School of Mathematical and Physical Sciences  
Department of Physics & Astronomy  
Research Fellow in Quantum Device Engineering (Quantum Logic Implementation)  
(Full time, Fixed term initially 1 year, with possibility of extension of up to 4 years)  
Salary range: starting at £32,004 and rising to £38,183 per annum  
Expected start date: 20/2/2017 or as soon as possible thereafter

Applications are invited for a Research Fellow in Quantum Devices Engineering in the Ion Quantum Technology Group in Sussex Centre for Quantum Technologies at the Department of Physics & Astronomy at the University of Sussex. The position is part of the UK National Quantum Technologies programme.

Trapped ions are one of the most mature implementation to deliver practical quantum technologies. Recently we have developed a fundamentally different approach for trapped-ion quantum computing that uses voltages and microwave fields to implement quantum gate operations, instead of lasers. This new approach is based on individually-controlled voltages applied to each logic gate location, analogous to a traditional transistor architecture within a classical computer processor. We have already implemented the core ingredient for this new method, we demonstrated a two-qubit quantum gate producing a maximally entangled state with fidelity close to the fault-tolerant threshold. This quantum gate also constitutes a simple-to-implement tool for quantum metrology, sensing and simulation. More details are available [here](http://www.sussex.ac.uk/physics/iqt/). This project focuses on further increasing the fidelity and speed of the quantum logic operations. Making use of our state-of-the-art microfabricated ion trap architectures, the project also includes the application of quantum gate operations to a larger number of ions to perform quantum algorithms and quantum simulations. The aim is to aid in the construction of a quantum computer demonstrator device and a quantum simulation engine at the University of Sussex.

The successful applicant should have an experimental PhD in a field related to our research area such as atomic physics, optical physics or quantum physics along with a good publication record. Previous ion trapping experience would be desirable. Some of the typical tasks for this position include operation of high power microwave setups, laser systems, optical setups and ultra-high vacuum setups as well as carry out quantum information science experiments and perform simulations of quantum systems. The group currently spans 5 Postdoctoral Fellows, 14 PhD students, 5 undergraduate students, and one member of faculty. The group has collaborations with universities and other research facilities around the world. The successful candidate is expected to actively engage in our research program, provide guidance to undergraduate and postgraduate students and to participate in the strategic planning of the group. The salary offered will be appropriate to the qualifications, standing and experience of the successful candidate.

Applicants are encouraged to also look at our other three current openings and apply for the most suitable position(s).

You can find out more about the group at:  
[http://www.sussex.ac.uk/physics/iqt/](http://www.sussex.ac.uk/physics/iqt/)

For more information, please email the head of group,  
Prof Winfried Hensinger  
(Professor of Quantum Technologies)
A short film about Professor Hensinger’s work can be found here. A popular science lecture given by Prof. Hensinger explaining the principles of quantum computing at the US Department of Energy can be found here.

Some recent media coverage about the group’s work can be found here:
Profile interview with Prof Winfried Hensinger
The supercomputer of the future? BBC NEWS
BBC Radio 4 Today interview, go to 2:51:14
Quantum computing breakthrough: UK scientists develop technique to greatly simplify trapped ions International Business Times
BBC WORLD SERVICE World Update, go to 18:07

Closing date for applications: 10th February 2017

Please include with your completed application form a CV, cover letter, the contact details of three referees and a list of relevant publications.

The University is committed to equality and valuing diversity, and applications are particularly welcomed from women and black and minority ethnic candidates, who are under-represented in academic posts in science, engineering and mathematics at Sussex.

For full details and how to apply see www.sussex.ac.uk/jobs

The University of Sussex is committed to equality of opportunity

2. Senior leadership and management

The Vice-Chancellor (Professor Adam Tickell) is the senior academic officer and, as Chief Executive, is responsible to the University Council for management of the University. He is supported by an executive group which includes the three Pro-Vice-Chancellors, the Registrar and Secretary, the Director of Finance and the Director of Human Resources. The Heads of the Schools of Studies at Sussex report to the Pro-Vice-Chancellors.

