ATLAS Tile Calorimeter Detector Control Systems
FCT Follow-up meeting

Miguel F. Medeiros (EP-ADE-CA)

Supervisor: Henric Wilkens

December 2018

Agenda

- **Short Bio**

- **Trainee position**

- **ATLAS Tile Calorimeter**

  - → Overview

  - → From a DCS Expert perspective

- **DCS Developer**

  - → Our role & responsibility

  - → Finite State Machine (FSM)

  - → Library development

  - → Scripting

- **Testbeam & Upgrade activities**

- **Final Remarks**

- Natural from **Azores**

Trust me, there is land there…

A Short Bio
Miguel F. Medeiros

linkedin.com/in/miguelfmedeiros   miguel.fontes.medeiros@cern.ch

- Natural from **Azores**

Trust me, there is land there...

ACADEMIC TRACK
- MSc in Electrical and Computer Engineering
  - → Focus on <u>Automation & Control</u>
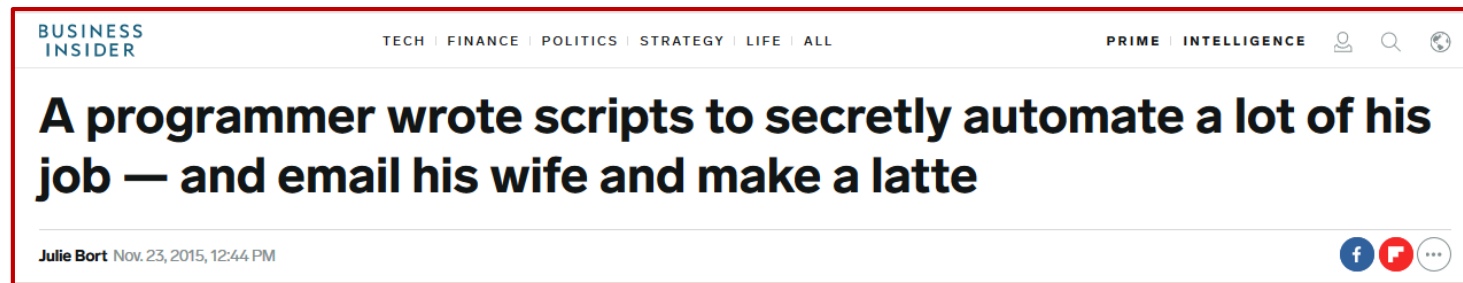- BSc in Electrical and Computer Engineering
- BSc in Renewable Energy

IT BACKGROUND
- Cisco Certified Network Associate
  - → Routing & Switching (CCNA)
  - → Security (CCNAS)
  - → Wireless (CCNAW)
- Certified Linux System Administrator (LPIC-1 & CompTIA Linux+)

EXTRA

1x 🏆 Award

5x 📝 Publications

2x ⚛ Research projects

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My motivation [obviously]…

BUSINESS INSIDER   TECH | FINANCE | POLITICS | STRATEGY | LIFE | ALL   PRIME | INTELLIGENCE

A programmer wrote scripts to secretly automate a lot of his job — and email his wife and make a latte

Julie Bort Nov. 23, 2015, 12:44 PM

Trainee: ATLAS Tile Calorimeter Detector Control System (DCS)

Traineeship
→ Started in May 2017
→ Tasks:
- Software developer
- On-Call duties
- Testbeam & Upgrade activities

ATLAS Control Room

Supervisor:
→ Henric Wilkens

ATLAS DCS Finite State Machine (FSM)

Overview

What is used for?

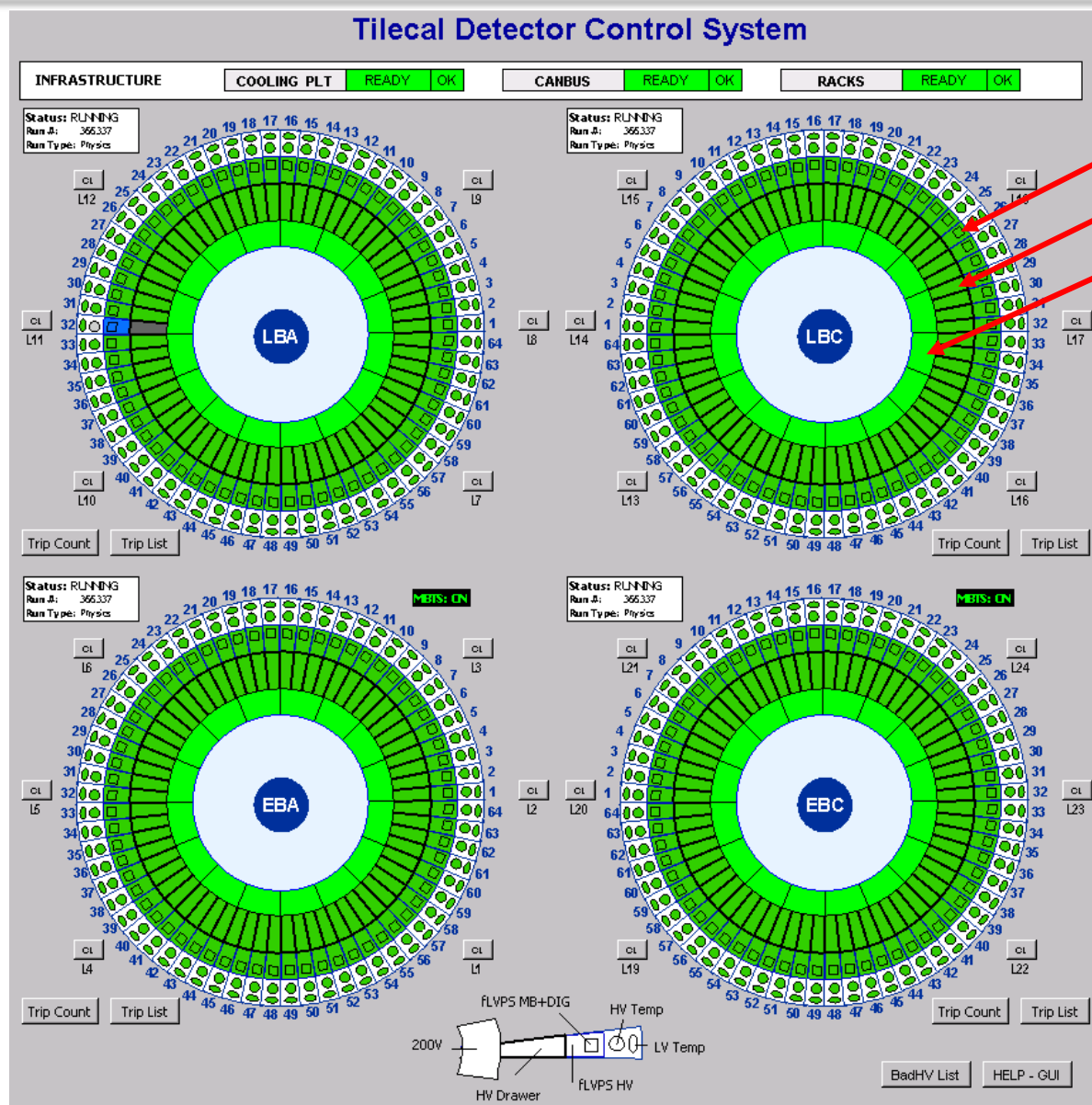- Measure energy (jet & missing energy)

