Large area photon detectors for large-scale experiments in neutrino physics

S.B. Lubsandorzhiev

Institute for Nuclear Research of RAS

Moscow, Russia

Large area photomultipliers are basic detecting elements of contemporary large-scale neutrino experiments

They are used in overwhelming majority of large-scale neutrino experiments

In some experiments – more than 10k PMTs

IceCUBE

Tunka/TAIGA

JUNO

Pierre Auger

LBNT

LHAASO

Super-Kamiokande

Antares

Hyper-Kamiokande

Double Chooz

Daya Bay

IMB

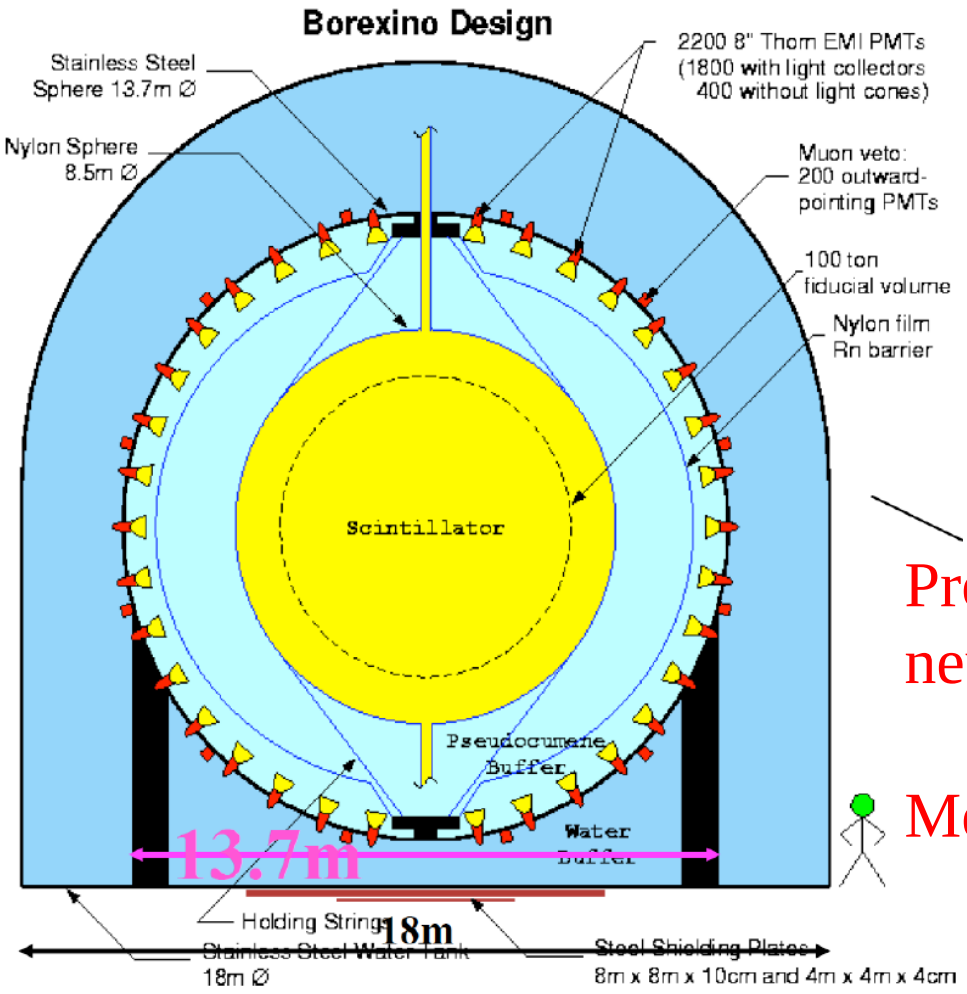
RENO

HAWC

GVD

8-inch (20 cm) PMTs

Experiment Borexino, ~2200 8” PMTs



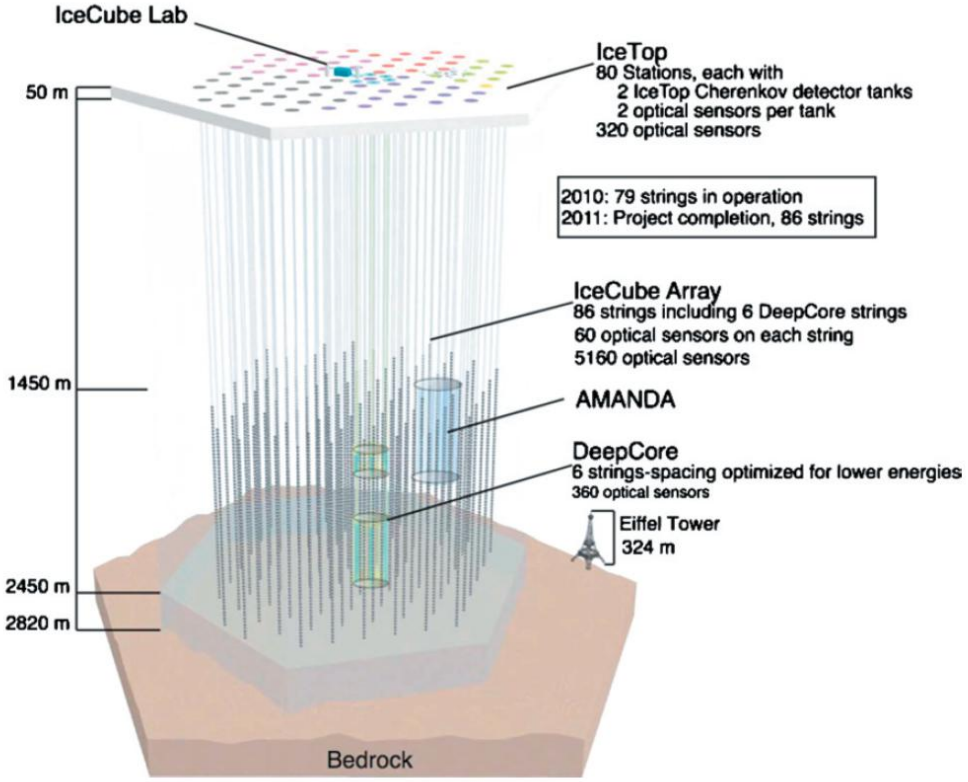
Electron Tubes ETL9351B

Precision measurements of solar neutrino fluxes;

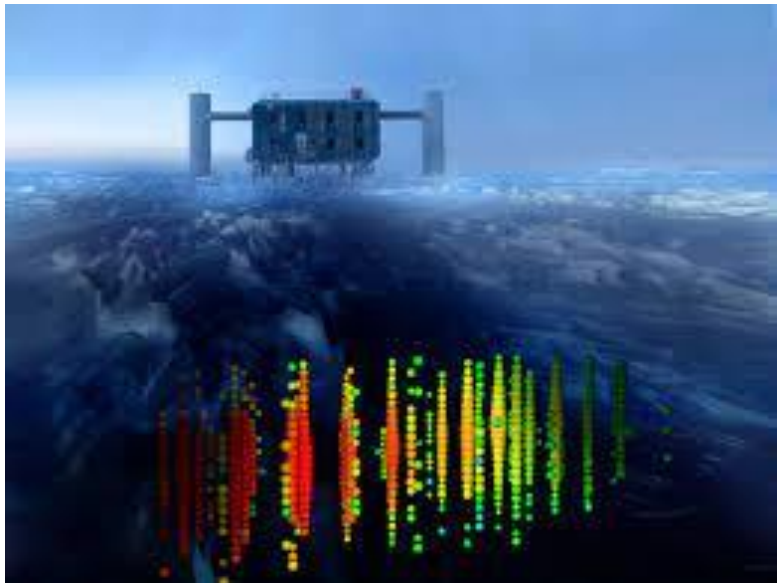
Measurements of geoneutrino flux

10-inch (25 cm) PMTs

Experiment IceCUBE, 5160 10” PMTs



Hamamatsu R7081



Starting neutrino astronomy!!!

