KNO
(Korea Neutrino Observatory)

(On behalf of KNO group)

전남대 주경광

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2019-09-20 @IBS, 대전

회의 목적

(Prof. I.T. Yu)

실험 발표자 분의 경우,
>
> - 실험목적 및 과학적인 중요성
>
> - 진행중인 실험의 경우, 과거의 실적 및 결과
>
> - 경쟁실험과 비교 시 상대적인 경쟁력
>
> - 한국 그룹의 연구인력, 검출기, 물리 연구 등의 측면에서 과거 공헌도 (진행중인 실험의 경우) 및 향후 계획
>
> - 향후 10년 동안의 실험 스케쥴
>
> - 향후 10년 동안의 예산 소요
>
> - 실험이 한국 HEP에 미치는 기대효과 (물리, 인력양성, 검출기 기술 등)

최대한 저희 쪽 의향이 전달될 수 있도록 노력

Fundamental Questions on Neutrino

- Absolute neutrino masses? (Why so small?)
- Neutrino mass ordering? (Normal or inverted?)
- Dirac or Majorana? (Neutrinoless double beta decay?)
- Leptonic CP violating phase? (쿼크 sector는 비교적 잘 알려져 있음)
- 3 ν paradigm enough? (Sterile neutrino?)
- Why so large neutrino mixing angles?
- Neutrino burst from a Supernova in our Galaxy, Solar neutrinos, Atmospheric neutrinos, Geo-neutrinos, etc

- 우주의 구성 원리와 진화 과정의 핵심을 관통하는 거대 주제들 중의 하나임
- 중성미자 물리학은 BSM을 살펴보기 위한 가장 큰 창문이며 좋은 역할을 담당해 옴

HK (Hyper-Kamiokande)

Kamiokande (1983-1996)
3000 ton

Super-Kamiokande (1996-)
50,000 ton

Hyper-Kamiokande (~2026-
2×260,000 ton

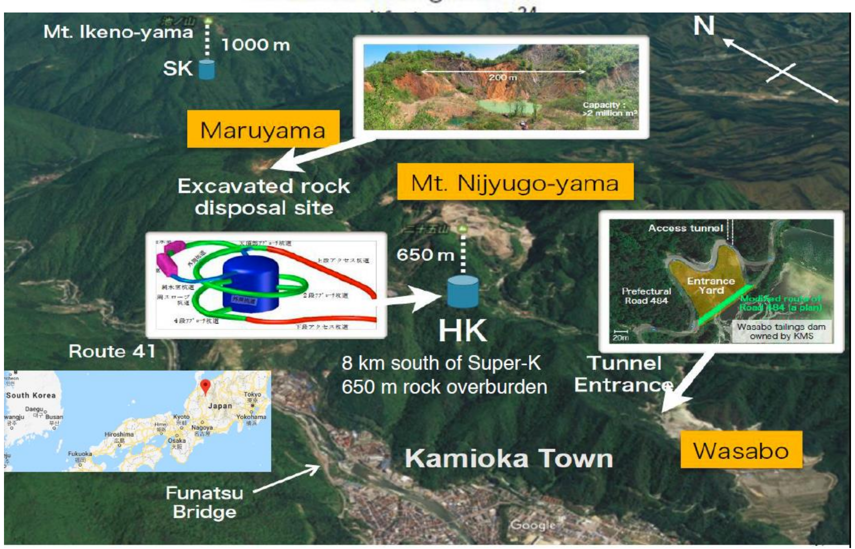
- Neutrinos from SN1987a.
- Atmospheric neutrino deficit.
- Solar neutrinos.

명실상부한
일본 중성미자
연구의 핵심장소
중의 하나

- Atmospheric neutrino oscillation.
- Solar neutrino oscillation with SNO.
- Far detector for KEK-PS (K2K) and J-PARC beam (T2K): electron neutrino appearance.
- World leading limit on

Physics programme:

- Neutrino oscillations: Mass Hierarchy, Leptonic CP violation, θ_{23} Octant,...
- Nucleon decay: $p \to e^+ \pi^0$, $p \to K^+ \bar{\nu}$,...
- Neutrino astrophysics: Solar neutrinos, Supernova neutrinos, WIMP searches



HK Status

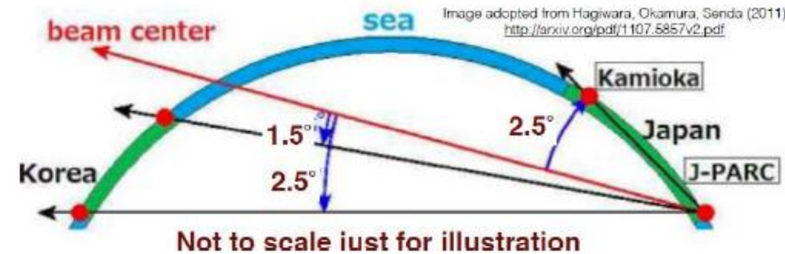
- HK proto-collaboration was formed
- U of Tokyo commitment ensures that the HK construction will begin in April, 2020
- Two host institutions:
  - U of Tokyo (ICRR)
  - KEK (IPNS)
- Japanese funding agency (MEXT) provided a seed funding for HK in 2019. → standard process in Japan for large projects to begin with a year of seed funding
- MEXT has made an official budget request in August according to Yomiuri newspaper (2019. 8. 21).

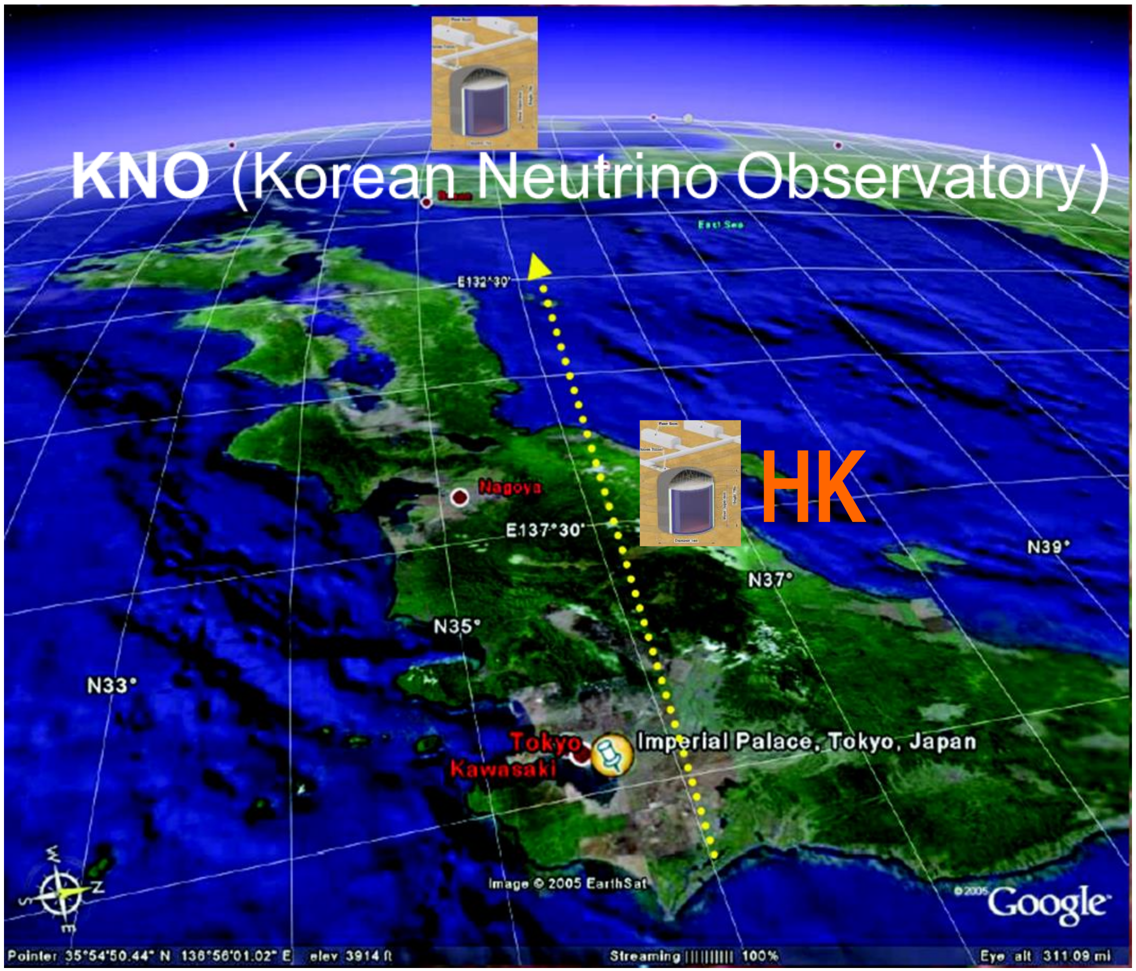
Operation (목표): 2027 ~

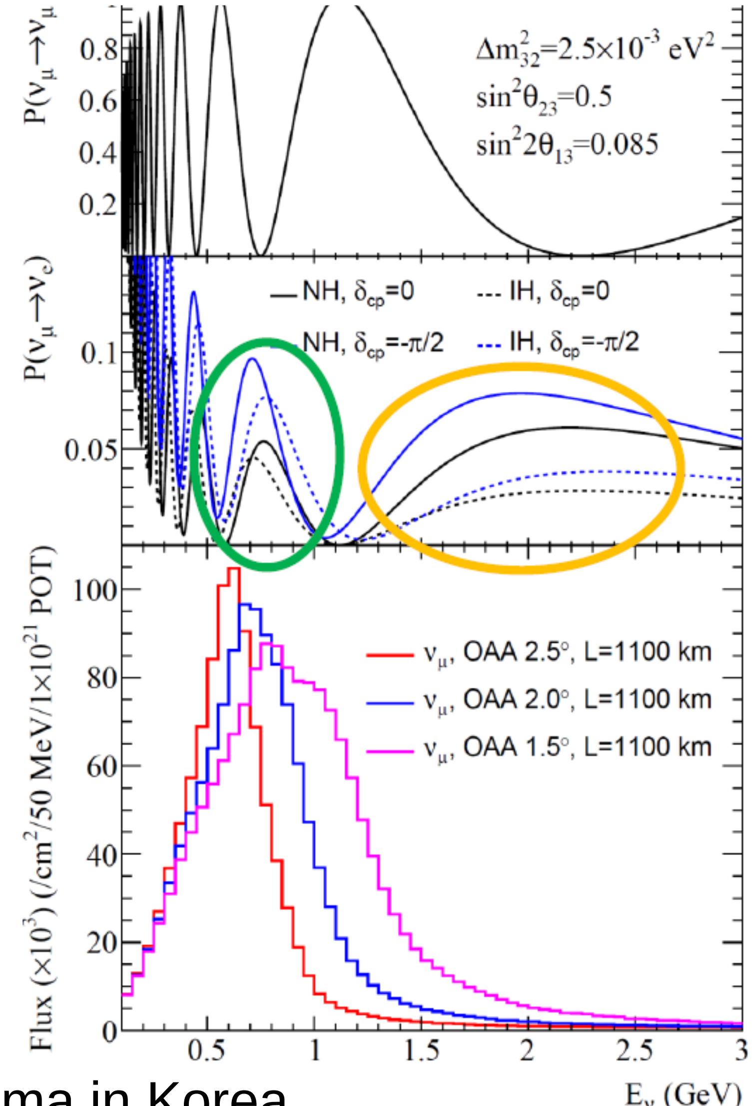
KNO

T2KK, T2HKK or **KNO**?
(played as a 2nd Hyper-K detector in Korea)

