



Closing Remarks

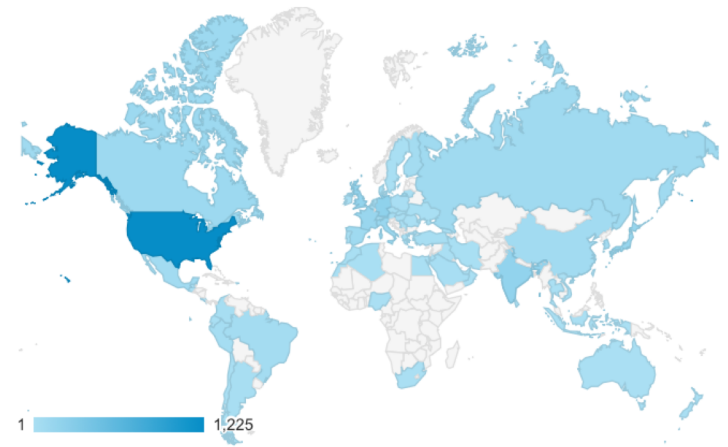
XXIX International Conference on Neutrino Physics and Astrophysics
Thursday 2 July 2020

on behalf of the Co-Chairs: Steve Brice, Marvin Marshak, Sam Zeller

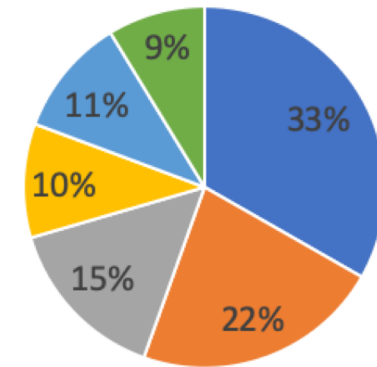
Some Statistics

(numbers as of July 1, 2020)

- **3,387** people from > 65 countries connected for talks
 - attendees connected from almost every region in the world including Macao, Ecuador, Kenya, Serbia, Indonesia, Argentina, and Oman (to name just a few examples)
 - ~60% were students and postdocs
- **3,409** unique visitors to the VR
- **5,800** YouTube views of posters
- **60,600** visits to our website
- Neutrino 2020 has had a far reach & allowed people to attend who might otherwise have been unable



participants connected from > 65 countries



■ graduate student ■ faculty
■ postdoc ■ undergraduate
■ lab scientist ■ other

Thank You, Speakers, Poster Presenters, Participants

- Thank you to all ...
 - 79 speakers
 - also, special thanks to Joe Formaggio and Goran Senjanovic for their outlook talks
 - 532 poster presenters
 - thousands of conference attendees
- Without you, this conference would not have been the success that it was
- Thank you all for your engagement on Slack during the conference. Lots of discussion on the talks and posters!
 - the conference triggered **23,078** messages on Slack over the past 2 weeks
 - included some interesting dialogue about the [#future_of_conferences](#)
 - there are some good aspects from Neutrino 2020 that will likely carry over into in-person conferences in the future

Thank You, International Advisory Committee (IAC)

- Superb committee that was highly engaged with formation of the agenda and deliberations on hosting an online conference

Luis Alvarez-Ruso

Alexander Barabash

John Beacom

Laura Baudis

Jun Cao

Amol Dighe

Peter Denton

Scott Dodelson

Yasaman Farzan

Raj Gandhi

Loredana Gastaldo

Andrea Giuliani

Roxanne Guenette

Yoshinari Hayato

Hallsie Reno

Soo-Bong Kim

Alysia Marino

Pedro Ochoa-Ricoux

Gabriel Orebi Gann

Marco Pallavicini

Silvia Pascoli

Mayly Sanchez

Gabriel Orebi Gann

Marco Pallavicini

Silvia Pascoli

Mayly Sanchez

Kate Scholberg

Sunny Seo

David Sinclair

Nigel Smith

Morimitsu Tanimoto

Mariam Tortola

Francesco Vissani

Morgan Wascko

Henry Wong

Elizabeth Worcester

Renata Zukanovich Funchal

Thank You, International Neutrino Commission (INC)

- We look forward to Neutrino 2022 in Seoul, South Korea!

