# Analysis and computing activities

***NEW*** CC-IN2P3 is now in the T2K Acknowledgments!

“*We also thank […] and the CNRS/IN2P3 Computing Center in France.*”

SCIENCES SORBONNE UNIVERSITÉ

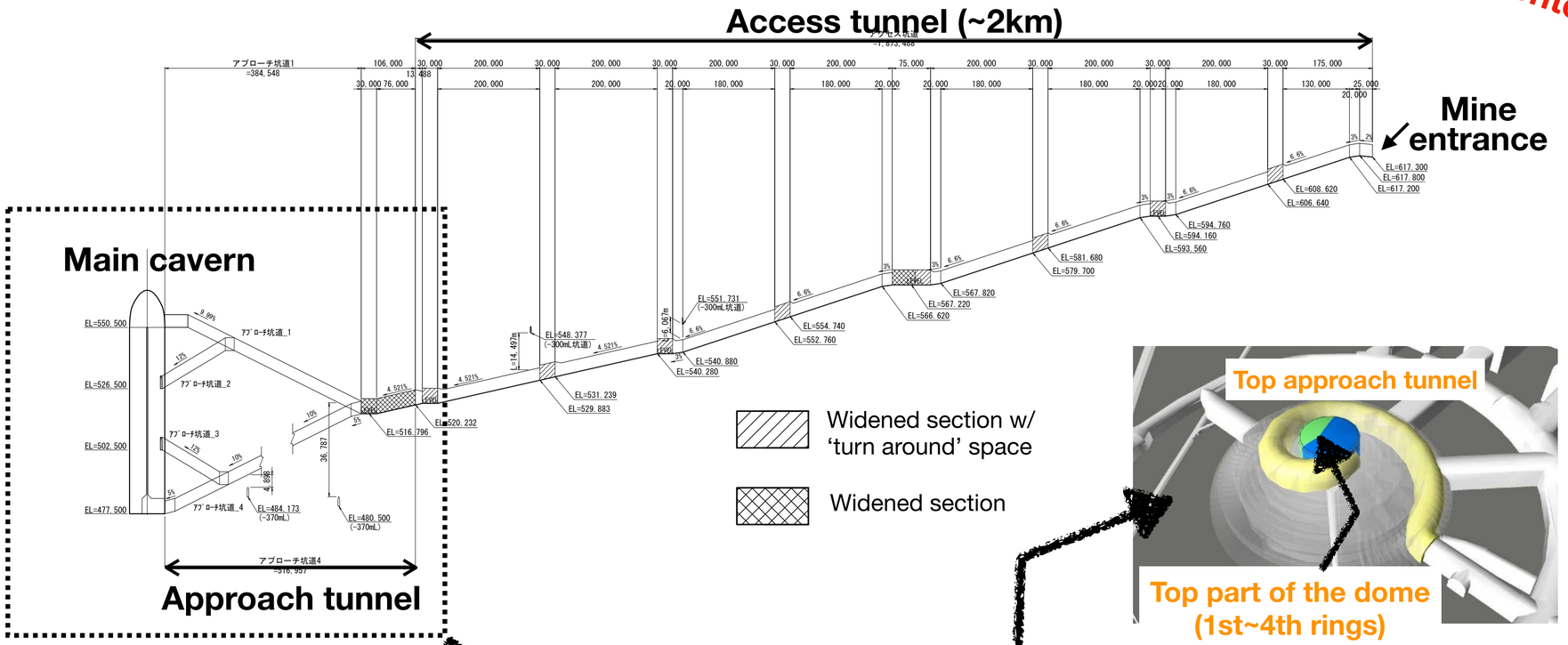
LPNHE PARIS

cnrs dépasser les frontières IN2P3 Les deux infinis

# News from HK Collaboration Meeting

## Overview of the cavern excavation

Presented June 29th 2023



