WP4
Upgrade of Irradiation and Characterization Facilities

Task 4.5: Design & Development of a New Electronics Characterization System for EMC Control (*ITAINNOVA, CNRS-IPHC*)

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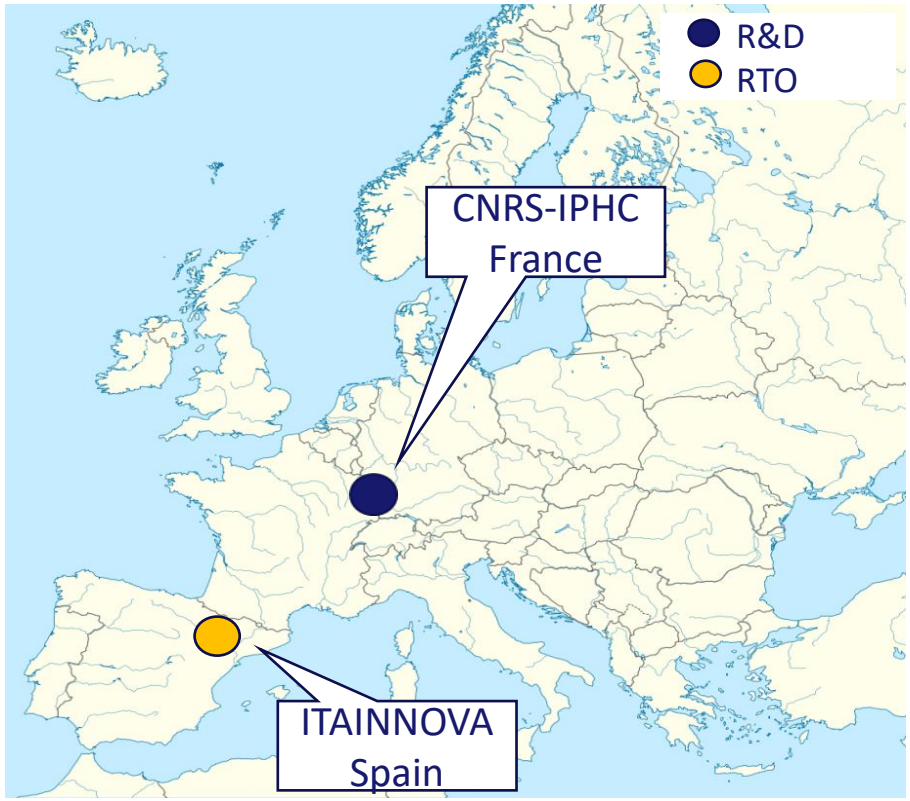
Outline

- 1. Introduction
- 2. WP4.T5 status and plans
- 3. Summary

1. Introduction

- **Goal:** The main goal of this activity is to upgrade Electromagnetic Compatibility (EMC) tests in order to improve the support for detector electronics designers.
  - Noise studies were greatly demanded on previous AIDA 2020 project
- **Activities:** Two activities are planned
  - Design and develop an automatic EMC test bench to measure the noise transfer functions (TF) of physics detectors.
  - Design and develop a portable test bench to perform in-situ EMC conducted emission measurements of power units in irradiation facilities.
- **What is the novelty of the activity ?**
  - There are no systems to measure the TF of any detector against electromagnetic noise.
  - There is not any portable test bench to measure the noise emissions of DC-DC converters or small PS units during the radiation test campaigns.

1. Introduction



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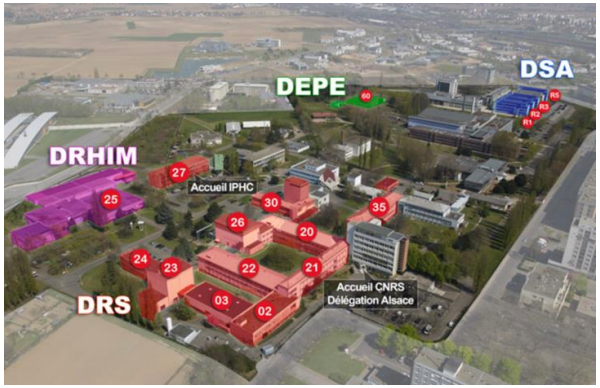


- Two institutes participates in this tasks:
  - Instituto Tecnológico de Aragón (ITAINNOVA) (Zaragoza, Spain)
  - Institut Pluridisciplinaire Hubert CURIEN (IPHC)/CNRS (Strasbourg, France)

