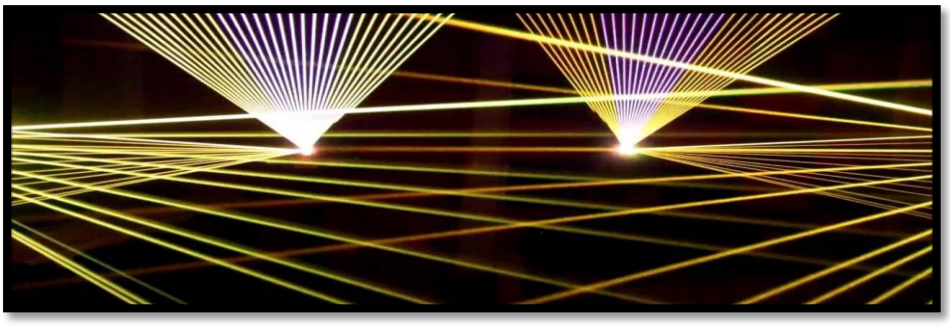
Theo Petrides

2016 Get Wet Report

9/20/2016

Flow Visualization: Legacy of Six Laser Show



Introduction

The art of flow visualization exists in many different mediums. The Legacy of Six laser show was created in a fog medium which was based around two laser projectors that stood next to each other on tripod mounts. The projectors emit beautiful beams of light which reflect off the surface of many individual fog particles to trace out each beam. The show was created using a program called QuickShow. Each projector was optimized through the program and external hardware to allow for proper color matching and zone settings which is explained in more depth later. The show was recorded with a Nikon camera in 1080p mounted to a tripod.

The choreography of the show was created and setup by myself, which took a total of 25 hours of show programming, and another five of setup which included: matching RGB color channels for each projector, ensuring the external bounce mirrors in targeted zones outside the camera's view. Furthermore, the show was projected against a black background to help minimize the amount of reflection of my room that occurred during the video.

This report outlines the basic setup of hardware and software needed to create a laser show. Reproducing this exact show from anyone point of view is difficult and each person must consider his or her artistic talent in order to make their own. I use different pictures throughout the report to demonstrate different concepts for laser show choreography and flow visualization processes.

A WORD OF CAUTION: Lasers are not toys to be played around with! One small move and you could permanently damage you or somebody else's vision. I have done extensive research on laser safety and have taken laser safety classes. Furthermore, I have approval for FDA variance and CDRH compliance to ensure the safety of use with my laser projectors. **I DO NOT** suggest trying to recreate this show if you are only looking to make a show. There is a lot to learn and this is by no means an extensive guide to run or create a laser show. I highly recommend attending laser safety classes before attempting anything with any laser.

Flow apparatus

The flow apparatus used was a 1,000-watt fog machine which can output 8,000 cubic ft. per min. The main apparatus in combination with a box fan and laser projectors allow the beams to reflect off the fog surface and become visible. Having the box fan run continuously will disperse the fog evenly throughout different laser projections and likewise, having it turned off will allow for uneven dispersion and show noticeable plumes. **Figure 1** demonstrates a camera shot facing the laser projection and highlights the difference between a fan run continuously vs. being turned off. The amount of fog emitted is controlled via a remote which is useful for ensuring proper amounts of fog in the room. Having too much fog can over contrast the beams and make the video too bright and blurry, and having too little won't allow the beams to show their proper intensity. The fog is made of a mixture between de-ionized water and a variation of different glycols. The amount of glycol varies from different manufacturers, but generally having more will increase fog density and overall hang time in the air.

