



Application of Blue Laser Diodes to underwater 3D imaging

L. De Dominicis

ENEA - Laboratory of Metrology and Diagnostic
Via E.Fermi 45 - 00044 Frascati (Rome)
Italy

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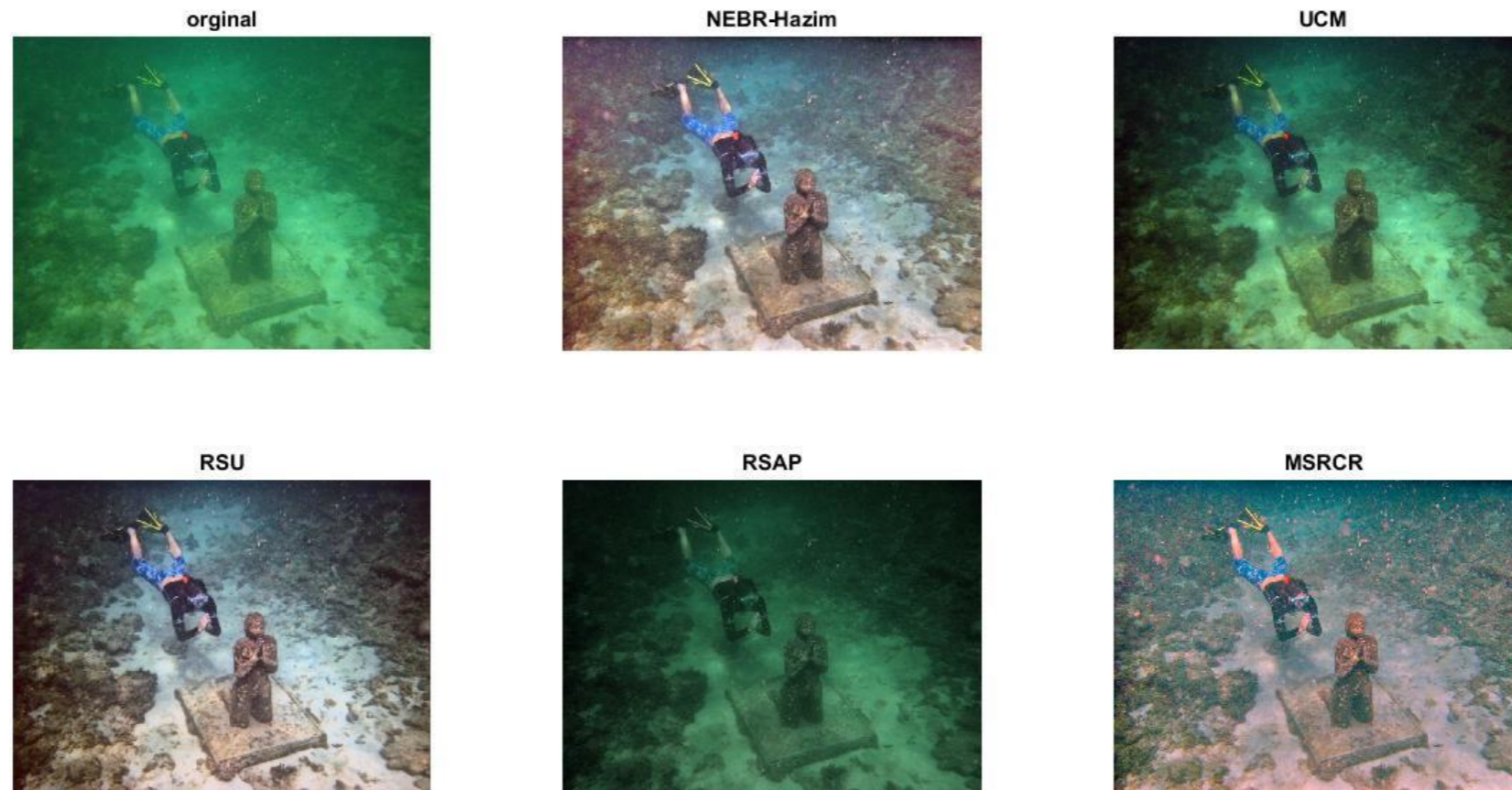
Imaging in underwater: a challenge

Underwater images recorded with conventional photocameras suffer of:

- **Low Contrast**
- **Limited range**
- **Colors alteration**



Limited inspection capabilities



Courtesy of Prof. A. Al Obaidi

Post-acquisition processing allows for image enhancement in terms of contrast and precise coloring.

