Graphical User Interface and Cooling System for EMC test station (T4.4.5)

EURO-LABS 3rd Annual Meeting

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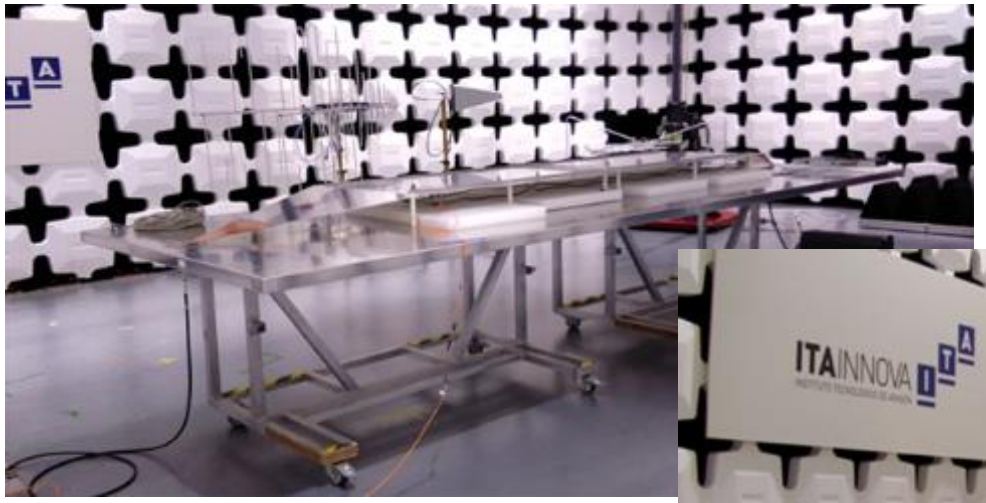
OUTLINE

- 1. Introduction
- 2. Graphical User Interface for EMC system.
- 3. Advance cooling system for EMC system.
- 4. System validation
- 5. Summary

1. Introduction

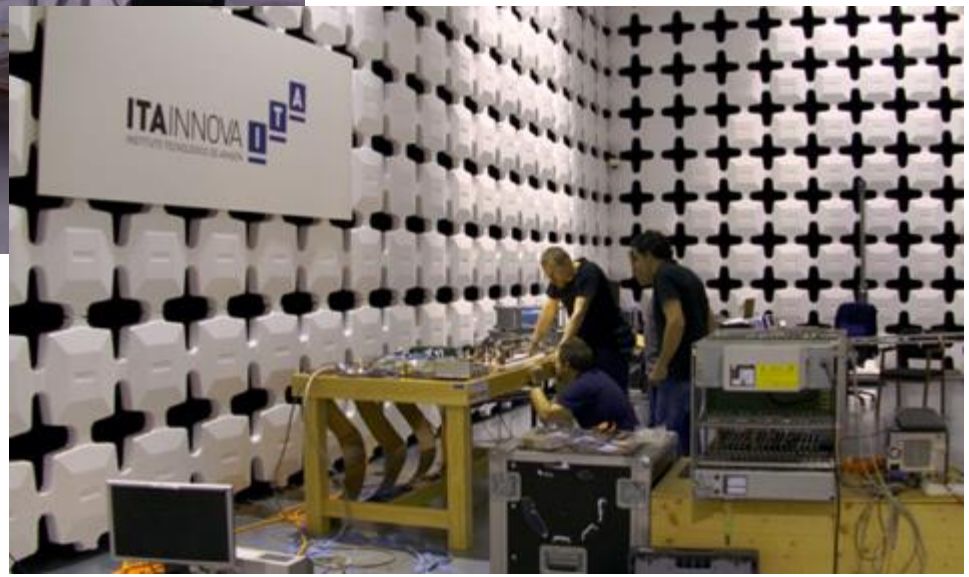
- ITA's EMCLab has been performing EMC-specific testing to identify EM noise susceptibility of detector electronics for several years.
- This test was in high demand during the AIDA 2020 project.
  - Many different systems were tested

CMS Pixel upgrade phase II – FEE (CERN)



DOSFET – Dosimeter for synchrotron radiation facility (Elettra) & Laser Pulsed facility

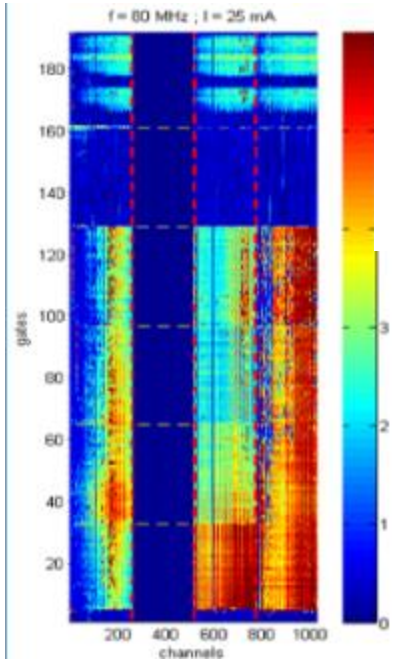
SVD of Belle II DEPFET detector (KEK)

