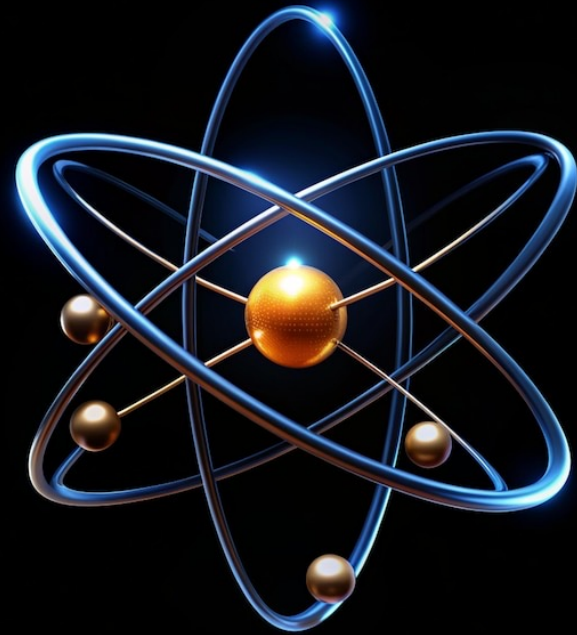
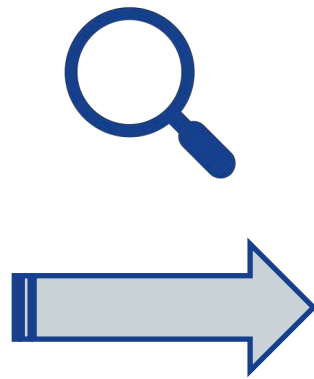
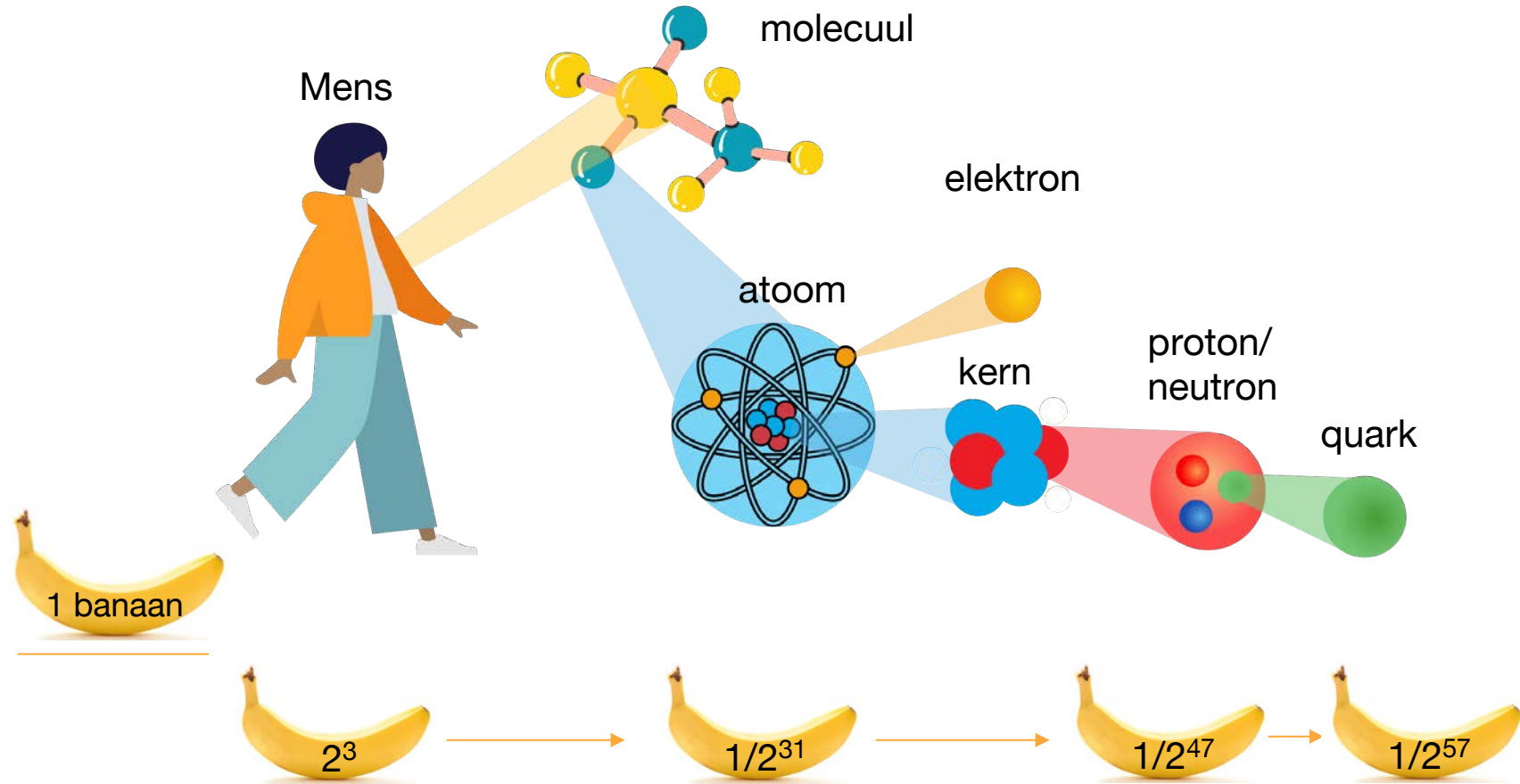


