewed by a trained stereographer.

2 Certifi3D overview

The Certifi3D program [2] was developed by Technicolor to check the conformity of produced stereoscopic 3D content against a set of criteria found to be related to the visual comfort and quality of S3D content. Certifi3D is used by the professional industry at key steps of the production and post-production workflow and prior to final distribution.

Certifi3D:

- evaluates 3D content against 15 objective criteria for stereographic reproduction to identify common errors that result in suboptimal 3D content and may cause viewer discomfort.
- is used to ensure that S3D material meets minimum comfort requirements before it is delivered to consumers.
- evaluates each shot against a set of objective criteria for stereographic reproduction

- uses a proprietary analysis software tool to analyze each shot of stereo content
- identifies elements that fall outside the established comfort threshold
- adjusts threshold values to accommodate for different viewing environments, from digital cinema to home TV

The list of the 15 evaluation criteria is as follows (see Annex):

1. Alignment/geometry
2. Luminance/colorimetry
3. Depth of field
4. Reflections, polarization, flares
5. Contamination
6. Sync/genlock
7. Full reverse stereo
8. Hyperconvergence
9. Hyperdivergence
10. Edge issues
11. Partial reverse stereo
12. Depth mismatch
13. Visual mismatch
14. 2D to 3D ratio
15. High contrast

3 Analysis of S3D source sequences

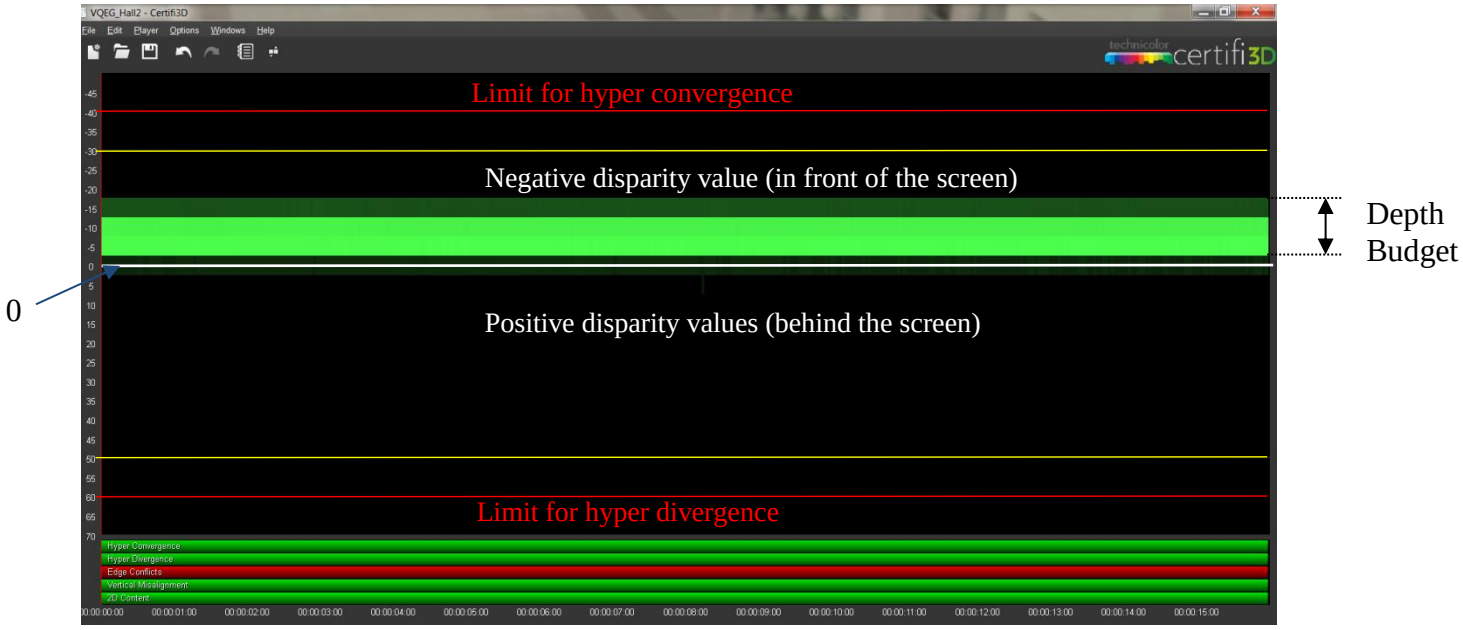
The figure below provides a brief overview of the analysis results provided by the Certifi3D user interface.

The main part of the interface shows a histogram of all disparity values of the 3D content.

The Y axis represents disparity values in pixels:

- Negative disparity values for objects in front of the screen
- Positive disparity values for objects behind the screen
- 0 value for objects in the screen plane

The X axis represents time.



The disparity histogram for a 1920x1080 HDTV content must be included in the following range [+60;-40]. Red lines. If not, a major rework of the scene is mandatory.

If the content goes over the yellow lines but stays below the red lines. It is considered as a minor deviation that may cause discomfort, re-work is recommended.

