NATIONAL RESEARCH NUCLEAR UNIVERSITY
MOSCOW ENGINEERING PHYSICS INSTITUTE

CTBTO
PREPARATORY COMMISSION

ESTIMATION OF ANTINEUTRINO REGISTRATION AS A METHOD OF MONITORING NUCLEAR EXPLOSIONS

CTBT SCIENCE AND TECHNOLOGY 2019 CONFERENCE

T3.1-03

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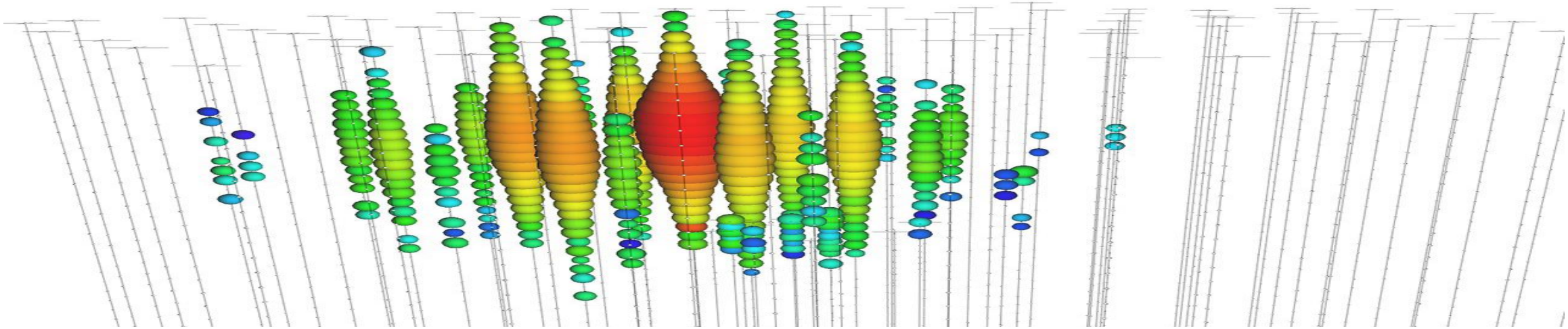
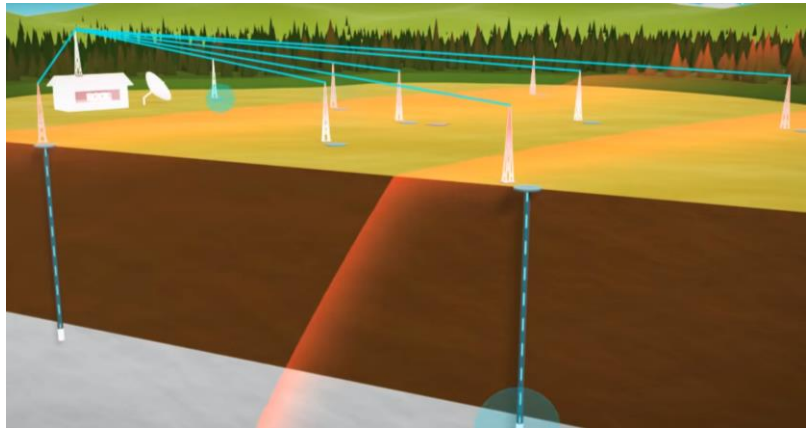
PRESENTATION CONTENTS

- Introduction
- What is the neutrino
- Neutrino and antineutrino detection
- General approach to detection
- Antineutrino registration
- Conclusion

