LNLS’s experience with Open Hardware
Open Hardware Workshop 2013, San Francisco

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Outline

- Introduction
- Current status
- Benefits of an open-source approach
- Difficulties found
- Possibilities of collaboration
- Conclusion
Introduction

Campinas, State of São Paulo, Brazil
Introduction

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First beam: mid-2016

Sirius

LNLS UVX storage ring
1.37 GeV 2nd generation light source
Operating since 1997
Introduction

September 2013
Current status

- 4 open hardware boards:
  1. Sirius BPM RF Front-End
  2. AMC FMC Carrier
  3. FMC ADC 4-channel 16-bit 130 MS/s
  4. FMC ADC 4-channel 16-bit 250 MS/s

- HDL and low-level software:
  - PCIe infrastructure (WB master, Linux device driver, C/C++ API)
  - A modular HAL: FMC Configuration Software (FCS)
  - Wishbone local bus infrastructure

- New round of boards: December’13

- CERN Open Hardware Licence + GNU General Public License (GPL)

- 1st version prototypes produced

- Come to see the talk Development of an Open-Source Hardware Platform for Sirius BPM and Orbit Feedback (WECOCB07) on this Wednesday (the 9th), Hardware Session! 😊
Current status (Sirius BPM RF Front-End)

HSWA2-30DR
P1dB = 30 dBm
Isolation = > 60 dB
IL = 0.7 dB

Calibration Tone

From BPM buttons

Designed by LNLS
Current status (Sirius BPM RF Front-End)
Current status (AMC FMC Carrier – AFC)

- FMC slot 1 (HPC)
  - 32-bit SDRAM DDR3 (256 MB or 2 GB)
  - FPGA
    - Xilinx Artix-7
    - 200T FFG1156
  - 8x MGT
  - Oscillators + DACs
  - Configuration Flash
  - IPMI Controller
- FMC slot 2 (HPC)
  - PCIe x4
  - 2x GbE
  - 8x M-LVDS
  - 32 MB NOR Flash
  - EEPROM / ID
- Standalone Power input
- Clock Crossbar

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Current status (AMC FMC Carrier – AFC)

Specified by LNLS
Designed by WUT
Current status (FMC ADC)
Current status (FMC ADC)

LTC2208 (130MS/s) – LNLS design

ISLA216P25 (250 MS/s) – WUT design

Common shielding/heatsink, front panel and connectors
Current status

- Some open-source code, tools and concepts in use:
  - Open Hardware Repository
  - Hdlmake
  - WB slave generator
  - GSI-patched LM32
  - Wishbone crossbar switch
  - PCIe HDL
  - PCIe Linux device driver
  - IPMI code for AFC’s MMC
  - Self Describing Bus (SDB)

- Planning to use:
  - Libre Filter Design and Analysis (FDA) Tool
  - Etherbone
  - White Rabbit
  - ZIO
  - KICAD
  - BNL’s Synchronous Device Interface (SDI)
Benefits of open-source

- Learning process
- Valuable inputs from:
  - experienced people
  - creative people
  - visionary people
  - curious people
  - hard-working people
  - the unexpected
- Design reuse largely employed
- Cost effective
- When successfully employed, naturally claims for:
  - good interfaces
  - good documentation
Difficulties found

- The start
- Diversity of code and support
- Local companies
- Funding
- Legal aspects?
Possibilities of collaboration

1. **Open-source MicroTCA platform**
   - CPU
   - MCH
   - Timing (distributed DDS over White Rabbit)
   - Software (IPMI, control system interface)

2. **A solution for multiple input/multiple output (MIMO) control with update rates > 100 kS/s**
   - Ultra low-latency data distribution
   - Beam synchronous
   - Fault-tolerant
   - Universal low-cost sensor/actuator node with SFP/MGT/FPGA interface
   - HDL for MIMO state-space feedback controller
   - Simulation tools
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Main drivers at this front now: Warsaw University of Technology and Creotech

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Conclusion

- Work is under way to build open-source BPM and orbit feedback systems for synchrotron light sources. The platform is generic and can be used for other purposes.

- Challenges exist and must be overcome.

- Fronts of possible collaboration for building open-source systems: MicroTCA and low-latency MIMO feedback.

- Massive adherence of the accelerator’s community to the open-source approach is desired and very much expected.
Thank you!

- Designs and codes hosted at:
  - [http://www.ohwr.org/projects/bpm](http://www.ohwr.org/projects/bpm)
  - [http://www.ohwr.org/projects/bpm-rffe](http://www.ohwr.org/projects/bpm-rffe)
  - [http://www.ohwr.org/projects/bpm-sw](http://www.ohwr.org/projects/bpm-sw)
  - [http://www.ohwr.org/projects/afc](http://www.ohwr.org/projects/afc)
  - [http://www.ohwr.org/projects/fmc-adc-130m-16b-4cha](http://www.ohwr.org/projects/fmc-adc-130m-16b-4cha)
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