

# Patrick Dunne

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## Research Experience

- 2016-present **Postdoctoral Research Associate**, *Imperial College*
- Carried out neutrino oscillation analysis with the T2K experiment
    - Led the MaCh3 analysis group which uses Bayesian Markov chain Monte Carlo techniques to fit T2K near and far detector, and neutrino and antineutrino data
    - Lead MaCh3 analyser of T2K data. These analyses resulted in the first exclusion of the CP conserving values of  $\delta_{CP}$  at 95% confidence level, which has been accepted for publication in Physical Review Letters as an editor's suggestion
    - Responsible for incorporating advances in neutrino-nucleus interaction models into the T2K oscillation analysis
    - Currently working on adding new far detector samples to the analysis and combined analysis of T2K and NOvA data
  - Developed a High Pressure Time Projection Chamber (HPTPC) prototype culminating in a beam test at CERN
    - A leading member of a collaboration which has constructed the world's largest electroluminescence HPTPC
    - Responsible for construction and running of the experiment's data acquisition (DAQ) and slow control systems
    - Lead postdoc responsible for day to day management of students in lab during construction phase at Royal Holloway
    - Responsible for managing shifts of students, postdocs and faculty during assembly and disassembly of the detector at CERN
    - Responsible for managing on-call experts during 24 hour running at CERN
    - Responsible for detector arrival and departure logistics and transport at CERN
  - Working on DUNE far detector DAQ
    - Part of a team writing VHDL firmware for data compression of UK DAQ project
- 2018-present **Visiting Academic**, *Royal Holloway University of London*
- Granted whilst working at Royal Holloway during construction of HPTPC
- 2012-2016 **PhD Student**, *Imperial College*
- 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
    - Twice resulted in the world's best Higgs boson invisible branching fraction limit
    - Published in European Physics Journal C as the cover of the journal, CMS-PAS-HIG-13-030 and CMS-PAS-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 measuring trigger efficiency, backgrounds, systematic uncertainties and setting limits on Higgs boson invisible branching fraction
    - Published in Journal of High Energy Physics and CMS-PAS-HIG-14-038

- One of the lead analysers in the world's first 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
    - Published in European Physics Journal C as the cover of the journal, and CMS-PAS-HIG-13-013
  - Interpreted 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, published in Physical Review D
  - 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

- 2012-2016 **PhD High Energy Physics, Imperial College**
- 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 excellent performance in preliminary examinations
- 2008 **Neate Physics Prize**, *Sutton Grammar School*
  - Awarded to best physics student in the school

## Teaching Experience

- 2016-present **PhD Student Supervision**, *Imperial College*
  - Edward Atkin (2018-present): Co-supervisor, Development and construction of a high pressure time projection chamber
  - Toby Nonnenmacher (2017-present): Co-supervisor, Development and construction of a high pressure time projection chamber, and development of proton final state interaction models
  - Artur Sztuc (2016-present): Co-supervisor for the aspects of the PhD involving neutrino oscillation analyses on the T2K experiment
- 2014-present **Masters Student Supervision**, *Imperial College*
  - Maria Mironova (Imperial College), Hardware construction and data acquisition system development of a high pressure time projection chamber
  - Priyanka Sadhwani (Imperial College), Simulations of event reconstruction in high pressure time projection chambers
  - Anisha Kadri (Imperial College), Simulations of event reconstruction in high pressure time projection chambers
  - Xiyuan Xia (Imperial College), Simulations of event reconstruction in high pressure time projection chambers
  - Alastair Lutton (Imperial College), Simulations of event reconstruction in high pressure time projection chambers
  - Miha Zgubic (Imperial College), Interpretations of searches for invisible Higgs boson final states
  - Annika Monari (Imperial College), Selection optimisation for searches for invisible Higgs boson final states
  - Daniel Gordon (Imperial College), Selection optimisation for searches for invisible Higgs boson final states
  - Padraic Calpin (Imperial College), Searches for VBF produced invisible Higgs boson final states
  - Achilleas Fragkoulis (Imperial College), Searches for VBF produced invisible Higgs boson final states

