uniklasers.com
info@uniklasers.com

The Challenges in Developing Lasers for Quantum Applications

Mark Mackenzie
mark.mackenzie@uniklasers.com

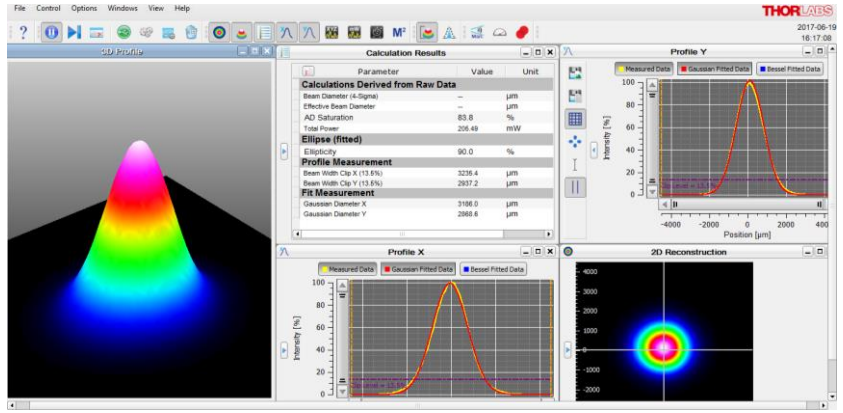
UniKLasers - Company

UniKLasers Ltd is a UK-based company founded in 2013 which produces CW Single Frequency DPSS lasers in a wide range of wavelengths for precision applications.

- Experts in Single Frequency DPSS lasers
- UV, Visible and Near-IR wavelengths

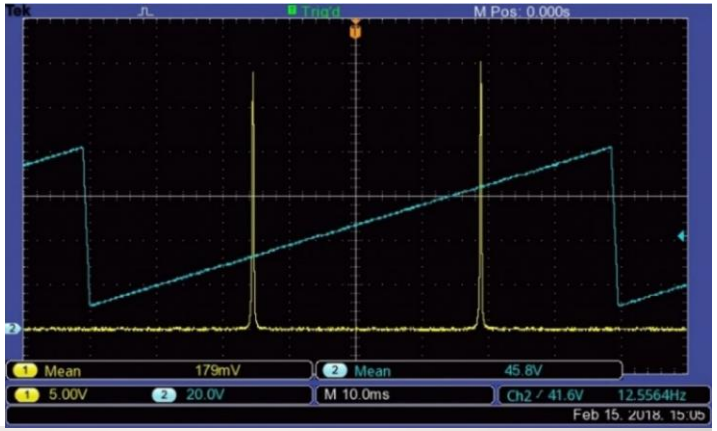
✓ Single frequency
✓ Power stability
✓ Wavelength stability
✓ TEM_{00} Beam quality

Common specifications	
Coherence length	>100 m
Linewidth	<0.5 MHz
Wavelength Stability	<0.5 pm
M^2	<1.1