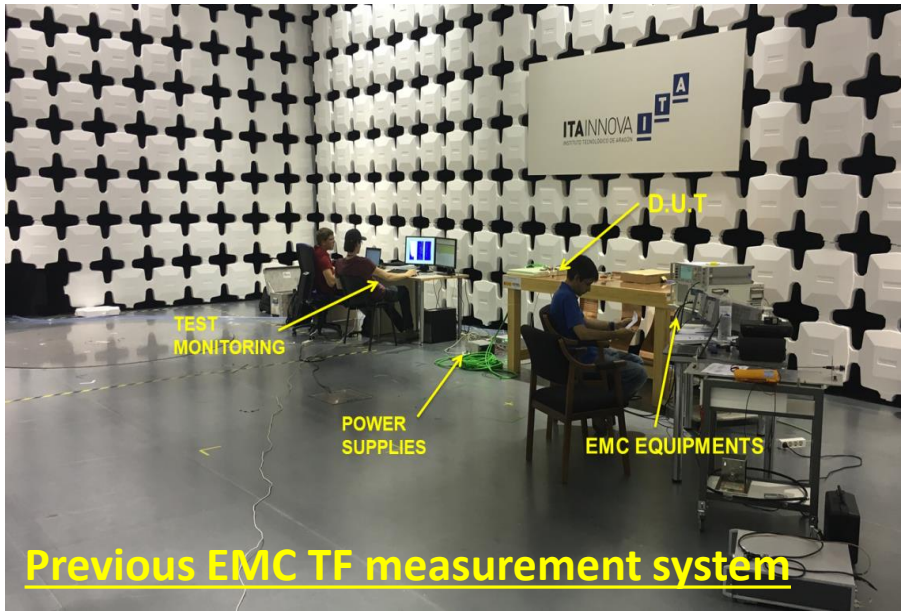
1. Introduction

- ITAINNOVA and IPHC will participate in both activities
  - ITAINNOVA will provide the design /control of the EMC equipment (both test benches)
  - IPHC-CNRS will be in charge of the *interface between the EMC system and the DAQ* of the detector for the TF test bench and the *technical background about radiation aspects and regular access* to its radiation facility.
- One Milestone and deliverable are planned:
  - **MS17: Apply TF test bench to FEE prototypes [M23]**
  - D4.5 : Develop a conductive noise test bench for irradiation facilities [M44]

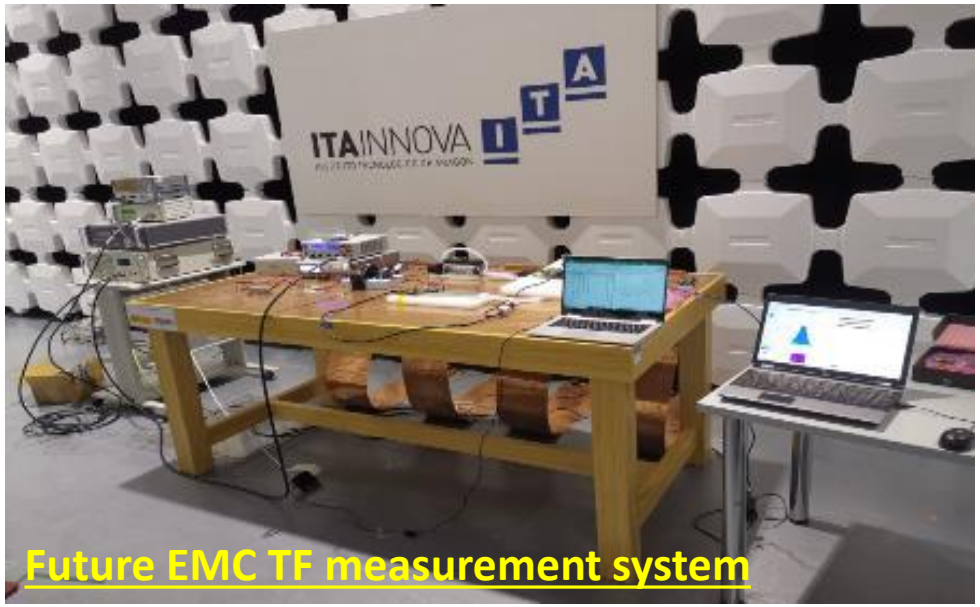
2. WP4.T5 status and plans

- During the first year of the project the activities has been focused the design and develop an **automatic EMC test bench to measure the noise transfer functions (TF)** of physics detectors.

