

The Matter of Origins

Ariane Koek discovers that physics and dance make for a great partnership.

A dance piece, conversation, floor show, game show and a chance to meet big minds – that’s how Liz Lerman, an award-winning American choreographer, bills her latest multimedia piece, *The Matter of Origins*. As the title playfully suggests, physics is the main partner for this new work, with dancers making equations with their bodies and pushing gravity to the limits.

But that’s not all. Physics also provides the intellectual framework on which the whole piece hangs. For one hour, dancers young and old, spin, leap, fall, balance and re-balance through critical moments of atomic and subatomic history: Marie Curie and the discovery of radium, the Manhattan Project, the LHC at CERN and the Hubble telescope.

These historical moments also provide the stunning visuals for the scenery, too, with the vast swathes of the New Mexico desert surrounding Los Alamos and a video tour of the LHC at CERN projected onto the dance space. *The Matter of Origins* is a fusion between the ideas of physics with the physical possibilities – and impossibilities – of dance. The normally reticent *Washington Post* this September critically acclaimed the world premiere at the University of Maryland as “a work of expansive range, emotional depth and singular beauty”.

The story of how this partnership between dance and physics happened was a total surprise, even to the choreographer. It began with a chance encounter between Lerman, who has run her own dance company, Dance Exchange, since 1976, and Gordy Kane, a physicist at the University of Michigan and director of the Michigan Center for Theoretical Physics. He knew that she was interested in science and the affect that it has on the way people think about themselves, having seen her previous work, *Ferocious Beauty: Genome*, which examined the nature of discovery and the implications of research into genetics.

Kane captivated her interest in physics by telling her about the search for the origins of



The Liz Lerman Dance Exchange fuse physics and dance in their critically acclaimed dance piece, The Matter of Origins. (Courtesy John Borstel.)

the universe at CERN and the mysteries of dark matter. So she came with her company of dancers to CERN for a few weeks in 2007/2008 to explore the possibility of making a piece, speaking to the scientists about their ideas and even dancing in the LHC tunnels and in several work spaces. And so, the project on *The Matter of Origins* was born, and in the process Lerman began to discover many unusual and quirky facts about the history of physics that might appear insignificant but nevertheless find their way into her piece.

Take, for example, the extraordinary story of Edith Warner, whom Robert Oppenheimer hired to feed the physicists working on the Manhattan Project at Los Alamos. She ran the Los Alamos tea house, serving her special chocolate cake to, among others, a scientist she knew as Dr Baker, but who was in fact Niels Bohr. The audience at *The Matter of Origins* is invited literally to chew over this fact – and many others, including Warner’s secret chocolate-cake recipe – because when the dance finishes at the end of Act One, they are unexpectedly swept into a room full of tea, tables and chocolate cake and asked to sit down for Act Two. At each table, a host – or provocateur, in Lerman’s words – who is

usually a physicist, invites the audience to discuss what they experienced watching the dance, as well as big science and its relation to society.

It is an extraordinary and exceptional bravura move, which Lerman readily explains: “Act One is, in European terms, a multimedia piece, with a video artist and animator, as well as the dancers and the science. It is a lot for an audience to take in. In my last science-dance piece, I noticed that the audience lingered and stayed to discuss the piece far more than normal. They didn’t want a post-performance discussion: they wanted to be the discussion. So my idea was to make this happen, giving individuals the chance to re-experience what they had just witnessed and to deepen their experience even further.”

Thus, between tea and talk, dancers also weave between the tables, adding yet more dimensions, including discussions about the uncertainty principle, which Lerman says is, in many ways, where every artist stands. “For an artist it is always a question of finding momentum and of poise while in uncertainty.”

Lerman is also adamant about another aspect that shows how dance and physics share common ground – it isn’t just in the intellectual footwork. “The arts can help people find the place where they intersect with science. Awe, imagination and the grit to be relentless to make something work – that’s what scientists and artists both do. What is fascinating in both cases, is the relationships scientists and artists have towards making mistakes – how we puzzle over them, and the obsession and passion, which ensures that we get it right in the end.”

But as Lerman’s piece shows, we may be merely at the beginning. Act Two ends with the beginning of Act One. The end has become a new beginning. Or, perhaps, it is just that the beginning is never ending.

● For more about the Liz Lerman Dance Exchange, see <http://danceexchange.org/>. Ariane Koek, CERN.

