Patrick Dunne

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Research Experience

2012-present **PhD Student**, *Imperial College*, Expect to submit early in 2016.

- Carried out searches for invisibly decaying Higgs bosons with the CMS detector focussing on the most powerful VBF production channel
- Led the combination of all CMS direct searches for invisible Higgs boson decays:
  - Carried out the statistical combination of the searches, studies of correlations between channels and set limits on the Higgs boson invisible branching fraction
  - Made public in CMS physics analysis summary HIG-15-012
- Led the search for invisibly decaying Higgs bosons in the VBF channel using parked CMS data from LHC run I
  - Responsible for trigger efficiency measurements, background estimation, systematic uncertainty studies and the setting of limits on the Higgs boson invisible branching fraction
  - Made public in CMS physics analysis summary HIG-14-038
- One of the lead analysers in the search for invisibly decaying Higgs bosons in the VBF channel using prompt CMS data from LHC run I
  - Performed background estimation and systematic uncertainty studies and set limits on the Higgs boson invisible branching fraction
  - Led the combination of this result with CMS searches in other channels, performing studies of correlations between the channels and limit setting
  - Made public in a paper selected for the cover of the European Physics Journal C and CMS physics analysis summary HIG-13-013
- Currently interpreting the results of these searches as limits on Higgs portal, two Higgs doublet and effective field theory dark matter models and studying data from LHC run II
- Co-founded a student seminar club to improve the presentation skills of students and inform the group of our research activities

2013 **Long Term Attachment**, *CERN*.

- Based at CERN for four months as part of my PhD research
- Carried out detector operations shifts on the CMS detector

2012 **Masters Project**, *University of Oxford*.

- Investigated the 'Qjets' algorithm for stochastic jet clustering as part of the ATLAS collaboration
- Identified improvements in the resolution of objects within jets with high transverse momentum

2005-2011 **Summer Projects**, *LLNL, Oxford, CERN, MIT.*

- 2011 - Lawrence Livermore National Laboratory (LLNL), California: Performed studies of metals at high pressure using the Jupiter Laser Facility
- 2010 - University of Oxford: Analysed data from the CDF experiment searching for non-standard model couplings in VBF produced W bosons
- 2007 - CERN: Assisted in assembling a frequency scanning interferometry system for monitoring of the ATLAS detector
- 2005 - MIT: Studied algorithms for robot control in the rapid prototyping group

Education

2008-2012 **MPhys Physics**, *University of Oxford*, First class honours degree.

2005-2008 **5 A levels, 11 GCSEs**, *Sutton Grammar School.*

- Grade A in physics, maths, further maths, electronics and chemistry A levels
- Advanced extension awards in physics (distinction) and maths (merit)

Academic Awards

2014 **Poster Prize**, *Imperial College Physics Department.*

- Prize at the postgraduate summer research symposium

2014 **Poster Prize**, *Imperial College Graduate School.*

- Won second prize in the college wide graduate school poster competition

2013 **Poster Prize**, *STFC.*

- Awarded for STFC high energy physics summer school poster competition

2012 **Peter Fisher Prize**, *Trinity College Oxford.*

- Prize awarded to the student in college with the best finals results in physics

2012 **Mitchell Scholarship for Outstanding Students**, *Trinity College Oxford.*

- Scholarship awarded to allow promising students to undertake research projects
- Funds won used to participate in studies of metals at very high pressures using the Jupiter Laser Facility at Lawrence Livermore National Laboratory

2010-2012 **Millard Scholarship**, *Trinity College Oxford.*

- Awarded for continued excellent performance in examinations

2010 **Gibbs Prize for Public Speaking**, *University of Oxford Physics Department.*

- Best talk in department-wide physics speaking competition with 170 entries

2010 **Examiners' Commendation**, *Oxford University Physics Department.*

- Awarded for outstanding performance in second year practical course

2009 **Millard Exhibition**, *Trinity College Oxford.*

- Awarded for performance in preliminary examinations

2008 **Neate Physics Prize**, *Sutton Grammar School.*

- Awarded to best physics student in the school

Teaching Experience

2014-present **Masters Student Supervision**, *Imperial College.*

- Supervised/supervising five students undertaking projects on searches for VBF produced invisible Higgs boson decays and their interpretations

2013-present **Undergraduate Lab Demonstration**, *Imperial College*.
- Demonstrated in second year radioactivity lab
- Voted best lab demonstrator by students in AC 2013/14 and 2014/15
- Responsible for interviewing students and marking their work

Outreach

2015 **Searching for the Higgs boson at the LHC**, *Sutton Grammar School*.

