Retrospective on Dr. Masatoshi Koshiba (1926 - 2020)

Atsuto Suzuki
(Iwate Prefectural University)

XIX International Workshop on Neutrino Telescopes, Padova, 19 Feb. 2021

Outline

1. Brief History up to 1962
2. Exploration of International e^- e^+ Collider Experiments
3. Birth of Kamiokande
4. Kamiokande Launch
5. SN1987A
6. Solar Neutrinos
7. Original Idea of Super-Kamiokande
8. One More Dream : Next Generation e^- e^+ Linear Collider (ILC) in Japan
9. Closing Remarks

Let me allow to omit honorific titles throughout my presentation

1. Brief Research History up to 1962

- Graduated from Physics Department of the Univ. of Tokyo in 1951

Unique Character and Existence

Nobel Laureate in Physics (1965)

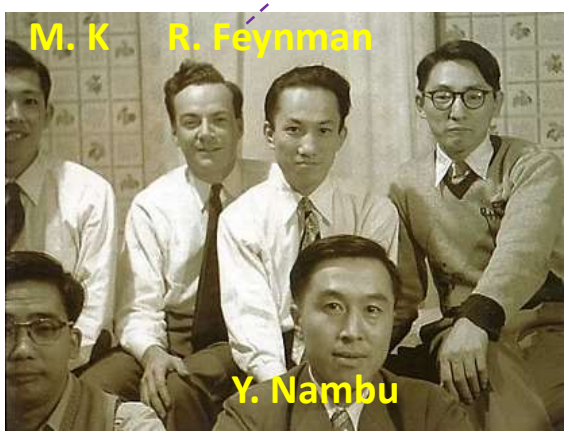
Kimono style in the high school days

- High school principal introduced Koshiba to the principal's friend, **Shinichiro Tomonaga**
- Koshiba : sake-drink partner of Tomonaga (heavy drinker)
- Since then, Tomonaga fully supported Koshiba

Nobel Prize in Physics of 1965

- 1953 : Moved to Graduate School of Rochester University

- Tomonaga : recommendation letter of Koshiba
- January, 1954 :
  Sukiyaki party at Koshiba's room
  2 future Nobel Raureates :
  Richard Feyman (1965)
  Yoichiro Nambu (2008)



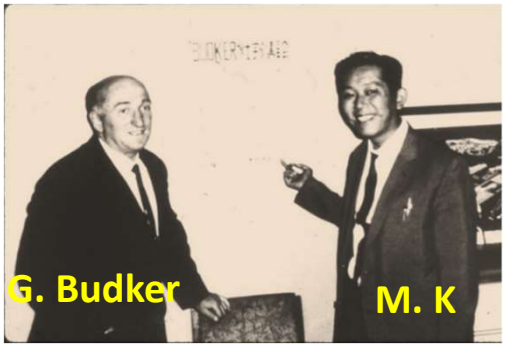
- In June, 1955 : PhD by Phenomena of Ultra High Energy Cosmic Rays
- Research Associate of Chicago University
- In 1958 : Returned to Japan as Associate Professor of the Univ. of Tokyo
- In October, 1959 : Married with Tomonaga's matchmaker

- In November, 1959, back to US for joining International Cosmic Ray Collaboration led by Marcel Schein (Univ. of Chicago)
- Project Leader in 1960
- In 1962, returned again to Univ. Tokyo
  after finishing the project successfully

2. Exploration of International $e^- e^+$ Collider Experiments

Collaboration at BINP (1968 ～ 1972)

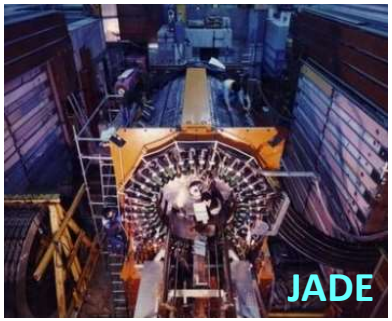
- In March, 1968 Budker proposed the collaboration of the world first $e^- e^+$ collider project to Koshiba



In August 1972, the collaboration terminated.

DASP Collaboration, using $e^- e^+$ collider DORIS at DESY (1973～)

JADE Collaboration, using $e^- e^+$ collider PETRA at DESY (1977～)



Yoji Totsuka : 1st Super-Kamiokande Spokesman) joined DORIS and JADE

OPAL Collaboration at LEP (1989～) → ATLAS Collaboration at LHC (2008～)

Koshiba developed a long term base for successful international collaborations in Europe

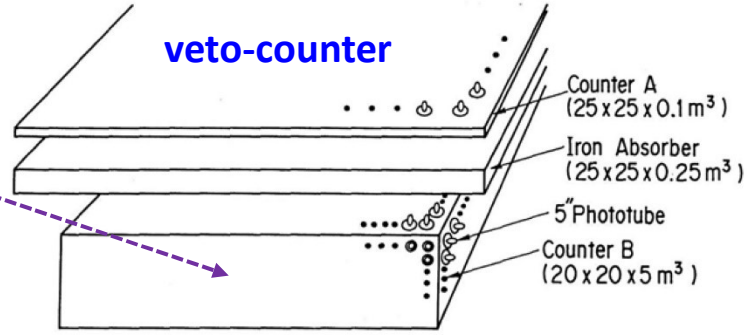
3. Birth of Kamiokande

Workshop on "The Unified Theory and the Baryon Number in the Universe" at KEK (1979)

Koshiba proposed the initial concept of Kamiokande

(KEK report: KEK-79-18 (1979), pp. 53-70)

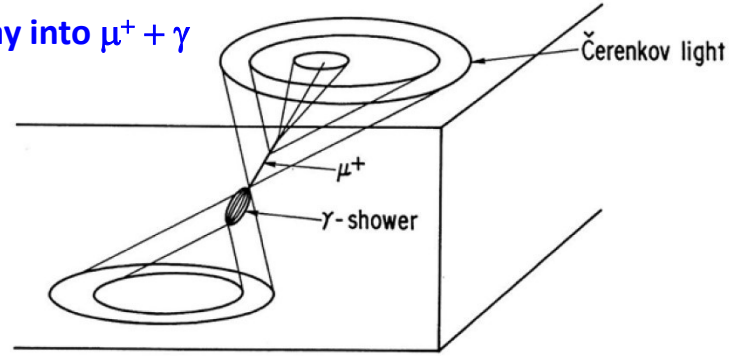
- detector size : 20 x 20 x 5 m^3 (2000 ton of water)
- 7500 5-inch PMTs



Cost saving for budget

- 1000 5-inch PMTs
- partially funded by Ministry of Education

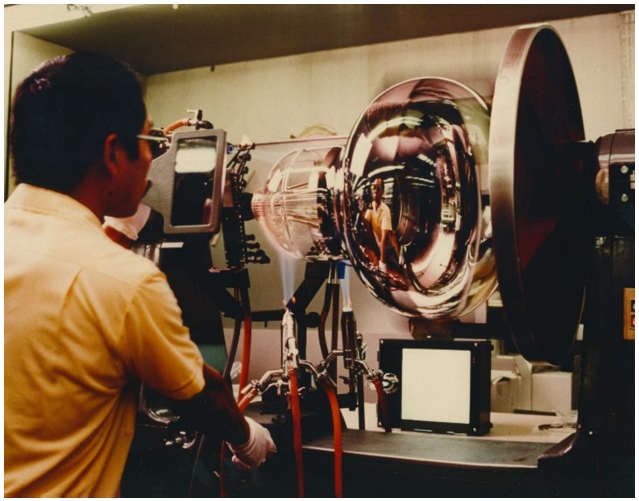
image of proton decay into $\mu^+ + \gamma$



