

**FUSION
FOR
ENERGY**

The Eco(no)system of Big Science

Leonardo Biagioni

SRON Symposium on Big Science

Leiden, November 14th 2023

BRINGING
THE **POWER**
OF THE **SUN**
TO **EARTH**



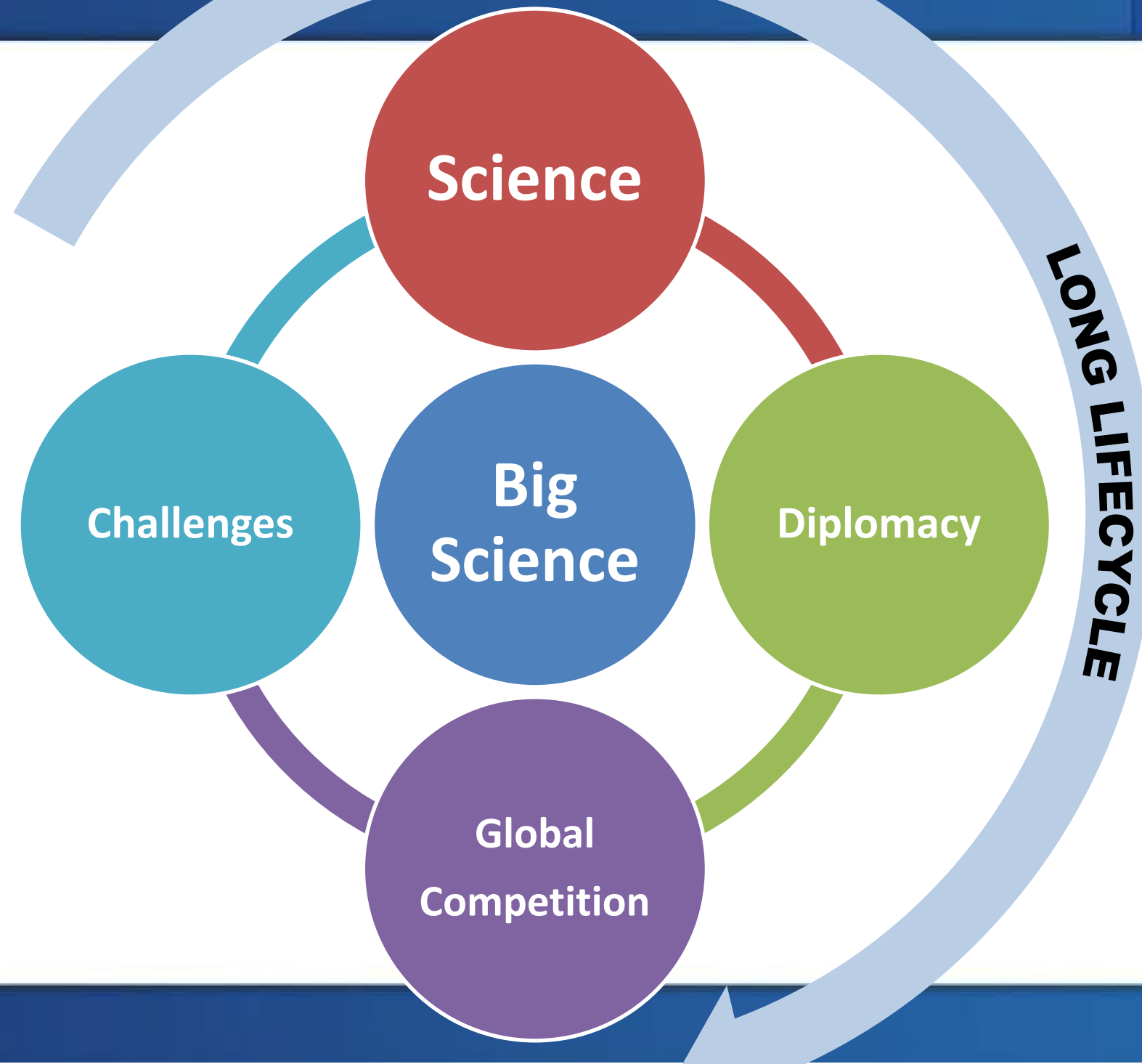
Fusion for Energy receives
funding from the
European Union budget

- **What is Big Science**
- **Big Science in history**
- **Big Science and economy**
- **Reflections about Big Science today**

“**Big Science**, style of scientific and technological research [...] characterized by large-scale instruments and facilities, supported by funding from government or international agencies, in which research is conducted by teams or groups of scientists and technicians.”