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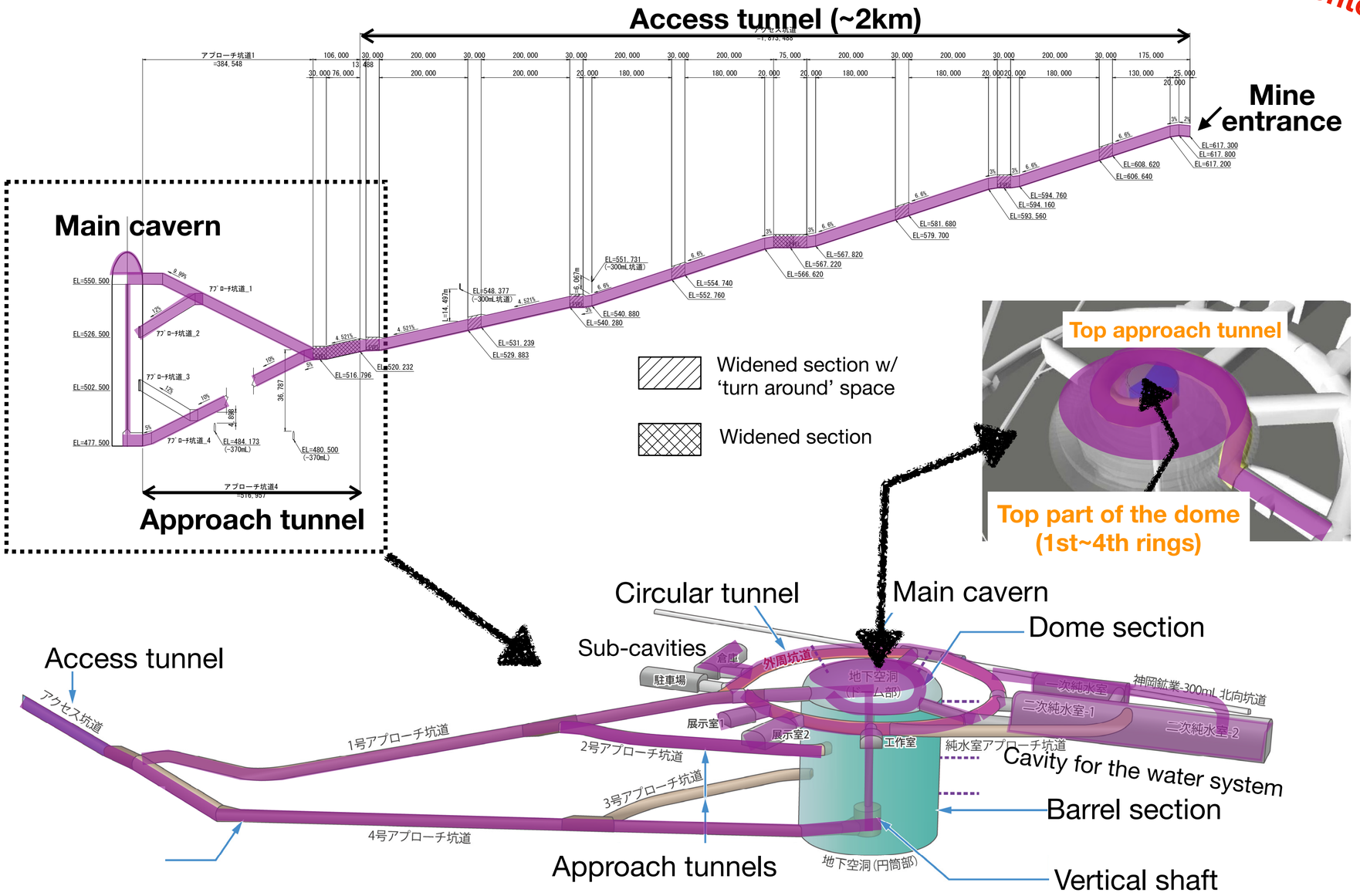


# ND280 Analysis with GUNDAM

*Generic fitter for Upgraded Near Detector Analysis Methods* developed by A. Blanchet

Much faster fitter than current T2K tools, much more flexible to include new data samples

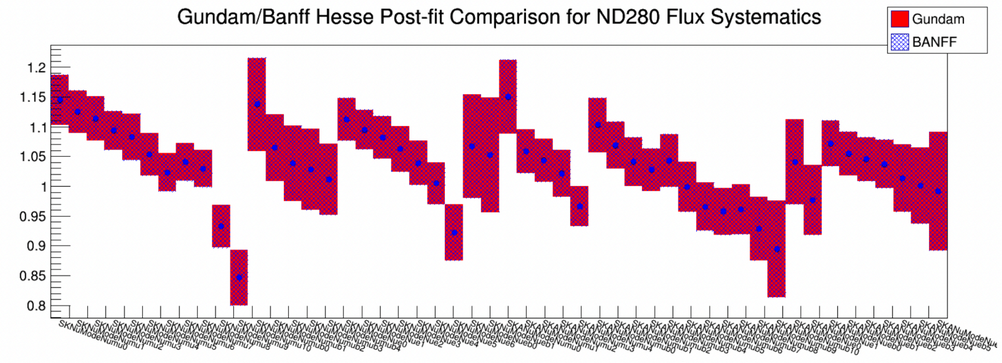
→ **Essential for exploiting ND280 Upgrade physics (and sparing CPU)!**

