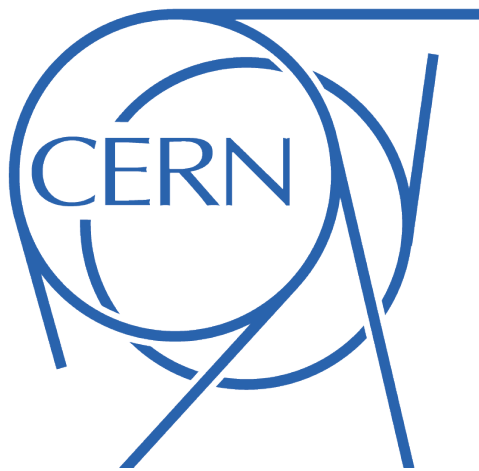


*University of Michigan
Summer 2010 REU at CERN*

Missing Transverse Energy and Jets in Proton-Proton Collision Events in the ATLAS Detector at CERN

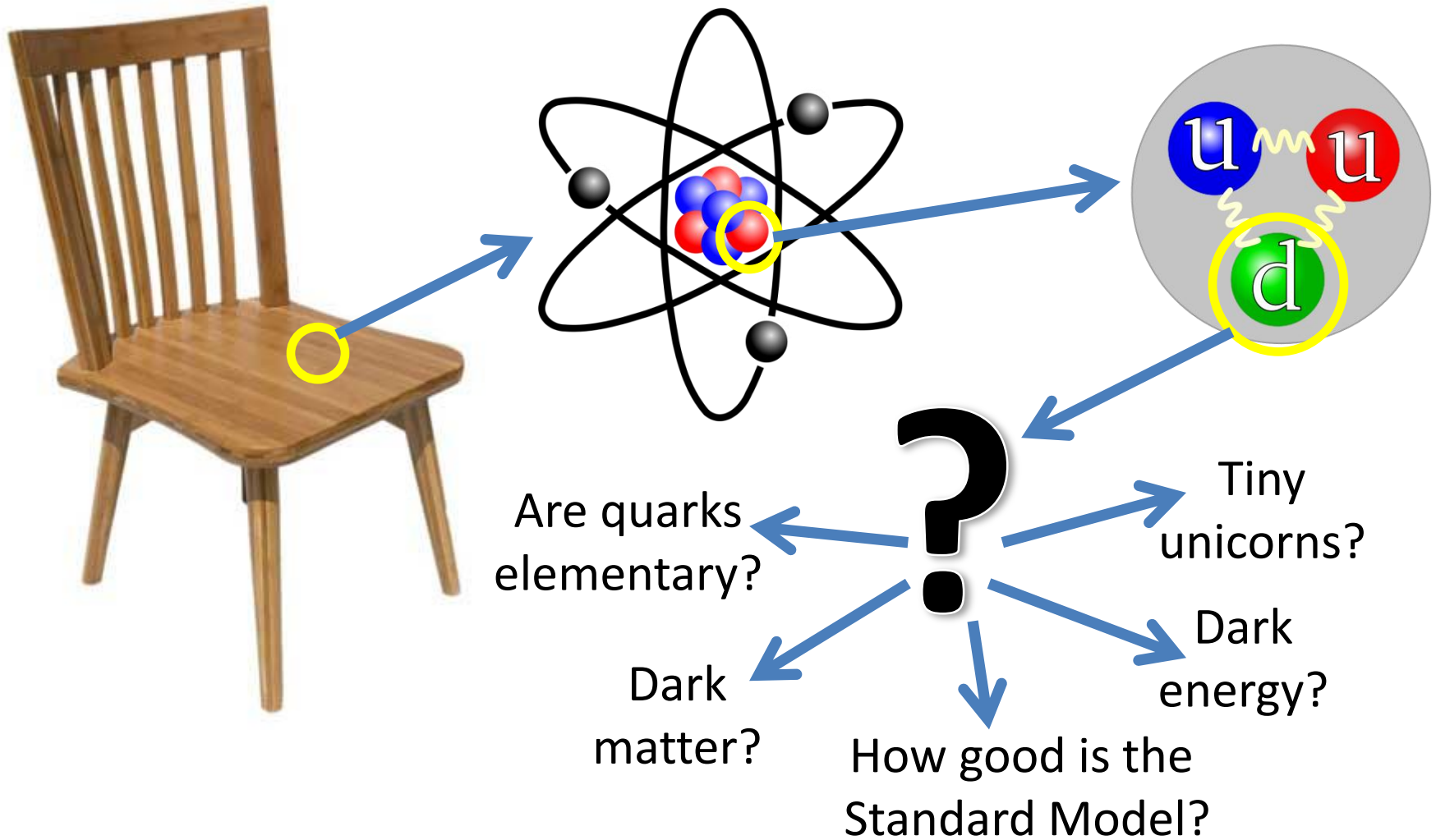


Judson Locke,
Florida Institute of Technology,
Melbourne, Florida, USA

Advisor: Richard Teuscher, Ph.D.,
University of Toronto,
Toronto, Ontario, Canada



Why Does CERN Exist?



The LHC is a microscope.

