Meeting Future Challenges in Accelerators:

Innovation, Collaboration & Communication

Dr. Suzie Sheehy

@suziesheehy

Accelerator. def:

Accelerator. def:

1. an apparatus for accelerating charged particles to high velocities; a particle accelerator.

2. a person or thing that causes something to happen or develop more quickly.

3. a device, typically a foot pedal, which controls the speed of a vehicle's engine.

Accelerator. def:

Accelerator. def:

1. an apparatus for accelerating charged particles to high velocities; a particle accelerator.

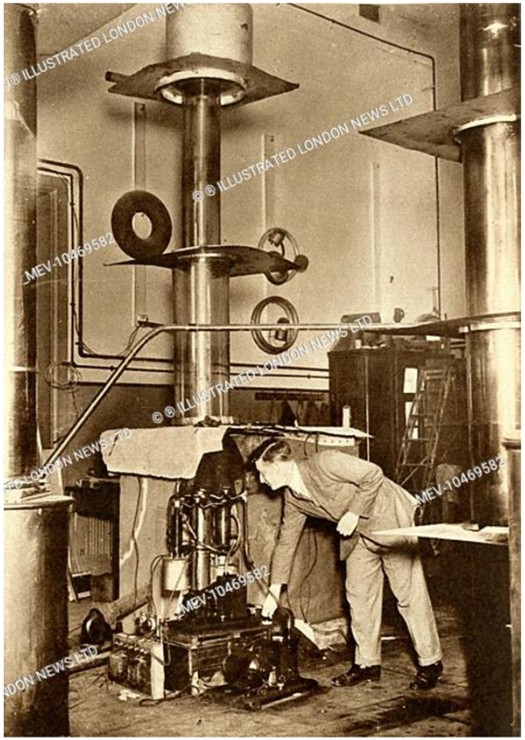
2. a person or thing that causes something to happen or develop more quickly.

The first accelerators

John Cockcroft: early in his career, worked for Metrovick (Metropolitan-Vickers).

- Collaborated with Metrovick for the HV insulators and other parts for the generator
- Realised the first particle accelerator: demonstrated coulomb barrier penetration & transmuted Lithium.

Collaboration between industry & academia has enabled accelerators from the very start



© ® ILLUSTRATED LONDON NEWS LTD/MARY EVANS
MEV-10469582 - agefotostock

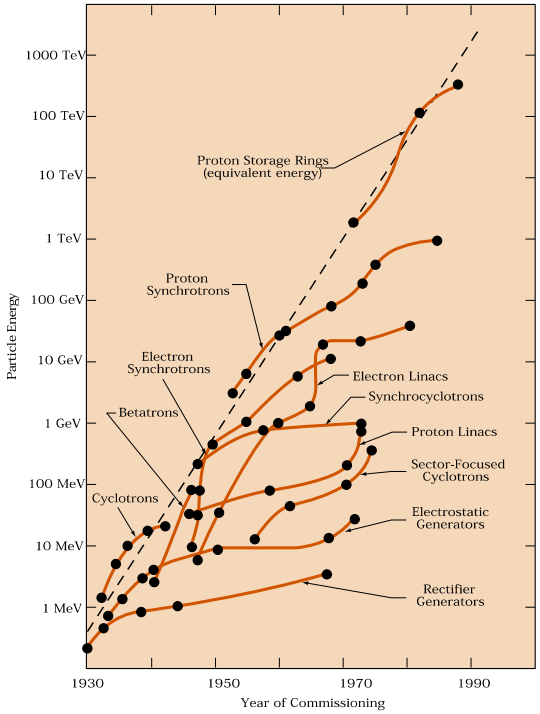
The dawn of nuclear medicine

In 1935, John came to Berkeley.

- Injected leukemic mice with radioactive phosphorus (then went fishing)
- On his return, the mouse had improved…
- Also became aware of need for radiation protection!

