SUPERPOSITION

Evaluation of 2013 pilot project for the Institute of Physics

by Elizabeth Lynch
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EXECUTIVE SUMMARY

*Superposition* is a pilot artist-in-residency programme that aims to explore and test ways in which the Institute of Physics (IOP) can work with artists to open up contemporary physics. *Superposition* enables a penetrating dialogue between a physicist and an artist over a considerable time period. It offers the artist a flexible and open opportunity to develop an ambitious piece of new work. The programme seeks to stimulate discussion among adults about the role that physics plays in their lives and offer a platform for physicists to engage with specialists outside their field.

The IOP commissioned artist Lyndall Phelps to collaborate with Dr Ben Still to create an artwork inspired by his research in the field of particle physics. They spent several months in dialogue, exploring particle detection and detectors, and data capture and visualisation. This in-depth conversation resulted in the creation of *Covariance*, which was exhibited in the ice wells beneath the London Canal Museum, 24 August – 20 October 2013.

The purpose of this evaluation is to capture the good practice and the learning from this pilot project in order to inform the development of the *Superposition* programme in future; to explore how the artist and physicist perceive the impact of the collaboration on their work; to assess the audience response in terms of the project’s stated aims and outcomes and to consider the role that IOP’s new initiative can play within the arts and science communities.

Both the artist and the scientist articulate benefits in terms of interdisciplinary insight, research and professional development. The project has contributed to a positive shift in the zeitgeist around scientists’ perceptions of the benefits of arts/science collaborations.

The partnership with London Canal Museum offered an ideal subterranean location for the installation, which developed in response to the site and built further resonances into the work. The venue had the advantages of a central London location in the new creative hub of King’s Cross and the organisation’s desire to build their existing audience by attracting new visitors to its restored Victorian ice wells.

The careful and thorough planning by the IOP Head of Public Engagement and her freelance team of Project Manager and Curator ensured that the project delivered on all its key objectives. The project successfully obtained Arts Council England funding, facilitated a genuinely open collaboration process for the artist and scientist, attracted high-profile media attention and exceeded estimated audience attendance figures by 31%. The recommendations arising from this evaluation’s findings are chiefly about maintaining, refining and developing the approach established during the pilot rather than making significant changes.

The artist and the scientist reached new audiences for art through their exploration of challenging and complex physics research, central to our understanding of the world. The findings on audience response were overwhelmingly positive, with 87% (254/291) of the open feedback comments articulating critical appreciation of the artwork in terms of aesthetic, intellectual, spiritual and sensory experiences. They also enjoyed how the work illuminated the science concepts and the strong sense of place afforded by the unusual
heritage setting. Those less engaged with the work – either critical of the art or the communication of or insight into the science – often offered constructive feedback.

There were a significant number of statements indicating an increased understanding of contemporary physics research, the desire to find out more about the ideas explored by Covariance and an increased understanding of the creative process and research involved in producing the artwork. Opportunities for discussion were offered through interaction with trained Visitor Assistants, recruited from backgrounds in arts, physics and heritage, and two In Conversation events.

Leading commissioners and advisors expressed the view that physics themes are under-represented in the landscape of arts/science collaborations and that the IOP could play a leading role in this area of practice. The strong and distinctive features of the Superposition residency programme are its research-based focus, the open nature of the commission and the length of time allowed for in-depth dialogue and process. Superposition should become a biennial project for the IOP. The organisation’s willingness and commitment to work with leading artists and arts specialists to develop Superposition will bring credibility to their platform as they plan future collaborations and partnerships.
INTRODUCTION

1.1 Institute of Physics

The Institute of Physics is a leading scientific society. They are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application.

They engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, they are world leaders in professional scientific communications. www.iop.org

1.2 Superposition programme and Covariance

Superposition is a pilot artist-in-residency programme with the aim of engaging adult audiences with contemporary physics. The Physics in Society team at the Institute of Physics (IOP) commissioned artist Lyndall Phelps to collaborate with particle physicist Ben Still from Queen Mary, University of London to create an artwork inspired by Ben’s research in the field of particle physics.

Ben and Lyndall spent several months in dialogue, exploring particle detection and detectors, and data capture and visualisation. This in-depth and evolving conversation was charted on a project blog, www.physics.org/superposition, and resulted in the creation of a new installation, Covariance, which was exhibited in the ice wells beneath the London Canal Museum (LCM) from 24 August to 20 October 2013.

Superposition was initiated and realised by IOP in collaboration with Annabel Lucas (Curator) and Sally Sheinman (Artist Advisor). The project was delivered in partnership with Martin Sach and his team at the LCM. This pilot phase of Superposition has been funded by IOP, the Arts Council England and supported by Gina Agnew Contemporary Art (the commercial gallery representing Lyndall).

Superposition was chosen as the title of this pilot programme to reflect two very different disciplines (art and physics) coming together, perhaps unexpectedly and perhaps with unexpected consequences. Ben and Lyndall jointly gave the artwork its own title, to identify it as one of many projects in the Superposition programme of art commissions. The title, Covariance, is a physics term that reflects their coming together (co) from different disciplines, to influence each other’s thinking and seeing (variance).

The programme schedule was as follows:

- Planning and commissioning from 28 May 2012; Lyndall commissioned October 2012
- Collaboration process from October 2012 to April 2013

1 “Superposition” is a physics concept describing two different phenomena:
- when two waves meet they overlap and interact, sometimes they will add to make a bigger wave, sometimes they will cancel each other out, and often it is a combination of both. The single resulting wave is a superposition of the two original waves
- in quantum mechanics, instead of thinking about a particle being in one state or changing between a variety of single defined states, particles are thought of as existing across all the possible states at the same time. This situation is known as a superposition.
1.3 Aims of Superposition

The Physics in Society team at IOP aims to bring positive experiences of physics to public audiences who do not seek out science and do not expect to be exposed to physics. To do this, the team seeks out audiences wherever they may be and provides them with tailor-made physics-related activities. Superposition aims to engage adult audiences with contemporary physics through contemporary visual art, reaching audiences online and within non-physics venues. The intention is not to explain or illustrate the physics concepts but to start conversations. The stated aims of Superposition are:

- To explore ways in which IOP can work with artists to engage new audiences in the field of contemporary physics
- To commission ambitious artworks that represent and penetrate contemporary physics, while also being broadly accessible and having meaningful impact
- To offer artist(s) unique, flexible and open opportunities to engage with contemporary physics and create new work
- To offer physicists a platform to engage non-physics specialists with their area of research and explore creative ways to represent their work visually that will appeal to a public audience
- To stimulate broader discussion among independent adults about the role that physics plays in their lives, while appreciating the cross-disciplinary ways artists are working.

Superposition will be seen as a success if it reaches new audiences, results in an awe-inspiring and rigorous new artwork and enables the target audience to positively engage with contemporary physics and appreciate the working processes of an artist.

1.4 Independent evaluator: Elizabeth Lynch

My interests and experience lie with arts organisations that explore imaginative approaches to engaging with audiences, young people, and communities. I have developed and led organisations that place young people’s participation at the heart of their vision, notably at the Roundhouse where I was a Director from 2001 to 2008. Recent work includes directing and producing performance projects, research and evaluations for Wellcome Collection, Oily Cart Theatre, Royal Opera House and Rajni Shah Projects. I am interested in evaluation as a process of enquiry, reflection and learning that can be used to both open up conversations and create a bridge to future work. I am Chair of the Board for the Arts Catalyst.
1.5 Purpose of the evaluation

The purpose of this evaluation is:
• to capture the good practice and the learning from this pilot project in order to inform the future development of the Superposition programme
• to capture the reflections of the artist and physicist on the impact of their collaboration on their work
• to analyse audience responses to the installation and programme of events in terms of the IOP’s stated outcomes, which are detailed in Part three: Audience response
• to consider the demand for this scheme within the arts and science communities and the broader benefit that it brings to IOP
• to assess attendance and media coverage against original project outcomes

1.6 Methodology

The following tools were used in the evaluation design:

Interviews:
• The artist, physicist and all members of the project team were interviewed by the evaluator during the project-planning process and then towards the end of the exhibition period or after it. Total 18 interviews
• Exit interviews with visitors, including 5 LCM volunteers, conducted by LCM volunteers and by the evaluator. Total 63 interviews
• Interviews with other commissioners of art and science projects and ACE officers. Total 6

Grand total of interviews: 87

Feedback postcards: Gathered audience profile data and e-mail addresses for sending the online survey. 1033 completed

Online survey: Gathered audience profile data and qualitative responses. 194 completed

Comments book: This captured comments written by visitors and observations recorded by Visitor Assistants. 112 comments

Monitoring data on attendances gathered by IOP and LCM, IOP web analytics

IOP log of links to media coverage and Twitter feed

This report is divided into four sections. Part one explores the impact of the project on the artist and the physicist. Part two gathers the insights and learning from the structuring and delivery of the pilot project, identifying what is useful in terms of recommendations for the future development of IOP artist residencies. Part three analyses audience responses framed by the IOP’s desired outcomes. Part four considers the demand for such a scheme within the landscape of arts and science commissions.
Note: Quotes from interviewees or written feedback are highlighted in green. Quotes are attributed to project team members and others with permission. Visitor quotes are unattributed but where required, the source method is indicated.
PART ONE
Impact of the collaboration on the physicist and the artist

1.1 The artist

*Lyndall Phelps* is a mid-career artist with a strong track record in producing site/context specific work, dependent on a process-based and research-led practice.

Lyndall found that particle physics is not a dry subject, it’s beautiful and that beauty is the way in, and that’s the thing that’s pleased me the most. *Ben Still*

*Lyndall Phelps* has experience of collaborating with professionals and “enthusiastic amateurs” from a range of other fields, including science, medicine, the natural world and the military, but working with a particle physicist was an intriguing and unexpected opportunity. And a challenge.

I like to create work that creates a strong emotion in the viewer when they experience it. At first, even though I was interested, I was thinking, am I going to find something in particle physics that has that kind of warmth and humanity, the things that I normally focus on? *Lyndall Phelps*

She also appreciated that for this project, the scientist was seeking the artist as opposed to the other way round, a good beginning for the dialogue that was to take place. Lyndall embraced the challenge of finding common ground and being taken out of her comfort zone.
At their first meeting Ben shared a visual image, a photograph of a particle detector Super-Kamiokande in Japan.

