Meeting of Spanish Network for Future Accelerators
Santander, 19th – 20th November 2018

ITAINNOVA activities for Future Accelerators

A general overview

A.Pradas, M.Iglesias, I.Echeverria, FJ Piedrafita,
C. Esteban, A. Gimeno, F.Arteche

Una manera de hacer Europa
Fondo Europeo de Desarrollo Regional (FEDER)
Unión Europea

OUTLINE

- 1. Introduction
- 2. ITAINNOVA activities for ILD
- 3. ITAINNOVA activities for Belle II-DEPFET PXD
- 4. ITAINNOVA activities for CMS PIXEL Phase II
  - ➢ RD53 contribution
  - ➢ HDI design & development
  - ➢ EMC activities
- 5. Summary

1. Introduction

- Since 2008 this group has been participating in high energy physics (HEP) projects for future accelerators
  - R&D on new powering schemes
  - R&D on EMC (grounding & shielding issues)
- It has been involved in :
  - ILD – ILC
  - Belle II (PXD DEPFET) – SuperB at KEK
  - CMS upgrade – HL-LHC at CERN
    - Si µ-strip Tracker
    - Pixel phase II

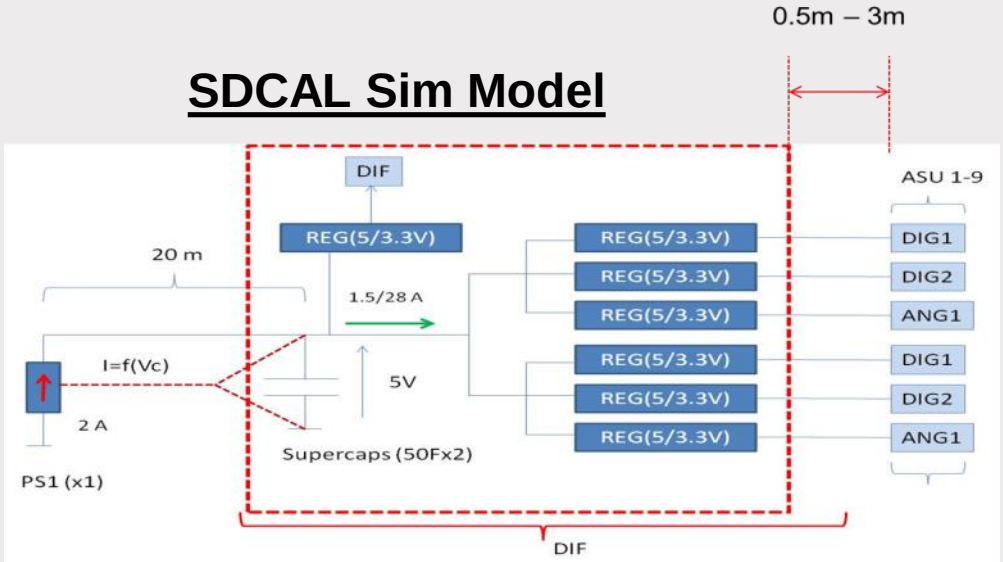
2. ITAINNOVA activities for ILD

- ITAINNOVA is collaborating with ILD project since 2011
- Our activities have been focused on:
  - Power supply distribution system for FTD-ILD / CALICE
    - Based on super-capacitors & DC-DC converters
  - Supercapacitor RAD assessment

	DC-DC	Super-caps
Power dissipation	228 W	395 W
EMI phenomena	Yes	No*
RAD tolerant	Yes	?
Material budget	(240 DC/DC) ?	(80 SC) ?
Reliability	?	?
Power pulse applications	Non frequent	Yes
Installed power	1.4 kW	0.48 kW
Primary PS	≈ 36 W	≈ 12 W
Mains protection (UPS effect)	No	Yes