Jenni Adams
Sidney Bludman
Tom Bowles
Arnon Dar
Guido Drexlin
Gary Feldman
Ettore Fiorini
Francis Halzen
Cecilia Jarlskog
Ed Kearns
Toshio Kitagaki

Konrad Kleinknecht
Takashi Kobayashi
John Learned
Manfred Lindner
Ken Long
Bill Louis
Art McDonald
Masayuki Nakahata
Tsuyoshi Nakaya
Vito Palladino

Stephen Parke (chair)
Silvia Pascoli
Herbert Pietschmann
Matts Roos
Norbert Schmitz
Jack Schneps
Yoichiro Suzuki
Francois Vannucci
Daniel Vignaud
Franz von Feilitzsch

Thank You, Local Organizing Committee (LOC)!

- We had a truly exceptional team to pull off an entirely online conference on a very short time scale



Marco Del Tutto (Fermilab)
Alec Habig (U Minnesota Duluth)



Max Hronek (Fermilab)

Tanaz Mohayai (Fermilab)

Anne Norrick (Fermilab)

Greg Pawloski (U Minnesota Twin Cities)

Fernanda Psihas (Fermilab)

Erica Snider (Fermilab)

Thomas Strauss (Fermilab)

Becky Thompson (Fermilab)

Joseph Zennamo (Fermilab)



Thank You To Our Session Chairs!



André de Gouvêa (Northwestern)
Laura Fields (Fermilab)
Wes Ketchum (Fermilab)
Kate Scholberg (Duke)
Peter Shanahan (Fermilab)



Also Thank You To ...

- ZOOM webinar: Farha Bhimji (Fermilab)
Sheila Cisko (Fermilab)
Lynn Johnson (Fermilab)
Ray Pasetes (Fermilab)
Kurt Riesselmann (Fermilab)
Liz Sexton-Kennedy (Fermilab)



- Indico: Jon Bakken (Fermilab)
Penelope Constanta (Fermilab)
Mike Rosier (Fermilab)

- Graphics/Logos: Diana Brandonisio (Fermilab)

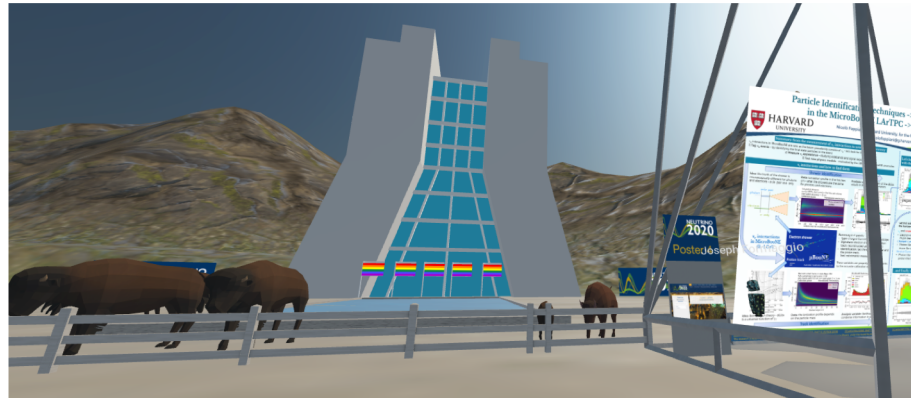
- Word Press: Maura Barone (Fermilab)

- Media:
Lauren Biron (Fermilab)

- Conference Office:
Joy Pomillo (Fermilab)
Melody Saperston (Fermilab)

Virtual Reality

- Marco Del Tutto (Fermilab) designed, built, and supported the VR also thank you to Burt Holzman (Fermilab) for technical support
- Thank you to Mozilla Hubs for the open source software and for their support in getting Hubs set up and customized for this event



> 3,400 conference attendees visited the VR platform

Neutrino Physics and Machine Learning (NPML) Satellite Meeting Lightning Talk Winner

- Congratulations to the best machine learning poster (by participants' vote)

