



EICASLABTM DEMO



*The Professional Software Suite
for Automatic Control Design and Forecasting*

EICASLAB Demo RT-PC

Welcome to Innovation



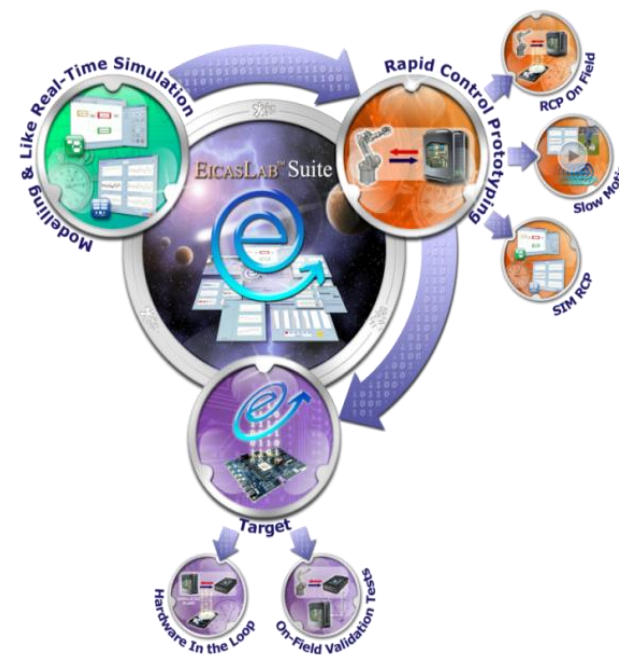


EICASLAB™ Demo RT-PC

Just 1 Software Suite

Just 1 Project

ALL the design phases



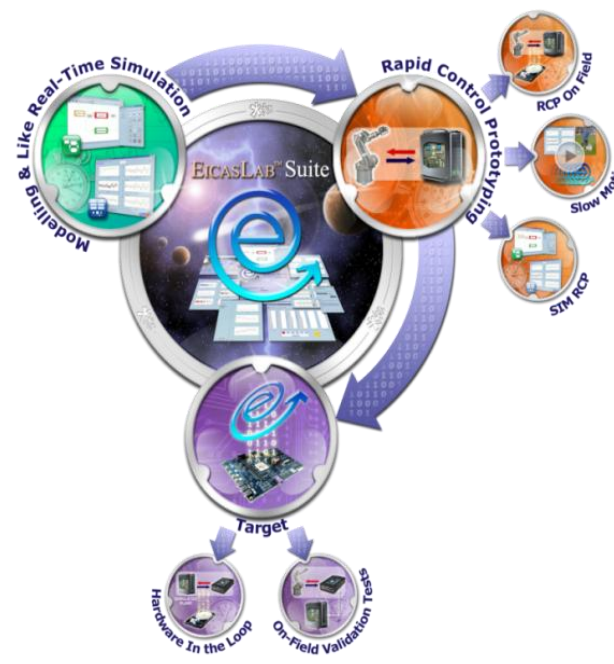
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EICASLAB™ Demo RT-PC

The operative modes:

- Modelling and Like Real-time Simulation
- Rapid Control Prototyping (RCP)
 - RCP On Field sub-mode
 - Slow Motion sub-mode
- Target
 - Hardware-in-the-loop (HIL) sub-mode
 - Final Validation Test (FVT) sub-mode



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Summary

Slide contents:

- Overview
- Requirements
- Operative modes
 - Modelling and Like Real-time Simulation
 - Rapid Control Prototyping On Field and Slow Motion
 - Hardware-in-the-loop
 - Final Validation Test
- Further information



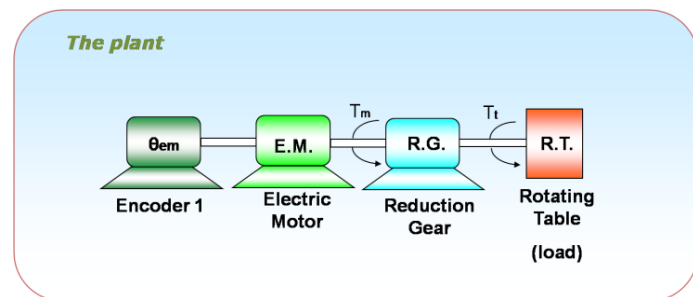
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Overview

Example of a **complete control design development**, from the Simulation to the download to Final Target.

The application case is the *rotating table* of the EICASLAB DEMO.



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Overview

EICASLAB Demo RT-PC = Real-Time on single PC

- Focus on the real-time operative modes: Rapid Control Prototyping (RCP), Hardware-in-the-loop (HIL) and Final Validation Test (FVT)
- Allows the user to experiment the real-time support using a single PC (no real plant and target required)





Overview

The EICASLAB RCP Platform

Standard multi-core
PC equipped with a
Real-Time Operative
System (RTOS) and the
EICASLAB Suite

RCP=Rapid Control
Prototyping



It is used to run
EICASLAB, execute
real-time tasks,
to cross-compile
the code for the
embedded board
and program it.

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Minimum requirements

This demo requires real-time performance, therefore it is only available in Linux version.

- Dual core CPU
- 2 GB of RAM
- 1 GB of disk space
- GNU/Linux operative system
- PREEMPT_RT kernel configuration (recommended)
- Networking interface to connect to the target (USB2.0 for BBB, Ethernet or WiFi for other boards)



rt.wiki.kernel.org

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Minimum requirements

The EICASLAB Demo RT-PC includes **three** projects in the **DEMO** menu of the MASTER tool:

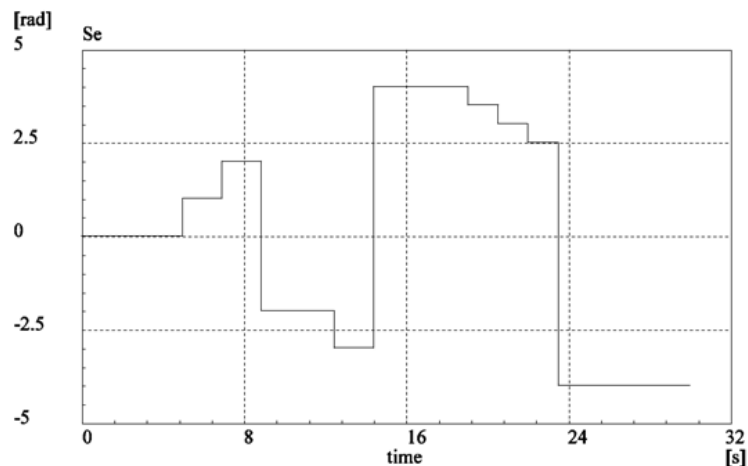
- the first with the pre-designed control algorithm by EICASLAB Automatic Algorithm Generation (**AAG**)
- the second with an empty control where the **user** can program his own algorithm
- the third is a “**real-time plant emulator**” which is used in a second instance of the demo program during Rapid Control Prototyping and Final Validation Test trials, as explained in the following.

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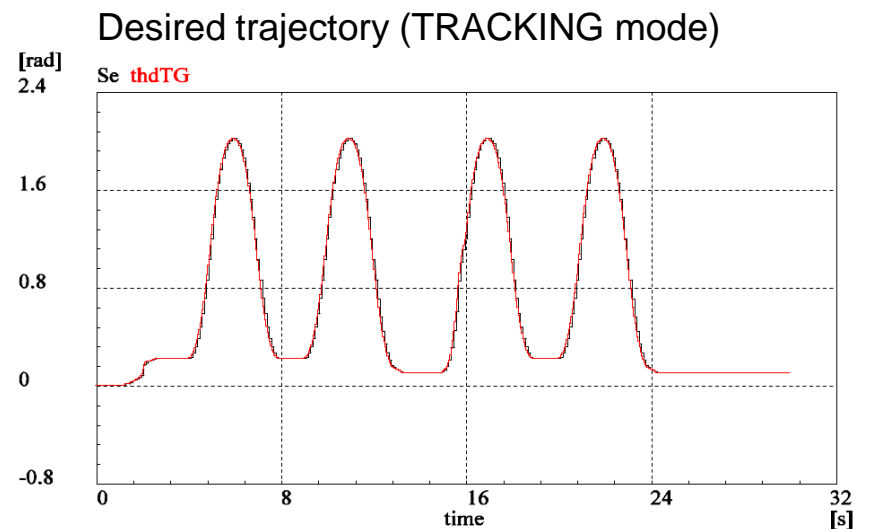


The control objective

- Impose the **desired trajectory** to a **rotating table**
- Actuator: electric motor acting on the rotating table
- Sensor: one **encoder** measuring motor angle



Desired angle (POINT-TO-POINT mode)