3. The School of Mathematical and Physical Sciences

The School of Mathematical and Physical Sciences was created in 2009 as part of a University wide restructuring. It brings together two outstanding and progressive departments – Mathematics, and Physics and Astronomy. The School aims to capitalise on the synergy between these subjects to deliver new and challenging opportunities for faculty and students.

The School of Mathematical and Physical Sciences combines pioneering research and stimulating teaching in an interdisciplinary academic setting. The faculty work at the frontiers of their fields, as is reflected in the recent growth of both subjects. Each department has a number of thriving research groups and links with outside agencies.

4. The Department of Physics and Astronomy

The Physics & Astronomy Department currently has 39 faculty divided into multiple research groups: Astronomy; Theoretical Particle Physics; Material Physics, Experimental Particle
Physics; and Atomic, Molecular & Optical Physics, Mathematical Physics, and the Sussex Centre for Quantum Technologies.

In the highly acclaimed Thomson Scientific 2006 ranking of the research impact of all departments in UK universities, the University of Sussex came top in Physics and in Space Science/Astronomy. It was ranked 8th in the UK in the Research Assessment Exercise of 2008. It was ranked 5th in Great Britain and 37th in the world according to the Times Higher Education World University Rankings (2010). Sussex is ranked 5th in UK for Physics in the Times Good University Guide (2013), and scored 100% for overall satisfaction in the 2013 National Student Survey.

We are part of the South East Physics Network (SEPNet) - a consortium of nine physics departments of the University of Sussex, University of Kent, Queen Mary University of London, Royal Holloway University of London, Southampton University, University of Surrey, University of Portsmouth, University of Hertfordshire, and the Open University. This has been awarded substantial government funding (from HEFCE) to support vital UK science research, teaching and development.

The Department has approximately 350 undergraduate students, 30 MSc students, 50 PhD students and 15 postdoctoral fellows.

Research groups
4.1. The Astronomy Centre

Current research interests are: physics of the early Universe; constraining cosmological models; numerical simulations of structure formation; extragalactic survey science; and galaxy formation and evolution. The first of these has strong overlaps with the Theoretical Particle Physics group.

The Centre consists of 12 permanent faculty members: Chris Byrnes (Royal Society URF), Ilian Iliev, Antony Lewis, Jon Loveday, Seb Oliver (Director of Research & KE for the School), Kathy Romer, Mark Sargent, David Seery, Robert Smith, Peter Thomas (Director of the Astronomy Centre), Stephen Wilkins; there are currently 8 postdoctoral researchers and 22 PhD students. The group’s main source of funding comes from a consolidated grant Science and Technology Facilities Council (STFC) and EU funding in the form of Starting, Consolidator and Cooperation grants.

The Centre’s activity is focussed around three themes: Theoretical cosmology, with focus on inflationary cosmology, the cosmic microwave background, dark energy, and statistical methods; Simulations/modelling of reionization, large-scale structure, galaxy and cluster formation; Observations; surveys of galaxies and clusters from the infra-red through to X-ray.

We have major roles in extra-galactic surveys: Seb Oliver coordinates the Herschel Multi-tiered Extra-galactic Survey (HerMES) and EU funded Herschel Extra-galactic Legacy Project (HELP); Kathy Romer leads the XMM Cluster Survey (XCS); Jon Loveday leads the Galaxy Mass Assembly (GAMA) spectra working group. We are partners in various supercomputing collaborations including COSMOS and VIRGO. We have key roles in Cosmology and Dark Energy studies including Planck and the Dark Energy Survey.

The Centre has access to substantial computing resources, including locally and various supercomputing consortia.

The Astronomy Centre’s web site is http://www.sussex.ac.uk/astronomy/
4.2. The Atomic, Molecular & Optical (AMO) Physics Group

Research in the AMO group at Sussex is devoted to the study of fundamental physics and quantum effects and technologies using the techniques of atomic and laser physics. The research covers both experimental and theoretical AMO physics.