All I wanted to do when I left was to find an underground lake and silently row across it, floating clear glass balls on the surface behind me. My preconception that particle physics might be a tad dry and abstract was shattered, replaced by the promise of poetry and rich sensory experiences. Lyndall Phelps

She was struck by the magical quality of the subterranean detectors, some located beneath ice, away from interference, dark spaces where light is used to detect the particles. The collaboration was productive for the artist in several ways. Superposition offered her time, time to play and experiment. She was able to create small works during the process that sparked ideas with Ben and moved their exploration forward.

Lyndall is continuing to apply this “thinking through making” approach to her next commission, making small works throughout the process, rather than just at the end. Another significant aspect of the project for Lyndall was how the combination of scale and the subterranean location brought such a strong sensory experience to Covariance. This was the first time one of her large pieces, shown in a non-gallery space, worked so well in a physical way. For the first time too, the artist took more control of the lighting of her work. In the past she has been happy to concede authority to a technician or curator but this time she saw how the lighting offered interesting potential, integral to the nature of the piece and worked closely with the designer. Expertise was contributed by Arup Lighting who sponsored this aspect of the exhibition and the team has since been nominated and shortlisted for a Lighting Design Award 2014 for Covariance.

Importantly, the artist expressed a high degree of satisfaction about the work she had produced, a powerful signal of excellence in artistic creation.

The collaboration with Ben and the Institute of Physics was wonderful. Their generosity and openness allowed me to absorb, ponder and enquire; be perplexed, fascinated and amazed. My journey started with nervousness and uncertainty; could my non-scientific brain get to grips, even a little bit, with particle physics? The answer was a resounding yes and I now have the desire and confidence to continue my exploration into this surprising, magical world and hope that through the legacy of Covariance and future projects I can encourage more people to do the same.
1.2 The physicist

Dr Ben Still is a research associate at Queen Mary, University of London, working on the international Tokai to Kamioka (T2K) experiment. This collaboration of around 500 scientists and engineers uses neutrinos to get a clearer understanding of what may have been happening after the Big Bang.

I think there’s a lot of similarity in the way scientists and artists think. Ben has a level of curiosity about the world in general and a thirst for experiencing things outside his world, and that’s a trait of an artist. Lyndall Phelps

Ben Still was excited by the opportunity to work with an artist for several reasons. While he had worked with designers and illustrators in the past, he hadn’t worked with a fine artist and was keen to explore new working methods and a more abstract approach to ideas and concepts.

Personally, I seem to learn best from visual keys and my type of communication lends itself to working with more visual people. I enjoy talking about the core ideas of the science because I don’t experience them in my day-to-day job, which is very much focussed on mathematical algorithms to try and condense data down into the physics, rather than the physics itself. Ben Still

Ben appreciated that potential challenges had been minimised by having good support from the IOP team and a proper budget, including a small fee for his time. While finding time was sometimes difficult, this has been manageable and worthwhile. Having the time to meet Lyndall, communicate and share knowledge and ideas, to visit museums together, to walk and talk in London parks – this, he says, was when the most ideas were sparked.
I learnt a lot by having to think around my understanding, talking to someone from a different discipline. It made me appreciate more the beauty of the science, how to look at it in depth from different angles. Ben Still

Ben described working with the artist as very different to previous collaborations, bringing him new insights on artistic processes and perspectives and illuminating how these inform his scientific practice.

Through working with Lyndall, it’s made me appreciate the aesthetics of the machinery that we work with and the way that we represent the data – all the information that’s fed to computers from these massive detectors. They’re just a stream of numbers, but then we use computer algorithms to distill them down on charts and plots. Lyndall has said she’s found real aesthetic quality in some of the plots that I’ve made. I want to develop the way that my data is presented and lean more towards that aesthetic. It could improve communication to other scientists. We have a lot of tools at our disposal but seem to restrict ourselves to very one-dimensional stacked histogram plots. I think there is something to be said about using more complicated methods, 3D and varied colour pallets. Infographics are lovely and they do get across certain key messages, but I think what we are exploring is probably somewhere in the middle where we are dealing with scientific rigour and aesthetics, I think they can inform each other and haven’t quite done that yet. Ben Still

In terms of the audience for the work, Ben acknowledges that particle physics is difficult and under-represented in the field of art/science collaborations. The subject offers great challenges for both scientists and artists to communicate, because it is extremely abstract yet its most basic principles are integral to everything in the world. Before the opening he asks, will Covariance, open up a space for audiences to discover, think and reflect?

After the exhibition period, he reflected on the overwhelmingly positive responses that he’d received and read and the significant interest from visitors who wouldn’t normally go to popular science events. He felt that he and Lyndall had achieved what they set out to do, to disrupt the perceived impenetrability of particle physics and share its beauty with a wider audience.

In terms of the impact of the project on his fellow scientists, Ben acknowledges the prevailing scepticism about the benefit of art/science collaboration among his peers, “they want to know what the scientist gains from the process”. However he says the question has shifted recently to the idea of “what does the physics community gain?”. This is important for the public’s perceptions of scientific research. The media profile of particle physics has received a great boost with the coverage about the Higgs Boson and this has had a positive impact on scientists’ attitudes to the value of interdisciplinary approaches. Colleagues at Queen Mary are now interesting in collaborating with an artist. He cited Jon Butterworth’s response, which is quoted from his blog below:

As I wrote before², I am not an uncritical fan of art-from-science, so it was with some trepidation that I put on my hard hat and began the descent into Carlo Gatti’s ice wells beneath the canal museum to see what Ben had let me in for this time. There was free alcohol on offer, but only after going down the well. Thus, not only had I not

diluted my cynicism, but if I hated it I would feel awkward taking advantage of their hospitality. Anyway, I need not have worried, the result is stunning. Points and intersecting planes of light hanging in darkness, reminiscent (to me anyway) of the huge chains dangling into the ice of the south pole and of the mysterious, elusive neutrinos that pass through us constantly and occasionally induce scintillating reactions. Jon Butterworth, Head of Physics at University College London
PART TWO
Project management, insights and recommendations

Note: Recommendations to inform the future development of the Superposition programme are highlighted in bold throughout this section. A summary of recommendations is included in Appendix 1.

2.1 Background

The IOP Superposition project team was led by the Head of Public Engagement, Caitlin Watson. She appointed Elizabeth Jeavans, a former IOP employee, as a freelance Project Manager when the internal employee responsible for this role left, and Annabel Lucas, a freelance Curator. Sally Sheinman, Chair of AIR was invited to advise as an advocate from the art world. The group was joined by the artist, Lyndall Phelps and the physicist Dr Ben Still, and from March 2013, the Chair of the London Canal Museum, Martin Sach. In June 2013 Dominic Galliano joined IOP as the new Outreach Officer and provided administrative support.

Additional input from within IOP was contributed by the Media Officer, Head of Media and the Outreach Officer (physics.org) who developed the Superposition blog, with content driven by the project team.

For this first commission, the physicist and the artist were identified through existing networks and recommendations. Dr Ben Still was already known to the IOP. Sally Sheinman recommended curator Annabel Lucas, who identified six artists and, with IOP, selected Lyndall Phelps. Ben and Lyndall began their conversations in October 2012 and the ice well was found by IOP in March 2013.

The IOP were successful in their application to the Arts Council England’s Grants for the Arts Fund. The request was for a research and development grant for a pilot project for an artist-in-residence programme at IOP “in order to explore ways of working with visual artists to represent aspects of contemporary physics and engage new audiences”. The London Canal Museum, home to the Victorian ice well where the installation was located, were important partners who collaborated with IOP on staffing, marketing, site management and safety, and supported data gathering for the evaluation.

The interviews for this report recorded praise for the organisational support provided by IOP to the artist and scientist. In turn, the IOP team appreciated that the artist and scientist “just got on with it” and were self-organising, which might not always be so in the future. Lyndall dealt with contractors directly, produced the installation schedule, etc. The arts project management expertise brought by Elizabeth Jeavans and Annabel Lucas was necessary and valuable, and as freelancers they brought expertise to the inhouse team.

The partnership with a small-scale heritage museum brought benefits and unforeseen difficulties arising from the nature of the project, a contemporary art installation, being a first for both parties. As with any pilot, despite the careful planning, there were various challenges.
during the course of the project. Below are recommendations for the future based on the pilot *Superposition* project team’s reflections and insights.

### 2.2 Superposition Advisory Group

A *Superposition* Advisory Group should be set up, chaired by Head of Public Engagement at IOP. The group will be a critical friend and sounding board for the *Superposition* delivery team. The membership should include:

1. IOP senior member
2. IOP Head of Public Engagement
3. Curator/project manager
4. Physicist with experience of public engagement
5. An artist
6. An experienced commissioner of high-profile arts and science projects, e.g. from the Science Museum, Wellcome Trust, the Arts Catalyst
7. Someone with knowledge of audiences from a gallery or museum background

They would meet quarterly to ensure that the vision, governance, partnerships and project management are on track. Their positions would be voluntary, in keeping with other IOP committees. **The Advisory Group could invite additional high-profile artists/arts professionals to join them for the commissioning process.** (See section 2.3 below).

### 2.3 Project team

Most curators are good project managers these days, they have to be. *Nicola Triscott, Director the Arts Catalyst*

To extend the capacity and skills of the IOP Head of Public Engagement to manage *Superposition*, there is a need to bring in specialist art/science project management expertise. To streamline communication and decision-making, it is recommended that **the roles of curator and project manager be carried out by one person**, with a realistic fee for this work included in the overall budget.

The role of the curator/project manager can be summarised as:

- To lead and guide the selection process of the artist with advisors and IOP
- To get the best out of the artist and help the artist get the best out of working with the scientist and the IOP
- To enable and facilitate the IOP and scientist getting the best out of the artist
- To broker and manage relationships and support IOP partners
- To articulate the work – e.g. the critical essay, as a basis for marketing and PR
- To produce or supervise schedules for planning including project milestones, tasks, responsibilities, deadlines, special events
- To support the IOP Head of Public Engagement with budget management
- To supervise the maintenance of the project blog

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3 The *Superposition* Advisory Group may wish to bring in some high-profile arts expertise in order to raise the profile of the IOP and the commission.
• To advise on marketing and public relations

The Head of Public Engagement would manage the curator/project manager and additional support would be provided by other members of the IOP team. **Roles, responsibilities and tasks should be clarified to ensure that resources and capacity are in place and continuity is ensured.** It needs clarifying whether the artist or curator/project manager will manage the production process and reflect this in the budget.

### 2.4 Commissioning process

The Head of Public Engagement will work with other IOP colleagues, the curator and members of the Advisory Group to identify a shortlist of physicists who have been invited to express an interest in collaborating with an artist. This can be accomplished easily using IOP inhouse knowledge and networks. The IOP would be looking for someone who is new to collaborating with an artist and who has strong/interesting ideas about how they might benefit from the experience. A series of conversations with the shortlisted candidates would inform the decision.