J-PARC off-axis neutrino beam comes to Korea





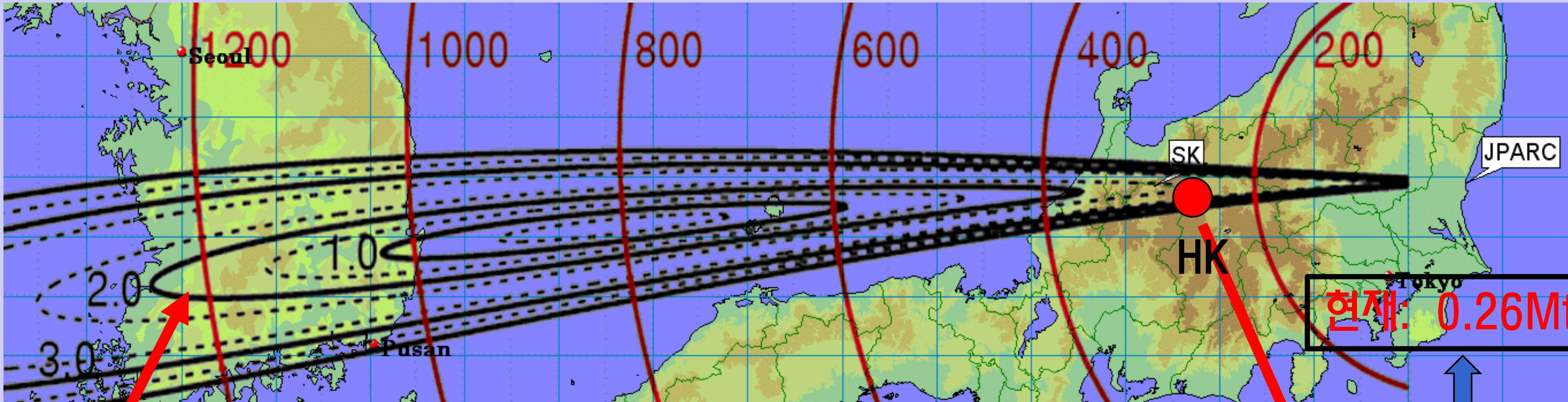


Baseline ~1100km: next oscillation maxima in Korea

J-PARC neutrino beam

Dr. Okamura & Prof. Hagiwara **(2005)**

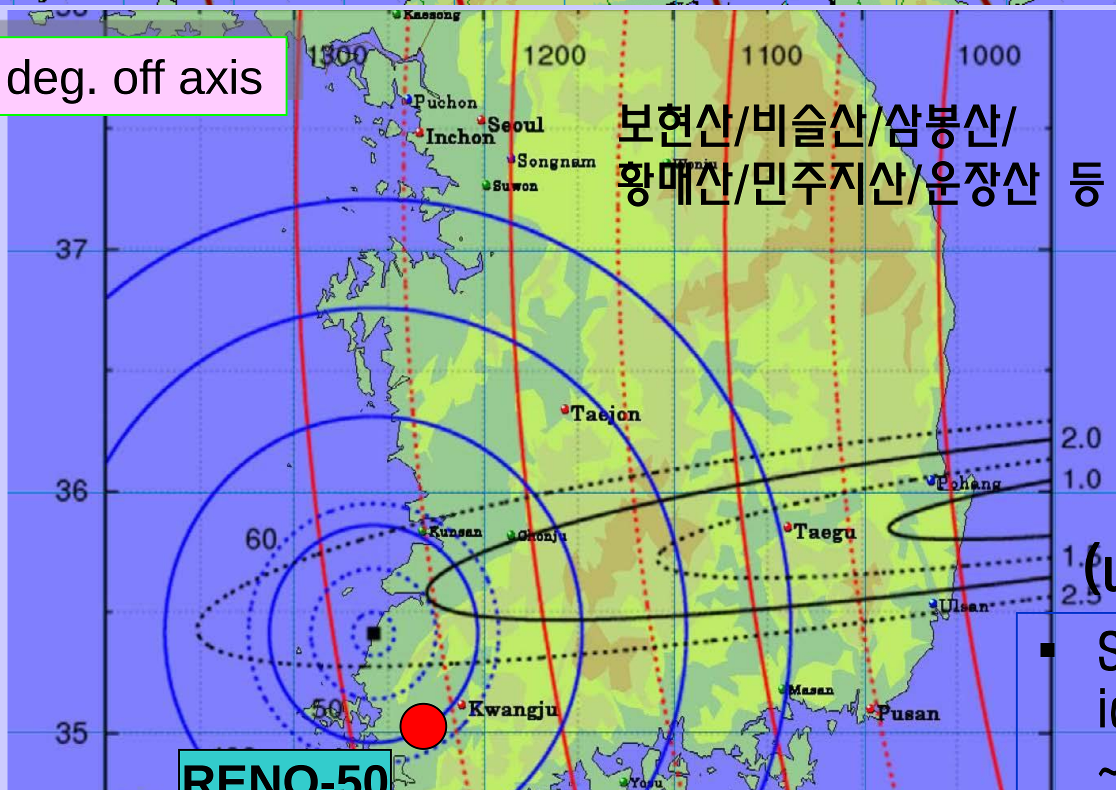
International Workshop on a Far Detector in Korea for the JPARC Neutrino Beam



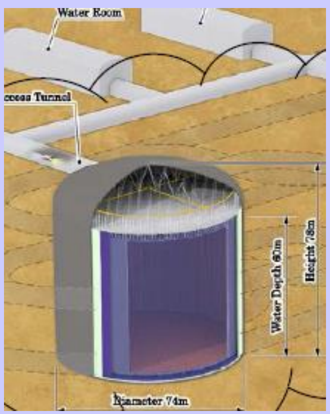
현재: 0.26Mt

0.5Mton

2~3 deg. off axis



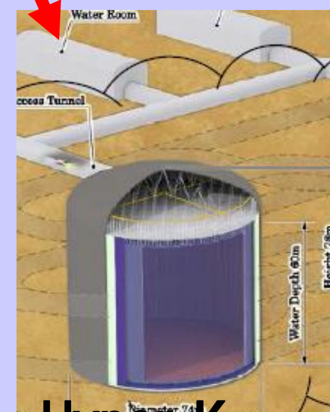
보현산/비슬산/삼봉산/
황매산/민주지산/운장산 등



0.5Mton

현재: 0.26Mt

RENO-50



Hyper-K
(under construction)

- Surprisingly, this idea was introduced ~15 yrs ago

History of KNO/T2HKK

- Oct. 17, 2000: Another far detector using a JHF neutrino beam by S.B. Kim (KOSEF-JSPS Joint Seminar at KIAS)

- 2005/2006/2007: A large Cherenkov detector in Korea using a J-PARC neutrino beam (T2KK) by T. Kajita
  → 3 joint workshops supported by KOSEF and JSPS

- 2011: Proposal of 0.5 M ton water Cherenkov Hyper-Kamiokande detector at Kamioka (LOI as arXiv:1109.3262 and arXiv:1412.4673v2)

- 2015: Staged construction of two HK detectors of each 0.26 Mton at Kamioka

- July 10, 2016: The first T2HKK meeting in London
  → present a proposal to the HK collaboration
  → T2HKK working group (S. Seo)

Activities of KNO/T2HKK

- Sep. 2, 2016: First Workshop on T2HKK in Korea (SNU)
- Oct. 20, 2016: Pioneering Symposium at Korean Physical Society meeting (Gwangju)
- Nov. 2016: A white report on T2HKK released. It was published in Prog. Theor. Exp. Phys. 2018, 063C01
- Nov. 21-22, 2016: International Workshop on 2nd Detector in Korea (SNU)
- Nov. 24, 2017: 1st KNO Workshop (KNU)
- Aug. 21, 2018: 2nd KNO Workshop (KASI)
- Nov. 2, 2018: 3rd KNO Workshop (KNU)
- Aug. 25, 2019: KNO (satellite) Workshop with NUFACT 2019 (KNU)
- Oct. 24, 2019: Pioneering Symposium at Korean Physical Society meeting (Gwangju, 예정중)

Korean Efforts on KNO Realization

- 2018. 10. 20: Kick-off Meeting for KNO organization including physicists and astronomers
- Detector R&D work is in progress
- Five working groups were formed in the meeting
- Each working group has held regular meetings
- Korean efforts are in very early stage
- Discussions with Korean government have been started
- Several options for KNO detector are being considered

Activities on KNO Science

- Particle physics subgroup identifies potential KNO physics topics through workshops and seminars
  - organize Korean neutrino meetings
  - carry out sensitivity studies using simplified simulations (published in PTEP 2018)
- Astronomy subgroup is preparing for a white paper on KNO astronomy
  - list of potential KNO astronomy topics
  - emphasis on multi-messenger astronomy using neutrinos

Working Groups of KNO Organization

(overall led by Prof. I.T. Yu) (tentatively)

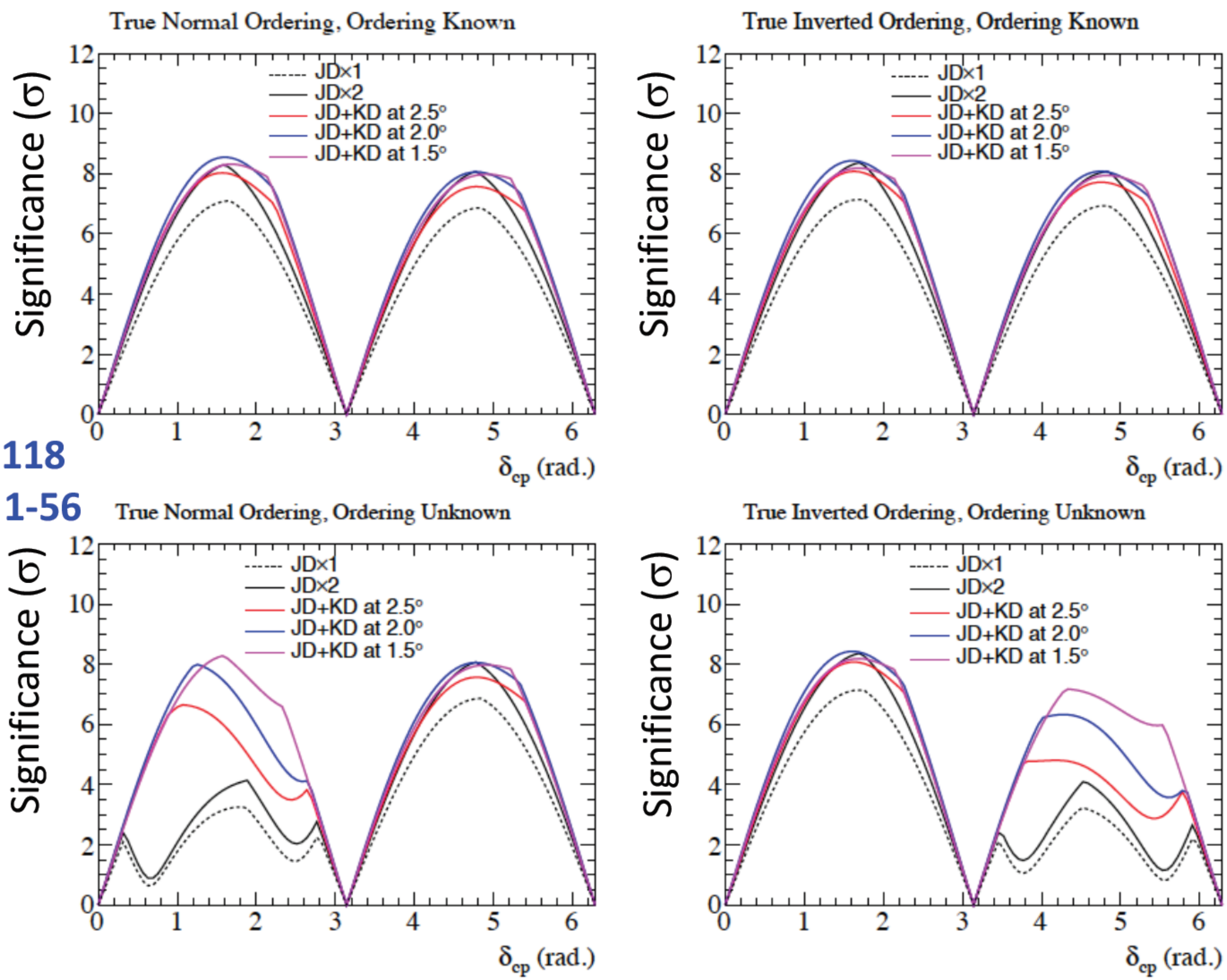
- Government Relations Working Group
  - contact and discussions with government and funding agency
- Detector R&D Working Group
  - photo sensor, water purification, DAQ, and etc
- Science Working Group
  - particle physics and astronomy subgroups
- Proposal Working Group
  - preparation for KNO proposals
- International Relations Working Group
  - foreign support and participation