Smart Imaging in Underwater with Laser

Smart Imaging in underwater environment based on **laser light** goes beyond conventional passive image acquisition and paves the way to a next level of useful information.

Benefits

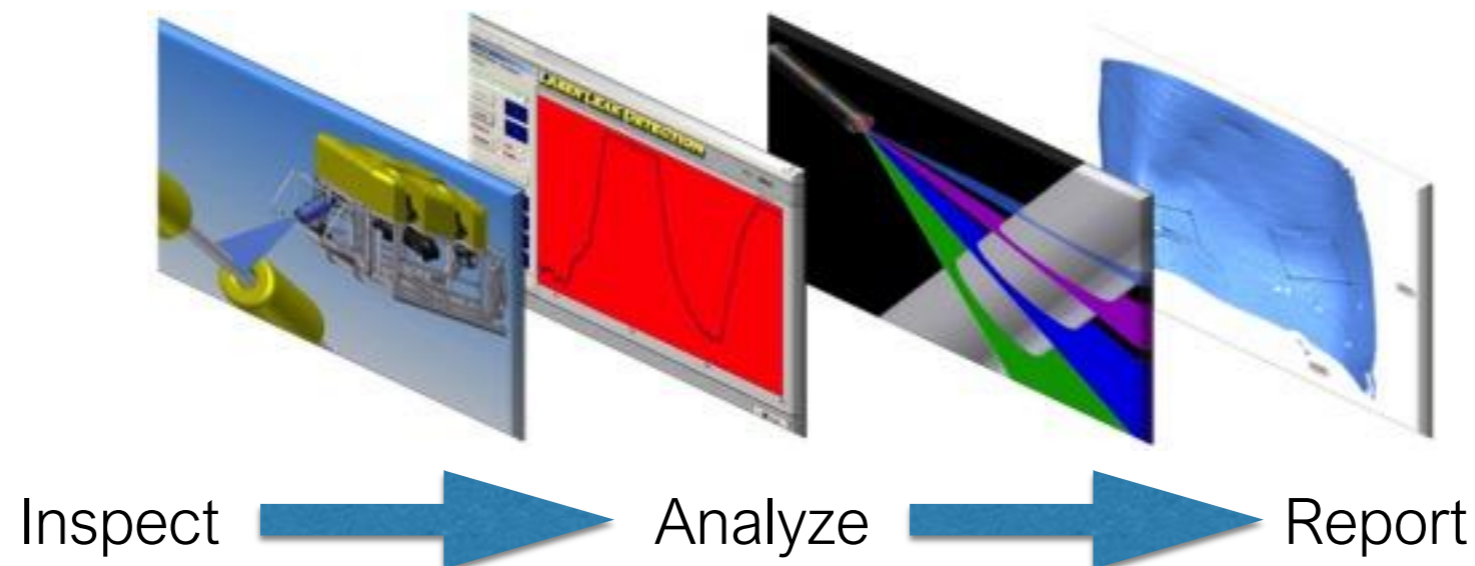
- **Contrast enhancement**
- **Extended range**
- **Quantitative analysis**
- **Real colors acquisition**
- **3D rendering**

Improved Inspection Capabilities

- **Subsea oil-fields**
- **Security**
- **Nuclear industry**
- **Naval disasters relief**
- **Cultural heritage**

