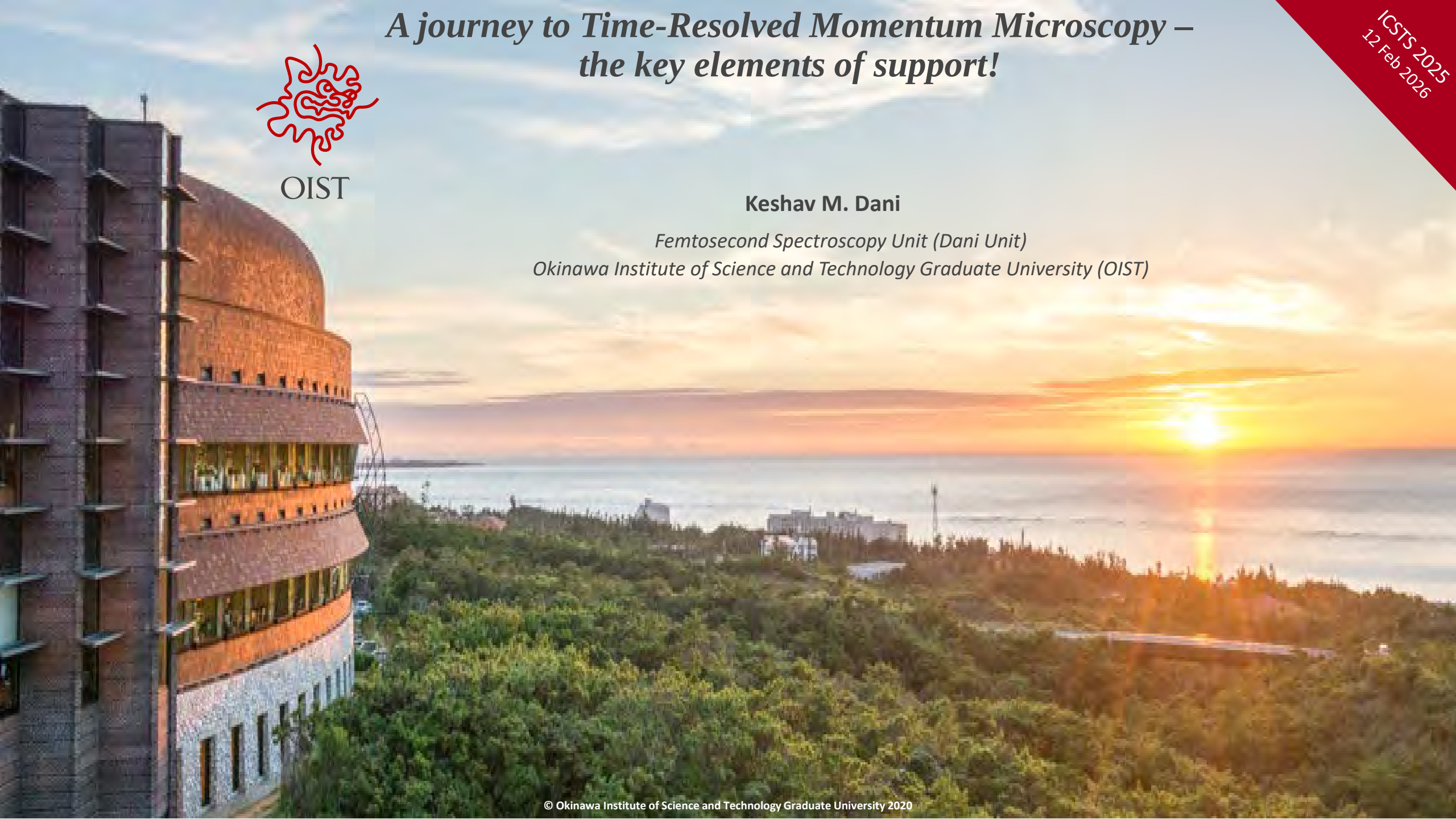
A journey to Time-Resolved Momentum Microscopy – the key elements of support!

ICSTS 2025
12 Feb 2026

Keshav M. Dani

Femtosecond Spectroscopy Unit (Dani Unit)
Okinawa Institute of Science and Technology Graduate University (OIST)



DANI, Keshav M.

