Applied laser/photon diagnostics

Background

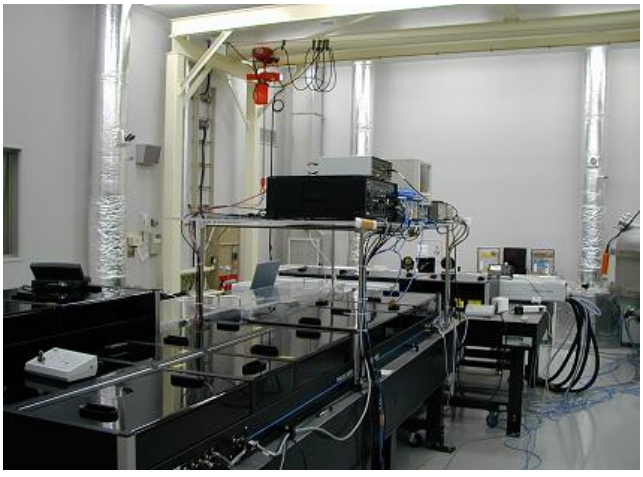
Laser technology enables non-contact and remote information acquisition, and is one of the key technologies in lifetime evaluation of electric power equipment and in environment monitoring system. We carry on developments of new diagnostics technology based on x-ray generation using a ultra-short pulse laser (T^3 Laser: Table Top Terawatt Laser) and laser radar systems for atmospheric observation.

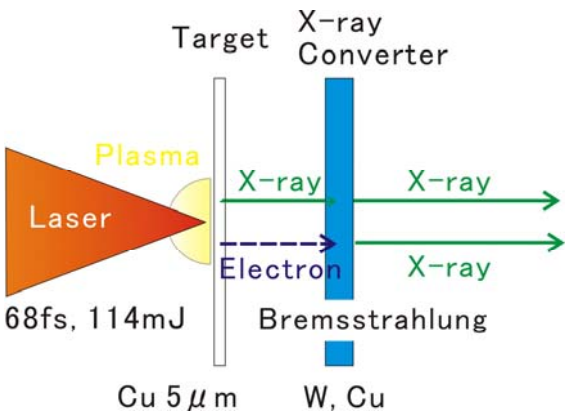
Principal results

Laser technologies for x-ray transmission inspection and remote measurement of aerosol constituents using a laser which concentrates energy in a short time (50 femtoseconds), gas leakage detection, power plant flue gas measurement, non-contact temperature measurement of high temperature metal parts, and flaw detection of metal parts have been developed. For environmental monitoring, a laser radar which can measure atmospheric SO_2, NO_2, and O_3 with the world's highest sensitivity has been developed.

Future Developments

New measurement diagnostics technologies which will enable non-destructive, non-contact, real time, remote measurement will be developed. These technologies are expected to contribute to lifetime elongation and efficient operation of electrical power transmission and distribution equipment, thermal power generation equipment, and nuclear power generation equipment. These technologies will also be applied to environmental monitoring and contribute to solution of environmental problems.





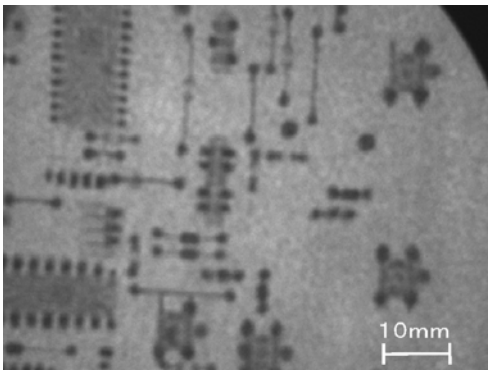
Concept of x-ray generation using T^3 laser

T^3 laser system

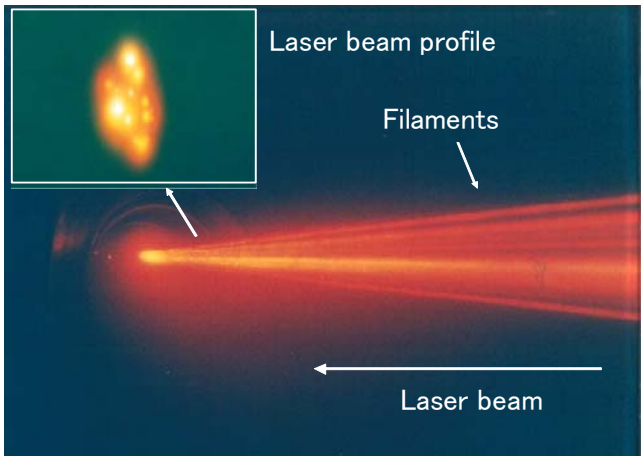
This system can emit ultra-high intensity laser beam with only 1Joule energy because of the ultra-short pulse duration (50fs) .

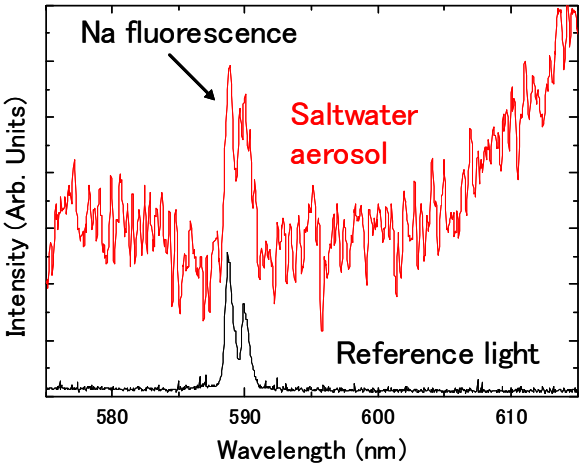
X-ray generation using T^3 laser

Focus irradiation of ultra-high intensity laser on a copper film generates high-temperature and high-density plasma instantaneously. X-ray is generated by electrons emitted from the plasma. Since laser-plasma x-ray can be superior to an x-ray tube or an isotope in small size, high energy and high spatial-resolution, application to precise radiographic testing in a narrow space is expected.