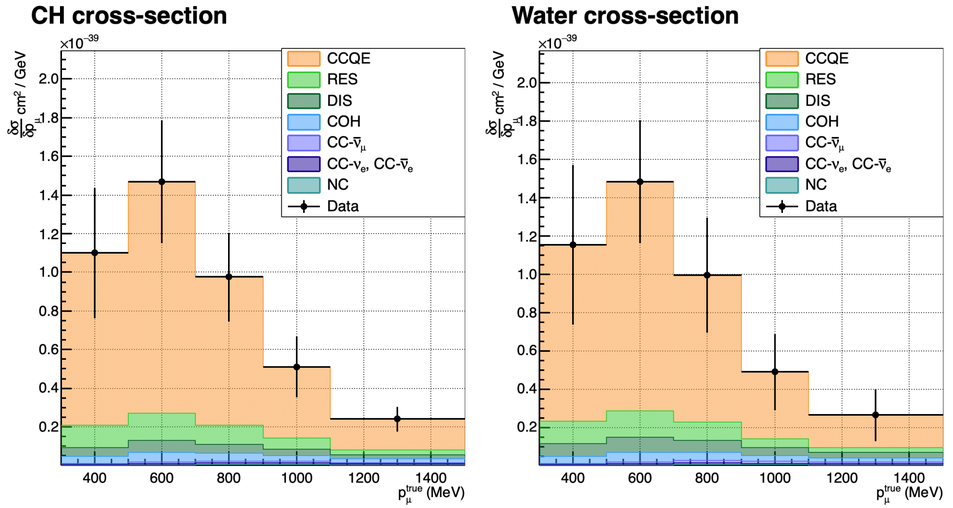
Full validation by Vlada for OA2022 done at CC-IN2P3

→ Will be used for next round of T2K-II/HK oscillation analysis

→ Official tool for ND Xsec analyses

→ Interest from other collaborations (ICARUS, DUNE…)



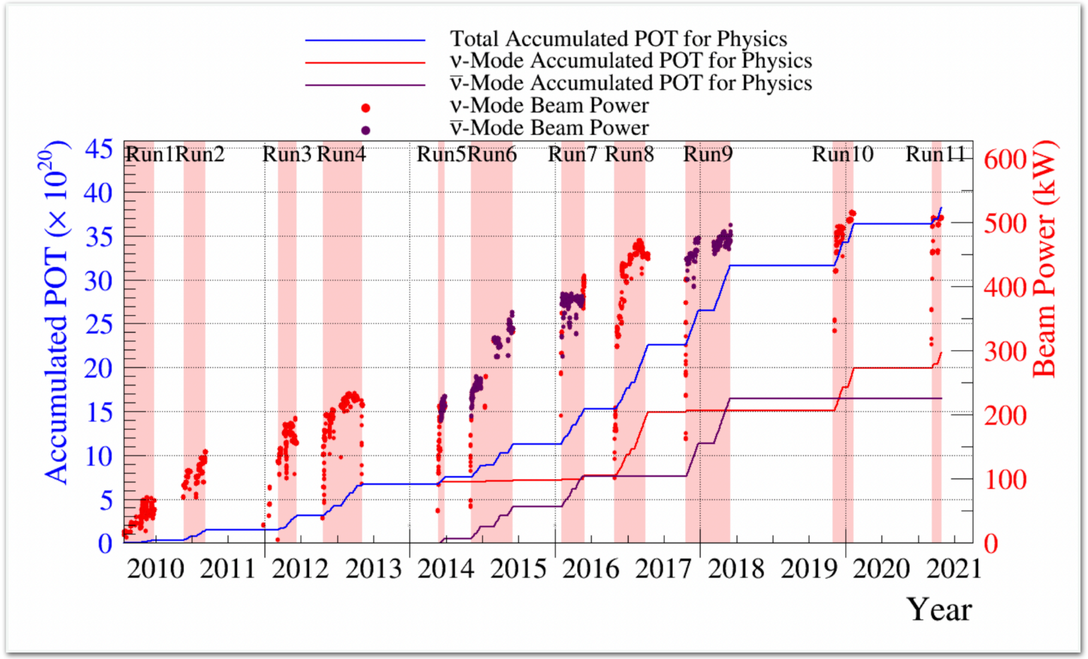




Gundam is the typical example of development done at LPNHE that can be used in both T2K and HK!