2026/3/4

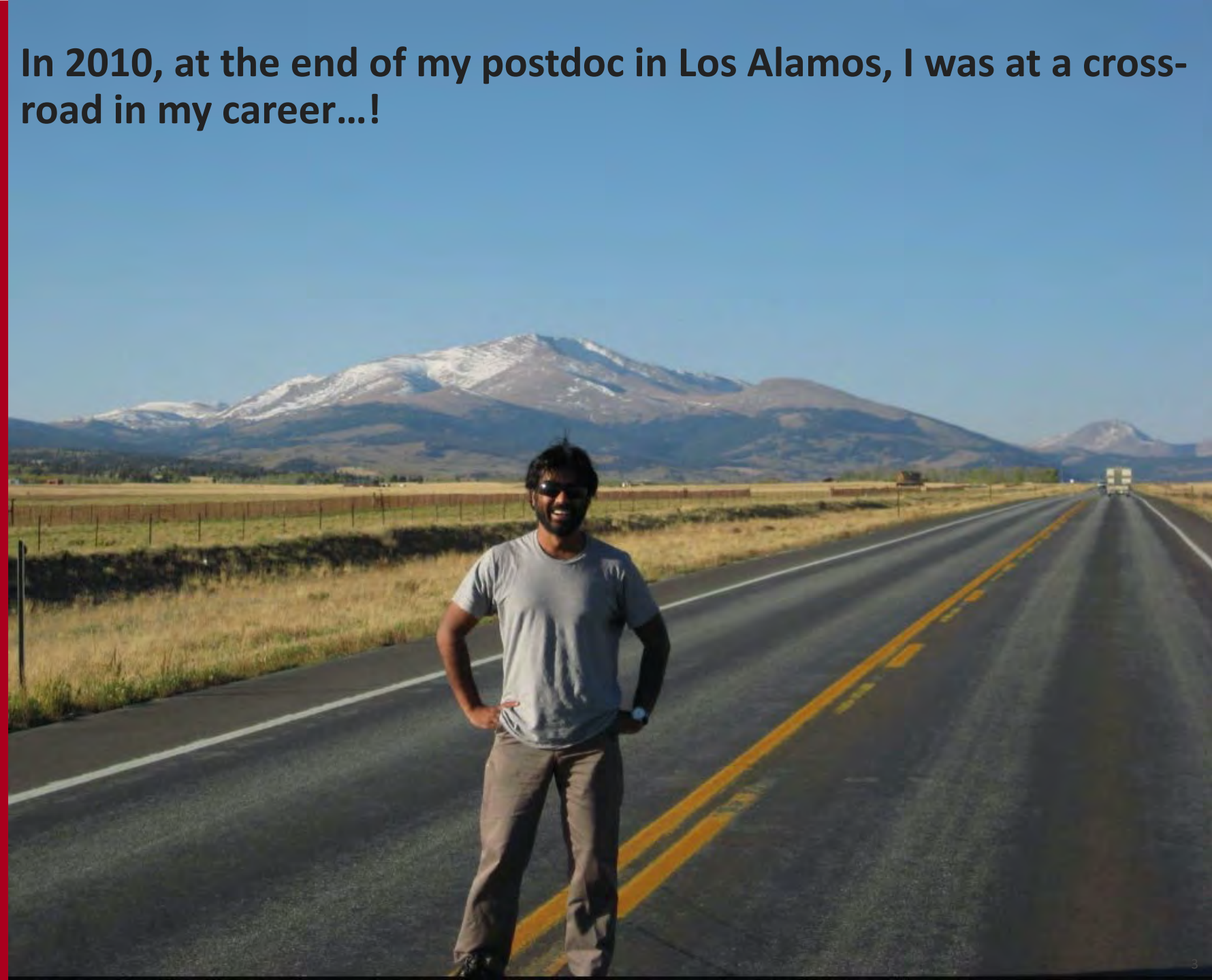
A BRIEF HISTORY

- Born & brought up in India
- BS Mathematics 2000, *Caltech*
  - *Senior Thesis in Quantum Information with John Preskill & Hideo Mabuchi*
- PhD Physics 2006, *University of California, Berkeley*
  - *Thesis in Ultrafast Nonlinear Optics with Daniel Chemla*
- Director's Postdoctoral Fellowship 2007 – 2011, *Los Alamos National Lab*
  - *Ultrafast response of metamaterials with Antoinette Taylor*

DANI, Keshav M.

2026/3/4

In 2010, at the end of my postdoc in Los Alamos, I was at a cross-road in my career…!



On a Sunday morning, drinking coffee in the iconic Railyard District of Santa Fe, I saw an unusual advertisement…

On a Sunday morning, drinking coffee in the iconic Railyard District of Santa Fe, I saw an unusual advertisement…

…a new university on a remote island in the pacific was recruiting!

…and they promised substantial funding to pursue *MY* research dreams!

OIST

Jonathan DORFAN
2011
Pres.-Elect OIST
Ex-Dir. SLAC

"If you have a scientific vision that the Americans or Europeans don't believe in, but you believe in, you come to OIST. We will back you!

Let your creativity go as far as the horizon.

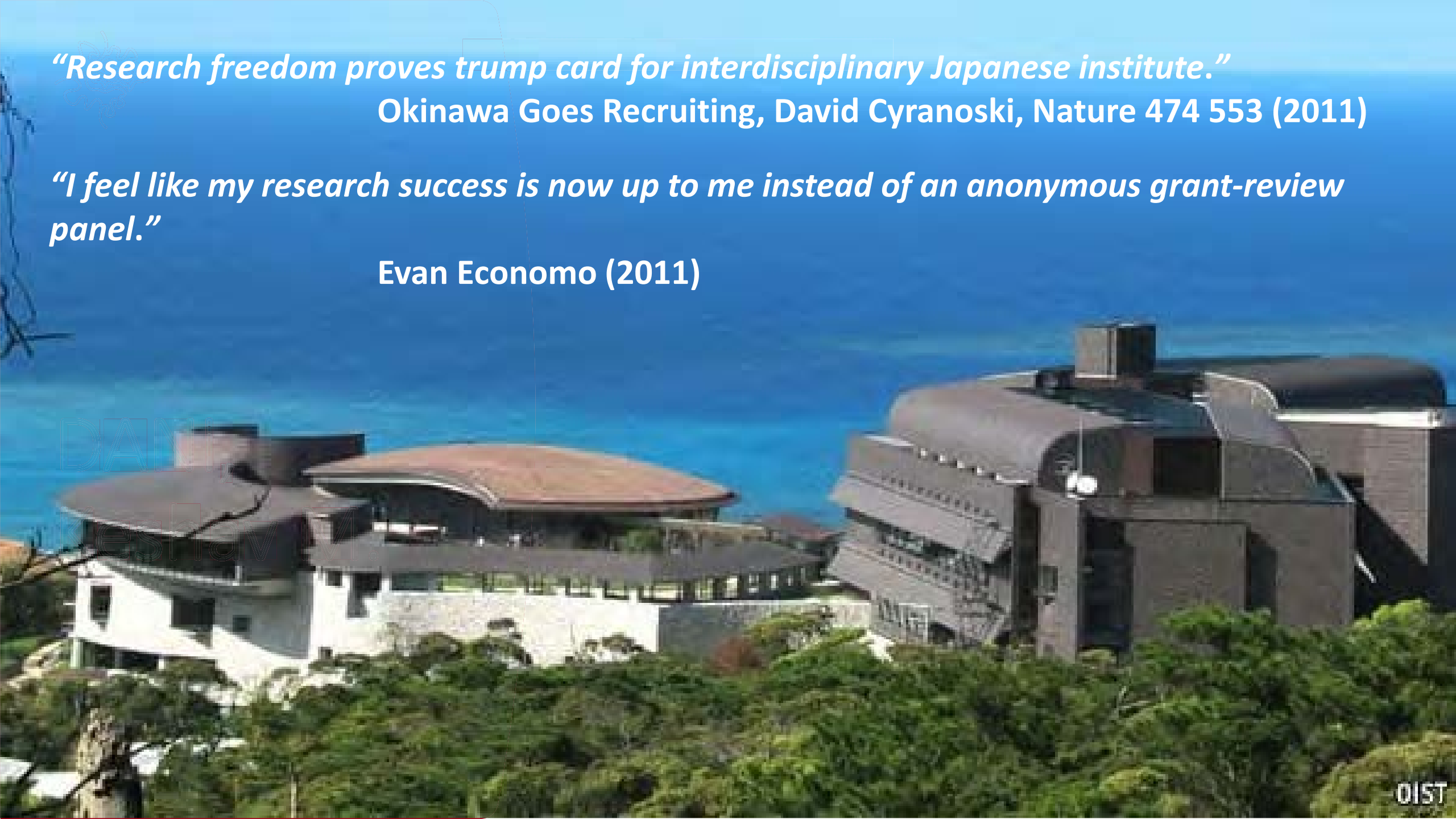
Do the bold far-reaching science you dreamt of."

“Research freedom proves trump card for interdisciplinary Japanese institute.”

Okinawa Goes Recruiting, David Cyranoski, Nature 474 553 (2011)

“I feel like my research success is now up to me instead of an anonymous grant-review panel.”

