中山大學 物理与天文学院
SUN YAT-SEN UNIVERSITY SCHOOL OF PHYSICS AND ASTRONOMY

The Status of NEON

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On behalf of NEON group

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Contents

- Scientific motivation and goal
- Deep-sea neutrino telescope design, and simulation
- Detector design and assemble
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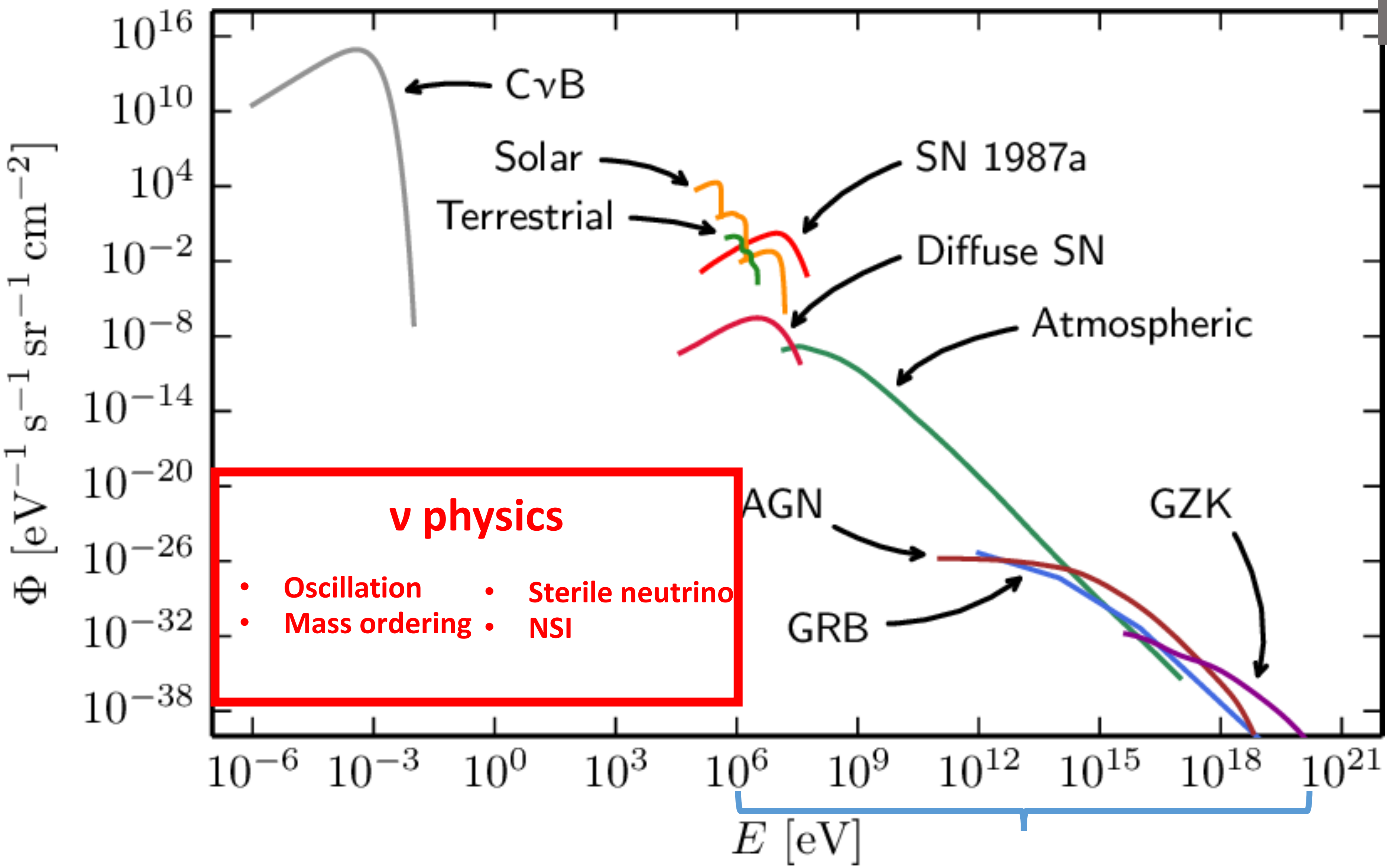
Scientific motivation and goal