Neutrino's

De spookdeeltjes van het universum

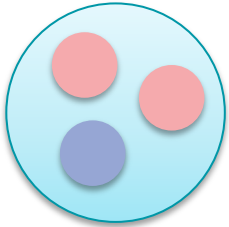




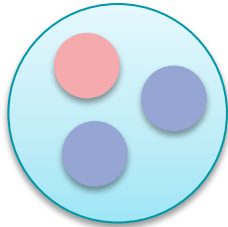


Deeltjes: de bouwstenen van het universum

Proton



Neutron

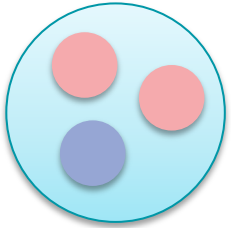


→ Bouwstenen van atomen

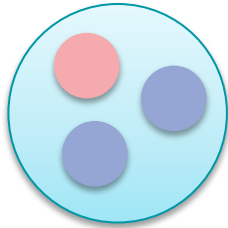


Deeltjes: de bouwstenen van het universum

Proton

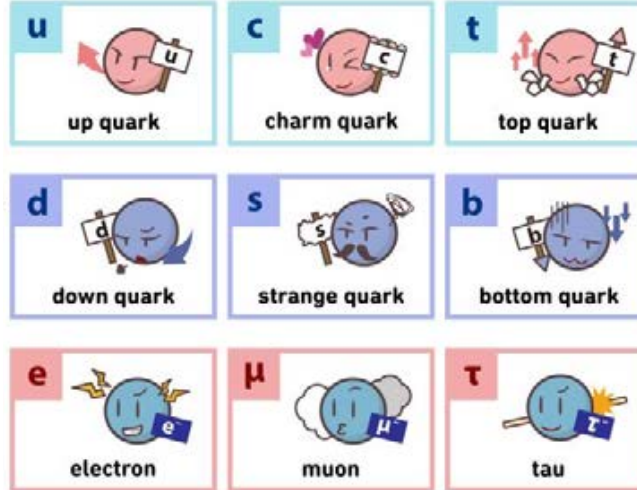


Neutron



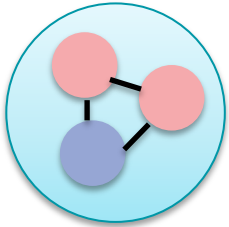
→ Bouwstenen van atomen

→ Zwaardere versies

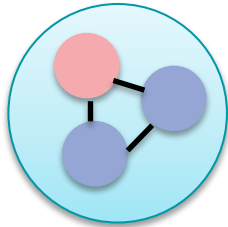


Deeltjes: de bouwstenen van het universum

Proton



Neutron



- Bouwstenen van atomen
- Zwaardere deeltjes
- Krachtdeeltjes



up quark



charm quark



top quark



photon



down quark



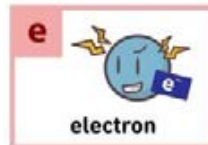
strange quark



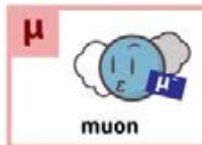
bottom quark



gluon



electron



muon



tau



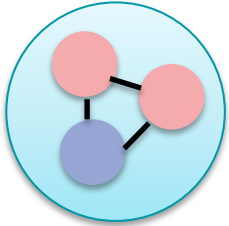
weak bosons



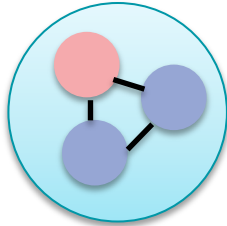
higgs boson

Deeltjes: de bouwstenen van het universum

Proton

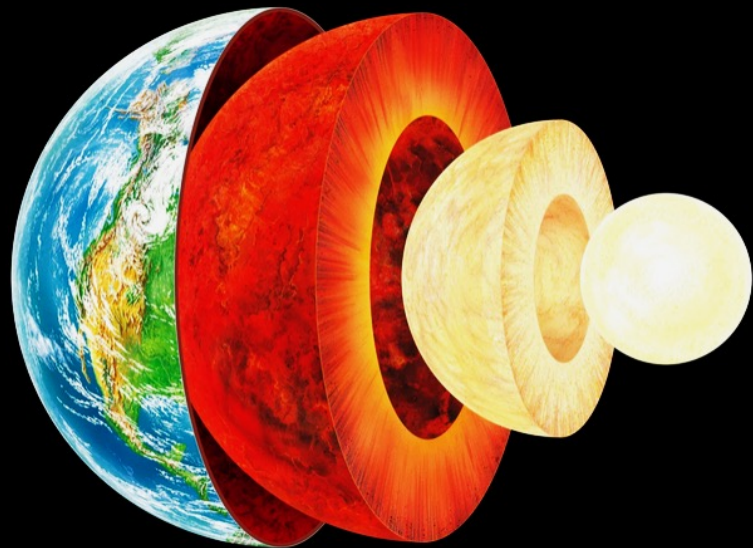
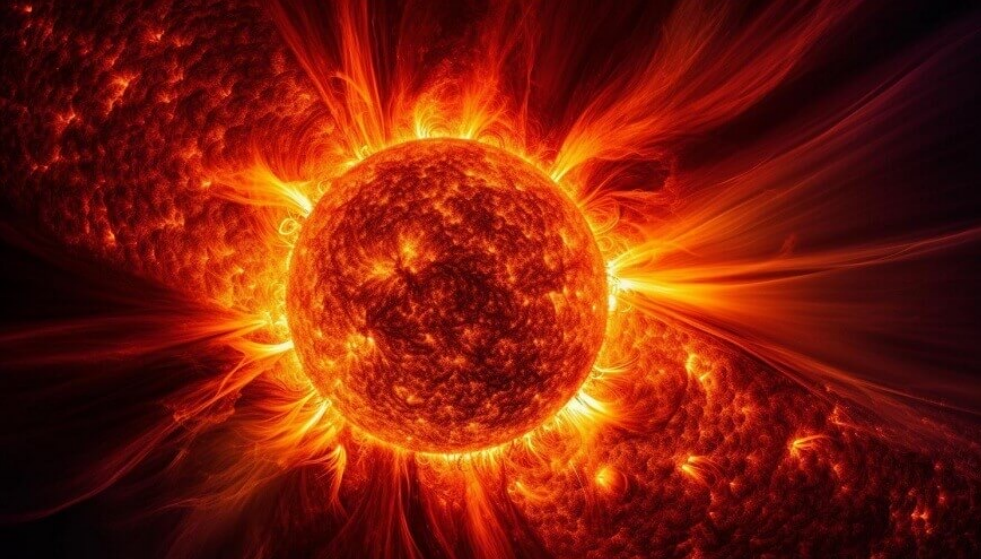


Neutron

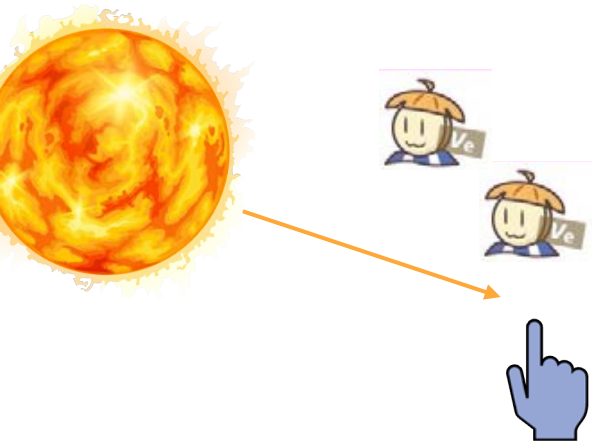


- Bouwstenen van atomen
- Zwaardere deeltjes
- Krachtdeeltjes
- Neutrinos!





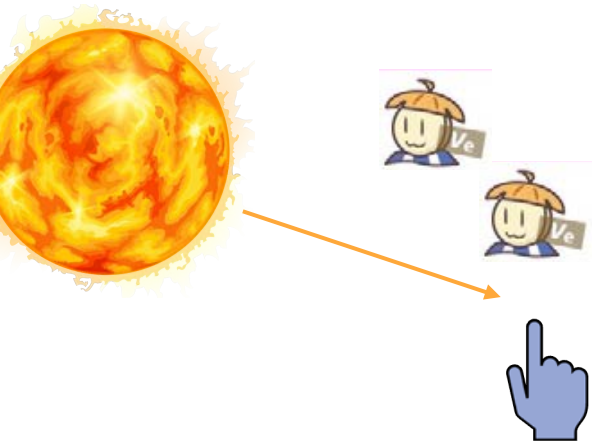
Maar er is een probleem!



Quiz tijd!

Hoeveel neutrino's gaan er per seconde door je vingernagel?

Maar er is een probleem!

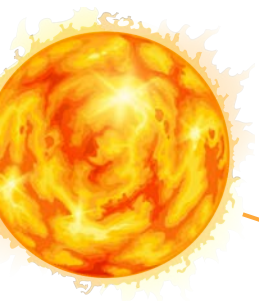


Quiz tijd!

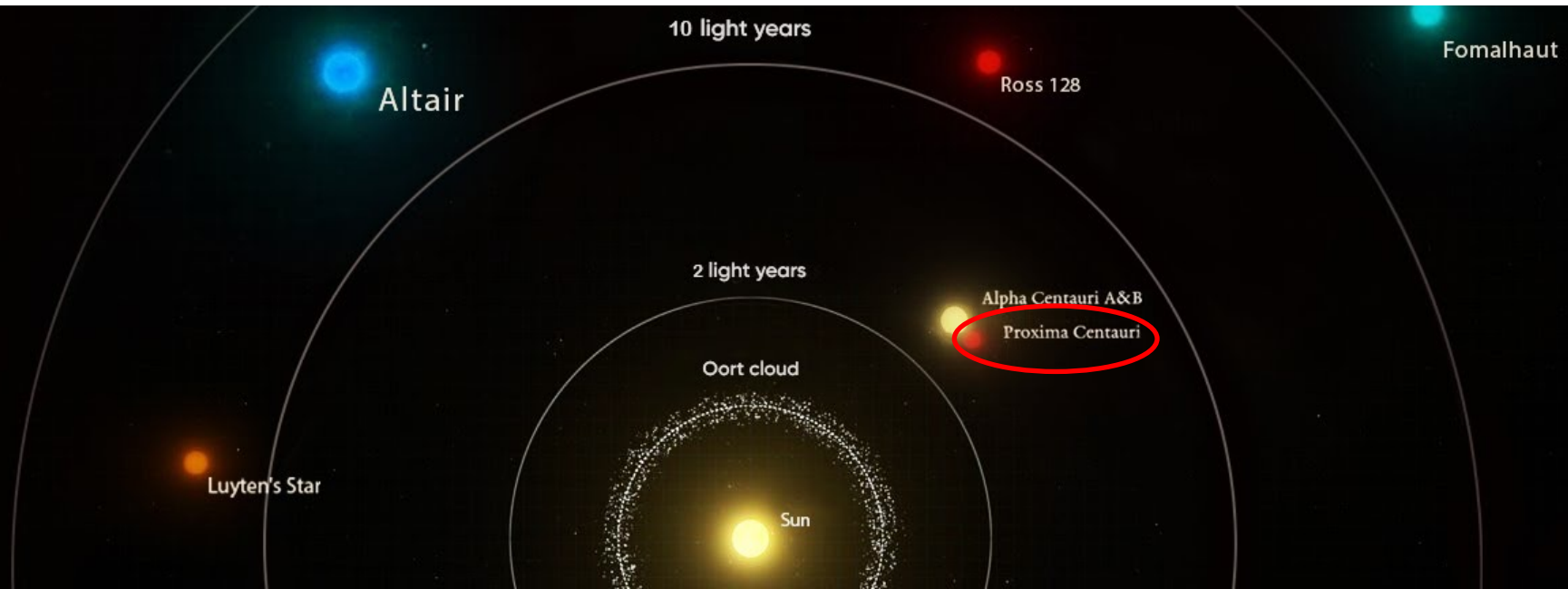
Hoeveel neutrino's gaan er per seconde door je vingernagel?

100 miljard!

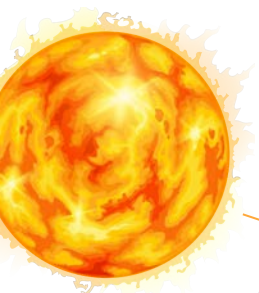
Maar er is een probleem!