The selected physicist would then join Advisory Group and be part of the artist **selection process.** A couple of additional high-profile arts specialists could also be invited to support the group on this particular task. Bringing recognised, art-world expertise into the decision-making adds credibility to the platform offered by the IOP. The curator would work with the Advisory Group to produce a shortlist of around 6–8 artists. A decision would be taken, based on conversations with these artists and knowledge of their previous work. The curator would then broker the relationship between the artist, the physicist and the IOP who would approve the proposal resulting from the collaborative process. The timescale for this should be agreed in advance to give sufficient time for planning and development – of the collaboration itself, other partnerships, location, funding and marketing.

The current Head of Public Engagement voiced openness to considering other art forms such as dance, music, theatre, for future Superposition commissions. This would obviously affect the choice of advisors and curator/producer. It could also have budget implications. The creation, rehearsal and technical production of live performance are expensive. The recommendation that has emerged from the conversations for this evaluation is that Superposition should build on its experience of working with a visual artist for the next project in 2015. The visual arts already offers a wide range of approaches that include, for example, site-specific installation, live performance, film, digital, sound art.

Arguments for and against an “open call” for artists were offered by those interviewed with substantial commissioning experience. The issue for IOP is one of capacity and managing the potential scale of that process. There was a strong consensus among the arts/science specialists consulted that the key ingredients for successful arts/science commissions were an experienced curator and artists commissioning panel, a clear sense of equity and mutual respect between the artist and scientist and astute brokering. The freedom to explore, without prior expectations and over-briefing, is seen as a key value in the Superposition pilot by the IOP team, the collaborators and external interviewees.

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*For example, companies already working in this area are Curious Directive and Untheatre*
Being open to change in the process is important. Don’t be too concerned with outcomes because most of our projects change along the way. Be concerned with relationships and process, because the unexpected things are often the interesting things. *Meroe Candy, Senior Arts Adviser, Wellcome Trust arts funding programme*

It was also seen as important by Meroe that the artist, like Lyndall, should have a track record of research and collaboration – an important factor for scientists who want to engage with artists.

The key to commissioning successful collaboration is to take care to match the personalities of the people. Choosing two people independently increases the risk of the relationship not working. The IOP demonstrated their understanding and commitment to this principle by making it clear to the artist and the physicist that if, after meeting twice, either of them felt it would not work, then they were free to leave the project. **It is recommended that for future projects the IOP maintain the approach to matching and brokering the inter-disciplinary relationship.**

### 2.5 Planning

Caitlin was decisive, clear-headed and strategic about how to work, with a good combination of openness and being prepared to embrace risks within some clear parameters and fantastic attention to the delivery of the detail. *Annabel Lucas, curator*

In addition to the structural recommendations about governance, commissioning and staffing described above, the recommendations to take forward from the planning of the *Superposition* pilot are as follows:

1. **Maintain the clarity of vision and effective leadership at IOP.** The success of the *Superposition* pilot is acknowledged by the project team to be due to the direction of the Head of Public Engagement, Caitlin Watson.

2. **Maintain and develop the *Superposition* blog.** This worked well, illuminating the relationship between the scientist and the artist as it progressed. It is part of the project’s legacy that people can continue to look at and explore the physics and the process of making *Covariance*. The curator/project manager should be involved from early on in the process to ensure that the look and feel of the blog is integrated with the whole project.

3. ** Maintain the project communications practice** of regular project meetings, involving venue and other partners as the project progresses. Schedules and project plans supported communications for overall project management and events. A learning point for future projects is to ensure a good balance between face-to-face and online communication.

4. **Anticipate the unknown.** Build flexibility into the Memorandum of Understanding with partners so that any unexpected aspects or conflicts are responded to and resolved in a spirit of good will.
5. **Agree default decision-making protocols** with project team and partners when speed is of the essence and part-time team members are unavailable. For example, agreeing a design and proofing sign-off process for when a principal team member is unavailable.

6. **Maintain thorough approach to operational planning.**

7. **Maintain robust health and safety management.** The London Canal Museum’s ability and willingness to manage risk brought confidence to the whole team and enhanced the installation.

8. **Maintain and develop the Visitor Assistant role**. This team proved popular with the public, offering information and making useful connections between the art, science and heritage elements of the experience.

   The visitor assistants have made a huge difference to the experience. Initially they were there for health and safety but their interpretation role has been essential. *Liz Jeavans, Project Manager*

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**2.6 Partnerships**

The blank slate offered to the artist and scientist meant that the location and venue for the installation had to be found after the work had been conceived. A publication from *Subterranea Britannica* led project manager Liz Jeavans to the London Canal Museum

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*See Part two for fuller description and evaluation of the Visitor Assistant role*
LCM) with its newly renovated Victorian ice wells. LCM brought several valuable and important elements to Superposition’s first project, several of which might be sought in future partnerships, irrespective of location.

- An ideal subterranean location for the installation, which developed in response to the site and built further resonances into the work
- A central London location in the new creative hub of King’s Cross for which IOP was not charged a fee
- An organisation that was motivated to engage more visitors with the ice well
- An organisation that could bring an existing audience, interested in industrial heritage, who may might not usually engage with contemporary art or physics
- Strong venue management, confident in taking on the health and safety risks associated with the public needing to descend into the ice well
- Capacity to supervise temporary part-time Visitor Assistants and pay them through the LCM payroll
- Volunteers willing to support the evaluation process and benefit from training
- Marketing input through LCM website and PR agency
- Online booking system (to support management of ice well capacity)

A key drawback was the inaccessibility of the ice well to people unable to descend the steep ladder. The museum set up a live feed from a couple of cameras to view at ground level and on the website but unfortunately, despite a huge effort, the technology proved unreliable/unstable.

The LCM was pleased that the project had been a success for them in terms of media coverage and visitors, both for Covariance and the museum itself. The LCM has recorded an increase in overall visitor numbers. This also brought financial benefit in terms of admission fees to the museum (admission to Covariance itself was free of charge). The volunteers have enjoyed the extra footfall and four of them took advantage of training by the independent evaluator to conduct 35 audio-recorded exit interviews with visitors.

For future Superposition projects, the technical and physical requirements will differ and it may not need to be site-specific. However it will be important that

- the key aims and objectives of the host partner are aligned with those of Superposition
- the partner can provide a venue that offers a high-quality location for the art with an excellent operations infrastructure
- the partner will be part of the arts/culture/heritage sector
- the venue already has an audience
- the partner/venue can attract the primary contemporary art audience of 20–40-year-olds who access art and culture independently
- the partner is interested in attracting new audiences
- Superposition will be promoted through the venue’s marketing, PR and networks that are already targeted and connected to the core audience
- the venue is fully accessible

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6 LCM had just had a National Heritage Lottery grant to renovate and make repairs to the wells. Superposition was an opportune project as it fitted well with a grant outcome which was to “engage people with the space”

7 The Visitor Assistants were funded by IOP, jointly appointed by IOP and LCM and reported to Chair of LCM

8 Admission to LCM is £4.00, concessions £3.00
2.7 Visitor Assistants

The Visitor Assistants (VA) were recruited for two reasons. Firstly, to supervise and assist the public’s descent down two vertical ladders into the ice wells. They ensured that all of the health and safety guidelines were observed including the donning of hard hats and sensible footwear. The other was to offer information and stimulate discussion about the process and ideas behind *Covariance* during each 15-minute time slot. Each VA came with specialist knowledge and training in one or two of the following areas: visual arts, particle physics and heritage that enhanced the conversations and varied the emphasis for each group. Two VAs were on duty at each session. They maintained a comments book and fed back useful observations to both the IOP and LCM teams.

They were sensitive to the different experiences that visitors might want to have and were careful to strike the right balance between offering information and responding to questions, not interpreting the work, but listening and sharing perspectives/ideas.

*Do they prefer their own observations or would they like more information? It’s a judgement call about how you approach each individual.*  *Rebecca Odell, VA*

The VAs learnt quite early on that people did value a minute’s introduction at the start of their visit. After this, further conversations ensued either among two or three individuals or with the whole group. During a 15-minute slot there was usually enough space left for people to be reflective, first as people descended the ladder and gathered one by one in the wells, and then at the end.
Obviously, the three of us have different backgrounds and have different takes on the work. I’ve had people go down twice to go down to get the different talk. *Mita Solanky, VA*

Several people commented on the value of the Visitor Assistants’ role and input.

I’d also like to say how great the Visitor Assistant on the day was. She was very knowledgeable and had a great perspective on both aspects of the project. It made it much more interesting to me than if I had just looked at it or read about it. Please pass on my thanks!

The commentary was good, I enjoyed listening to that. I took some photographs and I need to tell my friends about this. And I’ll be learning more about physics.

The whole experience is great, getting involved, putting on the hard hat, going down the ladder. And the wow moment. It really added to it having someone down there to talk to, I wish we had longer.

Despite the Visitor Assistants’ academic backgrounds and professional experience, plus the training that they received from the IOP and LCM, this critical view was expressed by one visitor:

It helped to have an explanation, although it would have been better to have trained people with knowledge of art and the physics side, not just reeling off what they’d been told and not being able to answer questions from people who wanted a deeper understanding.

It is clear that the presence of the VAs was a significant factor in sharing knowledge, information and creating discussion between visitors. They contributed to making the experience accessible and were able to signpost the curious to the blog and other resources. Also see Section 3.7 Discussion.

### 2.8 Delivery of the exhibition and events

I enjoyed seeing it, as it was beautiful but also conveying a great amount of information. I understood much more after the talk event. I would have liked to have had more information in the gallery too about the different patterns. *Online survey*

The installation of *Covariance*, press launch on 21 August, public opening on 24 August, private view on 4 September and two *In Conversation* events on 19 September and 17 October were all delivered to a high professional standard and were well attended. The responses by audiences to *Covariance* and the events are detailed in Part three.

Thank you for a fantastic event – beautiful art, intellectually exciting and a well organised event. You’ve opened my eyes to physics in a new way. *Private view guest*

The recommendations arising from the delivery aspect are to do with scheduling. IOP did not originally plan to open during the mid-August period, but due to a number of unforeseen factors including personnel changes in the project team, the planning stage was extended.
The installation was shown on 29 days – Thursday afternoons, Saturdays and Sundays – over an eight-week period. The findings from the team and art specialist interviewees suggest that in future, a summer/holiday period opening would not be the first choice for two main reasons. In addition to the mainstream audiences, IOP would like to encourage higher-education courses to bring students from both art and science backgrounds to visit Superposition and engage with the events programme. In order to attract both contemporary art audiences and critical responses from art-world reviewers, late August/early September is not the optimum period. Mid-September to mid-June is suggested, avoiding Easter and Christmas. Of course, future commissions and partnerships will bring different opportunities for showing work, including extended visitor opportunities, indoor/outdoor locations, digital platforms, participatory elements and other rich possibilities created by the artist.

