HIGH-ENERGY PHYSICS
RESEARCH CENTRE

High-Energy Physics

Nov 6, 2019, Brussels

Petra Van Mulders

HEP@VUB Coordinator:
Prof. Jorgen D'Hondt

HEP@VUB Group leaders:

Prof. Stijn Buitink	High-Energy Astrophysics
Prof. Ben Craps	Theoretical Physics
Prof. Jorgen D'Hondt	Particle Physics Experiments
Prof. Nick van Eijndhoven	Astro-Particle Physics

VUB HIGH-ENERGY PHYSICS RESEARCH CENTRE

Curiosity driven research

Observable universe

Visible with our eyes

~ 1.000.000.000.000.000.000.000.000.000 meter

~ 0.00000000000000000001 meter

Smallest particles

VUB HIGH-ENERGY PHYSICS RESEARCH CENTRE

Curiosity driven research

Standard Model of Cosmology
Gravity

Standard Model of Particle Physics
Quantum Field Theory

~ 1.000.000.000.000.000.000.000.000.000 meter

~ 0.00000000000000000001 meter

IceCube/ARA @ South Pole
LOFAR @ Netherlands
Auger @ Argentina

CMS @ CERN
SoLid @ Belgium

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Standard Model of Cosmology
Gravity

Standard Model of Particle Physics
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physicsworld BREAKTHROUGH OF THE YEAR 2013

IceCube/ARA @ South Pole
LOFAR @ Netherlands
Auger @ Argentina

CMS @ CERN
SoLid @ Belgium

BREAKTHROUGH of the YEAR The HIGGS BOSON 2012

For a profound understanding of Nature, we need to understand the interplay between high-energy phenomena on the largest and the smallest scales

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Strategic Research

With a view to excel on the international level in addressing the fundamental physics of the largest and smallest scales strategic research choices are to be made

In this context HEP@VUB was established to have a major impact in reaching these scientific objectives

Strong support from FWO and EWI

HIGH-ENERGY PHYSICS RESEARCH CENTRE

Coordinator: Prof. J. D'Hondt
Secretariat: M. Fabre and M. Goeman

Theoretical physics

- string theory
- holography
- cosmology

Prof. B. Craps
Prof. A. Sevrin

Part-time:
Prof. V. Balasubramanian
Prof. C. Blair
Prof. O. Evnin
Prof. L. Lopez Honorez
Prof. D. Thompson

Particle physics experiments

- high-energy colliders
- neutrino physics

Prof. F. Blekman (Odysseus 2)
Prof. J. D'Hondt
Prof. S. Lowette (Odysseus 2)

Part-time:
Prof. P. Van Mulders

Active emeriti:
Prof. S. Tavernier
Prof. W. Van Doninck

Astro-particle physics

- cosmic neutrinos
- dark matter
- multi-messenger observations

Prof. K. De Vries (ERC Starting Grant)
Prof. N. van Eijndhoven (Odysseus 1)

Part-time:
Prof. O. Scholten

Active emeriti:
Prof. C. De Clercq

High-energy astrophysics

- radio transients
- binary evolution
- gravitational waves

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Part-time:
Prof. J. Blommaert
Prof. T. Huege
Prof. K. Kolenberg

Guest professor:
Prof. D. Vanbeveren
Prof. J. Horandel (ERC Advanced Grant)

Phenomenology

Prof. A. Mariotti

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International Solvay Institutes

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- holography
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Particle physics experiments

- high-energy colliders
- neutrino physics

① CMS experiment

② SoLid experiment

Astro-particle physics

- cosmic neutrinos
- dark matter
- multi-messenger observations

③ IceCube observatory

④ ARA observatory

⑤ Auger observatory

High-energy astrophysics

- radio transients
- binary evolution

⑥ LOFAR observatory

⑦ SKA observatory

Phenomenology

- theoretical model building
- relation between small and large scales
- dark matter signatures and simplified models

① In total 9 professors and 12 part-time or guest professors

② Unique range of topics in Belgium, from large to small scales

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Some experiments where we are involved in the construction, operation and exploitation.

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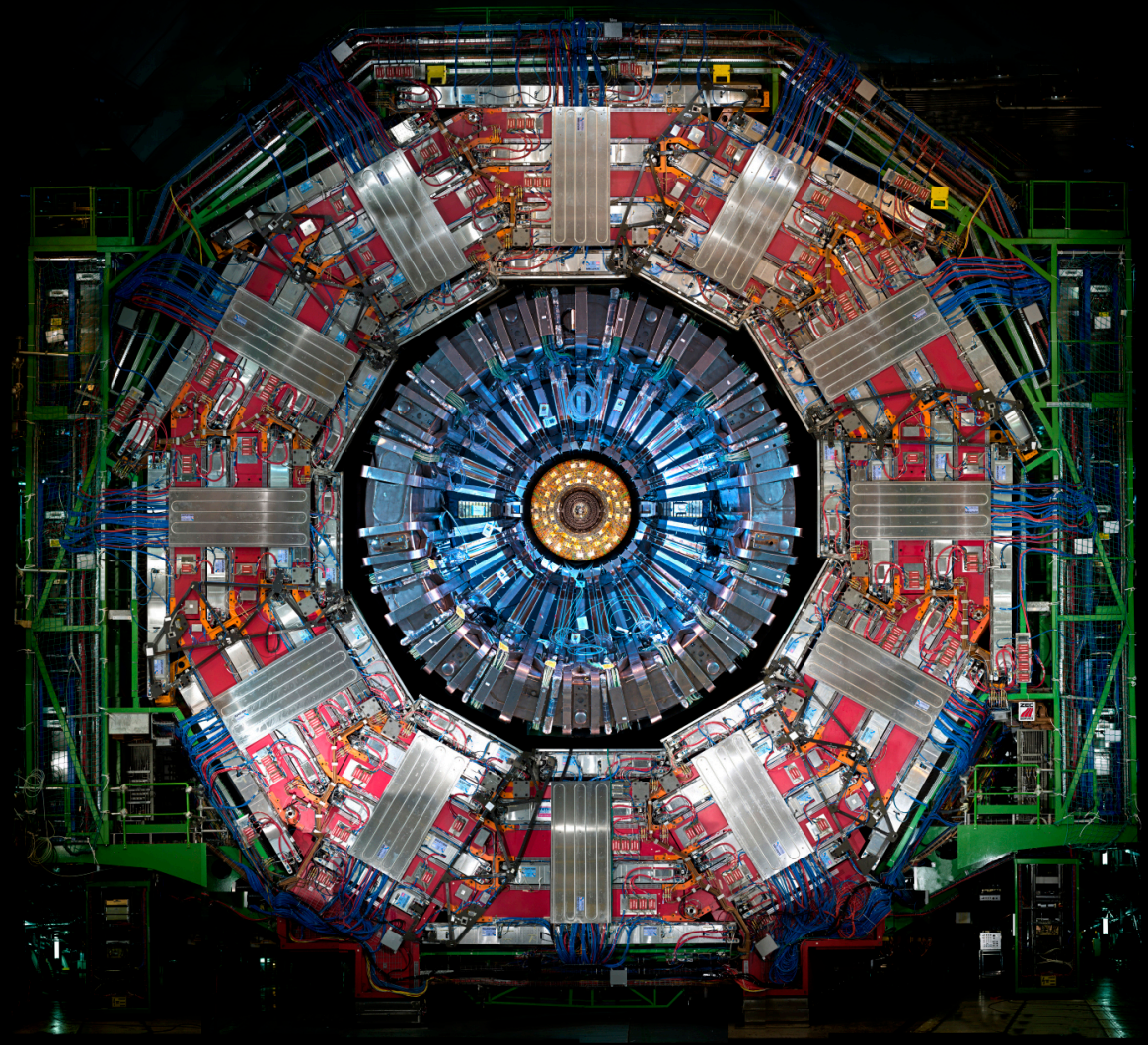
CMS experiment @ CERN