Britannica Online

What is Big Science?



21 July 1961, Volume 134, Number 3473

SCIENCE

Impact of Large-Scale Science on the United States

Big science is here to stay, but we have yet to make the hard financial and educational choices it imposes.

Alvin M. Weinberg

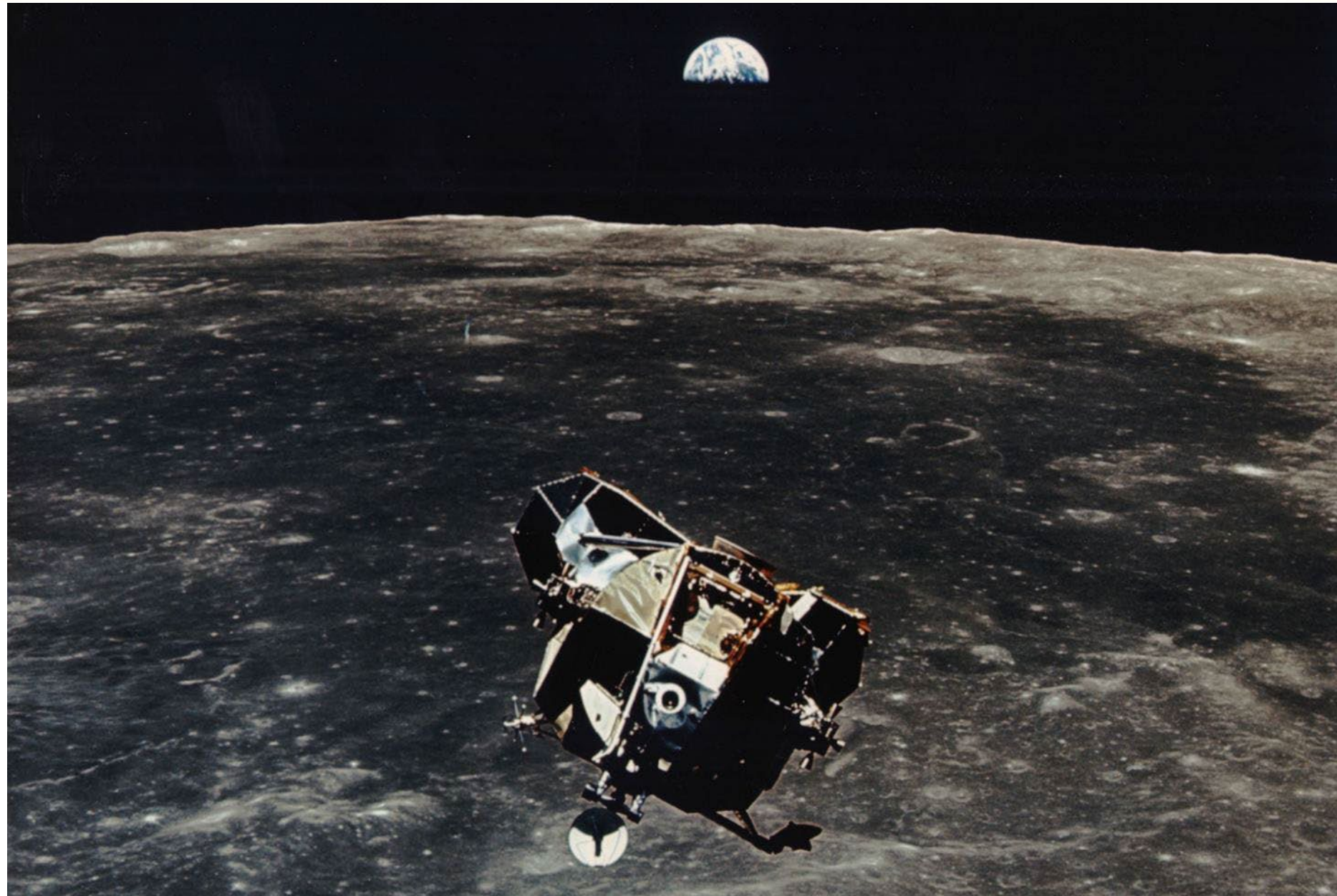
Throughout history, societies have expressed their aspirations in large-scale, monumental enterprises which, though not necessary for the survival of the

and the motivations of the church builders and the pyramid builders. We build our monuments in the name of scientific truth, they built theirs in the name of

