The invisibles: present and future

Federico Sanchez

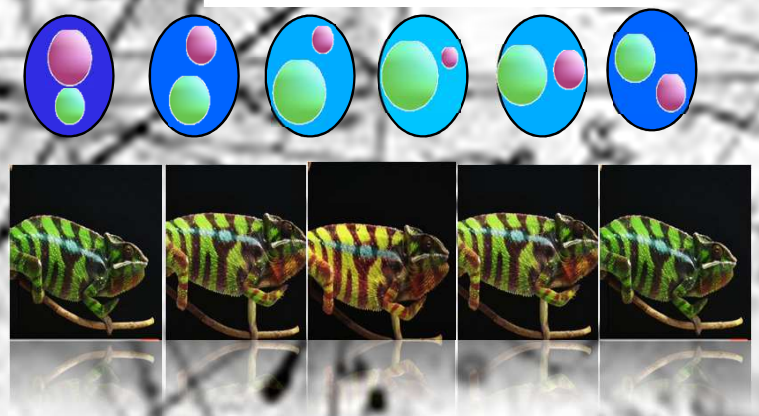
Neutrino oscillations in a nutshell

During its travel the neutrino is mixed and changed the flavor.

We produce neutrinos of one type (flavor)

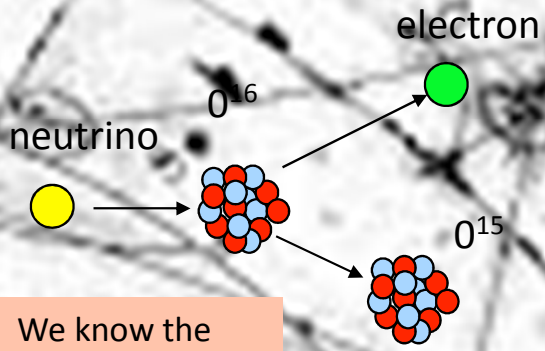
We know the type because we see know the associated particle. (muon)

Neutrino muon



Chameleons of space

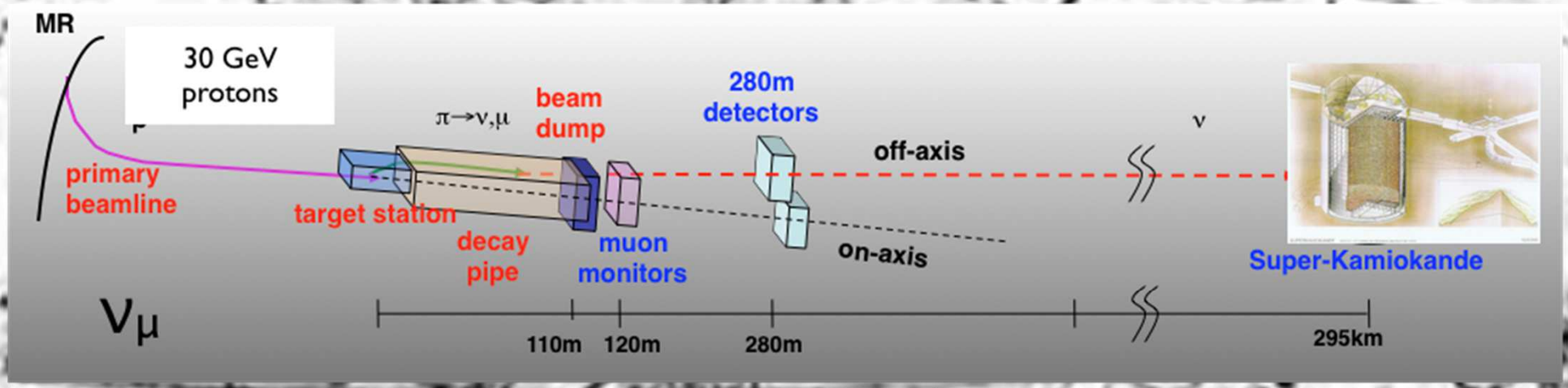
We detect the neutrino through and interacitons



We know the type through the associated particle (electron)

Neutrino electron

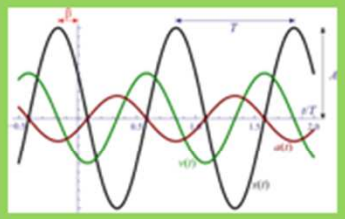
Neutrino oscillations in a nutshell



Neutrinos produced in a particle accelerators or nuclear reactors.