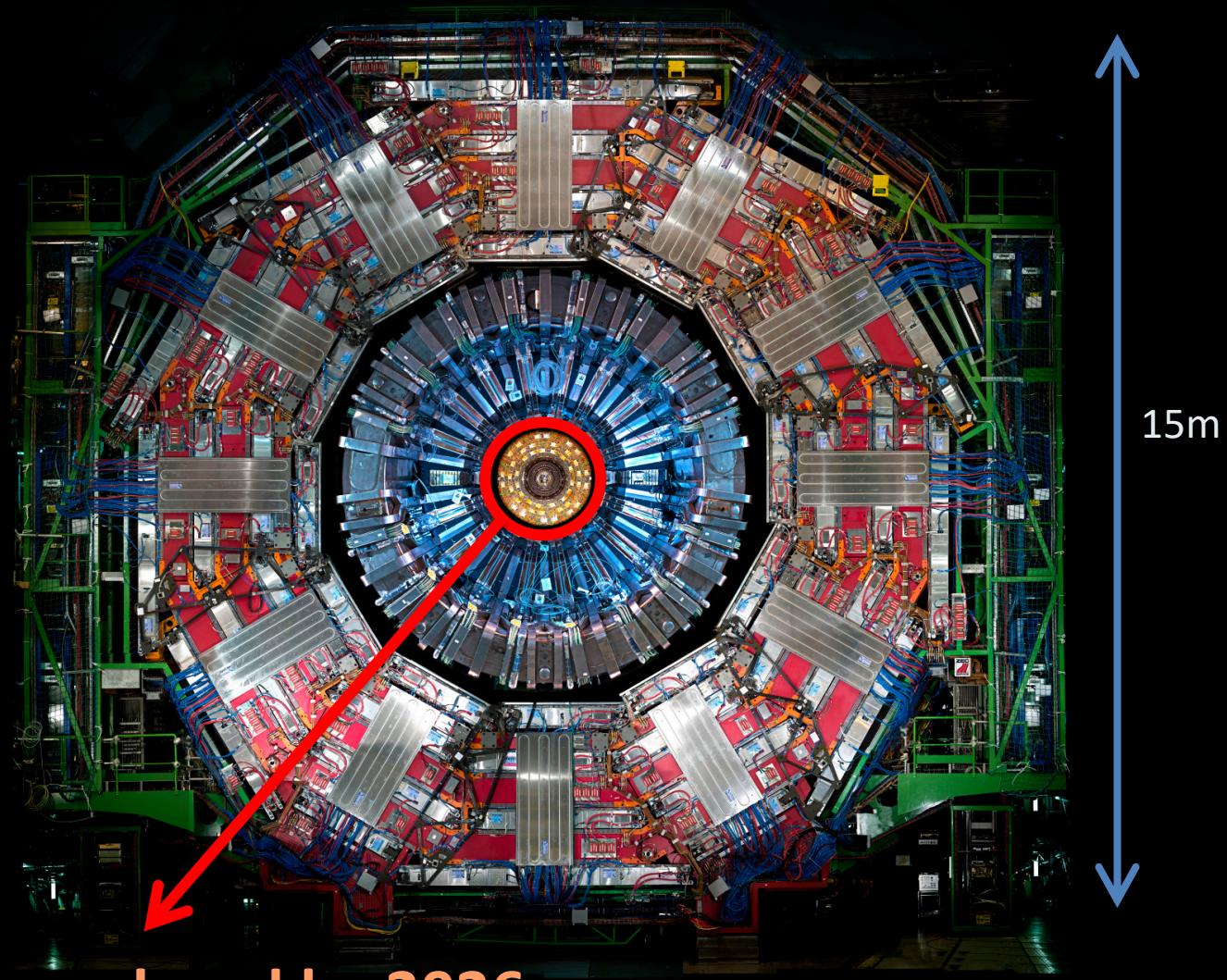
15m

BREAKTHROUGH of the YEAR
The HIGGS BOSON
2012

related to Nobel Prize in 2013

HIGH-ENERGY PHYSICS RESEARCH CENTRE

CMS experiment @ CERN



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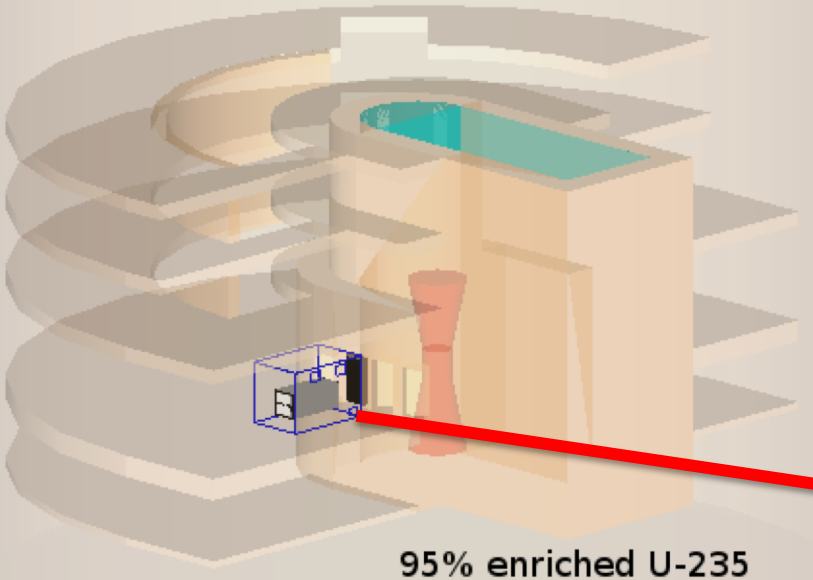
SoLid @ BR2 reactor

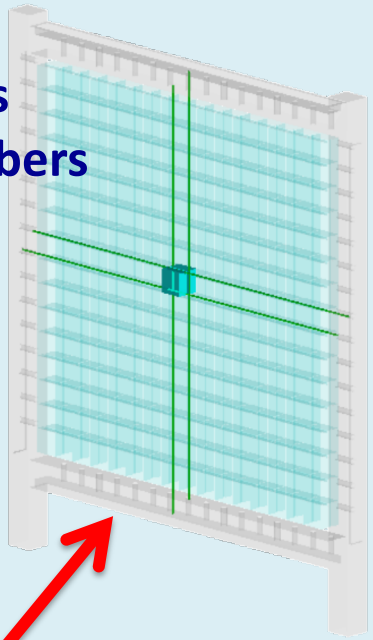
BR2 @ SCK-CEN
Belgium

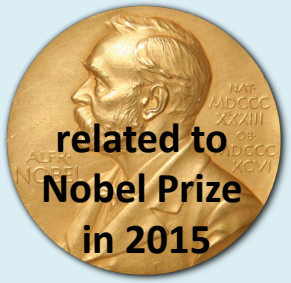
6 to 11m from reactor core



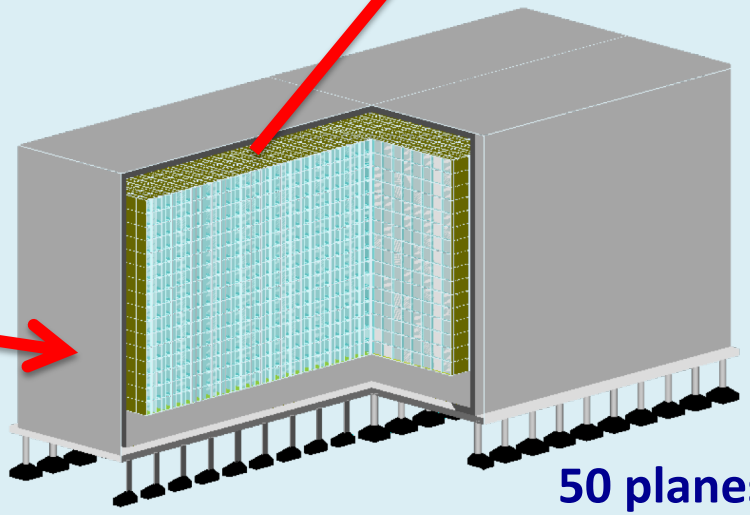
95% enriched U-235
0.5m core diameter
access ports for experiments

