

The European Digital Cinema Forum

A Buyers' Guide to Laser Projection

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Forward

- ▶ This Guide came about from a survey of EDCF members, which showed that there was some confusion surrounding laser illuminated projection.
- ▶ We have taken on the role of 'the Buyer' in this Guide, and members of UNIC very kindly put forward their questions about laser and we then asked the four cinema projector manufacturers to answer them.
- ▶ We then grouped the answers and summarised their responses into clear and concise answers to questions asked by the exhibitors. We then filled in a few gaps and tried to answer the unanswerable.
- ▶ Any errors and omissions are our fault and we would urge you to let us know of any as soon as possible.

David Hancock and Matt Jahans

Who produced this Guide

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- ▶ Guillaume Branders – UNIC

Thanks to...

The following companies and organisations have been closely associated with this project, and we thank them for their time and effort in helping us realise this guide.

- ▶ Barco
- ▶ Christie
- ▶ NEC
- ▶ Sony
- ▶ Harkness Screens
- ▶ UNIC

1. Technical considerations

What is laser projection?

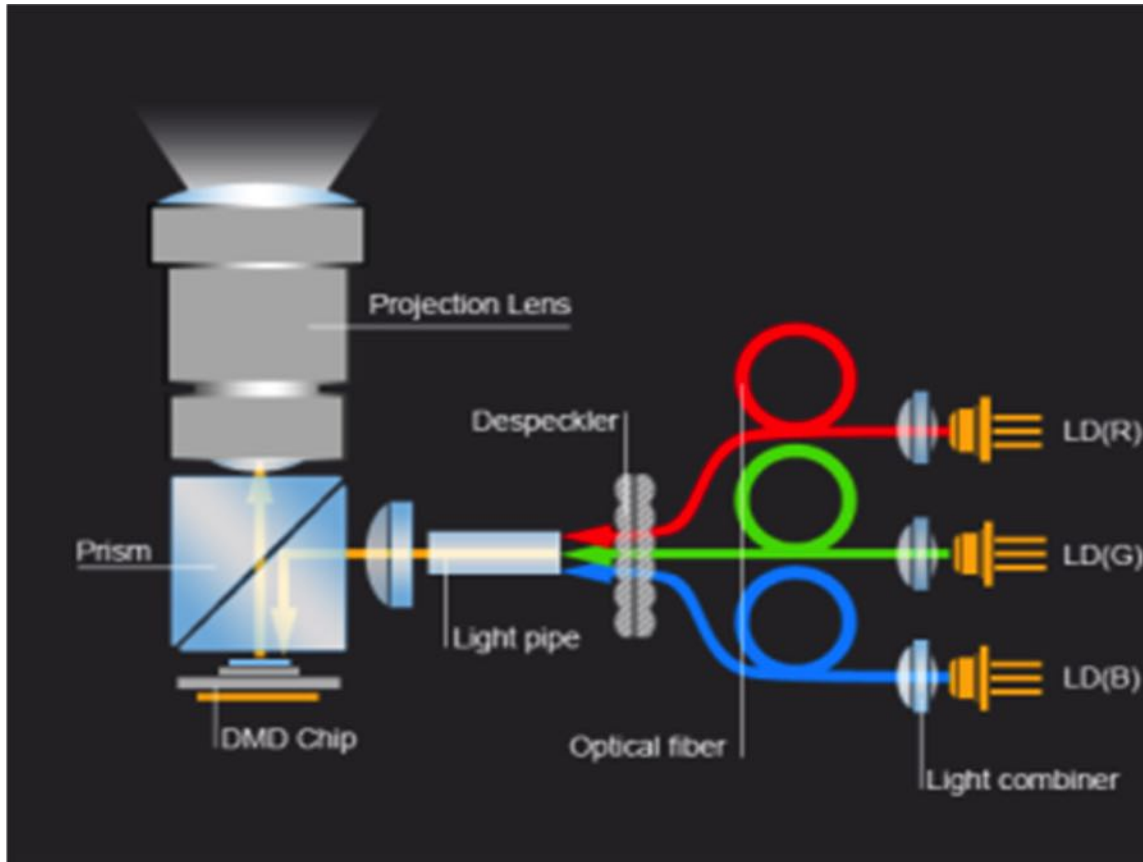
- ▶ Lasers are light source components that convert electricity into light. For the cinema, this means Red, Green and Blue (RGB) light instead of using lamp-based technology.
- ▶ RGB light is collected through a set of optics into a prism and through the lens.
- ▶ R, G and B are considered Primary (P) colours and projectors are made up of single, dual or modular units of each colour.
- ▶ All laser projectors, whatever type we refer to, need R, G and B colour although only RGB laser will use laser modules for R, G and B colours.