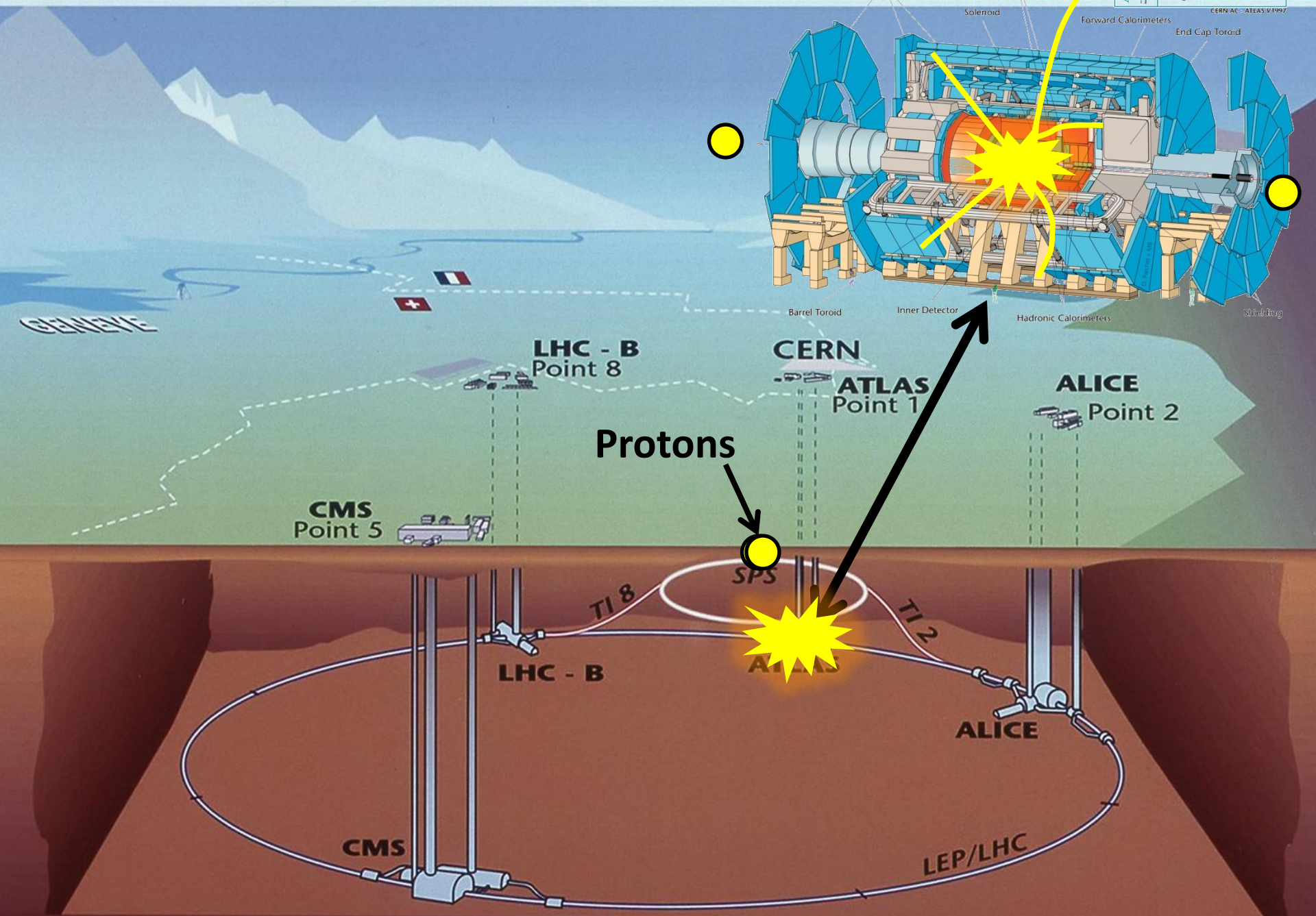
Why Spend the Money?

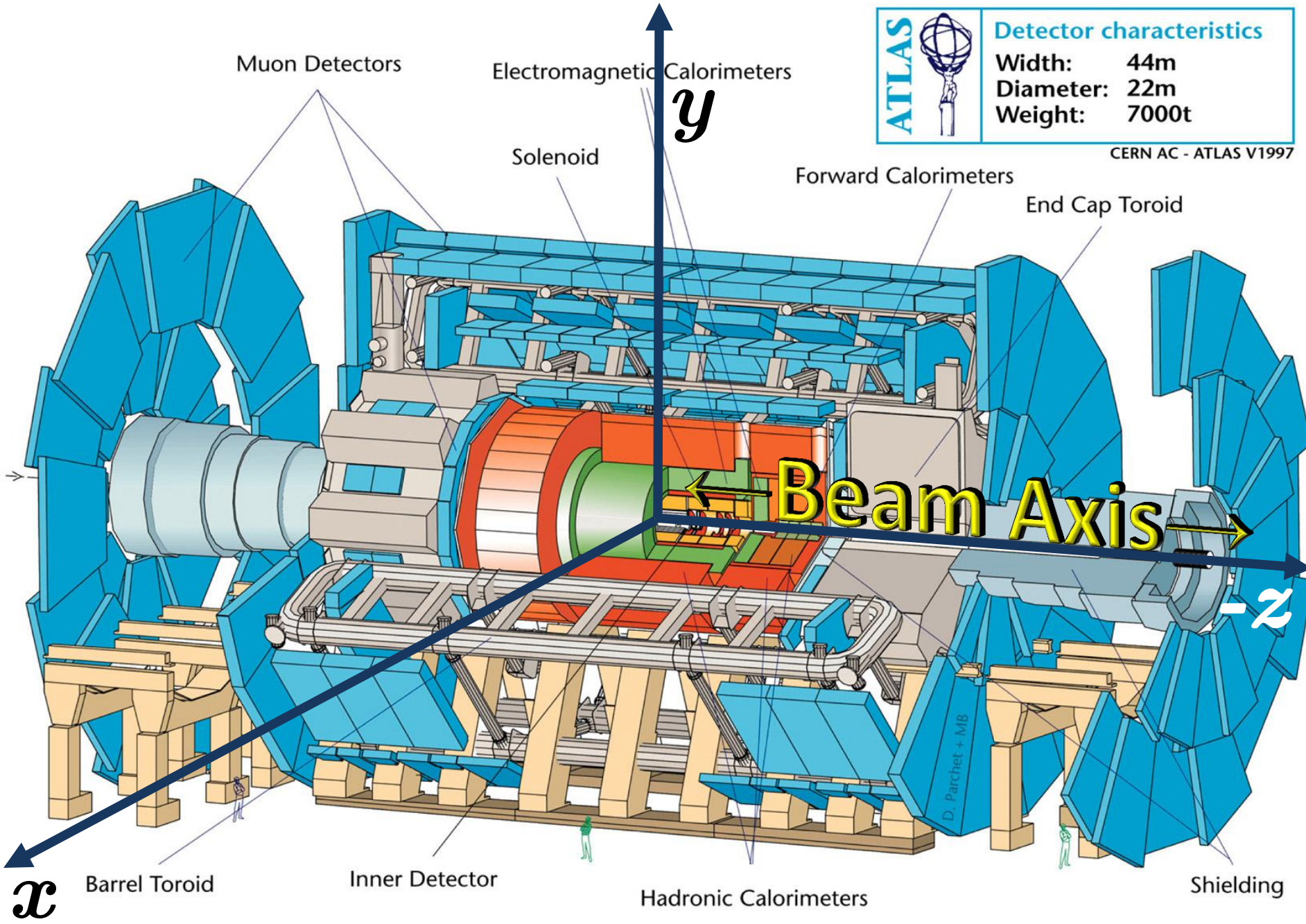
- Pure science.
- Technological advancement (i.e. the US manned spaceflight program).
- PhDs.


