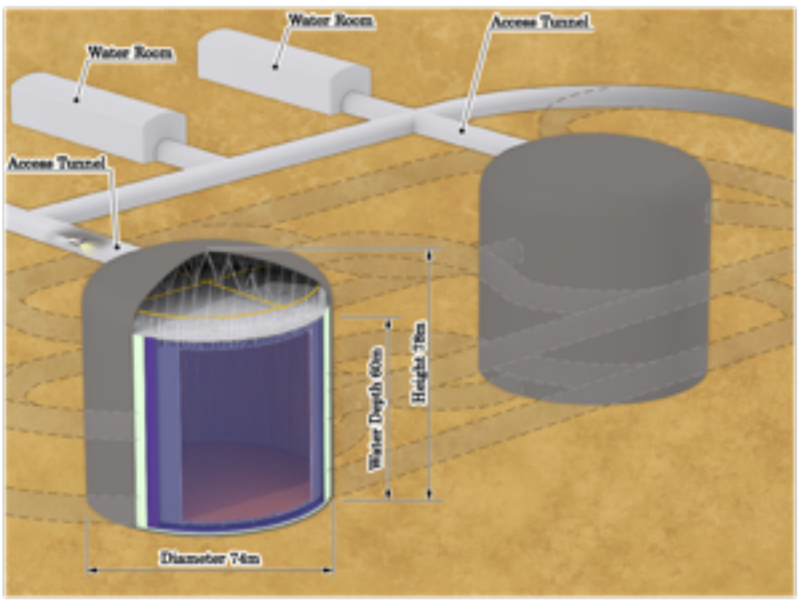
ELISA RESCONI, MANTS'16 - MAINZ

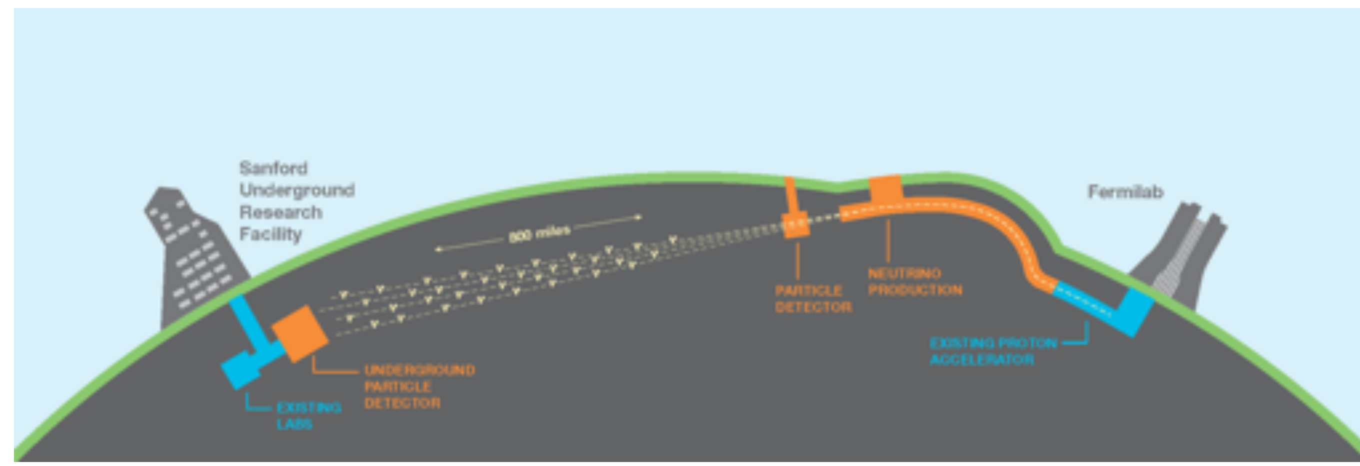
1ST ATMOSPHERIC NEUTRINO WORKSHOP (ANW'16), 7–9 FEBRUARY 2016

with Sebastian Böser, Tom Gaisser, Takaaki Kajita, Teppei Katori, Eligio Lisi.

