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Employment

07/16/2018 — Today

Postdoctoral Researcher, Robert Marshak fellow, University of Rochester,
Based at FNAL, working on T2K, DUNE and MINERvA.

T2K I convene the main T2K oscillation analysis and the near-detector constraints group. As such, I co-supervise about 7 Ph.D. students. Aside from convening, I have continued to develop the interaction model and oscillation analysis at T2K and remain an active developer and manager of key T2K analysis software. I primarily work on the joint near and far detector oscillation framework, developing the near-detector selections, the NEUT neutrino interaction generator, the T2KReWeight systematics package, and the neutrino interaction comparison tool NUISANCE.

DUNE Lending from my T2K experience, I was a central player in developing and implementing the DUNE interaction model, used in the DUNE long baseline analysis for the DUNE Technical Design Report. I also advised and discussed with the DUNE LBL analysers on methods and statistical techniques used on T2K.

I am heavily involved in the prototype for the DUNE near-detector, in which we are recycling MINERvA as a rock muon tagger, tracker and calorimeter for the proposed ArgonCube 2x2 demonstrator. I am supervising the reassembling of MINERvA and am responsible for modifying and integrating the updated MINERvA DAQ into the demonstrator system.

T2K-NOvA Being a T2K collaborator at FNAL has opened doors for the future T2K-NOvA joint analysis, of which I have been partaking in since its conception. I have significantly contributed to unifying the interaction model and statistical framework. I presented on the status of the project on behalf of the collaborations at the US-Japan Symposium of High Energy Physics.

T2K-SK T2K and SK have both signed MOUs to initiate a joint T2K beam and SK atmospheric oscillation analysis. I have taken a central role in developing the joint model of both experiments, which is set to be my main priority in late 2019.

Supervision During my time at Rochester I have supervised a Master's student on fitting neutrino interaction models to published MINERvA data using NUISANCE. I am co-supervising numerous Ph.D. students on the T2K oscillation analysis and implementing new uncertainties into the T2K systematics framework. I have also supervised MINERvA Ph.D. students on implementing alternative models into our frameworks, and working with NUISANCE to make multi-generator predictions for publications.

Education

10/01/2014 — 07/13/2018

Experimental High Energy Physics, Ph.D., Imperial College London.

I attended lectures in QFT, super-symmetry, experimental techniques in HEP, machine learning and general computing. On T2K I studied neutrino interaction modelling and using the near-detectors to minimise uncertainty in the oscillation analyses. I was an ECal expert for the ND280 detector during my stay in Japan. Funding was provided through the UK Science and Technology Facilities Council (STFC), and I was sponsored by NVIDIA's academic seeding project.

PhD thesis

Title *Neutrino oscillations, near-detector fitting and interaction physics at T2K*

Supervisor Dr. Morgan Wascko, Imperial College London

Description **Near-detector simulation fitting**

My PhD thesis concerned providing oscillation analyses at T2K with systematics constraints using external and near-detector data. I was responsible for the near-detector treatment for 2017 and 2018 analyses, which reduced uncertainty on ν_μ event rates at SK from 14% to 4%. I also made substantial improvement to the framework in terms of efficiency and methodology.

External neutrino scattering data

I looked at the current models' ability to predict published data and provided updated constraints on single pion production parameters for T2K. This machinery grew into the NUISANCE project (nuisance.hepforge.org)—an open-source framework providing users with the ability to compare and tune multiple neutrino interaction generators to over 250 published datasets. I remain an active developer and NUISANCE now has users from T2K, MINER ν A, NOvA, DUNE and MicroBooNE and is referenced by the Particle Data Group.

Generator development

I extensively worked with Monireh Kabirnezhad, now at University of Oxford, implementing her single pion production model and associated systematics for T2K and SK. I also extended the existing Rein-Sehgal implementation. Both models were used to estimate uncertainties for single pion production in 2018 oscillation analyses at T2K.

Detector experience, hardware

I was assigned ECal expert for the T2K ND280 detector during my long-term stay in Japan. I was supported with hardware from NVIDIA's academic seeding project.

Teaching and outreach**Supervision**

I supervised three Master's students during my Ph.D. The students worked on evaluating methods of neutrino energy reconstruction in a high pressure time projection chamber for DUNE.

Outreach

I organised student seminars and “coders club” events for the Imperial HEP group. Volunteered for Royal Society's LHCb and ALPHA “anti-matter matters” stall at the Imperial College Festival. Local helper for Neutrino 2016.