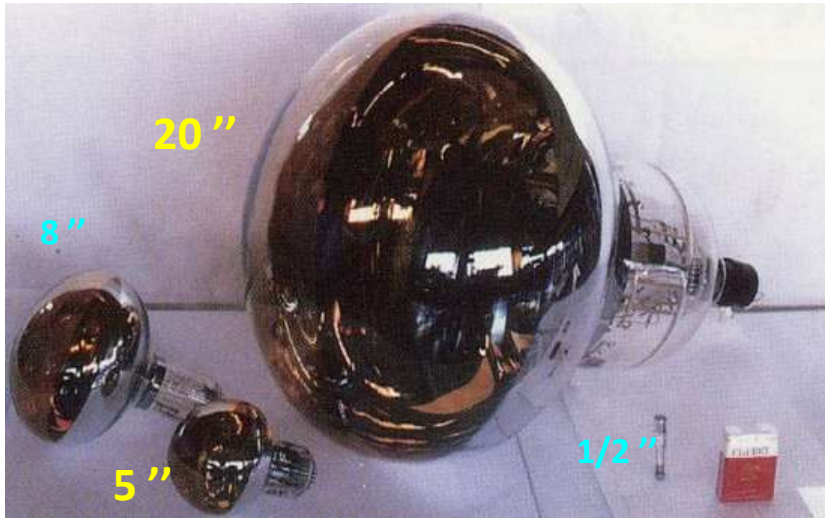
News from US

- IMB detector : 8000 ton water Cherenkov detector
- 2000 5-inch PMTs

Start to develop 20-inch diameter PMT : collaboration between Univ. of Tokyo and Hamamatsu TV (Photonics) Co. in 1979



- 20-inch PMT became a reality in 1981

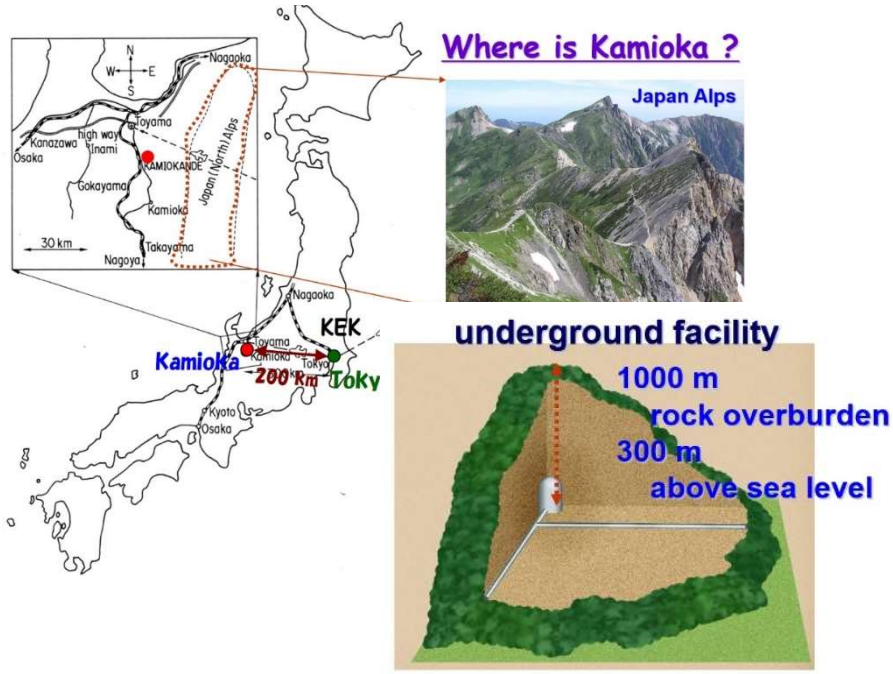


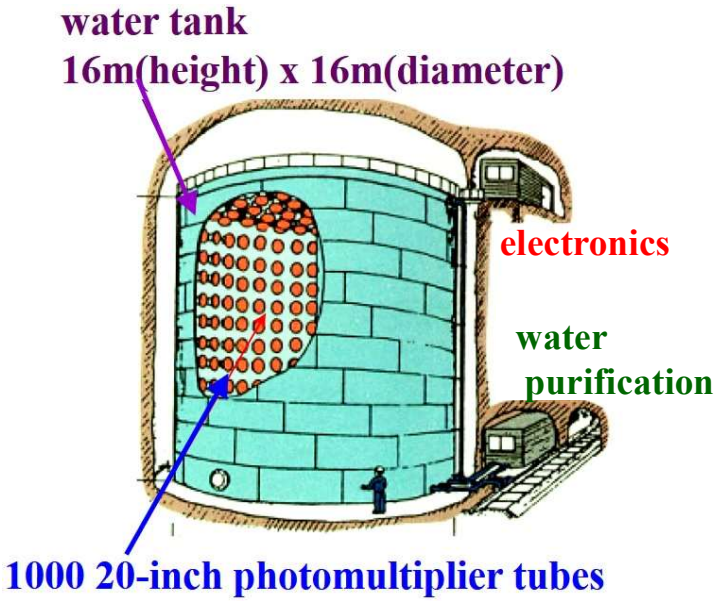
- KEK → Univ. of Tokyo in 1982

4. Kamiokande Launch

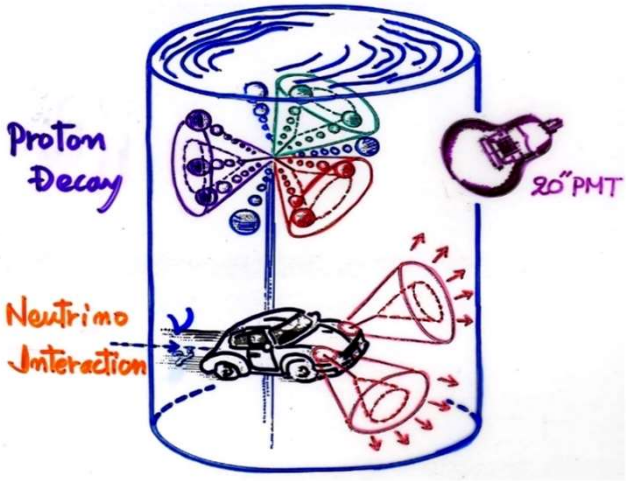
Kamiokande :
Kamioka Nucleon Decay Experiment