Adrien B. (ex-postdoc ANR/SU Emergence), Ulysse V. (PhD SU-IPI), Vlada Y. (PhD IN2P3)

# T2K Oscillation Analyses

## OA2022: 6 samples joint-analysis

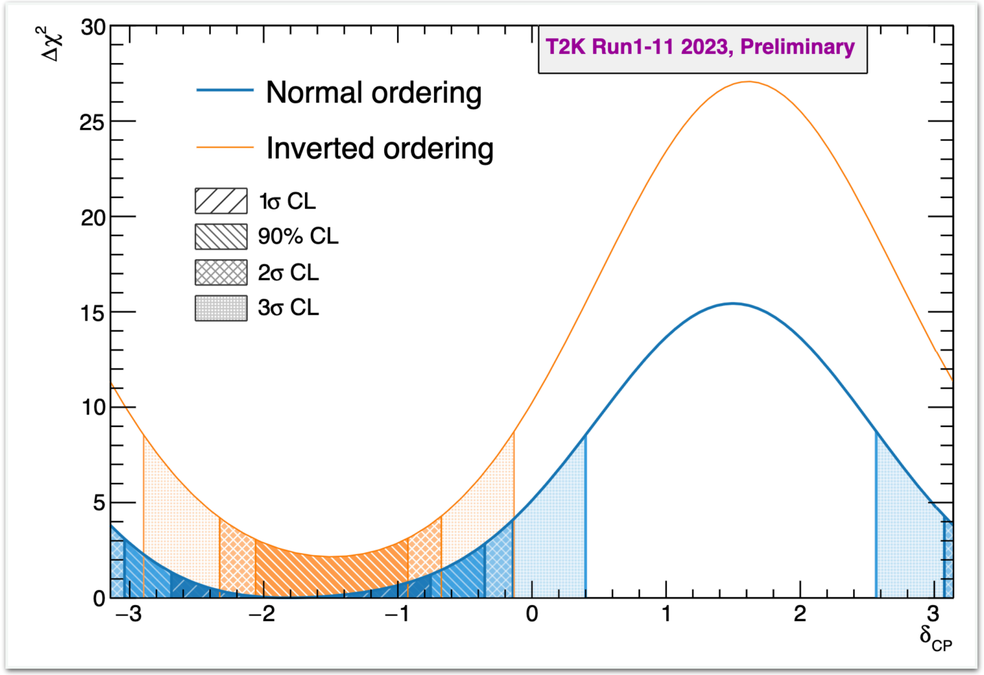


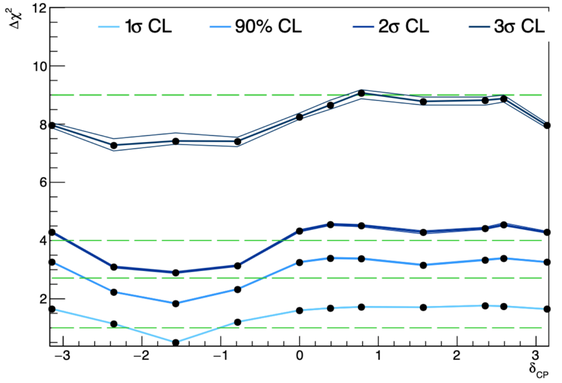

New features:

- New multi-ring sample $\nu_\mu$ cc $1\pi$
- 41 new systematic parameters!
- New treatment of removal energy $E_b$:

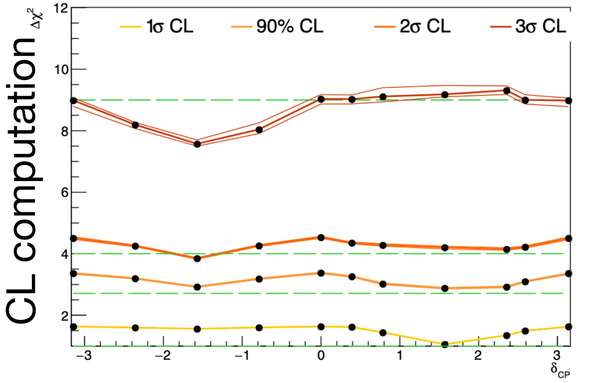
$$E_{\text{rec}}^{\text{CCQE}} = \frac{m_p^2 - \left(m_n - E_b\right)^2 - m_l^2 + 2\left(m_n - E_b\right)E_l}{2\left(m_n - E_b - E_l + p_l \cos\theta_l\right)}$$

