Physique des particules et hadronique

Equipe « Neutrino » (T2K)

LPNHE (Paris)
19/09/2023

cnrs IN2P3 Les deux infinis

LPNHE PARIS

Composition actuelle

- [5+1] permanents [signaler les HDR]
  Claudio Giganti (CR/HDR), Mathieu Guigue (MdC@SU), Boris Popov (DR), Stefano Russo (IR/HDR), Marco Zito (DR) + Marco Martini (PR@IPSA/HDR)
- [2] postdocs
  Gonzalo Diaz Lopez (ANR), William Saenz-Arevalo (ANR)
- [3] emerites
  Pierre Billoir, Alain Blondel, Jacques Dumarchez
- [4] doctorant

Lucile Mellet (2020-2023) [STEP'UP grant, T2K oscillation analysis + R&D timing HK],
Uladzislava Yevarouskaya (2020-2023) [CNRS grant, HA-TPC for ND280-upgrade]
Claire Dalmazzone (2022-2025) [Ecole Polytechnique grant, HK sensitivity studies + NA61/SHINE hadron production for T2K-II/HK]
Ulysse Virginet (2022-2025) [IPI grant, ND280-upgrade data analysis]

Évolution récente (3 dernières années)

- Permanents ---
- Postdocs (ANR)

  Adrien Blanchet (- Oct,2022) → T2K postdoc @ Geneva Univ

  Sergey Suvorov (- Oct,2022) → private company
- Thèses soutenues

  - Viet Nguyen (2019-2022) [CNRS grant, sensitivity studies with ND280-upgrade] → T2K postdoc @ LLR

  - Lucile Mellet (2020-2023) [STEP'UP grant, T2K oscillation analysis + R&D timing HK] → T2K/DUNE postdoc @ Michigan State University
- HDR obtenues ou imminentes

  - Marco Martini (2020), Stefano Russo (2021)
- Nouveaux doctorants
  - Anaelle Chalumeau (Oct 2023 -) [STEP'UP grant, HA-TPC track reconstruction based on ML + nue selection in ND280]
  - Lavinia Russo (Nov 2023 -) [CNRS grant, cross section studies with ND280-upgrade, oscillation analysis in T2K-II]

Good working environment

Organisation et fonctionnement

- [Chef(s) d'équipe(s), fréquence des réunions, segmentation en équipes ou projets, etc.]

Chef d'équipe : **Boris Popov**

Réunion : 1 réunion chaque semaine

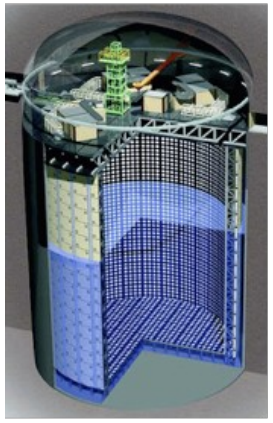
Projets : T2K & **T2K-II** (Near Detector upgrade installation in 2023) → coordination, HA-TPC readout electronics, DAQ, computing, etc.

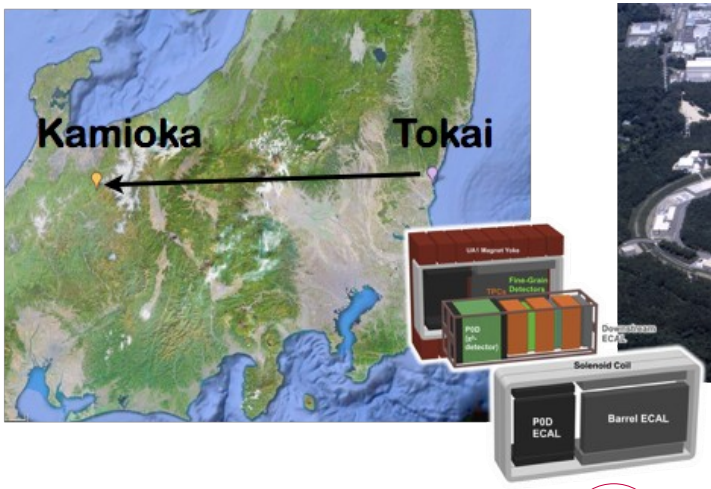
NA61/SHINE for T2K-II/HK and for future long baseline (LBL) experiments → new data collected with T2K replica target in 2022

Hyper-K (R&D and sensitivity studies in view of the beginning of the experiment in 2027) → responsibility for the HK timing system, etc.