- Detector : 3000 ton cylindrical water Cherenkov detector
- 1000 20-inch PMTs



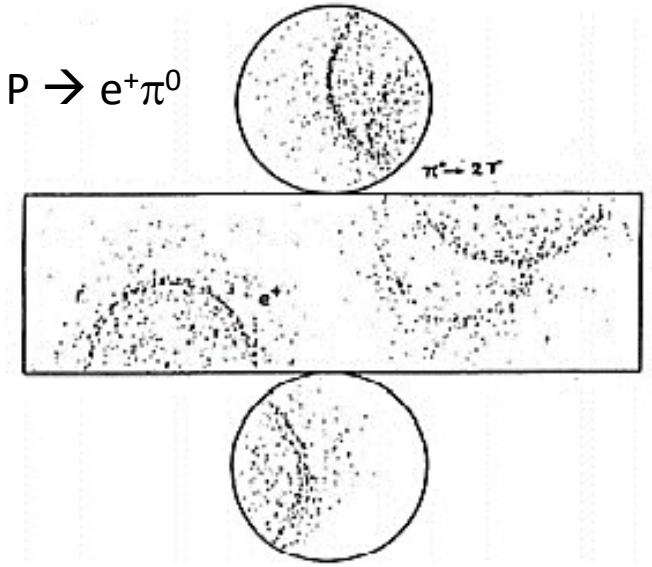


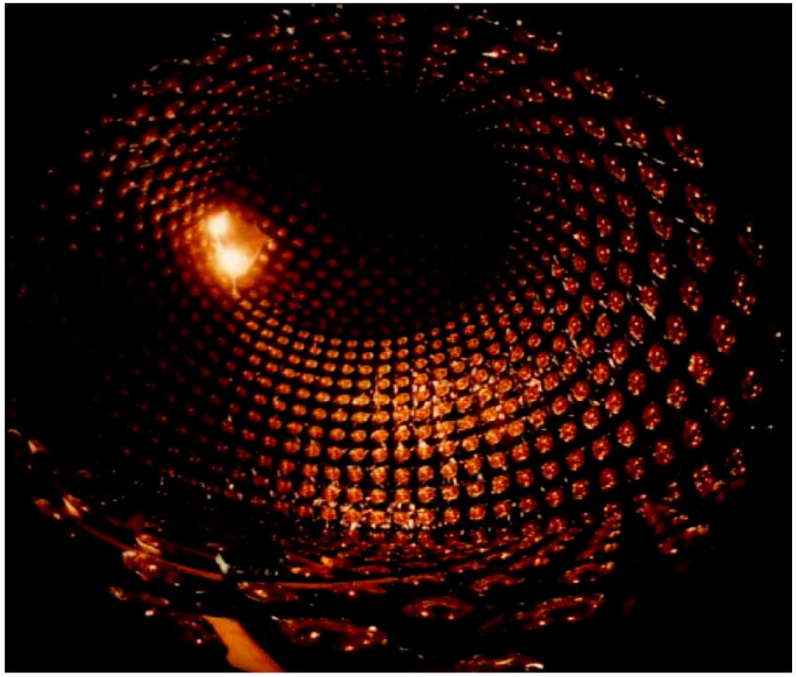
Imaging Water Cerenkov Detector



Construction : January, 1982 ～

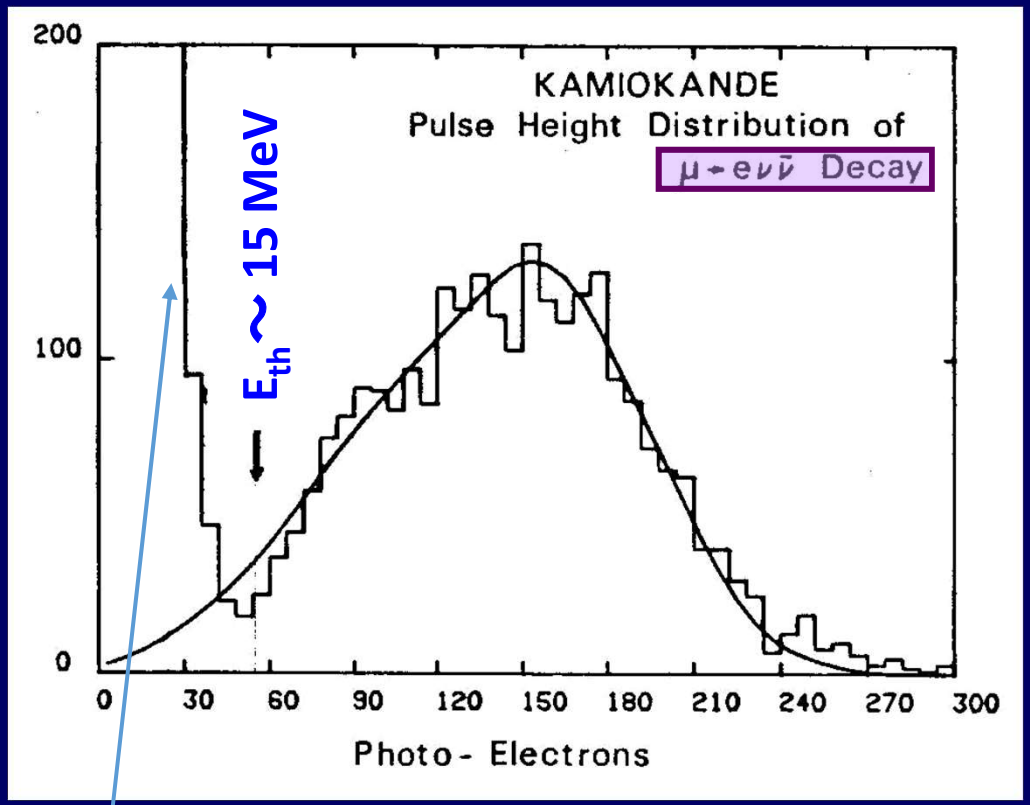
Data-taking from July, 1983





What invited Kamiokande-II ?

Only several months later after data-taking



Kamiokande-II :

huge background mountain stands in front of us

Koshiba :

Why not lower E_{th} down to 10 MeV to detect ^{8}B solar neutrinos

Proposal : not Improvisation, but his Deep Consideration

Koshiba :

Even before, the start of the experiment, I had been thinking that the Kamiokande should produce significant scientific results, even if proton decays were not observed.