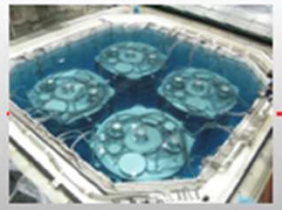
Neutrino flux meas

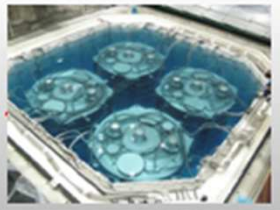
Oscillations



Neutrino flux meas

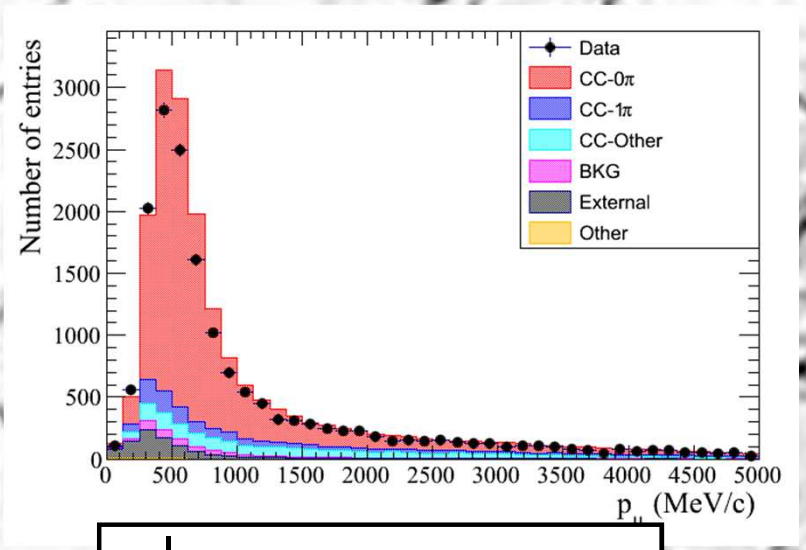
ν_e





T2K measurement

Near detector



Measurements

Predictions

Lucie Maret
Stephanie Bron

ν_μ

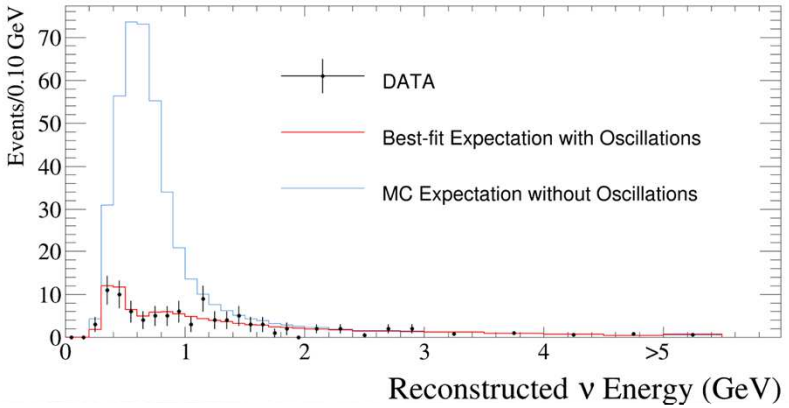
ν_τ

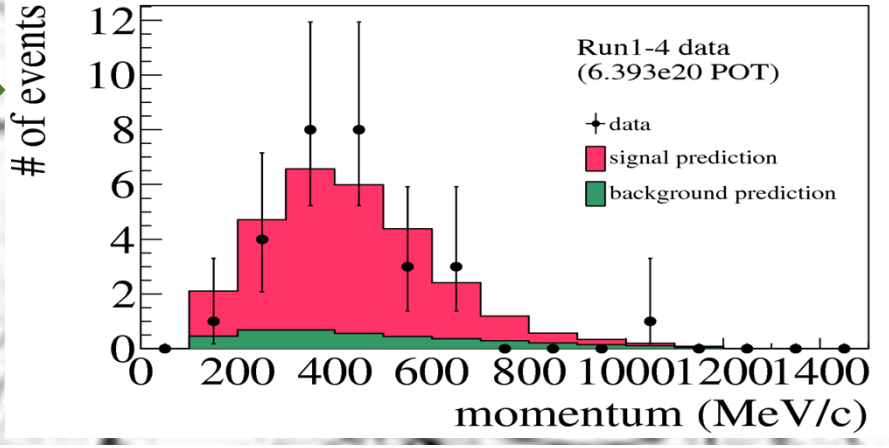
ν_μ

ν_e

Far detector

Invisible @ T2K
Not enough energy.





Detecting neutrinos

Few numbers!

