INAF
OSSERVATORIO ASTRONOMICO
DI CAPODIMONTE

HW & SW Strumentale

Control Hardware and integrated design

Christian Eredia

O.A. CAPODIMONTE - NAPOLI

FORUM DELLA RICERCA SPERIMENTALE E TECNOLOGICA 2022

RSN 5 - INAF

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OSSERVATORIO ASTRONOMICO
DI CAPODIMONTE

the Team

Christian Eredia
Electronics Design
(at PLC time)

Domenico D'Auria
RAMS and PA specialist
since yesterday

Vincenzo De Caprio
Mechanical Designer and FEM
analyst (at ALGOR age)

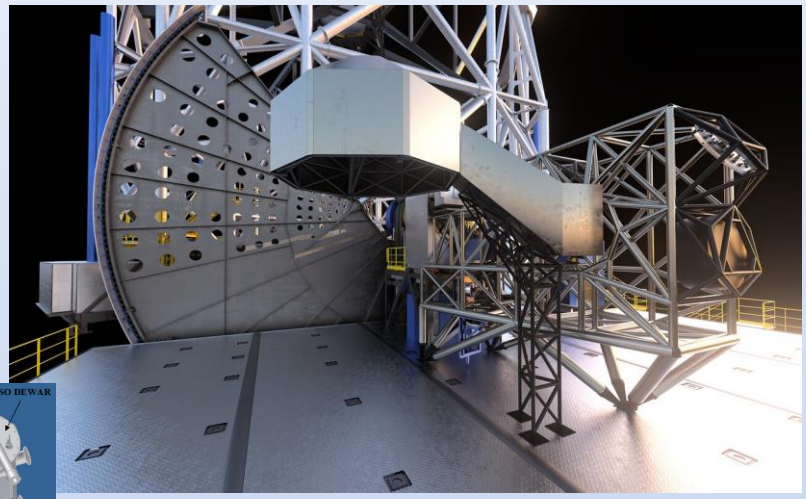
Vincenzo Cianniello
Mechanical Designer CAD & FEA
(at Ansys time)

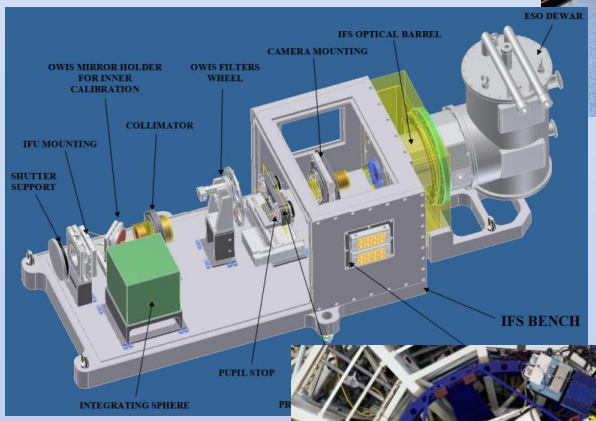
Enrico Cascone
Electronics Design
(at Maccon age)

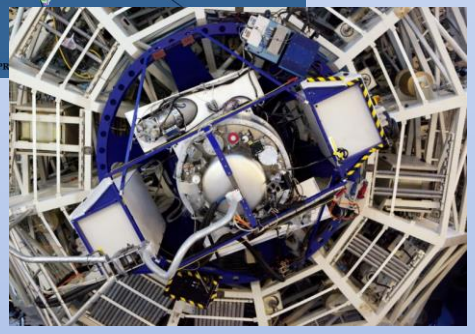
Main projects and activities

Main previous and current projects:

- MORFEO/MAORY
- CUBES
- SPHERE+
- ASTRI
- SPHERE - IFS
- X-SHOOTER
- …







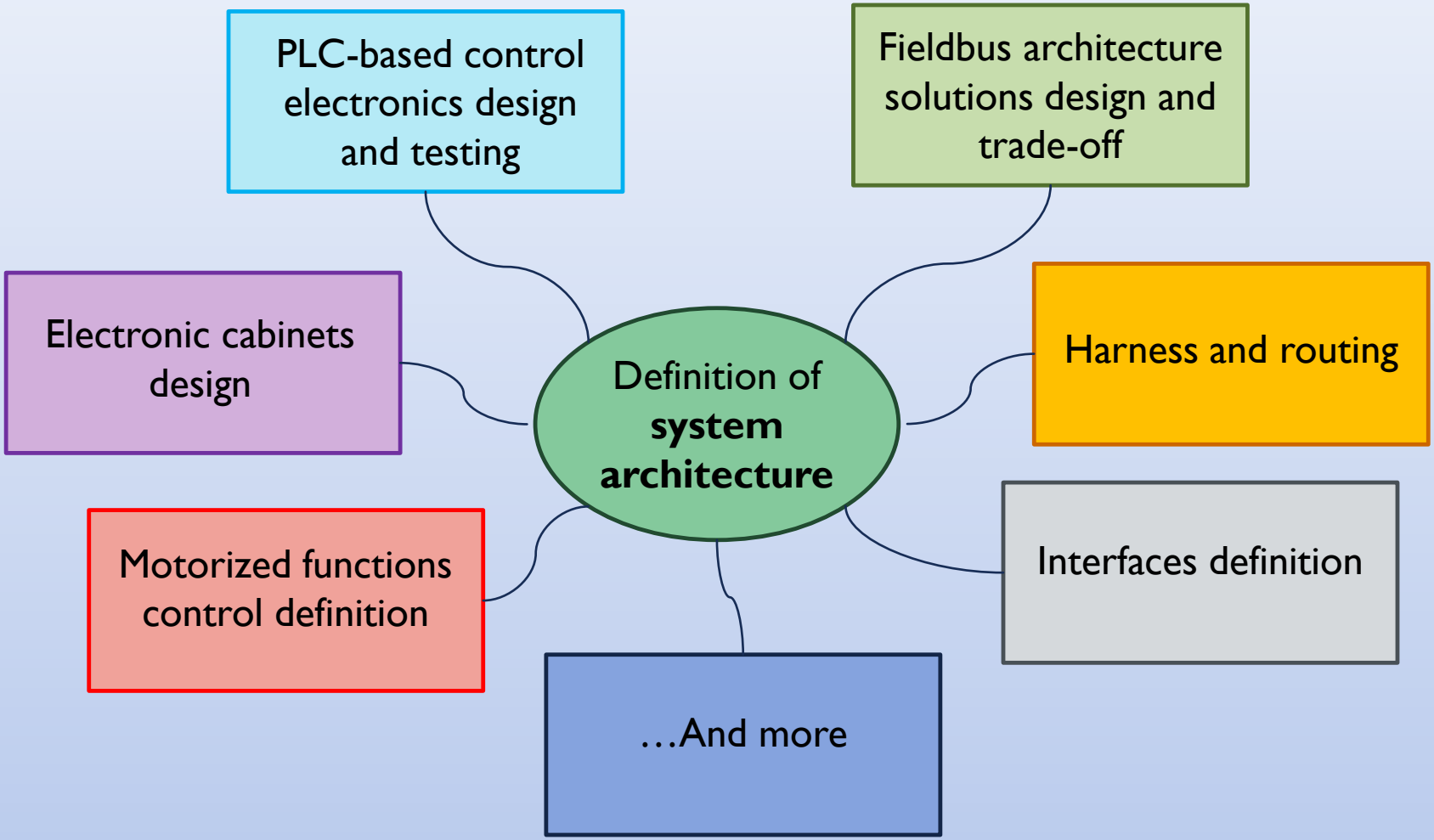
Team activities:

Mechanical design:
- 3D CAD
- FEA
- …

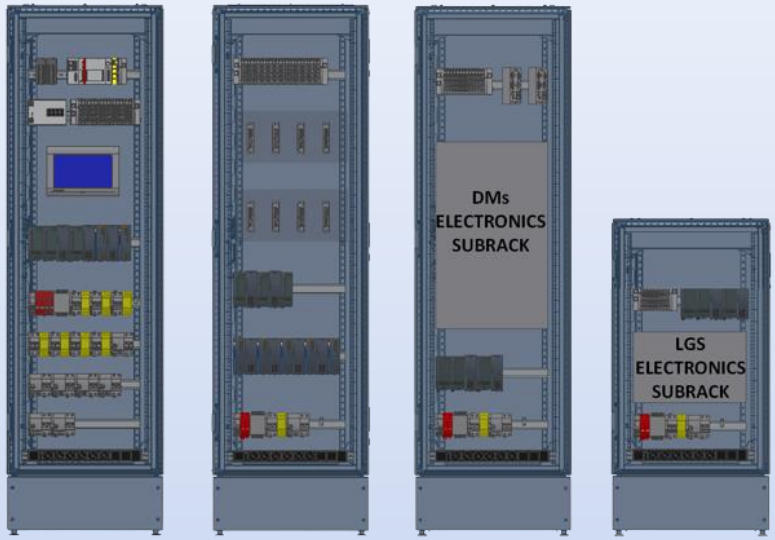
Electronics design:
- System architecture
- Control hardware design
- Harness
- …