## OA2023: Run 11 statistical update



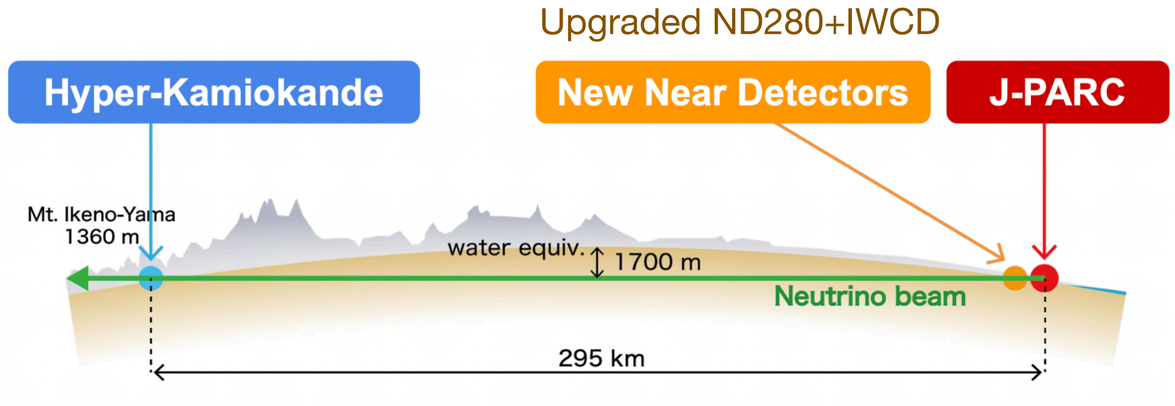

Feldman-Cousins CL computation




**Lot of studies done for T2K Oscillation Analysis at CC-IN2P3!**
**Upcoming OA analysis will be from CC-IN2P3!**

# Sensitivity studies for the HK long baseline program

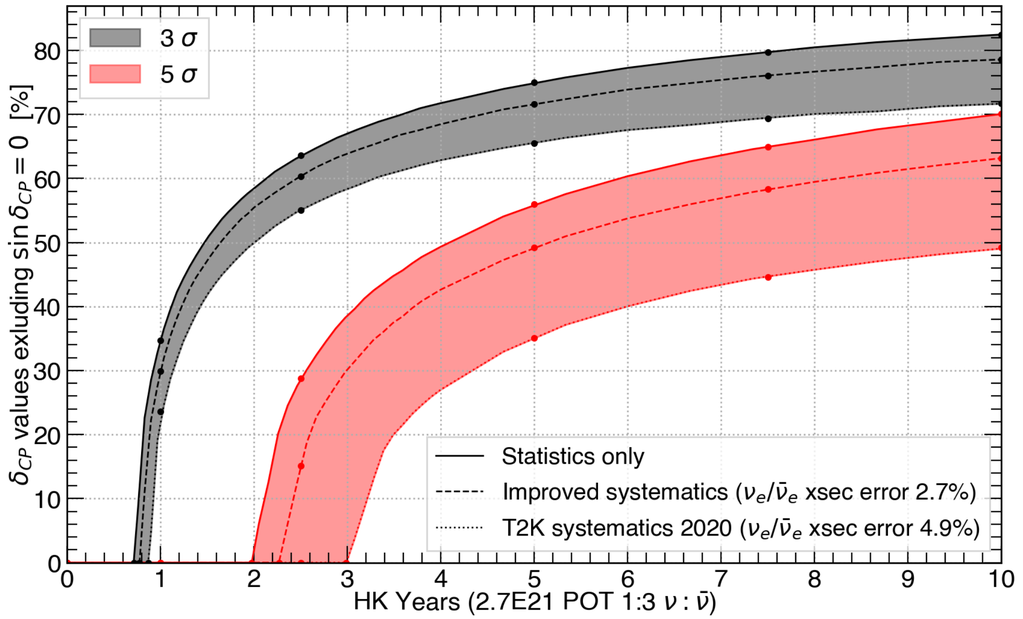
**@CC-IN2P3!**




Updated sensitivity studies with:
- T2K ~~2018~~ 2020 inputs (new neutrino interaction model)
- ~~Valor~~ P-theta framework (used for T2K OA)

**Status:**
- Validation of P-theta framework for HK-LBL ✅
- Updated estimations of sensitivity to oscillation parameters ✅
- Writing first technical note for HK-LBL sensitivity studies 🟰
- New plots should be officialised at the current CM 🟰

**Future plans:**
- Finer studies of systematic effects
- Add atmospheric neutrino samples
- Include IWCD systematics parametrisation




Claire D. (PhD X) & Ulysse V. (PhD SU-IPI)

# Reconstruction in WCTE/HK

PMT unhit probability PMT hit probability PMT charge pdf

$$L(\mathbf{x}) = \prod_{j}^{\text{unhit}} P_j(\text{unhit}|\mu_j) \prod_{i}^{\text{hit}} \{1 - P_i(\text{unhit}|\mu_i)\} f_q(q_i|\mu_i) f_t(t_i|\mathbf{x})$$

