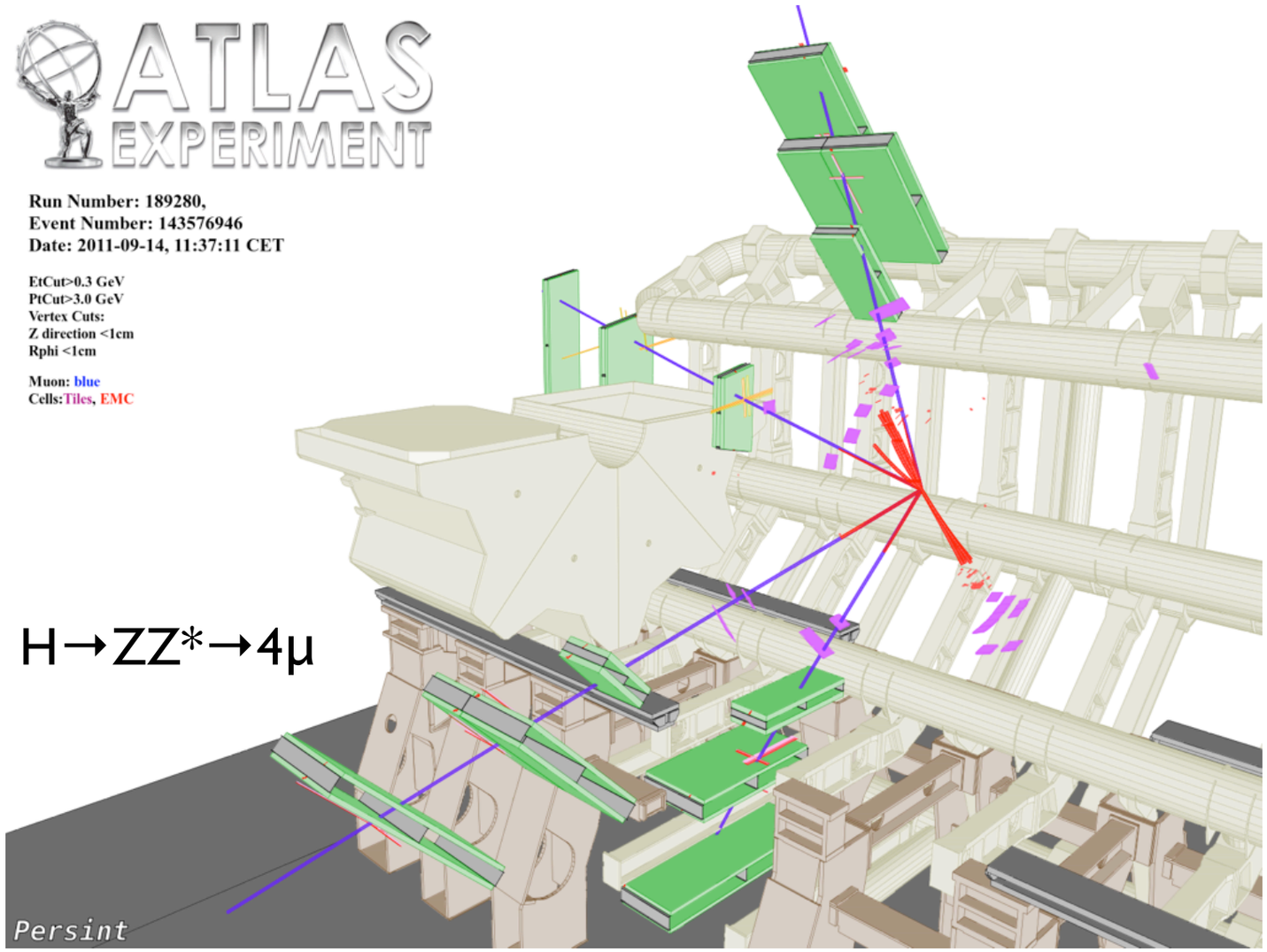
The Higgs, Muons, and Resistive Plate Chambers