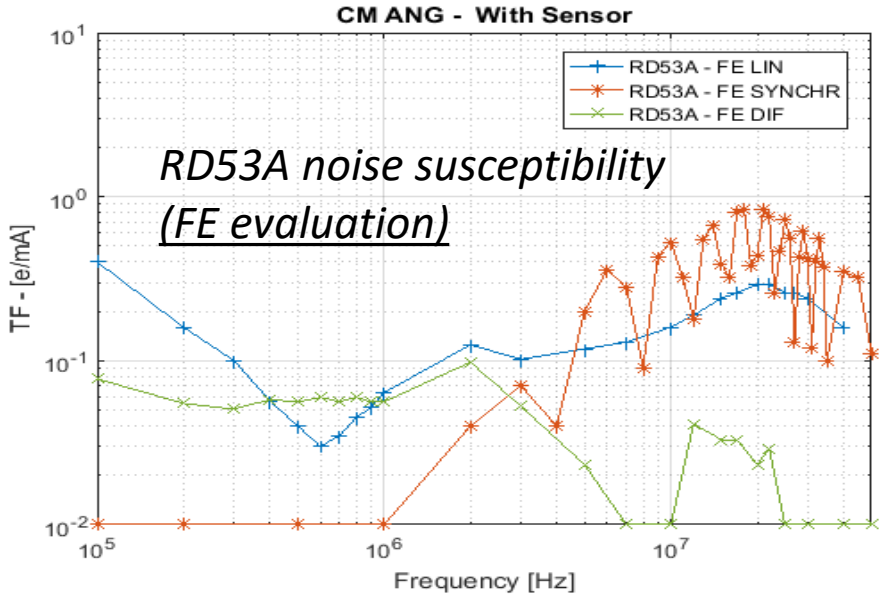


1. Introduction

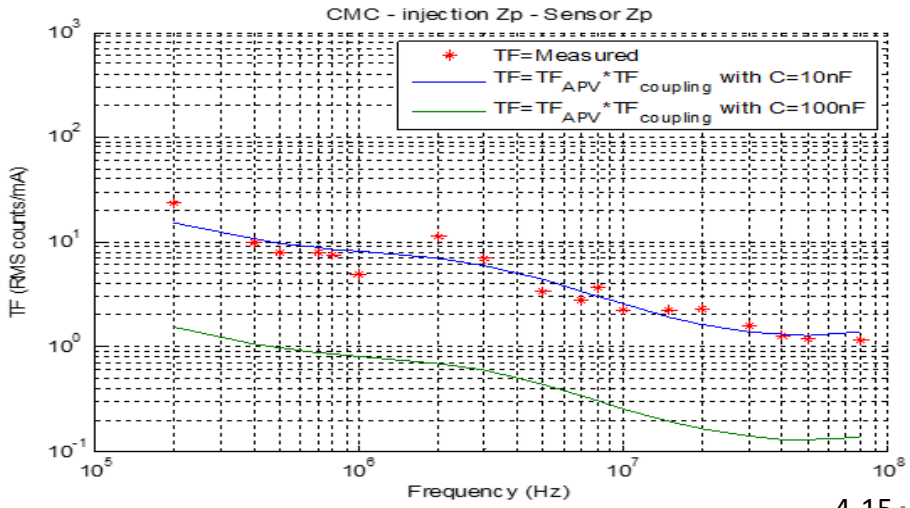
- What ´s the purpose of EMC susceptibility tests ?
- What is the information that can be obtained once the data is processed?
- It is very good for:
  - Grounding topologies evaluation
    - Diagnosis
  - FEE designs
  - Detection of sensitive areas
    - FEE frequency response to noise
  - Noise distributions – EM mapping
    - Conducted or radiated
  - Filter designs

Belle II Pixel Noise distribution



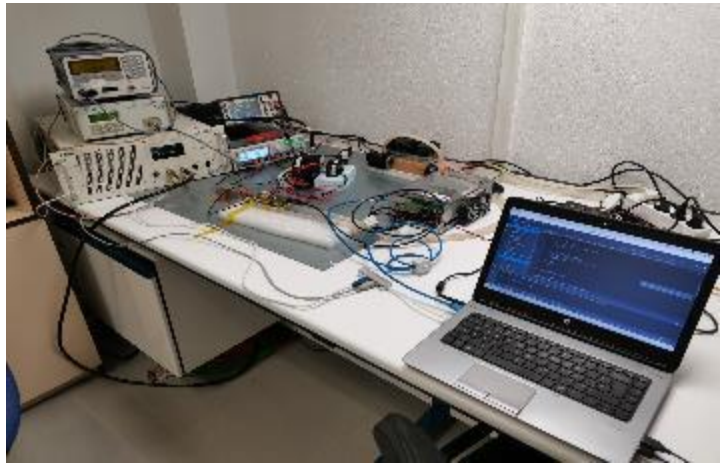


Belle II PXD SVF noise susceptibility (filter evaluation)

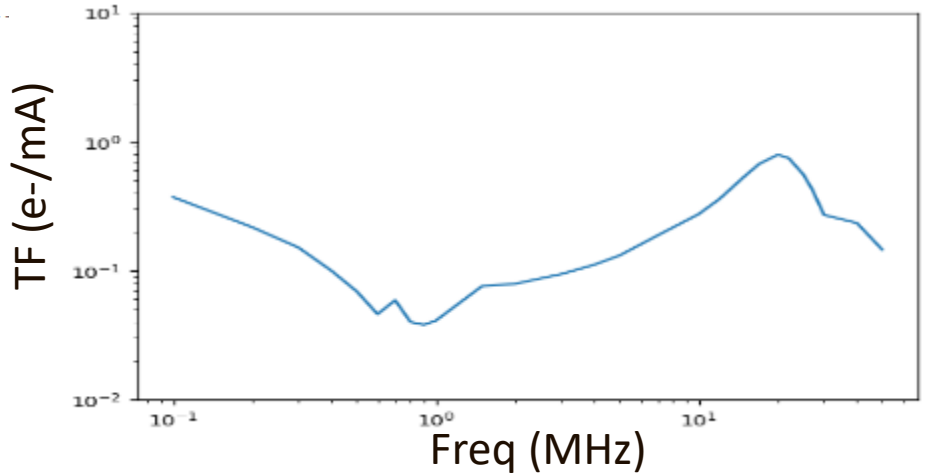


1. Introduction

- The test is used to measure the noise the TF of detector FEE (TF = mA / Counts)
  - However, the test was time-consuming, manually executed and required post-proc.
- During AIDAINNOVA project we have designed and develop an **automatic EMC test bench to measure the noise transfer functions (TF)** of physics detectors.



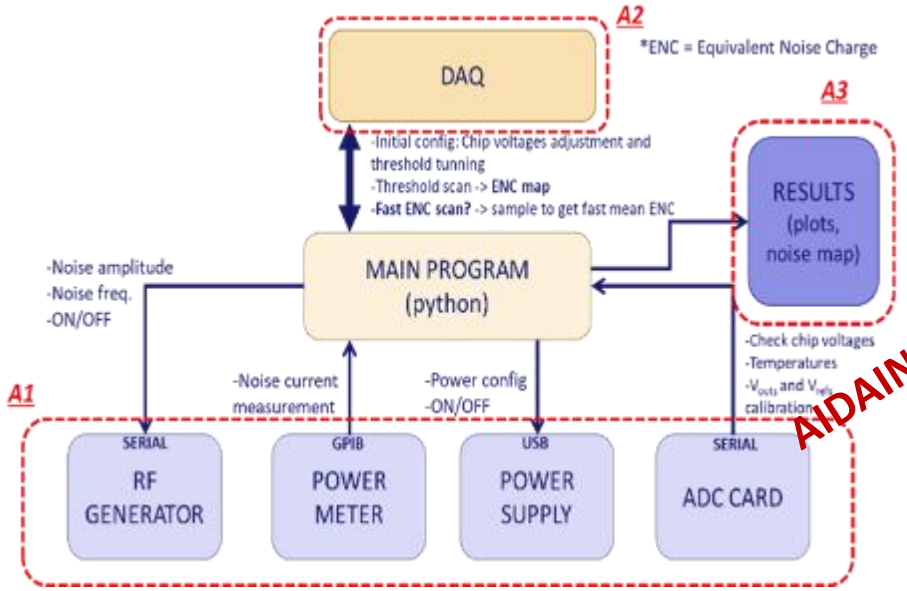
Freq. (MHz)	Current (mA)	ENC (e-)	TF (e-/mA)
REF	REF	71.676	0
0.1	297.1	84.178	0.149
0.2	400.5	97.07	0.163
0.3	500.6	141.478	0.244
0.4	794.2	115.415	0.114
0.5	797.9	80.408	0.046
0.6	852.5	74.603	0.024
0.7	845.4	73.021	0.017
0.8	892.8	73.396	0.018
0.9	896.4	73.403	0.018
1	797.8	73.526	0.021
1.5	601.7	73.614	0.028
2	795.3	77.388	0.037
3	795.0	79.95	0.045
4	699.6	82.064	0.057
5	597.8	83.156	0.071
7	500.4	87.049	0.099
10	605.1	115.01	0.149
12	595.1	138.763	0.2
15	602.8	193.674	0.298
17	522.7	211.626	0.381
20	337.9	170.988	0.459
22	318.0	155.026	0.432
25	302.1	123.389	0.332
27	250.9	98.803	0.271
30	252.2	86.833	0.194
40	200.5	73.459	0.08
50	139.7	72.165	0.06