T2K/T2K-II

- Expérience d'oscillations de neutrinos à grande distance

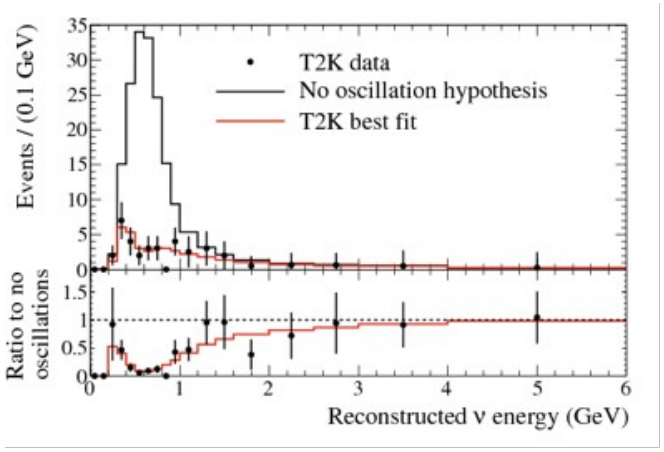


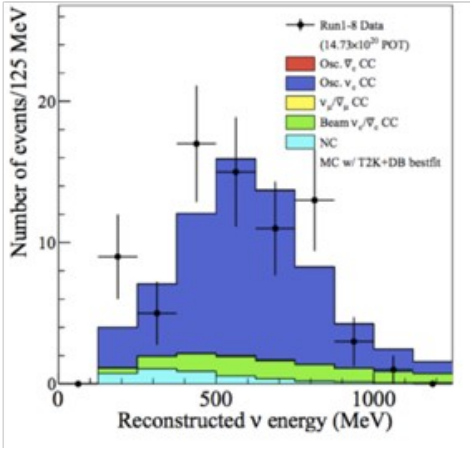


new goal

Apparition des neutrinos (et antineutrinos) électroniques (θ_{13}, δ_{CP})

Disparition des neutrinos (et antineutrinos) muoniques (θ_{23}, Δm^2_{23})





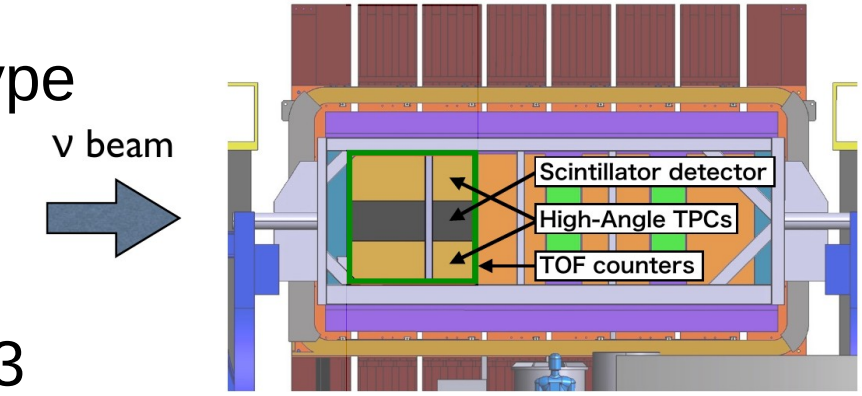
ND280 upgrade

- Participation in the ND280 upgrade
  - 84 Front-End Cards (FEC) produced at OUESTRONIC for the readout of the new horizontal TPCs (J.M.Parraud/F.Toussenel/E.Pierre/J.Coridian)
  - Cooling plates for FECs produced at CHANTELOUP (Y.Orain)
  - DAQ (A.Blanchet/D.Terront)