- To detect neutrinos, one needs:
  - A tube of 10^{21}cm filled with water (i.e. ~10^9 times the diameter of earth) decreases the number of neutrinos to half.

1 000 000 000 000 earth diameters

  - Or/and, a huge quantity (10^{21}) of neutrinos to detect one in ~1 meter of matter.
  - 10^{21} is of the order of the number of nuclei in 1 gram of matter.
    - (Avogadro Number = 6.023 10^{23}).

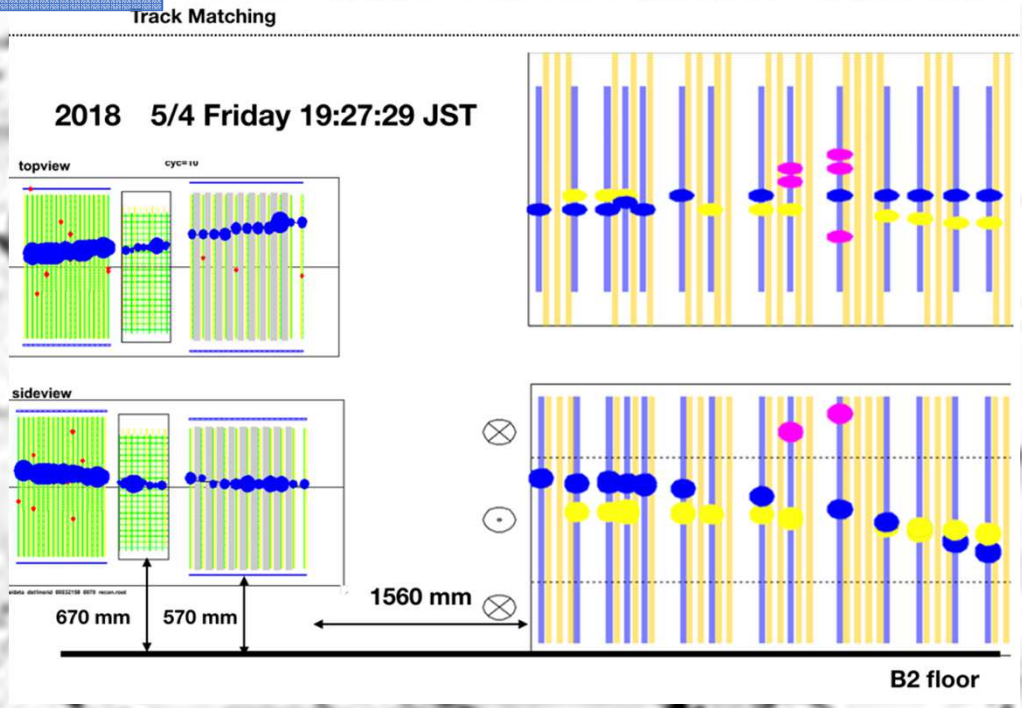
We need huge Detectors.