12800 cubes
3200 readout fibers





related to Nobel Prize in 2015



50 planes
1.5 ton

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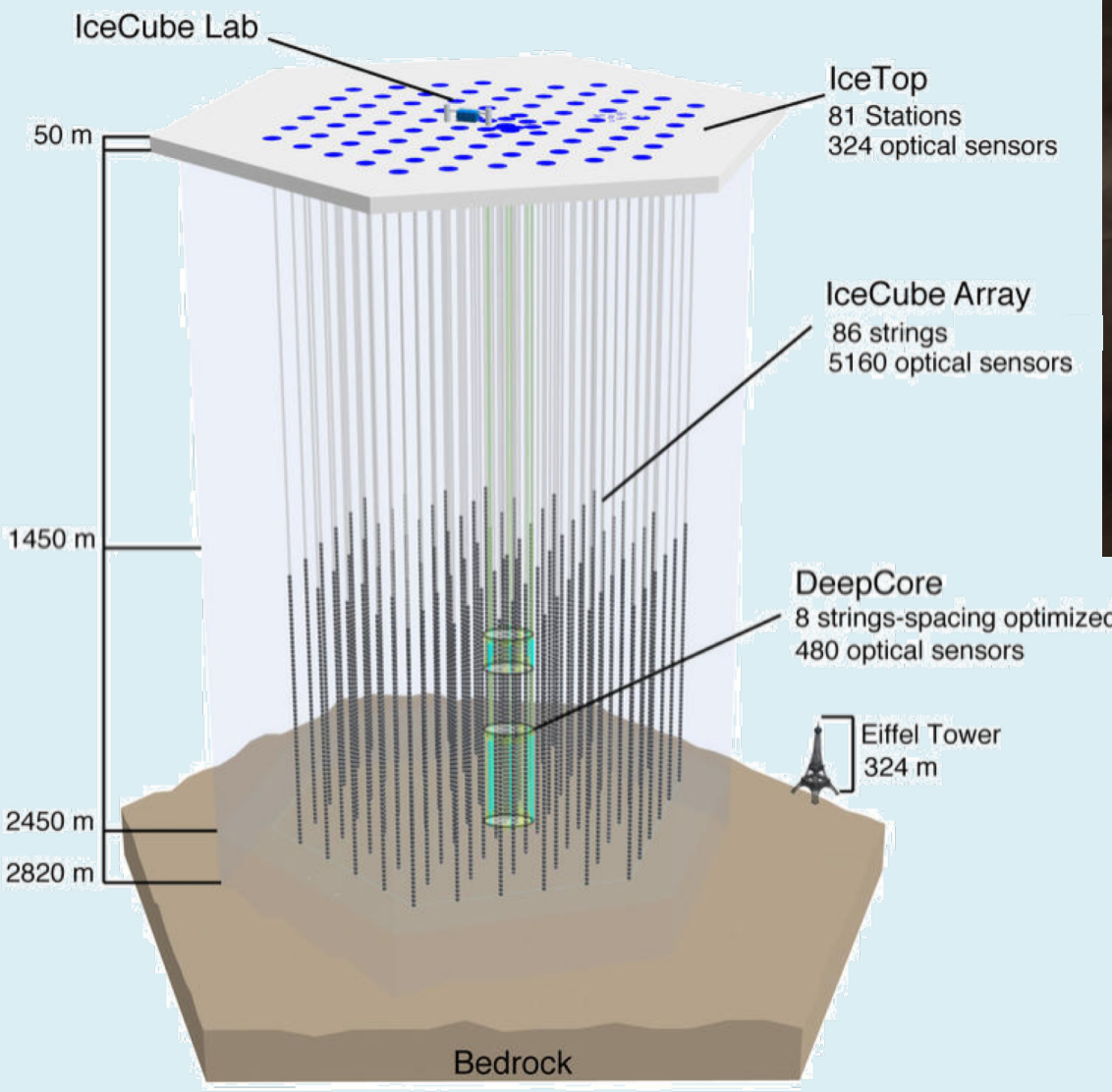
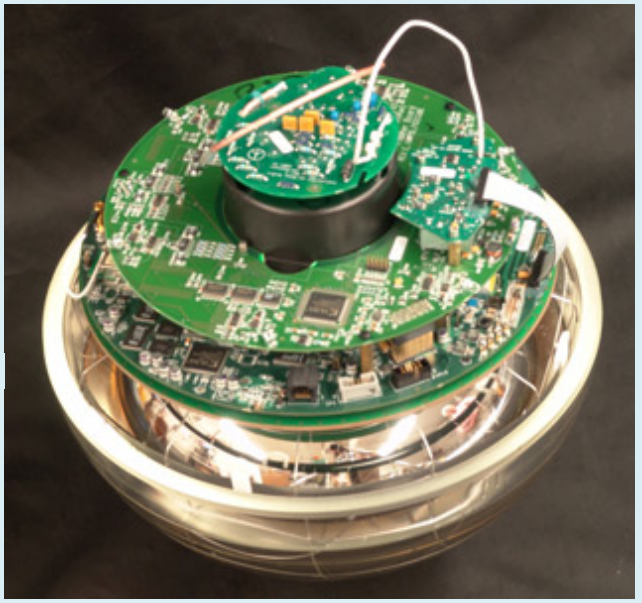
IceCube @ South Pole





physicsworld
BREAKTHROUGH OF THE YEAR
2013

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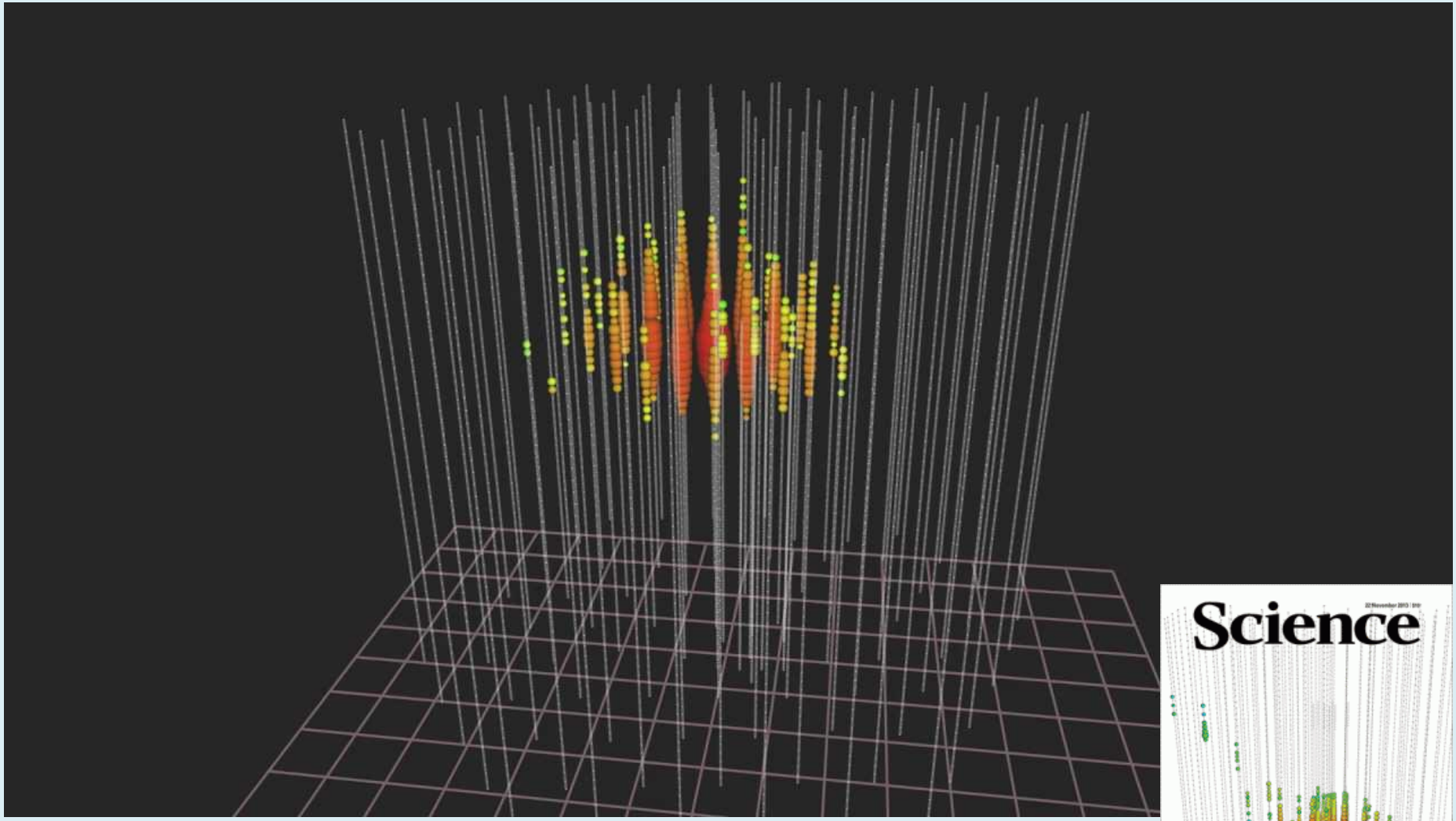
IceCube @ South Pole