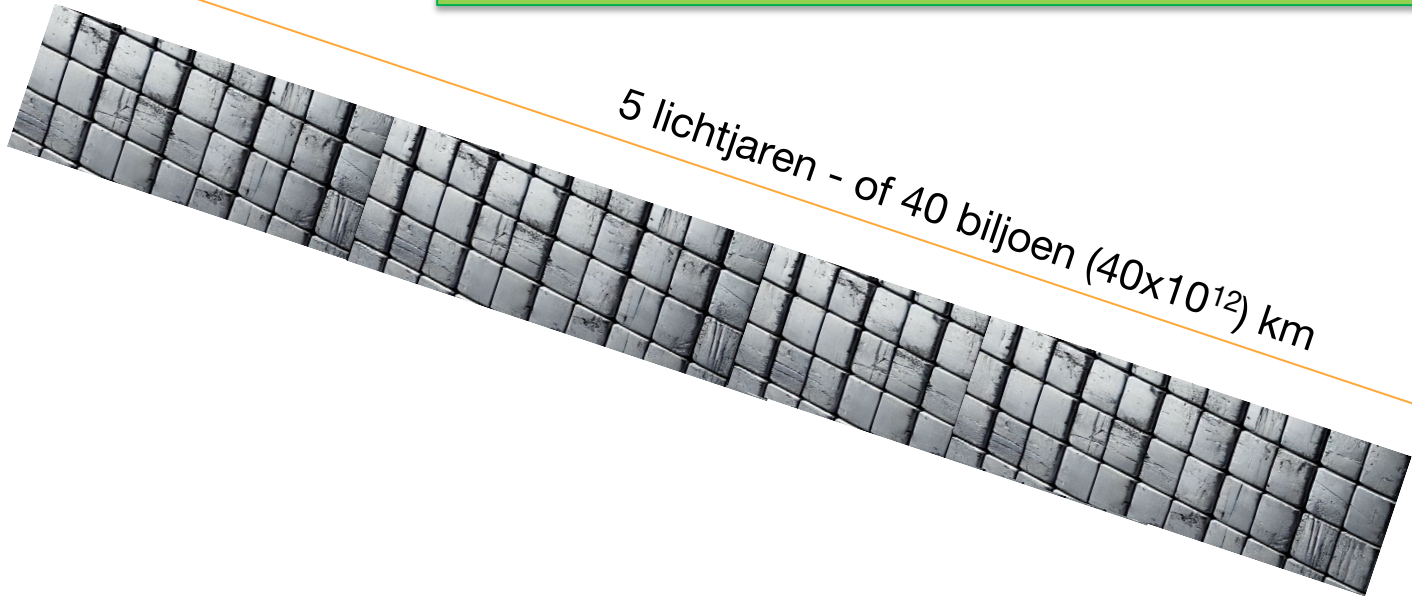
Quiz tijd!



Maar er is een probleem!



Quiz tijd!
Hoeveel neutrino's overleven de reis door de loden muur?

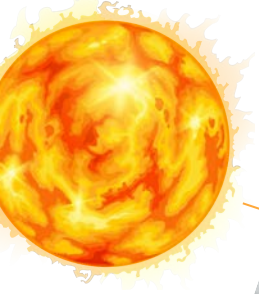


5 lichtjaren - of 40 biljoen (40×10^{12}) km

Dichtsbijzijnde
ster



Maar er is een probleem!



Quiz tijd!

Hoeveel neutrino's overleven de reis door de loden muur?

De helft!

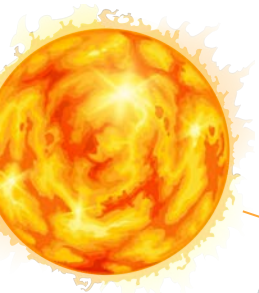
5 lichtjaren - of 40 biljoen (40×10^{12}) km



Dichtsbijzijnde
ster



Maar er is een probleem!



Quiz tijd!

Hoeveel neutrino's overleven de reis door de loden muur?

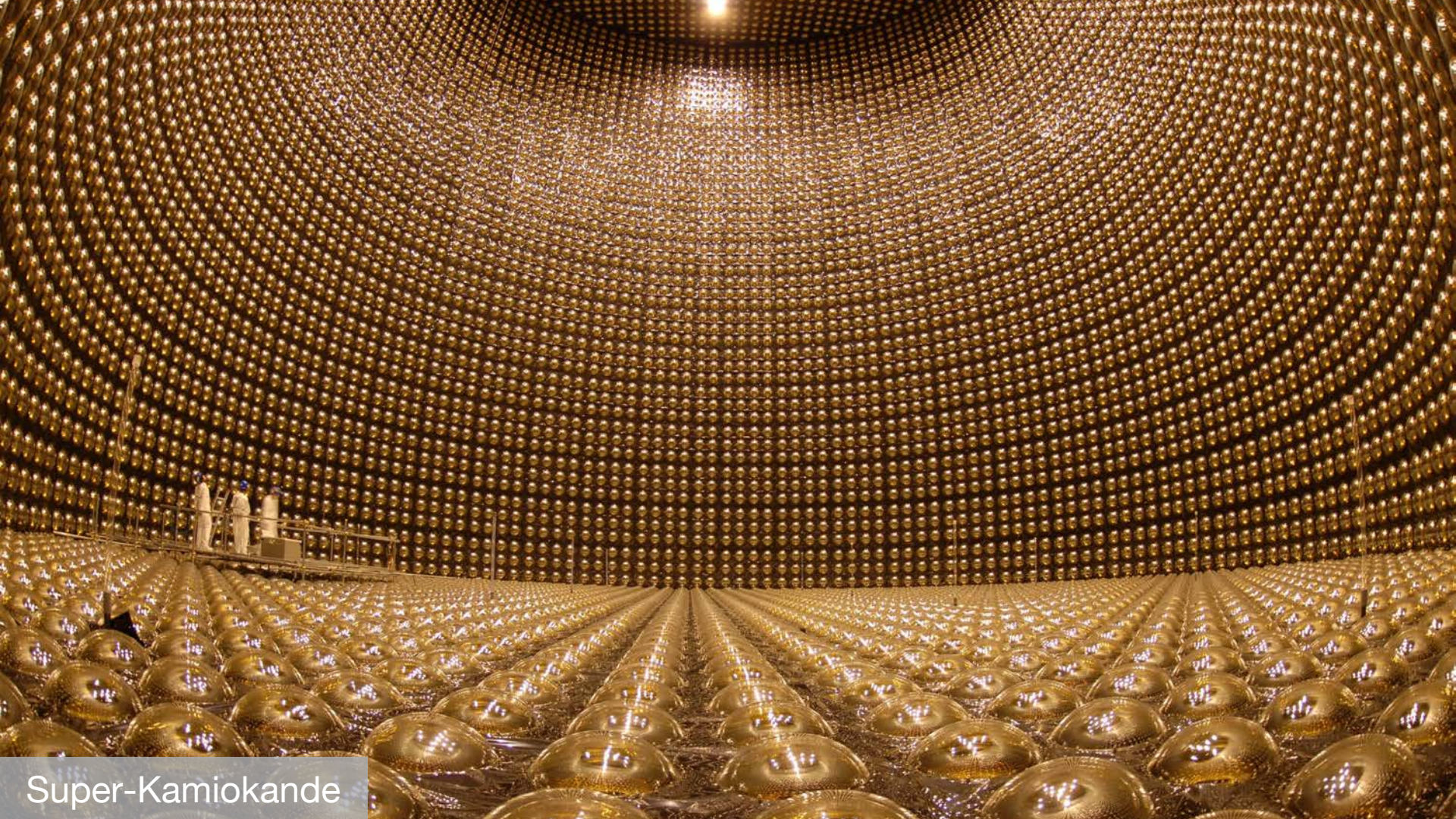
De helft!

5 lichtjaren - of 40 biljoen (40×10^{12}) km

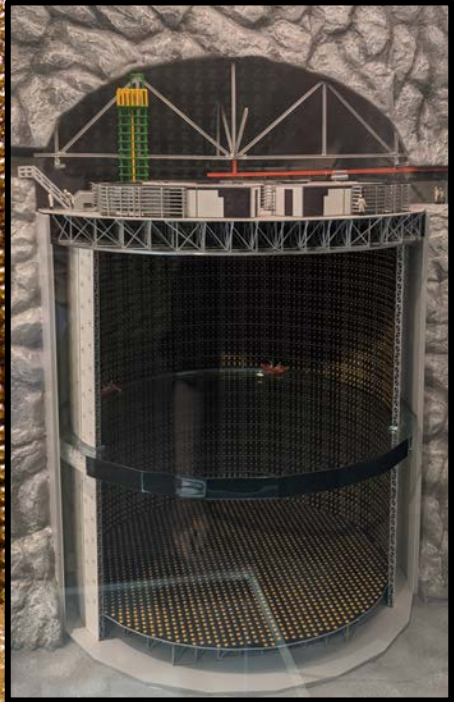
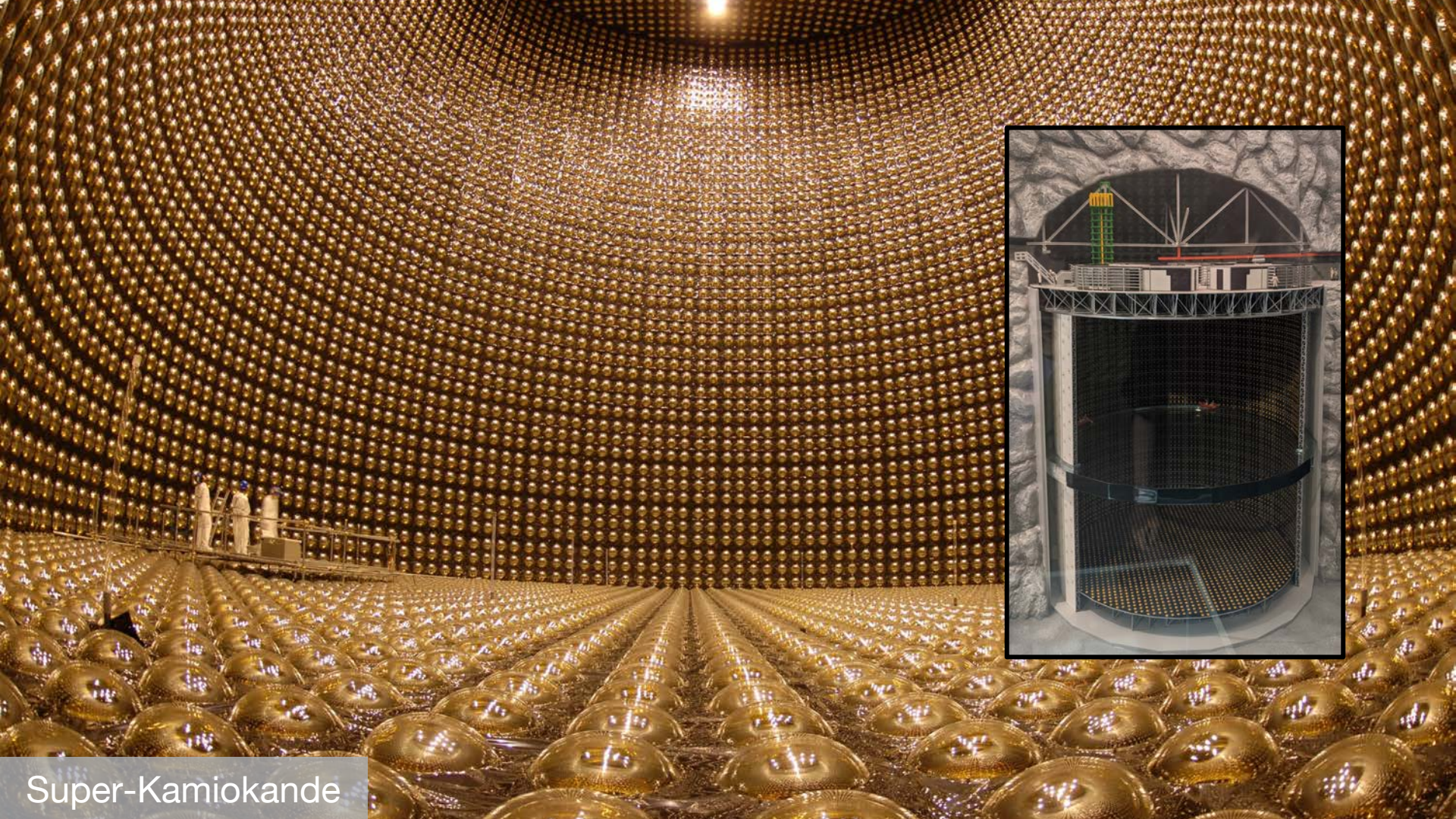


