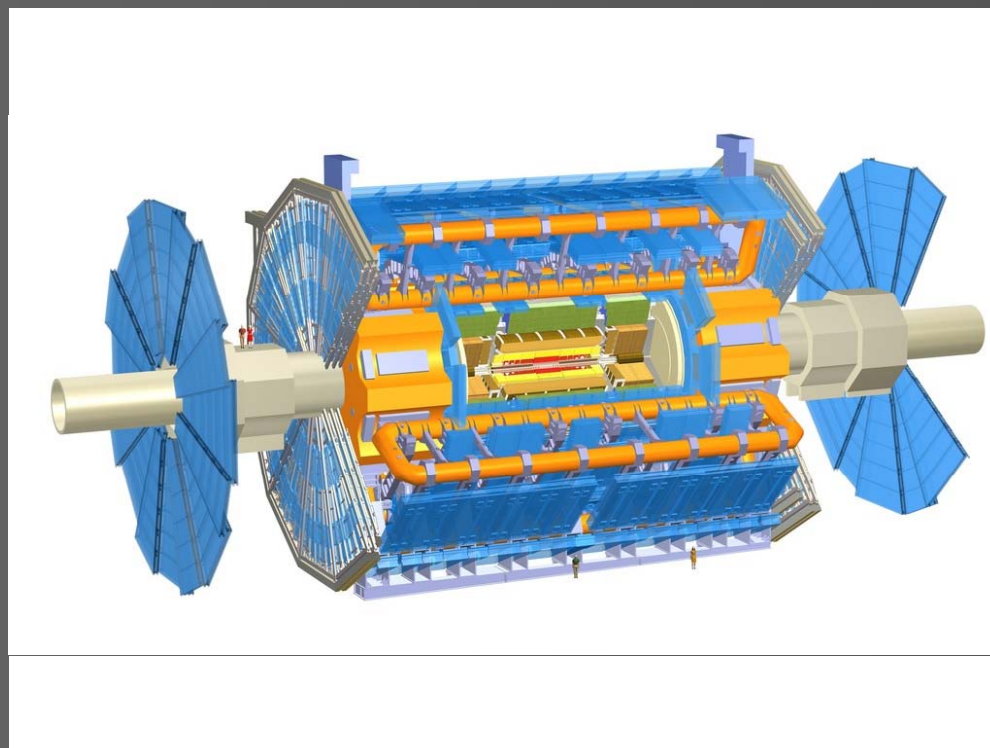


# ATLAS Commissioning: Liquid Argon Calorimeter Calibrations



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# Why Calibrate and Commission?

## ■ Some Philosophy of Science

- Science explains how phenomena relate to other phenomena, not how phenomena relate to the observer. (Bernard Lonergan)
- Thus, scientific equipment must be calibrated to known phenomena

## ■ Commissioning

- A bit like knowing what sounds your car should make
- ATLAS is still trying to figure out those sounds



# ATLAS

- General Purpose Detector in LHC
  - Made to measure the energy and tracks of many different types of particles
- Components
  - **Inner Detectors** (Pixel Detector, Semi Conductor Tracker, Transition Radiation Tracker)
  - **Calorimeters** (EM=Liquid Argon, Hadron=Scintillating Tile)
  - **Muon Spectrometer**
  - **Magnet System** (Solenoid, Toroidal)

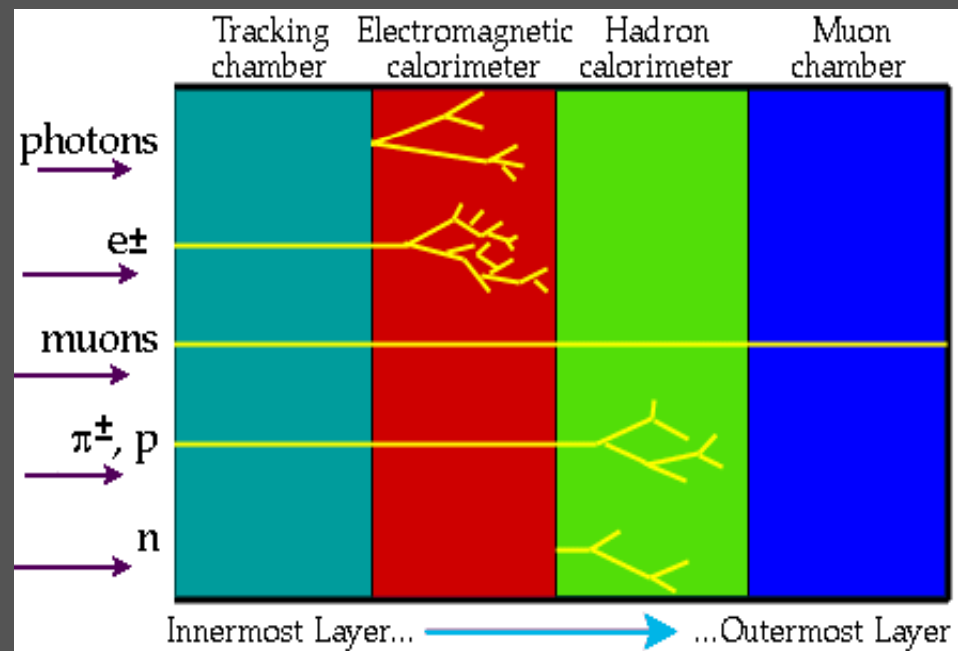
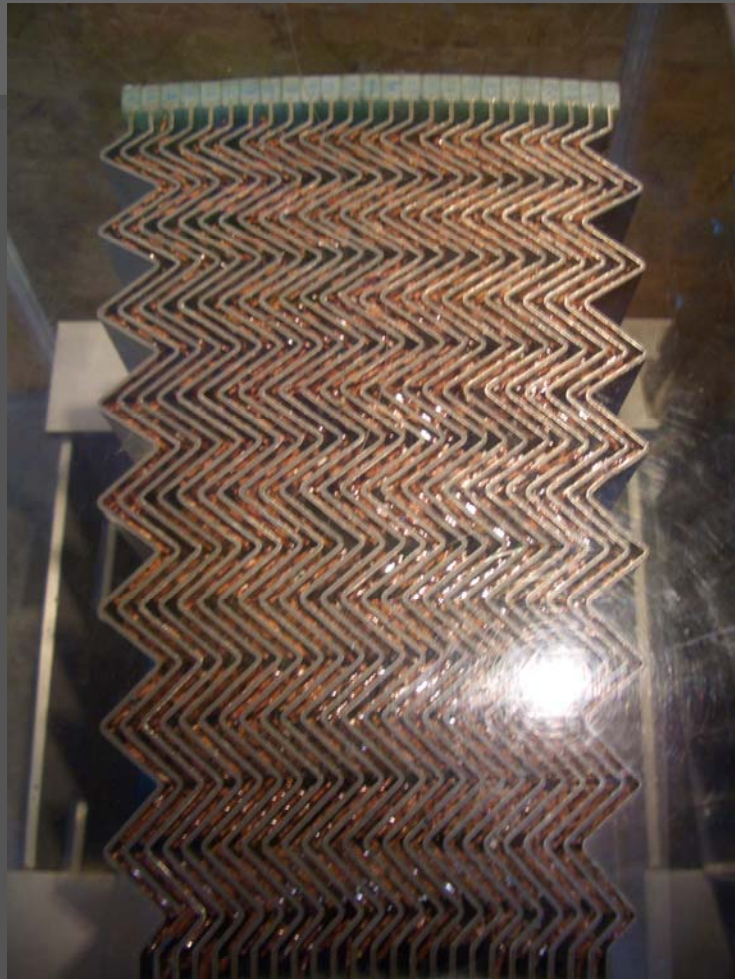


