

Searching for dark matter with the Higgs boson



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About me

- Vordiplom in Heidelberg (that's ~where I grew up, too)
- Master/PhD at Michigan State University (2007 - 2012)
- Postdoc at University of Pennsylvania (2012 -2016)

YIG leader in the DESY ATLAS group since September

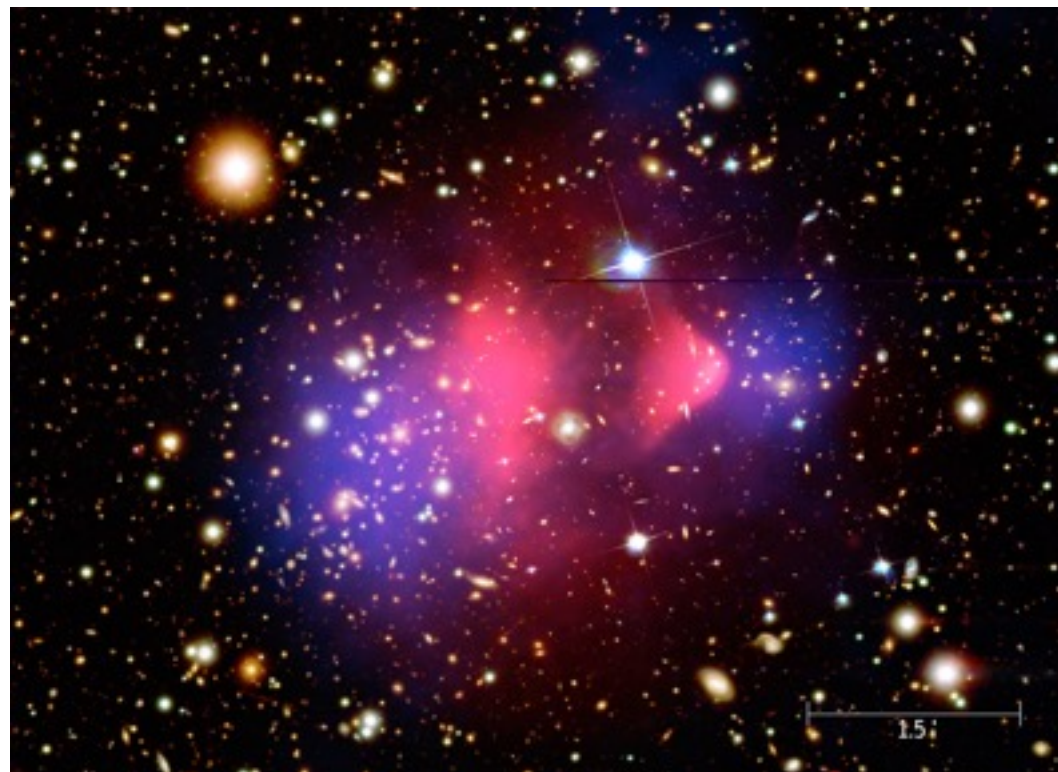
- People:
 - Will Leight (Postdoc)
 - Fang-Ying Tsai and Namgyun Jeong (PhD students)
- Topics:
 - Higgs physics and dark matter search
 - lepton/MET reconstruction
 - electronics tests and data acquisition for the new ATLAS Tracker





Dark matter

- 84% of all matter in the universe
 - not explained by the Standard Model of Particle physics
- of the most fundamental questions in physics today!