> 1 week → a few hours …



Previous EMC TF measurement system

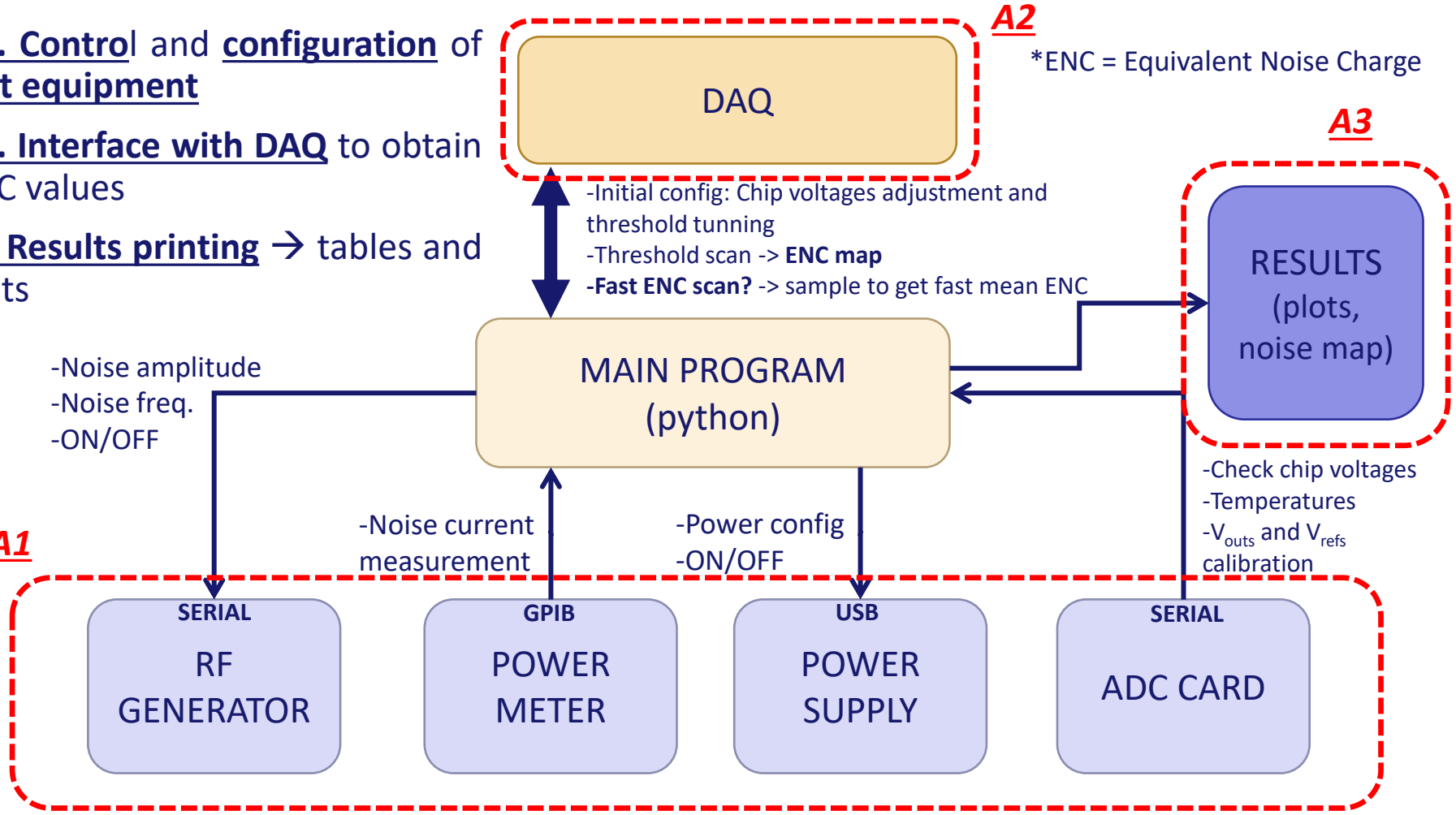


Future EMC TF measurement system

2. WP4.T5 status and plans

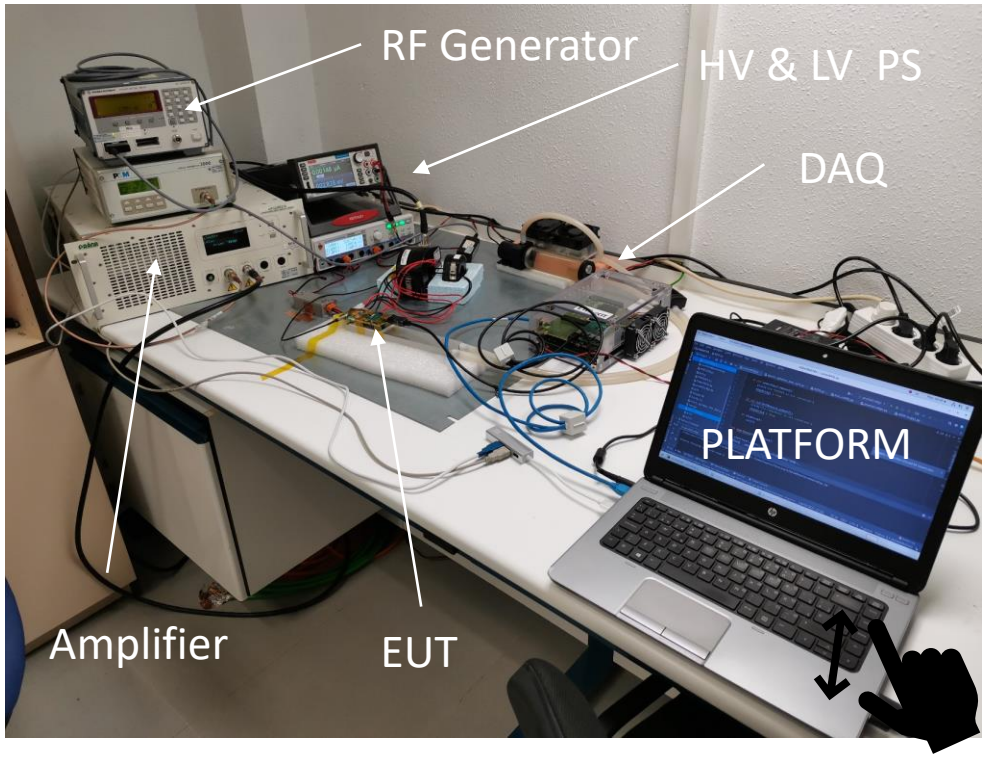
- This the simplified scheme of the system.

- **A1. Control** and **configuration** of **test equipment**
- **A2. Interface with DAQ** to obtain ENC values
- **A3 Results printing** → tables and plots



2. WP4.T5 status and plans

- **Routines to control test instruments are already done** and tested (**A1**).
  - They work properly on both Windows and Linux operating systems, for **easy adaptation to any DAQ detector.**




```
def acquire_mean_noise_from_1D(filelist, chipids):
    thrs = np.zeros((np.size(filelist), np.size(chipids)))
    for i in range(np.size(filelist)):
        for j in range(np.size(chipids)):
            f = ROOT.TFile.Open(filelist[i])
            canvas = f.Get('Detector/Board_0/OpticalGroup_0/Hybrid_0/Chip_' + chipids[j] + '/D_B(0)_O(0)_H(0)_Noise1D_Chip(' + chipids[j] +')')
            hist = canvas.GetPrimitive('D_B(0)_O(0)_H(0)_Noise1D_Chip(' + chipids[j] +')')
            tots = TH1F_to_matrix(hist)