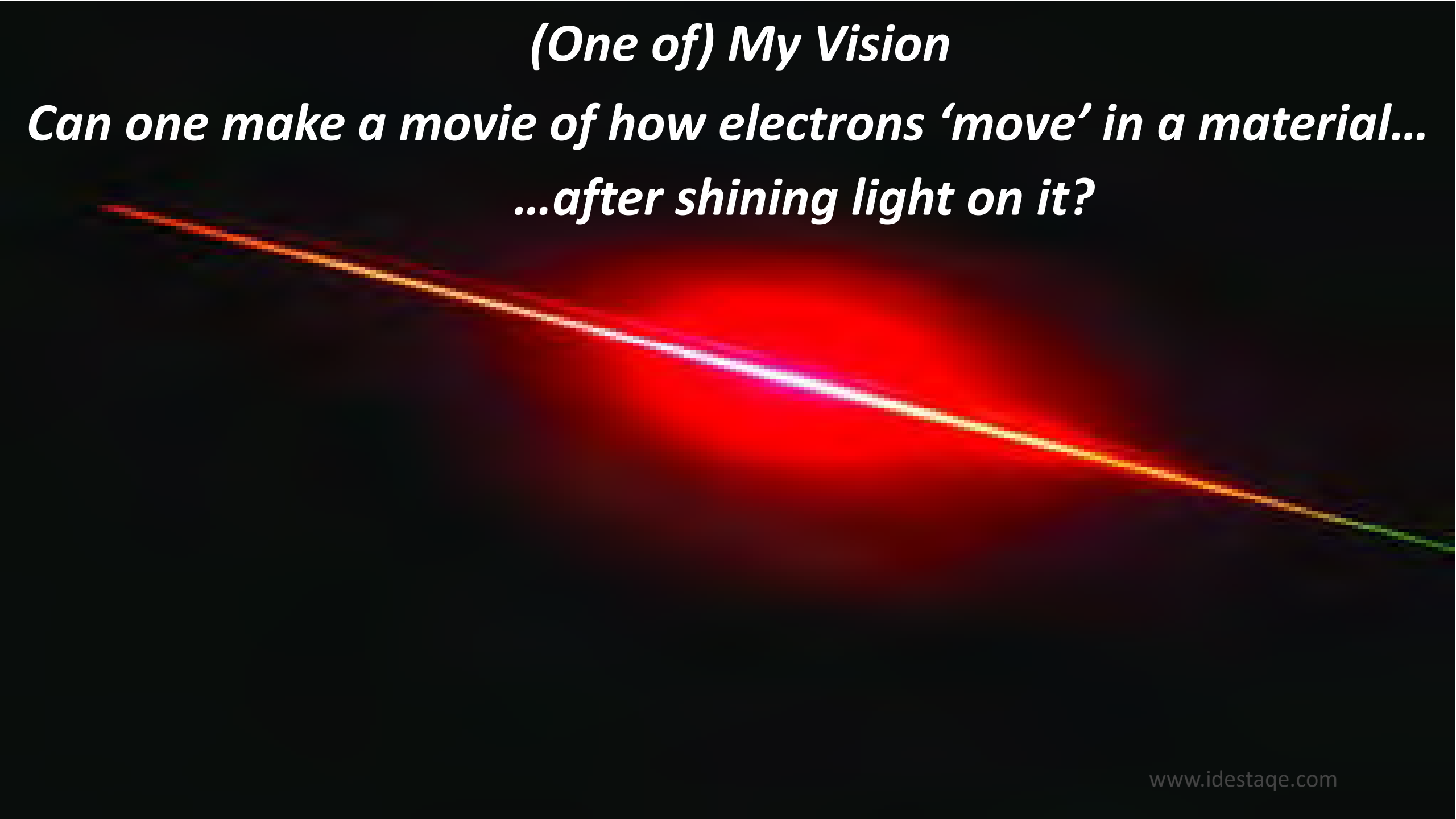
Evan Economo (2011)



(One of) My Vision

Can one make a movie of how electrons 'move' in a material…

…after shining light on it?



MY VISION

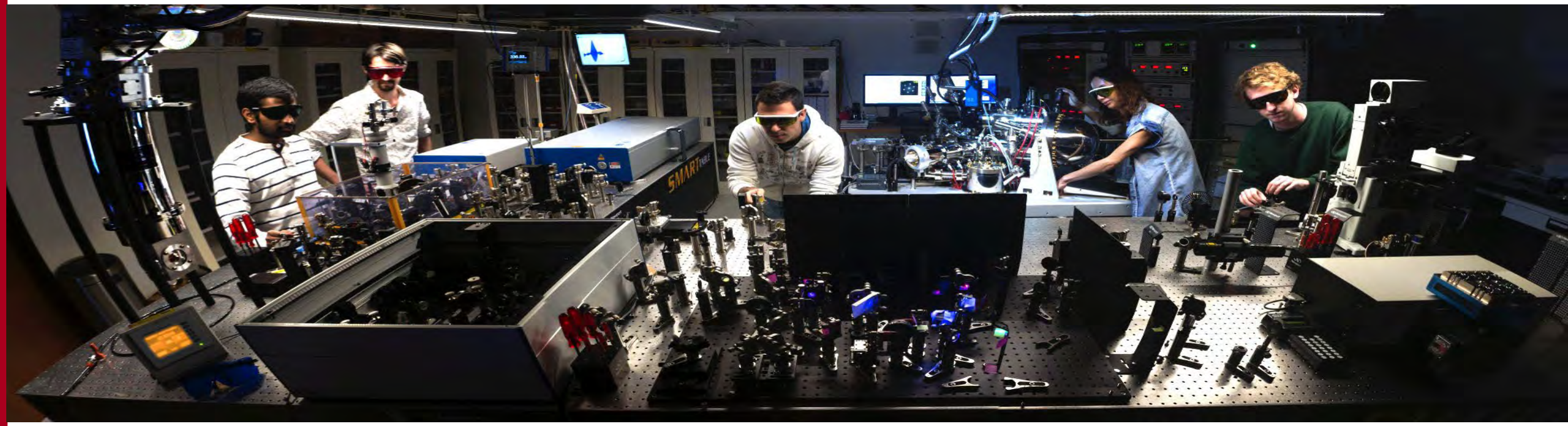
Can one make a movie of how electrons 'move' in a material…

…after shining light on it?

Electrons 'move' about a billionth of a meter…

…in about a millionth of a billionth of a second!

Over a decade, we worked hard to build cutting-edge instrumentation at OIST to image electrons in space time, energy, momentum & spin!