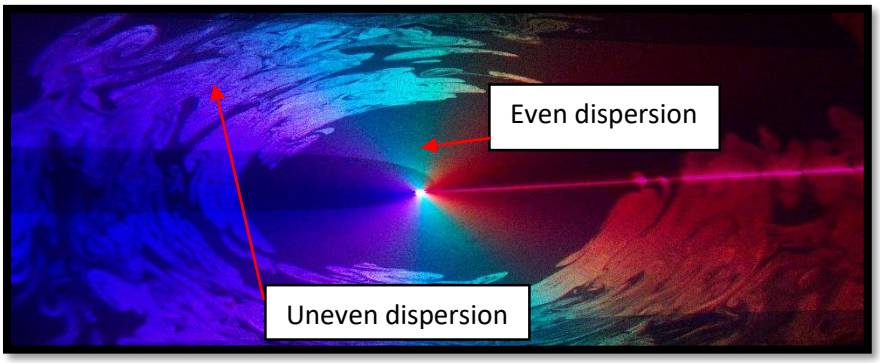


Figure 1 - displays a laser projection with even and uneven fog dispersion

The forces acting on the fog medium include initial dispersion of the fog into the room. According to the specs of the fog machine in the first paragraph above, holding the remote button down for ten seconds would allow for 1,333 cubic ft. to fill the room. In a room that is roughly 200 sq. ft. this is more than ample amount of fog. Once the fog has been initially output, the fan can run continuously until the fog plumes have dispersed evenly. This will ensure that the beams are uniform and have proper contrast when video recording.

Visualization technique

The visualization technique that was used requires the combination of the fog as well as the laser projectors. Each laser projector works similarly in the sense that there are red (R), green (G), and blue (B) laser diodes. Each laser diode combines through a set of dichroic optical mirrors to create an entire spectrum of colors see **Figure 2** on the next page. Each laser diode is driven by an electrical driver circuit, which has channel of 8 bits and integer values ranging from 0 to 256 (0 being lasers turned off, and 256 turned all the way on). That means multiplying each color channel RxGxB = 256x256x256 will allow an output of 16,777,216 possible colors. These RGB beams are then combined into white light and outputted to a set of galvanometer scanners which

essentially is a pair of x and y mirrors that sit on glorified stepper motors. This allows for very precise control and location of the beams. This is what allows many different projections to be created.

Figure 2 – The combination of the three laser diode beam emissions

Figure 3 – An output at the aperture shows the R, G, and B beams combined at the scanner pair

Photographic technique

Hardware setup

The photographic technique involves a setup with two lasers projectors on tripod stands with a camera facing the front of each projector shown in **Figure 4** on the next page. The camera setup in **Figure 5** on the next page is a distance of ten feet from the projectors and sits in a grid pattern to ensure the beams will be symmetric when recording. The camera is then placed in a beam attenuation map or BAM for short (via the QuickShow software). This means that beam irradiance does not hit the lens and damage the sensor of the camera. Setting up the zone area and BAM is crucial for recording.