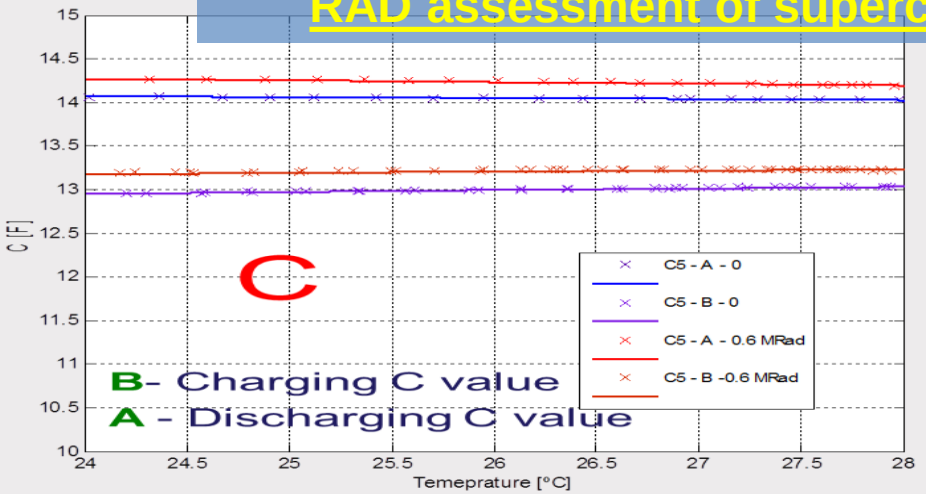
DC-DC Vs Supercapcitors FTD power system

