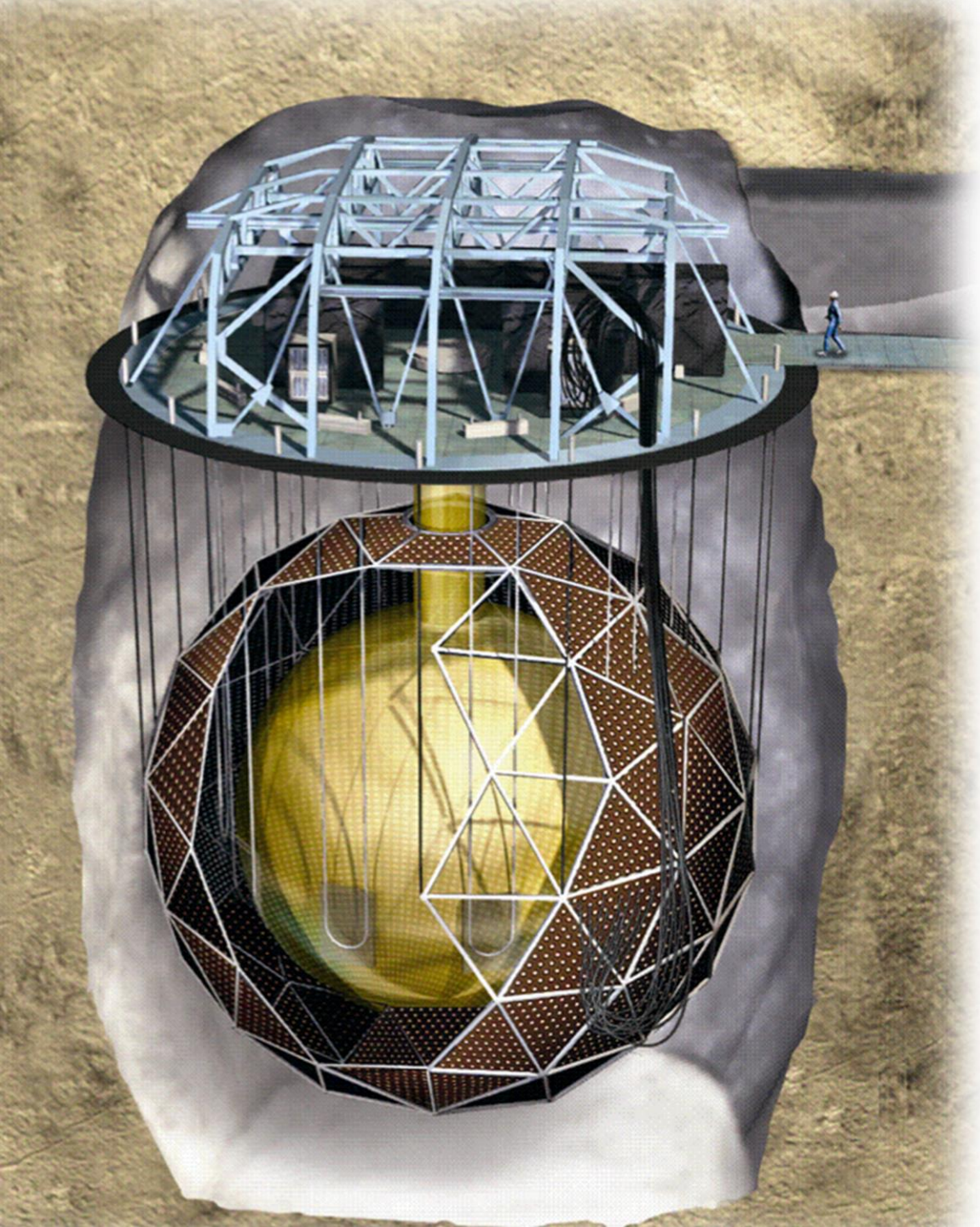
Detecting Antineutrinos Using the SNO+ Detector

PAWEL MEKARSKI

INVISIBLES17 WORKSHOP

JUNE 16, 2017



SNO+ Detector

Consists of:

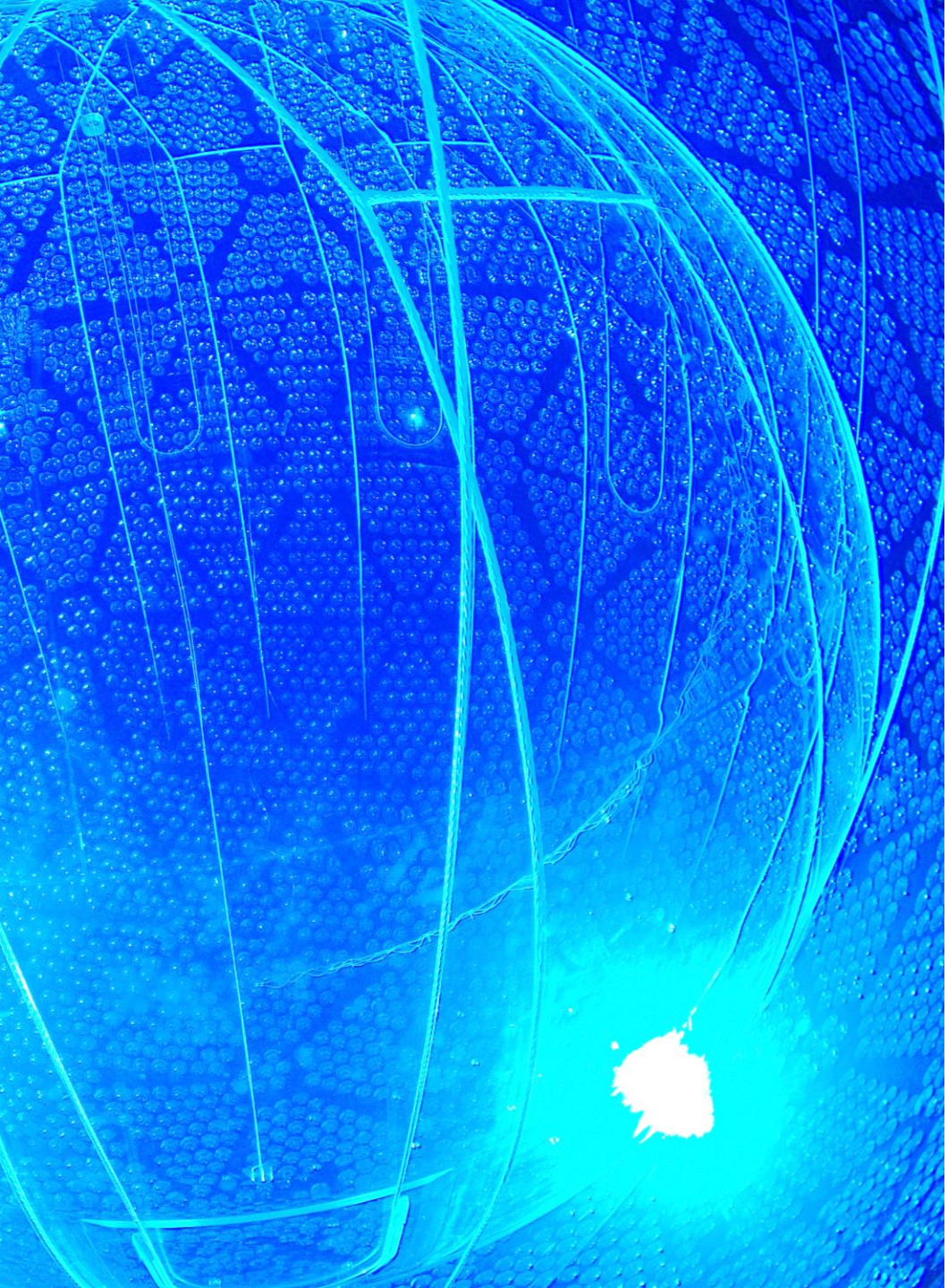
12 m diameter acrylic sphere

9300 photomultiplier tubes (PMTs)