How many type of laser projector are there?

- ▶ **There are three types of laser projection currently in cinema:**
- ▶ RGB Laser, which is split into 6P, 3P and less commonly 9P. The P refers to the number of primaries used to generate colours (eg 3P uses 3 primaries, one for each colour). Each Primary can comprise several lasers of different wavelengths, grouped together to make the Primary. 6P contains two red, two green and two blue primaries to enable one set for each eye in 3D mode.
- ▶ Laser Phosphor: Uses 1 Blue laser Lightsource for Blue and 1 Blue laser Lightsource to excite a phosphor wheel to generate Red and Green.
- ▶ RB Laser: Uses 2 Blue Laser Lightsources –1 for Blue, plus 1 to excite a phosphor wheel for Green- and a Red laser Lightsource to separately generate Red.
- ▶ There is also RGB Laser Phosphor but this is not currently in cinema projectors.

How do laser projectors work?

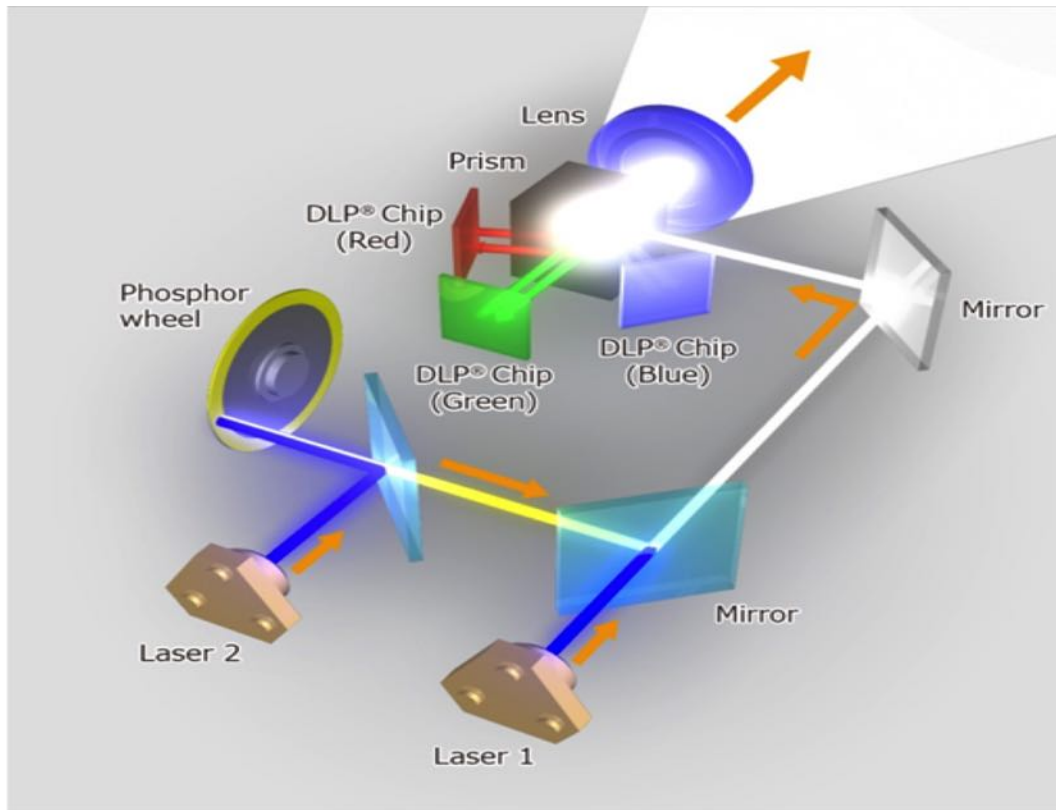
RGB



- ▶ The light source contains separate red, green and blue lasers that are mixed and directed to the display devices.
- ▶ This is sometimes configured as **direct-coupled** laser (the laser modules are installed within the projector) or **fibre-coupled** laser (where fibre-optic cables transmit the RGB laser light from external rack-mounted modules).
- ▶ RGB laser is theoretically modular, and if manufacturers support it, higher brightness can be added with new modules.