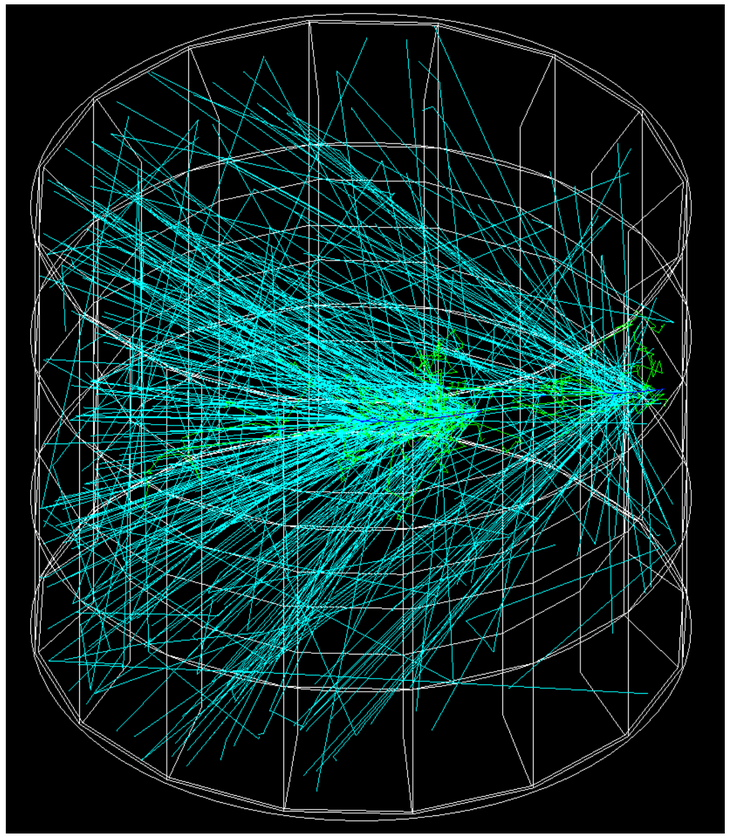
PMT timing pdf

WCTE as testbench for HK reconstruction

- Use of existing WCTE simulation framework (**WCSim**)
- Precursor of modernized HK **GHOST** simulation framework
- Simulation framework is a must in WCTE/HK reconstruction

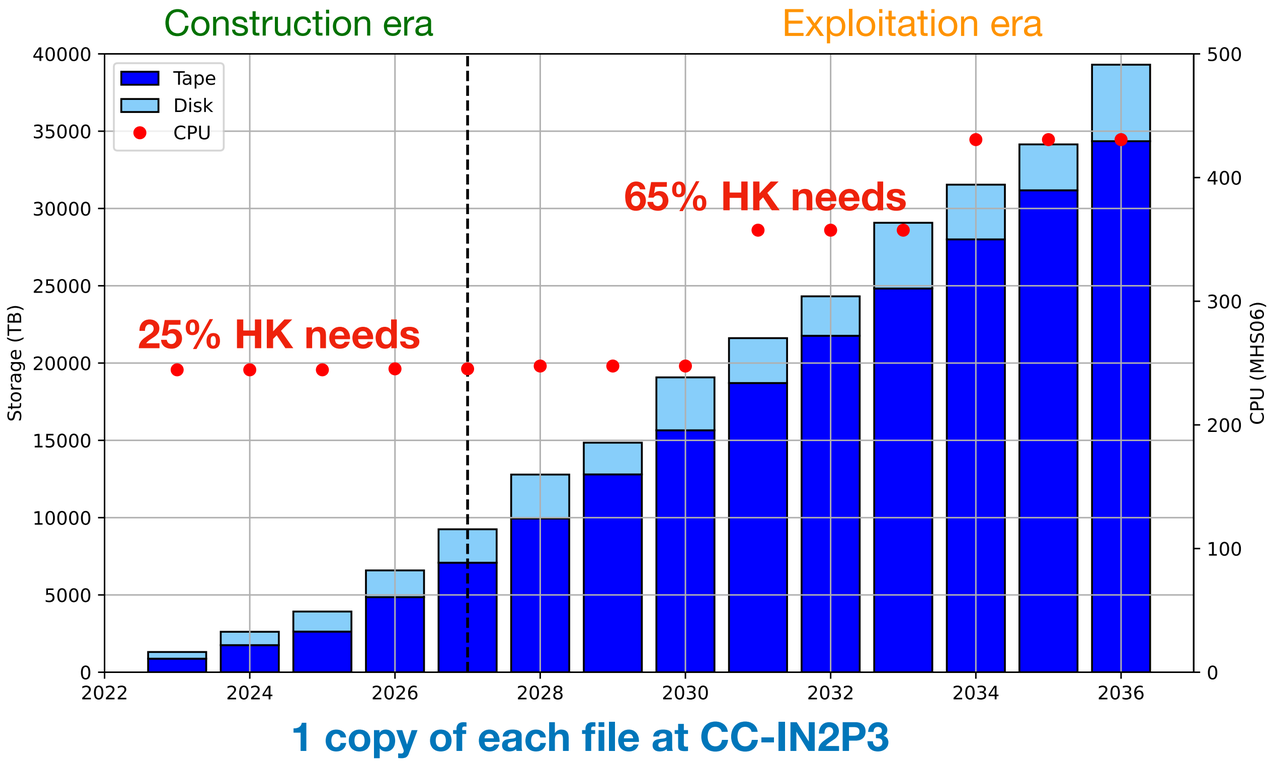
**fiTQun**: minimization algorithm to infer interaction properties (vertex, momentum, PID(s))

