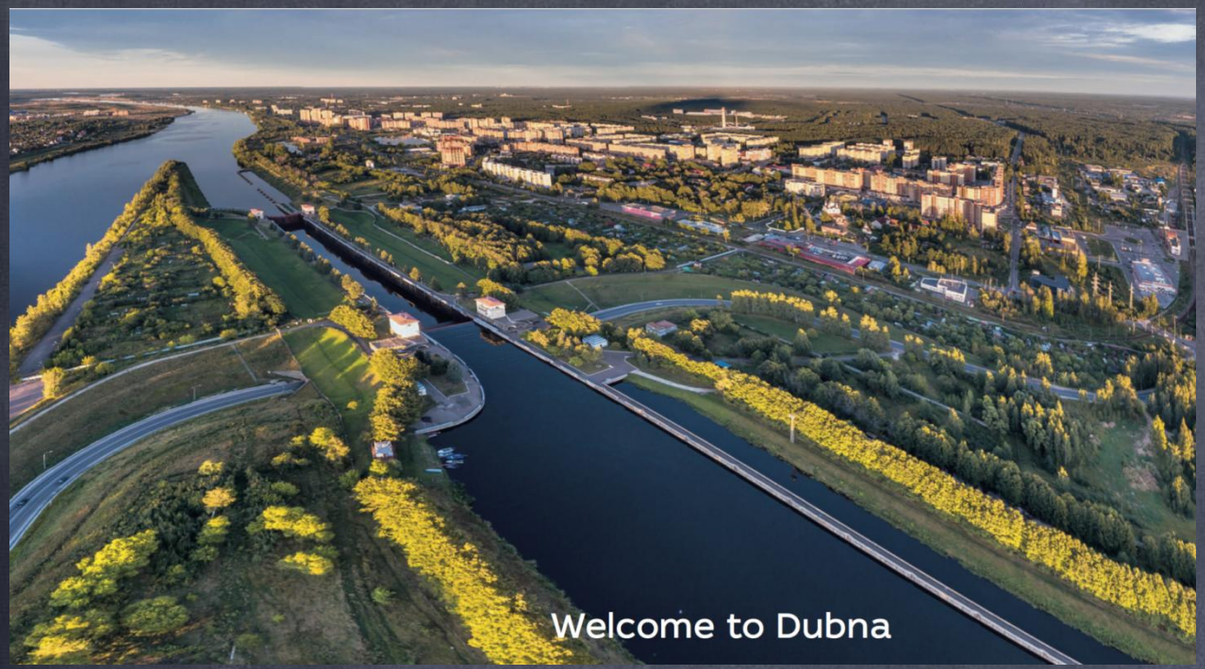
Dzhelepov Laboratory of Nuclear Problems

Dmitry V.Naumov
Presented by O.Smirnov

Dubna


Welcome to Dubna


ГОСУДАРСТВЕННЫЙ
УНИВЕРСИТЕТ
ПРИРОДЫ
ОБЩЕСТВА
ЧЕЛОВЕКА
ВАС ПРИВЕТСТВУЕТ
ГОСУДАРСТВЕННЫЙ
УНИВЕРСИТЕТ
"ДУБНА"!

JINR

- New elements 102, {103, 104, **105(Db)**, 107}, 114, 115, 116, 117, 118 are synthesized
- Hypothesis of neutrino oscillations (1957г.)
- New particles: anti-sigma-minus hyperon
- And many other discoveries

JINR

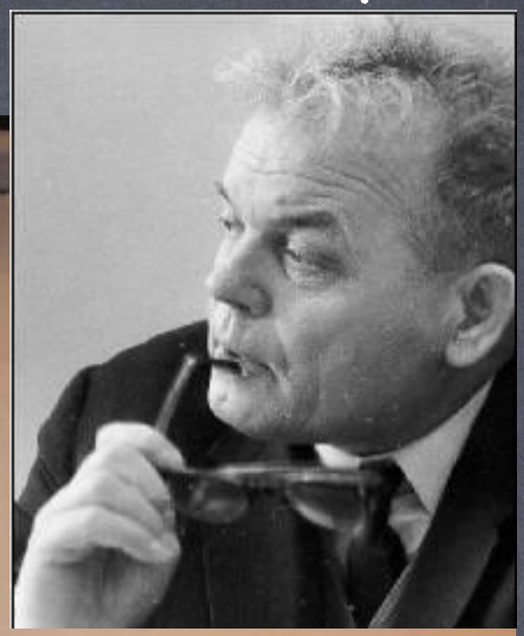
- Employed ~ **5000**: 1200 - scientists, 2000 - engineers
- **7 labs**. Each lab is as a big research institute
- **18 member-states and** 6 associated members
- **1500 scientific publications**
- Collaboration with **700 scientific centers and universities in** 64 countries
- Expected budget in 2017-2023 **1, 472 billion USD**

History

- **May, 7 1946. First discussion of «construction of a power cyclotron» at special committee of the government**
- **18 August 1946.** Soviet government approved the proposal of Academician Igor Kurchatov to construct in USSR „the installation M” for fundamental studies in nuclear physics.
- **14 December 1949.** The 480 MeV proton synchrocyclotron started operation at the Hydrotechnical Laboratory in Dubna, the most powerful accelerator in the world at that time.
- **26 March 1956.** Laboratory of Nuclear Problems of JINR has been founded.

Synchrocyclotron 680 MeV (1953)

M.G.Meshcheryakov



Discoveries

- Half of discoveries (37) in physics recorded in Soviet Union belongs to JINR
- 15 of these belongs to LNP
- Nowadays DLNP researchers are also awarded for important discoveries.

Discoveries → New Technologies→ Discoveries

LNP a laboratory with largest diversity → origin of most of laboratories in JINR

Institute of Nuclear Problems (now DLNP) + Electrophysical laboratory (now LHEP) → JINR

Structure of DLNP

- Particle Physics
- Accelerator Technologies
- Neutrino Physics & Astrophysics
- Radiation Medicine, Genetics, Molecular Genetics
- Radiochemistry & Nuclear Spectroscopy
- IT, design office, workshop, services, etc
- Education & Outreach
- about 650 employees
- among them about 500 scientific staff

SCEINCE & TECHNOLOGIES

Particle Physics

- ATLAS
- Mu2e, g-2
- COMET
- BES-III
- PANDA

Neutrino Physics & Astrophysics

- BAIKAL GVD
- Daya Bay/JUNO
- NOVA
- BOREXINO
- GERDA
- GEMMA/vGEN
- SuperNEMO
- TUS/Nucleon/TAIGA
- EDELWEISS

Technologies

- Precise Laser Metrology
- New semiconductor detectors
- Ultra cold temperatures