General Specifications:

- Steel plates as passive absorber and scintilating tiles as active material

- ~10 000 Photomultiplier tubes (PMTs)

- Splited in 3 physical cylindrical sections (Total length = 12 meters)

    → Divided into 4 operation partitions: EBA, LBA, LBC, EBC

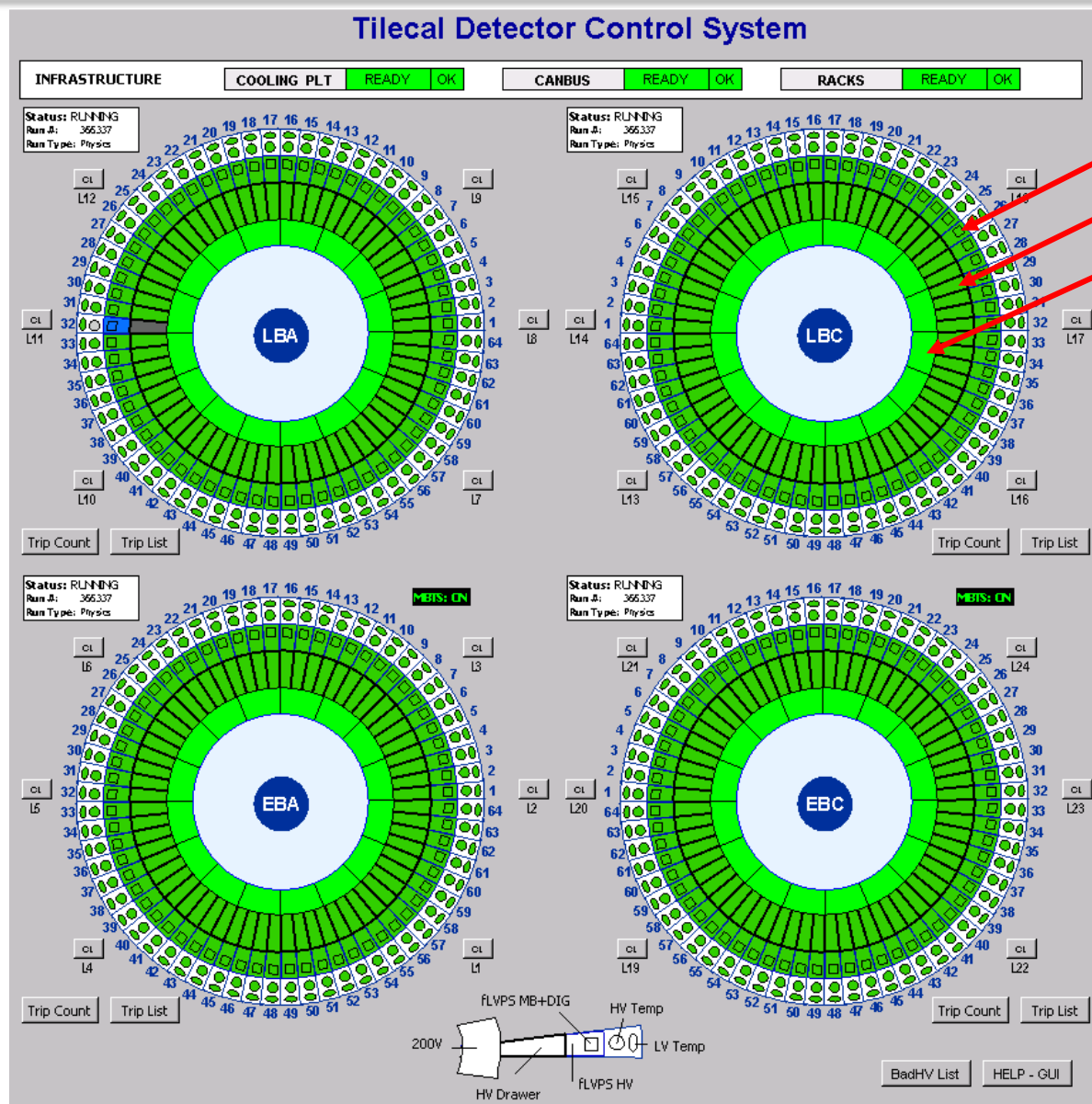- Each partition is divided in 64 modules