How do laser projectors work?

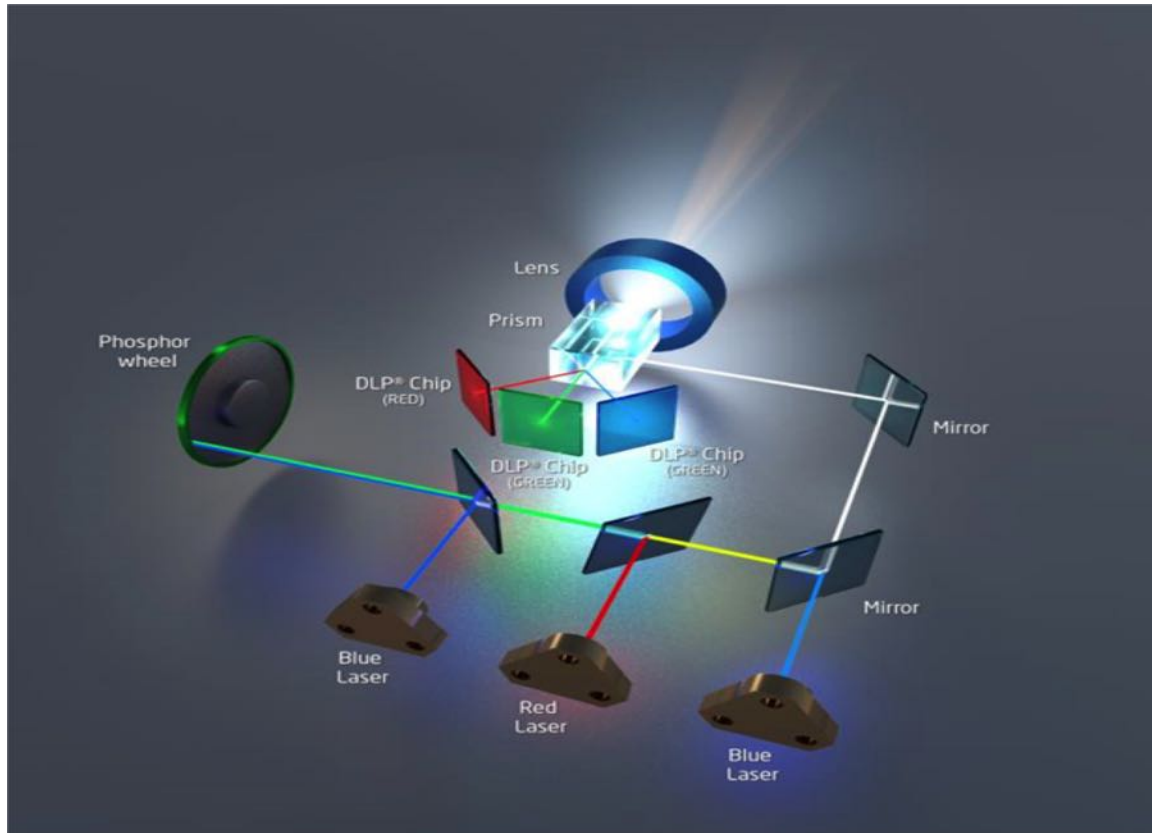
Laser phosphor



- The light source uses one Blue laser Lightsource for Blue and another Blue laser Lightsource to excite a phosphor wheel which generates the Red and the Green.

How do laser projectors work?

RB Laser



- The light source uses one Blue laser Lightsource for Blue and another Blue laser Lightsource to excite a phosphor wheel which generates only the Green. An additional Red laser Lightsource creates the Red.

Ways to acquire laser projection

- ▶ Buy the laser projector
- ▶ Retrofit laser is an option for upgrading existing lamp-based projectors enabling them to utilise a laser light source. There are two sources for retrofit:
 - ▶ OEM Retrofit – some manufacturers offer their own upgrade
 - ▶ Third party retrofit – In this case, consider the warranty and potential Safety responsibility very carefully because technical support may become divided.
 - ▶ DCI product compliance may also be compromised if the specific projector and modifications are not approved.
- ▶ Laser bank/farm – It is theoretically possible for a single laser light source to supply multiple projectors in the same site, although this has not yet made its way into cinemas.