Capacity will always be a factor but the In Conversation events were popular and indicate that perhaps more opportunities to discuss the work and related issues could be added to the programme.

To summarise, it is recommended that the IOP

- reviews the scheduling of Superposition in the calendar year to avoid mid-summer
- schedule the press launch and private view on the day prior to public opening
- considers planning more events as part of the programme

2.9 Marketing and publicity

While being visually light and uplifting, the work is also tightly packed with references, from female labour… the hard labour of the ice industry and, of course, the history of science – in particular the use of brass for scientific measuring instruments. The work conveys a sense of wonder that is entirely in keeping with the vast unknown that still attempts to understand, one particle at a time.

Pippa Koszerek, a-n (artists newsletter)

Press and promotion were discussed at every project meeting. Journalists from science and arts media were contacted and press releases planned during the course of the exhibition. The project was successful in attracting some high-profile national and regional media coverage from the BBC and New Scientist via the IOP Press Office and ITV, Evening Standard, Press Association via the LCM PR agency. Most of this consisted of news coverage arising from the press launch on 21 August. LCM’s agency also secured listings in Time Out. A small sum was invested in employing a freelancer to target visual art critics and arts social media. This is a difficult task and attracted one review in a-n newsletter. A full list of media coverage is in Appendix 3. Attracting attention from key art critics from print and online media is extremely challenging and although there can be no guarantees of success, it may be worthwhile investing more resources next time in engaging an experienced and well-connected arts media specialist.

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* The number of days was chiefly due to the necessary cost of employing the three Visitor Assistants.
2.10 Attendance data

1972 people visited *Covariance*. This attendance figure is well over the IOP’s estimated/desired attendance figure of 1500. 160 people attended the private view and a total of 69 attended the two *In Conversation* events. 909 (46% of total) people pre-booked their visit online via the LCM website, as requested in all the marketing material.

2.11 a) Analysis of marketing feedback

Chart 1

<table>
<thead>
<tr>
<th>How did you find out about <em>Superposition/Covariance</em>?</th>
<th>Exit postcard</th>
<th>Online survey</th>
<th>Exit interviews</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>1033</td>
<td>194</td>
<td>63</td>
<td>1290</td>
</tr>
<tr>
<td>Number completed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word of mouth</td>
<td>323</td>
<td>55</td>
<td>12</td>
<td>30.23%</td>
</tr>
<tr>
<td>LCM</td>
<td>356</td>
<td>38</td>
<td>8</td>
<td>31.16%</td>
</tr>
<tr>
<td>Other</td>
<td>354</td>
<td>101</td>
<td>43</td>
<td>38.61%</td>
</tr>
</tbody>
</table>

A wide range of sources were cited, with “word of mouth” and “London Canal Museum” indicated most often. This fits with the observation by Visitor Assistants that approximately just under 50% of *Covariance* attendees were already visiting the museum. Other main sources indicated were *Time Out*: 8.6%, *Evening Standard* and *Metro* 8%, the BBC (news and website) 5.8%.

The exit interview figures include several conducted at the private view and one *In Conversation* event. LCM’s visitor figures indicate that Open House, a local festival and boat trips in weeks five and six of the run had a significant impact on visitors to *Covariance*.

2.11 b) Social media: *Superposition* blog and Twitter

The data gathered on how people found out about *Superposition* and *Covariance* indicates that the *Superposition blog* was an insignificant factor in terms of promoting attendance at the installation. However, the web analytics reveal that the blog attracted a substantial number of visitors in the period after the private view, during September. It received 4012 unique visitors and 17,579 page views. 74% of this traffic consisted of new visitors to the IOP website. This is a pilot project and it isn’t surprising that the website and blog are not prime marketing tools. However, if as its seems, people visited the site either as result of attending the installation or out of interest without attending, it is a valuable element of the project. It offers a deepening of understanding and appreciation of the collaborative process and the research by the artist and the physicist. It is accessible in its visual and written styles. It stands as a useful legacy for IOP and is a useful resource for both academic study and general public interest. In future, *Superposition* should build on the blog and its potential for further creative uses and rich content. Resources to support this will need to be built into future budgets.
Again, although there was prolific tweeting, this was not indicated as a driver for attendance. Therefore analysis of Twitter traffic for Superposition on the IOP feed has not been analysed. It might be assumed that it contributed to one of the key means of promotion, “word of mouth”.

2.12 Budget

The overall cost of the project was just over £47,000 excluding in-kind contributions such as IOP staff time and the resources brought by the venue partner. For an outline of these costs, see Appendix 5. Just over 20% was contributed by the Arts Council England for research and development awarded through Grants for the Arts. It is envisaged that Superposition would be delivered every two years and, as the project came in on budget, a similar budget of £45–50,000 should be raised for 2015. The level of cash contribution by the IOP is not sustainable but the success of the pilot in terms of achieving its stated aims and outcomes offers a strong argument for attracting funding from both public and private sources.
PART THREE
Audience response

3.1 Purpose and methodology

The qualitative evaluation sought to explore whether the audience

• found the artwork accessible and thought-provoking
• have an increased understanding of contemporary physics research and the role it plays in their lives through engaging with artwork, blog and live events
• discussed contemporary physics as a result of engaging with artwork
• have an increased understanding of the creative process and research involved in producing the artwork through engaging with artwork
• want to find out more about the subjects being explored by the project

To recap, qualitative data on audience profile and feedback on their experience was gathered through postcards, visitor comments/observations book, exit interviews and an online survey.

In the exit interviews and survey, we asked how the experience of Covariance had resonated/struck a chord with them and whether anything had shifted or changed as a result, for example knowledge, perceptions and/or insight. The comments book offered a range of comments, opinions and feedback. In this section I have analysed these comments and linked them to the outcomes sought from this research. There was frequent mention of the information shared by VAs. It was often clear from feedback which VAs they had spoken to during their visit, as their comments reflected an emphasis on physics, art or heritage information and ideas.

For survey, postcard and interview questions see Appendix 4.

Breakdown of figures:

• 52% of visitors (1033/1972) completed postcards and 61% (633) of these provided their e-mail address in order to receive the online survey.
• 30.6% (194) subsequently completed the survey representing a 10% sample of the total visitor cohort.
• 65% of the total number of visitors offered quantitative data for the audience profile described in section 3.2 below.
• 19.5% of contributed qualitative feedback via one of the methods listed above.

It is possible that some individuals are accounted for twice in this reckoning. Overall, this represents a respectable and useful sample.

Quotes are highlighted in green and are taken from exit interviews and the online survey, unless otherwise stated.
3.2 Audience profile

a) Age and gender. Gender profile was captured through observation. The exit interviews aimed to gather feedback from an equal number of male and female visitors and across the age range 18–65 years. Observation by Visitor Assistants indicates a fairly even spread of male/female visitors, most of whom were in the 25–45 age range. Anecdotally, the Visitor Assistants gathered information about the distances travelled by some visitors, specifically to see Covariance. These included Bath, Birmingham, Cambridge, Dorset, Merseyside and Newcastle.

b) Attendance at art exhibitions

Chart 2

<table>
<thead>
<tr>
<th>Method</th>
<th>Exit postcard</th>
<th>Online survey</th>
<th>Exit interviews</th>
<th>Total</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequently 6+/yr</td>
<td>438</td>
<td>123</td>
<td>32</td>
<td>593</td>
<td>45.96</td>
</tr>
<tr>
<td>Occasionally</td>
<td>540</td>
<td>67</td>
<td>26</td>
<td>633</td>
<td>49.66</td>
</tr>
<tr>
<td>Never</td>
<td>55</td>
<td>4</td>
<td>5</td>
<td>64</td>
<td>4.96</td>
</tr>
</tbody>
</table>

c) Attendance at science events

Chart 3

This question was only asked in the online survey completed by 9.8% of total visitors and 15% of the total evaluation sample.

<table>
<thead>
<tr>
<th>How often do you attend science events?</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6 or more times/year</td>
<td>26</td>
<td></td>
<td></td>
<td>13.4%</td>
</tr>
<tr>
<td>2–3 times/year</td>
<td>37</td>
<td></td>
<td></td>
<td>19%</td>
</tr>
<tr>
<td>Occasionally</td>
<td>97</td>
<td></td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>Never</td>
<td>33</td>
<td></td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td>Total surveyed</td>
<td>194</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A comparison of the attendance figures for the survey sample indicates that five times as many are frequent art exhibition visitors compared to science event-goers and equal numbers identified themselves as regular but less frequent attendees for both types of activity. Half occasionally attend science events and 17% never attend science events compared to 2% who don’t visit art exhibitions. These figures are interesting in that they indicate that Covariance attracted people who are interested in art and that a significant proportion of them are already interested in attending science events.
d) Knowledge of physics:

Chart 4

<table>
<thead>
<tr>
<th>Method</th>
<th>Exit postcard</th>
<th>Online survey</th>
<th>Exit interviews</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>1033</td>
<td>194</td>
<td>63</td>
<td>1290</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>190</td>
<td>54</td>
<td>27</td>
<td>271</td>
<td>21.7</td>
</tr>
<tr>
<td>No</td>
<td>842</td>
<td>140</td>
<td>36</td>
<td>1018</td>
<td>78.21</td>
</tr>
</tbody>
</table>

The question was about physics rather than science in general. The survey was able to elicit a little more detail on this question, for example, the level to which physics has been studied, physics professionals (8), or in other scientific fields and personal interests in particle physics etc.

3.3 Key responses

A simple classification of the responses to the open questions in the online survey and exit interviews as “positive” or “negative” showed that 87% (254/291) were positive in their response to the artwork, as an aesthetic, intellectual, spiritual and sensory experience, as illuminating science concepts and offering a strong sense of place. The negative comments were either critical of the art or about the communication of, or insight into, the science, or that they couldn’t understand the science. However, nearly all the critical comments demonstrated engagement with the work and some people offered both positive and negative comments regarding different aspects of the work within the same statement.

The visitors commented with significant frequency on the following:

- the beauty of Covariance
- how Covariance illuminated the physics
- the value, interest in and enjoyment of an arts/science collaboration
- the quality of the work, the materials used, its intricacy and craftsmanship
- how the sensory experience of the ice well was integral to the concept of the work
- the use of light and colour
- the historical aspect of women’s involvement as “computers”

3.4 Appreciation

The majority of comments indicated that the artwork was accessible and thought-provoking and offered a strong and positive aesthetic experience.

