



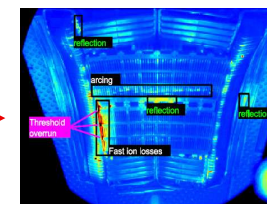
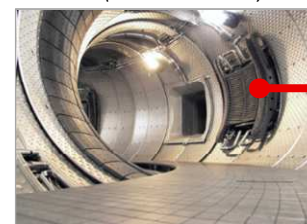
2. Context: magnetic confinement fusion



Institut de Recherche sur la Fusion par confinement Magnétique
(Cadarache)

- Installation:** ➤ WEST tokamak – test bed for ITER
- Missions:** ➤ R&D on magnetic confinement fusion / contribution to ITER
➤ Development of innovative technologies based on infrared thermography for in-vessel components safety

WEST (inner vessel view)



Infrared image of a heating antenna (x 7 cameras)

Problematic: how to efficiently analyze the VIS/IR movies for:

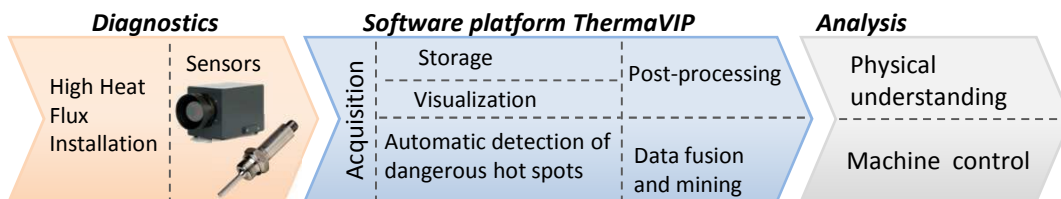
1. **Advanced Physical understanding**
2. **Real-time protection of the PFC (hot spot detection)**
3. **Plasma discharge optimization (false alarm mitigation)**

1. Value proposition



The **Thermadiag** company aims to provide a **modular range of services** (expertise, consulting, software component integration, on demand development...) based on the **ThermaVIP** platform for **High Heat Flux machine supervision and diagnostic data analysis**.

The company will take advantage of the **ThermaVIP** technology, a software platform managing the exploitation chain of imaging diagnostics (both visible and infrared) for offline analysis and online machine supervision. It has been especially designed for **multi sensor analysis based on data fusion techniques**.

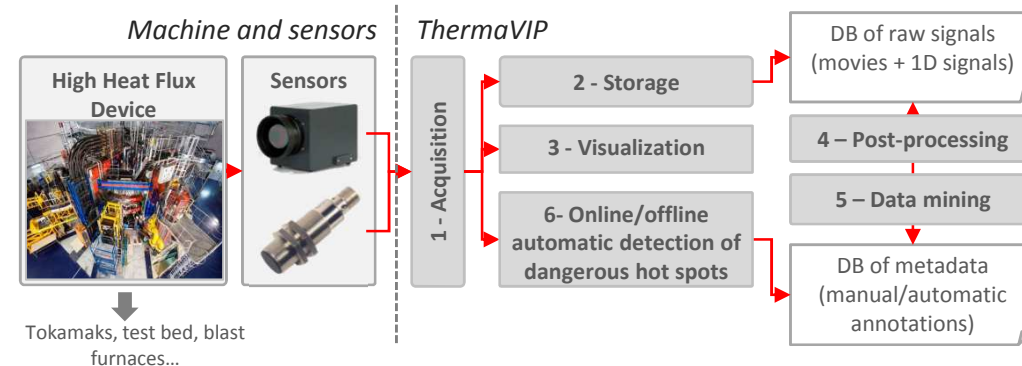


Thermadiag will provide a modular range of services to its customers :

1. **Expertise & consulting**
Support for the conception and exploitation of imaging diagnostics
2. **Open source software platform**
Software platform **ThermaVIP** for online and offline imaging diagnostics exploitation
3. **Software integration**
Requirements and needs understanding, integration into the machine diagnostic environment, development of specific modules
4. **Technical support**
End User training and Developer training for software architecture understanding

3. The software platform **ThermaVIP** (Viewing Imaging Platform)

- Software platform managing the **exploitation chain of imaging diagnostics** (both visible and infrared) for **offline analysis** and **online machine supervision**



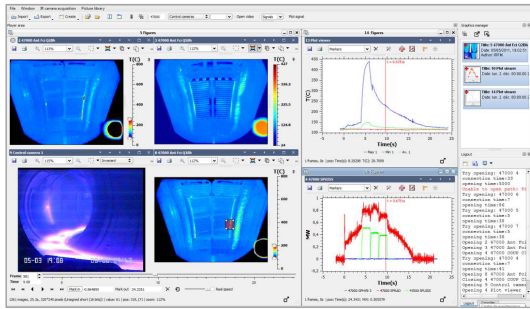
- Origin: **collaboration with INRIA-Sophia Antipolis**.
- **Modular architecture**, based on a C++ portable SDK (Software Development Kit) and a **plugin** mechanism.
- **6 years of development for a total cost of about 1 000 000 €**.
- **Currently used on 2 tokamaks:** WEST (FR) and JET (UK)