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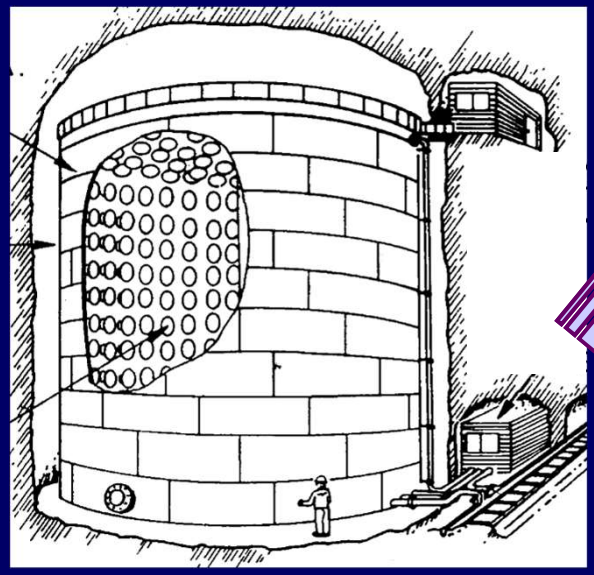
THE EUROPEAN PHYSICAL JOURNAL H

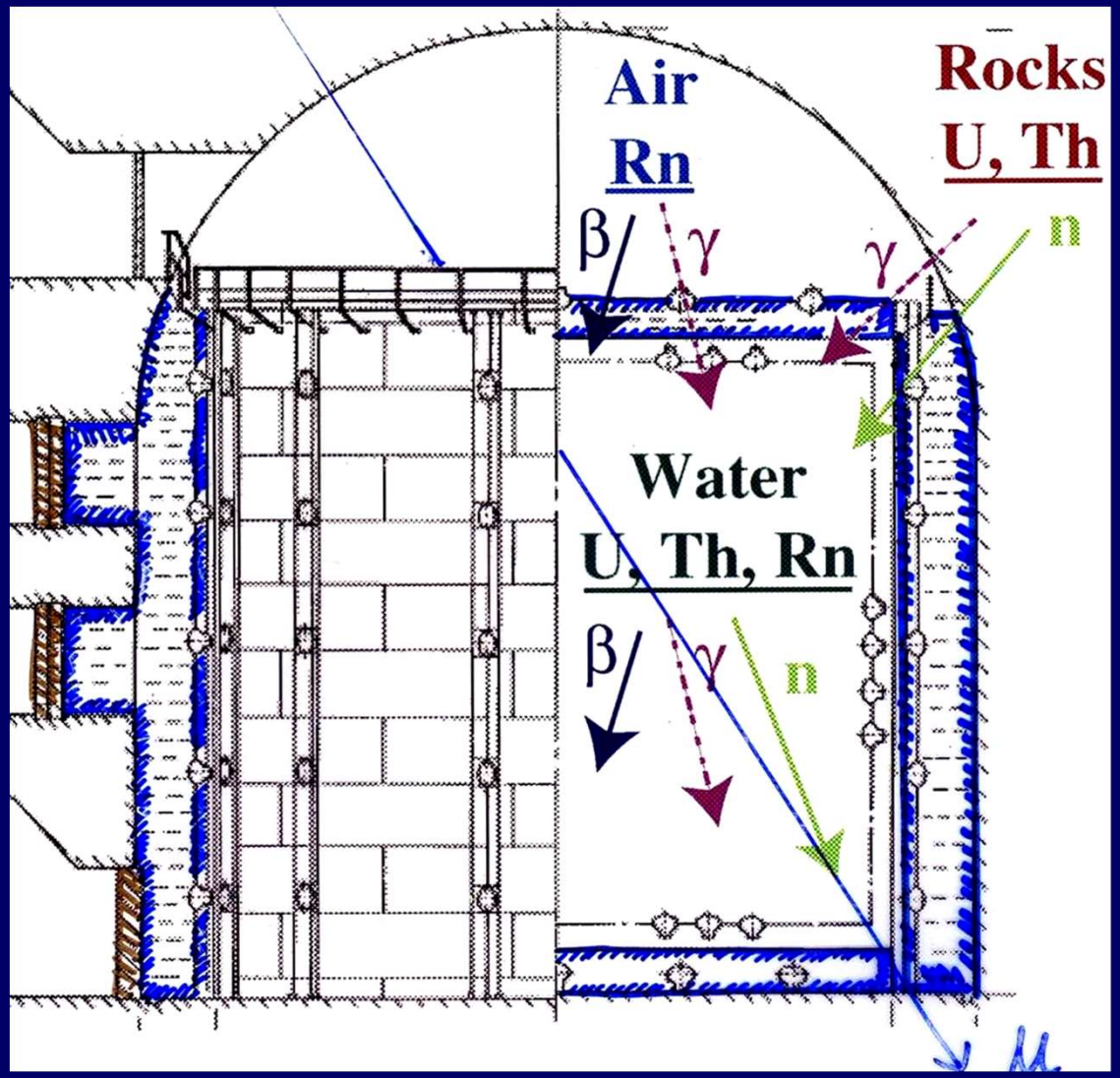
On the origin of the Kamiokande experiment and neutrino astrophysics

