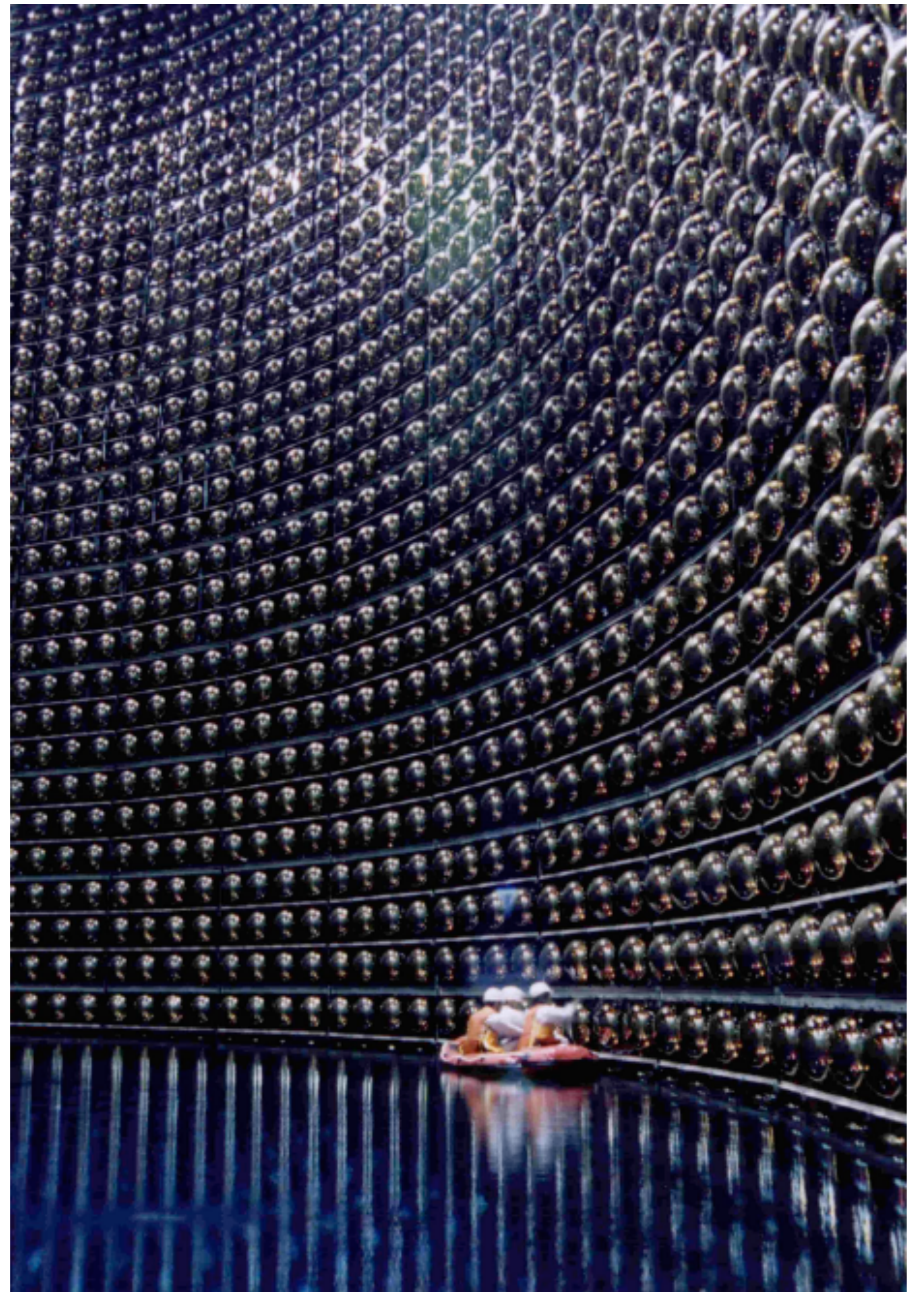


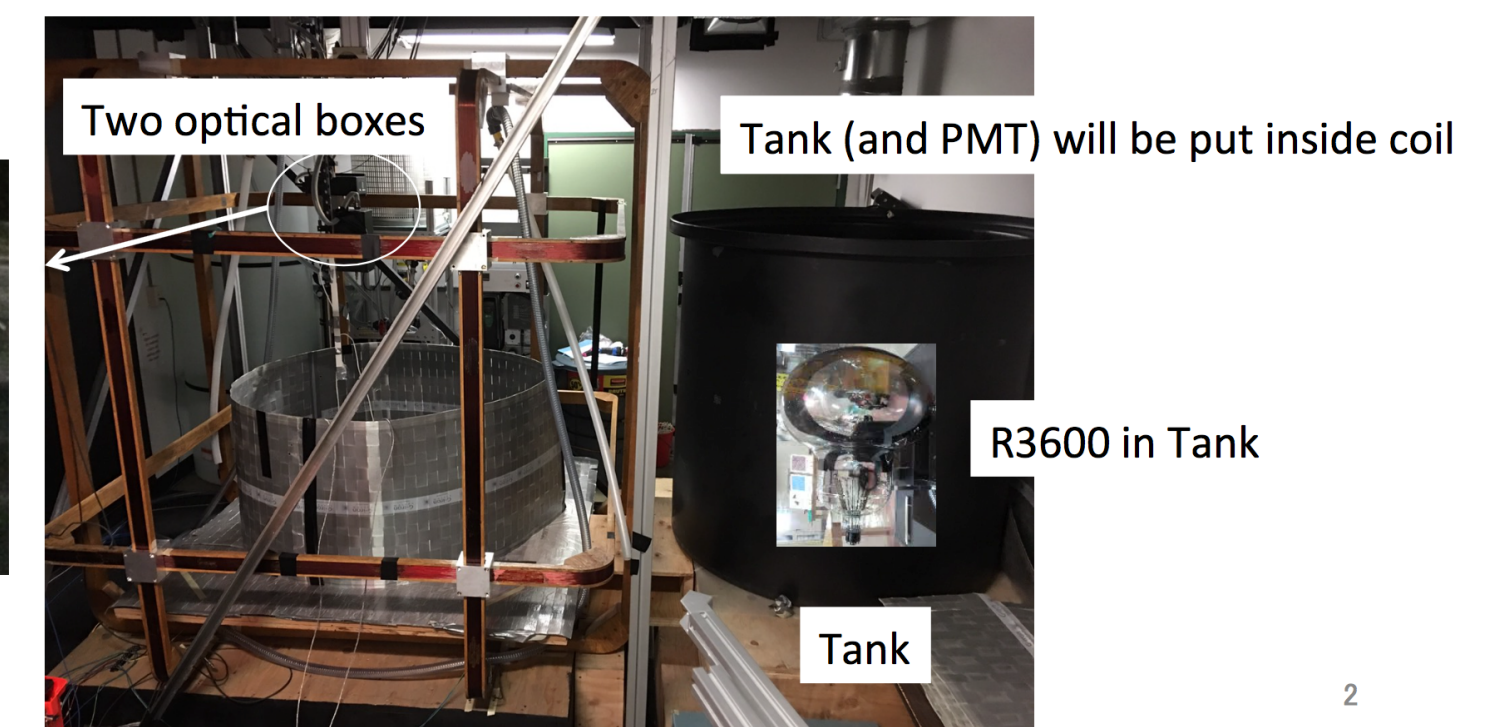
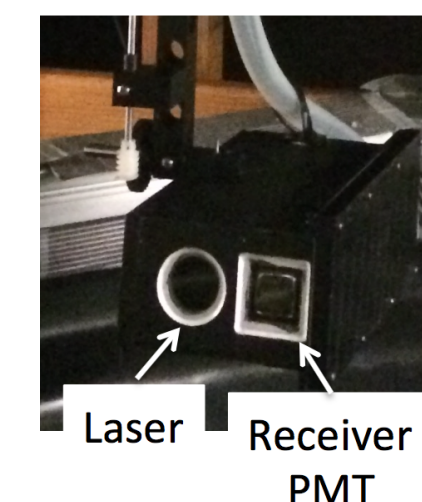
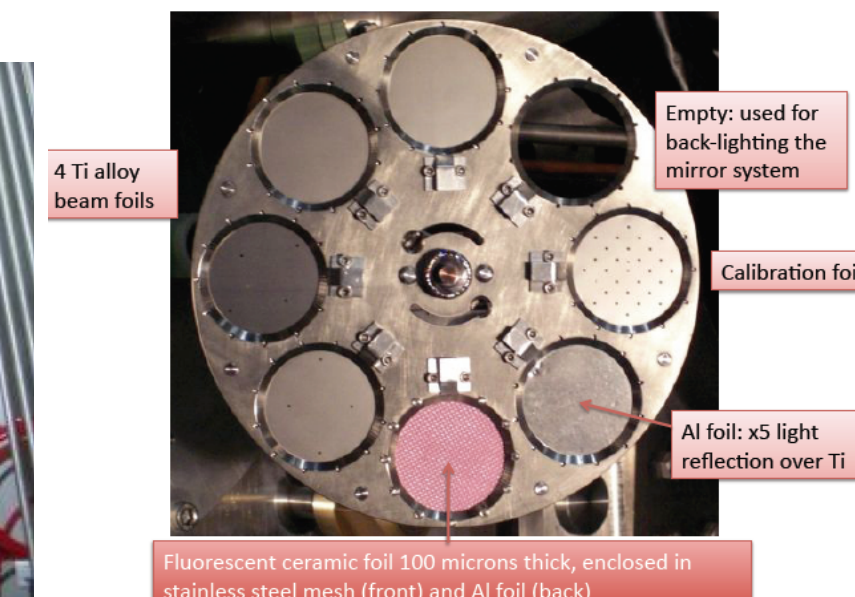
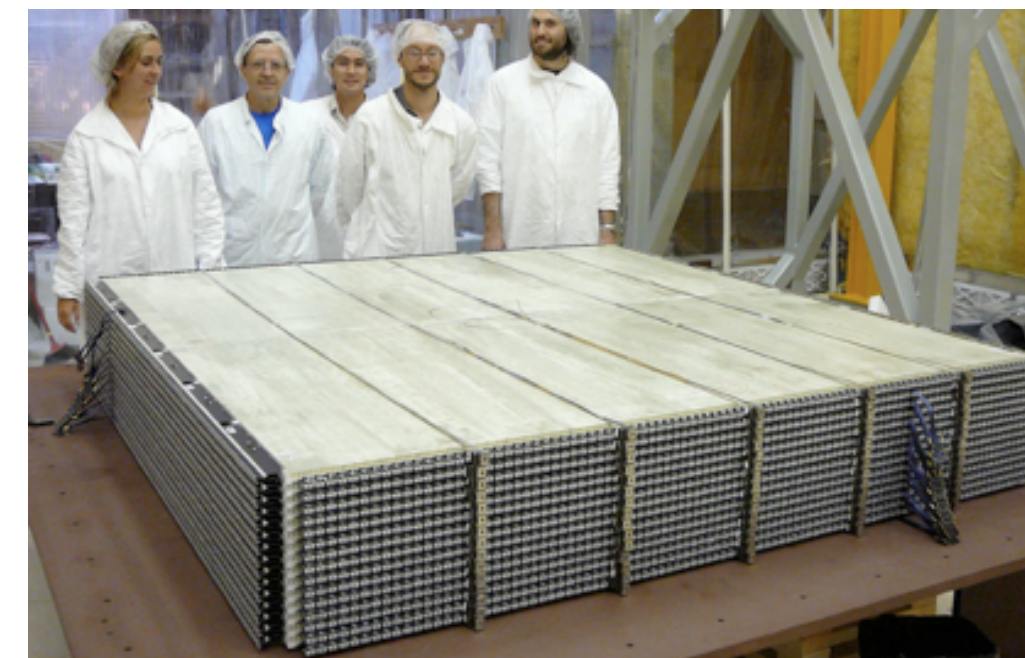
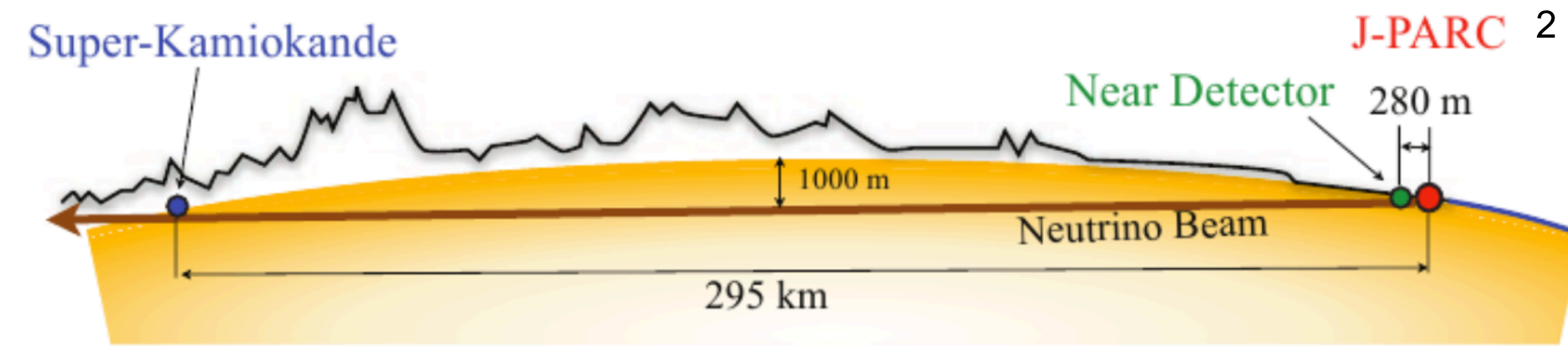
T2K/HyperK Updates



**Discovery,
accelerated**

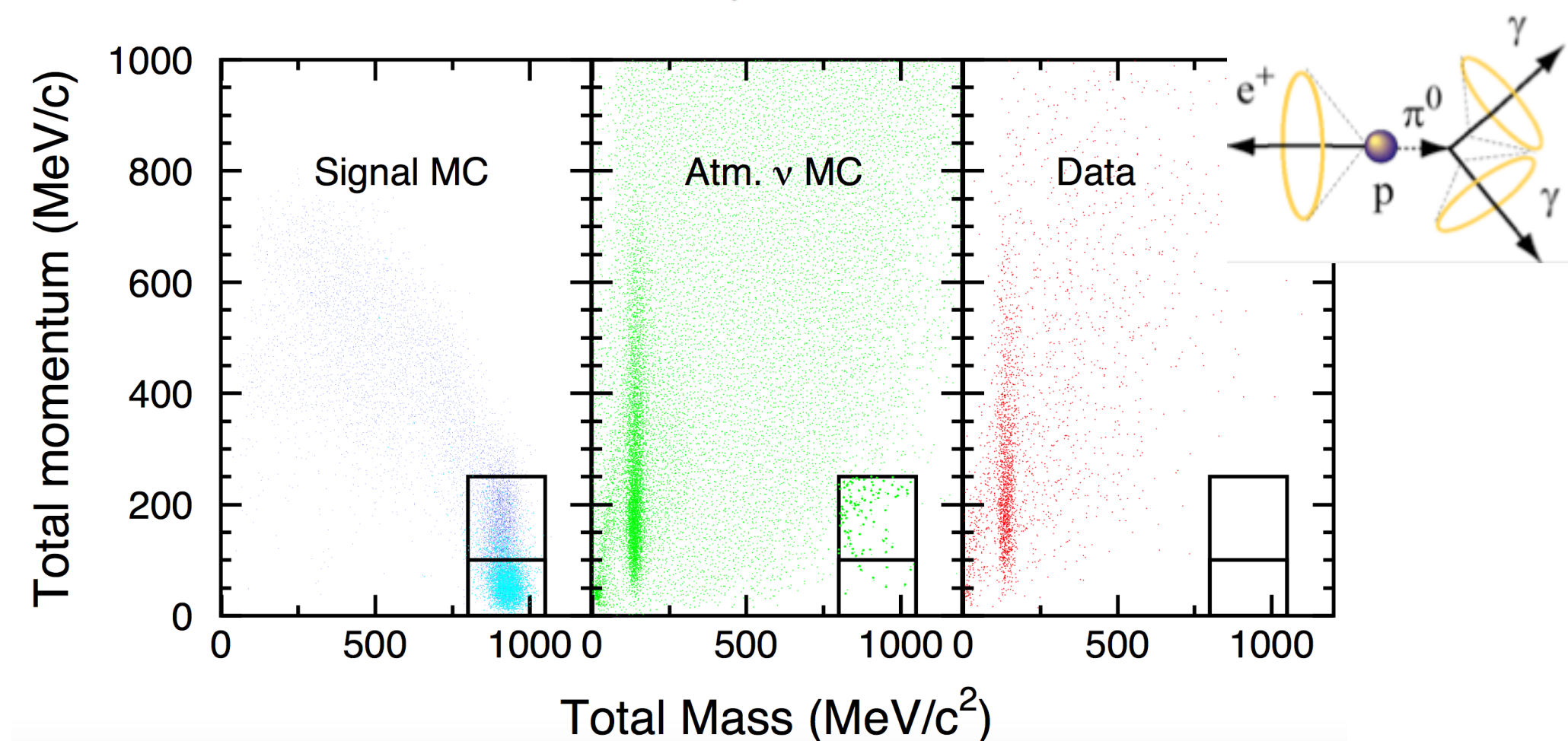
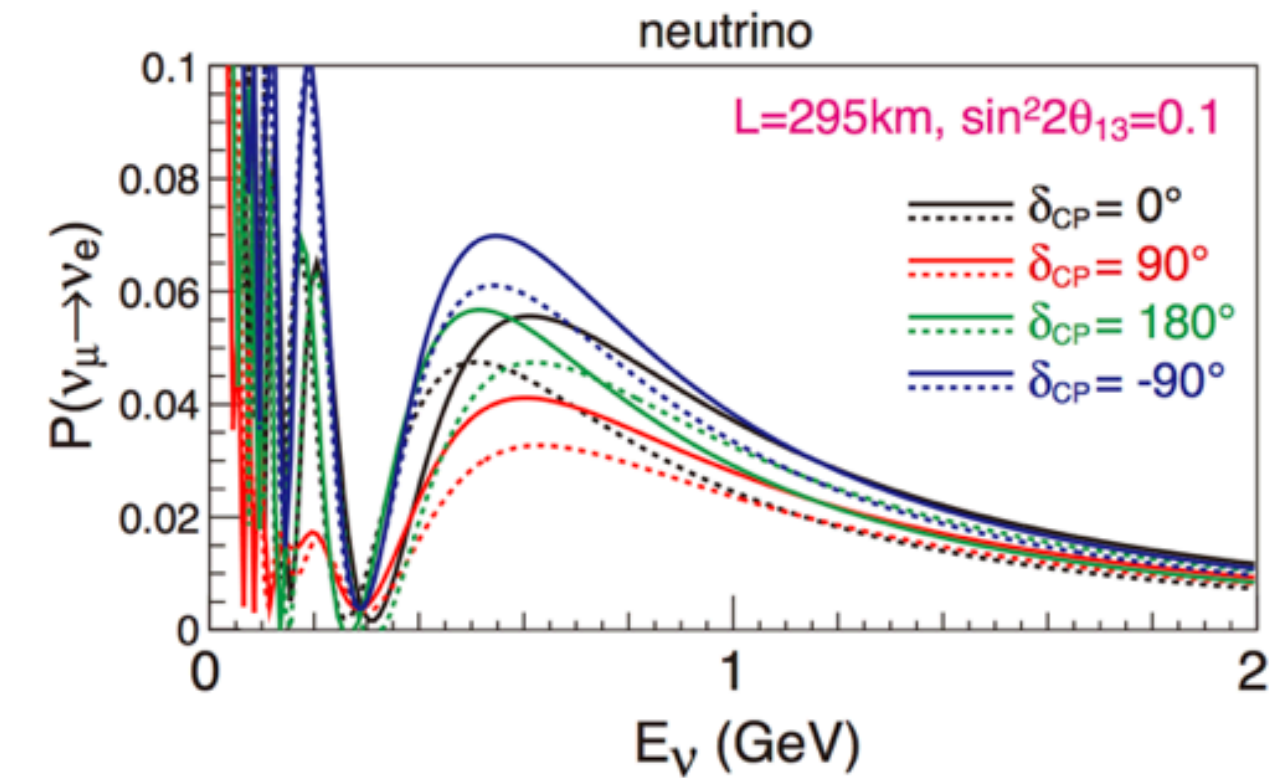
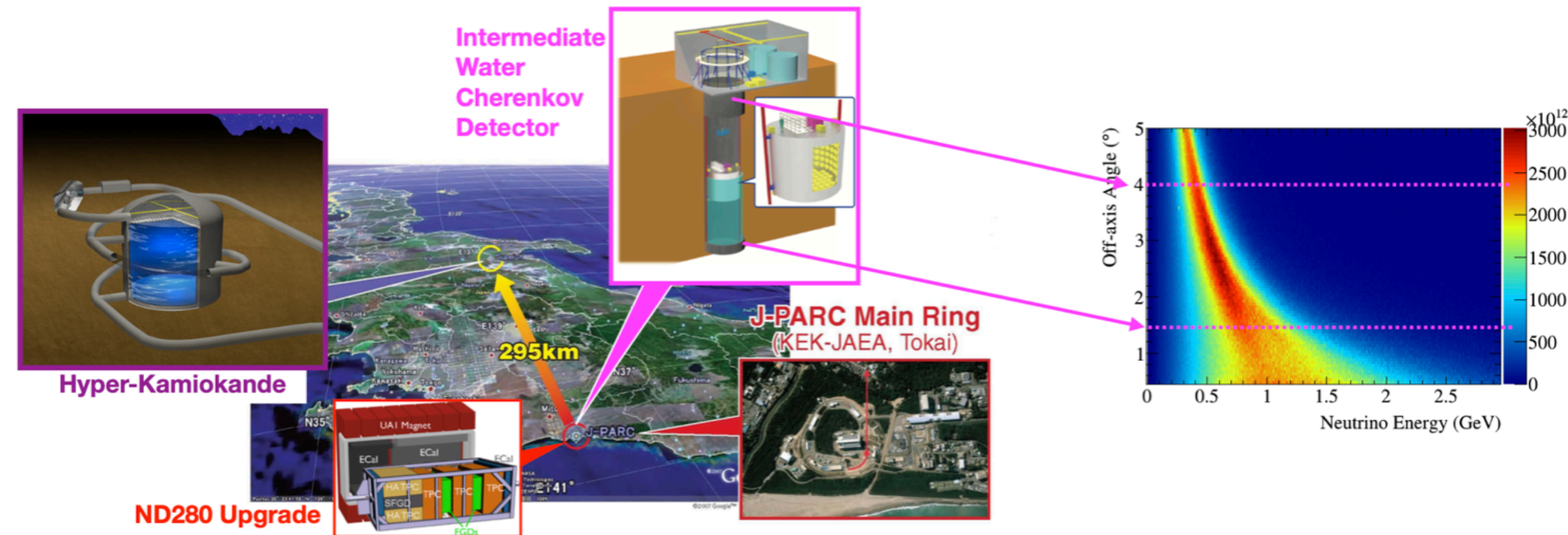
T2K and SuperK

- Canadian contributions to T2K and SuperK
 - Design: Off-axis beam concept, $\nu_\mu \rightarrow \nu_e$ with ν superbeam