Overall view of the LHC experiments.

| Detector characteristics | |
|--------------------------|-------|
| Width: | 44m |
| Diameter: | 22m |
| Weight: | 7000t |

CERN AC - ATLAS V.1997





| | | |
|--|---------------------------------|-------|
|  | Detector characteristics | |
| | Width: | 44m |
| | Diameter: | 22m |
| | Weight: | 7000t |

CERN AC - ATLAS V1997

x

y

z

Beam Axis

Barrel Toroid

Inner Detector

Hadronic Calorimeters

Shielding

Muon Detectors

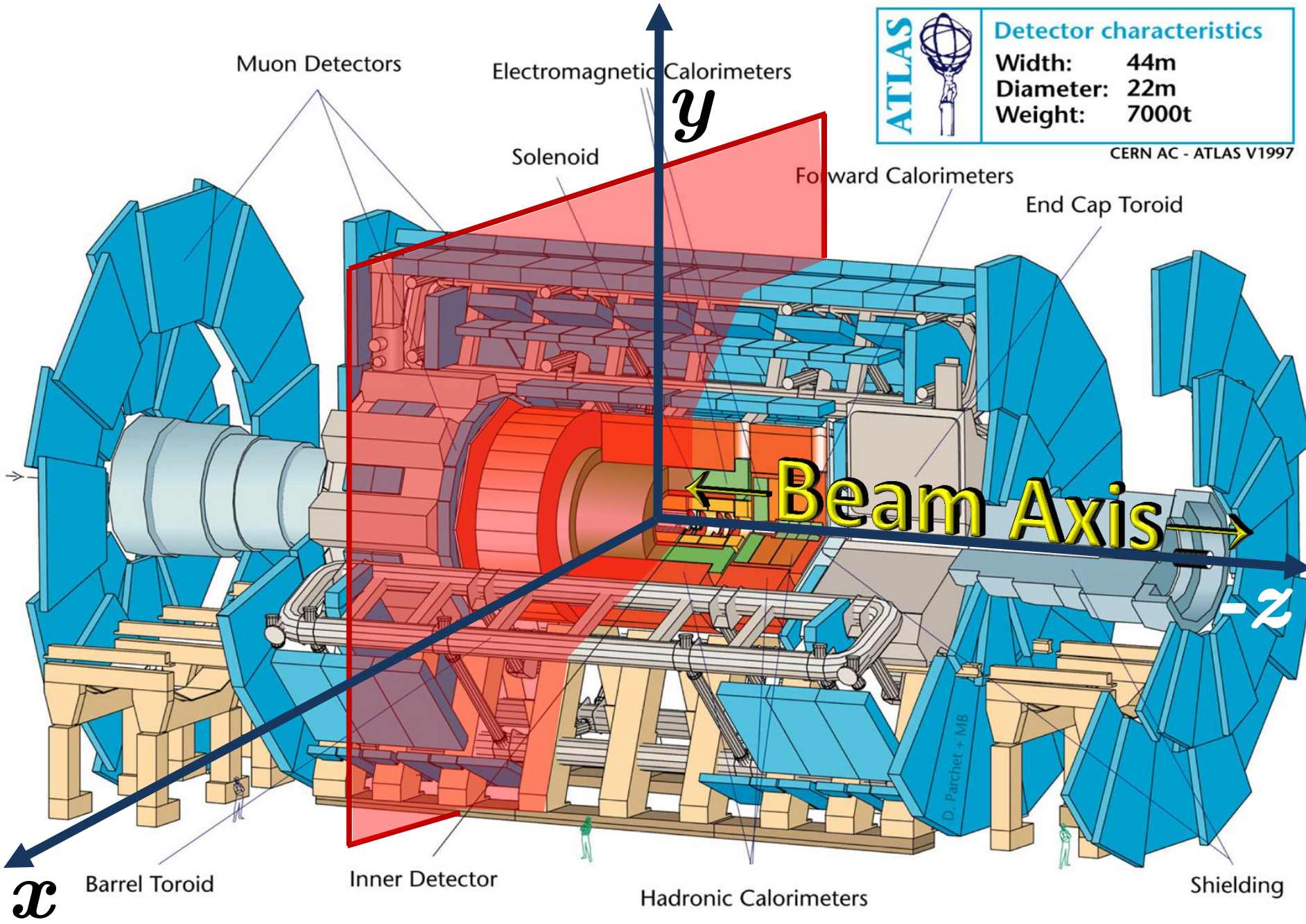
Electromagnetic Calorimeters


Solenoid

Forward Calorimeters

End Cap Toroid

D. Parquet + MB



| | | |
|--|---------------------------------|--------------|
|  ATLAS | Detector characteristics | |
| | Width: | 44m |
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CERN AC - ATLAS V1997

