Standard Model@LHC

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- Successful theory of fundamental interactions
- Survived numerous experimental tests
- Only missing the Higgs boson
- LHC built to look for the Higgs and Physics beyond the Standard Model

LHC

Confirmation

Each proton is accelerated to an energy of 7 TeV

Interaction Point
Center of mass energy of 14 TeV

Produced particles (hopefully a few supersymmetric ones)
ATLAS

Composed of three parts sensitive to different properties of different particles

Length: ~ 46 m
Radius: ~ 12 m
Weight: ~ 7000 tons
~ $10^8$ electronic channels
~ 3000 km of cables

The Higgs: What do we look for?

We look at all the products of the collisions

Basic idea is to figure out the energy of all the produced particles and see what particles could have been there…
The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider."

University of Melbourne team in the Higgs analyses

Academics  Postdocs  PhDs  Masters

Graduated  Now PhD


For more information you can look at the ATLAS detector story on: http://atlas.ch
Higgs properties measurements

The Higgs has been discovered, now we need to measure its properties

We have a crucial role in the most important Higgs analyses in run 2:

1. Higgs CP in Higgs decaying into $\tau\tau$: there is only one Higgs?

2. Associate production HW, HZ: still not observed! Need to confirm if we really did see the Higgs.

3. Htt not yet observed and is very important: is the universe in a stable or meta-stable state?

4. WWWW scattering: Is the SM the ultimate theory?

Neutrino Masses

Why neutrinos have masses? Not in SM!
A natural way to explain the small mass of neutrinos: Seesaw mechanisms or Zee-Babu models $\rightarrow$ new particles at the LHC energies

Can be a combined project with Ray Volkas
Dark Matter

Hunting dark matter
Models of dark matter@ Collider

There is space for many projects. Can be together with N. Bell

A. Brennan, DM@LHC, Oxford 2014

Dark matter direct detection

elastic scattering on nuclei of the detector

Optimal sensitivity for \( M_{\text{WIMP}} \sim M_{\text{RECOIL}} \)

Low rate < \( \text{evt/day/kg of detector} \) \( \Rightarrow \) low background and large detector mass

Deep underground sites

Radio-purity of components

Active/passive shielding

Recoil energy \( \sim 20 \text{ keV} \) \( \Rightarrow \) Low energy threshold
Evidence from direct detection experiments, especially DAMA/LIBRA annual modulation signal. The phase and period of modulation are predicted: $t_0 = 152$ (June 2), $T = 1$ year.

**Dark Matter Modulation**

**DAMA/LIBRA**

- No south hemisphere experiments yet!
- Effort is starting now: background study, R&D on the detector, simulation studies (many master projects).
Link with astrophysics

Produce expected radio spectra a high redshift, study structure formation/21 cm signal

Possibility of a combined project with E. Barberio and S. Wyithe