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4. ThermaVIP for imaging data analysis

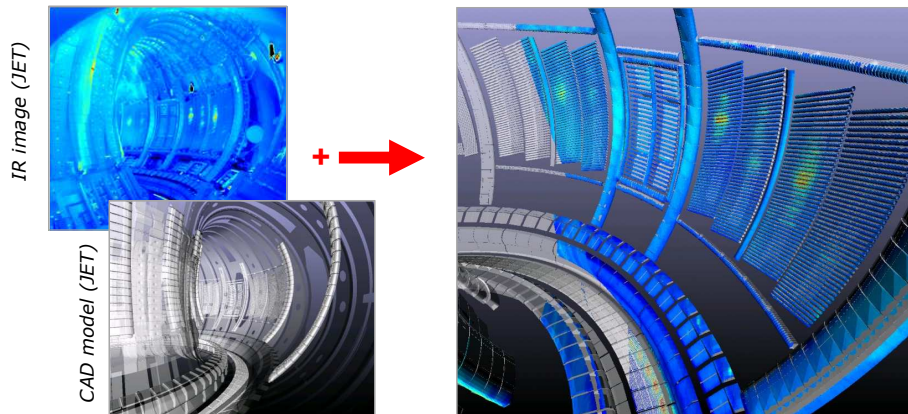


- Online/Offline **visualization, synchronization** and **storage** of heterogeneous signals
- Temporal evolution** of statistics inside **Regions Of Interest**
- Video events annotation**
- Embedded Python environment** for advanced processing

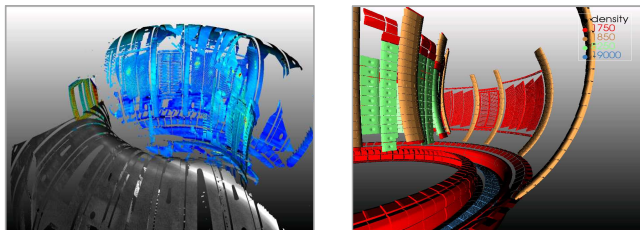
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FCU_02_2018.3.jpg	20/05/2018	SCM antenna	Q20
FCU_02_2018.4.jpg	20/05/2018	SCM antenna	Q20
FCU_02_2018.5.jpg	20/05/2018	SCM antenna	Q20
FCU_02_2018.6.jpg	20/05/2018	SCM antenna	Q20
FCU_02_2018.7.jpg	20/05/2018	SCM antenna	Q20

- Imaging databases management:** raw signals, picture library, manual/automatic video annotations

- Infrared image mapping** on 3D CAD models

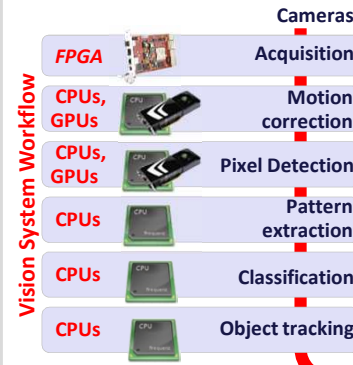


- Visualize camera **field of view covering**
- Annotate** 3D CAD models

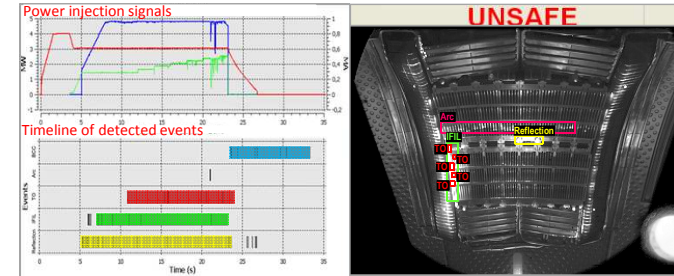


5. ThermaVIP for machine supervision

Use **cognitive vision techniques** and **multi-sensor data fusion** for automatic recognition and characterization of dangerous thermal phenomenon



- Online dashboard** of thermal events detection process



- Online saving** of automatic detections to a **SQL database**
- Alarm triggering**

Our strengths

- 7 years of experience in the field of software development for imaging diagnostics exploitation
- Technology feasibility established, deployment on several installations

Startup project supports

- CEA – Head office at valorization/ Spin-off



THERMADIAG <http://www-cadarache.cea.fr/valorisation/thermadiag/>
 THERMAL IMAGING SYSTEMS FOR MACHINERY DIAGNOSTIC
Creation in June 2015 <http://www.thermadiag.com>
 (under construction)

The CEA is the French Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives). It is a public body established in October 1945 by General de Gaulle. A leader in research, development and innovation, the CEA mission statement has two main objectives: To become the leading technological research organization in Europe and to ensure that the nuclear deterrent remains effective in the future.