NEXT GENERATION ATMOSPHERIC NEUTRINO EXPERIMENTS

⇒HIGH STATISTICS ATMOSPHERIC NEUTRINOS





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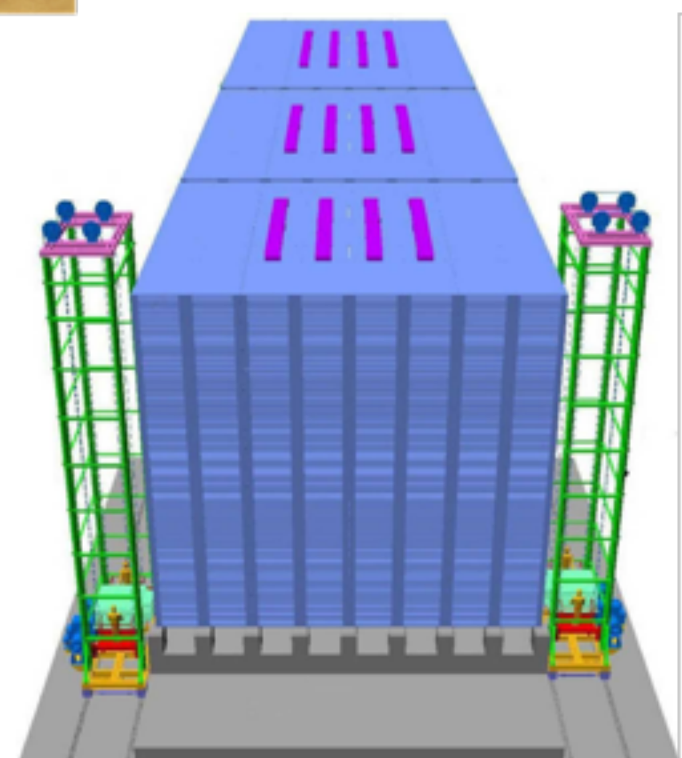
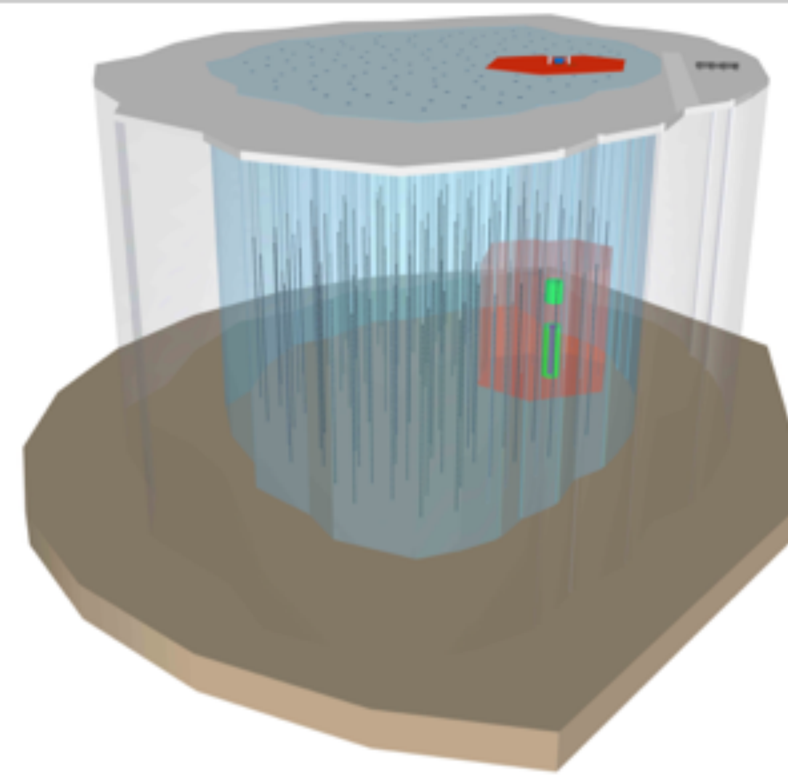
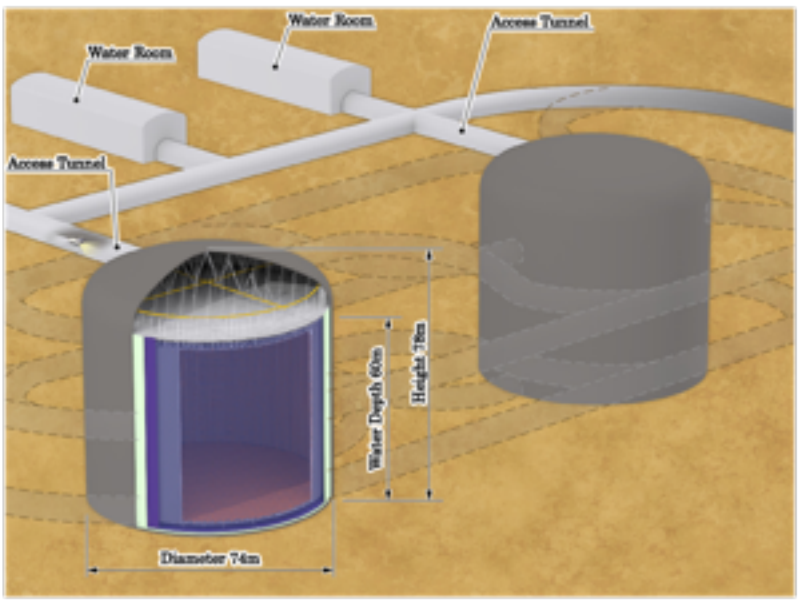
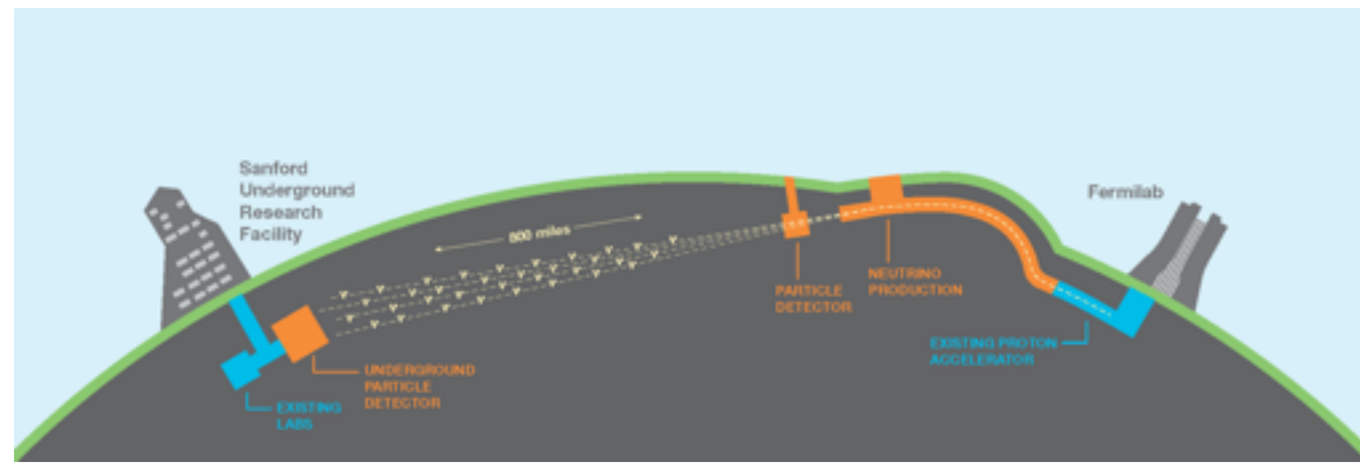


