CILEX-APOLLON PERSONNEL SAFETY SYSTEM

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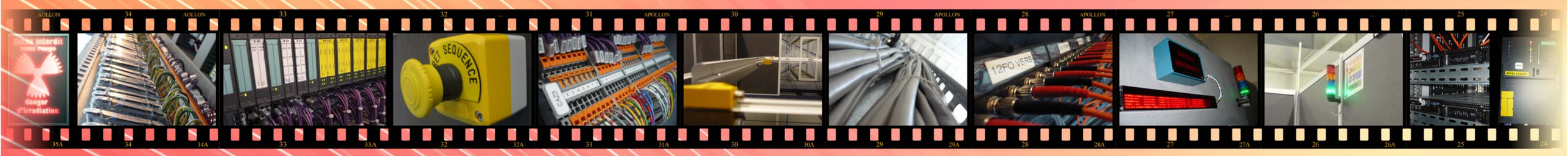
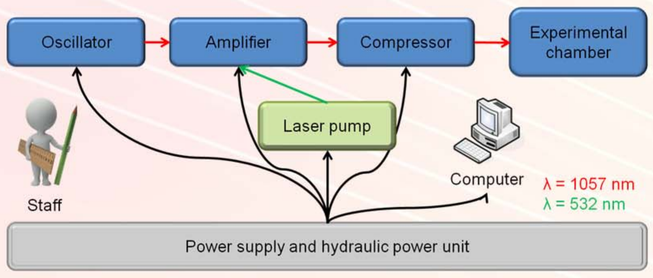
MOPPC04

Jean-Luc VERAY,
Jean-Luc PAILLARD,
Alexandre BONNY
(LULI, Ecole Polytechnique, route de Saclay, 91128 Palaiseau, FRANCE)



Cilex-Apollon is a high intensity laser facility delivering at least 5 PW pulses on targets at one shot per minute, to study physics such as laser plasma electron or ion accelerator and laser plasma X-Ray sources. Under construction, Apollon is a four beam laser installation with two target areas. Such a facility causes many risks, in particular laser and ionizing radiations. The Personnel Safety System (PSS) ensures to both decrease impact of dangers and limit exposure to them. This poster presents the concepts, the client-server architecture, from control screens to sensors and actuators, and interfaces with the access control system and the synchronization and sequence system.

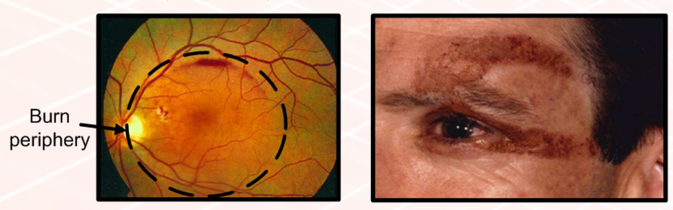
RISK ANALYSIS AND DESIGNING REQUIREMENTS



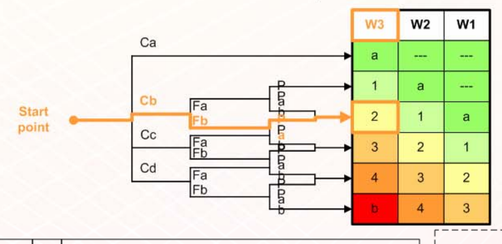
According to the **MOSAR** method (Risk Analysis Systemic Organised Method), the laser chain has been **divided into sub-systems** (considering the topology and the role of each element). The goal is to identify every source of danger and scenario of risks linked to sub-systems.
Then, scenarios are evaluated and ranked in terms of **gravity and frequency**.

The previous study lead the command-control team to identify two main dangers :
- **laser radiation** ;
- **ionizing radiation**.

Class IV laser light may cause damages to the skin and eyes due to its high energy (between 75 and 150 J). At least once a day, the staff needs to work near the laser light for day to day maintenance.
Nature of ionizing radiations depends on the target on wich laser beams are brought during an experiment (X rays, γ rays…).



The Security Integrity Level (SIL) has been determined via two norms derived from norm CEI 61508 : norms EN 62061 and CEI 61511. Here, **SIL value is 2**.



CEI 61511

Consequences	Ca	Minor incident
	Cb	Reversible effects
	Cc	Lethal effects within the site
	Cd	Lethal effects out of the site
Exposure	Fa	Rare exposure in the considered zone
	Fb	Regular exposure in the considered zone
Possibility to avoid danger	Pa	Possible with particular conditions
	Pb	Impossible
Occurrence rate	W1	Low probability (accident may happen)
	W2	Medium probability (accident already occured)
	W3	High probability (frequent accident, occured more than once)