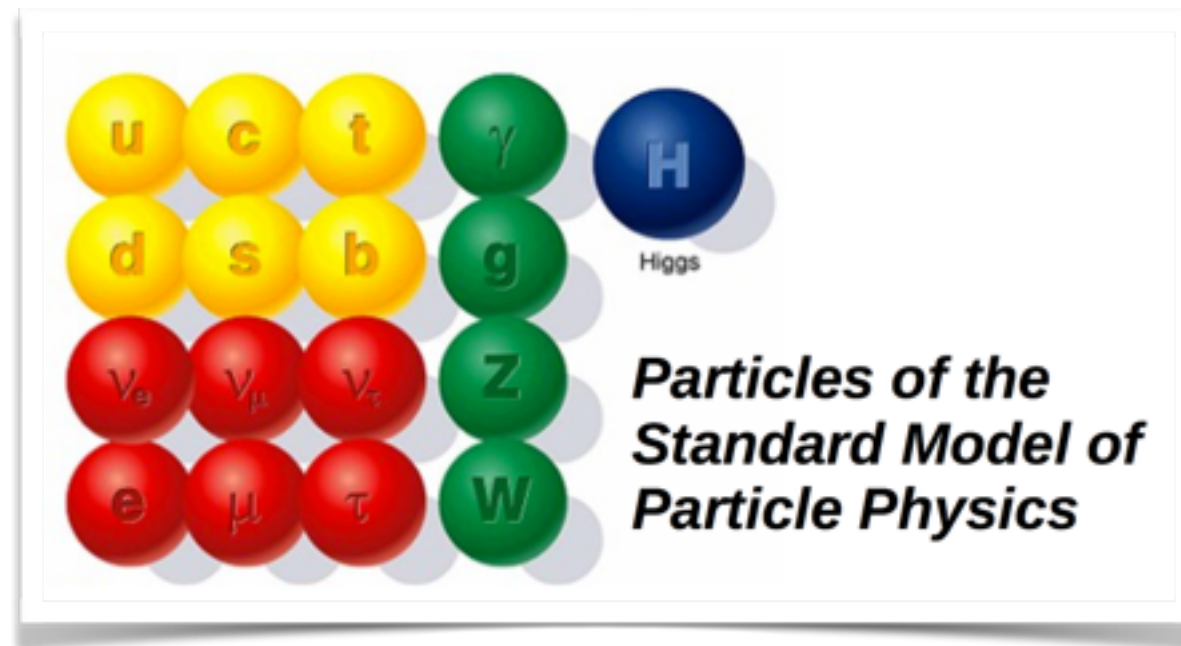


- depending on the model: could be produced in pp collisions at the LHC
 - invisible to the ATLAS detector
- would show up in the detector as missing transverse momentum



Higgs bosons at ATLAS

- found in 2012 by the ATLAS and CMS collaborations
- last missing piece of the Standard Model of Particle Physics



can use the Higgs
as a tool to search
for dark matter!

- result of the same mechanism that gives particles mass
- very likely that it couples to dark matter particles
- by 2018, 10 times as many Higgs bosons will be produced by the LHC than in 2010 - 2012

Higgs physics is just at the beginning!



Direct and indirect searches

- two ways to find new physics:
 - directly look for new phenomena
 - measure a Standard Model property and see if the result agrees with the expectations