T. Kajita[1,a], M. Koshiba[2], and A. Suzuki[3]

Kamiokande-I



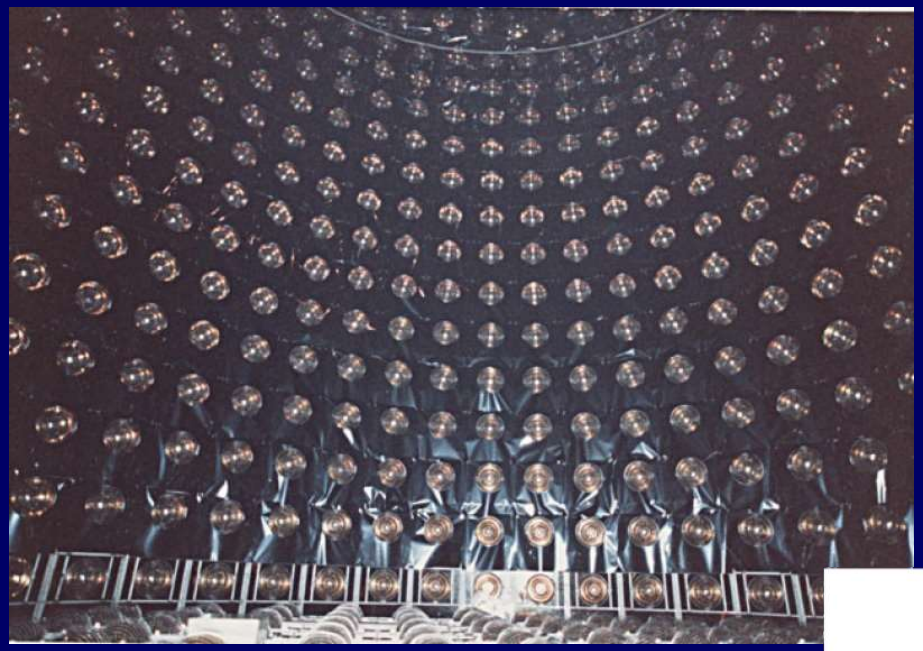
Kamiokande-II Detector

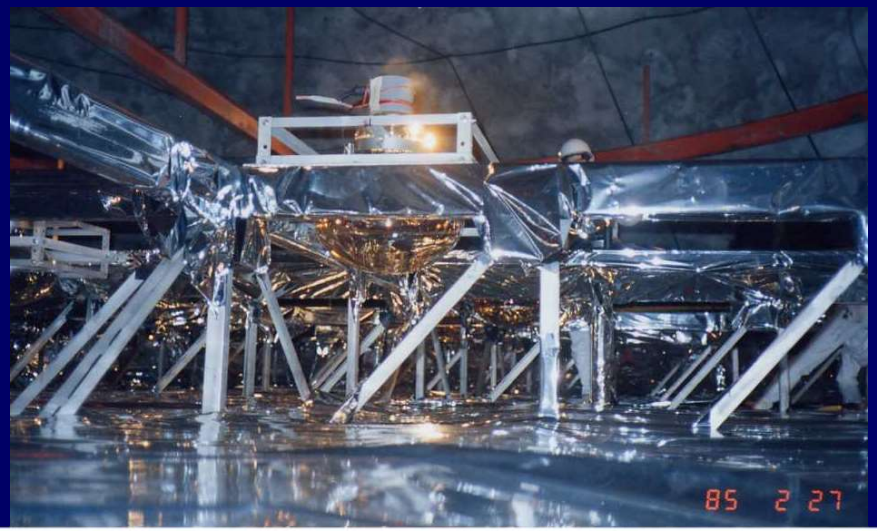


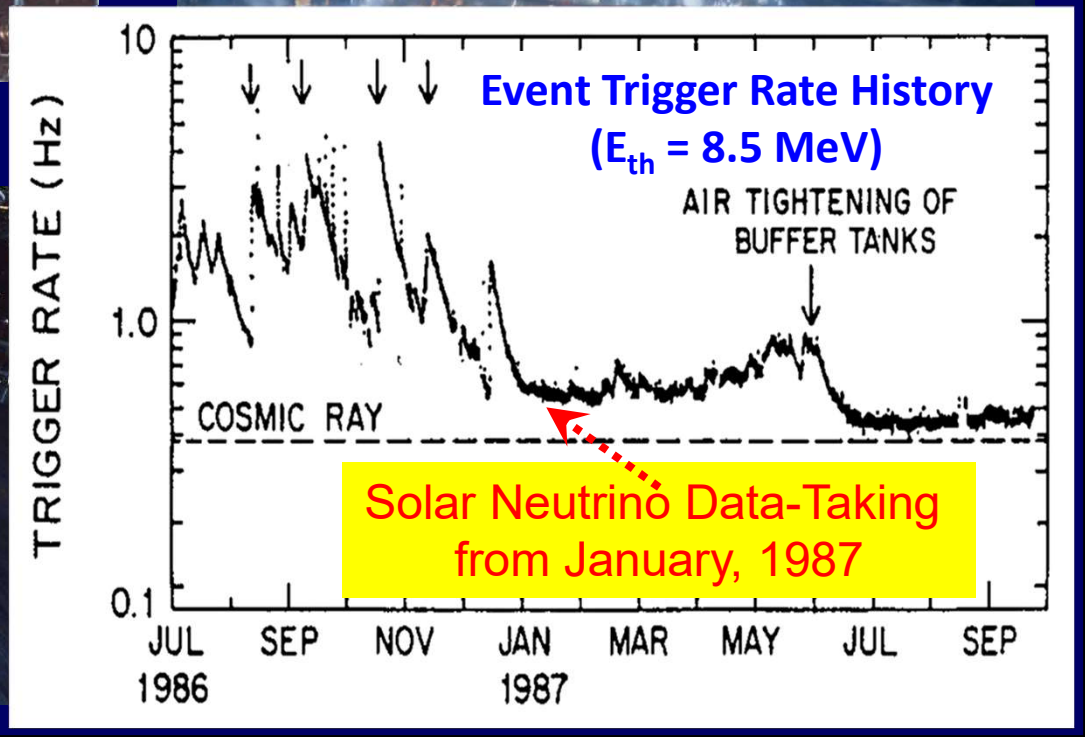
upgrade :

- **hermetic, live anticounter**
- **water purification system**
- **multi-hit time and charge measurement electronics**

Kamiokande-II Construction (September, 1984 ~)