1 Tile Module
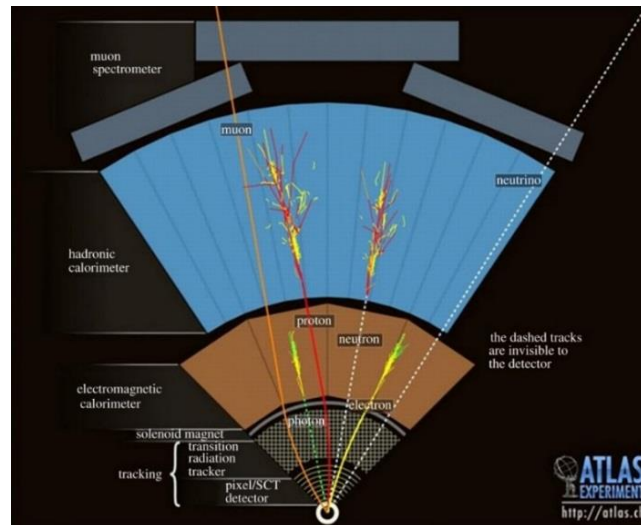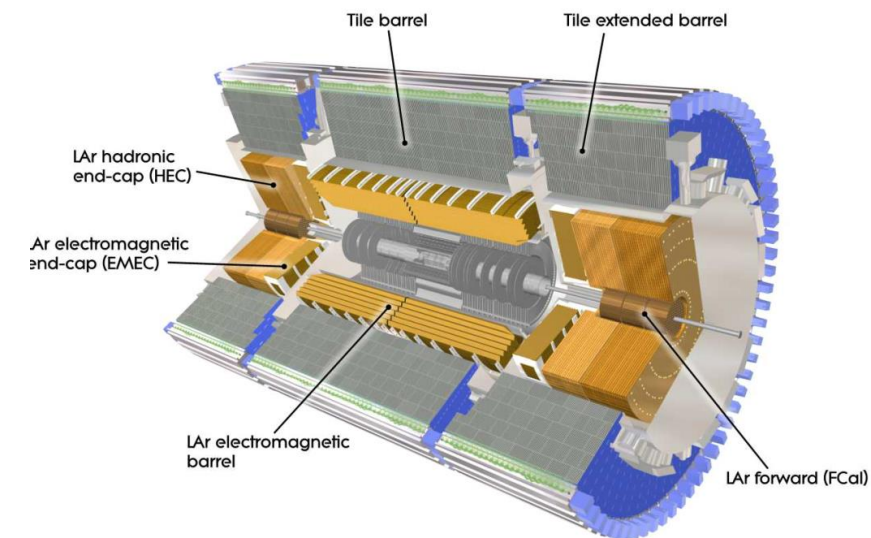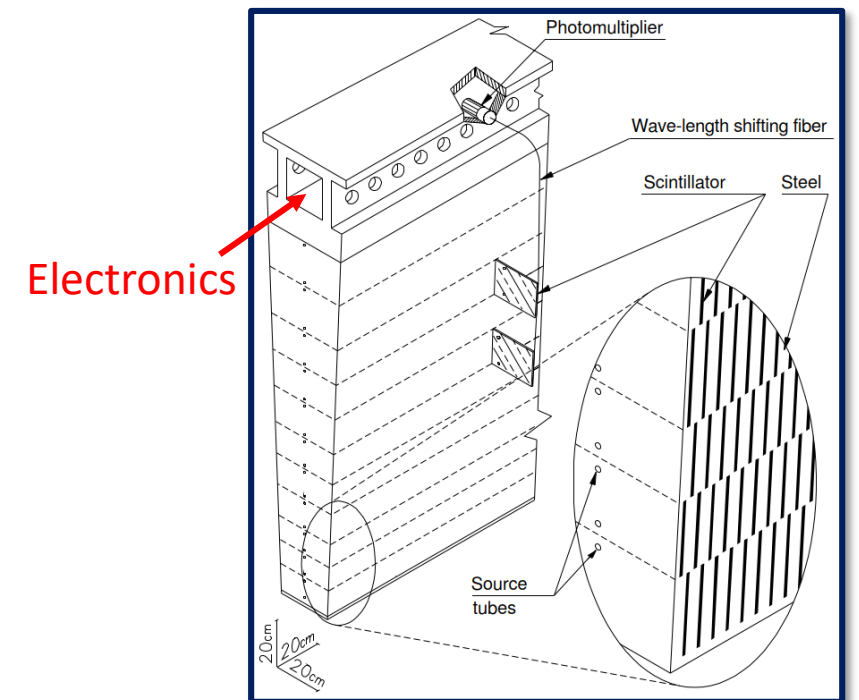
Electronics

From a DCS Expert perspective

Full control & monitoring of electronics inside detector

Low Voltage Power Supply

Drawer (High Voltage)

Low Voltage TDK (off-detector)

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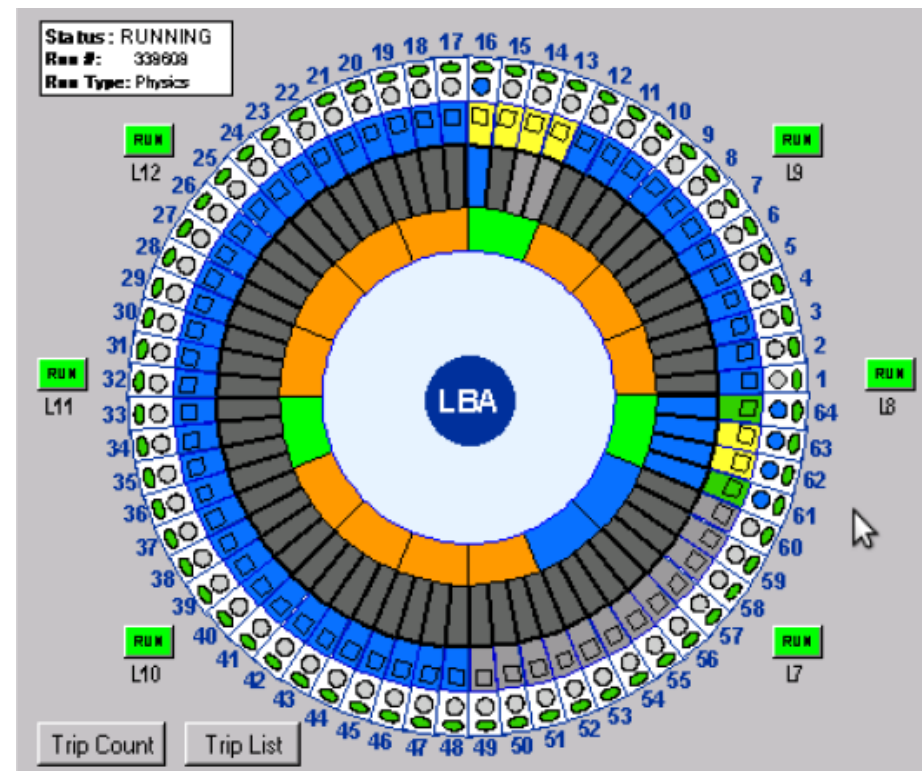
Our role & responsability