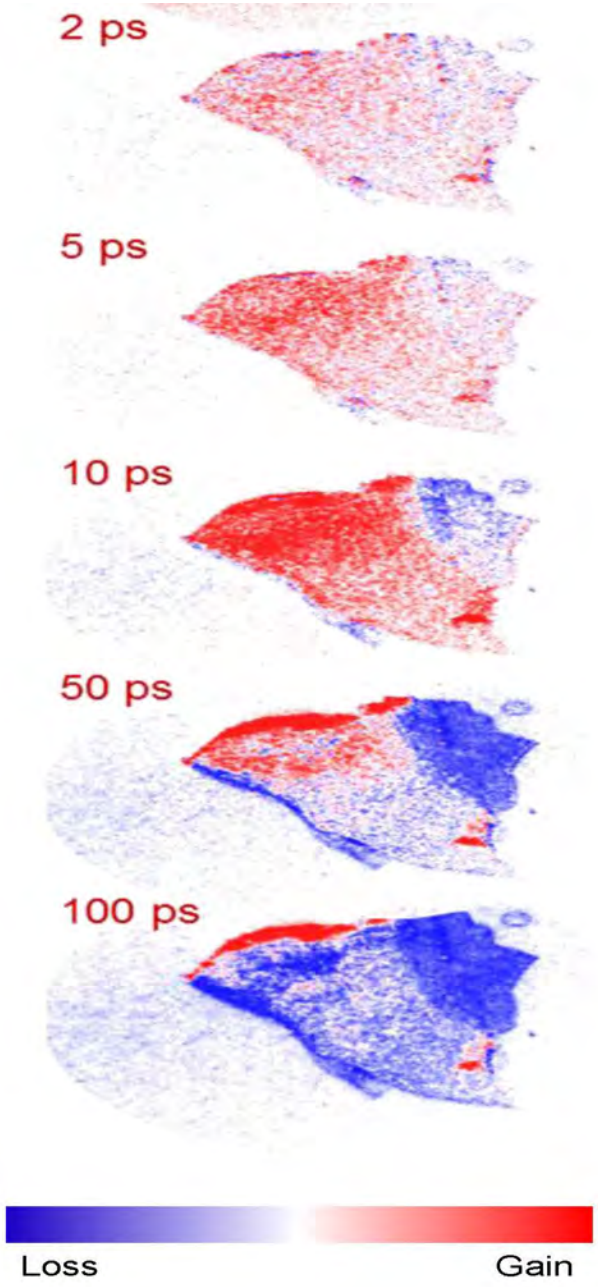
It is important to recognize, that for bold ambitious ventures, funding is necessary, but not sufficient!

Institutional support, institutional structure, institutional patience, ambition, risk-tolerance and understanding must align! OIST & the Cabinet Office did just that!

Peter GRUSS
2017
President, OIST
Ex-Pres., Max Planck Society

This isn't my first rodeo! It is important to be first in science!

Videography of the electron flow from GaAs to InSe!



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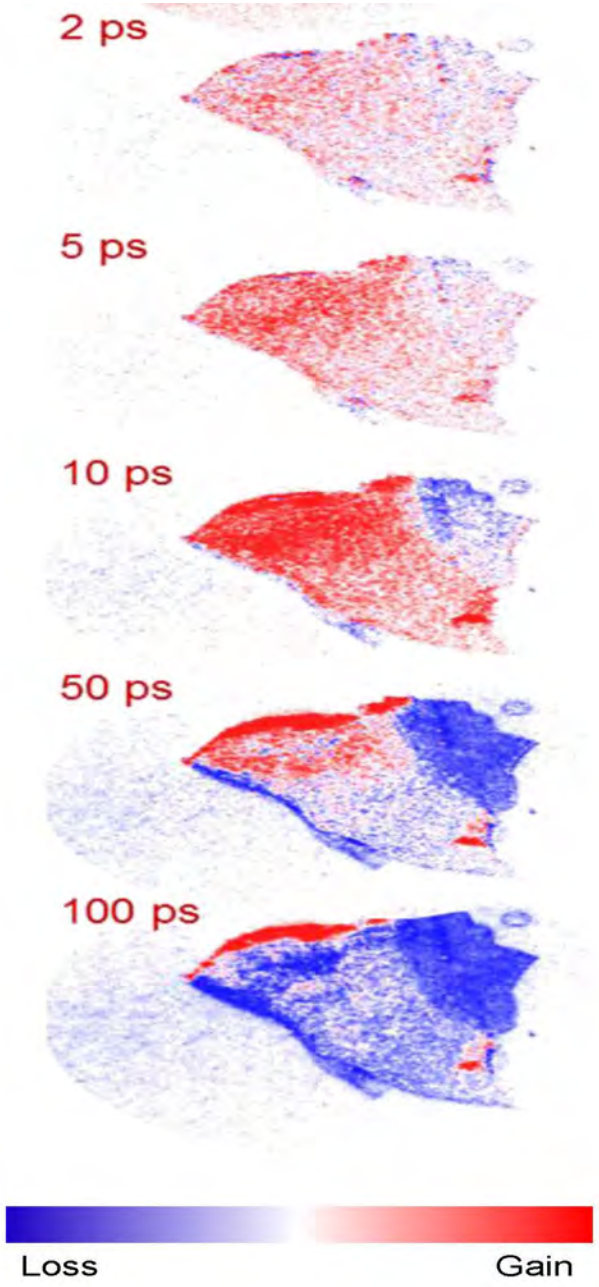
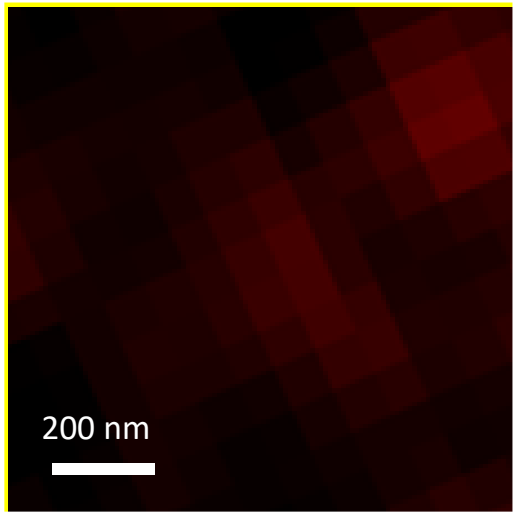
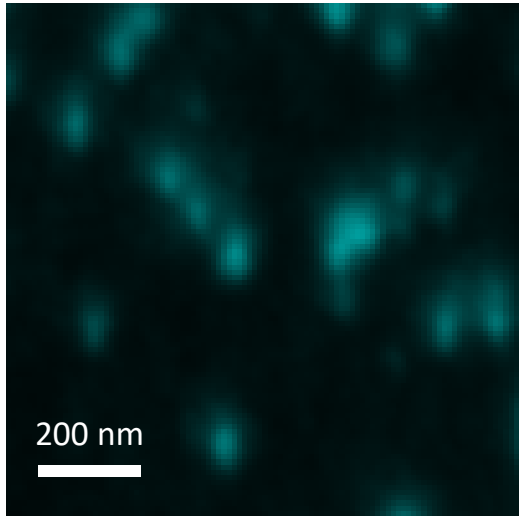