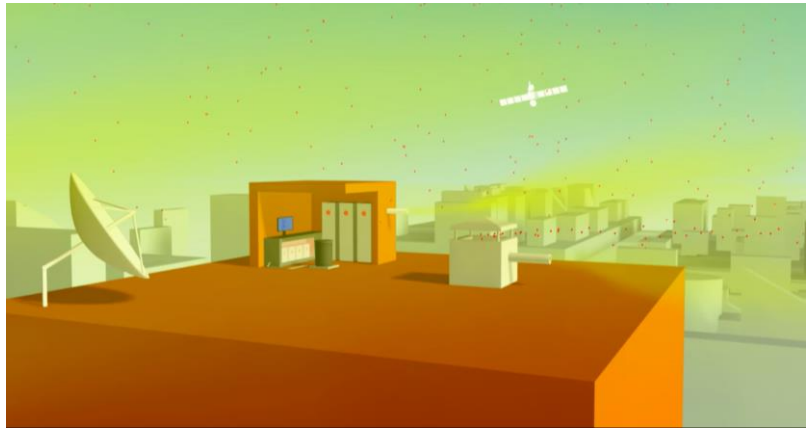


INTRODUCTION

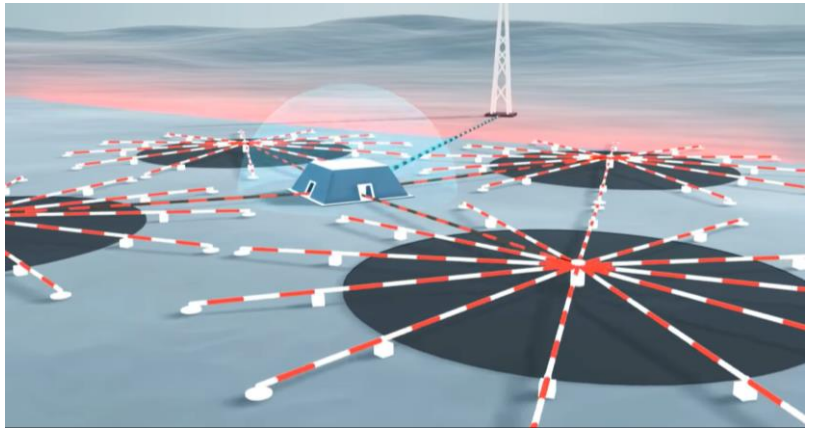


Seismic Stations

Hydroacoustic Stations



Radionuclide Stations

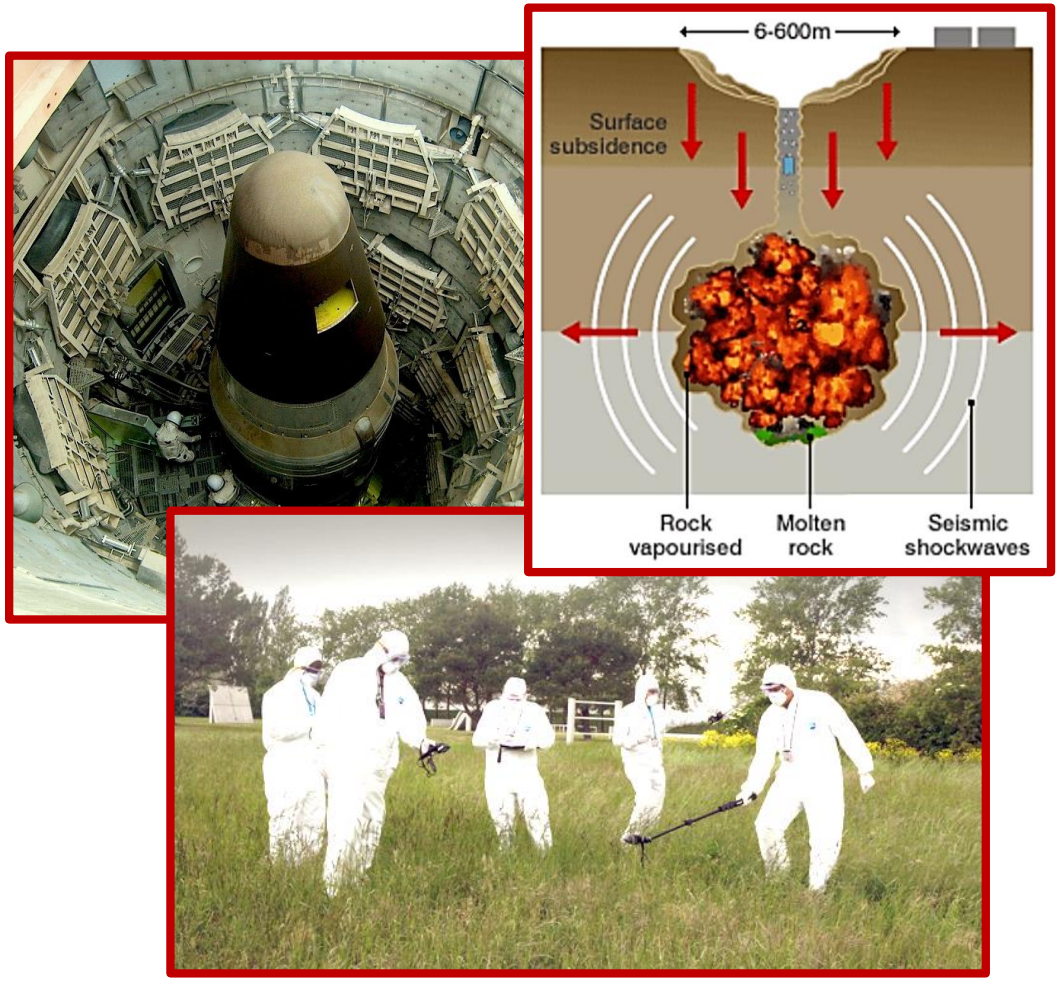


Infrasound Stations

INTRODUCTION

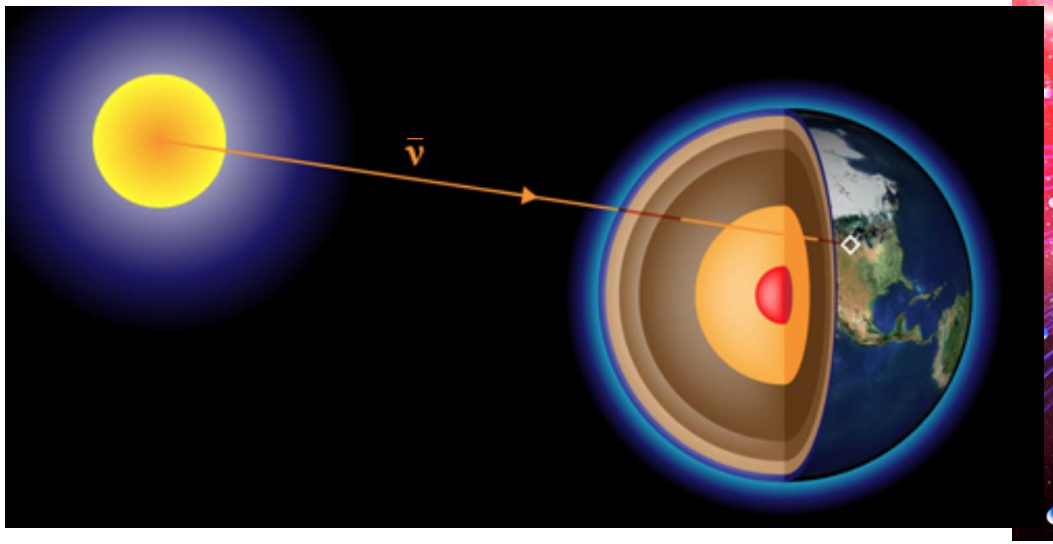
Problems

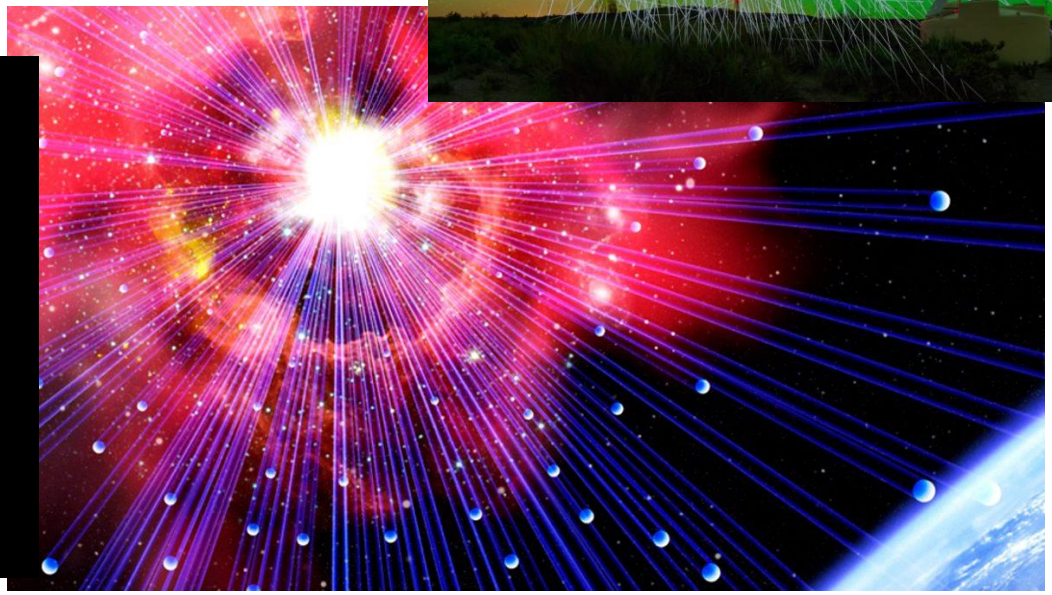
- Identification of nuclear and thermonuclear explosions without on-site inspection or laboratory testing of products