There are six experimental faculty in the AMO group. Winfried Hensinger is developing new quantum technologies using trapped ions. His group is developing a quantum simulation engine and they are in the process of constructing a large-scale trapped-ion quantum computer. Another research area is the development of portable quantum sensors. Peter Kruger, is starting a major activity in Quantum Systems and Technologies. This will involve a range of experiments and device development at the interface of cold atomic and condensed matter physics. Matthias Keller is investigating the interaction of single photons and ions assisted by optical cavities with the aim of generating large scale entangled states and developing quantum networks. His work also includes the physics of trapped molecular ions. Alessia Pasquazi is working on ultra-fast photonics and also on optical sources for quantum technologies. Marco Peccianti’s research is focussed on Tera-Hertz Imaging and applications of Tera-Hertz radiation. Jose Verdu’s team is developing a novel Penning trap technology based upon superconducting microwave transmission-lines. This work has applications to circuit-QED with trapped electrons, quantum metrology and mass spectrometry.

There are four theorists in the AMO group. Jacob Dunningham (AMO group leader) is investigating Bose-Einstein condensates and quantum technologies with a particular emphasis on quantum metrology, sensing, and imaging. Claudia Eberlein works on quantum field theory applied to atomic, optical, and nano-physics. Barry Garraway is developing new kinds of atom traps with applications to quantum information and quantum metrology and in addition works on cavity QED and non-Markovian dynamics. Diego Porras applies the techniques of quantum optics to condensed matter systems.

Along with the faculty there are currently 14 research fellows and 40 PhD students in the AMO group. Sources of funding include the European Union, EPSRC and European and national research networks on quantum information processing. The Atomic, Molecular & Optical Physics group web site is http://www.sussex.ac.uk/amo

4.3. The Experimental Particle Physics (EPP) Group

The Sussex EPP group counts ten permanent faculty members, plus one Emeritus Professor. The group’s main source of funding is the Science and Technology Facilities Council (STFC), with additional support from the European Research Council (ERC) and the Royal Society.

Antonella De Santo, who is also the EPP Group Leader, together with Fabrizio Salvatore has established and leads a fast-growing team working on the ATLAS experiment at the CERN Large Hadron Collider (LHC). The other ATLAS faculty members are Lily Asquith, Alessandro Cerri and Iacopo Vivarelli. The group has a long-standing leadership in the search for supersymmetry at ATLAS, and also leads in the areas of jet physics, Higgs physics, flavour physics, and top physics. Sussex also holds key responsibilities in the ATLAS High-Level Trigger (HLT) system, including in view of future LHC and ATLAS upgrades. It also has a major role in the proposed Level-1 tracking trigger project, for use by ATLAS at the High-Luminosity LHC.

Historically, the Sussex EPP is world-renowned for its high-precision measurement of the neutron electric dipole moment (EDM). The EDM is uniquely sensitive to physics beyond the
Standard Model, and the group is currently involved in the nEDM experiment at the PSI. Philip Harris leads this effort at Sussex together with Clark Griffith and Visiting Senior Lecturer Mike Hardiman.

Sussex EPP also boasts a vibrant and expanding programme of neutrino physics. Sussex is one of the leading UK institutes involved in the SNO+ experiment, which seeks to determine whether the neutrino is its own antiparticle by searching for neutrino-less double-beta decays. Simon Peeters leads the SNO+ effort at Sussex, together with Lisa Falk and Jeff Hartnell. Additionally, Jeff Hartnell was recently awarded substantial ERC funding to work on the Fermilab-based NOvA neutrino oscillation experiment and the future long-baseline programme (LBNE/LBNF). Peeters and Falk are also involved in LBNE/LBNF.