**Hardware that we are responsible for monitor & control:**

→ Front-End (On-Detector)
- Low Voltage Power Supplies (LVPS)
  - Embeded Local Monitor Board (ELMB)

- High Voltage system:
  - High voltage distribution boards (HV-Opto)
  - High voltage control & monitor (HV-Micro)

→ Back-End (Off-Detector)
- Auxiliary Boards (AUXBoards)
- Power Supplies:
  - High Voltage Power Supply (HVPS)
  - 200V DC TDK Power supply
  - CANbus power supplies (CAN PS)
- Wiener crates (supports Data Acquisition Infrastructure)
- Cooling system
- Laser system

HV-Micro

LVPS
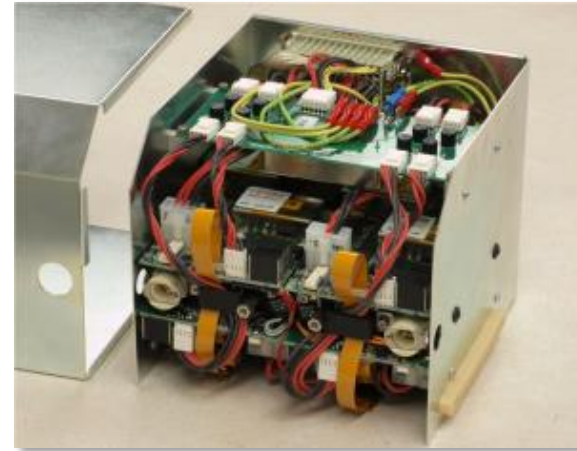
ELMB

HVPS   **AuxBoards**
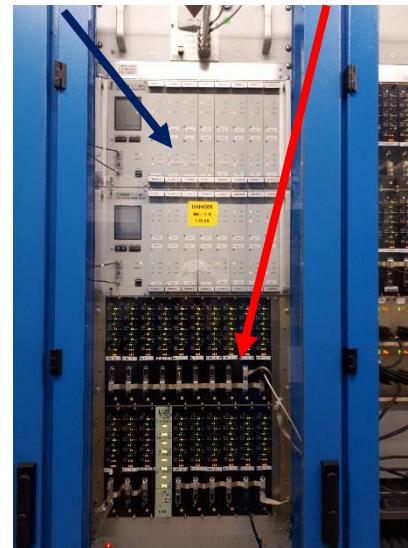
200V DC TDK

FSM Panel Examples (1/2)

A major refurbishment of TileCal FSM panels

→ Facilitate the work of ATLAS CR & DCS OnCall Shifters

→ Monitor hardware states & FSM state propagation

Supervisory Control and Data Acquisition (SCADA)

WinCC-OA tool

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FSM Panel Examples (2/2)

Library development

Behind the user interface layer, there is significant code running on backend...

Source Code ➕ **Doc Generator (e.g Doxygen)** ⬌ **Proper code Documentation**

Why should we care about libraries?

- Avoid duplicated code → Improves System Integration
- Centralizes code → Eases feature deployment
- Better documentation! → Avoids "pain" for future developers

Log improvement

You can never have too much logging...

Why should we care about logs?

- System Health monitoring
- Contributes to system improvement (bug fixes, etc)
- In case of issues:
  - "Re-live" the event → Understand how & why it happened
  - Improve the *post-mortem* analysis
  - Avoid issue in the future

Issue: **No timestamps**
Makes event tracking impossible

```
["Start ramping > "]["oldDAC="][4095]["DAC="][3350]
["Trim (box, a, DACvalue) "]["ELMB/LVCAN3/LVPS_44"]["M5V
["Start ramping > "]["oldDAC="][4095]["DAC="][3545]
["Trim (box, a, DACvalue) "]["ELMB/LVCAN3/LVPS_44"]["M15
```

Issue: **No message context**
Message belongs to which process?

```
2014.09.14 12:17:20.235["Running version with 1s delay"]
```

Issue: **Developer Debug messages**
Populating Logs → Disk Filling

```
    5: "ELMB/LVCAN4/LVPS_1"
    6: "ELMB/LVCAN4/LVPS_2"
    7: "ELMB/LVCAN4/LVPS_3"
    8: "ELMB/LVCAN4/LVPS_4"
]["ELMB/LVCAN3/LVPS_44"]
2014.09.14 12:17:31.858[dyn_string 8 items
    1: "ELMB/LVCAN2/LVPS_37"
    2: "ELMB/LVCAN2/LVPS_38"
```

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Log improvement

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```

Continuous effort on improving our logging system

- Log anything that can be useful in the future
- Several new tools & logs available

ELMB EmergencyErrorCodes Tools

Clear tool: click to clear ELMB alarms

CLEAR ELMB Alarms

```
LVPS_1  CAN communication
LVPS_2  ADC conversion timeout
LVPS_3  CAN communication
LVPS_4  Bootloader is now in control
```

Check tool: select the ELMB to check for errors

LVCAN4/LVPS_1   **Get**

Error code	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**
8100	44	28	9a	0	0

Decoded Error

Alarm state: **ACTIVE**
Last error update: 2018.11.26 17:36:22.601

Description: CAN communication

Close

```
2018.08.09 21:00:11.575, ATLTILLV02:ELMB/LVCAN4/LVPS_7,8100,44,28,1,0,CAN communication
2018.08.09 21:00:11.575, ATLTILLV02:ELMB/LVCAN4/LVPS_8,8100,44,28,1,0,CAN communication
2018.08.24 07:17:04.231, ATLTILLV02:ELMB/LVCAN2/LVPS_39,5000,1,35,0,0,ADC conversion timeout
2018.09.09 03:25:47.012, ATLTILLV02:ELMB/LVCAN3/LVPS_41,5000,1,3b,0,0,ADC conversion timeout
```

Operations routine? Automate it! (1/2)

DCS Data Viewer (DDV) → ATLAS DCS web interface tool that allows user to check DCS data & alarms

The routine:
1. Select Alarms
2. Select Time
3. Select Sub-detector
4. Yet another Select… (System)
5. Query the data
6. Check the data
7. Repeat steps 4-5 to check full TileCal…

