28PD5

DEVELOPMENT OF A CO_2 LASER FOR SPACEBORNE DOPPLER WINDLIDAR

David V Willetts and Michael R Harris
Defence Research Agency
St Andrews Road, Malvern, Worcs WR14 3PS, UK
Telephone +684 895414, facsimile +684 894166

Errico Armandillo and Callum Norrie
ESTEC, Keplerlaan 1
2201 AG Noordvijk, The Netherlands
Telephone +1719 83742, facsimile +1719 85430

Paul M Schwarzenberger and Steve Wallace
GEC Hirst Research Centre
Applied Physics Division, Elstree Way
Borehamwood WD6 1RX
Telephone +817320140, facsimile +812070331

Wolfgang Schäper and Mattheus Gollor
Dornier GmbH, PO Box 1420
D-7990 Friedrichshafen, Germany
Telephone +7545 84915, facsimile +7545 88983

Enrico Galletti and Emanuele Stucchi
CISE SpA, via Reggio Emilia 39
Segrate, Box 12081, I-20134 Milan, Italy
Telephone +22167 2651, facsimile +22167 2620

There is currently considerable interest in space-based Doppler wind lidar for weather forecasting and climate studies. The transmitter laser is recognised to be one of the most critical technologies and has been the subject of breadboarding activities in both Europe and the USA. Both communities have chosen carbon dioxide sources and we present the current status of an international activity, supported by the European Space Agency, to build a potentially space-qualifiable laser with appropriate performance characteristics. These are shown in Table 1.

Target Specification

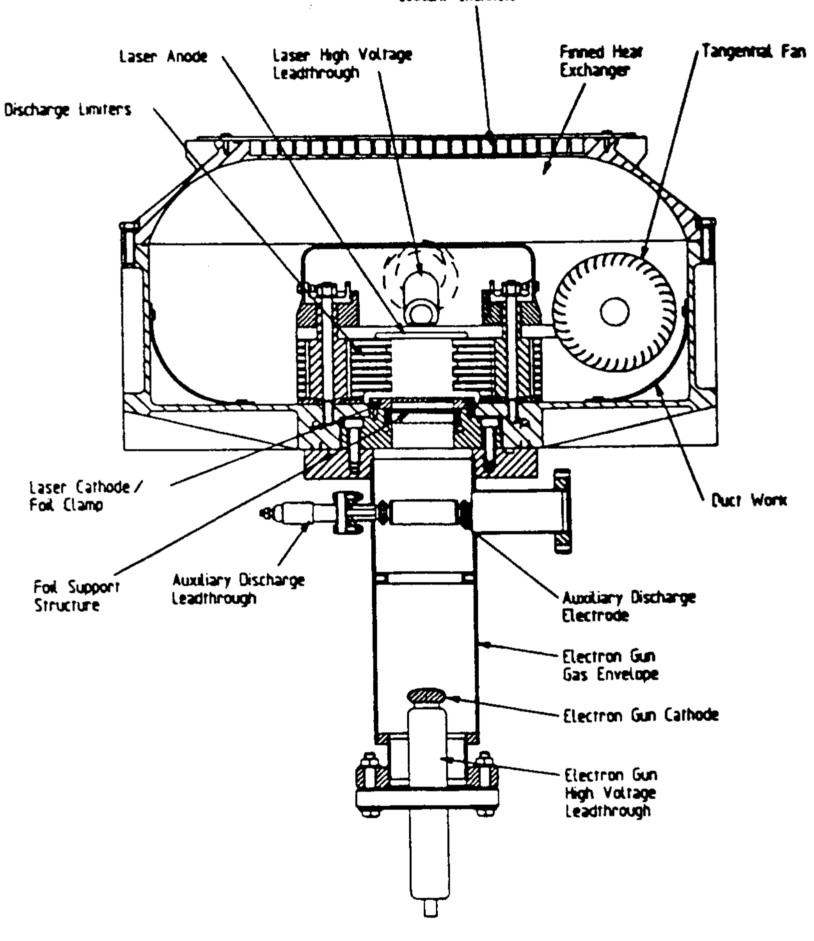
Operating lifetime	3 yrs	10^9 pulses
Pulse repetition frequency	10Hz	
Output energy		10J
Pulse length		5μs
Frequency stability within pulse		200 kHz
Wavelength		9.25μm
Polarisation		Linear
Pointing stability		< Beam divergence
Single mode efficiency		5% wallplug

Electron-beam sustained technology was selected to deliver the relatively long pulse length with maximal efficiency and excellent discharge stability. This required design of a suitable electron gun capable of satisfying the demanding lifetime requirement. Standard UHV technology was adopted; the design appears in Figure 1. Extensive thermal and fatigue tests have been carried out on the foil windows and 13μ titanium or titanium alloy have been selected on the basis of modest temperature rise (100°C), and consequent demonstrated fatigue life to 10^9 pulses in a simulator. A compact pulse transformer has been designed and built with a direct HV interconnect to the gun to prevent exposure of the 130kV pulses to space vacuum.

A further benefit of e-beam operation results from the reaction of O_2 and CO (formed in the secondary discharge and limiting gas life) by the high energy primary electrons. Parametric studies have revealed that the optimum gas mixture contains about 3% CO and < 0.2% O_2 in addition to CO_2, N_2, and He. Sealed runs have extended the validity of these studies to 10^7 pulses.

Figure 1 also shows the layout of the gain cell in cross section, which is of conventional transverse flow design. A cross-flow fan ensures gas changes between pulses. The ceramic discharge limiter structure supports and insulates the high voltage anode, and a finned heat exchanger extracts waste heat with a thermal conductance of about 1kW/°C. Design verification tests have led to an optimum pressure near 0.5 bar with an input energy loading of 125 J/l atm at a drift field of 5kV/cm atm, giving an efficiency of 17% multimode and 10% single transverse mode at a wavelength of 10.6μ. A positive-branch unstable resonator using graded-reflectivity output coupling was used for selecting the single mode.

Detailed results will be presented, including the latest tests on the assembled breadboard laser.



Cross-section Through Laser and Electron Gun