SCEINCE & TECHNOLOGIES

Medicine & Molecular Genetics

- Proton Therapy
- Medical-biological studies
- Radiation genetics

Education & Outreach

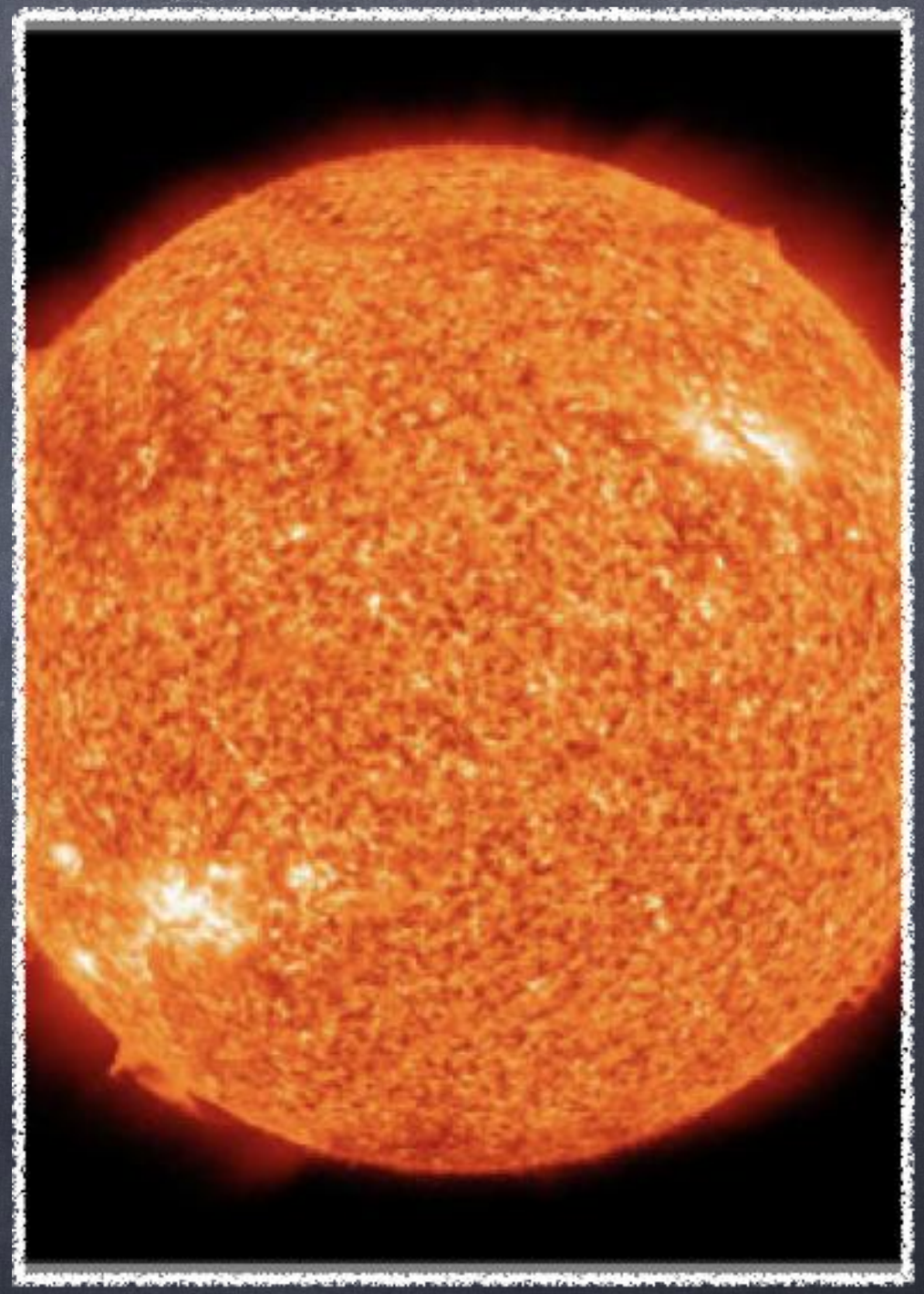
- Schools, conference, seminars
- Web-site of DLNP, social networks
- Lecturing at MSU, MIPT, «Dubna» University and others

Bruno Pontecorvo worked in JINR (1950-1993) establishing a School of Neutrino Physics

Why neutrino is an important particle?

$$p + p \rightarrow d + e^+ + \nu_e$$

Spin: $\underbrace{\frac{1}{2} + \frac{1}{2}}_{\text{even}} \rightarrow \underbrace{1 + \frac{1}{2} + \frac{1}{2}}_{\text{even}}$



Why neutrino is an important particle?

$$p + p \nrightarrow d + e^+$$

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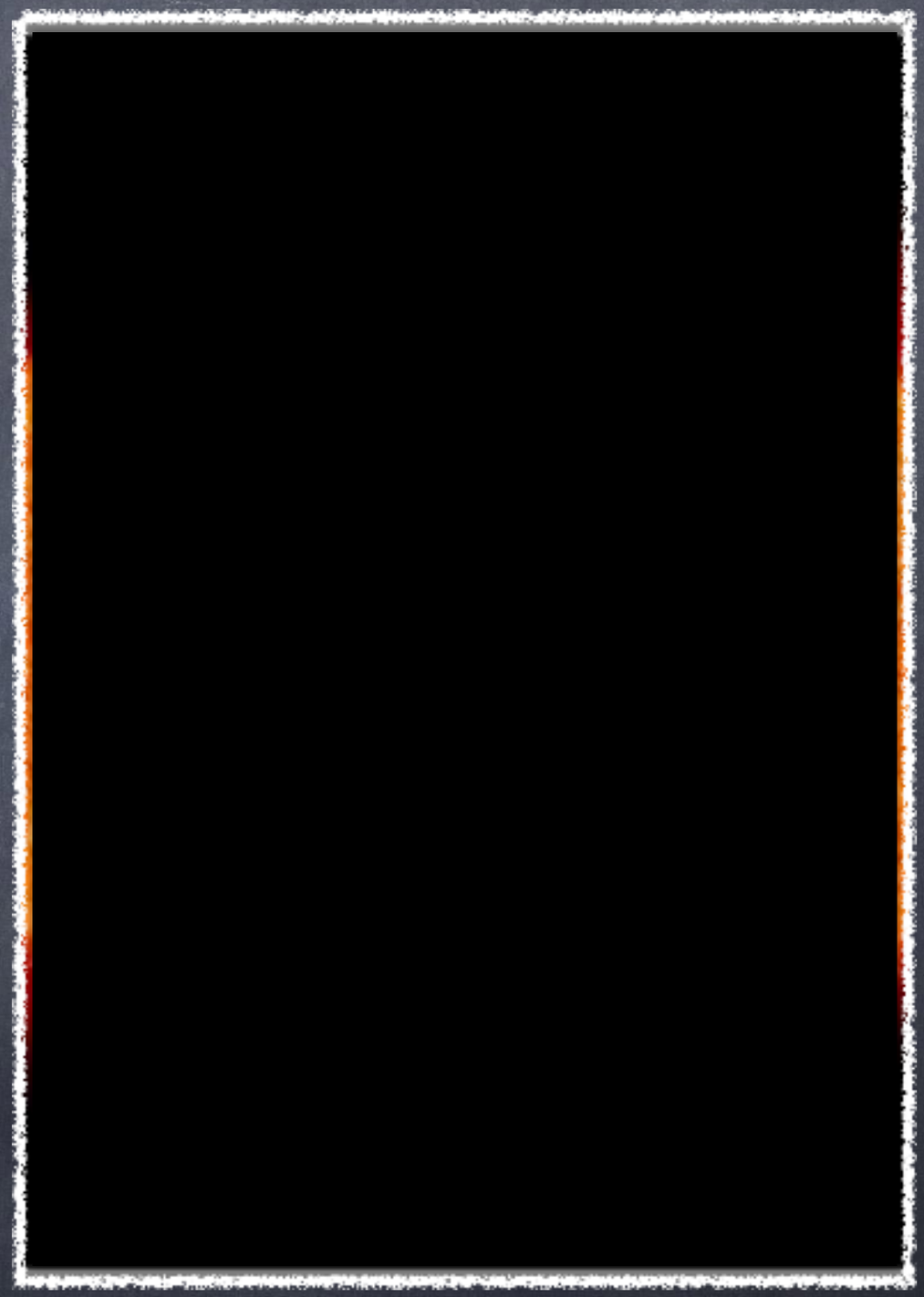


Nobel Prizes for Neutrino Physics

- 1988 (Leon M. Lederman, Melvin Schwartz and Jack Steinberger). Discovery of muon neutrino.

- 1995 (Frederick Reines). Discovery of electron antineutrino

- 2002 (Raymond Davis, Jr. и Masatoshi Koshiba). SN 1987A.