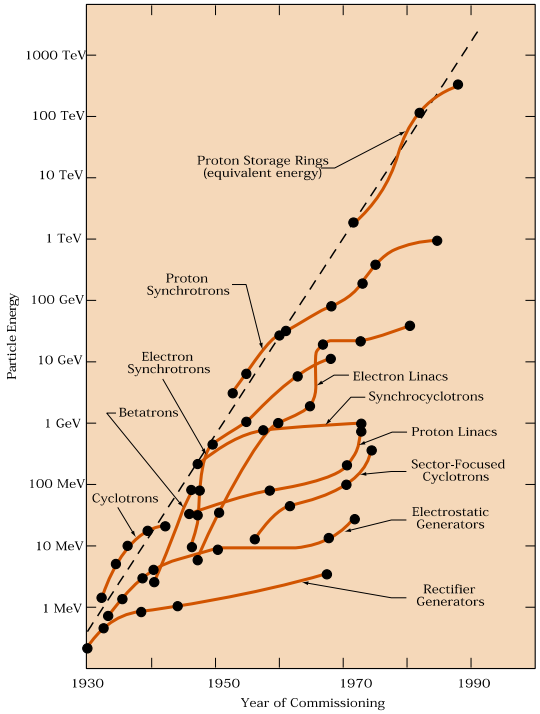
Ernest & John Lawrence, Berkeley Lab

Good communication & collaboration between disciplines has enabled accelerators to find applications we could never have imagined working in 'silos'



"The reasonable man adapts himself to the world: the unreasonable one persists in trying to adapt the world to himself. Therefore all progress depends on the unreasonable man." - George Bernard Shaw

economic-impact-of-basic-science



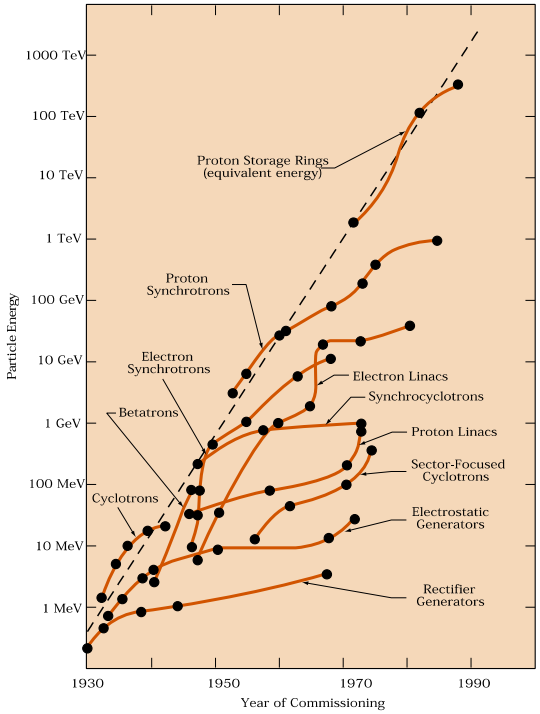
"The reasonable woman adapts herself to the world: the unreasonable one persists in trying to adapt the world to herself. Therefore all progress depends on the unreasonable woman."
- George Bernard Shaw

of STFC (UK) and now at ESS

. It makes unreasonable
nen those technologies, those
ppen, they spread out into the
uge impact."

economic-impact-of-basic-science

We are unreasonable



"The reasonable woman adapts herself to the world: the unreasonable one persists in trying to adapt the world to herself. Therefore all progress depends on the unreasonable woman."
- George Bernard Shaw