- Registration of underground nuclear explosions below the threshold of sensitivity of technical means
- Control over the development of new types of nuclear weapons at industrial enterprises



NEUTRINO

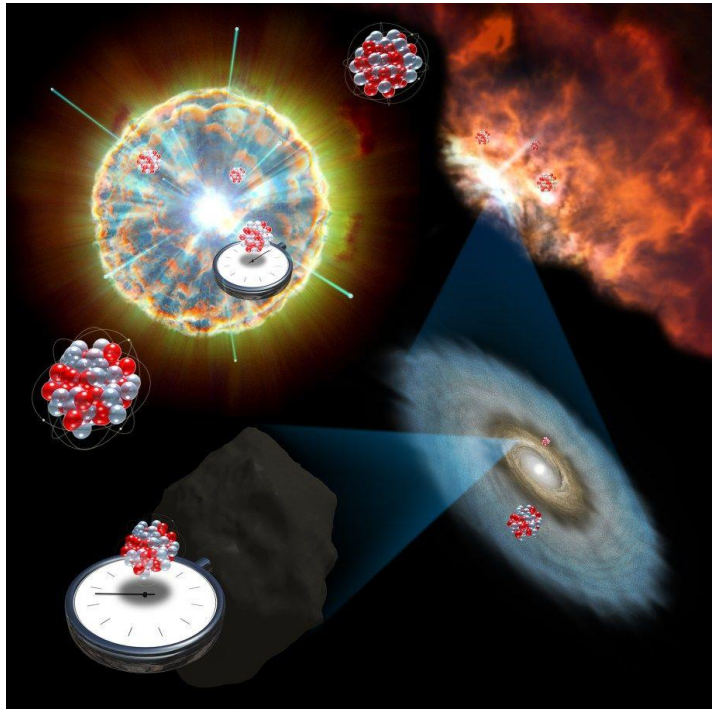
- Neutrino is a particle with a very small mass, which has no electric charge.
- Neutrino can travel through planets and stars with little or no interaction with them.



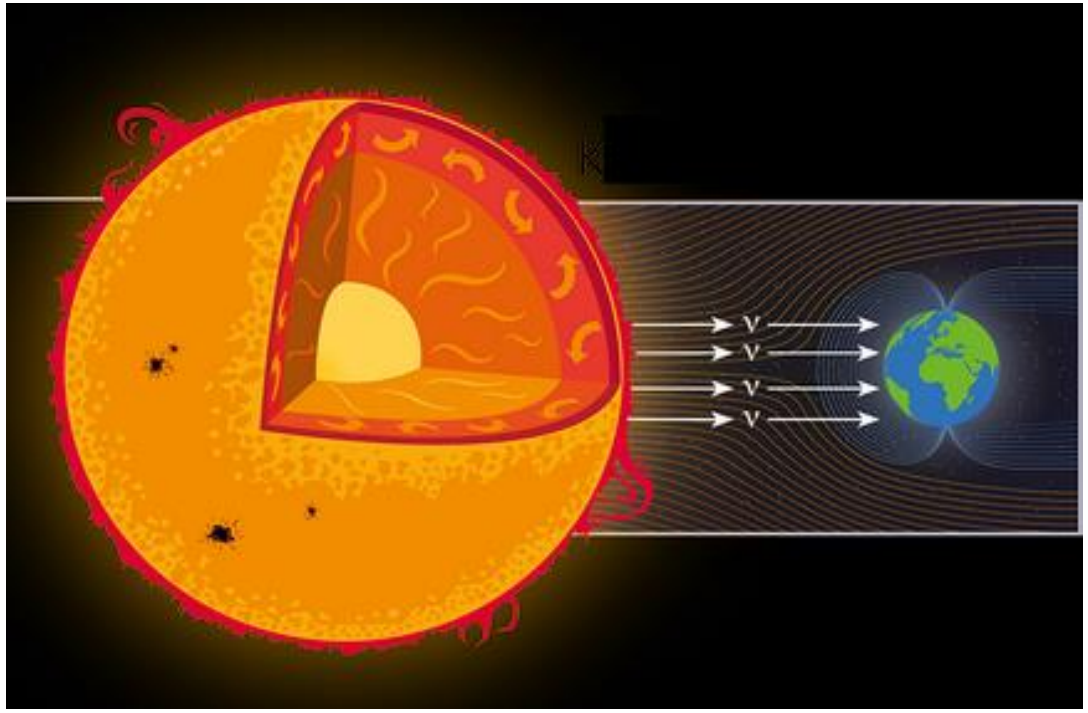


NEUTRINO AND ANTINEUTRINO DETECTION

Currently, antineutrino detection is used to:

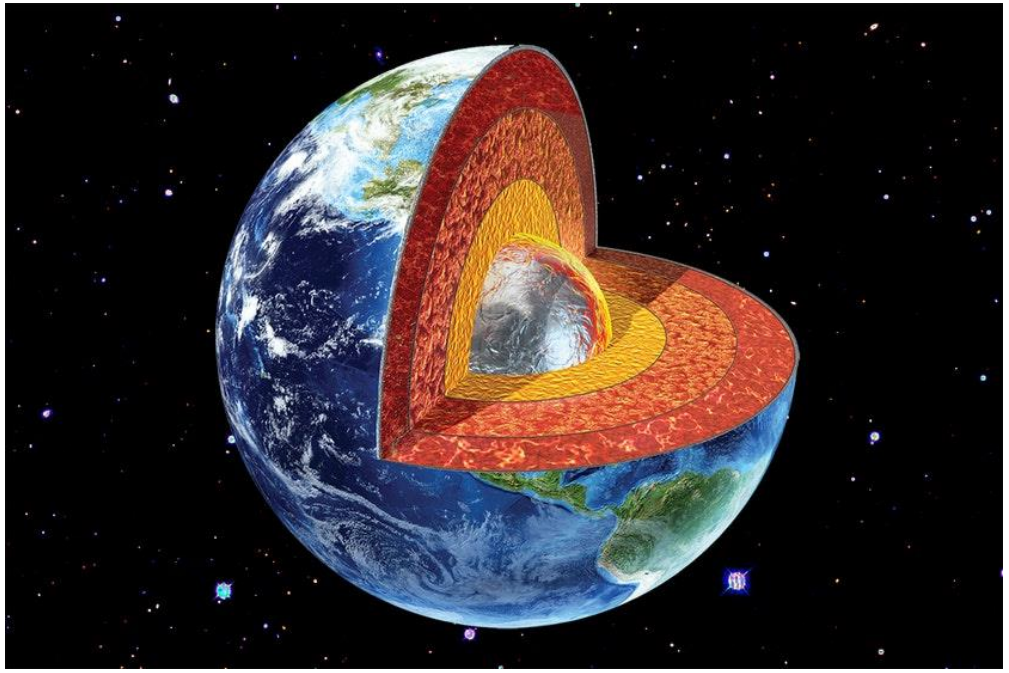


Understand the origin of the Universe

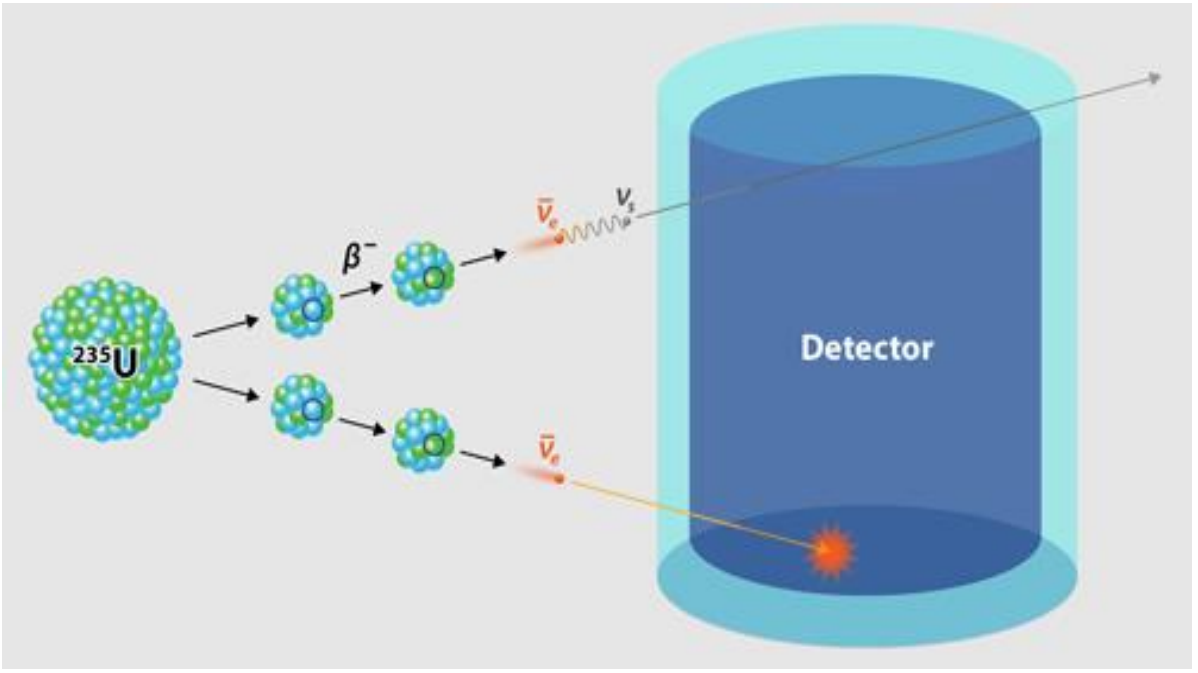


Study the structure of the Sun

NEUTRINO AND ANTINEUTRINO DETECTION

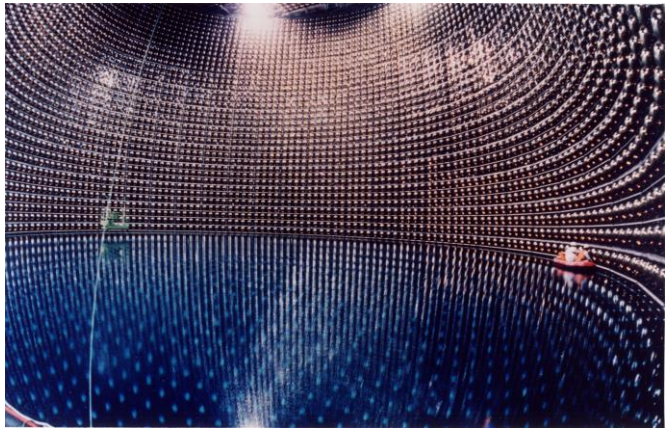


Study the structure of the Earth



Monitor the operation of nuclear power plants

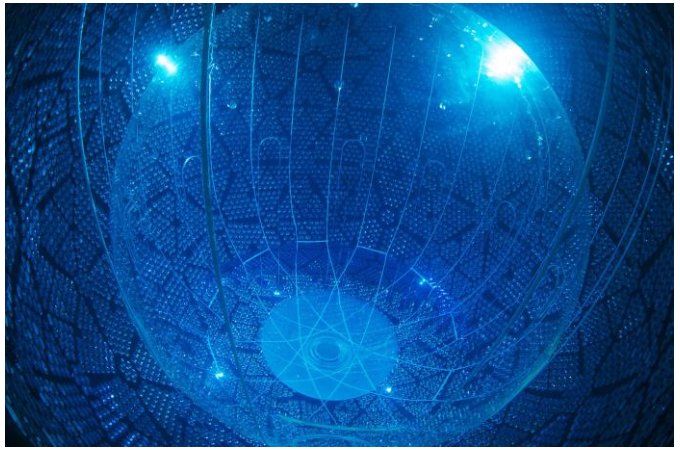
GENERAL APPROACH TO DETECTION



Kamiokande
(Japan)

$$N_{int} = \frac{\alpha Y V}{r^2}$$

The number of antineutrino interactions
(Adam Bernstein, Todd West, Vipin Gupt)