BabyMind

Laurent NICOLA
Franck CADOUX
Etam Noah
Saba Parsa
Alain Blondel

From installation to commission in 4 months

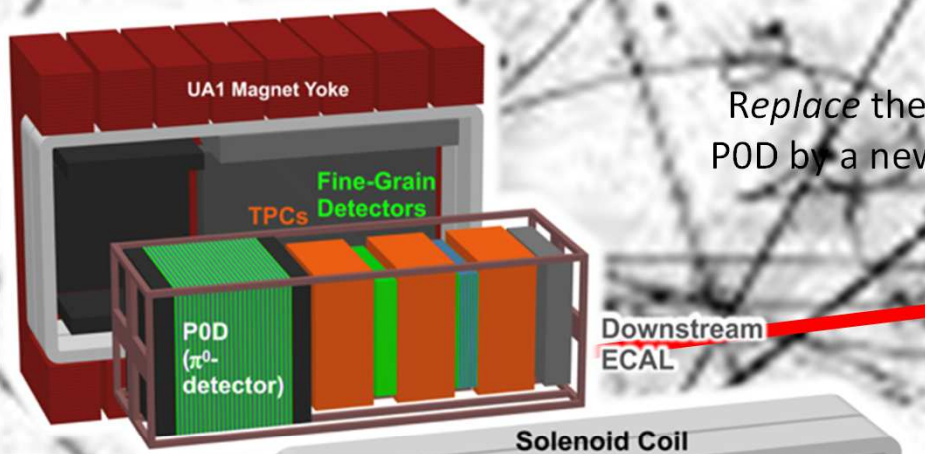
Photo: last day of heavy installation work: J-PARC February 2018



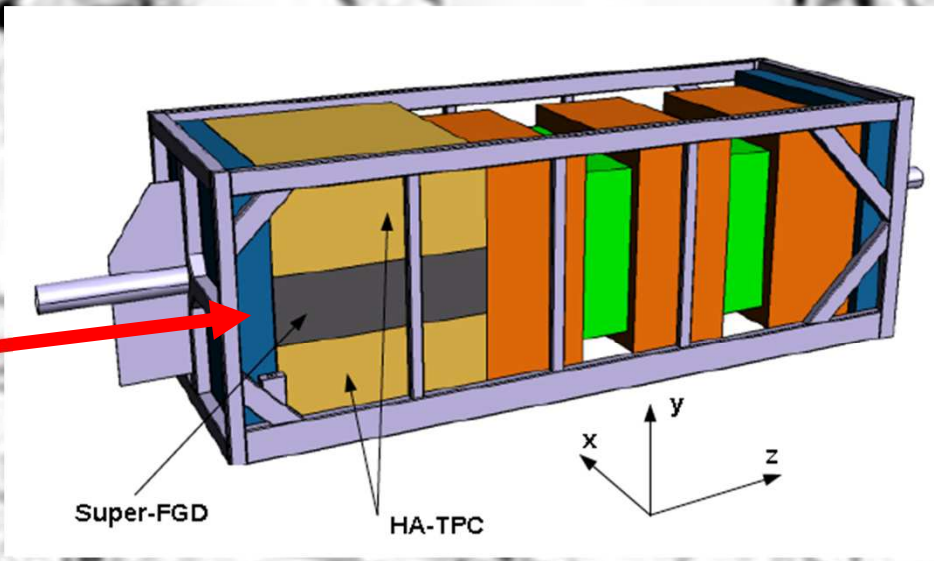
ND280 upgrade

Franck Cadoux involved in
Integration and ToF mechanics

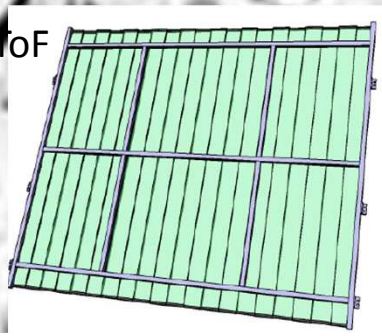
Federico Sanchez
Etam Noah
A.Blondel
Phillippe Mermod

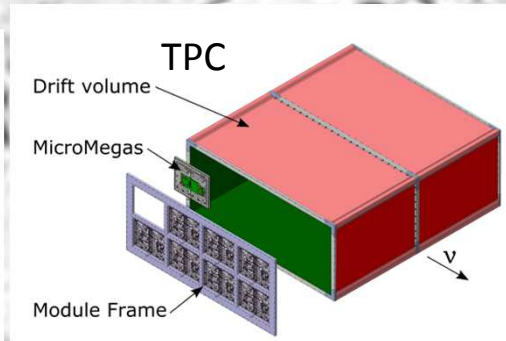


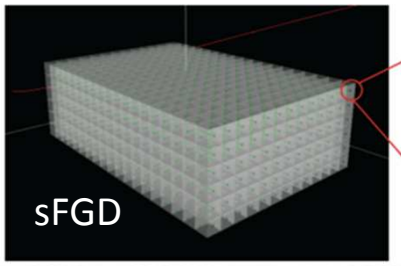
Replace the superseded
P0D by a new light tracker.