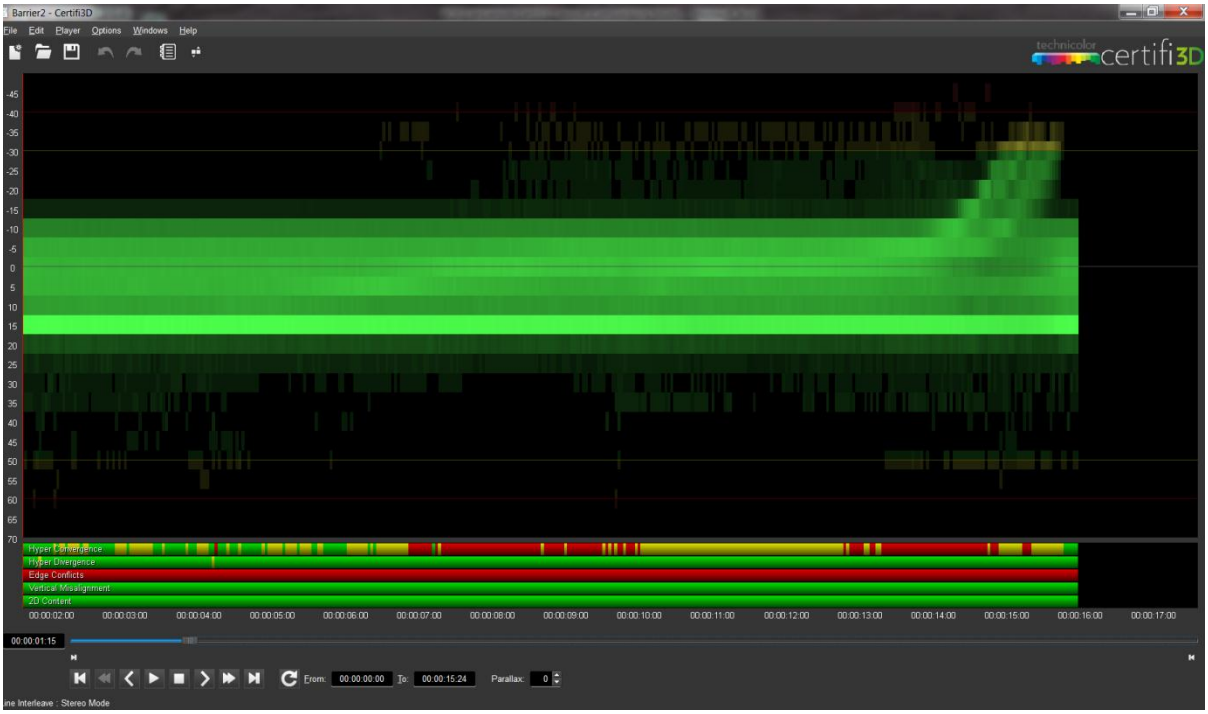
In the example above, the depth budget is pretty small, 3D will not be spectacular. All disparities are negative creating edge conflicts. Depth grading is necessary, pushing back the content by shifting left and right images versus each other will make edge conflicts disappear.

The five rows at the bottom of the screen indicate if, at a given time, there is one of the following issues:

- Hyper convergence
- Hyper divergence
- Edge conflicts
- Vertical misalignment
- 2D content

All the NAMA3DS1 source scenes have been analyzed according to the Certifi3D Quality Control process. The software tool can automatically analyze some of the 15 criteria. The remaining criteria are analyzed by a stereographer. A summary of the results is provided below.