Image from Richard Teuscher

# Liquid Argon Calorimeter



Taken on my journey to see ATLAS

- Lead initializes the particle shower
- Particles Ionize Argon
- Charge is collected on plates → electrical signal
- Total charge and EM shower depth is proportional to energy of incident particle

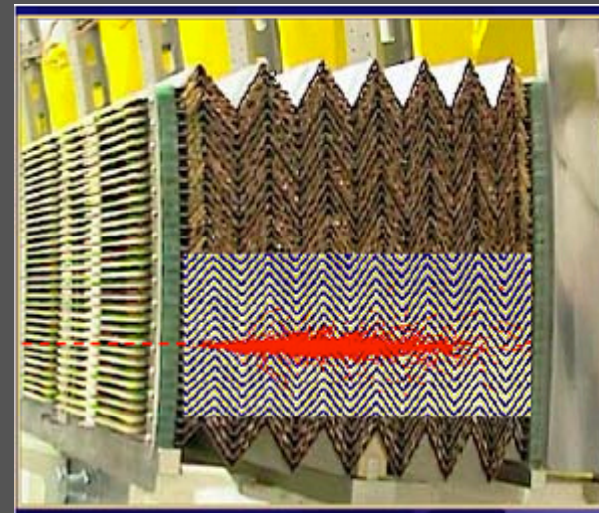
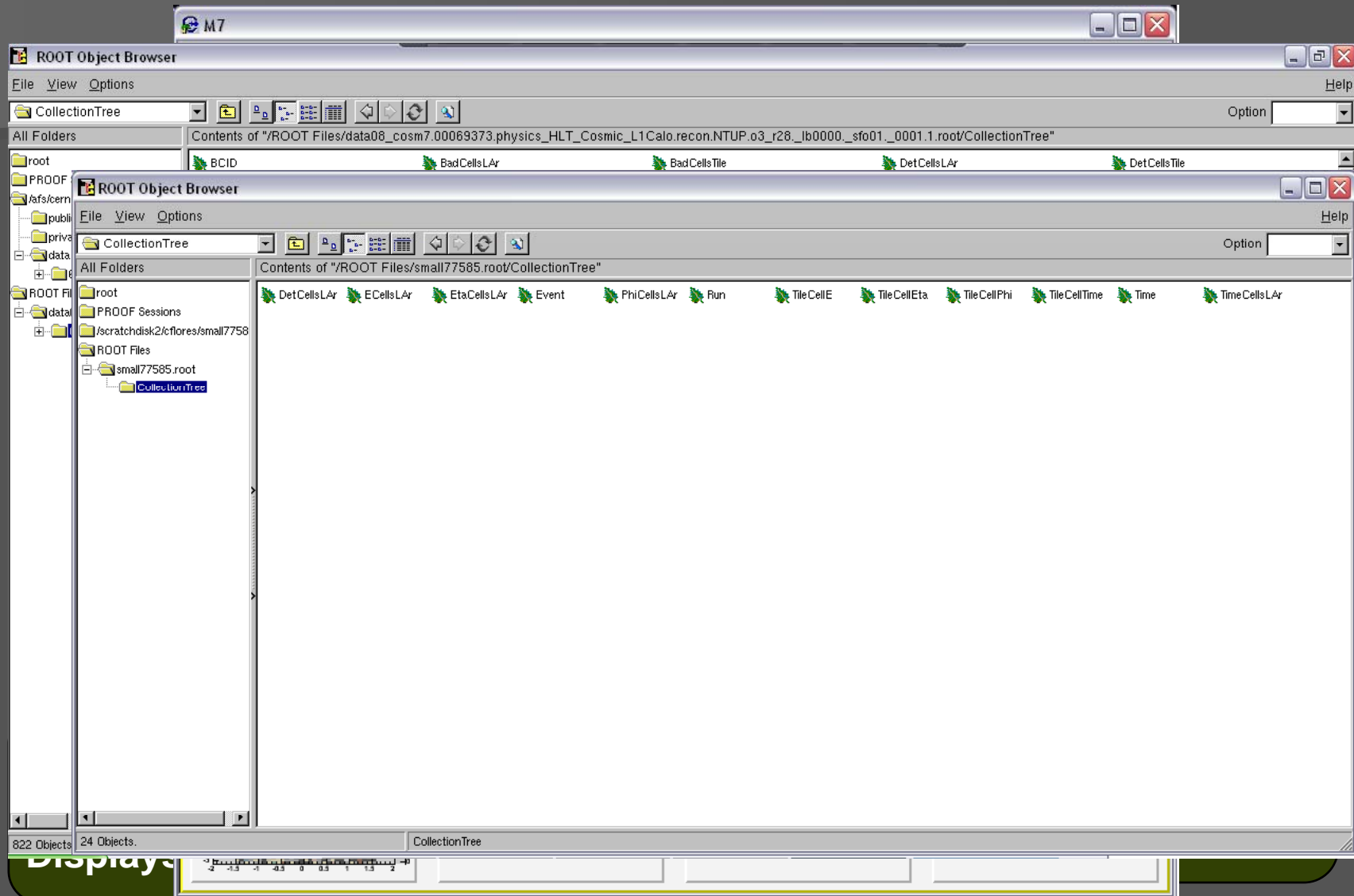


