Simulation and Debug

The Vertical Slice experience

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Why a simulation?

To provide feedback:

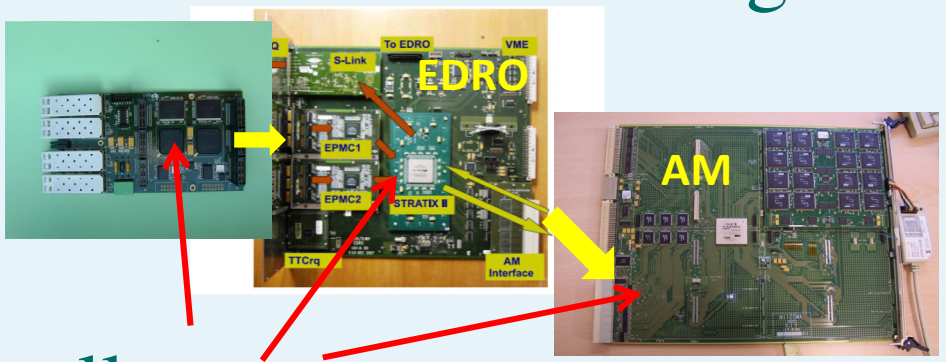
- During the development of boards
- During the development of firmware
- Assembling the boards
- To determine the characteristics of the system:
  - Efficiency
  - Purity

Structure (now) for the VS

C++ program, ROOT analysis tools.

Evolved together with the Vertical Slice:

- Data reading class
- FTK_IM mezzanine simulation: clustering
- EDRO simulation
- AM simulation



➔ **Compare results** at all steps

Validation of VS online simulation

- Debugged "VS online simulation" versus FTKSim
- Difference traced to **different format**
- Imported "bystream decoder" for SCT into FTK online simulation
- Differences found and corrected in **VS online simulation**
  - Inversion of strip number for SCT side = 1
  - Renumbering of link number

What we obtain

The HW and the simulation are compared for:

- **Hits** after mezzanine data clusterization
- **Roads** from the AMBoard

We can read Simulated values (event per event) of:

- **Hits** after EDRO data conversion
- **Roads** from AM Simulation
  - ➔ These are useful if we have saved the spy-buffers with the corresponding info in the hardware

When has it been used?

- To test the **EDRO-AMB system**
  - Firmware
  - Communication
- To test the communication with the **FTK_IM**
- To test the **FTK_IM** firmware
- To test the **whole VS system**
- To better understand the **necessary setup**

Tests

- Offline Tests of components
- Offline tests of full VS
- Online Tests without data
- Tests with real data:
  - Period January – February 2013
  - P-Pb collisions at 8 TeV and p-p collisions at 2.76 TeV
  - focusing on run 219171 p-p collisions at 2.76 TeV
  - Level 1 Rate ≈ 30 kHz