- 2015 (Takaaki Kajita and Arthur B. McDonald). Discovery of neutrino oscillations.

Breakthrough Prize for Neutrino Physics - 2015

BREAKTHROUGH PRIZE | **FUNDAMENTAL PHYSICS**

THE 2016 BREAKTHROUGH PRIZE IN FUNDAMENTAL PHYSICS IS AWARDED TO

Maxim Gonchar

AND COLLEAGUES AT DAYA BAY, KAMLAND, K2K & T2K,
SUDBURY NEUTRINO OBSERVATORY AND SUPER-KAMIOKANDE

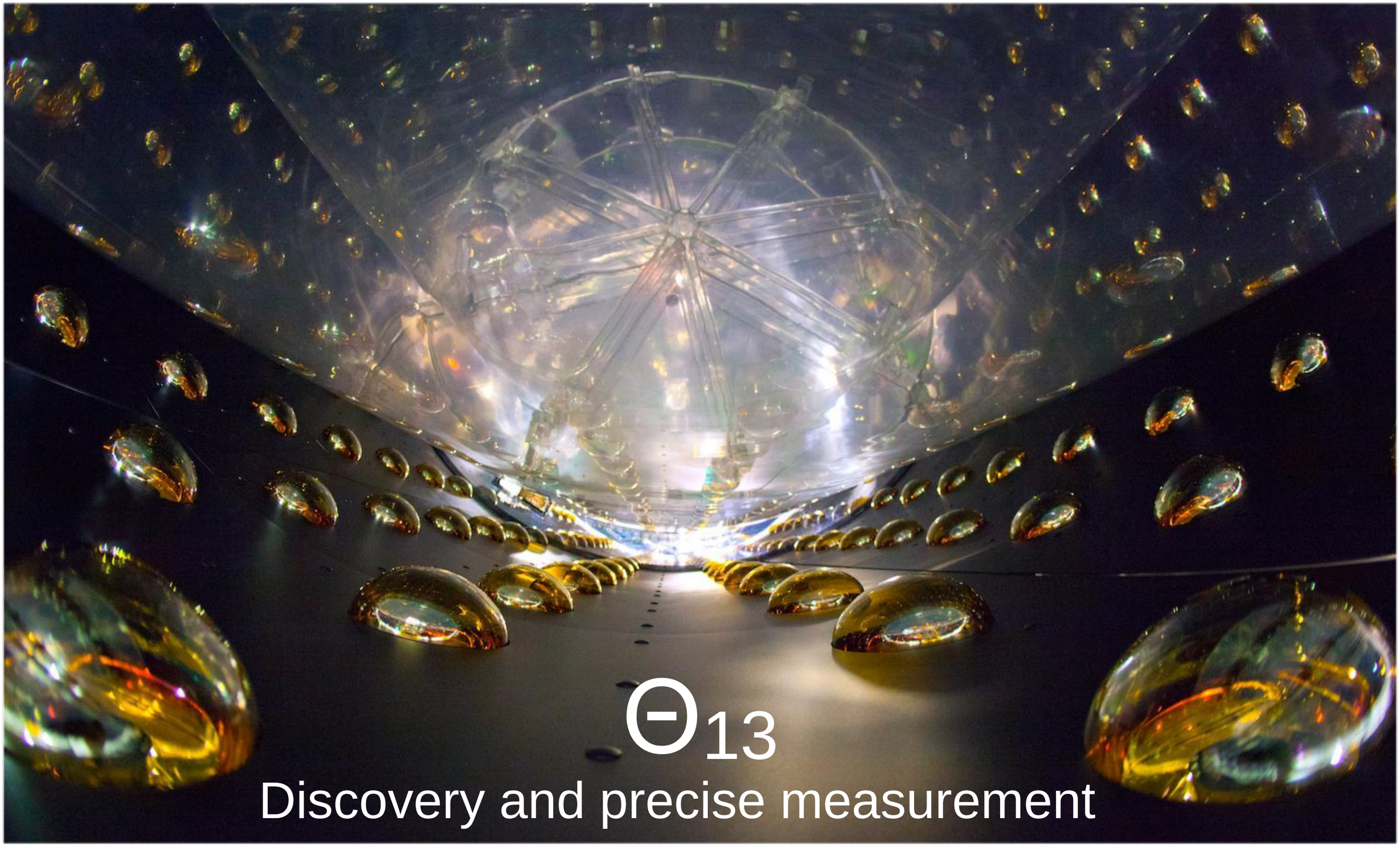
For the fundamental discovery and exploration of neutrino oscillations, revealing a new frontier beyond, and possibly far beyond, the standard model of particle physics.