erc

Extend the observatory with radio techniques

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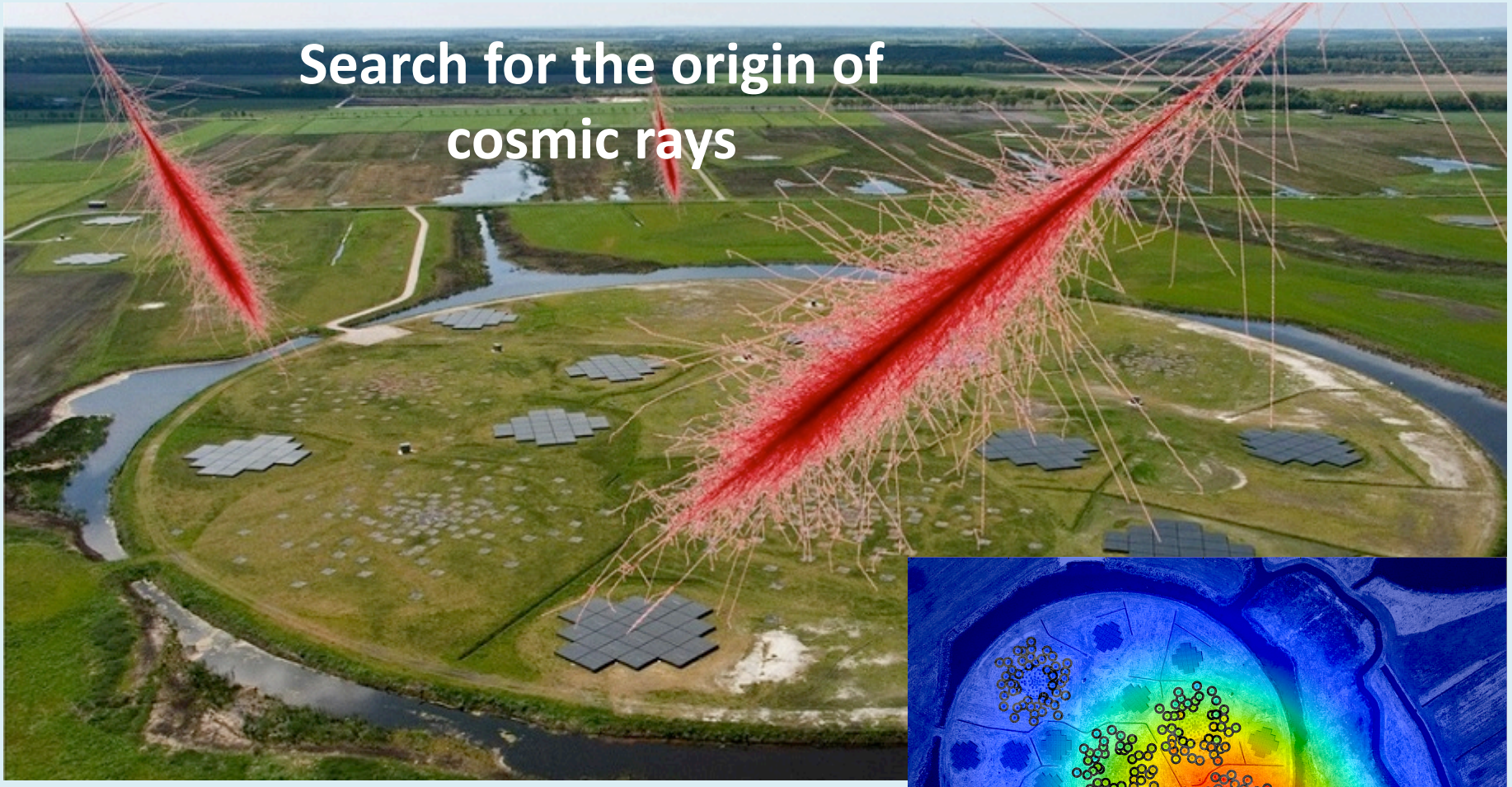
LOFAR @ Netherlands



erc

Low Frequency Array for novel radio astronomy in the 10-240 MHz range

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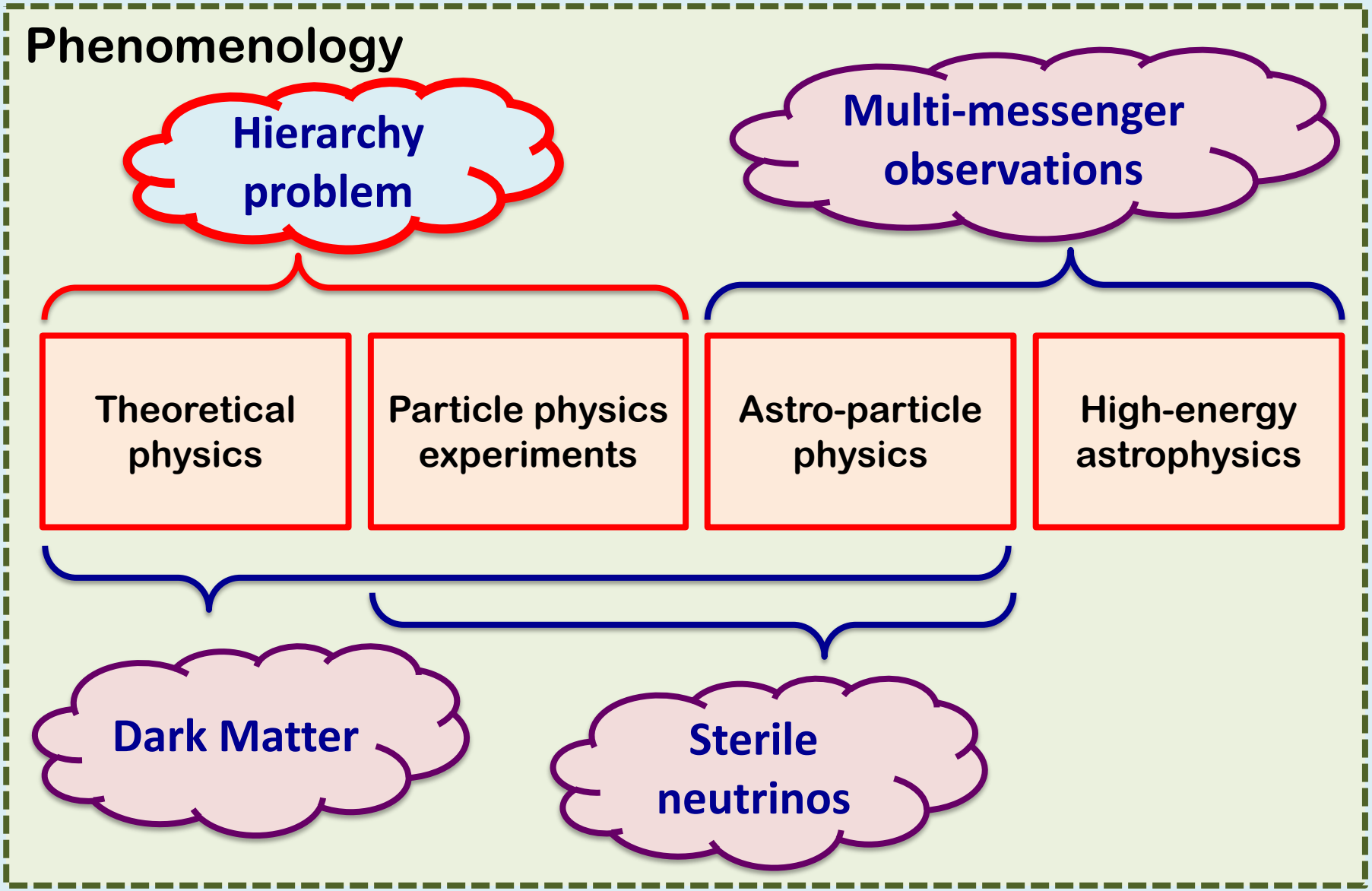
Essential research synergies