Active participation in the prototype construction and tests (at CEA, at DESY and at CERN)
HA-TPC assembly at CERN
Final installation in Japan in 2023

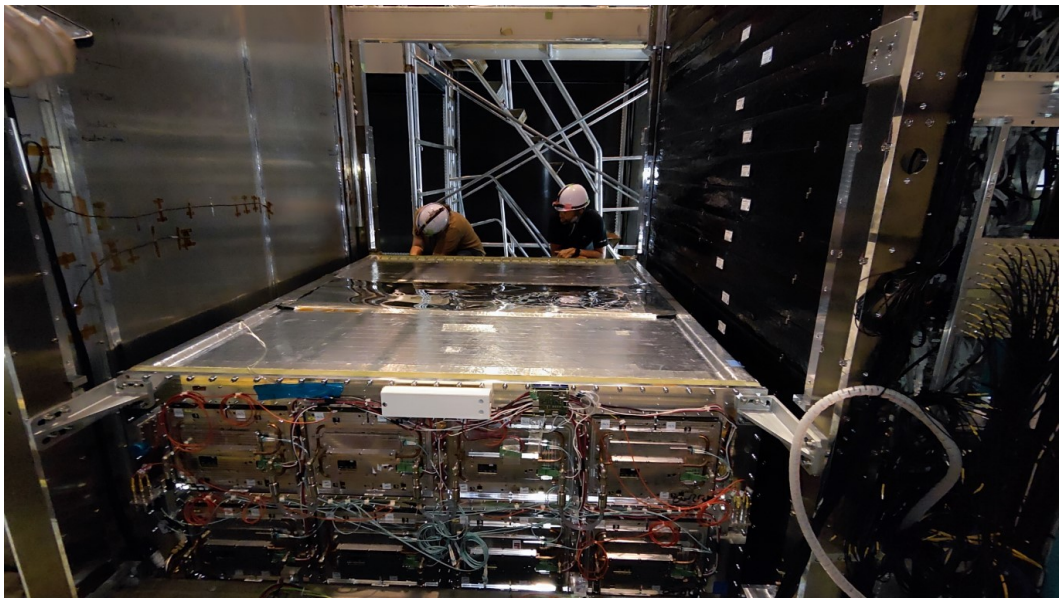
J.M.Parraud retired in Apr,2023

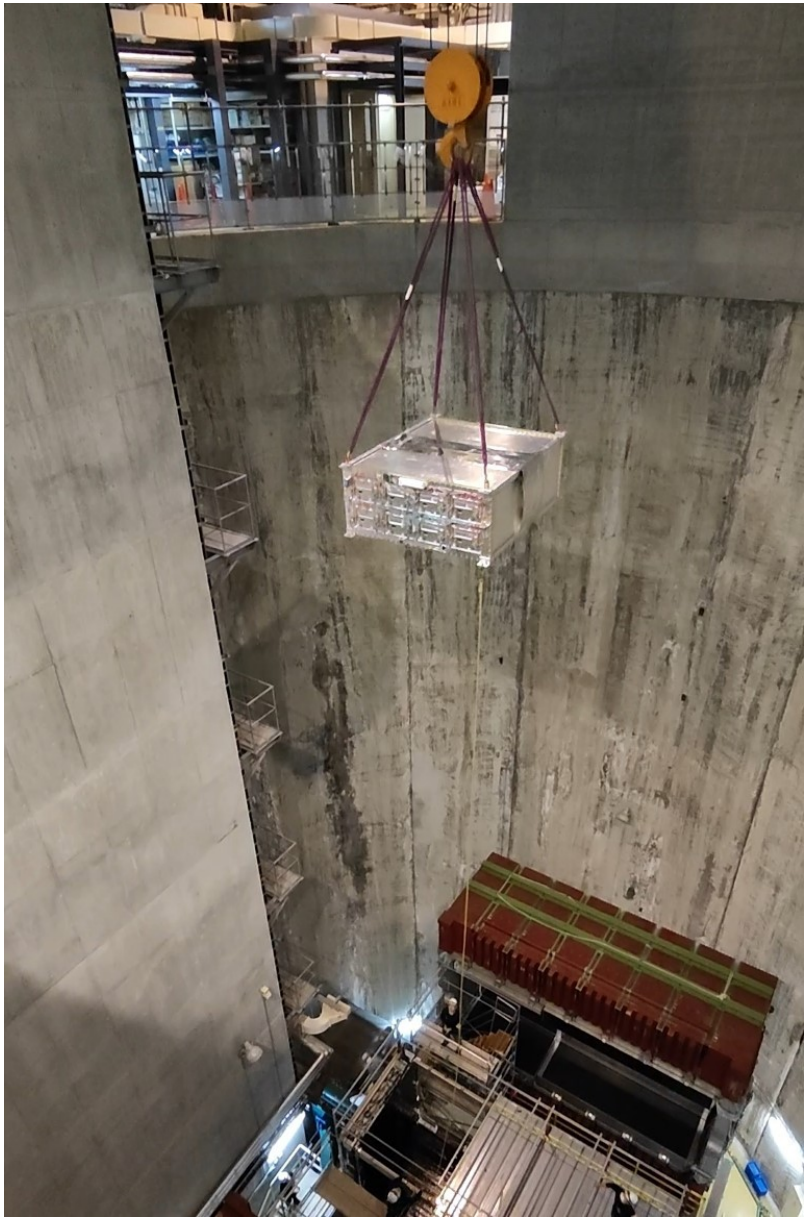
ND280 upgrade configuration



- Replace (most of) P0D with **Scintillator Detector** + **2 High-Angle TPCs** + **TOF**
  - Improve acceptance for large angle tracks
- Keep current "tracker" [2 FGDs + 3 TPCs] (& upstream part of P0D) as well as ECal, magnet & SMRD
  - For keeping continuity and forward acceptance

