Welcome to the State of the Nu-tion! (And Toronto)

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Speaker Logistics

- Agenda: https://nuint2017.physics.utoronto.ca/state-of-the-nu-tion-premeeting/program

- Presentations via this laptop, in order to get remote audio

- Please upload talks to indico page in advance if possible and/or data stick transfer at coffee breaks

Local Logistics

- Local information: https://nuint2017.physics.utoronto.ca/state-of-the-nu-tion-premeeting/logistics

- Workshop, coffee breaks located here (MP103)

  - MP110 (break room) available for side discussions

- Coffee break "registration" fee:

  - Please give Jacob Morrison CAD$30 in exchange for a receipt

- Internet: Use eduroam, or dormitory access:

  - Login/identity: ncsummer // password: ncsummerguest2017

  - If this fails, email: trevor.towstego@gmail.com, cnantais@physics.utoronto.ca, or htanaka@physics.utoronto.ca to get special arrangements
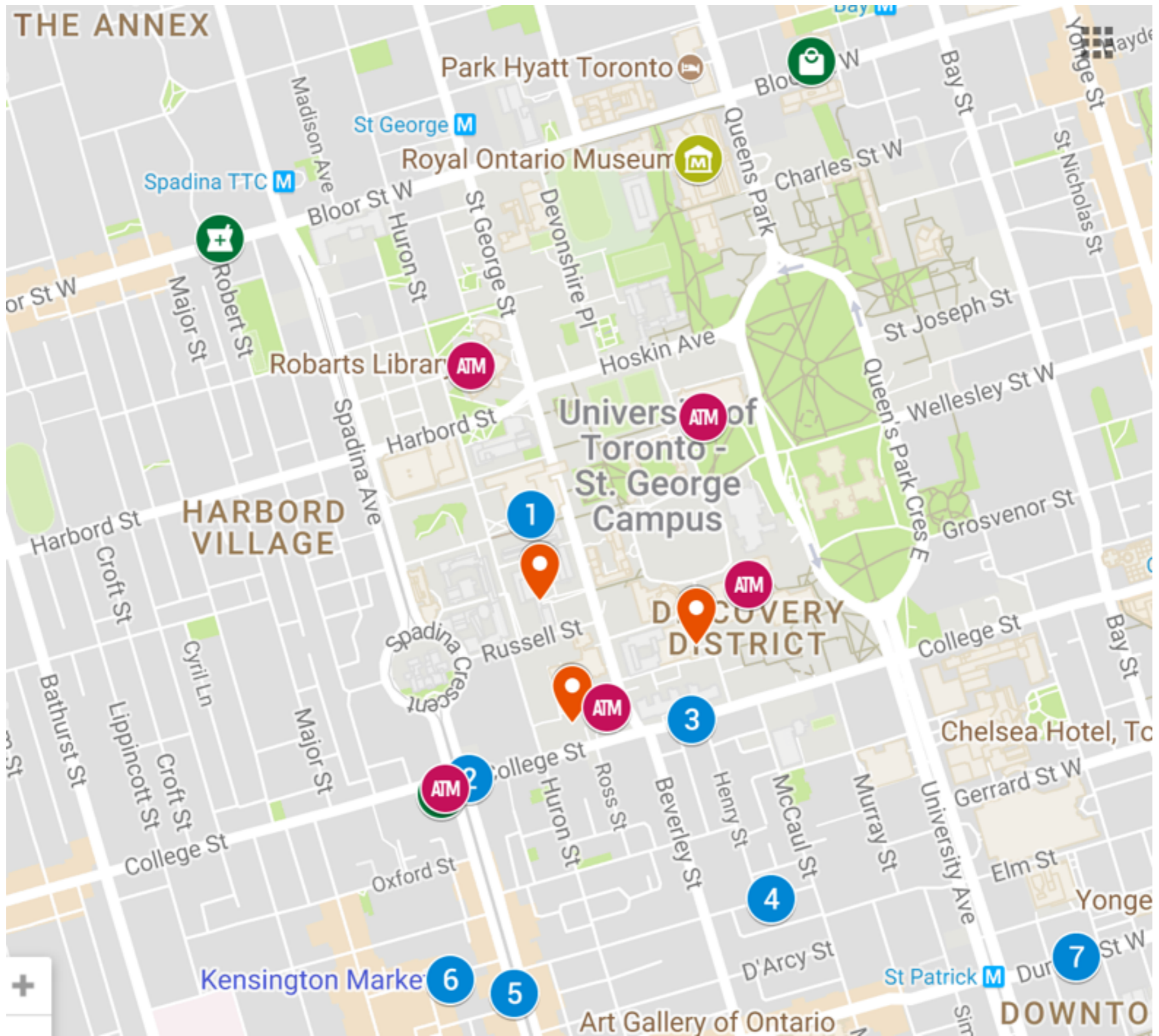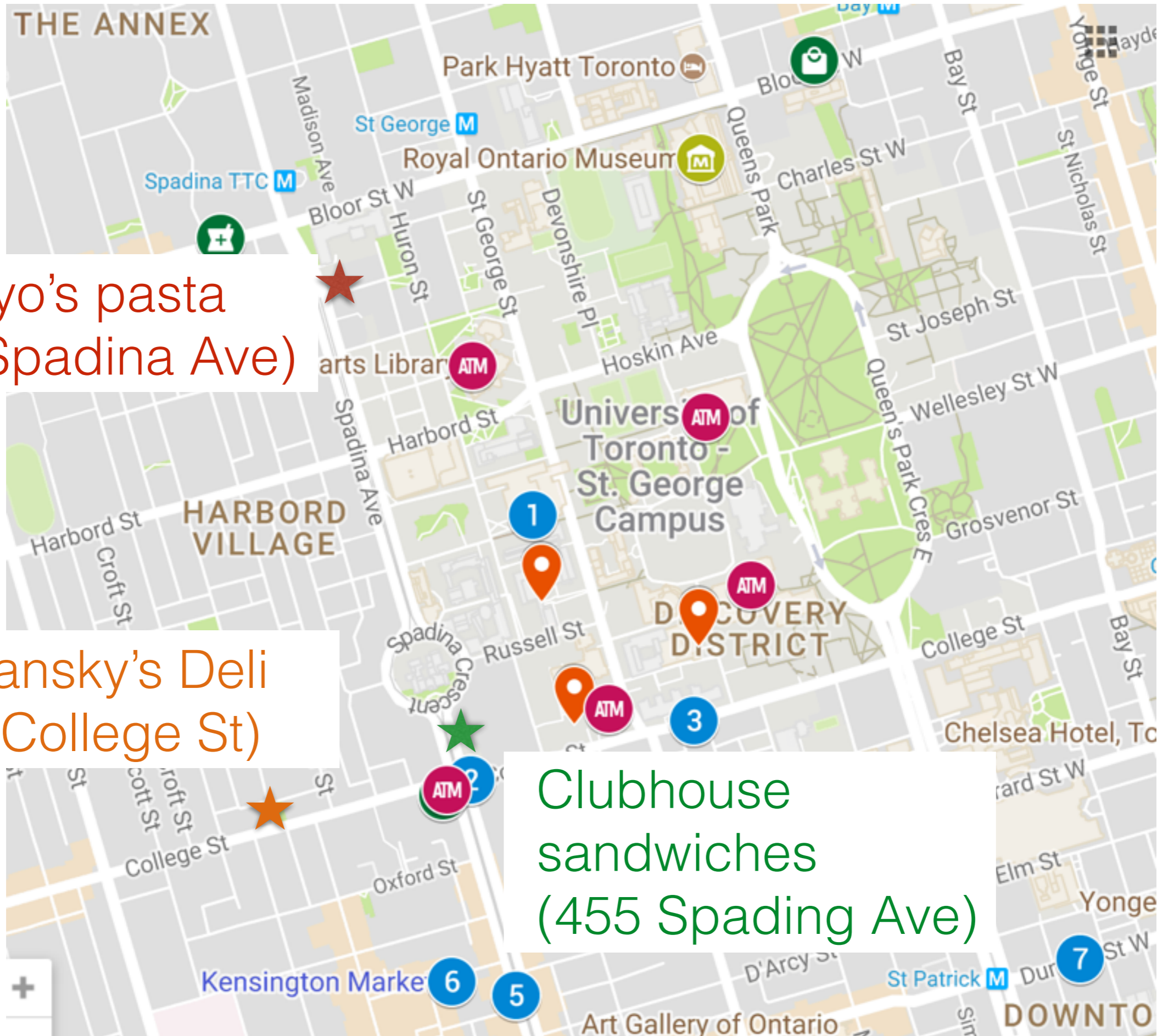
Daddyo's pasta
(673 Spadina Ave)

