INSTITUTO TECNOLÓGICO DE ARAGÓN

Power Pulsing: Recent progress

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Complex Electrical System Group at ITA

ILD meeting 2014
5th-9th September 2014
Oshu City, Japan

OUTLINE

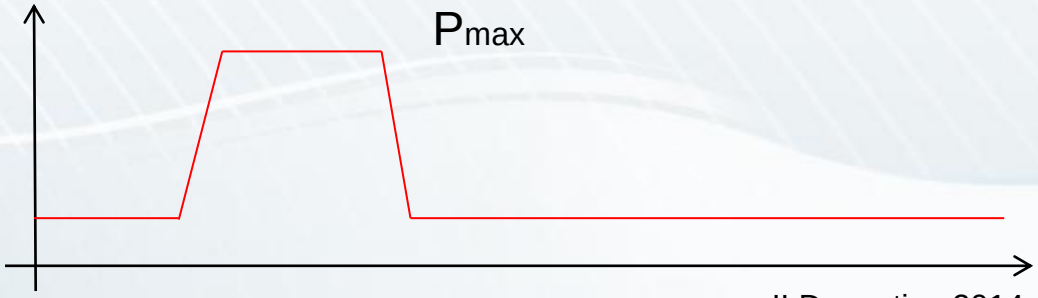
- 1. Introduction
- 2. Supercapacitors based power distribution system.
- 3.FTD +6 Group: Real prototype
  - Operation
- 4.Conclusions

1. Introduction

- Several studies have been carried out during the last 2 years focused on the power supply system for FTD-ILD.
  - They have been presented in LCWS2012, ECFA2013 & ILD 2013
    - Simulations and Radiation studies
- A power distribution system based on supercapacitor may be one of the option to supply power to FTD-ILD.
- The main elements of this topology are:
  - Supercapacitors:
    - Pulse power – Transients locally
  - LV regulators:
    - Stabilize FEE voltage
  - Current source :
    - Controls super-capacitor voltage

2. Supercapacitor based PS

- **The total Strip-FTD current / power demanded is:**
  - Bunch crossing state 458 A (≈ 860 W)
  - Stand-by state 91.6A (≈ 171W)
- **System – Granularity: 1/4 Petal**
  - Based on reliability and system design issues
- Several conservative considerations have been assumed in the electronics operation (previous simulations):
  - **Electronics duty cycle operation** (2.5% - 5ms / 200ms).
    - 1 ms power up / down
    - 3 ms operation state to stabilize power and operate.
  - **Power consumption during the standby** (20% Pmax). !!!



$P_{standby} = 20\% P_{max}$

2. Supercapacitor based PS FTD+6

20 m

AWG16

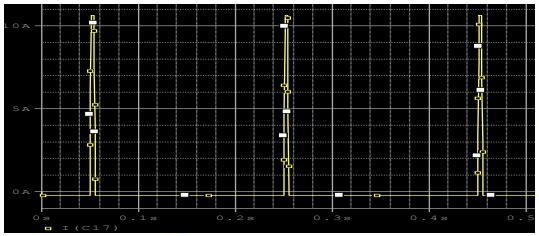
3/14 A

I=f(Vc)

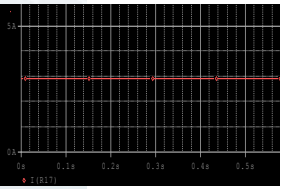
4V

3A

Supercaps (25Fx2)



PS1 (x1)



AWG27

PETAL1

REG(5/2.5V)

REG(5/1.5V)

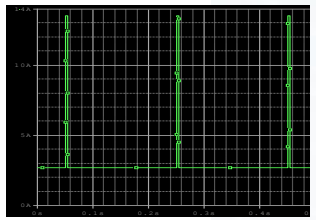
REG(5/1.5V)

PETAL2

REG(5/2.5V)

REG(5/1.5V)

REG(5/1.5V)



PETAL3

REG(5/2.5V)

REG(5/1.5V)

REG(5/1.5V)

PETAL4

REG(5/2.5V)