Laser and 3D

- ▶ In many cases, existing active and passive 3D systems used with lamp-based projectors can also work with laser-illuminated projectors.
- ▶ In addition to the above, RGB 6P projection can also offer its own version of 3D, using colour separation and non-disposable glasses. The advantage is that it gives high brightness 3D and almost no ghosting.
- ▶ The glasses used for Dolby3D don't work when using color separation based 6P laser 3D

Are laser projectors reliable?

- ▶ Broadly speaking, yes they are reliable
- ▶ As it is a relatively recent technology in cinema, no current installed cinema laser projectors have outlived their expected lifetime.
- ▶ Some manufacturers are prepared to offer significantly extended warranties as a measure of their confidence in their system's reliability.
- ▶ However, manufacturers have tested this technology in cinema conditions and have long experience of it in other non-cinema sectors so the technology is relatively well understood.

Can a cinema carry a spare laser source?

- ▶ Most manufacturers state that spare laser light sources are held in warehouses and can also be held on site in case of failure.
- ▶ However, these are expensive and an exhibitor may not want to carry a spare.
- ▶ The first signs of a laser failure would normally be light loss rather than a complete failure which would give the exhibitor time to react.

Laser speckle: what is it and what can I do about it?

- ▶ Laser speckle is an interference pattern which can affect all laser projectors, and to a different degree. It is more pronounced on RGB projectors. This can cause a subjectively 'disruptive' viewing experience for cinema goers.
- ▶ Under certain circumstances, speckle can also be present to a lesser degree when using lamp-based projectors.
- ▶ Projector manufacturers mitigate these effects in different ways and to different degrees. This can be done within the projector and sometimes additionally by vibrating the screen.
- ▶ Speckle is also influenced by the type of screen surface the image is projected on.

Do laser projectors reproduce colours like lamp-based technology ?

- ▶ Laser light gives the impression of more vibrant colours, which some consider is a colour issue with laser.
- ▶ This is a perception caused by the way the human eye receives colours.
- ▶ Providing the projector is correctly set-up the colour readings will be the same as Xenon.

What type of screen do you need with laser projectors?

- ▶ The type of screen suitable for laser projection depends largely on the laser system to be installed.
- ▶ Typically, any white or silver screen type is suitable for laser phosphor projectors.
- ▶ Laser speckle must be considered when using laser-illuminated projectors.
- ▶ In general, lower gain screens produce less noticeable speckle. However, screen surfaces differ by manufacturer and some are more effective than others at mitigating speckle.
- ▶ As with all technology choices, try to see a relevant demo.

Does laser light damage lenses?

- ▶ Projector manufacturers have tested lenses and have found no issues related to laser damaging lenses.
- ▶ Unlike Xenon, laser light does not contain any UV or IR light so it contributes less to lens ageing.

Does DCP change with laser projectors?

- ▶ The packaging requirements of the DCP do not change.
- ▶ However, the image files do change and grades can be delivered to the lab with higher foot Lamberts, as would be the case with any projector.
- ▶ Different versions may be supplied to suit the higher brightness capability of certain projectors. This has been done in the past to optimise the 3D presentation experience in each auditorium but it does increase the number of 'versions' required which is a cost consideration for the distributor.
- ▶ The actual delivered mastering level will depend on the distributor's requests.

How can we prevent colour from shifting once the laser diodes start to age?

- ▶ Unlike Xenon, colours can shift as laser diodes age.
- ▶ Colour shifting is prevented by monitoring and maintenance of the laser projector.
- ▶ Manufacturers have algorithms and sensors that detect colour issues. Servicing and calibration should suffice in most cases.

What are the technical concerns relating to Green laser?

- ▶ Until recently, it had been technically difficult and costly to achieve green light from a direct laser diode source at the power/brightness levels required by a cinema projector.
- ▶ As a workaround, manufacturers came up with Green laser frequency conversion modules. These tended to be bulky, inefficient and expensive. They also often exhibited high levels of speckle.
- ▶ Suitable direct Green lasers now exist and are starting to be introduced. They are smaller, lower cost and more efficient.

2. Financial and lifetime considerations

What are the lifetime expectations

- ▶ This varies according to the laser type and initial brightness of the projector.
- ▶ It also depends on the point at which you wish to replace the laser.
- ▶ For all laser projectors, manufacturers state that the lifetime is up to 30,000 hours, dependent on model and technology. Please check with your manufacturer, as this is evolving.
- ▶ The standard manufacturer warranty is typically in line with this.