- 2018-present **Bachelors Student Supervision, Imperial College**
- Hao-Yuan Chen (Imperial College), Processing of camera data taken during a high pressure time projection chamber beam test
  - Suvich Tachapalalert (Imperial College), Processing of camera data taken during a high pressure time projection chamber beam test
- 2017-present **Lecturer on PhD course on neutrino physics, Imperial College**
- Gave lectures on neutrino oscillation analysis techniques in current generation long baseline neutrino experiments
- 2017-present **Lecturer on computational physics course, Imperial College**
- Gave lectures on particle physics applications of computational techniques covered in the 4th year undergraduate course
- 2016-present **Third Year Tutorials, Imperial College**
- Responsible for teaching 6 classes of 4 students for the comprehensive exams, which is a synoptic problem solving focussed course covering all material from the first two years of the undergraduate program
  - Consistently good feedback in student evaluations, e.g.: “Great tutor, everything I could have wanted from the tutorial system”, “Best tutor for comprehensives - very approachable, his approach to questions was varied and stimulating!”, “Patrick was excellent, would highly recommend as a tutor”
- 2013-2016 **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

- 2018 **Gave lecture on neutrino oscillations at the High Energy Physics Masterclass, Imperial College, London**
- 2017 **Assisted at the High Energy Physics Masterclass, Imperial College, London**
- 2017 **Ran High Energy Physics stand at careers fair, Coombe Boys’ School**
- 2016 **Ran High Energy Physics stand at the Big Bang Fair, Sutton Grammar School**
- 2016 **Assisted at the High Energy Physics Masterclass, Imperial College, London**
- 2015 **Gave talk on Searching for the Higgs boson at the LHC, Sutton Grammar School**
- 2014 **Assisted at the Royal Society Summer Exhibition, London**
- 2014 **Assisted at the High Energy Physics Masterclass, Imperial College, London**
- 2013 **Tour Guide, CMS detector, CERN**
- 2013 **Assisted at the Bang Fair, ExCel Centre, London**
- 2013 **Assisted at the High Energy Physics Masterclass, Imperial College, London**

## Memberships and Collaborations

- 2018-present **DUNE Collaboration**
- 2017-present **HPTPC Collaboration**
- 2016-present **T2K Collaboration**

2012-2016 **CMS Collaboration**  
2008-present **Institute of Physics**  
2012 **ATLAS Collaboration**

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## Talks

- 2018 **Nu-print Workshop**, *Fermilab*, ‘Critical cross-section modeling issues for the oscillation program’
- 2017 **T2K-NOvA meeting**, *Tokai*, ‘T2K Oscillation Analysis Summary’
- 2017 **NuFACT 2017 Conference**, *Uppsala*, ‘Oscillation results and plans from the T2K experiment’
- 2016 **DMLHC Conference**, *Amsterdam*, ‘Latest results on invisibly decaying Higgs bosons’
- 2015 **IOP HEP Group Conference**, *Manchester*, ‘Searches for invisible decays of the Higgs boson with the CMS detector’
- 2014 **PANIC Conference**, *Hamburg*, ‘Searches for invisible decay modes of the Higgs boson with the CMS detector’

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## Seminars

- 2018 **University of Liverpool**, Latest neutrino oscillation results from T2K
- 2017 **Imperial College**, Latest neutrino oscillation results from T2K
- 2017 **University of Bristol**, Latest neutrino oscillation results from the T2K experiment
- 2016 **Royal Holloway University of London**, Higgs to invisible analyses at CMS

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## Service Positions

- 2018-present Imperial College Physics Department Postdoctoral Committee representative for High Energy Physics group
- 2018-present Seminar organiser for Imperial College High Energy Physics group
- 2018 Member of recruitment panel for new postdoc HPTPC postdoc at Imperial College
- 2017-2018 T2K Young representative for Europe
- 2018-present Fire warden for High Energy Physics group at Imperial College
- 2014-2016 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

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## Further Information

### Computing

- Experienced in C++, C, python and the ROOT analysis framework
- Basic knowledge of VHDL programming
- Have administered mysql and html servers on linux computers as part of a data acquisition system that required constant stable operation

### Languages

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