Dichtsbijzijnde
ster



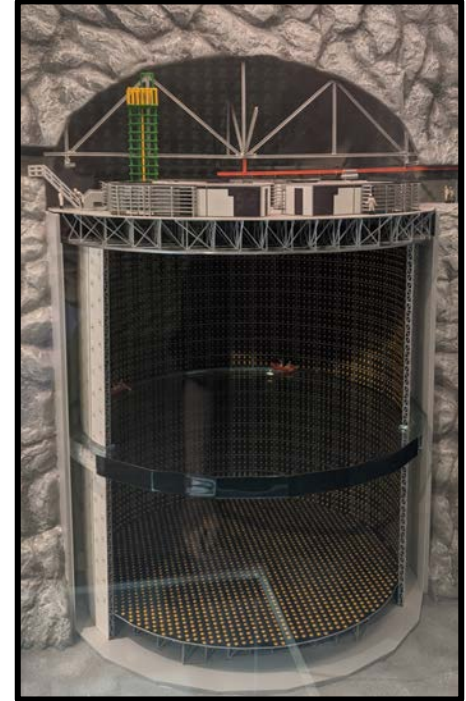
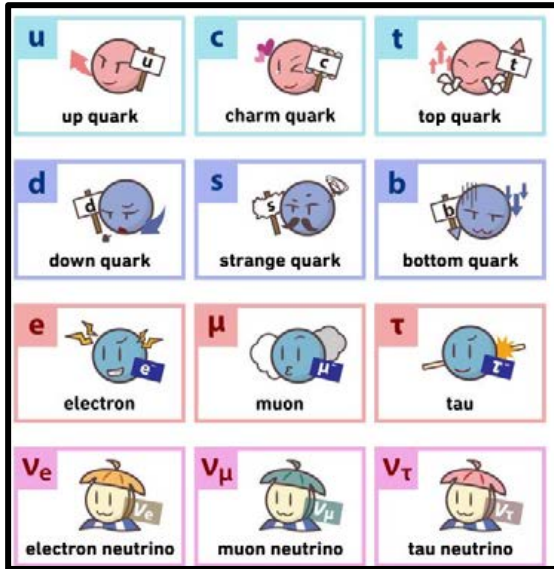


Super-Kamiokande

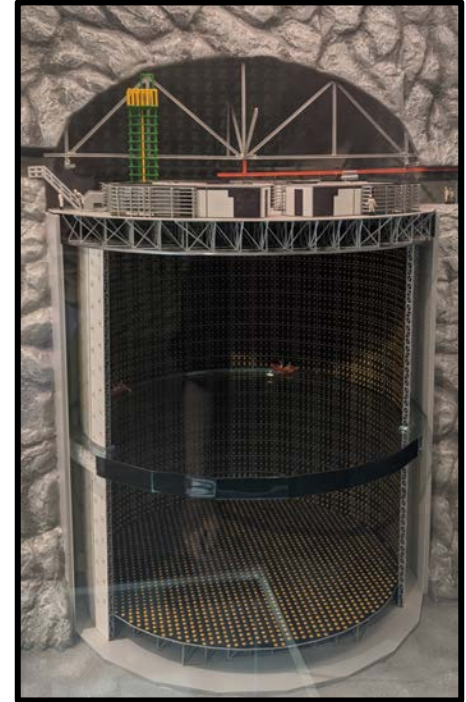
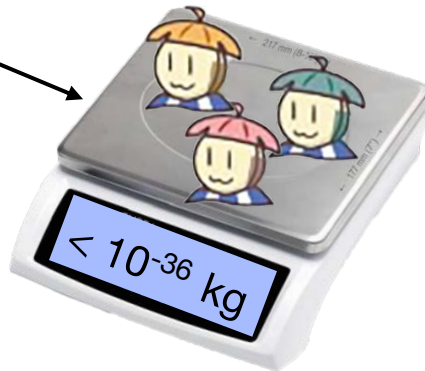
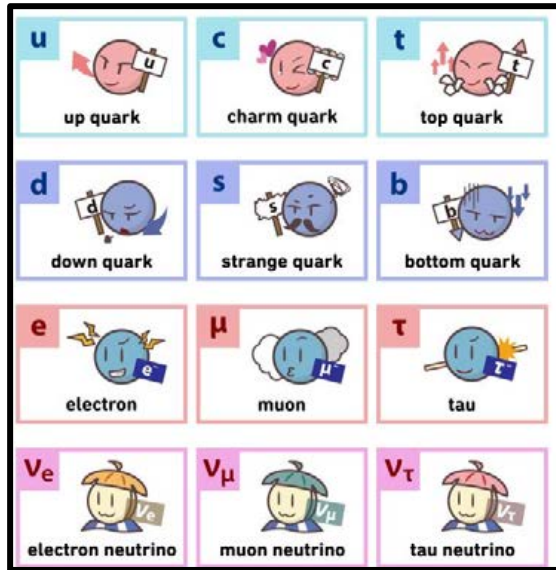


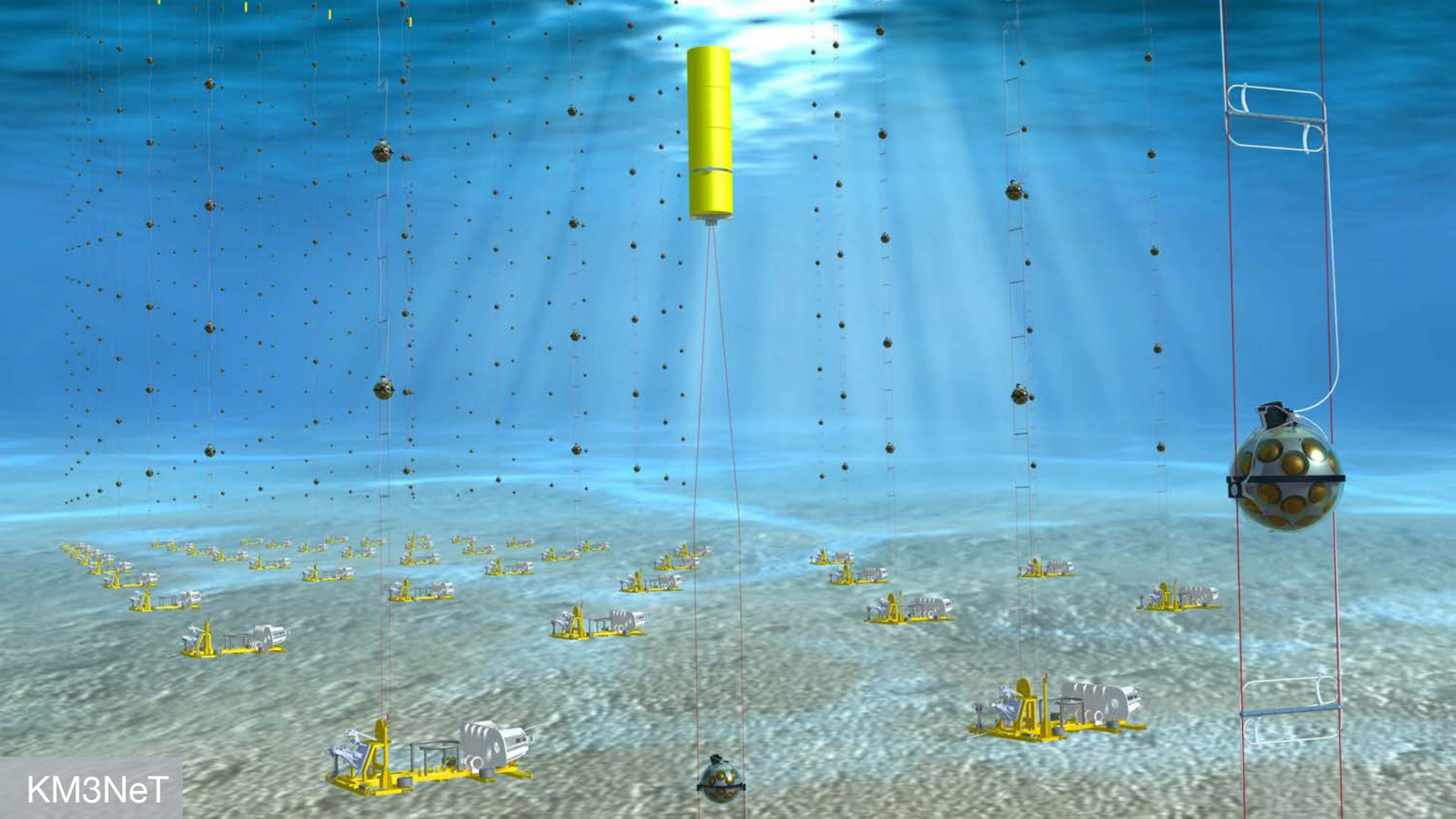
Super-Kamiokande

Onopgelost mysterie: neutrino's zijn niet massaloos?