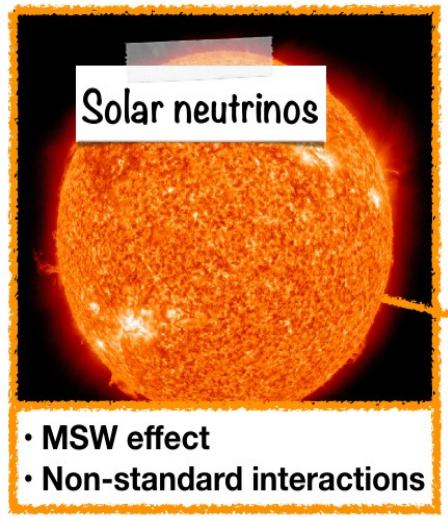
First HA-TPC installation @ J-PARC



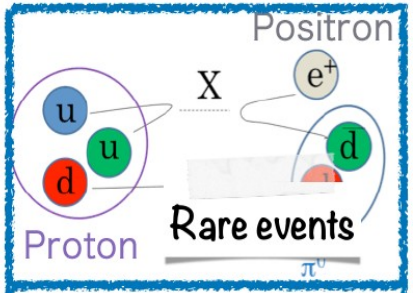


Hyper-Kamiokande

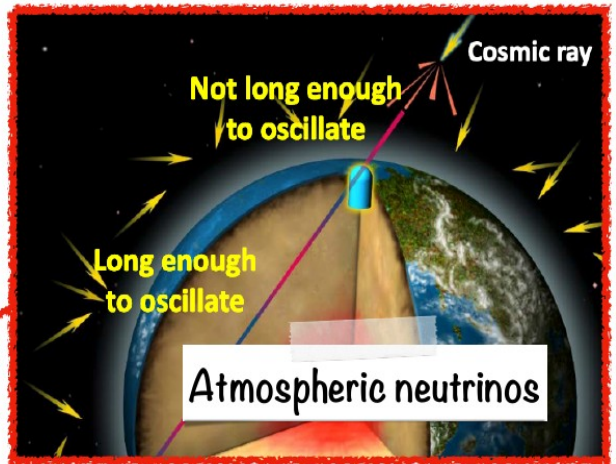
- Un observatoire unique des neutrinos



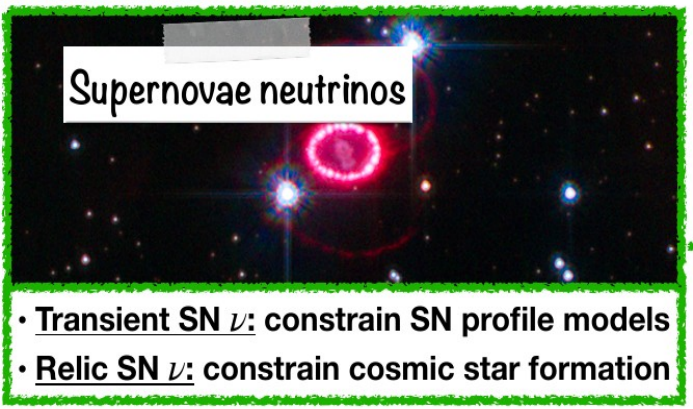
- MSW effect
- Non-standard interactions



- Probe Grand Unified Theories via p-decay or $n - \bar{n}$ oscillation



- Observe CP violation for leptons at 5σ
- Precise measurement of δ_{CP}
- High sensitivity to ν mass ordering



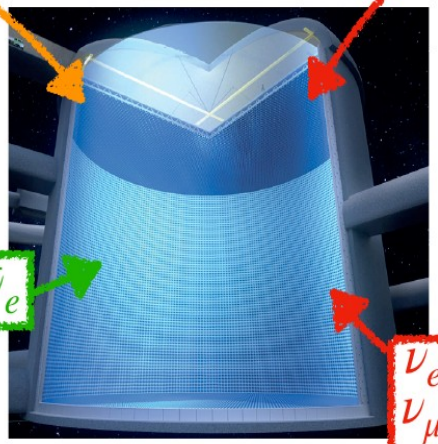
- Transient SN ν: constrain SN profile models
- Relic SN ν: constrain cosmic star formation