NOVEMBER 8, 2015

Karl Johansson
Director
Breakthrough Prize Foundation

Neutrino Physics

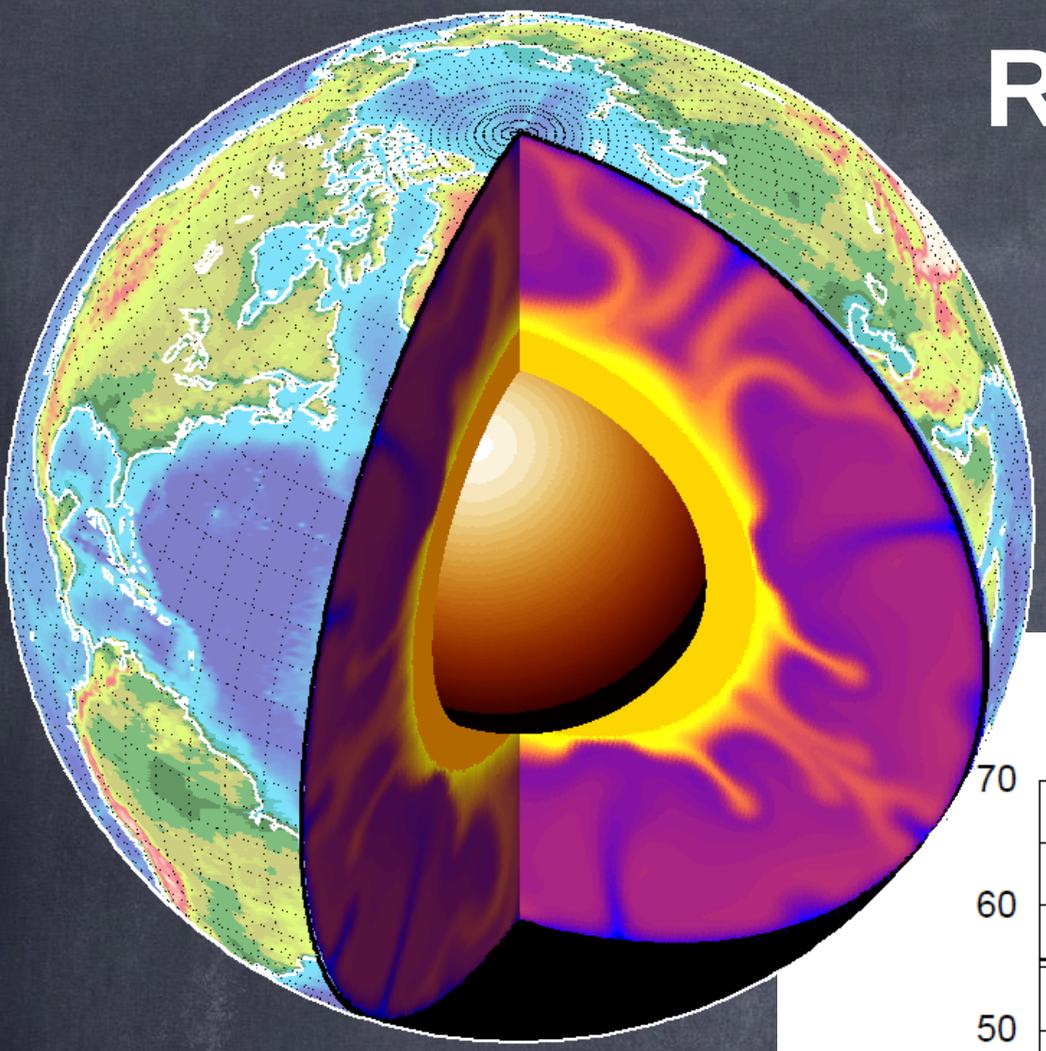
Daya Bay experiment

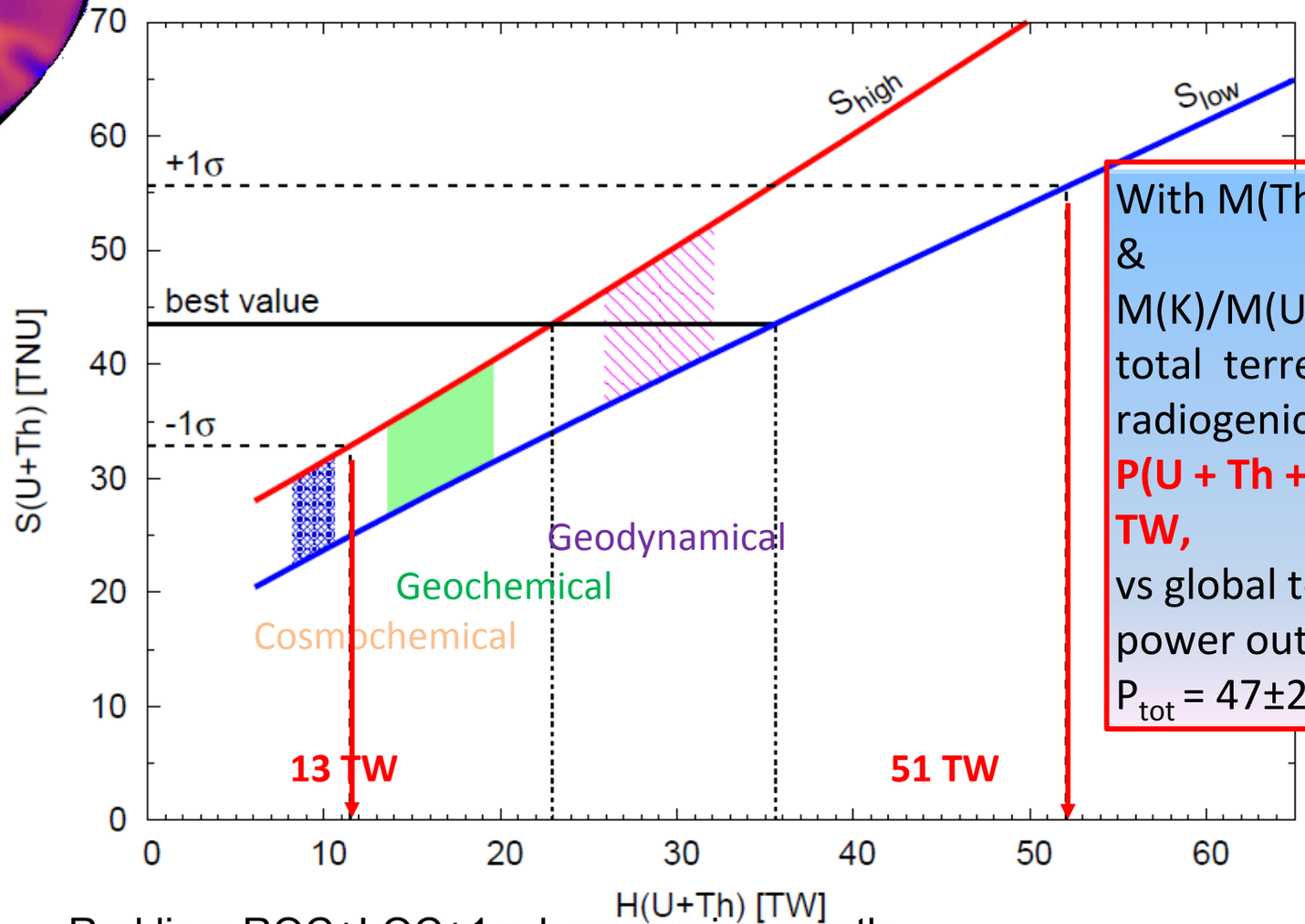


Θ_{13}

Discovery and precise measurement

Radiogenic heat: Borexino





With M(Th)/M(U)=3.9
&
M(K)/M(U) = 10^4 the total terrestrial radiogenic power :
$P(U + Th + K) = 33^{+28}_{-20}$ TW,
vs global terrestrial power output
P_{tot} = 47±2 TW

Red line: ROC+LOC+1σ, homogenios mantle
Blue line: ROC+LOC-1σ, radiogenic material on the mantle/core interface

Neutrino experiments at the Kalinin NPP

- **Pressurised Water Reactor (ВВЭР-1000)**
- **Thermal Power: 3 100 MW**
- **Core: ∅ 3.20 m × *h* 3.70 m**
- **Fuel (70 ton): ^{238}U + ^{235}U** (3.3-5.5%)
- **Neutrino Flux: $\sim 6\times10^{20}\ \overline{\nu_e}$ / 4π / day**
- **Campaign: 18 months + recharge (50 days)**
- **1100 kg of ^{235}U is burned out**
- **200 kg of ^{239}Pu is produced**
- **which changes neutrino flux and spectrum**

(Tver region, 285 km NW from Dubna)

GEMMA
(Neutrino Magnetic Moment)

νGeN
(Coherent ν-Ge scattering)

DANSS
(reactor monitoring and search for sterile neutrino oscillations)