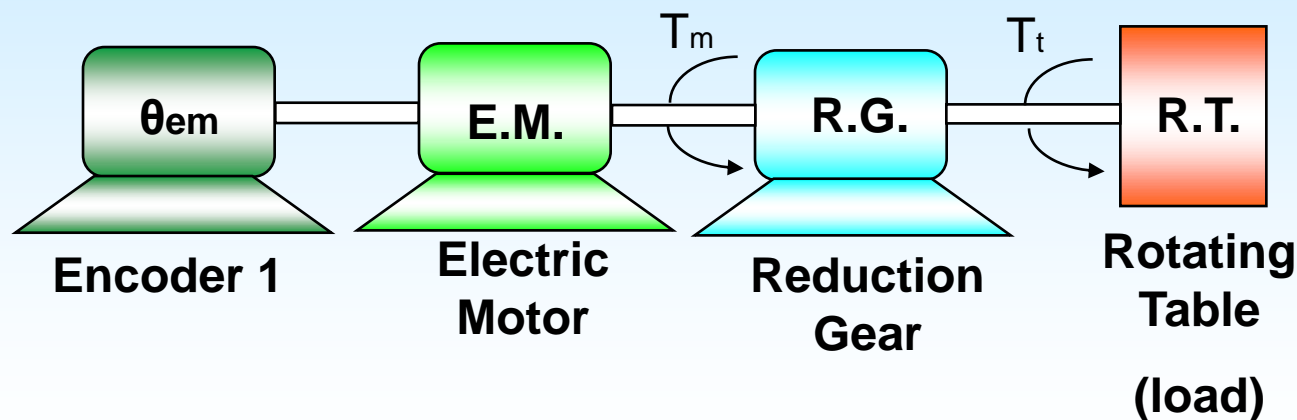
Desired trajectory (TRACKING mode)

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Rotating Table Physical Model

The plant

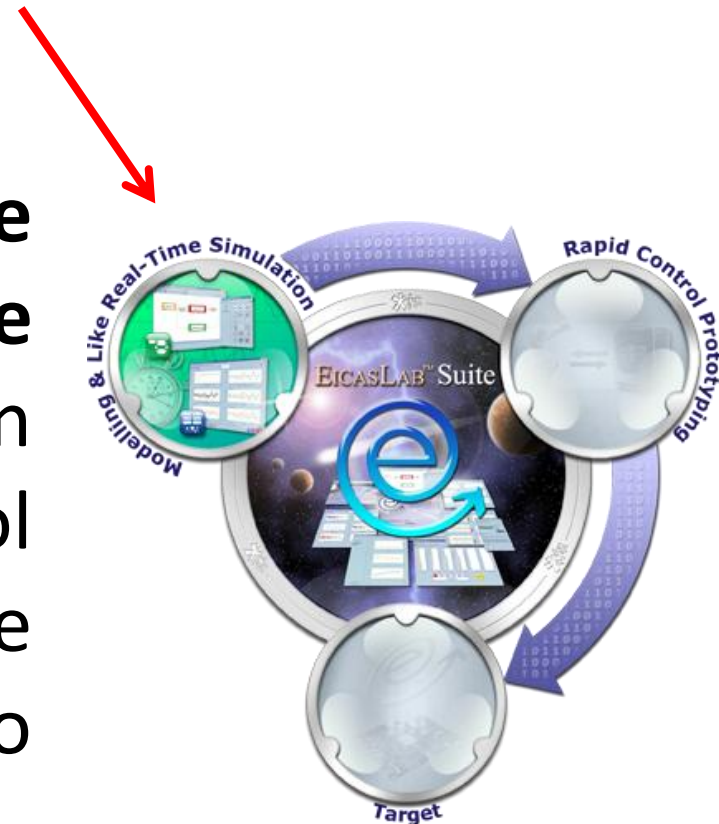


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Modelling and Like Real-time Simulation

The **Modelling and Like Real-time Simulation** mode allows the user to design and test the control algorithm and simulate the Rotating Table response to its commands.



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Modelling and Like Real-time Simulation

The main M&LRTS mode purposes are:

- to model the plant
- to run and to validate the model
- to design the control algorithm
- to run and to validate the algorithm against the simulated plant

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Modelling and Like Real-time Simulation

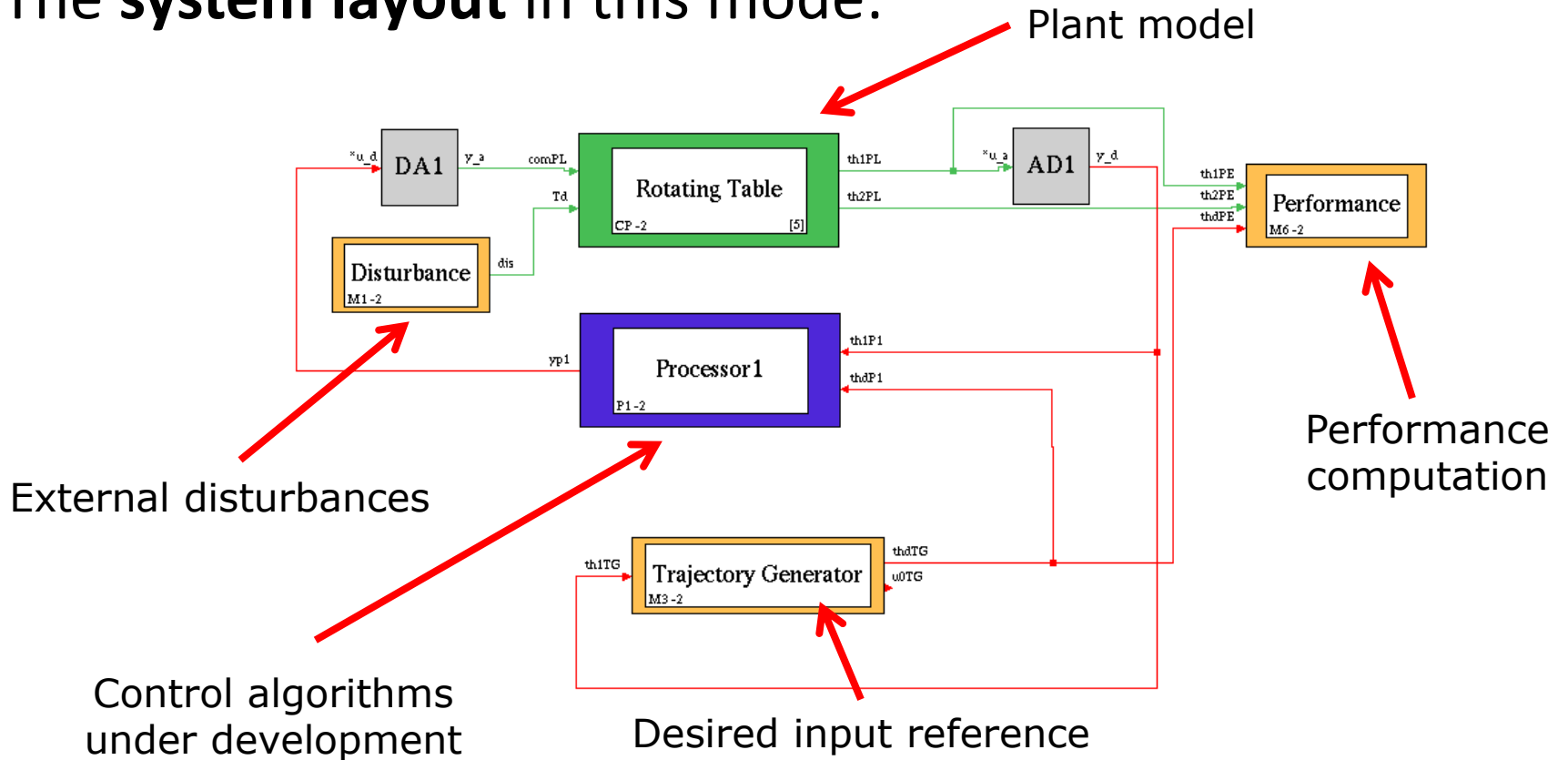
Who does what in Modelling and Like Real-time Simulation operative mode in RT-PC demo:

HW	EICASLAB RCP Platform	Local target	Rotating Table emulator
SW	run control logic simulate the plant	unused	unused

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Modelling and Like Real-time Simulation

The **system layout** in this mode:

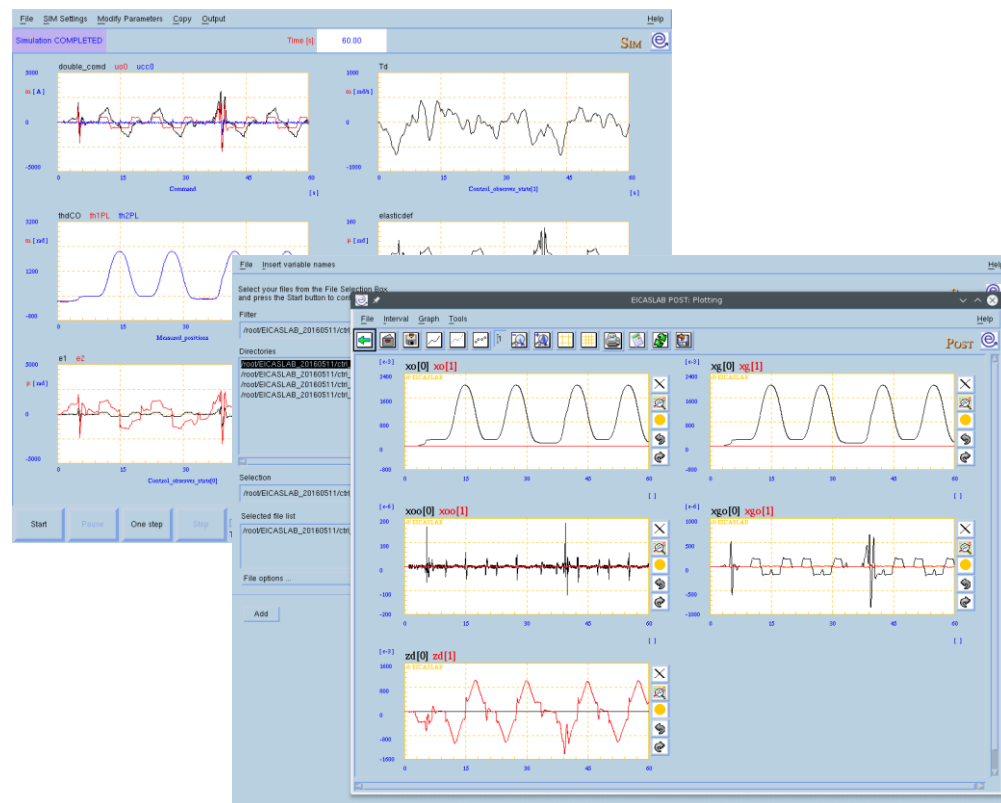


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Modelling and Like Real-time Simulation

The **SIM** tool allows the user to control the execution of simulation trials, providing diagrams, editing of run-time parameters and storage of data for post-analysis with the **POST** tool.



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Rapid Control Prototyping

The **Rapid Control Prototyping operative mode** allows the user to test the control algorithm under development directly on the **real plant** using the advanced (and comfortable) analysis, debug and recording tools available on the EICASLAB RCP Platform. It includes two operative sub-modes: **RCP On Field** and **Slow Motion**.



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Rapid Control Prototyping

The main RCP operative mode purposes are:

- to run and validate the algorithm against the **real** plant
- to monitor, record and tune real physical quantities and parameters
- to use debug and slow motion tools provided by the

EICASLAB RCP Platform

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RCP On Field

In **RCP On Field** operative sub-mode, EICASLAB runs the control as a real-time application, interfacing with the **real plant** through a set of I/O interfaces, created by EICASLAB Automatic Code Generation (ACG).

Rapid Control Prototyping scenario

Control algorithms



EICASLAB RCP Platform



I/O Interfaces

Linux RT-Preempt

measures

commands



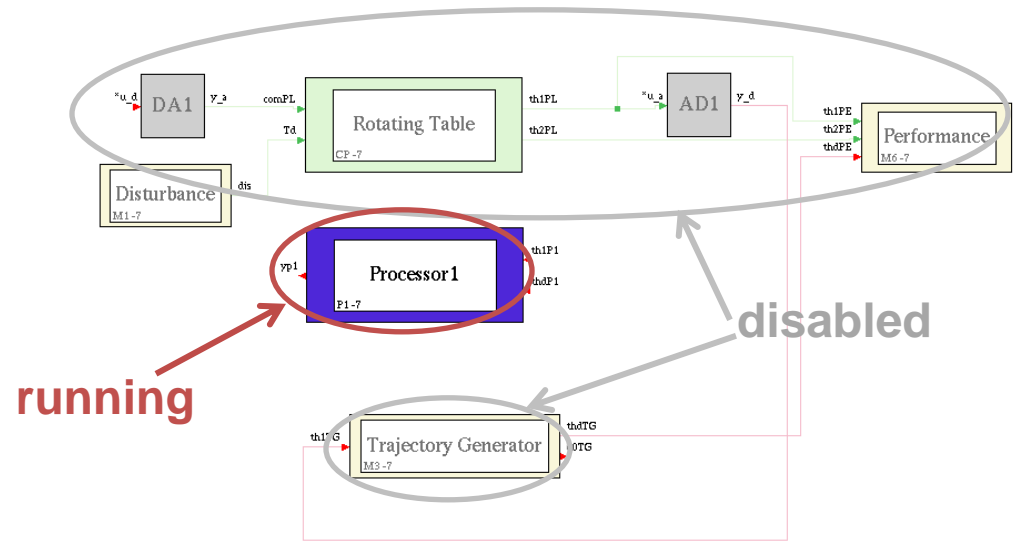
Real plant

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RCP On Field

The **project layout** in this sub-mode:

no more simulated by the main project

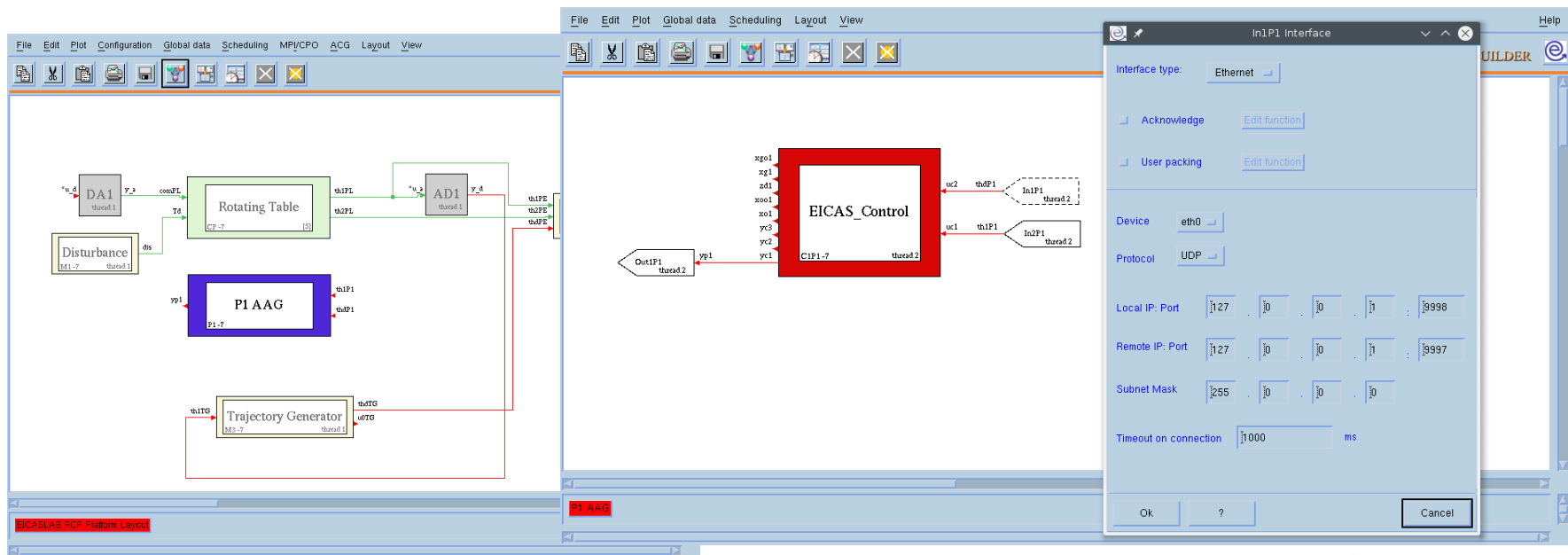


The System Layout of the Rotating Table project in RCP shows that all blocks except the *Processor* are **disabled**.

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RCP On Field

In this demo, the user can explore the system layout, its pre-defined configuration and the set of parameters for the RCP trial, then generate the real-time application.



The screenshot displays the EICAS software interface. On the left, a block diagram titled "EICASLAB RCP Platform Layout" shows a control system with components: DA1 (Disturbance), Rotating Table, PI AAG, Trajectory Generator, and AD1. On the right, a detailed view of the "EICAS_Control" block (CIP1-7) is shown with various input and output ports. A configuration window titled "InIP1 Interface" is open, showing settings for an Ethernet interface. The configuration includes:

- Interface type: Ethernet
- Device: eth0
- Protocol: UDP
- Local IP: Port: 127.0.0.1 : 3998
- Remote IP: Port: 127.0.0.1 : 3997
- Subnet Mask: 255.0.0.0
- Timeout on connection: 1000 ms

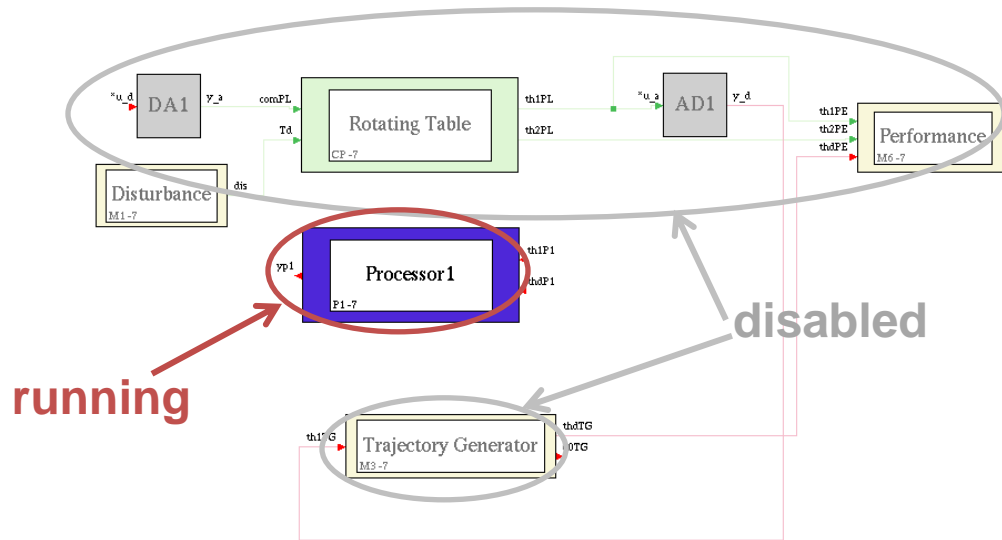
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RCP On Field

The **project layout** in this sub-mode:

no more simulated by the main project



Since the real rotating table is not available and we must close the loop, it will be simulated by using a separate project as real-time emulator.