Smart Imaging Generation

Powerful Information



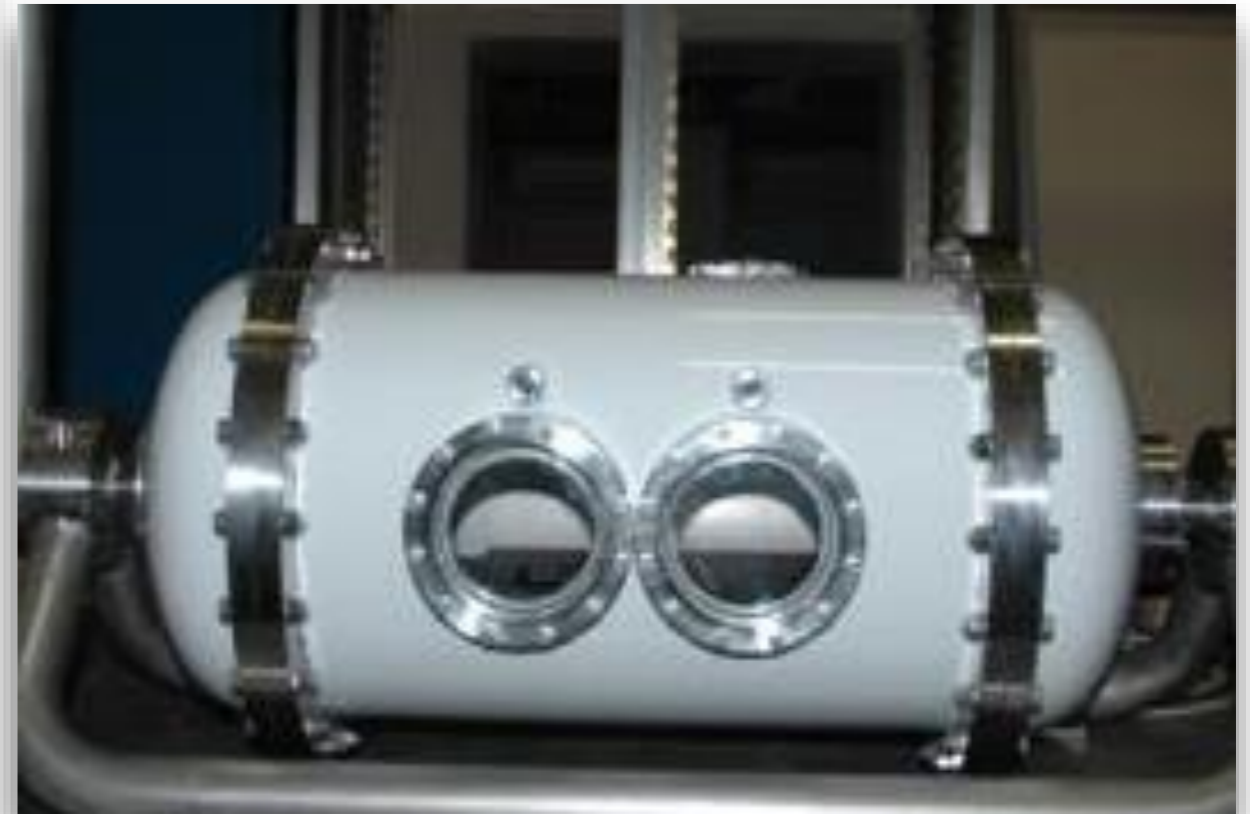