            tots2 = tots[0,:]*tots[1,:]
            thrs[i,j] = np.sum(tots2)/np.sum(tots[1,:])
    return thrs

def get_noise_ref ():
     editxml.modify_chip_settings( xml_path, '0', 'Vthreshold_LIN', Vthreshold_LIN_tune)
     editxml.modify_daq_settings(xml_path,'DoFast', '0')
     run_number = get_run_number()
     os.system('cd ' + daq_path + ' && CMSITminiDAQ -f ' + xml_path + ' -r')
     os.system('cd ' + daq_path + ' && CMSITminiDAQ -f ' + xml_path + ' -c scurve')
     #os.system('cd ' + daq_path + ' && CMSITminiDAQ -f ' + xml_path + ' -r')
     noise_ref = acquire_mean_noise_from_1D(get_filelist(run_number), chipids)
     print (noise_ref)
     return (noise_ref)



noise_ref = get_noise_ref()
data=open("noise_data.txt","w")
data.write("noise_ref: " + str(noise_ref) +"\n")
data.write("noise_ampl\t noise_freq\t noise_average\t Run_number\n")
#filelist = [('/storage/sjimenez/Ph2_ACF/myrun/Results/Run000044_SCurve.root')]
#vth is the freq value
#trim is the noise value
thrlist = np.arange(int(Vthreshold_LIN_stop), int(Vthreshold_LIN_start), int(Vthreshold_LIN_step))[::-1]
trimlist = np.arange(int(trimbit_stop), int(trimbit_start)+1, int(trimbit_step))[::-1]
```