It made me think of how stunningly beautiful even the hidden parts of our world are and how much science can challenge our imagination and perceptions.
It was so beautiful. I loved the repeating patterns of the beads, the transparency and the colour of the installation. I thought that the contrast between the old ice well and the modern material of the installation was very striking.

It has strengthened my belief that art and science can and must be interdependent otherwise significant developments cannot be shared and mutual influences may be lost.

All art and learning makes me think more deeply about the world and I often think about art installations for a while afterwards, about what it means in terms of day-to-day life, which I did after visiting Covariance.

It provided me with a very engaging aesthetic reference point for further thought about modern physics and how it can be used as metaphor for our humanness.

I find I'm more aware of the similarities that scientist and artists share, and feel more positively towards how greater collaboration could benefit both parties.

What's special about it is seeing an invisible process made visual, that's impactful. And the experience of making art in site-specific space. It's visceral. It's interesting how the two disciplines have come together and I like the fact that there is a history. It's a collision of history/science/art.

It made me think about how and why you enjoy an experience, and how it is often completely out of the control of the artist.

I absolutely loved it – I was particularly struck by the rigorous research that the artist did, for example into the role of “computers” in data entry. I love both science and art and too rarely see them together – this installation is an example of this kind of collaboration at its best.

I HATED physics at school and was thrown out of the class aged 13, never to return again. Had I seen something like this when I was that age, and realised that physics can be beautiful and a creative process, I may have studied it much further (not least since my father was a physicist). So I feel quite inspired now to think of physics as a discipline like any other that seeks to make sense of who we are and see the beauty around us... And even though I really don't understand the intricate particle physics behind it all, it doesn't really matter, as it has made me wonder.

The engagement both physically and intellectually of what can seem a very obscure and almost elitist subject.

I have never understood physics at all but this way of presenting in an art form helped a lot. The leaflet also helped to reinforce the explanation given.

It was the sort of thing that I imagine all the time so it made me feel more normal.

The installation is quite beautiful. I think that I understood what I was looking at and I have recommended it to many friends. I like thinking about ways of expressing complex ideas in a simple framework.
Wonder at the nature of neutrinos.

It worked really well as an artistic exhibit but the connection to the scientific experiment was very clear – and in a great setting.

My perception of complex scientific projects and ways of communicating them to a wider audience.

The way the light works was the most interesting thing. Moving around seeing the alignment change, the colour and pattern.

The contrast between the diamante piece set in the rough surrounding, the dark atmosphere of the well, primary colours in the dark atmosphere – these two contrasts, it's a great combination.

Visually striking and I was impressed by the craftsmanship. In any sense I thought it was stunning between the dirt and the pureness.

As a visual learner the work impacted – I could “see” the physics, almost touch it. Everyone can enjoy the beauty and wonder of both art and physics, and inspire curiosity in the world.

I thought it was wonderful. It had a much more tangible link to the particle physics side of things than I expected so was a good advocate for “sciart”! It felt like the relationship between the two was quite in-depth in this case, rather than just “art about science” or a very vague link.

I loved the environment, the relationship between the space and the work. The complexity of the work and the individual discs. The relationship between the work and the physics.

This installation really captured the beauty of particle physics as I have always imagined it. My physicist husband also really enjoyed the exhibit. I wish there were more places where art and science can meet, and where artists and scientists can work together to make science more accessible and make art more relevant.

The online survey yielded one moving and unexpected reflection:

My visit was part of a whole day of attempting change within myself, to become inspired again. I am currently in the support group of ESA following a breakdown and long-term depression and anxiety. The installation contributed greatly to me in becoming actively engaged with certain topics again, and also seeing and feeling a bigger picture separate to the problems I have and continue to face.
Some were less engaged with the overall concept and offered constructive feedback.

I didn't feel that I understood the science as much as I would have liked, but it did provide an opening to that arena.

It was beautiful, yet I wanted some movement from the piece. Yet my intellect tells me there isn't much real-time movement in the observation. The science is there, the art is there but the third leg, the exhibit-ism part is missing, perhaps due to funding.

It is very beautiful and, although I can understand how it was inspired by particle physics, it did nothing to increase my knowledge or understanding of particle physics.

I liked the space, the explanation of the process and the science more than the artistic result. I think that these collaborations between artists and scientists are interesting, but very difficult to make artistically satisfying.

Some engaged with the work critically, from both arts and science perspectives.

I was surprised that particle physicists think in terms of visual imagery. I had assumed that they think in terms of mathematics. This opens up the possibility for visual imagery to inform physics.

It makes me think and stand and look. While I was there I thought it might have been interesting to add a kinetic element to the installations that might go further to illustrate the particle/physics side as nothing is motionless.

A somewhat better insight – although perhaps not understanding – of particle physics. Confirmation that artists, writers and musicians need to be as receptive about science as scientists are about the arts. The sense that, as a writer, the more esoteric sciences are not altogether beyond me.
I thought it was a powerful experience, especially in the location of the ice well. The artwork provided some translation of the physics ideas but I felt that it did not fully live up to the promise of the location or the idea. The photographs in the light boxes were a bit lost and the contextual/orientation information was difficult to access. The main installation would have benefitted from sound and possibly movement to create a more immersive experience. The orientation from the steward was excellent, passionate and well informed. An interesting experience and worth the visit, but did not quite realise its potential as artwork or as scientific interpretation. Keep going, this work is important!

As a scientist and someone who appreciates art, it has shown me that even the smallest discovery in science can be manifested through a creative process into something completely different, that is still somehow true to the original discovery.

It showed concepts and ideas that were familiar to me in my everyday work, from an entirely different perspective – exploring how they influence our aesthetic sensitivity.

I do research and it has made me think of looking for artistic ways of presenting my own data.

I am very familiar with the science behind this installation, and was struck by how such concepts can spark artistic creativity in such a beautiful way.

I enjoyed the exhibition and could tell that the collaborative process had taught both the scientist and artist something new. I thought the piece of artwork did reflect the scientific process more than the underlying science, which I found slightly disappointing.

When I envision the processes in a particle accelerator, I envisage it more in terms of fireworks – a dynamic process with particles shooting off in all directions after the initial explosion. The art was attractive, but didn't capture the processes.
3.5 Discovery and surprise

The way it's lit creates a strange experience because you are seeing this beautiful bejeweled thing that you have to climb down to, a bit Raiders of the Lost Ark.

The online survey asked: What did you discover through experiencing Covariance? and to tick any of the four choices that chimed with them. 51% indicated “how complex ideas can be visualised”; 61% “the connection made between scientific and artistic processes” and 69% “how art can illuminate/offer a different perspective on scientific data”.

Chart 5

It surprised me and I was wowed by it. All the discs are different, the physical appearance. The link with science made it more interesting.
In response to “In which ways was Covariance surprising?” a significant number indicated “how art and physics inspire us to think about the world” (62.7%) and “it illuminated the mystery, excitement and beauty of particle physics research” (61.6%). 47% appreciated that “it was a striking new way to present data”.

**3.6 Knowledge and interest in physics**

There were a significant number of statements indicating an increased understanding of contemporary physics research and desire to find out more about the subjects being explored by the project. As indicated earlier\(^{11}\) 78% of the total evaluation sample indicated no knowledge of physics. This fits with the response of 46% in the survey indicating that one of the most challenging aspects of their experience was understanding the physics ideas (see chart 7 below). However the survey also indicated that 28% were surprised by the insight into particle physics (see Chart 6 above) and 17.7% indicated that they “want to find out more about particle physics”.

\(^{11}\) Audience profile, section 3.2 d)
There were 73 unique comments about increasing knowledge/receiving new information about particle physics from the encounter with Covariance, 61 of which were offered in the survey, where people had had time to reflect.\textsuperscript{12}

I learnt how in-depth research could be embodied in an artwork. That art is more than an aesthetic experience.

I’ve been aware of the various attempts to detect neutrinos for many years – but this installation has given me a better appreciation of the complexity of the experiment and of the sheer beauty that can be found in it in artistic terms.

My understanding of neutrinos and the like has greatly developed from seeing and reading the materials and hearing the talk. I also see the Canal Museum with new eyes, which is exciting.

I thought it was beautiful and amazing. It’s got me more interested in what physics is about. I would say it has given me a little more understanding of physics than I had 30 minutes ago – what the guide was saying about particle collisions and the fact it happened in subterranean places. I think it’s a shame that it’s not up permanently and if it can ever be brought back it should!

26 people explicitly stated that they intend to find out more about the physics. The comments were about specific information relating to the neutrino research, how physics is part of our experience of the world and the historical aspects such as the female “computers”.

I feel like I learned something new about particle physics and I now want to learn more about how the experiments are carried out.

\textsuperscript{12} Some of these reflections were in response to the open survey questions and so in some cases there two different comments may have been made by the same individual. 20\% of the exit interviewees and 30\% of those surveyed indicated finding out more about physics
I am going to try and find out more about neutrinos and the experiments set up to track them and other “elusive” particles.

For those with physics knowledge there was appreciation of the research undertaken by the artist, delight in the aesthetic, illustrative and intellectual aspects of the installation and a few critical reflections.

I've written papers on neutrino mass and seen umpteen pictures of Antares and Icecube. *Superposition* really captured that image of photo detectors on a string in a beautiful way. The intricacy of the glass beads in many colours was visually quite lovely and the location underground, with a little difficulty to access, hinted at the actuality of these experiments. I loved it and have been recommending it highly.

I am now more convinced than ever that the arts and the sciences need to support each other and draw on all the diverse means for hypothesising and testing hypotheses about the way the universe we exist in actually works. As a regular reader of *New Scientist* and viewer of science programmes on TV I have some understanding of particle physics but no specialist knowledge, but I believe that level of knowledge enhanced my positive response to the installation.

I now have the impetus to pursue my own work in immersive environment, how to bring data together with beauty.

*Covariance* has reinforced my interests in how research within science and art has direct comparables.

I’m just glad to see that people are linking art and science as they go hand in hand and they’ve done it in a really interesting way. Physics observations are beautiful as well. Science is beautiful anyway.

A Physicist loved the inclusion of diamante pieces, as he saw it as a lovely connection with diamond electronics used in physics. *Comments book*

### 3.7 Discussion

*Superposition* specifically created two types of “spaces” for discussion to take place about contemporary physics, as a result of engaging with the artwork: in the installation with the Visitor Assistants and/or with other visitors and at the Private View and *In Conversation* events.