- Old implementation: used in SK, refactoring needed
- Detector dependent, requires tunning
- Slow, requires speed-up for HK statistics
- Baseline for modern ML approaches



**Improvement of performance means reduced computation time, translating to a reduced cost to CC-IN2P3**

# CC-IN2P3 proposed contribution to HK




Strong contribution to large productions during construction period:
- 100 % of ND280+FD needs
- 10 % of IWCD needs

→ Total: 25% of HK overall needs

Maintain such involvement level during exploitation period:
- 100 % of ND280+FD needs
- 50 % of IWCD needs

→ Total: 65% of HK overall needs

Include 10 MHS06.h per year for IN2P3 end-users (already attributed for T2K/HK)

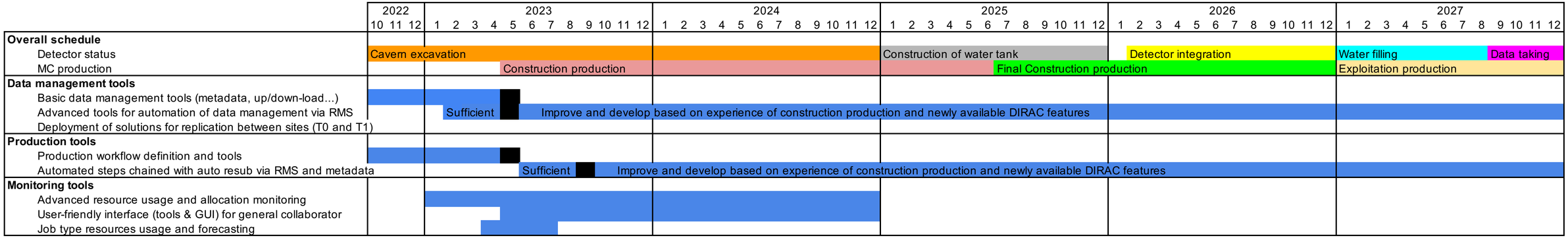
Storage commensurable with CC-IN2P3 contribution

→ Support storage of 1 copy of each file

Current understanding:
- Make CC-IN2P3 as T1 storage for HK until 2027
- Negotiate with HK management for after 2027

**Question:**
- Should we do our CPU/disk/tape request for 2024 as above?

# Development of DMS and WMS tools




Current computing management uses DIRAC vanilla version hosted in a shared instance at GridPP (UK)

→ Productions and data volumes very large compared with T2K!

→ Need to develop proper tools for data transfer and automated data processing via DIRAC system

**Data Management:**

- Faster replication mechanism via DIRAC requests: **DONE**
- Metadata and dataset definition, ancestry…: **IN PROGRESS**