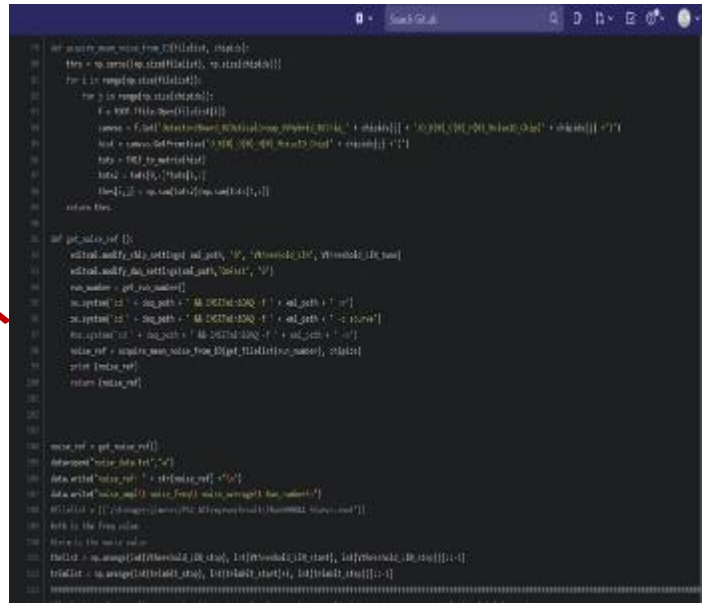
- Unfortunately, the system does not have a user-friendly interface (for easy handling) and the test cannot be performed at low temperatures.
- Two new improvements have been planed in EURO-LABS: **GUI & Colling system**

2. Graphical User Interface for EMC system

- During EUROLABS a GUI has been developed to simplify and improve the use of this software:
  - The interface that can be use by any technician.
  - It allows to easily choose between different chips and setups to use the proper DAQ and detector configuration
  - It automatically plot the most interesting results