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RCP On Field

Who does what in RCP On Field operative sub-mode in RT-PC demo:

HW	EICASLAB RCP Platform	Local target	Rotating Table emulator
SW	run control logic	unused	simulated by second project

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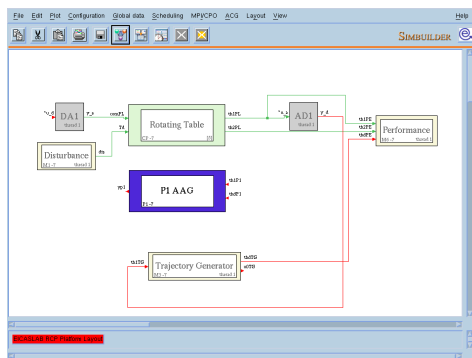


RCP On Field

The two projects in two EICASLAB instances

Linux PC

Main project in RCP



EICASLAB™ Demo #1

real-time communication on local interface

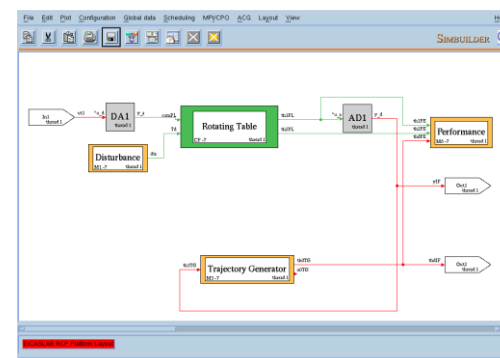
commands



measures



Plant emulator in RCP



EICASLAB™ Demo #2

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RCP On Field

The **RCP Manager tool** includes a GUI for controlling the execution of the real-time program and providing timing diagrams, performance reports and other functions.

The screenshot displays the RCP Manager interface with a 'RCP process COMPLETED' status. It features several timing charts and a log window. The log window contains the following text:

```

13 May 16 16:48:51 -> PRINT THREAD: STARTING.
13 May 16 16:48:51 -> UI THREAD: STARTING.
13 May 16 16:48:51 -> MAIN THREAD: Target is waiting to start ...
13 May 16 16:48:56 -> SCHED CONF THREAD: STARTING.
13 May 16 16:48:56 -> ACTIVITY THREAD: STARTING 'Th2'.
13 May 16 16:48:56 -> SCHED CONF THREAD: The thread 'Th2' is going to be started.
13 May 16 16:48:56 -> SLOW MOTION THREAD: STARTING.
13 May 16 16:48:56 -> POST THREAD: STARTING.
13 May 16 16:48:56 -> RCP PLOT THREAD: STARTING.
13 May 16 16:48:57 -> MAIN THREAD: Target is running.
13 May 16 16:47:26 -> SCHED CONF THREAD: The thread has been terminated.
13 May 16 16:47:26 -> ACTIVITY THREAD: The thread 'Th2' has been terminated.
13 May 16 16:47:28 -> SLOWTH: Task Deleted.
13 May 16 16:47:28 -> POSTTH: Task Deleted.
13 May 16 16:47:28 -> RCP PLOT THREAD: The thread has been terminated.
13 May 16 16:47:28 -> MAIN THREAD: Target has been stopped.
13 May 16 16:47:28 -> MAIN THREAD: Target is waiting to start ...

```

The interface also includes a 'Threads Properties' table:

ID	Thr Name	Expec. Period [ms]	Recorded Periods	ID Core	Priority	Sync/Async
2	Th2	1.000000e-06	28743	15	99	Async

Below it is the 'Control/Output Properties' table:

Name	Thr ID	Expec. Duration [ms]	Phase [ms]	Type-Cod	Recorded
ProcInPI_InPI1	2	0.000000e+00	0.000000e+00	IN1	sk
ProcInPI_InPI1	2	0.000000e+00	1.000000e+00	IN1	sk
CIP1_EICAS_Control - CIn2	2	3.000000e+00	0.000000e+00	CIn2	sk
ProcOutPI_OutPI1	2	0.000000e+00	0.000000e+00	Out3	sk

At the bottom, there is a 'Summarizing Time Chart' table:

Name	Expec. Duration [ms]	Max Duration [ms]	Average Duration [ms]	Min Duration [ms]
ProcInPI_InPI1 - In0	0.000000e+00	4.092433e-02	0.000000e-01	0.000000e-01
ProcInPI_InPI1 - In1	0.000000e+00	3.286200e-02	6.220274e-03	1.710000e-03
CIP1_EICAS_Control - CIn2	3.000000e+00	1.060400e-02	1.987200e-03	0.830000e-04
ProcOutPI_OutPI1 - Out3	0.000000e+00	3.105000e-02	1.086426e-02	7.453000e-03

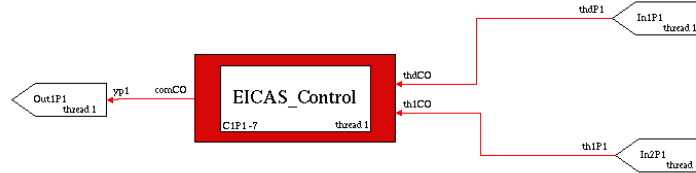
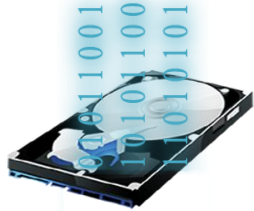
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RCP On Field

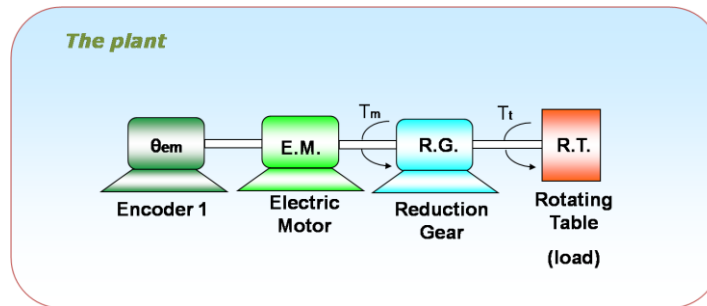
RCP Manager
Run-time parameters
and data recording

EICASLAB RCP Platform



Motor command
(UDP)

Plant



Position Measure
(UDP)

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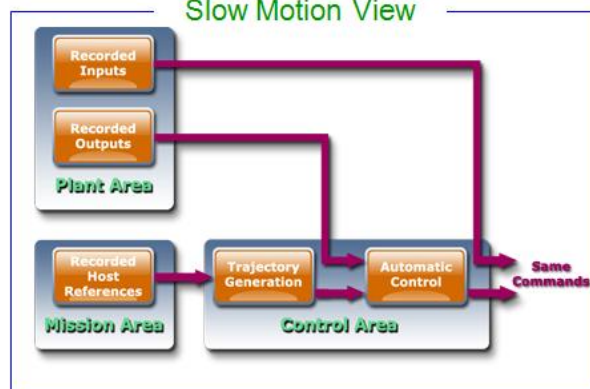
Slow Motion

The **Slow Motion operative sub-mode** is an offline **replay** of the algorithm execution, using data recorded during the previous RCP trials.



SLOW MOTION TOOL

Slow Motion View



Repeat the trial as a **MOVIOLA** with **EICASLAB™**



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Slow Motion

Who does what in Slow Motion operative sub-mode in RT-PC demo:

HW	EICASLAB RCP Platform	Local target	Rotating Table emulator
SW	run control logic	unused	unused

**simulated plant
from recorded data**

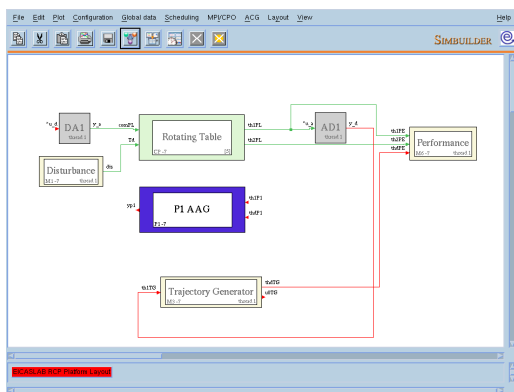
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Slow Motion

The **Slow Motion tool** includes a GUI for managing the execution of the replay of trials recorded on field, providing timing diagrams and other functions.