09/01/2010 — 06/01/2014**Theoretical Physics, MSci., University College London, First class Hons..**

I focussed on high energy physics and cosmology. Modules included particle physics, quantum field theories, general relativity, physical cosmology, dynamical systems, modelling in Mathematica and python, and a group project on surface physics applications and marketing. Master's thesis concerned global neutrino oscillation fits.

Master's thesis

Title *Determining the Neutrino Mass Hierarchy from neutrino oscillation experiments*

Supervisors Prof. Jenny Thomas, CBE

Description My MSci thesis developed a custom three flavour neutrino oscillation fitter, used to perform joint fits and sensitivity studies. I used public neutrino oscillation data from reactor (Daya Bay, RENO, Double Chooz and Kamland) and accelerator (MINOS and T2K) experiments to estimate required run-times to resolve the neutrino mass hierarchy. I assisted in PMT R&D, estimating efficiencies for the CHerenkov detectors In mine PitS experiment (CHIPS) at Fermilab.

09/01/2009 — 05/01/2010**Physics, kandidat (BSc.), University of Gothenburg, Sweden.**

Completed first year of undergraduate before moving to UCL – Awarded highest distinction.

Electronics & semi-conductors, Chalmers University of Technology, Sweden.

Emphasis on practical circuit-board work and simulations in PSpice – Awarded highest distinction.

01/08/2006 — 01/06/2009**International Baccalaureate, Hvitfeldtska Gymnasiet, Sweden, 37/45.**

“Extended essay” on cosmic muon decay, conducted at University of Gothenburg which was awarded highest distinction. Studied physics, mathematics, and chemistry at “higher level”.

Selected publications and notes**Publications**

“Search for CP violation in Neutrino and Antineutrino Oscillations by the T2K experiment with 2.2×10^{21} protons on target”, K. Abe *et al.*, *Phys. Rev. Lett.* 121, 171802, arXiv:1807.07891 [hep-ex].

"NUISANCE: a neutrino cross-section generator tuning and comparison framework", *P. Stowell, C. Wret, C. Wilkinson, L. Pickering et al.*, JINST, Vol 12, January 2017, arXiv:1612.07393[hep-ex].

"Tuning the GENIE Pion Production Model with MINERvA Data", *P. Stowell, C. Wret, C. Wilkinson, L. Pickering, and the MINERvA collaboration*, FERMILAB-PUB-19-093-ND, arXiv:1903.01558[hep-ex].

"Using world charged pion–nucleus scattering data to constrain an intranuclear cascade model", *E. S. Pinzon Guerra et al.*, Phys. Rev. D 99, 052007, arXiv:1812.06912[hep-ex].

"Measurement of neutrino and antineutrino oscillations by the T2K experiment including a new additional sample of ν_e interactions at the far detector", *K. Abe et al.*, Phys. Rev. D 96, 092006, arXiv:1707.01048[hep-ex].

"Comparisons and challenges of modern neutrino scattering experiments (TENSIONS2016 report)", *M. Betancourt et al.*, Physics Reports Volumes 773-774, arXiv:1805.07378[hep-ex].

Internal T2K notes "Constraining the Flux and Cross Section Models with Data from the ND280 Detector using FGD1 and FGD2 for the 2017 Joint Oscillation Analysis", *S. Bienstock, A. Kaborth, M. Scott, C. Wret*, 2017.

"A Joint ND280-SK $1R_\mu$ –SK $1R_e$ fit of neutrino and antineutrino-mode data using MCMC", *K. Duffy, P. Dunne, L. Haegel, A. Kaborth, E. Pinzon, C. Wret*, 2019.

"Bi-probability plots with an extra degree of freedom using MaCh3", *K. Duffy, P. Dunne, A. Kaborth, A. Sztuc, C. Wret*, 2018.

"NIWG model and uncertainties for 2017 oscillation analysis", *S. Bolognesi et al.*, 2017.

"MaCh3 joint ND+SK, $1R_\mu + 1R_e$ fit with SK ν_e CC- $1\pi^+$ sample", *K. Duffy, P. Dunne, L. Haegel, A. Kaborth, C. Wret*, 2016.

Selected talks and posters

Talks FNAL seminar (2019): "Neutrino interaction uncertainties in the GeV region: Past, Present, and Future".

NuSTEC, Neutrino-Nucleus Pion Production in the Resonance Region (Pittsburgh, 2019): "Impact of Neutrino-Nucleus Scattering Measurements on Resonance Modeling".