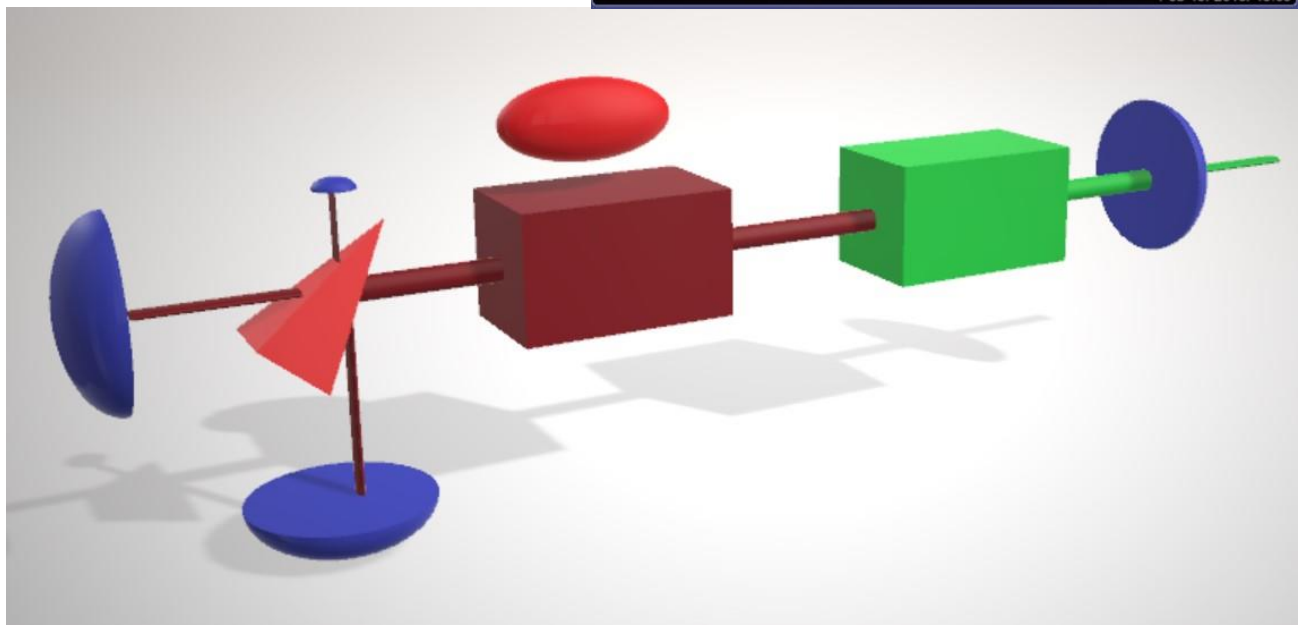


BRaMMS Stabilisation

Our lasers use our patented BRaMMS (Bragg Range Michelson Mode Selector) technology to ensure long term wavelength stability.



Single mode operation is obtained through the use of a volume Bragg grating and Michelson interferometer within the cavity. Stabilisation is then provided by the tilt locking method.