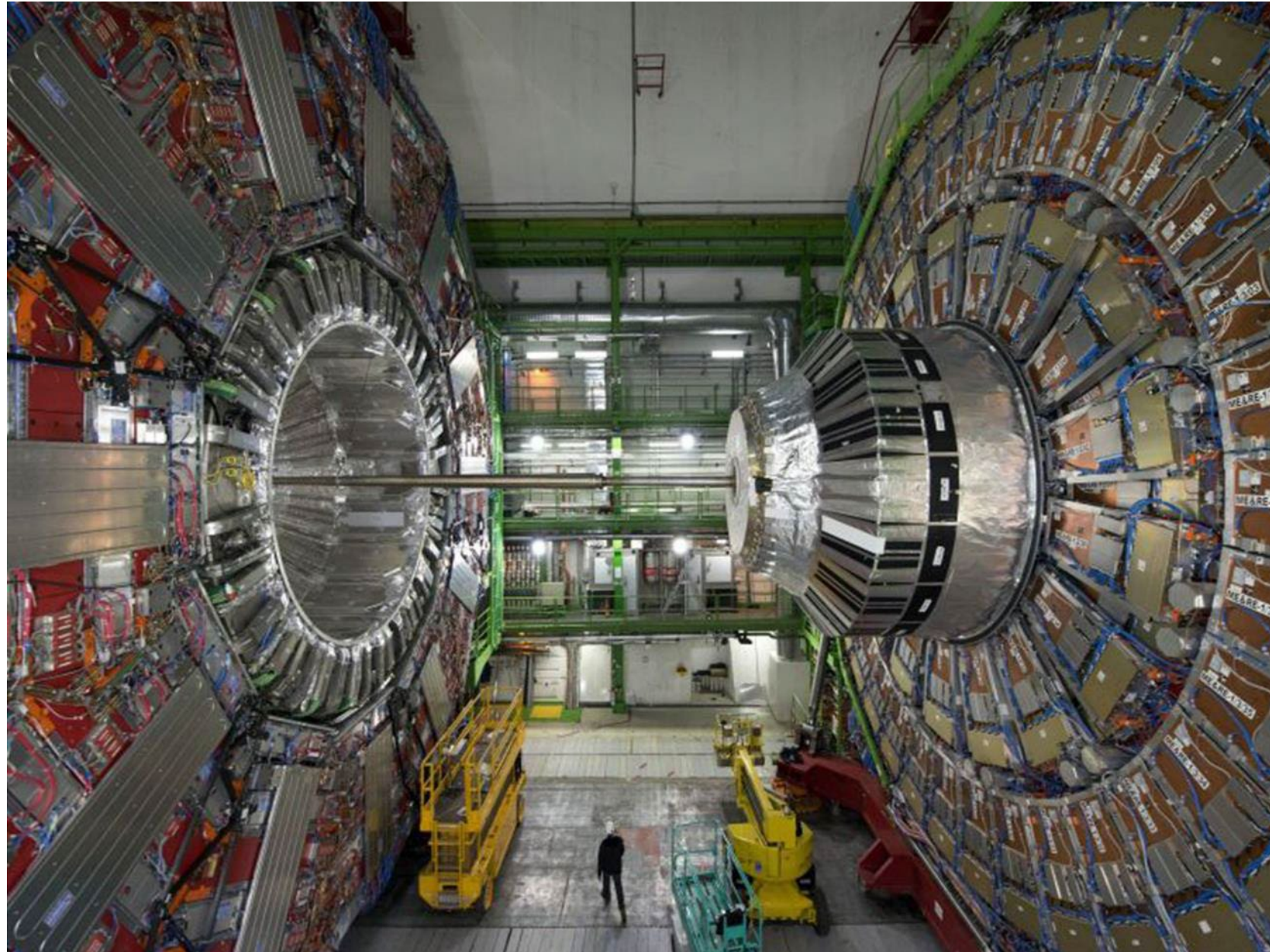
Is Big Science Ruining Science?