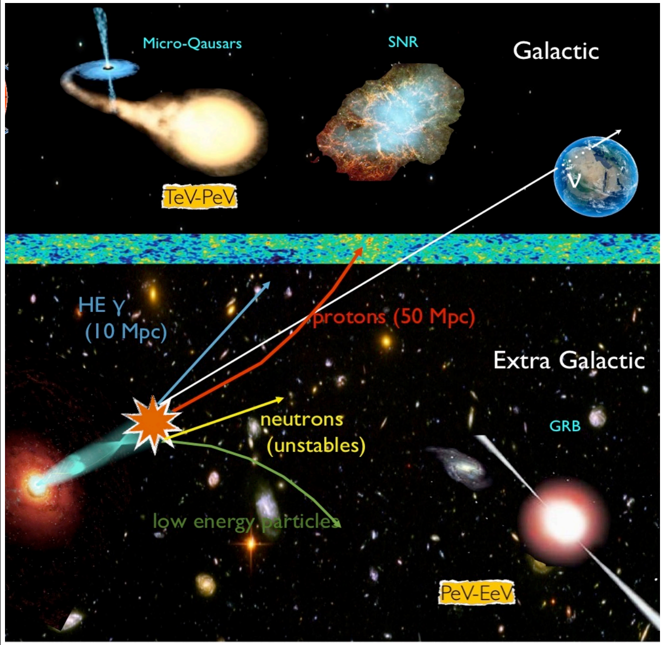


ν physics

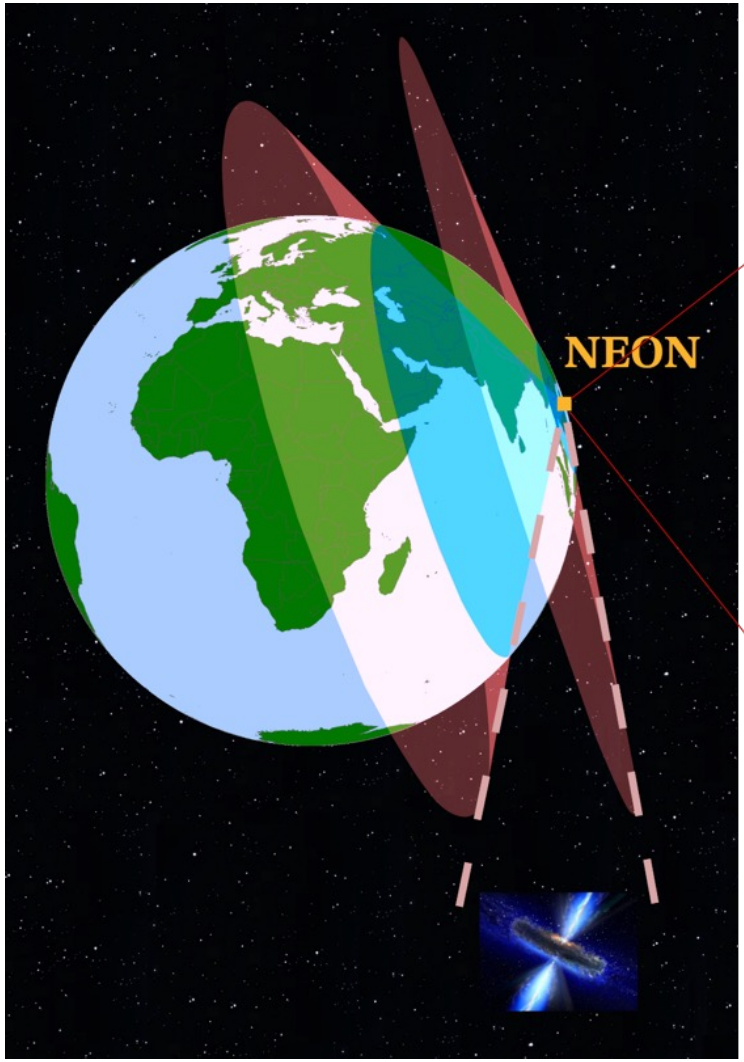
- Oscillation
- Mass ordering
- Sterile neutrino
- NSI

Astrophysics

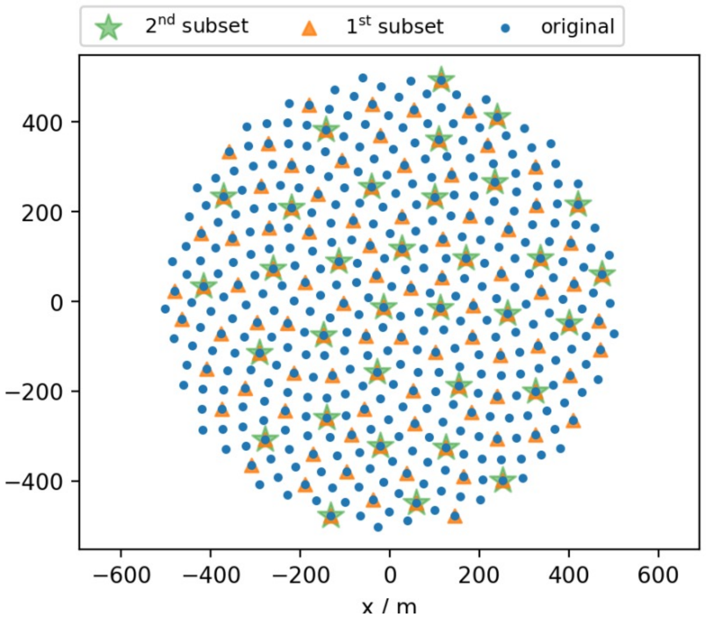
Multi-messenger Astronomy: Origin of CRs, astrophysical environments…



