A Roadmap	to Build Experimental High Energy Physics at ICISE, Vietnam
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I. INTRODUCTION

The International Center for Interdisciplinary Science and Education (ICISE), placed in the coastal city 9 named Quy Nhon, Vietnam, aims to bringing together scientists around the world to host conferences in various 10 disciplines, mainly physics field. We find that this Center is also a unique place to grow an experimental high 11 energy physics (HEP) group in Vietnam. In this report, a roadmap to build this group will be sketched very 12 preliminary. A small group collaborating with T2K experiment, which is one the biggest neutrino experiment 13 in the world with about 500 collaborators coming from 61 institutes of 11 countries, would play a key role 14 as a starter. In the short-term of 3-5 years, this group, which consists of a leader- a Japanese processor, 15 Vietnamese physicists and Ph.D students. Hiring a foreign postdoctoral researcher will be considered if the 16 financial condition is allowed. To further support Vietnamese group, an "assistant" group of three members: 17 one from KEK, one from ICRR and one from Japanese University are arranged. Furthermore, an advisory 18 committee is formed in order to guiding the group development. In the early stage, the group might focus 19 on data and Monte Carlo (MC) simulation analysis. For a longer term, the group would be expanded and a 20 possibility to build the R&D laboratory as well as real detectors placed at ICISE. The intermediate goal is 21 until 2026, when the next generation of the long-baseline neutrino experiments, Hyper-K and DUNE, come to 22 operate, our Vietnamese group can join directly these experiments as a strong group. 23

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II. NEUTRINO GROUP MANAGEMENT AND GROUP AT WORK

A. Neutrino Group Management

This group belongs to the Institute for interdisciplinary research in science and education (IFIRSE)". The leader is Prof. Tsuyoshi Nakaya, Kyoto University. Prof. Nakaya is now the spokeperson of both T2K and Hyper-K experiment. He is also the leader of MEXT KAKENHI (#2504) for developing neutrino science in Japan. Prof. Nakaya came to Vietnam first time on August 2016 to participate into the NuFACT workshop.

To help Prof. Nakaya in supervising the group, an "assistant" group of three members from KEK, ICRR and Japanese University is arranged. This is idea of Prof. Nakaya since his time for this group is fairly limited. Members in the "assistant" group will rotate their responsibility in helping directly Vietnamese group. Besides, they will alternatively came to Vietnam in summer in order to train Vietnamese students in the HEP field, especially Neutrino Physics.

In order to get official help from Prof. Nakaya and his colleagues, IFIRSE needs to prepare a Memorandum of Understanding (MoU) with Kyoto University as well as other related Japanese institutes. IFIRSE will support for traveling and accommodation of the leader and the "assistant" group when they visit Vietnam for working with this group.

On Vietnamese side, Dr. V. Nguyen will be hired by IFIRSE by the beginning of 2017. Dr. V. Nguyen will
play a key role in organizing the summer neutrino school for Vietnamese students in 2017 and select 1-2 Ph.D
candidate for group with help from Prof. Nakaya. The group will get direct help from Dr. S. Cao, Vietnamese

¹ physicist now at Kyoto University (will start work for KEK since December 2016). He has worked for the T2K

experiment for two-years and his experience in experimental neutrino physics will be helpful for Vietnamese
 group.

In order to guiding the group development, Prof. Nakaya is contacting to the top neutrino physicists in
the world to form an International Advisory Committee. So far, Prof. Takashi Kobayashi (KEK), Professor
of physics, Deputy director of Institute of particle and nuclear studies, KEK, Head of Particle and Nuclear
Physics division, J-PARC and Prof. Masayuki Nakahata (Kamioka, ICRR), Professor of physics, the directory of
Kamioka observatory, ICRR the spokesperson of Super-K, agree to serve the International advisory committee.

B. Neutrino Group At Work

This neutrino group has some unique features such as the leader is foreign professor, in collaboration with an international experiment. Thus the group needs to be flexible in operation to match with these features.