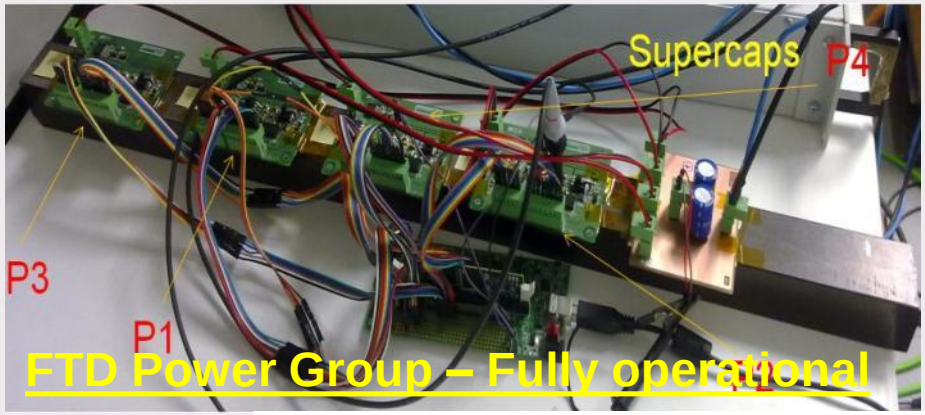
SDCAL Sim Model

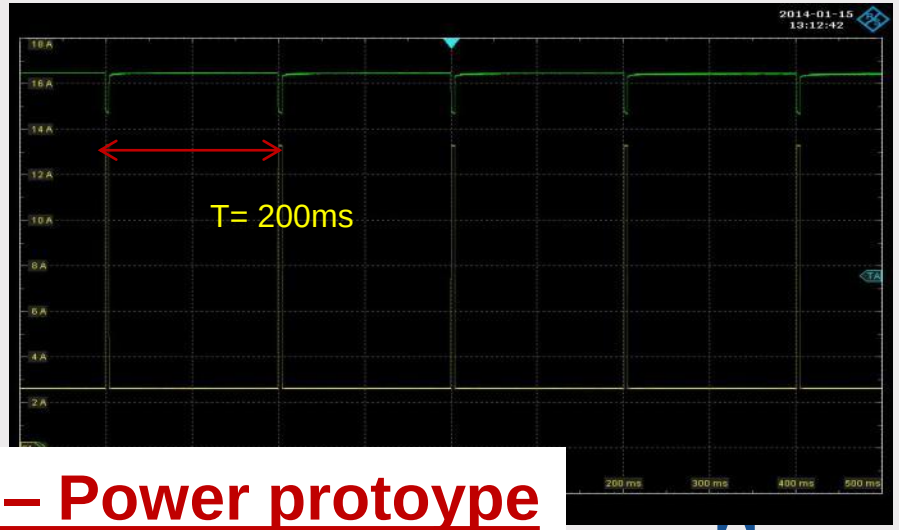


2. ITAINNOVA activities for ILD

RAD assessment of supercapacitors for ILC applications



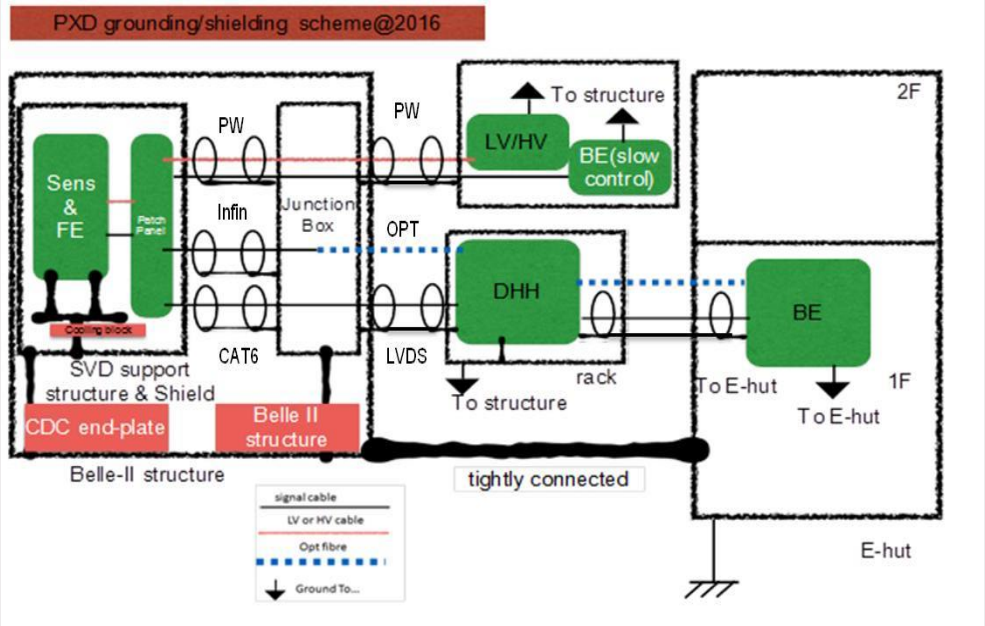




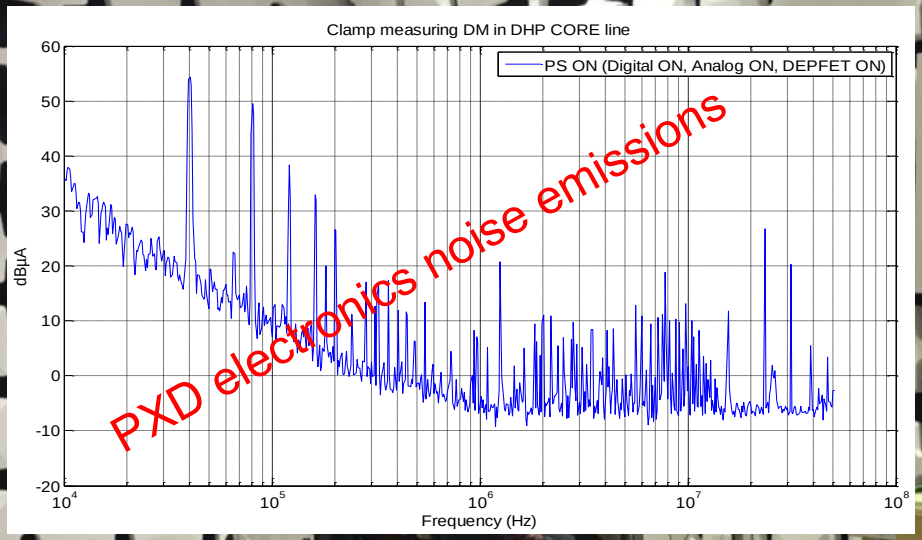
Power group FTD-ILD – Power protoype

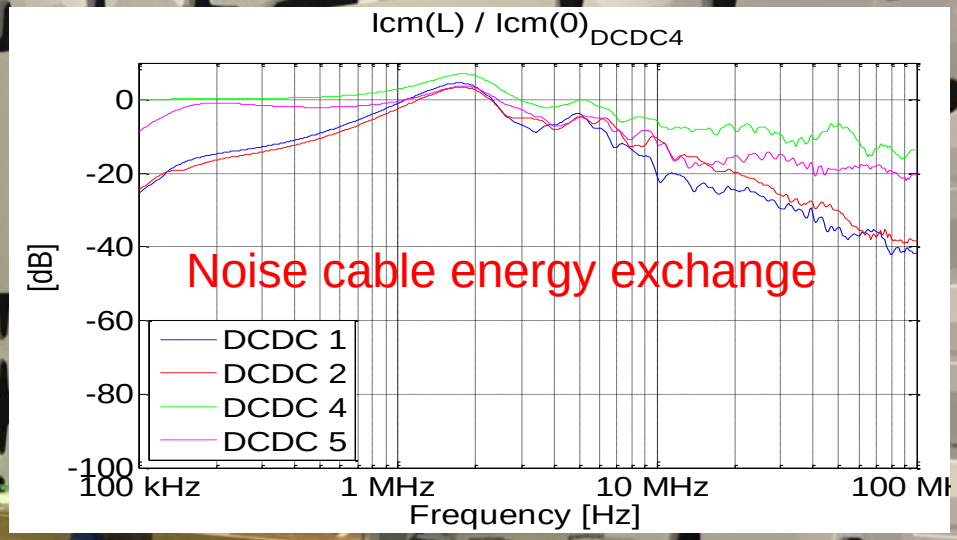
3. ITAINNOVA activities for Belle II-DEPFET PXD