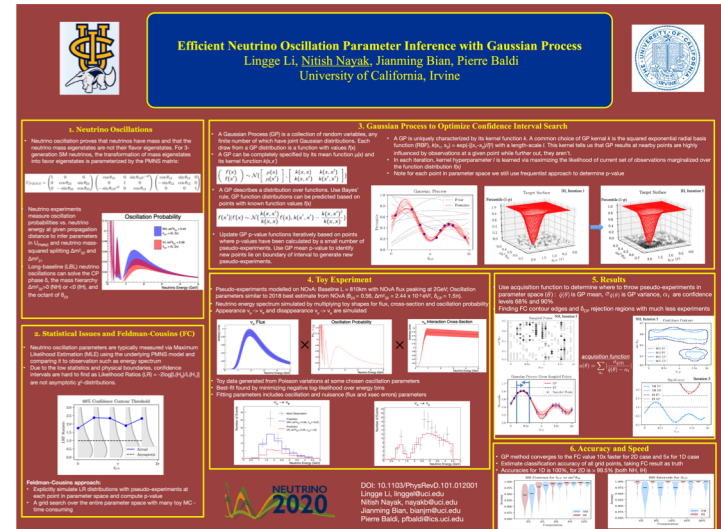
- Nitish Nayak (UC Irvine): *Efficient Neutrino Oscillation Parameter Inference Using Gaussian Processes* for his innovative ML application in neutrino model fits

- Nitish's lighting talk:

<https://indico.slac.stanford.edu/event/377/timetable/#6-efficient-neutrino-oscillati>

- NPML workshop continues (online) next week July 10-24

<https://indico.slac.stanford.edu/event/371/>



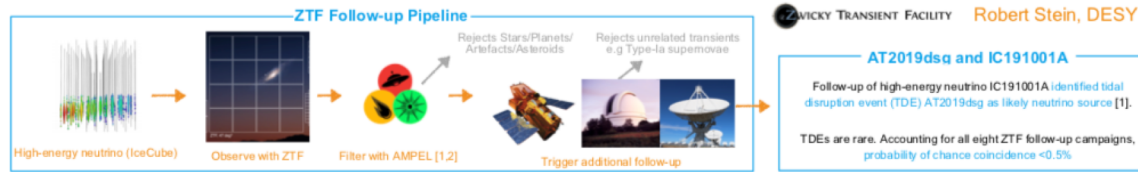
Neutrino 2020 Poster Session Winners

- The winners were selected by your votes!
- There are 4 winners, one for each poster session
- **786** poster scores entered
- **5,800** YouTube views of posters videos

Neutrino 2020 Poster Session Winners

- Congratulations to Poster Session 1 Winner (#347): Robert Stein (DESY Zeuthen): *A High Energy Neutrino Coincident with a Tidal Disruption Event*

A high-energy neutrino coincident with a tidal disruption event.



What is a TDE?

Credit: NASA/Goddard Space Flight Center/SDSS

Star approaches SMBH → Tidal Forces pull apart star → Stellar debris is partially accreted

Neutrinos from TDEs

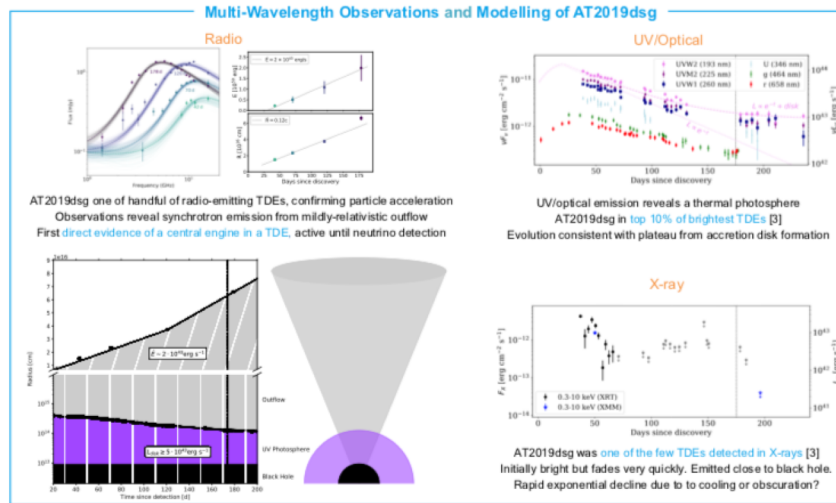
TDEs have long been suggested as possible sources of cosmic rays and neutrinos

TDEs are too rare to explain the entire neutrino flux, but could produce a sub-dominant component.

Conditions in AT2019dsg are consistent with requirements for PeV neutrino production [1, 4]

Coincidence suggests TDEs contribute to neutrino flux, compatible with previous search constraining contribution to <39% of total [5].

How many other TDEs have similar properties? Remains an open question.