3.1 Barrier

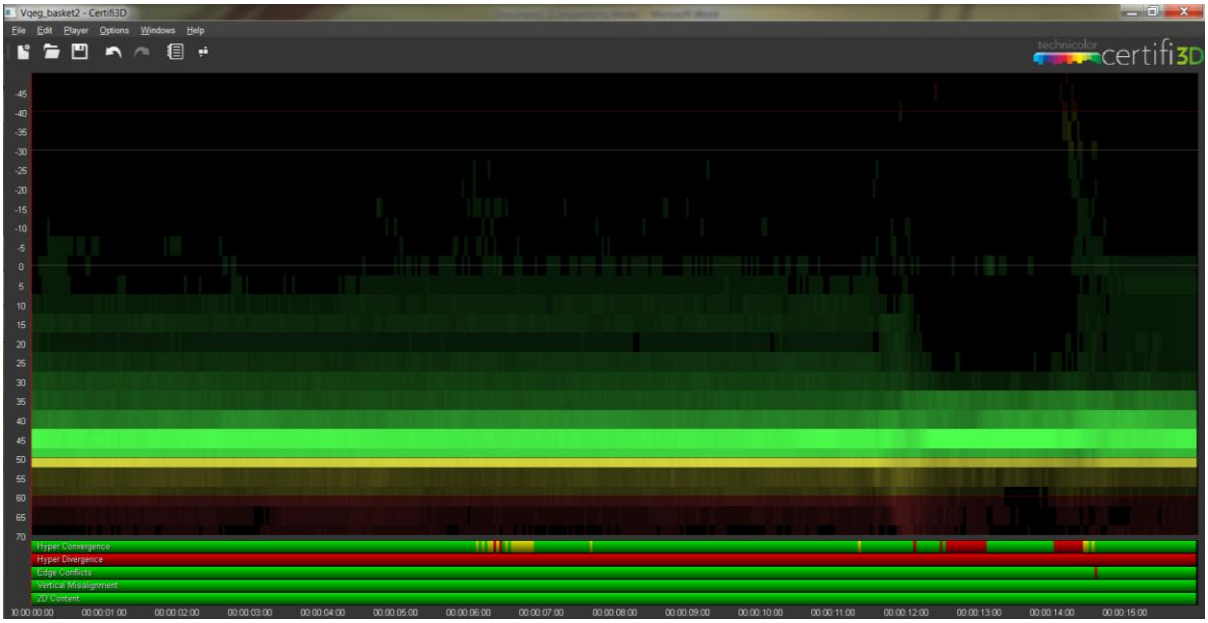


There is a vertical misalignment of 2 pixels between Left and Right pictures, which generates some noise in the disparity estimator as can be seen on the graph above, Right image is slightly brighter than left image. Color is also different. Those 3 issues can be corrected in post-production.

Depth budget is correct. Edge conflicts are present on the left and right side of the picture (grass and road) and when the car is coming out of the screen. It is pretty painful to watch since the 2D part of our brain sees the car occluded by the edge of the TV set (it looks as if it was behind the screen) and the 3D part of our brain sees negative disparity indicating that the car is in front of the screen. In addition, the car is in the yellow zone of hyper convergence. As we have some margin in the positive disparity zone, it is recommended to push the content backwards to avoid these issues.

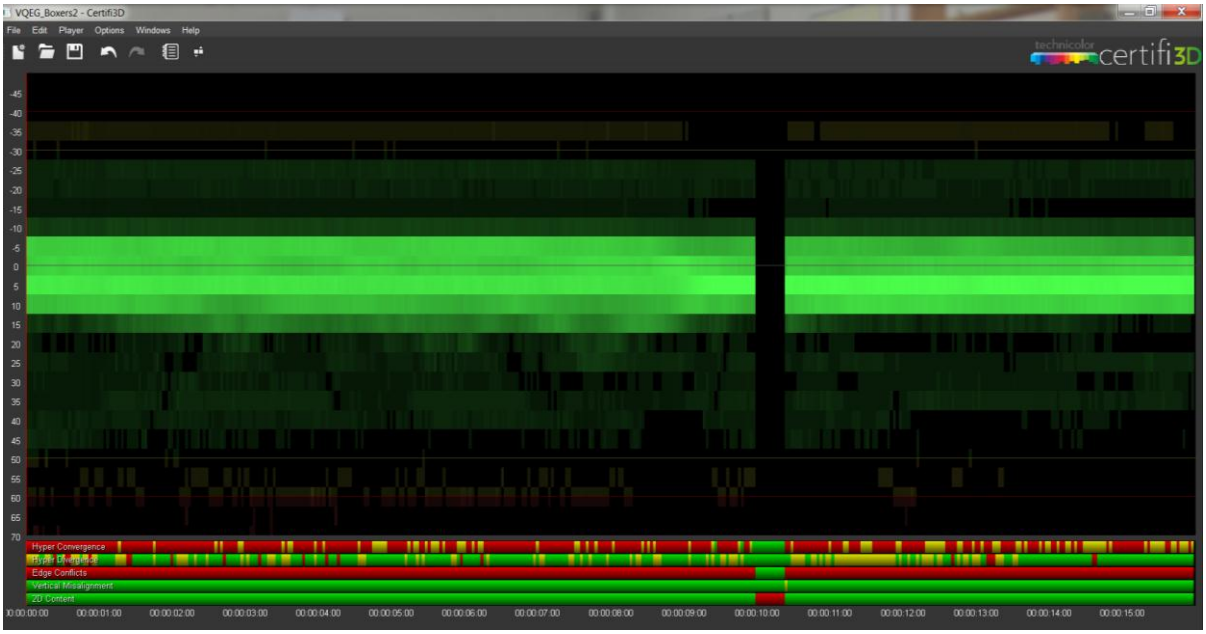
Reminder: when picture shifting the content, black bars appear on the sides, that can be removed by digitally zooming out the content

3.2 Basket



Vertical misalignment of 2 pixels between Left and Right pictures, Right image is slightly more yellowish than Left image. Depth budget is correct but there is a strong hyper divergence issue all along the scene. The background and subjects of interest (players) are too far behind the screen. The content should be pulled forward by around 25 pixels (not more to avoid edge conflicts on the hands of the spectator at the beginning of the scene).