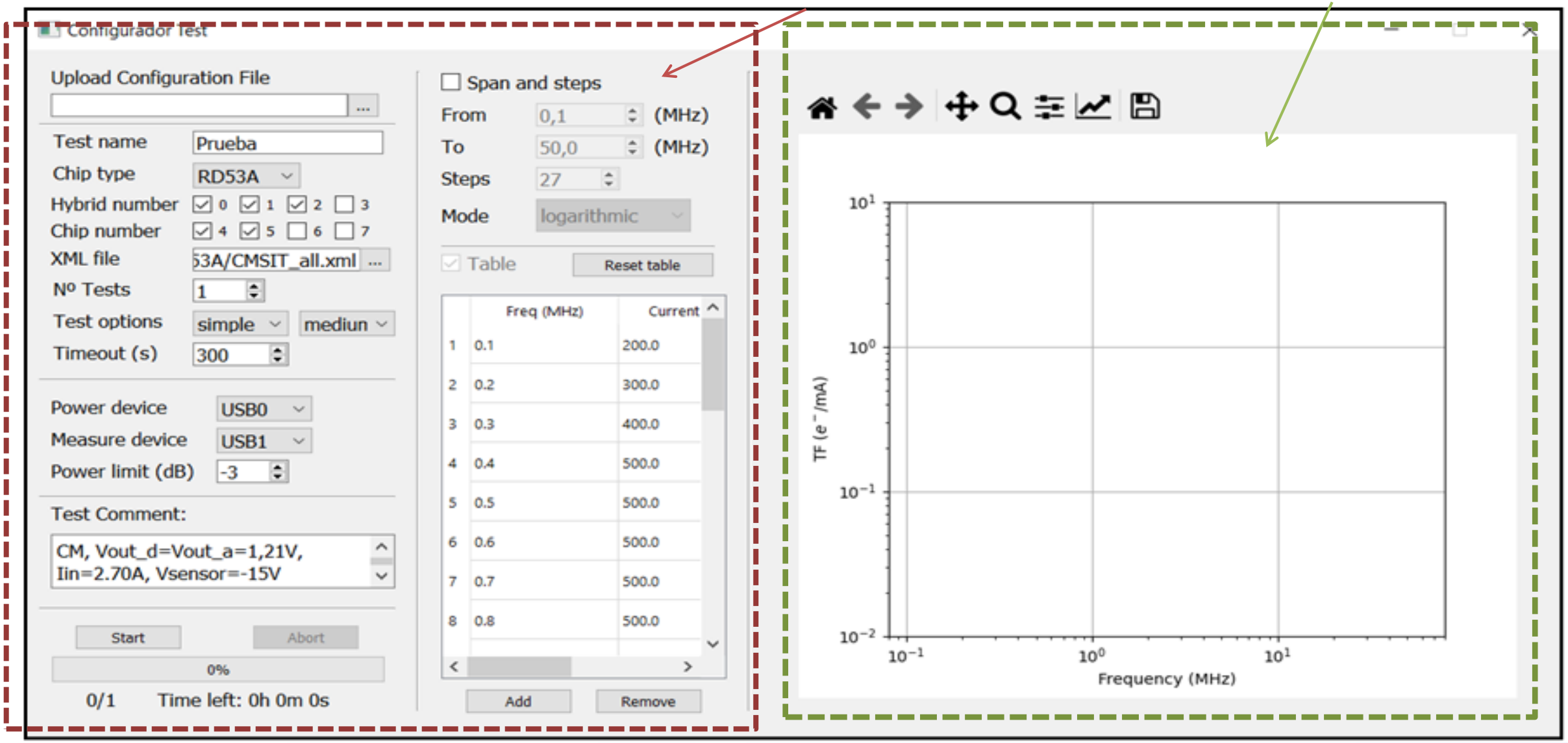
AIDAINNOVA



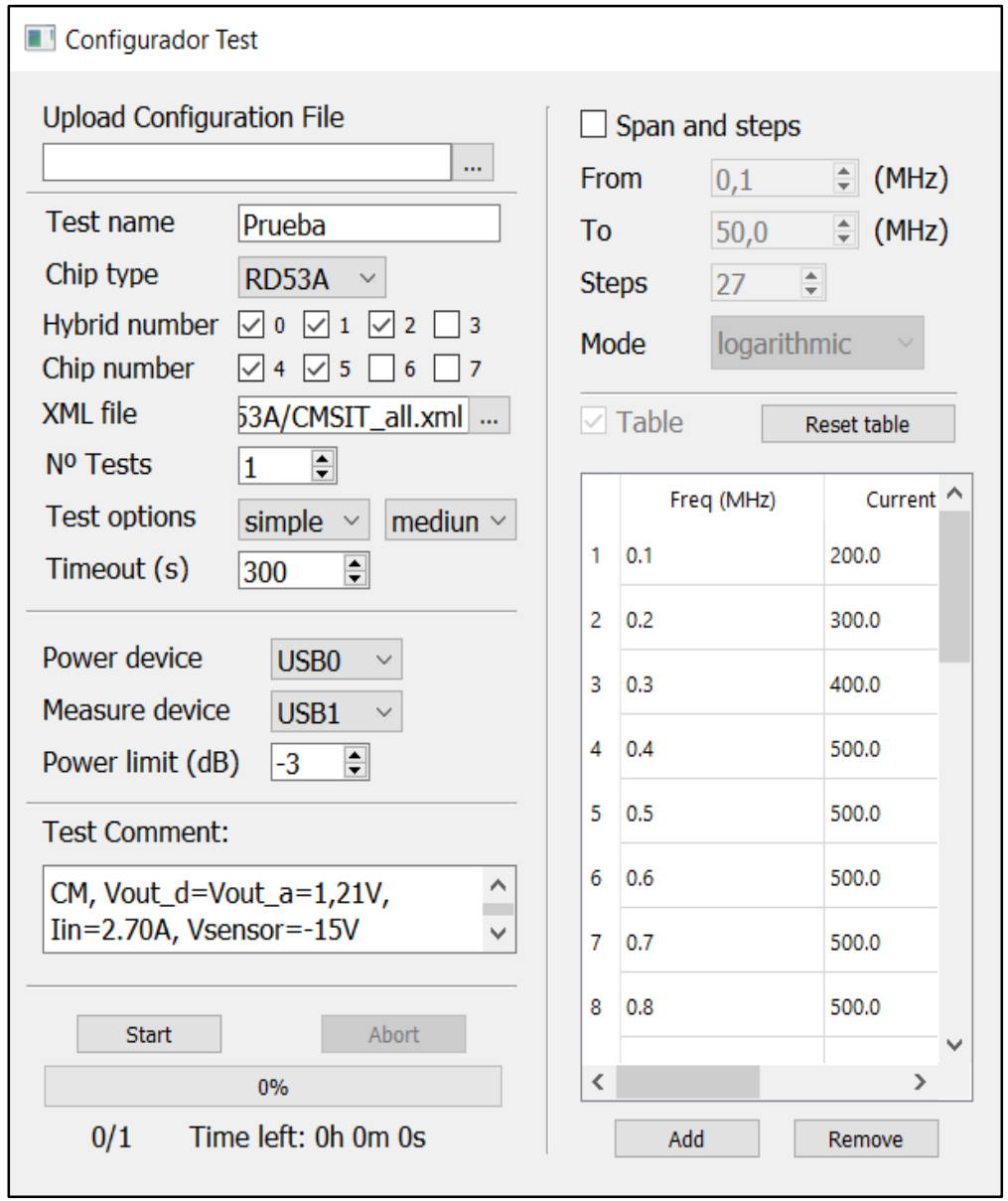
EUROLABS GUI to run easily the system

2. Graphical User Interface for EMC system

- The GUI consists of two main areas: **test parameter configuration** and **result display.**



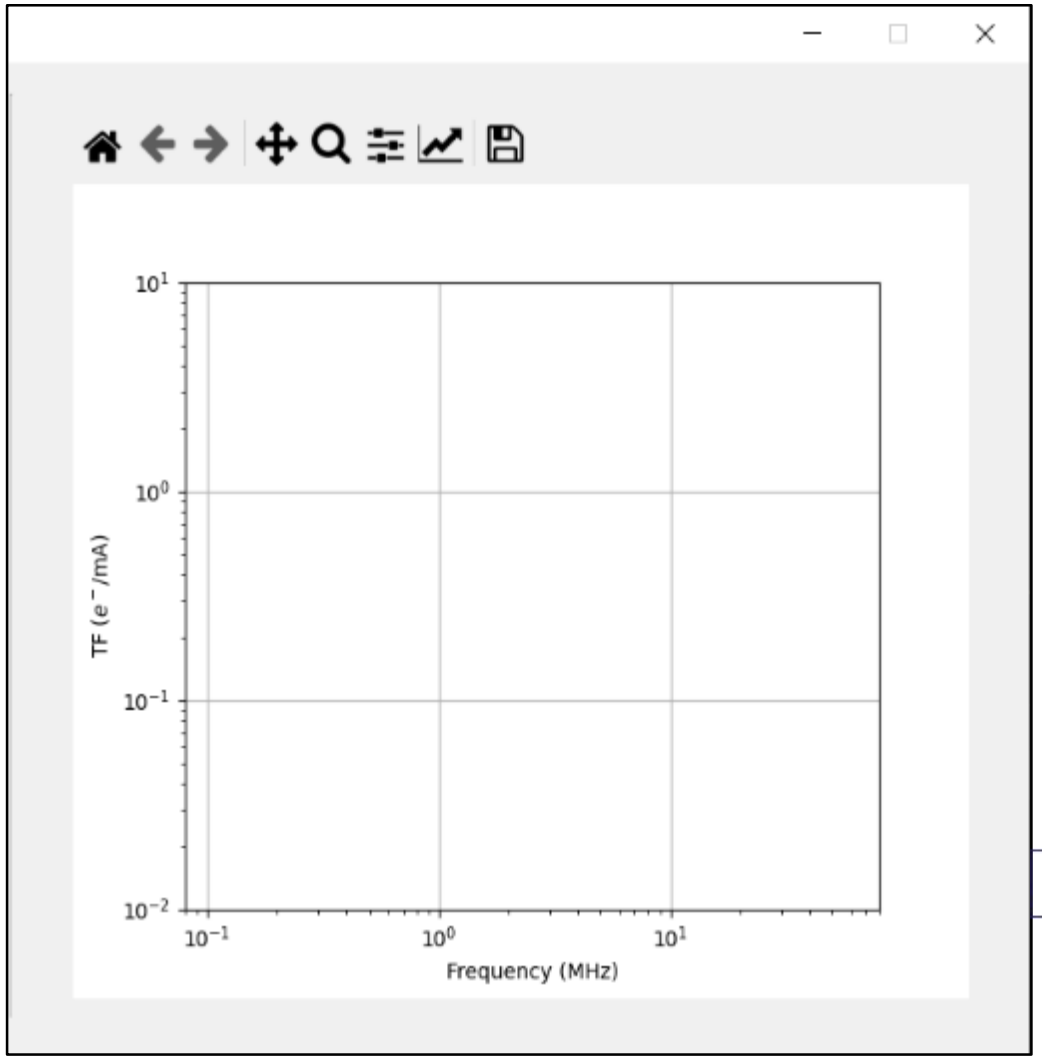
2. Graphical User Interface for EMC system



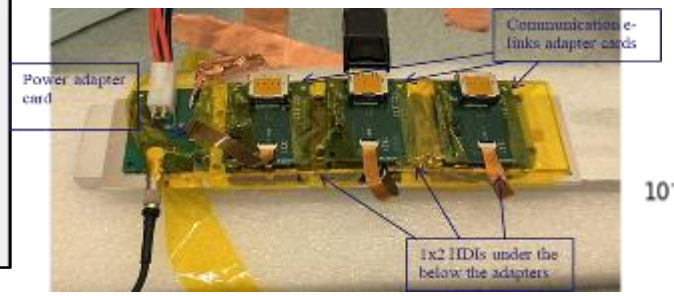
- The **configuration area** simplifies test setup by allowing users to load existing configuration files or define parameters as needed.
- The interface is divided into five main areas:
  - **Configuration Area**: Allows the upload of preconfigured files for quick setup.
  - **Input & Output Ports Area:** Displays ports for both source and measurement equipment connections.
    - Also enables settings for noise emission and power limitations.
  - **Comments Area:** Provides space for additional notes and comments.
  - **Start Area:** Contains controls for initiating the test setup.
  - **Frequency Area:** Dedicated to frequency-related settings.