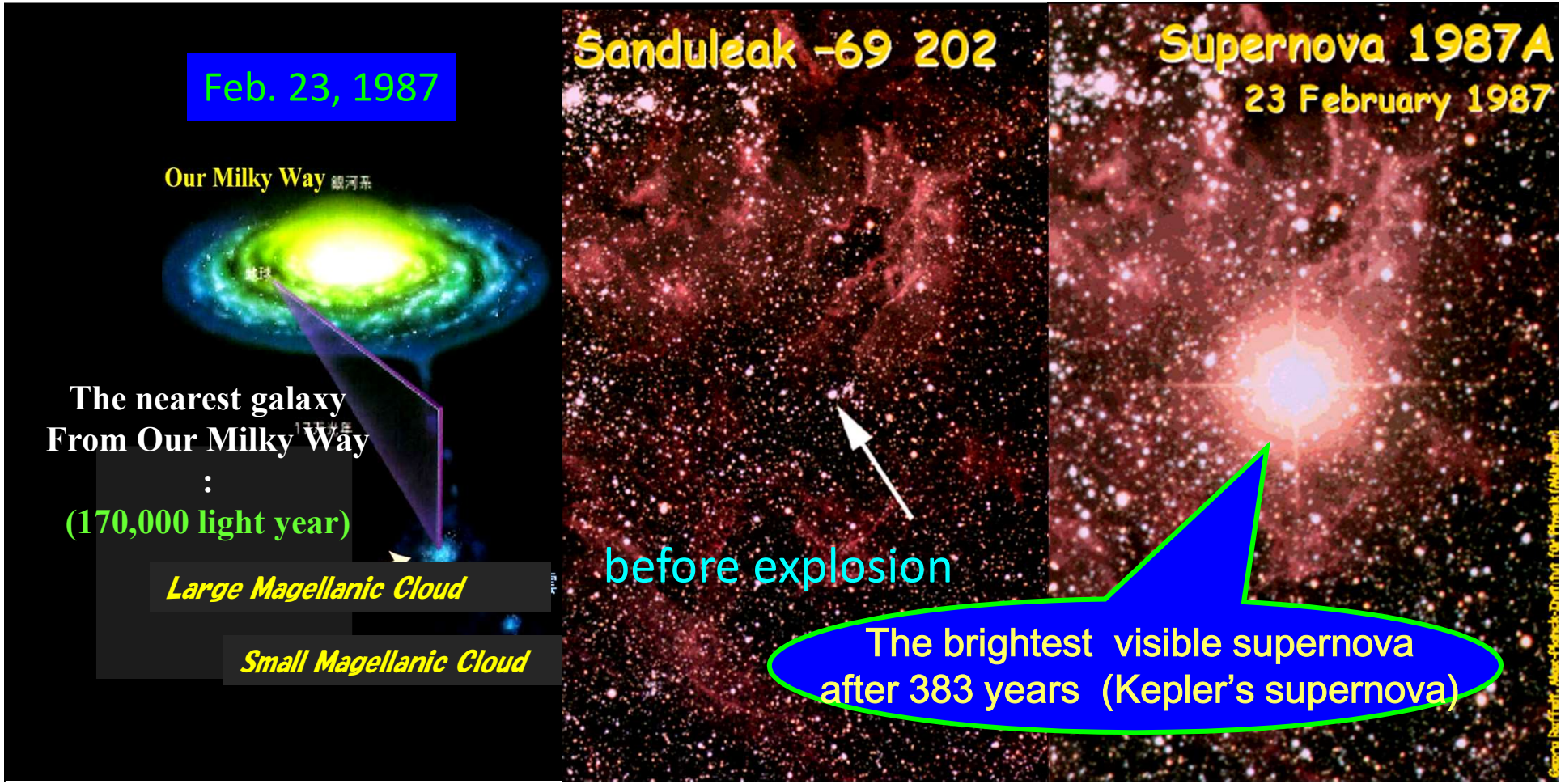






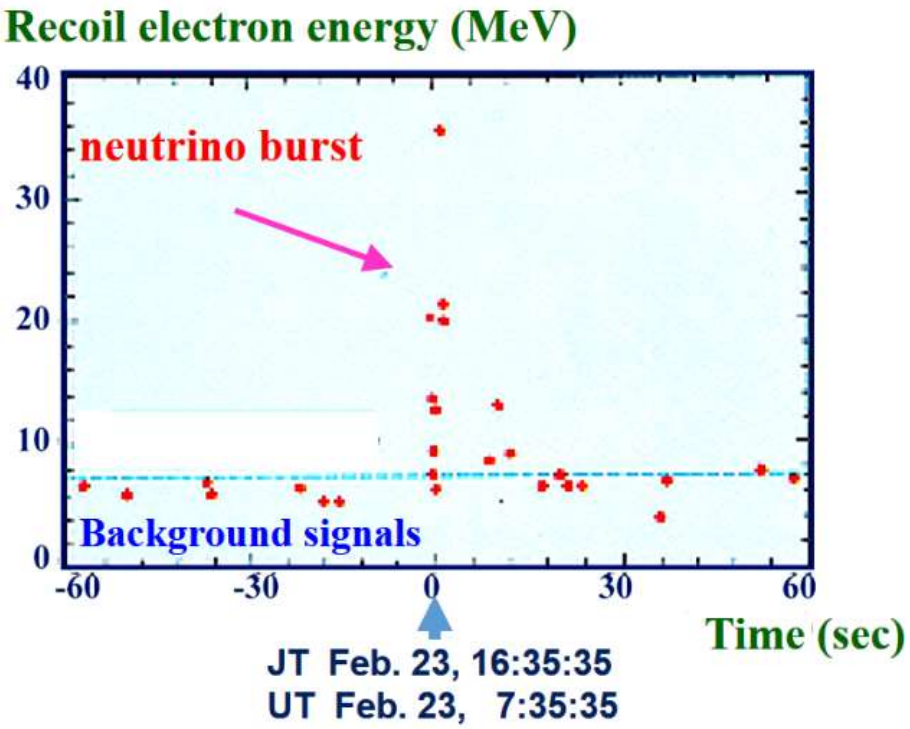
5. SN1987A

In less than 2 months after data-taking
a bunch of billions upon billions of extragalactic
messengers swept through the Earth.



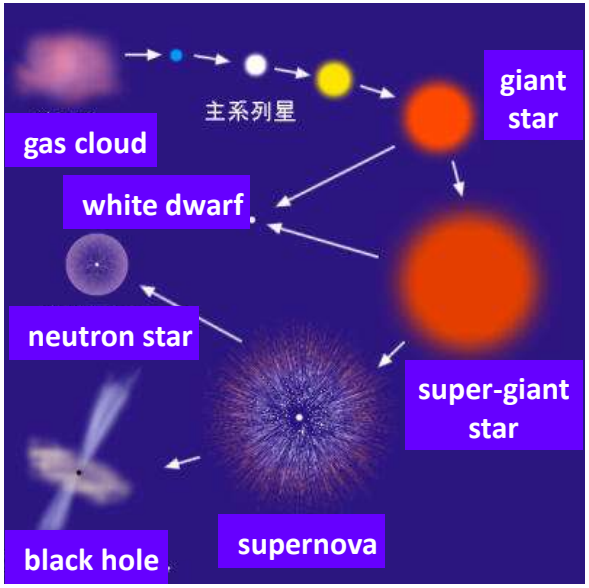
First Observation of Messengers : Supernova Neutrino Burst

11 events (E ≧7.5 MeV) during 13 sec.



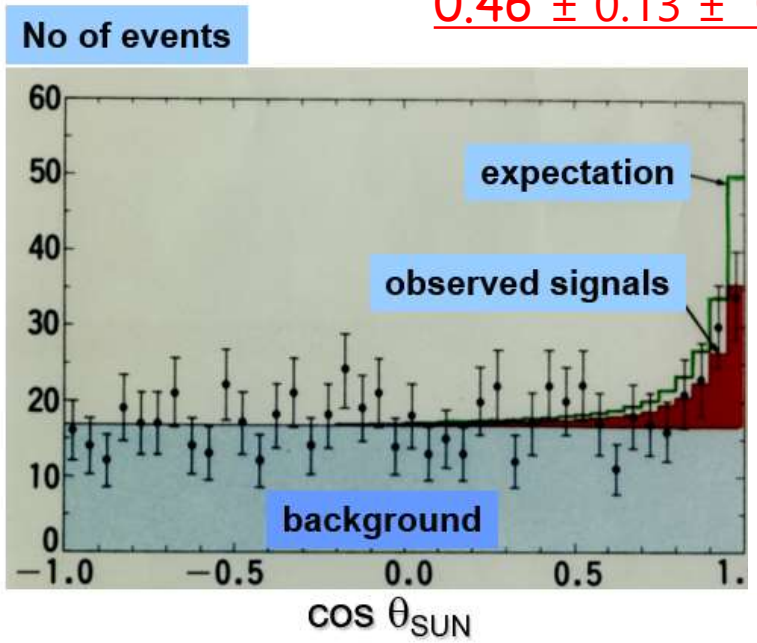
Event number	Event time (sec)	Number of PMT's (N_{hit})	Electron energy (MeV)	Electron angle (degrees)
1	0	58	20.0 ± 2.9	18 ± 18
2	0.107	36	13.5 ± 3.2	15 ± 27
3	0.303	25	7.5 ± 2.0	108 ± 32
4	0.324	26	9.2 ± 2.7	70 ± 30
5	0.507	39	12.8 ± 2.9	135 ± 23
6	0.686	16	6.3 ± 1.7	68 ± 77
7	1.541	83	35.4 ± 8.0	32 ± 16
8	1.728	54	21.0 ± 4.2	30 ± 18
9	1.915	51	19.8 ± 3.2	38 ± 22
10	9.219	21	8.6 ± 2.7	122 ± 30
11	10.433	37	13.0 ± 2.6	49 ± 26
12	12.439	24	8.9 ± 1.9	91 ± 39

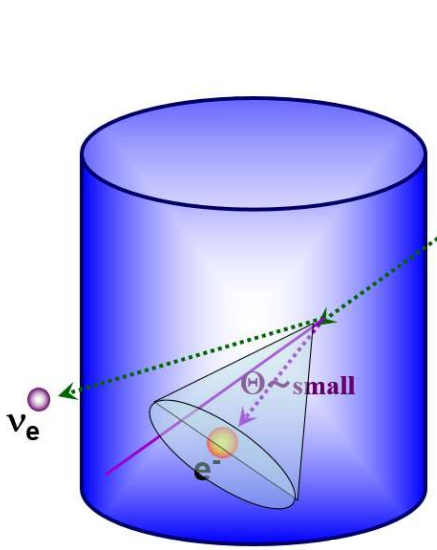
- First Experimental Verification of Star Evolution theory
- Open Neutrino Astronomy