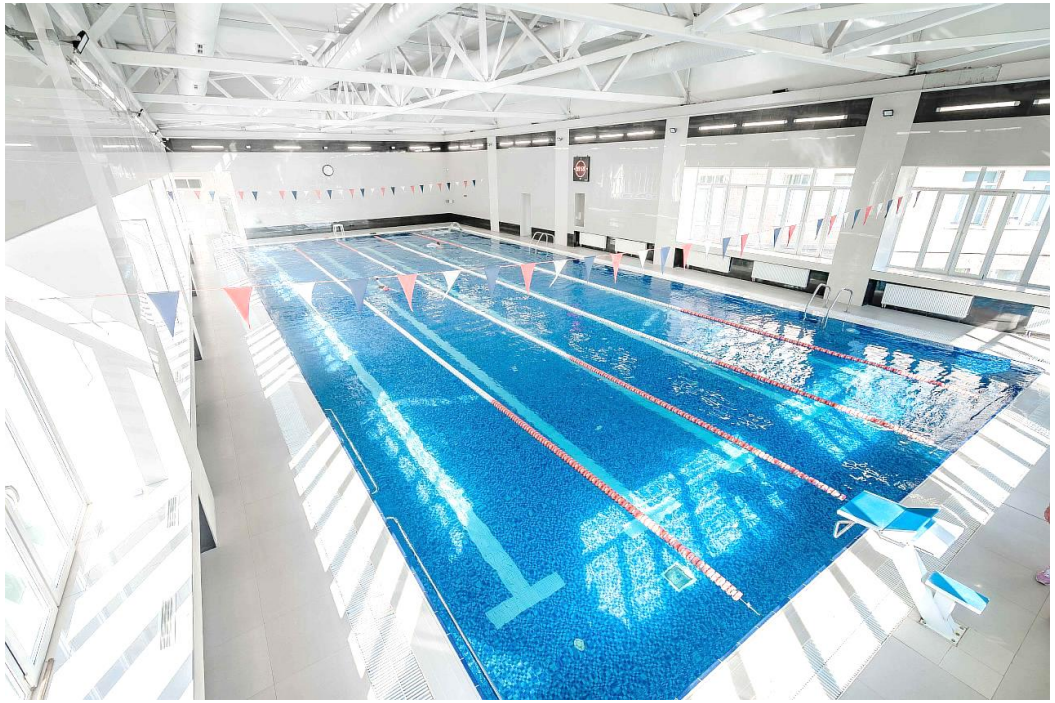
Borexino
(Italy)

V – volume in cubic meters
Y – energy release in fission reactions in kiloton
Coefficient α (expressed in $(kt)^{-1}m^{-1}$) depends on the density of the substance of the detector
r – distance from the explosion site to the detector in meters

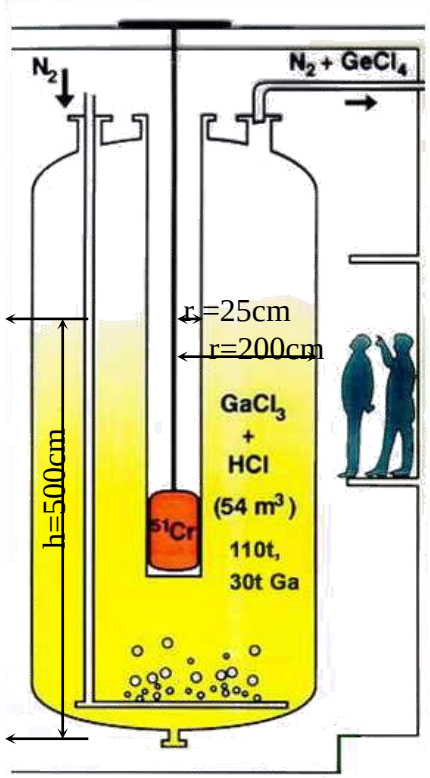
GENERAL APPROACH TO DETECTION

Volume required for registration with a 96% probability of at least two antineutrinos from a nuclear explosion with a capacity of 1 kt at a distance of 1000 km is approximately 420 cubic meters.