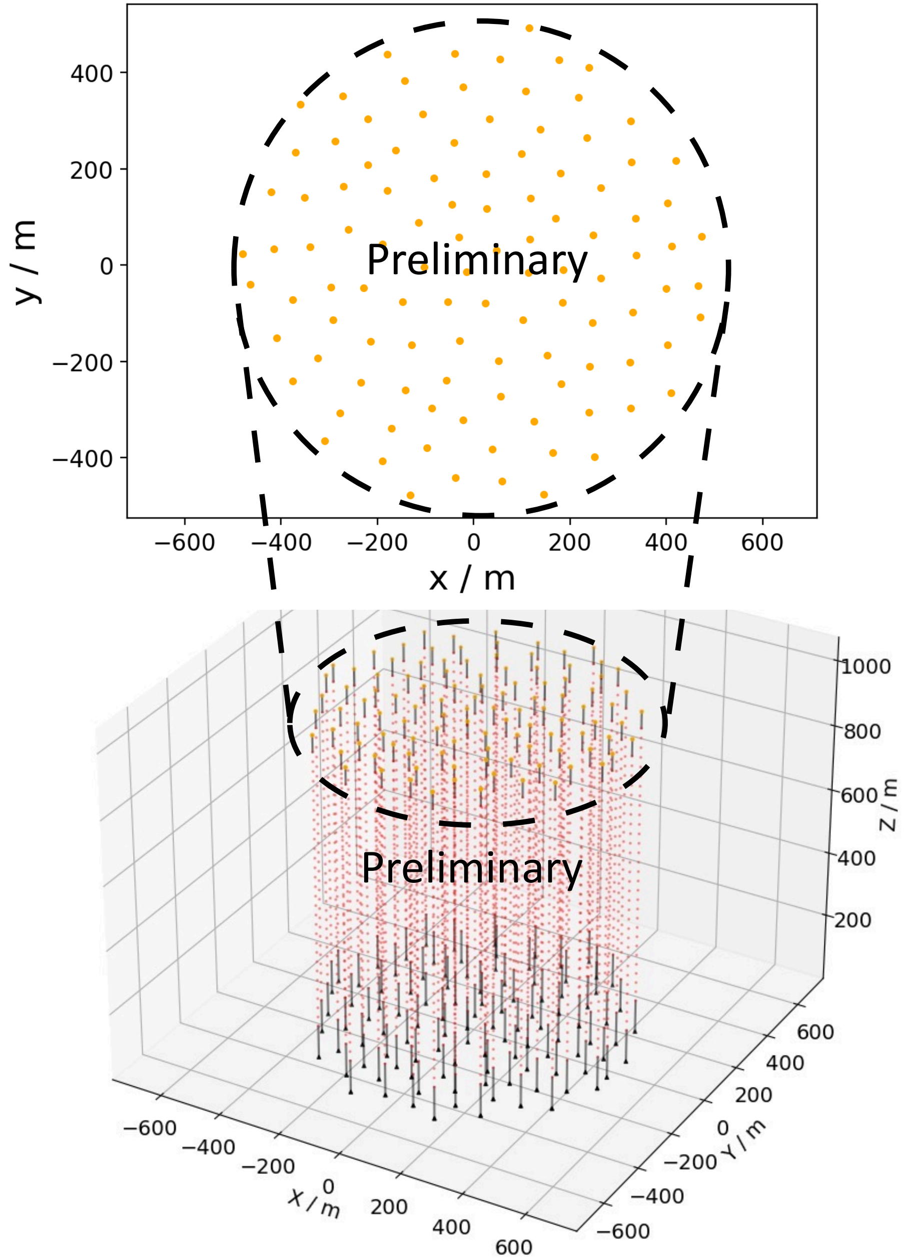
Neutrino Observatory in the Nanhai (NEON)



Array Design



Fibonacci layout

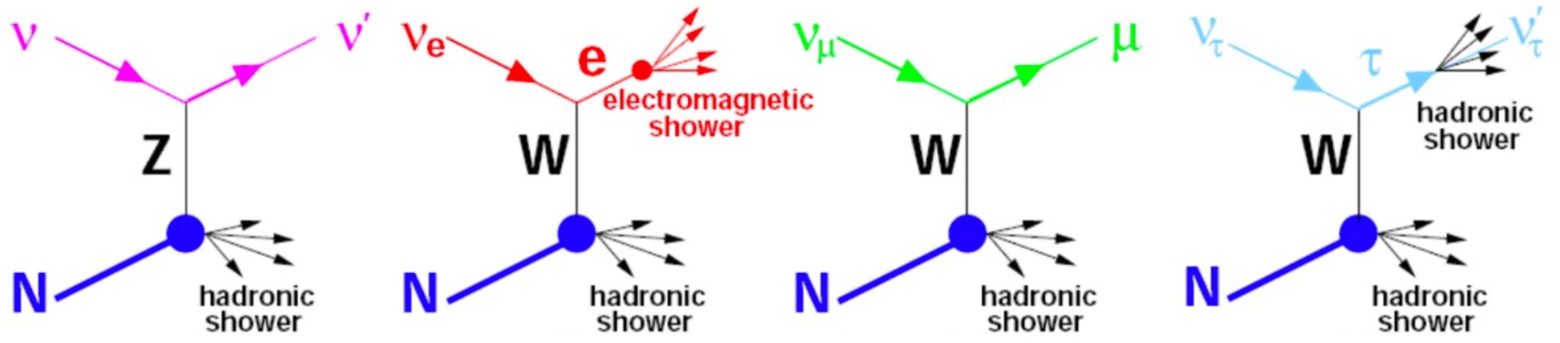


type	d_{vertical}	$d_{\text{horizontal}}$	R	Ψ_{50}
STD	30 m	100 m	250 m	0.4
$L^{\text{den}}_{\text{ver}}$	10 m	100 m	250 m	0.3
$L^{\text{spa}}_{\text{ver}}$	50 m	100 m	250 m	0.4
$L^{\text{den}}_{\text{hor}}$	30 m	50 m	250 m	0.2
$L^{\text{spa}}_{\text{hor}}$	30 m	200 m	250 m	1.2
L^{large}	30 m	100 m	500 m	0.2
L^{small}	30 m	100 m	125 m	0.8