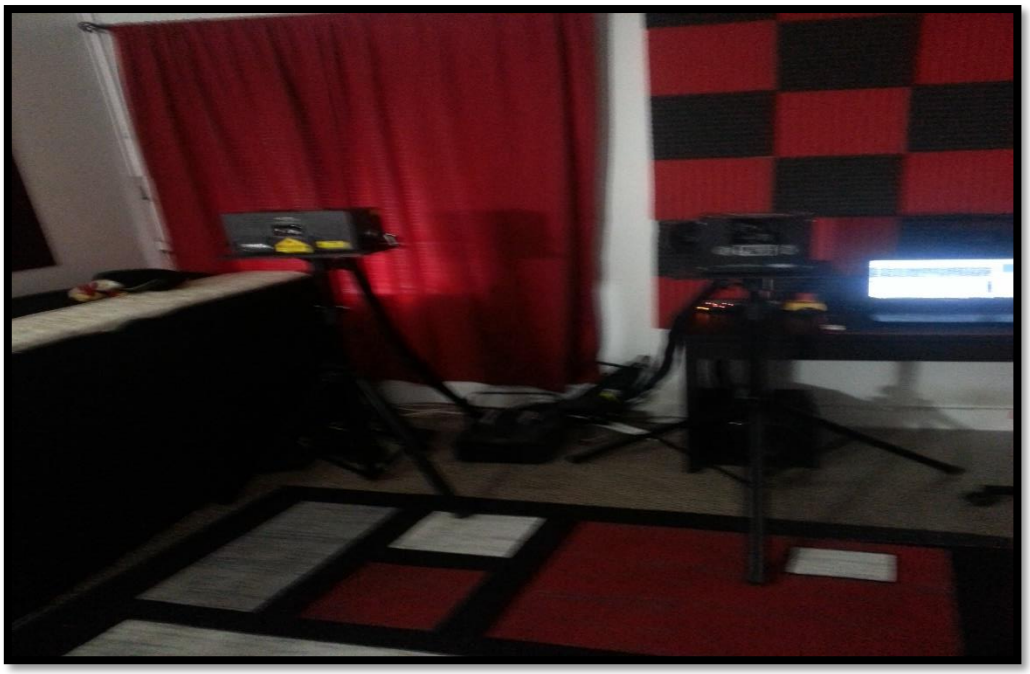


Figure 4 – Displays the projectors facing forward

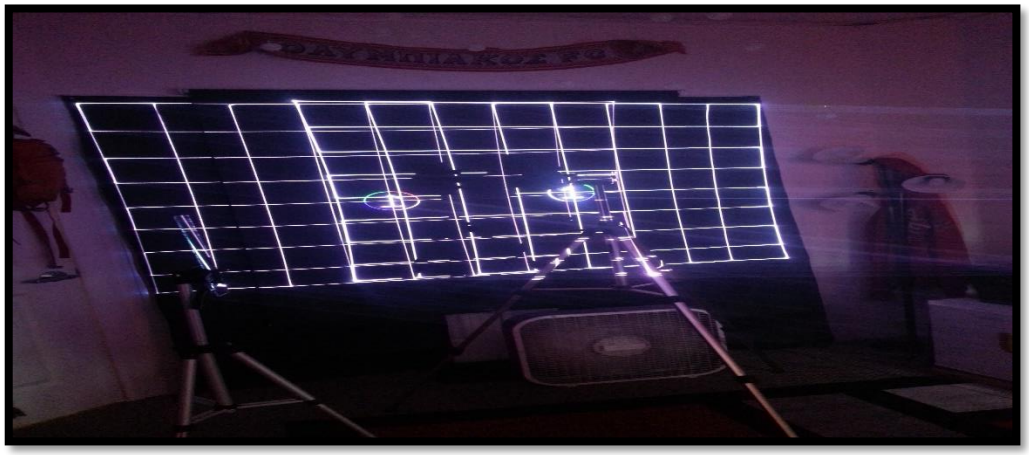


Figure 5 – The grid patterns help with beam symmetry and setting up the BAM for the camera.

Software setup

Inside QuickShow there are a number of things that need to be done in order to make a show. The first step in creating the show is importing music to the timeline interface. The music can be imported via MP3 file to the timeline using the small CD icon. **Figure 6** on the next page shows the timeline interface as well as the option for adding music into the timeline.

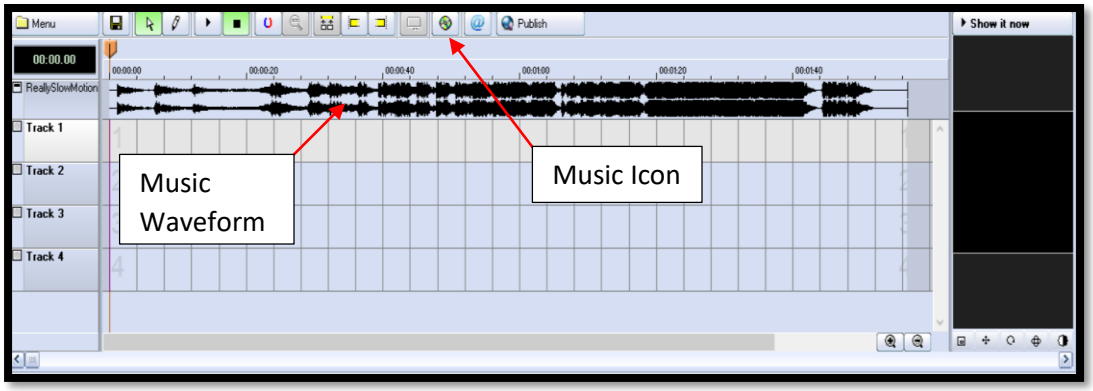


Figure 6 – Shows a blank interface for the timeline and ability to add music

The second step is to create a frame and add an effect to it, thus it animates to specific parts of the music. To do this you can right click a blue shaded box in the workspace and create a new abstract. This will pull up a set of tools seen in **Figure 7**, which you can make basic shapes that are used in many laser beam shows. You can adjust the coloring of it, add changing color effects, oscillatory effects to animate it, and more. The next step is to create that frame and then drag it to the timeline, this is fundamental for creating a laser show. In a nutshell, import the music, create a shape, add some color, animate it, and drag it to the timeline to fit it with the music. This is done until the show has been completed or song has ended. You can preview what your laser show will look like in real time via the preview area in the top right corner.