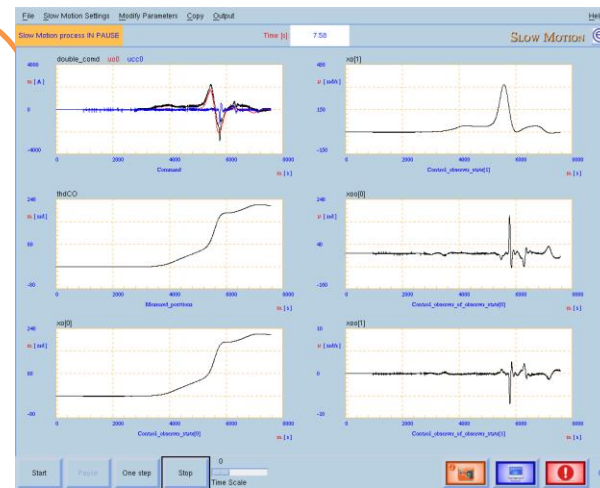
Main project in Slow Motion



Execution replay of control algorithms

Previous acquisition

measures

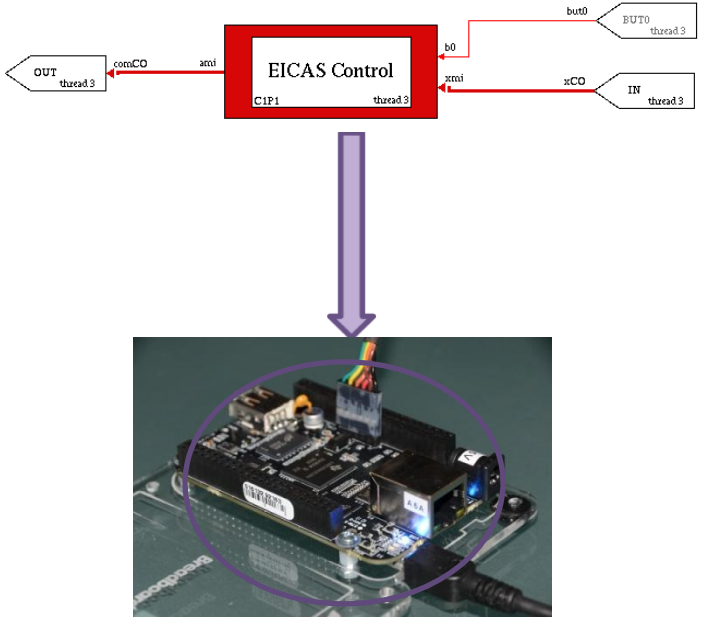


offline analysis, tuning

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Target

The **Target operative mode** allows the user to export the control algorithm to the **final hardware device** that will execute it to control first the simulated plant in Hardware-in-the-loop and then the real plant in Final Validation Test sub-modes.



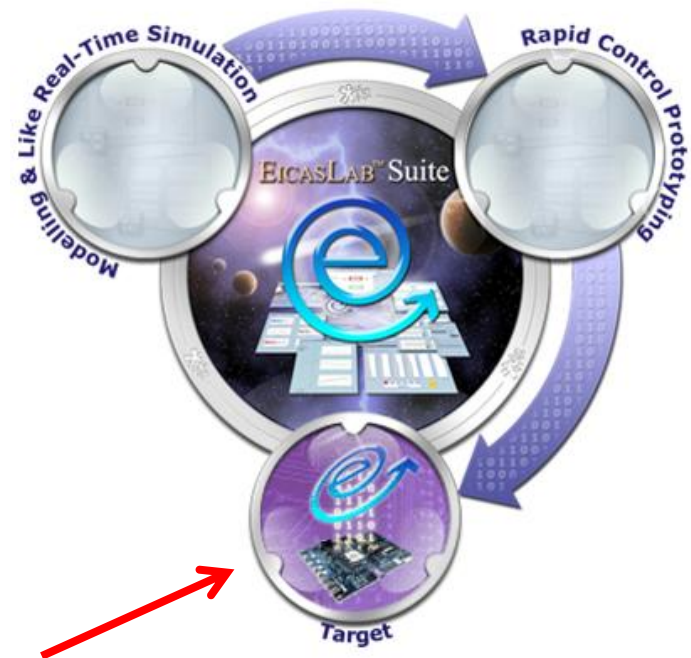
External target

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Target

The **Target operative mode** allows the user to export the control algorithm to the **final hardware device** that will execute it to control first the simulated plant in Hardware-in-the-loop and then the real plant in Final Validation Test sub-modes.



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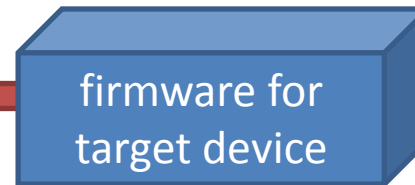


Target

EICASLAB provides the routines to generate the *Basic Software*, not only for the EICASLAB RCP Platform itself, but also for a family of devices or for a specific hardware architecture.

ACG means *Automatic Code Generation*

EICASLAB side



Target side



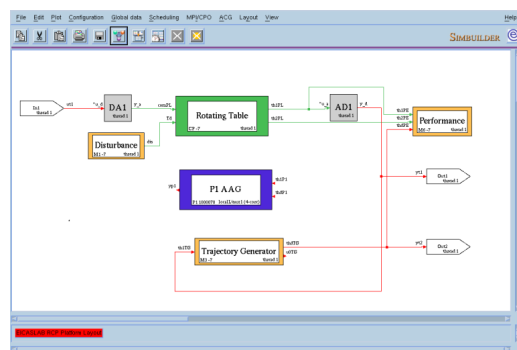
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Target

This demo is designed to show EICASLAB in action avoiding the need for an external target: the ACG output is a standalone real-time program to be run on the PC.

Main project



EICASLAB™ Demo

AS+BS ACG

Compile

Linux PC

Application and Basic Software
Source code, parameters, Makefile

Standalone real-time application
It_exe binary executable

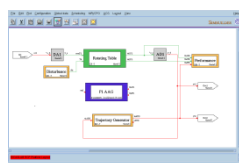
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Target

This demo includes HIL and FVT operative modes, so the ACG for target is repeated twice to build two different real-time applications on the “local target”.

Main project



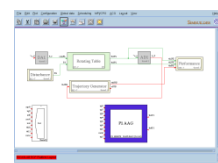
HIL mode

ACG, compile

Linux PC

Application for HIL trials

*a first **It_exe** binary executable*



FVT mode

ACG, compile

Application for FVT trials

*an other **It_exe** binary executable*

EICASLAB™ Demo

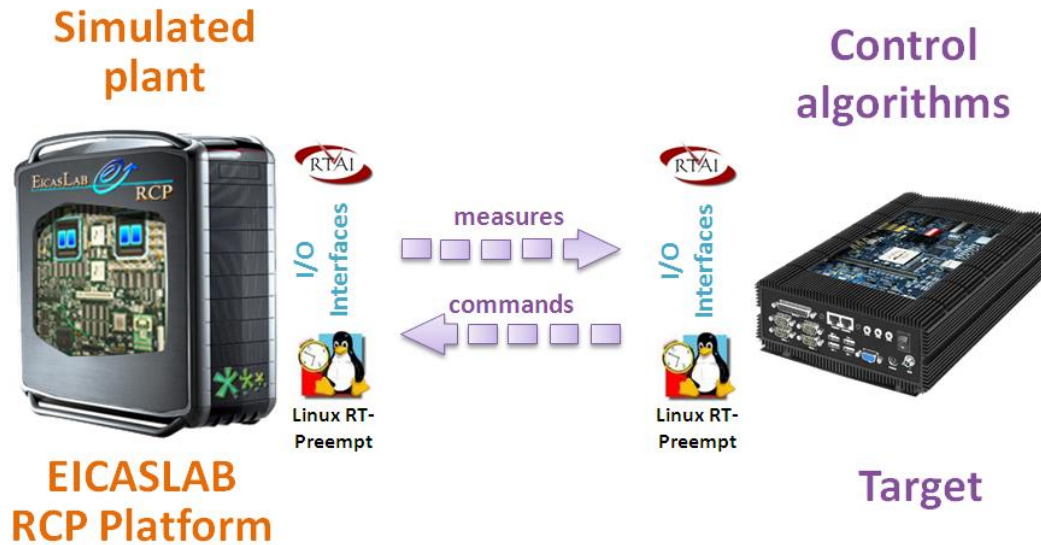
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Hardware-in-the-loop

The **Hardware-in-the-loop** operative sub-mode allows to test the control algorithm **execution on the target hardware** against a **simulated plant** executed in real time on the **EICASLAB RCP Platform**.