Imagine doing it several times a day…

Not compliant with "my automation mantra"…

Operations routine? Automate it! (2/2)

```
[mfontesm@lxplus007 alarmsGet]$ ./PullAlarms.py -h
usage: PullAlarms.py [-h] [-p [partition [partition ...]]]
                     [-t [period [period ...]]]

--------------------------------------------------
 This script gets the Alarms for TileDCS from DDV
--------------------------------------------------

@author: Miguel F. Medeiros
@contact: miguel.fontes.medeiros@cern.ch

optional arguments:
 -h, --help          show this help message and exit
 -p [partition [partition ...]]
                     Select partition: EBA, LBA, LBC, EBC. (default=ALL)
 -t [period [period ...]]
                     Time period:
                       -t (from) "dd-mm-year" (to) "dd-mm-year"
                       -t 3 (last 3 days)
                       -t 1 (last day) [default]
--------------------------------------------------
```

The full sequence of previous page is replaced by:

`[mfontesm@lxplus007 alarmsGet]$ ./PullAlarms.py`

```
TIL EBC Drawer 7 PMT 17 Output Voltage status    W        fwWarningNack    WARNING 0.000    28-04-2018 13:06:03:498 went
TIL EBC Drawer 7 PMT 18 Output Voltage status    E        fwErrorNack      ALERT   0.000    28-04-2018 13:06:03:507 went
TIL EBC Drawer 7 PMT 18 Output Voltage status    W        fwWarningNack    WARNING 0.000    28-04-2018 13:06:03:507 went
TIL EBC AUXboard AUXboard2 noToggle       E        fwErrorNack      no toggle != 5  127.000 28-04-2018 13:06:05:021 came
TIL EBC LVCAN4 LVPS_7 noToggle   E        fwErrorNack      no toggle != 5  5.000    28-04-2018 13:06:05:040 went
TIL EBC Drawer 7 State   E        fwErrorNack      NO CONNECTION   -1.000   28-04-2018 13:06:05:246 went
TIL EBC Drawer 7 PMT 21 Output Voltage status    E        fwErrorNack      ALERT   -5.000   28-04-2018 13:06:09:261 went
TIL EBC Drawer 7 PMT 21 Output Voltage status    W        fwWarningNack    WARNING -5.000   28-04-2018 13:06:09:261 went
TIL EBC Drawer 7 PMT 22 Output Voltage status    E        fwErrorNack      ALERT   -5.000   28-04-2018 13:06:09:279 went
TIL EBC Drawer 7 PMT 22 Output Voltage status    W        fwWarningNack    WARNING -5.000   28-04-2018 13:06:09:279 went
TIL EBC Drawer 7 PMT 23 Output Voltage status    E        fwErrorNack      ALERT   -5.000   28-04-2018 13:06:09:288 went
TIL EBC Drawer 7 PMT 23 Output Voltage status    W        fwWarningNack    WARNING -5.000   28-04-2018 13:06:09:288 went
TIL EBC Drawer 7 Voltage Reference vFix1         W        fwWarningNack    WARNING 2.000    28-04-2018 13:06:09:855 came
TIL EBC Drawer 7 Voltage Reference vFix1         E        fwErrorNack      ALERT   2.000    28-04-2018 13:06:09:855 came
TIL EBC AUXboard AUXboard2 noToggle       E        fwErrorNack      no toggle != 5  5.000    28-04-2018 13:06:15:021 went
TIL EBC Drawer 58 PMT 22 Output Voltage status   W        fwWarningNack    WARNING 1.000    28-04-2018 19:49:19:753 came
TIL EBC Drawer 58 PMT 22 Output Voltage status   W        fwWarningNack    WARNING 0.000    28-04-2018 19:49:29:747 went
TIL EBC Drawer 7 Voltage Reference vFix1         E        fwErrorNack      ALERT   0.000    28-04-2018 21:24:07:528 went
TIL EBC Drawer 7 Voltage Reference vFix1         W        fwWarningNack    WARNING 0.000    28-04-2018 21:24:07:528 went
TIL EBC Drawer 58 PMT 22 Output Voltage status   W        fwWarningNack    WARNING 1.000    28-04-2018 22:09:20:314 came
TIL EBC Drawer 58 PMT 22 Output Voltage status   W        fwWarningNack    WARNING 0.000    28-04-2018 22:09:30:300 went
TIL EBC Drawer 58 PMT 22 Output Voltage status   W        fwWarningNack    WARNING 1.000    29-04-2018 00:24:20:550 came
TIL EBC Drawer 58 PMT 22 Output Voltage status   W        fwWarningNack    WARNING 0.000    29-04-2018 00:24:30:572 went
```

<u>After you have them in plain text…</u>
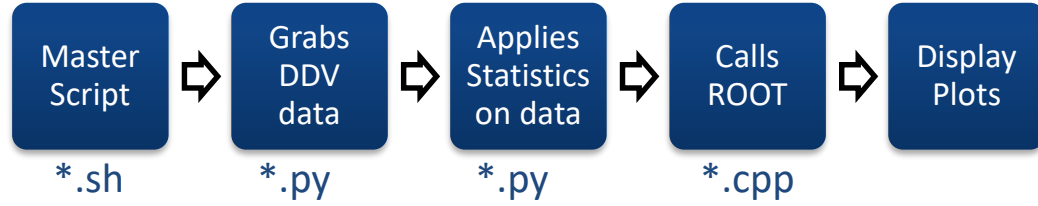→ Apply meaningful statistics
→ Better reports for maintenance
→ Go beyond in the automation…