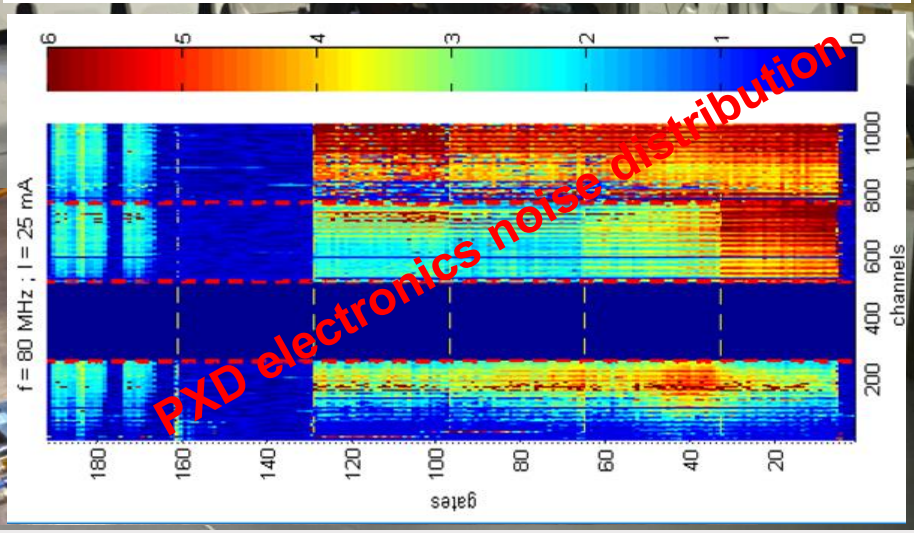
- ITAINNOVA has carried out a specific EMC plan for Belle II - DEPFET PXD
- It has been carried out within MoU ITAINNOVA – Max Planck Institute (DEPFET collaboration)
- It covered several aspects:
  - Grounding definition
  - Noise propagation studies
  - EMC test (very useful)
    - Emission Tests
    - Susceptibility Tests