The EDRO-AMB System

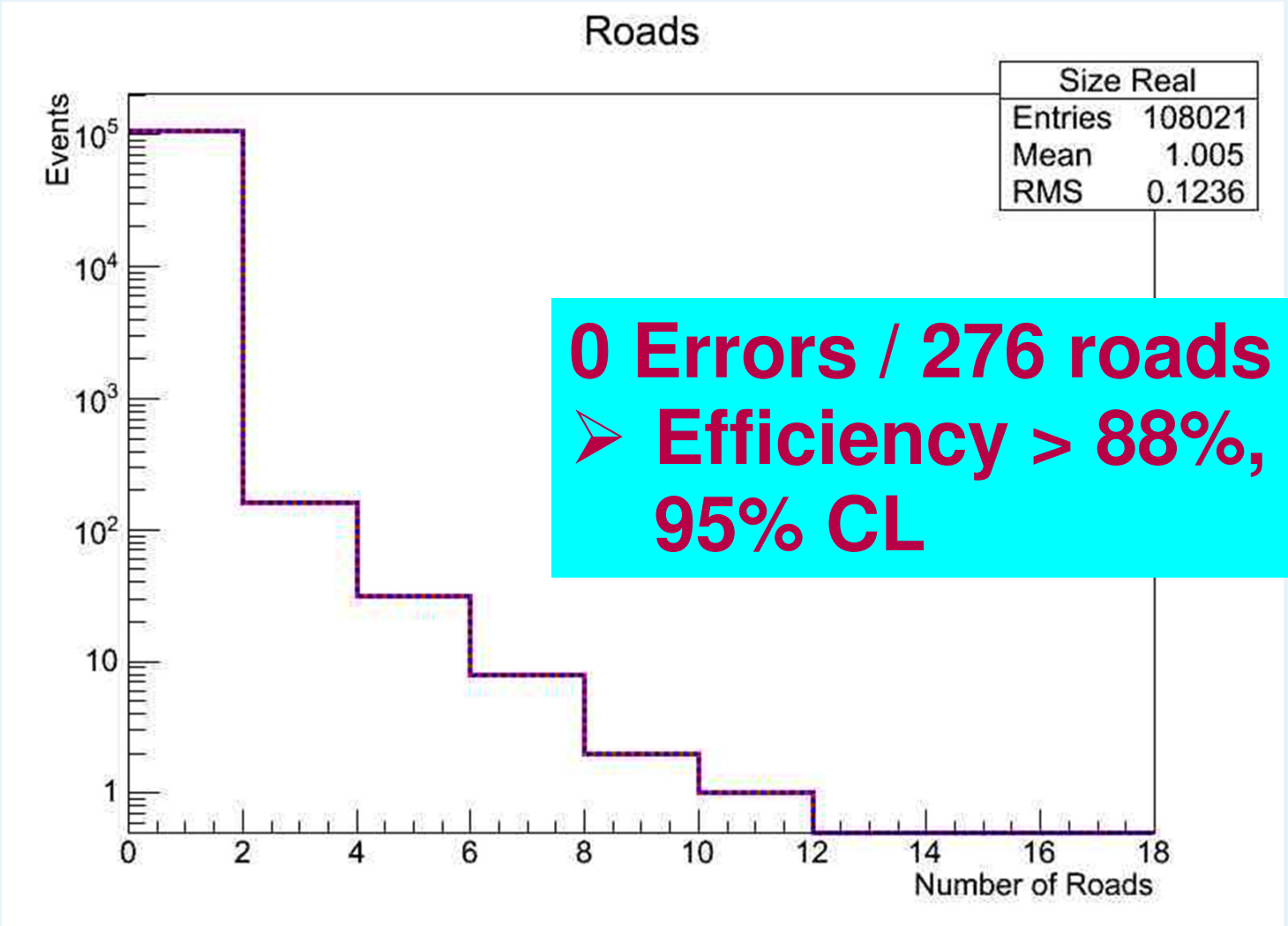
We have tested the system from the arrival of the hits in the EDRO board to the road firing.

DEFINITIONS

- **Efficiency** = Correct fired roads / expected roads
- **Purity** = Correct fired roads / total fired roads

Expected and **correct** means "**predicted by simulation**"