- 현재, 입자물리실험(~25)/이론(~10), 천문학(~15) 관심 참여 중
- 향후, 더 많은 연구자의 참여가 필요

→ (효율적으로 다시 확대 및 재편될 예정)

Physics Potential at KNO: δ_{cp}

Known MO



arXiv:1611.06118
PTEP 2018, 6, 1-56

Unknown MO

➡ 입자물리 관점: leptonic CP violation 측정이 핵심적인 목적 중의 하나

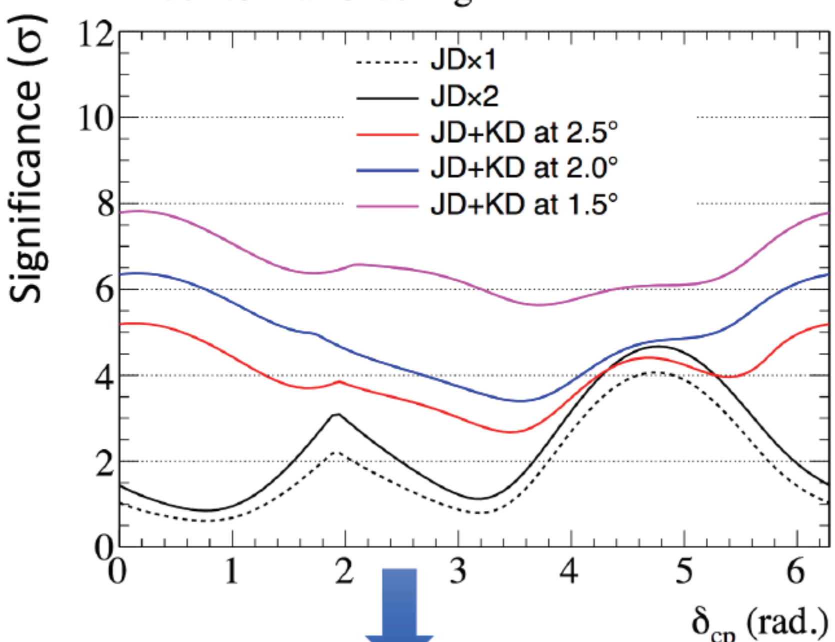
Physics Potential at KNO (Mass Ordering Sensitivities)

- 중요성: important input to CPV measurement & flavor model

arXiv:1611.06118
PTEP 2018, 6, 1-56

Normal

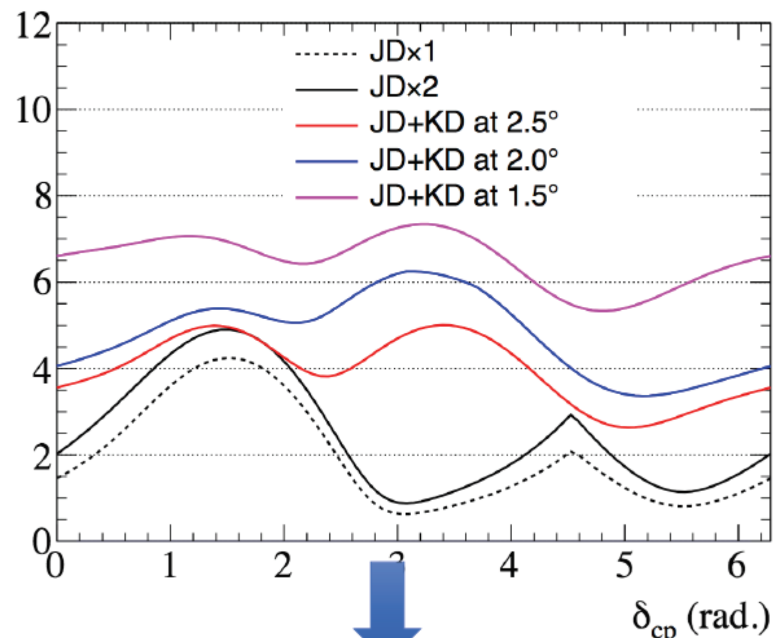
True Normal Ordering



JD+KD 1.5°: 6 ~ 8 σ for all δ_{CP}
JD x2 : 1 ~ 4.5 σ for all δ_{CP}
(< 3 σ for most cases)

Inverted

True Inverted Ordering



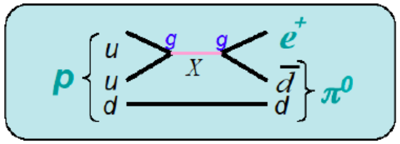
JD+KD 1.5°: 5.5 ~ 7 σ for all δ_{CP}
JD x2 : 1 ~ 5 σ for all δ_{CP}
(< 3 σ for most cases)

양성자 붕괴 탐색

World leading searches from SK to HK

- Two major modes predicted by many models

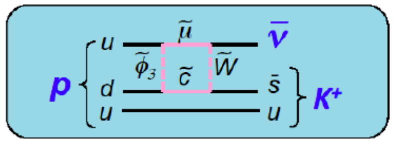
Mediated by gauge bosons



$p \to e^+\pi^0$

$$\Gamma(p \to e^+\pi^0) \sim \frac{g^4 m_p^5}{M_X^4}$$

SUSY mediated

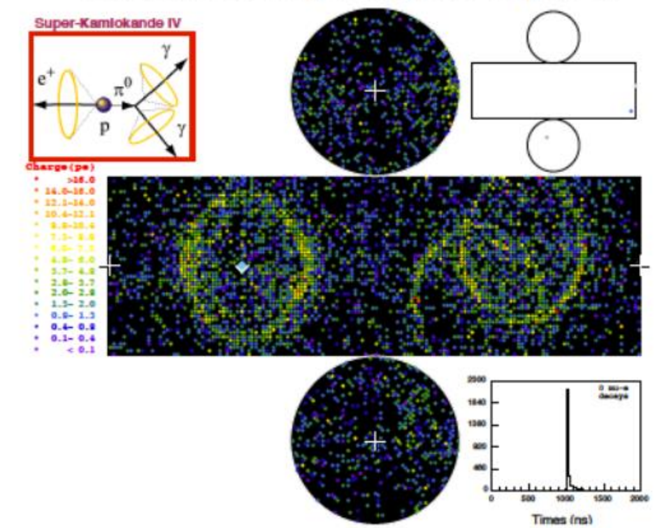


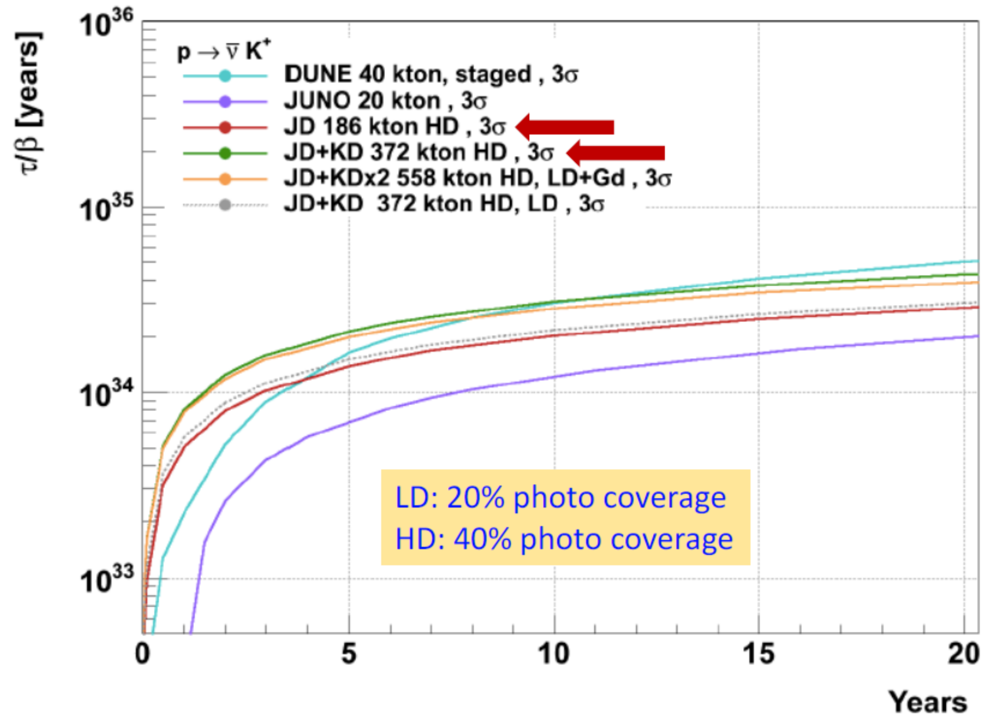
$p \to \nu K^+$

$$\Gamma(p \to \bar{\nu} K^+) \sim \frac{\tan^2\beta \times m_p^5}{M_{\tilde{q}}^2 \times M_3^2}$$

- Need broad searches including other possible modes

Cherenkov ring image in Super-K





For the case of
τ_{proton} = 1.4×10^{34} years
(Super-K limit)
~9σ discovery@HK

기타

- KNO has better sensitivity to non-standard neutrino interactions

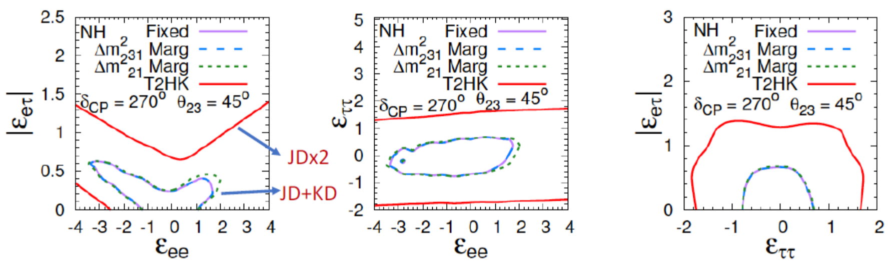
Non-standard ν Interaction Sensitivity

$$H = \frac{1}{2E}\left[U\begin{pmatrix}0 & 0 & 0\\ 0 & \delta m^2_{21} & 0\\ 0 & 0 & \delta m^2_{31}\end{pmatrix}U^\dagger + V\right]$$

$$V = A\begin{pmatrix}1+\epsilon_{ee} & \epsilon_{e\mu}e^{i\phi_{e\mu}} & \epsilon_{e\tau}e^{i\phi_{e\tau}}\\ \epsilon_{e\mu}e^{-i\phi_{e\mu}} & \epsilon_{\mu\mu} & \epsilon_{\mu\tau}e^{i\phi_{\mu\tau}}\\ \epsilon_{e\tau}e^{-i\phi_{e\tau}} & \epsilon_{\mu\tau}e^{-i\phi_{\mu\tau}} & \epsilon_{\tau\tau}\end{pmatrix}$$

arXiv:1611.06118
PTEP 2018, 6, 1-56

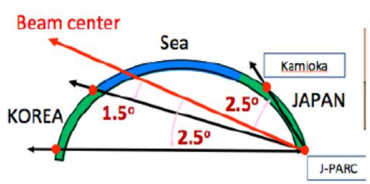
$$A \equiv 2\sqrt{2}G_F N_e E,$$

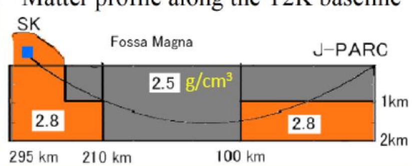


D. Marfatia@ICHEP2018: arXiv:1612.01443

"T2HKK has the best sensitivity to CP phase (even) in the presence of NSI."