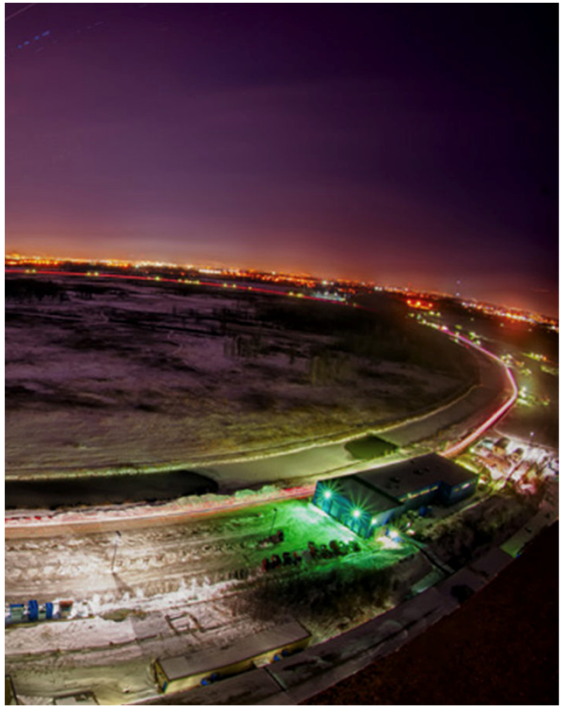
of STFC (UK) and now at ESS

. It makes unreasonable
en those technologies, those
ppen, they spread out into the
uge impact."

economic-impact-of-basic-science

The Tevatron

"It has nothing to do directly with defending our country except *to make it worth defending*." - R. R. Wilson, 1969



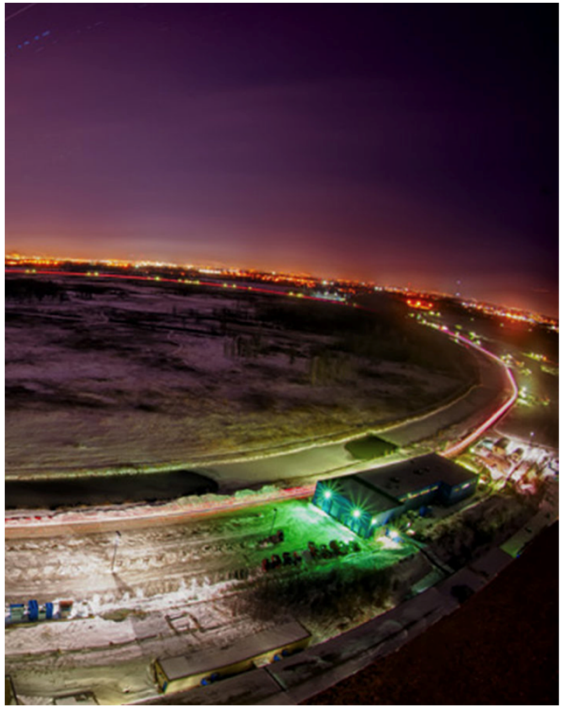
https://history.fnal.gov/testimony.html

The Tevatron

Senator: Essentially, the major purpose of this bevatron is for fundamental high-energy physics research, which is an educational and academic process, is it not?

Wilson: And a cultural process, yes, but with the firm expectation that technological developments will come. Directly, but after a very long time; from the results of the research will come new technology.

…because we are doing extremely difficult technical things, and because we are working in a strange kind of research, we know from past experience that new techniques inevitably develop, techniques which have paid, more than paid, for the cost of the basic research that was not pointed to such developments.



https://history.fnal.gov/testimony.html

And he was right…

MRI Scanner

Tevatron magnet

Tevatron (lower ring)

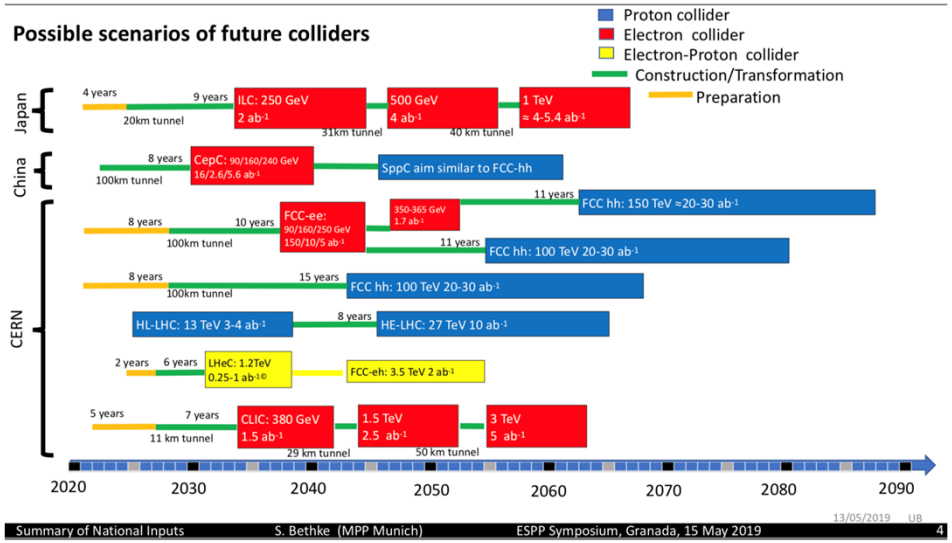
Communicating the coupled nature of curiosity driven and applied research in our field has been a key to its success