Caplansky's Deli
(356 College St)

Clubhouse
sandwiches
(455 Spading Ave)

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Surrounding area, activities

- Map: https://www.google.com/maps/d/viewer?mid=1Dlx1uQ-yTnVPK7i8B7WagvsOSt0&ll=43.65490411463043%2C-79.38251174999999&z=14

- Includes cash machines (ATM), restaurant areas, and places to buy items not in the dorms (towels, shampoo)

- Some popular areas in Toronto: Eaton Centre (large shopping centre), Nathan Phillips Square (where the "TORONTO" sign is located), Harbourfront (nice area to walk, can sometimes find festivals), the ROM (museum), the CN Tower, and the Distillery History District.

- Tonight and tomorrow: Toronto Craft Brewing Festival: http://tcbf.ca/

State of the Nu-tion Workshop
purpose, goals, structure

A Picturesque View of the State of the Nation for February 1778.

http://collections.rmg.co.uk/

British Commerce as a cow; France has entered the war on the side of the Americans in order to destroy British trade. Images include: America as an Indian; Britain lion sleeping; British people in despair; France, Spain as a man with a bowl of milk; Holland as a milkman

A Picturesque View of the State of the Nation for February 1778.

We are in an era of details and interdependencies

An overly generic oscillation analysis

$$N_{FD}^{\alpha \to \beta}(\mathbf{p}_{reco}) = \sum_i \phi_\alpha(E_{true}) \times \sigma_\beta^i(\mathbf{p}_{true}) \times P_{\alpha\beta}(E_{true}) \times \epsilon_\beta(\mathbf{p}_{true}) \times R_i(\mathbf{p}_{true}; \mathbf{p}_{reco})$$

Far detector rate used to determine oscillation (P)

- Flux (Φ), cross section processes (σ), efficiency (ϵ)

- Correct association of reconstructed objects to true kinematics of an event (R)