The leader, Prof. Nakaya and members of the "assistant" group will occasionally visit Vietnam with some defined purposes such as training students or develop the project. However Prof. Nakaya or mebers of the "assistant" group will be responsible for supervising the group's works weekly. Each T2K collaboration will be provided eZuceSRN account for video conference call and the leader uses this tool to communicate with the group. Besides, member of group needs to report regularly to related group in the T2K experiment. All reports will be recorded.

To be author for the T2K experiment, the members of group needs to take shift with detectors placed in Japan. We can apply for JSPS to get financial support when staying in Japan. Additionally, we can make an MoU with KEK for supporting Vietnamese physicists/students when staying in Japan.

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III. WHY EXPERIMENTAL NEUTRINO PHYSICS?

In this section, we try to pursue that we should start with a small group working in neutrino physics, particularly in collaboration with a well-known neutrino experiment in Asia. Different options of experiments chosen are also considered.

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A. Why is neutrino physics?

Since the first on-paper appearance as a desperate remedy proposed by W. Pauli for resolving the beta decay issue in 1930, neutrino is still surprising physicists and is a main stream to explore the physics beyond the Standard Model (SM). The Nobel prize in 2015 and the Breakthrough prize in 2016 are the valuable words for the vital role of neutrino in the modern physics. Following are some reasons why we choose to start with neutrino physics:

- It is very hot topic in the modern physics. Thus it is somehow easy but powerful in order to get the public and political supports. We might expect few Nobel prizes within couple coming decades for the CP violation, the neutrino mass hierarchy, the naturalness of neutrino mass, etc...
- The neutrino program is intense and for a very long term (Hyper-K and DUNE expects to start in 2026 and run data taking for 10 years. After these neutrino generation, it is predicted that a new generation of experiment will be built to explore the physics beyond the standard neutrino model.)
- The neutrino theory is not so difficult (in comparison to String Theory, for example) and experimental principle is not so complicated either (in comparison to gravitational wave detection or collider experiments). There are a number of Ph.Ds, who originated from Vietnam, have graduated from other fields than neutrino physics such as collider physics at LHC. It seems impossible for them to continue their

We have friends in neutrino experiments, especially Japanese physicists such as Kajita-san, Nakahata-san, Kobayashi-san, Nakaya-san, Saito-san...; Alain Blondel and Jacques Dumarchez from Europe and collaborating with Japanese experiments; well-recognized theorists around the worlds such as Boris Kayser from Fermilab, Serguey Petcov from SISSA.. They are excited with the idea of building neutrino physics group in Vietnam, particular in ICISE (In this center, we have official-established instituted called "Institute for interdisciplinary research in science and education (IFIRSE)").

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B. Why is experimental neutrinos physics?

Neutrino experiments are getting exciting, global and much bigger than before in manner of both detector size and physic potential. The NEUTRINO 2016 conference held at London, UK is the largest international neutrino conference so far with about 700 physicists. The new released results from T2K and NOvA immediately get attracted from the media although the statistic significance to CP violation, mass hierarchy is still marginal. Following are some reasons why we should consider to start with experimental group instead of theory group:

It will be the first and unique physicist group in Vietnam. There is no official Vietnam-based working
 group in experimental high energy physics that collaborates with international experiments. We would
 like to be a part of the latest discovery in the field of high energy physics, and therefore, an experimental
 group would give us better chance to do that.

- Results from neutrino experiments are still very interesting within a couple decades, even more. Also, it is not just about neutrinos, but other physics potentials such as proton decay, supernova, and even new physics. This brings us a chance to involve in the top discoveries to the world. In addition, the excitement of new results might inspire a young generation of scientists in Vietnam.
- The collaborations in neutrino experiments are not big like LHC. Thus contribution of each group is well-recognized by the other collaborators. This is important for a starting group since we would like to show that we can make significant contribution.
- Neutrino experiments are getting bigger as a requirement for higher precision and possibility of new physics. The next generation of neutrino experiments, Hyper-Kamiokande and DUNE are expected to start around 10 years from now. If we can start a small group early, we can join these collaborations by the time they start to take data with a number of experienced Vietnamese physicists.