Matter Density Profile





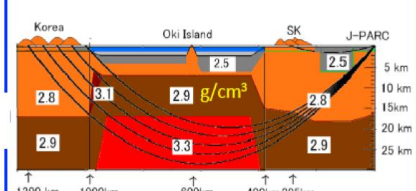
Matter density:

$$r_A = 2\sqrt{2}G_F N_e E_\nu/\Delta m^2_{31}$$

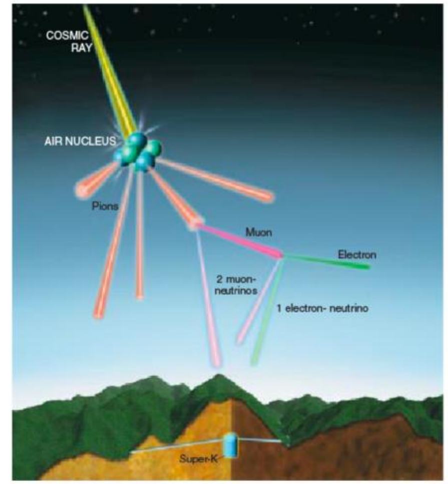
More matter effects

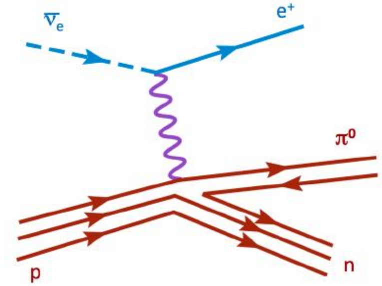
→ Better Measurement of Neutrino Mass Ordering

- Longer baseline
- Higher matter density
- Higher neutrino energy



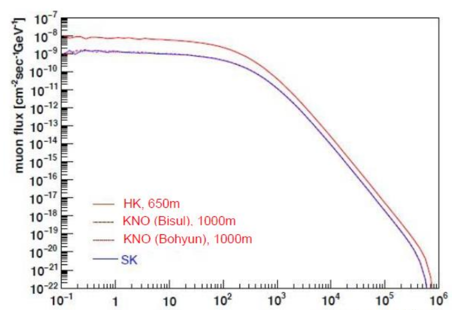
Background: Atmospheric Neutrinos

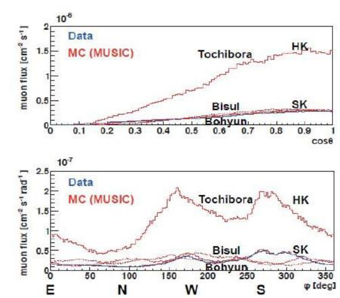




Cosmogenic Muon Flux

- Overburden of KNO site ~ 1000 m (HK: 650 m)
- Muon flux at KNO is 5 times smaller than HK flux → less cosmogenic backgrounds





Neutrinos of Astronomical Origins

- Neutrinos from active galactic nuclei and micro-quasars
- Neutrinos from interactions of cosmic protons and nuclei in the Galaxy
- Neutrinos from gamma-ray bursts (GRB)
- Neutrinos from clusters of galaxies
- Neutrinos from dark matter decays
- Solar Neutrinos
- Dark matter annihilation (solar dark matter and dark matter captured in the earth, exotics models such as boosted dark matter, etc)

➡ Multi-messenger astronomy를 위한 neutrino telescope 역할 또한 중요한 목적 중의 하나 임

(from Prof. M.G. Park)

List of KNO Related Astronomical Topics

- Neutrinos from the interactions between the comic-ray protons and the background nuclei in our Galaxy
- Neutrinos from Active Galactic Nuclei (AGN), Blazars, and microquasars
- Neutrinos from gamma-ray bursts (GRB) (binary neutron star merger)
- Neutrinos from clusters of galaxies
- Neutrinos from nearby starburst galaxies
- Supernova burst neutrinos
- Early follow-up electro-magnetic observations after supernova burst neutrinos
- Supernova relic neutrinos
- Neutrinos from failed supernova
- Neutrinos from the decay of dark matter
- Solar neutrinos
- Solar flare neutrinos
- Multi-Messenger Astronomical Observation

White Paper compiled by Sang-Chul Kim (KASI).

- **Neutrino astronomy 분야**
  - KNO가 DUNE보다 더 잘 할 수 있음
  - 일본 HK보다 더 깊은 곳에 위치하여 relic supernova 검출에 low background로 sensitivity가 높음

- **KNO neutrino astronomy**
  초신성의 중심에서 중성자별이 블랙홀로 변하는 과정을 중성미자로 관측 가능
  - 최근 전파 망원경으로 블랙홀의 외형 관측 됨
  - 중력파로 블랙홀의 충돌 관측
  - 중성미자를 통해 블랙홀의 탄생을 봄으로써 multi-messenger로 매우 중요한 역할을 담당할 것으로 기대

➡ 국내 천문학/천체물리 분야 연구진의 관심과 참여가 높음

Pros and Cons of KNO

- **Pros**

  - 1^{st} and 2^{nd} oscillation maxima at KNO → more sensitive to leptonic CP violation

  - Larger overburden (~1000 m) → better sensitivity to neutrinos of astronomical origin (solar/SN/galactic..)

  - Higher mass density and longer baseline → better determination of neutrino mass hierarchy and better sensitivity to non-standard neutrino interactions

- **Cons**

Neutrino beam flux at KNO is ~10 times smaller than HK flux due to longer baseline

KNO detector group R&D lists

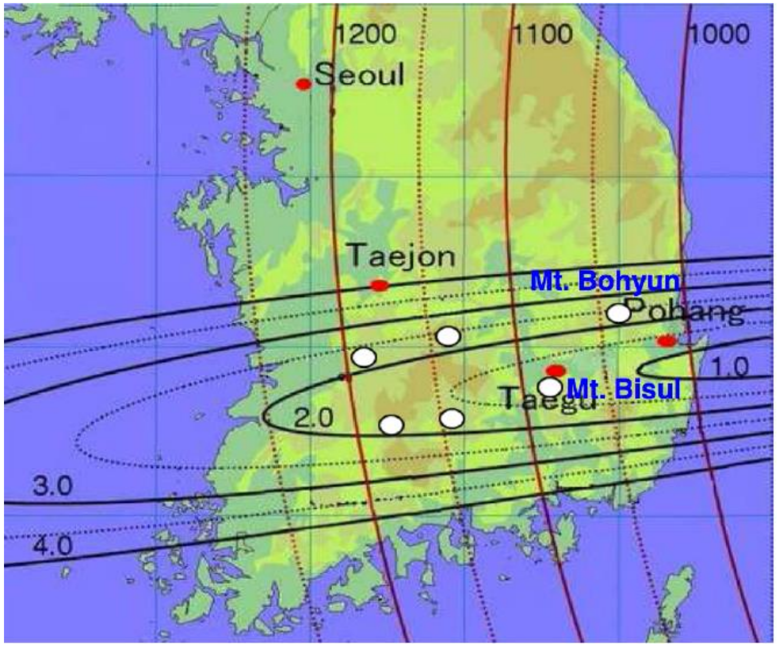
1st setup meeting for KNO R&D group was called on Dec18, 2018 (by Prof. HJ Kim)

- KNO R&D group skype/offline meeting (2019/01, 0308, 0312, 05)
- Currently, ~40 peoples are on the lists & jobs will be assigned (in progress)

current main topics

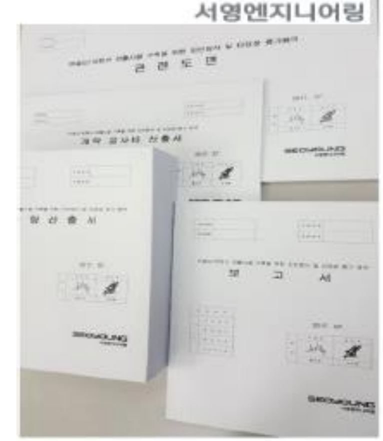
1) Detector hardware performance simulation
   Detector configuration, energy threshold, energy resolution optimization.
2) Detector materials
   Water purification, LSC or Gd-doping option
3) Photo Sensor
   (1) PMT by Silicon base
   (2) Photo-sensor by gas
4) Electronics & DAQ
5) Proto-type
6) Tank and mechanical design
7) Detector calibration (source, LED, laser)
8) Computing, software, DB
9) Radon monitoring system, safety etc