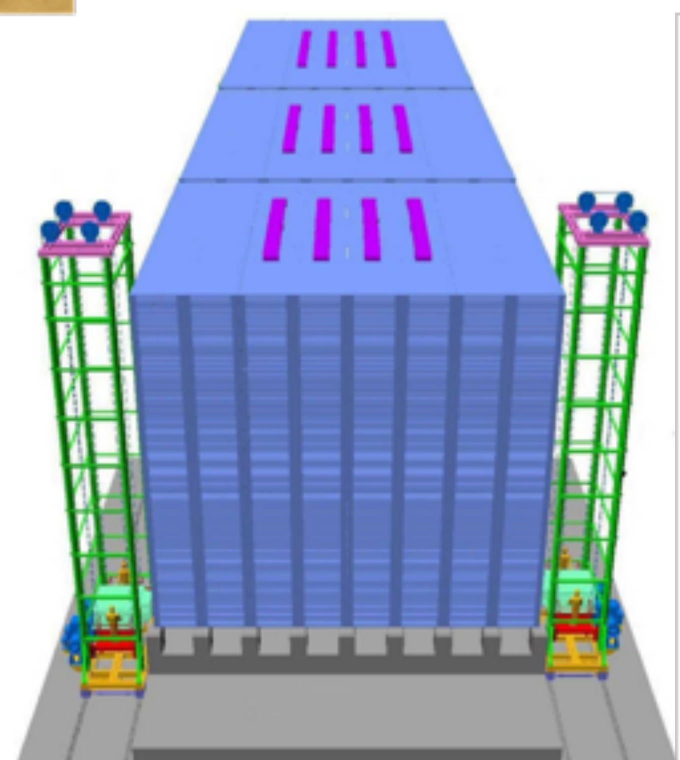


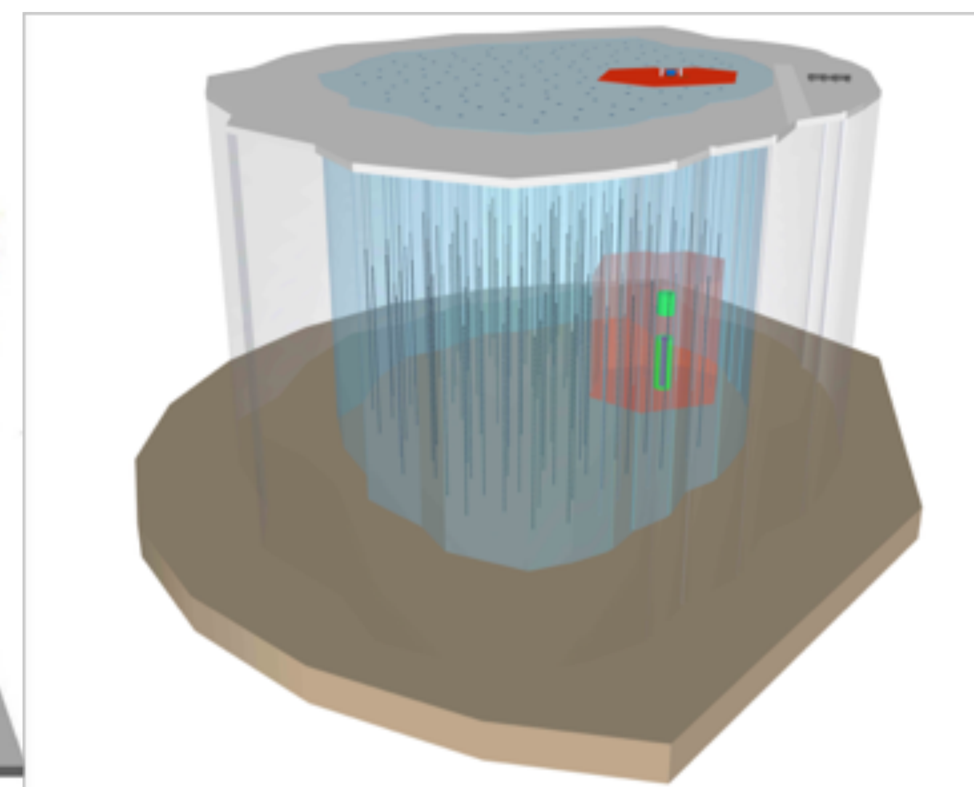
NEXT GENERATION ATMOSPHERIC NEUTRINO EXPERIMENTS

⇒HOW TO TAKE INTO ACCOUNT