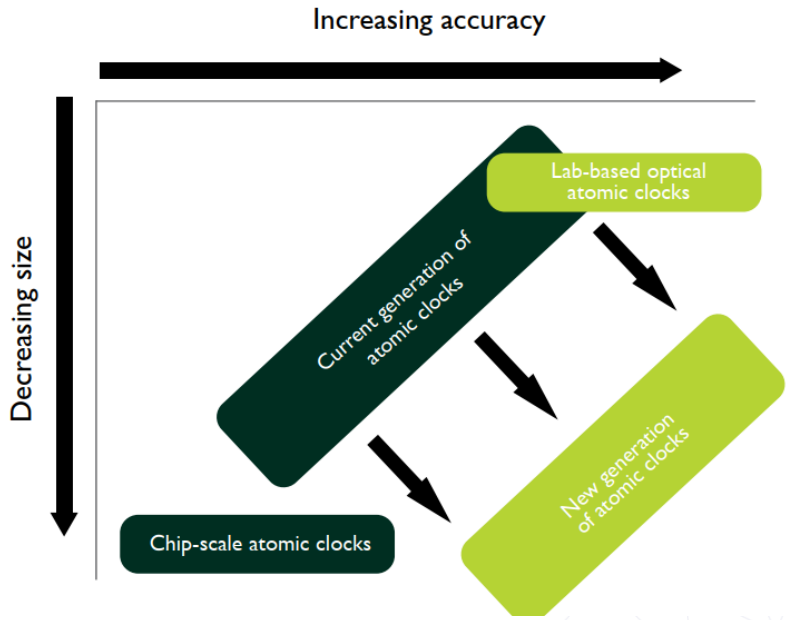


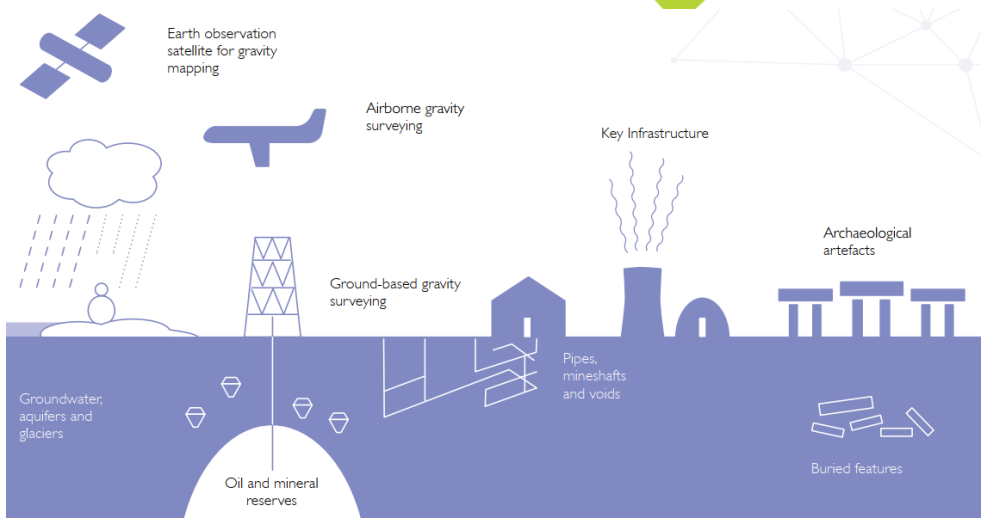
Requirements for Quantum Applications

There is research ongoing to produce quantum based devices which can improve current measurement techniques. These include quantum clocks and gravitometers which have applications such as navigation, trading and sensing.

These applications require extremely stable and narrow linewidth laser sources compared to other applications such as holograph and optical inspection.

To meet these requirements we have been involved in a number of projects to develop lasers targeting Strontium and Rubidium absorption lines.





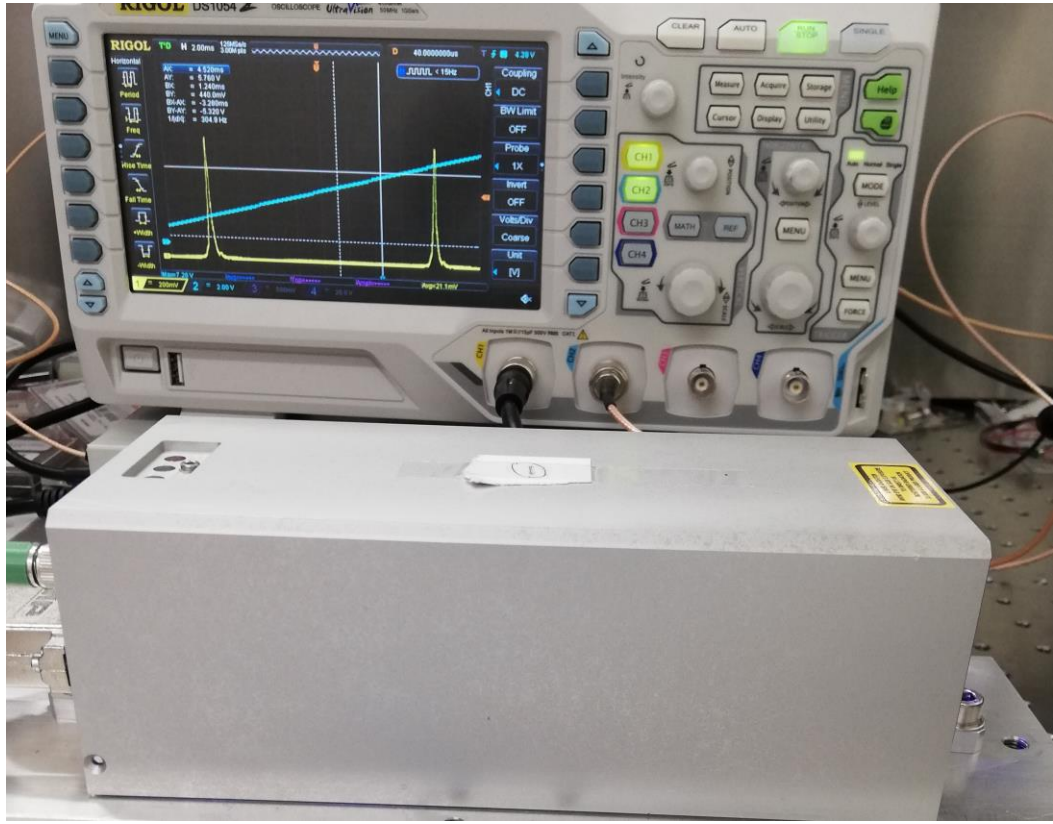
The quantum age: technology opportunities 2016

Laser Miniaturisation

The goal of the PLAID project was to develop a compact DPSS 698 nm laser system suitable for use in Strontium based clocks.