Sussex EPP currently has ten postdoctoral level researchers, eleven PhD students, three engineer/technician posts directly involved in EPP research, and a Linux system administrator. We have a number of well-equipped laboratories, and we enjoy good access to the University’s technical facilities, including shared technicians. Sussex EPP researchers have uncontented access to a dedicated Grid Tier-3 cluster, and Sussex is a member of the SouthGrid Tier-2 grouping of Grid-enabled research institutions in the South of England.

Sussex EPP has close links with colleagues in the Sussex Theoretical Particle Physics group and with other partners in the SEPnet consortium.

The Experimental Particle Physics group web site is http://www.sussex.ac.uk/epp

4.4. The Materials Physics Group

This is a new research group set up by Professor Alan Dalton who joined the Department from Surrey University in February 2016.

A number of new appointments are underway.

The group will focus on understanding the fundamental structure-property relationships in materials containing one- and two-dimensional structures such as carbon nanotubes, graphene and other layered nanomaterials. Prof Dalton is particularly interested in developing viable applications for nano-structured organic composites (mechanical, electrical and thermal). He is also interested in the directed-assembly and self-assembly of nanostructures into functional macrostructures and more recently interfacing biological materials with synthetic inorganic and organic materials and associated applications.

The Materials Physics group webpage is http://www.sussex.ac.uk/materials-physics/

4.5. Sussex Centre for Quantum Technologies

The Sussex Centre for Quantum Technologies is focused on the exploitation and development of disruptive quantum technologies. The Centre hosts ten research groups covering the broad spectrum of quantum technologies as well as hosting a number of associate member groups that share significant overlap with our mission.

Our research groups are involved in the UK Quantum Technology Hub on Networked Quantum Information Technologies and the UK Quantum Technology Hub for Sensors and Metrology as well as DSTL initiatives, Centres for Doctoral Training and numerous national and international collaborations. The centre is integrated within the UK National Quantum Technology Programme. The centre leadership consists of Prof. Winfried Hensinger (director) and Prof. Jacob Dunningham (deputy director).
The Centre’s five experimental research groups are led by Prof Winfried Hensinger (Ion Quantum Technology), Dr Matthias Keller (Ion Trap Cavity-QEG and Molecular Physics), Prof Peter Krueger (Quantum Systems and Technologies), Dr Alessia Pasquazi (Ultrafast Photonics), Dr Marco Peccianti (Tera-Hertz Imaging), and Dr Jose Verdu (Electrons in Quantum Circuits). The centre also hosts ground breaking theory groups led by Prof Claudia Eberlein (Quantum Field Theory in AMO), Prof. Jacob Dunningham (Quantum metrology, Bose-Einstein condensates and Entanglement), Prof Barry Garraway (Trapped Ultracold Atoms &Theoretical Quantum Optics) and Dr Diego Porras (Quantum optics and condensed matter systems).

The Sussex Centre for Quantum Technologies features numerous state-of-the-art quantum technology laboratories along with key infrastructure. In addition to the high quality research environment, training plays an integral role and the centre hosts the pioneering MSc in Frontiers of Quantum Technology as well as carrying out specialized quantum technology training for doctoral and postdoctoral researchers.

The Sussex Centre for Quantum Technologies web page is

http://www.sussex.ac.uk/scqt/

4.6. The Theoretical Particle Physics (TPP) Group

The current research activities in the group are: particle astrophysics and cosmology, including cosmological phase transitions, baryogenesis, topological defects, inflation, dark matter, and dark energy; collider and low-energy phenomenology, including Higgs and BSM physics, flavour, QCD, supersymmetry and extra dimensions; and quantum field theory, including quantum gravity, tests the asymptotic safety conjecture, the renormalisation group, effective theory and strong coupling phenomena.

The group consists of Andrea Banfi, Xavier Calmet, Mark Hindmarsh, Stephan Huber (group leader), Sebastian Jaeger, Daniel Litim, Veronica Sanz, Emeritus Professors David Bailin and Norman Dombey, two Postdoctoral Research Fellows, and about 20 PhD and MSc students. The group maintains a research consortium with Royal Holloway (Nikolas Kauer) and University College London (Frank Deppisch). The group’s research funding comes mainly from the UK Science and Technology Facilities Council (STFC), and is also supported by the European Science Foundation and the Higher Education Funding Council for England.