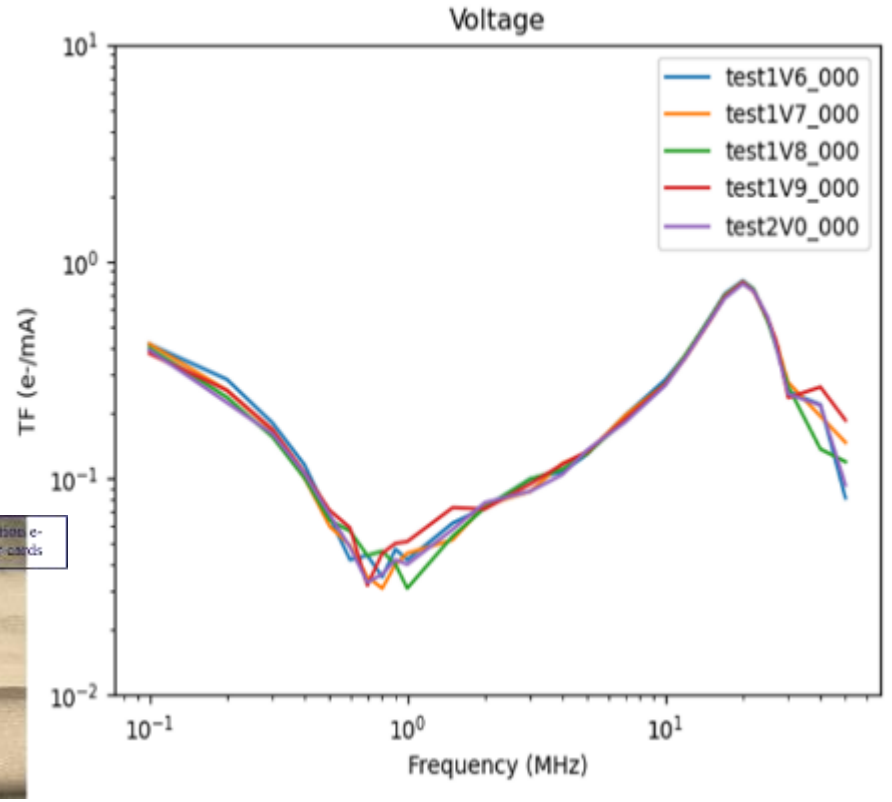
2. Graphical User Interface for EMC system

- The **results display area** presents a graph showing the TF of the selected test and offers customization tools.
  - ➢ Plots are automatically saved
  - ➢ Data are automatically saved to develop complex plots.



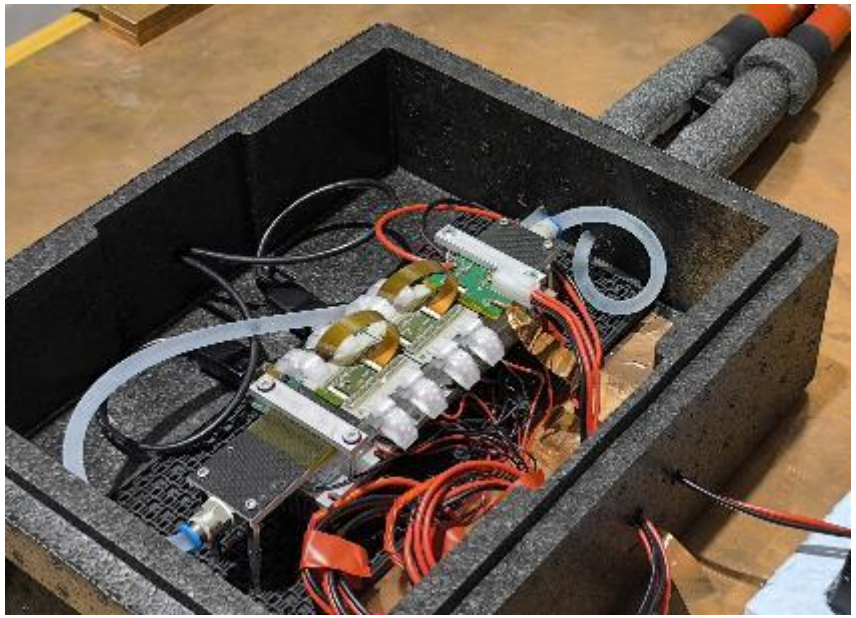
Data export





3. Advance cooling system for EMC system

- Advance cooling system for EMC system has been implemented
  - Liquid chiller (Huber – Ministat 240)
  - Control system allows to run tests in low temperature (up to -30C) and reliable control
  - Different cooling plates (even custom) can be used to adapt to each detector prototype.
  - Commercial cold box has been already included



3. Advance cooling system for EMC system

- Data sheet details

huber

Ministat 240

Refrigerated Heating Circulator Bath with air cooled cooling machine. Powerful, variable speed, pressure and suction pump, evaporator (cooler) and housing of stainless steel, CFC and HCFC free. With adjustable overtemperature protection according to DIN 12876.

Pilot ONE:
The new Pilot ONE controller with pioneering technology and advanced control functions brings numerous advantages to routine work. The extensive features list includes a brilliant 5,7" TFT touchscreen display, USB and network connections, an integrated technical glossary and language support in 13 languages (EN, DE, FR, IT, ES, RU, CN, PT, JP, CZ, PL, KO, TR). The Pilot ONE has a convenient navigation system with easily remembered icons and menu categories which are colour sorted to make routine work simpler. Thanks to a favourites menu and One Click operator guidance all important information is always just a few keystrokes away. Software wizards also help you to set up, ensuring correct settings. The USB port allows connection of the system to a PC or notebook. Together with the Spy software, requirements such as remote control or data transmission are easily achieved in a cost-effective manner. Network integration is easy with the Internet port.

The range of functions can be expanded very easily via E-grade at any time by entering a unit specific upgrade code:

E-grade "Exclusive": TAC (True Adaptive Control) - self optimising internal and cascade control, selectable temperature control mode (Internal/Process), programmer with 3 programs (max. 16 steps), ramp function (linear), 5 point calibration, scalable graphic display, favourites menu, display resolution 0,01 K.

E-grade "Professional": Programmer with 10 programs (max. 100 steps), ramp function for temperature gradients (linear and non-linear), 2nd set point, user menus (Administrator level), calendar start.

4-year warranty - registration required.

Technical data according to DIN 12876

Operating temperature range	-45...200 °C
Temperature stability at 10°C	0,02 K
temperature set point / display	5,7" colour Touchscreen
Internal temperature sensor	Pt100
Sensor external connection	Pt100
Interface digital	Ethernet, USB (Host u. Device), RS232
Safety classification	III / FL
Heating power at 240V	2,1 kW
Heating power at 230V	2 kW
Heating power at 220V	1,8 kW
Cooling power	
at 100°C	0,6 kW
at 20°C	0,6 kW
at 0°C	0,56 kW
at -10°C	0,42 kW
at -20°C	0,35 kW
at -30°C	0,125 kW
at -40°C	0,06 kW
Refrigeration machine	air-cooled, natural refrigerant
Refrigerant (ASHRAE, GHS)	R 290 (A3, H220)
Global Warming Potential (GWP)	0,02
Refrigerant quantity	0,069 kg
Gas warning sensor	without
Pressure pump	yes
max. delivery	22 l/min
max. delivery pressure	0,7 bar
Suction pump	yes
max. delivery (suction)	15 l/min
max. delivery pressure (suction)	0,4 bar
Pump connection	M16x1 male
max. permissible kin. viscosity	50 mm²/s
Bath volume	5,5 l
min. filling capacity	3,5 l
Bath capacity with displacement rack	2,6 l

Order-No.: 2016.0005.01

Peter Huber Kältemaschinenbau SE · Werner-von-Siemens-Str. 1 · D-77656 Offenburg · Tel. 0781/9603-0 · Fax 0781/9731-11 · www.huber-online.com

Technical data according to DIN 12876

Width bath opening WxD / bath depth	205 x 80 / 167 mm	
sound pressure level +/- 4 dB(A)	59 dB(A)	
Overall dimensions WxDxH **	360x486x515 mm	
Net weight	41 kg	
Power supply requirement	220-240V 1~/2~ 50/60Hz	
max. current	12 A	
Fuse	16 A	
Pressure equipment category	Art. 4.3 PED	
Degree of Protection	IP20	
max. ambient temperature	40 °C	
min. ambient temperature	5 °C	
from Serial-No.:	**401892**	**1.4/20**

Technical data's and dimensions are subject to change. No liability is accepted for errors or omissions. Illustrations can deviate from the original.