Direct and indirect searches

- two ways to find ~~new physics~~: dark matter using the Higgs

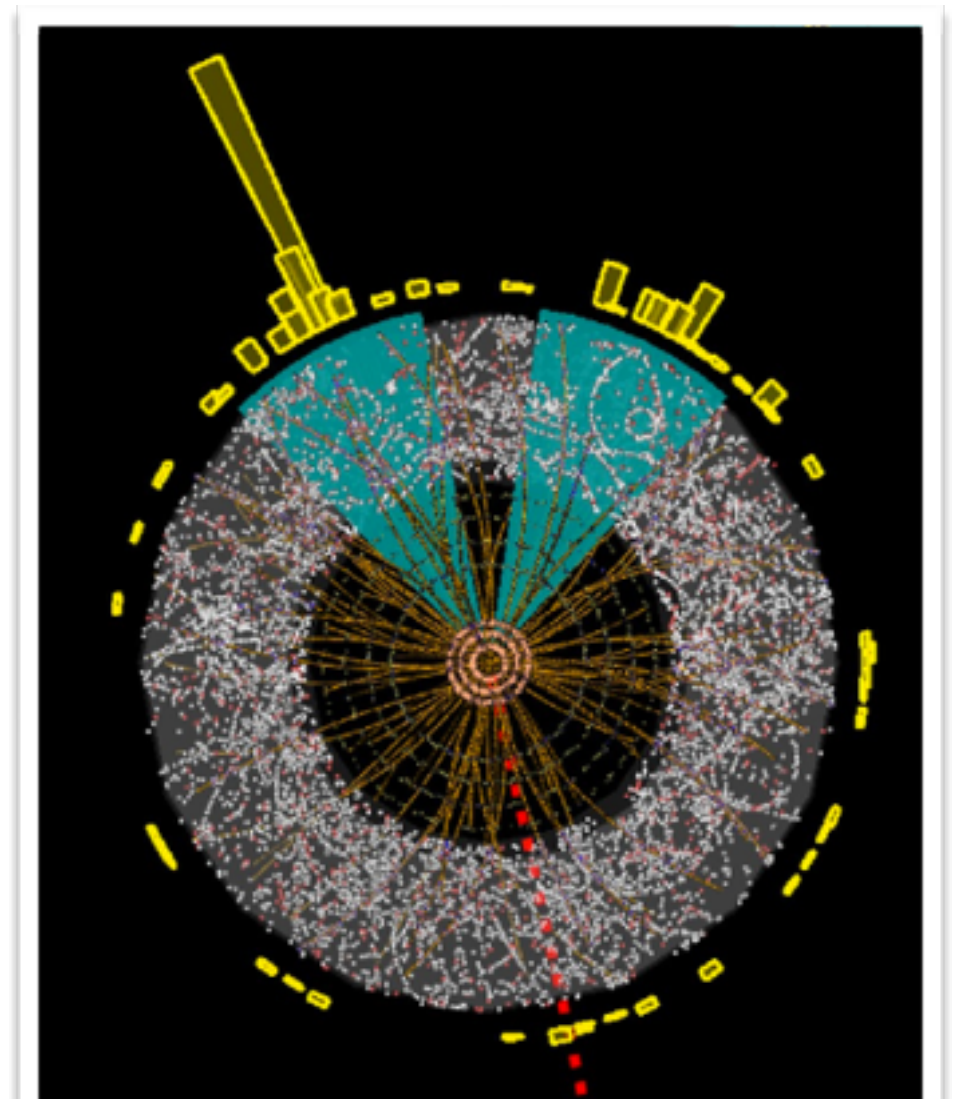
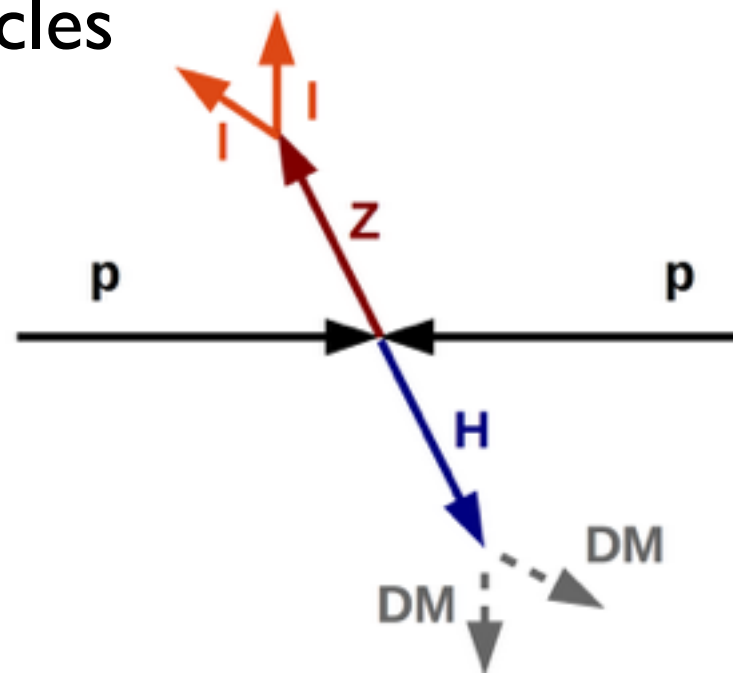
- directly look for new phenomena

Search for Higgs boson decays to invisible particles

- measure a Standard Model property and see if the result agrees with the expectations