KNO 후보지 선정과 지하 암반 탐사



40 km, 50 min.
from Dongdaegu
train station

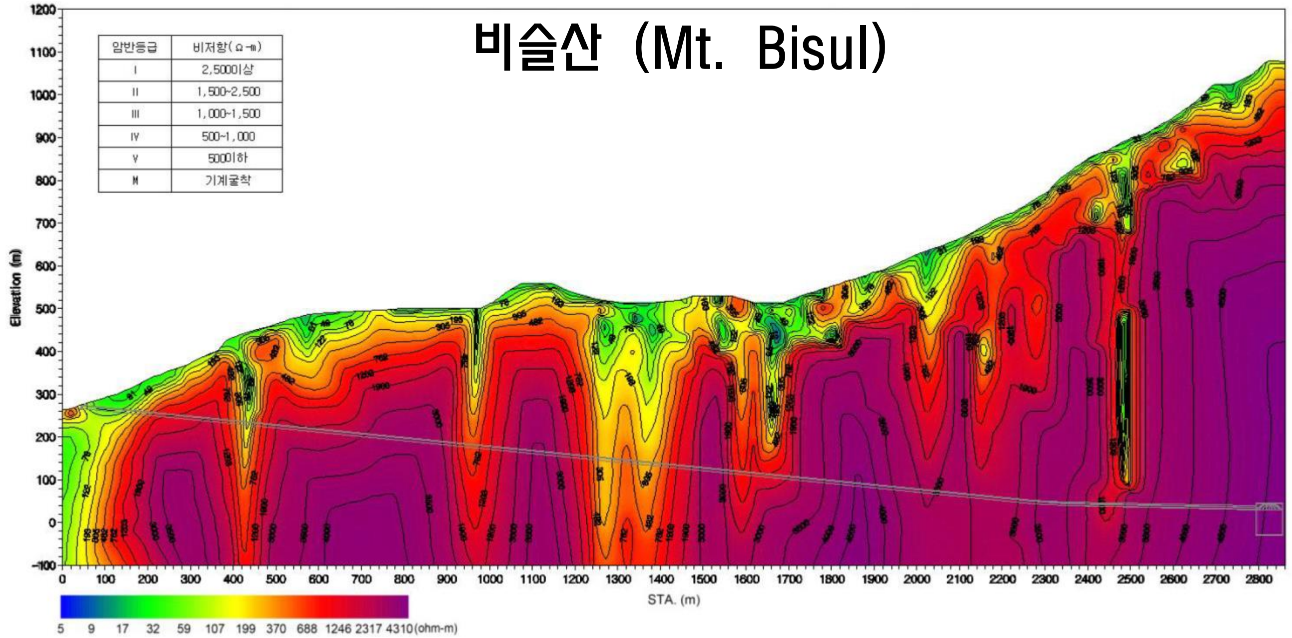
SEOYOUNG
서영엔지니어링

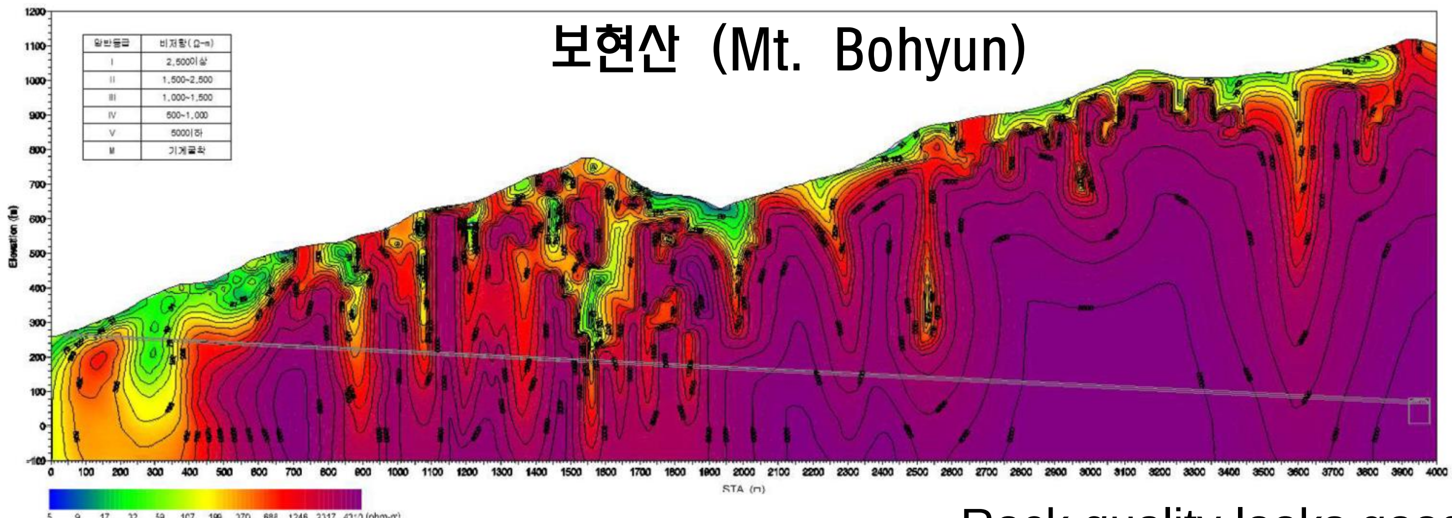


- 조달청 나라장터를 통해 입찰을 진행하여 용역회사를 2017년 5월 중순 선정함
  - 비슬산과 보현산 지반을 탐사하여 7월말 비용 산정 결과보고서 완료해 제출

- 서영 엔지니어링의 지표조사와 지반 탐사 (1.5억원) (2017년 6월)
- 스트레스 분석을 통한 개념 설계와 건설 비용 산정 (2017년 7월)

