RPC Link System *Slow Controller* Development in CMS/HL-LHC Experiment Update II

Programa de Pós-Graduação em Instrumentação e Óptica - PPGIO

Doutoramento em Engenharias Áreas IV

Doutorando: Eng.^{o} Fabio Marujo da Silva, M.Sc.
CEFET/RJ - Centro Federal de Educação Tecnológica Celso Suckow da Fonseca
Orientadora: Ana Barros, D.Sc. (CEFET/RJ)
Coorientador: Gilvan Augusto Alves, D.Sc. (CBPF)

February 13, 2020

Agenda

Muon Systems

- RPC Muon
- Link Board System

Slow Controller

- Overview
- FPGA-Kintex7

Operação

- Resultados

No CMS HL-LHC Upgrade (Phase-2):

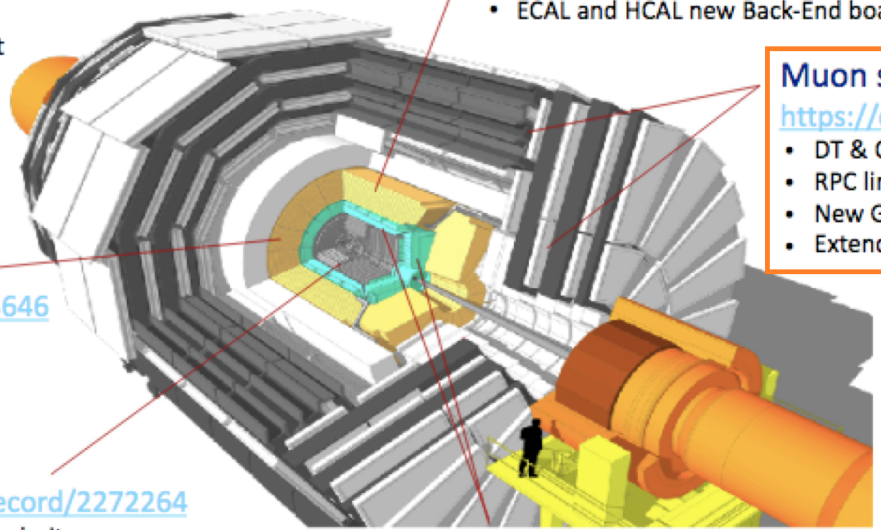
System Muon: Upgrade nas FE/BE readout e RPC Link Board

Technical proposal CERN-LHCC-2015-010 https://cds.cern.ch/record/2020886
Scope Document CERN-LHCC-2015-019 https://cds.cern.ch/record/2055167/files/LHCC-G-165.pdf

L1-Trigger/HLT/DAQ
https://cds.cern.ch/record/2283192
https://cds.cern.ch/record/2283193
- Tracks in L1-Trigger at 40 MHz
- PFlow-like selection 750 kHz output
- HLT output 7.5 kHz

Barrel Calorimeters
https://cds.cern.ch/record/2283187
- ECAL crystal granularity readout at 40 MHz with precise timing for e/γ at 30 GeV
- ECAL and HCAL new Back-End boards

Muon systems
https://cds.cern.ch/record/2283189
- DT & CSC new FE/BE readout
- RPC link -board
- New GEM/RPC $1.6 < \eta < 2.4$
- Extended coverage to $\eta \simeq 3$



Calorimeter Endcap
https://cds.cern.ch/record/2293646
- 3D showers and precise timing
- Si, Scint+SiPM in Pb/W-SS

Beam Radiation Instr. and Luminosity, and Common Systems and Infrastructure
https://cds.cern.ch/record/2020886