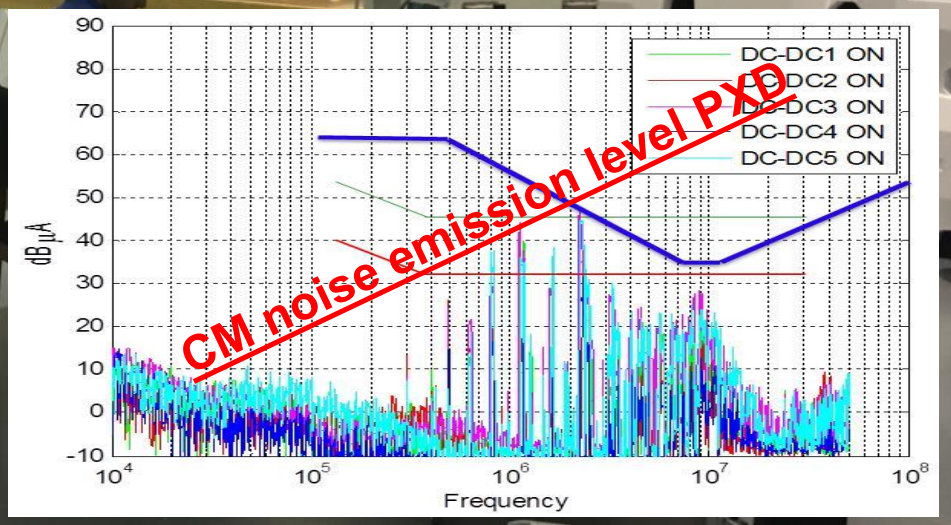


3. ITAINNOVA activities for Belle II-DEPFET PXD









4. ITAINNOVA activities for CMS-Pixel phase II

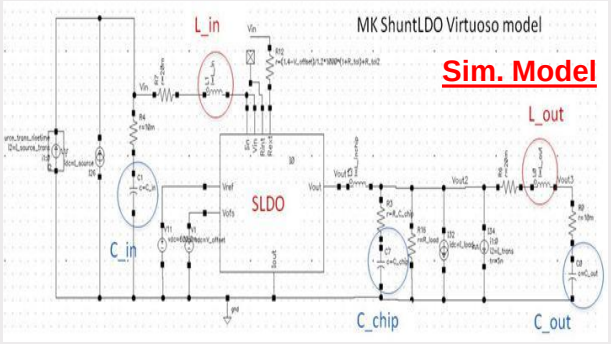
- ITAINNOVA contribution to CMS has been focused on:
  - Si µ-strip Tracker & Pixel phase II
- Since 2014 our activity has been focused on Pixel phase II
  - 2017-2018 A.Pradas has been based at CERN (J.Christiansen´s group)
  - Close collaboration with IFCA /IMB-CNM/US
- Our contribution to Pixel Phase II is focused on system aspects of pixel detector power supply distribution.
  - Simulations
  - Components & system prototype development
- These activities may be grouped in three areas:
  - RD53 ROC (power stage)
  - HDI design and development (HDI-BPIX)
  - EMC (grounding and transients) studies

4.1 ITAINNOVA activities for CMS-Pixel phase II: RD53 contribution

- ITAINNOVA has been collaborating with RD53 since 2017.
  - Since January 2018 formal member of RD53
- Our main activity is to develop simulation models to study the performance of the power stage of the RD53A & B chip.
- For that purpose several activities have been carried out:
  - Simulations models development
    - It has been used to find any failure scenario of Shunt-LDO before the chip submission, and to analyze system level behavior.
  - Shunt-LDO verification test
  - Low power mode circuit design (Start-up)
    - Alvaro´s proposal will be implemented in next Shunt-LDO circuit submission

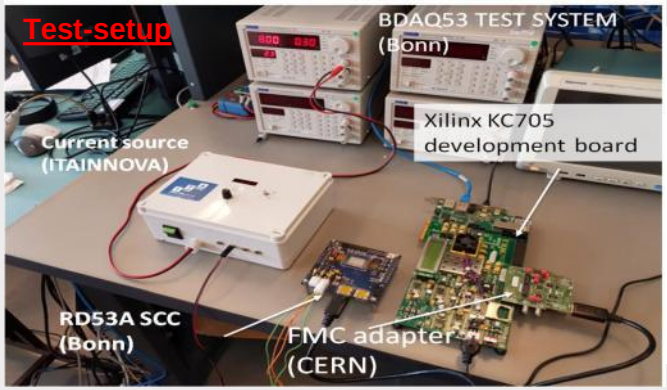
4.1 ITAINNOVA activities for CMS-Pixel phase II: RD53 contribution

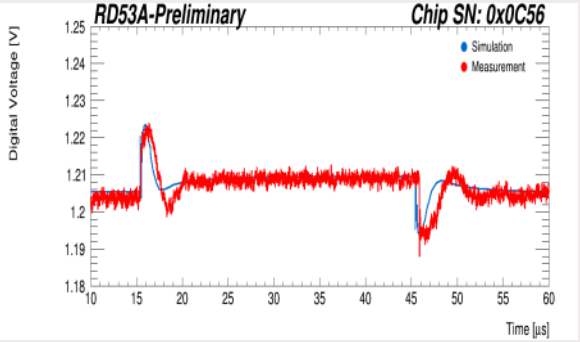
- These activities have been performed in close collaboration with CERN (Jorgen Christiansen) and Dortmund FH (M. Karagounis).
- These activities have included simulation models and real test on RD53A ROC.
  - Dynamic response of the SLDO
  - SLDO configuration (Voffset, Rin)
  - Start-up behavior (BG, Current source, ..)
  - ROC power dissipation