Neutrino experiments are not so complicated in principle. In the short-term, we can start with small group working mainly in data analysis and leaving hardware development for the next step when we have enough people as well as financial support to build an experimental laboratory. Details of roadmap are discussed in Section IV.

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C. Why should we start with T2K experiment?

It would be more convenient to collaborate with an neutrino experiment in Asia, especially Japan. They have many top experiments of the world such as Super-Kamiokande, T2K, etc... They are close to Vietnam and that would save a significant amount of money for travel. Also friendship is an important key. We also have few Vietnamese physicists who have worked on these experiments in Japan, such as Dr. Trung Le (now postdoc at Tuft Univ., USA), Dr. Son Cao (now postdoc at Kyoto, JP), Ms. Nhi Quach (Ph.D student at KEK), some Ph.D students at Osaka working at Kamioka project, etc. Furthermore, Prof. Nakaya, who agreed to be leader
 of the group, is the spokeperson of T2K.

T2K is a long-baseline neutrino experiment, using a almost pure ν_{μ} ($\bar{\nu}_{\mu}$) beam from J-PARC to study the neutrino oscillations with two detectors separated by approximately 295 km. The main physics topics are the standard neutrino oscillation, non-standard neutrino physics, and neutrino interactions. T2K is one of six experiments that received the Breakthrough prize in fundamental physics in 2016. Following are few reasons why we should consider to be in T2K collaboration as a starter:

- Along with NOvA, this is the top long-baseline neutrino experiment at present. New results release every year and very important contribution for CP violation, mass hierarchy, precision of mixing angles θ₂₃, θ₁₃ and even new physics. Program of neutrino interactions are also rich and we can involve into these programs.
- Prof. Nakaya, who agreed to be leader of the group, is the spokesperson of T2K experiment. Also, Dr.
 S. Cao is working in this experiment.
- T2K collaboration is proposing to extend the data taking until 2026 (at present, T2K is accepted to run until 2020) and the proposal got the Stage-I approval. Extending the data taking will guarantee the job for the group.

Hyper-K, the next generation of neutrino experiment in Japan, is similar to T2K in principle but the detector size is much larger. Thus, the experience when working in T2K can be applied directly when we would like to join Hyper-K.

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D. Why are we building group at ICISE ?

ICISE is an international conference center with more than 1000 physicist coming from around the world annually. This is the great chance to exchange knowledge, establish the relationships. The high-level academic environment is the key to maintain and develop scientific group. On the other hand, ICISE is fairly isolated and this might be good for work concentration. Also, ICISE with large area will be good for building an experimental laboratory later. Last but not least, we need a new and open procedure to hire foreign researchers for the group, and ICISE with great support from government and local officials has ability to do that.

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IV. A PRELIMINARY ROADMAP TO BUILD HEP IN ICISE

In this section, a preliminary roadmap to build experimental HEP in ICISE is preliminarily sketched. Three periods of development are considered: i) pilot study (summer 2017), ii) short-term (fall 2017-2023), iii) longterm (2023~). We will discuss what we need and what we might get for each period.

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A. Pilot study (summer 2017)

We will have "unofficial" group to work on a specific research topic. It consists of one leader, 3-4 postdoctoral researchers, and no Ph.D student involved yet. They will all stay in ICISE for about 2-3 month in summer 2017. Thought the group is not official yet but the leader is chosen as the official one, for both this period and "short-term" period which is described below. Also it is supposed that Dr. V. Nguyen would be hired already to be the core member in Vietnam. She might be invited to go to Japan as visitor for about 2 months.

- It is good to have result along with published papers
- If possible, include ICISE in acknowledgement

• Introduce group and show some results in some conference held in ICISE.