The group has close links with both the Experimental Particle Physics and Astronomy research groups, and is a member of the NExT Institute, a regional collaboration for particle physics phenomenology. It benefits from excellent computing resources including a Linux-based system of workstations and servers and access to the University’s High Performance Computing cluster.

The Theoretical Particle Physics group web page is http://www.sussex.ac.uk/tpp/

The Ion Quantum Technology group is headed by Prof. Winfried Hensinger. Their aim is to develop new quantum technologies, in particular, the trapped ion quantum computer as well as trapped ion quantum simulators and trapped ion quantum sensors. For this purpose, research focuses on applied experimental quantum information science, quantum devices engineering, quantum control and large scale entanglement generation. We also develop a new generation of quantum microchips based on Silicon manufacturing technology that provide the core for the quantum technology devices we develop. We are in the process of constructing a quantum simulation engine and a large-scale trapped-ion quantum computer. We also develop portable quantum sensors. The group is part of the UK Quantum
5 Job Description

Job Title: Research Fellow in Quantum Device Engineering (Quantum Logic Implementation)
Grade: Research Fellow, Grade 7
School: Mathematical and Physical Sciences
Location: Pevensey II
Responsible to: Prof Winfried Hensinger through to Head of School
Direct reports: n/a
Key contacts: Prof Winfried Hensinger
Role description: Research Fellow I is an early career-grade research position. Post-holders will be expected to contribute to the work of the research team, and also to develop their research skills with support from more experienced members of staff.

PRINCIPAL ACCOUNTABILITIES

To engage in individual and/or collaborative research activity resulting in high-quality publications; and to develop research funding and knowledge exchange income individually or in collaboration with others, as appropriate, depending on the size and scope of the bid. To contribute to School teaching activities

KEY RESPONSIBILITIES

1. Research, Scholarship & Enterprise

1.1 Develop research objectives and proposals for own or joint research, at acceptable levels, with assistance if required.
1.2 Conduct research projects individually and in collaboration with others.
1.3 Analyse and interpret research findings and draw conclusions on the outcomes.
1.4 Produce high-quality research outputs for publication in monographs or recognised high-quality journals, or performance/exhibition, as appropriate, and contribute to the School’s REF submission at acceptable levels of volume and academic excellence.
1.5 Contribute to the preparation of proposals and applications to external bodies, for example for funding purposes.

1.6 Individually or with colleagues, explore opportunities for enterprise activity, knowledge exchange income and/or consultancy, where permissible.

1.7 Build internal contacts and participate in internal networks and relevant external networks in order to form relationships and collaborations.

1.8 Continually update knowledge and understanding in field or specialism, and engage in continuous professional development.

2. **Teaching & Student Support**

2.1 Undertake teaching duties, if required.

2.2 Assist in the assessment of student knowledge and supervision of student projects if required.

2.3 Assist in the development of student research skills, for example as part of a postgraduate supervision team.

3. **Contribution to School & University**

3.1 Attend and contribute to relevant School and project meetings.

Undertake additional duties, as required by the Principal Investigator and/or Head of School.

4. **Role-specific duties**

1. Operation and construction of ion trap experiments

2. Participate in the development of group strategy and its efficient implementation

3. Supervision of undergraduate and doctoral students

4. Dissemination of research findings

5. Assist and when required take a lead in the preparation proposals and reports to external bodies, for funding and contractual purposes.

6. Participate in shaping research directions and leadership making use of detailed expertise in the research area

Specific Duties

1. **Operation and construction of ion trap experiments**

   This involves work with state-of-the-art ion trap experiments, operation of microfabricated ion trap chips, implementation of coherent quantum operations along
with the day to day support of the experiment such as building and upkeep of electronics and other experimental components.

