superposition looks into how we understand the reality of nature on an atomic scale. This project was inspired by the mathematical ideas and notions of quantum field that deals with this particular characteristic of nature: one cannot fully describe the behaviour of a single particle, but in terms of probabilities. To describe a particle, one must list all possible states a particle can be found in alongside probability of the particle being in that state.

superposition questions the boundaries between music, visual arts and performing arts, while exploring in depth the intersection between art and science.

superposition [performance] is Ryoji Ikeda's performance piece which was created in November 2012 in Paris.

For the first time in his work, other performers appear on stage as operator / conductor / observer / examinee to complement a wide range of video images and other innovative technologies. All material used on stage are shown in a state of superposition - sound, visuals, physical phenomena, mathematical concepts, human behaviour and randomness - and are simultaneously arranged and re-arranged in a single performance piece.

The exhibition supersymmetry created in April 2014 is an artistic re-orchestration of Ikeda's performance piece superposition (2012-). This exhibition version consists of 2 spaces and conceptually deconstructs and re-composes its original elements — transformations, visualizations and sonifications of a vast amount of scientific data set, mathematical operations and real-time information from the installation works themselves at the exhibition. Ikeda and his team employ real-time program computations and data scanning/processing to create a further abstraction of the original performance version of superposition. The technical dynamics, such as extremely fast frame rates and variable bit depths, continue to challenge and explore the thresholds of our perceptions.
superposition explores a new notion of information: quantum information.

The language of classical information is BIT (binary digits) — 0 or 1, which is the most fundamental building block of our judgement and logical thoughts.

The language of quantum information is QUBIT (quantum binary digits) — 0 and 1 superposed at the same time, which is a new way for us to capture the truth of nature at an extremely small sub-atomic scale — such as behaviors of photons or electrons.

When we try to observe a sub-atomic particle we cannot know both its position and its speed at the same time.
Once we observe the position, we understand the information of the position but lose that of the speed.
Before we observed the position, the single sub-atomic particle was actually located at all possible positions simultaneously, which is the so-called "superposition state".
In short, our observation fixes the position. It is unbelievably counterintuitive and is beyond our human comprehension.
No one can know the very nature of nature. On such an extremely small scale, we can know only a single value of a single parameter from the infinite facets of nature.

BIT is digital. QUBIT is analog — analogous to nature.
BIT is discrete. QUBIT is continuous — a continuum.
Quantum computing is to read how sub-atomic particles behave by means of the language of QUBIT; i.e. Nature computes. We decipher it.

Nature is always here and there. We forcefully try to understand and demystify the nature of nature by means of our scientific knowledge, but we're also part of nature, nature is unthinkably vast — from an atom to the universe. Some esoteric codes will remain secret and beyond human comprehension, perhaps forever.

superposition is inspired by all these thoughts and is foolhardily and quixotically aiming to explore the new kind of information through art.

Ryoji Ikeda
MORE ABOUT THE PRINCIPLE OF SUPERPOSITION

Quantum superposition is a principle of quantum theory that describes a challenging concept about the nature and behavior of matter and forces at the sub-atomic level. The principle of superposition claims that while we do not know what the state of any object is, it is actually in all possible states simultaneously. According to Erwin's Schrödinger equation, which is linear, a solution that takes into account all possible states will be a linear combination of the solutions for each individual state.

The principle of superposition claims that if the world can be in any configuration, i.e. any possible arrangement of particles or fields, but can also be in another configuration, then the world can be found in a state of superposition of the two configurations, where the amount of each configuration in the superposition is specified by a complex number.

Quantum computing enables us to understand the quantum behaviors of nature on an atomic scale. The language of quantum computing is Quantum Bit = Qubit.

Bit is the basic unit of information in computing and telecommunications information.
Bit equals 0 or 1, true or false, on or off.
In quantum computing, a quantum bit is a quantum system that can exist in superposition of two bit values: 0 and 1, true and false, on and off. Once we measure the position or speed of an atomic particle, all superposed states are reduced to a specific state. In other words, one cannot assign exact simultaneous values to the position and speed of an atomic particle. This is called the Uncertainty Principle. Quantum computing uses this principle alongside quantum entanglement and superposition.