Included Accessories:
mini USB cable 6048/9, blank plug , hose connector NW12 , sleeve nuts thread , bath cover .

Optional accessories:
drain valve, displacement insert to reduce bath volume, calibration insert, Com.G@te, temperature control / - connection hoses, thermofluids, further accessories, etc.: see catalog.

Output data valid for: Room temperature 20°C. If the ambient temperature rises, the cooling capacity may drop.

In accordance with EN60034-1 the following voltage and frequency tolerances are valid:
Voltage + / - 5% with a simultaneous frequency tolerance of + / - 2%.
Example: -5% voltage and + 2% frequency => not allowed!
-5% voltage and - 2% frequency => allowed

Information to Electromagnetic compatibility:
Classification (disturbance) to EN55011: Class A, Group 1

Standard delivery conditions - Power cable configuration:
1. Single / two-phase devices (100V to 240V) => with power cable and country-specific plug (please specify when ordering)
2. Three-phase devices with current consumption less than 63A => with cable, without plug
3. Three-phase devices with current consumption greater than 63A => without cable, without plug

This equipment is compliant to US-SNAP and all applicable EU laws. The US-SNAP end-use for this equipment is the industrial process refrigeration. Certification by a Notified Body upon request.

** Please respect space requirements. See operating conditions at www.huber-online.com

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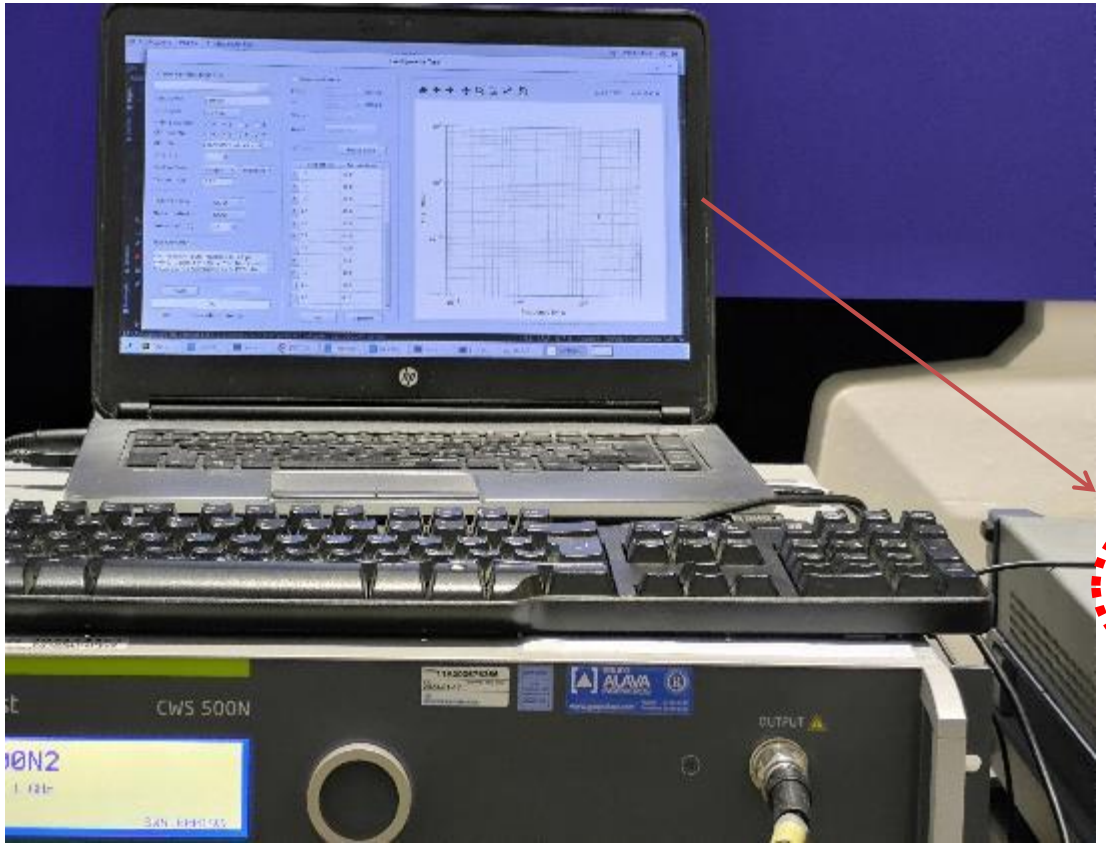
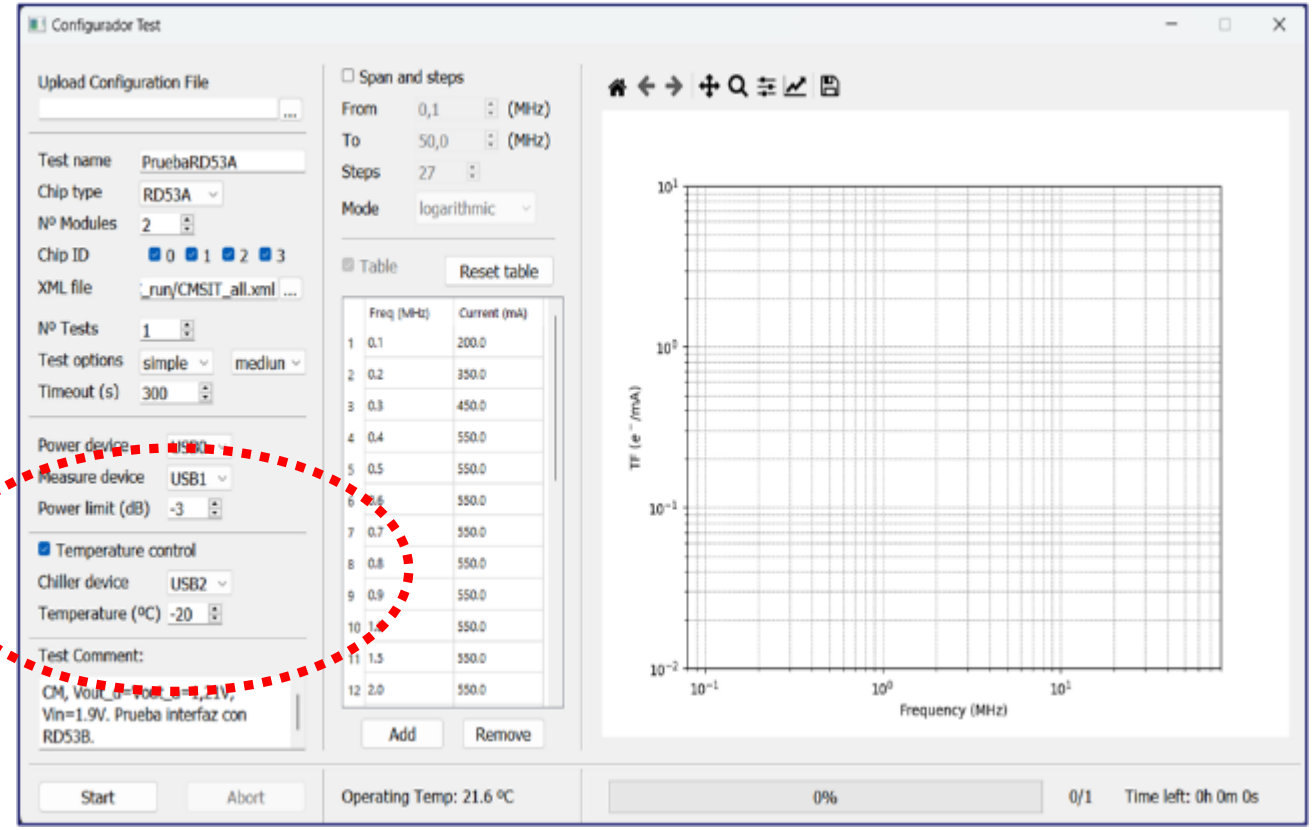
3. Advance cooling system for EMC system