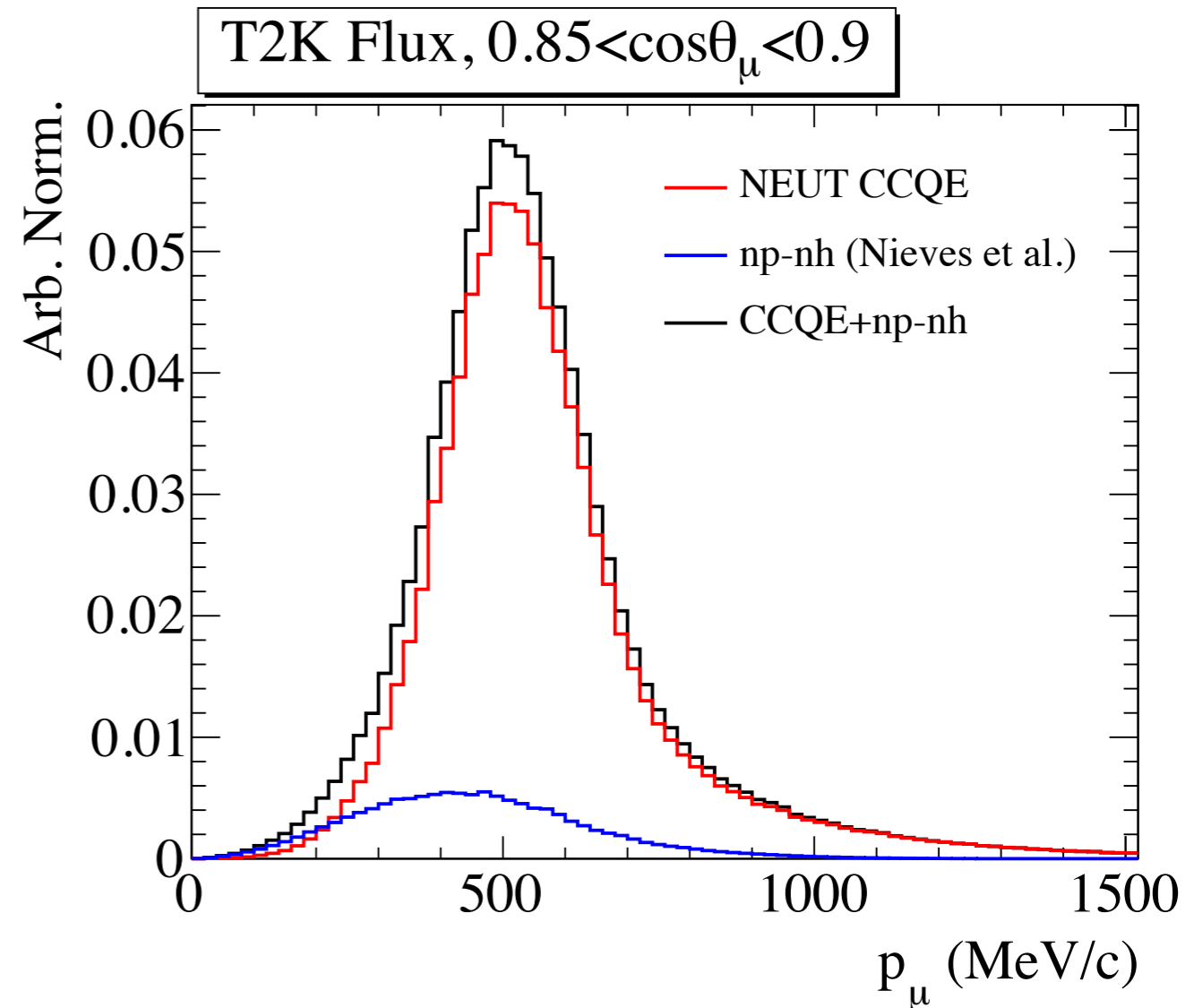# An overly generic oscillation analysis

$$N_{FD}^{\alpha \to \beta}(\mathbf{p}_{reco}) = \sum_i \phi_\alpha(E_{true}) \times \sigma_\beta^i(\mathbf{p}_{true}) \times P_{\alpha\beta}(E_{true}) \times \epsilon_\beta(\mathbf{p}_{true}) \times R_i(\mathbf{p}_{true}; \mathbf{p}_{reco})$$

$$N_{ND}^{\alpha}(\mathbf{p}_{reco}) = \sum_i \phi_\alpha(E_{true}) \times \sigma_\alpha^i(\mathbf{p}_{true}) \times \epsilon_\alpha(\mathbf{p}_{true}) \times R_i(\mathbf{p}_{true}; \mathbf{p}_{reco})|,$$

Near detector measures rate:

- Multiple energies result in multiple processes (and physics effects)