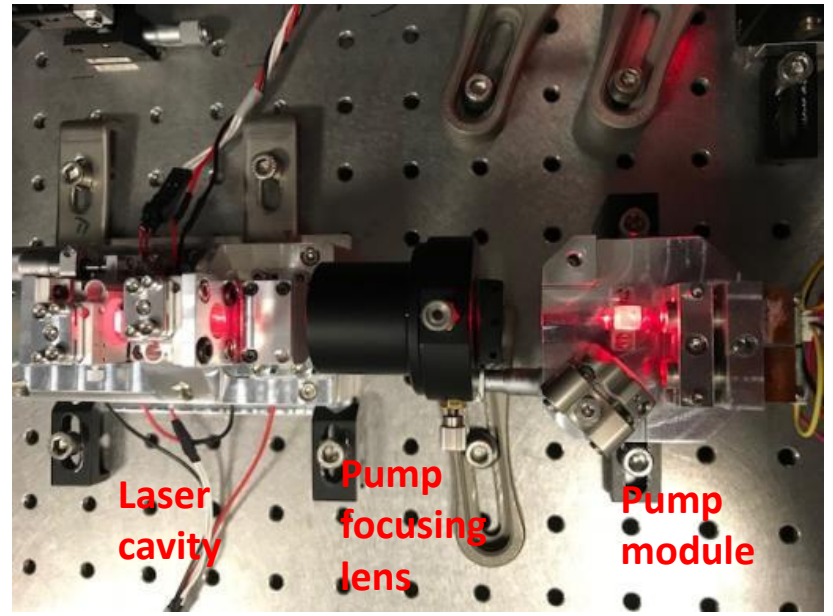
These are required if such clocks are to be made portable as large scale systems are unsuitable to the task.

We produced a system with a footprint of 20x8x7 cm tuneable over 698-698.7nm with power levels up to 70mW.

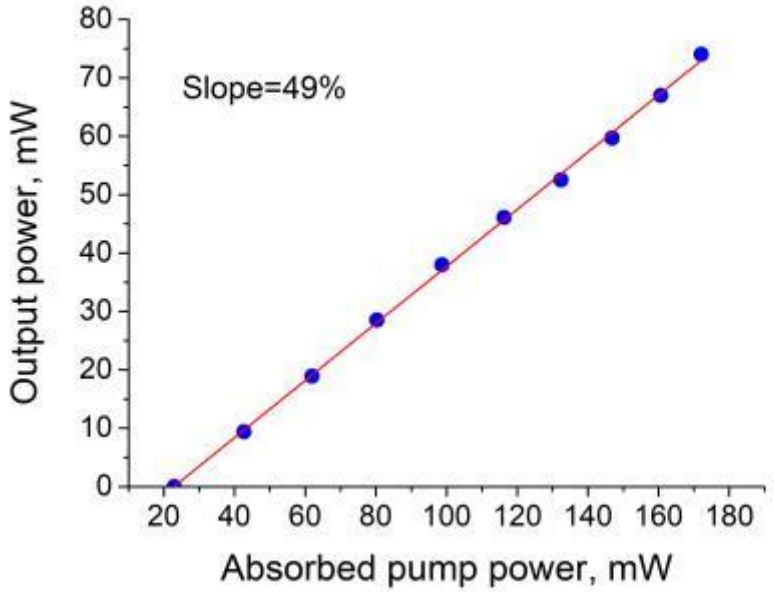


Laser Miniaturisation

If atomic clocks based on Rubidium atoms are to become widely used they must be portable. The MINUSQULE project aimed to develop a compact DPSS excitation laser operating at 780 nm.



This project used 640 nm diodes for efficiency and a compact cavity based on a VBG and HR output coupler.



This was successful producing a compact system with output power of up to 80 mW. These results fed into future projects.