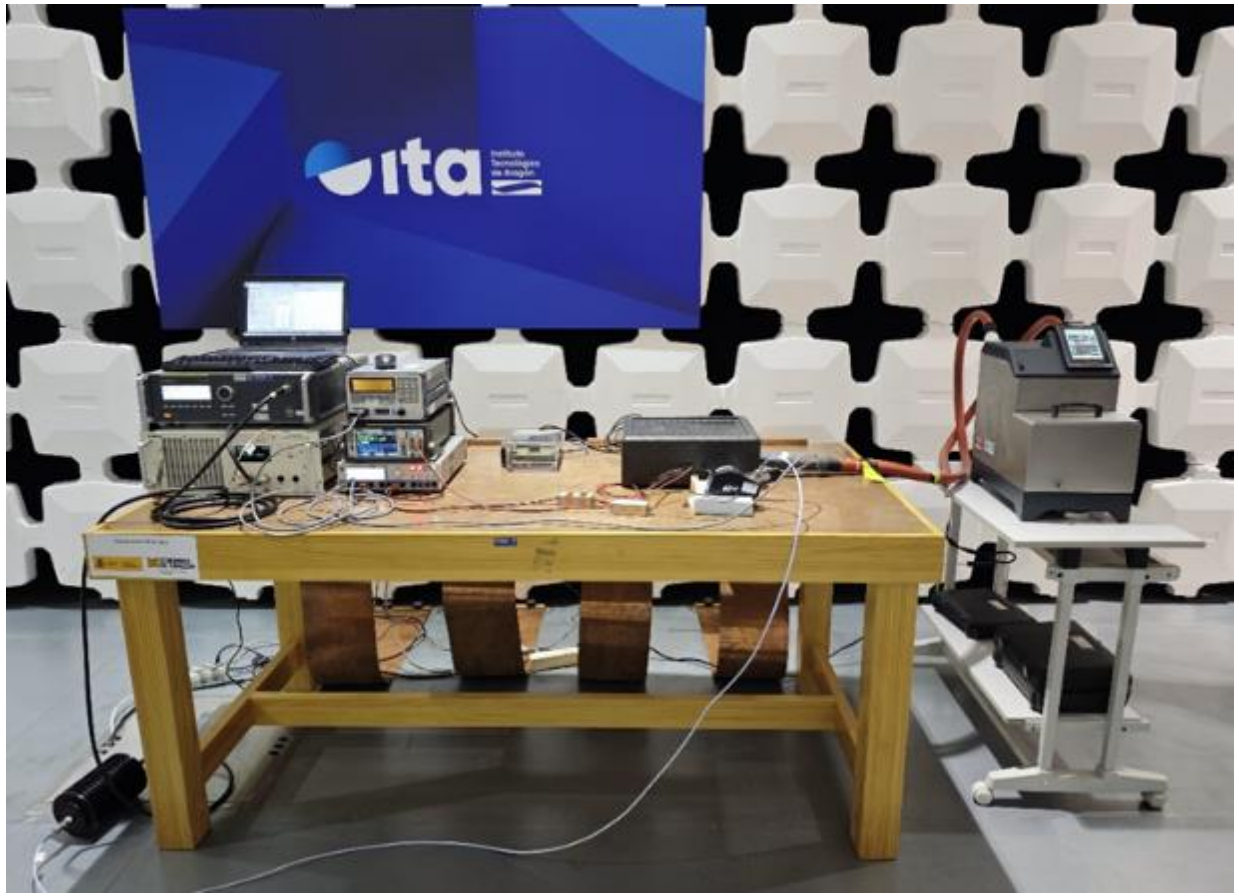
- Control has also been implemented in the software GUI allowing automatic temperature tests

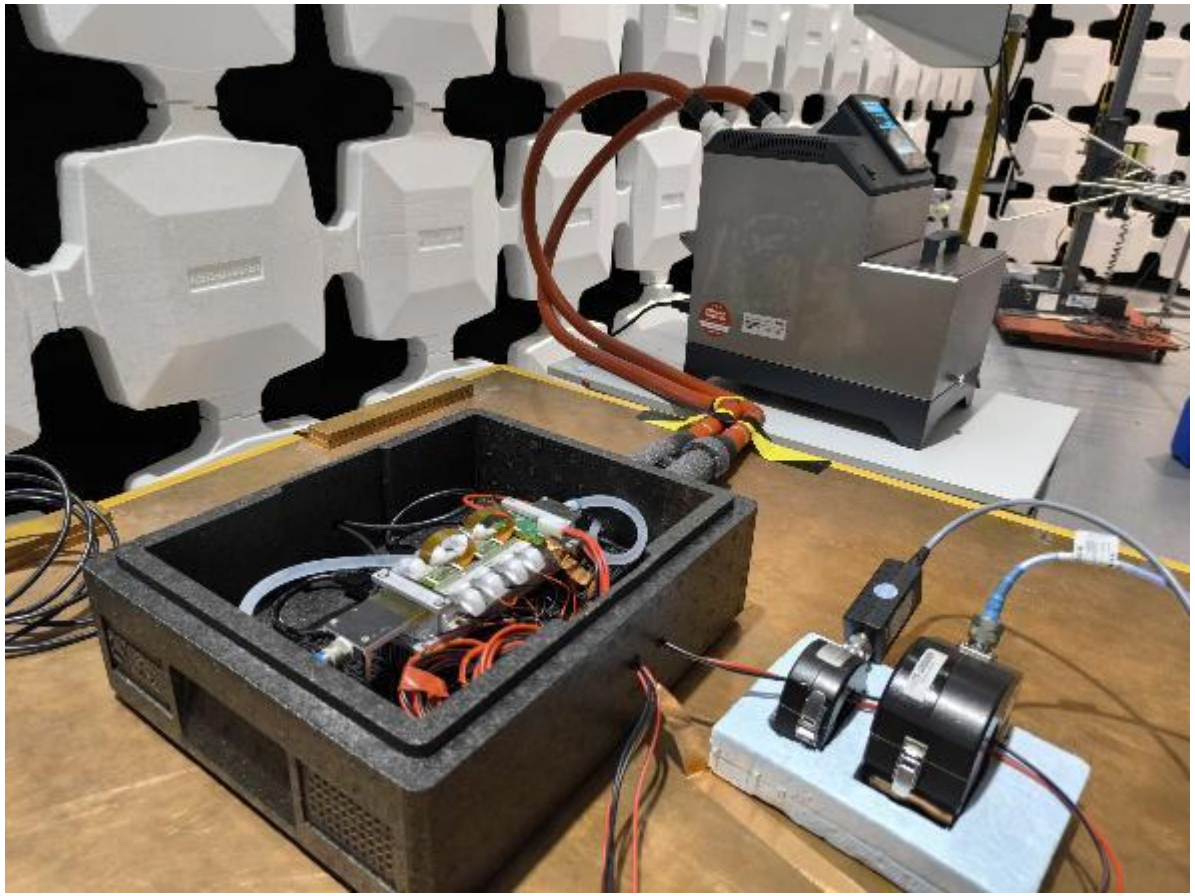




4. System validation

- Both systems are totally operational
- They have been validated by testing a serial chain of two prototype of tracker barrel pixel modules with (2x2) RD53A readout chips (2x2 TBPX RD53A modules) with planar sensors.