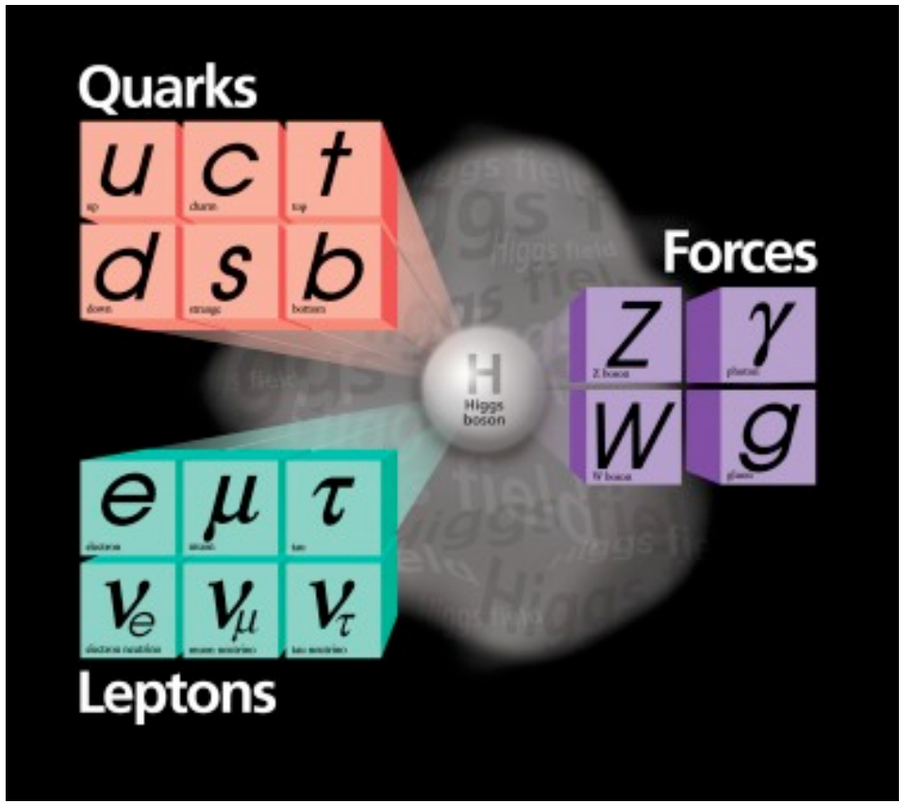


https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2011-162/fig_10a.png

Danielle Norcini
University of Michigan REU 2012 Symposium

The Higgs and the LHC

- Mass?
- Spontaneous symmetry breaking
- Higgs mechanism

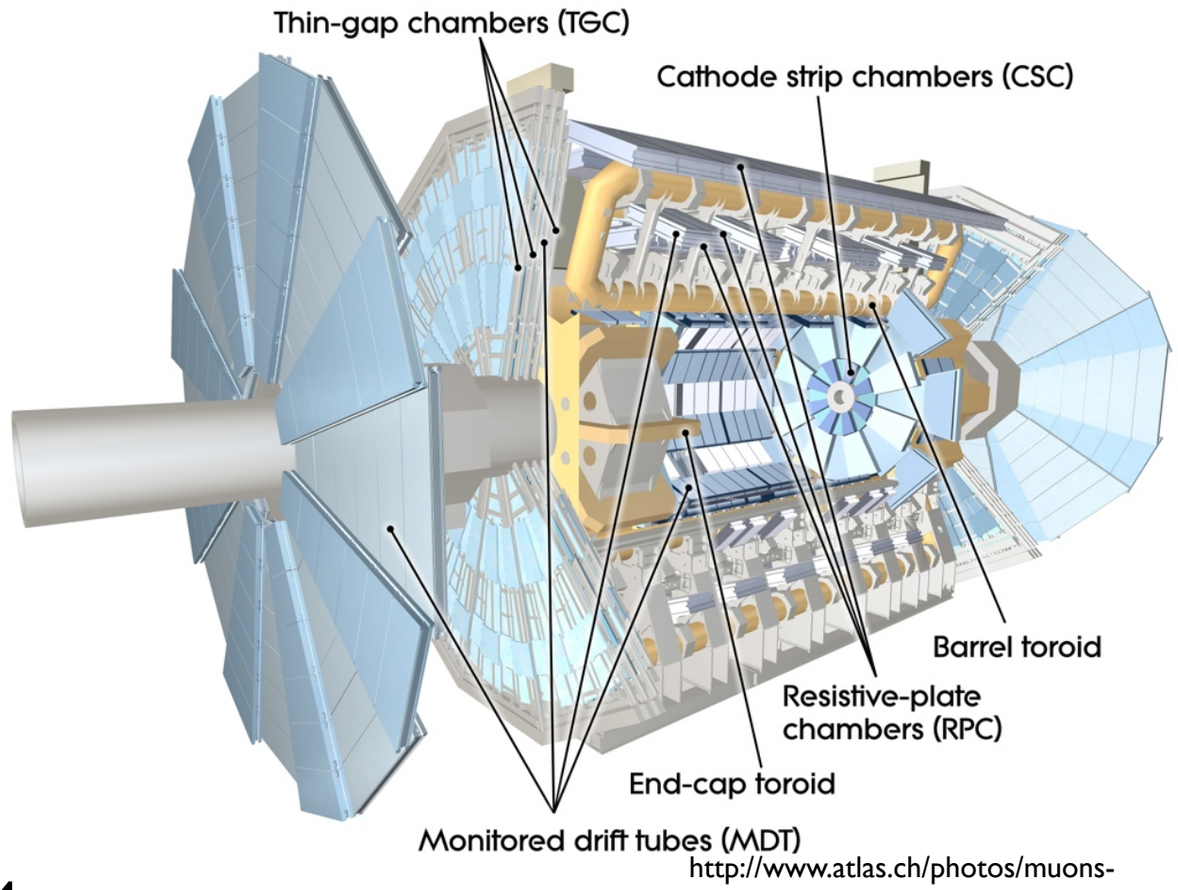


http://ucrtoday.ucr.edu/7538

- Proton-proton synchrotron
- $\sqrt{s}$=8 TeV
- Why is so much energy required?

ATLAS and Muons

- A Toroidal LHC ApparatuS
- Tracking detector,
  calorimeters,
  magnet system,
  muon spectrometer



http://www.atlas.ch/photos/muons-

- Muon, 200x electron
- ‘Golden’ channel H→ZZ*→4μ

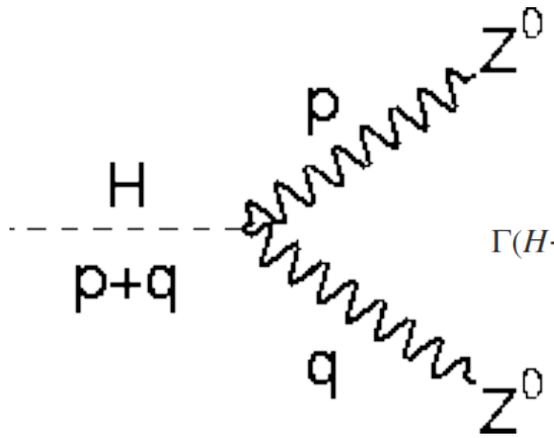
Widths and Branching Ratios