Single Photon Counting
No Noise
High Dynamic Range
Fast Frame Rate
Adjustable Energy Threshold

DECTRIS X-ray detector systems

DECTRIS offers a wide variety of detector systems for a broad range of applications

PILATUS 2-D detector systems

PILATUS detector systems are based on CMOS hybrid-pixel technology and deliver outstanding results in various applications. A wide range of models ensures that a suitable PILATUS detector can be chosen for every measurement.



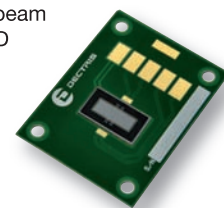
MYTHEN 1-D detector systems

MYTHEN is a one dimensional silicon strip detector system, which can be combined to form multi-detector arrays covering large angles (MYTHEN 6K).



XBPM Beam Position Monitors

XBPM4 is a 4-quadrant x-ray beam position monitor based on CVD diamond technology, suitable for hard x-ray synchrotron beam lines.



CAEN Silicon PhotoMultiplier Development Kit

The all-in-one solution for Single Photon Counting and Spectroscopy Applications

CAEN realized a modular development kit dedicated to Silicon Photomultipliers, representing the state-of-the-art in low light field detection with photon number resolving capabilities.



Desktop Digitizer (DT5720A)

- 2 Channel 12bit 250 MS/s Digitizer
- Digital Pulse Processing for Charge Integration DPP - CI
- Best suited for PMT and SiPM/MPPC readout at low and high rates
- Mid-High speed signals (Typ: output of PMT/SiPM)
- Good timing resolution with fast signals (rise time < 100 ns)
- Optical Link and USB 2.0 interfaces



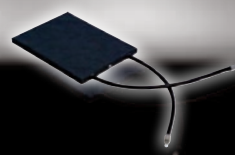
2 Channels General Purpose Amplifier and Power Supply Unit (SP5600)

- Variable amplification gain (up to 50 dB)
- Low noise, not to spoil the sensor performances for small signals
- Wideband, to comply with the fast sensor response
- Fast leading edge discriminator and time coincidence
- Provides the bias for the sensors with gain stabilization
- USB 2.0 interface
- Mechanical structures with two embedded SiPM 1 x 1 mm²



Led Driver (SP5601)

- Width of pulse $3 \div 60$ ns
- LED color: violet (400nm) 1500 mcd
- Pulse generator: internal/external
- Optical output connectors: FC
- Optical fiber included



Scintillating Tile (SP5602)

- Sensitive volume: 100 x 100 x 10 mm³
- Scintillator: polystyrene
- Light guide: embedded WLS fiber
- Output connectors: FC



Mini Spectrometer (SP5603)

- Mechanical structure for optimal SiPM to crystal coupling
- Crystal dimensions: 3 x 3 x 15 mm³
- Included crystals: LYSO, BGO, CsI
- One SiPM 3 x 3 mm² embedded

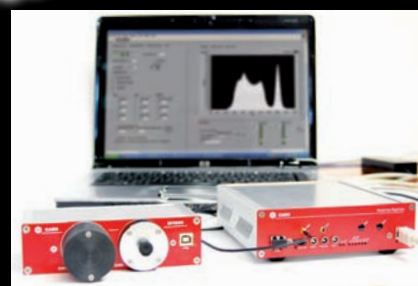
Control Software included



Set-up for SiPM testing & characterization



Set-up for detecting cosmic rays and β particles



Set-up for detecting gamma rays

The different building blocks can be assembled in a customized configuration, according to the specific application and the user's requirements. Upon request, sensors from the main producers can be provided, fully integrated in the mechanical structures.

The kit was developed within the EC-FP6 project RAPSODI, licensed to CAEN by the Research & Technology Development parties.

www.caen.it

Small details Great differences

Meet us at the following events:

Environmental Radioactivity 2010 – New Frontiers and Developments
October 24 - 28, 2010

2010 Nuclear Science Symposium and Medical Imaging Conference
October 30 - November 6, 2010

Discrete 2010 - Symposium on Prospects in the Physics of Discrete Symmetries
December 6 - 11, 2010

SPIE Photonics West
January 22 - 27, 2011

XLIX International Winter Meeting on Nuclear Physics
January 23 - 29, 2011