

Laser Roundtable Panel: Audience Scanning and Safety

Being inside beam effects is much more beautiful than seeing beams overhead. Audience-scanned beams provide unlimited possibilities for creative laser expression – but it must be done safely. What is the difference between correct and incorrect audience scanning? An international roundtable of laser display experts discuss this very popular and common use of lasers. Participants in the panel are William Benner (Pangolin Laser Systems), Hugo Bunk (Laserimage, b.v.), Jim Hardaway (Neo Laser), Alex Hennig (LOBO), Steve Jander (Showlasers), and Greg Makhov (Lighting Systems Design, Inc.). You can read additional comments and more details online at www.laserist.org/laserist2008.

Is it legal to do audience scanning everywhere? What are your memories of the evolution of audience scanning?

Alex Hennig: Audience scanning is allowed in Europe and most of all other countries in the world. In general and under certain circumstances it is even allowed in the USA. Some countries have very strict regulations on audience scanning, others don't have any clear regulations at all.

William Benner: It is legal to do audience scanning in most places in the world, including the USA. There has historically been a misconception that it was not legal in the USA. In fact, audience scanning has always been possible in the USA, as long as you can prove to the CDRH that it is safe, and could provide calculations and other forms of proof. Regarding my memories of the "evolution", really I guess audience scanning started long ago with people pointing a laser projector toward people and doing audience scanning. It was Ruediger Mueller, one of the founders of the famous German laser company called "tarm", who claims he started doing audience scanning within Germany. He claims that before him, the German laws restricted it, but that somehow he was able to convince them to change the law.

Greg Makhov: The question of legality actually goes to the nature of individual countries' laws and regulations, and certainly the issue of enforcement. At one of the ILSC [International Laser Safety Conference] sessions some years ago, we had several presentations on audience scan-

ning, and the gentleman from Sweden stood up and declared that audience scanning was a source of man-made radiation and could never be justified for human exposure. To the best of my knowledge, Sweden does not allow audience scanning at all. I have heard rumors that Thailand has also restricted audience scanning, because of widespread abuse, but I am not sure if this is enforced.

Hugo Bunk: At least in Sweden it is not allowed. It has always been there for me, but since we entered the age of cheap high power DPSS lasers and more amateurs, I see more shows where I am concerned about safety.

Jim Hardaway: I have been around the world a bit and seen my fair share of audience scanning lasers. I wouldn't really term it evolution of audience scanning; I would probably call it the de-evolution of audience scanning. I would expand on that but I may offend some people in government or in "laser safety" fields.

Steve Jander: My experience is mostly in the USA. My first recollection of the FDA was when I toured with Led Zeppelin in 1977. I believe the FDA's involvement was a result of the trail of fear and ill will in the wake

of Blue Oyster Cult's tour around that time, in which a performer with a fiber optic laser bracelet illuminated a mirror ball and also pointed it directly into the audience. They were stunning effects but very dangerous in my opinion. I first saw an audience scan effect at a Who concert in 1976. This was before any US regulations.

By 1980, I had come up with some audience scan effects and ways to make them legal and safe. The FDA - BRH (Bureau of Radiation Health, which preceded the CDRH) sent electro-optic specialists/inspectors with four big red flight cases full of measuring equipment to follow me around for a couple of weeks, taking measurements and observing procedures. I had my own measuring equipment, and we were able to compare measurements and calculations. They were satisfied that my audience scan effects and procedures were safe and legal. I have continued scanning since then with no problems.

Are the basic restrictions the same everywhere? Is it just a matter that in some countries there are "guidelines" while others have "laws"?

William Benner: The accepted "safe levels" of laser light are virtually the



William Benner

Hugo Bunk

Alex Hennig

Steve Jander

Greg Makhov

same all over the world. I believe Russia has a slightly different "safe level" for pulses whose width is less than 20 microseconds or so. But we can say that there is a consensus for the level of laser light that is safe, all over the world. There are several laser safety standards available for people to examine and follow. The units of measure are different among the standards (for example, watts per square meter in the European standard, and watts per square centimeter in one of the American standards) but the actual levels are the same.

Alex Hennig: Independent of the valid regulations of the given venue, it makes sense to make any endeavor ensuring safe laser performances, as it is not just a question of applicable laws and regulations at the given country or venue, but finally a question whether people are harmed or not. Certainly sometimes inspectors have more or less expertise (as in any other field of work).

Jim Hardaway: You have some countries like China who have no rules, no laws about audience scanning, the application of lasers into navigable airspace yet no planes have fallen from the sky that we know of. Most developing nations and underdeveloped nations have little to no regulations. It is the developed nations who perhaps have too much time on their hands and need more things to create jobs.

The Maximum Permissible Exposure (MPE) is the highest level to which a person may be exposed. Is there an "orange zone" above the MPE where scanning is still safe - even though it may not be legal?

Steve Jander: I think so ...