Image from Richard Teuscher

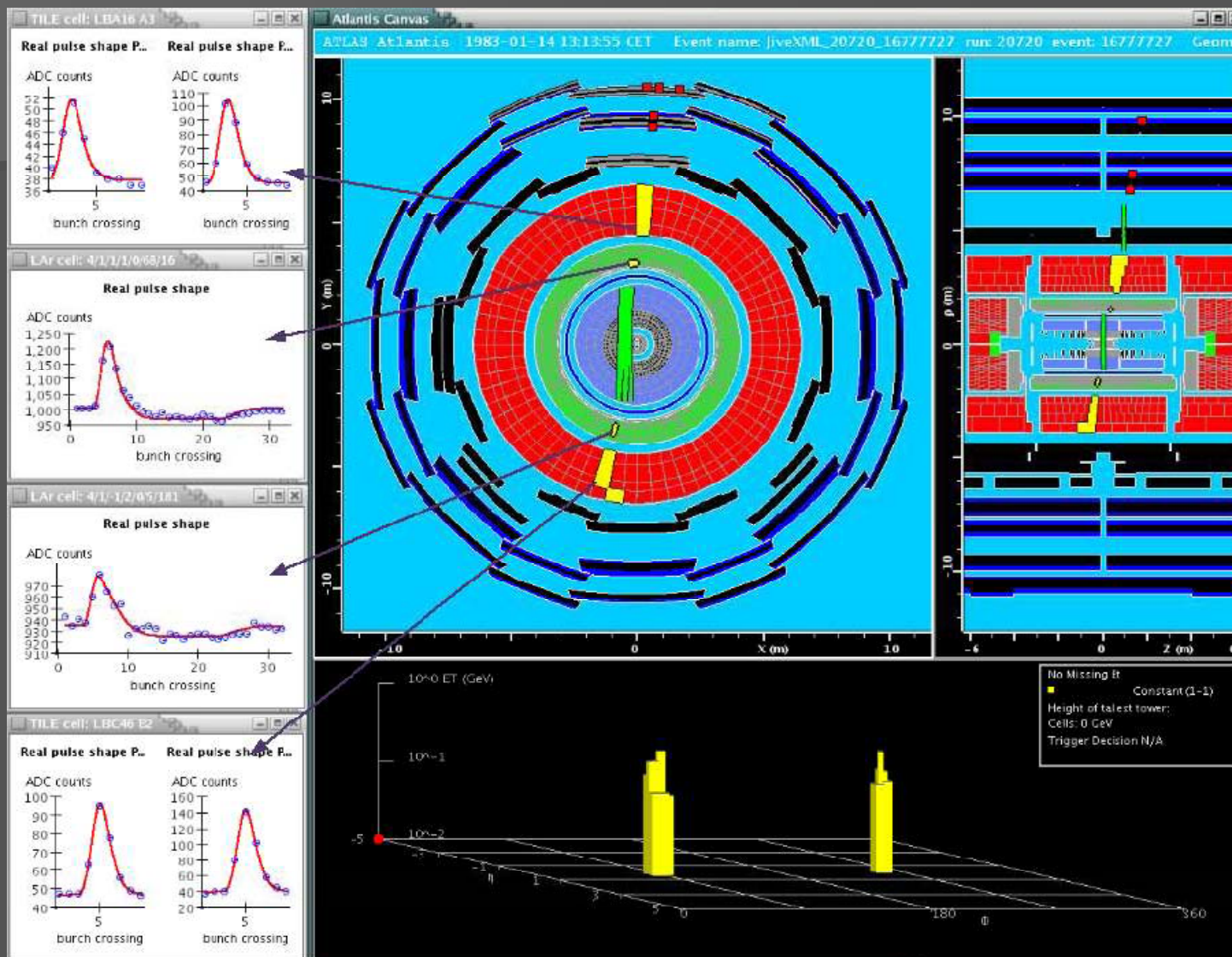
# From Collision to Science



on

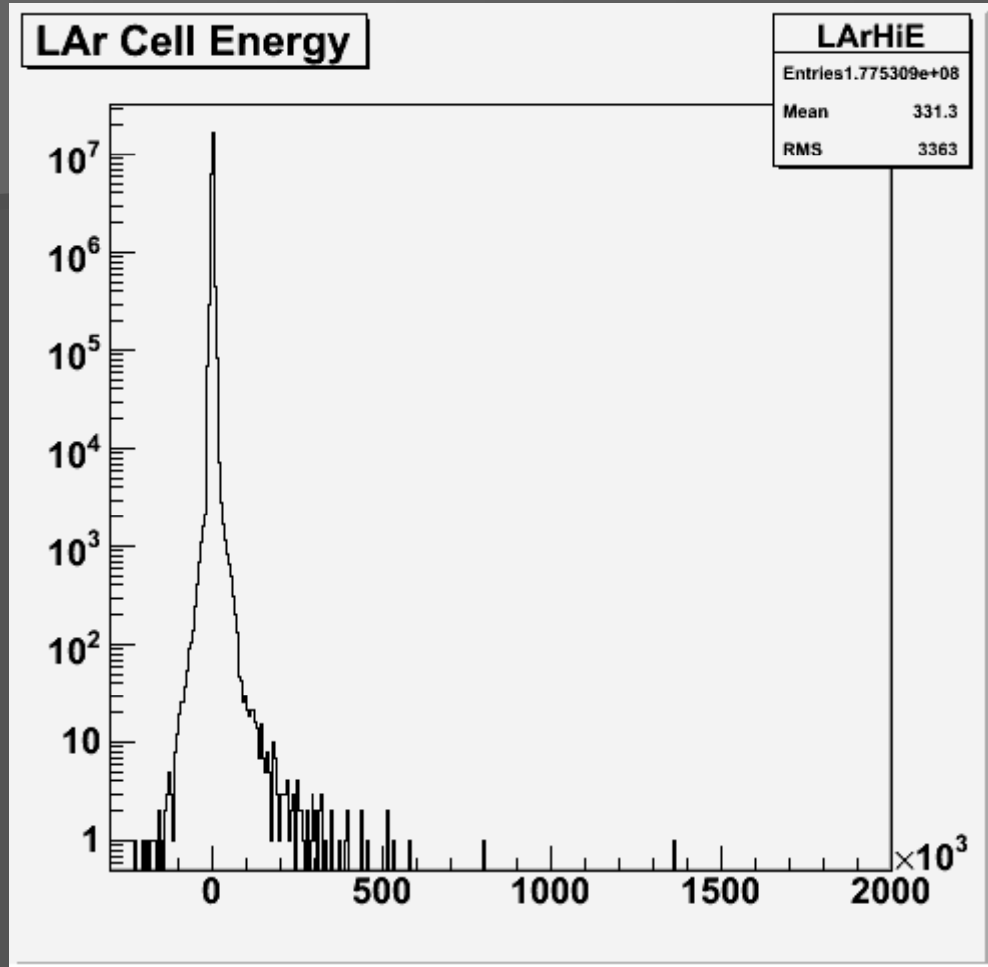
Displays

# Expected Results



Latest M4 Cosmic Runs, Bin Guo, Univ. Toronto

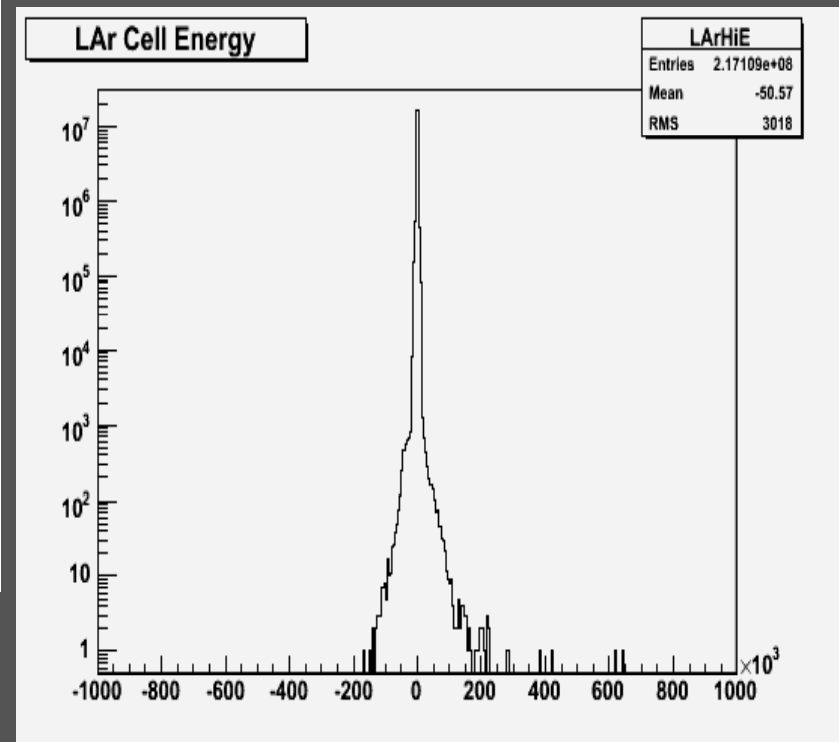
# My Results



Run 70237:

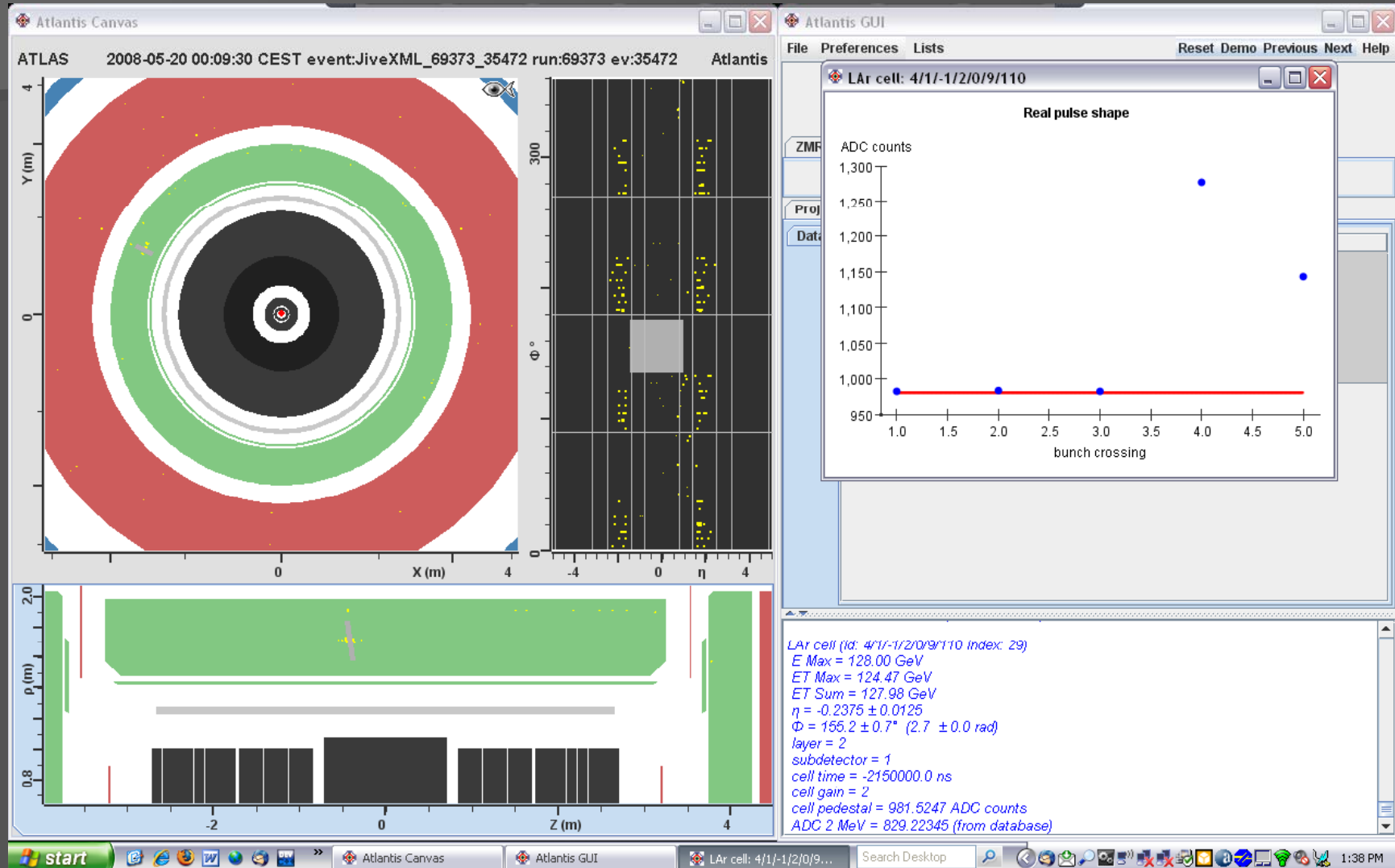
x=cell energy (GeV), y=Ncells

Run 69373:  
x=cell energy (GeV), y=Ncells



# Run 69373, Event 35472

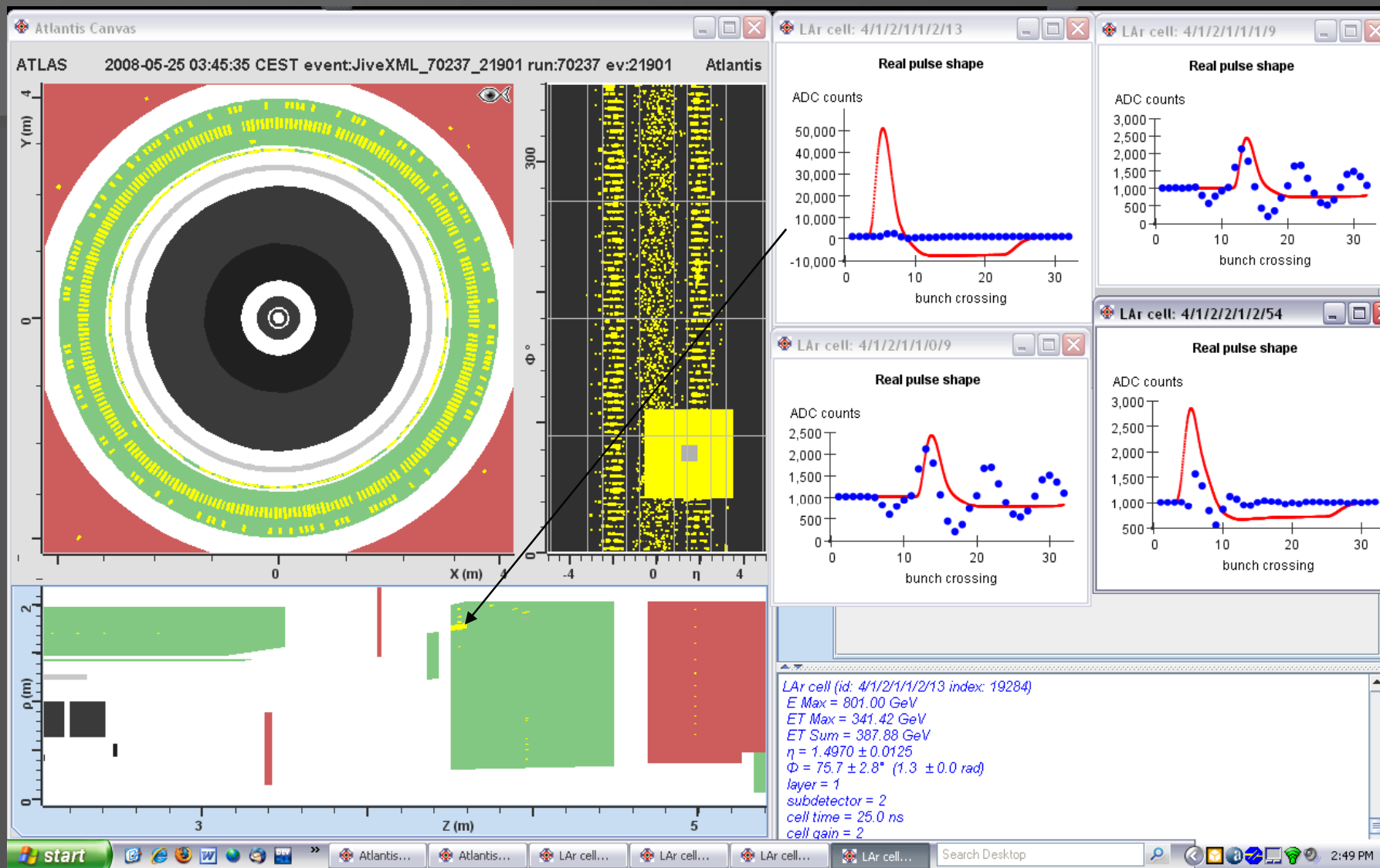
Athena V. 14.0.10.9, COMCOND-005-02