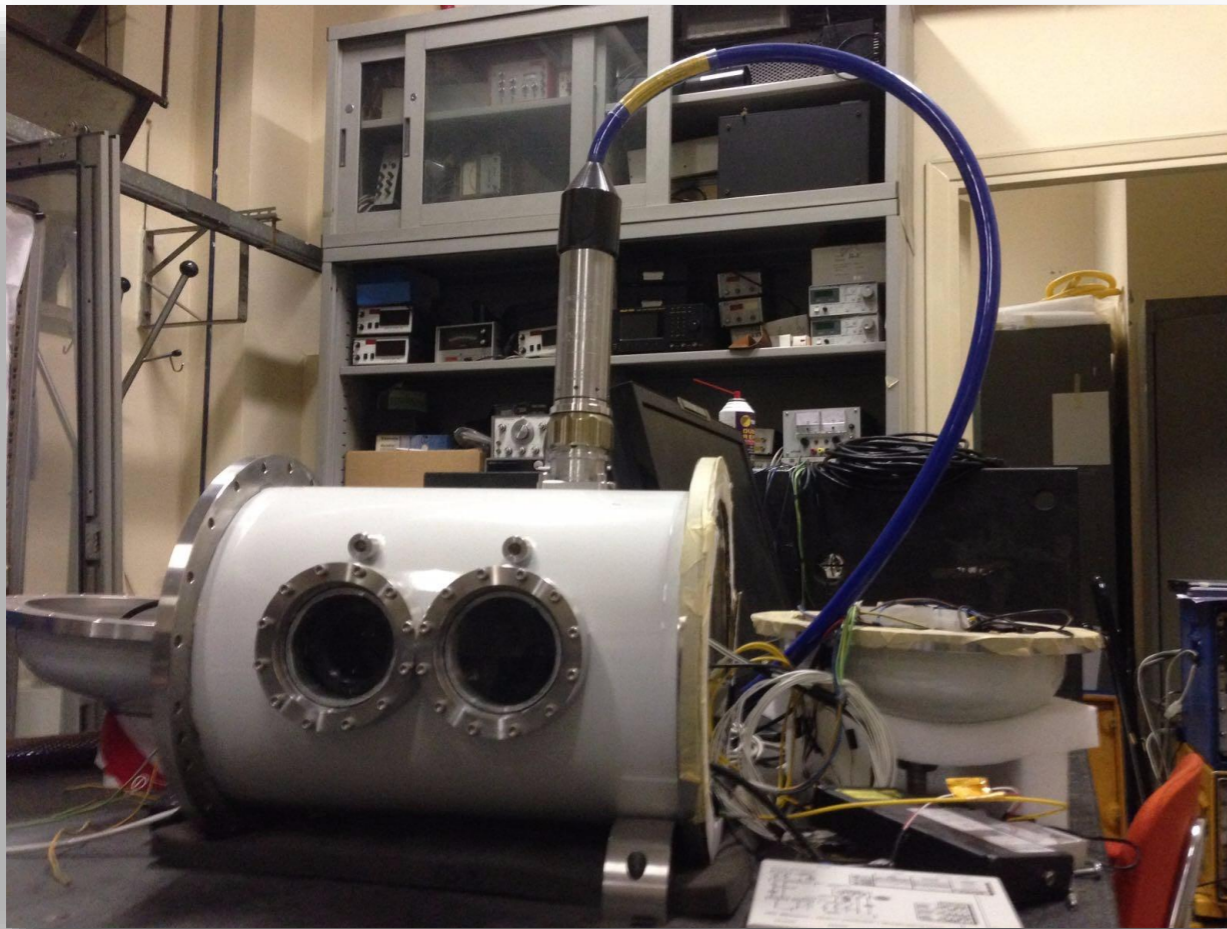
The role of blue laser diodes in underwater laser imaging