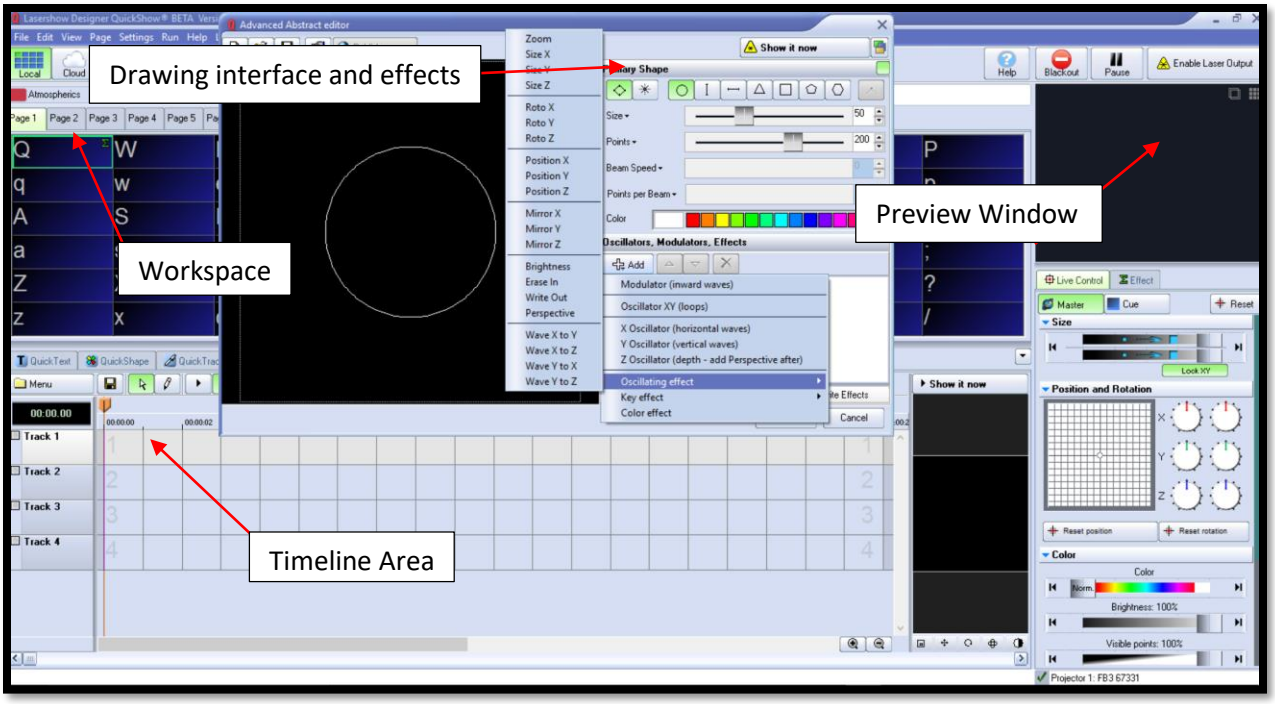


Figure 7 – Displays the workspace and tools required to make simple shapes and effects

The third step is to create a zone where the camera will record. Setting up the BAM, **Figure 8** on next page, as mentioned previously with an intensity of zero percent is crucial to our recording process. We can place the camera in that zone so it is safe from the beams. It is highly advised to setup the tripods without the camera beforehand to get an idea of where the BAM is being placed, and then place the camera on the tripod later.