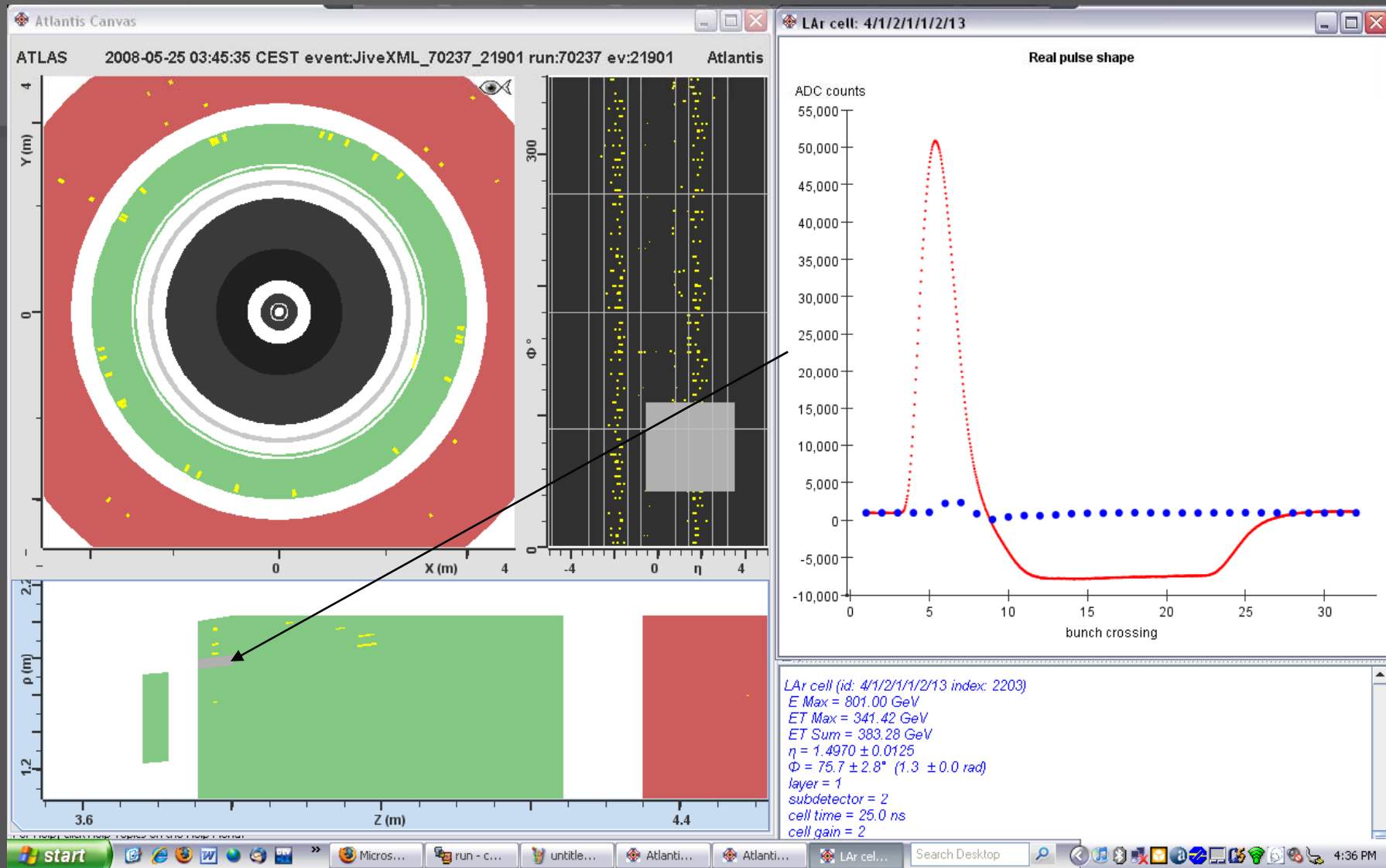
# Run 70237, Event 21901 Evolution: 1st

Athena V. 14.0.10.9, COMCOND-004-01



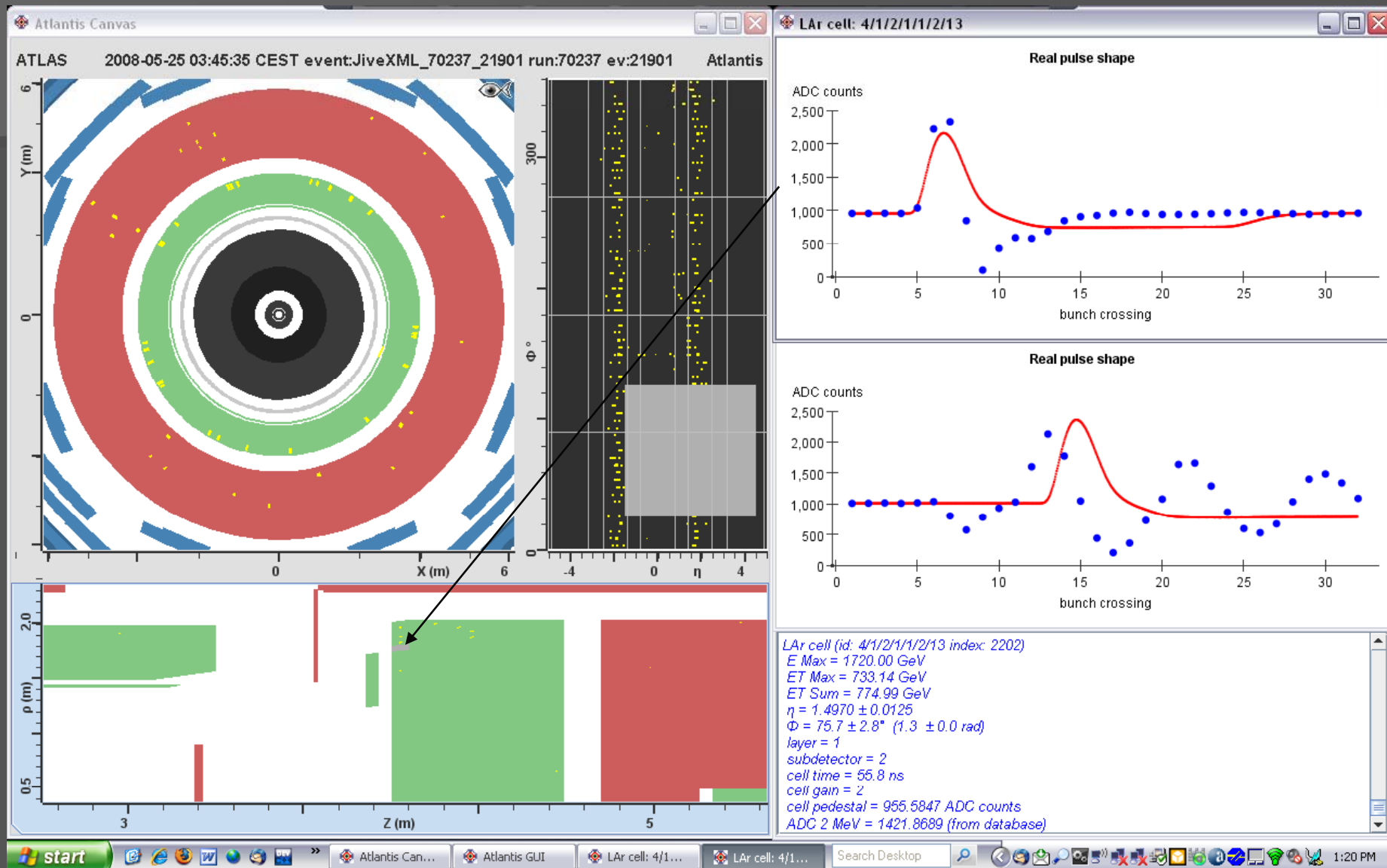
# Run 70237, Event 21901 Evolution: 2nd

Athena V. 14.0.10.9, COMCOND-004-01