$$\Gamma = \left(\frac{\hbar}{\tau} \right) \qquad BR = \left(\frac{\Gamma_i}{\Gamma} \right)$$

- Mean lifetime
- $\Delta E \Delta t \sim \hbar$

- Short determined lifetime, energy spread
- Matrix element and phase space
- Tells how often the decay will occur
- Higgs to bb, tt, $W^{\pm}W^{\pm}$, Z^0Z^0, $\gamma\gamma$

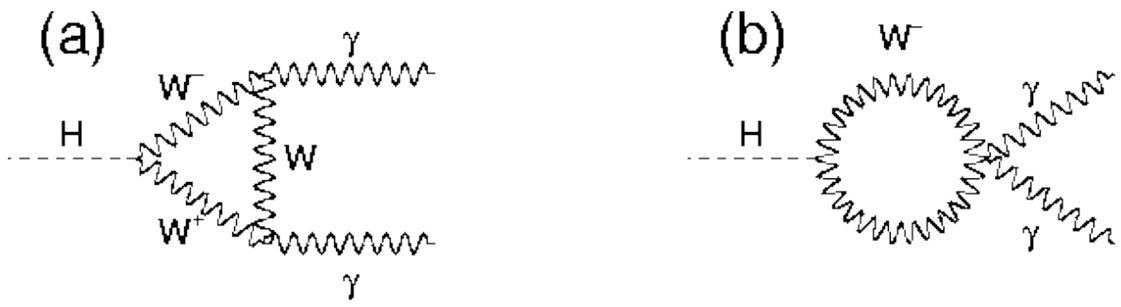
Tree-Level and Loops



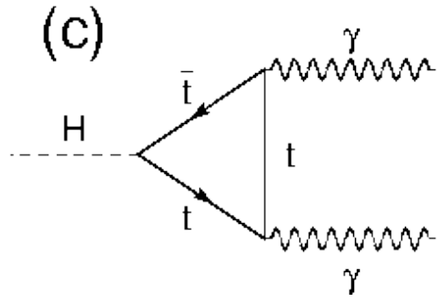
$$\Gamma(H\to ZZ)=\frac{G_F m_h^2}{16\pi\sqrt{2}}\sqrt{1-x_Z}\left(1-x_Z+\frac{3}{4}x_Z^2\right)$$

- $b\bar{b}$, $t\bar{t}$, $W^{\pm}W^{\pm}$, Z^0Z^0
- Direct coupling
- Virtual when $m_h<2m_v$

$$\Gamma(H\to\gamma\gamma)=\frac{\alpha^2 G_F}{128\sqrt{2}\,\pi^2}m_h^3\left|\sum_i N_{ci}e_i^2F_i\right|^2$$