 - Remote handling cell, FODO combined function lattice
 - KEK-TRIUMF collaboration from KAON factory
 - TPC (MPGD), FGD (SiPM), OTR in front of the target
 - Analysis: beam, near detector (Banff fit), SK fit (FitQun)
 - Analysis coordinator (leader): Hiro Tanaka, Mark Hartz
discovery of $\nu_\mu \rightarrow \nu_e$ appearance and hint(?) of CP viol.
- On-going and future contributions
 - Operation and upgrade of the OTR monitor (RTI)
 - Remote handling upgrade at the final focusing section (RTI)
 - PMT characterization at the photosensor test facility (PTF)
 - Urgent magnetic field effect study on-going
 - SuperK event reconstruction using machine learning
 - WatChMal (Water Cherenkov Machine Learning)
 - improved angular resolution and particle identification



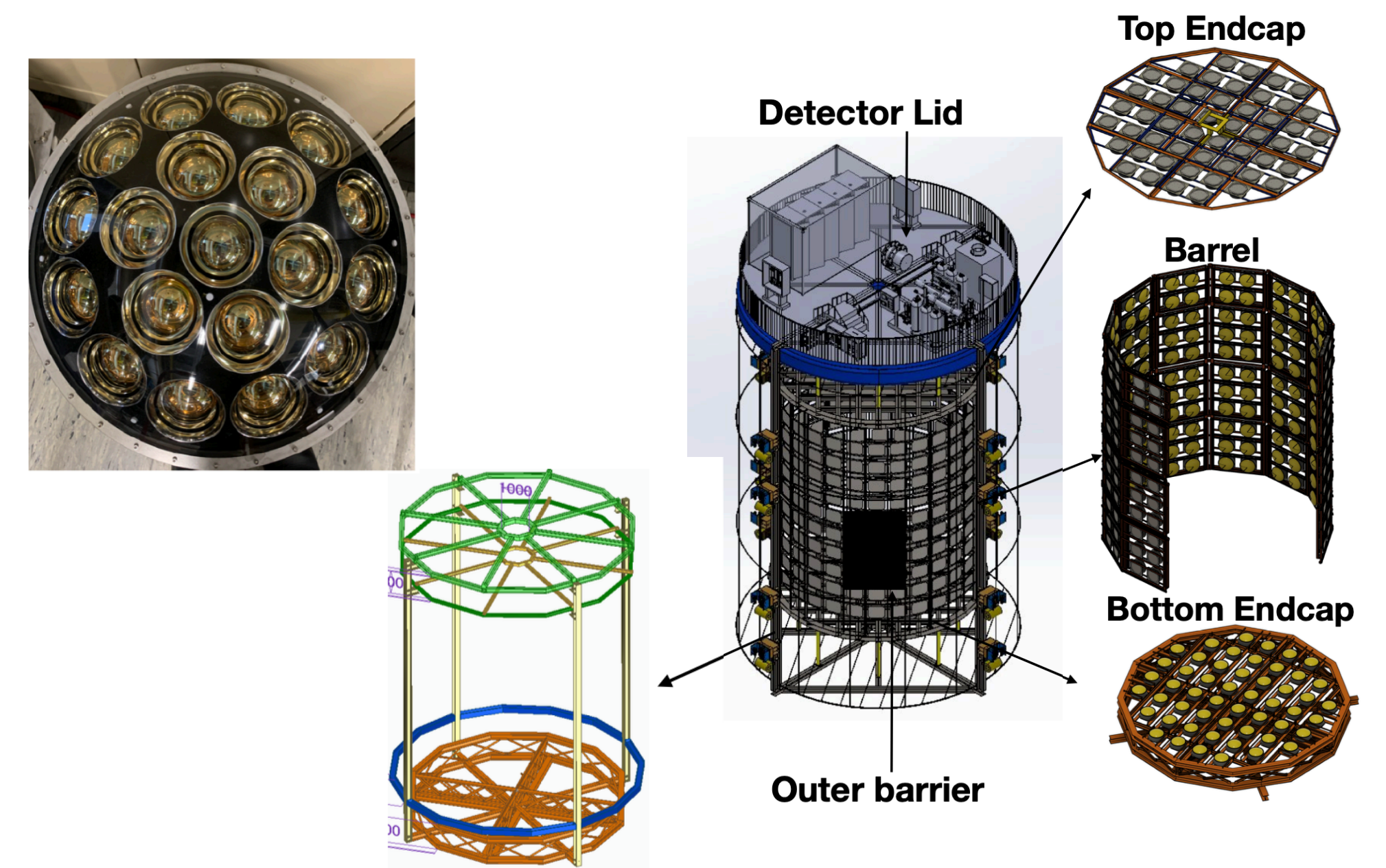
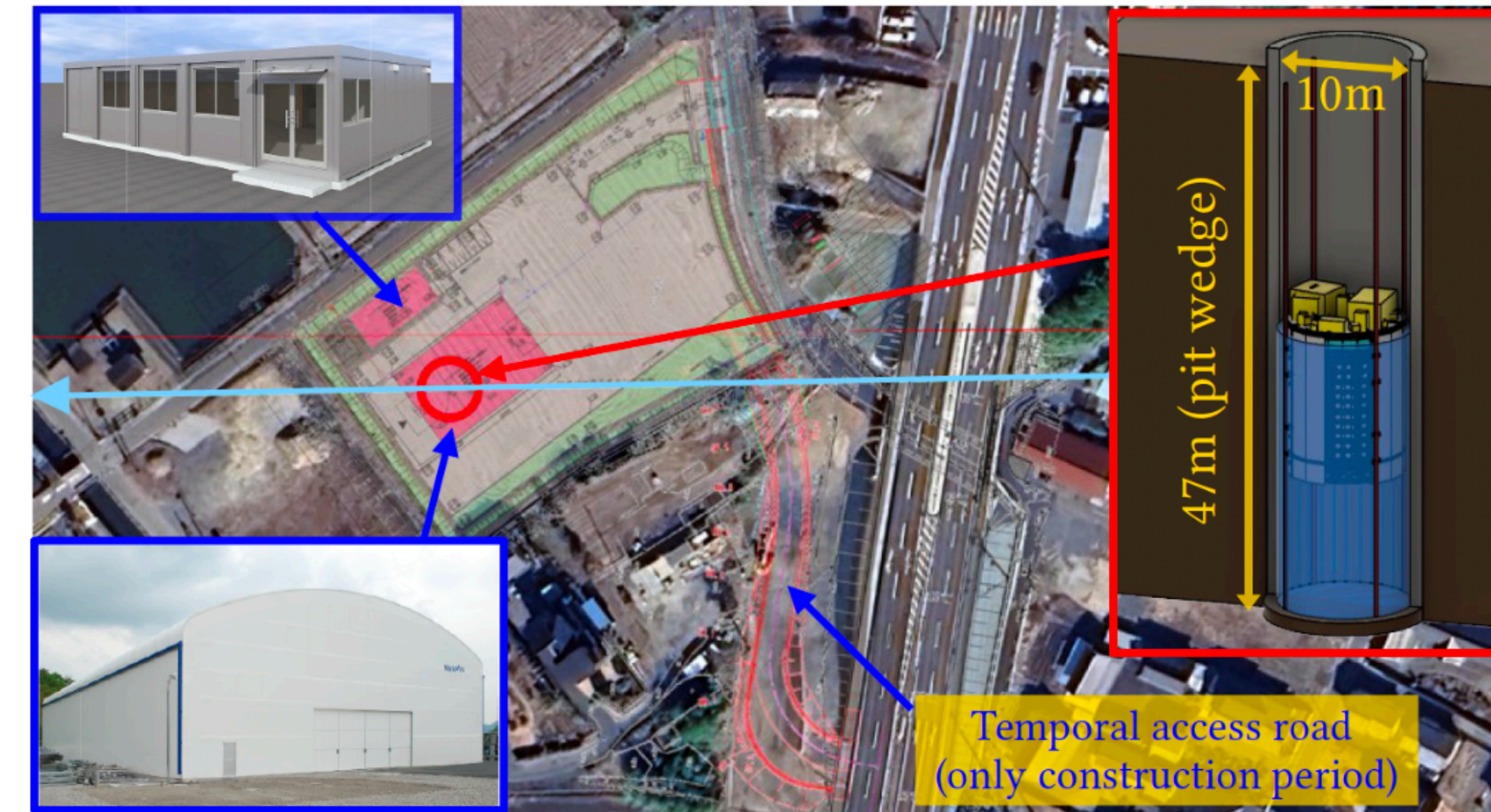
HyperK

- The next generation HyperK construction under way
 - x8 larger fiducial volume, x2.5 higher intensity (1.3MW)
 - Near water Cherenkov (IWCD) proposed/lead by Canada
 - “Prism” approach, also adopted by DUNE
 - Project leader: Mark Hartz
 - Start data taking in the end of 2027
- Wide range of physics topics