System activities:
- PA/QA
- RAMS
- Requirements
- …

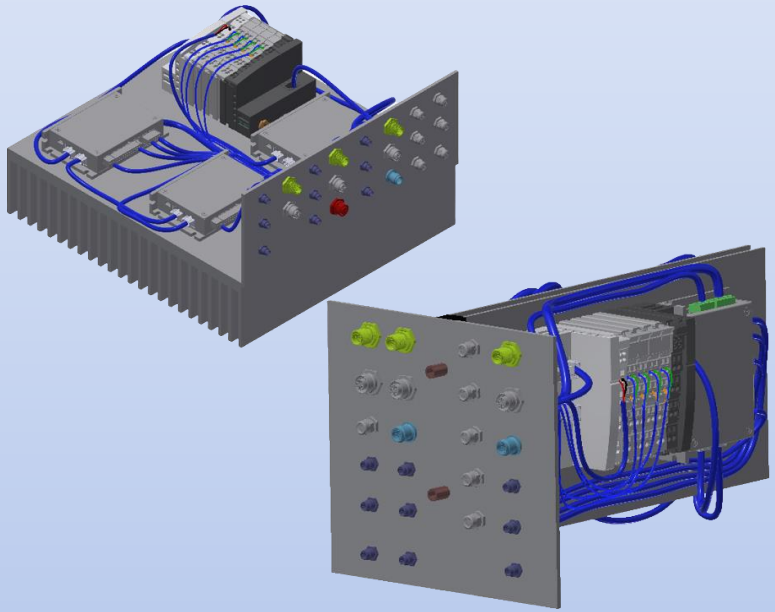
Control Hardware



Control Hardware



For ESO projects, compliance and discussions on ESO standards and requirements is a significant input in the design process (e.g. cabinets cooling system design).



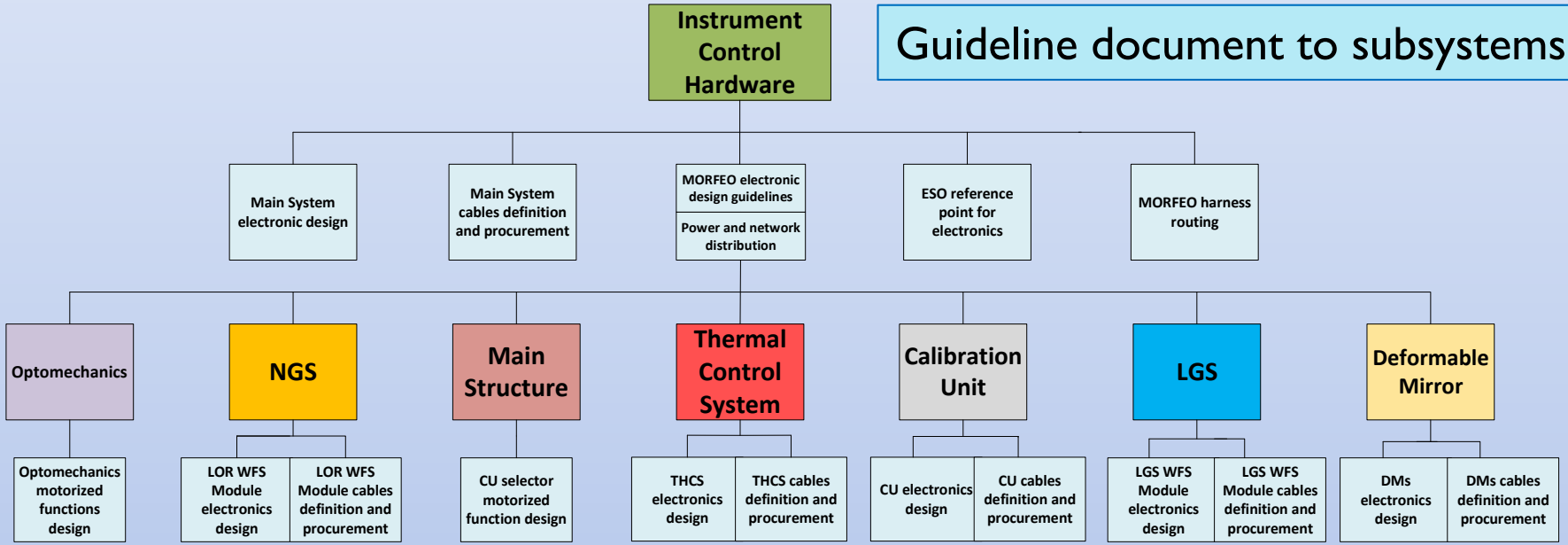
COTS components selection, from motor drives to PLC safety modules, is also often subject to discussion, both from HW and SW point of view.