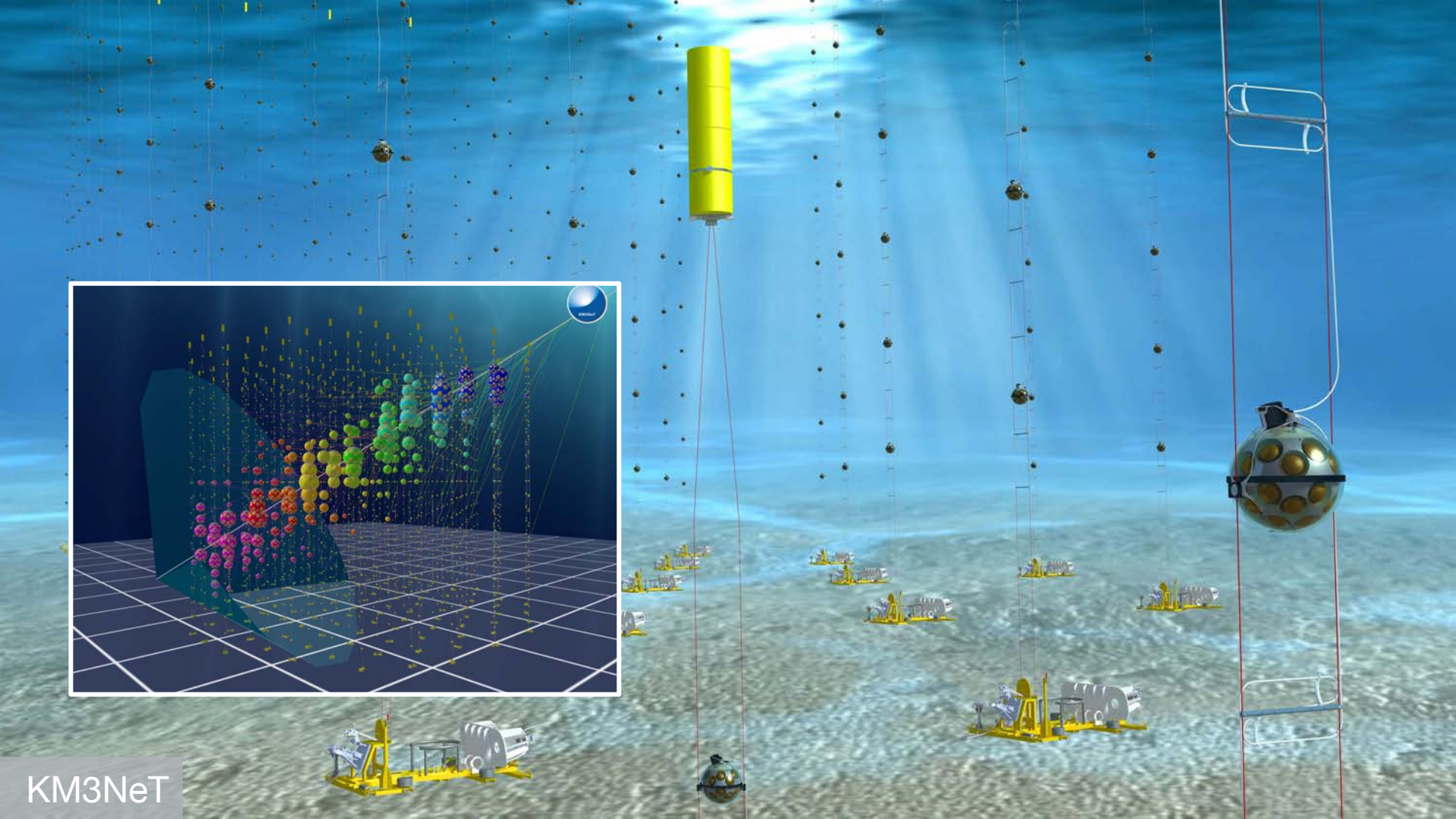


Onopgelost mysterie: neutrino's zijn niet massaloos?





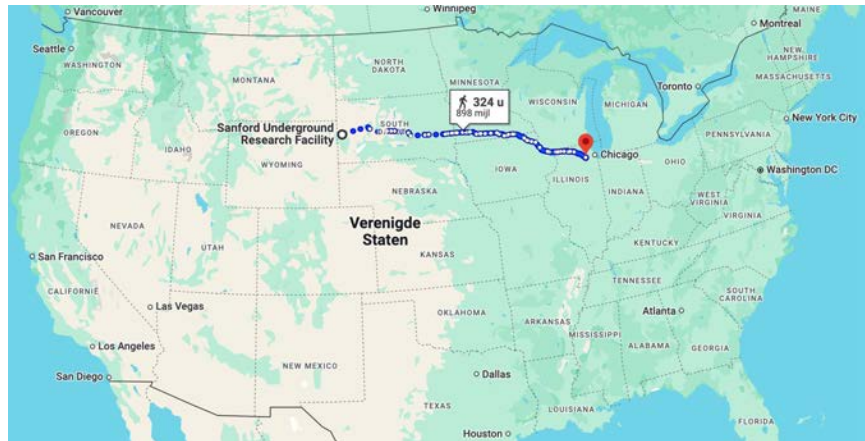
KM3NeT



KM3NeT

DUNE

DEEP UNDERGROUND NEUTRINO EXPERIMENT



Sanford Underground
Research Facility

Fermilab

800 miles
(1300 kilometers)