7000 tonnes of surrounding water

Will be filled with **780 tonnes** of liquid scintillator

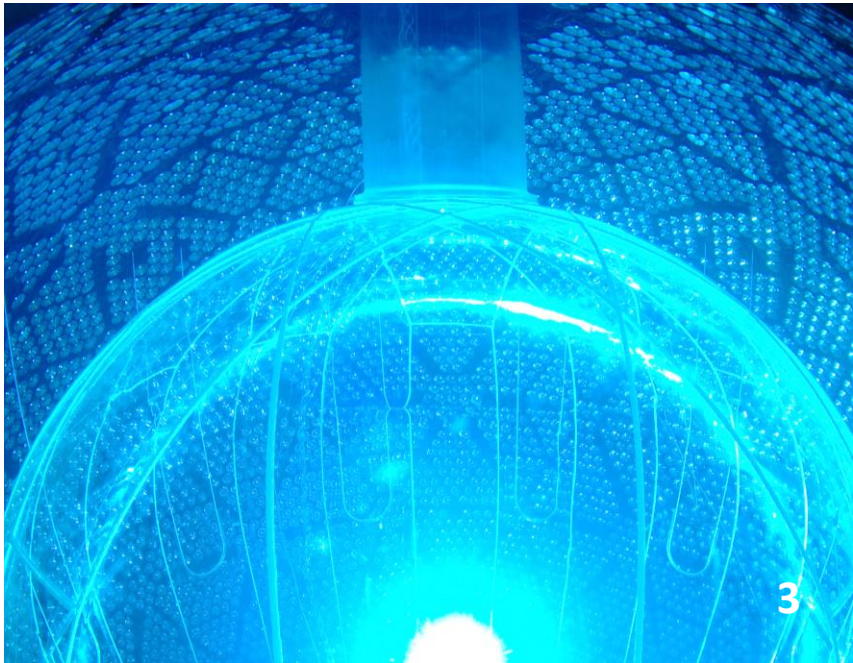
- Also **3.9 tonnes** of natural tellurium