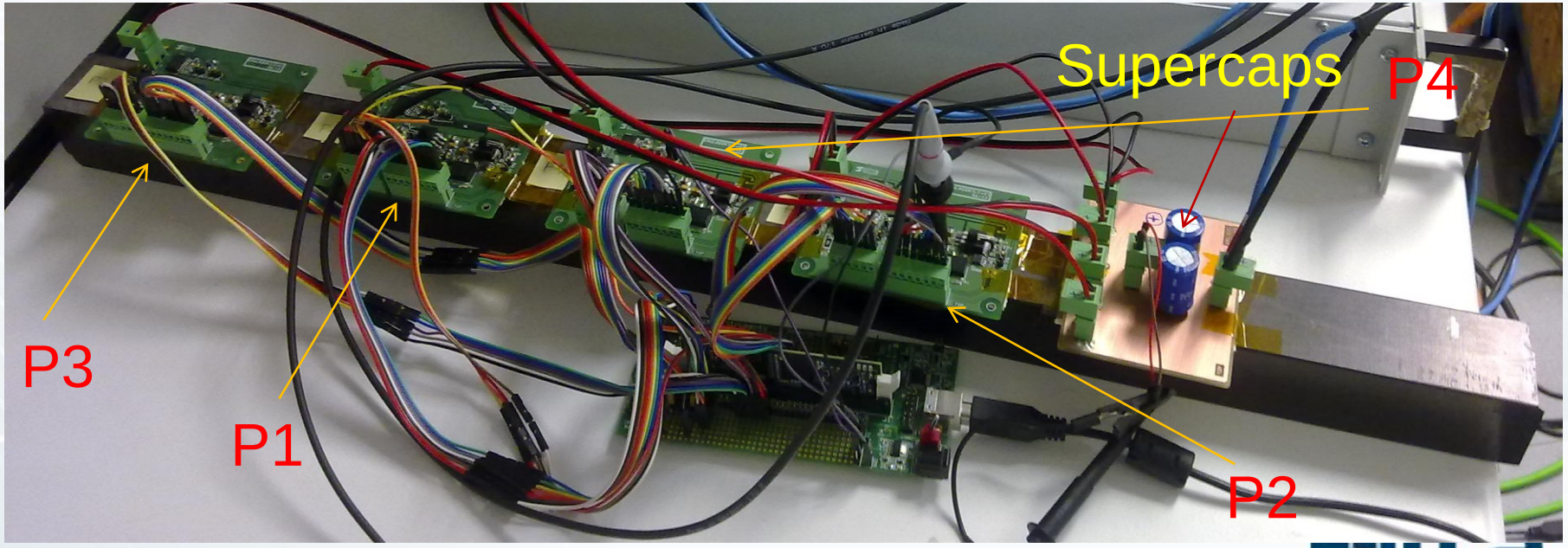
REG(5/1.5V)

REG(5/1.5V)

¼ Disk

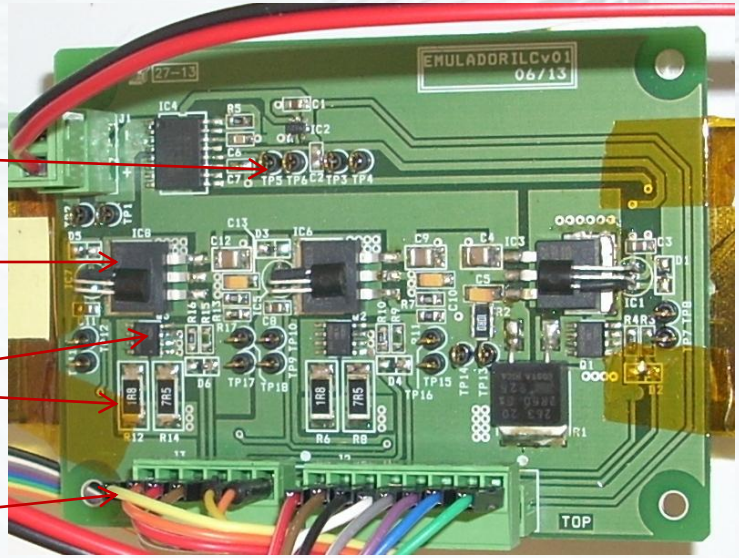
3.FTD +6 Group: Real prototype

- A real prototype of 1 Group of FTD sub-detector (FTD +6) has been developed
  - 4 load boards - It simulates the FEE (hybrid) per petal
  - 2 Super-capacitors
  - 1CF structure
  - Ip=13.5A – Isb =2.7A (Per petal – Ip=3.4A / Isb=0.7A)
  - Vsc = 4.2 V / Vinp=4V