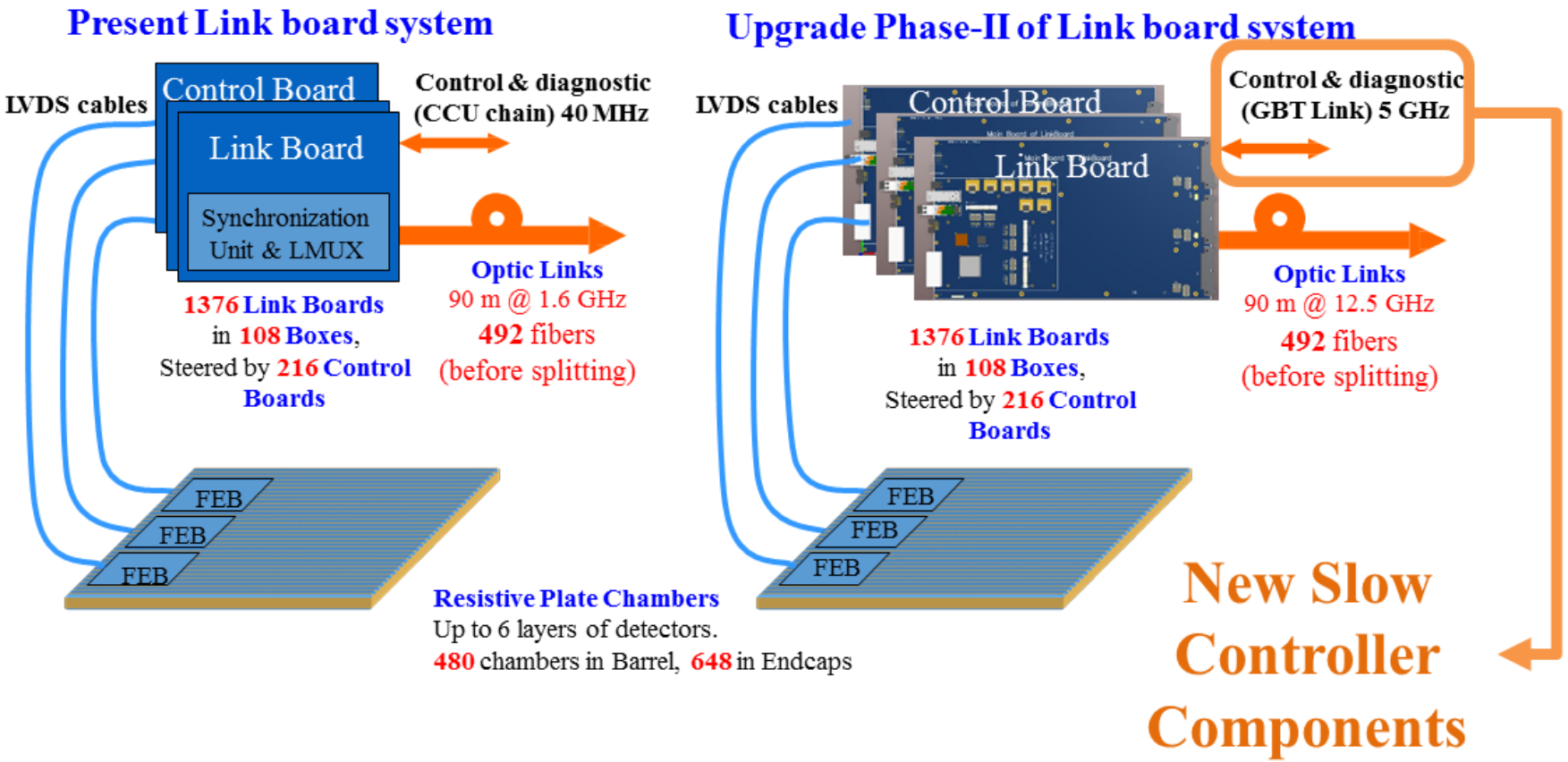
Tracker https://cds.cern.ch/record/2272264
- Si-Strip and Pixels increased granularity
- Design for tracking in L1-Trigger
- Extended coverage to $\eta \simeq 3.8$