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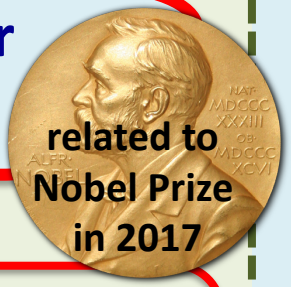
Essential research synergies

Phenomenology

Hierarchy problem

Multi-messenger observations



Theoretical physics

Particle physics experiments

Astro-particle physics

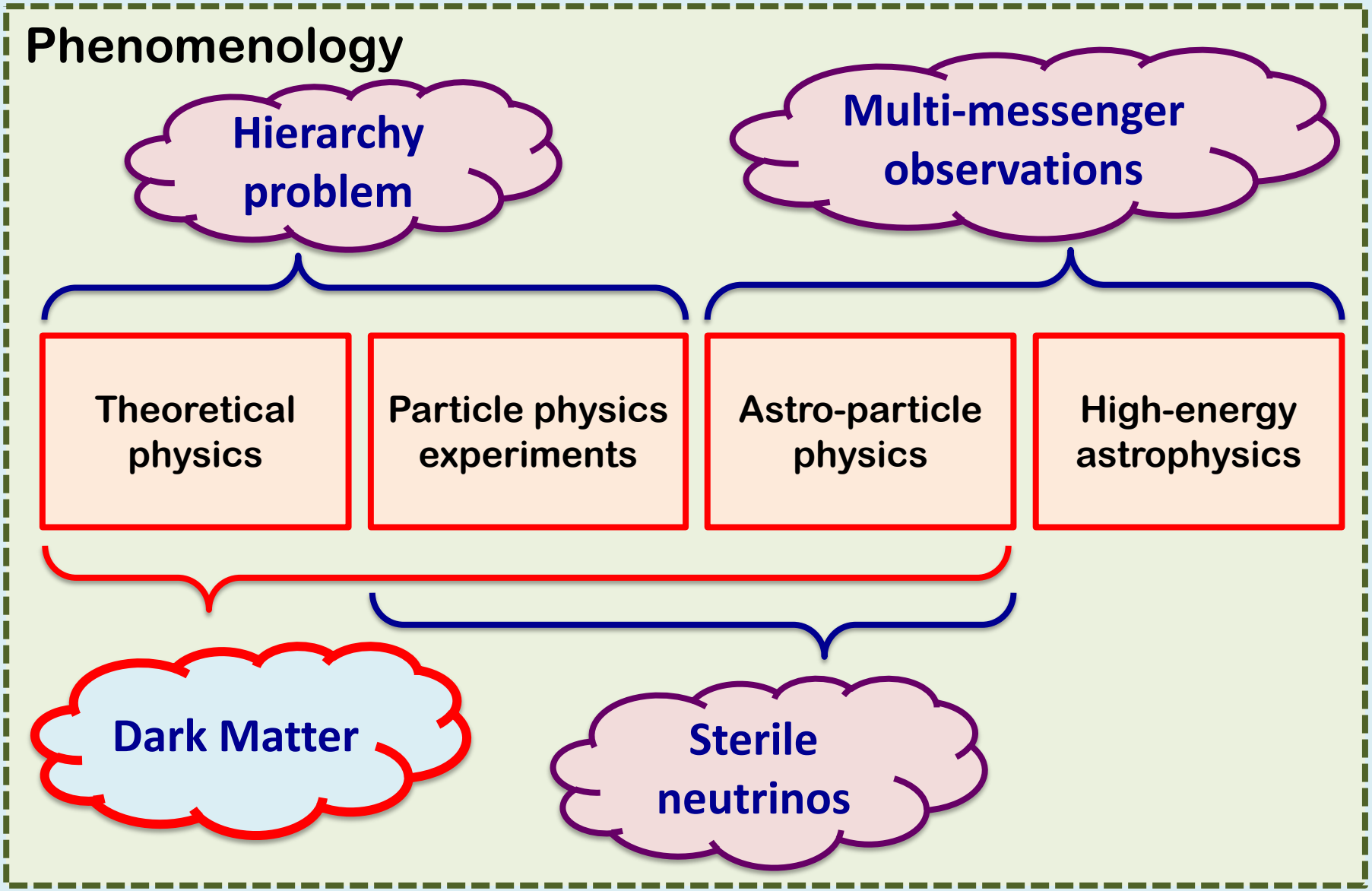
High-energy astrophysics

Dark Matter

Sterile neutrinos

VUB HIGH-ENERGY PHYSICS RESEARCH CENTRE

Essential research synergies



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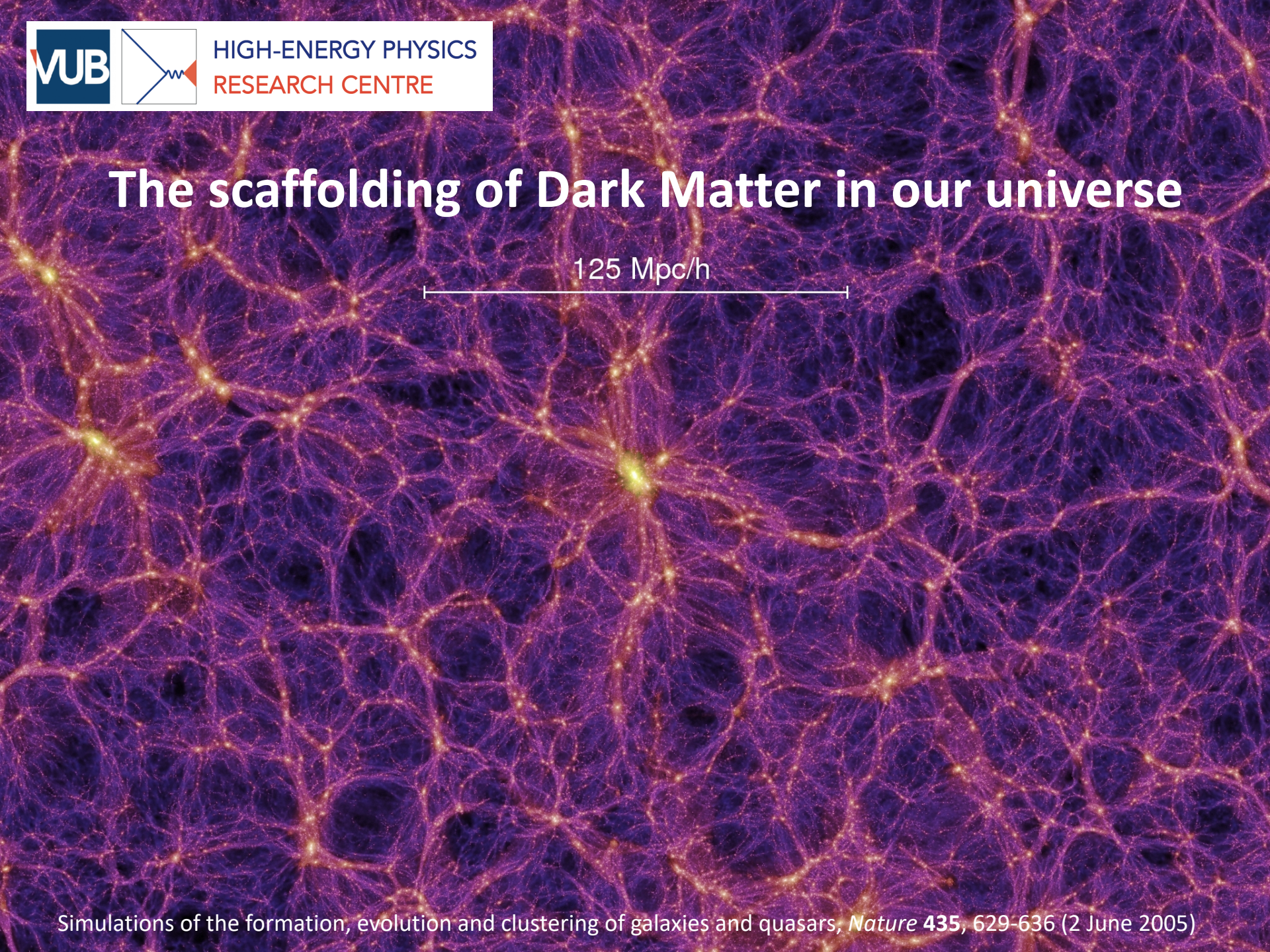
The scaffolding of Dark Matter in our universe