ν_e

$\bar{\nu}_e$

ν_e $\bar{\nu}_e$
ν_μ $\bar{\nu}_\mu$

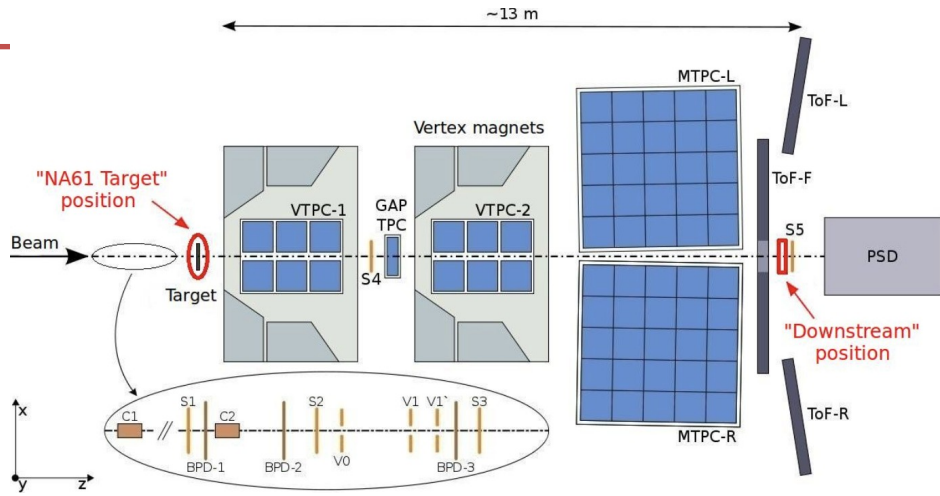
ν_e $\bar{\nu}_e$
ν_μ $\bar{\nu}_\mu$



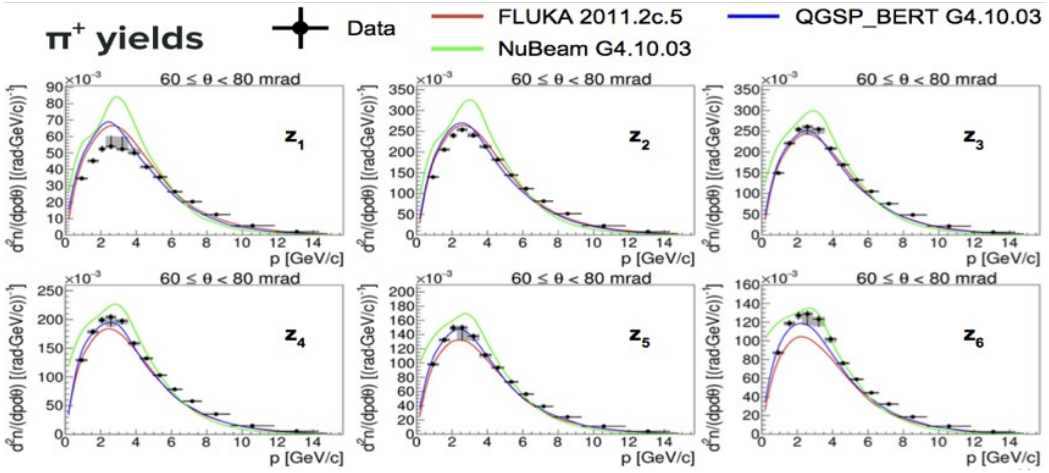
Timing R&D: S.Russo, V.Voisin, L.Mellet, M.Guigue, etc.
Computing: M.Guigue

NA61/SHINE

- Pour réduire l'une des systématiques les plus importantes des expériences LBL: prédiction du flux de neutrinos
- L'inclusion des resultats de la cible réplique de T2K a permis de réduire les incertitudes sur le flux à <5% (10% avec les donnés de la cible mince)



collecté de nouvelles données pour T2K en 2022



Data analysis: Claire Dalmazzone

Projets scientifiques (à 5 ans)

- Utilisation de l'**upgrade de ND280** pour **T2K-II**
- Analyses des données **T2K-II** pour l'oscillations et sections efficaces
- Analyse des données de **NA61/SHINE** pour T2K-II/HK et les futurs LBL
- Participation dans **Hyper-Kamiokande** (expérience LBL de prochaine génération au Japon)
  - Collaboration avec les groupes LLR, Omega et IRFU-Saclay
  - Conseils scientifiques du LPNHE et de l'IN2P3 en 2018, 2021 et 2022
  - Contributions bien définies (MoU à signer)

Responsabilités scientifiques

- T2K ND280-upgrade co-convener (CG)
- T2K Executive Committee member (CG)