Control Hardware

ICH as electronics reference point between ESO and subsystems

- Requirements flowdown
- Design harmonization
- Choice of components
- General architecture definition

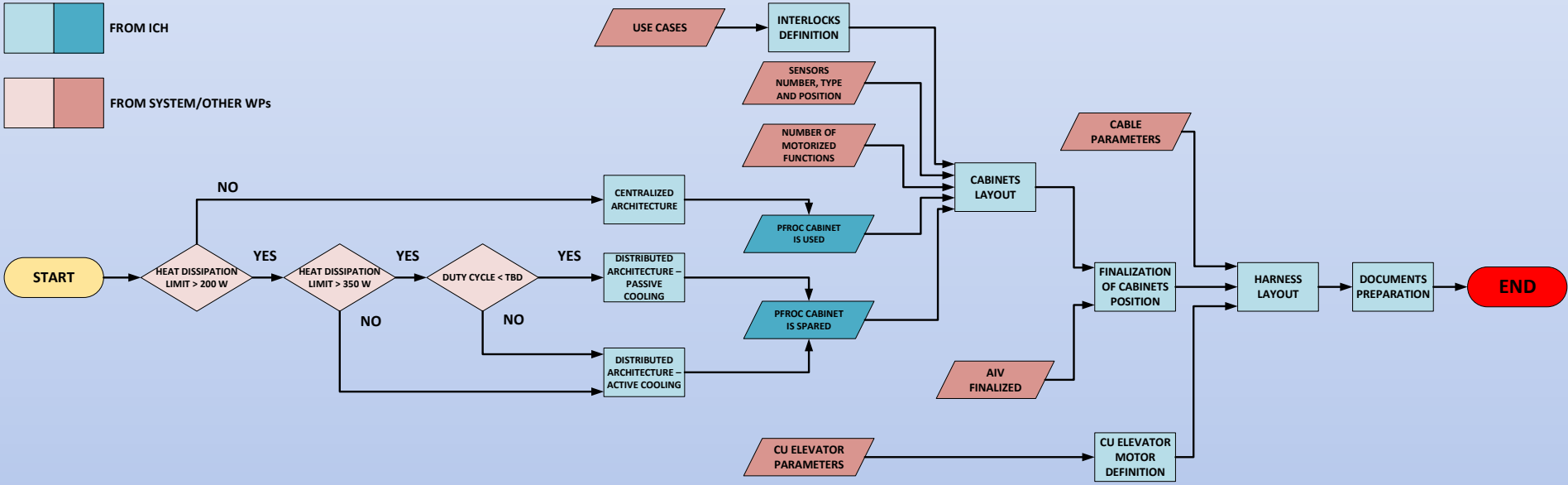
Guideline document to subsystems