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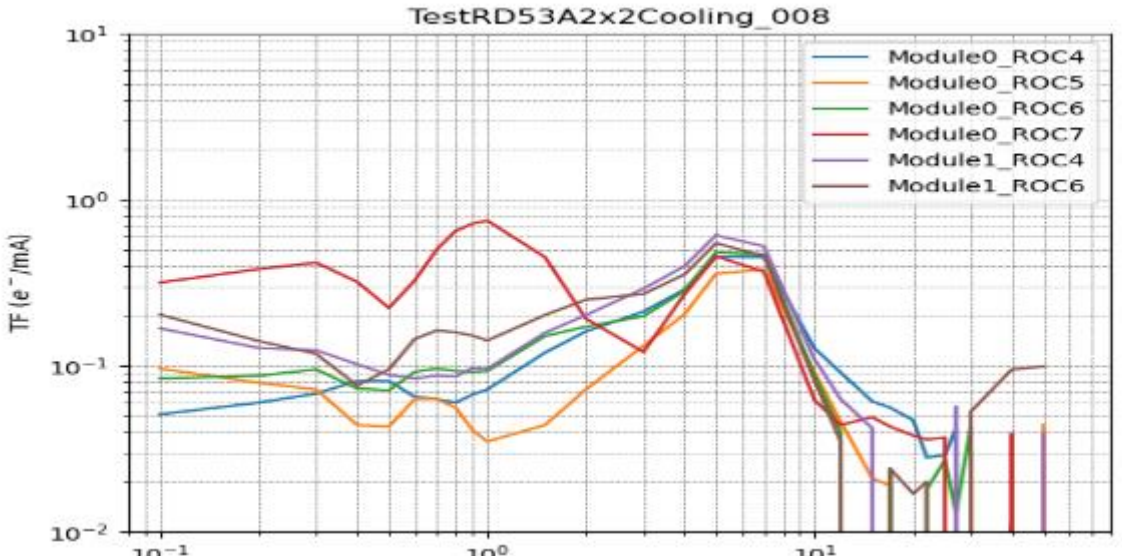

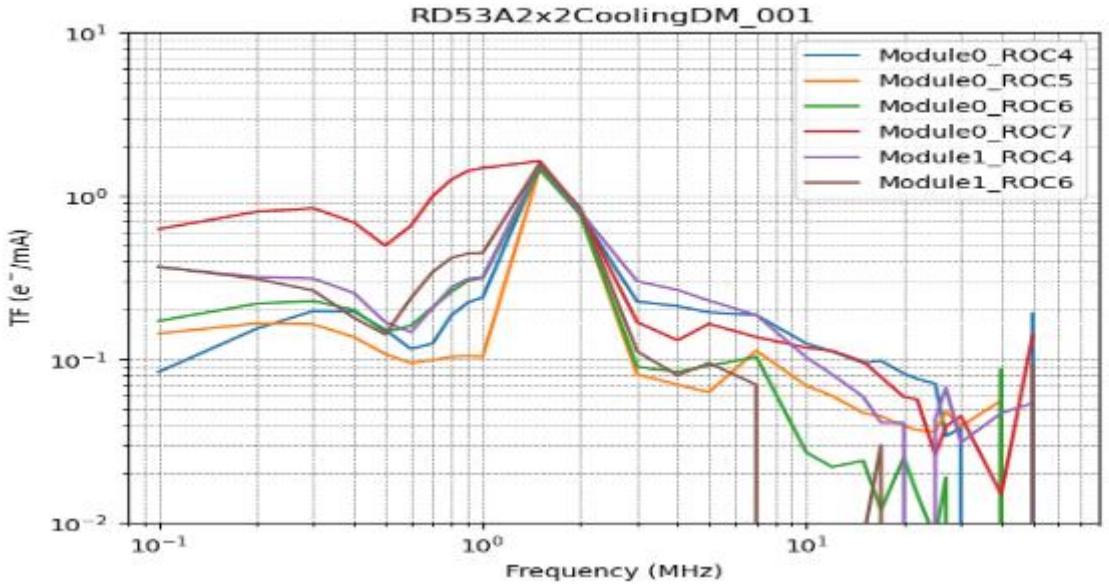

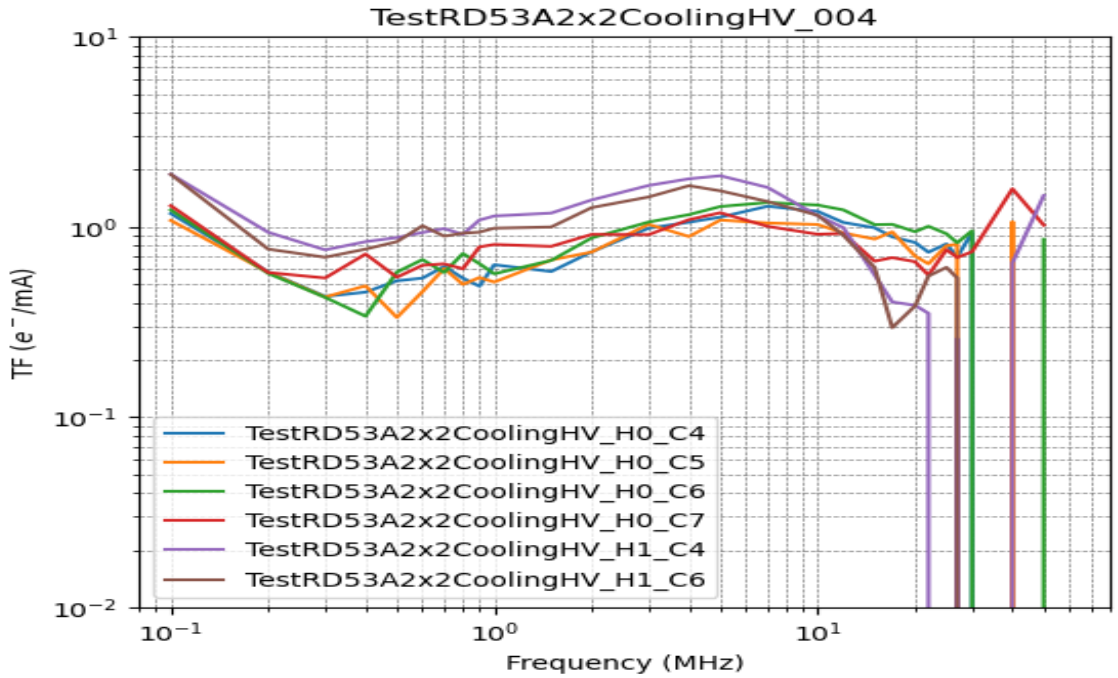

5. Summary

- Improvements have been presented in one of the EMC test at ITA.
- A new **graphical user interface (GUI)** has been developed to program and operate the automated transfer function measurement system.
- A **new cooling system** has been implemented to facilitate transfer function measurements at low temperatures.
  - Cooling options have been integrated into the GUI.
- Users can already benefit from these improvements – They are functional
  - A test campaign has been successfully conducted within EUROLABS using the upgraded EMC system.
- This important update has been the result of collaboration in two projects (EURO-LABS / AIDAINNOVA).