HELMHOLTZ
Young Investigators

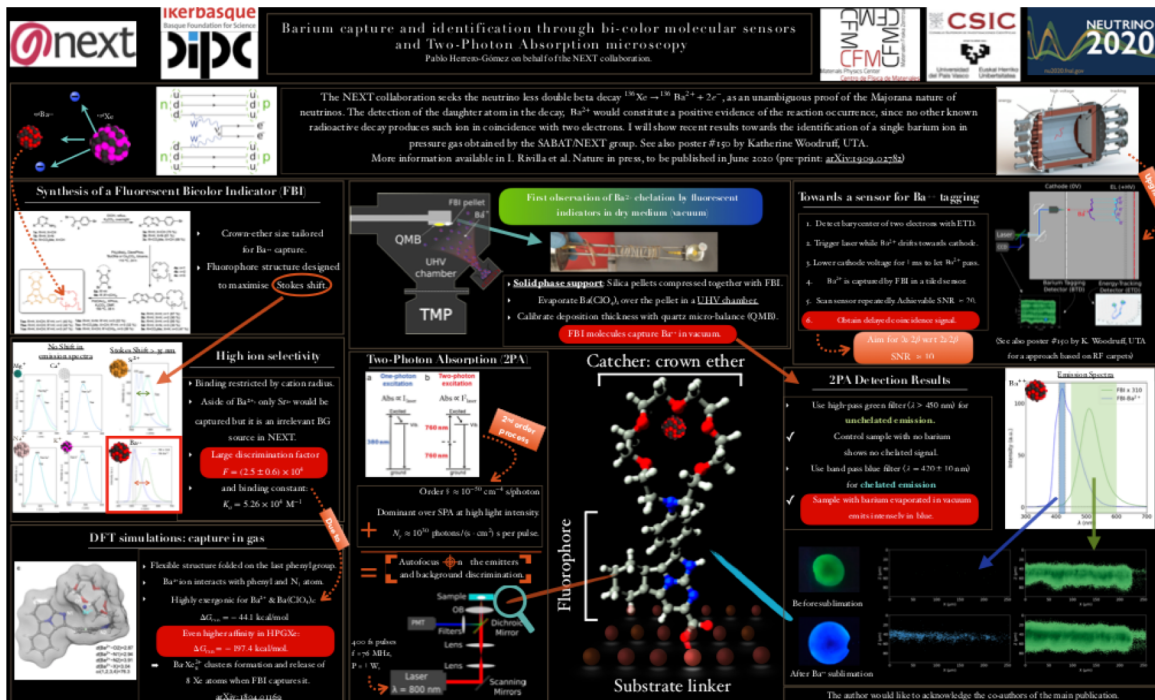
References:

- * "A high-energy neutrino coincident with a tidal disruption event", R. Stein, et al. submitted, (2020)
- ** "Transient processing and analysis using AMPEL", J. Nordin et al. A&A 631, (2019)
- ** "Intermediate Tidal Disruption Events from the First Half of ZTF: Survey Observations Entering a New Era of Population Studies", van Velzen et al., submitted (2020)
- ** "A coincidence scenario for the observation of a neutrino from the Tidal Disruption Event AT 2019dsg", W. Winter and C. Lunardini, submitted (2020)
- ** "Search for Neutrinos from Populations of Optically Transient", R. Stein for the IceCube Collaboration, 30th International Cosmic Ray Conference, (2019)