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Hardware-in-the-loop

Who does what in Hardware-in-the-loop operative sub-mode in RT-PC demo:

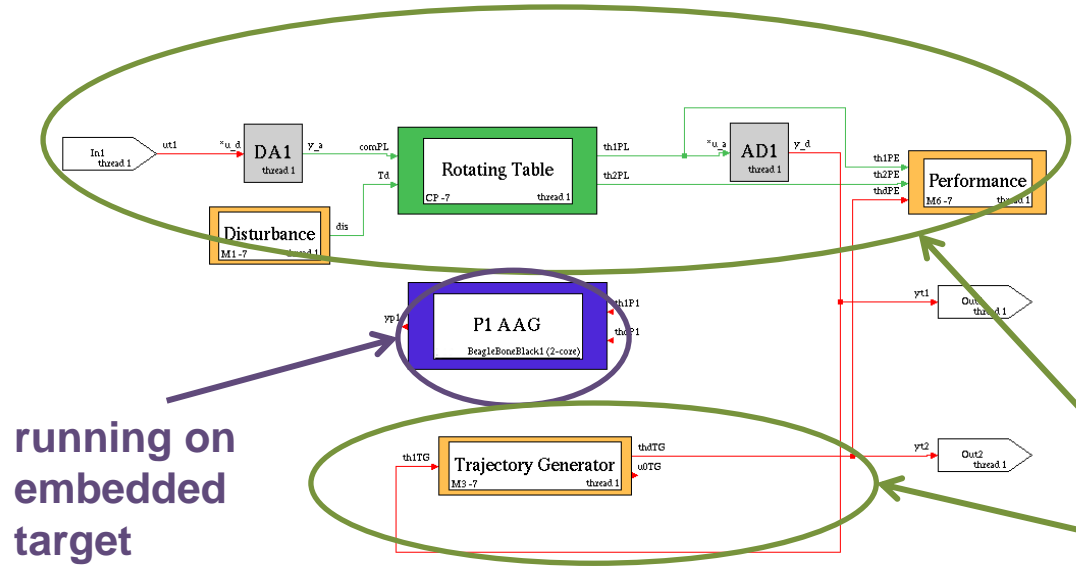
HW	EICASLAB RCP Platform	Local target	Rotating Table emulator
SW	simulates plant	runs control logic	unused

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Hardware-in-the-loop

The **project layout** in HIL sub-mode:

The system layout shows that the *Plant Area* is enabled again: during the HIL trials it is simulated by the **EICASLAB RCP Platform**.



running on embedded target

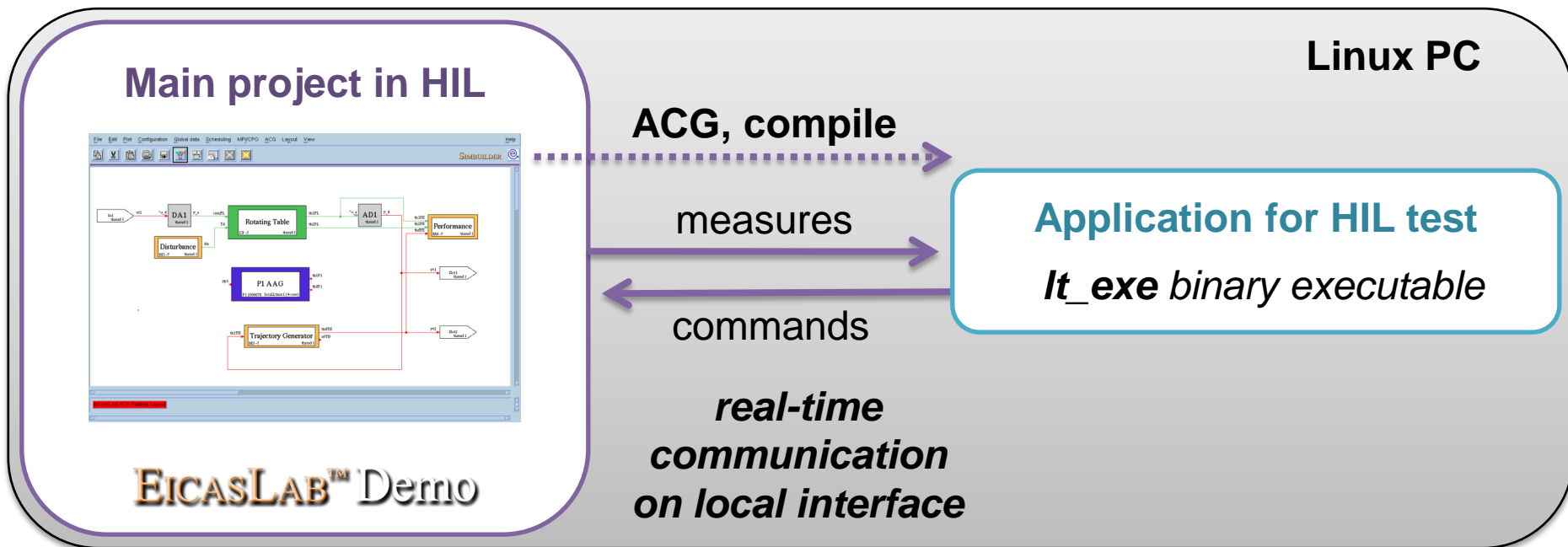
real-time simulated

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Hardware-in-the-loop

When the code of the local target was exported and is running as separated process on the Linux PC, the HIL trial is ready to be executed.