--- = no safety requirements

a = no particular safety requirements

b = one safety system is not enough

1, 2, 3 and 4 = safety integrity level

FUNCTIONAL ANALYSIS, DESIGN AND ARCHITECURE

A DEDICATED ACCESS CONTROL

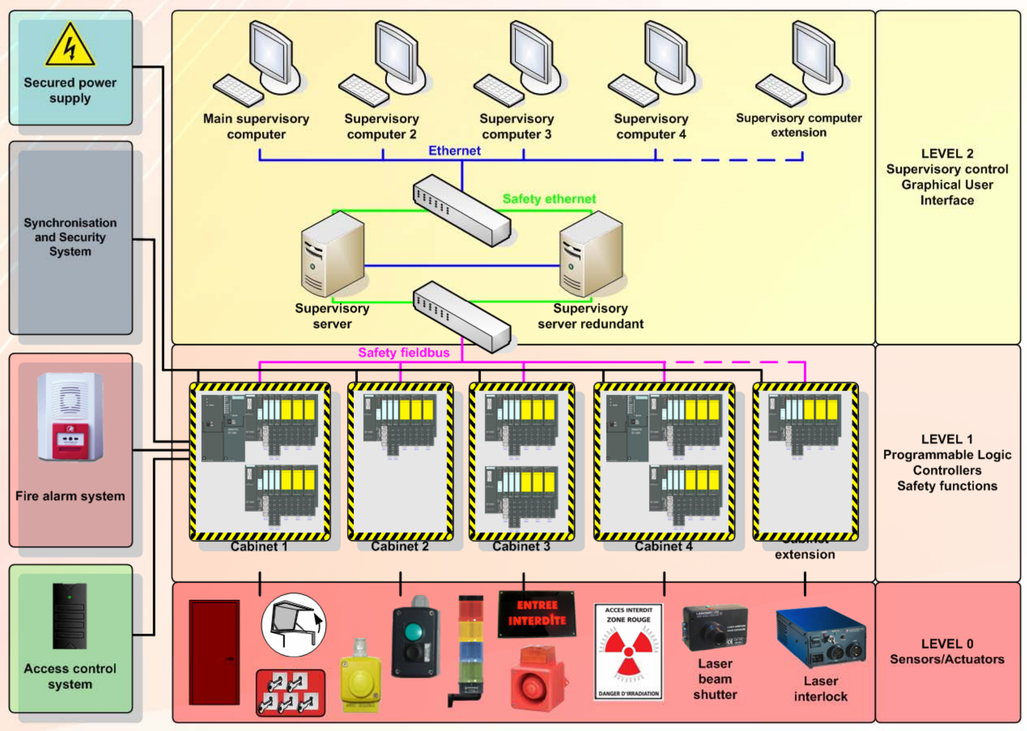
There are different access authorizations for staff :
- green LED : **everyone is authorized** to come into the area ;
- blue LED : only people with a **level 1 laser authorization** are allowed to work in the area ;
- yellow LED : only people with a **level 2 laser authorization** are allowed to work in the area ;
- red LED : **no one is allowed** in the area (excepted external companies for specific maintenance operations).

ANOTHER DEFINITION OF SAFETY

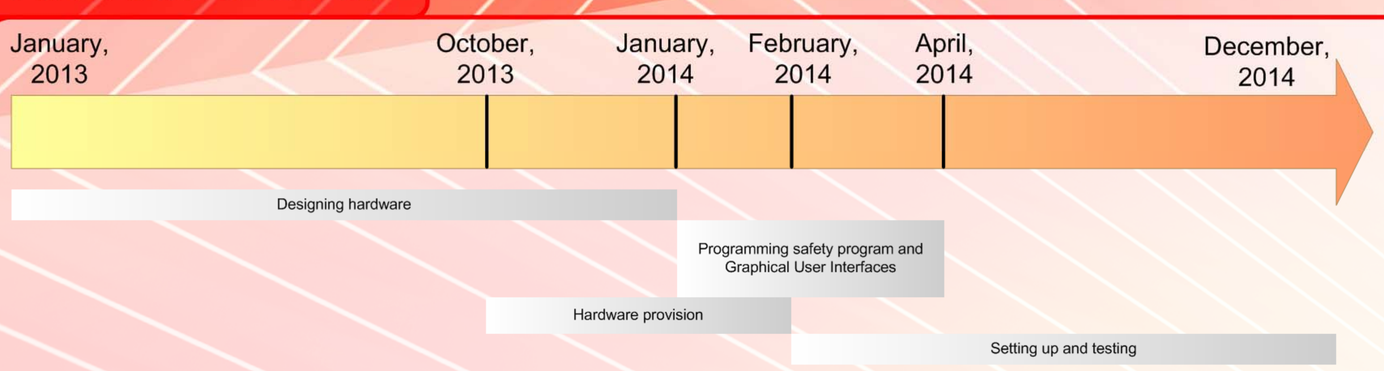
How to protect oneself efficiently when there are **two different wavelenghts** in the same area (ω = 1057 nm, 2ω = 532 nm) ? The protection system cannot answer this question. As a consequence, danger is reported in a different way :
- green LED : laser interlocks are open, **no laser radiation** possible ;
- blue LED : low or high laser energy, **safety barriers are closed** and protection glasses are not necessary ;
- yellow LED : low laser energy, safety barriers may be opened and **staff must wear protection glasses**, door opening is limited to 20s;
- red LED : low or high energy, safety barriers may be opened, **no one is allowed in the area** because protection glasses are not efficient. In the experimental room, ionizing radiations may be present.

AN HOMOGENEOUS ARCHITECTURE

The functional architecture is a typical automated system architecture :
- level 0 : level closest to **safety and standard equipments**. Laser beam shutters and safety key panels deserve a particular study because of very high laser power and ionizing radiations in the experimental room.
- level 1 : this level is composed of cabinets containing **safety Programmable Logic Controller** and **input/output cards**. Controllers communicate with each others via a **safety fieldbus** (PROFIsafe by Siemens).
- level 2 : **monitoring computers and redundant servers** compose this level. Extensions are possible thanks to a client-server structure. A failure in this level does not impact staff safety. Graphical User Interfaces need a user to be identified (default acknowledgement, laser interlock control, laser beam shutter control…). It is also possible to archive defaults for statistics.



PROVISIONAL PLANNING



KEY FIGURES

4 control rooms
1 PLC
256 output signals
27 laser beam shutters
122 input signals
2 experimental rooms
21 safety functions
514.000 $
2 years
60 graphical views
88 m² for each control room
300.000 €
76 Input/Output cards
4 laser beams
5 supervisory computers
2 redundant servers
110 m long fieldbus
1400 m²
25 laser interlocks
750 variables to communicate between GUI and PLC

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