3. **Supervision of undergraduate and postgraduate students**

Helping in the supervision of the undergraduate and postgraduate students in the group taking a lead in doing so when required

4. **Dissemination of research findings**

Dissemination routes that the candidate is expected to assist in are: conference presentations; writing articles for physics journals

5. **Assist in the preparation proposals and reports to external bodies, eg for funding and contractual purposes.**

This involves underlying physics calculations as well as the preparation of materials as well as any required developments for group strategy.

This Job Description sets out current duties of the post that may vary from time to time without changing the general character of the post or the level of responsibility entailed.

**INDICATIVE PERFORMANCE CRITERIA**

- Regular published output of original research at international level (refereed journal papers, monographs, book chapters, text-books).
- Other evidence of original research contribution to the field, such as through invited conference contributions, membership of editorial panels etc.
- Evidence of successful co-supervision of doctoral students.
- Evidence of the successful supervision of others within the research group.
- Evidence of contribution to the process of obtaining competitive/peer reviewed research support funding or collaboration in significant research projects with institutions of equivalent standing.
- Involvement in the creation, transfer and use of the results of research through a range of knowledge exchange activities.
- Success in transferring research results to commercial, professional, public sector or other practical use.
- Evidence of successful engagement in teaching or supervision.
6 Person Specification

ESSENTIAL CRITERIA

1. Normally educated to doctoral level, or other equivalent qualification, or appropriate level of experience, as appropriate to the discipline (see role-specific criteria below).

2. Evidence of engagement in high-quality research activity.

3. Excellent presentation skills, with the ability to communicate effectively, both orally and in writing, with students, colleagues and external audiences.

4. Ability to work individually on own initiative and without close supervision, and as part of a team.

5. Ability to exercise a degree of innovation and creative problem-solving.

6. Excellent organisational and administrative skills.

7. Ability to prioritise and meet deadlines.

8. Excellent IT skills.

DESIRABLE CRITERIA

1. Emerging track record of high-quality publications in reputable journals and other appropriate media of similar standing.

2. Experience of generating research or knowledge exchange income.

ROLE-SPECIFIC CRITERIA

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<th>SKILLS / ABILITIES</th>
<th>Essential</th>
<th>Desirable</th>
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<tr>
<td>Ability to carry out original research in experimental cold atom / ion research</td>
<td>✓</td>
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<td>Skills working with optics and diode lasers</td>
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<td>Competence in using data acquisition software (LabView) and data analysis software</td>
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<td>Good communication skills, written and oral</td>
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<td>Electronics skills</td>
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<td>Writing journal articles</td>
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<td>Skills in operating microfabricated ion traps</td>
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<td>Clear leadership potential in the specific research area</td>
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<td><strong>KNOWLEDGE</strong></td>
<td>Essential</td>
<td>Desirable</td>
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<tr>
<td>Atomic physics, quantum information, quantum optics</td>
<td>✓</td>
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<td><strong>EXPERIENCE</strong></td>
<td>Essential</td>
<td>Desirable</td>
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<td>Experiments in atomic or ion physics and stabilization and frequency-locking of diode lasers</td>
<td>✓</td>
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<td>Coherent manipulation of neutral atoms or ions</td>
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<td>Operation of microfabricated ion traps</td>
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<td>Handling of ultra-high vacuum equipment</td>
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<td>Experiments with cryogenic vacuum systems</td>
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<td>Proven record of writing journal articles</td>
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<td>Proven record of writing high profile journal articles</td>
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<td><strong>QUALIFICATIONS</strong></td>
<td>Essential</td>
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<td>PhD in experimental atomic physics, quantum optics or microfabrication or equivalent level of scholarly achievement</td>
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<td>A proven track record of experience in experimental quantum optics, microfabrication or atomic physics</td>
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<td><strong>PERSONAL ATTRIBUTES AND CIRCUMSTANCES</strong></td>
<td>Essential</td>
<td>Desirable</td>
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<td>Ability to work independently</td>
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<td>Active commitment to team work</td>
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<td>Demonstrated leadership abilities</td>
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