THEORETICAL SYSTEMATICS UNCERTAINTIES?









STATUS OF EXISTING CALCULATIONS

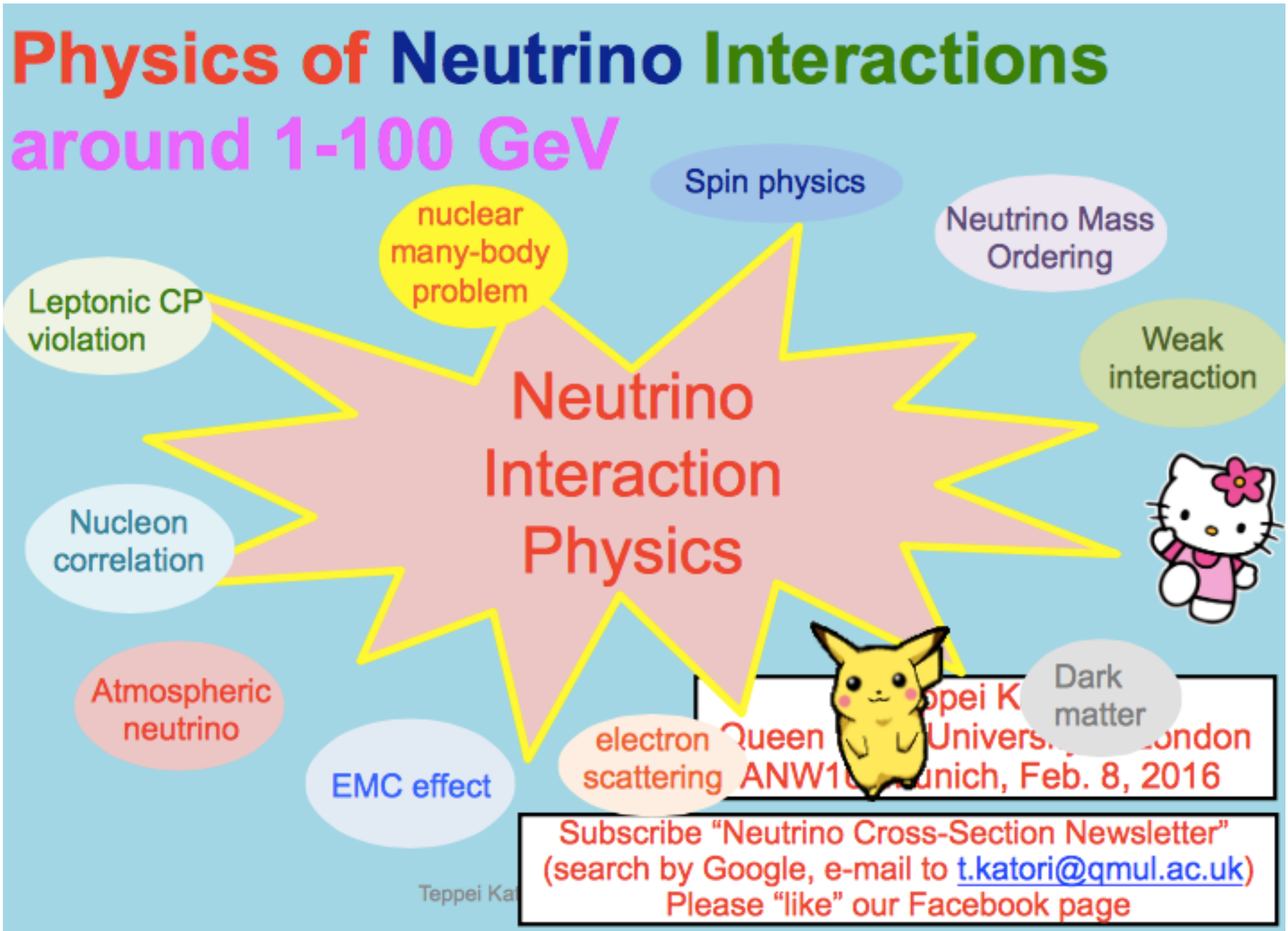
Conventional atmospheric neutrinos:

- HKKM atmospheric neutrino fluxes (M. HONDA)
- Bartol atmospheric neutrino fluxes (G. BARR)
- CORSIKA conventional atmospheric neutrinos (A. FEDYNITCH)
- (FLUKA)

Prompt atmospheric neutrinos:

- Prompt atmospheric leptons (A. FEDYNITCH)
- Theoretical uncertainties on prompt neutrino fluxes (M. V. GARZELLI)
- Extreme calculation of the prompt neutrino flux (L. WILLE)
- The prompt atmospheric neutrino flux in the light of LHCb (J. TALBERT)

1–100 GEV


Physics of Neutrino Interactions
around 1-100 GeV
Spin physics
nuclear many-body problem
Neutrino Mass Ordering
Leptonic CP violation
Weak interaction
Neutrino Interaction Physics
Nucleon correlation
Atmospheric neutrino
Dark matter
electron scattering
EMC effect
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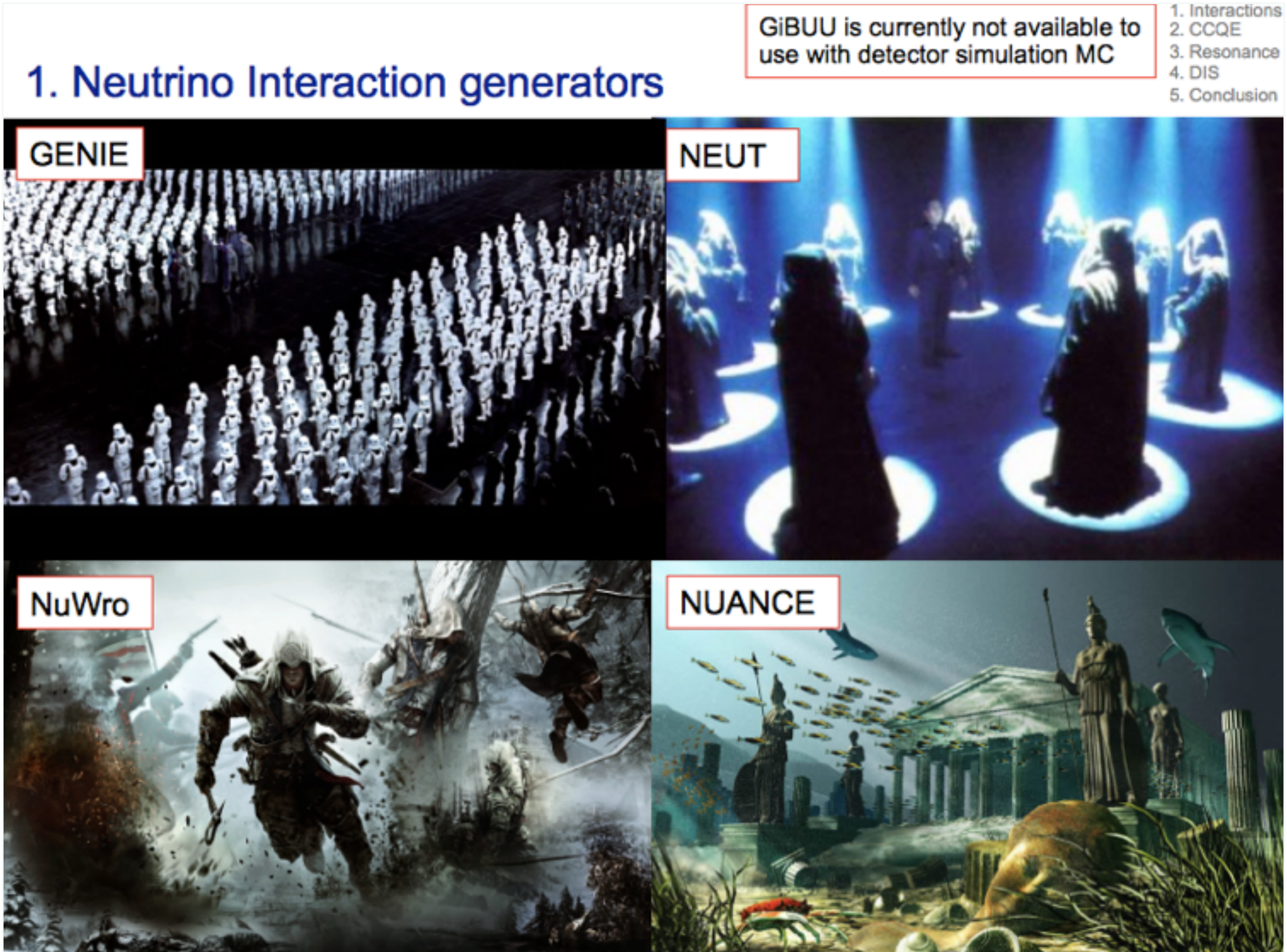
1-100 GEV