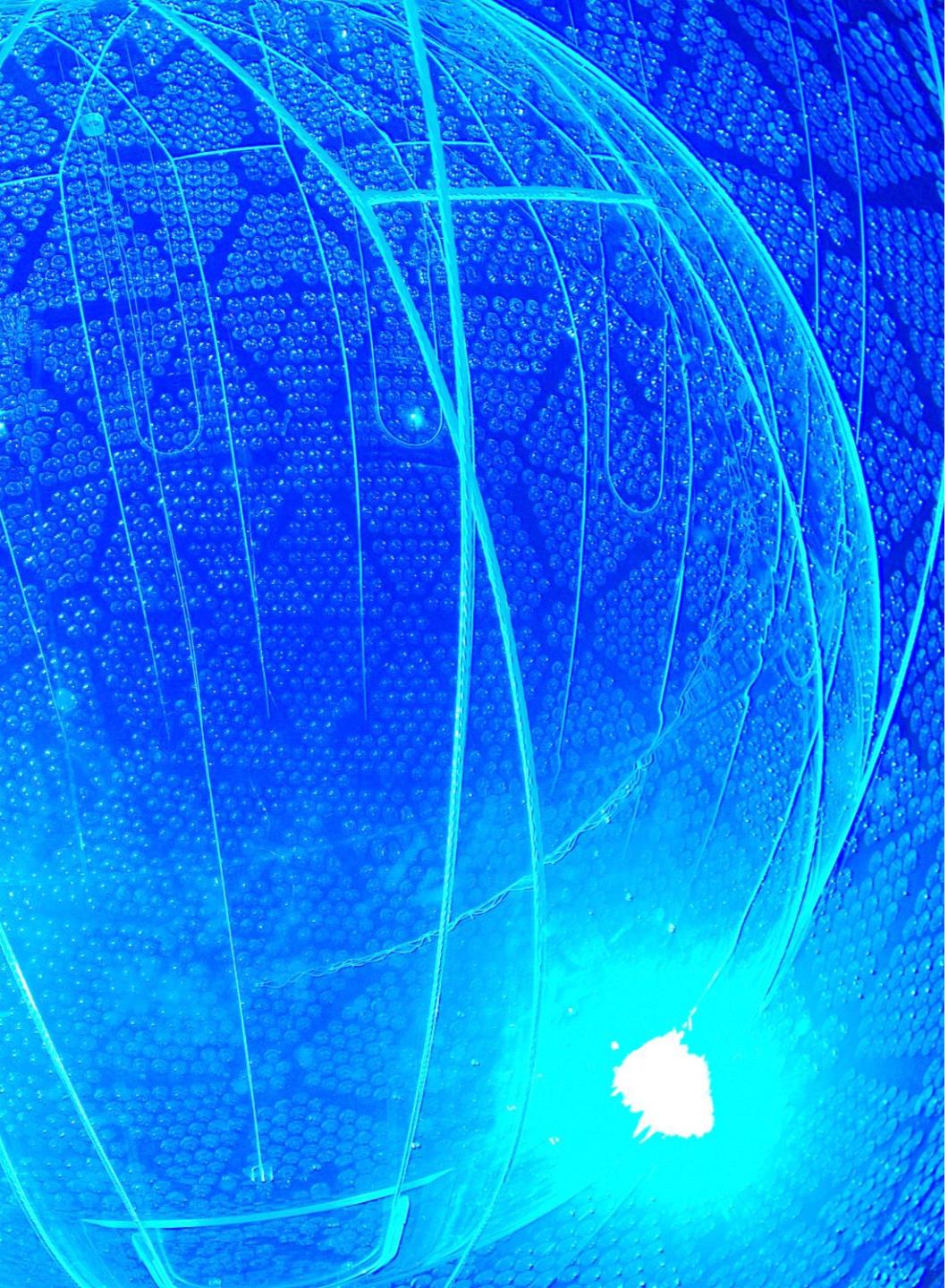


Currently…

Filled with **water**

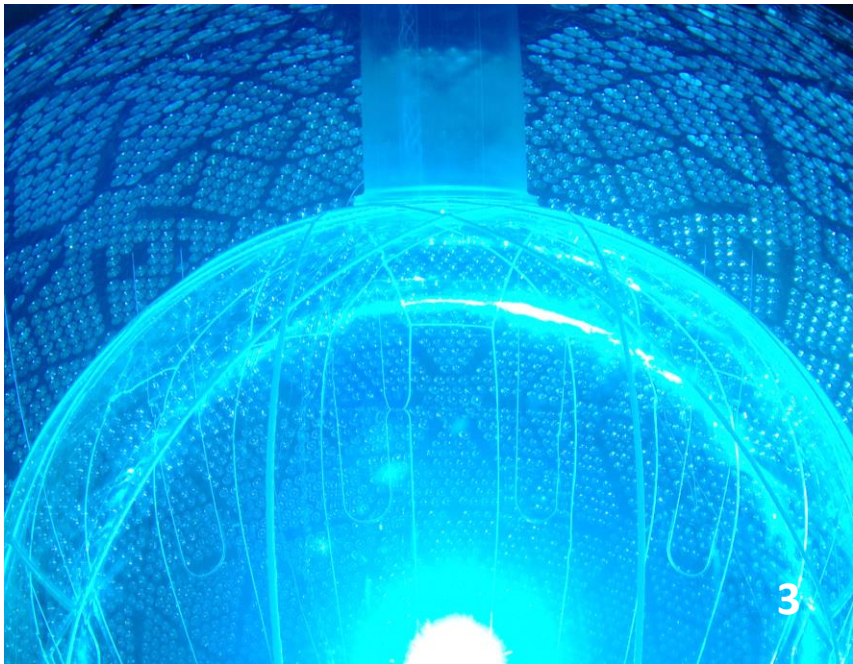
Now collecting **physics data**



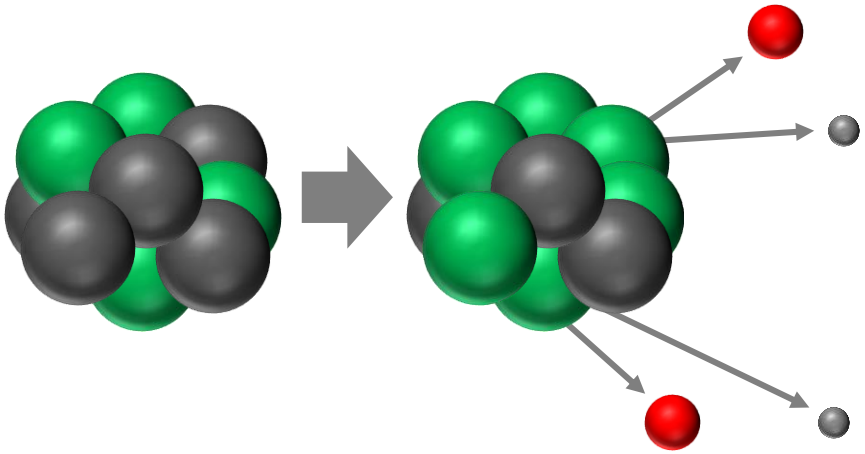


Soon…

Will be filled with
liquid scintillator
(*scheduled: Late 2017*)



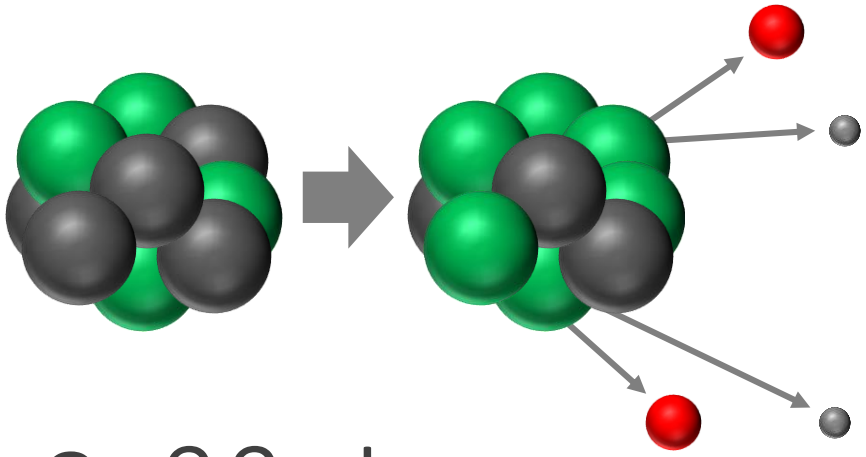
ββ decay



Small subset of radioactive isotopes **undergo double beta (ββ) decay**

Produces 2 $\mathbf{e^-}$ and 2 $\overline{\boldsymbol{\nu}}_{\mathbf{e}}$

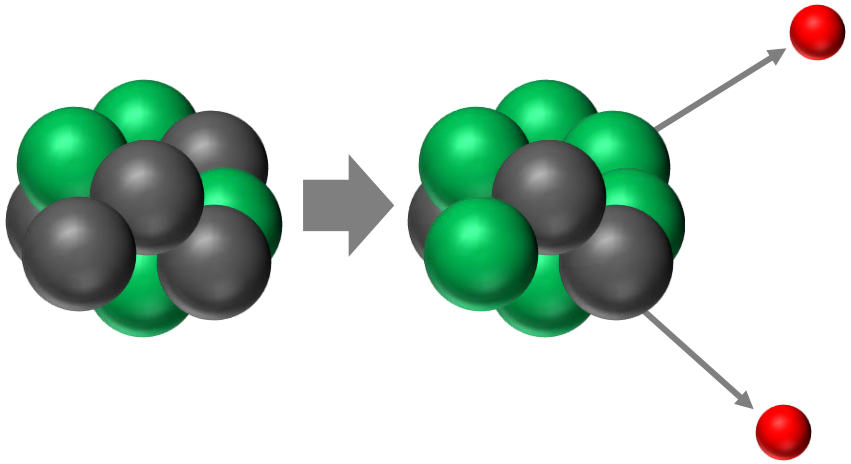
ββ decay



Small subset of radioactive isotopes **undergo double beta (ββ) decay**

Produces 2 $\mathbf{e^-}$ and 2 $\overline{\boldsymbol{\nu}}_{\mathbf{e}}$

0νββ decay

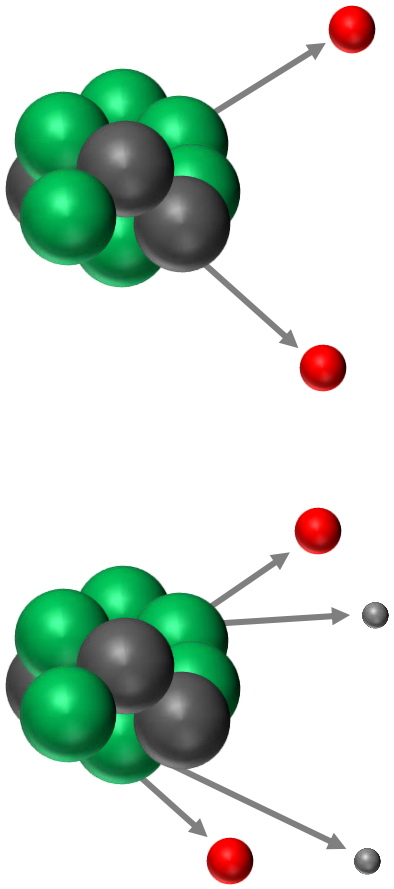


… but if the neutrino is a Majorana particle (its own antiparticle)…

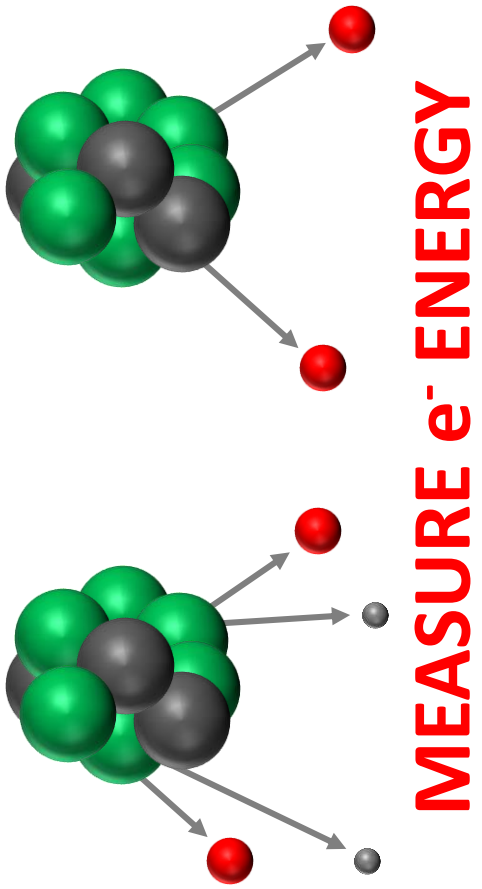
Neutrinoless double beta (0νββ) can also occur