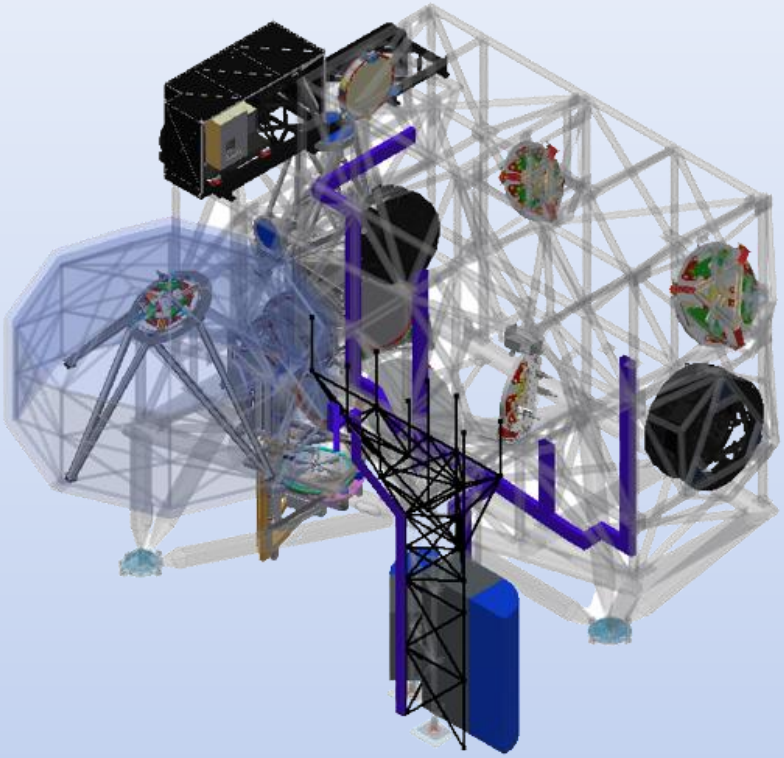
Control Hardware

ICH design requires a vision at system level under multiple aspects:

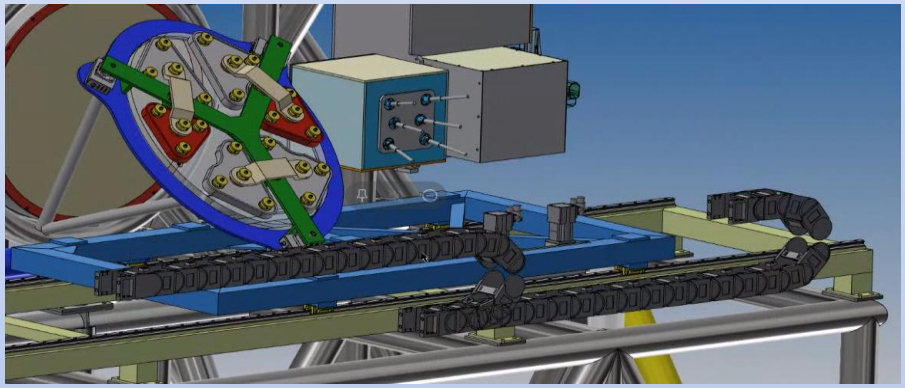
- System functionality
- General requirements
- AIV
- RAMS analysis
- Harmonization of the design
- …