An example of x-ray imaging using the laser-plasma x-ray (IC circuit)



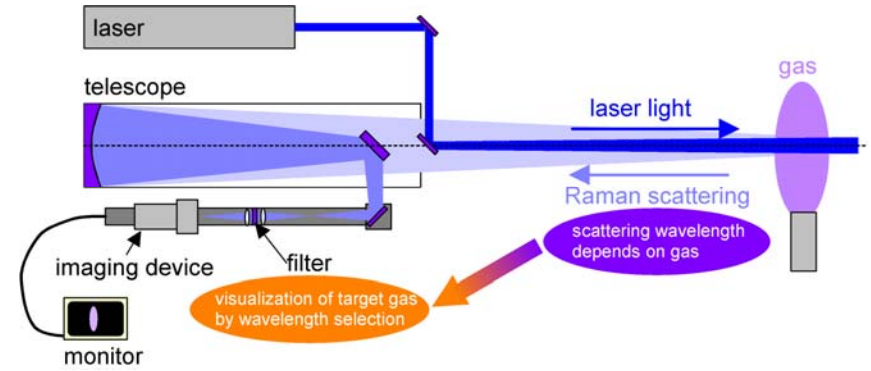


Filament propagation and laser beam profile

Spectra of Na fluorescence from saltwater aerosols

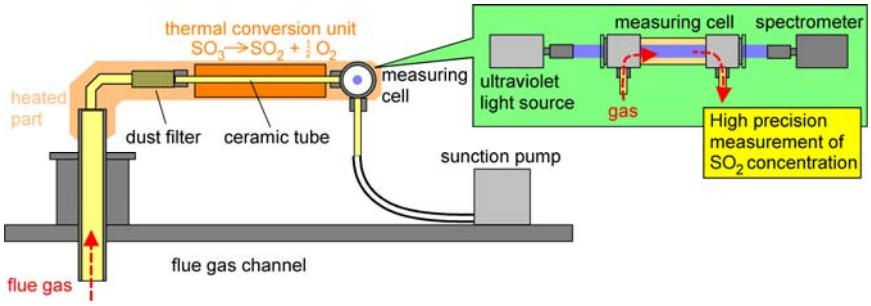
Remote measurement of constituents of microparticles in air by laser-induced breakdown spectroscopy

Propagation of an ultrashort high-intensity laser pulse in the atmosphere produces a bundle of filaments, which can propagate with focused condition for a long distance. We demonstrated remote measurement of Na fluorescence from artificial saltwater aerosols in air at a distance of 16 m by laser-induced breakdown spectroscopy (LIBS) using filaments. This technology is useful for identification of the constituents of atmospheric aerosols and diagnostics of equipments.



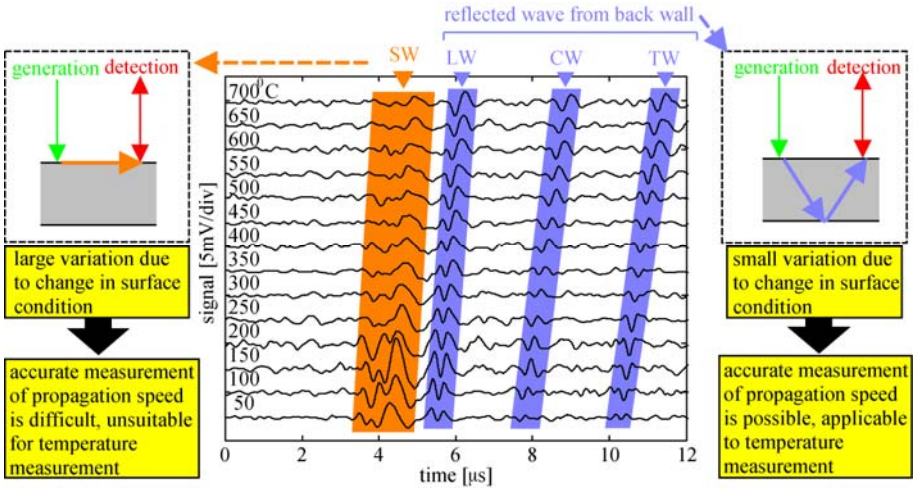
Remote leak gas detection using Raman scattering

When laser light is irradiated on gas, Raman scattering light, whose wavelength depends on the type of gas, is generated. By spectral analysis of Raman scattering light, the gas can be identified. This technology is useful for remote detection of gas leaks in industrial plants.



Flue gas measurement

Measuring SO_3 concentration in flue gas in thermal power plants is important for their efficient operation. A method for high resolution measurement of SO_3 concentration using conversion of SO_3 to SO_2 was developed.



Non-contact temperature measurement of high temperature metal parts

Internal temperature of metal parts can be measured by measurement of propagation speed of ultrasonic waves, which can be generated and detected using lasers. This technology can be used for non-contact measurement of rotating parts under high temperature, and can also be applied to flaw detection.