Measure the Higgs boson properties and compare to Standard Model expectations

- look for the Higgs boson decaying into invisible particles
 - dark matter candidates!
- invisible particles are reconstructed as missing transverse momentum
- need to tag the events somehow:
use distinct Higgs production modes
in which the Higgs is produced together with other particles

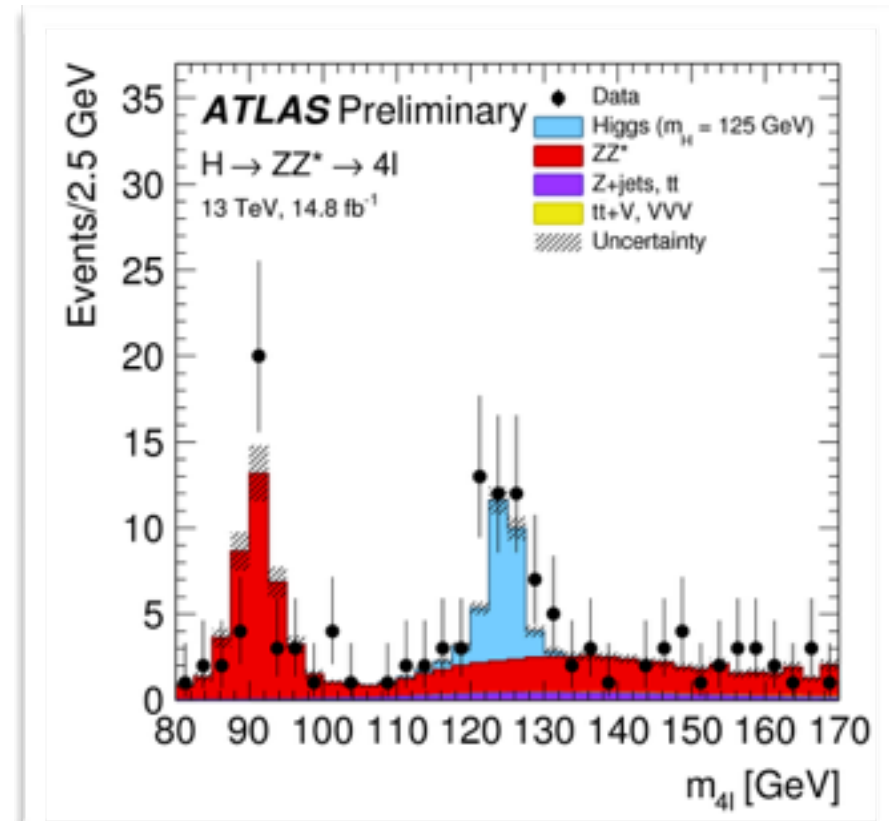
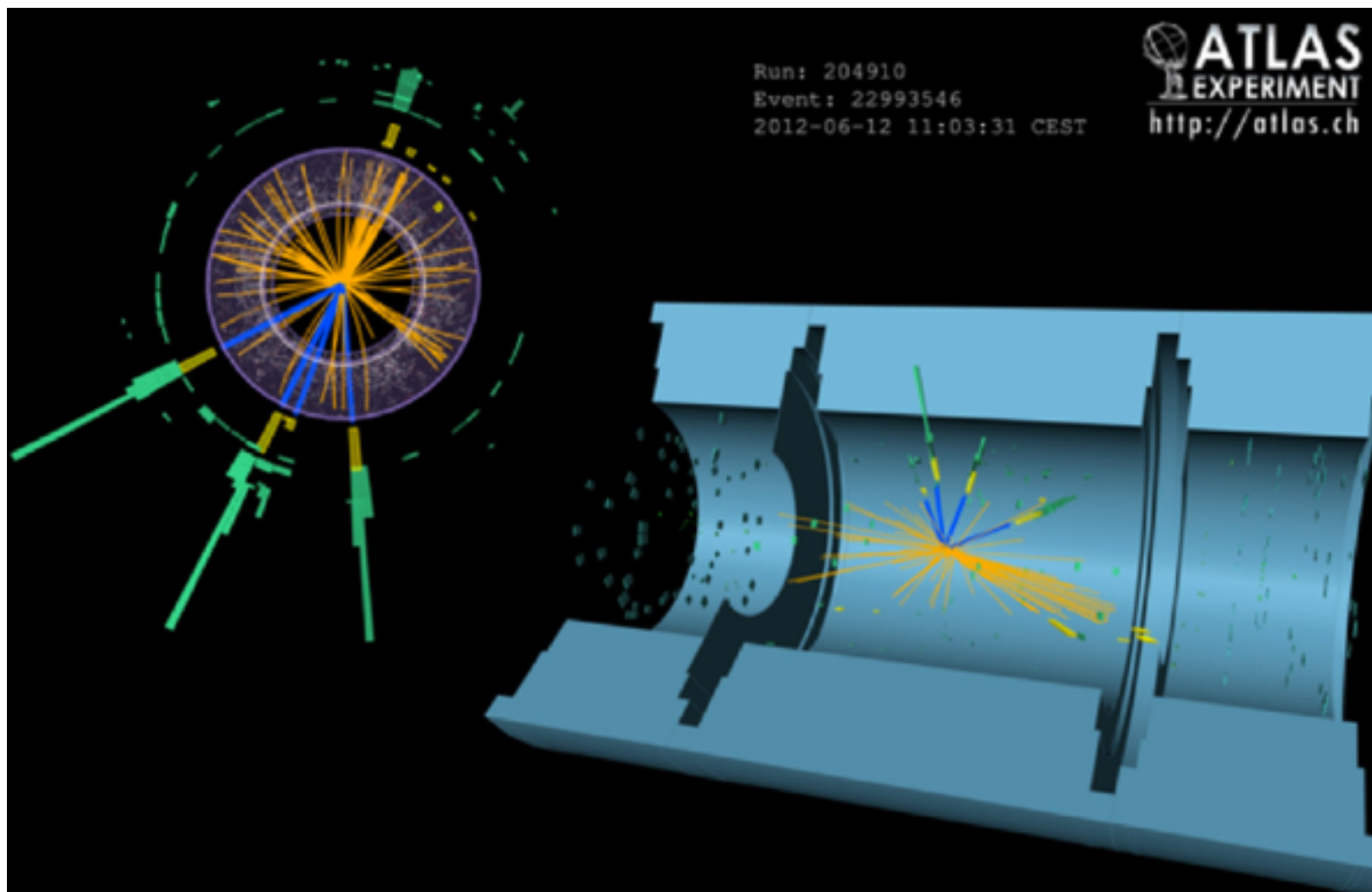
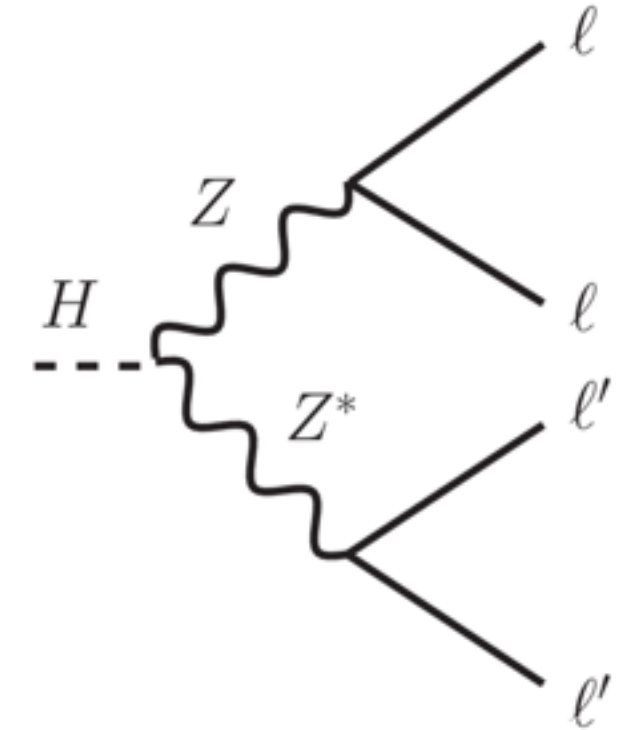


