STELLARATOR MONITORED BY CYGNETS

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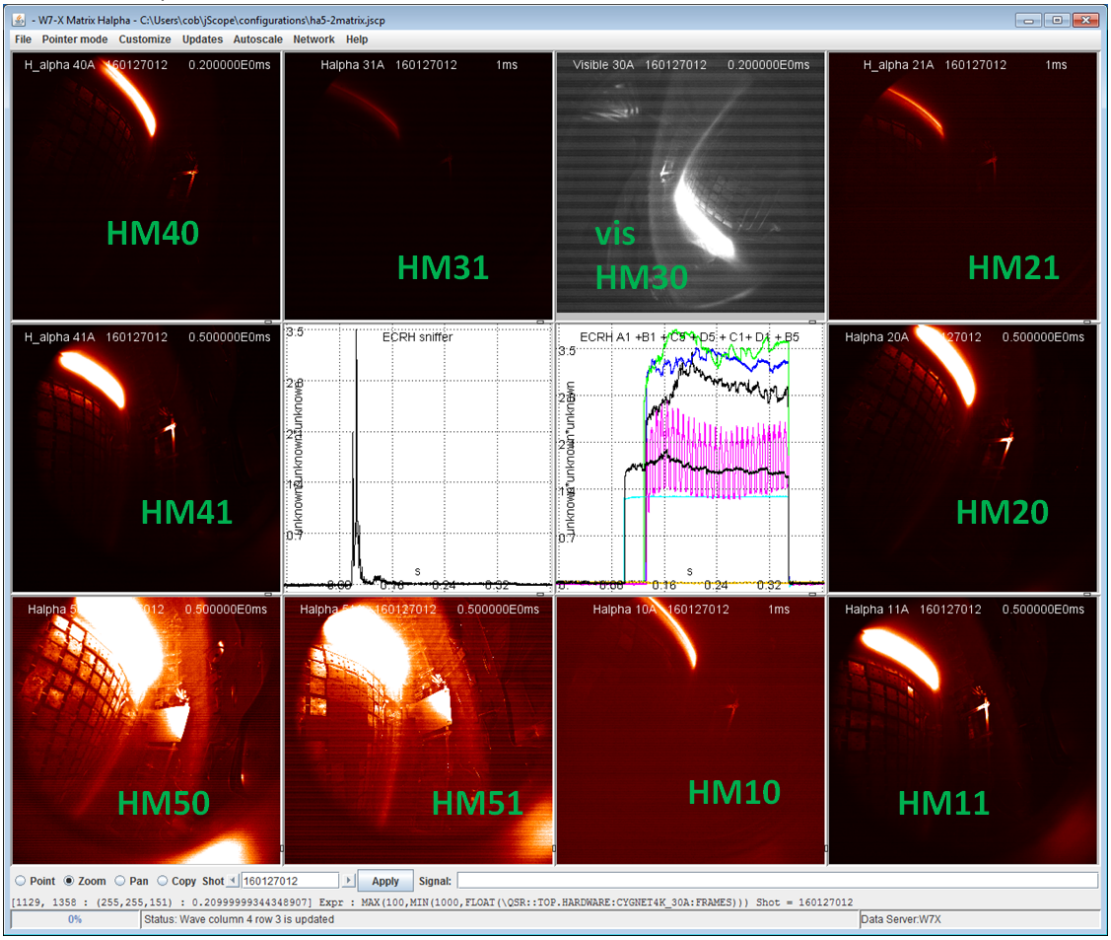
Cygnets at the Max-Planck-Institut für Plasmaphysik:

Courtesy of Dr. Christoph Biedermann

In order to monitor the plasma within the Wendelstein 7-X stellarator, the IPP needed cameras capable of fitting into the tight space around the instrument and more importantly to operate reliably close to the large magnetic field necessary for the confinement. The Cygnet was successfully tested up to 1.8 Tesla and the Owl up to 2.3 Teslas. 20 Cygnet cameras in the 10 immersion tubes work and produce images surveying the divertor and the limiter region. Below is a set of the camera images arranged according to the position in the Wendelstein plasma vessel.



All the images are taken with Raptor Photonics' Cygnet cameras. The reddish images are taken with an H-alpha (Hα) filter at 656nm mounted in front of the sensor. One position has a different objective and no filter (labeled vis HM30). In the middle there are time traces of the microwave radiation showing the absorbed power and the heating of the plasma. The bright light is emitted right at the limiter structure. There the plasma is fairly cold and the hydrogen atoms emit strong H-alpha light. The exposure of the images is different for the various port positions. The images are recorded at the maximum repetition frequency of the camera at 25Hz to catch the development of the plasma and explore the behavior during the discharge.

The CameraLink interface used by the Cygnet allows sustaining the high bandwidth necessary to combine high resolution, speed and dynamic range.

Standard 5 meters CameraLink cables allow access to the cameras close to the instrument.

The signal is then converted by a 24 bit fiber adapter and transferred to the control room 100 m away using fiber optics.

“The Cygnet is the only camera capable of functioning reliably within the extreme magnetic field generated by the Wendelstein 7-X fusion device. In total, we use 20 cameras to monitor the experiment.”

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Figure 1: Cygnet CMOS camera

- **2.1MP 2/3” OR 4.2MP 1” Scientific CMOS sensor**. Enables optimum image resolution in low light imaging applications
- **5.5µm x 5.5µm pixels.** Enables ultra sharp image resolution
- **Quantum Efficiency: >63% @ 500nm and >34% @ 850nm.** Optimum Photon collection
- **High frame rate: up to 52Hz full Frame.** Enables realtime imaging in full HD format

Figure 2: Owl 320 and 640 InGaAS cameras

- **SWIR technology.** Enables high sensitivity imaging from 0.9µm to 1.7µm
- **Optional Visible extention.** Enables high sensitivity imaging from 0.4µm to 1.7µm
- **14 bit CameraLink output.** Enables high speed digital video with intelligent auto AGC
- **On-board Automated Gain Control (AGC).** Enables clear video in all light conditions
- **On-board intelligent 3 point NUC.** Enables highest quality images
- **Active Image Enhancement.** Further increases the image resolution and quality of the 640x512 sensor
- **Easy control of camera parameters.** Enables control of Exposure, Gamma and intelligent AGC
- **500ns minimum exposure.** Ideal for active imaging applications
- **Ultra compact, Low power (< 5W).** Ideal for hand-held, mobile or airborne systems
- **Rugged, No fan.** Enables integration into UAV, handheld or any Electro-Optic systems

About Raptor Photonics

Raptor Photonics Limited is a global leader and manufacturer of high performance, industrial-grade and extremely rugged ultra-low light digital & analogue cameras. Raptor specializes in complete cameras and core engine solutions using CCD, EMCCD, Scientific CMOS and SWIR sensor technology. The extreme low light capability of Raptor's cameras makes them ideal for day/night surveillance, homeland security and scientific markets. Raptor Photonics Ltd is a registered ISO 9001:2008 company and is headquartered in Larne, Northern Ireland.

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