 - Precision measurement of neutrino oscillation and CP violation
 - long baseline from J-PARC, atmospheric neutrinos
 - BSM physics: nucleon decays, dark matter search, $n-\bar{n}$ oscillation
 - Neutrino astronomy: supernova burst, diffused (relic) supernova
- Canadian contributions
 - IWCD to address systematic uncertainty in flux and cross section
 - Calibration in the far detector: funded by CFI2023
 - LED multi-PMT (mPMT): 7000 pulsed sub-nsec LED
 - photogrammetry for geometry measurement and water monitoring



Intermediate Water Cherenkov detector (IWCD)

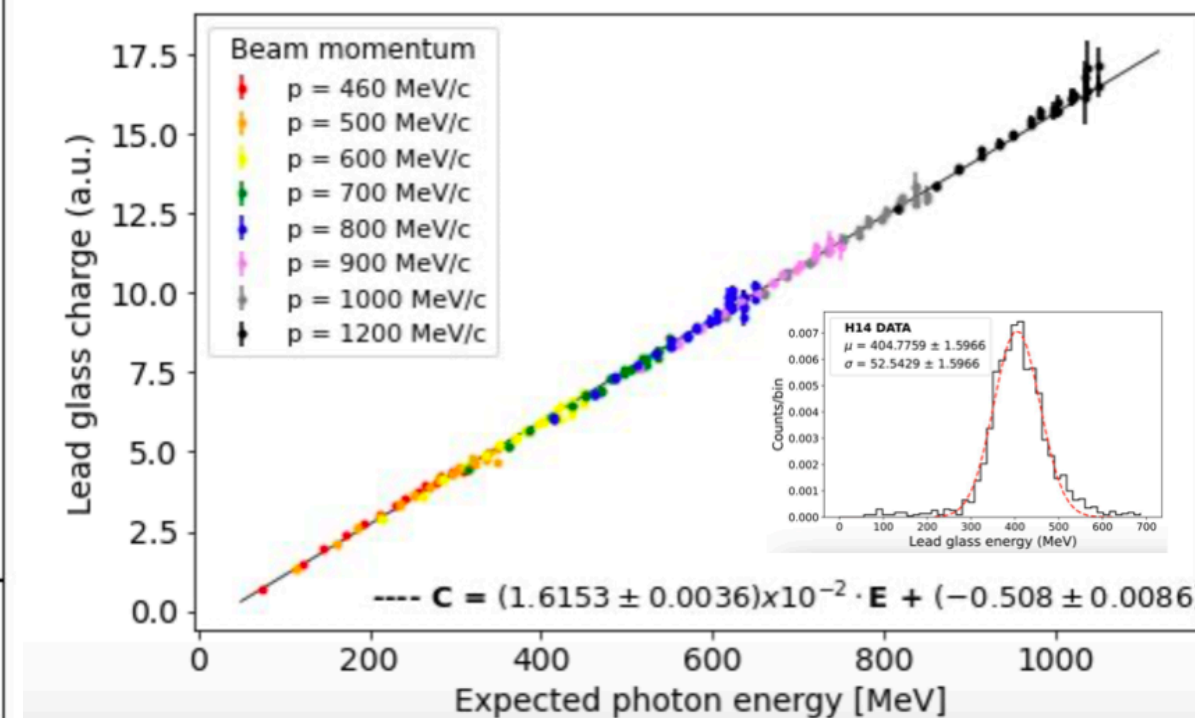