NEUTRINO
PRODUCTION

PARTICLE
DETECTOR

PROTON
ACCELERATOR

UNDERGROUND
PARTICLE DETECTOR

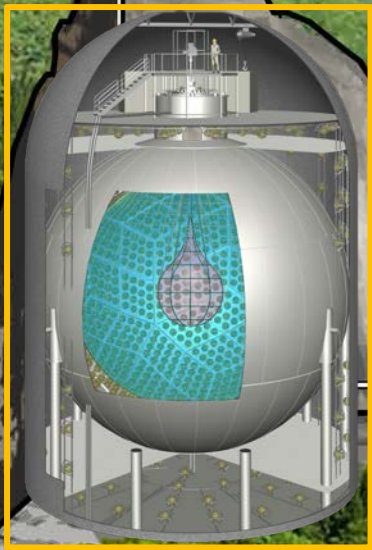
EXISTING
LABS



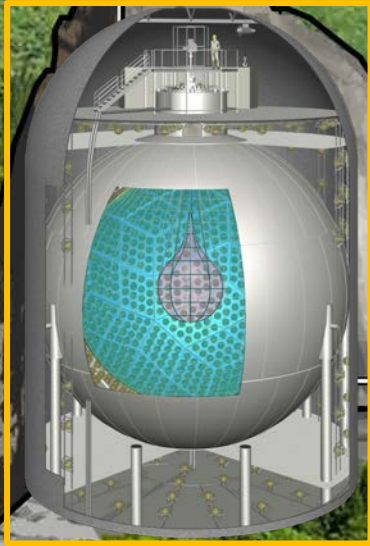
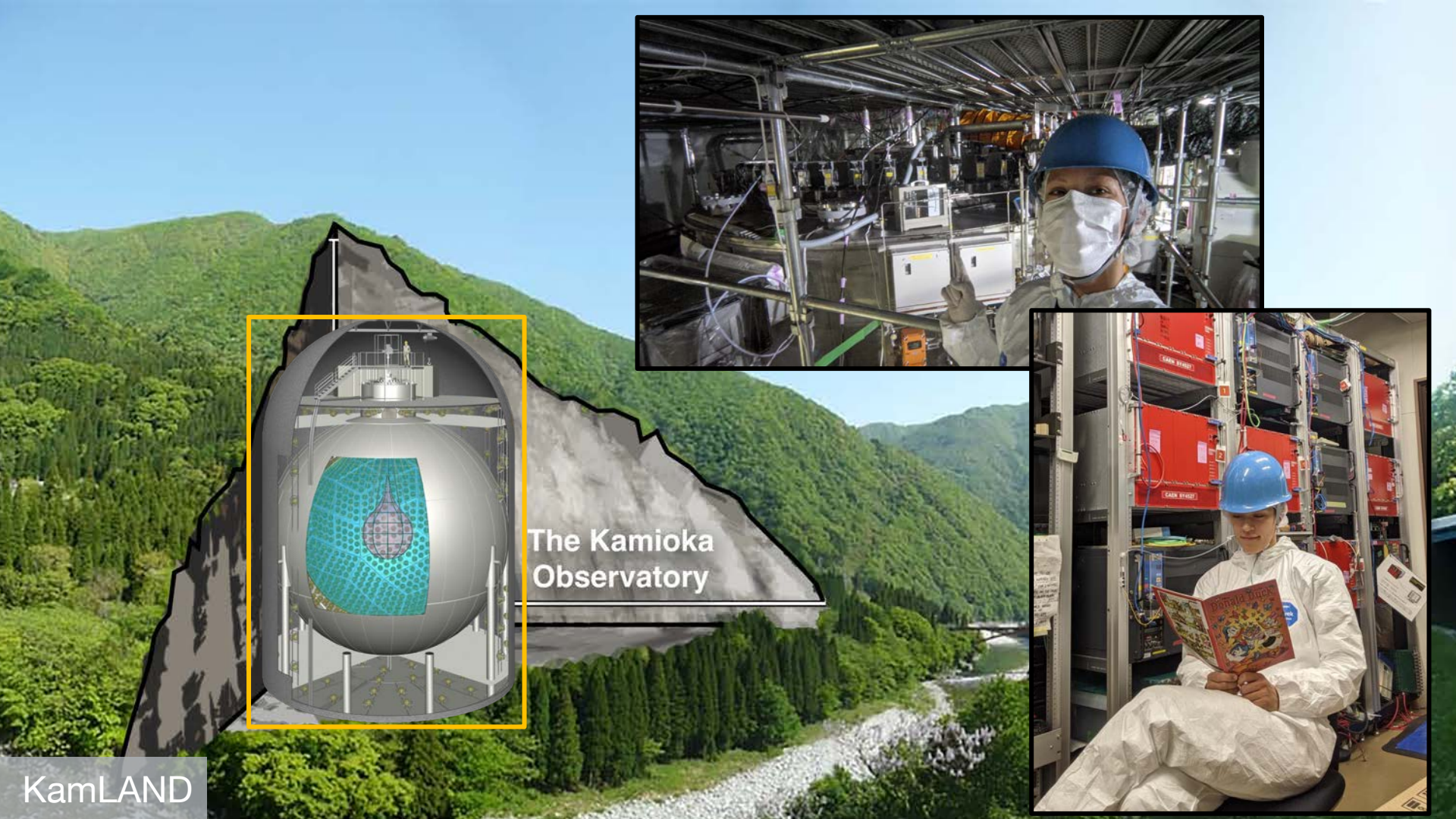
The Kamioka
Observatory



KamLAND



The Kamioka
Observatory



The Kamioka Observatory

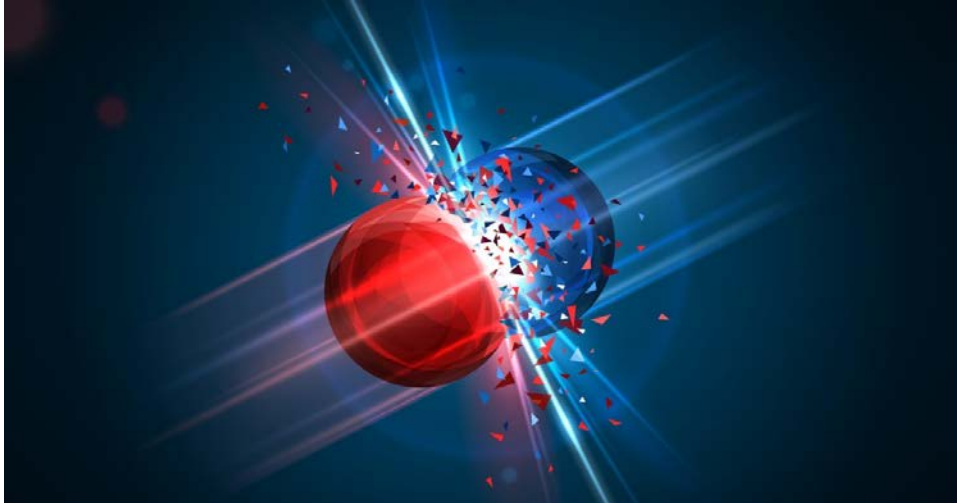


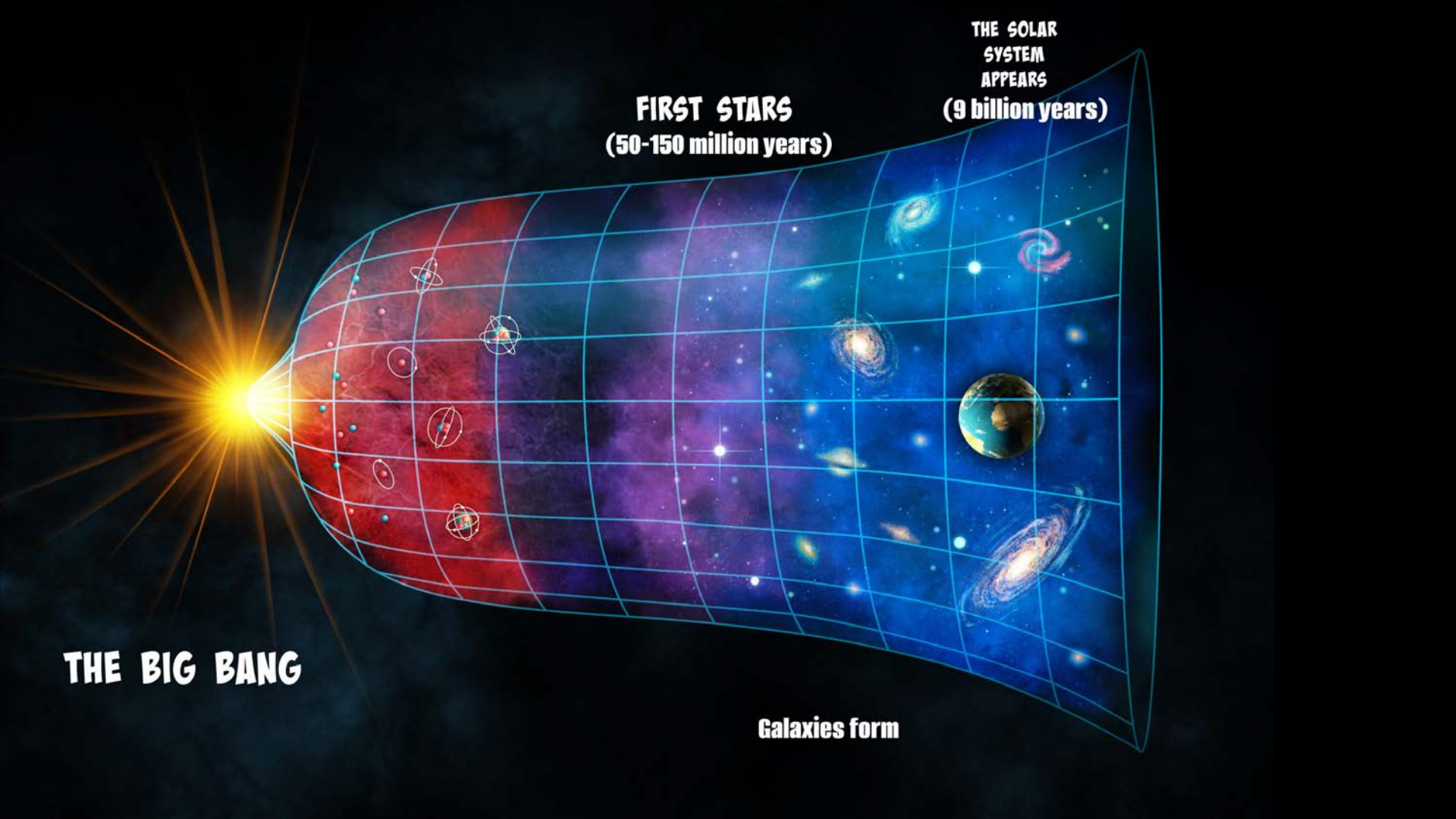
Waarom zijn er niet evenveel deeltjes als antideeltjes?

Elektron



Positron





**THE SOLAR
SYSTEM
APPEARS
(9 billion years)**

**FIRST STARS
(50-150 million years)**

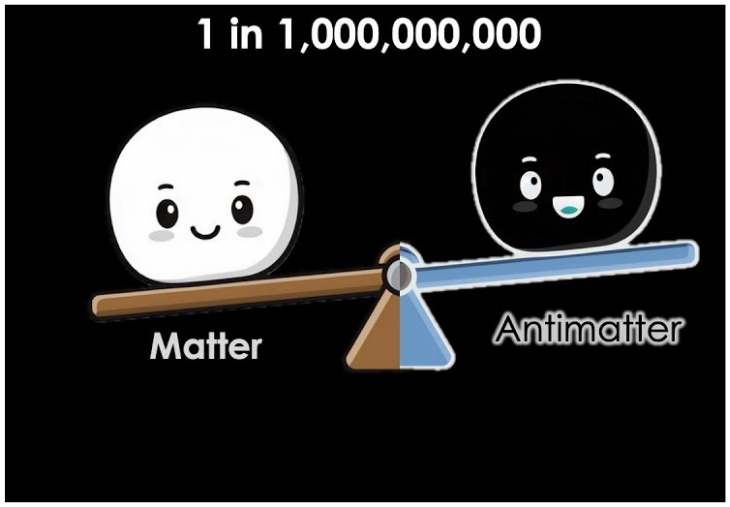
THE BIG BANG

Galaxies form

THE BIG BANG

FIRST STARS
(50-150 million years)

**THE SOLAR
SYSTEM
APPEARS**
(9 billion years)



Galaxies form

Waarom zijn er niet evenveel deeltjes als antideeltjes?