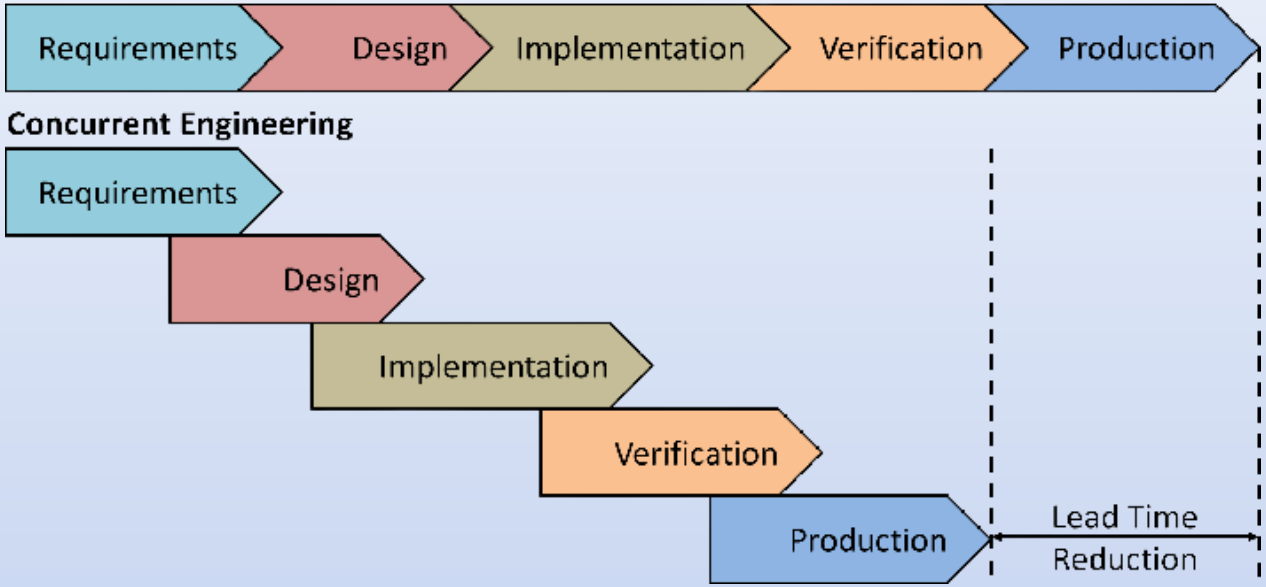
Integrated design



Established day-to-day collaboration among the members of the team for all aspects of the design



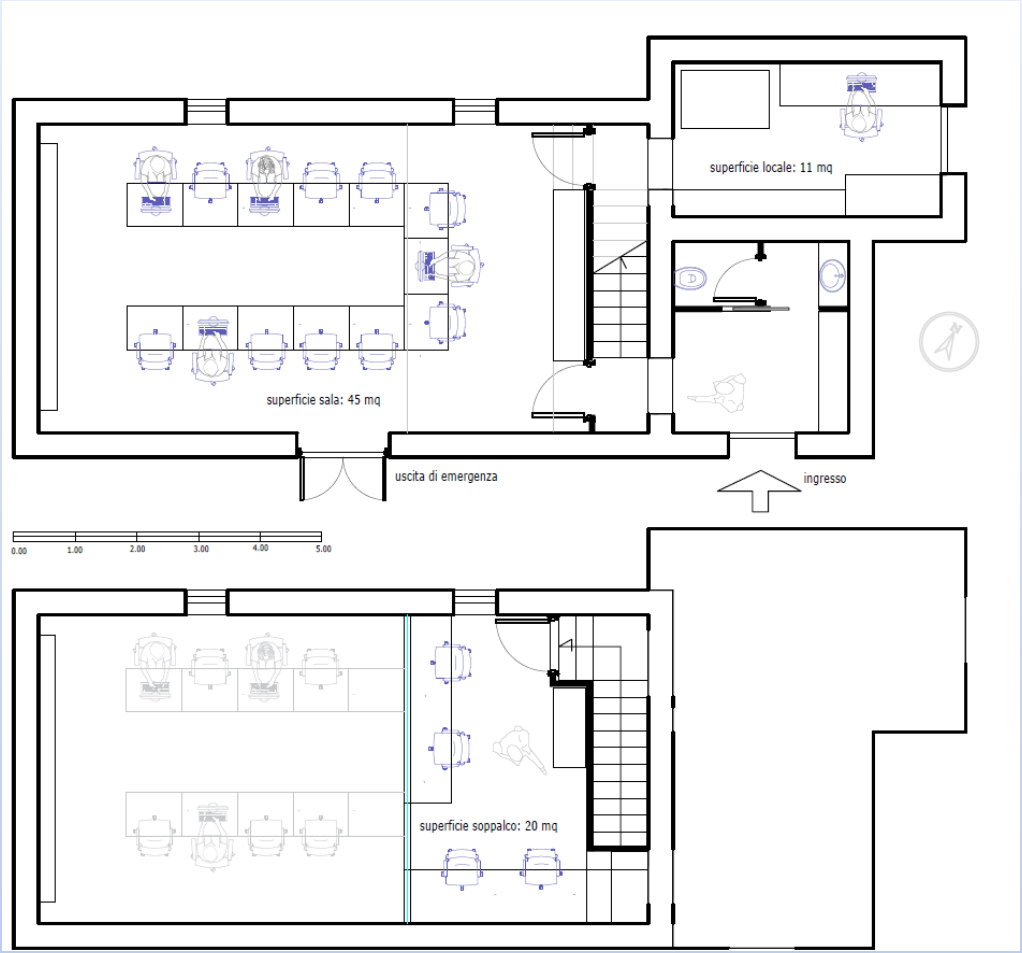
Concurrent design



- ✓ Reduced development time
- ✓ Criticalities are identified in early design phases
- ✓ Better quality of interactions
- ✓ Better traceability of the design steps through product data management tool