Themes:

- **Collaboration**
- **Communication**
- **Innovation**

Challenge 1: future colliders

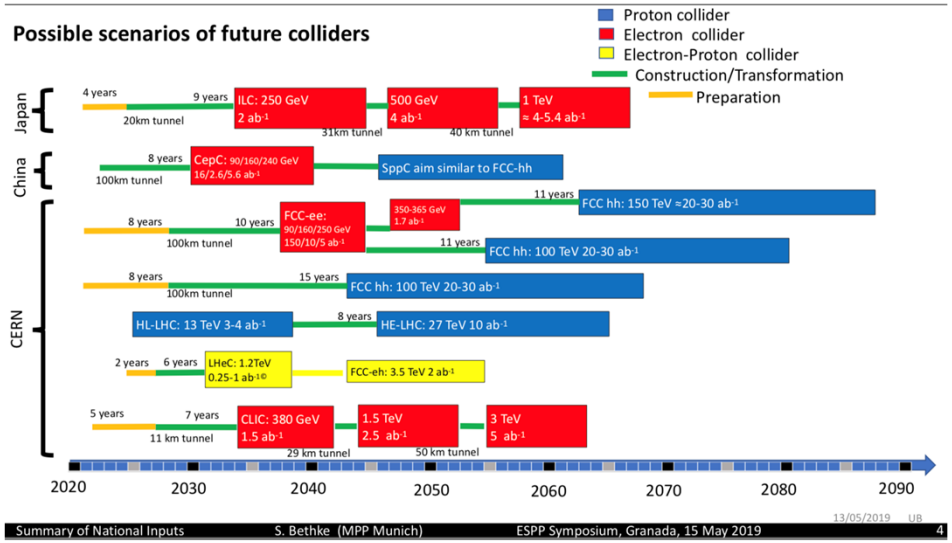
Update from the European
Strategy Meeting last week…



https://indico.cern.ch/event/808335/contributions/3365090/attachments/1844919/3026522/Granada-nat-roadmaps.pdf

Challenge 1: future colliders

Update from the European Strategy Meeting last week…



SIZE

COST

ENERGY CONSUMPTION

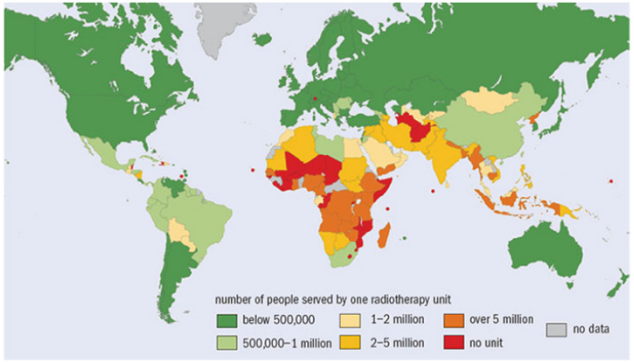
TIMESCALE

https://indico.cern.ch/event/808335/contributions/3365090/attachments/1844919/3026522/Granada-nat-roadmaps.pdf

Challenge 2: global radiotherapy

The annual global incidence of cancer is expected to rise from 15 million cases in 2015 to as many as 25 million cases in 2035.