The Visitor Assistants (VAs) recorded that discussions took place during the experience of *Covariance*, both 1:1 and between the groups. These discussions arose out of information offered by or requested from the VAs and frequently generated independent discussions between individuals and groups during and after the descent to view the installation.

The art work inspired two visitors [strangers], one a non-physicist who came as part of trying to learn more about physics before a visit to CERN, the other someone who had studied both art and physics, to have an extended conversation about both physics and art, with both adding new information. *Comments book*
Physicist inspired to share anecdote with group about how an underground pond was utilised as a successful neutrino detector. Comments book

What was so interesting was the journey that you had to go down the ladders. I really understood that when I actually had to do it. The ritual of waiting, you feel a commitment that you've explored and discovered. I'm an artist myself so that relationship between art/science is fascinating. It was interesting to see the dialogue between Lyndall and Ben. There's an idea that artists like making work alone, but actually we crave collaboration. And clearly this was fruitful and very clear; you can see this is a result of a dialogue. Ultimately, what you have there is a piece of art and it's not illustrative of the science it’s an interpretation/reflection/response to the science by an artist, I don’t think it would be right if it was purely illustrative. There was someone here tonight explaining neutrinos with Lego, which I quite like. At the heart you have an artwork. If you are commissioning an artist what you are ending up with is an artwork and that should be enough I think, but it’s the journey/dialogue/writing the essay/events, the little tally of who was who and it was a third artists/scientists/other. Private view visitor

69 people attended the In Conversation events (out of a total of 136 registered), which generated open discussion about contemporary physics and art. The comments gathered across the evaluation methods indicate that there were further conversations afterwards with friends and family. The attendance figures, the high incidence of promotion through word of mouth, the strong response to engagement with the evaluation and the quality of the responses, the visits to the blog and Twitter activity – all these indicate that reasonable assumptions about an increased level of discussion could be made. As with any short-term, small-scale evaluation, we cannot predict or imagine how individuals will be influenced by or appropriate their experiences of Covariance over the months and years to come. What can be usefully concluded is that creating space to facilitate discussion was a successful aspect of Covariance.

It is recommended that future projects build on this success and consider how the events programme could be extended through partnerships with host venues, academic institutions such as Central St Martin’s MA Art & Science, University College London Arts and Sciences (BASc) programmes, and forums for inter-disciplinary debate such as Intelligence Squared, The School of Life, Café Scientifique, Salon London.
3.8 Understanding of the creative process and research for the artwork

A significant percentage of the feedback indicated an increased understanding of the creative process and research involved in producing the artwork through engaging with the artwork and events. 21% indicated in the survey that “understanding the artistic process” was most challenging about Covariance. 29.7% indicated that they were “very stimulated by the artwork” (see chart 7 above).

The experience of being in a special, difficult to access space to discover a work of art with strong correlations to particle physics strengthened my firmly held belief that aesthetic as well as scientific research in conjunction are necessary to more fully understand the world that we exist in. The fact that the space itself was originally constructed to serve a commercial purpose rendered unnecessary by science was also a major resonance for me.

I loved the silence down there. It was quite moving in a way. It made me think about the environment that physicists are working in. It did very well in getting the empty vacuum across to you … I’m going to look up more online to remind myself. Neutrinos are very small and famously elusive. I’ll notice things in the press more.

I have never really been interested in art but integrating it with science gave me a greater appreciation.
It struck me how meticulous the artist has been. Every aspect is there for a reason. The light the use of glass, all there for a reason. Everything led back to her research and the physics.

What I found especially interesting about it was that I’ve not really thought about physics as something physical before. I thought about them as mental leaps and the exhibition and photographs made me think about it in more of a tangible way. It made it more accessible for me as someone without a science background. I think there is a barrier. I found physics as the hardest subject at school and I steered away from it. I don’t think I feel that any more – it’s opened my eyes to the subject. It’s stunning as an artwork, beautifully made.

I was particularly struck by the rigorous research that the artist did.

In-depth research can be embodied in an artwork. Art is more than aesthetic experience.

Art is about looking at the world in a symbolic way, physics is about looking at the world in a material way.

Really like art that collaborates with other disciplines, it opens up your mind to things that you may not otherwise think about, really good, really enjoyed it and got us thinking. Comments book

3.9 The ice wells

It’s just beautiful when you go down the ladder, you come through the doorway and it’s so quiet and still. It’s so magical that it’s hidden and you have to find it.

The survey asked “How does the ice well environment positively affect your experience of the art installation?” and this was rated highly at 75%.
This statistic is supported by 75 comments across all the data that mentioned the ice well environment. It was described as an unexpected benefit that surprised and delighted them. The words used to describe underground ice wells included: unique, ethereal, rough, dark, architecturally interesting, impressive, secret, hidden, primitive, muddy, dank smelling and atmospheric.

I loved the underground space and immersive quality.

The setting. I can't imagine it having the same impact in a regular gallery. It was beautifully done. The use of the chamber, likening it to a particle detector, was inspired.

The site-specific nature of the installation is amazing – and complements/references physics experiment processes really creatively.

The location was a good reminder of the need to protect the research locations from contamination.

I thought it was incredibly beautiful, and I liked the juxtaposition of the roughness of the well with the crystalline shapes. I also liked the way the light shone through the glass panels and made diffraction-like patterns on the well walls.

The journey, the mystery, the sense of exploration was cited as a part of the experience that resonated with visitors and enhanced their sensory appreciation of the installation as well as providing a fascinating industrial heritage context. Many of the new visitors to LCM were delighted to have found the museum and to explore the rest of its displays.
PART FOUR
Superposition and the art/science landscape

There are individuals in all fields who want to look beyond their own processes. 
Meroe Candy, Senior Arts Adviser, Wellcome Trust arts funding programme

Leading commissioners of art and science collaborations were interviewed about their perception and knowledge of the landscape of art and science collaborations. These were at director/senior management level in Wellcome Trust, Science Museum, Commission Projects and The Arts Catalyst. In addition two Arts Council England Relationship Managers, with experience of working with arts organisations in this area of work, were also consulted. The individuals are listed in Appendix 2.

The unanimous view was that the area of physics in the arts/science territory is under-populated and an initiative led by a well respected organisation such as IOP is welcome.

We have an increasing culture where there is recognition that research and its communication can involve lots of different practitioners. Hannah Redler, Head of Media Space and Arts Programme, Science Museum

High-profile science developments and increased media coverage have made science an everyday news item. Collaborative practice between artists and scientists is one way to engage critically with the scientific research and discovery. Artists interrogate the social and cultural implications of the science and can imagine developments nobody has considered.

I think those projects are really critical, they are very influential (in the arts community). They allow a kind of freedom that has impact later on, further down the line. David Wright, Director Commission Projects

In terms of financial and resource support for artists wanting to work in physics, this is much smaller than for biomedical science, due of course to the substantial support offered by Wellcome Trust. There is the significant artist in residency programme at CERN13 that is taking place over a number of years but this is specifically about that institution and its work.

We discussed the balance and status between the artist and scientist during the collaboration process, the value that each side places on the partnership and the limitations of any expectation that wants the artist to create work that merely communicates scientific information and ideas. Meroe Candy was clear that communicating science and critical engagement with the ideas by an artist are not mutually exclusive. However, the dialogue, the conversations that might not have been imagined beforehand, can raise questions, more ideas and inform research for both sides.

The benefits for artists collaborating with scientists are more widely articulated than the other way round. However, recent research by Wellcome Trust (that will appear their new online

13 “The CERN programme connects and collides the world’s leading scientists with international artists through carefully-curated “creative collisions”, which take the form of interactions, interplay and interventions. The mission is for the artists and scientists to inspire and challenge each other to go beyond paradigms.” http://arts.web.cern.ch/
publication *Mosaic* in 2014), has gathered the perspectives of 12 scientists who have collaborated with artists, some for over a 10-year period. Some of the key benefits articulated are to do with the way that they look at their subjects, the conceptual nature of what they do and, particularly relevant to someone from a physics background, the philosophical contexts of their work. Learning to talk about their work in a different language enables them to think about it in a different language. It also enables them to communicate differently with the people that they work with, which in turn has an impact on perceptions within their organisations and there is a cultural shift.

Those consulted were emphatic that the commissioning process needs to clearly articulate the IOP’s artistic policy and involve a knowledgeable, experienced and respected selection committee (as outlined in part 2.3).

The support of the Arts Council England is a valuable signal of quality and can help the organisation to attract future funding from commercial, philanthropic and charitable sources. There are many opportunities for partnerships, with arts, culture and heritage organisations, business and academic institutions. There was total agreement that the IOP could play a leading role in capacity building for this area of practice. It is recommended that the IOP maintains the research-based focus for the collaboration, as established for the pilot project. This approach is attractive to artists, scientists and potential funders.

**Conclusion**

The findings of the evaluation indicate value and benefit for the IOP, the artist and physicist, audiences and the field of arts/science collaboration and exploration. The artist and the physicist reached new audiences for art through their exploration of challenging and complex physics research, central to our understanding of the world. Leading commissioners and advisors expressed the view that physics themes are under-represented in the landscape of arts/science collaborations and that the IOP could play a leading role in this area of practice. The strong and distinctive features of the *Superposition* residency programme are its research-based focus, the open nature of the commission and the length of time allowed for in-depth dialogue and process. *Superposition* should become a biennial project for the Institute of Physics. The organisation’s willingness and commitment to work with leading artists and arts specialists to develop *Superposition* will bring credibility to their platform as they plan future collaborations and partnerships.

**Elizabeth Lynch**
December 2013
APPENDIX 1
Summary of recommendations

Commissioning and management

1. *Superposition* should be become a biennial project for the Institute of Physics

2. A *Superposition Advisory Group* should be set up, chaired by Head of Public Engagement at IOP.

3. The Advisory Group could invite additional high-profile artists/arts professionals to join them for the commissioning process.

4. The Head of Public Engagement will work with other IOP colleagues, the Curator and members of the Advisory Group to identify a shortlist of physicists. The selected physicist would then join the Advisory Group and be part of the artist selection process.

5. The roles of curator and project manager should be carried out by one person.

6. Within the project team, roles, responsibilities and tasks should be clarified to ensure that resources and capacity are in place and continuity is ensured over the project timeline.

7. The IOP should maintain the existing approach to matching and brokering the artist/physicist relationship.

Planning

8. Maintain the clarity of vision and effective leadership at IOP. The success of the *Superposition* pilot is acknowledged by the project team to be due to the direction of the Head of Public Engagement, Caitlin Watson.