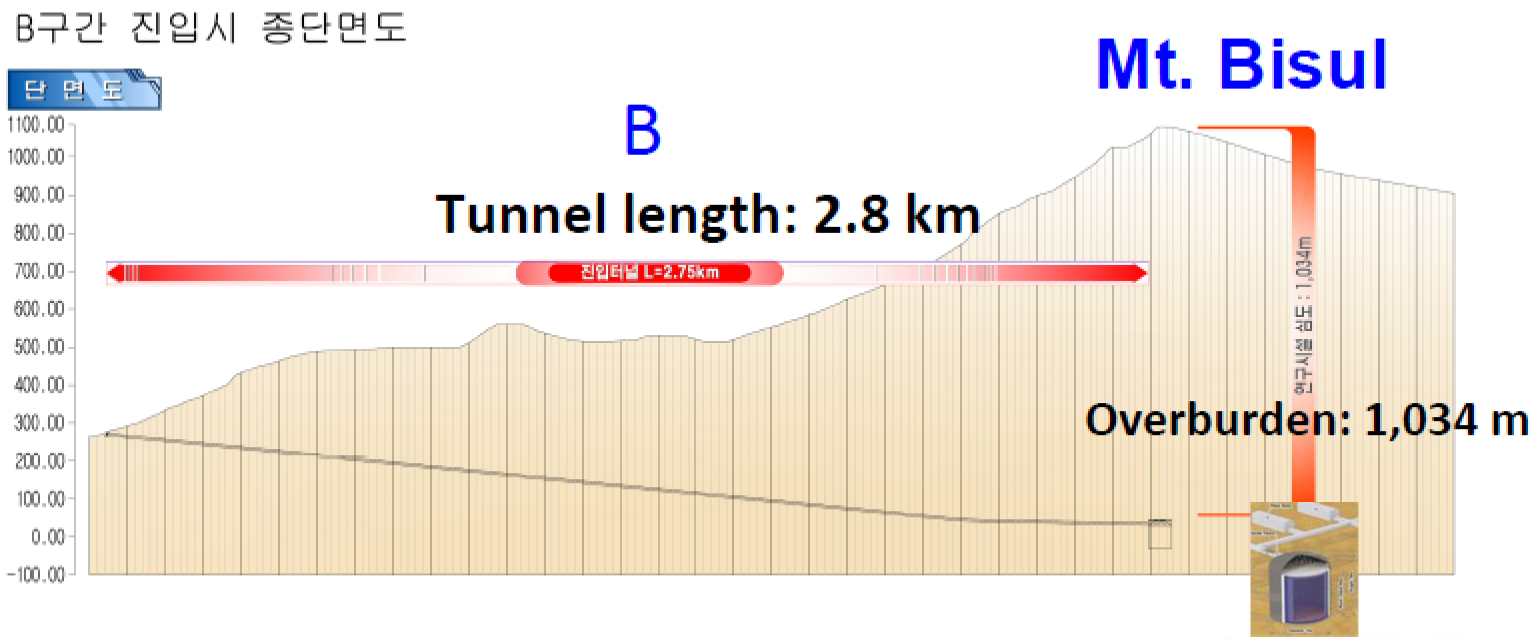
KNO Rock Strength of Underground

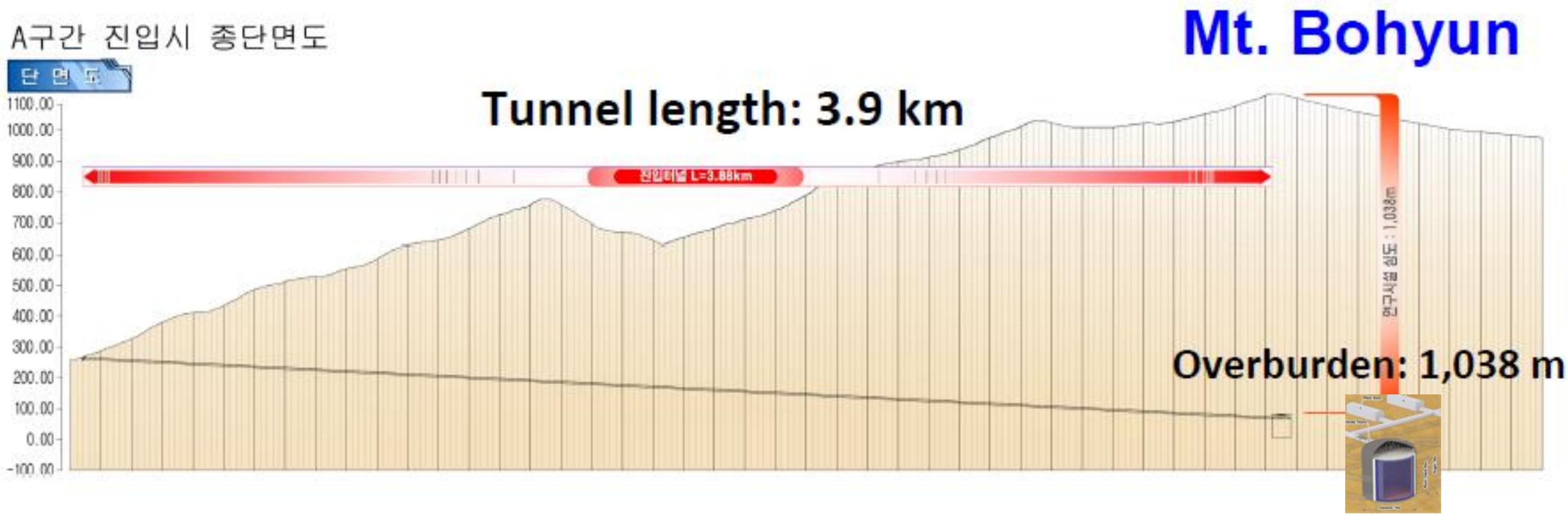




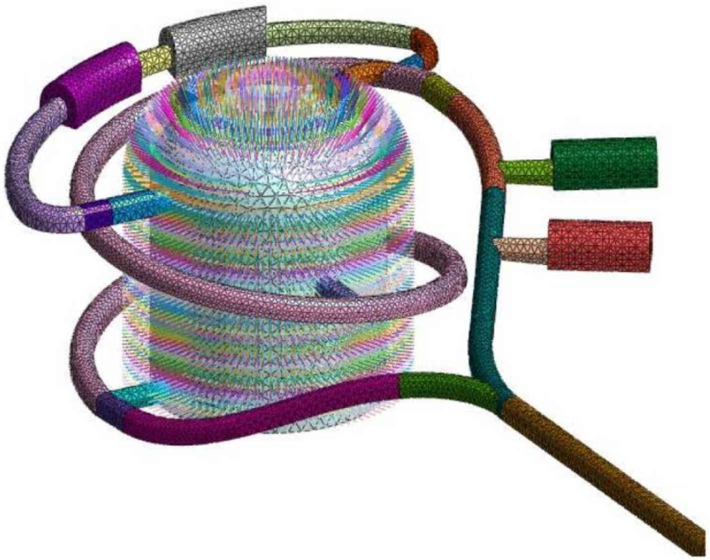
Rock quality looks good

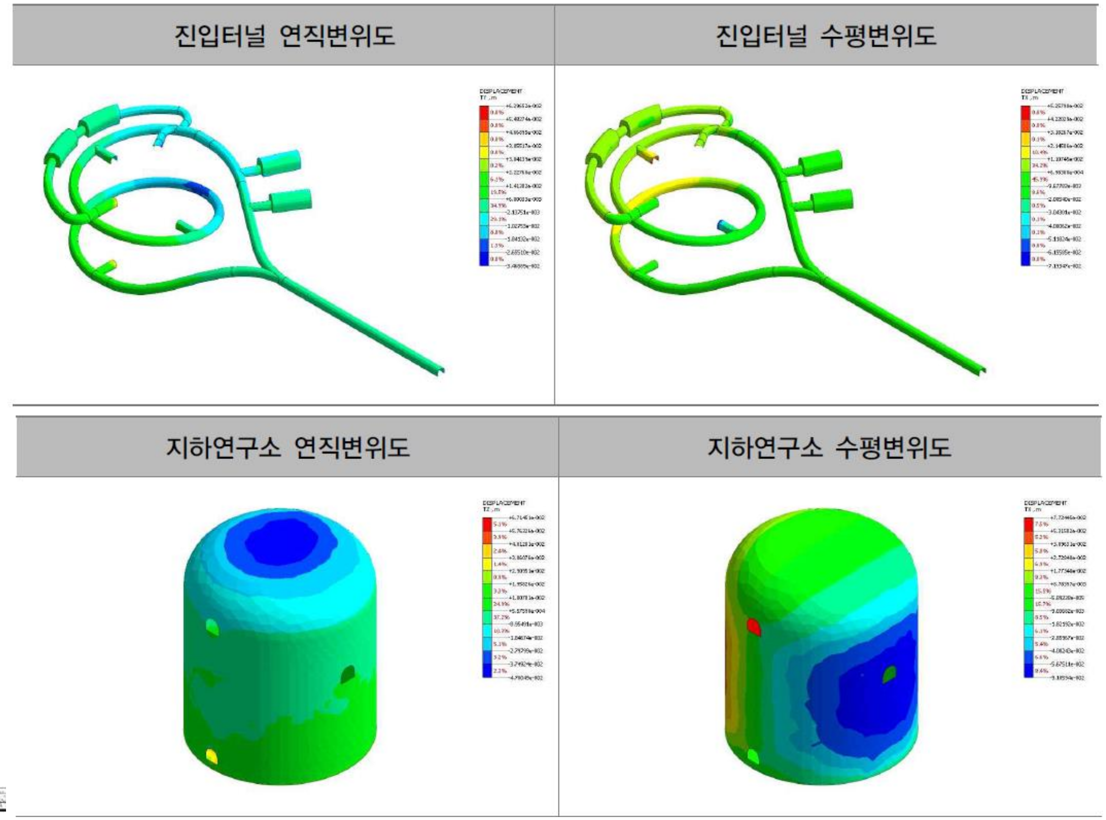
KNO Underground Facility

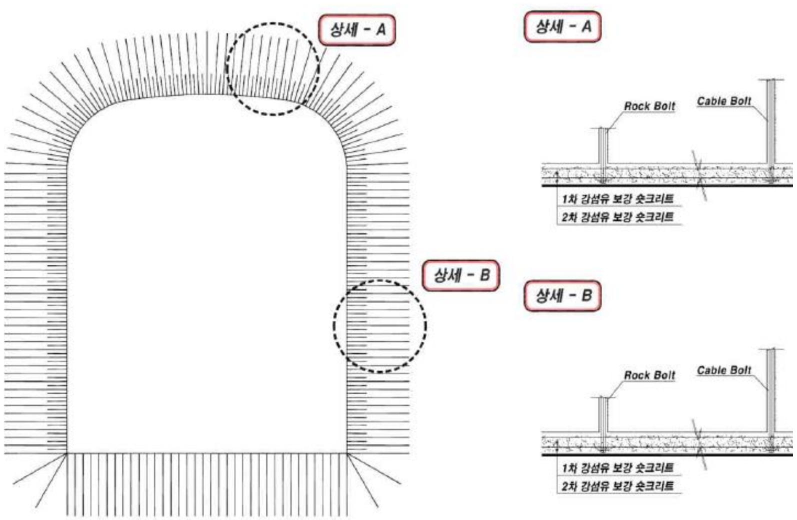




Stress Analysis와 필요한 보강



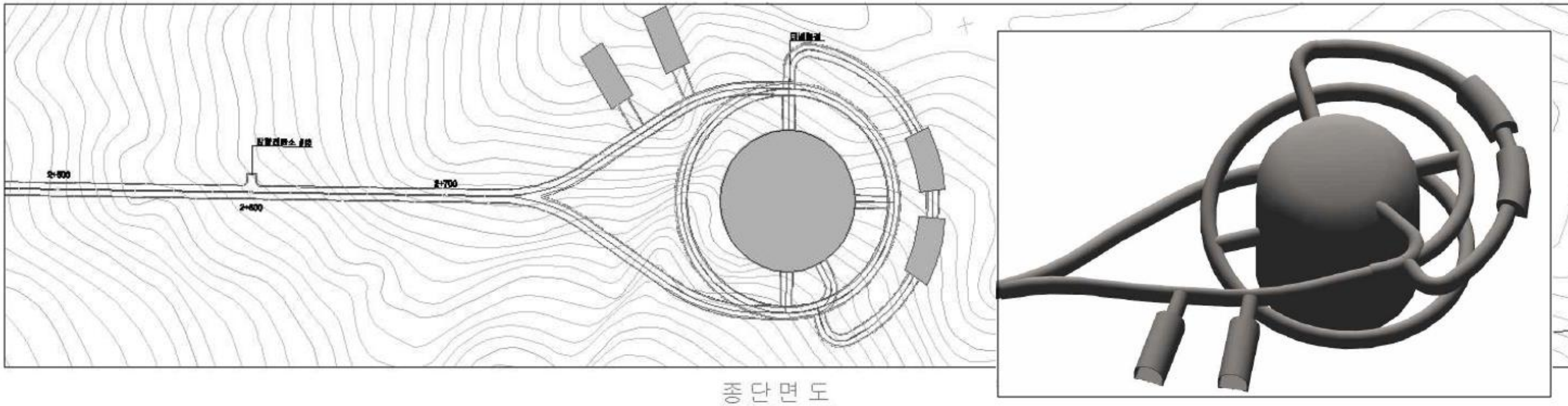




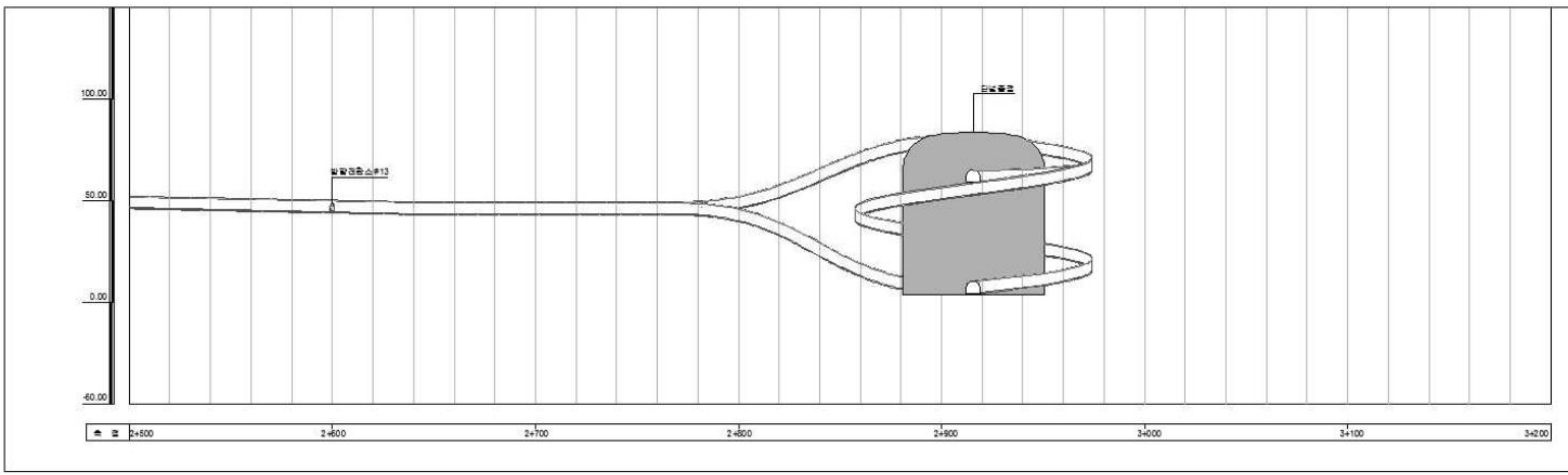
- 예상된 지하시설 구축 비용: 600~700 억원

- 예상되는 지하수 양과 질을 파악함

Experimental Hall (Cavern)

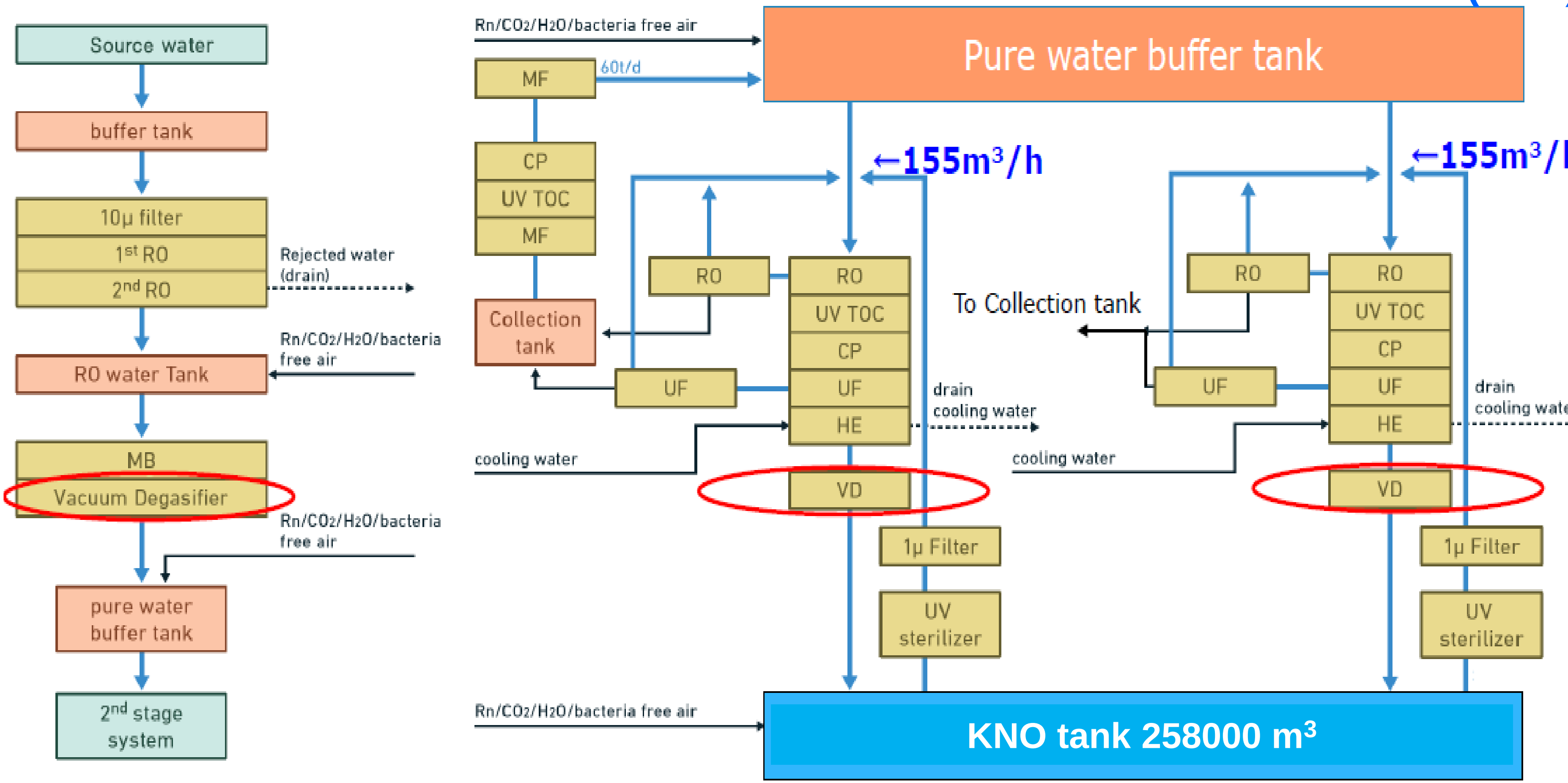


종 단 면 도



Design and development of water purification system

Prof. SB Kim (SNU)



- 일본 HK의 도움을 받고 국내 회사 디코텍과 함께 제작 비용 산정 완료
- 초순수 생산량: 처음 생산량 78 m^3/hr 순환 시 공급량 310 m^3

Measurement of water quality at Mt. Bisul

- Water samples from Mt. Bisul was collected
- Water quality is found to be excellent and easy to make water transparency ~100 m by the KNO water purification system.

