The Solid State Laser (SSL) Myth

By: Dr Oded Amichai, Omedia – The Security Agenda, 19.1.2007

A laser systems expert, Dr Oded Amichai, argues that we should use the available Skyguard system to intercept the Qassams and other short and medium range rockets, instead of waiting for a new and better laser system

One of the arguments against implementation of the available Skyguard system to intercept the Qassams and the other short and medium range rockets, launched from the Gaza strip and the Southern Lebanese areas, is the expectation for a new and a better laser – a Solid State Laser (SSL) at power levels of 100-150KW. This is an insubstantial wish, for the following 7 reasons:

(Note: By Solid State Lasers we refer here both to Solid State Nd:Yag and Nd:Glass slab lasers and to Solid State Fiber Lasers).

1. System: The laser is only a small part of the entire weapon system, including target identification, acquisition, tracking, pointing, etc. If and when a better laser will be available, which may not necessarily be a SSL, it may easily be integrated in the Skyguard weapon system, replacing the Chemical Laser.

Northrop Grumman, the company which has developed the Skyguard, is also the leading company in SSL development, demonstrating the highest power (25KW) SSL with good beam quality and long run times to date. The company has clearly stated that it will take close to a decade before a laser weapon demonstrator based on a SSL could be developed. So why should we wait for a better laser when an efficient and a cost effective weapon system – the Skyguard, already exists?

2. Know-how Gap: The current state of the art for slab-based SSLs with good beam quality and operational run times is 25KW. A modular scale up of this laser to 100KW output power in a laboratory configuration is currently underway at Northrop Grumman and is expected to be completed in two years. Even this may not be enough to defend populated areas and high-quality targets, having a too short lethal range against various rockets.

The fiber lasers are even more premature, with demonstrated power levels of only 2KW per fiber at a good beam quality. The quoted figures of tens of kilowatts of laser powers relate to bundled fiber lasers with a poor beam quality, which are inadequate to defend large areas against rockets, due to the low laser power and the bad beam quality.

3. Power Source: The state of the art SSLs, both slabs and fibers, are laser diodes pumped, with efficiencies in the order of 10%, which hasn't been demonstrated yet in the needed high powers. Therefore, a 100KW laser requires a megawatt class power supply, which is bulky and certainly not easy to field.

4. Heat Removal: 90% of the electrical power not converted to laser power shows up as heat which must be removed in real time as the laser is lasing, for it to continue lasing. There are currently no efficient and compact heat removal systems in the one megawatt range.

5. Beam Quality: High beam quality in SSL has been demonstrated with power at or below 25KW, while high beam quality in fiber lasers has been achieved with power at or below 2KW only. This is mainly due to the basic difficulty of heat dissipation in slabs and the need to bundle many low power fibers to achieve higher powers. In some experiments, good beam quality has been achieved at higher powers in slabs, for short periods until the beam quality declined using the heat sink idea. This can be accepted in demonstrations but not in real weapon systems.

6. Atmospheric propagation: Having a much shorter wavelength (1 micron for SSL, vs. the 3.8 micron DF chemical Laser), a SSL laser beam is degraded by the atmosphere much more than a DF laser beam and it will be much more sensitive to the weather conditions. Turbulence causes a large beam spread and any atmospheric particulates (dust and haze)

cause much larger scattering, both reducing the beam intensity on target. In fact, for a SSL to be effective at all it requires advanced atmospheric compensation techniques, much as Adaptive Optics, which have not been demonstrated yet.

7. Safety: SSLs, operating at 1 micron, are not eye-safe. The main problem is not only from direct radiation but actually from scattered light, which may blind the people that it meant to protect. Solid state eye-safe lasers are much more premature.

Hence, the current high power SSLs, both slabs and fibers, are unproven technologies. No one knows that they will work, or if they do, how well they will do so with regard to availability, reliability and effectiveness.

This is in contrast to the Skyguard, based on 30 years of proven chemical laser technology, which has inherently solved the SSL's major difficulties:

a. Its power source results from burning fuels, eliminating the need of electrical power supplies.

b. The major part of the heat is dissipated with the high speed gas flow.

c. Excellent beam quality has been demonstrated at the relevant power levels.

d. The scale up rules are self evident, enabling reaching almost any desired power.

e. Its wavelength is ideal for atmospheric propagation, and lastly

f. Its radiation is eye-safe.

The Skyguard is already operating at full scale with dozens of successful interceptions of various rockets at 100% effectiveness. The state of the art SSLs are not a real challenge to the available, efficient, cost effective and matured Skyguard system. Currently, it is like comparing a toy revolver to a sub-machine gun. If and when a better laser will be developed, it may easily be implemented in the Skyguard weapon system, replacing the current chemical laser.

Physicist, Dr Oded Amichai, is a laser systems expert and consultant in the commercial development of lasers and electro-optics. He served as the head of the physicality department at Rafael, and is the Chief Engineer at the Center for Advanced Development (Elron). He is the founder, CEO, and President of Optomic, a satellite communication and commercial lasers company. He was one of the fathers of the Nautilus program and supervised it voluntarily from its start until today.