Produces only 2 $\mathbf{e^-}$

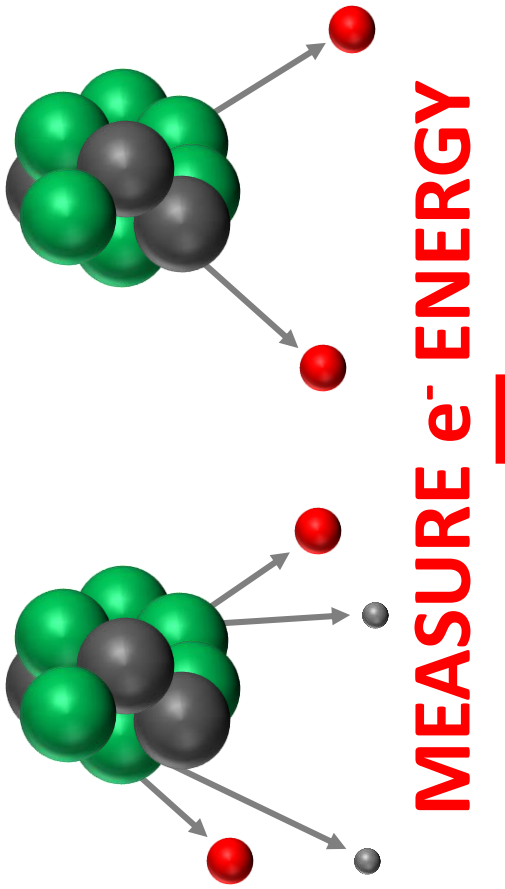
0νββ decay signal



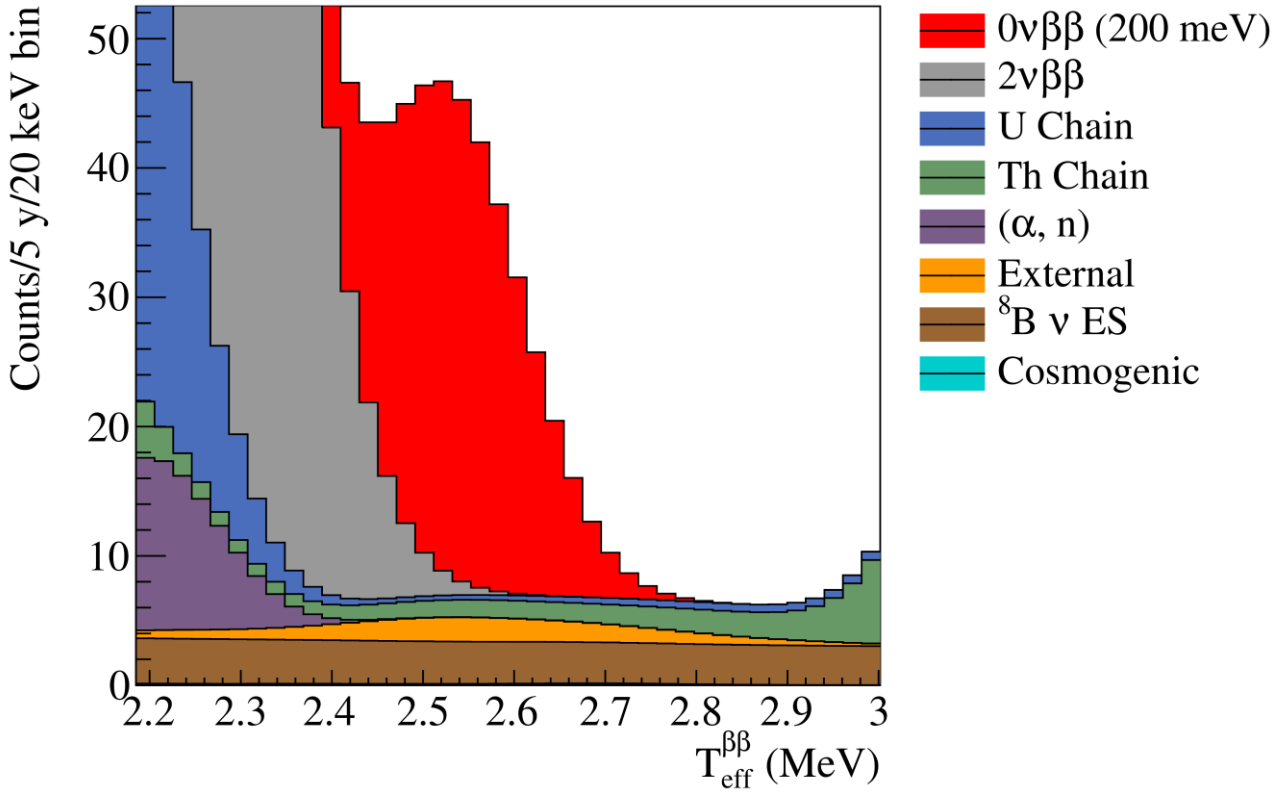
0νββ decay signal



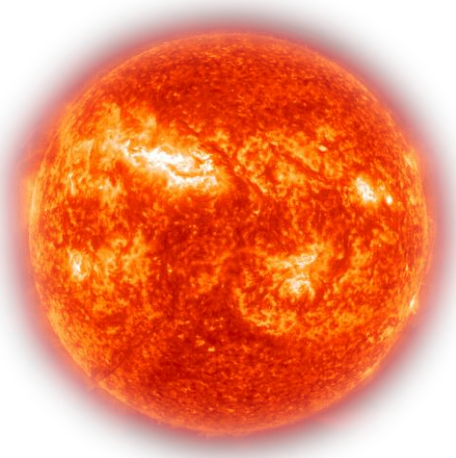
0νββ decay signal



MEASURE e^- ENERGY



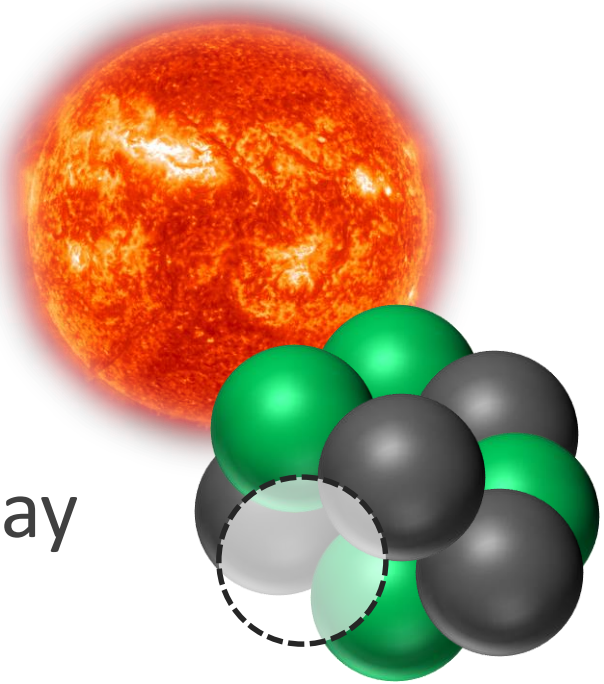
Solar neutrinos



Other physics

Other physics

Solar neutrinos



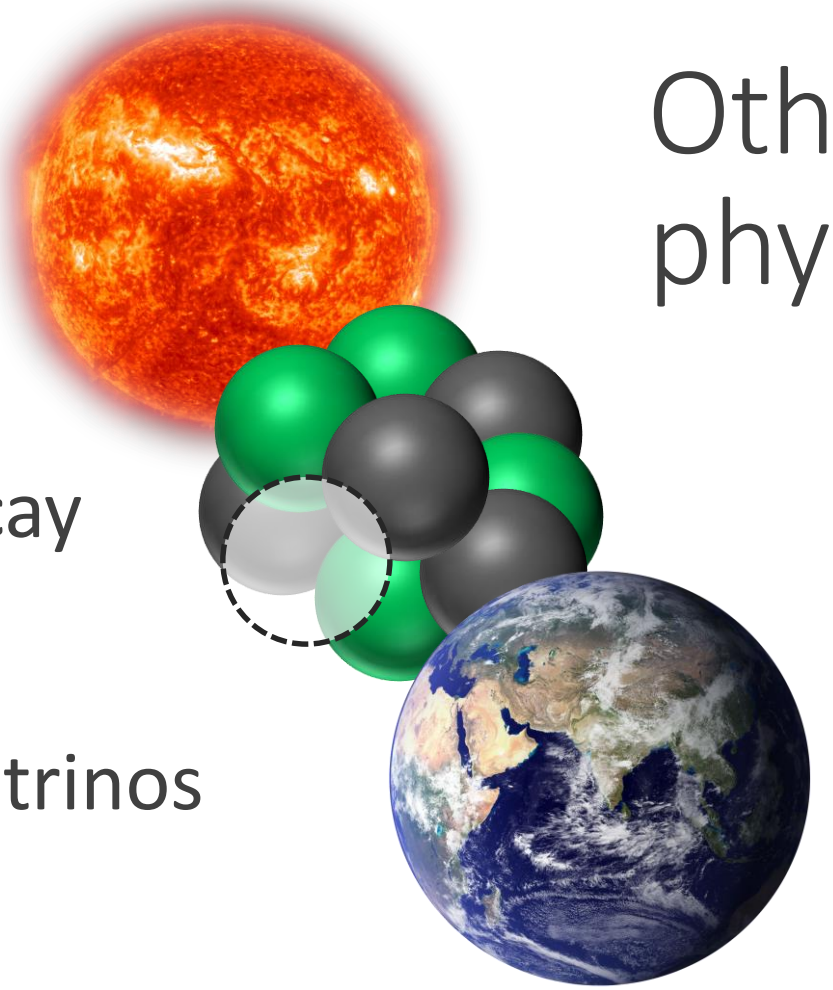