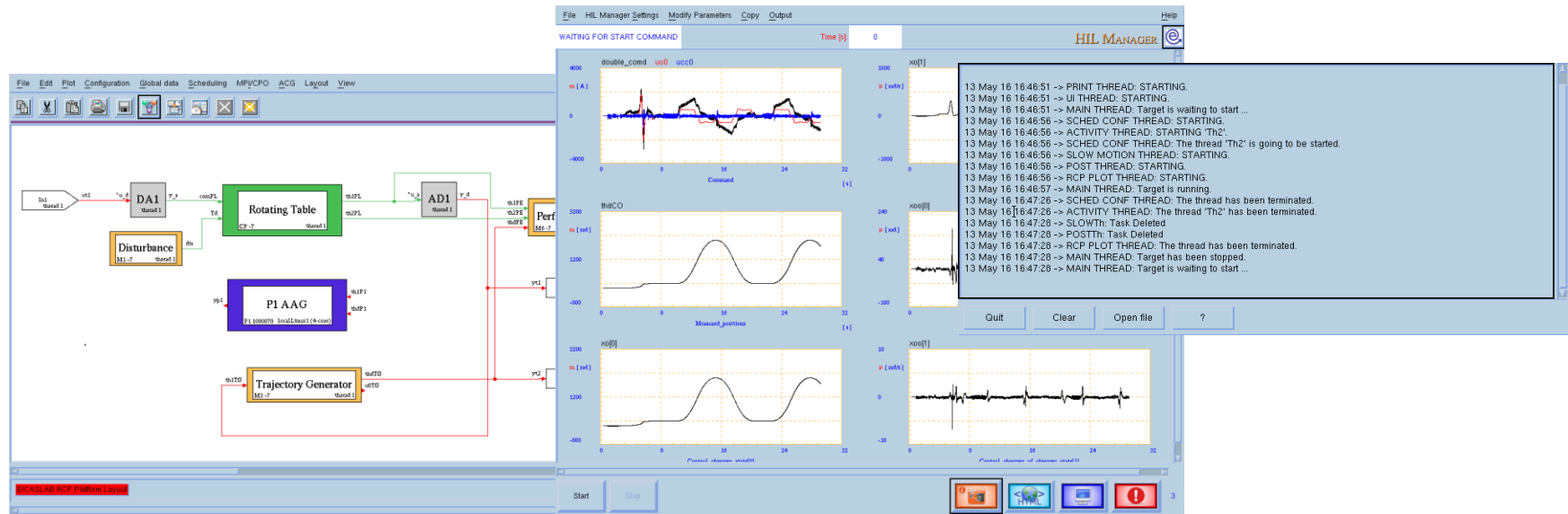


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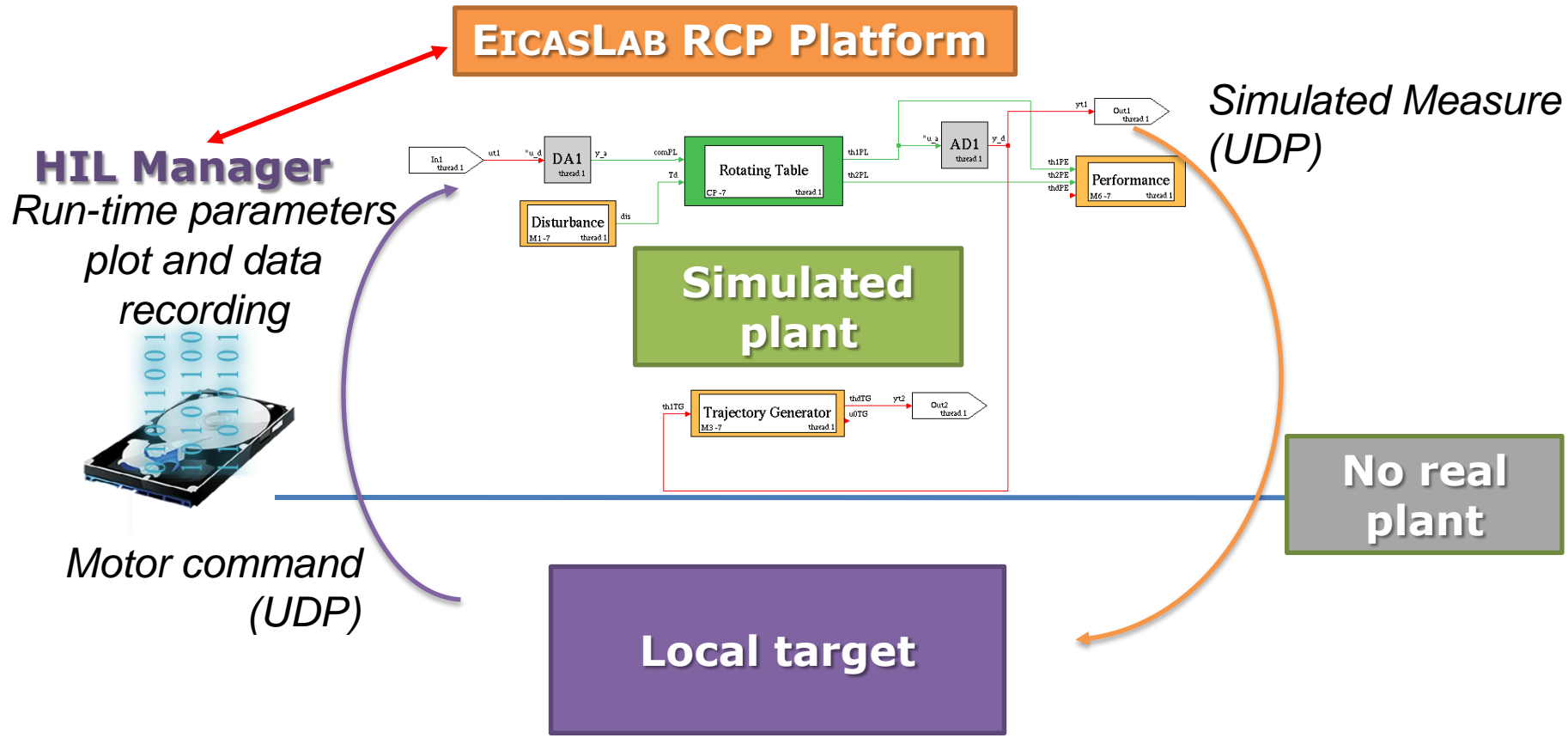
Hardware-in-the-loop

The **HIL Manager** includes a GUI for managing the execution of the real-time plant simulator program, similarly to RCP Manager for RCP operative mode.



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Hardware-in-the-loop



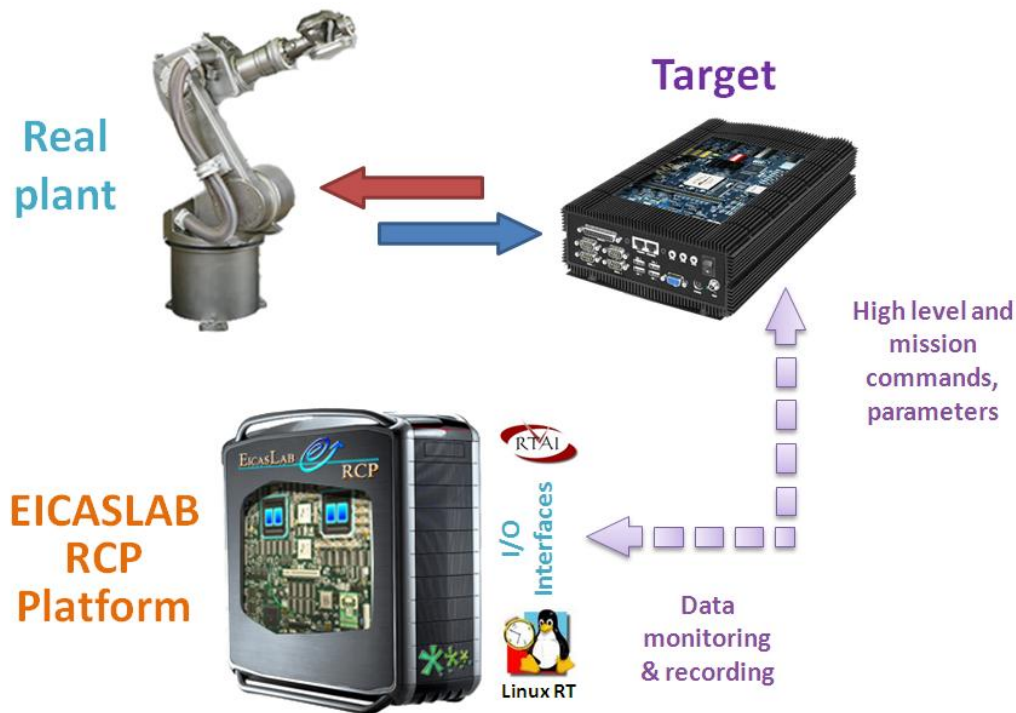
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Final Validation Test

The **Final Validation Test operative sub-mode** allows the user to test the control algorithm **execution on the target hardware** controlling the **real plant**.

Final Validation Test scenario



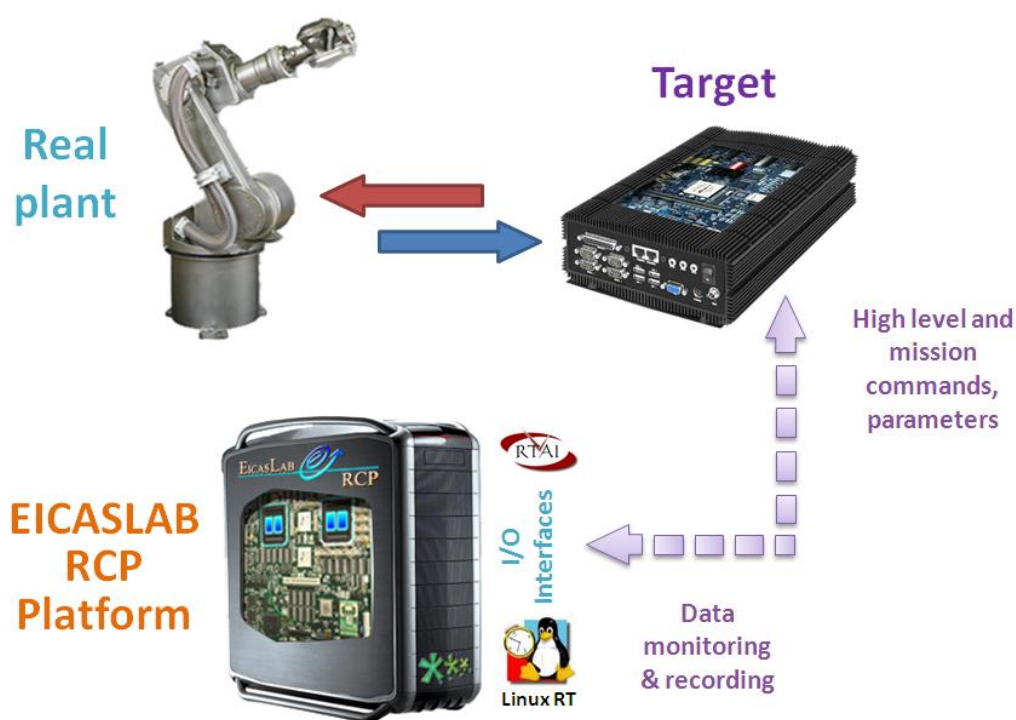
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Final Validation Test

The monitoring and run-time tuning are provided exploiting the real time execution features by the **EICASLAB RCP Platform**.