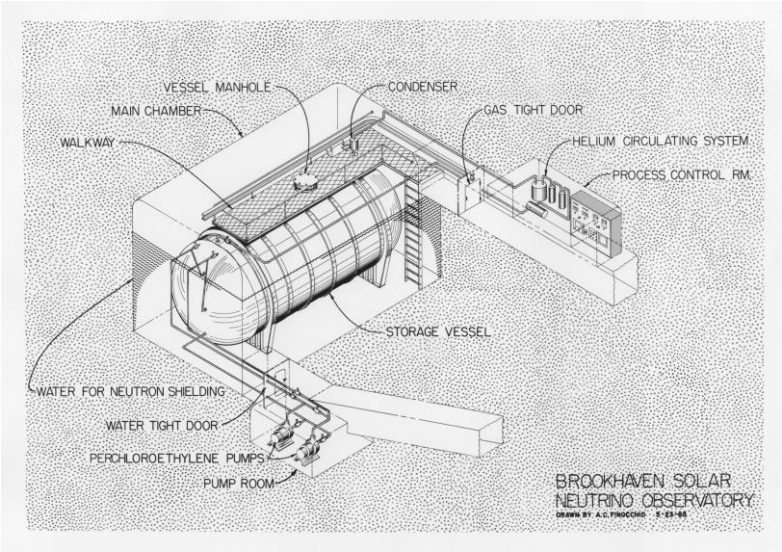
This volume is comparable to a pool of 25 by 6.5 meters.



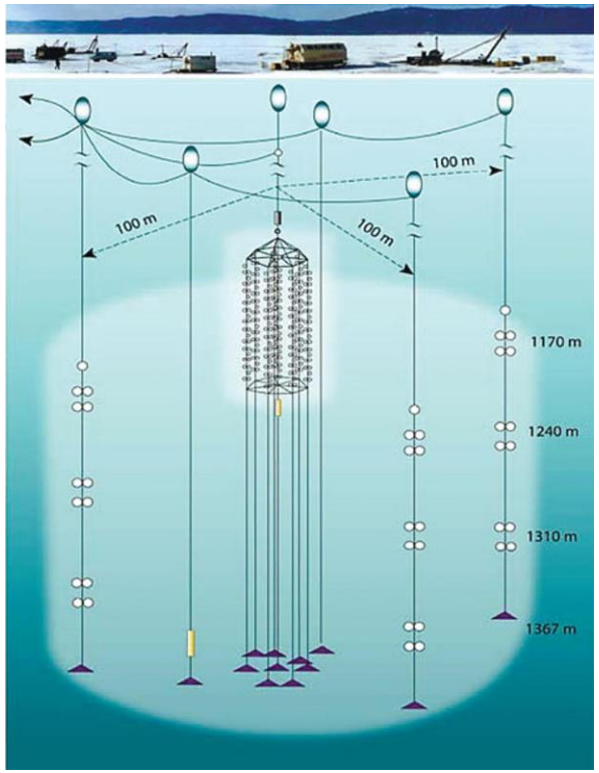
GENERAL APPROACH TO DETECTION



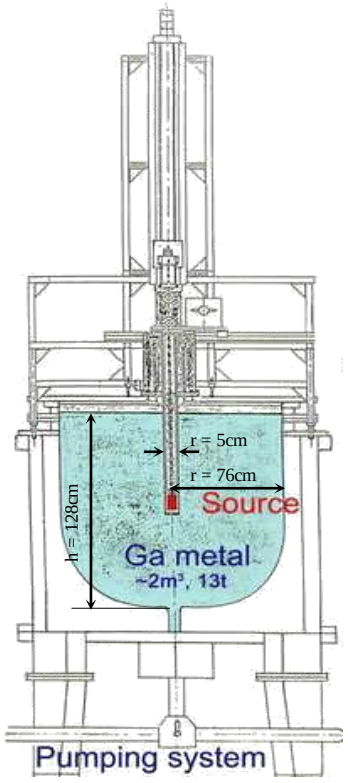
SAGE (Russia)



Homestake (USA)

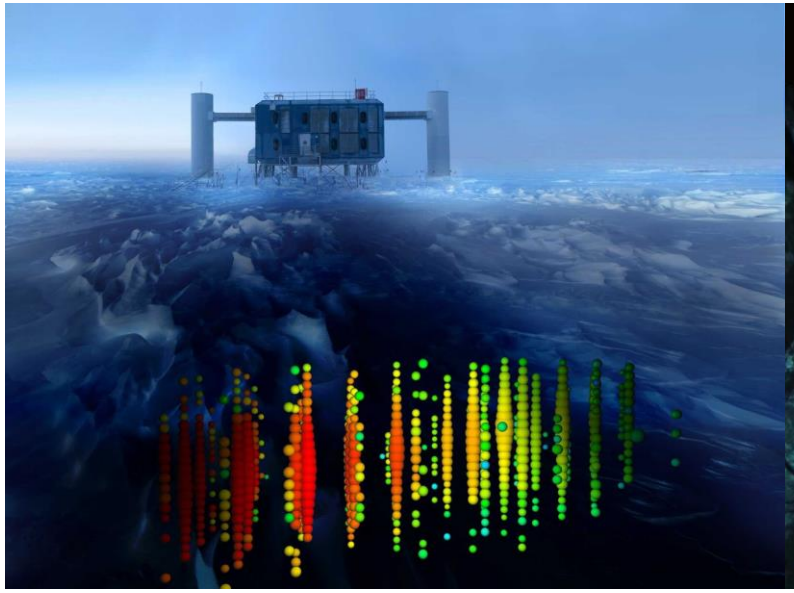


Baikal-GVD (Russia)