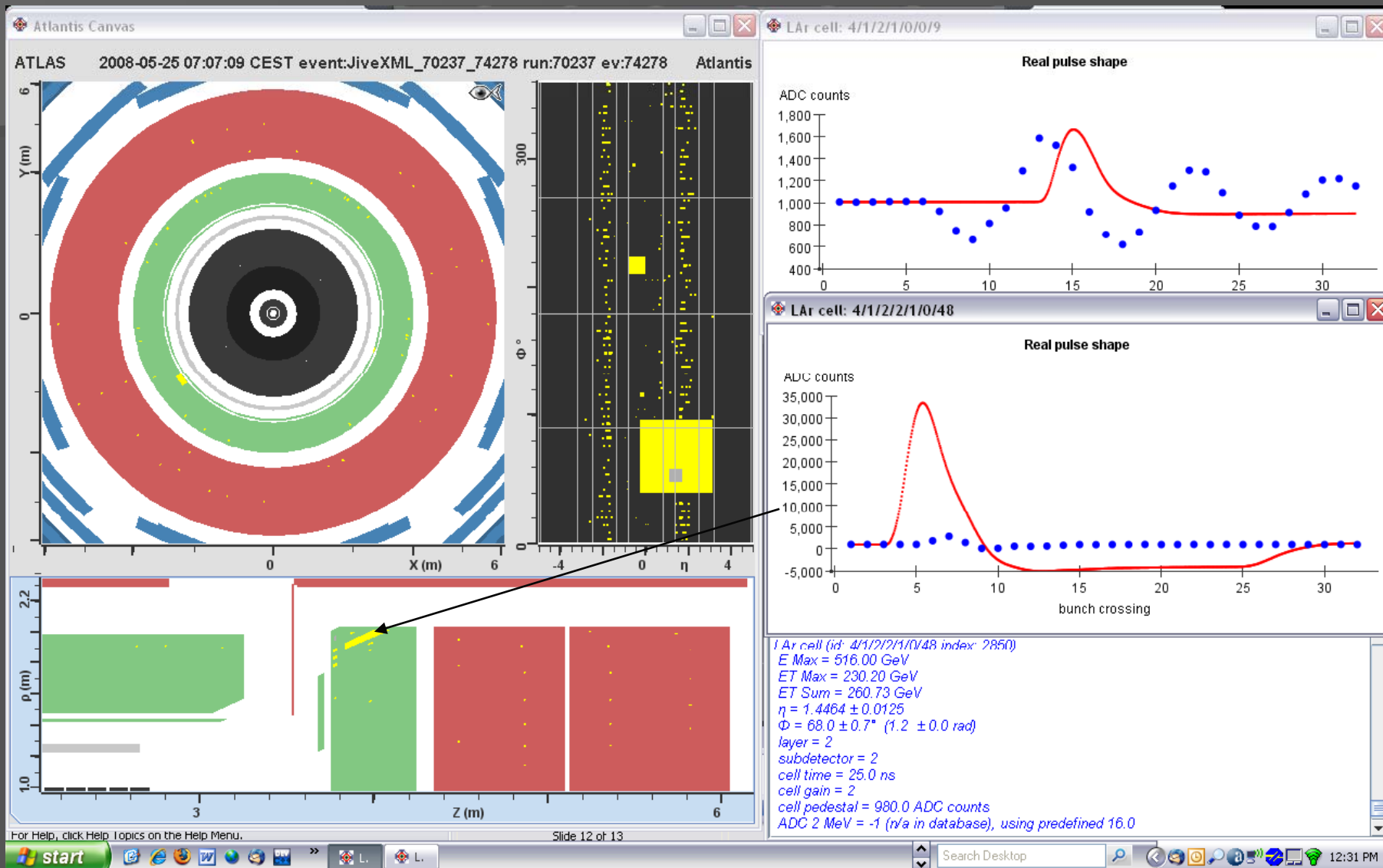
# Run 70237, Event 21901 Evolution: 3rd

Athena V. 14.1.0.4, COMCOND-005-02



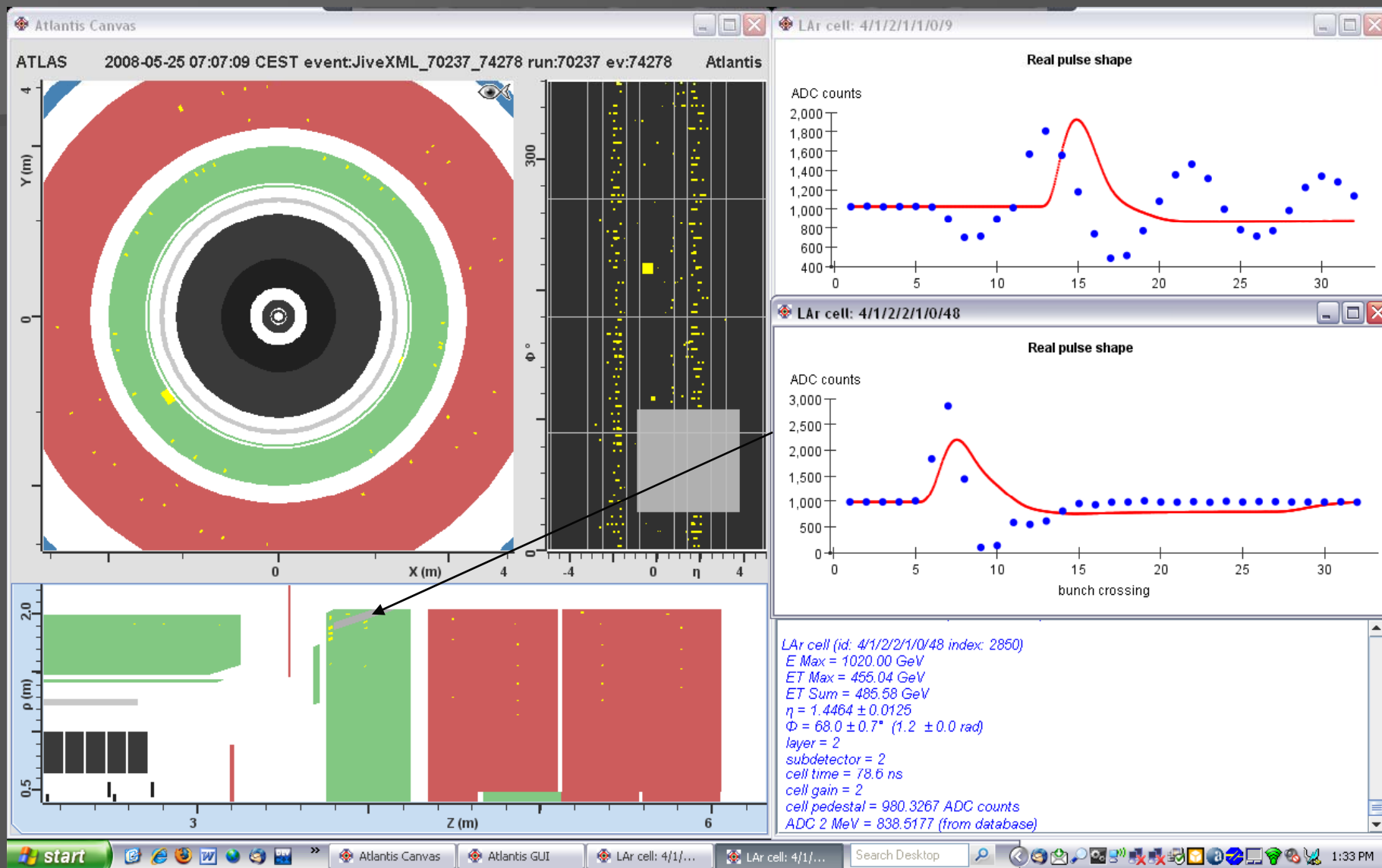
# Run 70237, Event 24278 Evolution: 1st

Athena V. 14.0.10.9, COMCOND-004-01