The English astronomer Fred Hoyle recently set off a lively controversy by arguing against the United Kingdom's going into large-scale space research. His argument, which applies to much of Big Science, is twofold: first, that the intrinsic scientific interest of space research is not worth the money and manpower that goes into it and certainly does not justify spending more on it than on any other branch of science; and second, that wherever science is fed by too *much* money, it becomes fat and lazy. He claims to see evidence that the tight intellectual discipline necessary for science is, especially in America, being loosened. I shall touch later upon Hoyle's first point: Is Big Science giving us our money's worth? For the moment I want to discuss his

Big Science in the 20th-21st century



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Big Science in the 20th-21st century



Is **Big Science** a feature of modern age?

“**Big Science**, style of scientific and technological research [...] characterized by large-scale instruments and facilities, supported by funding from government or international agencies, in which research is conducted by teams or groups of scientists and technicians.”

Britannica Online

“**Big Science**, style of knowledge initiative [...] characterized by large-scale participation, supported by funding from communities of people, in which activities are performed by large groups of experts and craftsmen.”

Big Science circa 3000 BC

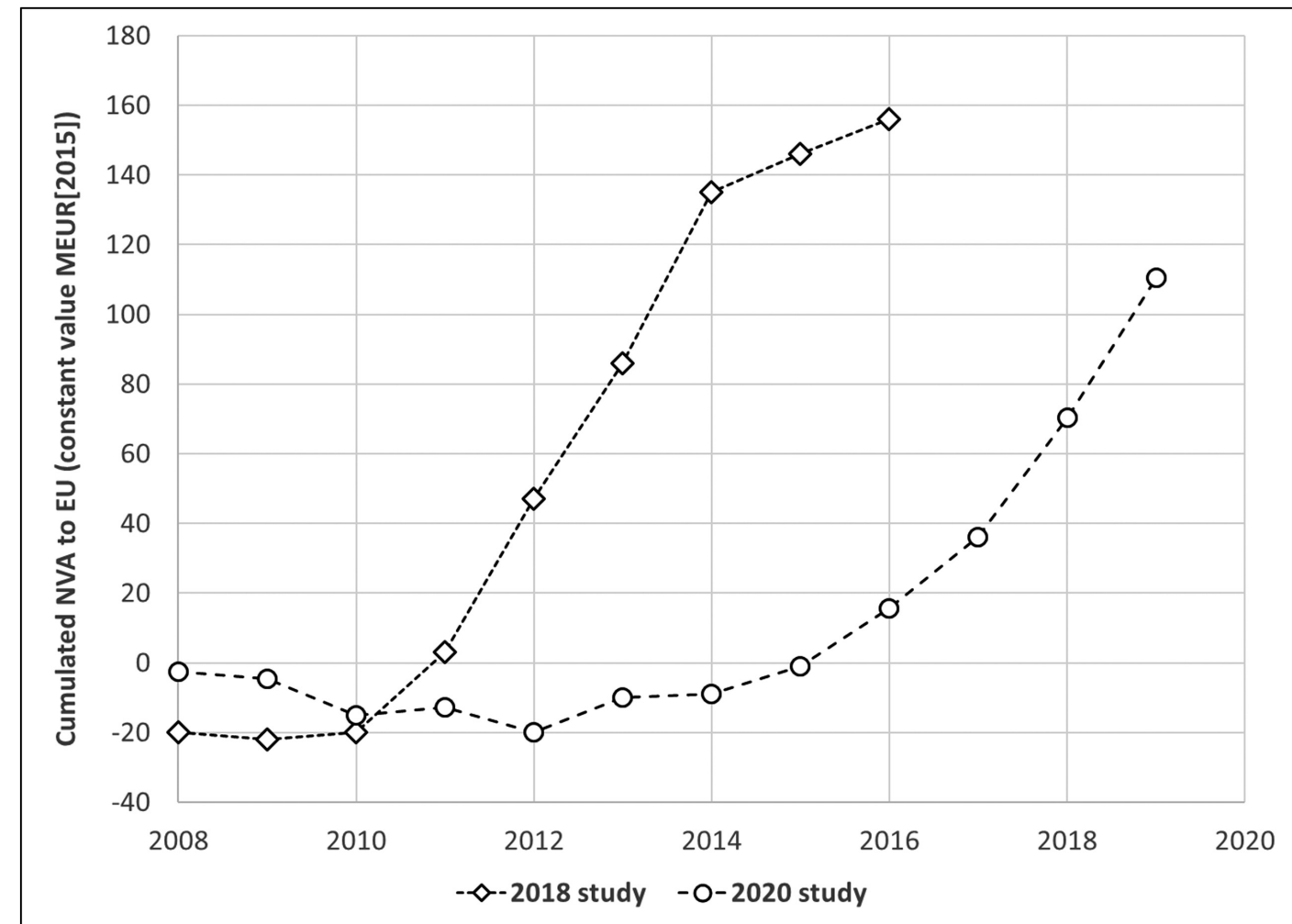


Big Science in the 15th-18th century



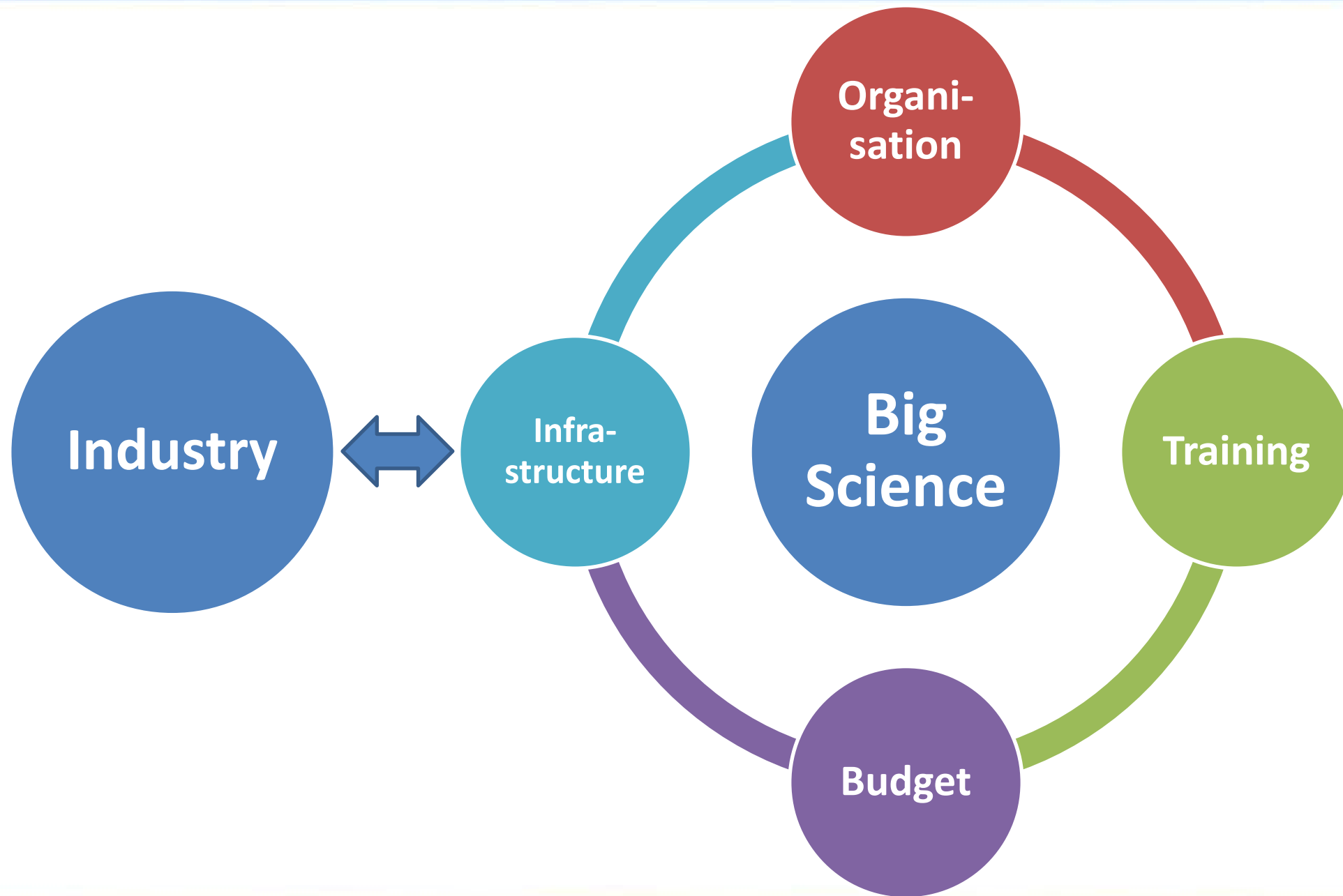
Is **Big Science** only relevant to scientists?