Simulations of the formation, evolution and clustering of galaxies and quasars, *Nature* **435**, 629-636 (2 June 2005)

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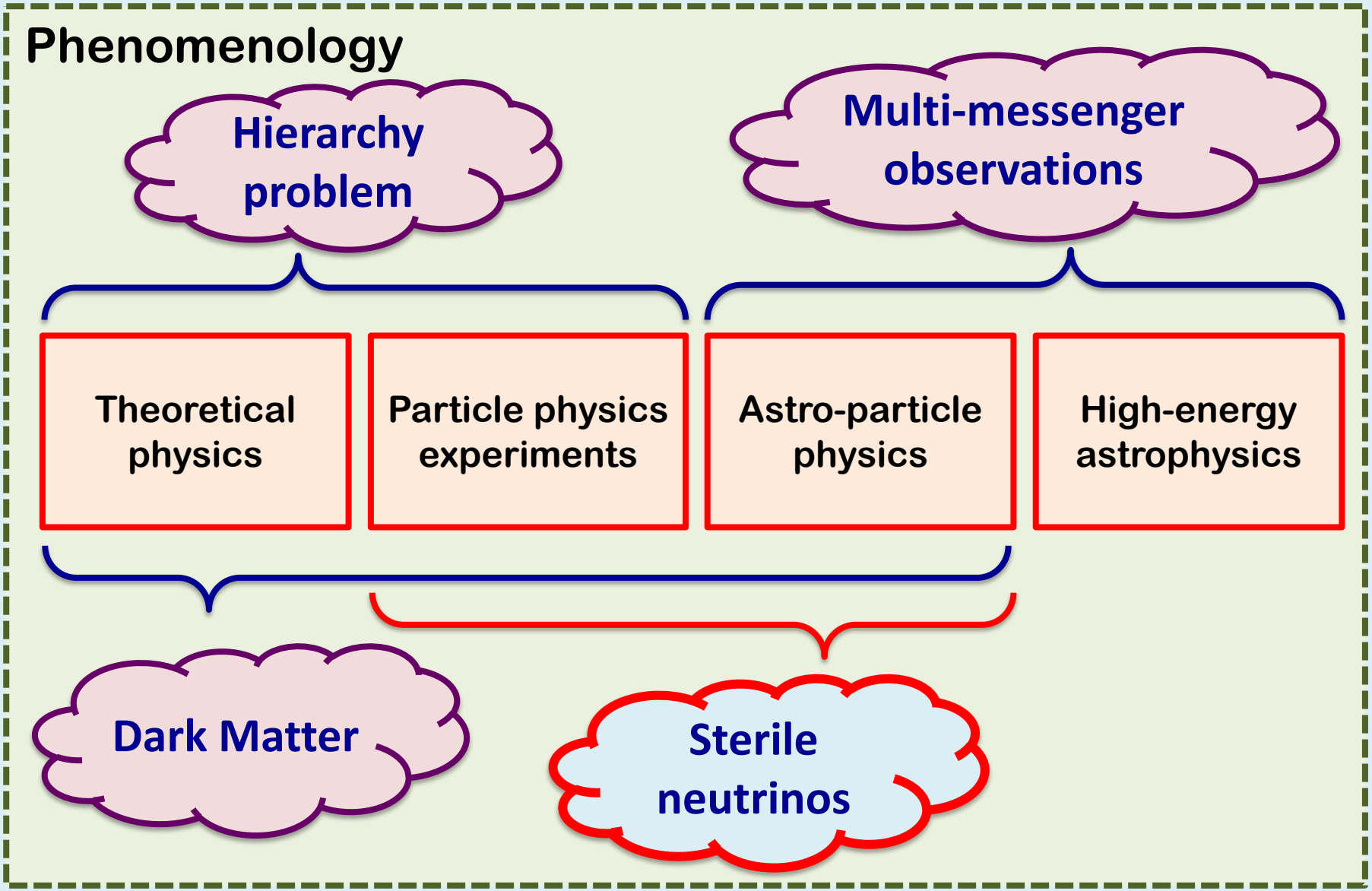
Essential research synergies



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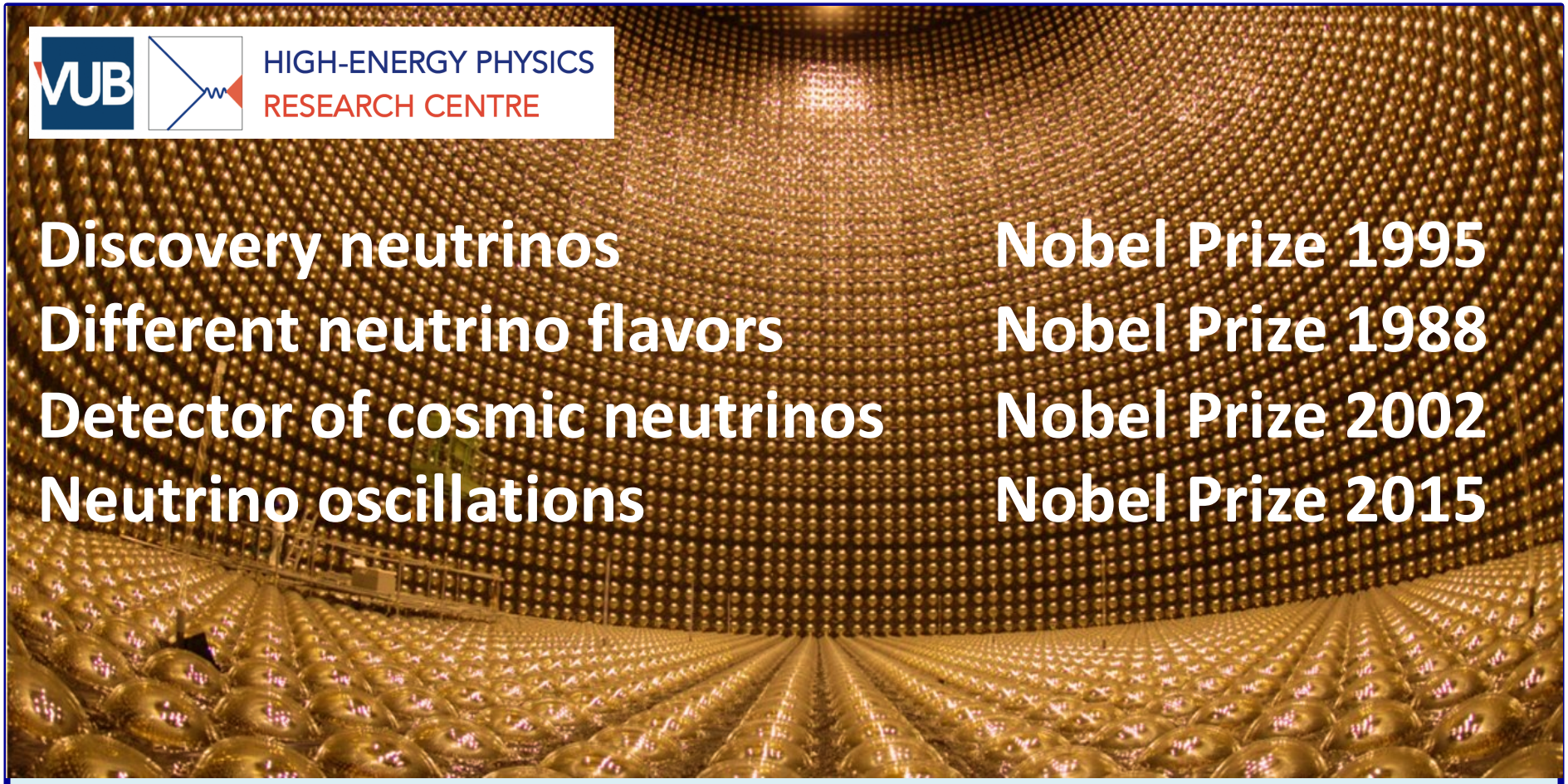