About the postdoctoral researchers, we will have at least two Vietnamese physicists (Dr. V. Nguyen and Dr. 2 S. Cao) and we would like to invite one or two additional postdoctoral researchers. So far, we have enough 3 rooms for researchers staying right in the ICISE center. The good Internet connection is available. Also since 4 we will need to work as group, a computer cluster to share working tools. Kyoto Cluster is one options with 5 our relationship but we will need permission. 6

There are few topics to work together in this period: 7

• Do something with real data/MC from experiments (such as T2K, SuperK). Although this is helpful for 8 the short-term, we need to get agreement from the collaboration. This requires a lot of work from the 9 leader actually. 10

• Do something with public data/MC released by experiments: We can build a framework to incorporate all neutrino data, for example, or using the public tools to optimize the running of some experiments, detector design etc... 13

• Prof. Nakaya's idea?

We would like to organize a small school in order to train number of selected Vietnamese Ph.D candidates (the 15 number is from 5-10, selected from all regions of Vietnam) focusing on the technique applied in the neutrino 16 experiment. There are two conferences on Summer 2017 held at ICISE: Neutrino Physics (July 16-22) and 17 Flavour Physics (August 13-19). It is good to introduce our work as well as our group in this period as well. 18

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В. Short-term (fall 2017-2023)

The short-term of the group development is about 3-5 years, start might be from fall 2017. We will have 20 "official" group and join in a collaboration as data/MC analyzers. The group will be leaded by Prof. Nakaya 21 from Kyoto University, Japan. Prof. Nakaya works mainly from Japan and can be in Vietnam for few weeks in 22 the summer or occasionally in Viet Nam to report the progress of group. In the first years, the onsite (staying at 23 ICISE) member includes Dr. Hong Van and two Vietnamese Ph.D students. The Ph.D student can be enrolled 24 each year. The group will get help from Dr. S. Cao (work at KEK since December 2016). Also we should 25 consider to hire foreign postdoctoral researcher for the group. Some tentative timeline 26

- Officialize the group by early Fall 2017 (early September?)
- Make a proposal to join the T2K/Super-K experiment (late Fall 2017) 28
 - Enroll Ph.D students (fall 2017)
 - Looking for the foreign postdoc (from fall 2017)
- Apply JSPS funding? NAFOSTED? 31
- The physic topics when join T2K 32
 - Neutrino interactions with T2K Near Detector (INGRID?)
 - Neutrino and antineutrino oscillations
- Looking neutrino physics beyond the standard neutrino model 35
 - Design the neutrino detectors for future

This period is super important if we want to go further in this field. We need to show that we can made 1 significant contribution in this field. 2

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C. Long-term (2023 \sim).

After the short-term period as discussed above, we will have a number of Vietnamese physicists with high 5 experience in this field. We will consider to expand the group to 10-15 physicists and students. It might be 6 good to keep a balance between Vietnamese and foreign physicists. In this period, it is important to build an 7 experimental lab. The lab can serve a R&D detection techniques for long-baseline experiment and/or double-8 less beta decay and/or moving to another physics topic like the dark matter search. That will cost a signifiant 9 amount of money. However, if we do well in the short-term, we might get higher support from the government, 10 local officials and even some private companies. In this period, we will need a onsite leader, either Vietnamese 11 or foreign physicists. The lab might not be just for neutrino experiment but we might expand our field to dark 12 matter or physics in collider. Furthermore, it might be possible to have joint theoretical - experimental group 13 inside IFIRSE. At present, a theoretical groups of two Vietnamese physicists working on physics in collider has 14 already been hired by IFIRSE. If both groups can work well, we might see an institute of both theoretical and 15 experimental physicists working together in the near future. 16

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V. FUNDING

ICISE center will provide the base funding at the beginning. Besides, NAFOSTED is providing good funding for Vietnamese physicists. However this group also includes a number of foreign researcher and we need to know if NAFOSTED has any support for this. We need to find further support from The Vietnam Minister of Education and Training and/or the Vietnam Minister of Science and Technology. Besides, we need to look for international support, such as JSPS from Japan. We need to apply JSPS as soon as possible to support Vietnamese physicists/students when working at Japan.

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VI. CONCLUSION

We would like make Vietnam and Vietnamese scientists more visible to the scientific community, particularly physics. Building the experimental neutrino group in ICISE might be a promising move for this path. We would like to hear your advice as much as possible to make this happen.