Greg Makhov: Most laser safety professionals will not accept any exposure over the MPE, although this may happen with some frequency in the real world. For example, in addition to the MPE for ocular exposure, there is an MPE for skin exposure (nominally 1.1 W/cm²). Skin exposure

above the MPE can result in burns, but technicians, scientists, and even doctors routinely expose their skin to levels well in excess of the MPE when evaluating lasers.

Jim Hardaway: It is a little-known secret that the government standards are about 60% less than what truly is safe. There is room for error above the stated MPE, so the MPE is too low and can be raised to brighter visible levels without hurting anyone.

Alex Hennig: Every industry has its safety standards. Every standard has a certain safety margin, taking into account that sometimes unforeseen things happen.

William Benner: All standards make some number of assumptions. The assumptions made by the laser safety standards in coming up with the MPE is that the pupil is fully dilated -- meaning 7mm. Assumptions are also made as to how the light is "pulsed" and other factors. And the assumption is made that as these pulses enter the eye, the person will not do anything to evade the pulses (such as turn their heads or move out of the way of the beam). It could very well be that for the practice of audience scanning, some of these assumptions are not valid.

So yes, there could very well be an orange zone. It could very well be that the green zone is wider than we think. However, to me it comes down to how well you want to sleep at night. I sleep very well, because I simply never break the law.

You've all have seen certified safe legal audience scanning, and the colors have been dim. Only when the laser was turned up beyond this point did the laser colors look really good. Is this the experience of the panel, and how do you make your shows look good using legal safe audience scanning?

William Benner: I actually disagree with this statement. The colors have been bright, and in fact the brightness depends on several factors including

power level and divergence. Higher power can be used, which results in brighter colors AS LONG AS divergence is made higher. Empirically we can say that audience scanning -- even when done by nearly complete idiots -- must be pretty safe, because it has gone on for 30 years - with no body bags.

Why haven't we seen it in the US? Well, it's because historically there has been a large barrier to entry inasmuch as CDRH insisting that people prove that it is safe. This proof must be done both mathematically, and also procedurally. As a rule, laserists are not very mathematically inclined, and also are not very procedurally inclined, so those individuals could not prove it.

Jim Hardaway: With some audience scanning safety systems you can decrease the MPE in audience areas and increase them in areas in the Nominal Hazard Zones, thus creating the illusion it is a brighter laser show. A lot of this has to do with the ambient lighting and how LD's program "around" the limitation of audience scanning with conventional lights. You can make it look brighter if you turn down the discharge lamps or use complimentary colors. The use of lasers in the US on shows has gone down because of many factors. Cost per cue is still higher than lights, other lights and effects got cooler, LED and well ... NO AUDIENCE SCANNING! I think one huge factor here is the 3 Meter Rule. I believe in safety for certain, but I also believe in freedom. Freedom comes with risks and as long as you know the risks you can make the choice.

Greg Makhov: I am not sure I would agree with the "colors are dim" statement. The brightness is controlled, and an aversion response is not triggered. This gets into some very technical matters concerning color palettes and linearity of the brightness in the laser projectors. This is perhaps parallel to an old sound tech saying it doesn't sound good until the meter reads 115 to 120 dB! Most of us are

quite happy at 90-95 dB.

On the other hand, there is a delicate balance between beam divergence and allowable power. The “softness” of the scanned pattern is usually a function of the enhanced divergence, which allows more laser power to be used. But this is certainly an artistic judgment, and can be accommodated by adjustment, as long as the measured irradiance is within the limits. The problem with very tight beams is that the irradiance limit imposes a very low power limit on the beam, so the question becomes do you prefer dim and tight, or brighter and softer. This can only be done by experiment.

On July 5, approximately 30 persons attending a rave suffered eye injuries when a laser, intended for a sky show, was instead aimed into the audience. ILDA issued a press release stating, “It appears that a pulsed laser was used in a completely unapproved way. It was shocking to us – any competent laser operator should know to never direct a pulsed beam towards an audience.” (The full press release and additional information on the incident is at ILDA’s website).

In your view, what happened in Russia?

Jim Hardaway: The same thing that happens each time a car goes out of control and smashes into a park bench full of people. Someone who should not have been operating that car/laser was behind the wheel.

Greg Makhov: In simple terms, we don’t know. I think we can make some pretty good guesses, however, based on the video we have seen. The laser appears to be pulsed, and single color, which strongly suggests a Q-switched Nd:YAG laser. These are common on the surplus medical market, at significantly discounted prices. Finding such a piece of gear at a rave party is not too surprising. My best guess is that this was initially setup in a reasonably safe manner, intending to project beams overhead (which is quite reasonable with the Q-switched laser). A second guess is

that the tech that set up this laser was not present when the laser was redirected into the audience. I honestly don’t believe that anyone competent and experienced would simply project it into the audience in such a careless manner. We have heard numbers of 30 watts, which is quite believable given this technology, and certainly could cause the type of damage reported.