ToF



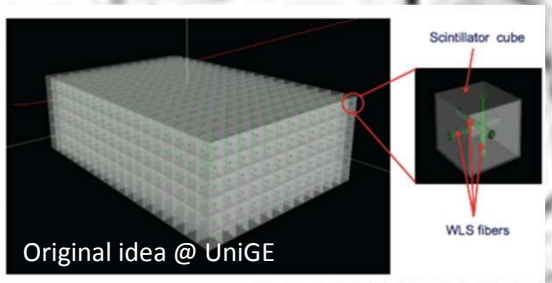


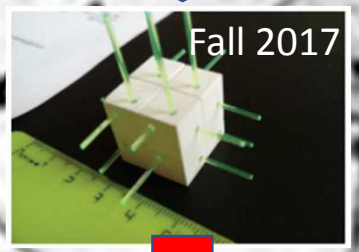


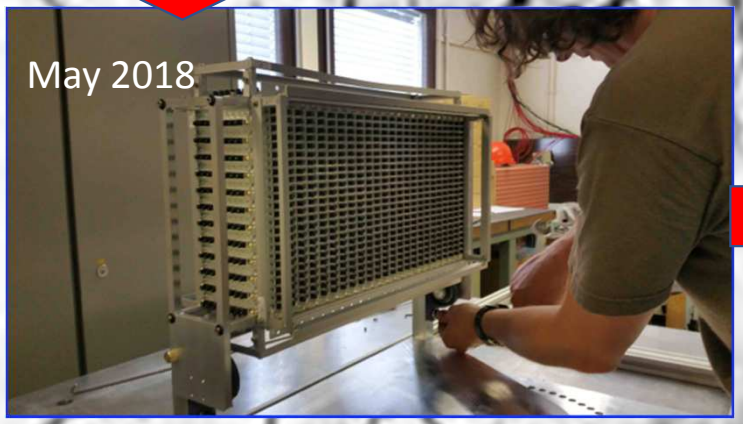
sFGD

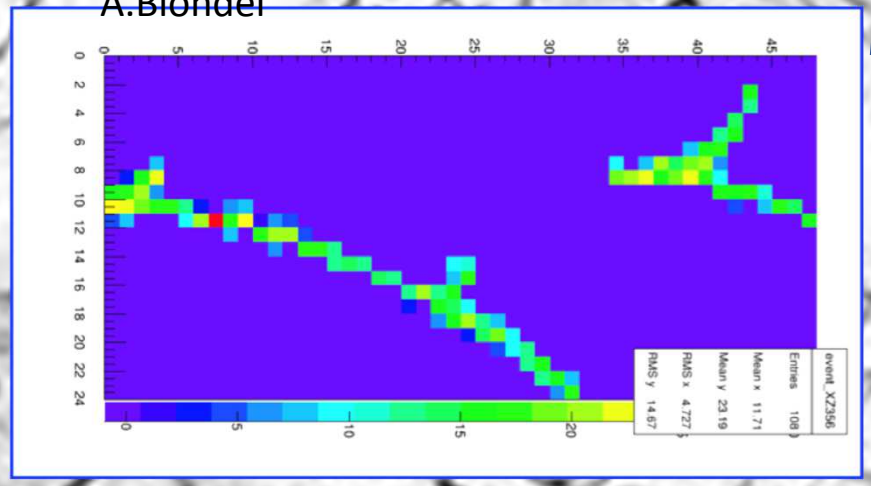
Laurent NICOLA
Sylvain PAMPALONI
Franck CADOUX
Etam Noah
Saba Parsa
Dana Douqa
A.Blondel

From first units to full
Detector test beam in 1 year.