- T2K ND280-G4 Group member (BP)
- T2K ND280 Sim and Recon co-convener (MG)
- NA61/SHINE analysis coordinator (BP)
- HK Distributed computing convener (MG)
- HK timing responsible (SR)
- HK technical coordinator for electronics assembly at CERN (SR)
- Member of NuSTEC committee (MM)
- Membre des comités éditoriaux pour 3 papiers T2K et 6 papiers NA61/SHINE

Enseignement, animation, gestion

- Membre du Conseil du Laboratoire (MG, LM)
- Membre du Conseil Scientifique du LPNHE (CG, SR)
- Responsable National T2K (CG), NA61 (BP)
- Membre du Conseil de l'UFR Physique SU (MG)
- Responsable IRN-Neutrino WG (CG)
- Membre du comité du programme scientifique de NuFact (MM), NNN (BP)
- Participation des membres du groupe à la Fête de la science

Visibilité et rayonnement

- [12] présentations en conférence (permanents, postdocs et doctorants)
  - 2021 : Neutrino Telescopes (MG, SS)…
  - 2021 : NOW (VN), Blois (AB, SS)…
  - 2022 : ICHEP (VY), NUFACT (LM, MM), Ecole GIF (MM)
  - 2023 : ILANCE/IPMU/ICRR seminar (LM), TAUP (LM), NNN (CD)
- Organisations de conférences, workshops, réunions de collaboration
  - 2021-2023 : Moriond (JDZ), Blois (JDZ), Vietnam(JDZ)
  - 2022 : Ecole de GIF at LPNHE (JDZ/MG/BP)
  - 2023 : CP2023 (MG)