9. Maintain and develop the *Superposition* blog. This worked well, illuminating the relationship between the scientist and the artist as it progressed. It is part of the project’s legacy that people can continue to look at and explore the physics and the process of making *Covariance*. The curator/project manager should be involved from early on in the process to ensure that the look and feel of the blog is integrated with the whole project.

10. Maintain the project communications practice of regular project meetings, involving venue and other partners as the project progresses. Schedules and project plans supported communications for overall project management and events. A learning point for future projects is to ensure a good balance between face-to-face and online communication.
11. **Anticipate the unknown.** Build flexibility into the Memorandum of Understanding with partners so that any unexpected aspects or conflicts are responded to and resolved in a spirit of good will.

12. **Agree default decision-making protocols** with project team and partners when speed is of the essence and part-time team members are unavailable. For example, agreeing a design and proofing sign-off process for when a principal team member is unavailable.

13. **Maintain a thorough approach to operational planning.**

14. **Maintain robust health and safety management.** The London Canal Museum’s ability and willingness to manage risk brought confidence to the whole team and enhanced the installation.

15. **Maintain and develop Visitor Assistant role†.** This trained team proved popular with the public. They shared knowledge and supported/generated discussion between visitors.

**Partnerships**

**For the Superposition programme in the future, it will be important that:**

16. The key aims and objectives of the host partner are aligned with those of Superposition.
17. The partner can provide a venue that offers a high-quality location for the art with an excellent operations infrastructure.
18. The partner will be part of the arts/culture/heritage sector.
19. The venue already has audience.
20. The partner/venue can attract the primary contemporary art audience of 20-40 year olds who access art and culture independently.
21. The partner is interested in attracting new audiences.
22. **Superposition** will be promoted through the venue’s marketing, PR and networks that already targeted and connected to the core audience.
23. The venue is fully accessible.

**Scheduling**

24. The IOP should review the scheduling of **Superposition** in the calendar year to avoid mid-summer.
25. The Press Launch and Private View should be scheduled on the day prior to public opening.
26. The IOP should consider planning more events as part of the programme

**Marketing and public relations**

† See part two for fuller description and evaluation of the Visitor Assistant role
27. Invest more resources in engaging an experienced and well connected arts media specialist.
28. Future *Superposition* projects should build on the Superpostion blog and its potential for further creative uses and rich content.

**Programme**

29. Consider how the events programme could be extended through partnerships with *host venues, academic institutions* and existing forums for inter-disciplinary debate.
30. The IOP could play a leading role in the landscape of arts/science collaborations where physics themes are under-represented.
31. Maintain the strong and distinctive features of the *Superposition* residency programme which are:
   • its research-based focus
   • the open nature of the commission
   • the length of time allowed for in-depth dialogue and process.
APPENDIX 2
Acknowledgements

Sincere thanks to all those who have contributed to this evaluation – the audiences who gave us valuable feedback, the IOP project team, London Canal Museum team and colleagues in the field of art and science commissions.

Institute of Physics
Caitlin Watson: Head of Public Engagement
Liz Jeavans: Project Manager
Annabel Lucas: Curator
Lyndall Phelps: Artist
Dr Ben Still: Physicist
Sally Sheinman: Artist, Advisor to Project Team
Dominic Galliano: Outreach Officer

London Canal Museum
Martin Sach: Chair of Trustees
Charlie Forman
Philip Hollowday
Tony Ricks
Elena Gatti

Art and science specialists
Meroe Candy: Senior Arts Adviser, Wellcome Trust arts funding programme
Mat Jenner: Relationship Manager, Visual Arts, Arts Council England
Hannah Redler: Head of Media Space and Arts Programme, Science Museum
Lucy Sollitt: Relationship Manager, Visual Arts London, Arts Council England
Nicola Triscott: Director, The Arts Catalyst
David Wright: Director, Commission Projects

For a full list of acknowledgements for the whole project, please see Appendix 6 of the Superposition essay booklet.
APPENDIX 3
Press and media coverage

Libertine

a-n

Guardian – John Butterworth

Culture 24

Wired
http://www.wired.co.uk/news/archive/2013-08/27/covariance-installation

Artlyst

BBC Science & Environment

Evening Standard (also see PDF attached)
http://www.standard.co.uk/comment/comment/future-london-will-be-just-as-joyfully-messy-8781683.html

International Business Times
http://www.ibtimes.com/physics-art-meets-london-ice-well-covariance-art-installation-explores-beauty-particle-detectors

Axis blog

Physics World blog
http://blog.physicsworld.com/2013/08/22/particle-lights-up-victorian-ice-well/

Londonist
QMUL also have a version of the press release on their website
http://www.qmul.ac.uk/media/news/items/se/112761.html

ITV

Mature Times
http://admin.maturetimes.co.uk/travel/uk-travel/day-trips/5841-scientific-artwork-to-sparkle-in-subterranean-ice-well-at-london-canal-museum.html

Yahoo
http://homes.yahoo.com/photos/lyndall-phelps-installation-london-canal-museum-photo-133550733.html

Daily Dish

London Art New Blog
http://coxsoft.blogspot.co.uk/2013/08/superposition.html

FQXi podcast
http://fqxi.org/community/podcast
Our segment is the last 18 minutes. This includes interviews with Lyndall and Ben.

FQXi post
http://fqxi.org/community/forum/topic/1935
APPENDIX 4
Survey, postcard and interview questions

Survey questions:

1. **How often do you attend art exhibitions (please tick one box below)**
   a) 6 or more times/year
   b) 2–3 times/year
   c) Occasionally
   d) Never

2. **How often do you attend science events?**
   a) 6 or more times/year
   b) 2–3 times/year
   c) Occasionally
   d) Never

3. **Do you have any specialist knowledge of physics?**
   a) No
   b) Yes (please describe in box below)

4. **How did you find out about Superposition and Covariance? (please tick one box below)**
   a) www.physics.org
   b) London Canal Museum
   c) Twitter
   d) eflyer
   e) Word of mouth
   f) Other (please say) ..............

   About your experience of Covariance

5. **How does the ice-well environment positively affect your experience of the art installation?** Please indicate on scale of 1–6 below:
   Greatly enhances experience 6   5   4   3  2  1 Has little impact

6. **What did you discover through experiencing Covariance?** Tick all choices that apply:
   a) How complex scientific ideas can be visualised
   b) The connection made between scientific and artistic processes
   c) How art can illuminate/offer a different perspective on scientific data
   d) Other – please say

7. **In which ways was Covariance surprising?** Tick all choices that apply:
   a) It gave me an insight into particle physics
   b) It was a striking new way to present data
   c) How both art and physics inspire us to think about the world
   d) It illuminated the mystery, excitement and beauty of particle physics research
   e) Other – please say

8. **What was most challenging about Covariance?** Tick one choice below:
   a) Understanding the physics ideas
   b) Understanding the artistic process
   c) I was very stimulated by the artwork
   d) I now want to find out more about particle physics
9 How did the installation resonate with you?

10 What has shifted or changed for you as a result of this experience? (e.g. your knowledge, perception, insight?)

Postcard questions:

1. Do you attend art exhibitions regularly? Frequently/occasionally/never
2. Do you have any specialist knowledge of physics? Yes/No
3. How did you find out about Superposition?
   www.physics.org
   Canal Museum
   www.canalmuseum.org.uk
   Word of mouth
   Twitter
   Other (please specify)

Please enter your e-mail address below if you would like to complete a short feedback questionnaire. Completed surveys will be entered into a prize draw. Your e-mail address will only be held by us for the duration of the project and will not be distributed to any other parties.

Exit interview questions:

1. How did you hear about Superposition and Covariance?
2. How often do you visit art exhibitions?
3. Do you have any specialist knowledge of physics? (If yes, can you briefly describe that?)
4. How did the installation strike a chord with you? (prompts: what was new, interesting, surprising?)
5. What has shifted for you as a result of this experience? (prompts: knowledge, perceptions of art, physics, new insights?)
**APPENDIX 5**

**Budget**

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<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Artistic spending</strong></td>
<td>£32,740</td>
</tr>
<tr>
<td>(Including project management, artist costs, physicist costs, curator, advisor and blog development)</td>
<td></td>
</tr>
<tr>
<td><strong>Making your project accessible</strong></td>
<td>£5,450</td>
</tr>
<tr>
<td>(Including costs of invigilation, interpretation and signage)</td>
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</tr>
<tr>
<td><strong>Marketing and developing audiences</strong></td>
<td>£4,610</td>
</tr>
<tr>
<td>(Including PR, in conversation events and private view)</td>
<td></td>
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<tr>
<td><strong>Evaluation of project</strong></td>
<td>£4,220</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>£47,020</strong></td>
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</tbody>
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APPENDIX 6
Superposition: Covariance booklet

(see following pages)
Superposition
A series of physicists and artists in conversation

Covariance
A collaboration between Lyndall Phelps and Dr Ben Still
Covariance: a collaboration about everything

Early in the research phase for this project, Lyndall Phelps and Dr Ben Still visited the Science Museum to help explore the context of the neutrino [1] research being undertaken by the International Tokai to Kamioka (T2K) experiment.

After exploring directly relevant displays, they visited the King’s Gallery; an internationally significant collection of early to mid 18th century scientific instruments designed to examine the physical world in ways more sophisticated than before, from the microscopic to the cosmic. They were the cutting-edge research tools of their day.

When Phelps posed the question to Still, among the gleaming 200 year old instruments, “what in this room links to your work?”, after a pause the reply came, “everything”. This reveals both the fundamental nature of the neutrino observations performed at T2K and yet how distant they can seem from an everyday perception of how the world works.

Today, the T2K experiment is at the cutting edge of one branch of one scientific discipline: particle physics. The experiment observes neutrinos, to learn more about what they are and how they behave. Part of the experiment is located at Super-Kamiokande, an underground neutrino observatory in Japan. In a disused mine, a space 40m in diameter and 40m deep has been excavated and filled with purified water. Hand-blown glass detectors line the space, and they are triggered when light is released as neutrinos interact with the water. The data is collected in Japan, and then distributed to Still in London and collaborators around the world for analysis.

For Phelps, this has provided a rich context for collaboration. The constituent elements within the Covariance installation are drawn from her journey into the science and its context. She adopts brass hanging rods and transparent disks to allude to an earlier age of scientific experimentation and instrumentation. The decorative motifs of the suspended elements are inspired by the neutrino detector spirals and data analysis grids, and from the latter comes the colour palette and its modulation sequence.