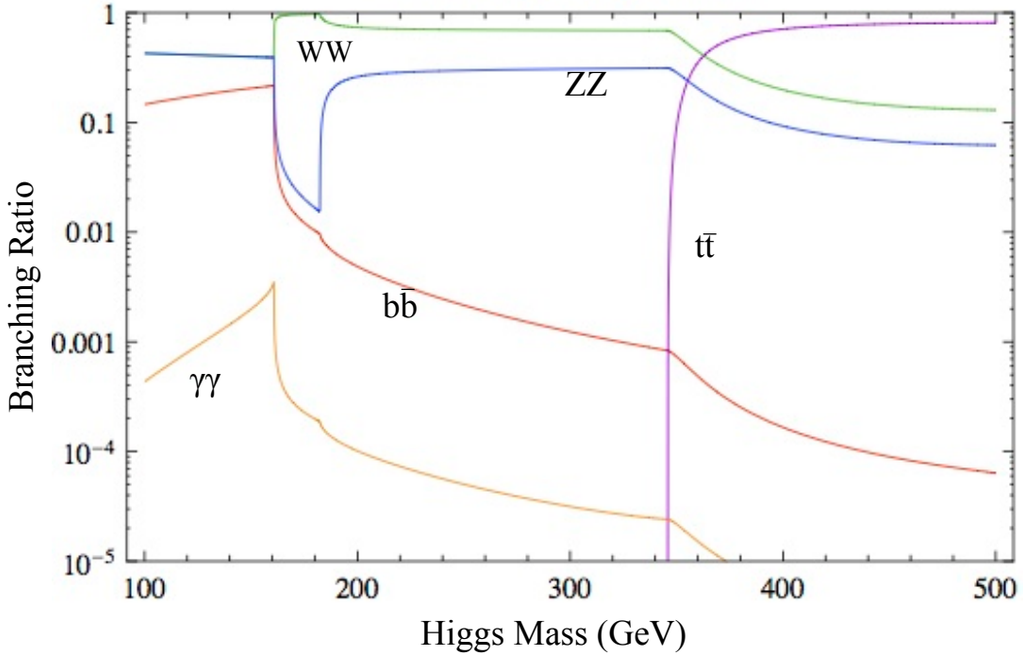
- Intermediate charged loop
- Summation, spin-0,1/2,1



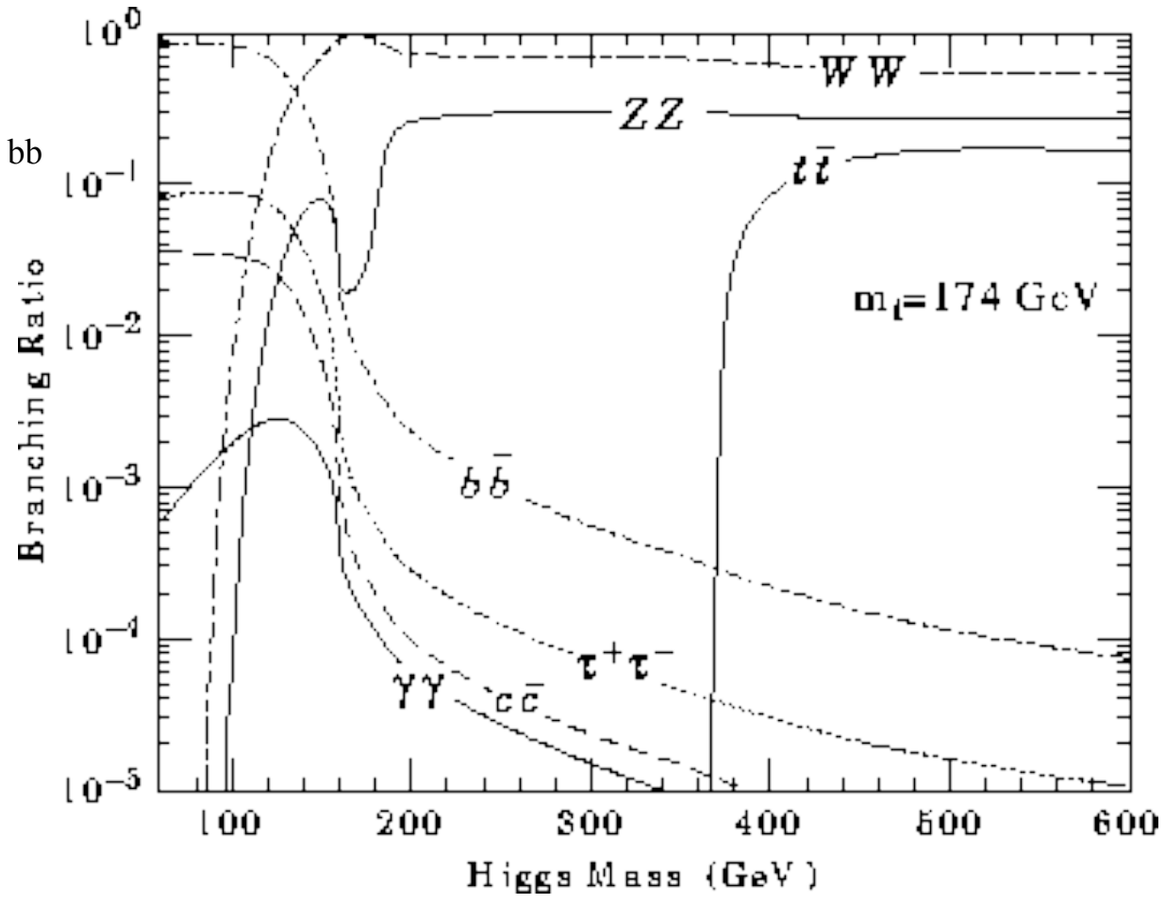
http://www.hep.lu.se/atlas/thesis/egede/thesis-