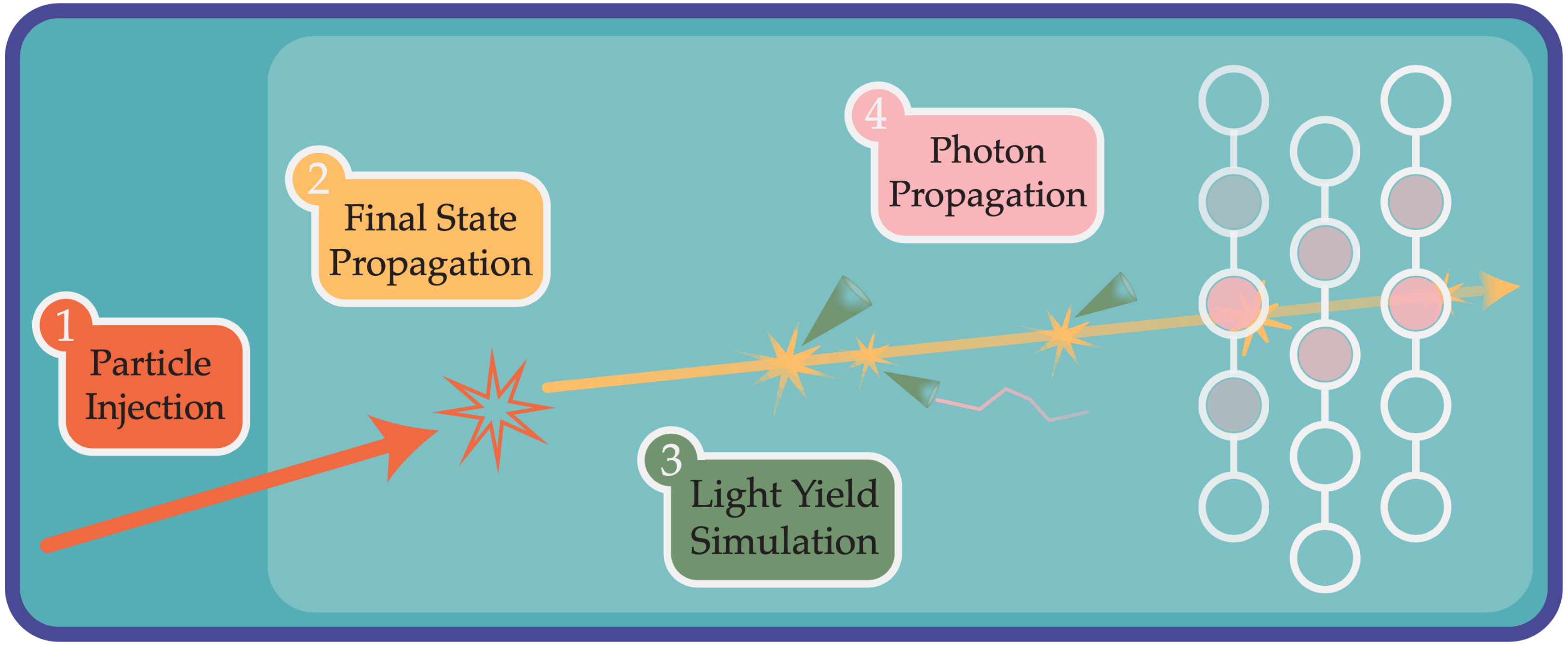
The behavior of some subsets.

The simulation chain

- Neutrino interacts with water
- Secondaries propagating in water
- Photons are emitted secondary particles
- Propagation of photons, considering scattering and absorption



Neutrino interactions:
NC, $\nu_e CC, \nu_\mu CC, \nu_\tau CC$

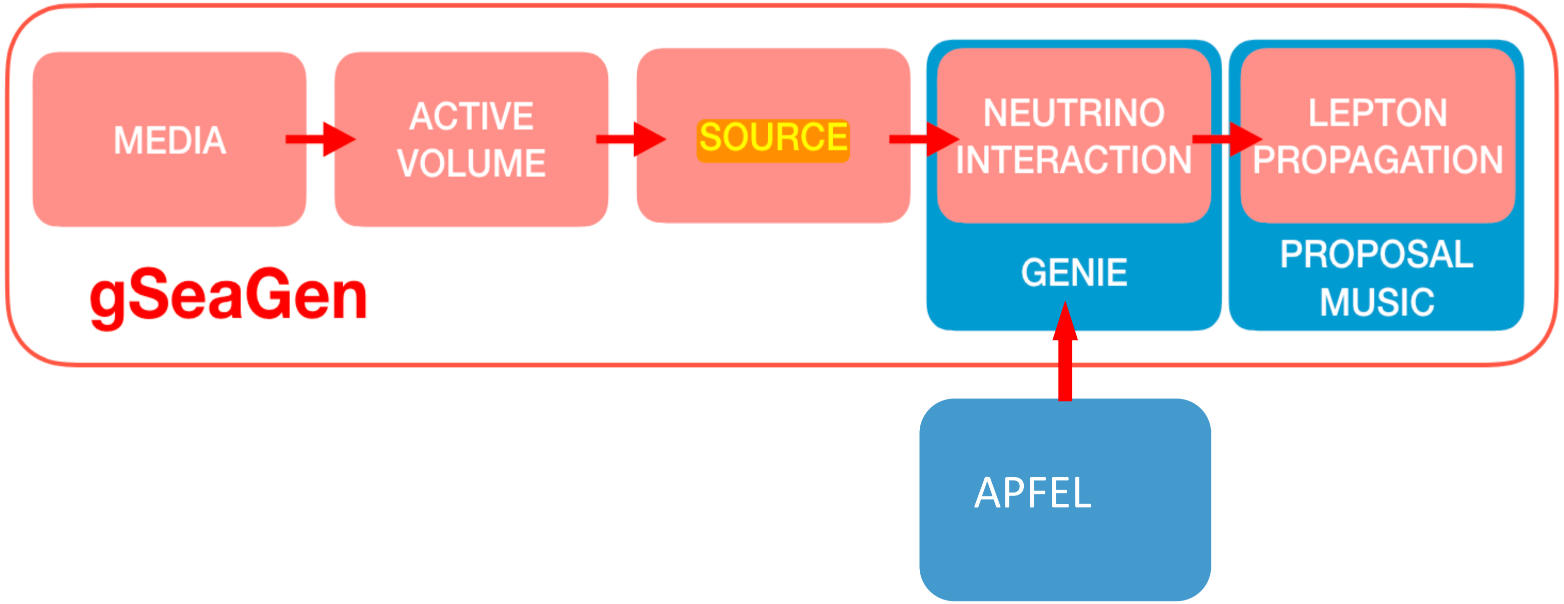


Event generator:

- gSeaGen (Base on GENIE)
- High Energy Extension: APFEL

Energy range: 100keV - 100PeV

Neutrino type: All type



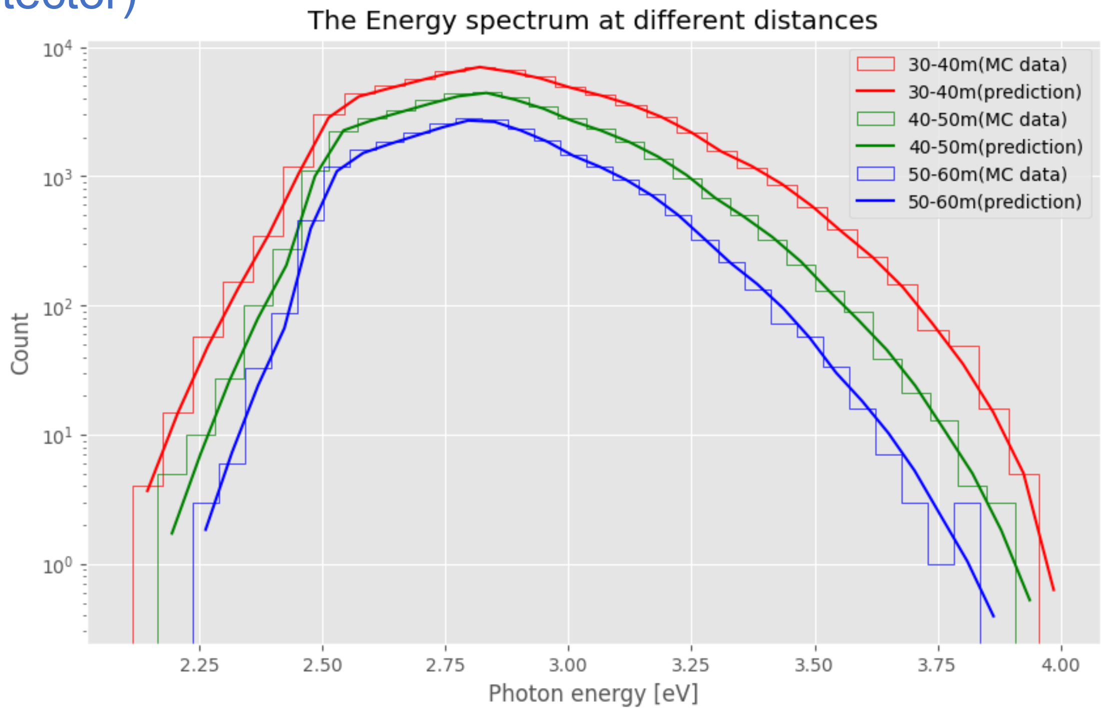
The ^{40}K background study

$$N_{photon}^{obs}(r) = A \times \sum_{\lambda}\left(Q_{\lambda} \times \eta_{\lambda} \times e^{-\frac{r}{L'_{\lambda}}}\right)$$

Simulation parameters

Obtained with simulation in Geant4 (^{40}K decay near to detector)

(1) Reasonable and Effective
(2) Easily apply to other isotopes and detectors.

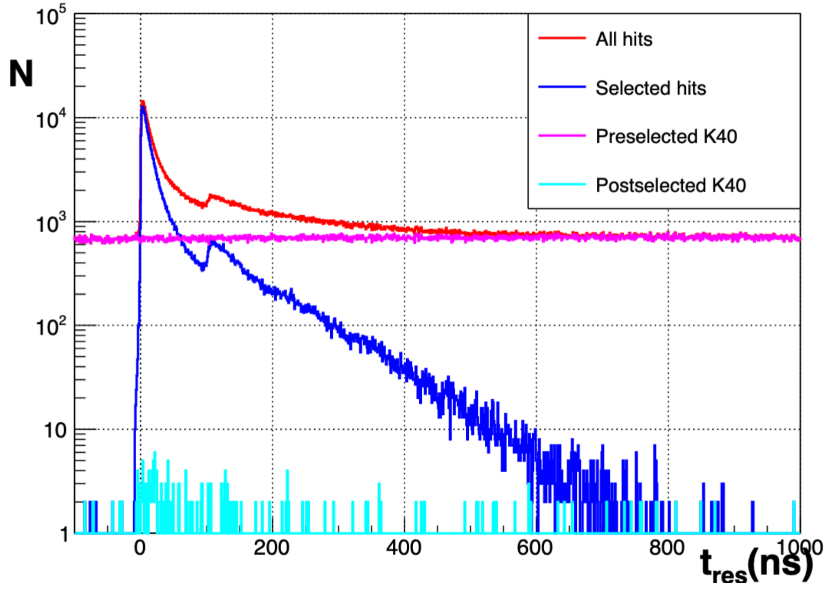


Max opacity: 28m

The number of hited PMT in 10 ns	Event Count [%]
1	97.16
2	2.79
3	4.78×10^{-2}
4	4.93×10^{-4}

Reconstructioin

$$|\Delta t| - \frac{\Delta r}{v} < 20\text{ns} \, , \left| |\Delta t| - \frac{\Delta r}{c} \right| < 500\text{ns}$$



- **K40 decay (major noise).**
- Light emitted by organic matter when it is disturbed, or by deep-sea fish as a biological response.
- PMT dark current.