Higgs properties in the $H \rightarrow ZZ^* \rightarrow 4l$ final state

“Golden channel”:

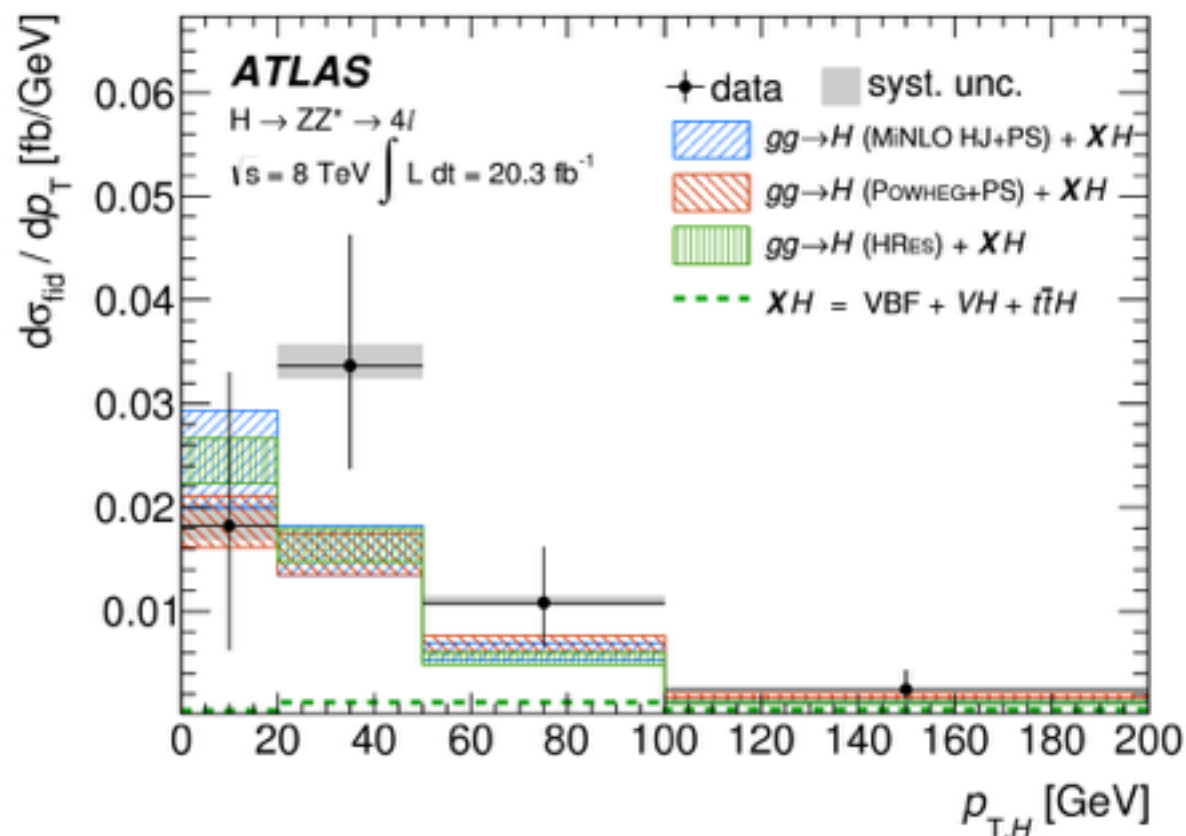
small event yields but very little background

→ excellent for precision measurements



Higgs property measurements

- mass, spin/parity, **cross-sections**
- can measure cross-sections
 - per production mode (ggF, VBF, etc.)
 - as a function of the Higgs transverse momentum or other variables



- if the Higgs is produced in association with dark matter particles
→ distorted spectrum
- also tests Standard model calculations

Conclusions

1. Higgs physics will be very exciting in the next years
2. Will use the Higgs boson as a tool to search for dark matter