William Benner: Plain and simple, a complete idiot used an industrial laser to perform a light show. I have spoken to the top people in Russia, and it still is not known (or not admitted) as to who did the show. But the type of laser has been confirmed as an industrial pulsed YAG laser. Pulsed YAG lasers are great for cutting metal, but completely inappropriate for doing laser shows. Unfortunately, there are plenty of complete idiots in the world, whether they get their hands on a laser or not. For example, take a look at the number of people killed by drunk drivers every day. As Jessie Ventura says, you can’t legislate against stupidity. Although I wish you could!

What baseline of knowledge is needed to do audience scanning? Do I need to take an IEC safety course or a special laser show meter to calculate safe audience scanning? Is a projector with a scan-fail safeguard 100% safe?

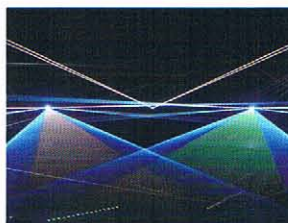
William Benner: What kind of knowledge? Well, you need, let’s say, “better than basic” laser safety knowledge. Knowledge of the MPE is good, and ability to calculate it with a calculator would be a good thing to be able to demonstrate -- even if the calculations were not done routinely for shows. An IEC safety course may do little to foster the understanding of how to do audience scanning itself, but it help to understand laser safety basics, and how the MPE works.

A “special laser show meter” is not necessarily needed. You would

certainly need some kind of instrumentation – for example, a light energy meter capable of measuring relatively low light levels, and having a detector area that is 1 square centimeter. A projector with any kind of scan-fail safeguard is not 100% safe. Going even further than this, even a projector with a scan-fail safeguard and good safety practices might not be 100% safe. Many scan-fail safeguards are not designed very well at all.

However, lets set this aside for a moment, and look at the problem from another angle. An unsafe projector and show scenario with a scan-fail safeguard will be unsafe. BUT, a projector and show scenario that are properly configured for safe audience scanning will be safe (at least until something goes wrong when the scan-fail safeguard would be required to act). Therefore the emphasis should be on making shows safe, not on the equipment itself. The bottom line is that despite the high degree of mystery around audience scanning safety calculations and measurements, it’s all quite easy to setup and perform; if you have the light energy meter mentioned above, you could perform a single measurement at the closest point of audience access, and that one measurement will give you a good indication as to whether the entire show will be safe or not, regardless of the actual show content. I will allow Greg Makhov to describe how this is done ...

Greg Makhov: With a lot of discussion and research into scanning parameters and how they can affect exposure, I believe we can make a valid generalization that will effectively limit the exposure within the MPE for normal scanning behavior, particularly if we have a highly respon-



sive scan-fail monitor. However, it is important to understand that limiting the irradiance is far more important than monitoring the scanning.

With the development of the PASS system [Professional Audience Safety System, a commercial scanning safety device], it is possible to have a pre-calibrated laser projector that can be used at a preset range, and only a confirmation measurement is required in the field. This was all that was necessary with the set up of the projector at the ILDA Theater last fall.

Alex Hennig: LOBO has invested a lot of time and money to make audience scanning safe. This not only refers to our DDL safety system, but also to the laser show safety meter LMS-2 we produce. According to our experience, there is no valid recipe or what you call a "baseline knowledge". This is the reason why LOBO provides a free and individual laser safety training for each client who purchases a LOBO system. This gives you the practical knowledge to apply the system in a safe way.

Steve Jander: I think anyone who can pass the New York State test to obtain a Class B Laser Oper-

ator's Certificate probably has a sufficient baseline of knowledge needed to do audience scanning. Measuring equipment is useful. Calculations are probably sufficient if worst case assumptions are made. My philosophy is to have multiple parameters independently interlocked so that a failure of any one parameter will shut off the beam, even though more than one parameter would have to fail for the MPE to be exceeded.

The interlocks should fail in a safe mode, and their reaction time should be much faster than the scan failure time.

What can a producer do to hire a company that knows what they are doing versus one full of hot air?

Hugo Bunk: Well he can ask for references before hiring them

Steve Jander: Research the company's background and experience. Make sure they have a variance that allows audience scanning (for U.S. companies).

William Benner: Within the U.S. it's simple math. Ask to see the variance document that shows that audience scanning is approved. Outside the U.S., ask to see that some form of documentation as some kind of proof. I also think it is not such a bad idea to ask to see their insurance policy or other "bonding" credentials.

Greg Makhov: Other than the reputation of the company, there is little a producer can know to evaluate a laser show provider. This is true for both the artistic and technical aspects, and the complex safety of audience scanning is pretty far beyond any layperson to comprehend. Part of the problem is that there is so much technical jargon associated with laser displays, even people inside the industry can get confused. As we go forward, we may develop some industry qualification for laser projectors that provide audience scanning, which would be a significant step forward.