The first part of Covariance that visitors encounter is a group of three light-boxes created by Phelps, seen through an opening in the London Canal Museum’s floor. The sleek, glowing objects show photographs of colourful structures being revealed through melting ice - creating an intriguing painterly texture on a flat image. Visitors have a truly extraordinary experience: drawn away from a conventional museum setting

Photography Peter Mennim
they descend to a raw space with beaten earth floors, with different scent and temperature to the outside world. Once underground, visitors glimpse a sliver of light and sparkle through the opening to the second chamber, occupied by the main suspended installation of Covariance.

Layers of hovering disks with subtly altering patterns and colour variation capture the viewer’s imagination. The attention to detail and accumulative scale reflect the artist’s rigorous making practice; she has worked tirelessly, eight hours a day, every day, for over three months to create the work. Despite absorbing and processing so much source material, there is no sense of excess: the work has become what it needs to be. Working at this scale represents a significant development in Phelps’s practice to consolidate a strong research-led collaboration into a single, major installation of Covariance. Phelps is keen to emphasise the equally collaborative nature of her work, both conceptually and physically. Dr Still has participated in the manufacture of the suspended installation, and the work developed through intense discussions between artist and scientists.

Covariance also developed in response to the site found for its installation, which builds further resonances into the work. The London Canal Museum is housed within a huge ice warehouse built for 19th century ice cream maker Carlo Gatti. Ice was imported from Norway by ship and canal boat to be stored in the underground ice wells below the warehouse. Purified still water is a fundamental part of the T2K detector, with other research facilities boring into Arctic ice. There is an element of post-industrial mirroring, too: the act of repurposing two underground chambers in London to host the installation occurs just as plans for a second set of underground chambers are being proposed at Super-Kamiokande. These links across the world within the artwork echo the global community of scientists linked to the T2K experiment.

Within the multitude of examples where collaboration has been facilitated between artists and scientists in recent years, there has often been an over-emphasis on the artistic outcome to ‘communicate science’; that is, to aid the transmission of understood facts to a public audience. Art has its own practice (way of working) and agency (power to change), as distinct from science. To limit the role of art to merely a fact-communication vehicle for science defeats the purpose of cross-disciplinary collaboration. By contrast, exchange of ideas between artists and scientists should have a mutually beneficial outcome to both disciplines: “behind these diverging streams of intention runs a turbulent river of shared intuitions about the order and disorder of things” [2].

Artistic outcomes from such rich collaboration are independent art works: they resonate, and exist in parallel, with scientific knowledge and are not subordinate to it. Such art works may be viewed as a form of lateral – as opposed to literal – interpretation: they provoke the viewer to desire more knowledge through a rich, multisensory, intellectual and emotional experience. Key funders and supporters of rich collaborative initiatives such as the Wellcome Trust and the Science Museum – and now the Institute of Physics – are to be lauded.

Phelps has prefigured the best aspirations of these established programmes through her interactions with Still. At times their interaction has influenced Still’s thinking and methodology; mirroring Phelps’s previous project with radar researchers at Cranfield University (Softkill project, 2011) where their collaboration precipitated new developments in radar technology [3].

On a global stage, there is a currency to the themes and circumstances of this collaboration, and specifically Covariance. The 55th Venice Biennale [4] stages The Encyclopedic Palace, a huge exposition of contemporary art practice exploring different systems of understanding the world by artists and others. Psychological approaches of Carl Gustav Jung are included, as are the radical educational approaches of Rudolf Steiner. Seen in this context, Covariance establishes Phelps’s work as being engaged with current critical and artistic practice from around the world. As research science uncovers ever more detail about the fundamental particles of life, there is a danger that it becomes distant from the wider public. We all need systems to understand the world, and artists of Lyndall Phelps’s power and rigour to provoke us with their vision.

Tom Freshwater
Contemporary Art
Programme Manager,
National Trust
The quiet voice of the neutrino

The neutrino is the shyest of all of what physicists call “fundamental particles”, the basic building blocks of everything in the universe. This year has seen great leaps in our understanding of neutrinos, but we still have limited knowledge of exactly what secrets they might hold.

To see a neutrino, we first go underground. This removes any interference from the showers of particles originating in deep space that constantly bombard the surface of the Earth. On the Earth’s surface the neutrino is a quiet voice and these particle showers a loud concert. Underground, the noise is all but removed, and the neutrino’s quiet voice is easier to pick out.

A neutrino rarely interacts with its surroundings, but when it does it produces new particles: electrons, muons or tauons. These particles have an electric charge, and so interfere strongly with their environment – and we can see this effect in particle detectors. Most detectors use materials that transform the energy of these particles into some form of light. This light is then turned into electrical signals by sensitive electronics, and then into information stored on computer. With thousands of sensors we can build up an image of the interference and link it back to the original neutrino that started the whole chain of events.

With a number of sightings we can start to understand the way in which neutrinos interact with the world. Mathematical models of what we think should happen are compared to what is actually seen and a confidence in how accurately the models describe the data is calculated. Day to day I work on new methods of looking for patterns in the data and fitting them to the fundamental physics. We then use the data, along with pseudo data from the mathematical models, to tease out the underlying physics. All of this is in an effort to understand the character of neutrinos.

The ghostly behaviour of neutrinos renders them the least well known facet of nature. There are many interesting theoretical, mathematical models that fit the vague picture we have of them.

The model suggests that the way in which particles interact shows some small preference for matter over antimatter, its mirror-image counterpart. With further understanding of the neutrino it is hoped that they may reveal this preference.

All of this research is the pursuit of knowledge in its purest form, pushing back the boundaries of our understanding. Despite its seemingly disjointed appearance, particle physics has had a profound effect on our modern lives, from the web to medical imaging. The technologies and data analysis techniques behind the science have a direct link to our everyday lives.

Dr Ben Still
Research Associate at the School of Physics and Astronomy Queen Mary, University of London.
The SUPERPOSITION series seeks to engage an adult audience in contemporary physics through contemporary visual art. The series supports long-term relationships between individual physicists and artists, to generate new thinking and new artworks. Covariance is the Institute of Physics’ first project in the SUPERPOSITION series.

Covariance (24 August – 20 October 2013) was commissioned by the Institute of Physics.

Curated by Annabel Lucas

Hosted by the London Canal Museum

Exhibition and publication made possible through a partnership with the London Canal Museum, with funding from The Arts Council and Gina Agnew Gallery, and generous support from ARUP Lighting, ACDC Lighting, Architectural FX, LEDLinear and Cube Lighting.

physics.org/superposition

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Lyndall and Ben would like to thank:
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Kelly Oakes
Joseph Winters
Institute of Physics
Martin Sach
Rachel Ball
Roger Squires
Malcolm Tucker
London Canal Museum
Elizabeth Jeavans
Annabel Lucas
Sally Sheinman
Jack Hutchinson
Gina Agnew
Tom Freshwater
Grace Thorne
Maryla Twin
Aaron Head
Matthew Smith

Alison Gallager
Dwayne Shillingford
Paula Longato
Guillermo Martinez Pajares

ARUP Lighting
ACDC Lighting
Architectural FX
LEDLinear
Cube Lighting
Michael Lewis
Dale Moss
M&M Welding Fabrication Ltd

Kevin Hill
K2 Associates Limited

Richard Davies
Peter Mennim
Photography

Colin Goodhew
Lucid Design

Tabitha Globle
Rebecca Odell
Mita Solanky
Visitor Assistants
APPENDIX 7
Information leaflet

(see following pages)
Discover the magical art installation in the ice wells beneath your feet, created by artist Lyndall Phelps in collaboration with physicist Dr Ben Still.

This installation is the first in a programme of artists-in-residence commissioned by the Institute of Physics called Superposition, which brings together artists and physicists to develop new ideas and artworks.

Since November 2012, Ben and Lyndall have been exploring aspects of particle physics. Their evolving conversation has been charted on a project blog, www.physics.org/superposition, and has led to the creation of the art installation. The artist and physicist jointly chose *Covariance* as the title for the final artwork to reflect their coming together (co) from different disciplines to influence each other’s thinking and seeing (variance).

Ben is a Research Associate at the School of Physics and Astronomy, Queen Mary, University of London and works on the International Tokai to Kamioka experiment. This collaboration of around 500 scientists and engineers uses neutrinos (a kind of particle) to get a clearer understanding of what may have happened just after the Big Bang. He offered Lyndall a broad introduction to his specialist field, from which she developed an interest in particle detection and detectors, and Ben’s visualisation of data.

*Covariance* is a two-part installation combining an ambitious suspended sculpture and a series of light-box images. It was informed by several aspects of Lyndall’s research. She was struck by the inherent beauty and sense of awe inspired by the detectors. There is a magical quality about their subterranean locations, some located beneath ice, away from interference. These are dark spaces where light is used to detect the particles.

Lyndall also became interested in the way data from the detectors is visualised and analysed by physicists, from Ben's unique digital coloured dot diagrams, to the huge number of women employed in the past to manually process the information (known as the first 'computers'). Ben’s use of dots in grid formation and in the rainbow colour spectrum, is integral to the central disks in the installation, where red represents the highest level of activity, blue the lowest. The outer circle of disks, with its concentric circle patterns, echoes the structure of particle detectors.
The installation is created from a range of everyday materials, which in combination take on new life: glass beads, diamantés, acrylic disks, brass rods, ice, sheet metal. Some of the materials relate to women’s craft (beads, diamantés) – a link back to the female computers, while others (brass rods) refer back to the history of science, where brass was commonly used in the making of scientific instruments. The quantities of materials used are remarkable: 380 acrylic disks, 1 kilometre of brass rods, 28,000 glass beads and 36,000 diamantés!

Lyndall has distilled a huge amount of visual and scientific information into this magical installation – it seeks to respond and contribute to Ben’s research, sharing new data and ideas with people at the London Canal Museum. Lyndall has created an immersive experience for visitors, which takes them on a physical and imaginative journey.

The ice wells are more than an exhibition gallery for the installation, they are integral to the installation and have informed its design and content significantly. The dark spaces of the wells enhance visitors’ appreciation of the artwork and in turn, it is hoped that Covariance offers new perspectives on and experiences of the wells…

If you are unable to physically access the ice wells please view the artwork on the CCTV camera.

Open to the public every
Thursday 1.30 p.m. – 4 p.m.
Saturday and Sunday 11 a.m. – 4 p.m.
Last tours at 3.40 p.m.

Advance booking is recommended via
www.canalmuseum.org.uk/book

Join in the conversation on:
Thursday 19 September at 6.30 p.m.
Thursday 17 October at 6.30 p.m.
Free of charge.

Find out more about the project and follow
Ben and Lyndall’s journey at
www.physics.org/superposition