

# NEUTRINO INTERACTIONS FOR NEXT-GENERATION OSCILLATION EXPERIMENTS



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With support from:



# Benvenuti



Thank you for coming!

# Last time @ ECT\*



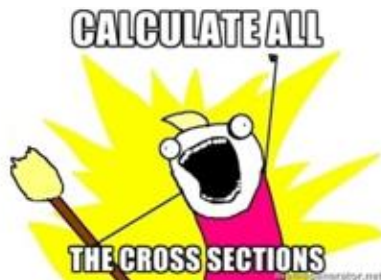
## Modeling neutrino-nucleus interactions

9–13 Jul 2018  
ECT\* - Villa Tambosi - Trento  
Europe/Rome timezone

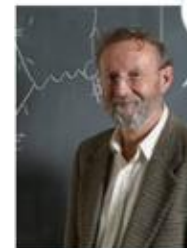
<https://indico.ectstar.eu/event/19>

2018

Progression of the workshop (from G. Perdue's GENIE talk)



ALL the cross sections?



Actually,  
you can't calculate  
any of those cross  
sections....

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**ECT\*** Modeling neutrino-nucleus interactions

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**ECT\*** Testing and Improving Models of Neutrino Nucleus Interactions in Generators

3–7 Jun 2019  
ECT\* - Trento  
Europe/Rome timezone

<https://indico.ectstar.eu/event/53>

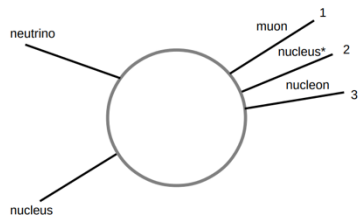
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2018

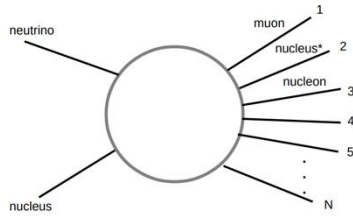
2019

Key discussions started ... since expanded!

What generators need (R. Gonzalez-Jimenez)



Quasielastic scattering (difficult)



Impossible

What is the best **seed** for a Cascade?

Phys. Rev. C **105**, 054603

- Hadron kinematic predictions are made using "factorisation" approximations (FA) – ad-hoc and possibly unreliable
- Showed some very simple tests of FA – need more detailed analysis to better assess validity

Phys. Rev. D **109**, 013004, Phys. Rev. D **106**, 113005

■ Work goals (2.2.2)

- Summarize differences in FSI models in different generators independent of their neutrino-nucleus interaction models.

Phys. Rev. D **104**, 053006

# Last time @ ECT\*



Modeling neutrino-nucleus interactions

9–13 Jul 2018  
ECT\* - Villa Tambosi - Trento  
Europe/Rome timezone

<https://indico.ectstar.eu/event/19>

Measuring neutrino interactions for next-generation oscillation experiments

Oct 21 – 25, 2024  
ECT\*  
Europe/Rome timezone

<https://indico.ectstar.eu/event/216/>

Enter your search term



Testing and Improving Models of Neutrino Nucleus Interactions in Generators

3–7 Jun 2019  
ECT\* - Trento  
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<https://indico.ectstar.eu/event/53>

Enter your search term

2018

2019

Today

I'm sure we have plenty to talk about!

# Workshop goals



We want to facilitate cross-field discussion to help steer future neutrino interaction measurements to fulfil the needs of next generation experiments

- Ascertain what aspects of neutrino interactions must be most carefully controlled to avoid biases or large systematic uncertainties for DUNE & HK
- Establish which measurements can be made to constrain them
- Determine how to best ensure the longevity of measurements in support of experiments taking place in a decade's time

We expect to produce a short-format summary document on the workshop outcomes, providing a resource for establishing a cross-collaboration strategy towards making the measurements needed for the future

# The idea

*Neutrino interactions for next generation experiments*

## **Monday**

- What matters for next-generation experiments?
- The state of the generators
- The state of theory

## **Tuesday**

- Treatment of uncertainties in the experiments
- Treatment of uncertainties in theory

## **Wednesday**

- Final state interactions in generators and theory
- Alternative probes of the nucleus and SIS

## **Thursday**

- Free nucleon cross sections, theory & measurements
- Measuring neutrons from neutrino interactions

## **Friday**

- Measurements, model dependence and data utility
- Planning measurements for the future

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Introduction and context  
30+10' talks

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Discussion focussed

## Thursday

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- Measuring neutrons from neutrino interactions

- Mix of 30+10' and 20+10' talks
- Panel discussions
- Open discussion sessions

## Friday

- Measurements, model dependence and data utility
- Planning measurements for the future



# The idea

*Neutrino interactions for next generation experiments*

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## Tuesday

- Treatment of uncertainties in the experiments
- Treatment of

We want to foster engaging discussions, respecting human attention spans

## Wednesday

- Final state int
- Alternative p

- Sessions limited to ~1.5 hours
- Long coffee breaks (30 mins)
- Long lunch breaks (1.5 hours)
- Sessions only in working hours (~9:00-17:00)
- Beautiful surroundings
- Excellent food!

Discussion focussed

10' and 20+10' talks

Discussions

Discussion sessions

## Thursday

- Free nucleon
- Measuring ne

## Friday

- Measurements, model dependence and data utility
- Planning measurements for the future

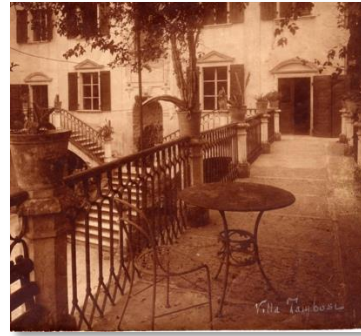
# Logistics

## Indico

- <https://indico.ectstar.eu/event/216/>

## Lunches + coffee breaks

- All at the villa



## Dinners

- Tonight, 20:00, Restaurant Antico Pozzo, Vicolo della Sat, 6 - 38122 - Trento
  - <https://www.antico-pozzo.it/>
- Thursday, 20:00, Restaurant Orso Grigio, Via degli Orti, 19 - 38122 - Trento
  - <https://www.orso-grigio.it/>



## Acknowledgements

- This workshop is partially funded by EUROLABS, part of EU Horizon funding
- If you publish work based on discussions here, please add:



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## Thank you to ECT\*, EUROLABS, INFN and Susan Driessen

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- Susan has helped enormously in the organisation of the workshop!

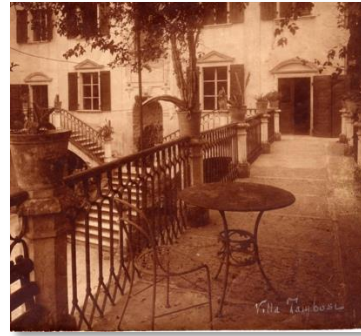
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# Enjoy the workshop!