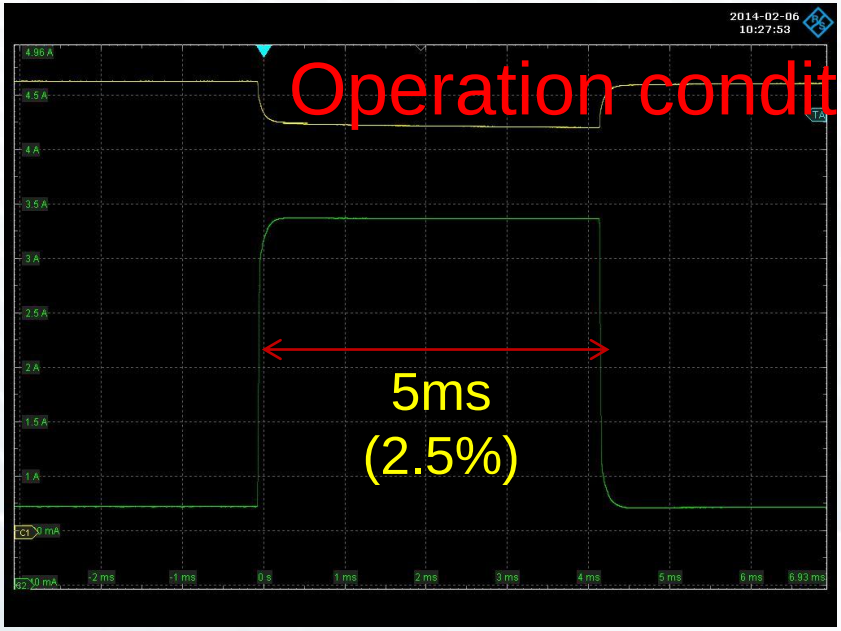


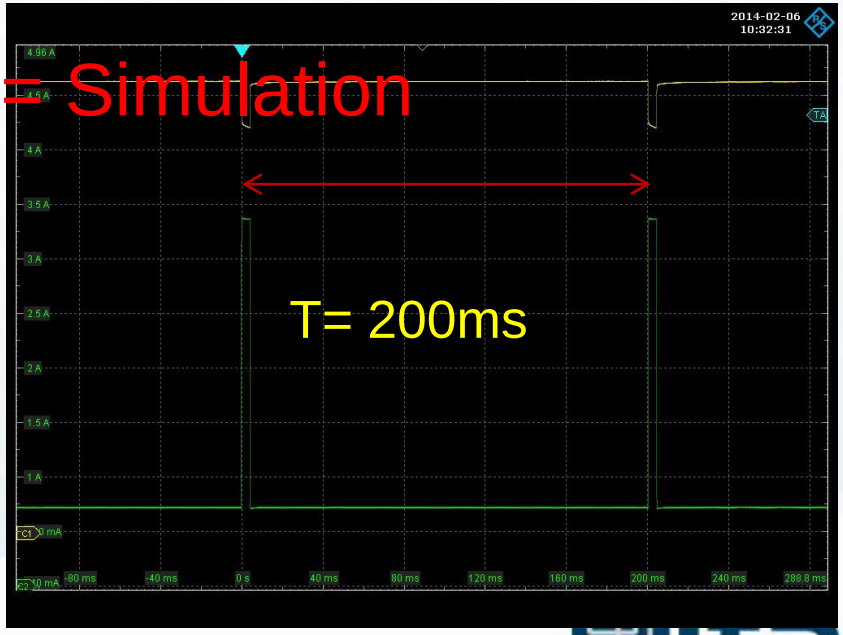
3.FTD +6 Group: Real prototype

- An ILC emulator has been designed
  - Testing points
- 3 LV regulators
  - 2x1.5V / 1x2.5V
- Pulse load: 3 x (2 resistors)
  - 3 x MOSFET
  - Driven by Texas Instruments CB