- **Pure water has a minimum of absorption around 450nm**
- **COTS Blue laser diodes, compact and with low power consumption**
- **Trend in increasing optical power output**
- **Possibility of efficient and reliable coupling in single mode fibers**
- **Possibility of amplitude modulation (digital and analogic) up to the RF range**



Blue laser diodes ideal sources for triangulation and amplitude modulated systems for 3D underwater imaging

The ENEA laser 3D imaging system for subsea applications



ENEA 3D laser imaging system based on Amplitude Modulation

Laser source: 450 nm laser diode

Modulation up to 200MhZ (analogic), 350MhZ (Digital)

Spatial single mode, fiber coupled with monolithic pigtailed solution

Power: 30mW

Scanning system qualified to operate up 1000m of depth

Weight: 30Kg

Volume: 50 L

Tethered with optical fibers

The ENEA laser 3D imaging system for subsea applications



3D model of a spool piece acquired immersing the version 2 of the device in a test pool.

Water depth 5m

Distance of the target from the sensor: 10m

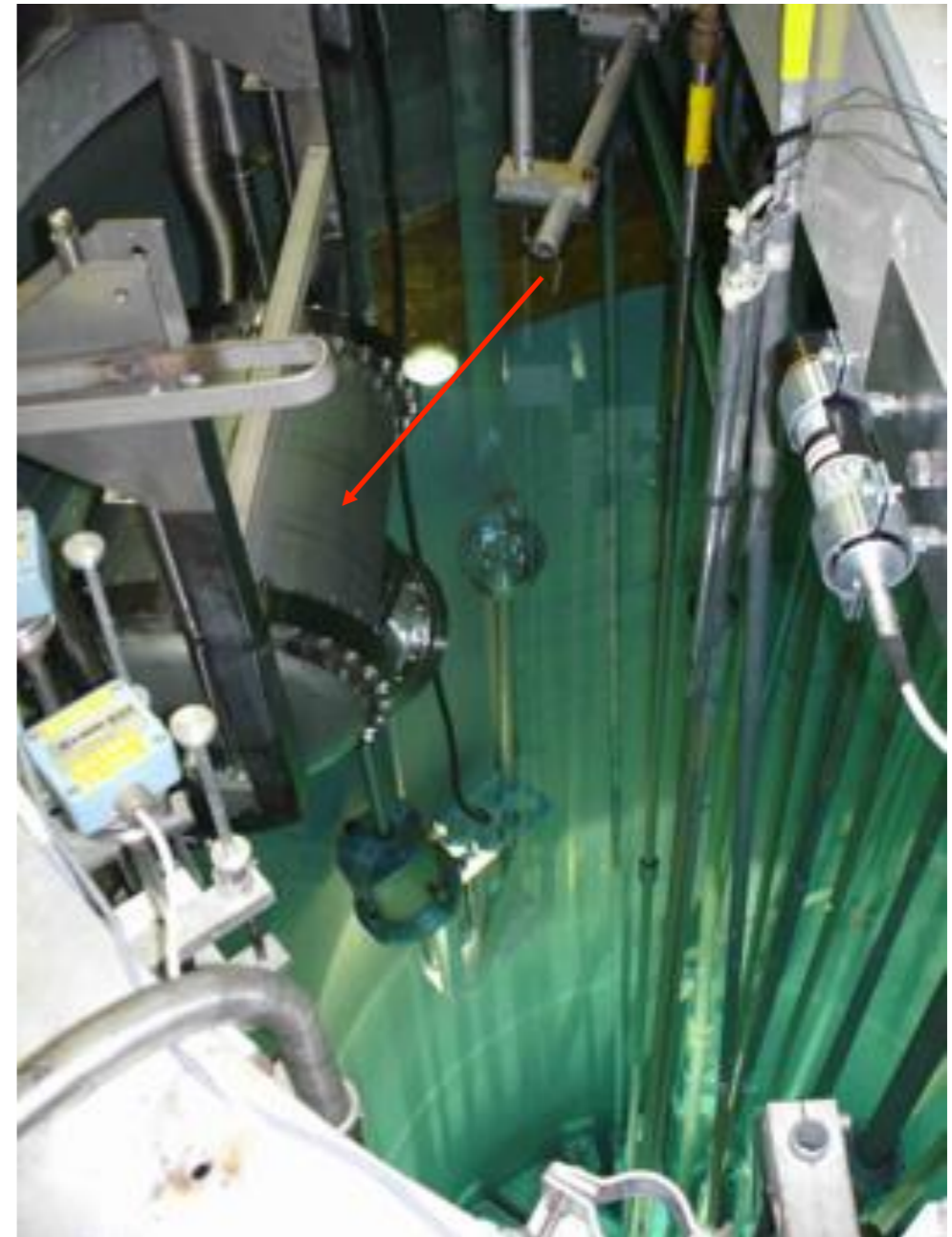
Modulation frequency 85MHz

Digital model with accuracy of 4%

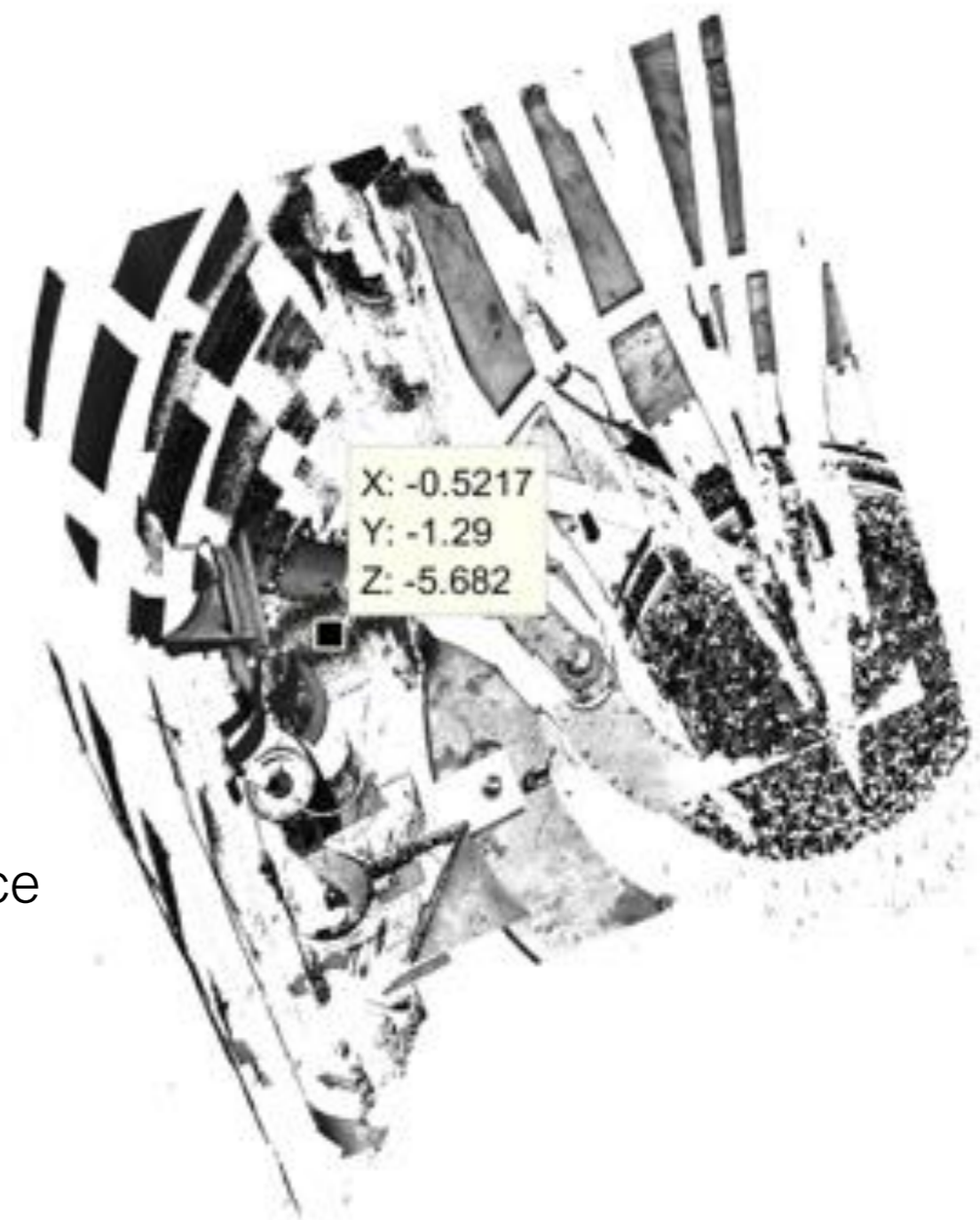
The ENEA laser 3D imaging system for the nuclear industry