Concurrent design

- Concurrent design main facility in Naples as part of STILES proposal
- Two other CDF nodes in Brera and Medicina
- New nodes in other INAF Institutes could potentially be integrated in the future



Concurrent design

Short Abstract

In the last few years, PLC-based control automation has become the standard for the new class of astronomical ground-based instrumentation.
The industrial approach offers many design opportunities, some of which have yet to be fully explored.
The main objective of this proposal is to acquire the know-how to exploit these opportunities. Furthermore, an in-depth study will be conducted to develop the necessary skills to integrate the electronics development process with the other aspects of the design, with the ultimate aim of achieving an innovative concurrent design approach. Concurrent engineering allows for a far more efficient and quick design process. This know-how will find implementation in both current and future projects, with immediate application in MAORY.

Description

This proposal is connected to the Multi-conjugated Adaptive Optics RelaY (MAORY) project. The PI of the proposal, Christian Eredia, is an electronic engineer and temporary research fellow working at the MAORY instrument control hardware design, at INAF OACN. More information on the participants to the proposal is given in the dedicated section. The following is a description of the proposal, starting from an introduction to the current context in electronic design for ground-based instrumentation, and to the potential paths of innovation. Finally, the expected outputs of the proposal, i.e. the personal growth of the proponent and the overall present and future contributions to the Institute, are illustrated.

Introduction

In recent years, the design of the control hardware for astronomical ground-based instrumentation has undergone a change towards an industrial automation oriented approach. The implementation of Programmable Logic Controllers (PLCs) has become the new standard for projects funded by the European Southern Observatory (ESO). The instrument control hardware design of the first class of instrumentation for the Extremely Large Telescope (ELT), and of the telescope itself, is largely based on the use of industrial PLCs and fieldbus protocols, with COTS elements.
This allows for rapid development, lower costs for spare parts and a widespread understanding of architecture among specialized firms.
PLC-driven electronic design is also employed for the project this proposal is connected to, MAORY, a post-focal adaptive optics module for the ELT designed to help compensate for distortions caused by turbulence in the atmosphere.

New features of a PLC-based electronic design

Industrial automation offers a wide variety of functionalities: from motion control to HMI projects, from data exchange to safety applications.
While these features provide efficient solutions to both common and complex design issues, they require a level of knowledge to fully exploit their potentialities.
Due to the recent adoption of this standard, there are many topics to be studied and put into practice through an in-depth analysis. The PLC safety modules, for example, efficiently establish and manage from one to multiple safety systems, in communication among each other, at the same time. These modules allow the implementation of complex functions, while keeping a high Safety Integrity Level. They need, however, dedicated projects that are separated from the standard hardware and software design, and a different methodology compared to other common safety architectures. For this reason, an in-depth study of this application, guided by the main manufacturers, would be valuable to better understand the system capabilities and potential issues. Similar arguments can be made for other aforementioned functionalities.

Mini-grant proposal for concurrent engineering from the electronics design point of view

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Electrical CAD

Tool	Price (single licence)	Notes
WSCAD	> 6000 €	German, no Italian reference point. Module for cabinet design. Employed by MPIA Heidelberg.
EPLAN	4.000€	Educational licence. 15000€ for commercial one. German with Italian reference point. 3D harness module. Used in ESO.
IGE XAO	> 3000 €	French with Italian reference point. Different tools for electrical design and manufacturing.
SPAC	3.000€	Italian. Additional module for harness (Cabling 4D).
iDEA CAD	< 3000 €	Italian. Based on AutoCAD. Module for 3D harness and conduit parameters analysis.
Sabik	< 2500 €	Italian, indepedent graphics engine.
ElettraCAD	2000-2500€	Italian. Based on AutoCAD. Cabling module.
Altium	1.500€	3000 € for two licences (educational). More indicated for PCB design. Used by INAF OAA and OATs.
ELCAD/Aucotec	1.200€	Tool Engineering Base. Educational licence. German with Italian reference point. Used by MPE Garching.
RapidHarness	1.000€	5000 € per year for 5 licences. Used by INAF OAA.

Possibility of adopting an electrical CAD to be used among all interested INAF institutes

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GRAZIE

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