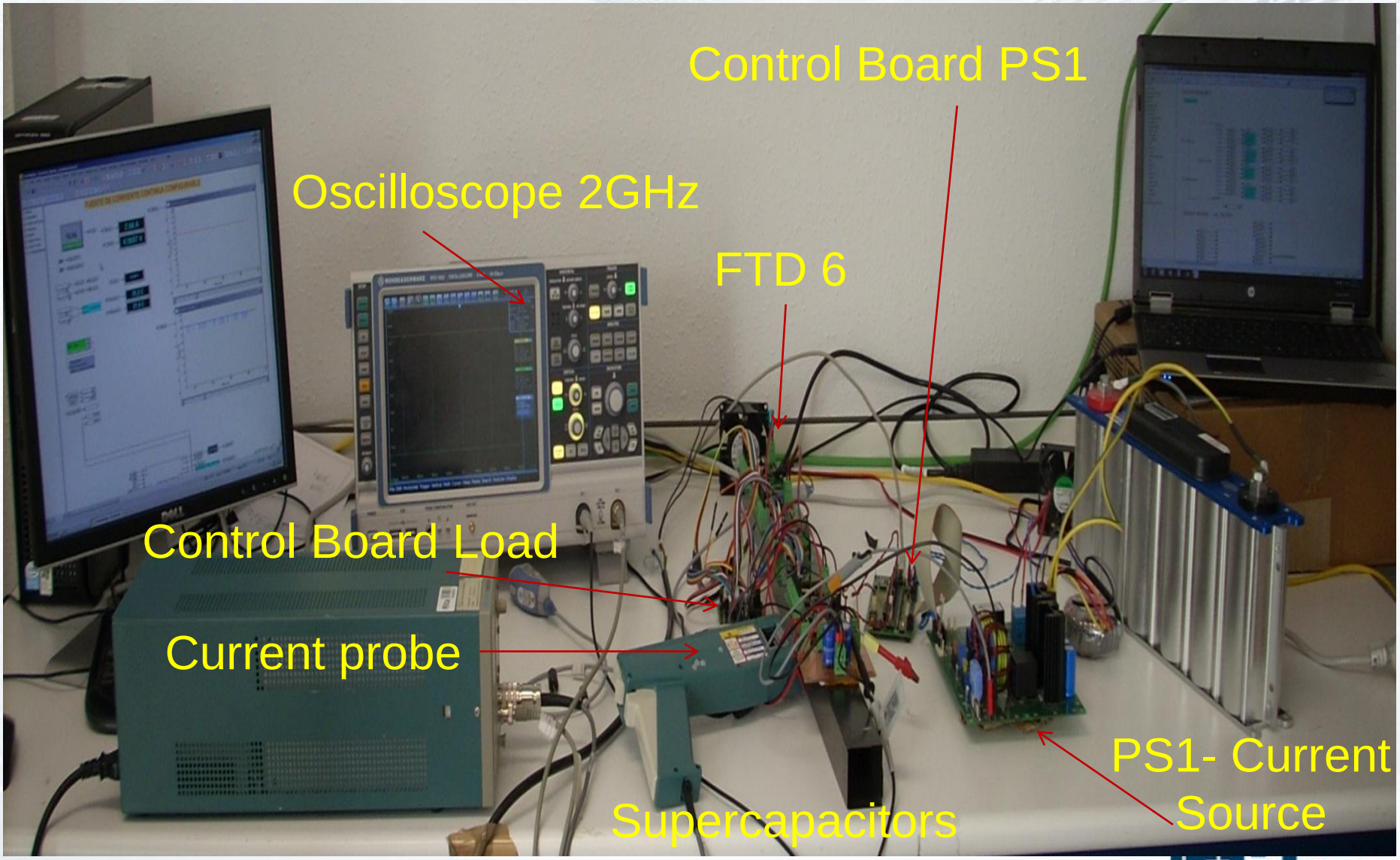


Operation condition = Simulation

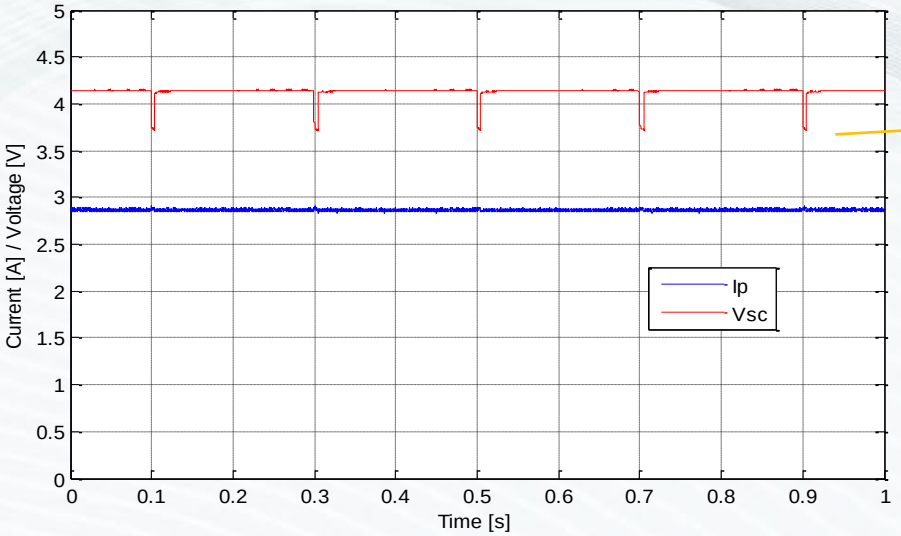


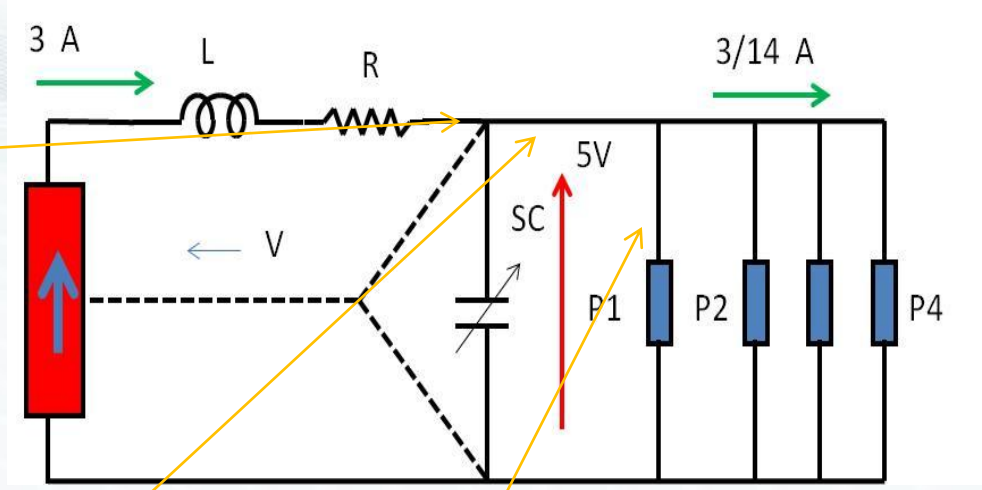


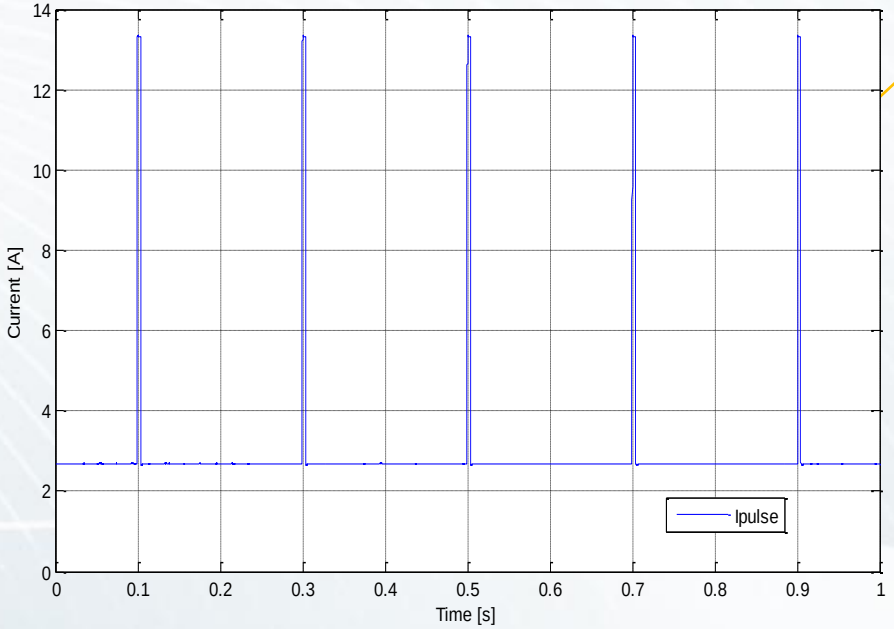
3.FTD +6 Group: Real prototype

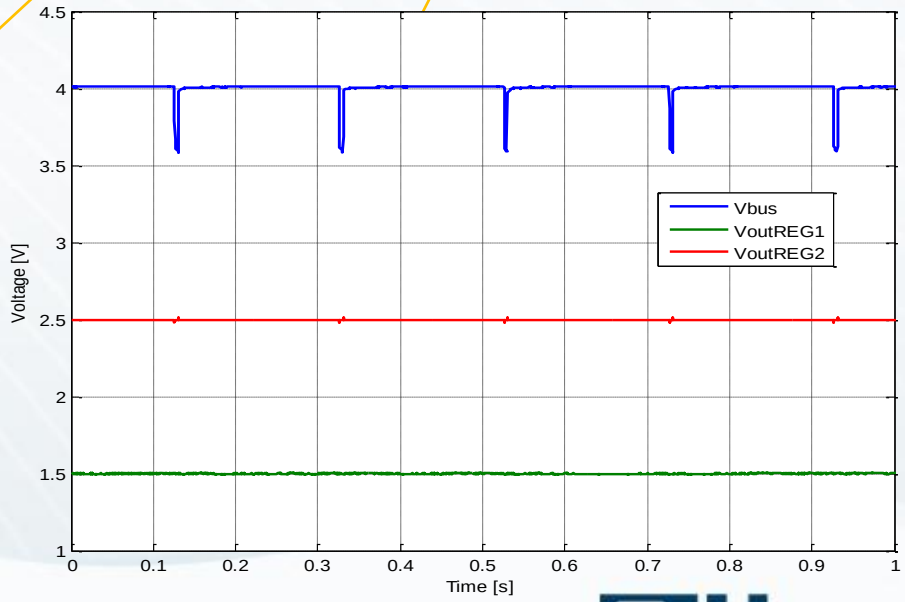


3.1 FTD +6 Group: Real prototype - Operation

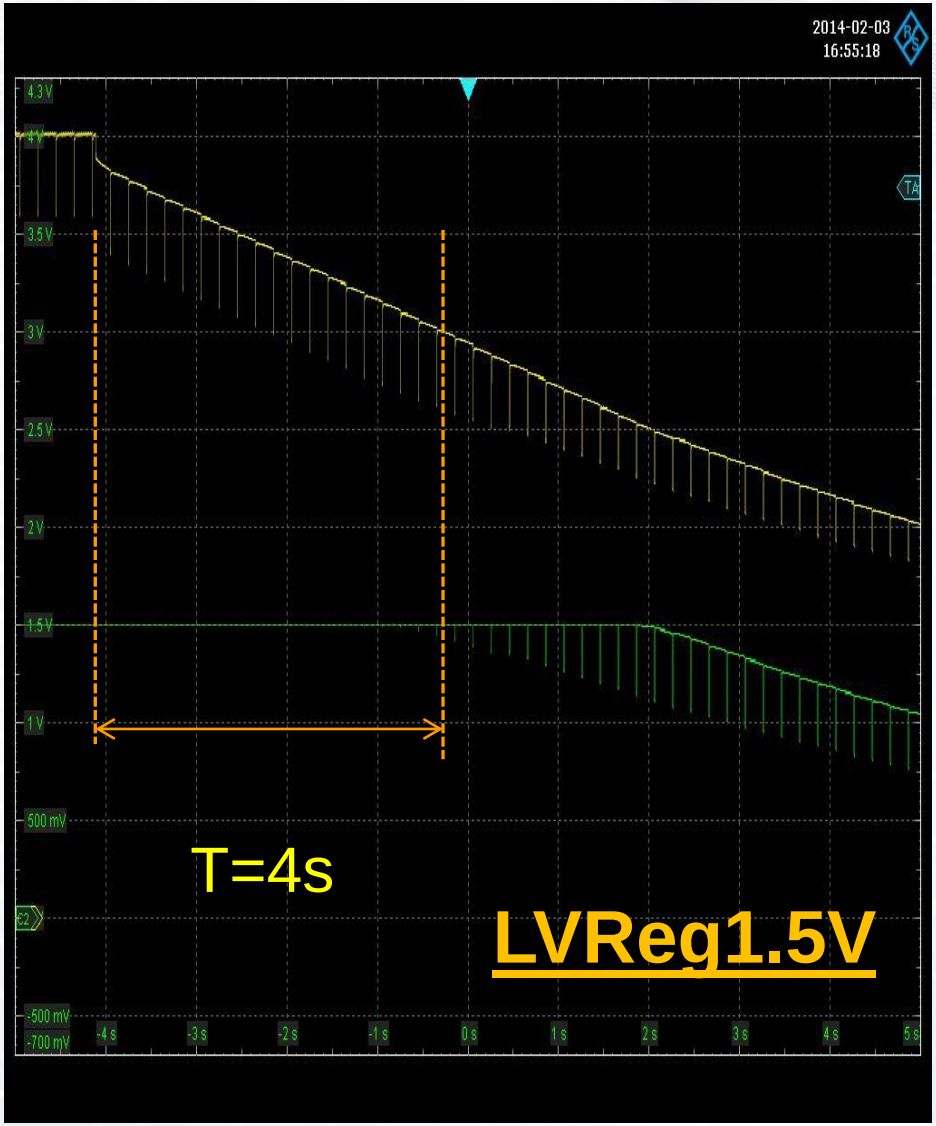


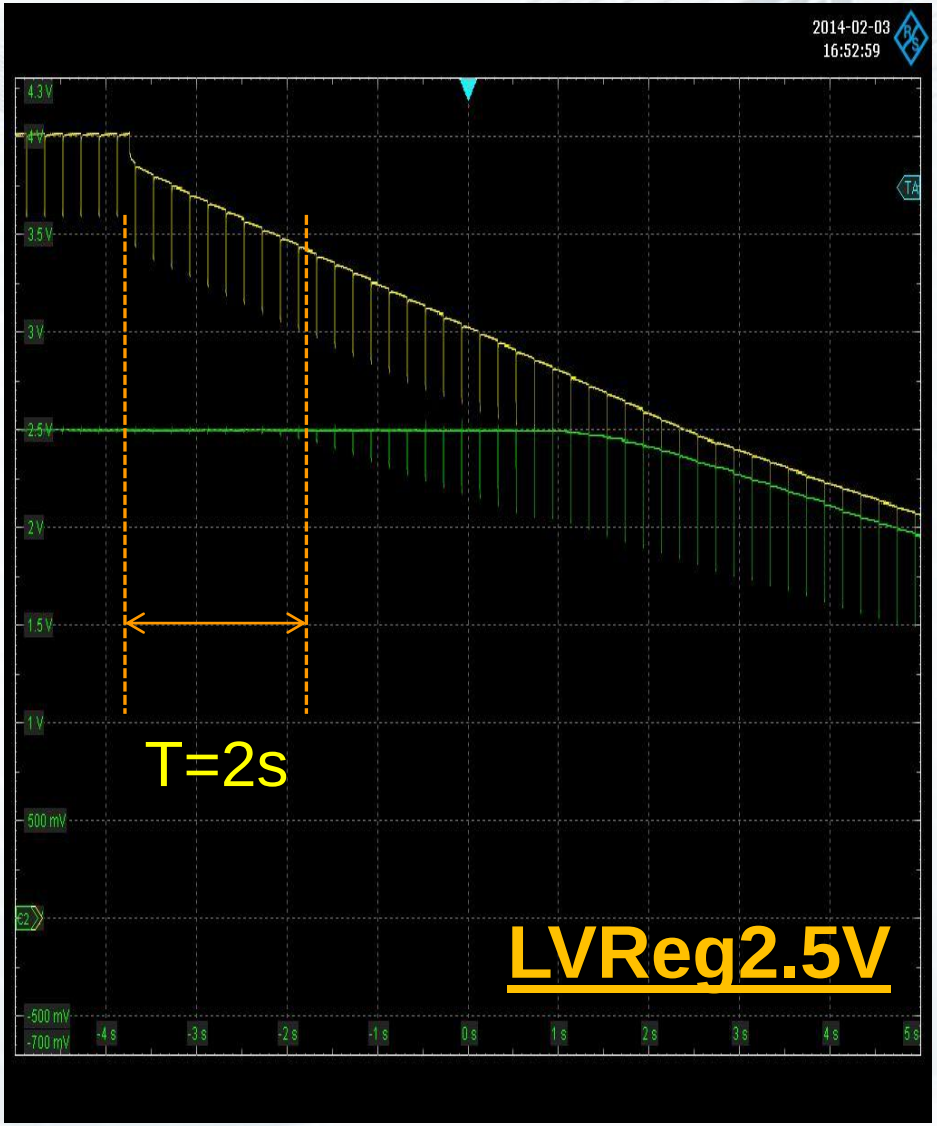