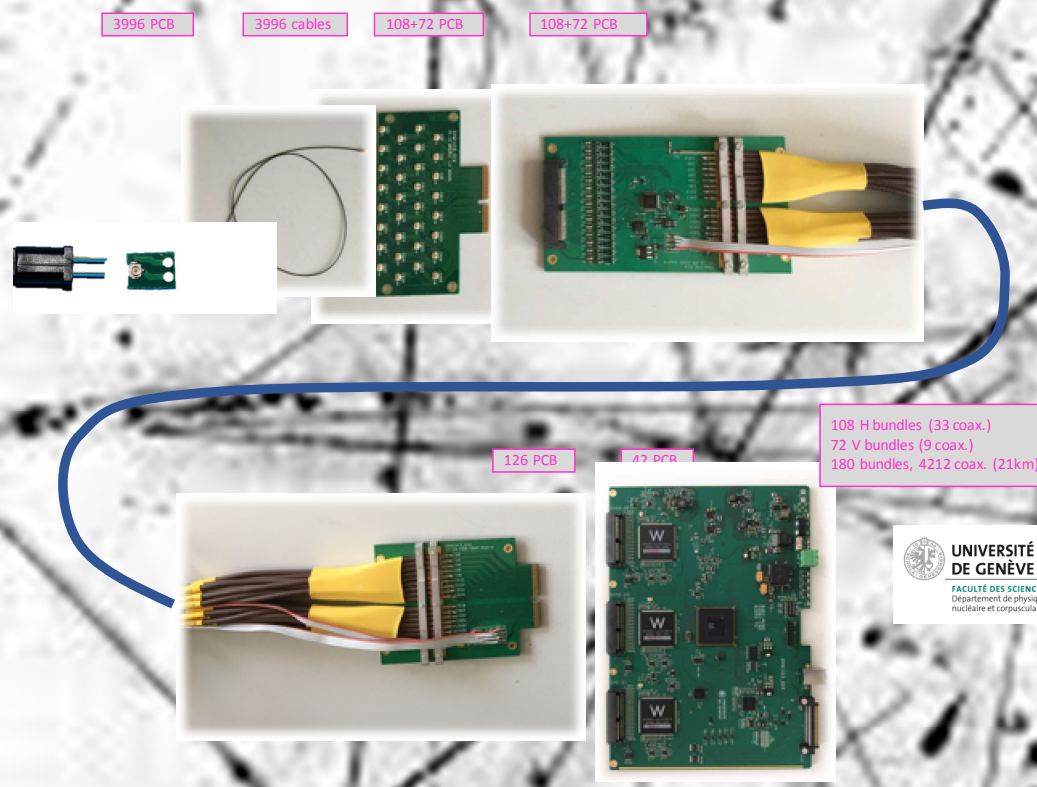




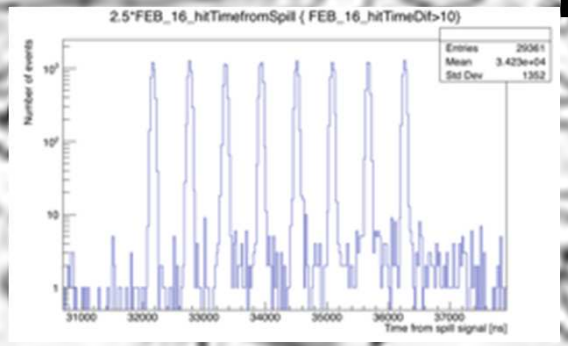


Electronics for sFGD and BabyMind

Yannick Favre
Javier Mesa
Gabriel Pelleriti
Etam Noah
Saba Parsa
Franck Cadoux

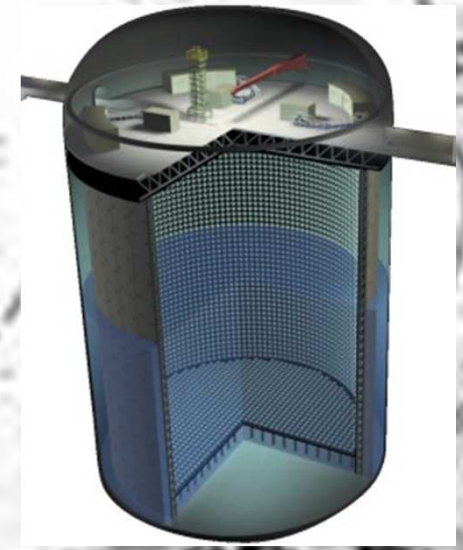


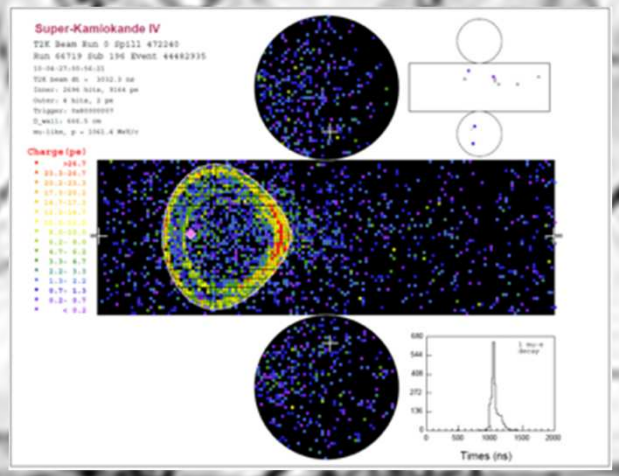
Very efficient
wave catcher
at low cost.



Selected as the baseline of the sFGD for the ND280 upgrade.
Widely used at DPNC by several groups: synergies!
Critical asset for the neutrino group.

SuperKamiokande



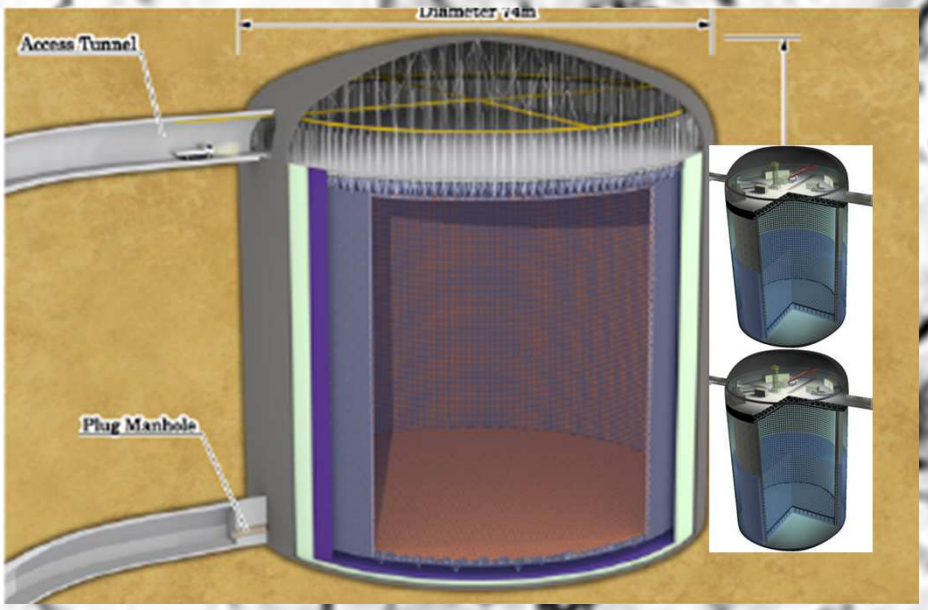


- In summer 2018, Superkamiokande was opened to fix a leak.
  - We will fill it with a Gadolinium salt to detect neutrons.
  - Gadolinium is toxic and it should not leak into water springs.
- Photomultipliers were replaced.
- T2K collaborators from UniGe helped & enjoyed in the process.

Stephanie Bron

Even bigger: Hyperkamiokande

The future of T2K



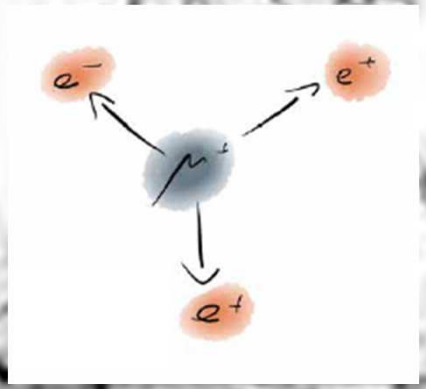
- HyperKamiokande is a new detector with 10 times the mass of SuperKamiokande.
- 10 times more mass is 10 times more neutrinos for the same “accelerator” operation cost.