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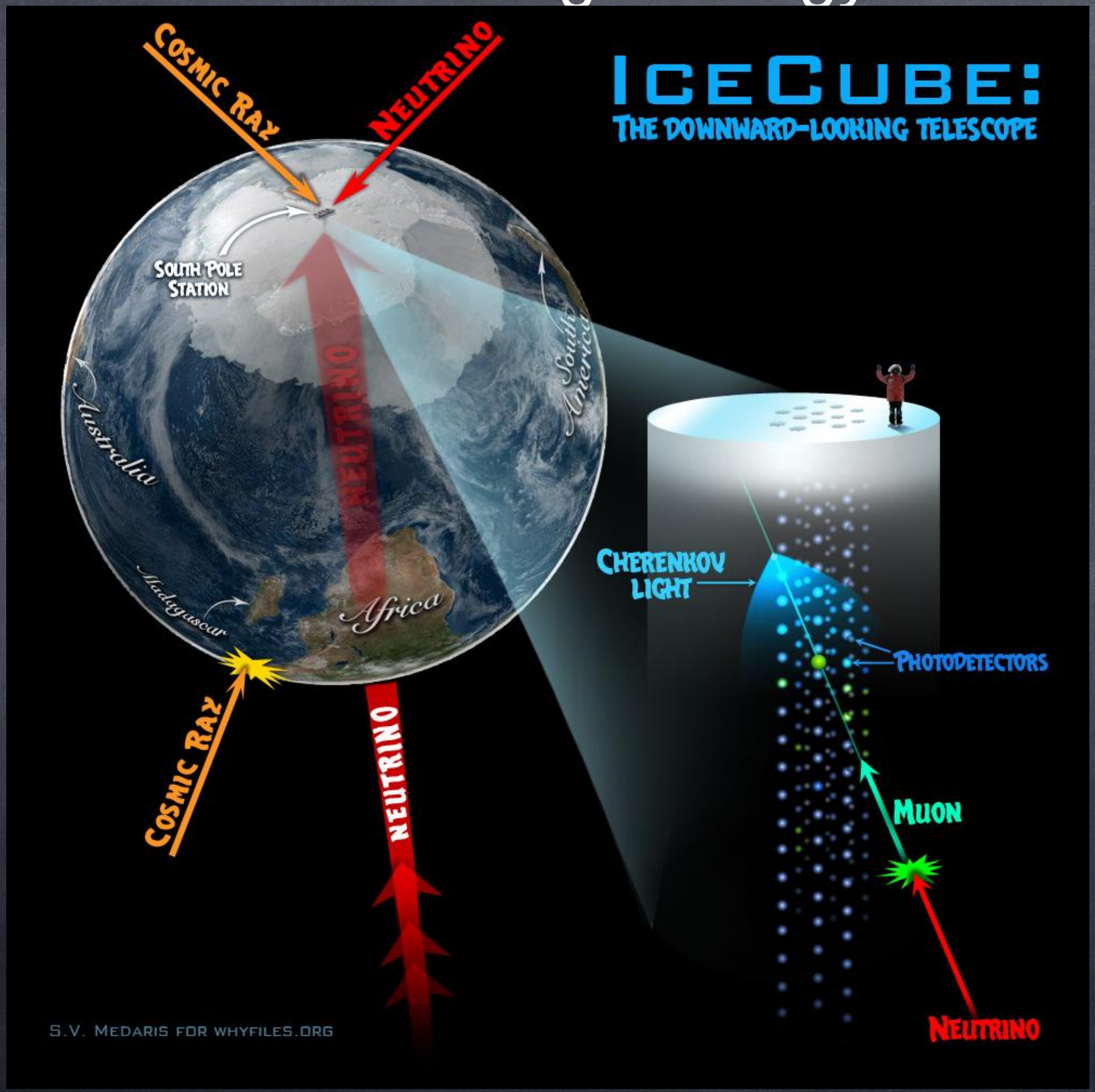
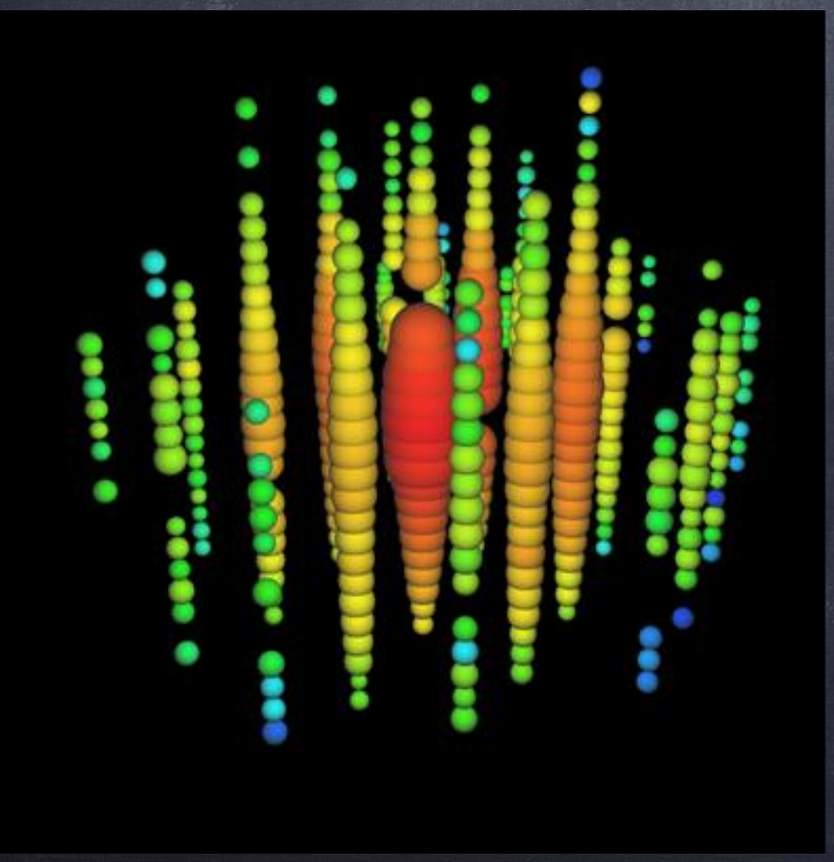
Astrophysical sources
BAIKAL GVD

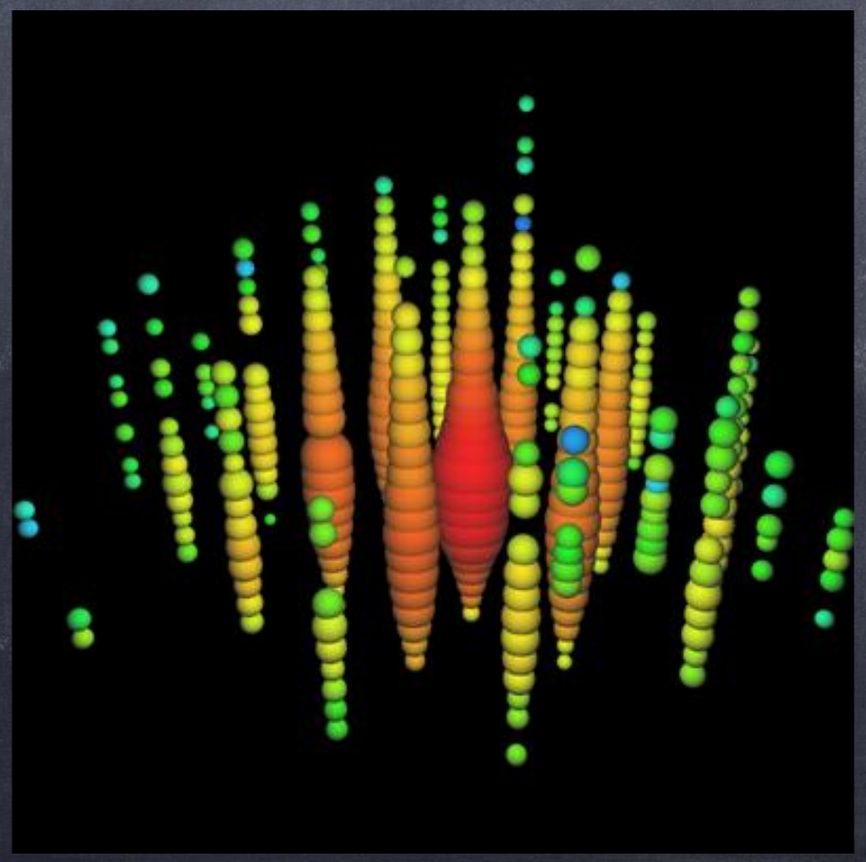
Detection of ultra-high energy neutrinos