Analyzing data from this part Sim vs real VS



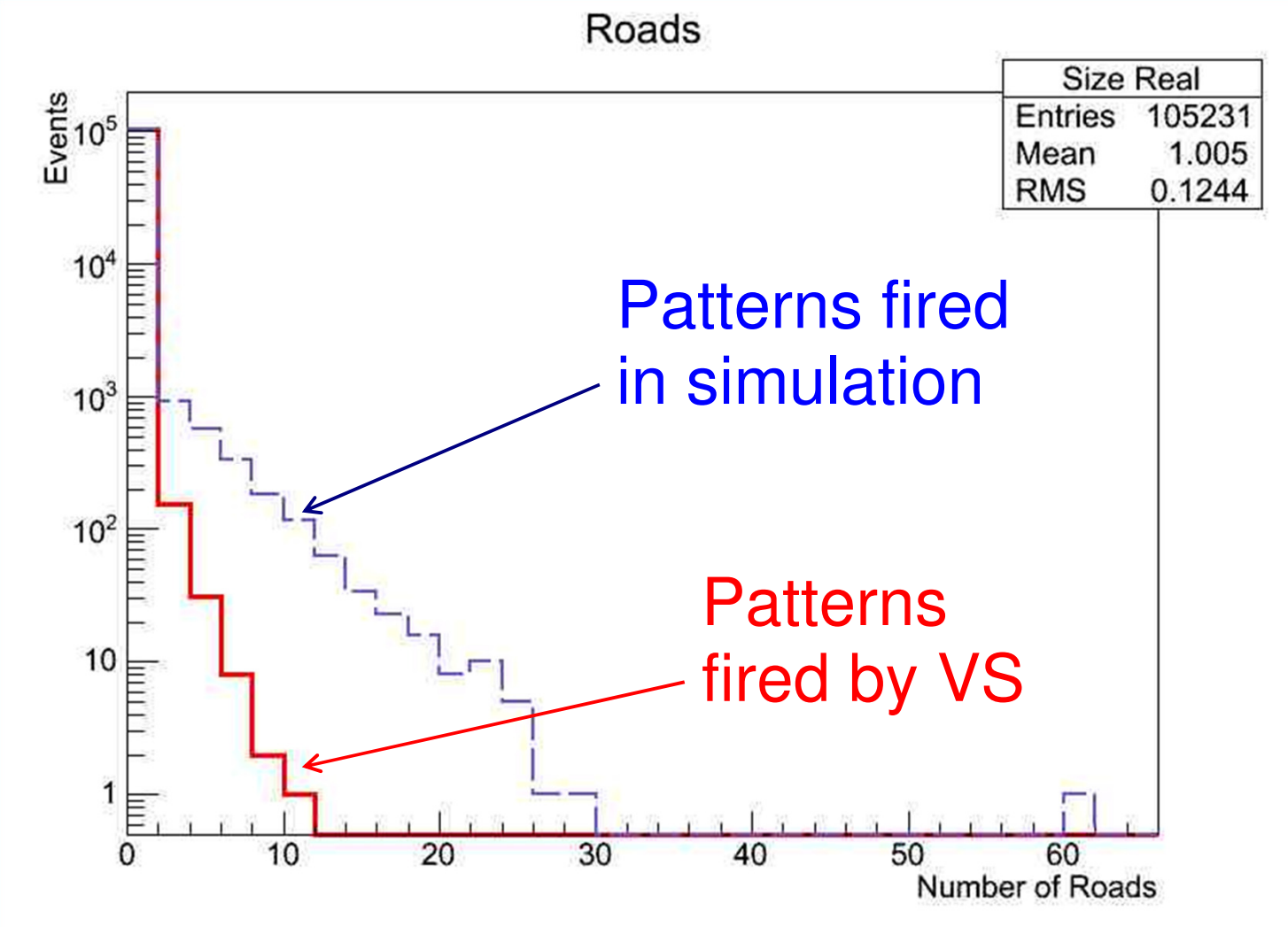
0 Errors / 276 roads

- **Efficiency > 88%, at 95% CL**

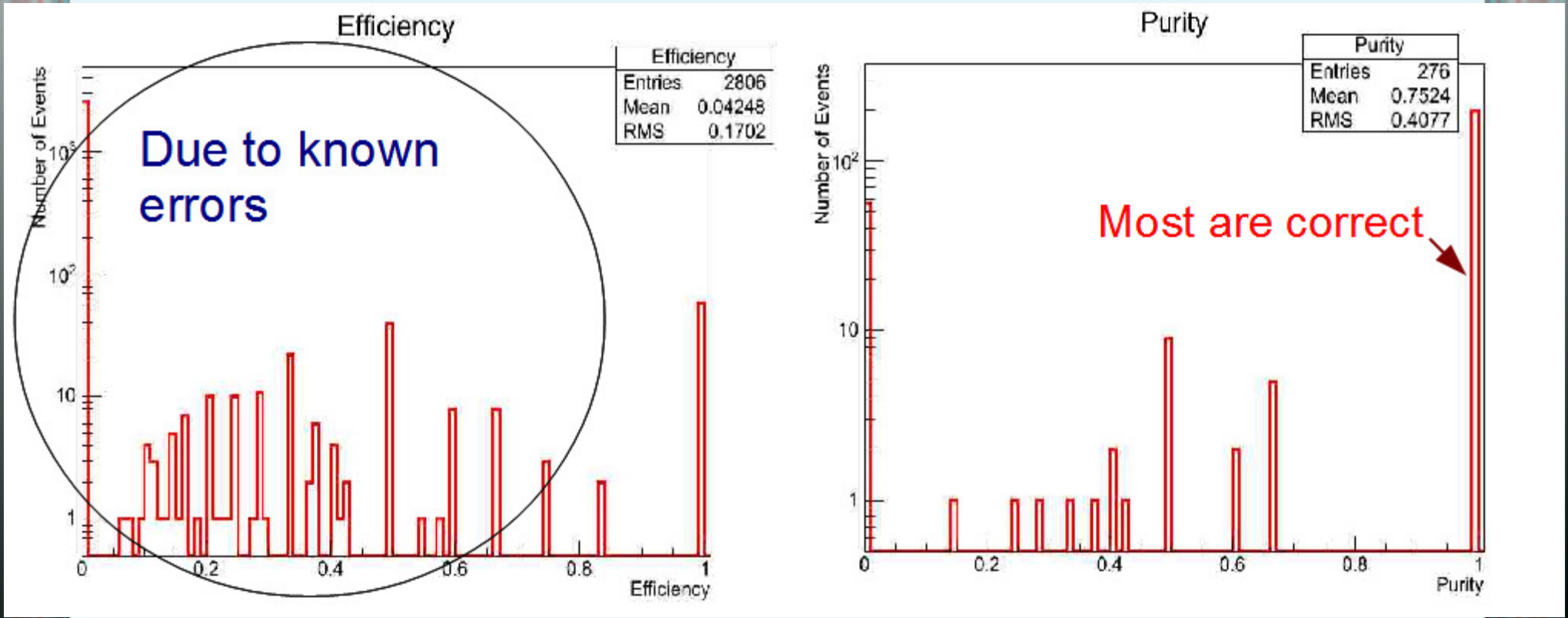
Issues Discovered in FTK_IM

- **Wrong** interpretation of the hit values in different layers
- Mezzanine Firmware production of **wrong** Module ID
- Hit **duplicated** in mezzanine
- We **should have solved** these issues, however we had **no time to do it** before shutdown