Tensions in Neutrino-Nucleus Scattering (Pittsburgh, 2019): "Tuning the GENIE interaction model to MINERvA single pion production data" and "Constraining systematics at T2K with near-detector data".

NuFact18 (Blacksburg, 2019): "The Role of Cross Sections in the Oscillaton Analysis: The T2K Experience" and "Recent Cross Section Results from the T2K Experiment".

MINERvA+NOvA meeting (FNAL, 2018): "Comparing the MINERvA and NOvA nominal and tuned models with NUISANCE".

T2K+NOvA meeting (FNAL, 2018): "Comparing the T2K and NOvA nominal and tuned models with NUISANCE", "The T2K ND280 and SK acceptance maps" and "Selections entering T2K oscillation analyses at ND280 and SK".

NuInt and State of the Nu-tion workshop (Toronto, 2017): "NUISANCE, a framework for comparing and fitting neutrino interaction generators".

Institute of Physics Joint APP and HEPP Annual Conference (Sheffield, 2018): "Constraining systematics for oscillation analyses at T2K using external and near-detector data".

Tensions Neutrino Cross-Section Workshop (Pittsburgh, 2016): "Tuning the single pion production interaction to external data".

Posters US-Japan Symposium on High Energy Physics, 2019: "Progress on a joint NOvA-T2K oscillation analysis".

NuInt (Toronto, 2019): "NUISANCE, NeUtrino Interaction Synthesiser Aggregating Constraints from Experiments".

Neutrino (London, 2016): "Evaluating single pion production in the NEUT interaction generator".

Phystat- ν (Tokyo, 2016): "Fitting neutrino cross-section models to external data".

Awards and Scholarships

Postdoc Robert Marshak Fellowship: Awarded by the University of Rochester to support young scientists to pursue innovative research.

PhD IoP travel grant: Supported by Institute of Physics travel grant for State of the Nu-tion workshop.

Nulnt funding: Received funding from conference to present talk and poster on NUISANCE.

NVIDIA GPU grant: Supported by NVIDIA hardware in 2016 through academic seeding project.

Undergraduate Willinska Stiftelsen: Awarded in 2011, 2012, 2013 for academic merit at UCL.

Nya Gyllensteen: Awarded in 2012 to allow continuation of studies in London.

Stiftelsen AAA: Awarded in 2011, 2012 for academic merit at UCL.

Felix Neuberghs stipendiefond: Awarded in 2010 for academic merit at University of Gothenburg and Hvitfeldtska Gymnasiet to encourage studies abroad.

Computing

Languages Formal training and developer experience in C (99), C++ (03, 11) and Fortran (77, 95). Good understanding and frequent user of python, bash, html5, and “arduino code”.

Accelerators Developer of OpenMP accelerated code for multi-threading applications. Formal training and developer in CUDA, implemented in oscillation analysis framework at T2K. Rudimentary use of OpenACC for GPGPU applications. OpenMP and CUDA implementation reduced analysis time by $\times 14$.

HEP tools Experienced user of neutrino interaction generators NEUT, GENIE and NuWro. Developer of NEUT generator, experience in model development and reweighting libraries. Experienced user of the ROOT and CERNLIB libraries.

Profilers, debuggers Frequent user of debuggers such as gdb and cuda-gdb. Have extensively used optimisation profilers like valgrind (massif, memcheck, cachegrind, callgrind), gperftools and the NVIDIA visual profiler.

Others Undergraduate projects in Mathematica and Matlab, focussed on modelling dynamic systems. Experienced git, svn and cvs user. Experienced Linux and Windows user.

Work experience

Vocational

2010–2016 **Freelance photographer**, London, UK.

Clients included business networking companies, nightclubs and universities.

2009 **Secretary for solicitor firm**, Gothenburg, Sweden.

Organised invoices in spreadsheets and contacted clients for meetings.

Voluntary

2011–2014 **UCLU Photographic Society**, UCL, London, UK.

Committee member of society throughout. Organised joint exhibitions, social activities, photographic services, inviting external speakers, and teaching studio and darkroom workshops.

2010–2012 **Volunteering Services Unit**, UCL, London, UK.

Volunteered through the university service at homeless shelters for young people.

2009 **Fibre-optic for housing co-operative**, BRF Galeasen, Gothenburg, Sweden.

Elected by the co-operative to research and inquire about upgrading the ageing local network. I managed planning, negotiations with contractors, and final proposals.