x

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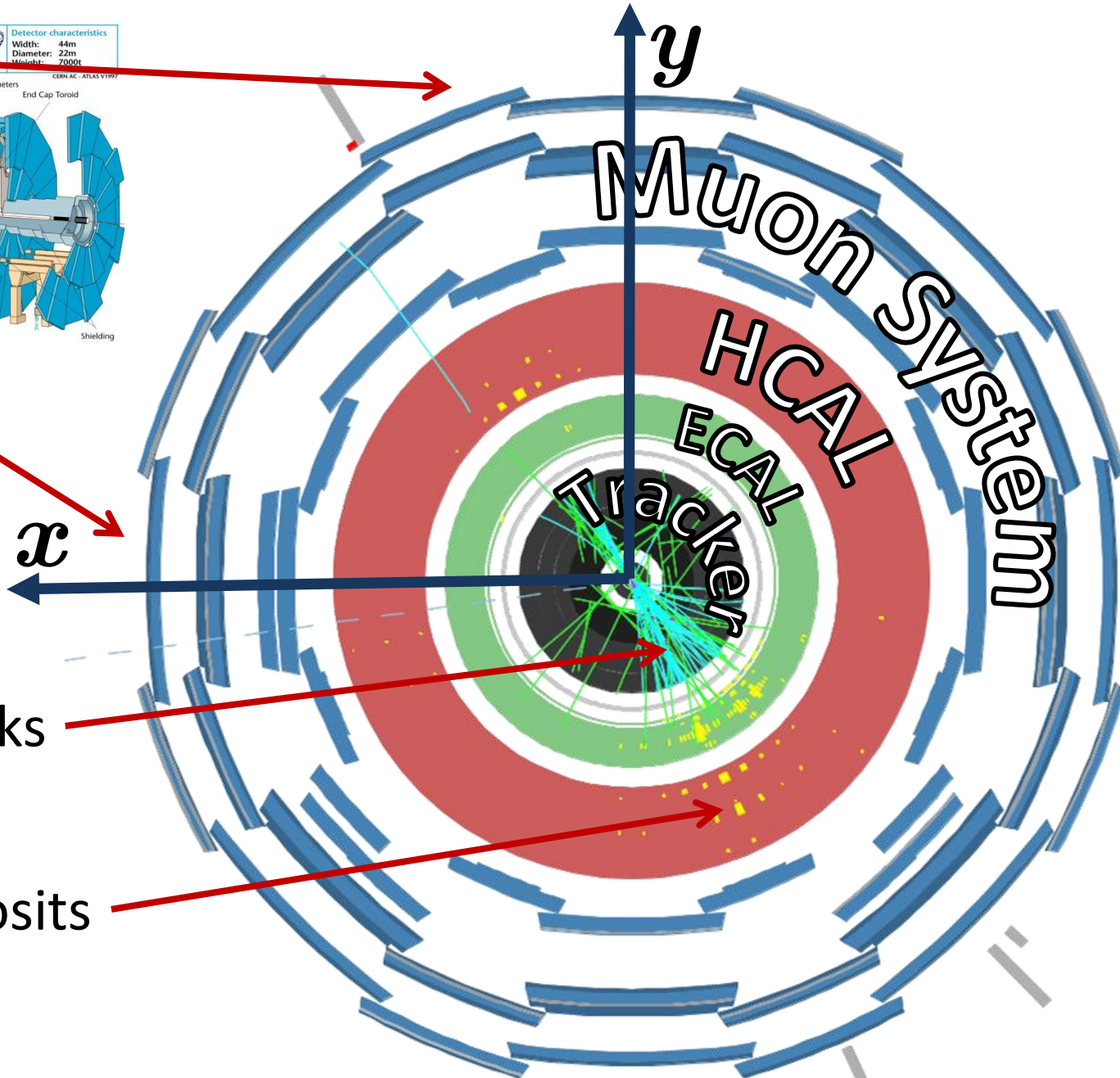
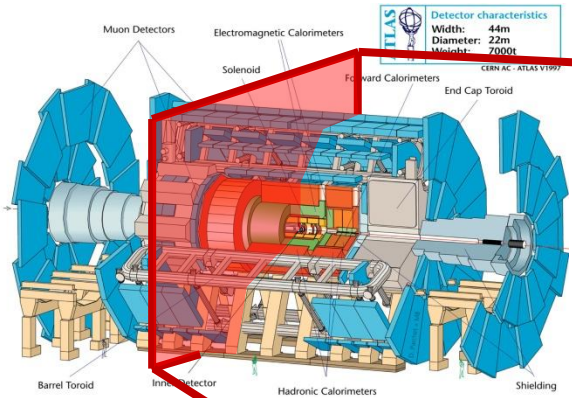
Electromagnetic Calorimeters