Branching Ratio Summary

My Plot



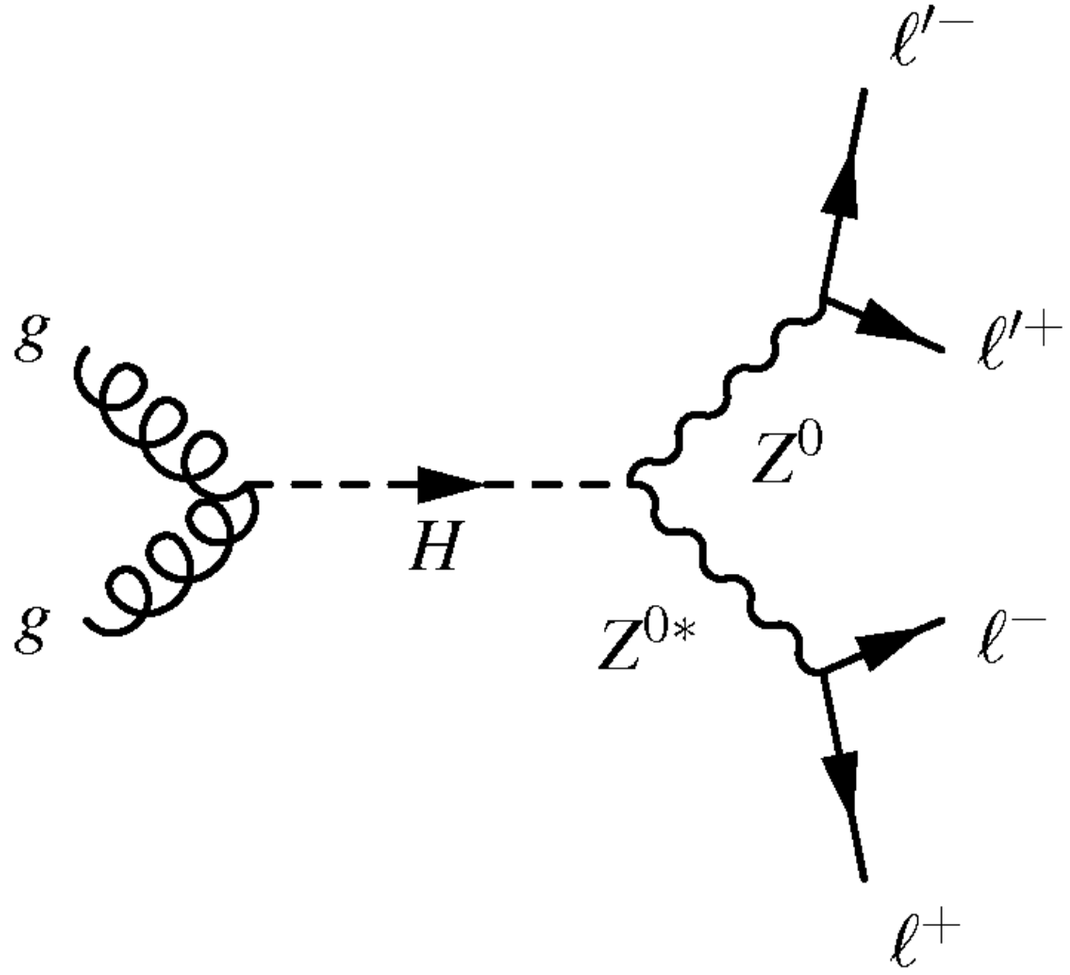
Standard Plot



http://www.quora.com/Tau-Lepton/

Monte Carlo: $gg \rightarrow H \rightarrow ZZ^* \rightarrow \mu^+\mu^-\mu^+\mu^-$

- Monte Carlo, simulate processes
- ATLAS: m_h~126GeV with 5.9σ, $\sqrt{s}$ = 8TeV
- Simplified ggF production, 4μ decay
- ggF in colliding pp, top loop
- $pp \rightarrow H+X$
- Momentum fraction $x_1 > x_2$



http://www-cdf.fnal.gov/physics/new/hdg/Results_files/results/ZZ4leptons_120307/

Do the muons hit the detector?