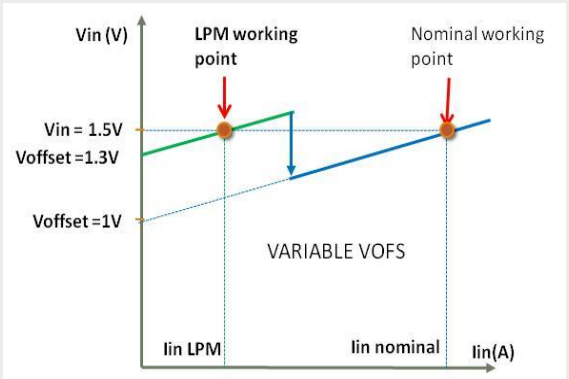


Dynamic response of SLDO

LPM operation



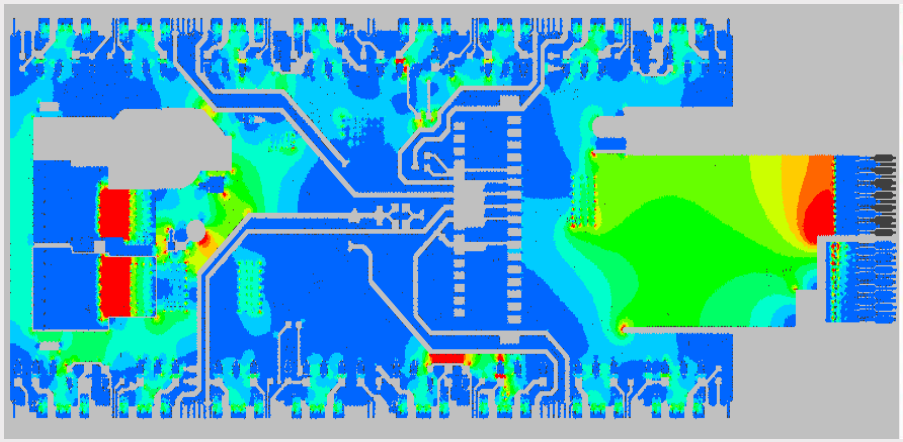




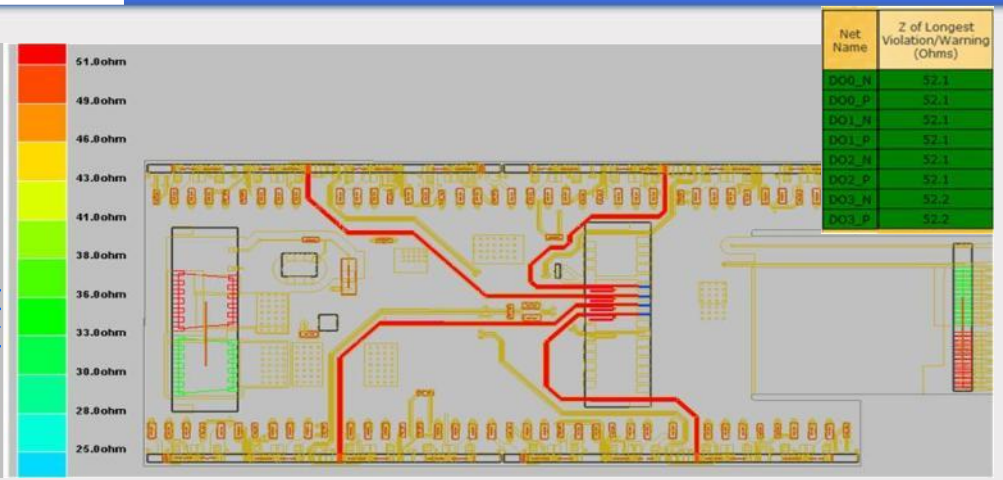
4.2 ITAINNOVA activities for CMS-Pixel phase II: HDI design & development

- ITAINNOVA is involved in the BPX-HDI design (2x2 and 2x1)
- The activity is divided in two parts :
  - Perform several simulations of the HDI in order to verify the performance of the HDI
    - It helps a lot to evaluate designs
  - Design the HDI 2x1 BPIX design
- This activity is coordinated with ETHZ (Malthe Backhaus) and within HDI working group.
- Actual status
  - Simulations models of the HDI2x2 RD53A
  - Design and Simulations of HDI2x1 RD53A

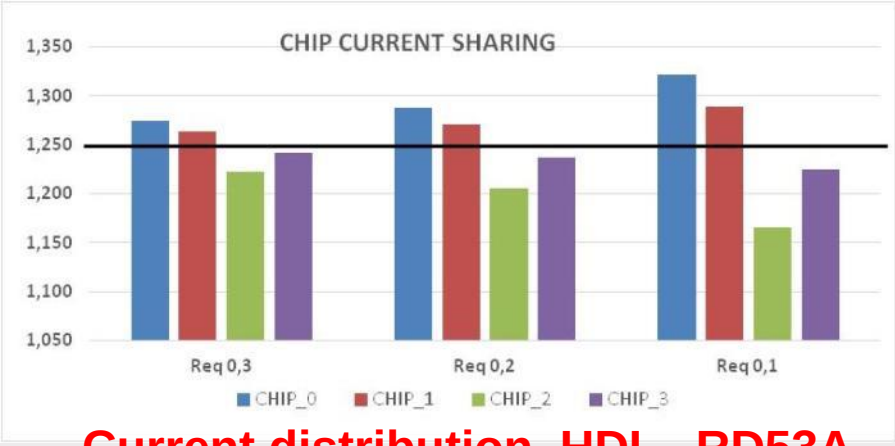
4.2 ITAINNOVA activities for CMS-Pixel phase II: HDI design & development