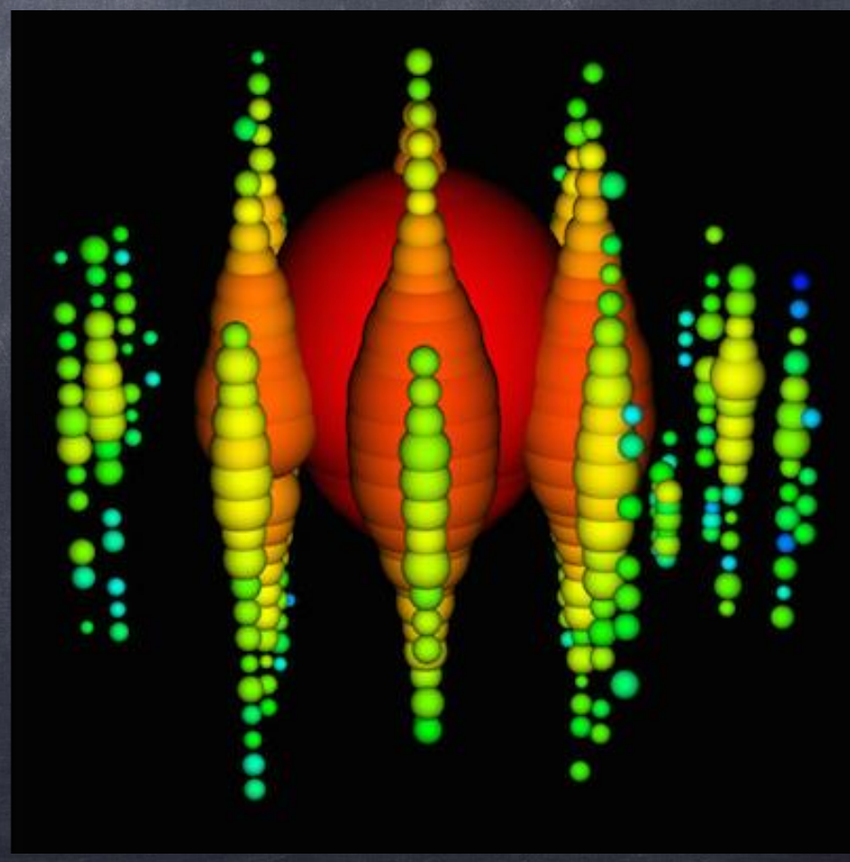


Astrophysical neutrinos of Ultra High Energies (UHE) do exist (IceCube)

- Bert, Ernie, Big Bird with energies 1, 1.1 and 2.2 PeV
- Followed by several dozens of less energetic but astrophysical neutrinos
- UHE Neutrino Astronomy was born





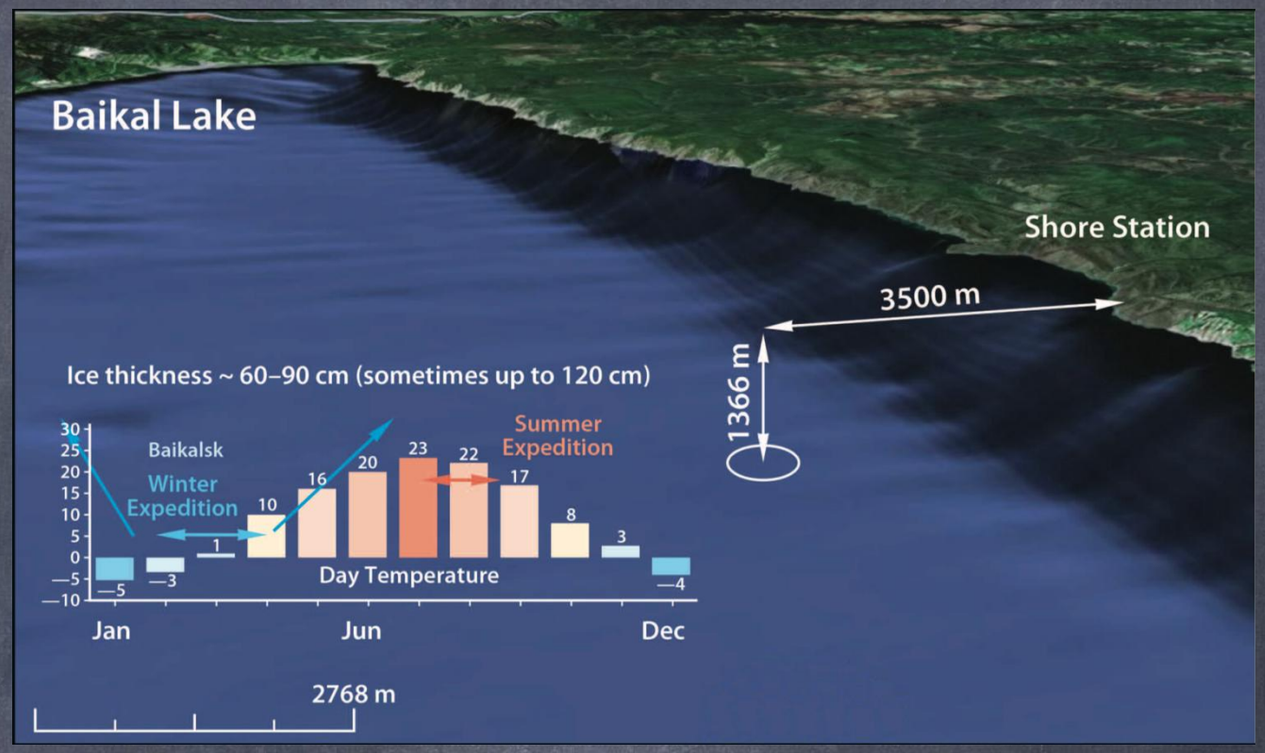


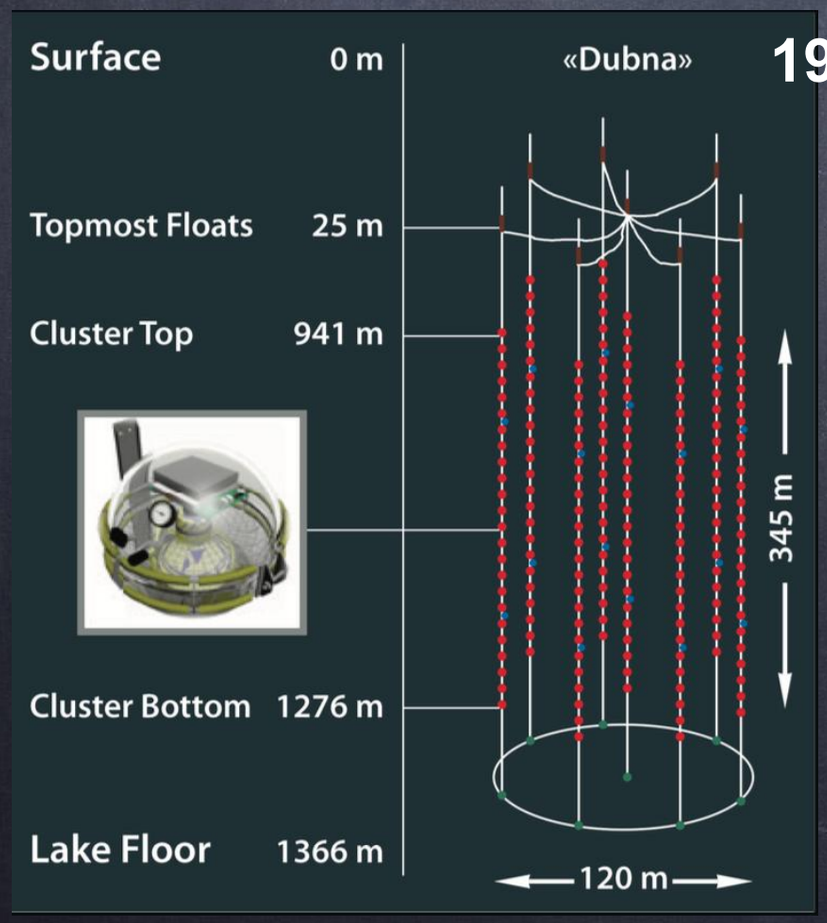
Why BAIKAL GVD?