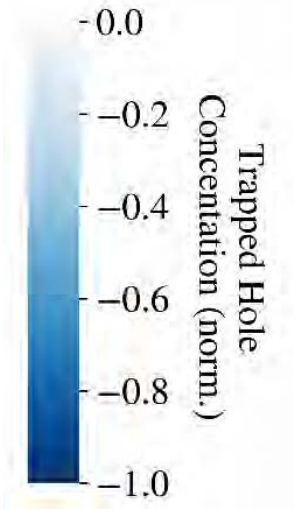
CINEMATOGRAPHY OF CHARGE

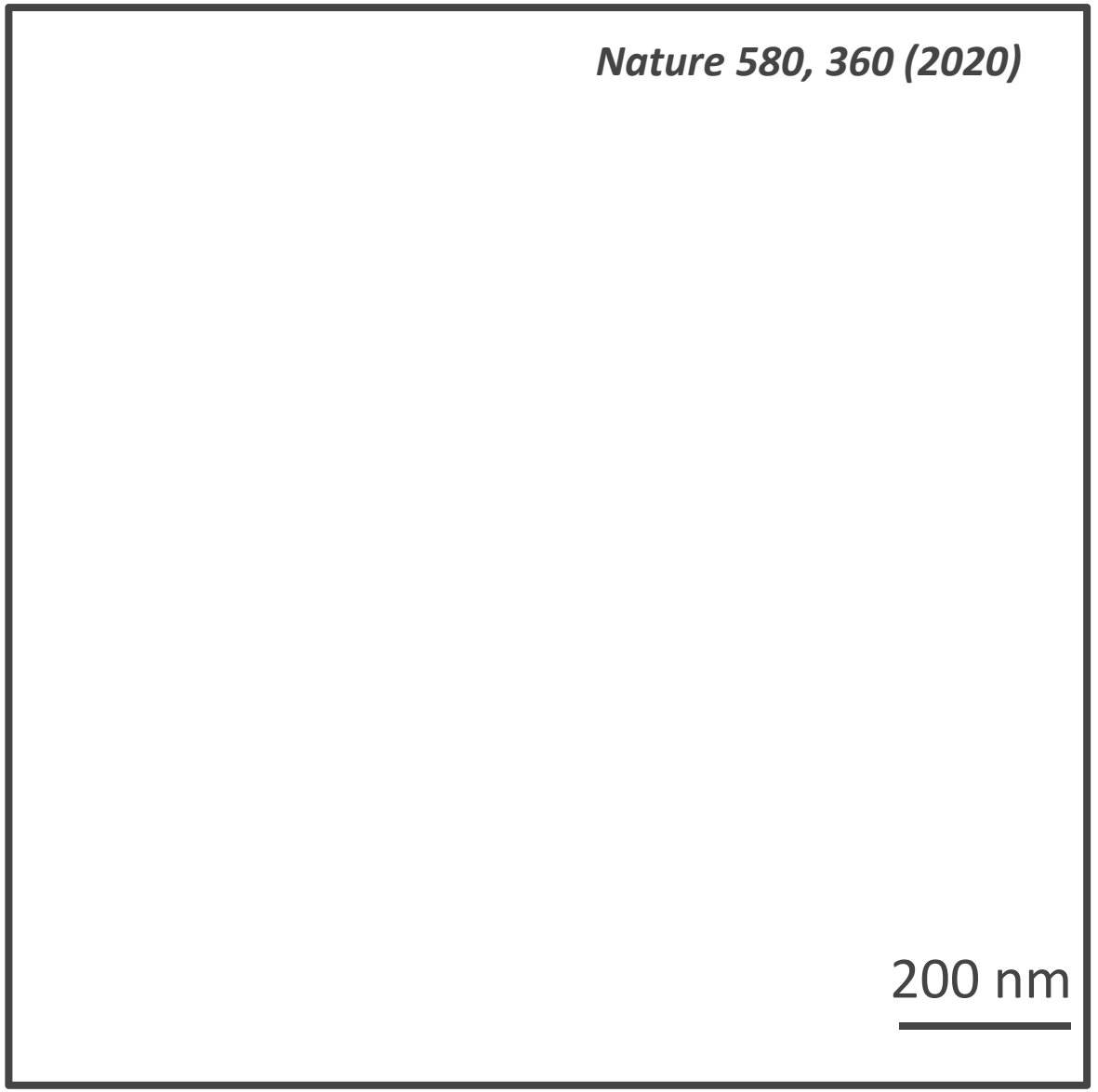
Nature Nanotech. 12, 36-40 (2017)

Role of defects in perovskites – one of the most promising photovoltaic materials today: *limiting efficiency and acting as seeds of degradation!*







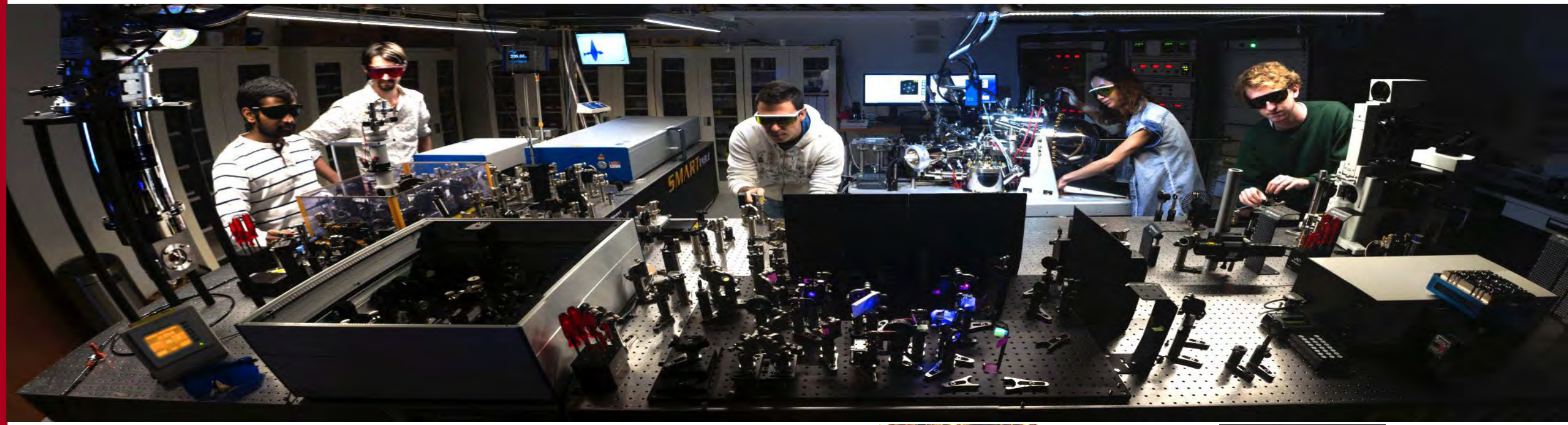


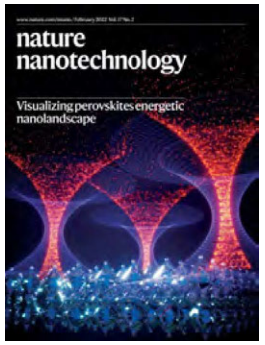
Dynamics of the WSe_2 Dark Exciton – *Resonant Excitation*.

Science 370, 1199 (2020)

Femtosecond Spectroscopy Unit (Dani)

Our Time-, Energy- & Spin-resolved photoemission electron microscopy & momentum microscopy led to a number of breakthroughs in the past few years, and continues to make important advances in energy materials and condensed matter physics!





Nature Nanotech 17, 190-196 (2022)

Nature 607 294-300 (2022)

Nature 603 247-252 (2022)

Science Advances 7 (17), eabg0192 (2021).

EE&S 14, 6320-6328 (2021).

Nature 580, 360-366 (2020)

Science 370, 1199-1204 (2020)

Science Advances 4 (9), eaat9722 (2018)

Nature Nanotech 12, 36 (2017).