- Inherent degeneracy between flux and cross section

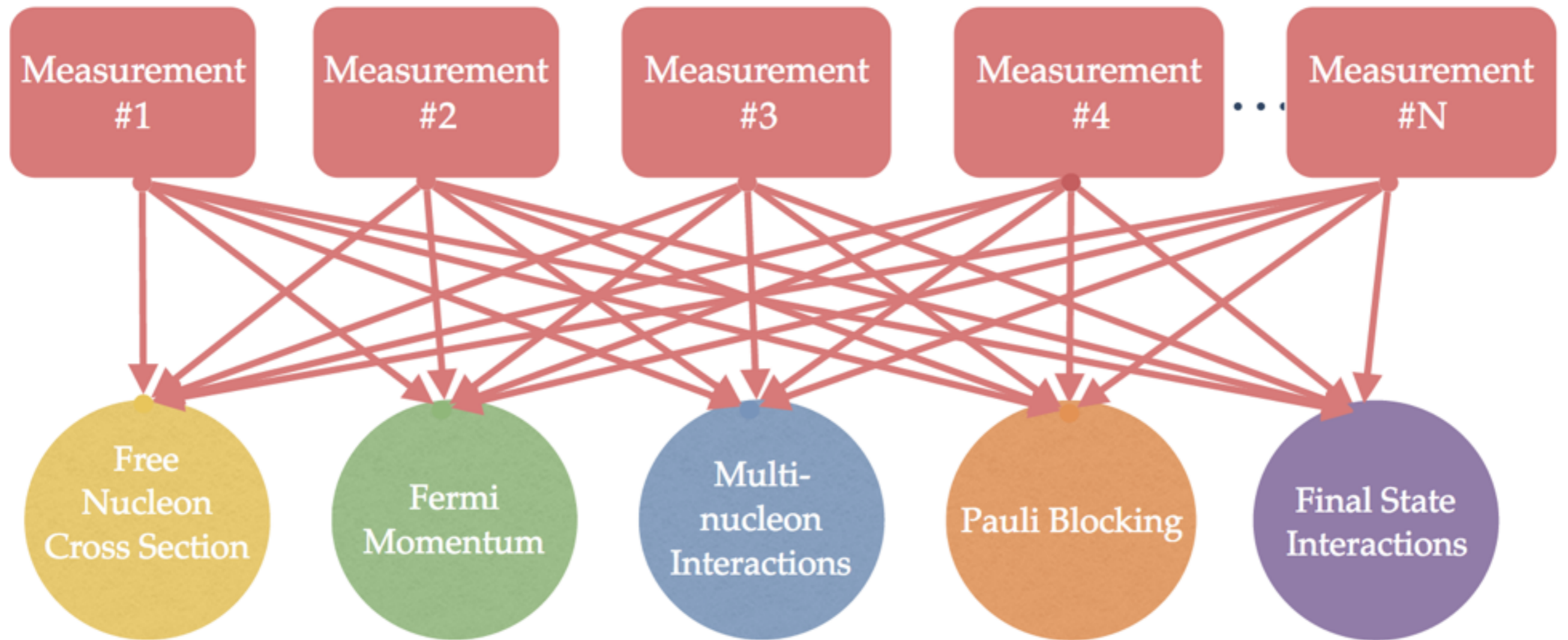*plot from M. Hartz*

It takes a village

Image from L. Fields

- Use many cross section measurements made with different beam energies, neutrinos and antineutrinos, target materials, topologies to infer **underlying physics model(s)**

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Global fits to cross section measurements *are difficult*

Inability to reconcile MiniBooNE, MINERvA QE-like, and single pion measurements within a single model ("data tensions")

- T2K fits to QE-like data [PRD93 no.7, 072010 (2016)]

- MINERvA comparisons to MiniBooNE [PRD92, 092008 (2015)]
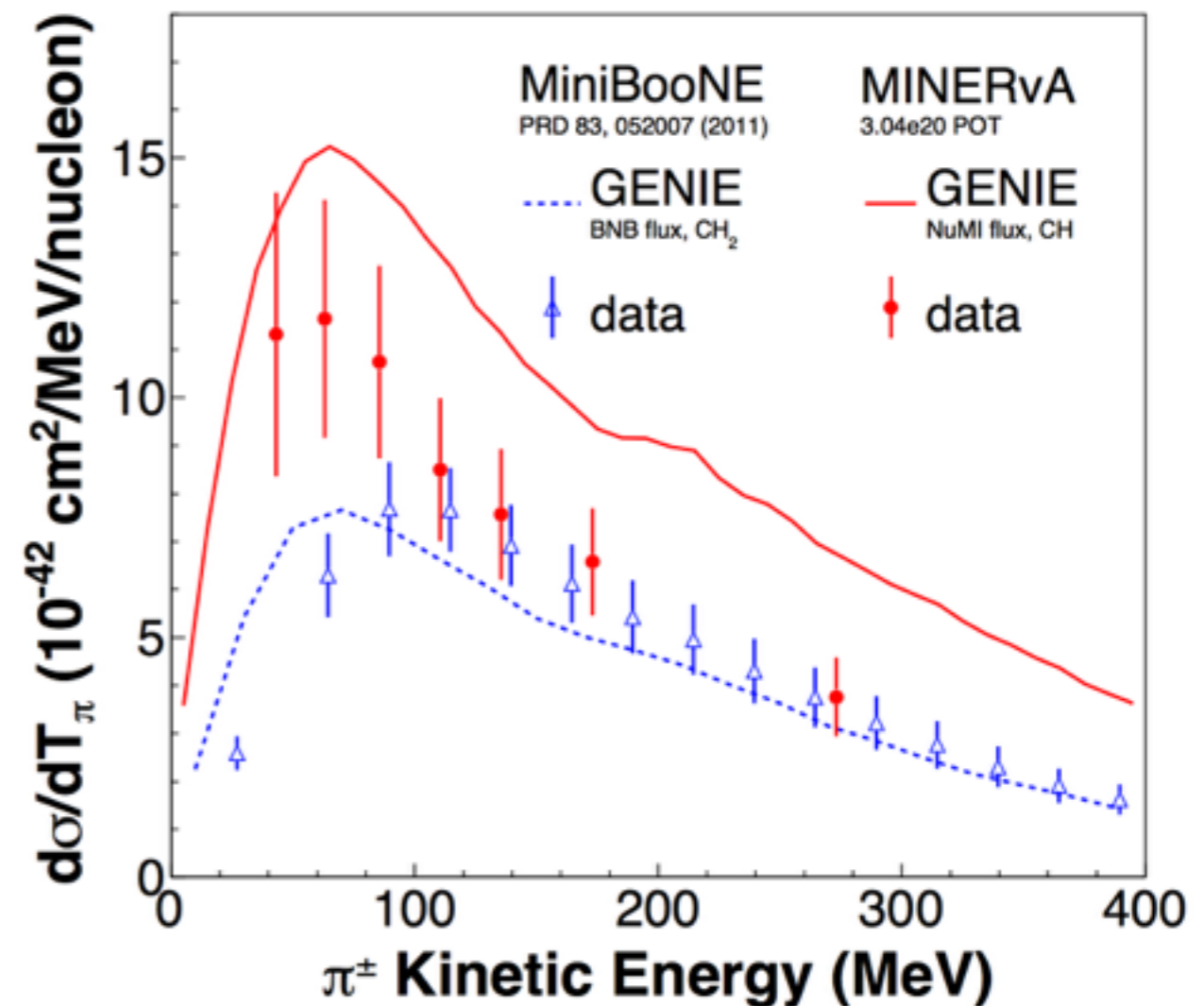
What could be happening?