- Large 20th century **Big Science** projects have generated 3x-7x long term RoI ...
- ... but present day projects already add value to economy during their construction

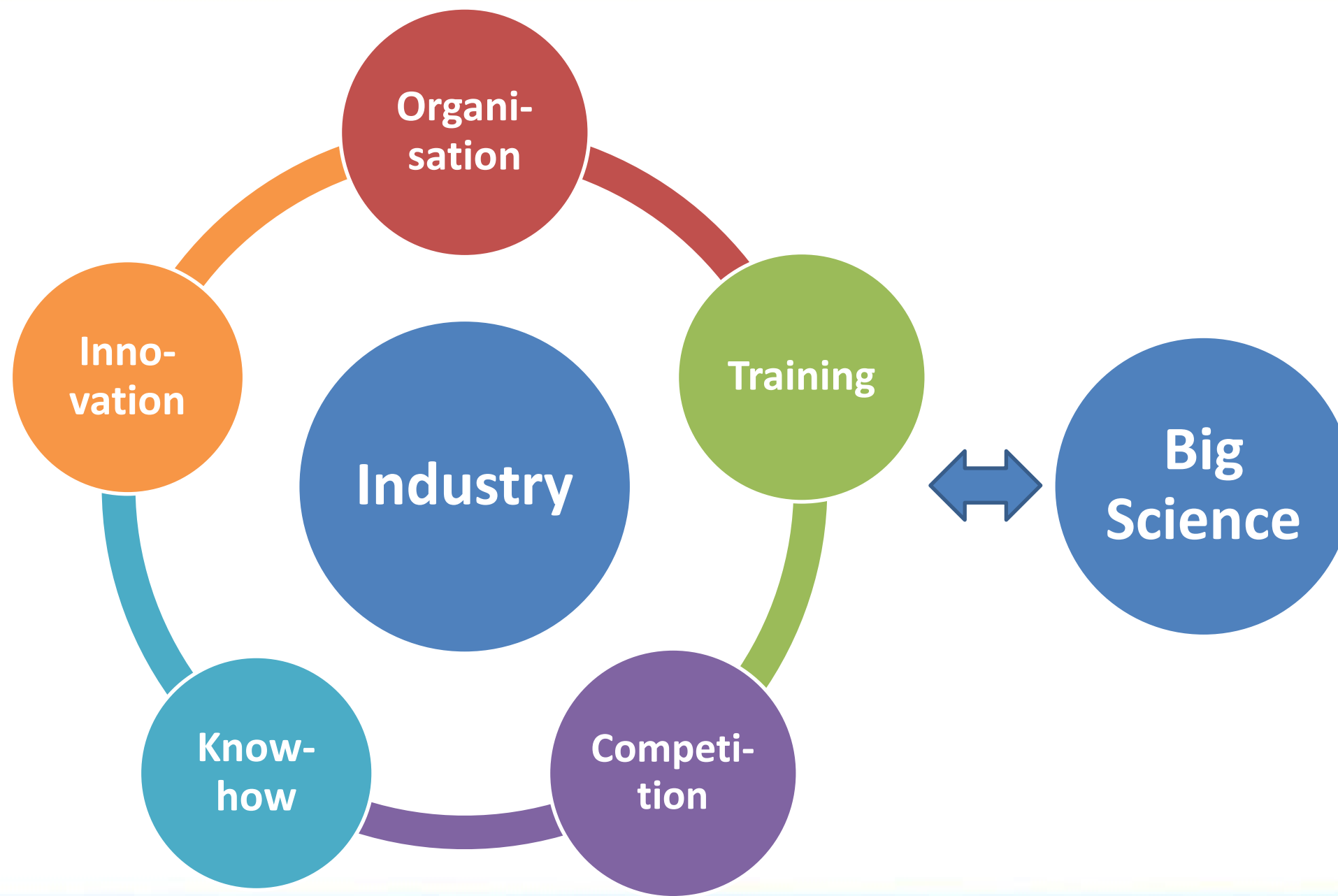


“Big Science in the 21st Century” – IOP Publishing 2023

A symbiotic exchange with industry



A symbiotic exchange with industry





TNO 1996

2007

2012

3D-Metal Forming

Big Science and economy - late 20th century

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The World Wide Web project

                                WORLD WIDE WEB

The WorldWideWeb (W3) is a wide-area hypermedia[1] information retrieval
initiative aiming to give universal access to a large universe of documents.