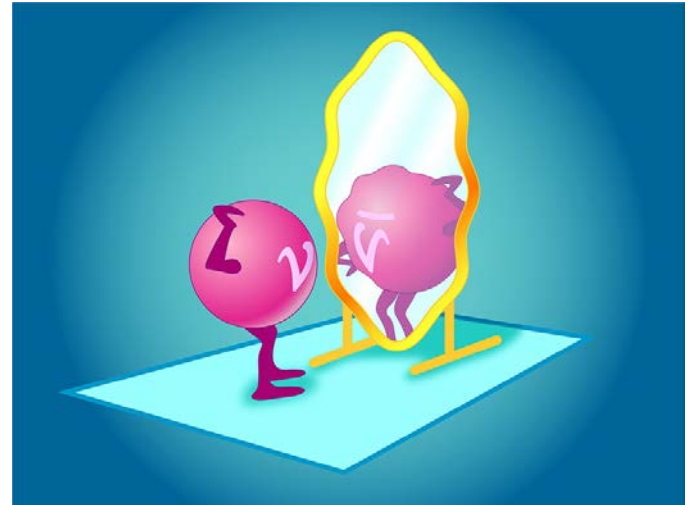
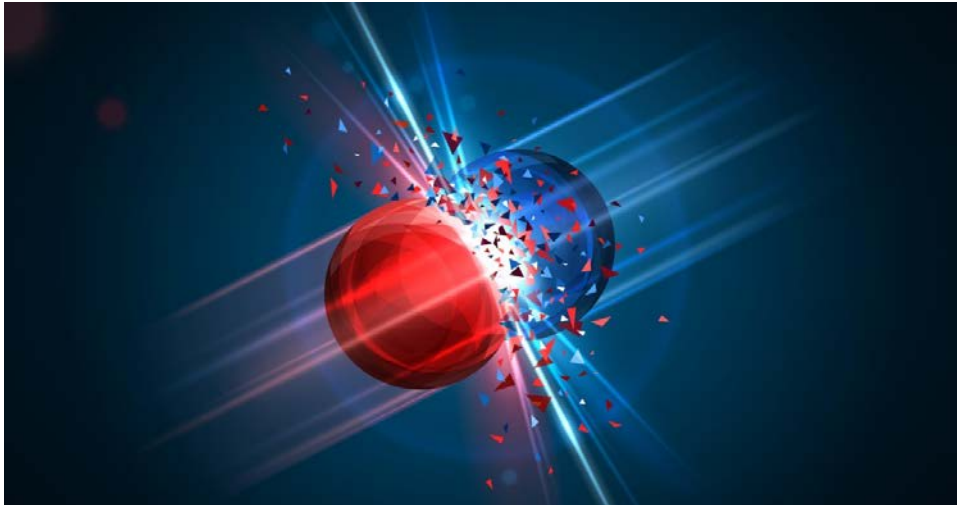
Elektron



Positron



Neutrino



Waarom zijn er niet evenveel deeltjes als antideeltjes?

Elektron



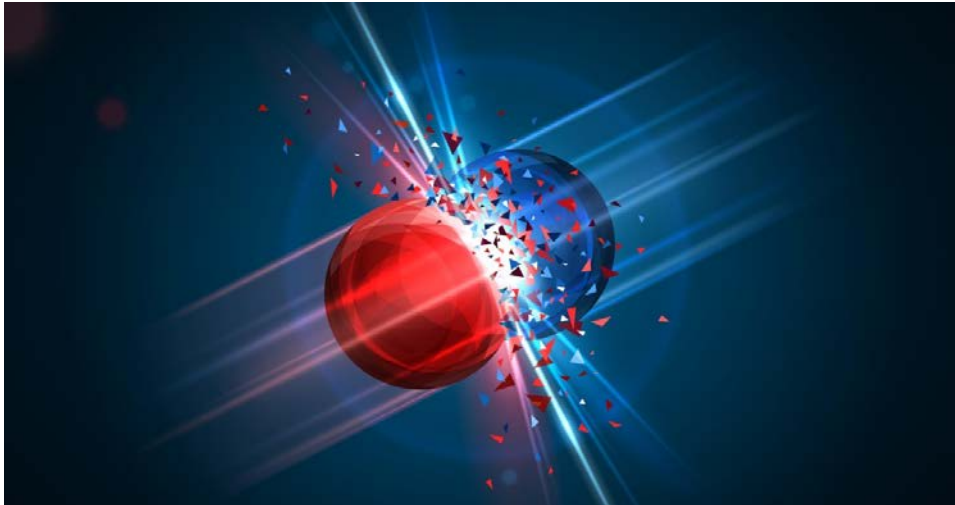
Positron



Neutrino



Is de neutrino zijn eigen antideeltje?



Blijf op de hoogte voor meer!

@physicswithkelly



@PHYSICSWITHKELLY

Kelly Weerman

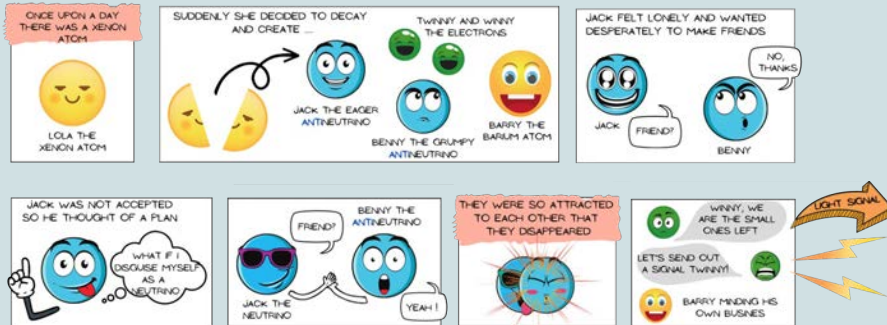
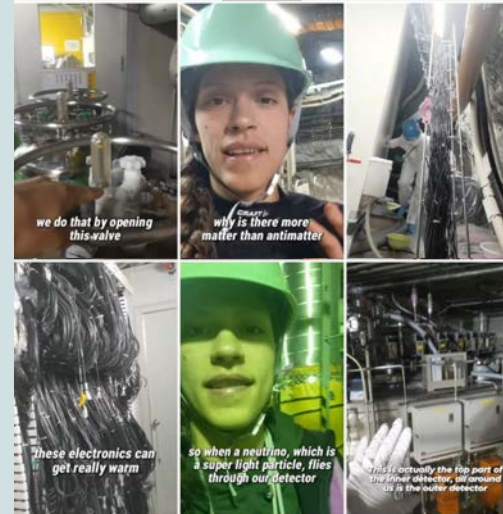
Experimental particle physics PhD student working on the KamLAND detector in Japan 🇯🇵🔬🌟

← physicswithkelly 🔍 ⋮

 17 posts 5.792 followers 43 following

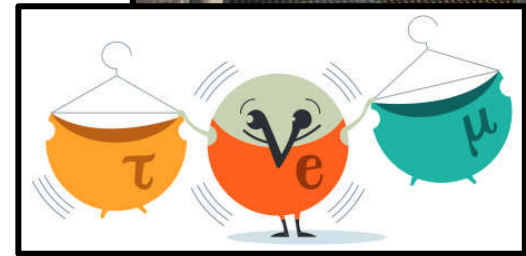
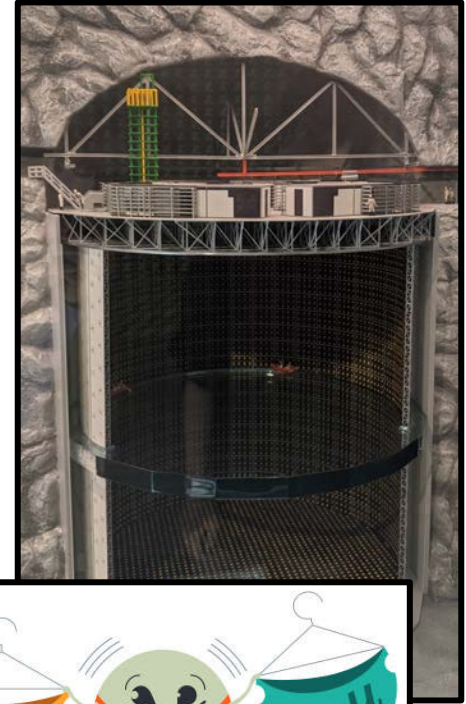
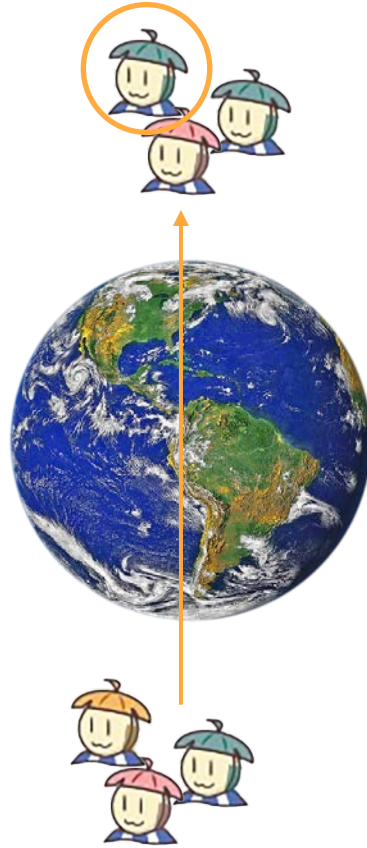
Kelly Weerman
Scientist
Experimental particle physics PhD student working on the KamLAND detector in Japan 🇯🇵🔬🌟