1. Linear fit (fastest)

$$\vec{d} = \sum_{i,j\,(t_j > t_i)} w_{ij}(\vec{P_j} - \vec{P_i}), \text{ where } w_{i,j} = q_j + q_i \text{ and } q \text{ is}$$

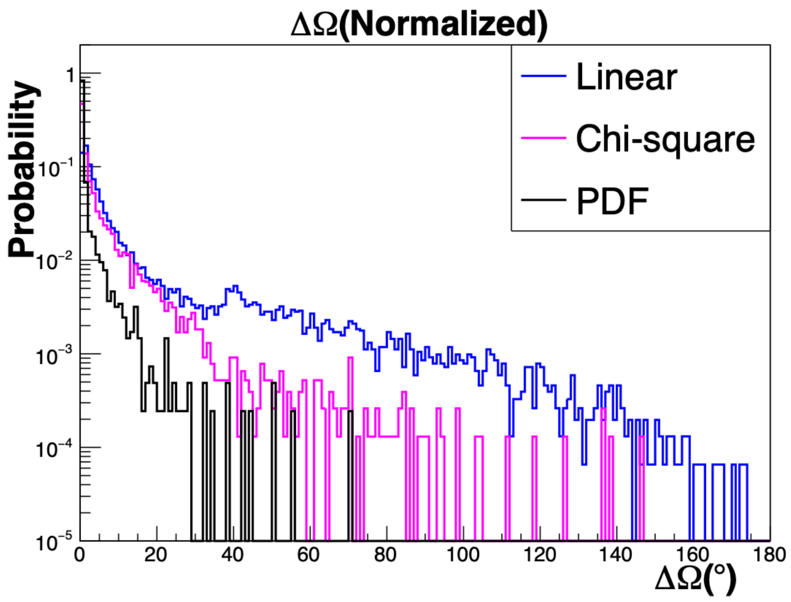
photon electron

2. Chi-square fit

$$\chi^2 = \sum_i (t^i_{\text{res}})^2$$

3. PDF fit (the most accurate)

$$L(t^1_{\text{res}}, t^2_{\text{res}}, \ldots, t^n_{\text{res}} \mid \vec{P}, \vec{d}) = \sum_i f(t^i_{\text{res}} \mid \vec{P}, \vec{d})$$



Reconstructioin

- **K40 decay**
- Light emitte
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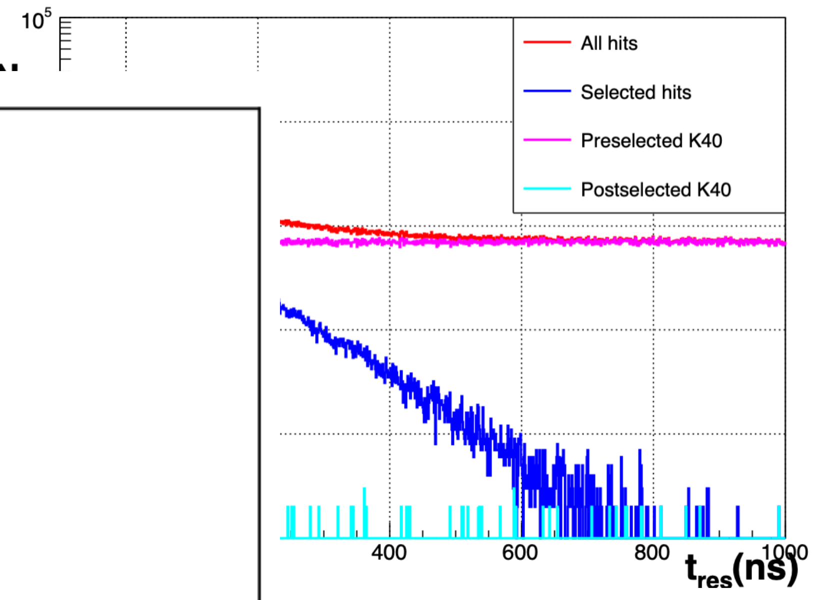
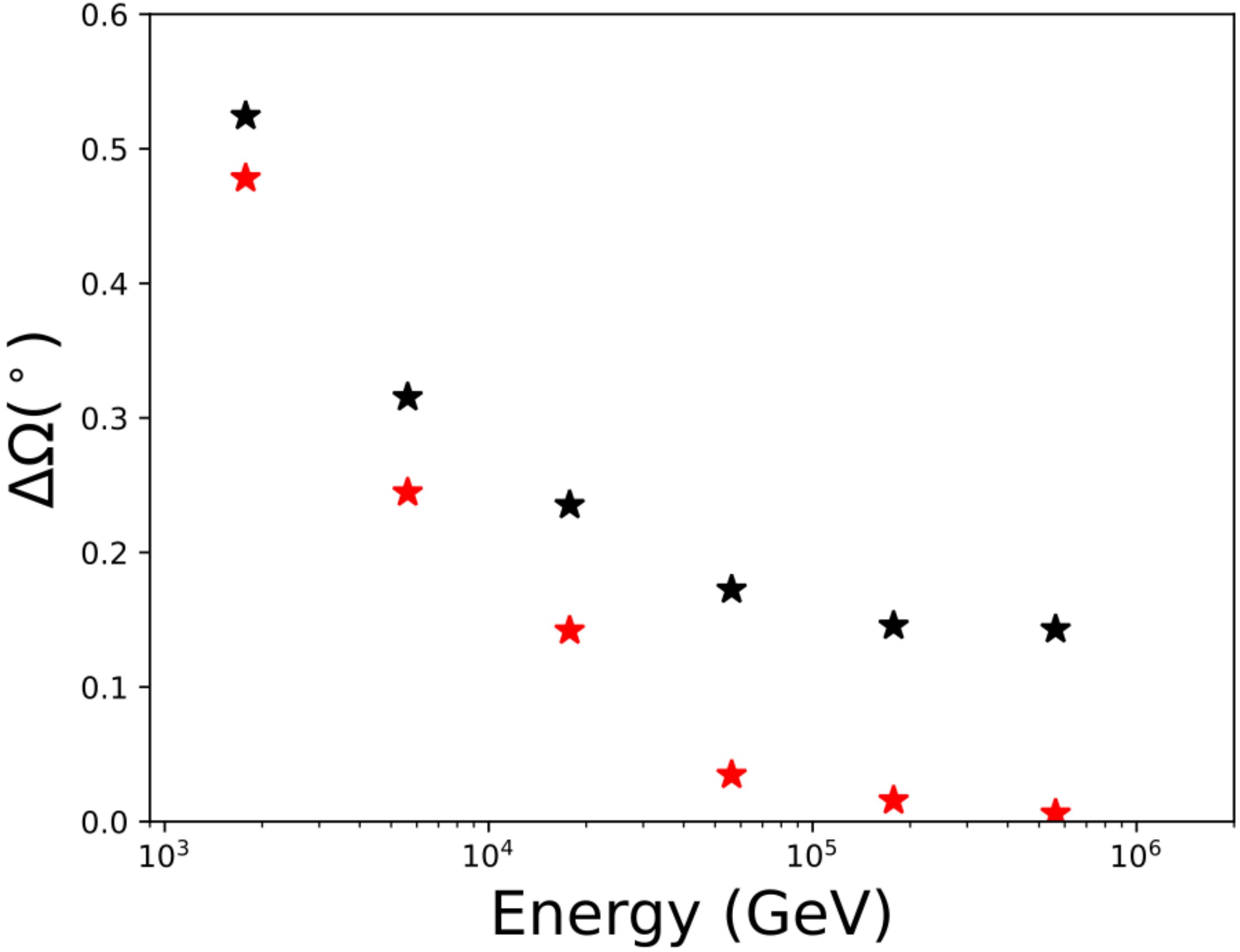
- PMT dark cu