An overly generic cross section analysis

$$\frac{d\sigma}{dx_i} = \frac{\sum_j \widetilde{U}_{ij}^{-1}(N_j - B_j)}{\Phi_\nu T \Delta x_i \epsilon_i}$$

- Calculate cross section from measured rate (N) and background (B)

- Correcting for neutrino source (flux, Φ), target (T) and efficiency (ϵ)

- Differential measurement in variable x, correcting for smearing (U)

"Deep dive" example talks by:

S. Dolan, D. Ruterbories, T. Yang, M. Muether

Possible problem: detector-model coupling

$$\frac{d\sigma}{dx_i} = \frac{\sum_j \widetilde{U}_{ij}^{-1}(N_j - B_j)}{\Phi_\nu T \Delta x_i \epsilon_i}$$

- Signal choice depends how detector responds to different processes - **M. Betancourt**

- What is the latest methodology for determining physics quantities (x) from detectors? - **A. Ghosh, J. Mousseau, T. Fukuda**

Possible problem: model dependance

$$\frac{d\sigma}{dx_i} = \frac{\sum_j \tilde{U}_{ij}^{-1} \left(N_j - B_j\right)}{\Phi_\nu T \Delta x_i \epsilon_i}$$

Measurements are made with different models. How does our chosen cross section model enter the measurement?

- Background considerations - **D. Harris**

- Global fits and problems discovered - **C. Wret**

Possible problem: unsmearing

$$\frac{d\sigma}{dx_i} = \frac{\sum_j \widetilde{U}_{ij}^{-1}(N_j - B_j)}{\Phi_\nu T \Delta x_i \epsilon_i}$$

- PhyStat-nu workshop (draft write-up): "the general advice is to smear the theory to match the data, rather than to try to unsmear the data [Cousins et al, 1607.07038]"

- Thoughts on unfolding from a statistician - **M. Kuusela**

- Example smearing based analysis - **L. Koch** and alternatives to unfolding - **M. Wascko**

Workshop structure
Let's learn from each other

- Generous talk time and discussion time. Discussion archival through dedicated note-takers (THANK YOU!) and chairs

  - If you have comments, add to the notes: goo.gl/L3mdJY

  - If you have questions, add them here: goo.gl/31fAuh

- Discussion may be provocative, but is intended to be constructive.

  - Please, ask "How was this done?". Give lots of detail. give details. Good for students!

  - Please, reflect on what worked, and what hasn't and WHY with examples. Good for experienced analysers!

...the state of this nation is good
the heart of this nation is sound
the spirit of this nation is strong
the faith of this nation is eternal.