3.1 .FTD +6 Group: Real prototype - Operation

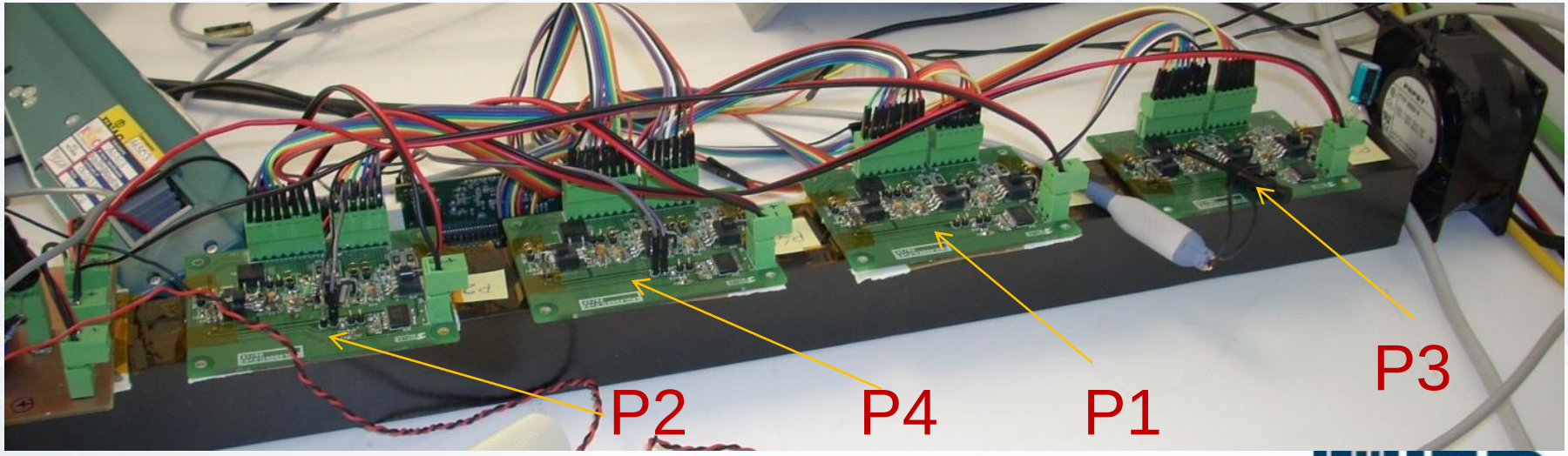




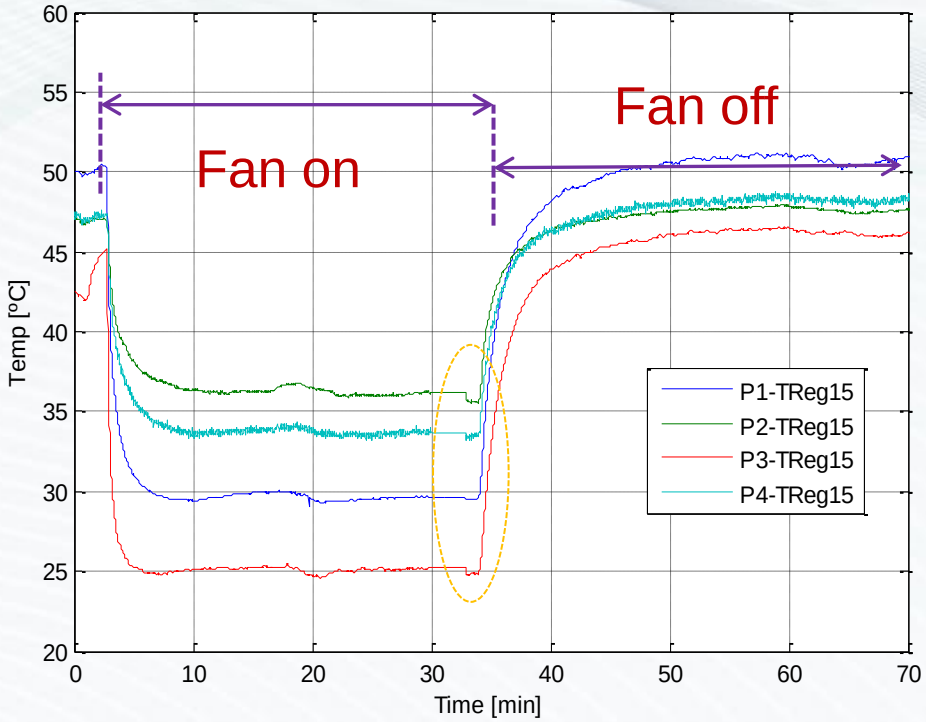
Major Fault – UPS capability

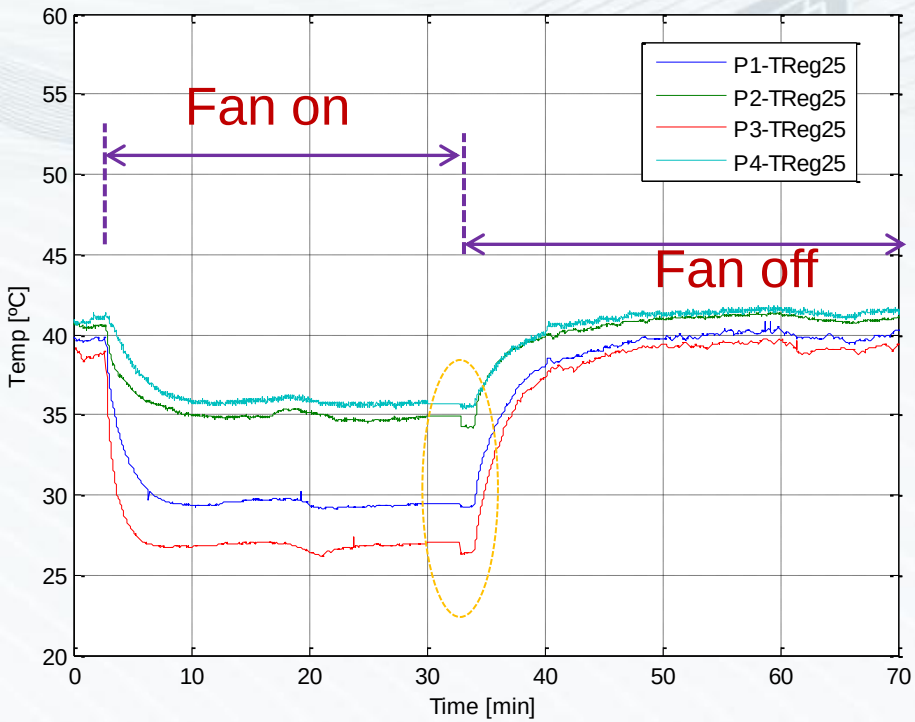
3.1 FTD +6 Group: Real prototype - Operation

- A very simple temperature test has been performed
- Temperature sensors were installed on each board:
  - One Termistor (PTC) per LV regulator