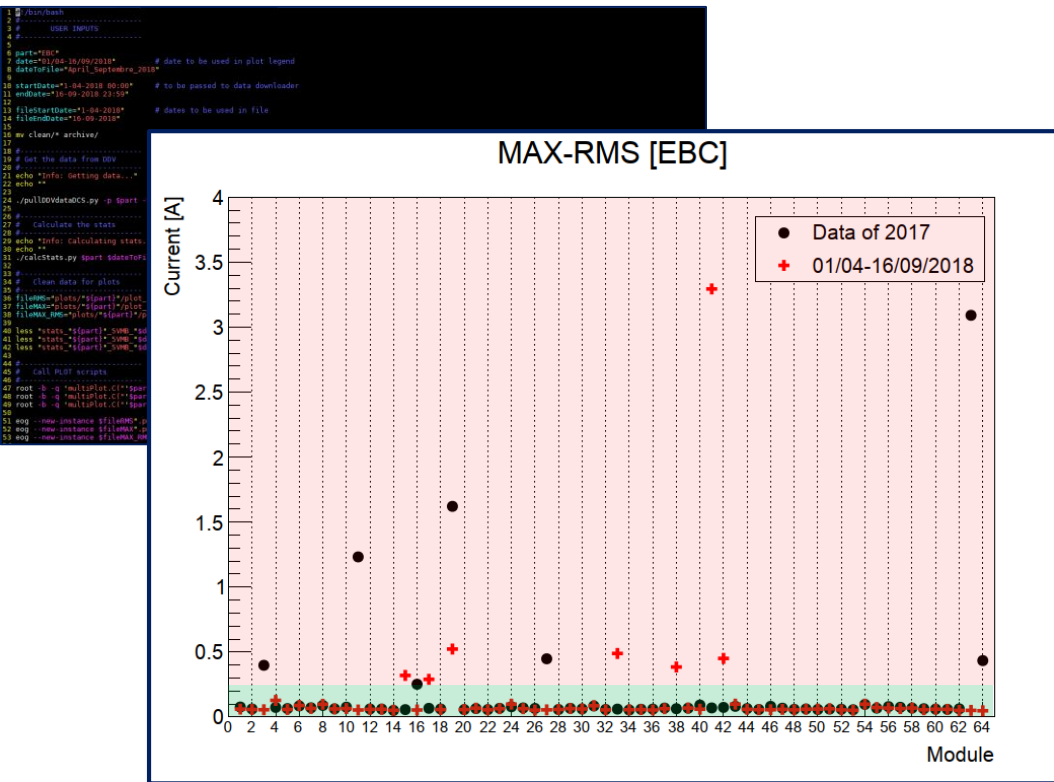https://gitlab.cern.ch/mfontesm/public

→ You can also find there a script for sending Emails & SMS using shell

# Spotting overcurrents of LVPS [Offline]

Spot overcurrents (and activates DCS protection) of Low Voltage Power Supply (LVPS) 5V Output Current

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Spotting overcurrents of LVPS [Offline]

Master Script *.sh → Grabs DDV data *.py → Applies Statistics on data *.py → Calls ROOT *.cpp → Display Plots