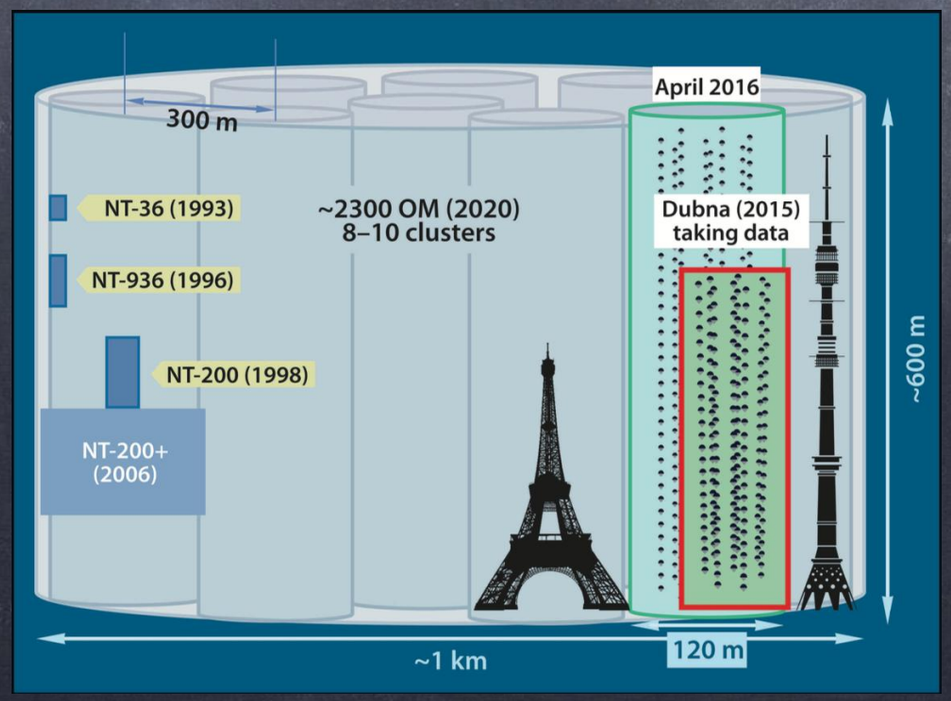
- UHE neutrinos exist. Their sources are unknown. Angular accuracy does not allow yet to identify the sources

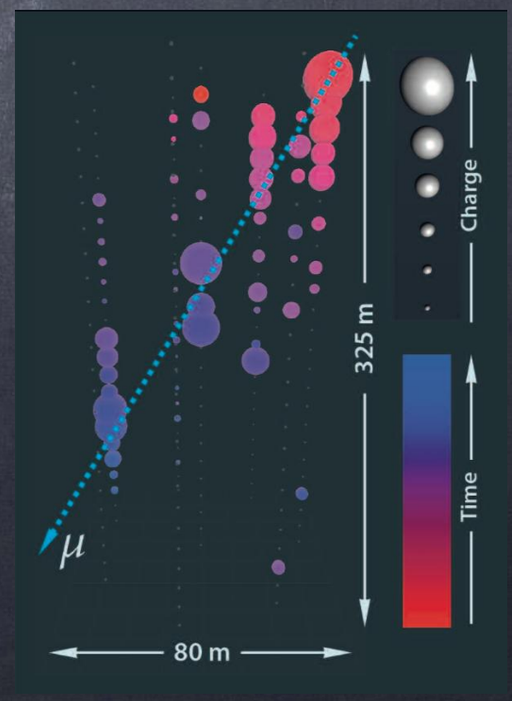
Experiment	Absorption Length, m	Scattering Length, m	Angular resolution muons	Angular resolution showers	Dark Rate, kHz
IceCube	40-150	0.4-2.4	0.5-1^o	15^o	0.3-0.6
KM3NET	50-70	30-60	0.2^o	2^o	30
BAIKAL GVD	22-25	30-50	0.3-0.5^o	2-3^o	15

