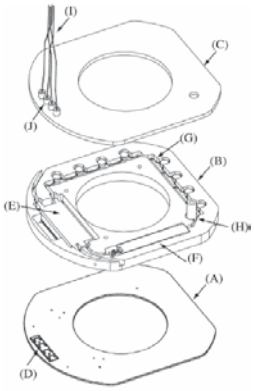
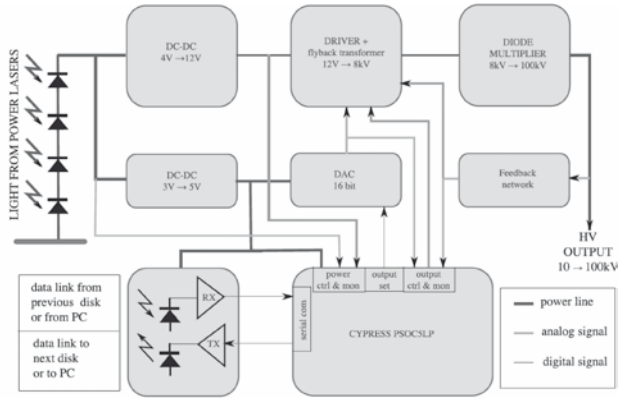
Realization of a high voltage generator by series connection of floating modules

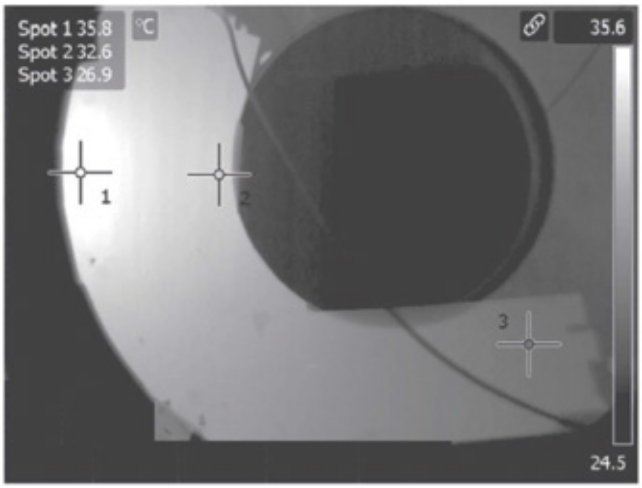
High Voltage (HV) generators, which are able to provide current up to 100 μA, can be used in a variety of applications, including the production of ion beams for proton-induced X-ray emission (PIXE) and ion implantation among others. The usual Van de Graaff high voltage generation scheme has the drawback of having moving parts. The requirement of avoiding this drawback led to the development of capacitively coupled Cockcroft-Walton high voltage power supplies that are more reliable and compact devices, being fully static objects. They are now the state-of-the art generators in the megavolt (MV) range. The HV is normally generated on two terminals in a single step by means of electrostatic belts (in a Van de Graaff generator) or by HV multiplication (in a Cockcroft-Walton generator) starting from a single low voltage, high power source. This research deals with the actual realization of a high voltage generator prototype, based on a series connection of lower voltage modules, whose feasibility was originally argued in previous researches. The power source is a laser system providing the power to the high voltage multiplier through light conversion by the photovoltaic effect on high efficiency solar cells. This wireless powering scheme allows the development of relatively low voltage floating modules which could be connected in series in order to provide higher voltages. The advantage of a modular approach with respect to current systems in the MV range is clearly in the maintenance since any intervention requires simply the replacement of the broken module. Furthermore the proposed technique allows upgrades of the system by simply adding more modules and replacing, if needed, its containment tank.



Exploded view of a 100 kV high voltage module



Block diagram of the setup and control electronics



Thermographic image of the temperature distribution on the surface of the back side of the radiator disc. The power cells are placed at spot #1 position on the front side.

Ingegneria dei sistemi elettrici

Electric Systems

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DIPARTIMENTO DI FISICA E ASTRONOMIA "GALILEO GALILEI"

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Main research topics:

- Metrology of high impulse voltages; Long distance sparks in air and influence of waveshape;
- Partial discharges. Metrology and pattern analysis in relation to component defects;
- Interturn stress analysis for MV rotating machines. Measurement of fast transients.