Spot overcurrents (and activates DCS protection) of Low Voltage Power Supply (LVPS) 5V Output Current
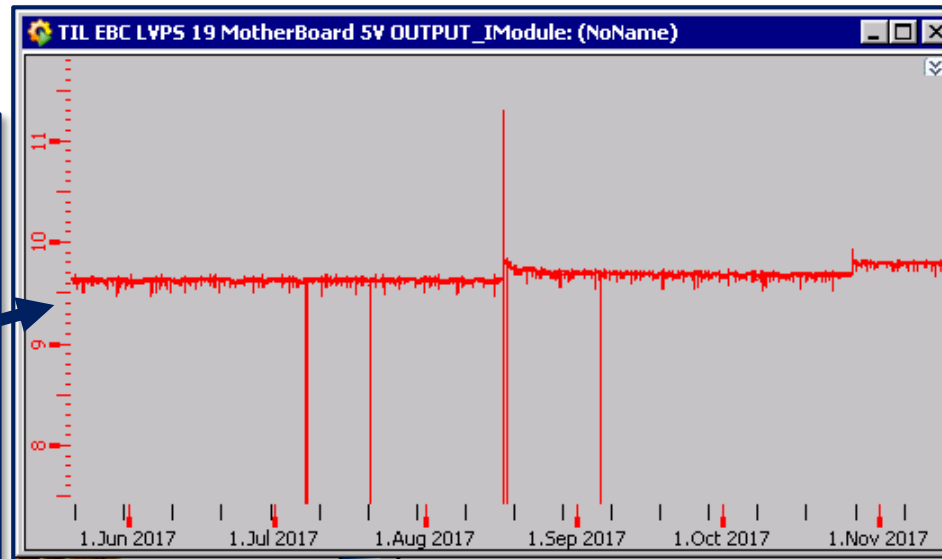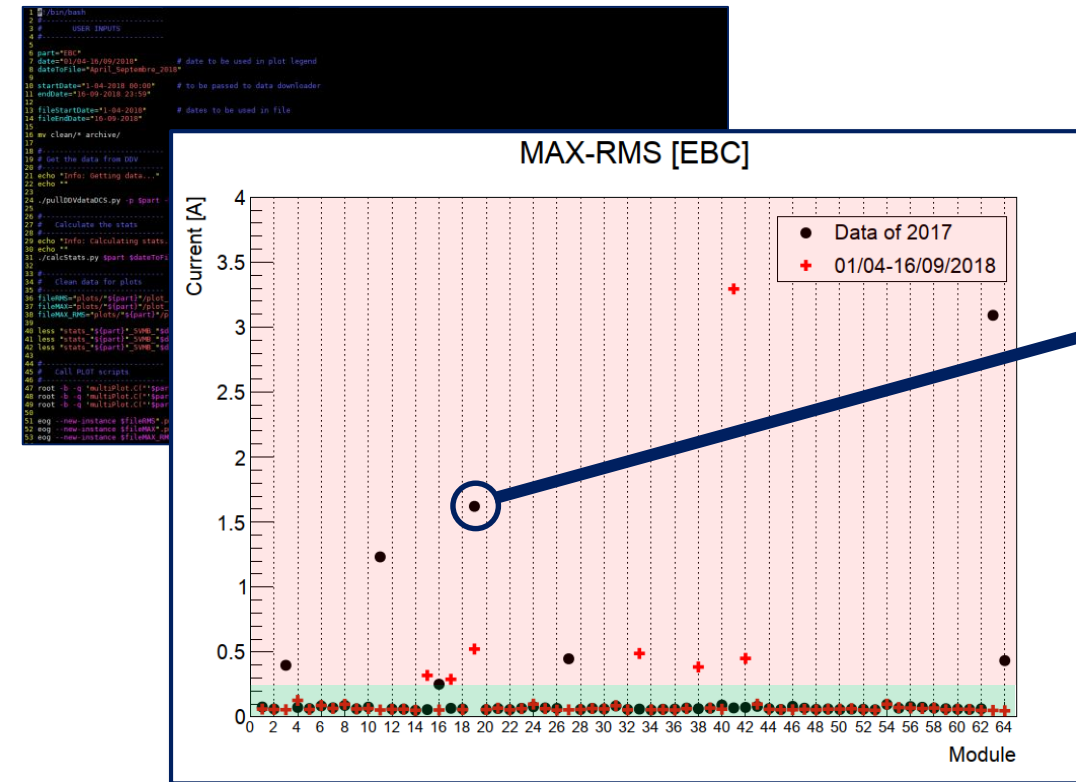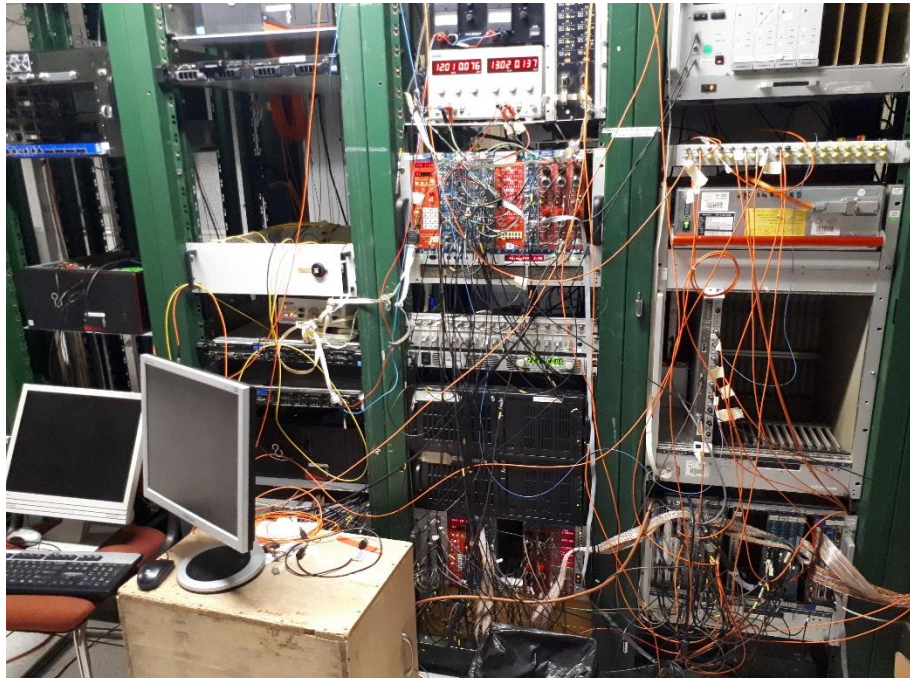
We report to calibration experts (crosscheck)
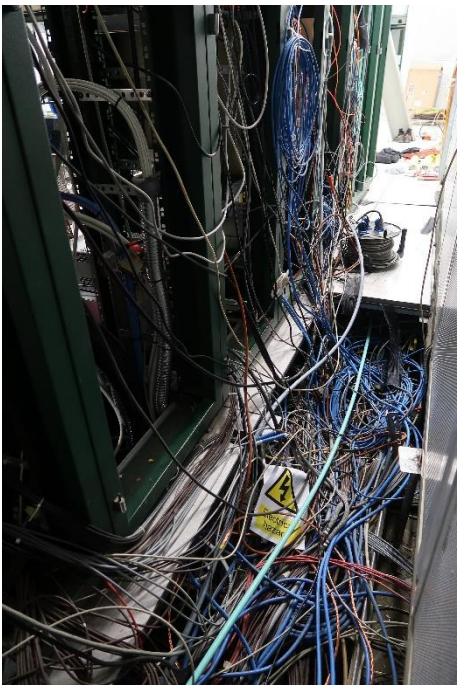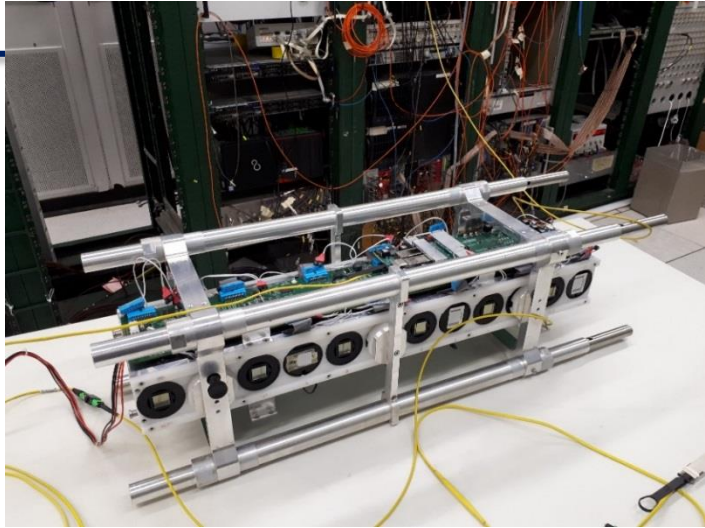If Bad→ Flag for maintenance