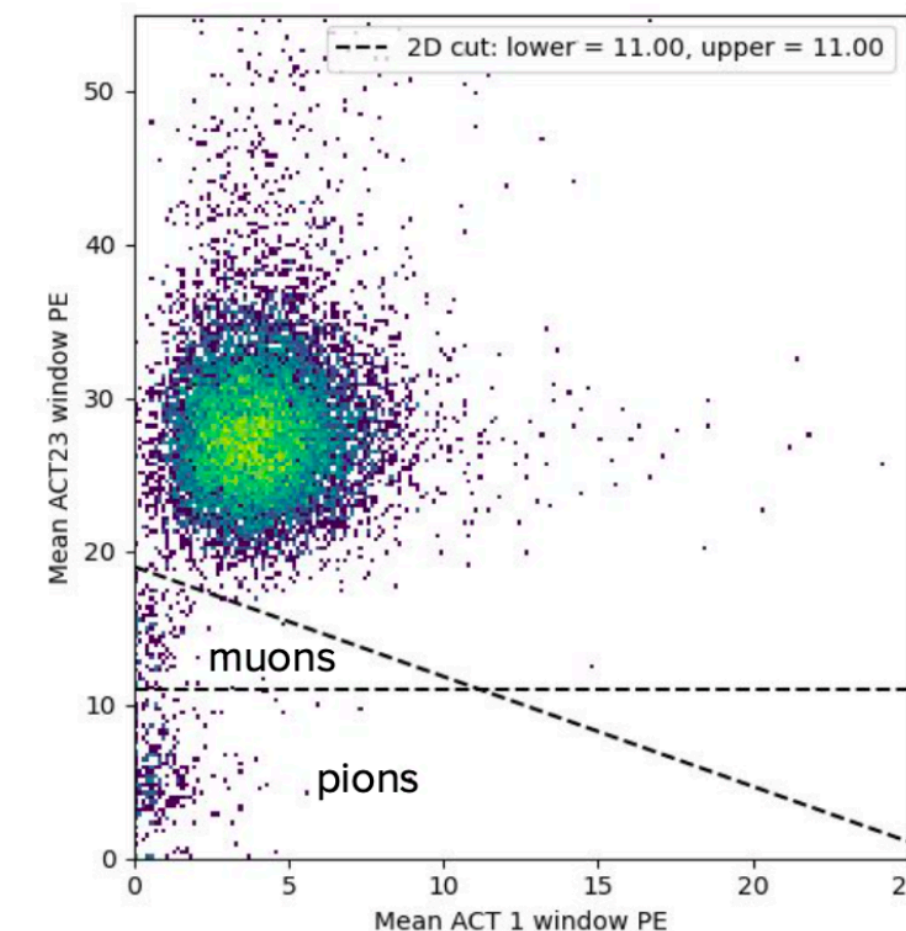
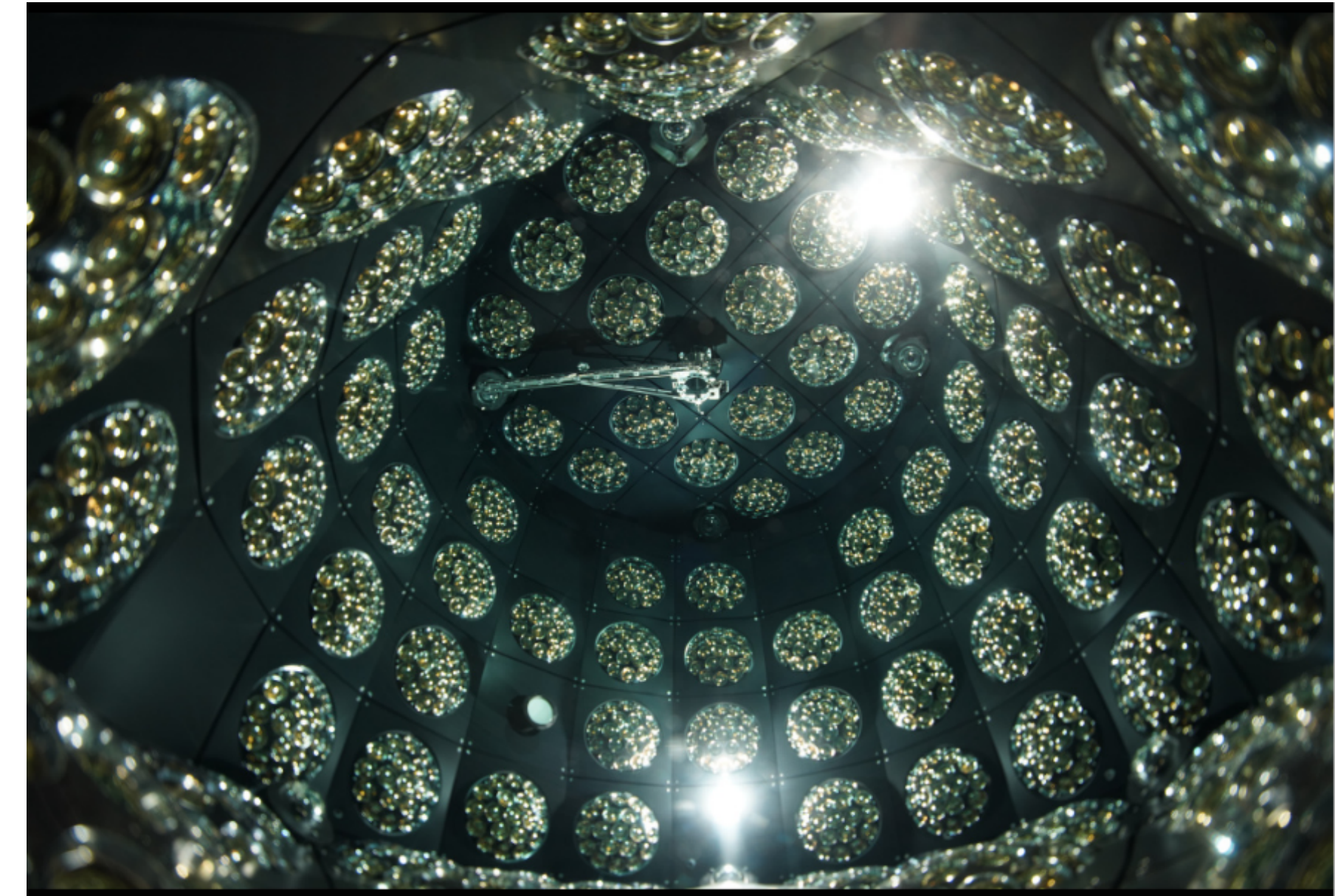
- NuPRISM concept developed at TRIUMF
 - Correlated neutrino flux at different off-axis angles
 - Cancel (flux x cross-section) systematics
 - linear combination for monochromatic ν energy response
 - electron neutrino cross-section measurement
- Detailed engineering design is underway
 - Low-cost elevator by changing the pit water height
 - Facility funded in Japan, and the land is secured by KEK
- Canadian contributions
 - Main mPMT (250) and photogrammetry: CFI2020
 - Project leadership: Mark Hartz (TRIUMF)