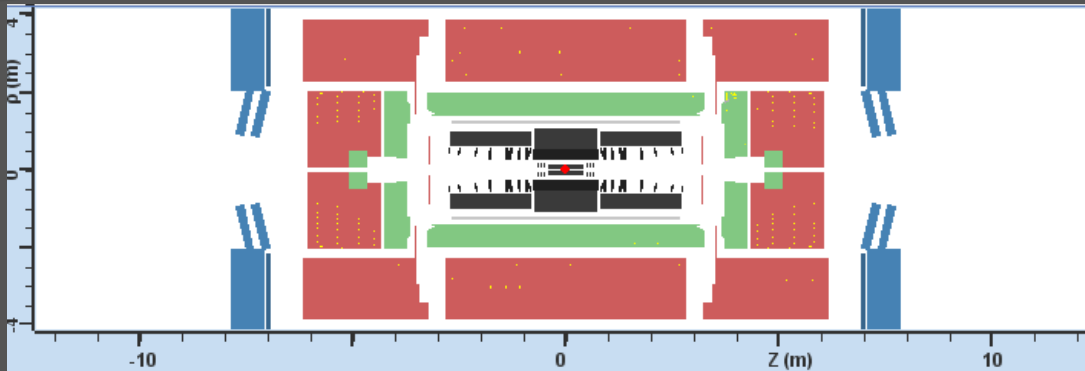
# Run 70237, Event 24278 Evolution: 2nd

Athena V. 14.1.0.4, COMCOND-005-02



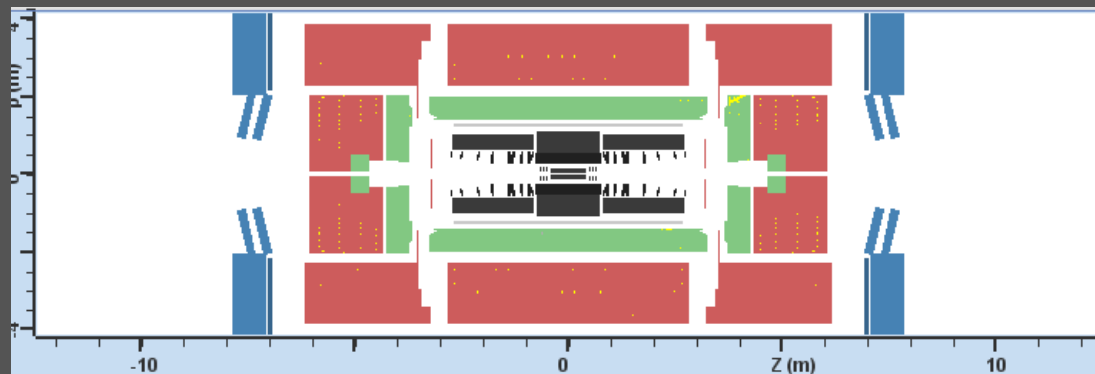
# What are They?

- Cosmic Muons?