20-inch (50 cm) PMTs

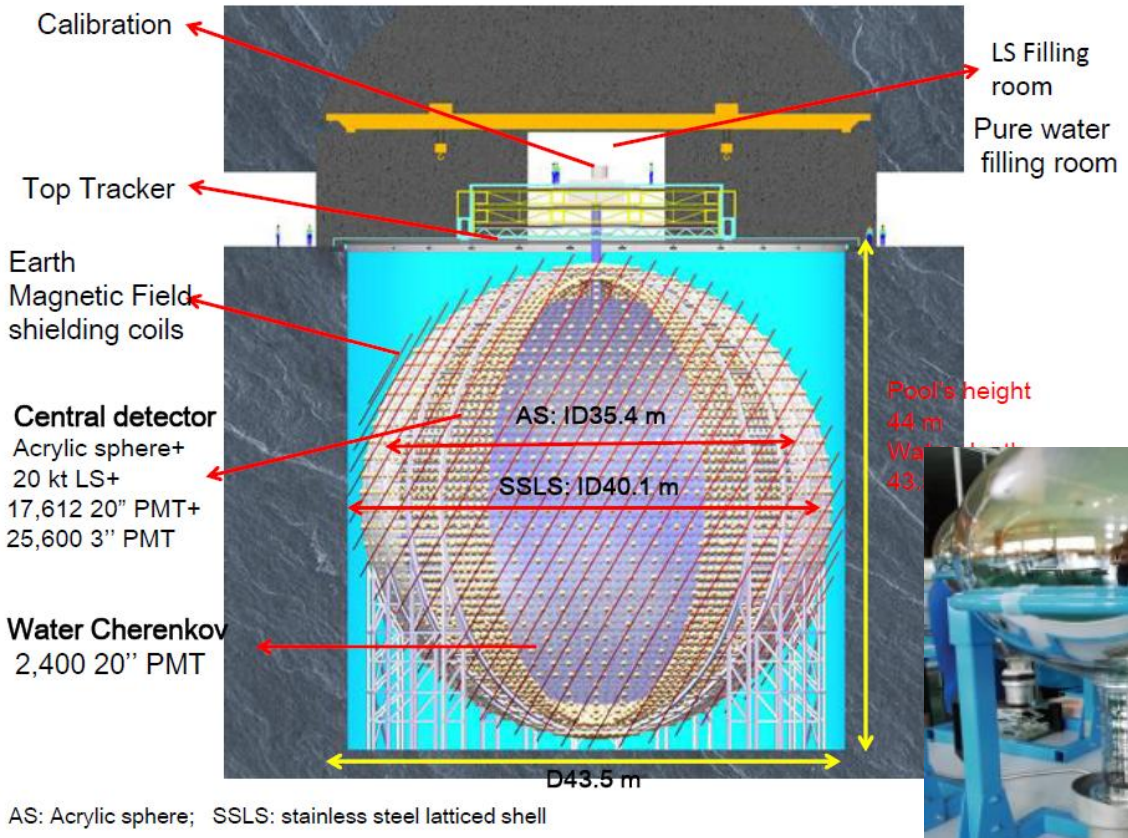
Experiment Super-Kamiokande, >11100 20” PMTs

Hamamatsu R3600

Discovery of neutrino oscillation!!!

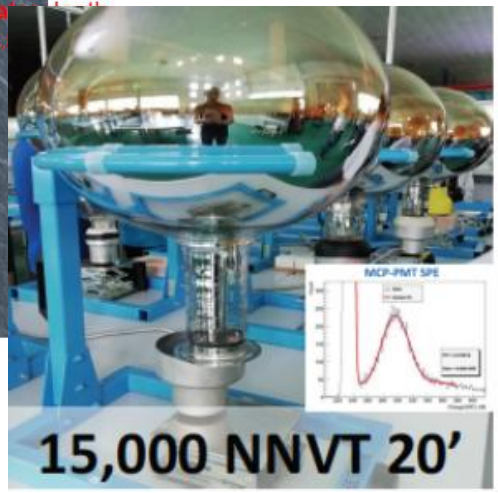
20-inch (50 cm) PMTs

Experiment JUNO, ~20k 20” PMTs



NNVT MCP-PMT

Hamamatsu R3600



Measurement neutrino mass hierarchy

Multi-PMT Optical Modules

Experiments ORCA and PINGU, >200т 3” PMTs

Hamamatsu R14374

HZC XP72B22

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Conclusion

Large area photon detectors play a key role in running and planning large-scale experiments in astroparticle physics, in neutrino physics in particular.