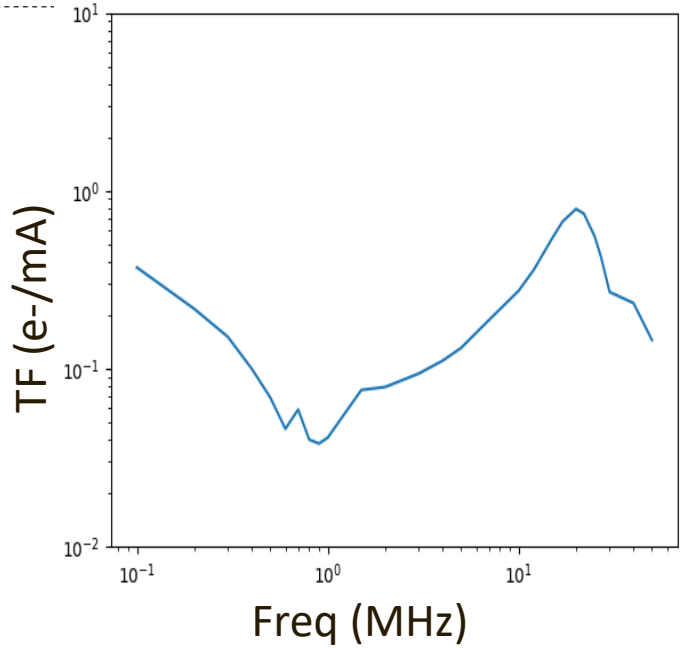
2. WP4.T5 status and plans

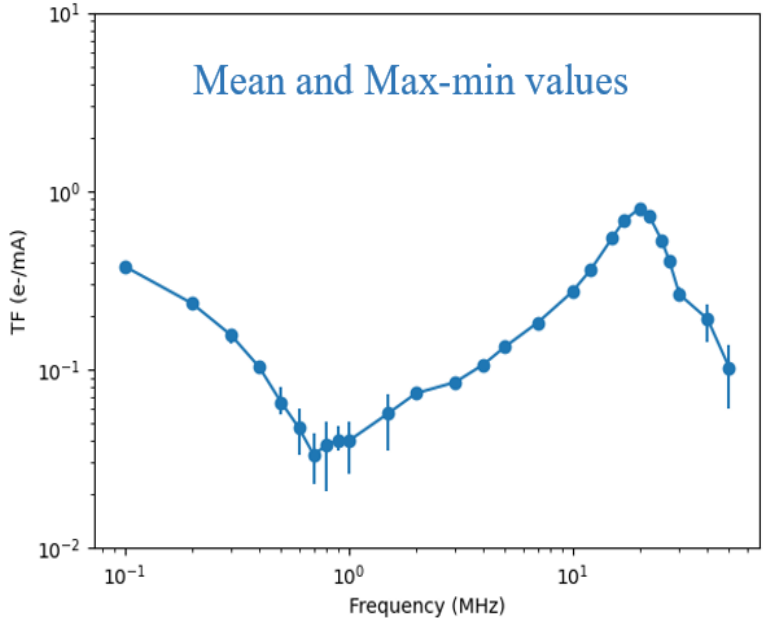
- **Interface with DAQ is complete** -> multiplatform compatibility with some sub-routines adjustments (**A2**)
  - It reads and modifies the DAQ configuration files to adjust different chip parameters when needed.
  - It configure and launch noise scans and read the results from the DAQ output.
  - Fast noise scan has been implemented (using only a small sample of pixels) in order to quickly adjust injected noise before launching a full noise scan.
  - Valid for different DAQ - Already tested for CMS DAQ and also BDAQ53 (Atlas DAQ)
- **The main program is fully functional.**
  - It works as a high-level control capable of running complex test procedures, while controlling all the test instruments, and interfacing with the DAQ software.
  - The results are initially presented in a text file and plot images. (**A3**)

2. WP4.T5 status and plans

- **First automated test was completed – RD53 TF**
  - The test were carried out on a RD53A Single Chip Card (SCC) and CMS Ph2 ACF
  - The **robustness, reliability and repeatability** of the system have been tested
    - To this end, 10 tests have been carried out on an RD53A-SC.(max, min, Std,..)
    - The results are **very consistent and reliable.**