Nucleon decay

Other physics

Solar neutrinos

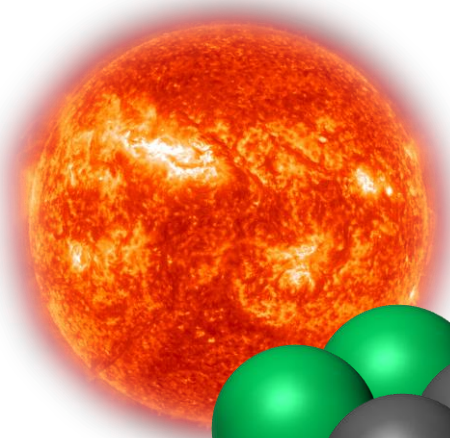
Nucleon decay

Geoneutrinos

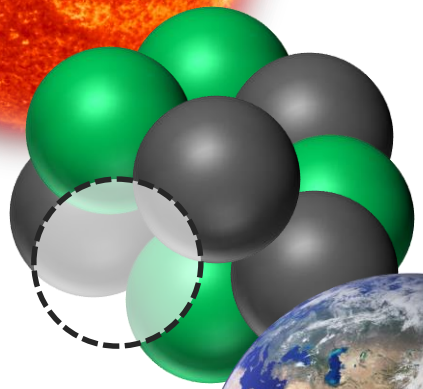


Other physics

Solar neutrinos

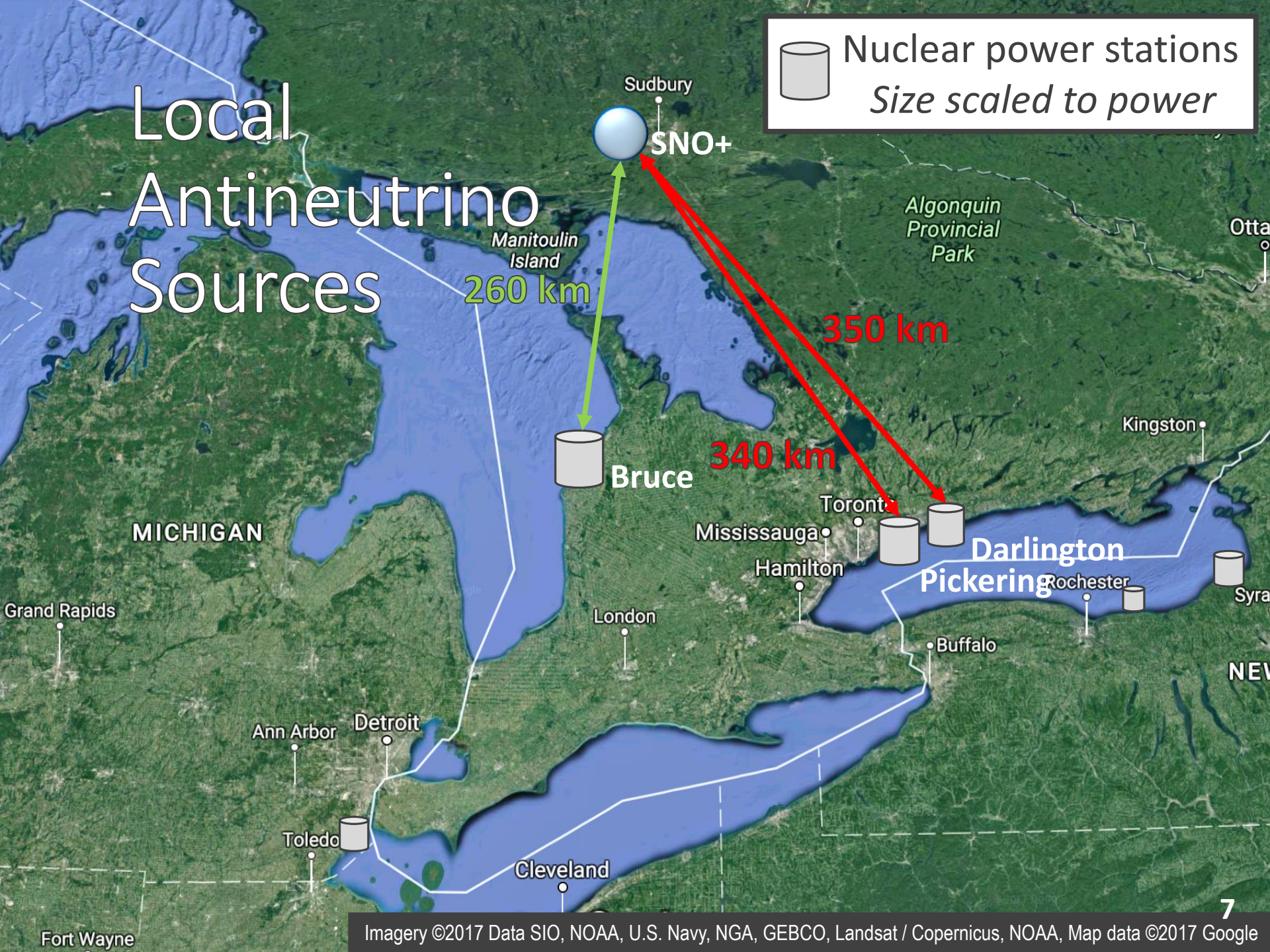


Nucleon decay



Geoneutrinos

Reactor antineutrinos


Local Antineutrino Sources
Nuclear power stations
Size scaled to power
Sudbury
SNO+