1. Neutrino Interaction generators
GiBUU is currently not available to use with detector simulation MC
1. Interactions
2. CCQE
3. Resonance
4. DIS
5. Conclusion
GENIE
NEUT
NuWro
NUANCE

1–100 GEV

- Atmospheric neutrino measurement and neutrino interaction physics (Y. HAYATO)
- Neutrino interaction physics overview (T. KATORI)
- Neutrino Interactions with Nucleons and Nuclei (U. MOSEL)
- QE, nucleon correlations (O. BENHAR)

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MEANWHILE WE GET FUNDS … LET'S GET READY

1. ATMOSPHERIC NEUTRINO FLUX CALCULATION
2. NEUTRINO INTERACTION

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FROM THE COMMUNITY TO THE COMMUNITY

"AtmoPy"

GOAL:

- Unified framework to perform
  - over the entire energy range
  - 3-D estimations atmospheric muons and neutrinos flux with very high statistics
  - envelope of systematic uncertainty
- Bring available resources together & avoid duplication of efforts.

FROM THE COMMUNITY TO THE COMMUNITY

"AtmoPy"

LONG TERM VISION:

- World-wide map of atmospheric muons and neutrinos to be input into the specific propagation codes of the various experiments.
- Allow combined analysis among different experiments, allow apple to apple comparisons.
- Bring the particle physics community to take a precision measurement seriously enough to be included in the PDG.

GREAT EFFORTS ALREADY ON-GOING:

MCEq - Cascade equations for atmospheric flux calculation

https://github.com/afedynitch/MCEq

(see MANTS Talk 2015)

It promises to be the new core development from low energy till prompt.