Neutrino 2020 Poster Session Winners

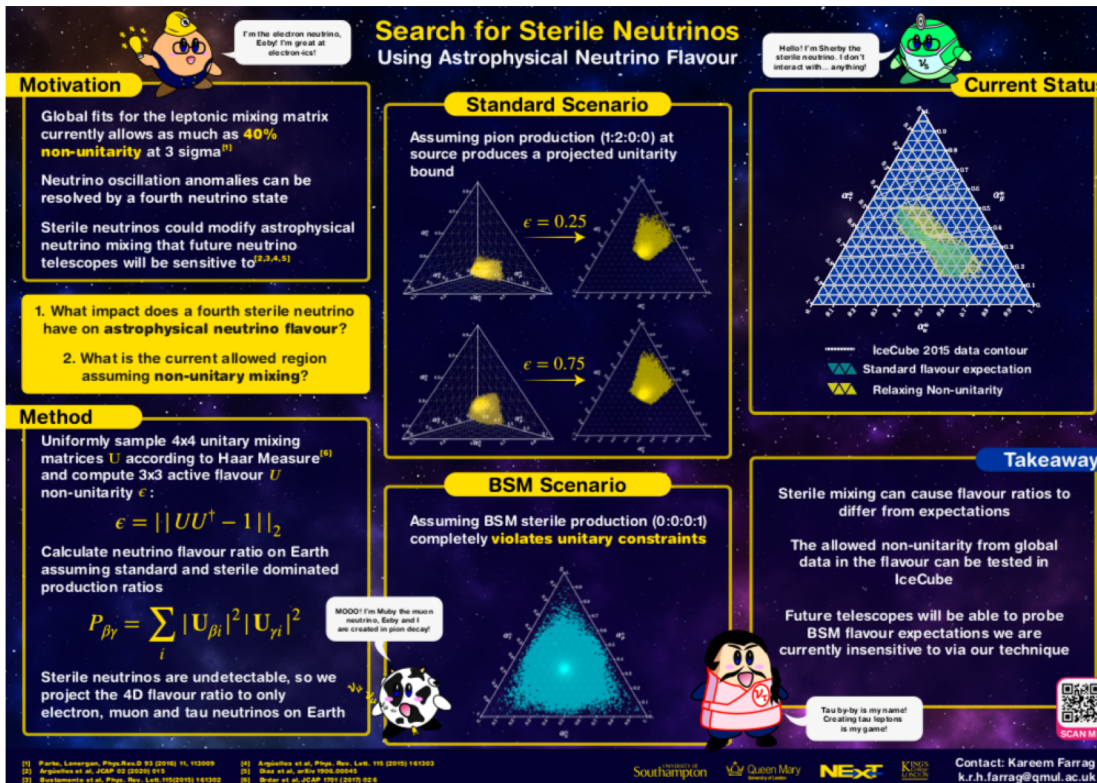
- Congratulations to Poster Session 2 Winner (#193): Pablo Herrero Gomez (DIPC) for the NEXT collaboration: *Barium Capture and Identification Through Bi-Color Molecular Sensors and Two-Photon Absorption Microscopy*



with Borja Aparicio (UPV/EHU), Celia Rogero-Blanco (MPC/CSIC), Fernando Cossio (UPV/EHU), Francesc Monrabal (IFIC), Ivan Rivilla De La Cruz (DIPC), J.J. Gomez-Cadenas (DIPC), Zoraida Freixa (UPV/EHU)

Neutrino 2020 Poster Session Winners

- Congratulations to Poster Session 3 Winner (#495):
Kareem Farrag (Queen Mary University of London): *Search for Sterile Neutrinos Using Astrophysical Neutrinos*



with
 Carlos Arguelles (MIT),
 Jordi Salvado (Barcelona),
 Khandelwal Rishbah
 (Wisconsin Madison),
 Shivesh Mandalia (Queen
 Mary), and Teppei Katori
 (Queen Mary)

Neutrino 2020 Poster Session Winners

- Congratulations to Poster Session 4 Winner (#44):
Matheus Hostert (University of Minnesota): *Hints and Tests of Dark Neutrino Sectors*



HINTS AND TESTS OF DARK NEUTRINO SECTORS

MATHEUS HOSTERT w/ Peter Ballet and Silvia Pascoli
University of Minnesota & Perimeter Institute
m.hostert@umn.edu

arXiv: 1903.07589 & 1903.07590
See also Poster #583 by Asli Abdullahi



THE MODEL

$\mathcal{L}_{SM} + (D_\mu \Phi)^\dagger (D^\mu \Phi) - V(\Phi, H)$

$-\frac{1}{4} X^{\mu\nu} X_{\mu\nu} + \bar{N} i \not{\partial} N + \bar{\nu}_D i \not{\partial} \nu_D$

$-\left[y_\nu^i (\bar{L}_i \cdot \vec{H}) N^c + \frac{h'}{2} \bar{N} N^c + y_N \bar{N} \nu_D^c \Phi + \text{h.c.} \right]$

	$U(1)_Y$	$U(1)'$
\bar{N}	0	0
ν_D	0	Q
Φ	0	Q

Portal couplings
Scalar $\lambda_{\mu H} H^\dagger H |\Phi|^2$

Vector $\frac{m_{\mu Z'}}{2} \bar{L}_\mu X^{\mu\nu}$

Neutrino $\kappa (L \cdot \vec{H}) N^c$

Dark neutrinos, ν_D , are charged under a hidden $U(1)'$ symmetry, spontaneously broken by a new complex scalar.