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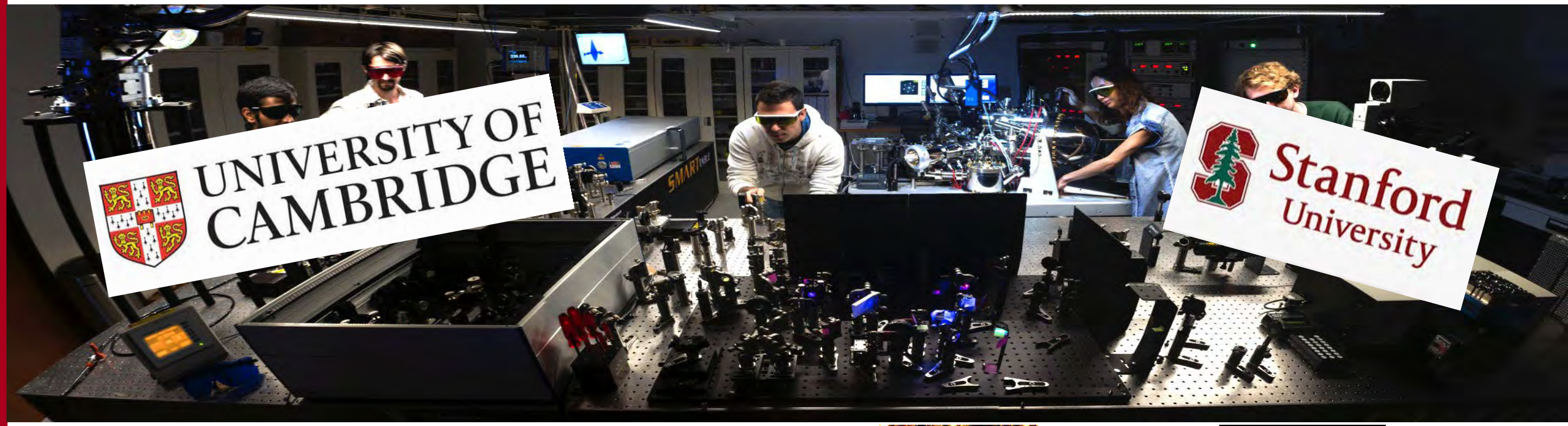

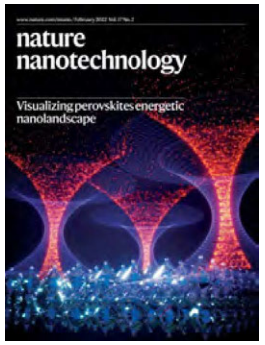

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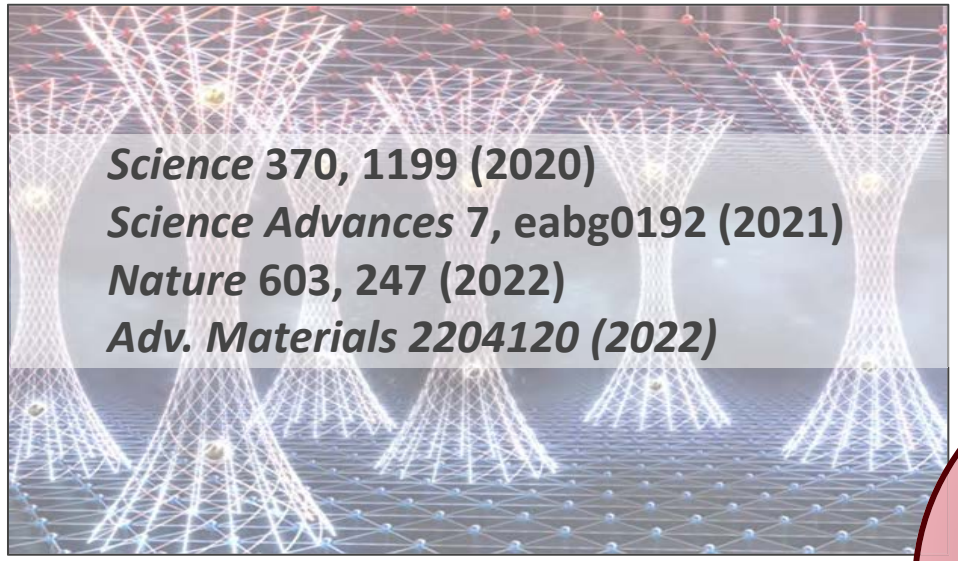
Science 370, 1199-1204 (2020)

Science Advances 4 (9), eaat9722 (2018)

Nature Nanotech 12, 36 (2017).

RECENT RESEARCH OVERVIEW & IMPACT

Excitons in 2D Semiconductors



Science 370, 1199 (2020)
Science Advances 7, eabg0192 (2021)
Nature 603, 247 (2022)
Adv. Materials 2204120 (2022)

Research themes

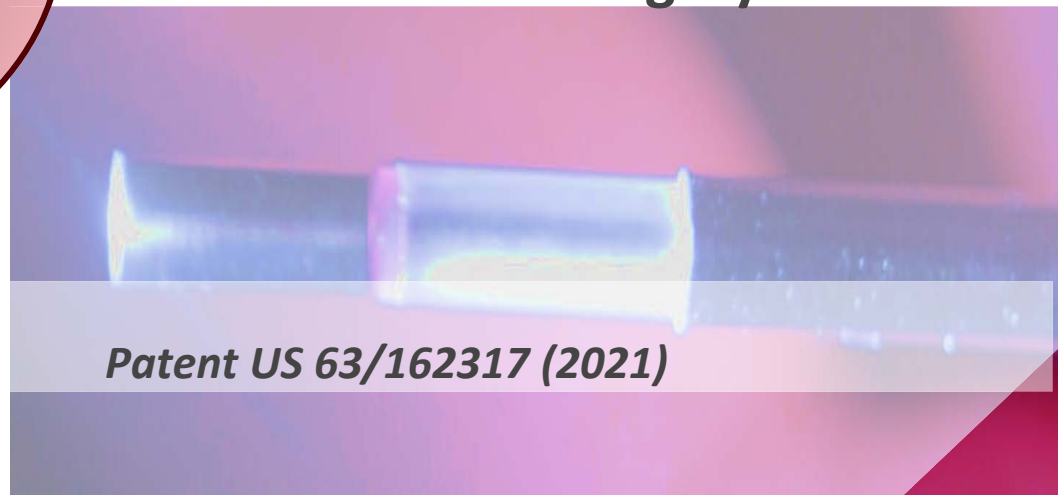
Energy Materials

Nature Nanotech. 12, 36 (2017)
Science Adv. 4, eaat9722 (2018)
Nature 580, 360 (2020)
Energy & Env. Science 14, 6320 (2021)
Nature 607, 294 (2022)
Nature Nanotech. 17, 190 (2022)