At the IceCube meeting many studies on MCEq: example: Steven Eulig (Bochum), Tania Wood (Alberta) …

GREAT EFFORTS ALREADY ON-GOING:

MCEq

Using MCEq instead of CORSIKA

Benefits

Efficient and flexibe:

+ At least same precision as full Monte Carlo simulation with CORSIKA
+ Consumes much less CPU time
+ Flexible code with interchangeable parametrizations and models

Limitations

- No event by event based results (enough for flux determination, but not a full replacement of CORSIKA)

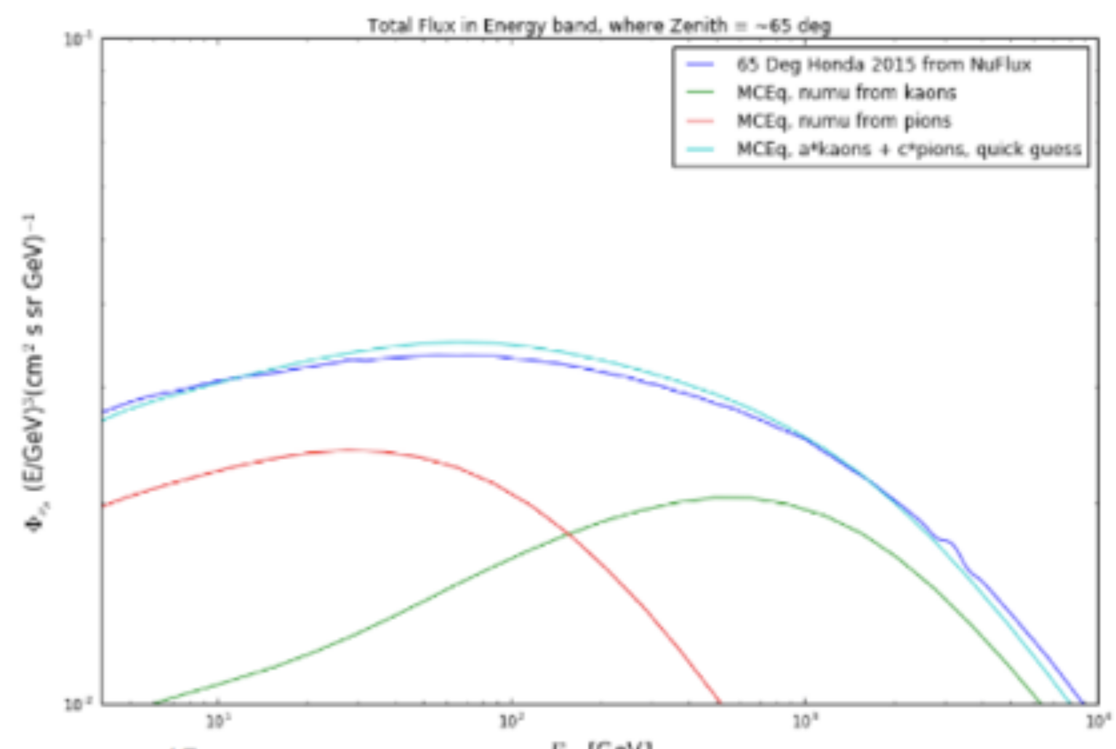
1-D calculation does not consider:

- Bending in B-field
- Geomagnetic effects
- Lateral particle distribution
- Geometrical effects influencing zenith dependence

MCEq is **advantageous for high-energy** flux calculations

MCEq verification against Honda (low energy):

- Plan to create scaling factors for the various flux spectrum components to 'create' a Honda spectrum as an alternative if muon calibrated hadronic model (as honda uses) proves difficult to implement
  - Otherwise will expect to see some shape differences due to different underlying flux model



Plots created with MCEq (development version)

UNIVERSITY OF ALBERTA
Tania Wood, trwood@ualberta.ca

2ND ATMOSPHERIC NEUTRINO WORKSHOP (ANW'17)??

PRELIMINARY GOALs:

- Roadmap to common framework for atmospheric neutrino and muon flux calculation
- Define core package (e.g. MCEq)
- Define verifications on core package
- Define affiliated packages
- Collect resources around the community ….

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STAY TUNED!!!