3D laser imaging system qualified to operate in nuclear vessels (contaminated water up to 1MGy)

The device has been tested in a nuclear reactor at ENEA centre of Casaccia



The ENEA laser 3D imaging system for the nuclear industry

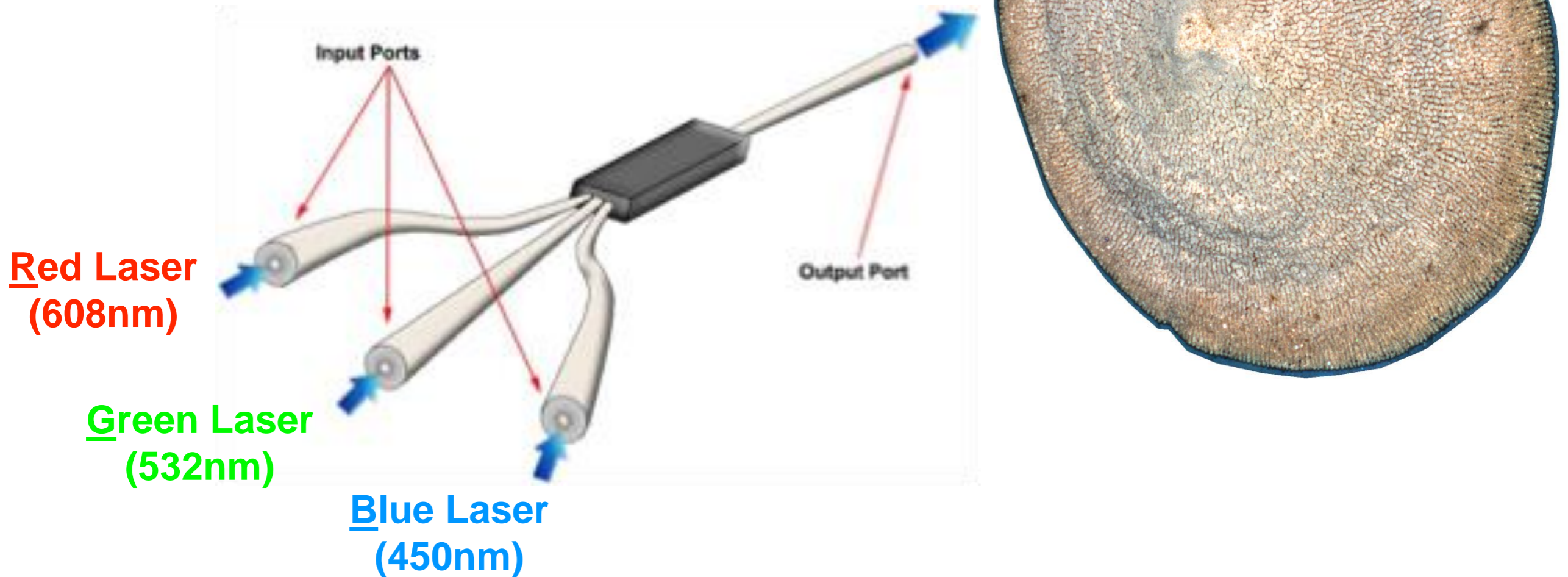


3D models acquired at 7m of distance

The ENEA laser 3D imaging system for subsea applications: real colors

3D model of a sea sponge with colors

used in water
of distance from the laser sensor
ultaneous acquisition of 3D shape and **colors**
n resolution (details of 1mm resolved)



Thank for your attention!

luigi.dedominicis@enea.it