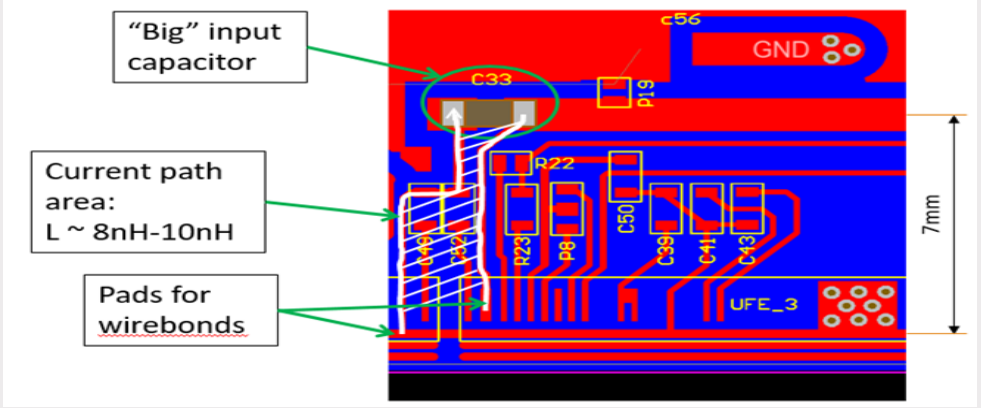
Power density HDI – RD53A



Signal line Impedance (CM &DM) HDI



Current distribution HDI – RD53A

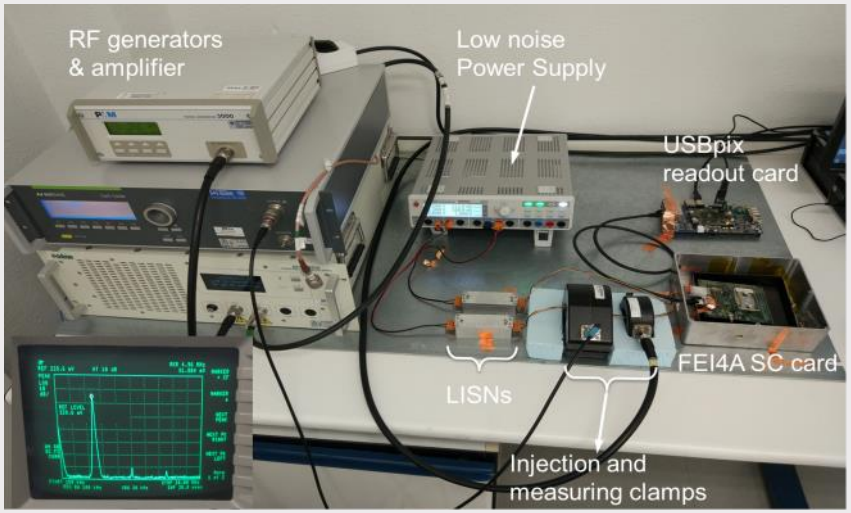


2x2 HDI design support – EMC based design

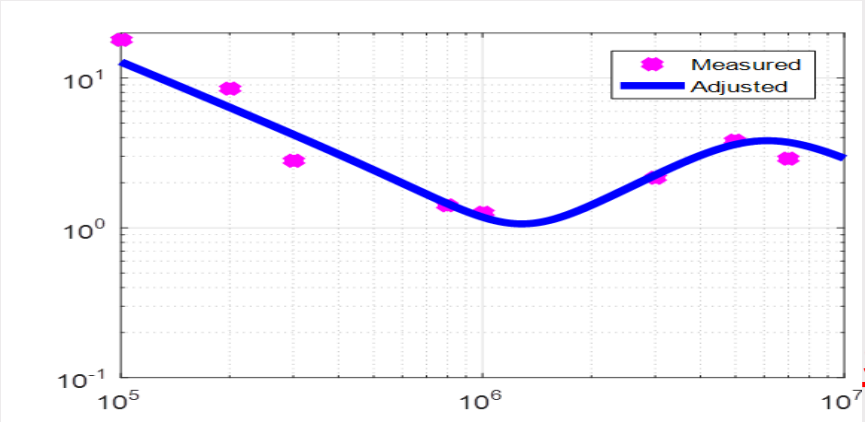
4.3 ITAINNOVA activities for CMS-Pixel phase II: EMC activities