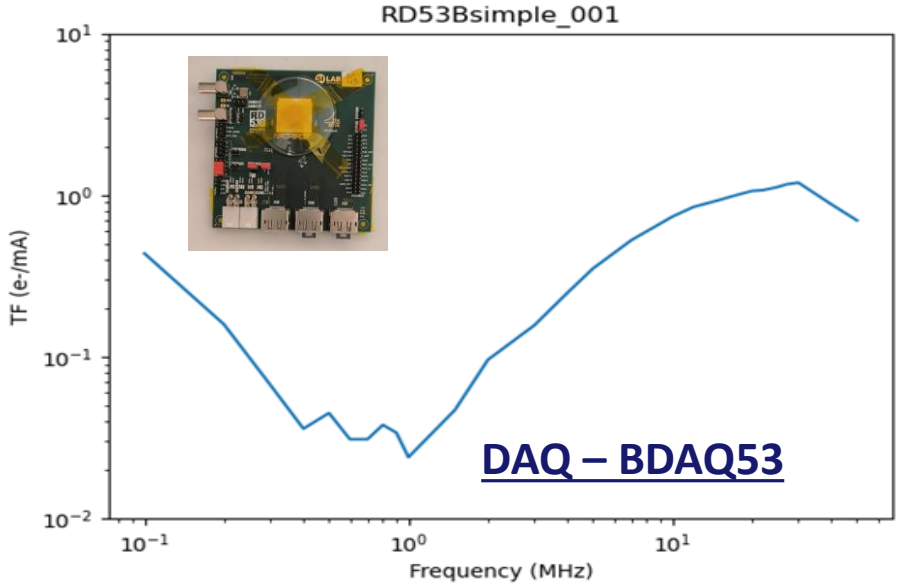
Freq. (MHz)	Current (mA)	ENC (e-)	TF (e-/mA)
REF	REF	71.676	0
0.1	297.1	84.178	0.149
0.2	400.5	97.07	0.163
0.3	500.6	141.478	0.244
0.4	794.2	115.415	0.114
0.5	797.9	80.408	0.046
0.6	852.5	74.603	0.024
0.7	845.4	73.021	0.017
0.8	892.8	73.396	0.018
0.9	896.4	73.403	0.018
1	797.8	73.526	0.021
1.5	601.7	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

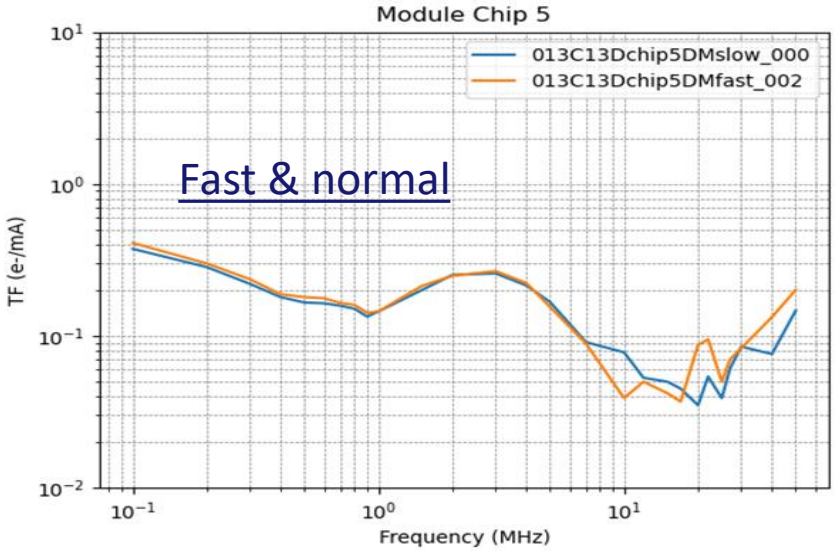




2. WP4.T5 status and plans

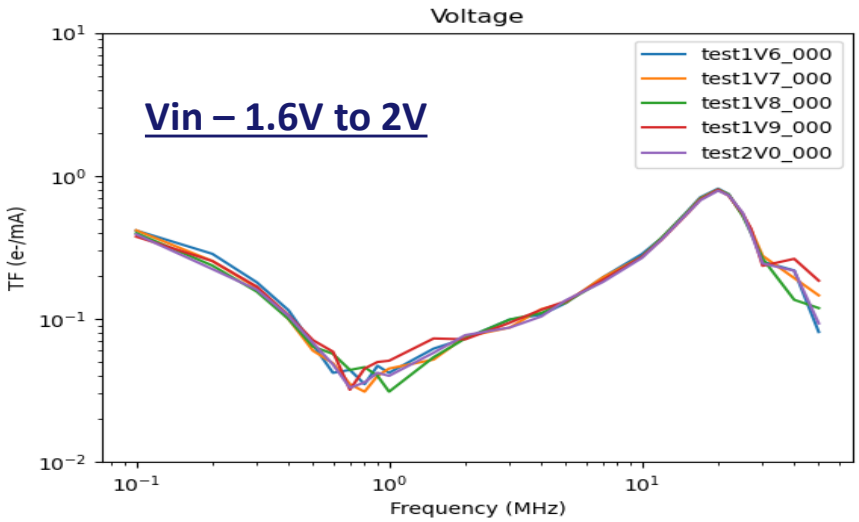
- System has been tested **with a diferent DAQ system** - BDAQ53 (ATLAS)
- A **feature to increase the speed of tests** has been implemented (configurable)
  - Weeks - hours – Now even minutes
  - It may be used to perform a preliminary test.