항목	유가사 밑 (입구)	유가사 약수 지붕	비슬산수련원 참숯찜질방		
pH	6.33	6.45	7.39		
COND	30.3	31.6	94.7		
Turb	0.56	0.19	0.59		
T-Al (ppm CaCO3)	2.2	2.5	19.6		
Cl	3.5	3.7	11.6		
SO_4	2.5	2.3	3.3		
Aluminum	TR	TR	TR		
Ba	TR	TR	TR		
Ca (ppm CaCO3)	4.7	4.17	23.1		
Cu	TR	TR	TR		
Fe	TR	TR	TR		
K	0.2	0.17	0.11		
Mg(ppm CaCO3)	1.68	1.64	6.64		
Mn	TR	TR	TR		
Na	2.07	2.27	6.80		
P	TR	TR	TR		
Zn	TR	TR	TR		
SiO_2	6.4	6.62	24.6		
Sr	TR	TR	TR		
TOC	10.8	1.06	0.23		
SS	2.0	0.0	1.8		
Comments					
분석자	석 다 영				

* 시험방법 : ASTM에 의한 ICP와 TITRATION방법

Development of radon vacuum degasifier (VD)

- 96% Rn removal efficiency to lower trigger efficiency at ~5 MeV (99% oxygen)
- HK: 300 tons/hr (3-4 M$/tower) ← SK: 60 tons/hr (1 M$/tower)
- Electric polished vacuum SUS tower: ~3 kPa
- Vacuum pump (SK): 410 m^3/hr, 11 KW

SK vacuum degasifier tower

- Developing a prototype VD with DICOTECH Co.

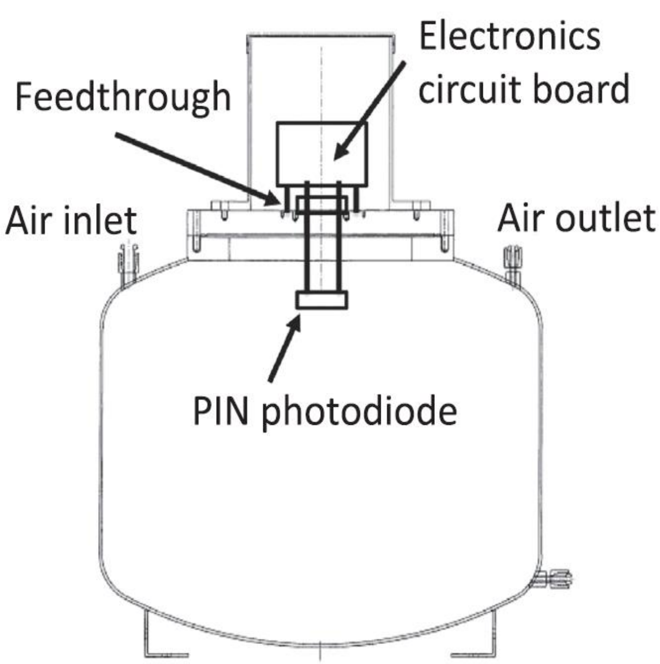
Key point: increase surface area by spraying

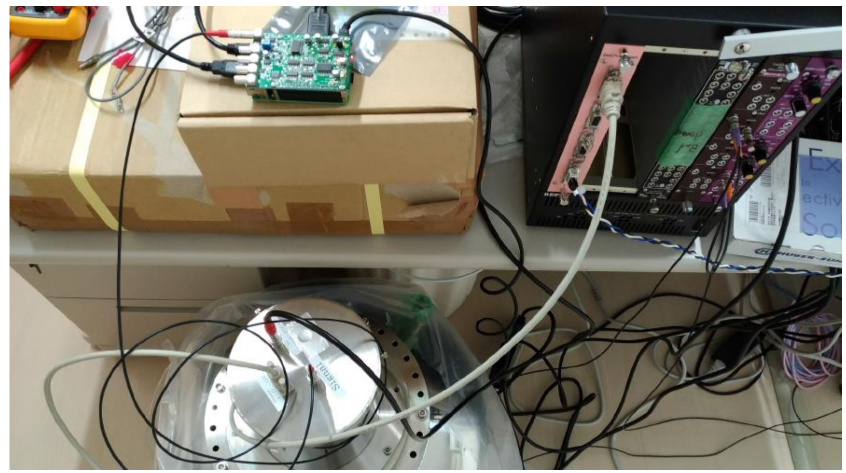
Radon measuring device in water

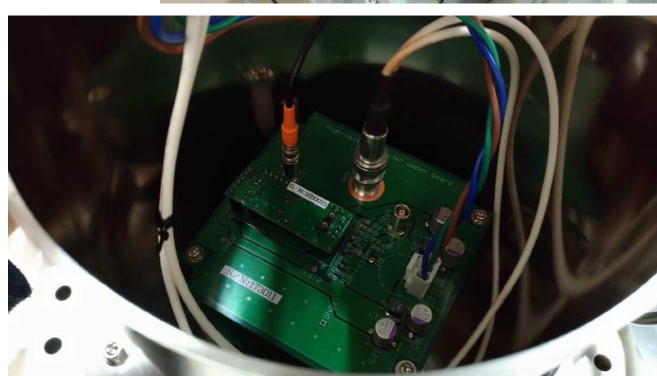
Prof. SB Kim (SNU)

- 80 L SUS vacuum container with electric polishing:
- PIN photodiode sensor (Hamamatsu S3204-09 at -1.9 kV)
- Vacuum feedthrough and copper gaskets
- DAQ electric module system

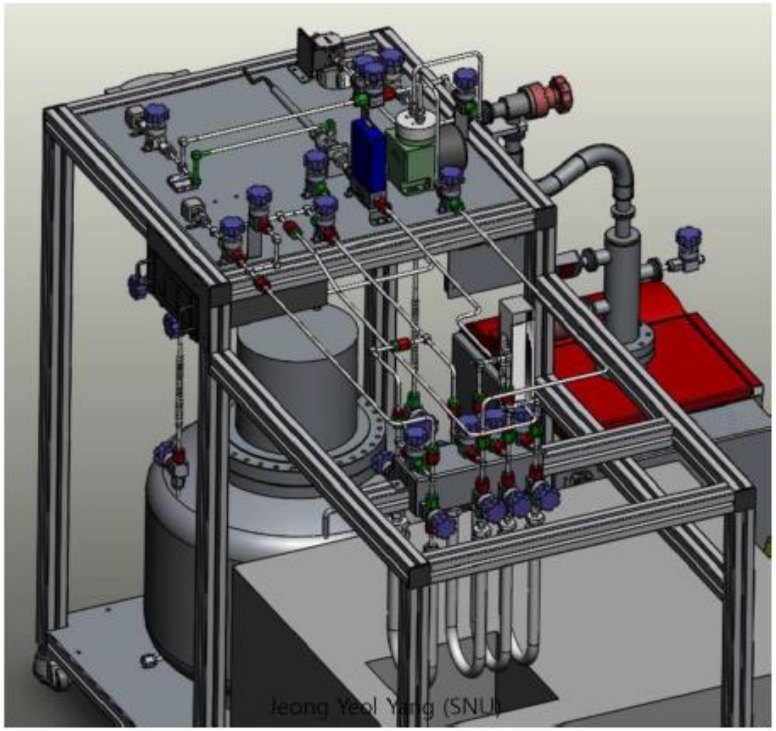
→ Expected sensitivity of Rn concentration measurement: ±0.1 mBq/m^3







초정밀 물 속 라돈 측정 장치 개발



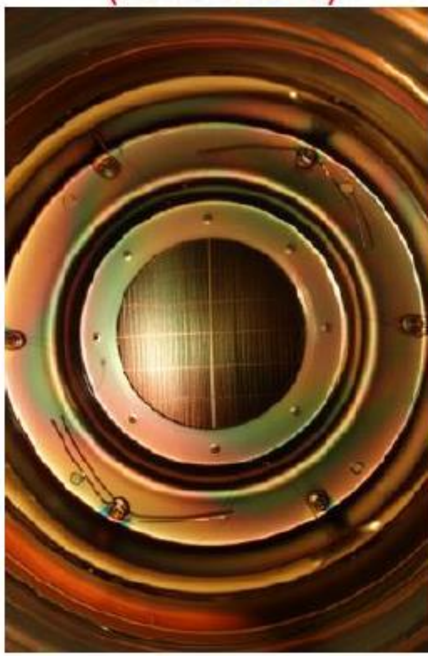
Designed radon measurement device at SNU

Assembled radon measurement device at SNU

- Developing a radon removal tower from water with DICOTECH Co. in order to measure radon content in water
- Ready for calibration and radon measurement

50 cm Photodetectors in world

(+Kamiokande PMT)
Super-K PMT
(HPK R3600)

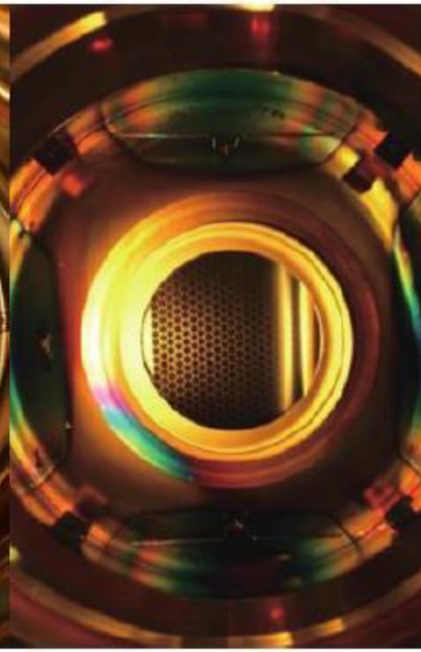


CANNOT withstand 60m water height

→ Bye

11k in SK

Box&Line PMT
(HPK R12860)

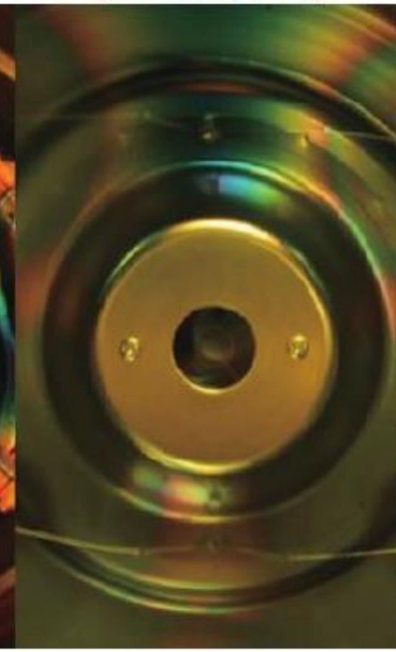


Candidate HK PD

→ Lower background

34 in ICRR
+140 this FY

HPD
(HPK R12850)

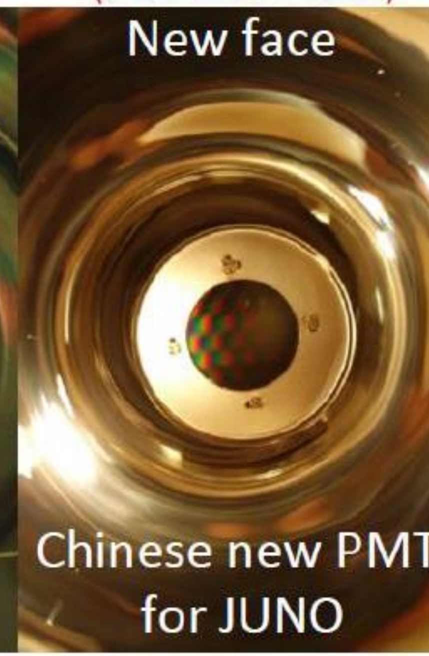


R&D in progress

→ Take R&D over abroad

11 in ICRR
+ Need R&D budget

MCP PMT
(NNVT GDB-6201)



NOT alternative candidate now!