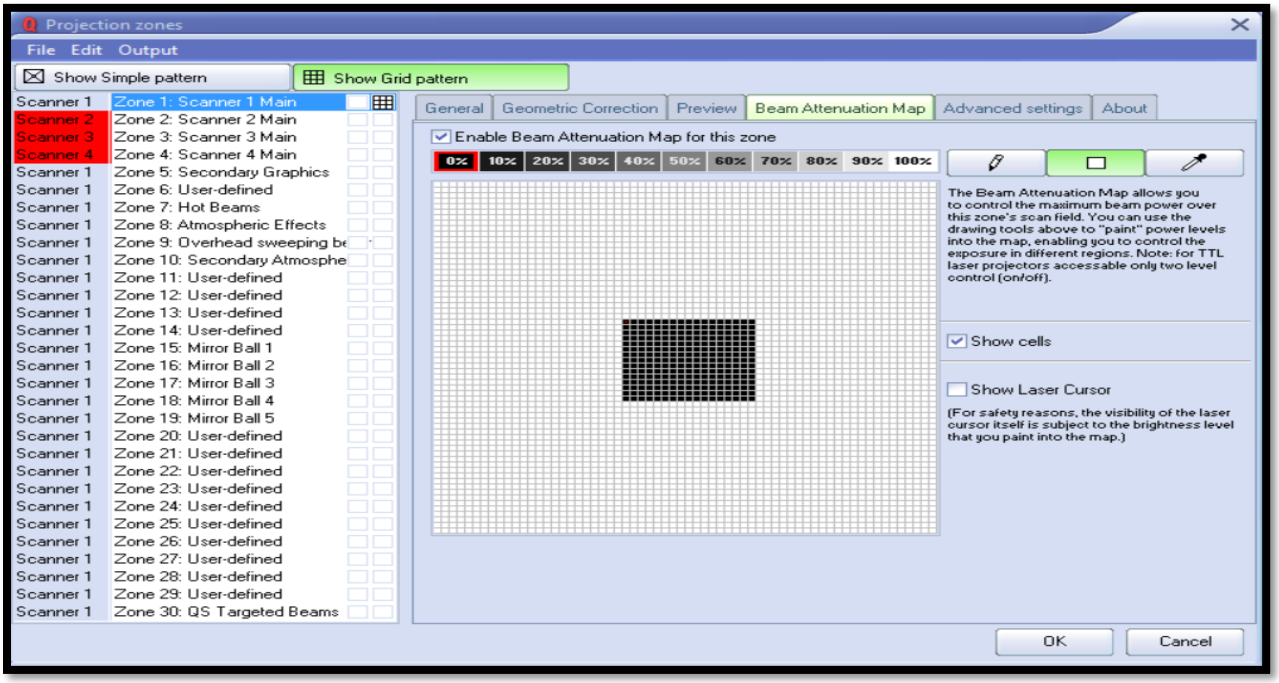


Figure 8 – Displays the BAM with areas in black where the laser won't lase

The fourth step is to output to the laser projectors using a digital-to-analog converter (DAC), thus the digital input from QuickShow sends and analog output from the laser projector. The lasers are connected with a DAC hardware to the computer called flashback 3 (FB3) via USB connection to an ILDA (International Laser Display Association) standard DB25 cable. The main projector is then daisy chained to the secondary laser or slave projector to create similar and symmetric effects.

The fifth step is to ensure that the laser projectors are powered on, safety key switches are turned to the correct position, interlocks are engaged, fog is evenly dispersed in the room, and laser output is enabled in QuickShow. Finally, press the record button on the camera, press the play button in the timeline and enjoy the most beautiful coherent light in the universe!