Everything there is online about W3 is linked directly or indirectly to this
document, including an executive summary[2] of the project, Mailing lists[3] ,
Policy[4] , November's W3 news[5] , Frequently Asked Questions[6] .

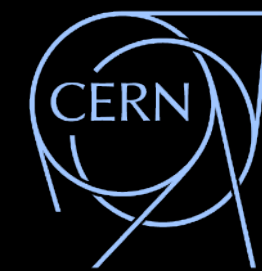
    What's out there?[7]Pointers to the world's online information,
                                subjects[8] , W3 servers[9], etc.

    Help[10]                        on the browser you are using

    Software                         A list of W3 project components and their current
    Products[11]                    state. (e.g. Line Mode[12] ,X11 Viola[13] ,
                                NeXTStep[14] , Servers[15] , Tools[16] , Mail
                                robot[17] , Library[18] )

    Technical[19]                   Details of protocols, formats, program internals
                                etc

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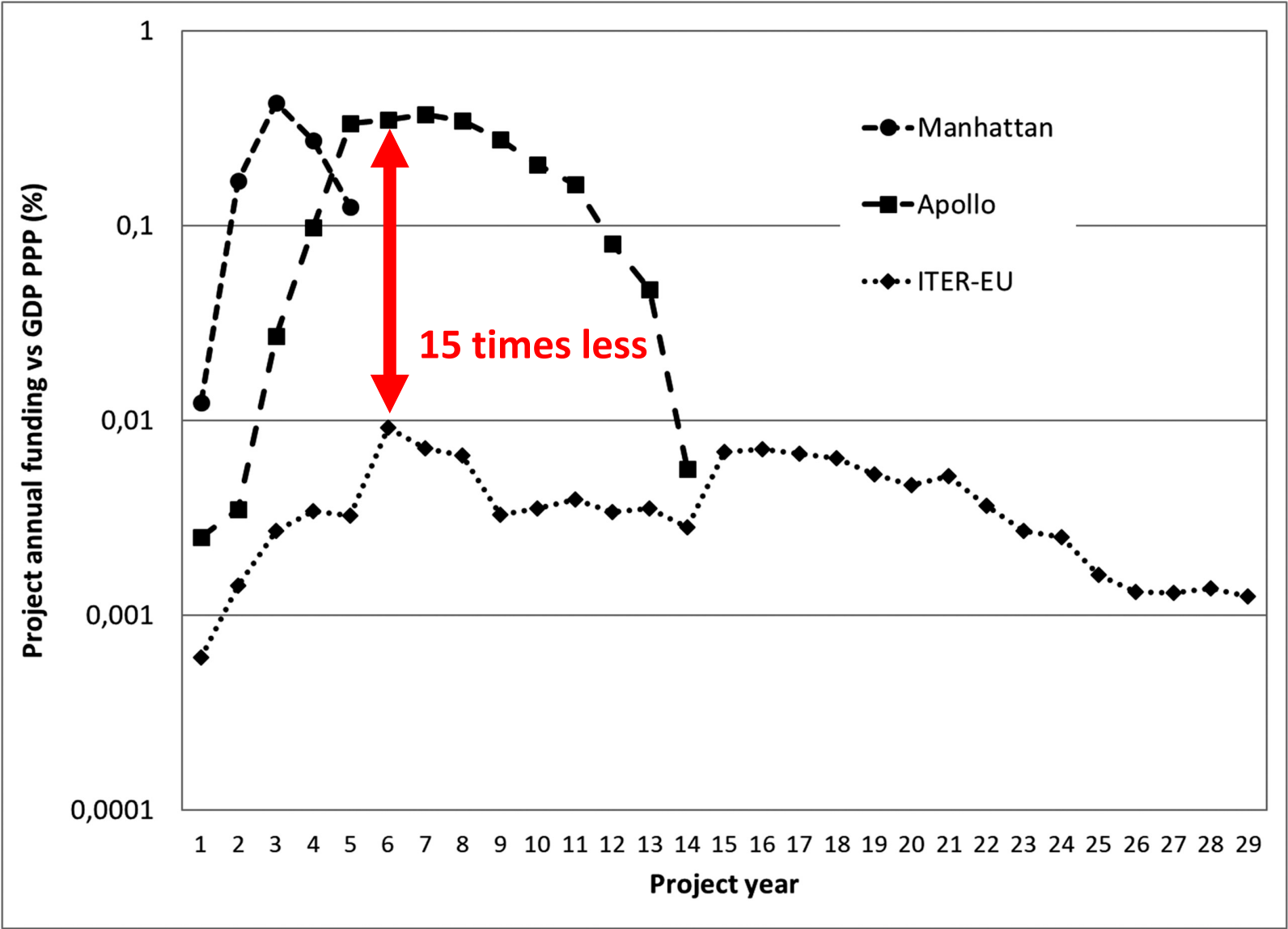
Big Science and economy - 16th-18th century