2014 **Royal Society Summer Exhibition**, *London*.

2014 **High Energy Physics Masterclass**, *Imperial College, London*.

2013 **Tour Guide**, *CMS detector, CERN*.

2013 **Bang Fair**, *ExCel Centre, London*.

2013 **High Energy Physics Masterclass**, *Imperial College, London*.

Memberships and Collaborations

2012-present **CMS Collaboration**.

2008-present **Institute of Physics**.

2012 **ATLAS Collaboration**.

Talks

2015 **CMS Higgs Group**, *Approval and pre-approval talks for analysis HIG-15-012*, A combination of searches for the invisible decays of the Higgs boson using the CMS detector.

2015 **IOP HEP Group Conference**, *Manchester*, Searches for invisible decays of the Higgs boson with the CMS detector.

2015 **CMS UK Collaboration Meeting**, VBF Higgs to Invisible - Towards Run II.

2014 **CMS Higgs Group**, *Pre-approval talk for analysis HIG-14-038*, Search for invisible decays of Higgs bosons in the vector boson fusion production mode.

2014 **PANIC Conference**, *Hamburg*, Searches for invisible decay modes of the Higgs boson with the CMS detector.

2014 **CMS Higgs Group**, *Approval talk for analysis HIG-13-030*, Search for invisible decays of Higgs bosons in the vector boson fusion and associated ZH production modes.

2014 **CMS UK Collaboration Meeting**, Higgs to invisible analyses at CMS.

Publications

Co-author on 139 citable papers as part of the CMS collaboration (inSPIRE HEP, October 2015) and have an h_{hep} index of 30. Selected papers with substantial contributions are given below:

2015 **CMS Collaboration**, *'A combination of searches for the invisible decays of the Higgs boson using the CMS detector'*, CMS Physics Analysis Summary - HIG-15-012.
- Was the main analysis contact for the CMS review process
- Led the analysis and performed the statistical combination of the separate searches, studies of correlations between channels and limit setting

2015 **CMS Collaboration**, *'Search for invisible decays of Higgs bosons in the vector boson fusion production mode'*, CMS Physics Analysis Summary - HIG-14-038.
- Was the main analysis contact for the CMS review process
- Led the analysis and was responsible for trigger efficiency measurement, background estimation, systematic uncertainty studies and setting limits on the Higgs boson invisible branching fraction

2014 **CMS Collaboration**, *'Search for invisible decays of Higgs bosons in the vector boson fusion and associated ZH production modes'*, Eur. Phys. J. C 74 (2014) 2980.
- One of the lead analysers responsible for background estimation, systematic uncertainty studies and the setting of limits on the Higgs boson invisible branching fraction in the most powerful VBF channel
- Led the statistical combination of the separate searches and studies of correlations between channels
- This paper has received 124 citations (inSPIRE HEP, October 2015)

2013 **CMS Collaboration**, *'Search for invisible decays of Higgs bosons in the VBF channel'*, CMS Physics Analysis Summary - HIG-13-013.
- One of the lead analysers responsible for background estimation and systematic uncertainty studies
- First limit on the Higgs boson's invisible branching fraction in the most sensitive VBF channel

Further Information

Computing.
- Experienced in C++, C, python and the ROOT analysis framework
- Use the MagGraph and Delphes packages for Monte Carlo event generation and detector simulation

Languages.
- English (native), French and German (limited working proficiency)

Positions of Responsibility.

2014-present Member of Imperial College high energy physics student seminar organising committee.

2010-2013 Youth representative to national council of the Scout Association.

2010-2012 Returning officer and webmaster for Trinity College Junior and Middle Common Rooms.

References

Dr. David Colling, *Reader in high energy physics*, Imperial College.
d.colling@imperial.ac.uk

Dr. James Brooke, *Research associate*, University of Bristol.
james.brooke@bristol.ac.uk

Dr. Marco Pieri, *Researcher*, University of California San Diego.
marco.pieri@cern.ch