PIONEER GRAVITY

GRAVITY PIONEER
Gravity-pioneer.org

For over 30 years, universities and academics have been exploiting the strange effects of quantum superposition to measure gravity with astonishing sensitivity. Using a process called cold-atom interferometry, the wave-partial duality of a rubidium atom is compared to the phase of a laser beam in a way which can detect very small changes in the way atoms fall freely in a vacuum.

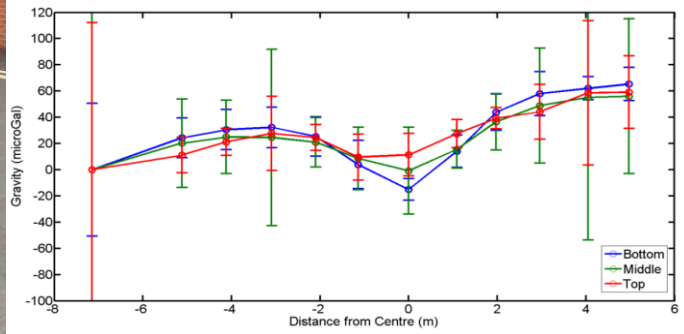
Changes in this free-fall can be used to determine the local strength of gravity and if this measurement is sensitive enough, the measurement can be used to tell whether there are voids, pipes, tunnels, oil and gas reserves in the ground beneath your feet.