Microplasma sources

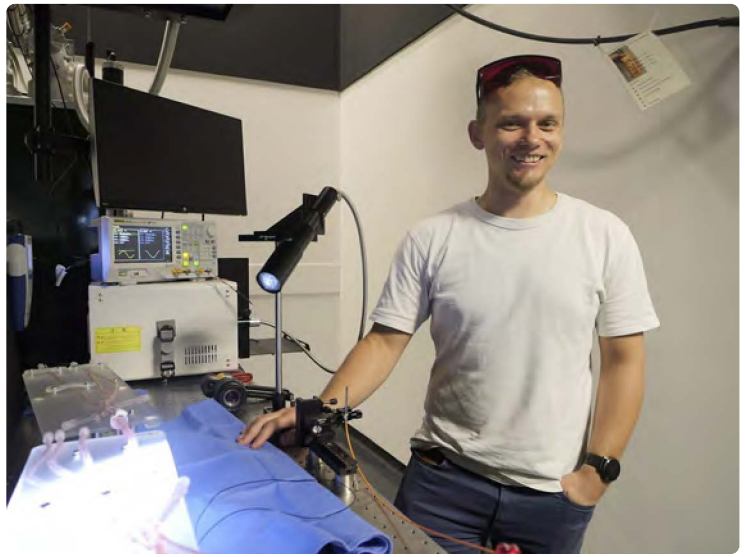
Patent US 16/982,428 (2019)
Patent US 16/845419 (2020)

Femtosurgery



Patent US 63/162317 (2021)

From Lab To Startup



Chiore medical
キオレ

Chiore Medical, Inc.

Dr Viktoras Lisicovas - Founder and CEO

- Femtosecond-laser catheter for atherectomy
- Licensed technology developed in the Dani Unit
- Investors: UTEC (lead) and Lifetime Ventures
- OIST Graduate Student, Technology Pioneer Fellowship alumnus (POC Program)

OIST

Key factors in my journey…

ICSTS 2025
12 Feb 2026

Traditional Grant Based Funding

- Competitive, rigorous & thorough peer-review of ideas
- Enables the progress of solid, reliable, community-vetted science
- Should still form the bulk of govt. funding

Traditional Grant Based Funding

However, almost by definition, a broad, community-based vetting process scuttles ideas that go counter to existing knowledge and understanding.

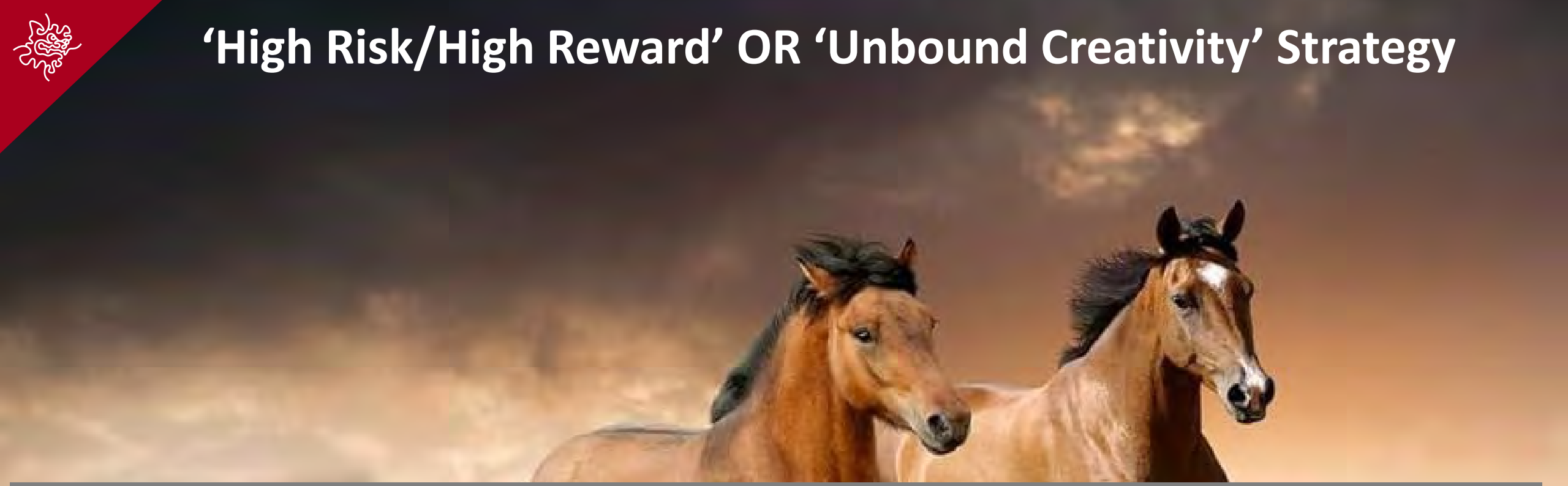
But this is exactly where bold new knowledge is created!

‘High Risk/High Reward’ OR ‘Unbound Creativity’ Strategy

-

Enable youth & ambition to drive bold, risky, innovative ideas!

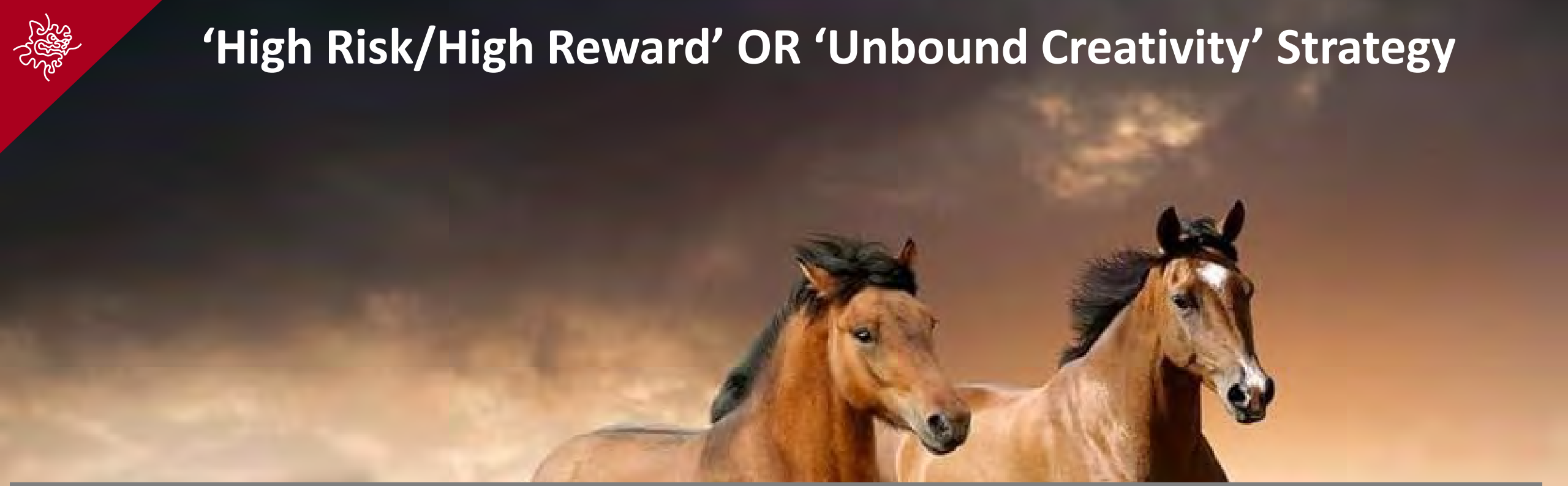
‘High Risk/High Reward’ OR ‘Unbound Creativity’ Strategy



One part of the national funding portfolio or strategy

- Seek to deliver unknown breakthroughs, new fields, impossible challenges
- Traditional peer-reviewed and national initiatives still needed. They progress traditional science and pursue known, existing national priorities.
- Failure is one measure of the risk undertaken. A 90% success rate of program likely means one has been quite conservative in choices.