BAIKAL Gigaton Volume Detector



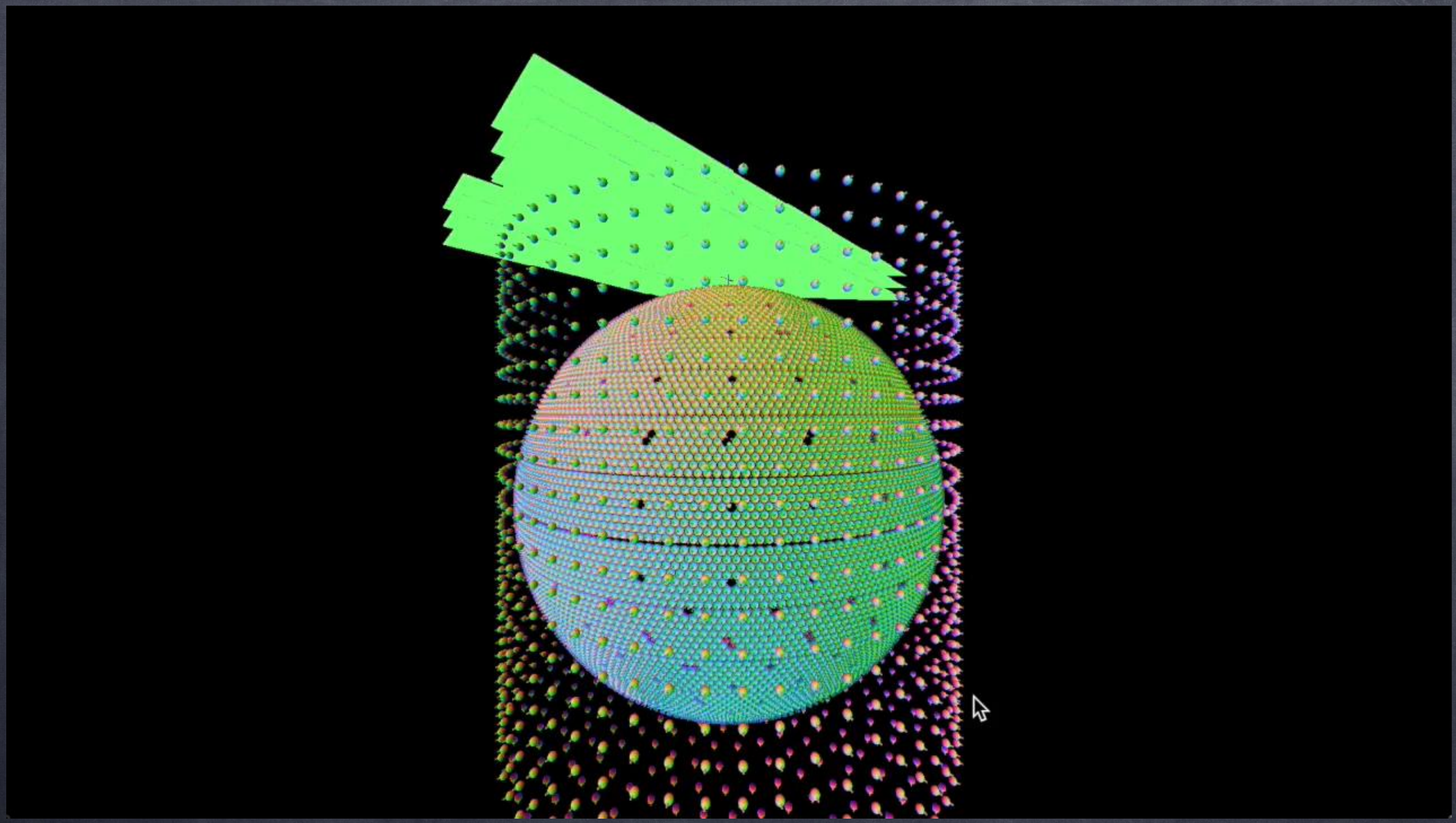






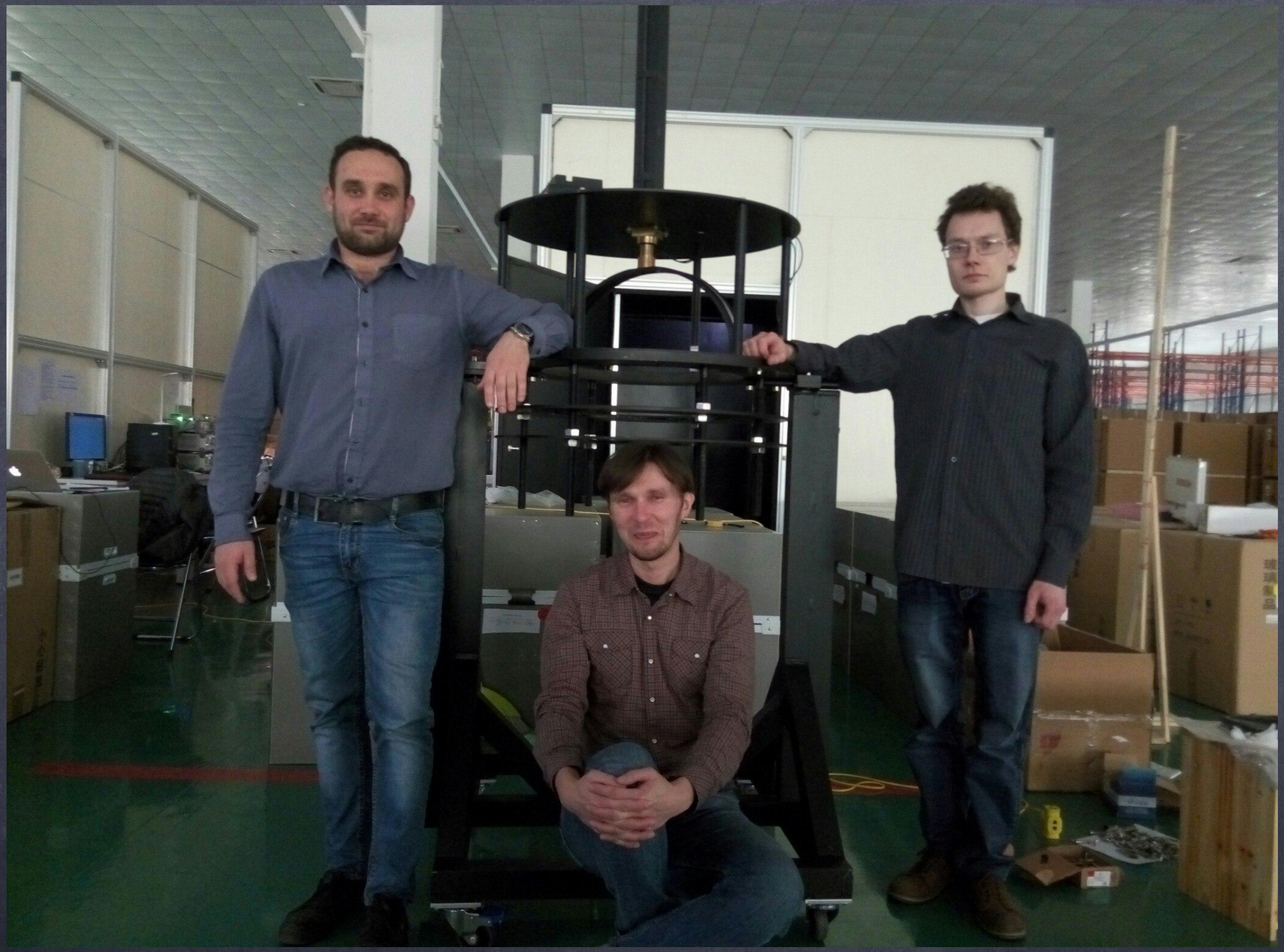
BAIKAL Gigaton Volume Detector

2018: Three clusters installed



JINR is a major foreign contributor to JUNO.

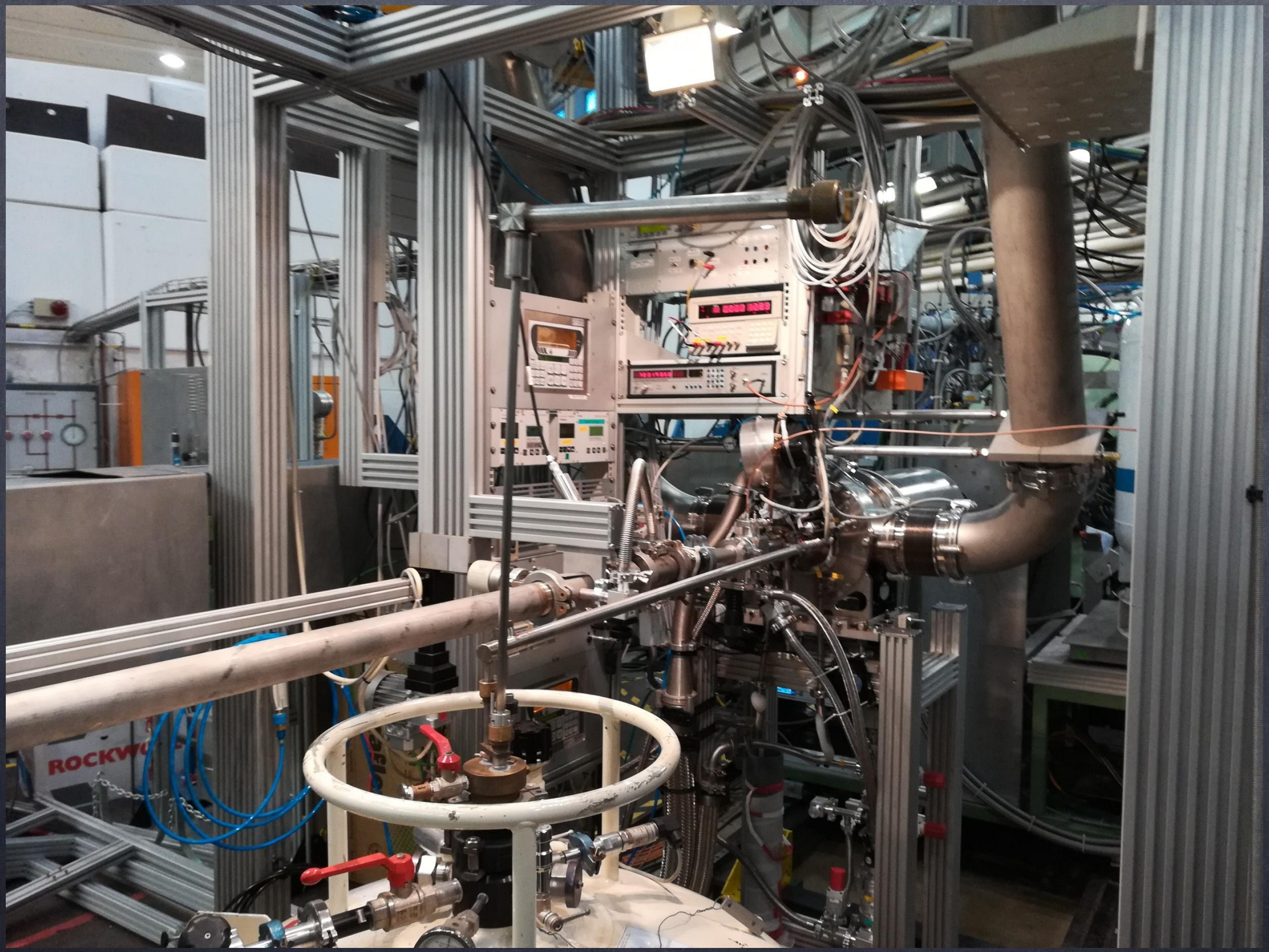
Video Credit to S.Blyth



PMT Scanning Stations

And its team

Ultracold temperatures



Education & Outreach


ПРОХОД
ЗАКРЫТ

We organize

- International Pontecorvo School on Neutrino Physics
- International Baikal Summer School on Physics of Elementary Particles and Astrophysics
- New Trends in High Energy Physics
- NANP
- Valday

Renovations