$$|\Delta t| - \frac{\Delta r}{\,} < 20\text{ns}\,,\ \left||\Delta t| - \frac{\Delta r}{\,}\right| < 500\text{ns}$$





1. Linear fi

$\vec{d} = \sum_{i,j\,(t_j>t}$

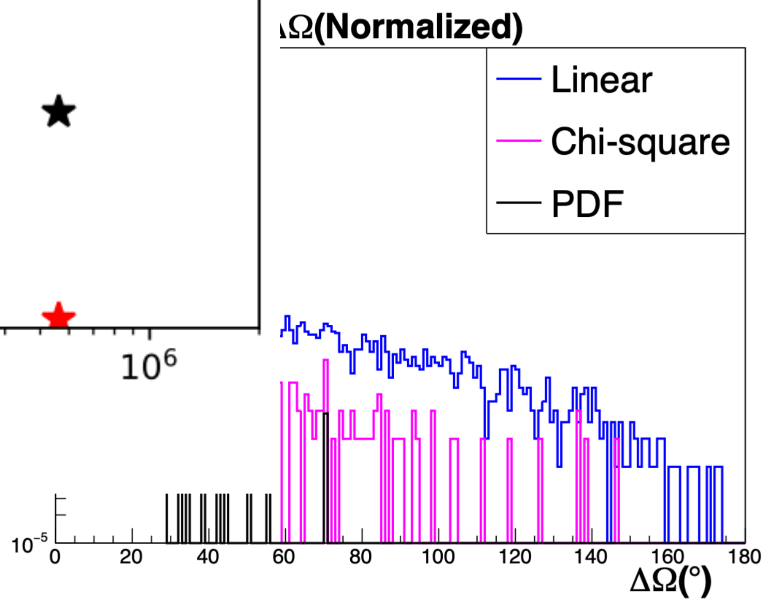
photon el

2. Chi-squa

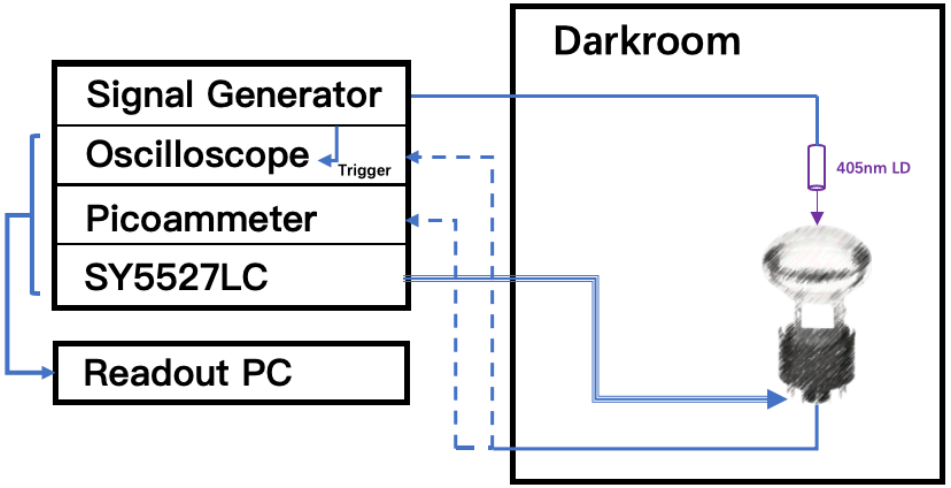
$\chi^2 = \sum_i$

3. PDF fit (

$$L(t^1_{\text{res}}, t^2_{\text{res}}, \ldots, t^n_{\text{res}} \mid \overrightarrow{P}, \vec{d}) = \sum_i f(t^i_{\text{res}} \mid \overrightarrow{P}, \vec{d})$$