All neutral leptons feel the new dark force due to neutrino mixing, induced by the sterile neutrinos, N .

A dark photon kinetically mixes with the SM hypercharge, and the scalar may mix with the Higgs.

Light neutrino masses cancel at tree-level, but appear at loop-level — Radiative Inverse Seesaw.

$$\begin{pmatrix} 0 & m & 0 \\ m & \mu & \Lambda \\ 0 & \Lambda & 0 \end{pmatrix} \begin{pmatrix} \nu_L^c \\ N^c \\ \nu_D^c \end{pmatrix}$$

For light bosons and ISS limit:
 $m_\nu \sim \frac{g'^2 m_{\nu D}^2 \mu'}{8\pi^2 m_{Z'}^2} \times \text{loop functions}$

TAKE HOME

1) "New dark force leaks to the SM via three portals"

2) "Radiative seesaw mechanism w/ new light mediators"

3) "MiniBooNE explanation and a smoking-gun signals at NA62"

PHENOMENOLOGY

1) Neutrino upscattering

Light neutrinos upscatter into heavy ones, which promptly decay into $e+e^-$ pairs, faking a photon signature.

This provides an explanation to the MiniBooNE low energy excess, and can be tested in LAr experiments by searching for $e+e^-$ pairs produced in scattering.

GeV-scale dark photon is preferred to explain the angular dist.

MisID'd as a one EM shower

Fast 3-body decays $\nu_N \rightarrow \nu_L e^+ e^-$

2) Rare kaon decays $K^+ \rightarrow \mu^+ e^+ e^- \nu$

In peak searches for such heavy neutrinos, we predict that $e+e^-$ pairs are produced in the detector. This both relaxes existing constraints slightly, and provides a new opportunity to search for our dark sector.

The heavy neutrino and light dark photon resonances on top of backgrounds provides a smoking gun signal that NA62 can search for with current data.

Small backgrounds above $m_{\nu} > 140$ MeV. Below that, pion Dalitz decay presents a challenge, but signals come as displaced vertex, missing mass = 0, and 2-body kin.

Our estimate for NA62 single event sensitivity with a background-free search using 2016/18 dataset, showing significant improvement on existing constraints.

A measurement could reveal both the heavy neutrino and the dark photon masses. Dark scalars, although longer lived, could also contribute.

with
Peter Ballet
and Silvia Pascoli
(Perimeter Institute)



Neutrino 2020 Physics Slam



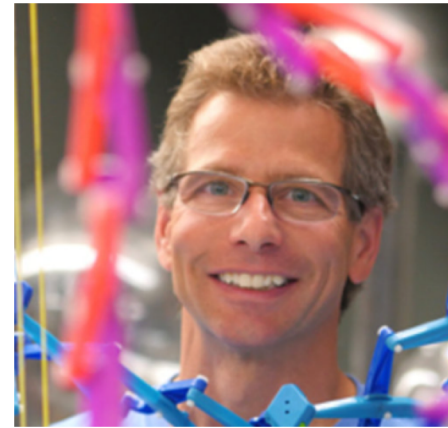
Becky Thompson (Fermilab)



Kirsty Duffy,
Fermilab



Alan Poon,
Berkeley Lab



Sam Sempere
Syracuse University

- This will be the closing event of the conference
 - 3 presenters will tell the world about neutrino research in 10 minutes or less using whatever (virtual) means they can think of in the hopes of becoming Slam Champion
- July 2 at 4:30-5:30 CDT (UTC-5)
- Sponsored by Chicago Council on Science and Technology (C2ST) and Fermilab
- Registration is free but required: <https://www.c2st.org/event/neutrino-2020-physics-slam/>

After the Conference

- Neutrino 2020 website, poster portal, poster videos, and recordings of all plenary talks will remain available online and will be permanently archived
- Conference content will be additionally archived to Zenodo
- We will also post the complete list of conference participants on the conference website
- The Virtual Reality will remain open through the weekend

On behalf of the Co-Chairs and
the Neutrino 2020 Local Organizing Committee

Thank You All!

The End