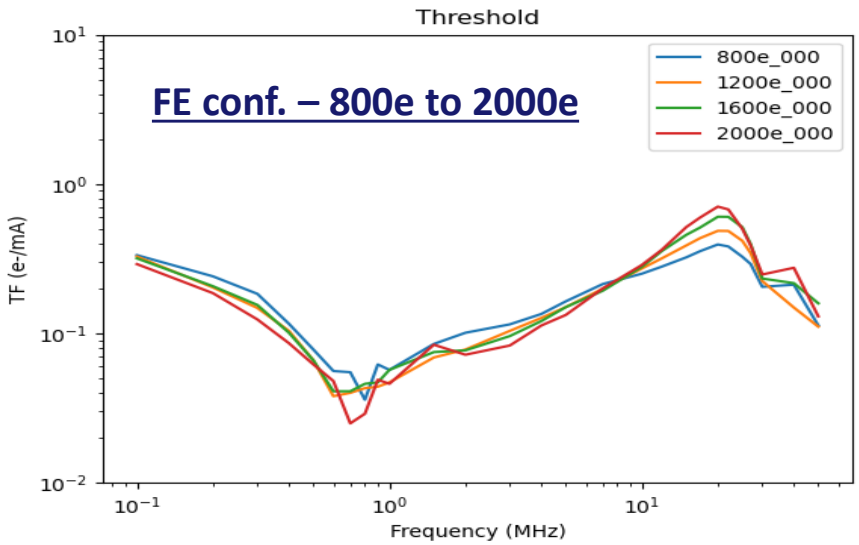




2. WP4.T5 status and plans

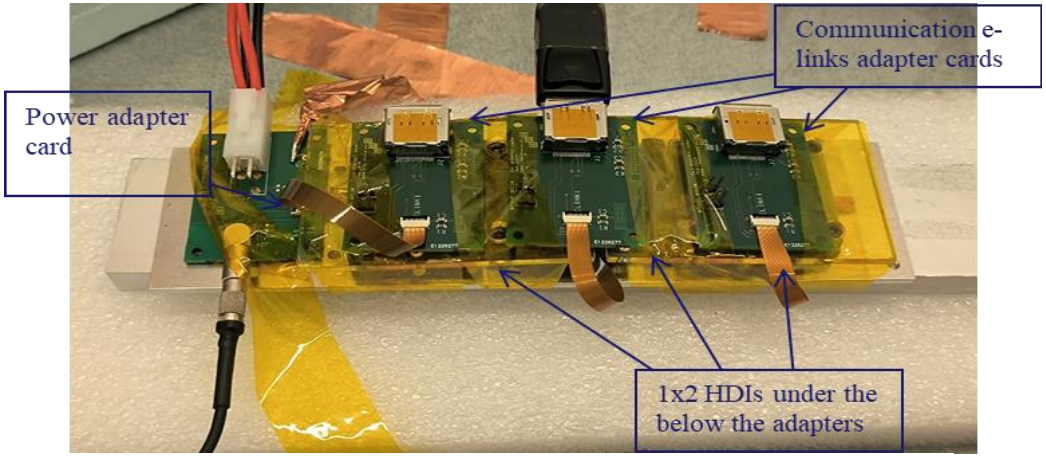
- A set of **complex test** has been performed in orde to demonstrate the potential of the system (we have used as reference RD53A EMC test)
  - **SLDO regulator sentsitivity to operation point** (In this case the SLDO es configured as LDO only)
    - Input voltage varying from 1.6V to 2.0V
  - **Different Front end chip threshold configuration**
    - Varying it from 800 to 2000 electrons.