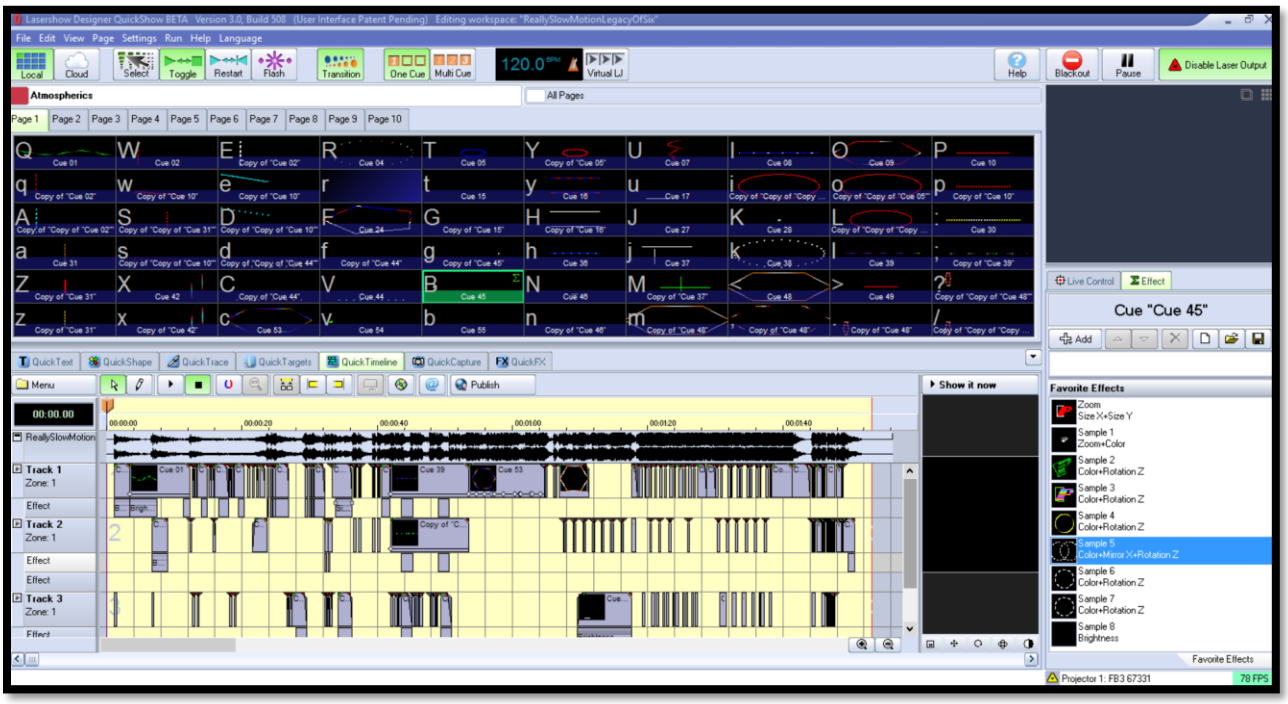
Conclusion

Although there may be a lot to learn when it comes to the safety of lasers and the learning curves of the software and extensive setups… It is by far one of the most rewarding things I have ever done. Being able to spend countless hours with production setup and choreographing a show that may only be a few minutes long is well worth the time. I have a strong passion for music which

made me thankful that Really Slow Motion let me use their music non-commercially. Refer to Appendix for right of use in this show.

What did we learn? Well, we learned what it means to use a fog machine as a flow apparatus and how a fan can disperse it and create beautiful plumes in different laser projections. We learned how to setup the projectors and camera to ensure proper photographic techniques and learned more about the inner workings of them. We also learned what a laser show software such as QuickShow has to offer when creating artistically synced shows with music.

Below is the workspace and timeline in QuickShow for the Legacy of Six laser show.



Comments

Per the comments via ‘Get Wet 2016’ there was a lot of feedback regarding adding a black screen behind the projectors to minimize reflections in the room. This will keep the video background much darker and focus more on the laser projections. This is something I have looked into and will definitely consider looking into purchasing more equipment to make my shows better! More importantly, I would like to use a better camera in the future where different settings like exposure, frame rate, etc. can be changed manually as opposed to the auto features used in my Nikon. This will make the video look much better.

Appendix

Music: Really Slow Motion – Legacy of Six

license Inbox x

FanSense | ReallySlowMotion <fansense@reallyslowmotion.com> Aug 30

to me

Hi!!

Thanks for your interest in our music.

**If you want to use our music in your YouTube video with no commercial purpose just go for it!! You just need to ignore the copyright claim and you will not get a strike but, please, credit us in the description with links to digital stores to let people know they can purchase our music online, please use the following credits:

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