3.3 Boxers

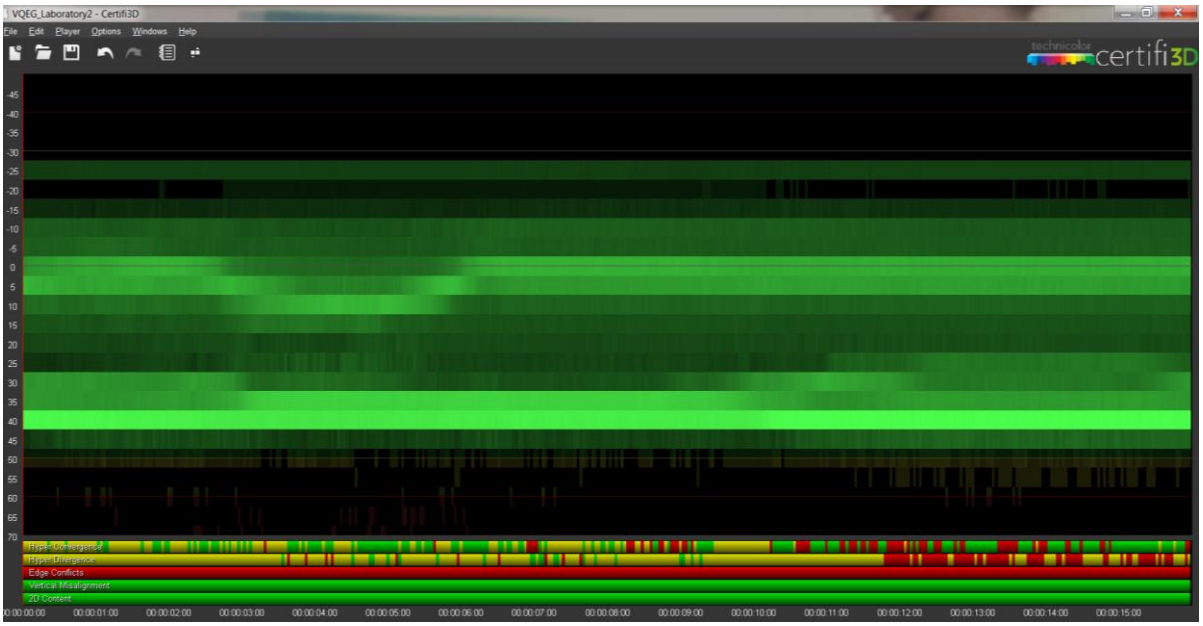


Vertical misalignment of 2 pixels between Left and Right pictures, No other major issues to mention. Good content; depth budget is conservative (30 pixels).

3.4 Hall

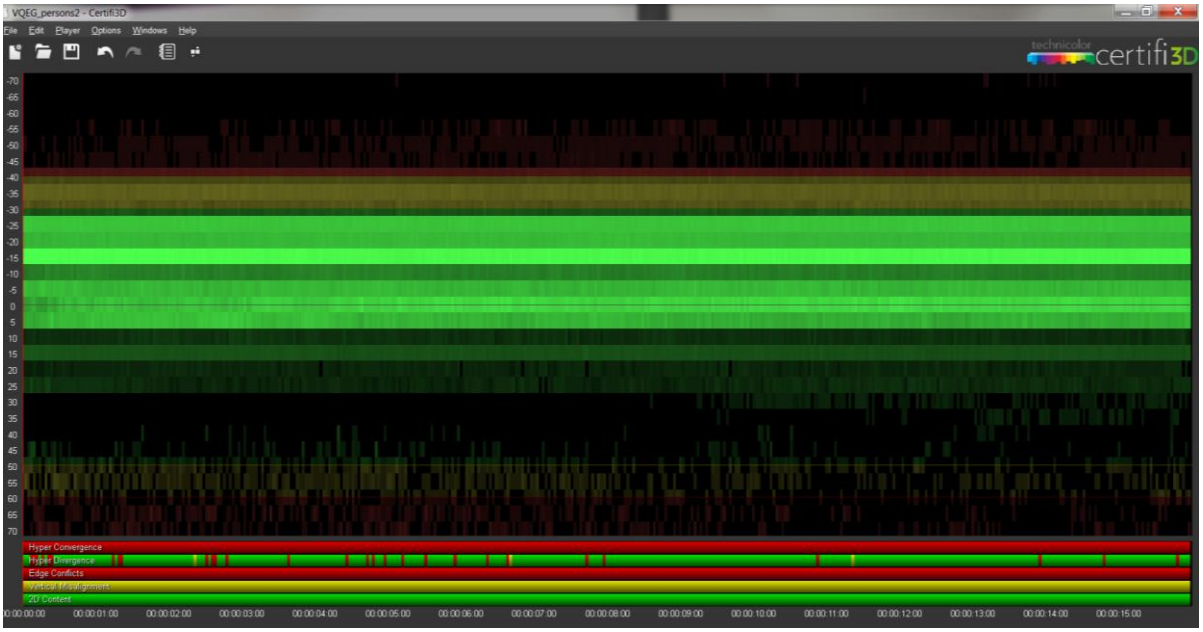
Vertical misalignment of 2 pixels between Left and Right pictures. Left image is slightly brighter and more reddish than Right image. Depth budget is conservative (20 pixels out of 80 available). The floor at the bottom is generating edge conflicts but it is quite acceptable since it may not be the major area of interest.