Manitoulin Island
260 km
Algonquin Provincial Park
350 km
340 km
Bruce
Kingston
Toronto
Mississauga
Hamilton
Darlington
Pickering
Rochester
MICHIGAN
Grand Rapids
London
Buffalo
Ann Arbor
Detroit
Toledo
Cleveland
Fort Wayne
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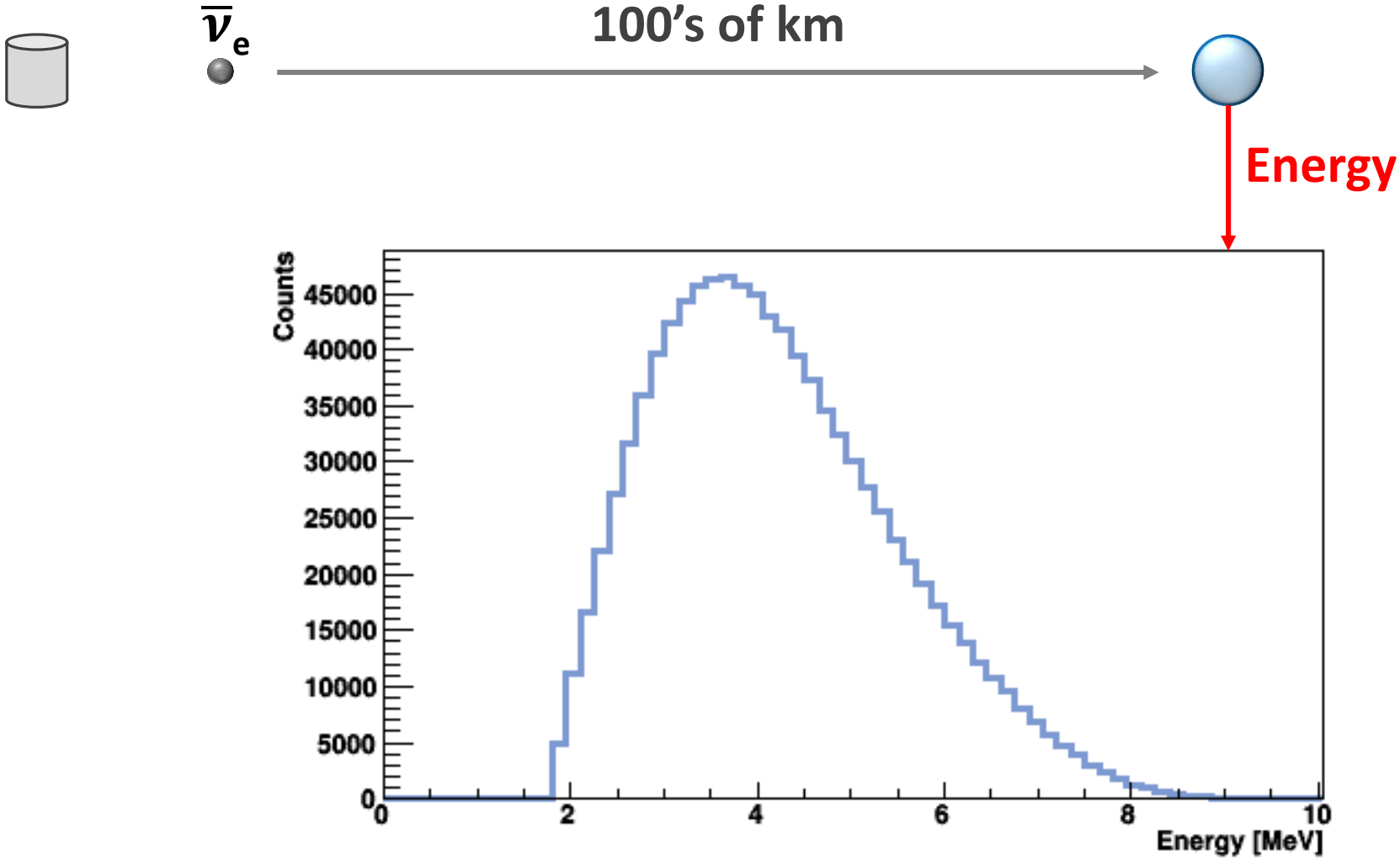
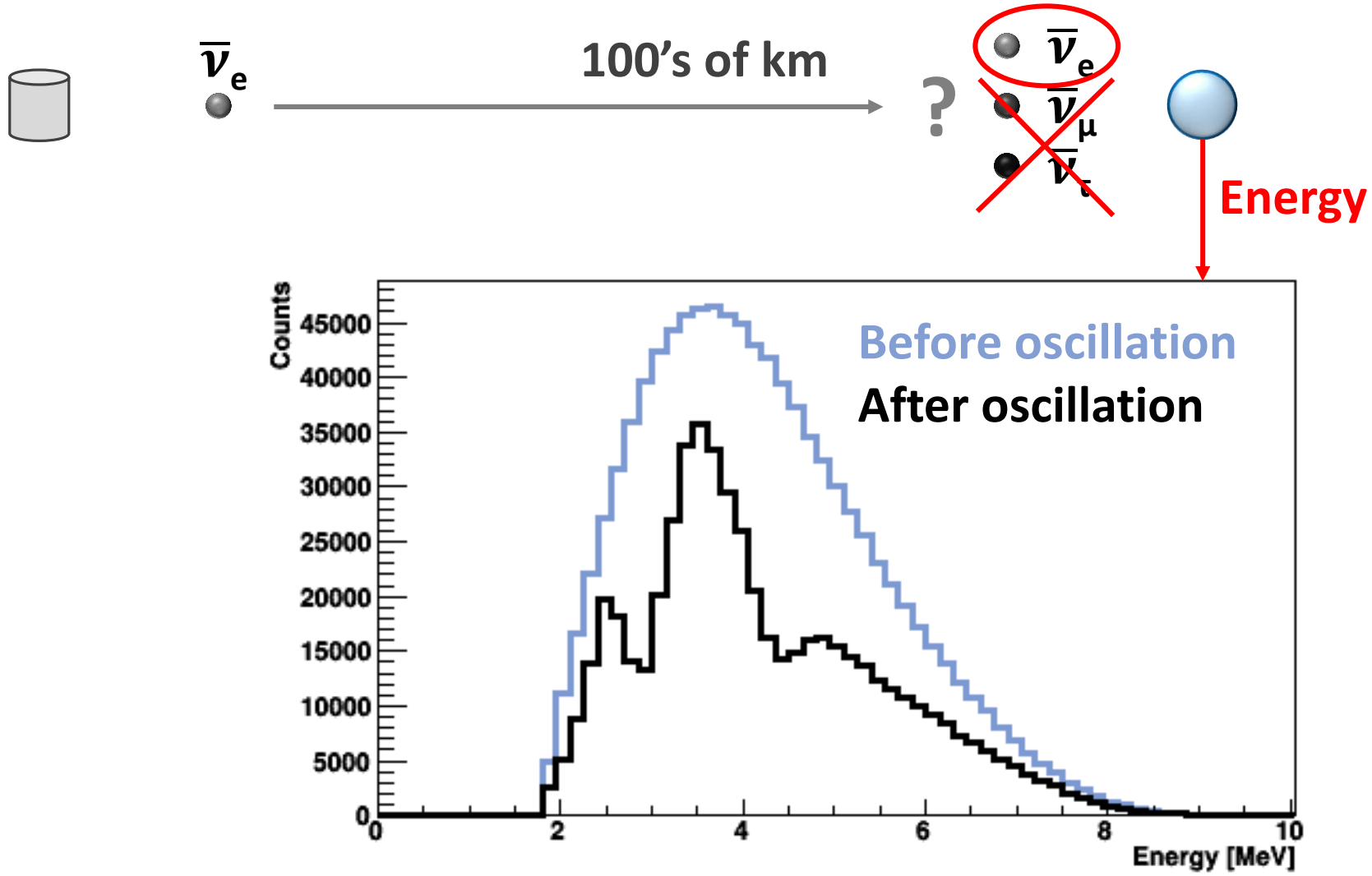
Antineutrino Oscillation