MIP Timing Detector
https://cds.cern.ch/record/2296612
Precision timing with:
- Barrel layer: Crystals + SiPMs
- Endcap layer: Low Gain Avalanche Diodes

Innovative and extremely challenging new capabilities

Link Board system Overview

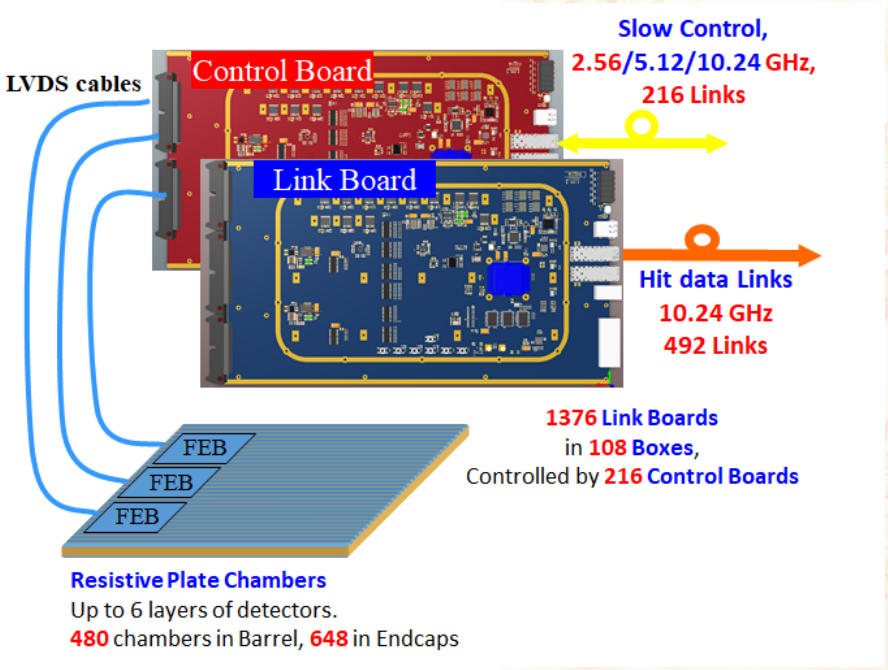
Upgrade Motivação



New Link System Overview

New Link system Upgrade Phase-II no LS2

Baseado numa FPGA Kintex-7 da Xilinx

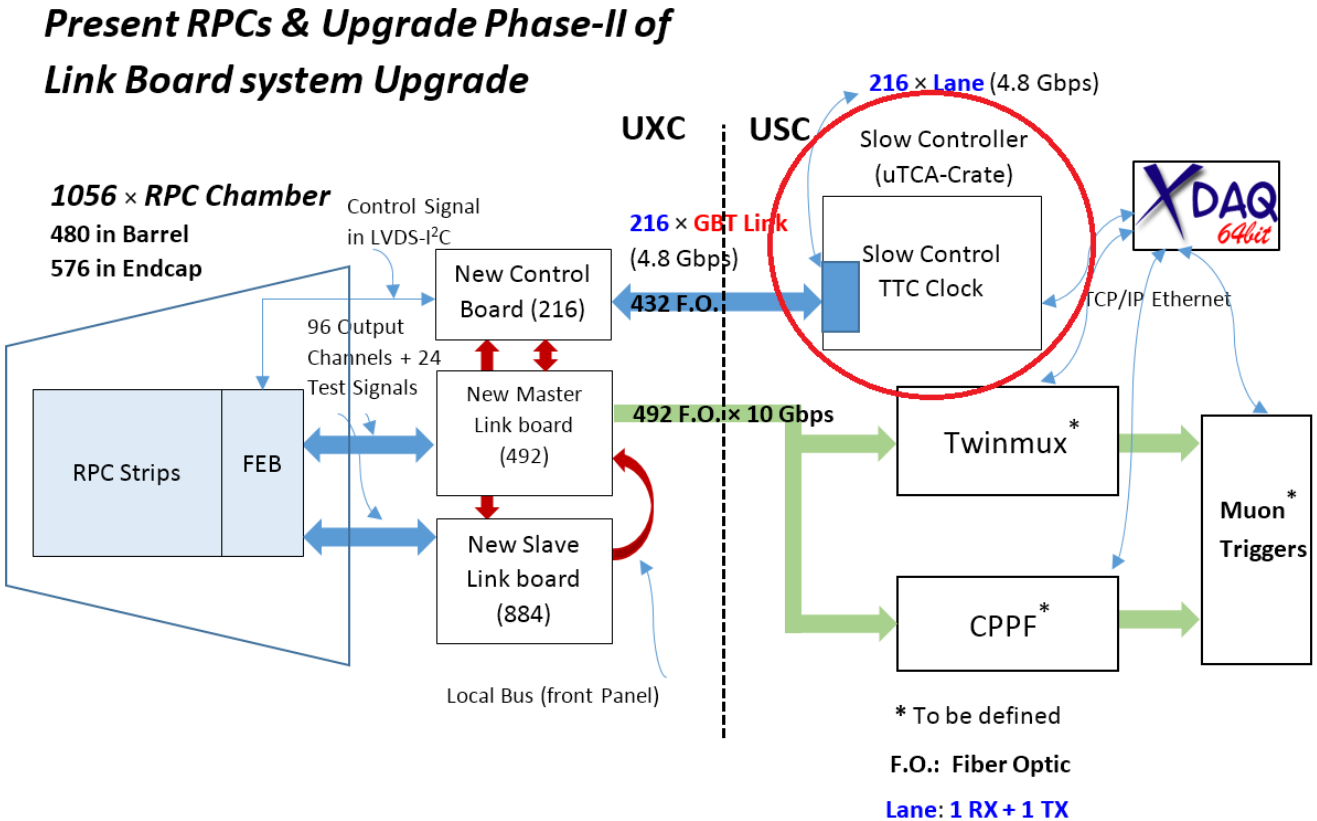


New Link Board System e Control Board

- FPGA XC7K160T - Versão Industrial
- Link óptico redundante
- Programação remota
- Transmissão de dados em alta velocidade em LATÊNCIA FIXA
- Conexão de fibra óptica ponto a ponto entre as placas de controle e o ***Slow Controller***

O que é Slow Controller

Sistema: monitora/controla um ou mais sistemas

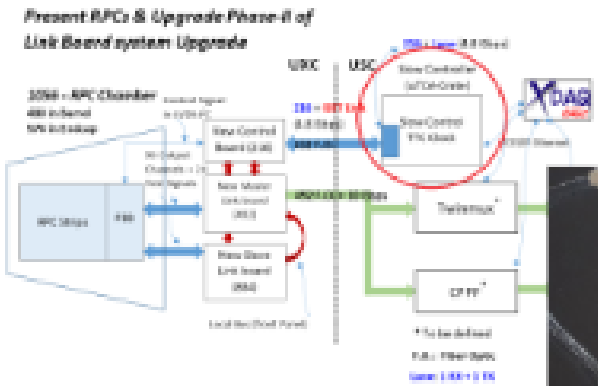


Prevenção de falhas, monitoramento, controle direto pelo usuário ou controle automatizado