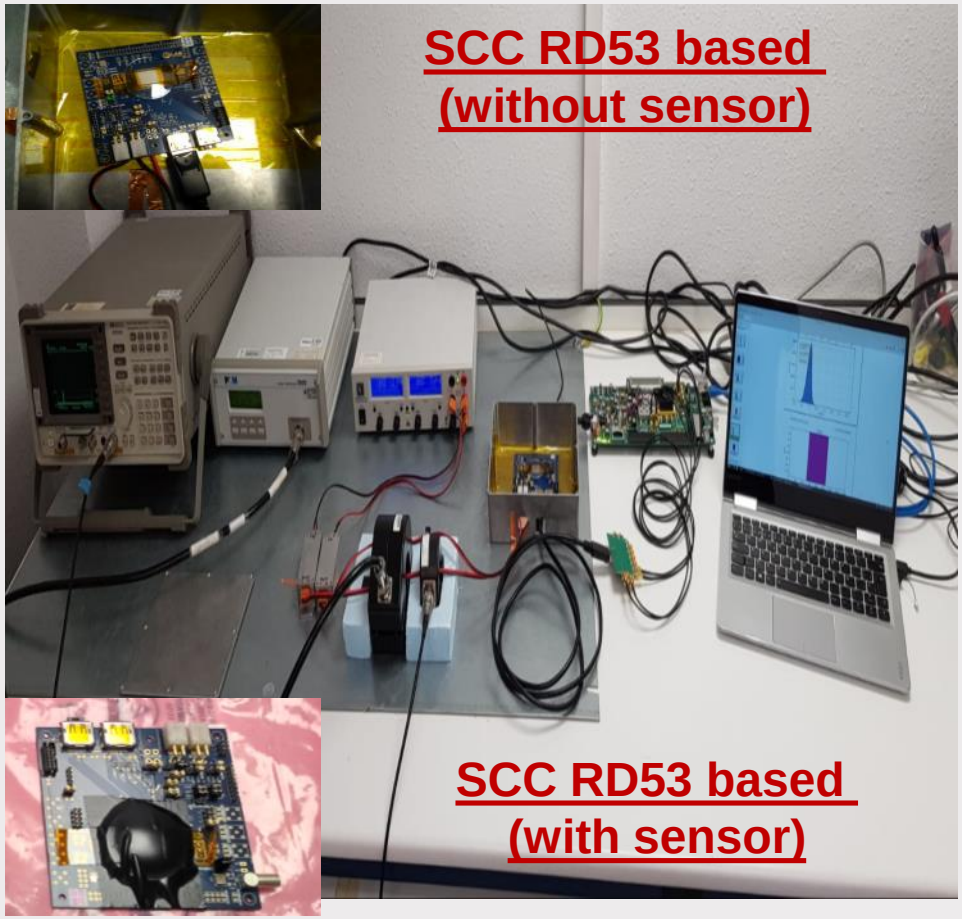
- The main goal of these activity is to perform EMC studies that will be used to evaluate grounding topology and transients present in SP power distribution system
  - The idea is to perform several EMC test that allow to gain insight in the noise issues of SP topology.
- For that purpose several activities have been planned
  - SCC with & without sensor susceptibility (FEI4 ROC)
  - SCC with & without sensor susceptibility (RD53A ROC)
  - Small serial power chain with 4 SCC (3 no sensor as a dummies & 1 with sensor) – Grounding configuration.
  - Serial power chain susceptibility with HDI 2x2 /2x1
  - Current source prototype development

4.3 ITAINNOVA activities for CMS-Pixel phase II: EMC activities



SCC- FEI4 based Trasnfer Function





SCC- RD53A based : EMC tests are on going

5. Summary

- ITAINNOVA activities on future colliders has been presented
  - They have been focused on power issues and EMC
- Today our main activity is focused on serial powering aspects of CMS pixel phase II
  - RD53 design – Power stage
  - HDI design
  - EMC test – Prototype development
- ITAINNOVA plan to continue this activity (Future plans)
  - RD53 : LPM , SLDO verification , Failure scenarios, BG effects.
  - HDI: Design and Simulations of HDI2x1 RD53A & HDI 2x2 Support
  - EMC test : EMC test on SCC (1 & serial power chain 4 SCC)
  - Super-capacitors: RAD assessment (update – New test are planned)

Unión Europea

Una manera de hacer Europa
Fondo Europeo de Desarrollo Regional (FEDER)

Thank you for your attention

ITAINNOVA
INSTITUTO TECNOLÓGICO DE ARAGÓN

www.itainnova.es

@ITAINNOVA

ITAINNOVA

ITAINNOVA · Instituto Tecnológico de Aragón