3.5 Laboratory



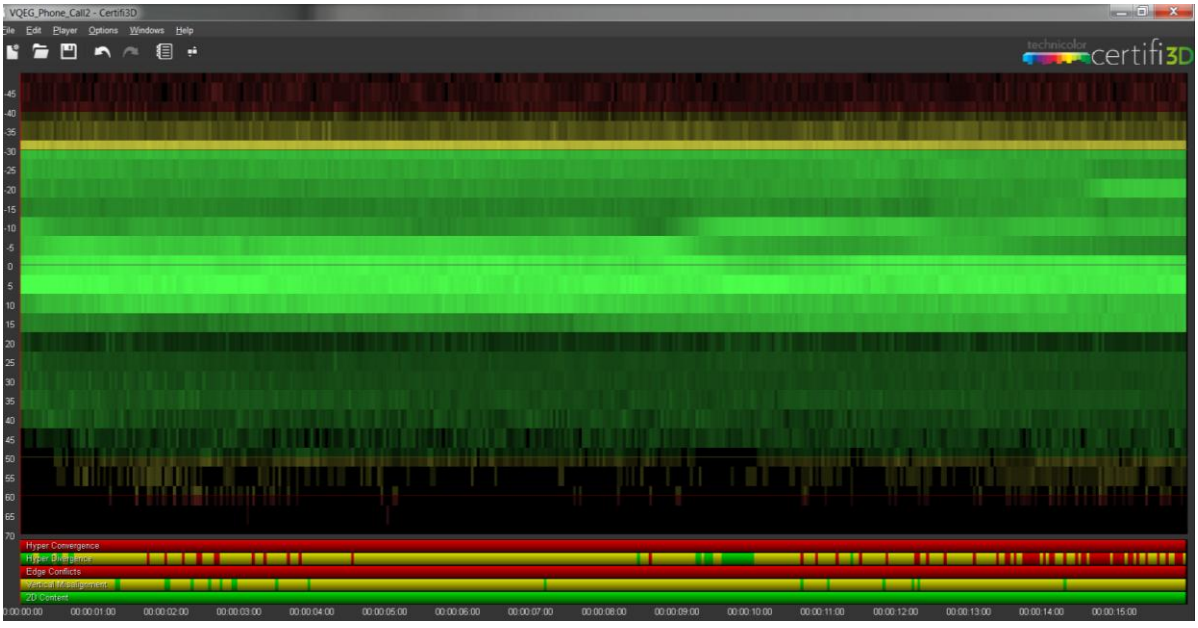
Vertical misalignment of 3 pixels between Left and Right pictures. Depth budget is a bit too high. The scene is reaching both limits of hyper divergence and hyper convergence. No margin for depth grading. No edge conflicts on the left and right sides. But problems of reflections on the table and bottles, which are present in one eye only (problems of symmetry). The use of quarter wave plates and polarizing filters are recommended on the 2 cameras to minimize reflections problems. The scene is overexposed at the beginning and correct at the end.

3.6 Persons reporting



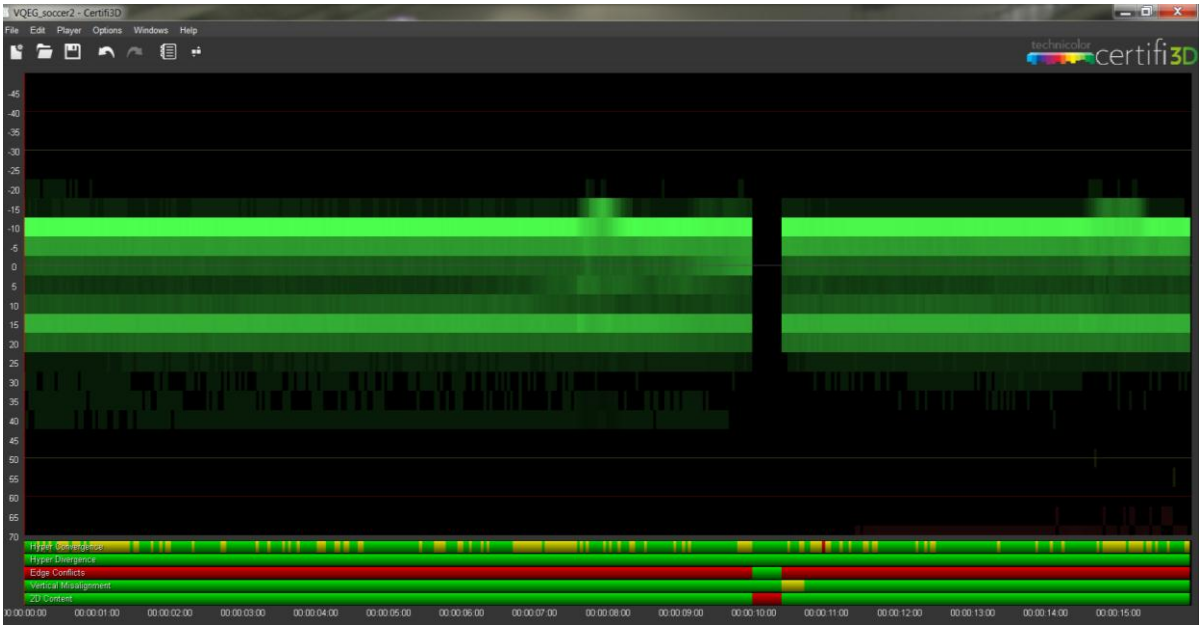
Vertical misalignment of 2 pixels between Left and Right pictures. Strong hyper convergence issue on the table. Strong edge conflict on the left side of the picture (monitor and table). Content should ideally be pushed back by 20 pixels. Characters and objects appear flat and small.

