T2K – Canada
Accelerator & Detector Status

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Canadian contributions to T2K

- Early design ideas (proposed off-axis concept)
- Initial consultation on accelerator design
- Beamline monitor stack
- OTR monitor
- Remote manipulator system
- Near detector tracking system:
  - Fine grained detectors – active target
  - Time projection chambers – spectrometer
- General DAQ and slow controls
Accelerator

- TRIUMF accelerator physicists were consulted in the early design phase, in particular for the kicker and damper systems
  - the kicker system, however, was designed and constructed by Japanese groups
  - the damper system is not included in the initial accelerator design

- there may be opportunity for further consultation, as the accelerator systems are brought on-line and the beam intensity is ramped up to ~1 MW (and eventually 4 MW)
Beamline monitor stack

- Downstream of the final focussing magnet
  - proton beam position and profile (SSEM and BPM)

- TRIUMF has the responsibility to design, construct, test, and install

- Capital cost ~ $ 0.2 M
Optical Transition Radiation (OTR) detector

- measures proton beam position and profile directly in front of the target

- capital provided by NSERC grant
- TRIUMF / York U / Toronto U responsibility
Optical Transition Radiation (OTR) detector

- concept demonstrated with a prototype using a 20 MeV electron beam at NRC Ottawa:

- optics and mechanical design close to final
- radiation tests of foils and mirrors have been done at TRIUMF, and more are planned
  - results are encouraging
Remote manipulator system

- Target elements have a high risk for failure
  - TRIUMF has developed design for remote maintenance of target, horn, and beam monitors

- TRIUMF will construct the remote manipulator system and install. Capital cost ~ $0.5 M
Near detector tracker

- Designed for the critical T2K measurements:
  - $\nu_\mu$ disappearance:
    - flux and spectrum of $\nu_\mu$ prior to oscillation
    - study processes that SK will misinterpret and assign an incorrect $\nu_\mu$ energy
  - $\nu_e$ appearance:
    - flux and spectrum of $\nu_e$ in beam
    - study processes that SK will misinterpret as coming from $\nu_e$
  - Golden channel: charged current quasi elastic

$$\nu_\mu + n \rightarrow \mu^- + p \quad \nu_e + n \rightarrow e^- + p$$
Near detector tracker

- UA1 magnet will provide 0.2 T field
  - Tracker: 2 FGD scintillator target modules surrounded by 3 TPC tracking modules
FGD

- Design: 1 cm² scintillator bars arranged in 30 layers perpendicular to the neutrino beam
  - 2nd FGD has some layers replaced by water to study nucleus dependence
- scintillator extrusion completed at local firm
- first double layer completed at TRIUMF

Collaboration between:
- UBC, Kyoto U, U Regina, TRIUMF, and U Victoria
FGD electronics

- Scintillator light readout through WLS fibres to Hamamatsu SiPMs (MPPC)
- MPPC signals processed with ASIC developed for the TPC (SACLAY)
- Front end electronics system is a responsibility of TRIUMF / UBC / UVic
- Urgent that manpower from TRIUMF for Crate Master Board design be identified
TPC

- Each TPC has a double box structure:
  - inner box walls make up the field cage
  - outer box walls at ground
  - gas insulator between them
  - all walls are composite with ~1 cm rohacell cores

- Micromegas devices used for readout

- Collaboration between Canada, France, Spain, Switzerland, Germany
  - Canada (TRIUMF/UVic/UBC) : mechanical, gas system, integration
TPC

- Prototype TPC demonstrated the concept

- New large router now used to construct full size pre-production module
  - problems: schedule slipping
Tracker performance

- full simulations with GEANT4 progressing

- CCQE selection looks promising:

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Without proton requirement

E_{\nu} (38574 CCQE Events, All and False CCQE Candidates)

- E_{\nu}^{\text{true}} (38574 CCQE Events)
- E_{\nu}^{\text{es}} (34782 CCQE Candidates)
- E_{\nu}^{\text{res}} (6585 False CCQE Cand)

True CCQE Candidates = 28197
CCQE Efficiency = 73.1%
CCQE Purity = 81.1%

With proton requirement

E_{\nu} (38574 CCQE Events, All and False CCQE Candidates)

- E_{\nu}^{\text{true}} (38574 CCQE Events)
- E_{\nu}^{\text{es}} (8823 CCQE Candidates)
- E_{\nu}^{\text{res}} (6943 False CCQE Cand)

True CCQE Candidates = 8089
CCQE Efficiency = 21.0%
CCQE Purity = 91.7%
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DAQ and slow controls

- TRIUMF DAQ team provides equipment and support to several prototype and test setups (FGD and TPC)
- TRIUMF group responsible for:
  - Design and programming of slow control hardware for the FGD electronics, and the TPC gas and sensor systems
  - Design and prototyping of the Global Slow Control and Monitoring for the near detector
Summary

- Canada has several important responsibilities in the T2K experiment (accelerator and detector)
  - TRIUMF is the cornerstone of the Canadian effort – the prominent Canadian role would not have been possible otherwise

- Good progress on all T2K-Canada projects
  - Delays in the design of the FGD front end electronics and the construction of the TPC pre-production module are of concern