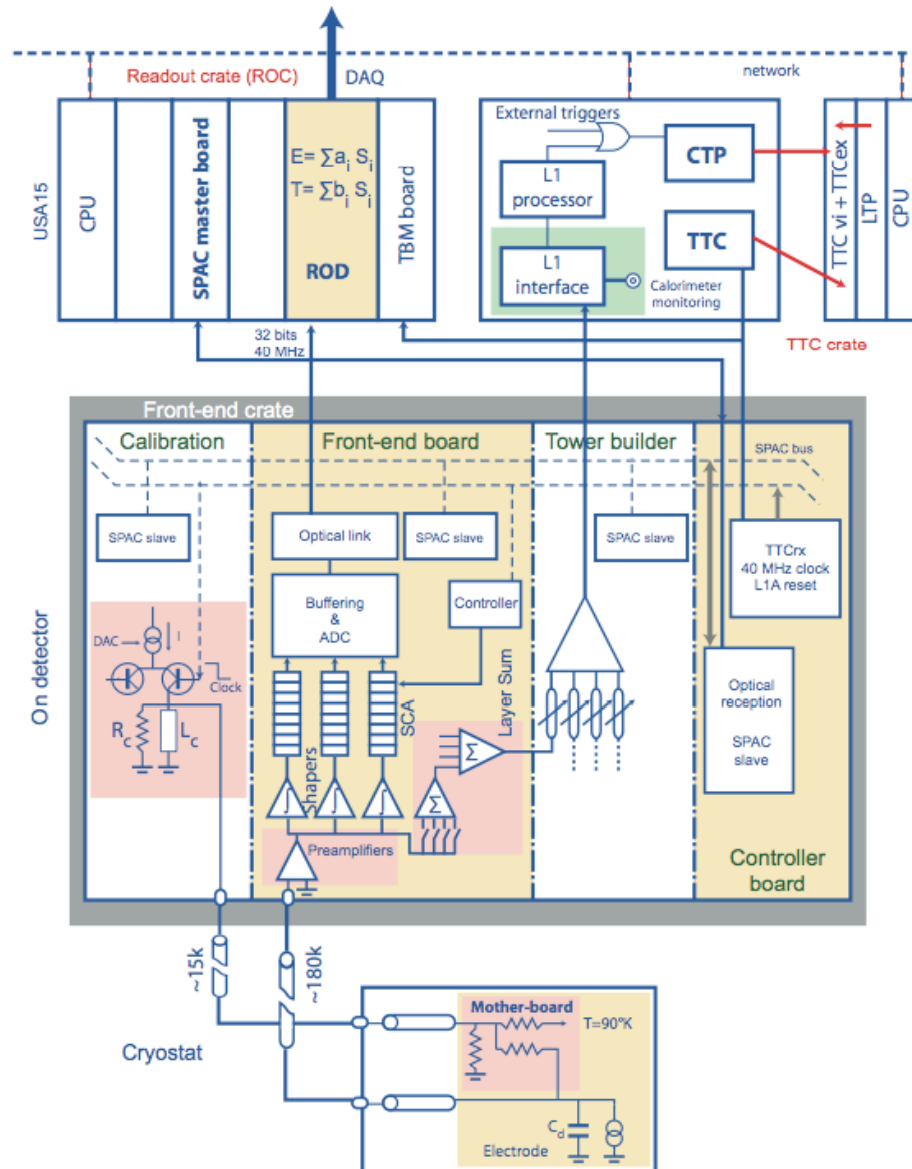
Run: 70237  
Event: 21901

Run: 70237  
Event: 24278



- Not likely since there are no corresponding active cells on the other side of the calorimeter.

# What are They?



- Analysis Technique:
  - Is there a common denominator in the hardware?
  - Electronics?
    - Hot Channel?
  - Power Supply?

# What are They?

- Hardware Problems?

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	<b>High Energy Events in the Lar</b>												
2													
3	<b>Run</b>	<b>Event</b>	<b>E (GeV)</b>	<b>Atlantis ID</b>	<b>Identifier</b>	<b>FT/Slot/Ch</b>	<b>Eta</b>	<b>Phi</b>	<b>Neighboring Active Cells</b>				
4	69373	35472	128	4/1/-1/2/0/9/110	<a href="#">759181020</a>	2/12/29	-0.6	2.71	<a href="#">759174366</a>	<a href="#">759174362</a>	<a href="#">759174360</a>		
5	69373	47447	145	4/1/1/2/0/23/245	<a href="#">767569898</a>	30/12/93	0.58	-0.26	<a href="#">767569384</a>	<a href="#">767568876</a>	<a href="#">767568878</a>		
6	69373	67248	278	4/1/1/2/0/54/244	<a href="#">767585768</a>	30/14/56	1.36	-0.28	<a href="#">767585258</a>	<a href="#">767584748</a>	<a href="#">767584750</a>		
7	69373	70577	276	4/1/2/2/1/5/229	<a href="#">776211402</a>	2/11/25	1.56	-0.65	<a href="#">776211914</a>	<a href="#">776210888</a>	<a href="#">776210382</a>	<a href="#">778044362</a>	<a href="#">778043850</a>
8	70237	1182	238	4/1/2/2/1/1/55	<a href="#">776209006</a>	2/4/91	1.47	1.4	<a href="#">774112280</a>	<a href="#">774111768</a>	<a href="#">774111256</a>	<a href="#">775946346</a>	<a href="#">776209514</a>
9	70237	21901	1720	4/1/2/1/1/2/13	<a href="#">774112280</a>	2/2/87	1.49	1.32	<a href="#">774111762</a>	<a href="#">774111250</a>	<a href="#">773849106</a>	<a href="#">776209514</a>	<a href="#">776209002</a>
10	70237	61510	755	4/1/2/2/1/0/50	<a href="#">776208484</a>	2/4/70	1.44	1.24	<a href="#">773849106</a>	<a href="#">774111250</a>	<a href="#">774111762</a>	<a href="#">774112272</a>	<a href="#">775946340</a>
11	70237	74278	1020	4/1/2/2/1/0/48	<a href="#">776208480</a>	2/4/68	1.44	1.19	<a href="#">775946350</a>	<a href="#">776208992</a>	<a href="#">773849106</a>	<a href="#">774111250</a>	<a href="#">774111762</a>
12	70237	87111	342	4/1/2/2/1/0/50	<a href="#">776208484</a>	2/4/70	1.44	1.24	<a href="#">775946340</a>	<a href="#">776208996</a>	<a href="#">776209508</a>	<a href="#">773849114</a>	<a href="#">774111258</a>
13	70237	87131	246	4/1/2/2/0/0/55	<a href="#">775946350</a>	2/4/87	1.44	1.36	<a href="#">776208494</a>	<a href="#">776209006</a>	<a href="#">776209510</a>	<a href="#">774112280</a>	<a href="#">774111768</a>
14	70237	91964	306	4/1/-1/2/0/12/115	<a href="#">759175398</a>	1/11/12	-0.3	2.84	<a href="#">759175908</a>	<a href="#">759175906</a>	<a href="#">759175904</a>	<a href="#">759175400</a>	<a href="#">761269992</a>

- Much more likely. Note: Most events in 70237 occur in same Feed Through and Slot.



# Project Future

- Bin Guo, a Univ. Toronto graduate student will continue collecting high energy events from the LAr for further analysis.
- This will hopefully lead to an understanding of what is causing these events.

# Cultural Experiences

- Talking to other physics students from around the world
- Traveling to the various regions of Switzerland to experience the
  - Dining experience/food
  - Architecture
  - Languages

# Pictures!

Geneva



# Acknowledgements

- Richard Teuscher, Adam Gibson, and everyone from Univ. Toronto!
- Prof. Krisch, Campbell, Neal, Goldfarb (Univ. Michigan)
- Jeremy Herr (Univ. Michigan)
- Prof. Richard Cardenas, Olga Lobban, Gary Karshner (St. Mary's University)
- All of You!



Questions?