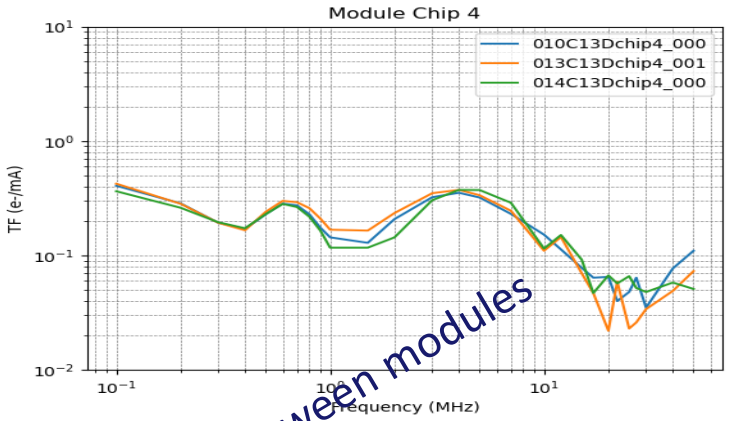




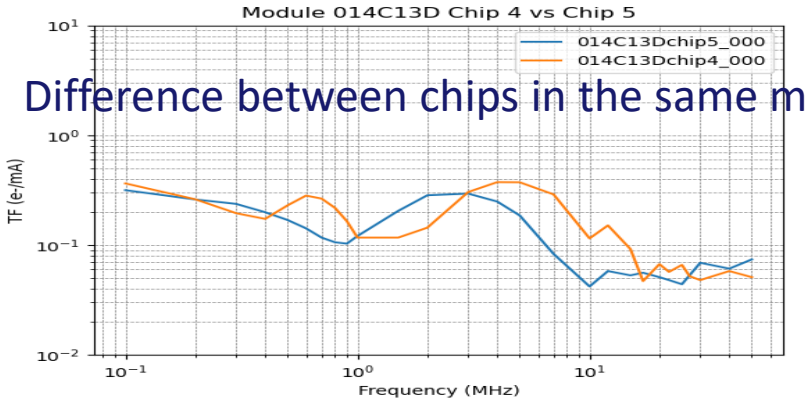
2. WP4.T5 status and plans

- **Studies at system level** - Small power group of CMS pixel -phase II
  - 3 modules connected in series - CMS –HDI -1x2 3D sensors

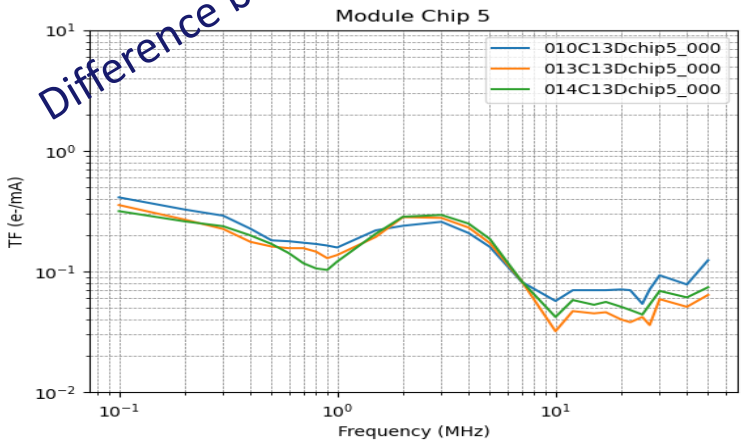




Difference between modules

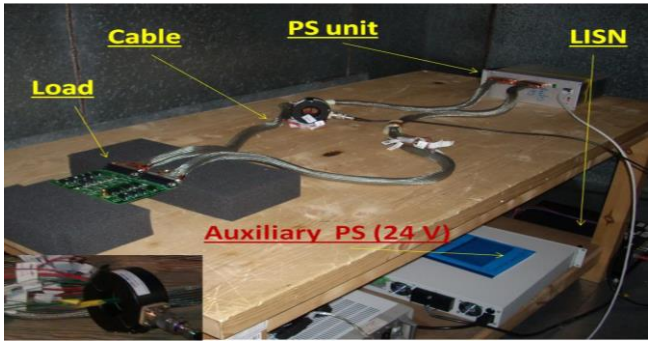


Difference between chips in the same module

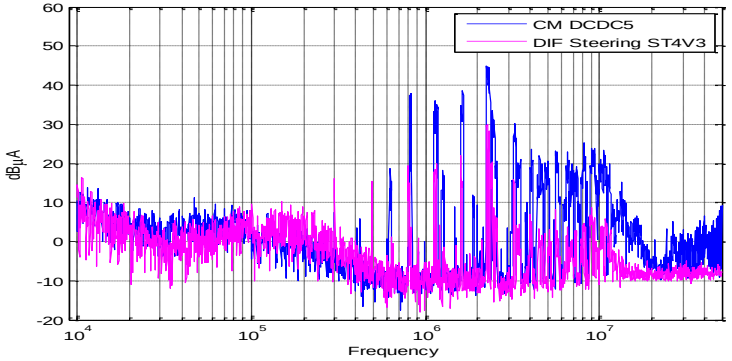


2. WP4.T5 status and plans

- We move on to the next stage of the task.
- **Design and develop** a **portable test bench** to perform in-situ **conducted EMC emission** measurements of power units **in irradiation facilities.**



Old setup



- A GaN transistor based DC-DC converter will be used as a reference power unit to design the system (current source).
  - The unit has already been designed
- Test validation will be performed at IPHC -Strasburg

3. Summary

- An overview of the status and plans for WP4.T5. has been presented
- The **task is progressing well**, with a significant focus on the development of the automatic TF measurement system.
  - This activity has now been completed.
  - It is a very valuable tools to perform many noise studies
  - **MS17 has already been submitted**.
  - **EUROLABS project will benefit** form this developments. (TA facility)
- Our **next steps involve designing and developing a portable test bench to perform in-situ conducted EMC emis**sion measurements of power units in irradiation facilities.