Solenoid

Forward Calorimeters

End Cap Toroid

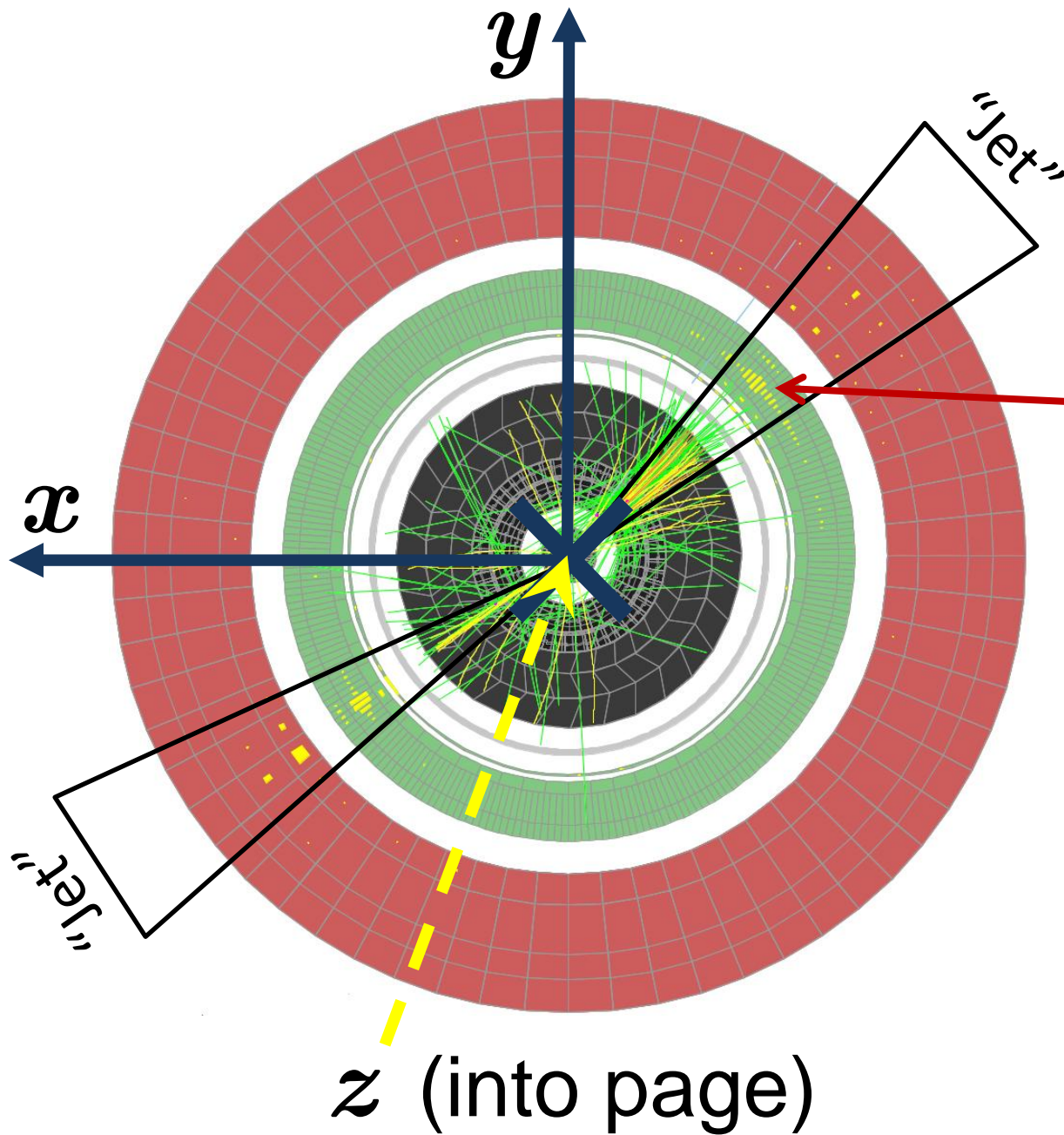
D. Parquet + MB



Particle Tracks

Energy Deposits

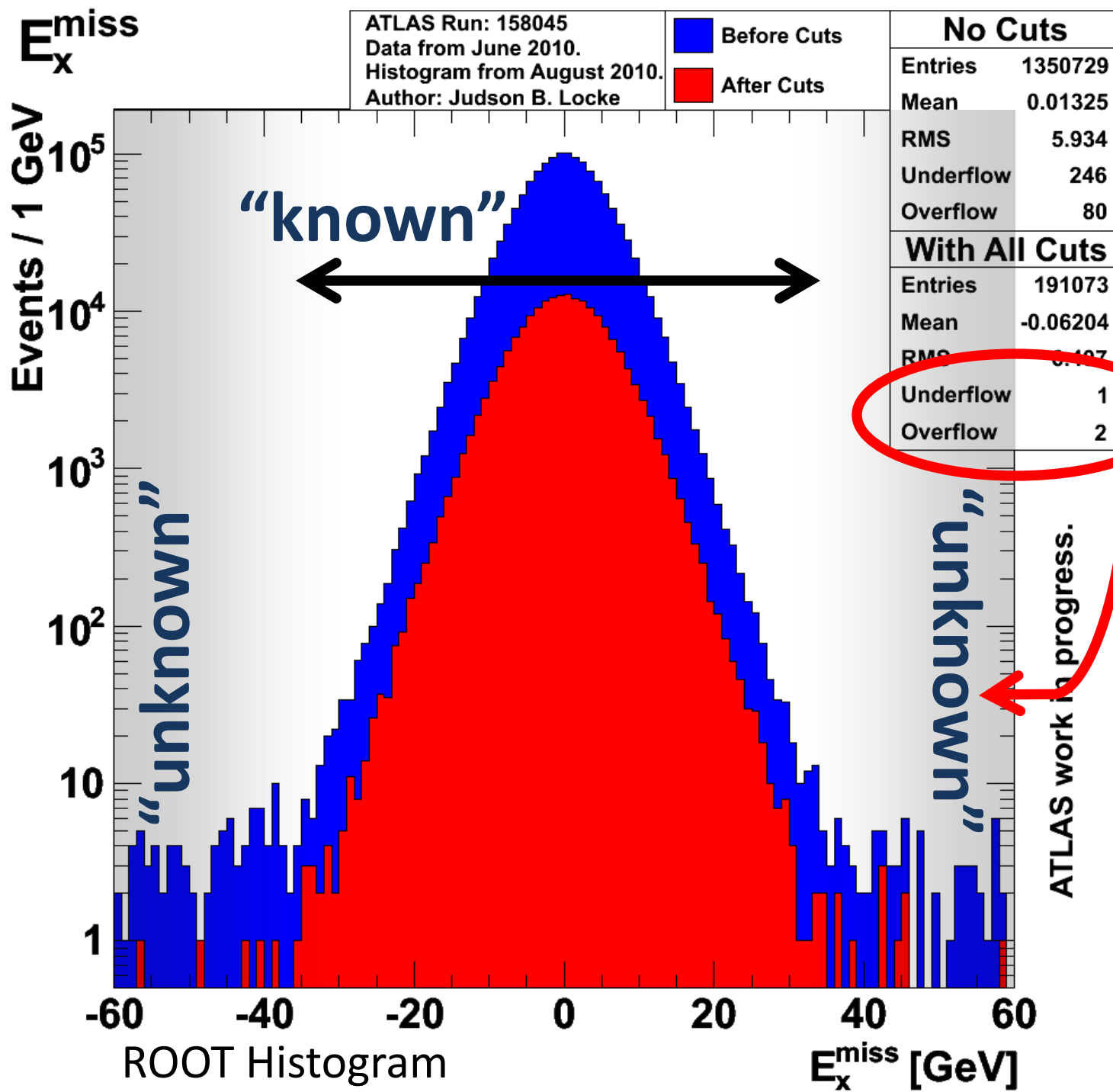
Atlantis Event Display Software

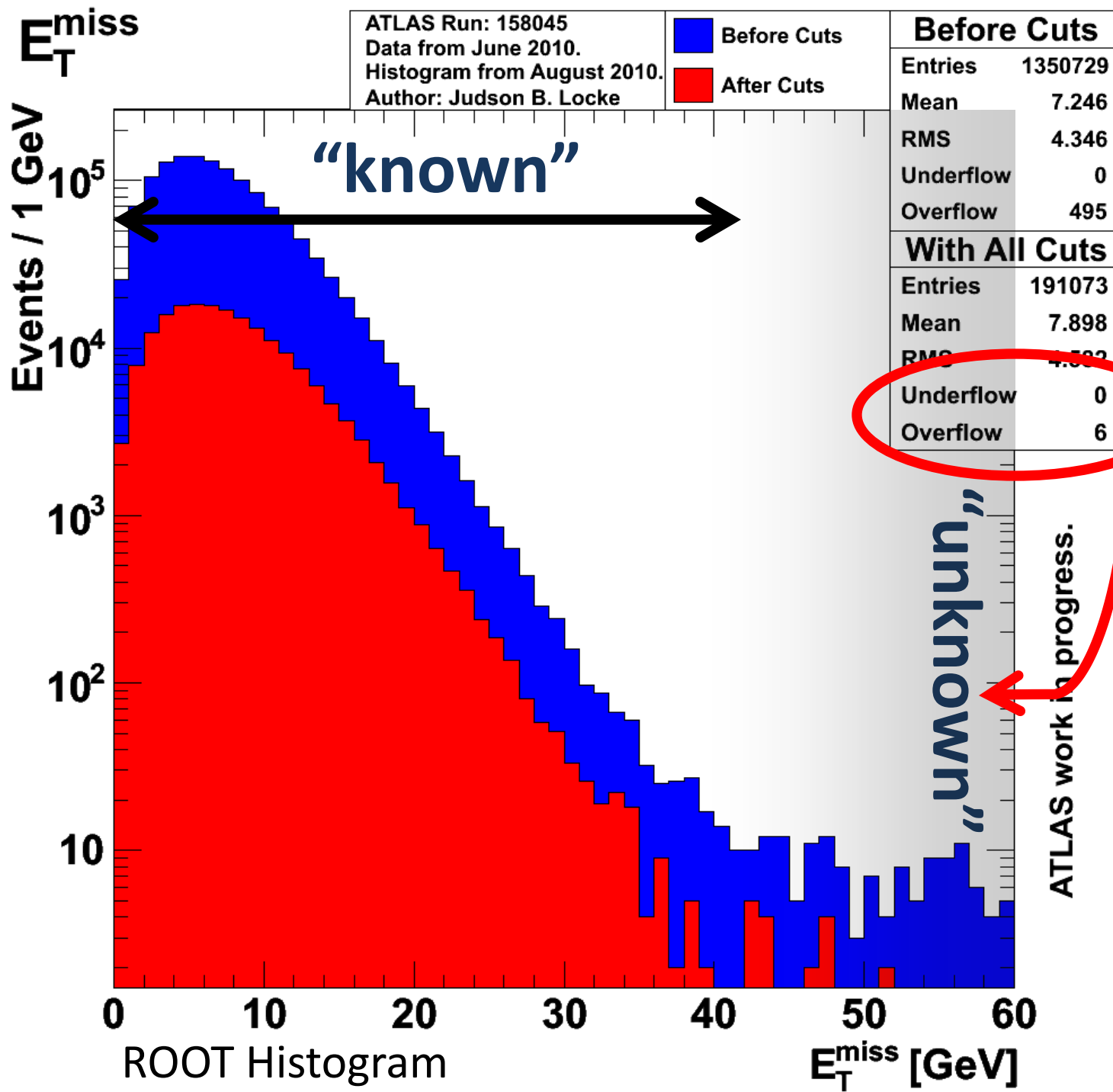


Jet energy is sum of energy in each calorimeter cell in a jet, corrected for the position of each cell. The proton beam is in the z direction, so no missing energy should be in x or y .

Missing Transverse Energy (E_T^{miss})

- Sometimes, the energy in x and/or y is nonzero.
- Why missing energy?
 - Detector failures.
 - Neutrino production (neutrinos cannot be detected by ATLAS).
 - Mismeasurements of jets and muons.
 - New physics?
- E_x^{miss} = missing energy in x .
- E_y^{miss} = missing energy in y .