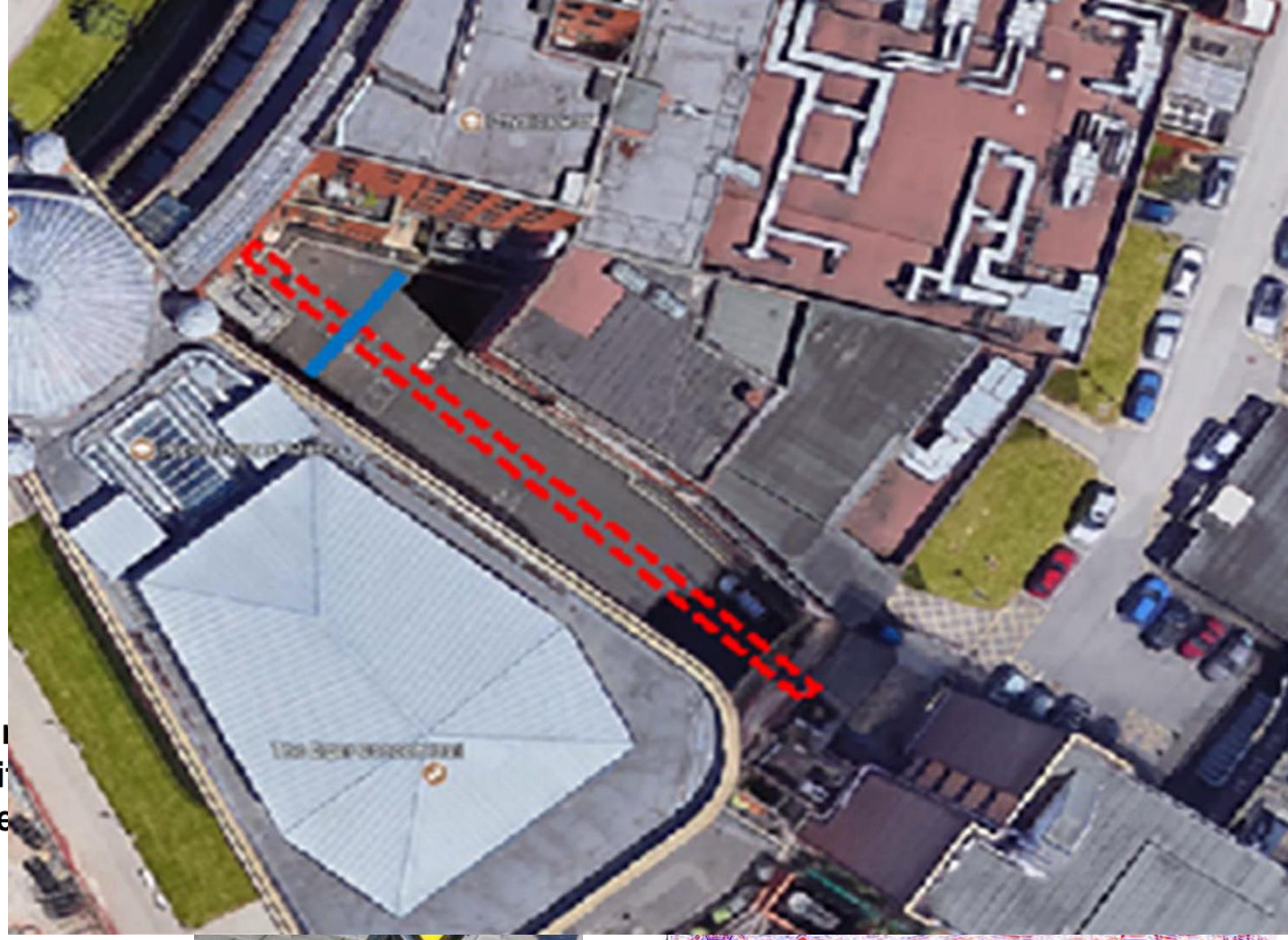
GRAVITY PIONEER

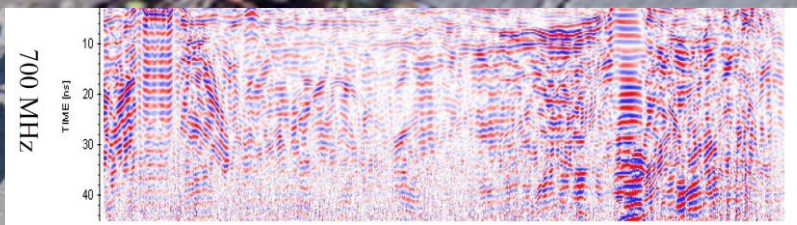
Initial target selected, a tunnel at the University of Birmingham.

Backup sites also investigated.

