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| ID: NU\_09 | Title:Characterization of the upgraded J-PARC neutrino beam for T2K-II and HK experiments | | | | | | | | | | | | | |
| Project Leader | **French Group** | | | | | | **Japanese Group** | | | | | | | |
| name | email | **title** | **lab** | | | **name** | | **email** | | | **title** | | **lab** |
| Popov Boris | popov@lpnhe.in2p3.fr | Dr | LPNHE | | | Sakashita Ken | | kensh@post.kek.jp | | | Prof | | KEK |
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| **Spending on French Funds** | | | | | | | | | | | | | | |
| **Description** | | | **€/unit** | | **Nb of units** | | | Total (€) | | Provided by:1 | | | | |
| Visit to Japan | | | 100/day | | 10 days | | | 1000 | | IN2P3 | | | | |
| Travel | | | 1000 | | 1 travel | | | 1000 | | IN2P3 | | | | |
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| Total | | |  | |  | | | 2000 | |  | | | | |
| **Spending on KEK Fund** | | | | | | | | | | | | | | |
| **Description** | | | **k¥/Unit** | | **Nb of units** | | | **Total (k¥)** | | Provided by:1 | | | | |
| Visit to France | | | 20/day | | 10 days | | | 200 | | KEK | | | | |
| Travel | | | 150 | | 1 travel | | | 150 | | KEK | | | | |
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| Total | | |  | |  | | | 350 | |  | | | | |
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| **Additional spending on French funds** | | | | | | **Additional spending on Japan funds** | | | | | | | | |
| **Provided by:2** | | **Type** | | **€** | | **Provided by:3** | | | | | **Type** | | **k¥** | |
| IN2P3 AP | |  | | 31000 | | JSPS | | | | | travel | | 140 | |
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| Total | |  | | 31000 | | Total | | | | |  | |  | |

1 IN2P3, Irfu or KEK. 2 French Embassy, other CNRS or CEA programs, PICS, European grants…. 3 JSPS, RIKEN, Universities …

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| **Summary**  **of**  **2024 Activities** | The main goal of this joint France-Japan project is to improve our knowledge on the upgraded (anti)neutrino beam produced at J-PARC for T2K-II and HyperKamiokande (HK) experiments. The important upgrade of the J-PARC neutrino beamline was finalized in 2023. Operation with a horn current set at 320 kA (instead of 250 kA used previously) has started since the end of 2023 and successfully continues till now. The record beam power of 800 kW has been reached.  Dedicated hadron production data collected with a replica of the T2K target using a significantly upgraded NA61/SHINE spectrometer at the CERN SPS are being used to improve our knowledge about the obtained (anti)neutrino flux. The measurements of hadron yields from the surface of the T2K target are crucial for detailed characterization of the J-PARC neutrino beam and already allowed to achieve unprecedented precision on T2K/HK flux uncertainties. New data (180 M triggers compared to 10 M used previously) collected during the 2022 NA61/SHINE run will allow to improve this even further. These data are currently being thoroughly calibrated and analyzed by a joint team of Japanese and French physicists. A significant progress has been achieved during 2024.  Another important task for the long-baseline neutrino experiment is the synchronization of the accelerator spill from J-PARC with neutrino interactions observed in the near (ND280) and far (SK or HK) detector. In the framework of this project a new time synchronization system is being developed and being installed at J-PARC by the joint French-Japanese team. An intensive R&D has already been performed at LPNHE and important tests of the selected equipment (GNSS antenna and receiver) were performed in both 2023 and beginning of 2025 at both J-PARC and HK sites. A required scheme of the timing system with a free-running Rubidium atomic clock accompanied by a set of GNSS antenna and receivers is being deployed and tested. A dedicated correction algorithm has been successfully developed and tested in order to align the local reference time with the UTC. This is crucial for future multi-messenger astrophysics with the HK detector.  Finally, new important sensitivity studies for neutrino oscillation parameters with the HK long-baseline neutrino program were finalized in 2024. These results have been reported at international conferences and are being submitted for publication. |
| **Workshop / satellite session at annual workshop** | The group meets regularly on the occasion of NA61/SHINE, T2K and HK collaboration meetings. We also organize dedicated Zoom meetings in order to discuss the ongoing activities and to define plans for the future. At the beginning of 2025 a workshop devoted to the calibration of the upgraded NA61/SHINE spectrometer and analysis of the T2K replica target data was organized in Japan. A talk on the NA61/SHINE experiment (Claire Dalmazzone) and two posters on charged (Shiraishi-san) and neutral (Nishimori-san) kaon production from the T2K replica target have been presented at the J-PARC symposium in October 2024. |
| **Articles, conference talks & posters related to the TYL project** | Precise synchronization of a free-running Rubidium atomic clock with GPS Time for applications in experimental particle physics, [Claire Dalmazzone, Lucile Mellet](https://inspirehep.net/authors/1881201), [Mathieu Guigue](https://inspirehep.net/authors/1391600), [Boris Popov](https://inspirehep.net/authors/992965), [Stefano Russo](https://inspirehep.net/authors/1948198),[Vincent Voisin](https://inspirehep.net/authors/2056517), 2024, e-Print: [2407.20825](https://arxiv.org/abs/2407.20825) [physics.ins-det], to appear in NIM AFirst Joint Oscillation Analysis of Super-Kamiokande Atmospheric and T2K Accelerator Neutrino Data, T2K and SK Collaborations, K.Abe et al, 2023, *Phys.Rev.Lett.* 134 (2025) 1, 011801; DOI: [10.1103/PhysRevLett.134.011801](https://doi.org/10.1103/PhysRevLett.134.011801)KS0​ meson production in inelastic p+p interactions at 31, 40 and 80 GeV/c beam momentum measured by NA61/SHINE at the CERN SPS, NA61/SHINE Collaboration, N.Abgrall et al, 2024, *Eur.Phys.J. C* 84 (2024) 8, 820; DOI:[10.1140/epjc/s10052-024-13056-2](https://doi.org/10.1140/epjc/s10052-024-13056-2)NA61/SHINE experiment at the CERN SPS, C.Dalmazzone (for NA61/SHINE collaboration), talk at the J-PARC symposium, October 2024 |
| **Jointly Supervised Students** |  |