Of these, it is estimated that 65–70% will occur in low-and middle- income countries (LMICs)

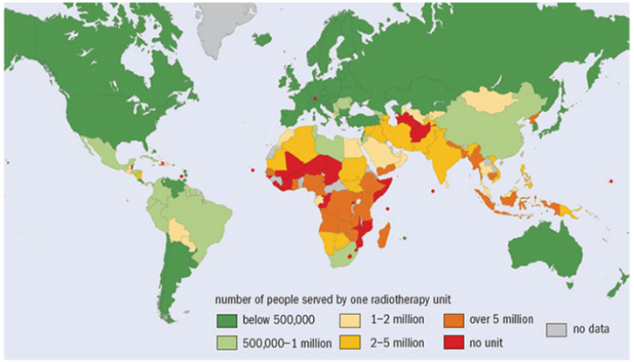


X

Challenge 2: global radiotherapy

The annual global incidence of cancer is expected to rise from 15 million cases in 2015 to as many as 25 million cases in 2035.

Of these, it is estimated that 65–70% will occur in low-and middle- income countries (LMICs)



RELIABILITY

COST

EXPERTISE

X

Synergies with Australian needs

- Rural & regional patients can miss out on radiotherapy care
- Utilization of radiation therapy decreases by 10% with every 100 km a patient has to travel to a radiation therapy centre
- Australian innovations include: innovative patient set-up, image guidance, telemedicine and miniaturisation of equipment
- Huge potential for synergy with global context

- http://www.health.gov.au/internet/main/publishing.nsf/Content/ national-strategic-framework-rural-remote-health
- G. Gabriel, M. Barton, G. P. Delaney, The effect of travel distance on radiotherapy utilization in NSW and ACT. *Radiother Oncol* **117**, 386-389 (2015).

Interdisciplinary Collaboration

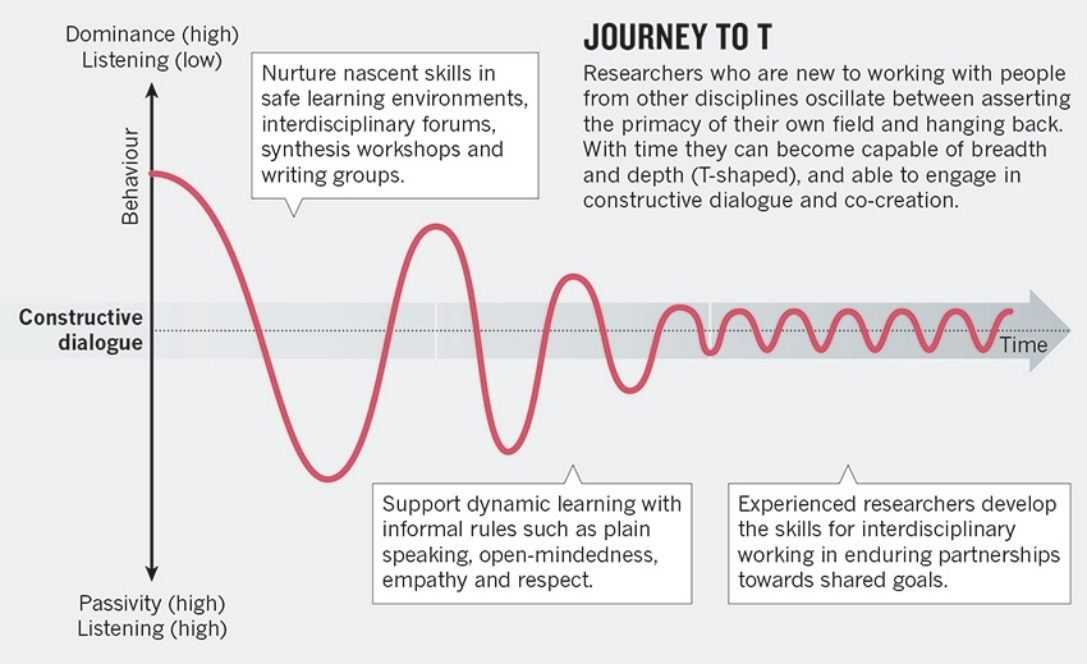
All of the challenges we face require *interdisciplinary* innovation

One study of 466 researchers* found that:
Fundamentally, scientists saw boundary-crossing research as offering high levels of professional risk with low rewards and only meagre professional returns.
Because: *"most scientists work within institutional and professional contexts that overwhelmingly favour and reward deep specialization"*.