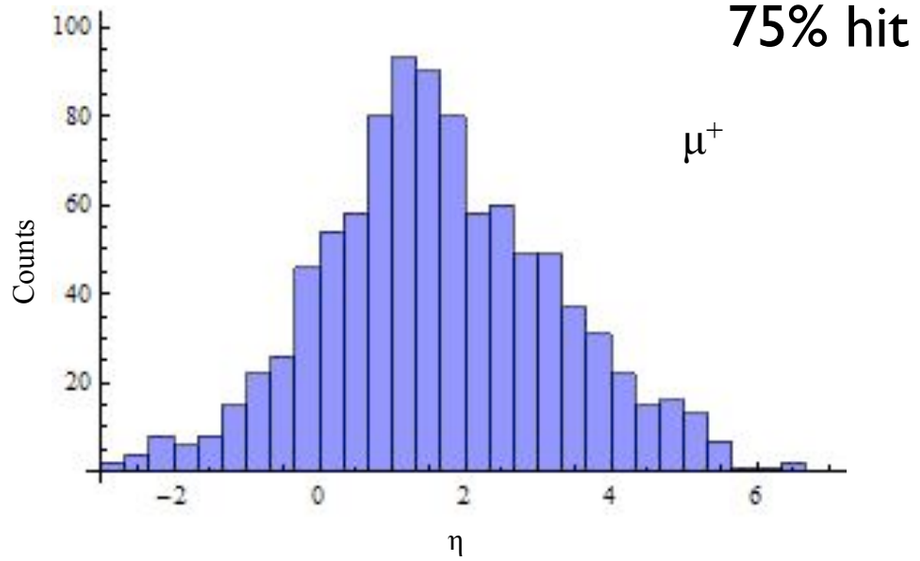
- Angular distribution dimuons
- Simulated Z to $\mu^+\mu^-$
- Lorentz boost in y, z(beam line)

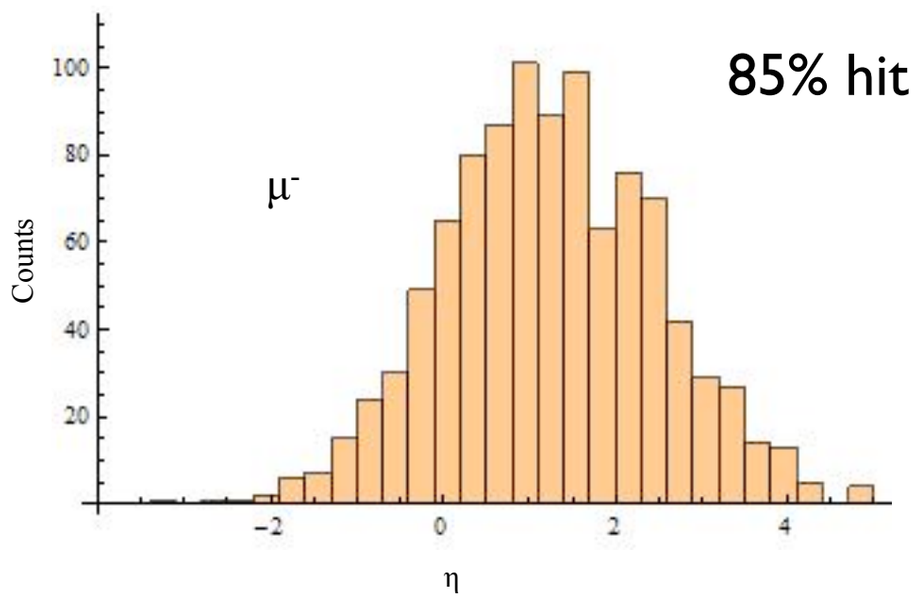
$$p_z=\gamma(p_z'+\beta E')$$
$$E=\gamma(E'+\beta p_z')$$