After maintenance…

Testbeam & Upgrade Activities (1/2)
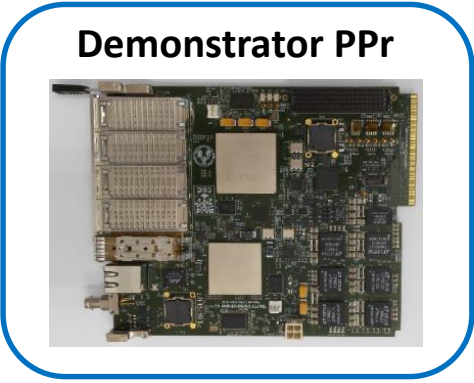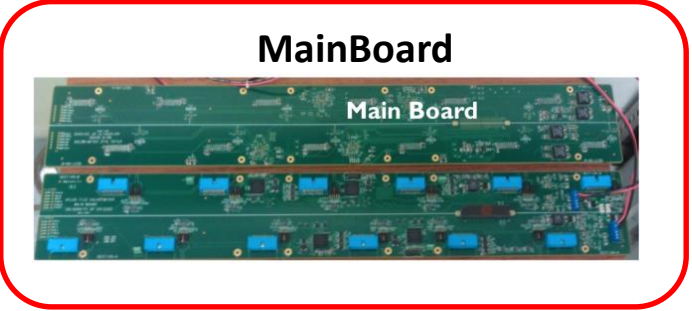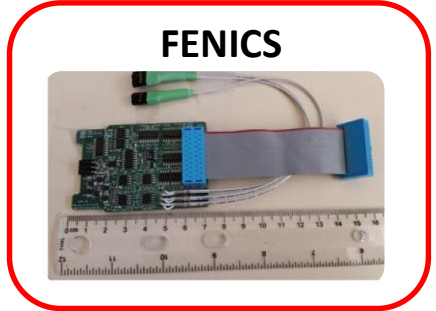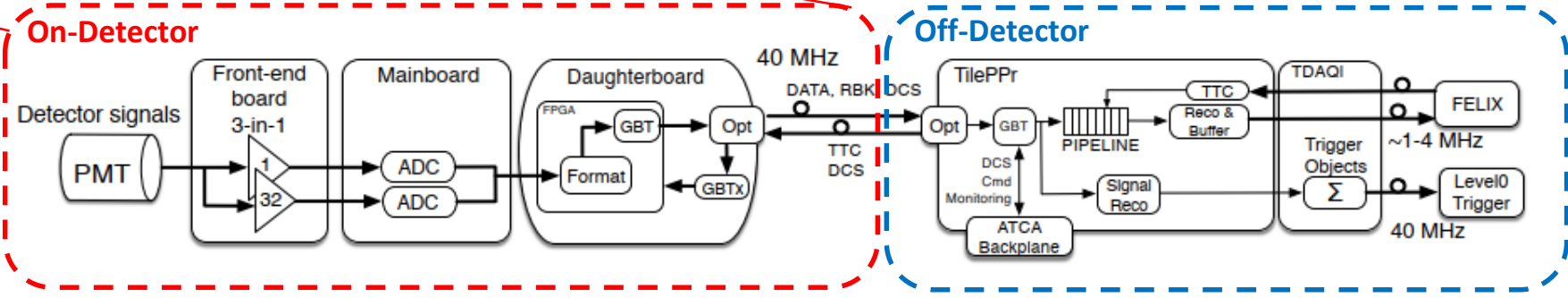

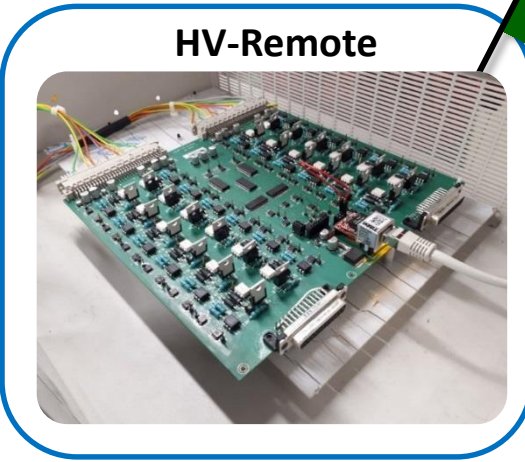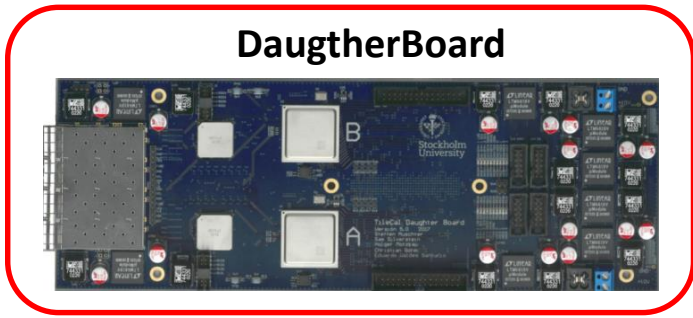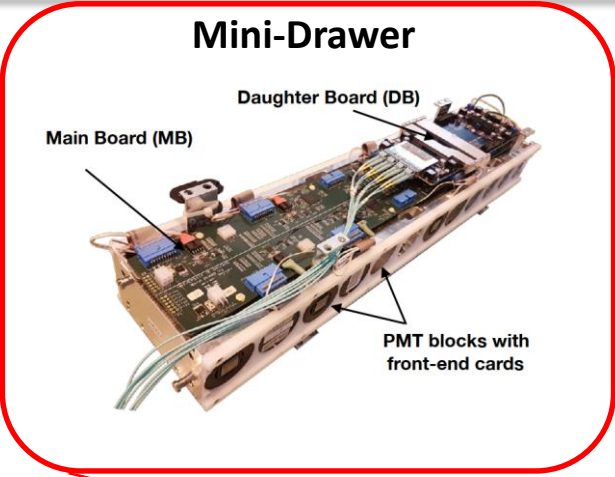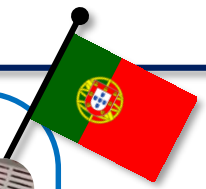**What do we do at Testbeams? ... and why?**

"There are <u>known knowns</u>. These are things <u>we know that we know.</u>
There are <u>known unknowns</u>. That is to say, there are things that <u>we know we don't know</u>.
But there are also <u>unknown unknowns</u>. There are things <u>we don't know we don't know</u>."
-Donald Rumsfeld

Objective → Validate TileCal electronics for Phase-II Upgrade

Testbeam & Upgrade Activities (2/2)

Mini-Drawer

DaugtherBoard

HV-Remote

On-Detector / Off-Detector block diagram

TDAQi

FENICS

MainBoard

Demonstrator PPr

Training & Other opportunities

Formal training

- JCOP Framework and WinCC-OA

- JCOP Finite State Machines

- International School of Trigger and Data Acquisition
  (ISOTDAQ18)

- C++ Part 1: Hands-On Introduction

- First Aider

- Self-Rescue Mask

Other learnings

- LabVIEW workshop

- Summer Student Lectures

- Academic Lectures

- CERN Computer Security (CERN WhiteHats)

ISOTDAQ18 Vienna, Austria

TileCal Week Tbilisi, Georgia

Acknowledgements

Thank you FCT for the trainee opportunity!

- Henric Wilkens

- Filipe Martins & LIP colleagues

- TileCal colleagues

- Jennifer Dembski

- Portuguese community @ CERN

- University Professors

- Friends

- Family

Thank you all for this experience!

"As we express our gratitude, we must never forget that the highest appreciation is not to utter words, but to live by them."
—John F. Kennedy

Thank you for your attention!

Questions?