Gravity







UNIVERSITY OF BIRMINGHAM

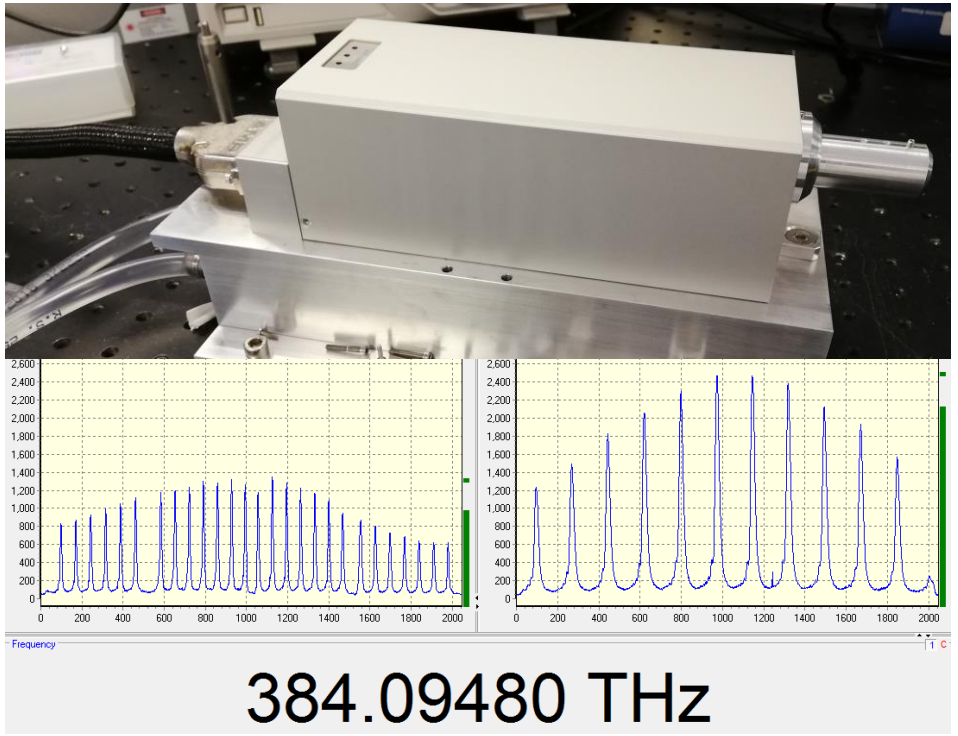
Geomatrix EARTH SCIENCE LTD

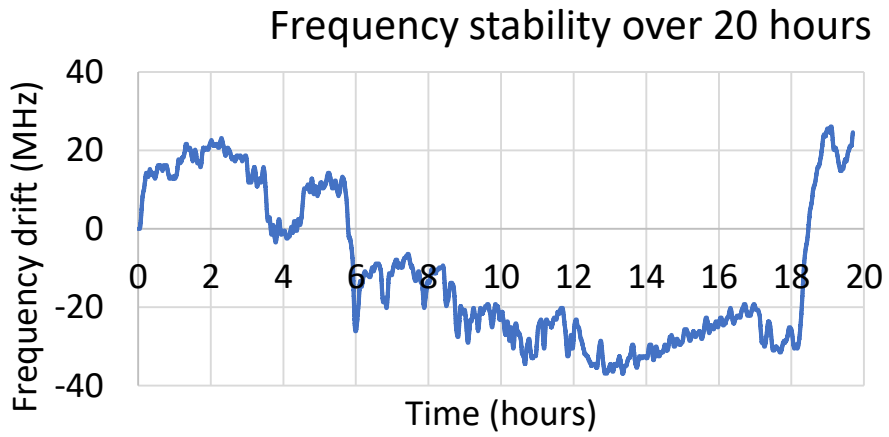
GRAVITY PIONEER

The demands for the project are very high. Not only must the laser be stable with narrow linewidth it must also be able to operate outside lab based environments. In a field with large temperature swings and significant vibrations.

The initial system produced for this project shows high stability and is undergoing testing by project partners.

A second improved system is in production with higher power and more tunability reduced linewidth based on results of previous system.





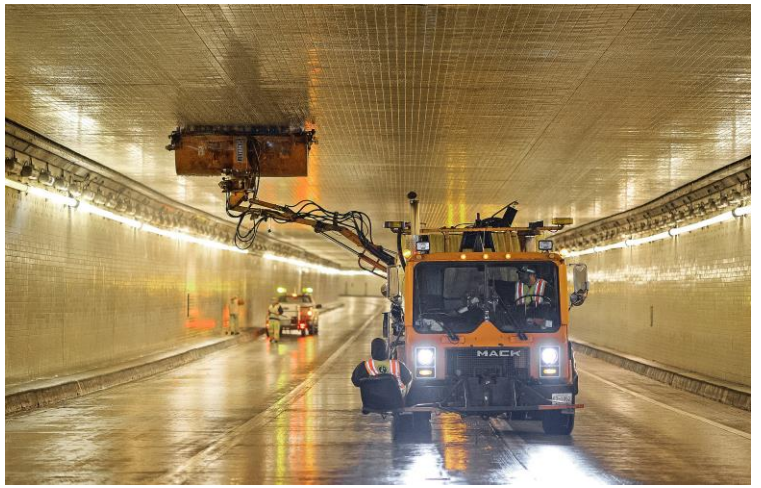
GRAVITY PIONEER

The next stages of the PIONEER project involve integration of laser sub components into the overall quantum gravity sensor.

Filed trials are planned against known gravity features and will lead to further improvements to the systems.

The end goal of the project is to produce a quantum based gravity sensor which is of commercial interest and the project partners are in talks with several companies to take part in final testing.

Project website: **Gravity-pioneer.org**



Conclusion

Home of Single Frequency DPSS Lasers

UNIK LASERS

Thanks to partners involved in development of laser systems and application testing through the following projects.

MINUSQULE

Fraunhofer UK

PLAID

University of Birmingham & Fraunhofer UK

GRAVITY PIONEER

RSK, TELEDYNE e2V, University of Birmingham, Fraunhofer UK, Optocap, University of Southampton, Magnetic Shields Electromagnetic Engineering, SMG Silicon Microgravity, QinetiQ, Altran & Geomatrix earth science LTD

UNIVERSITY OF BIRMINGHAM

Fraunhofer UK

Geomatrix EARTH SCIENCE LTD

GRAVITY PIONEER

This presentation was presented at EPIC Meeting on New Space 2019

HOSTED BY

European Space Agency

SILVER SPONSORS

EU initiatives funded by
www.photonics21.org

BRONZE SPONSORS