What we observed: many roads are lost by the VS



Efficiency and Purity

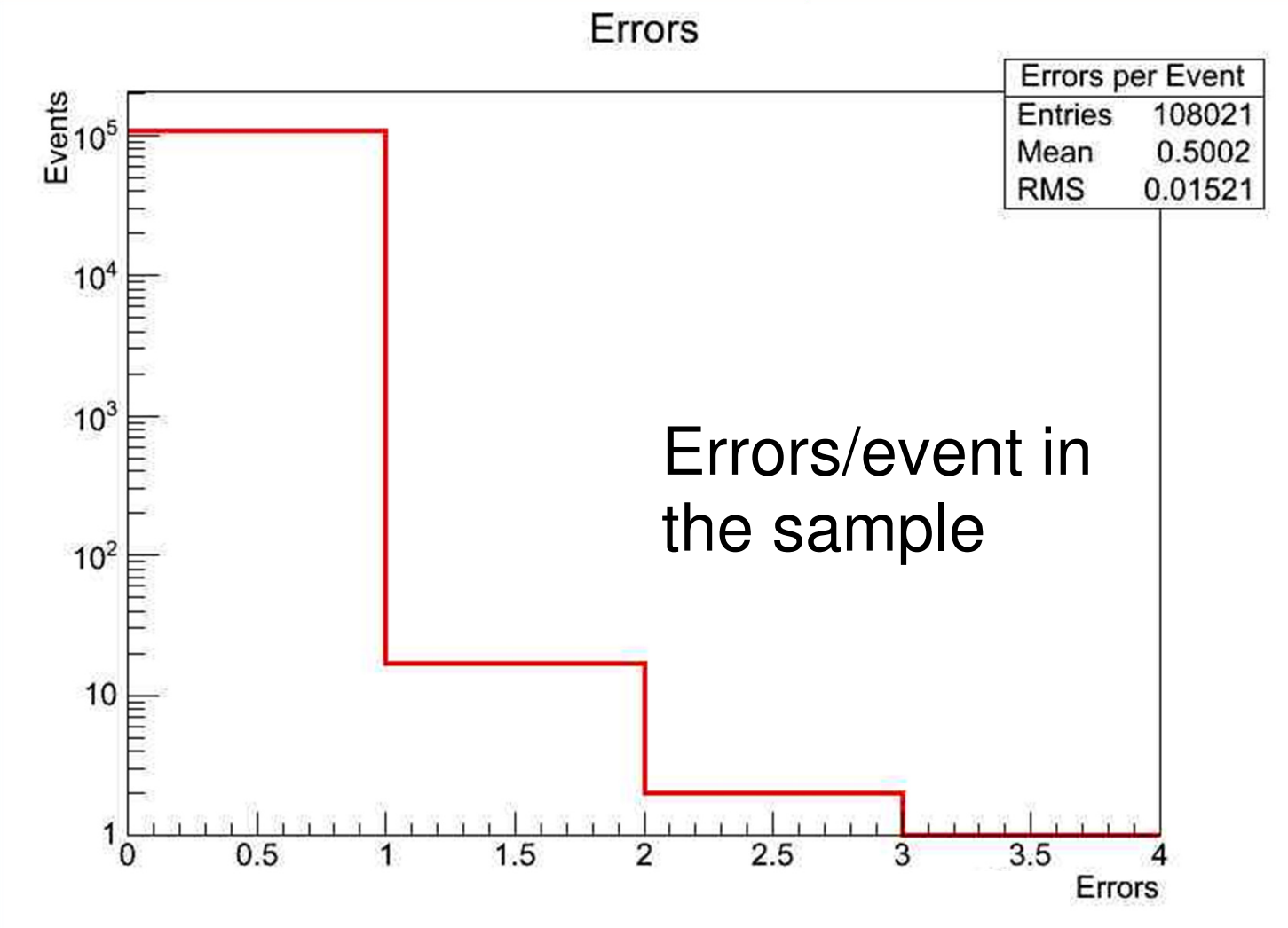


Both should go to 1 when correcting for known errors

Dataflow problems also…

- Rare **data-flow problems** for roads
  - Wrong end-words
  - Missing end-words
  - Very rare missing FTK fragments
- **Data-flow stops** (unclear origin)
  - At warm start
  - After long periods of data-taking

Data-flow error rate (much lower)



Conclusions

- Validated **VS Simulation** using **FTKSim**
- Used it to test the VS and its components from development to integration in ATLAS
- Found several **issues** and the **sources** of some
- Provided **efficiency** and **purity** of the components and the whole VS system
- **TODO**: fix data-manipulation issues, investigate data-flow issues