3.7 Phone call



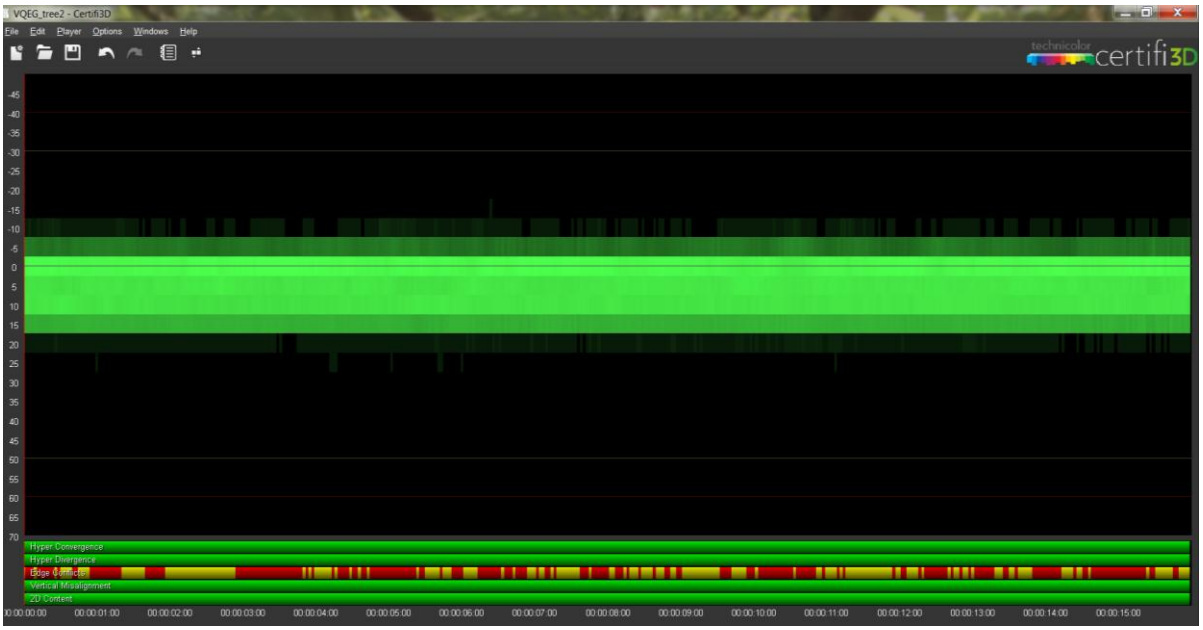
Vertical misalignment of 2 pixels between Left and Right pictures. Even stronger hyper convergence issue on the table. Slight edge conflict on the left side of the picture. Content should ideally be pushed back by 15 pixels.

3.8 Soccer



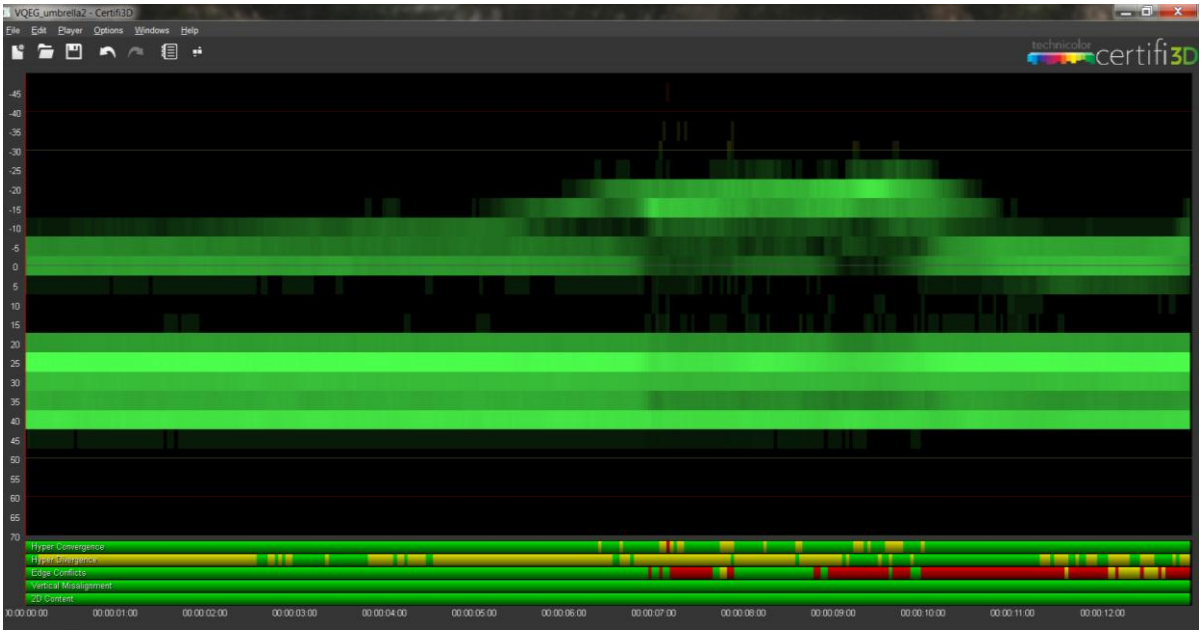
Vertical misalignment of 2 pixels between Left and Right pictures. Good scene. Good depth budget. Good balance between positive and negative space. Slight edge conflict on the floor at the bottom of the scene, which is acceptable since it is not the area of interest.