Age of maritime exploration helped establishing centuries of European global lead



Is **Big Science** still “big” today?

The scale of modern Big Science



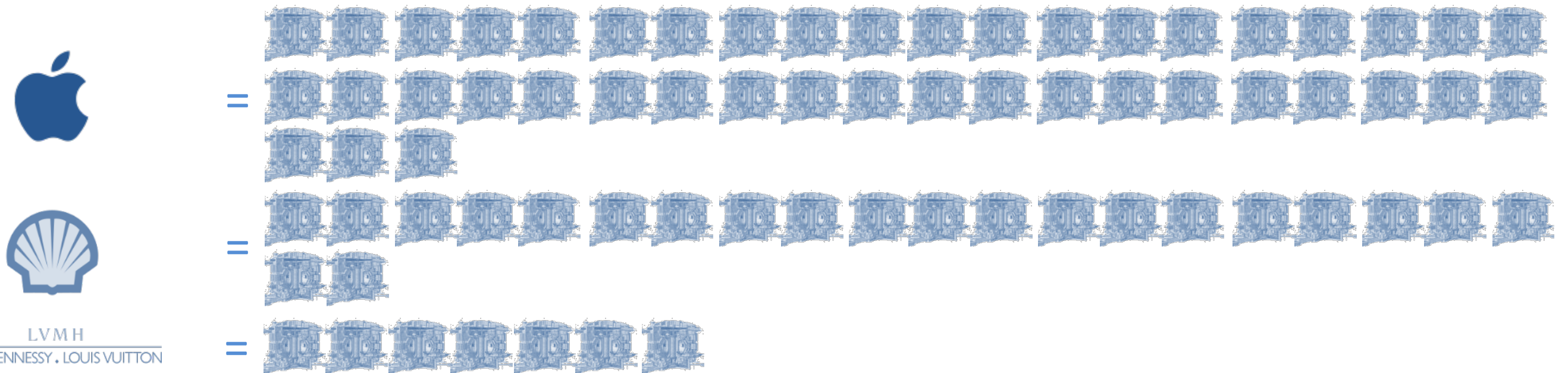
“Big Science in the 21st Century” – IOP Publishing 2023

The scale of modern Big Science

One year of profits vs one year of Apollo (circa 1969):



One year of profits vs one year of ITER (2022):



LVMH
MOËT HENNESSY · LOUIS VUITTON

- **Big Science** in the broad sense is a permanent feature of human history
- **Big Science** initiatives have significant economic added value – sometimes they bring global paradigm change
- **Big Science** is becoming less and less relevant in 21st century
EU economies: can we afford this?

A construction site at dusk. In the foreground, a worker wearing a blue hard hat and a high-visibility yellow vest with a logo on the back stands on a metal railing, looking out over the site. The vest has a circular logo and the text "FUSION FOR ENERGY". The background shows a large building under construction with several tall cranes. The sky is a mix of blue and orange from the setting sun. A semi-truck is parked in the middle ground. In the lower left, there are stacks of rebar and other construction materials.

Thank You