→ Need evaluation

4 in ICRR
+ a few w/ improved

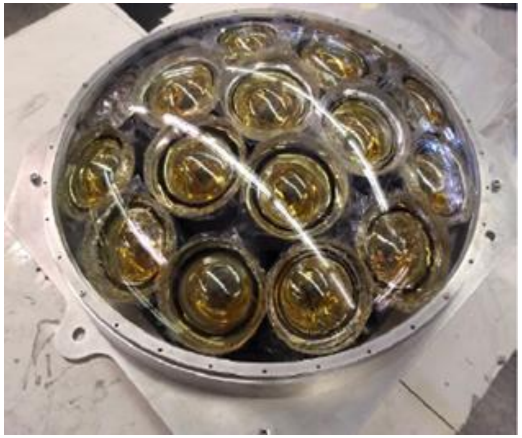
대구경 광센서 국산화 가능성 연구

- KNO 핵심 부품이며 일본 Hamamatsu Photonics Co.가 세계 시장 독점 생산하는 대구경(직경 50 cm) 광센서의 국산화

- 러시아 연구 기관과의 협력을 통해 기술 이전으로 국내 생산 모색 중 (서울대, 경북대, 서울시립대, 메카로㈜ 공동 연구 수행 중)

- 진공 챔버 속에서 유리 표면에 알칼리 금속의 고른 흡착과 dynode를 설치한 후 조립하는 기술 필요

- 우선 직경 3인치 소형의 광센서 제작 기술 개발 후 점차적으로 더 큰 광센서 제작 기술 개발 (여러 개를 합쳐 하나의 모듈로 대구경 광센서의 대체도 모색 중)



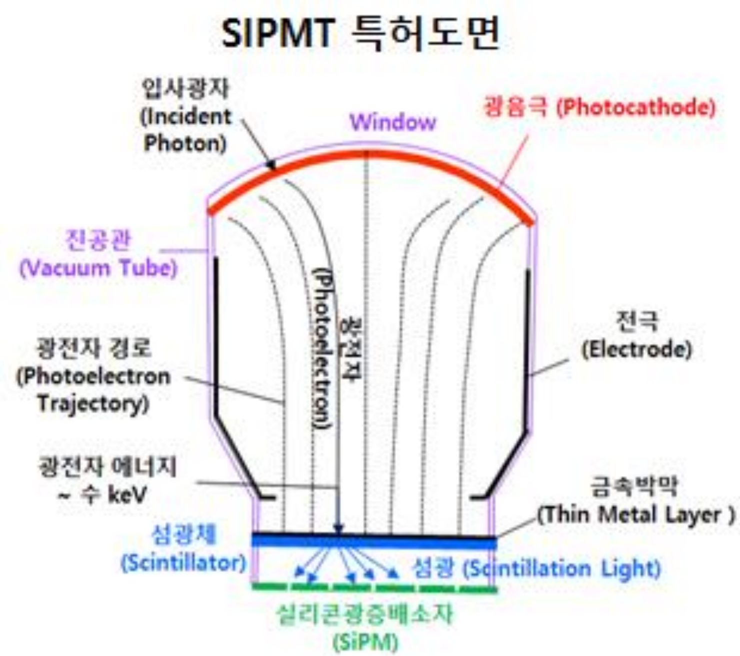
대구경 광센서 국산화 연구 수행

- Photocathode 증착 기술과 진공에서의 packaging 기술 습득을 위해 2019년 5월 러시아 Ektran회사와 BINP 연구소 방문하여 기술 이전 모색

- 서울시립대/메카로㈜ : dynode 제작 기술과 ALD를 사용하여 photocathode 알칼리 금속 증착 기술 개발 **(Prof I. K. Park)**

- 경북대 : 광자 관측 분해능을 개선할 SiPMT 광센서 개발

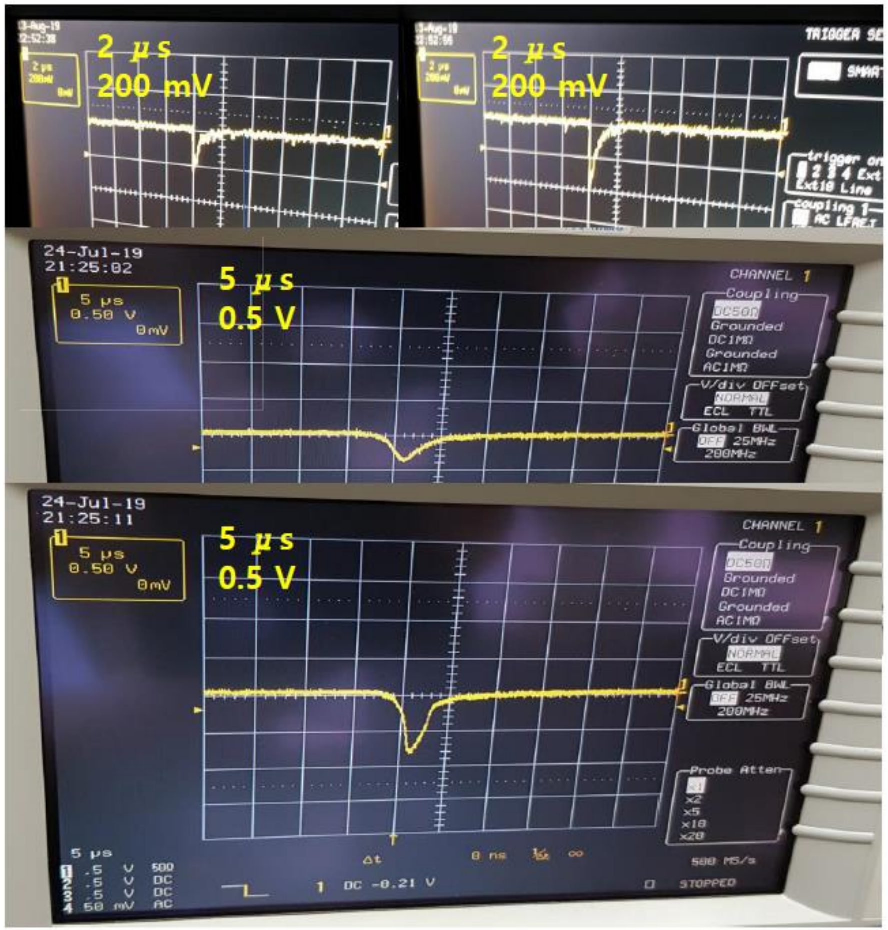
Prof. HJ Kim, J. Lee (KNU)



BINP 2" Photo-triode

(from Prof. H.J. Kim)

Demonstrator for SiPMT performance



Very First Output from the Demonstrator

In air,
Am241 source
on CsI+SiPM+preamp
~20 keV/60 keV X-ray signals

In chamber of ~ 10^{-3} torr,
laser of 266nm(4.66eV)
on Ag photocathode
at ΔV= -3 kV
relative to
CsI+SiPM+preamp

Preliminary (Need to confirm)!

In chamber of ~ 10^{-3} torr,
laser of 266nm(4.66eV)
on Ag photocathode
at ΔV= -4 kV
relative to
CsI+SiPM+preamp

Frontend Electronics R&D

(from Prof. H.J. Kim)

NUFACT2019@KNU

Charge digitization option

1) 500 MHz FADC with 12 bit

2) 32 channel Shaping preamp + 65 MHz FADC

3) 32 channel analog ASIC for SIPM (Ex: Citiloc chip)

Timing digitization option

1) 1 GHz timing digitization by FPGA chip

2) Analog ASIC TDC chip

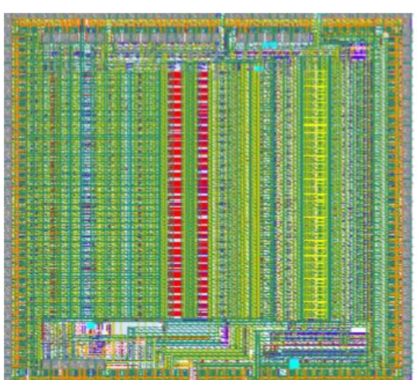


Figure 1 - ASIC layout

32 channel ASIC for SiPM

500 MHz FADC by NOTICE Co.

32 channel 64 MHz FADC

(Tentative) Schedule & Milestone, 기타

- **건설 시기:** Hyper-K나 DUNE이 (2027~2028년경) 완공을 목표로 건설 중이라고 가정할 때, KNO가 위 실험과 비슷하거나 조금 늦게 시작하려 한다면, 2021~2022년에는 시작되어야 함

  (만약 2022년 말까지 funding 확보 어려움 시, KNO는 시간 상 어려운 상황에 직면 가능성)

- **소요 예산:** HK와 같은 종류의 detector라면 예산은 최소 >3000억 이상 예상

- **기대 효과:**

- KNO 시설은 건설 후 약 50년 이상 장기간 활용이 가능
- 한국이 이 분야의 최전선에서 활동할 수 있는 기지가 됨

  (비록 약 3000억원의 큰 비용이 드는 것 같지만 건설에 약 7년, 활용에 50년 이상을 생각할 때 매년 투자되는 비용은 사실 상 과도하게 큰 것은 아님)

- **국제공동연구 필요성:**

  - KNO가 본격적으로 시작 시 국내연구자 확대뿐만 아니라 해외연구자들과의 공동연구를 본격적인 추진 필요성

  - Funding, manpower, detector 등에서 외국 그룹의 공헌이 중요한 역할 담당.
    (특히 Hyper-K와의 협력은 핵심적이며 매우 중요)

- **Future vision**

  - KNO를 토대로 장차 KEK와 같은 입자/핵/천체물리학/천문학을 포함하는 국립연구소로 발전 가능성 모색
  - 후속 세대에게 보다 발전된 안정적인 환경에서 연구 지속 가능성 제시

- 기타

  - 0.5Mt (현재 HK 0.26Mt)으로 규모 확대
    (유럽의 ESSnuSB의 Far Detector도 현재 0.5Mt의 water cherenkov detector로 계획 중)
    이 경우, KNO 예산에 따라 PMT의 숫자 감소, low energy physics는 어려움 존재, 하지만 leptonic CP violation 측정은 큰 영향을 받지 않음. 따라서, 여러 상황을 다시 고려해야 함
  - Gd option: 향후 여러가지 논의 필요

- 한국 그룹의 능력:

  (Since last ~30 yrs, Korean group has joined various neutrino program internationally and domestically and performed successfully. 예, K2K, T2K, SK, HK, RENO, NEOS, CUP, JSNS^2, IceCube 등에서 틈새 연구분야에 두각을 나타냄)

→ 실제로 실행에 옮길 수 있는 충분한 능력은 검증 됨

- **KNO 실험의 특성:**
  - One man project가 아니라 국내외 중성미자 실험 참여자 전체가 조화롭게 추구하는 실험

- 이미 여러가지 충분한 핵심 R&D가 진행 중 (이론 그룹 및 천문/천제물리 포함)

- 기 경험: 장/단거리 터널 구축, 대형 중성미자 검출기 완성, 실험 데이터 분석, DAQ에 필요 한 여러가지 핵심 전자장비 (electronics) 및 모듈 국산화 및 제작 등

➡ Community 지원과 더 많은 관심이 매우 중요하며 핵심적임

Closing Remarks

Excellent physics cases: (using long baseline neutrino beam)
KNO greatly enhances physics sensitivities in the measurements of leptonic CP violation, mass ordering, proton decay, NSI, and many others

Excellent astronomy/astrophysics cases:
KNO also serves as a powerful neutrino telescope for multi-messenger astronomy

KNO organization and working groups are formed and active, will be expanded (including foreign collaborators)

Efforts on detector R&D and science are in progress

KNO can be a flagship project for Korean HEP for the next ~20 years and more

[Note] 대부분의 자료들은 NUFACT2019 (satellite workshop)에서 찾을 수 있음