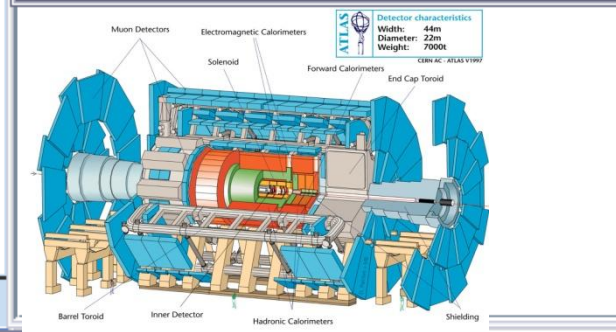
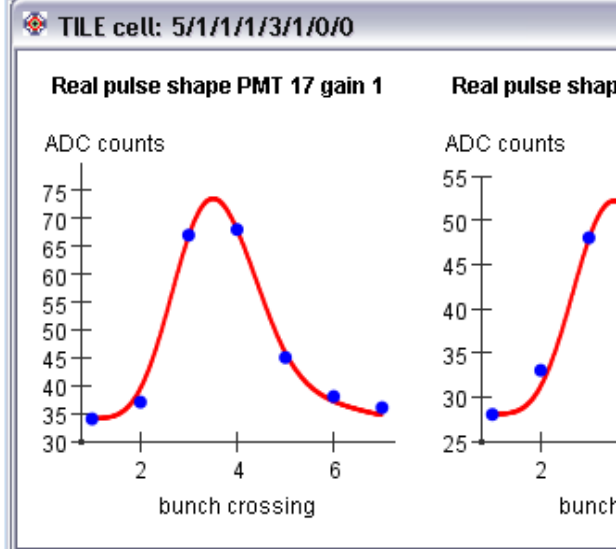
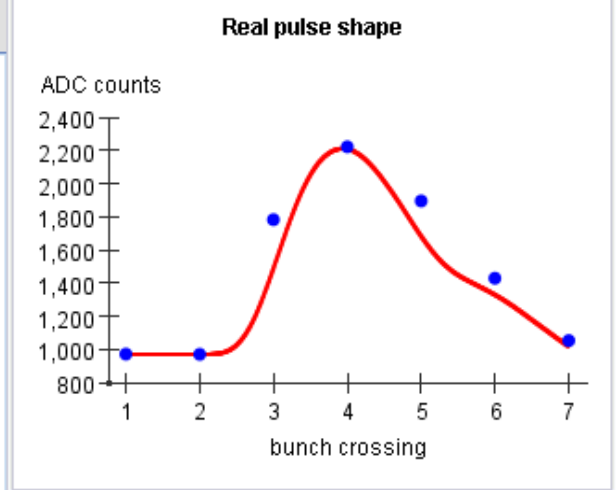
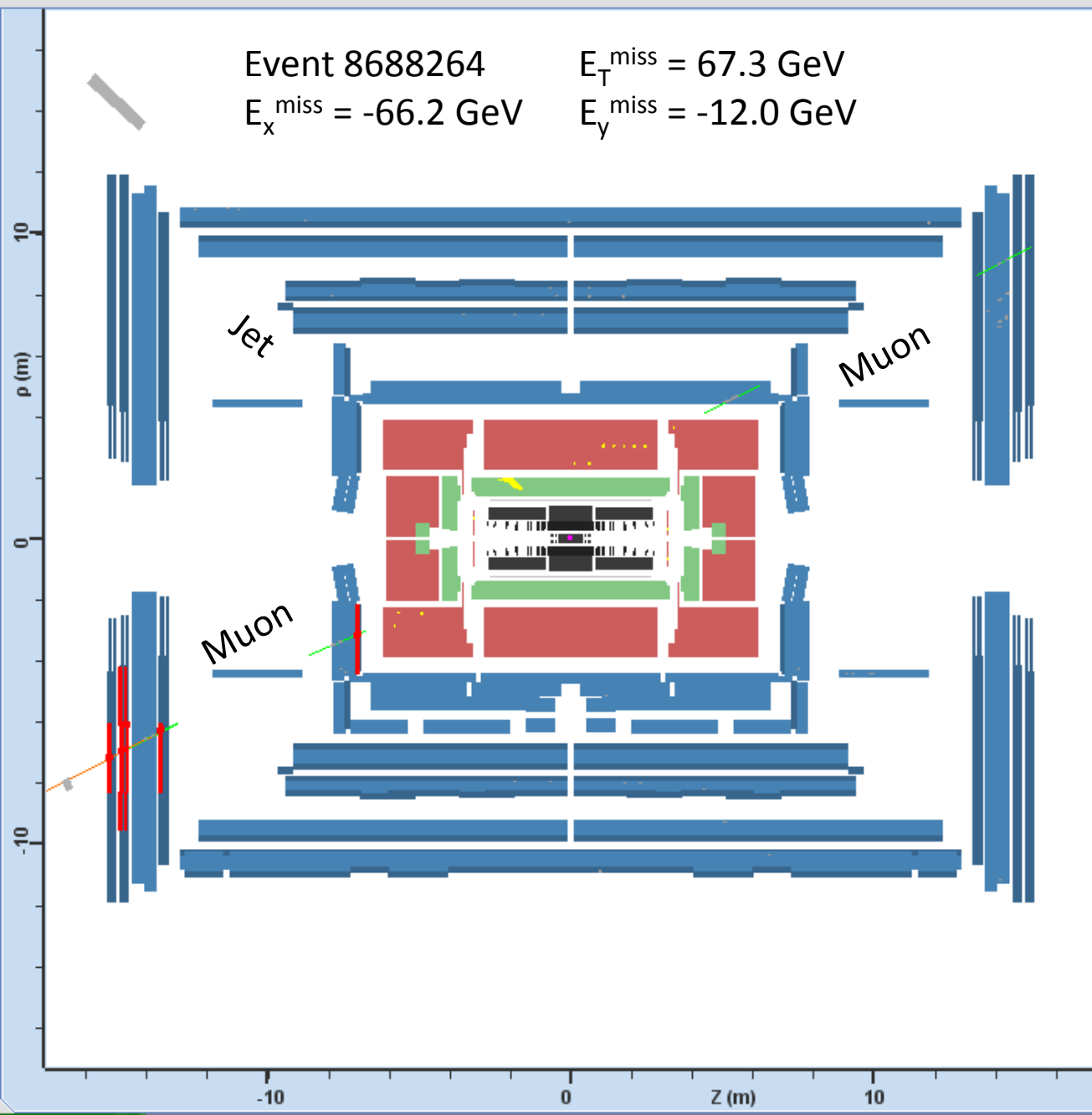
ROOT Histogram

E_T^{miss} [GeV]