Bilan de publications (2021-23)

- 11 Publications de T2K, 5 de ND280-upgrade, 16 de NA61/SHINE et 1 de HK
- Avec contributions directes de l'équipe (responsable du papier)

- D.Attie et al., Analysis of test beam data taken with a prototype of TPC with resistive Micromegas for T2K Near Detector upgrade, NIM A 1052 (2023) 168248
- S.Dolan et al., Sensitivity of the upgraded T2K Near Detector to constrain neutrino and antineutrino interactions with no mesons in the final state by exploiting nucleon-lepton correlations, Phys.Rev.D 105 (2022) 3, 032010
- D.Attie et al., Characterization of resistive Micromegas detectors for the upgrade of the T2K Near Detector Time Projection Chambers, NIM A 1025 (2023) 166109
- NA61/SHINE Collaboration, Measurement of the production cross section of 31 GeV/c protons on carbon via beam attenuation in a 90-cm-long target, Phys.Rev.D 103 (2021) 1, 012006

Évolution prévue (en personnel)

- Lucile -> fin contrat thèse (- Sept. 2023), postdoc @ Michigan State University
- Vlada -> fin contrat thèse (- Oct. 2023), postdoc @ Stony Brook University

SWOT (1)

- Strength :

LPNHE physicists have, since many years, leading roles in the operation of T2K Near Detector and in the corresponding reduction of systematics uncertainties. Hyper-Kamiokande will use the neutrino beam and the near detector complex built for T2K, thus saving large amount of money for the long-baseline program. In addition, the combination of well-understood (anti)neutrino beams (characterized using NA61/SHINE hadron production measurements) and near detectors will allow a significant reduction of systematics uncertainties from the first day of the experiment.

- Weakness :

The LPNHE-Neutrino group is relatively small and physicists are already committed to the operation of T2K-II and R&D towards HK. This weakness is partially mitigated by the large overlap in terms of physics case, technologies and tools between the two collaborations, but, given the ambitious physics program, the group would certainly benefit of additional researchers that could be hired in the coming years.

SWOT (2)

- Opportunity :

Hyper-Kamiokande has the great potential to be the first experiment to measure CP violation in the leptonic sector. No experiments before Hyper-Kamiokande have the sensitivity to measure CP violation at more than 3σ and, once online, Hyper-Kamiokande will acquire statistics much faster than other future neutrino experiments. The huge target mass of Hyper-Kamiokande will make it the most sensitive observatory for rare events in the MeV–TeV energy region. It will have, for example, the best sensitivity to proton decay and detection of SN neutrinos.

- Risk :

There is not yet a signed MoU about the participation of IN2P3 physicists in the Hyper-Kamiokande with clearly defined contributions to the experiment.

Attentes (vis-a-vis de l`IN2P3)

- A new CRCN position at LPNHE for accelerator neutrino physics
- Support for participation in T2K-II with upgraded ND280
- Well-defined financial support of our participation in the Hyper-Kamiokande project starting from 2024

Ressources 2021-2023

Récapitulatifs de l'ensemble des ressources de l'équipe sur 2021-2022-2023:

Origin	2021	2022	2023	Prévision 2024 (pour RP connues)	Description
AP IN2P3	T2K: 50k+60k NA61: - RD4HK: -	T2K: 40k+30k NA61: 2k RD4HK: 15k	T2K: 45k+15k NA61: 2k ? HK: 20k+15k	T2K: 50k+10k NA61: 2k HK:30k+250k	
ANR	2 postdocs	2 postdocs	2 postdocs	2 postdocs	
JENNIFER					

ANR JCJC 2019 project «SUNCORE» (C.Giganti) on the ND280 upgrade for T2K-II

ANR JCJC 2021 project «BERTHA» (M.Guigue) on the timing for Hyper-Kamiokande

Dedicated funding in 2022 for HK to buy components for final production (2 PUMA procedures): 136k (FPGA + laser SFP)