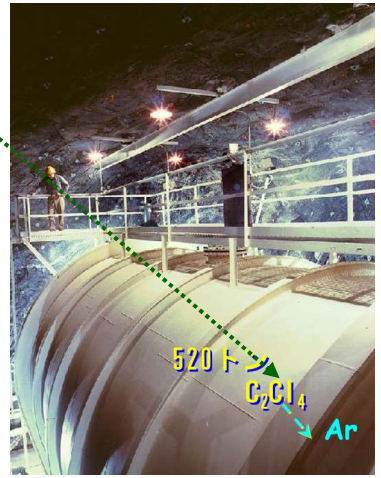


6. Solar Neutrinos

Kamiokande-II "Observation of ^{8}B Solar Neutrinos" Result :
0.46 ± 0.13 ± 0.08 of Standard Solar Model (1989)

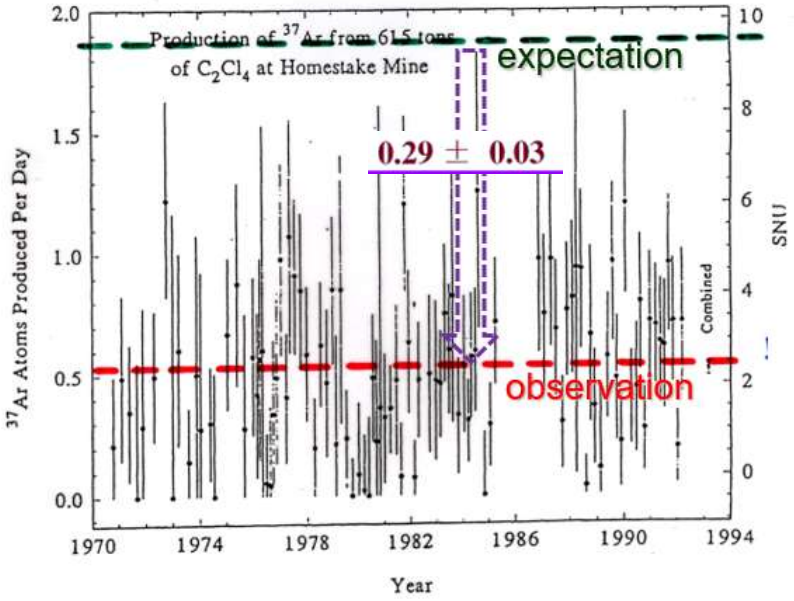




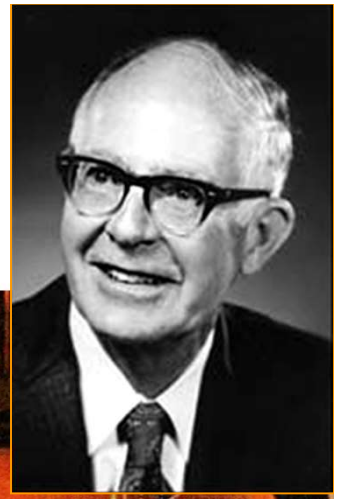


Kamiokande-II Confirmed
"Solar Neutrino Deficit"

originally observed in Homestake experiment led by Ray Davis



Masatoshi Koshiba & Ray Davis
Nobel Prize in Physics
(December 10, 2002)



pioneering contribution to astrophysics,
particular for the detection of cosmic neutrinos

7. Original Idea of Super-Kamiokande

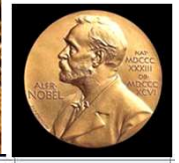
More Neutrinos

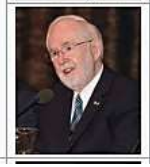
+

More Chances

to detect proton decays

More Light



2015		Takaaki Kajita **Super-Kamiokande**
		**SNO** Arthur B. McDonald

for the discovery of neutrino oscillations, which shows that neutrinos have mass

Koshiba : Original Idea in 1983

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THE EUROPEAN PHYSICAL JOURNAL H

On the origin of the Kamiokande experiment and neutrino astrophysics

T. Kajita[1,a], M. Koshiba[2], and A. Suzuki[3]

As a future major experiment at Kamioka, a large water Cherenkov detector with a sensitive mass of 32,000 ton was proposed in 1983 and presented, for the first time, at the Workshop on Grand Unified Theories and Cosmology, which was held in KEK (KEK report: KEK-84-12, pp. 24-31). The name of the experiment was initially called **JACK** (Japan-America Collaboration at Kamioka).

In the autumn of 1983, when the ^{8}B solar neutrino studies with Kamiokande was proposed, M. Koshiba thought that the event rate was too low for Kamiokande to carry out detailed studies of solar neutrinos as an observatory. Therefore, in order to really open a new field of neutrino astrophysics, a detector with much higher event rate, and therefore a much larger detector than Kamiokande, was required. This was the motivation for M. Koshiba to propose this detector.