- θ not invariant
- Introduce pseudorapidity

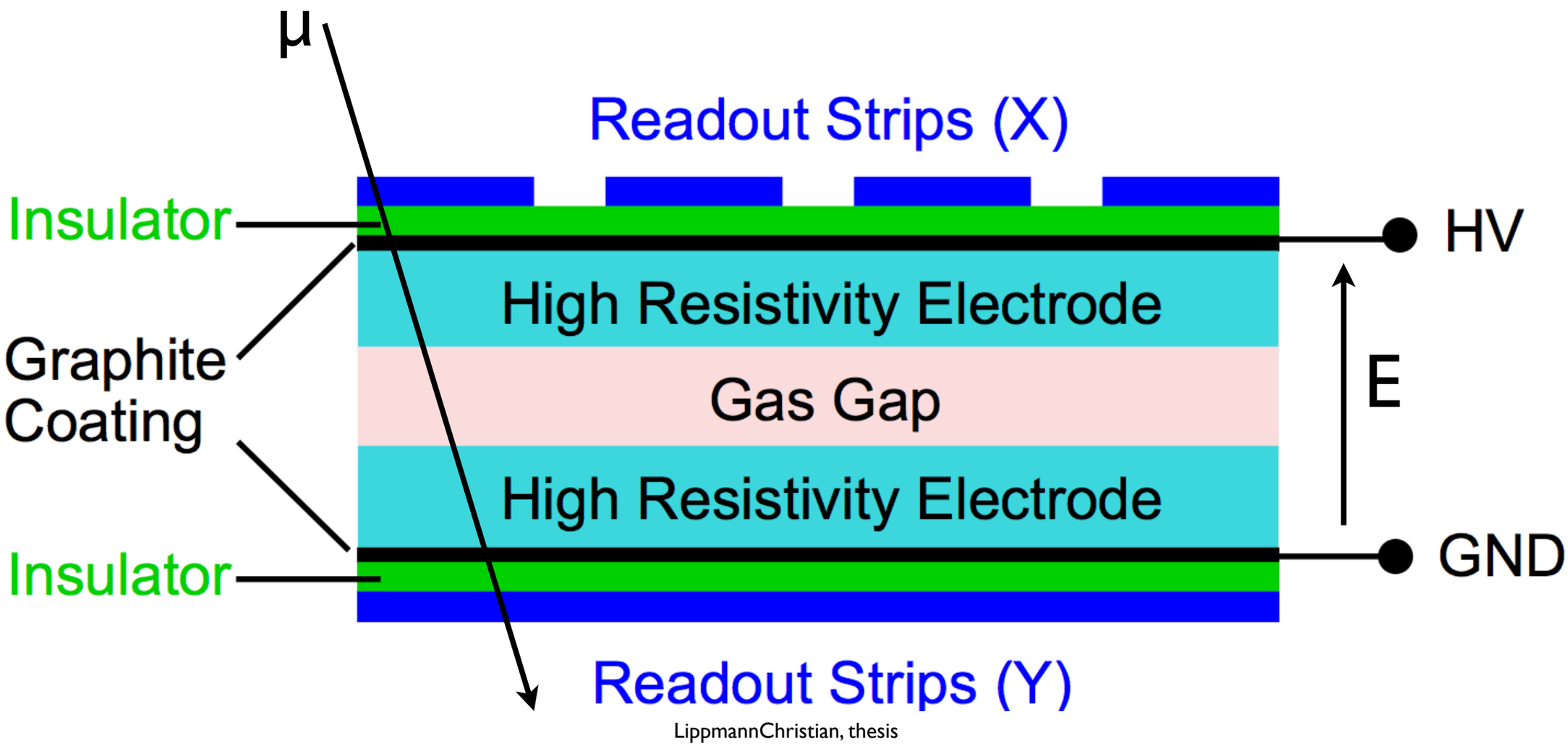
$$\eta=-ln\left[tan\left(\frac{\theta}{2}\right)\right]$$