3.9 Tree branches



Vertical misalignment of 2 pixels between Left and Right pictures. Conservative depth budget. No strong issues; slight edge violations of one branch (middle left of the picture).

3.10 Umbrella



Vertical misalignment of 2 pixels between Left and Right pictures. Left image is slightly brighter and more reddish than left image. Good depth budget. No divergence/convergence issues. Some kind of cardboard effects, objects/characters and backgrounds look flat at different depth values. It is likely that too long focal lenses have been used. Also, at the beginning of the sequence, the forearms of the characters look very long, which may be due to a large interaxial distance used.

4 Conclusions

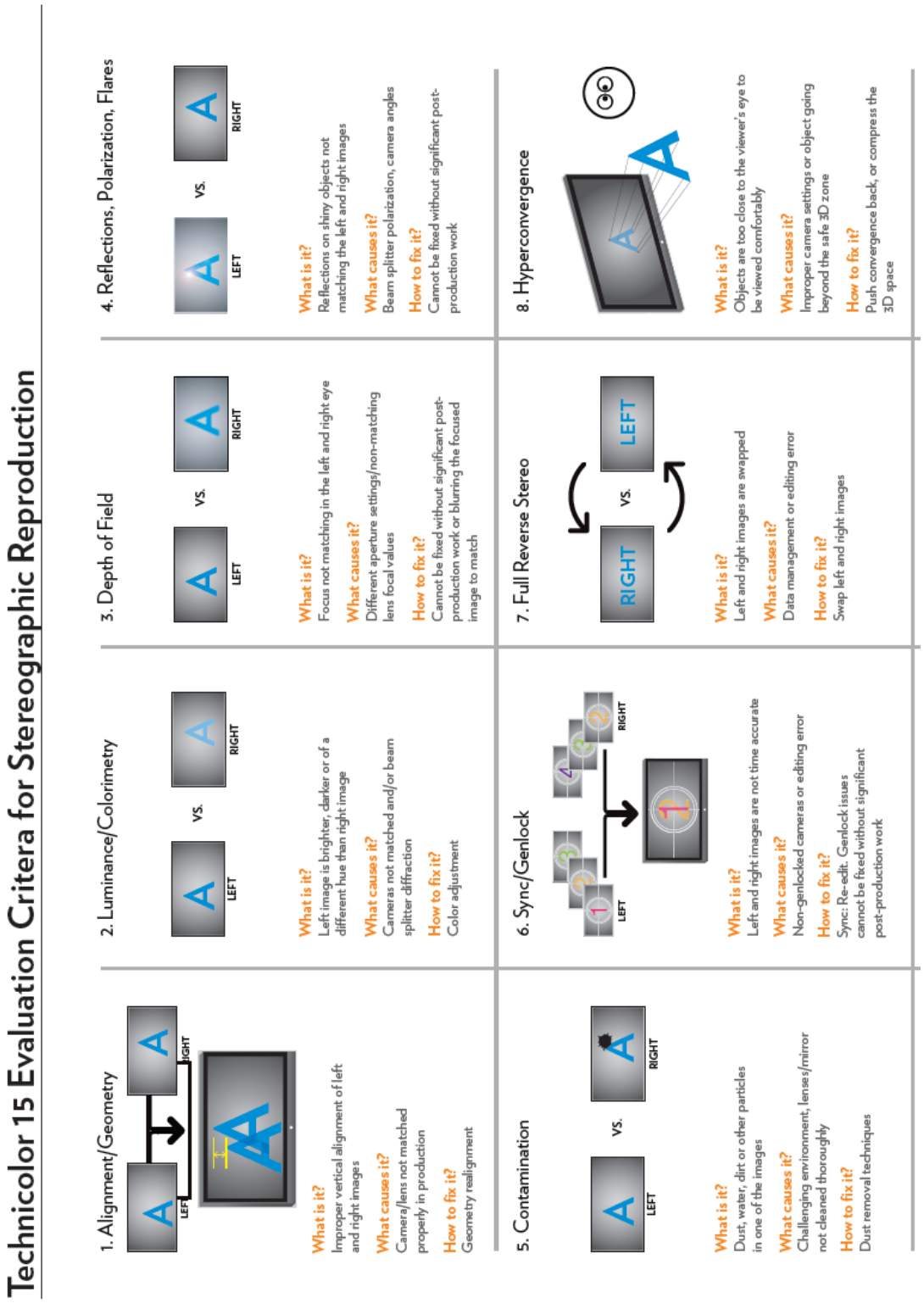
We analyzed the NAMA3DS1 source sequences with our Quality Control Process, which is widely used in the professional industry. Although, subjective testing has indicated that subjective quality of most of these sequences varies between MOS of 3.96 to 4.75, the source sequences contain some imperfections that should be taken into account in future work. For example a sequence with small depth budget could be problematic to be used in conditions where disparity has a significant influence on subjective quality, such as asymmetric coding. Vertical disparity present in the sequences can also be problematic in testing conditions where such mis-alignment can cause an increased visual discomfort.