32 Kton Water Cerenkov Detector(JACK)

A proposal for detailed studies of nucleon decays

and for low energy neutrino detection

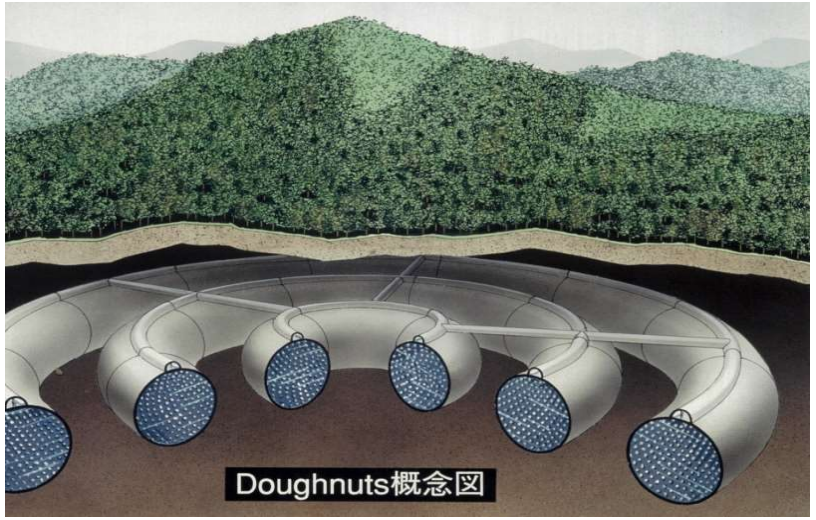
KAMIOKANDE collaboration

M.KOSHIBA

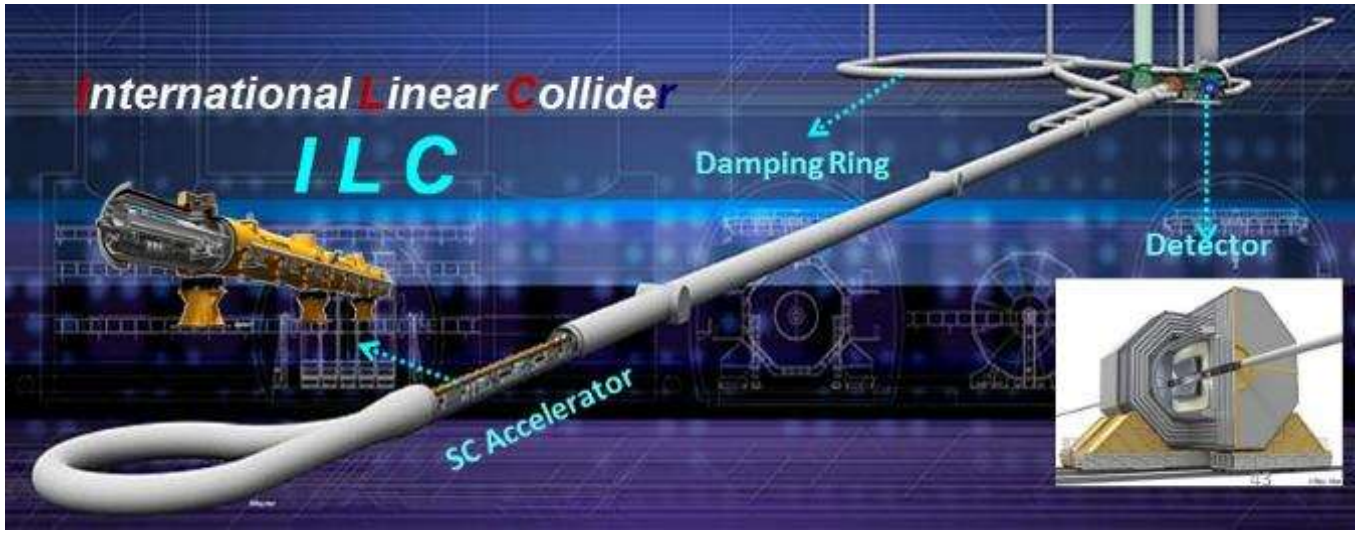
The name of **Super-Kamiokande** was given in the following year (1984).

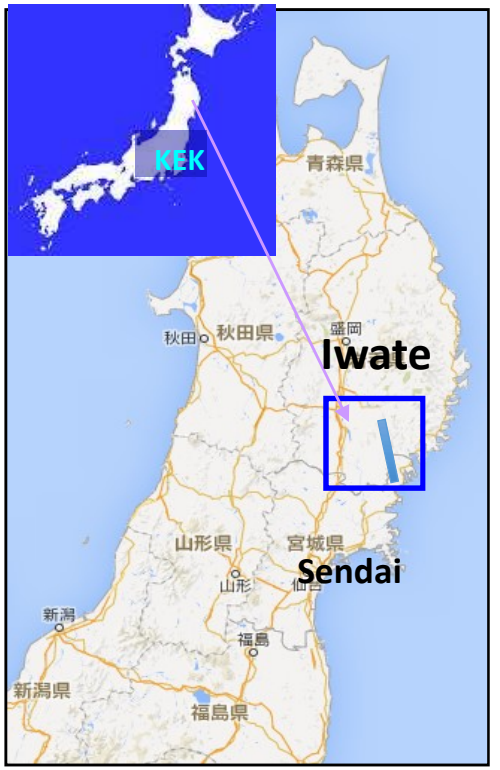
Koshiba's Hyper-Kamiokande idea in 1990's

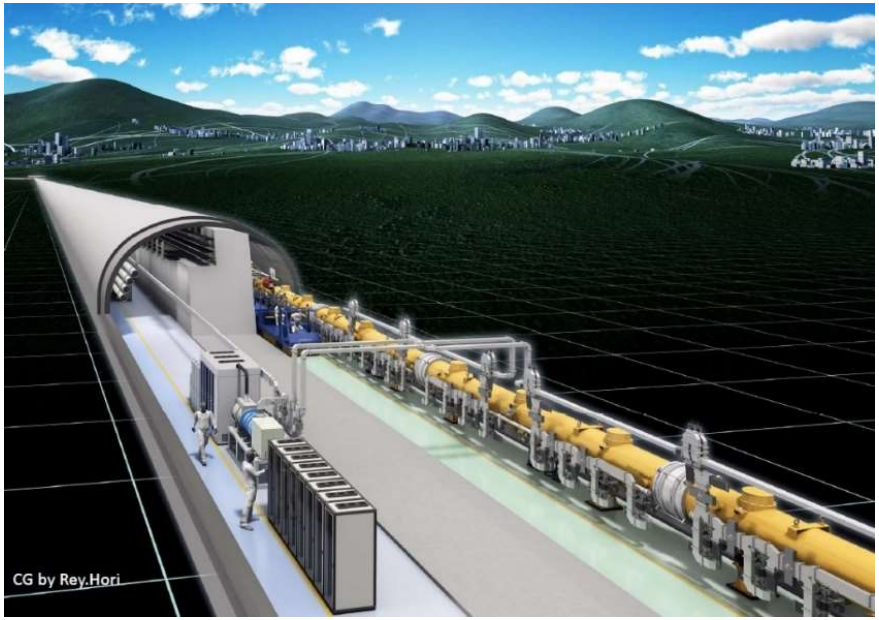
Doughnuts : overcomes less transparency of water, and promotes Neutrino Telescope.



8. One More Dream : Next Generation e^- e^+ Collider (ILC) in Japan







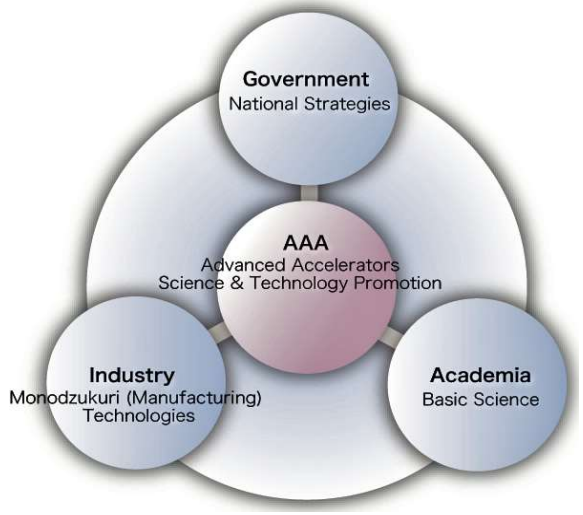
Federation of Diet Members for promotion of the ILC project

Kickoff Meeting : July 31st, 2008

(June 11, 2008)

Advanced Accelerator Association Promoting Science & Technology

Honorary Chairman : *Masatoshi Koshiba*



ILC Milestone

9. Closing Remarks

- Koshiba always worked on his research with keen intuition, passion, and outstanding planning and leadership.

- His innovative ideas inspired younger researchers, who built on his work to realize his dreams.

Koshiba's Didactic Messages :

① A researcher should always hold three or four "eggs" (research ideas) at a time but should regularly ask whether each egg can still become a bird. If not, then the idea is no longer worth holding.

② Experimental equipment should incorporate as many distinctive devices as possible. That way, even if you fail catch the prey you are aiming for, you will have a chance to catch other prey.