Discovery neutrinos	Nobel Prize 1995
Different neutrino flavors	Nobel Prize 1988
Detector of cosmic neutrinos	Nobel Prize 2002
Neutrino oscillations	Nobel Prize 2015

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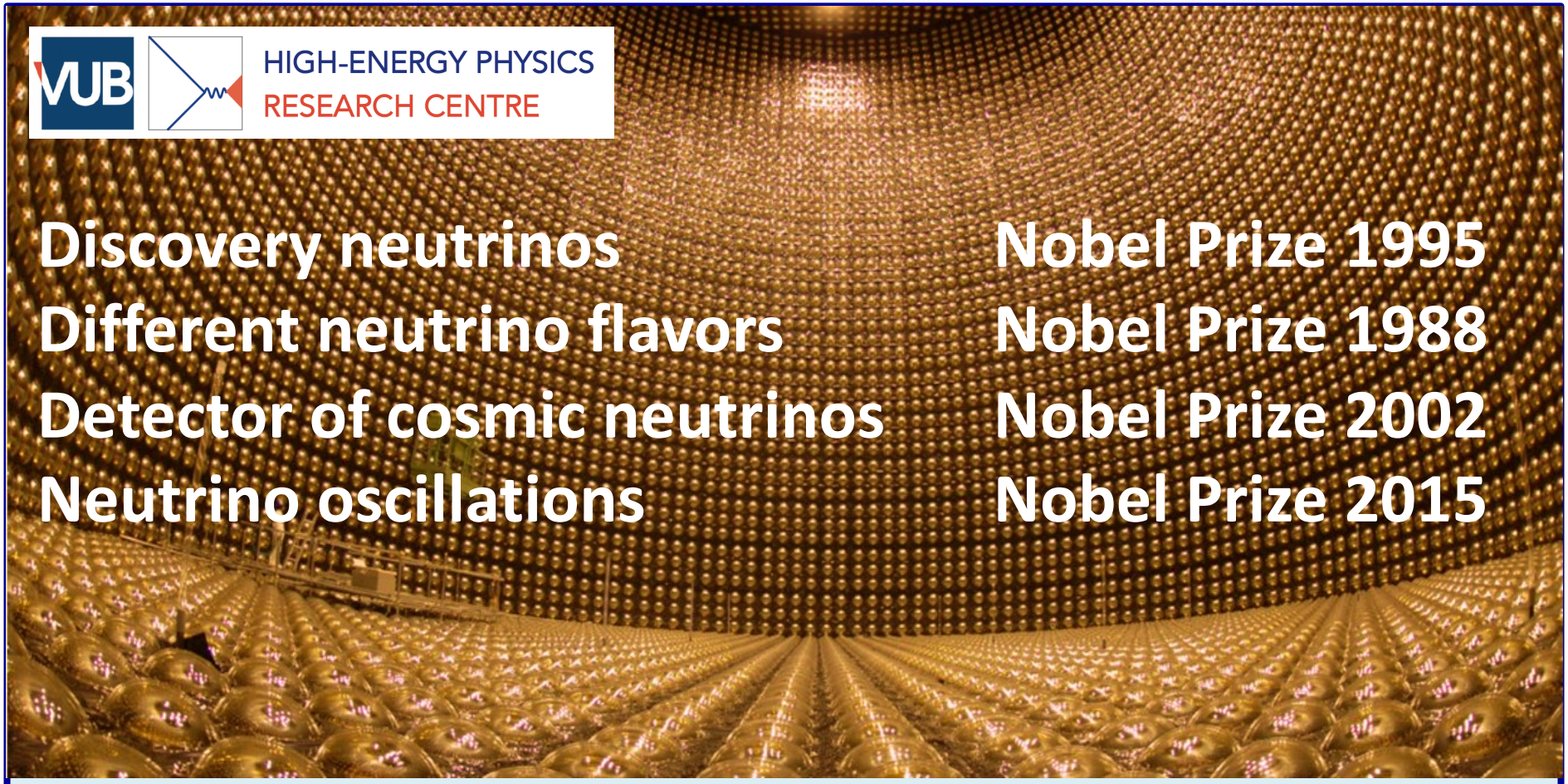

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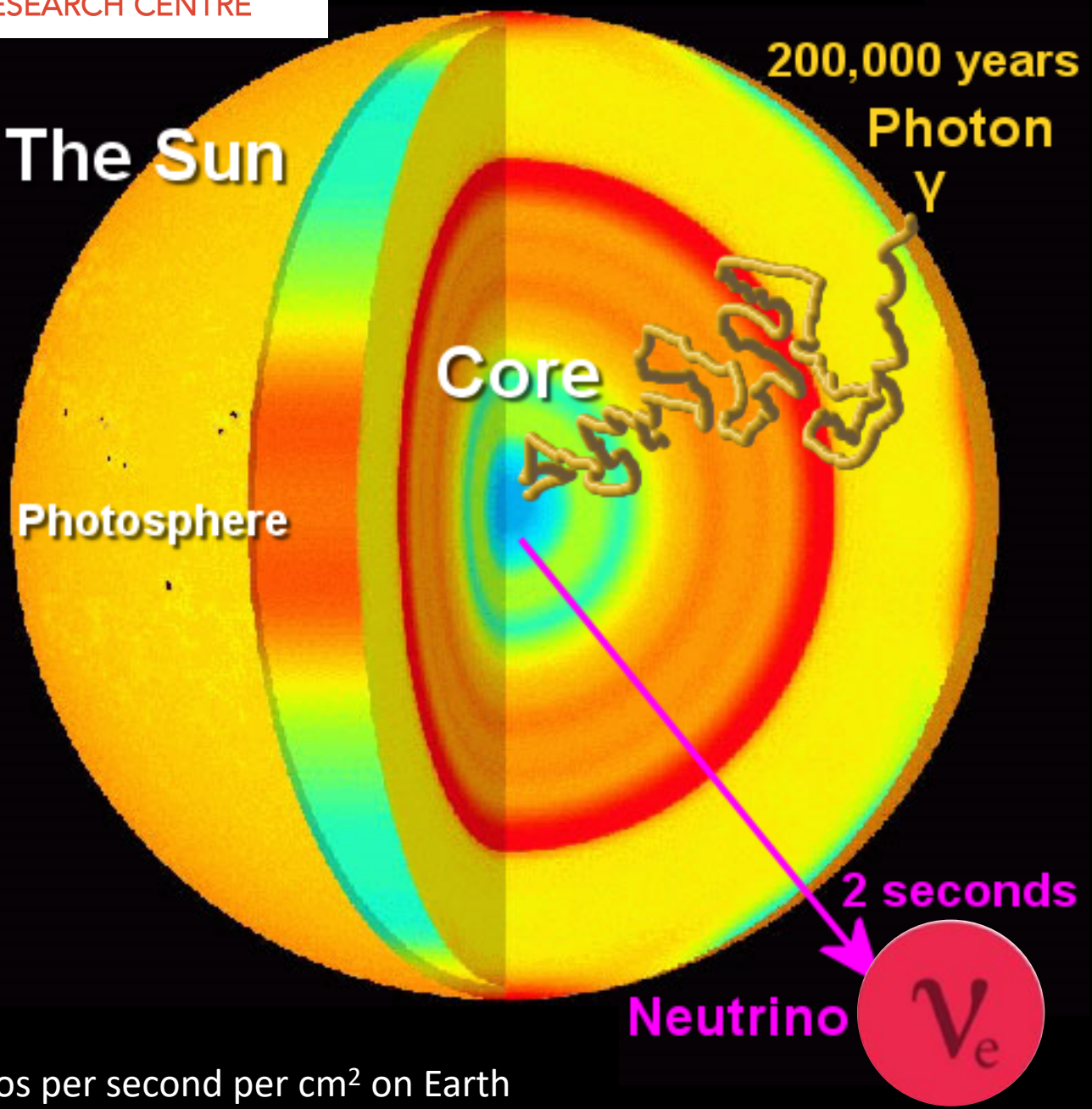