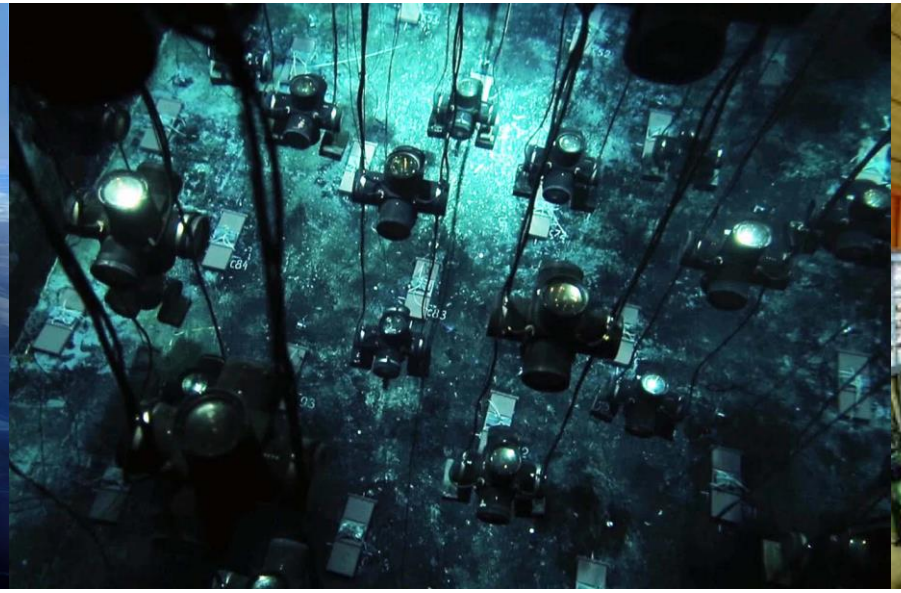


GALLEX (Italy)

GENERAL APPROACH TO DETECTION



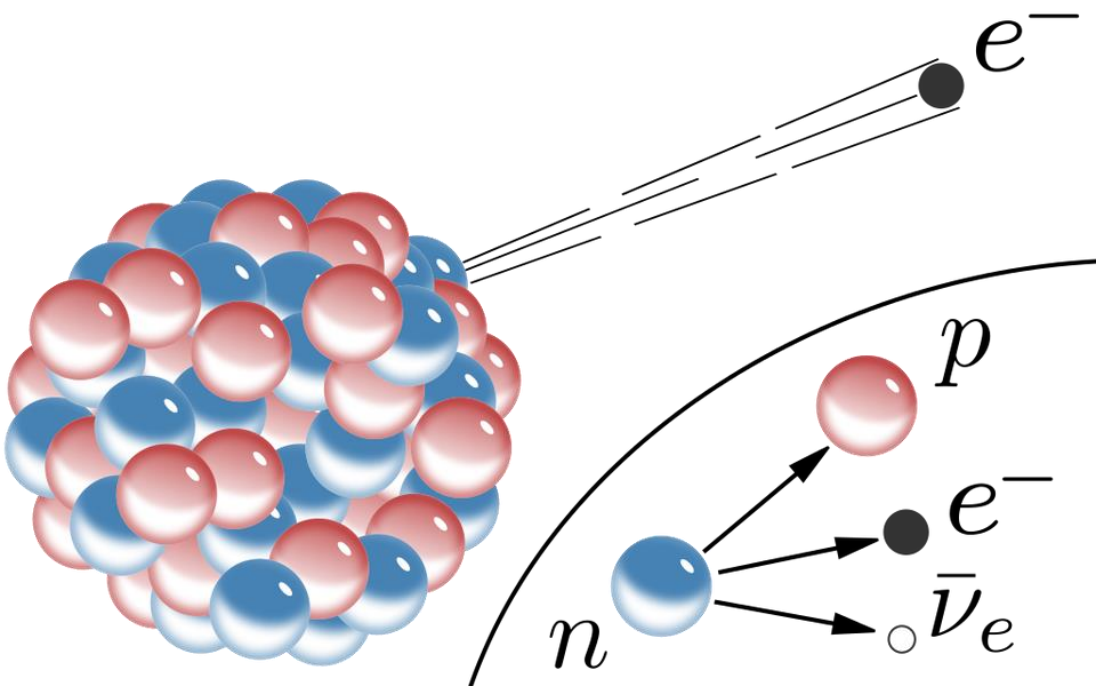
IceCube (Antarctica)



NEVOD (Russia, MEPhI)

LVD (Italy)

ANTINEUTRINO REGISTRATION



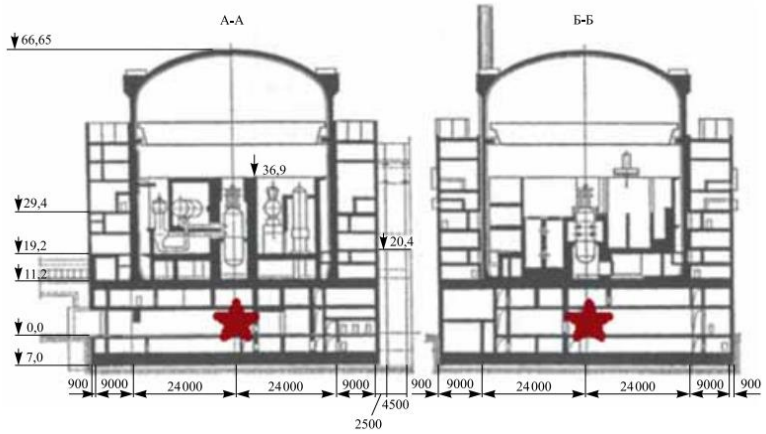
$$n^0 \rightarrow p^+ + e^- + \bar{\nu}_e$$