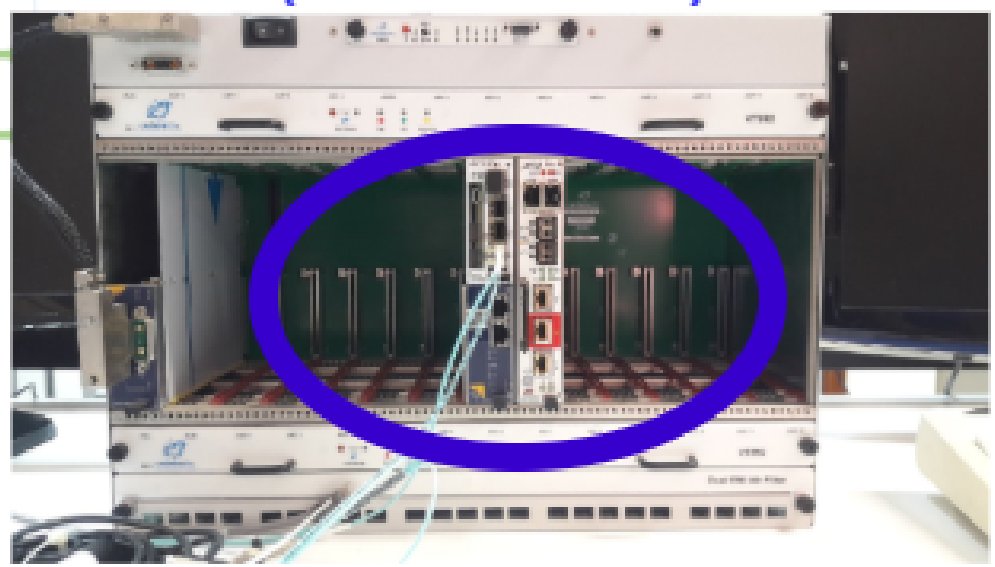
Desenvolvimento do *Slow Controller*

Implementação: FPGA-Kintex7, Rack μTCA e AMC13

Hardware para o Slow Controller



Slow Controller
(uTCA-Crate)