References

[1] M. Urvoy, J. Gutiérrez, M. Barkowsky, R. Cousseau, Y. Koudota, V. Ricordel, P. Le Callet, and N. Garcia, “NAMA3DS1-COSPAD1: Subjective video quality assessment database on coding conditions introducing freely available high quality 3D stereoscopic sequences,” in *Proc. IEEE Fourth International Workshop on Quality of Multimedia Experience (QoMEX)*, 2012.

[2] Certifi3D by Technicolor. Available at http://www.technicolor.com/en/hi/3d/certifi3d

Annex


Technicolor 15 Evaluation Critera for Stereographic Reproduction
1. Alignment/Geometry
LEFT
RIGHT
What is it?
Improper vertical alignment of left and right images
What causes it?
Camera/lens not matched properly in production
How to fix it?
Geometry realignment
2. Luminance/Colorimetry
LEFT
VS.
RIGHT
What is it?
Left image is brighter, darker or of a different hue than right image
What causes it?
Cameras not matched and/or beam splitter diffraction
How to fix it?
Color adjustment
3. Depth of Field
LEFT
VS.
RIGHT
What is it?
Focus not matching in the left and right eye
What causes it?
Different aperture settings/non-matching lens focal values
How to fix it?
Cannot be fixed without significant post-production work or blurring the focused image to match
4. Reflections, Polarization, Flares
LEFT
VS.
RIGHT
What is it?
Reflections on shiny objects not matching the left and right images
What causes it?
Beam splitter polarization, camera angles
How to fix it?
Cannot be fixed without significant post-production work
5. Contamination
LEFT
VS.
RIGHT
What is it?
Dust, water, dirt or other particles in one of the images
What causes it?
Challenging environment, lenses/mirror not cleaned thoroughly
How to fix it?
Dust removal techniques
6. Sync/Genlock
LEFT
RIGHT
What is it?
Left and right images are not time accurate
What causes it?
Non-genlocked cameras or editing error
How to fix it?
Sync: Re-edit. Genlock issues cannot be fixed without significant post-production work
7. Full Reverse Stereo
RIGHT
VS.
LEFT
What is it?
Left and right images are swapped
What causes it?
Data management or editing error
How to fix it?
Swap left and right images
8. Hyperconvergence
What is it?
Objects are too close to the viewer's eye to be viewed comfortably
What causes it?
Improper camera settings or object going beyond the safe 3D zone
How to fix it?
Push convergence back, or compress the 3D space

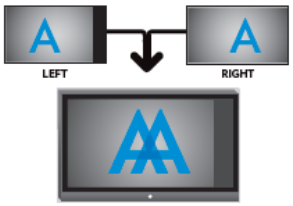
9. Hyperdivergence

What is it?
Objects are too far back to be viewed comfortably

What causes it?
Improper camera settings or objects going beyond the safe 3D zone

How to fix it?
Pull convergence forward or compress the 3D space

10. Edge Issues



What is it?
Mismatch left and right edges do not match due to the addition of "floating windows" vignetting or post-production convergence adjustment

How to fix it?
Fill the frame for 3D HDTV presentation
Re-converge to avoid edge violation

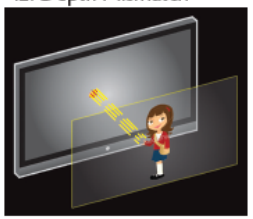
11. Partial Reverse Stereo

What is it?
Some of the layers in a 3D composition are reversed left and right

What causes it?
3D compositing error

How to fix it?
Swap incorrect layers in compositing.
Cannot be fixed on the final image without significant post-production work

12. Depth Mismatch



What is it?
Elements within a 3D composition are not in the correct depth to the scene

What causes it?
3D compositing error

How to fix it?
Fix composition. Cannot be fixed on the final image without significant post-production work

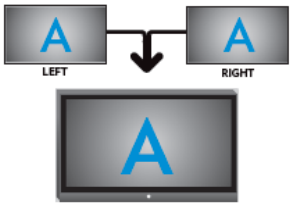
13. Visual Mismatch

What is it?
Elements within a 3D composition that do not match left and right

What causes it?
3D compositing error

How to fix it?
Fix composition. Cannot be fixed on the final image without significant post-production work

14. 2D to 3D Ratio

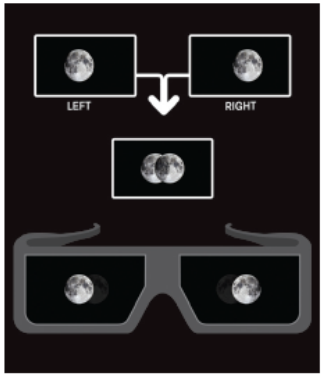


What is it?
Too many shots in 2D to qualify the show as genuine 3D

What causes it?
Lack of 3D content

How to fix it?
Replace non-stereo content with stereo content

15. High Contrast



What is it?
An element deep inside or far out of the window in high contrast with its environment, creating a double image on the display

What causes it?
Refresh rate of the display device/partial separation of left and right images by the 3D glasses

How to fix it?
Reduce contrast, change convergence or compress the 3D space

TECHNICOLOR
6040 Sunset Blvd
Hollywood, CA 90028
United States
Tel: +1 (323) 817-6600

www.technicolor.com

Pete Routhier
pierre.routhier@technicolor.com

Thierry Borel
thierry.borel@technicolor.com

technicolor