neutron **proton** **electron** **antineutrino**

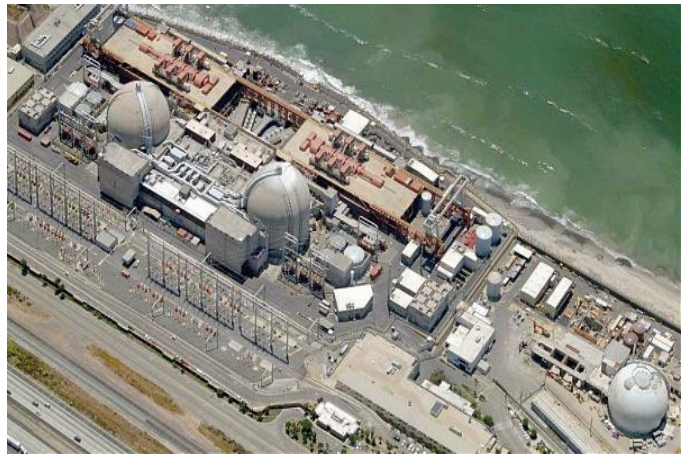
ANTINEUTRINO REGISTRATION

ANGRA (Brazil)

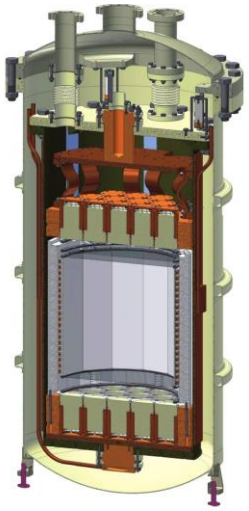
Nucifer(Osiris), (France)



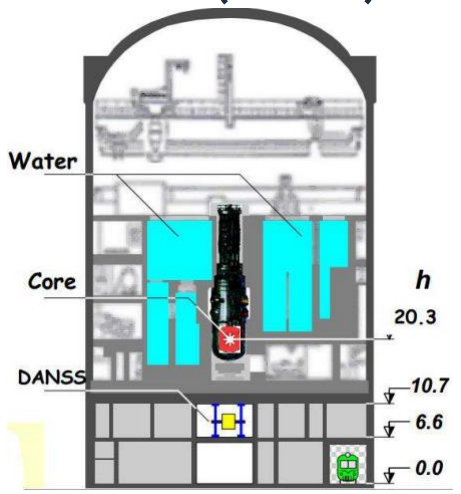
iDream (Russia)



SONGS (USA)



RED-100 (Russia, MEPhI)



DANSS (Russia)

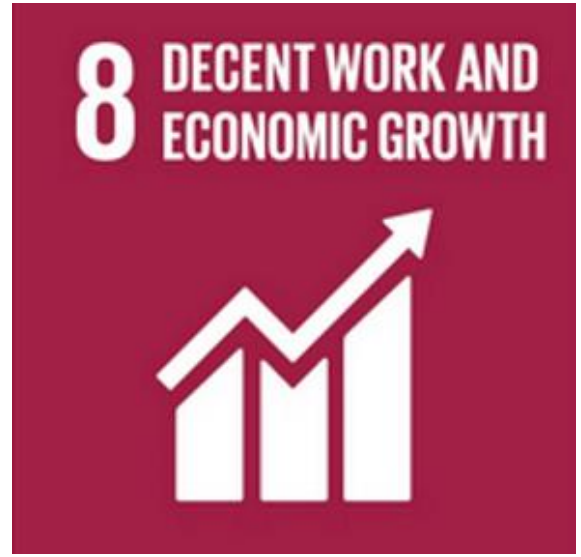
COMPARATIVE CHARACTERISTIC

	IBD	CEvNS
Example	SONGS	RED-100
Volume	1 m^3	0,25 m^3
Number of interactions	n	10n

CONCLUSION

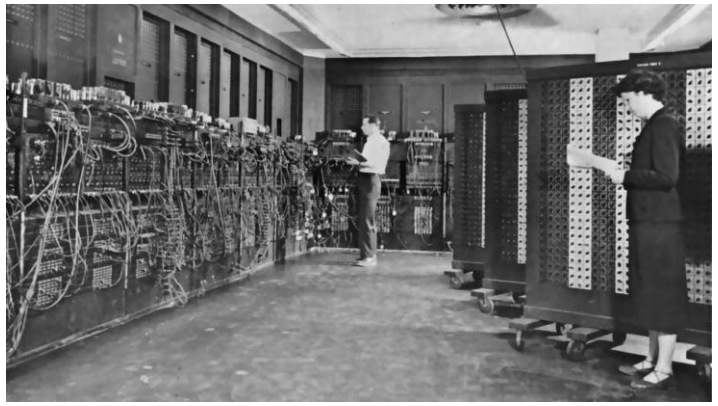
Promote to the process of disarmament, building a peaceful and inclusive society

SUSTAINABLE DEVELOPMENT GOALS



Promote job creation and full employment in knowledge-intensive industries

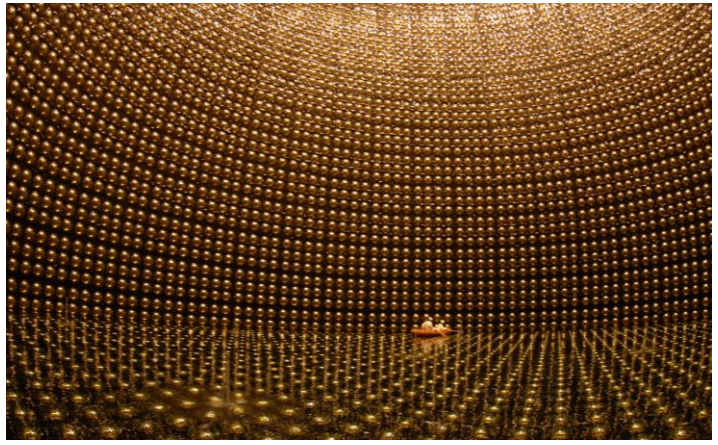
CONCLUSION



The first computer

In 2000th

Now



Super-Kamiokande

RED-100

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THANK YOU FOR YOUR ATTENTION

QUESTIONS

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