*interdisciplinary collaborations have the greatest chance of success when researchers are 'T-shaped'- able to cultivate both their own discipline, and to look beyond it. Breadth and depth are key. ***

*https://theconversation.com/scientists-tend-to-superspecialize-but-there-are-ways-they-can-change-51644
** Nature 525, 315–317 (17 September 2015) doi:10.1038/525315a

What is a T-shaped researcher?



Nature 525, 315–317 (17 September 2015) doi:10.1038/525315a

A story about chickens…

https://www.ted.com/talks/margaret_heffernan_why_it_s_time_to_forget_the_pecking_order_at_work?language=en

Muir, W. M. (2013). *In Genetics and the Behaviour of Domestic Animals*, 2nd Edition. (Vol. 2, pp. 1-30).

A story about chickens…

https://www.ted.com/talks/margaret_heffernan_why_it_s_time_to_forget_the_pecking_order_at_work?language=en

Muir, W. M. (2013). *In Genetics and the Behaviour of Domestic Animals*, 2nd Edition. (Vol. 2, pp. 1-30).

A story about chickens…

Purdue university ran a study on the productivity of chickens…

1. Control group: leave for 2 generations
2. ‘Super chicken’ group: select out most productive & breed for 2 generations

https://www.ted.com/talks/margaret_heffernan_why_it_s_time_to_forget_the_pecking_order_at_work?language=en

Muir, W. M. (2013). *In Genetics and the Behaviour of Domestic Animals*, 2nd Edition. (Vol. 2, pp. 1-30).

A story about chickens…

Purdue university ran a study on the productivity of chickens…

1. Control group: leave for 2 generations
2. ‘Super chicken’ group: select out most productive & breed for 2 generations

The result?

The control group were healthy, plump and laying more eggs than ever before.

https://www.ted.com/talks/margaret_heffernan_why_it_s_time_to_forget_the_pecking_order_at_work?language=en

Muir, W. M. (2013). *In Genetics and the Behaviour of Domestic Animals*, 2nd Edition. (Vol. 2, pp. 1-30).

A story about chickens…

Purdue university ran a study on the productivity of chickens…

1. Control group: leave for 2 generations
2. ‘Super chicken’ group: select out most productive & breed for 2 generations

The result?

The control group were healthy, plump and laying more eggs than ever before.

In the superchicken group… all but 3 were dead.

https://www.ted.com/talks/margaret_heffernan_why_it_s_time_to_forget_the_pecking_order_at_work?language=en

Muir, W. M. (2013). *In Genetics and the Behaviour of Domestic Animals*, 2nd Edition. (Vol. 2, pp. 1-30).

And a story about people…

MIT scientists ran a study where they put people into groups and asked them to solve difficult problems (including math problems).

https://www.15five.com/blog/corporate-superchickens-destroying-productivity/

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0115212

And a story about people…

MIT scientists ran a study where they put people into groups and asked them to solve difficult problems (including math problems).

The factors to group success were NOT IQ or average IQ, instead they were:

1. High degree of emotional intelligence (social sensitivity)
2. Giving equal time to all group members

https://www.15five.com/blog/corporate-superchickens-destroying-productivity/

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0115212

And a story about people…

MIT scientists ran a study where they put people into groups and asked them to solve difficult problems (including math problems).

The factors to group success were NOT IQ or average IQ, instead they were:

1. High degree of emotional intelligence (social sensitivity)
2. Giving equal time to all group members
3. More women in the group

"Creating a culture of helpfulness will outperform a culture that supports the individual contributions of superstars. Every time."

https://www.15five.com/blog/corporate-superchickens-destroying-productivity/

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0115212

Building social capital

Credit: CERNLAND

Building social capital

Credit: CERNLAND

Building social capital

Credit: CERNLAND

Building social capital

Credit: CERNLAND

Building social capital

Credit: CERNLAND

On the whole, social capital compounds with time together.

Thankyou

Dr. Suzie Sheehy

@suziesheehy