- After 10 years! University of Tokyo announced in August 2018 that they are committed to the construction of the experiment **by 2026!.**
- S.Bravar and A.Blondel were involved in the readout electronics proposal. F.Sanchez in the improvement of near detector.

Neutrino physics without neutrinos

Lepton Flavor Violation & Mu3e @ PSI
Searching For New Physics At PeV Scale

Franck CADOUX
Daniel LA MARRA
Coralie HUSI
Antoaneta Damyanova
Luis David Medina
Sandro Bravar

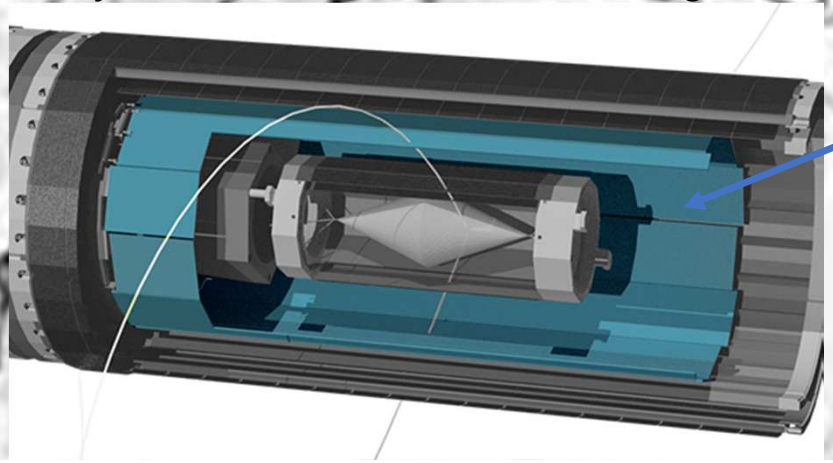


Forbidden is the Standard Model (with $m_\nu = 0$)

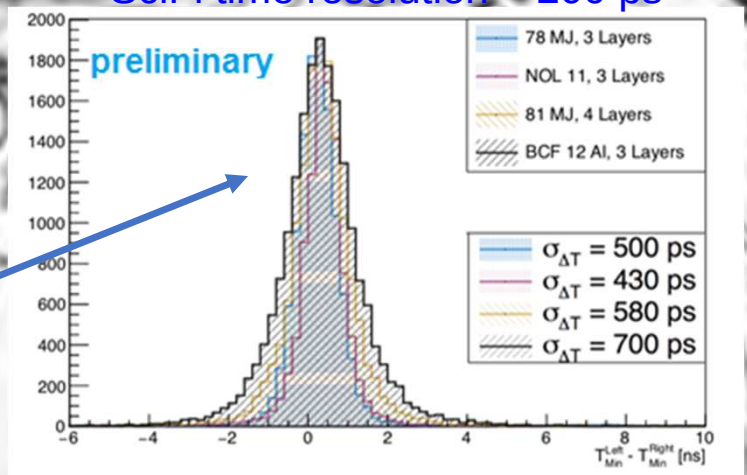
Lepton Flavor Violation observed in neutrino oscillations

Does it manifest also in the muon decay $\mu^+ \rightarrow e^+ e^- e^+$?

UniGE is developing and constructing the SciFi detector (thickness 0.7 mm !) for Mu3e to reject all forms of accidental backgrounds



SciFi time resolution ~ 200 ps



SciFi spatial resolution ~ 100 μm
SciFi efficiency > 96 %

Integration task

Liliane Nagy
Catherine Blanchard
DPNC
Federico Sanchez

- I would like to thank everybody at the DPNC for their warmest welcome.
- Very special thanks to Catherine Blanchard and even more specially to **Lilian Nagy**.
  - Thanks for their patience and support in my struggling through the new bureaucracy.
  - Thanks for their everyday smile.