Over/Underflow Events

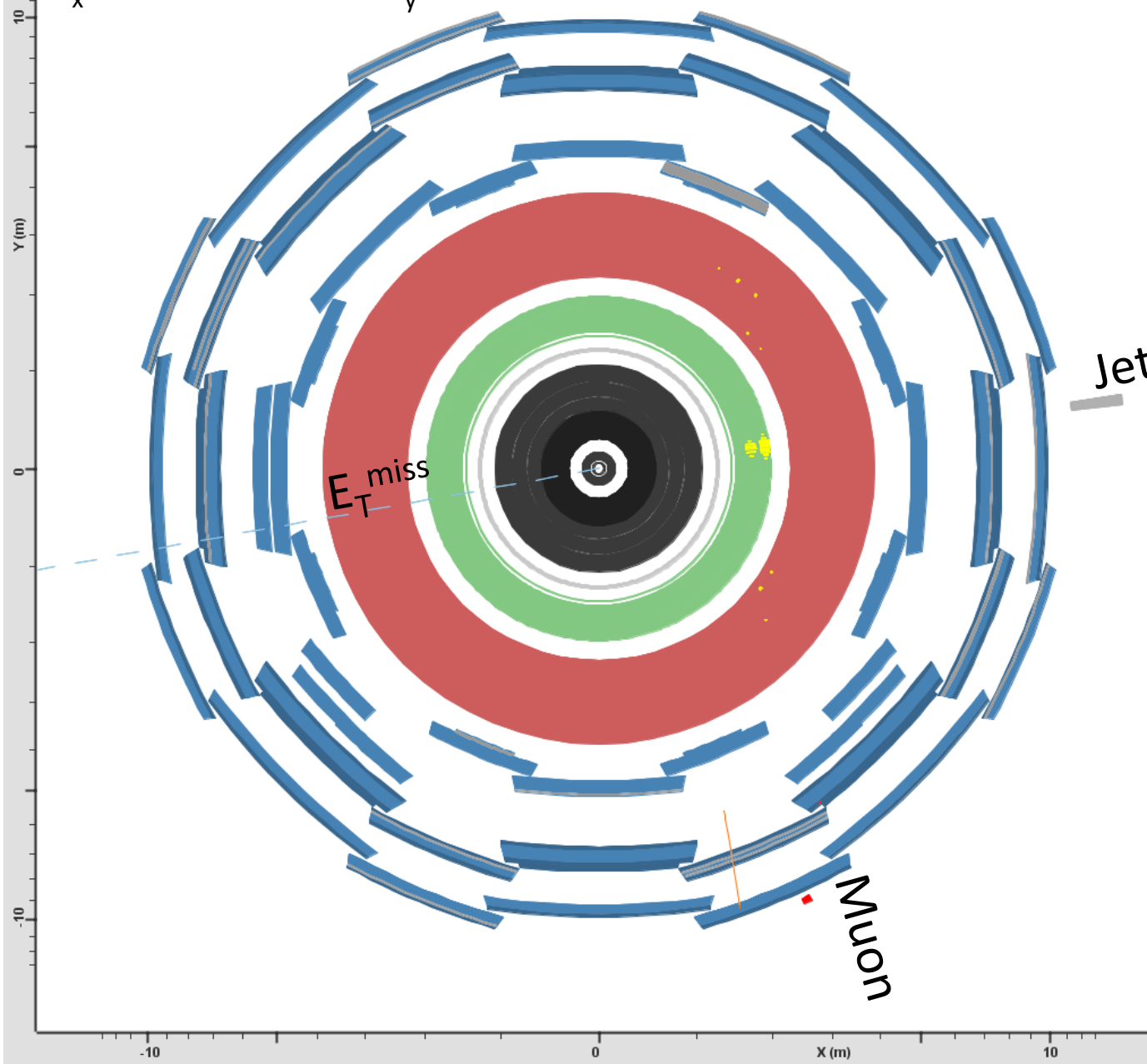
- We have to explain events with energies in the “unknown” region.
- Why?
 - New physics can be hiding here.
 - Background and detector problems could be here.
 - *Before we claim new physics, we must understand our detector and background!!!*

Event 8688264 $E_T^{miss} = 67.3 \text{ GeV}$
 $E_x^{miss} = -66.2 \text{ GeV}$ $E_y^{miss} = -12.0 \text{ GeV}$





Event 8688264

 $E_T^{\text{miss}} = 67.3 \text{ GeV}$ $E_x^{\text{miss}} = -66.2 \text{ GeV}$ $E_y^{\text{miss}} = -12.0 \text{ GeV}$ 

Contribution

- Catalogued interesting events from run 158045.
- These events may be used for future studies to characterize the ATLAS detector and background.
- A tiny contribution, but very illuminating for me.



CERN



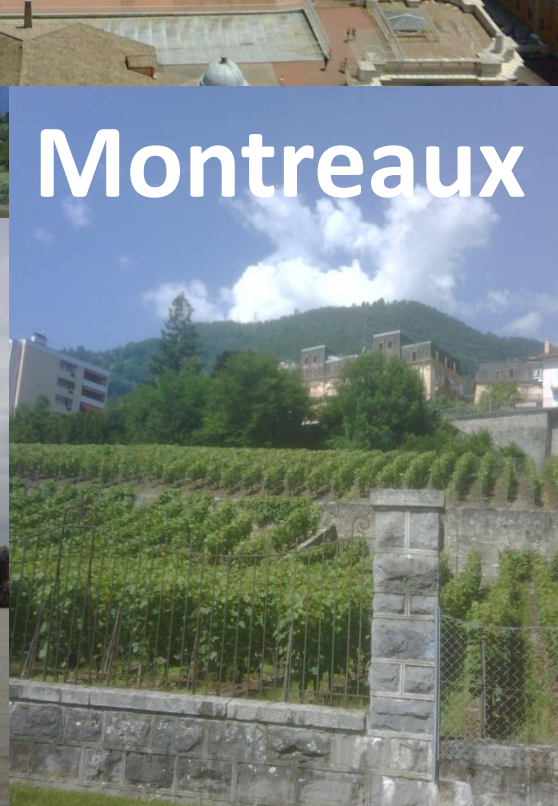
Rome



Paris



Dardigny



Montreaux



London

Acknowledgements

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- Thanks to Jeremy Herr, Jean Krisch, and Homer Neal for making the UM CERN REU operate.
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- Thanks to CERN and Wikipedia for pictures.