

# 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 semiconductor tracker
  - 2005 - MIT: Studied algorithms for robot control in the rapid prototyping group

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## Education

- 2008-2012 **MPhys Physics**, *University of Oxford*, First class honours degree
- 2005-2008 **5 A levels, 12 GCSEs (2 short course)**, *Sutton Grammar School*
- Grade A in physics, maths, further maths, electronics and chemistry A levels
  - Advanced extension awards in physics (distinction) and maths (merit)

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## 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

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## 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  $h_{\text{hep}}$  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 MadGraph 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

**Prof. Gavin Davies**, *Professor of High Energy Physics*, Imperial College, [g.j.davies@imperial.ac.uk](mailto:g.j.davies@imperial.ac.uk)

**Dr. James Brooke**, *Research associate*, University of Bristol  
[james.brooke@bristol.ac.uk](mailto:james.brooke@bristol.ac.uk)

**Dr. Marco Pieri**, *Researcher*, University of California San Diego  
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