 - WCTE as a prototype test at CERN



Water Cherenkov Test Experiment (WCTE)

- Prototype IWCD (1/2 in scale in each dimension)
 - Test of mPMT and its calibration
 - Photogrammetry and water monitoring test
 - Water Cherenkov response for sub-GeV e, μ, π, p and γ
 - Aerogel Cherenkov with index of 1.006-1.15
 - Compact tagged γ facility using Neodymium magnet (1.7T)
- Rich physics program for training next generation scientists
 - pion response in water Cherenkov \rightarrow CC1 π /NC π
 - e/μ energy scale calibration \rightarrow Δm^2 for ν mass ordering
 - demonstrate e/γ separation using machine learning
 - μ quasi-elastic scattering to constrain ν interaction model
 - hadronic 9Li production for the diffused (relic) supernova search
- Status: currently taking beam data at CERN (2024 and 2025)

Inside WCTE Filled with Water



Water quality monitoring

- Water transmission needs to be monitored precisely
 - Rayleigh scattering, Absorption, Mie scattering
 - Raman scattering is not negligible and study newly
- High sensitivity water monitoring system
 - improved version from SuperK water monitoring system
 - 8m-long sample volume
 - Photon counting: $\text{Prob}(0 \text{ hit}) = \exp(-\mu)$ [Poisson distrib.]
 - sub- nsec LED (200-600nm) focused by parabolic mirror
- Application to drinking water monitoring
 - reaching drinking water sensitivity by online measurement: current approach requires 1-2 weeks of laboratory tests
 - new paradigm in water monitoring
 - UVC LED down to 200nm is sensitive to organics and metals
 - Microcystin (cyanotoxin in lakes), Mercury from melting permafrost
 - Collaboration with First Nations community and municipal water facility
 - MOU with the First Nations University of Canada