  - Temperature is processed by the control board
- A fan has been installed on one side of the CF structure
  - It has been switched on /off
- Systems were running more than 3 hours
- Baseline Temperature : 21ºC



3.1 .FTD +6 Group: Real prototype – Operation





- LVReg (1.5V) dissipates more power than LV (2.5V)
- From the point of view of electronics, “this prototype” does not need to be cooled (resistances dissipate power too)
  - Not Cooled: Tmax(P1)≈51ºC (ΔT ≈ 30ºC) / Tmin(P3)≈ 46ºC (ΔT ≈ 25ºC)
  - Cooled: Tmax(P2)≈34ºC (ΔT ≈ 13ºC) / Tmin(P3)≈ 25ºC (ΔT ≈ 4ºC)
- Pulsing effect is very small from the point of view temperature

4. Conclusions

- A real prototype of 1 FTD power group has been developed and tested
  - Very good agreement with simulations (Presented in LCWS 2012 & ECFA 2013)
- Main characteristics and key elements have been shown
  - Operation condition (regulation, pulsing, supercapacitors,.)
- Supercapacitor fits quite well power pulsing requirements
- Power dissipation aspects :
  - From electronics point of view, this system does not need to be cooled
  - The pulsing effect seems not to have a big impact
- The results are very promising but a long system study is required in order to define final specification