📖 🎥 📷



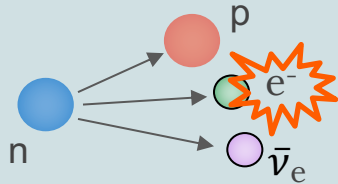
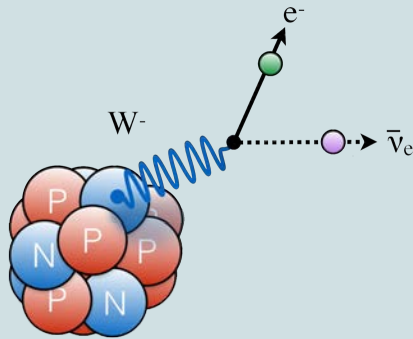
Onopgelost mysterie: neutrino's zijn niet massaloos?

u up quark	c charm quark	t top quark
d down quark	s strange quark	b bottom quark
e electron	μ muon	τ tau
ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino

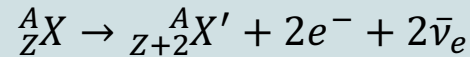
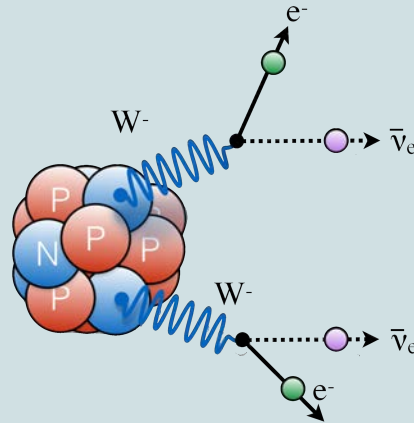


How do we observe the possible Majorana nature of neutrinos?

β -decay

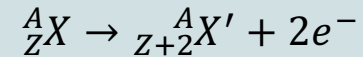
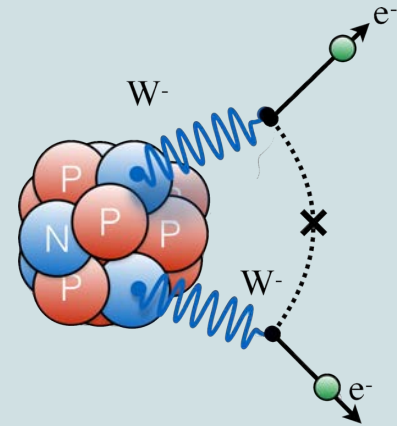


Double β -decay



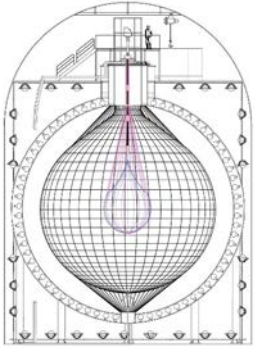
$$T_{1/2} \sim 10^{18-24} \text{ years}$$

Neutrinoless Double β -decay



$$T_{1/2} > 10^{26} \text{ years}$$

Future prospects: KamLAND2-Zen



KamLAND dismantling

2024

Current limit: $m_{\beta\beta} < (28 - 122) \text{ meV}$

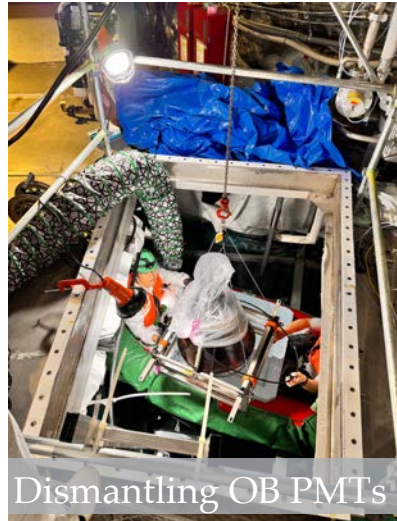
KamLAND2 construction

2027

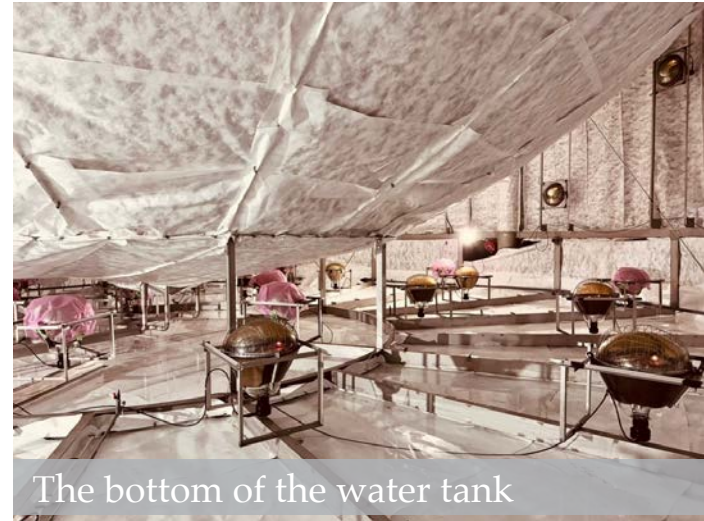
Target: $\langle m_{\beta\beta} \rangle = 20 \text{ meV}$



Water tank

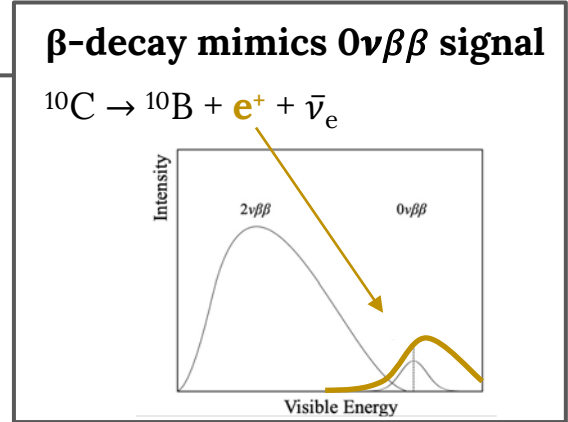
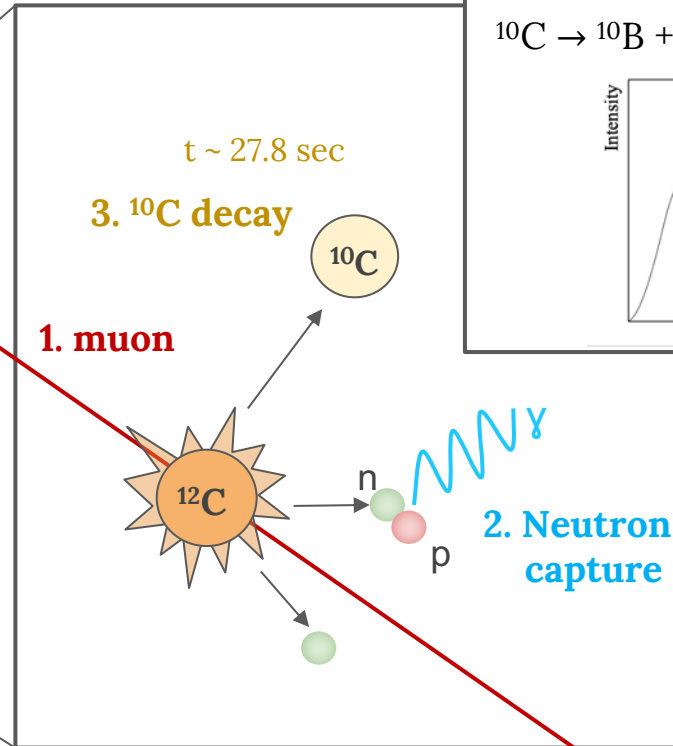
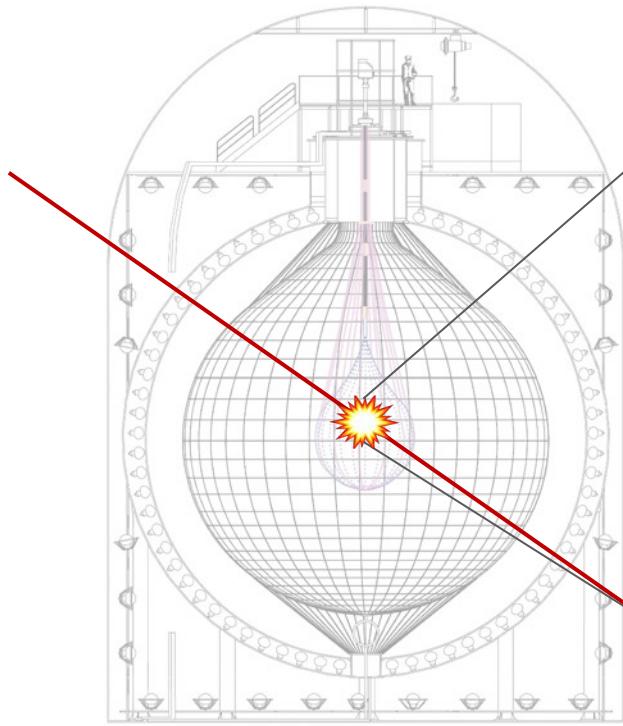


Dismantling OB PMTs



The bottom of the water tank

Isotope production from carbon spallation



Triple coincidence tagging