After almost a decade of research on the discrete and the continuous, mathematical beauty and sublimation, Ryoji Ikeda has finally found a space where all mathematical concepts find an explanation in the notion of qubit, an infinite grey area between 0 and 1 in which probability and uncertainty coexist. As opposed to the arithmetical continuum of real numbers, the grey area of qubit expands to the notion of complex projective line in projective geometry.

(In quantum mechanics, the Bloch sphere is a geometrical representation of the pure state space of a two-level quantum mechanical system. The points on the surface of the sphere represent the pure states of a single qubit, the interior of the sphere represents the mixed states.)
CREDITS

Ryoji Ikeda

concept, direction and music

in collaboration with

Stéphane Garin, performers
Amélie Grould

Tomonaga Tokuyama, programming, graphics and computer system
Norimichi Hirakawa,
Yoshito Onishi

Norimichi Hirakawa optical devices

Simon MacColl stage manager

Tomonaga Tokuyama technical manager

Preview: 5 August 2012, ZKM (Karlsruhe, DE)
World Première: 14, 15, 16 November 2012, Centre Pompidou / Festival d’Automne à Paris (FR)

Commissioned by Festival d’Automne à Paris for the musical part

Created and developed at EPPGH La Villette (Paris, FR), [YCAM] Yamaguchi Center for Arts and media (JP) and ZKM (Karlsruhe, DE)

Production: Ryoji Ikeda Studio, Quaternaire (FR), Forma (UK)

Co-production: Festival d’Automne à Paris (FR), Les Spectacles Vivants-Centre Pompidou (Paris, FR), the Barbican (London, UK), Concertgebouw Brugge (BE), Festival de Marseille (FR), EPPGH La Villette (Paris, FR), Kyoto Experiment (JP), ZKM (Karlsruhe, DE), STRP Art and Technology Festival (Eindhoven, NL), Stereolux / Festival Scopitone / le lieu unique (Nantes, FR)

With the support of the DICRéAM-CNC (FR)

Touring: Epidemic (Richard Castelli, assisted by Chara Skiadelli, Florence Berthaud, Claire Dugot)

photos: Kazuo Fukunaga, courtesy of Kyoto Experiment
DESCRIPTION

The performance version was created for a traditional theatre with a stage, a proscenium and audience seating. Like in other works by Ryoji Ikeda, all elements on the stage – sound, light, video, set – are assembled with the highest precision. They are all integrated and orchestrated into a single powerful audio-visual performance piece.

General
- 2 performers/operators on stage.

Video
- 21 video screens are set on stage; 1 large screen at the back, 10 screens in the middle, 10 displays at the front. These can be considered as a “video ensemble” that is synchronised with the musical composition. The 3 layers of screens are superposed on stage, the combination of these 21 screens can offer up to $5,842,587,018,385,980,000,000,000,000$ potential visual permutations.

Sound
- A multi-channel sound system is installed on the proscenium and on the ceiling (or walls) of the auditorium. This system delivers a spatial sound field across the entire theatre.

Performers
- The artist composed for non-musical instruments such as tuning forks, metronomes, telegraph keys, typewriters etc. Performers play those instruments on stage. The score is both musical and mathematical but is also influenced by various other creative forms such as information theory, semiotics and choreography.
- Throughout the composition, performers generate both movement and sound (performance and music).
- These actions generate visual elements (i.e. words, numbers, type-written phrases) on all 21 screens. These movements are also translated in real-time into computer data codes and are then rescreened on stage alongside various other graphical material (converted data from the performers’ actions) or real images (e.g. close-ups of performers’ handwriting or typewriting) via a video camera based on stage.