**Workload Management:**

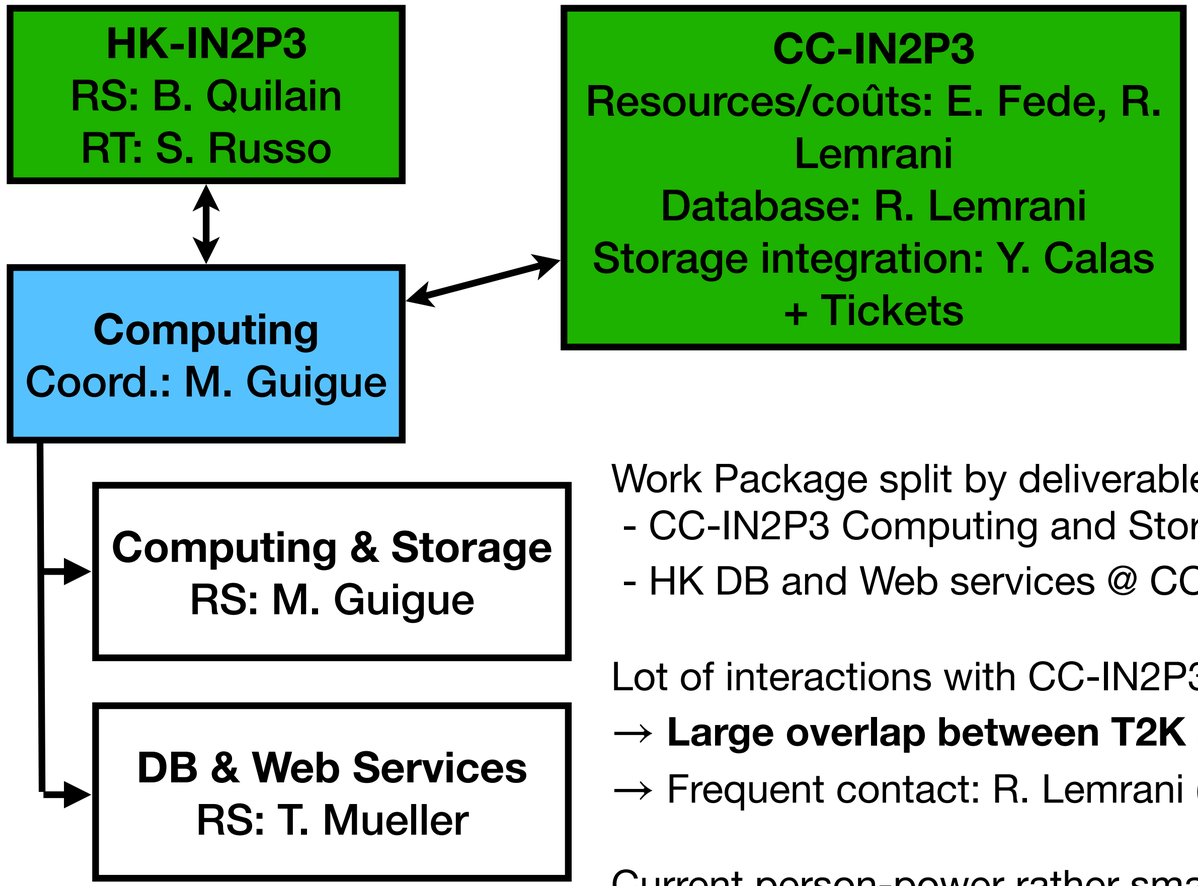
- Containerisation of ND280 and HK Software: **DONE**
- Implementation of Dirac transformations based on metadata: **TO DO**

**Continuous Integration:** developed by LPNHE and hosted on LPNHE-Cloud

**Knowledge shared within Jennifer-II consortium (Belle-II, HK) +T2K**

| Name | Which files? | Description/notes |
|---|---|---|
| type | all | MC, real-data, parameter file… |
| hk_version | production | HK software release tag. |
| nd280_version | production | ND280 software release tag. |
| prod_version | production | Eg « 6A », « 7A »... |
| package_config_version | production | Version of the config file used for the production. |
| data_level | all | Defines at which step of the processing the file (MC or data) is: raw, preprocessing, reconstruction, OA, plot... |
| unique_id | production | Allows to follow a file from raw MC to fully processed file. |
| run_id | data | Defines the run number (associated with a specific time period). |
| detector | all | Defines which detector this file has been produced for (ND280, IWCD, HK). |
| geometry_ID | all | Defines the large-scale geometry version (ND280 baseline, HK far detector configuration…). |

# HK-IN2P3 FTE & Interactions with CC-IN2P3




| | | 2023 | 2024 | 2025 | 2026 | 2027 | 2028+ |
|---|---|---|---|---|---|---|---|
| **Storage and computing** | | | | | | | |
| M. Guigue | MCF | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| G. Diaz Lopez | Postdoc ANR | 0.25 | 0.25 | 0.25 | | | |
| TBI | LPNHE ITA | | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| TBI | CC-IN2P3 IT | | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| **Databases** | | | | | | | |
| T. Mueller | CR | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| TBI | LLR ITA | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |

Work Package split by deliverables:
- CC-IN2P3 Computing and Storage (LPNHE)
- HK DB and Web services @ CC-IN2P3 (→ contact person: Thomas Mueller@LLR)

Lot of interactions with CC-IN2P3 staff over past years
→ **Large overlap between T2K and HK!**
→ Frequent contact: R. Lemrani (resources allocations, DB implementations…)

Current person-power rather small (ANR support ending in 2026)
Need long-term support to maintain and use the infrastructure
→ **Dedicating 25% CC-IN2P3 staff FTE would secure proper use of investment!**

**Question:** Does this person-power allocation sound feasible?

# Summary

**Questions:**

- Should we do our CPU/disk/tape request for 2024 as above?
- Does this person-power allocation sound feasible?