FRANKLIN D. ROOSEVELT
from his message to Congress, January 7, 1943

http://www.phil-harris.com/

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Backup slides

Phase space

http://www.t2k.org/nd280/physics/xsec/meetings/2017/ jan25/plotdiscussion/view Comparisons between data sets are difficult. Different fluxes, and different acceptances

"Reduced phase space" Avoid reporting what we don't measure, probably can't avoid the model entirely…
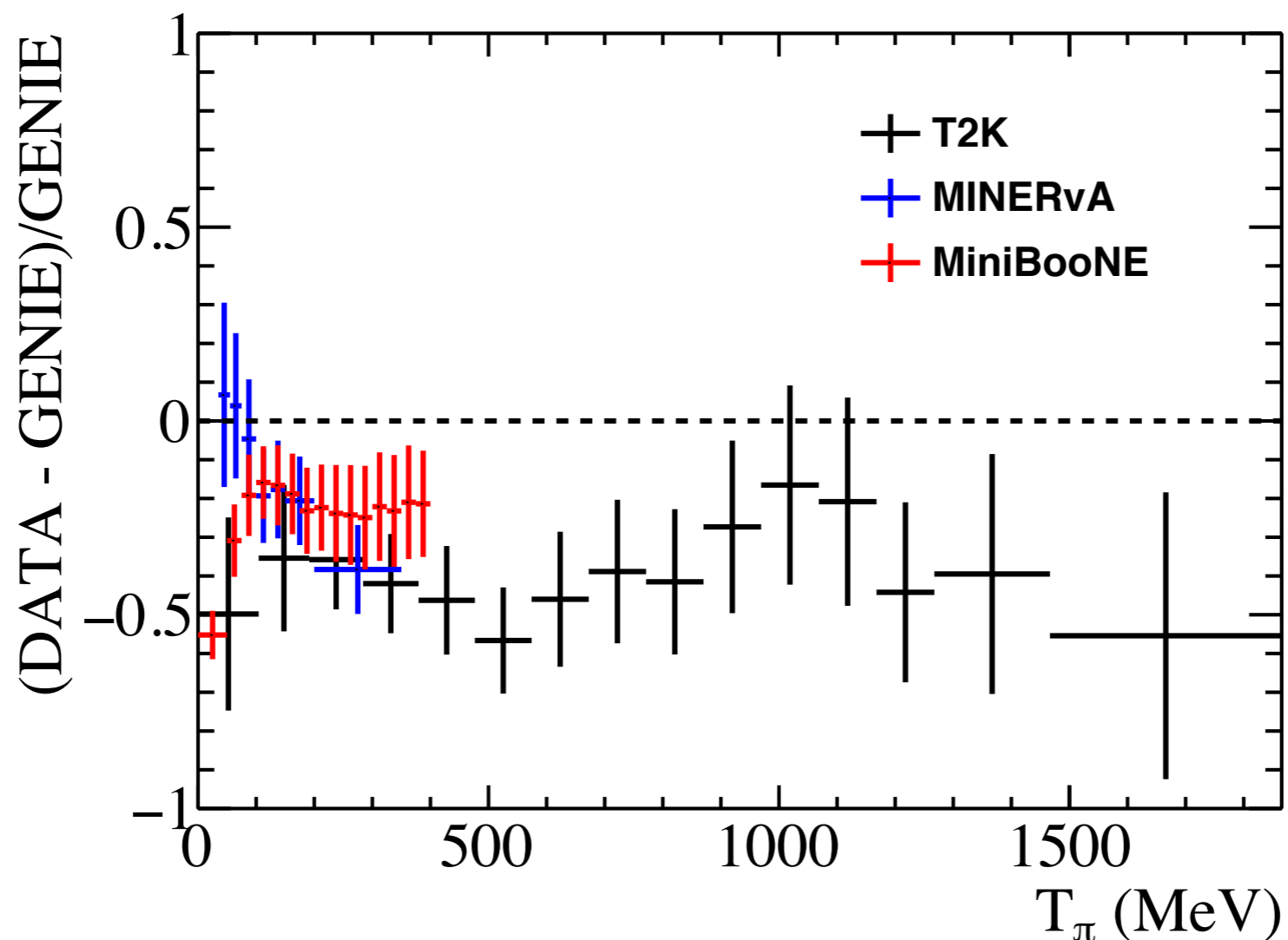
TENSIONS2016 Workshop
the Pittsburgh workshop

Lack of information on what exactly was done, signal definitions

This stuff is really complicated…

Archival is hard!