Final Validation Test scenario



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www.eicas.it



Final Validation Test

Who does what in Final Validation Test operative sub-mode in RT-PC demo:

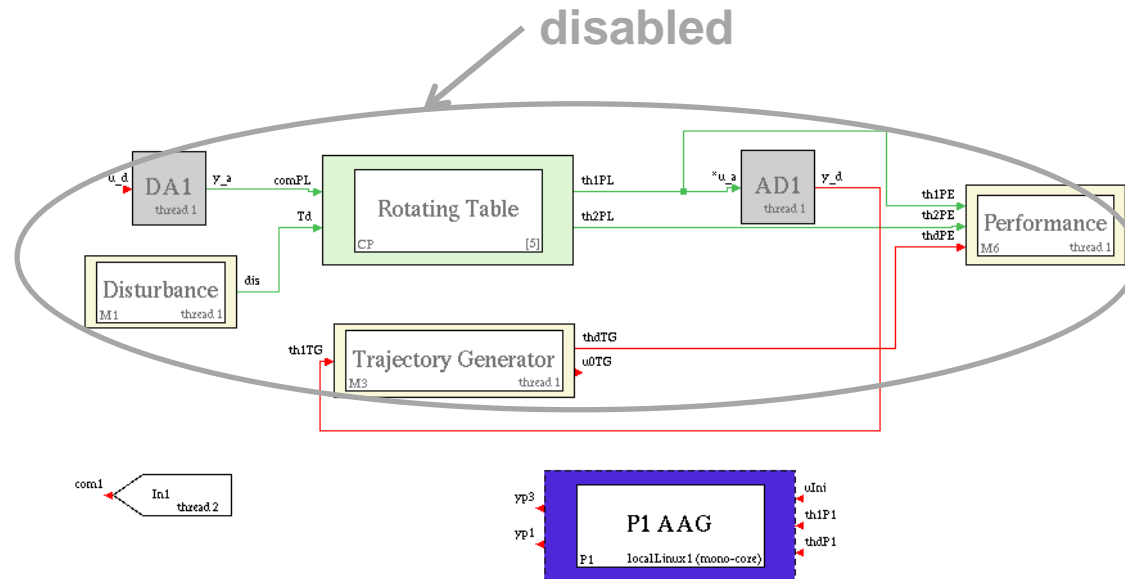
HW	EICASLAB RCP Platform	Local target	Rotating Table emulator
SW	monitoring supervisor	runs control logic	simulated by second project

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Final Validation Test

The **project layout** in this mode:

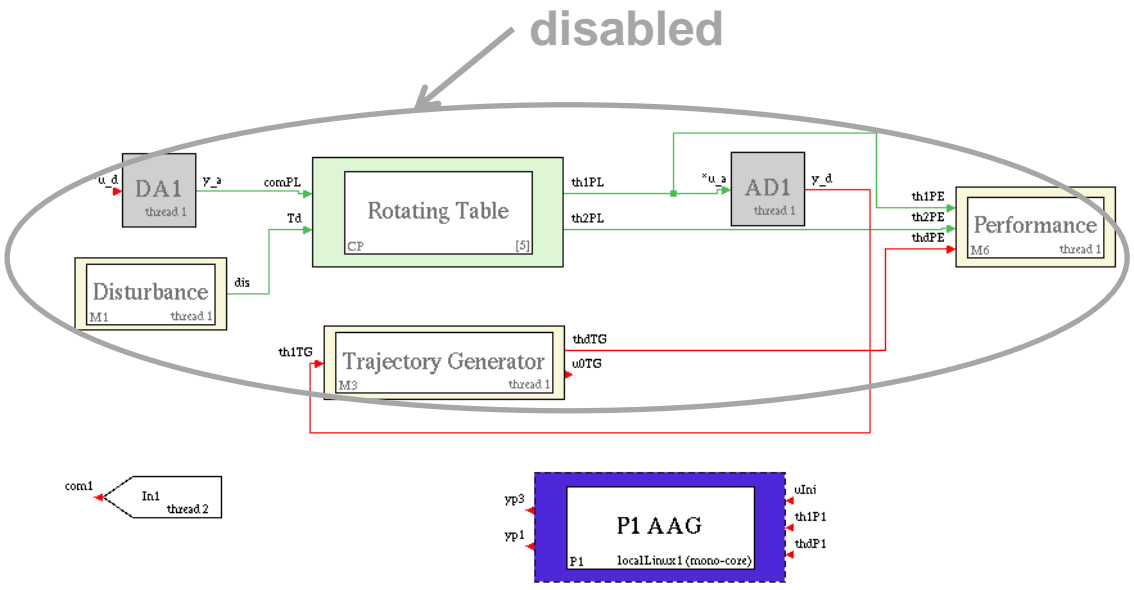


The system layout shows that the *Plant Area* is disabled again, because during the FVT trials the **real plant** is simulated using a separate project.

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Final Validation Test

The **project layout** in this mode:



The control algorithm is executed by external **hardware target**, as in HIL trials.

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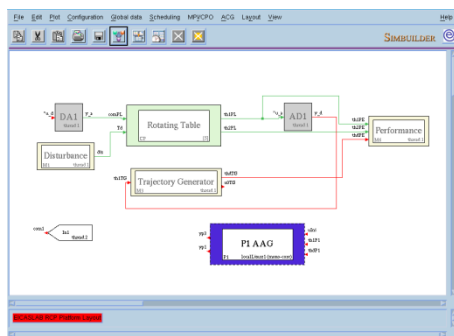


Final Validation Test

Similarly as done in RCP On Field, this demo works without real plant: the user has to run the plant emulator in a second instance of EICASLAB demo.

Linux PC

Main project in FVT



EICASLAB™ Demo #1

ACG, compile

Application for FVT test

It_exe binary executable

data monitoring
(in run time)

measures \updownarrow commands

*real-time
communication
on local interface*

Plant emulator in RCP

EICASLAB™ Demo #2

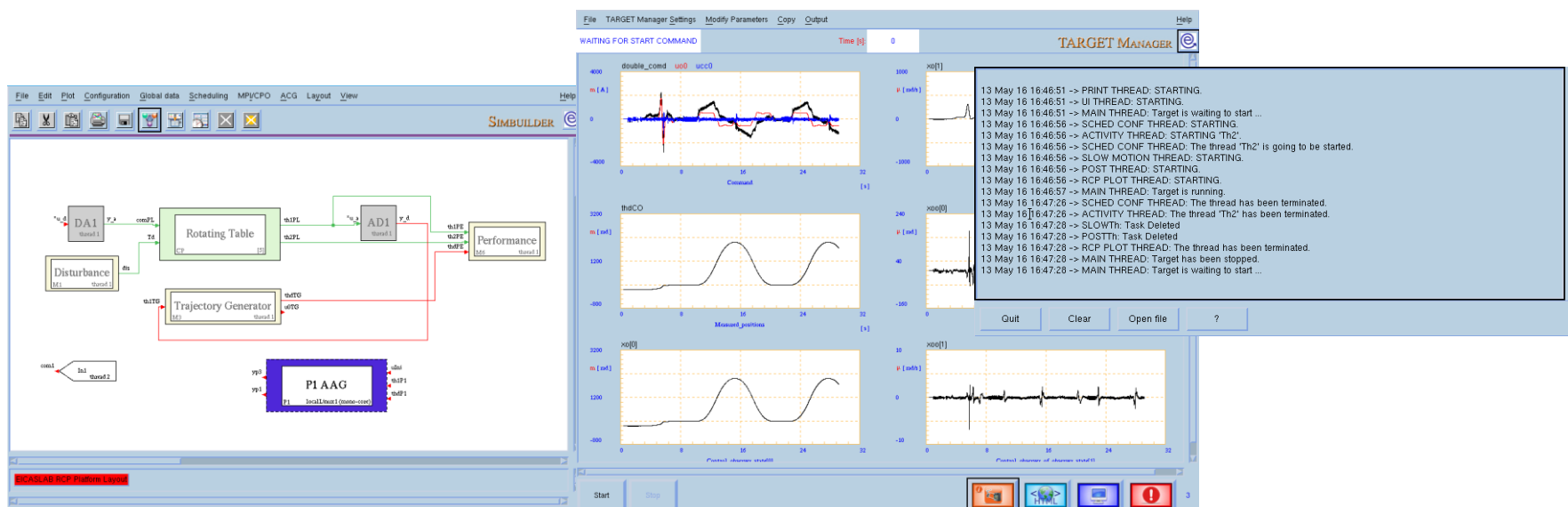
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Final Validation Test

The **TARGET Manager** includes a GUI for managing the execution of the real-time FVT program, similarly to RCP Manager and HIL Manager.



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Final Validation Test

TARGET Manager

Run-time parameters
plot and data
recording



EICASLAB RCP Platform

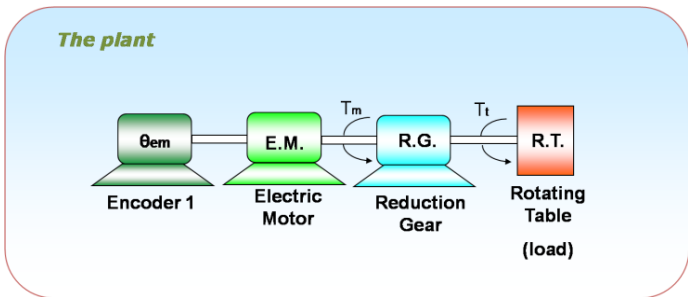
Run-time parameters
(UDP)

Monitoring data
(UDP)

Local target

Motor command
(UDP)

Real plant



Trajectory measure
(UDP)

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Further readings

About this demo:

- EICASLAB Demo RT-PC Webinar
- EICASLAB Demo RT-PC User Manual
- Rotating table technical note

About EICASLAB :

- EICASLAB User Manual
- Other EICASLAB Webinars

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The demo installer is downloadable from EICASLAB website (www.eicaslab.com)



For more info,
please contact:
support@eicaslab.com



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