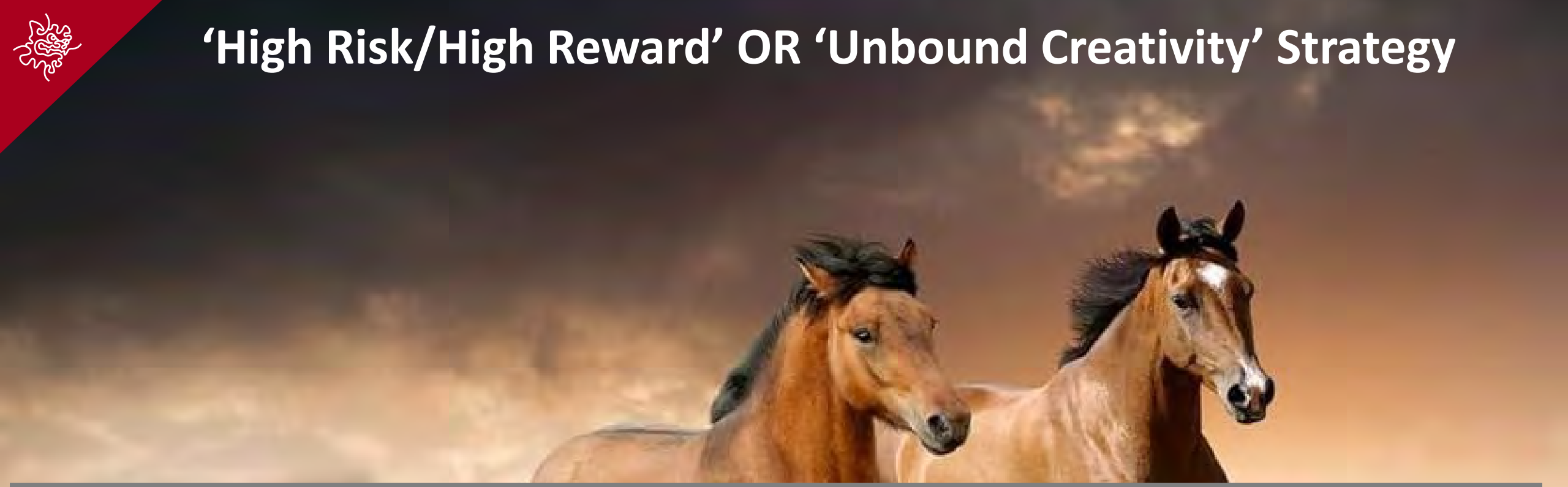
‘High Risk/High Reward’ OR ‘Unbound Creativity’ Strategy



Youth-based & Early Career

- Their daring, risk-appetite and naivety are important to go beyond traditional knowledge.
- As we get older, we ‘know’ too much, and have less energy to take risks or fail
- Generous support in 30s and 40s. Funding. Institutional support. Independence.
- In their 50s and 60s, these leaders and their funding can transform to support different aspects of the national strategy
- ‘Early-career Max Plank Directors’

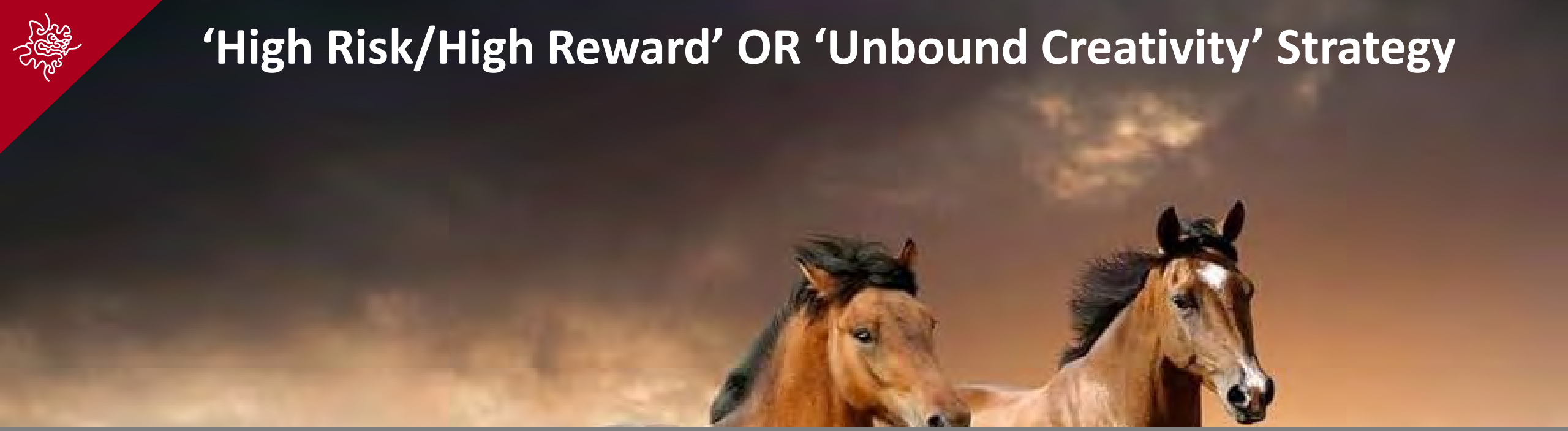
‘High Risk/High Reward’ OR ‘Unbound Creativity’ Strategy



Selection Process & Oversight

- Needs careful thought!
- Selection may need to go beyond traditional paper-based and interview applications
- Candidates will require a particular mix of creativity, independence, maturity, knowledge among other aspects
- Oversight of tax-payer money and Mentorship is essential. Yet should ensure that candidates’ independence and pursuit of unexpected breakthroughs is preserved.

‘High Risk/High Reward’ OR ‘Unbound Creativity’ Strategy



Cultivate a Culture of Respect for Commercialization & Science Policy

- Fundamental science, like art, appeals to our basic human instincts – curiosity, beauty, humility and awe.
- But science and technology also prodoundly impact how society functions and lives.
- Even fundamental scientists need to play a key role in identifying the role their discoveries might play a role in how our societies function through the market or govt. policy
- In turn, institute needs to provide the tools to support this process – scientists wanting to make an impact on commercialization and policy.

‘High Risk/High Reward’ OR ‘Unbound Creativity’ Strategy

Balancing connectedness & isolation

- Globally connected, but insulated from global pressure to follow trends
- Access to mentorship, but freedom to make independent choices
- For me, global collaborations essential, but also to ignore voices that said ideas wouldn’t work

‘High Risk/High Reward’ OR ‘Unbound Creativity’ Strategy

Personal Support

- Salaries consumerate to international ones based on standard of living
- Support for spouses and children
- Administrative support for work and life in Japan