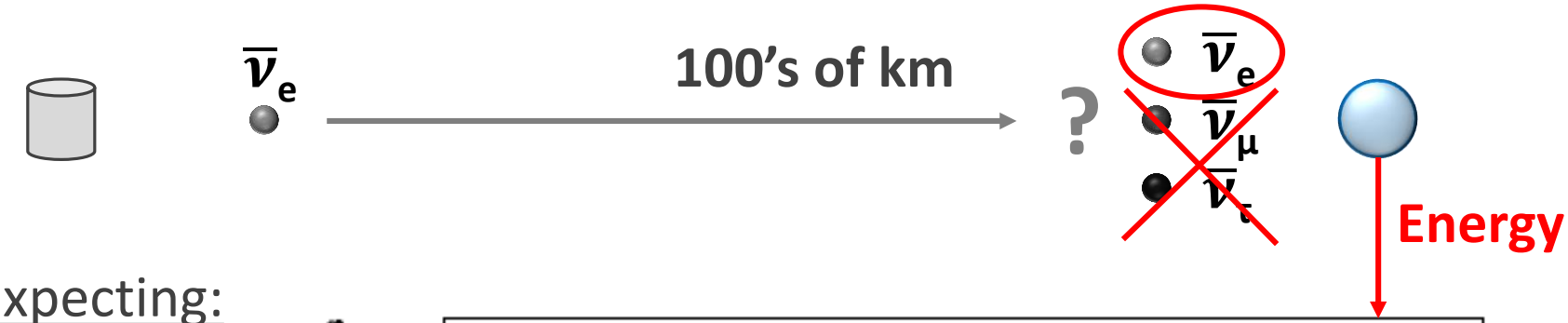
Antineutrino Oscillation



Antineutrino Oscillation



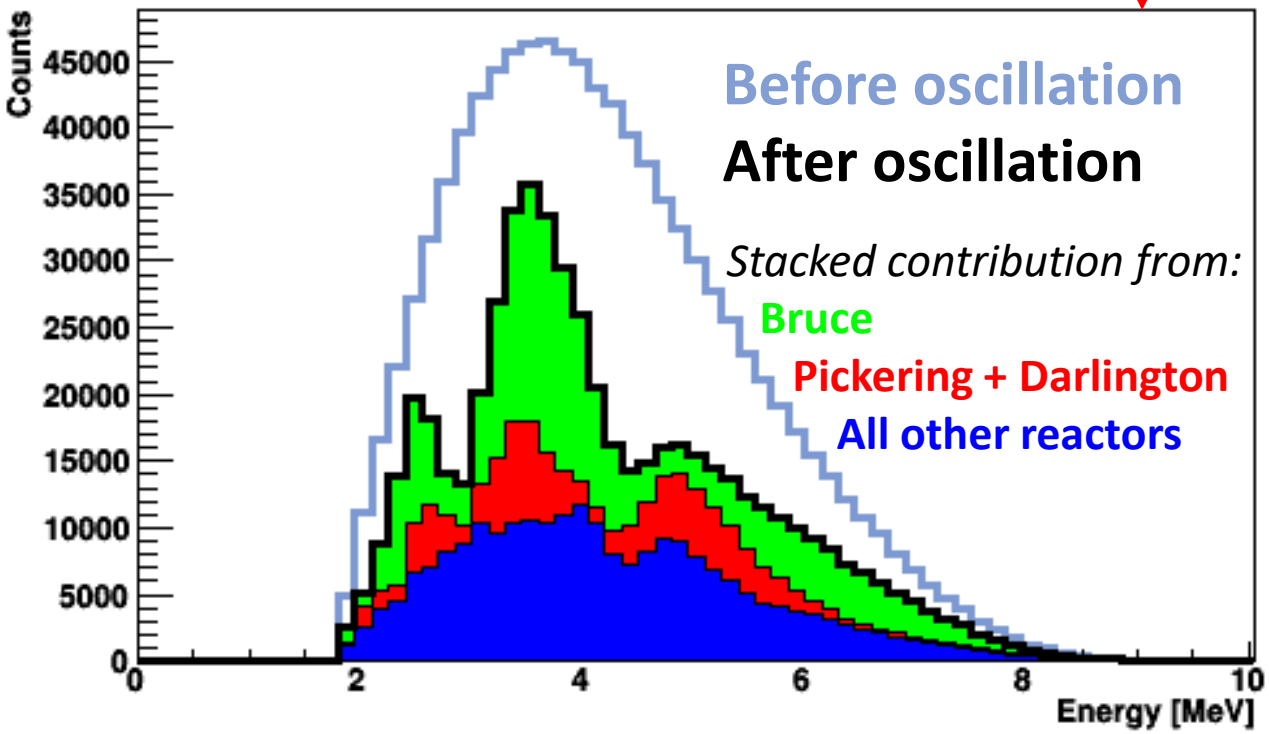
Antineutrino Interaction



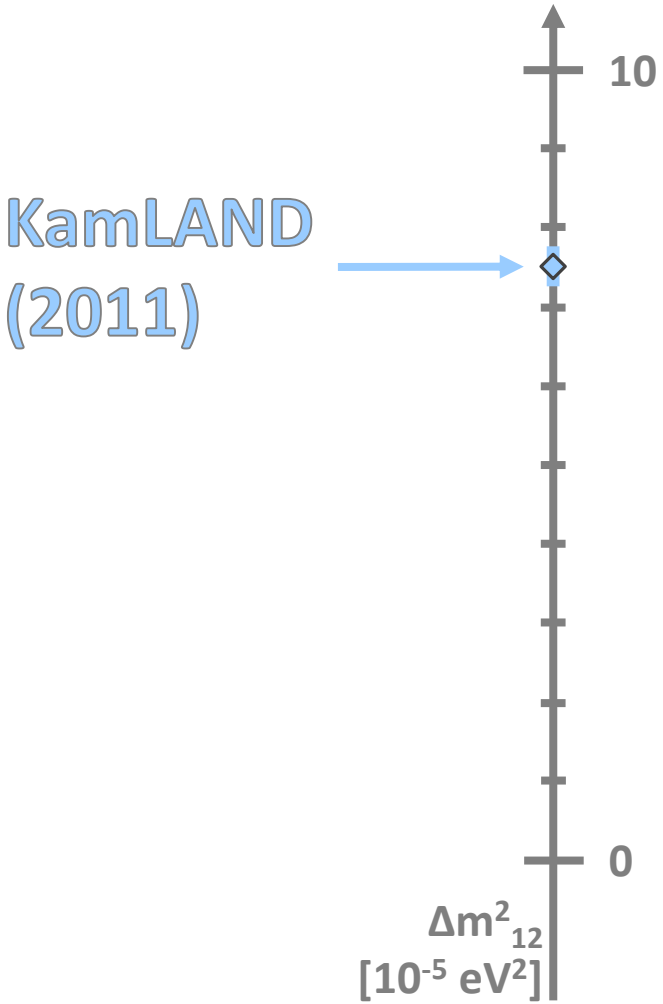
Expecting:

110 interactions per year

Sensitivity to Δm^2_{12} of **0.2×10^{-5} eV^2**



Added motivation



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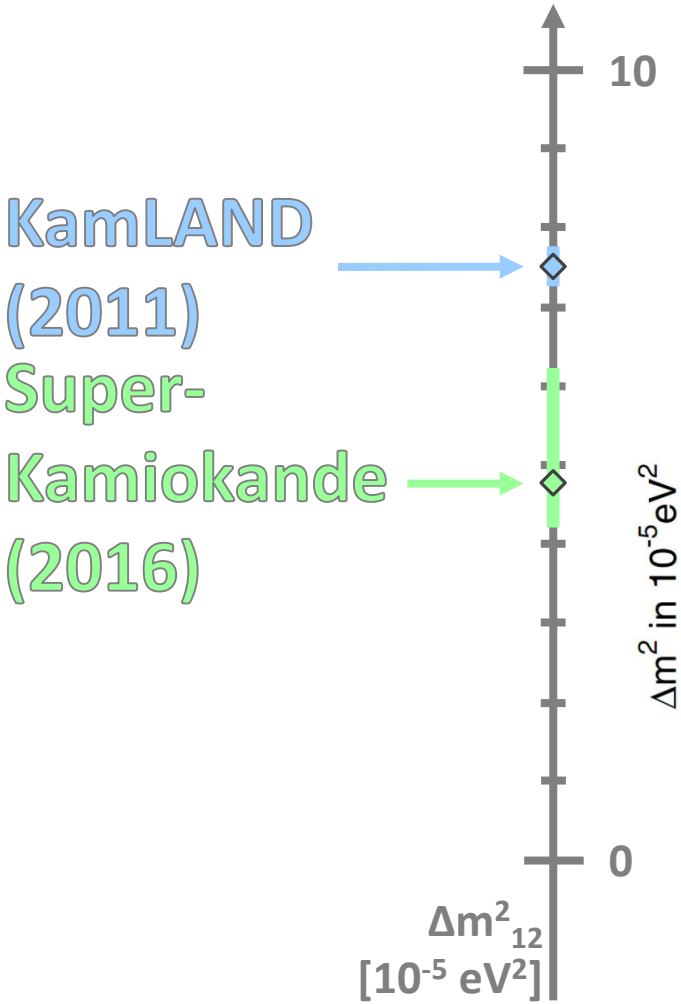
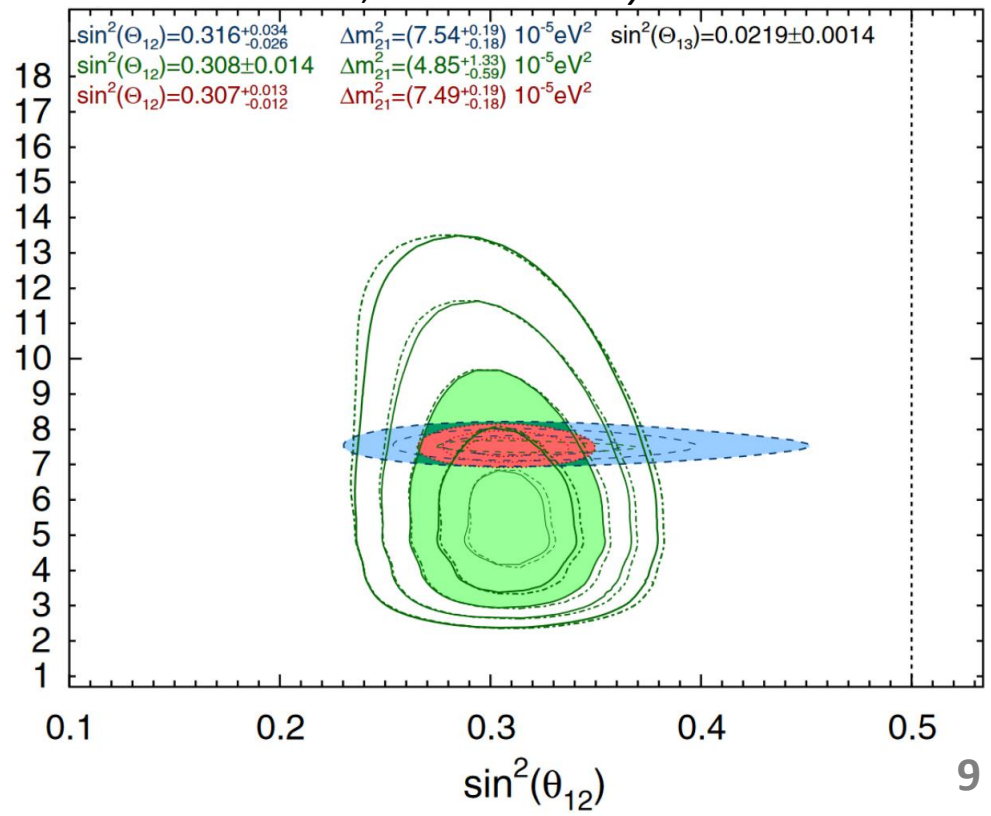


K. Abe, et al. 2016. *Phys. Rev. D* 94:052010



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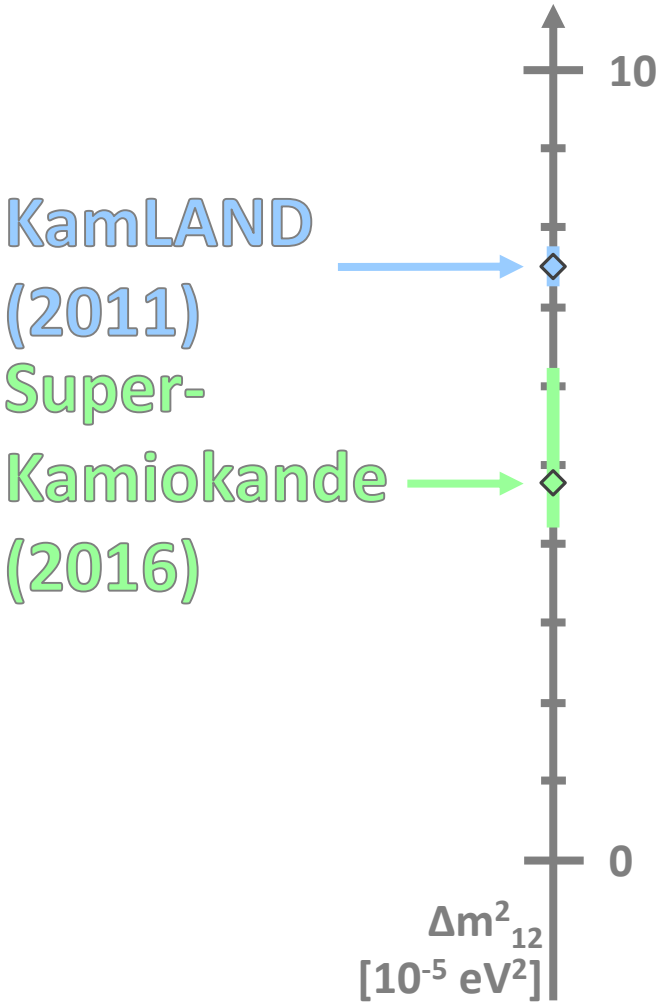

SNO+ will be able to add an independent measurement