What about savings on electricity and energy?

- ▶ There are savings to be made on electricity usage and efficiency for laser projection.
- ▶ However, how much of a saving depends on a number of factors, including projector model, cooling system required, the type of laser projection system.
- ▶ The situation is also changing quickly as projectors become more efficient eg direct Green lasers.
- ▶ It is worth speaking to the manufacturer or dealer at the time of purchase.

How do laser projectors impact the booth ventilation and AC systems?

- ▶ There is an impact on booth ventilation and Air Conditioning systems.
- ▶ In most cases, switching from lamp to laser allows for either booth exhaust recycling or full extraction out of the booth through the ceiling. In both cases significant HVAC and electricity savings can typically be made.
- ▶ In some cases, the efficiency of the laser projector over the lamp projector it replaces is that much higher it's possible to completely remove the exhaust. This saves a lot of electrical power for moving and managing the air as well as improving the spatial flexibility of the booth and cinema.

Any other benefits?

- ▶ Laser illuminated projectors do not require lamps to be changed regularly, which is a considerable operational and health and safety benefit.

What if I am smaller cinema?

- ▶ Some smaller cinemas are concerned that they will not be able to afford laser projection if they screen significantly fewer hours a week, and therefore have reduced capacity to pay back the cost of a laser system.
- ▶ There can be a break-even point where payback is positive even for smaller auditoria. There is a wide variation in the pricing of different laser systems, but the relevant calculation now is not the immediate cost of the projector but the Total Cost of Ownership over its lifetime.

Does the light output of laser projectors degrade over time?

- ▶ Yes, it does, in two distinct ways.
- ▶ Over the useable life of the laser projector, the lasers do also degrade. Manufacturers usually factor this in at the customer consultation stage by building in a suitable headroom to allow for light loss.
- ▶ The operational life of lasers may vary depending on temperature. Systems should be operated within the manufacturer's guidelines for temperature.
- ▶ Optics of a projector degrade over time but not in same way as xenon (better than Xenon).

Will laser projection mean a higher foot lambert grade for 3D?

- ▶ With high lumen output laser projectors, it is possible to project at higher 3D light levels.
- ▶ However, even if brighter 3D levels are possible, most DCPs are mastered at between 3.5 to 5.5 fL. In such cases, projecting 3D at higher levels will affect the colour reproduction and contrast and could increase 3D ghosting in polarized systems.
- ▶ In addition, even if a higher brightness DCP is needed, the relevant version from the distributor may not be available.
- ▶ However, as high lumen projectors become more common, it is likely that higher grade DCPs will become more commonplace and help 3D to become brighter and retain quality levels.

Can you replace a laser source at end of life?

- ▶ Yes, it is possible to replace a laser light source once it ceases to be viable.
- ▶ However, the light source may outlast the projector where laser is used as a light source.

3. Safety and Training

What are the risks of laser projection

- ▶ Laser Projectors are rapidly becoming the pre-eminent technology of choice as users search for higher brightness, lower running costs and higher performance for all shows.
- ▶ Initial concerns about laser safety have been managed within designs to mitigate risks for both technicians and audiences.
- ▶ It's worth remembering that lamp-based projectors are not risk-free and also need specialist training and care. The same is true for laser illuminated systems. Make sure instructions are read and followed carefully.
- ▶ Lasers deserve appropriate care which varies with model and brightness level. It's wise to ensure that the audiences don't stare directly into bright lights of any kind to protect the retina of the eye.
- ▶ Specific measures will be advised by manufacturers and installers to ensure users and audiences get the best possible and safe experience to enjoy movies.

Who can work on laser projectors?

- ▶ Most projector manufacturers advise that the person operating the projector needs to have a minimum required level of laser and projection training e.g. factory-based training programmes. Please check with your manufacturer or integrator and adhere to the local company health and safety policy.

Maintenance

- ▶ Apart from the specifics of the light source, which is the only real difference, laser projectors are treated the same as a lamp-based projector and a suitable maintenance regime is as important.

Lamp-based projectors have risks too

- ▶ Xenon lamps are not risk free when it comes to lamps that can explode when mishandled.
- ▶ Xenon lamps can also emit dangerous levels of UV if the projector is not properly maintained.
- ▶ While normal screen viewing is not harmful, looking directly into a lamp (Xenon and Mercury) light source will damage eyesight.