Duration
65 minutes.
### TOURS 2012-2016

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<td>DEC 7-8, 2012</td>
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<td>Concertgebouw, Brugges</td>
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<td>OCT 11 - 12, 2014</td>
<td>Théâtre Maisonneuve / Musée d'art contemporain de Montréal</td>
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<td>OCT 17 - 18, 2014</td>
<td>The Metropolitan Museum</td>
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<td>NOV 7, 2014</td>
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<td>DEC 2, 2014</td>
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<td>NOV 18-19, 2016</td>
<td>New Vision Arts Festival 2016</td>
<td>Hong Kong</td>
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<td>MAY 2-3, 2017</td>
<td>Teatro Colsubsidio, Bogota</td>
<td>Bogota, CO</td>
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</table>
BIOGRAPHIES

RYOJI IKEDA
Born in 1966 in Gifu, Japan, lives in Paris and Kyoto.

Japan's leading electronic composer and visual artist Ryoji Ikeda focuses on the essential characteristics of sound itself and that of visuals as light by means of both mathematical precision and mathematical aesthetics. Ikeda has gained a reputation as one of the few international artists working convincingly across both visual and sonic media. He elaborately orchestrates sound, visuals, materials, physical phenomena and mathematical notions into immersive live performances and installations. Alongside of pure musical activity, Ikeda has been working on long-term projects through live performances, installations, books and CD’s such as datamatics (2006-), test pattern (2008-), spectra (2001-), cyclo, a collaborative project with Carsten Nicolai, superposition (2012-), supersymmetry (2014-) and micro l macro (2015-).


In 2016-17, he premiered the acoustic stage piece music for percussion in collaboration with ensemble Eklektro (Geneva) which is currently on tour. He took part in group exhibitions such as "Elevation 1049: Avalanche" (Gstaad, CH), Centre Pompidou Metz (FR), La Villette / Festival d’Automne (Paris, FR), Center for the Art of Performance at UCLA (Los Angeles, USA) and presented a drone symphony, A [for 100 cars], commissioned by Red Bull Music Academy Festival Los Angeles.

In 2018, he is part of group exhibitions such as "Artists and Robots", Grand Palais (Paris, FR), "Experience Traps", Middelheim Museum (Antwerp, BE) among others, and presents solo exhibitions at Centre Pompidou (Paris, FR), Carriageworks (Sydney, AU) Garage (Moscow, RU) and Eye Film Museum (Amsterdam, NL). In June, he launched spectra as a permanent installation at Mona Museum (Hobart, Tasmania, AU). He presented concert pieces in Centre Pompidou / Festival ManiFeste (Paris, FR) and Spiral Hall (Tokyo, JP).


He is the award winner of the Prix Ars Electronica Collide@CERN 2014.
**STEPHANE GARIN**  
Born in 1974 in Bayonne, France, lives in France.

Stéphane Garin has performed within the ensemble Intercontemporain (EIC), the orchestra Les Siècles, the Brussels philharmonic, etc. conducted by Pierre Boulez, Péter Eötvös, François-Xavier Roth, etc. with musicians, dancers, performers and directors such as Pascal Battus, Olivier Bernet (recording of the soundtrack of the film *Persepolis*), Carl Craig, Pascal Comelade, Mathias Delplanque, Pierre-Yves Macé, Stephan Mathieu, Thierry Madiot, Moritz von Oswald (Basic channel), Shua group (*Giant Place Detail* installation and performance project, Winter garden, World Financial Center, NYC).

Founder of 0 [zero] with Sylvain Chauveau & Joël Merah. He is now a member of the ensemble of contemporary music Dedalus conducted by Didier Aschour.

Phonography works: Gurs/ Drancy/ Bobigny's Train Station/ Auschwitz/ Birkenau/ Chelmno-Kulmhof/ Majdanek/ Sobibor/ Treblinka. Since 2005, he has been working in collaboration with the visual artist Sylvestre Gobart on an artistic work on the memory of extermination during World War II (France, Poland, Ukraine). It presents recent pictures (photographies, videos) and audio recordings taken on the very grounds of internment, deportation and extermination. This work was presented as an installation at Biarritz multimedia library and at Sol Del Rio Arte Contemporanea gallery (Guatemala).