- ATLAS, $|\eta|<2.7$ with $\eta\neq 0$





Resistive Plate Chambers

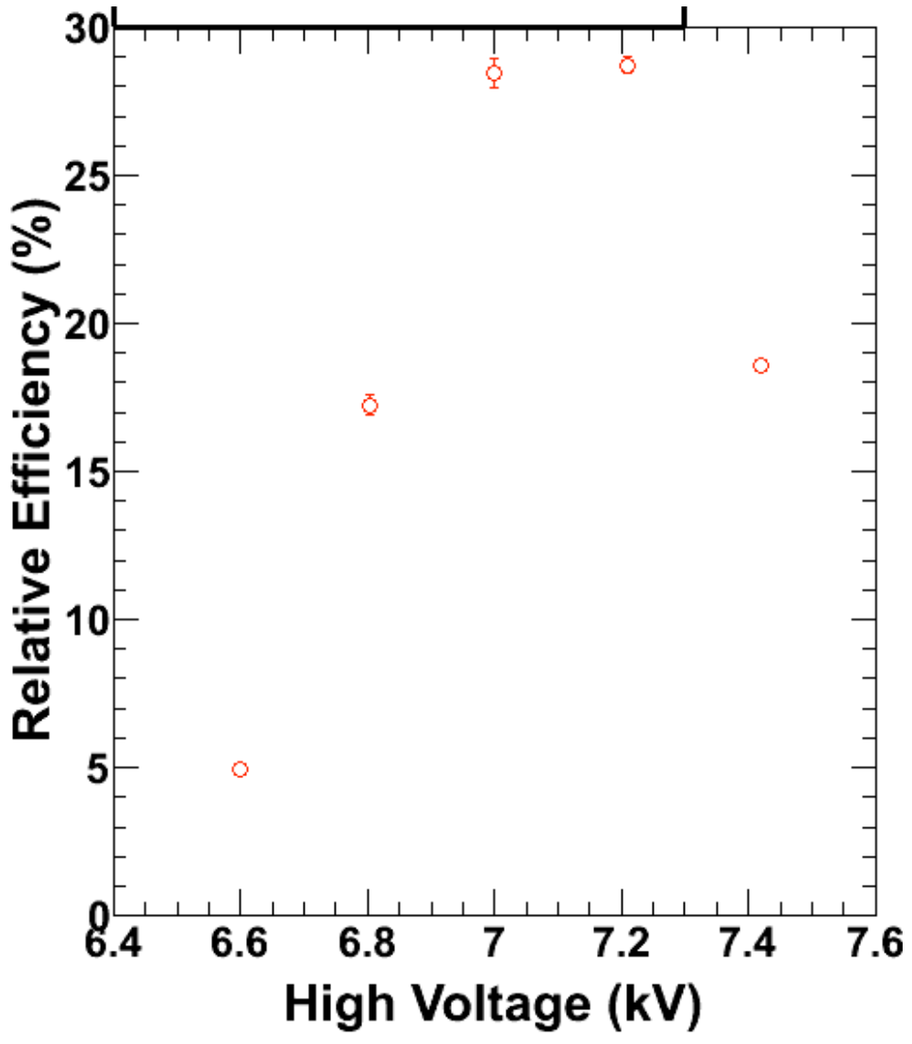


LippmannChristian, thesis

Gas gap = 1.2mm

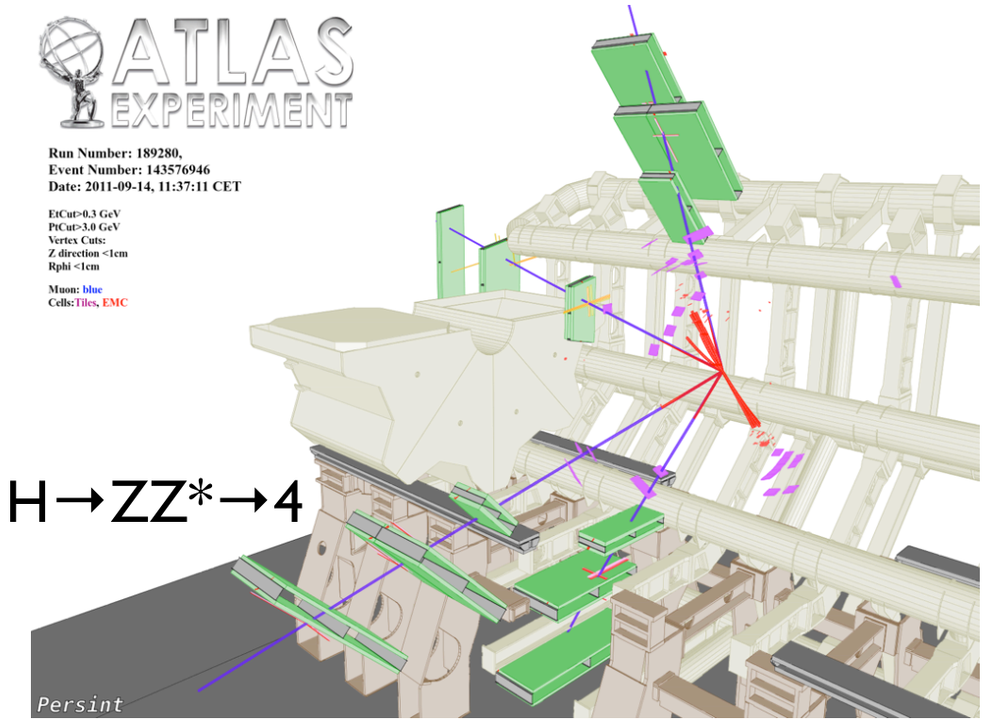
More RPCs and Results

- 1.2mm gas gap, V↓ fluctuations ↓
- High efficiency, ~98%
- 1 ns time resolution for trigger
- Conditioned to 7000V
- Efficiency tested.. well attempted



Summary and Acknowledgements

- Simulation methods and steps
- Operation of detectors at LHC
- Lab is hard



$H \rightarrow ZZ^* \rightarrow 4$

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-

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