4. Warranties

What is the standard warranty and is light output over time covered?

- ▶ The standard warranty for laser projectors is two or three years, depending on the manufacturer.
- ▶ There is no difference between the standard warranty period for RGB Laser and Laser Phosphor.
- ▶ The manufacturers do also offer extended warranties for a greater cost. Currently, extended warranties are between 6 and 10 years, depending on the type of projector and the manufacturer in question.
- ▶ Light output over time can be guaranteed. This varies by manufacturer and projector type.

Does the warranty carry stipulations regarding the ambient temperature of the projection room?

- ▶ Yes, there are stipulations on temperatures within the projection room. This has always been the case, including where lamps are used as a light source.
- ▶ Manufacturers have varying stipulations and these typically range between 25 and 35 degrees Celsius.
- ▶ Typically, this is monitored using log files and remote monitoring.

5. Questions we can't answer

5. Questions we can't answer...

Q: Does laser look better than Xenon?

- ▶ Laser-illuminated projectors now come in many shapes and sizes, and the image differs accordingly. Laser can look better than Xenon but doesn't necessarily.

Q: Do customers really notice the difference between laser and xenon illumination?

- ▶ This is very subjective, and almost unanswerable, but it's certainly not a clear tangible difference such as between a 2D presentation and 3D presentation.

5. Questions we can't answer...

Q: Are laser projectors worth the increased cost?

- ▶ There is now a wide range of laser illuminated projection available. These machines are not always necessarily more expensive than their digital equivalents, especially in the case of laser phosphor. The cost of RGB laser machines is also on the way down. An exhibitor needs to look at the screen by screen requirements within their estate, and judge whether the cost differential, if it exists, is worth the extra performance. Ultimately, each screen offers a different business case.

5. Questions we can't answer...

Q: Will laser projection revive interest in 3D due to greater brightness capabilities?

- ▶ The standard of 14fL is a long way off for most 3D images. As an industry, we have accepted this lower brightness as a way to get 3D out there but one of the issues with 3D has been brightness of the image once it gets to the customer's eye. High lumen laser illumination will address this issue in part or full by adding brightness to the image, but brightness is not the only issue that people have with 3D. Laser cannot address all the issues, such as quality and supply of content and the need to wear glasses. Therefore, it is hard to say whether laser illumination alone will be able to revive 3D.

5. Questions we can't answer...

Q: Will LED supersede laser illuminated projection?

- ▶ It is too early to tell when and whether LED screens will replace projectors in cinema auditoriums. We should not assume they will just because they are in the market, and by the same token we shouldn't assume they won't because they are not the way Cinema is done. The number of LED screens installed is still very low, and the technology is still being tested by exhibitors and technology companies alike. Any market conversion to LED will necessarily take time, maybe a decade given the installed base of projectors.

5. Questions we can't answer...

Q: How do we explain the value of laser projection to consumers?

- ▶ This slide deck is mainly concerned with explaining the basics of laser-illuminated projection, not with the marketing of this technology. However, we can note that a small number of pioneer exhibitors have chosen to talk up laser, building a brand around it.

5. Questions we can't answer...

Q: Is phosphor laser a real long term alternative to RGB?

- ▶ Laser phosphor has been installed in the thousands of units, over 10,000 at last count. Many of these are in China. It is more of a workhorse technology than RGB laser, relatively cheap and replacing Xenon-based machines in small to medium sized auditoria. As RGB laser comes down in price, the need for a laser-phosphor alternative may become reduced but the numbers already in the market could also suggest that it is a technology that has enough distinct difference from RGB laser and traditional Xenon and mercury-based illumination to warrant its continued existence.

6. Further sources of information

- ▶ For more information, including from manufacturers, here are some useful links:
- ▶ <https://www.lipainfo.org/>
- ▶ <http://www.lamptolaser.com/>
- ▶ <https://www.barco.com/en/aboutbarco/Corporate%20Sustainability/Compliance/WEEE>
- ▶ <https://www.barco.com/en/support/training/Barco-High-Brightness-Safety-training.aspx>

7. Important Note

- ▶ There are many permutations of laser projectors, 3D systems, screen types and auditoria and we have not attempted to break down what works best with what.
- ▶ For this reason, it is very important for a cinema exhibitor to test all technology into which they are investing in the appropriate screen and under as realistic conditions as possible.