65 billion neutrinos per second per cm^2 on Earth

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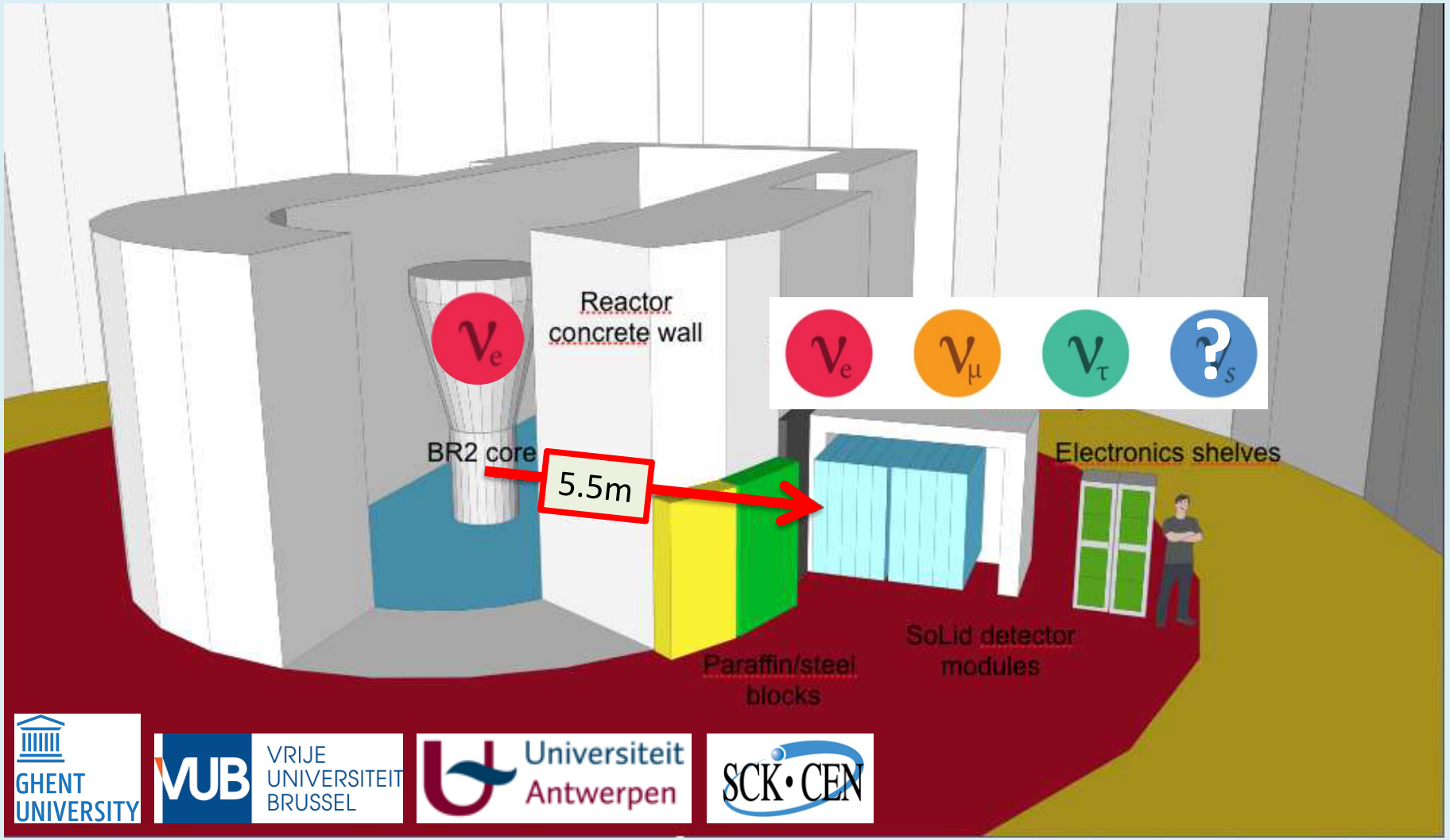
SoLid experiment @ BR2



Potential to discover oscillations to a fourth kind of neutrino particles

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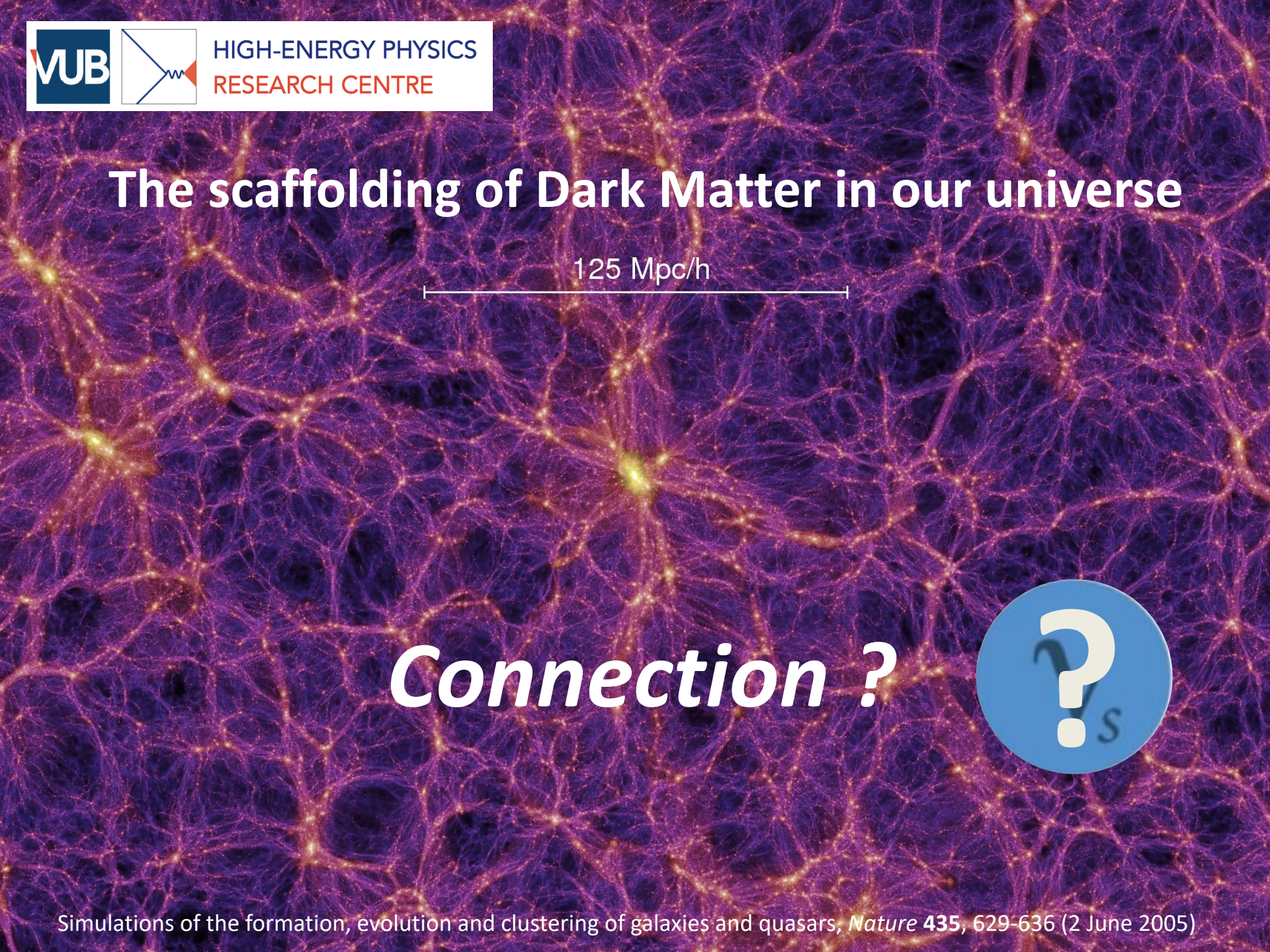
The scaffolding of Dark Matter in our universe



Connection ?

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HEP @ VUB

"high-energy physics"

There must be new physics phenomena out there

It is our main objective to discover them in an effort to understand fundamental physics at the largest and smallest scales in nature

On the technology side we have to make visible the invisible at these scales

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Thank you for your attention!