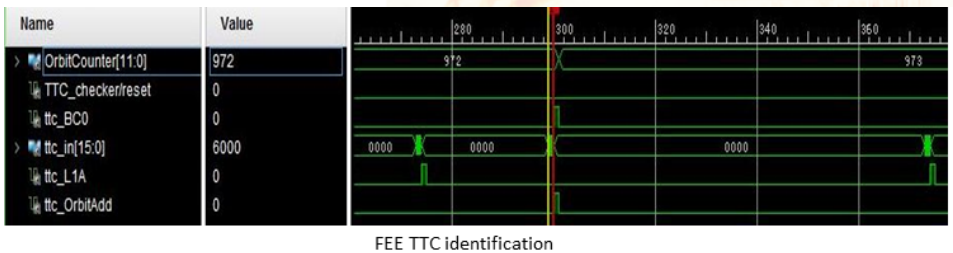
- Linux Embarcado
- FPGA

Implementação do ***Firmware*** no Linux Embarcado do μTCA

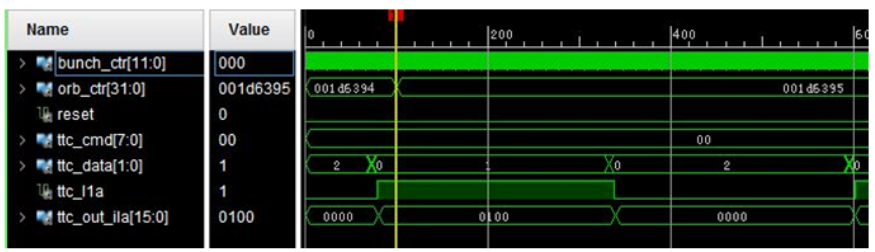
Desenvolvimento do *Slow Controller*

Implementação: FPGA-Kintex7, Rack μTCA e AMC13

Software (Firmware) para o Slow Controller



FEE TTC identification



BEE TTC decode

Firmware para um Protocolo com 256 bits

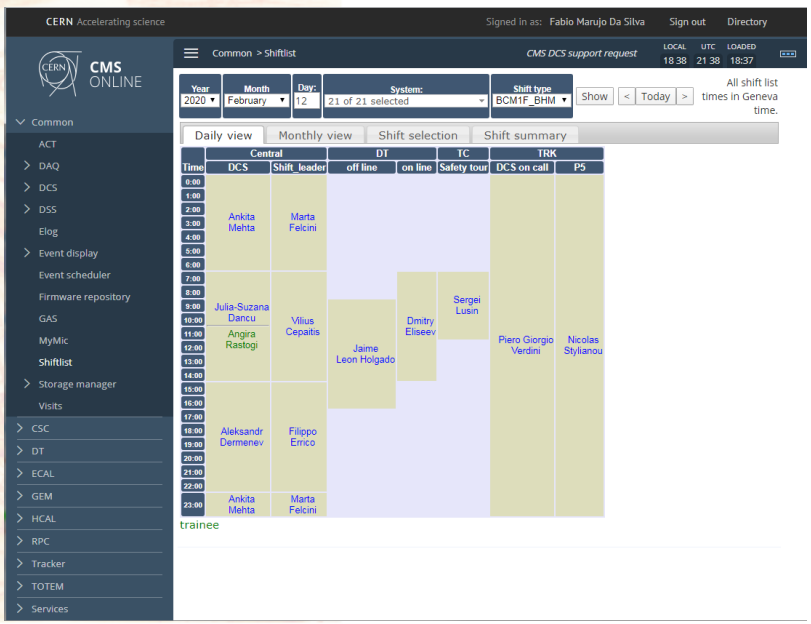
Item	Header + FEC [0..23]	L1A [24]	BC0 [25]	EC0 [26]	Hard Reset [27]	Command Type [28..30]	Command Value A [31..38]	Command Value B [39..54]	Command Value C [55..253]	End of Data [254, 255]
Bit	24	1	1	1	1	3	8	16	199	2

Operação e Funcionamento do *Slow Controller*

O software Online RPC (Back-End) utiliza o *Slow Controller*

Recebido do software Online RPC

- Configuração de Threshold de FEB
- Ajuste de precisão do clock TTC (LHC)
- Configuração de janelas abertas/fechadas
- Arquivo de configuração do FPGA (programação remota)

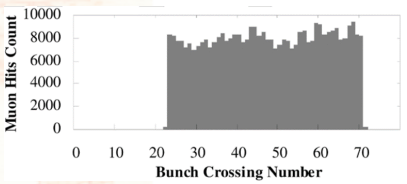


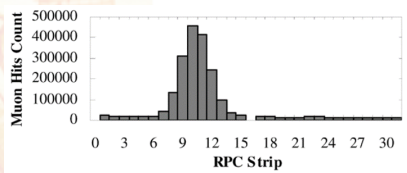
Perspectivas & Resultados do *Slow Controller*

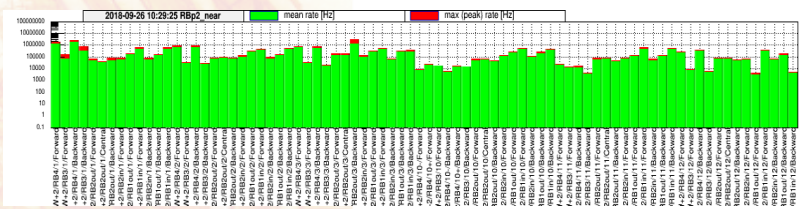
O Software ONLINE:

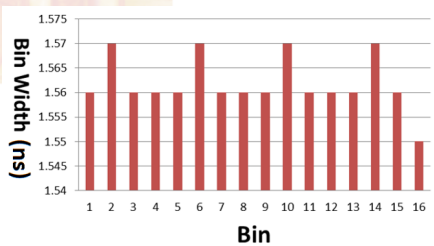
Requisita/controla serviços através do Slow controller

- CMS OnLine
  - *Slow Controller*
    - Calibration mode
    - Link Board Parameter Setting
    - Control Board Parameter setting
    - Physics RUN
    - Standby
    - Histogram
    - Diagnostic
    - FEB Test









Perguntas?

OBRIGADO PELA SUA ATENÇÃO!