**AMELIE GROULD**  
Born in 1984, France.

Amélie Grould studied percussion with Beatrice Répécaud at the Val Maubuée’s music school and graduated in 2006 in music analysis, chamber music and percussion. She then went to Rueil-Malmaison’s Music School, where she studied under Eve Payeur and specialised in contemporary music and musical theatre, working in collaboration with several composers such as Yann Maresz, Philippe Hurel, Bruno Giner, François Paris, Martin Matalon, Jacques Demierre, Philippe Leroux. In 2009 she created the Trio Tro ï ka with two other percussionists, Rose Devas and Bénédictie Albanhac.

Since graduating with distinction in 2010, Amélie has worked with several composers and conductors such as Jun Märkl, Laurent Goossaert, Bruno Giner, José Luis Campana and the Arcema’s ensemble. Most recently, she has collaborated with the composer Ivo Malec, played Maurice Ohana’s works (*Silenciable*) with the C Barré’s ensemble, Darius Milhaud’s work with the 2e2m’s ensemble, and played *Metropolis* by Martin Matalon for the Fritz Lang’s movie with the Court Circuit’s ensemble at the Vilnius Theater (Lituania, during the Gaïka’s festival).

In 2010, Amélie also worked with Thierry De Mey (*Musique de table*) at the Maison de la musique de Nanterre. She has been part of the artist in residency for the Aum’s ensemble at the 104 and is now broadening her musical field of action by playing contemporary jazz music and experimental rock.

Amélie holds two teaching’s distinctions (Diplôme d’Etat and concours du CNFPT) and teaches percussion at Le Havre’s music school.
TOMONAGA TOKUYAMA
Born in 1984 in Tokyo, lives and works in Paris and Tokyo.

Tomonaga graduated from Kyoto University and went on a scholarship with FABRICA, Benetton's Communications Research Center. He works internationally in the fields of audiovisual art, architecture, info-graphics and programming. Tomonaga has worked with architects such as Kengo Kuma and Junya Ishigami in designing and developing softwares. He was nominated for the Iakov Chernikhov Prize in 2010 for his contributions to architecture. Since 2009, Tomonaga has been based in Paris and working for Ryoji Ikeda's main installation and concert pieces. Tomonaga has played in audiovisual concerts in collaboration with Takeshi Kurosawa (Sora) and took part in group shows alongside Arata Isozaki's exhibition in the Venice Biennale in 2012.

YOSHITO ONISHI
Born in 1986 in Shiga, Japan, lives in Tokyo.

Yoshito is a graduate from Tama Art University. He is specialised in minute procedural paintings and sculptures using coding, softwares and devices. He also makes experimental movies using virtual worlds (sandbox. etc) and works alongside many artists as software/hardware developer, moviemaker or designer.

NORIMICHI HIRAKAWA
Born in 1982 in Shimane, Japan, lives in Tokyo.

His work, focused on real-time processed and computer programmed audio visual installations, has been shown at national and international art exhibitions as well as Media Art Festivals. Norimichi has received many awards including the Excellence Prize at the Japan Media Art Festival in 2004 and the Award of Distinction at Prix Ars Electronica in 2008. Having been involved in a wide range of activities, he has worked on a concert piece production for Ryoji Ikeda, collaborated with Yoshihide Otomo, Yuki Kimura and Benedict Drew, participated in the Lexus Art Exhibition at Milan Design week and live performances with Typingmonkeys.

DAISUKE SEKINE

After graduating from the Ecole Spéciale d'Architecture in 2012, Daisuke founded ARCHIEE, an international Architecture research and design unit in Paris, France. Before setting up his practice, he collaborated with DORELL.GHOTMEH.TANE/ARCHITECTS in Paris and TAMON in Tokyo. He often works alongside interdisciplinary profiles (artist, scientist, social scientist, philosopher etc.) to extend his architectural domain. His practice ARCHIEE was awarded "PRIX SPECIALE" at the Winter 2011.
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