Detector design and assemble



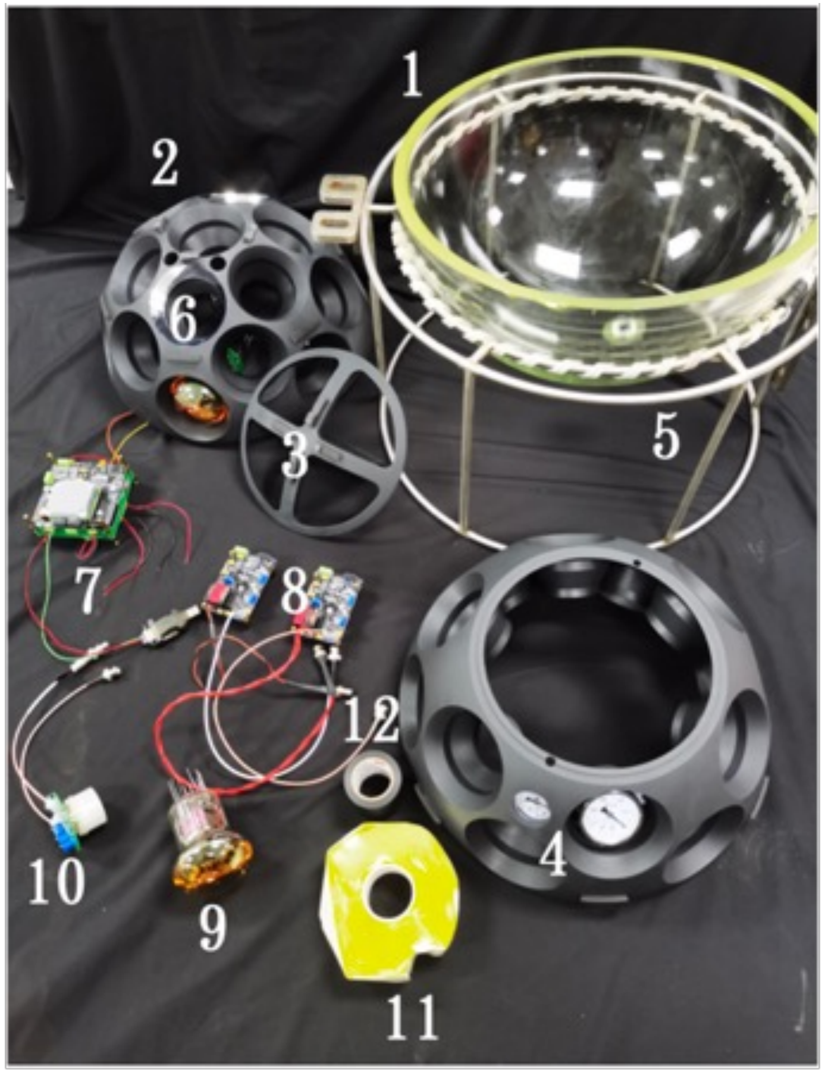
- Higher QE, SNR and PMT production consistency are important for NEON.
- Two types of PMTs are acceptable

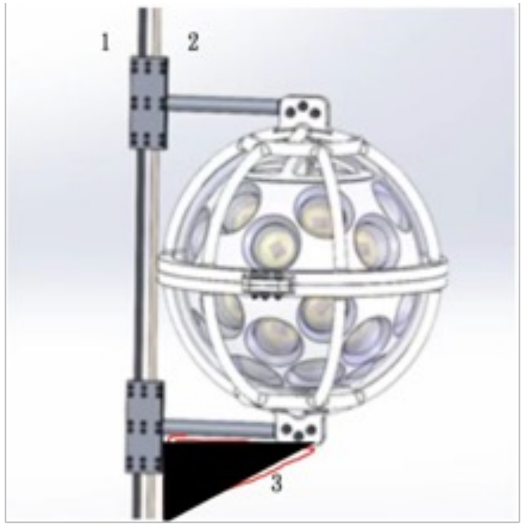
	Serial number	QE(%)	Voltage(V)	Gain	P/V	Dark current (nA)	DCR(Hz)
						Dark performance	
NNV	PN2304-1128	29.7	985	5.50E+06	2.62	0.56	459
NNV	PN2304-1135	29.9	1058	5.35E+06	2.15	1.32	1993
NNV	PN2303-5507	28.5	1005	5.34E+06	2.05	1.35	526
NNV	PN2304-1365	27.8	990	4.85E+06	2.26	0.35	360
Hamamatsu	KM57217	29.0	1000	5.01E+06	2.14	0.60	437
Hamamatsu	KM61655	29.8	1025	5.05E+06	2.98	0.87	633
Hamamatsu	KM57154	27.1	1000	4.88E+06	2.25	1.23	1178
Hamamatsu	KM57446	28.2	1010	5.13E+06	3.05	1.56	912

Hamamatsu

Certain Gain Range

OM Design and Assemble





Future Plan

- As one of the most important member in multi-messenger astronomy, neutrinos telescopes should be constructed with better resolution and sensitivity.
- As we had the first attempt last week, future improvement is planned and ongoing.
- GNN technique will be applied to shower/track identification and reconstruction.
- Upgrade the FPGA and lower the power consumption.
- The build and construction of deep-sea neutrino telescope is challenging, but super attractive.

Thank you!